



June 23-28 Montpellier, FRANCE

The Joint Annual Meeting of
The Bioelectromagnetics Society and the
European BioElectromagnetics Association
Technical Program and General Information



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United Kingdom

From the Co-chairs of the Local Organizing Committee

The **BioEM2019 Local Organizing Committee** welcomes you to **Montpellier, France** for the Joint Annual Meeting of The Bioelectromagnetics Society (BEMS) and the European BioElectromagnetics Association (EBEA).

As the premier international conference in the area of bioelectromagnetics, BioEM2019 is expected to stimulate further research in this field through the exchange of ideas and invigorating discussions, consolidating the state-of-the-art knowledge, and identifying existing gaps.

The BioEM2019 conference is held in the **Corum of Montpellier** which is located in the heart of the city. **Le Corum Conference Center**: A prestigious complex at the heart of the city (10 min walk from the train station. Corum tram stop on 3 lines) in the heart of France's largest pedestrianized area. With its innovative design, this prestigious multi-faceted venue is one of the great facilities that have earned Montpellier its place among the Mediterranean's top business tourism destinations. As well as one of France's top Conference Centers, it also houses the Berlioz Opera House, known for its excellent acoustics and its National Orchestra. The Corum brings two worlds together within one venue - business events for between 50 and 2,000 people and music, both classical and contemporary.

With 440,000 residents, the city of Montpellier distinguishes itself from other European metropolises, with outsider advantages. It is a major place for culture, featuring two opera houses, one of the leading arenas in France, an international dance complex, and one of the country's richest regional fine- arts museums.

With the Mediterranean only 11 km away, the seaside is an integral part of the metropolitan area. The bicycle path sets off from Montpellier along the river Lez and takes you to the coast, beaches such as La Grande Motte, Carnon and Palavas-les-Flots, perfect for the family, the beautiful beaches of Villeneuve-lès-Maguelone, les Aresquiers (Frontignan) or l'Espiguette (Grau du Roi). During April and October, some ephemere private beaches are built all the coastine long, ideal for afterworks and original gala diners. Many water activities such as catamaran, regattas, jetski, canoe, paddle, kitesurf etc.

On the hillsides of the region, grape wine is cultivated since the Antiquity. AOC et countryside wines represent the main part of the production, a wide diversity of vineyards with, for each one, different soils, climates and grape varieties of which the diverse blends make out unique wines with a constantly growing quality. You will love the variety. Wine has been produced all around Montpellier since Antiquity and Languedoc Roussillon is home to a wide variety of wine-growing soils. Most of the local production is composed of AOC and Vins de Pays. There are around a dozen outstanding appellations amongst the Coteaux du Languedoc: Faugères, Saint- Chinian, Pic Saint-Loup, and also the Mireval, Frontignan and Lunel muscats. Don't miss the Grés de Montpellier, grown in Montpellier itself. All part of the local heritage that you will enjoy tasting in the city's best restaurants and bars, in the wine shops or directly at the wineries, as well as in the popular wine bars of Montpellier.

And if you feel like travelling a bit further after the congress, you only need to drive a couple of hours to get to the Pyrenees and 3 to 5 hours for the French riviera or the Alps.

We believe that this will be a fruitful scientific meeting in stimulant and exciting environment in a Mediterranean atmosphere.

We are delighted to welcome you all at BioEM2019 in Montpellier, France!

Alexandre Legros, LHRI and EuroStim at EuroMov, Univ. of Montpellier, LOC Chair

Isabelle Lagroye, EPHE, IMS, Bordeaux, LOC Co-chair

Julien Modolo, LTSI, INSERM, Rennes LOC Co-chair

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Co-chair
Italy



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Canada



Maxim Zhadobov
France

From the Co-chairs of the Technical Program Committee

Dear Colleague,

On behalf of the Technical Program Committee (TPC), it is our great pleasure to welcome you to the BioEM2019, the annual joint meeting of two societies: the Bioelectromagnetics Society (BEMS) and the European BioElectromagnetics Association (EBEA). BioEM is the largest annual international conference in the field of Bioelectromagnetics bringing together leading scientists from different disciplines to discuss latest achievements and future challenges of the field.

Thanks to contributions from members of both societies, the TPC received record number of proposals for plenaries, tutorials, and workshops, on a wide variety of subjects. This allowed us to put together an exciting and stimulating program covering a wide range of subjects: plenaries on 5G exposure assessment, topicality of IARC evidence for carcinogenicity from RF-EMF, interaction mechanisms, millimeter waves applications, noninvasive stimulation of the nervous system, and one tutorial on body temperature regulation. We are grateful to all invited speakers for accepting our invitation and to workshop organizers for their contribution to the program.

We are also thankful to all of you who have overwhelmed the TPC with the number and quality of the abstracts submitted for BioEM2019. This year, we received 272 papers from 28 countries across the world, 53 of them from students. BioEM conference has a comprehensive and robust reviewing system that involved a board of 103 reviewers, providing at least 5 independent reviews per abstract. The allocation of poster/platform presentation is a complex process depending on availability of sessions, priority of subjects of interest and reviewers scores. Both platform and poster sessions are very well attended, and the authors always get ample opportunities to present their results and have lively and inspiring discussions during the poster sessions, don't miss them!

With a wide range of accepted abstracts, the TPC managed to allocate 14 oral sessions balanced between health protection and biomedical applications, spanning from basic research to standards, from proteins to humans. To give the participants a choice to attend the talks of their interest, sessions are set to cover biological/medical topics in parallel with engineering/physical ones at a given time.

BioEM2019 will also honor colleagues for their contribution to the field. We will have the Chiabrera Lecture for Excellence in Bioelectromagnetics, award from EBEA to outstanding early stage researcher, the Arthur Pilla young scientist award, and the d'Arsonval Lecture, award from BEMS to senior scientist as recognition of outstanding career. The authors of the most influential BEM journal paper for 2019 will be recognised and we will close the BioEM2019 with the traditional awards for the best student presentations (poster and platform).

We hope that BioEM2019 will provide a multidisciplinary and interdisciplinary forum to exchange ideas, and share knowledge. This conference is a unique opportunity to bridge the gaps and establish networks in the field of Bioelectromagnetics.

Our special thanks are due to members of TPC, for their dedication and hard work, the Local Organizing Committee for their efforts in accommodating the program and organizing special moments together, the sponsors for their help and support in realizing all this at the best, and last but not least, the Lawson Institute for their hard work in providing IT services.

We hope you have an enjoyable experience in Montpellier!

Micaela Liberti and Azadeh Peyman (BioEM2019 TPC Co-chairs)

Technical Program Review Committee



Francesca Apollonio
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Quirino Balzano
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Elena della Valle
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Schedule at a Glance

Sunday, June 23, 2019

Time	Session	Name	Location
09:00 - 12:30	M1	BEMS Board Meeting	Joffre 4
09:00 - 12:30	M2	EBEA Council Meeting	Joffre 5
14:00 - 17:00	PW	Pre Conference Workshop - Theory and hands-on practical for transcranial Direct Current Stimulation (tDCS) and transcranial Alternating Current Stimulation (tACS)	Barthez
18:30 - 21:30		Welcome Reception	Joffre 1

Monday, June 24, 2019

Time	Session	Name	Location
09:00 - 09:30		Welcome	Einstein
09:30 - 10:30	P1	Plenary 1 - Non invasive electrical brain stimulation	Einstein
10:30 - 11:00		Coffee Break	Joffre 2-3
11:00 - 12:30	S01	Electric and magnetic stimulation of the nervous system	Einstein
11:00 - 12:30	S02	Cellular effects of radiofrequency fields and millimeter waves	Barthez
12:30 - 14:00		Lunch	Joffre 1
14:00 - 15:00	FA	Student Flash Poster Session A	Einstein
15:00 - 16:30	PA	Poster Session A	Joffre 2-3
16:30 - 17:00		Coffee Break	Joffre 2-3
17:00 - 18:30	S03	Numerical dosimetry of RF fields	Einstein
17:00 - 18:30	S04	Effects of electromagnetic fields (in-vivo)	Barthez
19:30 - 22:00		Student Ice Breaker	Le Clandestin piano-bar

Tuesday, June 25, 2019

Time	Session	Name	Location
08:30 - 09:30	P2	Plenary 2 - Has evidence for carcinogenicity of RF-EMF changed since IARC's assessment?	Einstein
09:30 - 10:00		Coffee Break	Joffre 2-3
10:00 - 11:00	CA	Chiabrera Award	Einstein
11:00 - 12:30	S05	Epidemiological Studies	Barthez
11:00 - 12:30	S06	Human Studies	Einstein
12:30 - 14:00		Lunch	Joffre 1
13:00 - 14:00	M3	EBEA Assembly	Barthez
14:00 - 15:00	FB	Student Flash Poster Session B	Einstein
15:00 - 16:30	PB	Poster Session B	Joffre 2-3
16:30 - 17:00		Coffee Break	Joffre 2-3
17:00 - 18:30	W1	Workshop 1 - Atmospheric electromagnetic field bioeffects	Barthez
17:00 - 18:30	W2	Workshop 2 - Differences of exposure limits between the new ICNIRP Guidelines and IEEE C95.1 Standard	Einstein
19:00 - 23:00		Conference Dinner	Domaine des Moures

Wednesday, June 26, 2019

Time	Session	Name	Location
09:00 - 10:30	P3	Plenary 3 - 5G real-life exposure: how to assess and optimize?	Einstein
10:30 - 11:00		Coffee Break	Joffre 2-3
11:00 - 12:00	T1	Tutorial 1 - Body temperature regulation in Mammals	Einstein
12:00 - 13:00	S07	Risk, Safety Standards & Policy	Einstein

12:00 - 13:00	S08	Effects of ELF magnetic fields (in-vitro)	Barthez
13:00		Lunch (not provided)	

Thursday, June 27, 2019

Time	Session	Name	Location
09:00 - 10:00	DA	d'Arsonval Award	Einstein
10:00 - 11:30	S09	Exposure assessment techniques I	Barthez
10:00 - 11:30	S10	Interaction Mechanisms (theoretical and experimental)	Einstein
11:30 - 12:00		Coffee Break	Joffre 2-3
12:00 - 13:00	P4	Plenary 4 - Can membrane proteins act as biological probes for EM fields?	Einstein
13:00 - 14:30		Lunch	Joffre 1
13:30 - 14:30	M4	BEMS Assembly	Barthez
14:30 - 16:00	S11	Dosimetry of ELF/LF fields	Einstein
14:30 - 16:00	S12	Electroporation Studies and Effects of Pulsed Electric Fields	Barthez
16:00 - 16:30		Coffee Break	Joffre 2-3
16:30 - 18:00	W3	Workshop 3 - Dosimetric aspects in exposure assessment to wireless power transfer systems	Einstein
16:30 - 18:30	W4	Workshop 4 - Toward an innovative use of ultrashort electric pulses in medicine: From biological effects to therapeutic applications	Barthez

Friday, June 28, 2019

Time	Session	Name	Location
09:00 - 10:30	S13	Exposure assessment techniques II	Barthez
09:00 - 10:30	S14	Emerging and Future Biomedical Applications	Einstein

10:30 - 11:00		Coffee Break	Joffre 2-3
11:00 - 12:00	P5	Plenary 5 - Millimeter- and submillimeter-wave applications in biology and medicine: Potential and challenges	Einstein
12:00 - 13:00	SA	Awards Session	Einstein
13:00 - 13:30		Closing Ceremony	Einstein
15:00 - 18:00	M5	BEMS Board Meeting	Joffre 4
15:00 - 18:00	M6	EBEA Council Meeting	Joffre 5

General Information

THE CONFERENCE VENUE

BioEM2019 will be held in the **Corum Conference Center**, a prestigious complex at the heart of **Montpellier** (10 minute walk from the train station) in the heart of France's largest pedestrianized area. With its innovative design, this prestigious multi-faceted venue is one of the great facilities that have earned Montpellier its place among the Mediterranean's top business tourism destinations.

Montpellier is the 7th largest city of France, and the fastest growing city over the last 25 years. Rich in character, and located at the crossroads of Europe, its creativity, effervescence and dynamism have contributed to the international visibility of Montpellier. Montpellier is also a city of medicine, and is also at the cutting edge of research activities and the digital economy. It offers all the facilities required for high profile national and international events and all types of business meetings, always with a promise of excellence.

Montpellier benefits from a Mediterranean climate with hot, dry summers, and the temperature in June (at the time of the conference) is typically between 16 and 26 degrees Celsius.

REGISTRATION AND INFORMATION DESK

When you enter the conference venue through the main entrance of the Corum on level 1, signs will guide you to the Registration and Information desk located at the entrance of the room Joffre 1.

On Sunday, June 23, the Registration Desk will be open from 13:30.

From Monday, June 24 until Friday, June 28, the Registration Desk will be open from 8:00 until the end of the last meeting session of each day.

CONFERENCE BADGE

Badges must be worn at all times during the meeting and during all social events (registered guests as well). The badges will be delivered at the Registration desk and will include the WIFI information.

CONFERENCE LUNCH AND COFFEE BREAKS

A buffet lunch will be provided in Joffre 1 on Monday June 24, on Tuesday June 25, and on Thursday June 27 but NOT on Wednesday June 26.

Coffee breaks will take place in the morning and in the afternoons in Joffre 2-3 near the posters.

SOCIAL EVENTS

1. GENERAL INFORMATION

The Corum of Montpellier is located downtown Montpellier and you are less than 5-min walk from the Place de la Comédie, which is the main place of the city, in the center of one of the biggest urban walking areas in France. From there you can access the infinity of old charming little streets and places and enjoy shopping, bars and restaurants. There is also a lot inside or outside visits you can make, and you'll be provided in your conference bag with a map of the city and a book detailing many activities and visits you could select from.

2. WELCOME RECEPTION, Sunday June 23

Sunday, June 23, 18:30 at the conference venue (Corum room Joffre 1). Expected end time: approximately 21:30.

3. STUDENT ICE BREAKER, Monday June 24

The Student Ice Breaker will be held on Monday June 24 at the piano-bar Le Clandestin (18 Rue de la Valfere, 34000 Montpellier). This will be a great occasion to get to know each other sharing tapas and a few drinks while performing at the blind test lead by the pianist! Let's get to the bar starting at 19:30 for a blind test (in teams) starting at 20:00.

4. CONFERENCE DINNER, Tuesday June 25.

Please join us Tuesday June 25, 18:30 for the Conference dinner. We will leave from the Corum by bus for the Domaine de Moures (Chemin des Moures - 34750 VILLENEUVE LÈS MAGUELONE), a site with 1.5 km of salted lake shore surrounded by wheat fields as far as you can see and its own 18th century chapel.

Please make sure to be ready at the Corum starting at 18:30 for the first bus, the last bus is scheduled to leave at 18:50. 20 to 30 minutes later you'll arrive at the Domaine des Moures and begin with a cocktail before having the Gala dinner served in this magic environment. Of course you will need your dancing shoes on to properly end the night!

5. TOURISTIC SUGGESTIONS for the free afternoon on Wednesday June 25

The LOC recommends some touristic activities in Montpellier and its surroundings. Although just walking through the city with your touristic map and discovering the Arc de Triumph, the Peyrou garden or the Botanic garden, seeing cathedrals St Roch and St Anne, stopping for a drink Place Jean Jaures or Place de la Canourgue may already fill your free time, below is a list of suggestions you may be interested in.

- You could for example be interested in a guided tour of the historical center of Montpellier (<https://book.montpellier-france.com/en/event/a1133667/visit-montpellier-guided-city-tour-in-english-historical-c/showdetails>)
- Or a bus city tour: <https://www.montpellier-tourisme.fr/offre/fiche/montpellier-city-tour/LOILAR034V50FM3B>
- Or a little train city tour: <https://www.montpellier-france.com/offre/fiche/le-petit-train-de-montpellier/LOILAR034FS0014L>
- Why not book a guided tour of the medicine university, that is the oldest one worldwide still in activity (13th century), and in particular of the famous « Conservatoire d'anatomie » (Anatomy Museum, <https://www.umontpellier.fr/patrimoine/musees/musee-danatomie>)
- You could also visit the famous Fabre art museum (<http://museefabre-en.montpellier3m.fr>)
- Or the Pavillon Populaire if you like photography (<https://www.montpellier.fr/506-les-expos-du-pavillon-populaire-a-montpellier.htm>)
- Or maybe some wine tasting would suit you better: <https://www.montpellier-france.com/offre/fiche/montpellier-wine-tours/ORGLAR034V50FLC8>

If you are more adventurous and you want to explore a bit further the surrounding:

- On the sea side is Villeneuve-Les-Maguelone (<https://www.montpellier-france.com/Prepare-Book/Discoveries/Montpellier-metropole/Villeneuve-les-Maguelone>) and its Cathedral: <https://www.sitesdexception.fr/sites/maguelone-cathedral/?lang=en>
- If you want to head towards St. Guilhem-Le-Désert (<https://www.saintguilhem-valleeherault.fr>), you can stop to the pont du Diable (<https://www.montpellier-france.com/offre/fiche//PNALAR0340000029>) or Clamouse Cave (<https://www.clamouse.com/en/home/>)
- Aigues-Morte is also a nice half day option (<https://www.montpellier-france.com/Prepare-Book/Discoveries/In-the-region/Historic-cities-and-towns/Aigues-Mortes>)
- If you are more a beach person, we would recommend that you head to a "Paillote" on the beach of the Grand Travers such as la Paillote Bambou (<https://www.lapaillotebambou.com>) or l'Effet Mer (<http://www.effetmer.com>), or from Maguelone such as for example Le Carré Mer (<https://www.carre-mer.fr>).

If you need a taxi, a good way to go: <http://www.taxibleudumidi.fr/?lang=2>

For more, you will have a touristic book in your conference bag that will prove helpful. Also, more can be found here: <https://www.montpellier-france.com>

ORAL AND POSTER PRESENTATION GUIDELINES

Please find below some potentially useful material to assist you in preparing a presentation for BioEM2019.

Papers are to be presented in two basic formats: Oral and Poster Presentations. Below you will find specific information concerning these two formats.

If for any reason you find yourself unable to personally present your paper, please try to arrange for someone else to present it. **If nobody is available to present your work, you must notify the TPC Chairs well ahead of time (at tpc@bioem.org). If the presentation does not take place, the corresponding abstract will be removed from the online abstract book.**

NO PHOTOS ARE ALLOWED DURING THESE PRESENTATIONS

Oral Presentations

All oral presentations have been allocated a 15-minute time slot. These 15-minutes must include the presentation, questions, and transitioning to the next speaker. It is recommended that speakers plan on a 12 minute presentation to allow for questions and discussion (3 minutes). It is important to strictly adhere to this schedule as most oral presentations are scheduled in parallel sessions. Arrive at least 10 minutes early prior to the start of the session and introduce yourself to the chair and familiarize yourself with the audio-visual equipment.

Each meeting room will be equipped with a personal computer to accommodate PowerPoint and PDF presentation formats. Technical support will be present in each meeting room to ensure flawless execution. Authors must upload their presentations onto the designated computer at the conference venue during the break before their session at the latest. Presenters will not be allowed to connect their own computer to the projection system. Presentations can be loaded via USB flash memory stick. Authors are urged to try to minimise any potential problems by taking advantage of redundancy whenever possible: save and bring presentations in multiple formats (PowerPoint and Adobe PDF), store presentations in more than one media, and keep the media on your person during travel.

The best student oral presentation(s) will be awarded.

All oral presenters are expected to support their presentation with a corresponding slideshow.

The slides should be prepared in either PowerPoint (PPT/PPTX) or PDF format to ensure maximum compatibility with the equipment available on-site. Videos should either be embedded into the slides, or, if linked, physically accompany the main presentation document.

There will be a designated contact person coordinating the upload of your file in your session room. Please coordinate with this person to upload your presentation preferably the day before.

Presenters are strongly encouraged to verify that their presentation materials uploaded properly on the on-site equipment.

Poster Presentations

Poster sessions are an important part of the BioEM2019 conference and a method for immediate and effective communication between all those interested in specific subjects, actions or programs. Posters should be carefully designed and prepared to ensure their full impact.

Two poster sessions, i.e., A on Monday, June 24 at 15:00, and B on Tuesday, June 25 at 15:00, are planned in Joffre 2-3 meeting room (Level 1).

The poster presenters are kindly requested to follow the instructions below:

Double-sided boards in portrait format (120 cm x 100 cm), will be available for each author to attach their poster to and authors are advised to limit their poster size to 120 cm (height) X 90 cm (width) – this includes format A0. Material will be provided by the organizers for mounting posters. The boards will be numbered to correspond with poster numbers in the Program and student posters will be clearly

identified.

Authors should be present at their stations for the duration of their assigned session to discuss their work and answer questions, as there will be a flux of attendees.

Mounting: Posters can be mounted from 16:00 on Sunday June 23.

Each board will be marked with the poster number, as indicated in the final program.

Removal: Posters must be removed before 18:00 on Thursday June 27.

Student Poster Presentations with Flash Presentation

All student posters will also be presented as poster flash presentation. The two poster flash sessions will take place in Einstein meeting room (Level 0) on Monday, June 24 from 14:00 to 15:00 (FA), and on Tuesday, June 25 from 14:00 to 15:00 (FB).

Please ensure that you plan your communication carefully. The language is English.

Each presenter will have a 3 minutes time to present 4 slides maximum for the flash presentation (discussions will follow afterwards at your poster). Please introduce yourself in the beginning of your presentation and point out the main findings of your work. Hence your presentation should not include new material that is not shown on your poster.

The Chairs will call up the next presenter after the 3 min are over and you have to leave the podium.

Please upload your presentation at the computer available in the Einstein room on Monday, June 24 before 13:30 for the FA session, and on Tuesday June 25 before 13:30 for the FB session either in PowerPoint (PPT/PPTX) or PDF format, since all flash poster presentations will be uploaded beforehand on the same computer. The presenters will not be allowed to use their USB memory sticks or laptops during the session.

The best student poster(s) will be awarded.

CONFERENCE ORGANIZERS

Conference Organizing and Service, Events Planning, Registration and Accommodation Arrangement, Meeting Website Maintenance

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Julien Modolo,
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INSERM U1099
Laboratoire de Traitement
du Signal et de l'Image
(LTSI)
Rennes, France



In addition, Sud Congrès Conseil was hired in order to assist with all the conference organizing matter:

162 cours du Marechal Galliéni
33400 Talence, France



Lawson Health Research Institute BioEM Website, Communication and Meeting Support

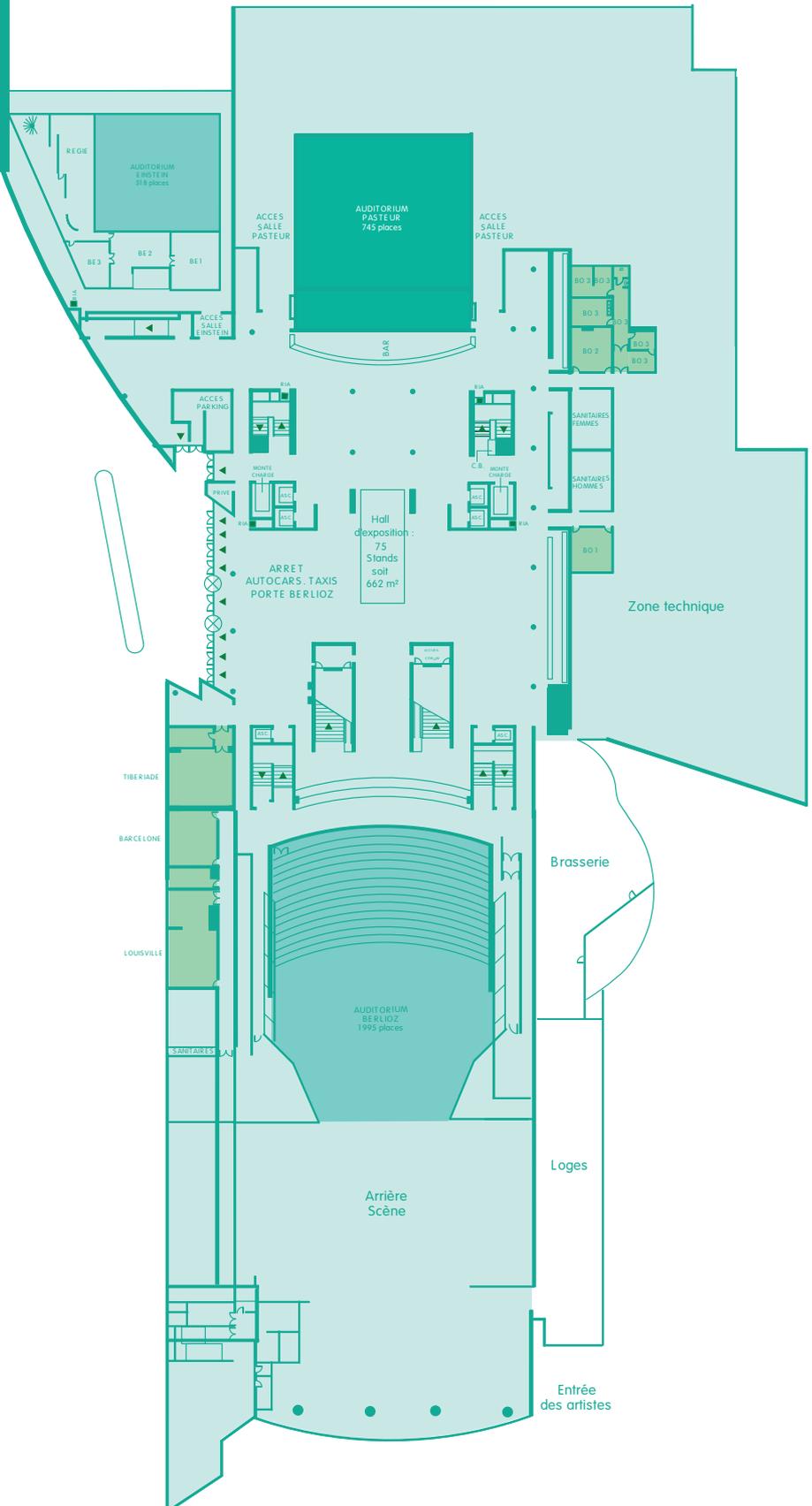
Abstract submission, abstract review and assignment, email campaigns, program and abstract books, Arthur Pilla and Student award judging, and meeting survey

Astrid Chamson-Reig, PhD
Jeffrey Carson, PhD

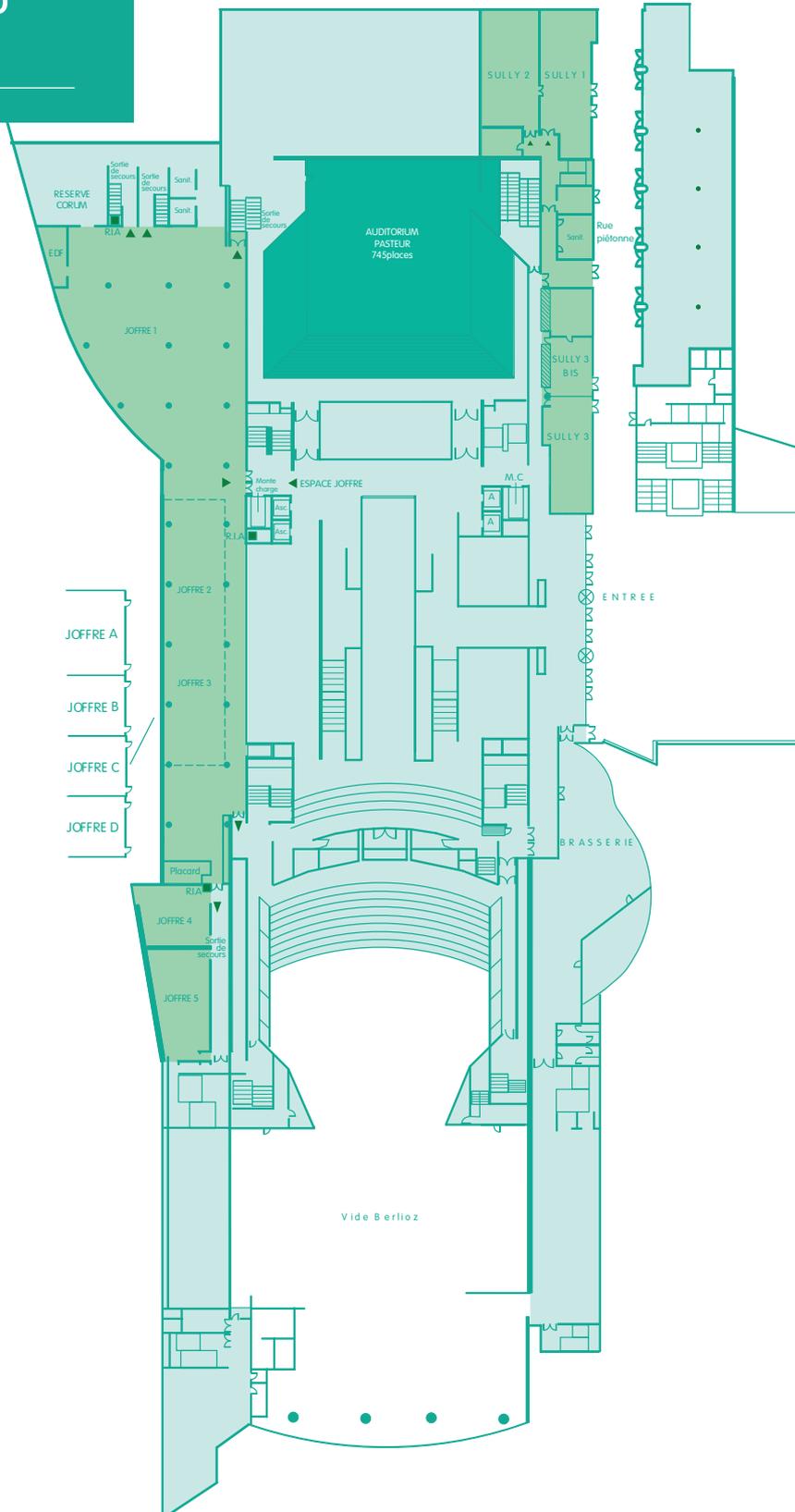
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Niveau 0



Niveau 1



Technical Program

Sunday June 23, 2019

**Session: M1
BEMS Board Meeting
Sunday June 23, 2019 • 09:00 - 12:30
Joffre 4**

**Session: M2
EBEA Council Meeting
Sunday June 23, 2019 • 09:00 - 12:30
Joffre 5**

**Session: PW
Pre Conference Workshop - Theory and hands-on practical for transcranial Direct Current Stimulation (tDCS) and transcranial Alternating Current Stimulation (tACS)
Sunday June 23, 2019 • 14:00 - 17:00
Barthez
Chairs: Marom Bikson & Bruno Vandelanotte**

PW-1 [14:00]

Workshop instructors and Schedule

Marom Bikson¹ & Bruno Vandelanotte²

¹*The City College of New York, New York, NY, USA, 10031*

²*Vandelanotte Consulting, Brugge, Belgium, B-8200*

This workshop is open to participants of all backgrounds interested in a broad introduction to the principles and applications of tDCS and tACS. The theory portion will introduce basic concepts in dosing such as anode/cathode, electrode portion, current intensity, and frequency. The hands-on portion will allow participants to practice application of tDCS/tACS including using conventional electrodes and High-Definition electrodes. Advanced technique to ensure outcome reproducibility and tolerability will be explained. How to apply tDCS/tACS in home settings and how to integrates with brain imaging (EEG) will also be introduced. All participants will be provided workshop slide handouts, a certificate of attendance, and electrodes.

Schedule

- Introductory remarks [Bikson and Vandelanotte]
- tDCS – Principles and mechanisms [Bikson]
- Stimulation parameters and protocols [Bikson]
- Safety [Bikson]
- Clinical implementation & hands-on practical exercises [Bikson and Vandelanotte]
- Professional standards and recap [Bikson and Vandelanotte]

**Welcome Reception
Sunday June 23, 2019 • 18:30 - 21:30
Joffre 1**

Monday June 24, 2019

Welcome
Monday June 24, 2019 • 09:00 - 09:30
Einstein

Session: P1
Plenary 1 - Non invasive electrical brain stimulation
Monday June 24, 2019 • 09:30 - 10:30
Einstein
Chairs: Alexandre Legros & Azadeh Peyman

P1-1 [09:30]

Electrical brain stimulation

Marom Bikson¹

¹*The City College of New York, New York, NY, USA, 10031*



Biographical sketch

Marom Bikson is the Shame Professor of Biomedical Engineering at The City College of New York. He is known for his work on the cellular mechanisms of electrical stimulation and translational medical device design. Dr. Bikson group focuses on electrical stimulation devices for neurological and psychiatric disorders. He has published over 250 articles on medical device technology and brain stimulation. Technologies invented in Dr. Bikson's lab are in hundreds of medical centers globally.

Abstract

Non-invasive electrical brain stimulation with low intensity currents are now broadly investigated for their therapeutic potency in clinical populations and modulation of cognition in health individuals. Among these interventions, transcranial Direct Current Stimulation (tDCS) is the most broadly and intensively investigated as well as transcranial Alternating Current Stimulation (tACS). During tDCS and tACS low-amplitude (few mA) current is applied for tens of minutes to the brain through electrodes on the scalp. For tDCS the waveform is a sustained current while for tACS the waveform is sinusoidal of typically low (<100 Hz) frequency, though higher frequencies (>1 kHz) are also explored. tDCS and tACS are well tolerated producing only mild transient skin irritation and are considered safe enough to test even in healthy individuals. tDCS and tACS produce static and oscillating, respectively, electric fields in the brain of <1 V/m amplitude. tDCS and tACS can produce immediate acute changes in brain excitability and, especially when applied in repeated sessions, long term changes in brain function. The therapeutic applications of tDCS and tACS include depression, chronic pain, multiple sclerosis, movement disorders (Parkinson's), schizophrenia, rehabilitation following injury, attention-deficit hyperactivity disorder (ADHS), post-traumatic stress disorder (PTSD) and various forms of addiction. In health individuals tDCS and tACS have been tested to enhance learning, working memory, creativity, and sports performance. Summarizing decades research and highlighting emerging concepts, this talk addresses four closely related questions. How do the low intensity electric fields produced by tACS and tDCS modulate complex brain functions? What the cellular mechanisms of tDCS and tACS? How are so many different application of tDCS and tACS possible? Are there legitimate concerns about long-term side-effects of tDCS and tACS exposure?

P1-2 [10:00]

Non invasive deep brain stimulation via delivery of temporally interfering electric fields

Nir Grossman¹

¹*Imperial College London, London, United Kingdom*

Biographical sketch

Nir is an assistant professor at Imperial College London and a founding fellow of the UK Dementia Research Institute. The long-term goal of his research is to develop neuromodulatory interventions for brain disorders by direct control of the aberrant neural activity. Nir received a BSc in physics from the Israeli Institute of Technology (Technion), an MSc in electromagnetic engineering from the Technical University of Hamburg-Harburg, and a PhD in neuroscience from Imperial College London. He then completed a postdoc training, as a Wellcome Trust Fellow, at the Massachusetts Institute of Technology (MIT) and Harvard University. Nir was recently awarded the 2018 Science & PINS Prize for Neuromodulation for describing how temporal interfering of electric fields can stimulate deep brain structures non-invasively.



Abstract

Electrical brain stimulation is a key technique in research and clinical neuroscience studies, and also is in increasingly widespread use from a therapeutic standpoint. However, to date all methods of electrical stimulation of the brain either require surgery to implant an electrode at a defined site, or involve the application of non-focal electric fields to large fractions of the brain. We report a noninvasive strategy for electrically stimulating neurons at depth. By delivering to the brain multiple electric fields at frequencies too high to recruit neural firing, but which differ by a frequency within the dynamic range of neural firing, we can electrically stimulate neurons throughout a region where interference between the multiple fields results in a prominent electric field envelope modulated at the difference frequency. We validated this temporal interference (TI) concept via modeling and physics experiments, and verified that neurons in the living mouse brain could follow the electric field envelope. We

demonstrate the utility of TI stimulation by stimulating neurons in the hippocampus of living mice without recruiting neurons of the overlying cortex. Finally, we show that by altering the currents delivered to a set of immobile electrodes, we can steerably evoke different motor patterns in living mice.

Coffee Break
Monday June 24, 2019 • 10:30 - 11:00
Joffre 2-3

Session: S01
Electric and magnetic stimulation of the nervous system
Monday June 24, 2019 • 11:00 - 12:30
Einstein
Chairs: Julien Modolo & Heidi Danker-Hopfe

Session: S02
Cellular effects of radiofrequency fields and millimeter waves
Monday June 24, 2019 • 11:00 - 12:30
Barthez
Chairs: Claudia Consales & Isabelle Lagroye

S01-1 [11:00]

Dosimetric analysis on the pain matrix exposed to low-intensity extremely low-frequency magnetic fields

Martina Galli¹, Micol Colella¹, Alessandra Paffi¹, Alex Thomas², Francesca Apollonio¹, Frank S. Prato² & Micaela Liberti¹

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²*Lawson Health Research Institute, London, Ontario, Canada, N6C 2R5*

Keywords: Dosimetry (computational), ELF/LF, Completed (unpublished)

S02-1 [11:00]

STUDENT PAPER

Do radiofrequency electromagnetic fields (RF-EMF) alter neuronal differentiation and mitochondrial function?

