Run12 Spin PHENIX Report

Outline:

- **Physics Goals**
- **Run12 Achievements**

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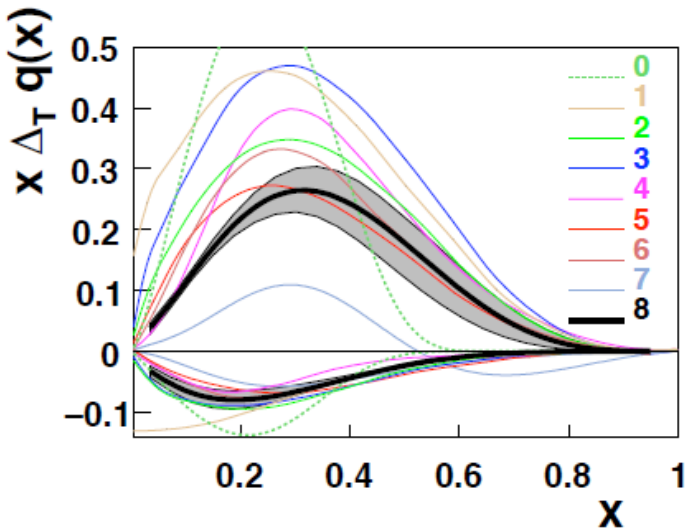
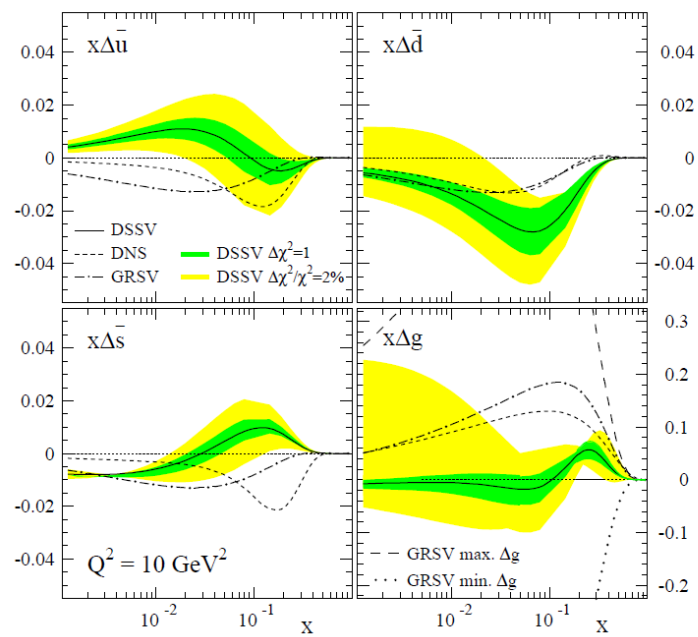
RBRC
RHIC & AGS Users Meeting
2012/06/14

PHENIX Run12 Spin Goals

- 200 GeV with Transverse Polarization
  - What is transverse structure of proton?
- 500 GeV with Longitudinal Polarization
  - What is the sea quark and gluon spin contribution to the proton?

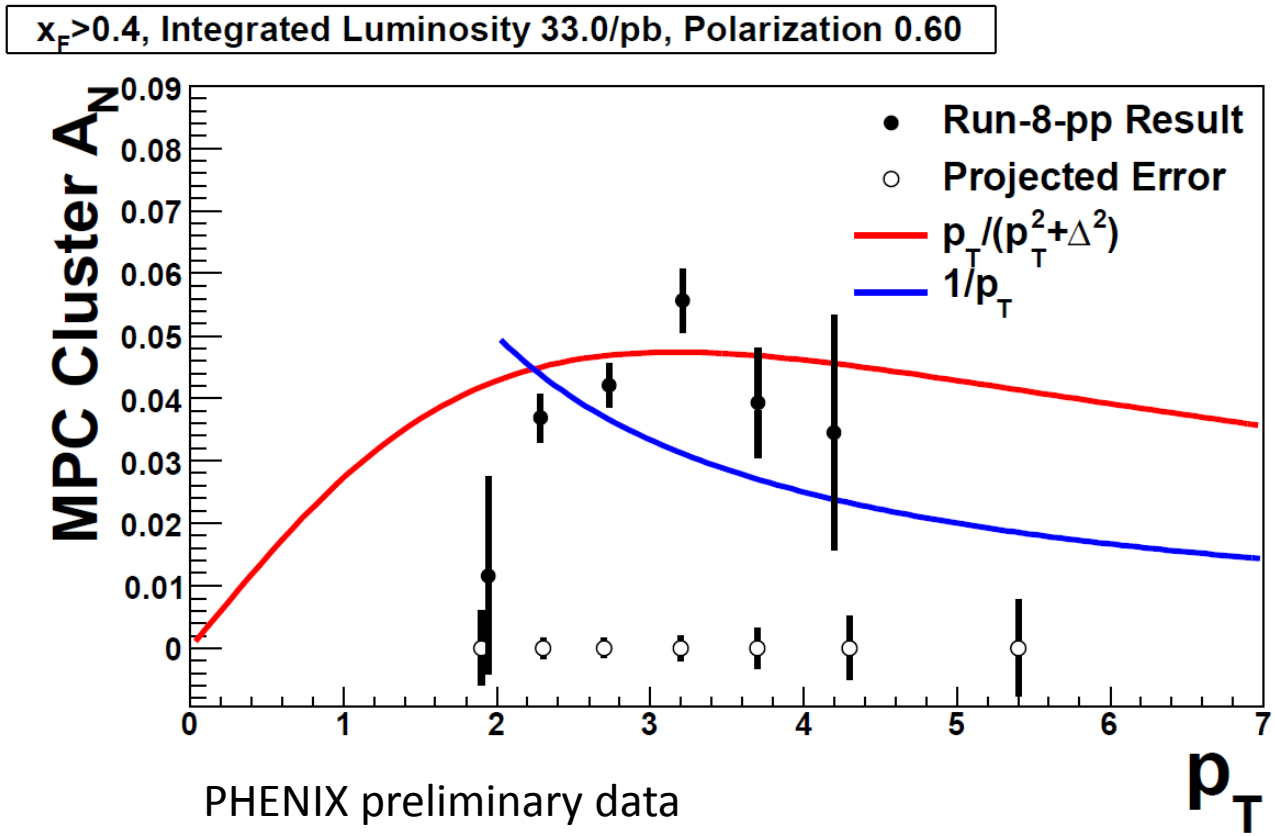




Transversity distributions from A. Prokudin
DSSV: *Phys.Rev.Lett.101:072001,2008*

High p_T Neutral Pion A_N

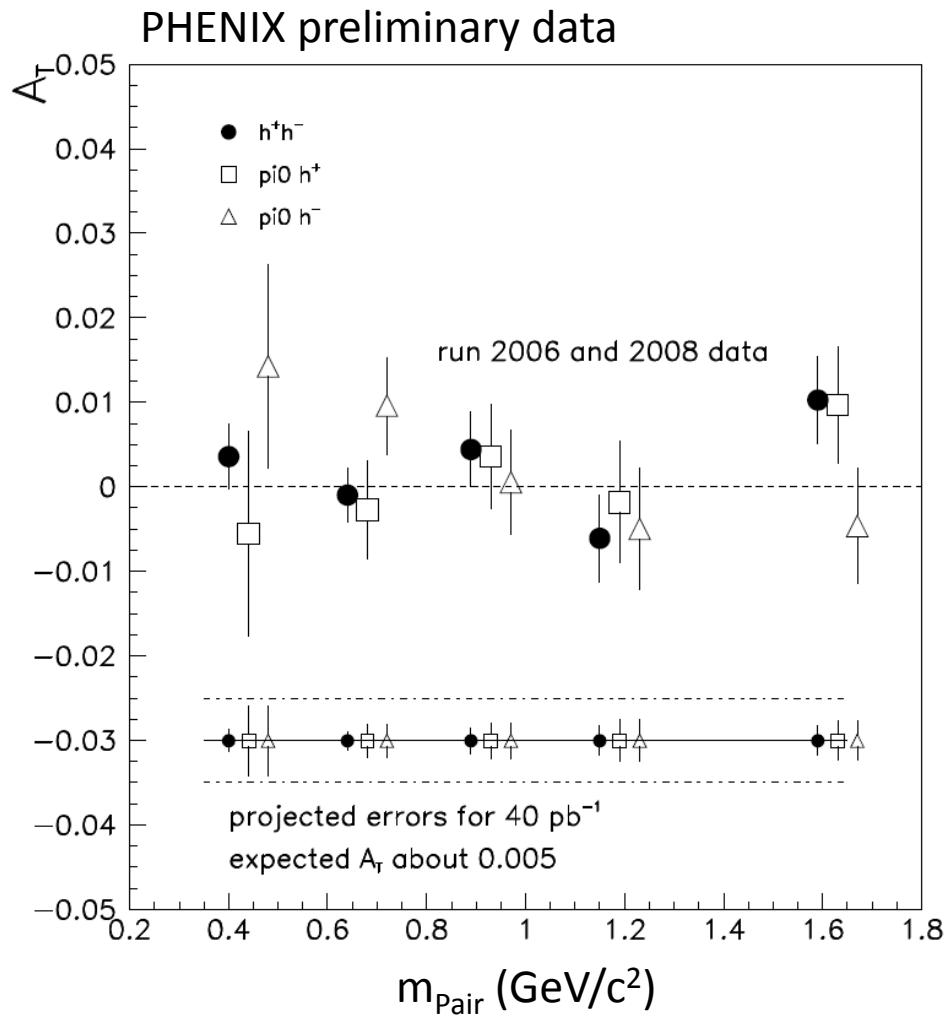
- Motivation: Search for expected falloff of A_N at large p_T
- Run 12 goal: Reduce statistical errors
  - Will be aided by upgraded electronics for Run12



