

September 2023

Issue n°2

## *eXperience activities have not stopped during the best season...*



Dear Colleagues,

I am very happy to share with you the latest news about our EXPERIENCE project. The activities have never stopped after the successful review meeting and following months, including summertime where we were supposed to take a break to recover forces after such hard work. On the contrary, the reviewers' positive comments and eloges, seem to have encouraged us all to work even harder to produce more results, because now we have the confirmation that the project is going on the correct direction.

During the last months, the EXPERIENCE Wearable System tests were completed by carrying out an internal campaign on humans that allowed verify that the quality of the measured signals were good enough to implement the foreseen use case. Now the consortium counts, together with the VR projection devices, with its own set of tools to start the clinical trials and we are ready to validate the complete system in the selected scenario of use.

I am also astonished to realize that our publication list and dissemination activities have even increased and that the partners keep representing us all with such high-class publications in journals and talks in conferences. Indeed, I feel very proud of being part of such prestigious community of scientists.

Please take a moment to review our second newsletter and thank you for your continuous dedication and commitment to this project.

The EXPERIENCE Wearable System Leader  
**Gabriela Dudnik**



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**Name:** Gabriela  
**Surname:** Dudnik  
**Title:** Project Manager



**Affiliation:** Centre Suisse d'Electronique et de Microtechnique S.A.  
 – Recherche et Développement

### 1. Favourite areas of interest and research

*With background in Electronics and professional experience in electronics, firmware, software, system design, development and further management of medical, industrial and agriculture (IoF) projects, my current favourites areas are the digital health, the environment care and the renewable energies.*

### 2. Can you mention some of the most promising research directions in the digital health field?

*There are so many research directions advancing very fast. All combined are boosting each other and converging in new powerful healthcare and medical systems for both diagnostics and treatment, starting from wearable miniaturization, that achieves the integration of all kind of physiological measurements in small and lightweight devices with very high data logging capacity, embedding edge and lightweight machine learning and artificial intelligence, continuing by an incredible advancement in wireless communication technologies, by modern approaches in data management like federated database architecture, just to mention few of them. On top of that, the greatest healthcare thinkers now focus on patient-centred and personalized disease prevention and prediction approaches.*

### 3. Which innovation influenced mostly your professional world in the last 10-20 years?

*The evolution of the solid-state technology brought the miniaturization and optimization of electronic component manufacturing techniques leading to the reduction of dimensions and power consumption, to the increase of the mass storage capacity and CPU computing capability and processing speed, resulting in powerful and efficient devices, feeding in consequence all the other technical and scientific activities with new things every day. The exponential advancement in communications, the connectivity and the Internet has democratized and simplified the arrival of the information, the educational, technical and scientific resources are available to everybody everywhere, and I leave aside the misuse the governments can make of them. On the positive side of use, if covid-19 pandemics has helped in something, it was to show how the scientific community could cooperate in sharing knowledge and working together, aiming at finding a vaccine to cure the disease. Moreover, the worldwide availability of the Internet and the infrastructure behind, acted as a relief for all the people physically disconnected from families and friends, and to the workers to which teleworking enabled continue with the working lives.*

### 4. What was your motivation to become an electronic engineer ?

*The strong desire to design things useful to the society around.*

### 5. eXperience is....

*A great opportunity to witness such amazing team of brilliant scientists working together towards an objective that can help improving the quality of life of people with the psychological troubles addressed in the project.*

#### 1. My favourite non-scientific book, musician, singer and movie...

*There are too many, but if I must choose,*

**Book:** *Argentinos (Jorge Lanata), Homo Sapiens (Yuval Noah Harari)*

**Musician:** *Daniel Barenboim, Ennio Morricone, Astor Piazzolla, Lito Vitale*

**Singer:** *Freddy Mercury, Lady Gaga, Andrea Bocelli, Whitney Houston*

**Movie:** *Cinema Paradiso, Flashdance, Amadeus, Life is Beautiful*

#### 2. I like to spend my free-time / vacation in....

*At home in Rosario, in the countryside in Entre Rios, in the Caribbean Islands when possible....*

