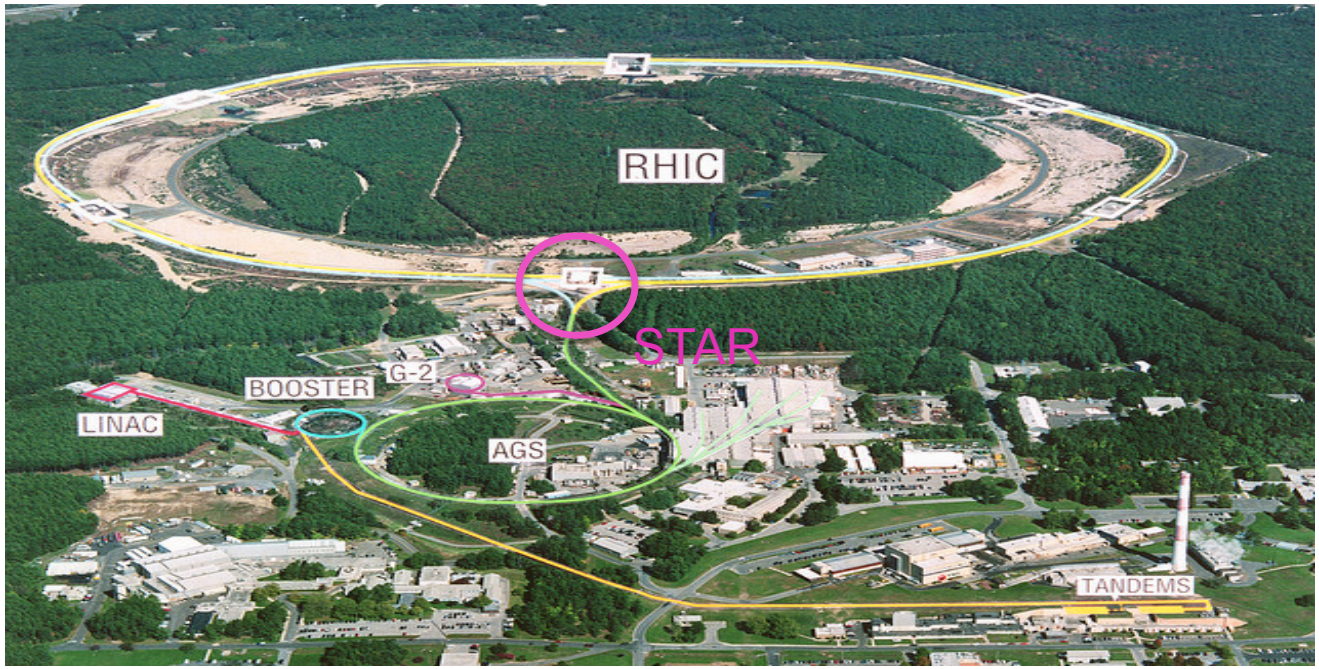
The STAR W program and the FGT



Xuan Li for the STAR Collaboration

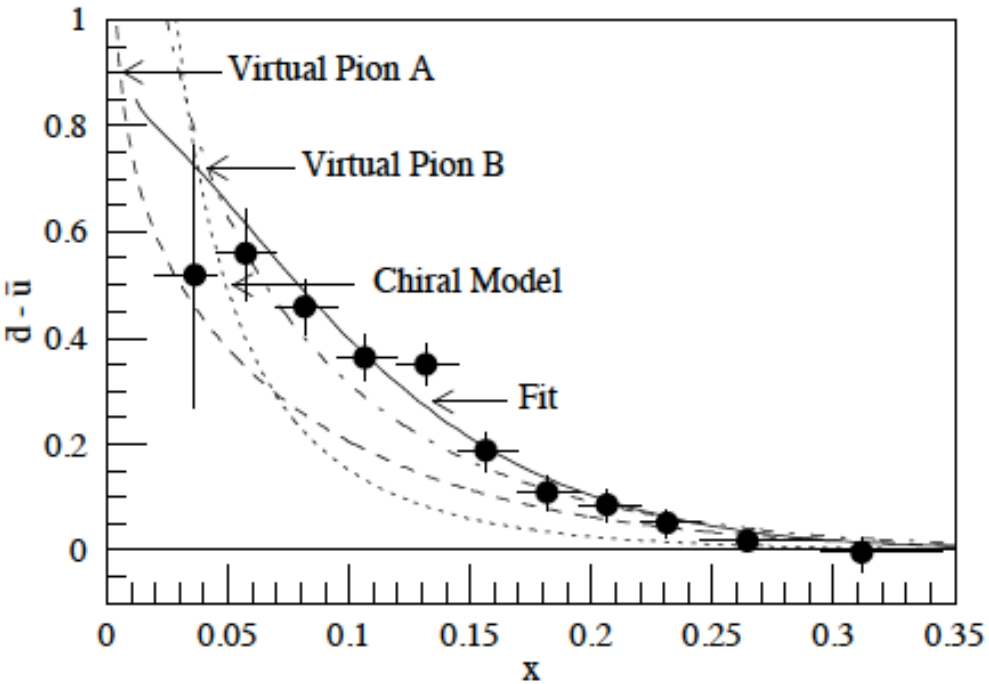
Temple University

Outline

- Motivation
  - STAR W physics and the Forward GEM Tracker (FGT) program
- FGT status for Run13
  - Cosmic ray results for RHIC Run 13
  - FGT status from run13 online data
- Summary and Outlook

Motivation

- Asymmetry of unpolarized sea quark distribution function had been found in Drell-Yan process ($p+N \longrightarrow \mu^+\mu^-$) from the E866 experiment (800GeV proton interact with hydrogen and deuterium targets).

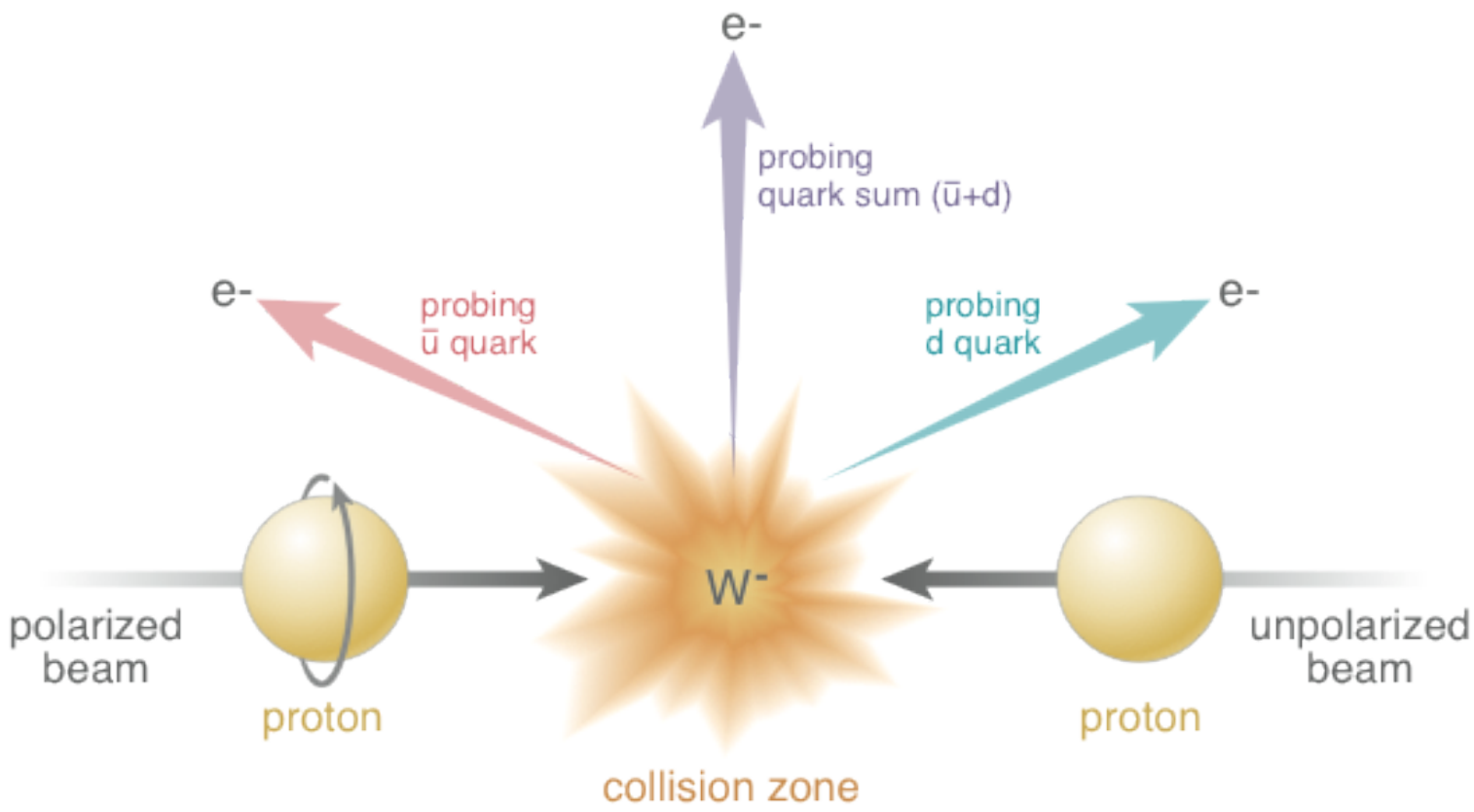


T.C.Awes et al., Phys.Rev.D58:092004,1998

- Other channels?
- How about polarized sea quark distribution?

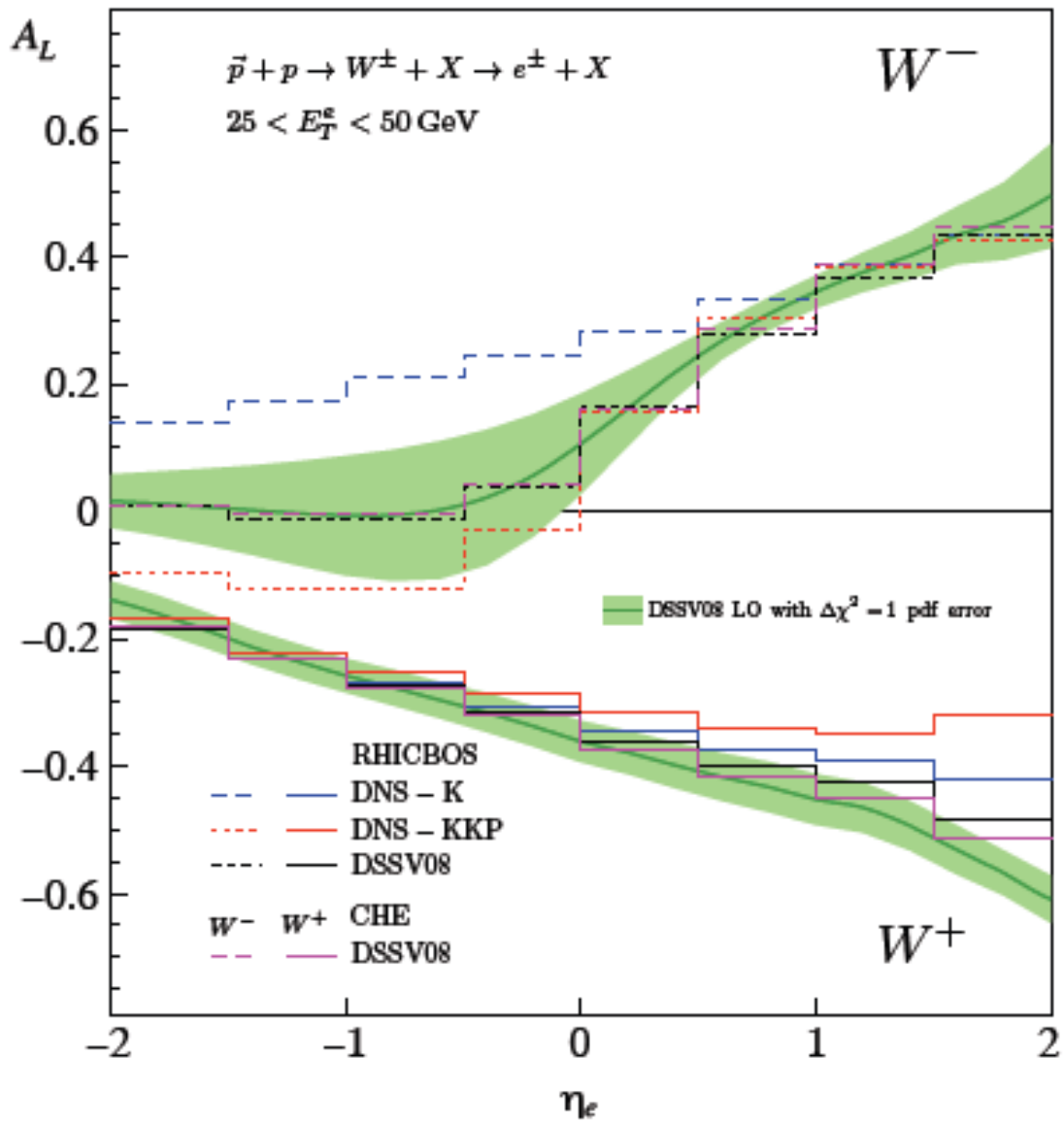
W production – unique new probe to measure quark polarization

