

PHENIX Local Polarimeter

Sanghwa Park
(SNU/RIKEN)

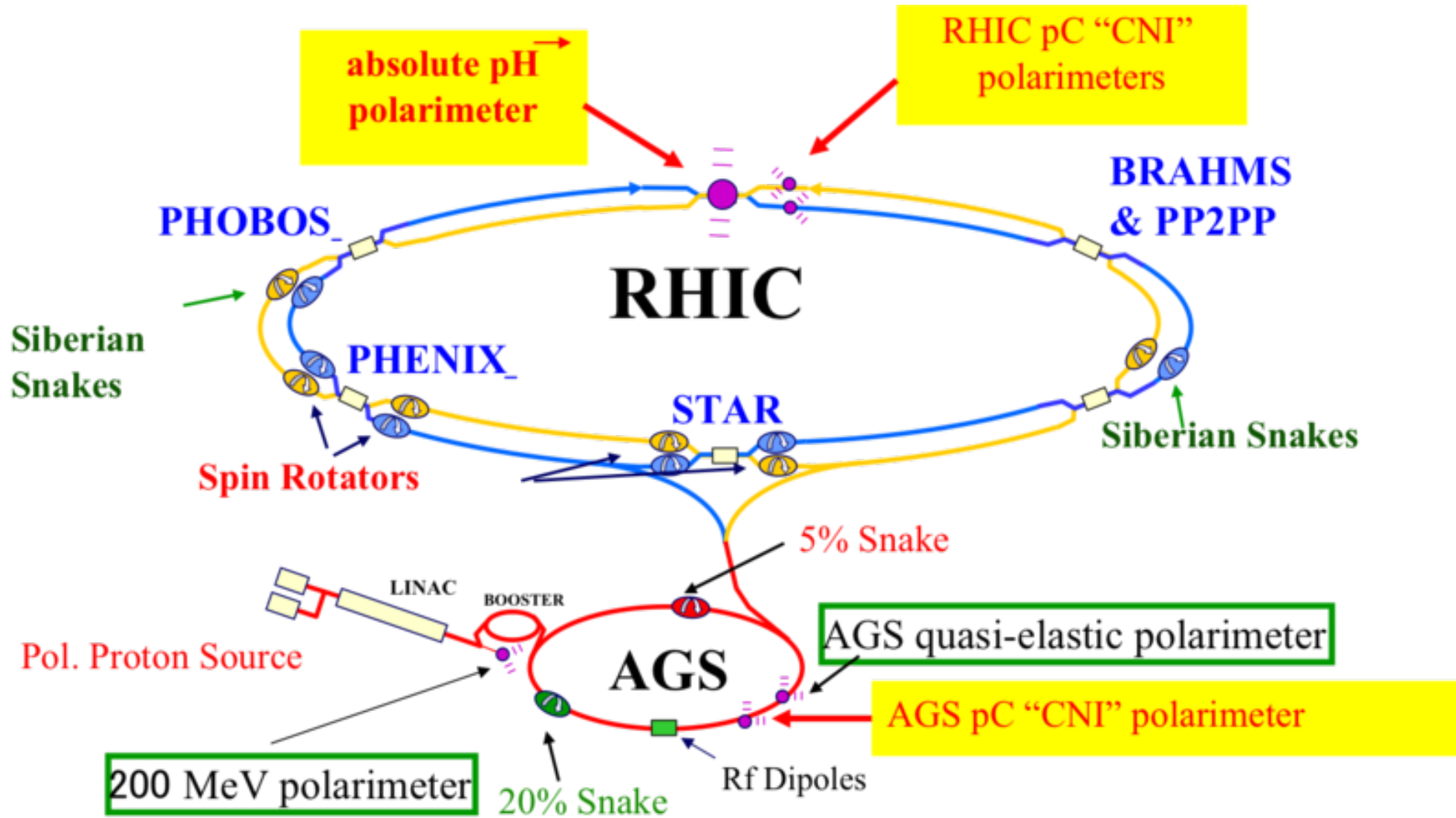
Local Polarimetry

- What does “Local” polarimetry mean?
- Why do we need it? (why is it important?)
- How do we use it?
- How do we analyze data?

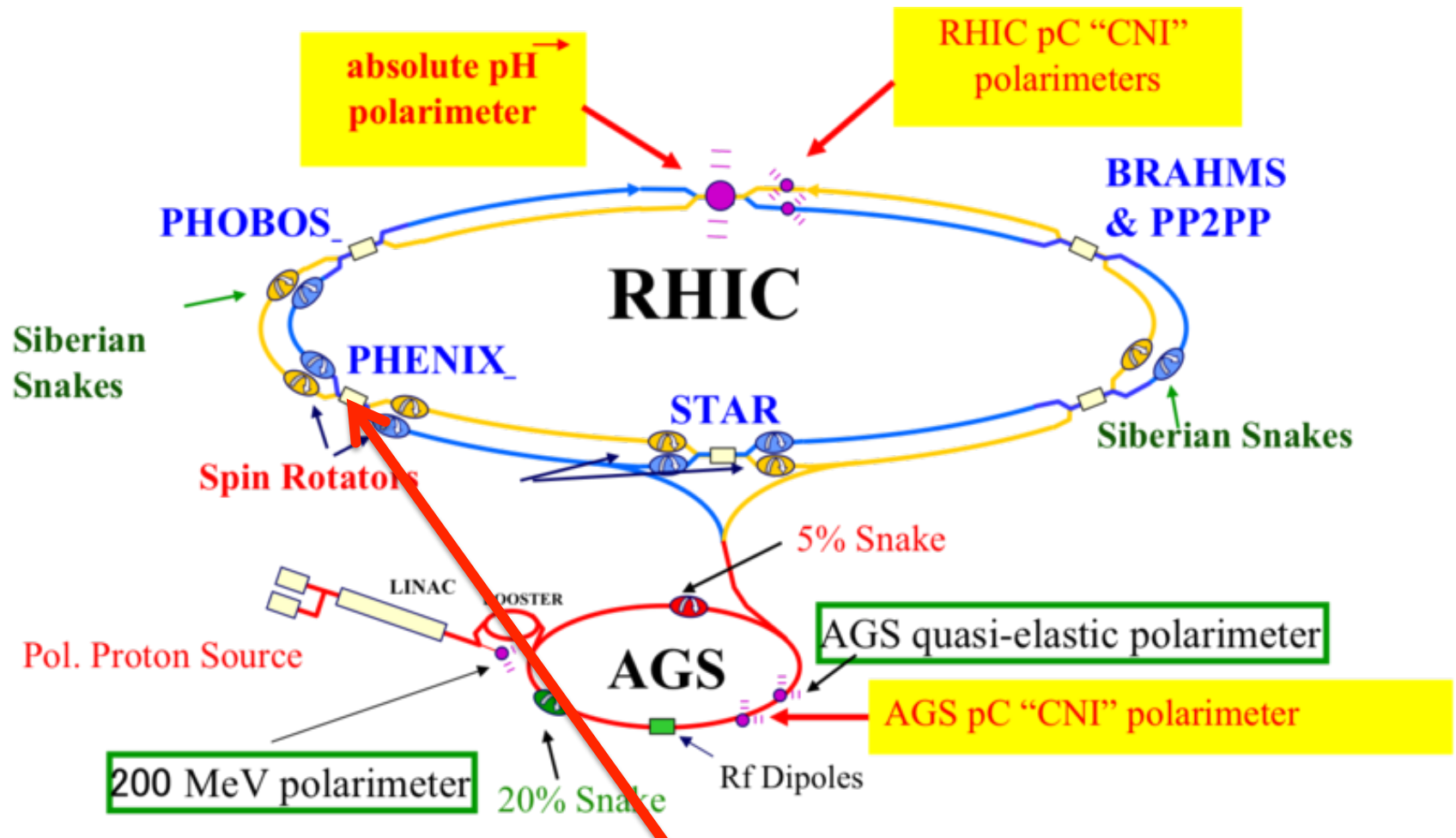
RHIC Polarimeters

- H-Jet
 - Absolute Polarization
 - Slow to get the measurement
- pC
 - Carbon target
 - Very fast, but relative polarization.
- “Local” Polarimeters (in PHENIX and STAR)

RHIC Polarimetry



RHIC Polarimetry

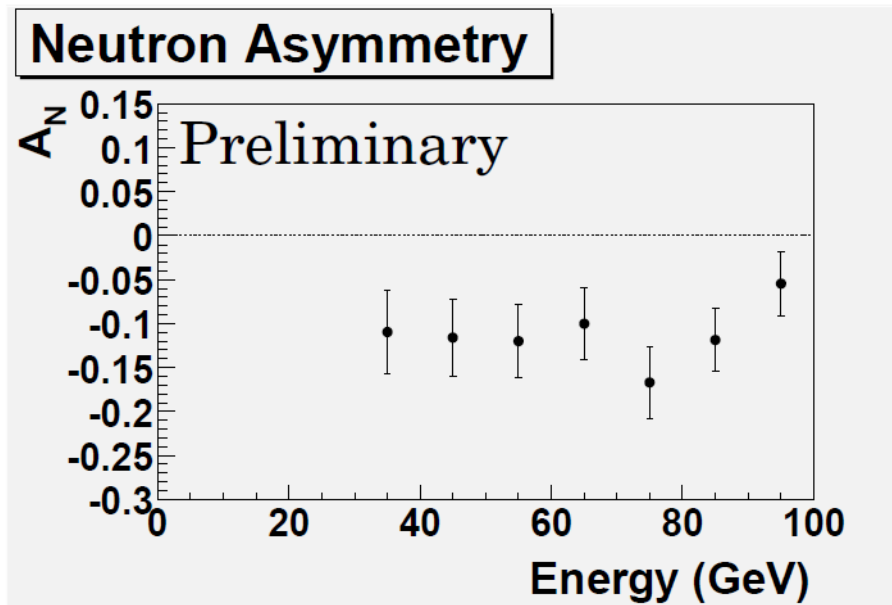


How the beam polarization is at the experiment area?