PHENIX preliminary data

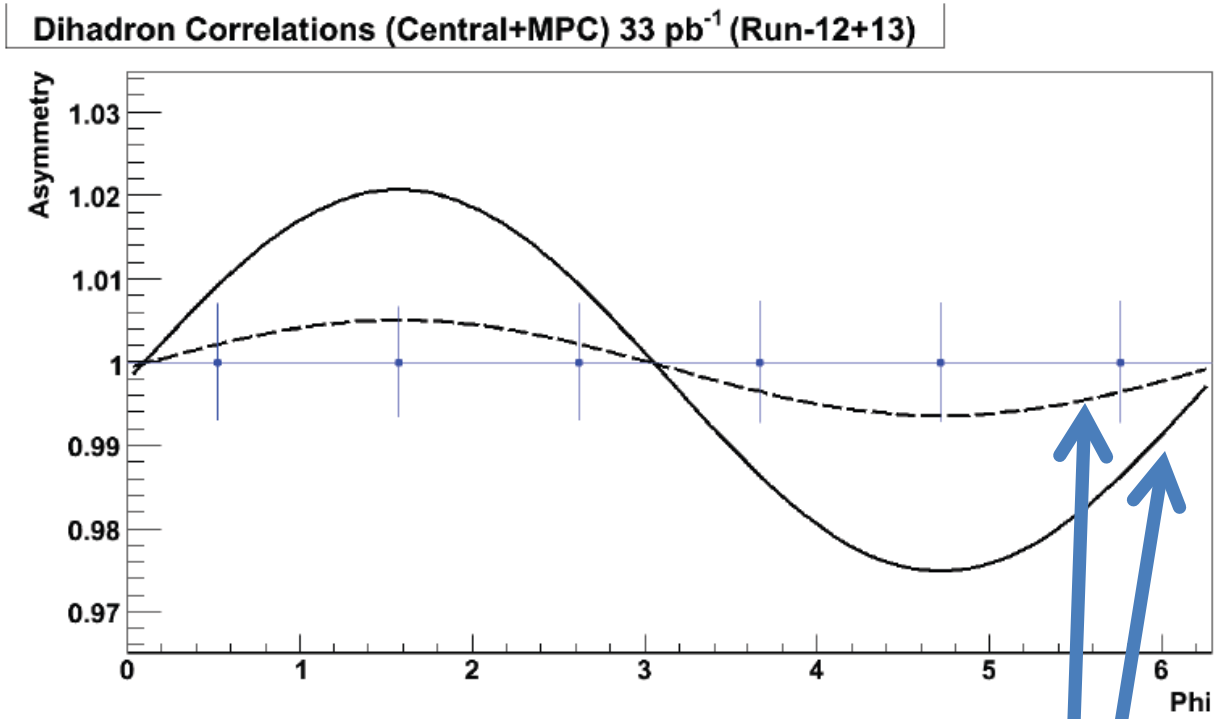
Probing the Transversity Distribution

- Motivation: extract the transversity distribution using Interference FF
- Run 12 goal: reduce statistical errors on our existing measurement.



Probing the Transversity Distribution

- Motivation: Extract transversity distribution using Collins FF
- What is magnitude of expected asymmetries?



Transversity tuned to produce:

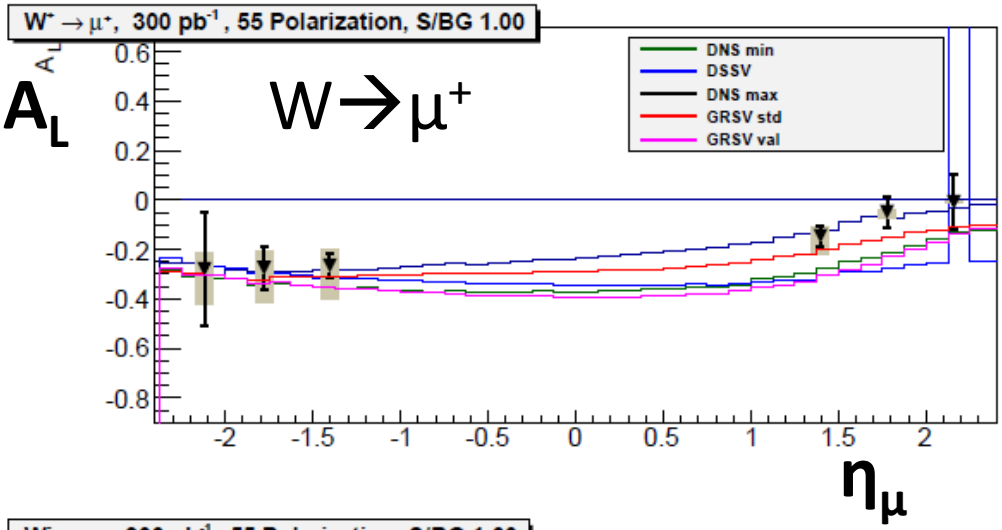
25% of PHENIX forward A_N

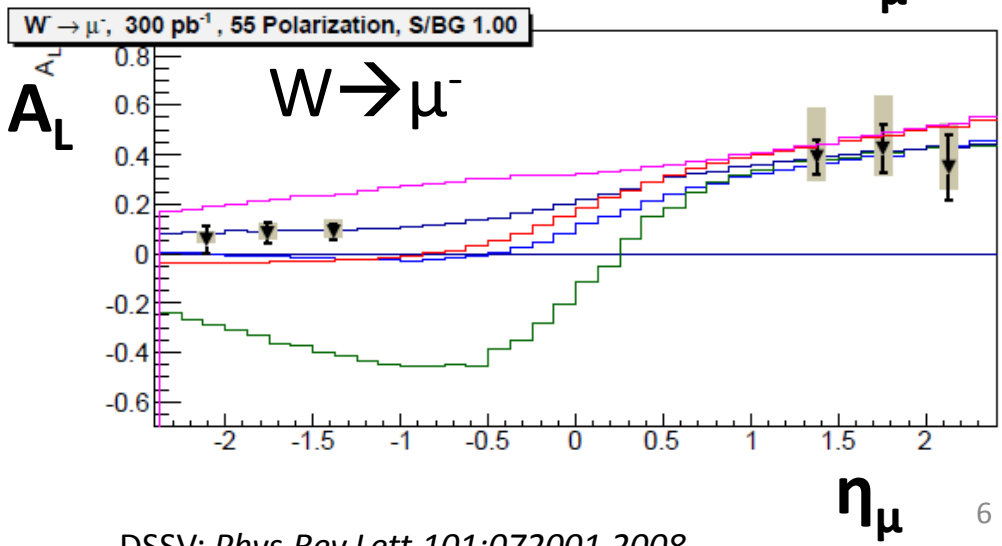
100% of PHENIX forward A_N

Simulations by J. Perry and J. Lajoie

Accessing the sea quark polarization

- Projections based on 300 pb^{-1} at 55% polarization
- High luminosity and polarization are important for hitting goals.
- Hardware for efficient triggering in place for forward muons



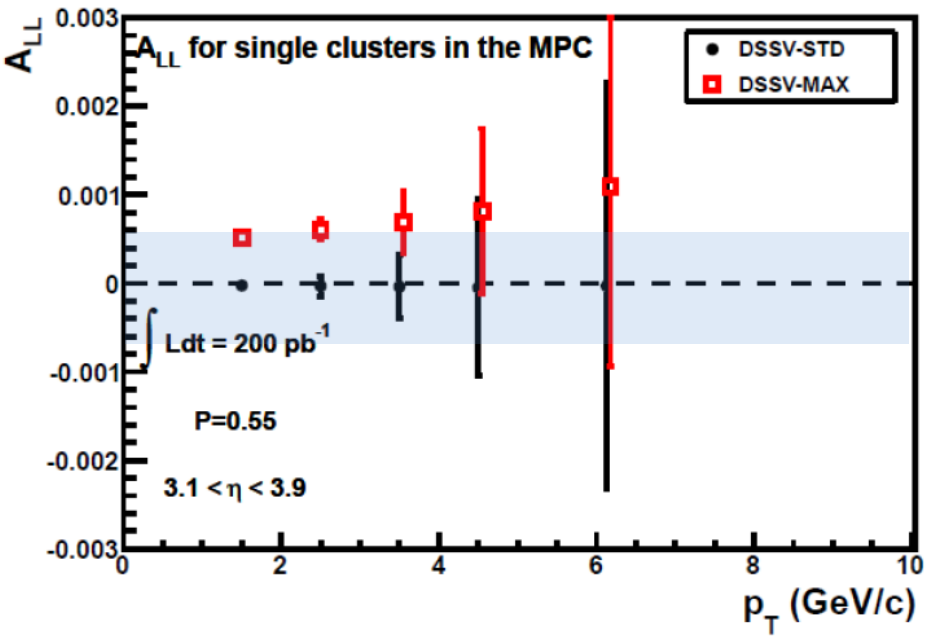


DSSV: *Phys.Rev.Lett.101:072001,2008*

Access the low-x gluon polarization

- Projected A_{LL} for neutral pions at forward rapidity using DSSV para.
- Probes the low-x region
- Will take advantage of large projected luminosity but requires reduction of PHENIX's relative luminosity errors

