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STAR Local Polarimetry

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on behalf of the STAR Collaboration

Outline

- Overview of STAR local polarimetry
- Experience at 200 GeV
- Run 9 500 GeV commissioning
- Comments

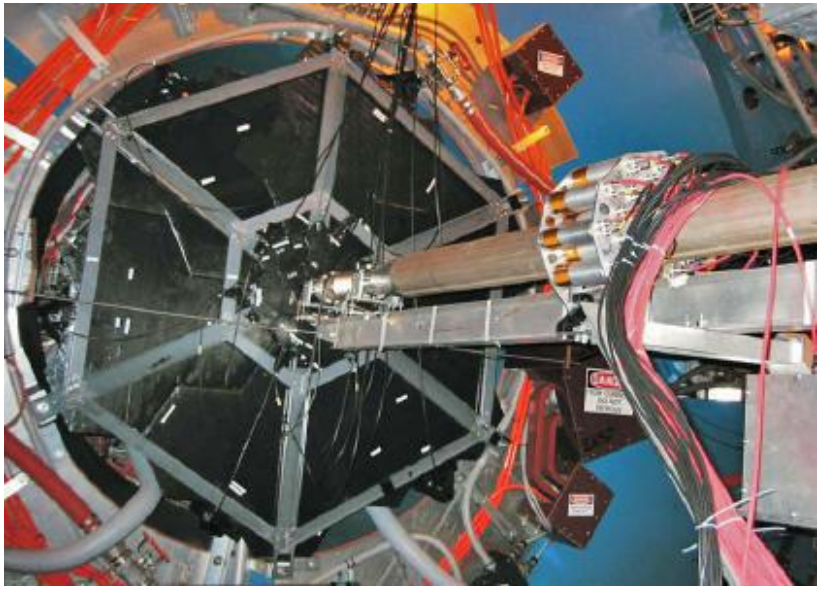
Local Polarimetry at STAR

Zero **D**egree **C**alorimeter

Detector	|z| (cm)	|η| Range
BBC	374	3.3, 5
VPD	568	4.2, 5
ZDC	1800	6.5, 7.5

Vertex **P**osition **D**etector

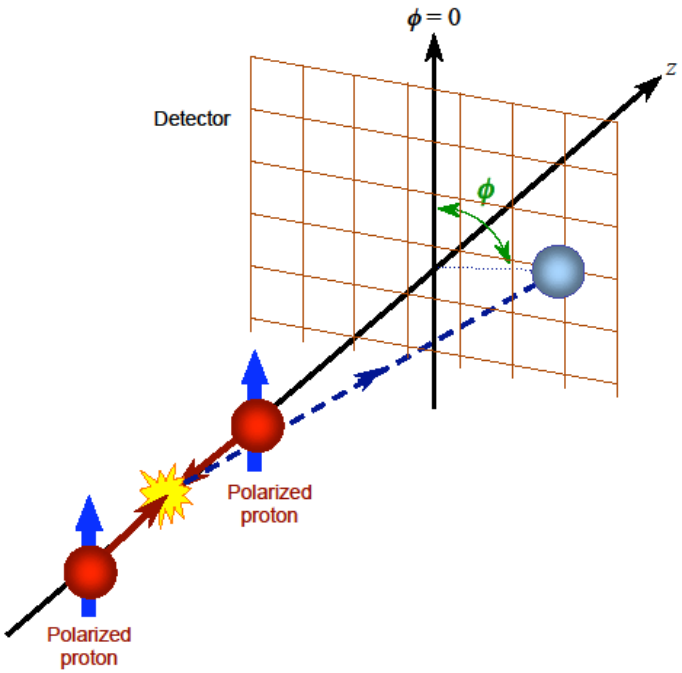
Beam-**B**eam **C**ounter



Single Spin Asymmetry

$$\varepsilon_{phys} = \frac{\sqrt{N_L^{\uparrow} N_R^{\downarrow}} - \sqrt{N_L^{\downarrow} N_R^{\uparrow}}}{\sqrt{N_L^{\uparrow} N_R^{\downarrow}} + \sqrt{N_L^{\downarrow} N_R^{\uparrow}}}$$