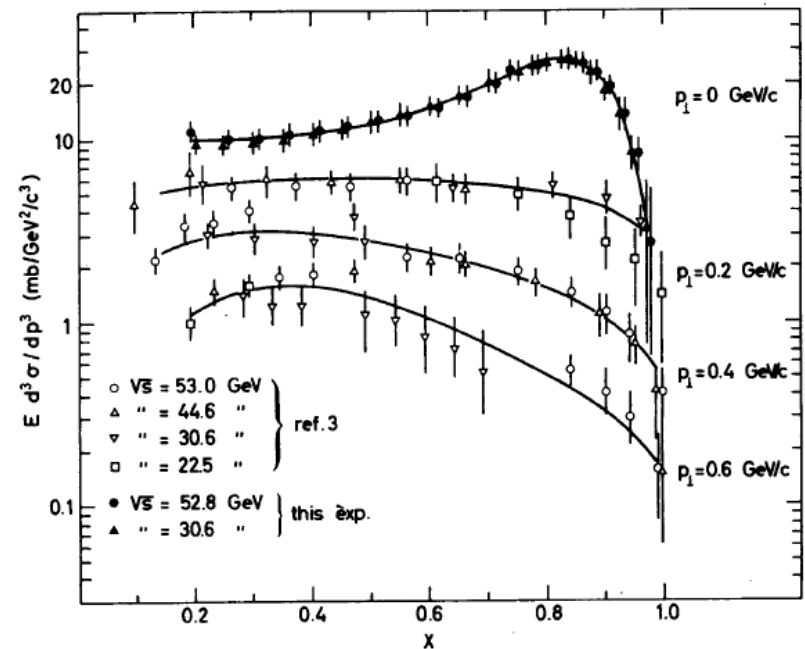
very important for the longitudinal spin physics

How do we monitor the beam polarization?

- Neutron Production in polarized pp collisions at very forward region
- A_N measured in IP12 experiment

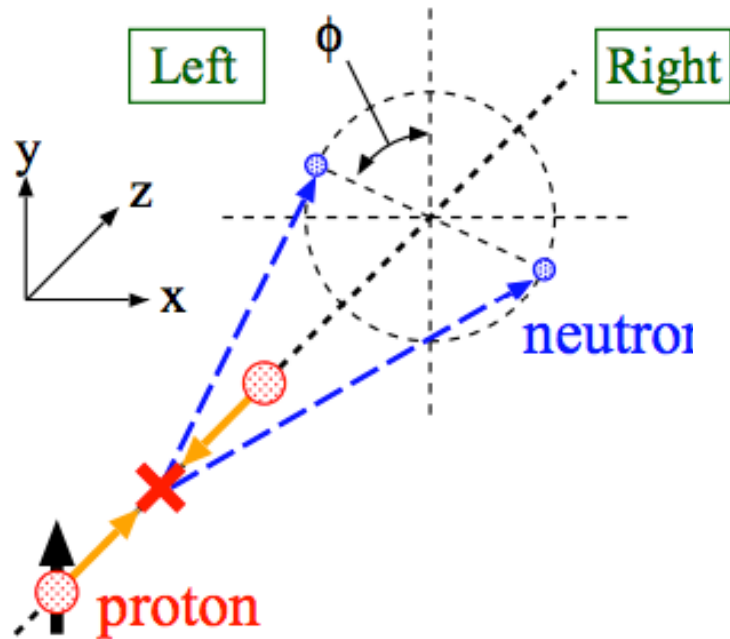


$\langle A_N \rangle = -0.110 \pm 0.015$
(Hadron Calorimeter)



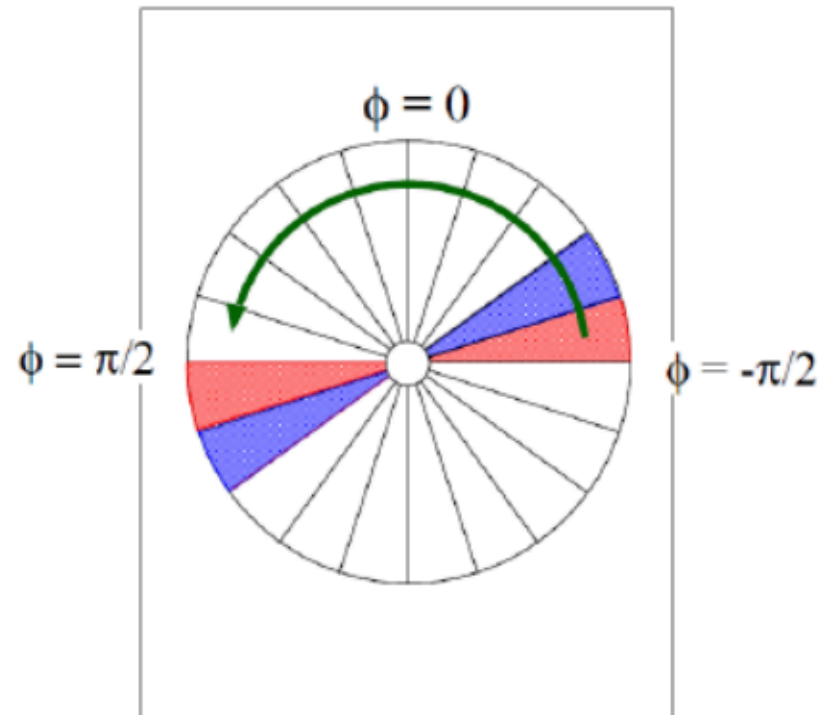
Neutron xsec from ISR experiment

Basic picture of Local Pol.

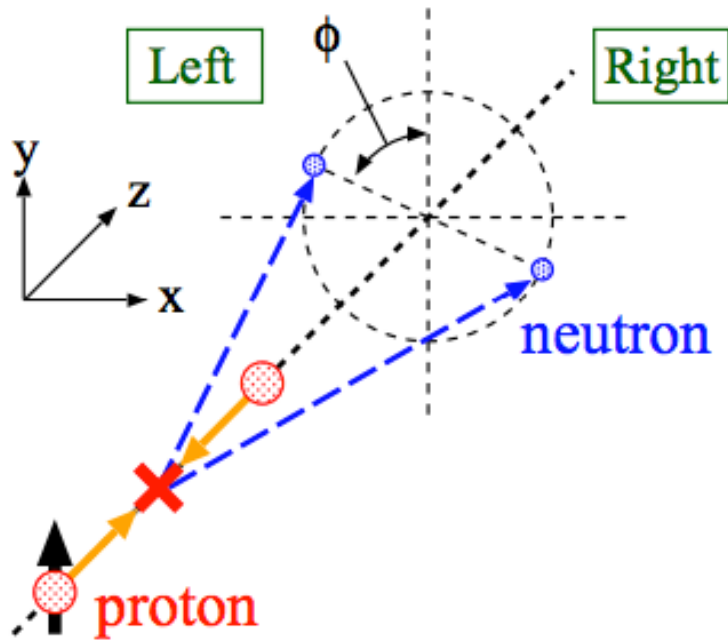


Rotator OFF

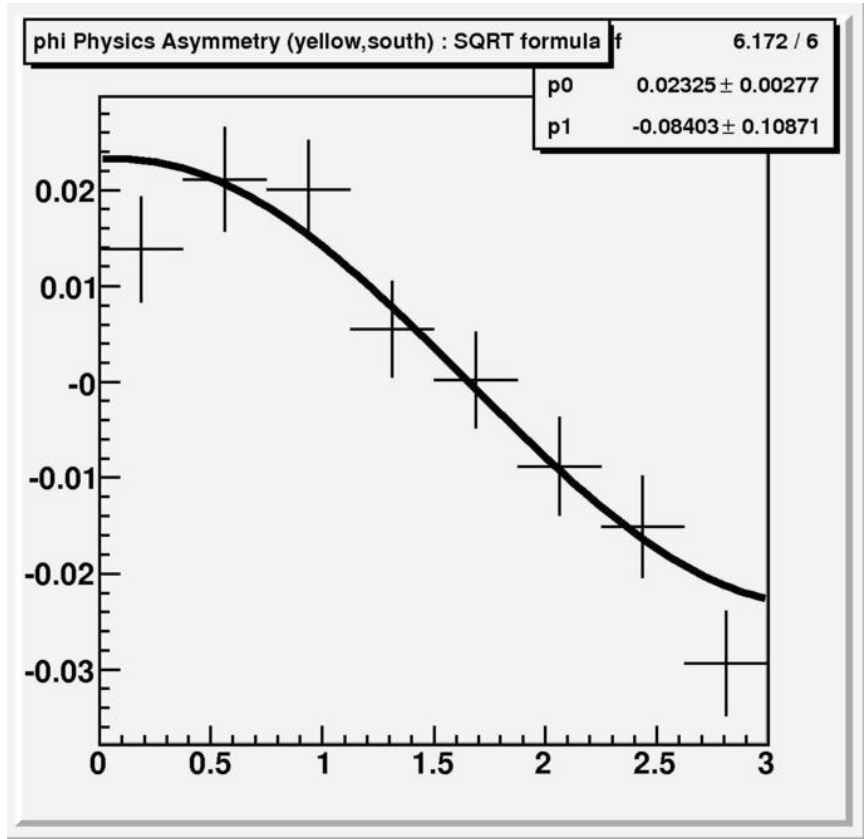
Azimuthal angle dependence of the asymmetry \rightarrow phi asymmetry



Basic picture of Local Pol.

