

Toward understanding relativistic heavy-ion collisions with the STAR detector at RHIC

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I. Calibrations

A. Barrel Pre-Shower Detector

We have been fine-tuning the calibrations of the BPS channels for the Run-7 (Au+Au collisions) data. We first recalculated the calibration factors by fitting the slopes of the ADC spectra. Fig. 1 shows the slopes before and after calibration. Then we applied these constants and required a 1 GeV charged track to pointing to a channel to check whether the resulting Minimum Ionizing Peaks (MIP's) were aligned for all channels as a result of these calibration factors.

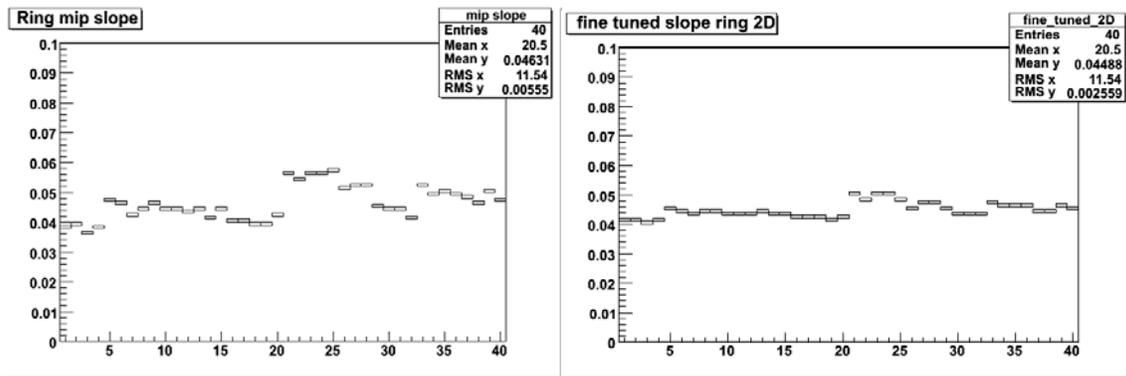


FIG. 1. Average slope per ring before calibration (left) and after calibration (right).

B. Barrel Shower Maximum Detector

We have also been working on the strip-by-strip (18000 strips total) calibration of the Barrel Shower-Max detector (BSMD). Since we are using the BSMD in the γ -jet analysis to discriminate between γ and π^0 , fluctuations in the gain can smear out the differences in shower-shape observed for photons and π^0 . A strip-by-strip calibration can hopefully sharpen the differences, making the shower-shape cut to identify direct photons more efficient. We plan to apply the calibrations and re-analyze the data, with the goal of reducing the systematic errors. Fig. 2 shows the ADC distribution of a single strip in the BSMD. The feature to note is that the spectrum is not a pure exponential in ADC.

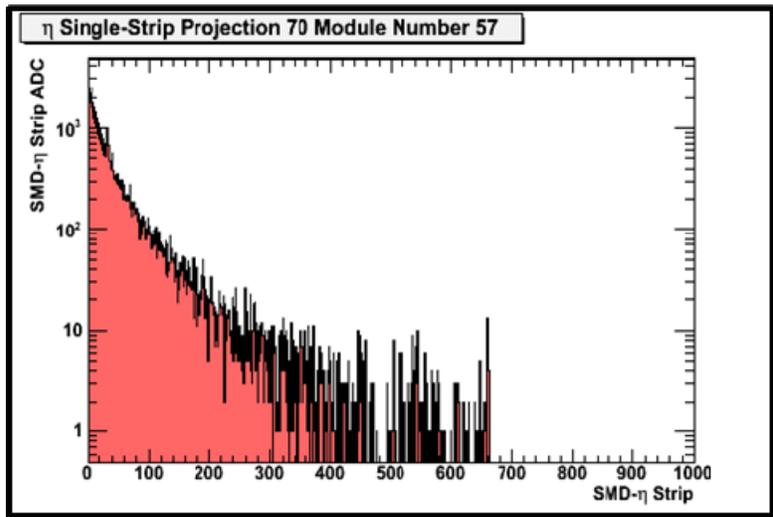


FIG. 2. ADC distribution of one BSMD strip.

