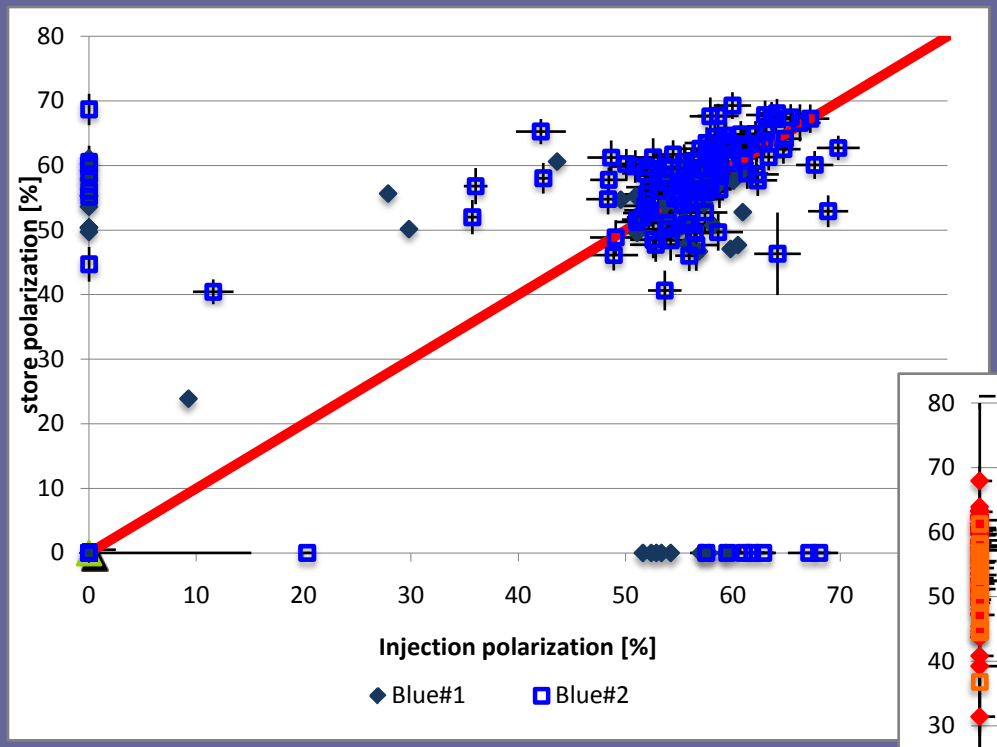
RHIC Polarization

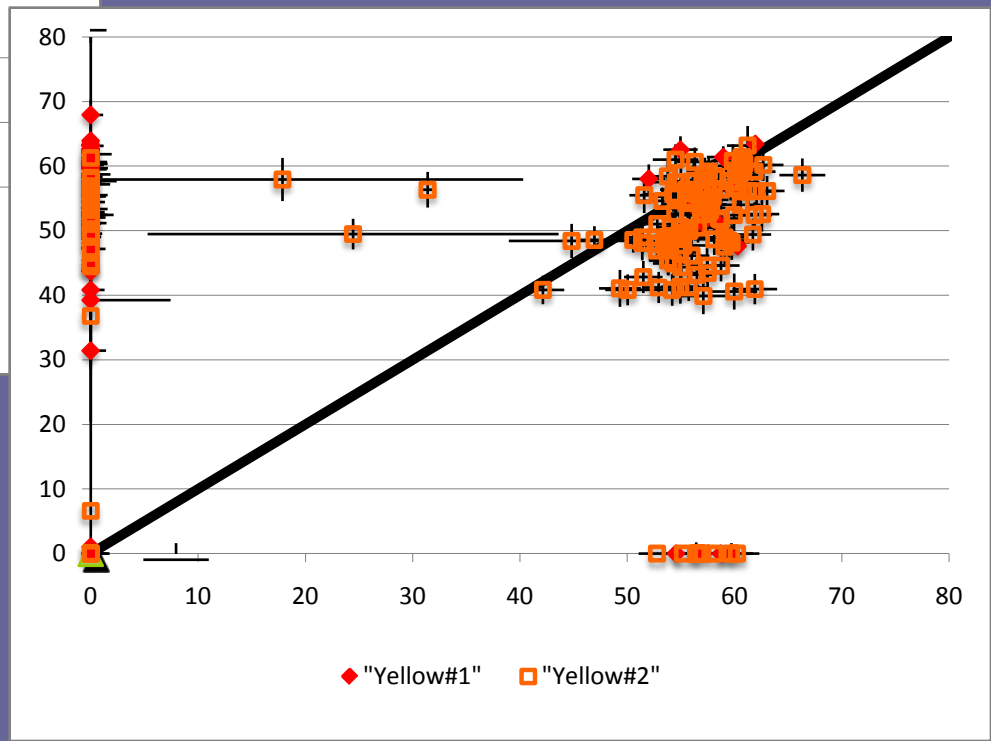
Outline

- Polarization Status:
  - Achieved polarization at 100 GeV and 250 GeV
  - Polarization lifetime issues
- Preliminary results/conclusions from polarization studies
  - Tune scan at two working points
  - Spin tune as function of horizontal orbital angle between snakes
- How to achieve > 50% polarization beyond 100 GeV?
  - How to avoid polarization losses during acceleration?
  - Polarization lifetime