- Probing polarized quark distribution via W production.



W measurement at STAR

- STAR A_L results and projection.

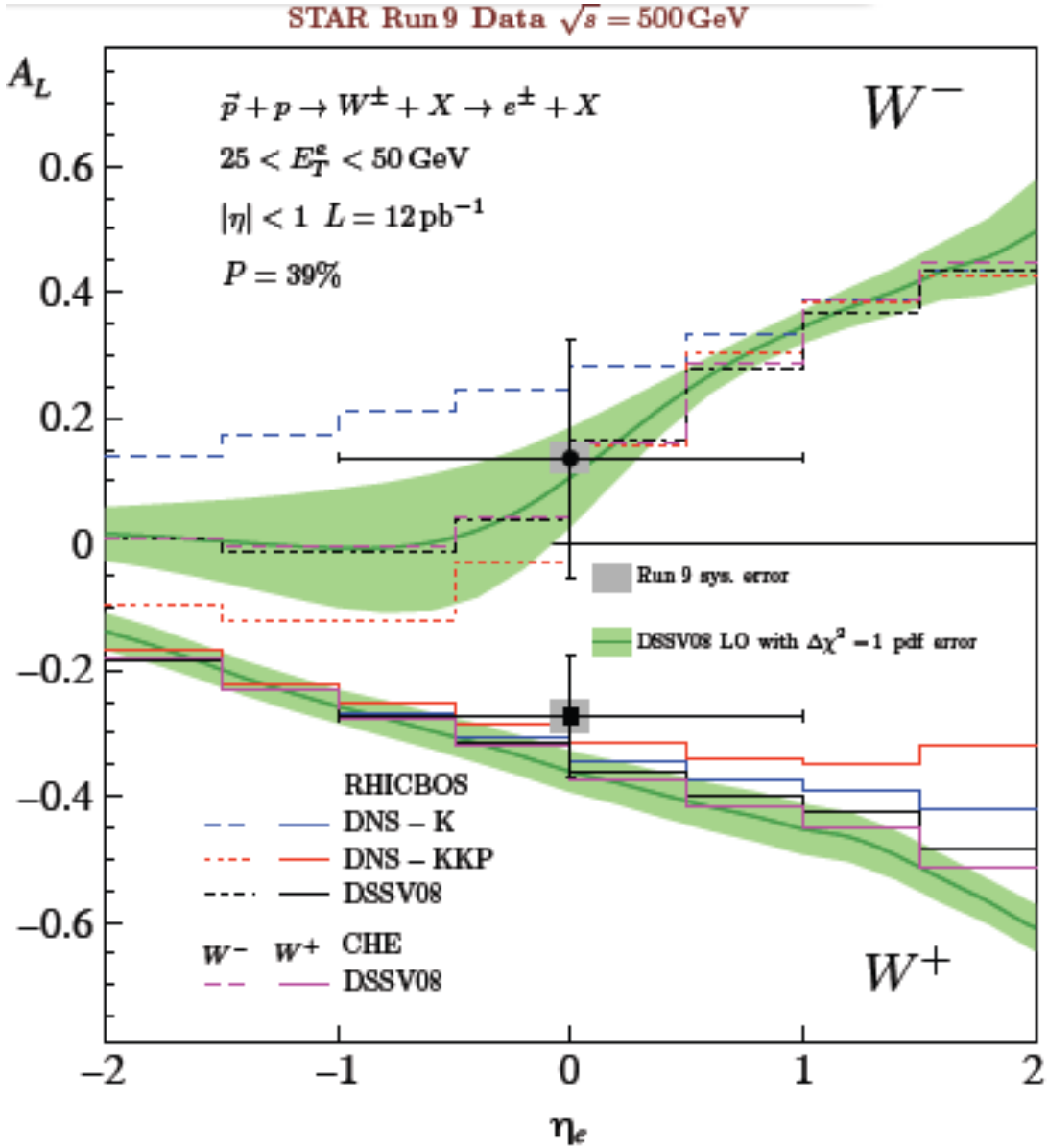


W measurement at STAR

- STAR A_L results and projection.

Measured asymmetries (Run 9) are in agreement with theory evaluations using polarized pdf's (DSSV) constrained by polarized DIS data

⇒ Universality of helicity distr. functions!



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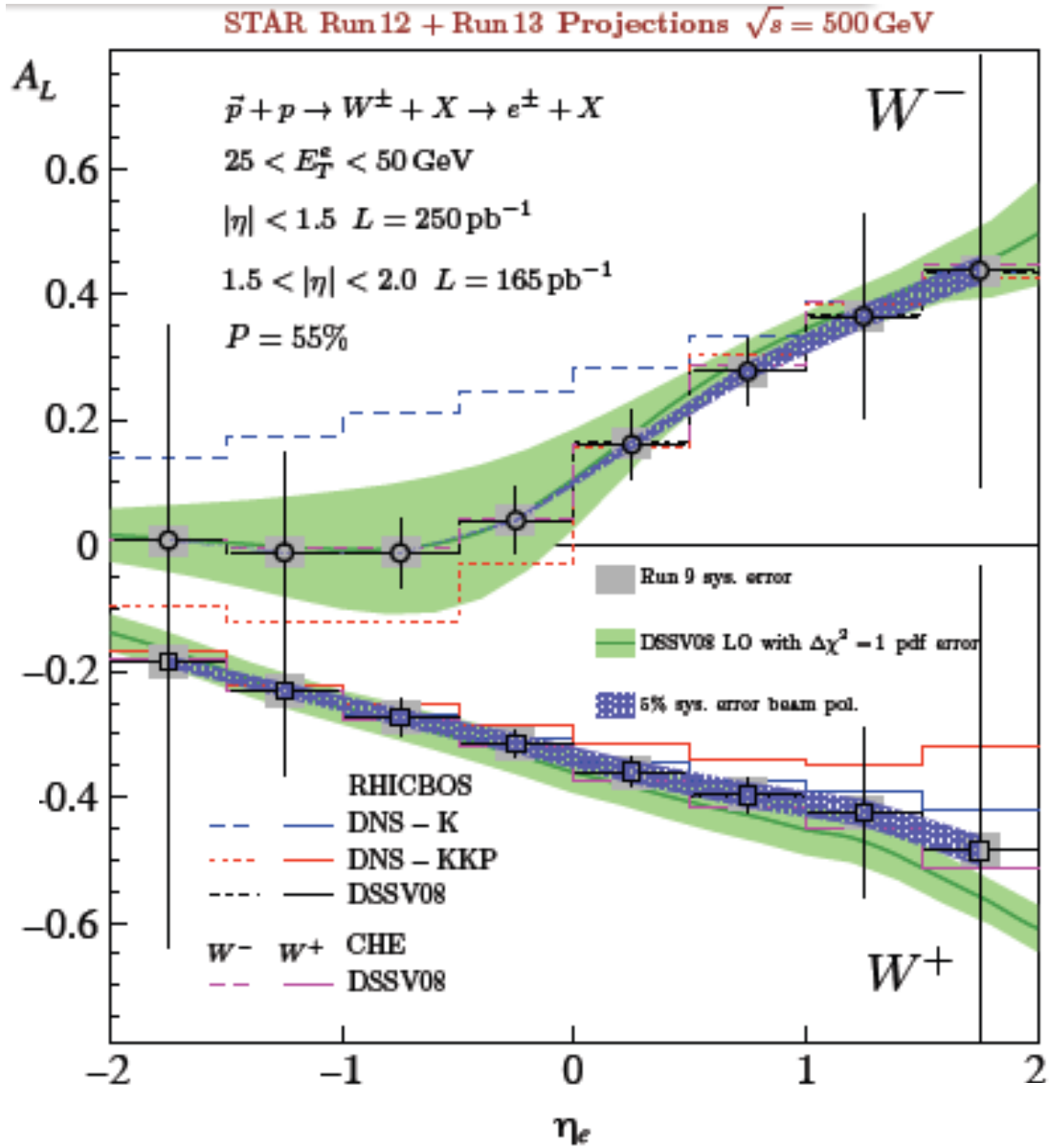
Critical: Measurement of W^+ and W^- asymmetries as a function η_e