$$A_N = \frac{\varepsilon_{phys}}{P}$$

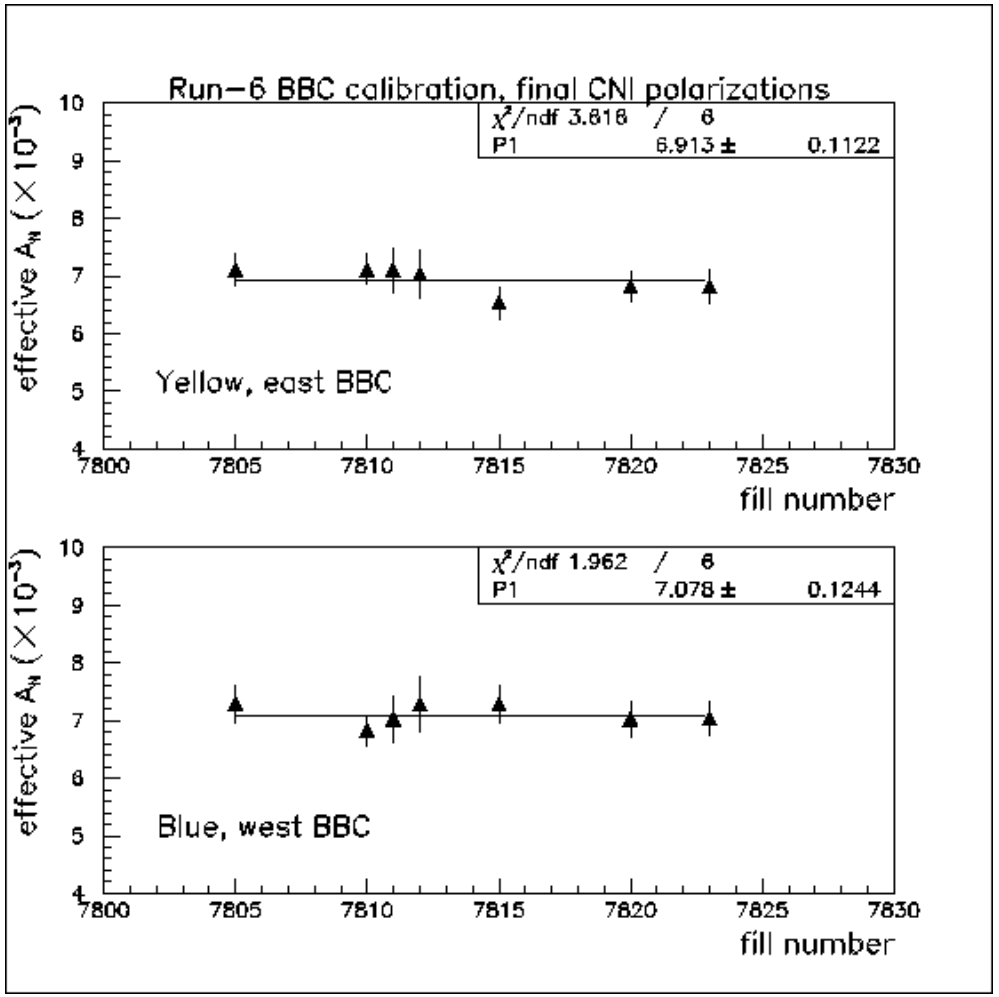


Yellow beam travels to the east – sum over blue beam states.

Blue beam travels to the west – sum over yellow beam states.

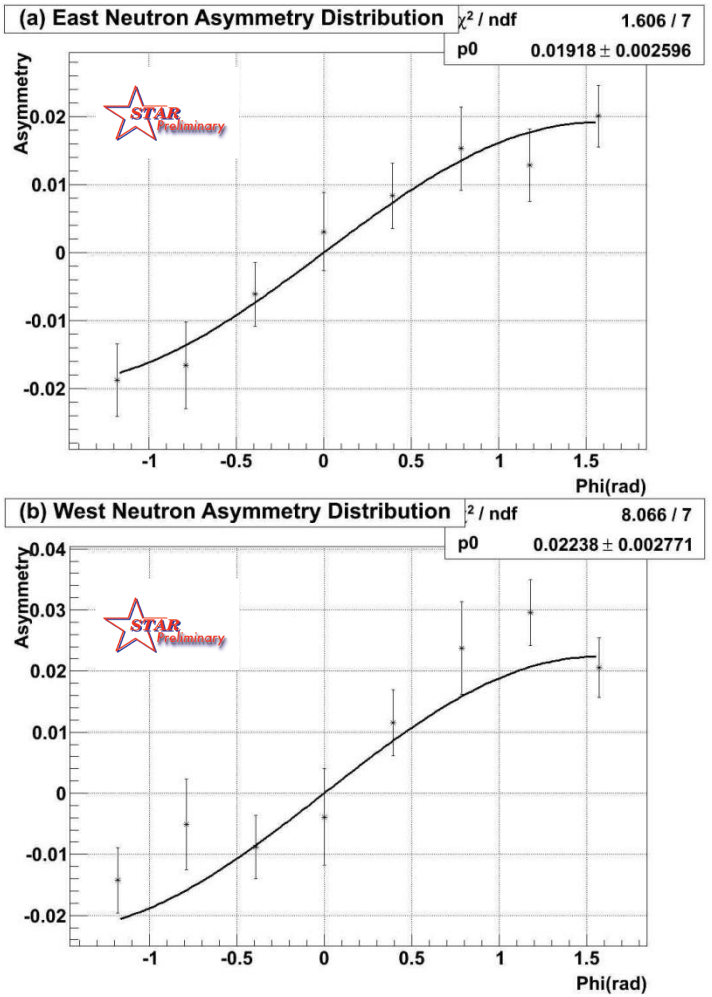
BBC – the Local Polarimeter at 200 GeV

- BBC serves many purposes
  - Triggering
  - Integrated luminosity measurement
  - Relative luminosity monitoring
  - Polarimetry
- Fast readout with scalers
- $A_N^{BBC} \sim 0.7\%$



ZDC Commissioning at 200 GeV

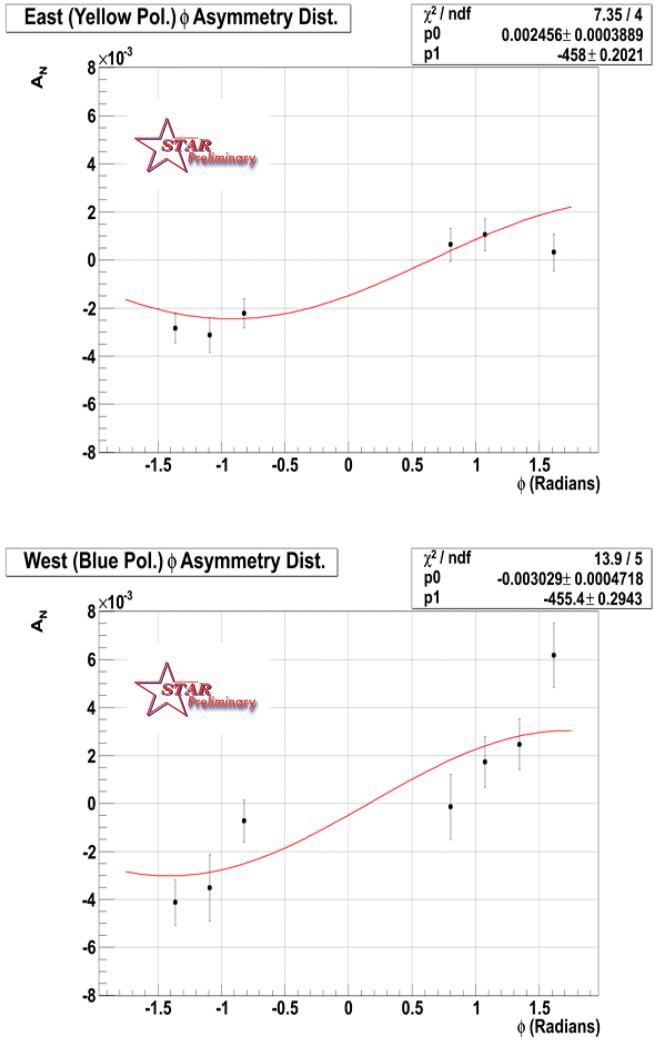
- About one hour of test data taken in 2004
  - Fill 5170
  - Beam polarization ~ 26 %
  - Collect ~ 8 million events
  - See > 7 sigma LR asymmetry
- $A_N^{ZDC} \sim 8\%$



