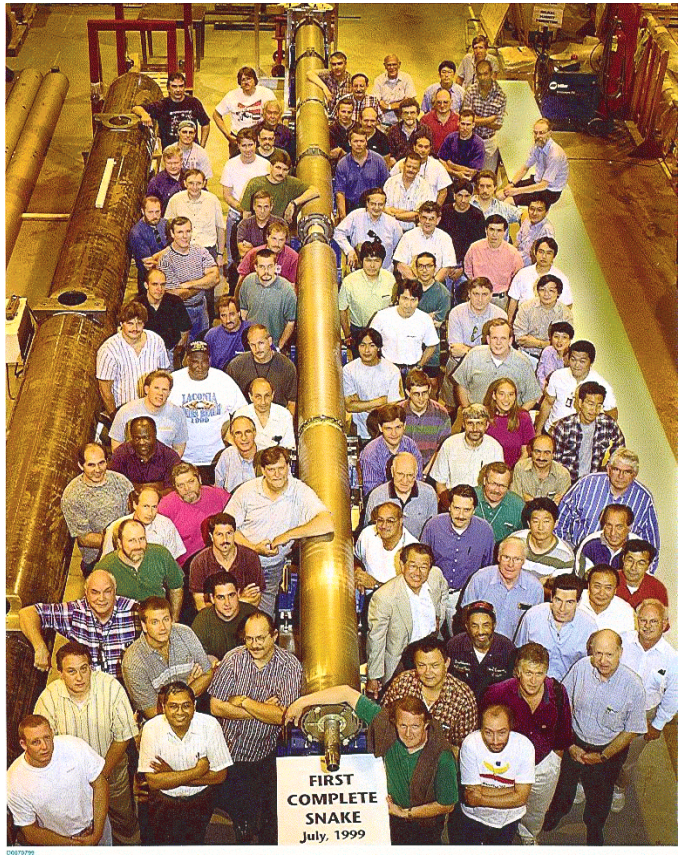
Commissioning and Future Plans for Polarized Protons in RHIC

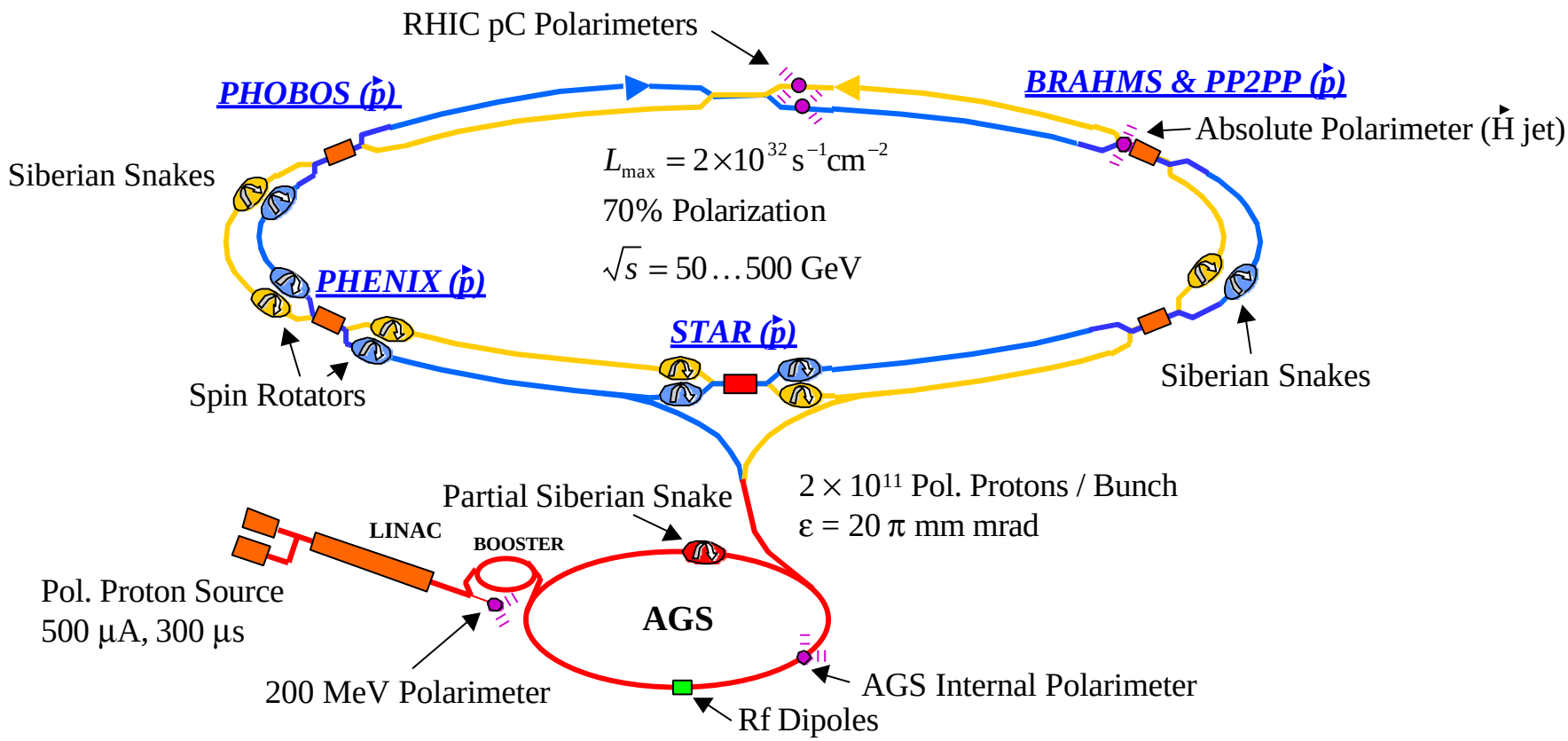
- Overview: polarized proton project
- Helical Siberian Snake
- Polarimeter
- Results from 2000
- Future plans