Nicole von Niederhäusern¹, Angélique Ducray¹, Manuel Murbach² & Meike Mevissen¹

¹*Division of Veterinary Pharmacology & Toxicology, University of Bern, Bern, Switzerland, 3012*

²*IT'IS Foundation, Zurich, Switzerland, 8004*

Keywords: In vitro, RF/Microwaves, Work in Progress

Presented by: Nicole von Niederhäusern

A number of studies addressed the possible relationship between radiofrequency

Presented by: Alessandra Paffi

A realistic 3D model of the cortical areas deputed to the pain processing, i.e. Pain Matrix, has been developed. The model of the Pain Matrix has been inserted inside the human head model Duke (ViP, v1) with the aim to carry out a comparative dosimetric analysis on such areas when exposed to the complex neuroelectromagnetic pulse (CNP) by means of two exposure systems used in studies on volunteers: a Z-gradient coil system and a suitably designed headset. Results show that the two systems induce very different exposure conditions, in terms of both magnetic induction field B and electric field E, thus feeding conditions of the two stimulators should be properly adjusted in order for them to elicit similar effects.

S01-2 [11:15]

Extremely low-frequency magnetic fields as neuroprotective treatment in acute ischemic stroke: models, mechanisms and clinical application

Fioravante Capone¹, Micol Colella², Francesco Motolese¹, Maria Grazia Rossi¹, Francesca Camera², Francesca Apollonio², Vincenzo Di Lazzaro¹ & Micaela Liberti²

¹*Unit of Neurology, Neurophysiology, Neurobiology, Department of Medicine, Università Campus Bio-Medico, Rome, Italy, 00128*

²*Department of Information Engineering, Electronics and Telecommunication (DIET), University of Rome "La Sapienza", Rome, Italy*

Keywords: Human, ELF/LF, Completed (unpublished)

Presented by: Fioravante Capone

Extremely low frequency magnetic fields (ELF-MF) could be an alternative neuroprotective treatment for stroke because preclinical studies demonstrated their effects on the mechanisms underlying ischemia. Preliminary data showed the safety and tolerability of the ELF-MF in patients. However, the mechanisms of action are still unclear. Dosimetry can describe electrical and magnetic quantities induced in brain and biophysical models can simulate how ELF-MF interact with neurons. Neurophysiology represents the main tool to explore, in vivo, ELF-MF effects. Here, we describe the potentialities of such multidisciplinary approach to gain new insights into experimental data, and to test novel hypotheses regarding mechanisms of actions of ELF-MF.

electromagnetic field (RF-EMF) exposure and neurodegenerative diseases. During neuronal differentiation, cells undergo major changes including a metabolic switch from glycolysis to oxidative phosphorylation and underlying signaling pathways. The aim of our study was to evaluate the impact of RF-EMF exposure before and during neuronal differentiation using an in vitro model. Our data show that RF-EMF did not alter the neuronal differentiation into dopaminergic and cholinergic phenotypes nor their underlying signaling pathways and mitochondrial function and fusion.

S02-2 [11:15]

Real-time study of the effects of radiofrequency fields at the cellular and molecular levels: the results of the Geronimo project

Emmanuelle Poque-Haro¹, Hermanus Ruigrok¹, Delia Arnaud-Cormos², Rémy Renom¹, Annabelle Hurtier¹, Florence Poulletier De Gannes¹, Isabelle Lagroye¹, Bernard Veyret¹, Philippe Leveque² & Yann Percherancier¹

¹*Laboratoire de l'Intégration du Matériau au Système, CNRS UMR 5218, Talence, France, 33400*

²*XLIM, CNRS UMR 7252, Limoges, France, 87000*

Keywords: In vitro, RF/Microwaves, Completed (unpublished)

Presented by: Yann Percherancier

Within the Geronimo European project, we used cellular impedance and molecular probes based on the Bioluminescence Resonance Energy Transfer technique (BRET) to assess the real-time cellular and molecular effects of 1800 MHz radiofrequency fields, continuous wave (CW) or modulated with environmental signals (up to 6 W/kg for BRET experiments and 25 W/kg for cellular impedance), in live cells. We found that radiofrequency field exposure (i) altered neither basal level of HSF-1 and RAS/ERK stress response pathways nor the potency or the efficacy of chemicals to activate these molecular pathways, and (ii) did not modify primary rat astrocytes and neurons global cell behavior and their response to a chemical pollutant.

S01-3 [11:30]**Electric field dependent effects of transcranial direct current stimulation of the motor cortex**Ilkka Laakso¹, Marko Mikkonen¹ & Satoshi Tanaka²¹*Department of Electrical Engineering and Automation, Aalto University, Espoo, Finland, 00076*²*Laboratory of Psychology, Hamamatsu University School of Medicine, Hamamatsu, Japan, 431-3192***Keywords: Clinical (therapy), Static, Completed (unpublished)****Presented by: Ilkka Laakso**

Transcranial direct current stimulation (tDCS) generates weak electric fields that can modulate the excitability of the motor cortex. The changes in excitability are, however, highly variable between individuals. Recent findings suggest that anatomical differences give rise to large inter-individual variations in the electric fields, which could partly explain the variable excitability changes. Here, we used individualized MRI-based modelling to investigate the hypothesized effect of electric fields on response variability. The results in nine subjects suggested that the after-effects of 1 mA 10 min anodal tDCS were proportional to the electric fields in the motor cortex, higher fields producing larger increases in cortical excitability.

S02-3 [11:30]**In vitro study with a multimethodological approach on human fibroblasts exposed to 2.45 GHz: Biological effects of continuous and pulsed wave signals**Elisa Regalbuto^{1, 2}, Anna Anselmo¹, Stefania De Sanctis¹, Valeria Franchini¹, Elisa Coluzzi², Roberto Bei³, Monica Benvenuto³, Laura Masuelli⁴,Guglielmo d'Inzeo⁵, Alessandra Paffi⁵, Eugenio Trodella⁵, Florigio Lista¹ & Antonella Sgura²¹*Scientific Department, Army Medical Center of Rome, Rome, Italy, 00184*²*Department of Science, University of Rome "Roma Tre", Rome, Italy, 00146*³*Department of Clinical Sciences and Translational Medicine, University of Rome "Tor Vergata", Rome, Italy, 00133*⁴*Department of Experimental Medicine, University of Rome "La Sapienza", Rome, Italy, 00184*⁵*Department of Information Engineering, Electronics and Telecommunications, University of Rome "La Sapienza", Rome, Italy, 00184***Keywords: In vitro, RF/Microwaves, Work in Progress****Presented by: Alessandra Paffi**

In this study the potential genotoxic effects of 2.45 GHz, mainly used in Wi-Fi technologies, were evaluated on human fibroblasts with both continuous and pulsed signals. The aim of this research is to perform good quality investigation on the potential non-thermal biological effects induced by 2.45 GHz exposures by a well experimental design and a characterized exposure system.

S01-4 [11:45]**STUDENT PAPER****A μ TMS coil for ultra-focal noninvasive magnetic stimulation**Micol Colella^{1, 2}, Rebecca M. Laher³, Daniel Z. Press³, Courtney E. McIllduff³, Seward B. Rutkove³, Alvaro Pascual-Leone³, Francesca Apollonio¹, Micaela Liberti¹ & Giorgio Bonmassar²¹*Department of Information Engineering, Electronics and Telecommunications (DIET), University of Rome "La Sapienza", Rome, Italy, 00184*²*Athinoula A. Martinos Center for Biomedical Imaging, Department of Radiology, Massachusetts General Hospital, Harvard Medical School, Charlestown, MA, USA, 02129*³*Berenson-Allen Center for Noninvasive Brain Stimulation, Department of Neurology, Beth Israel***S02-4 [11:45]****WITHDRAWN**

Deaconess Medical Center, Harvard Medical School, Boston, MA, USA, 02215

Keywords: Clinical (therapy), Pulsed, Work in Progress

Presented by: Micol Colella

A miniaturized figure-of-eight coil (μ Coil) for TMS applications has been developed taking advantage of the Flex circuit technology. First experiments on volunteers demonstrated the ability of the μ Coil to elicit sensorial action potentials of the peripheral nervous system. The necessity of reducing the size of standard TMS coils arises from the poor spatial resolution of the latter. The aim of this study is to present the first prototype of μ Coil and its computational model. Numerical results confirmed that the μ Coil is capable of inducing a focalized electric field inside the tissues with amplitudes up to 70V/m consistent with the observed peripheral nervous stimulation in healthy volunteers.

S01-5 [12:00]

Induced fields variation in deep brain regions due to head-specific H-coil design

Mai Lu¹ & Shoogo Ueno²

¹*Key Lab. of Opt-Electronic Technology and Intelligent Control of Ministry of Education, Lanzhou Jiaotong University, Lanzhou, China, 730070*

²*Department of Applied Quantum Physics, Kyushu University, Fukuoka, Japan, 812-8581*

Keywords: Clinical (therapy), ELF/LF, Work in Progress

Presented by: Shoogo Ueno

Stimulation of deeper brain structures by transcranial magnetic stimulation (TMS) plays a role in the study of reward and motivation mechanisms. H-coil was developed for deep transcranial magnetic stimulation (dTMS). This work presents the design of H-coil by employing different realistic head models. The induced magnetic and electric fields in head tissues were obtained by impedance method. It was found the head-specific H-coil will generate great variation of induced fields in brain tissues. For developing H-coil for child dTMS, the coil parameters, such as wire turns, magnitude of injected currents etc. should be carefully considered.

S02-5 [12:00]

STUDENT PAPER

Heat shock response of melanoma cells induced by continuous and pulsed millimeter-wave heating

Rosa Orlacchio¹, Yann Le Page², Yves Le Dréan², Rémy Le Guével³, Ronan Sauleau¹, Stanislav Alekseev⁴ & Maxim Zhadobov¹

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²*Univ Rennes, Inserm, EHESP, IRSET (Institut de recherche en santé, environnement et travail) – UMR_S 1085, F-35000, Rennes, France*

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⁴*Institute of Cell Biophysics of Russian Academy of Sciences, Pushchino, Russian Federation*

Keywords: In vitro, RF/Microwaves, Completed (unpublished)

Presented by: Rosa Orlacchio

This study aims to evaluate the heat shock response of in vitro melanoma cells exposed to continuous or pulsed-modulated millimeter wave (MMW)-induced heating with the same average temperature rise. The phosphorylation of a small heat shock protein (HSP27) was detected 6 h post exposure using an experimental approach based on microscopy image analysis to follow the spatial variation of the biological response. Results evidenced that thermal pulses with a duration of 1.5 s induced significantly higher heat shock response in the melanoma cell monolayer than the one induced by continuous heating with the same average temperature dynamics.

**S01-6 [12:15]
STUDENT PAPER**

Electrostimulation thresholds for transcranial magnetic stimulation

Marko Mikkonen¹, Marco Soldati¹, Ilkka Laakso¹, Takenobu Murakami², Yoshikazu Ugawa², Satoshi Tanaka³ & Akimasa Hirata⁴

¹*Department of Electrical Engineering and Automation, Aalto University, Espoo, Finland*

²*Department of Neurology, Fukushima Medical University, Fukushima, Japan*

³*Laboratory of Psychology, Hamamatsu University School of Medicine, Hamamatsu, Japan*

⁴*Department of Computer Science and Engineering, Nagoya Institute of Technology, Nagoya, Japan*

Keywords: Dosimetry (computational), IF, Completed (unpublished)

Presented by: Marko Mikkonen

We studied the electrostimulation thresholds using transcranial magnetic stimulation. This was done using resting motor threshold data from two different muscles on opposing sides of the body and employing subjects' individual MRI in modeling of the cortical electric fields. We found that the stimulation threshold at the target is approximately 100 V/m and that the threshold for stimulating a muscle at rest does not differ for two different muscles on opposing sides of the body.

**S02-6 [12:15]
WITHDRAWN**

**Lunch
Monday June 24, 2019 • 12:30 - 14:00
Joffre 1**

**Session: FA
Student Flash Poster Session A
Monday June 24, 2019 • 14:00 - 15:00
Einstein
Chairs: Niels Kuster & Christopher Portier**

**Session: PA
Poster Session A
Monday June 24, 2019 • 15:00 - 16:30
Joffre 2-3**

**Coffee Break
Monday June 24, 2019 • 16:30 - 17:00
Joffre 2-3**

Session: S03
Numerical dosimetry of RF fields
Monday June 24, 2019 • 17:00 - 18:30
Einstein
Chairs: Guangdi Chen & Wout Joseph

S03-1 [17:00]

The effect of vasculature detailedness on thermal estimations in next generation anatomical human models

Manuel Murbach¹, Bryn Lloyd¹, Silvia Farcito¹, Esra Neufeld¹ & Niels Kuster^{1, 2}

¹*IT'IS Foundation, Zurich, Switzerland, 8004*

²*ETH Zurich, Zurich, Switzerland, 8092*

Keywords: Dosimetry (computational),

RF/Microwaves, Work in Progress

Presented by: Manuel Murbach

The numerical assessment of the radiofrequency (RF)-induced local temperature increase inside a patient undergoing magnetic resonance imaging (MRI) diagnostics is state-of-the-art in MRI safety studies. In light of the continuous improvement in the resolution of anatomical models, we investigated the impact of the level of detail in the vasculature models on estimates of temperature increase. Results show that the difference of the peak temperature increase for the investigated high-exposure scenario is in the order of 20%. Future investigations should broaden the studied exposure scenarios and consider vascular convection.

S03-2 [17:15] - YOUNG SCIENTIST PAPER

THz absorption pattern in modelled human skin with its appendages

Alireza Lajevardipour¹, Zoltan Vilagosh¹ & Andrew Wood¹

¹*Health and Medical Sciences, Swinburne University of Technology, Melbourne, Australia, 3122*

Keywords: Dosimetry (computational), THz, Work in Progress

Presented by: Alireza Lajevardipour

Session: S04
Effects of electromagnetic fields (in-vivo)
Monday June 24, 2019 • 17:00 - 18:30
Barthez
Chairs: Florence Poulletier De Gannes & Richard Nuccitelli

S04-1 [17:00]

Gene responses to GSM-1800 MHz electromagnetic field in brain cells affected by a neuroinflammatory reaction

Julie Lameth¹, Severine Boillée¹, Delia Arnaud-Cormos², Philippe Leveque², Jean-Marc Edeline³ & Michel Mallat¹

¹*INSERM U.1127, Institut du cerveau et de la moelle (ICM), Paris, France, 75013*

²*CNRS, XLIM, UMR 7252, Université de Limoges, Limoges, France, 87000*

³*UMR 9197 CNRS, université Paris-Sud, Paris Saclay Institute of Neuroscience, Neuro-PSI, Paris, France, 91405*

Keywords: In vivo, RF/Microwaves, Completed (unpublished)

Presented by: Michel Mallat

We have investigated gene responses to a 2 h head exposure to GSM-1800 MHz in rats undergoing neuroinflammation. mRNA profiling (RNA seq) was performed in a area of the cerebral cortex where the mean SAR value was 3.22 W/Kg. GSM exposure induced significant modulations in the transcript level of 321 genes, including genes involved in protein dephosphorylation or ubiquitination. Quantitative RT-PCR analyses of a set of GSM-responsive genes confirmed RNA seq data and showed that significant gene responses also occurred in the entorhinal cerebral cortex where the SAR was reduced to 1.21 W/Kg. In contrast, none of these genes were affected in GSM-exposed healthy rats, indicating that neuroinflammation promoted gene responses to GSM signals.

S04-2 [17:15]

Superficial damage to skin from 5.8, 8.2, and 95 GHz microwave exposures in swine

William Voorhees¹, James E Parker³, Christine Kowalczewski², Jason Payne¹, Andrew Kowalczewski², Robert Christy² & Jeffrey Whitmore¹

¹*Radio Frequency Bioeffects Branch, Air Force Research Laboratory, JBSA Fort Sam Houston, San Antonio, Texas, USA, 78234*

²*US Army Institute of Surgical Research, JBSA Fort*

A model human skin with hair and associated bacterial spores is exposed to 1 THz radiation and SAR values computed, using dielectric values for each layer extrapolated from literature values. SAR was computed purely to measure energy absorption rather than temperature rise. The FDTD simulations indicate strong fields induced in lipid part of spore, in cortex layer of hair and within sweat duct. For an excitation with a plane wave of 1 V/m, the averaged SAR values reduces by increasing radius of cylindrical skin model. The max SAR value (0.0625 W/kg) happens in inner membrane of spores. In the case of sweat duct, max SAR values are vastly dependent on how to choose conductivity values.

S03-3 [17:30] STUDENT PAPER

Hybrid Ray-Tracing/Finite-Difference Time-Domain method for user EMF-exposure assessment of a massive MIMO technology

Sergei Shikhantsov¹, Arno Thielens^{1, 2}, Gunter Vermeeren¹, Emmeric Tanghe¹, Piet Demeester¹, Guy Torfs¹, Luc Martens¹ & Wout Joseph¹

¹Department of Information Technology, Ghent University/IMEC, Ghent, Belgium, 9000

²Department of Electrical Engineering and Computer Sciences, University of California Berkeley, Berkeley, CA, USA, 94704

Keywords: Dosimetry (computational), RF/Microwaves, Completed (unpublished)
Presented by: Sergei Shikhantsov

The paper presents a novel method for numerical assessment of the massive MIMO exposure. Ray-tracing is used for a site-specific propagation modeling and the Finite-Difference Time-Domain method is applied to evaluate exposure of a realistic human phantom in terms of the Specific Absorption Rate. We discuss in detail the impact of the coupling between the user equipment and the phantom on the massive MIMO channel and propose a technique to incorporate it into the ray-tracing results for a more accurate exposure estimate. We show that the coupling with the head results in up to 19 dB variation of the incident electric field.

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³General Dynamics Information Technology, JBSA Fort Sam Houston, San Antonio, Texas, USA, 78234

Keywords: In vivo, RF/Microwaves, Work in Progress

Presented by: William Voorhees

The 711th Human Performance Wing, Radio Frequency Bioeffects Branch (711 HPW/RHDR) is undertaking a multi-disciplinary, research effort to improve estimates of damage thresholds across the RF spectrum. This effort, referred to as Probability of Injury from RF Exposure (PIRE), will require significant collaboration between physiology and dosimetry to assess the impact of RF energy at the low end of the spectrum since the energy is deposited throughout the body. This presentation is on the first set of experiments, which investigates skin burn thresholds for 5.6 GHz, 8.2 GHz, and 95 GHz exposures in the Yorkshire pig.

S04-3 [17:30]

Commentary on the recent findings of the NTP cell phone bioassay: Has thermal stress been underestimated?

Jens Kuhne¹, Janine-Alison Schmidt¹, Dirk Geschwentner¹, Blanka Pophof¹ & Gunde Ziegelberger¹

¹Radiation and Health, German Federal Office for Radiation Protection, Oberschleißheim/Neuherberg, Germany, 85764

Keywords: In vivo, RF/Microwaves, Review, Commentary, Recommendation, Evaluation
Presented by: Jens Kuhne

Recently, the final reports of a large two year study on mice and rats exposed to chronic cell phone radiofrequency radiation (RFR) were published by the National Toxicology Program (NTP). The most prominent effects were observed in male rats. Assuming that the observed effects are indeed related to exposure, we discuss the results of the NTP-study in the context of thermal stress. Taking into account the results of the temperature measurements in the pilot studies performed in order to set appropriate SAR for the two year study, we argue that significant body heating in adult male rats is likely the cause for some of the findings. Suggestions how to improve future study designs are made.

S03-4 [17:45] - YOUNG SCIENTIST PAPER

Exposure assessment of body-implanted capsules in the 100-MHz–5-GHz range

Denys Nikolayev^{1, 2}, Wout Joseph², Maxim Zhadobov³, Ronan Sauleau³, Luc Martens² & Anja Skrivervik¹

¹*Microwaves and Antennas Group (MAG), École polytechnique fédérale de Lausanne, Lausanne, Switzerland, CH-1015*

²*INTEC – WAVES, imec / Ghent University, Ghent, Belgium, BE-9052*

³*Univ Rennes, CNRS, IETR (Institut d'Électronique et de Télécommunications de Rennes) UMR–6164, Rennes, France, FR-35000*

Keywords: Dosimetry (computational), RF/Microwaves, Completed (unpublished)

Presented by: Denys Nikolayev

Body-implanted bioelectronics rely on antennas to interface with external on- or off-body equipment. For a given input power, the antenna type and operating frequency significantly affect the power dissipation in tissues. This study addresses the exposure by realistic magnetic and electric equivalent sources using full-wave modeling techniques. The effect of equivalent source configuration on the power dissipation, exposure, and radiation performance is here quantified for the first time. The results demonstrate the existence of mode-dependent optimal operating frequency that maximizes the achievable radiation efficiency and minimizes Specific Absorption Rate (SAR) for a given input power.

S03-5 [18:00]

Design and dosimetric characterization of an exposure facility for a human provocation study concerning possible effects of 2.45GHz WLAN radiation on sleep

Gernot Schmid¹, Rene Hirtl¹, Hans Dorn², Torsten Eggert², Ana Bueno-Lopez² & Heidi Danker-Hopfe²

¹*EMC & Optics, Seibersdorf Laboratories, Seibersdorf, Austria, A-2444*

²*Charité - University Medicine Berlin, Berlin, Germany, D-12200*

Keywords: Dosimetry (computational), RF/Microwaves, Completed (unpublished)

Presented by: Gernot Schmid

The developed exposure facility deploys six simultaneously radiating patch antennas, arranged every 60° along a virtual circle of 120 cm diameter. This antenna arrangement is positioned upright (i.e. virtual circle in vertical plane) at the head end of the bed, such that the test subject's head is located in

S04-4 [17:45]

Bioelectrical signaling regulates eye regeneration

Taylor Birkholz², Cindy Kha¹, Wendy Beane² & Kelly Ai-Sun Tseng¹

¹*School of Life Sciences, University of Nevada, Las Vegas, Las Vegas, NV, USA, 89154*

²*Biological Sciences, Western Michigan University, Kalamazoo, MI, USA, 49008*

Keywords: In vivo, Static, Work in Progress
Presented by: Kelly Ai-Sun Tseng

Understanding how some animals can regenerate entire organs is critical for developing improved strategies for repair. We have identified a novel role for membrane potential, mediated by the V-ATPase proton pump, in regulating eye regrowth in both *Xenopus* tadpoles and planarian flatworms. Our data show that both eye fields are normally hyperpolarized. In both species, we found that ectopic hyperpolarization (by genetic ion transporter manipulation) resulted in the growth of extra eyes, while ectopic depolarization (by pharmacological ion transport modulation) inhibited eye regeneration. Together, these results suggest an ancestrally conserved regenerative bioelectrical pathway that regulates successful eye regeneration in diverse species.

S04-5 [18:00]

WITHDRAWN

the center of the virtual circle. The computer controlled exposure facility allows double-blind and randomized application of realistic worst case WLAN exposure levels and sham exposure to the head of test subjects during sleep and continuous monitoring and recording of all relevant exposure metrics. The applied exposure signal represents different transmission conditions of real WLAN data traffic.

**S03-6 [18:15]
STUDENT PAPER**

Near-field relationship between maximum local SAR and maximum field intensity in FM frequencies

Bader Fetouri¹, Allal Ouberehil², Philippe De Doncker³ & Joe Wiat¹

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Keywords: Dosimetry (computational), RF/Microwaves, Completed (published)

Presented by: Bader Fetouri

This abstract dedicated to the near-field assessment of the specific absorption rate in FM frequencies. In this case the study focuses on linking maximum local specific absorption rate and maximum field intensity. We provide a new method to generalize electromagnetic field exposure.

**S04-6 [18:15]
STUDENT PAPER**

Effect of radiofrequency exposure on body temperature in mice

Thi-Cuc Mai^{1, 2}, Amandine Pelletier^{1, 2} & Rene De Seze^{1, 2}

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Keywords: In vivo, RF/Microwaves, Work in Progress

Presented by: Thi Cuc Mai

The evolution of communication technology brings great benefits to our daily life. Besides, this rapid expansion has raised concerns about their possible impact on public health. In this study, we found that repeated exposure to a low intensity 900 MHz radiofrequency induced changes in body temperature of mice. However, TRPM8 receptors don't seem to be involved in mediating the effect of radiofrequency.

**Student Ice Breaker
Monday June 24, 2019 • 19:30 - 22:00
Le Clandestin piano-bar**

Tuesday June 25, 2019

Session: P2
Plenary 2 - Has evidence for carcinogenicity of RF-EMF changed since IARC's assessment?

Tuesday June 25, 2019 • 08:30 - 09:30

Einstein

Chairs: Martin Rööslä & Elisabeth Cardis

P2-1 [08:30]

Update on epidemiological research

Maria Feychting¹

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Biographical sketch

Maria Feychting is Professor of Epidemiology at Karolinska Institutet, Institute of Environmental Medicine, and Head of the Unit of Epidemiology. Her research is focused on risk factors for chronic diseases, primarily cancer but also other chronic diseases. She has a specific interest in childhood cancer and adult brain tumors, both in terms of risk factors such as environmental and genetic factors, and factors affecting survival, as well as long-term socioeconomic consequences of childhood cancer. She has conducted research on potential health effects of non-ionizing radiation since the late 1980s, and she is the PI for the Swedish parts of the Interphone study, the Cefalo study, the Sotan study and the COSMOS study. She has extensive experience from register based research utilizing nationwide health data registers and combining data from the Nordic countries. She has published around 300 original scientific articles, brief communications, review articles, editorials, letters, and book chapters,

including 208 articles listed in PubMed (WoS h-index 51). She is currently the PI of several registry based studies on brain tumors, childhood cancers, and genetic syndromes, funded by the main Swedish national research councils, the Swedish Cancer Society, and Nordforsk. She has been invited expert in several health risk assessment expert groups, e.g. for the WHO, and other international and national scientific committees. Since May 2012, she is the vice Chairman of the International Commission on Non-Ionizing Radiation Protection (ICNIRP), an independent body suggesting science based guidelines for non-ionizing radiation protection. She teaches advanced epidemiology courses at the Karolinska Institutet PhD program in epidemiology, and the Master of Public Health Program "Public Health Epidemiology".

Abstract

In 2011 the International Agency for Research on Cancer (IARC) reviewed the scientific literature on the potential carcinogenic effect of exposure to radiofrequency electromagnetic fields. Based on epidemiologic data from some case-control studies on mobile phone use and brain tumor risk (the Interphone study and a set of case-control studies from the Hardell group in Sweden), the IARC working group concluded that there was limited evidence from studies in humans for an effect of radiofrequency field exposure on the risk of glioma and acoustic neuroma. Evidence from a prospective cohort study which reported no associations was considered affected by non-differential exposure misclassification and available incidence time trend studies, which saw no increase in the occurrence of these tumors, were assessed as covering a too short time period to be informative. Within the working group a minority opinion assessed the evidence as inadequate, and judged the case-control studies as inconsistent and pointed to the lack of increased rates of glioma and acoustic neuroma since the introduction of mobile phones. Since the IARC evaluation, a number of additional case-control studies and prospective cohort studies have been published, including also the first study on brain tumors in children, as well as a considerable number of incidence time trend studies from different countries, covering an additional 10-15 years of observation, in total almost 30 years since handheld mobile phones were introduced. Furthermore, incidence trend simulation studies have been conducted where the expected incidence trends have been modelled under different assumptions of risk, as a consistency check of results from the case-control studies. Additional data are also available that shed light on the observed reduced risk estimates in some case-control studies, such as the Interphone study. This presentation will summarize the evidence from epidemiological studies published since the IARC evaluation.

P2-2 [09:00]

Update on animal research

Florence Poullétier De Gannes¹

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Biographical sketch

Florence Poullétier de Gannes got her PhD in Biological and Health Sciences from the University of Bordeaux, France. She joined the Bioelectromagnetics group of the IMS laboratory as postdoc in 2001 and she is still involved with the team as a CNRS research engineer. Her research deals mainly with the adverse and beneficial biological effects of non-invasive electromagnetic fields (RF and ELF) and is mostly oriented towards the CNS and neurological diseases. She has been involved in several programmes, both national (Ministry of research, French research foundation, ANR) and foreign (German BfS, Swiss research foundation Swiss research foundation and European Geronimo project). She has also worked on EMF health risk assessment in vitro and in vivo (animals) studies, within the European EFHRAN project.

She is a reviewer for major journals in the field of bioelectromagnetics (Bioelectromagnetics and Radiation Research). Florence Poullétier de

Gannes is an elected member of EBEA committee. She is author of twenty-four peer-reviewed papers and more than hundred meeting publications in the field of Bioelectromagnetics.

Abstract

In 2011, IARC classified RF-EMF as possibly carcinogenic for humans, mainly based on the Interphone study and Hardell results on mobile phone use and glioma as well as acoustic neuroma. However, animal studies were considered giving “limited evidence” for RF-EMF carcinogenicity. Since then various epidemiological and animal studies have been published, and in particular the so-called “NTP study” performed in the USA. This raises the question about whether these new data have changed the evidence for carcinogenicity? An overview of the state of knowledge in animal researches will be given. Scientific arguments for and against a link between RF-EMF and carcinogenicity based on in vivo studies will be presented transparently.

Coffee Break
Tuesday June 25, 2019 • 09:30 - 10:00
Joffre 2-3

Session: CA
Chiabrera Award
Tuesday June 25, 2019 • 10:00 - 11:00
Einstein
Chair: Anke Huss

CA-1 [10:00]

Personal RF exposure assessment in current and future telecommunication networks

Arno Thielens¹

¹*Department of Information Technology (INTEC), Ghent University/imec, Ghent, Belgium*



Biographical sketch

Arno Thielens is a postdoctoral researcher at UC Berkeley and Ghent University. He received a M.S. degree and a Ph. D. degree in applied physics at Ghent University in 2010 and 2015, respectively. He is affiliated to Ghent University's Waves group as a postdoctoral researcher, where his research focuses on personal exposure assessment to radio-frequency electromagnetic fields and numerical dosimetry. Since 2017, he is also a member of the Berkeley Wireless Research Center at the University of California, Berkeley, where he is working on: antenna design, body area networks, and the development of the human intranet.

Dr. Thielens is the recipient of the Joseph James Morrissey Memorial Award issued by the Bioelectromagnetics Society (BEMS) and the European Bio Electromagnetics Association (EBEA) in June 2013. He also received the 2015 URSI young scientist award. He obtained an FWO [PEGASUS]² Marie Skłodowska-Curie Fellowship in 2017 funded by the European Union's

Horizon 2020 research and innovation programme. He also received an Honorary Fellowship by the Belgian American Education Foundation (BAEF) in the same year.

Abstract

Radio-Frequency (RF) electromagnetic fields (EMFs) enable wireless communication between billions of users worldwide. Humans are exposed to these fields, but quantifying this exposure has proven to be challenging. There exist methods for measuring personal exposure to RF-EMFs emitted by far-field sources, but these are faced with uncertainties. This talk will present some techniques to reduce these measurement uncertainties and further improvements that could be made in the future, alongside measurements of exposure to near-field RF-EMF sources. These research efforts should improve our understanding of personal exposure to RF EMFs in the current telecommunication networks. However, future networks will use new technologies. Three of those are studied in terms of RF-EMF exposure: distributed small-cell networks, (massive) MiMo antennas, and higher carrier frequencies.

Session: S05
Epidemiological Studies
Tuesday June 25, 2019 • 11:00 - 12:30
Barthez
Chairs: Maria Feychting & Anke Huss

S05-1 [11:00]

Long-term effect of mobile phone use on sleep quality: results from the Cohort Study of Mobile Phone Use and Health (COSMOS)

Giorgio Tettamanti¹, Anssi Auvinen², Torbjörn Åkerstedt³, Katja Kojo⁴, Anders Ahlbom¹, Sirpa Heinavaara⁵, Paul Elliott⁶, Mireille Toledano⁶,

Session: S06
Human Studies
Tuesday June 25, 2019 • 11:00 - 12:30
Einstein
Chairs: Gunnhild Oftedal & Sarah Loughran

S06-1 [11:00]

STUDENT PAPER

RF-EMF exposure, sleep EEG, and memory consolidation

Sheridan Findlay^{1, 2}, Rodney Croft^{1, 2, 3} & Sarah Loughran^{1, 2, 3}

¹*Australian Centre for Electromagnetic Bioeffects*

Joachim Schüz⁷, Isabelle Deltour⁷, Hans Kromhout⁸, Roel Vermeulen⁸, Christoffer Johansen⁹, Aslak Harbo Poulsen⁹, Maria Feychting¹ & Lena Hillert¹

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⁹*Danish Cancer Society Research Center, Copenhagen, Denmark, DK 2100*

Keywords: Epidemiology, RF/Microwaves, Completed (unpublished)

Presented by: Maria Feychting

The majority of studies on the effect of radiofrequency fields from mobile phone use on sleep are cross-sectional; only a few prospective studies are available. In this study based on the Swedish and Finnish COSMOS participants, we evaluated whether operator recorded mobile phone calling time at baseline was associated with different sleep outcomes at the 4-year follow-up. The highest category of mobile phone call time was associated with a somewhat higher prevalence of insomnia. The effect estimate was slightly higher for calling time on the UMTS than on the GSM network, despite considerably higher RF exposure from GSM, suggesting that other aspects associated with extensive call time are more plausible explanations than RF field exposure.

S05-2 [11:15]

***In-utero* Exposure to high magnetic field non-ionizing radiation and the risk of headaches and migraines in offspring: A prospective cohort study with up to 21 years of follow-up**

De-Kun Li¹, Hong Chen¹, Andrew Hirst¹, Jeannette Ferber¹ & Roxana Odouli¹

Research, University of Wollongong, Wollongong, Australia, 2522

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³*Population Health Research on Electromagnetic Energy, Monash University, Melbourne, Australia, 3800*

Keywords: Human, RF/Microwaves, Completed (unpublished)

Presented by: Sheridan Findlay

The purpose of the present study was to determine whether RF-EMF exposure immediately prior to sleep, improves memory consolidation, while also improving on previous methods by the use of repeated testing within the individual. The findings from the pilot data of this study showed no differences in sleep spindle frequency or memory consolidation between the sham and the active RF-EMF exposure conditions, however there is insufficient statistical power to draw strong conclusions. Data collection is now complete and the results of the full data set will be presented at the BioEM2019 conference.

S06-2 [11:15]

STUDENT PAPER

Orientation and disorientation effects of a 50 mT extremely low frequency magnetic fields on human postural control

Nicolas Bouisset^{1, 2}, Sebastien Villard^{1, 2}, Daniel Goulet⁷, Michel Plante⁷, Martine Souques⁶,

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Keywords: Epidemiology, Static, Completed (published)

Presented by: De-Kun Li

In this prospective cohort study of 734 mother-child pairs, pregnant women were asked to carry an EMDEX meter to measure their level of exposure to magnetic field non-ionizing radiation (MF) during pregnancy. Their offspring were followed throughout childhood for any physician diagnosed headaches and/or migraines. Maternal exposure to high MF levels during pregnancy is associated with an increased risk of headaches and/or migraines in offspring. The association appears to be stronger for children with both headaches and migraines. Whites and male offspring also appeared to have a higher risk than non-Whites and female offspring, respectively.

François Deschamps⁵, Genevieve Ostiguy⁷, Jacques Lambrozo⁶ & Alexandre Legros^{1, 2, 3, 4, 8}

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Keywords: Human, ELF/LF, Work in Progress
Presented by: Nicolas Bouisset

Exposure to high levels of extremely low frequency magnetic fields (ELF-MF) modulates nervous system function, for example through magnetophosphenes perception. Electric and magnetic stimulation studies suggest that magnetophosphenes results from retinal cells activation. Given the close neurophysiological characteristics existing between the retina and the vestibular system, we chose to investigate the vestibular response to ELF-MF and electrical currents, and to analyze their impact on body sway. Here we find an orientation effect at 20 Hz and a disorientation effect at power line frequencies.

S05-3 [11:30]

Survival of glioma patients in relation to mobile phone use in Denmark, Finland and Sweden

Ann Olsson¹, Liacine Bouaoun¹, Anssi Auvinen², Maria Feychting³, Christoffer Johansen⁴, Tiit Mathiesen⁵, Beatrice Melin⁶, Anna Lahkola⁷, Suvi Larjavaara⁸, Anne-Sophie Villegier⁹, Graham Byrnes¹, Isabelle Deltour¹ & Joachim Schüz¹

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⁴*Oncology clinic, 5073 Rigshospitalet, University of Copenhagen, Copenhagen, Denmark, 2100*

S06-3 [11:30]

Magnetophosphenes perception and adaptation to the darkness: perception decreases as retinal sensitivity increases

Sebastien Villard^{1, 2}, Michael Corbacio¹, Nicolas Bouisset², Daniel Goulet³, Michel Plante³, Martine Souques⁴, François Deschamps⁵, Genevieve Ostiguy³, Jacques Lambrozo⁴ & Alexandre Legros^{1, 2, 6, 7}

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Keywords: Epidemiology, RF/Microwaves, Completed (published)

Presented by: Isabelle Deltour

Gliomas are the most common cancer of the brain. We investigated whether pre-diagnostic mobile phone use was associated with survival. Glioma cases (n=806) in the INTERPHONE study in Denmark, Finland and Sweden were followed up for survival via registry linkages. Cox regression models were used to calculate hazard ratios and 95% confidence intervals. No reduced survival among glioblastoma patients was observed for various measures of mobile phone use relative to no or non-regular use. All significant associations suggested better survival for mobile phone users. Results were similar for high-grade and low-grade gliomas. In conclusion we found no evidence of reduced survival among glioma patients in relation to previous mobile phone use.

