

Pushing the Spatial Resolution of Hybrid Pixel Detectors Using Machine Learning



Speaker: Dr. Xiangyu Xie

Host: Prof. Wei Wei

Time: 12th Dec, Friday, 10:00

Location: Multidisciplinary 122

Indico: <https://indico.ihep.ac.cn/event/27990>

Zoom: <https://zoom.us/j/93309476589?pwd=VdTVa4nXcO7bDondLuT1PebYC4ca0Z.1>

Password: 876612

Abstract:

Originally developed for high-energy physics, hybrid pixel detectors (HPDs) have found widespread application in photon science and are increasingly adopted in electron microscopy, thanks to their exceptional single-particle counting capability, radiation hardness, and fast readout. This talk will provide an overview of HPD development activities at the Paul Scherrer Institute (PSI), including efforts to extend counting performance, integrate new sensor technologies, and enhance spatial resolution.

For applications such as cryo-electron microscopy (cryo-EM) tomography and X-ray energy resolved imaging, HPDs have faster readout and superior radiation hardness compared to commercial MAPS detectors, while with limited spatial resolution. To address this, we conduct dedicated machine learning studies using the MÖNCH detector, a charge-integrating HPD with a 25 μm pixel pitch, aimed at pushing the spatial resolution limits of HPDs for both electrons and photons.

We have established two experimental approaches to generate training data for electron imaging and, in particular, developed an accurate Monte Carlo simulation framework that explicitly incorporates Coulomb repulsion effects to facilitate machine learning. Furthermore, a novel calibration method has been implemented to fully exploit the potential of the MÖNCH detector through pixel-wise non-linearity correction. The talk will present technical details of these developments and showcase comparative results between machine learning-enhanced and conventional methods for both electron and photon imaging modalities.

About the speaker:

Xiangyu earned his Ph.D. in experimental particle physics in 2022 from the University of Science and Technology of China, focusing on the thin-gap resistive plate chambers (RPCs) for the ATLAS Phase-II upgrade at CERN. After completing his degree, he joined the Photon Science detector group at Paul Scherrer Institut (PSI, Switzerland) as a postdoctoral researcher. His work centers on enhancing the spatial resolution of the MÖNCH detector through machine learning, with applications in photon science and electron microscopy. His expertise also extends to silicon charge transport simulations and advanced detector calibration techniques.