BioEM 2024 CRETE GREECE

THE THIRD ANNUAL CONFERENCE OF BioEM

Technical Program and general information

16 - 21 June 2024

Minoa Palace

Chania, Crete

BioEM

Table of contents

Welcome from the President *4*

BioEM – Officers and Board of Directors *5*

2022-2024 ..... **5**

2024-2026 ..... **6**

From the Co-Chairs of the Local Organizing Committee *7*

From the Co-Chairs of the Technical Program Committee *9*

Special thanks to the Reviewers *11*

The Venue *13*

Minoa Palace Resort **13**

General info *14*

Reception and information desk **14**

Conference badge **14**

Conference lunch and coffee breaks **14**

Schedule at a glance *15*

Social events *16*

Welcome Reception **16**

Student Ice Breaker **16**

Conference Dinner **17**

Sponsors *18*

Technical Program *19*

Sunday June 16th 19

Monday June 17th 19

Poster Flash A 19

Oral Session 1 31

Oral Session 2 35

Oral Session 3 39

Oral Session 4 42

Oral Session 5 45

Poster Session 1 49

Tuesday June 18th 96

Poster Flash B 96

Oral Session 6 107

Oral Session 7 109

Plenary 1 113

Poster Session B 116

Wednesday June 19th 160

Tutorial 1 160

Oral Session 8 161

Oral Session 9 165

Oral Session 10 169
Thursday June 20th 172
Plenary 2 172
Oral Session 11 172
Oral Session 12 175
Workshop 1 178
Workshop 2 181
Workshop 3 183
Friday June 20th 187
Oral Session 13 187
Oral Session 14 189
Award Ceremony 193
Young Investigator Lecture 193
Author Index ***194***

Welcome from the President

Dear BioEM2024 Congress Participants,

On behalf of BioEM and its board of directors, I am delighted to welcome you to the third congress of our society, BioEM. Once again, we are set for a fantastic congress where we will all either present or listen to new research findings, engage in discussions after the talks and during coffee breaks, enjoy the opening reception and dinner, and immerse ourselves in the wonderful environment of Chania, Crete.

This year, we will transition the leadership of our society to the new board of directors. I am very confident that under the presidency of Azadeh Peyman, the new board will continue to elevate our society's success.

We will also gather our members for the third General Assembly, where we will report on the society's activities over the past year, our financial status, future plans, and updates on our journal, Bioelectromagnetics.

I would like to extend my gratitude to the local committee, led by co-chairs Nikolaos Petroulakis and Gregorios Tsagkatakis, with the assistance of Melanie De Coster. Many thanks as well to the Technical Program Committee, with co-chairs Anke Huss and Julian Modolo, for creating an outstanding program featuring a variety of interesting sessions and engaging invited talks.

I would also like to thank the reviewers, the awards committee, and the judges for their great contributions to the conference.

And last but not least, I thank you. Without your participation and contributions, there would be no congress!

I look forward to seeing you all in Crete.

Best regards,

Luc Martens
President, BioEM

BioEM – Officers and Board of Directors

2022-2024

Luc Martens
President
Belgium

Azadeh Peyman
President-Elect
United Kingdom

Niels Kuster
Treasurer
Switzerland

Anke Huss
Board member
Netherlands

Bennett Ibey
Board member
United States

Wout Joseph
Board member
Belgium

Richard Nuccitelli
Board member
United States

Lucas Portelli
Board member
United States

Florence Poulletier De Gannes
Board member
France

Frank Prato
Board member
Canada

Olga Zeni
Board member
Italy

2024-2026

Azadeh Peyman
President
United Kingdom

Micaela Liberti
President-Elect
Italy

Francesca Apollonio
Board member
Italy

Myles Capstick
Board member
Switzerland

Anke Huss
Board member
Netherlands

Wout Joseph
Board member
Belgium

Lena Kranold
Board member
Australia

Sarah Loughran
Board member
Australia

Damijan Miklavčič
Board member
Slovenia

Florence Poulletier De Gannes
Board member
France

Akira Ushiyama
Board member
Japan

Maxim Zhadobov
Board member
France

From the Co-Chairs of the Local Organizing Committee

Dear colleagues,

On behalf of Local Organizers Committee, it is our great pleasure to welcome you in the BioEM 2024 that is taking place in Chania, at the beautiful island of Crete, Greece, from June 16th to 21st 2024.

BioEM is the largest and most significant international conference worldwide in the area of bioelectromagnetics that attracts academic and industrial participants from all over the world. BioEM 2024 will be the third annual meeting of the new BIOEM Society, after the merger between the Bioelectromagnetics Society (BEMS) and the European BioElectromagnetics Association (EBEA).

The conference will be hosted in Minoa Palace Resort Hotel, a luxury 5* beach-side hotel located at the cosmopolitan area of Platanias, 12km west of the town of Chania and 30min drive from Chania International Airport. The Minoa Palace Conference Center is a great host for all sorts of corporate events, conferences, workshops & exhibitions, offering flexibility and functionality, as well as state of the art facilities and the latest audiovisual equipment, high class decoration and cutting-edge design. Minoa Palace invites you to enjoy a luxurious experience in a beautiful location with a view of the blue Aegean Sea.

BioEM 2024 will give the chance to participants to exchange and disseminate scientific achievements, state-of-the-art studies, highlight knowledge gaps and facilitate the establishment and strengthening of professional relationships. The five-day program of BioEM 2024 will feature invited talks by world-recognized scientists, as well as special sessions, workshops, and tutorials in the field of bioelectromagnetics. In addition, the program will contain technical and poster sessions together with social functions.

Significant emphasis will be given upon the student contributions as the future researchers of the scientific community. They will have the opportunity to present their work in oral and poster sessions, developing their presentation skills, participating in student competitions and networking with other members of the community from around the world.

In addition to scientific activities, BioEM 2024 will be your opportunity to visit the historical city of Chania, the second largest city in Crete and one of the most appealing and worldwide popular tourist destinations of Greece. Crete is the fifth biggest island in the Mediterranean Sea that lies in the southern frontier of Europe, attracting every year thousands of visitors. Crete is the birthplace of the oldest advanced European civilization, the Minoan, which flourished between 3000 BC and 1200 BC.

Apart from the ancient history, Crete combines mountains and sea, the new alongside with the old and ancient with contemporary history. It's a cultural crossroad due to its strategic geographical position Crete is the place where myths look like history and history is like a myth. From the distant past to the present day, every place on the island has a short or long story to tell.

We wish you a fruitful conference and a enjoyable week in Chania.

Sincerely,

Nikolaos Petroulakis and Gregorios Tsagkatakis
LOC Co-Chairs BioEM 2024

Nikolaos Petroulakis
Co-Chair 2024
Greece

Gregorios Tsagkatakis
Co-Chair 2024
Greece

Panos Chatziadam
Publicity Chair
Greece

Katerina Koronaiou
Admin and Financial
Greece

Melanie De Coster
Management BioEM
Belgium

From the Co-Chairs of the Technical Program Committee

Dear Colleagues,

On behalf of the Technical Program Committee (TPC), it is our great pleasure to welcome you to BioEM 2024, the third annual conference of the BioEM society. BioEM is the largest annual international conference in the field of Bioelectromagnetics, bringing together leading scientists from different disciplines to discuss the latest achievements and future challenges of the field, and also a unique opportunity for students to showcase their research.

First of all, we thank BioEM members and all contributors for the high-quality number of proposals for plenaries, tutorials, and workshops. Thanks to those submissions, we were able to put together an exciting and stimulating program covering a wide range of subjects, including a fascinating plenary on the applications of optogenetics. Three workshops will be on breakthroughs in exposure assessment, risk communication, and collaborative research on EMF and human health. We are grateful to all invited speakers for accepting our invitation and to workshop organizers for their contribution to the program.

Second, we are also thankful to all of you who submitted a large number of high-quality abstracts to our BioEM 2024 conference. This year, we received 250 papers from 24 countries across the world, including 64 from students. An outstanding number of 114 reviewers thoroughly reviewed all abstracts, for which we would like to express a very large thanks! Thanks to you, we put together an interesting program spanning 14 oral sessions balanced between dosimetry and biological/medical topics, spanning from basic research to standards, from cells to humans, and of course many more posters that invite lively and inspiring discussion.

Please don't miss the flash presentations preceding the poster sessions as an extra opportunity for the students to showcase their results!

As done in previous years, BioEM 2024 will also honor a young scientist with the Arthur Pilla Award, and we will close the conference with the traditional awards for the best student presentations (poster and platform) and the prestigious D'Arsonval award.

We hope that BioEM 2024 will provide a multidisciplinary forum to exchange ideas, share knowledge, and trigger new collaborations. This conference is a unique opportunity to bridge gaps and establish networks in the field of Bioelectromagnetics.

Finally, we would like to thank the members of the Local Organizing Committee for their

efforts in accommodating the program and organizing special moments together, and all the sponsors for their support in making this event a success. Finally, last but not least, special thanks to Melanie De Coster for her tremendous support in the management of abstract review, conference website, abstract book, awards, and (much) more…

Kind regards,
Anke Huss and Julien Modolo
TPC Co-Chairs BioEM 2024

Anke Huss
TPC 2024
Netherlands

Julien Modolo
TPC 2024
France

Florence Poulletier De Gannes
TPC 2023
France

Yasir Alfadhl
TPC 2023
United Kingdom

Special thanks to the Reviewers

Aerts Sam
Anzai Daisuke
Balzano quirino
Bernabò Nicola
Bian Stan
Bixler Joel
Bolte John
Bornkessel Christian
Brennan Allan
Capstick Myles
Cavagnaro Marta
Chen Guangdi
Chou Chung-Kwang
Cifra Michal
Cleveland Robert
Colella Micol
consales claudia
Croft Rodney
Cuppen Jan
De Sanctis Stefania
De Santis Valerio
de Seze Rene
De Vocht Frank
Dechent Dagmar
Deng Chao
Di Meo Simona
Douglas Mark
Driessen Sarah
Ducray Angélique
Eberhard Jürg
Echchgadda Ibtissam
Faraone Antonio
Foster Kenneth
gajšek peter
Gledhill Martin
Guller Anna
Guxens Monica
Hansson Mild Kjell
Hirtl Rene
Huss Anke
Ibey Bennett
Jalilian Hamed
Jimenez Hugo
Joseph Wout
Karipidis Ken
Kesic Srdjan
Koohestani Mohsen
Korkmaz Erdal
Korpinen Leena
Kos Bor
Laakso Ilkka
Leszczynski Dariusz
maestu ceferino
Magne Isabelle
marino carmela
Martens Luc
Massa Rita
Mattsson Mats-Olof
McGarr Greg
McIntosh Rob
Merla Caterina
Mevissen Meike
Meyer Felix
Mezei Gabor
Miclaus Simona
Modenese Alberto
Modolo Julien
Morega Mihaela
Nagaoka Tomoaki
Najera Alberto
Nixdorf Don
Oftedal Gunnhild

Ohkubo Chiyoji

Okano Hideyuki

Onishi Teruo

orlacchio rosa

Pakhomov Andrei

Parazzini Marta

Parker Jim

Pasian Marco

Perrin Anne

Pinto Rosanna

Pophof Blanka

Poulletier de Gannes Florence

Recuero Laura

Rodriguez Roberto

Romeo Stefania

Röösli Martin

Rowley Jack

Sacco Giulia

Salati Simona

Salvatore JR

Šarolić Antonio

Schiffarth Anna-Malin

Schmid Gernot

Schneeweiss Pia

Schürmann David

Sekino Masaki

Selmaoui Brahim

Simko Myrtill

Simms Stephen

Soyka Florian

Tognola Gabriella

Tornevik Christer

Ueno Shoogo

Ur Rehman Masood

Wang Jianqing

Watanuki Keiichi

Wood Andrew

Yamaguchi-Sekino Sachiko

Yamazaki Kenichi

Zeni Olga

ZHADOBOV Maxim

司 重光

The Venue

Minoa Palace Resort

ΞΕΝΟΔΟΧ. ΜΙΝΟΑ ΠΑΛΑΣ, Platanias 730 14, Greece

1. Thalassa Bar - Welcome reception
2. Conference Center
3. Registration Upper floor
4. Registration Down floor
5. Elia - Lunch Area
6. Athena Hall - Poster sessions

General info

Reception and information desk

The Registration desk will be open during following hours:

Sunday 16th June	12:00 - 18:00
Monday 17th June	08:30 - 17:30
Tuesday 18th June	08:30 - 17:30
Wednesday 19th June	08:30 - 13:00
Thursday 20th June	08:30 - 17:30
Friday 21st June	08:30 - 13:30

Conference badge

Badges must be worn at all times during the conference and during all social events (registered guests as well).
The badges can be picked up at the registration desk on Sunday.

Conference lunch and coffee breaks

Lunch will be provided from Monday to Thursday and will be served at the Elia Restaurant in the hotel between 13:00-14:00.
Coffee breaks will be available in the morning and afternoon from Monday through Thursday. On Friday, coffee breaks will only be available in the morning

BioEM Conference 2024, June 16-21, Crete, Greece

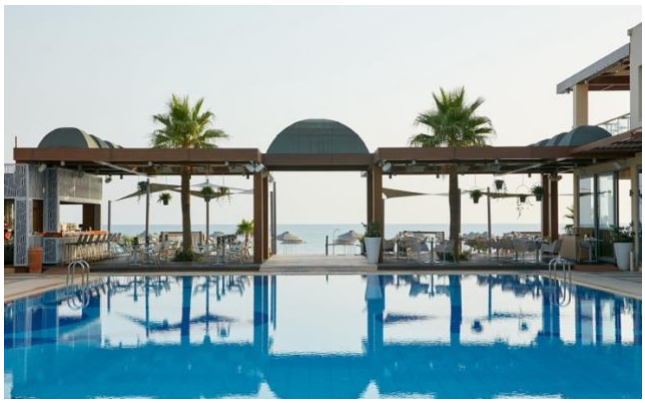
	Sunday 16/06/2024	Monday 17/06/2024	Tuesday 18/06/2024	Wednesday 19/06/2024	Thursday 20/06/2024	Friday 21/06/2024
8:30-9:00		Welcome - *Main Hall*				
9:00-9:30		Poster Flash A *Main Hall*	Poster Flash B *Main Hall*	Tutorial 1 *Main Hall*	Plenary 2 D'Arsonval lecture *Main Hall*	Oral Session 13 *Main Hall*
9:30-10:00	BioEM Board Meeting *Ariadne*					
10:00-10:30		Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break
10:30-11:00		Oral Sessions 1/2 *Main Hall/Hall 3*	Oral Sessions 6/7 *Main Hall/Hall 3*	Oral Sessions 8/9 *Main Hall/Hall 3*	Oral Session 11 *Main Hall*	Oral Session 14 *Main Hall*
11:00-11:30						
11:30-12:00						
12:00-12:30		Oral Session 3 *Main Hall*	Plenary 1 *Main Hall*	Oral Session 10 *Main Hall*	Oral Session 12 *Main Hall*	Award Ceremony (Young Inv. lecture + prizes) *Main Hall*
12:30-13:00						
13:00-13:30		Lunch	Lunch	Lunch	Lunch	Closing Ceremony - *Main Hall*
13:30-14:00	SEAWave Workshop *Main Hall*					
14:00-14:30		Oral Sessions 4/5 *Main Hall/Hall 3*	General Assembly *Main Hall*	CLUE-H 3rd Annual Meeting *Main Hall*	Workshop 1 *Main Hall*	BioEM Board Meeting *Ariadne*
14:30-15:00						
15:00-15:30						
15:30-16:00	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break	
16:00-16:30	SEAWave Workshop (cont.) *Main Hall*	Poster Session A *Athina*	Poster Session B *Athina*	CLUE-H 3rd Annual Meeting (cont.) *Main Hall*	Workshop 2 *Main Hall*	
16:30-17:00						
17:00-17:30						
17:30-18:00				End of Poster Display	Workshop 3 *Main Hall*	
18:00-18:30						
18:30-19:00						
19:00-19:30	Welcome Reception					
19:30-20:00		Student Icebreaker	Conference Dinner			
20:00						
21:00						

v1.6

Schedule at a glance

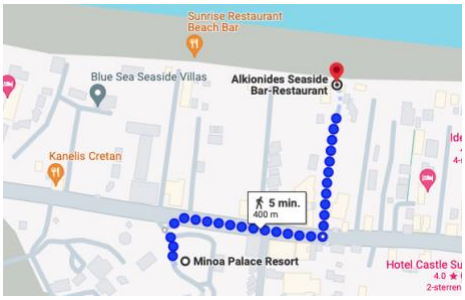
Social events

Welcome Reception



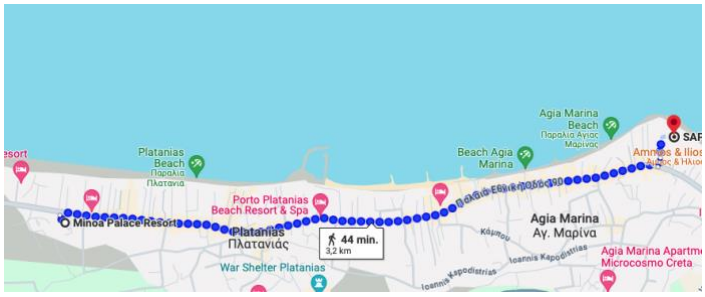
We are pleased to invite you to the Welcome Reception on the first day of the conference. The event will be held Sunday June 16th from 19:00 to 21:00 at the Thalassa Bar in the Minoa Palace Resort, located near the beach. We look forward to greeting you and enjoying a drink to kick off a successful week.

Student Ice Breaker



We are excited to invite all student attendees to the Student Ice Breaker on Monday, 17th June, from 19:30 to 23:00 at Alkionides Seaside Bar. This vibrant venue, situated on the beach, offers a perfect atmosphere for socializing and networking.
When you collect your goodie bag and badge at registration on Sunday, you will also receive vouchers to use at the bar during the event. Complimentary snacks will be provided throughout the evening.
This is a wonderful opportunity to connect with fellow students and start the conference on a high note. We look forward to seeing you there!

Conference Dinner



The conference dinner will be held on Tuesday, 18th June, at Sapel Hall, located at Agia Marina 730 14. The evening will begin at 20:00.

A shuttle bus will be available to transport attendees from the Minoa Palace Resort, departing from the hotel entrance between 19:15 and 19:45.

During the dinner, attendees will be treated to vibrant local Greek music, dancers, and a DJ. We look forward to a delightful and memorable evening together.

Sponsors

Platinum Sponsor

MWF Mobile & Wireless Forum

Silver Sponsor

GSMA

Bronze Sponsor

INTRACOM TELECOM

Supported by

FORTH INSTITUTE OF COMPUTER SCIENCE

CCBS Greece Travel, Conference & Business Services

Technical Program

Sunday June 16th

09:30-12:00	BioEM Board Meeting	Ariadne
12:00 - 18:00	SEAWAVE Workshop	Main Hall
19:00- 21:00	Welcome Reception	Thalassa Bar

Monday June 17th

08:30 - 09:00	Welcome		Main Hall
09:00 - 10:00	Poster Flash A	Niels Kuster Luc Martens	Main Hall

FA01

The effect of 50 Hz MFs on DNA damage in senescent human fetal lung fibroblasts

Miss Zhu Longtao[1], Mr Sun Chuan[2], Mrs Wei Xiaoxia[3], Mr Mao Genxiang[2], Prof Chen Guangdi[1]

[1]Bioelectromagnetics Laboratory, Zhejiang University School of Medicine, Hangzhou, China. [2]Zhejiang Provincial Key Lab of Geriatrics & Geriatrics Institute of Zhejiang Province, Department of Geriatrics, Zhejiang Hospital, Hangzhou, China. [3]Sir Run Run Shaw Hospital, Zhejiang University School of medicine, Hangzhou, China

Abstract Subject Area(s)

["In vitro","ELF/LF"]

Summary

Objective: To investigate the effect of 50 Hz magnetic fields (MFs) on DNA damage in senescent cells.

Methods: Senescent human fetal fibroblasts were exposed to 50 Hz MFs at 0.4, 0.7, and 1.0 mT for 24 h. After exposure the DNA fragmentation were determined by alkaline comet assay.

Results: Exposure to 50 Hz MFs at 0.4 or 0.7 mT significantly decreased DNA fragmentation while exposure to 50 Hz MFs at 1.0 mT significantlyincreased DNA fragmentation in senescent cells.

Conclusion: Exposure to 50 Hz MFs at low-intensity have an effect in inhibiting DNA damage while high-intensity have an effect in inducing DNA damage in senescent cells.

Is the work in progress?

Yes

FA02

Near-field wire-probe as thz sensor to detect collective oscillations of biomolecules

Mr Tristan Béranger[1], Dr Sandra Ruffenach[2], Mr Laurent Bonnet[2], Prof Frederic Teppe[2], Prof Jeremie Torrès[1]

[1]Institut d'Electronique et des Systèmes (IES), Université de Montpellier, CNRS, Montpellier, France, Montpellier, France. [2]Laboratoire Charles Coulomb (L2C), Université de Montpellier, CNRS, Montpellier, France, Montpellier, France

Abstract Subject Area(s)

["In vitro","Mechanisms","MM Waves","Biological and medical applications"]

Summary

Although collective oscillations of macromolecules have long been theorised, Preto et al have recently shown that the non-linear internal couplings between the normal modes of the protein cause it to undergo a phase transition only when the rate of energy input exceeds a threshold, i.e., when the proteins are driven out of thermodynamic equilibrium. This transition takes place from a state where the energy is distributed incoherently between the normal modes to a state where the energy is channelled into the lowest frequency mode, leading to a coherent oscillation of the whole molecule in the THz frequency range (phonon condensation state). Misunderstandings of the theoretical formalism, lack of experimental methods, and water strong absorption in this frequency range complicated the observation of spectral signatures of these oscillations. Confirmation of this phenomenon has therefore only recently been demonstrated using complementary THz and fluorescence correlation spectroscopies on BSA proteins. This study led to the development of a new experimental THz near-field probe. It consists of a metallic micro-wire inserted into a rectangular waveguide connected to a spectrum analyser. THz waves (70-110 GHz range) are focused on the protein solution and the absorption spectra are recorded. The characterisation of our near-field probe was carried-out by comparing our results with those already obtained using a field-effect transistor (FET) as a local sensor, on R-PE proteins. The three states of the phase transition (equipartition, transition and condensation) were reproduced with our new device and the behaviour of the power threshold was highlighted.

Is the work in progress?

Yes

FA03

Non-thermal electro-sterilization of Streptococcus mutans from temperature-time product point of view.

Mr Atsushi Matsuoka[1], Prof Masatake Akutagawa[1], Prof Hiromichi Yumoto[2], Prof Minato Akizuki[2], Prof Takahiro Emoto[1], Prof Hiroo Tarao[3], Prof Toshihiko Tominaga[4], Prof Eiichirou Tada[4], Prof Toshitaka Ikehara[5], Prof Emiko Yasuno[6], Prof Yohsuke Kinouchi[1]

[1]Faculty of Science and Technology, Tokushima University, Tokushima, Japan. [2]Division of Oral Science, Graduate School of Biomedical Sciences, Tokushima, Japan. [3]National Institute of Technology, Kagawa College, Takamatsu, Japan. [4]Tominaga Dental Clinic, Naruto, Japan. [5]Department of Human Welfare, Faculty of Health and Welfare, Tokushima Bunri University, Tokushima, Japan. [6]National Institute of Technology, Anan College, Anan, Japan

Abstract Subject Area(s)

["In vitro","Biological and medical applications"]

Summary

The Electro-Magnetic Apical Treatment was proposed as treatment of the apical periodontitis. However, the sterilization mechanisms and optimal conditions for electrical stimulation in the treatment have not been clarified sufficiently. This study compares the sterilization effectiveness of heat and electric sterilization under similar temperature-time product conditions and investigates the presence of non-thermal effects. As results of the experiments, no non-thermal effect that would promote the sterilization effect could be confirmed under the current electrical conditions.

Is the work in progress?

Yes

FA04

On Electromagnetic Stimulation in Biomanufacturing – Optimisation Using Fluorescent Reporters as a Proxy for Productivity

Ms Afra Alkatheeri, Prof Alistair Elfick

University of Edinburgh, Edinburgh, United Kingdom

Abstract Subject Area(s)

["Mechanisms","Biological and medical applications"]

Summary

The endless pursuit for process optimization in biotechnology has fuelled tremendous efforts in research toward the development of innovative approaches. The use of electromagnetic fields (EMF) coupled with bioreactors has emerged as a promising technology to boost cellular performance in a low cost, environmentally friendly manner. Our limited understanding of field parameters interplay in electromagnetic based treatment is one of the causes for the delayed maturation of industrial scale applications. Grasping its effect on the cell metabolic state is desirable yet challenging credited to the complexity of biology and lack of developed characterization tools. Hence, the proposed method for tracking intracellular behaviour through genetically encoded fluorescent tagging. Fluorescence embedded yeast subjected to the application of oscillating magnetic fields with paramagnetic particles will be inspected for their protein expression levels while varying frequency, intensity, and exposure period, and testing for treatment effect longevity. An incubating microplate reader was used to assess cell density and fluorescence of treated cells and controls. Pilot results show potential for fluorescent tagging paired with spectrophotometry for the study of magnetobiological response.

Is the work in progress?

Yes

FA05

Effects of Extremely Low Frequency Weak Magnetic Fields Superimposed on Geomagnetic Field on HT-1080 Fibrosarcoma Cells

Nhat Dang[1], Marek Bajtos[2], Dr Hakki Gurhan[1], Prof Frank Barnes[1]
[1]University of Colorado Boulder, Boulder, USA. [2]University of Zilina, Zilina, Slovakia

Abstract Subject Area(s)

["In vitro","Mechanisms","ELF/LF","Biological and medical applications"]

Summary

Fibrosarcoma, an aggressive form of soft tissue cancer, has demonstrated interactions with electromagnetic fields (EMF), particularly within the low frequency spectrum such as radio waves. Modeling cancer cells as feedback systems with time delays and considering nuclear spin coupling as potential modifiers for chemical reaction rates, their interaction with extremely low frequency (ELF) and low energy magnetic fields can be predicted. This study aims to investigate the effects of weak magnetic fields at extremely low frequencies superimposed on a geomagnetic field background on the growth rate of in vitro fibrosarcoma cultures. High-permeability metal enclosures are utilized to eliminate unaccounted environmental electromagnetic fields within the low frequency range. The experiments reveal that reversing the orientation of the applied static field relative to the geomagnetic magnitude along the vertical axis similarly affects growth rates across various frequencies of the alternating field. Notably, altering the frequency of the alternating magnetic field, rather than the amplitude, can significantly impact fibrosarcoma growth rates, with shifts as small as 0.25 Hz resulting in transitions between acceleration and inhibition. Furthermore, investigation into mitochondrial calcium and superoxide levels at frequencies associated with accelerated growth reveals an overall reduction in both quantities, albeit to varying degrees. These observations suggest the existence of a permanent dipole within cancer cells, likely resulting from adherent culturing conditions, and their sensitivity to minor frequency changes due to multiple oscillatory biochemical pathways.

Is the work in progress?

Yes

FA06

Delayed growth in immature male rats exposed to 900MHz radiofrequency.

Mr Raphaël Bodin[1,2], Mr Franck Robidel[1], Mrs Stéphanie Rodriguez[1], Mr Anthony Lecomte[1], Dr Anne-Sophie Villégier[1,2]
[1]INERIS, Verneuil-en-Halatte, France. [2]UPJV PERITOX UMR_I 01, Amiens, France

Abstract Subject Area(s)

["in vivo","RF/Microwave"]

Summary

People have been exposed to the 900 MHz mobile phone electromagnetic field for approximately 30 years, with the 2nd generation (2G) Global System for Mobile communications (GSM) network. However, there is still no conclusion from immature rodent experiments regarding the potential effects of nonthermal radiofrequency (RF) 900 MHz continuous waves exposure during the biological development. Here, we aimed to test the hypothesis that when mother rats received a whole-body SAR occupational limit of the International Commission on Non-Ionizing Radiation Protection

for human (0.4 W/kg) clinical growth and development was impacted in the descendant, with less (or no) effect at public limit (0.08 W/kg). Sprague Dawley pregnant rats (mothers, M) whole body SAR of 0.4 W/kg and 0.08 W/kg were reached with 30.2 V/m electric field (PEF) and 67.5 V/m electric field (OEF) for 330 g body weight. Exposure was 8 h/day from gestational day 8 until postnatal day 21 (n = 8-9/group). The neonate males showed earlier pinna ear detachment only for OEF group and earlier eye opening only for the PEF exposed group compared to the sham. Compared to the sham-exposed and to the PEF exposed males, the OEF exposed juvenile males showed lower body weight until adolescence. Both OEF and PEF RF-exposed females groups showed earlier pinna ear detachment and eye opening but similar bodyweight compared to the sham-exposed females. The present study suggested that pre- and post-natal exposure to 900 MHz continuous waves at human levels of occupational and general public level led to clinical effects in the neonatal and adolescent rats.

Is the work in progress?

Yes

FA07

Temporal Change of Outdoor RF-EMF levels in European Countries: a Microenvironmental Measurement Study – Example of the Netherlands.

Ms Lea Belackova[1], Prof Marloes Eeftens[2,3], Dr Reza Aminzadeh[4], Mr Han Van Bladel[4], Dr Matthias Van Den Bossche[4], Dr Vincent Griffon[5], Prof Elisabeth Cardis[6], Dr Stefan Dongus[2,3], Ms Adriana Fernandes Veludo[2,3], Prof Mònica Guxens[6], Prof Wout Joseph[4], Ms Patricia de Llobet[6], Dr Paul Mazet[7], Dr Patrick Van Torre[4], Prof Arno Thielens[4,8], Prof Roel Vermeulen[1], Prof Joe Wiart[9], Prof Martin Röösli[2,3], Dr Anke Huss[1]

[1]IRAS, Utrecht University, Utrecht, Netherlands. [2]Swiss Tropical and Public Health Institute, Allschwil, Switzerland. [3]University of Basel, Basel, Switzerland. [4]Ghent University, Ghent, Belgium. [5]Ineris, Paris, France. [6]IS Global, Barcelona, Spain. [7]Cetim, Senlis, France. [8]The Graduate Center of the City University of New York, New York, USA. [9]Telecom Paris, Paris, France

Abstract Subject Area(s)

["Epidemiology"]

Summary

INTRODUCTION

Between 2017 to 2023 telecommunication systems have further developed. It is unknown if this has resulted in changes of outdoor exposure levels to Radio-Frequency Electromagnetic fields (RF-EMF).

Objective: To compare RF-EMF exposure levels measured in 2016 and 2018 with corresponding measurements from 2023 collected in the same microenvironments regarding temporal changes and exploring possible effects of spatial predictors including population and antenna density.

METHODS

The data was collected as part of the ACCEDERA (2016-2018), ETAIN (2023) and GOLIAT (2023) projects. Exposure levels were measured by walking the same paths with ExpoM-RF3 (2016, 2018 and 2023) and ExpoM-RF4 (2023) in the Netherlands. Paths were chosen to represent common microenvironments including residential areas, parks, public

transport, and universities. Summary statistics (mean and SD) for total exposure and frequency bands were created for each year to compare the temporal trends.
RESULTS
There was a statistically significant difference in the mean exposure levels between the years. No statistically significant linear trend was observed in total RF-EMF exposure measured across any of the types of microenvironments between 2016 to 2023 (all $p > 0.05$). Correlation and regression analysis showed population density as the only significant predictor of RF-EMF exposure levels.
CONCLUSION
Over the last few years, the development of the telecommunication system has not resulted in linearly increasing exposure levels of RF-EMF in public microenvironments in the Netherlands, although levels in 2017 were statistically significantly lower than in later years. Population density showed to be the only statistically significant predictor of the exposure levels.

Is the work in progress?

Yes

FA08

Sinusoidal magnetic fields on working memory performance and eeg signals in humans

Miss Maëlys Moulin[1,2], Dr Sofiane Ramdani[1], Dr Alexandre Legros[2,3,4,5,6]
[1]LIRMM, University of Montpellier, Montpellier, France. [2]EuroMov Digital Health in Motion, University of Montpellier, Montpellier, France. [3]Eurostim, Montpellier, France. [4]Bioelectromagnetics and Human Threshold Research Group, Imaging Program, Lawson Health Research Institute, London, Canada. [5]School of Kinesiology, Western University, London, Canada. [6]Departments of Medical Biophysics and Medical Imaging, Western University, London, Canada

Abstract Subject Area(s)

["Human studies","Standards and public health policy","Biological and medical applications"]

Summary

Delineating the threshold effects of magnetic field (MF) stimulation is of paramount importance to the health of the public and workers, as defined by major regulatory agencies. Current definitions are based on magnetophosphene perception, primarily associated with retinal function. However, extrapolation of these effects to the broader CNS faces limitations due to different neuronal characteristics. To fill this gap, our study will aim to investigate the effects of MF on working memory, a key cognitive function, building on Reinhart's findings regarding improved performance during electrical stimulation. Using 50 Hz MF exposure, we intend to replicate and expand on these observations, using EEG monitoring and psychometric testing. Our experimental design will involve healthy volunteers undergoing EEG recording while engaging in a working memory task under various MF exposures. Data analysis will encompass behavioral measurements and EEG signal processing, including with non-linear methods. Expected results include improved working memory performance during facilitative MF frequencies, similar to Reinhart's results (2019), suggesting potential therapeutic implications for cognitive improvement in aging populations. Additionally, our study will

address broader public health concerns regarding neurocognitive aging and dementia. By exploring FM as an alternative to transcranial alternating current stimulation (tACS), we will aim to overcome the limitations of tACS, such as skin irritation and limited cortical penetration depth, thereby advancing non-current brain stimulation techniques. invasive for therapeutic applications. Overall, this research will help redefine the threshold effects of MF on the CNS and inform standards for public health protection.

Is the work in progress?

Yes

FA09

5G Base Station Electromagnetic Field Strength Estimation Method using Deep Learning for Compliance Test

Mr Dongryul Park[1], Mr Seunghun Ryu[1], Mr Seonghi Lee[1], Prof Namwoo Kang[1], Prof Seongsin Kim[2], Dr Kihwea Kim[3], Dr Donggeun Choi[3], Prof Seungyoung Ahn[1]

[1]Korea Advanced Institute of Science and Technology, Daejeon, Korea, Republic of. [2]Seongsill University, Seoul, Korea, Republic of. [3]National Radio Research Agency, Naju, Korea, Republic of

Abstract Subject Area(s)

["MM Waves","Risk assessment","Standards and public health policy"]

Summary

Recently, with the commercialization of 5G, a new electromagnetic field (EMF) evaluation methods is need. However, conventional EMF evaluation methods are only based on measurements that practically impossible to apply to 5G base station (BS). Therefore, in this paper, we propose a 5G BS EMF evaluation method using deep learning (DL) as an alternative to traditional measurement-based evaluation. We selects a Unet that can analyze the entire area based on the technical characteristics of 5G. Furthermore, we design a 2D and numeric converter to inform the physical information of the wireless channel to the U-net. Through network design based on technical features and physical information, the proposed DL model can effectively predicts the EMF radiated from BS. Then, we generate data through simulations that reflect real-world scenarios and use it for training. The results of the training show that the proposed method achieves very high accuracy in various cases, regardless of location and antenna specifications. Furthermore, when quantitatively evaluated, the proposed method only have an 8% low mean absolute error (MAE), thus demonstrating the superiority of the proposed method. These verification results confirm that the potential of the proposed method can replace EMF evaluations based on measurements with DL-based evaluations in the future.

This work was supported by Institute of Information & communications Technology Planning & Evaluation (IITP) grant funded by the Korea government(MSIT) (No.2022-0-00986, Development of artificial intelligence-based base station electromagnetic wave human exposure prediction algorithm)

Is the work in progress?

Yes

FA10

DESIGN OF A LOW SAR 4-PORT MIMO ANTENNA FOR 3.5 GHZ 5G AND 5.8 GHZ ISM BANDS

Mr Md Abu Sufian[1], Dr Anees Abbas[1], Mr Domin Choi[1], Mr Jaemin Lee[1], Prof Niamat Hussain[2], Prof Nam Kim[1]

[1]Department of Information and Communication Engineering, Chungbuk National University, Cheongju-si, Korea, Republic of. [2]Department of Intelligent Mechatronics Engineering, Sejong University, Seoul, Korea, Republic of

Abstract Subject Area(s)

["RF/Microwave","Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

In this work, a low SAR 4-port MIMO antenna is presented for the 3.5 GHz 5G and 5.8 GHz ISM band communication applications. The proposed antenna is designed on a 0.2 mm thick Rogers 5880 substrate having tangent delta = 0.0009, and ε_r =2.2. The overall antenna occupies a compact size of 36.2 mm × 36.2 mm. At the operational frequency ranges, the proposed dual-band MIMO antenna also offers an effective radiation efficiency of more than 90%, with a maximum gain of 2.01 dBi at 3.5 GHz and 1.71 dBi at 5.8 GHz, respectively. To check the suitability of the designed antenna operating near a human body, a 3-layer human tissue model is designed, and the SAR values are calculated at both 3.5 GHz and 5.8 GHz. The recommended 4-port MIMO antenna performs at 3.5 GHz and 5.8 GHz with a SAR value of 1.92 W/kg and 0.465 W/kg, respectively, at 125 mW of input power. With its SAR value within the mandated limit and other shown MIMO antenna performance metrics, the proposed antenna is a strong candidate for sub-6 GHz dual-band MIMO applications.

Is the work in progress?

Yes

FA11

A novel non-invasive magnetic acoustic electric composite field focusing stimulation method (M-TMAS)

Dr Xu Liu, Prof Zhipeng Liu

Institute of Biomedical Engineering, Tianjin, China

Abstract Subject Area(s)

["in vivo","Electroporation and pulsed electric field applications"]

Summary

In the study of brain fine structure and function, as well as the clinical diagnosis and treatment of brain diseases, the application of invasive electrical stimulation in clinical promotion and brain research is limited; Non invasive electromagnetic stimulation is still unable to break through the technical bottlenecks of focus and stimulation depth, and achieve precise stimulation of deep functional nuclei. This abstract proposes a research on non-invasive focused stimulation technology with principle innovation in composite fields. Based on the magneto acoustic coupling effect, a pulsed magnetic field with orthogonal directions and a focused ultrasound field are used to generate a magneto acoustic coupling electric field. The direction of the magnetic stimulation coil is controlled to make the direction of the magnetic induction electric field consistent with that of the magneto acoustic coupling electric field, forming a composite physical field of

sound field, magneto acoustic coupling electric field, and magnetic induction electric field. Realize high spatial resolution focused stimulation in various intracranial tissues, forming non-invasive focused stimulation technology and instruments. To provide non-invasive and precise regulation technology for cognitive function research in neuroscience, and to provide important technical means for the study and diagnosis of the occurrence and development mechanisms of brain diseases.

Is the work in progress?

Yes

FA12

PDMS BASED FLEXIBLE AND LOW SAR DUAL BAND ANTENNA FOR BODY AREA NETWORK

Dr Anees Abbas[1], Dr Wahaj Abbas Awan[1], Mr Domin Choi[1], Mr Jaemin Lee[1], Prof Niamat Hussain[2], Prof Nam Kim[1]

[1]Chungbuk National University, Cheongju, Korea, Republic of. [2]Sejong University, Seoul, Korea, Republic of

Abstract Subject Area(s)

["RF/Microwave","Biological and medical applications"]

Summary

With the rapid advancement of radio frequency technology and the proliferation of diverse wireless communications in recent times, human dependence on wireless communication has significantly increased. The World Health Organization (WHO) has cautioned that antenna radiations emitted by wireless devices, especially those incorporated into personal electronics, may pose a risk of cancer. To safeguard consumers from electromagnetic exposure, international bodies have instituted safety regulations, particularly regarding Specific Absorption Rate (SAR). The Federal Communications Commission (FCC) has recommended a SAR limit of 1.6 W/kg averaged over 1 gram of head tissue, as per ANSI/IEEE C95.1-2005 standards. This study proposes a relatively compact dual-band antenna suitable for wearable applications in the Industrial, Scientific, and Medical (ISM) bands at 2.45 GHz and 5.8 GHz. It offers low SAR values and broadband advantages for both conformal and non-conformal devices.

FA13

Microwave surgical energy device with controllable heating region

Mr Tsugumi Nishidate, Prof Kazuyuki Saito

Chiba University, Chiba, Japan

Abstract Subject Area(s)

["RF/Microwave","Biological and medical applications"]

Summary

Microwave surgical energy devices are used for hemostasis and anastomosis in modern surgery. These hemostasis and anastomoses are safely performed due to the frictional heat between water molecules generated by electric field vibration. The operating frequency is 2.45 GHz as defined by ISM (Industrial, Scientific and Medical) band. The heating region produced by this device depends on the antenna geometry, heating time, and heating power. In case a sufficient heating region in the depth direction is desired, the heating time is set to be long, or the heating power is increased. As a result, the

heating region on the tissue surface also increases. Therefore, in this study, a device structure that can control only the heating region in the depth direction was validated. Specifically, a waveguide filled with dielectric material is used as a microwave transmission line and as a radiator. The dielectric material is appropriately selected to shorten wavelength, allowing the adoption of waveguide with small cross section. The tip of the waveguide is brought into contact with the biological tissue for heating. As a method of changing the distribution of the heating region in the depth direction, a metallic plate was installed inside the waveguide tip. From numerical calculations, it was confirmed that the electric field at the tip of the waveguide was increased by this metallic plate. Furthermore, the heating region was also confirmed to be deeply distributed compared to normal waveguide.

Is the work in progress?

Yes

FA14

Ray Tracing-based Analysis of the Influence on the Scattering of the Electric Field Caused by the Measuring Person at 6G Frequencies

Mr Thanh Tam Julian Ta[1], Ms Anna-Malin Schiffarth[1], Dr Christian Bornkessel[2], Ms Lisa-Marie Schilling[3], Prof Matthias Hein[2], Prof Dirk Heberling[1,4]

[1]Institute of High Frequency Technology, RWTH Aachen University, Aachen, Germany. [2]RF & Microwave Research Laboratory, Thuringian Center of Innovation in Mobility, TU Ilmenau, Ilmenau, Germany. [3]RF & Microwave Research Laboratory, Thuringian Center of Innovation in Mobility, TU Ilmeau, Ilmenau, Germany. [4]Fraunhofer Institute for High Frequency Physics and Radar Techniques, Wachtberg, Germany

Abstract Subject Area(s)

["Numerical dosimetry","MM Waves","Standards and public health policy"]

Summary

For radiation protection it is important to obtain reliable data on the actual electromagnetic exposure to ensure that the exposure safety limits are not exceeded. The presence of the person performing a measurement can distort the electric field and reflection occurring from the body can superimpose with the incident waves and lead to a standing wave with constructive and deconstructive interferences. This may lead to a misinterpretation of the actual exposure.

In this study, a ray-tracing based analysis was done to estimate the potential electric field variations caused by the presence of a person at 6G frequencies and different incident wave angles. The comparison of the electric field with and without a person showed a large field variation of up to 14 dB, which can lead to an overestimation of the actual exposure. However, to apply the simulation results to a real measurement and to determine the uncertainty more precisely, the simulation needs to be extended and more in-depth investigations need to be carried out.

Is the work in progress?

Yes

FA15

5G NR FR1 CONTRIBUTION TO THE TOTAL EMF EXPOSURE LEVELS DURING GROUND LEVEL SPOT MEASUREMENTS IN URBAN AND SUBURBAN ENVIRONMENTS IN GREECE

Mr Athanasios Manassas[1], Dr Maria Christopoulou[2], Mr Nikos Papanikolaou[2], Mr Spyridon Delidimitriou[1], Prof Theodoros Samaras[1], Dr Efthymios Karabetsos[2]
[1]Aristotle University, Thessaloniki, Greece. [2]Greek Atomic Energy Commission, Athens, Greece

Abstract Subject Area(s)

["RF/Microwave"]

Summary

Results of 400 in situ spot measurements of radiofrequency electromagnetic fields, conducted at ground level in urban and suburban environments in Greece, are presented and discussed. Measurement data are assessed, emphasizing the 5G contribution to the measured total electric field (E-field). The correlation of the measured E-field in the 5G NR FR1 to the distance of the base stations (BSA) and small cell antennas (SCA) operating at this frequency range is explored.

Is the work in progress?

Yes

FA16

Generation of Silent Voice Commands Based on High-Density Laryngeal Electromyography

Ms Yuanyuan Li[1], Ms Haoyue Wang[1], Mr Kaixiang Shen[1], Ms Siyao Chen[1], Prof Zheng Zhao[1], Dr Li Shi[2], Prof Hui Cao[1], Prof Jiangtao Li[1]
[1]Xi'an Jiaotong University, Xi'an, China. [2]Xijing Hospital, Xi'an, China

Abstract Subject Area(s)

["In vitro","Mechanisms","Biological and medical applications"]

Summary

Laryngeal electromyography (LEMG) signal is an important bioelectrical signal that has attracted widespread attention in the field of pattern recognition. Due to the influence of electrode placement and number, traditional surface electromyography cannot accurately reflect the activity information of the motor unit. Therefore, the aim of this study was to propose a method for generating silent voice commands based on high-density array electrodes. In this experiment, a kind of ionic gel with wide mechanical properties is used as the conductive medium to collect the laryngeal muscle electrical signals using the high-density flexible FPC signal acquisition electrode, and the classification algorithm and model optimization algorithm are combined to realize the recognition of silent voice instructions. The results indicated that compared with traditional electrodes, high-density electrodes have higher spatiotemporal resolution and can achieve high accuracy and real-time recognition of silent voice commands. This provides a good research foundation for studying the mechanism of speech generation and achieving silent speech recognition.

Is the work in progress?

Yes

FA17 - Withdrawn

FA18

Sensor Model Linearization via Artificial Intelligence

Mr Alessandro Fasse[1], Mr Romain Meyer[2], Dr Cédric Bujard[1], Mr Maxim Haas[2], Dr Nicolas Chavannes[2], Dr Esra Neufeld[1], Prof Niels Kuster[1,2,3]

[1]Foundation for Research on Information Technologies in Society (IT'IS), Zurich, Switzerland. [2]Schmid & Partner Engineering AG (SPEAG), Zurich, Switzerland. [3]Department of Information Technology and Electrical Engineering, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland

Abstract Subject Area(s)

["Experimental dosimetry","Numerical dosimetry","RF/Microwave"]

Summary

Resistively loaded diode detectors are commonly employed for highly standardized near-field characterization in regulatory assessment of radiofrequency exposure. The required accuracy demands linearization of the calibration to compensate for non-ideal response characteristics and manufacturing tolerances. The challenge of linearization has existed and expanded over recent years [1, 2, 3], mostly as a result of the increasingly diverse and complex modulation schemes introduced with 5G. Current approaches demand inverse problem solving, where each evaluation requires the slow and costly simulation of a differential equation representing the detector circuit. As a result, the procedure has become computationally demanding and inflexible. A novel approach has been developed to accelerate the simulations by a factor of more than 10×, while at the same time enhancing accuracy, allowing a large number of evaluations with varying probe characteristics and signal parameters to be performed, and on which a Deep Neural Network was trained to predict linearization parameters on the fly. The neural network was validated by means of test simulations and laboratory measurements. Furthermore, a recently introduced Gaussian Process model procedure [4] was used to characterize the network's accuracy in a critical, unbiased, and implementation-agnostic manner. This artificial intelligence approach was found to produce a maximum error of 0.4 dB at up to temporal peak specific absorption rate value of 100 W/kg and to accelerate the computations of the linearization parameters by a total factor greater than 8000×.

Is the work in progress?

Yes

FA19

Robust Validation Methods for Systems Determining the Absorbed Power Density

Mr Ninad Chitnis[1], Dr Sven Kuehn[1], Prof Niels Kuster[1,2]

[1]IT'IS Foundation, Zurich, Switzerland. [2]ETH Zurich, Zurich, Switzerland

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","MM Waves","Standards and public health policy"]

Summary

A robust validation method for absorbed power density (APD) measurement systems is presented. The method validates the absolute measurement accuracy, including modulated signal dynamic characteristics and feedback on the device under test

through a phantom. The validation tests the system utilizing the normalized error concept (En). The method was applied to the commercial APD assessment system DASY8 in the 6 to 30 GHz frequency range, validating its fitness with En <<1.

FA20

High-Resolution Voxel-Based Numerical Modelling of the Eye Exposure to Electromagnetic Fields Beyond 6 GHz

Ms Fatima Alzaabi, Dr Yasir Alfadhl, Prof Xiaodong Chen
Queen Mary University of London, London, United Kingdom

Abstract Subject Area(s)

["Numerical dosimetry","MM Waves","Standards and public health policy"]

Summary

This paper outlines the improvements in numerical modelling of the human eye's exposure to mm-waves. It presents strategies to manage the increased computational demands due to a higher number of voxels and challenges in short-wavelength solutions. The research includes detailed analysis using a virtual human model to study the eye's response to EM waves at various frequencies, including a specific focus on the eye region for frequencies of 0.9, 2.45 and 5 GHz where SAR is assessed. Additionally, evaluating a hard-head model at a frequency of 12 GHz highlighting the power density measures to be a relevant tool for beyond 6 GHz.

10:00 - 10:30	Coffee break		Athina
10:30 - 12:00	OS 1 - Dosimetry 1 - Numerical Dosimetry	Blaž Valič Robin Wydaeghe	Main Hall

OS01-01

Characterization of Human Exposure to Electromagnetic Fields in Realistic Scenarios

Mrs Soukaina Mifdal[1], Dr Marylene Cueille[1], Dr Abdelrahman IJJEH[1], Dr laurence richard[2], Dr stephane pannetrat[2], Prof Jean-Lou. Dubard[1]
[1]University of Cote d'Azur, CNRS, LEAT, 06903 Sophia Antipolis, France. [2]ART-Fi, Orsay, France

Abstract Subject Area(s)

["Experimental dosimetry","Numerical dosimetry","RF/Microwave","MM Waves"]

Summary

This article presents an innovative project aiming to characterize human exposure to electromagnetic fields (EMF) emitted by communication devices used in close proximity to the human body. The main objective is to develop a characterization protocol for EMF exposure in realistic environments and scenarios. This protocol will use and combine experimental measurements (supplied by ART-Fi) and numerical simulations (provided by LEAT). A variety of EMF sources will be considered to accurately assess the levels of energy/power absorbed by the biological tissues of a diverse population (including

adults, children, pregnant women, and the elderly). The combination of an RF near-field phasor probe array and powerful simulation techniques allow to address those challenges taking into account both research and industrial goals.

Is the work in progress?

Yes

OS01-02

Comparative Analysis of Non-Invasive and Invasive Tumor Treatment Fields: A Simulation Study

Dr Minmin Wang, Dr Yue Lan, Prof Yun pan, Prof Guangdi Chen, Prof Shaomin Zhang
Zhejiang University, 310027, China

Abstract Subject Area(s)

["Numerical dosimetry","Risk assessment","Electroporation and pulsed electric field applications"]

Summary

A noticeable research gap exists in the comparative analysis of invasive and non-invasive methods through quantitative evaluation. In this study, we investigate electric field and temperature distributions for these two approaches employing four-layer spherical head models representing the scalp, skull, cerebrospinal fluid, and brain. Non-invasive TTFields utilize scalp transducers, while invasive methods involve electrode implantation into tumors. Our findings underscore the advantages of invasive TTFields, showcasing their superior tumor-targeting abilities and reduced energy requirements. Furthermore, our analysis of brain tissue temperature changes in response to TTFields indicates that non-invasive TTFields primarily generate heat on the scalp, whereas implantation methods concentrate heat production within tumors, preserving normal brain tissue. In conclusion, invasive TTFields demonstrates potential for precise and effective tumor treatment. Its enhanced targeting capabilities and limited impact on healthy tissue make it a promising avenue for further research in the realm of cancer treatment.

Is the work in progress?

Yes

OS01-03

Assessment of Human RF Exposure from ITS-5.9 GHz Vehicular-Road Connectivity by Numerical Dosimetry and In-lab Measurements

Mr Yizhen Yang[1], Prof Günter Vermeeren[1], Dr Daniel Van den Akker[2], Mrs Leen Verloock[1], Prof Joe Wiart[3], Dr Gabriella Tognola[4], Prof Wout Joseph[1]
[1]Department of Information Technology, Ghent University\IMEC, Ghent, Belgium.
[2]Department of Electronics–ICT, University of Antwerp\IMEC, Antwerp, Belgium.
[3]Telecom Paris, Institut Polytechnique de Paris, Palaiseau, France. [4]Institute of Electronics, Computer and Telecommunication Engineering (IEIIT), CNR, Milano, Italy

Abstract Subject Area(s)

["Experimental dosimetry","Numerical dosimetry"]

Summary

The development of Vehicle-to-Everything (V2X) connectivity technology has prompted new considerations for radio-frequency electromagnetic field (RF EMF) exposure safety of the human body. This study assesses the RF EMF exposure levels of the human body

generated by communication technologies implemented in Roadside Units (RSUs) within V2X communication scenarios. Focusing on the novel V2X 5.9 GHz band, Finite Difference Time Domain (FDTD) simulations were conducted to calculate the electric field around the RSU with antennas operating at this band (input power 23 dBm), as well as the specific absorption rate (SAR) with human models (adults and children) placed around the RSU (input power of 1 W). We found that, in the worst-case scenario, the peak local and whole-body SAR (WBS) are 264 mW/kg and 1.06 mW/kg, respectively, both significantly below the ICNIRP limits for general public exposure. In-lab experiments measured EMF exposure levels at various distances around the RSU, evidencing that the maximum exposure level was 5.8 V/m, 10 times below the ICNIRP reference levels. Furthermore, a comparison between the measured and simulated results, with a maximum deviation of no more than 3 dB, validated the reliability of the numerical dosimetry.

OS01-04

Effect of beamforming on EMF exposure at an office environment

Mr Christos Apostolidis, Prof Theodoros Samaras
Aristotle University of Thessaloniki, Thessaloniki, Greece

Abstract Subject Area(s)

["Numerical dosimetry","RF/Microwave"]

Summary

This work explores the impact of beamforming on exposure to radiofrequency electromagnetic fields (RF-EMF) in office environments. The study focuses on a realistic office setting with five workstations and investigates exposure variations when a Wi-Fi 6 access point (AP) is operating at the frequency range of 5GHz. Exposure levels are compared between cases where static radiation patterns are utilized and when beamforming is employed.

Using a numerical tool developed in Matlab, the incident field is calculated considering propagation paths and interactions with the environment. The study evaluates scenarios with static radiation patterns and beamforming where high-gain beams are directed towards specific workstations. Results indicate significant exposure increases at the targeted workstation and decreases for nearby locations, while other positions show smaller but notable changes.

The results demonstrate the unpredictability of exposure assessment with beamforming, especially when the transmitting antenna has multiple beams with subtle differences in gain. Further research is under way to explore additional scenarios and validate the findings with measurements.

Is the work in progress?

Yes

OS01-05

Evaluating Electro Pulsed Bio-hybrid in vivo electrostimulation of spinal cord injury in rats using numerical dosimetry

Dr Micol Colella[1], Dr Noemi Dolciotti[1], Miss Giulia De Luca[1], Prof Alessandra Paffi[1], Dr Laura Caramazza[1], Dr Sara Fontana[1], Dr Victoria Moreno-Manzano[2], Dr Claudia Consales[3], Prof Francesca Apollonio[1], Prof Micaela Liberti[1]

[1]Sapienza University of Rome, Rome, Italy. [2]Centro de Investigacion Principe Felipe, Valencia, Spain. [3]Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Rome, Italy

Abstract Subject Area(s)

["in vivo","Numerical dosimetry","Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

The European funded project (FET Open of Horizon Europe Program 2020) "Regeneration of injured spinal cord by electro pulsed bio-hybrid approach" (RISEUP) aims at developing an innovative method for spinal cord regeneration based on stem cells transplantation and electric stimulation via µs-Pulsed Electric Fields (µsPEF) and direct current (DC) stimulation, delivered by an Electro Pulsed Bio-hybrid (EPB) device. In this frame, the present study aims to evaluate the electric (E-) field induced by the EPB when placed inside a realistic anatomical model of a rat affected by spinal cord injury. Results showed that the E-field intensities estimated are in line with values able to induce differentiation and proliferation of transplanted stem cells. However, the dosimetric results under DC conditions showed that most of the lesion volume experienced intensities below 10 V/m, so not sufficiently high to support axonal elongation. This required the design of an ad hoc external DC device, with specifically shaped electrodes.

Is the work in progress?

Yes

OS01-06

Microdosimetry of µsPEFs on advanced stem cells 3D models in microfibrils' electrified scaffolds

Sara Fontana[1,2], Noemi Dolciotti[1], Laura Caramazza[1], Micol Colella[1], Alessandra Paffi[1], Victoria Moreno-Manzano[3], Lluis M. Mir[4], Franck M. Andre[4], Claudia Consales[5], Francesca Apollonio[1,2], Micaela Liberti[1,2]

[1]Department of Information Engineering, Electronics and Telecommunications (DIET), Sapienza University of Rome, Rome, Italy. [2]Center for Life Nano- & Neuro-Science, Fondazione Istituto Italiano di Tecnologia (IIT), Rome, Italy. [3]Neuronal and Tissue Regeneration Lab, Centro de Investigacion Prıncipe Felipe, Valencia, Spain. [4]UMR 9018 METSY, CNRS, Université Paris-Saclay, Gustave Roussy, Villejuif, France. [5]Division of Health Protection Technologies, ENEA, Rome, Italy

Abstract Subject Area(s)

["Numerical dosimetry","Electroporation and pulsed electric field applications"]

Summary

Stem cells-based treatments are offering tantalizing prospectives within neuronal tissue engineering, as a versatile tool to promote nerve regeneration after injuries, such as the Spinal Cord Injury (SCI). In this context, the European project RISEUP aims at SCI regeneration through an Electro Pulsed Bio-hybrid (EPB) implantable device, that will support stem cells in a polylactic acid microfibrils' scaffold. The cells' differentiation in neuronal lineage will be fostered through the application of microsecond pulsed electric fields (µsPEFs), typically used for electroporation-based applications. In this work, a microdosimetric study on a mixture of advanced 3D realistic cells' models, including

subcellular structures and internal organelles, hosted in a sparser and a denser microfibrils' distribution is presented. The aim is to quantify the induced electrical quantities and the pore formation dynamics at cellular and subcellular level, to evaluate the biophysical effects induced after μsPEFs stimulation.

Is the work in progress?

Yes

10:30 - 12:00	OS2 - Effects in humans	Carmela Marino Rohan Mate	Hall 3

OS02-01

A methodology for assessing the risks encountered by employees with pacemakers exposed to low-frequency occupational electric fields

Dr Mengxi Zhou[1,2], Prof Djilali Kourtiche[1,2], Dr Julien Claudel[1,2], Dr Isabelle Mange[3], Mr Francois Deschamps[4], Mr Patrice Roth[2,1], Mr Pierre Schmitt[1,2], Prof Mustapha Nadi[1,2]
[1]University of Lorrain, Nancy, France. [2]Jean Lamour Institution, Nancy, France. [3]EDF, Paris, France. [4]RTE, Paris, France

Abstract Subject Area(s)

["ELF/LF","Occupational exposure","Risk assessment","Standards and public health policy"]

Summary

Within the framework of occupational health and safety regulations, employees equipped with cardiac active implantable medical devices (AIMD), such as pacemakers (PM) or implantable defibrillators (ICD), constitute a group of individuals at particular risk when exposed to electromagnetic fields (EMF), necessitating precautions against the potential hazards posed by electromagnetic interference (EMI). This paper describes a methodology for assessing the risks faced by employees with pacemakers exposed to EMF, aligning with the EN 50527-2 standards. We present two case studies of two workers bearing pacemakers, aiming to provide practical insights into conducting risk assessments.

OS02-02

Physiological and health-related effects of 5G-relevant radiofrequency fields (3–30 GHz): a systematic review of experimental and epidemiological studies in humans and non-human mammals

Dr Lambert Bodewein[1], Ms Dagmar Dechent[1], Ms Tanja Emonds[1], Mr David Graefrath[1], Dr Julia Krabbe[2], Ms Philine Johanna Scheelhaase[2], Mr Gernot Schmid[3], Ms Pia Schneeweiss[3], Dr Sarah Driessen[1]
[1]Research Center for Bioelectromagnetic Interaction (femu)-Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany. [2]Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany. [3]EMC & Optics, Seibersdorf Laboratories, Seibersdorf, Austria

Abstract Subject Area(s)

["RF/Microwave","Risk assessment"]

Summary

Background: The introduction of the latest mobile communications standard 5G is accompanied by controversial discussions about potential health risks. According to the current state of knowledge, there is no health risk for frequencies in the range of existing mobile communications applications (approx. 800 MHz–3 GHz) below the recommended international limits. However, for higher frequencies used for 5G (> 3 GHz), there are significantly fewer studies available on physiological and health-related effects than for frequencies in the range of existing mobile communications applications and the current state of knowledge has not yet been systematically evaluated.