S05-4 [11:45]

Radiofrequency electromagnetic fields, screen time, and cognitive function in children and adolescents at 9-18 years old

Mònica Guxens¹, Alba Cabré¹, Luuk van Wel², Ilaria Liorni³, Myles Capstick³, Roel Vermeulen², Lúcia González⁴, Jesus Ibarluzea⁵, Maties Torrent⁶ & Martine Vrijheid¹

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Keywords: Epidemiology, RF/Microwaves, Completed (unpublished)

Presented by: Monica Guxens

We evaluated the association between radiofrequency electromagnetic fields (RF-EMF), screen time, and cognitive functions in children and adolescents aged 9-18 years. We found that RF-EMF dose to the brain was associated with poorer

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Keywords: Human, ELF/LF, Work in Progress
Presented by: Sebastien Villard

Magnetophosphene (MP) perception has been used as model of interaction between extremely low frequency magnetic fields (ELF-MF) and the central nervous system (CNS). The origin of this interaction is most likely retinal, but the underlying mechanisms remains unclear. We proposed to re-explore the adaptation to the darkness paradigm (Lovsund, 1980) to better understand the perception of MP at the photoreceptors level. 3 groups of 20 healthy participants will be exposed to respectively 20, 50 and 60Hz ELF-MF up to 75mT. MP thresholds were taken over 45 minutes in the dark. Observations from 26 participants show an increase in MP thresholds but no effect of the frequency of stimulation. A thorough discussion will be presented at the conference

S06-4 [11:45]

Are there sex differences in possible effects of RF-EMF exposure on the macro- and microstructure of sleep between healthy elderly (60-80 years) men and women?

Heidi Danker-Hopfe¹, Hans Dorn¹, Gernot Schmid², Cornelia Sauter¹, Rene Hirt² & Torsten Eggert¹

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Keywords: Human, RF/Microwaves, Completed (unpublished)

Presented by: Heidi Danker-Hopfe

The study aims to analyse possible differences in RF-EMF effects on the macrostructure and the microstructure of sleep between healthy elderly men and women. The results indicate differences in effects of GSM 900 and TETRA exposure in healthy elderly (60-80 years) men and women. The results observed so far are not indicative of a disturbed sleep under RF-EMF exposure.

cognitive function including non-verbal IQ, attentional function, visuomotor coordination, and working memory. However, screen time has different pattern of association depending on the cognitive function.

S05-5 [12:00]

Parental occupational exposure to low-frequency magnetic fields and risk of leukaemia in the offspring: Findings from the Childhood Leukaemia International Consortium (CLIC)

Madar Talibov¹, Ann Olsson¹, Helen D. Bailey², Friederike Erdmann³, Catherine Metayer⁴, Corrado Magnani⁵, Eleni T. Petridou⁶, Anssi Auvinen⁷, Logan G. Spector⁸, Jacqueline Clavel⁹, Eve Roman¹⁰, John D. Dockerty¹¹, Atte Nikkilä¹², Olli Lohi¹³, Alice Kang¹⁴, Theodora Psaltopoulou¹⁵, Lucia Miligi¹⁶, Javier Vila¹⁷, Elisabeth Cardis¹⁷, Isabelle Deltour¹ & Joachim Schüz¹

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¹³*Tampere Center for Child Health Research, University of Tampere, Tampere, Finland, 33014*

S06-5 [12:00]

STUDENT PAPER

Effect of exposure to 900 MHz radiofrequency on the MEG alpha band activity at rest

Jasmina Wallace^{1, 2}, Lydia Yahia-Cherif^{3, 4}, Christophe Gitton^{3, 4}, Laurent Hugueville^{3, 4}, Jean-Didier Lemaréchal^{3, 4} & Brahim Selmaoui^{1, 2}

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Keywords: Clinical (diagnostics), RF/Microwaves, Work in Progress
Presented by: Jasmina Wallace

With the extensive use of mobile phones several studies have been realized to understand the effects of radiofrequency exposure on brain activity. Results show changes in the alpha band spectral power. To better understand the cortical structures involved in these changes after exposure at 900 MHz, we carried out electroencephalography and magnetoencephalography recordings followed by the anatomical magnetic resonance imaging. Healthy volunteers were selected according to strict inclusion criteria. Preliminary results on MEG sensor space showed a modification of the alpha band right after exposure. Data analyses of MEG recordings on sensor space and source space are still under process and ready results will be presented at the conference.

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Keywords: Epidemiology, ELF/LF, Completed (unpublished)

Presented by: Isabelle Deltour

Evidence from previously published studies on parental occupational exposure to extremely low-frequency magnetic fields (ELF-MF) and risk of leukemia in their offspring is inconsistent. 11 case-control studies including 9,723 childhood leukemia cases and 17,099 controls were pooled. Parental occupational ELF-MF exposure was assigned by linking jobs to an ELF-MF job-exposure matrix (JEM). The current study did not find association between parental occupational ELF-MF exposure and childhood leukemia.

S05-6 [12:15]

Exposure of adults to ELF magnetic field in France: statistical analysis of the data

Isabelle Magne¹, Martine Souques¹, Laurène Courouve², Anne Duburcq², Emmanuel Remy³ & Pierre-André Cabanes¹

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Keywords: Epidemiology, ELF/LF, Completed (unpublished)

Presented by: Isabelle Magne

The exposure assessment to ELF magnetic fields remains an important question in the context of epidemiological studies. We present here the final results of the first study characterizing personal exposure of adults at a national scale. Descriptive statistical analyses were performed for all the adults, and only for adults where no alarm clock was identified, as in some cases this requirement of the measurement protocol was not respected. We looked in particular to the most exposed class, as to the adults living close to high voltage power line.

S06-6 [12:15]

Electromagnetic hypersensitivity: A critical review of explanatory hypotheses

Maël Dieudonné¹

¹*Max Weber Center (CMW), Lyon, France, 69007*

Keywords: Behavioural, All Frequencies, Review, Commentary, Recommendation, Evaluation

Presented by: Maël Dieudonné

Electromagnetic hypersensitivity (EHS) is a condition defined by the attribution of symptoms to electromagnetic fields (EMF). Its nature remains disputed despite a growing scientific literature. This presentation reviews critically the main explanatory hypotheses that have been put forward: (1) the electromagnetic hypothesis, attributing EHS to EMF exposure; (2) the cognitive hypothesis, assuming that EHS results from false beliefs in EMF harmfulness, promoting nocebo responses to perceived exposure; (3) the attributive hypothesis, conceiving EHS as a coping strategy for pre-existing conditions. The implications for future research are discussed in conclusion.

Lunch
Tuesday June 25, 2019 • 12:30 - 14:00
Joffre 1

Session: M3
EBEA Assembly
Tuesday June 25, 2019 • 13:00 - 14:00
Barthez

Session: FB
Student Flash Poster Session B
Tuesday June 25, 2019 • 14:00 - 15:00
Einstein
Chairs: Christopher Portier & Niels Kuster

Session: PB
Poster Session B
Tuesday June 25, 2019 • 15:00 - 16:30
Joffre 2-3

Coffee Break
Tuesday June 25, 2019 • 16:30 - 17:00
Joffre 2-3

Session: W1
Workshop 1 - Atmospheric
electromagnetic field bioeffects
Tuesday June 25, 2019 • 17:00 - 18:30
Barthez
Chairs: Michal Cifra & Lluís M. Mir

Session: W2
Workshop 2 - Differences of exposure
limits between the new ICNIRP
Guidelines and IEEE C95.1 Standard
Tuesday June 25, 2019 • 17:00 - 18:30
Einstein
Chairs: C. K. Chou & Eric Van Rongen

W1-1 [17:00]

Introduction of the workshop and Electromet COST action

Michal Cifra¹ & Lluís M. Mir²

¹*Bioelectrodynamics research team, Institute of
Photonics and Electronics of the Czech Academy of
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²*Vectorology and Anticancer Therapies, UMR 8203
CNRS, Univ. Paris-Sud, Gustave Roussy, Université
Paris-Saclay, Villejuif, France*

W2-1 [17:00]

Differences of exposure limits between the new ICNIRP guidelines and IEEE C95.1 standard

C. K. Chou¹ & Eric Van Rongen²

¹*ICES TC95, IEEE, Piscataway, New Jersey, USA,
08854*

²*ICNIRP, Munich, Germany, 85764*

Two international organizations develop EMF exposure limits. IEEE's involvement with RF safety issues predates the first C95.1 EMF standard published in 1966 by the American Standards Institute. The latest version of the IEEE C95.1 standard published in March 2019 covers 0 to 300 GHz. The International Commission on Non-ionizing Radiation and Protection (ICNIRP), a collaborating organization of the World Health Organization, published guidelines for up to 300 GHz in 1998 and below 100 kHz in 2010. Currently, ICNIRP is working on revised guidelines for radiofrequencies above 100 kHz. Differences of the limits between IEEE C95.1-2019 and ICNIRP newly

developed radiofrequency limits will be the main discussion of this workshop.

W1-2 [17:10]

Spectral perspective on natural Earth electromagnetic phenomena

Michal Cifra¹

¹*Bioelectrodynamics research team, Institute of Photonics and Electronics of the Czech Academy of Sciences, Prague, Czech Republic, 18200*

This presentation is a part of the ATMOSPHERIC ELECTROMAGNETIC FIELD BIOEFFECTS workshop. We present here a brief overview of electromagnetic phenomena naturally present in the biotope of Earth organisms. Spectrally, the main focus is from 0 Hz to 300 GHz.

W1-3 [17:30]

Atmospheric electricity and other “natural” voltage gradient sources: the case of pyroelectricity

Lluís M. Mir¹, Adeline Muscat¹, Isabelle Leray¹ & Tomás García-Sánchez¹

¹*Vectorology and Anticancer Therapies, UMR 8203 CNRS, Univ. Paris-Sud, Gustave Roussy, Université Paris-Saclay, Villejuif, France*

Pyroelectricity consists in the generation of an electric field (EF) at the surface of some materials when a change in temperature is produced. Here tourmaline microparticles, which are known to display pyroelectrical properties, were subjected to different changes in temperature prior their exposure to cells in order to induce an EF at the cell surface. Then, changes in the permeability of the cell membrane to a nonpermeant cytotoxic agent were assessed by a cloning efficacy test. An increase in cell membrane permeability was only detected when tourmaline was subjected to a change in temperature, suggesting that an induced pyroelectrical EF on the material could actually be involved in the observed enhancement of the membrane permeability.

W1-4 [17:50]

New insights from a Bayesian analysis of melatonin levels and low-frequency magnetic fields

Nicolas Bouche¹ & Kevin McConway²

¹*CRAL, University of Lyon1, St Genis Laval, France, F-69230*

²*Mathematics And Statistics, The Open University,*

W2-2 [17:15]

Overview of the Revised International Commission on Non-Ionizing Radiation Protection (ICNIRP) Radiofrequency Guidelines

Rodney Croft^{1, 2}

¹*School of Psychology, Illawarra Health & Medical Research Institute, University of Wollongong, Wollongong, Australia, 2522*

²*Australian Centre for Electromagnetic Bioeffects Research, Wollongong, Australia, 2522*

This talk provides an overview of the upcoming International Commission on Non-Ionizing Radiation Protection (ICNIRP) radiofrequency guidelines.

W2-3 [17:30]

Review of dosimetry studies for setting the ICNIRP Guidelines

Akimasa Hirata^{1, 2}

¹*Department of Electrical and Mechanical Engineering, Nagoya Institute of Technology, Nagoya, Japan, 466-8555*

²*Center of Biomedical Physics and Information Technology, Nagoya Institute of Technology, Nagoya, Japan, 466-8555*

This talk reviews the rationale of the metrics, basic restrictions, and reference levels in the upcoming International Commission on Non-Ionizing Radiation Protection (ICNIRP) radiofrequency guidelines.

W2-4 [17:45]

Thermal modeling and IEEE RF exposure limits above 6 GHz

Kenneth Foster¹, Marvin Ziskin² & Quirino Balzano³

¹*Department of Bioengineering, University of Pennsylvania, Philadelphia, PA, USA, 19104*

²*Temple University Medical School, Philadelphia, PA, USA, 19104*

Milton Keynes, United Kingdom, MK7 6AA

The epidemiological study of Wertheimer¹⁹⁷⁹ raised concerns for adverse health effects due to Extremely Low Frequency magnetic fields (ELF MF) generated by power lines. Since, epidemiological studies and laboratory studies on rats have often been contradictory. Here, we revisit the possible connection between ELF MF and the biomarker Melatonin in humans and laboratory rats using two modern approaches: a Bayesian model and a non-parametric approach. Both methods reveal the same surprising well ordered pattern which reconciles past contradictory results.

W1-5 [18:10]

Roundtable: Open contributions on the “atmospheric electricity and EMF” - facts, hypothesis and consequences on the biological objects and their evolution

³*Department of Electrical and Computer Engineering, University of Maryland, College Park, MD, USA, 20742*

This talk reviews the rationale for revisions of IEEE C95.1 RF exposure limits above the “transition frequency” of 6 GHz, where the limits (the exposure reference level, ERL) are expressed in terms of power density incident on skin.

W2-5 [18:00]

Differences of exposure limits between the new ICNIRP Guidelines and IEEE C95.1 Standard

Richard Tell¹

¹*Richard Tell Associates, Inc, 10037 Long Meadow Road, Madison, AL, USA, 35756*

Two specific aspects of the new IEEE standard C95.1 and how it differs from the proposed revision of the ICNIRP Guidelines on RF exposure are discussed. These two issues are (a) the designation of who may be exposed to specific levels of RF energy and (b) limits on local exposure. Both the IEEE standard and ICNIRP guidelines incorporate upper and lower tiers of exposure limits.

**Conference Dinner
Tuesday June 25, 2019 • 19:00 - 23:00
Domaine des Mours**

Wednesday June 26, 2019

Session: P3
Plenary 3 - 5G real-life exposure: how to assess and optimize?
Wednesday June 26, 2019 • 09:00 - 10:30
Einstein
Chairs: Luc Martens & Sami Gabriel

P3-1 [09:00]

Procedures for in-situ 5G-NR MaMIMO exposure evaluation and first trial results

Wout Joseph¹

¹*Department of Information Technology (INTEC), Ghent University/imec, Ghent, Belgium*



Biographical sketch

Wout Joseph was born in Ostend, Belgium on October 21, 1977. He received the M. Sc. degree in electrical engineering from Ghent University (Belgium), in July 2000. From September 2000 to March 2005 he was a research assistant at the Department of Information Technology (INTEC) of the same university. During this period, his scientific work was focused on electromagnetic exposure assessment. His research work dealt with measuring and modelling of electromagnetic fields around base stations for mobile communications related to the health effects of the exposure to electromagnetic radiation. This work led to a Ph. D. degree in March 2005. He was postdoctoral researcher for iMinds-UGent/INTEC until 2009. From October 2007 to October 2013, he was a Post-Doctoral Fellow of the FWO-V (Research Foundation – Flanders). Since October 2009, he is professor in the domain of Experimental Characterization of wireless communication systems. He is IMEC PI since 2017. His professional

interests are electromagnetic field exposure assessment, in-body electromagnetic field modelling, electromagnetic medical applications, propagation for wireless communication systems, IoT, antennas and calibration.

Abstract

The first commercial 5G mobile networks are being deployed at the end of 2018 and people will be exposed to this new technology. Regulators urgently need in-situ evaluations and will need to have procedures and tools for the assessment of realistic human exposure. This leads to a need of on-site (in situ) measurements of the RF exposure from the 5G base station radios taken into operation.

The 5G mobile networks being rolled-out consist of 5G new radio (NR) technology, Massive MIMO (MaMIMO) where the base stations will in most cases use beamforming, small cells, and mm-wave technology. MaMIMO as 5G technology enables benefits such as excellent spectral efficiency and superior energy efficiency. The main concept is to use large base station antenna arrays to simultaneously serve multiple user equipment.

Up to now, there is no methodology available on how to conduct in-situ 5G exposure measurements, nor to perform 5G network planning with minimal exposure. An important challenge is to obtain correct realistic exposure and avoid unrealistic overestimations by assuming continuous beamforming.

The aim of this plenary is to propose in a general understandable way (i) new measurement methodologies to assess the instantaneous as well as (realistic) maximum 5G exposure, (ii) first in-situ 5G base station exposure assessments, (iii) insights into 5G-NR equipment, device usage and 5G field distributions, (iv) and concepts for 5G network planning with minimal exposure.

P3-2 [09:10]

5G network planning with minimum exposure in real environments

Margot Deruyck¹

¹*Department of Information Technology (INTEC), Ghent University/imec, Ghent, Belgium*

Biographical sketch

Margot Deruyck was born in Kortrijk, Belgium, on July 14, 1985. She received the M. Sc. degree in Computer Science Engineering and the Ph. D. degree from Ghent University, Ghent, Belgium, in 2009 and 2015, respectively. From September 2009 to January 2015, she was a Research Assistant with Ghent University - IMEC – WAVES (Wireless, Acoustics, Environment & Expert Systems – Department of Information Technology). Her scientific work is focused on green wireless access networks with minimal power consumption and minimal exposure from human beings. This work led to the Ph.D. degree. Since January 2015, she has been a Postdoctoral Researcher at the same institution where she continues her work in green wireless access network planning. Since October 2016, she is a Post-Doctoral Fellow of the FWO-V (Research Foundation - Flanders).

Abstract



In the last decades, not only an increase in mobile devices has been noticed, but these devices are also becoming more powerful, allowing quite demanding services such as streaming music or video. Wireless access networks need to expand to cope with these extra demands to keep the user satisfied. Wireless network planning is a complex problem which targets the minimization of CAPEX by the network operator by jointly (i) selecting proper locations for the sites hosting the base stations; (ii) dimensioning the radio equipment installed at each BS, and (iii) fulfilling performance constraints on coverage, capacity, and quality of service perceived by end users.

Besides network expansion, new technologies are being developed such as 5G NR (New Radio) with features like massive MIMO, beamforming, small cells and the use of mm-wave frequencies. Similar as for the currently deployed 2 to 4G technologies, the new 5G deployments will have to satisfy applicable regulations on Electromagnetic Field exposure.

Factoring in both EMF exposure limits and the 5G specifications in terms of EMF emissions further complicates the network planning described above. This talk will discuss 5G network planning accounting for human exposure, as well as the minimization of the global network exposure.

P3-3 [09:20]

5G small cells and MaMIMO exposure assessment in real environments

Joe Wiaart¹

¹Chaire C2M, Télécom ParisTech, Paris, France

P3-4 [09:30]

Determination of time-averaged power levels for assessment of actual RF-EMF exposure from massive MIMO antennas

Christer Tornevik¹

¹Ericsson Research, Ericsson AB, Stockholm, Sweden



Biographical sketch

Christer Törnevik received the M.Sc. degree in applied physics from the Linköping University, Linköping, Sweden, in 1986, and the Licentiate degree in materials science from the Royal Institute of Technology, Stockholm, Sweden, in 1991. He joined Ericsson in 1991. Since 1993, he has been involved in research activities related to radio frequency exposure from wireless communication equipment. He is currently a Senior Expert with responsibility for electromagnetic fields and health within the Ericsson Group. From 2003 to 2005, he was the Chairman of the Mobile & Wireless Forum, where he is currently the Secretary of the Board. Since 2006, he has been leading the Technical Committee on electromagnetic fields of the Swedish Electrotechnical Standardization Organization, SEK, and he has as an expert contributed to the development of several CENELEC, IEC, ITU and IEEE standards on the assessment of RF exposure from wireless

equipment.

P3-5 [09:40]

How to assess RF exposure compliance of base stations based on actual network service

Christophe Grangeat¹

¹*Nokia Bell Labs, Stuttgart, Germany*



Biographical sketch

Christophe Grangeat has almost 30-year experience in managing innovation and technologies dealing with EMF exposure and sustainable telecom networks. He is currently RF exposure and energy efficiency Senior Specialist within the 5G & Small Cells Business Unit of Nokia Mobile Networks Business Group. He is coordinating activities involving products and features architecture design, portfolio management, R&D, compliance assessment and standardization. He contributed to multiple research projects such as Comobio, Adonis, OperaNet and SooGreen. He is actively developing and coordinating international standards within the IEC, CENELEC, ITU and ETSI. He is co-convenor of IEC TC106 MT3. He is promoting stakeholder's dialog through industry fora like the GSMA or the Small Cell Forum.

P3-6 [09:50]

Assessment of maximally allowable power-density averaging area for conservative electromagnetic exposure assessment above 6 GHz

Manuel Murbach¹

¹*IT'IS Foundation, Zurich, Switzerland, 8004*

P3-7 [10:00]

Round table

Coffee Break
Wednesday June 26, 2019 • 10:30 - 11:00
Joffre 2-3

Session: T1
Tutorial 1 - Body temperature regulation in Mammals
Wednesday June 26, 2019 • 11:00 - 12:00
Einstein
Chairs: Rene De Seze & Carmela Marino

T1-1 [11:00]

Body temperature regulation in mammals

Shaun Morrison¹

¹*Oregon Health & Science University, Portland, OR, USA*



Biographical sketch

Dr. Shaun Morrison received his Ph.D. in Physiology and Biophysics from the University of Vermont, defending a thesis on the central nervous system regulation of blood pressure in spontaneously hypertensive rats. At Cornell University, he continued to study the neural circuits in the brain that regulate the sympathetic nerve activity to blood vessels. As a Professor of Physiology at Northwestern University, he pioneered neurophysiological investigations into the neural basis for the differential brain regulation of the sympathetic outflows to different tissues, including the adrenal gland and the brown adipose tissue. These studies led to a focus on the brain regulation of body temperature, which Dr. Morrison has pursued at Oregon Health and Sciences University, where he is a Professor in the Department of Neurological Surgery. Of particular interest are the brain mechanisms controlling heat production in brown adipose tissue and through skeletal muscle shivering.

Abstract

Maintenance of a homeostatic body core temperature is a critical brain function accomplished by a central neural network which orchestrates a complex behavioral and autonomic repertoire in response to environmental temperature challenges or to declining energy homeostasis, and in support of immune responses and many behavioral states, including stress, sleep, and reproduction. This tutorial will present an overview of the anatomical, neurotransmitter, and functional relationships within the central neural network that controls the principal thermoeffectors: cutaneous vasoconstriction regulating heat loss, and shivering and brown adipose tissue for heat production. The core thermoregulatory network regulating these thermoeffectors consists of parallel but distinct central efferent pathways that share a common peripheral thermal sensory input. Hopefully this précis will provide a framework for understanding potential central neural mechanisms which may underlie the effects of exposure to radio frequency electromagnetic fields on body temperature. Supported by USPHS National Institutes of Health grant R01 NS091066.

Session: S07
Risk, Safety Standards & Policy
Wednesday June 26, 2019 • 12:00 - 13:00
Einstein
Chairs: Andrew Wood & Rodney Croft

S07-1 [12:00]

Application of non-ionizing radiation on humans for non-medical purposes. New regulation in Germany

Blanka Pophof¹, Monika Asmuss¹, Jens Kuhne¹, Daniela Weiskopf¹ & Gunde Ziegelberger¹

¹*Radiation and Health, Federal Office for Radiation Protection, Oberschleißheim/Neuherberg, Germany, D-85764*

Keywords: Public Health Policy, All Frequencies, Completed (published)

Presented by: Blanka Pophof

In December 2018 Germany released a new ordinance to protect customers from adverse effects of non-ionizing radiation applied to humans for cosmetic and other non-medical purposes. It covers the commercial application of optical radiation, electric, magnetic and electromagnetic fields and ultrasound. The ordinance will enter into force on December 31st 2020.

S07-2 [12:15]

Consistency of electromagnetic exposure safety frameworks for localized and pulsed exposure above 6 GHz

Esra Neufeld¹, Theodoros Samaras² & Niels Kuster^{1, 3}

¹*Foundation for Research on Information Technologies in Society (IT²IS Found, Zurich, Switzerland, 8004*

²*Department of Physics, Aristotle University of*

Session: S08
Effects of ELF magnetic fields (in-vitro)
Wednesday June 26, 2019 • 12:00 - 13:00
Barthez
Chairs: Barbara Benassi & Bennett Ibey

S08-1 [12:00]

50-Hz magnetic field impairs the expression of iron-related genes in the *in vitro* SOD1^{G93A} model of amyotrophic lateral sclerosis

Claudia Consales¹, Martina Panatta², Alessio Butera³, Giuseppe Filomeni⁴, Caterina Merla¹, Carmela Marino¹ & Barbara Benassi¹

¹*Division of Health Protection Technologies, ENEA, Rome, Italy, 00123*

²*Department of Chemistry and Biochemistry, University of Bern, Bern, Switzerland, 3012*

³*Department of Biology, University of Rome Tor Vergata, Rome, Italy, 00133*

⁴*Cell Stress and Survival Unit, Danish Cancer Society Research Center, Copenhagen, Denmark, 2100*

Keywords: In vitro, ELF/LF, Completed (published)

Presented by: Claudia Consales

We characterized the response to the extremely low frequency magnetic field (ELF-MF) in an *in vitro* model of Amyotrophic Lateral Sclerosis, carrying two mutant variants of the superoxide dismutase 1 (SOD1) gene. SH-SY5Y human neuroblastoma cells, stably over-expressing the wild type, the G93A or the H46R mutant SOD1 cDNA, were exposed to either the ELF-MF (50 Hz, 1 mT) or the sham control field, up to 72 hours. We report that 50-Hz MF exposure does not induce any change in proliferation and viability, but triggers a significant deregulation in the expression of iron-related genes IRP1, MFRN1 and TfR1, this evidence being exclusive for the SOD1^{G93A} clone and associated with a slight (P=0.0512) difference in the total iron content.

S08-2 [12:15]

50 Hz magnetic field exposure modulates Nitric Oxide Synthase 2 (NOS2) expression in N9 microglia cells

Barbara Benassi¹, Caterina Merla¹, Claudia Consales¹, Flavia Novelli¹, Roberta Vitali¹, Carmela Marino¹ & Claudio Pioli¹

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Keywords: In vitro, ELF/LF, Work in Progress

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³Swiss Federal Institute of Technology (ETHZ),
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**Keywords: Standards, RF/Microwaves,
Completed (published)**

Presented by: Niels Kuster

Exposure safety frameworks have been proposed for EM fields at frequencies above 6GHz. This study investigates whether the proposed limits are consistent with the goal of preventing potentially hazardous local heating. The results demonstrate that in the case of short pulses, duration-independent limits imposed on transmitted energy density (fluence) alone cannot preclude the induction of high skin temperature increases. Pulse-duration-independent fluence-limits are not suitable. They should either be replaced by duration-dependent ones or by limits on the peak exposure. The limits should be set considering narrow exposures. The current maximum averaging area should be replaced by a continuously frequency-dependent one.

S07-3 [12:30]

Safety concerns for MRI heating of fractured and adjacent metallic implants

Manuel Murbach¹, Nassim Nasser¹, Esra Neufeld¹
& Niels Kuster^{1, 2}

¹IT'IS Foundation, Zurich, Switzerland, 8004

²ETH Zurich, Zurich, Switzerland, 8092

**Keywords: Dosimetry (computational),
RF/Microwaves, Completed (published)**

Presented by: Manuel Murbach

Test methods for safety assessment regarding radiofrequency (RF) heating of small metallic medical implants in magnetic resonance imaging (MRI) are standardized by ASTM. The test is focused on individual or electrically connected implant systems; non-electrically connected combinations of fractured or multiple adjacent implants, which have not yet been sufficiently investigated, may lead to considerably altered RF coupling. In this study, we assessed induced heating as a function of the separation distance between two simple metal rods. Results show that the fracture or gap can shift the resonance frequency of the entire implant and may lead to 10-fold higher heating than an electrically connected implant of the same length.

Presented by: Barbara Benassi

The characterization of microglia response to electro-magnetic stimulation is a challenging field of research, as experimental results are still limited. With the aim to assess the effect driven by the extremely low frequency magnetic fields (ELF-MFs), we exposed the N9 mouse microglia cells to 50 Hz (1 mT) MF for 24 h, followed by 24 h treatment with the lipopolysaccharide(LPS). We found that ELF exposure was not toxic to cells, as both proliferation and viability were not affected by the radiation; conversely, the expression of NOS2 gene was stimulated by the ELF exposure. The characterization of the NOS2-mediated pathway and its impact on functional features of microglia cells is ongoing.

S08-3 [12:30]

STUDENT PAPER

The duration of 50-Hz extremely low frequency magnetic field pre-exposure affects the repair rate of bleomycin-induced DNA damage in murine FDC-P1 hematopoietic cells

Ehab Mustafa¹, Jukka Luukkonen¹ & Jonne Naarala¹

¹Department of Environmental and Biological Sciences, University of Eastern Finland, Kuopio, Finland, 70211

**Keywords: In vitro, ELF/LF, Work in Progress
Presented by: Ehab Mustafa**

According to current understanding, the disruption of circadian rhythm may lead to carcinogenesis by impairing the DNA damage responses. This association motivated us to explore whether the duration of exposure to extremely low frequency (ELF) magnetic fields (MFs) plays a role in the response to subsequent chemical treatment. We found that pre-exposure to 24-h and 48-h ELF MFs (50 Hz, 200 μ T) modified the repair rate of bleomycin-induced DNA damage in murine FDC-P1 hematopoietic cells, while no consistent effects were detected after 15-min or 2-h MF exposure durations. To identify the underlying mechanisms of the observed effects, we are currently performing gene expression analyses of the circadian rhythm and DNA damage responses.

S07-4 [12:45]**Assessment of average power density definitions in free space using real mm-Waves antennas and devices**

Walid El Hajj¹, Khodor Rida¹, John Roman² & Nawfal Asrih¹

¹*Wireless RF Lab (WRF), iCDG , Intel Corporation, Antibes, France, 06600*

²*Government, Markets, and Trade (GMT), Intel Corporation, Hillsboro , Oregon, USA, 97124*

Keywords: Standards, RF/Microwaves, Other
Presented by: Walid El Hajj

This paper shows a comparison between the two candidates for the definition of power density: 1) the normal component of Poynting vector crossing the surface, 2) the norm of Poynting Vector. We illustrate the difference as the ratio between the averaged power density values obtained using both definitions (1)/ (2). The ratio between 0 and 1 is studied for different source types and different distances from the sources. It shows that the ratio in can go from 56% to 98% depending on the distance, source type, and the EM environment around the antenna when integrated into device.

S08-4 [12:45]**EGFR-mediated activation of MAPK signaling in human neuroblastoma cells exposed to weak, power-frequency magnetic field**

Maria Martinez¹, Alejandro Ubeda¹ & Maria Angeles Trillo¹

¹*Investigación-BEM, Hosp. Universitario Ramón y Cajal-IRYCIS, Madrid, Spain, 28034*

Keywords: In vitro, ELF/LF, Completed (unpublished)

Presented by: Maria Angeles Trillo

The involvement of the EGFR receptor in the previously reported proliferation and activation of MAPK (-ERK1/2, -p38 and -JNK) in NB69 cells was investigated. The results confirmed that MF-exposure induces proliferation and activation of MAPK, and showed that these effects were blocked with erlotinib. The data also showed that, exposure induces increases in the expression of MMP-9 and p-EGFR at 5 and 15 min from the exposure onset, respectively. Together with our previously published results, these data suggest that the proliferative response induced in NB69 by a 63-hour exposure to a 100 μ T, power frequency MF, is mediated by early transient activation of EGFR potentially involving MMP-9.

Lunch (not provided)
Wednesday June 26, 2019 • 13:00 - 14:00

Thursday June 27, 2019

**Session: DA
d'Arsonval Award
Thursday June 27, 2019 • 09:00 - 10:00
Einstein
Chair: Azadeh Peyman**

DA-1 [09:00]

J. Patrick Reilly is the 2018 d'Arsonval Award winner

J. Patrick Reilly¹

¹*Silver Spring, MD, USA*



The Bioelectromagnetics Society has a rigorous procedure to choose from outstanding nominations competing for the d'Arsonval Award. These nominations are initially carefully reviewed by members of the BEMS Awards Committee (composed of 5 board members and the last 5 d'Arsonval Award winners) before a recommendation is submitted to the Board of Director for the final vote.

It is an honour to announce that the Board of Directors of BEMS has supported the recommendation from the awards committee to give the d'Arsonval Award (2018) to J. Patrick Reilly in recognition of his outstanding achievements in Bioelectromagnetics Research.

Pat Reilly has been conducting bioelectromagnetics research for over 50 years, with over 160 published works, including 4 major text books. He first studied radar propagation at the Johns Hopkins University Applied Physics Laboratory beginning in 1965 when he was in graduate school. In the mid 70's, he started to investigate electrical influence on environment and people, and was a principle advisor to the Maryland State Department of Natural Resources providing biologically-based assessment of the electromagnetic effects of transmission lines across the electromagnetic spectrum. Since the early 80's, Pat Reilly has concentrated his focus on human sensitivity to electrical stimulation by contact currents and by induction from exposure to electric and magnetic fields. More recently he has been providing consulting work on the safety and effectiveness of electrical stun devices and electrical effects on astronauts during extravehicular activities.

Pat Reilly has provided invaluable service to the bioelectromagnetics community by serving on several standard-setting committees, and was the primary resource for technical development of IEEE Standard C95.6-2002, "IEEE Standard for Safety Levels with Respect to Human Exposure to Electromagnetic Fields, 0-3 kHz." His work as a consultant also influenced development and revision of guidelines prepared by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). Reilly became a member of BEMS in 1983, and has been a participant on various BEMS working groups and program planning committees.

Pat Reilly's research, scholarly works, and extensive service to the bioelectromagnetics community at large, has been acknowledged and praised by several colleagues including previous winners of d'Arsonval award who submitted his nomination to BEMS awards committee.

Pat is also a keen Harmonica player and is known amongst colleagues and friends as the "Harmonica Guy"!

Many congratulations Pat!

Session: S09
Exposure assessment techniques I
Thursday June 27, 2019 • 10:00 - 11:30
Barthez
Chairs: Teruo Onishi & Joe Wiart

S09-1 [10:00]
STUDENT PAPER

A wearable multi-band SAR_{wb}-meter for RF dosimetry in indoor environments

Reza Aminzadeh¹, Arno Thielens^{1, 2}, Luc Martens¹ & Wout Joseph¹

¹*Department of Information Technology, Ghent University/imec, Ghent, Belgium, 9052*

²*Department of Electrical Engineering and Computer Sciences, University of California, Berkeley, California, USA, CA 94704*

Keywords: Dosimetry (measurements), RF/Microwaves, Completed (unpublished)
Presented by: Reza Aminzadeh

In this paper we propose a novel wearable multi-band whole-body averaged specific absorption rate (SAR_{wb}) meter calibrated in a reverberation chamber for radio-frequency (RF) dosimetry in an indoor diffuse environment. A novel concept of mass factor is introduced that enables direct and straightforward in-situ measurement of SAR_{wb} from the received powers on textile antennas in different frequency bands. The proposed method does not require numerical simulations. The meter has a low measurement uncertainty in terms of combined 50% confidence interval of its mass factor below 4.1 dB. The proposed meter is validated using a tri-axial broadband antenna and a spectrum analyzer.

S09-2 [10:15] - YOUNG SCIENTIST PAPER

A five-country study of microenvironmental electromagnetic fields using two personal exposimeters and a distributed body-worn sensor

Marloes Eeftens^{1, 2}, Reza Aminzadeh³, Stefan Dongus^{1, 2}, Anke Huss⁴, Rene De Seze⁵, Patricia de Llobet^{6, 7}, Matthias Van Den Bossche³, Elisabeth Cardis^{6, 7}, Elodie Vauquelin⁸, Arno Thielens³, Patrick Van Torre³, Sam Agneessens³,

Session: S10
Interaction Mechanisms (theoretical and experimental)
Thursday June 27, 2019 • 10:00 - 11:30
Einstein
Chairs: Frank S. Prato & Frank Barnes

S10-1 [10:00]

How genes from magnetotactic bacteria can transform magnetic resonance imaging into a powerful molecular imaging technology

Frank S. Prato^{1, 2, 4, 5}, Qin Sun^{1, 2}, Cecile Fradin³, R. Terry Thompson^{1, 2, 5} & Donna Goldhawk^{1, 2, 5}

¹*Lawson Imaging, Lawson Health Research Institute, London, Ontario, Canada, N6A 4V2*

²*Medical Biophysics, Western University, London, Ontario, Canada, N6A 3K7*

³*Physics and Astronomy, McMaster University, Hamilton, Ontario, Canada, L8S 4L8*

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Keywords: Clinical (diagnostics), Static, Completed (unpublished)
Presented by: Frank Prato

Optical reporter genes, such as firefly luciferase, are a powerful tool for imaging molecular activity in cells, tissues and small rodents. In larger animals and humans, a successful reporter gene is needed; one specific for magnetic resonance imaging (MRI) would be ideal. Magnetotactic bacteria produce iron particles of magnetite, which is the strongest MRI contrast agent known. Over the last decade, we have successfully introduced some of the needed magnetotactic bacterial genes into mammalian cells. As a proof of principle, weak MRI contrast has been achieved using only one such gene. More genetic engineering using additional bacterial genes to increase MRI contrast is currently being investigated.

S10-2 [10:15]
STUDENT PAPER

Collective oscillations of proteins proven by terahertz spectroscopy in aqueous medium

Yoann Meriguet^{1, 2}, Mathias Lechelon^{3, 4}, Matteo Gori³, Ilaria Nardecchia³, Anastasiia Kudashova¹, Dominique Coquillat², Luca Varani¹, Marco Pettini³ & Jeremie Torres¹

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Roel Vermeulen^{4, 9}, Wout Joseph³ & Martin Röösl^{1, 2}

¹Department of Environment and Public Health, Swiss Tropical and Public Health Institute, Basel, Switzerland

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³Department of Information Technology (INTEC), Ghent University/imec, Ghent, Belgium

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⁵TOXI/PERITOX UMRI-01, National Institute for Industrial Environment and Risks (INERIS), Verneuil-en-Halatte, France

⁶ISGlobal, Barcelona Institute for Global Health, Barcelona, Spain

⁷Pompeu Fabra University, Barcelona, Spain

⁸Technical Center for Mechanical Industries (CETIM), Senlis, France

⁹Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, Utrecht, the Netherlands

Keywords: Dosimetry (measurements), RF/Microwaves, Completed (unpublished)
Presented by: Marloes Eeftens

We characterized exposure to RF-EMF in 357 different unique microenvironments in five European countries, using two personal exposimeters, as well as a vest with integrated sensors. We found substantial exposure differences between large cities, medium-sized towns and small villages, and found consistently higher total exposures in central, busy places with many people (business, shopping districts) than in quieter, residential areas.

