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DESIGN OF A PHOTODETECTOR UNIT OF A NEW SHASHLYK **EM** CALORIMETER FOR **COMPASS** II

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Дизайн блока фотодетекторов нового ЭМ-калориметра
типа «Шашлык» для COMPASS II

Разработан и создан девятиканальный блок фотодетекторов на микропиксельных лавинных фотодиодах (MAPD) с прецизионной термостабилизацией, основанной на компактном модуле Пельтье. Использовались MAPD-3N со сверхвысокой плотностью пикселей $1{,}5 \cdot 10^4$ мм$^{-2}$ и площадью 3×3 мм, изготовленные компанией «Zecotek».

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Design of a Photodetector Unit of a New Shashlyk
EM Calorimeter for COMPASS II

A nine-channel photodetector unit with micropixel avalanche photodiodes (MAPD) and precision thermostabilization based on the compact Peltier module was designed and constructed. MAPD-3N with a high pixel density of $1.5 \cdot 10^4$ mm^{-2} and area 3×3 mm produced by Zecotek were used.

The investigation has been performed at the Dzhelepov Laboratory of Nuclear Problems, JINR.

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A new-generation high-granularity Shashlyk electromagnetic calorimeter ECAL0 was designed at JINR for studying generalized parton distributions at COMPASS II [1].

The design of the calorimeter module was chosen as a result of a series of tests of various prototypes of electromagnetic calorimeters read out by micropixel avalanche photodiodes (MAPD) [2, 3]. Usage of photomultipliers as photodetectors is almost impossible, since the calorimeter will be located close to the magnet. The gain and photon detection efficiency (PDE) of the MAPD significantly depend on the temperature (few percent per Celsius degree). It is therefore necessary to precisely stabilize the temperature of the photodiodes.

The design of the Shashlyk calorimeter module is shown in Fig. 1. The module 120×120 mm in cross section consists of a calorimeter (3×3 cells)

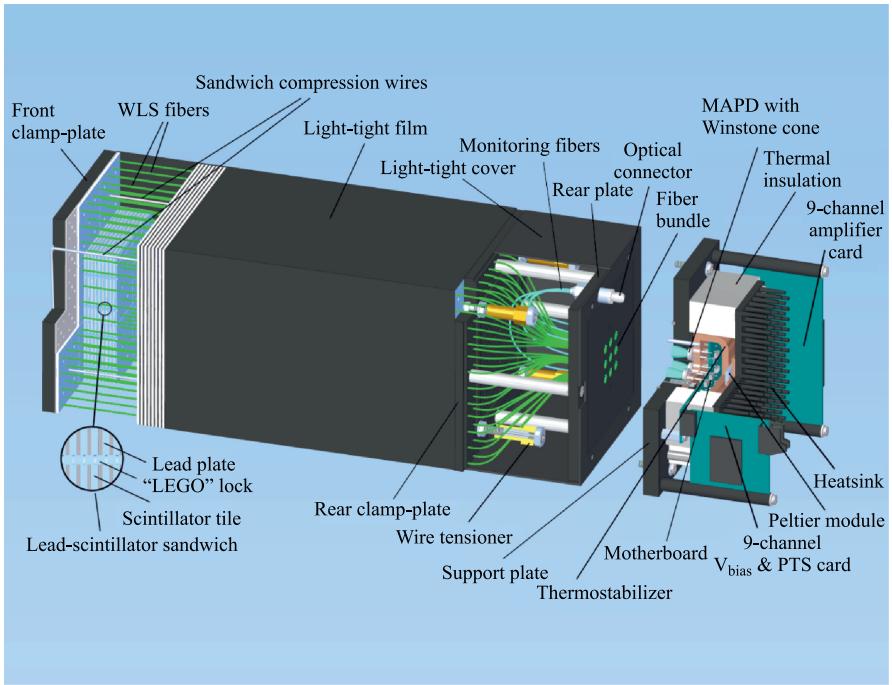

Fig. 1. Design of the Shashlyk calorimeter module

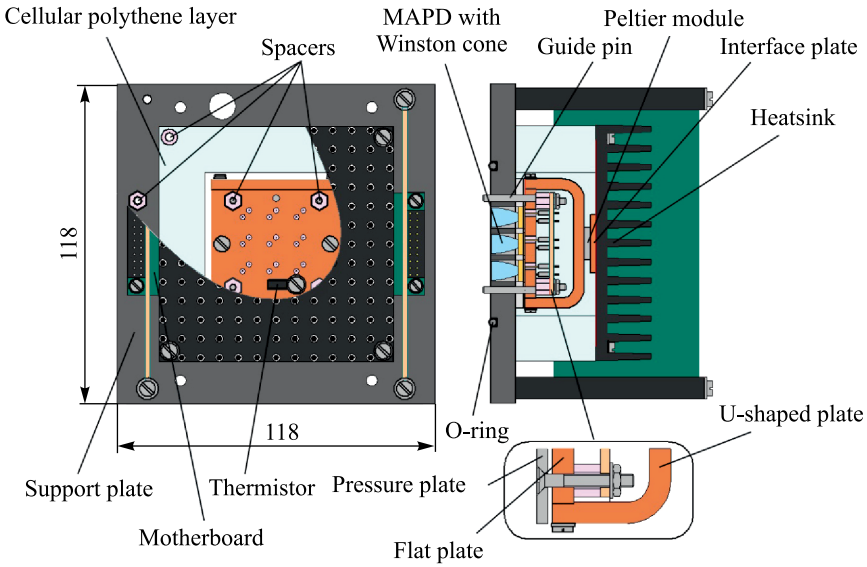

Fig. 2. Drawing of a nine-channel photodetector unit

and a nine-channel photodetector unit. The detailed calorimeter construction is described in [4].