Objective: We conducted a systematic review of experimental and epidemiological studies investigating the physiological and health-related effects of 5G-relevant radiofrequency fields (3–30 GHz) in humans and mammals.

Methods: The review protocol was developed in advance and registered in PROSPERO (CRD42022374434). The systematic review conforms to the PRISMA guidelines. The risk of bias and the quality of included studies was assessed using the recommended approach by OHAT/NTP.

Preliminary results: A total of 107 experimental studies (100 on mammals, 7 in humans) were included in the review. Of these, 11 had good study quality (1st tier), 39 moderate quality (2nd tier), and 57 had low quality (3rd tier). The investigated endpoints were very heterogeneous. Most studies investigated effects on the central nervous system, cognition, and behavior (30 studies), the immune system (17 studies), and reproduction and teratogenicity (13 studies).

Outlook: The final results will be presented at BioEM 2024.

Is the work in progress?

Yes

OS02-03

Occupational Exposure to Radiofrequency Electromagnetic Fields and the risk of glioma

Mr Rohan Mate[1], Dr Geza Benke[1], Prof Sarah Loughran[2], Prof Michael Abramson[1], Prof Claire Vajdic[3], Prof Michelle Turner[4], Mr Maxime Turuban[4], Prof Elisabeth Cardis[4], Prof Ken Karipidis[2]

[1]Monash University, Melbourne, Australia. [2]ARPANSA, Melbourne, Australia. [3]University of New South Wales, Sydney, Australia. [4]ISGlobal, Barcelona, Spain

Abstract Subject Area(s)

["Epidemiology","RF/Microwave","Occupational exposure"]

Summary

The relationship between exposure to occupational sources of radiofrequency electromagnetic fields (RF-EMF) and possible health effects has raised public concerns for many years, particularly for incidence of brain cancer. Exposure to RF-EMF is generally low, however, for workers near RF-EMF sources the exposure can be relatively high. Previous studies have had deficiencies in occupational RF-EMF exposure assessment and because of this have not been able to discount a possible health. Recently, two Job-exposure-matrixes (JEM), the INTEROCC JEM and CANJEM, that have provided RF-EMF exposure information for many occupations, 119 and 468 respectively.

These JEMs will allow for a better-informed investigation of how occupational RF-EMF affects human health. Using exposure data from the Canadian JEM (CANJEM) and INTEROCC RF JEM and cancer incidence data from the Australian Genomics and Clinical Outcomes of Glioma case-control study we investigated the association between RF-EMF exposure and glioma. The analysis used unconditional binary logistic regression to calculate odds ratios (ORs) and 95% confidence intervals (95% CIs). We found no association between RF EMF exposure and glioma for the analysis using CANJEM (OR: 0.99 (95% CI: 0.99-1.00)) or using the INTEROCC RF JEM (OR 1.00 (95% CI 0.99-1.01)). The preliminary results do not support a positive association between occupational exposure to RF EMF and glioma, however, further analysis is required.

Is the work in progress?

Yes

OS02-04

Electrodermal activity and body temperature during and after short-term exposure to 3.5 GHz frequencies in healthy young adults

Ms Lisa MICHELANT[1,2], Ms Layla JAMAL[1,2], Mr Stéphane DELANAUD[3], Mr Laurent HUGUEVILLE[4], Mr Paul MAZET[5], Ms Tamara BAZ[1,2], Mr Philippe LÉVÊQUE[6], Ms Amandine CARRIE[4], Ms Véronique BACH[3], Mr Brahim SELMAOUI[1,2]

[1]Department of Experimental Toxicology and Modeling (TEAM), Institut National de l'Environnement Industriel et des Risques (INERIS), Verneuil-en-Halatte, France. [2]PériTox laboratory (UMR_I 01), INERIS/UPJV, INERIS, Verneuil-en-Halatte, France. [3]PériTox laboratory (UMR_I 01), INERIS/UPJV, INERIS, Amiens, France. [4]Paris Brain Institute (ICM), Center for NeuroImaging Research (CENIR), Paris, France. [5]Technical Center for Mechanical Industries (CETIM), Senlis, France. [6]University of Limoges, CNRS, XLIM, UMR 7252, Limoges, France

Abstract Subject Area(s)

["Human studies","RF/Microwave","Risk assessment","Standards and public health policy"]

Summary

In the context of deployement of 5G networks, the possible impact of these networks on human health is becoming the subject of extensive research.

This study aims to explore the potential effects on the electrodermal activity (EDA) and skin body temperature of human volunteers exposed to 3.5 GHz according to 5G legal standards.

This research comprises one "real" and one "sham" exposure session with a triple-blinded randomized crossover design. The 44 healthy young subjects were exposed to short-term (25 minutes 30) of a 3.5 GHz with an effective electric field strength (mean square root) of 2 V/m at the head and 1.5 V/m at the trunk measured by a field meter (NBM 550, Narda Safety Test Solutions GmbH, Germany) Each session is divided into 3 parts: pre-exposure phase, exposure phase and post-exposure phase divided into 7 runs.

Each run begins with a 150-second segment of EDA recordings, measuring event-related skin conductance responses stimulated by 10 consecutive 0.3-second auditory beeps. The series continues with 180 seconds of eyes-open recording without EDA

measurement, and 180 seconds of eyes-closed recording without EDA measurement. Temperature is measured continuously every 30 seconds (hand, head and neck).
No significant effect of exposure on body temperature or on EDA was found. It is important to note that results may be subject to modification the final stages of statistical analysis and will be completed and ready for the oral presentation.

Is the work in progress?

Yes

OS02-05

Effects of acute RF-EMF exposure and eMedia use on the quality of sleep in Swiss adolescents: a panel study nested in the HERMES3 cohort

Valentin Jaki Waibl[1], Laura Tincknell[1], Nasrullah Arslan[1], Irina Wipf[1], Lena Steck[1], Adriana Fernandes Veludo[1], Dr Hamed Jalilian[1], Dr Stefan Dongus[1], Prof Monica Guxens[2], Prof Martin Röösli[1]

[1]Swiss TPH, Allschwil, Switzerland. [2]IS Global, Barcelona, Spain

Abstract Subject Area(s)

["Human studies","Epidemiology","RF/Microwave"]

Summary

The HERMES3 (Health Effects Related to Mobile phone usE in adolescentS) study, in the frame of the EU funded GOLiAT project, examines the effects of RF-EMF (radiofrequency electromagnetic fields) and side effects of extensive eMedia (electronic media) use on mental health, cognition and behavior in adolescents. The main study aims to gain a better understanding of psychological and biophysical pathways, following two previous HERMES cohorts conducted between 2012 and 2015. Nested within this cohort, a panel study is conducted. The primary goal of this measurement study is to objectively measure sleep and RF-EMF exposure. Therefore, 150 participants from the main cohort are invited to collect personal RF-EMF measurements, monitor sleep patterns and physical activity using GENEActiv accelerometers, and fill a sleep log that covers also daily eMedia usage. A preliminary analysis of data from the first 42 participants did not indicate significant associations between sleep efficiency, number of awakenings during night, sleep duration and various aspects of eMedia use.

Is the work in progress?

Yes

OS02-06

Chicken or egg? Testing attribution hypothesis and nocebo hypothesis to explain symptoms associated to EMF exposure.

Dr Silvia Ariccio, Dr Eugenio Traini, Dr Lützen Portengen, Dr Astrid Martens, Dr Pauline Slottje, Prof Roel Vermeulen, Prof Anke Huss

Institute of Risk Assessment Sciences, Utrecht, Netherlands

Abstract Subject Area(s)

["Human studies","Epidemiology","Risk assessment","Standards and public health policy"]

Summary

The aim of this study was to understand the temporal relationship between the somatisation symptoms sometimes associated with EMF and EMF perceived exposure.

The study tested the attribution hypothesis, i.e., identifying EMF as the cause of pre-existing unexplained symptoms, and the nocebo hypothesis, i.e., reporting somatisation symptoms after perceived EMF exposure. For comparison reasons, both EMF-related exposures as well as other exposures, e.g., traffic related air pollution or noise and UV-radiation were included, to understand if any observed relationships also apply to other exposures. In this prospective study, data from the Dutch Occupational and Environmental Health Cohort Study (AMIGO) was analysed, consisting of a baseline questionnaire collected in 2011 (14,829 participants) and a follow-up questionnaire collected in 2015 (7,904 participants). Participants completed a questionnaire providing information on their health status, perceived environmental exposures, and demographics. Two sets of multiple linear regressions were conducted to test the two hypotheses. The first set of analyses showed weak positive associations between somatisation at baseline and perceived exposure at follow-up, in line with the attribution hypothesis. The second set of analyses showed weak positive associations between perceived exposure at baseline and for both phone and traffic exposure and somatisation at follow-up. Overall, our study therefore does not provide a definitive answer on the relevance of the attribution and the nocebo hypotheses, which could also simply describe two different phases of the person-somatisation-exposure relationship. Further analyses are ongoing to explore (possible) non-linear relations and (possible) effects of having received a diagnosis of a chronic condition.

Is the work in progress?

Yes

12:00 - 13:00	OS3 - Mechanisms	Angelique Ducray Maëlys Moulin	Main Hall

OS03-01

Quantum Biology of ROS Production in ETF and CRY

Dr Carlos Martino, Dr Michael Salerno, Dr Nam Le, Dr Ryan McQuillen, Mrs Megan Hannegan

Johns Hopkins University Applied Physics Laboratory, Laurel, USA

Abstract Subject Area(s)

["In vitro","Mechanisms"]

Summary

We propose a novel domain within quantum biology: control of the biological production of reactive oxygen species (ROS) by influencing spin dynamics in a radical pair (RP) reaction. Our exemplar system is the human electron transfer flavoprotein (ETF). We test the hypotheses that the flavin:superoxide [$FADH^{\bullet}...O_2^{\bullet-}$] RP plays a key role in the partitioning of ROS products from ETF, and furthermore that the partitioning can be affected by external fields.

We show evidence that $O_2^{\bullet-}$ could meet strict constraints for possible involvement in magnetic field effects in the system $FADH^{\bullet}...O_2^{\bullet-}$. The main constraint set forth previously is that the fast spin relaxation of $O_2^{\bullet-}$, if unimpeded, would lead to RP

coherence lifetimes too short to be influenced by external fields. To that end, we have recent evidence that $O_2^{\bullet-}$ can bind tightly to certain sites in ETF and be stabilized by nearby charged protein residues. Our recent relevant findings are summarized here and published. Moreover, theoretical calculations indicate that nuclear spin interactions in the flavin and $O_2^{\bullet-}$ system are highly anisotropic, and thus potentially susceptible to external field effects. In coupled experiments, we have purified ETF and begun to characterize preliminary magnetic field effects on ROS production.

We test and exploit the anisotropic hyperfine centers of the flavin:superoxide RP system in ETF to maximize coherent lifetimes, which will result in higher magnetic sensitivity. Guided by our published and preliminary work, we use point mutations near the binding site and external magnetic fields, to enhance coherent lifetimes.

OS03-02

Brain in a dish – Effects of RF-EMF (5G) on brain development and neurodegeneration

Dr Selina Thomas[1], Dr Angélique Ducray[2], Dr Myles Capstick[3], Prof Niels Kuster[3], Prof Meike Mevissen[2]

[1]Vet.-Pharmacology & Toxicology, DCR-VPH, Vetsuisse Faculty, University Bern, Bern, Switzerland. [2]Vet. Pharmacology & Toxicology, Vetsuisse Faculty, University of Bern, Bern, Switzerland. [3]IT'IS Foundation, Zurich, Switzerland

Abstract Subject Area(s)

["In vitro","Mechanisms","RF/Microwave"]

Summary

The expansion of wireless communication technologies has led to a significant increase in public exposure to radiofrequency electromagnetic fields (RF-EMF), with the latest technology being the 5G New Radio (NR) mobile phone network. Frequent use of cell phones with their position near the head, requires research on possible effects of RF-EMF on the brain including neuronal development.

In our research, midbrain and cerebral organoids were generated from human induced pluripotent stem cells (iPSCs) and exposed to 1950 MHz RF-EMF to study possible effects on neuronal development.

5G RF-EMF exposure did not alter the dopaminergic phenotype or neuronal maturity. A significant decrease in synaptophysin protein levels was obtained after RF-EMF exposure at day 30, indicating a reduced synaptic activity. RF-EMF exposure decreased neuronal progenitor cells expressed in ventricle-like zones in cerebral organoids, whereas an increase of these cells was found in midbrain organoids. In midbrain organoids, a significant decrease of the astrocyte marker S100beta was observed at day 30 of development, while GFAP was not detected. At day 60, both astrocytic markers were found upregulated after RF-EMF, with the effect being significant for GFAP. Overall, midbrain organoids were observed to be more sensitive to RF-EMF compared to cerebral organoids.

This project provides insight into potential effects of 5G NR FR1 RF-EMF exposure during sensitive stages of brain development. Ongoing studies include investigations using chemical and genetically engineered disease models to evaluate possible effects of 5G NR RF-EMF on neurodegeneration.

OS03-03

Contribution of Ion Channel Nonlinearities to the Mechanism of Temporal Interference Stimulation

Mr Tom Plovie, Dr Ruben Schoeters, Dr Thomas Tarnaud, Prof Wout Joseph, Prof Emmeric Tanghe
Ghent University, Ghent, Belgium

Abstract Subject Area(s)

["Mechanisms","ELF/LF","Biological and medical applications"]

Summary

The goal of this study is to get more insights into the underlying mechanism of temporal interference (TI) stimulation on single neuron level. The idea is to use a model that is relatively easy to understand. This knowledge can then be used to interpret more complex models. The single compartment Frankenhaeuser-Huxley model and adaptations of this model are used to investigate the different responses to a temporal interference signal and a single sinusoidal signal. The adaptations that were made are the linearisation of the Goldman-Hodgkin-Katz (GHK) flux equation, the alteration of the time constant of ion gates and the variation of the steady state constants of the gates. The linearisation of the GHK nonlinearity has only a minor influence on the exact neuron response. The specific combination of ion gate characteristics determines largely whether TI has a lower activation threshold than a single sine.

OS03-04

RF EM Fields Effects on Transient Receptor Potential Channels: A Computational Approach

Dr Laura Caramazza[1,2], Miss Carmen Pisano[1], Dr Paolo Marracino[3], Mr Federico Del Signore[1], Prof Micaela Liberti[1,2], Prof Francesca Apollonio[1,2]
[1]Sapienza University, Rome, Italy. [2]Center for Life Nano- & Neuro-Science, Fondazione Istituto Italiano di Tecnologia (IIT), Rome, Italy. [3]Rise Technology S.r.l., Rome, Italy

Abstract Subject Area(s)

["Mechanisms","RF/Microwave"]

Summary

In recent years, extensive research has focused on the health effects of radiofrequency electromagnetic fields (RF-EMF) and this has prompted ongoing investigations into possible effects at biological level. Previous experiments using low-level RF signals at 900 and 1800 MHz have hinted at potential involvement in thermo-sensitive receptors, particularly transient receptor potential (TRP) channels, which play vital roles in cellular processes, including anti-inflammatory pathways, and respond to stimuli like temperature changes. However, directly observing physical changes in TRP channels requires costly equipment. Molecular dynamics (MD) simulations offer a cost-effective approach, allowing exploration of biomolecular conformational changes in response to environmental stimuli, including EM fields.
Challenges in simulating EM field effects on TRP channels include accurately modeling receptors with primary and secondary protein structures and specific interaction sites. In this study, authors investigated computationally the effect of an RF-EMF stimulus on TRPV4 and TRPM8 receptors, key targets for understanding molecular interaction

mechanisms. A four-step procedure was employed to obtain molecular models for both receptors, used in 100 ns MD simulations with and without a 900 MHz RF signal. Results suggest that RF field affects the secondary structures of proteins in contact with the aqueous solution. These findings offer predictive insights into cellular-scale effects and provide a basis for further analysis with 5G signals.

Is the work in progress?

Yes

13:00 - 14:00	Lunch		Elia Minoa Palace
14:00 - 15:30	OS4 - Measurements in different settings	Martin Roosli Lea Belackova	Main Hall

OS04-01

EMF assessment based on actual output power of 5G base stations in a stadium with 100,000 people

Carla Di Paola, Paramananda Joshi, Davide Colombi, Bo Xu, Jens Eilers Bischoff, Stanislav Stefanov Zhekov, Christer Törnevik

Ericsson AB, Stockholm, Sweden

Abstract Subject Area(s)

["RF/Microwave"]

Summary

In this study, the actual output power levels of nine 5G massive multiple-input multiple-output base stations located inside the Melbourne Cricket Ground were measured to assess compliance with electromagnetic field exposure limits. Measurements were conducted during the 2023 Australian Football League Grand Final with over 100,000 attendants (full stadium capacity), under extreme mobile traffic and user density conditions. Logged precoding matrix indicator and time-averaged output power data were collected from the BSs using a network monitoring tool to obtain actual time-averaged output power statistics considering the spatial distribution of power transmission in different beam directions. The results show that, even under exceptional traffic conditions, the actual time-averaged output power per beam direction was significantly below the configured maximum power, with the mean and 95th percentile values being 7.6% and 9.5%, respectively, of the maximum.

OS04-02

Exploratory analysis of 4G and 5G uplink RF-EMF exposure using network parameters in outdoor microenvironments in Belgium during a maximum uplink usage scenario

Mr Bram Stroobandt[1], Mr Han Van Bladel[1], Mr Samuel Goegebeur[1], Dr Sam Aerts[2], Mr Kenneth Deprez[1], Ms Leen Verloock[1], Miss Adriana Fernandes Veludo[3,4], Prof Martin Röösli[3,4], Prof Mònica Guxens[5], Prof Wout Joseph[1]

[1]Ghent University - imec, Ghent, Belgium. [2]The Hague University of Applied Sciences, Delft, Netherlands. [3]Swiss Tropical and Public Health Institute (Swiss TPH), Allschwil, Switzerland. [4]University of Basel, Basel, Switzerland. [5]ISGlobal, Barcelona, Spain

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave"]

Summary

In this study, a novel methodology using a mobile network monitoring application (QualiPoc) is used to analyse 4G and 5G uplink (UL) radiofrequency electromagnetic field (RF-EMF) exposure during a maximum UL usage scenario in a commercial mobile network. The measurements were performed in five different types of outdoor microenvironments in five areas in Belgium, classified by their degree of urbanization. Whereas microenvironmental studies typically only discuss environmental RF-EMF exposure, this study investigated the UL exposure distributions and frequency band usage, based on network parameters. Negatively skewed distributions of the 1-s-averaged transmit (Tx) power were found and multimodality was observed for the first time, where a combination of 4G and 5G UL frequency bands was present. The largest median 1-s-averaged Tx power of 22.0 dBm was found in the rural area, followed by suburban (21.5 and 20.0 dBm) and urban (20.2 and 19.0 dBm) areas.

OS04-03

Design of a low-cost triaxial 5G RF-EMF exposure sensor

Mr Jeroen Van der Straeten[1], Mr Han Van Bladel[1], Mr Kenneth Deprez[1], Prof Sam Aerts[1,2], Prof Günter Vermeeren[1], Prof Wout Joseph[1]

[1]Department of Information Technology, Ghent University / imec, Ghent, Belgium. [2]Smart Sensor Systems research group, The Hague University of Applied Sciences, Delft, Netherlands

Abstract Subject Area(s)

["RF/Microwave","Risk assessment"]

Summary

A low-cost monitoring network, to measure the radio frequency electromagnetic field (RF-EMF) exposure induced by 5G, is required for risk communication and to support biological research into adverse health effects related to 5G technologies. Two different low-cost triaxial 5G RF-EMF exposure sensors were developed, calibrated, and tested. The sensors have a novel isotropic measurement design and are able to measure the exposure induced by 5G communication in the n77 (3300-4200 MHz) frequency band. The sensitivity of the Triple ADC and the Simultaneous ADC based triaxial sensor is 0.12 V/m and 0.04 V/m, respectively. The sensors were tested in an indoor (commercial 5G network) and an outdoor environment (private 5G network). The maximum measured electric-field level induced by 5G (n77 band) was 0.65 V/m (500 m from a commercial base station) and 2.69 V/m (50 m from a private base station), respectively. A temporal analysis of the measurement data was also performed.

OS04-04

DEVIN 5G: How does personal Up-Link Exposimeter tackle 5G specificities?

Dr Taghrid Mazloum, Dr Serge Bories, David Dassonville, Laurent Lombard, Prince RAMAHEFA-ANDRY

CEA-LETI, Grenoble, France

Abstract Subject Area(s)

["Epidemiology","Experimental dosimetry","RF/Microwave","MM Waves"]

Summary

DEVIN is a miniature personal uplink (UL) exposimeter designed to fill two different goals: 1) for epidemiologists, it assesses the long-term evolution and diversity of electromagnetic field (EMF) exposure of a population; 2) for Telecom engineers, it is able to quantify the impact of a new technology or usage, on the UL exposure from the mobile. DEVIN is dedicated to i) measure the transmitted (Tx) power emitted by the mobile phones and ii) identify the mobile phone usage, including the relative position with respect to the human body. With 5G roll on, a new version of the in-situ exposimeter has been released (DEVIN5G). Additionally to six cellular and two WiFi bands, DEVIN5G supports also the new 5G band (3500 MHz) and new WiFi6E standard (6 GHz band). Moreover, it is able to detect scenarios of antenna switching, where the phone may emit signals using multiple antennas. At last, its thickness has been decreased to only 10 mm while its battery autonomy has been improved.

OS04-05

Case studies of RF exposure measurements from a 5G NR base station operating in the 28-GHz frequency band assuming maximum traffic

Mr Junji Higashiyama, Mr Yoshitoshi Tochikura, Dr Takahiro Iyama, Dr Yasunori Suzuki
6G Network Innovation Department, NTT DOCOMO, INC., Yokosuka, Kanagawa, Japan

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","MM Waves"]

Summary

This paper presents case studies of evaluating RF exposure level from a 5G NR base station operating in the 28 GHz-frequency band using the extrapolation and direct methods and proposes contents that should be improved in the future in IEC 62232 based on the experience obtained from the case studies. The extrapolation method is prescribed in IEC 62232, the direct method is the method based on frequency spectrum measurement in situations where intentionally high communication is maintained and the ratio of RF exposure levels obtained by the two methods at the evaluation location was 0.2 dB. Based on the experience of the case studies, to add two improvements are proposed. One is the consideration of the number of MIMO branches in the extrapolation method, and another is the measurement procedure that can avoid underestimation of RF exposure levels when isotropic receiving antennas cannot be used.

OS04-06

RF-EMF exposure assessment with add-on uplink exposure sensor in different microenvironments in three European countries

Mr Han Van Bladel[1], Mr Bram stroobandt[1], Ms Adriana Fernandes Veludo[2,3], Mr Kenneth Deprez[1], Prof Martin Röösli[3,2], Prof Monica Guxens[4], Prof Wout Joseph[1]
[1]Department of Information Technology, Ghent University / imec, Ghent, Belgium. [2]Swiss Tropical and Public Health Institute (Swiss TPH), Basel, Switzerland. [3]University of Basel, Basel, Switzerland. [4]ISGlobal, Barcelona, Spain

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","Occupational exposure"]

Summary

As new telecommunication technologies emerge, concerns regarding possible health effects by radiofrequency electromagnetic field (RF-EMF) exposure increase. Activity-based microenvironmental surveys, for 5G New Radio (NR) networks, are performed with a compact add-on monitoring sensor for smartphones in Belgium, Switzerland, and The Netherlands. It provides a low-cost and low-complexity solution for personal exposure assessment. The device is attached at a fixed position on a smartphone to quantify the auto-induced uplink (a-UL) transmission component of the total exposure. In-situ measurements were performed for three usage scenarios in a large city, a secondary city, and three villages. This is a pilot study for further research on any trends between different countries, cities, section of the cities, type of environments, and usage scenarios. For maximum uplink scenarios, where the mobile phone under test continuously performs an FTP upload, a highest median power of 18.8 dBm was measured in a village in The Netherlands. The median powers measured in Belgium and Switzerland were 16.0 dBm and 15.0 dBm respectively. This is 14,5 dBm, 14,4 dBm and 14,6 dBm higher than for the non-user scenarios for The Netherlands, Belgium and Switzerland respectively.

14:00 - 15:30	OS5 - Animal Studies	Hiroaki Myagi Rosella Rizzo	Hall 3

OS05-01

Improvement of cognitive performances via a compound rhythmic pulsed magnetic field in cognitive declined mice

Dr Pingping Wang[1], Dr Xue Wang[1,2], Dr Qingmeng Wang[1], Dr Xuting Wang[1,2], Ms Yangkun Jiao[1,2], Dr Changyou Chen[1], Dr Haitao Chen[1], Prof Tao Song[1,2]

[1]Beijing Key Laboratory of Bioelectromagnetism, Institute of Electrical Engineering, Chinese Academy of Sciences, Beijing, China. [2]University of the Chinese Academy of Sciences, Beijing, China

Abstract Subject Area(s)

["in vivo","Biological and medical applications"]

Summary

Rhythmic physical stimulations have emerged as effective noninvasive intervention strategies in the treatment of cognitive deficits. Transcranial magnetic stimulation (TMS) can improve learning and memory abilities of rodents or patients with cognitive deterioration. However, the effects on cognitive decline of elaborate magnetic stimulation with low intensity remain unclear. Based on the complexity of cognitive related rhythmic neural oscillations, herein we developed a compound pulsed magnetic field (CPMF) stimulation with a complex pattern in the theta repeated frequency and gamma carrier frequency, and determined the effects of this rhythmic CPMF on the cognitive function of D-galactose (D-gal) induced aging mice and transgenic model mice of Alzheimer's disease (AD). As to the accelerated aging mice, D-gal injected mice treated

with CPMF with a relative low intensity (10 mT), exhibited an enhanced learning and memory abilities compared with the sham exposed mice in Morris water maze (MWM) test, indicated as the shorter swimming latency time and more significant preference in the target area. The neuron degeneration in hippocampus upon D-gal injection, could also be partially rescued by CPMF application. Furthermore, in the 5×FAD mice, the cognitive performances of AD mice were also significantly improved and the Aβ depositions were alleviated especially by the early intervention with the CPMF. Conclusively, the compound PMF with a relative low intensity, could effectively improve the learning and memory abilities in different pathological mouse models, which might provide a new safe therapeutic strategy for cognitive deficits as well as other neurological disorders.

Is the work in progress?

Yes

OS05-02

The therapeutic effect of different intensities of alternating electric fields in melanoma

Miss Yue Lan, Prof Guangdi Chen
Department of Public Health, Zhejiang University School of Medicine, Hangzhou, China

Abstract Subject Area(s)

["in vivo"]

Summary

The alternating electric fields with specific intensity and frequency parameters have been developed as a non-invasive anti-tumor treatment strategy, named tumor treatment fields (TTFields) by Novocure ltd. The therapeutic efficacy of TTFields has been validated through clinical trials EF-11 and EF-14, specifically demonstrating positive outcomes in patients with glioblastoma. TTFields have received approval from the Food and Drug Administration (FDA) for clinical treatment in glioblastoma patients. Further exploration awaits to elucidate the anti-tumor effect and detailed mechanism of alternating electric fields on different tumors.

In this study, an alternating electric fields animal treatment device was established. A sine wave electrical power, with a voltage of 5 V and a frequency of 200 kHz, was administrated on treating the low-intensity group. Similarly, a voltage of 10 V, along with a frequency of 200 kHz, was applied to administer treatment to the high-intensity group in malignant melanoma models. Following treatment, an investigation was conducted to assess the impact of alternating electric fields on the tumor immune microenvironment. The results showed that alternating electric fields treatment significantly inhibited the progression of malignant melanoma with intensity-response. Furthermore, a noteworthy increase in the proportion of DC cells and T cells was found in the tumor microenvironment after alternating electric fields treatment, particularly cytotoxic T lymphocytes.

In conclusion, our data suggested that alternating electric fields exerted a potent inhibitory effect on the progression of mouse melanoma models, potentially inducing immune activation.

Is the work in progress?

Yes

OS05-03

Chondroprotective effects of rotating magnetic field on osteoarthritis in rats via the restoration of mitochondrial function

Dr Hua Yang[1], Dr Yunpeng Wei[2], Dr Umer Anayyat[2], Dr Wentao Zhang[3], Prof Xiaomei Wang[4]

[1]Magnetobiology Group, Department of Physiology, School of Basic Medical Sciences, Shenzhen University Medical School, Shenzhen University,, Shenzhen, China. [2]Magnetobiology Group, Department of Physiology, School of Basic Medical Sciences, Shenzhen University Medical School, Shenzhen University, Shenzhen, China. [3]Department of Sports Medicine, the Eighth Affiliated Hospital, Sun Yat-sen University, Shenzhen, China. [4]xmwang@szu.edu.cn, Shenzhen, China

Abstract Subject Area(s)

["Biological and medical applications"]

Summary

Osteoarthritis (OA) is a prevalent chronic degenerative joint disease characterized by cartilage deterioration. Mitochondrial dysfunction and apoptosis, both outcomes of oxidative stress, strongly correlate with OA. However, existing treatment approaches for OA face challenges due to varying side effects and limited effectiveness. Therefore, developing a safe and effective therapeutic strategy providing long-lasting relief for OA patients is imperative. This study investigates the potential of a non-invasive and moderately effective therapy known as the rotating magnetic field (RMF) for osteoarticular diseases. We investigated the effects of RMF (0.2 T, 4 Hz, 2 h/d) on the monosodium iodoacetate (MIA, 1.5 mg/50 μL)-induced OA rat model. RMF results in an improvement in the locomotor ability, an alleviation of cartilage erosion, an increase of antioxidant enzyme activity, and a reduction in the pro-inflammatory cytokine production of OA rats. The transcriptome sequencing and molecular pathological investigations of rat cartilage indicates that RMF reduces chondrocyte apoptosis and extracellular matrix degradation by regulating mitophagy through the activation of the 5' adenosine monophosphate-activated protein kinase (AMPK)-mTOR-Unc-51-like kinase 1 (ULK1) signaling pathway. Our study highlights the remarkable chondroprotective effects of RMF via facilitating mitophagy and ameliorating chondrocyte apoptosis. These findings underscore the potential of RMF as a promising clinical preventive and therapeutic strategy for OA and related conditions.

Keywords: Osteoarthritis; Rotating magnetic field; Apoptosis; Mitochondrial dynamics; Autophagy; Mitophagy

OS05-04

Impact of repeated head-exposures to a 5G-3.5GHz signal on behaviors and intracerebral gene expression in adult male mice

Ms Julie Lameth[1], Dr Juliette Royer[2], Ms Alexandra Martin[2], Dr Delia Arnaud-Cormos[3,4], Dr Philippe Lévêque[3], Dr Roseline Poirier[2], Dr Michel Mallat[1]

[1]Institut du Cerveau-Paris Brain Institute, ICM, Paris, France. [2]NeuroPSI - Institut des Neurosciences Paris-Saclay, Saclay, France. [3]XLIM - UMR 7252 CNRS, Limoges, France. [4]Institut Universitaire de France, Paris, France

Abstract Subject Area(s)
["in vivo"]
Summary
We have investigated behaviors and gene responses in adult mice submitted to daily 1h head-only exposures to 5G-3.5 GHz signal, 5 days per week over a six- week period, with an average brain SAR value of 0,18 W/kg. Locomotor activity in an open field, place memory and object recognitions were assessed repeatedly after four weeks of exposure and did not reveal any significant change in the locomotion, level of anxiety or memory skills, when comparing exposed and pseudo-exposed animals. Genome-wide mRNA profiling was carried out at the end of the exposure period in a cerebro-cortical area where the mean SAR value was maximal and reached 0.5 W/kg. Exposure to the 5G signal resulted in significant changes in the level of expression of 0.5% of the expressed genes, including a group of genes involved in mitochondrial functions. Together, our data show that repeated head-exposures to 5G-3.5GHz can trigger mild transcriptome alterations without obvious change in cognitive capacities or emotional state.

OS05-05
Characterisation of the Core Temperature Response of Free-Moving Rats to 1.95GHz Electromagnetic Fields
Mr Nathan Bala[1,2], Prof Rodney Croft[2,3], Dr Steve Iskra[4,5], Mr John Frankland[4], Mr Raymond McKenzie[4,6], Prof Chao Deng[1,2]
[1]University of Wollongong, School of Medical, Indigenous and Health Science, Wollongong, Australia. [2]Wollongong Bioelectromagnetics Laboratory, Wollongong, Australia. [3]University of Wollongong, School of Psychology, Wollongong, Australia. [4]Swinburne University of Technology, Department of Health & Medical Sciences, Hawthorn, Australia. [5]Telstra Limited, Melbourne, Australia. [6]Australian Mobile Telecommunications Association (AMTA), Canberra, Australia
Abstract Subject Area(s)
["in vivo","RF/Microwave"]
Summary
The present study investigated the core body temperature (CBT) response of free-moving adult male and female Sprague Dawley rats, during and following a 3-hour exposure to 1.95 GHz radiofrequency electromagnetic fields (RF-EMF) within custom built reverberation chambers, using temperature capsules implanted within the intraperitoneal cavity and data transmitted via radiotelemetry. Comparing RF-EMF exposures (at whole body average (WBA) specific absorption rate (SAR) levels of 0.1 W/kg, 0.4 W/kg and 4 W/kg) to the sham exposed condition, we identified a statistically significant peak in CBT after 26 minutes of RF-EMF exposure (WBA-SAR) at 4 W/kg (+0.49 °C) which remained for the remainder of the exposure period. Immediately before the end of exposure, CBT was significantly increased in the 0.4 W/kg and 4 W/kg conditions compared to the sham. Based on our findings, it is apparent that rats can effectively compensate for increased thermal loads at 4 W/kg WBA-SAR. In addition, the elevated CBT towards the end of the exposure period in the 4 W/kg condition was significantly reduced immediately after exposure cessation, indicating that measures of

CBT following RF-EMF exposure cessation may not reflect RF-EMF mediated changes in the CBT of rats.

OS05-06

Effect of 1950MHz whole-body radiofrequency electromagnetic field exposure on brown adipose tissue activity in C57BL/6 mice

Ms Emma Sylvester[1,2], Dr Jiamei Lian[1,2], Prof Chao Deng[1,2], Dr Robert McIntosh[3,4], Dr Steve Iskra[3,4], Mr John Frankland[3], Mr Raymond McKenzie[3,5], Prof Rodney Croft[2,6]
[1]University of Wollongong, School of Medical, Indigenous and Health Science, Wollongong, Australia. [2]Wollongong Bioelectromagnetics Laboratory, Wollongong, Australia. [3]Swinburne University of Technology, Department of Health and Medical Sciences, Hawthorn, Australia. [4]Telstra Limited, Melbourne, Australia. [5]Australian Mobile Telecommunications Association (AMTA), Canberra, Australia. [6]University of Wollongong, School of Psychology, Wollongong, Australia

Abstract Subject Area(s)

["in vivo","RF/Microwave"]

Summary

Recently, we have shown that a two-hour exposure to a high power (5 W/kg) whole body average (WBA) RF-EMF induces a small core body temperature (CBT) rise of approximately 0.3 °C in free-moving mice. The rise in CBT was evident primarily within the first 16 minutes of exposure, after which CBT reduced towards baseline, indicating mice are able to regulate the increased thermal load induced by RF-EMF exposure. It is not clear whether the expression of thermogenesis biomarkers within brown adipose tissue (BAT), a specialised tissue critical for the maintenance of CBT in mice, is affected by an acute high power RF-EMF exposure in mice. In this study, BAT samples were collected from male and female mice following a 2-h exposure to a 1.95 GHz RF-EMF (WBA SAR 5 W/kg) within custom-built reverberation chambers. RT-qPCR analysis was undertaken to examine the genetic expression of thermogenesis biomarkers. Preliminary tests have found that the relative mRNA expression of *Ppargc1a* and *Prdm16* was significantly higher following RF-EMF exposure (U=36.00, p=0.038 and U=28.00, p=0.011, respectively) compared to sham exposure, which may suggest that acute RF-EMF exposure can influence the expression of these genes. However, RT-qPCR analysis needs to be performed with another appropriate reference gene, and the effect of multiple comparisons on the statistics needs to be further considered before this finding can be confirmed.

Is the work in progress?

Yes

15:30 - 16:00	Coffee break	Athina
16:00 - 17:30	Poster Session A	Athina

001A

Modeling the Biological Effects of RF Exposure on Human Health Using Human Neural Organoids

Dr Courtney McMahon[1], Mr Sean Tritley[2], Dr Jorge Gomez[1], Dr Gleb Tolstykh[3], Dr Benjamin Kasukonis[2]

[1]General Dynamics Information Technology, San Antonio, USA. [2]Air Force Research Lab, San Antonio, USA. [3]General Dynamics Information Technology, san antonio, USA

Abstract Subject Area(s)

["In vitro","Mechanisms","Human studies","RF/Microwave"]

Summary

The exposure to radiofrequency electromagnetic fields (RF-EMF) is continually increasing with the advances in technology in recent years, particularly for service members working in close proximity to communication devices, radar, and even security scanning devices. Concern has been raised regarding the effects of exposure on human health, and more specifically, the central nervous system. An *in vitro* model system that has emerged in recent years is human stem cell-derived neural organoids (hNOs), which are three-dimensional (3D) cultures of specific regions of the human brain. These models display self-organization and, in many ways, have higher cellular and molecular accuracy to the *in vivo* human brain than alternative models, allowing for high-throughput studies of various neurological disorders. The effects of RF-EMF exposure on the human brain requires further investigation, thus, we propose to use hNOs to elucidate cellular and molecular effects following exposure to RF-EMF.

Is the work in progress?

Yes

003A

Investigation of the possibility of increasing the effectiveness of antitumor drugs by increasing the degree of their binding to tissues due to the effects of non-ionizing electromagnetic radiation

Dr Vitali Kalantaryan[1], Prof Radik Martirosyan[2], Prof Yura Babayan[3], Dr Ruzanna Khazaryan[1]

[1]Yerevan State University, Yerevan, Armenia. [2]Armenian National Academy of Sciences, Yerevan, Armenia. [3]Yerevan State Medic University, Yerevan, Armenia

Abstract Subject Area(s)

["In vitro","RF/Microwave","MM Waves","Biological and medical applications"]

Summary

A study on the use of non-ionizing and non-thermal millimeter electromagnetic radiation in tumor therapy was conducted. DNA released from sarcoma 45 tumor (DNA_t) and healthy rats (DNA_h) in water-saline solution was irradiated during 90 min by frequencies at both resonances for oscillations of water molecular structures (at 64.5 GHz and 50.3 GHz) and non-resonance (48.3 GHz). Non-irradiated and irradiated DNA_t and DNA_h binding constants with anti-tumors drugs doxorubicin (DX) and netropsin (NT) were studied. The absorption spectra of non-irradiated and irradiated complexes of DNA with DX and NT were obtained by spectroscopic method. From the absorption spectra, binding constants at 290K, 300K, and 310K temperatures have been determined. According to our calculations, doxorubicin and netropsin with irradiated DNA form were more stable complexes and much stronger with DNA_t irradiated at resonant

frequencies: selective binding of doxorubicin and netropsin was observed. For a DNA irradiation at resonant frequencies of 64.5 GHz and 50.3 GHz, the binding constant K to DX and to NT is almost an order of magnitude higher than for the non-irradiated DNA. The obtained data suggest that the irradiation of malignant tumors by non-thermal (extremely-weak intensity) millimeter electromagnetic waves in combination with anticancer drugs may be promising for clinical oncology. The same antitumor effect can be achieved at much lower doses of medicines (considerable dose reduction). This is essential from the point of view of the application of gentle therapies for patients and the reduction of expenses associated with acquisition of expensive medicines

Is the work in progress?

Yes

005A

Generation of Silent Voice Commands Based on High-Density Laryngeal Electromyography

Ms Yuanyuan Li[1], Ms Haoyue Wang[1], Mr Kaixiang Shen[1], Ms Siyao Chen[1], Prof Zheng Zhao[1], Dr Li Shi[2], Prof Hui Cao[1], Prof Jiangtao Li[1]

[1]Xi'an Jiaotong University, Xi'an, China. [2]Xijing Hospital, Xi'an, China

Abstract Subject Area(s)

["In vitro","Mechanisms","Biological and medical applications"]

Summary

Laryngeal electromyography (LEMG) signal is an important bioelectrical signal that has attracted widespread attention in the field of pattern recognition. Due to the influence of electrode placement and number, traditional surface electromyography cannot accurately reflect the activity information of the motor unit. Therefore, the aim of this study was to propose a method for generating silent voice commands based on high-density array electrodes. In this experiment, a kind of ionic gel with wide mechanical properties is used as the conductive medium to collect the laryngeal muscle electrical signals using the high-density flexible FPC signal acquisition electrode, and the classification algorithm and model optimization algorithm are combined to realize the recognition of silent voice instructions. The results indicated that compared with traditional electrodes, high-density electrodes have higher spatiotemporal resolution and can achieve high accuracy and real-time recognition of silent voice commands. This provides a good research foundation for studying the mechanism of speech generation and achieving silent speech recognition.

Is the work in progress?

Yes

007A

Investigating Free-Field Temporal Interference in an In Vitro Neuronal Preparation

Ms Mikayla Rincon[1], Dr Allen Kiester[2], Dr Aryana Cruz Santory[1], Dr Joel Bixler[2], Dr Jeffrey Whitmore[2]

[1]General Dynamics Information Technology, San Antonio, USA. [2]Radio Frequency Bioeffects Branch, Air Force Research Laboratory, San Antonio, USA

Abstract Subject Area(s)

["In vitro","RF/Microwave","Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

Temporal interference in neurons is a technique in which electric fields are slightly offset to create a focal, low frequency electric field. Temporal interference has been used to stimulate deeper brain regions with minimal excitation of overlying cortex, which represents a potential advancement in the treatment of severe neurological disorders. The present study sought to determine if temporal interference-based stimulation could be generated by free-field exposures in an *in vitro* cell preparation. Cells were exposed to two sinusoidal oscillating electric fields generated by a pair of parallel plate electrodes operating at 7 kHz with 0° phase shift and 6.9 kHz with a 180° phase shift and a power of ~187.5 W. Fluorescent dye was used to evaluate changes in calcium activity within cells during exposures. The study found no change in calcium activity with free-field exposures, indicating that direct contact with the electrodes may be necessary for temporal interference and reliable modulation of cell activity.

009A - Withdrawn

011A

Visualizing monopolar generation in cells exposed to bipolar waveforms by quadrature electrodes

Dr Bennett Ibey[1], Dr Iurii Semenov[2], Dr Allen Kiester[3], Prof Andrei Pakhomov[2], Dr Joel Bixler[3]

[1]Air Force Office of Scientific Research, San Antonio, TX, USA. [2]Frank Reidy Research Center for Bioelectrics; Old Dominion University, Norfolk, VA, USA. [3]Air Force Research Lab, San Antonio, TX, USA

Abstract Subject Area(s)

["In vitro","Electroporation and pulsed electric field applications"]

Summary

Application of intense micro- and millisecond duration electric pulses to cells can induce electroporation enabling uptake of otherwise impermeable material (plasmids, toxins) through the plasma membrane. Nanosecond duration electric pulses have been shown to cause a myriad of cellular effects, ranging from subtle changes in permeabilization of small ions to electroporation of cellular membranes based on the exposure intensity. One critical limitation to using nanosecond electric pulse stimulation is controlling the precise location and depth of exposed cells. Recently, it was shown that bipolar nanosecond duration pulses are significantly less effective at inducing effects in cells. This discovery opened the door to creative pulse sequences using more than two electrodes to generate spatially precise nanopermeabilization by bipolar pulse mixing (creating monopolar equivalents in space). Previously, our team verified the utility of strobe photography for tracking the charging of cells in repeated sinusoidal electric fields generated by a pair of tungsten electrodes. Through repeated non-destructive imaging, we were able to reconstruct the charging and discharging of the plasma membrane of CHO cells labeled with FluoVolt. This reconstruction was validated against existing single shell membrane charging models giving us confidence that we were able to visualize plasma membrane charging dynamics in “real time”. In this paper, we

deployed strobe photography to better understand the cellular dynamics of bipolar waveform mixing using 4 electrode stimulation.

013A

The effect of 50 Hz MFs on DNA damage in senescent human fetal lung fibroblasts

Miss Zhu Longtao[1], Mr Sun Chuan[2], Mrs Wei Xiaoxia[3], Mr Mao Genxiang[2], Prof Chen Guangdi[1]

[1]Bioelectromagnetics Laboratory, Zhejiang University School of Medicine, Hangzhou, China. [2]Zhejiang Provincial Key Lab of Geriatrics & Geriatrics Institute of Zhejiang Province, Department of Geriatrics, Zhejiang Hospital, Hangzhou, China. [3]Sir Run Run Shaw Hospital, Zhejiang University School of medicine, Hangzhou, China

Abstract Subject Area(s)

["In vitro","ELF/LF"]

Summary

Objective: To investigate the effect of 50 Hz magnetic fields (MFs) on DNA damage in senescent cells. **Methods:** Senescent human fetal fibroblasts were exposed to 50 Hz MFs at 0.4, 0.7, and 1.0 mT for 24 h. After exposure the DNA fragmentation were determined by alkaline comet assay. **Results:** Exposure to 50 Hz MFs at 0.4 or 0.7 mT significantly decreased DNA fragmentation while exposure to 50 Hz MFs at 1.0 mT significantlyincreased DNA fragmentation in senescent cells. **Conclusion:** Exposure to 50 Hz MFs at low-intensity have an effect in inhibiting DNA damage while high-intensity have an effect in inducing DNA damage in senescent cells.

Is the work in progress?

Yes

015A

Near-field wire-probe as THZ sensor to detect collective oscillations of biomolecules

Mr Tristan Béranger[1], Dr Sandra Ruffenach[2], Mr Laurent Bonnet[2], Prof Frederic Teppe[2], Prof Jeremie Torrès[1]

[1]Institut d'Electronique et des Systèmes (IES), Université de Montpellier, CNRS, Montpellier, France, Montpellier, France. [2]Laboratoire Charles Coulomb (L2C), Université de Montpellier, CNRS, Montpellier, France, Montpellier, France

Abstract Subject Area(s)

["In vitro","Mechanisms","MM Waves","Biological and medical applications"]

Summary

Although collective oscillations of macromolecules have long been theorised, Preto et al have recently shown that the non-linear internal couplings between the normal modes of the protein cause it to undergo a phase transition only when the rate of energy input exceeds a threshold, i.e., when the proteins are driven out of thermodynamic equilibrium. This transition takes place from a state where the energy is distributed incoherently between the normal modes to a state where the energy is channelled into the lowest frequency mode, leading to a coherent oscillation of the whole molecule in the THz frequency range (phonon condensation state). Misunderstandings of the theoretical formalism, lack of experimental methods, and water strong absorption in this frequency range complicated the observation of spectral signatures of these

oscillations. Confirmation of this phenomenon has therefore only recently been demonstrated using complementary THz and fluorescence correlation spectroscopies on BSA proteins. This study led to the development of a new experimental THz near-field probe. It consists of a metallic micro-wire inserted into a rectangular waveguide connected to a spectrum analyser. THz waves (70-110 GHz range) are focused on the protein solution and the absorption spectra are recorded. The characterisation of our near-field probe was carried-out by comparing our results with those already obtained using a field-effect transistor (FET) as a local sensor, on R-PE proteins. The three states of the phase transition (equipartition, transition and condensation) were reproduced with our new device and the behaviour of the power threshold was highlighted.

Is the work in progress?

Yes

017A

Study of genotoxic and cytotoxic effects in human dermal fibroblasts exposed to 1.6 GHz with pulsed and continuous waves

Dr Luca Massaro[1,2], Dr Stefania De Sanctis[1], Dr Valeria Franchini[1], Dr Elisa Regalbuto[1], Dr Gaetano Alfano[1], Dr Chiara Focaccetti[2], Dr Monica Benvenuto[2], Prof Loredana Cifaldi[2], Prof Antonella Sgura[3], Dr Francesco Berardinelli[3], Dr Jessica Marinaccio[3], Dr Federica Barbato[3], Prof Laura Masuelli[4], Dr Daniela Nardozi[4], Prof Roberto Bei[2], Dr Florigio Lista[1]
[1]Defence Institute for Biomedical Sciences, Rome, Italy. [2]University of Rome "Tor Vergata"- Department of Clinical Sciences and Translational Medicine, Rome, Italy. [3]University of Rome "Roma Tre"- Department of Science, Rome, Italy, Rome, Italy. [4]University of Rome "La Sapienza"- Department of Experimental Medicine, Rome, Italy, Rome, Italy

Abstract Subject Area(s)

["In vitro","RF/Microwave"]

Summary

The increasing proliferation of radiofrequency (RF) sources, spanning from everyday household devices to citywide telecommunication infrastructure/personal mobile phones and military installations, heightened concerns about potential health risks of exposure among international policy authorities and general public. Thermal effects of electromagnetic fields (EMFs) are widely acknowledged, while non-thermal effects remain a debated topic within scientific community for the conflicting results probably due to lack of characterized exposure system/conditions, different cell/animal models and methodologies used and flawed experimental design. Moreover, the biological impact associated with different modulations of the RF signal, such as continuous (CW) and pulsed waves (PW), remains poorly explored.

This study aims to provide an overview on non-thermal biological effects in human dermal fibroblasts (HDF) exposed to 1.6 GHz both CW and PW waves for 2 hours, at a specific absorption rate (SAR) of 0.4 W/kg. To investigate both cytotoxic and genotoxic effects, a multi-methodological approach was employed, including γ-H2AX/53BP foci , Micronuclei-CREST, chromosome mis-segregation, mitotic spindle, cell cycle, ultrastructural and protein expression analyses. Results are reported and discussed.

019A

Evaluation of stimulus responses under power-frequency electric fields exposure on calcium oscillation in human cortical spheroid

Dr Atsushi Saito[1], Dr Takeo Shiina[2], Mr Yoichi Sekiba[3]
[1]CRIEPI, Chiba, Japan. [2]CRIEPI, Kanagawa, Japan. [3]DCC, Tokyo, Japan

Abstract Subject Area(s)

["In vitro","Mechanisms"]

Summary

Low-frequency (1 Hz to 100 kHz) electric or magnetic fields induce electrical excitation of neuronal tissues. However, the stimulus thresholds and mechanisms on the neuronal modulation in nervous system remains uncertain. Here, we evaluated changes in neuronal network activity during electric fields (EFs) exposure by measuring intracellular calcium ([Ca2+]i) oscillations to precisely assess changes in the neuronal network activity. We used a human cortical spheroid (hCS), which is a three-dimensional cultured neuronal network generated from human induced pluripotent stem cell (hiPSC)-derived cortical neurons. High-intensity and 50 Hz sinusoidal wave EF exposure caused a direct modulation of [Ca2+]i oscillations in hCS. The stimulus effects were related to both EF exposure intensity and duration, with threshold value was over 250 V/m for peak values in hCS. Therefore, our results suggest that three-dimensional neuronal networks may be more robust to EF exposure than single neuron.

Is the work in progress?

Yes

021A

Why Alzheimer is a research topic for the BfS

Dr Felix Meyer[1], Dr Blanka Pophof[2], Dr Cornelia Sauter[3], Dr Julian Hellmann-Regen[4], Prof Heidi Danker-Hopfe[3], Dr Gunde Ziegelberger[2]
[1]Federal Office for Radiation Protection (BfS), Department Effects and Risks of Ionizing and Non-ionizing Radiation, Cottbus, Germany. [2]Federal Office for Radiation Protection (BfS), Department Effects and Risks of Ionizing and Non-ionizing Radiation, Munich, Germany. [3]Charité, Competence Center for Sleep Medicine, Berlin, Germany. [4]Charité, Clinical Neurobiology Lab, Berlin, Germany

Abstract Subject Area(s)

["In vitro","Human studies","ELF/LF"]

Summary

Alzheimer's disease (AD) is the most frequent cause of dementia. It is characterized by a progressive loss of cognitive functions. The most conspicuous pathological changes in AD are aggregations of protein plaques and tangles, leading to neurodegeneration. Among many risk factors, epidemiological studies found associations between low frequency magnetic field (LF-MF) exposure and i) low quality of sleep, which is a risk factor for AD and ii) a weak, but consistent evidence for an association between occupational LF-MF-exposure and an increased risk to develop AD. To investigate these possible associations, the BfS initiated two research projects: i) an experimental study in humans on the effects of LF-MF exposure on sleep and markers of AD. Briefly, the n= 40 participants are exposed to 1 and 30 microtesla (µT) or sham exposed during night time. Sleep parameters are documented, biomarkers for sleep and AD in the plasma and

urine are measured and memory consolidation is tested. ii) A cell culture study on the effects of LF-MF exposure on the development of AD. Briefly, human cell culture models of neuronal cells are exposed *in vitro* for 2 - 120h to 16 Hertz (Hz) and 50 Hz with exposure levels of 0 μT, 0.04 μT and 200 μT reference value at 50 Hz under controlled laboratory conditions. After exposure, protein and mRNA expression of AD associated factors, as well as oxidative stress, are measured. The concepts of both studies will be presented and discussed.

Is the work in progress?

Yes

023A

HnRNPA2B1-Mediated Trkb m6A-Dependent Downregulation of BDNF Contributes to Cognitive Dysfunction Post-Microwave Radiation

Dr Weijia Zhi, Prof Lifeng Wang, Prof Xiangjun Hu
Beijing Institute of Radiation Medicine, Beijing, China

Abstract Subject Area(s)

["in vivo","Mechanisms","RF/Microwave","Biological and medical applications"]

Summary

In the face of pervasive natural and anthropogenic electromagnetic fields, concerns about their impacts on human health, particularly cognitive functions, have escalated. This study focuses on the effects of microwave radiation, with frequencies ranging from 300 MHz to 300 GHz, on the hippocampal dentate gyrus (DG) region, pivotal for mood regulation and memory. We investigate how microwave radiation influences synaptic plasticity in this area, potentially leading to cognitive impairments. Our research reveals that microwave exposure disrupts the normal function of hippocampal neurons and neural stem cells (NSCs), particularly affecting the proliferation and differentiation of NSCs. Central to our findings is the role of Heterogeneous nuclear ribonucleoprotein A2B1 (hnRNPA2B1) in this process. hnRNPA2B1, by recognizing and binding to m^6A-modified Trkb mRNA, maintains its stability. Microwave radiation, however, compromises this mechanism, leading to decreased Trkb mRNA stability and, subsequently, reduced brain-derived neurotrophic factor (BDNF) expression through negative feedback. These molecular changes contribute to the observed cognitive dysfunctions. Our study provides insights into the genetic and molecular underpinnings of microwave radiation-induced cognitive impairments, offering potential targets for prevention and treatment.

Is the work in progress?

Yes

025A

Non-thermal electro-sterilization of Streptococcus mutans from temperature-time product point of view.

Mr Atsushi Matsuoka[1], Prof Masatake Akutagawa[1], Prof Hiromichi Yumoto[2], Prof Minato Akizuki[2], Prof Takahiro Emoto[1], Prof Hiroo Tarao[3], Prof Toshihiko Tominaga[4], Prof Eiichirou Tada[4], Prof Toshitaka Ikehara[5], Prof Emiko Yasuno[6], Prof Yohsuke Kinouchi[1]
[1]Faculty of Science and Technology, Tokushima University, Tokushima, Japan. [2]Division of Oral Science, Graduate School of Biomedical Sciences, Tokushima, Japan. [3]National

Institute of Technology, Kagawa College, Takamatsu, Japan. [4]Tominaga Dental Clinic, Naruto, Japan. [5]Department of Human Welfare, Faculty of Health and Welfare, Tokushima Bunri University, Tokushima, Japan. [6]National Institute of Technology, Anan College, Anan, Japan

Abstract Subject Area(s)

["In vitro","Biological and medical applications"]

Summary

The Electro-Magnetic Apical Treatment was proposed as treatment of the apical periodontitis. However, the sterilization mechanisms and optimal conditions for electrical stimulation in the treatment have not been clarified sufficiently. This study compares the sterilization effectiveness of heat and electric sterilization under similar temperature-time product conditions and investigates the presence of non-thermal effects. As results of the experiments, no non-thermal effect that would promote the sterilization effect could be confirmed under the current electrical conditions.

Is the work in progress?

Yes

027A

Characterization of a reverberation chamber-based 5G *in vitro* exposure system: a biological perspective

Dr Anna Sannino[1], Dr Mariateresa Allocca[1], Dr Stefania Romeo[1], Dr Maria Rosaria Scarfì[1], Dr Gaetano Chirico[2], Prof Fulvio Schettino[2], Dr Olga Zeni[1]

[1]National Research Council of Italy (CNR), Institute for Electromagnetic Sensing of the Environment (IREA), Naples, Italy. [2]Department of Electrical and Information Engineering "Maurizio Scarano" (DIEI), University of Cassino and Southern Lazio, Cassino, Italy

Abstract Subject Area(s)

["In vitro","RF/Microwave"]

Summary

The potential biological and health impact of the new radiofrequency electromagnetic fields (RF-EMF) exposure scenario due to the deployment of 5G technologies has been attracting increasing attention and deserves to be carefully analysed. In this respect, *in vitro* studies deserve particular attention since they allow to corroborate evidence and provide biological plausibility to other types of studies, given that the quality of the study design, exposure assessment methods, and biological assay validity is carefully addressed.

Here we present the results of the characterization of a reverberation chamber-based exposure system for *in vitro* exposure to 5G signal by using two chambers in sham-configuration. Specifically, we used a reverberation chamber that has been designed, manufactured, and characterized by the University of Cassino for *in vitro* exposures at 26.5 GHz. Experiments were carried out in two different human cell models, neuroblastoma (SH-SY5Y) and keratinocytes (HaCaT) cells, to assess the eventual impact of the environmental conditions inside the chambers. In particular, sample volume reduction and pH value have been considered as environmental parameters, whereas viability and cell cycle progression were evaluated to test the metabolic status of cell cultures, having samples in a cell culture incubator as reference control.

The results indicate that, after 24 h the reverberation chamber environment does not affect sample volume and pH, as well as does not induce cytotoxicity in two different cell types. The lack of effects confirms the suitability of the reverberation chamber-based exposure system for its use in bioelectromagnetic experiments.

029A

Improvement of *in vitro* Test Protocol for Evaluation of Biological Effects by Exposure to Extremely High Frequency Electromagnetic Field

Dr Masateru Ikehata[1], Dr Toshio Kamijyo[2], Dr Alfred Kik[2], Mrs Aki Hada[2], Dr Sachiko Yoshie[1], Dr Akira Ushiyama[3], Prof Kenji Hattori[4], Prof Keiji Wada[2], Prof Yukihisa Suzuki[2]
[1]Railway Technical Research Institute, Tokyo, Japan. [2]Tokyo Metropolitan University, Tokyo, Japan. [3]National Institute of Public Health, Saitama, Japan. [4]Meiji Pharmaceutical University, Tokyo, Japan

Abstract Subject Area(s)

["In vitro"]

Summary

In this study, we improved the in vitro test protocol for evaluation of the biological effects of 28 GHz electromagnetic fields for long exposure duration to apply jigs to fix samples to exposure site and wider input power range by inhouse software. This improvement caused increasing accuracy and reproducibility of millimetre exposure in wider range and long duration keeping from contamination of test samples.

Is the work in progress?

Yes

031A

On Electromagnetic Stimulation in Biomanufacturing – Optimisation Using Fluorescent Reporters as a Proxy for Productivity

Ms Afra Alkatheeri, Prof Alistair Elfick
University of Edinburgh, Edinburgh, United Kingdom

Abstract Subject Area(s)

["Mechanisms","Biological and medical applications"]

Summary

The endless pursuit for process optimization in biotechnology has fuelled tremendous efforts in research toward the development of innovative approaches. The use of electromagnetic fields (EMF) coupled with bioreactors has emerged as a promising technology to boost cellular performance in a low cost, environmentally friendly manner. Our limited understanding of field parameters interplay in electromagnetic based treatment is one of the causes for the delayed maturation of industrial scale applications. Grasping its effect on the cell metabolic state is desirable yet challenging credited to the complexity of biology and lack of developed characterization tools. Hence, the proposed method for tracking intracellular behaviour through genetically encoded fluorescent tagging. Fluorescence embedded yeast subjected to the application of oscillating magnetic fields with paramagnetic particles will be inspected for their protein expression levels while varying frequency, intensity, and exposure period, and testing for treatment effect longevity. An incubating microplate reader was used to assess cell density and fluorescence of treated cells and controls. Pilot results show

potential for fluorescent tagging paired with spectrophotometry for the study of magnetobiological response.

Is the work in progress?

Yes

033A – Withdrawn

035A

CAN A CAPACITIVELY COUPLED ELECTROSTATIC FIELD AFFECT CELL MIGRATION IN VITRO?