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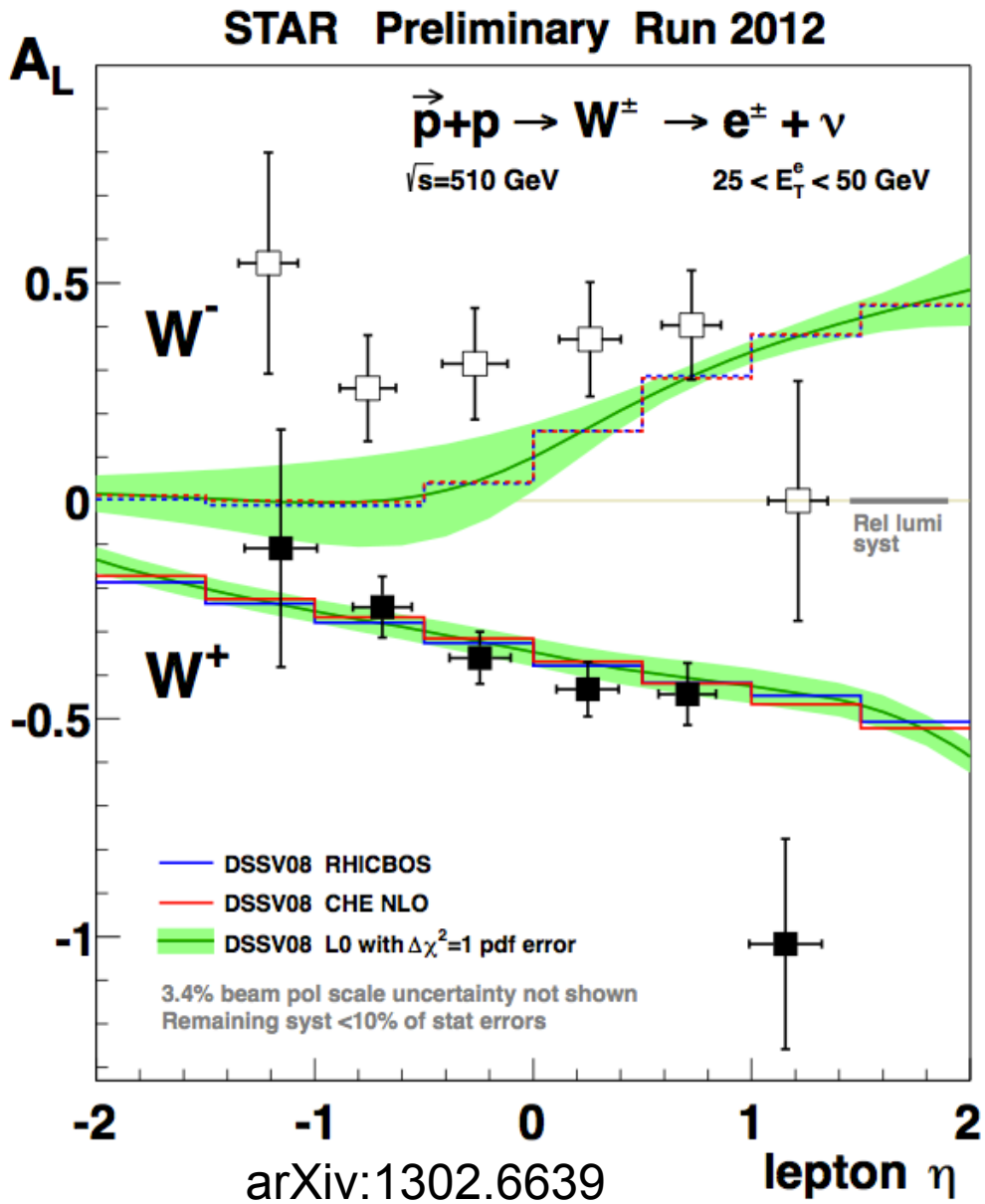
Extension of backward / forward η_e acceptance enhances sensitivity to anti-u / anti-d quark polarization

⇒ STAR Forward GEM Tracker ($1<|\eta_e|<2$)



arXiv:1302.6639

W measurement at STAR

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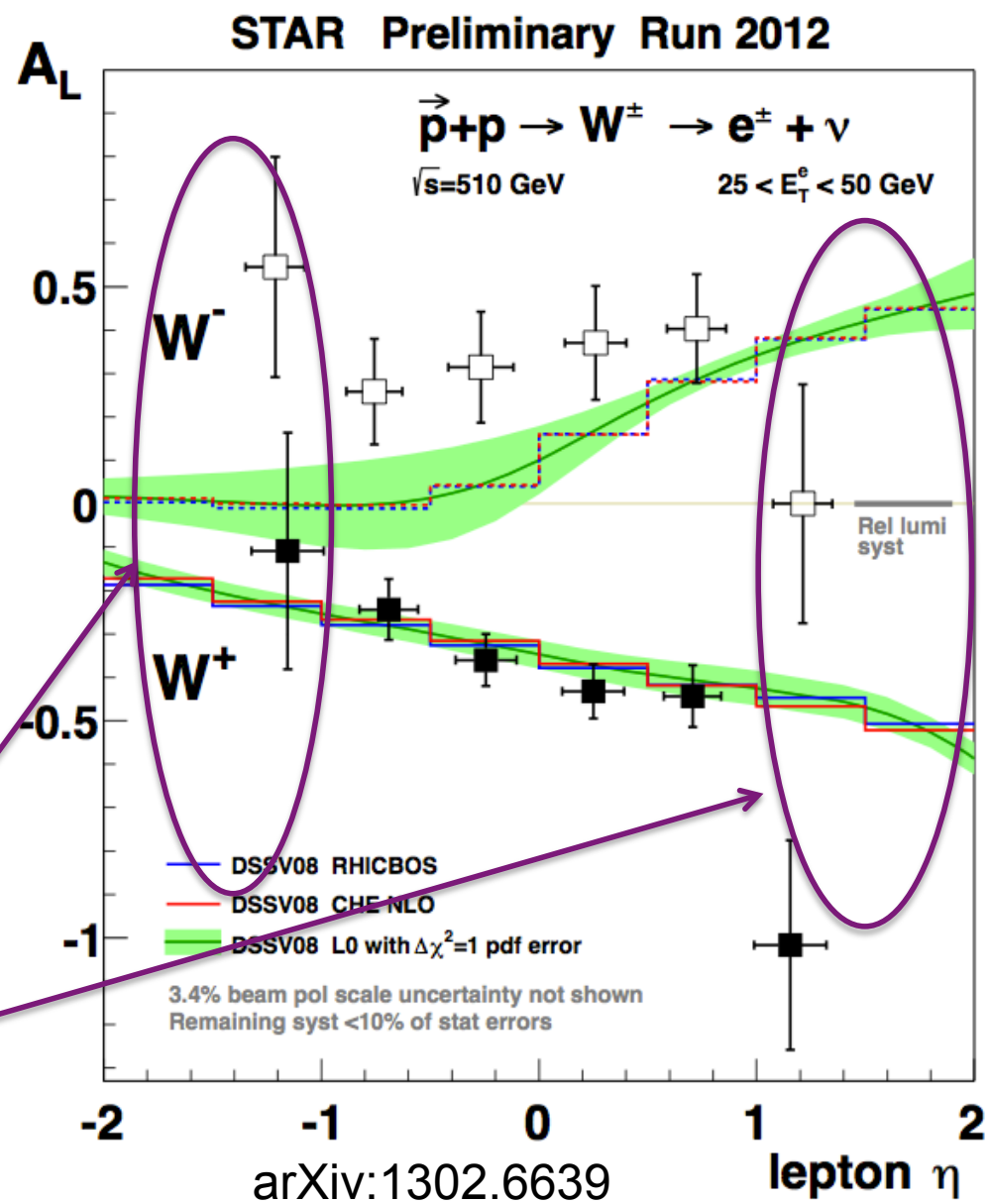
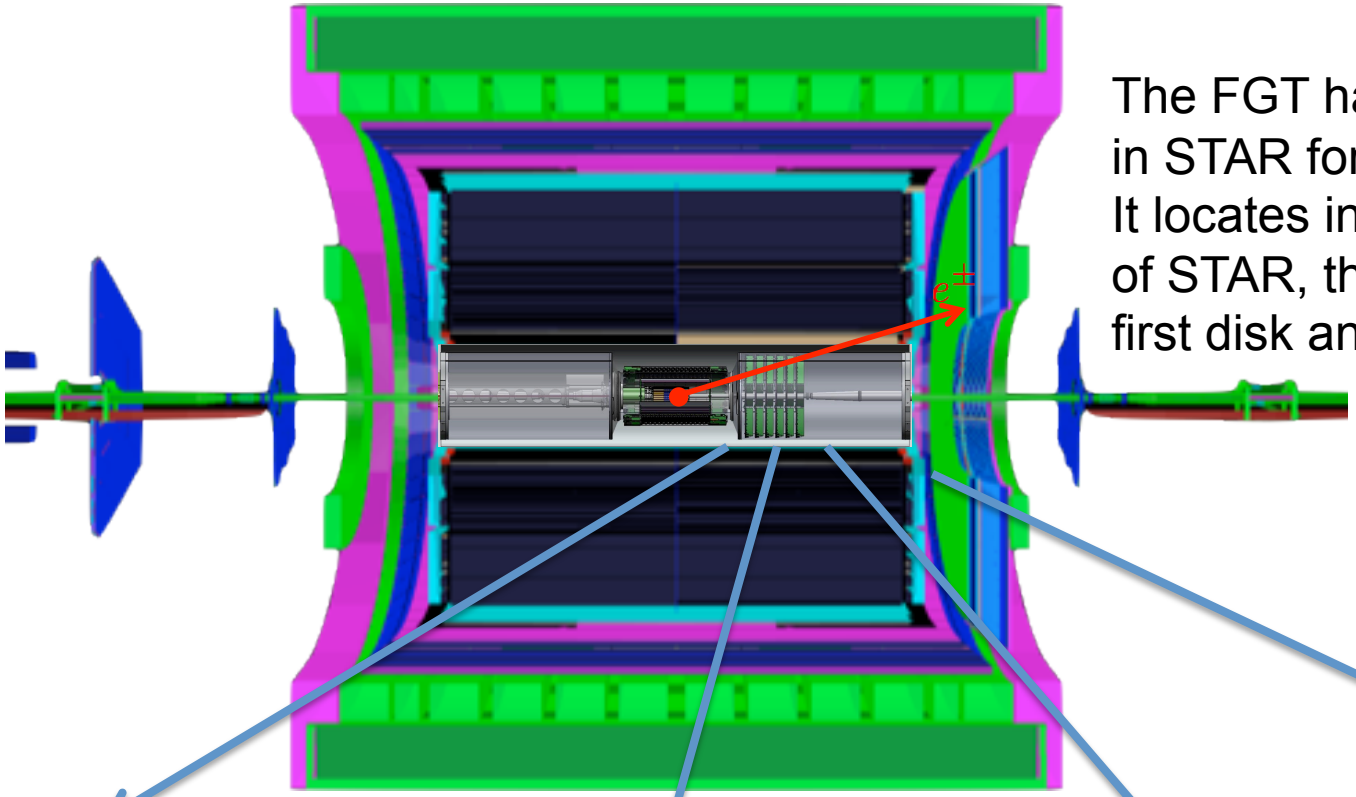


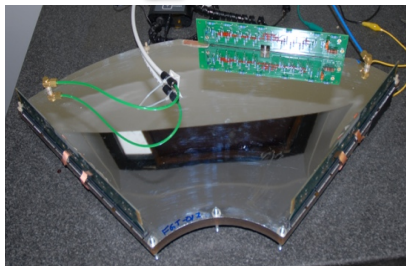
arXiv:1302.6639

FGT overview - construction

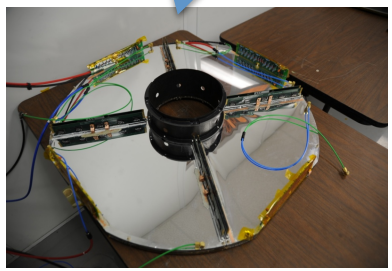
- Forward GEM Tracker - layout



The FGT has been fully installed in STAR for RHIC Run 13.
It locates in the west side of STAR, the distance between the first disk and the IR is 70 cm.