S09-3 [10:30]

Personal RF-EMF exposure from mobile phone base stations during populous temporary events

Raquel Ramírez-Vazquez¹, Jesus Gonzalez-Rubio², Enrique Arribas¹ & Alberto Nájera²

¹Applied Physics, University of Castilla-La Mancha, Albacete, Spain, 02008

²Medical Sciences, University of Castilla-La Mancha, Albacete, Spain, 02008

Keywords: Dosimetry (measurements), RF/Microwaves, Completed (unpublished)
Presented by: Alberto Nájera

Summary: Personal RF-EMF exposure from mobile phones (uplink) and mobile phone base stations (downlink) installed at the 2017 Albacete Fair

²Laboratoire Charles Coulomb (L2C), University of Montpellier, CNRS, Montpellier, France

³Centre de Physique Théorique (CPT), Aix-Marseille University, CNRS, Marseille, France

⁴Centre d'Immunologie de Marseille-Luminy (CIML), Aix-Marseille University, Marseille, France

Keywords: Mechanistic/Theoretical, THz, Completed (published)

Presented by: Yoann Meriguet

Understanding the forces that enable protein interaction is a major scientific challenge. Indeed, Brownian diffusion alone, which is usually considered as the main engine of protein dynamics, does not explain the rapidity and efficiency of the biomolecular reactions at work in cells. In this presentation we will present the first observation of the collective oscillations of a model protein driven out-of-equilibrium by means of optical excitation using terahertz spectroscopy.

S10-3 [10:30]

STUDENT PAPER

D3M: A new pathway to magneto-sensitivity exemplified by lipid autoxidation

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Keywords: Mechanistic/Theoretical, Static, Completed (unpublished)
Presented by: Robert H. Keens

The Radical Pair Mechanism is a canonical model for the magnetosensitivity of chemical reactions. Its key ingredient is the hyperfine interaction that

(Spain) was recorded. Measurements were repeated on a weekday, at the weekend and the day after the Fair ended after temporary base stations had been removed. Installing mobile phone base stations, and a dense public using mobile phones, imply a significant increase in personal RF-EMF exposure compared to that recorded during normal periods in the same area. However, the recorded measurements were below legally established limits. Personal RF-EMF exposure from mobile phones (uplink) and mobile phone base stations (downlink) installed at the 2017 Albacete Fair (Spain) was recorded.

S09-4 [10:45]

Comparing the accuracy of personal radiofrequency measurements using commercially available exposimeters with a novel body-worn measurement device

Anke Huss¹, Stefan Dongus², Reza Aminzadeh³, Arno Thielens^{3, 5}, Sam Agneessens³, Patrick Van Torre³, Rene De Seze⁴, Elisabeth Cardis⁶, Marloes Eeftens², Wout Joseph³, Roel Vermeulen¹ & Martin Röösli²

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Keywords: Dosimetry (measurements), RF/Microwaves, Completed (published)
Presented by: Anke Huss

We developed a new RF-EMF meter with sensors distributed over the front and back side of a vest, performed measurements in different microenvironments in five countries and compared results with commercially available exposimeters that are frequently used in epidemiological studies.

S09-5 [11:00]

A comparison between a measured and modelled assessment of the EMF exposure compliance boundary of an in-situ massive MIMO 4G LTE mobile radio base station

induces a coherent mixing of singlet and triplet electron spin states in pairs of radicals, thereby facilitating magnetic field effects (MFEs) on reaction yields. We have developed an alternative model, dubbed D3M, that demonstrates that the hyperfine interaction is not a categorical requirement to realize the sensitivity of radical reactions to weak magnetic fields. In systems comprising three instead of two radicals, dipolar interactions provide an alternative pathway for biologically relevant MFEs. We will apply these new ideas to the putative magnetosensitivity of lipid peroxidation.

S10-4 [10:45]

Membrane receptor-mediated ROS generation upon ELF exposure in neuroblastoma cells: an experimental and computational study

Caterina Merla¹, Micaela Liberti², Claudia Consales¹, Agnese Denzi², Francesca Apollonio², Carmela Marino¹ & Barbara Benassi¹

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Keywords: Mechanistic/Theoretical, ELF/LF, Completed (unpublished)
Presented by: Caterina Merla

In this work, the role of NADPH oxidase (Nox1) in ELF-MF mediated ROS generation is investigated. To this aim, we treated SH-SY5Y human neuroblastoma cells with the DPI, prior to exposure to 50 Hz, 1 mT MF for 24 hours. To locally quantify electric quantities and verify their biological relevance in the different cell compartments, microscopic electric fields and current densities in the surroundings of the plasma membrane of single cells have been computed. Our microdosimetric evaluations support experimental data demonstrating that a membrane receptor as Nox1 can be activated by the induced level of local current densities, thus indicating the membrane/extra-cellular medium interface as preferential target for ELF-neuron interactions.

S10-5 [11:00]

WITHDRAWN

Rob Werner¹ & Phillip Knipe²

¹*Network Governance, Singtel Optus, Brisbane, Australia, 4017*

²*Total Radiations Solutions Pty Ltd, Perth, Australia*

Keywords: Dosimetry (measurements),

RF/Microwaves, Work in Progress

Presented by: Rob Werner

Determining the realistic electromagnetic field (EMF) compliance boundary around a mobile phone base station antenna that utilizes beam forming massive multiple input multiple output (mMIMO) technology presents a challenge for mobile operators. Typically, compliance boundaries computed using a 'worst case' approach leads to a significant over estimation of realistic, everyday EMF levels. In this paper we show that in situ measurements of EMFs from an LTE 4G beam forming multi-user mMIMO antenna in a high mobile traffic urban environment are up to 12 dB lower than levels computed using a 'worst case' approach. In this high mobile traffic urban environment, the 'worst case' measurement was 7.3% of computed maximum level.

S09-6 [11:15]

STUDENT PAPER

Personal RF-EMF exposure levels in five Belgian cities

Maarten Velghe¹, Wout Joseph¹, Senne Debouvere¹, Reza Aminzadeh¹, Luc Martens¹ & Arno Thielens^{1, 2}

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Keywords: Dosimetry (measurements), RF/Microwaves, Completed (unpublished)

Presented by: Maarten Velghe

We characterized personal exposure to radio frequency-electromagnetic fields in 5 of the largest cities in Belgium using body-worn personal exposimeters. We related exposure to population density, regulatory limits, and time (rush and non-rush hours). The median values for total exposure showed a high repeatability and representativeness ($r=0.95$ and $r=0.88$ respectively). The highest average total exposure was found in Brussels (2.63 mW/m²). However, higher average downlink exposure was observed in a less densely populated city than Brussels. This might for the first time indicate an effect of the more stringent regulatory

S10-6 [11:15]

Is tubulin a sensitive target of nanosecond-scale intense electric field? A molecular dynamics study

Paolo Marracino¹, Daniel Havelka², Jiří Průša², Micaela Liberti¹, Jack A. Tuszynski³, Ahmed T. Ayoub⁴, Francesca Apollonio¹ & Michal Cifra²

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⁴*Medicinal Chemistry Department, Heliopolis University, Cairo, Egypt, 11777*

Keywords: Mechanistic/Theoretical, Pulsed, Completed (unpublished)

Presented by: Jack A. Tuszynski

Intense pulsed electric fields are known to act at the cell membrane level and are already being exploited in biomedical and biotechnological applications. However, it is not clear if intra-cellular components such as cytoskeletal proteins could be directly influenced by electric pulses within biomedically-attainable parameters. Our results with molecular dynamics on a tubulin heterodimer, suggest that intense nanosecond electric pulses

limits on outdoor exposure levels in Brussels.

could be used for physical modulation of microtubule dynamics. Since nanosecond pulsed electric field can penetrate cellular membranes due to its broadband spectrum, our results are also potentially significant for the development of novel therapeutic protocols.

Coffee Break
Thursday June 27, 2019 • 11:30 - 12:00
Joffre 2-3

Session: P4
Plenary 4 - Can membrane proteins act as biological probes for EM fields?
Thursday June 27, 2019 • 12:00 - 13:00
Einstein
Chairs: Olga Pakhomova & Olga Zeni

P4-1 [12:00]

Can membrane proteins act as biological probes for EM fields?

Francesca Apollonio¹

¹*Information Engineering, Electronics and Telecommunications, University of Rome Sapienza, Rome, Italy, 00184*



Biographical sketch

Francesca Apollonio received the Doctorate degree from the Sapienza University of Rome, Rome, Italy, 1998. Since 2000, she joined the Department of Electronic Engineering, Sapienza University of Rome as Assistant Professor and since 2019 she is Associate Professor. Dr. Apollonio is a member of the National Scientific Commission CNR-URSI, Commission K "Electromagnetics in Biology and Medicine" since 2011. From 2012 to 2015, she served on the Board of Directors of the Bioelectromagnetic Society. Presently she is National Representative of COST CA15211, "Atmospheric Electricity Network: coupling with the Earth System, climate and biological systems".

Her current research interests include the interaction between electromagnetic fields and biological systems using both theoretical and

experimental approaches.

Abstract

Membrane proteins are incorporated in the lipid bilayer of cells and allow signal transduction and transport of ligand molecules across the membrane. Because of these functions membrane proteins are the gatekeepers of cellular membranes where they act as enzymes, transporters, signaling receptors, or in energy conversion. In view of the role that they have on the sensory systems of living organisms when detecting and responding to various environmental stimuli, they can be also considered a probe for electromagnetic (EM) fields. Therefore in the present lecture starting from literature data supporting an involvement of membrane proteins as target for electric/magnetic or electromagnetic field, an attempt to unify the mechanism of interaction with EM fields will be provided, making use of computational techniques based on molecular dynamics (MD) simulations. MD simulations offer a great and distinct approach to investigate the structure of membrane proteins in ways that are complementary to experimental procedures. Due to the recent evolutions in computational efficiency, MD simulations have become a valuable tool for characterizing the organizational principles of cell membranes, for investigating the ligand-binding process and for elucidating mechanisms of interaction between electric and/or magnetic field and membrane proteins.

Adenosine receptors as pathways for beneficial effects of pulsed electromagnetic fields

Fabrizio Vincenzi¹ & Simona Salati²

¹Pharmacology and Toxicology, University of Ferrara, Ferrara, Italy, 44121

²IGEA S.p.A., Carpi, Italy



Biographical sketch

Fabrizio Vincenzi is a researcher and lecturer of Pharmacology and Toxicology at the University of Ferrara, Italy. His research activity is in the field of membrane receptors, with a specific interest in adenosine receptors and their involvement in different pathologies at both the central and peripheral level. The objectives of his works are to understand the mechanisms of membrane receptor modulation in response to pathological states and chemical or physical stimuli. He dedicated part of his research activity to the interaction between pulsed electromagnetic fields and adenosine receptors investigating how adenosine receptor could represent a biological pathway for the observed effects of pulsed electromagnetic fields. Fabrizio Vincenzi received his Bachelor's degree in Biology and a PhD in Pharmacology and Molecular Oncology at the University of Ferrara, on studies of the role of adenosine receptors in Huntington's disease. He carried out his postdoctoral research in the group directed by Professor

Pier Andrea Borea and Professor Katia Varani at the Institute of Pharmacology, Department of Medical Sciences of the University of Ferrara. He is author of 85 papers, various book chapters and co-editor of a recent book on adenosine receptors edited by Springer for the series "The Receptors". He is a member of the Italian Society of Pharmacology and Italian Purine Club.



Biographical sketch

Simona Salati received her Doctorate degree in Biotechnology and Molecular Medicine in 2004 from the University of Modena and Reggio Emilia. Her postdoctoral training was carried on in the lab directed by Dr. Bhatia, at the Stem Cell and Cancer Research Institute, Canada. Her research activity has been focused on the study of the molecular mechanisms regulating self-renewal and differentiation of normal and leukemic hematopoietic stem cells. She is currently research coordinator of pre-clinical studies at IGEA, Italy. Her research interest is now focused on the study of effects exerted by pulsed electromagnetic fields on biological systems, such as bone, articular cartilage and neurons.

She is author of 29 papers.

Abstract

The beneficial therapeutic effects of pulsed electromagnetic field (PEMF) have been documented with increasing frequency over the last decades. PEMF stimulation therapies have been clinically successful in treating a variety of medical conditions, including expedited healing of non-union long bone fractures and arrested progression of osteoarthritis. One of the most prominent features of PEMF therapy is to protect the articular micro environment from inflammation and degeneration processes. The molecular and cellular effects of PEMF exposure on pathways involved in the resolution of inflammation are a subject of intense investigations. In the attempt to clarify the mechanisms that underpin the beneficial effect of PEMF, we focused on membrane receptors a potential link between physical stimulation and biological response. In the last two decades, we collected numerous evidence that allowed us to identify adenosine receptors as candidates for the biological pathways of the anti-inflammatory and protective effect of PEMF. Adenosine has been reported to be a potent immunomodulatory agent, with reports of receptor activation on varied cells curtailing exuberant inflammatory responses. Of the four G-protein-coupled receptors, PEMF specifically influence A_{2A} and A₃ subtypes, enhancing the anti-inflammatory and protective functions of adenosine.

In this talk, I will discuss how PEMF exposure affects membrane protein functions and the data indicating adenosine receptors as a biological pathway for the cellular and molecular effects of PEMF.

Lunch
Thursday June 27, 2019 • 13:00 - 14:30
Joffre 1

Session: M4
BEMS Assembly
Thursday June 27, 2019 • 13:30 - 14:30
Barthez

Session: S11
Dosimetry of ELF/LF fields
Thursday June 27, 2019 • 14:30 - 16:00
Einstein
Chairs: Philippe Leveque & Kenichi Yamazaki

Session: S12
Electroporation Studies and Effects of Pulsed Electric Fields
Thursday June 27, 2019 • 14:30 - 16:00
Barthez
Chairs: Lluís M. Mir & P. Thomas Vernier

S11-1 [14:30]
STUDENT PAPER

Computational errors of the induced electric field in voxelized and tetrahedral anatomical head models exposed to spatially uniform magnetic field

Marco Soldati¹ & Ilkka Laakso¹

¹*Department of Electrical Engineering and Automation, Espoo, Finland*

Keywords: Dosimetry (computational), ELF/LF, Completed (published)

Presented by: Marco Soldati

The magnitude of the induced electric field is used as the dosimetric quantity for human protection at low frequencies. To compute the induced electric field, numerical methods based on voxel models are used, which introduce staircasing approximation errors. By contrast, those artifacts are absent in case of tetrahedral meshes. The 99th percentile of the induced electric field is recommended in the ICNIRP guidelines to remove computational artifacts. Here, the electric fields induced by uniform magnetic field exposure at 50 Hz were evaluated using two computational methods based on cubical and tetrahedral elements, respectively. The purpose is to evaluate how the 99th, 99.9th and 99.99th percentiles depend on the meshing approach.

S12-1 [14:30]

Microdosimetric realistic model of cell with endoplasmic reticulum under the action of nanosecond pulses

Annalisa De Angelis¹, Agnese Denzi¹, Caterina Merla², Franck Andre³, Tomás García-Sánchez³, Lluís M. Mir³, Francesca Apollonio¹ & Micaela Liberti¹

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Keywords: Electroporation, Pulsed, Work in Progress

Presented by: Annalisa De Angelis

With the aim to investigate the biophysical effects induced by a high intensity electric field on a biological cell at cellular and subcellular level, authors present a microdosimetric study based on a 2D realistic model of a cell and its endoplasmic reticulum. The microdosimetric analysis of the cell and endoplasmic reticulum was quantified in terms of electric field and transmembrane potential induced by an externally applied high amplitude 10-ns pulsed electric field. In addition, electroporated local membrane sites and pore densities were also evaluated. This study opens the way to numerically assist experimental applications of nanosecond pulsed electric fields for controlled bio-manipulation of cells and subcellular organelles.

S11-2 [14:45]
STUDENT PAPER

The risk of cardiac ventricular fibrillation in humans due to body currents of frequencies up to 100 kHz determined by the use of computational pig models

Pia Schneeweiss¹, Kai Jagielski¹, Dominik Stunder¹, Tobias Theiler¹ & Thomas Kraus¹

¹*Research Center for Bioelectromagnetic Interaction (femu), RWTH Aachen University, Aachen, Germany, 52074*

Keywords: Dosimetry (computational), All Frequencies, Work in Progress
Presented by: Pia Schneeweiss

According to the German Social Accident Insurance Institution (BG ETEM), 88% of the 3463 reported occupational electricity accidents in 2016 were in the low-voltage sector (AC < 1 kV or DC < 1.5 kV), whereof five victims died. One of the most common causes of death in this voltage range is ventricular fibrillation, which shows itself in a very rapid and uncontrolled contraction and relaxation of the heart. In order to take successful preventive measures, it is essential to determine the body currents that induce ventricular fibrillation. Therefore, we compare the data of published in vivo animal studies with numerical simulations of animals and humans. We present the preliminary data as well as the future planned work.

S11-3 [15:00]
STUDENT PAPER

Stochastic dosimetry applied for the assessment of children exposure variability to near-field sources in the ELFSTAT project

Marta Bonato^{1, 2}, Emma Chiamarello¹, Serena Fiocchi¹, Gabriella Tognola¹, Marta Parazzini¹ & Paolo Ravazzani¹

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Keywords: Dosimetry (computational), ELF/LF, Completed (unpublished)
Presented by: Marta Bonato

The work is performed in the context of the ELFSTAT project, which aims at characterizing children's exposure to ELF-MF in real exposure scenarios using stochastic approaches. Since also domestic appliances could be relevant for children

S12-2 [14:45]

Calcium ion activation by nanoporation and opening of voltage-gated calcium channels by nanosecond pulsed electric field

Olga Pakhomova¹, Uma Mangalanathan¹, Kiril Hristov¹, Maura Casciola¹, Shu Xiao¹ & Andrei Pakhomov¹

¹*Frank Reidy Research Center for Bioelectrics, Old Dominion University, Norfolk, Virginia, USA, 23508*

Keywords: Electroporation, Pulsed, Work in Progress

Presented by: Olga Pakhomova

Our data indicate that direct activation of voltage-gated calcium channels (VGCC) by short 300-ns PEF stimuli is possible, although the thresholds for VGCC stimulation and electroporation are very close.

S12-3 [15:00]

Evaluation of membrane potential changes induced by oscillating nanosecond duration electric fields

Bennett Ibey¹, Caleb Roth¹, Ronald Barnes¹ & Hope Beier¹

¹*Air Force Research Laboratory, Fort Sam Houston, Texas, USA, 78234*

Keywords: Electroporation, Pulsed, Work in Progress

Presented by: Bennett Ibey

INTRODUCTION Recently, we pioneered a new imaging system called a streak camera microscope (SCM) that is able to resolve sub nanosecond membrane potential changes in cells loaded with FluoVolt dye¹. This technique opens the window into the response of cell membrane potential to rapidly applied electric fields. Having demonstrated this response on single bipolar and unipolar electric pulses, we have begun to investigate the rapid charging and discharging of the plasma membrane during bursts of alternating current (AC) frequencies. We believe that understanding the dynamics of plasma membrane charging during AC

level exposure, this work aims to assess the exposure variability due to near-field sources, not limiting it only on worst-case exposure scenario. In this paper the child exposure to a hairdryer model is evaluated using a stochastic dosimetry approach based on Polynomial Chaos theory (PC). The electric field amplitudes induced in specific tissues composing the CNS and the PNS were analyzed. The results highlight a high exposure variability depending on source position in respect with the child head.

S11-4 [15:15]

Unsupervised Machine Learning techniques for the characterization of children exposure to ELF MF

Gabriella Tognola¹, Marta Bonato¹, Emma Chiaramello¹, Serena Focchi¹, Isabelle Magne², Martine Souques², Marta Parazzini¹ & Paolo Ravazzani¹

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Keywords: Dosimetry (measurements), ELF/LF, Completed (unpublished)

Presented by: Gabriella Tognola

In this study we characterized children exposure to extremely low frequency (ELF) magnetic fields using cluster analysis – a Machine Learning approach. Indoor personal exposure measurements from 977 children in France were analyzed to discover how electric networks near child home or school could influence exposure patterns. 225 kV/400 kV overhead lines characterized the cluster of children with the highest exposure; 63 kV/150 kV overhead lines characterized the cluster with mid-to-high exposure; 400 V/20 kV substations and underground networks characterized mid-to-low exposures. 400 V/20 kV overhead lines and 63-225 kV underground networks had a marginal contribution in differentiating and characterizing the exposure clusters.

S11-5 [15:30]

STUDENT PAPER

Measurement and health assessment of electromagnetic fields by electric vehicles during road traffic operation using driving characteristics

Kai Jagielski¹, Pia Schneeweiss¹ & Thomas Kraus¹

¹*Research Center for Bioelectromagnetic*

pulses will better inform those using such pulses to modify cell physiology².

S12-4 [15:15]

STUDENT PAPER

Low-intensity nanosecond pulsed electric field exposure modulates adenosine triphosphate *in vitro*

Hollie Ryan^{1, 2, 3}, Bennett Ibey³ & Caleb Roth³

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Keywords: Electrochemistry, Pulsed, Completed (unpublished)

Presented by: Hollie Ryan

Nanosecond pulsed electric fields have been shown to stimulate intracellular calcium release, with corresponding rates of cell survival higher when the incident pulse is bipolar vs. unipolar. NsPEF effects on wider intracellular processes, however, are not fully understood. This *in vitro* study focused on adenosine triphosphate (ATP), the complex organic chemical that provides the energy to drive many processes in living cells. Results indicate that electric field strength, pulse polarity and cell type all play a role in the differential modulation of nanosecond pulse stimulation of ATP synthesis and release of ATP into the extracellular environment.

S12-5 [15:30]

Direct effects of nanosecond-scale electric field on tubulin

Djamel E. Chafai¹ & Michal Cifra¹

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Keywords: Mechanistic/Theoretical, Pulsed,

Interaction (femu), RWTH Aachen University, Aachen, Germany, 52074

Keywords: Dosimetry (measurements), Pulsed, Work in Progress

Presented by: Kai Jagielski

Electromagnetic field measurements in the frequency range between 1 Hz and 400 kHz were performed on five purely electrically operated passenger cars. The additional recording of the driving style, with acceleration sensor and GPS module, allows a detailed investigation of the influence of various vehicle components on the magnetic field spectrum. First measurements show that the maximum exposures assessed with ICNIRP 2010 gen. pub. are not to be found at standardized measuring points at the seats, but often in the footwell or along the back seat. Sharp switching flanks are found during switching processes and charging, which partly exceed the limit values. First measurement results of the Tesla Model S will be shown at the BioEM 2019.

S11-6 [15:45]

Mitigation of LF magnetic fields generated by welding guns

Luca Giaccone¹, Vincenzo Cirimele¹ & Aldo Canova¹

¹*Dipartimento Energia "G. Ferraris", Politecnico di Torino, Torino, Italy, 10129*

Keywords: Dosimetry (computational), Pulsed, Completed (published)

Presented by: Luca Giaccone

Among the different welding technologies, portable welding guns are one of the most critical devices in relation to human exposure to electromagnetic fields. This paper focuses on medium frequency direct current guns proposing an effective solution to mitigate the predominant magnetic field that is generated by the electrodes of the welding gun. The analysis of the field waveforms shows that the rise time of the welding current pulse is the main parameter affecting the exposure index. The effect of the increase of the rise time is investigated through experimental and numerical analyses. The results prove that a small increase of the rise time causes a significant reduction of the exposure level.

Completed (unpublished)

Presented by: Michal Cifra

We experimentally demonstrate in vitro direct effects of intense (20 kV/cm), pulsed electric field (100 – 800 pulses, 1 Hz, 10 ns pulse width) – nsPEF - on tubulin capacity of self-assembly into microtubules – structures crucial for cell division and intracellular transport. We used multiple complementary assays (turbidimetry, autofluorescence, and zeta potential assay) and atomic force microscopy to show that tubulin structure and an effective charge is affected in a dose-dependent manner, which leads to a perturbation of its polymerization capability into microtubules. Our results demonstrate that nsPEF can directly modulate tubulin function in vitro hence bringing insights into nsPEF biological effects.

S12-6 [15:45]

Simulation and *in-vitro* study of nanosecond electric pulse width effect on cancer cells

Xin Rao¹, Xiaodong Chen^{1, 3}, Jun Zhou¹ & Yiyao Liu²

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Keywords: In vitro, Pulsed, Completed (unpublished)

Presented by: Xiaodong Chen

Nanosecond pulsed electric fields (nsPEF) have been shown to induce cancerous cell death and cause the remission of tumors in animals. In most of these studies, a fixed pulse width generator is adopted and the effect of pulse width is not clearly. Therefore, this paper presents our investigation into the pulse width effect when nsPEF interacting with cancer cells through electromagnetic (EM) simulation and in-vitro experiments. Our study shows that nsPEF with different pulse width interacts with the cell structure in a different manner and induces different proportion of cell apoptosis.

Coffee Break
Thursday June 27, 2019 • 16:00 - 16:30
Joffre 2-3

Session: W3
Workshop 3 - Dosimetric aspects in exposure assessment to wireless power transfer systems
Thursday June 27, 2019 • 16:30 - 18:00
Einstein
Chairs: Teruo Onishi & Rosanna Pinto

Session: W4
Workshop 4 - Toward an innovative use of ultrashort electric pulses in medicine: From biological effects to therapeutic applications
Thursday June 27, 2019 • 16:30 - 18:30
Barthez
Chairs: Claudia Consales & Lluís M. Mir

W3-1 [16:30]

Standardization activities of exposure assessment methods for Wireless Power Transfer (WPT)

Teruo Onishi¹ & Kanako Wake²

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²*National Institute of Information and Communications Technology, Koganei, Japan, 1848795*

Standardization activities of exposure assessment methods for Wireless Power Transfer (WPT) are introduced. Recently WPT systems are getting popular for mobile terminals, Electric Vehicle (EV), and etc. over the world, however there is no standardized exposure assessment methods for WPT systems. Therefore International Electrotechnical Committee (IEC) TC106 established a working group (WG9) investigating the exposure assessment methods for WPT systems in 2015. After that TC106 established a new project, PT63184 to standardize a basic exposure assessment method based on TR62905 while the WG9 focuses on microwave WPT systems.

W3-2 [16:45]

Brief review of human dosimetry for exposure from wireless power transfer system at intermediate frequencies

Akimasa Hirata¹

¹*Department of Electrical and Mechanical Engineering, Nagoya Institute of Technology, Nagoya, Japan, 4668555*

This presentation reviews the computational dosimetry for electromagnetic fields from wireless power transfer systems. Computational results are shown to discuss the compliance with international guidelines/standards.

W4-1 [16:30]

Auricular vagus nerve stimulation: from basics to challenges

Eugenijus Kaniusas¹

¹*Research group "Biomedical Sensing", Institute of Electrodynamics, Microwave and Circuit Engineering, Vienna, Austria, 1040*

Electrical stimulation of the auricular vagus nerve is an emerging electroceutical technology using digital doses of electrical pulses. The stimulation shows sustainable effects in treatment of systemic disorders of humans while restoring their homeostasis.

W4-2 [16:50]

Modulation by field reversal — Cell volume, membrane potential, and 2 ns electrostimulation of excitable cells

Esin B Sözer¹ & P. Thomas Vernier¹

¹*Frank Reidy Research Center for Bioelectronics, Old Dominion University, Norfolk, VA, USA, 23508*

Cell volume, intracellular ion concentrations, and membrane potential are interconnected. Changes in one will result in changes in the others. We report unexpected volume changes in cells exposed to 2 ns unipolar and bipolar electric pulses, and we propose that different permeabilizing structure sizes are responsible. We discuss whether these observations can help to explain the responses of

adrenal chromaffin cells to 2 ns electrical stimuli, where a transient rise in $[Ca^{2+}]_i$ caused by a unipolar pulse can be eliminated by an immediately following pulse of the opposite polarity. This cancellation disappears for interphase intervals greater than 30 ns.

W3-3 [17:00] - YOUNG SCIENTIST PAPER

Physics-based closed coupling factors for evaluating exposures to gradient magnetic fields

Ilaria Liorni¹, Myles Capstick¹, Sven Kuehn¹, Esra Neufeld¹ & Niels Kuster^{1, 2}

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²ETH Zuerich, Zuerich, Switzerland

Gradient magnetic fields (MFs) generated by wireless power transfer (WPT) systems can exceed the reference levels (RL) valid for homogeneous exposure. In RL-based testing, the MF gradient is neglected, and the exposure assessment based on basic restrictions (BR) can be overestimated by up to 40dB. In this study, we further improved the coupling factor for ICNIRP 1998 to translate the measured MF amplitudes and gradients into induced metrics for direct comparison with the BR. The coupling factor approximation has been simplified and is now supported by physics-based considerations and an extended numerical study. The same approach is currently being extended to coupling factors derived on the basis of all other published safety guidelines.

W3-4 [17:15]

Exposure assessment of a Wireless Power Transfer system to recharge deep implants as leadless pacemakers

Valerio De Santis¹, Tommaso Campi¹, Silvano Cruciani¹ & Mauro Feliziani¹

¹Department of Industrial and Information Engineering and Economics, University of L'Aquila, Italy, Italy, 67100

This study deals with the battery recharge of a leadless pacemaker, which has been recently introduced in the market, by means of the wireless power transfer (WPT) technology based on the magnetic resonant coupling. The main difficulty is given by the depth of the leadless pacemaker implantation inside the human body. The electromagnetic problem mainly consists in the selection of the on-body excitation (primary coil current and frequency), which must adequately energize the leadless pacemaker without any

W4-3 [17:10]

Investigational applications of Nano-Pulse Stimulation therapy in dermatology

Richard Nuccitelli¹ & Darrin Uecker¹

¹Biology, Pulse Biosciences, Hayward, USA, 94545

Nano-Pulse Stimulation and CellFX are for Investigational Use Only and Exclusively for Clinical Investigators. Pulse Biosciences has completed several clinical trials using a proprietary Nano-Pulse Stimulation™ CellFX™ System. The first clinical investigations are in cosmetic dermatology where several clinical trials have demonstrated safety and effectiveness in the treatment of both epidermal lesions such as seborrheic keratosis and dermal lesions such as sebaceous hyperplasia.

W4-4 [17:30]

Lowering stimulation threshold by megahertz compression of nanosecond pulse bursts

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A major limitation of nanosecond pulse stimulation (NPS) in research and clinical practice is the need for high pulse voltages, in order to exceed the electric field threshold for short pulse durations. This threshold increases as a power function with pulse shortening, up to tens of kV/cm for nanosecond-duration stimuli. We achieved

exceedance of the basic restrictions (BRs) specified by the electromagnetic field (EMF) safety standards.

W3-5 [17:30]

A 3 kW prototype for dynamic wireless power transfer: design and preliminary exposure assessment to emitted stray magnetic field

Rosanna Pinto¹, Vanni Lopresto¹, Umberto Abronzini², Damiano Capraro², Mauro Di² & Antonino Genovese³

¹*Division of Health Protection Technologies, ENEA, Rome, Italy*

²*University of Cassino and Southern Lazio, Cassino, Italy*

³*Production, Conversion and Use of Energy Division, ENEA, Rome, Italy*

Dynamic Wireless Power Transfer (DWPT) can represent a future solution for limited on-board energy resources of electric vehicles (EVs). In this paper a complete DWPT bench prototype is presented. A procedure for the exposure assessment to stray magnetic fields emitted by the prototype has been developed, to assess the compliance with the European reference levels for the general public. The compliance distance from the bench prototype is no less than 50 cm. The B-field plots during the movement of the pick-up coil have been measured. Future work will be devoted to the exposure assessment when the pick-up coil will be mounted on an EV. A numerical model of the actual exposure scenario will be realized for numerical dosimetry.

threshold reduction by more than an order of magnitude by delivering bursts of nanosecond pulses at ultra-high repetition rates (up to several MHz). We explored how the NPS threshold in mammalian cells and in nerve fibers depends on pulse duration, number of pulses, and their repetition rate or duty cycle.

W4-5 [17:50]

Long term control of cytosolic calcium oscillations in Mesenchymal Stem Cells using repeated electric pulses

Shirmone Botha¹, Borja Lopez², Adeline Muscat¹, Óscar Lucía², Héctor Sarnago², Alejandro Naval², José-Miguel Burdio², Tomás García-Sánchez¹, Lluís M. Mir¹ & Franck Andre¹

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²*Department of Electronic Engineering and Communications, University of Zaragoza, Zaragoza, Spain, 50018*

In mesenchymal stem cells (MSCs), numerous studies describe the spontaneous oscillations of cytosolic calcium and their implication in MSCs differentiation. We demonstrate here that the application of high voltage micro second pulses can cancel natural calcium oscillations making it possible to insert an additional synthetic calcium oscillation pattern using repeated electric pulses over many hours. Pulsed electric fields can therefore be used as a tool for the long term control of cytosolic calcium oscillations in human adipose derived MSCs using a novel pulse generator as the one specifically developed. This tool could improve MSCs quality and differentiation.

W4-6 [18:10]

Molecular characterization of neuroblastoma cell line to single microsecond and nanosecond electric pulses: comparing low and high field amplitudes

Claudia Consales¹, Caterina Merla¹, Barbara Benassi¹, Adeline Muscat², Tomás García-Sánchez², Carmela Marino¹ & Lluís M. Mir²

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Application of high voltage short electric pulses has attracted attention as a unique tool in life sciences, especially in cancer treatment, but the molecular mechanisms of their action on living organisms has not been yet fully elucidated. In this work the biological responses of the SH-SY5Y cells, a neuronal like cell line, exposed to high voltage short electric pulses, was investigated. In particular, four different types of voltage pulses lasting 100 microseconds and two different types of voltage pulses lasting 10 nanoseconds were applied to these cells. Cells responses were evaluated after a single pulse by analyzing cells redox metabolism modulation, apoptosis induction, and gene expression.

Friday June 28, 2019

Session: S13

Exposure assessment techniques II
Friday June 28, 2019 • 09:00 - 10:30

Barthez

Chairs: Akimasa Hirata & Marthinus Van Wyk

Session: S14

Emerging and Future Biomedical
Applications

Friday June 28, 2019 • 09:00 - 10:30

Einstein

Chairs: Andrei Pakhomov & Theodoros Samaras

S13-1 [09:00]

RF EMF exposure sensing network in a smart-city context

Gunter Vermeeren¹, Matthias Van Den Bossche¹,
Reza Aminzadeh¹, Sam Aerts¹, Philip Leroux²,
Mats De Meyer³, Johan Bergs³, Astrid Philippron⁴,
Luc Martens¹ & Wout Joseph¹

¹*imec - WAVES, Department of Information Technology at Ghent University, Ghent, Belgium, 9052*

²*imec - IDLab Ghent - Ghent University, Ghent, Belgium, 9052*

³*University of Antwerp - imec - IDLab - Department of Mathematics and Comput, Antwerp, Belgium, 2000*

⁴*Imec – City of Things, IoT & Connected Health Solutions, Antwerp, Belgium, 2000*

Keywords: Dosimetry (measurements), RF/Microwaves, Completed (published)
Presented by: Gunter Vermeeren

Spatio-temporal radio-frequency (RF) electromagnetic field (EMF) exposure assessment is of interest for epidemiologists, governmental agencies dealing with environmental issues, and the general public. We designed low-cost EMF sensors and deployed an RF EMF exposure sensing network in the city of Antwerp (Belgium) consisting of eleven fixed EMF sensors and five mobile EMF sensors installed on the roof of postal vans. The EMF sensors were calibrated and validated in a lab environment and in the EMF sensor network in Antwerp using frequency-selective measurements. Such an EMF exposure network will enable long-term spatio-temporal exposure assessment on a local scale.

S13-2 [09:15]

Measurement scheme consideration for near-field reconstruction based on plane wave spectrum expansion using a phased array antenna at 28 GHz

Kun Li¹, Kensuke Sasaki¹, Soichi Watanabe¹,
Kanakano Wake¹, Junji Higashiyama² & Teruo Onishi²

S14-1 [09:00]

WITHDRAWN

S14-2 [09:15]

STUDENT PAPER

Bifurcation analysis of a stimulated Wendling's neural mass model

Marouan Arrais¹, Fabrice Wendling¹ & Julien Modolo¹

¹*Laboratoire Traitement du Signal et de l'Image*

¹National Institute of Information and Communications Technology, Tokyo, Japan

²NTT DoCoMo, Inc., Yokosuka, Japan

Keywords: Dosimetry (measurements), RF/Microwaves, Work in Progress
Presented by: Kun Li

For the compliance assessment of wireless devices operated at frequencies over 6 GHz, we have proposed a near-field reconstruction technique to estimate the power density to protect humans from excessive local temperature elevation due to millimeter wave exposure. The estimation accuracy and reproducibility of this method have been validated by standard gain horn and patch array antennas. In this study, the measurement conditions of employing the reconstruction technique for the assessment of power density were investigated using a phased patch array antenna at 28 GHz.

