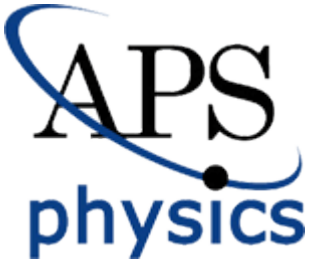
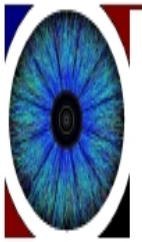
Using the Calorimeter Pre-Shower Detector in STAR

- Overview of the STAR Preshower detector
- Calibration using the 2007 run 7 data
- Current status of commissioning

Rory Clarke for the STAR Collaboration

For DNP 2007



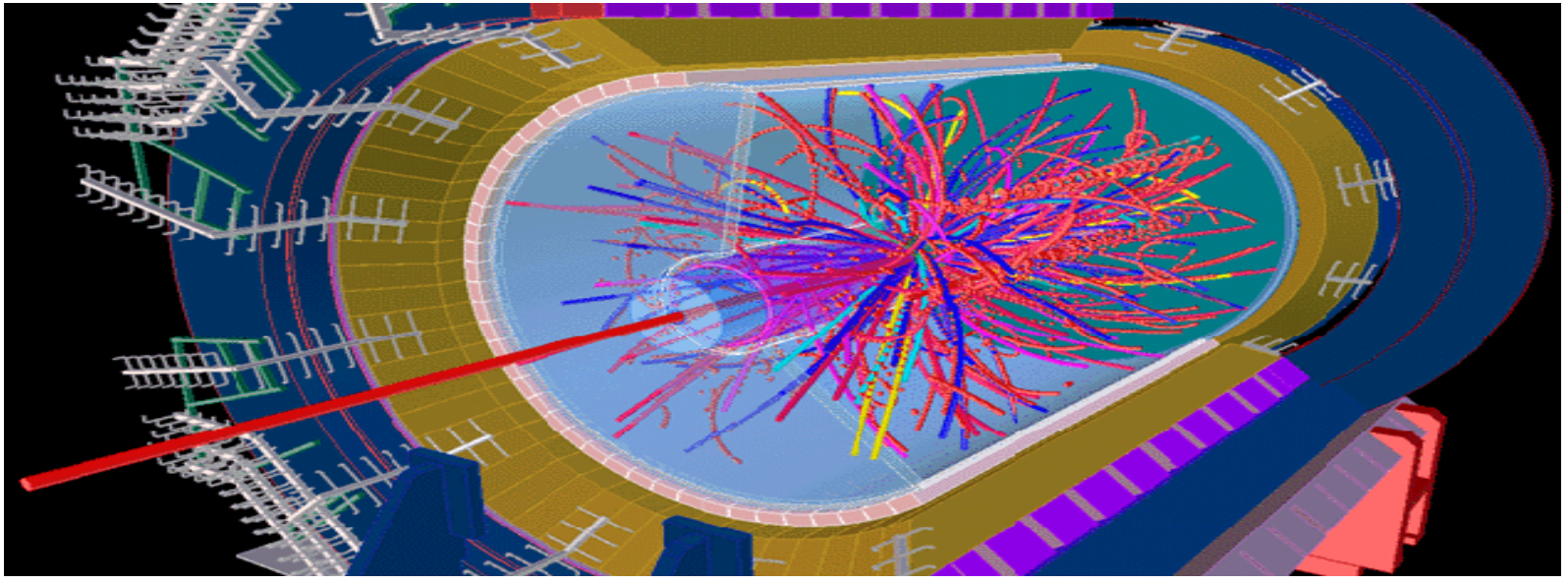


The STAR experiment

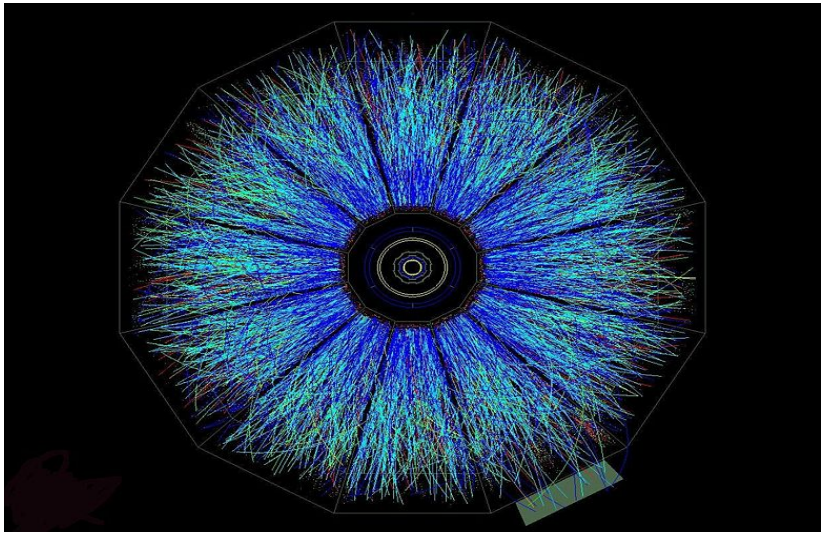
at the Relativistic Heavy Ion Collider, Brookhaven National Laboratory