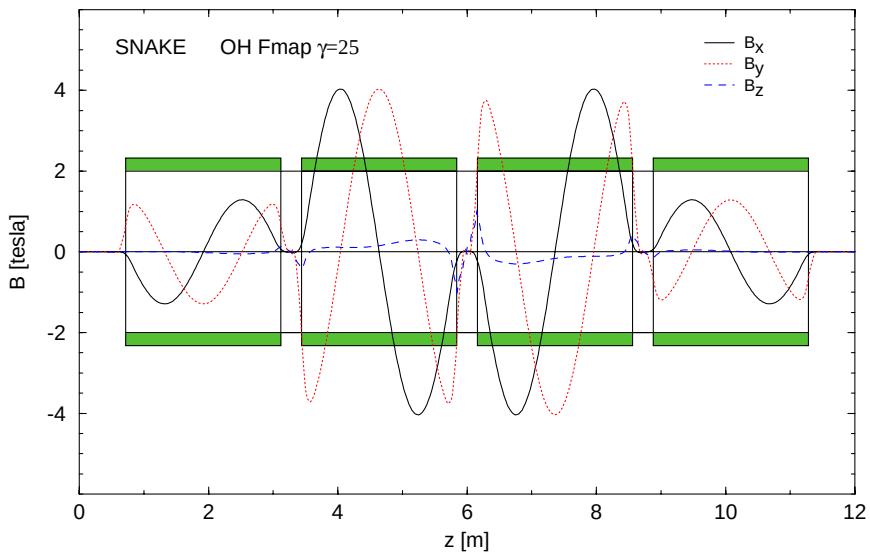


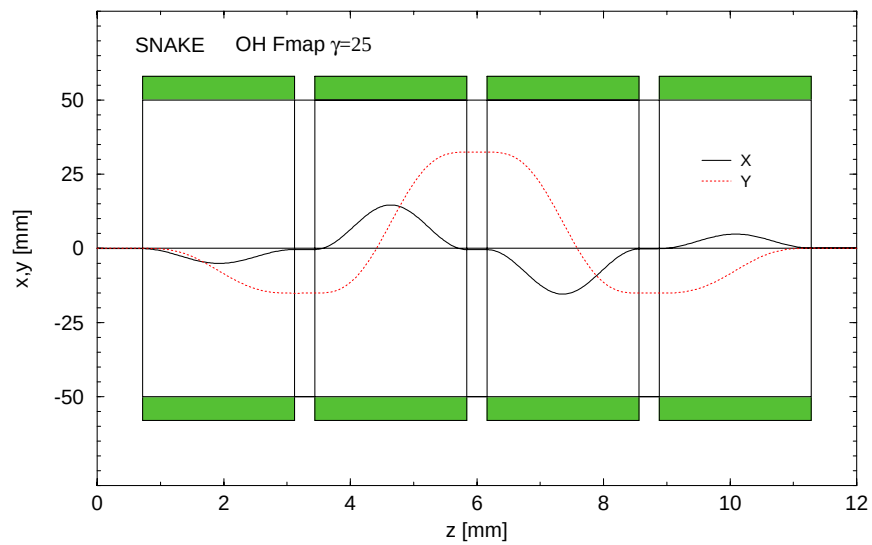
BROOKHAVEN NATIONAL LABORATORY

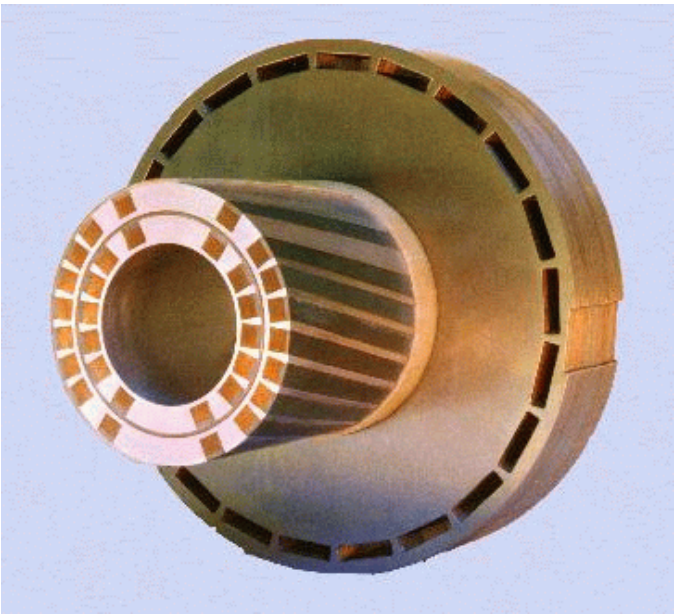
Waldo MacKay
PAC2001, 18 June, 2001

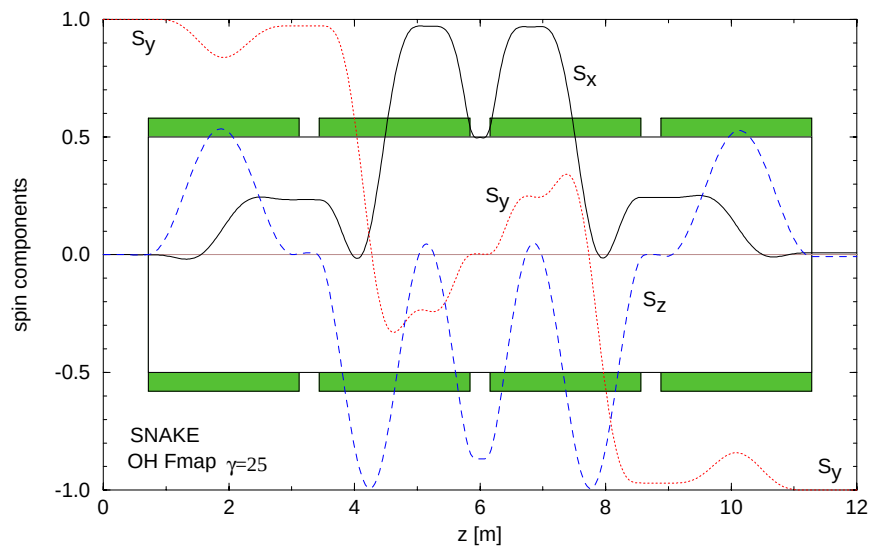
Layout of Polarized Proton Complex



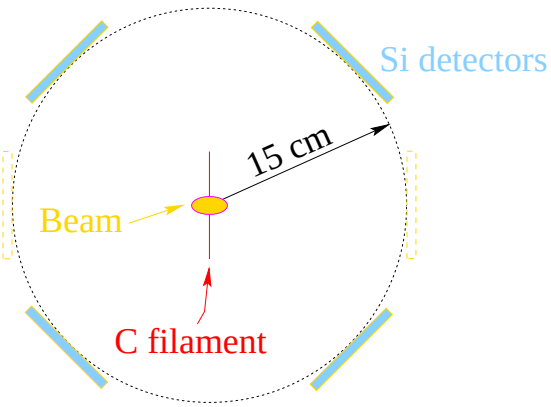

