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# Next generation microchannel plate detectors for high spatial and temporal resolution

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Multi-anode Microchannel Plate (MCP) detectors provide unique performance, especially with regards to sub 30ps timing resolution, signal photon sensitivity, and modular design. Developments for HEP applications such as the TORCH project, require increasing the photon rate capability and higher spatial granularity of existing designs.

These demands are being tackled in two ways, firstly by developing a higher granularity custom readout for the TORCH project of 16x96 (0.55 mm pitch), to enable their application in using Cerenkov radiation for partial identification. Secondly, for applications such as life science and medical imaging, a novel design has been established, utilising resistive sea technology to introduce charge sharing across multiple pads, thus improving spatial resolution (at the cost of occupancy) beyond the physical pitch of the anode readout.

To assess the performance of the novel detector readout, a series of characterization tests are detailed. These include measuring cross-talk to evaluate FWHM spatial resolution, analysing single pad pulse height distributions to determine gain, and timing single pad responses to assess Transmission Time Spread (TTS). Additionally, the study aims to evaluate the effect of image performance with different sample rates.

Developing charge sharing techniques achieves megapixel-scale spatial resolution by using a resistive layer for charge collection. A ceramic insulator between this layer and the anode spreads the charge across multiple pads via capacitive coupling, thus making spatial resolution independent of anode pad size. Within this configuration each ʻpixelʼof the anode is connected to a channel of the TOFPET2d electronics, which measures the timestamp and charge of all 256 channels individually. This research details results and optimisation methods of using this electronic readout to train neural networks to reconstruct single photons comparing the method to previous algorithmic techniques. Characterisation of the Resistive Sea MCP detector is discussed, including uniformity, timing and amplitude walk correction.

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**Authors:** Dr BARANOV, Alexander (University of Leicester); DAVIDSON, Alexander (University of Warwick (GB)); MARKFORT, Amelia; Prof. TYUKIN, Ivan (King's college London); CONNEELY, Thomas (Photek LTD)

**Co-authors:** Mrs DURAN, Ayse (Photek); MILNES, James; Prof. LAPINGTON, Jon (University of Leicester (GB)); KREPS, Michal (University of Warwick (GB)); BLAKE, Thomas (University of Warwick)

**Presenter:** CONNEELY, Thomas (Photek LTD)

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