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Status of the Medipix MCP-HPD development

Authors

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Background

The Medipix2 collaboration (www.cern.ch/medipix) has recently started the development of a Micro Channel Plate - Hybrid Photon Detector (MCP-HPD) prototype. The MCP-HPD consists of a vacuum tube housing, an MCP and pixel read out chips, sealed with a transparent optical input window having a photocathode coating. The aim of the development is to extend this concept, previously presented by Vallerga et al., to a rectangular 4-side tileable MCP-HPD, which allows large areas to be covered with a high active sensing area fraction. The described design utilizes currently available technologies, specifically the Timepix read out chips, and the Photonis Planacon MCP-PMT vacuum tubes. Presented here is the mechanical and thermal design of the prototype detector.

Detector platform:

- Photonis Planacon XP85012 MCP-PMT tube
- Rectangular 58 x 58 mm body
- Active area 50 x 50 mm (Close to 75 %)
- MCP: 25 µm pore size, 40:1 L/D ratio
- Chevron -type stack of 2 MCPs
- Getter pumps inside the tube
- Selection of high sensitivity photocathodes available (Fig. 2)
- Excellent and versatile platform for MCP-HDP development
- Maximum operating and storage temperature 50 °C due to the low temperature melting Indium alloy used for tube sealing

Figure 1. Photonis Planacon detector (Image courtesy of Photonis)

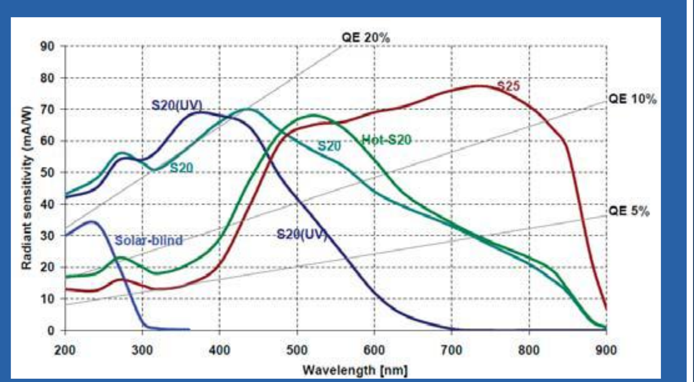

Figure 2. Photocathode sensitivities (Image courtesy of Photonis)

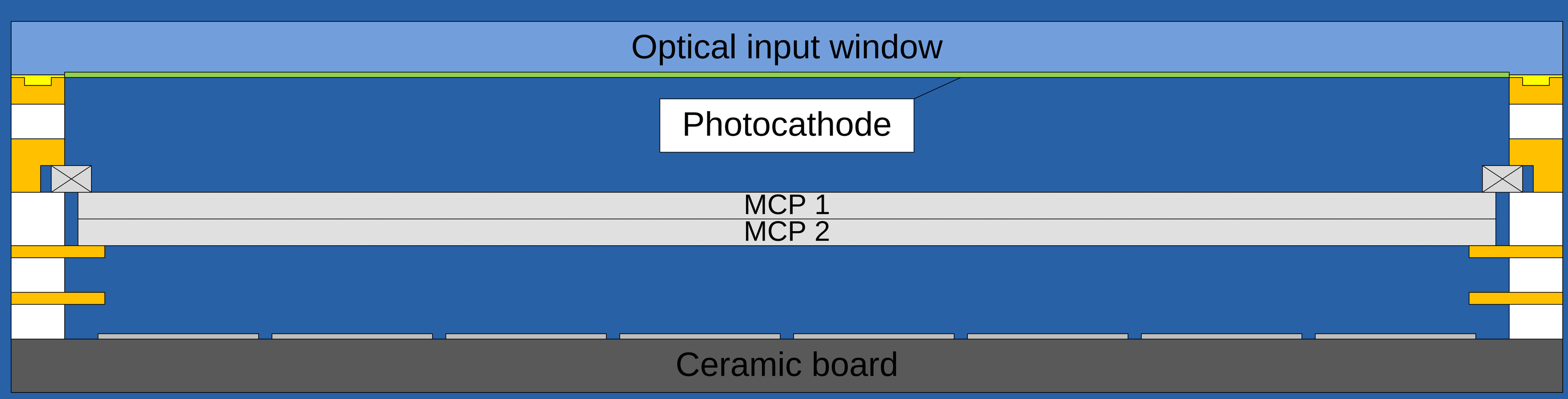

Figure 3. Cross sectional illustration of Photonis planacon

Prototype design:

- The ceramic anode plate of the tube is replaced with a custom design multilayer ceramic board
- The anode and cathode gaps are reduced to 0.5 mm
  - Flat input window is replaced with a step-down window
  - Chips are mounted on top of a spacer
- The chips and the spacer are mounted on the ceramic board with glass silver adhesive
- Pin Grid Array (PGA) pins are attached to the ceramic board to allow connection to a Zero Insertion Force (ZIF) socket 7 connector
- A custom adapter board is designed to connect the detector to existing Medipix read-out electronics

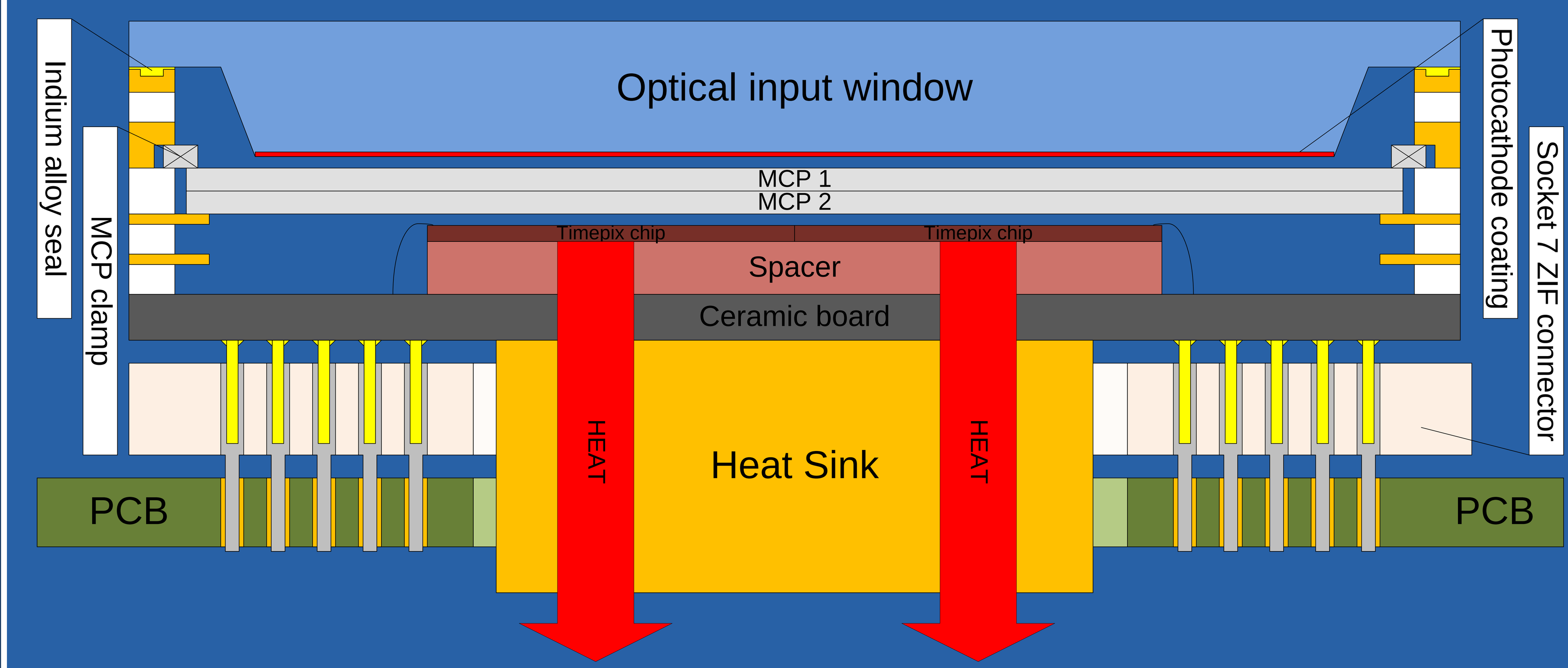

Figure 4. Cross sectional illustration of the prototype design

Thermal simulations:

- Thermal simulations were done to investigate the need of cooling and how it could be efficiently implemented to the design
- Simulation model setup, scenario A (No cooling):
  - 4 W heat flux in from the chip surface
  - Convection from the outside surfaces, except the bottom surface
  - Radiation from the outside surfaces, except the outside surface
  - Ambient temperature 20 °C
- The scenario B (With cooling) was the same as A but the back of the heat sink fixed to a temperature of 20 °C
- The radiation and convection from the bottom surface was neglected due to its close proximity to the connector and the adapter board
- The radiation from surface to surface inside the tube was omitted to simplify the simulations
- It was found that cooling is required to extract the heat from the detector and to maintain the integrity of the Indium alloy vacuum seal

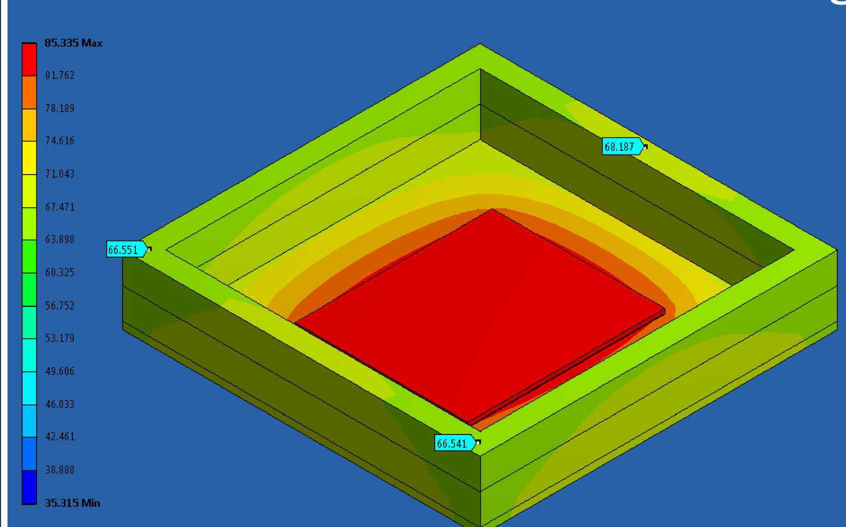

Figure 5. Simulation scenario A (No cooling)

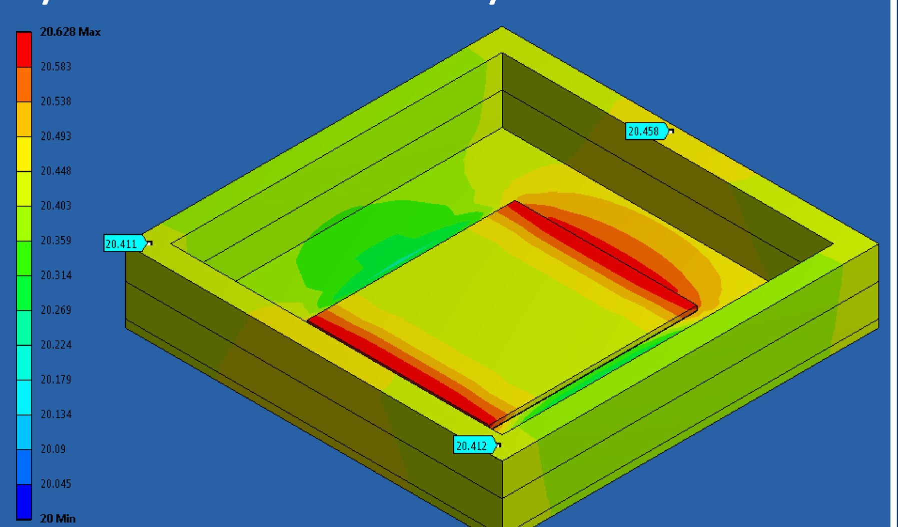

Figure 6. Simulation scenario B (With cooling)

Prototype assembly plan (tentative):