#### 3. My favourite course (meal)...

*A big multicolour salad enriched with eggs and/or shrimps or tuna fish, parmesan cheese and seeds*

#### 4. The character trait I really dislike....

*Arrogance, authoritarianism, selfishness*

#### 5. A best sentence...

*"The greatest glory in living lies not in never falling, but in rising every time we fall" - Author: Nelson Mandela*





### Gabriela Dudnik



Gabriela Dudnik received her BE degree in Electronics from the University of Rosario in Argentina. She started working at CSEM in 2006 as R&D engineer executing and managing several EU projects. She is currently a Project Manager with the Edge & Cloud Software Group, Business Unit D – MedTech, where she shares the time between project management and acquisition. She is a generalist in Electronics, Firmware and Software, and an expert in Architectural System Design for Health, Agricultural and Environmental care applications.

### Abdessamad Falhi



Abdessamad Falhi received his MSc degree in Computer Sciences at the Swiss Federal Institute of Technology. He started working at CSEM in 2005 and is currently a Senior R&D Engineer in Edge & Cloud Software Group, Business Unit D – MedTech. He is involved in many tasks related to software development from firmware to cloud computing including Android development. He has also the background to work in signal and image processing using algorithms and neural networks in the medical field.

Participation in eXperience WPs: WP1, WP3.

### Mathilde Crettaz

Mathilde Crettaz received her MSc degree in University of Applied Sciences and Art Western Switzerland in Lausanne (HES-SO) while working at CSEM as a trainee. Then, she continued working as a mechanical designer. Her areas of expertise are the ergonomics and the usability mainly of wearable and medical devices, the CAD and user-centered design, as well as the prototyping.



Participation in eXperience WPs: WP1

### Jacques-André Porchet

Jacques-André Porchet received his degree in Electronic Engineering at the University of Applied Sciences of west Switzerland (HEIG-VD). He worked first as R&D engineer at the same university developing motion control systems, power supplies, biofeedback systems and real time controllers. He started working at CSEM where he is involved in the development of electronic systems for industrial applications in the domain of smart sensors and biomedical processing. He will now become the leader of the Prototyping Group.



Participation in eXperience WPs: WP1

### João Pedro Forjaco Jorge

João Jorge obtained a MSc degree in Biomedical Engineering from the University of Lisbon (IST) in 2011, and a PhD in Physics and Biomedical Engineering from the Swiss Federal Institute of Technology in Lausanne, Switzerland (EPFL) in 2016. He worked at the Center for Biomedical Imaging (CIBM), Switzerland, as a post-doctoral fellow for 3 years. Throughout his research career, Dr. Jorge has been deeply involved in methodological developments for EEG and fMRI. He is one of the pioneers of combined EEG-fMRI at ultra-high magnetic field (7 Tesla) worldwide and was involved in its first ever application to epilepsy patients. At CSEM, Dr. Jorge is currently actively working on cardiovascular and neurotechnology R&D.



Participation in eXperience WPs: WP1, WP3

### Gürkan YILMAZ

Dr Gürkan Yilmaz received his PhD degree in microelectronics and microsystems from the Swiss Institute of Technology, Lausanne (EPFL), Switzerland, in 2014. His doctoral thesis was on wireless power transfer and data communication for intracranial neural implants, with a case study on epilepsy patients. He spent two years at EPFL as a post-doctoral researcher developing high performance frequency synthesizers for medical imaging applications. In 2017 he joined CSEM, where he is involved in the execution and management of several projects at different TRLs, focusing particularly on wearable medical device development.