Dr Isabella Zironi[1], Prof Tobias Cramer[1], Dr Alessandro Fuschi[1], Dr Giacomo Giuliani[1], Dr Maria Calienni[1], Dr Laura Caramazza[2], Prof Micaela Liberti[2], Prof Francesca Apollonio[2], Prof Daniel Remondini[1], Prof Gastone Castellani[1]

[1]Department of Physics and Astronomy "Augusto Righi" (DIFA), Alma Mater Studiorum University of Bologna, Bologna, Italy. [2]BioEM Lab, Department of Information Engineering, Electronics and Telecommunications (DIET), Sapienza University of Rome, Roma, Italy

Abstract Subject Area(s)

["In vitro","Mechanisms","Numerical dosimetry","Biological and medical applications"]

Summary

The cellular motility is essential to realize and maintain multicellular organisms throughout their lifespan. Migrating cells can move either individually or collectively by a crawling movement which interconnects the cytoskeletal activity to the adhesion surface generating traction forces at the extracellular matrix interface. The onset of a static potential of about 35 V between the externally placed positive and ground electrodes generated two different electric fields (E-Fields), which, using a numerical dosimetry analysis are identified as: i) a strong E-field generated across dielectric substrates with a uniform intensity distribution of about 10^3 V/m; ii) a small continuous ionic current at the culture medium level due to a residual charge density flowing through non-null conductivity of the humid air, having a spatial and material-dependent distribution ranging from 0.02 up to 0.12 V/m. The scratch assay was performed on a glioma cells line to test the effects of these electrical stimulations on cell's migration, resulting in a boosted motility in those population crawling on polystyrene surfaces. Our results do not support the hypothesis of a directionality effect. This work demonstrated that C-Coupled system exposed to a DC stimulus can generate forces capable of influence cell behavior if dielectric materials such as polystyrene are present on which the cells are interfaced.

037A

Effects of Extremely Low Frequency Weak Magnetic Fields Superimposed on Geomagnetic Field on HT-1080 Fibrosarcoma Cells

Nhat Dang[1], Marek Bajtos[2], Dr Hakki Gurhan[1], Prof Frank Barnes[1]

[1]University of Colorado Boulder, Boulder, USA. [2]University of Zilina, Zilina, Slovakia

Abstract Subject Area(s)

["In vitro","Mechanisms","ELF/LF","Biological and medical applications"]

Summary

Fibrosarcoma, an aggressive form of soft tissue cancer, has demonstrated interactions with electromagnetic fields (EMF), particularly within the low frequency spectrum such as radio waves. Modeling cancer cells as feedback systems with time delays and considering nuclear spin coupling as potential modifiers for chemical reaction rates, their interaction with extremely low frequency (ELF) and low energy magnetic fields can be predicted. This study aims to investigate the effects of weak magnetic fields at extremely low frequencies superimposed on a geomagnetic field background on the growth rate of in vitro fibrosarcoma cultures. High-permeability metal enclosures are utilized to eliminate unaccounted environmental electromagnetic fields within the low frequency range. The experiments reveal that reversing the orientation of the applied static field relative to the geomagnetic magnitude along the vertical axis similarly affects growth rates across various frequencies of the alternating field. Notably, altering the frequency of the alternating magnetic field, rather than the amplitude, can significantly impact fibrosarcoma growth rates, with shifts as small as 0.25 Hz resulting in transitions between acceleration and inhibition. Furthermore, investigation into mitochondrial calcium and superoxide levels at frequencies associated with accelerated growth reveals an overall reduction in both quantities, albeit to varying degrees. These observations suggest the existence of a permanent dipole within cancer cells, likely resulting from adherent culturing conditions, and their sensitivity to minor frequency changes due to multiple oscillatory biochemical pathways.

Is the work in progress?

Yes

039A

Evaluating sleep architecture with mmW radar

Dr Tongning Wu, Dr Congsheng Li
China Academy of Information and Communications Technology, Beijing, China

Abstract Subject Area(s)

["Human studies","MM Waves","Biological and medical applications"]

Summary

Sleep architecture consists of awake (N0), non-rapid eye movement (N1–N3), and rapid eye movement sleep. N3 is the most recuperative sleep period and is often indicative of high-quality sleep. Therefore, deciphering the individual stage is important to evaluate the sleep quality.

Polysomnography /EEG has been used to staging the sleep however the contacting with the patients resulted in many concerns. FMCW mmW radar can detect the heat pulse and breath rate without any contact with the body. As the correlation of these physiological signals with the respective sleep stages has been revealed, researchers attempted to stage the sleep with FMCW mmW radar. The principle was to computed the phase difference of between the emitting and the reflective frequency modulated continuous signals, which was related to the intricate move motion by respiration and heartbeat.

The study proposed the development of the radar system as well as the signal processing algorithms. The first novelty of the algorithm was the elimination of the interference by static clutter, random body motion signals and respiratory harmonics using moving target detection (MTD). The second novelty of the study was the

separation of respiratory and heartbeat signals by the IIR filter after the target phase difference signal was extracted by phase unwinding. The third novelty was the extraction and estimation of the respiratory and heartbeat signals by the vibrational mode decomposition and multi-signal classification (VMD-MUSIC). The experimental results showed that the proposed algorithm demonstrated good performance in sleep staging and the robustness of the system.

Is the work in progress?

No

041A

Delayed growth in immature male rats exposed to 900MHz radiofrequency.

Mr Raphaël Bodin[1,2], Mr Franck Robidel[1], Mrs Stéphanie Rodriguez[1], Mr Anthony Lecomte[1], Dr Anne-Sophie Villégier[1,2]

[1]INERIS, Verneuil-en-Halatte, France. [2]UPJV PERITOX UMR_I 01, Amiens, France

Abstract Subject Area(s)

["in vivo","RF/Microwave"]

Summary

People have been exposed to the 900 MHz mobile phone electromagnetic field for approximately 30 years, with the 2nd generation (2G) Global System for Mobile communications (GSM) network. However, there is still no conclusion from immature rodent experiments regarding the potential effects of nonthermal radiofrequency (RF) 900 MHz continuous waves exposure during the biological development. Here, we aimed to test the hypothesis that when mother rats received a whole-body SAR occupational limit of the International Commission on Non-Ionizing Radiation Protection for human (0.4 W/kg) clinical growth and development was impacted in the descendant, with less (or no) effect at public limit (0.08 W/kg). Sprague Dawley pregnant rats (mothers, M) whole body SAR of 0.4 W/kg and 0.08 W/kg were reached with 30.2 V/m electric field (PEF) and 67.5 V/m electric field (OEF) for 330 g body weight. Exposure was 8 h/day from gestational day 8 until postnatal day 21 (n = 8-9/group). The neonate males showed earlier pinna ear detachment only for OEF group and earlier eye opening only for the PEF exposed group compared to the sham. Compared to the sham-exposed and to the PEF exposed males, the OEF exposed juvenile males showed lower body weight until adolescence. Both OEF and PEF RF-exposed females groups showed earlier pinna ear detachment and eye opening but similar bodyweight compared to the sham-exposed females. The present study suggested that pre- and post-natal exposure to 900 MHz continuous waves at human levels of occupational and general public level led to clinical effects in the neonatal and adolescent rats.

Is the work in progress?

Yes

043A

Non-Invasive Specific Absorption Rate Reconstruction Using Translated Spherical Wave Expansion and Inverse Equivalent Current Method

Dr Zain Haider, Prof Joe Wiart

Telecom Paris, Palaiseau, France

Abstract Subject Area(s)

["Experimental dosimetry","Numerical dosimetry","RF/Microwave","Standards and public health policy"]

Summary

Human exposure to radiofrequency electromagnetic fields is characterized by specific absorption rate (SAR). The arrival of 5G and MIMO technologies have made conventional SAR measurement a very lengthy process. Although, non-invasive SAR measurements techniques are faster, they are plagued by SAR reconstruction errors due to the coupling between device under test (DUT) and phantom. The aim of this work was to reduce SAR reconstruction errors by taking into account DUT/phantom coupling. In this approach, the origin of the measurement sphere enclosing patch antenna (@1.8 GHz) and phantom was translated to enclose only the patch antenna using translated spherical wave expansion. The translated spherical modes were subsequently filtered based on the patch antenna minimum sphere. The resulting near field was used to generate a Huygens box (MVG INSIGHT) which is in turn was imported in a full wave simulation software (CST Microwave Studio) to reconstruct SAR. The SAR reconstruction errors were 31% (patch antenna alone) and 15.1% (patch antenna and phantom) compared to the full wave simulations. The SAR reconstruction errors were improved by roughly 50% compared to the approach which didn't take into account the effect of phantom/DUT coupling. The proposed method is attractive for rapid pre-compliance SAR assessment of modern communication devices.

Is the work in progress?

Yes

045A

LEVELS AND DETERMINANTS OF RECEIVED SIGNAL STRENTHS INDICATORS DURING EVERYDAY LIFE ACTIVITIES IN CALVADOS, FRANCE

Dr Isabelle Deltour[1], Mrs Elsa Lubart[1], Mrs Monika Moissonnier[1], Dr Emmanuelle Conil[2], Dr Olivier Dejardin[3], Dr Anke Huss[4], Dr Joe Wiart[5], Dr Joachim Schüz[6], Dr Florence Guida[6]

[1]IARC/WHO, LYON, France. [2]ANFR, Maisons-Alfort, France. [3]CHU Caen, CAEN, France. [4]IRAS, Utrecht, Netherlands. [5]Telecom Paris, Palaiseau, France. [6]IARC/WHO, Lyon, France

Abstract Subject Area(s)

["Epidemiology"]

Summary

The Smartphones study aims at estimating exposure to radiofrequency electromagnetic fields (RF-EMF) from mobile telephony in France by measuring indicators of RF-EMF exposure levels of 300 volunteers in 4 departments. In this first analysis, we explore the variability of the received signal strength indicators (RSSI) from 4G signals collected in one center.

From November 2022 to January 2023, we recruited volunteers using Android smartphones in Calvados. Sociodemographic information, smartphone brand and operator were collected during an interview. Participants' smartphones were equipped with the XMobiSensePlus App recording timestamped RSSI power levels (in decibel-milliwatts dBm) of the LTE network, and GPS coordinates, for one week. Geocoded information on RF-EMF emitters were obtained from ANFR's cartoradio website and population densities from French Institute on Statistics and Economical Studies. Statistical analysis used mixed models.

73 participants (53% women, 18-78 years old) were monitored for 5.1 days on average (994,567 observations, on average every 30 seconds). There were subscribed to the 4 French operators, and most (70%) had smartphones of the same brand. Average LTE-RSSI level was 80.6 dBm [IQR: -93 dBm; -69 dBm]. In mutually adjusted models, larger distance to the closest antenna was associated to decreased RSSI, higher population density and daytime (vs nighttime) to increased RSSI, though it explained a small fraction of the RSSI's total variability. Age, sex, operator, and brand were not significantly associated to RSSI.
In this analysis of the RSSIs, participants' levels were qualified as fair on average, according to the classification proposed by Brzozeck and colleagues.

047A

Investigation of the acute effects of 50 Hz magnetic fields on ischemia of the lower limb and the hand in a more prolonged immobilized sitting posture

Dr Hideyuki Okano[1], Ms Hiromi Ishiwatari[2], Prof Keiichi Watanuki[1,3]
[1]Advanced Institute of Innovative Technology, Saitama University, Saitama, Japan. [2]Soken Medical Co., Ltd., Tokyo, Japan. [3]Graduate School of Science and Engineering, Saitama University, Saitama, Japan

Abstract Subject Area(s)

["Human studies","ELF/LF","Biological and medical applications"]

Summary

Many people in Japan have used 50/60 Hz magnetic field (MF) therapy devices to alleviate the symptoms of edema without special attention. These devices were reported to be effective in relieving edema, by which blood circulation is expected to be increased. Previously we suggested that 50 Hz MFs (B_{max} 180 mT for 10 min) could improve the circulatory disturbance in the lower limb. In this study, we examined the acute effects of 50 Hz MFs on the recovery of cutaneous blood flow volume in the lower limb and hand of healthy male adults in a more prolonged immobilized sitting posture for 70 min. The blood flow volume in the calf and palm was significantly reduced from baseline immediately after tourniquet compression. Reperfusion was induced when tourniquet pressure was released after ischemia. Calf and foot exposure to MFs significantly recovered the change rate of blood flow volume relative to sham control. In addition, hand and arm exposure to MFs also significantly recovered the change rate of blood flow volume compared with sham control. The regional MF exposure returned the blood flow volume to baseline significantly faster than the sham control and the effect lasted for several minutes examined in this period. These results suggest that MFs improve the ischemia caused by circulatory disturbance.

Is the work in progress?

Yes

048A

Case study on personal exposure to RF-EMF in educational microenvironments in Hungary

Dr Zsuzsanna Vecsei[1], Ms Adriana Fernandes Veludo[2,3], Mr Péter Pál Necz[1], Mr Kenneth Deprez[4], Mr Bram Stroobandt[4], Mr Han Van Bladel[4], Prof Mònica Guxens[5], Prof Wout Joseph[4], Prof Martin Röösli[2,3], Dr György Thuróczy[1]

[1]National Center for Public Health and Pharmacy, Budapest, Hungary. [2]Swiss Tropical and Public Health Institute, Allschwil, Switzerland. [3]University of Basel, Basel, Switzerland. [4]Department of Information Technology, Ghent University / imec, Ghent, Belgium. [5]IS Global, Barcelona, Spain

Abstract Subject Area(s)

["Epidemiology","RF/Microwave"]

Summary

The objective of present study was to conduct micro-environmental surveys to assess radio-frequency electromagnetic field (RF-EMF) exposure from current and newly introduced technologies in different educational environments of Hungary using a personal exposimeter (ExpoM-RF 4).

The method was harmonized within the GOLIAT Project of the European Union between 10 European and 2 Asian countries. The measurements were carried out in a total of 9 schools from 5 individual study areas with different population densities (as large city, small city and village). The roughly 10-minute measurements per microenvironment included both outdoor and indoor observations. From the predefined frequency bands of the exposimeter (with a range of 50 MHz to 6 GHz), we formed separate groups from the uplink (UL) and downlink (DL) bands of earlier (2G, 3G, 4G) mobile generations (*Mobile*), from bands operate *Wi-Fi* and *5G* (0.7-3.5 GHz) respectively, while all other RF bands were treated as *Other*.

Based on the results, the RF-EMF exposure from previous mobile technologies is still dominant over the 5G technology. As our data confirms, with regard to Hungarian schools, students in more densely populated areas and at increasingly higher level of educational institutes are more exposed to RF-EMF. However, the level of total RF exposure exceeded neither the directives of national decree nor international guidelines of RF-EMF public exposure limits in any of the measured educational microenvironments.

049A

COSMOS-FRANCE, A COHORT NESTED IN THE CONSTANCES COHORT: FIRST DESCRIPTIVE ANALYSIS

Dr Isabelle Deltour[1], Mrs Veronique Luzon[1], Dr Celine Ribet[2,3,4,5,6], Prof Marie Zins[2,3,4,5,6], Prof Marcel Goldberg[2,3,4,5,6], Dr Joachim Schüz[1]

[1]IARC/WHO, LYON, France. [2]Université Paris Cité, Paris, France. [3]INSERM, Paris, France. [4]Paris Saclay University, Paris, France. [5]UVSQ, Paris, France. [6]UMS 011, Paris, France

Abstract Subject Area(s)

["Epidemiology"]

Summary

COSMOS is an international prospective cohort study that investigates if the use of mobile phones and other wireless technologies are associated with health effects and symptoms (cancers, cardio-vascular diseases, neurologic pathologies, tinnitus, headaches, sleep and mood disturbances). Here we provide first descriptive results on the Cosmos-France cohort, set up in the framework of the Constances cohort, a general population -based cohort of adults. Participation in the Cosmos-France cohort was 47.2%. 18,494 persons were included in this analysis. First analyses are underway, and results will be presented.

Is the work in progress?

Yes

051A

A qualitative exploration of 5G, its implementation across Europe, and its role in the workplace

Dr Paige Hulls[1], Dr Mònica Guxens[2], Dr Gemma Castaño[2], Dr Martin Roosli[3], Dr Wout Joesph[4], Dr Kinga Polańska[5], Dr Piotr Politański[5], Dr Frank de Vocht[1]
[1]University of Bristol, Bristol, United Kingdom. [2]IS Global, Barcelona, Spain. [3]SwissTPH, Basel, Switzerland. [4]Ghent University, Ghent, Belgium. [5]Nofer Institute of Occupational Medicine, Lodz, Poland

Abstract Subject Area(s)

["Human studies","RF/Microwave","Occupational exposure"]

Summary

Introduction

For businesses, there is now the opportunity to incorporate 5G into working practices, to deliver contextual information in real time and connect large numbers of devices, alongside artificial intelligence applications.

The aim was to gain insights into the development, implementation and/or use of 5G in Europe and obtain an overview of developments associated specifically for occupational settings.

Methods

We interviewed 14 stakeholders and professionals from the UK, Belgium, Spain, Poland and Switzerland between March and September 2023. Conducted by PMH via Microsoft Teams. Interviews were transcribed, coded and analysed thematically.

Results

Participants had mixed opinions about 5G as "*it will not be the solution to the problems that we thought*", but that "*5G is still developing*". The introduction of 5G in workplaces was viewed as *"pretty small"* and in several countries *"it hasn't been very well taken up"*.

Occupational settings where 5G had been taken up included farming, airports, and university campuses. Introduction was also influenced by government-funded schemes to pilot 5G within businesses.

Participants felt it could lead to a *"natural evolution in factories"*. However, this would require continuing investment in user equipment and resources, as *"all equipment would need to be able to connect to the 5G network"*.

Experiences varied, but participants acknowledged that COVID-19 had had an impact on public perception, with misinformation being a prominent factor.

Conclusion

Although work on 5G began in 2015, 5G deployment is continuing across Europe. Further research is needed to understand how businesses can effectively implement 5G.

Is the work in progress?

Yes

053A

Temporal Change of Outdoor RF-EMF levels in European Countries: a Microenvironmental Measurement Study – Example of the Netherlands.

Ms Lea Belackova[1], Prof Marloes Eeftens[2,3], Dr Reza Aminzadeh[4], Mr Han Van Bladel[4], Dr Matthias Van Den Bossche[4], Dr Vincent Griffon[5], Prof Elisabeth Cardis[6], Dr Stefan Dongus[2,3], Ms Adriana Fernandes Veludo[2,3], Prof Mònica Guxens[6], Prof Wout Joseph[4], Ms Patricia de Llobet[6], Dr Paul Mazet[7], Dr Patrick Van Torre[4], Prof Arno Thielens[4,8], Prof Roel Vermeulen[1], Prof Joe Wiart[9], Prof Martin Röösli[2,3], Dr Anke Huss[1]
[1]IRAS, Utrecht University, Utrecht, Netherlands. [2]Swiss Tropical and Public Health Institute, Allschwil, Switzerland. [3]University of Basel, Basel, Switzerland. [4]Ghent University, Ghent, Belgium. [5]Ineris, Paris, France. [6]IS Global, Barcelona, Spain. [7]Cetim, Senlis, France. [8]The Graduate Center of the City University of New York, New York, USA. [9]Telecom Paris, Paris, France

Abstract Subject Area(s)

["Epidemiology"]

Summary

INTRODUCTION

Between 2017 to 2023 telecommunication systems have further developed. It is unknown if this has resulted in changes of outdoor exposure levels to Radio-Frequency Electromagnetic fields (RF-EMF).

Objective: To compare RF-EMF exposure levels measured in 2016 and 2018 with corresponding measurements from 2023 collected in the same microenvironments regarding temporal changes and exploring possible effects of spatial predictors including population and antenna density.

METHODS

The data was collected as part of the ACCEDERA (2016-2018), ETAIN (2023) and GOLIAT (2023) projects. Exposure levels were measured by walking the same paths with ExpoM-RF3 (2016, 2018 and 2023) and ExpoM-RF4 (2023) in the Netherlands. Paths were chosen to represent common microenvironments including residential areas, parks, public transport, and universities. Summary statistics (mean and SD) for total exposure and frequency bands were created for each year to compare the temporal trends.

RESULTS

There was a statistically significant difference in the mean exposure levels between the years. No statistically significant linear trend was observed in total RF-EMF exposure measured across any of the types of microenvironments between 2016 to 2023 (all $p > 0.05$). Correlation and regression analysis showed population density as the only significant predictor of RF-EMF exposure levels.

CONCLUSION

Over the last few years, the development of the telecommunication system has not resulted in linearly increasing exposure levels of RF-EMF in public microenvironments in the Netherlands, although levels in 2017 were statistically significantly lower than in later years. Population density showed to be the only statistically significant predictor of the exposure levels.

Is the work in progress?

Yes

055A

EMF Exposure Assessments in Urban EU Cities by Drive Test Measurements

Dr Shanshan Wang[1], Dr Yarui Zhang[2], Dr Jiang Liu[2], Dr Emmanuelle Conil[3], Dr Ourouk Jawad[3], Mr Athanasios Manassas[4], Dr Spyridon Delidimitriou[4], Dr Dimitrios Babas[4], Prof Theodoros Samaras[4], Dr Maria Christopoulou[5], Dr Efthymios Karabetsos[5], Dr Sven Kuehn[6], Dr Blaz Valic[7], Dr Peter Gajšek[7], Prof Nikola Djuric[8], Dr Joe Wiart[2]
[1]CY Cergy Paris University, Cergy, France. [2]Télécom Paris, Palaiseau, France. [3]ANFR, Maisons-Alfort, France. [4]Aristotle University of Thessaloniki, Thessaloniki, Greece. [5]EEAE, Athens, Greece. [6]ITIS, Zurich, Switzerland. [7]INIS, Ljubljana, Slovenia. [8]University of Novi Sad, Novi Sad, Serbia
Abstract Subject Area(s)
["RF/Microwave","Risk assessment"]
Summary
In this work, we present the comparison of drive test measurements conducted in 7 different EU cities. The frequency band comparison is to demonstrate the contribution from different generations of networks. The results show that contribution from 3.5GHz band is not significant. The statistical information also reveals proportional relationship between population density and EMF exposure level.
Is the work in progress?
Yes

057A
Design and dosimetric characterization of an exposure facility for a large-scale study concerning possible effects of 85 kHz and 140 kHz magnetic fields on mice
Mr Gernot Schmid[1], Mr Rene Hirtl[1], Ms Pia Schneeweiss[1], Mr Johannes Kainz[1], Mr Dmitrij Sachno[2], Dr Daria Gödecke[2], Dr Gustav Bruer[2], Dr Annette Bitsch[2]
[1]Seibersdorf Laboratories, EMC & Optics, Seibersdorf, Austria. [2]Fraunhofer Institute for Toxicology and Experimental Medicine, Chemical Safety and Toxicology, Hannover, Germany
Abstract Subject Area(s)
["in vivo","Experimental dosimetry","Numerical dosimetry","ELF/LF"]
Summary
The developed exposure facility allows the exposure of 80 animals per group (sham and exposed) in a test room sized 3 m x 8 m and enables a fully blinded study design. The system concept is based on coil racks housing 4 animal cages of 4 mice each and can easily be scaled to lower and higher number of animals/cages. The coils are operated in resonance and tuned to the target frequencies by capacitor networks in series with the coils, so that a magnetic flux density B of up to 200 µT (RMS) can be achieved with commercially available programmable current sources (which can supply 15 V / 8 A RMS) under ideal conditions (higher B values are possible with more powerful current sources). Metallic environments closer than 30 cm to the coil racks may degrade the achievable magnetic flux density (e.g., approximately 120 µT at 20 cm distance to metallic walls at 15 V RMS supply voltage). Coil currents, magnetic flux densities, and temperatures are continuously (every 30 seconds) recorded for every coil rack during operation. For the particular study under consideration, the target magnetic flux density was set to 115 µT (RMS), leading to induced electric field strengths inside the animals slightly above the values expected in humans when exposed at the reference level of 6.25 µT according to the ICNIRP 1998 guidelines. Whole body SAR values at the applied

magnetic field strength remain below 0.1 mW/kg, i.e., MF-associated thermal load to the animals can be excluded.

059A

Sinusoidal magnetic fields on working memory performance and EEG signals in humans

Miss Maëlys Moulin[1,2], Dr Sofiane Ramdani[1], Dr Alexandre Legros[2,3,4,5,6]
[1]LIRMM, University of Montpellier, Montpellier, France. [2]EuroMov Digital Health in Motion, University of Montpellier, Montpellier, France. [3]Eurostim, Montpellier, France. [4]Bioelectromagnetics and Human Threshold Research Group, Imaging Program, Lawson Health Research Institute, London, Canada. [5]School of Kinesiology, Western University, London, Canada. [6]Departments of Medical Biophysics and Medical Imaging, Western University, London, Canada

Abstract Subject Area(s)

["Human studies","Standards and public health policy","Biological and medical applications"]

Summary

Delineating the threshold effects of magnetic field (MF) stimulation is of paramount importance to the health of the public and workers, as defined by major regulatory agencies. Current definitions are based on magnetophosphene perception, primarily associated with retinal function. However, extrapolation of these effects to the broader CNS faces limitations due to different neuronal characteristics. To fill this gap, our study will aim to investigate the effects of MF on working memory, a key cognitive function, building on Reinhart's findings regarding improved performance during electrical stimulation. Using 50 Hz MF exposure, we intend to replicate and expand on these observations, using EEG monitoring and psychometric testing. Our experimental design will involve healthy volunteers undergoing EEG recording while engaging in a working memory task under various MF exposures. Data analysis will encompass behavioral measurements and EEG signal processing, including with non-linear methods. Expected results include improved working memory performance during facilitative MF frequencies, similar to Reinhart's results (2019), suggesting potential therapeutic implications for cognitive improvement in aging populations. Additionally, our study will address broader public health concerns regarding neurocognitive aging and dementia. By exploring FM as an alternative to transcranial alternating current stimulation (tACS), we will aim to overcome the limitations of tACS, such as skin irritation and limited cortical penetration depth, thereby advancing non-current brain stimulation techniques. invasive for therapeutic applications. Overall, this research will help redefine the threshold effects of MF on the CNS and inform standards for public health protection.

Is the work in progress?

Yes

061A

A Comparison of the Effects of Antenna-Tissue Spacing on Port Reflection at 6 GHz Between the Human Forearm and a Simulated 3-layer Tissue Model

Gregory McGarr[1,2], Shea Gordon-McIntosh[1], Theodore Egube[1,2], Ryan Lefebvre[1], Abaigeal Kelso[1], Abdelelah Alzahed[1]

[1]Consumer and Clinical Radiation Protection Bureau, Health Canada, Ottawa, Canada.
[2]School of Human Kinetics, University of Ottawa, Ottawa, Canada
Abstract Subject Area(s)
["in vivo","Human studies","RF/Microwave","Biological and medical applications"]
Summary
Introduction: We investigated the effects of antenna-to-tissue spacing on port reflection characteristics for a 6 GHz open-ended waveguide and horn antenna. Experimentally derived responses from a human forearm were compared with simulated responses from a three-layer tissue model. **Methods:** Written and informed consent was obtained prior to participation (Health Canada REB 2021-012H). One healthy male completed testing (age = 24 years, height = 186 cm, mass = 99 kg). The participant rested supine for 30 min with the right arm extended on a table next to the bed (air temperature = 20°C, relative humidity = 27%). The medial half of the volar forearm was exposed to the antenna. Effects of separation distance between the antenna aperture and skin surface on the reflection coefficient were evaluated for an open-ended waveguide and horn antenna. Measured distances ranged from 25-100 mm (7 equal increments) spanning one-half to two wavelengths at 6 GHz. Skin and subcutaneous adipose tissue (SAT) layer thicknesses were measured with B-mode ultrasound with a 20 MHz probe. Simulated responses were evaluated for a 3-layer tissue model in Sim4Life with skin (1.5 mm), SAT (2.3 mm), and muscle (60 mm), thickness values derived from ultrasound measurements. **Results and conclusion:** Examination of the measured responses from the human forearm indicates that the horn showed lower reflection coefficients across the range of antenna-tissue separation distances we evaluated compared to the open-ended waveguide. However, across this range the uncertainty (root mean squared error) associated with each separation distance was generally greater for the horn.
Is the work in progress?
Yes

063A
Heath surveillance of workers with active implanted or wearable medical devices exposed to electromagnetic fields
Prof Alberto Modenese, Prof Fabriziomaria Gobba
Department of Biomedical, Metabolic and Neural Sciences, University of Modena & Reggio Emilia, Modena, Italy
Abstract Subject Area(s)
["Epidemiology","ELF/LF","RF/Microwave","Occupational exposure","Risk assessment","Standards and public health policy"]
Summary
Occupational exposure to electromagnetic fields (EMF) is nowadays almost ubiquitous: the problem of electromagnetic interference with the functioning of Active Implanted Medical Devices (AIMD) and with Active Wearable Medical Devices (AWMD) can be relevant for an appropriate Health Surveilance(HS) of workers.
A questionnaire-based investigation has been performed in a group of Occupational Physicians (OPs) in the framework of the Italian project BRIC 22 ID 36 project, supported by INAIL. The survey has 15 items, of which nine specifically investigating different

groups of AIMD or AWMD and asking to the OP show many workers with these devices they examined in the past year.
The preliminary results of our questionnaire-based investigation include answers from OPs based on data from a population of about 30-thousands workers. Considering AIMD and EMF health risk at the workplaces, the most relevant situations seem those related to subjects with pacemakers or implanted cardioverter defibrillators, representing the 0.3% of the total number of workers followed by the OPs. Regarding wearable devices, both hormone/drugs pumps and hearing aids are frequent, involving about the 0.5% of the total number of workers visited.
The occupational HS of EMF-exposed workers needs to include a full examination of all the possible conditions resulting in an increased susceptibility to the risk for the workers, in partiular the use of AIMD and AWMD. Our survey among a group of Italian OPs highlights the most common implanted and wearable devices in workers, giving a relevant indication for the prevention of the EMF-related risk.

Is the work in progress?

Yes

065A

Study of the effects of human exposure to 5G millimeter-wave electromagnetic fields: development of an exposure system.

Mr Benjamin Vatovez[1], Mrs Maryse Ledent[2], Prof Marco Spirito[3], Prof Fulvio Schettino[4], Prof Anna Bogdanova[5]
[1]ISSeP, Liège, Belgium. [2]Sciensano, Brussels, Belgium. [3]Delft University of Technology, Delft, Netherlands. [4]University of Cassino and Southern Lazio, Cassino, Italy. [5]University of Zurich, Zurich, Switzerland

Abstract Subject Area(s)

["Human studies","MM Waves"]

Summary

A double-blind exposure system is being developed in order to take part to two separate but complementary research projects on the possible health effects of 5G exposure. The first study is a part of NextGEM project which focuses on studying possible effects of 5G exposure on human red blood cells in the mm-wave band; the second is a work package of the 5GINC project which aims at improving knowledge on EMF hypersensitivity in the same range.
Exposure sessions, skin characterization measurements as well as any collection of biological samples will take place in a dedicated room in a controlled environment (temperature, humidity and low EMF levels). The system is designed for a double-blind 5G-like exposure in the millimeter-wave range (FR2). The exposure is localized on the forearm, in an area close to the wrist.
The system is configured to generate a modulated OFDM 5G signal at 26,5 GHz. The modulated signal is realized using a software defined radio (SDR) unit or employing a vector signal generator at an intermediate frequency (IF). The IF signal is moved to the FR2 band, employing a custom designed up-converter and filtered for out of band unwanted signals. The upconverted signal will be amplified using a linear amplification stage. A controllable switch will be placed to allow selection between the two transmitting antennas located just a few centimeters from the exposed area.

Is the work in progress?
Yes

067A
Uncertainty Analysis of RF Exposure of Digital Rat Phantom at 1 GHz and 2.45 GHz
Dr Clarissa Vazquez-Colon[1], Dr Benjamin Kalinosky[1], Dr Roberto Rodriguez[1], Dr Joseph Butterworth[2], Mr Jason Payne[2]
[1]General Dynamics Information Technology, JBSA Fort Sam Houston, USA. [2]Air Force Research Laboratory, JBSA Fort Sam Houston, USA
Abstract Subject Area(s)
["Numerical dosimetry","RF/Microwave","Risk assessment","Standards and public health policy"]
Summary
In this work, we investigated how the uncertainty of different simulation parameters impacted the estimated radiofrequency (RF) specific absorption rate (SAR) and thermal computational dosimetry. The study was performed on high resolution digital rat phantoms exposed to RF with a plane-wave at two different frequencies. The parameters under study were source frequency, model air padding, perfectly matched layer thickness, spatial resolution, dielectric properties, model morphology, and brain blood flow parameters. SAR averaged in the whole-body, whole-brain, and specific brain regions were obtained as a function of the simulation parameters. An uncertainty budget analysis was performed to quantify the effect of the different simulation parameters on the simulation output results. Characterization of SAR uncertainty in digital rat phantoms will provide a better-informed analysis of the dose-response relationship within experimental studies.

069A
5G Base Station Electromagnetic Field Strength Estimation Method using Deep Learning for Compliance Test
Mr Dongryul Park[1], Mr Seunghun Ryu[1], Mr Seonghi Lee[1], Prof Namwoo Kang[1], Prof Seongsin Kim[2], Dr Kihwea Kim[3], Dr Donggeun Choi[3], Prof Seungyoung Ahn[1]
[1]Korea Advanced Institute of Science and Technology, Daejeon, Korea, Republic of. [2]Seongsill University, Seoul, Korea, Republic of. [3]National Radio Research Agency, Naju, Korea, Republic of
Abstract Subject Area(s)
["MM Waves","Risk assessment","Standards and public health policy"]
Summary
Recently, with the commercialization of 5G, a new electromagnetic field (EMF) evaluation methods is need. However, conventional EMF evaluation methods are only based on measurements that practically impossible to apply to 5G base station (BS). Therefore, in this paper, we propose a 5G BS EMF evaluation method using deep learning (DL) as an alternative to traditional measurement-based evaluation. We selects a Unet that can analyze the entire area based on the technical characteristics of 5G. Furthermore, we design a 2D and numeric converter to inform the physical information of the wireless channel to the U-net. Through network design based on technical features and physical information, the proposed DL model can effectively predicts the EMF radiated from BS.

Then, we generate data through simulations that reflect real-world scenarios and use it for training. The results of the training show that the proposed method achieves very high accuracy in various cases, regardless of location and antenna specifications. Furthermore, when quantitatively evaluated, the proposed method only have an 8% low mean absolute error (MAE), thus demonstrating the superiority of the proposed method. These verification results confirm that the potential of the proposed method can replace EMF evaluations based on measurements with DL-based evaluations in the future.
This work was supported by Institute of Information & communications Technology Planning & Evaluation (IITP) grant funded by the Korea government(MSIT) (No.2022-0-00986, Development of artificial intelligence-based base station electromagnetic wave human exposure prediction algorithm)
Is the work in progress?
Yes

071A
Analysis of civil complaints current situation and measured values related to electromagnetic waves at mobile communication base stations in Korea
Mr GyuHwan Choi, Mr MyoungDong Lee
Korea Radio Promotion Association (RAPA), Seoul, Korea, Republic of
Abstract Subject Area(s)
["ELF/LF","RF/Microwave","Risk assessment","Standards and public health policy"]
Summary
Korea Radio Promotion Association (RAPA) is responding to civil complaints about electromagnetic waves from mobile communication base station in Korea. And analyzed the types of complaints and electromagnetic intensity in real life based on accumulated experiences and the latest data in the of 2023.
In this paper, Based on the 2023 civil complaint response data, we will analyze electromagnetic waves by residence type and wireless station type to find ways to solve civil complaints through electromagnetic wave measurement.
Electromagnetic intensity : The electromagnetic measurement value averaged 1.35 V/m, which was weak at 3.09% compared to ICINRP's human protection standards applied in Korea.
As a result of the analysis, many civil complaints occur on the top floor of apartment houses and wireless stations installed in the building, and most civil complaints tended to be resolved by explaining lower measurements compared to human protection standards after guiding accurate electromagnetic measurement methods at the site.

073A
Modeling the Interaction of 5G Electromagnetic Fields with the Murine Foetus: Exposure to High-Band (26 GHz)
Dr Negin Foroughimehr, Dr Zoltan Vilagosh, Dr Robert McIntosh, Dr Ali Yavari, Prof Andrew Wood
6G Research and Innovation Lab, Swinburne University of Technology, Hawthorn, VIC, 3122, Melbourne, Australia
Abstract Subject Area(s)

["Numerical dosimetry","RF/Microwave","MM Waves","Biological and medical applications"]

Summary

This study focuses on the 26 gigahertz (GHz) frequency currently used in deploying fifth-generation (5G) high-band systems. We employ a high-resolution, anatomically accurate model of a pregnant mouse to explore the effects of millimeter wave (mmWave) high-band frequency (i.e., 26 GHz). The computational solver XFdtd Bio-Pro, a three-dimensional (3D) full-wave electromagnetic (EM) solver, is used for simulations, building on previous work with a 900 megahertz (MHz) dosimetry study. The model is adapted for 26 GHz simulations, emphasizing the need for comprehensive investigations into the potential impacts of high-band 5G on the foetus. The results suggest that, at this frequency, the radio frequency (RF)-EM field does not reach the uterus due to the depth within the body; instead, it is primarily absorbed by the skin. Further experimental work is necessary to examine potential effects thoroughly.

Is the work in progress?

Yes

075A

Design of a low SAR 4-port MIMO antenna for 3.5 GHz 5G and 5.8 GHz ISM bands

Mr Md Abu Sufian[1], Dr Anees Abbas[1], Mr Domin Choi[1], Mr Jaemin Lee[1], Prof Niamat Hussain[2], Prof Nam Kim[1]

[1]Department of Information and Communication Engineering, Chungbuk National University, Cheongju-si, Korea, Republic of. [2]Department of Intelligent Mechatronics Engineering, Sejong University, Seoul, Korea, Republic of

Abstract Subject Area(s)

["RF/Microwave","Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

In this work, a low SAR 4-port MIMO antenna is presented for the 3.5 GHz 5G and 5.8 GHz ISM band communication applications. The proposed antenna is designed on a 0.2 mm thick Rogers 5880 substrate having tangent delta = 0.0009, and ε_r =2.2. The overall antenna occupies a compact size of 36.2 mm × 36.2 mm. At the operational frequency ranges, the proposed dual-band MIMO antenna also offers an effective radiation efficiency of more than 90%, with a maximum gain of 2.01 dBi at 3.5 GHz and 1.71 dBi at 5.8 GHz, respectively. To check the suitability of the designed antenna operating near a human body, a 3-layer human tissue model is designed, and the SAR values are calculated at both 3.5 GHz and 5.8 GHz. The recommended 4-port MIMO antenna performs at 3.5 GHz and 5.8 GHz with a SAR value of 1.92 W/kg and 0.465 W/kg, respectively, at 125 mW of input power. With its SAR value within the mandated limit and other shown MIMO antenna performance metrics, the proposed antenna is a strong candidate for sub-6 GHz dual-band MIMO applications.

Is the work in progress?

Yes

077A

Predication of field exposure generates in urban setting by its-5.9 ghz V2X vehicular connectivity with co-kriging spatial interpolation

Miss Martina Benini[1,2], Mr Samuel Goegebeur[3], Dr Marta Bonato[1], Dr Silvia Gallucci[1], Dr Marta Parazzini[1], Prof Wout Joseph[3], Dr Gabriella Tognola[1]
[1]Institute of Electronics, Information Engineering and Telecommunications (IEIIT), CNR, Milan, Italy. [2]Department of Electronics, Information and Bioengineering (DEIB), Politecnico di Milano, Milan, Italy. [3]Department of Information Technology, Ghent university, Imec, Ghent, Belgium

Abstract Subject Area(s)

["RF/Microwave"]

Summary

With the continuing spread of vehicular connectivity technologies within the Intelligent-Transport-System field, innovative methodologies are needed to predict exposure fields in urban vehicular scenarios. In this regard, Artificial Neural Networks are very promising, but their reliability relies on being trained on extensive exposure field datasets. In this study, we demonstrate the feasibility of the ordinary-kriging and co-kriging methods as a valid interpolation technique for predicting field exposure in vehicular scenarios. By doing so, we aim to build a big exposure field dataset for training Artificial Neural Networks in a second step. To that purpose, an urban area was modeled on Remcom Wireless Insite, and the E-field was investigated with the Raytracing technique for four different vehicular scenarios. Two vehicular connectivity technologies were considered as electromagnetic sources, i.e., Vehicle-to-Vehicle and Vehicle-to-Infrastructure communication antennas, both operating at 5.9 GHz. The extracted E-field values were then used to train and validate the ordinary-kriging and the co-kriging models. The performance of both ordinary-kriging and co-kriging was evaluated in terms of the Pearson correlation coefficient between the input data and the predicted one. For a training/validation ratio of 1/8, the Pearson coefficient ranged from 0.89 to 0.97 for the four scenarios. The high accuracy of co-kriging overcomes the computational time limitation of deterministic methods. Indeed, the scenario can be discretized with 8 times fewer receivers and afterwards interpolate the E-field with up to 97% accuracy using co-kriging.

Is the work in progress?

Yes

079A

Establishing an international framework of risk communication on EMF

Mr Yuji Takada[1], Mr Hiroaki Miyagi[2,3], Mr Christian Raupach[4], Mr Lukas Gernand[4], Prof Andrzej Krawczyk[5], Mr Mirosław Śmiałek[6], Ms Marta Brzoza[6], Dr Chiyoji Ohkubo[1]
[1]Japan EMF Information Center, Tokyo, Japan. [2]HM Research & Consulting Co., Ltd., Tokyo, Japan. [3]University of Tsukuba, Tsukuba, Japan. [4]Federal Office for Radiation Protection/Competence Centre for Electromagnetic Fields, Cottbus, Germany. [5]Polish Society of Applied Electromagnetics, Warsaw, Poland. [6]Polish Chamber of Information Technology and Telecommunications, Warsaw, Poland

Abstract Subject Area(s)

["ELF/LF","RF/Microwave","MM Waves","Standards and public health policy"]

Summary

While electromagnetic fields (EMF) occur naturally (e.g., geomagnetic field, cosmic microwave background), many kinds of anthropogenic EMF technologies have been developed over the past century mainly due to the demand for electricity, wireless telecommunications and medical application. As a result, people around the world are now exposed to EMF through sources such as high-voltage transmission lines, household electrical appliances, radio/TV broadcasting facilities, mobile telephones and their base stations, and wireless internet access, and not a small number of people are concerned about the adverse health effects of EMF.
In relation to this issue, the European Commission conducted questionnaire surveys on EMF risk perception in 2006 and 2010. Since then, however, EMF-related technologies and applications have been drastically developed further, with the deployment of 5G mobile technology, high-voltage direct current transmission lines, electrified vehicles and wireless power transmission systems.
Therefore, it is very important to conduct a similar survey again in several countries and compare/analyse the results to understand the current status of risk perception among the general public on the health effects of EMF, and to establish better risk communication methods, whether common or country-specific.
We have concluded the MoU to establish an effective partnership among parties to promote and improve risk communication activities regarding potential health effects caused by EMF exposure and to disseminate related information based on sound science.
Development of a common/country-specific questionnaire has been completed and the survey is scheduled to be conducted in 2024.
Participation from other countries/regions is very welcome.

Is the work in progress?

Yes

081A

Pdms based flexible and low SAR dual band antenna for body area network

Dr Anees Abbas[1], Dr Wahaj Abbas Awan[1], Mr Domin Choi[1], Mr Jaemin Lee[1], Prof Niamat Hussain[2], Prof Nam Kim[1]
[1]Chungbuk National University, Cheongju, Korea, Republic of. [2]Sejong University, Seoul, Korea, Republic of

Abstract Subject Area(s)

["RF/Microwave","Biological and medical applications"]

Summary

With the rapid advancement of radio frequency technology and the proliferation of diverse wireless communications in recent times, human dependence on wireless communication has significantly increased. The World Health Organization (WHO) has cautioned that antenna radiations emitted by wireless devices, especially those incorporated into personal electronics, may pose a risk of cancer. To safeguard consumers from electromagnetic exposure, international bodies have instituted safety regulations, particularly regarding Specific Absorption Rate (SAR). The Federal Communications Commission (FCC) has recommended a SAR limit of 1.6 W/kg averaged over 1 gram of head tissue, as per ANSI/IEEE C95.1-2005 standards. This study proposes a relatively compact dual-band antenna suitable for wearable applications in the

Industrial, Scientific, and Medical (ISM) bands at 2.45 GHz and 5.8 GHz. It offers low SAR values and broadband advantages for both conformal and non-conformal devices.

083A

Microwave surgical energy device with controllable heating region

Mr Tsugumi Nishidate, Prof Kazuyuki Saito
Chiba University, Chiba, Japan

Abstract Subject Area(s)

["RF/Microwave","Biological and medical applications"]

Summary

Microwave surgical energy devices are used for hemostasis and anastomosis in modern surgery. These hemostasis and anastomoses are safely performed due to the frictional heat between water molecules generated by electric field vibration. The operating frequency is 2.45 GHz as defined by ISM (Industrial, Scientific and Medical) band. The heating region produced by this device depends on the antenna geometry, heating time, and heating power. In case a sufficient heating region in the depth direction is desired, the heating time is set to be long, or the heating power is increased. As a result, the heating region on the tissue surface also increases. Therefore, in this study, a device structure that can control only the heating region in the depth direction was validated. Specifically, a waveguide filled with dielectric material is used as a microwave transmission line and as a radiator. The dielectric material is appropriately selected to shorten wavelength, allowing the adoption of waveguide with small cross section. The tip of the waveguide is brought into contact with the biological tissue for heating. As a method of changing the distribution of the heating region in the depth direction, a metallic plate was installed inside the waveguide tip. From numerical calculations, it was confirmed that the electric field at the tip of the waveguide was increased by this metallic plate. Furthermore, the heating region was also confirmed to be deeply distributed compared to normal waveguide.

Is the work in progress?

Yes

085A

Numerical Estimation of Relationship between Peak Spatial-Averaged SAR and Temperature Elevation Due to Implanted Metal Plates Exposed to Microwaves in the Cellular Frequency Band

Mr Shuhei Waki[1], Ms Funa Tsumura[1], Prof Takashi Hikage[1], Dr Tomoaki Nagaoka[2]
[1]Hokkaido University, Sapporo, Japan. [2]National Institute of Information and Communications Technology, Koganei, Japan

Abstract Subject Area(s)

["Numerical dosimetry","RF/Microwave"]

Summary

Recently, many types of medical devices, such as implantable cardiac pacemakers and implanted metal plates, have been developed. Therefore, the possible adverse effect on these devices exposed to electromagnetic fields is one of the most important issues. We focused on the implanted metal plates used for the treatment of mandibular fractures and investigated the potential risks of temperature increase due to these plates.

Previous studies have suggested that when two metal plates are implanted in parallel, the power absorption may increase significantly in the plate gap. In this study, we conducted a precise examination of the averaged mass dependencies of the peak spatial-averaged specific absorption rate (psSAR) on the temperature elevation to establish a correlation between the temperature increase and SAR enhancement in the human tissue around implanted metal plates.

Is the work in progress?

Yes

087A

A Field Study on Compliance Assessment for Base Stations for Mobile Communication using the Actual Maximum Transmitted Power in Urban Areas of Japan

Mr Yoshitoshi Tochikura, Dr Takahiro Iyama, Mr Junji Higashiyama, Dr Yasunori Suzuki
6G Network Innovation Department, NTT DOCOMO, INC., Yokosuka, Kanagawa, Japan

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","Risk assessment"]

Summary

This study quantitatively presents the effect of the actual maximum transmitted power used for compliance evaluation referring to IEC 62232:2022, using the data of many base stations in Japan. The results show that for most base stations, the ratio of the actual transmitted power to the configured transmitted power was between 0 and -2dB. A correlation was also found between this ratio and some traffic indicators, such as the number of active users and the downlink resource block usage rate. However, given the broad variation in both the ratio and the traffic indicators, it was suggested that accurately predicting the R_{AC} value based on each traffic indicator may be difficult.

Is the work in progress?

Yes

089A

Assessment of RF-EMF Exposure in Shopping Centers and Covered Markets in Paris

Dr Yarui Zhang[1], Dr Shanshan Wang[2], Dr Jiang Liu[1], Dr Ce Zheng[1], Prof Theodoros Samaras[3], Prof Joe Wiart[1]
[1]Télécom Paris, IP Paris, Palaiseau, France. [2]CY Cergy Paris Université, Cergy-Pontoise, France. [3]Aristotle University of Thessaloniki, Thessaloniki, Greece

Abstract Subject Area(s)

["RF/Microwave","Risk assessment"]

Summary

The widespread use of wireless communication technologies has led to a significant public perception of risk associated with exposure to radiofrequency electromagnetic fields (RF-EMF), and the deployment of the 5G wireless network has further increased this risk [1, 2]. Consequently, considerable efforts have been dedicated to assessing EMF exposure [3]. This study aims to assess the levels of RF-EMF to which the public is exposed in densely populated urban areas. Specifically, it focuses on Paris City's shopping centers and covered markets, which attract a significant daily flow. The evaluation covered six major shopping centers and the most frequented covered

markets in Paris. Measurements were conducted using a frequency-selective personal dosimeters named EME Spy Evolution, spanning a range of frequency bands: 700MHz, 800MHz, 900MHz, 1800MHz, 2100MHz, 2600MHz, 3500TDD, and two Wi-Fi bands. A comprehensive analysis across different technologies, including 2G, 3G, 4G, and 5G, has been conducted, focusing on downlink (DL) exposure. The present contribution examines the data collected from these various scenarios and over different frequency bands to provide a detailed understanding of RF-EMF exposure in these high-traffic urban settings.

Is the work in progress?

Yes

091A

Sensor Model Linearization via Artificial Intelligence

Mr Alessandro Fasse[1], Mr Romain Meyer[2], Dr Cédric Bujard[1], Mr Maxim Haas[2], Dr Nicolas Chavannes[2], Dr Esra Neufeld[1], Prof Niels Kuster[1,2,3]

[1]Foundation for Research on Information Technologies in Society (IT'IS), Zurich, Switzerland. [2]Schmid & Partner Engineering AG (SPEAG), Zurich, Switzerland. [3]Department of Information Technology and Electrical Engineering, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland

Abstract Subject Area(s)

["Experimental dosimetry","Numerical dosimetry","RF/Microwave"]

Summary

Resistively loaded diode detectors are commonly employed for highly standardized near-field characterization in regulatory assessment of radiofrequency exposure. The required accuracy demands linearization of the calibration to compensate for non-ideal response characteristics and manufacturing tolerances. The challenge of linearization has existed and expanded over recent years [1, 2, 3], mostly as a result of the increasingly diverse and complex modulation schemes introduced with 5G. Current approaches demand inverse problem solving, where each evaluation requires the slow and costly simulation of a differential equation representing the detector circuit. As a result, the procedure has become computationally demanding and inflexible. A novel approach has been developed to accelerate the simulations by a factor of more than 10×, while at the same time enhancing accuracy, allowing a large number of evaluations with varying probe characteristics and signal parameters to be performed, and on which a Deep Neural Network was trained to predict linearization parameters on the fly. The neural network was validated by means of test simulations and laboratory measurements. Furthermore, a recently introduced Gaussian Process model procedure [4] was used to characterize the network's accuracy in a critical, unbiased, and implementation-agnostic manner. This artificial intelligence approach was found to produce a maximum error of 0.4 dB at up to temporal peak specific absorption rate value of 100 W/kg and to accelerate the computations of the linearization parameters by a total factor greater than 8000×.

Is the work in progress?

Yes

093A

Personal Exposure Levels to Radiofrequency Electromagnetic Field (RF-EMF) in Daily Life in Japan

Ms Miwa Ikuyo[1], Dr Teruo Onishi[2], Prof Masao Taki[2], Dr Soichi Watanabe[2]
[1]National Institute of Information and Communications Technology, Koganei, Tokyo, Japan. [2]National Institute of Information and Communications Technology, Koganei, Japan

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave"]

Summary

Our research project of acquisition, accumulation, and application of electromagnetic fields (EMF) exposure monitoring data in Japan is ongoing since 2019. The project aims are to clarify actual human exposure levels to RF-EMF in daily life, as well as investigate risk communication methods using RF-EMF exposure level monitoring data. In this project, 32 participants, which were selected as measurement volunteers from 1852 acceptors recruited from the 1st web questionnaire survey (N=6085;2022yr.), and 22 participants, which were selected from the 2nd web questionnaire survey (N=1501;2023yr.), measured the personal RF-EMF exposure levels from mobile communication systems (including 5G FR1), wireless LAN, and terrestrial broadcasts using a portable measurement device. The results showed that people living in sparsely residential areas tended to have lower levels of personal RF-EMF exposure than those living in densely residential areas, but there was no clear significant difference. Also, the contribution to the total personal RF EMF exposure levels was not only the RF EMF exposure level from mobile base station but also wireless LAN devices (including other sources used in ISM bands), which was similar to the results of our spot measurement in a residence. The personal RF-EMF exposure levels by 54 participants were 0.04 % or lower than those of the Japanese radio radiation protection guidelines.

Is the work in progress?

No

095A

Absorbed power density measurement in tissue equivalent liquid using standard dipole antenna at 6 GHz to 10 GHz

Dr Yuto Shimizu, Dr Andrey Andrenko, Dr Tomoaki Nagaoka
National Insistute of Information and Communications Technology, Tokyo, Japan

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","Standards and public health policy"]

Summary

Wireless communication devices used in close proximity to a human body need to be assessed for human exposure. Recently, the compliance test method based on an absorbed power density (APD) at frequencies from 6 GHz to 10 GHz has been published as publicly available specification (PAS) by the International Electrotechnical Commission (IEC). This method obtains the APD by using the specific absorption rate (SAR). Therefore, when APD is evaluated for the compliance test at the frequency from 6 GHz to 10 GHz, SAR measurement must be performed according to the compliance test standard. Moreover, this study aims to validate whether our measurement system can obtain APD according to the published PAS. According to this, 4 cm^2 averaged APD in the

flat and head phantoms were measured using the reference dipole antenna at the frequency range from 6 GHz to 10 GHz. Measured 4 cm^2 averaged APD agrees with the numerical reference within the 15 % difference. In addition, measured APD was also compared with simulated APD based on Poynting vector calculation. The difference between both APDs was within 25 %. According to the APD measurement uncertainty, the obtained results have been validated. Therefore, it should be concluded that our measurement system can measure the APD in some types of phantoms.

Is the work in progress?

No

097A

Downlink electromagnetic fields exposure assessment using personal exposimeter: a case study in Athens metro network

Maria Christopoulou, Nikos Papanikolaou, Efthymios Karabetsos
Greek Atomic Energy Commission, Athens, Greece

Abstract Subject Area(s)

["RF/Microwave","Standards and public health policy"]

Summary

This study summarizes the preliminary results of the RF EMF exposure levels monitoring using MVG EME Spy 200 personal exposimeter in 67 stations and moving trains of Athens metro network in Greece. Measurements have been conducted at 20 predefined frequency bands, providing data about the 5G FR1 (5th Generation Frequency Range 1) contribution to the total exposure level. Conclusions have been derived considering the indoor small cell antenna installation sites at selected metro stations, the exposure differences at each metro line between stations and moving train as well as the over ground and underground parts of each line.

Is the work in progress?

Yes

099A

Ray Tracing-based Analysis of the Influence on the Scattering of the Electric Field Caused by the Measuring Person at 6G Frequencies

Mr Thanh Tam Julian Ta[1], Ms Anna-Malin Schiffarth[1], Dr Christian Bornkessel[2], Ms Lisa-Marie Schilling[3], Prof Matthias Hein[2], Prof Dirk Heberling[1,4]
[1]Institute of High Frequency Technology, RWTH Aachen University, Aachen, Germany. [2]RF & Microwave Research Laboratory, Thuringian Center of Innovation in Mobility, TU Ilmenau, Ilmenau, Germany. [3]RF & Microwave Research Laboratory, Thuringian Center of Innovation in Mobility, TU Ilmeau, Ilmenau, Germany. [4]Fraunhofer Institute for High Frequency Physics and Radar Techniques, Wachtberg, Germany

Abstract Subject Area(s)

["Numerical dosimetry","MM Waves","Standards and public health policy"]

Summary

For radiation protection it is important to obtain reliable data on the actual electromagnetic exposure to ensure that the exposure safety limits are not exceeded. The presence of the person performing a measurement can distort the electric field and reflection occurring from the body can superimpose with the incident waves and lead to

a standing wave with constructive and deconstructive interferences. This may lead to a misinterpretation of the actual exposure.
In this study, a ray-tracing based analysis was done to estimate the potential electric field variations caused by the presence of a person at 6G frequencies and different incident wave angles. The comparison of the electric field with and without a person showed a large field variation of up to 14 dB, which can lead to an overestimation of the actual exposure. However, to apply the simulation results to a real measurement and to determine the uncertainty more precisely, the simulation needs to be extended and more in-depth investigations need to be carried out.

Is the work in progress?

Yes

101A

5G NR FR1 contribution to the total EMF exposure levels during ground level spot measurements in urban and suburban environments in Greece

Mr Athanasios Manassas[1], Dr Maria Christopoulou[2], Mr Nikos Papanikolaou[2], Mr Spyridon Delidimitriou[1], Prof Theodoros Samaras[1], Dr Efthymios Karabetsos[2]
[1]Aristotle University, Thessaloniki, Greece. [2]Greek Atomic Energy Commission, Athens, Greece

Abstract Subject Area(s)

["RF/Microwave"]

Summary

Results of 400 in situ spot measurements of radiofrequency electromagnetic fields, conducted at ground level in urban and suburban environments in Greece, are presented and discussed. Measurement data are assessed, emphasizing the 5G contribution to the measured total electric field (E-field). The correlation of the measured E-field in the 5G NR FR1 to the distance of the base stations (BSA) and small cell antennas (SCA) operating at this frequency range is explored.

Is the work in progress?

Yes

103A

Withdrawn

105A

Assessment of the influence of mobile telephony on electromagnetic field exposure.

Prof Pablo Luis Lopez Espi, Prof Rocio Sanchez Montero, Mr Jorge Guillen Pina, Mr Ricardo Chocano del Cerro, Prof Juan Antonio Martinez Rojas
University of Alcala, Alcala de Henares, Spain

Abstract Subject Area(s)

["RF/Microwave","Occupational exposure","Risk assessment","Standards and public health policy"]

Summary

This contribution presents a work that analyzes the exposure to radiofrequency electromagnetic fields from the point of view of the contribution of the different services

present in a location. It permits to analyze the values of each of them and assess the influence of a new installation. The measurements have been compared with standard broadband techniques and the spatial representations have been performed using kriging interpolation techniques. The results show that the greatest contribution to exposure is due to mobile telephony.

Is the work in progress?

Yes

107A

Impact of Rat Skin and Fur on Microwave Absorption in the frequency range 10 – 40 GHz

Richard Überbacher, Gernot Schmid
Seibersdorf Laboratories, EMC & Optics, Seibersdorf, Austria

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","MM Waves"]

Summary

In view of future 5G networks operating at millimeter wave (mmW) frequencies accurate dosimetric characterization of mmW absorption in rodents is of interest in the frame of corresponding health risk assessment studies. Due to the decreased penetration depth at mmW frequencies the absorption in the skin increases. Therefore, an appropriate representation of the skin of numerical animal models is essential. In this study we experimentally investigated the impact of rat skin and fur on absorption in the frequency range 10 – 40 GHz. The obtained results show that significant local differences in the skin thickness over the body of adult rats can occur which consequently may have significant impact of the absorption of mmW energy in deeper body tissues, depending on the direction of incidence of the waves. This is considered to be of importance for dosimetric characterization of exposure setups for future mmW health risk studies with rodents, as present animal models do not properly reflect this local differences in skin tissue thickness along the body. For rat models generated by MRI imaging a final verification of the correct dimensions of the skin is suggested e.g. by use of a cryosection method for a few defined positions. An additional observation is, that up- and down-scaling of rat models to different body weights need to be done carefully, because the skin thickness is not scalable in the same way than body weight.

109A

Factors affecting uncertainty in mass calculation of population RF exposure from base stations and possible methods to manage them

Mr Balázs Gyulai[1], Mr József Krausz[1], Dr György Thuróczy[2]
[1]National Media and Infocommunications Authority, Budapest, Hungary. [2]National Center for Public Health and Pharmacy, Budapest, Hungary

Abstract Subject Area(s)

["RF/Microwave","Risk assessment"]

Summary

Mass RF exposure calculations over large geographical areas can be used to assess general public exposure.