SNAKE OH Fmap γ=25
Bx
By
Bz
B [tesla]
z [m]


SNAKE OH Fmap γ=25
X
Y
x,y [mm]
z [mm]

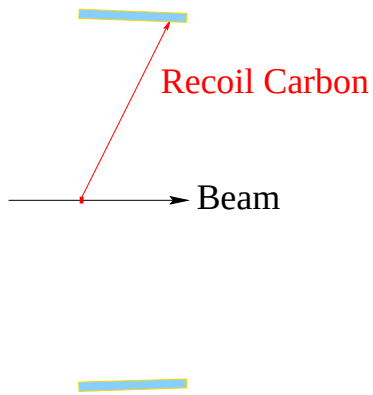



Sy
Sx
Sy
Sz
Sy
SNAKE
OH Fmap γ=25
spin components
z [m]

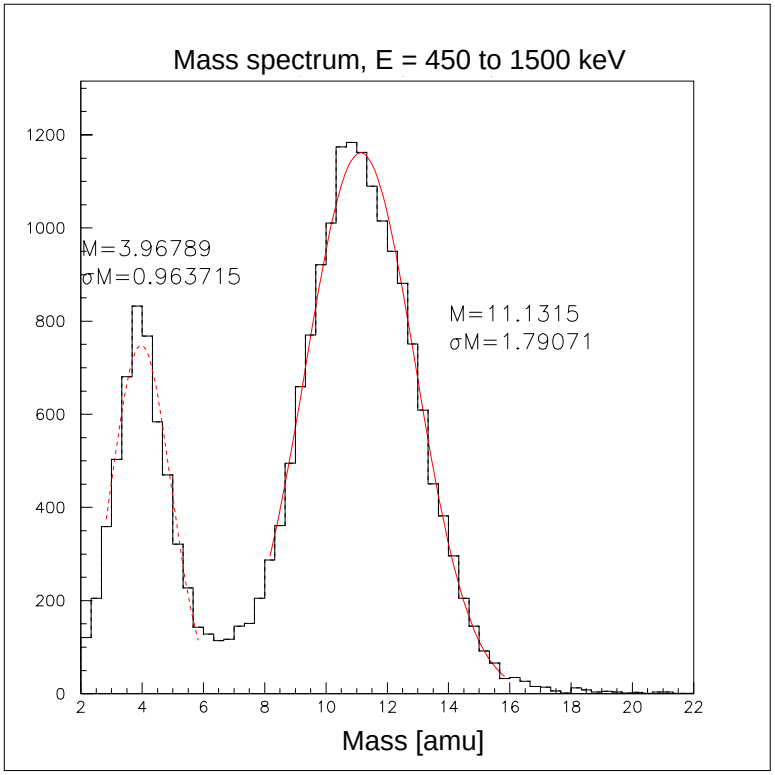
Polarimeter using
p+C Coulomb-Nuclear Interference (CNI)