The photodetector unit consists of a thermostabilizer with the MAPD and motherboard, heatsink, nine-channel amplifier-shaper card, nine-channel bias voltage MAPD, and Peltier temperature stabilization (PTS) card [5], which are mounted on the ABS black plastic support plate (Figs. 1 and 2).

The MAPD-3N in metal packages TO-39 with an area 3×3 mm, gain of $4{\cdot}10^4$, PDE $\simeq 25\%$ in the green region, high pixel density $1.5{\cdot}10^4$ mm^{-2} produced by Zecotek were used as photodetectors [2, 6]. Since the WLS fiber bundle of the calorimeter is 6 mm in diameter while the sensitive area of the MAPD-3N is a 3×3 mm square, an injection-molded polystyrene Winston cone light guide ($L = 10.1$ mm, $D_1 = 7.2$ mm, $D_2 = 3.3$ mm) glued to the MAPD surface is used to increase light collection. The measured light collection efficiency of the Winston cone is about 95%.

The thermostabilizer is based on the compact high-resistance ($R = 10\ \Omega$) TB-66-0, 45-1, 3HT(200) Peltier module with the dimensions $12 \times 9 \times 2.3$ mm and is made of two copper plates with flat and U-shaped geometry. Two guide pins pressed into the copper flat plate are used for alignment. The MAPD are fixed and aligned on a flat plate by the duralumin pressure plate with nine holes with a diameter matching the TO-39 metal can and two holes for guide pins (Fig. 3).

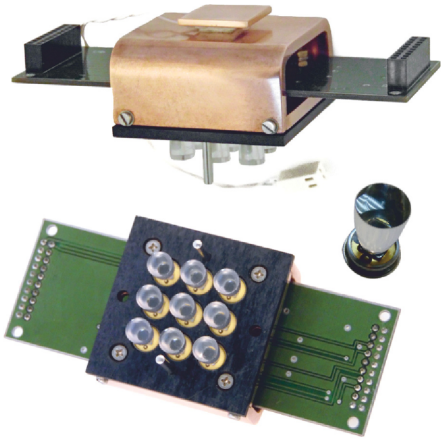

Fig. 3. Side and top views of the thermostabilizer with the motherboard and MAPD

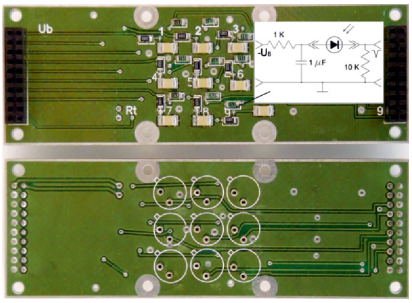

Fig. 4. Top and bottom views of the motherboard

The Peltier module is glued to the U-shaped and interface plates by the heat-conducting glue E-SOLDER 3025. The interface copper plate is cooled by the heatsink, which is mounted on four spacers. To guarantee good thermal contact between the interface plate and the heatsink, thermally conductive silicone paste is applied. The thickness of the paste layer is about 50 μm. It is important to note that the interface plate substantially increases the cooling efficiency of the Peltier module in comparison with the prototypes, in which the heat side of the module is cooled directly by the heatsink [3, 4].

The MAPD biasing circuits, connectors for the photodiodes and electronic cards are mounted on the motherboard, which is installed on eight hexagonal

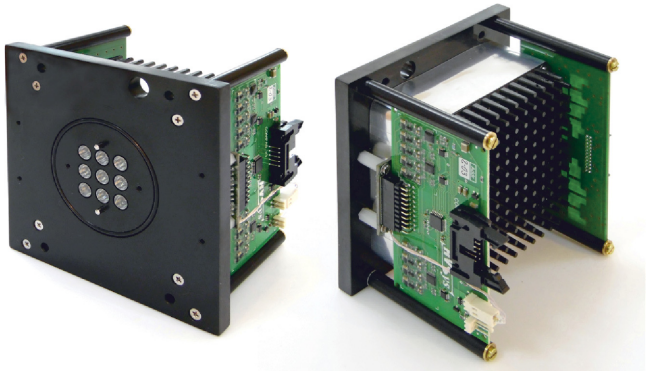

Fig. 5. Views of the photodetector unit

spacers (Figs. 2 and 4). To measure the temperature, the B57861S303F40 thermistor fixed on the copper flat plate is used. The rubber O-ring is embedded in the groove of support plate to prevent light penetration between the rear and support plates in the calorimeter module assembly.

The thermal insulation of the thermostabilizer against ambient temperatures consists of a stack of cellular polythene layers. The thermostabilizer keeps the MAPD temperature at 16 °C with an accuracy about 0.01 °C. Figure 5 shows photographs of the photodetector unit.

The calorimeter modules with prototype photodetector units were successfully tested at the beams of CERN and of the ELSA facility (Bonn) [3, 7].

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