Quarter section



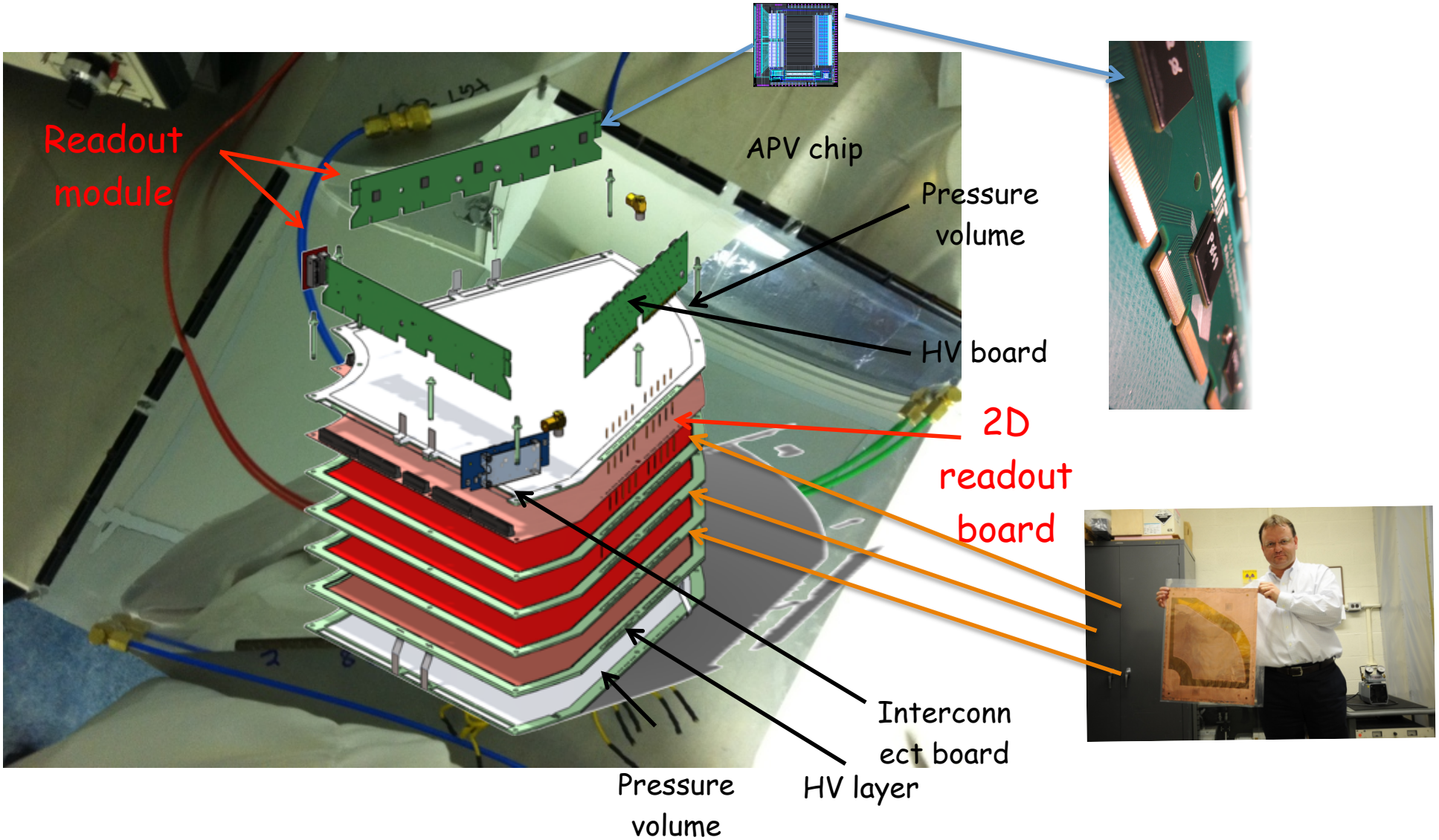
Disk

FGT consists of 6 disks

West Support Cylinder (WSC) for FGT

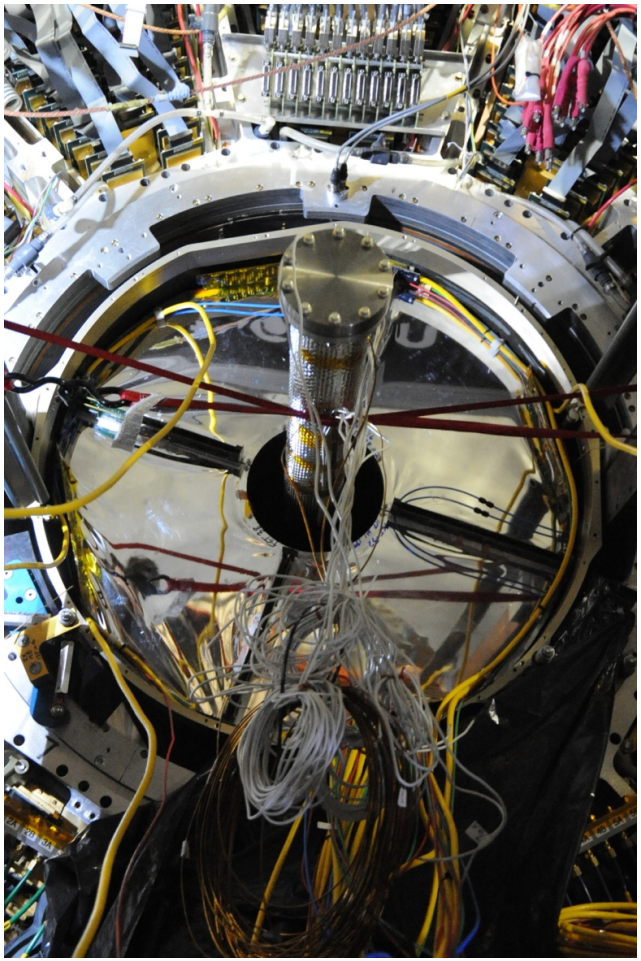
Look inside FGT quadrant

- FGT quarter section - layout

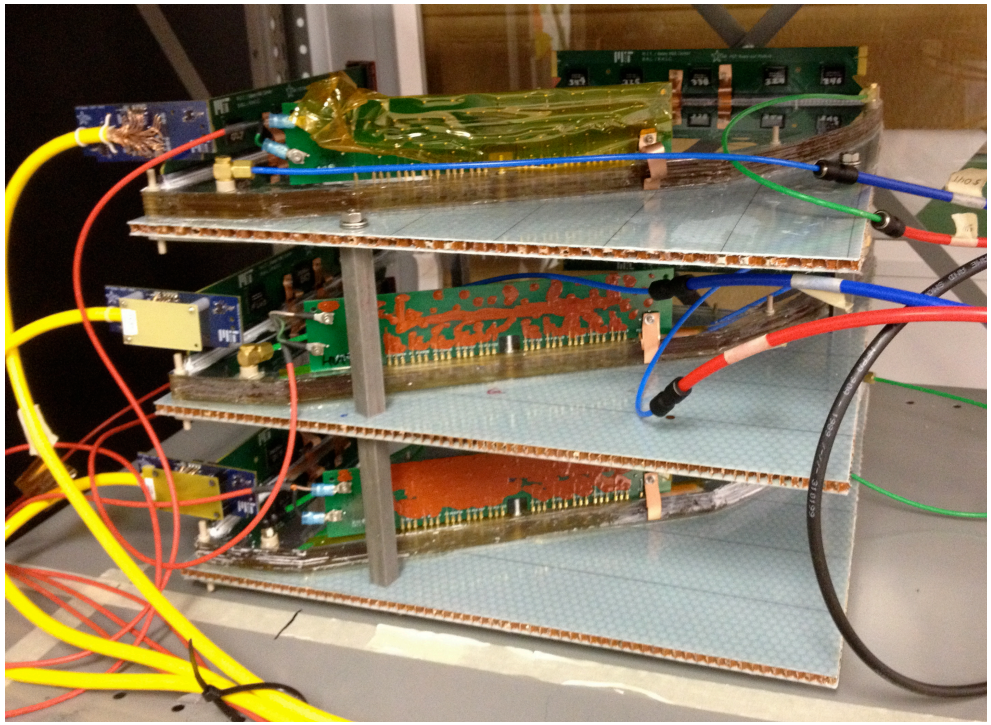


FGT preparation for Run13

- FGT has been fully installed in STAR for RHIC run13.



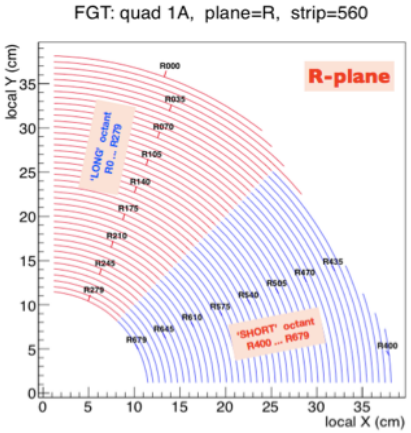
- Tune HV and APV parameters with three layers of FGT quadrants in cosmic ray test.

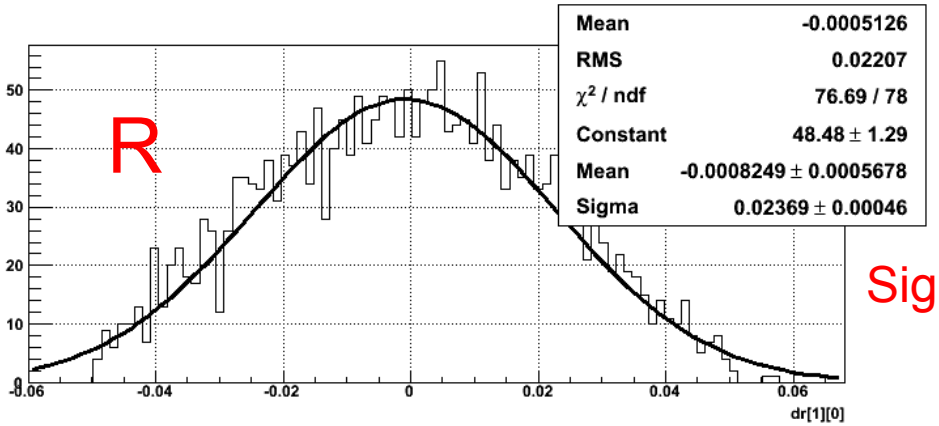


- Trigger scintillating counters not shown in this picture located above and below the FGT cosmic ray setup.

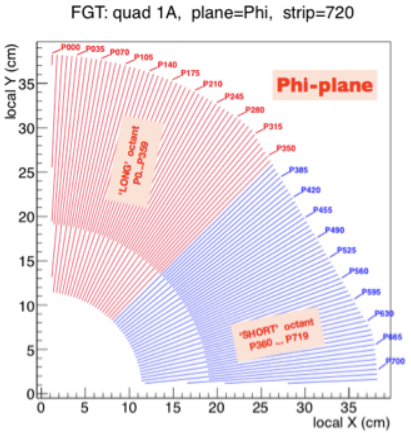
FGT cosmic ray test - residual

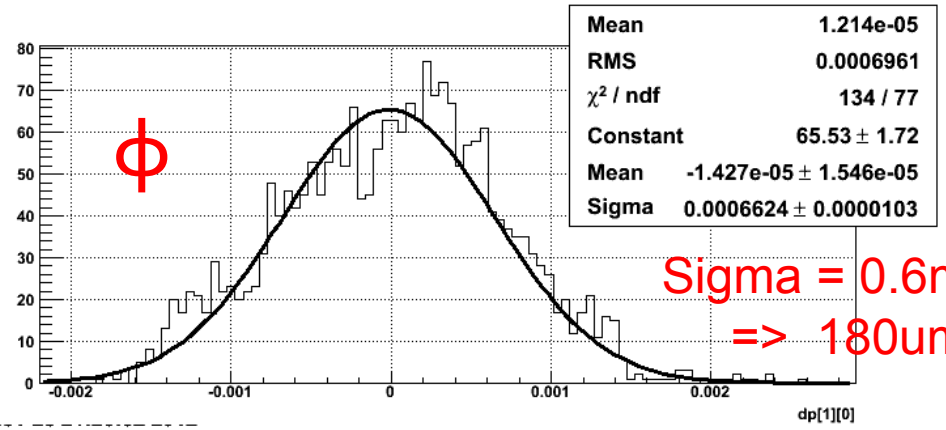
- Use the top and bottom quadrants to determine the projected value for the middle quadrant.





