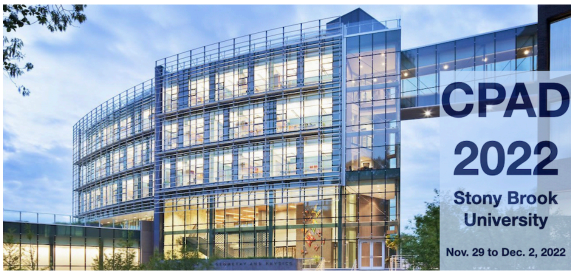

Contribution ID: **102** Type: **Contribution Talk**

Micro-Machined Vacuum Single Photon Photodetector with sub-ns time resolution, 100's MHz rates and high dynamic range

Thursday, 1 December 2022 11:15 (20 minutes)

At present a single pixel or camera plane capable of detecting single photons with high dynamic range, time resolution approaching 10ps, and frame rates above 100's MHz are unavailable. MicroChannel Plate (MCP) based imaging tubes or PMT have superior time resolution compared with PMT, and performance in magnetic fields due to secondary electrons with laterally confined paths to the anode. On the other hand, an MCP-PMT or Image Tube has rate, dynamic range and linearity deficits as it is inherently a resistance-dominated component, as compared for example with a dynode stack with independently powered dynodes. The quiescent current drawn from the HV for an MCP-PMT typically must be ~x100 higher than the signal current for linear behavior and dynamic range. The RC time constant, like a PMT with a purely resistive base, lowers rate and linearity performance. At high rates, the Ohmic heating of the resistive microchannel walls can cause thermal emission image blur. Similarly, consideration of an array of Single Photon Avalanche Diode (SPADs in SiPM) have a similar drawback as being inherently resistive; after an avalanche a SPAD has an RC dead time even with active recharging. No SiPM operates at rates exceeding a ~10 MHz even on single photons, and dense arrays of SPADS have noise from crosstalk when adjacent SPADs fire. A PMT with individual dynode HV draws very little power. We demonstrate combining PMT and Imaging MCP technology by channelizing the dynodes. MEMS (micro-electromechanical system) techniques and 3D printed glass form a thin sheet array of secondary emission channels similar to those of an MCP (microchannel plate) but with an aspect ratio length/diameter of only 1-5 (10-25 μm diameters) which serves as a single dynode stage, rather than as an MCP with a resistive wall. The glass walls and the top side are coated with conducting secondary emission (SE) oxide metal films similar to those used for PMT dynodes -stable and survive the electron bombardment in PMT. The bottom of each sheet dynode is insulated with spin-on glass or printed glass with a dielectric strength of ~10V/μm, to a thickness of ~10-30 μm. Voltages ~100-150V are applied between adjacent staked sheets, with stepped side tabs protruding to connect to dynode voltages. The sheets of micromachined dynodes are aligned so that confined helical channels are formed from the top to the bottom like a traditional MCP but without a significant resistive load. A 10 dynode stack is ~3 mm thick, similar to a traditional MCP.

Primary author: WINN, David (Fairfield University)

Presenter: WINN, David (Fairfield University)

Session Classification: WG7: Photon Detectors (incl. CCDs)

Track Classification: WG7: Photon Detectors (incl. CCDs)