The relevant measurement standard describes in detail how to determine the uncertainty connected with the individual calculation. In addition, other factors have to be considered for mass calculations that are not specified in the standard.
During the construction of the mass computing system in National Media and Communications Authority of Hungary (NMHH), the database of radio stations was carefully reviewed. The survey identified several types of discrepancies, ranging from isolated cases to system-wide inconsistencies.
In a few cases, the mobile operators provide the specifications of radio station in different way. For example, some operators take the antenna height in the middle of the antenna, while others take lowest points of the antenna. Similar differences cannot be excluded automatically in case of emission ERP/EIRP or antenna gain dBi/dBd units.
In many cases the coordinates of a base station are ten metres from the tower that supports it. On the other hand, in the absence of building databases and integrated property registers, false calculations results can occur related to RF reference levels for public, since the categories of residential area may not be accurate.
The experience gained from the development of the NMHH mass calculation system, the methods used for manage uncertainty can be used as a checklist for further studies.

111A

Fundamental Study of Absorbed Power Density Evaluation Using a Horn Antenna At 40 GHz Using the Inverse Source Method

Dr Rasyidah Hanan Binti Mohd Baharin, Dr Tomoaki Nagaoka
National Institute Of Information And Communications Technology (NICT), Koganei, Tokyo, Japan

Abstract Subject Area(s)

["MM Waves"]

Summary

The absorbed power density (APD) is the metric for exposure introduced in the guideline as the basic restriction for human protection from electromagnetic exposure for 6 to 300 GHz. In this paper, we performed a fundamental study on the APD using the inverse source method (ISM) for 40 GHz, which is one of the candidates of the 5G-millimeter wave communication system using computational simulation. In ISM, the simulated electric field is extracted and used to inversely calculate the equivalent electromagnetic currents on the aperture of the AUT. The equivalent currents then calculate for an APD of PPE using the Poynting vector definition, and in turn are used as initial solution to calculate APD of skin.
In a previous study by the authors in evaluating APD at 28 GHz, the optimum thickness, t, of the phantom using polypropylene-ether, PPE, was proposed as t = 6.4 mm, corresponding to about 0.6λ for 28 GHz. Applying such case for 40 GHz, we initially guessed the thickness for this frequency to be t = 4.5 mm. By performing the numerical calculations, APD was calculated and the difference between ISM and reference from direct calculation for t = 4.5 mm and t = 6.4 mm are 1.13 dB and 2.06 dB, respectively. This indicates that adjusting the thickness of phantom with respect to the wavelength is necessary.

Is the work in progress?

Yes

113A

Robust Validation Methods for Systems Determining the Absorbed Power Density

Mr Ninad Chitnis[1], Dr Sven Kuehn[1], Prof Niels Kuster[1,2]
[1]IT'IS Foundation, Zurich, Switzerland. [2]ETH Zurich, Zurich, Switzerland

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","MM Waves","Standards and public health policy"]

Summary

A robust validation method for absorbed power density (APD) measurement systems is presented. The method validates the absolute measurement accuracy, including modulated signal dynamic characteristics and feedback on the device under test through a phantom. The validation tests the system utilizing the normalized error concept (En). The method was applied to the commercial APD assessment system DASY8 in the 6 to 30 GHz frequency range, validating its fitness with En <<1.

115A

Study on nanosecond pulsed electric field ablation of triple-negative breast cancer and induction of tumor immunity in mice

Dr Zhentian Xu[1], Prof Xinhua Chen[2], Prof Lin Zhou[2], Prof Shusen Zheng[2]
[1]Sir Run Run Shaw Hospital, Hangzhou, China. [2]The First Affiliated Hospital, Zhejiang University School of Medicine, Hangzhou, China

Abstract Subject Area(s)

["Electroporation and pulsed electric field applications"]

Summary

This study verified that nanosecond pulsed electric field (nsPEF) induced apoptosis of triple negative breast cancer cells and activated apoptosis-related pathways. We demonstrated that nanosecond pulsed electric fields induced immunogenic cell death in triple-negative breast cancer and released damage-associated molecular patterns to activate immunity and immune memory. Nanosecond pulsed electric fields activated the immune response within the tumor and promoted the recruitment of CD8+ T cells to enhance anti-tumor immunity. We demonstrated for the first time that the immune response induced by nanosecond pulsed electric field ablation of triple-negative breast cancer in mice was CD8+ T cell-dependent and that recruitment of CD8+ T cells was CXCL9 chemokine axon-dependent. Nanosecond pulsed electric field ablation combined with anti-PD-1 enhanced the therapeutic efficacy of triple-negative breast cancer and reduces the proportion of terminally depleted CD8+ T cells with tumor invasion. Combination therapy is beneficial to maintain the function of cytotoxic CD8+ T and prolongs the survival of mice.

Is the work in progress?

Yes

117A

Effects of tACS-induced phase entrainment in cortical neuronal models

Dr Maxime Yochum[1], Dr Mariam Al Harrach[1], Dr Gabriel Gaugain[2], Dr Fabrice Wendling[1], Dr Denys Nikolayev[2], Dr Julien Modolo[1]

[1]Univ Rennes, INSERM, LTSI – UMR 1099, rennes, France. [2]Univ Rennes, CNRS, IETR – UMR 6164, rennes, France

Abstract Subject Area(s)

["Electroporation and pulsed electric field applications"]

Summary

In this study, we used two complementary types of realistic models – detailed and simplified based on the Hodgkin–Huxley (HH) formalism – to investigate the phase entrainment of neocortical cell types during transcranial alternating current stimulation (tACS). Our objective using this dual-model approach was two-fold: first, understanding further cell-specific frequency responses to tACS, thereby improving stimulation design for targeted cellular stimulation; and second, facilitating comparisons between detailed and simplified models. The latter are particularly valuable for fast computation and network modeling, especially to characterize how low-magnitude electric field effects on entire networks.

Our results reveal that Layer 5 pyramidal cells exhibit low-pass filter behavior, showing a type of frequency-dependent entrainment. In contrast, GABAergic interneurons (bipolar, BP; parvalbumin, PV; and somatostatin, SST) demonstrate different resonant frequencies, suggesting the potential for selective targeting of specific neuronal types through frequency targeting. The study also finds that vasoactive intestinal peptide interneurons do not show reliable entrainment, underscoring the importance of input-dependent entrainment.

Notably, both detailed and simplified models showed similar responses to electrical field, with entrainment increasing linearly with electrical field amplitude. This consistency between models suggests the potential for using simplified models in broader network studies, given their lower computational demands and realistic cell response replication. Overall, our results highlight the nuanced interactions between tACS and different neuronal types, emphasizing the need for considering both cell-specific responses and network dynamics in future research.

119A

The Real Magneto-acoustic Coupling Electric Field Detection and Analysis in Tissue-like Solutions of Transcranial Magneto-acoustic Stimulation

Dr Xiaoqing Zhou, Mr Kai Zhu, Mr Xu LIu, Prof Tao Yin, Prof Zhipeng Liu

Chinese Academy of Medical Sciences & Peking Union Medical College， Institute of Biomedical Engineering, Tianjin, China

Abstract Subject Area(s)

["Biological and medical applications"]

Summary

Transcranial magneto-acoustic stimulation (TMAS) is a novel multi-physical field coupled neuromodulation technique. It can achieve a mm-level accurate focused electrical field in the whole brain even the deep regions by using focused ultrasound and Lorentz forces in tissue. The real stimulation magneto-acoustic electric field distribution is the important physical basis and has significance for TMAS technology. However, the previous studies have only involved the detection of magneto-acoustic electric field in the metals with high conductivities. In this paper, we built a precise vector detection system and quantitatively detected and analysed the real magneto-

acoustic coupling electric field in tissue-like saline solutions with different low conductivities for the first time. The values of magneto-acoustic electric field are 15.5mV/m (B=0.2T) and 37.1mV/m (B=0.5T) when σ=1S/m; While the electric field values are 46.4mV/m (B=0.2T) and 106.5mV/m (B=0.5T) when σ=6S/m. The intensity of the magneto-acoustic coupling electric field is positively linearly related to the magnetic induction intensity.
Unlike the metallic materials, the magneto-acoustic coupling electric field intensity of the tissue-like solution is lower than the corresponding theoretical value. In addition, the value of magneto-acoustic coupling electric field is positively related to the conductivity of the solution. It means that the there is a certain coefficient of magneto-acoustic coupling efficiency in a non-ideal tissue-like solution. The existing magneto-acoustic coupling theory maybe no longer applicable and need to be corrected for the actual TMS practical application.

Is the work in progress?

Yes

121A

Impedance Matching Circuit Design of Capacitive Power Transfer System for Implantable Medical Devices Considering Dielectric Constant of Human Tissue

Dr Jangyong Ahn[1], Mr Sungryul Huh[2], Dr Ae-Kyoung Lee[1], Dr Haerim Kim[2], Mr Dongryul Park[2], Dr Seon-Eui Hong[1], Dr Hyung-Do Choi[1], Dr Jung-Ick Moon[1], Prof Seungyoung Ahn[2]
[1]Electronics and Telecommunications Research Institute, Daejeon, Korea, Republic of.
[2]Korea Advanced Institute of Science and Technology, Daejeon, Korea, Republic of

Abstract Subject Area(s)

["Biological and medical applications"]

Summary

The human body environment has a very high dielectric constant compared to air, so it is an advantageous environment for Capacitive Power Transfer (CPT) because sufficient coupling can be achieved even with small plates and long separation distances. Therefore, based on these characteristics, research is being actively conducted to apply the CPT method to IMD.
The design of CPT for IMDs should consider the human tissue environment, which is composed of multiple layers, and designing and impedance matching circuit that takes this into account is essential. In particular, in the kHz to MHz band, where the WPT system for IMD is mainly used, the dielectric constant of each tissue varies greatly, so the variable dielectric constant is an important consideration when designing the compensation networks. Furthermore, from the perspective of use of the IMD system after product design, changes in human tissue may occur depending on the application area or the patients. Therefore, in this study, we analyzed a method of designing an impedance matching circuit of CPT for IMDs by considering the variable dielectric constant of the propagation media generated accordingly, and propose a design method that improves efficiency and reduces human exposure. Additionally, it is verified through power transmission efficiency and induced electric field inside the human body.

Is the work in progress?

Yes

123A

Assessment of the PEMFs neuroprotective effect through semi-specific numerical dosimetry: towards the validation of the model

Dr Micol Colella[1], Dr Noemi Dolciotti[1], Miss Lucrezia Di Nardo[1], Dr Sara Fontana[1], Dr Simona Salati[2], Prof Ruggero Cadossi[2], Prof Francesca Apollonio[1], Prof Micaela Liberti[1]
[1]Sapienza University of Rome, Rome, Italy. [2]IGEA Biophysics Laboratory, Carpi, Italy

Abstract Subject Area(s)

["Experimental dosimetry","Numerical dosimetry","ELF/LF","Biological and medical applications"]

Summary

The application of low intensity and low frequency pulsed electro-magnetic fields (LF-PEMFs) may represent a neuroprotective treatment of acute ischemic stroke. The ongoing I-NIC project is a double-blind study, which aims to validate PEMFs stimulation as a non-invasive, effective, tolerable, and safe tool to treat cerebral damages in patients affected by ischemic stroke. Dosimetric evaluation through the novel semi-specific numerical modelling approach, applied on active and placebo patients recruited for the I-NIC project, is currently ongoing and is showing promising results towards demonstrating the possible correlation between the reduction of the ischemic lesion and the magnetic field values induced by the PEMFs stimulation.

Is the work in progress?

Yes

125A

Functional intervention levels to manage safety hazards caused by static magnetic field in MRI work environment

Dr Jolanta Karpowicz
Central Institute for Labour Protection - National Research Institute (CIOP-PIB), Warszawa, Poland

Abstract Subject Area(s)

["Occupational exposure","Risk assessment","Biological and medical applications"]

Summary

The relevant characterization of safety hazards caused by static magnetic field (SMF) surrounding magnets of magnetic resonance imaging (MRI) scanners in the diagnostic chamber belongs to the priority research in bioelectomagnetics, as well as the core task in managing of occupational hazards at work. Taking into account mentioned practical challenges, the spatial distribution of SMF have been examined in the vicinity of 16 MRI scanners from various manufacturers (of the most popular in Europe 1.5T or 3T magnets) with respect to the location of space affected by SMF enable to cause: (a) movement-related balance disturbances, which may cause direct safety hazards for affected worker or patient; (b) projectile effect in heavy ferromagnetic objects, which may cause lethal hazard for workers and patients, as well as serious damages of the MRI scanner; (c) projectile effect in small ferromagnetic objects, which may cause smaller hazards for workers or patients, for example by cutting the skin of person hit by flying object, but usually is not dangerous for the MRI scanner itself. In the second step the functional intervention levels (FIL) have been derived in the context of spatial location of particular hazards.

127A

Threshold Values To Assess the Safety of Workers With Cardiac Implants Exposed to Magnetic Fields (16 Hz to 200 kHz)

Dr Carsten Alteköster[1], Dr Dominik Stunder[2], Dr Florian Soyka[1]
[1]Institute for Occupational Safety and Health of the German Social Accident Insurance, Sankt Augustin, Germany. [2]Research Center for Bioelectromagnetic Interaction of the Institute for Occupational, Social and Environmental Medicine, Aachen, Germany

Abstract Subject Area(s)

["ELF/LF","Occupational exposure","Risk assessment"]

Summary

The number of people wearing a cardiac implantable electronic device (cardiac implant), like a pacemaker (PM) or an implantable cardioverter-defibrillator (ICD), has been growing steadily for years. In everyday life and at work, these people are regularly exposed to magnetic fields that may interfere with the implant and could lead to an adverse effect. In particular, the functionality of many industrial applications is linked to the use of high magnetic fields, which can potentially lead to high exposures of workers at these workplaces.
In such situations, a precise risk assessment for implant wearers is essential to define any necessary measures to ensure their safety. To this end, the magnetic fields at the workplace must be compared to adequate threshold values, which should reflect the implant immunity from interference due to magnetic fields, or interference immunity for short, as best as possible. Instead of such specific threshold values, values derived for the general public without implants are often used as a criterion, which leads to unnecessarily conservative assessment results.
This work specifies threshold values for magnetic fields in the frequency range of 16 Hz to 200 kHz, which are based on experimental research results and requirements for implants to be immune from interference due to magnetic fields defined by standards. These values will enable more precise risk assessments in the future.

129A

Investigating on Mobile Phone Transmitting Power for VoIP in Paris

Jiang LIU[1], Yarui Zhang[1], Wassim Ben Chikha[1], Shanshan Wang[2], Theodoros Samaras[3], Ourouk Jawad[4], Lamine Ourak[5], Emmanuelle Conil[4], Joe Wiart[1]
[1]Telecom Paris, Palaiseau, France. [2]ETIS, Cergy, France. [3]Aristotle University of Thessaloniki, Thessaloniki, Greece. [4]ANFR, Maisons-Alfort, France. [5]EXEM, Toulouse, France

Abstract Subject Area(s)

["Experimental dosimetry","Risk assessment"]

Summary

In this study, to assess the electromagnetic radiation from the uplink of wireless communication, we utilized NEMO Handy from Keysight Technologies to investigate the transmit (TX) power of Android phones during Voice over Internet Protocol (VoIP). This paper investigated TX power of mobile phone running WhatsApp VoIP. In the Great Paris region, 378 locations are chosen to conduct measurements. Without any limitation on the mobile phone technology selection, measurements in UMTS, LTE and NR-NSA are

collected. Statistical results of measurements conducted at 378 locations in the Greater Paris area are presented, a comparison of TX powers using a 5G-disabled and 5G-enabled mobile phone is given. To compare TX powers of different technologies, average TX power of LTE and NR is calculated based on duty cycle. The results indicate that 5G NR non standalone (NSA) has lower TX power compared to previous technologies.

Is the work in progress?

Yes

131A

Measurements of DC magnetic fields generated from HVDC transmission lines

Mr Fumiaki Kawabe, Mr Norihiro Minami, Mr Yuji Takada, Dr Chiyoji Ohkubo
Japan Emf Information Center, Tokyo, Japan

Abstract Subject Area(s)

["Experimental dosimetry","ELF/LF","Standards and public health policy"]

Summary

Japan EMF Information Center (JEIC) is conducting various activities for communicating scientific information regarding electromagnetic fields (EMF) in easily understandable form to resolve anxieties of the general public about EMF.

In recent years, high voltage direct current (HVDC) transmission liness are newly installed or upgraded in Japan to strengthen transmission capacity of interregional connecting facilities. HVDC transmission lines are also increasing in Eurpoe. In view of such situation, it is anticipated that public concern about health effects, including environmental effects, of magnetic fields generated from HVDC transmission lines (DC magnetic fields) will be increased. Since the limited number of reports are available on measurement of DC magnetic fields in Japan, we conducted measurements of DC magnetic fields generated from all the existing DC transmission lines (4 lines) in compliance with the International Electrotechnical Commission (IEC) Stadard 61786-1:2013.

It was confirmed that the measured values of DC magnetic fields range from 39.7 to 154.8 μT, well below the exposure limit value of 400 mT for the general public of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines (2009) and is almost comparable to the geomagnetic field. We believe that these findings are valuable for our risk communication activities with the general public regarding EMF.

Is the work in progress?

No

133A

Assessment of magnetic fields close to conductive and inductive charging systems for electric cars

Pia Schneeweiss[1], Rene Hirtl[1], Gernot Schmid[1], Johannes Kainz[1,2], Sarah Driessen[2], Michael Kubocz[2], Luis Kalb[3], Dino Silvestro[3], Matthias Vogt[3]
[1]Seibersdorf Laboratories, EMC & Optics, Seibersdorf, Austria. [2]Research Center for Bioelectromagnetic Interaction (femu)-Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany. [3]ADAC Technik Zentrum, Landsberg am Lech, Germany

Abstract Subject Area(s)
["Experimental dosimetry","ELF/LF"]
Summary
The magnetic field (MF) exposure for persons close to conductive and inductive charging systems of electric vehicles (EV) was assessed by a systematic measurement series with six different EV at five different conductive charging systems and one hybrid electric vehicle (HEV) at one inductive charging system. The charging process started at two states of charge (SoC): < 10 % and > 95 % battery status. For the measurements we used the recently developed multichannel measurement system MF EASY with ten isotropic MF probes positioned either in a Styrofoam tower (height corresponding to a standing person) or a Styrofoam dummy inside the vehicles at the positions of interest.
While the measurements have been completed, the exposure indices (ExpInd) related to the reference levels for general public exposure according to the European council recommendation 1999/519/EC and the ICNIRP 2010 guidelines are currently being analyzed. The results will be presented at the BioEM 2024.

135A
ELF and LF magnetic field assessment in public transportation with electric drive systems
Pia Schneeweiss[1], Rene Hirtl[1], Gernot Schmid[1], Johannes Kainz[1,2], Sarah Driessen[2], Michael Kubocz[2], Luis Kalb[3], Dino Silvestro[3], Matthias Vogt[3]
[1]Seibersdorf Laboratories, EMC & Optics, Seibersdorf, Austria. [2]Research Center for Bioelectromagnetic Interaction (femu)-Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany. [3]ADAC Technik Zentrum, Landsberg am Lech, Germany
Abstract Subject Area(s)
["Experimental dosimetry","ELF/LF"]
Summary
The extremely low frequency (ELF) and low frequency (LF) magnetic fields (MF) occurring in public transportation with electric drive systems were measured in the course of a comprehensive study in Germany. The means of transportation examined included high-speed trains (Intercity Express ICE), express trains (Intercity IC), regional trains (RE and RB), urban-suburban trains (S-Bahn), and light rail carriages (overground and underground trams, such as Cologne Stadtbahn). Measurements were executed on several seating and standing positions during different driving maneuvers (acceleration, constant driving, braking, and standstill) as well as on the respective platforms during arrival, standstill, and departure of the trains. The mobile measurement setup was carried in a backpack and covered a frequency range of 1 Hz – 400 kHz.
In ICE, IC, RE, RB, and Stadtbahn, higher peak values of the magnetic flux density were measured inside the means of transport compared to the corresponding platforms. However, the peak magnetic flux density measurements on S-Bahn platforms exceeded the ones inside the carriages. Of all the considered public transport systems, the highest exposure indices were found in light rail carriages, such as subways and tramways (up to 177 % of the European council recommendation 1999/519/EC reference levels for the general public). However, the highest magnetic flux density peak value was measured at a standing place on the upper level of an IC (65 µT).

137A

ELF and LF magnetic field assessment on electric scooters and motorcycles

Rene Hirtl[1], Pia Schneeweiss[1], Gernot Schmid[1], Johannes Kainz[2,1], Sarah Driessen[2], Michael Kubocz[2], Luis Kalb[3], Dino Silvestro[3], Matthias Vogt[3]
[1]Seibersdorf Laboratories, EMC & Optics, A-2444 Seibersdorf, Austria. [2]Research Center for Bioelectromagnetic Interaction (femu)-Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany. [3]ADAC Technik Zentrum, D-86899 Landsberg am Lech, Germany

Abstract Subject Area(s)

["Experimental dosimetry","ELF/LF"]

Summary

Magnetic field (MF) exposure caused by electric scooters and motorcycles has been systematically investigated in a thorough measurement campaign on a dynamometer test bench and a test track. The magnetic induction (up to 400 kHz) has been recorded in time domain in up to ten different positions on the driver and passenger seats while performing well defined driving maneuvers, such as acceleration, braking, and driving at different constant speeds. Results show remarkably high temporal peak values of the magnetic induction of up to B_{PEAK} = 365 µT. Exposure indices (ExpInd), determined by applying the weighted peak method in time domain (WPM-TD) according to reference levels for the general public defined in European Council recommendation 1999/519/EC, show values up to 8.24. However, ExpInd determined by applying the WPM-TD according to reference levels for the general public defined in ICNIRP 2010 guidelines only slightly exceeds unity (1.05). For all four investigated vehicles, highest magnetic induction was found during acceleration in lower body part regions, such as feet, lower legs, i.e., in close proximity to the electric drive parts. ExpInd in upper body parts, like chest and head, always remained below 0.2. Although the reference levels are partially exceeded to a high extent, numerical computations show compliance in terms of the induced electric field strength in the anatomical body models.

139A

Exposure Assessment to Wearable 5G Antenna: Effect of Multi-Layer Skin in Anatomical Human Model

Dr Silvia Gallucci[1], Miss Martina Benini[1,2], Dr Marta Bonato[1], Dr Gabriella Tognola[1], Dr Marta Parazzini[1]
[1]CNR - IEIIT, Milan, Italy. [2]DEIB - Politecnico di Milano, Milan, Italy

Abstract Subject Area(s)

["Numerical dosimetry"]

Summary

The aim of the present work is to study the impact of the choice of multi-layer model of the skin rather than the homogeneous one. Specifically, the study was focused on a new technology that is the wearable antenna tuned to 28 GHz, that are posed close to the body user, consequently involving the human tissue in the power absorption. Moreover, the present work is a first attempt to integrate the inner structure of the skin with the anatomy of the human user, by using a realistic human model. For assessing the human exposure, we have extracted the Absorbed Power Density (S_{ab}) averaged over a square

of both 1 cm^2 according to the international guidelines limits. As a results, it is clear that the homogeneous model of the skin underestimates the exposure levels if compared with the ones estimated in the stratum corneum, the outermost stratum of the multi-layer model.

Is the work in progress?

Yes

141A

Normalized Induction Factor for Internal Electric Fields in Human Head Exposed to Non-uniform Magnetic Fields in the Vicinity of Power Lines with Multiconductor Bundle

Dr Takeo Shiina[1], Mr Yoichi Sekiba[2], Dr Kenichi Yamazaki[1]

[1]Central Research Institute of Electric Power Industry, Yokosuka, Japan. [2]Denryoku Computing Center, Komae, Japan

Abstract Subject Area(s)

["Numerical dosimetry"]

Summary

We calculated the normalized induction factor for the internal electric field in the human body caused by a non-uniform magnetic field in the vicinity of a current path, assuming that the head is close to a power line. From the obtained results, we found that the normalized induction factor calculated in the head in close proximity to power lines was higher than that in the whole body. Furthermore, we found that the normalized induction factor for the exposure to magnetic fields from multiple power lines was higher than that of the single conductor.

Is the work in progress?

Yes

143A

Comparison of three equivalent source models for APD assessment

Ms Jiawen Zheng, Dr Yinliang Diao

SCAU, Guangzhou, China

Abstract Subject Area(s)

["Numerical dosimetry"]

Summary

The international guidelines and standard specified the area-averaged absorbed/epithelial power density (APD/EPD) as the basic restriction at frequencies above 6 GHz. Measurement at higher frequencies usually suffers from larger uncertainty due to the interaction. In this study, we compared the accuracy of three equivalent source models in estimating the APD and found that using only electric field or magnetic field as equivalent source would result in relatively large differences in computed APD. The results can be informative for selecting the equivalent source model to be used for APD assessment.

Is the work in progress?

Yes

145A

Low frequency magnetic fields exposure - health effects and the precautionary principle recommendations of different countries

Dr Amnon Duvdevany
IIOSH (Israel Institute for Occupational Safety and Hygiene), Tel-Aviv, Israel

Abstract Subject Area(s)

["ELF/LF","Standards and public health policy"]

Summary

Human exposure to Low Frequency (LF) magnetic fields raises concerns regarding potential health effects. These concerns are associated mainly with the exposure to magnetic fields that originate from the electrical grid but may be also related to electrical facilities and equipment, and to fields that originate from emerging technologies (e.g., hybrid and electrical cars).
Current knowledge regarding human health effects of exposure to LF magnetic fields will be discussed: acute effects vs. chronic effects; the positions on the risk of these effects taken by international bodies; later studies and adoption of the precautionary principle by various countries according to several comprehensive surveys as well as other publications. Among 48 countries that were included in the surveys, 23 (48%) adopt the precautionary principle either by adopting low target exposure levels (lower than ICNIRP or IEEE levels), or by administrative steps.

147A

Effects of website-based risk communication on general public in Japan

Dr Sachiko Yamaguchi-Sekino, Dr kazuhisa Kamegai, Ms Miwa Ikuyo, Prof Masao Taki, Dr Teruo Onishi, Dr Soichi Watanabe
National Institute of Information and Communications Technology, Koganei, Japan

Abstract Subject Area(s)

["Standards and public health policy"]

Summary

This study focused on risk communication for radio frequency electromagnetic fields (RF-EMF) and involved the development of a pilot website with monitoring data, targeting the general public's response. The study followed a protocol involving a baseline survey, an immediate impact assessment post-website viewing, and a follow-up survey after five weeks. Views of RF-EMF were categorized based on baseline responses and the website's influence on various clusters was examined. Four clusters were identified: Cluster 1: non-anxious, Cluster 2: anxious, Cluster 3: low interest, Cluster 4: high interest. Immediate website viewing temporarily increased RF-EMF awareness significantly, but it returned to baseline levels after 5 weeks later in cluster 1 and 3 (non-anxious and low interest, $p<0.05$, Mann-Whitney U test). In Cluster 4 (high interest), subjective RF-EMF exposure levels tended to decrease after website viewing. A temporal reduction in health concerns about RF-EMFs was observed in Cluster 2 (anxious, $p<0.05$, Mann-Whitney U test), which showed a decreasing tendency 5 weeks later. The health concerns about RF-EMFs showed a temporal increase in Cluster 3 (low interest) immediately after website viewing ($p<0.05$, Mann-Whitney U test) but returned to the same level as the baseline after 5 weeks. These findings highlight that the impact of risk communication varies across clusters, emphasizing the need for tailored approaches to address different perceptions and knowledge levels within the public.

Is the work in progress?
Yes

149A
Comparison of TMS Dosimetry between structured and unstructured grids using different solvers
Dr Francesca Camera[1], Dr Caterina Merla[1], Prof Valerio De Santis[2]
[1]Division of Health Protection Technologies, Italian National Agency for Energy, New Technologies and Sustainable Economic Development (ENEA), Rome, Italy. [2]Department of Industrial and Information Engineering and Economics, University of L'Aquila, L'Aquila, Italy
Abstract Subject Area(s)
["Numerical dosimetry"]
Summary
In recent years, the interest in transcranial magnetic stimulation (TMS) has surged, necessitating a deeper understanding of low-frequency (LF) numerical dosimetry for TMS studies. While various ad-hoc models exist, commercial software tools like SimNIBS and Sim4Life are preferred for their user-friendliness and versatility. SimNIBS utilizes unstructured tetrahedral mesh models, while Sim4Life employs voxel-based models on a structured grid, both evaluating induced electric fields using the finite element method (FEM) with different numerical solvers. Past studies primarily focused on uniform exposures and voxelized models, lacking realism. Our study compares these solvers across simplified and realistic anatomical models to assess their accuracy in capturing induced electric fields. We examined three scenarios: a single-shell sphere, a sphere with an orthogonal slab, and an MRI-derived head model. The comparison revealed small discrepancies in induced electric fields, mainly in regions of low field intensity. Overall, the differences were contained (below 2% for spherical models and below 10% for the head model), showcasing the potential of computational tools in advancing exposure assessment protocols for TMS applications.
Is the work in progress?
Yes

151A
A novel non-invasive magnetic acoustic electric composite field focusing stimulation method (M-TMAS)
Dr Xu Liu, Prof Zhipeng Liu
Institute of Biomedical Engineering, Tianjin, China
Abstract Subject Area(s)
["in vivo","Electroporation and pulsed electric field applications"]
Summary
In the study of brain fine structure and function, as well as the clinical diagnosis and treatment of brain diseases, the application of invasive electrical stimulation in clinical promotion and brain research is limited; Non invasive electromagnetic stimulation is still unable to break through the technical bottlenecks of focus and stimulation depth, and achieve precise stimulation of deep functional nuclei. This abstract proposes a research on non-invasive focused stimulation technology with principle innovation in composite

fields. Based on the magneto acoustic coupling effect, a pulsed magnetic field with orthogonal directions and a focused ultrasound field are used to generate a magneto acoustic coupling electric field. The direction of the magnetic stimulation coil is controlled to make the direction of the magnetic induction electric field consistent with that of the magneto acoustic coupling electric field, forming a composite physical field of sound field, magneto acoustic coupling electric field, and magnetic induction electric field. Realize high spatial resolution focused stimulation in various intracranial tissues, forming non-invasive focused stimulation technology and instruments. To provide non-invasive and precise regulation technology for cognitive function research in neuroscience, and to provide important technical means for the study and diagnosis of the occurrence and development mechanisms of brain diseases.

Is the work in progress?

Yes

153A

High-Resolution Voxel-Based Numerical Modelling of the Eye Exposure to Electromagnetic Fields Beyond 6 GHz

Ms Fatima Alzaabi, Dr Yasir Alfadhl, Prof Xiaodong Chen
Queen Mary University of London, London, United Kingdom

Abstract Subject Area(s)

["Numerical dosimetry","MM Waves","Standards and public health policy"]

Summary

This paper outlines the improvements in numerical modelling of the human eye's exposure to mm-waves. It presents strategies to manage the increased computational demands due to a higher number of voxels and challenges in short-wavelength solutions. The research includes detailed analysis using a virtual human model to study the eye's response to EM waves at various frequencies, including a specific focus on the eye region for frequencies of 0.9, 2.45 and 5 GHz where SAR is assessed. Additionally, evaluating a hard-head model at a frequency of 12 GHz highlighting the power density measures to be a relevant tool for beyond 6 GHz.

19:30 - 22:30	Student Ice Breaker	Alkionides Seaside restaurant

Tuesday June 18th

09:00 - 10:00	Poster Flash B	Niels Kuster Luc Martens	Main Hall

FB01

A wearable cardiac physiological signal monitoring method assisted by seismocardiogram signal

Ms Haoyue Wang, Dr Yifeng Wang, Prof Jiangtao Li
Xi'an Jiaotong University, Xi'an, China

Abstract Subject Area(s)

["In vitro","Biological and medical applications"]

Summary

With the increasing number of people suffering from cardiovascular diseases worldwide, the prevention and treatment of cardiovascular diseases are paid more and more attention. In this context, the use of portable and comfortable cardiac monitoring equipment for cardiovascular disease monitoring and alarm has become a general trend. Although the ECG signal has become the "gold standard" in the diagnosis of cardiovascular disease, the ECG has limitations in the diagnosis of some structural heart diseases, so the combination of SCG signal analysis is necessary. A non-contact ECG and SCG synchronous acquisition system is proposed in this paper, which can realize the long-term acquisition of ECG and SCG without the sensor touching the skin directly. Using this system, the diagnosis of cardiovascular diseases based on SCG assistance can be realized. In order to explore the influence of non-contact acquisition on signal quality, theoretical calculation and practical test are carried out in this paper. The calculation and measured results show that the high-frequency part of ECG and SCG signals in non-contact acquisition is attenuated, but the degree of attenuation is acceptable. In addition, the EMD algorithm is used to remove the motion artifacts of ECG and SCG signals, which improves the signal-to-noise ratio of ECG and SCG signals. At the same time, the algorithm can be used to extract respiratory wave from SCG original signal to obtain more abundant physiological information.

Is the work in progress?

No

FB02

High precision temperature analysis considering temperature-dependent physical properties for renal denervation.

Mr Tohgo Hosoda, Prof Kazuyuki Saito
Chiba University, Chiba, Japan

Abstract Subject Area(s)

["In vitro","RF/Microwave","Biological and medical applications"]

Summary

Renal denervation has been noted as a treatment for hypertension, which performed by introducing a catheter into the renal artery and ablating nerves located outside the renal

artery. However, recent clinical trial has not shown sufficient effects due to insufficient ablation of the renal nerves. The catheter used in the clinical trial for ablation of the renal nerves was an RF current based catheter, which is currently the most common method. However, it has been reported that microwave denervation devices are capable of heating a wider region than the RF devices. Therefore, we investigated the characteristics of microwave RDN devices in biological tissues. In the previous temperature analysis on microwave heating, we used stable values for the temperature analysis. However, it has been reported that the physical properties of biological tissues are temperature-dependent, and a few studies has been reported on the difference in the heating area in the renal denervation depending on the temperature dependence of the biological tissues. In this study, temperature analysis was performed using temperature dependence of physical properties in order to analyze the characteristics of microwave denervation devices more precisely. The analytical model with temperature dependence, compared to the analytical model with constant physical properties, showed temperature differences. In particular, there were differences in some organs and tissues until a thermal equilibrium state was reached. From the results, it can be said that the temperature dependence physical properties will be one of the variables to consider when an accurate temperature analysis is required.

Is the work in progress?

Yes

FB03 - Withdrawn

FB04

Effects of fifth-generation (5G) environmental radiofrequency signals on oxidative stress and DNA repair in skin cells: a BRET study.

Miss Jana Haidar[1], Mrs Patricia Nabos[1], Dr Rosa Orlacchio[1], Mrs Annabelle Hurtier[1], Dr Florence Poulletier De Gannes[1], Mrs Delia Arnaud-Cormos[2], Mr Philippe LEVEQUE[2], Dr Isabelle lagroye[1], Dr Yann Percherancier[1]

[1]IMS, Bordeaux, France. [2]XLIM - UMR 7252 CNRS, LIMOGES, France

Abstract Subject Area(s)

["In vitro"]

Summary

This study aims to assess the impact of 5G environmental RF signals on oxidative stress and DNA repair in human skin cells using Bioluminescence Resonance Energy Transfer (BRET) assays.

In response to the ongoing debate on the effects of RF-EMF on human cells, we address the specific question of whether 5G exposure induces oxidative stress and DNA damage, with a focus on the skin as a novel biological target. Previous research has predominantly explored the thermal effects of RF-EMF, but the potential "non-thermal" impacts remain uncertain, urging the need for empirical investigations.

The exploration of the DNA damage response (DDR) and oxidative stress in the context of RF fields represents an intricate and developing area of research. Although some studies propose potential associations between RF fields and DNA damage or oxidative stress, the overall scientific consensus remains inconclusive, prompting further research.

In this study, we employ innovative BRET molecular probes on SV-40 immortalized skin fibroblast line and HaCaT keratinocytes for detecting reactive oxygen species (ROS) and DDR in cells that were exposed to 5G-modulated 700 MHz using transverse electromagnetic (TEM), and 3.5 GHz signals using a reverberation chamber for 24h at various specific absorption rates (SAR) ranging from 0.4 to 4 W/kg. Successive exposure to UV and 5G-modulated signals will also be investigated. All results will be presented at the meeting.

Is the work in progress?

Yes

FB05

Cytogenetic effects of in vitro exposure to 5G-Modulated 3.5 GHz signal on HaCaT cell line: preliminary results from the NextGEM Project.

Mr Seppe Segers[1,2], Mrs Maryse Ledent[1], Mr Roel Anthonissen[1], Prof Lutgart Braeckman[2], Dr Birgit Mertens[1]

[1]Sciensano, Brussels, Belgium. [2]UGent, Gent, Belgium

Abstract Subject Area(s)

["In vitro"]

Summary

The rapid advancement, particularly in telecommunications, presents global environmental, health, technical, and regulatory challenges. Potential health effects arising from the exposure to radiofrequency electromagnetic fields remain a contested topic. While the 3.5 GHz 5G-NR signal falls within the range of currently used frequencies, understanding the potential risks associated with RF-EMF exposure is essential for informing regulatory policies and developing mitigation strategies to safeguard public health in the era of wireless communication advancements.

The Next Generation Integrated Sensing and Analytical System for Monitoring and Assessing Radiofrequency Electromagnetic Field Exposure and Health (NextGEM) project endeavors to investigate these potential effects using stringent *in vitro* testing methodologies. This presentation discusses the findings from the NextGEM projects inquiry into the cytogenetic impacts of RF-EMF, with a particular emphasis on 5G-modulated frequencies on the HaCaT cell line. Utilising in vitro techniques with high measures of quality control, HaCaT cells were exposed to varying intensities of RF-EMF. Cytogenetic endpoints including micronuclei formation and DNA damage were assessed to elucidate potential genotoxic effects through the use of the in vitro micronucleus assay and the in vitro alkaline comet assay respectively. Additionally, cell viability assays were conducted to evaluate overall cellular health and response to RF-EMF exposure. In this presentation, we aim to give an overview of the preliminary results obtained over the course of the project so far.

Is the work in progress?

Yes

FB06

Delayed growth in immature male rats exposed to 900 MHz radiofrequency

Mr Raphaël Bodin[1,2], Mr Franck Robidel[1], Mrs Stéphanie Rodriguez[1], Mr Anthony Lecomte[1], Dr Anne-Sophie Villégier[1,2]

[1]INERIS, Verneuil-en-Halatte, France. [2]UPJV/INERIS UMR_I 01, Amiens, France
Abstract Subject Area(s)
["in vivo","RF/Microwave","Biological and medical applications"]
Summary
People have been exposed to the 900MHz mobile phone electromagnetic field for approximately 30 years, with the 2nd generation (2G) Global System for Mobile communications network. However, there is still no conclusion from immature rodent experiments regarding the potential effects of nonthermal radiofrequency 900MHz continuous waves exposure during the biological development. Here, we aimed to test the hypothesis that when mother rats received a whole-body SAR occupational limit of the International Commission on Non-Ionizing Radiation Protection for human (0.4W/kg) clinical growth and development was impacted in the descendant, with less (or no) effect at public limit (0.08W/kg). Sprague Dawley pregnant rats (mothers, M) whole-body SAR of 0.4W/kg and 0.08W/kg were reached with 30.2V/m electric field (PEF) and 67.5V/m electric field (OEF) for 330g body weight. Exposure was 8h/day from gestational day 8 until postnatal day 21 (n = 8-9/group). The neonate males showed earlier pinna ear detachment only for OEF group and earlier eye opening only for the PEF exposed group compared to the sham. Compared to the sham-exposed and to the PEF exposed males, the OEF exposed juvenile males showed lower body weight until adolescence. Both OEF and PEF radiofrequency-exposed females groups showed earlier pinna ear detachment and eye opening but similar bodyweight compared to the sham-exposed females. The present study suggested that pre- and post-natal exposure to 900 MHz continuous waves at human levels of occupational and general public level led to clinical effects in the neonatal and adolescent rats.
Is the work in progress?
Yes

FB07
Changes in ambient radiofrequency electromagnetic fields (RF-EMF) levels between 2021 and 2023 in Switzerland: a 5G Hiker Story
Mr Nicolas Loizeau[1,2], Dr Dominik Haas[3], Dr Marco Zahner[4], Dr Johannes Schindler[3], Mrs Christa Stephan[3], Dr Jürg Fröhlich[4], Mr Markus Gugler[5], Mr Toni Ziegler[3], Prof Martin Röösli[1,6]
[1]Swiss Tropical and Public Health Institute, 4123 Allschwil, Switzerland. [2]University of Basel, 4001, Switzerland. [3]Grolimund + Partner AG Environmental Engineerging, 3097 Bern, Switzerland. [4]Fields at Work GmbH, 8032 Zürich, Switzerland. [5]NED-TECH AG, 3380 Wangen an der Aare, Switzerland. [6]University of Basel, 4001 Basel, Switzerland
Abstract Subject Area(s)
["Epidemiology","RF/Microwave","Risk assessment","Standards and public health policy"]
Summary
The fifth generation of mobile technology (5G) has been extensively deployed across Switzerland since 2021. There are public concerns about a potential increase in ambient radiofrequency electromagnetic fields (RF-EMF) levels, while mobile communication stakeholders argue that the new adaptive antennas will reduce or not change the ambient RF-EMF exposure. Therefore, we aim to assess the changes in ambient exposure to RF-EMF in Switzerland between 2021 and 2023 following the rollout of 5G.

We measured ambient RF-EMF using portable devices in 75 outdoor areas and 43 public spaces twice at the same time of the day in 2021 and 2023. RF-EMF levels were measured with two ExpoM-RF4, which cover 35 RF bands from 80MHz to 6GHz and record the root-mean-square (RMS) signal and the instantaneous highest signal (Peak-Hold) within a 50ms interval. In public spaces, the mean RMS levels increased from 0.38 V/m to 0.41 V/m between 2021 and 2023, whereas the mean Peak-Hold levels increased from 2.15 V/m to 2.81 V/m. The most significant increase in Peak-Hold mean levels occurred in the 5G bands, rising from 0.68 V/m to 1.44V/m. In outdoor areas, the mean RMS levels remained unchanged between 2021 and 2023 (0.28 V/m) and mean Peak-Hold levels increased from 1.52 V/m to 1.70 V/m. Although the mean RMS levels remained relatively stable between 2021 and 2023 despite the continuing increase in mobile data traffic, the increase in mean “Peak-Hold” levels can be attributed to the more dynamic capabilities of 5G.

Is the work in progress?

Yes

FB08

A Serious Game Approach to Increase the Public’s Understanding of Scientific Uncertainty in Risk Assessment and Communication

Mr Ferdinand Abacioglu, Dr Marie Eggeling, Ms Sarah Link, Prof Christoph Boehmert
IU Internationale Hochschule, Erfurt, Germany

Abstract Subject Area(s)

["RF/Microwave","MM Waves","Risk assessment"]

Summary

Existing research on risk communication about radiofrequency electromagnetic fields (RF-EMF) has a notable limitation in its predominant emphasis on one-way, text-based communication. Notably, interactive online formats designed for informational or educational purposes, such as serious games, remain unexplored in the context of RF-EMF risk communication. However, serious games have demonstrated effectiveness in knowledge acquisition and various other outcomes. Despite their potential, no serious games have been developed specifically for RF-EMF risk communication thus far. One aim of the Horizon-Europe funded project SEAWave (Scientific-Based Exposure and Risk Assessment of Radiofrequency and mm-Wave Systems from children to elderly [5G and Beyond]) is to design, develop and evaluate a corresponding browser game (i.e. serious game). The main goal of this serious game is to increase scientific literacy with a focus on scientific uncertainty and conveying state-of-the-art knowledge on RF-EMF risk assessment to the interested general public. In the game, players take on the role of a science communicator, navigating communication scenarios and being confronted with the inherent uncertainty in empirical sciences. The game incorporates expert insights and public input, emphasizing factual accuracy and citizen engagement. An advisory board of eight citizens from different European countries has been formed, which actively contributes to the game's development. Currently game contents are being developed, game mechanics refined, and a target group analysis through risk communicator interviews is being conducted. The final web application is expected to launch in May 2025.

Is the work in progress?

Yes

FB09

A low SAR PDMS based irs loaded antenna for 5G sub-6-GHz body area network

Mr Wahaj Abbas Awan[1], Mr Domin Choi[1], Mr Jaemin Lee[2], Prof Niamat Hussain[3], Prof Nam Kim[1]

[1]Chungbuk National University, Cheongju, Korea, Republic of. [2]Chungbuk National University, Cheongju, Korea, Democratic People's Republic of. [3]Sejong University, Seoul, Korea, Republic of

Abstract Subject Area(s)

["RF/Microwave","Biological and medical applications"]

Summary

The demand for reconfigurable antennas is burgeoning due to advances in communication systems and wireless devices. Modern applications require intelligent antenna systems capable of switching radiation patterns without sacrificing performance. Additionally, conformal devices offer durability, cost-effectiveness, and improved performance, appealing to wireless users across various domains. Recent literature discusses several approaches to meet the needs of modern communication systems. For instance, one study proposes a narrow-band pattern reconfigurable antenna for ISM band applications, utilizing PIN diodes to adjust its ground plane shape [1]. Another introduces a frequency and pattern reconfigurable flexible antenna using open-ended stubs and PIN diodes [2]. However, limitations such as narrow bandwidth and low gain persist. This paper addresses the demand for low SAR efficient antennas by presenting a flexible, semi-transparent, pattern reconfigurable antenna for the 5G sub-6 GHz band. Notably, it pioneers the use of PDMS as a substrate for designing intelligent reflective surface-backed antennas, offering pattern reconfigurability along with low SAR for body are network.

FB10

Predictive modeling of exposure to environmental electromagnetic fields using artificial intelligence: data collection and analysis

Mr Athanasios Manassas, Prof Theodoros Samaras

Aristotle University, Thessaloniki, Greece

Abstract Subject Area(s)

["RF/Microwave"]

Summary

The scope of this ongoing work is to build Artificial Intelligence (AI) models using either Machine Learning (ML) or Deep Learning (DL) techniques to predict electromagnetic field values at ground level. The target values are collected either by spot measurements using a spectrum analyzer or by drive test measurements using an electric bike equipped with an exposimeter and GPS. So far, the focus of the work has been on collecting publicly available data, known as 'features', that can contribute to predicting the target values. These features include the distance between the points of interest (POI) and the antennas, the transmitted power of the antennas, and information collected by GIS systems, including the built environment around the POI. Special

attention was given to validating and correcting the accuracy of feature data, a process known as data cleaning in AI.

Is the work in progress?

Yes

FB11

Analytical model for RF propagation in layered spheres: use of high permittivity materials in ultra-high field magnetic resonance of the brain

Mr Vincenzo Miranda[1], Prof Riccardo Lattanzi[2], Prof Daniele Riccio[1], Prof Giuseppe Ruello[1]

[1]University of Napoli Federico II, Department of Electrical Engineering and Information Technology, Naples, Italy. [2]New York University Grossman School of Medicine, Center for Advanced Imaging Innovation and Research (CAI2R) and Bernard and Irene Schwartz Center for Biomedical Imaging, Department of Radiology, 660 First Avenue, 10016, New York, USA

Abstract Subject Area(s)

["RF/Microwave","Biological and medical applications"]

Summary

A new analytical model has been developed to investigate on the role of High Permittivity Materials (HPM's) in Magnetic Resonance Imaging (MRI), in order to optimize the configuration of such materials, guiding subsequent numerical simulations and reducing the time required. In this work we extend the use of the model, applied so far by considering the human head as a homogeneous medium, to a case study in which it is simulated through a multilayer model to approach a real case. The analytical model, based on Mie's scattering theory, reformulates the electromagnetic field in each medium as the superposition of a progressive and regressive wave, exploiting parallelism with transmission lines and allowing a physical interpretation of the phenomenon through simple scalar parameters such as reflection coefficient and impedance. This new formulation makes it possible to study, analytically and in a simple way, the effects of high permittivity materials (HPM's) in ultrahigh field MRI, as a function of permittivity value or thickness, and allowing an intuitive understanding of the scattering phenomenon in terms of interference between progressive and regressive waves. The results of this work show that by introducing a multilayer model, the permittivity value for maximizing the RF field deviates by about 10% from the homogeneous head case. The magnetic induction field strength obtains a maximum increase of about 40% in the case where the HPM is present with the multilayer model, compared to the 20% increase of the case where the head is considered as homogeneous.

Is the work in progress?

No

FB12

A High-Voltage Tunable Pulse System with Tens of Nanosecond Pulse Width for Low Impedance Biological Solution Loads

Miss Wen Dang[1], Dr Xiao Rao[2], Prof Xiaodong Chen[1], Dr Yasir Alfadhl[1]

[1]Queen Mary University of London, London, United Kingdom. [2]Hangzhou Dianzi University, Hangzhou, China

Abstract Subject Area(s)

["Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

This paper introduces a high-voltage tunable nanosecond pulse system for low-impedance biological solution loads, operating at a repetition rate of 1 Hz. The proposed system consists of two primary parts: a high-isolation driver module and a high-voltage module. In the driver module, an optocoupler serves dual roles, acting as a driver gate and providing high isolation due to the absence of electrical contact between input and output. Additionally, a transient-voltage-suppression (TVS) diode is utilized to suppress voltage spikes and clamp the voltage between the gate and source of the silicon carbide (SiC) metal-oxide-semiconductor field-effect transistor (MOSFET). Moving to the high-power module, an energy capacitor is directly charged by a single SiC MOSFET, and subsequently discharged into the load. Numerical analysis shows the proposed system can generate the pulse signal with a pulse width of 30 ns and an amplitude of 1 kV for various loads. Experimental verification is conducted on saline with resistance of 30 Ohms, subjected to pulses of 30 ns and 50 ns.

Is the work in progress?

Yes

FB13

Prediction of therapeutic effect to transcranial magnetic stimulation therapy for treatment-resistant depression using a combination of electric field simulation and functional connectivity analysis index

Mr Yutaro Soejima[1], Ms Anna Iino[1], Dr Masataka Wada[2], Ms Shiori Honda[2], Ms Mayuko Takano[2], Dr Shinichiro Nakajima[2], Prof Masaki Sekino[1], Prof Yoshihiro Noda[2]
[1]Graduate School of Engineering, The University of Tokyo, Tokyo, Japan. [2]Department of Neuropsychiatry, Keio University School of Medicine, Tokyo, Japan

Abstract Subject Area(s)

["Biological and medical applications"]

Summary

Transcranial magnetic stimulation (TMS) is an established treatment for patients with treatment-resistant depression (TRD) who do not respond to medication. Although TMS is an effective treatment for about half of TRDs, it is crucial in practice to be able to predict the therapeutic effect of TMS therapy prior to the start of treatment, because TMS therapy is an economically and physically burdensome treatment for the patient. Thus, in the present study, a novel predictive index utilizing electric field simulation analysis and resting-state functional magnetic resonance imaging analysis was developed to enable highly accurate prediction of the efficacy of TMS therapy for TRD. The following three approaches were implemented in the present study:

1. Prediction considering the whole brain region
2. Prediction by a novel index of stimulus distribution that multiplies electric field and functional connectivity

3. Prediction that perform pre-training on a large dataset without intervention in depression to be able to predict even with a small size of dataset with intervention.

The results showed that the predictions using only the simulated electric field and the simple combination of the simulated electric field and functional connectivity data in Method 1 were the most accurate. These methods were comparable to the previous studies in terms of accuracy. In contrast, Methods 2 and 3 were not more accurate than Method 1. Prediction of therapeutic effect using only electric field simulation analysis is considered feasible and clinically applicable because the method is based on MRI data, which is clinically accessible.

FB14

The effect of 50 Hz MFs on human cytomegalovirus infection in human fetal lung fibroblasts

Miss Zhu Longtao[1], Mr Sun Chuan[2], Mrs Wei Xiaoxia[3], Mr Mao Genxiang[2], Prof Chen Guangdi[1]

[1]Bioelectromagnetics Laboratory, Zhejiang University School of Medicine, Hangzhou, China. [2]Zhejiang Provincial Key Lab of Geriatrics & Geriatrics Institute of Zhejiang Province, Department of Geriatrics, Zhejiang Hospital, Hangzhou, China. [3]Sir Run Run Shaw Hospital, Zhejiang University School of medicine, Hangzhou, China

Abstract Subject Area(s)

["In vitro","ELF/LF"]

Summary

Objective: To investigate the effect of 50 Hz magnetic fields (MFs) on human cytomegalovirus (HCMV) infection in cells. **Methods:** Human fetal fibroblasts were infected with HCMV for 3 days and then exposed to 50 Hz MFs at 0.4, 0.7, and 1.0 mT for 24 h. After exposure the gene copies of HCMV in cells were determined.

Results: Exposure to 50 Hz MFs at 0.4 mT significantly increased HCMV gene copy while exposure to 50 Hz MFs at 0.7 or 1.0 mT significantly inhibited HCMV gene copy in cells. **Conclusion:** Exposure to 50 Hz MFs at low-intensity have an effect in promoting HCMV proliferation while high-intensity have an anti-HCMV effect in human fetal lung fibroblasts.

Is the work in progress?

Yes

FB15

Methods of Reducing the Uncertainty of Dielectric Tissue Properties at Low Frequencies and Its Impact on Dosimetry

Ms Cindy Karina[1,2], Dr Myles Capstick[2], Dr Azadeh Peyman[3], Prof Niels Kuster[1,2]

[1]Department of Information Technology and Electrical Engineering, ETH Zurich, Zurich, Switzerland. [2]Foundation for Research on Information Technologies in Society (IT'IS), Zurich, Switzerland. [3]Radiation Dosimetry, UK Health Security Agency, Chilton, United Kingdom

Abstract Subject Area(s)

["Experimental dosimetry","ELF/LF","Biological and medical applications"]

Summary

Knowledge of the dielectric properties of biological tissues is essential in understanding the response of biological entities to external electromagnetic fields (EMF). However, literature values for dielectric properties at frequencies below 10 MHz are scarce and have large uncertainties, exceeding 100% for the conductivities of some tissues and a few orders of magnitude for permittivity. This work is based on knowledge of the physical properties of tissues as well as other techniques and methods employed to reduce the uncertainty of permittivity assessments even in the presence of electrode polarization. Additionally, ability to measure conductivity with greater confidence at lower frequencies provides an indication of the presence or otherwise of dielectric relaxations as the permittivity cannot change without a corresponding change in conductivity. The study then goes on to investigate the impact the dielectric property uncertainties on uncertainty of dosimetric quantities (induced electric field and current density) across a range of realistic scenarios.

Is the work in progress?

Yes

FB16

Planning 5G non-public network in a real hospital-case scenario: a ray tracing simulation study

Miss Francesca Lodato[1], Dr Andrea Garzia[2], Dr Simona Valbonesi[2], Prof Antonio Iodice[3], Dr Francesco Matera[2], Prof Giuseppe Ruello[3], Dr Pierpaolo Salvo[2], Prof Rita Massa[1]
[1]University of Naples Federico II, Department of Physics "Ettore Pancini", Naples, Italy. [2]Fondazione Ugo Bordoni, Rome, Italy. [3]University of Naples Federico II, Department of Electrical Engineering and Information Technology, Naples, Italy

Abstract Subject Area(s)

["Occupational exposure","Risk assessment"]

Summary

Fifth generation (5G) technologies can allow the deployment of advanced techniques in healthcare field, enhancing the quality of services provided to patients. The installation of 5G non-public networks seems to be very suitable for healthcare environments. However, due to 5G signal characteristics, an optimization study is necessary before introducing them in clinical practice. Ray tracing is a very promising technique for the prediction of electromagnetic field levels generated by 5G systems. The aim of this work is to present a ray tracing analysis on a real-hospital case scenario, planning the introduction of a 5G non-public network. Two proprietary tools based on ray tracing technique were involved and an intercomparison between their results have been carried out in terms of simulated cumulative distribution function and percentiles. A good agreement was found, and this was a starting point for the optimization of the 3.7 AAS (Advanced Antenna Systems) antenna parameters introduced in the selected scenario. The optimization involved antenna position and small cell configuration (E2 or E10). Simulation results have shown that E2 small cell configuration was the best in terms of coverage and energy consumption. Moreover, the optimal antenna position was found. This work demonstrates that the considered tools may be very useful for the design of 5G non-public networks in hospital scenarios. The activity is ongoing and will be extended in future developments for study of performance improvements using

small cell network and quality field parameters, analysis of other outdoor and indoor scenarios or comparison with on-site measurements.

Is the work in progress?

No

FB17

Ultrasonic vibration potential effect in magneto-acoustic coupled electrical stimulation

Mr kai zhu, Prof Xiaoqing Zhou, Mr Xu Liu, Prof Tao Yin, Prof Zhipeng Liu
Institute of Biomedical Engineering Chinese Academy of Medical Sciences & Peking Union Medical College, tianjin, China

Abstract Subject Area(s)

["Mechanisms","Biological and medical applications"]

Summary

In this paper, the characteristics of ultrasonic vibration potential in different salt water with different magnetic induction intensity are discussed. The ultrasonic electromotive force phenomenon in TMAS is found and analyzed, which provides a physical basis for the action mechanism and influencing factors of TMAS effect. The effect of ultrasonic electromotive force on neuroregulation should be considered during the actual stimulation of the organism. The electric field characteristics and mechanism of TMAS are more complex and need further study. This study promotes the application of TMAS in the treatment of neurological and brain aging diseases in the future.

Is the work in progress?

Yes

10:00 - 10:30	Coffee break		Athina
10:30 - 12:00	OS6- Communication risk or exposure/policy	Martin Gledhill Valentin Jaki Waibl	Main Hall

OS06-01

Visualizing Magnetic Field Measurements with Augmented Reality Helps Understanding the Exposure at Workplaces

Dr Florian Soyka, Dr Carsten Alteköster
Institute for Occupational Safety and Health of the German Social Accident Insurance, Sankt Augustin, Germany

Abstract Subject Area(s)

["ELF/LF","Occupational exposure","Risk assessment"]

Summary

People can be exposed to magnetic fields at workplaces. In most cases the exposure is sufficiently low such that no further action is required. However, sometimes safety distances must be obeyed. For workers it can be difficult to understand the exposure scenario and the hazard potential. A visualization of the exposure could be helpful to improve the understanding. An augmented reality system was developed consisting of a magnetic field measurement device combined with a smartphone. It allows visualizing measurements and resulting safety distances directly during the safety evaluation process. Images and videos of the exposure situation can easily be created and shown to workers at a later stage. An online survey was performed showing that the understanding of a measurement report can be significantly improved by including such pictures in the report. A better understanding of the potential hazard could in turn lead to an increase in safety at the workplace.

OS06-02

Response to ICBE-EMF comments on the IEEE EMF Safety Standard

Dr Chung-Kwang Chou
C-K. Chou Consulting, Dublin, USA

Abstract Subject Area(s)

["Standards and public health policy"]

Summary

The comments by the International Commission on the Biological effects of Electromagnetic Field (ICBE-EMF) on the IEEE EMF Safety Standard noted that IEEE has seven blind spots. This discussion will address the specific seven issues based on the IEEE C95.1-2019 standard and not the 2005 version as used in their comments. The basic difference between ICBE-EMF view and the IEEE Standard is the type of effect that an RF exposure limit provides protection for, i.e., an established adverse health effect or reported biological effects. The general approach to public health protection and setting exposure limits by previous Soviet and current Russian committees is that people should not have to compensate for any effects produced by RF exposure, even though

they are not shown to be adverse to health (pathological). Exposure limits are then set that do not cause any possible biological consequence among the population (regardless of age or gender) that could be detected by modern methods during the RF exposure period or long after it has finished. This is an important difference from the approach used by the IEEE and ICNIRP to develop EMF exposure limits; both have developed exposure limits based on adverse health effects. Apparently, the ICBE-EMF group promotes the development of RF exposure limits in a similar way to be precautionary. The reality is that most national and international health agencies and expert groups have issued statements that no adverse health effects have been confirmed below the IEEE and ICNIRP international RF exposure limits.

OS06-03

Risk Communication Using EMF Exposure Levels in Japan – Challenges in 5 Years Project

Dr Sachiko Yamaguchi-Sekino, Dr Kazuhisa Kamegai, Mrs Miwa Ikuyo, Prof Masao Taki, Dr Teruo Onishi, Dr Soichi Waatanabe
National Institute of Information and Communications Technology, Koganei, Japan

Abstract Subject Area(s)

["Standards and public health policy"]

Summary

Our research group has conducted a five-year project involving the monitoring of radio frequency electromagnetic fields (RF-EMFs) in daily life and using these data for risk communication. In surveys assessing the usage and awareness of RF-EMFs in daily life (N=6085), 17.8% of the respondents expressed concerns about the carcinogenic risk associated with RF-EMFs. Health concerns regarding RF-EMF-utilized activities and attitudes towards the carcinogenic potential of other factors (e.g., UV) were found to be correlated with perceptions of radio wave risks (r=0.504 and 0.495, p<0.001, Spearman's rank correlation coefficient). High-objective knowledge about radio waves was associated with certain demographics, including gender (male), age (50 years and older), and active use of communication devices (chi-square test, p<0.001). Feedback from a participatory measurement survey with 27 participants showed that awareness of RF-EMFs increased immediately after receiving feedback but returned to pre-feedback levels after six months (p<0.001, Friedman test). Awareness of the carcinogenic risk of RF-EMFs showed a declining trend, with 44.4% of patients experiencing a decrease, 22.2% remaining unchanged, and 33.3% increasing their risk perception among the respondents six months after the feedback. These results shed light on the attitudes toward RF-EMFs among the Japanese general public and suggest the potential long-term impact of risk communication using monitoring data.