Participation in eXperience WPs: WP1, WP3

# Research topics & IDEAS

## eXperience PROJECT

### **NeuroTec Sitem-Insel Bern: Closing the Last Mile in Neurology**

Neurology is focused on a model where patients receive their care through repeated visits to clinics and doctor's offices. Diagnostic tests often require expensive and specialized equipment that are only available in clinics. However, this current model has significant drawbacks. First, diagnostic tests, such as daytime EEG and sleep studies, occur under artificial conditions in the clinic, which may mask or wrongly emphasize clinically important features. Second, early detection and high-quality management of chronic neurological disorders require repeat measurements to accurately capture the dynamics of the disease process, which is impractical to execute in the clinic for economical and logistical reasons. Third, clinic visits remain inaccessible to many patients due to geographical and economical circumstances. Fourth, global disruptions to daily life, such as the one caused by COVID-19, can seriously harm patients if access to in-person clinical visits for diagnostic and treatment purposes is throttled. Thus, translating diagnostic and treatment procedures to patients' homes will convey multiple substantial benefits and has the potential to substantially improve clinical outcomes while reducing cost. NeuroTec was founded to accelerate the re-imagining of neurology and to promote the convergence of technological, scientific, medical and societal processes.

The goal is to identify and validate new digital biomarkers that can close the last mile in neurology by enabling the translation of personalized diagnostics and therapeutic interventions from the clinic to the patient's home.

*Kaspar A. Schindler, Tobias Nef, Maxime O. Baud, Athina Tzovara, Gürkan Yilmaz, Gerd Tinkhauser, Stephan M. Gerber, Oriella Gnarra, Jan D. Warncke, Narayan Schütz, Samuel E. J. Knobel, Markus H. Schmidt, Paul Krack, Flavio Fröhlich, Raphael Sznitman, Simon Rothen and Claudio L. A. Bassetti, 2021, MDPI, clinical and translational neuroscience.*

### **BigBrain-MR: Development and in-vivo validation of a multimodal digital phantom for MRI methods at 100 $\mu\text{m}$**

The growing availability of powerful magnetic resonance imaging (MRI) systems that allow sub-millimeter resolution imaging has created a need for new simulation platforms to help develop high-resolution imaging methods. BigBrain-MR is a new simulation framework for mapping real MR properties (obtained from in-vivo data) to the fine structural scale of BigBrain, a publicly available histological brain dataset collected with optical methods at 100 $\mu\text{m}$ . To validate this digital phantom, its behavior has been compared with respect to in-vivo data in two relevant applications: (i) super-resolution imaging (SR) and (ii) parallel imaging reconstruction (PI).

The framework successfully yielded a multimodal phantom with realistic MR properties, at a fine resolution comparable to the original BigBrain (100 $\mu\text{m}$ ).

SR-validation: The dependence of image sharpness and noise on the regularization weighting was comparable in both BigBrain-MR and in-vivo.

PI-validation: BigBrain-MR and the in-vivo data showed similar dependences on acceleration factor, sampling scheme, and regularization weighting.

In conclusion, real-data validation indicates that this novel multimodal digital phantom constitutes a valid and useful simulation tool for ultra-high-resolution methods development. The platform will be made publicly available to the community.

*Cristina Sainz Martinez, Meritxell Bach Cuadra, João Jorge*



# FLASH NEWS

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## EXPERIENCE Wearable System verification tests are finalized !

The successful results of the Safety and EMC tests enabled the following step of the verification plan, which was to complete a first campaign of tests with humans. The goal was to assess the quality of the measurements.

A group of six adult volunteers (three male, three female) were tested in a quiet, unshielded room. Each participant underwent several recordings with the system, each recording with a specific cognitive protocol, designed to elicit specific brain activity and/or artifacts in a systematic manner. The recordings were then processed offline, and different metrics of signal quality and functional sensitivity were estimated.

The experimental protocol was based on few consecutive steps where the user had to perform the following activities while the system was recording, first **sitting** eyes-open, still; then **standing** eyes-open, still; then blocks of eyes-open followed by eyes-closed, still; blocks of eyes-open and eyes-closed, while performing head movements, eye movements, arm movements, jaw movements, still; finally **marching** eyes-open, marching; blocks of eyes-open followed by eyes-closed, marching.