Sigma = 240um





Sigma = 0.6mrad
=> 180um @ R=30cm

Assuming all quadrants have same resolution:

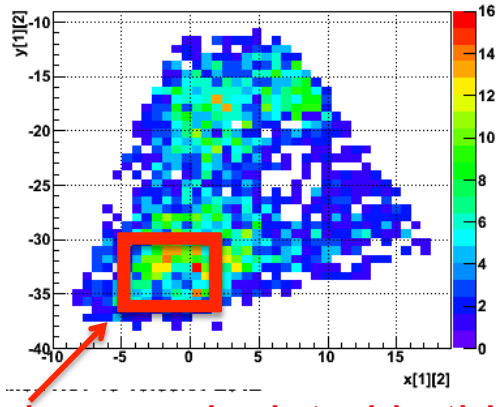
Single detector position resolution = Residual at middle quad/1.22 (from simple geometry)

180um residual @ Middle => 150um resolution at each detector

FGT cosmic ray test - efficiency

- "Good event": with clean one cluster in R&ϕ of two quadrants and calculate efficiency for the third quadrant within good trigger area.
- Sensitive to noise at higher HV & low Threshold.

Top-Short "Golden event" Hit Map



Efficiency calculated in this area only

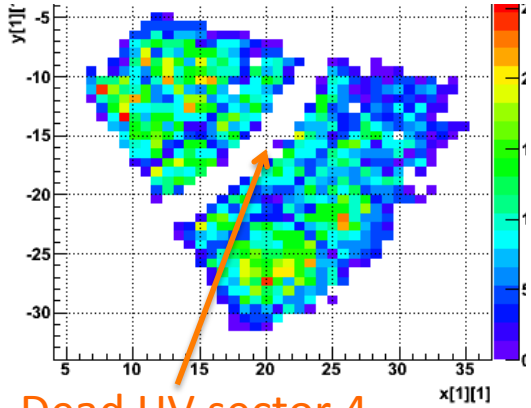
Reading the short octant

	Top	Middle	Bottom
3.3kV	73%	83%	81% → higher thr 76%
3.4kV	83%	88%	78% → higher thr 86%
3.5kV	87%	95%	61% → higher thr 86%

Default Thr= 4*PedRMS(~40)*3timebin ~ 500

Higher Thr = 7 * PedRMS(~40)*3timebin ~ 850

Middle-Long "Golden event" Hit Map



Dead HV sector 4

FGT cosmic ray test - efficiency

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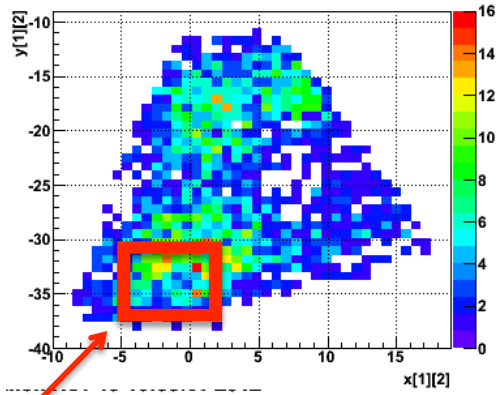
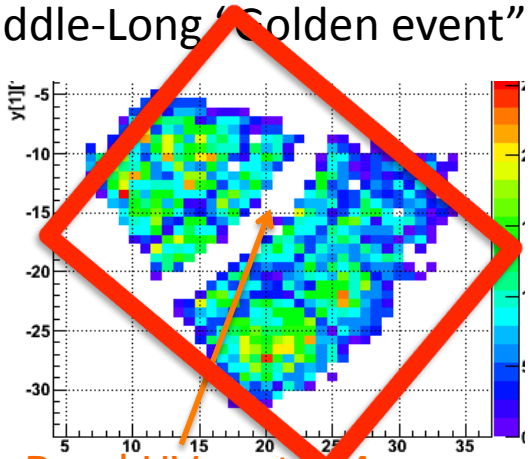
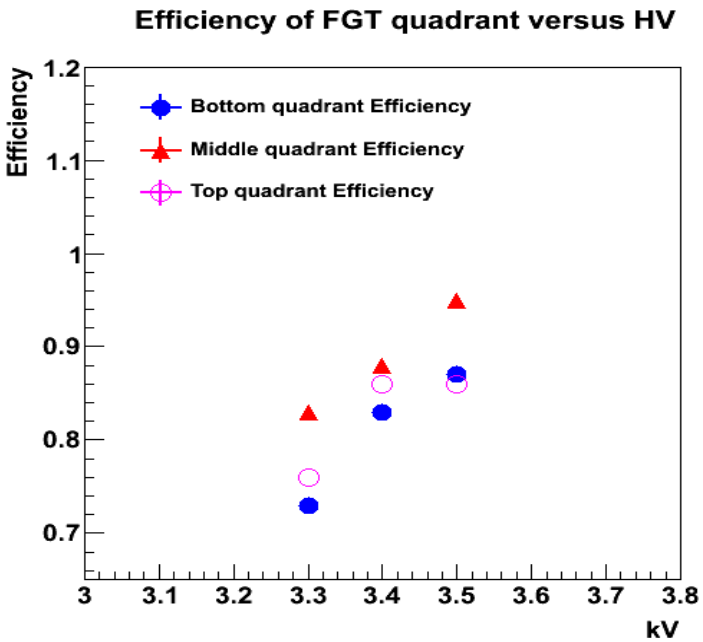


Efficiency calculated in this area only

Middle-Long "Golden event" Hit Map



Dead HV sector 4



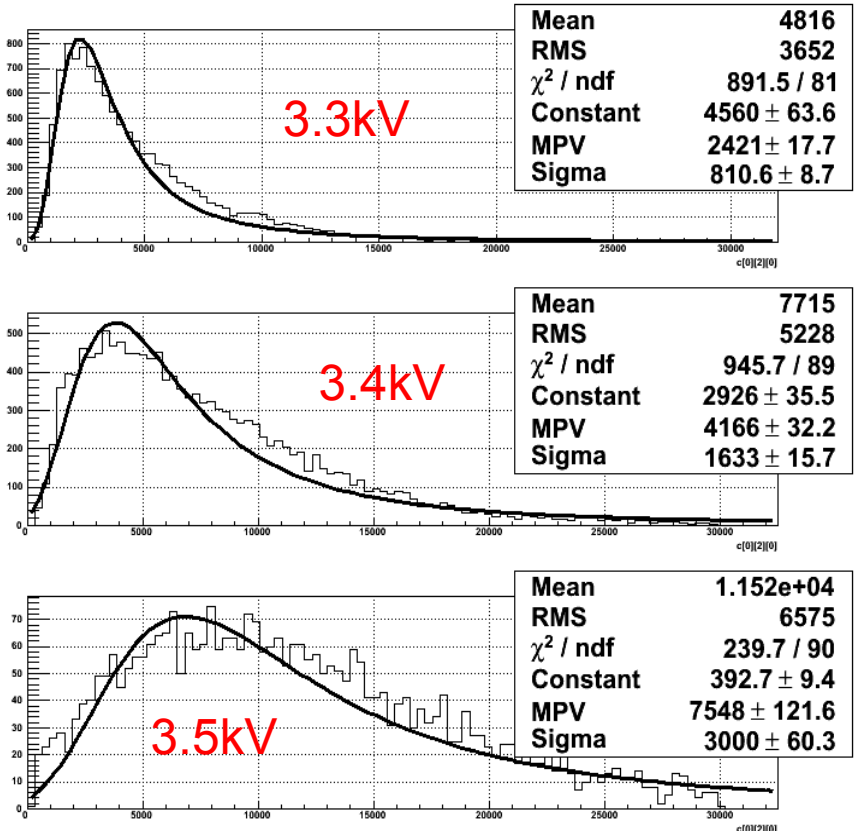
	Top	Middle	Bottom
3.4kV	72%	60%	70%

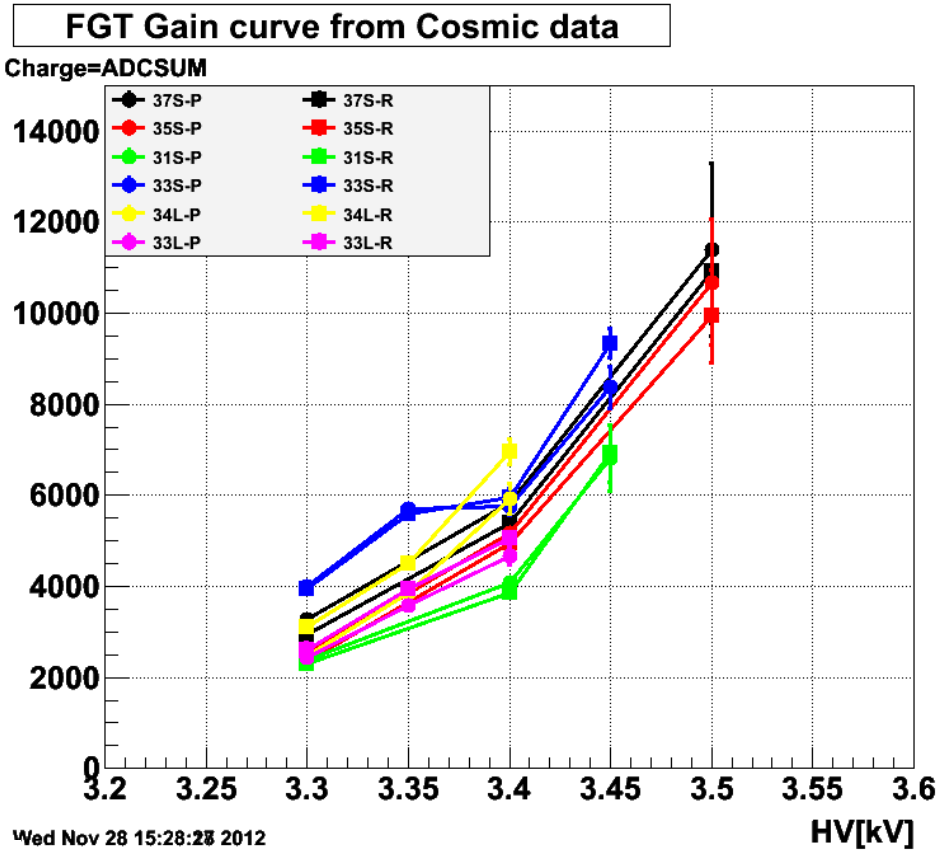
Efficiency calculated in whole octant

- Use the cosmic ray results to decide which quadrant for final installation.

