Measuring jets with ALICE

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The general-purpose heavy ion experiment ALICE at LHC has been designed to measure single- and two-particle distributions of identified mesons, leptons, and photons in central collisions of two lead ions at $\sqrt{s}$=5.5 TeV. In this note we present an estimate of the ALICE ability to measure hard QCD jets.

The rate of jets expected in ALICE was determined using PYTHIA. We first calculated the inclusive jet cross section in p$\bar{\text{p}}$ collision at $\sqrt{s}$=1.8 TeV and compared it to the data of the D0 experiment[1]. As shown in Fig. 1, the PYTHIA calculation, up-scaled by K=1.5, describes the data reasonably well. The calculation was performed in three runs differing by the value of the CKIN(50) parameter which defines the minimum momentum transfer, i.e. the “hardness” of a collision. The three curves, corresponding to CKIN(3) of 50, 100, and 200 GeV, nicely match in overlap regions. The CTEQ4HJ structure function was used.

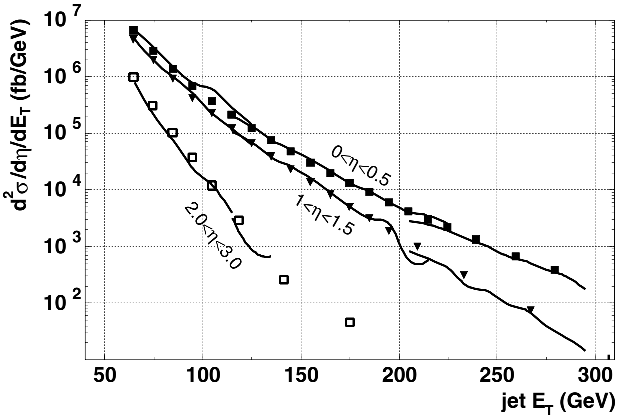

Figure 1: PYTHIA calculation of the inclusive jet cross section in p$\bar{\text{p}}$ at $\sqrt{s}$=1.8 TeV, compared to the D0 data.

Subsequently, we ran PYTHIA for pp at $\sqrt{s}$=5.5 TeV and applied the same K-factor of 1.5. The jet multiplicity in central 15% lead-lead collisions was then calculated by multiplying the obtained cross sections by 22 mb^{-1}, the nuclear overlap function T_{AB} averaged over impact parameter within the considered centrality range [2]. Assuming a rate of clean minimum bias collisions of 1000/s, and with the acceptance of the ALICE TPC of 1.8 pseudorapidity units, we arrive to the expected rate of 1 (0.01) central event with a jet of E_T>100 (250) GeV per second.

The traditional way of detecting jets is to use hadronic calorimeters. In ALICE, the Time Projection Chamber (TPC) and the readout chambers of the Transition Radiation Detector (TRD) provide an alternative access to jets via charged particles. The fraction of the jet energy carried by charged particles was estimated to be about 60-70 percent, rather independent on jet energy (Fig. 2). Furthermore, TRD can provide a trigger, needed for jets with E_T>150 GeV. The trigger can be constructed by requiring a number of high $p_T$charged particles within a solid angle cone. The p_T is determined from the curvature of the track crossing the six planes of the TRD. The optimum size of the cone roughly coincides with the size of a TRD module, $\Delta\eta$=0.36 x $\Delta\phi$=0.35. The efficiency of such a trigger, simulated using jets from PYTHIA, was found to be sufficiently high (Fig. 3).

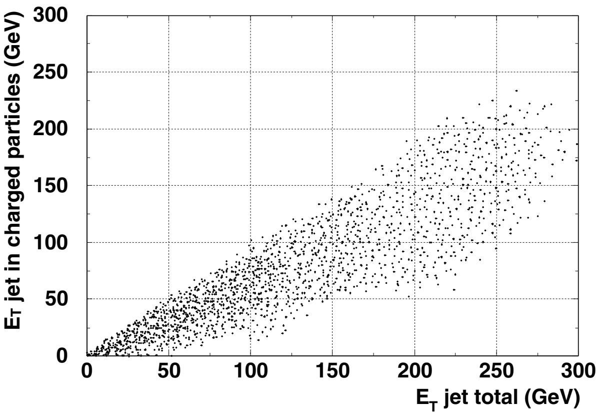

Figure 2: Fraction of jet energy carried by charged particles – PYTHIA calculation for $\sqrt{s}$=5.5 TeV.

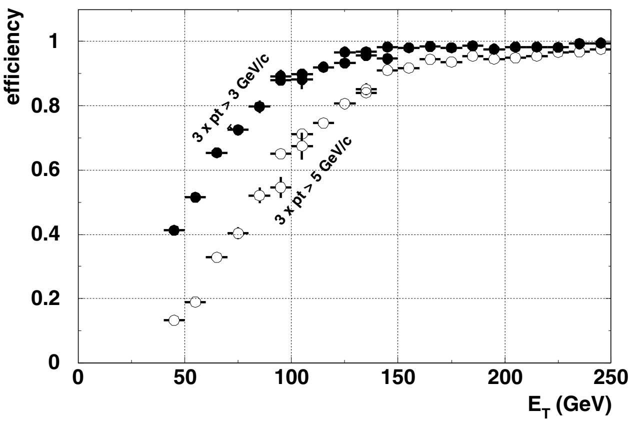

Figure 3: Efficiency of a jet trigger based on requiring three high p_T charged particles in any of the 90 TRD modules.

The jets in ALICE will be embedded in a background from soft processes. Random combinations of hard tracks lead to fake triggers. With the 3-tracks-above-5-GeV trigger (open symbols in Fig. 3) the rate of fake triggers was estimated to be below the rate of good jet events. The total rate is well within the expected data acquisition capability.

References

[1] B. Abott *et al.*, Phys. Rev. Lett. **86**, 1707 (2001).

[2] `http://www.gsi.de/~misko/overlap`