S13-3 [09:30]

Fast SAR estimation based on 3D field reconstructions and associated uncertainty quantifications

Zicheng Liu¹ & Joe Wiart¹

¹Chaire C2M, LTCI, Télécom ParisTech, Université Paris-Saclay, Paris, France, 75013

Keywords: Dosimetry (computational), RF/Microwaves, Work in Progress
Presented by: Joe Wiart

Fast SAR (specific absorption rate) estimation is achieved with the field reconstruction based on complex measurements on a single plane or phaseless measurements on two parallel planes. Expanding the measured fields into planar waves, the field reconstruction with complex measurements is performed through the retrieval of expansion coefficients. For phaseless measurements, estimating phase by the plane-to-plane algorithm, the field reconstruction follows the same approach with the complex measurements. Effects on SAR estimation by uncertain factors including the accuracy of measurements and liquid properties, position and coupling effects of probes will be considered and quantified by standard uncertainty and Sobol' indices.

(LTSI) - INSERM U1099, Rennes, France, 35700

Keywords: Mechanistic/Theoretical, ELF/LF, Completed (unpublished)
Presented by: Marouan Arrais

Objective: Neurostimulation in epilepsy is a method of potential therapeutic value. First, we aim at simulating the local field potentials (LFPs) of an epileptogenic brain region under sinusoidal stimulation. Second, we aim at providing a detailed description of behaviors when stimulation parameters were varied.

Methods: We generated LFPs during stimulation using Wendling's neural mass model, simulating LFPs under normal and epileptic conditions. Bifurcations of the stimulated model were investigated.

Results: We identified sets of stimulation parameters that resulted in a switch epileptiform to normal background activity.

Conclusion: This model-guided approach leads to optimal stimulation parameters for seizure abortion.

S14-3 [09:30]

STUDENT PAPER

Effects of 50 Hz magnetic field on muscle hardness of the left forearm after muscle loading

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Keywords: Human, ELF/LF, Work in Progress
Presented by: Tsukasa Kondo

This study focuses on the acute influence of 50 Hz magnetic field (B_{\max} 180 mT, B_{rms} 127 mT for 15 min) on muscle hardness of the left forearm after muscle loading. In a randomised, double blind and crossover study design, magnetic field (MF) and sham control (CTL) exposures were carried out with 10 healthy volunteer subjects. The muscle loading in the left forearm was performed by the method of wrist curl training for 5 min using a dumbbell (3 kg). MF exposure significantly decreased the elevated muscle hardness of flexor carpi radialis compared with sham exposure. These results suggested that MF exposure could partially restore the elevated muscle hardness by muscle loading and thereby might ameliorate muscle fatigue and pain.

S13-4 [09:45]

Challenges to assess human exposure to 5G massive MIMO base stations

Christian Bornkessel¹, Thomas Kopacz², Sascha Schiessl², Dirk Heberling^{2, 3} & Matthias Hein¹

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Keywords: Dosimetry (measurements), RF/Microwaves, Work in Progress

Presented by: Christian Bornkessel

5G radio base stations have to comply with safety limits with regard to human exposure in radio frequency electromagnetic fields (RF EMF) and thus are subject to national certification procedures. Due to different signal structures and the spatial beamforming, measurement- and calculation-based exposure assessment methods used for conventional mobile radio systems with static beams (2G, 3G, 4G) are no longer applicable for 5G massive MIMO base stations. This paper describes the most important exposure-relevant differences between conventional and 5G systems, formulates challenges for assessment, and sketches first concepts for correct exposure measurements.

S13-5 [10:00]

Measurement-based modeling of RF-EMF exposure in urban environments using artificial intelligence techniques

Sam Aerts¹, Yuanyuan Huang², Luc Martens¹, Wout Joseph¹ & Joe Wiart²

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²*Chaire C2M, Télécom ParisTech, Paris, France*

Keywords: Dosimetry (measurements), RF/Microwaves, Work in Progress

Presented by: Sam Aerts

This study explores the use of artificial intelligence (AI) techniques to model the exposure to environmental radiofrequency (RF) electromagnetic fields (EMF) in an urban environment. For this, a spatial RF-EMF distribution was simulated in the 14th district of Paris, France, based on the existing base station infrastructure and a simple path loss model. Then, a number of sample measurements

S14-4 [09:45]

The extremely low-frequency electromagnetic field could induce apoptosis via accumulation of ROS and activation of L-type Calcium channels in breast cancer

Alireza Madjid Ansari¹, Mojdeh Barati², Mohammad Amin Javidi¹ & Hossein Fahimi²

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Keywords: Mechanistic/Theoretical, ELF/LF, Completed (unpublished)

Presented by: Alireza Madjid Ansari

ELF-EMF has been proposed as a potential adjuvant therapy in cancer treatment. Although there are many pieces of evidence about the apoptotic effects of ELF-EMF on cancer cells, the mechanism of action is still unknown. In this study, we evaluated the role of ROS and calcium channels during apoptosis induction by ELF-EMF. Our results showed that the inhibition of ROS as well as blocking the L-type calcium channels would lead to cease ELF-EMF induced apoptosis. Also, p38 and p21 genes expression were evaluated by using real-time PCR. In conclusion, we suggested that ELF-EMF might induce apoptosis in MC4L2 triple positive cell line by the accumulation of ROS, and benefiting from Ca²⁺ L-type channels through calcium-ROS cell arrest pathway.

S14-5 [10:00]

NEUROMAN: Reference neuro-electrophysiology enabled computational human body models

Bryn Lloyd¹, Silvia Farcito¹, Antonino Mario Cassara¹, Esra Neufeld¹, Beom Sun Chung³, Jin Seo Park⁴, Min Suk Chung³ & Niels Kuster^{1, 2}

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Keywords: Dosimetry (computational), ELF/LF, Completed (unpublished)

Presented by: Bryn Lloyd

To develop novel therapeutic electrostimulation devices, there is a need to build predictive computational tools, which allow to investigate mechanisms, and optimize treatments. While much progress has been made in recent years, computational electrophysiology still is lacking

were used to build and compare an artificial neural network (ANN) model and a conventional kriging interpolation model. The ability to use additional information (such as distance to base stations) in the NN model results in a promising approach – especially when measurement data are scarce – and more research is encouraged.

S13-6 [10:15]

WITHDRAWN

anatomical models with detailed peripheral nerve connectivity. To this end, we are developing reference human anatomical models with unprecedented details in the peripheral nervous system, connectivity to organs and muscles, and functionalized with compartmental nerve models to investigate interactions with neuronal electrophysiology. The first of models, the Korean female Yoon-Sun V4, was recently released and the male Jeduk V4, will become available shortly

S14-6 [10:15]

Development of microfluidic tools to fabricate multicellular constructs and analyze their electromagnetic properties

Marie Frénéa-Robin¹, Jonathan Cottet^{2, 7}, Julien Marchalot³, Charlotte Rivière⁴, Laure Franqueville², Damien Voyer⁵, Clair Poignard⁶, Riccardo Scorretti² & Philippe Renaud⁷

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Keywords: Electroporation, IF, Work in Progress
Presented by: Marie Frénéa-Robin

Electroporation has many applications in the medical field such as electrochemotherapy, gene therapy and genetic screening. However, a thorough understanding of the effect of electrical pulses on tissues requires consideration of cell organization, interactions and microenvironment. Therefore, current studies aiming at studying electroporation in vitro are not only conducted on cell suspensions but also on 3D models closer from tissues, such as cell spheroids. We present the development of microfluidic tools dedicated to the reproducible construction of such 3D cellular assemblies. This bottom-up approach should also enable to analyze how electrical properties of multicellular constructs and of isolated cells relate to each other.

Coffee Break
Friday June 28, 2019 • 10:30 - 11:00
Joffe 2-3

Session: P5
Plenary 5 - Millimeter- and submillimeter-wave applications in biology and medicine:
Potential and challenges
Friday June 28, 2019 • 11:00 - 12:00
Einstein
Chairs: Maxim Zhadobov & Yasir Alfadhli

P5-1 [11:00]

Millimeter- and Submillimeter-Wave applications in biology: Potential and challenges

Peter H. Siegel¹

¹*Caltech University, Pasadena, CA, USA, 91125*



Biographical sketch

Peter H. Siegel has held appointments as Faculty Associate in Electrical Engineering and Senior Scientist in Biology at the California Institute of Technology, and Senior Research Scientist at the NASA Jet Propulsion Laboratory, both in Pasadena, California. At JPL, he founded and led for 25 years, the Submillimeter Wave Advanced Technology (SWAT) team, a group of 20+ scientists and engineers developing THz technology for NASA's near and long term space missions. This included delivering key components for four major satellite missions and leading more than 75 smaller R&D programs for NASA and the US department of defence. At Caltech, Dr. Siegel has been involved in new biological and medical applications of THz, especially low power effects on neurons and most recently, millimeter-wave monitoring of blood chemistry. Among many other functions, he served as founding Editor-in-Chief of the IEEE Transactions on Terahertz Science and Technology (2010-2015) and founder, and now

the General Secretary, of the International Society of Infrared, Millimeter, and Terahertz Waves, the world's largest society devoted exclusively to THz science and technology. He is also an IEEE Fellow, and has served as an IEEE Distinguished lecturer, vice-chair and chair of IEEE MTTs Committee 4 – THz Technology, and an ad-hoc member of the MTTs AdCom for 5 years. Dr. Siegel has published more than 300 articles on THz components and technology and has given more than 250 invited talks on this subject throughout his career of 40 years in THz. His current appointments include: CEO of THz Global, a small R&D company specializing in RF bio applications; Senior Scientist Emeritus Biology and Electrical Engineering at Caltech; and Senior Research Scientist Emeritus and Principal Engineer at the NASA Jet Propulsion Laboratory.

Web Pages: <http://www.thz.caltech.edu>, <http://www.irmmw-thz.org>, <http://www.thz.ieee.org>,

Email: phs@caltech.edu.

Abstract

The millimeter and submillimeter wave regimes, roughly spanning 30-3000 GHz, have moved to the forefront of recent expansion and innovative use of the RF spectrum. Traditional motivations for working at millimeter wavelengths have tended to focus mainly on commercial and defense-related wireless applications, such as communications, radar and to some extent, imaging. At higher THz frequencies, despite considerable commercial pressure, most of the emphasis is still on basic science, with a strong concentration in fundamental physics and chemistry, spectroscopy, and ground and space-based astrophysics, planetary atmospheres, and Earth science. As we move from the "Space Age" into the "Age of Biology" it is appropriate to take a closer look at what we can already do with millimeter and submillimeter-wave technology, and whether we might turn up any interesting new applications, or at least find some low hanging fruit which can be easily plucked, by simply refocusing some existing circuits and techniques. On the way, there are essential tweaks that have to be made to common devices and circuits in order to accommodate the constraints of water-based tissue. This talk will highlight some of the work the author has been involved with in applying high frequency circuits and techniques to problems in biology and medicine.

**Session: SA
Awards Session
Friday June 28, 2019 • 12:00 - 13:00
Einstein
Chairs: Azadeh Peyman & Anke Huss**

SA-1 [12:00] -

Most Influential BEM Journal Papers for 2019 Award

SA-2 [12:20] -

Arthur Pilla Young Scientist Award

SA-3 [12:40] -

Students Awards

**Closing Ceremony
Friday June 28, 2019 • 13:00 - 13:30
Einstein**

**Session: M5
BEMS Board Meeting
Friday June 28, 2019 • 15:00 - 18:00
Joffre 4**

**Session: M6
EBEA Council Meeting
Friday June 28, 2019 • 15:00 - 18:00
Joffre 5**

Session: FA
Student Flash Poster Session A
Monday June 24, 2019 • 14:00 - 15:00
Einstein
Chairs: Niels Kuster & Christopher Portier

FA-1 [14:00]
STUDENT PAPER

Development of microwave denervation catheter and its performance evaluation method

Shohei Matsuhara¹, Kazuyuki Saito¹, Tomoyuki Tajima³ & Nobuyoshi Takeshita²

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³*The University of Tokyo Hospital, Tokyo, Japan*

Keywords: *Clinical (therapy), RF/Microwaves, Work in Progress*

Presented by: *Shohei Matsuhara*

In this study, a catheter which ablates extravascular nerve by the thermal effect of microwave is introduced. Moreover, heating characteristics of the catheter are evaluated by the numerical calculation and the experimental investigation. In addition, we consider a new method for evaluating the heating characteristics of microwave applicator. As a result, temperature distributions around the catheter became evident and the usefulness of a new method for evaluating the heating characteristics was suggested.

FA-2 [14:03]
STUDENT PAPER

Comparison of human body models for electromagnetic field exposure in a low-frequency band

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Keywords: *Dosimetry (computational), Static, Work in Progress*

Presented by: *Jangyong Ahn*

In the process of assessment of human exposure to electromagnetic fields, the evaluation against the basic restriction may be different depending on the human body models. In this paper, the evaluations of the internal quantities were performed using a WPT system operating at 140 kHz, and the calculated results were compared using several human body models. The results show that the electrostimulation effects dominate the thermal effects in the low-frequency band. In addition, the current density can be easily evaluated by using a simplified model with an equivalent conductivity value. On the other hand, the internal electric field differs depending on the physical shape so the anatomical model is used for the worst-case evaluation.

FA-3 [14:06]
STUDENT PAPER

Dosimetric analysis of hands exposure during handling of strong permanent magnets

Mauro David^{1, 2} & Gernot Schmid^{1, 2}

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²*Seibersdorf Laboratories, Seibersdorf, Austria*

Keywords: *Dosimetry (computational), Static, Completed (unpublished)*

Presented by: *Mauro David*

Workers in a production line for synchronous motors reported tingling sensations in their hands when handling strong permanent magnets. To determine the dB/dt occurring along the hands a "measurement glove" containing 12 Hall sensors was realized and a new detailed anatomical hand model was developed. Temporal peak electric field strength (E_i) induced inside the hand were estimated by numerical computations. The highest measured dB/dt along the palmar side of the hand was 51.17 T/s. The max E_i in soft tissue was

1.96 V/m, a factor of 1.8 higher than the applicable exposure limit value, but still lower than what is presently assumed the lowest stimulation threshold for peripheral nerves.

FA-4 [14:09]

STUDENT PAPER

Mobile phone transmit power levels across signal strength for radiofrequency electromagnetic field exposure assessment

Christopher Brzozek^{1, 2}, Berihun Zeleke^{1, 2}, Michael Abramson^{1, 2}, Kurt Benke^{3, 4} & Geza Benke^{1, 2}

¹*Centre for Population Health Research on Electromagnetic Energy (PRESEE), Monash University, Melbourne, Australia, 3004*

²*Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, Australia, 3004*

³*University of Melbourne, Melbourne, Australia, 3052*

⁴*Department of Economic Development, Jobs, Transport and Resources (DEDJTR), AgriBio, Melbourne, Australia, 3083*

Keywords: *Dosimetry (measurements), RF/Microwaves, Work in Progress*

Presented by: *Christopher Brzozek*

Radiofrequency electromagnetic field (RF-EMF) exposure assessment via mobile phone use is prone to measurement error. One aspect that is often overlooked is the different signal strengths over mobile phone transmission (Tx) power. The Qualipoc handheld android (SwissQual, Munich, DE), a tool for RF optimization, provides information on both signal strength and Tx power. We collected simultaneous measurements for Received Signal Strength Indicator, Reference Signal Received Power, Received Signal Code Power, Reference Signal Received Quality and Tx power on the 3G and 4G networks for analysis. In this analysis, the correlations with signal strength and variations in Tx power over different levels of signal strength are demonstrated.

FA-5 [14:12]

STUDENT PAPER

nsPEFs exposure of liposomes to explore controlled drug delivery applications

Laura Caramazza^{1, 2}, Martina Nardoni³, Annalisa De Angelis¹, Elena della Valle⁴, Agnese Denzi¹, Patrizia Paolicelli³, Caterina Merla⁵, Micaela Liberti¹, Francesca Apollonio¹ & Stefania Petralito³

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⁵*Division of Health Protection Technologies, ENEA, Rome, Italy, 00123*

Keywords: *Electroporation, Pulsed, Work in Progress*

Presented by: *Laura Caramazza*

The increasing interest towards biocompatible nanotechnologies in medicine, combined with electric fields stimulation, is leading to the development of electro-sensitive smart systems for drug delivery applications. Among the known electro-sensitive materials, phospholipids can be used to design nano-sized vesicles suitable for external electric actuation. To this regard, recently the use of pulsed electric fields to trigger release across phospholipid membranes has been numerically studied, for a deeper understanding of the phenomena at the molecular scale. Aim of this work is to give an experimental validation of the feasibility of controlling drug release from liposomes mediated by nanosecond pulsed electric fields.

FA-6 [14:15]

STUDENT PAPER

Extremely low-frequency weak electromagnetic effects on fibrosarcoma (HT1080) and weak static magnetic field effects on Bacillus Subtilis

Sahithi Kandala¹, Mark Hernandez² & Frank Barnes¹

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²*Environmental and Civil Engineering, University of Colorado , Boulder, Colorado, USA, 80309*

Keywords: *In vitro, ELF/LF, Work in Progress*

Presented by: *Sahithi Kandala*

This paper explores the weak extremely-low-frequency electromagnetic effects on Fibrosarcoma cells and static magnetic field effects on Bacillus Subtiliscells. The effects of changes in frequency with constant electromagnetic field strength and changes in the magnetic field strength with constant frequency on growth rate and electron transport chain are discussed.

FA-7 [14:18]

STUDENT PAPER

Inhibition of bacterial growth by application of small AC electric fields: a study to understand the interaction mechanisms

Médéric Vindret¹, Eric Chamberod², Pascal Xavier¹, Jean Martins³ & Dominique Raully¹

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Keywords: *In vitro, IF, Work in Progress*

Presented by: *Médéric Vindret*

An innovative process was patented for the inhibition of bacterial growth in liquid media by the application of a low amplitude (< 1V/cm) AC electric field randomly varying into a wide band (10kHz-40MHz). An electrical modeling of the bacterial cell placed in a uniform AC field was carried out in parallel. To refine this modeling, an experimental study of the interaction of small amplitude electric fields with bacteria is described here to understand the origin of growth inhibition. This combines an electric field treatment of the suspension and simultaneous analysis by Electrical Impedance Spectroscopy (EIS). Particular attention has been paid to precisely control the applied electric field. Temperature of the liquid is also measured.

FA-8 [14:21]

STUDENT PAPER

Acute exposure to cellphone radiofrequency signal: effect on young adolescent rat brain

Kumari Singh^{1, 2}, Rakesh Arya^{2, 3}, Jayprakash Nirala¹, Ranjan Nanda² & Paulraj Rajamani¹

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Keywords: *In vivo, RF/Microwaves, Work in Progress*

Presented by: *Kumari Singh*

Now a days continuous use of cellphone for a long stretch of time are quite common specially among young adolescents, So present study was aimed at assesing effects of long term cellphone radiofrequency exposure on hippocampal redox enveronment and rate of neurogenesis in young adolescent rats.

FA-9 [14:24]

STUDENT PAPER

Effects of 50 Hz magnetic field on cutaneous blood flow volume by cold, room temperature and warm water immersion test

Nur Izyana Faradila Binti Azmi¹, Hideyuki Okano², Hiromi Ishiwatari³ & Keiichi Watanuki^{1, 2, 4}

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Keywords: Human, ELF/LF, Work in Progress

Presented by: Nur Izyana Faradila Binti Azmi

This study focuses on the acute influence of 50 Hz magnetic field (B_{\max} 180 mT, B_{rms} 127 mT for 10 min) on recovery of cutaneous blood flow volume after cold (5°C), room temperature (25°C) and warm (42°C) water immersion for 1 min. In a randomised, double blind and crossover study design, magnetic field (MF) and sham control exposures were carried out with 10 healthy volunteers using a 2D laser speckle flowmetry. Except for the warm water immersion, the results showed that the blood flow recovery rate of part of the fingers was significantly faster and higher under MF exposure. These results suggested that MF could partially restore the reduced blood microcirculation in cold stress-induced ischemic conditions.

FA-10 [14:27]

WITHDRAWN

FA-11 [14:30]

STUDENT PAPER

Experimental model simulation on electromagnetic wave therapy of apical periodontitis

Hideo Taketani¹, Masatake Akutagawa², Hiromichi Yumoto³, Kouji Hirao³, Takahiro Emoto², Hiroo Tarao⁴, Toshihiko Tominaga⁵, Toshitaka Ikehara⁶ & Yohsuke Kinouchi²

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Keywords: Mechanistic/Theoretical, IF, Work in Progress

Presented by: Hideo Taketani

The major current treatment of the apical periodontitis is cleaning of the root canal with chemicals. Recently EMAT(electro-magnetic apical treatment) have been proposed. EMAT is a treatment for sterilizing the root canal and regenerating the alveolar bone by applying voltage into the root canal. Although the experiment about the effect with EMAT is currently performed, the current density distribution in the experimental environment is still unknown. Thus, a experimental model was created and the current density distribution was obtained by simulation. As a result, it was thought that heat by applying voltage was transferred by convection from the electrode tips to the outside of the electrodes, and it was distributed to the whole PBS.

FA-12 [14:33]

WITHDRAWN

Session: PA
Poster Session A
Monday June 24, 2019 • 15:00 - 16:30
Joffre 2-3

PA-1 [15:00]

Radiofrequency electromagnetic fields hypersensitivity or idiopathic environmental intolerance: an updated systematic review of provocation studies, perception and media influence

Víctor Cristóbal¹, Jesus Gonzalez-Rubio¹ & Alberto Nájera¹

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Keywords: Behavioural, RF/Microwaves, Work in Progress

Presented by: Alberto Nájera

An updated systematic review of provocation studies, perception and media influence about radiofrequency electromagnetic fields hypersensitivity or idiopathic environmental intolerance during the years 2011-18

PA-3 [15:00]

WITHDRAWN

PA-5 [15:00]

WITHDRAWN

PA-7 [15:00]

Spontaneous motility of yeast cells as a tool for biological electromagnetic effect assessment

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Keywords: Clinical (diagnostics), All Frequencies, Work in Progress

Presented by: Michal Teplan

Inverted light microscopy connected to a digital camera provides a monitoring tool for quantitative characterization of motility and morphology of yeast cells in liquid solution. The video frames are segmented by an automatic image processing. Algorithms for image pre-processing, including segmentation followed by tracking procedures of the segmented image objects are investigated. Measure of cell spatial fluctuation have been derived from frequency spectrum. Obtained frequency spectra reflect periodicity in cells' vibrational movement. Derived cell motility measures reflect viability and metabolic activity of cells.

PA-9 [15:00]

STUDENT PAPER

Development of microwave denervation catheter and its performance evaluation method

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Keywords: Clinical (therapy), RF/Microwaves, Work in Progress

Presented by: Shohei Matsuhara

In this study, a catheter which ablates extravascular nerve by the thermal effect of microwave is introduced. Moreover, heating characteristics of the catheter are evaluated by the numerical calculation and the experimental investigation. In addition, we consider a new method for evaluating the heating characteristics of microwave applicator. As a result, temperature distributions around the catheter became evident and the usefulness of a new method for evaluating the heating characteristics was suggested.

PA-11 [15:00]
STUDENT PAPER

Comparison of human body models for electromagnetic field exposure in a low-frequency band

Jangyong Ahn¹, Seon-eui Hong², Haerim Kim¹, Hyung-Do Choi² & Seungyoung Ahn¹

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Keywords: *Dosimetry (computational), Static, Work in Progress*

Presented by: *Jangyong Ahn*

In the process of assessment of human exposure to electromagnetic fields, the evaluation against the basic restriction may be different depending on the human body models. In this paper, the evaluations of the internal quantities were performed using a WPT system operating at 140 kHz, and the calculated results were compared using several human body models. The results show that the electrostimulation effects dominate the thermal effects in the low-frequency band. In addition, the current density can be easily evaluated by using a simplified model with an equivalent conductivity value. On the other hand, the internal electric field differs depending on the physical shape so the anatomical model is used for the worst-case evaluation.

PA-13 [15:00]

Innovative stochastic modeling of residential exposure due to a WiFi source placed in uncertain position

Emma Chiaramello¹, David Plets², Serena Fiocchi¹, Marta Bonato^{1, 4}, Gabriella Tognola¹, Marta Parazzini¹, Laurent Le Brusquet³, Luc Martens², Wout Joseph² & Paolo Ravazzani¹

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Keywords: *Dosimetry (computational), RF/Microwaves, Completed (unpublished)*

Presented by: *Emma Chiaramello*

This study focused on the exposure evaluation of the 2D spatial distribution of the E-field in a one-floor apartment when a WiFi source is placed in uncertain position. An innovative approach that combines a Principal Component Analysis and Kriging model in order to build space-dependent surrogate models was applied and validated. Results showed the feasibility of the approach.

PA-15 [15:00]

Numerical evaluation of the influence of RF-exposure conditions on heating induced by interventional catheters

Micol Colella¹, Elena Lucano^{1, 2}, Francesca Apollonio¹, Qi Zeng³, Jingshen Liu³, Tom Lloyd⁴, Steve Wedan⁴, Ji Chen³, Wolfgang Kainz⁵, Micaela Liberti¹ & Leonardo M. Angelone⁵

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Keywords: *Dosimetry (computational), RF/Microwaves, Completed (unpublished)*

Presented by: *Micol Colella*

This study aims to numerically investigate the temperature increase that occurs at the tip of a "dual wire"

partially-implanted lead due to the RF-induced heating. We explored 32 different exposure conditions for the human body model Duke of the Virtual Population. The temperature increase is computed using the transfer function experimentally determined for the specific lead.

PA-17 [15:00]

STUDENT PAPER

Dosimetric analysis of hands exposure during handling of strong permanent magnets

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²*Seibersdorf Laboratories, Seibersdorf, Austria*

Keywords: *Dosimetry (computational), Static, Completed (unpublished)*

Presented by: *Mauro David*

Workers in a production line for synchronous motors reported tingling sensations in their hands when handling strong permanent magnets. To determine the dB/dt occurring along the hands a “measurement glove” containing 12 Hall sensors was realized and a new detailed anatomical hand model was developed. Temporal peak electric field strength (E_i) induced inside the hand were estimated by numerical computations. The highest measured dB/dt along the palmar side of the hand was 51.17 T/s. The max E_i in soft tissue was 1.96 V/m, a factor of 1.8 higher than the applicable exposure limit value, but still lower than what is presently assumed the lowest stimulation threshold for peripheral nerves.

PA-19 [15:00]

New formulations for numerical dosimetry at intermediate frequencies

Giacomo di Benedetto¹, Riccardo Scorretti¹, Christophe Geuzaine², Kassem Jomaa³, Méлина Bouldi⁴ & Fabien Ndagijimana³

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Keywords: *Dosimetry (computational), RF/Microwaves, Work in Progress*

Presented by: *Riccardo Scorretti*

Numerical dosimetry is an essential step to assess the safety of workers exposed to electromagnetic fields. In the case of intermediate frequencies exposure happens in close field and classical numerical formulations for numerical dosimetry require the electric field as source. In these conditions, experimental measurement of the electric field is quite a difficult task, whereas the magnetic field is much simpler to measure. In this work new formulations which make use of the magnetic field as source term are developed.

PA-21 [15:00]

Magnetic targeting on heart tissues: modelling of magnetic forces

Serena Focchi¹, Marta Bonato^{1,2}, Emma Chiaramello¹, Gabriella Tognola¹, Marta Parazzini¹ & Paolo Ravazzani¹

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Keywords: *Dosimetry (computational), Static, Work in Progress*

Presented by: *Marta Bonato*

The successful use of nanoparticles in therapeutic applications has recently prompted scientists to look for effective strategies to focus them in specific organs. Among these methods, magnetic targeting consists in the use of magnets or coils capable of producing high-gradient magnetic fields (and therefore magnetic forces) on the magnetic nanoparticles, thus increasing their concentration in the target. Although some

experimental studies have shown the efficacy of this technique, there are still few studies able to quantify the experimental results. In this study, the behavior of various magnetic targeting systems, optimized on the anatomy of different anatomical models, was evaluated by means of computational electromagnetic techniques.

PA-23 [15:00]

Which deep brain regions are most activated in a group of subjects by non-invasive stimulation techniques?

Jose Gomez-Tames¹, Akihiro Asai¹, Atsushi Hamasaka¹, Ilkka Laakso², Mai Lu³, Shoogo Ueno⁴ & Akimasa Hirata¹

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Keywords: *Dosimetry (computational), ELF/LF, Completed (published)*

Presented by: *Jose Gomez-Tames*

Neuromodulation dosage delivered by non-invasive stimulation techniques has been determined in a group of subjects at deep brain regions. We used high-resolution computational models with registration techniques for post-processing analysis at group-level using an average template of deep brain regions for the first time. Despite the inter-individual variations, a systematic tendency of the electric field hotspot emerges in specific deep brain locations

PA-25 [15:00]

Exposure assessment of induced electric fields in the human body for different realistic occupational scenarios in 50Hz high voltage plants

Rene Hirtl¹, Gernot Schmid¹, Katrin Friedl² & Klemens Reich³

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Keywords: *Dosimetry (computational), ELF/LF, Completed (unpublished)*

Presented by: *Rene Hirtl*

Electric fields in areas of 50Hz high voltage plants are typically found to be close to the reference values or action levels, or may even locally exceed them. In such electrically dominant exposure situations, demonstration of compliance with exposure limits is often only possible based on the induced electric field strengths inside the body and comparison with the exposure limit values. Numerical simulations of several exposure situations in the area of such high voltage plants were therefore conducted and analyzed with realistic human body models. Evaluation of induced electric field strengths have shown compliance with the exposure limit values in all investigated realistic exposure scenarios, even when action levels were exceeded.

PA-27 [15:00]

Analyzing the impact of grating lobes of 5G massive MIMO antennas on the vertical compliance distance

Thomas Kopacz¹, Sascha Schiessl¹ & Dirk Heberling^{1, 2}

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Keywords: *Dosimetry (computational), RF/Microwaves, Work in Progress*

Presented by: *Thomas Kopacz*

An important factor for the rollout of 5G networks are high-gain massive MIMO antennas which allow for

beamforming and steering which, in turn, increases spectral efficiency. To reduce complexity, the antenna consists of subarrays causing grating lobes in case of beam steering. In this paper, we investigate the impact of the vertical scanning range on the vertical compliance distance and compare the results to an antenna without grating lobes. The main lobe dominates the vertical compliance distance as long as a part of it is below the horizon. In case of a downtilt of the main beam, the grating lobes even reduce the vertical compliance distance. In case of an uptilt, they strongly increase the vertical compliance distance.

PA-29 [15:00]

Occupational compliance distances for multiband base station antennas

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Keywords: Dosimetry (computational), RF/Microwaves, Completed (published)

Presented by: Gunter Vermeeren

We designed a generic multi-band base station antenna model (BSA) based on a commercially available dual-band BSA. The model, consisting of 64 crossed-polarized dipole elements, showed good agreement with the commercial BSA in terms of maximum gain (maximum deviation of 1.3 dB for the frequency bands of 700MHz, 800MHz, 900MHz, 1800MHz, 2100MHz, and 2600MHz). Using the generic BSA model, we assessed the compliance distance by evaluating the exposure according to CENELEC EN50383 and comparing the exposure with ICNIRP reference levels for occupational exposure. As expected, the compliance distance is the smallest in front of the BSA (e.g., at 700MHz the compliance distance is 1.5m for a power of 50dBm) and the largest at the back of the BSA.

PA-31 [15:00]

Development of detailed surface-based numerical hand models for computational dosimetry

Richard Überbacher¹, Gerhard Netzker², Rene Hirtl¹, Klaus Schiessl² & Gernot Schmid¹

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Keywords: Dosimetry (computational), All Frequencies, Work in Progress

Presented by: Gernot Schmid

Three novel surface-based highly detailed anatomical models of the hand and lower arm region, in different frequently observed hand postures have been developed based on MRI images. In total 15 different tissues types were distinguished during segmentation, including a multilayer skin model separating subcutaneous adipose tissue, dermis, epidermis and stratum corneum. These models are intended to enable a detailed analysis of the spatial distribution of induced electric field strengths inside the hand, particularly in case of highly localized magnetic field exposure of the hands and lower arms, as it may be frequently observed in occupational settings. However, the developed hand/lower arm models may also be used in biomedical applications.

PA-33 [15:00]

WITHDRAWN

PA-35 [15:00]

STUDENT PAPER

Mobile phone transmit power levels across signal strength for radiofrequency electromagnetic field exposure assessment

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Keywords: *Dosimetry (measurements), RF/Microwaves, Work in Progress*

Presented by: *Christopher Brzozek*

Radiofrequency electromagnetic field (RF-EMF) exposure assessment via mobile phone use is prone to measurement error. One aspect that is often overlooked is the different signal strengths over mobile phone transmission (Tx) power. The Qualipoc handheld android (SwissQual, Munich, DE), a tool for RF optimization, provides information on both signal strength and Tx power. We collected simultaneous measurements for Received Signal Strength Indicator, Reference Signal Received Power, Received Signal Code Power, Reference Signal Received Quality and Tx power on the 3G and 4G networks for analysis. In this analysis, the correlations with signal strength and variations in Tx power over different levels of signal strength are demonstrated.

PA-37 [15:00]

Epigenetic changes following exposure to radiofrequency fields

Ibtissam Echchgadda¹, Xomalin Peralta², Cesar Cerna³ & Jody Cantu³

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Keywords: *Dosimetry (measurements), RF/Microwaves, Work in Progress*

Presented by: *Ibtissam Echchgadda*

It remains unclear if exposure to RF fields induce epigenetic modifications in cells that would influence gene expression. In this study, we examined how exposure to RF fields at various E fields and durations can affect DNA methylation. We exposed primary human keratinocytes to 900 MHz RF and measured global changes in DNA methylation using methylation sensitive restriction digestion and ELISA. Results show differential DNA methylation patterns in RF exposed cells compared to non-exposed control cells under non-thermal and non-toxic exposure conditions. This suggests that RF exposure changes DNA methylation patterns, which could potentially have downstream effects on gene expression.

PA-39 [15:00]

A real-world quality assessment study in six ExpoM-RF measurement devices

Marloes Eeftens^{1, 2}, Stefan Dongus^{1, 2}, Alexandra Bürgler^{1, 2} & Martin Röösli^{1, 2}

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Keywords: *Dosimetry (measurements), RF/Microwaves, Completed (unpublished)*

Presented by: *Marloes Eeftens*

Exposimeters for mobile measurements of radiofrequency electromagnetic fields are usually calibrated in an anechoic chamber using defined signals and standardized orientations. However, it is not clear how measurements from different devices compare in real-world environments. We thus tested the comparability of six ExpoM-RF exposimeters before and after calibration by varying their position and orientation while repeatedly measuring 15 microenvironments on six different days. We found that systematic differences introduced by device ID, calibration, day of the week, orientation and position are relatively small compared to exposure differences between microenvironments. This supports the validity of studies relying on ExpoM-RF devices.

PA-41 [15:00]

Experimental estimation on temperature rise in human tissue due to implanted metal plates using novel translucent semi-solid phantom

Takashi Hikage¹, Suzune Ito¹, Toshio Nojima¹, Tomoaki Nagaoka² & Soichi Watanabe²

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Keywords: *Dosimetry (measurements), RF/Microwaves, Work in Progress*

Presented by: *Takashi Hikage*

This paper introduced experimental evaluations for temperature rise in human tissue with two metal implants aligned in parallel. To investigate the impact of the two metal implants, temperature increase measurements using newly developed translucent semi-solid phantoms were conducted. In the measured distributions, temperature rise due to the metallic plates was clearly observed in the gap of two metal plates region.

PA-43 [15:00]

Assessment of electromagnetic field exposure levels from wireless charging system for drone

Seon-eui Hong¹ & Hyung-Do Choi¹

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Keywords: *Dosimetry (measurements), ELF/LF, Work in Progress*

Presented by: *Seon-eui Hong*

Wireless charging technologies are widely applied mobile bodies such as drones, robots, and electric vehicles. In this paper, we investigate electromagnetic field (EM) levels from wireless charging system for drone. The operating system and transmitting power are 140 kHz and 200 W, respectively. It was shown that electric field and magnetic field strengths around the wireless charging exceed the reference level of ICNIRP's guideline.

PA-45 [15:00]

Analysis of electromagnetic fields exposure measurement around substation and sensitive area

Jeongill Hwang¹, Sang-su Noh¹, Kyungku Nah¹, Chang-nam Jin¹, Seungwoo Lee² & Ho Sung An²

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Keywords: *Dosimetry (measurements), ELF/LF, Work in Progress*

Presented by: *Kyungku Nah*

In this study, about 150 substations were selected to be measured by classifying Korean Substations, and the amount of MF exposure was measured and analyzed for the substation area and sensitive facilities near the substation. The amount of EMF variation with distance was analyzed. Further, for long term exposure analysis, 24 hours of long-term measurement was performed for substations with relatively large electromagnetic fields exposure. The analysis showed that the average exposure amount was between 0.055~2.282uT around the substation, and the maximum value was 0.25 to 1.7uT with 24 hours of measurement for particular substations. We found these values are very small compared to the reference value.

PA-47 [15:00]

Assessment of actual maximum RF EMF exposure from radio base stations with massive MIMO antennas

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Keywords: *Dosimetry (measurements), RF/Microwaves, Completed (published)*

Presented by: *Paramananda Joshi*

The actual output power levels of radio base stations (RBSs) with massive MIMO (mMIMO) antennas have been assessed via a network-based study conducted in an operating mobile network. Knowledge of spatial distribution of output power, in addition to the total output power, is essential for accurate evaluations of RF EMF exposure from mMIMO antennas. With the method used in this study, which was found to be consistent with a mathematical model to evaluate EMF exposure from mMIMO antennas, actual output power (95th

percentile) per beam under high traffic conditions and considering a Time Division Duplexing (TDD) downlink duty cycle of about 75% was found to be 16% of the maximum possible output power from the RBSs.