STAR Note 480

VPD Commissioning at 200 GeV

- Almost one month of data collected in 2008
  - Fills 9866-10002
  - Beam Polarization ~ 40%
  - Collect ~ 66 million events
  - See > 10 sigma LR asymmetry
- $A_N^{VPD} \sim 0.3\ \%$



Run 9 500 GeV Running

- Expected and observed a small A_N^{BBC}
- Focused on optimizing ZDC
- VPD was not fully commissioned

ZDC Analysis Details

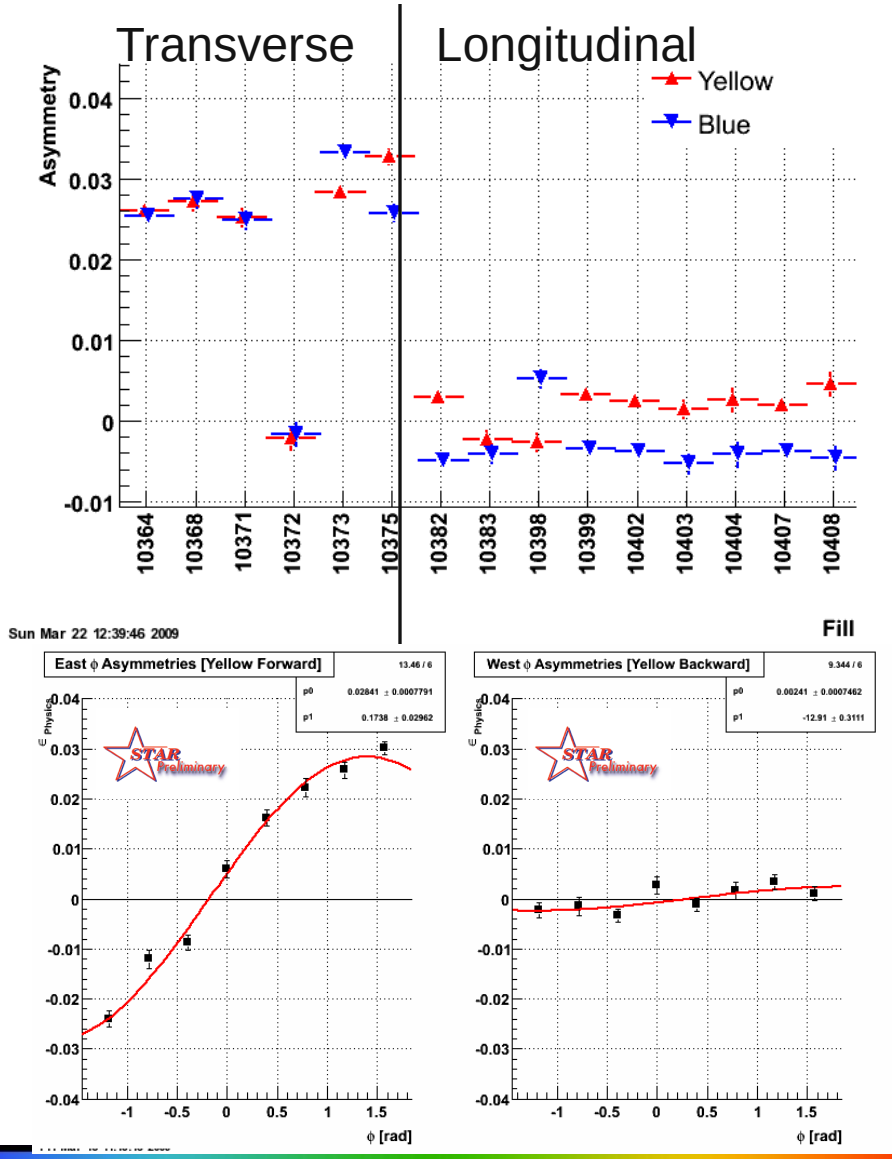
- Shower maximum detector located after 1st ZDC module
- SMD ADC counts are pedestal-subtracted and gain-matched
- Require coincidence of vertical & horizontal slats above threshold and count the single highest hit
- Calculate left-right asymmetries in opposite bins as a function of Φ

ZDC Trigger Details

- Trigger imposes various BBC and ZDC SMD requirements
  - BBC ADC > Threshold
  - ZDC front and back ADC > Threshold
  - BBC/ZDC TAC
- 200 GeV commissioning runs
  - (BBC E > X) && (BBC W > X) && (BBC TAC Diff) && (ZDC E TAC || ZDC W TAC)
- 500 GeV runs tested many conditions
  - ((ZDC E Front > X && ZDC E Back > Y)||(ZDC W Front > X && ZDC W Back > Y)) with and without BBC E >X && BBC W>X
  - (ZDC E Front > X && ZDC E Back > Y) && BBC E > X
  - (ZDC E Front > X && ZDC E Back > Y) && BBC W > X
  - Etc….

