Snake orbit effect on the spin tune in RHIC

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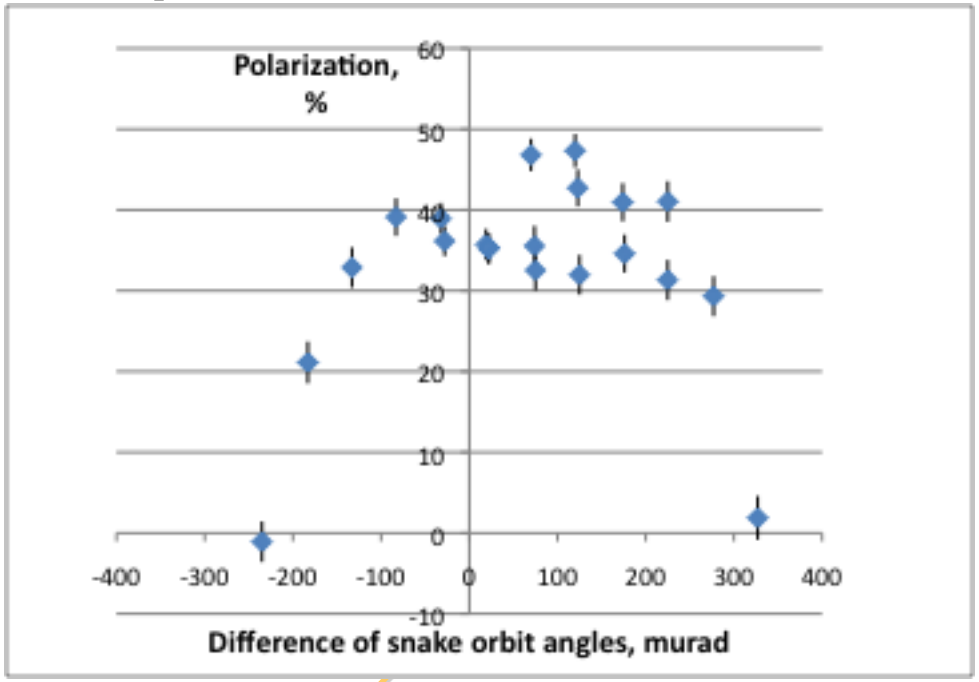
Spin tune versus snake orbit angle

Example of measurements done in Blue at 250 GeV



Horizontal orbit angle measured, using BPMs, at 3 o'clock snake minus similar angle measured at 9 o'clock snake

Making use of the depolarization by 0.75 (second order) spin resonance:

- vertical betatron tune is put sufficiently close to 0.75 (in this example, $Q_y = 0.73$)
-gradual change of the snake orbit angles causes the spin tune shift from ½ and therefore the shift of spin resonance from 0.75
-the depolarization is observed when the spin resonance shifted to the location of Q_y

Goals:

- To verify analytical formulas for spin tune dependence on snake orbit angle
- To verify the value of the spin tune itself

Spin tune versus snake orbit angle (2)

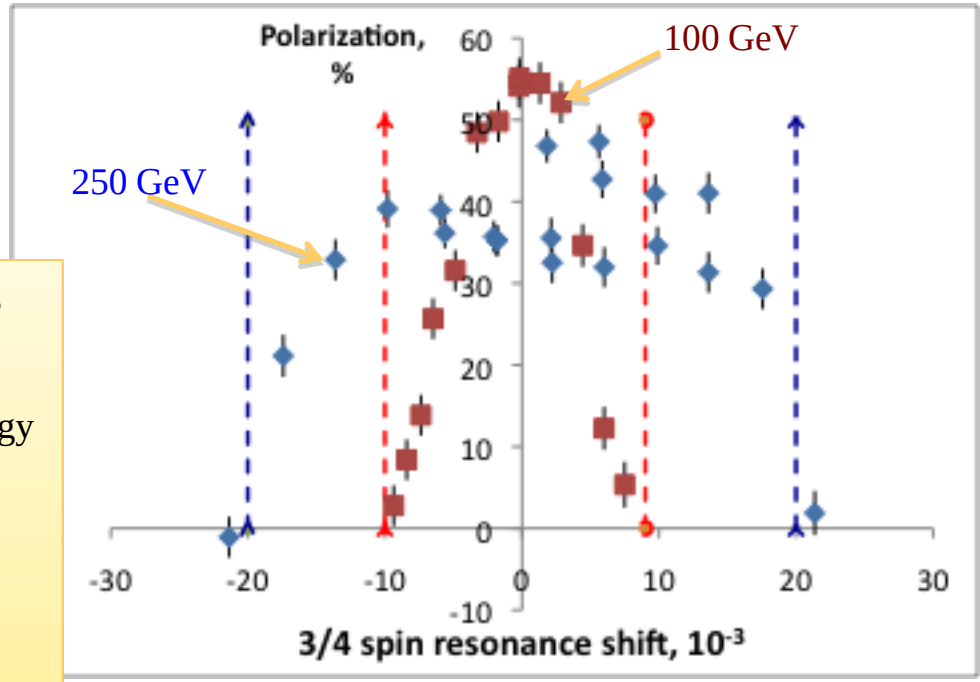
$\alpha_{sn} = x'_{sn3} - x'_{sn9}$ - measured snake orbit angle difference

$$\delta\nu_{3/4} = \frac{\delta\nu_{sp}}{2} = \frac{1}{2}\left[\Delta\nu_{sn} + \frac{1+G\gamma}{\pi}\left(\alpha_{sn} - \alpha_0\right)\right]$$