Polarization Status: 100 GeV

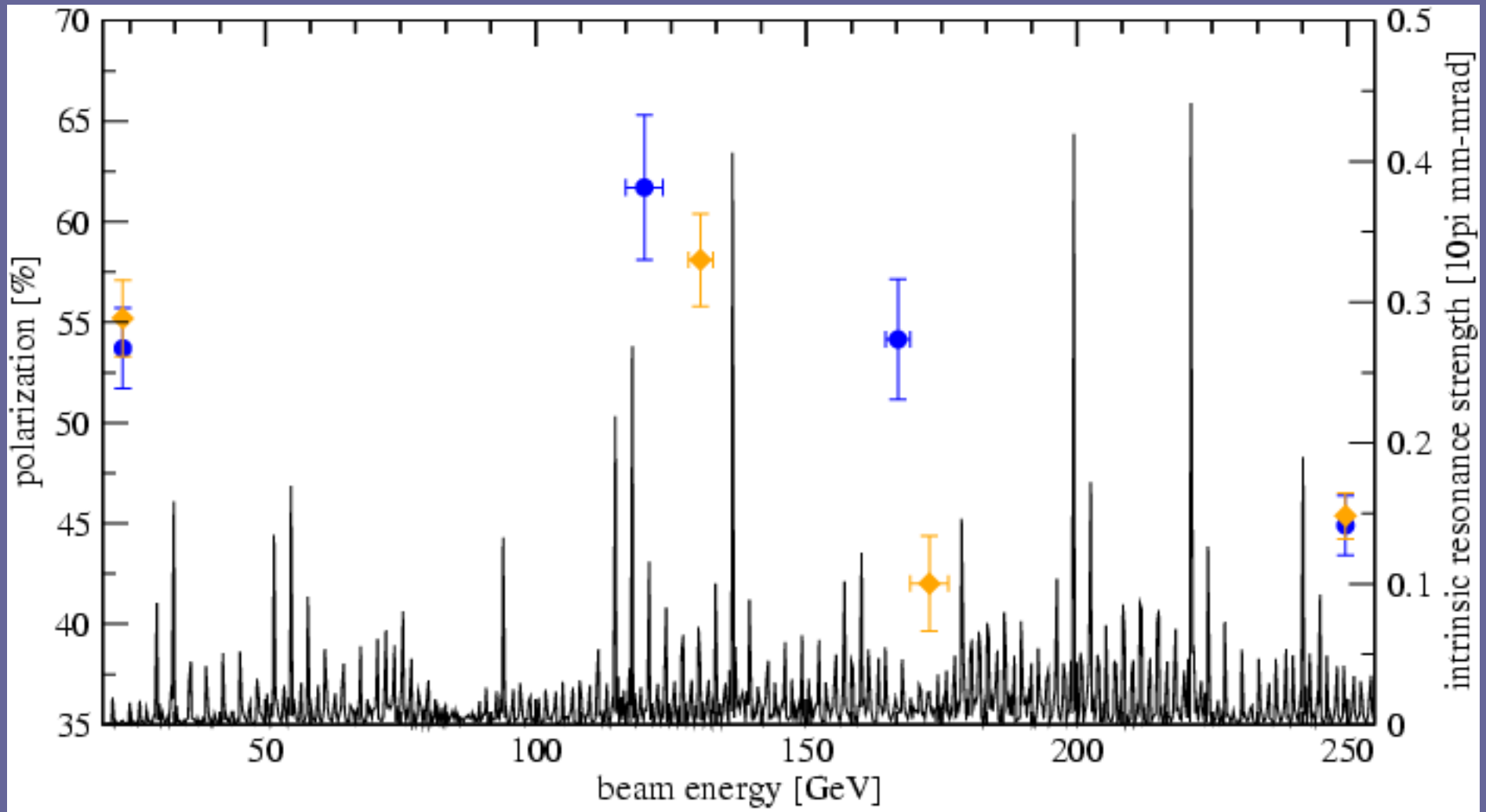
- Achieved ~100% polarization transmission efficiency up to 100 GeV