Is the work in progress?

Yes

OS06-04

What is the effect of alarmist media reports and RF-EMF exposure on salivary cortisol and non-specific symptoms?

Dr Adam Verrender[1,2], Miss Nikkeah K. Wallace[1,2], Dr Sarah P. Loughran[1,2,3], Prof Rodney J. Croft[1,2]

[1]Australian Centre for Electromagnetic Bioeffects Research, Wollongong, Australia. [2]School of Psychology, Faculty of Arts, Social Sciences, and Humanities, University of Wollongong, Wollongong, Australia. [3]Australian Radiation Protection and Nuclear Safety Agency, Melbourne, Australia

Abstract Subject Area(s)

["Human studies","RF/Microwave"]

Summary

While there has been consistent evidence that the wide range of non-specific symptoms reported by individuals who experience Idiopathic Environmental Intolerance attributed to Electromagnetic Fields (IEI-EMF) are more closely related to a nocebo response and that alarmist media reports may contribute to this nocebo response, some methodological criticisms of IEI-EMF provocation studies remain to be resolved.
The present study aimed to determine whether viewing an alarmist video and being knowingly exposed to RF-EMF could induce a salivary cortisol response and to test whether this stress response was associated with an increase in symptoms. Although the results showed that participants who were aware that they were being exposed to RF-EMF had an increase in symptoms compared to participants who were aware they were not being exposed (an important replication of previous findings), the current study failed to replicate the effect of viewing an alarmist media report on symptoms and failed to identify an effect of viewing an alarmist media report and being openly exposed to RF-EMF on salivary cortisol. These results suggests that the RF-EMF nocebo effect, in healthy controls, may be more closely associated with higher-level neural processing than lower-level neural processing, where cognitions may play a more important role than underlying physiological processes.

10:30 – 12:00	OS7 – Dosimetry 2 – Experimental dosimetry	Wout Joseph Emma Sylvester	Hall 3

OS07-01

Metal-free Fiber-bundle Fluorescence Microscopy for Quantifying Single-Cell Responses to Radiofrequency Sources

Dr Zachary Steelman[1], Dr Sean O'Connor[2], Ms Anna Sedelnikova[2], Dr Joel Bixler[1]
[1]Air Force Research Laboratory, JBSA Fort Sam Houston, USA. [2]SAIC, San Antonio, USA

Abstract Subject Area(s)

["In vitro","Experimental dosimetry","RF/Microwave","Risk assessment"]

Summary

Significant efforts have been made to quantify biological responses to radiofrequency radiation. Much of this work has been performed in in vivo models. Single-cell studies are highly desirable to isolate effect thresholds and mechanisms in various cell types, however, these efforts are limited as microscopes capable of detecting cellular responses generally consist of metal and electronic components which can alter the applied field. In this work, we present a custom-built microscope with a 3D-printed objective utilizing no metal or electronic components. A coherent imaging fiber bundle is used to relay the image out of the exposure zone to a custom fluorescence

microscope which is kept at a safe distance from the radiation so as to not perturb the field. Full characterization of the system was undertaken to determine our spatial resolution, sensitivity to photobleaching, and ability to capture cell responses to positive control stimuli. Our system compares favorably with confocal microscopy, though our spatial resolution is somewhat limited. Single-cell exposures to free-field 2.8 GHz radiation are ongoing.

Is the work in progress?

Yes

OS07-02

Efficient retrieval of sample permittivity from microwave planar passive devices measurements across a wide frequency range

Mr Petr Kurka, Dr Jaroslav Havlicek, Dr Daniel Havelka, Dr Michal Cifra
Institute of Photonics and Electronics of the Czech Academy of Sciences, Prague, Czech Republic

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","MM Waves"]

Summary

We created a semi-analytical method for obtaining broadband complex permittivity spectra from S-parameters. Testing on conductor–backed coplanar waveguide line S-parameters with water and biomolecule samples up to 50 GHz, we compared the results with a coaxial probe reference. This broadband permittivity extraction method shows promise for developing a versatile permittivity sensing device.

Is the work in progress?

Yes

OS07-03

A non-metallic robotic Cartesian positioning platform for EMF assessment in future wireless networks

Dr Sergei Shikhantsov, Dr Olivier Caytan, Mr Arno Moerman, Prof Guy Torfs, Prof Hendrik Rogier, Prof Luc Martens, Prof Wout Joseph
Ghent University/imec, Ghent, Belgium

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","MM Waves"]

Summary

This paper describes the design and characterization of a numerically-controlled actuator system which uses nearly no conducting parts in its construction. It was developed for accurate and repeatable assessment (mapping) of the electromagnetic field (EMF) via automated remote positioning of EMF probes. Eliminating movement of conducting elements during the probe positioning aims to reduce disruption of the EMF in the measurement procedure. This is critically important in measurements with large antenna array wireless systems operating in the time division duplex mode (such as massive MIMO), as they rely on electromagnetic stationarity of the propagation environment for uplink-downlink channel estimation. We present results of the Finite-Difference Time-Domain simulations comparing actuator systems of identical simplified geometry and different materials, (e.g., perfect electric conductor, plastic, glass) by the

degree to which their translational movement impacts wireless point-to-point channel (transmission coefficient) between two thin half-wave dipole antennas at 3.5 GHz. In addition, an in-house manufactured prototype of a modular linear actuator is evaluated with anechoic chamber measurements, and its design considerations are discussed in detail.

Is the work in progress?

No

OS07-04

Dosimetry of Realistic 3D Human Skin Models at the Millimeter Waves Band of 5G

Mr Serafeim Iakovidis[1], Dr Christine Pich-Bavastro[2], Ms Zhouxing Su[2], Prof Dorothea Kapoukranidou[1], Prof Olivier Gaide[2], Prof Theodoros Samaras[1]

[1]Aristotle University of Thessaloniki, Thessaloniki, Greece. [2]Lausanne University Hospital, University of Lausanne, Lausanne, Switzerland

Abstract Subject Area(s)

["Numerical dosimetry","MM Waves"]

Summary

The FR2 frequency band (millimeter waves) has already been used by the mobile industry to meet the requirements of modern 5G networks. From an EMF exposure perspective, skin is the organ that is dominantly exposed to this radiation and, consequently, needs to be studied. In this work, a method for the construction of 3D realistic human skin models, intended to be used for dosimetry assessment, is presented. The method, which is based on optical coherent tomography and ultrasound data, enables individualized skin dosimetry. Preliminary results show a larger variation of dosimetric quantities in the realistic models compared to the largely used planar ones.

Is the work in progress?

Yes

OS07-05

Fast high-resolution infrared-based evaluation of absorbed power density

Dr Massinissa Ziane, Dr Artem Boriskin, Dr Maxim Zhadobov

Univ. Rennes | CNRS, Rennes, France

Abstract Subject Area(s)

["Experimental dosimetry"]

Summary

The use of the millimeter-wave (mmWave) spectrum is an attractive solution to enable traffic growth over the next decade. The future mmWave 5G/6G networks will rely on mmWave technologies to allow for larger channel bandwidth, higher data rates, ultra-low latency, and reduced interference with adjacent cells. Frequencies above 6 GHz are also considered as promising for other body-centric applications including wireless sensors networks and wireless body-area networks. These new use cases and services will involve interaction of radiating devices with the human body, both in terms of the body impact on wireless device performance, as well as in terms of user exposure. This presentation provides an overview of a novel method for absorbed power density (APD) measurements using a reflectivity-based phantom emulating the scattering

characteristics of human skin and enabling efficient conversion of the mmWave radiation, absorbed in the phantom, into infrared (IR) signal, remotely recorded by an IR camera and used to retrieve APD at the air/skin interface. The method was validated for various antennas, demonstrating its highly promising potential for experimental dosimetry and compliance testing of wireless devices above 6 GHz.

OS07-06

In-situ assessment of uplink duty cycle for 4G and 5G wireless communications

Dr Günter Vermeeren, Mrs Leen Verloock, Dr Sam Aerts, Dr Luc Martens, Dr Wout Joseph
imec - UGent - WAVES, Ghent, Belgium

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave"]

Summary

With the fifth generation (5G) wireless communication technology, new and higher frequency bands, beamforming, and massive multiple-input multiple-output (MIMO) techniques are introduced to further enhance the efficiency of the radio access network (RAN) allowing ultra-reliable communications, broadband communication, and massive deployment of wireless IoT devices. As electromagnetic field (EMF) exposure quantities are time-averaged quantities, knowledge of the duty cycle – a measure of the fraction of the time a mobile phone is transmitting – for realistic use cases plays a key role in the accurate evaluation of the EMF exposure assessment. In this study, we measured in-situ the uplink duty cycles of a smartphone for 5G NR and 4G LTE for a total of six use cases covering voice, video, and data applications. The duty cycles were assessed at ten positions near a 4G and 5G base station site in Belgium. For Twitch, VoLTE, and WhatsApp, the duty cycle ranged between 4% and 22% in time for 4G and between 4 % and 14 % for 5G NR. The maximum duty cycle for 5G NR was 20%, based on the used TDD slot format DDDSU. For 5G NR, these duty-cycles resulted in a higher UL-allotted time due to Time Division Duplexing at 3.7 GHz frequency band. Ping showed median duty cycles of 2% for 5G NR and 50% for 4G LTE. FTP upload and iPerf resulted in duty cycles close to 100% for 4G LTE and 20 % for 5G NR.

12:00 - 13:00	Plenary 1 - Ed Boyden Optical Tools for Seeing and Controlling Biological Systems	Niels Kuster Azadeh Peyman	Main Hall

Biography Ed Boyden

Ed Boyden is Y. Eva Tan Professor in Neurotechnology at MIT, an investigator of the Howard Hughes Medical Institute and the MIT McGovern Institute, and professor of Brain and Cognitive Sciences, Media Arts and Sciences, and Biological Engineering at MIT. He leads the Synthetic Neurobiology Group, which develops tools for analyzing and repairing complex biological systems, such as the brain, and applies them systematically to reveal ground truth principles of biological function and to repair these systems. These inventions include optogenetic tools, which enable control of neural activity with light; expansion microscopy, which enables ordinary microscopes to do nanoimaging; new tools for high-speed imaging of living biological signals and networks; noninvasive brain stimulation strategies that may help with conditions ranging from Alzheimer's to blindness; and new strategies for inexpensively creating 3-D nanotechnology. He co-directs the MIT Center for Neurobiological Engineering, which aims to develop new tools to accelerate neuroscience progress, and the K. Lisa Yang Center for Bionics, which pioneers transformational bionic interventions across a broad range of conditions affecting the body and mind. He is a faculty member of the MIT Center for Environmental Health Sciences, Computational & Systems Biology Initiative, and Koch Institute.

Amongst other recognitions, he has received the Wilhelm Exner Medal (2020), the Croonian Medal (2019), the Lennart Nilsson Award (2019), the Warren Alpert Foundation Prize (2019), the Rumford Prize (2019), the Canada Gairdner International Award (2018), the Breakthrough Prize in Life Sciences (2016), the BBVA Foundation Frontiers of Knowledge Award (2015), the Carnegie Prize in Mind and Brain Sciences (2015), the Jacob Heskel Gabbay Award (2013), the Grete Lundbeck Brain Prize (2013), the NIH Director's Pioneer Award (2013), and the Perl/UNC Neuroscience Prize (2011). He was named to the World Economic Forum Young Scientist list (2013) and the Technology Review World's "Top 35 Innovators under Age 35" list (2006), and is an elected member of the National Academy of Sciences (2019), the American Academy of Arts and Sciences (2017), the National Academy of Inventors (2017), and the American Institute for Medical and Biological Engineering (2018). His group has hosted hundreds of visitors to learn how to use new biotechnologies, and he also regularly teaches at summer courses and

workshops in neuroscience, and delivers lectures to the broader public (e.g., TED (2011), TED Summit (2016), World Economic Forum (2012, 2013, 2016)).

Ed received his Ph.D. in neurosciences from Stanford University as a Hertz Fellow, working in the labs of Jennifer Raymond and Richard Tsien, where he discovered that the molecular mechanisms used to store a memory are determined by the content to be learned. In parallel to his PhD, as an independent side project, he co-invented optogenetic control of neurons, which is now used throughout neuroscience. Previously, he studied chemistry at the Texas Academy of Math and Science at the University of North Texas, starting college at age 14, where he worked in Paul Braterman's group on origins of life chemistry. He went on to earn three degrees in electrical engineering and computer science, and physics, from MIT, graduating at age 19, while working on quantum computing in Neil Gershenfeld's group. Long-term, he hopes that understanding how the brain generates the mind will help provide a deeper understanding of the human condition, and help humanity achieve a more enlightened state.

Introduction

Understanding and repairing complex biological systems, such as the brain, requires technologies for systematically observing and controlling these systems. We are discovering new molecular principles that enable such technologies. For example, we discovered that one can physically magnify biological specimens by synthesizing dense networks of swellable polymer throughout them, and then chemically processing the specimens to isotropically swell them. This method, which we call expansion microscopy, enables ordinary microscopes to do nanoimaging – important for mapping molecules throughout cells, and cells throughout brain circuits. Expansion of biomolecules away from each other also decrowds them, enabling previously invisible nanostructures to be labeled, and seen. As a second example, we discovered that microbial opsins, genetically expressed in neurons, could enable their electrical activities to be precisely controlled in response to light. These molecules, called optogenetic tools, enable causal assessment of how neurons contribute to behaviors and pathological states, and are yielding insights into new treatment strategies for brain diseases. They are also beginning to be used in human patients, in experimental clinical contexts like treating blindness. Finally, we are developing, using new strategies such as robotic directed evolution, fluorescent reporters that enable the precision measurement of signals such as voltage. In order to reveal relationships between different molecular signals within a cell, we are developing spatial and temporal multiplexing strategies that enable many such signals to be imaged at once in the same living cell, using ordinary microscopes, and requiring only fully genetically encoded constructs. We share all these tools freely, and aim to integrate the use of these tools so as to enable comprehensive understandings of neural circuits.

13:00 - 14:00	Lunch		Elia Minoa Palace
14:00 - 15:30	General Assembly	BioEM Members	Main Hall
15:30 - 16:00	Coffee break		Athina

16:00 - 17:30	Poster Session B	Athina

002B

Exposure to 10 Hz pulsed magnetic fields induce apoptosis in cancer cells pre-treated with 433 MHz microwave

Dr Chuan Sun[1], Miss Sisi Chen[2], Prof Zhenghong Lao[3], Prof Zhibing Wu[1]
[1]Zhejiang Hospital, Hangzhou, China. [2]Zhejiang Chinese Medical University, Hangzhou, China. [3]Deqing People's Hospital, Huzhou, China

Abstract Subject Area(s)

["In vitro","ELF/LF","RF/Microwave","Biological and medical applications"]

Summary

Cancer has become one of the most threatening diseases to human life. Although humans have made significant progress in cancer treatment, the therapeutic effect is still very limited, especially for advanced cancer. Therefore, it is still necessary to seek new and effective treatment methods. Microwave therapy has been proven to be an effective cancer treatment, especially suitable for advanced cancer, but there is still a problem of tumor recurrence because the microwaves can also cause a burden on the body and cannot be used for a long time which needs to be optimized. Pulsed magnetic fields (MFs) has extremely low load on the body and have been widely used in clinical treatment. In the case, we thought that if pulsed MFs can be applied to consolidate the therapeutic effect of microwaves. We did an *in vitro* study to investigate the combined effects of microwaves and pulsed MFs on cancer cells and found that exposure to 433 MHz microwaves at 41 – 43 ℃ for 1 h would sensitize cancer cells to 10 Hz pulsed MFs at low intensity (0.62 mT). Based on our results, we believe that the combination of extremely low frequency pulsed MFs with microwaves had the potential to become a new cancer treatment.

Is the work in progress?

Yes

004B

Assessing Microtubule Behavior and Cell State Changes Following Exposure to Radiofrequency Waves

Dr Richard De La Rosa[1], Ms Anna Sedelnikova[2], Mr Nicholas Mennona[3], Dr Ibtissam Echchgadda[1]
[1]AFRL, San Antonio, USA. [2]Science Applications International, San Antonio, USA. [3]University of Maryland, University of Maryland, College Park, USA

Abstract Subject Area(s)

["In vitro","Mechanisms","RF/Microwave","Biological and medical applications"]

Summary

In this study, cells were labeled with microtubule (MT) markers and were exposed to 3.0 GHz radiofrequency electromagnetic fields (RF- EMFs). Confocal microscopy analysis was performed following exposures to examine effects due to RF exposures on the cell state

and on the behavior of MTs. RF exposures induced changes were compared to controls, including, sham exposures and treatments with MT-targeting drugs. Image processing techniques were used to quantify changes in cell morphology as well as on the organization of MT and overall cytoskeletal network.

Is the work in progress?

Yes

006B

A wearable cardiac physiological signal monitoring method assisted by seismocardiogram signal

Ms Haoyue Wang, Dr Yifeng Wang, Prof Jiangtao Li
Xi'an Jiaotong University, Xi'an, China

Abstract Subject Area(s)

["In vitro","Biological and medical applications"]

Summary

With the increasing number of people suffering from cardiovascular diseases worldwide, the prevention and treatment of cardiovascular diseases are paid more and more attention. In this context, the use of portable and comfortable cardiac monitoring equipment for cardiovascular disease monitoring and alarm has become a general trend. Although the ECG signal has become the "gold standard" in the diagnosis of cardiovascular disease, the ECG has limitations in the diagnosis of some structural heart diseases, so the combination of SCG signal analysis is necessary. A non-contact ECG and SCG synchronous acquisition system is proposed in this paper, which can realize the long-term acquisition of ECG and SCG without the sensor touching the skin directly. Using this system, the diagnosis of cardiovascular diseases based on SCG assistance can be realized. In order to explore the influence of non-contact acquisition on signal quality, theoretical calculation and practical test are carried out in this paper. The calculation and measured results show that the high-frequency part of ECG and SCG signals in non-contact acquisition is attenuated, but the degree of attenuation is acceptable. In addition, the EMD algorithm is used to remove the motion artifacts of ECG and SCG signals, which improves the signal-to-noise ratio of ECG and SCG signals. At the same time, the algorithm can be used to extract respiratory wave from SCG original signal to obtain more abundant physiological information.

Is the work in progress?

No

008B

Numerical dosimetry starting from *B*–field values affected by localized errors

Prof Fabio Freschi, Prof Luca Giaccone
Politecnico di Torino, Torino, Italy

Abstract Subject Area(s)

["In vitro","Numerical dosimetry","ELF/LF"]

Summary

In this paper we consider two methods to perform numerical dosimetry in the low frequency range starting from the knowledge of the magnetic flux density. Previous studies showed that both methods provide stable results even in the presence of

random noise on the magnetic flux density. However, error lower than 10% (e.g. typical measurement uncertainty) is often considered. In this paper we analyze the effect of localized and high errors (even higher than 200%) of the magnetic flux density showing that with one of the two methods hot spots of the induced electric field may arise even at places that are far from the region with localized errors.

Is the work in progress?

Yes

010B

Ultrafast imaging to directly visualize the full biophysics of nanosecond pulsed electric field delivery

Dr Joel Bixler[1], Mr Gary Noojin[1], Dr Bennett Ibey[2]
[1]Air Force Research Lab, San Antonio, USA. [2]Air Force Office of Scientific Research, San Antonio, USA

Abstract Subject Area(s)

["Mechanisms","Experimental dosimetry"]

Summary

Delivery of pulsed electric fields using a pair of electrodes produces a variety of physical effects, including temperature rise, electrochemistry, and mechanical oscillation of the electrodes. Visualizing the mechanical contribution of the pulsed electric field to a biological system is difficult due to the speed at which acoustic waves propagate in water. We have developed a novel imaging platform that can be used to directly record the acoustic transients generated from applying high voltage nanosecond pulsed electric fields.

012B

High precision temperature analysis considering temperature-dependent physical properties for renal denervation.

Mr Tohgo Hosoda, Prof Kazuyuki Saito
Chiba University, Chiba, Japan

Abstract Subject Area(s)

["In vitro","RF/Microwave","Biological and medical applications"]

Summary

Renal denervation has been noted as a treatment for hypertension, which performed by introducing a catheter into the renal artery and ablating nerves located outside the renal artery. However, recent clinical trial has not shown sufficient effects due to insufficient ablation of the renal nerves. The catheter used in the clinical trial for ablation of the renal nerves was an RF current based catheter, which is currently the most common method. However, it has been reported that microwave denervation devices are capable of heating a wider region than the RF devices. Therefore, we investigated the characteristics of microwave RDN devices in biological tissues. In the previous temperature analysis on microwave heating, we used stable values for the temperature analysis. However, it has been reported that the physical properties of biological tissues are temperature-dependent, and a few studies has been reported on the difference in the heating area in the renal denervation depending on the temperature dependence of the biological tissues. In this study, temperature analysis was performed using

temperature dependence of physical properties in order to analyze the characteristics of microwave denervation devices more precisely. The analytical model with temperature dependence, compared to the analytical model with constant physical properties, showed temperature differences. In particular, there were differences in some organs and tissues until a thermal equilibrium state was reached. From the results, it can be said that the temperature dependence physical properties will be one of the variables to consider when an accurate temperature analysis is required.

Is the work in progress?

Yes

014B

The effect of 50 Hz MFs on human cytomegalovirus infection in human fetal lung fibroblasts

Miss Zhu Longtao[1], Mr Sun Chuan[2], Mrs Wei Xiaoxia[3], Mr Mao Genxiang[2], Prof Chen Guangdi[1]

[1]Bioelectromagnetics Laboratory, Zhejiang University School of Medicine, Hangzhou, China. [2]Zhejiang Provincial Key Lab of Geriatrics & Geriatrics Institute of Zhejiang Province, Department of Geriatrics, Zhejiang Hospital, Hangzhou, China. [3]Sir Run Run Shaw Hospital, Zhejiang University School of medicine, Hangzhou, China

Abstract Subject Area(s)

["In vitro","ELF/LF"]

Summary

Objective: To investigate the effect of 50 Hz magnetic fields (MFs) on human cytomegalovirus (HCMV) infection in cells. **Methods:** Human fetal fibroblasts were infected with HCMV for 3 days and then exposed to 50 Hz MFs at 0.4, 0.7, and 1.0 mT for 24 h. After exposure the gene copies of HCMV in cells were determined. **Results:** Exposure to 50 Hz MFs at 0.4 mT significantly increased HCMV gene copy while exposure to 50 Hz MFs at 0.7 or 1.0 mT significantly inhibited HCMV gene copy in cells. **Conclusion:** Exposure to 50 Hz MFs at low-intensity have an effect in promoting HCMV proliferation while high-intensity have an anti-HCMV effect in human fetal lung fibroblasts.

Is the work in progress?

Yes

016B

Numerical and Analytical Inspection of Magnetic Field Effects in the Radical Pair Mechanism by a Simplified Rate Equation Model

Dr Andreas Deser[1], Dr Jens Kuhne[2], Dr Heinrich A.M. Leymann[1]

[1]German Federal Office for Radiation Protection, Cottbus, Germany. [2]German Federal Office for Radiation Protection, Neuherberg, Germany

Abstract Subject Area(s)

["Mechanisms","ELF/LF"]

Summary

The Radical Pair Mechanism is by now the most prominent candidate for a biologically relevant quantum effect: Pairs of radicals form combined spin states, whose coherent interconversion is altered by external magnetic fields. N. Ikeya and J.R. Woodward

demonstrated a magnetic field effect for sub extremely low frequency fields in the mT range by investigating the autofluorescence spectrum of flavin adenine dinucleotide in living HeLa cells. They found that the effects are no longer observable above 1 Hz. In the present work, we present a simple rate equation model for a continuously illuminated photocycle to show numerically and analytically that magnetic field effects can be expected to exist in the whole ELF range, at least in principle. The simplicity of the model allows us to provide mathematically precise statements about the existence of an MFE.

018B

Effects of microsecond electrical pulses on cells of the immune system

Miss Giorgia Innamorati[1,2], Dr Francesca Camera[2], Mr Romain Fernandes[3], Dr Leslie Vallet[3], Miss Sara Fontana[4], Miss Noemi Dolciotti[4], Miss Carmen Pisano[4], Dr Caterina Merla[2], Dr Franck Andre[3], Dr Claudia Consales[2]

[1]Tor Vergata University of Rome, Rome, Italy. [2]ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Rome, Italy. [3]Université Paris-Saclay, Institut Gustave Roussy, CNRS,, Villejuif, France. [4]BioEMLab Group, DIET, Sapienza University of Rome, Rome, Italy

Abstract Subject Area(s)

["In vitro","Human studies","Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

Spinal cord injury (SCI) is a neurological and pathological state characterized by motor, sensory, and autonomic dysfunction, caused by direct damage of the spinal cord or of the tissue and vertebrae surrounding it. So far, several therapeutic strategies have been studied, but an effective protocol for spinal cord regeneration is still missing.

RISEUP project, funded by the European community in the H2020 FET-OPEN program, provides for the development of an innovative system for the regeneration of SCI based on the transplantation and the microsecond electric pulses (μsPEFs) stimulation of mesenchymal (MSCs) and induced neuronal (iNSCs) stem cells, through a biocompatible, biodegradable, and electrified support.

The hypothesis is to modulate through μsPEFs the proliferation and differentiation of these cells; iNSCs could differentiate in mature neurons to regenerate the lesioned area, and MSCs in neuronal-like cells to release neurotrophic factors. To better understand the effect of this device on the pro-inflammatory environment of SCI, the two μsPEFs protocols (proliferation and differentiation), identified in the context of the project, have been tested on human cell line of monocytes (U937 and THP-1), macrophages (obtained by treating monocytes with PMA) and microglia (HMC3).

Here we present the first results obtained by applying these stimulation protocols to the cells mentioned above in terms of proliferation, gene expression, and inflammatory response.

The purpose of these analyses is to assess the effect of the final device on the pro-inflammatory environment of SCI, to avoid any side effects, hoping for the induction of a beneficial anti-inflammatory effect.

Is the work in progress?

Yes

020B

Changes of Neuronal Membrane Potential After Exposure to a Single Microsecond Electric Pulse, or 5 MHz Burst of Low Energy Nanosecond Electric Pulse

Dr Gleb Tolstykh[1], Mr Bryan Gamboa[2], Dr Jeffrey Whitmore[2], Dr Benjamin Kasukonis[2]
[1]General Dynamics Information Technology, Inc, San Antonio, USA. [2]Air Force Research Laboratory, San Antonio, USA

Abstract Subject Area(s)

["In vitro","Electroporation and pulsed electric field applications"]

Summary

It is accepted that low energy micro- and millisecond electric pulses (EPs) excite muscular and neuronal cells below an electroporation threshold. These EPs efficiently charge and depolarize the plasma membrane (PM) to initiate excitation (Pakhomov & Pakhomova, 2020). In contrast, the nanosecond electric pulses (NSEPs) are not long enough to charge the PM of cells to trigger depolarization. Thus, a single NSEP could depolarize the PM via electroporation after application of an extremely high electric field (EF). In this case, an influx of positively charged cations (like Ca^{2+} and Na^{+}) cause PM depolarization. Since high energy NSEP induces nanoporation and cellular damage (Chopinet & Rols, 2015), this approach is unsuitable for non-damaging neurostimulation (Pakhomov & Pakhomova, 2020). To overcome the high EF requirement for NSEP stimulation, Pakhomov et al. proposed using a very low EF in combination with a very high pulse repetition rate (PRR) to cause temporal summation of NSEPs (Pakhomov et al., 2019). Indeed, the burst of low energy NSEPs with PRR at MHz frequency is shown to stimulate neurons at low EF (0.01–0.2 kV/cm) without any PM damage (Silkunas et al., 2022). This NSEP stimulation mode, the bursts of low energy EPs, is important for development of novel damage-free neuromodulation devices.

022B

Effects of 1800 MHz radiofrequency fields on signal transduction protein expression in differentiated human THP-1 cells

Gregory McGarr[1,2], Pascale Bellier[1], Sandy Smiley[1], James McNamee[1]
[1]Non-Ionizing Radiation Health Sciences Division, Consumer and Clinical Radiation Protection Bureau, Health Canada, Ottawa, Canada. [2]School of Human Kinetics, Faculty of Health Sciences, University of Ottawa, Ottawa, Canada

Abstract Subject Area(s)

["In vitro","Mechanisms","RF/Microwave","Biological and medical applications"]

Summary

We determined if continuous-wave or GSM-modulated 1800 MHz RF-EMF at a specific absorption rate (SAR) of 2 W/kg increased ST protein expression in human THP-1 cells. Cells were differentiated with 30 nM PMA for 72-hours, plus 24-hour rest in complete media. During exposure to continuous-wave (n = 5) or GSM-modulated (n = 5) RF-EMFs for 0.5, 4, or 24-hours at SAR of 2 W/kg (RF-EMF) or 0 W/kg (sham), cell cultures were maintained at 37 ± 0.04 °C (5% CO_2) for all experiments. Positive (33 µg/mL anisomycin, 1 hour; 100 ng/mL lipopolysaccharide, 4 hours) and vehicle (dimethyl sulfoxide, 1 hour; endotoxin free water, 4 hours) controls were included for all experiments. Phosphorylated ST protein levels (CREB, JNK, NF-κB, p38, ERK1/2) from cell lysates were assessed using Milliplex magnetic bead array panels. There were no significant

interactions between exposure condition and duration and no significant effects of condition for any ST proteins for continuous-wave or GSM-modulation experiments (all $P \geq 0.148$). There was a significant effect of duration for CREB during continuous-wave experiments ($P < 0.001$), but no significant effect of duration for CREB during the GSM-modulation experiments and no significant effects of duration for any other ST proteins for continuous-wave or GSM-modulation experiments (all $P \geq 0.113$). Positive controls showed significant increases for CREB, JNK, NF-κB, p38, and ERK1/2 relative to negative controls (all $P \leq 0.042$). Future studies examining additional time-points and exposure levels under well-controlled exposure conditions may help in understanding potential interactions between RF-EMFs and biological systems.

024B – Withdrawn

026B

In Vitro Imaging and Molecular Characterization of Ca^{2+} Flux Modulation by Nanosecond Pulsed Electric Fields

Dr Francesca Camera[1], Dr Eleonora Colantoni[1], Dr Tomas Garcia-Sanchez[2], Dr Barbara Benassi[1], Dr Claudia Consales[1], Mrs Adeline Muscat[3], Dr Leslie Vallet[3], Dr Lluis M. Mir[3], Dr Franck André[3], Dr Caterina Merla[1]

[1]Division of Health Protection Technologies, Italian National Agency for Energy, New Technologies and Sustainable Economic Development (ENEA), Rome, Italy. [2]Department of Information and Communication Technologies, Pompeu Fabra University, Barcelona, Spain. [3]CNRS, Metabolic and Systemic Aspects of the Oncogenesis, (METSY), Institute Gustave Roussy, Paris-Saclay University, Villejuif, France

Abstract Subject Area(s)

["In vitro","Electroporation and pulsed electric field applications"]

Summary

Cell electroporation, a technique known for enhancing substance uptake without cell death, is crucial in treatments like electrochemotherapy. Conversely, higher amplitude pulsed electric fields are used in irreversible electroporation for ablative medical procedures. Some authors observed, looking at the electric field-mediated uptake of specific fluorescent dyes and at the cell death, cells “sensitization” if the delivered electric pulses dose was split in a few fractions, but the mechanism of this phenomenon is still debated and unclear. These previous studies mainly focused on microsecond electric pulses.

This study aims to explore electrosensitization with nanosecond signals across human neuroblastoma cell line SH-SY5Y and human adipose-derived mesenchymal stem cells (HaMSCs). To do this, electric pulses lasting 10 ns were delivered using a coplanar waveguide with various stimulation protocols, with fractioned and unfractionated doses. The analysis was performed in terms of comparison of Ca^{2+} fluxes and gene expression in exposed and unexposed samples.

Higher repetition frequencies led to significantly higher Ca^{2+} fluxes in both cell lines, but no electrosensitization effect was observed with fractionated pulse doses. On the other side, gene expression analysis revealed increased expression of certain genes, particularly at higher repetition rates in SH-SY5Y cells. Fractionated pulse doses showed a cumulative effect on gene expression.

Further research is needed to explore additional parameters and molecular pathways related to electric pulse treatments.

028B

Electromanipulation Of Calcium Oscillations In Mesenchymal Stem Cells In Proliferation and Differentiation

Dr Leslie Vallet[1], Dr Marina Sanchez Petidier[1,2], Mr Romain Fernandes[1], Dr Nataliia Naumova[1], Ms Giorgia Innamorati[3], Dr Claudia Consales[3], Prof Caterina Merla[3], Dr Franck M. Andre[1], Prof Lluis M. Mir[1]

[1]Université Paris-Saclay, CNRS, Gustave Roussy, Metabolic and systemic aspects of oncogenesis (METSY), Villejuif, France. [2]Neural Circuits and Behaviour Lab, Fundación Hospital Nacional de Parapléjicos, Toledo, Spain. [3]Division of Health Protection Technologies, Italian National Agency for Energy, New Technologies and Sustainable Economic Development (ENEA), Rome, Italy

Abstract Subject Area(s)

["In vitro","Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

Mesenchymal stem cells (MSCs) are adult multipotent stem cells capable of differentiating into osteoblasts, adipocytes, chondrocytes, muscle cells, or even neuron-like cells. MSCs also have immunomodulatory properties as well as rescuing behavior towards cells in metabolic stress in their environment. For all these reasons, there has been great interest in the use of these cells in regenerative therapies in recent decades. In another respect, calcium, as a ubiquitous cellular second messenger, is known to encode important information in the form of oscillations. MSCs spontaneously exhibit calcium oscillations whose frequency varies during proliferation and differentiation processes. The main question addressed in this work is whether by manipulating the frequency of calcium oscillations, using short high voltage pulsed electric fields, we can influence proliferation or differentiation events in MSCs.

Is the work in progress?

Yes

030B

A comparative study of different doses of ultraviolet radiation impacted bystander effect on human keratinocyte cells *in vitro*

Mrs Zsófia Szilágyi, Mr Bertalan Pintér, Mrs Györgyi Kubinyi, Dr György Thuróczy

National Center for Public Health and Pharmacy, Budapest, Hungary

Abstract Subject Area(s)

["In vitro","RF/Microwave","MM Waves","Biological and medical applications"]

Summary

Using the 5G millimetre wave technology, the most exposed organ to the electromagnetic field is the skin. In an everyday situation - especially on a sunny day - not only EMF, but also UV radiation from solar light effects on humans. In the future, we would like to create a model for in vitro studies, when human skin cells will be exposed to 26 GHz millimetre wavelengths and UV radiation. Here we performed a preliminary study to compare the effects of different UV wavelengths, using a LED technology UV

lamp prototype, which was developed especially for laboratory usage with the contribution of our research group. We investigated the UV radiation-induced bystander effect on human keratinocyte cells.

Is the work in progress?

Yes

032B

Measurement of oxidative stress and CPD formation in human keratinocyte cells exposed to 26 GHz 5G FR2 band microwave and solar ultraviolet radiation *in vitro*

Mr Bertalan Pintér, Mrs Zsófia Szilágyi, Mrs Györgyi Kubinyi, Dr György Thuróczy
National Center for Public Health and Pharmacy, Budapest, Hungary

Abstract Subject Area(s)

["In vitro","RF/Microwave"]

Summary

5G is the fifth generation of wireless cellular network technology anticipated to revolutionize the world with faster mobile speed, faster data transfer and low latency. It is essential to understand the effect of the 5G network on human tissues. In the European Commission the high-frequency 26 GHz band is approved, which will soon be used in telecommunications. As the frequency increases the penetration depth decreases, therefore the 26 GHz frequency MW is absorbed in the skin. The 26 GHz MW and also solar UV radiation are absorbed by the upper layer of the skin, so it is necessary to study the combined effect of these non-ionising radiation. The aim of this study was to examine whether 26 GHz MW and solar UV radiation have any effect on the oxidative stress or CPD formation on human keratinocytes *in vitro.*

Is the work in progress?

Yes

034B

Effects of fifth-generation (5G) environmental radiofrequency signals on oxidative stress and DNA repair in skin cells: a BRET study.

Miss Jana Haidar[1], Mrs Patricia Nabos[1], Dr Rosa Orlacchio[1], Mrs Annabelle Hurtier[1], Dr Florence Poulletier De Gannes[1], Mrs Delia Arnaud-Cormos[2], Mr Philippe LEVEQUE[2], Dr Isabelle lagroye[1], Dr Yann Percherancier[1]
[1]IMS, Bordeaux, France. [2]XLIM - UMR 7252 CNRS, LIMOGES, France

Abstract Subject Area(s)

["In vitro"]

Summary

This study aims to assess the impact of 5G environmental RF signals on oxidative stress and DNA repair in human skin cells using Bioluminescence Resonance Energy Transfer (BRET) assays.

In response to the ongoing debate on the effects of RF-EMF on human cells, we address the specific question of whether 5G exposure induces oxidative stress and DNA damage, with a focus on the skin as a novel biological target. Previous research has predominantly explored the thermal effects of RF-EMF, but the potential "non-thermal" impacts remain uncertain, urging the need for empirical investigations.

The exploration of the DNA damage response (DDR) and oxidative stress in the context of RF fields represents an intricate and developing area of research. Although some studies propose potential associations between RF fields and DNA damage or oxidative stress, the overall scientific consensus remains inconclusive, prompting further research.
In this study, we employ innovative BRET molecular probes on SV-40 immortalized skin fibroblast line and HaCaT keratinocytes for detecting reactive oxygen species (ROS) and DDR in cells that were exposed to 5G-modulated 700 MHz using transverse electromagnetic (TEM), and 3.5 GHz signals using a reverberation chamber for 24h at various specific absorption rates (SAR) ranging from 0.4 to 4 W/kg. Successive exposure to UV and 5G-modulated signals will also be investigated. All results will be presented at the meeting.

Is the work in progress?

Yes

036B

Cytogenetic effects of in vitro exposure to 5G-Modulated 3.5 GHz signal on HaCaT cell line: preliminary results from the NextGEM Project.

Mr Seppe Segers[1,2], Mrs Maryse Ledent[1], Mr Roel Anthonissen[1], Prof Lutgart Braeckman[2], Dr Birgit Mertens[1]
[1]Sciensano, Brussels, Belgium. [2]UGent, Gent, Belgium

Abstract Subject Area(s)

["In vitro"]

Summary

The rapid advancement, particularly in telecommunications, presents global environmental, health, technical, and regulatory challenges. Potential health effects arising from the exposure to radiofrequency electromagnetic fields remain a contested topic. While the 3.5 GHz 5G-NR signal falls within the range of currently used frequencies, understanding the potential risks associated with RF-EMF exposure is essential for informing regulatory policies and developing mitigation strategies to safeguard public health in the era of wireless communication advancements.
The Next Generation Integrated Sensing and Analytical System for Monitoring and Assessing Radiofrequency Electromagnetic Field Exposure and Health (NextGEM) project endeavors to investigate these potential effects using stringent *in vitro* testing methodologies. This presentation discusses the findings from the NextGEM projects inquiry into the cytogenetic impacts of RF-EMF, with a particular emphasis on 5G-modulated frequencies on the HaCaT cell line. Utilising in vitro techniques with high measures of quality control, HaCaT cells were exposed to varying intensities of RF-EMF. Cytogenetic endpoints including micronuclei formation and DNA damage were assessed to elucidate potential genotoxic effects through the use of the in vitro micronucleus assay and the in vitro alkaline comet assay respectively. Additionally, cell viability assays were conducted to evaluate overall cellular health and response to RF-EMF exposure.
In this presentation, we aim to give an overview of the preliminary results obtained over the course of the project so far.

Is the work in progress?

Yes

038B

In-utero Exposure to High Levels of Magnetic Fields and the Risk of Pituitary Gland Dysfunction in Offspring: A Long-term cohort study with up to 20 years of follow-up

Dr De-Kun Li, Ms Jeannette Ferber, Ms Roxana Odouli
Division of Research, Kaiser Foundation Research Institute, Oakland, California, USA

Abstract Subject Area(s)

["Human studies","Epidemiology","ELF/LF"]

Summary

In this prospective cohort study, *in-utero* exposure to high MF levels was found to be associated with increased risk of pituitary disorders manifested as both low TSH and T4 thyroid hormone levels in offspring. The observed association indicates an adverse MF impact on the pituitary gland during fetal development of the brain. The finding of this important association needs to be further examined in future studies.

040B

Effects of electromagnetic fields from long-term evolution on event-related potential and simple reaction time in healthy humans

Prof Setsu Nakatani-Enomoto[1,2], Mrs Kaoru Yuasa[2], Dr Mitsunari Abe[3,2], Prof Shunsuke Kobayashi[4,2], Prof Yoshikazu Ugawa[5,2]
[1]Department of Rehabilitation, Faculty of Health Care and Medical Sports, Teikyo Heisei University, Chiba, Japan. [2]Department of Neurology, School of Medicine, Fukushima Medical University, Fukushima, Japan. [3]Integrative Brain Imaging Center, National Center of Neurology and Psychiatry, Tokyo, Japan. [4]Department of Neurology, Teikyo University, Tokyo, Japan. [5]Department of Human Neurophysiology, School of Medicine, Fukushima Medical University, Fukushima, Japan

Abstract Subject Area(s)

["Human studies","RF/Microwave"]

Summary

Mobile phones are indispensable for daily life, and the adverse effects of the electromagnetic field (EMF) they emit are of great concern. The effects of long-term evolution (LTE)-like EMF for 30 min on event-related potential (ERP) and simple reaction time (RT) were studied in 27 healthy volunteers aged 42–64 years. ERP and RT were recorded before and after EMF or sham exposure in a double blind, randomized study. The maximum local specific absorption rate of the EMF averaged over a 10-g mass was 2.0 W/kg. All the subjects participated in the experiments under different exposure conditions on two different days. In the ERP recording, the ratio of target to non-target stimuli presentation was 1:4 during the auditory oddball paradigm. The latencies and amplitudes of N100, N200, and P300 after target stimulation and N100 after non-target stimulation were measured. Neither the latency nor amplitude of the four ERP components differed significantly between the EMF and sham exposures. In the RT test, reaction times to a beep sound were measured and were not significantly different between the EMF and sham exposures. We concluded that LTE-like exposure for 30 min had no detectable harmful effects on ERP and RT in healthy humans.

042B

Delayed growth in immature male rats exposed to 900 MHz radiofrequency

Mr Raphaël Bodin[1,2], Mr Franck Robidel[1], Mrs Stéphanie Rodriguez[1], Mr Anthony Lecomte[1], Dr Anne-Sophie Villégier[1,2]

[1]INERIS, Verneuil-en-Halatte, France. [2]UPJV/INERIS UMR_I 01, Amiens, France

Abstract Subject Area(s)

["in vivo","RF/Microwave","Biological and medical applications"]

Summary

People have been exposed to the 900MHz mobile phone electromagnetic field for approximately 30 years, with the 2nd generation (2G) Global System for Mobile communications network. However, there is still no conclusion from immature rodent experiments regarding the potential effects of nonthermal radiofrequency 900MHz continuous waves exposure during the biological development. Here, we aimed to test the hypothesis that when mother rats received a whole-body SAR occupational limit of the International Commission on Non-Ionizing Radiation Protection for human (0.4W/kg) clinical growth and development was impacted in the descendant, with less (or no) effect at public limit (0.08W/kg). Sprague Dawley pregnant rats (mothers, M) whole-body SAR of 0.4W/kg and 0.08W/kg were reached with 30.2V/m electric field (PEF) and 67.5V/m electric field (OEF) for 330g body weight. Exposure was 8h/day from gestational day 8 until postnatal day 21 (n = 8-9/group). The neonate males showed earlier pinna ear detachment only for OEF group and earlier eye opening only for the PEF exposed group compared to the sham. Compared to the sham-exposed and to the PEF exposed males, the OEF exposed juvenile males showed lower body weight until adolescence. Both OEF and PEF radiofrequency-exposed females groups showed earlier pinna ear detachment and eye opening but similar bodyweight compared to the sham-exposed females. The present study suggested that pre- and post-natal exposure to 900 MHz continuous waves at human levels of occupational and general public level led to clinical effects in the neonatal and adolescent rats.

Is the work in progress?

Yes

044B

The human and environmental safety case for microwave-based space-based power systems: A review of current knowledge and call for action

Prof Brian Collins

School of Electrical Engineering & Computer Science, Queen Mary University of London, London, United Kingdom. BSC Associates, Ely, United Kingdom

Abstract Subject Area(s)

["Human studies","RF/Microwave","Risk assessment","Standards and public health policy"]

Summary

The reduced launch cost of space hardware has renewed international interest in the possibility of constructing space-based solar power (SBSP) systems providing green electrical power by harvesting solar energy in space and beaming it to the ground by by microwave radio, The possible effects of exposure to electromagnetic fields on human health have been extensively studied and there is significant knowledge of effects on

animals, particularly rats and mice. Separate studies have reported effects on insects, birds, trees, plants and other life forms. Proposals for SBSP schemes with output power levels of several gigawatts typically assume a peak ground level power density of 230 W/m^2 at frequencies between 2.4 GHz and 10 GHz, with high levels existing continuously in time over a contiguous area of several square kilometres, but very few existing studies have used these parameters. Large sums of money have been spent on previous studies at lower power densities, but the quality of experimental design and reporting has often left much to be desired.
The paper will review the present state of knowledge and draw lessons for the development of SBSP. The public perception of the mobile radio industry is that successive new systems have been put into service before a long-term safety case has been demonstrated. Investigations to clear the way for SBSP will need to be long-term and wide-ranging. They will require investment, new channels for cooperation between engineering, medical, biological and environmental communities, and new ways to communicate findings to society at large.

Is the work in progress?

Yes

046B

Investigation of Antenna-Subject Spacing Effects on Port Reflection and SAR in a 6 GHz Exposure System

Abdelelah Alzahed[1], Theodore Egube[2,3], Shea Gordon-McIntosh[2], Abaigeal Kelso[2], Ryan Lefebvre[2], Gregory McGarr[2,3]

[1]Non-Ionizing Radiation Physical Sciences Division, Consumer and Clinical Radiation Protection Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Canada. [2]Non-Ionizing Radiation Health Sciences Division, Consumer and Clinical Radiation Protection Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Canada. [3]School of Human Kinetics, Faculty of Health Sciences, University of Ottawa, Ottawa, Canada

Abstract Subject Area(s)

["Human studies","Experimental dosimetry","Numerical dosimetry","RF/Microwave"]

Summary

Introduction: We explored how varying antenna-to-subject distances affects port characteristics and Specific Absorption Rate (SAR), for an open-ended waveguide and horn antenna (both at 6 GHz) to improve performance for our upcoming human exposure experiments. **Methods:** We used FDTD simulations (Sim4Life) to analyze distance variations between the tissue surface and aperture for both antennas. Distances from 25-100 mm, spanning half to two wavelengths at 6 GHz, were explored. Tissues included skin (1 mm), subcutaneous adipose tissue (SAT; 6 mm), and muscle (60 mm). Antennas were excited via a waveguide port with a cutoff frequency of 4.3 GHz. **Results:** Our findings presented the reflection coefficient of the antenna port and peak SAR (pSAR) at the skin surface. The latter was examined for each distance, facilitating comparison across the range of exposure scenarios. There were significant differences between the antennas. Horn antenna pSAR was nearly double that of the waveguide. Reflection coefficient results indicated minimal variation with distance for the waveguide, contrasting with significant distance-dependent behavior for the horn

antenna due to strong coupling between tissues and the antenna port. Observing the simulated averaged SAR (10 g) over the 2-dimensional skin surface for both antennas revealed notable differences in SAR distribution. **Conclusion:** Factors such as antenna design, tissue properties, and user positioning converged to shape SAR distribution. By revealing the complex interplay between these variables, we pave the way for more robust protocols and antenna designs for human exposure research that prioritize safety while maximizing efficacy.

050B

900MHz microwave radiation improving cognitive ability of AD mice by enhanced gamma rhythmic oscillaitons

Prof Xiangjun Hu, Prof Lifeng Wang, Mr Weiming Yuan, Dr Yong Zou
Beijing Institute of Radiation Medicine, Beijing, China

Abstract Subject Area(s)

["in vivo","RF/Microwave","Biological and medical applications"]

Summary

In the study, multi-channel wire electrodes were used to detect the local field potentials (LFPs) of hippocampal CA1 area in C57BL/6 and 5xFAD mice during resting state. A real-time microwave exposure recording platform was established to investigate the effect of the brain slices under different frequencies (600MHz, 900MHz, 1800MHz, 2400MHz), repetition rates (10Hz, 20Hz, 30Hz, 40Hz), and average power densities (0.1mW/cm^2 and 0.4mW/cm^2) exposure. Microwave exposure on 5xFAD mice was performed using 900MHz with repetition rate 40Hz, average power densities of 0.8mW/cm^2 and 4mW/cm^2. It was found that gamma oscillations enhanced in the brain slices of C57BL/6 mice after 900MHz microwave exposure with repetition rate of 40Hz, and the time of peak appearance was advanced by the average power density of 0.4mW/cm^2 compared with 0.1mW/cm^2. Gamma oscillations in brain slices of 5xFAD mice were also significantly enhanced after 900MHz microwave exposure with repetition rate of 40Hz and average power density of 0.4mW/cm^2. Low gamma (30-50Hz) and high gamma (50Hz-90Hz) rhythmic oscillation in the CA1 region of the hippocampi of 5xFAD mice were enhanced, Aβ deposition and APP content in the brain were reduced after 900MHz microwave exposure with repetition rate of 40Hz. Moreover, compared with 0.8mW/cm^2 microwave exposure, the peak time of gamma oscillation is earlier and the cognitive ability is improved in 5xFAD mice after 4mW/cm^2 microwave exposure. The study could provide a new physical neural modulation approach for the prevention and treatment of AD.

Is the work in progress?

Yes

052B

Body Temperature Dynamics under Intermittent Radiofrequency Radiation Exposure in Rat

Ms Hye Sun Kim[1,2], Dr YoungIm Kim[2], Dr Sang Bong Jeon[3], Dr Ae-Kyoung Lee[3], Dr Hyung-Do Choi[3], Prof Jeong-Ki Pack[4], Prof Nam Kim[5], Prof Young Hwan Ahn[1,2]
[1]Ajou University School of medicine, Suwon, Korea, Republic of. [2]Graduate School of Ajou University, Suwon, Korea, Republic of. [3]Electronics and Telecommunications

Research Institute, DaeJeon, Korea, Republic of. [4]Chungnam National Universtiy, DaeJeon, Korea, Republic of. [5]Chungbuk National Universtiy, Cheongju, Korea, Republic of

Abstract Subject Area(s)

["in vivo"]

Summary

The study examined the impact of radiofrequency radiation (RFR) on the body temperature of rats under both continuous and intermittent exposure conditions. The programmable Temperature Transponder (IPTT-300) were implanted in the interscapular region of 58 male Sprague-Dawley rats three days before the RF exposure. Using a reverberation system, the rats were exposed to a 915 MHz LTE signal in four groups (0 W/kg, n=6, and 4, 6, 8 W/kg, n=6 each) continuously for 9 h. Additionally, two groups (0 W/kg, n=4, and 8 W/kg, n=6) underwent intermittent exposure (10 minutes on/10 minutes off) for 10 h. Body temperature was measured hourly during continuous exposure and every two hours during intermittent exposure. While there was no significant temperature increase at 4 W/kg and 6 W/kg wbSAR during continuous exposure, an increase of over 1 °C was observed at 8 W/kg after 3 h, persisting until the end of RF exposure. In intermittent exposure at 8 W/kg, a temperature increase of over 1 °C occurred after 6 h, returning to baseline by 8 h. In conclusion, exposure to a 915 MHz LTE signal at 8 W/kg wbSAR induced a temperature increase of over 1 °C in both modes in healthy male rats, with variations in temperature dynamics depending on the exposure mode.

This work was supported by the ICT R&D program of MSIT/IITP [2019-0-00102, A Study on Public Health and Safety in a Complex EMF Environment]

Is the work in progress?

Yes

054B

Development and validation of power-frequency magnetic field exposure system for animal experiment

Dr Masayuki Takahashi[1], Dr Izumi Nishimura[1], Mr Toshihiko Toda[2], Mr Shuichi Monma[3]
[1]Central Research Institute of Electric Power Industry, Chiba, Japan. [2]JAC, Tokyo, Japan. [3]Techno Electric Industry, Kanagawa, Japan

Abstract Subject Area(s)

["in vivo"]

Summary

Epidemiological studies have indicated an association between exposure to power-frequency magnetic fields (MFs) and the development of childhood leukemia. However, further research is necessary because the causal relationship remains unclear. We developed an exposure system to investigate the biological effects of 50 Hz MFs on experimental animals. To uniformly expose animals placed at the center of the coil to MFs, we fabricated a Merritt-type coil consisting of four rectangular bobbins stacked vertically, each measuring 820 mm per side. The coil was water-cooled to prevent any effects of heat radiation on the animals. The spatial variability of MF in the cubic space inside the coil was within ±5% of a target intensity, and the coil current was about 50 A when the 50 Hz, sinusoidal MF was at the facility maximum, 5 mT(rms). Next, we

established the humanized mice by transplanting human cord blood-derived CD34+ cells into severely immunodeficient mice. We validated our exposure system by exposing the mice to 5 mT(rms) of 50 Hz MFs for 2 months. During the exposure experiment, the exposed mice grew as well as the control mice, and any abnormal behavior was not observed. This indicates no artifacts associated with animals' breeding caused by the exposure system. In this presentation, we also report the results of the detailed evaluation of human hematopoietic cells within the humanized mice exposed to MFs.

Is the work in progress?

Yes

056B

Rotating Magnetic Field Improved Cognitive and Memory Impairments in a Sporadic AD Model of Mice by Regulating Microglial Polarization

Miss Mengqing Li[1], Mr Umer Anayyat[1], Mrs Hua Yang[1], Prof Xiaomei Wang[1], Dr Yunpeng Wei[2]

[1]Shenzhen University, Shenzhen, China. [2]Songgang People's Hospital, Shenzhen, China

Abstract Subject Area(s)

["in vivo"]

Summary

Many studies indicate that neuroinflammation plays an important role in the initiation and development of Alzheimer's disease (AD), in which microglia, the intrinsic immune effector cells in the central nervous system, play crucial roles. The microglia activation in the central nervous system (CNS) can be divided into the M1 phenotype and the M2 phenotype. Microglia can produce cytotoxic or neuroprotective effects according to the activated phenotype. This study investigated the effects of a non-invasive rotating magnetic field (RMF) (0.2T, 4Hz) on a sporadic AD model of mice induced by AlCl3 and D-gal. The results showed that after RMF treatment, the cognitive impairment of AD model mice was significantly improved, the number of activated microglia and plaque burden in the hippocampus and cortical regions were significantly reduced, and the protein levels of NeuN were upregulated. Moreover, the RMF can significantly inhibit phosphorylation levels of IKKα/β, IκBα, NF-κB p65, JNK, p38, and ERK. These results demonstrate that RMF improved memory and cognitive impairments in a sporadic AD model of mice probably by promoting the transition of microglia polarization from M1 to M2 type via inhibiting the NF-κB/MAPK signaling pathway, suggesting potential applications of RMF in the clinical treatment of AD.

058B

Scientific Committee on Radiofrequency and Health (CCARS) report on RF-EMF and Health Risk (2020-2022)

Dr Alberto Nájera[1], Dr Francisco Javier Lafuente[2], Dr Antonio Hernando[3], Dr Rosa Magallón[4], Dr Concepción García-Pardo[5], Dr Fernando Luis Las-Heras[6], Dr José Ignacio Alonso[7]

[1]University of Castilla-La Mancha, Albacete, Spain. [2]Servicio de Radiodiagnóstico del Hospital General Universitario Gregorio Marañón de la Comunidad Autónoma de Madrid, Madrid, Spain. [3]Universidad Complutense de Madrid, Madrid, Spain. [4]Servicio de

Oncología Radioterápica de la Clínica Puerta de Hierro de Madrid, Madrid, Spain. [5]Instituto de Telecomunicaciones y Aplicaciones Multimedia (iTEAM) de la Universitat Politècnica de València, Valencia, Spain. [6]Universidad de Oviedo, Oviedo, Spain. [7]Universidad Politécnica de Madrid, Madrid, Spain

Abstract Subject Area(s)

["Human studies","Epidemiology","RF/Microwave","Risk assessment"]

Summary

The Scientific Committee on Radiofrequency and Health (CCARS) in Spain, formed in 2005, is an independent body of experts tasked with providing judgment, information, and advice on issues related to radiofrequencies and health. The latest CCARS report reviews scientific evidence from 2020 to 2022 concerning the potential health effects of radiofrequency electromagnetic fields (RF-EMF), with a focus on 5G technology. The report confirms that there is no conclusive evidence of health risks within regulatory limits and updates earlier findings.

This edition employs diverse methodologies, including systematic reviews based on PRISMA for personal exposure and risk perception, and scope reviews for the breadth of in vivo, in vitro, and epidemiological studies. The report observes methodological inconsistencies in personal exposure studies, suggesting a need for standardized approaches for precise assessment.

Experimental studies show mixed results, with most indicating no significant adverse health impacts at normal exposure levels, even as they explore complex effects like carcinogenesis and genotoxicity. Clinical and epidemiological research has not established any direct links between mobile phone use and increased tumour incidence. The report also addresses electromagnetic hypersensitivity, noting a lack of evidence for a causal link with RF-EMF exposure.

Ongoing research, such as the COSMOS Study and WHO projects, is crucial for reaching scientific consensus. The report underscores the importance of effective communication to address public concerns, considering subjective perceptions of risk and emphasizing that constant monitoring and international collaboration are key for guiding public health policies and safety standards.

060B

Changes in ambient radiofrequency electromagnetic fields (RF-EMF) levels between 2021 and 2023 in Switzerland: a 5G Hiker Story

Mr Nicolas Loizeau[1,2], Dr Dominik Haas[3], Dr Marco Zahner[4], Dr Johannes Schindler[3], Mrs Christa Stephan[3], Dr Jürg Fröhlich[4], Mr Markus Gugler[5], Mr Toni Ziegler[3], Prof Martin Röösli[1,6]

[1]Swiss Tropical and Public Health Institute, 4123 Allschwil, Switzerland. [2]University of Basel, 4001, Switzerland. [3]Grolimund + Partner AG Environmental Engineerging, 3097 Bern, Switzerland. [4]Fields at Work GmbH, 8032 Zürich, Switzerland. [5]NED-TECH AG, 3380 Wangen an der Aare, Switzerland. [6]University of Basel, 4001 Basel, Switzerland

Abstract Subject Area(s)

["Epidemiology","RF/Microwave","Risk assessment","Standards and public health policy"]

Summary

The fifth generation of mobile technology (5G) has been extensively deployed across Switzerland since 2021. There are public concerns about a potential increase in ambient

radiofrequency electromagnetic fields (RF-EMF) levels, while mobile communication stakeholders argue that the new adaptive antennas will reduce or not change the ambient RF-EMF exposure. Therefore, we aim to assess the changes in ambient exposure to RF-EMF in Switzerland between 2021 and 2023 following the rollout of 5G. We measured ambient RF-EMF using portable devices in 75 outdoor areas and 43 public spaces twice at the same time of the day in 2021 and 2023. RF-EMF levels were measured with two ExpoM-RF4, which cover 35 RF bands from 80MHz to 6GHz and record the root-mean-square (RMS) signal and the instantaneous highest signal (Peak-Hold) within a 50ms interval. In public spaces, the mean RMS levels increased from 0.38 V/m to 0.41 V/m between 2021 and 2023, whereas the mean Peak-Hold levels increased from 2.15 V/m to 2.81 V/m. The most significant increase in Peak-Hold mean levels occurred in the 5G bands, rising from 0.68 V/m to 1.44V/m. In outdoor areas, the mean RMS levels remained unchanged between 2021 and 2023 (0.28 V/m) and mean Peak-Hold levels increased from 1.52 V/m to 1.70 V/m. Although the mean RMS levels remained relatively stable between 2021 and 2023 despite the continuing increase in mobile data traffic, the increase in mean "Peak-Hold" levels can be attributed to the more dynamic capabilities of 5G.

Is the work in progress?

