Cosmic ray background in PHENIX detector†

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High energy photon is an important probe in the nuclear physics. It brings early stage information of nuclear collisions. At PHENIX[1)], photons are detected by the electromagnetic calorimeters (EMCal). Once a cosmic ray makes a cluster in the EMCal and in coincidence with the collision trigger timing, the event can be identified as a direct photon event. Fig. 1 shows examples of EMCal cluster shape in cosmic ray events. Most of the case it can be easily eliminated with the shape (Fig. 1(a)), but some fraction of them are perfectly fine as a photon cluster (Fig. 1(b)). It is a competition between the rates of the real signal and the cosmic event. Because the signal rate is much less in proton proton collisions, it is more serious problem in $p+p$ than in $Au+Au$ collisions.

In 2007, control data were taken with no activity in the accelerator. The total accumulated period is about 20k [sec]. Fig. 2 shows the energy spectra of this data set. The EMCal miscalculates the energy deposit of cosmic ray hits, because it is calibrated for photons from the collision.

Fig. 3 shows the energy spectra corresponds to the total 6.5e10 $p+p$ (at $\sqrt{s}=200$GeV) collision triggered events. The thick line shows the total, the dashed line is with time of flight (ToF) cut ($|ToF|<5$[ns]), and the thin line shows the out of ToF clusters. Because one beam crossing is about 100[ns], it is expected a factor 10 background reduction with the ToF requirement. The background is dominated at high energy region.

Two plots are compared by multiplying a factor calculated from the data accumulation period and the probability of having collisions in coincidence. The factor is obtained by the following formula.

$$T_1 \cdot \frac{1}{T_0} \cdot \frac{R}{R_{crossing}} = \frac{6.5e10}{R} \cdot \frac{1}{20300} \cdot \frac{R}{10e6} = 0.32$$

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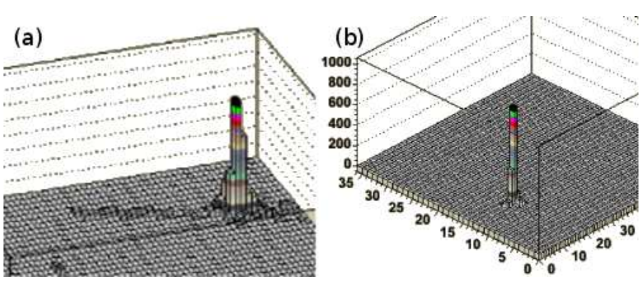

Fig. 1. Cosmic ray cluster examples. Each square corresponds to a EMCal tower. The hight is proportional to the pulse hight.

, where R is the rate of collisions. With this factor, the background component in Fig.3 is explained by the cosmic ray background.

In this report, data from $p+p$ collisions at $\sqrt{s}=200$ GeV are discussed. At higher center of mass energy (e.g. 500 GeV), we need to handle rarer signal. The ToF information is essential to reduce those background components.

References
1) K. Adcox et al.: Nucl. Inst. Meth. A**499**, 469 (2003).

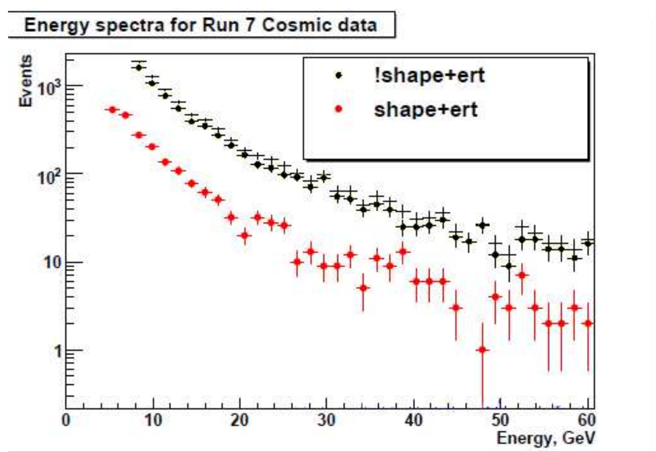

Fig. 2. Energy distribution of about 20k [sec] cosmic ray data. All cluster (the top histogram) is divided into two groups by the shape cut. The bottom histogram is for good shape clusters.

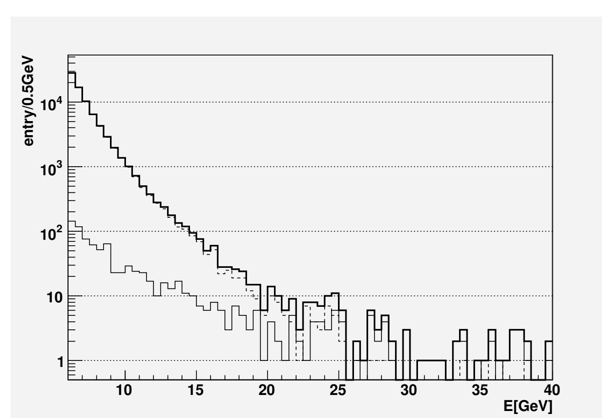

Fig. 3. Photon like cluster spectra with 6.5e10 minimum bias collision triggered data (RHIC Run5pp). The bottom thin histogram is for clusters of out of collision timing ($|ToF|>5$ [ns]).