

## Development and characterization of hybrid photodetector based on MCP and an embedded Timepix4 ASIC anode

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An innovative single-photon detector based on a vacuum tube containing 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  $7\text{ cm}^2$  active area, achieving simultaneously excellent position and timing resolution of  $5\text{--}10\text{ }\mu\text{m}$  and less than  $50\text{ ps}$ . With around 230 thousand pixels equipped with both analog and digital front-end electronics, the Timepix4 ASIC employs a data-driven architecture, enabling data transmission with a bandwidth reaching up to  $160\text{ Gb/s}$ .

The Timepix4 configuration and readout are managed by FPGA-based external electronics.

Timepix4 measurements, conducted using an assembly bonded to a  $100\text{ }\mu\text{m}$  thick n-on-p Si sensor illuminated by an infrared pulsed picosecond laser, demonstrated a timing resolution per single pixel hit of  $110\text{ ps}$ , accounting for the silicon's contribution. The resolution further improves below  $50\text{ ps}$  when pixel clusters are considered.

A preliminary characterization of the first prototypes will be presented.

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