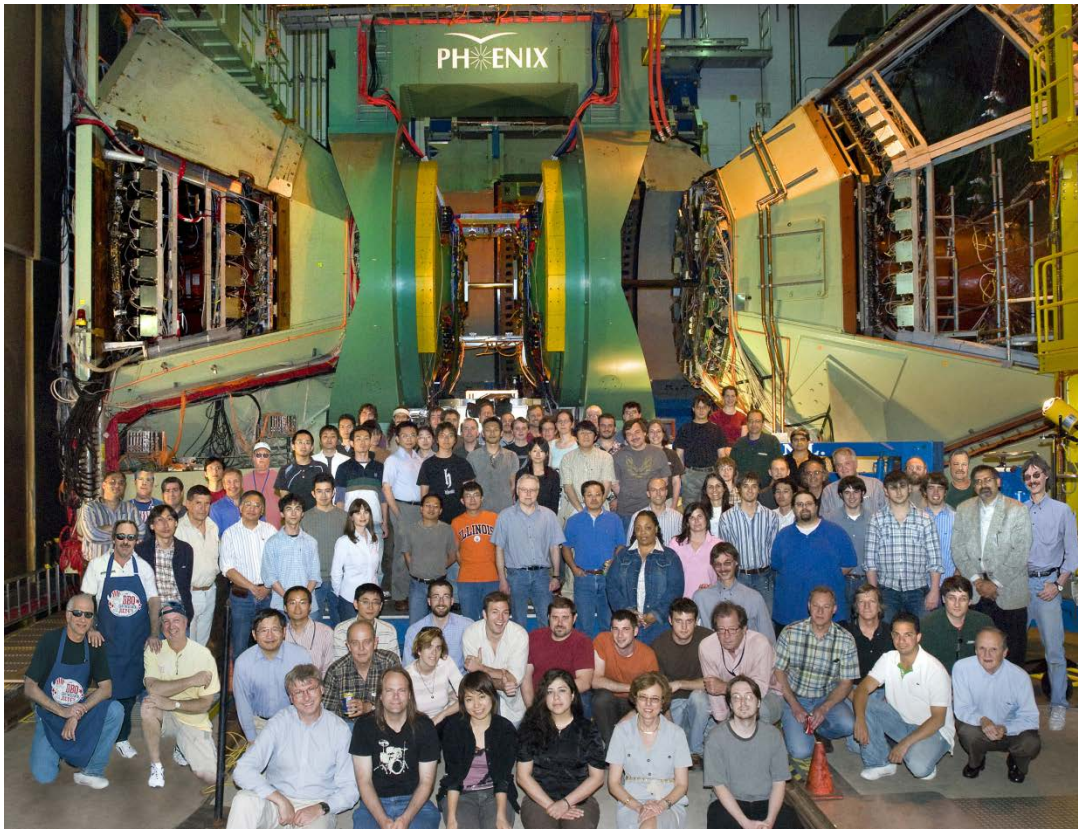
Projected asymmetry and statistical errors



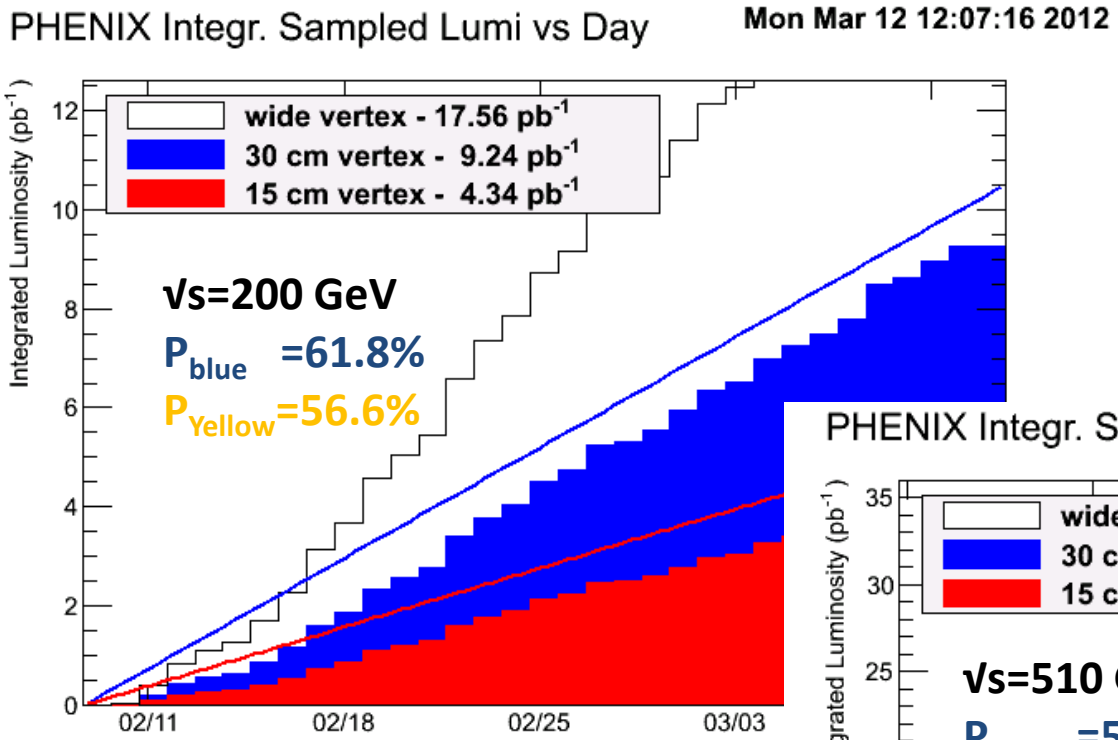
DSSV: *Phys.Rev.Lett.101:072001,2008*
Simulations by C. McKinney

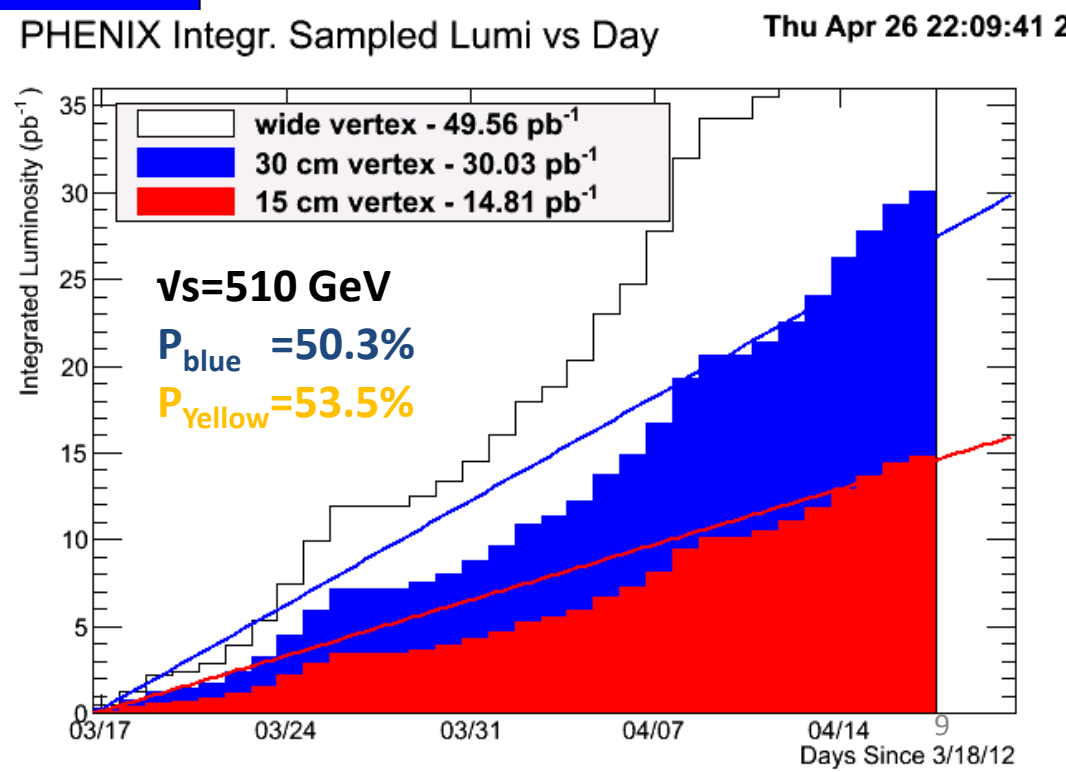
Run12 Achievements

- Depended on strong collaboration involvement and hard work of fast production team.
- Close to 100% of the muon arm data was produced in real-time
- Many problems were caught early, debugged and fixed.



Run12pp Integrated Luminosity



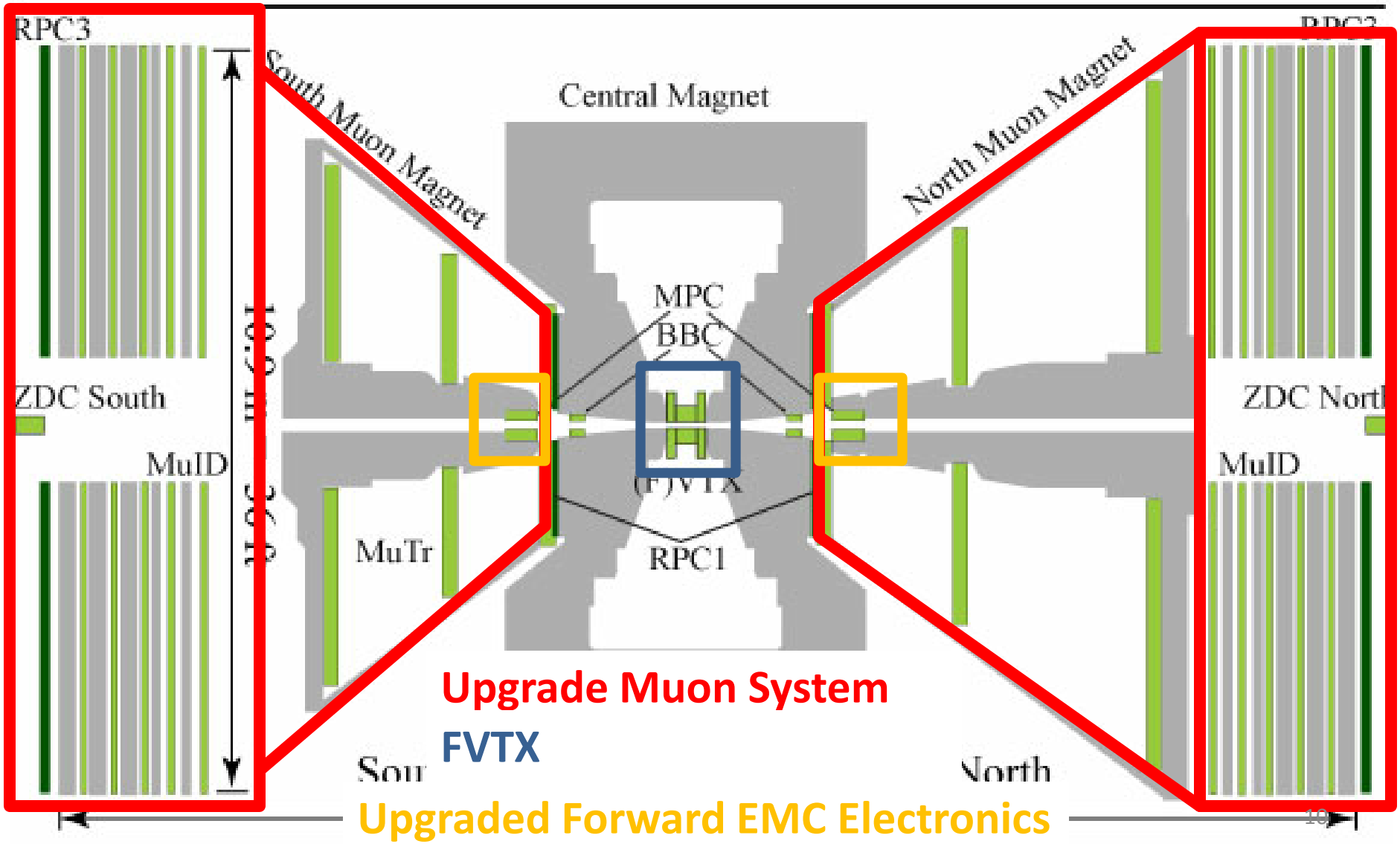


Fantastic data-sets!

