



Polarization Status at pC and STAR

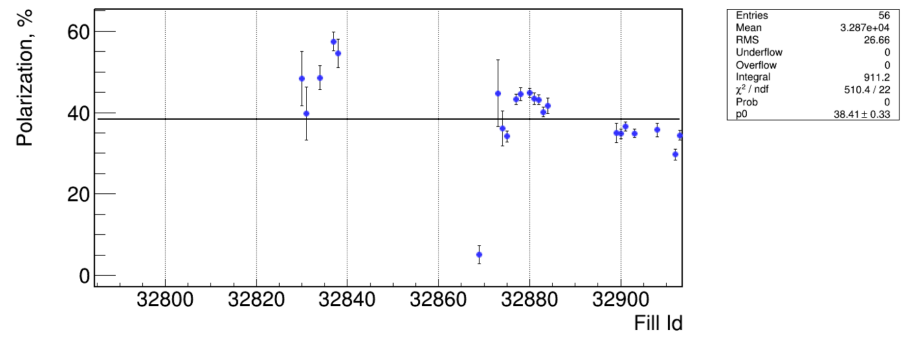
E.C. Aschenauer



Electron-Ion Collider

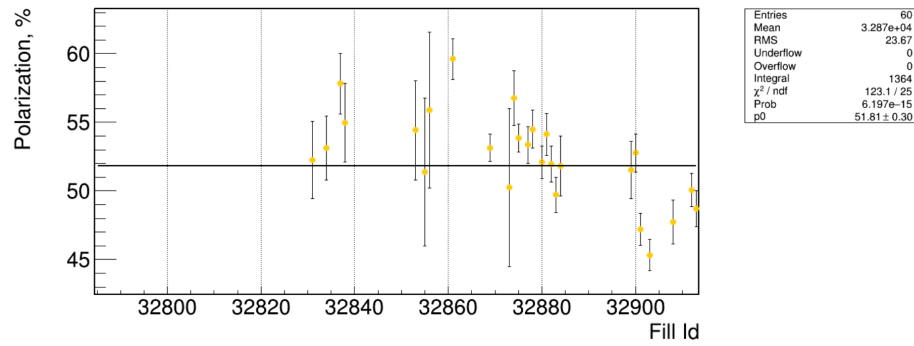
Measurements by pC

Fills 32785--32913, Analyzed Tue Dec 28 11:14:01 2021, Version v2.2.10M, zchang



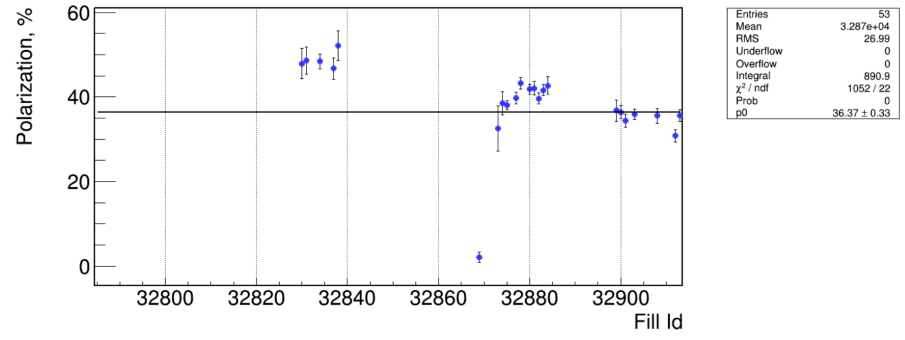
B1U

Fills 32785--32913, Analyzed Tue Dec 28 11:14:01 2021, Version v2.2.10M, zchang



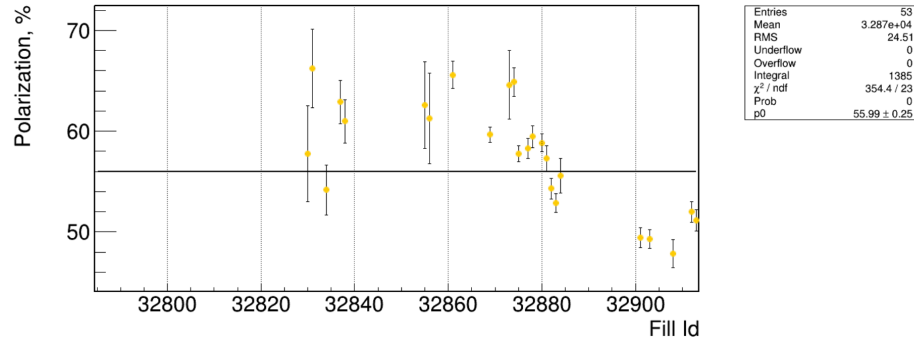
Y2U

Fills 32785--32913, Analyzed Tue Dec 28 11:14:01 2021, Version v2.2.10M, zchang



B2D

Fills 32785--32913, Analyzed Tue Dec 28 11:14:01 2021, Version v2.2.10M, zchang



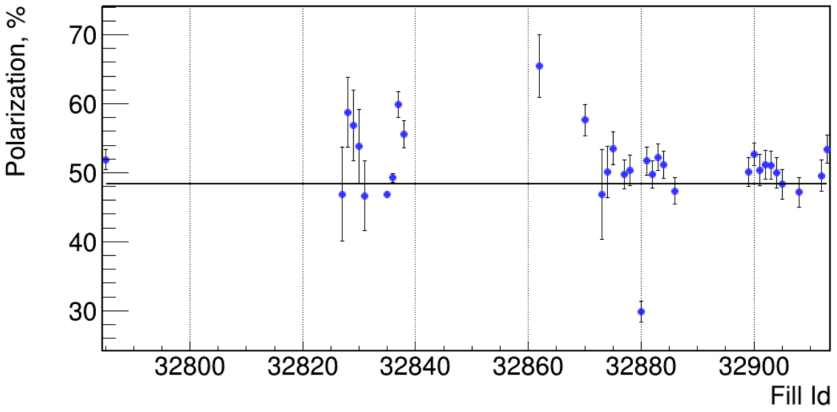
Y1D

→ Yellow polarization is also on the low site in the last fills
 → 2017 – values: Blue: 54.7 Yellow: 55.8



