# Guest Editorial—Selected Papers From the 2023 IEEE International Symposium on Circuits and Systems

THE IEEE International Symposium on Circuits and Systems (ISCAS) is the flagship conference of the IEEE Circuits and Systems (CAS) Society and the world's premiere forum for researchers in the fields of theory, design and implementation of circuits and systems. The IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS (TBioCAS) highlights selected papers from ISCAS on topics related to biological and healthcare applications. This special section features three selected papers from ISCAS 2023, held in Monterey, California, USA from May 21 to 25, 2023.

The ISCAS 2023 technical committee invited original work in all areas of circuits and systems, including topics such as circuits and systems for analog, mixed-signal, digital, power/energy, sensory, communication, and biomedical applications, as well as digital signal processing and intelligent sensors and systems. The TBioCAS received a total of nine papers from ISCAS 2023, out of which three papers were accepted, resulting in an acceptance rate of 33%. The selection of these papers was based on a thorough peer review process (we acknowledge the TBioCAS Editor-in-Chief, Prof. Kea-Tiong Tang for his support). The selected papers cover several topics and can be combined broadly in the category of intelligent sensors and systems.

The paper by Taiyu Zhu et al. from Bio-Inspired Technology, Department of Electrical and Electronic Engineering, Imperial College London (United Kingdom) describes a population-specific real-time blood glucose (BG) prediction model for continuous glucose monitoring (CGM), which leverages the temporal fusion Transformer (TFT) to adjust predictions based on personal demographic data. The trained model is subsequently embedded within a system-on-chip, integral to a low-power and low-cost customized wearable device. When evaluated on two publicly available clinical datasets with a total of 124 participants with type 1 diabetes (T1D) and type 2 diabetes (T2D), the embedded TFT model achieves remarkably low prediction errors when compared with other machine learning baseline methods. Executing the TFT model on the wearable device developed by the authors requires minimal memory and power consumption, enabling continuous decision support for more than 51 days on a single Li-Poly battery charge.

The paper by Markus Sporer et al. from the Institute of Microelectronics, University of Ulm (Germany) presents the system architecture called NeuroBus for ultra-flexible neural interface implants. In this architecture, the tiny distributed direct digitizing neural recorder ASICs on an ultra-flexible polyimide substrate are connected in a bus-like structure, allowing short connections between electrode and recording front-end with low wiring effort and high customizability. The small size (344 $\mu$m $\times$ 294 $\mu$m) of the ASICs and the ultra-flexible substrate allow a low bending stiffness, enabling the implant to adapt to the curvature of the brain and achieving high structural biocompatibility. The architecture, the integrated building blocks, and the post-CMOS processes required to realize a NeuroBus are described in detail. The prototyped direct digitizing neural recorder front-end as well as polyimide-based ECoG brain interface has been characterized. A rodent animal model has been used to validate the joint capability of the recording front-end and thin-film electrode array.

The paper by Jiajia Wu et al. from the University of California San Diego (USA) presents a novel system on chip for neural recording. The 16-channel prototype is fabricated in 65-nm CMOS technology and provides excellent performance in terms of noise (32 nV/sqrt(Hz) achieved with chopping) and area occupation (0.017 mm$^2$/channel) advancing the state of the art in the field of digitizers for bio-potentials. About 70% of the power dissipation is due to the input amplifier of the channel. The analog bandwidth is from 1 Hz to 1 kHz and the ADC is a sigma-delta type. The chip can operate in continuous mode and sample-level duty cycle mode, to operate at lower power and lower frequency (below 1 Hz) where it is important to reduce flicker noise by means of correlated double sampling. The chip was successfully validated on human subjects by performing both EEG (electroencephalogram) and EGG (electrogastrogram) recordings, operating in different sampling frequency ranges.

Altogether, these works represent interesting highlights of the advancements in implantable and wearable devices for monitoring and diagnostics, combining miniaturization of sensors and embedded processing, in particular of low-power machine learning.

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**Ulkuhan Guler** received the B.Sc. degree in electronics and telecommunication engineering from Istanbul Technical University, Istanbul, Turkey, the M.E degree in electronics engineering from the University of Tokyo, Tokyo, Japan, and the Ph.D. degree from Bogazici University, Istanbul, Turkey. She is an Associate Professor of electrical and computer engineering and a Director with the Integrated Circuits and Systems (ICAS) Laboratory, Worcester Polytechnic Institute (WPI), MA, USA. Before joining WPI in 2018, she was a Postdoctoral Researcher with Georgia Tech, GA, USA. Her research interests include in the broad area of circuits and systems, and her primary area of interest is analog/mixed-signal integrated circuits. More specifically, she is interested in the circuit design of sensing interfaces, bioelectronics, energy harvesting and wireless power transmission systems, and security for applications in healthcare. Recently, her research interest has focused on determining how electronic interfaces can be engineered along with biosensors to facilitate the creation of wireless wearable sensors that measure physiological parameters in the human body. She is the recipient of the 2022 NSF CAREER award and the Interstellar Initiative Young Investigator award. She serves as an Associate Editor for several IEEE journals, including *IEEE Solid-State Circuits Letters*, IEEE Transactions on Biomedical Circuits and Systems, and IEEE Transactions on Circuits and Systems II: Express Briefs. She co-authored three book chapters. She also serves a Steering Committee Member of IEEE CICC and TPC Member of IEEE BioCAS conferences. In addition, she is a Member of several solid-state circuits and circuits and system communities, including the Women in Circuits Committee.

**Marco Carminati** (Senior Member, IEEE) received the B.S., M.S., and Ph.D. degrees *summa cum laude* from Politecnico di Milano, Italy, in 2003, 2005 and 2010, respectively. In 2008, he was a Visiting Student with MIT, USA. He joined DEIB, Politecnico di Milano as Assistant Professor in 2016 where, since 2021 he is an Associate Professor. He is also affiliated with the National Italian Institute of Nuclear Physics (INFN) where he is a National Coordinator of the TRISTAN experiment. His research interests include low-noise analog electronics and instrumentation for miniaturized solid-state sensors, eye tracking and radiation detectors with application to healthcare and the environment. He has co-authored more than 300 peer reviewed papers (3700 citations, h-index of 31). He was awarded the Best Paper Award at IEEE Conferences ICECS 2012, SSD 2014 and ISCAS 2019. He was a Tutorial Speaker at BioCAS 2019, MeMeA 2021 and ISCAS 2023. He was an Associate Editor for IEEE Transactions on Biomedical Circuits and Systems (TBioCAS) and now for IEEE Transactions on AgriFood Electronics (TAFE) as well as a Secretary of the Italy Chapter of the IEEE Nuclear and Plasma Science Society (NPSS) and a Member of the TPC of several IEEE conferences.