The Star Detector

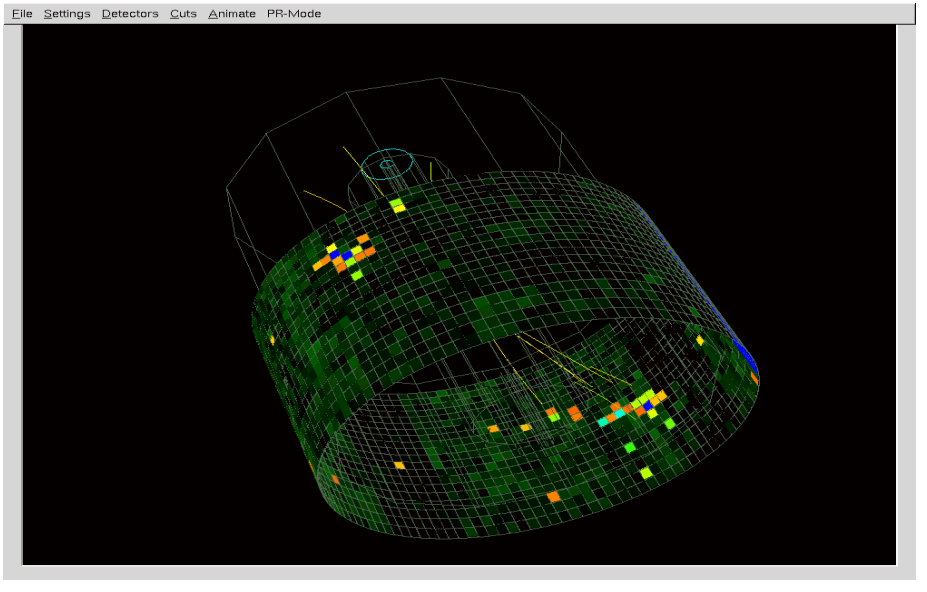
Detector cross section, TPC and Barrel EMC can be seen here



Tracks from event in the TPC AuAu 200Gev



Hits in the barrel EMC



Physics Motivation

- Heavy-quarkonium is predicted to be strongly suppressed in heavy-ion collisions with respect to binary scaling from the p+p collisions.