Thus, fitting with a constant slope value depends strongly on the ADC range used in the fit. Therefore, we fit the ADC spectra with the following function,

$$e^{[P_0 + P_1(x + \alpha x^2)]}$$

where α is a constant value for all strips and P_1 is the fit-extracted gain (per strip). Fig. 3 shows a profile histogram of the gains as a function of pseudorapidity. The left is before the calibration, and the right is after. The pseudorapidity dependence was kept the same through the calibration procedure. The gains per pseudorapidity bin were adjusted to match the average value. The spreads on the right have been reduced from the left, showing that the calibration has tightened up the distribution of relative gains per pseudorapidity bin.

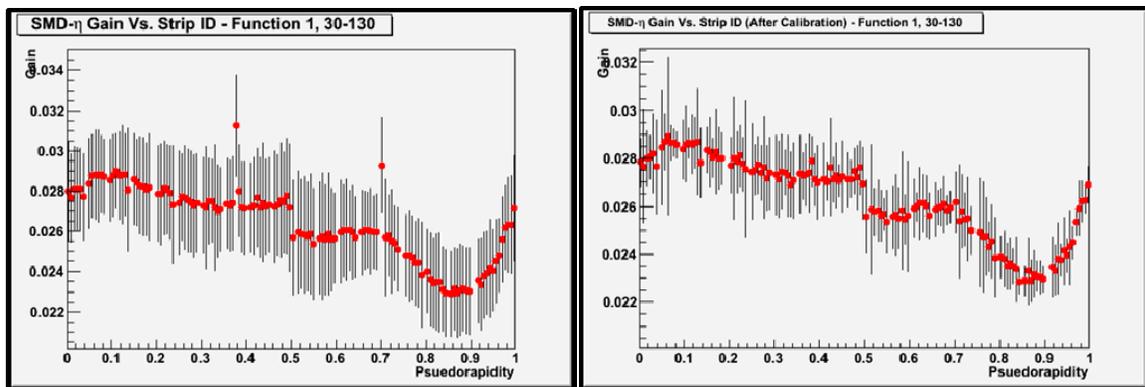


FIG. 3. Average gain as a function of pseudorapidity before calibration (left) and after calibration (right).

II. Physics Analyses

We are studying relativistic heavy-ion collisions with two different probes: bottomonium and γ -jet. The bottomonium measurement is important to disentangle competing effects, screening in the deconfined plasma vs. $q\bar{q}$ recombination, both possibly playing a role in the production of charmonium in heavy-ion collisions. Photon-hadron correlations (γ -jet) measure the medium-induced parton energy loss as a function of the parton's original energy.

A. Upsilon Analysis

We have performed the Upsilon analysis on the Run-8 d+Au data set, where the background is smaller. Fig. 4 shows the reconstructed mass from e^+e^- pairs (black) and like-sign pairs (red). There is very little background observed even without background subtraction, and a cut on the BPRS is not necessary with such a large signal-to-background ratio. This analysis now awaits results from embedding Upsilon particles into real events in order to evaluate the efficiency corrections.

