

Electromagnetic Calorimeter for HADES Experiment

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Abstract. Electromagnetic calorimeter (ECAL) is being developed to complement dilepton spectrometer HADES. ECAL will enable the HADES@FAIR experiment to measure data on neutral meson production in heavy ion collisions at the energy range of 2-10 AGeV on the beam of future accelerator SIS100@FAIR. We will report results of the last beam test with quasi-monoenergetic photons carried out in MAMI facility at Johannes Gutenberg Universität Mainz.

1 Introduction

The electromagnetic calorimeter (ECAL) will extend the HADES experimental possibilities in several directions. First of all, the ECAL will enable measurement of photons from various sources like meson decays or decays of neutral $\Lambda(1405)$ and $\Sigma(1385)$ resonances. The ECAL will also improve electron/pion separation at large momenta over 400 MeV/c. Basic design of the ECAL is given by the HADES geometry – six separate sectors covering almost full azimuthal angle and polar angle 18° to 45° .

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2 Experimental layout

A new beam test of calorimeter modules and read-out concepts was performed between 7th and 10th January 2014. Line beam with energy of 1508.4 MeV was directed to a copper target, energy of produced photons was determined using the method of tagged electrons in dedicated TAGGER [?] detector in MAMI A2 hall. Four ECAL [?] modules were placed on a movable platform one meter behind the tagger shielding. Photon beam cross section was of 6 mm diameter. One ECAL module was equipped with 1.5" inch PMT EMI 9903KB. Two modules were equipped with 3" Hamamatsu R6091 PMT's and the last module contained 1" Hamamatsu R8619 PMT.

2.1 Relative energy resolution

The energy resolution of the ECAL modules equipped with 1", 1.5" and 3" PMTs deliver comparable relative energy resolution (5.8% at 1 GeV photon with 1.5" EMI and 5.5% with 3" Hamamatsu), whereas the module with 1" Hamamatsu PMT gives by 1.6% worse energy resolution and non-linear response.

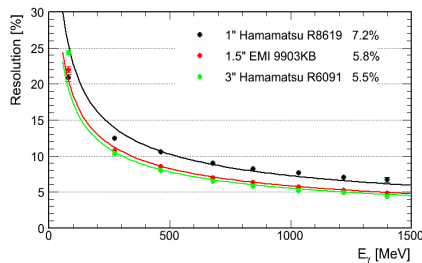


Figure 1. Relative energy resolution of calorimeter modules equipped with different photomultipliers.

2.2 Energy leakage into neighbor module parallel with the beam

Two identical modules equipped with 3" PMT were irradiated with photon beam parallel with the module Z axis (along the module). Three measurements were done with the beam position in the center of the first module, 1 cm, 2 cm, 3 cm and 4 cm from the center closer to the second module. Most of the energy was still deposited in the first module in the case of beam in the center or two centimeters far from the center of the module and it was possible to fully recover original photon. Unfortunately some energy is lost in the case of photon beam placed close to the module border, most probably due to brass walls between the modules. Some of the secondary particles (mainly electrons) created in the gamma interaction interact with the non-active volume of the detector and are lost, see Fig. 1.

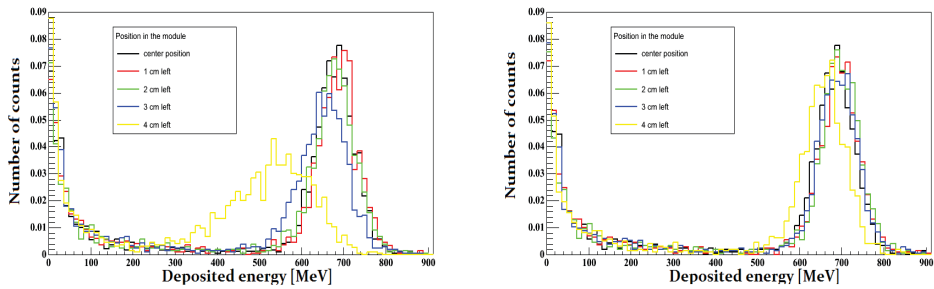


Figure 2. Energy deposited in the first module hit by the beam (left) and sum of energies deposited in both neighboring modules (right). Two cases for photon beam energy 680 MeV.

2.3 Energy leakage into neighbor module inclined 6° and 12° respect to the longitudinal axis

The response of the ECAL modules on photons coming under non-zero angle is very important as most of the modules will be declined with respect to the incoming particles. Two sets of measurements with photon inclination angle 6° and 12° were done. Beam was moved over the front surface of one module in the steps -2 cm, 0 cm (center of the module), +2 cm closer to the second module, and +4 cm. The original photon energy was recovered as a sum of energies stored in single modules. It was demonstrated, that almost no energy is lost between the modules and we are able to recover original energy of photon, see Fig. 2.

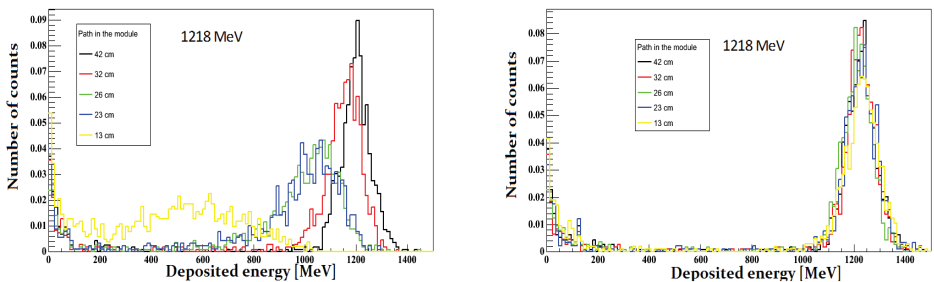


Figure 3. Energy deposited in one module hit by the photon beam (left) and sum of energies deposited in both neighboring modules (right). Two cases for photon beam energy 1217.8 MeV.

3 Conclusions

Both 1.5" and 3" PMTs fulfil the requirements for the required resolution. Energy resolution was studied to decide the size of PMT taking into account physical and economic point of view. Energy leakage between the neighbor modules was tested with parallel and declined beams. Energy of original photon was successfully recovered as a sum of energies deposited in each of the modules. Some

part of the original energy was lost only in the case of parallel photon beam placed close to module boarder. This effect can be corrected for using results of the presented test.

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