Polarization at Injection & Ramp Efficiency

Fills 32785--32913, Analyzed Tue Dec 28 11:51:05 2021, Version v2.2.10M, zchang

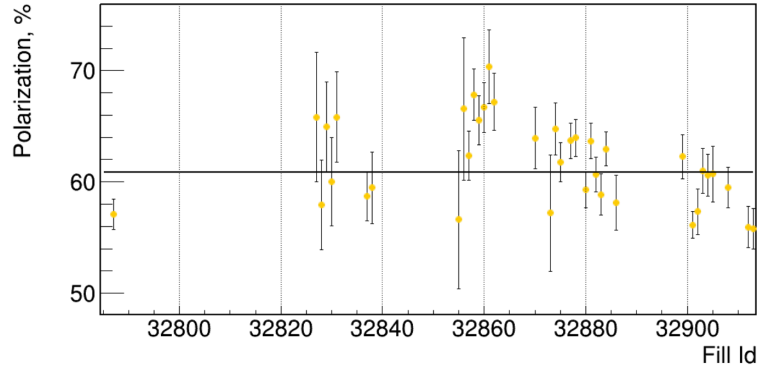


Entries	110
Mean	3.287e+04
RMS	32.04
Underflow	0
Overflow	0
Integral	1686
χ^2 / ndf	301.4 / 32
Prob	1.401e-45
p0	48.3 ± 0.2

BIU

Polarization@24 GeV

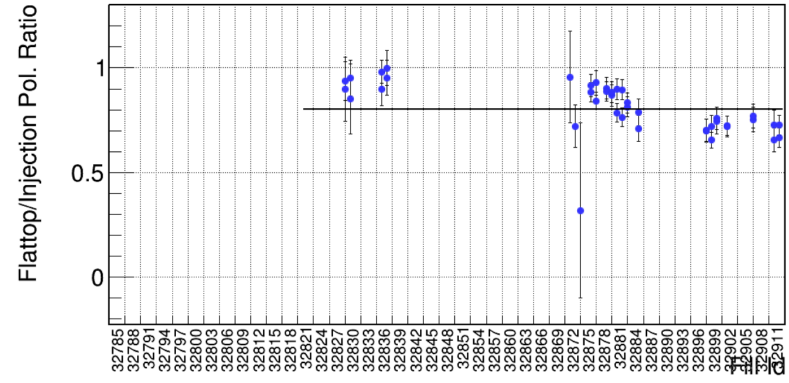
Fills 32785--32913, Analyzed Tue Dec 28 11:51:05 2021, Version v2.2.10M, zchang



Entries	55
Mean	3.287e+04
RMS	28.47
Underflow	0
Overflow	0
Integral	2281
χ^2 / ndf	102.8 / 36
Prob	2.406e-08
p0	60.88 ± 0.34

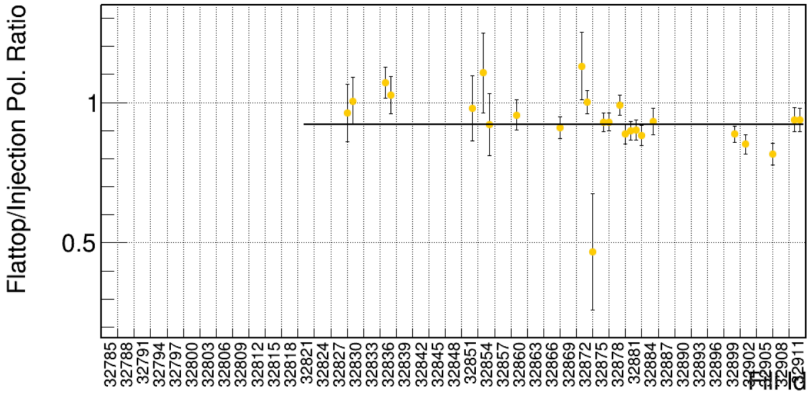
Y1D

Fills 32785--32913, Analyzed Tue Dec 28 11:51:05 2021, Version v2.2.10M, zchang



χ^2 / ndf	116.3 / 40
Prob	2.232e-09
const	0.8013 ± 0.008773
σ_y	0.1245 ± 0

Blue



χ^2 / ndf	44.92 / 24
Prob	0.005952
const	0.9201 ± 0.008797
σ_y	0.1199 ± 0

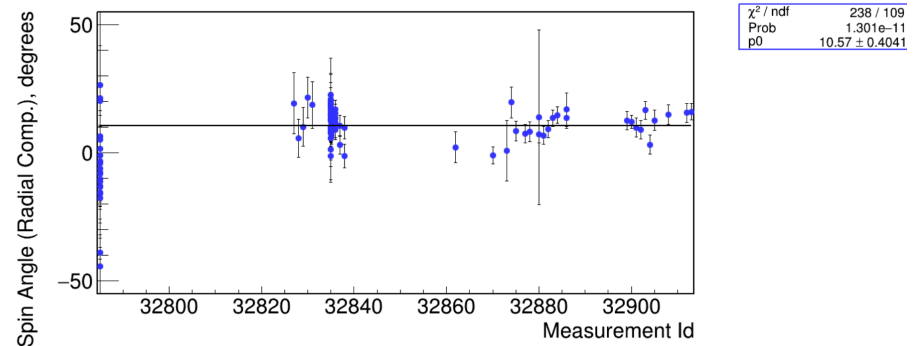
Yellow



Polarization direction at pC

24 GeV

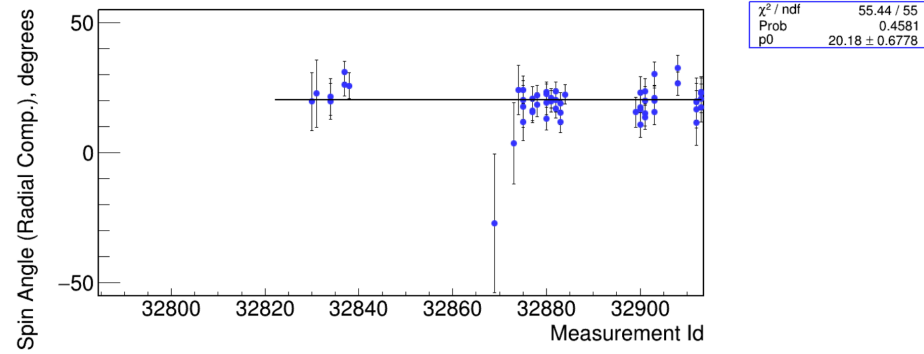
Fills 32785--32913, Analyzed Tue Dec 28 11:14:01 2021, Version v2.2.10M, zchang



