Performance of GEM Chambers to Monitor the TPC Tracking Calibrations (GMT) in STAR at RHIC

Sabita Das (for the STAR Collaboration)

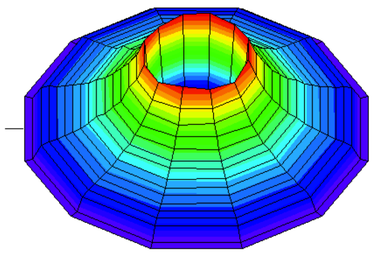
Brookhaven National Laboratory, USA

Institute of physics, India

Abstract

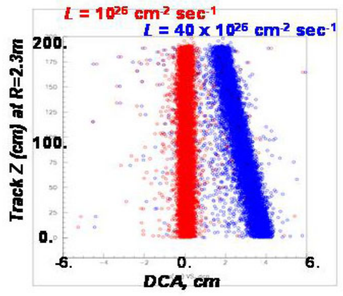
As RHIC luminosity increases to enable high statistics measurements, suppressing systematics that contribute to the Time Projection Chamber (TPC) tracking resolution becomes more important for various physics goals like separation of upsilon (Y) states, high pt tracking for jet studies. Additionally, it will be necessary to maintain good pointing resolution to the silicon detectors at the inner radii in STAR to have efficient track matching for charm reconstruction. Major corrections for tracking include the space charge distortions. Earlier a model of the accumulated charge in the TPC was used to correct distortions which can be checked at radii smaller than the inner radius of the TPC by using the interaction vertex and by using the silicon detectors. However, no precision points outside the TPC were available to check the corrected tracks. Having such points will provide a strong constraint on the space charge distortion corrections. With this purpose eight GEM based tracking chambers to monitor the TPC (GMT) have been installed at eight locations at the Time of Flight (TOF) radius in the year 2013.

Space Charge Distortion

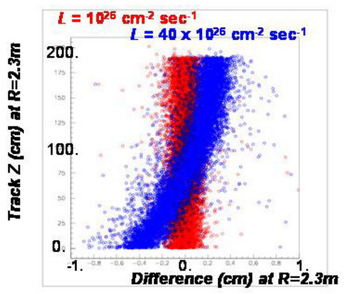


- The space charge is assumed to be uniform in φ and z, and vary in r as ~ $1/r^2$. The overall magnitude of the space charge increases with luminosity.

Simulation for space charge



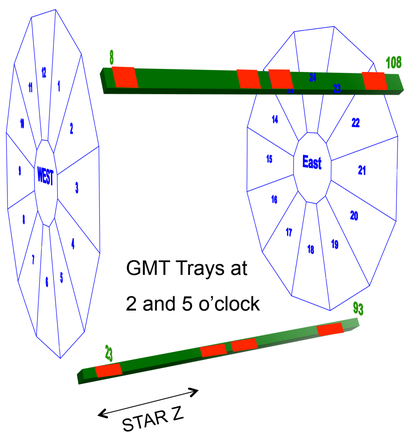
- The distance of closest approach (DCA) distribution of TPC tracks from primary vertex with no correction for space charge distortion for low luminosities (red) and high (blue) as a function of the z position of the track at the TOF radius.

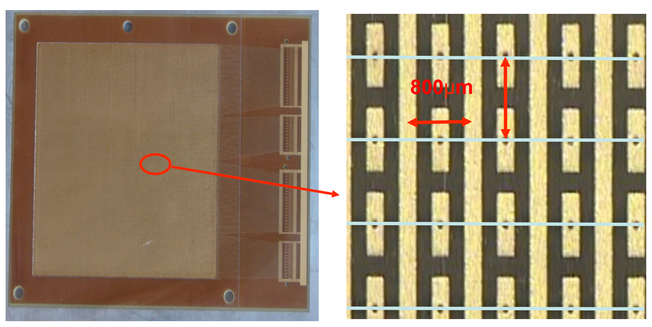


- The difference between the position of the track at the TOF radius and the projection from the helix fit with no space charge corrections at luminosities of low (red) and high (blue) as a function of the z position of the track at the TOF radius.