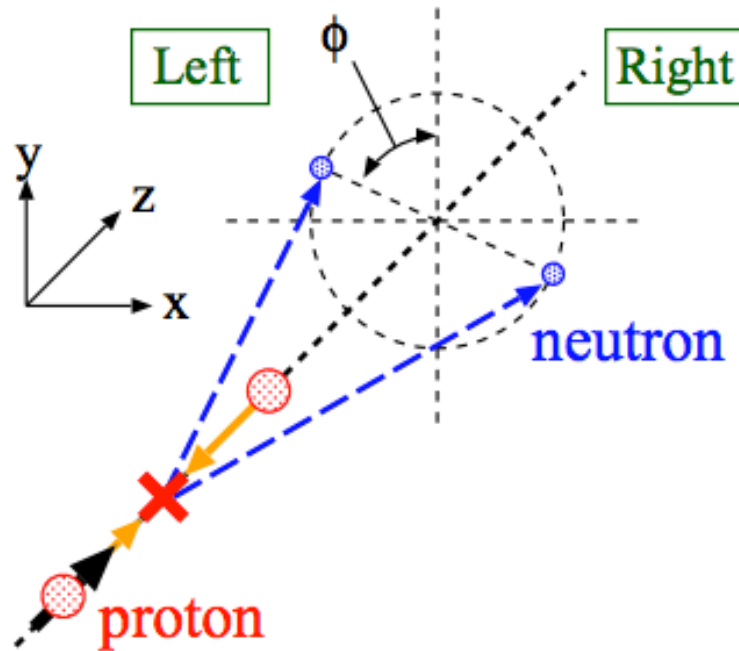


Rotator **OFF**
(transverse running)

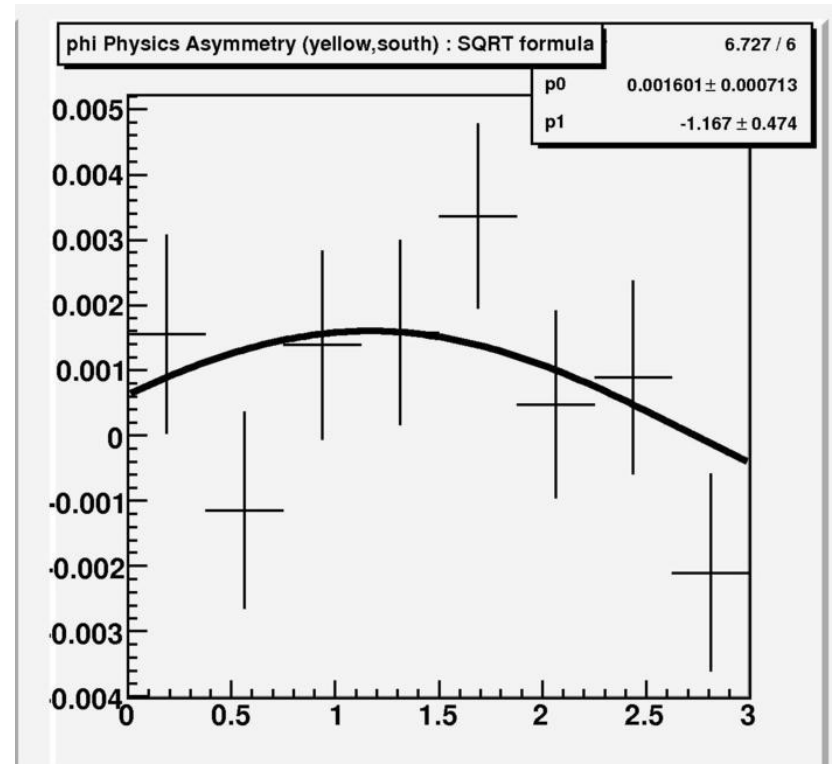


Yellow beam, phi asymmetry (Run11)

Basic picture of Local Pol.

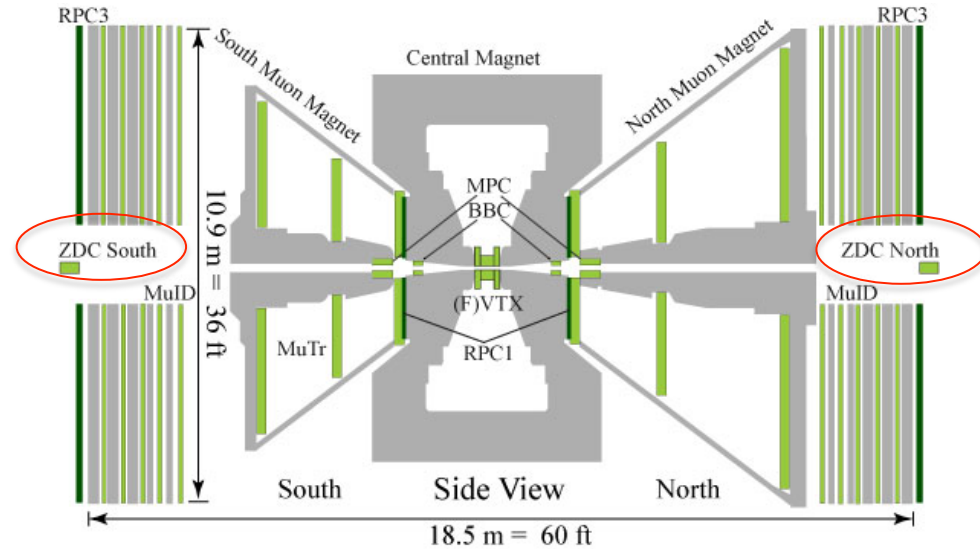
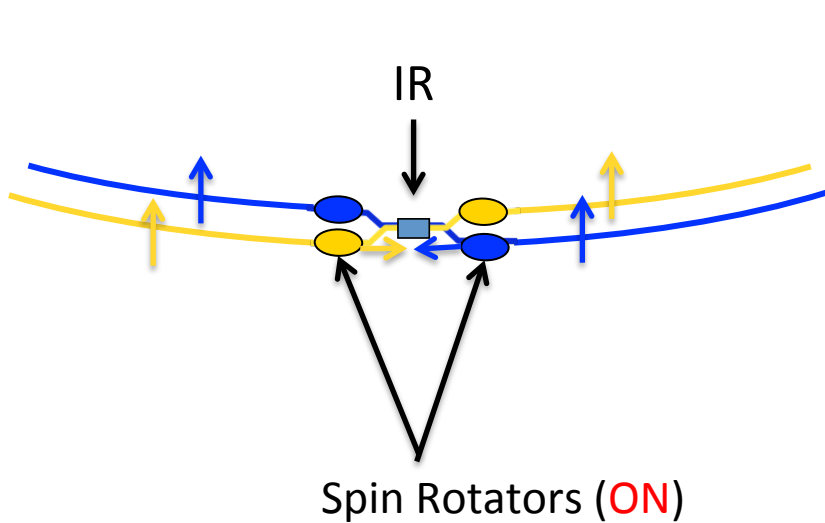


Rotator **ON**
(longitudinal running)



Yellow beam, phi asymmetry (Run11)