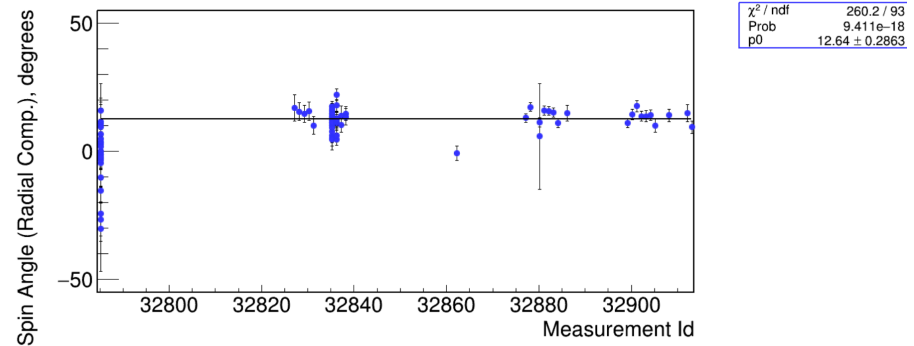
B1U

255 GeV

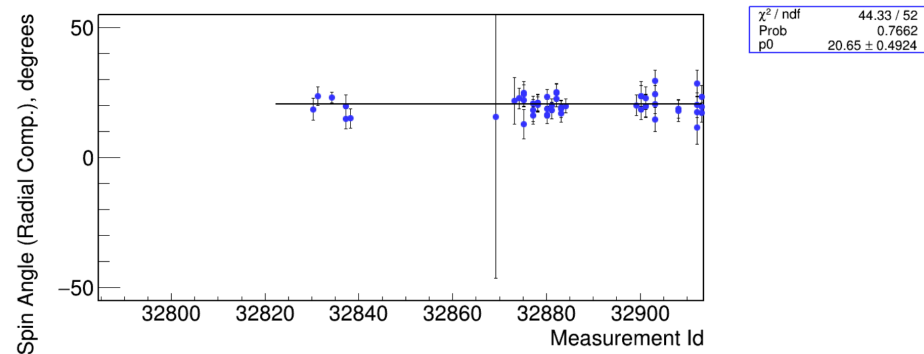
Fills 32785--32913, Analyzed Tue Dec 28 11:14:01 2021, Version v2.2.10M, zchang



B1U



B2D



B2D

spin tilts @ store

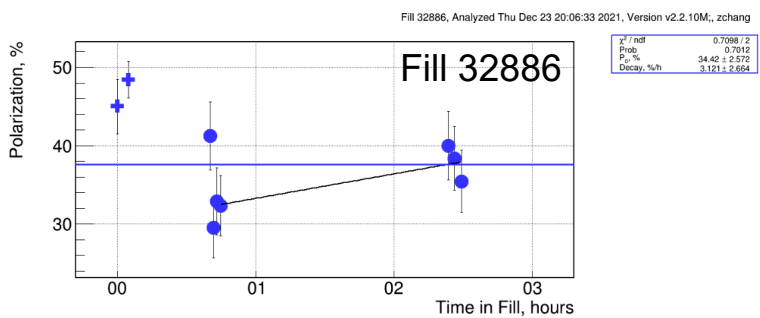
$\phi_{pC} (^{\circ})$	Blu	Yel
Run9-100	6	5
Run11-250	3	1
Run12-100	3	3
Run12-255	11	7
Run13-255	16	9
Run15-100 pp	3	2
Run15-104 pAu	0	-
Run15-104 pAl	1	-
Run17-255	12	8

Blue:
 $+\phi_{pC}$: spin tilted towards ring - inside

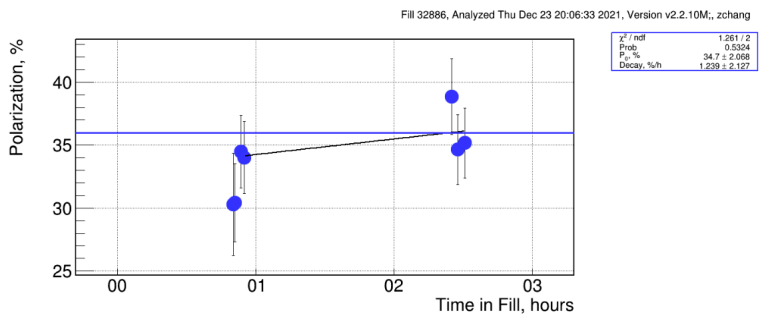
2022: no spin tilt in yellow at injection and at flat top

Beam Energy Scan

Ggamma	485	485.5	486	486.5	487
Brho [Tm]	846.6492256	847.5220718	848.3949179	849.2677641	850.1405896
pc [GeV]	253.8190524	254.0807251	254.3423978	254.6040705	254.865737

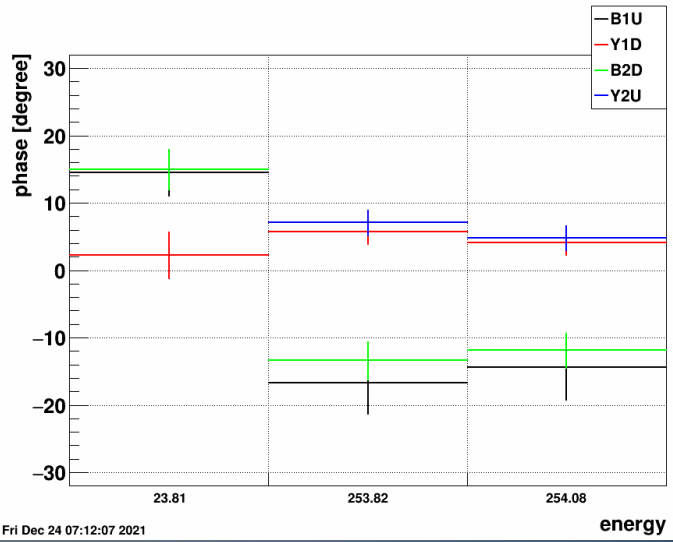
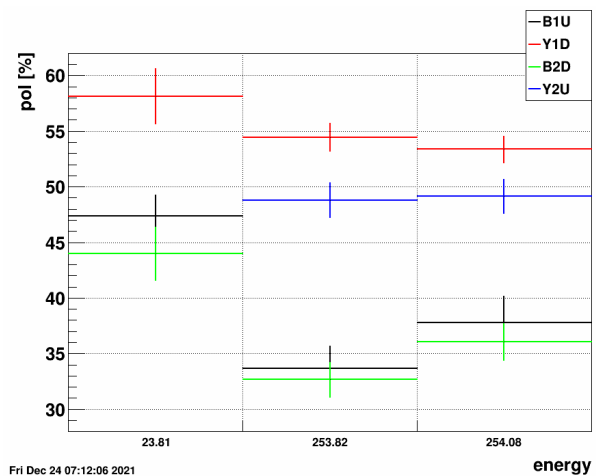