FGT cosmic ray test – Gain curve

- Gain VS HV





Cluster threshold = 4*PedRMS(~40)*3timebin ~ 500

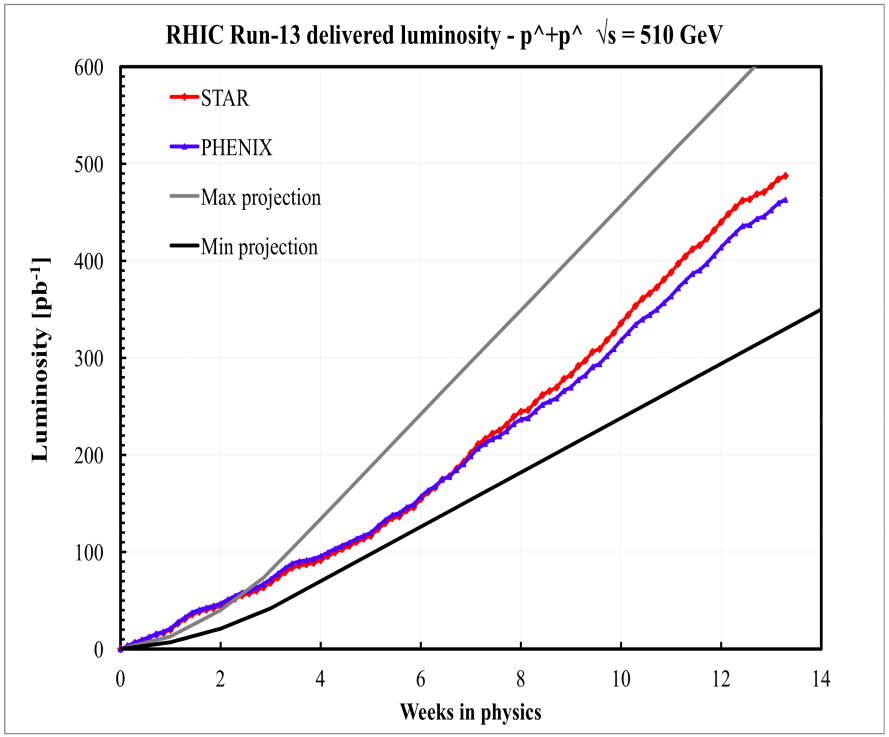
ADC saturate at peak time-bin of peak strip for

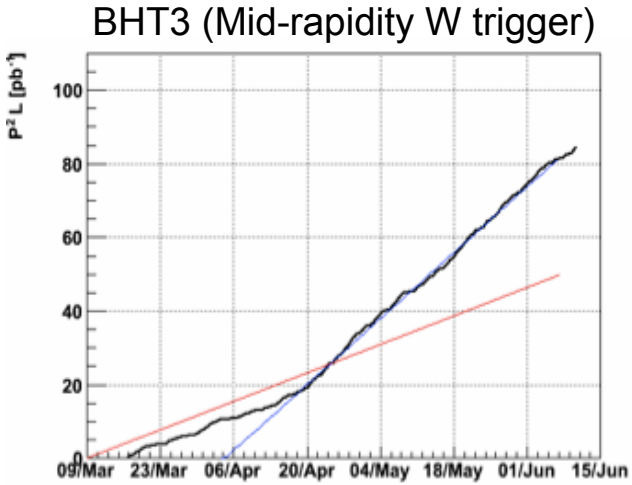
~10% of pulses at 3.4kV

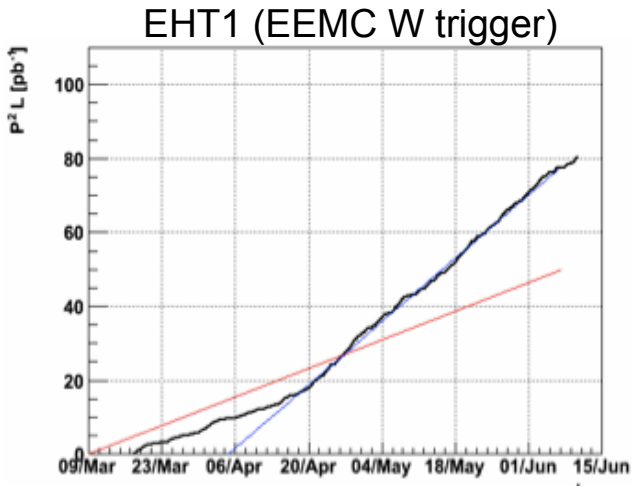
~50% of pulses at 3.5kV (but no visible effect on residual yet)

RHIC run13 luminosity projection

- In the 1.5<|η|<2 region, STAR requested 165 pb^{-1} recorded luminosity (275 pb^{-1} delivered luminosity equivalent), ≥ 55% polarization



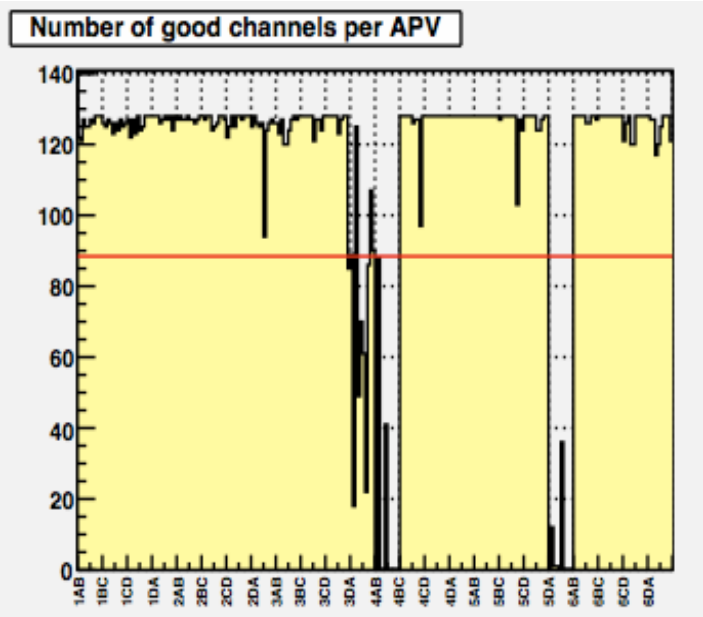




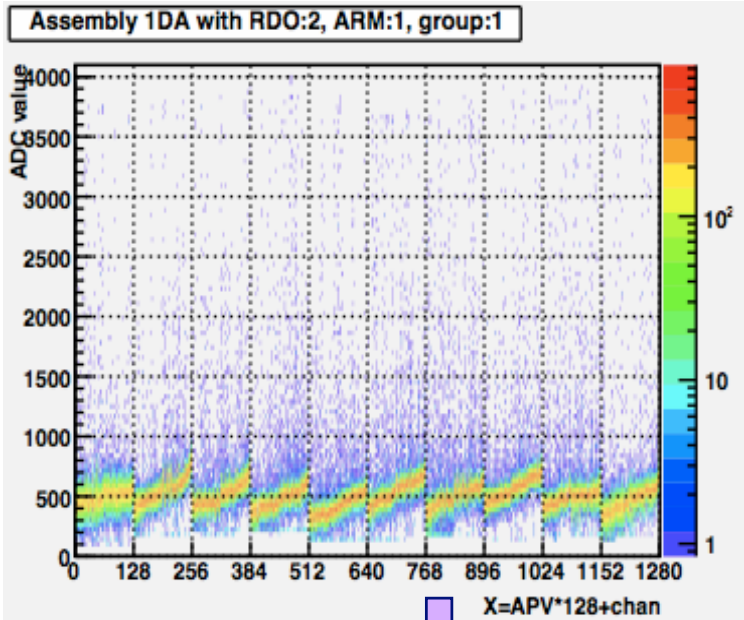
- The online and offline software to monitor the FGT performance has been developed for run13.

FGT DAQ monitor from Run13 data

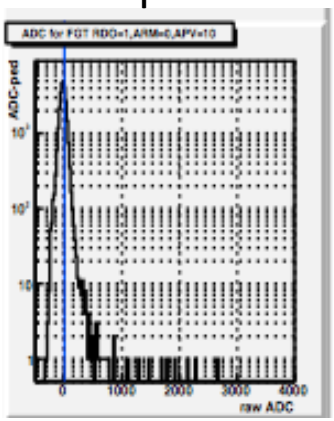
Full FGT, 3 quadrants disabled



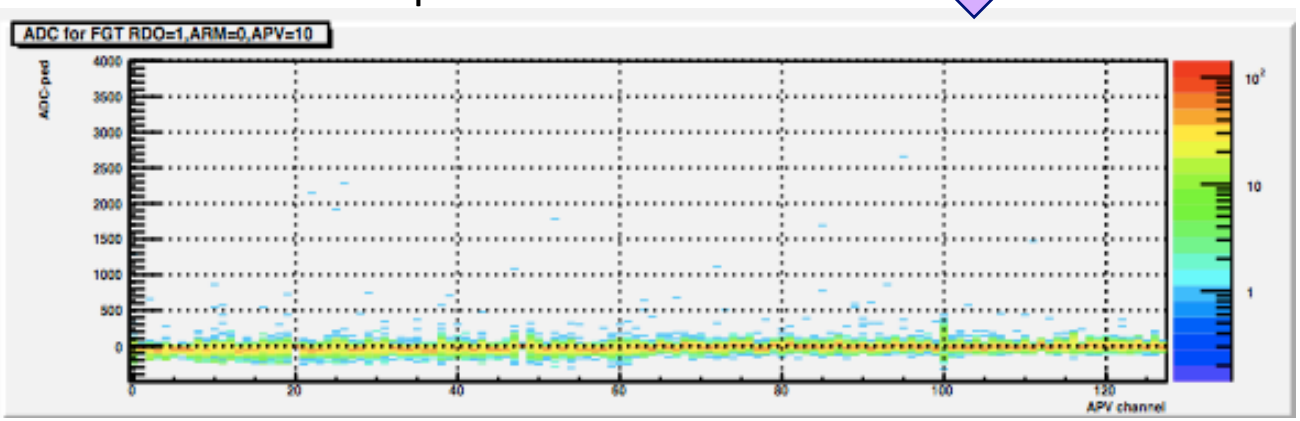
One quadrant readout consists of 10 APV



Raw spectrum



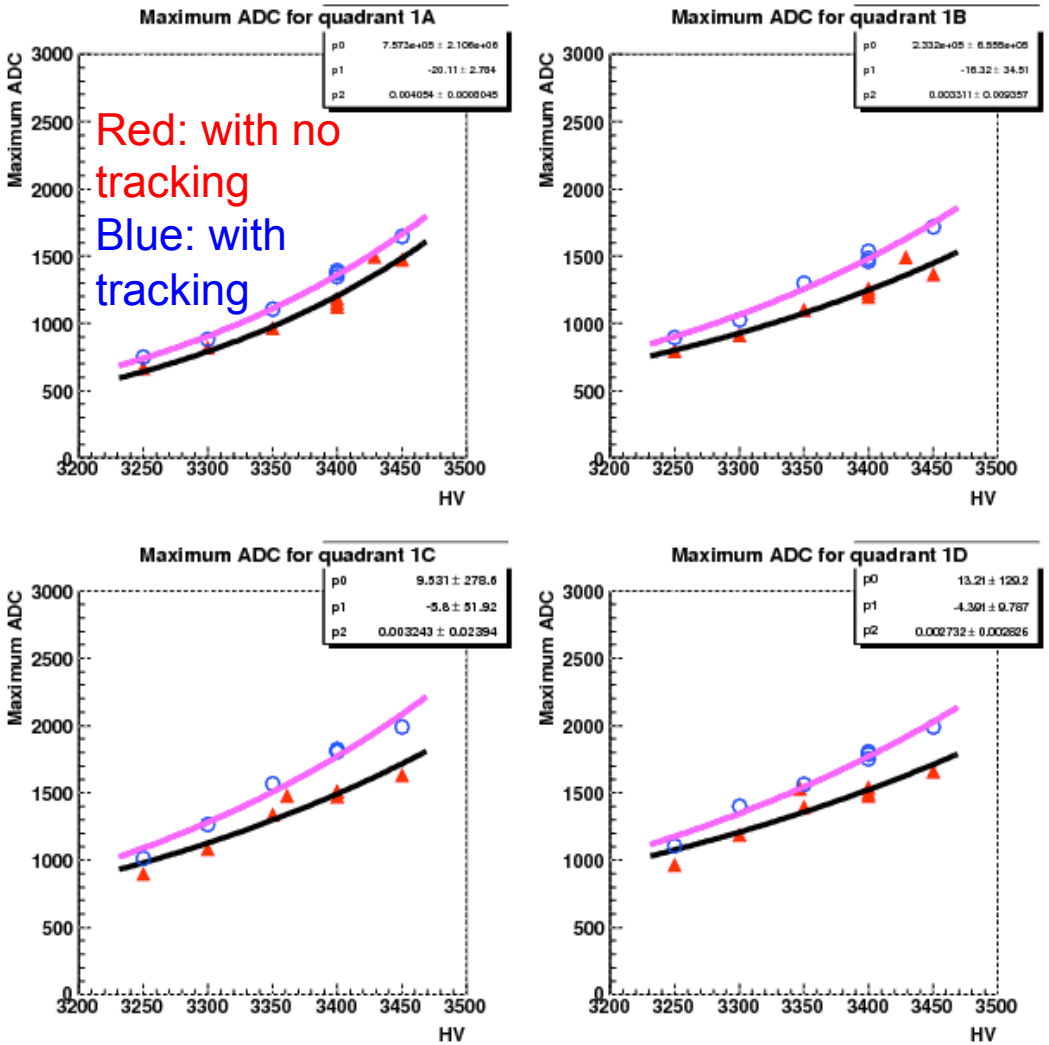
One APV chip consists of 128 channels



- The FGT DAQ software can monitor the whole FGT to individual channel.