Beam's-eye view of detectors

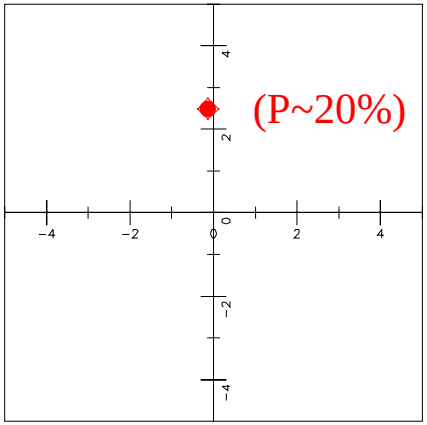


Side View



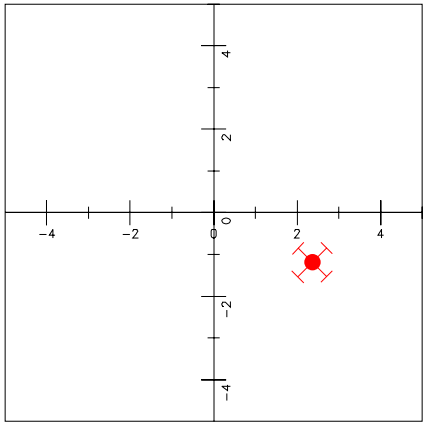
Measurements

Inject, snake off
$G\gamma = 46.5$



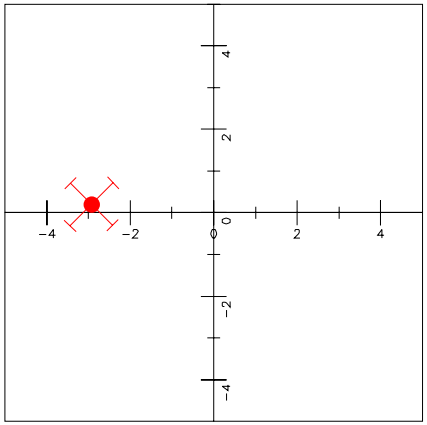
$\Rightarrow$

Turn on snake
$G\gamma = 46.5$



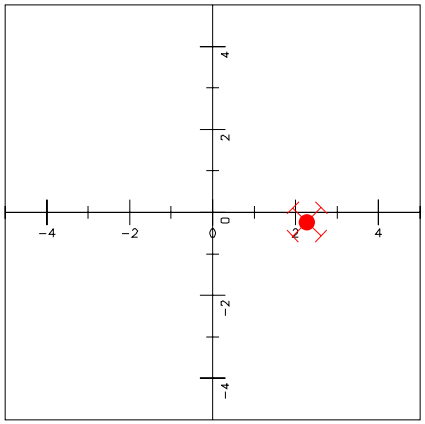
$\Rightarrow$

Ramp to
$G\gamma = 48$



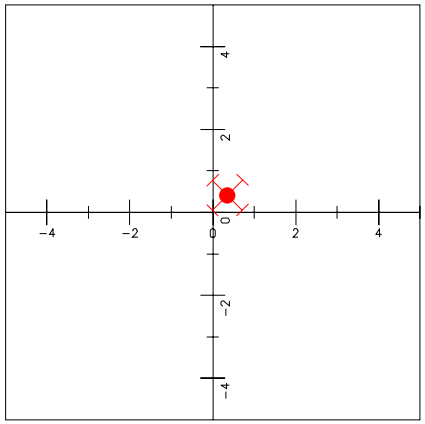
$\Rightarrow$

Ramp to
$G\gamma = 55.7$



$\Rightarrow$

Ramp to
$G\gamma = 60.3$



Depolarized

Future Plans

FY2001 run:

- 4 Snakes installed (2 per ring)✓
- 2 polarimeters installed (1 per ring)✓
- Goals:
  - 100GeV×100GeV collisions with long. pol. at IR's
    Inject and accelerate to $G\gamma = 192$ with two snakes
    Turn off one snake to obtain long. pol. at IP's
  - Accelerate polarized beam to 250GeV