B1U



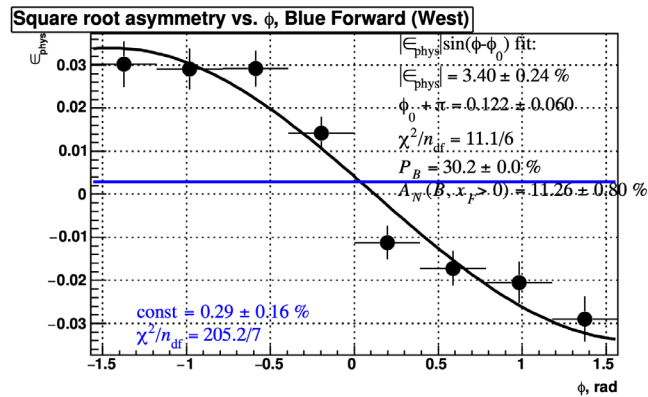
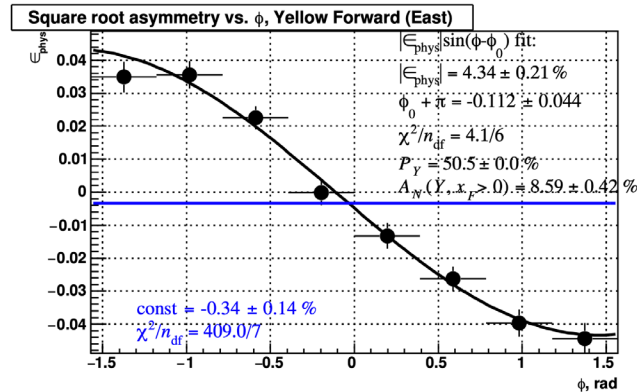
B2D

Change in **Blue** polarization moving longitudinal spin into transverse direction
Yellow remained in statistics the same



STAR Local Polarimetry

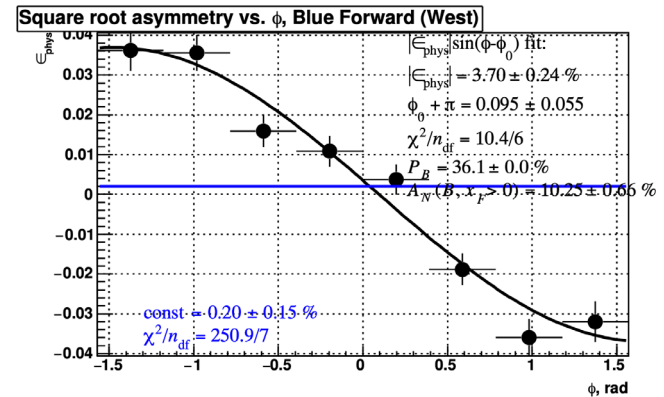
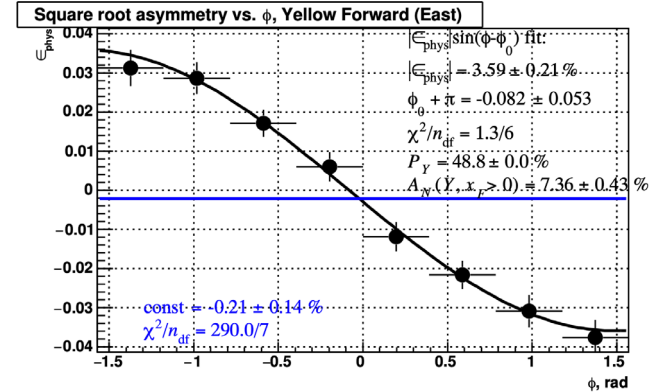
Fill 32912



ZDC Single Spin Asymmetry (run 22361028)

Mon Dec 27 18:53:55 2021

Fill 32913



ZDC Single Spin Asymmetry (run 22362007)

Tue Dec 28 02:58:52 2021

- Small radial component both in Yellow and Blue
- pC significant radial component
- Blue: transverse component at IP6 and pC are different
- A_N Yellow \neq A_N Blue

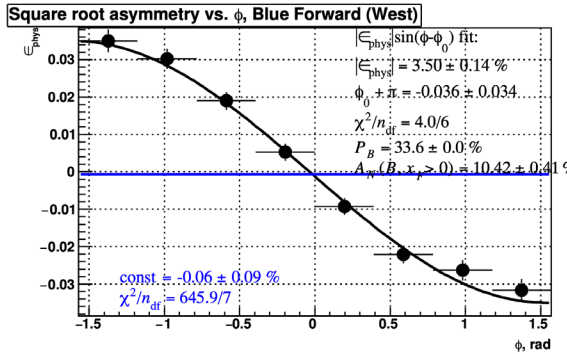
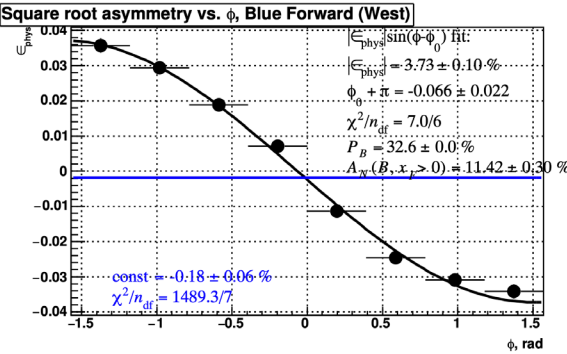
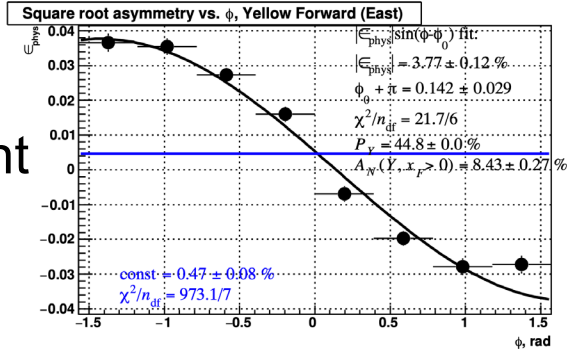
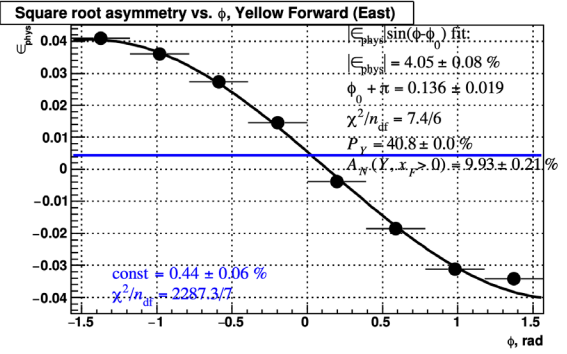
longitudinal component at IP-6 and pC need to be determined through machine studies