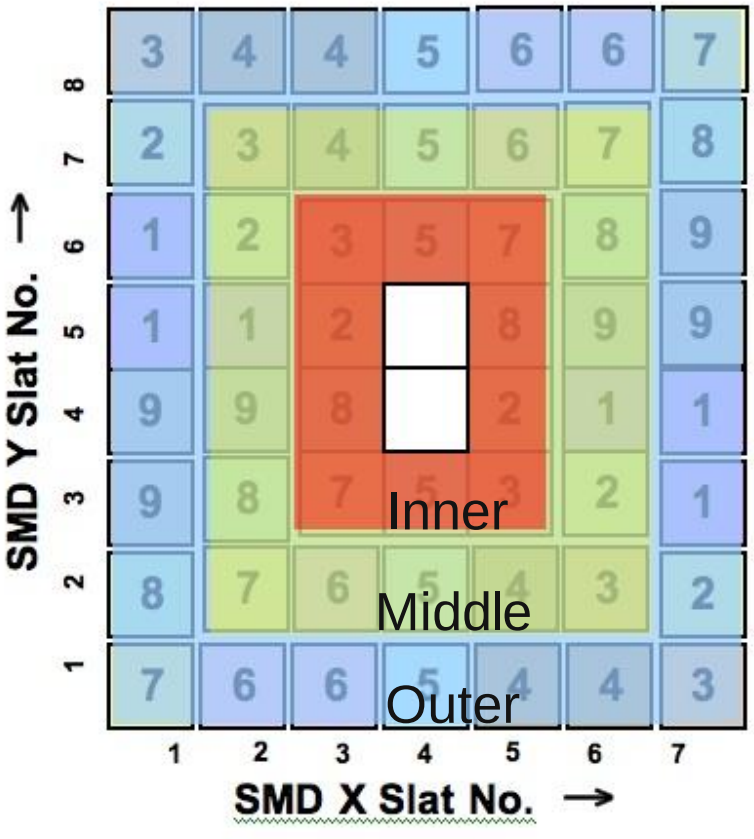
ZDC Analysis at 500 GeV

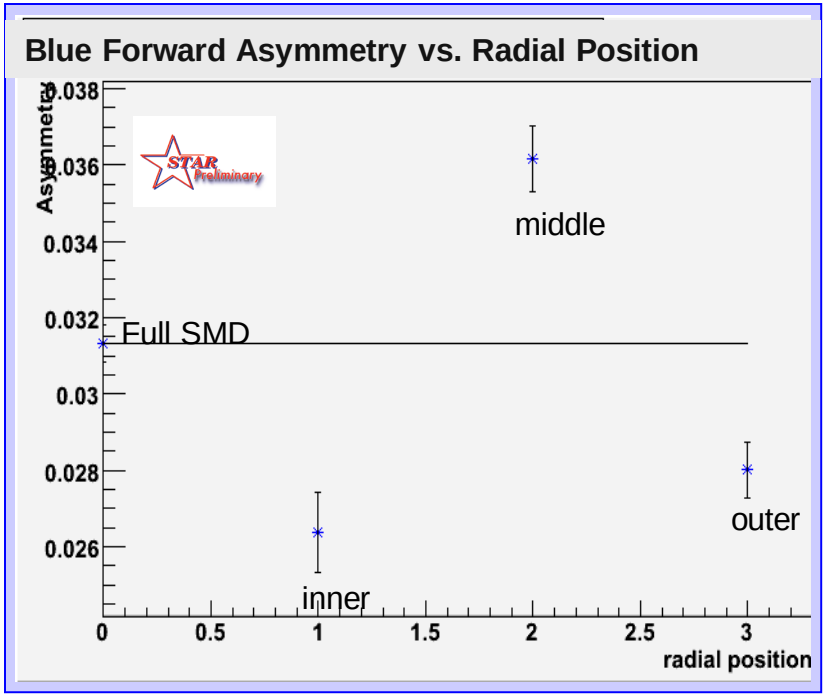
- Intense effort during transverse running
  - Tested various trigger conditions
    - *A_N^{ZDC} relatively insensitive to trigger*
    - *Largest drop to A_N^{ZDC} when removing BBC Coincidence*
  - Online monitoring implemented
- $A_N^{ZDC} \sim 8\%$



Offline ZDC Analysis: Radial Dependence

500 GeV

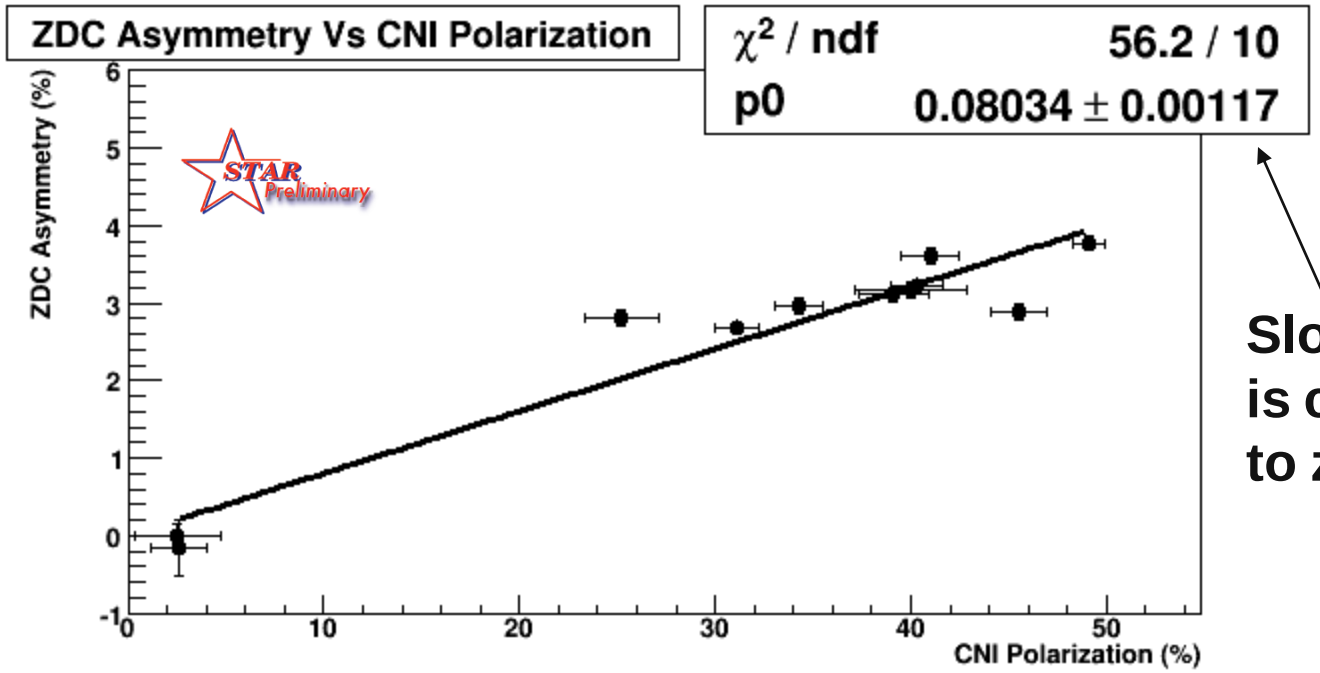




- **Observed radial dependence is currently under study.**
- **Radial dependence not fully explained by beam displacement**