Spin tune shift due to a snake error

Orbit angle measurement error: BPM offsets, quad misalignments shift

Conversion of the measured orbit angles to the spin tune shift, using the analytical formula works very well!
The depolarization happens at the locations of the vertical betatron tunes during the measurements (dashed lines)



Measurements done at two different energies allows to calculate $\Delta\nu_{sp}$ and α_0 (for Blue beam):

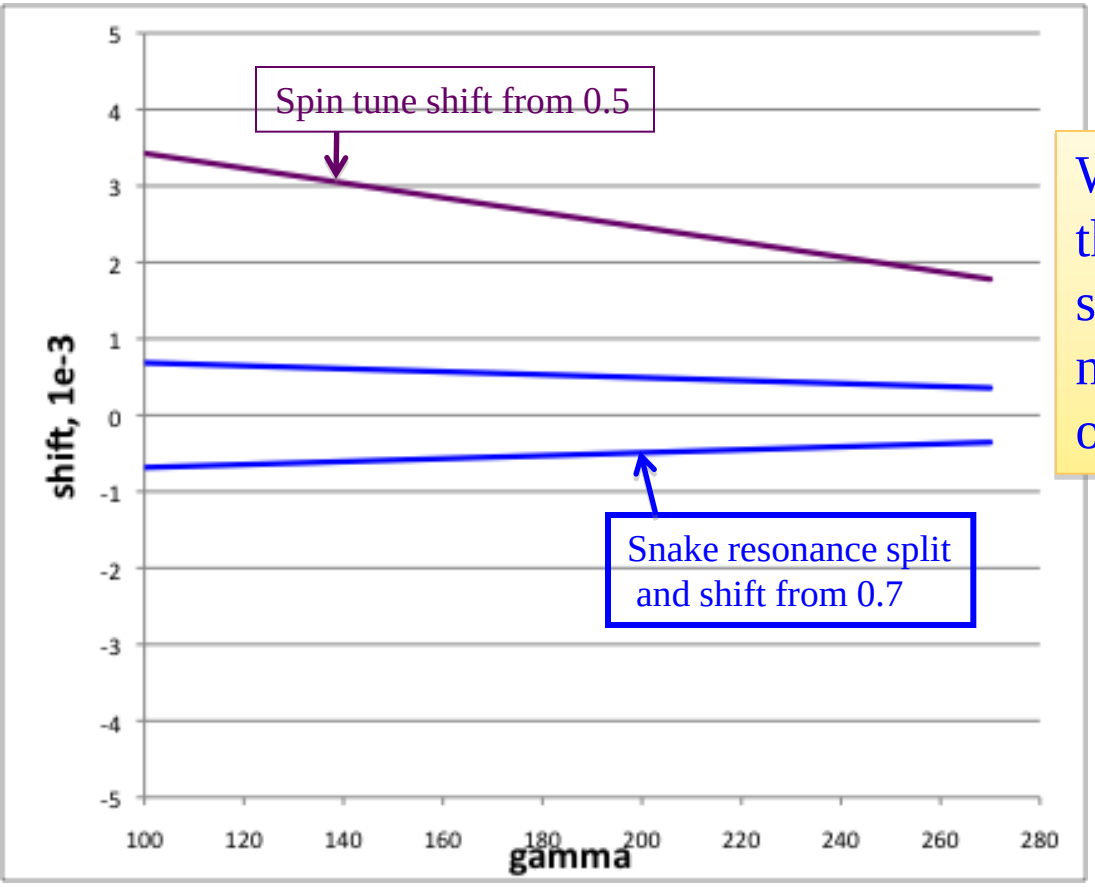
$\Delta\nu_{sn}$ = 4.4 (+-2.5) 10^{-3} - may be consistent with small energy dependence of snake rotation axes

α_0 = 17 (+-15) murad

α_0 calculated from reversed BPM offsets error: -24 murad

Spin tune on the ramp

Using the experimental results we can evaluate the spin tune and 0.7 resonance shift during the course of the acceleration.



With well corrected snake orbits the shift of 0.7 resonance was quite small on the whole ramp and could not be a cause for the depolarization on the ramp

The plot presents the case of the snake orbit angle corrected to 0 according to BPMs