



# EM Digital Twins for Head-Brain Medium: Dosimetry, Imaging, Diagnostics

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EEG from scalp potentials, and its source-reconstruction counterpart, is a mature and widely used modality for activity tracking and functional brain imaging. However, high-resolution source reconstruction remains fundamentally limited by the accuracy and scalability of the underlying electromagnetic models, as well as by persistent computational bottlenecks. In focal epilepsy, these limitations directly affect source localization in presurgical workflows; in BCI applications, they constrain spatial resolution, robustness, and real-time performance.

High-resolution EEG systems are, in fact, computationally demanding, as a substantial part of the imaging pipeline relies on advanced electromagnetic models of signal propagation in the head. For this reason, innovations in computational methods, modeling strategies, and algorithmic approaches have become central to cross-disciplinary research at the intersection of Computational Electromagnetics (CEM), neuroengineering, and applied electromagnetics.

This talk will present recent advances in CEM-enabled neuroimaging, focusing on technologies for brain diagnosis, therapy, and interaction, where improved computational methods and dedicated platforms enable more accurate and scalable solutions. Current trends and open Grand Challenges will be discussed alongside established results and ongoing research activities, including those carried out within the ERC project *TurboEEG* and the EIC Pathfinder project *CEREBRO*. Without dwelling excessively on technical details, the talk will highlight recent theoretical and experimental developments and relate them to applications in diagnostics, immersive neurofeedback and brain-machine interfaces.





*Speaker's Bio*

**Francesco P. ANDRIULLI** received the Laurea in electrical engineering from the Politecnico di Torino, Italy, in 2004, the MSc in electrical engineering and computer science from the University of Illinois at Chicago in 2004, and the PhD in electrical engineering from the University of Michigan at Ann Arbor in 2008. From 2008 to 2010 he was a Research Associate with the Politecnico di Torino. From 2010 to 2017 he was an Associate Professor (2010-2014) and then Full Professor with the École Nationale Supérieure Mines-Télécom Atlantique (IMT Atlantique), Brest, France. Since 2017 he has been a Full Professor with the Politecnico di Torino, Turin, Italy. His research interests are in computational electromagnetics including frequency- and time-domain integral equation solvers, well-conditioned formulations, fast solvers, low-frequency electromagnetic analyses, and modeling techniques for antennas, wireless components, microwave circuits, and biomedical applications with a special focus on brain imaging.

Prof. Andriulli received several best paper awards at conferences and symposia (URSI NA 2007, IEEE AP-S 2008, ICEAA IEEE-APWC 2015) also in co-authorship with his students and collaborators (EMTS 2025, ICEAA IEEE-APWC 2021, EMTS 2016, URSI-DE Meeting 2014, ICEAA 2009) with whom received also a second prize conference paper (URSI GASS 2014), a third prize conference paper (IEEE-APS 2018), seven honorable mention conference papers (ICEAA 2011, URSI/IEEE-APS 2013, 4 in URSI/IEEE-APS 2022, URSI/IEEE-APS 2023) and other three finalist conference papers (URSI/IEEE-APS 2012, URSI/IEEE-APS 2007, URSI/IEEE-APS 2006, URSI/IEEE-APS 2022)). Moreover, he received the 2014 IEEE AP-S Donald G. Dudley Jr. Undergraduate Teaching Award, the triennium 2014-2016 URSI Issac Koga Gold Medal, and the 2015 L. B. Felsen Award for Excellence in Electrodynamics.

Prof. Andriulli is a Fellow of the IEEE and of the International Union of Radio Science (URSI), and a member of Eta Kappa Nu, Tau Beta Pi, and Phi Kappa Phi. He serves as the 2026 President-Elect of the IEEE Antennas and Propagation Society and served as IEEE AP-S Vice-President of Publications 2025, as Editor-in-Chief of the IEEE Antennas and Propagation Magazine, Track Editor for the IEEE Transactions on Antennas and Propagation and as an Associate Editor for the IEEE Antennas and Wireless Propagation Letters, IEEE Access, URSI Radio Science Letters, and IET-MAP.

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