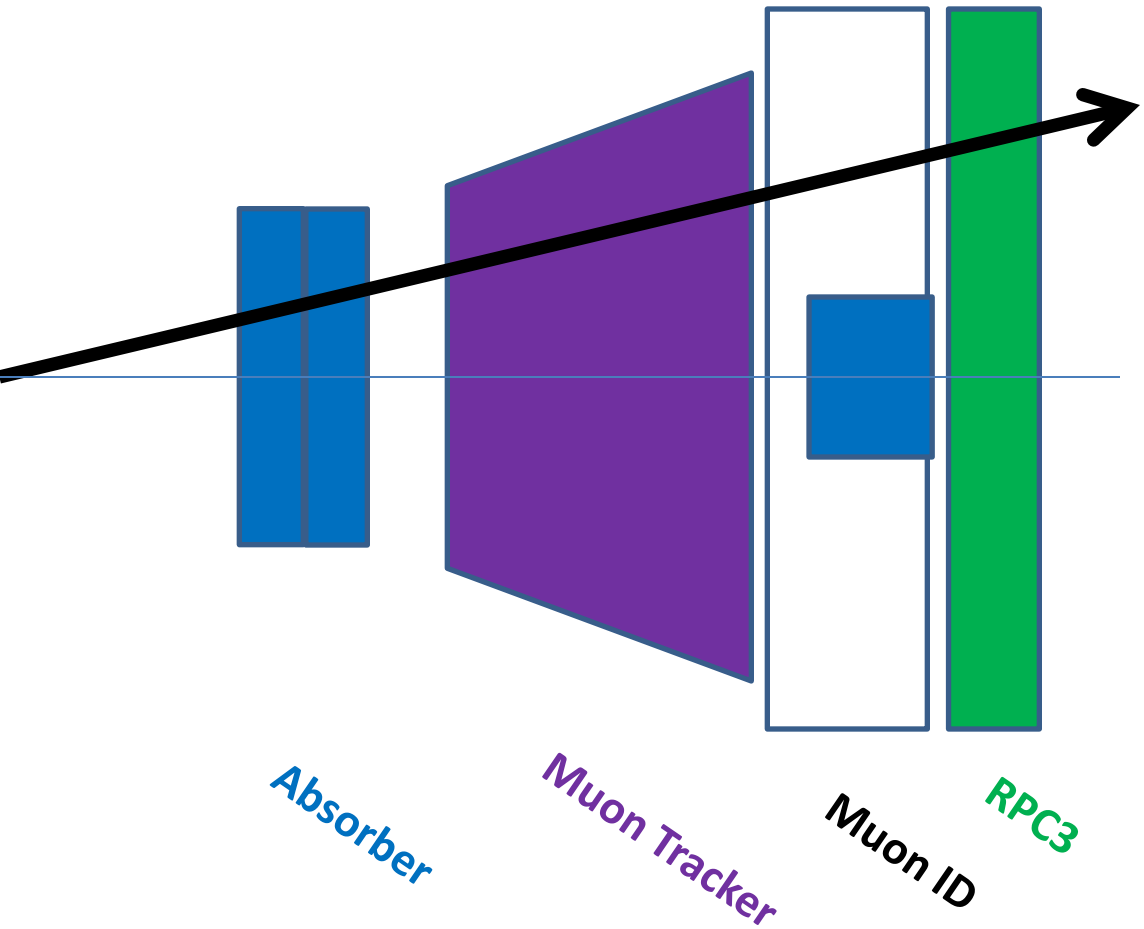
Areas to improve:

- Polarization
- Luminosity
- Data-taking efficiency (exp.)