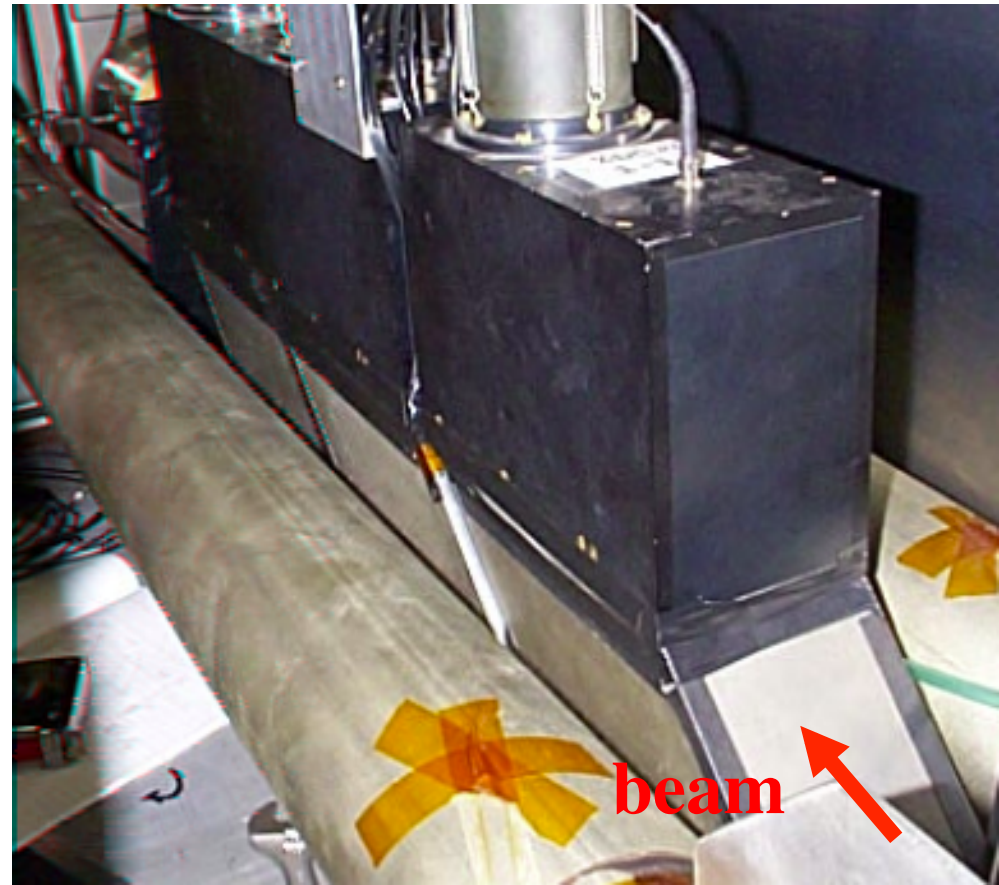
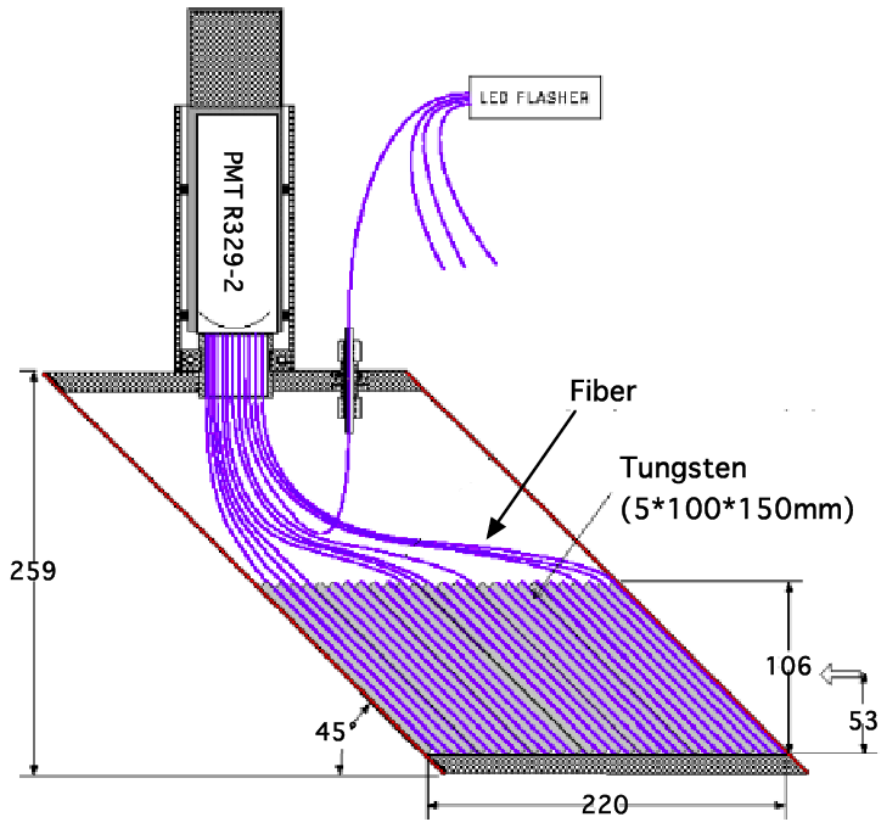
Let's have closer look..



- PHENIX has ZDC/SMD for local polarimetry at very forward region.
 - 3 ZDC (Zero Degree Calorimeter) for each south and north
 - SMD (shower Maximum Detector) between 1st and 2nd ZDC modules

ZDC/SMD

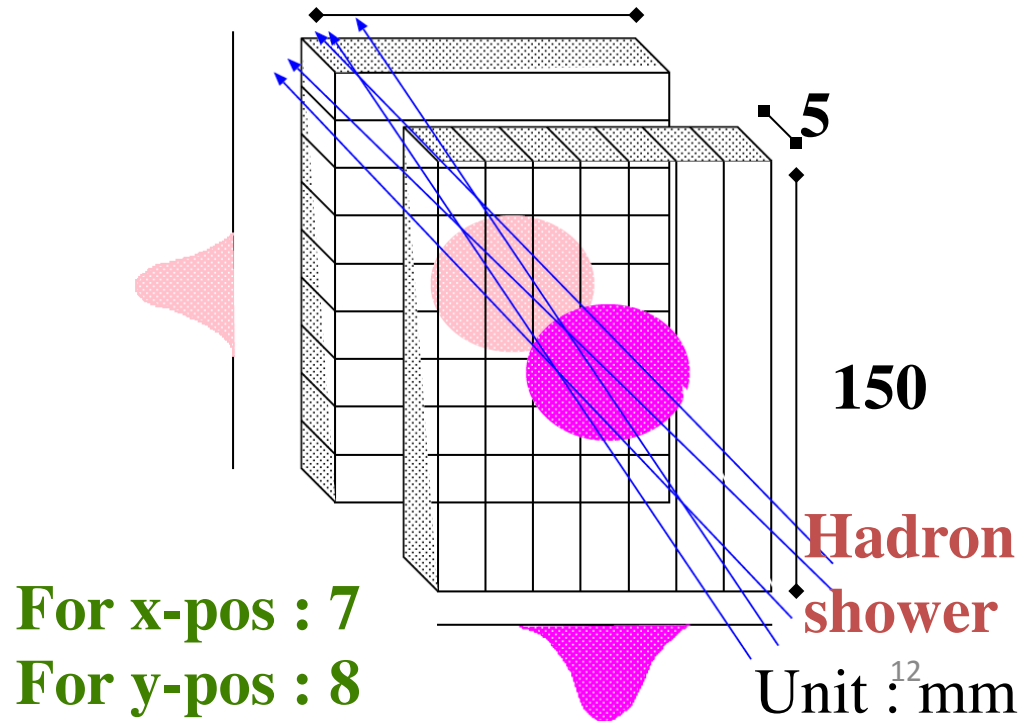
ZDC (Zero Degree Calorimeter)



ZDC/SMD



SMD (Shower Maximum Detector)



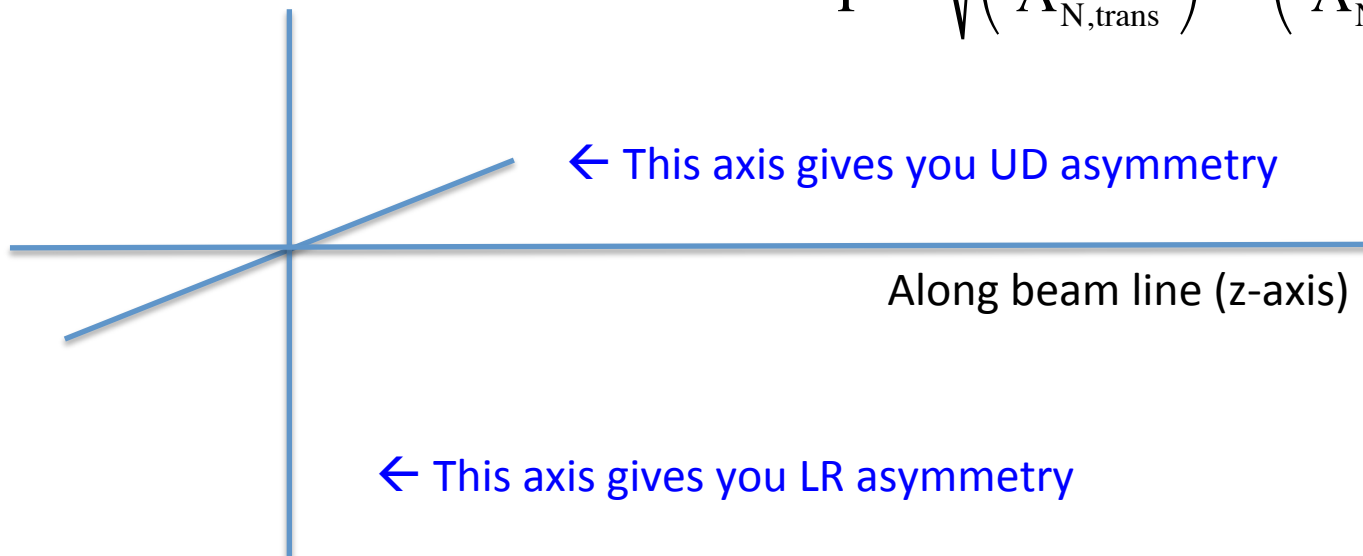
Basic picture of Local Pol.