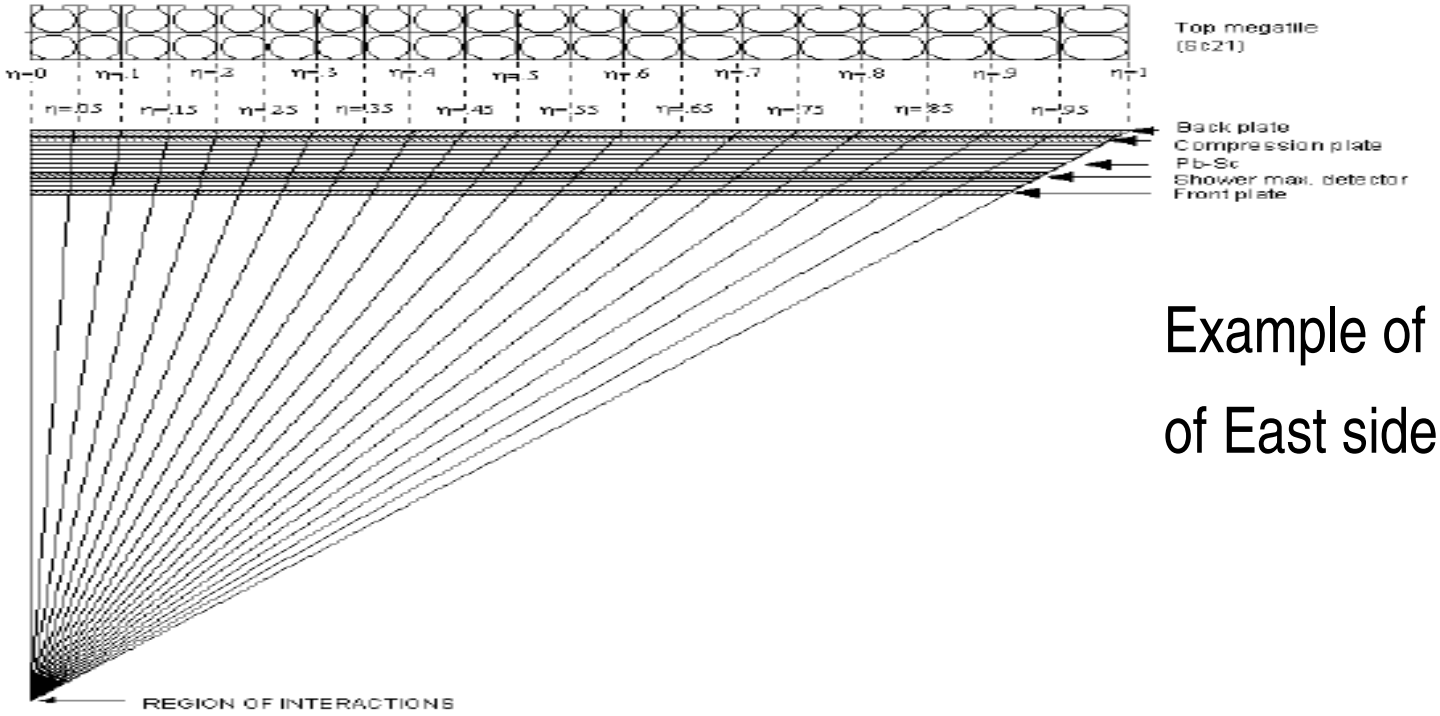
- Full spectroscopy of the J/ψ and Υ may corroborate the existence of deconfinement in the QGP. The Upsilon is not expected to undergo recombination like J/ψ and this could be used to compliment the J/ψ signal.

- The large acceptance of the STAR detector is ideal for reconstructing the wide opening angle of the dilepton decay channels from these signals

- These signals will have a large hadronic background. The Preshower reduces this hadronic background in an analysis by increasing the electon, hadron separation in the EMC

Barrel Electromagnetic Calorimeter layout

- The BEMC surrounds the barrel of the star tracking chamber (TPC).
- It is arranged as modules in two strips of 20 tower calorimeter units.
- These cover the barrel in two sections of sixty, on the West and East side.
- The 4800 towers cover rapidity range, eta, from -1 to 1 and phi from 0-2 π segmented in 0.5 for eta and phi