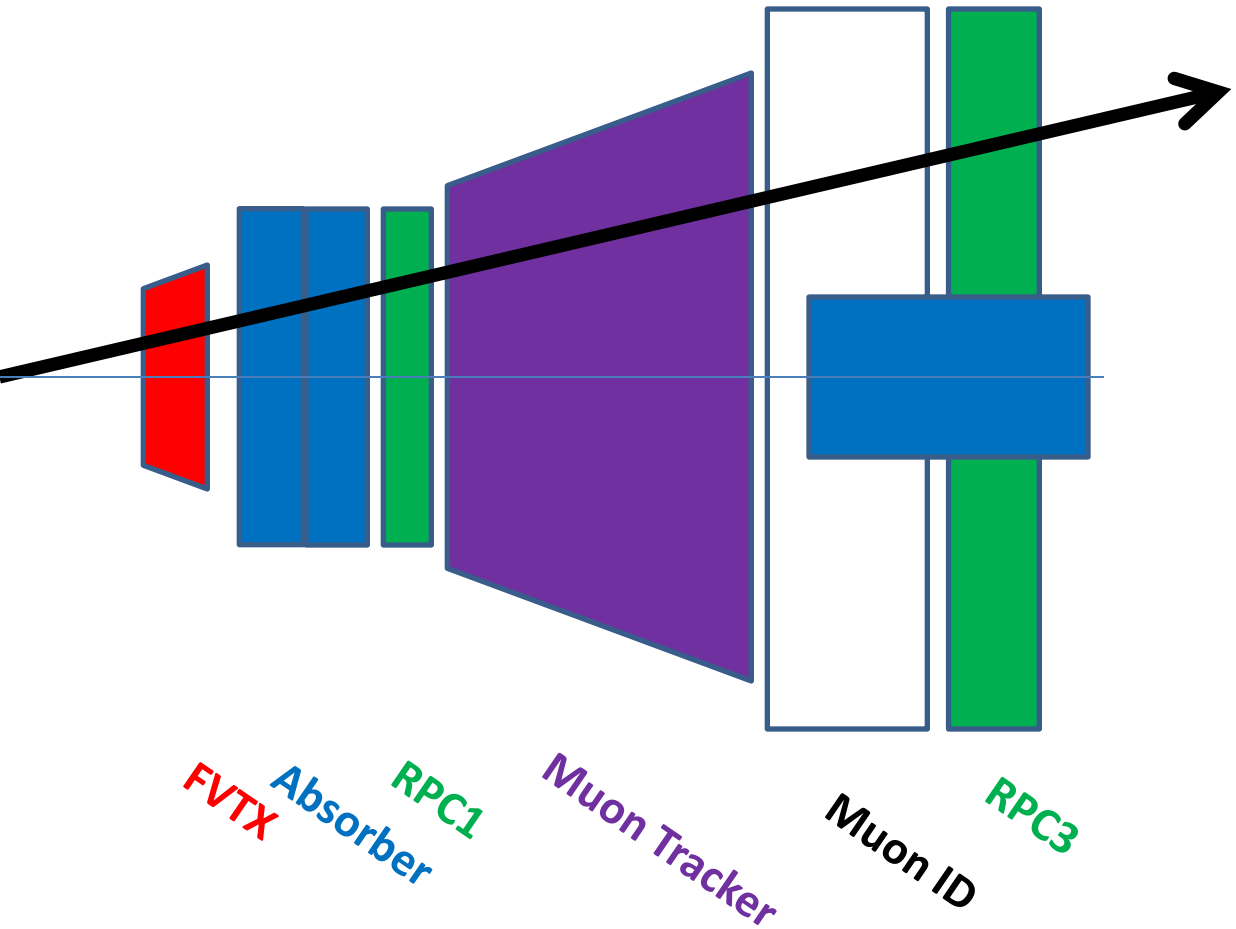
Hardware Additions for Run12



Run11 Muon Trigger Hardware



Run12 Muon Trigger Hardware



FVTX Upgrade

+Adds tracking

RPC1

+Adds acceptance

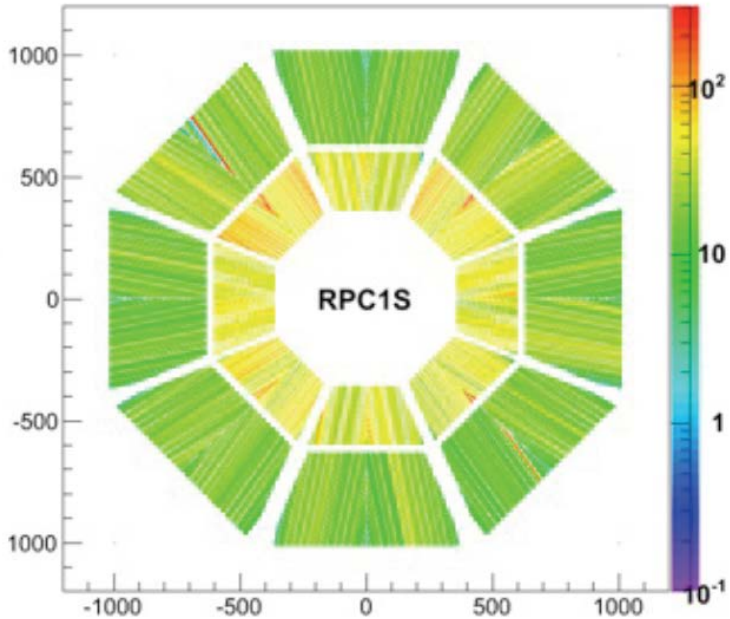
+Adds trigger rejection

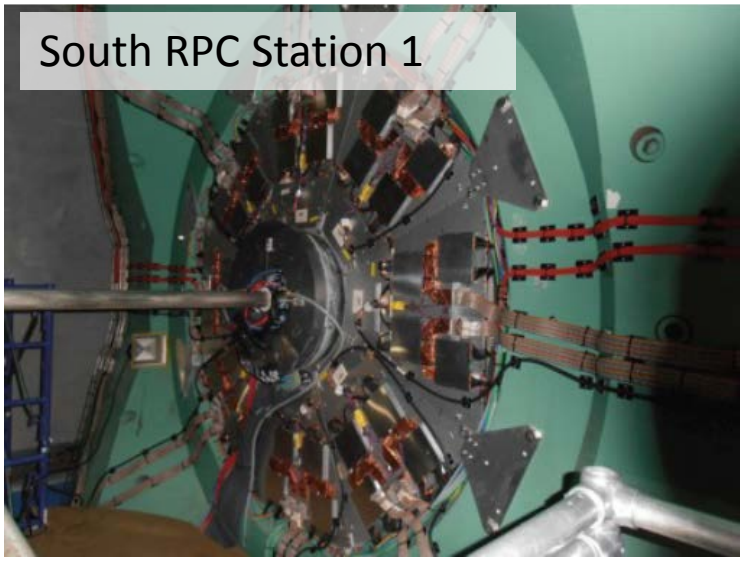
Additional Absorber

+Shields detector from in-time backgrounds

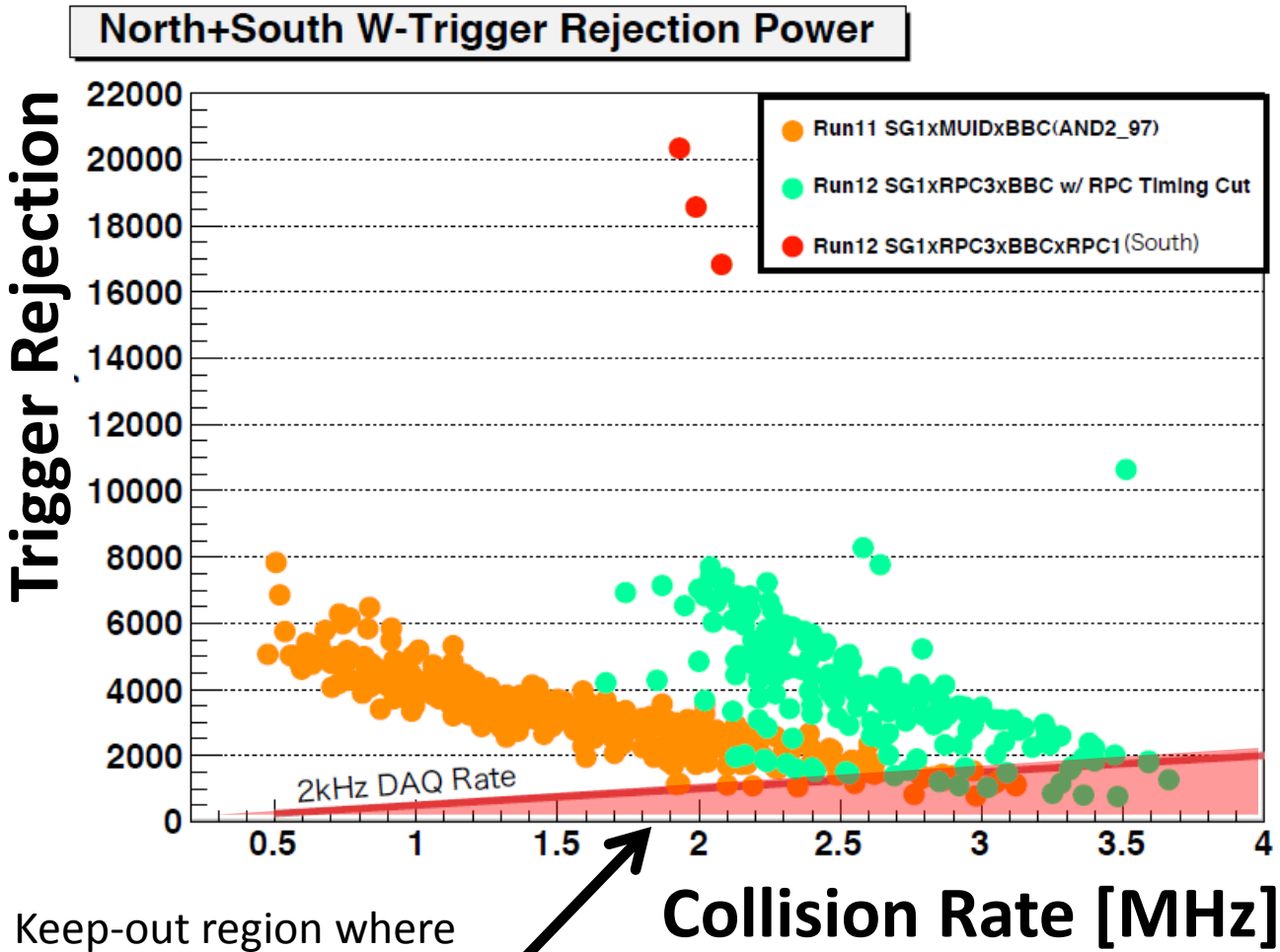
W→μ: RPC1 Commissioning

- RPC1 Successfully installed for Run-12
- Offline readout working during 510 GeV period



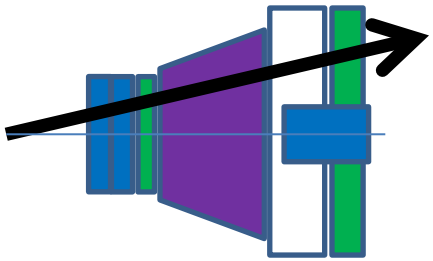


W→μ: Trigger Commissioning

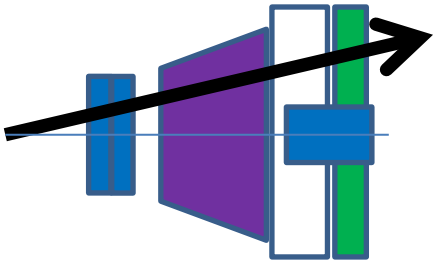


Keep-out region where trigger will take too much DAQ bandwidth

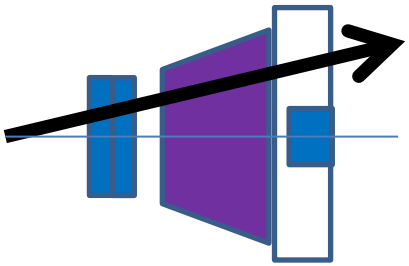
Run13 Production Trigger



Run12 Production Trigger



Run11 Production Trigger

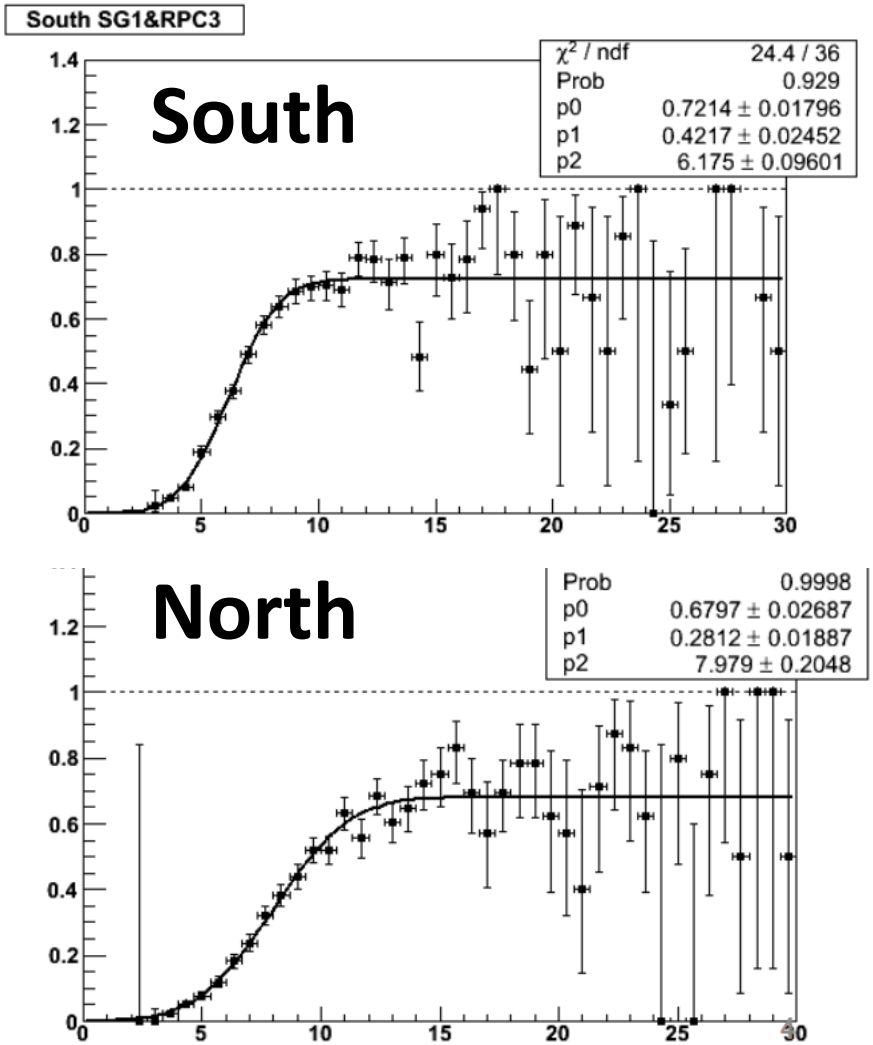


Results from Y. Imazu, S. Park, I. Nakagawa

W→μ: Trigger Commissioning

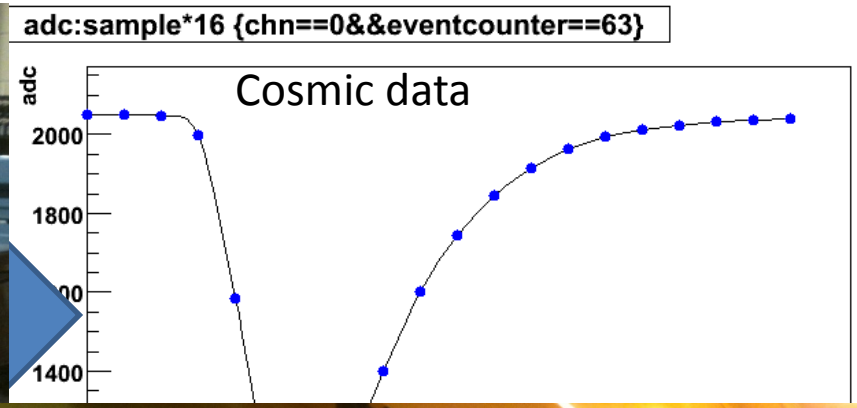
- Run12 Muon-like track turn on curve
- Yield (Production Trigger) / Yield (Minimum Bias)