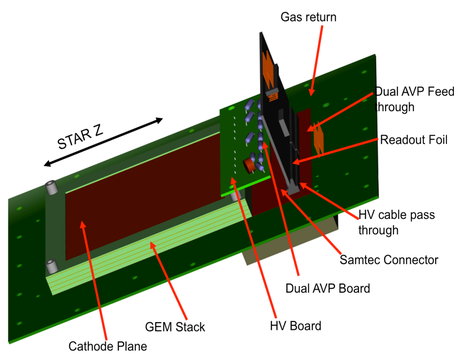
GMT in STAR

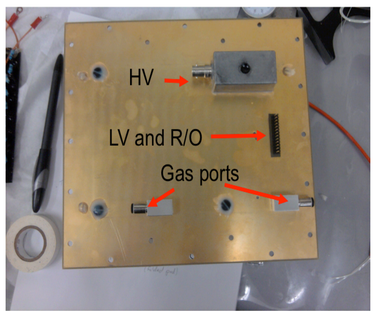
- 10cm x 10cm Gas Electron Multiplier (GEM) based chambers (GMT) have been installed in eight locations outside TPC to provide precision points at large radius for tracks crossing those chambers.
- Readout : strip (X) and pad (Y)
- Pitch width: 800μm





2D readout foil





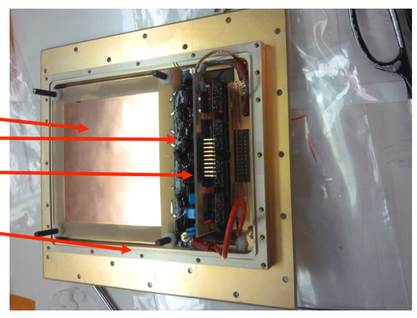
A GMT Chamber

GEM Stack and cathode

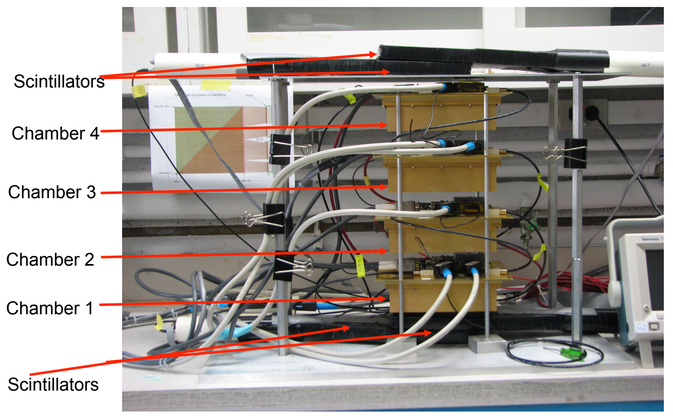
HV Divider board

Front End Electronics (FEE)

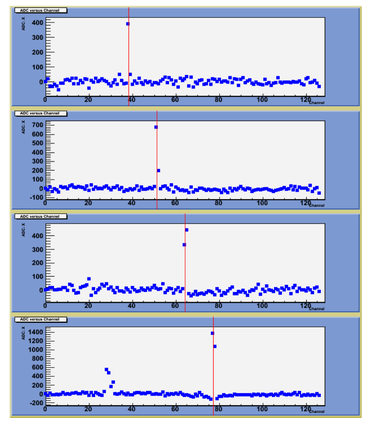
Flange for gas seal



Cosmic ray test stand at BNL



- Trigger = Scintillator 4-fold
- Scintillators ~12 x 12 cm^2
- GMT = 10 x 10 cm^2
- Gas = Ar (90%) + CO_2(10%)