FGT performance from run 13 (I)

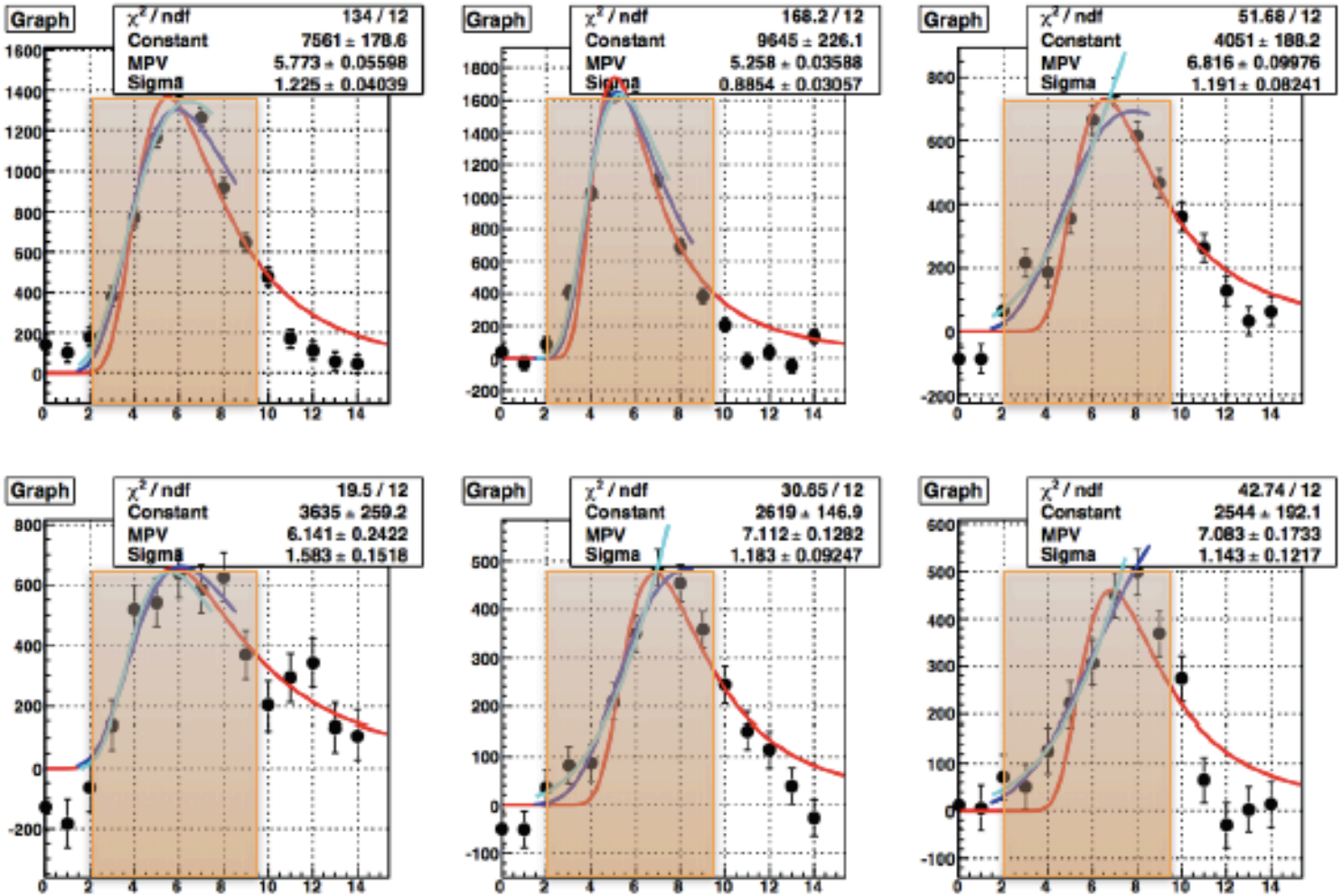
- HV gain curve (eg. Disk 1)



- Characterize gain curve for each quadrant.
- Optimize the operation HV for individual quadrant considering gain, high leakage current and etc.

FGT performance from run 13 (II)

- Different time bin fit



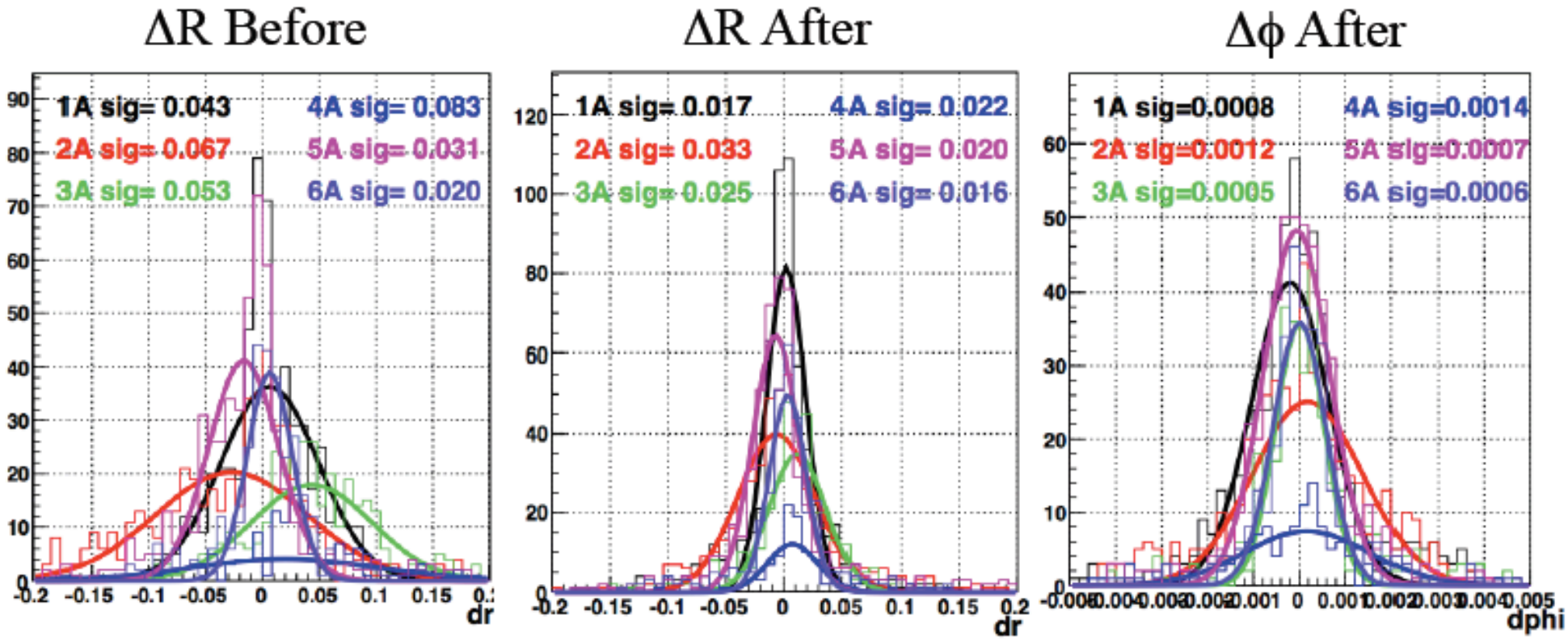
Pulses from 15 time-bins readout during commissioning:

Fit (Landau distr.) with:

- 15 time-bins
- 7 time-bins
- 6 time-bins
- 8 time-bins readout (Compromise agains deadtime!)

FGT performance from run 13 (III)

- Residual calculation

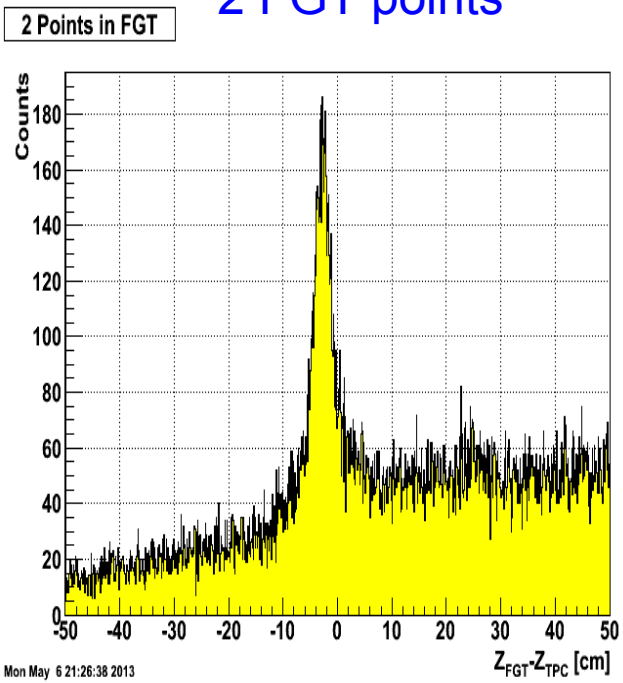


- Shift up to around 1mm (R) and around 0.5 mrad (ϕ)
- Residual ~ 300 μm (R) and ~ 1mrad (ϕ) (0.5 mrad at R=30cm is equivalent 150 μm)
- Results are consistent with cosmic ray test and run12 Cu+Au results.

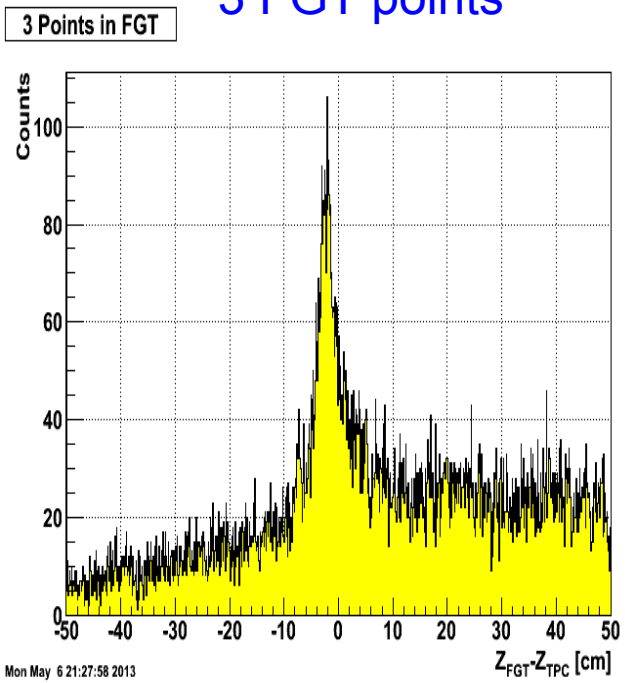
FGT tracking status

- With 50k events of run13 p+p 500 GeV data, the differences between the FGT straight line tracking vertex (2, 3 and 4 FGT points) and the TPC tracking vertex.