PA-49 [15:00]

Measurement for the extremely low frequency magnetic field in the shared electric vehicles

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Keywords: *Dosimetry (measurements), ELF/LF, Completed (published)*

Presented by: *Tongning Wu*

Shared EVs emerged and were used by more and more people. Shared EVs may be frequently used and they were undergone more frequent maintenance compared to the private owned EVs. The mounting and dismounting during the regular maintenance could potentially modify the layout of the electric system as well as the coverage in the vehicle. As result, the magnetic field distribution in the vehicle could alter. In the study, we measured the magnetic flux density (B) for 3 popular shared EVs in Beijing. In total, four driving sessions of the EVs were involved in the measurements,. The results were recorded and compared for three times of maintenance.

PA-51 [15:00]

Impact of 60 Hz magnetic and electric fields at high intensity on automated external defibrillator (AED)

Duc-Hai Nguyen¹, Alain Turgeon¹ & Genevieve Ostiguy²

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Keywords: *Dosimetry (measurements), ELF/LF, Completed (unpublished)*

Presented by: *Duc-Hai Nguyen*

The automated external defibrillator (AED) is more and more required in work place. The device is exposed to the environment of power utilities installations, such as substation areas and power generation floors to verify if the device can operate securely and reliably in a high intensity of magnetic or electric field.

PA-53 [15:00]

Smartphone measurements as a basis for a crowdsourcing-based monitoring of EMF exposure

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Keywords: *Dosimetry (measurements), RF/Microwaves, Work in Progress*

Presented by: *Sascha Schiessl*

The continuous monitoring of exposure to radio-frequency electromagnetic fields is a great challenge when considering the classical assessment methods using professional measuring equipment, which are costly and can only be carried out on a limited scale. A possible way to solve this problem could be a crowdsourcing-based approach, which relies on the use of common smartphones and their built-in measurement capability. In this paper, we present the essential parameters that a mobile device captures and discuss how they can serve as a measure of EMF exposure. In addition, the results of some tests to verify the applicability are provided. Furthermore, we will discuss some challenges to make use of smartphone measurements.

PA-55 [15:00]

An innovative experimental protocol for the study of electromagnetic hypersensitivity: overview of technical aspects

Benjamin Vatovez¹, Ahmed Guettafi¹, Luc Verschaeve², Maryse Ledent², Christophe Geuzaine³, Veronique Beauvois³, Maël Dieudonné⁴, Jimmy Bordarie⁵, Nicolas Prignot⁶ & Willy Pirard¹

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Keywords: Dosimetry (measurements), RF/Microwaves, Work in Progress

Presented by: Benjamin Vatovez

The ExpoComm project aims at developing an innovative protocol for the experimental study of electromagnetic hypersensitivity (EHS). Its first part consisted in a collaborative work between EHS volunteers and scientists to define crucial aspects of the protocol, notably exposure parameters. The protocol is now fully developed, and its implementation has begun. It includes a specific design within an exposure room where EMF level from outer sources is as low as realistically achievable. Because dosimetry and exposure control are key issues in provocation studies, this abstract outlines technical developments and presents the volunteers' exposure assessment.

PA-57 [15:00]

Telstra's smart home measurement program in Australia

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Keywords: Dosimetry (measurements), RF/Microwaves, Work in Progress

Presented by: Debbie Wills

Smart home technology already lets us do everything from turn off the iron to check on our pets. With the expectation that there will be around 18 billion connected devices globally by 2022, a large portion of these devices will be used in our homes including security systems, smart appliances, wireless watering systems and smart locks. Telstra has commenced an in-home measurement program to determine typical cumulative RF levels in a residential home. This data will be used to provide our customers with the most up to date information on environmental EME levels from wireless devices.

PA-59 [15:00]
STUDENT PAPER

nsPEFs exposure of liposomes to explore controlled drug delivery applications

Laura Caramazza^{1, 2}, Martina Nardoni³, Annalisa De Angelis¹, Elena della Valle⁴, Agnese Denzi¹, Patrizia Paolicelli³, Caterina Merla⁵, Micaela Liberti¹, Francesca Apollonio¹ & Stefania Petralito³

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Keywords: Electroporation, Pulsed, Work in Progress

Presented by: Laura Caramazza

The increasing interest towards biocompatible nanotechnologies in medicine, combined with electric fields stimulation, is leading to the development of electro-sensitive smart systems for drug delivery applications. Among the known electro-sensitive materials, phospholipids can be used to design nano-sized vesicles suitable for external electric actuation. To this regard, recently the use of pulsed electric fields to trigger release across phospholipid membranes has been numerically studied, for a deeper understanding of the phenomena at the molecular scale. Aim of this work is to give an experimental validation of the feasibility of controlling drug release from liposomes mediated by nanosecond pulsed electric fields.

PA-61 [15:00]

A microdosimetric realistic model to study frequency-dependent AC electroporation in a cell with endoplasmic reticulum

Annalisa De Angelis¹, Agnese Denzi¹, Caterina Merla², Franck Andre³, Tomás García-Sánchez³, Lluís M. Mir³, Francesca Apollonio¹ & Micaela Liberti¹

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Keywords: Electroporation, Pulsed, Work in Progress

Presented by: Annalisa De Angelis

The study of the frequency-dependent response of a biological cell and its organelles to an intense electric field is of growing interest in the bioelectromagnetic area. The possibility offered by continuous waves to uncouple the effects of the electric field during electroporation is employed in this work using a numerical model including the realistic shape of cell and endoplasmic reticulum membranes. The higher efficiency of the microwave signals in electroporating the subcellular structures, in comparison with the radiofrequency signals, is highlighted.

PA-63 [15:00]

Lactobacillus acidophilus and Escherichia coli inactivation by 600-ns pulsed electric fields

Stacey Martens¹, Savannah Klein¹, Ronald Barnes¹, Caleb Roth¹ & Bennett Ibey¹

¹*Air Force Research Laboratory, Fort Sam Houston, Texas, USA, 78234*

Keywords: Electroporation, RF/Microwaves, Completed (unpublished)

Presented by: Stacey Martens

Pulsed electric fields (PEF) are utilized as a novel technique to inactivate prokaryotic cells through irreversible electroporation. In this study, we investigated the inactivation effects of 600-ns PEF on *Lactobacillus acidophilus* and *Escherichia coli*.

PA-65 [15:00]

Mobile phone or tablet use and online activities among children: Results from an internet survey by parents

Noriko Kojimahara¹, Yasuto Sato¹ & Masao Taki²

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²*Department of Systems Design, Tokyo Metropolitan University, Tokyo, Japan, 1920397*

Keywords: Epidemiology, RF/Microwaves, Completed (unpublished)

Presented by: Noriko Kojimahara

The aim of this study was to examine whether children's health relates to their mobile phone or tablet device use, and online activities. We conducted an internet survey of 1,545 caregivers living with children aged 0–14 years in Japan to compare the regular use of both mobile phones and tablet devices. The total time using mobile phones was related to age, number of siblings, availability of Wi-Fi at home, and the child's ownership of a mobile phone. Age and availability of Wi-Fi at home were positively related to tablet device use, but both number of siblings and child's ownership of a tablet device were not. The use of a tablet device was related to worse health among preschool children.

PA-67 [15:00]

Definition of areas of interest in the study of long-term 50 Hz exposure of Brussels inhabitants

Maryse Ledent^{1, 4}, Raf Aerts¹, Veronique Beauvois², Maxime Spirlet², Christophe Geuzaine², Isabelle Magne³ & Catherine Bouland⁴

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Keywords: Epidemiology, ELF/LF, Work in Progress

Presented by: Maryse Ledent

Fifty-hertz magnetic fields related to the transmission and the distribution of electricity are one of the environmental agents studied in the new BBEMG project on cumulative exposure in the Brussels population. The objectives of the study are to analyse the perceptions, behaviours and health of individuals living in the vicinity of visible and non-visible electrical infrastructure contributing to similar exposures, and to explore links between the visibility of sources and hypersensitivity to 50 Hz magnetic fields. A complementary objective is to compare exposure of people living in areas of dense vs sparse energized electrical infrastructure. This paper will focus on the definition of statistical sectors of interest in Brussels.

PA-69 [15:00] - YOUNG SCIENTIST PAPER

Perception of health risks from Wi-Fi radiofrequency electromagnetic field exposure: A risk perception study

Berihun Zeleke^{1, 2}, Christopher Brzozek^{1, 2}, Chhavi Bhatt^{1, 2}, Michael Abramson^{1, 2}, Rodney Croft³, Frederik Freudenstein³, Peter Wiedemann³ & Geza Benke^{1, 2}

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Keywords: Epidemiology, RF/Microwaves, Completed (unpublished)

Presented by: Berihun Zeleke

People's perceptions towards radiofrequency electromagnetic fields (RF-EMF) exposure and possible health risks are not well understood. We investigated the risk perception of people towards RF-EMF emitted from

Wi-Fi sources in three groups of participants. Before assessment of perception to exposure and risk from Wi-Fi, we provided participants with either basic text, precautionary information, or a summarized personal RF-EMF exposure measurement from Wi-Fi (ISM 2.4 GHz). Subsequently, using a self-administered questionnaire, we assessed exposure perception and risk perception to Wi-Fi. The exposure and risk perception of people towards Wi-Fi differed by the type of information provided prior to assessment of risk perception to RF-EMF.

PA-71 [15:00]

Monitoring of low frequency magnetic and pulsed electric field biological effects on yeast cells using biological autoluminescence

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Keywords: *In vitro, ELF/LF, Work in Progress*

Presented by: *Martin Bereta*

The aim of presented work is to show the potential application of biological autoluminescence (BAL) for monitoring of electromagnetic field biological effects on yeasts. The yeast cell culture (*Saccharomyces cerevisiae*) is exposed to low frequency magnetic field (800 Hz, 1.5 mT) and pulsed electric field (pulse duration: 1-25 μ s, electric field strength up to 1 kV.cm⁻¹) and the BAL is monitored during exposure. The results indicate detectable differences in BAL dynamics when low frequency magnetic or pulsed electric field is applied. Due to its non-invasive and label-free application, the BAL could be used as a useful tool for monitoring of electromagnetic field biological effects.

PA-73 [15:00]

Observations of changes in cell growth rates, ROS/RNS and other cellular parameters of HT-1080 cells in weak static magnetic fields

Hakki Gurhan¹, Rodolfo Bruzon¹ & Frank Barnes¹

¹*Electrical, Computer and Energy Engineering, Boulder, Colorado, USA, 80309*

Keywords: *In vitro, Static, Completed (unpublished)*

Presented by: *Frank Barnes*

Effects of Weak Static Magnetic Fields (SMF) on cell proliferation and oxidative stress are explored. Upon exposure to magnetic flux densities between 0.5 μ T to 600 μ T, calcium influx related metabolic rate changes are observed. Changes in cell plasma membrane potential and intracellular pH levels are also highly related to cell growth rates. In addition, nonlinear changes in oxidative stress are found due to imbalance between pro-oxidants and antioxidants in different SMF exposures. We believe this nonlinear response can be explained with the changes in the free radical concentrations.

PA-75 [15:00]

Frequency characteristics of neural cell response to electric field exposure by real-time single cell observation

Masateru Ikehata¹, Kei Makino², Yukihiisa Suzuki², Atsushi Saito³, Sachiko Yoshie¹ & Satoshi Nakasono³

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²*Tokyo Metropolitan University, Tokyo, Japan*

³*Central Research Institute of Electric Power Industry, Chiba, Japan*

Keywords: *In vitro, ELF/LF, Work in Progress*

Presented by: *Masateru Ikehata*

In this study, neural cell response threshold of 10Hz to 50kHz sinusoidal electric field that applied by originally

developed fork shape small electrode was evaluated by originally developed a real-time single cell observation system as alteration of intracellular concentration of Ca²⁺. Similar input voltage of cellular response threshold was observed between 10 to 1,000 Hz. On the other hand, input voltage threshold to induce cellular response was increased depended on frequency from 1 kHz to 50 kHz. Exposure dosimetry of electric field on the surface of cell culture is underway and will be presented at the congress.

PA-77 [15:00]

The effects of 50 Hz magnetic fields and low dose cadmium co-exposure on cell viability in JEG-3 cells

Yumin Jin¹, Aziguli Yimaer¹, Liling Su^{1, 2} & Guangdi Chen¹

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²*Department of Clinical Medicine, Shangrao, China*

Keywords: *In vitro, ELF/LF, Work in Progress*

Presented by: *Guangdi Chen*

To investigate the effects of 50 Hz magnetic fields (MF) and low dose cadmium co-exposure on cell viability in JEG-3 cells. JEG-3 cells were used as research cell model. The effects of exposure to 50 Hz MF and co-exposure to low dose cadmium and 50 Hz MF on cell viability were examined using CCK-8 assay. Proteomic and metabolomics approaches were applied to further explore the mechanisms of 50 Hz MF influenced cell viability. Under current exposure conditions, 3.0 mT 50 Hz MF may enhance JEG-3 cell viability during a certain time of exposure. The results of proteome and metabolomics profiling will be presented during the conference.

PA-79 [15:00]

STUDENT PAPER

Extremely low-frequency weak electromagnetic effects on fibrosarcoma (HT1080) and weak static magnetic field effects on Bacillus Subtilis

Sahithi Kandala¹, Mark Hernandez² & Frank Barnes¹

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Keywords: *In vitro, ELF/LF, Work in Progress*

Presented by: *Sahithi Kandala*

This paper explores the weak extremely-low-frequency electromagnetic effects on Fibrosarcoma cells and static magnetic field effects on Bacillus Subtiliscells. The effects of changes in frequency with constant electromagnetic field strength and changes in the magnetic field strength with constant frequency on growth rate and electron transport chain are discussed.

PA-81 [15:00]

Impact of exposure at 60 GHz on cellular metabolism of HaCaT keratinocytes

Pierre Le Pogam^{1, 3}, Morgane Lebosq², Yann Le Page², Denis Habauzit², Maxim Zhadobov¹, Ronan Sauleau¹, Yves Le Dréan² & David Rondeau¹

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Keywords: *In vitro, RF/Microwaves, Completed (unpublished)*

Presented by: *Morgane Lebosq*

Human keratinocytes were in vitro exposed to millimeter waves (MMW at 60.4 GHz) with an incident power density of 20 mW/cm², which correspond to the upper local exposure limit for general public. After a 24h-

exposure, endo- and extracellular extracts were performed and submitted to ultrahigh performance liquid chromatography coupled to high resolution mass spectrometry for analysis. Data analysis show a very limited number of altered features in intracellular metabolomic, whereas important dysregulations could be found in extracellular metabolomic profiles, suggesting that excretion or loss of permeability may occur under MMW exposure.

PA-83 [15:00]

Effect of exposure to intermediate frequency at 85kHz in cultured human cells

Eijiro Narita¹, Shin Koyama¹, Yoko Shimizu¹, Naoki Shinohara¹ & Junji Miyakoshi¹

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Keywords: In vitro, IF, Work in Progress

Presented by: Eijiro Narita

We developed an exposure apparatus that generates an intermediate frequency at 85 kHz. This device has already been confirmed that retains a normal culture environment without any artefact. We then performed exhaustive gene analysis by an RNA sequence which is a standard cell experiment method widely used as safety evaluation. As a result of examining gene expression variability by an RNA sequence, there is no effect of the 85 kHz EMF wave in CCD32Sk, HDFa, XP2SA and AT2KY cells.

PA-85 [15:00]

Broadband exposure systems for *in vitro* and *ex vivo* experiments

Alessandra Paffi^{1, 2}, Alessandro Banin¹, Agnese Denzi¹, Maura Casciola³, Micaela Liberti^{1, 2} & Francesca Apollonio^{1, 2}

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Keywords: In vitro, Pulsed, Completed (unpublished)

Presented by: Alessandra Paffi

Two different systems for exposing *in vitro* and *ex vivo* biological samples to electromagnetic (EM) fields in the microwave range have been developed. Both of them are broadband and suitable for real-time experiments. The two systems have been compared in terms of their performance numerically and experimentally evaluated.

PA-87 [15:00]

Real-time detection of IF-MF exposure-induced neuronal response using non-conductive fiber-optic imaging system

Atsushi Saito¹, Tatsuya Terai², Kei Makino², Masayuki Takahashi¹, Sachiko Yoshie³, Masateru Ikehata³, Yasuhiko Jimbo⁴, Keiji Wada², Yukihiisa Suzuki² & Satoshi Nakasono¹

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Keywords: In vitro, IF, Completed (published)

Presented by: Atsushi Saito

Threshold values of nerve stimulation associated with exposure to time-varying electromagnetic fields contribute to establish a human protection guidelines. However, biological knowledge about intermediate-frequency magnetic field (IF-MF) are limited. Here, the intracellular calcium ([Ca²⁺]_i) spikes during 20-kHz IF-

MF exposure in rat brain-derived cultured neurons were evaluated by a novel IF-MF exposure and fiber-optic imaging system. In addition, dosimetry of the induced electrical field in the extracellular solution indicated quantitative differences in the excitation thresholds of neuronal cell bodies and fibers.

PA-89 [15:00]

The biological effect of the 50 Hz MF-exposed EGF solution on cellular functions in FL cells

Liling Su^{1, 2, 3}, Yue Fei², Yumin Jin² & Guangdi Chen²

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²*Bioelectromagnetics Laboratory, Hangzhou, China*

³*Department of Clinical Medicine, Shangrao, China*

Keywords: *In vitro, ELF/LF, Completed (unpublished)*

Presented by: *Liling Su*

To explore the biophysical mechanism of ELF-MF induced biological effects, this study examined the effect of 50 Hz MF exposure on the physical properties of biomacromolecules epidermal growth factor (EGF) with phase-interrogation surface plasmon resonance (SPR) sensing. The 30 µg/mL of EGF solution was exposed or sham-exposed to 50 Hz MF at 4.0 mT for 1 h, and the SPR signals were evaluated by the phase-sensitive SPR system. The results showed that exposure to 50 Hz MF at 4.0 mT for 1 h significantly decreased SPR signals of EGF solution. However, we found that 50 Hz MF exposed EGF did not affect the interaction between EGF and EGF receptor (EGFR) in vitro, EGF-enhanced cell viability and EGF-induced EGFR clustering in FL cells.

PA-91 [15:00]

STUDENT PAPER

Inhibition of bacterial growth by application of small AC electric fields: a study to understand the interaction mechanisms

Médéric Vindret¹, Eric Chamberod², Pascal Xavier¹, Jean Martins³ & Dominique Rauly¹

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Keywords: *In vitro, IF, Work in Progress*

Presented by: *Médéric Vindret*

An innovative process was patented for the inhibition of bacterial growth in liquid media by the application of a low amplitude (< 1V/cm) AC electric field randomly varying into a wide band (10kHz-40MHz). An electrical modeling of the bacterial cell placed in a uniform AC field was carried out in parallel. To refine this modeling, an experimental study of the interaction of small amplitude electric fields with bacteria is described here to understand the origin of growth inhibition. This combines an electric field treatment of the suspension and simultaneous analysis by Electrical Impedance Spectroscopy (EIS). Particular attention has been paid to precisely control the applied electric field. Temperature of the liquid is also measured.

PA-93 [15:00]

WITHDRAWN

PA-95 [15:00]

Non-linear effects on stem cell-mediated regeneration following weak magnetic field (WMF) exposure

Wendy Beane¹, Alanna Van Huizen¹, Luke Kinsey¹ & Frank Barnes²

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Keywords: *In vivo, Static, Work in Progress*

Presented by: *Wendy Beane*

Reactive oxygen species (ROS) play fundamental roles in driving regenerative growth. Previous data showed that 200 μ T WMFs inhibit ROS at the wound site, reducing stem cell proliferation during planarian regeneration. Our recent data reveal 500 μ T exposure yields the opposite result, increased growth—similar to directly increasing ROS levels via loss of superoxide dismutase (which increases superoxide anion levels). Our work aims to identify changes in gene expression, proliferation and differentiation with 500 μ T exposure. Together, the data suggest non-linear responses to different WMF strengths may be useful in designing therapies to either promote (for regenerative medicine) or inhibit (for cancer treatments) cell proliferation.

PA-97 [15:00]

Behavioral assessment of Alzheimer's transgenic mice following long-term RF exposure

Ye Ji Jeong¹, Hyung-Do Choi², Jeong-Ki Pack³, Nam Kim⁴, Yun-Sil Lee⁵ & Hae-June Lee¹

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Keywords: *In vivo, RF/Microwaves, Completed (unpublished)*

Presented by: *Hae-June Lee*

To investigate the effect of RF-EMF on neurodegenerative disease, we exposed 5xFAD AD mice to 3, 6 and 8-month RF-EMF and assessed behavioral changes. We found that the RF-EMFs shows improvement of anxiety and memory behaviors in the animal model of Alzheimer's disease, although the significance of the results is different according to the exposure time. The effects of RF-EMF exposure for 6 months or longer were more significant. Especially, the 8-month exposure to RF-EMFs significantly improved brain function such as memory loss and brain glucose metabolism accompanied by beta -amyloid Alzheimer 's disease.

PA-99 [15:00]

Effects of high intensity local exposure of a 10 GHz-electromagnetic field on glial activity in rat brain

Hiroshi Masuda¹, Itsuki Kageyama^{1, 2}, Tatsuya Ishitake¹, Akimasa Hirata², Sachiko Kodera², Takuji Arima³, Yasutaka Murakami³ & Yoshitaka Morimatsu¹

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Keywords: *In vivo, RF/Microwaves, Work in Progress*

Presented by: *Hiroshi Masuda*

The possibility of radio-frequency electromagnetic fields (RF-EMF) of mobile phones to cause any adverse health effects on the brain is a subject of numerous studies and publications. However, the intensity level of RF-EMF exposure, which can occur the activation of glial cells, is still arguable. Aim of the present study was to investigate a threshold of the local exposure intensity of RF-EMF for the activation of glial cells. We found that obvious morphological difference between sham-exposed and exposed animals in both glial cells 3 days after the RF-EMF exposure under high intensity exposure conditions.

PA-101 [15:00]

In vivo assessment of genotoxicity for high intensity intermediate-frequency magnetic fields exposure

Shin Ohtani¹, Akira Ushiyama², Keiji Wada³, Yukihisa Suzuki³, Kazuyuki Ishii¹ & Kenji Hattori¹

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Keywords: *In vivo*, *IF*, *Work in Progress*

Presented by: *Shin Ohtani*

Intermediate frequency magnetic fields (IF-MFs) at around 85 kHz are a component of wireless power transfer (WPT) systems. To explore the possible genotoxic effects of IF-MF, we developed the system of high intensity intermittent IF-MF exposure. Pig-a assay and micronucleus test were performed in the mice blood sampled after IF-MF exposure. We found that there was no significant change in the ratio of Pig-a mutated erythrocytes and the micronucleus-containing erythrocytes after intermittent IF-MF exposure for one day (1hr/day). In addition, we are examining the Pig-a assay and the micronucleus test after 10 days (1hr/day) IF-MF exposure. Results are currently under analysis and will be shown in our presentation.

PA-103 [15:00]

Thermoelastic pressure transients generated by High Peak Power pulsed radiofrequency exposures can induce Heat Shock Protein 70 up-regulation in mice

Caleb Roth¹, Cesario Cerna², Benjamin Kasokonis^{2, 3}, Kaitlin Nelson¹, Jeffrey Whitmore¹, Bennett Ibey¹, Ronald Barnes¹, Christopher Valdez¹ & Jason Payne¹

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Keywords: *In vivo*, *RF/Microwaves*, *Work in Progress*

Presented by: *Caleb Roth*

Modeling and simulation of HPP exposures on rodents suggests that certain HPP systems are capable of generating thermoelastic pressure transients of a sufficient magnitude to cause damage to cellular proteins within the rodent. To validate these models, we used the transgenic mouse model (FVB/NJ-Tg(Hspa1a-luc,-EGFP)2Chco/J) to detect potential mechanical stress *in vivo*. Our data suggests that this transgenic mouse model has the potential to be used as an *in vivo* dosimeter for RF mediated mechanical stress.

PA-105 [15:00]

STUDENT PAPER

Acute exposure to cellphone radiofrequency signal: effect on young adolescent rat brain

Kumari Singh^{1, 2}, Rakesh Arya^{2, 3}, Jayprakash Nirala¹, Ranjan Nanda² & Paulraj Rajamani¹

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Keywords: *In vivo*, *RF/Microwaves*, *Work in Progress*

Presented by: *Kumari Singh*

Now a days continuous use of cellphone for a long stretch of time are quite common specially among young adolescents, So present study was aimed at assesing effects of long term cellphone radiofrequency exposure on hippocampal redox enveronment and rate of neurogenesis in young adolescent rats.

PA-107 [15:00]

Exposure to 835 MHz electromagnetic fields cause a down-regulation of tyrosine hydroxylase expression in aging-PD mice model

Woosun Wang¹, Ju-Hwan Kim¹, Hakrim Kim¹, Hyung-Gun Kim¹ & Jin-Koo Lee¹

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Keywords: *In vivo*, *RF/Microwaves*, *Work in Progress*

Presented by: *Jin-Koo Lee*

Chronic exposure to RFR in aging-PD mice model cause the reduction of dopamine metabolism in striatum. Dopamine metabolism abnormalities can lead to abnormal behavioral responses in aging-PD animal models.

PA-109 [15:00]

WITHDRAWN

PA-111 [15:00]

WITHDRAWN

PA-113 [15:00]

STUDENT PAPER

Effects of 50 Hz magnetic field on cutaneous blood flow volume by cold, room temperature and warm water immersion test

Nur Izyana Faradila Binti Azmi¹, Hideyuki Okano², Hiromi Ishiwatari³ & Keiichi Watanuki^{1, 2, 4}

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Keywords: Human, ELF/LF, Work in Progress

Presented by: Nur Izyana Faradila Binti Azmi

This study focuses on the acute influence of 50 Hz magnetic field (B_{\max} 180 mT, B_{rms} 127 mT for 10 min) on recovery of cutaneous blood flow volume after cold (5°C), room temperature (25°C) and warm (42°C) water immersion for 1 min. In a randomised, double blind and crossover study design, magnetic field (MF) and sham control exposures were carried out with 10 healthy volunteers using a 2D laser speckle flowmetry. Except for the warm water immersion, the results showed that the blood flow recovery rate of part of the fingers was significantly faster and higher under MF exposure. These results suggested that MF could partially restore the reduced blood microcirculation in cold stress-induced ischemic conditions.

PA-115 [15:00]

Design of a metasurfaced phone case for the reduction of specific absorption rate

Niamat Hussain¹, Min-Joo Jeong¹, Ji Woong Park¹, Hanul Bong¹ & Nam Kim¹

¹*College of Electrical and Computer Engineering, Chungbuk National University, Cheongju-si, Korea, 28644*

Keywords: Human, RF/Microwaves, Work in Progress

Presented by: Min-Joo Jeong

This paper presents the design of a mobile phone case by employing a metasurface for the reduction of Specific Absorption Rate (SAR) for the 5G mobile devices operating at 3.5 GHz. The simulation results show that the SAR is significantly reduced when the antenna in the phone housing is incorporated with the metasurfaced phone case. The SAR value for 1 g with a normal phone is noted to be 0.8 W/kg, which is reduced to 0.5 W/kg for the phone case with the metasurface. The proposed method does not only provide an effective way to suppress 5G mobile phone radiation exposure but also invites more researchers to work on metasurfaced phone cases to minimize increased health risks in the 5G mobile communication.

PA-117 [15:00] - YOUNG SCIENTIST PAPER

50 Hz electric field effect on heart rate variability

Tarmo Koppel¹ & Inese Vilcane¹

¹*Department of Labor Environment and Safety, Tallinn University of Technology, Tallinn, Estonia* **Keywords:**

Human, ELF/LF, Work in Progress

Presented by: Tarmo Koppel

This study exposed subjects (N=60) to 50 Hz sinusoidal electric field at 1500-2000 V m⁻¹. The exposure was focused at the feet. The exposure set-up represented a typical office workstation scenario, where workers would place their feet on top of the power wires. The test was done under blind test conditions, consisting of five stages, including control and exposure stages, each lasting for about two minutes. The exposure took place in two stages. The results show, the average heart rate increased due course of the test. In addition, the total power of the heart rate variability (HRV) was statistically significantly lower during exposure stages than control stages.

PA-119 [15:00]

Towards personalized treatment for TMS: Reducing the segmentation time

Maria Tzirini¹, George Tsanidis¹, Ioannis Markakis¹, Yiftach Roth^{2, 3} & Theodoros Samaras^{4, 5}

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Keywords: Human, ELF/LF, Work in Progress

Presented by: Theodoros Samaras

In order to apply personalized treatment for TMS, the segmentation time needs to be reduced. A method which uses fewer tissues models has been developed and its results have been validated with the use of three full-tissue high-resolution ViP models. The results are compared in terms of electric field distribution, induced by a Hased coil in the cerebral tissues, and its maximum value. Moreover, the necessity of the dura mater design in the fewer tissue models is discussed.

PA-121 [15:00]

WITHDRAWN

PA-123 [15:00]

Transprotein-electropore characterization: A molecular dynamics investigation on human AQP4

Paolo Marracino¹, Mario Bernardi¹, Micaela Liberti¹, Federico Del Signore¹, Josè Antonio Garate³, Christian Burnham², Francesca Apollonio¹ & Niall English²

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Keywords: Mechanistic/Theoretical, Static, Completed (published)

Presented by: Francesca Apollonio

Electroporation characterization is a topic of intensive interest probed by extensive ongoing research efforts. Usually, these studies are carried out on lipid-bilayer electroporation. Surprisingly, the possibility of water-channel electropore formation across transmembrane proteins themselves, particularly in view of such a promising application, has not yet been elucidated. The present work examines the geometrical and kinetic aspects of electropores and their stability in such a protein milieu.

PA-125 [15:00]

STUDENT PAPER

Experimental model simulation on electromagnetic wave therapy of apical periodontitis

Hideo Taketani¹, Masatake Akutagawa², Hiromichi Yumoto³, Kouji Hirao³, Takahiro Emoto², Hiroo Tarao⁴, Toshihiko Tominaga⁵, Toshitaka Ikehara⁶ & Yohsuke Kinouchi²

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Keywords: Mechanistic/Theoretical, IF, Work in Progress

Presented by: Hideo Taketani

The major current treatment of the apical periodontitis is cleaning of the root canal with chemicals. Recently EMAT (electro-magnetic apical treatment) have been proposed. EMAT is a treatment for sterilizing the root canal and regenerating the alveolar bone by applying voltage into the root canal. Although the experiment about the effect with EMAT is currently performed, the current density distribution in the experimental environment is still unknown. Thus, an experimental model was created and the current density distribution was obtained by simulation. As a result, it was thought that heat by applying voltage was transferred by convection from the electrode tips to the outside of the electrodes, and it was distributed to the whole PBS.

PA-127 [15:00]

WITHDRAWN

PA-129 [15:00]

WITHDRAWN

PA-131 [15:00]

Interference of cardiac devices by electronic article surveillance systems - Still a problem?

Carsten Alteköster¹, Ingo Bömmels¹ & Corinna Becker²

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Keywords: Occupational, All Frequencies, Work in Progress

Presented by: Carsten Alteköster

Many employees, who are insured by the German Social Accident Insurance Institution for the trade and distribution industry (BGHW), are working in the retail industry and are exposed to electromagnetic fields (EMF) from electronic article surveillance (EAS) systems in their workplace. For the mandatory competent risk assessment of those, the Institute of Occupational Safety and Health (IFA) supported the BGHW by carrying out measurements at various currently used EAS systems. Although it is known, that EAS systems can emit EMF at a level that are possibly hazardous for employees with or without implanted cardiac devices [1, 2], it was found that these systems are still in use. Hence, there is a need of action for preventive measures.

PA-133 [15:00]

Evaluation of electromagnetic exposure during the use of induction hobs in ergonomically realistic numerical modeling

Krzysztof Gryz¹, Jolanta Karpowicz¹ & Patryk Zradziński¹

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Keywords: Occupational, IF, Work in Progress

Presented by: Jolanta Karpowicz

The exposure to electromagnetic field (EMF) emitted by studied induction hob (maximum 1.8 kW power, 25

kHz frequency) were evaluated by measurements and numerical simulations of the electric field (E_{in}) induced in the tissues of females body models. The results of ongoing study shown e.g. that E_{in} values in the body 5 cm away from the induction hob heating coil approach general public exposure limit values in case the magnetic field strength is higher than 11 A/m (such exposure condition exists up to 20 cm from heating zone covered by pot in centred position). In order to prevent potential exposures exceeding safety limits, the use of induction hobs in the work place needs to involve technical or organisational protection measures.

PA-135 [15:00]

Evaluation of exposures to electromagnetic radiofrequency radiation from radio communication devices and systems in suburbs of medical resort function in Poland

Jolanta Karpowicz¹ & Krzysztof Gryz¹

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Keywords: Occupational, RF/Microwaves, Completed (unpublished)

Presented by: Jolanta Karpowicz

Exposure to electromagnetic radiofrequency radiation (ERR) from RTV, mobile telephony, Internet access, etc. (whole-body exposure, WBE, from system antennas; and localized exposure, LE, from portable terminals) was evaluated by: broadband measurements of ERR spatial distribution, spectrum measurements and frequency-selective estimation of its variability. In the three large urban centers and their suburbs of medical resort's function in Poland measurements showed average ERR in particular urban and suburb locations, respectively [V/m]: 0.3-0.5/0.10; 0.6-1.2/0.15; 0.5-1.2/0.05; in the urban centers: LE at least 3-times lower than WBE, and in the resort's suburbs: LE at least 5-times lower than WBE.

PA-137 [15:00]

Evaluation of in situ electric fields and tissue warming in proximity to metallic implants for low to intermediate frequency magnetic field exposure at workplace

Rene Hirtl¹, Klaus Schiessl², Richard Überbacher¹, Tobias Jhala¹ & Gernot Schmid¹

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Keywords: Occupational, ELF/LF, Completed (unpublished)

Presented by: Klaus Schiessl

Although within workplace legislation, such as EU-Directive 2013/35/EU, enhanced risks due to metallic implants need to be accounted for, only few systematic reviews exist. Evaluation against the exposure limit values of 2013/35/EU up to 10MHz has been performed under consideration of abundant metallic implants. Risk of nerve stimulation and tissue warming due to heating of the metallic implant itself has been evaluated with numerical simulations. Several experiments with inductions heaters in the frequency range up to 100kHz have been conducted for validation. Reduction factors, to be applied on action levels of 2013/35/EU, have been found, ensuring compliance with the underlying exposure limit values for workers with metallic implants.

PA-139 [15:00]

Analyses of background factors on allocating MRI scan duties to pregnant employees

Sachiko Yamaguchi-Sekino¹, Humio Maeyatsu², Tsukasa Doi³, Takeo Hikichi⁴, Hideki Fujita⁵, Shinya Imai⁶, Manabu Akahane⁷, Shuhei Izawa¹ & Rui-Sheng Wang¹

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Keywords: Occupational, Static, Completed (published)

Presented by: Sachiko Yamaguchi-Sekino

In our previous study, we sent 5763 questionnaires to facilities equipped with MRI devices in Japan in order to survey their policies on allocating MRI scan duties to pregnant employees. This study analyzed background factors in duty allocation, particularly the “less-promoted allocation pattern” choice for pregnant employees. Classification tree modeling and binomial logistic regression analyses showed that concerns of adverse health effects caused by non-ionizing radiation (NIR) exposure were strong motivations in deciding a pregnant employee’s allocation. Views on exposure to NIR and concerns of physical load also played an important role in the decision-making process.

PA-141 [15:00]

Examples of magnetic field measurements in two electric cars

Rauno Pääkkönen¹ & Leena Korpinen²

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²*Clinical Physiology and Neurophysiology Unit, The North Karelia Central Hospital, Joensuu, Finland*

Keywords: Public Health Policy, ELF/LF, Completed (published)

Presented by: Leena Korpinen

Smart cities contain various electromagnetic field sources, e.g., electric cars (EVs) and the charging technology of EVs. We have performed this work on sample measurements of electric cars related to electromagnetic exposures. The fields have generally been less than the recommended values.

PA-143 [15:00]

A role for learned societies in promoting good scientific practice and open science

Andrew Wood^{1, 3} & Robert McIntosh^{1, 2, 3}

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Keywords: Public Health Policy, RF/Microwaves, Review, Commentary, Recommendation, Evaluation

Presented by: Andrew Wood

Inconsistency of outcomes has long been a feature of bioelectromagnetics research. Learned societies (e.g. BEMS) and associated journals, can play a role in promoting good practices, in order to set out and reduce areas of uncertainty. The society webpage in particular can provide a portal to useful experimental resources and advice on experimental design, particularly in regard to dosimetry, methodology and data analysis. It can also provide access to facilities for data repository, pre-registration of protocols and open source computer codes. The journal Bioelectromagnetics can also provide similar resources (and has). The purpose of this poster is to stimulate further discussion in this area and to collect feedback from viewers.

PA-145 [15:00]

Comparison of SARs measured by vector probe array-based SAR measurement systems using commercially available smartphones

Tomoaki Nagaoka¹, Kanako Wake¹ & Soichi Watanabe¹

¹*National Institute of Information and Communications Technology, Tokyo, Japan, 184-8795*

Keywords: Standards, RF/Microwaves, Work in Progress

Presented by: Tomoaki Nagaoka

SAR measurement is indispensable for testing the compliance of wireless communication products with safety limits. The procedures of SAR measurement are established by the international standards. In these standards, SAR should be measured in all possible measurement settings, which are combinations of

frequencies and device positions. Since a conventional SAR measurement method requires a great deal of time, a vector probe array-based SAR measurement system has recently been developed as a next-generation SAR measurement system. In this study, we measured the SARs of the latest smartphones using two types of vector probe array-based SAR measurement system and compared the SARs measured by these two systems as a basic study.