Overall, these tests demonstrate that the EXPERIENCE Wearable System is capable of detecting true meaningful aspects of brain activity (in this case, alpha waves). As expected, the signals are noisier than with gel electrodes, and highly susceptible to interference from motion. However, the use of multi-channel denoising techniques such as ICA may effectively help cleaning/separating a substantial part of these artifacts from the activity of interest, allowing information to be extracted even from periods of large motion.

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## CEA-UNIFI joint conference on time and space manipulation in extended reality !

De Pra, Y., Catrambone, V., van Wassenhove, V., Valenza, G., and Bianchi, M. *'Toward the manipulation of time and space in extended reality: a preliminary study on multimodal Tau and Kappa illusions in the visual-tactile domain'*. Proceedings of 2022 IEEE-RAS RO-MAN. August 29-September 2, 2023. Naples (Italy)

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# FLASH NEWS

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## EXPERIENCE consortium joint conference on Extended-Personal Reality through Automated VR Environments and Explainable AI !

G Valenza, M Alcañiz, AL Alfeo, M Bianchi, V Carli, V Catrambone, MCGA Cimino, G Dudnik, A Duggento, M Ferrante, C Gentili, J Guixeres, S Rossi, N Toschi, V van Wassenhove, *"The EXPERIENCE Project: Unveiling Extended-Personal Reality through Automated VR Environments and Explainable Artificial Intelligence"*, Proceedings of the IEEE International Conference on Metrology for eXtended Reality, Artificial Intelligence and Neural Engineering (MetroXRAINE), 2023

## Several publications have been submitted and accepted in prestigious journals during this period !

Scarciglia A., Catrambone V., Bonanno C., Valenza G.,(2023) *"Physiological Noise: Definition, Estimation, and Characterization in Complex Biomedical Signals"*. IEEE Transactions on Biomedical Engineering, pp.1-11, July 2023

Gunasekaran, H., Azizi, L., van Wassenhove, V. et al. (2023) *"Characterizing endogenous delta oscillations in human MEG"* Scientific Report, 7 July 2023

Rossi, S., Cinti, A., Viberti, F., Benelli, A., Neri, F., De Monte, D., ... & Mandalà, M. (2023) *"Frequency-dependent tuning of the human vestibular "sixth sense" by transcranial oscillatory currents"*. Clinical Neurophysiology, 153, 123-132, September 2023

Leila Azizi, Ignacio Polti and Virginie van Wassenhove *"Spontaneous alpha brain dynamics track the episodic "when" journal of Neuroscience, 13 September 2023*

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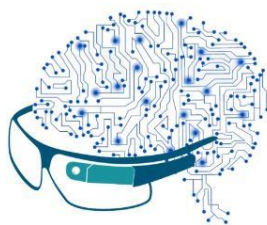
# Last&Next Events

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25-27 October 2023 | Milano, Italy

## IEEE MetroXRAINE

The **2023 IEEE International Conference on Metrology for eXtended Reality, Artificial Intelligence and Neural Engineering - IEEE MetroXRAINE 2023** - will be an international event mainly aimed at creating a synergy between experts in eXtended Reality, Brain-Computer Interface, and Artificial Intelligence, with special attention to the Measurement.



IEEE MetroXRAINE  
Milano 2023

2023 IEEE INTERNATIONAL CONFERENCE ON

## Metrology for eXtended Reality, Artificial Intelligence and Neural Engineering

23 November 2023 | London, UK

## SECTG Early Career Workshop

The **SECTG Early Career Workshop** will take place on the 23rd of November 2023 at Imperial College London (Dyson School of Engineering at the South Kensington Campus of Imperial College London).

This transformative event is designed exclusively for aspiring researchers - a free 1-day workshop focused on fostering collaboration, innovation, and idea-sharing. This unique gathering aims to provide a platform for you to present your work, exchange ideas, and network with fellow scholars from diverse fields.

At the event, there will be three ECR 15-minute presentations from each of the five sister projects. In the audience, it is expected to have WP leaders from each project as well as other ECRs who will ask questions. A demo session is also planned to facilitate further serendipitous interactions and networking opportunities.

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