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High Energy Beam Test of PHENIX EM Calorimeter at CERN

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[pp interaction, Structure function, Spin, Asymmetry, Polarized beam]

PHENIX experiment at RHIC comes near to running for the heavy ion physics and the spin physics[1]. PHENIX EM Calorimeter plays an important role in both physics in especially photon measurement. In heavy ion physics, thermal photon radiation extending to a few hundred MeV could be a possible signature of the quark gluon plasma(QGP). In spin physics at $\sqrt{s} = 500$ GeV, copious weak bosons are produced and the maximum energy of decay electron/positron also reaches approximately 80 GeV. Prompt photon measurement requires a p_t range up to 30 GeV/c. Spin physics also requires the non-linearity less than 2% for the steep slope cross section measurement of prompt photon and π^0 production. To perform both heavy ion and spin physics, photon measurements in less than 2% non-linearity with wide dynamic range between a few hundred MeV to 80 GeV are required.

PHENIX EM Calorimeter was originaly designed for the heavy ion physics. The performance with linearity, resolution, and hadron rejection up to 7 GeV already was measured at BNL[2] before. High Energy Beam Test has been done at CERN to know the performance of PHENIX EM Calorimeter for spin physics [3] from 6 GeV up to 80 GeV.

One lead scintillator(PbSc) super module and 4 lead glass(PbGl) super module were set up at the CERN SPS H6 beam line. Separated e/π beams tracked by the chamber were exposed to the surface of the calorimeters. The 60cm iron blocks followd by two μ counter was placed in back of calorimeters to tag μ beam.

The systematic scans of beam energy, incident angle, and hit position were performed with e^- beam from 6 GeV/c to 80 GeV/c. Hadron response data with 40 GeV π^+ beams were taken for the hadron background estimation. We also got energy calibration data with 10 GeV/c $\mu-$ beam for PbSc and 10 GeV/c e^- beam for PbGl.

The energy scan data of electron beam on PbSc are being analyzed in the following way: 1) Correction of gains between towers with muon beam and electron beam; 2) Correction of each tower's gain drift as a function of time by laser system; 3) Correction of (5x5 towers)summed energy as a function of hit position; 4) Absolute energy was scaled at 20 GeV beam energy.

The data analysis is now in progress. Fig.1 and Fig.2 shows a preliminary result of the PbSc resolution and linearity with BNL data. Resolution was fitted with function as preliminary $1.9\% \oplus 8.2\% \sqrt{E}$. Linearity is defined as the difference between the 5x5 towers summed energy and beam energy divided by beam energy like this; $(E_{PbSc} - E_{beam})/E_{beam} * 100$. We have systematic errors larger than 2% in CERN data in Fig.2. These systematic errors is very preliminary. These non-linearity results from some reasons, shower leak, attenuation in fiber, PMT[4], ADC module, etc. We need more careful analysis and making progress to connect two different data of BNL and CERN.

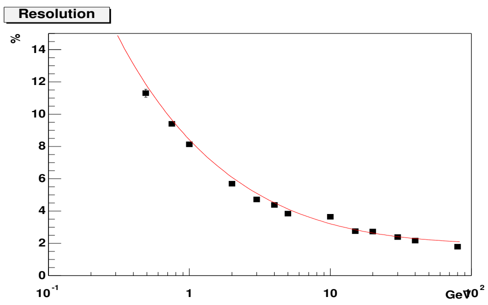

Fig. 1. Preliminary PbSc resolution with AGS data with fitted function $1.9\% \oplus 8.2\% \sqrt{E}$

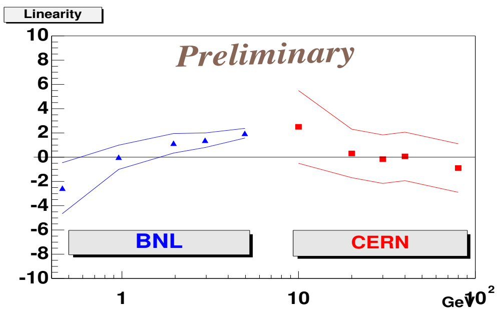

Fig. 2. Preliminary PbSc linearity with AGS data

As for the software development, a fast Monte Carlo simulation program is necessary to make our simulation program run faster. We will utilize the results of our high energy beam test, such as the shower shape, to make the simulation program reproduce the real shower shape precisely. Shower reconstruction program also has to be checked and developed to obtain a good γ/π^0 discrimination and a good electro-magnetic-shower/hadron-shower discrimination.

References

1) Y. Batygin et al.: RIKEN Accell. Prog. Rep. **32**, 44 (1999).
2) *in preparation.*
3) Y. Goto et al.: RIKEN Accell. Prog. Rep. **32**, 47 (1999).
4) G. David et al.: IEEE Trans. Nucl. Sci. **42**:306-310,1995.