PA-147 [15:00]

Probability of Injury from Radio Frequency Exposure (PIRE): Categorizing the hazards of superficial RF insults

Jeffrey Whitmore¹, William Voorhees¹ & Jason Payne¹

¹*Radio Frequency Bioeffects Branch, Air Force Research Laboratory, San Antonio, Texas, USA, 78234*

Keywords: Standards, RF/Microwaves, Work in Progress

Presented by: Jeffrey Whitmore

Modeled thermal profile of various superficially penetrating radio frequency exposures. Collected exposure data for radio frequency (RF) exposures on excised swine skin at several different incidence angles and compared to model predictions. Related the predictions and observations to standards and damage metrics. Used this information to inform a hazard construct for superficially penetrating RF systems.

Session: FB
Student Flash Poster Session B
Tuesday June 25, 2019 • 14:00 - 15:00
Einstein
Chairs: Christopher Portier & Niels Kuster

FB-1 [14:00]
STUDENT PAPER

Three dimensional microdosimetry study at millimeter waves

Zain Haider¹, Maxim Zhadobov¹, Yves Le Dréan² & Ronan Sauleau¹

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²*Univ Rennes, Inserm, EHESP, IRSET (Institut de recherche en santé, environnement et travail) – UMR_S 1085, F-35000 Rennes, France*

Keywords: *Dosimetry (computational), RF/Microwaves, Work in Progress*

Presented by: *Zain Haider*

A microdosimetric study is performed on biological cells models in the 60 GHz band. Complex permittivity data of dielectric models of the membrane, cytoplasm, and extracellular medium at microwaves have been extrapolated to millimeter-wave frequencies. A quasi-static electromagnetic (EM) analysis is employed to solve the Laplace equation both analytically and numerically. Preliminary results provide insight into millimeter-wave power deposition at the sub-cellular level.

FB-2 [14:03]
STUDENT PAPER

Characteristics of temperature rise in a human eyeball due to a dipole antenna in frequency range from 6 GHz to 30 GHz

Shugo Nishikawa^{1, 2}, Tomoaki Nagaoka², Soichi Watanabe², Ryosuke Suga¹, Kanako Wake² & Osamu Hashimoto¹

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Keywords: *Dosimetry (computational), RF/Microwaves, Work in Progress*

Presented by: *Shugo Nishikawa*

Recently, the use of smartphones and tablet terminals for data communication has increased. For 5G, data communication via mobile terminals is expected to increase more than ever. In a frequency band above 6 GHz, the electromagnetic energy is mainly absorbed on the surface of the human body. Therefore, we focused on the temperature in the eyeball and its surroundings by placing a wireless communication terminal in front of the eyes. In this study, we estimated the temperature rise in the eyeball due to a half-wavelength dipole antenna in a frequency range from 6 GHz to 30 GHz located close to a human eye using an anatomical model with high fidelity and high resolution.

FB-3 [14:06]
STUDENT PAPER

Measurement campaign for the assessment of electromagnetic fields near cellular base stations in Belgium

Rachel Nkem Iyare¹, Vladimir Volskiy¹ & Guy A.E Vandenbosch¹

¹*Electrical Engineering, Katholieke Universiteit, Leuven, Belgium, 3001*

Keywords: *Dosimetry (measurements), RF/Microwaves, Completed (unpublished)*

Presented by: *Rachel Nkem Iyare*

The electromagnetic radiation emitted by cellular base stations in Belgium is measured. The objective of this assessment is to provide the relevant information on electromagnetic fields produced by cellular base stations and to investigate the changes of electromagnetic exposure within a typical day and over multiple

days in the vicinity of these base stations. The measurements were performed using highly precise measurement equipment in public areas comprising different locations. The exposure was carried out for mobile communication networks. The results show that all analyzed locations are in compliance with the exposure limits recommended by ICNIRP and that the exposure levels are reproducible over a time span of ca. one month.

FB-4 [14:09]

STUDENT PAPER

Dosimetric study of electrophysiological recording devices based on micro-electrodes under Radio-Frequency exposures

Amani Nefzi¹, Clement E. Lemerrier², Noëlle Lewis², Isabelle Lagroye^{2, 3}, Philippe Leveque¹ & Delia Arnaud-Cormos¹

¹*Univ. Limoges, CNRS, XLIM, UMR 7252, Limoges, France, 87000*

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³*Paris "Sciences et Lettres" Research University, EPHE, Paris, France*

Keywords: Dosimetry (measurements), RF/Microwaves, Work in Progress

Presented by: Amani Nefzi

In this work, recording devices based on micro-electrodes were developed to study the electrical activity of neurons while exposed to RF fields. The exposure system used for RF application is a Transverse Electromagnetic (TEM) cell. An RF exposure setup is described, the results of the experimental dosimetry of the two micro-electrodes recording devices are explored. Experimental dosimetry proved that TEM cell containing the micro-electrodes devices has a good energy transfer with a return loss under -10 dB the frequency band up to 3 GHz. Applying 5 W for 30 minutes to 1 mL of biological medium within the micro-electrode device induced a temperature elevation of around 1.5°C.

FB-5 [14:12]

STUDENT PAPER

Microsecond kinetics of ion transport and interface binding in electrically stressed phospholipid bilayers

Federica Castellani^{1, 2}, Esin B Sözer¹ & P. Thomas Vernier¹

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²*Biomedical Engineering, Frank Batten College of Engineering and Technology, Norfolk, Va, USA, 23508*

Keywords: Electroporation, Pulsed, Work in Progress

Presented by: Federica Castellani

Formation of bilayer-spanning water bridges and conductive lipid pores is enhanced by the application of transmembrane electric fields. Drugs, nucleic acids, and other normally impermeant material can enter cells through these lipid electropores. The mechanisms underlying this process, called electroporation or electropermeabilization, are not well understood. Molecular dynamics simulations of lipid membranes in electric fields can be used to investigate this phenomenon at the experimentally inaccessible nanoscale. Here we describe the previously unexplored microsecond kinetics of ion binding to phospholipid bilayers and transport through lipid electropores in double bilayer systems containing K⁺, Ca²⁺, and Cl⁻.

FB-6 [14:15]

STUDENT PAPER

Development of estimation model for exposure of magnetic field at intermediate frequency from household induction cooker

Takumi Kitajima¹, Akemi Morita¹, Wakaha Ikeda², Mukaide Takahiro¹, Yoshikazu Matsuda¹, Amexo Jennifer¹, Kuurdor Deku-Mwin¹, Thida Win¹, Masao Taki³ & Shigeru Sokejima^{1, 2}

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Keywords: *Epidemiology, IF, Work in Progress*

Presented by: *Takumi Kitajima*

Epidemiological studies have not yet been conducted to investigate health effects due to exposure of electromagnetic fields at the intermediate frequency (IF) band. As a first step this study, we tried to develop an IF exposure estimation model from Induction cooker in the home environment. As a result, it was found that the distance relation from the hob, diameter of cooking pan, heat power wattage, width of heater housing greatly contributed. Also, the current model tends to lose accuracy as the estimate of high value becomes higher. The future task is to examine question sentences to accurately answer the positional relationship with the body surface.

FB-7 [14:18]

STUDENT PAPER

Biohacking *in vitro* wound healing models with electrotherapy

Jerome Hunckler¹, Lucien Bartram³, Janice Tsui¹ & Brian Cousins²

¹*University College London, London, United Kingdom, NW3 2PS*

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³*Globe Microsystems Ltd, Esher, United Kingdom, KT10 8BL*

Keywords: *In vitro, Static, Work in Progress*

Presented by: *Jerome Hunckler*

Wounded skin possesses a specific pattern of electrical activity called current of injury that is essential to healing. Applying electrical stimulation on chronic wounds may mimic the natural current of injury and enhance regeneration. The overall aim of this study is to set up a model of a cutaneous injury *in vitro*, optimize the electrical stimulation parameters on this model using human dermal fibroblasts, and investigate the behaviour of cells derived from patient with specific diseases under optimised direct current, pulsed current and Naturepulse ® clinical device (Globe Microsystems Ltd, UK).

FB-8 [14:21]

STUDENT PAPER

Manipulation of weak magnetic fields alters stem cell proliferation during regeneration

Alanna Van Huizen¹, Luke Kinsey¹, Frank Barnes² & Wendy Beane¹

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²*Department of Electrical, Computer, and Energy Engineering, University of Colorado, Boulder, Boulder, Colorado, USA, 80309-0425*

Keywords: *In vivo, Static, Completed (published)*

Presented by: *Alanna Van Huizen*

Weak magnetic fields (WMFs) can affect the rate of cellular proliferation. Using the planarian regeneration model, we show exposure to 200 μ T WMFs inhibits new tissue (blastema) growth, as compared to 45 μ T (earth-normal) controls. Growth inhibition occurred due to loss of reactive oxygen species (ROS) at the wound site, which reduced heat shock protein 70 expression (which in turn is required for stem cell proliferation). Variations in WMFs are thought to change electron spin states in radical molecules, thus affecting radical pair recombination rates. These data reveal that based on field strength, WMF exposure can increase or decrease new tissue formation *in vivo*, suggesting WMFs as a potential tool to manipulate mitotic activity.

FB-9 [14:24]

STUDENT PAPER

On the development of an imaging system at mm-wave frequencies for biological applications: dielectric characterization of tissues and first preliminary results on phantoms

Simona Di Meo¹, Marco Pasian¹, Giulia Matrone¹, Lorenzo Pasotti¹, Lourdes Farrugia² & Charles Sammut²

¹*Department of Electrical, Computer and Biomedical Engineering, University of Pavia, Pavia, Italy, 27100*

²*Electromagnetics Laboratory, Department of Physics, University of Malta, Msida, Malta, 2080*

Keywords: Human, RF/Microwaves, Work in Progress

Presented by: Simona Di Meo

In this abstract, the work still in progress done by the Microwave Laboratory of the University of Pavia is presented. The abstract addresses all the main aspects of the research from the dielectric characterization of human breast ex-vivo tissues (up to 50GHz) to the final test of the mm-wave imaging prototype on realistic breast phantoms. The future work regarding the dielectric characterization of in-vivo samples on a relatively small colony of mice is also presented, along with the current collaboration with the University of Malta mainly intended to assess (and possibly quantify) the statistical difference between the dielectric properties derived from ex-vivo samples taken from animals and taken from human cadavers.

FB-10 [14:27]

STUDENT PAPER

Specific absorption rate analysis of a dual-band planar monopole antenna with a metasurface resonator for 5G / WLAN applications

Min-Joo Jeong¹, Niamat Hussain¹, Hanul Bong¹, Ji Woong Park¹, Seungwoo Lee² & Nam Kim¹

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Keywords: Human, RF/Microwaves, Work in Progress

Presented by: Min-Joo Jeong

In this paper, we present a dual-band planar monopole antenna using metasurface (MS) resonator with low specific absorption rate (SAR) for 5G and WLAN applications. The proposed antenna is designed by adding an MS resonator to a monopole antenna fed by a co-planar waveguide (CPW). We calculated the SAR for 1 g and 10 g tissue at 0 mm distance of antenna from the head instead of 10 mm, which is stricter than the international standards, and computed the SAR values at 3.5 GHz and 5.8 GHz. The SAR values are found to be 0.823 W/kg for 1 g and 0.584 W/kg for 10 g at 3.5 GHz and 1.3 W/kg for 1 g, and 0.877 W/kg for 10 g at 5.8 GHz, which are under the international safety SAR standards.

FB-11 [14:30]

WITHDRAWN

FB-12 [14:33]

WITHDRAWN

FB-13 [14:36]

WITHDRAWN

FB-14 [14:39]

WITHDRAWN

Session: PB
Poster Session B
Tuesday June 25, 2019 • 15:00 - 16:30
Joffre 2-3

PB-2 [15:00]

Radiofrequency electromagnetic fields exposure, screen time, brain morphology, and attention problems in school-age children

Mònica Guxens^{1, 2}, Alba Cabré¹, Ryan Muetzel², Luuk van Wel³, Ilaria Liorni⁴, Myles Capstick⁴, Roel Vermeulen³, Martine Vrijheid¹, Tonya White² & Hanan El-Marroun²

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²*ErasmusMC, Rotterdam, the Netherlands*

³*IRAS, Utrecht University, Utrecht, the Netherlands*

⁴*IT'IS Foundation, Zurich, Switzerland*

Keywords: Behavioural, Static, Completed (published)

Presented by: Monica Guxens

We investigated the association between radiofrequency electromagnetic fields (RF-EMF) exposure, screen time, and brain morphology in school-age children and to assess whether brain morphology mediated the association between RF-EMF exposure, screen time, and behaviour problems. We found that RF-EMF dose to the brain was not associated with brain morphology alterations. However, longer use of screen devices, in particular television use, was associated with smaller brain volume, and these alterations partially mediated the association between higher television use and higher attention problems.

PB-4 [15:00]

WITHDRAWN

PB-6 [15:00]

WITHDRAWN

PB-8 [15:00]

Novel coil design for deep transcranial magnetic stimulation

Mai Lu¹ & Shoogo Ueno²

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²*Department of Applied Quantum Physics, Kyushu University, Fukuoka, Japan, 812-8581*

Keywords: Clinical (therapy), ELF/LF, Work in Progress

Presented by: Shoogo Ueno

New coil designs have been developed by considering both H- and Halo coils. The induced magnetic and electric fields in head tissues were obtained by applying the H-Halo-1 and H-Halo-2 coils, respectively. And the results were compared with that of conventional H-coil. Both the H-Halo-1 and H-Halo-2 coils have significant depth penetration compared to that of the conventional H-coil. The novel coil design in this work offer advantage over the H-coil of simple windings and deeper penetration depth.

PB-10 [15:00]

Numerical calculation of biological tissue coagulated region generated by microwave surgical device

Kazuyuki Saito¹ & Ryo Manago¹

¹*Chiba University, Chiba, Japan, 2638522*

Keywords: Clinical (therapy), RF/Microwaves, Work in Progress

Presented by: Kazuyuki Saito

In the surgical treatment, the microwave energy increases temperature on surface of the biological tissue such as any organs and generates a coagulated region. Generally, biological tissue coagulates at approximately 60 °C or higher. Therefore, distributions of temperature elevation have been calculated and analyzed. However, when the heating time is long, the biological tissue coagulates even if it is less than 60 °C. Therefore, shape of the coagulated region generated by the surgical device should also be investigated. In this study, shape of the coagulated region by a microwave surgical device is calculated. In addition, validity of the calculation method could be found by comparison with experimental result.

PB-12 [15:00]

Uncertainty quantification of RF exposure for assessment of RF impacts on brain activity

Xi Cheng¹, Clement Henry², Francesco Andriulli² & Joe Wiart¹

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²Politecnico di Torino, Turin, Italy

Keywords: Dosimetry (computational), RF/Microwaves, Work in Progress

Presented by: Xi Cheng

The study of the effects of radio frequency (RF) radiation on brain activity represent an application and research scenario of central and fundamental importance. This paper focuses on quantifying the uncertainty in specific absorption rate (SAR) induced by the uncertainty of the position of the electroencephalographic electrodes. It contributes to the work aimed to perform a high resolution electroencephalography (EEG) measurement to assess the effects of a RF radiation on brain activity without substantially perturbing it. An experimental design is obtained, and the idea of a space-dependent surrogate model which combines principal component analysis (PCA) and Kriging model or polynomial chaos expansion (PCE) is presented.

PB-14 [15:00]

Influence of skin conductivity on the electric field induced in the head by noninvasive brain stimulation techniques

Micol Colella¹, Alessandra Paffi¹, Sara Fontana¹, Federico Rossano¹, Valerio De Santis², Francesca Apollonio¹ & Micaela Liberti¹

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Keywords: Dosimetry (computational), ELF/LF, Work in Progress

Presented by: Micol Colella

Numerical evaluation of the electromagnetic (EM) quantities induced inside the brain during noninvasive brain stimulation techniques is a fundamental step to obtain the optimization of the treatment in terms of position of the stimulator and intensity of the stimulation. In this sense, the electromagnetic properties used to characterize the tissues have an influence on the EM solution. Thus, the aim of this study is to evaluate how different skin conductivities influence the electric field induced inside the brain of the detailed anatomical human head model MIDA by a TMS coil and by tDCS electrodes.

PB-16 [15:00]

A simple and reliable exposure system for seed magneto-priming applications

Claudio D'Elia¹, Aniello Crescenzi³, Nicola D'Ambrosio² & Rita Massa¹

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³SAFE- School of Agricultural, Forest, Food and Environmental Sciences, Università della Basilicata, Potenza, Italy, 85100

Keywords: Dosimetry (computational), Static, Completed (unpublished)

Presented by: Claudio D'Elia

An exposure system has been designed, realized and characterized on the basis of uniformity criteria and the desired magnetic induction level (50 mT - 320 mT range). It has been configured as a magnetic circuit able to confine induction magnetic field, generated by a couple of permanent magnets, with an high homogeneity field distribution (CV less than 0.02) in a maximum volume of about 3.5 cm³. The applicator will be used in the framework of a project which aim is the evaluation of static magnetic induction mechanisms on seeds for enhancing their quality.

PB-18 [15:00]

STUDENT PAPER

Three dimensional microdosimetry study at millimeter waves

Zain Haider¹, Maxim Zhadobov¹, Yves Le Dréan² & Ronan Sauleau¹

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²Univ Rennes, Inserm, EHESP, IRSET (Institut de recherche en santé, environnement et travail) – UMR_S 1085, F-35000 Rennes, France

Keywords: Dosimetry (computational), RF/Microwaves, Work in Progress

Presented by: Zain Haider

A microdosimetric study is performed on biological cells models in the 60 GHz band. Complex permittivity data of dielectric models of the membrane, cytoplasm, and extracellular medium at microwaves have been extrapolated to millimeter-wave frequencies. A quasi-static electromagnetic (EM) analysis is employed to solve the Laplace equation both analytically and numerically. Preliminary results provide insight into millimeter-wave power deposition at the sub-cellular level.

PB-20 [15:00]

Development and management of the magnetic field prediction software for overhead and underground transmission lines

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Keywords: Dosimetry (computational), ELF/LF, Work in Progress

Presented by: Seungwoo Lee

In this study, the magnetic field prediction software exposed by overhead and unground transmission lines is developed. The software can be reduced by considering the human effects of the magnetic fields exposed by the transmission lines before construction design stages. The software produced very similar values that measured in the actual environment, and it is believed that the magnetic field could be reduced to the desired values by considering the results prior to construction of the transmission line.

PB-22 [15:00]

STUDENT PAPER

Characteristics of temperature rise in a human eyeball due to a dipole antenna in frequency range from 6 GHz to 30 GHz

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Keywords: Dosimetry (computational), RF/Microwaves, Work in Progress

Presented by: Shugo Nishikawa

Recently, the use of smartphones and tablet terminals for data communication has increased. For 5G, data

communication via mobile terminals is expected to increase more than ever. In a frequency band above 6 GHz, the electromagnetic energy is mainly absorbed on the surface of the human body. Therefore, we focused on the temperature in the eyeball and its surroundings by placing a wireless communication terminal in front of the eyes. In this study, we estimated the temperature rise in the eyeball due to a half-wavelength dipole antenna in a frequency range from 6 GHz to 30 GHz located close to a human eye using an anatomical model with high fidelity and high resolution.

PB-24 [15:00]

Potential underestimation of exposure when applying simplified body models proposed in product standards IEC 62822-x for welding equipment

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Keywords: *Dosimetry (computational), ELF/LF, Work in Progress*

Presented by: *Gernot Schmid*

For assessing magnetic field exposure IEC 62822-x proposes a simplified procedure in which body parts are modelled as homogeneous circular disk models. According to IEC 62822-x this approach can then be used to compute worst case in situ electric field strength E_i inside body parts at a certain distance to welding equipment. However, we failed to validate the mentioned procedure for the situation of a welding cable along the lower arm and hand, based on numerical computations using four different anatomical body models. The results show that the disk model-based approach may substantially underestimate actual exposure due to the fact that the disks oversimplify anatomical features relevant for the resulting maximum E_i .

PB-26 [15:00]

Computer simulations of the penetration of 30 to 90 GHz radiation into the human ear

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Keywords: *Dosimetry (computational), RF/Microwaves, Completed (unpublished)*

Presented by: *Zoltan Vilagosh*

Given the interest in expanding communication to 30-90 GHz frequencies, and the capacity of the outer ear to act as waveguide, the penetration of these frequencies into the ear needs to be explored. Simulations show that at 30 GHz the tympanic membrane is shielded from radiation from all angles with the tympanic membrane experiencing a power density (PD) in the order of 2% of that of the outer skin. At 90 GHz, exposure reaches 10% of the incident PD. Given that the tympanic membrane is richly innervated and well supplied with blood, the thermal and sensory effect of the incident radiation at these frequencies needs to be explored, as the recommendations for exposure of the outer skin may not be adequate.

PB-28 [15:00]

Evaluation of SAR in adult anatomical model caused by exposure from UHF RFID readers

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Keywords: *Dosimetry (computational), RF/Microwaves, Work in Progress*

Presented by: *Patryk Zradziński*

The ultra-high frequency radiofrequency identification (UHF RFID) readers are widely used e.g. in shops, libraries, hospitals. The nature of the work of employees of these institutions often requires approaching to such readers and even holding them close to the body and thus exposure to the electromagnetic field. The SAR value is evaluating in human body model present near UHF RFID readers operating at 856 MHz considering various exposure scenarios. The results of ongoing study showed e.g. that SAR values from UHF

RFID readers 5 cm away from the body approach general public exposure limit values, during 6 minute exposure for radiated power higher than 3.3 W.

PB-30 [15:00]

Features of the second generation of personal EM exposimeter DEVIN

Serge Bories¹, David Dassonville¹, Saifeddine Aloui¹, Laurent Lombard¹, Joe Wiart³ & Isabelle Deltour²

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Keywords: *Dosimetry (measurements), RF/Microwaves, Work in Progress*

Presented by: *Serge Bories*

The population EM exposure and its long-term evolution will be better assessed through daily, in situ measurements, and by embracing the wide diversity of usages, of telecom and wireless standards but also the network infrastructure technological deployment choices. The innovating personal exposimeter DEVIN is simply attached to the user's smartphone in order to log both the effective transmitted RF power and to classify the user activities all along the day. This second generation of exposimeter has been miniaturized. WiFi and new cellular bands have been implemented. Four proximity sensors are used to accurately estimate the source position regarding the user's body. These new features are presented in this paper.

PB-32 [15:00]

EMF exposure evaluation for manhole type base stations

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Keywords: *Dosimetry (measurements), RF/Microwaves, Work in Progress*

Presented by: *Junji Higashiyama*

This paper presents the measurement results of radio frequency exposure to manhole-type base stations installed underground using the measurement methods standardized in IEC 62232: 2017, in order to evaluate exposure to these base stations and obtain some reference data to consider suitable computation methods for exposure evaluations for such the base stations installed underground.

PB-34 [15:00]

STUDENT PAPER

Measurement campaign for the assessment of electromagnetic fields near cellular base stations in Belgium

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Keywords: *Dosimetry (measurements), RF/Microwaves, Completed (unpublished)*

Presented by: *Rachel Nkem Iyare*

The electromagnetic radiation emitted by cellular base stations in Belgium is measured. The objective of this assessment is to provide the relevant information on electromagnetic fields produced by cellular base stations and to investigate the changes of electromagnetic exposure within a typical day and over multiple days in the vicinity of these base stations. The measurements were performed using highly precise measurement equipment in public areas comprising different locations. The exposure was carried out for mobile communication networks. The results show that all analyzed locations are in compliance with the exposure limits recommended by ICNIRP and that the exposure levels are reproducible over a time span of ca. one month.

PB-36 [15:00]

A study on power density measurement method for 5G mobile phone

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Keywords: Dosimetry (measurements), RF/Microwaves, Completed (published)

Presented by: Kihwea Kim

A measurement method of the power density (28 GHz) in near-field region was proposed to verify the compliance of the 5G mobile phone with the electromagnetic wave human protection standards. We were verified through simulation and measurement considering the beamforming technology, the measurement technology of the electromagnetic wave in high frequency, the setting of the minimum separation distance for the evaluation, use of reconstruction algorithm method, etc. Based on this, the world's first power density measurement method of 5G mobile phone was proposed.

PB-38 [15:00]

CDMA, WCDMA and LTE networks and transmitted power of mobile phones

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Keywords: Dosimetry (measurements), RF/Microwaves, Work in Progress

Presented by: Ae-kyoung Lee

In 2015 and 2017, the transmitted power data of mobile phones during a voice call had been collected in operating CDMA 2000, WCDMA, and LTE networks in Seoul, Korea to utilize the results in epidemiological studies [1], [2]. The objective of this abstract is to present the change in the frequency bands of LTE as well as the Tx power level between the two different time windows. As a result, the Tx power has mostly decreased in 2017 compared to that in 2015. However, connection proportions between LTE bands have greatly varied and significant differences between operators were observed.

PB-40 [15:00]

Broadband and band-selective measurements of radiofrequency EM field with drone system – A feasibility study

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Keywords: Dosimetry (measurements), RF/Microwaves, Work in Progress

Presented by: Peter Necz

The aim of present study was to check the feasibility of a method to measure the RF field and exposure patterns of fixed outdoor RF sources at locations difficult to access by drone system. Other aim was to check how to use common RF survey broadband meter (Narda NBM-550) and lightweight personal exposimeter (ExpoM-RF) in the study. We found that the synchronization of both position and data logging are the most important parameters in the RF exposimetry by drones. Conducting measurements by common, commercially available exposimeters should be useful in the future exposimetry studies, nevertheless several conditions must be considered in the planning phase and carrying out such studies.

PB-42 [15:00]

STUDENT PAPER

Dosimetric study of electrophysiological recording devices based on micro-electrodes under Radio-Frequency exposures

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Keywords: *Dosimetry (measurements), RF/Microwaves, Work in Progress*

Presented by: *Amani Nefzi*

In this work, recording devices based on micro-electrodes were developed to study the electrical activity of neurons while exposed to RF fields. The exposure system used for RF application is a Transverse Electromagnetic (TEM) cell. An RF exposure setup is described, the results of the experimental dosimetry of the two micro-electrodes recording devices are explored. Experimental dosimetry proved that TEM cell containing the micro-electrodes devices has a good energy transfer with a return loss under -10 dB the frequency band up to 3 GHz. Applying 5 W for 30 minutes to 1 mL of biological medium within the micro-electrode device induced a temperature elevation of around 1.5°C.

PB-44 [15:00]

Thermal convection in *in vitro* samples exposed to millimeter waves in continuous and pulse-modulated regimes

Rosa Orlacchio¹, Maxim Zhadobov¹, Stanislav Alekseev², Denys Nikolayev³, Ronan Sauleau¹, Yann Le Page⁴, Denis Habauzit⁴ & Yves Le Dréan⁴

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Keywords: *Dosimetry (measurements), RF/Microwaves, Completed (unpublished)*

Presented by: *Rosa Orlacchio*

This study investigates the impact of convection on temperature dynamics in a typical *in vitro* exposure scenario during continuous and pulsed millimetre-wave (MMW) induced heating. Results showed that the onset of convection during continuous heating i) is preceded by the appearance of a temperature peak, which occurrence in time depends on SAR (the higher the SAR, the earlier the convection is triggered), ii) depends on the liquid volume (larger volumes result in earlier triggering of convection and greater cooling effect), and iii) depends on the viscosity of the medium. For the pulsed-induced heating results showed that long pulses facilitate the occurrence of convection, which in turn impacts the heat pulse amplitude and cooling rate.

PB-46 [15:00]

Characterisation of personal exposure to environmental radiofrequency electromagnetic fields in Albacete (Spain) and assessment of risk perception

Raquel Ramírez-Vazquez², Jesus Gonzalez-Rubio¹, Enrique Arribas² & Alberto Nájera¹

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Keywords: *Dosimetry (measurements), RF/Microwaves, Completed (published)*

Presented by: *Alberto Nájera*

RF-EMF exposure was measured in Albacete (Spain) using personal exposimeters. A description of personal exposure is provided in temporary and spatial terms. Levels of personal exposure were extremely low compared to regulatory limits. Volunteers were informed about the results. Access to the results could help reduce the population's risk perception. Paper is available at: <https://doi.org/10.1016/j.envres.2019.02.015>

PB-48 [15:00]

Characterization of magnetic fields from an EAS system used in libraries

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Keywords: Dosimetry (measurements), IF, Work in Progress

Presented by: Masao Taki

Magnetic field distribution was measured in consideration of the phase of each vector component for the gate of an electronic article surveillance system used in a library. The magnetic field was found elliptically polarized with different ellipticity depending on the location in the gate. Distribution of the ellipticity was examined for incident magnetic field. The induced electric field was also calculated numerically by impedance method assuming a human model passing through the gate.

PB-50 [15:00]

WITHDRAWN

PB-52 [15:00]

WITHDRAWN

PB-54 [15:00]

Is an electrostatic field able to induce a galvanotactic phenomenon? Investigation in a scrape wound model

Isabella Zironi¹, Gabriele D'Amen², Annalisa De Angelis³, Laura Caramazza³, Alessandro Gabrielli² & Gastone Castellani^{1, 2}

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Keywords: Electrochemistry, Static, Work in Progress

Presented by: Annalisa De Angelis

Galvanotaxis is a bioelectronic phenomenon representing the movement of a living organism in response to an electric stimulus. The majority of the experiments in the galvanotaxis area are conducted under the action of a d.c. field, and involve metal electrodes directly inserted into the medium containing the cells. In the present work, we investigated the alterations in cell migratory capacity in response to a "non contact" EF application by an in vitro scrape wound assay and a prediction of the dose at the cell level by numerical modelling.

PB-56 [15:00]

Numerical investigations on the action of CW electric fields on lipid vesicles for drug delivery

Laura Caramazza^{1, 2}, Annalisa De Angelis¹, Elena della Valle³, Agnese Denzi¹, Martina Nardoni⁴, Patrizia Paolicelli⁴, Stefania Petralito⁴, Francesca Apollonio¹ & Micaela Liberti¹

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Keywords: Electroporation, RF/Microwaves, Work in Progress

Presented by: Laura Caramazza

The electromagnetic (EM) fields application together with the use of biocompatible drugs nanocarriers has been recently studied to enhance medical treatments. In this context, liposomes, biocompatible lipid vesicles, are recently under investigation both as EM fields triggerable carriers and as simple model mimicking cell membrane response. In this work, 2D microdosimetric analyses on single liposomes, with a range dimension from the nano to the micro-meter scale, have been performed studying the feasibility to increase biological membrane permeability through radiofrequency fields. Lastly, the response of a 2D model of 142 randomly placed nanosized liposomes has been proposed as a more realistic drug delivery systems suspension.

PB-58 [15:00]
STUDENT PAPER

Microsecond kinetics of ion transport and interface binding in electrically stressed phospholipid bilayers

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Keywords: Electroporation, Pulsed, Work in Progress

Presented by: Federica Castellani

Formation of bilayer-spanning water bridges and conductive lipid pores is enhanced by the application of transmembrane electric fields. Drugs, nucleic acids, and other normally impermeant material can enter cells through these lipid electropores. The mechanisms underlying this process, called electroporation or electropermeabilization, are not well understood. Molecular dynamics simulations of lipid membranes in electric fields can be used to investigate this phenomenon at the experimentally inaccessible nanoscale. Here we describe the previously unexplored microsecond kinetics of ion binding to phospholipid bilayers and transport through lipid electropores in double bilayer systems containing K⁺, Ca²⁺, and Cl⁻.

PB-60 [15:00]
STUDENT PAPER

Development of estimation model for exposure of magnetic field at intermediate frequency from household induction cooker

Takumi Kitajima¹, Akemi Morita¹, Wakaha Ikeda², Mukaide Takahiro¹, Yoshikazu Matsuda¹, Amexo Jennifer¹, Kuurdor Deku-Mwin¹, Thida Win¹, Masao Taki³ & Shigeru Sokejima^{1, 2}

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Keywords: Epidemiology, IF, Work in Progress

Presented by: Takumi Kitajima

Epidemiological studies have not yet been conducted to investigate health effects due to exposure of electromagnetic fields at the intermediate frequency (IF) band. As a first step this study, we tried to develop an IF exposure estimation model from Induction cooker in the home environment. As a result, it was found that the distance relation from the hob, diameter of cooking pan, heat power wattage, width of heater housing greatly contributed. Also, the current model tends to lose accuracy as the estimate of high value becomes higher. The future task is to examine question sentences to accurately answer the positional relationship with the body surface.

PB-62 [15:00]

Exposure to intermediate-frequency electromagnetic fields generated by induction cookers

Akemi Morita¹, Takumi Kitajima¹, Wakaha Ikeda², Mukaide Takahiro¹, Yoshikazu Matsuda¹, Amexo Jennifer¹, Kuurdor Deku-Mwin¹, Thida Win¹, Masao Taki³ & Shigeru Sokejima^{1, 2}

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Keywords: Epidemiology, IF, Work in Progress

Presented by: Akemi Morita

Intermediate-frequency (IF) electromagnetic fields (EMF) are generated by induction-heating (IH) cookers and a variety of industrial facilities. Unfortunately, research for the potential health effects associated with exposure to IF-EMF are lacking. We investigated usage of IF-EMF emitting appliances and exposure level from IH cookers in the household. We conducted a web survey of usage of IF emitting appliances for Japanese women aged 20-54 in Mie prefecture and measured the exposure level from the IH cookers in 50 households. Thirty three % of the respondents had IH cooker in their home. Average maximum magnetic flux density exposed by IH cookers is 4 micro T. The exposure level from IH cookers was suggested to be limited.

PB-64 [15:00]

Prenatal and postnatal mobile phone use and cognitive functions in 5-year-old children

Heesun Yang¹, Hyunjoo Joo¹, Xue Han², Yong-Han Lee², Eun-Hee Ha³, Hyesook Park⁴, Yangho Kim⁵, Yun-Chul Hong⁶, Nam Kim⁷, Jong Hwa Kwon⁸, Hyung-Do Choi⁸, Ae-kyoung Lee⁸, Kyung-Hwa Choi², Sanghyuk Bae⁹, Mina Ha² & Ho-Jang Kwon²

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Keywords: Epidemiology, RF/Microwaves, Work in Progress

Presented by: Kyung-Hwa Choi

This study examined the relationship between pre- and postnatal mobile phone use and the cognitive scores of 5-year-old children. The IQ of the 5-year-old child was lower by -6.91 in the group with heavy users (≥ 6 / day) in both pre- and postnatal mobile phone use compared to the group with light users (< 6 / day) in both pre- and postnatal mobile phone use, but it was not significant (p value = 0.15). We found no evidence for a significant association between prenatal and postnatal mobile phone use and children's cognitive development in 5-year-old children.

PB-66 [15:00]

24-hour monitoring of nsPEF-induced morphological changes, in U-87 MG cells, using digital holographic microscopy

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Keywords: In vitro, Pulsed, Work in Progress

Presented by: Lynn Carr

Digital holographic microscopy is a technique that allows real-time visualisation of cellular morphology. We

used the M4 Holomonitor, which is adapted for use in an incubator, to monitor changes in U-87 MG cells over a 24 hour time period following exposure to nanosecond pulsed electric fields (nsPEF). Pulse exposure was shown to cause a reduction in cell-cell interactions and to induce cellular rounding.

PB-68 [15:00]

RF signaling by cancer cells and bacteria?

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Keywords: Behavioural, All Frequencies, Completed (published)

Presented by: Frank Barnes

This paper discusses about the possible electromagnetic communication between fibrosarcoma and bacillus subtilis cells in the radio frequency range and lower.

PB-70 [15:00]

Iron/Sulphur complexes as regulators of redox balance and effects of combined EMF and static fields on ROS production

Hakki Gurhan¹ & Frank Barnes¹

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Keywords: In vitro, RF/Microwaves, Work in Progress

Presented by: Frank Barnes

In this study, we're exposing HT-1080 Human fibrosarcoma cells with both EMF and Static Fields. We're using AC electromagnetic waves in the region between 0.1 MHz and 10 MHz since hyperfine coupling for different Iron/Sulphur Complexes occur in this range. Due to their electric and magnetic properties, Iron/Sulphur proteins may affect production of Reactive Oxygen Species (ROS) with the existence of external fields. These proteins are located in membrane bound complexes which are thought to be the major sites of ROS production.

PB-72 [15:00]

High frequency electromagnetic fields and diesel exhaust nanoparticles co-exposures effects on *in vitro* blood-brain barrier permeability and drug efflux transporter activity

Samir Dekali¹, Alexandre Boyard¹, Flavia Del Vecchio¹ & David Crouzier¹

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Keywords: In vitro, RF/Microwaves, Work in Progress

Presented by: Samir Dekali

The aim of the study was to investigate combined effects of diesel exhaust nanoparticles (DEP) and electromagnetic fields (EMF, 100 MHz, modulated square shaped signal at 100 kHz, duty cycle of 10%, power density 100W/m², SAR 0.14W/kg calculated by numerical simulation) at non thermal level on permeability and drug efflux transporter activity of a blood-brain barrier *in vitro* model (BBB). Co-cultures of brain microvascular endothelial cells and microglial cells were exposed in bicameral chambers to DEP in apical compartment with or without EMF during 24h. Results showed significant increase of BBB permeability in case of EMF / DEP co-exposures, while functional P-glycoprotein (P-gp) activity is mainly decreased by DEP exposure.

PB-74 [15:00]

STUDENT PAPER

Biohacking *in vitro* wound healing models with electrotherapy

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Keywords: *In vitro*, Static, Work in Progress

Presented by: Jerome Hunckler

Wounded skin possesses a specific pattern of electrical activity called current of injury that is essential to healing. Applying electrical stimulation on chronic wounds may mimic the natural current of injury and enhance regeneration. The overall aim of this study is to set up a model of a cutaneous injury *in vitro*, optimize the electrical stimulation parameters on this model using human dermal fibroblasts, and investigate the behaviour of cells derived from patient with specific diseases under optimised direct current, pulsed current and Naturepulse ® clinical device (Globe Microsystems Ltd, UK).