- Assembly temperatures:
  - Ceramic board firing ~1300 °C
  - PGA pin brazing ~1100 °C
  - Subassembly brazing ~800 °C
  - Spacer and chip attachment ~400 °C
  - Vacuum bakeout ~300 °C
  - Tube sealing ~100 °C
- The spacer and chip assembly with glass silver adhesive
- First tests with blank ceramic and silicon pieces to determine
  - Planarity and position tolerances of chips
  - Outgassing
- Gold ball wire bonding
  - Deep access machine available
  - Good high temperature reliability
- The plan is to build:
  - 20 ceramic boards
  - 5 – 7 subassemblies
  - 3 detector prototypes

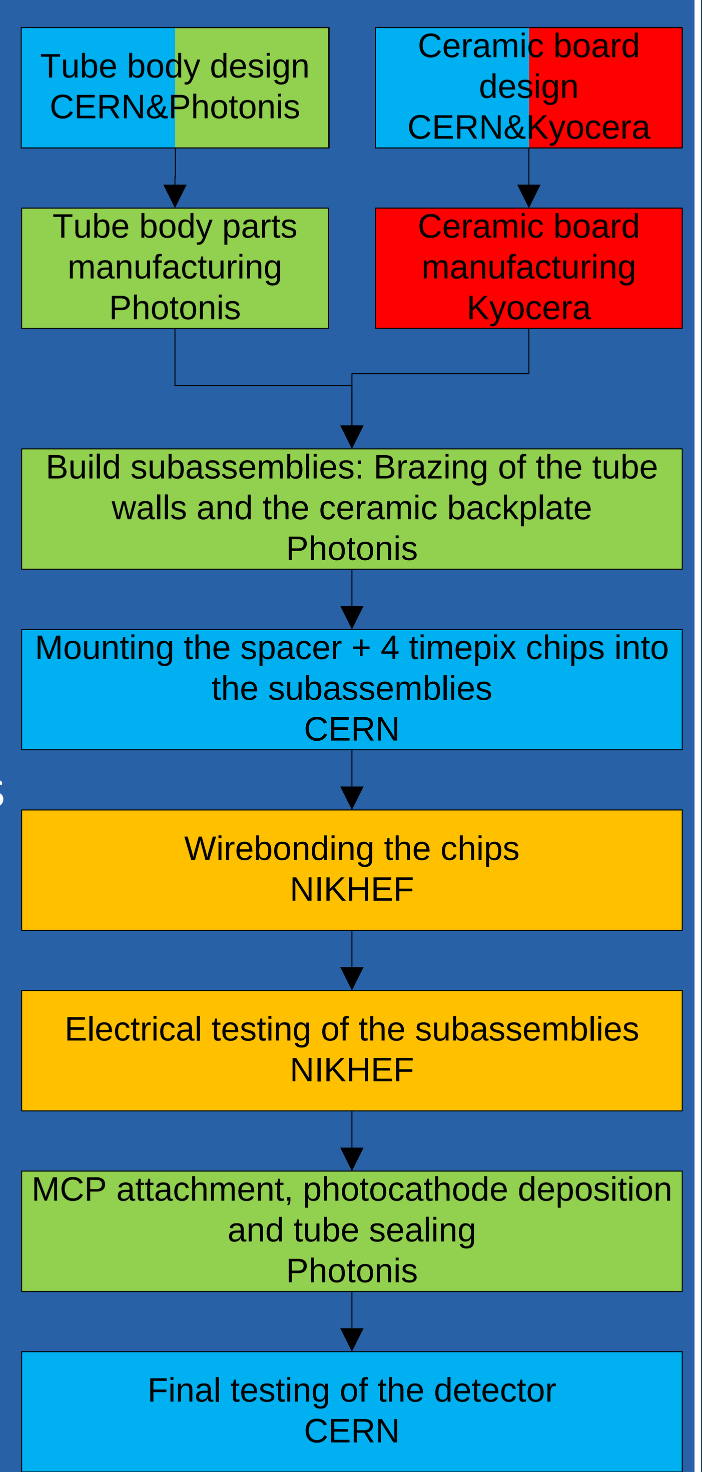

Figure 7. Detector assembly plan

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