Cosmic ray track passing through 4 chambers

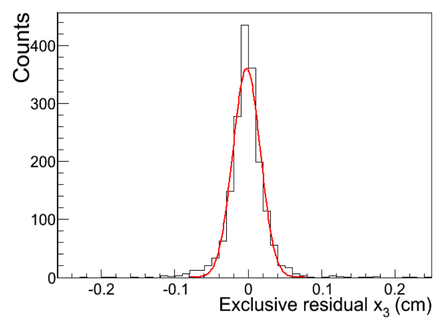
Intrinsic Spatial Resolution

- *Intrinsic resolutin $\sigma_{intr} = \sqrt{\{ \sigma_{excl}^2 - \sigma'^2_{intr} [(\sigma_{excl} / \sigma_{incl}) - 1] \}}$

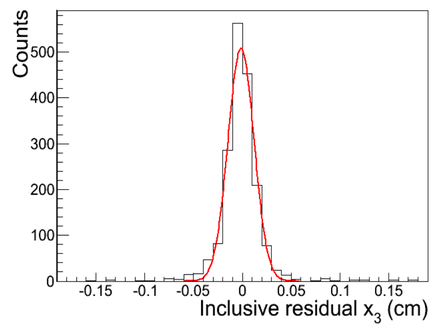
σ_{excl}^2 = resolution from the variance of residuals from the exclusion of a module's hits in the track fit

σ_{incl}^2 = resolution from the the variance of residuals from the inclusion of a module's hits in the track fit

Residual for X: excluding module

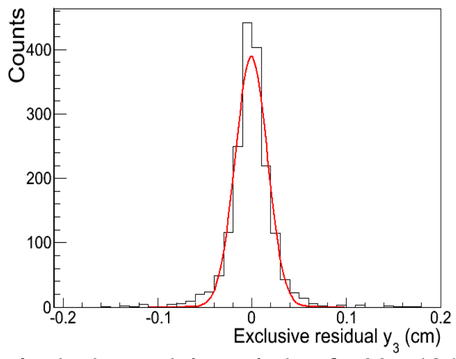


Residual for X: including module

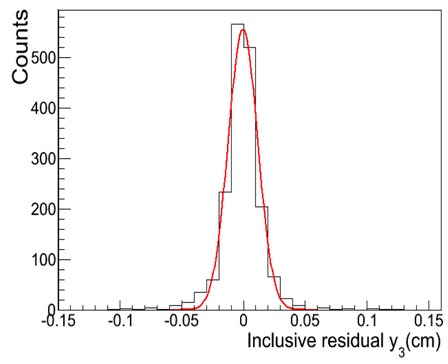


- Intrinsic spatial resolution for X ~ 150μm

Residual for Y: excluding module



Residual for Y: including module



- Intrinsic spatial resolution for Y ~ 134μm

Summary

- GMT modules has been fabricated and tested for installation in STAR using cosmic ray data in test stand at BNL.
- A multiple-scattering dominated upper limit for the resolution has been measured using the cosmic ray test stand and meets the requirement of being significantly better than the TPC pointing resolution to the chambers (~ 1 mm).
- Eight GMT modules has been installed in STAR in Run-13 and data was taken including GMT detector.

Outlook

- Spatial resolution will be obtained using pp510GeV in Run13 data.
- Detection efficiencv will also be studied.

References

1. F.Simon et.al, Nuclear Instruments and Methods in Physics Research A 598 (2009) 432–438
2. G.Van Buren et.al, Nuclear Instruments and Methods in Physics Research A 566 (2006) 22–25
3. *http://drupal.star.bnl.gov/STAR/comp/calib/docs/intrinsic-resolution-a-tracking-element

Office of Science U.S. DEPARTMENT OF ENERGY

RHIC & AGS Annual Users' Meeting
Hosted By Brookhaven National Laboratory

BROOKHAVEN NATIONAL LABORATORY