π^0 Production in Au+Au Collisions at $\sqrt{s_{\rm NN}} = 130$ GeV

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The $\pi^0 \to \gamma\gamma$ decay is the predominant mechanism of photon production in heavy ion collisions. It is estimated that 85% of the photons produced in heavy ion collisions come from π^0 decays. The π^0 decay vertices and the collision vertex are inseparable given the combination of the short lifetime of the π^0, $c\tau = 25$ nm, and the track resolution limits of modern detectors. Although individual π^0 photon pairs are not detected, the cross section of π^0 production can still be measured by calculating the invariant mass of all possible pairs of photons and looking for an enhancement at the π^0 mass.

The STAR Time Projection Chamber (TPC)[1] has been used to reconstruct photons through e^+e^- pair creation. The directional resolution of this method reduces background from secondary photons created by other particles passing through detector material. The few percent energy resolution leads to a $\pi^0 \to \gamma\gamma$ with $p_t < 1$GeV/c signal to background ratio of 1/6 (Fig.1). At low p_t and for high multiplicities the signal to background ratio is reduced by the increase of random combinations around π^0 mass.

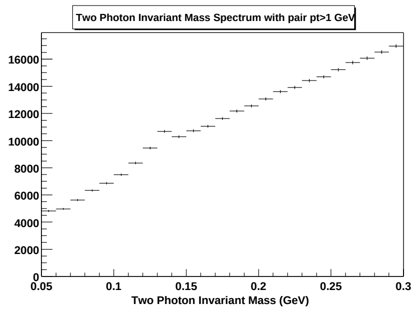

Figure 1: *With a high pt cut, $p_t > 1$ GeV/c, and peak width, sigma ~ 6 MeV/c^2 the peak to background ratio is 1 to 6. The photon energy resolution of this method makes it possible to extract π^0 yields at transverse momenta as low as a few hundred MeV/c.*

The two photon invariant mass combinatoric background can be estimated by combining photons from different events. This method is called event mixing. The event mixing method is ideal because it eliminates all true π^0 correlations and includes all acceptance and efficiency effects. A comparison of a real event to mixed event two photon invariant mass spectrum is shown in Fig. 2. In Figure 2 there is a suppression at lower invariant mass, M< 700 MeV/c^2. This suppression is attributed to two photon correlations arising from a strong collective flow, as seen for charged particles. A strong collective flow would decrease the average opening angle of photons in the same event, but would not create this bias in mixed events. The bias will produce higher invariant mass pairs in the mixed events than in the same events. Future version of the event mixer will align event reaction planes to simulate flow effects.

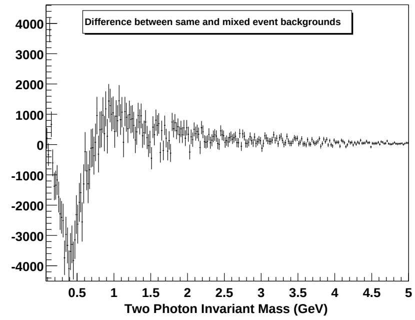

Figure 2: *In this figure it is apparent that the current mixed event background does not reproduce all physics effect. We attributed the difference to a strong collective flow.*

A clear π^0 peak is left after the mixed event background is subtracted from the same event two photon invariant mass spectrum, as shown in Fig. 3. The π^0 cross section will be obtained by extracting a yield from the data and correcting it for detector acceptance and efficiency. The peak, in Fig. 3, is fit with a Gaussian function plus a constant. A Gaussian function is chosen instead of a Breit-Wigner function, because the peak width is purely detector resolution, ~ 6 MeV/c^2, and not a result of the intrinsic width of the π^0, ~ 8 eV.

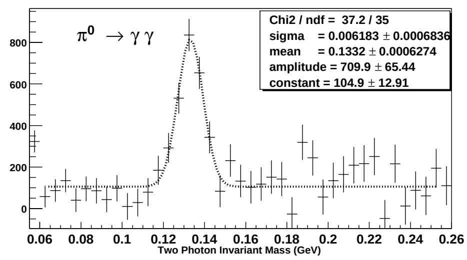

Figure 3: *The $\pi^0 \to \gamma\gamma$ peak is clearly visible after a mixed event background is subtracted. At this point uncorrected yield may be extracted.*

Footnotes and References
[1]J.Harris,(STAR Collaboration) '*Quark Matter 2001 Proceedings*',Stony Brook, January 15-20, 2001, F. Retiere, (STAR Collaboration) '*Quark Matter 2001 Proceedings*',Stony Brook, January 15-20, 2001.