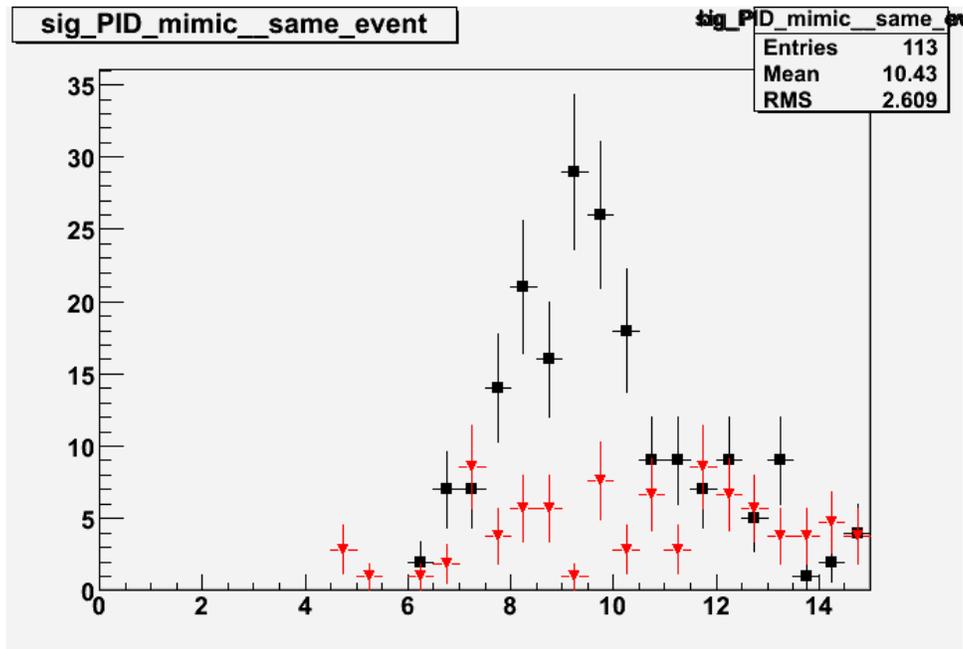


FIG. 4. Invariant mass distribution of e^+e^- pairs (black) and like-sign pairs (red) calculated in d+Au events.

B. Photon-Jet Analysis:

We have taken the initial analysis of γ -jet correlations in Run-7 Au+Au collisions, and recalculated the yields in bins of z_T , which is the fractional transverse momentum of the associated hadron to that of the trigger photon ($z_T = p_{T,associated}/p_{T,trigger}$), shown in Fig. 5. This gives us a more direct

measure of the modification of the fragmentation function due to the medium. The results have been presented at several national and international meetings (e.g. [1]-[3]). They also appeared in a theory paper in which our results were compared with a calculation of energy loss in the medium [4]. Recently, we have concentrated on finalizing a detailed study of the systematic errors for the publication of our results. We currently have a paper draft (to be submitted to Physical Review Letters) circulated within the STAR Collaboration. We plan to follow this letter with a longer, more detailed publication, which will include also the details of the π^0 -triggered correlated hadron yields.

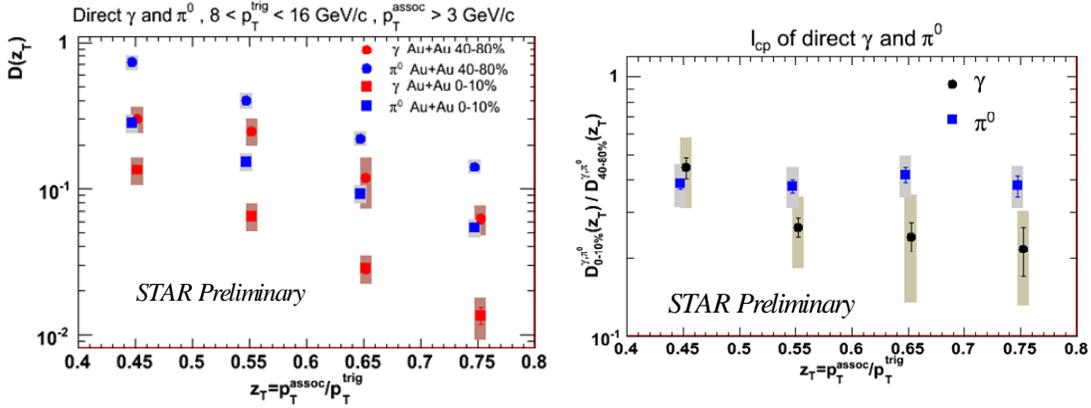


FIG. 5. (Left) Associated yields of hadrons correlated with a high- p_T direct γ (red) or π^0 (blue) trigger, as a function of z_T ($=p_T^{\text{assoc}}/p_T^{\text{trig}}$) for 0-10% centrality and 40-80% centrality. (Right) Ratio of central to peripheral yields for direct photon triggers (black) and π^0 triggers (blue).

- [1] A. M. Hamed (for the STAR Collaboration), *Proceedings of the 34th International Conference on High Energy Physics (ICHEP 2008) (submitted)*; arXiv:0810.3743.
- [2] A. M. Hamed (for the STAR Collaboration), *Proceedings of the 3rd International Conference on Hard and Electromagnetic Probes of High-Energy Nuclear Collisions (HP2008) (submitted)*, arXiv:0809.1462.
- [3] A. M. Hamed for the STAR Collaboration, *J. Phys. G* **35**, 104120 (2008).
- [4] H. Zhang, J. F. Owens, E. Wang, and X. -N. Wang, arXiv:0902.4000.