- Square-root formula:

$$A_N = \frac{1}{P} \times \frac{\sqrt{N_L^\uparrow N_R^\downarrow} - \sqrt{N_R^\uparrow N_L^\downarrow}}{\sqrt{N_L^\uparrow N_R^\downarrow} + \sqrt{N_R^\uparrow N_L^\downarrow}} \quad (\text{in the same way, we can get UD asymmetry})$$

- Transverse component:

$$\frac{P_T}{P} = \sqrt{\left(\frac{A_{LR, \text{long}}}{A_{N, \text{trans}}}\right)^2 + \left(\frac{A_{UD, \text{long}}}{A_{N, \text{trans}}}\right)^2}$$



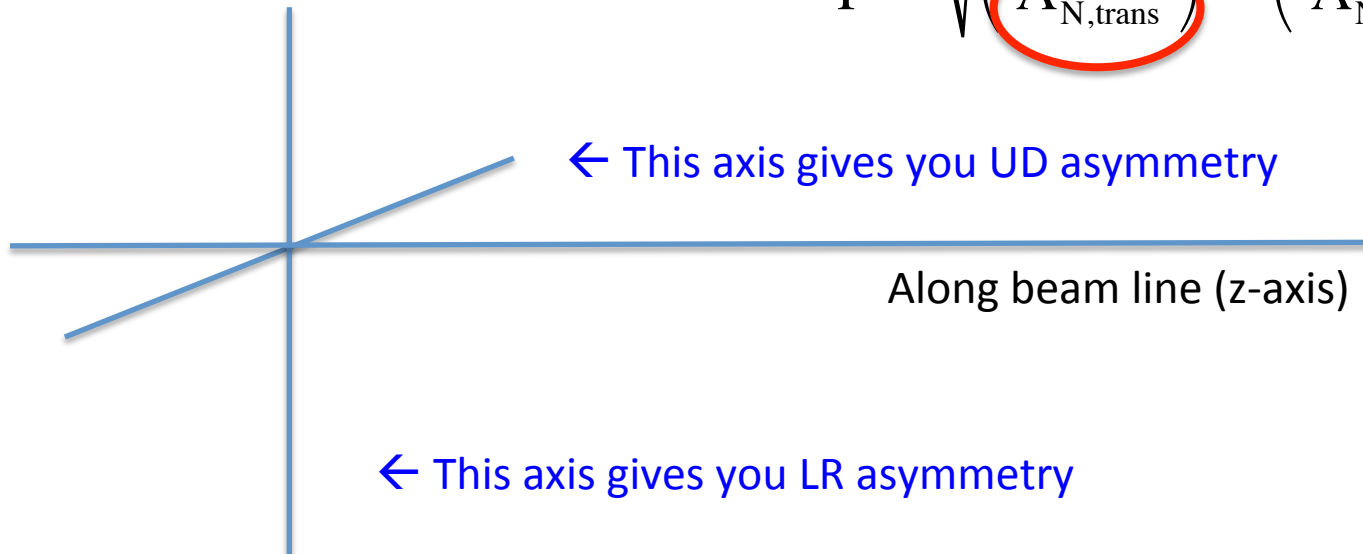
Basic picture of Local Pol.

- Square-root formula:

$$A_{LR} = \frac{1}{P} \times \frac{\sqrt{N_L^\uparrow N_R^\downarrow} - \sqrt{N_R^\uparrow N_L^\downarrow}}{\sqrt{N_L^\uparrow N_R^\downarrow} + \sqrt{N_R^\uparrow N_L^\downarrow}} \quad (\text{in the same way, we can get UD asymmetry})$$

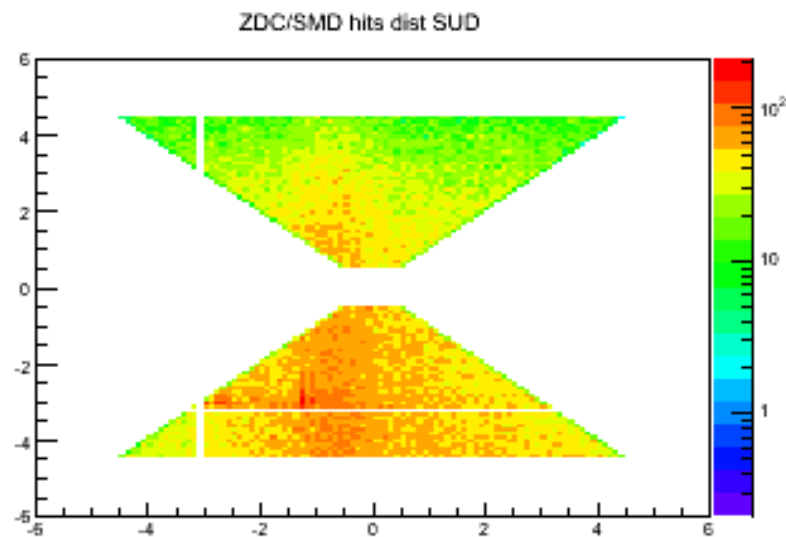
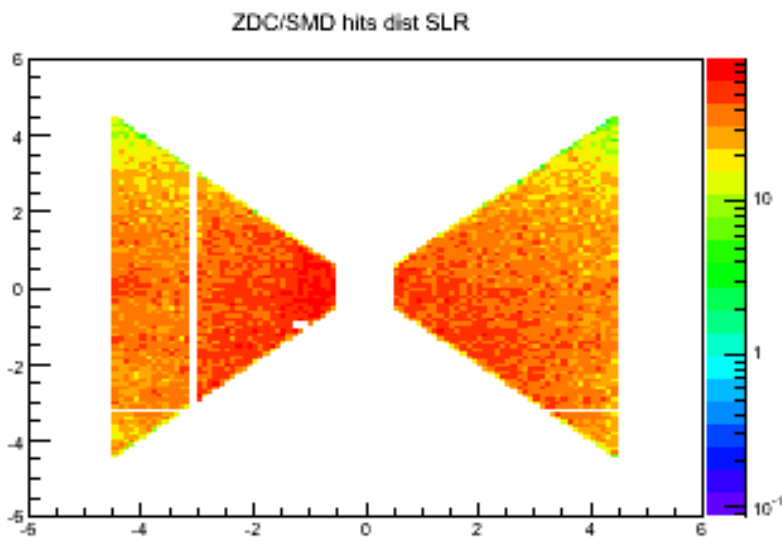
- Transverse component:

$$\frac{P_T}{P} = \sqrt{\left(\frac{A_{LR, \text{long}}}{A_{N, \text{trans}}} \right)^2 + \left(\frac{A_{UD, \text{long}}}{A_{N, \text{trans}}} \right)^2}$$



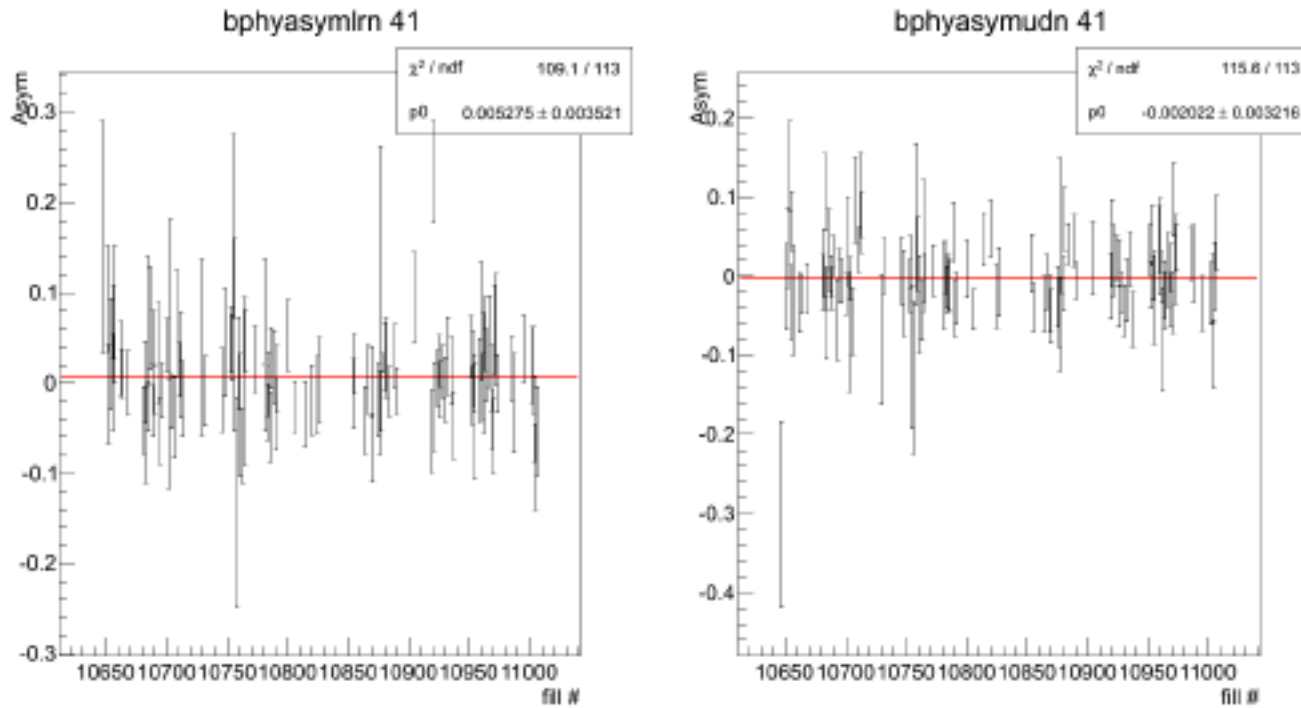
Basic picture of PHENIX Local Pol.