Offline ZDC Analysis: Correlation with CNI

500 GeV



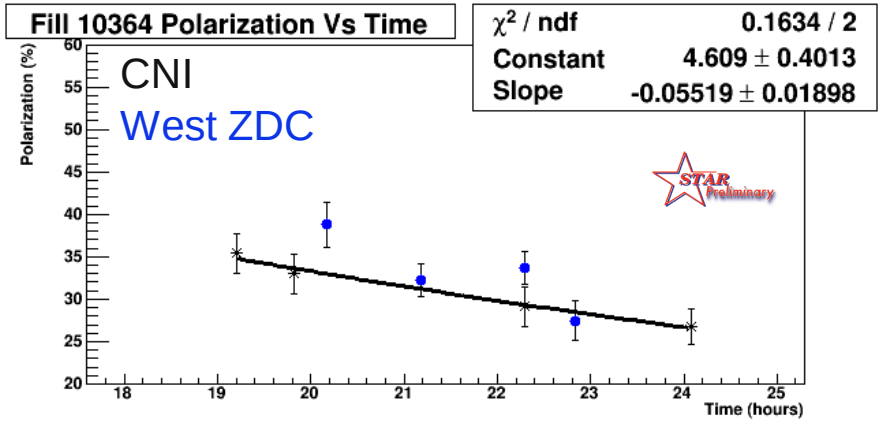
Slope, intercept is constrained to zero.

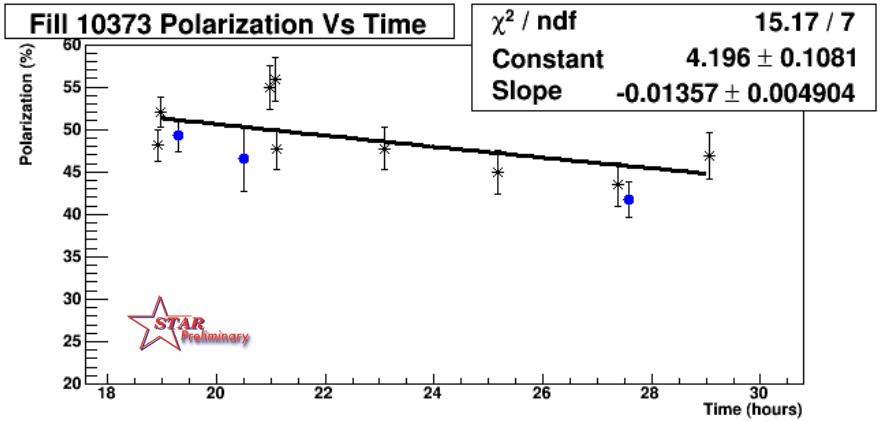
A_N Yellow 7.7±0.3%

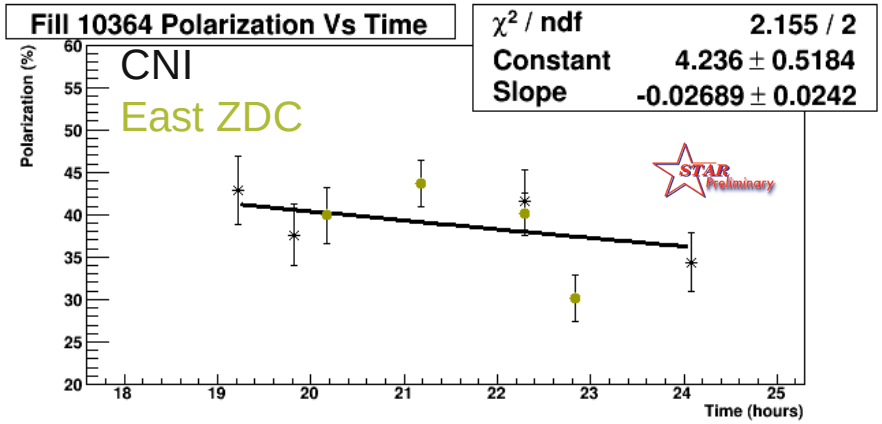
A_N Blue 8.2±0.2%

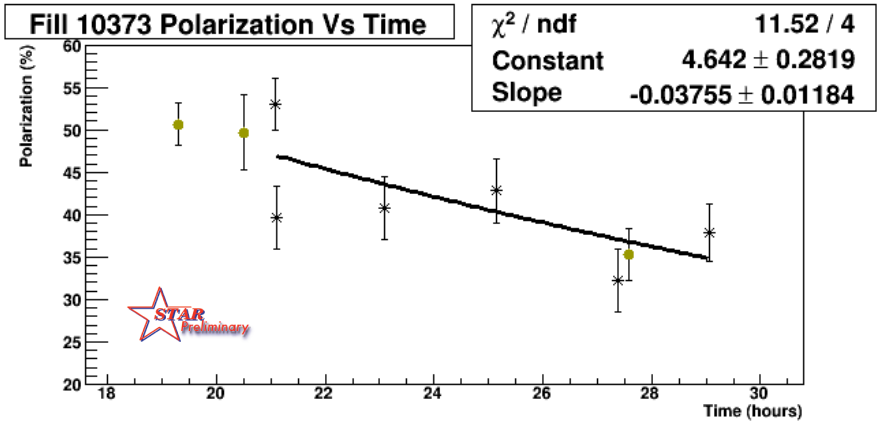
Offline ZDC Analysis: Tracking Polarization Drop