Example of top and side view of East side module

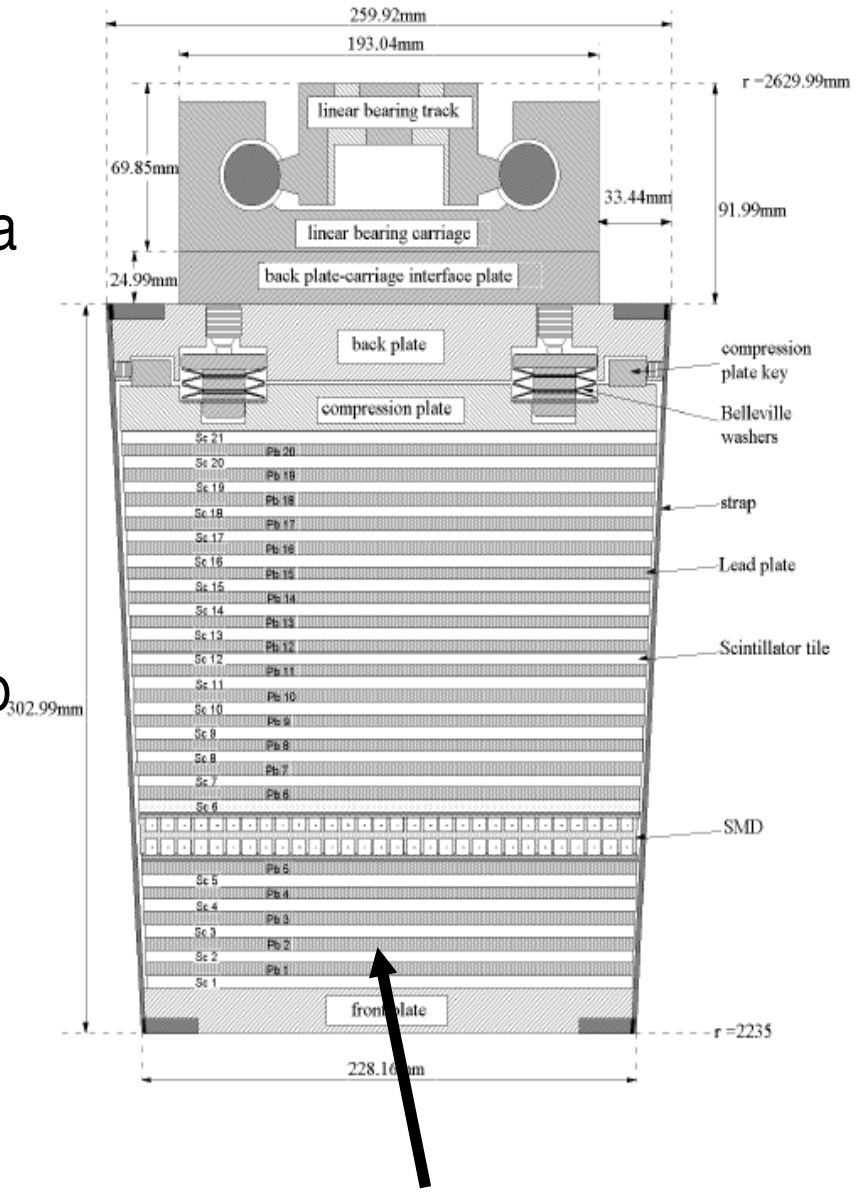
Barrel Electromagnetic Preshower

- The Calorimeter units, are made of a sandwich of lead and scintillator. After the first 5 layers there is a layer for the Shower Maximum Detector (SMD) to improve position resolution.

- Each layer is one radiation length and the whole tower is one nuclear interaction length. The first two layers form the preshower

- Approximately 63% of electrons will shower before scintillator layer 1 and ~84% before layer 2.

- Approximately 3% of hadrons interact before the first layer and 6% before the second layer.



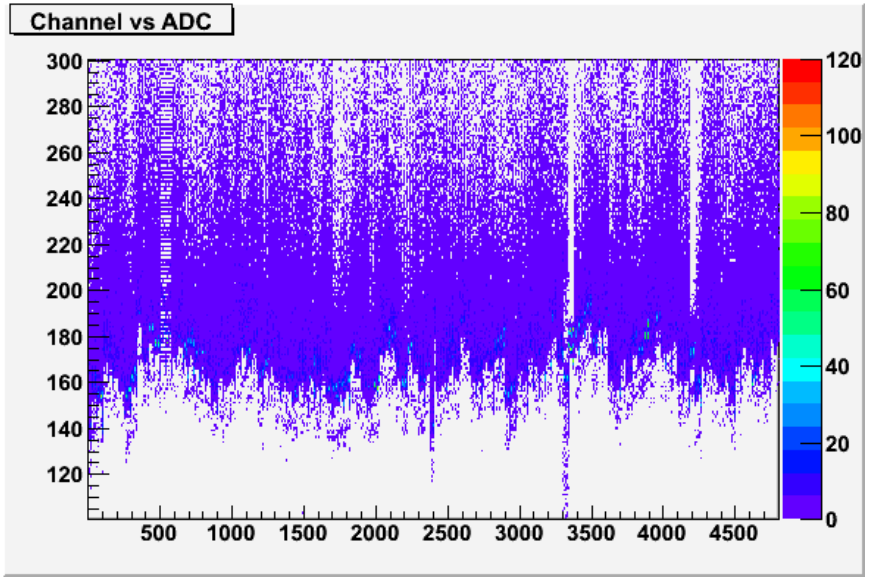
Calorimeter unit, preshower is first two layers