- Lpol Trigger: BBCL1(noVtx)&(ZDCN || S)
- Neutron identification:
 - 50 to 300 GeV (500GeV running)
 - signal for both x and y direction in the SMD



LR, UD acceptance, and the hit distributions on the face of ZDC

Run9 Results



Remaining transverse components:

$$0.113 \pm_{-0.076}^{+0.058} \text{ (stat) } \quad \text{for blue beam}$$

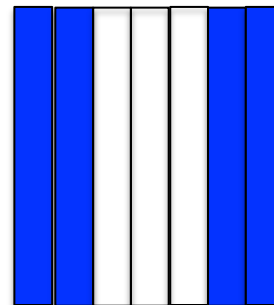
$$0.228 \pm_{-0.073}^{+0.065} \text{ (stat) } \quad \text{for blue beam}$$

Awesome Feature - SMD scaler

- Especially, during the experiment, we need to monitor the beam polarization at our IR, and get quick feedback if something is going wrong.
- Offline analysis is not suitable for monitoring.
- SMD scaler:
 - Counts hits for LR and UD → Hit pattern to ZDCLL1 board
 - Abundant statistics regardless of DAQ bandwidth
 - Fast online analysis → online monitoring
 - Also, it is used for the rotator commissioning at the beginning of the experiment



→ UD



→ LR

SMD Scaler

PHENIX SMD Local Polarimeter

connected to database daq on phnxdb1

select * from zdcscalers where capturetime < '2013-05-02 04:20:03' order by capturetime desc limit 1

Date (yyyy-mm-dd hh:mm or now):

2013-05-02 04:20:02

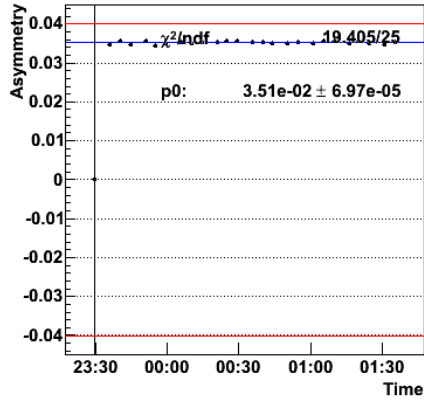
TimeStamp	B N LR val	B N LR err	B N UD val	B N UD err	B S LR val	B S LR err	B S UD val	B S UD err
2013-05-02 04:20:02	-0.000247722	0.000165259	0.003205	0.000172874	-0.000145239	0.00018902	-0.000335435	0.000220178
TimeStamp	Y N LR val	Y N LR err	Y N UD val	Y N UD err	Y S LR val	Y S LR err	Y S UD val	Y S UD err
2013-05-02 04:20:02	1.11147e-05	0.000165259	-0.000258764	0.000172876	-0.000128605	0.00018902	0.000130205	0.00022018

Crossing	N Left	N Right	N Top	N Bottom	S Left	S Right	S Top	S Bottom	N L-R	N T-B	S L-R	S T-B
1	172482	129093	133117	137722	126350	99892	71848	94921	0.143875	-0.017003	0.116946	-0.138353
2	178350	133329	137641	142886	131225	103440	74584	98365	0.144447	-0.018697	0.118403	-0.137503
3	180340	134614	139260	142788	132557	104827	75117	99567	0.145183	-0.012509	0.116815	-0.139967
4	183665	136871	141948	145138	134470	105631	76713	100844	0.145987	-0.011112	0.120112	-0.135906
5	197697	148286	151929	157566	145766	115046	82935	109610	0.142813	-0.018214	0.117786	-0.138539
6	187869	140043	143443	148791	138418	108245	78569	103398	0.145850	-0.018300	0.122325	-0.136448
7	206010	152940	158741	162650	151632	119666	86311	114218	0.147848	-0.012163	0.117826	-0.139167
8	204047	152631	157839	161102	149774	118772	85488	112937	0.144152	-0.010231	0.115444	-0.138334
9	198021	147704	152430	157440	146297	115309	83279	109490	0.145541	-0.016168	0.118453	-0.135971

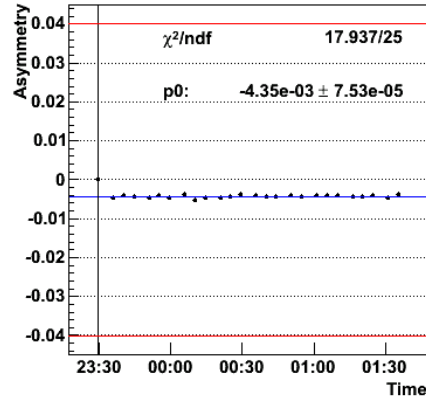
PHENIX LPol. Online Monitor

LOCALPOLMON_0 Run 385985, Fill 17169, Time: Tue Mar 5 07:38:46 2013

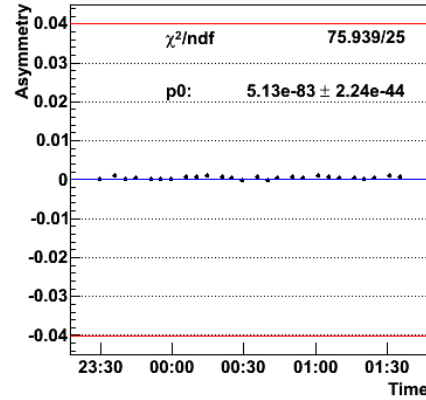
Asym_Blue_N_LR



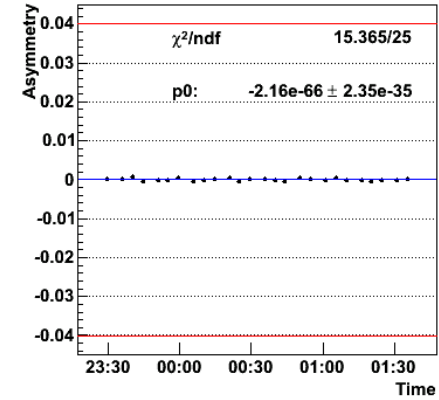
Asym_Blue_N_UD



Asym_Yellow_N_LR

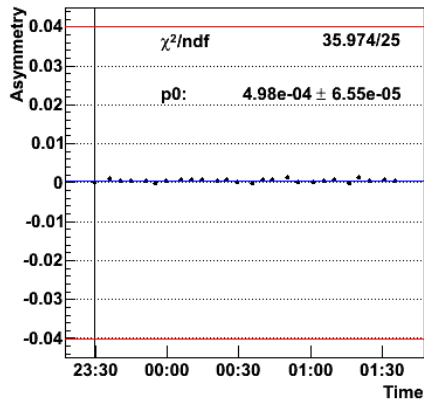


Asym_Yellow_N_UD

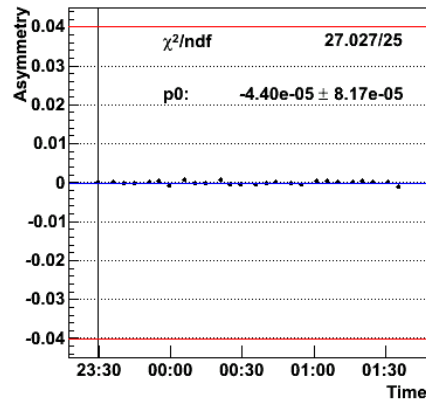


Zero asym seen, is the SMD High Voltage on?