500 GeV





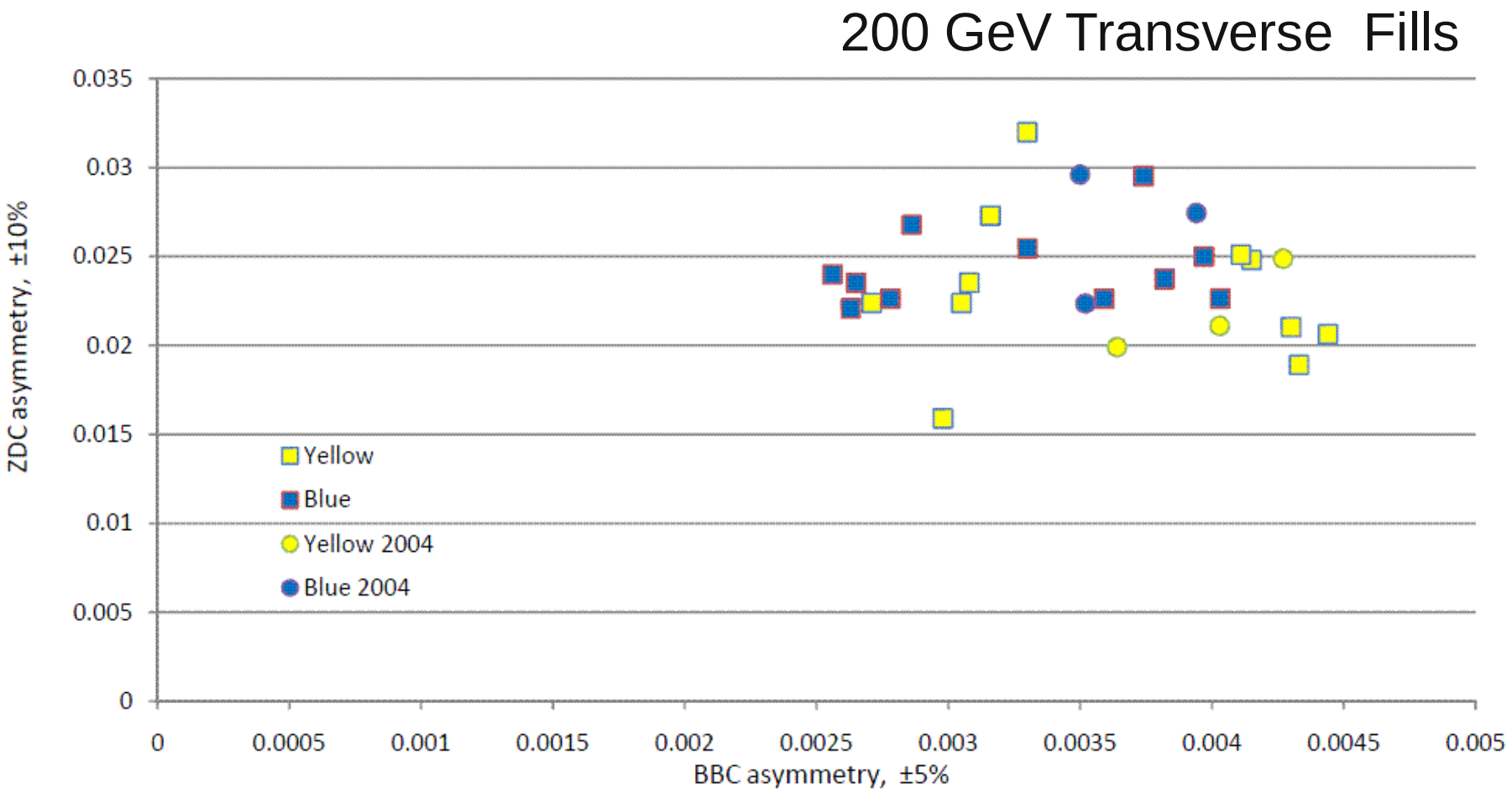




A_N Yellow 7.7±0.3%

A_N Blue 8.2±0.2%

ZDC and BBC Asymmetry Comparison



A ZDC Scaler System

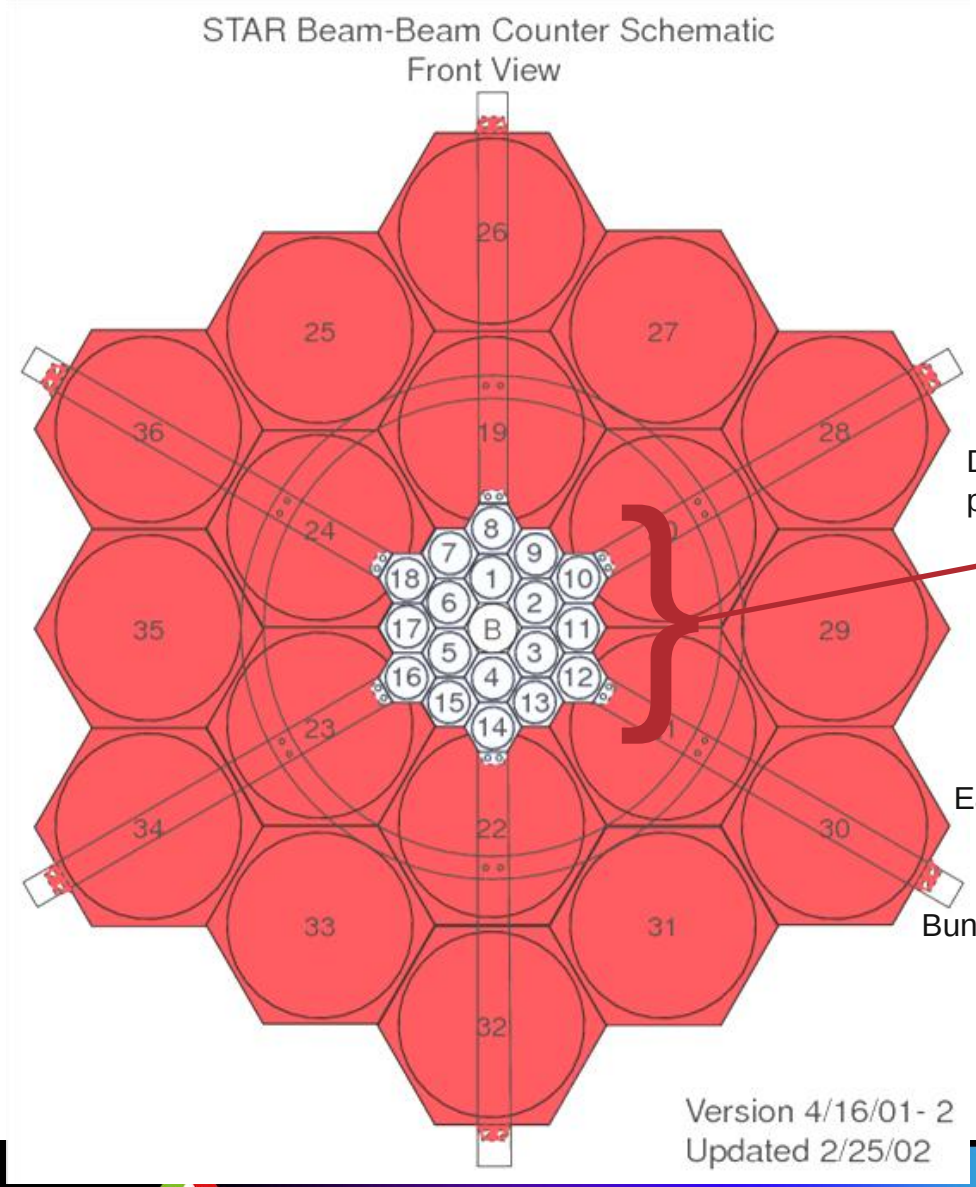
- Currently have online monitoring of ZDC
  - Results available within minutes of completing a run
- Ideally we would like a scaler system
  - Does not require dedicated runs
  - Need to decide on exact inputs
    - *24 bit word*
      - 7 bits for bunch id
      - 15 bits for each slat
      - ?