2007 Preshower Data

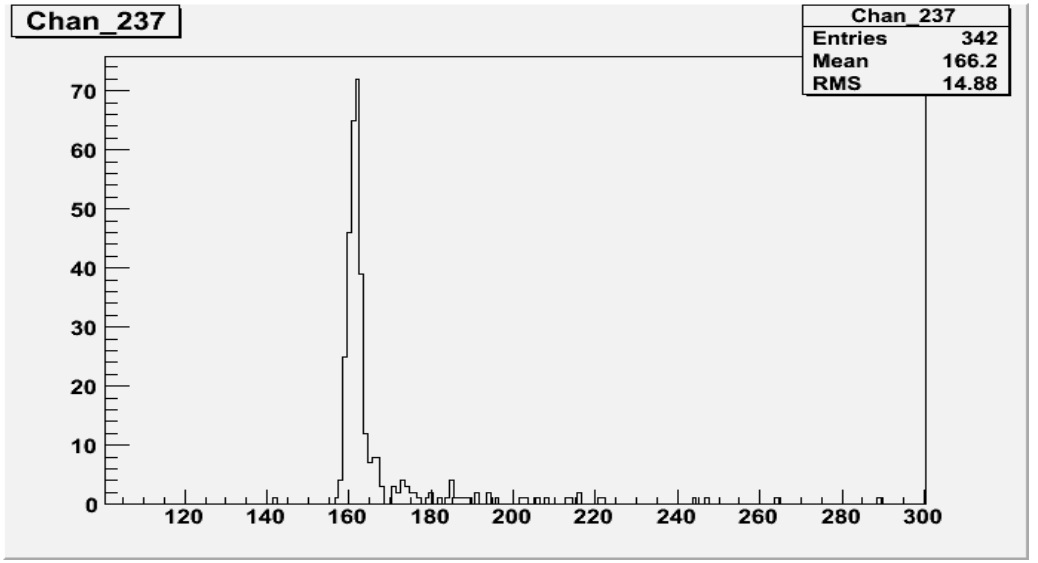
Condition of the raw data

- The hits in the scintillator are converted to electrical signals (ADC) shown here for the RECENT 2007 run 7 data from the STAR detector.
- Hardware/Software readout issues have been fixed, giving us 10-15% improved resolution and bad channels masked giving 88% working preshower channels
- Periodically data is taken from a no-beam run to calculate pedestals. This background can then be subtracted from the physics data for each channel