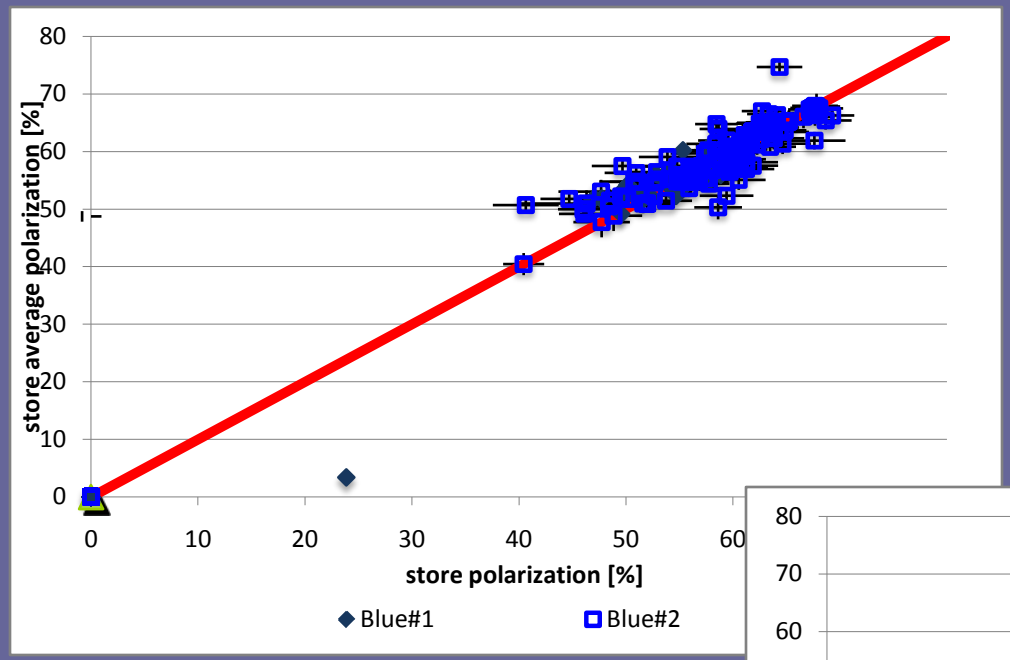


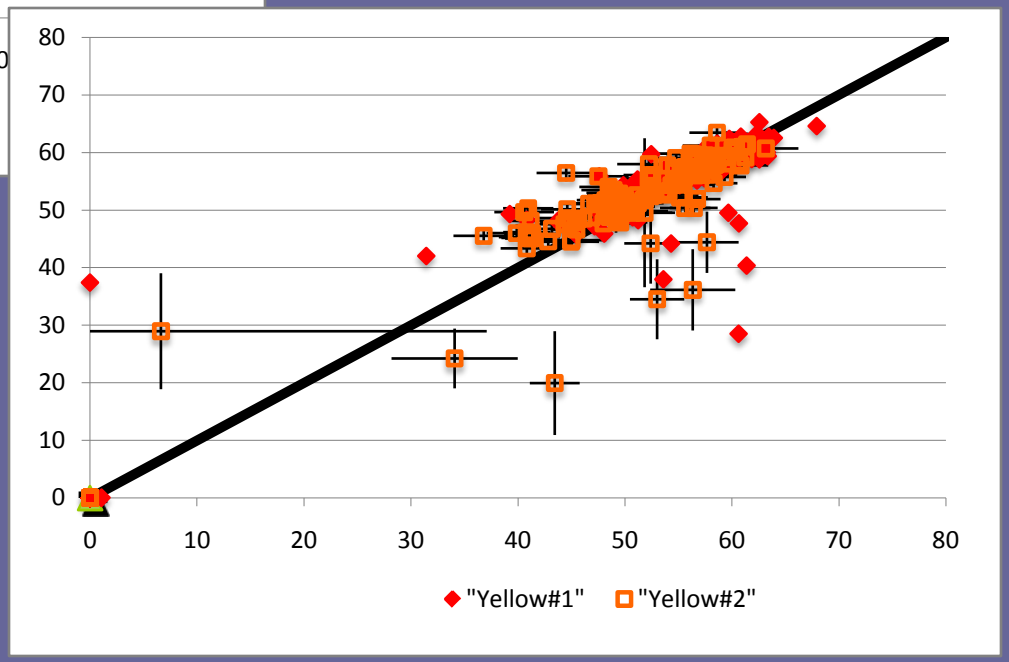
Polarization Status: 250 GeV

- polarization were lost beyond 100 GeV to 250 GeV
- Average polarization transmission efficiency: ~80%
- Best polarization achieved w.o. rotator: ~54%