Trigger maintains high rejection and selects high momentum tracks

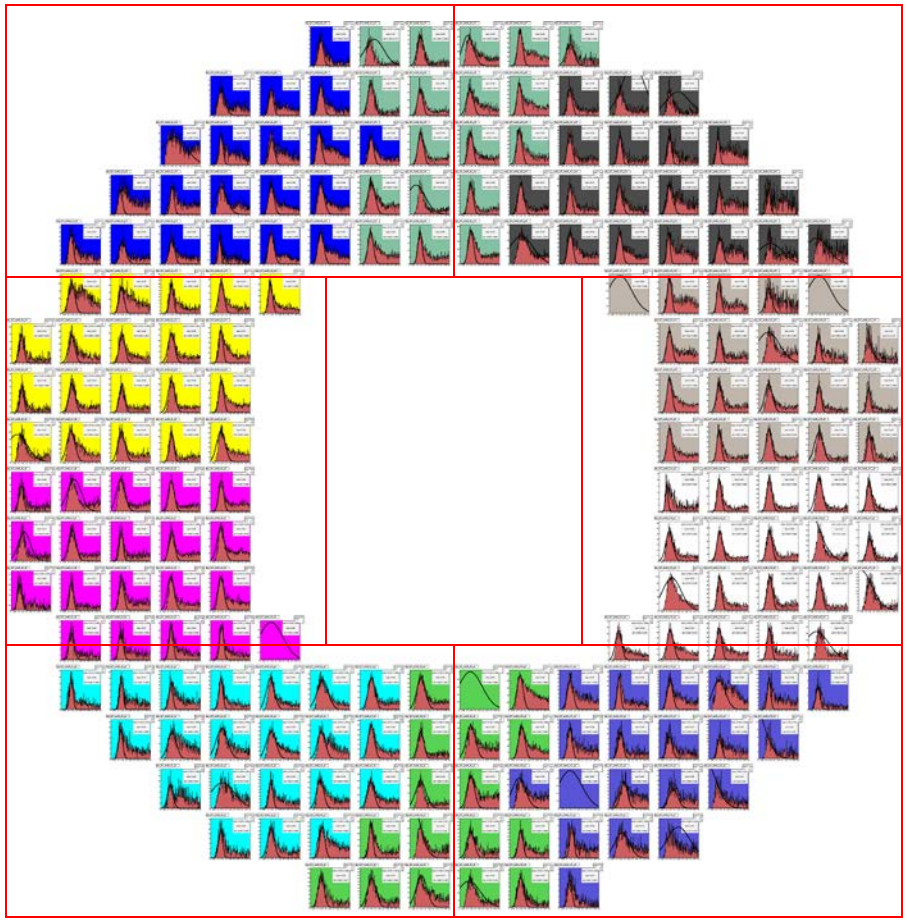


Results from Y. Imazu, S. Park, I. Nakagawa

MPC Electronics Upgrade

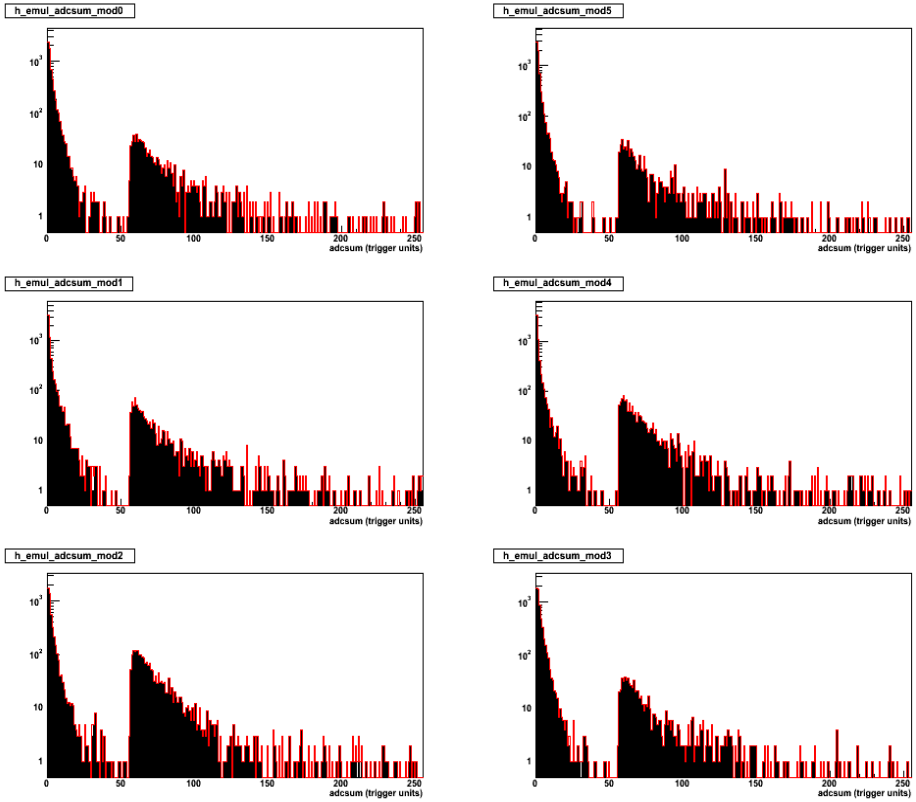


MPC Electronics Upgrade



π^0 tower-by-tower calibration

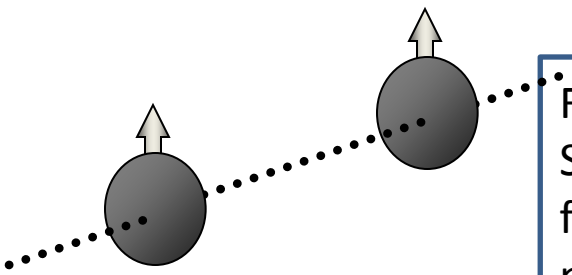
Run 361772, 03-Mar-2012



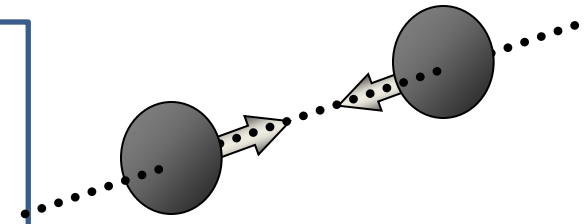
Sharp (Digital) Trigger Threshold

Results from M. Chiu, S. Wolin, C. McKinney, E. Zarndt

PHENIX Online Polarimetry



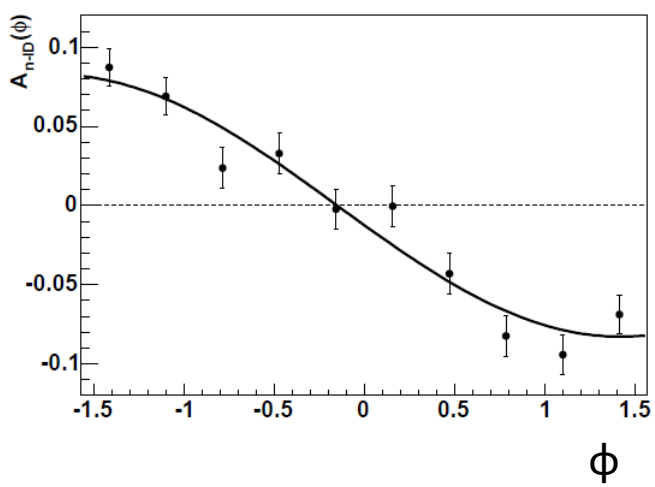
For Longitudinal Running:
Spin direction needs to be rotated from perpendicular to parallel to proton beam
Setting magnets rely on PHENIX pol.