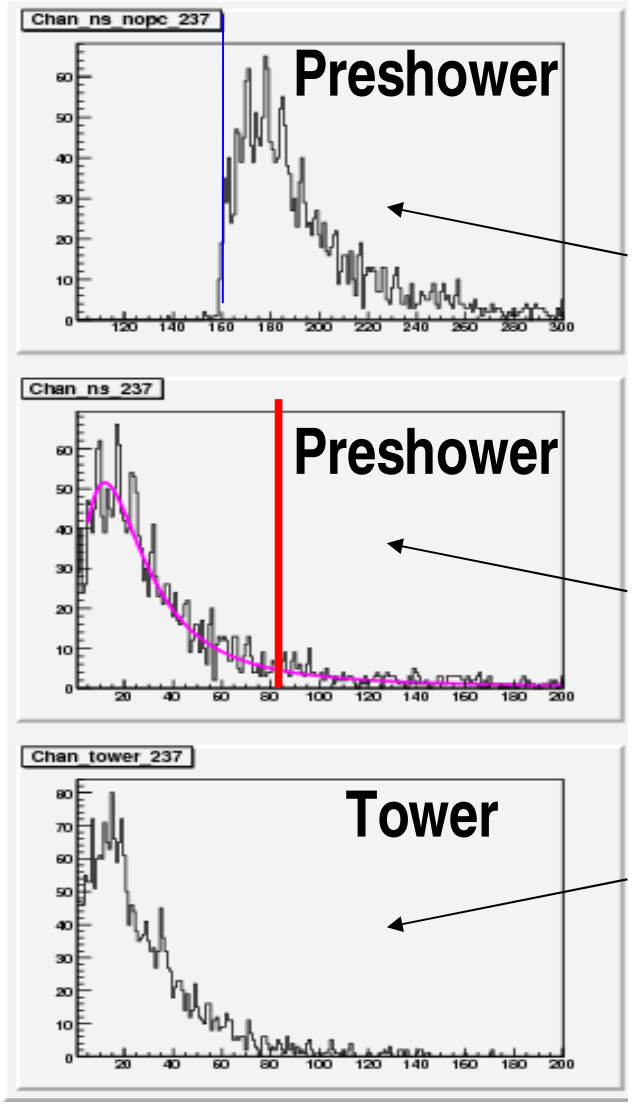
Typical ADC readout for 2007 run



Pedestal from run with no beam



Minimum Bias, with tracking, ADC spectra

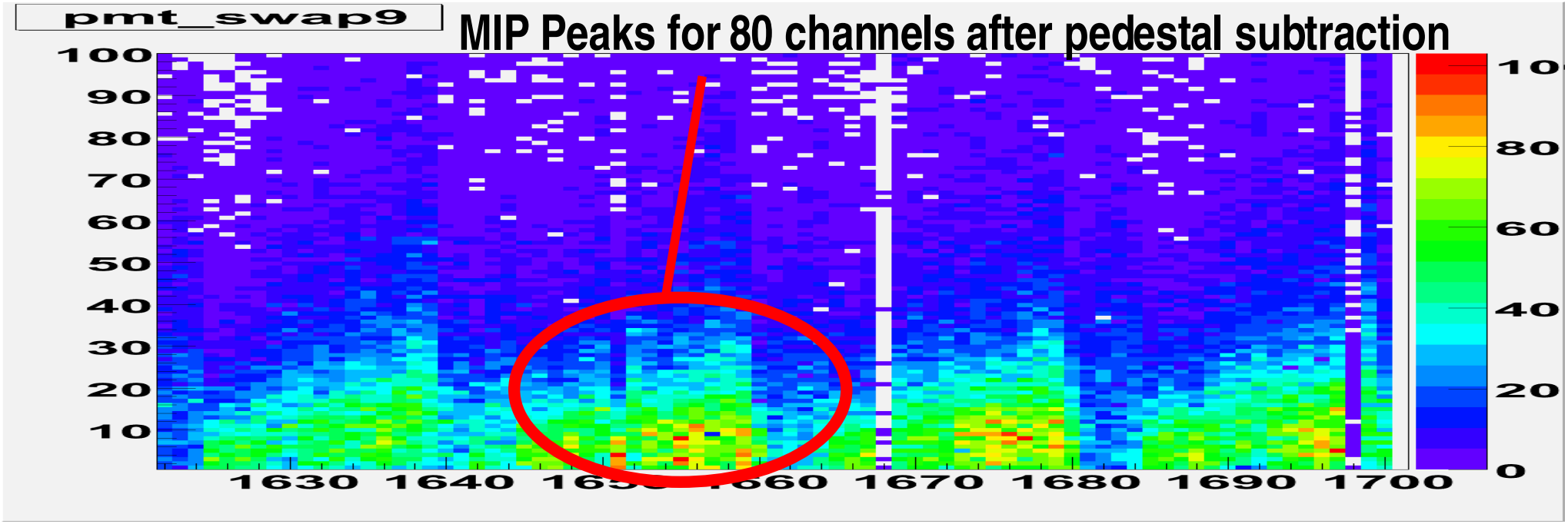


- **For these data a track from TPC must pass through the tower and point to an interaction vertex**
- **Blue line** shows the location of the pedestal position. The peak to the right is from Minimum Ionizing Particles (Mips)
- Middle: The pedestal has been subtracted. A fit has been made to possible MIP signal. This can be cut to leave electron signal (red line) as the high end of the slope on the right
- Lower: For comparison the full tower with pedestal cut. Again we see the MIP peak

Calibration Steps

Current analysis:

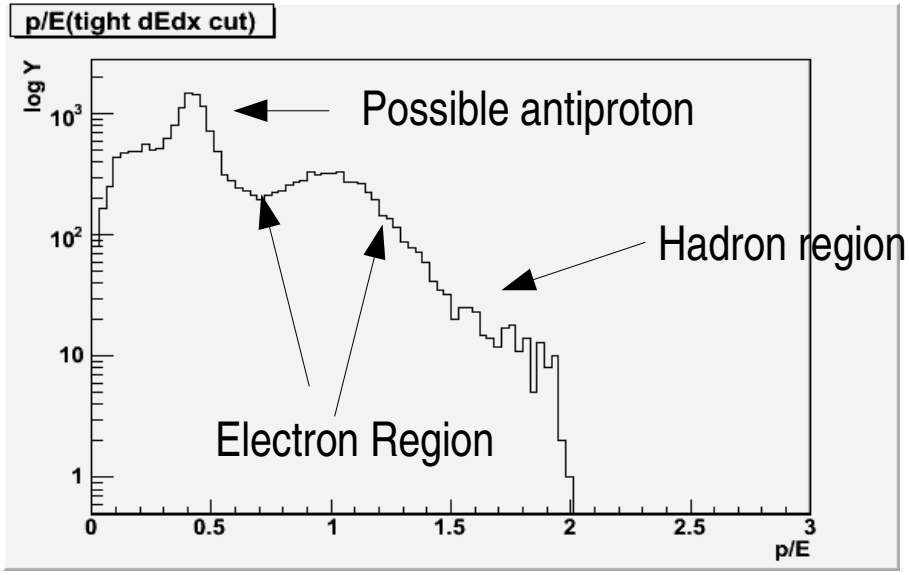
- Once a MIP peak has been found a fit can be made. The slopes have to be calibrated to remove various effects from the electronics set up.
- Full calibration will also be a function of Eta, seen as “sloped” data in this plot
- We can use these gains to convert ADC to Energy in the preshower
- The preliminary peaks and slopes per channel have been used (see M.Cervantes talk)



To P/E or not to P/E?