Electron-Ion Collider

STAR Local Polarimetry Energy Scan

Ggamma	485	485.5	486	486.5	487
Brho [Tm]	846.6492256	847.5220718	848.3949179	849.2677641	850.1405896
pc [GeV]	253.8190524	254.0807251	254.3423978	254.6040705	254.865737

radial component
in Yellow



ZDC Single Spin Asymmetry (run 22357034)

Thu Dec 23 13:31:14 2021

ZDC Single Spin Asymmetry (run 22357039)

Thu Dec 23 14:55:49 2021

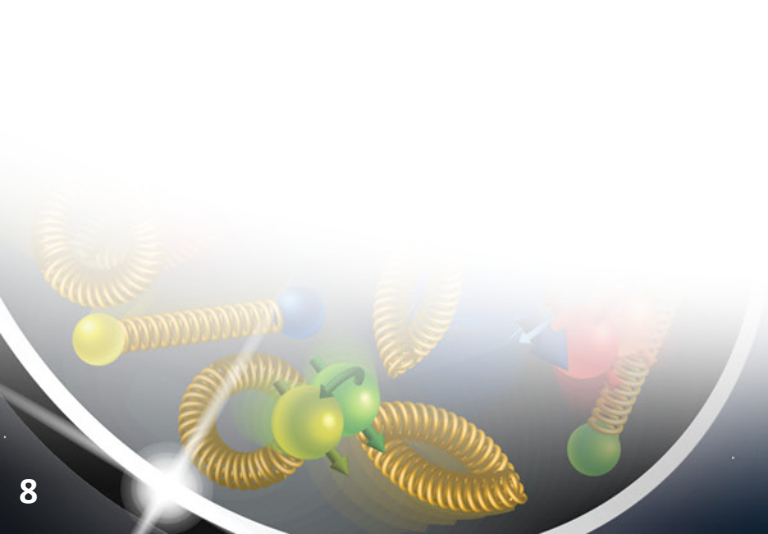
very small radial component
in Blue
transverse component at pC < STAR

no radial component
in Blue
transverse component at pC & STAR

agree a bit better
Electron-Ion Collider

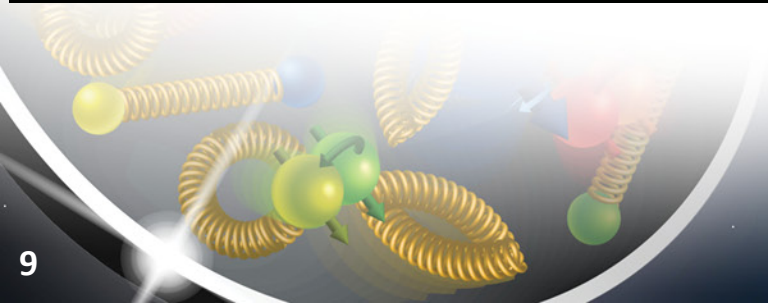
Summary

- Transverse component at STAR and pC are different
 - transverse component at STAR seems bigger as at pC
 - What do the spin tracking results show/predict?
 - ✓ do we have the same spin direction at H-jet and pC?
- No clear idea about longitudinal component
 - ➔ really need to do a systematic check
 - ✓ continue energy scan
 - ✓ turn on rotator around STAR