PB-76 [15:00]

Effects of reactive oxygen species induced by 405 nm light irradiation on HeLa S3 cells

Toshitaka Ikehara^{1, 2}, Mutsumi Nakahashi³, Takahiro Emoto⁴, Masatake Akutagawa⁴, Koichiro Tsuchiya⁵, Akira Takahashi⁵ & Yohsuke Kinouchi⁴

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Keywords: *In vitro*, RF/Microwaves, Work in Progress

Presented by: Toshitaka Ikehara

We tested effects of 405 nm light irradiation on HeLa cells. The irradiation for at least 3 hr did not affect the cell viability, but ROS (reactive oxygen species) induced in cells was increased rapidly by the irradiation. This ROS measured by a fluorescent probe was mainly singlet oxygen. A decrease in intracellular glutathione by 1-chloro-2,4-dinitrobenzene strongly increased the intracellular ROS. These results suggest that the intracellular GSH plays as a physiological scavenger of intracellular ROS induced by the light irradiation.

PB-78 [15:00]

Combined exposure to ultraviolet and radiofrequency radiation of reconstructed human skin model *in vitro* (SKIN-RF project)

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Keywords: *In vitro*, RF/Microwaves, Work in Progress

Presented by: Zsofia Szilagyj

The aim of this study was to examine whether the combined exposure to solar ultraviolet (UV) radiation and radiofrequency (RF) exposure have any effect on cytokine (IL-1 α , IL-6, IL-8) and MMP-1 enzyme secretion on *in vitro* reconstructed human skin model. The full thickness skin models were exposed to UV radiation (2 SED, 4 SED) and radiofrequency (Wi-Fi, UMTS). The IL-1 α , IL-6, IL-8 and MMP-1 concentrations were measured 24 hours after UV and RF exposures from the culture media by the ELISA method. This experiment was done for the project named "Cellular response to co-exposure of radiofrequency (RF) and solar ultraviolet (UV) radiation in human *in vitro* skin model (SKIN-RF)".

PB-80 [15:00]

Prediction of the tumor promoting potential of ultrahigh and intermediate frequency electromagnetic waves using the Bhas 42 cell transformation assay

Kiyomi Ohmori¹, Toru Fukumitsu¹, Iwaki Nishi¹, Ken Tachibana², Ken Takeda², Shin Koyama³, Eijiro Narita³, Junji Miyakoshi³ & Naoki Shinohara³

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Keywords: *In vitro, RF/Microwaves, Completed (unpublished)*

Presented by: *Kiyomi Ohmori*

The Bhas 42 cell transformation assay (Bhas 42 CTA) was recognized by the Organization for Economic Cooperation and Development (OECD) guidance document as a cell transformation assay in 2016, and became the first internationally recognized in vitro assay that was able to predict tumor promoting potential, including non-genotoxic carcinogenicity. We attempted to predict the tumor promoting potential of ultrahigh and intermediate frequency electromagnetic waves using Bhas 42 CTA. Furthermore, we analyzed the mechanisms of the effects of electromagnetic waves on Bhas 42 cells using molecular biological approaches.

PB-82 [15:00]

The effect of a long-term evolution (LTE) on the intracellular calcium concentration

Tomonori Sakurai¹

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Keywords: *In vitro, RF/Microwaves, Completed (unpublished)*

Presented by: *Tomonori Sakurai*

In this study, we evaluated the effects of a long-term evolution (LTE) exposure on the intracellular calcium concentration in mammalian cells. We investigated 11 conditions of LTE exposure operated at 1.95 GHz with IMR-32 and NG108-15 cells, which were reported to be affected by exposure to the electromagnetic fields in Blackman's researches. In all the experimental conditions, we could not detect the effects of LTE exposure on intracellular calcium concentration in the cell lines; although the treatment with H₂O₂ resulted in an increase in intracellular calcium concentration.

PB-84 [15:00]

Electrostimulation of adrenal chromaffin cells by 2 ns electric pulses can be modulated by an electric field reversal

Josette Zaklit¹, Gale Craviso², Normand Leblanc², P. Thomas Vernier³ & Esin B Sözer³

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Keywords: *In vitro, Static, Work in Progress*

Presented by: *Thomas Vernier*

Bipolar pulse cancellation refers to the suppression of the effect of a unipolar pulse by a following second unipolar pulse of opposite polarity. The purpose of this study is to investigate the effect of 2 ns, 16 MV/m electric pulses on chromaffin cells and to assess whether bipolar pulse cancellation occurs in this neurosecretory cell model. We show that a transient rise in [Ca²⁺]_i caused by a 2 ns unipolar pulse can be totally eliminated by an immediately following pulse of the same duration and opposite polarity. This cancellation disappears as the interphase interval is increased beyond 30 ns. These results are the first observations that the bipolar pulse cancellation is modulated with interphase intervals of tens of nanoseconds.

PB-86 [15:00]

Gender and age differences in the suppressive effect of a 50 Hz electric field on the immobilization-induced increase of plasma glucocorticoid in mice

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Keywords: *In vivo, ELF/LF, Completed (unpublished)*

Presented by: *Takuya Hori*

We recently reported the suppression of an immobilization-induced increase in glucocorticoid (GC) levels in mice upon exposure to a 50 Hz electric field (EF) in a strength-dependent manner. The present study extends this research by assessing differences in the effects of EFs by age and gender. We compared the GC levels among control, EF-alone, immobilization-alone, and co-treatment groups. Plasma GC levels were similar in EF-alone and control groups regardless of gender or age. However, the immobilization-induced increase in the GC levels was suppressed by EF application in the male, intact female, and ovariectomized female mice. Furthermore, in all age groups, the immobilization-induced increase in the GC level was suppressed by the EF.

PB-88 [15:00]

Protective effects of RF with different signal modulations in cultured human lymphocytes treated with chemicals

Stefania Romeo¹, Anna Sannino¹, Olga Zeni¹, Rita Massa^{1, 2} & Maria Rosaria Scarfi¹

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Keywords: *In vitro, RF/Microwaves, Work in Progress*

Presented by: *Rita Massa*

The present paper reports about the induction of protective effects from chemically induced DNA damage, in cultured human lymphocytes pre-exposed to RF electromagnetic fields at 1950 MHz under continuous wave and modulated signals. The results suggest that protective effect of RF takes place in presence of modulated signals and depends on both the bandwidth and applied SAR. Keywords—Radiofrequency, adaptive response, in vitro, modulation, DNA damage

PB-90 [15:00]

Exposures of *Phaseolus vulgaris* L. sprouts to 2.45 GHz induce changes in photosynthesis of adult plants.

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Keywords: *In vivo, RF/Microwaves, Completed (published)*

Presented by: *Rita Massa*

Sprouts of *Phaseolus vulgaris* L. were exposed for 24 hours to 2.45 GHz at a 40mW/g SAR level. The controlled dosimetric conditions allowed to determine the thermal increase induced by exposure. After the sprouts were put in pots to obtain adult plants. On fully expanded leaves the photosynthesis was assessed and compared to that of leaves from plants whose sprouts had undergone only temperature increase by conventional heating (like the shoots exposed), and from control plants. In this way we differentiated the thermal and non-thermal effects induced by 2.45 GHz exposure. The initial leaves of plants from sprouts exposed showed a higher photosynthesis, not decreasing during the observation period, unlike the other experimental conditions.

PB-92 [15:00]

Alteration of hippocampal gene expression profiles by RF-EMFs

Ye Ji Jeong¹, Hyung-Do Choi², Jeong-Ki Pack³, Nam Kim⁴ & Hae-June Lee¹

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Keywords: *In vivo, RF/Microwaves, Work in Progress*

Presented by: *Ye Ji Jeong*

To explore the chronic RF-EMF effect on gene expression in hippocampus of brains of mice at different age, we performed 8 months RF-EMF exposure to both young and aged C57BL/6 mice (SAR 5 W/kg, 2 hours/day, 5 days/week) and investigated the changes of gene expression profile using whole gene microarray approach. The genes in the hippocampus showed different patterns in young and aged brains. And we found a group of genes that changed commonly in both groups by RF-EMFs. These will be used as important basic data to identify the molecular biological mechanism of RF-EMFs.

PB-94 [15:00]

Gestational RF-EMF exposure disrupts the maternal hypothalamic-pituitary-adrenal axis, but not placental barrier

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Keywords: *In vivo, RF/Microwaves, Completed (unpublished)*

Presented by: *Hye Sun Kim*

We examined the impact of RF exposure at whole-body SAR of 4 W/kg on maternal HPA axis and placental barrier. Gestational RF-EMF exposure at 4 W/kg SAR can cause a significant elevation of maternal level of cortisol, however fetus can be protected by placental barrier.

PB-96 [15:00]

The structural and functional alterations of neurotransmission in central nervous system induced by RF-EMF exposure

Ju-Hwan Kim¹, Yang Hoon Huh², Jin-Koo Lee¹, Hyung-Gun Kim¹ & Hakrim Kim¹

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Keywords: *In vivo, RF/Microwaves, Completed (published)*

Presented by: *Ju-Hwan Kim*

The exposure to RF-EMF could affect the neurotransmission through altered profiles of synaptic vesicles in neuron, which might influence behavioral phenotype after long term exposure of RF-EMF and suggested that the exposure to RF-EMF could induce the structural and functional changes of neuron in the multiple pathways.

PB-98 [15:00]

Intravital microscopic observation of modulatory actions of the angiogenesis under static magnetic field exposure

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Keywords: In vivo, Static, Work in Progress

Presented by: Hiroshi Masuda

To observe dynamic changes in the angiogenic process under exposure to a static magnetic field, we improved on the traditional closed cranial window method for rodent animals. Male C57BL/6NCrSlc mice were used for this experiment and exposed to a static magnetic field using neodymium permanent magnets placed on the window. The improved method allowed for in vivo and repeated imaging of the angiogenesis in mouse brains under the exposure for one month. The angiogenic process at early stages seemed to be accelerated with the exposure.

PB-100 [15:00]

Influence of electromagnetic fields on prooxidant/antioxidant balance in rat stomach

Karolina Sieron¹, Grzegorz Onik¹, Ewa Birkner², Grzegorz Cieslar³, Andrzej Krawczyk⁴, Pawel Sowa⁵ & Aleksander Sieron⁶

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Keywords: In vivo, RF/Microwaves, Completed (unpublished)

Presented by: Karolina Sieron

Health consequences of exposure to high-voltage industrial frequency and radio-frequency electromagnetic fields are not clearly established. The study aim was to evaluate the impact of different electromagnetic fields on prooxidant and antioxidant processes in the stomach tissue of 40 male rats. Obtained results proved that four-week exposure to electromagnetic field emitted by typical high-voltage electric current transmission lines and a mobile leads to pro- and antioxidative status alterations in rat stomach.

PB-102 [15:00]

nsPEF dramatically affects peritoneal carcinomatosis tumors in a syngeneic orthotopic graft murine model

Abdelkader Taibi¹, Marie-Laure Perrin², Jérémie Albouys¹, Catherine Yardin¹, Sylvaine Durand-Fontanier¹ & Sylvia M. Bardet²

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Keywords: In vivo, Pulsed, Work in Progress

Presented by: Sylvia M. Bardet

New immunocompetent cancer models are still needed for the identification and preclinical validation of novel

therapeutic targets in colorectal cancer. We have developed 4 models by syngeneic intravenous, subcutaneous, intraperitoneal or laparotomy graft of luciferase expressing CT-26 cells with or w/o 10 ns PEF exposure, a promising tool for tumor ablation. Anatomic and histologic analysis corroborated the existence of tumoral nodules, and multiphoton microscopy was used to describe peritoneal tumoral fibrosis. In vitro CT-26 cells were also analyzed for their sensitivity to nsPEF (survival, mitochondrial potential, calcium waves and permeabilization). We were able to show a drastic effect of nsPEF on in vivo tumor morphology and survival.

PB-104 [15:00]
STUDENT PAPER

Manipulation of weak magnetic fields alters stem cell proliferation during regeneration

Alanna Van Huizen¹, Luke Kinsey¹, Frank Barnes² & Wendy Beane¹

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Keywords: *In vivo, Static, Completed (published)*

Presented by: *Alanna Van Huizen*

Weak magnetic fields (WMFs) can affect the rate of cellular proliferation. Using the planarian regeneration model, we show exposure to 200 μ T WMFs inhibits new tissue (blastema) growth, as compared to 45 μ T (earth-normal) controls. Growth inhibition occurred due to loss of reactive oxygen species (ROS) at the wound site, which reduced heat shock protein 70 expression (which in turn is required for stem cell proliferation). Variations in WMFs are thought to change electron spin states in radical molecules, thus affecting radical pair recombination rates. These data reveal that based on field strength, WMF exposure can increase or decrease new tissue formation in vivo, suggesting WMFs as a potential tool to manipulate mitotic activity.

PB-106 [15:00]
STUDENT PAPER

On the development of an imaging system at mm-wave frequencies for biological applications: dielectric characterization of tissues and first preliminary results on phantoms

Simona Di Meo¹, Marco Pasian¹, Giulia Matrone¹, Lorenzo Pasotti¹, Lourdes Farrugia² & Charles Sammut²

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Keywords: *Human, RF/Microwaves, Work in Progress*

Presented by: *Simona Di Meo*

In this abstract, the work still in progress done by the Microwave Laboratory of the University of Pavia is presented. The abstract addresses all the main aspects of the research from the dielectric characterization of human breast ex-vivo tissues (up to 50GHz) to the final test of the mm-wave imaging prototype on realistic breast phantoms. The future work regarding the dielectric characterization of in-vivo samples on a relatively small colony of mice is also presented, along with the current collaboration with the University of Malta mainly intended to assess (and possibly quantify) the statistical difference between the dielectric properties derived from ex-vivo samples taken from animals and taken from human cadavers.

PB-108 [15:00]

Are there age-related differences in possible effects of RF-EMF exposure on the macro- and microstructure of sleep between healthy young (18-30 years) and healthy elderly men (60-80 years)?

Torsten Eggert¹, Hans Dorn¹, Gernot Schmid², Cornelia Sauter¹, Rene Hirtl² & Heidi Danker-Hopfe¹

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Keywords: *Human, RF/Microwaves, Completed (unpublished)*

Presented by: *Torsten Eggert*

The study aims to analyse possible differences in RF-EMF effects on the macrostructure and the microstructure of sleep between healthy young and healthy elderly men. The results indicate no clear differences in effects of GSM 900 and TETRA exposure in healthy young (18-30 years) and elderly men (60-80 years). The results observed so far are not indicative of a disturbed sleep under RF-EMF exposure.

PB-110 [15:00]
STUDENT PAPER

Specific absorption rate analysis of a dual-band planar monopole antenna with a metasurface resonator for 5G / WLAN applications

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Keywords: Human, RF/Microwaves, Work in Progress

Presented by: Min-Joo Jeong

In this paper, we present a dual-band planar monopole antenna using metasurface (MS) resonator with low specific absorption rate (SAR) for 5G and WLAN applications. The proposed antenna is designed by adding an MS resonator to a monopole antenna fed by a co-planar waveguide (CPW). We calculated the SAR for 1 g and 10 g tissue at 0 mm distance of antenna from the head instead of 10 mm, which is stricter than the international standards, and computed the SAR values at 3.5 GHz and 5.8 GHz. The SAR values are found to be 0.823 W/kg for 1 g and 0.584 W/kg for 10 g at 3.5 GHz and 1.3 W/kg for 1 g, and 0.877 W/kg for 10 g at 5.8 GHz, which are under the international safety SAR standards.

PB-112 [15:00]

Characteristics of skin temperature elevation under the local exposure of 28 GHz-millimeter-wave in phantom and real human body

Itsuki Kageyama^{1, 3}, Takashi Hikage², Keita Sakakibara², Akimasa Hirata³, Sachiko Kodera³, Kenji Taguchi⁴, Tatsuya Kashiwa⁴, Yoshitaka Morimatsu¹, Tatsuya Ishitake¹ & Hiroshi Masuda¹

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Keywords: Human, RF/Microwaves, Work in Progress

Presented by: Itsuki Kageyama

There is little information about the biological effects of millimeter-waves (MMW) such as 5th generation wireless systems (5G) and WiGig (IEEE 802.11ad) on human body surface including the function of skin blood flow. Aim of this study was to develop new systems for local skin exposure of 28 GHz band and to evaluate temperature elevation at body surface under the local exposure in phantom and human body. The temperature elevation was found locally in and around the target area. In addition, obvious elevation of temperature was observed at 0.5 W of antenna input power in both surfaces.

PB-114 [15:00]

Photonic bridges & EMF: a new approach to identify natural solutions to regulate ambroisa and reduce its allergic impact on human health

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Keywords: Human, Optical, Work in Progress

Presented by: Georges Vieilledent

In 2014, as part of BioEm's Annual Meeting (Cape Town, South Africa), we presented a poster on new applications of the corona effect and in particular on a phenomenon never before identified that we have called "photonic bridges". These phenomena seem to indicate an affinity or not between the products tested. In the context of the research for innovative solutions capable of inhibiting the development of ambrosia, a particularly invasive weed in agricultural environments and capable of causing strong allergic reactions, we present here the first results obtained with the use of photonic bridges. These promising results open up important research opportunities, particularly in the field of health

PB-116 [15:00]

Absorption of RF energy in the cell layer of biological preparations

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Keywords: Dosimetry (computational), RF/Microwaves, Work in Progress

Presented by: Alessandra Paffi

The exposure of cell preparations to RF energy is often performed in Petri dishes supported by a metal ground plane, such as inside TEM cells or radial waveguides. Due to the thickness of the cell layer (order of 10^{-5} m) at the bottom of a Petri dish, numerical tools used for dosimetric calculation present problems in managing the mesh. Here, we employ an analytic method for plane waves propagating through the cell layer and overlying medium. Our calculations suggest that a transverse resonance can occur if a wave incident on the medium surface excites a trapped wave. Although our calculations are obtained with an idealized model, they predict transverse resonant phenomena that are not easily anticipated by numerical EM computations.

PB-118 [15:00]

Dipolar coupling between CW electric fields and water solution: a rationale for non-linear responses in molecular dynamics simulations

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Keywords: Mechanistic/Theoretical, RF/Microwaves, Work in Progress

Presented by: Alessandra Paffi

Many approaches for calculation of the field-dependent dielectric constant of water solutions rely on the Onsager and Kirkwood theories of polar dielectrics. Such basic theories implicitly consider the electric field applied to fulfill the so-called 'weak field conditions', i.e. to produce a linear response in the system. In this work we made use of molecular dynamics (MD) simulations to investigate possible non-linear effects induced by high intensity electric fields, specifically continuous waves burst with nanosecond duration, and eventually compare such effects with the ones predicted by the literature.

PB-120 [15:00]

Molecular simulations of the A2A adenosine receptor in presence of magnetic field: an insight on the binding site environment

Federico Del Signore¹, Paolo Marracino², Elena della Valle³, Davide Cocco¹, Stefania Setti⁴, Ruggero Cadossi⁴, Micaela Liberti¹ & Francesca Apollonio¹

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Keywords: Mechanistic/Theoretical, Static, Work in Progress
Presented by: Francesca Apollonio

In this paper, we present the results of the application of an external static magnetic field with the Velocity Verlet algorithm for performing Molecular Dynamics simulations of the A_{2A} receptor protein embedded in a phospholipidic bilayer. Molecular Dynamics simulations allow to understand at molecular level the interaction mechanisms between atoms under specific conditions. Here MD simulations of a receptor protein have been performed in presence of an external magnetic field in order to try to elucidate specific endpoints of interaction with the field. In particular an insight on the binding site environment has been carried out.

PB-122 [15:00]

WITHDRAWN

PB-124 [15:00]

Comparison between two electric conduction models related to Ohm's law and Drude's conductivity formula

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Keywords: Mechanistic/Theoretical, Static, Work in Progress
Presented by: Shoogo Ueno

From a point of electrical engineers' view, we are interested in electric conduction, in particular, microscopic movements of electric carriers in conductive materials such as electrically driven electron in copper wire of solid state. We studied the most fundamental law; Ohm's law and Drude's conductivity formula. The two models seem independent models, namely, the one model is a periodic-collision model and the other is a viscosity model. Our study, however, concludes that the two models have the same expression in both Ohm's law and Drude's conductivity formula. The results obtained in this study are useful in understanding electric conductivities in conductive materials used in bioelectricity and bioelectromagnetics.

PB-126 [15:00]

WITHDRAWN

PB-128 [15:00]

Evaluation of EMF emitted by WiFi modems in laptops' ergonomical use

Krzysztof Gryz¹, Jolanta Karpowicz¹ & Patryk Zradziński¹

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Keywords: Occupational, RF/Microwaves, Work in Progress
Presented by: Krzysztof Gryz

The exposure to electromagnetic field (EMF) emitted by WiFi modems of laptops were evaluated by numerical simulations of the specific absorption rate (SAR) values in virtual human body models (male and female). The results of numerical calculation of SAR values in human models were below limits when considered exposure scenarios were ergonomically realistic, but shown significantly higher EMF exposure effects while using laptop closer to the body. When EMF exposures caused by the use of portable computer device, the ergonomics of exposure conditions in the exposure scenarios need to be considered. Further

analysis with next exposure scenarios are under considerations.

PB-130 [15:00]

Assessment of occupational exposure during arc welding

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Keywords: Occupational, ELF/LF, Completed (unpublished)

Presented by: Lucien Hammen

Arc welding stations are widely use in the industry. During the process the worker is exposed to an EMF and an associated risk assessment has to be done. Because of the inhomogeneous field distribution over the welder, the compliance should be determined using ELVs comparison. This study has identified the influencing parameters and their effects. The B field determination was based on a comparative method between theoretical and experimental distributions. The internal E field was estimated using 2 different approaches: the use of a standard (IEC62822-2) and numerical simulation. It shows that for some configurations the ELVs could be exceeded. It will provide some guidances to ensure that worker exposure doesn't exceed the field limits.

PB-132 [15:00]

Long term load from the exposure to static magnetic field during workers activities in magnetic resonance medical diagnostics

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Keywords: Occupational, Static, Completed (unpublished)

Presented by: Jolanta Karpowicz

The aim of the study was to estimate long term load from SMF near 1.5 T MRI scanners used for regular medical diagnostics. Taking into account the usual work practice in the MRI centers, the most frequently only the radiographers' exposure needs to be analyzed with respect to the long term SMF load. It was found that in routine examination of one patient the radiographer is exposed to SMF>0.5mT over 1-7minutes and SMF dose is 0.06(0.1)Txmin, median(maximum) value. During several decades of possible work activities SMF load of radiographers may exceed the threshold for possible developing of hypertension from the long term exposure to MRI-related SMF (dose>7500Txmin). In further epidemiological studies they need to be considered.

PB-134 [15:00]

Occupational environments where electromagnetic fields exposure can exceed Directive 2013/35/EU limits: identification of scenarios and preliminary measurement survey

Rosanna Pinto¹, Angela Coniglio², Gian Marco Contessa³, Simona D'Agostino⁴, Rosaria Falsaperla⁴, Vanni Lopresto¹ & Alessandro Polichetti⁵

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Keywords: Occupational, ELF/LF, Work in Progress

Presented by: Rosanna Pinto

In this paper a scientific review is presented, aimed to the identification of occupational scenarios where the exposure to stray electromagnetic fields (EMFs) can exceed the exposure limit values (ELVs) defined in

Directive 2013/35/EU. A total number of 56 papers was examined, and some critical exposure scenarios have been selected for further deepening. Among these, a device for transcranial magnetic stimulation (TMS) was chosen for a first measurement survey. Preliminary results of operators' exposure assessment are shown.

PB-136 [15:00]

WITHDRAWN

PB-138 [15:00]

EMF measurement approaches for 5G – spot and long-term measurements

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Keywords: Public Health Policy, RF/Microwaves, Work in Progress

Presented by: Holger Schwarz

With 5G there are new sources of electromagnetic emissions to be considered. There is already some public concern and discussion about new frequencies used by 5G and the new technologies. Narda and Telstra have performed instantaneous spot measurements for health & safety at work assessments, and also long-term measurements as an approach for environmental assessment purposes. Additionally we have assessed the safe work procedures for working safely on 5G base stations.

PB-140 [15:00]

Derivation of an averaging time threshold for U.S. FCC time constraints on impulse heating from localized exposure

Martin Doczkat¹ & Edwin Mantiply²

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Keywords: Standards, RF/Microwaves, Completed (unpublished)

Presented by: Martin Doczkat

For typical consumer devices, instantaneous exposures are time-averaged based on an inherent property or duty-cycle of a device, such as over a single time slot in a TDMA transmission scheme. New technologies enable a device to actively monitor potential exposure to its user over longer times. Averaging time thresholds are derived based on the FCC SAR limit of 1.6 W/kg over 1-g of tissue. This method is a simple alternative to more complex detailed anatomical modeling analyses which consider other effects such as heat conduction, blood flow, convection, and evaporation (which tend to shed heat away from the body), while arriving at similar conclusions – about 100 seconds at 3 GHz, to a couple of seconds at 100 GHz.

PB-142 [15:00]

Telstra's EME assessment and preparation for 5G in Australia

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Keywords: Standards, RF/Microwaves, Work in Progress

Presented by: Mike Wood

This paper looks at the preparation for 5G and extensive electromagnetic emissions (EME) testing and analysis on the Telstra 5G trial networks and the new 3.5GHz commercial network in Australia.

PB-144 [15:00]

Evaluation of the IEC-62232:2017 standard for radiocommunication base stations with focus on

children

Richard Überbacher¹, Gernot Schmid¹ & Stefan Cecil¹

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Keywords: Standards, RF/Microwaves, Work in Progress

Presented by: Gernot Schmid

The IEC 62232:2017 standard describes methods to ensure compliance of base stations regarding to EMF safety of humans. In this work we investigate the robustness of the proposed standard spatial averaging scheme applied to children. In numerical simulations with an optical method a complex virtual test site was generated from an existing real exposure scenario. The results suggests, that for children because of their smaller stature the standard 9-point averaging scheme leads to an underestimation of the exposure in the vicinity of base stations. For a future release of the IEC 62232 further considerations for the EMF exposure of children or smaller persons are recommended to ensure the compliance with the safety limits.

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Mobile & Wireless Forum

The MWF is an international association of companies with an interest in mobile and wireless communications including the evolution to 5G and the Internet of Things. Bergbosstraat 115 – Merelbeke 9820, Belgium; enquiries@mwfai.org; <http://www.mwfai.org>



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Hydro-Québec is a public utility that manages the generation, transmission and distribution of electricity in Quebec. It was established by the Government of Quebec in 1944 from the expropriation of private firms. This was followed by massive investment in hydro-electric projects like the James Bay Project. Today, with 63 hydroelectric power stations, the combined output capacity is 37,370 megawatts. Extra power is exported from the province and Hydro-Québec supplies 10 per cent of New England's power requirements. Hydro-Québec is a state-owned enterprise based in Montreal. In 2018, it paid CAD\$2.39 billion in dividends to its sole shareholder, the Government of Québec. Its residential power rates are among the lowest in North America. More than 40 percent of Canada's water resources are in Québec and Hydro-Québec is the fourth largest hydropower producer in the world. The company logo, a stylized "Q" fashioned out of a circle and a lightning bolt, was designed by Montreal-based design agency Gagnon/Valkus in 1960.



Réseau de Transport d'Électricité (Electricity Transmission Network), usually known as RTE, is the electricity transmission system operator of France. It is responsible for the operation, maintenance and development of the French high-voltage transmission system, which at approximately 100,000 kilometres (62,000 mi), is Europe's largest. RTE is a wholly owned subsidiary of the partially public-owned French generator Électricité de France (EdF), headquartered in Paris. It is a limited liability corporation, known in France as a société anonyme.



The GSMA represents the interests of mobile operators worldwide, uniting nearly 800 operators with almost 300 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces industry-leading events such as Mobile World Congress, Mobile World Congress Shanghai, Mobile World Congress Americas and the Mobile 360 Series of conferences. For more information on GSMA activities related to electromagnetic fields please visit <http://www.gsma.com/publicpolicy/consumer-affairs/emf-and-health>. GSMA – London, EC4N 8AF, United Kingdom; info@gsma.com; <https://www.gsma.com/publicpolicy/consumer-affairs/emf-and-health>



The Electric Power Research Institute, Inc. (EPRI), is an American independent, nonprofit organization that conducts research and development related to the generation, delivery, and use of electricity to help address challenges in electricity, including reliability, efficiency, affordability, health, safety, and the environment. EPRI's principal offices and laboratories are located in Palo Alto, California; Charlotte, N.C.; Knoxville, TN; and Lenox, MA.

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Occitanie is an administrative region of France that was created on January 1, 2016 from the former French regions of Languedoc-Roussillon and Midi-Pyrénées. France's Conseil d'État approved Occitanie as the new name of the region on September 28, 2016, coming into effect on September 30, 2016. The modern administrative region is named after the cultural and historical region of Occitania, which covers a larger area. The region as it is today covers a territory similar to that ruled by the Counts of Toulouse in the 12th and 13th centuries. The banner of arms of the Counts of Toulouse, known colloquially as the Occitan cross, is used by the modern region and is also a popular cultural symbol. The new region covers an area of more than 72,724 km² (28,079 square miles), and has a population of 5,626,858. It borders Nouvelle-Aquitaine, Auvergne-Rhône-Alpes, Provence-Alpes-Côte d'Azur, Andorra (Canillo, Encamp, La Massana, Ordino) and Spain (Aragon and Catalonia). [From Wikipedia] <https://www.regionlrmp.fr>



École Pratique
des Hautes Études



L'École Pratique des Hautes Études est un grand établissement où l'on pratique la recherche en Sciences de la vie et de la terre, Sciences historiques et philologiques, et Sciences religieuses. Son enseignement est dispensé au niveau master, doctorat et post-doctorat ainsi que pour la préparation de son diplôme propre. Elle accueille depuis toujours des auditeurs libres. L'EPHE couvre des territoires de la connaissance originaux. Participer aux conférences et autres enseignements qui y sont dispensés par plus de 260 enseignants-chercheurs, c'est pratiquer la recherche dans des champs aussi variés que les langues et les religions de l'Asie centrale pré-islamique, les grands monothéismes, l'archéologie chinoise, la paléographie hébraïque ou la dialectologie grecque et les humanités numériques pour les sciences humaines et sociales ; la biodiversité des récifs coralliens, les neurosciences et les cognosciences, l'environnement et la régulation cellulaires pour les sciences de la vie et de la terre... sans oublier les questions transdisciplinaires qui se posent à l'interface de ces grands domaines du savoir. À sa création en 1868, l'EPHE avait pour mission d'introduire dans le monde universitaire un mode original de formation fondé sur la fréquentation de séminaires et le travail en laboratoire. Elle comprenait alors quatre sections : Mathématiques, Physique et chimie, Sciences naturelles et physiologie, et Sciences historiques et philologiques. Une Ve section de Sciences religieuses y fut adjointe en 1886. La VIe section, dévolue aux Sciences économiques et sociales, créée en 1947, s'autonomisa en 1975 pour devenir l'EHESS. À la même époque, les sections de mathématiques et de physique-chimie furent dissoutes. Fidèle à sa mission initiale, l'EPHE continue de former à la recherche par la pratique de la recherche, mais en s'adaptant au nouveau paysage scientifique mondial : ses chercheurs et ses doctorants tissent un intense réseau international ; nombre de ses équipes sont contractualisées avec le CNRS ou d'autres organismes ; elle est membre de l'Université PSL où elle collabore avec d'autres prestigieux établissements ; elle est partie prenante du projet Campus Condorcet, la Cité des humanités et sciences sociales qui se bâtit à Aubervilliers. Attentive aux enjeux sociétaux des questions scientifiques qu'elle étudie, l'EPHE a trois instituts qui offrent des formations et exercent une fonction d'observatoire : l'Institut européen en sciences des religions, l'Institut des récifs coralliens du Pacifique et l'Institut transdisciplinaire d'étude du vieillissement. *Ecole Pratique des Hautes Études (EPHE)* <https://www.ephe.fr>



*maîtriser le risque
pour un développement durable*

L'Institut national de l'environnement industriel et des risques (INERIS) est un établissement public à caractère industriel et commercial (EPIC) créé en 1990 et placé sous la tutelle du Ministère de la Transition Ecologique et Solidaire français. Il est pour 80 % l'héritier du CERCHAR, Centre d'Etudes et Recherches des Charbonnages de France (1947-1990) et pour 20 % de l'IRCHA, l'Institut National de Recherche Chimique Appliquée. Sa mission est d'évaluer et de prévenir les risques accidentels ou chroniques pour l'homme et l'environnement liés aux installations industrielles, aux substances chimiques et aux exploitations souterraines. L'établissement compte deux sites, l'un à Verneuil-en-Halatte dans l'Oise (avec une grande partie des salariés) et un autre à Nancy. Il dispose également d'équipes à Bourges, Lyon et Aix-en-Provence.



La Société Française de Radioprotection (SFRP) est née en 1965 de la fusion de deux précédentes Sociétés : la Société de Radioprotection créée sur l'initiative du Docteur Henri Jammet et la Section Française de la Société Américaine "Health Physics Society" mise en place par Monsieur Francis Duhamel. Le général Norbert Chassende-Barroz fut le Président fondateur de la SFRP. La déclaration de création, sous le régime des associations sans but lucratif, a été déposée en préfecture le 18 février 1965. La Commission Juridique et du Règlement veille à la conformité des actions de l'Association au regard des statuts et des règlements intérieurs. La revue "Radioprotection" a été créée en 1966 avec pour objectif d'être la revue scientifique française consacrée à la Radioprotection, mais aussi le bulletin officiel de l'Association. La Commission de la Revue, qui assure la réalisation des quatre numéros annuels, a su préserver, au cours du temps, cette double vocation. Depuis son adhésion, en juin 1965, à l'Association Internationale de Radioprotection (IRPA), la SFRP a constamment contribué à la promotion de la radioprotection française au plan international. Dans la composition actuelle du conseil exécutif de l'IRPA, le poste de secrétaire général est tenu par Bernard Le Guen membre du conseil d'administration de la SFRP. Dans ce cadre, l'Association entretient des relations privilégiées avec des Sociétés européennes, en vue d'échanger les expériences et contribuer en commun à la mise en œuvre des concepts, de la réglementation et des techniques de la radioprotection. Ainsi, par exemple, la SFRP organise régulièrement, en France ou à l'étranger, des manifestations en collaboration avec les Sociétés belge, britannique, espagnole, germano-suisse et italienne affiliées à l'IRPA. La SFRP a adopté le code de l'éthique de l'IRPA. La SFRP compte 1300 membres actifs et une dizaine de membres bienfaiteurs.



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The *Institut national de la santé et de la recherche médicale* (Inserm, the French National Institute of Health & Medical Research) is the only public sector research institution in France exclusively dedicated to human health. Under the dual aegis of the Ministries of Health and Research, Inserm has a budget of 998 million euros and employs 15,000 scientists, engineers and technicians all with one shared objective, namely to promote health—by advancing knowledge about living organisms and their diseases, developing innovative treatment modalities and conducting research on public health. Inserm has more than 365 research units spread across France and internationally. These are supported by 13 Regional Commissions for local oversight. Scientific activities are organized around 9 “Inserm Thematic Institutes”, corresponding to the main fields of biomedical and health research. Since its foundation in 1964, Inserm has played a part in many key, historic medical advances, including the first prenatal diagnostic tests, how the HLA system works, the first in vitro fertilisation, identification of the Human Immunodeficiency Virus, radiotherapy for cancer, the first skin grafting, deep brain stimulation and gene therapy. Inserm is the leading academic patent applicant in European biomedical research, the 6th applicant in France across all sectors, the 2nd in the field of biotechnology and the first in pharmaceuticals (2016 European Patent Office figures). In 2016, Inserm held a portfolio of 1,555 live patent families. Inserm Transfert, its private subsidiary responsible for managing the Institute’s intellectual property, has issued licenses for over a quarter of this portfolio to companies in France and around the world (including big commercial health care groups, intermediate-sized enterprises, SMEs or start-ups). On average, some ten spin- off companies are created each year. In 2016, Inserm was the 9th most innovative public sector research institution in the world, according to Thomson-Reuters. <http://www.inserm.fr>

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Cobham Microwave France has a long term experience in design and manufacture of Microwave Components and Systems for space, defense & security, industrial, scientific and medical applications. Our areas of capabilities are Silicon Diodes, RF & Microwave Modules, Isolators & Circulators, Filters & Duplexers, Waveguides and Systems. Our products are qualified and embedded on major space, defense & security, industrial, scientific and medical programmes and platforms worldwide.

Vector SAR

Specific absorption rate (SAR) is a measure of the rate at which energy is absorbed by the human body when exposed to a radio frequency electromagnetic field (EMF) and must be evaluated during the production of smartphones. This project will provide the methods, software tools and datasets required for traceable calibration and uncertainty analysis of vector probe array systems (array of vector probes that automatically determines the 3D electromagnetic field mapping using amplitude and phase information through a 3D reconstruction algorithm), which are used to measure the SAR of emitting mobile telecommunication devices. This work will contribute to the international standard IEC 62209-3 and future standardisation of fifth generation (5G) devices within IEC Technical Committee TC 106. This project will enable the full-compliance of mobile telecommunication devices against IEC 62209-3 in terms of EMF exposure limits to be tested with better reliability, and will enable testing times to be reduced, which will benefit the telecommunications industry.

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