Yes

062B

MM-WAVE BAND PERMITTIVITY CHARACTERIZATION OF C. ELEGANS

Dr Pol Alonso[1], Dr Gaetano Chirico[2], Dr Anna Laromaine[1], Prof Rita Massa[3,4], Prof Marco Donald Migliore[2], Prof Fulvio Schettino[2]

[1]Nanoparticles and Nanocomposites Group (nn.icmab.es) Institut Ciencia de Materials de Barcelona (ICMAB-CSIC) Campus UAB, Bellaterra, Spain. [2]Dep. of Electrical and Information Engineering "Maurizio Scarano", University of Cassino and Southern Lazio, Cassino, Italy. [3]IREA CNR, Napoli, Italy. [4]Dep. of Physics "Ettore Pancini", Un. of Naples Federico II, Napoli, Italy

Abstract Subject Area(s)

["in vivo","Experimental dosimetry","RF/Microwave","MM Waves"]

Summary

Dosimetric assessment need**s** the knowledge of dielectric properties of the materials involved in the exposure. Aim of this work was to evaluate the permittivity in the FR2 band of the nematode *C. elegans* and the relative growth medium that will be adopted in the exposure system as *in vivo* model in the E**U** project NEXTGEM. The analysis of the measured permittivity clearly shows that in the FR2 range the characteristics of NGM alone and NGM with *C. elegans* are practically undistinguishable and very similar to NaCl (0.05 M) solution. These results confirm that the permittivity and dielectric losses of the biological sample at millimeter-wave frequencies are essentially determined by its free-water content.

Is the work in progress?

Yes

064B

Numerical Dosimetry of Rodent Cohorts in a Realistic Reverberation Chamber at 900 MHz

Dr Antonio Faraone[1], Dr Giorgi Bit-Babik[1], Prof Paola Russo[2], Prof Alfredo De Leo[2], Prof Valter Mariani Primiani[2], Prof Valerio De Santis[3]
[1]Motorola Solutions Inc., Fort Lauderdale, USA. [2]Università Politecnica delle Marche, Ancona, Italy. [3]The University of L'Aquila, L'Aquila, Italy

Abstract Subject Area(s)

["in vivo","Numerical dosimetry","RF/Microwave"]

Summary

Reverberation chambers (RCs) have been widely employed in bioelectromagnetics large-scale rodent bioassays, to investigate potential effects of lifetime RF exposures. Numerical RF dosimetry has been of the utmost importance in determining the range of exposures, in terms of whole-body and organ SAR, and its uniformity across large animal cohorts. Hence, numerical dosimetry may quantitatively inform key decisions in the design of in-vivo animal studies (exposure levels, number of animals per room, etc.). In this work, we expand prior research on rodents' numerical dosimetry in RCs based on a realistic RC configuration, comprising a mode stirrer, diffusers and various types of antennas. The exposure prediction modeling involves a Monte-Carlo (MC) approach recently developed by the authors, taking into account their size distribution, as well as their posture, position and orientation within individual cages. The feasibility of conducting whole-RC dosimetry within a multivariate MC framework for large rodent cohorts at 900 MHz was demonstrated, showing larger wbSAR variability than previously estimated, and suggesting that exposures in some of the cages may be consistently higher or lower than a cohort mean wbSAR target. Future work will include the implementation of smaller antennas, hemispherical field diffusers, and the study of the effects of metal water-distribution piping on the rodents wbSAR statistics.

Is the work in progress?

Yes

066B

Specific Absorption Rate and Epithelial Power Density in Biometric Human Face Models Exposed to 95 GHz Radiofrequency

Dr Benjamin Kalinosky[1], Dr Roberto Rodriguez[1], Mr Jason Payne[2]
[1]General Dynamics Information Technology, Fort Sam Houston, TX, USA. [2]Air Force Research Laboratory, Fort Sam Houston, TX, USA

Abstract Subject Area(s)

["Numerical dosimetry","RF/Microwave","MM Waves","Risk assessment"]

Summary

We generated a dataset of human head phantoms with biometric variability and applied the finite-difference time-domain method to study common spatial patterns in specific absorption rate (SAR) and epithelial power density (EPD) for 95 GHz radiofrequency exposures. The resulting SAR and EPD maps each exhibited similar heterogeneous spatial features common across biometric models. The peak mass-averaged SAR and peak area-averaged EPD were compared against the Institute of Electrical and Electronics Engineers (IEEE) exposure limits.

068B

In-situ radiofrequency electromagnetic field measurements around 5G macro base stations in the UK

Dr Carolina Calderon, Mr Darren Addison, Dr Azadeh Peyman
UKHSA, Chilton, United Kingdom

Abstract Subject Area(s)

["RF/Microwave","Risk assessment","Standards and public health policy"]

Summary

As part of this remit, the UK Health Security Agency (UKHSA) is undertaking a measurement campaign to quantify exposure of people to radiofrequency (RF) signals from 5G mobile phone base stations in the UK, where 5G networks currently operate in the FR1 frequency range.
Measurements are performed in publicly accessible areas with line-of-sight (LOS) to active Non Stand Alone (NSA) 5G masts across various microenvironments (commercial, residential, industrial and parks) from all major UK mobile network operators. Both beamforming and non-beamforming masts of different types (rooftops, lattice and StreetWorks) are being investigated.
Channel power measurements are performed under three scenarios: idle, streaming and speed test. Extrapolation of SS-RSRP 5G decoder measurements is performed, following IEC 62232:2022 standard, as well as Safety Evaluation measurements, for comparison with other radiofrequency sources in the environment.
At the time of writing, measurements have been carried out on 23 masts from 12 different sites in the southeast of England. Collected data so far suggests exposure from 5G FR1 base stations in the UK are below 1% of ICNIRP public reference levels. Exposure from beam forming masts has not been found to be statistically greater than non-beamforming masts, albeit that the sample size is small.
It is envisaged that the exposure measurement programme will be finished by June 2024; and the complete set of results will be presented during the conference.

Is the work in progress?

Yes

070B

Monitoring Transmitted and Received Powers of a 28 GHz Band 5G Smartphone

Dr Sen Liu, Mr Kazuhiro Tobita, Dr Teruo Onishi, Prof Masao Taki, Dr Soichi Watanabe
NICT, Tokyo, Japan

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","MM Waves"]

Summary

In this abstract, the latest measurement results on the transmitted (Tx) and received (Rx) powers of a 28 GHz band 5G smartphone are reported. The Tx power reasonably reveals an inverse relation with the Rx power in both the 5G 28 GHz band and anchor 4G LTE band. At the same level of Rx power, the maximal Tx power in anchor 4G LTE band can be 10 dB higher than that in 5G 28 GHz band, which may be due to the fact that the noise level (in other words, signal to noise ratio) is different for the two bands. Measurements of electric-field (E-field) strength from the 5G 28 GHz band base station (BS) are also simultaneously performed. It is found that the E-field strength (1-min time-

average) that is purely resulted from the 28 GHz band 5G BS demonstrates a positive relation with the Rx power of the smartphone, implying that a lower Rx power usually corresponds to a lower E-field strength (purely resulted from the BS). Compared with our previous measurement results on a 5G sub-6 GHz band smartphone, the Rx power (median) and Tx power (median) in this work (5G 28 GHz band) are approximately 24 dB higher and 25 dB lower. However, at the same level of Rx power, the Tx power in 5G sub-6 GHz band can be only several dB higher than that in 5G 28 GHz band.

Is the work in progress?

No

072B

Compact Exposimeter Device for the Characterization of Electromagnetic Fields from 78 MHz to 6 GHz with Several Narrow Bands (300 kHz)

Dr Marco Xavier Rivera González[1,2], Miss Isabel López de Mingo[1,3], Miss Alexandra Amuneke Ramírez[3], Dr Ceferino Maestú[1,3,4]

[1]Centro de Tecnología Biomédica (CTB), Universidad Politécnica de Madrid, Madrid, Spain. [2]Escuela Técnica Superior de Ingenieros Informáticos (ETSIINF), Universidad Politécnica de Madrid,, Madrid, Spain. [3]Escuela Técnica Superior de Ingenieros de Telecomunicación (ETSIT), Universidad Politécnica de Madrid, Madrid, Spain. [4]CIBER-BBN, Centro de Investigación Biomédica en Red, Madrid, Spain

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave"]

Summary

A novel compact device with spectrum analyzer characteristics has been designed, which allows the measuring of the maximum power received in multiple narrow frequency bands of 300 kHz, recording the entire spectrum from 78 MHz to 6 GHz; the device is capable of measuring the entire communications spectrum and detecting multiple sources of electromagnetic fields using the same communications band. The proposed device permits the evaluation of the cross-talk effect that, in conventional exposimeters, generates a mistake estimation of electromagnetic fields. The device was calibrated in an anechoic chamber for far-fields and was validated against a portable spectrum analyzer in a residential area.

Is the work in progress?

Yes

074B

Measurement of the 5G EME Levels from small cells at customer homes - What have we found?

Mr Mike Wood[1], Dr Phillip Knipe[2]

[1]Telstra Corporation, Melbourne, Australia. [2]Total Radiation Solutions, Perth, Australia

Abstract Subject Area(s)

["RF/Microwave","MM Waves","Risk assessment","Standards and public health policy"]

Summary

As Telstra continues its 5G rollout around Australia, they are committed to providing the latest information from health agencies on the safety of 5G and sharing the results of real-world measurements of 5G electromagnetic energy (EME) levels.

As part of this commitment, regular and rigorous EME measurements of small cells are conducted to ensure that the radio frequency (RF) EME levels from the small cells comply to the regulatory safety standard.
Small cells are low-powered radio transmitters for mobile phone services. Their small size makes them more discreet. Telstra uses small cells to improve coverage, connectivity, and customer mobile experience without the need to build as many big mobile towers.
Recently, Telstra reached out to communities and residents living near their small cells to offer a measurement of RF EME levels inside and near their homes. Based on the responses received, measurements were carried out for a number of locations.
The key findings from the small cell EME measurements in and around residential homes are as follows:

1. RF EME levels were consistently over 1000 times below the public safety limits – both outdoors and indoors.
2. RF EME levels inside homes were substantially lower than outside.
3. RF EME levels inside homes from the small cells were low, and similar to Wi-Fi.

These measurement results should reassure those people concerned about 5G Small Cells.
You can watch a video of Telstra's 5G small cell measurements at Barwon Heads in Australia here https://www.youtube.com/watch?v=XLUic3o2NyA&t=3s

076B

The improvement study of the maximum EMF strength measurement based on the reference signal for the 3.5 GHz 5G base station

Dr Donggeun Choi[1], Dr Kihwea Kim[1], Dr Sungwon Moon[2]
[1]National Radio Research Agency(RRA), Naju, Korea, Republic of. [2]AGOS, Seoul, Korea, Republic of

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave"]

Summary

Currently, the electromagnetic field strength measurement is using the measurement method that consider 5G beamforming technology, and we are continuously trying to improve the measurement method [1]. As the installation of 5G base stations increases, the need to research the electromagnetic field strength measurement methods considering various EMF exposure environments is emerging. Accordingly, as the existing EMF measurement point selection method takes a lot of measurement time, it is necessary to consider the electromagnetic field strength measurement method of the beamforming signal that can implement the fast and accurate point of investigation (PoI) selection method and Multi User-Multi Input Multi Output (MU-MIMO). In this paper, we are proposed the new selection method of the measurement starting point (PoI) for measuring the electromagnetic field strength of the 3.5 GHz 5G base station, and suggested the verification results on the method for measuring the maximum electromagnetic field strength derived from through the real-time reference signal (RS) measurement.

Is the work in progress?

Yes

078B

A Serious Game Approach to Increase the Public's Understanding of Scientific Uncertainty in Risk Assessment and Communication

Mr Ferdinand Abacioglu, Dr Marie Eggeling, Ms Sarah Link, Prof Christoph Boehmert
IU Internationale Hochschule, Erfurt, Germany

Abstract Subject Area(s)

["RF/Microwave","MM Waves","Risk assessment"]

Summary

Existing research on risk communication about radiofrequency electromagnetic fields (RF-EMF) has a notable limitation in its predominant emphasis on one-way, text-based communication. Notably, interactive online formats designed for informational or educational purposes, such as serious games, remain unexplored in the context of RF-EMF risk communication. However, serious games have demonstrated effectiveness in knowledge acquisition and various other outcomes. Despite their potential, no serious games have been developed specifically for RF-EMF risk communication thus far. One aim of the Horizon-Europe funded project SEAWave (Scientific-Based Exposure and Risk Assessment of Radiofrequency and mm-Wave Systems from children to elderly [5G and Beyond]) is to design, develop and evaluate a corresponding browser game (i.e. serious game). The main goal of this serious game is to increase scientific literacy with a focus on scientific uncertainty and conveying state-of-the-art knowledge on RF-EMF risk assessment to the interested general public. In the game, players take on the role of a science communicator, navigating communication scenarios and being confronted with the inherent uncertainty in empirical sciences. The game incorporates expert insights and public input, emphasizing factual accuracy and citizen engagement. An advisory board of eight citizens from different European countries has been formed, which actively contributes to the game's development. Currently game contents are being developed, game mechanics refined, and a target group analysis through risk communicator interviews is being conducted. The final web application is expected to launch in May 2025.

Is the work in progress?

Yes

080B

Fluorescence Lifetime Imaging Microscopy (FLIM) Study on the Porcine Cornea Exposed to 26 GHz Electromagnetic Field

Dr Negin Foroughimehr, Dr Ali Yavari
6G Research and Innovation Lab, Swinburne University of Technology, Hawthorn, VIC, 3122, Melbourne, Australia

Abstract Subject Area(s)

["Numerical dosimetry","RF/Microwave","MM Waves","Biological and medical applications"]

Summary

A well-characterised millimeter wave (mmWave) radiation exposure system has been successfully implemented within an anechoic chamber, providing a robust system for extensive biological investigations into radiofrequency (RF)-electromagnetic (EM) wave

exposure at 26 gigahertz (GHz). Characterized by a 1 cm radiation spot size, the system operates at 26 GHz, demonstrating its suitability for biological studies.
Using this mmWave exposure system, we conducted RF-EMF exposure experiments on porcine eyeballs at 26 GHz. The potential effects were examined through Fluorescence Lifetime Imaging Microscopy (FLIM), revealing changes in the molecular environment of fluorophores within the corneal layer induced by RF exposure. These alterations might impact fluorescence lifetime and intensity, leading to variations in the polar plot. The influence of RF radiation on cellular processes, potentially affecting emitted fluorescence in FLIM images, requires further exploration for conclusive insights.

Is the work in progress?

Yes

082B

A LOW SAR PDMS BASED IRS LOADED ANTENNA FOR 5G SUB-6-GHZ BODY AREA NETWORK

Mr Wahaj Abbas Awan[1], Mr Domin Choi[1], Mr Jaemin Lee[2], Prof Niamat Hussain[3], Prof Nam Kim[1]

[1]Chungbuk National University, Cheongju, Korea, Republic of. [2]Chungbuk National University, Cheongju, Korea, Democratic People's Republic of. [3]Sejong University, Seoul, Korea, Republic of

Abstract Subject Area(s)

["RF/Microwave","Biological and medical applications"]

Summary

The demand for reconfigurable antennas is burgeoning due to advances in communication systems and wireless devices. Modern applications require intelligent antenna systems capable of switching radiation patterns without sacrificing performance. Additionally, conformal devices offer durability, cost-effectiveness, and improved performance, appealing to wireless users across various domains. Recent literature discusses several approaches to meet the needs of modern communication systems. For instance, one study proposes a narrow-band pattern reconfigurable antenna for ISM band applications, utilizing PIN diodes to adjust its ground plane shape [1]. Another introduces a frequency and pattern reconfigurable flexible antenna using open-ended stubs and PIN diodes [2]. However, limitations such as narrow bandwidth and low gain persist. This paper addresses the demand for low SAR efficient antennas by presenting a flexible, semi-transparent, pattern reconfigurable antenna for the 5G sub-6 GHz band. Notably, it pioneers the use of PDMS as a substrate for designing intelligent reflective surface-backed antennas, offering pattern reconfigurability along with low SAR for body are network.

084B

Spotlight on EMF Research: A new literature review service by the German Federal Office for Radiation Protection

Heinrich Alexander M. Leymann[1], Alexander Astanin[1], Dan Baaken[1], Dimitri Belenki[1], Katja Czieselsky[1], Andreas Deser[1], Lukas Gernand[1], Dirk Geschwentner[2], Florian P. M. Kohn[1], Denise Kottwitz[1], Jens Kuhne[2], Felix Meyer[1], Blanka Pophof[2], Martin Rothe[1],

Janine-Alison Schmidt[2], Evelyn Weiser[1], Heide Wilsdorf-Koehler[1], Martin Zang[2], Gunde Ziegelberger[2]
[1]Federal Office for Radiation Protection, Cottbus, Germany. [2]Federal Office for Radiation Protection, München, Germany
Abstract Subject Area(s)
["ELF/LF","RF/Microwave","MM Waves","Risk assessment"]
Summary
The German Federal Office for Radiation Protection (BfS) is delighted to present the newly established information service “Spotlight on EMF Research”, which offers reviews of recent publications with a particular focus on their relevance for radiation protection. These publications are selected from well over 100 scientific articles related to radiation protection from electromagnetic fields and published internationally every month. The articles are summarized and reviewed by our experts from the BfS Competence Centre for Electromagnetic Fields. In compact articles, BfS contextualizes the study results to the current state of knowledge and assesses their relevance for radiation protection. In addition, we offer literature suggestions to further interesting publications.
Our short reviews comprise approximately 1000 words, and we aim that our reader not only gets to know the main results, motivations, and general contexts of conducted research but also understands the well-founded position of the BfS on the validity of the data and the authors' conclusions.
You can find out our latest efforts on: www.bfs.de/en-spotlight.

086B
Simplification of Mobile Terminal Numerical Models for SAR Evaluation
Miss Erina Kawai[1,2], Prof Kazuyuki Saito[1,2], Prof Masaharu Takahashi[1], Dr Tomoaki Nagaoka[2]
[1]Chiba University, Chiba, Japan. [2]National Institute of Information and Communications Technology, Tokyo, Japan
Abstract Subject Area(s)
["Numerical dosimetry","RF/Microwave"]
Summary
With the widespread use of various wireless devices such as smartphones, opportunities to use electromagnetic waves are increasing. Therefore, it is essential to evaluate the effects of electromagnetic radiation on the human body. In previous study, exposure assessment has been performed by electromagnetic field analysis based on simulations assuming real environments using numerical human models and terminal models. However, the terminal structure is becoming more complex due to the recent development of smartphone terminals. Therefore, it is becoming more difficult to understand the detailed internal structure of smartphones. As a result, numerical modeling of smartphones is extremely time-consuming. Therefore, in this study, we focused on SAR (Specific Absorption Rate), an indicator for evaluating electromagnetic radiation exposure, and devised a simpler method for creating a smartphone model that is used only for numerical calculations. Since the purpose of this paper was to make a comparison in the human model, a simplified smartphone model was created using a detailed smartphone model that could reproduce the actual measurements made in a

previous study, and the accuracy of the simplified smartphone model was compared with the human model.

Is the work in progress?

Yes

088B

Development of Irradiation Power Control Module Using Wire Grids for Exposure System at 265 GHz

Dr Maya Mizuno[1], Prof Yoshinori Tatematsu[2], Prof Masafumi Fukunari[2], Dr Shota Yamazaki[1], Dr Tomoaki Nagaoka[1]

[1]National Institute of Information and Communications Technology, Koganei, Japan. [2]University of Fukui, Fukui, Japan

Abstract Subject Area(s)

["MM Waves"]

Summary

The frequency region over 100 GHz, called terahertz (THz), has been considered for next-generation mobile communication systems. Regarding the safe use of radio waves, the International Commission on Non-Ionizing Radiation Protection guidelines have already included exposure limits for the region of THz frequencies. However, exposure experiment data is insufficient in the THz frequency region and is required to be accumulated more. We have therefore conducted a study on high-power THz exposure systems for performing exposure experiments. In this study, we developed the THz irradiation power control module with wire grids for the exposure system at 265 GHz and verified its properties. The property data indicated a possible way of setting to the specified THz power.

Is the work in progress?

Yes

090B

Trends in scientific research on exposure to electromagnetic fields and biological and health-related effects in the past 40 years: Temporal, geospatial and co-author network analyses based on data of the EMF-Portal

Dagmar Dechent[1], Dr Lambert Bodewein[1], Tanja Emonds[1], David Graefrath[1], Prof Thomas Kraus[2], Dr Sarah Driessen[1]

[1]Research Center for Bioelectromagnetic Interaction (femu), Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany. [2]Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany

Abstract Subject Area(s)

["ELF/LF","RF/Microwave","Risk assessment"]

Summary

The EMF-Portal (https://www.emf-portal.org) is an internet information system on the effects of electromagnetic fields (EMF) and provides all information free of charge in English, German and Japanese. The core of the EMF-Portal is an extensive literature database with an inventory of about 41,000 publications and 7,000 summaries of individual scientific studies (as of February 2024). Using the database of the EMF-Portal,

we analyzed the global scientific efforts in conducting scientific studies on the biological effects of exposure to mobile communications and 50/60 Hz magnetic and electric fields. We present temporal trends in number of publications, Top 10 journals, countries with high publications output and co-author network analysis.

Is the work in progress?

Yes

092B

Accurate and Efficient Modelling of MRI Heating of Active Implantable Medical Device Leads Using a Lumped Element Approach

Dr Aiping Yao[1], Dr Jing Wang[2], Dr Pengfei Yang[2], Dr Tolga Goren[3], Prof Niels Kuster[3]
[1]Nanchang University, Nanchang, China. [2]Center for Medical Device Evaluation, National Medical Products Administration (NMPA), Beijing, China. [3]IT'IS Foundation, Zurich, Switzerland

Abstract Subject Area(s)

["Numerical dosimetry","RF/Microwave","Risk assessment"]

Summary

The assessment of RF-induced heating for patients wearing Active Implantable Medical Devices (AIMD) under MRI exposure is crucial for ensuring patient safety [1-2]. The current standard of ISO/TS 10974[3] proposes a 4-Tier approach for this evaluation, with Tier 4 being the most accurate but requiring full-wave modeling of anatomical models with AIMD implanted. However, due to the complex and sub-millimeter AIMD electrode structure, modeling AIMD with anatomical models is often not feasible. To address this challenge, this paper proposes a modeling approach of AIMD electrode lead with equivalent lumped element models. This approach simplifies the complex lead structures into inductive elements with equivalent electromagnetic characteristics, significantly reducing the computational requirements and the modeling process. This allows for an efficient and reliable assessment of RF safety of AIMDs under MRI.

Is the work in progress?

Yes

094B

Comparative Analysis of RF-EMF Measurement Results and Changes in Anxiety of RF-EMF

Mr Jongchan Kim, Dr Taewook Hwang
Korea Communication Agency, Na-ju, Korea, Republic of

Abstract Subject Area(s)

["RF/Microwave"]

Summary

In this paper, we compared and analysed the RF-EMF measurement results for facilities where children and adolescents live and the changes in anxiety of RF-EMF through RF-EMF measurement. According to the measurement results, it was confirmed that the intensity of RF-EMF in facilities where Korean children and adolescents live and receive education is at a very low level of up to 2.86% compared with ICNIRP guideline. However, as various sources of RF-EMF exposure, such as BSs and WIFI routers, increase every year, the intensity of RF-EMF in the facility also increases, and it is judged that

continuous investigation and management is necessary. In addition, it was confirmed that anxiety of RF-EMF was improved by providing RF-EMF measurement results and guidance on ways to reduce RF-EMF exposure in daily life. In light of these results, it is inferred that providing objective information in understanding and communicating with the public who has anxiety about RF-EMF has a positive effect in alleviating anxiety and improving anxiety. Therefore, in the future, we plan to expand RF-EMF measurements to various facilities and provide information to improve the public's anxiety of RF-EMF.

096B

Comparison of Measured SARs between Full and Fast SAR Measurement Systems Using Various Smartphones

Dr Tomoaki Nagaoka, Dr Yuto Shimizu, Mr Hiroshi Kawakami
National Institute of Information and Communications Technology, Koganei, Japan

Abstract Subject Area(s)

["RF/Microwave","Standards and public health policy"]

Summary

Fast SAR measurment systems are currently used primarily for screening, but are expected to be adopted for compliance testing in the future. Recent research comparing SAR values from over 8,000 conditions on 80 different commercially availablesmartphones using two fast SAR measurement systems revealed significant differences likely influenced by the DUTs. In this study, SAR values from both conventional and fast systems were compared using smartphones in test mode in order to climinate DUT-induced discrepancies.

Is the work in progress?

Yes

098B

Assessing antenna performance and electromagnetic impact (sar) on the head using variously structured models of wearable radiofrequency communication devices

Dr Patryk Zradziński, Dr Jolanta Karpowicz, Dr Krzysztof Gryz
Central Institute for Labour Protection – National Research Institute, Warszawa, Poland

Abstract Subject Area(s)

["Numerical dosimetry","RF/Microwave","Occupational exposure"]

Summary

Investigations were focused on examining the impact that the structure of models of a wearable device equipped with a wireless communication module operating at 2.45 GHz frequency has on the results of computer modelling regarding its antenna performance and related battery operating time, as well as associated SAR in the user's head. The preliminary results of these ongoing studies showed a possible reduction in a body-worn device’s battery operating time by approximately (20-30)%, compared to the device operating in free space while maintaining the same quality of wireless connection. They also revealed up to 60% variations of 10g-SAR in the user's head among the examined exposure scenarios where the structure and spatial configuration of the device models employed in numerical simulations differed.

Is the work in progress?

Yes

100B

Predictive modeling of exposure to environmental electromagnetic fields using artificial intelligence: data collection and analysis

Mr Athanasios Manassas, Prof Theodoros Samaras
Aristotle University, Thessaloniki, Greece

Abstract Subject Area(s)

["RF/Microwave"]

Summary

The scope of this ongoing work is to build Artificial Intelligence (AI) models using either Machine Learning (ML) or Deep Learning (DL) techniques to predict electromagnetic field values at ground level. The target values are collected either by spot measurements using a spectrum analyzer or by drive test measurements using an electric bike equipped with an exposimeter and GPS. So far, the focus of the work has been on collecting publicly available data, known as 'features', that can contribute to predicting the target values. These features include the distance between the points of interest (POI) and the antennas, the transmitted power of the antennas, and information collected by GIS systems, including the built environment around the POI. Special attention was given to validating and correcting the accuracy of feature data, a process known as data cleaning in AI.

Is the work in progress?

Yes

102B

Comparison of the Electromagnetic Energy Absorbed in Human Tissue and in the Standardized Test Phantom when Transmitters are Operated in Closest Proximity to the Skin

Dr Ercole Matteo Amadei[1], Prof Niels Kuster[1,2]
[1]IT'IS Foundation, Zurich, Switzerland. [2]Swiss Federal Institute of Technology (ETH) Zurich, Zurich, Switzerland

Abstract Subject Area(s)

["Numerical dosimetry","RF/Microwave","Standards and public health policy"]

Summary

IEC TC106) is currently revising the standard for the compliance testing of wireless communication devices operating at the head and body investigating the specification of a measurement distance close to the dosimetric phantom. This study compares the SAR assessed with the standardized tissue simulants of the phantom to the exposure of a layered skin model as a function of distance. The results demonstrate that the flat phantom and the tissue simulants generally yield a conservative exposure estimate of the exposure at all distances. The exceptions are discussed with respect to their relevance for compliance testing.

Is the work in progress?

Yes

104B

Remote Powering Cortical Implant for Brain Computer Interface

Dr Megdouda BENAMARA, Dr Mélanie DESCHARLES, Dr François FRASSATI
CEA, GRENOBLE, France

Abstract Subject Area(s)

["RF/Microwave","Biological and medical applications"]

Summary

Brain Computer Interface (BCI) technology is based on ECoG recording System. The system contains two main parts, the cortical implant and the terminal. Both incorporates electronic boards and antennae. The power is provided to the implant by inductive coupling at 13;56 MHz and the data is transferred by the UHF electromagnetic link at 400 MHz. This article describe the methodology of developing the real time remote powering system used in BCI technology. Analytical analysis based on the minimum requested voltage and magnetic field activation is developed. The trade-off between operating distance and load effects is discussed.

106B

Analytical model for RF propagation in layered spheres: use of high permittivity materials in ultra-high field magnetic resonance of the brain

Mr Vincenzo Miranda[1], Prof Riccardo Lattanzi[2], Prof Daniele Riccio[1], Prof Giuseppe Ruello[1]

[1]University of Napoli Federico II, Department of Electrical Engineering and Information Technology, Naples, Italy. [2]New York University Grossman School of Medicine, Center for Advanced Imaging Innovation and Research (CAI2R) and Bernard and Irene Schwartz Center for Biomedical Imaging, Department of Radiology, 660 First Avenue, 10016, New York, USA

Abstract Subject Area(s)

["RF/Microwave","Biological and medical applications"]

Summary

A new analytical model has been developed to investigate on the role of High Permittivity Materials (HPM's) in Magnetic Resonance Imaging (MRI), in order to optimize the configuration of such materials, guiding subsequent numerical simulations and reducing the time required. In this work we extend the use of the model, applied so far by considering the human head as a homogeneous medium, to a case study in which it is simulated through a multilayer model to approach a real case. The analytical model, based on Mie's scattering theory, reformulates the electromagnetic field in each medium as the superposition of a progressive and regressive wave, exploiting parallelism with transmission lines and allowing a physical interpretation of the phenomenon through simple scalar parameters such as reflection coefficient and impedance. This new formulation makes it possible to study, analytically and in a simple way, the effects of high permittivity materials (HPM's) in ultrahigh field MRI, as a function of permittivity value or thickness, and allowing an intuitive understanding of the scattering phenomenon in terms of interference between progressive and regressive waves. The results of this work show that by introducing a multilayer model, the permittivity value for maximizing the RF field deviates by about 10% from the homogeneous head case. The magnetic induction field strength obtains a maximum increase of about 40% in the case where the HPM is present with the multilayer model,

compared to the 20% increase of the case where the head is considered as homogeneous.

Is the work in progress?

No

108B

A narrative review on 5G NR EMF exposure sensing technologies

Dr Erdal Korkmaz[1], Dr Sam Sam Aerts[1], Mr Richard Richard Coesoij[2], Dr Chhavi Raj Bhatt[3], Mr Maarten Velghe[4], Mr Derek Land[1], Dr Nikolaos Petroulakis[5], Dr Marco Spirito[2], Dr John Bolte[1,4]

[1]The Hague University of Applied Sciences, Research Group Smart Sensor Systems, Delft, Netherlands. [2]Delft University of Technology, Department of Microelectronics, Delft, Netherlands. [3]Australian Radiation Protection and Nuclear Safety Agency, Yallambie, Australia. [4]National Institute for Public Health and the Environment, Centre for Sustainability, Environment and Health, Bilthoven, Netherlands. [5]Institute of Computer Science, Foundation for Research and Technology-Hellas, Heraklion, Greece

Abstract Subject Area(s)

["RF/Microwave","MM Waves"]

Summary

This review provides a comprehensive analysis of current radio frequency (RF) electromagnetic field (EMF) assessment tools, covering high-end spectrum analyzers, field meters, stationary nodes or area monitors, and lab-developed sensors. Furthermore, the growing application of mobile apps for personal exposure data collection in 5G New Radio (NR) networks is highlighted. It discusses both standardized and non-standardized measurement protocols to gather insights into the diversity of methodologies. The review revealed a notable demand for cost-effective and robust sensors, essential for personal exposure assessments, mobile (vehicle-integrated) measurements, and distributed sensor networks. However, there is a notable scarcity of comprehensive information regarding existing custom RF-EMF measurement tools, particularly regarding measurement uncertainty. Additionally, real-time, fast-sampling solutions are needed to adequately capture the irregular temporal variability of EMF distribution in next-generation networks. Conclusively, due to the diversity of tools and methods, a comprehensive comparison is vital to determine the necessary statistical tools for aggregating available measurement data.

Is the work in progress?

Yes

110B

Assessment of exposure to 5G Radiofrequency Electromagnetic Fields in primary care health centres in Albacete (Spain): a comparative study of traffic-generated and non-traffic-generated scenarios

Mr Samuel Puche, Dr Jesús González-Rubio, Dr Alberto Nájera

University of Castilla-La Mancha, Albacete, Spain

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","MM Waves"]

Summary

This study investigates the exposure to Radiofrequency Electromagnetic Fields (RF-EMF), with focus on 5G, in primary healthcare centres in Albacete, Spain. Given the increasing public health concerns regarding RF-EMF exposure and the significance of healthcare settings as sensitive environments, this research aims to fill the gap in existing literature by assessing exposure levels in such facilities, especially considering the rollout of 5G technology.
We conducted spot measurements both inside and outside eight primary healthcare centres using an MVG Evolution exposimeter. Measurements were taken over six minutes while generating traffic through a Samsung Galaxy S20 Ultra downloading 8K HD movies on YouTube, and then for thirty minutes without generating traffic. Outdoor measurements were similarly conducted over six minutes with and without traffic.
The study revealed variable exposure levels, with higher intensities observed outdoors compared to indoors and the detection of 5G signals in the 3.5 GHz band. All measured values were significantly below the ICNIRP guidelines.
The strength of this study lies in its novel focus on 5G technology in exposure assessment. However, the experimental design poses limitations, such as the short duration of measurements and potential variability in environmental conditions. Additionally, the reliance on traffic-generated by a single device may not fully represent typical scenarios.
Exposure to 5G RF-EMF in primary healthcare centres remains well within international standards. Despite the methodological limitations, this study contributes important baseline data on RF-EMF exposure in healthcare environments. Further research is recommended to expand on these findings and explore long-term exposure assessments.

112B

The frequency pattern of the outdoor radiofrequency electromagnetic exposure on the passenger boats and piers in various seasons

Dr Jolanta Karpowicz
Central Institute for Labour Protection - National Research Institute (CIOP-PIB), Warszawa, Poland

Abstract Subject Area(s)

["RF/Microwave","Occupational exposure","Risk assessment"]

Summary

By the use of the frequency-selective portable, autonomous, radiofrequency exposure data-loggers, the frequency pattern of radiofrequency exposure (indicating also sources of exposure) was investigated on passenger boats and piers during various passengers' traffic (low and high touristic activieties). The significantly different relative contribution from fixed antennas of communication networks (BTS antennas emitting downlink signals to terminals) and mobile terminals used by passengers (emitting uplink signals to BTS) to the total exposure from all types of emissions was found between seasons. Similar to various passenger vehicles (such as trains or busses), significant contribution from mobile terminals was found in case of measurements during high passengers' traffic in the harbour or on boat (by visual observations it was noticed significant up-streaming activities of many tourists). In such conditions the passengers' terminals are

the significant source of workers' exposure, which is not present during the low season and also not common in other microenvironments.

Is the work in progress?

Yes

114B

Research on magneto-acoustic-electrical tomography method based on liquid metal and M coded excitation.

Prof Shunqi Zhang

Institute of Biomedical Engineering, Chinese Academy of Medical Science & Peking Union Medical College,, Tianjin, China. Tianjin Key Laboratory of Neuroregulation and Neurorepair, Tianjin, China. State Key Laboratory of Advanced Medical Materials and Devices,, Tianjin, China. Engineering Research Center of Pulmonary and Critical Care Medicine Technology and Device (Ministry of Education), Tianjin, China

Abstract Subject Area(s)

["Biological and medical applications"]

Summary

Magneto-acoustic-electric tomography has important research value in the early diagnosis of tumors and biocurrent monitoring. In this study, we propose a magneto-acoustic-electric tomography method combining liquid metal image improvement and M-coded excitation to improve the SNR of MAET. The results showed that the liquid metal can achieve image enhancement of tissue magneto-acoustic-electrical tomography. When 7, 15, 31, and 63bit M-coded excitations were applied to the samples, the SNR was improved by 28 dB, 34 dB, 40 dB, and 45 dB, respectively. The experimental results prove the feasibility of applying the maximum-length sequence code to rotational MAET and reveal the important significance of liquid metal to improve the quality of magneto-acoustic-electric tomography.

116B

Influence of inter-train interval incorporated into high frequency rTMS on oscillatory brain activity

Dr Jingna Jin, Dr He Wang, Dr Xin Wang, Dr Ying Li, Prof Zhipeng Liu, Prof Tao Yin

Institute of Biomedical Engineering, Chinese Academy of Medical Sciences & Peking Union Medical College, Tianjin, China

Abstract Subject Area(s)

["Biological and medical applications"]

Summary

Background and objective: Recent studies have indicated that inter-train intervals (ITI) are incorporated into high frequency repetitive transcranial magnetic stimulation (rTMS) protocols not only to avoid overheating and for safety, but also because they are essential for eliciting excitatory effects. However, the influence of ITI duration incorporated into rTMS on oscillatory brain activity remains unclear.

Methods: Four rTMS protocols with sessions separated by at least 5 days, including three active rTMS protocols with 25 s ITI, 50 s ITI, 100 s ITI, and a sham rTMS protocol, were performed over the primary motor cortex. Electroencephalography (EEG) in resting

state with eyes closed was recorded before and after each rTMS protocol. The changes in oscillatory brain activities were evaluated by comparing the spectral power density.
Results: The 100 s ITI rTMS caused a significant increase of spectral power density in alpha and beta frequency band, particularly in central and temporal cortices of stimulated hemisphere. However, 25 s ITI and 50 s rTMS did not change the spectral power density in any frequency bands. Furthermore, we found only change of power spectral density induced by 100 s ITI was significantly different from thata induced by sham rTMS.
Conclusion: The effects of rTMS with different ITI on oscillatory brain activity were significantly different. Longer ITI rTMS might have a different effect on oscillatory brain activity compared with shorter ITI rTMS. These results indicate the importance of ITI parameters in rTMS protocols.

118B

A High-Voltage Tunable Pulse System with Tens of Nanosecond Pulse Width for Low Impedance Biological Solution Loads

Miss Wen Dang[1], Dr Xiao Rao[2], Prof Xiaodong Chen[1], Dr Yasir Alfadhl[1]
[1]Queen Mary University of London, London, United Kingdom. [2]Hangzhou Dianzi University, Hangzhou, China

Abstract Subject Area(s)
["Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

This paper introduces a high-voltage tunable nanosecond pulse system for low-impedance biological solution loads, operating at a repetition rate of 1 Hz. The proposed system consists of two primary parts: a high-isolation driver module and a high-voltage module. In the driver module, an optocoupler serves dual roles, acting as a driver gate and providing high isolation due to the absence of electrical contact between input and output. Additionally, a transient-voltage-suppression (TVS) diode is utilized to suppress voltage spikes and clamp the voltage between the gate and source of the silicon carbide (SiC) metal-oxide-semiconductor field-effect transistor (MOSFET). Moving to the high-power module, an energy capacitor is directly charged by a single SiC MOSFET, and subsequently discharged into the load. Numerical analysis shows the proposed system can generate the pulse signal with a pulse width of 30 ns and an amplitude of 1 kV for various loads. Experimental verification is conducted on saline with resistance of 30 Ohms, subjected to pulses of 30 ns and 50 ns.

Is the work in progress?
Yes

120B

Prediction of therapeutic effect to transcranial magnetic stimulation therapy for treatment-resistant depression using a combination of electric field simulation and functional connectivity analysis index

Mr Yutaro Soejima[1], Ms Anna Iino[1], Dr Masataka Wada[2], Ms Shiori Honda[2], Ms Mayuko Takano[2], Dr Shinichiro Nakajima[2], Prof Masaki Sekino[1], Prof Yoshihiro Noda[2]

[1]Graduate School of Engineering, The University of Tokyo, Tokyo, Japan. [2]Department of Neuropsychiatry, Keio University School of Medicine, Tokyo, Japan

Abstract Subject Area(s)

["Biological and medical applications"]

Summary

Transcranial magnetic stimulation (TMS) is an established treatment for patients with treatment-resistant depression (TRD) who do not respond to medication. Although TMS is an effective treatment for about half of TRDs, it is crucial in practice to be able to predict the therapeutic effect of TMS therapy prior to the start of treatment, because TMS therapy is an economically and physically burdensome treatment for the patient. Thus, in the present study, a novel predictive index utilizing electric field simulation analysis and resting-state functional magnetic resonance imaging analysis was developed to enable highly accurate prediction of the efficacy of TMS therapy for TRD. The following three approaches were implemented in the present study:

4. Prediction considering the whole brain region
5. Prediction by a novel index of stimulus distribution that multiplies electric field and functional connectivity
6. Prediction that perform pre-training on a large dataset without intervention in depression to be able to predict even with a small size of dataset with intervention.

The results showed that the predictions using only the simulated electric field and the simple combination of the simulated electric field and functional connectivity data in Method 1 were the most accurate. These methods were comparable to the previous studies in terms of accuracy. In contrast, Methods 2 and 3 were not more accurate than Method 1. Prediction of therapeutic effect using only electric field simulation analysis is considered feasible and clinically applicable because the method is based on MRI data, which is clinically accessible.

122B

Magnetoelectric nanoparticles for neuroprothesis: a feasibility study

Miss Valentina Galletta[1,2], Dr Serena Fiocchi[2], Dr Emma Chiaramello[2], Dr Alessandra Marrella[2], Dr Giulia Suarato[2], Dr Marta Bonato[2], Dr Silvia Gallucci[2], Miss Martina Benini[2], Dr Marta Parazzini[2], Prof Paolo Ravazzani[2]

[1]Politecnico of Milan, Milano, Italy. [2]CNR-IEIIT, Milano, Italy

Abstract Subject Area(s)

["Numerical dosimetry","ELF/LF","Biological and medical applications"]

Summary

The objective of this work was the feasibility assessment of using MENPs as tools for the stimulation of peripheral nerves. The analysis was computationally performed, by paring the electromagnetic distribution and the neuronal dynamic of the fiber. An estimation of the initial spike time value, and the related values of the equivalent injected current and of the external potential sensed by the fiber were calculated. The results opened towards the optimization of the MENPs configurations and relative positions, and the improvement of the MENPs – fiber interaction aiming at the enhancement of the use of the MENPs as stimulating tools to control the peripheral nervous systems.

124B

Methods of Reducing the Uncertainty of Dielectric Tissue Properties at Low Frequencies and Its Impact on Dosimetry

Ms Cindy Karina[1,2], Dr Myles Capstick[2], Dr Azadeh Peyman[3], Prof Niels Kuster[1,2]
[1]Department of Information Technology and Electrical Engineering, ETH Zurich, Zurich, Switzerland. [2]Foundation for Research on Information Technologies in Society (IT'IS), Zurich, Switzerland. [3]Radiation Dosimetry, UK Health Security Agency, Chilton, United Kingdom

Abstract Subject Area(s)

["Experimental dosimetry","ELF/LF","Biological and medical applications"]

Summary

Knowledge of the dielectric properties of biological tissues is essential in understanding the response of biological entities to external electromagnetic fields (EMF). However, literature values for dielectric properties at frequencies below 10 MHz are scarce and have large uncertainties, exceeding 100% for the conductivities of some tissues and a few orders of magnitude for permittivity. This work is based on knowledge of the physical properties of tissues as well as other techniques and methods employed to reduce the uncertainty of permittivity assessments even in the presence of electrode polarization. Additionally, ability to measure conductivity with greater confidence at lower frequencies provides an indication of the presence or otherwise of dielectric relaxations as the permittivity cannot change without a corresponding change in conductivity. The study then goes on to investigate the impact the dielectric property uncertainties on uncertainty of dosimetric quantities (induced electric field and current density) across a range of realistic scenarios.

Is the work in progress?

Yes

126B

Reducing magnetic fields exposure of electric and hybrid cars – an innovative solution and an evaluation according to ec/ icnirp guidelines and chronic exposure target levels

Dr Amnon Duvdevany[1], Mr Shaul Shulman[2], Mr Oded Einat[2]
[1]IIOSH (Israel Institute for Occupational Safety and Hygiene). Submitted as an individual, Tel-Aviv, Israel. [2]SafeFields Technologies Inc., Herzliya, Israel

Abstract Subject Area(s)

["ELF/LF","Risk assessment","Standards and public health policy"]

Summary

Electric and hybrid cars increasing spread raises concerns regarding human exposure to Low Frequency (LF) magnetic fields. An innovative solution has been developed by SafeFields Technologies Inc. for reducing the LF magnetic fields, based upon delivering magnetic fields generated by dedicated coils (“tailored” to each car) to reduce the human exposure. Evaluation of exposure reduction by the solution, according to car’s magnetic fields measurements performed using a dynamometer, will be presented and discussed. Exposure analyzing according to EC/ ICNIRP recommendations and according to precautionary principle-based target levels regarding electrical grid chronic exposure reduction, will be discussed as well.

Is the work in progress?
Yes

128B
The role of different time averaged loads on extremely low frequency magnetic fields around high-voltage power lines in Slovenia
Prof Peter Gajšek[1,2], Prof Tadej Kotnik[2], Dr Blaž Valič[1,2]
[1]Institute of Nonionizing Radiation, Ljubljana, Slovenia. [2]University of Ljubljana, Faculty of Electrical Engineering, Ljubljana, Slovenia
Abstract Subject Area(s)
["Experimental dosimetry","ELF/LF","Risk assessment","Standards and public health policy"]
Summary
To allow calculations of ELF MF around high voltage (HV) power lines (PL) for Slovenia, a new three-dimensional method including precision terrain elevation data to calculate the long-term average ELF MF was developed. This method provides a fast tool to determine the ELF MF values for the territory of the whole country for any desired load conditions of the power distribution network. This method was already applied by our group for assessment of possible increased cancer risk in children and adolescents, but it is also applicable also for the broader purpose of exposure assessment, including the planning of proper placement of HV PL into the environment, and of new housing near the existing HV PL.
There is a big difference in the size of areas with increased values of the ELF MF around HV PL between the nominal load and the long term (1. 1. 2006 to 31. 12. 2017) average loads of HV PL which suggests that more attention is required for objective assessment of such loads and interpretation of the implications

130B
Planning 5G non-public network in a real hospital-case scenario: a ray tracing simulation study
Miss Francesca Lodato[1], Dr Andrea Garzia[2], Dr Simona Valbonesi[2], Prof Antonio Iodice[3], Dr Francesco Matera[2], Prof Giuseppe Ruello[3], Dr Pierpaolo Salvo[2], Prof Rita Massa[1]
[1]University of Naples Federico II, Department of Physics "Ettore Pancini", Naples, Italy. [2]Fondazione Ugo Bordoni, Rome, Italy. [3]University of Naples Federico II, Department of Electrical Engineering and Information Technology, Naples, Italy
Abstract Subject Area(s)
["Occupational exposure","Risk assessment"]
Summary
Fifth generation (5G) technologies can allow the deployment of advanced techniques in healthcare field, enhancing the quality of services provided to patients. The installation of 5G non-public networks seems to be very suitable for healthcare environments. However, due to 5G signal characteristics, an optimization study is necessary before introducing them in clinical practice. Ray tracing is a very promising technique for the prediction of electromagnetic field levels generated by 5G systems. The aim of this work is to present a ray tracing analysis on a real-hospital case scenario, planning the introduction of a 5G non-public network. Two proprietary tools based on ray tracing

technique were involved and an intercomparison between their results have been carried out in terms of simulated cumulative distribution function and percentiles. A good agreement was found, and this was a starting point for the optimization of the 3.7 AAS (Advanced Antenna Systems) antenna parameters introduced in the selected scenario. The optimization involved antenna position and small cell configuration (E2 or E10). Simulation results have shown that E2 small cell configuration was the best in terms of coverage and energy consumption. Moreover, the optimal antenna position was found. This work demonstrates that the considered tools may be very useful for the design of 5G non-public networks in hospital scenarios. The activity is ongoing and will be extended in future developments for study of performance improvements using small cell network and quality field parameters, analysis of other outdoor and indoor scenarios or comparison with on-site measurements.

Is the work in progress?

No

132B

Measurements of magnetic fields generated from mobile electric fans

Mr Yuichi Kawagishi, Mr Norihiro Minami, Dr Chiyoji Ohkubo
Japan EMF Information Center, Tokyo, Japan

Abstract Subject Area(s)

["Experimental dosimetry","ELF/LF","Standards and public health policy"]

Summary

An increasing number of people use mobile electric fans to cool down themselves during severe heat conditions in summer season in Japan, Korea and other countries. They are getting more and more popularity and are considered as a must-have item especially for younger people, leading to various kinds of mobile electric fans are introduced to the market.

However, we recognized a media article that a citizens group in Korea had raised an issue that “mobile electric fans generate magnetic fields (MF) stronger than the exposure level (0.4 μT) which were one of the bases for classifying low frequency (50/60 Hz) magnetic field as ‘possibly carcinogenic to humans (Group 2B)’ by the International Agency for Research on Cancer (IARC) in 2002”. While this may raise concern among the Japanese general public, no such articles have been observed domestically regarding measurement values of MF generated from mobile electric fans.

In view of such situation, we measured the MF (magnetic flux density: MFD) generated from eight models of mobile electric fans in compliance with the International Electrotechnical Commission (IEC) Standard 62233:2005.

We believe that the findings will be helpful for our risk communication activities with the general public regarding EMF.

134B

Comparison of long-term magnetic field exposure in electric vehicles and public transportation with electric drive systems

Pia Schneeweiss[1], Rene Hirtl[1], Gernot Schmid[1], Johannes Kainz[1,2], Sarah Driessen[2], Michael Kubocz[2], Luis Kalb[3], Dino Silvestro[3], Matthias Vogt[3]

[1]Seibersdorf Laboratories, EMC & Optics, Seibersdorf, Austria. [2]Research Center for Bioelectromagnetic Interaction (femu)-Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany. [3]ADAC Technik Zentrum, Landsberg am Lech, Germany

Abstract Subject Area(s)

["Experimental dosimetry","ELF/LF"]

Summary

Long-term (10-273 minutes) measurements of the extremely low frequency (ELF) and low frequency (LF) magnetic field (MF) exposure in electric vehicles and public transportation with electric drive systems were conducted in the course of a comprehensive study and compared with each other. The study included eleven electric vehicles (EV), two plug-in electric vehicles (PHEV), one electric motorcycle, three electric scooter, high-speed and express trains (Intercity Express ICE and Intercity IC), regional trains (RE and RB), urban-suburban trains (S-Bahn), and light rail carriages (overground and underground trams, such as Cologne Stadtbahn). In the case of vehicles and two-wheelers, the measurements were carried out according to standardized test procedures (WLTC and WMTC, respectively) and in real traffic rides.

The comparison is based on the long-term root mean square (RMS) of the magnetic flux density B_{RMS} values resulting from the measurements in the different measurement positions. The study is to some degree exploratory, as currently no scientifically proven health effect is linked to MF long term exposure.

The RMS maximum was found on the upper floor of double-deck regional train (18.0 µT in RE). All results for EV, PHEV, and on the electric two-wheelers were lower.

136B

Numerical assessment of maximum induced electric field strength in the body of drivers and passengers of electric vehicles

Pia Schneeweiss[1], Rene Hirtl[1], Gernot Schmid[1], Johannes Kainz[1,2], Sarah Driessen[2], Michael Kubocz[2], Luis Kalb[3], Dino Silvestro[3], Matthias Vogt[3]

[1]Seibersdorf Laboratories, EMC & Optics, Seibersdorf, Austria. [2]Research Center for Bioelectromagnetic Interaction (femu)-Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany. [3]ADAC Technik Zentrum, Landsberg am Lech, Germany

Abstract Subject Area(s)

["Numerical dosimetry","ELF/LF"]

Summary

The effects of previously measured magnetic fields inside an electric vehicle (EV), a plug-in hybrid electric vehicle (PHEV), on a scooter, and a motorcycle, both with electric drive, were analyzed as part of systematic numerical calculations. For this purpose, two different anatomical body models (Duke and Ella from the Virtual Population, IT'IS Foundation) were placed in the respective sitting position and exposed to the magnetic field recorded in detail beforehand. The calculations were executed using a magneto quasi-static solver (based on the Finite Elements Method) at a grid of 1 x 1 x 1 mm^3 and the results were analyzed regarding the exposure indices related to the basic restrictions for the general public given in ICNIRP 2010 using a scaling method based on the Weighted Peak Method in Time Domain.

Despite exceeding the reference levels given in European council recommendation 1999/519/EC regarding the magnetic flux density, the induced electric field strengths in the body remained below the basic restrictions specified in ICNIRP 2010 for the general public.

138B

Analysis of the Effectiveness of RF-EMF Recognition Enhancement through RF-EMF Self-Test

Mr Hyeongyeol Lim, Ms Mina Shin, Mr Taewook Hwang
Korea Communications Agency, 760, Bitgaram-ro, Naju-si, Jeollanam-do, Korea, Republic of

Abstract Subject Area(s)

["RF/Microwave"]

Summary

With the commercialization of 5G services in South Korea, the number of 5G base stations (BSs) surpassed 330,000 in 2023, representing an approximately 4.7 times increase compared to 70,000 in 2019. Alongside the proliferation of BSs, concerns regarding radio-frequency electromagnetic field (RF-EMF) have escalated, leading to an increase in complaints such as opposition to BS installations. Moreover, there is a growing demand for RF-EMF measurements due to increased public interest in RF-EMF and its effects on living environments, rising from 2,468 cases in 2021 to 6,415 cases in 2023, representing a 2.6 times increase.
There are limitations for professionals to physically measure RF-EMF in each individual's living area. Therefore, this paper aims to confirm changes in awareness of RF-EMF through self-test using RF-EMF measurement devices that individuals can directly use to measure and verify the intensity of RF-EMF in the spaces where they primarily reside.
In this paper, we conducted a self-test of RF-EMF using small RF-EMF measurement devices capable of separately measuring frequencies from the 800 MHz to 6 GHz band on 2,012 peoples. While there existed vague anxiety regarding high levels of RF-EMF in living spaces, this self-test allowed for direct measurement and confirmation of RF-EMF, revealing a reduction in anxiety towards RF-EMF due to the observed low levels of RF-EMF. The effectiveness of improving RF-EMF awareness, coupled with high satisfaction levels observed in RF-EMF self-test, suggests the need for expanding experience services tailored to the public's understanding and needs.

Is the work in progress?

No

140B

Transient ELF and LF magnetic fields inside electric and conventional vehicles measured at standstill

Mr Gernot Schmid[1], Mr Rene Hirtl[1], Ms Pia Schneeweiss[1], Mr Johannes Kainz[1,2], Dr Sarah Driessen[2], Dr Michael Kubocz[2], Mr Luis Kalb[3], Mr Dino Silvestro[3], Mr Matthias Vogt[3]
[1]Seibersdorf Laboratories, EMC & Optics, Seibersdorf, Austria. [2]Research Center for Bioelectromagnetic Interaction (femu)-Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany. [3]ADAC Technik Zentrum, Landsberg am Lech, Germany

Abstract Subject Area(s)
["Experimental dosimetry","ELF/LF"]
Summary
Magnetic field (MF) exposure assessments in the frequency range DC – 400 kHz in eleven electric vehicles (EV), two plug-in electric vehicles (PHEV) and one conventional passenger car with combustion engine (CEV) were carried out at standstill while activating installed electric components/systems not associated with the electric drive system, i.e., door lock, vehicle main switch on (ignition on in CEV), seat heater, driving light, turn signal, window lifter, fan of air condition, and actuation of the brake pedal. The results show remarkably high peak magnetic induction (B_{PEAK}) and exposure index values related to the reference levels according to the European Council recommendation 1999/519/EC ($ExpInd_{1999/519/EC}$). In 13 out of 14 investigated vehicles, transient MF of duration less than 200 ms caused maximum local $ExpInd_{1999/519/EC}$ above unity. The overall maximum found B_{PEAK} was 243 µT, corresponding to $ExpInd_{1999/519/EC}$ of 15, and occurred in the foot region of an PHEV, caused by activation of the main switch. However, MF transients are obviously not only an issue in vehicles with electric drive systems, as also the investigated CEV exhibits maximum $ExpInd_{1999/519/EC}$ of up to 5.76, when activating the car (ignition on). Moreover, some but not all seat heaters installed in the cars exhibit $ExpInd_{1999/519/EC}$ up to 2.4.
These findings raise questions regarding assessment of transient magnetic field exposures in international test protocols. For example, the applicable IEC 62764 1:2022 needs a thorough revision, as in the present version of this standard magnetic field transients of lengths shorter than 200 ms are exempted from exposure assessment.
Is the work in progress?
No

142B
Underground medium voltage lines: effects of cable type on magnetic induction and EMC issues
Dr Claudio Cecchetti[1], Dr Luigi D'Orazio[2], Dr Marcello Folli[1], Dr Andrea Garzia[1], Dr Paolo Grazioso[1], Dr Simona Valbonesi[1]
[1]Fondazione Ugo Bordoni, Bologna, Italy. [2]Enel Grids, Rome, Italy
Abstract Subject Area(s)
["Numerical dosimetry","ELF/LF","Standards and public health policy"]
Summary
The ever-increasing diffusion of all sorts of power-hungry devices caused skyrocketing needs of electrical power that must be distributed from power plants to the final users. This new scenario led to the need to evaluate and minimise the exposures to Extremely Low Frequency (ELF) electromagnetic fields produced by the power distribution networks. Power lines visual impact is another critical issue: in the last few years underground power lines have been increasingly deployed to minimise their environmental/visual impact. In designing and deploying an underground power line, one must ensure that electromagnetic field levels generated in the environment around the line comply with the exposure limits and that, in case of fault generating a high-level current, this doesn't cause unacceptable exposure to nearby telecommunication infrastructure and to people that for any reason may touch any metallic part of the

telecommunication infrastructure. Aim of the present work is to evaluate field levels generated by different underground power lines cable types and deployment layouts, and induced electromotive force on adjacent telecommunication cables in case of a fault current generated by a power line. These evaluations were carried out through simulations and numerical analyses. Results of the study performed on different scenarios with different types of cable and deployment configurations have led to a set of indications about the factors that determine increases in exposure and to some systemic indications relating to the configurations to be used to minimise deployment costs in monetary terms and in terms of impact on people and the environment.

144B

A Superposition-Based Evaluation Method for Whole-Body Exposure from 5G Base Stations

Dr Yujiro Kushiyama, Dr Tomoaki Nagaoka
National Institute of Information and Communications Technology, Tokyo, Japan

Abstract Subject Area(s)

["Numerical dosimetry"]

Summary

This study aims to develop a computationally efficient method for assessing whole-body exposure to 5G base stations equipped with beamforming and polarization control. As the frequency rises, simulating whole-body average specific absorption rate (SAR) becomes increasingly costly, posing challenges for comprehensive studies. While superposition-based techniques are efficient for exposure assessments with multiple sources, such as an array of antennas, conventional antenna element-wise superposition requires data re-acquisition for each antenna design change. This study investigates an exposure evaluation method based on the superposition of spherical waves, in which pre-calculated electric fields required for superposition are non-antenna-specific. We compute the whole-body average SAR of the numerical human body under beam exposure and confirm the validity of our method by comparing the results with those obtained by a conventional method.

Is the work in progress?

Yes

146B

Australia's experience calming community concerns.

Mr David Sibenaler, Prof Ken Karipidis, Dr Stuart Henderson, Mr Rohan Mate, Ms Jenni Stiffe, Prof Sarah Loughran
Australian Radiation Protection and Nuclear Safety Agency, Melbourne, Australia

Abstract Subject Area(s)

["Standards and public health policy"]

Summary

There was opposition to 5G when it was first introduced to Australia in 2018. This is despite telecommunications towers being a ubiquitous part of global landscapes for many years, and concerns about wireless technology being far from new. Authorities like the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) have an obligation to provide clear and reliable information to the public about their radiation

risk to prevent social and economic disruptions. As Australia's primary radiation protection authority, we do this in many ways:

- We provide a Talk to a Scientist phone and online service, allowing the community to speak directly with our scientists
- We reactively and proactively engage the media to share our expertise with the public
- We are active on social media
- We engage all levels of government

Our Talk to a Scientist program receives approximately 800 enquiries each year. In recent years, we have seen the positive impact of our communications efforts, with the program receiving fewer phone calls about 5G. Another reason we maintain these communication activities is to support effective crisis communication. This is important because when there are radiation incidents, it is vital that the public knows who to turn to for clear and reliable information. We assessed how effective ARPANSA's efforts have been to calm community concerns and to establish itself as Australia's primary radiation protection authority.