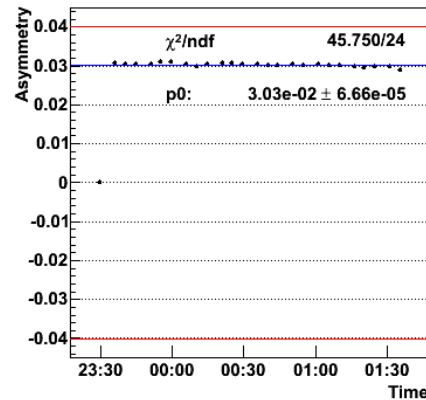
Asym_Blue_S_LR



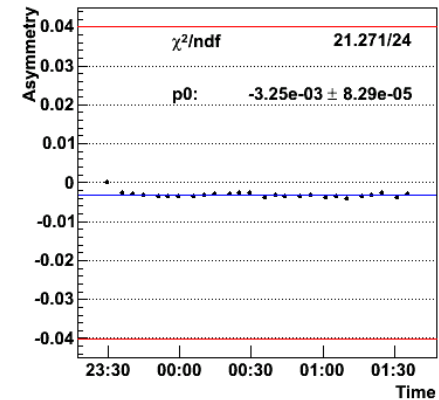
Asym_Blue_S_UD



Asym_Yellow_S_LR



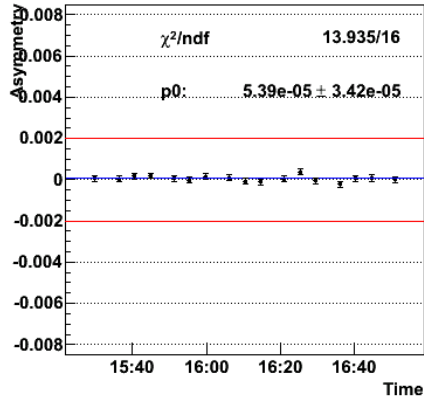
Asym_Yellow_S_UD



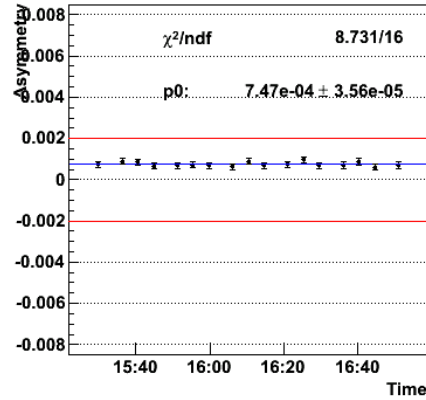
PHENIX LPol. Online Monitor

LOCALPOLMON_0 Run 391442, Fill 17382, Time: Sun Apr 14 22:53:43 2013

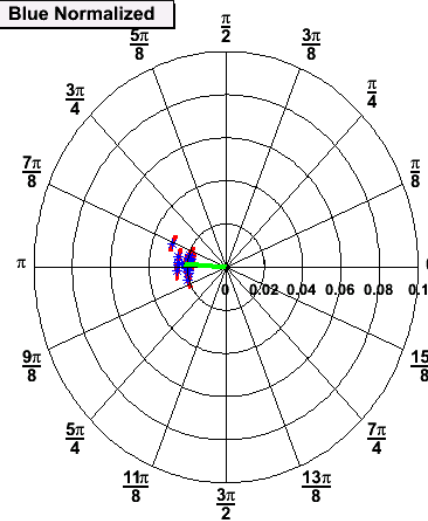
Asym_Blue_N_LR



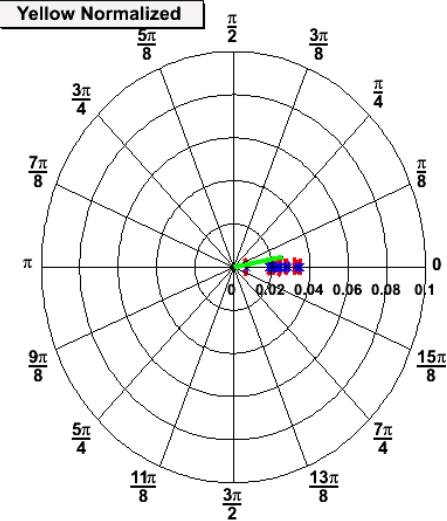
Asym_Blue_N_UD



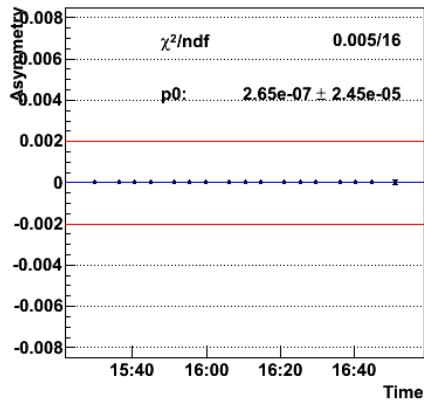
Blue Normalized



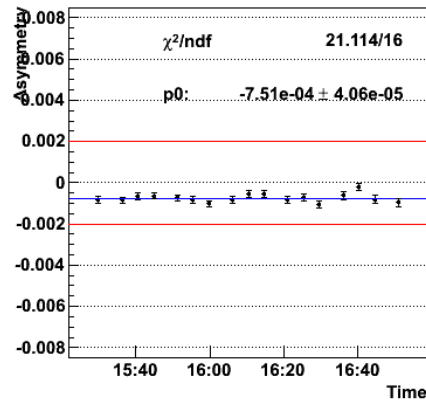
Yellow Normalized



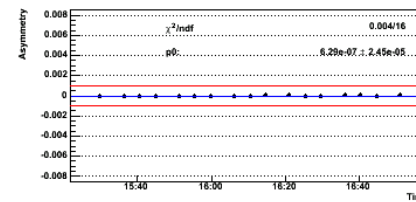
Asym_Yellow_S_LR



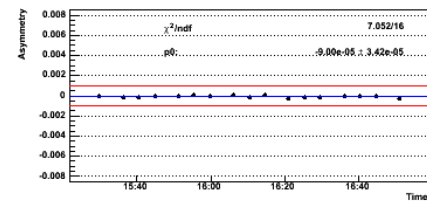
Asym_Yellow_S_UD



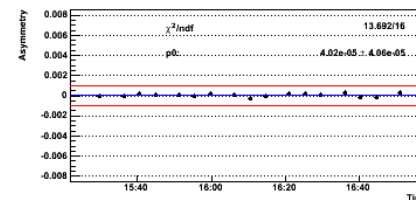
Asym_Blue_S_LR



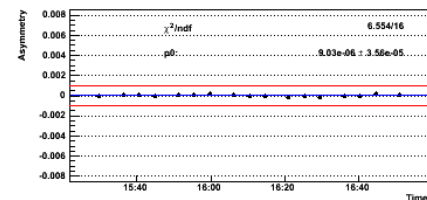
Asym_Yellow_N_LR



Asym_Blue_S_UD



Asym_Yellow_N_UD



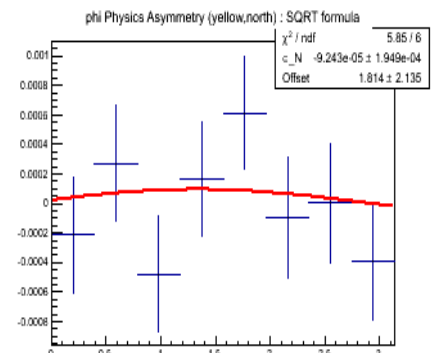
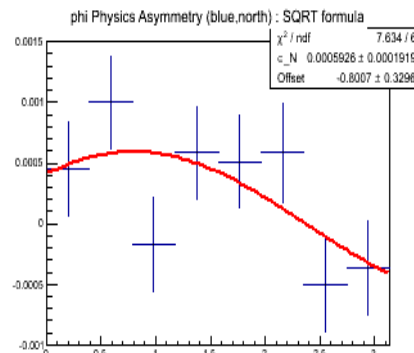
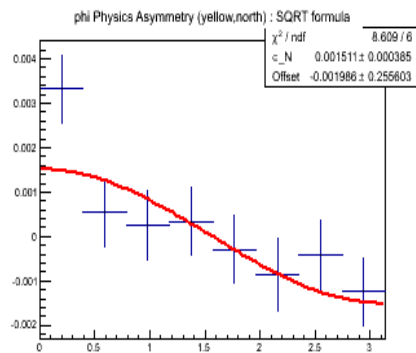
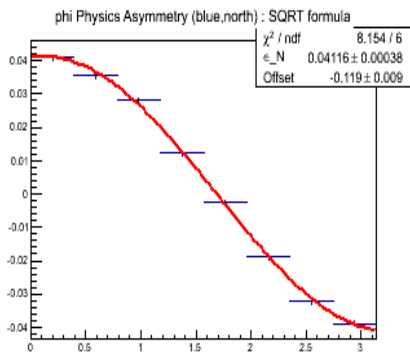
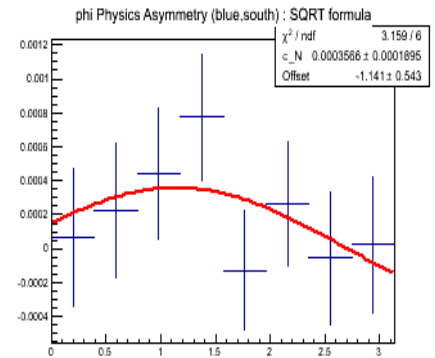
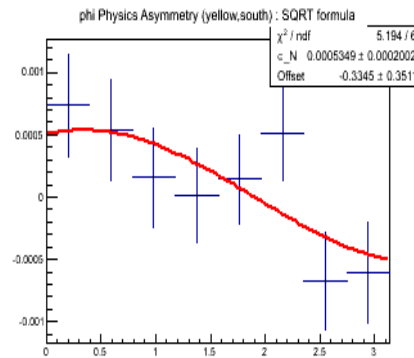
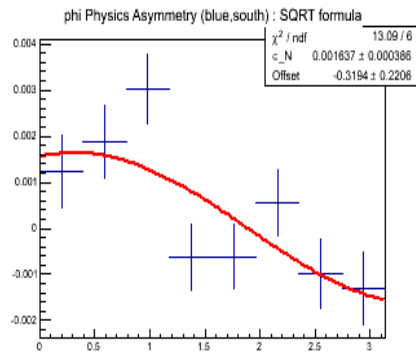
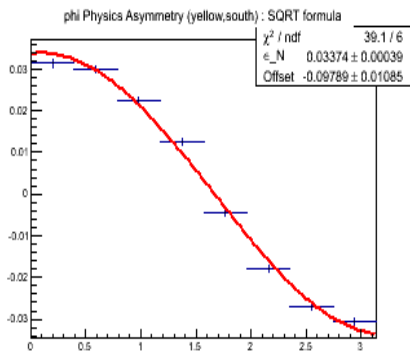
Rotator Commissioning (Run13)

- Using SMD scaler, get the quick feedback for various rotator current settings.
- Run13 Rotator Commissioning (Minjung Kim, Ciprian Gal, Sanghwa Park)

Setting	inner	outer	Fill#	Run#	RT_B	dRT_B	RT_Y	dRT_Y	angle offset blue [deg]	angle offset yellow [deg]
transverse			17178	386224						
setting 1	0	0	17178	386227	0.06	0.01	0.01	0.01	107.60	81.30
setting 2	+5	0	17178	386229	0.04	0.01	0.06	0.01	167.82	90.03
setting 3	-5	0	17178	386230	0.11	0.01	0.08	0.01	82.30	-51.04
setting 4	0	+5	17178	386235	0.09	0.01	0.09	0.01	24.40	26.87
setting 5	0	-5	17178	386239	0.10	0.01	0.07	0.01	146.67	-163.13
setting 6	+5	+5	17178	386240	0.07	0.01	0.11	0.01	-1.26	52.36
setting 7	-5	-5	17178	386241	0.15	0.01	0.07	0.01	120.02	-122.03
transverse			17178	386243						

Rotator Commissioning (Run13)

- After rotator current tuning, we take the dedicated Lpol run (~250M events) to confirm the transverse components are as we want using offline analysis.
- Remaining transverse components at the commissioning period:
1.5% (blue), 2.7% (yellow)

