Contribution ID: **368** Type: **Oral**

# Development of a hybrid single-photon detector with pixelated anode and integrated CMOS analog and digital front-end.

*Monday, 23 May 2022 16:10 (15 minutes)*

We present the development of a single-photon detector encapsulating the analog and digital front-end electronics and the connected data acquisition electronics.

This 'hybrid' detector is composed of a vacuum tube, transmission photocathode, micro-channel plate stack and a pixelated CMOS read-out anode encapsulating the analog and digital-front end electronics.
The detector will be capable of sustaining a rate of up to $10^9$ photons per second with simultaneous measurement of position and time.
This assembly will be able to reach 5-10 $\mu$m position resolution and timing resolution of $o(10)$ ps.
The detector will be highly compact thanks to the encapsulated front-end electronics allowing local data processing and digitization.

A dual-micro-channel plate chevron stack operated at low gain ($< 10^4$) and treated with atomic layer deposition, allows a lifetime of $> 20$ C/cm$^2$ accumulated charge.
The pixelated read-out anode used is based on the Timepix4 ASIC designed in the framework of the Medipix collaboration.
This ASIC integrates an array of $512 \times 448$ pixels distributed with a 55 $\mu$m square pitch over a sensitive area of 6.94 cm$^2$.
It features 50-70 e$^-$ equivalent noise charge, a maximum rate of 2.5 Ghits/s, and allows to time-stamp the leading-edge time and to measure the Time-over-Threshold (\textit{ToT}) for each pixel.
The pixel-cluster position combined with its ToT information allows to reach 5-10 $\mu$m position resolution.
This information can also be used to correct for the leading-edge time-walk achieving a timing resolution of $o(10)$ ps.

An FPGA-based data acquisition board, placed far from the detector, will receive the detector hits using 16 links operated at 10.24 Gbps.
The data acquisition board will decode the information and store the relevant data in a server for offline analysis.

These performance will allow significant advances in particle physics, life sciences, quantum optics or other emerging fields where the detection of single photons with excellent timing and position resolutions are simultaneously required.

## Collaboration

4DPHOTON

**Primary authors:** COTTA RAMUSINO, Angelo (Istituto Nazionale di Fisica Nucleare); ALOZY, Jérôme (CERN); GUARISE, Marco (University of Ferrara); FIORINI, Massimiliano (Istituto Nazionale di Fisica Nucleare); CAMPBELL, Michael (CERN); BIESUZ, Nicolò Vladi (INFN, Ferrara (IT)); BOLZONELLA, Riccardo (Istituto

Nazionale di Fisica Nucleare); CAVALLINI, Viola (Istituto Nazionale di Fisica Nucleare); LLOPART-CUDIE, Xavi (CERN)

**Presenter:** BIESUZ, Nicolò Vladi (INFN, Ferrara (IT))

**Session Classification:** Photo Detectors and Particle ID