148B

Heart rate variability in people reporting idiopathic environmental intolerance attributed to electromagnetic fields : a co-designed provocation test

Mrs Maryse Ledent[1,2], Dr Ruben Casado Arroyo[3], Dr Jacques Vanderstraeten[2], Dr Eva M. De Clercq[1], Prof Catherine Bouland[2], Mr Benjamin Vatovez[4]
[1]Sciensano, Brussels, Belgium. [2]ULB - School of Public Health, Brussels, Belgium. [3]Erasmus Hospital, Brussels, Belgium. [4]ISSeP, Liège, Belgium

Abstract Subject Area(s)

["Human studies","ELF/LF","RF/Microwave"]

Summary

An increasing number of people reporting idiopathic environmental intolerance (IEI-EMF) question the validity of provocation tests provocation tests in which people are deliberately exposed to EMF signals. Notwithstanding these criticisms, this type of experiment remains the most suitable tool for determining the role of EMF and for verifying the accuracy of attributions in IEI-EMF. However, it is important to use innovative protocols and to rely on measurements rather than perceptions.
A provocation test protocol was designed and implemented in collaboration with people with IEI-EMF. Several bodily measurements were taken before, during and after double-blind exposure sessions. We present here the results of heart rate variability in the following groups of volunteers: people reporting IEI-EMF or wondering about their sensitivity, people with non-specific symptoms (NSS) not attributed to EMF, and healthy people without NSS.

150B

Review for Risk Communication Effectiveness Using Information Disclosure Device for RF-EMF

Mr JaeHo Park, Mr Hyeong-Yeol Lim, Mr Jong-Chan Kim, Mr Taewook Hwang
Korea Communications Agency, NAJU-SI, Korea, Republic of

Abstract Subject Area(s)
["RF/Microwave","Standards and public health policy"]
Summary
This article reviews the development and implementation of information disclosure for Radiofrequency Electromagnetic Fields (RF-EMF).
We have developed a real-time RF-EMF measurement device called the RF-EMF Exposure Light (REL) to address conflicts caused by RF-EMF.
We introduce the REL through its operation plot, design, and real picture, and present cases of conflict resolution using the REL.
This paper presents the results of measuring RF-EMF by installing REL in different locations.
The focus is on resolving conflicts caused by RF-EMF from base stations in various areas, including apartments in Korea.
Furthermore, we confirmed the effectiveness of REL based on a survey of 114 local residents who have installed them.
The survey also examined how these devices, which provide real-time RF-EMF information, contribute to resolving conflicts.
Is the work in progress?
Yes

152B
Ultrasonic vibration potential effect in magneto-acoustic coupled electrical stimulation
Mr kai zhu, Prof Xiaoqing Zhou, Mr Xu Liu, Prof Tao Yin, Prof Zhipeng Liu
Institute of Biomedical Engineering Chinese Academy of Medical Sciences & Peking Union Medical College, tianjin, China
Abstract Subject Area(s)
["Mechanisms","Biological and medical applications"]
Summary
In this paper, the characteristics of ultrasonic vibration potential in different salt water with different magnetic induction intensity are discussed. The ultrasonic electromotive force phenomenon in TMAS is found and analyzed, which provides a physical basis for the action mechanism and influencing factors of TMAS effect. The effect of ultrasonic electromotive force on neuroregulation should be considered during the actual stimulation of the organism. The electric field characteristics and mechanism of TMAS are more complex and need further study. This study promotes the application of TMAS in the treatment of neurological and brain aging diseases in the future.
Is the work in progress?
Yes

20:00	Conference dinner Schuttle available at reception Minoa from 19:15-19:45	Sapel Hall Agia Marina

Wednesday June 19th

09:00 - 10:00	Tutorial - Neuroprotective Effects of Pulsed Electromagnetic Fields in Acute Stroke	Floravante Capone	Main Hall

Neuroprotective Effects of Pulsed Electromagnetic Fields in Acute Stroke.

Dr Fioravante Capone[1,2], Dr Andrea Zini[3], Dr Franco Valzania[4], Prof Marina Diomedi[5], Prof Valeria Tugnoli[6], Prof Letizia Leocani[7], Prof Giancarlo Comi[8], Prof Nicoletta Anzalone[9], Dr Sara Contardi[3], Dr Micol Colella[10], Prof Micaela Liberti[10], Dr Simona Salati[11], Dr Stefania Setti[11], Dr Ruggero Cadossi[11], Prof Vincenzo Di Lazzaro[1,2]

[1]Università Campus Bio-Medico di Roma, Roma, Italy. [2]Fondazione Policlinico Universitario Campus Bio-Medico, Roma, Italy. [3]IRCCS Istituto delle Scienze Neurologiche di Bologna, Bologna, Italy. [4]Azienda USL-IRCCS di Reggio Emilia, Reggio Emilia, Italy. [5]Tor Vergata University, Roma, Italy. [6]University Hospital of Ferrara, Ferrara, Italy. [7]University Vita-Salute San Raffaele, Milano, Italy. [8]Casa di Cura Igea, Milano, Italy. [9]Scientific Institute San Raffaele, Milano, Italy. [10]Department of Information Engineering, Electronics and Telecommunications (DIET), Sapienza University of Rome, Roma, Italy. [11]Medical division, IGEA, Carpi, Italy

Abstract Subject Area(s)

["in vivo","Human studies","ELF/LF","Biological and medical applications"]

Summary

The time window of intervention for thrombolysis and thrombectomy is limited to the first hours after acute ischemic stroke (AIS), thus there is an urgent need for additional therapies capable of reducing the consequences of brain ischemia beyond this short period of time.

After AIS, an inflammatory response extends the functional and structural damage to the surrounding tissue, “penumbra”. Pulsed Electromagnetic Fields (PEMFs) provide neuroprotection in preclinical models of AIS by limiting inflammation and promoting neuron survival.

We conducted a multicentre double-blind, placebo-controlled randomized study to assess whether PEMF exposure is able to reduce the MRI infarct volume in stroke patients and favour functional recovery. Thirty-four patients completed the study, 14 in the active and 20 in the placebo group. At 45 days, PEMFs reduced the average MRI infarct volume of 13.7 ± 16.8 cm^3 over baseline (p=0.023) *vs* 5.6 ± 11.6 cm^3 (p=0.065) in the placebo group. Clinical scores showed a significant improvement in both groups: Barthel index and modified Rankin scale changes were larger and earlier in the active compared to the placebo group. In patients undergoing both reperfusion therapy and PEMFs, the average MRI infarct volume was significantly reduced in the active group (19.5 ± 18.9 cm^3) vs the placebo group (7.3 ± 14.7 cm^3; p = 0.046). PEMF in AIS is safe and well tolerated, favours clinical recovery and promotes the resolution of tissue damage.

These findings point to PEMFs as a novel non-invasive, brain-targeted neuroprotective intervention for AIS.

Is the work in progress?

No

OS08-01

Exploring RF-EMF levels in Swiss microenvironments: An evaluation of environmental and auto-induced downlink exposure in the era of 5G.

Ms Adriana Fernandes Veludo[1,2], Mr Bram Stroobandt[3], Mr Han van Bladel[3], Mr Nicolas Loizeau[1,2], Mrs Nekane Sandoval-Diez[1,2], Dr Hamed Jalilian[1,2], Prof Mònica Guxens[4], Prof Wout Joseph[3], Prof Martin Röösli[1,2]

[1]Swiss Tropical and Public Health Institute, Allschwil, Switzerland. [2]University of Basel, Basel, Switzerland. [3]Ghent University / imec, Ghent, Belgium. [4]ISGlobal, Barcelona, Spain

Abstract Subject Area(s)

["Epidemiology","RF/Microwave"]

Summary

5G New Radio (NR) base stations use beamforming to direct signals towards a user's device, ultimately resulting in higher downlink (DL) exposure uncertainties. In this study, activity-based microenvironmental surveys were conducted in Switzerland with the aim of disentangling environmental from auto-induced DL radiofrequency electromagnetic field (RF-EMF) exposure. Indoor and outdoor microenvironments (MEs) were defined and measured in five study areas (two urban and three rural areas). Measurements were conducted using a user equipment in flight mode (non-user) or inducing maximum DL traffic (user max DL exposure) and a personal exposimeter to measure exposure from DL bands. Summary statistics for total DL RF-EMF levels were obtained for each ME. A linear mixed-effect model (LME) was performed to examine potential RF-EMF exposure predictors (study area, usage scenario, and type of ME).Higher RF-EMF levels were measured in Zürich business centre (median 0.84 mW/m2) and in Basel industrial centre (median 12.10 mW/m2) for the non-user and user max DL scenario, respectively. The 2100 MHz DL (21%) and 3500 MHz TDD (time division duplex) (57%) bands were the main contributors to the total DL exposure in the non-user and max DL exposure scenario, respectively. A significant increase in RF-EMF levels was observed when inducing DL traffic compared to non-user scenario (log β-estimate 1.89 mW/m2) and exposure levels were significantly lower in rural areas compared to urban areas (log β-estimate -0.92 mW/m2). However, given the duplex nature of TDD bands, further studies are needed to understand the real contribution of beamforming when inducing DL traffic.

Is the work in progress?
Yes

OS08-02
Signal-Strength-Based RF-EMF Exposure Estimation Using the ETAIN EMF Monitor App: First Results From a Far-Field Calibration Function
Miss Nekane Sandoval-Diez[1,2], Miss Lea Belácková[3], Miss Adriana Fernandes Veludo[1,2], Dr Hamed Jalilian[1,2], Prof Arno Thielens[4,5], Dr Marco Zahner[6], Dr Jürg Fröhlich[6], Prof Anke Huss[3], Prof Martin Röösli[1,2]
[1]Swiss Tropical and Public Health Institute, Allschwil, Switzerland. [2]University of Basel, Basel, Switzerland. [3]Utrecht University, Utrecht, Netherlands. [4]Ghent University, Ghent, Belgium. [5]The Graduate Center of the City University of New York, New York, USA. [6]Fields at Work LLC, Zürich, Switzerland
Abstract Subject Area(s)
["Epidemiology"]
Summary
Mobile phones continuously monitor and calculate indicators of the received signal strengths of surrounding radio cells to maintain and optimize the phone´s wireless services. These signal strength indicators may be informative about environmental radiofrequency electromagnetic field (RF-EMF) exposure. Within the framework of the Horizon-Europe funded ETAIN (Exposure To electromAgnetic fields and plaNetary health) project, an open-access RF-EMF exposure app for smartphones, named "ETAIN EMF Monitor", has been developed using a citizen-science approach. To translate smartphone-derived signal strength indicators into meaningful exposure estimates, calibration functions are needed.
Measurements were done in 14 locations in the Netherlands to establish an association between validated measurement methods (i.e. personal exposimeter ExpoM-RF4) and data generated by the EMF monitor app. The primary focus was on assessing the relationship between the Long Term Evolution Receive Signal Strength Indicator (LTE-RSSI) and total downlink electric field strength in LTE bands. LTE-RSSI exhibited an identifiable average log-linear relationship with downlink electric field strength from the LTE active bands. On average, the relation between downlink field strength and one LTE signal strength indicator is robust; however, individual measurement points exhibited a high degree of variation.
Is the work in progress?
Yes

OS08-03
Personal Radiofrequency Electromagnetic Fields Exposure Measurement of Swiss Adolescents: HERMES3 panel study
Dr Hamed Jalilian[1,2], Mr Valentina Jaki Waibl[1,2], Mr Nasrullah Arslan[1,2], Mrs Nekane Sandoval Diez[1,2], Ms Adriana Fernandes Veludo[1,2], Ms Laura Tincknell[1,2], Ms Irina Wipf[1,2], Dr Stefan Dongus[1,2], Prof Monica Guxens[3,4,5,6], Prof Martin Röösli[1,2]
[1]Swiss Tropical and Public Health Institute, Basel, Switzerland. [2]University of Basel, Petersplatz, Basel, Switzerland. [3]ISGlobal, Barcelona, Spain. [4]Universitat Pompeu Fabra,

Barcelona, Spain. [5]Instituto de Salud Carlos III, Madrid, Spain. [6]University Medical Centre, Rotterdam, Netherlands

Abstract Subject Area(s)

["Human studies","Epidemiology","RF/Microwave","Risk assessment"]

Summary

Communication technology has undergone rapid transformation in the past decade, marked by the emergence of new technologies with unknown radiofrequency electromagnetic fields (RF-EMF) exposure profiles. The aim of the HERMES (Health Effects Related to Mobile PhonE Use in AdolescentS) study is to enhance our understanding of the daily electronic media use and personal RF-EMF exposure and its potential health effects.

HERMES3 is a prospective cohort study (n=900) among 7th- and 8th-grade Swiss students, with a one-year follow-up period. A subsample of 150 participants is provided with a personal RF-EMF meter (ExpoM-RF) and a smartphone for collecting 72-h personal RF-EMF exposure as well as diary data, respectively. After processing and quality checks of RF-EMF data for charging and crosstalk effects, frequency bands are categorized, and descriptive analysis is performed.

As of January 2024, data collection is ongoing with 41 adolescents having completed personal RF-EMF measurements. Preliminary analysis reveals mean and median RF-EMF exposure levels of 77.91 μW/m^2 (0.17 V/m) and 13.85 μW/m^2 (0.07 V/m), respectively. The analysis of daily RF-EMF exposure reveals that Wi-Fi band is the highest contributor at 37.1%, followed by broadcast at 35%, uplink at 15%, downlink at 9.7%, Time division duplex (TDD) at 2.7%, and Digital Enhanced Cordless Telecommunications at (DECT) 0.5%.

This is the first personal measurement study in Europe since 5G deployment. The results suggest that daily RF-EMF exposure among adolescents has remained consistent over the past decade despite introduction of 5G in Switzerland.

Is the work in progress?

Yes

OS08-04

Use of communication devices among young people: results from a multicountry survey

Dr Gemma Castaño-Vinyals[1,2], Ms Adriana Fernandes Veludo[3,4], Dr Milena M Maule[5], Dr Kinga Polanska[6], Dr Tanja Vrijkotte[7], Dr Gabriella Tognola[8], Dr Joe Wiart[9], Dr Wout Joseph[10], Dr Martin Röösli[3,4], Dr Mònica Guxens[1,2]

[1]ISGlobal, Barcelona, Spain. [2]CIBER Epidemiología y Salud Pública, Madrid, Spain. [3]Swiss TPH, Allschwill, Switzerland. [4]University of Basel, Basel, Switzerland. [5]University of Turin, Turin, Italy. [6]NIOM, Lodz, Poland. [7]Amstermdam UMC, Amsterdam, Netherlands. [8]CNR, Milano, Italy. [9]Telecom Paris, Palaiseau, France. [10]Ghent University/IMEC, Ghent, Belgium

Abstract Subject Area(s)

["Human studies","Epidemiology"]

Summary

In this study, we aim to characterize the exposure to communication devices and technologies in young people within the GOLIAT project.

We carried out a survey in 4,000 individuals in 4 countries (1,000 individuals per country: Spain, Italy, Poland, and Switzerland), aged 16-25 years.
Mean age of the participants was 20.9 years (SD 2.6), with 50% females. Overall, 91% of the participants reported using a smartphone, with no differences observed by age group, but differences by country: 80% of the participants from Switzerland report using smartphones, compared to 94% in Spain and Italy, and 96% in Poland.
Main uses for the smartphone were using social media (67%), voice calls (64%), and texting or sending pictures, sending e-mails and/or Internet browsing (63%); no differences by age group were observed but some differences by country. Median time of use per each activity was 23 minutes/day.
Online video streaming (21%), sending emails and/or Internet browsing (17%) and using social media (16%) were the most common activities reported by the participants that used a tablet. The proportion of young people using laptop increased with age, from 61% of users in the youngest group (16-18 years) to 73% in the oldest one (23-25 years). 12% of the participants reported using cordless phones, and 23% using smartwatches/activity trackers.
This is the most comprehensive survey of wireless communication use among young people in Europe. Results will feed together with measurements into other information to develop the RF-EMF (radiofrequency electromagnetic fields) dose model.

OS08-05

Impact of 5G technology on public exposure to electromagnetic fields : 2020-2023 measurement campaign review

Dr Ourouk Jawad, Dr Lydia Sefsouf, Mr Jean-Benoît Agnani, Dr Emmanuelle Conil
Agence nationale des fréquences (ANFR), Maisons-Alfort, France

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","Standards and public health policy"]

Summary

This study presents the results of a large-scale measurement campaign of the level of exposure in front of 5G FR1 base stations in many french cities from 2020 to 2023.
The campaign consist in a protocol composed by three types of measurement :

- broadband ISO17025 accredited measurement between 100 kHz and 6 GHz,
- frequency selective ISO17025 accredited measurement on same frequency band,
- and an exploratory measurement consisting in a two step measurement with and without an emulation of base station load profile (download of 1 GB file) .

These measurement have been carried out at more than 1000 positions, 7 times between 2020 to 2023.The goals of this study are to demonstrate that 5G NR technology is compliant with the national limits, to assess accurately the increase of the level of exposure in different bands where 5G have been deployed and to emphasize global knowledge of 5G exposure answering the public concern.

OS08-06

Occupational Exposure Due To Private 5g Networks In Smart Industries

Dr Blaž Valič, Dr Peter Gajšek
Institute of Non-Ionizing Radiation, Ljubljana, Slovenia

Abstract Subject Area(s)

["RF/Microwave","Occupational exposure"]

Summary

5G private networks are becoming a platform for 'wire-free' networking for professional applications from factory floor automation through to automated warehousing, logistics, autonomous vehicle deployments in campus environments, mining, material processing and more. Although the time-averaged transmit power of used radio transceivers is likely to be low, the resulting overall magnitude and temporal pattern of exposure to which workers are exposed in such situations is yet unknown.
To obtain an insight of the occupational exposure to RF EMF emitted by 5G private networks, analysis was carried on a real case scenario in the Port of Koper, Slovenia. Two different types of infrastructure were analysed: private standalone 5G base station and public non-standalone 5G base station operating at 3,5 GHz, located inside the area of Port of Koper with a private slice dedicated for private use. Besides, the RF EMF exposure of a driver in a terminal tractor equipped with 5G getaway was measured.
RF EMF exposure of the workers due to 5G networks in the analysed cases was found to be low. Mainly there are two reasons for this. First, the output power of most 5G sources used for private 5G networks, was quite low. It is expected that this is similar also for most indoor scenarios due to relative low output powers of base stations used for indoor private networks. Second, it is common practice to mount the antennas of base stations at the adequate height, mainly to obtain good coverage, thus reducing the exposure on human accessible locations.

Is the work in progress?

Yes

10:30 - 12:00	OS9 - ELF/IF exposure and possible effects	Gabor Mezei Han Van Bladel	Hall 3

OS09-01

Electromagnetic compatibility assessment of pacemakers in occupational environments: parameters affecting their functioning

Mr Lucien Hammen[1,2,3], Mr Lionel Pichon[2,3], Mr Yann Le Bihan[2,3], Mr Mohamed Bensetti[2,3], Mr Gérard Fleury[1]

[1]Laboratoire d'Electromagnéstisme, Vibrations et Optique Institut national de recherche et de sécurité (INRS), Vandoeuvre-lès-Nancy, France. [2]Laboratoire de Génie Electrique et Electronique de Paris Université Paris-Saclay, CentraleSupelec, CNRS, Gif-sur-Yvette, France. [3]Laboratoire de Génie Electrique et Electronique de Paris Sorbonne Université, CNRS, Paris, France

Abstract Subject Area(s)

["In vitro","ELF/LF","Occupational exposure","Risk assessment"]

Summary

More and more workers are equipped with active medical implants that can interfere with the magnetic fields encountered in the workplace. With occupational exposure limits higher than those for the general population, there is potentially more intense exposure at work. To study the response of active implants to electromagnetic fields

encountered in industry, a new *in vitro* test method was proposed. It consists of exposing the implant to a representative field of occupational exposure using a specific test bench. This new test method was applied to pacemakers, which are by far the most commonly used active medical implant. The tests evaluated the influence of a large number of parameters, such as the direction of the magnetic field, its frequency or the position of the leads, on the functioning of a pacemaker. The three most relevant parameters for assessing the risk are the field amplitude, the field frequency and the detection sensitivity of the cardiac activity depending on the device settings. The study also provided a better understanding of the interaction mechanisms. It was observed that, above a specific field intensity, the device considers the electromagnetic disturbance as a cardiac contraction. This test method can also be applied to other active implants, such as implantable cardioverter-defibrillators or insulin pumps.

OS09-02

Perceptional Threshold of Electrostimulation and Heating for Intermediate Contact Current

Prof Akimasa Hirata[1], Mr Shoya Kimura[1], Prof Sachiko Kodera[1], Prof Shintaro Uehara[2], Dr Akiko Yuasa[2], Dr Kazuki Ushizawa[2], Prof Yohei Otaka[2]
[1]Nagoya Institute of Technology, Nagoya, Japan. [2]Fujita Health University School of Health Sciences, Toyoake, Japan

Abstract Subject Area(s)

["Human studies","Numerical dosimetry","RF/Microwave"]

Summary

When a human touches an object with different electrical potential, contact current flowing into the human body is expected. Indirect exposure is potentially stricter than direct exposure. The limits for contact current are prescribed in the international guidelines and standard for human protection from electromagnetic fields. However, its rationale is limited as compared with that for direct exposure. This study evaluated computationally the perceptional threshold for electrostimulation and heating from 10 kHz to 10 MHz. The time course of the temperature rise for contact current was calculated until each subject perceived the contact current. The perception of current was then estimated considering the nerve activation modeling. The estimated current threshold for perception of electrostimulation was consistent with the measured data at 100 kHz and increased linearly with increasing frequency. By contrast, the estimated perceptual temperature increase was smaller at 100 kHz than at 300 kHz and above. From these results, the transient frequency of the threshold for stimulation and heating is between 100 and 300 kHz, supporting the transition frequency of contact current in the international guidelines and standard.

OS09-03

Investigation of the frequency response of electrical vestibular stimulation with frequency-modulated currents

Janita Nissi, Prof Ilkka Laakso
Department of Electrical Engineering and Automation, Aalto University, Espoo, Finland

Abstract Subject Area(s)

["Human studies","ELF/LF"]

Summary
The sense of balance can be disturbed by applying electrical stimulation through the vestibular system. This technique is called electrical vestibular stimulation (EVS) and has been used to study the function and sensory processing related vestibular system. However, there are gaps in the current understanding of how EVS stimulates the vestibular system as well as the relationship between intensity and frequency of the stimulation. Therefore, the purpose of the study is to measure responses to EVS through in vivo experiments and examine how frequency and current amplitude of sinusoidal alternating current relate to the magnitude of the sway response in different conditions.
Is the work in progress?
Yes

OS09-04
Estimating forearm tissue conductivities from 30 Hz to 1 MHz using measurements and modelling
Mr Otto Kangasmaa, Prof Ilkka Laakso
Department of Electrical Engineering and Automation, Aalto University, Espoo, Finland
Abstract Subject Area(s)
["in vivo","Human studies","Numerical dosimetry","ELF/LF"]
Summary
Uncertainty in the electrical properties of human tissues leads to errors when modelling the interactions between electromagnetic fields and the human body. The aim of this study is to better estimate human tissue conductivities at low frequencies. Non-invasive impedance measurements (30 Hz to 1 MHz), medical imaging and 3D surface scanning were performed on the forearms of ten volunteer test subjects. By creating subject-specific anatomical forearm models and numerically solving an electrostatic forward problem, the forearm tissue conductivities can be derived by solving an inverse problem.
Is the work in progress?
Yes

OS09-05
Using EEG to characterize brain activity in response to peripheral magnetic stimulation
Eleonore Fresnel[1,2], Dr Nicolas Bouisset[1,3], François Deschamps[4], Dr Martine Souques[5], Isabelle Magne[5], Dr Pierre-André Cabanes[5], Dr Geneviève Ostiguy[6], Dr Michel Plante[6], Dr Alexandre Legros[1,2,3,7,8]
[1]Human Threshold Research Group, Lawson Health Research Institute, London, Canada. [2]Department of Medical Biophysics, Western University, London, Canada. [3]Department of Kinesiology, Western University, London, Canada. [4]Réseau de Transport d'Électricité (RTE), Paris, France. [5]Service des Études Médicales, Électricité de France (EDF), Paris, France. [6]Hydro-Québec, Montréal, Canada. [7]Department of Medical Imaging, Western University, London, Canada. [8]EuroStim and EuroMov DHM, Montpellier, France
Abstract Subject Area(s)
["Human studies","ELF/LF"]
Summary

Uncertainties exist regarding peripheral nerve stimulation (PNS) thresholds and the absence of subjective and objective data for magnetic field exposure at powerline frequencies (i.e., 50 and 60 Hz). Current PNS values are computed and extrapolated resulting in a wide range from 2.3 V/m to 6.15 V/m in situ electric field. Experimental studies are necessary to assess thresholds in humans and improve the accuracy of the standards and guidelines. This study aims to investigate the PNS threshold at powerline frequencies and its neurophysiological effects using electroencephalography (EEG) recording. To investigate this, we have designed a randomized, double-blind controlled protocol that will be conducted on healthy subjects. A powerline-frequency MF device allowing for limb exposure has been built for human legs. Participants will report sensations and assign perception intensity under 11 different exposure intensities via button press. Moreover, brain activity will be recorded to analyze somatosensory and motor responses to each stimulation. Our pilot data confirm the feasibility of the protocol, especially regarding the identification of a perception threshold and regarding the identification of the specific alpha-band frequency.
Keywords: Extremely Low Frequency Magnetic Fields, Peripheral Nervous System, Threshold, Perception, EEG

OS09-06

Eye Movements with Vestibular-Specific Extremely Low-Frequency Magnetic Fields Stimulations at Powerline Frequencies

Dr Nicolas Bouisset[1], Eleonore Fresnel[1], . Janita Nissi[2], Dr Ilkka Laakso[2], François Deschamps[3], Isabelle Magne[4], Pierre André Cabanes[4], Martine Souques[4], Michel Plante[5], Geneviève Ostiguy[6], Alexandre Legros[7]
[1]Western, London, Canada. [2]Aalto University, Espoo, Finland. [3]RTE, Paris-La Défense, France. [4]EDF, , Levallois-Perret Cedex, France. [5]Hydro Quebec, Montreal, Canada. [6]Hydro Quebec, Montreal, France. [7]Western, London, France

Abstract Subject Area(s)

["Human studies"]

Summary

Exposure to Extremely Low-Frequency Magnetic Fields (ELF-MF) generates electric fields (E-fields) within the human body, influencing its neurophysiology. Animal and semicircular canal models offer support for electromagnetic induction affecting the vestibular system. While minimal E-fields can easily activate the vestibular system, no current evidence has, to date, demonstrated an ELF-MF modulation specific to the human vestibular system. Based on new dosimetry work, this study further explores the behavioral impact of ELF-MF stimulation on the human vestibulo-ocular reflex, highlighting potential implications for standards, guidelines, and clinical applications.

Is the work in progress?

Yes

12:00 - 13:00	OS10 - ELF/IF exposure and possible effects	Sarah Loughran Nicolas Loizeau	Main Hall

OS10-01

ELF and LF magnetic field assessment in electric and plug-in hybrid electric passenger cars while driving

Mr Gernot Schmid[1], Mr Rene Hirtl[1], Ms Pia Schneeweiss[1], Mr Johannes Kainz[1,2], Dr Sarah Driessen[2], Mr Michael Kubocz[2], Mr Luis Kalb[3], Mr Dino Silvestro[3], Mr Matthias Vogt[3]
[1]Seibersdorf Laboratories, EMC & Optics, Seibersdorf, Austria. [2]Research Center for Bioelectromagnetic Interaction (femu)-Institute for Occupational, Social and Environmental Medicine, Medical Faculty, RWTH Aachen University, Aachen, Germany. [3]ADAC Technik Zentrum, Landsberg am Lech, Germany

Abstract Subject Area(s)

["Experimental dosimetry","ELF/LF"]

Summary

For a systematic and comprehensive assessment of magnetic field exposure in electrically driven passenger cars, measurements including eleven electric vehicles (EV) and two plug-in hybrid electric vehicles (PHEV) were carried out. Magnetic induction (DC – 400 kHz) was measured in time domain while the vehicle was operated on a dynamometer test bench at different speeds, torques, acceleration and braking, during drives on a test track, and during a 90-minutes drive in real traffic. The results showed a wide variety of peak magnetic induction (B_{PEAK}) and exposure index values ($ExpInd_{1999/519/EC}$, related to the reference levels according to EU recommendation 1999/519/EC), depending on vehicle model, driving conditions, and location inside the car. Highest B_{PEAK} and $ExpInd_{1999/519/EC}$ typically occurred in the feet region during acceleration and/or braking, respectively, while at constant speed, magnetic fields were relatively low. In some vehicles, comparatively high values were also found in the lower abdomen region of the rear seat row. Absolute maxima of exposure were in most cases caused by transient magnetic fields occurring in connection with acceleration and/or braking processes. In five out of the 13 investigated vehicles, maximum $ExpInd_{1999/519/EC}$ was higher than 1, i.e., reference levels were exceeded (up to a factor of 12). However, these field maxima typically occurred very localized, and the magnetic induction decreased rapidly with distance to the field sources, i.e., in upper body parts the exposure remained below the reference levels in all investigated cases. The experience gained during this project indicates the need to a thorough revision of IEC 62764-1:2022.

Is the work in progress?

No

OS10-02

Uncertainty quantification in the assessment of human exposure to pulsed or multi-frequency fields

Prof Luca Giaccone
Politecnico di Torino - Dipartimento Energia "G. Ferraris", Torino, Italy

Abstract Subject Area(s)

["ELF/LF","Standards and public health policy"]

Summary

Objective: this paper deals with the uncertainty quantification associated to the methods for the analysis of pulsed fields or waveforms with multi-frequency content. **Approach**: the weighted peak method is widely employed in standards and guidelines, therefore, in this paper, we consider its implementation both in time domain and frequency domain. For the uncertainty quantification the polynomial chaos expansion theory is used. A parametric analysis is carried out to point out consistencies and inconsistencies with reference to basic principles of electrostimulation. **Main findings**: it is shown that the time domain implementation of the weighted peak method provides results in agreement with the basilar mechanisms of electromagnetic induction and electrostimulation. On the opposite, the WPM in frequency domain is found to be too sensitive to parameters that should not influence the exposure index. To overcome this issue, a new definition for the phase of the weight function in frequency domain is proposed. **Significance**: it is shown that the time domain implementation of the weighted peak method is the more accurate and precise. The standard WPM in frequency domain has some issues that can be avoided with the proposed modification. All the codes used in this paper are hosted on a GitHub and can be freely accessed at https://github.com/giaccone/wpm_uncertainty.

OS10-03

In-depth exposure assessment to extremely low frequency magnetic fields (ELF-MF) in Switzerland between 2021 and 2023 in numerous public areas, in transport and in private homes

Mr Nicolas Loizeau[1,2], Dr Dominik Haas[3], Dr Marco Zahner[4], Dr Johannes Schindler[3], Mrs Christa Stephan[3], Dr Jürg Fröhlich[4], Mr Markus Gugler[5], Prof Martin Röösli[1,2]
[1]Swiss Tropical and Public Health Institute, 4123 Allschwil, Switzerland. [2]University of Basel, 4001 Basel, Switzerland. [3]Grolimund + Partner AG Environmental Engineerging, 3097 Bern, Switzerland. [4]Fields at Work GmbH, 8032 Zürich, Switzerland. [5]NED-TECH AG, 3380 Wangen an der Aare, Switzerland

Abstract Subject Area(s)

["ELF/LF","Risk assessment","Standards and public health policy"]

Summary

Exposure to extremely low frequency magnetic fields (ELF-MF) is ubiquitous in our daily environment. The goal of this study is to provide a comprehensive overview of ELF-MF exposure for the Swiss population at typical places of prolonged stay. Magnetic flux density levels (µT) were measured with a portable exposimeter for the main anthropogenic ELF sources: railway power (16.7 Hz), domestic power (50 Hz), and tramway residual ripple (300 Hz) between 2021 and 2023. We collected ELF-MF levels in 300 outdoor areas (e.g. city centres, residential areas) for at least 15 minutes, as well as 243 public spaces (e.g. train stations, schools) and numerous transport journeys (e.g. train, cars) for at least 5 minutes. Outdoor areas were selected to be representative in terms of the presence of ELF sources (e.g. high voltage lines, railway lines). We also conducted ELF-MF measurements in 31 private homes for 24-hour in bedrooms, and 30 minutes in the living areas. Over all environments, the medians of the ELF-MF exposure are the highest in trains (median: 0.44 µT), in train stations (median: 0.38 µT), and in homes near HVL of 220 and 380 kV (median: 0.33 µT). All measurements are well below the Swiss regulatory limit. Out of the 31 private homes measured, one home

consistently showed measurements between 1.25 μT and 2.05 μT, exceeding the Swiss precautionary limit of 1.0 μT in sensitive use places. Hence, systematic protocols and controls to minimize ELF-MF exposure from high voltage lines, particularly in sensitive use locations, remain pertinent.

Is the work in progress?

Yes

OS10-04

High-Voltage Power Line Magnetic Field Monitoring: A Sensor Solution

Mr Kenneth Deprez[1], Mr Tom Van de Steene[1], Ms Leen Verloock[1], Prof Emmeric Tanghe[1], Dr Liesbeth Gommé[2], Mr Michel Goethals[2], Mr Mart Verlaek[2], Dr Karen Van Campenhout[2], Prof David Plets[1], Prof Wout Joseph[1]

[1]Ghent university/IMEC, Ghent, Belgium. [2]Department of Environment & Spatial Development Flanders, Brussels, Belgium

Abstract Subject Area(s)

["Experimental dosimetry","ELF/LF"]

Summary

A low-cost, tri-axial 50 Hz magnetic field monitoring sensor was designed, calibrated and verified. The sensor was designed using off-the-shelf components and commercially available antennas. It can measure 50 Hz magnetic fields originating from high-voltage power lines from 0.08 μT to 364 μT, divided in two measurement ranges.

The sensor was calibrated both on-board and in-lab. The on-board calibration takes the circuit attenuation, noise and parasitic components into account. In the in-lab calibration, the output of the developed sensor is compared to the baseline, a narrowband EHP-50. The sensor was then verified in-situ. It was compared to the EHP-50, for which average deviation of 6.2% and 1.4% were found, respectively. The measured field values were between 0.10 μT and 13.43 μT, which is in agreement with other reported measurement values under high-voltage power lines in literature. Our network had a high uptime of 96% during a 2-month interval, which confirms that the proposed solution can be used for this monitoring.

Is the work in progress?

No

13:00 - 14:00	Lunch	Elia Minoa Palace
14:00 - 18:00	CLUE-H 3rd - Annual Meeting	Main Hall
17:00 - 17:30	End of Poster Display	Athina

OS11-01

Flexible Electromagnetic Phantom with Electrotextile Backing for 60 GHz Wearables and Remote Monitoring

Ms Rossella Rizzo[1], Dr Maxim Zhadobov[2], Dr Giulia Sacco[2]
[1]University of Rennes, Rennes, France. [2]CNRS, Rennes, France

Abstract Subject Area(s)

["MM Waves"]

Summary

This paper introduces the first flexible electrotextile-based solid millimeter-wave (mmW) phantom designed to emulate the electromagnetic (EM) reflection properties of human skin. The phantom is constituted of a layer of silicone doped with carbon powder and backed by an electrotextile. The carbon/silicone layer's thickness and composition are optimized to replicate the reflection coefficient at the air/skin interface at 60 GHz. To validate the phantom's performances, scattering parameter measurements are performed using a transmission/reflection system within the 55-65 GHz range. Measurements and simulations are in good agreement (relative error within 16.2%). The obtained results show the promising potential of this phantom to reproduce conformal body surfaces for wireless body-centric sensor testing.

Is the work in progress?

Yes

OS11-02

Monitoring of EMF Exposure Levels by Japanese National Project

Dr Teruo Onishi, Dr Sen Liu, Mr Kazuhiro Tobita, Ms Miwa Ikuyo, Ms Kaoro Esaki, Prof Masao Taki, Dr Soichi Watanabe
National Institute of Information and Communications Technology, Tokyo, Japan

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","MM Waves"]

Summary

Monitoring results in Japan using spot measurements, portable measurement by individuals carrying small measuring devices, and measurement using cars in the 5 years term Japanese national project of monitoring electromagnetic field (EMF) exposure levels in Japan are presented. One of the important findings is that all of the measured data including 5G are below the radio-radiation protection guidelines. The results of these measurement will be utilized for risk communication and epidemiological studies.

OS11-03

Comparison of RF EME surveys in Melbourne, Australia – how has the RF EME environment changed from 2011 to 2022?

Dr Stuart Henderson, Dr Chhavi Bhatt, Prof Sarah Loughran
ARPANSA, Melbourne, Australia

Abstract Subject Area(s)

["RF/Microwave","Standards and public health policy"]

Summary

To address public concern regarding exposure to RF EME from telecommunication and broadcast services, ARPANSA conducts survey programs to assess RF EME levels in the community. Measurements of RF EME from broadcast services and mobile network base stations were collected at 20 sites in publicly accessible areas using a spectrum analyser. This paper compares the results from earlier surveys in 2011 and 2013/14 with the most recent survey conducted across the Melbourne suburban area in 2022. The purpose of this study was to determine if there have been changes in the RF EME environment experienced by the general public as a result of the deployment of new technology.

OS11-04

Evaluation of the Impact of Buffering a 5G Application on the Instantaneous Exposure Compared to a Constant Data Rate in the Vicinity of Massive MIMO Base Stations

Ms Anna-Malin Schiffarth[1], Mr Thanh Tam Julian Ta[1], Dr Christian Bornkessel[2], Ms Lisa-Marie Schilling[2], Prof Matthias Hein[2], Prof Dirk Heberling[1,3]
[1]Institute of High Frequency Technology, RWTH Aachen University, Aachen, Germany. [2]RF & Microwave Research Laboratory, Thuringian Center of Innovation in Mobility, TU Ilmenau, Ilmenau, Germany. [3]Fraunhofer Institute for High Frequency Physics and Radar Techniques, Wachtberg, Germany

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave","Occupational exposure","Risk assessment"]

Summary

In the context of risk communication, it is being discussed whether it is advantageous to define a typical instantaneous exposure in addition to the theoretical maximum exposure, especially for 5G Massive MIMO base stations. However, there is currently no reliable measurement method for this purpose. Initial investigations into the definition of a typical data rate of various user applications that can be achieved using iPerf and the reproducible measurement of such typical exposures was already carried out.
In this study, the open question has been investigated whether there is a difference in exposure between three typical applications with buffering of the payload data and a

constant data rate obtained with iPerf in the vicinity of four Massive MIMO base stations at four measurement points each. Overall, it is found that only in 10% of the cases the 5G exposure shows a deviation greater than the expanded uncertainty of ±3 dB, which only in 4% result in a deviation larger than 3 dB in the total exposure (4G+5G). Therefore, it can be concluded that setting a constant data rate in iPerf is equivalent in terms of exposure compared to typical use case applications.

Is the work in progress?

Yes

OS11-05

Characterization of EMF hotspots for realistic exposure assessment in end-to-end simulations using a hybrid QuaDRiGa/FDTD tool

Mr Robin Wydaeghe, Dr Sergei Shikhantsov, Prof Emmeric Tanghe, Prof Günter Vermeeren, Prof Wout Joseph

WAVES, Department of Information Technology and IMEC, Gent, Belgium

Abstract Subject Area(s)

["Numerical dosimetry","RF/Microwave","MM Waves"]

Summary

Next-generation cellular networks features a higher antenna density and higher frequencies. The hybrid QuaDRiGa/FDTD tool is improved in efficiency and features. In realistic end-to-end simulations, hotspots can appear in an interference pattern of different incident beams. These hotspots are characterized by Full Width at Half-Maximum (FWHM), Prominence to Peak (P/P) ratio and dimensionality at 28 GHz in a realistic 3D environment with a 6G Cell-Free Massive MIMO (CF-MaMIMO) network. While there is a high variability across time, the average hotspot features a specific shape. Up to 3 side-lobes are seen around a central peak. Two averaging techniques are proposed and compared: propagation-wise and exposure-wise averaging. The shape of the hotspot in the exposure metric S_{inc} is also examined. Finally, the exposure metrics are plotted as a function of time in a walk through New York City and compared with the ICNIRP guidelines. The exposure metric remain vastly below their limits.

OS11-06

Accelerating mmWave exposure simulations and the OUTREACH idea to industry

Mr Robin Wydaeghe[1], Dr Erdem Ofli[2], Dr Stefan Benkler[3], Dr Guillermo Del Castillo[2], Dr Sergei Shikhantsov[4], Prof Emmeric Tanghe[4], Prof Günter Vermeeren[4], Prof Luc Martens[4], Prof Niels Kuster[5], Prof Wout Joseph[4]

[1]WAVES, Department of Information Technology and IMEC, Ghent, Belgium. [2]ZMT Zurich MedTech AG, Zurich, Switzerland. [3]ZMT Zurich MedTech AG, Zurich, Belgium. [4]WAVES, Department of Information Technology and IMEC, Gent, Belgium. [5]The Foundation for Research on Information Technologies in Society (IT'IS) Foundation, Zurich, Switzerland

Abstract Subject Area(s)

["Numerical dosimetry","MM Waves","Risk assessment","Standards and public health policy"]

Summary

This paper first presents techniques to improve the accuracy and efficiency of Radio-Frequency-Electromagnetic Field (RF-EMF) human exposure simulations. The efficiency

of a coated dielectric layered skin model applied to a human head is examined for the first time. A new method to efficiently interface with Huygens boxes yields a 16-fold speed increase at 28 GHz. In total, a 64-fold increase is obtained in exposure assessment speed for a 6-minute walk in New York City. A growing population is concerned about health effect of 5G and 6G. While simulation studies with a “worst-case” methodology dismiss this, an important knowledge gap in literature remains on the layman’s simple question: “how much exposure do I *realistically* experience in daily life from 5G?” To enable comprehensive end-to-end simulations, our OUTREACH (OUTdoor Realistic Exposure Assessment from next-generation Cellular networks on Humans) idea aims to collaborate with industrial partner to share accurate data, including e.g. real smartphone radiation patterns, real base station antenna patterns, and more. This is described in the second section of the paper. The goal and feasibility of the idea are outlined in a short survey. Then, a case is made for industrial and governmental partners to share data securely. Support will be garnered among experts at the BioEM 2024 conference.

12:00 - 13:00	OS12 - Electroporation	Andrei Pakhomov Peter Lombergar	Main Hall

OS12-01

Impact of pulse protocol parameters on the efficacy of electrochemotherapy *in vitro*.

Mr Fabio Lepore[1], Dr Simona Salati[2], Dr Francesca De Terlizzi[2], Dr Giulia Grisendi[1], Dr Roberta Fusco[2], Prof Massimo Dominici[1], Dr Matteo Cadossi[2], Dr Ruggero Cadossi[2]
[1]University of Modena and Reggio Emilia, Modena, Italy. [2]IGEA, Carpi, Italy

Abstract Subject Area(s)

["Electroporation and pulsed electric field applications"]

Summary

In this work, a systematic approach was applied to identify the Reversible Electroporation Absorbed Dose (READ) formula and the equivalent absorbed dose (EqAbDOSE) threshold necessary to achieve reversible electroporation. Results from in vitro experiments will be presented. Results from in vitro experiments will be further validated in relevant cancer animal models. Moreover, following the READ formula, high frequency and bipolar pulse protocols will be identified to guarantee ECT efficacy while reducing the pain sensation and the muscle contraction associated with electric pulses delivery.
This study will lead to the development of a new pulse generator that will integrate the READ formula for the identification of appropriate pulse protocols (modulating pulse amplitude, number, duration, and frequency) to obtain complete coverage of the target volume with sufficient energy to achieve effective electroporation. This technological advancement will increase ECT efficacy and flexibility of use, will optimize the number of electrodes needed to cover the tumour volume and will limit muscle contractions and pain reducing the invasiveness of the procedure.

Is the work in progress?

Yes

OS12-02

A MULTI-SCALE IN SILICO MODELING OF MAGNETOELECTRIC NANOPARTICLES FUNCTIONALIZED POLYMERIC PATCH FOR WIRELESS NERVES STIMULATION

Dr Giulia Suarato[1], Dr Alessandra Marrella[1], Miss Anna Tommasini[2], Dr Serena Fiocchi[1], Dr Emma Chiaramello[1], Dr Marta Bonato[1], Miss Valentina Galletta[2], Dr Marta Parazzini[1], Prof Paolo Ravazzani[1]

[1]CNR-IEIIT, Milano, Italy. [2]Politecnico di Milano (DEIB), Milano, Italy

Abstract Subject Area(s)

["Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

Electrical stimulation promotes the repair of nerve injuries, however, their large-scale application in vivo is still limited due to the issues related to invasive and not-mechanically compliant commonly-used stimulators.

Recently, magnetoelectric nanoparticles (MENPs) have been proposed thanks to their ability to locally generate electricity, when activated by external and low intensity magnetic fields. Here, a new paradigm based on the use of MENPs-loaded 3D polymeric patch has been demonstrated through a multi-scale *in silico* framework. In particular the electric field generated by a millimetric, biomechanically compliant, magnetoelectric patch in the surrounding nerve tissue model was evaluated, showing that it is higher than threshold values recognized as necessary to elicit a neuron response. Our results pave the way for a remote and wireless electricity generation by using novel magnetoelectric-based biomaterials, able to deliver the extremely localized effects of individual MENPs.

OS12-03

MICRO-SYSTEM FOR CULTURE AND ELECTROPORATION PARAMETERS SCREENING ON A POPULATION OF SPHEROIDS USING A GRADIENT OF ELECTRIC FIELD

Mr Théo Le Berre[1], Dr Julien Marchalot[1], Dr Guilhem Rival[2], Dr Charlotte Riviere[3,4,5], Prof Marie Frénéa Robin[1]

[1]Ecole Centrale de Lyon, INSA Lyon, Université Claude Bernard Lyon 1, CNRS, Ampère, UMR5005, Ecully 69130, France. [2]Electrical Engineering and Ferroelectricity Laboratory LGEF UR682 - INSA Lyon, Villeurbanne 69621, France. [3]Univ Lyon, Université Claude Bernard Lyon 1, CNRS, Institut Lumière Matière, Villeurbanne 69622, France. [4]Institut Universitaire de France (IUF), Paris, France. [5]Institut Convergence PLAsCAN, Centre de Cancérologie de Lyon, INSERM U1052- CNRS UMR5286, Université de Lyon, Université Claude Bernard Lyon 1, Centre Léon Bérard, Lyon 69000, France

Abstract Subject Area(s)

["In vitro","Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

The development of new EPN-based cancer treatment procedures involves drug screening to identify the most promising molecules and the concentrations to be used, as well as optimization of electroporation parameters.

The micro-system presented here allows for the culture, treatment, and observation of a population of 320 spheroids, with an electroporation presenting a gradient of electric field intensity. This allows for the precise plot of permeabilization depending on intensity, and the investigation of different parameters of the EPN protocol, such as waveform, duration, number of pulses, and repetition frequency. The system is compatible with other in vitro models, such as tumour slices or tumoroids.
The application presented of the device is the direct observation of the whole plot of the intensity-efficiency relationship using fluorophores with an electrical protocol following the electrochemotherapy guidelines. This kind of experiment could nurture the existing model to investigate the exact role of each parameter in EPN and allow for the improvement of specialized protocols such as electrochemotherapy, irreversible electroporation, and other treatments using pulsed electric fields, like electroimmunotherapy or gene electrotransfer.

Is the work in progress?

Yes

OS12-04

A numerical model of bubble formation during intracardiac PFA

Mr Peter Lombergar[1], Prof Samo Mahnič-Kalamiza[1], Prof Damijan Miklavčič[1], Dr Blaž Mikuž[2], Dr Lars Mattison[3], Dr Daniel Sigg[3], Prof Bor Kos[1]
[1]University of Ljubljana, Faculty of Electrical Engineering, Ljubljana, Slovenia. [2]Jožef Stefan Institute, Reactor Engineering Division, Ljubljana, Slovenia. [3]Medtronic, Minneapolis, USA

Abstract Subject Area(s)

["Electroporation and pulsed electric field applications"]

Summary

Pulsed field ablation (PFA) of cardiac tissue is currently one of the most promising applications of irreversible electroporation in the field of medicine. The main advantage of PFA is achieving tissue ablation by a non-thermal mechanism. However, in PFA, high voltage and high pulse number protocols are often used, which can result in temperature increases in tissue and blood. This can lead to the formation of gas bubbles and coagula at the catheter-blood interface that can be released into the bloodstream which can lead to coronary occlusion, stroke, or silent cerebral events. To investigate the thermal mechanisms of bubble formation (i.e., boiling and degassing) during intracardiac PFA we developed a numerical model of a bipolar ablation catheter immersed in saline that can accurately predict the spatial and temporal temperature distribution. The model was validated with experiments using a high-speed camera to record bubble formation during pulse delivery. The model gives insights into the critical points of the catheter geometry where the highest temperature increases are observed, which is consistent with the locations where bubble formation was predominantly observed in the camera recordings. Our study shows the effects of different pulse protocols and delivered energies on the temporal temperature distribution and thermal mechanisms of bubble formation. The results suggest that to minimize bubble formation during intracardiac PFA, it is important to choose an appropriate treatment protocol (duration, duty factor, energy/power) and to consider the catheter/electrode configuration to avoid high current densities and excessive heating near the electrodes.

13:00 - 14:00	Lunch		Elia Minoa Palace
14:00 - 15:30	WS1 - European Research Cluster on EMF and Health (CLUE-H)	Florence Poulletier de Gannes Erdal Korkmaz	Main Hall

WS1-01

ETAIN – Exposure To electromAgnetic fIelds and plaNetary health

Dr Anke Huss
IRAS, Utrecht University, Utrecht, Netherlands

Abstract Subject Area(s)

["RF/Microwave","MM Waves"]

Summary

The ongoing introduction of new telecommunication technologies (5G now, 6G next) comes with changes in exposure patterns and of biological interaction with humans and ecosystems. E.g., mm-wave technology will lead to higher dose in human skin and eyes and higher absorption in small bodies, like insects. It is unclear if these changes are accompanied by adverse effects and what that would mean from a planetary health perspective. ETAIN's objectives relate to (A) development of technologies and tools for exposure assessment and dose calculations, as well as to exposure reduction techniques; and (B) to assessment of possible impact on health with a planetary health perspective.

Is the work in progress?

Yes

WS1-02

Project SEAWave: Scientific-based Exposure and risk Assessment of radiofrequency and mm-Wave systems from children to elderly (5G and Beyond)

Prof Theodoros Samaras
Aristotle University of Thessaloniki, Thessaloniki, Greece

Abstract Subject Area(s)

["Risk assessment"]

Summary

Project SEAWave aims to

- quantify the differences in exposure patterns between 2G-4G and 5G for the entire population including children,
- provide new tools and instruments for reliable exposure evaluation of base stations, local networks in factories, and end-user devices,
- provide the means to minimise exposure,
- generate important new scientific data with its complimentary in vitro, animal and human studies for assessing the health risk from exposure to the new

frequency bands (FR2), especially with regard to the potential (co-)carcinogenicity of skin exposure, and
- assess public perception of 5G exposure and provide the knowledge and tools for effective health risk communication and dissemination to various stakeholders.

Is the work in progress?
Yes

WS1-03
NextGEM - Next Generation Integrated Sensing and Analytical System for Monitoring and Assessing Radiofrequency Electromagnetic Field Exposure and Health
Dr Nikolaos Petroulakis
Institute of Computer Science - Foundation for Research and Technology - Hellas, Heraklion, Greece
Abstract Subject Area(s)
["In vitro","in vivo","Human studies","MM Waves","Risk assessment"]
Summary
The advancement of emerging technologies utilizing Radio Frequency Electromagnetic Field (RF-EMF) has increased the interest among both the scientific community and society concerning potential adverse impacts on human health and the environment. The NextGEM project aims to ensure the safety of EU citizens in the utilization of current and future EMF-based telecommunication technologies. This objective is achieved by generating relevant knowledge to determine suitable preventive measures and responsive actions concerning RF-EMF exposure across residential, public, and occupational settings.
Is the work in progress?
Yes

WS1-04
Project GOLIAT – 5G exposure, causal effects, and risk perception through citizen engagement
Prof Monica Guxens[1], Milena Maule[2], Martin Röösli[3], Kinga Polanska[4], Tanja Vrijkotte[5], Joel Schwartz[6], Marie-Abèle Bind[7], Mina Ha[8], Keiko Yamazaki[9], Wout Joseph[10,11], Philippe Leveque[12], Brahim Selmaoui[13], Yann Percherancier[14], James Grellier[15], Nora Salas[16], Pau Rubio[1], Deborah Oughton[17], Elisabeth Cardis[1], Gemma Castaño-Vinyals[1]
[1]ISGlobal, Barcelona, Spain. [2]University of Turin, Turin, Italy. [3]SwissTPH, Basel, Switzerland. [4]Nofer Institute of Occupational Medicine, Lodz, Poland. [5]Amsterdam Medical Center, Amsterdam, Netherlands. [6]Harvard School Public Health, Boston, USA. [7]Massachussets General Hospital, Boston, USA. [8]Dankook University, Cheonan, Korea, Republic of. [9]Hokkaido University Center for Environmental and Health Sciences, Sapporo, Japan. [10]University of Gent, Gent, Belgium. [11]IMEC, Gent, Belgium. [12]Centre National de la Recherche Scientifique, Limoges, France. [13]Institut national de l'environnement industriel et des risques, Verneuil-en-Halatte, France. [14]Centre National de la Recherche Scientifique, Bordeaux, France. [15]Exeter University, Exeter, United

Kingdom. [16]Science for Change, Barcelona, Spain. [17]Norwegian University of Life Sciences, As, Norway

Abstract Subject Area(s)

["Epidemiology"]

Summary

Despite the rapid growth in novel applications of wireless technology, comparatively little is known about their potential impacts on health, in particular to the most vulnerable (i.e., young people) and most exposed (i.e., workers) populations. The aims of GOLIAT are to monitor radiofrequency electromagnetic fields (RF-EMF) exposure, particularly from 5G, provide novel insights into its potential causal health effects, and understand how exposures and risks are perceived and best communicated using citizen engagement. We will i) develop next-generation exposure assessment methods to estimate aggregated RF-EMF dose to the whole-body and organs in young people; ii) identify new occupational RF-EMF sources resulting from 5G deployment and estimate RF-EMF exposure levels and patterns in workers; iii) assess neuropsychological effects of RF-EMF in young people and workers using causal inference, iv) assess effects of 5G on brain function, thermoregulation, and radical stress using in vitro, in vivo, human, and in silico experiments; v) identify effective means of exposure reduction; vi) better understand risk perceptions to (5G) RF-EMF; vii) co-design communication methods/tools to address RF-EMF concerns and misconceptions; viii) disseminate GOLIAT's results to stakeholders and integrate them into policy actions; and ix) implement a broader analysis of the societal and ethical implications of (5G) RF-EMF. The expected results will serve to deliver robust evidence on the potential effects of (5G) RF-EMF exposure in young people and workers, and contribute to developing guidelines for exposure prevention/reduction from new generation radio-communication networks. GOLIAT is part of the European cluster on EMFs and health (CLUE-H).

Is the work in progress?

Yes

15:30 - 16:00	Coffee break		Conference center
16:00 - 17:30	WS2 - From exposure to dose measure: what are suitable concepts for public communication and research	Martin Roosli Theodoros Samaras	Main Hall

WS2-01
Dosimetric challenges and uncertainties for (combining) near and far field RF-EMF sources
Prof Wout Joseph
Ghent University\IMEC, Ghent, Belgium
Abstract Subject Area(s)
["Experimental dosimetry","RF/Microwave"]
Summary
This abstract is part of the BioEM 2024 CLUE-H Workshop “from exposure to dose measure: what are suitable concepts for public communication and research”.
Challenges for far-field and near field radiofrequency assessment and uncertainties will be explained

WS2-02
Are there appropriate exposure/dose metrics for RF-EMF health risk assessment?
Prof Mats Olof Mattsson, Prof Myrtill Simko
SciProof International AB, Östersund, Sweden
Abstract Subject Area(s)
["Risk assessment","Standards and public health policy"]
Summary
The traditional approach to health risk assessment is made up of several procedures, initially including hazard identification (is an agent toxic?), hazard characterization (including finding out dose-response relationships, effect threshold determination, analysis of mode of action), and exposure assessment (who is exposed, how are the populations exposed, and a quantification of exposure). These activities are integrated into a risk characterisation, which in turn is used to perform the proper risk assessment (qualitative or quantitative).
This presentation will discuss especially the needs of a risk assessor regarding the physical factors underpinning what can be considered a relevant dose in health risk assessment of RF-EMF, and what is needed from exposure assessment to provide such a fundamental basis for further assessment activities.

WS2-03
What is the laypeople’s exposure perception? Results and experience from SEAWave

Dr Marie Eggeling, Prof Christoph Boehmert, Mrs Sarah Link, Mr Ferdinand Abacioglu
IU International University, Erfurt, Germany
Abstract Subject Area(s)
["RF/Microwave","Standards and public health policy"]
Summary
Communicating exposure-related information on radiofrequency electromagnetic fields (RF-EMF) to the public is important, for example when introducing new technological advancements as the implementation of 5G in mobile communications (MC). However, most citizens know little about how mobile radio works and rely on intuitions when assessing exposure to RF-EMF, which poses a challenge for scientists and risk communicators.
As part of the workshop this talk presents results of recent studies on laypeople's exposure perceptions from the SEAWave project. Based on our findings and previous research, we derive conclusions and recommendations for scientists or risk communicators who communicate exposure-related information to the public.
To investigate laypeople's exposure perceptions regarding RF-EMF used for MC with a particular focus on 5G and health, a qualitative and a quantitative study were conducted. The quantitative study was planned and conducted in collaboration with the project GOLIAT under the CLUE-H cluster. Main findings were that laypeople often have different understandings of exposure than experts, that misconceptions and intuitive assessments are common, and that personal relevance is often low.
Risk communicators should adjust their communication to the target audience and aim to engage people by using new and vivid formats of communication. Rather than communicating complex findings about doses and exposures, basic principles, i.e.," rules of thumb" may be more helpful for the public. They should also keep in mind that reception of scientific information may be influenced by prior knowledge, attitudes, and emotions.

WS2-04
Communicating dose concepts to the public by means of an app: The ETAIN project
Dr Anke Huss[1], Ms Lea Belackova[1], Dr Juerg Froehlich[2], Dr Marco Zahner[2], Mr Timon Schmid[2], Mr Rob Tieben[3], Mr Rene Luigies[3], Mr Giovanni Maccani[4], Ms Nekane Sandoval Diez[5], Dr Hamed Jalilian[5], Prof Arno Thielens[6], Prof Martin Roosli[5]
[1]IRAS, Utrecht University, Utrecht, Netherlands. [2]Fields at Work, Zurich, Switzerland. [3]GSL, Eindhoven, Netherlands. [4]Ideas for Change, Barcelona, Spain. [5]Swiss TPH, Basel, Switzerland. [6]Ghent University, Ghent, Belgium
Abstract Subject Area(s)
["RF/Microwave","MM Waves"]
Summary
The EU Horizon project ETAIN addresses population exposure to RF-EMF, leveraging a citizen science approach based on a Smartphone app to assess exposure of phone users, and to subsequently map environmental RF-EMF exposure. One of the main aims of the app is to empower people to understand their everyday RF-EMF exposure and the factors affecting it.
Is the work in progress?
Yes

17:30 - 19:00	WS3 - Breakthroughs in numerical and experimental EMF exposure assessment: The contribution of BIOEM young scientists	Micol Colella Giulia Sacco	Main Hall

WS3-01

On advancing radiofrequency electromagnetic field exposure assessment in mobile-phone networks

Dr Sam Aerts[1], Prof Joe Wiart[2], Prof John Bolte[1,3]

[1]The Hague University of Applied Sciences, Delft, Netherlands. [2]Télécom Paris, Institut Polytechnique de Paris, Palaiseau, France. [3]National Institute for Public Health and the Environment (RIVM), Bilthoven, Netherlands

Abstract Subject Area(s)

["Experimental dosimetry","RF/Microwave"]

Summary

Technological advances in radiocommunications drive the need for advanced radiofrequency (RF) electromagnetic field (EMF) assessment tools to accurately characterize the RF-EMF exposure in one's environment as well as over one's lifetime. This paper briefly describes the progress in their development over the past decade and identifies further research needs, of which several are currently being investigated in projects under the European Research Cluster on EMF and Health cluster (CLUE-H).

Is the work in progress?