Summary

- STAR makes use of many polarimetry devices
  - BBC primary at 200 GeV
  - ZDC primary at 500 GeV
- Overall good results with ZDC at 500 GeV
  - A scaler system needs more thought
- Thank you to the many STAR collaborators who contributed to this work

Backup

BBC Scaler Readout



Scaler Boards

Discriminated phototube outputs

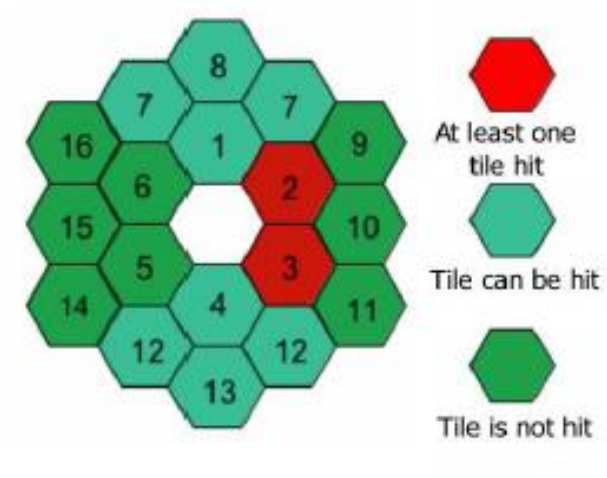
East-West Coincidence

Bunch Crossing (7-bit)

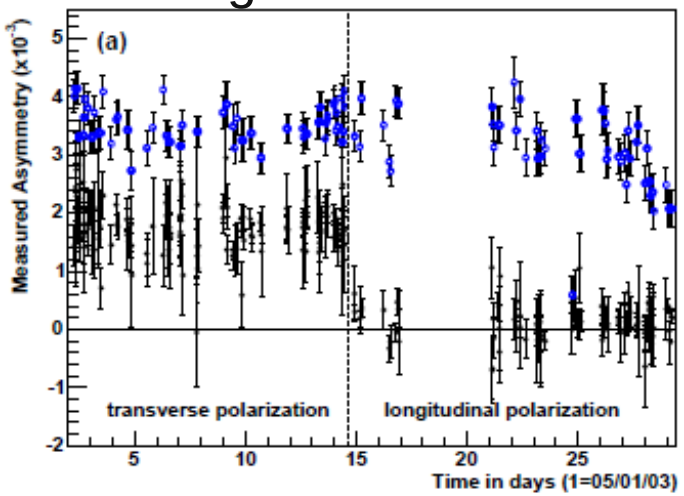
24-bit word is histogrammed every clock cycle

BBC Asymmetry

Inner right tiles.