FY2002 run:

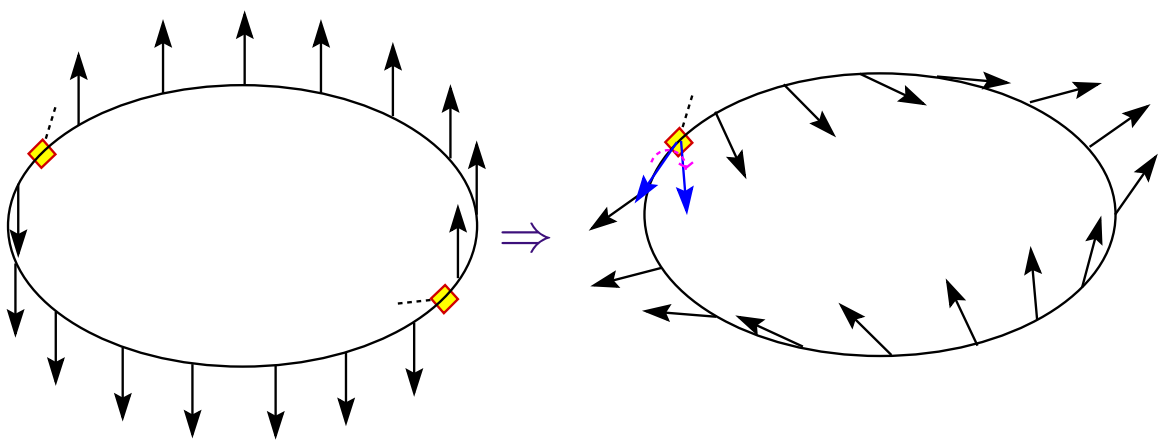
- Install all eight spin rotators
- Goal: 250GeV×250GeV collisions with long. pol. at STAR and PHENIX

FY2003 run:

- Install polarized hydrogen jet target for absolute polarimetry

Longitudinal Polarization in RHIC

- Inject vertically polarized protons with both snakes on.
  $E \sim 24.3$ GeV ($G\gamma \sim 46.5$)
- Accelerate beams to 100.48 GeV ($G\gamma = 192$)
- Turn off one snake in each ring: polarization $\Rightarrow$ horizontal plane.
  (Long. Pol. at IR's.)



Polariation with a Single Snake On

At $E = 100.48$ GeV:

$G\gamma = 192 = 3 \times 64$

Helicity alternates at IP's

For $\frac{\Delta p}{p} = \pm 0.001$

STAR/BRAHMS:

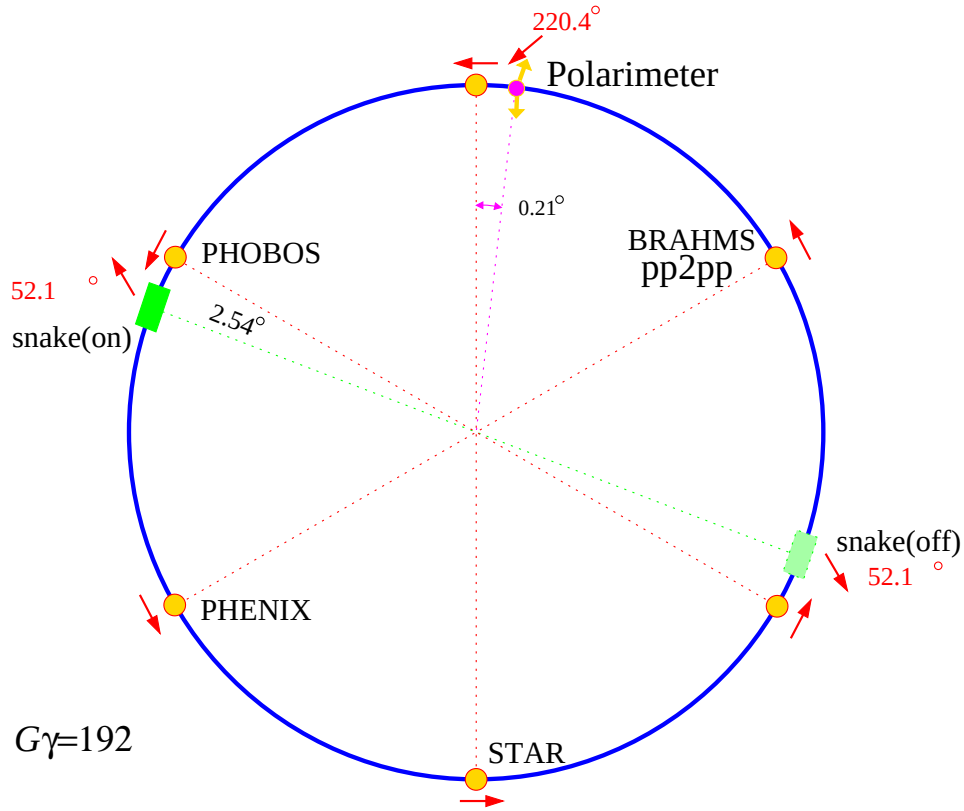
$$32 \times \frac{\Delta p}{p} \times 360^\circ = \pm 12^\circ \ [0.98]$$