Yes

WS3-02

Stochastic Dosimetry for Assessing Human RF-EMF Exposure Variability in Emerging Realistic Scenarios

Dr Marta Bonato[1], Miss Martina Benini[1,2], Dr Silvia Gallucci[1], Dr Emma Chiaramello[1], Dr Serena Fiocchi[1], Dr Gabriella Tognola[1], Dr Marta Parazzini[1]

[1]IEIIT, CNR, Milan, Italy. [2]DEIB, Politecnico di Milano, Milan, Italy

Abstract Subject Area(s)

["Numerical dosimetry","RF/Microwave"]

Summary

Stochastic dosimetry, combining electromagnetic computational techniques and statistics to build surrogate models, allows assessing exposure to EMF accounting for variability and uncertainty intrinsic of real scenarios. Indeed, since the deployment of 5th generation (5G) and 6th generation (6G) networks, the EMF scenarios are characterized more and more by uncertainty and heterogeneity variability, due to the introduction of innovation technologies such as the use of mm-wave working frequencies, of MIMO antenna, of 3D beamforming techniques, etc. For this reason, in this study, we present two applications of exposure variability assessment of humans to RF devices in uncertain scenarios using stochastic dosimetry. The first case is an indoor 5G scenario,

where the presence of a 5G Access Point is simulated, whereas the secondo one is in the context of Cooperative Intelligent Transport Systems (C-ITS) and involved a car equipped with a 5G-V2X antenna for vehicular communication. In both cases we used the Polynomial Chaos Kriging (PC-K) technique for evaluating the human exposure levels variability in terms of SAR, following the ICNIRP guidelines. The use of stochastic dosimetry coupled with the classical computational techniques allowed to obtain a fast estimation of the variability of the exposure in 5G realistic exposure scenarios.

WS3-03

REFLECTIVITY-BASED SKIN EQUIVALENT PHANTOM: TOWARDS A NOVEL CONCEPT FOR APD EVALUATION

Dr Massinissa Ziane, Dr Artem Boriskin, Dr Maxim Zhadobov
Univ. Rennes | CNRS, Rennes, France

Abstract Subject Area(s)

["Experimental dosimetry"]

Summary

This paper reports a conceptually new method for absorbed power density (APD) measurement for millimeter-wave (mmWave) devices, accounting for antenna/body coupling. A reflectivity-based thin planar solid phantom is employed to mimic the scattering characteristics of human skin. The proposed reflectivity-based phantom enables two types of APD measurements: (1) free-space E-field measurements behind the phantom and back-propagation to the APD evaluation plane; (2) fast infrared (IR) 2D measurements and subsequent reconstruction of APD. The technique was validated for reference antennas demonstrating its highly promising potential for experimental dosimetry and compliance testing of wireless devices above 6 GHz.

WS3-04

Error Analysis of APD Calculations Using High-Resolution Anatomical Rat Models for Millimeter-Wave Antenna Exposure

Dr Kun Li[1], Dr Takashi Hikage[2], Dr Hiroshi Masuda[3], Dr Etsuko Ijima[3], Dr Akiko Nagai[4], Dr Kenji Taguchi[5]
[1]The University of Electro-Communications, Tokyo, Japan. [2]Hokkaido University, Hokkaido, Japan. [3]Kurume University School of Medicine, Fukuoka, Japan. [4]Aichi-Gakuin University School of Dentistry, Nagoya, Japan. [5]Kitami Institute of Technology, Kitami, Japan

Abstract Subject Area(s)

["Numerical dosimetry","MM Waves"]

Summary

This study presents a numerical error analysis of the calculated absorbed power density (APD) for millimeter-wave exposures using a realistic animal voxel model. We employed anatomical rat head models with varying high resolutions, ranging from 0.125 mm to 0.03125 mm. Dipole and dipole array antennas operating at frequencies from 20 to 60 GHz were used, which were placed in close proximity to the rat head's skin surface, simulating a local exposure scenario. Additionally, we compared three different methods for averaging APD on the rat's skin surface based on the location for the volume integral center of absorbed power. The results indicate that the numerical error

resulting from differences in model resolution is not significant. Furthermore, the peak SAR center used for spatially averaging APD exhibits the highest value compared to averages around the gemetrical center of model and antenna.

Is the work in progress?

Yes

WS3-05

3D Virtual Cell Model in Microdosimetry Assessment

Dr Laura Caramazza[1,2], Prof Francesca Apollonio[1,2], Dr Lluis M. Mir[3], Prof Micaela Liberti[1,2]

[1]Sapienza University, Rome, Italy. [2]Center for Life Nano-& Neuro-Science, Fondazione Istituto Italiano di Tecnologia (IIT), Rome, Italy. [3]UMR 9018 METSY, CNRS, Université Paris-Saclay, Gustave Roussy, Villejuif, France

Abstract Subject Area(s)

["Numerical dosimetry","RF/Microwave","Risk assessment","Biological and medical applications"]

Summary

In recent years, electromagnetic (EM) fields have seen increasing use in biomedical applications and telecommunication technologies. As such, understanding how EM fields interact with biological systems becomes an essential issue for proper applications. Given the complexities of biological structures at the microscopic level, microdosimetric studies play a key role in estimating electrical quantities at the cellular level. The literature presents various cell models, ranging from 2D models to simplified or irregularly shaped 3D models, with or without intracellular organelles. However, there is not a clear consensus on the accuracy of the numerical data produced by these models.

In this work, authors propose the use of 3D virtual cell models, which include intracellular structures, as a versatile tool capable of reproducing diverse exposure scenarios and providing accurate estimation of the local electrical quantities resulting from EM field interaction. Through comparative analysis of results obtained with 3D virtual cells with the ones coming from 2D and from simplified 3D cell models, our work aims to highlight the trade-offs involved and underscore the critical importance of employing a 3D virtual cell model. These models offer a virtual experiments perspective for reliable comparison with *in vitro* experiments.

Is the work in progress?

Yes

WS3-06

Macroscopic and microscopic temperature measurements during exposure of multicellular spheroid tumors to nanosecond pulsed electric fields (nsPEF)

Dr Rosa Orlacchio[1,2], Dr Jelena Kolosnjaj-Tabi[3], Mr Nicolas Mattei[3], Dr Philippe Leveque[4], Dr Marie-Pierre Rols[3], Dr Delia Arnaud-Cormos[4,5], Dr Muriel Golzio[3]

[1]Univ. Bordeaux, CNRS, IMS, UMR 5218, F-33400 Talence, France, Bordeaux, France. [2]École Pratique des Hautes Études, PSL Research University, 75014, Paris, France. [3]Institut de Pharmacologie et de Biologie Structurale (IPBS), Université de Toulouse, CNRS, Université Toulouse III - Paul Sabatier (UT3), Toulouse, France. [4]Univ. Limoges,

CNRS, XLIM, UMR 7252 F-87000, Limoges, France. [5]Institut Universitaire de France (IUF), 75005, Paris, France

Abstract Subject Area(s)

["In vitro","Experimental dosimetry","Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

Nanosecond pulsed electric fields (nsPEF) stimulation emerges as a promising alternative in cancer treatment facilitating precise and localized tumor removal. Recent research highlights that nsPEF ablation not only addresses the significant concerns of pain associated with conventional PEFs (100 µs - 1 ms) but also leads to diminished neuromuscular stimulation. Although most published studies involve pulses above 100 ns, our recent investigations have shown that, under specific exposure conditions, pulses between 2 and 10 ns (up to 100 kV/cm) can induce cellular death and growth inhibition of 3D multicellular spheroids (MCSs) tumors. Reducing pulse duration holds significant appeal due to its potential to target deep-seated tumors. To comprehensively explore the use of ultrashort pulses in oncology, further studies are imperative for a thorough understanding of the effects of various parameters, such as pulse width, interphase interval, amplitude, number, pulsing buffer electrical conductivity and ions composition, as well as induced-temperature increase. Indeed, local temperature elevation has been identified as a potential element influencing cellular response. This abstract mainly focuses on the measurement of the induced temperature elevation of the pulsing buffer, where MCSs are situated, during exposure to trains of 2, 6, and 10 ns electric pulses with an electric field intensity ranging between 90 and 100 kV/cm. Macroscopic and microscopic temperature measurements were performed using a fiber optic temperature probe and fluorescence microscopy, respectively. Additionally, results of cellular viability of MCSs up to 32 h post-exposure are presented.

Friday June 20th

09:00 - 10:00	OS 13 - Medical Applications	Laura Caramazza Eleonore Fresnel	Main Hall

OS13-01

Three years of RISEUP project: how microsecond electric pulses stimulation are applied to induce the spinal cord regeneration.

Dr Claudia Consales[1], Prof Manuel Monleon Pradas[2], Dr Paolo Marracino[3], Dr Micol Colella[4], Dr Franck André[5], Prof Victoria Moreno Manzano[6], Prof Francesca Apollonio[4], Prof Micaela Liberti[4]

[1]Health and Environment Laboratory, ENEA, Rome, Italy. [2]Center for Biomaterials and Tissue Engineering, Polytechnic University Valencia, Valencia, Spain. [3]Rise Technology S.r.L, Rome, Italy. [4]BioEM Lab, Department of Information Engineering, Electronics and Telecommunications (DIET), Sapienza University of Rome, Rome, Italy. [5]CNRS, Metabolic and Systemic Aspects of the Oncogenesis, (METSY), Institute Gustave Roussy, Paris-Saclay Universit, Villejuif, France. [6]Neuronal and Tissue Regeneration Laboratory, Centro de Investigación Príncipe Felipe, Valencia, Spain

Abstract Subject Area(s)

["In vitro","in vivo","Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

Spinal Cord Injury (SCI) is a devasting condition characterized by motor, sensory and autonomic dysfunction, caused by a direct injury of any part of the spinal cord or from damage to the tissue and bones that surround the spinal canal. This is recognized as the major cause of paralysis, which currently has no effective therapies.

RISEUP project, funded by the European community in the H2020 FET-OPEN program, provides for the development of an innovative system for the regeneration of SCI based on the transplantation and the microsecond (μsec) electric pulses stimulation of mesenchymal (MSCs) and induced neuronal (iNSCs) stem cells, through a biocompatible, biodegradable, and electrified support.

Here we present an overview of the technological and biological results achieved during the project in the last three years.

Is the work in progress?

Yes

OS13-02

A Convolutional Neural Network Based Transfer Function Evaluation Approach for Subcutaneous and Partially-Implanted Implantable Medical Devices under MRI Exposure

Dr Aiping Yao[1], Dr Jing Wang[2], Dr Pengfei Yang[2]

[1]Nanchang University, Nanchang, China. [2]Center for Medical Device Evaluation, National Medical Products Administration (NMPA), Beijing, China

Abstract Subject Area(s)
["Numerical dosimetry","Risk assessment"]
Summary
This work provides a novel and efficient RF transfer function evaluation approach for patients with subcutaneous and partially-implanted medical implantable devices under MRI exposure. Through the combination of classical electromagnetic theory and convolutional neural network, the physical and electromagnetic properties of the medical implants are characterized and optimized by a well-designed convolutional neural network. The preliminary results show that the proposed approach has the potential to provide an efficient evaluation of the RF transfer function for subcutaneous and partially implanted medical implants under MRI exposure.
Is the work in progress?
Yes

OS13-03
Enabling EEG Recordings During Temporal Interference Neuromodulation
Dr Myles Capstick[1], Mr Mischa Sabathy[2], Dr Stefan Beerli[1], Prof Peter Achermann[3], Prof Niels Kuster[1,4]
[1]IT'IS Foundation, Zurich, Switzerland. [2]SPEAG, Zurich, Switzerland. [3]University of Zurich, Zurich, Switzerland. [4]ETH, Zurich, Switzerland
Abstract Subject Area(s)
["Human studies","Biological and medical applications"]
Summary
Many research groups would like to perform closed-loop neuromodulation studies. We report here on the design and performance of the new filters we have developed specifically to enable uncompromised high-density encephalogram recordings during temporal interference stimulation.
Temporal interference (TI) stimulation enables 3D focal non-invasive electrical neural stimulation of both superficial and deep regions in the brain. In its simplest form, the technology is based on two electric fields that are applied at slightly different frequencies within the kilohertz range (e.g., 2.01 kHz and 2.00 kHz) to drive neural dynamics at the difference frequency (i.e., 10 Hz) at locations where the corresponding currents intersect. Preliminary experimental results have shown that improved performance can be obtained when stimulation is synchronized with neuronal activity. The electroencephalogram (EEG), which uses a various number of sensing electrodes, is often used to monitor brain activity, with recorded signals in the microvolt range, whereas TI involves stimulating the scalp with volts or tens of volts to achieve the desired currents. To be able to stimulate and record simultaneously, two main problems must be overcome. In this abstract we describe the problems and our solution to overcome them.

OS13-04
Probing the extracellular space in epileptic tissue with low-intensity electrical stimulation

Dr Stanislas Lagarde[1,2,3], Dr Julien Modolo[4], Dr Maxime Yochum[4], Dr Andres Carvallo[4], Dr Alice Ballabeni[1,5], Dr Didier Scavarda[2,6], Dr Romain Carron[2,7], Dr Nathalie Villeneuve[8], Dr Fabrice Bartolomei[1,2], Dr Fabrice Wendling[4]
[1]APHM, Timone Hospital, Epileptology and Cerebral Rhytmology Department, Marseille, France. [2]Univ Aix Marseille, INSERM, INS, Inst Neurosci Syst, Marseille, France. [3]University Hospitals of Geneva (HUG), University of Geneva (UNIGE), Geneva, Switzerland. [4]Univ Rennes, INSERM, LTSI - U1099, Rennes, France. [5]University of Modena and Reggio-Emilia, Modena, Italy. [6]APHM, Timone Hospital, Pediatric Neurosurgery Department, Marseille, France. [7]APHM, Timone Hospital, Stereotactic and Functional Neurosurgery Department, Marseille, France. [8]APHM, Timone Hospital, Pediatric Neurology Department, Marseille, France

Abstract Subject Area(s)

["Mechanisms","Human studies","Biological and medical applications"]

Summary

For approximately one third of patients with epilepsy, antiseizure medications are not fully efficient in controlling seizures. For some of these drug-refractory patients, resective surgery can be an option, and could involve the surgical implantation of intracerebral electrodes (stereoelectroencephalography, SEEG) to delineate the epileptogenic zone from recorded signals. The use of electrical stimulation during SEEG is a standard procedure to identify pathological post-discharges, which can be viewed as abnormally long and high “neuronal echoes” in response to pulsed stimulation. However, such protocols of stimulation involve a subjective interpretation, are time-consuming for both the neurologist and the patient, and can involve discomfort for the patient (due to the potential of such stimulations to trigger seizures). In order to address these shortcomings, we recently developed a technique based on low-intensity pulsed stimulation delivered through SEEG electrodes, which eliminates the risk of triggering seizures, to measure the possible difference in electrical conductivity between healthy brain tissue and epileptic tissue. The first results using this technique were promising, although only two patients were included at the time. In order to generalize these results, we decided to increase the sample size (N=16) to investigate the robustness of our findings. Here, we present partial results from this clinical study, and provide evidence for a consistent decrease in electrical conductivity in epileptic tissue. By discussing the involved biophysical mechanisms underlying these results, we argue that our technique enables the direct probing of the electrical properties of the extracellular space, which have therapeutic implications for epilepsy and beyond.

10:00 - 10:30	Coffee break		Conference center
10:30 - 12:00	OS14 - In vitro	Guangdi Chen Jana Haidar	Main Hall

OS14-01

Cellular effects of radiofrequency exposure to 1950 MHz, LTE signal, in human neuroblastoma cells in combination with menadione.

Dr Mariateresa Allocca[1], Dr Anna Sannino[1], Dr Stefania Romeo[1], Dr Maria Rosaria Scarfì[1], Prof Fulvio Schettino[2], Dr Gaetano Chirico[2], Dr Olga Zeni[1]
[1]National Research Council of Italy (CNR), Institute for Electromagnetic Sensing of the Environment (IREA), Naples, Italy. [2]Department of Electrical and Information Engineering "Maurizio Scarano" (DIEI), University of Cassino and Southern Lazio, Cassino, Italy

Abstract Subject Area(s)

["In vitro","Mechanisms","RF/Microwave"]

Summary

In previous investigations, we reported that pre-exposure to radiofrequency (RF) with different frequencies, modulation patterns, and specific absorption rate (SAR) levels, can reduce the damage induced by physical and chemical agents in different cell models. This study carried out within the NextGEM project funded by the European Union, concerns the evaluation of the non-thermal effects of exposure and co-exposure of human neuroblastoma cells (SH-SY5Y) to RF, in terms of ROS formation, apoptosis, and cell cycle progression.
SH-SY5Y cells were exposed for three hours to 1950 MHz, LTE signal at SAR levels of 0.3 and 1.25 W/kg, and co-exposed to menadione, a well-known cytotoxic chemical agent. To date, the effect on ROS formation has been carried out by flow cytometer. The preliminary results here reported indicate: i) no effect on ROS formation after exposure to RF alone at both SAR levels investigated, ii) induction of ROS formation by MD treatments as a function of MD concentration, and iii) no effect of combined exposure of RF with 20 μM MD. Subsequent investigations will be carried out to consolidate these results and to assess the effects on apoptosis and cell cycle.

Is the work in progress?

Yes

OS14-02

Development of the porcine cornea-equivalent phantom for exposure assessment in THz frequency region and non-invasive three-dimensional temperature imaging

Dr Shota Yamazaki, Dr Maya Mizuno, Dr Tomoaki Nagaoka
National Institute of Information and Communications Technology, Koganei, Japan

Abstract Subject Area(s)

["In vitro","MM Waves","Risk assessment","Biological and medical applications"]

Summary

Since the utilization of the terahertz (THz) frequency region is anticipated in the next generation wireless communication system (Beyond 5G), there has been a rising interest in the electromagnetic field (EMF) safety within this frequency region. In this study, the complex relative permittivity of the porcine cornea was analysed by the Terahertz time-domain attenuated total reflection (THz TD-ATR) spectroscopy, and we developed cornea-equivalent phantom for exposure assessment in THz frequency region. Moreover, we employed the fluorescence thermoprobe as a material of the cornea-equivalent phantom and enabled non-invasive imaging of temperature distribution

inside the phantom by the confocal laser scanning microscopy with high spatial resolution.

Is the work in progress?

Yes

OS14-03

In Vitro Neuronal Excitation by Complex Electric Waveforms in the Context of Targeted Neuromodulation

Dr Iurii Semenov, Dr Vitalii Kim, Dr Andrei Pakhomov
Frank Reidy Research Center for Bioelectrics, Old Dominion University, Norfolk, USA

Abstract Subject Area(s)

["In vitro","Mechanisms","Biological and medical applications","Electroporation and pulsed electric field applications"]

Summary

Targeted non-invasive deep brain electrostimulation, aimed at activating deep neural structures without stimulation at the surface, relies on the interference of electric fields from two or more sources. The waveforms employed for it should be inefficient for stimulation near the surface electrodes, but will overlap at the remote target into a new waveform efficient for neurostimulation despite a weaker electric field. Techniques like temporal interference (TI) use slightly shifted high-frequency sine waves to create an amplitude-modulated stimulus at the target. Similarly, the cancellation of cancellation (CANCAN) strategy overlaps two inefficient bipolar pulses to form a potent unipolar pulse remotely. Additionally, TI can be achieved with two identical high-frequency signals in opposite phases and containing transient distortions such as phase or frequency shifts. The high-frequency signals cancel each other at the target while the distortions add up, triggering neuron firing. Understanding pulse parameters that govern electrostimulation efficiency is crucial for designing effective waveforms and protocols for targeted electrostimulation. Our studies in dissociated primary neurons analyzed neuroexcitation with various waveforms, including bipolar pulses, sine waves, and amplitude-modulated signals, with the goal of refining remote targeting techniques.

OS14-04

Effect of Ca2+ and Poloxamer 188 on membrane repair in mammalian cells permeabilized by nanosecond electric pulses.

Dr Olga Pakhomova, Dr Sayak Bhattacharya, Dr Andrei Pakhomov
Old Dominion University, Norfolk, USA

Abstract Subject Area(s)

["In vitro","Mechanisms","Electroporation and pulsed electric field applications"]

Summary

Plasma membrane (PM) repair is essential for cellular recovery from damage caused by physiological activities or external factors. A key element in PM repair across all cell types is the influx of Ca^{2+} from the external environment, which activates calcium-sensitive proteins in the repair machinery. However, mechanisms of membrane repair in cells electroporated with nanosecond pulses have not been explored. We measured YO-PRO-1 (YP) dye influx into HEK and BPAE cells exposed to a single 300 ns pulse at 14.7 kV/cm, in the medium with and without Ca^{2+} ions. A fast-step perfusion system was employed to change the medium in 100 ms after the nsEP delivery. The presence of Ca^{2+}

profoundly facilitated repairs, reducing cumulative YP uptake up to threefold. A copolymer Poloxamer 188 (P188) at 100 μM facilitated membrane resealing, reducing the cumulative YP entry by 23-40%. The protective effect of P188 was observed with or without Ca^{2+} in the medium and apparently did not rely on Ca^{2+}dependent membrane repair machinery.

OS14-05

Biochemiluminescence Sensing of Pro- and Antioxidants Modulation of the Electrochemical Effects of Pulsed Electric Field in Protein Solutions

Mrs Kateřina Červinková[1], Dr Petra Vahalová[1], Mrs Michaela Poplová[1], Dr Tomáš Zakar[1], Dr Daniel Havelka[1], Prof Martin Paidar[2], Dr Viliam Kolivoška[3], Michal Cifra[1]
[1]Institute of Photonics and Electronics of the Czech Academy fo Sciences, Prague, Czech Republic. [2]University of Chemistry and Technology, Prague, Czech Republic. [3]J. Heyrovský Institute of Physical Chemistry of the Czech Academy of Sciences, Prague, Czech Republic

Abstract Subject Area(s)

["Mechanisms","Electroporation and pulsed electric field applications"]

Summary

Pulsed electric field (PEF) technology represents a significant emerging tool in biomedicine and the food industry, yet the precise mechanisms by which PEF impacts biomolecules remain unclear. Indications suggest that PEF might affect proteins by generating electrogenerated reactive oxygen species. However, the modulation of this action by pro- and antioxidant species present in the biosample is not fully understood. This knowledge gap often stems from the limited sensitivity of detection assays. We utilized a recently developed endogenous (bio)chemiluminescence sensing platform to address this challenge, enabling sensitive detection of oxidative processes induced by PEF in protein solutions.
Our findings reveal a notable increase in the chemiluminescence signal from bovine serum albumin (BSA) protein samples in the presence of H_2O_2 as a prooxidant, particularly when subjected to PEF treatment. Conversely, the chemiluminescence signal decreases with the addition of antioxidant enzymes (catalase, superoxide dismutase), suggesting the involvement of both H_2O_2 and electrogenerated superoxide in oxidation-reporting chemiluminescence signal before, during, and after PEF treatment. Furthermore, additional biochemical and biophysical assays confirmed structural changes in BSA following H_2O_2 treatment, with PEF exerting only minor effects. We proposed a scheme elucidating the reactions from charge transfer at the anode/electrolyte interface, where ROS are generated, to the actual photon emission, thus aiding in understanding the mechanisms of PEF action on proteins. These results hold promise for the future application of PEF technology.

Is the work in progress?

Yes

OS14-06

Real-Time Electrophysiology Experiments: Coplanar Waveguide Exposure System for 5G

Dr Carmen Pisano, Dr Noemi Dolciotti, Miss Elisa Fumarola, Miss Anna Marasà, Miss Flaminia Benetti, Miss Diana Valeriani, Prof Alessandra Paffi, Prof Micaela Liberti, Prof Francesca Apollonio
University Sapienza of Rome, Rome, Italy

Abstract Subject Area(s)

["In vitro","Experimental dosimetry","RF/Microwave"]

Summary

The current adoption of the fifth generation (5G) technology standard for mobile networks and for a wide range of applications operating in spectral bands new respect to previous technologies, requests further studies related to risk assessment.
In this context investigating cellular stress responses and ionic channel functions under exposure to new RF-EMF technologies, remains pivotal in assessing associated biological effects. Moreover, understanding such a response through real-time electrophysiological studies becomes of paramount importance when excitable cells and ion channels are the favoured target.
In this work, an appropriately shielded-CPW exposure system for real-time patch-clamp experiments targeting 700 MHz and 3.5 GHz frequencies is presented. The system is designed and optimized to avoid electromagnetic coupling both with the electronic laboratory equipment needed for electrophysiology acquisitions and with the microscope setup to be used for single cell selection, despite these considerations, the system maintains the capability to apply the necessary electromagnetic dose to cell cultures.

12:00 - 13:00	Award Ceremony - Young investigator lecture + prizes	Main Hall
13:00 - 13:30	Closing Ceremony	Main Hall
14:00-16:00	BioEM Board Meeting	Ariadne

Author Index

Author name	Program Codes*
Abacioglu, Ferdinand	078B & FB08, WS2
Abbas, Anees	081A & FA12, 075A & FA10
Abe, Mitsunari	040B
Abramson, Michael	OS02-03
Achermann, Peter	OS13-03
Addison, Darren	068B
Aerts, Sam	108B, OS04-02, OS04-03, OS07-06, WS3
Agnani, Jean-Benoît	OS08-05
Ahn, Jangyong	121A
Ahn, Seungyoung	069A & FA09, 121A
Ahn, Young Hwan	052B
Akizuki, Minato	025A & FA03
Akutagawa, Masatake	025A & FA03
Al Harrach, Mariam	117A
Alfadhl, Yasir	118B & FB12, 153A & FA20
Alfano, Gaetano	017A
Alkatheeri, Afra	031A & FA04
Allocca, Mariateresa	027A, OS14-03
Alonso, José Ignacio	058B
Alonso, Pol	062B
Alteköster, Carsten	127A, OS06-01
Alzaabi, Fatima	153A & FA20
Alzahed, Abdelelah	046B, 061A
Amadei, Ercole Matteo	102B
Aminzadeh, Reza	053A & FA07
Amuneke Ramírez, Alexandra	072B
Anayyat, Umer	056B, OS05-03
Andre, Franck M.	018B, 026B, 028B, OS01-06, OS13-01
Andrenko, Andrey	095A
Anthonissen, Roel	036B & FB05
Anzalone, Nicoletta	T1
Apollonio, Francesca	035A, 123A, OS01-05, OS01-06, OS03-04, OS13-01, OS14-06, WS3
Apostolidis, Christos	OS01-04
Ariccio, Silvia	OS02-06
Arnaud-Cormos, Delia	034B & FB04, OS05-04, WS3
Arslan, Nasrullah	OS02-05, OS08-03
Astanin, Alexander	084B
Awan, Wahaj Abbas	081A & FA12, 082B & FB09
Baaken, Dan	084B
Babas, Dimitrios	055A
Babayan, Yura	003A
Bach, Véronique	OS02-04
Bajtos, Marek	037A & FA05
Bala, Nathan	OS05-05
Ballabeni, Alice	OS13-04
Barbato, Federica	017A

Author name	Program Codes*
Barnes, Frank	037A & FA05
Bartolomei, Fabrice	OS13-04
Baz, Tamara	OS02-04
Beerli, Stefan	OS13-03
Bei, Roberto	017A
Belackova, Lea	053A & FA07, WS2
Belenki, Dimitri	084B
Bellier, Pascale	022B
Belácková, Lea	OS08-02
Ben Chikha, Wassim	129A
Benamara, Megdouda	104B
Benassi, Barbara	026B
Benetti, Flaminia	OS14-06
Benini, Martina	077A, 122B, 139A, WS3
Benke, Geza	OS02-03
Benkler, Stefan	OS11-06
Bensetti, Mohamed	OS09-01
Benvenuto, Monica	017A
Berardinelli, Francesco	017A
Bhatt, Chhavi	108B, OS11-03
Bhattacharya, Sayak	OS14-04
Bind, Marie-Abèle	WS1
Binti Mohd Baharin, Rasyidah Hanan	111A
Bit-Babik, Giorgi	064B
Bitsch, Annette	057A
Bixler, Joel	007A, 010B, 011A, OS07-01
Bodewein, Lambert	090B, OS02-02

Author name	Program Codes*
Bodin, Raphaël	041A & FA06, 042B & FB06
Boehmert, Christoph	078B & FB08, WS2
Bogdanova, Anna	065A
Bolte, John	108B, WS3
Bonato, Marta	077A, 122B, 139A, OS12-02, WS3
Bonnet, Laurent	015A & FA02
Bories, Serge	OS04-04
Boriskin, Artem	OS07-05, WS3
Bornkessel, Christian	099A & FA14, OS11-04
Bouisset, Nicolas	OS09-05, OS09-06
Bouland, Catherine	148B
Braeckman, Lutgart	036B & FB05
Bruer, Gustav	057A
Brzoza, Marta	079A
Bujard, Cédric	091A & FA18
Butterworth, Joseph	067A
Béranger, Tristan	015A & FA02
Cabanes, Pierre André	OS09-05, OS09-06
Cadossi, Matteo	OS12-01
Cadossi, Ruggero	123A, OS12-01, T1
Calderon, Carolina	068B
Calienni, Maria	035A
Camera, Francesca	018B, 026B, 149A
Cao, Hui	005A & FA16
Capone, Fioravante	T1
Capstick, Myles	124B & FB15, OS03-02, OS13-03

Author name	Program Codes*
Caramazza, Laura	035A, OS01-05, OS01-06, OS03-04, WS3
Cardis, Elisabeth	053A & FA07, OS02-03, WS1
Carrie, Amandine	OS02-04
Carron, Romain	OS13-04
Carvallo, Andres	OS13-04
Casado Arroyo, Ruben	148B
Castaño-Vinyals, Gemma	051A, OS08-04, WS1
Castellani, Gastone	035A
Caytan, Olivier	OS07-03
Cecchetti, Claudio	142B
Chavannes, Nicolas	091A & FA18
Chen, Changyou	OS05-01
Chen, Guangdi	OS01-02, OS05-02
Chen, Haitao	OS05-01
Chen, Sisi	002B
Chen, Siyao	005A & FA16
Chen, Xiaodong	118B & FB12, 153A & FA20
Chen, Xinhua	115A
Chiaramello, Emma	122B, OS12-02, WS3
Chirico, Gaetano	027A, 062B, OS14-03
Chitnis, Ninad	113A & FA19
Chocano Del Cerro, Ricardo	105A
Choi, Domin	075A & FA10, 081A & FA12, 082B & FB09
Choi, Donggeun	069A & FA09, 076B
Choi, Gyuhwan	071A
Choi, Hyung-Do	052B, 121A
Chou, Chung-Kwang	OS06-02
Christopoulou, Maria	055A, 097A, 101A & FA15
Chuan, Sun	013A & FA01, 014B & FB14
Cifaldi, Loredana	017A
Cifra, Michal	OS07-02, OS14-05
Claudel, Julien	OS02-01
Colantoni, Eleonora	026B
Colella, Micol	123A, OS01-05, OS01-06, OS13-01, T1
Collins, Brian	044B
Colombi, Davide	OS04-01
Comi, Giancarlo	T1
Conil, Emmanuelle	045A, 055A, 129A, OS08-05
Consales, Claudia	018B, 026B, 028B, OS01-05, OS01-06, OS13-01
Contardi, Sara	T1
Cramer, Tobias	035A
Croft, Rodney	OS05-05, OS05-06, OS06-04
Cruz Santory, Aryana	007A
Cueille, Marylene	OS01-01
Czieselsky, Katja	084B
D'orazio, Luigi	142B
Dang, Nhat	037A & FA05
Dang, Wen	118B & FB12
Danker-Hopfe, Heidi	021A
Dassonville, David	OS04-04
De Clercq, Eva M.	148B
De La Rosa, Richard	004B
De Leo, Alfredo	064B
De Llobet, Patricia	053A & FA07

Author name	Program Codes*
De Luca, Giulia	OS01-05
De Sanctis, Stefania	017A
De Santis, Valerio	064B, 149A
De Terlizzi, Francesca	OS12-01
De Vocht, Frank	051A
Dechent, Dagmar	090B, OS02-02
Dejardin, Olivier	045A
Del Castillo, Guillermo	OS11-06
Del Signore, Federico	OS03-04
Delanaud, Stéphane	OS02-04
Delidimitriou, Spyridon	055A, 101A & FA15
Deltour, Isabelle	045A, 049A
Deng, Chao	OS05-05, OS05-06
Deprez, Kenneth	048B, OS04-02, OS04-03, OS04-06, OS10-04
Deschamps, François	OS02-0, OS09-05, OS09-06
Descharles, Mélanie	104B
Deser, Andreas	016B, 084B
Di Lazzaro, Vincenzo	T1
Di Nardo, Lucrezia	123A
Di Paola, Carla	OS04-01
Diao, Yinliang	143A
Diomedi, Marina	T1
Djuric, Nikola	055A
Dolciotti, Noemi	018B, 123A, OS01-05, OS01-06, OS14-06
Dominici, Massimo	OS12-01
Dongus, Stefan	053A & FA07, OS02-05, OS08-03
Driessen, Sarah	090B, 133A, 134B, 135A, 136B, 137A, 140B, OS02-02, OS10-01
Dubard, Jean-Lou.	OS01-01
Ducray, Angélique	OS03-02
Duvdevany, Amnon	126B, 145A
Echchgadda, Ibtissam	004B
Eeftens, Marloes	053A & FA07
Eggeling, Marie	078B & FB08, WS2
Egube, Theodore	046B, 061A
Eilers Bischoff, Jens	OS04-01
Einat, Oded	126B
Elfick, Alistair	031A & FA04
Emonds, Tanja	090B, OS02-02
Emoto, Takahiro	025A & FA03
Esaki, Kaoro	OS11-02
Faraone, Antonio	064B
Fasse, Alessandro	091A & FA18
Ferber, Jeannette	038B
Fernandes Veludo, Adriana	053A & FA07, OS02-05, OS04-02, OS04-06, OS08-01, OS08-02, OS08-03, OS08-04
Fernandes, Romain	018B, 028B
Fiocchi, Serena	122B, OS12-02, WS3
Fleury, Gérard	OS09-01
Focaccetti, Chiara	017A
Folli, Marcello	142B
Fontana, Sara	018B, 123A, OS01-05, OS01-06

Author name	Program Codes*
Foroughimehr, Negin	073A, 080B
Franchini, Valeria	017A
Frankland, John	OS05-05, OS05-06
Frassati, François	104B
Freschi, Fabio	008B
Fresnel, Eleonore	OS09-05, OS09-06
Froehlich, Juerg	WS2
Frénéa Robin, Marie	OS12-03
Fröhlich, Jürg	060B & FB07, OS08-02, OS10-03
Fukunari, Masafumi	088B
Fumarola, Elisa	OS14-06
Fuschi, Alessandro	035A
Fusco, Roberta	OS12-01
Gaide, Olivier	OS07-04
Gajšek, Peter	055A, 128B, OS08-06
Galletta, Valentina	122B, OS12-02
Gallucci, Silvia	077A, 122B, 139A, WS3
Gamboa, Bryan	020B
Garcia-Sanchez, Tomas	026B
García-Pardo, Concepción	058B
Garzia, Andrea	130B & FB16, 142B
Gaugain, Gabriel	117A
Genxiang, Mao	013A & FA01, 014B & FB14
Gernand, Lukas	079A, 084B
Geschwentner, Dirk	084B
Giaccone, Luca	008B, OS10-02
Giuliani, Giacomo	035A

Author name	Program Codes*
Gobba, Fabriziomaria	063A
Goegebeur, Samuel	077A, OS04-02
Goethals, Michel	OS10-04
Goldberg, Marcel	049A
Golzio, Muriel	WS3
Gomez, Jorge	001A
Gommé, Liesbeth	OS10-04
González-Rubio, Jesús	110B
Gordon-Mcintosh, Shea	046B, 061A
Goren, Tolga	092B
Graefrath, David	090B, OS02-02
Grazioso, Paolo	142B
Grellier, James	WS1
Griffon, Vincent	053A & FA07
Grisendi, Giulia	OS12-01
Gryz, Krzysztof	098B
Guangdi, Chen	013A & FA01, 014B & FB14
Gugler, Markus	060B & FB07, OS10-03
Guida, Florence	045A
Guillen Pina, Jorge	105A
Gurhan, Hakki	037A & FA05
Guxens, Monica	OS02-05, OS04-06, OS08-03, WS1
Guxens, Mònica	048B, 051A, 053A & FA07, OS02-05, OS04-02, OS04-06, OS08-01, OS08-03, OS08-04, WS1
Gyulai, Balázs	109A
Gödecke, Daria	057A
Ha, Mina	WS1
Haas, Dominik	060B & FB07, OS10-03

Author name	Program Codes*
Haas, Maxim	091A & FA18
Hada, Aki	029A
Haidar, Jana	034B & FB04
Haider, Zain	043A
Hammen, Lucien	OS09-01
Hannegan, Megan	OS03-01
Hattori, Kenji	029A
Havelka, Daniel	OS07-02, OS14-05
Havlicek, Jaroslav	OS07-02
Heberling, Dirk	099A & FA14, OS11-04
Hein, Matthias	099A & FA14, OS11-04
Hellmann-Regen, Julian	021A
Henderson, Stuart	146B, OS11-03
Hernando, Antonio	058B
Higashiyama, Junji	087A, OS04-05
Hikage, Takashi	085A, WS3
Hirata, Akimasa	OS09-02
Hirtl, Rene	057A, 133A, 134B, 135A, 136B, 137A, 140B, OS10-01
Honda, Shiori	120B & FB13
Hong, Seon-Eui	121A
Hosoda, Tohgo	012B & FB02
Hu, Xiangjun	023A, 050B
Hugueville, Laurent	OS02-04
Huh, Sungryul	121A
Hulls, Paige	051A
Hurtier, Annabelle	034B & FB04
Huss, Anke	045A, 053A & FA07, OS02-06, OS08-02, WS1, WS2

Author name	Program Codes*
Hussain, Niamat	075A & FA10; 081A & FA12, 082B & FB09
Hwang, Taewook	094B, 138B, 150B
Iakovidis, Serafeim	OS07-04
Ibey, Bennett	010B, 011A
Iino, Anna	120B & FB13
Ijima, Etsuko	WS3
Ijjeh, Abdelrahman	OS01-01
Ikehara, Toshitaka	025A & FA03
Ikehata, Masateru	029A
Ikuyo, Miwa	093A, 147A, OS06-03, OS11-02
Innamorati, Giorgia	018B, 028B
Iodice, Antonio	130B & FB16
Ishiwatari, Hiromi	047A
Iskra, Steve	OS05-05, OS05-06
Iyama, Takahiro	087A, OS04-05
Jalilian, Hamed	OS02-05, OS08-01, OS08-02, OS08-03, WS2
Jamal, Layla	OS02-04
Jawad, Ourouk	055A, 129A, OS08-05
Jeon, Sang Bong	052B
Jiao, Yangkun	OS05-01
Jin, Jingna	116B
Joseph, Wout	048B, 051A 053A & FA07, 077A, OS01-03, OS03-03, OS04-02, OS04-03, OS04-06, OS07-03, OS07-06, OS08-01, OS08-04, OS10-04, OS11-05, OS11-06, WS1, WS2
Joshi, Paramananda	OS04-01

Author name	Program Codes*
Kainz, Johannes	057A, 133A, 134B, 135A, 136B, 137A, 140B, OS10-01
Kalantaryan, Vitali	003A
Kalb, Luis	133A, 134B, 135A, 136B, 137A, 140B, OS10-01
Kalinosky, Benjamin	066B, 067A
Kamegai, Kazuhisa	OS06-03
Kamegai, Kazuhisa	147A
Kamijyo, Toshio	029A
Kang, Namwoo	069A & FA09
Kangasmaa, Otto	OS09-04
Kapoukranidou, Dorothea	OS07-04
Karabetsos, Efthymios	055A, 097A, 101A & FA15
Karina, Cindy	124B & FB15
Karipidis, Ken	146B, OS02-03
Karpowicz, Jolanta	098B, 112B, 125A
Kasukonis, Benjamin	001A, 020B
Kawabe, Fumiaki	131A
Kawagishi, Yuichi	132B
Kawai, Erina	086B
Kawakami, Hiroshi	096B
Kelso, Abaigeal	046B, 061A
Khazaryan, Ruzanna	003A
Kiester, Allen	007A, 011A
Kik, Alfred	029A
Kim, Haerim	121A
Kim, Hye Sun	052B
Kim, Jong-Chan	150B
Kim, Jongchan	094B
Kim, Kihwea	069A & FA09, 076B
Kim, Nam	075A & FA10
Kim, Nam	052B, 081A & FA12, 082B & FB09
Kim, Seongsin	069A & FA09
Kim, Vitalii	OS14-01
Kim, Youngim	052B
Kimura, Shoya	OS09-02
Kinouchi, Yohsuke	025A & FA03
Knipe, Phillip	074B
Kobayashi, Shunsuke	040B
Kodera, Sachiko	OS09-02
Kohn, Florian P. M.	084B
Kolivoška, Viliam	OS14-05
Kolosnjaj-Tabi, Jelena	WS3
Korkmaz, Erdal	108B
Kos, Bor	OS12-04
Kotnik, Tadej	128B
Kottwitz, Denise	084B
Kourtiche, Djilali	OS02-01
Krabbe, Julia	OS02-02
Kraus, Thomas	090B
Krausz, József	109A
Krawczyk, Andrzej	079A
Kubinyi, Györgyi	030B, 032B
Kubocz, Michael	133A, 134B, 135A, 136B, 137A, 140B, OS10-01
Kuehn, Sven	055A, 113A & FA19
Kuhne, Jens	016B, 084B
Kurka, Petr	OS07-02
Kushiyama, Yujiro	144B

Author name	Program Codes*
Kuster, Niels	091A & FA18, 092B, 102B, 113A & FA19, 124B & FB15, OS03-02, OS11-06, OS13-03
Laakso, Ilkka	OS09-03, OS09-04, OS09-06
Lafuente, Francisco Javier	058B
Lagarde, Stanislas	OS13-04
Lagroye, Isabelle	034B & FB04
Lameth, Julie	OS05-04
Lan, Yue	OS01-02, OS05-02
Land, Derek	108B
Lao, Zhenghong	002B
Laromaine, Anna	062B
Las-Heras, Fernando Luis	058B
Lattanzi, Riccardo	106B & FB11
Le Berre, Théo	OS12-03
Le Bihan, Yann	OS09-01
Le, Nam	OS03-01
Lecomte, Anthony	041A & FA06, 042B & FB06
Ledent, Maryse	036B & FB05, 065A, 148B
Lee, Ae-Kyoung	052B, 121A
Lee, Jaemin	075A & FA10, 081A & FA12, 082B & FB09
Lee, Myoungdong	071A
Lee, Seonghi	069A & FA09
Lefebvre, Ryan	046B, 061A
Legros, Alexandre	059A & FA08, OS09-05, OS09-06
Leocani, Letizia	T1
Lepore, Fabio	OS12-01
Leveque, Philippe	034B & FB04, WS1, WS3
Leymann, Heinrich A.M.	016B, 084B
Li, Congsheng	039A
Li, De-Kun	038B
Li, Jiangtao	005A & FA16, 006B & FB01
Li, Kun	WS3
Li, Mengqing	056B
Li, Ying	116B
Li, Yuanyuan	005A & FA16
Lian, Jiamei	OS05-06
Liberti, Micaela	035A, 123A, OS01-05, OS01-06, OS03-04, OS13-01, OS14-06, T1, WS3
Lim, Hyeong-Yeol	138B, 150B
Link, Sarah	078B & FB08, WS2
Lista, Florigio	017A
Liu, Jiang	055A, 089A, 129A
Liu, Sen	070B, OS11-02
Liu, Xu	119A, 151A & FA11, 152B & FB17
Liu, Zhipeng	116B, 119A, 151A & FA11, 152B & FB17
Lodato, Francesca	130B & FB16
Loizeau, Nicolas	060B & FB07, OS08-01, OS10-03
Lombard, Laurent	OS04-04
Lombergar, Peter	OS12-04
Longtao, Zhu	013A & FA01, 014B & FB14
Lopez Espi, Pablo Luis	105A
Loughran, Sarah	146B, OS02-03, OS06-04, OS11-03
Lubart, Elsa	045A
Luigies, Rene	WS2
Luzon, Veronique	049A

Author name	Program Codes*
Lévêque, Philippe	OS02-04, OS05-04
López De Mingo, Isabel	072B
Maccani, Giovanni	WS2
Maestú, Ceferino	072B
Magallón, Rosa	058B
Magne, Isabelle	OS09-05, OS09-06
Mahnič-Kalamiza, Samo	OS12-04
Mallat, Michel	OS05-04
Manassas, Athanasios	055A, 100B & FB10, 101A & FA15
Mange, Isabelle	OS02-01
Marasà, Anna	OS14-06
Marchalot, Julien	OS12-03
Mariani Primiani, Valter	064B
Marinaccio, Jessica	017A
Marracino, Paolo	OS03-04, OS13-01
Marrella, Alessandra	122B, OS12-02
Martens, Astrid	OS02-06
Martens, Luc	OS07-03, OS07-06, OS11-06
Martin, Alexandra	OS05-04
Martinez Rojas, Juan Antonio	105A
Martino, Carlos	OS03-01
Martirosyan, Radik	003A
Massa, Rita	062B, 130B & FB16
Massaro, Luca	017A
Masuda, Hiroshi	WS3
Masuelli, Laura	017A
Mate, Rohan	146B, OS02-03

Author name	Program Codes*
Matera, Francesco	130B & FB16
Matsuoka, Atsushi	025A & FA03
Mattei, Nicolas	WS3
Mattison, Lars	OS12-04
Mattsson, Mats Olof	WS2
Maule, Milena M	OS08-04, WS1
Mazet, Paul	053A & FA07, OS02-04
Mazloum, Taghrid	OS04-04
Mcgarr, Gregory	022B, 046B, 061A
Mcintosh, Robert	073A, OS05-06
Mckenzie, Raymond	OS05-05, OS05-06
Mcmahon, Courtney	001A
Mcnamee, James	022B
Mcquillen, Ryan	OS03-01
Mennona, Nicholas	004B
Merla, Caterina	018B, 026B, 028B, 149A
Mertens, Birgit	036B & FB05
Mevissen, Meike	OS03-02
Meyer, Felix	021A, 084B
Meyer, Romain	091A & FA18
Michelant, Lisa	OS02-04
Mifdal, Soukaina	OS01-01
Migliore, Marco Donald	062B
Miklavčič, Damijan	OS12-04
Mikuž, Blaž	OS12-04
Minami, Norihiro	131A, 132B
Mir, Lluis M.	026B, 028B, OS01-06, WS3

Author name	Program Codes*
Miranda, Vincenzo	106B & FB11
Miyagi, Hiroaki	079A, 103A
Mizuno, Maya	088B, OS14-02
Modenese, Alberto	063A
Modolo, Julien	117A, OS13-04
Moerman, Arno	OS07-03
Moissonnier, Monika	045A
Monleon Pradas, Manuel	OS13-01
Monma, Shuichi	054B
Moon, Jung-Ick	121A
Moon, Sungwon	076B
Moreno-Manzano, Victoria	OS01-05, OS01-06, OS13-01
Moulin, Maëlys	059A & FA08
Muscat, Adeline	026B
Nabos, Patricia	034B & FB04
Nadi, Mustapha	OS02-01
Nagai, Akiko	WS3
Nagaoka, Tomoaki	085A, 086B, 088B, 095A, 096B, 111A, 144B, OS14-02
Nakajima, Shinichiro	120B & FB13
Nakatani-Enomoto, Setsu	040B
Nardozi, Daniela	017A
Naumova, Nataliia	028B
Necz, Péter Pál	048B
Neufeld, Esra	091A & FA18
Nikolayev, Denys	117A
Nishidate, Tsugumi	083A & FA13
Nishimura, Izumi	054B
Nissi, . Janita	OS09-03, OS09-06
Noda, Yoshihiro	120B & FB13
Noojin, Gary	010B
Nájera, Alberto	058B, 110B
O'connor, Sean	OS07-01
Odouli, Roxana	038B
Ofli, Erdem	OS11-06
Ohkubo, Chiyoji	079A, 131A, 132B
Okano, Hideyuki	047A
Onishi, Teruo	070B, 093A, 147A, OS06-03, OS11-02
Orlacchio, Rosa	034B & FB04, WS3
Ostiguy, Geneviève	OS09-05, OS09-06
Otaka, Yohei	OS09-02
Oughton, Deborah	WS1
Ourak, Lamine	129A
Pack, Jeong-Ki	052B
Paffi, Alessandra	OS01-05, OS01-06, OS14-06
Paidar, Martin	OS14-05
Pakhomov, Andrei	011A, OS14-01, OS14-04
Pakhomova, Olga	OS14-04
Pan, Yun	OS01-02
Pannetrat, Stephane	OS01-01
Papanikolaou, Nikos	097A, 101A & FA15
Parazzini, Marta	077A, 122B, 139A, OS12-02, WS3
Park, Dongryul	069A & FA09, 121A
Park, Jaeho	150B
Payne, Jason	066B, 067A
Percherancier, Yann	034B & FB04, WS1
Petroulakis, Nikolaos	108B, WS1

Author name	Program Codes*
Peyman, Azadeh	068B, 124B & FB15
Pich-Bavastro, Christine	OS07-04
Pichon, Lionel	OS09-01
Pintér, Bertalan	030B, 032B
Pisano, Carmen	018B, OS03-04, OS14-06
Plante, Michel	OS09-05, OS09-06
Plets, David	OS10-04
Plovie, Tom	OS03-03
Poirier, Roseline	OS05-04
Polanska, Kinga	051A, OS08-04, WS1
Politański, Piotr	051A
Pophof, Blanka	021A, 084B
Poplová, Michaela	OS14-05
Portengen, Lützen	OS02-06
Poulletier De Gannes, Florence	034B & FB04
Puche, Samuel	110B
Ramahefa-Andry, Prince	OS04-04
Ramdani, Sofiane	059A & FA08
Rao, Xiao	118B & FB12
Raupach, Christian	079A
Ravazzani, Paolo	122B, OS12-02
Regalbuto, Elisa	017A
Remondini, Daniel	035A
Ribet, Celine	049A
Riccio, Daniele	106B & FB11
Richard Coesoij, Richard	108B
Richard, Laurence	OS01-01
Rincon, Mikayla	007A
Rival, Guilhem	OS12-03

Author name	Program Codes*
Rivera González, Marco Xavier	072B
Riviere, Charlotte	OS12-03
Rizzo, Rossella	OS11-01
Robidel, Franck	041A & FA06, 042B & FB06
Rodriguez, Roberto	066B, 067A
Rodriguez, Stéphanie	041A & FA06, 042B & FB06
Rogier, Hendrik	OS07-03
Rols, Marie-Pierre	WS3
Romeo, Stefania	027A, OS14-03
Roosli, Martin	051A, WS2
Roth, Patrice	OS02-01
Rothe, Martin	084B
Royer, Juliette	OS05-04
Rubio, Pau	WS1
Ruello, Giuseppe	106B & FB11, 130B & FB16
Ruffenach, Sandra	015A & FA02
Russo, Paola	064B
Ryu, Seunghun	069A & FA09
Röösli, Martin	048B, 053A & FA07, 060B & FB07, OS02-05, OS04-02, OS04-06, OS08-01, OS08-02, OS08-03, OS08-04, OS10-03, WS1
Sabathy, Mischa	OS13-03
Sacco, Giulia	OS11-01
Sachno, Dmitrij	057A
Saito, Atsushi	019A
Saito, Kazuyuki	012B & FB02, 083A & FA13, 086B
Salas, Nora	WS1
Salati, Simona	123A, OS12-01, T1
Salerno, Michael	OS03-01

Author name	Program Codes*
Salvo, Pierpaolo	130B & FB16
Samaras, Theodoros	055A, 089A, 100B & FB10, 101A & FA15, 129A, OS01-04, OS07-04, WS1
Sanchez Montero, Rocio	105A
Sanchez Petidier, Marina	028B
Sandoval-Diez, Nekane	OS08-01, OS08-02, OS08-03, WS2
Sannino, Anna	027A, OS14-03
Sauter, Cornelia	021A
Scarfì, Maria Rosaria	027A, OS14-03
Scavarda, Didier	OS13-04
Scheelhaase, Philine Johanna	OS02-02
Schettino, Fulvio	027A, 062B, 065A, OS14-03
Schiffarth, Anna-Malin	099A & FA14, OS11-04
Schilling, Lisa-Marie	099A & FA14, OS11-04
Schindler, Johannes	060B & FB07, OS10-03
Schmid, Gernot	057A, 107A, 133A, 134B, 135A, 136B, 137A, 140B, OS02-02, OS10-01
Schmid, Timon	WS2
Schmidt, Janine-Alison	084B
Schmitt, Pierre	OS02-01
Schneeweiss, Pia	057A, 133A, 134B, 135A, 136B, 137A, 140B, OS02-02, OS10-01
Schoeters, Ruben	OS03-03
Schwartz, Joel	WS1
Schüz, Joachim	045A, 049A

Author name	Program Codes*
Sedelnikova, Anna	004B, OS07-01
Sefsouf, Lydia	OS08-05
Segers, Seppe	036B & FB05
Sekiba, Yoichi	019A, 141A
Sekino, Masaki	120B & FB13
Selmaoui, Brahim	OS02-04, WS1
Semenov, Iurii	011A, OS14-01
Setti, Stefania	T1
Sgura, Antonella	017A
Shen, Kaixiang	005A & FA16
Shi, Li	005A & FA16
Shiina, Takeo	019A, 141A
Shikhantsov, Sergei	OS07-03, OS11-05, OS11-06
Shimizu, Yuto	095A, 096B
Shin, Mina	138B
Shulman, Shaul	126B
Sibenaler, David	146B
Sigg, Daniel	OS12-04
Silvestro, Dino	133A, 134B, 135A, 136B, 137A, 140B, OS10-01
Simko, Myrtill	WS2
Slottje, Pauline	OS02-06
Smiley, Sandy	022B
Soejima, Yutaro	120B & FB13
Song, Tao	OS05-01
Souques, Martine	OS09-05, OS09-06
Soyka, Florian	127A, OS06-01
Spirito, Marco	065A, 108B
Steck, Lena	OS02-05
Steelman, Zachary	OS07-01
Stefanov Zhekov, Stanislav	OS04-01
Stephan, Christa	060B & FB07, OS10-03
Stiffe, Jenni	146B

Author name	Program Codes*
Stroobandt, Bram	048B, OS04-02, OS04-06, OS08-01
Stunder, Dominik	127A
Su, Zhouxing	OS07-04
Suarato, Giulia	122B, OS12-02
Sufian, Md Abu	075A & FA10
Sun, Chuan	002B
Suzuki, Yasunori	087A, OS04-05
Suzuki, Yukihisa	029A
Sylvester, Emma	OS05-06
Szilágyi, Zsófia	030B, 032B
Ta, Thanh Tam Julian	099A & FA14, OS11-04
Tada, Eiichirou	025A & FA03
Taguchi, Kenji	WS3
Takada, Yuji	079A, 131A
Takahashi, Masaharu	086B
Takahashi, Masayuki	054B
Takano, Mayuko	120B & FB13
Taki, Masao	070B, 093A, 147A, OS06-03, OS11-02
Tanghe, Emmeric	OS03-03, OS10-04, OS11-05, OS11-06
Tarao, Hiroo	025A & FA03
Tarnaud, Thomas	OS03-03
Tatematsu, Yoshinori	088B
Teppe, Frederic	015A & FA02
Thielens, Arno	053A & FA07, OS08-02, WS2
Thomas, Selina	OS03-02
Thuróczy, György	030B, 032B, 048B, 109A
Tieben, Rob	WS2
Tincknell, Laura	OS02-05, OS08-03
Tobita, Kazuhiro	070B, OS11-02

Author name	Program Codes*
Tochikura, Yoshitoshi	087A, OS04-05
Toda, Toshihiko	054B
Tognola, Gabriella	077A, 139A, OS01-03, OS08-04, WS3
Tolstykh, Gleb	001A, 020B
Tominaga, Toshihiko	025A & FA03
Tommasini, Anna	OS12-02
Torfs, Guy	OS07-03
Torrès, Jeremie	015A & FA02
Traini, Eugenio	OS02-06
Tritley, Sean	001A
Tsumura, Funa	085A
Tugnoli, Valeria	T1
Turner, Michelle	OS02-03
Turuban, Maxime	OS02-03
Törnevik, Christer	OS04-01
Uehara, Shintaro	OS09-02
Ugawa, Yoshikazu	040B
Ushiyama, Akira	029A, 103A
Ushizawa, Kazuki	OS09-02
Vahalová, Petra	OS14-05
Vajdic, Claire	OS02-03
Valbonesi, Simona	130B & FB16, 142B
Valeriani, Diana	OS14-06
Valič, Blaž	055A, 128B, OS08-06
Vallet, Leslie	018B, 026B, 028B
Valzania, Franco	T1
Van Bladel, Han	048B, 053A & FA07, OS04-02, OS04-03, OS04-06, OS08-01
Van Campenhout, Karen	OS10-04
Van De Steene, Tom	OS10-04

Author name	Program Codes*
Van Den Akker, Daniel	OS01-03
Van Den Bossche, Matthias	053A & FA07
Van Der Straeten, Jeroen	OS04-03
Van Torre, Patrick	053A & FA07
Vanderstraeten, Jacques	148B
Vatovez, Benjamin	065A, 148B
Vazquez-Colon, Clarissa	067A
Vecsei, Zsuzsanna	048B
Velghe, Maarten	108B
Veludo, Adriana Fernandes	048B
Verlaek, Mart	OS10-04
Verloock, Leen	OS01-03, OS04-02, OS07-06, OS10-04
Vermeeren, Günter	OS01-03, OS04-03, OS07-06, OS11-05, OS11-06
Vermeulen, Roel	053A & FA07, OS02-06
Verrender, Adam	OS06-04
Vilagosh, Zoltan	073A
Villeneuve, Nathalie	OS13-04
Villégier, Anne-Sophie	041A & FA06, 042B & FB06
Vogt, Matthias	133A, 134B, 135A, 136B, 137A, 140B, OS10-01
Vrijkotte, Tanja	OS08-04, WS1
Waatanabe, Soichi	OS06-03
Wada, Keiji	029A
Wada, Masataka	120B & FB13
Waibl, Valentin Jaki	OS02-05, OS08-03
Waki, Shuhei	085A
Wallace, Nikkeah K.	OS06-04
Wang, Haoyue	005A & FA16, 006B & FB01
Wang, He	116B
Wang, Jing	092B, OS13-02
Wang, Lifeng	023A, 050B
Wang, Minmin	OS01-02
Wang, Pingping	OS05-01
Wang, Qingmeng	OS05-01
Wang, Shanshan	055A, 089A, 129A
Wang, Xiaomei	056B, OS05-03
Wang, Xin	116B
Wang, Xue	OS05-01
Wang, Xuting	OS05-01
Wang, Yifeng	006B & FB01
Watanabe, Soichi	070B, 093A, 147A, OS11-02
Watanuki, Keiichi	047A
Wei, Yunpeng	056B, OS05-03
Weiser, Evelyn	084B
Wendling, Fabrice	117A, OS13-04
Whitmore, Jeffrey	007A, 020B
Wiart, Joe	043A, 045A, 053A & FA07, 055A, 089A, 129A, OS01-03, OS08-04, WS3
Wilsdorf-Koehler, Heide	084B
Wipf, Irina	OS02-05, OS08-03
Wood, Andrew	073A
Wood, Mike	074B
Wu, Tongning	039A
Wu, Zhibing	002B
Wydaeghe, Robin	OS11-05, OS11-06

Author name	Program Codes*
Xiaoxia, Wei	013A & FA01, 014B & FB14
Xu, Bo	OS04-01
Xu, Zhentian	115A
Yamaguchi-Sekino, Sachiko	147A, OS06-03
Yamazaki, Keiko	WS1
Yamazaki, Kenichi	141A
Yamazaki, Shota	088B, OS14-02
Yang, Hua	056B, OS05-03
Yang, Pengfei	092B, OS13-02
Yang, Yizhen	OS01-03
Yao, Aiping	092B, OS13-02
Yasuno, Emiko	025A & FA03
Yavari, Ali	073A, 080B
Yin, Tao	116B, 119A, 152B & FB17
Yochum, Maxime	117A, OS13-04
Yoshie, Sachiko	029A
Yuan, Weiming	050B
Yuasa, Akiko	OS09-02
Yuasa, Kaoru	040B
Yumoto, Hiromichi	025A & FA03
Zahner, Marco	060B & FB07, OS08-02, OS10-03, WS2
Zakar, Tomáš	OS14-05
Zang, Martin	084B
Zeni, Olga	027A, OS14-03
Zhadobov, Maxim	OS07-05, OS11-01, WS3
Zhang, Shaomin	OS01-02
Zhang, Shunqi	114B
Zhang, Wentao	OS05-03
Zhang, Yarui	055A, 089A, 129A
Zhao, Zheng	005A & FA16
Zheng, Ce	089A
Zheng, Jiawen	143A
Zheng, Shusen	115A
Zhi, Weijia	023A
Zhou, Lin	115A
Zhou, Mengxi	OS02-01
Zhou, Xiaoqing	119A, 152B & FB17
Zhu, Kai	119A, 152B & FB17
Ziane, Massinissa	OS07-05, WS3
Ziegelberger, Gunde	021A, 084B
Ziegler, Toni	060B & FB07
Zini, Andrea	T1
Zins, Marie	049A
Zironi, Isabella	035A
Zou, Yong	050B
Zradziński, Patryk	098B
Überbacher, Richard	107A
Červinková, Kateřina	OS14-05
Śmiałek, Mirosław	079A