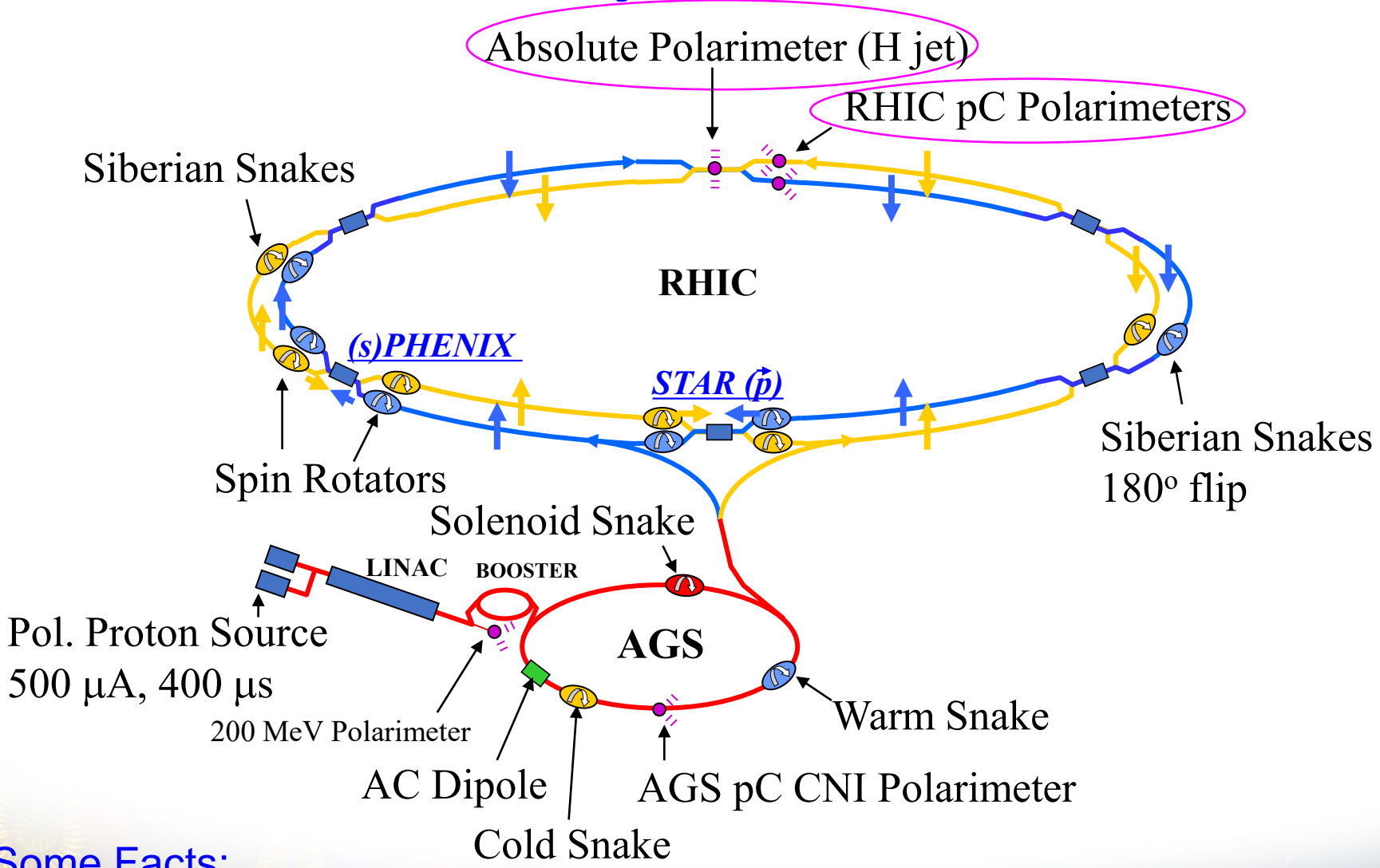




BACK UP



RHIC and Polarimetry

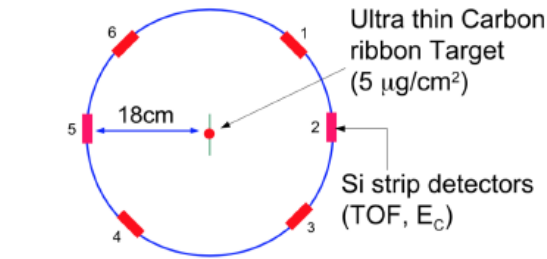
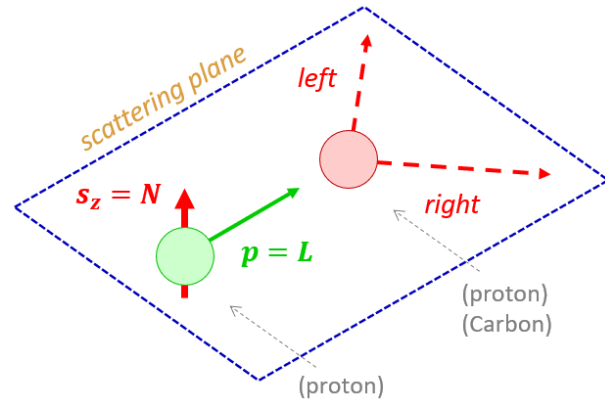
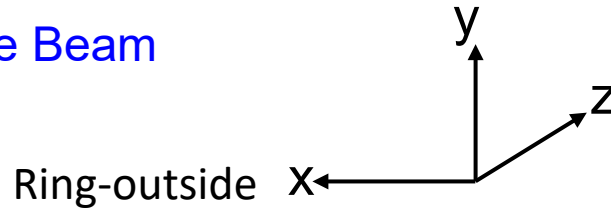


Some Facts:

CDEV spin direction the one at the source, id even spin flips source to RHIC
 IP-12 spin direction and source are the same \rightarrow IP-6 spin direction == **-IP-12**

pC Polarimetry

Coordinate System: → Blue Beam



Note:

$$\Phi = 0 = +y$$

For yellow beam x-axis is flipped
+x points ring-inside

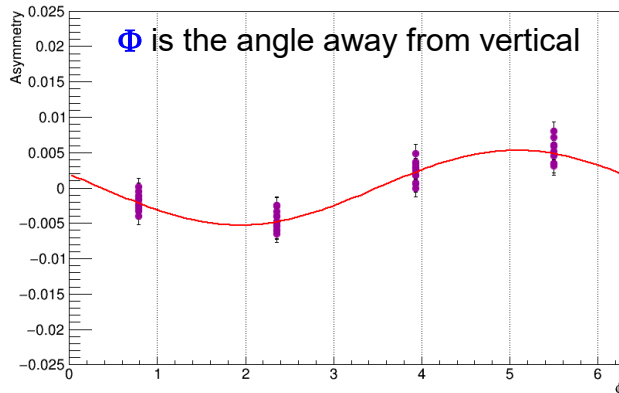
spin tilts @ store

$\phi_{pC} (^{\circ})$	Blu	Yel
Run9-100	6	5
Run11-250	3	1
Run12-100	3	3
Run12-255	11	7
Run13-255	16	9
Run15-100 pp	3	2
Run15-104 pAu	0	-
Run15-104 pAl	1	-
Run17-255	12	8

Blue:

+ ϕ_{pC} : spin tilted
towards ring - inside

32877.202: Recorded Mon Dec 20 20:27:03 2021, Analyzed Mon Dec 20 21:17:50 2021, Version v2.2.10M,, zchang



χ^2 / ndf 57.37 / 45
Prob 0.1021
Asym 0.005293 ± 0.0002589
 ϕ 0.365 ± 0.04764

B2D

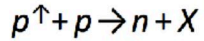
Run22 24 GeV 8-10 0
Run22 255 GeV 20 0

Polarimeter-Info: <https://www.cnipol.bnl.gov/rundb/>

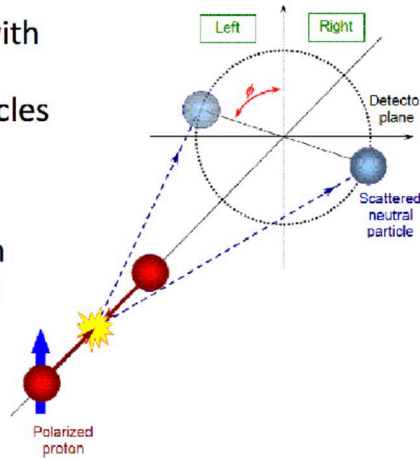
STAR Local Polarimetry

Single-spin asymmetry at zero angle

Hadronic calorimeter equipped with Shower Maximum Detector detects very forward neutral particles