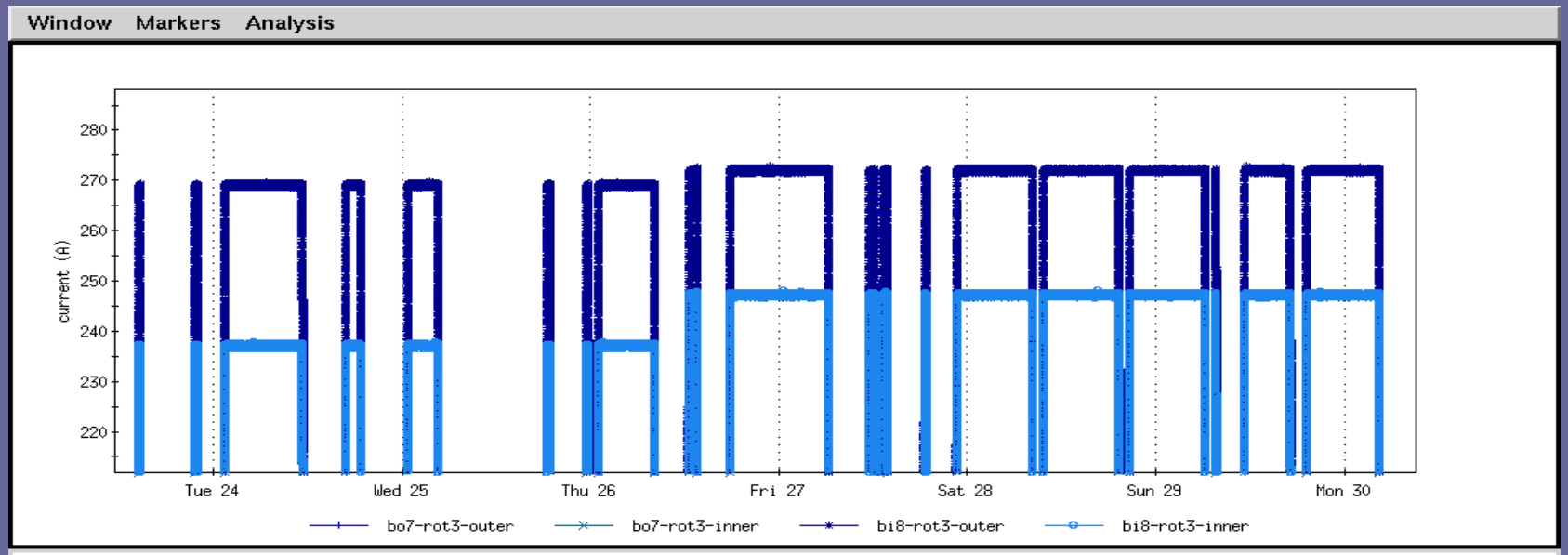
Polarization Lifetime: 100 GeV

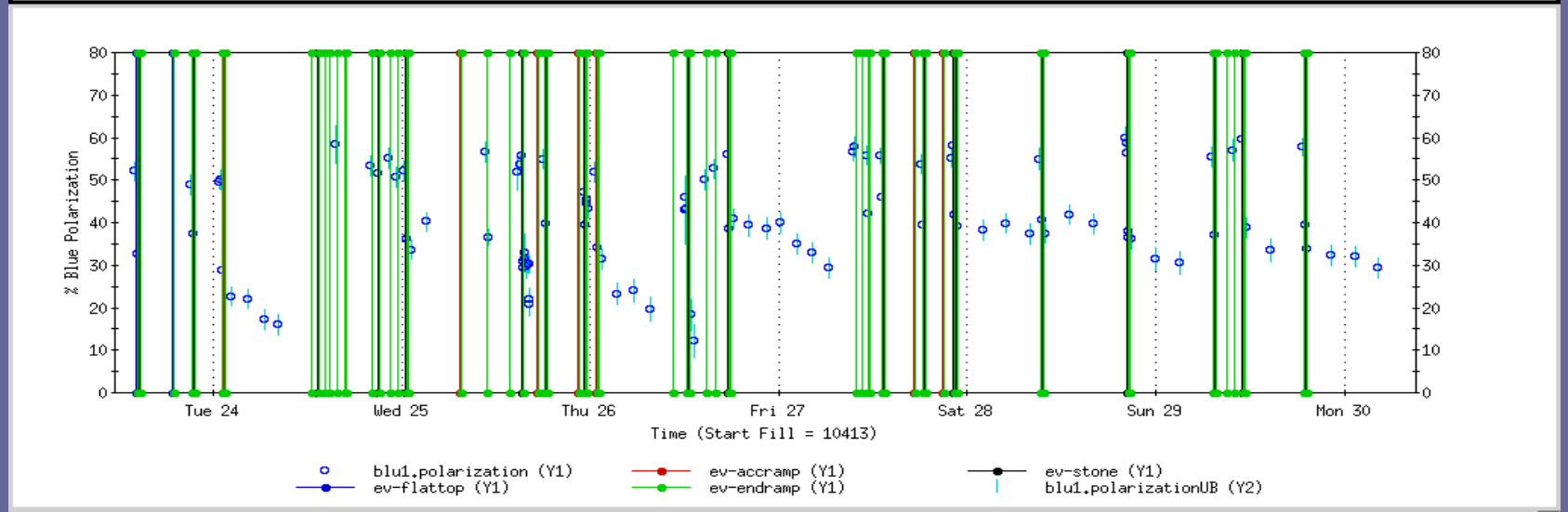




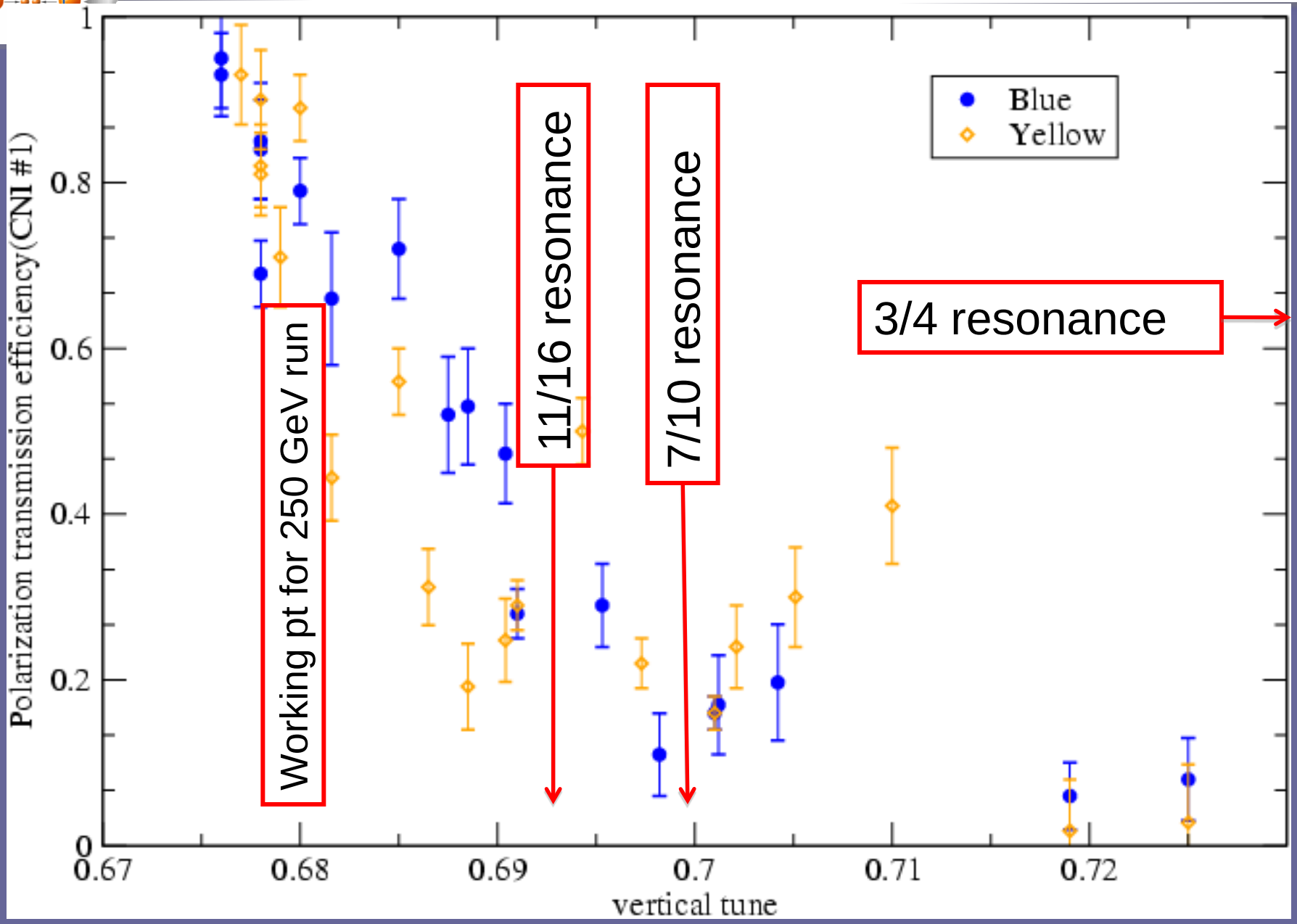
Polarization Lifetime: 250 GeV

