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Development and characterization of hybrid MCP-PMT with embedded Timepix4 ASIC used as pixelated anode

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An innovative single-photon detector based on a vacuum tube with a photocathode, a microchannel plate, and a Timepix4 CMOS ASIC as its read-out anode is presented. This detector is designed to detect up to 1 billion photons per second over a 7 cm^2 active area, achieving simultaneously exceptional position and timing resolutions of $5-10\ \mu m$ and less than $50\ ps$, respectively. Comprising approximately 230,000 pixels equipped with both analog and digital front-end electronics, the Timepix4 ASIC allow to perform measurements using a data-driven architecture and to reach data transmission rates of up to 160 Gb/s.

The configuration and readout of the Timepix4 are controlled by FPGA-based external electronics. Experimental measurements performed using an assembly bonded to a $100\ \mu m$ thick n-on-p Si sensor, illuminated by an infrared pulsed picosecond laser, demonstrated a timing resolution of $110\ ps$ per single pixel hit, accounting for contributions from the silicon substrate. This resolution improves to below $50\ ps$ when considering pixel clusters.

Six detector prototypes with different types of MCP-stacks and end-spoiling depths have been produced by Hamamatsu Photonics. Their characterisation will be presented, including dark count rate, gain, spatial and timing resolution measurements, performed in the lab and in a test-beam campaign at the CERN SPS facility.

Primary experiment

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