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Status of the Medipix MCP-HPD development

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This paper describes the design of a high-speed, single-photon counting, hybrid photon detector. The detector consists of a vacuum tube, containing a micro channel plate and 4 CMOS pixel read out chips, sealed with a transparent optical input window with a photocathode.
The described design utilizes currently available technologies, specifically the Timepix read out chips, and the Photonis Planacon MCP-PMT vacuum tubes. The aim of the project is to demonstrate the feasibility of 4-side buttable square hybrid photon tube with high fractional sensitive area.
Presented here is the mechanical and thermal design of the prototype detector.

Summary

The Medipix2 collaboration (www.cern.ch/medipix) has recently started the development of a Micro Channel Plate - Hybrid Photon Detector (MCP-HPD) prototype based on the concept previously described by Vallerga et al [1]. The MCP-HPD consists of a vacuum tube housing, a MCP and a pixel read out chip, sealed with a transparent optical input window with a photocathode coating. The aim of the development is to extend the previously presented concept to a rectangular 4-side tileable MCP-HPD, which allows large areas to be covered with a high active sensing area fraction.

Existing components and technologies have been utilized as much as possible in the design of the prototype detector. The vacuum tube design is based on a modified Photonis Planacon MCP-PMT vacuum tube body. The tube dimensions are 58 mm x 58 mm and the thickness of the package is approximately 10 mm. The Planacon tube body is constructed of interleaved ceramic and metal rings and a ceramic anode plate that are brazed together to form a vacuum tight body. The optical input window and the MCP are mounted on the metal rings to provide bias inside the vacuum. A "chevron"configuration of two MCPs was selected for this prototype.

To build the MCP-HDP prototype the anode plate of the Planacon tube is replaced with a custom design. This is a multilayer ceramic board on which the Timepix read out chips are mounted. The ceramic board provides vacuum feed throughs for the read out chip I/O signals and for getter activation currents. Additionally, the dimensions of the walls in the original Planacon design are redesigned to reduce the spacing between the photocathode and MCP and the MCP and the anode plane. A conservative target gap of 0.5 mm was selected for both to reduce the likelihood of short circuits. As experience is gained with this prototype, it is hoped that these dimensions can be reduced further still, improving the resolution achievable.

To be able to reliably operate the tube an efficient cooling is required to remove up to 4 watts of heat generated by the 4 Timepix chips. The optical input window is sealed with an Indium alloy joint, these typically have a melting point in the range of 100 - 150 ℃ and therefore, without cooling, there is a risk of breaking the tube seal. Even running the detector at only slightly elevated operating temperatures will significantly increase the diffusion of element in the indium joint interface, over time compromising the joint tightness. The anode plate has been designed in a way that allows different cooling scenarios to be applied later. The I/O output signals on the back side are arranged around the perimeter, leaving room for a heat sink or cooling element, directly under the read out chips. Based on initial thermal simulations, active cooling will be needed to keep the detector from overheating.

[1] Vallerga, J V, McPhate, J, Mikulec, B, Tremsin, A, Clark, A G, Siegmund, O H W, Noiseless imaging detector for adaptive optics with kHz frame rates. In: Proc. SPIE 5490 (2004) pp.1256-1267

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