Calibration of the Shower Maximum Detector in the Barrel EMC at STAR

By Kara Farnsworth *University of Arizona*

Mentors: Saskia Mioduszewski and Martin Codrington *Texas A&M Cyclotron Institute*

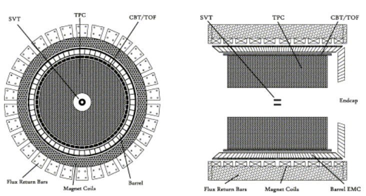
Cyclotron Institute
Texas A&M University

Background

Physics Motivation

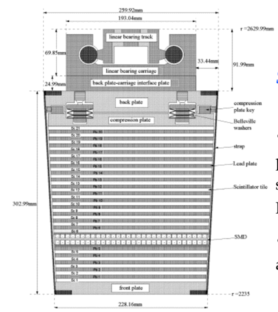
The Solenoid Tracker at RHIC (STAR) was designed to look for signatures of the quark-gluon plasma (QGP), believed to be created in high-energy heavy-ion collisions. One of the best probes of the dense matter created in these collisions is the γ-jet probe. In a hard scattering process, a jet can be produced back to back with a direct photon (γ-jet). Because the photon does not interact via the strong force, it escapes the medium without further interaction. It thus carries the initial energy of the o pposite jet, which is useful for determining the modification of the jet due to the medium. However, there is a significant source of background photons from π^0 decays. It is therefore important to be able to discriminate between direct photons (γ) and two close photons originating from a π^0 decay, at large transverse momenta.

Barrel Electromagnetic Calorimeter (BEMC)



Head-on (left) and side view (right) of Barrel EMC *

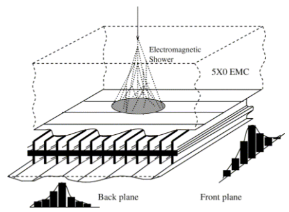
- Coverage: $-1 < \eta < 1$ (pseudorapidity) and $\phi = 2\pi$ (azimuth)
- Total detector: 4800 towers, each with a coverage of $\Delta\phi = 0.05$ rad by $\Delta\eta = 0.05$
- Each tower consists of 20 layers of lead (Pb) alternating with 21 layers of scintillator (Sc).



Cut-away view of tower *

Shower Maximum Detector (SMD)

- Useful for γ/π^0 discrimination, key to the γ-jet analysis, by providing spatial resolution of shower particles when the shower has reached its maximum size (after 5 layers of Pb/Sc)
- Total detector: 18,000 strips for determining position in η and 18,000 strips for ϕ



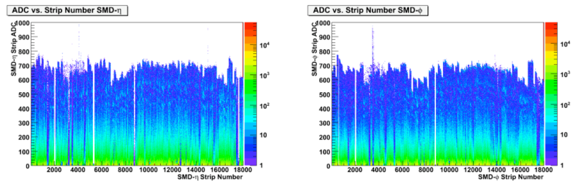
Schematic of shower maximum detector *

*Figures obtained from *The STAR Barrel Electromagnetic Calorimeter* by M. Beddo et al.

Calibration

Raw Data

- 3 million minimum-biased 200 GeV Au+Au collisions
- Pedestal runs had been taken during each RHIC beam fill and stored in a database
- Pedestal Mean and RMS values were retrieved from database and subtracted from raw ADC values ($ADC - Mean_{ped} - 5\sigma_{ped}$)
- Plots of pedestal-subtracted ADC values vs. SMD strip number for η - strips (left) and ϕ - strips (right)



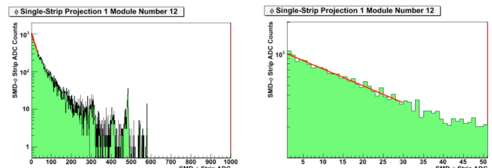
Two dimensional histograms of pedestal-subtracted ADC vs. strip number for η strips (left) and ϕ strips (right)

Quality Assurance and Slope Fits

These two dimensional histograms were then projected by single strip for both η and ϕ. Once projected, each histogram was given a status indicator based on the following system:

- 0 - Dead Channel (< 5 entries)
- 1 - Good Channel
- 3 - Cold Channel (number of entries < 1/5 of the average channel entries)
- 4 - Hot Channel (number of entries > 5 times the average channel entries)

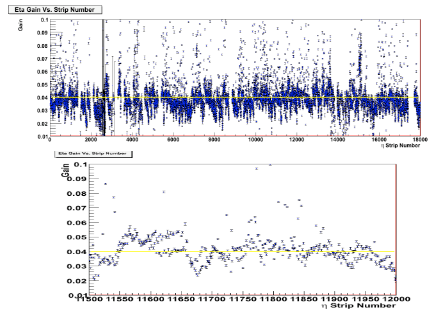
The projections for good channels were then fit with an exponential function for ADC values between 1 and 30.



Example projection of a single ϕ - strip (left) with exponential fit (right)

Obtaining Calibration Constants

- The |slope| vs. strip number is shown below.



Gain vs. strip number, shown for η-strips over all 18,000 strips (top) and zoomed in to 500 strip range (bottom).

- The strip-by-strip gain factors are determined by the variation of the slopes with respect to a constant.
- These multiplicative constants will be stored in a database and applied to the data when it is reprocessed for physics analyses (such as the γ-jet analysis)
- This accomplishes a relative calibration of all SMD strips.

Acknowledgements

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