A cooling system for the HADES pion tracker*

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One of the next proposed experiments at the SIS18 with the HADES spectrometer plans the employment of a pion beam on nuclear and LH2 targets. The fact that the pion beam is a secondary beam leads to rather wide spread ($\sim 8\%$) of its momentum. Since the precise knowledge of the momentum is essential for exclusive measurements as planned by the HADES collaboration, the momentum for each pion has to be determined.
For this propose our group is developing a pion beam tracking system called CERBEROS. The system consists of two silicon detector, which are located directly along the pion beam chicane between the production target and the HADES spectrometer. Consequently, these detectors have to tolerate the high intensity of the pion beam, that close to the secondary beam production target reaches the value of 10^8 part./s. Cooling improves the radiation hardness and performance of the detectors, which is crucial for the measurement of MIPs like pions.

Since the detectors have to be located inside the beam pipe, we have developed a vacuum chamber which is compatible with the beam pipe structure. The vacuum chamber for each detector consists of two identical aluminium parts that are arranged face to face. Between them is a feed-through PCB for the electronic read out. One of the chamber parts has additional feed-throughs for the cooling and vacuum pump. In Fig. 1 one can see one half of the vacuum chamber.

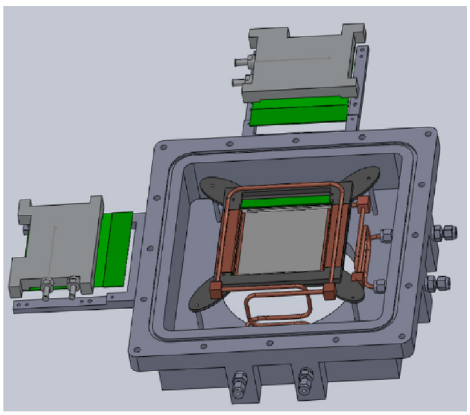


Figure 1: View of one half of the vacuum chamber. The detector and also the cooling is mounted in the center. The front-end electronic is located outside the chamber.

Development of a cooling system

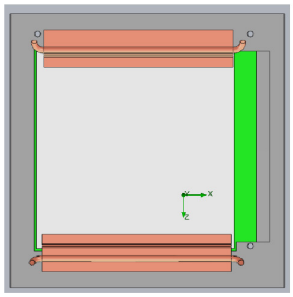


Figure 2: Technical drawing of detector with attached cooling device.[1]

The cooling system was developed relying on the results of thermal simulation that are based on the Finite Element Method.
In Fig. 2 one can see the technical drawing of the cooling device. It consists of two quadratic FR4 blocks, which surround the detector. Mounted on each block are two bent copper plates. The copper plates are connected to the silicon wafer through heat conduction pads that are included as a thermal resistance. These heat conduction pads isolate voltages and thus ensure that the copper plates introduce no short cuts on the silicon wafer . The copper plates are located parallel to the strips of the wafer. The silicon detector is located in a vacuum pipe. The outer side of the vacuum pipe is set to 20°C and Propane is used as cooling liquid at a temperature of -15°C. The glue between the silicon wafer and the PCB is included in the simulation as a thermal resistance . Moreover heat is exchanged through heat radiation between the elements.[1]

By cooling the detector on the four sides we achieved a quit homogeneous temperature distribution at temperature around -10°C. All in all only little losses are expected and a prototype has been already built and is currently under testing procedure.[1]

References

[1] J. Wirth, "Development of a cooling system for a silicon particle detector" (2012), http://www.e12.ph.tum.de/groups/kcluster/Documents/ Publications/bachelorthesis_joana_wirth.pdf.

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