- Polarization lifetime is very sensitive to the PHENIX rotator setting

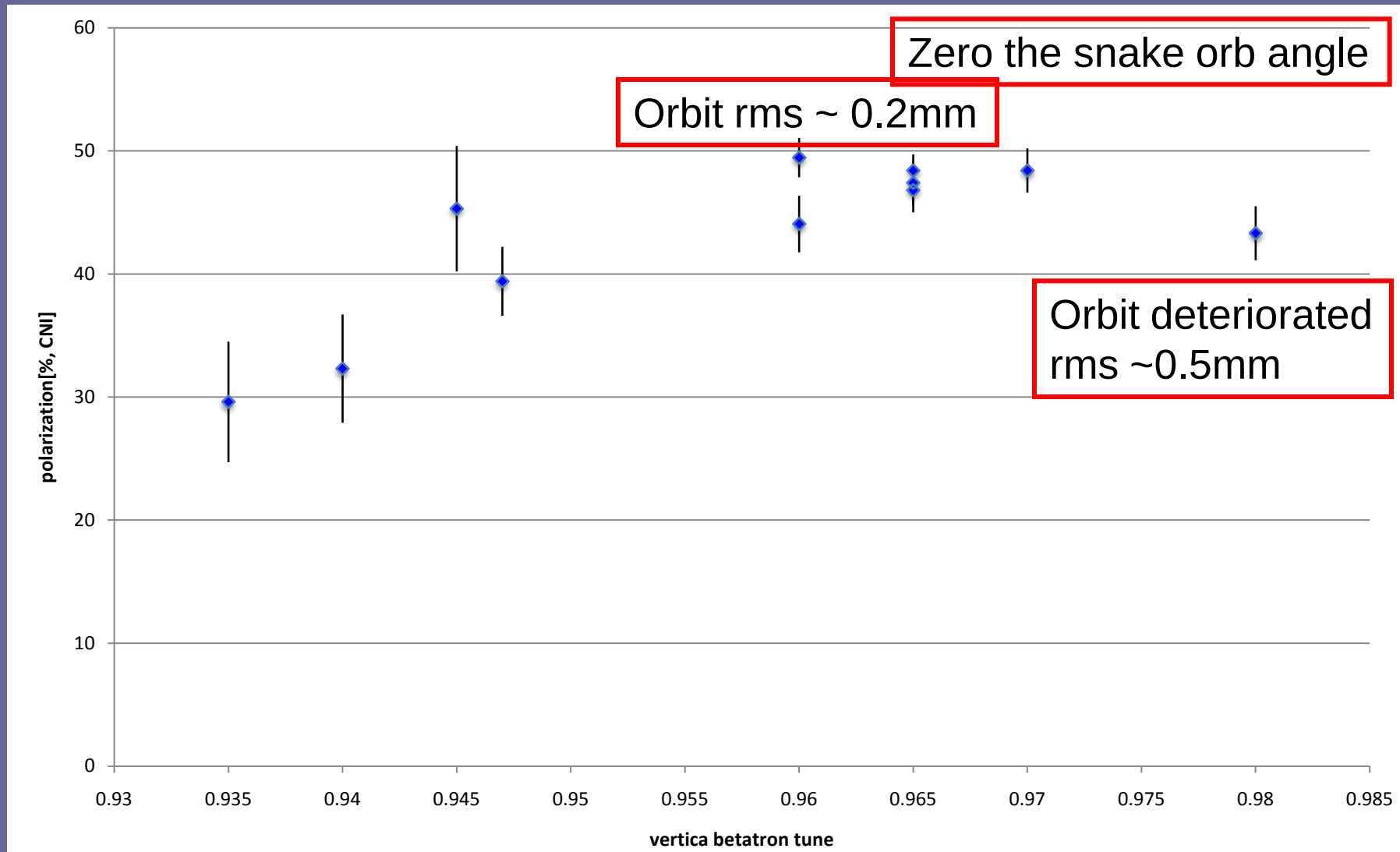




Tune Scan of 250GeV: gg260, gg381, gg422



Investigating polarization at near Integer