PHENIX:

$$64 \times \frac{\Delta p}{p} \times 360^\circ = \pm 23^\circ \ [0.92]$$

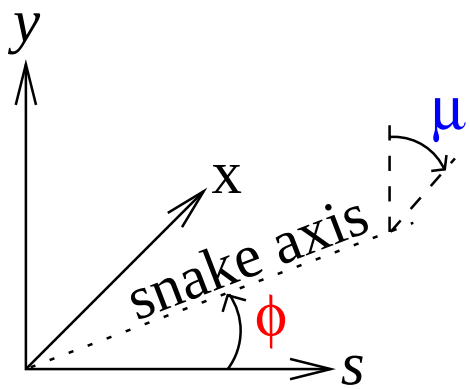
PHOBOS:

$$96 \times \frac{\Delta p}{p} \times 360^\circ = \pm 35^\circ \ [0.82]$$



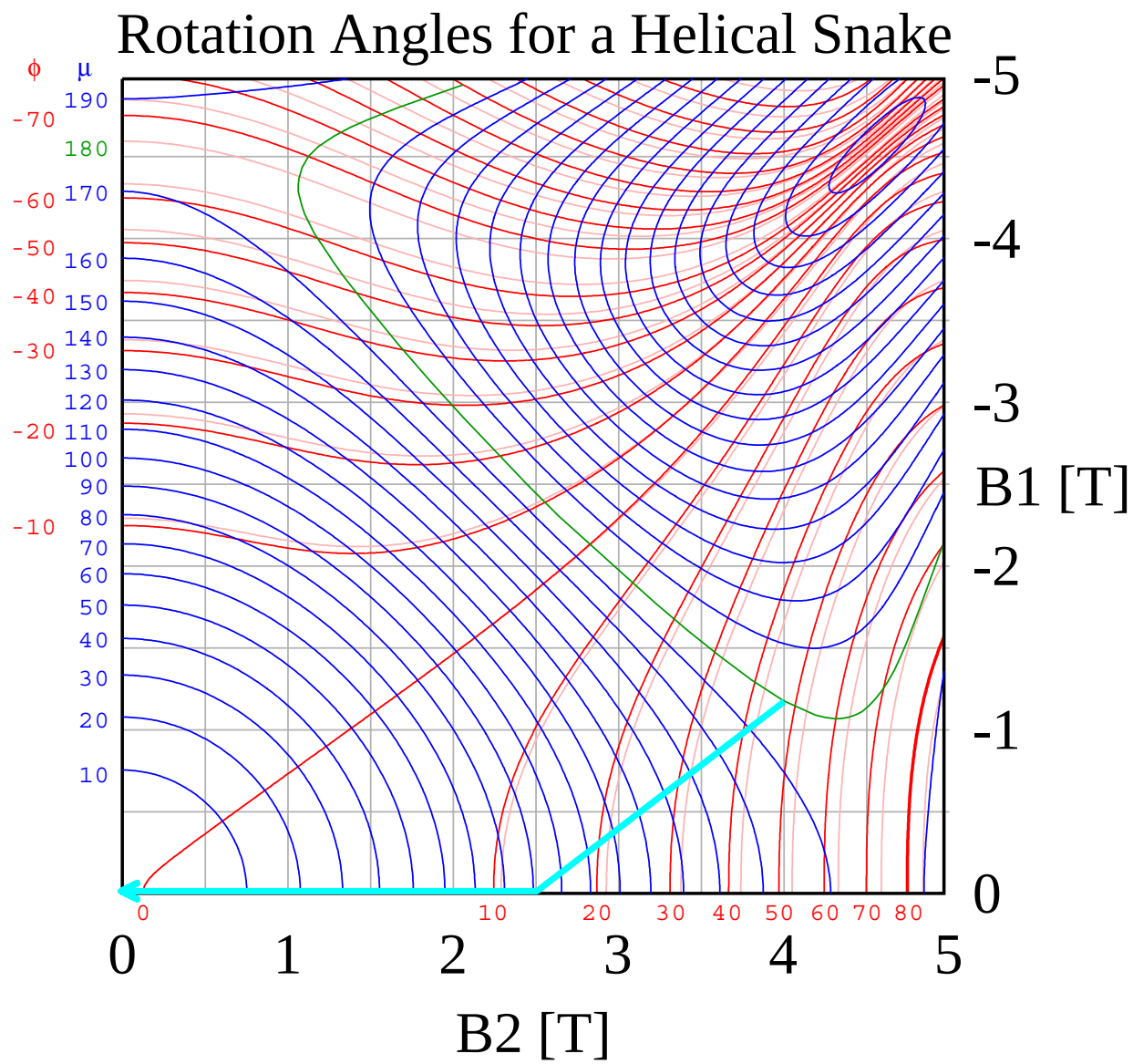
Polarization in Blue Ring with One Snake On

Note: Opp. snake $\Rightarrow$ PHOBOS: $\pm 0^\circ$; PHENIX: $\pm 12^\circ$; STAR/BRAHMS: $\pm 23^\circ$.

