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Recent progress in high resolution photon counting detectors with Microchannel Plates

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Detectors with Microchannel Plates have found niche applications in soft X-ray UV photon detection, where event counting with high spatial and timing resolution is needed. Different types of readouts for these detectors have been developed over the last several decades. The Timepix readout ASIC placed directly below the MCP in the vacuum is one of the possible readout options. The capability of pixelated Timepix readout to detect many simultaneous events substantially increases the count rate capabilities of these devices to GHz levels. In this talk, we review the possible readout configurations for the MCP detectors, present the recent developments of this photon counting technology and present the results obtained with an MCP detector coupled to a quad Timepix/ Timepix3 and a single-chip Timepix4 readouts. The spatial resolution of this detector can routinely reach ~6 μm values (the size of the MCP pores). This resolution is achieved in real time through the event centroiding. Optimization of detector characteristics needs to be performed to achieve such a high spatial resolution. The timing resolution is ~2 ns with Timepix3 readout and is expected to be ~200 ps with the latest generation Timepix4 readout. A couple of application examples of these detectors at Resonance Inelastic X-ray Scattering (RIXS) and X-ray Photon Correlation Spectroscopy (XPCS) experiments demonstrate the unique capabilities of such devices for certain synchrotron-based techniques. These MCP/Timepix detectors could be very attractive for applications where the photon/electron/ion/neutron counting is required with high spatial and temporal resolution, such as Time of Flight experiments in energy-resolving neutron imaging at spallation neutron sources, fluorescence lifetime imaging and, if adapted for the electron detection, experiments in photoelectron spectroscopy.

Authors: US SALEHEEN, Ahmad (Lawrence Berkeley Laboratory); HARRER, Anton (Stockholm University); TREMSIN, Anton (University of California at Berkeley); Dr SCHUESSLER, Christian (BESSY); TERCERO, Dennis (University of California at Berkeley); Dr SCHWENKE, Jorg (MAX-IV); Prof. BEYE, Martin (Stockholm University); AHSAN, Safiya (Stockholm University); Dr MORLEY, Sophie (Lawrence Berkeley Laboratory); Dr ROY, Sujoy (Lawrence Berkeley Laboratory); Dr CURTIS, Travis (University of California at Berkeley)

Presenter: TREMSIN, Anton (University of California at Berkeley)

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