Physics Measurement in 2002@IP12

$$A_N = \varepsilon_N / P_{Transverse}$$

A_N = Physics quantity
ε_N = Measured "raw" asymmetry
$P_{Transverse}$ = Transverse beam component



Phys.Lett.B650:325-330,2007

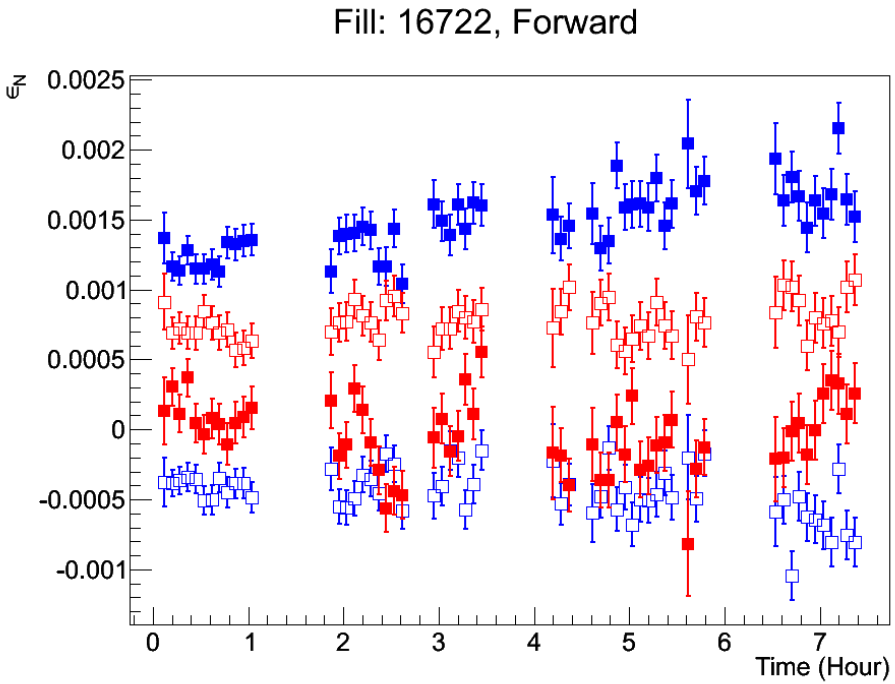
Residual Polarization Measurement at PHENIX

$$P_{Transverse} = \varepsilon_N / A_N$$

PHENIX tracks imperfections in spin alignment.
Important for systematic errors on A_{LL}

Online Local Polarimetry

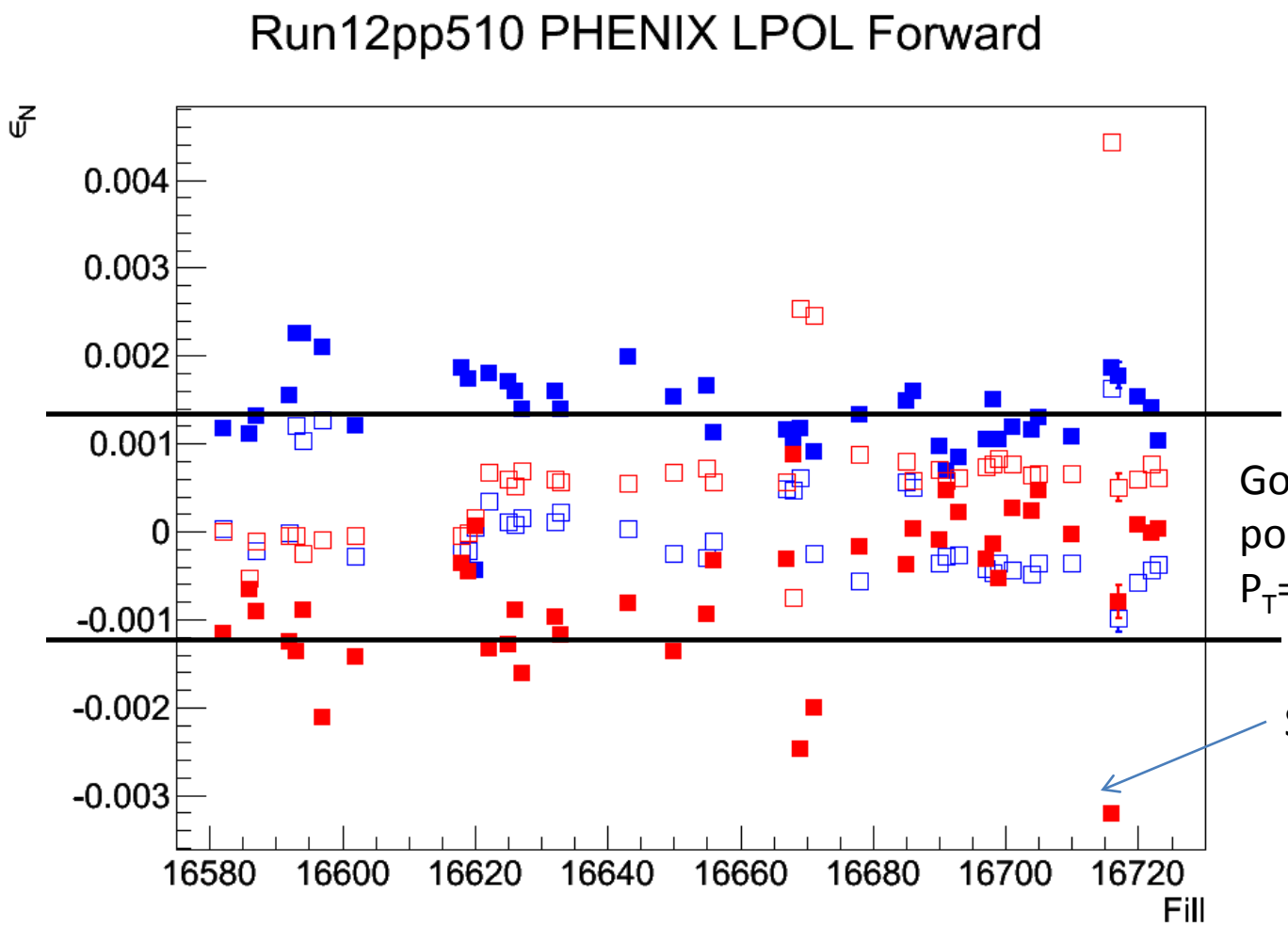
- Scaler based polarimetry: tracks beam polarization direction
  - Blue and yellow beams tracked independently
  - Polarization direction tracked, i.e. Up/Down or Into/Out ring



Blue and Yellow beam residual for one fill

Results from C. Gal, S. Park, J. Perry

Online Local Polarimetry



Goal zone for residual polarization P_T=2.5%

Some large outliers

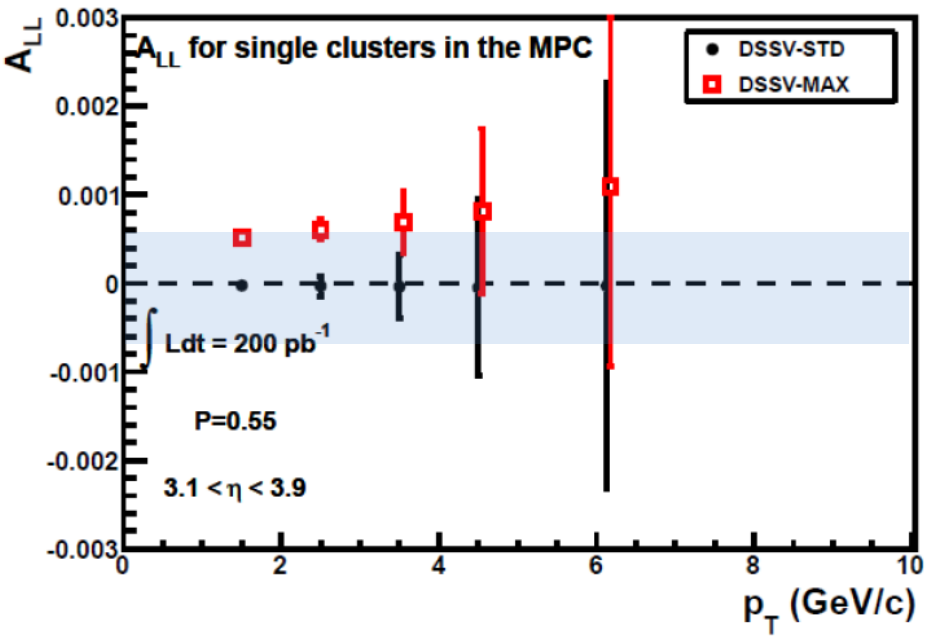
Blue and Yellow beam residual

Results from C. Gal, S. Park, J. Perry

Reducing A_{LL} Systematic Errors

- Important for PHENIX reduce its limiting A_{LL} systematic errors.
- One theory:
  1. Single transverse spin asymmetry in neutron production
     Phys.Lett.B650:325-330,2007
  2. Residual transverse spin component during Longitudina running
  3. Acceptance effects in the PHENIX ZDC