- We select on P(from TPC)/E(From Tower) within a region of dE/dx (energy loss in TPC) with an electron signal. As the electron mass << than momentum we would expect a distribution of electrons at P/E=1 and we can select the region around this.
- However, the hadrons will be smeared over the P/E distribution as they do not deposit all their energy in the calorimeter
- The preshower should further improve the resolution in this region by reducing the hadronic signal directly around P/E=1

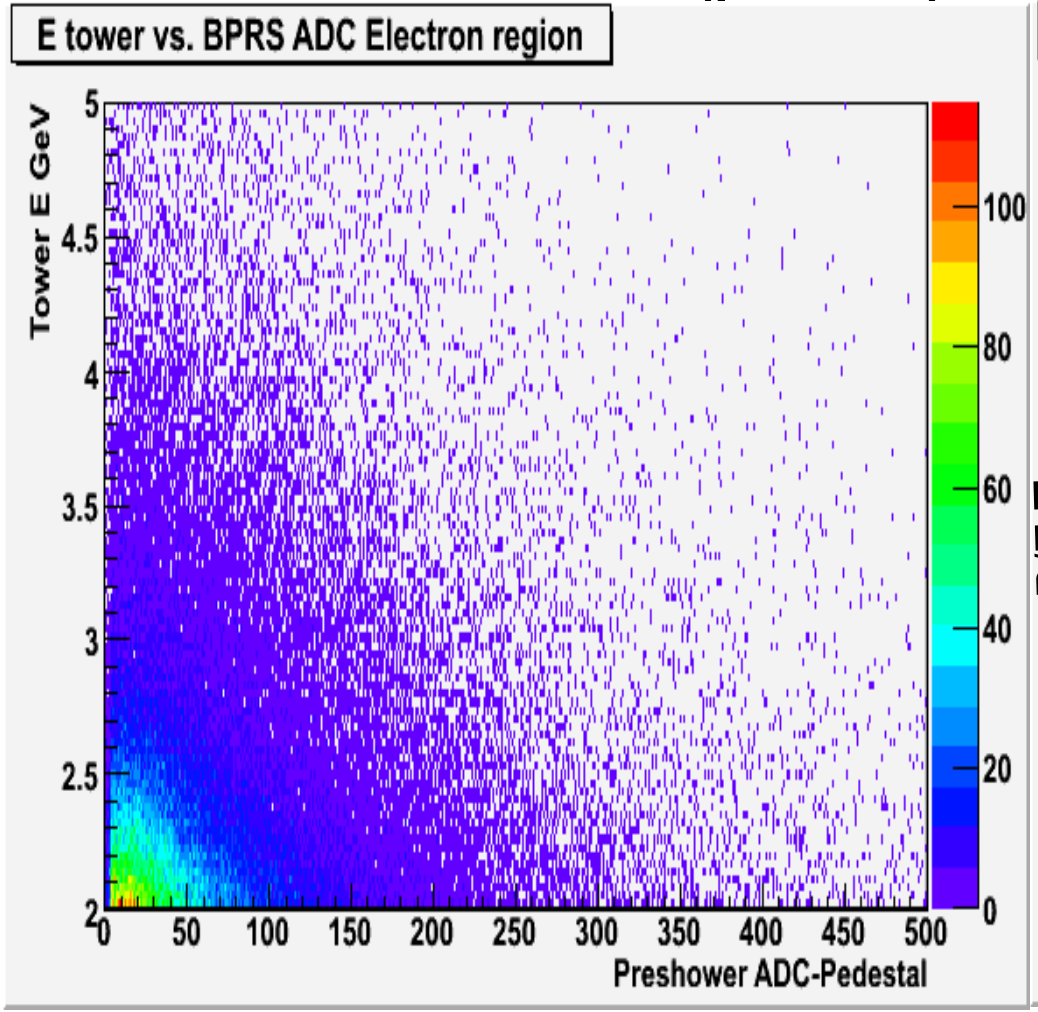
No Preshower, dEdx cut in electon region (3.4e-6 5.0e-6 KeV/cm)



