Development of Electromagnetic Calorimeter Using GSO and LYSO Crystals for the J-PARC Muon-to-Electron Conversion Search Experiment

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An electromagnetic calorimeter (ECAL) has been developed for the COMET experiment at J-PARC [1], which searches for muon-to-electron conversion in aluminium nucleus, $\mu^- + Al \rightarrow e^- + Al$, as a direct evidence of charged lepton flavor violation. The ECAL must be operational in vacuum and a magnetic field of 1 T, with energy resolution better than 5% at 105 MeV, position resolution smaller than 1 cm, and time response faster than 100 ns. To meet the requirements, the ECAL has been designed to consist of an array of inorganic crystals with readout of Avalanche Photo Diodes (APD). A prototype ECAL was developed with the candidate crystals of GSO (Gd_2SiO_5) and LYSO ($Lu_{2-x}Y_xSiO_5$) with dimensions of $20 \times 20 \times 150$ mm^3 and $20 \times 20 \times 120$ mm^3, respectively. The APD has a sensitive area of 5×5 mm^2 and a fast low-noise preamplifier was newly developed. To study the prototype performance, we carried out a beam test using an electron beam with momenta of 65, 85, 105, 125, and 145 MeV/c in March 2014 at the Research Center for Electron Photon Science in Tohoku University. The results showed that the GSO and LYSO detectors had an excellent linearity within 1%. The energy resolution was measured to be 5.7% for GSO and 4.7% for LYSO at 105 MeV/c as shown in Fig. 1. Details of the prototype detector development, the beam test results, and the COMET ECAL system will be described in the symposium.

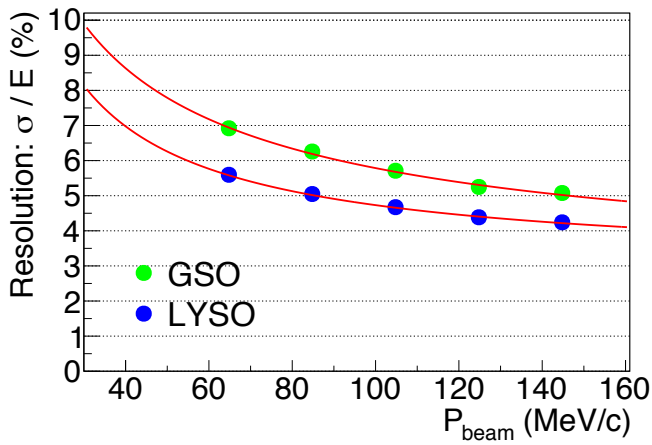

Fig. 1 Energy resolution of the GSO ($20 \times 20 \times 150$ mm^3) and LYSO ($20 \times 20 \times 120$ mm^3) detectors as a function of the beam momentum.

References

[1] The COMET Collaboration, D. Bryman et al., COMET Proposal, (2007).