Direct Photon Detection in the ALICE EMCal

H.M. Gray[1,2], T.C. Awes[3], G. Odyniec[1], M. van Leeuwen[1]

[1] *Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720*

[2] *Department of Physics, University of Cape Town, Rondebosch, 7701, South Africa*

[3] *Oakridge National Laboratory, Tennessee*

The strong suppression of high-p_T hadrons in central Au+Au collisions is one of the most exciting results observed at RHIC and provides information about the hot dense medium produced. Direct photons have long been considered a golden probe of QGP formation because they have a mean free path much larger than the medium. In the γ-jet process, a photon and a parton are produced in a hard scattering with identical energies but opposite directions. The parton loses energy while passing through the medium and fragments into a jet. A comparison of the photon energy and the jet energy distribution will provide a measure of in-medium parton energy loss. In this report we present a technique for reducing the contamination from photons produced in π^0 decays to the direct photons in the context of the EMCal of the future ALICE experiment.

The largest source of background to direct photons are the photons produced in neutral meson decays, such as π^0 and η. There are three experimental techniques for distinguishing these decay photons. Each technique is applicable at different energies determined by the relationship between the photon opening angle and the calorimeter tower size, with the opening angle decreasing with increasing energy. At low energies the two photons are reconstructed as two separate clusters and invariant mass is used to identify those from meson decays. At higher energies they are reconstructed as a single elongated cluster. Shower shape analysis parametrises the cluster shape to discriminate between clusters containing one or two photons. At even higher energies the photons have an opening angle small enough that two photon clusters are identical to single photon clusters. Isolation cuts exploit the fact that high energy π^0s are predominantly produced in jet fragmentation and are accompanied by other particles. A cone is formed around a direct photon candidate and if there are other high energy particles within that cone the candidate is assumed to have been produced in jet fragmentation.

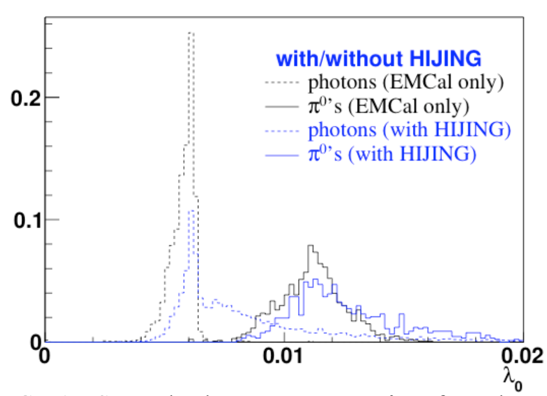

FIG. 1: Second cluster moment, λ_0, for photons (dashed) and π^0s (solid) for single particles (black) and embedded in a Pb+Pb event (blue).

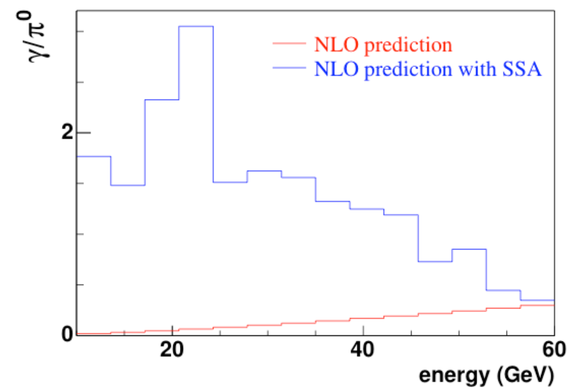

FIG. 2: The γ-π^0 ratio obtained after applying a p_T –dependent λ_0 cut [2] compared to a NLO pQCD calculation [3].

In shower shape analysis, the shower tensor is calculated from the sum of the distance of each tower in the cluster from the cluster centre. The distance is weighted by a logarithm of the tower energy [1] to account for the logarithmic fall-off in shower energy. The eigenvalues of the shower shape tensor measure the major and minor axes (λ_0 and λ_1 respectively) of the cluster.

The second cluster moment, λ_0, provides a direct measure of the photon opening angle and can be used for γ-π^0 discrimination. Figure 2 shows the λ_0 distribution for single photons (dashed line) and π^0s (solid line) with energies between 12 and 14 GeV. The blue histograms show the λ_0 distribution after the addition of background from the underlying event. The background contribution was reduced by applying a 500 MeV tower energy threshold [2]. In order to discriminate between photons and π^0s, a p_T-dependent cut on λ_0 was implemented. The optimal value of the cut was determined in energy bins of width 2 GeV.

Figure 2 compares the γ-π^0 ratio obtained after applying the λ_0 cut (blue) to the ratio predicted by NLO pQCD calculations (red) [3]. The decrease in the opening angle with energy means that shower shape analysis is most effective at low energies, but can be used until ~50 GeV. Shower shape analysis applied in the EMCal significantly increases the high-pt photon coverage of ALICE [2].

REFERENCES

[1] T. Awes et al, NIM A 311 (1992).

[2] H. M. Gray, MSc Thesis, University of Cape Town, 2005

[3] F. Arleo et al, Photon Physics in heavy ion collisions at the LHC, 2003