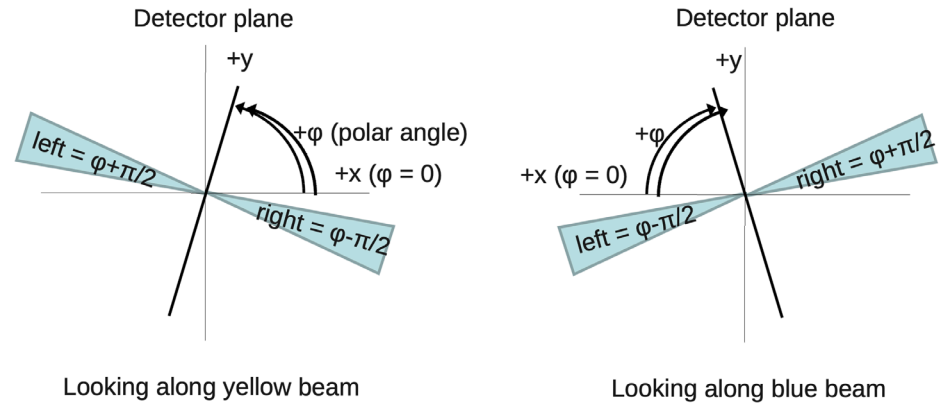


Large asymmetry A_N of neutron production enables its use as a local polarimeter

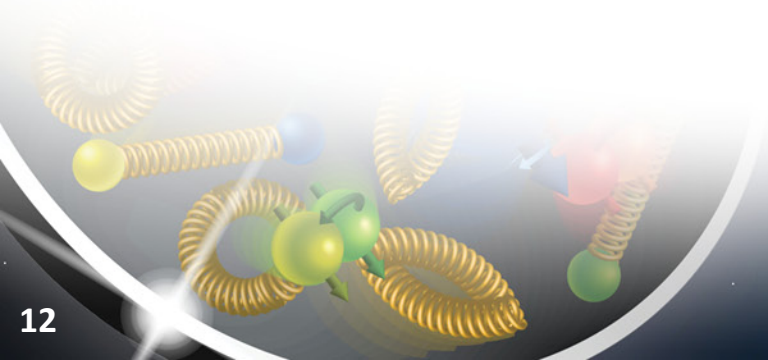


Local polarimeter normally used to ensure beam is longitudinal if spin rotators are used
 $\rightarrow A_N$ disappears if spin is longitudinal

Geometry definition

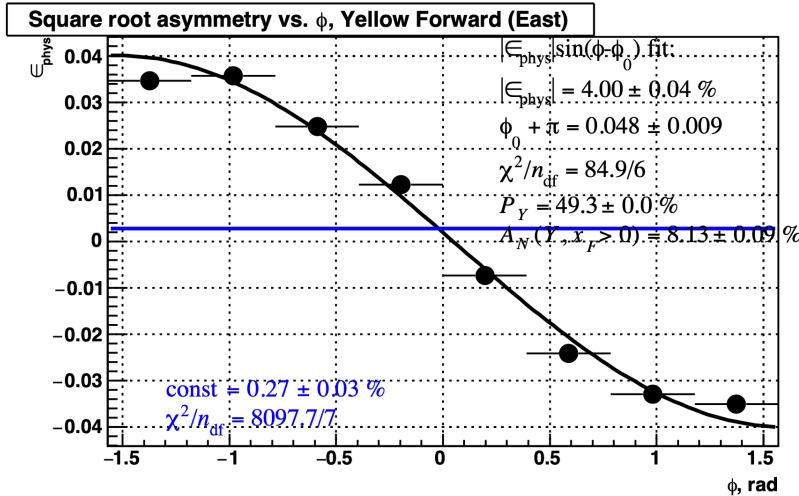


ϵ_{phys} is a left-right asymmetry with respect to $\varphi = \text{const}$ plane, looking along the incident beam



STAR Local Polarimetry

Run-17

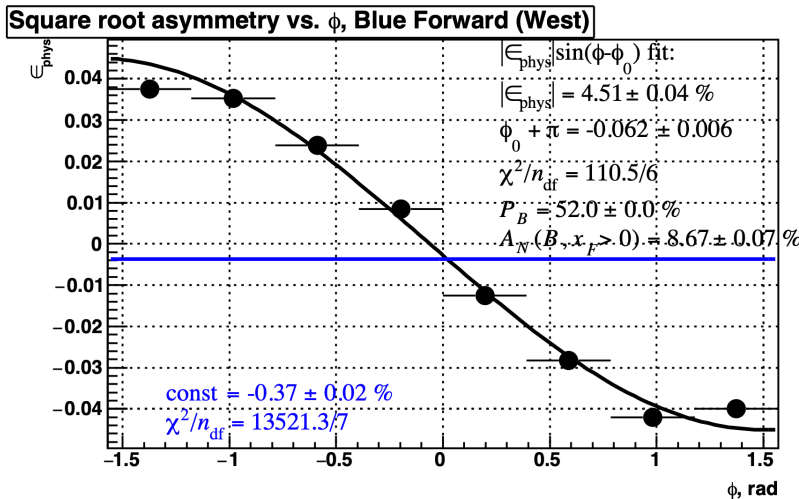


Note:

$$1/P \times \epsilon_{\text{phys}} = A_N$$

$$A_N \text{ Yellow} = A_N \text{ Blue}$$

$$\frac{e_{\text{Phys}}^{\text{Blue}}}{e_{\text{Phys}}^{\text{Yellow}}} = \frac{P_B}{P_Y}$$



All worked out in Run-17

ZDC Single Spin Asymmetry (run 18074020)

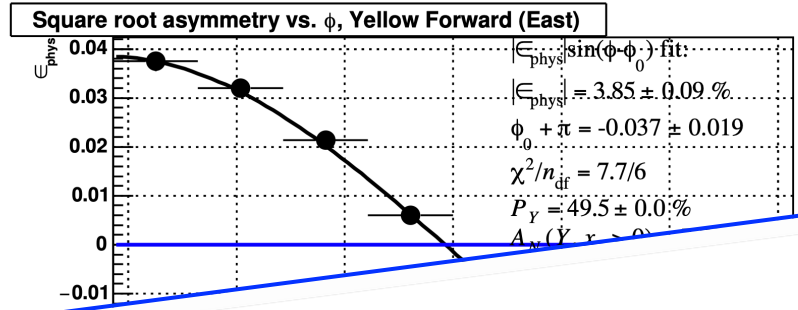
Wed Mar 15 09:34:01 2017

STAR Local Polarimetry

Run-22 – Result from last Tuesday

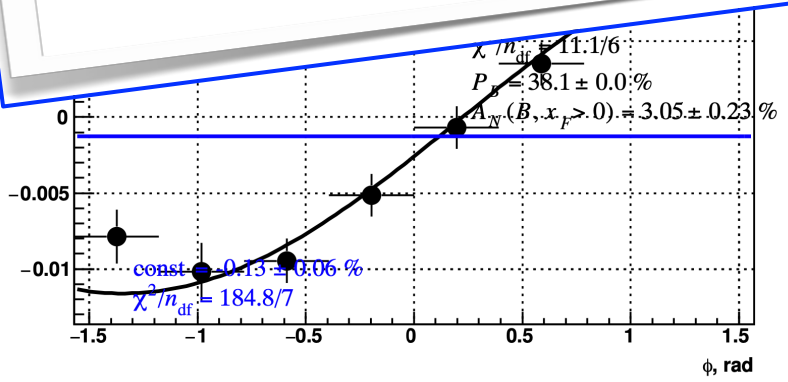
Note:
 $1/P \times \epsilon_{\text{phys}} = A_N$

