Volkmar Schulz

Short Biography:

Volkmar Schulz is a major innovator and researcher in the field of medical imaging. He was born in Germany and has dedicated his career to improving healthcare through cutting-edge imaging technologies. He graduated with a first degree in electrical engineering from Bielefeld University in 1993. He completed his second diploma in information technology at the University of Paderborn, Germany, in 1996. His academic journey culminated in a doctorate in electrical engineering from the University of Paderborn in 2001.

In 2000, he embarked on his industrial career at the renowned Philips Research Laboratories in Hamburg, Germany, working in the field of Magnetic Resonance Imaging (MRI)systems. In 2005, he shifted his research focus to combining Positron Emission Tomography (PET) and MRI, earning him the position of Principal Scientist in this area.

In 2013, Volkmar Schulz was appointed Full Professor of Physics in Molecular Imaging Systems at RWTH Aachen University. Currently, he serves as the CEO/CTO and co-founder of Hyperion Hybrid Imaging Systems, a medical imaging company based in Germany, which he established in 2019.

Schulz has received numerous international awards. In 2023, he was awarded the Fraunhofer Attract Prize. In 2021, he was elected as a senior member of the Institute of Electrical and Electronics Engineers (IEEE) and previously served on the IEEE Nuclear Medicine Imaging Steering Committee (NMISC) from 2016 to 2017. Over the years, he has been a prolific inventor with more than 70 patent applications in the field of medical imaging. He participates in organizing international scientific meetings and serves on editorial boards of renowned journals. As an educator, he has taught and mentored numerous graduate students and postdoctoral fellows, furthering the careers of young researchers.

His significant collaborations with distinguished researchers and industry leaders worldwide have further cemented his impact on medical imaging. He works closely with prominent companies such as Siemens, Philips, and Bruker to translate his research findings from the laboratory to real-world clinical applications. He has received several grants from the EU, DFG, BMBF, and industry. With a track record of obtaining research funding from the EU, DFG, BMBF, and industry for his projects, Volkmar continues to lead the advancement of medical imaging technologies.

Abstract:

Artificial intelligence (AI) has witnessed growing integration in medical imaging, playing a pivotal role in advancing positron emission tomography (PET) research. Conventionally, AI is intensively applied to image reconstruction and postprocessing, yielding promising results in enhancing image quality and aiding medical diagnoses. However, the scope of AI's impact in PET extends beyond these areas, with potential benefits throughout the entire imaging chain, encompassing the detection of physical signals and the processing of acquired data.

In this context, our work focuses on harnessing the power of learning algorithms, in conjunction with the principles of residual physics, to address an important aspect of PET imaging—the Coincidence Time Resolution (CTR). The CTR represents a vital metric governing the temporal resolution of PET detectors. High-quality CTR values are critical for the use of time-of-flight (TOF) information, which can lead to improved signal-to-noise ratio (SNR), better PET image quality, and more accurate quantitative measurements. Previous research has focused on novel scintillation materials, hardware solutions, and advanced calibration procedures to enhance detector timing performance.

In this invited talk, we present the findings of our proof-of-concept study on a residual physics approach to enhance the PET detector's temporal resolution. Our previous research proposed analytical timing calibration techniques. However, these techniques have limitations in fully describing the complex physical situation and accounting for higher-order effects. In this work, we propose a machine learning approach combined with a special experimental data generation technique, incorporating simple prior physical knowledge into the model. This introduces the concept of residual physics, allowing the algorithm to learn higher-order effects without explicitly modeling the entire scintillation and detection process. Gradient-boosted decision trees are employed as the learning algorithm due to their ability to handle heterogenous and missing data and suitability for real-time processing systems. The proposed approach is evaluated using experimental data acquired from a coincidence setup equipped with a semi-monolithic and a one-to-one coupled detector array concept. Multiple models are trained on the acquired data, and their performance is assessed based on physics-related learning tasks, agreement with theoretical expectations and bias effects, and the achieved CTR values.