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LAPPD operation using FASTIC and PETSYS ASICs

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Single photon sensitive detectors used in high energy physics are required to cover very large areas, with a strong demand for an ever finer imaging capability. We are evaluating the LAPPD as a possible candidate for future Cherenkov ring imaging detectors, performing tests on a generation I device, which is capacitively coupled to a custom designed anode back plane, consisting of various pixels and strips varying in size, and allows for connecting various readout systems, such as standard laboratory equipment, as well as the ToFPET2 ASIC from Petsys and the FASTIC ASIC developed by UB and CERN.

Summary (500 words)

Ring Imaging Cherenkov detectors represent an indispensable tool for particle identification. A small number of photons being emitted from radiators, such as Aerogels or gas mixtures, need to be detected on a focal plane of usually very large size, and require considerable spatial resolution for imaging Cherenkov rings. Nowadays the time of flight (TOF) information from the vertex to the detector plane is also under consideration to extend its capabilities, requiring the TOF information below some 100ps.

The LAPPD Gen I is a large size device which uses a photo-cathode for quantum conversion and a dual chevron stacked 20um MCP for signal amplification. These vacuum sealed devices, the size of 8x8 inch, enable to capacitively couple an anode plane through a 4mm thick glass on the back side, enabling the user to design a customized anode plane, using the readout system of one's preference. Some commercially designed readout systems using waveform sampling technology to sense the strip line patterns on the anode backplane, extrapolating the X and Y coordinate from the time of arrival at each end in one dimension, and charge sharing for the other were already proposed. We explore the possibility to physically pixelate the device in view of the demanding RICH requirements, having the need to drive the pixel size toward a 1mm pitch, and the difficulties arising from this choice.

In the first part we evaluate the LAPPD response illuminated with mostly single photons via laser induced picosecond pulses, using standard laboratory equipment. Even with moderately low voltages applied to the MCP stack, the output pulses from the LAPPD can be measured with peaks in the range of a few dozen millivolts, of some nanosecond width with the jitter sigma around 100 picoseconds. In this part we focus on the findings of the detector timming ability in various conditions, as well as some remarks on the limitations of using a capacitive coupled anode.

In the second, a more exploratory part, we use two available ASICs, the TOFPET2 ASIC and the FASTIC, where both chips have a current sensing front-end design, and a very different readout approach. Both chips are attached to PCB boards, which in turn capacitively couple the LAPPD using our anode backplane having multiple pixel arrays composed of various pixel sizes. We explore both system responses in terms of charge collection efficiency, measured back scattered electrons, pad to pad crosstalk, timming ability, channel crosstalk within the ASIC, and the amount of charge measured per single event.

We present the obtained results and first impressions of such combination, and compare them with the aim, to provide some guidelines for future consideration in adapting the LAPPD for specific purposes, as well provide information for future ASICs and readout systems designs, aiming at very large channel counts deriving from the small pixel pitch.

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