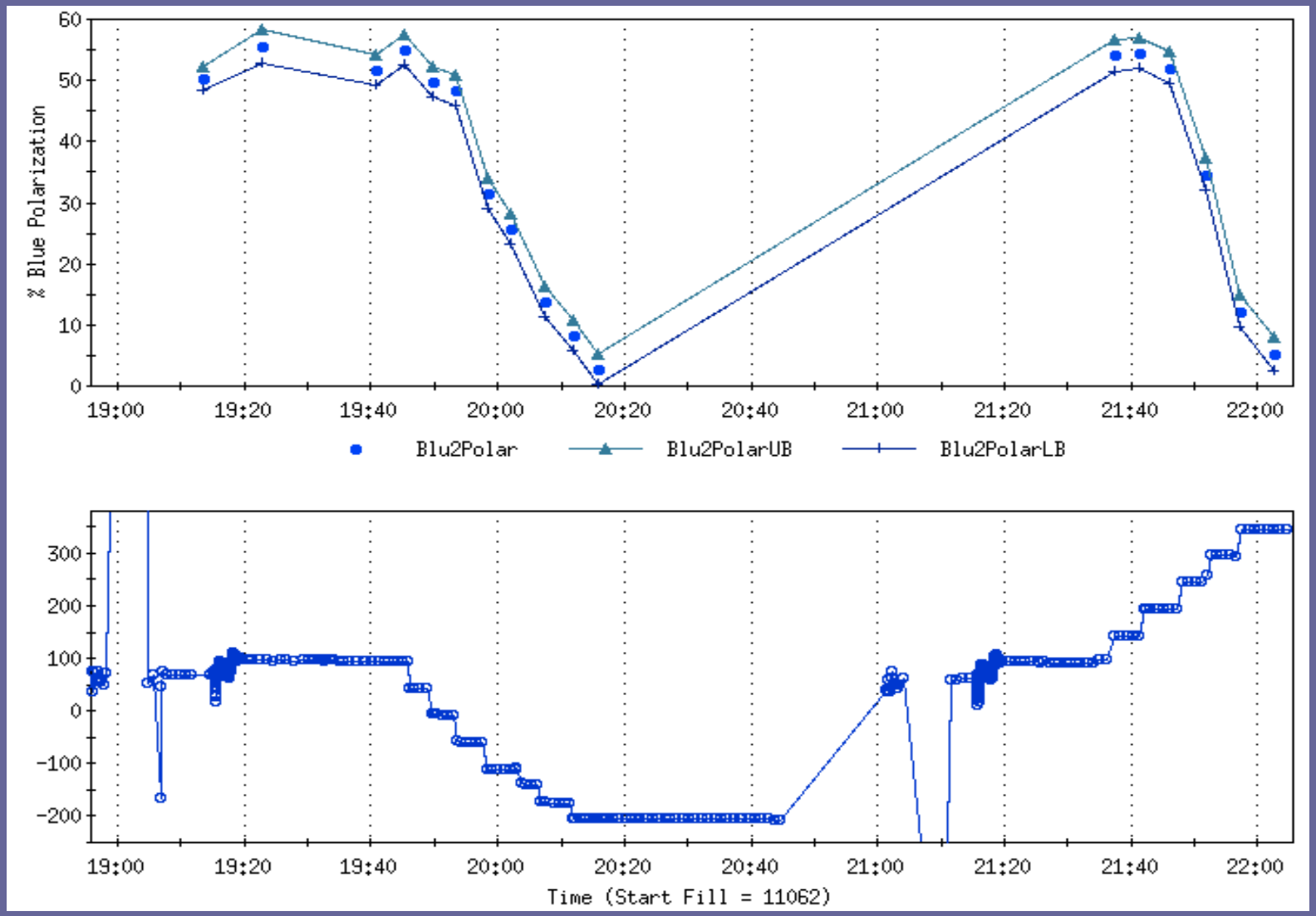
Spin tune as function of H orbital angle between snakes

$$Q_s = \frac{|\phi_1 - \phi_2|}{\pi} - (G\gamma + 1)\frac{\Delta\theta}{\pi}$$

- Measurements were done at 100 GeV as well as 250 GeV
- These data sets will allow us to distinguish the contribution to the spin tune shift from snake imperfection and from horizontal angle between snakes