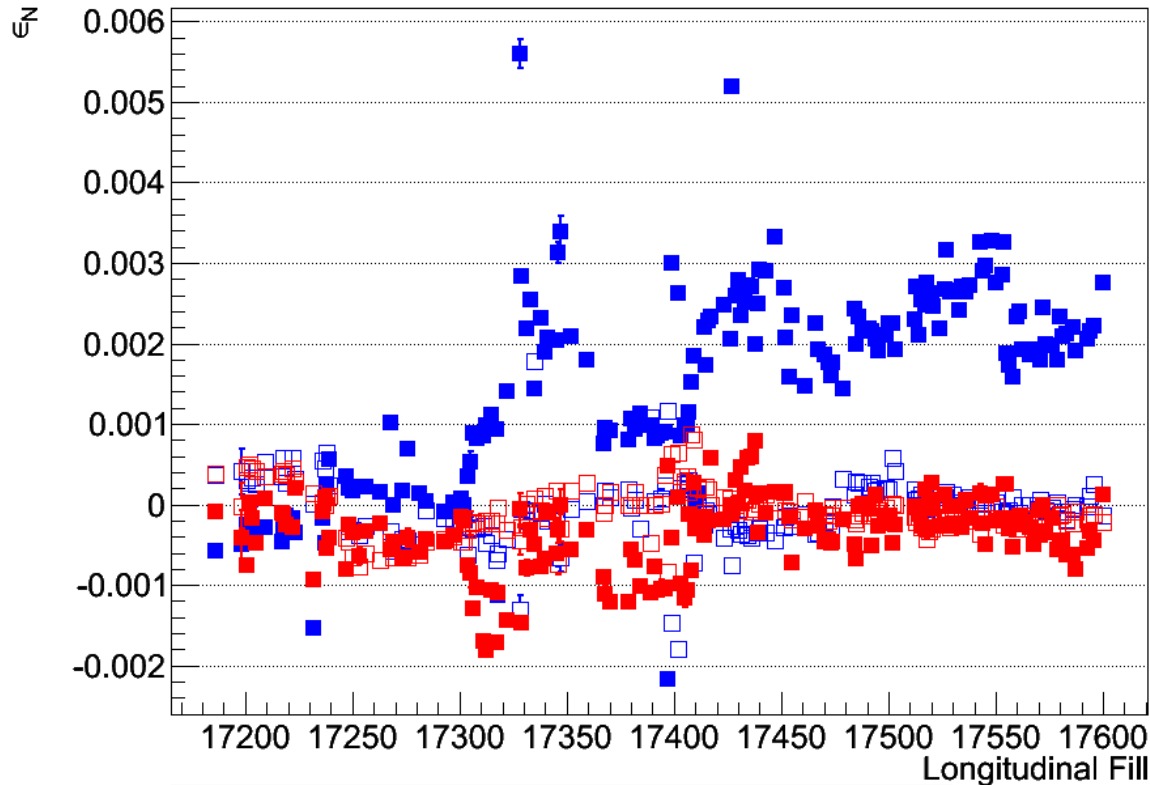


Raw asymmetry for transverse fill

Raw asymmetry for longitudinal fill

During Run13

Run13pp510 PHENIX LPOL Forward

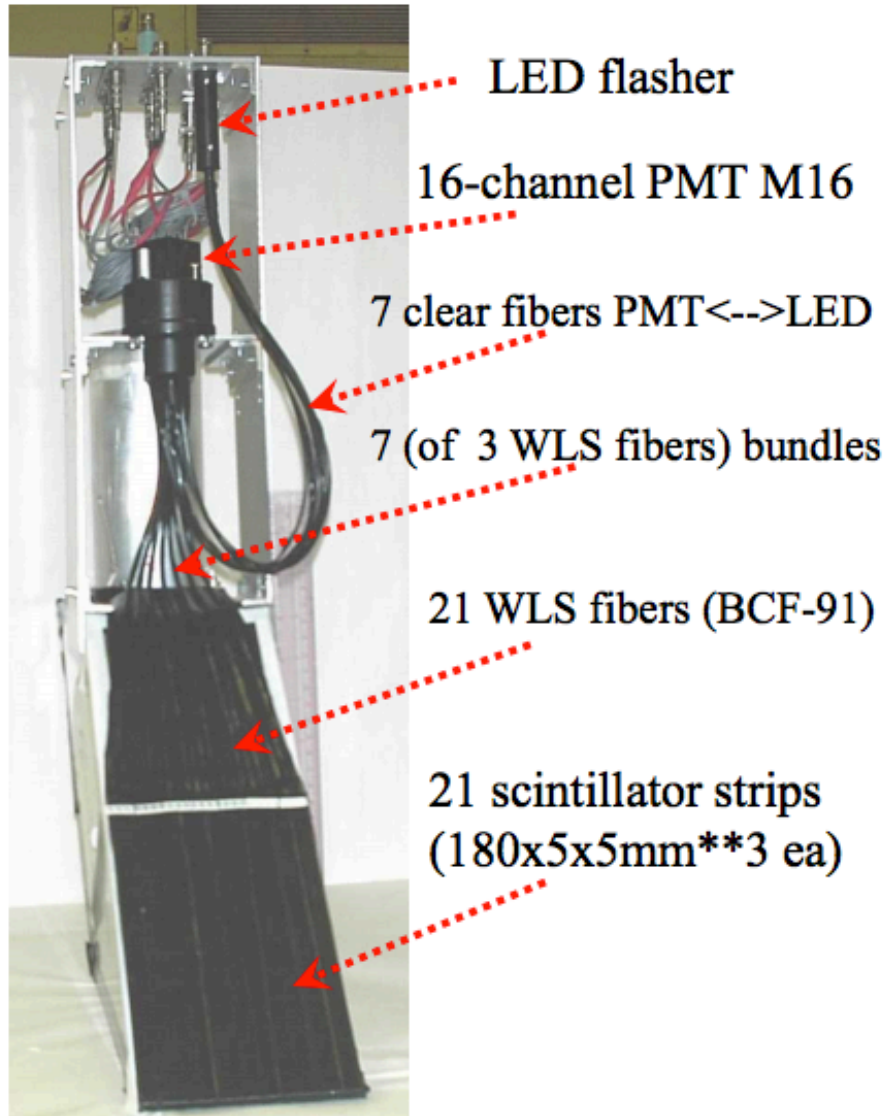


- Raw asymmetry (w/o take into account the beam polarization)
- Monitored using scaler analysis

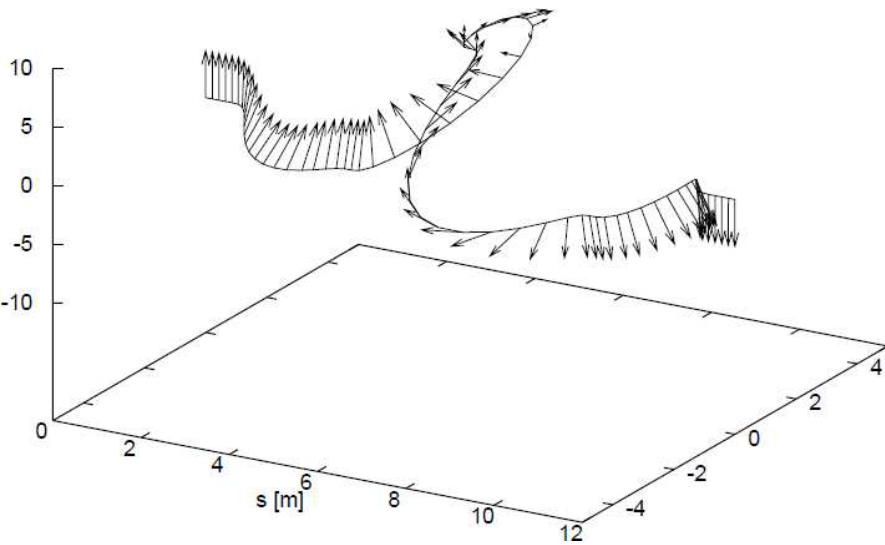
■ BNUD □ BNLR ■ YSUD □ YSLR

Backup

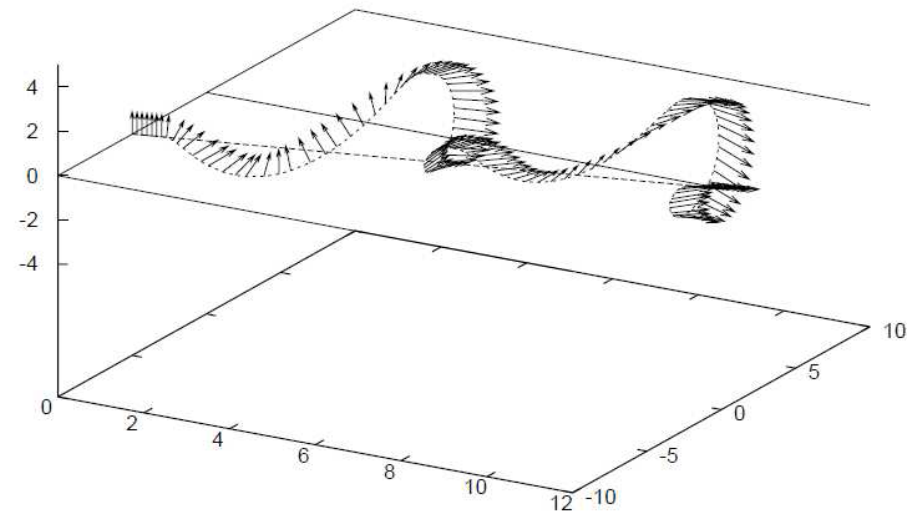
Closer Look at SMD



Spin Motion Images inside of rotator



Siberian Snakes



Spin Rotator