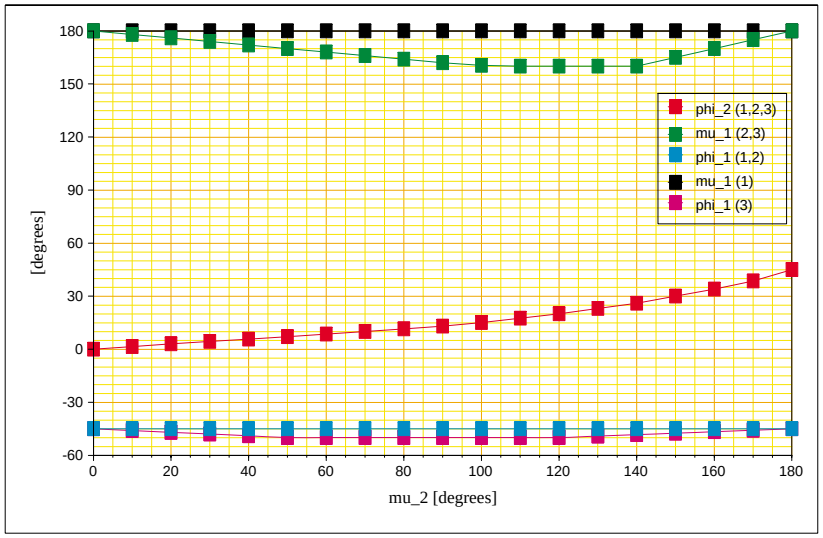


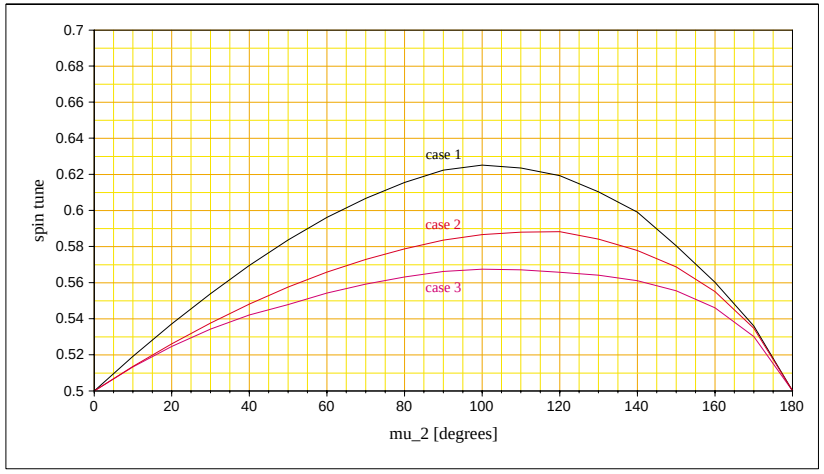
The rotation axis of the snake is ϕ, and μ is the rotation angle.

Note that the ϕ contours shift slightly from injection (red) at 25 GeV to storage (pink) at 250 GeV.