Projected asymmetry and statistical errors

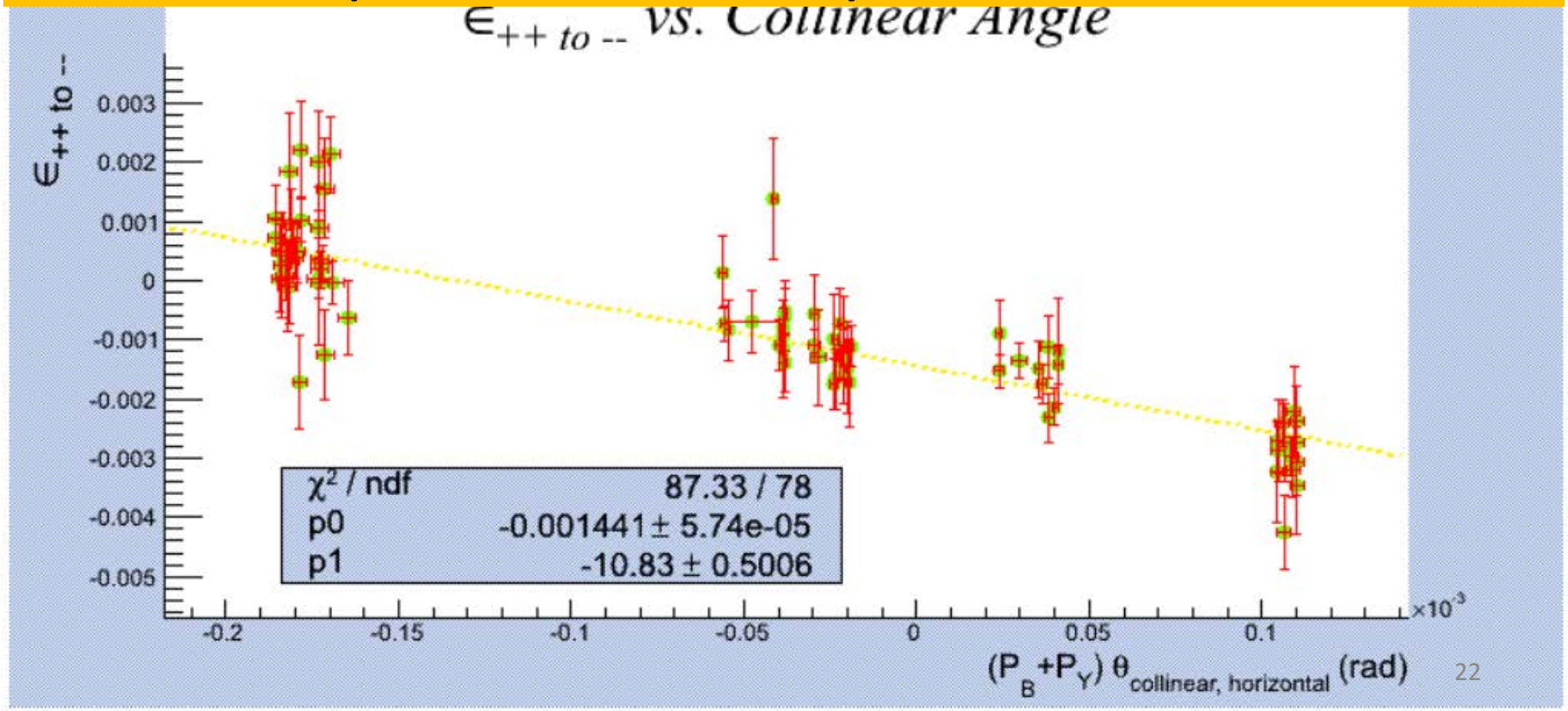


1+2+3 = Large (~10^{-3}) systematic error?

Approach:
Vary the acceptance effect by changing the beam angle

Reducing A_{LL} Systematic Errors

Results scale with the beam angle linearly, as expected by toy Monte-Carlo.
More tests planned for next year.

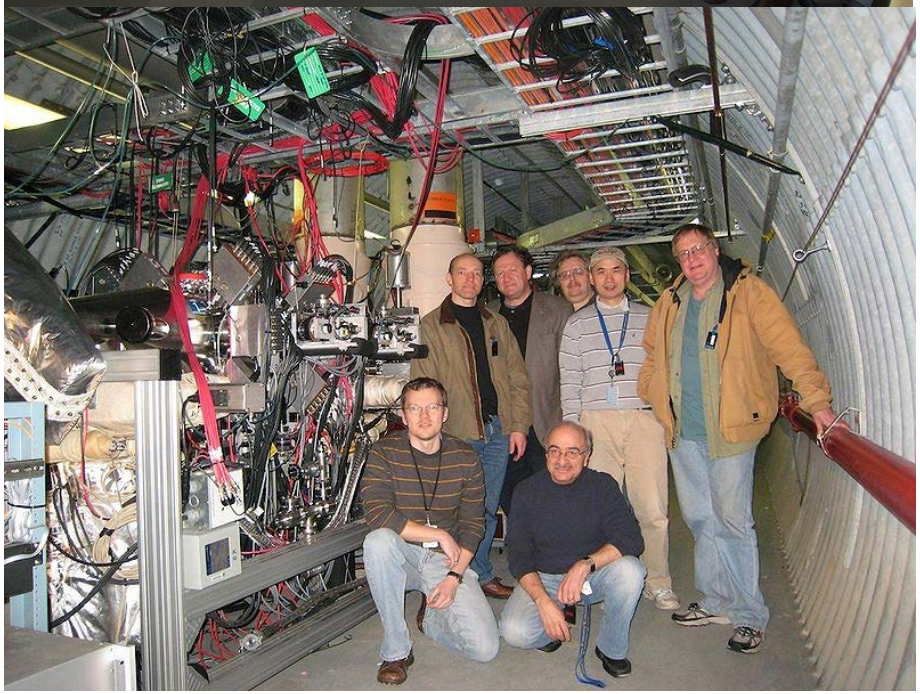


Summary

- Run12 – Huge success for RHIC/AGS
- Great dataset collected at PHENIX
  - High statistics transverse p+p opens door to high statistics transversity measurements+high p_T A_N
  - ΔG:
    - New MPC electronics will give better statistics for low-x measurement
    - Special beam studies will help to resolve limiting sys. errors.
  - Sea-quark polarization:

Muon Trigger hardware in place, tested and implemented.
Trigger was active for 510 GeV data-taking.

Acknowledgements



CAD

Polarimetry Group

PHENIX

+members of STAR

Extras

PHENIX BUP Run13

15+5 cryo-week proposal for Run-13:

1. 500 GeV $p+p$ for 10 weeks
2. 500 GeV $p+p$ for 1-5 additional weeks, if needed to reach 250 pb^{-1} sampled inside $\pm$ 30 cm
3. 200 GeV $p+p$ if 3-4 weeks remain following the 500 GeV run
4. if fewer than 3 weeks remain following the 500 GeV Run, we request 4.2 pb^{-1} delivered of 39 GeV $p+p$ ($\approx$ 1 week)

PHENIX BUP Run14

15+5 cryo-week proposal for Run-14, assuming 200 GeV $p+p$ is done

in Run-13:

1. 200 GeV Au+Au for 6-8 weeks, to collect 1 nb^{-1} in $\pm$ 10 cm
2. 200 GeV d+Au for the remainder of the Run

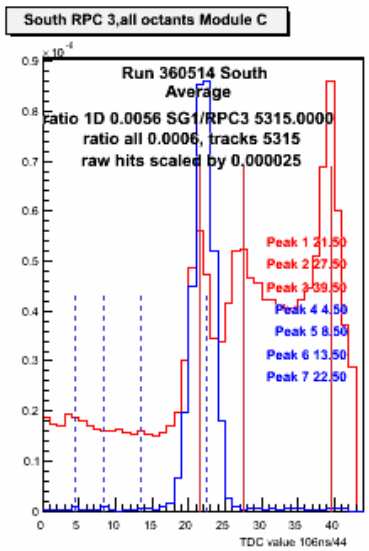
15+5 cryo-week proposal for Run-14, assuming no 200 GeV $p+p$ in Run-13:

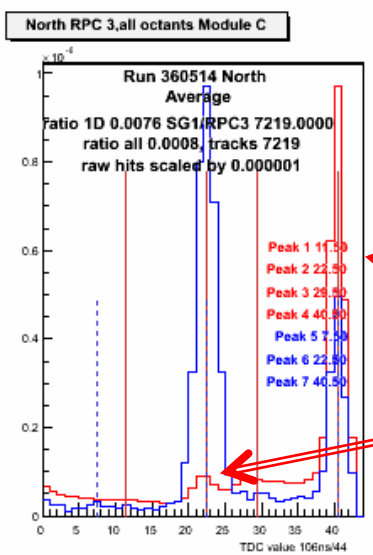
1. 200 GeV Au+Au for 6-8 weeks, to collect 1 nb^{-1} in $\pm$ 10 cm
2. 200 GeV $p+p$ for 4 weeks
3. 200 GeV d+Au for the remainder of the Run

Slide by Ralf Seidl

Overall RPC timing and BG

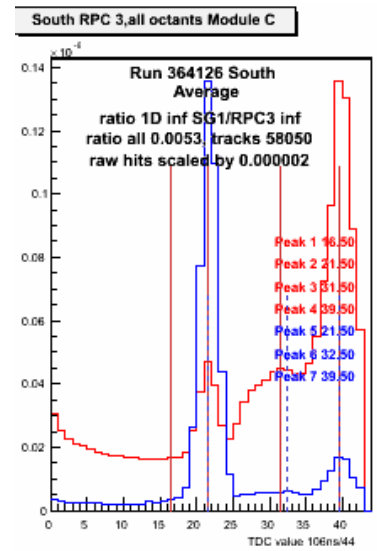
200 GeV

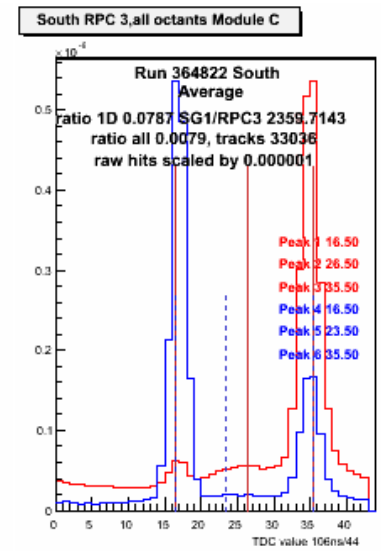


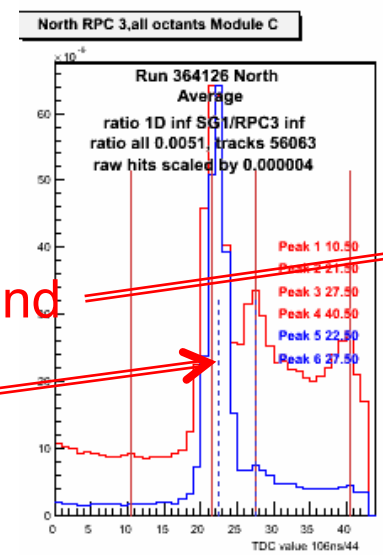


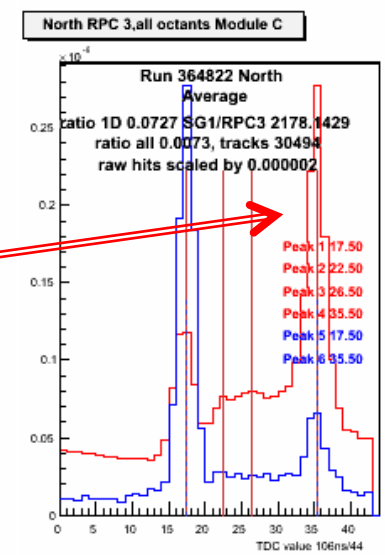
- Outer RPC3s in the tunnel most sensitive to incoming BG
- Blue (North) sees more background at 510 GeV
- However beam conditions change very much – study Collimator and Vernier scan data

510 GeV









Incoming Background

Collision related

Muon arm track related hits (different scale)