Development of the insulation for the $\overline{\text{P}}$ANDA-EMC*

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Introduction

The Electromagnetic Calorimeter (EMC) of the $\overline{\text{P}}$ANDA experiment consists of two endcaps and a barrel part and is placed inside a superconducting solenoid. Lead tungstate ($PbWO_4$) will be used as scintillator material because of its compactness, fast response, sufficient energy resolution over the large range of photon energies and an adequate radiation hardness.

The operation temperature of the $\overline{\text{P}}$ANDA-EMC is set to -25°C to increase the light yield by a factor of ≈ 4 when compared to room temperature at +25°C. The average temperature gradient of the light yield amounts to $\sim$ -3%/K [1].

In order to achieve a stable operation temperature, a thermal insulation under the constraints of a low thermal conductivity, a high mechanical stability, a proper thermal shock resistance in the given temperature range, and high precision in size and thickness is necessary. Further requirements are a minimal contribution to the material budget and a small thickness due to the space limitations inside the solenoid.

The EMC Endcap Prototype

A full-size prototype of a cut-out of the inner section of the EMC forward endcap of the $\overline{\text{P}}$ANDA experiment consisting of 216 lead tungstate crystals has been set up. To fulfill the requirement of a stable operational temperature of -25°C with a small temperature gradient inside the cooled volume, the prototype is cooled by three cooling circuits: the front cooling, the main cooling connected directly to the aluminium backplate, and a dried air cooling system.

Thermal insulation is realised using vacuum insulation panels with a thickness of 30 mm. These vacuum insulation panels consist of a micro porous core and a gas barrier film. They are sealed with a glass fiber wrapping to increase the mechanical shock protection. The thermal conductivity including aging and edge losses of these panels is 0.007 W/(m·K) and 0.020 W/(m·K) if the protection wrapping is damaged and the panels are aired [2].

Tests under realistic conditions during several beamtimes at the SPS accelerator at CERN, at ELSA in Bonn and at MAMI in Mainz, have proven that the chosen vacuum insulation panels fulfill the requirements mentioned above [3].

Further Development

For the $\overline{\text{P}}$ANDA-EMC forward endcap an insulation with a thickness of 20 to 30 mm is foreseen, limited by the available space. For maintenance and repairs, the front and back insulation parts will be attached in a removable manner to the front cooling plates in front of the crystals or to the aluminium back cover of the electronics space, respectively. To feed through all cables from the cooled inside to the outside at room temperature, 36 openings [4] are foreseen, which have to be insulated individually.

The insulation will be split up into several parts of small thickness to achieve a stacked and overlapping arrangement of the panels to avoid thermal bridges at the borders of the panels.

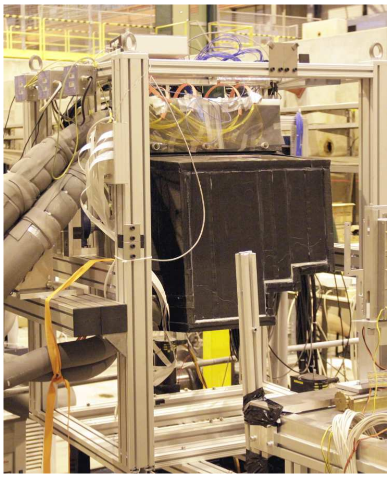

Figure 1: Front view of the prototype with the mounted insulation (black).

References

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