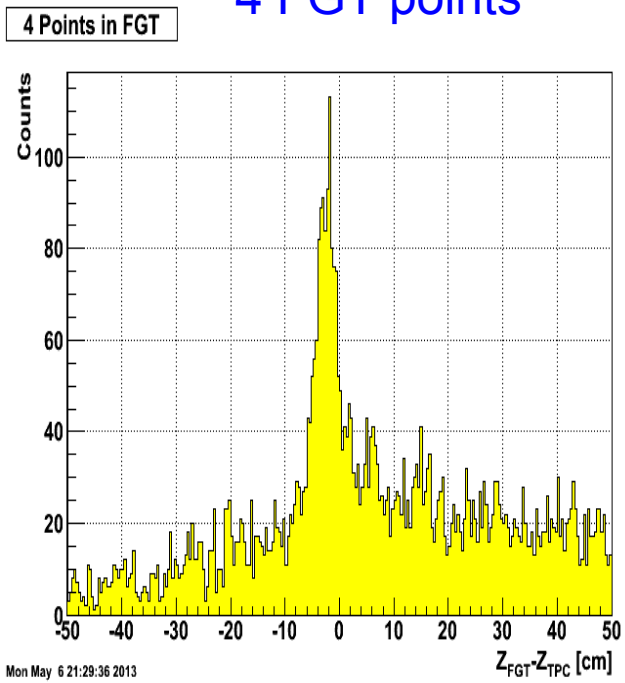
2 FGT points



3 FGT points



4 FGT points



- FGT can reconstruct tracks, the FGT z vertex is correlated with the TPC z vertex. The offset between the two will be surveyed.
- Further developments of FGT tracking to find W candidates are ongoing.

Summary

- STAR run12 W A_L preliminary result suggests a large anti-u quark polarization.
- Successful assembly and installation of the full FGT (six disks) for run13.
  - Online and offline tools to characterize the FGT readout/gas/HV have been developed.
  - Run13 online data show consistent residual results in run12 Cu+Au data and cosmic-ray tests.
  - Efficiency in fiducial, fully working area is about 90% from cosmic-ray tests.

Outlook

- Tracking using the FGT together with STAR TPC and EEMC which is essential for the charge sign separation is under developing.
- The FGT is planed to be taken out from STAR and moved to Temple University in this summer for repair and test. This includes FEE debugging and tuning, detector repair, beam test and etc.

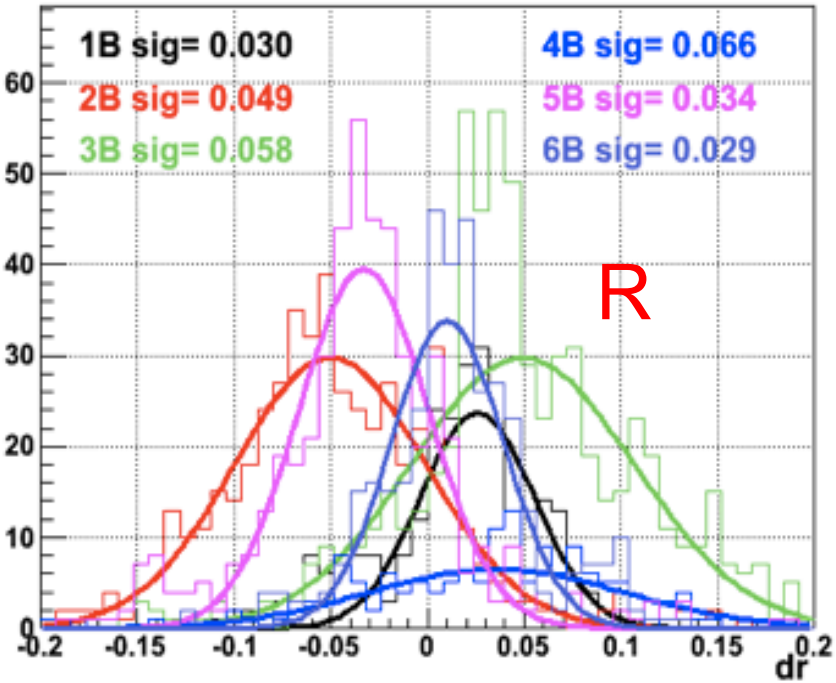
Thank STAR members for their contributions to the FGT

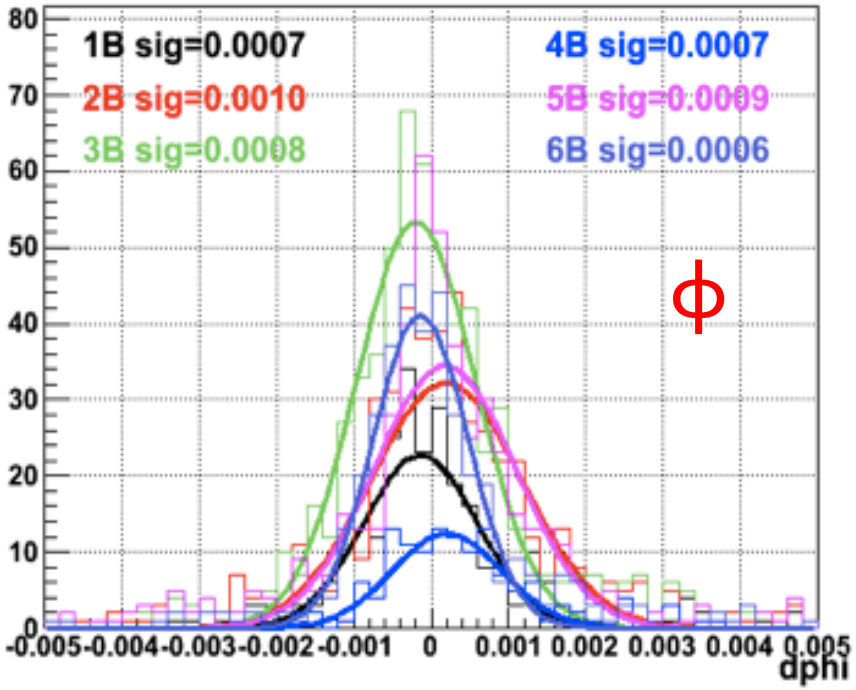
- Thank STAR FGT group for their hard work.
  - Thank Jason Bessuille, Benjamin Buck, Ross Corliss, Gerrit van Nieuwenhuizen, Will Leight (MIT), Joseph Osborn (UKY), Hairong Li, Gerard Visser (IU), Donald Koetke, Paul Nord (Valparaiso Uni.), Bernd Surrow (TU) and etc. for the FGT final installation.
  - Thank Anselm Vossen, Emily Zarndt, William Jacobs, Michael Skoby (IU), Renee Fatemi (UKY), Akio Ogawa, Ramiro Debbe (BNL), Jan Balewski (MIT), Leonard Eun (LBNL), Devika Gunarathne, Daniel Olvitt Jr., Maxence Vandenbroucke (TU) and etc. for the FGT software discussion and update.
- Thank the STAR Software Computing team for the software update help. Thanks Victor Perevoztchikov, Jason Web (BNL) for the STV tracking development.
- Thank the STAR Collaboration for their support to the FGT program.

Backup

Residual calculations with Run12 Cu+Au data

- With straight line tracking, calculate the residual before alignment.

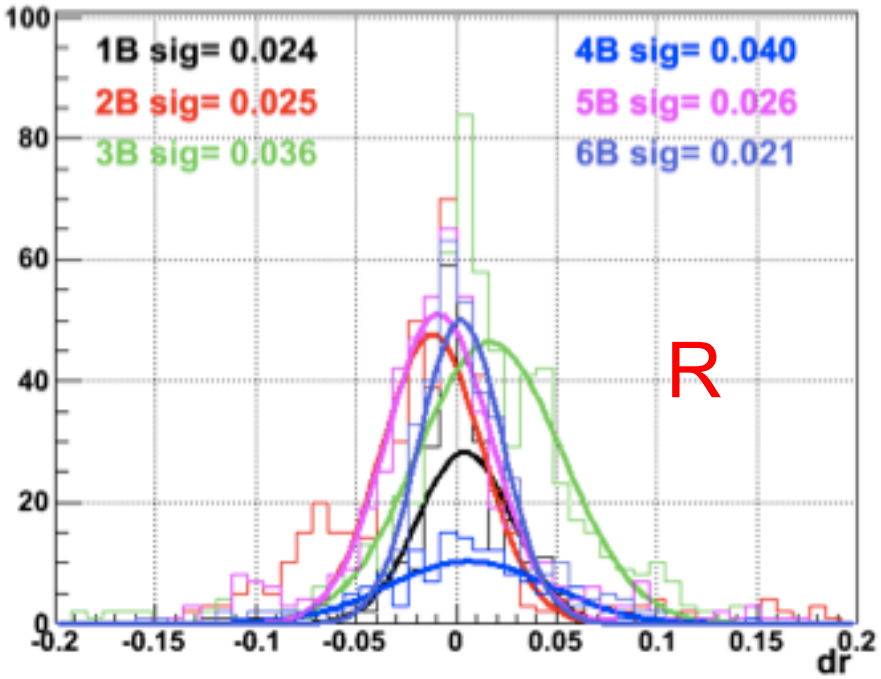


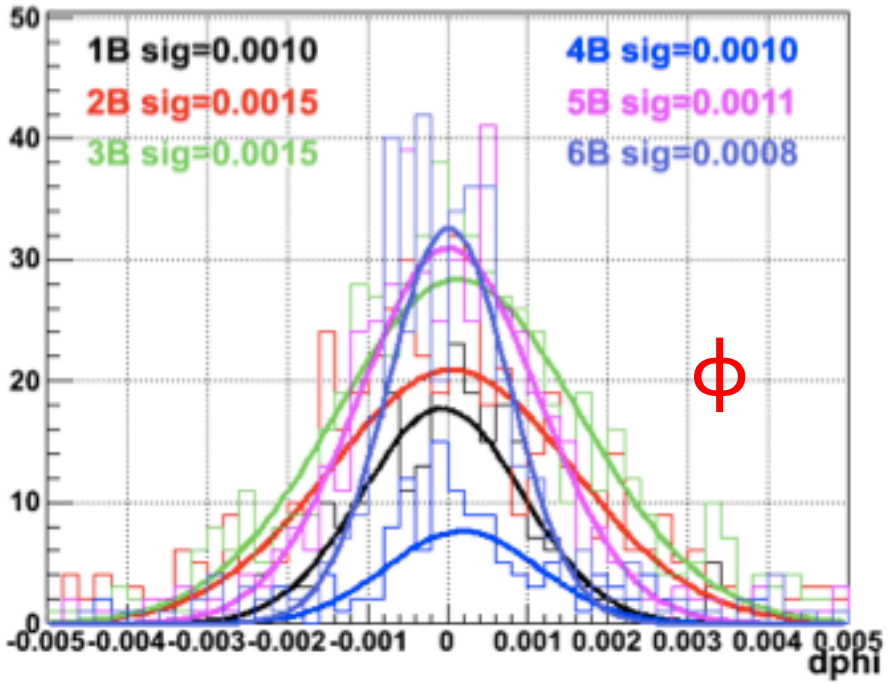


- Before alignment, residual in R is ~ 300um and ~ 1mrad in ϕ.

Residual calculations with Run12 Cu+Au data

- With straight line tracking, calculate the residual after alignment.





- Offset in R goes up to ~ 1mm and ~ 0.5mrad in ϕ.
- With helix tracking, residual in ϕ goes down to ~0.5mrad (0.5mrad@30cm = 150um). Cu+Au data result is consistent with cosmic ray test result.