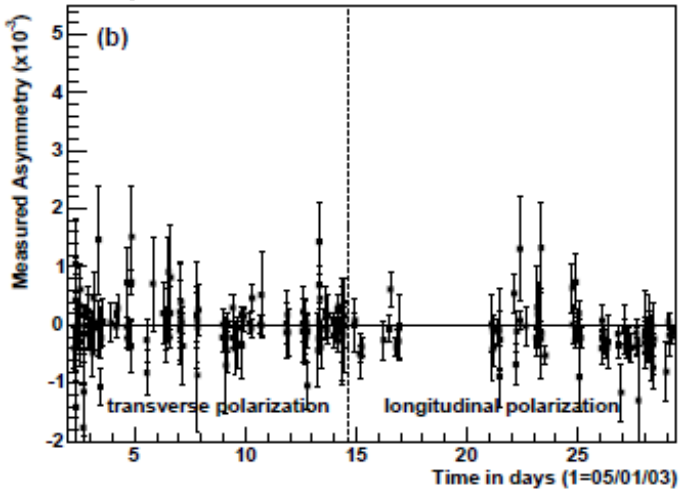


Left-right



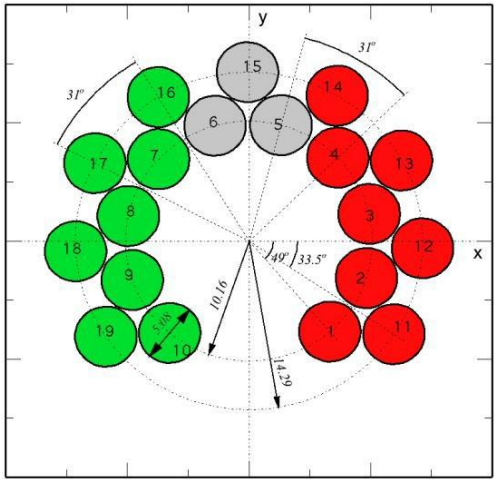
CNI
BBC

Up-down

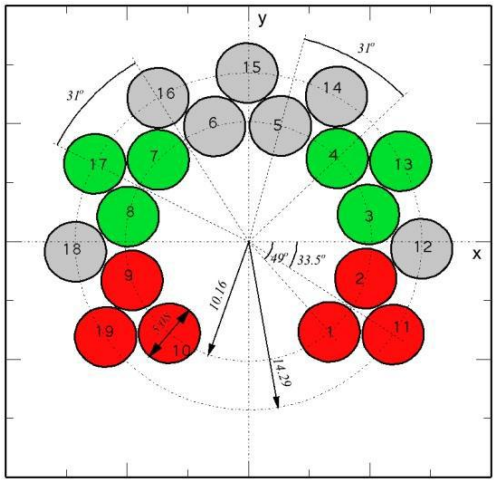


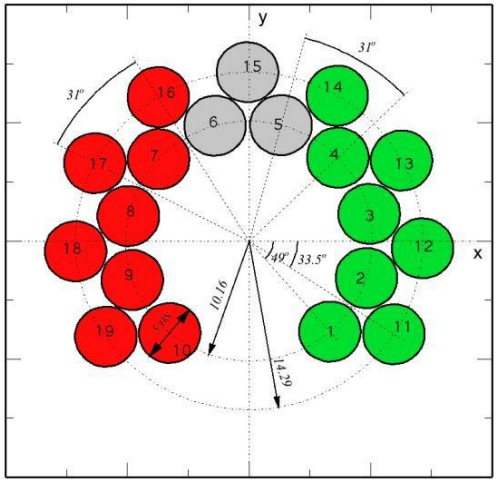
VPD Asymmetry

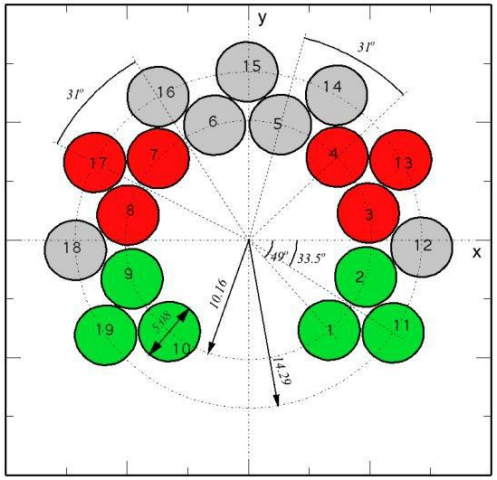
Left-Right



Top-Bottom





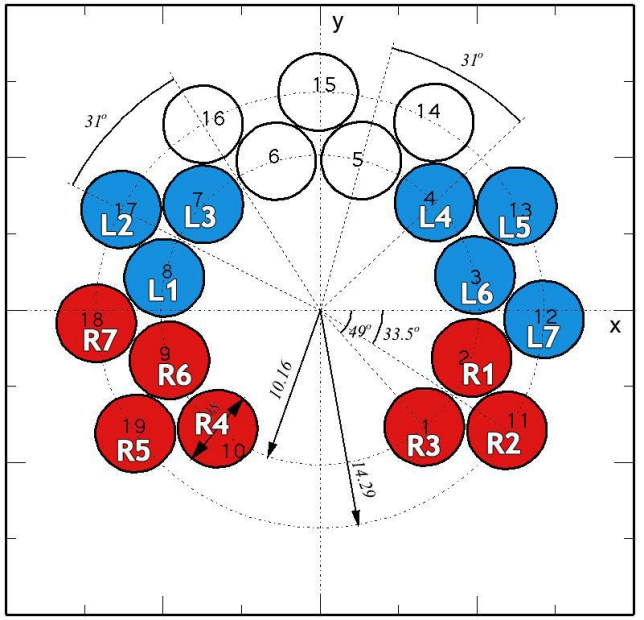


Hits Allowed

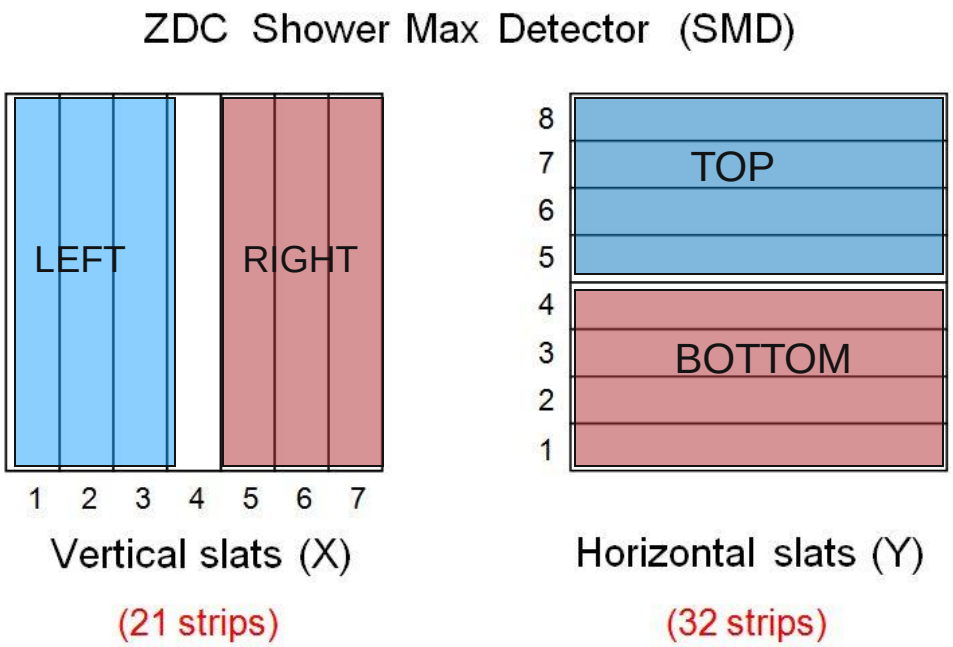
No Hits Allowed

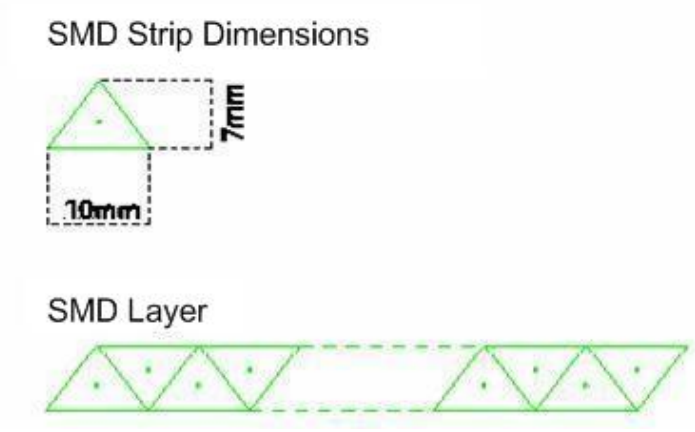
No Restriction

Phi Distribution



ZDC Asymmetry





Phi Distribution