Turning off one snake at fixed energy

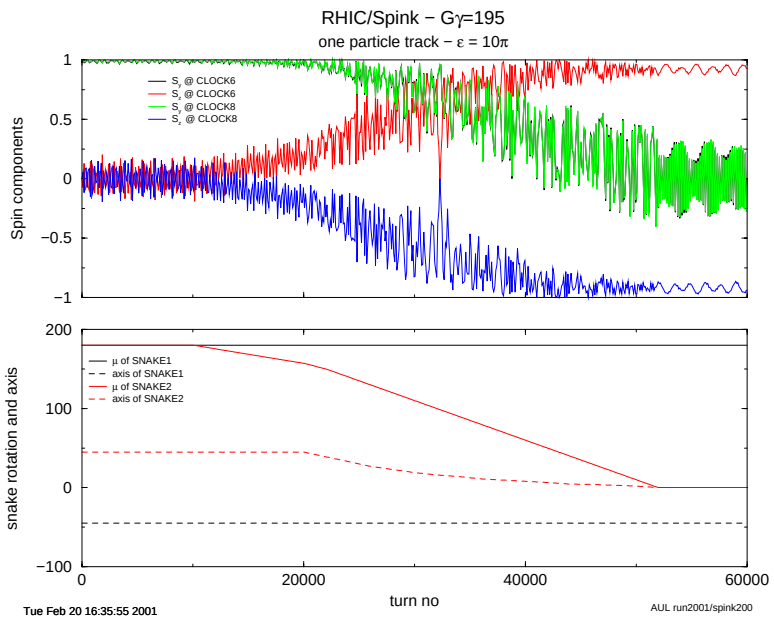




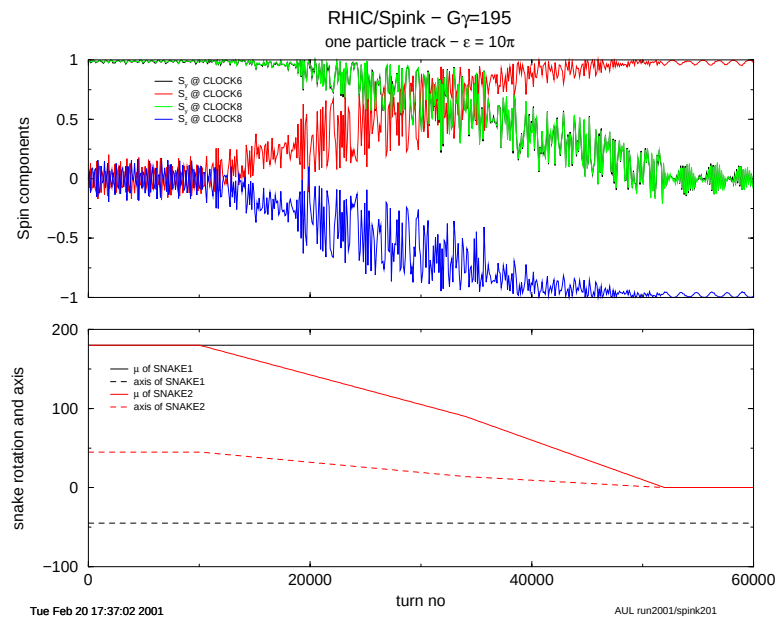
	Snake one		Snake two					
G*gamma	mu1	phi1	mu2	phi2	cos(pi*nu)	nu	1-nu	case 2
192	180	-45	180	45	0.0000	0.5000	0.5000	
192	175	-45	170	38.5	-0.1089	0.5347	0.4653	
192	170	-45	160	34	-0.1721	0.5550	0.4450	
192	165	-45	150	30	-0.2141	0.5687	0.4313	
192	160	-45	140	26	-0.2419	0.5778	0.4222	
192	160	-45	130	23	-0.2610	0.5840	0.4160	
192	160	-45	120	20	-0.2736	0.5882	0.4118	
192	160	-45	110	17.5	-0.2729	0.5880	0.4120	
192	160.5	-45	100	15	-0.2686	0.5866	0.4134	
192	162	-45	90	13	-0.2595	0.5836	0.4164	
192	164	-45	80	11.5	-0.2447	0.5787	0.4213	
192	166	-45	70	10	-0.2267	0.5728	0.4272	
192	168	-45	60	8.5	-0.2053	0.5658	0.4342	
192	170	-45	50	7.1	-0.1796	0.5575	0.4425	
192	172	-45	40	5.7	-0.1506	0.5481	0.4519	
192	174	-45	30	4.4	-0.1176	0.5375	0.4625	
192	176	-45	20	3	-0.0818	0.5261	0.4739	
192	178	-45	10	1.5	-0.0426	0.5136	0.4864	
192	180	-45	0	0	-0.0000	0.5000	0.5000	
G*gamma	mu1	phi1	mu2	phi2	cos(pi*nu)	nu	1-nu	case 3
192	180	-45.0	180	45	0.0000	0.5000	0.5000	
192	175	-45.8	170	38.5	-0.0945	0.5301	0.4699	
192	170	-46.7	160	34	-0.1440	0.5460	0.4540	
192	165	-47.5	150	30	-0.1735	0.5555	0.4445	
192	160	-48.3	140	26	-0.1905	0.5610	0.4390	
192	160	-49.2	130	23	-0.2000	0.5641	0.4359	
192	160	-50.0	120	20	-0.2049	0.5657	0.4343	
192	160	-50.0	110	17.5	-0.2091	0.5671	0.4329	
192	160.5	-50.0	100	15	-0.2102	0.5674	0.4326	
192	162	-50.0	90	13	-0.2065	0.5662	0.4338	
192	164	-50.0	80	11.5	-0.1971	0.5632	0.4368	
192	166	-50.0	70	10	-0.1848	0.5592	0.4408	
192	168	-50.0	60	8.5	-0.1693	0.5541	0.4459	
192	170	-50.0	50	7.1	-0.1497	0.5478	0.4522	
192	172	-49.0	40	5.7	-0.1316	0.5420	0.4580	
192	174	-48.0	30	4.4	-0.1071	0.5342	0.4658	
192	176	-47.0	20	3	-0.0772	0.5246	0.4754	
192	178	-46.0	10	1.5	-0.0415	0.5132	0.4868	
192	180	-45.0	0	0	-0.0000	0.5000	0.5000	

Preliminary Single Particle Tracking

Turning off one snake at fixed energy



Following solid cyan curve on p. 8.



Following dashed cyan curve on p. 8.

Note: Here the snake was turned off in less than 1 second. In the actual case, it will take 5 to 10 minutes to turn off the snake.