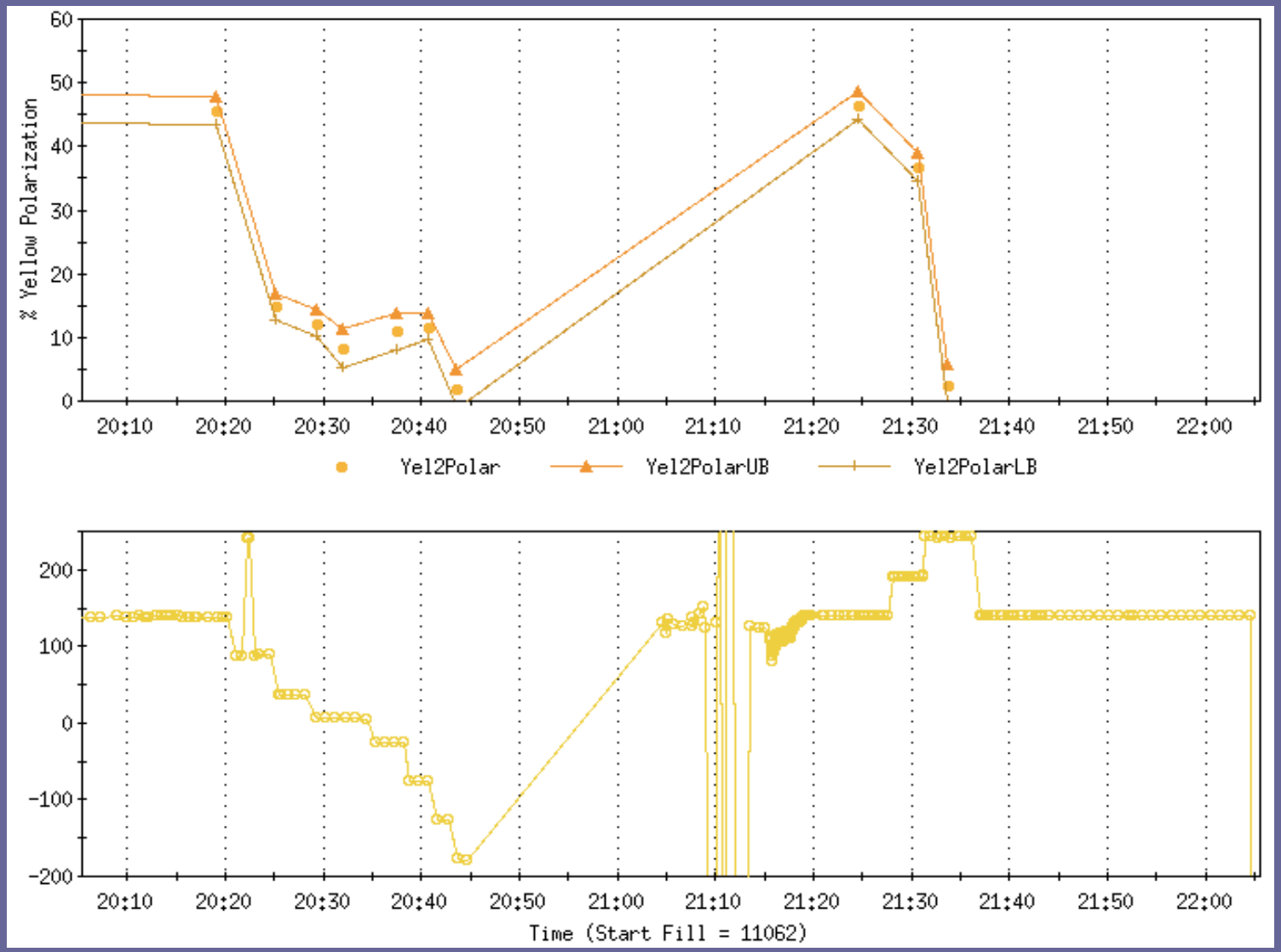
Spin tune as function of H orbital angle between snakes

- Blue Qy = 0.74



Spin tune as function of H orbital angle between snakes

- Yellow Qy = 0.744



How to achieve >50% polarization at 250 GeV?

- Beam dynamics/parameters (achieved)
  - Orbit distortion
    - Below 100 GeV: ~ 0.3 mm
    - From 100 GeV: 0.2~0.3 mm
    - Can orbit correction reach less than 0.2mm rms distortion?
  - Horizontal orbital angle between snakes
    - < 0.1 mrad variation during the ramp
  - Optics
    - With the help of tune/coupling feedback system, both coupling and tune excursions along the ramp were corrected
    - However, chromaticity was not really under control and this may cause wider spin tune spread and result in polarization loss

How to achieve >50% polarization at 250 GeV?

- Polarization transmission efficiency
  - Explore the possibility of accelerating polarized protons at working point between 0.67-0.675
    - 250 GeV tune scan data indicates a polarization transmission efficiency of 90% and more can be achieved
    - Assuming polarization at RHIC injection reaches >60%, the polarization at 250 GeV can reach > 50%
- Polarization lifetime: detailed data analysis
  - What's impact of Blue PHENIX rotator setting on spin tune?
    - Did the local orbit at rotators matter? Should demonstrate the correlation from the data
- Optimize the snake setting (current and orbital angle) at store based on the spin tune measurement
- Revisit spin tracking
  - Bench making spin tracking code(s) using experimental data