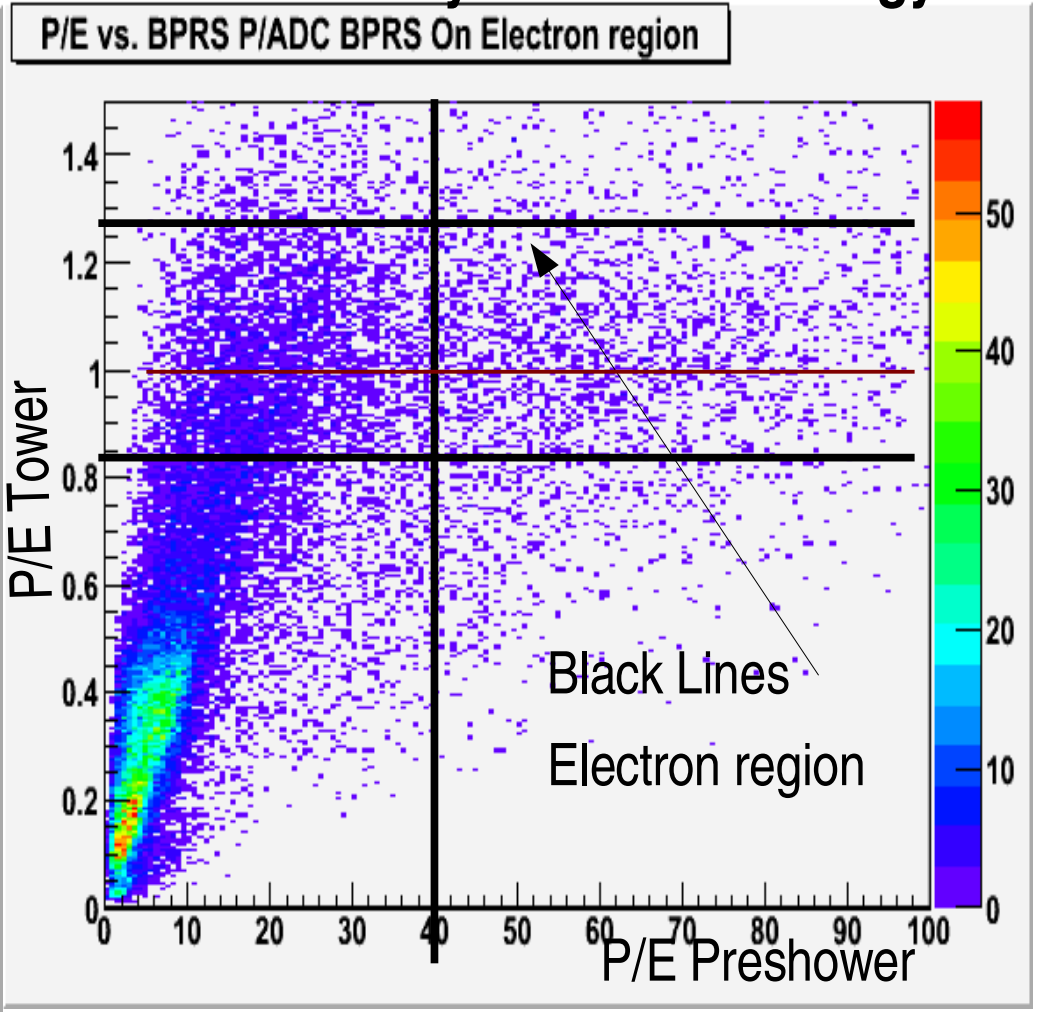
P/E Tower vs. P/E preshower

When the calibrations are complete we can tie the ADC values to Energy. However, as a first approximation we can say that ADC*Value=E and estimate the P/E distribution for the preshower. These plots are for 3.5 < dE/dx 5.0, the electron rich region

Tower E vs. Preshower ADC (ped sub.)



With Preliminary Preshower Energy Cut



Conclusion

- For the first time in STAR we are seeing data from the preshower detector that shows a clear correlation with the data from the calorimeter (previous slide, left)

- Correlation also seem for the likely anti-proton signal in P/E plots

- We have solved major problems with the Electronics/Software and can see MIP peaks and slopes

- The data we see is as we would expect, i.e eta dependence of the MIP peaks

- We are now in a position to do an initial energy calibration and analysis using the preshower on real data. For an example of this see M. Cervantes talk next

Further Work

- We are currently finalizing an initial calibration for the STAR preshower detector. We have the tools largely in place from the 2006 Run-6 and 2007 Run-7 analysis.

- The previous plot with an energy cut estimated from the ADC shows promising results for improved electron identification

- Combined with the dE/dx from the TPC, the P/E and the SMD signal the Preshower will provide improved hadron rejection (See M. Cervantes talk next)

- The next step planned is to examine a MonteCarlo which includes the preshower

- Finally, perform an analysis and see the effect of the preshower using the electron sample. STAR has 4.9 M Upsilon triggered events on tape from Run 7

Backup Slides

1) Other Preshower Signals

Physics Motivation

- Another signal that will benefit from the preshower is the φ deacy.

The branching ratio of φ -> ee to φ -> KK may be a direct observable for chiral symmetry restoration in the QGP

- Also, direct photos will have a background for the high-p_T photons from π^0 decays.

The Preshower would extend the searches for the direct photon to a region where Pt > 20GeV, and compliment the efficiency of the SMD below this limit.

- All of the above physics will benefit from the commissioning of the preshower with its improved low Pt electron identification and uniform electron/hadron separation over all energies.

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