$A_N \text{ Yellow} = A_N \text{ Blue}$



BUT

can the difference in spin direction between IP-6 and IP-12 be soo big
 Result also inconsistent with spin tracking simulations
 → let's dig a bit deeper



side do not agree
 still different by 2.55

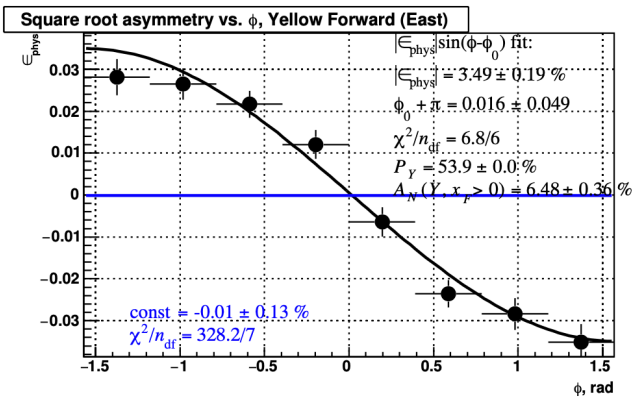
this would need P_{Blue} to be significantly higher

→ only explanation
 significant longitudinal component at STAR

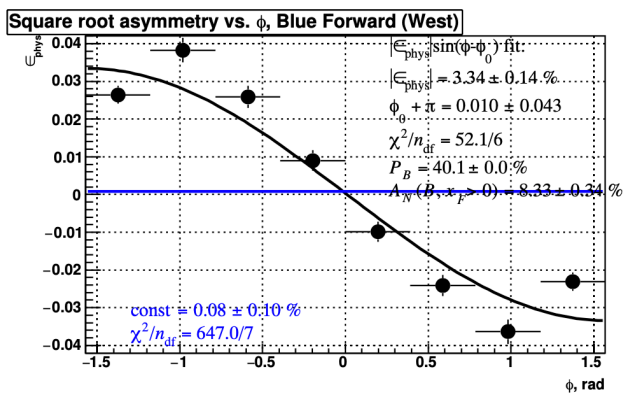
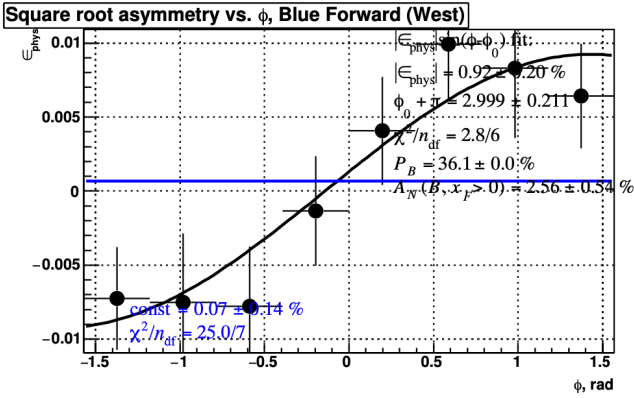
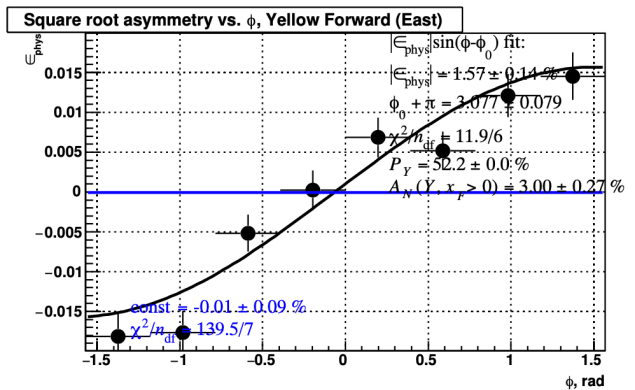
ZDC Single Spin Asymmetry (run 22355037)

STAR Local Polarimetry

Fill 32881



Fill 32882



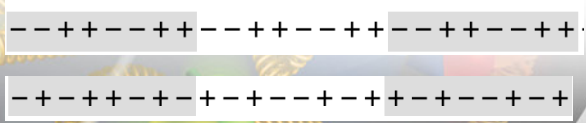
ZDC Single Spin Asymmetry (run 22356039)

Wed Dec 22 18:58:12 2021

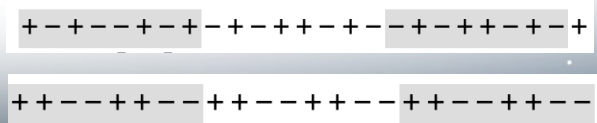
ZDC Single Spin Asymmetry (run 22356048)

Wed Dec 22 19:14:02 2021

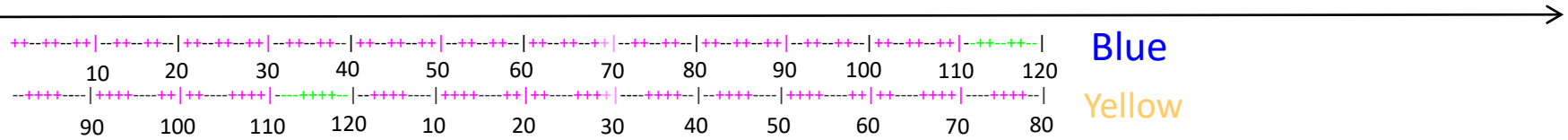
Only change between fills the spin pattern



Yellow
Blue



STAR Local Polarimetry



green bunches: empty bunches → abort gaps

For local polarimetry it is critical to have bunch – id and spin direction at STAR correctly correlated

→ Till 2017: reference was blue beam

Somewhen this was switched to yellow beam, maybe during BES fixed target running

→ Local Polarimeter code was not modified 

Fun Facts:

does not matter a lot for `---+---+---+---+---+---+---+---+` spin patterns

→ Therefore, Yellow agreed between 2017 and 2022 and Blue was screwed up

