Update on the understanding of the polarization in RHIC

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RHIC Polarization Setup

- 2 Siberian Snakes per ring hold the spin tune ½ all the way up during the acceleration
- The vertical tune was chosen at 0.23, between 2 high–order spin resonances:
  - 1/4=0.25 ; depends on vertical orbit
  - 3/14=0.2143; exists even without orbit errors
- The special vertical orbit, "really" flat was used as the ideal orbit
  - Made from measured misalignment data (3 years old).
  - The goal number for vertical orbit correction was 0.5mm rms
  - No measured orbit data in defocusing quads

The vertical tune was put between two higher order spin resonances

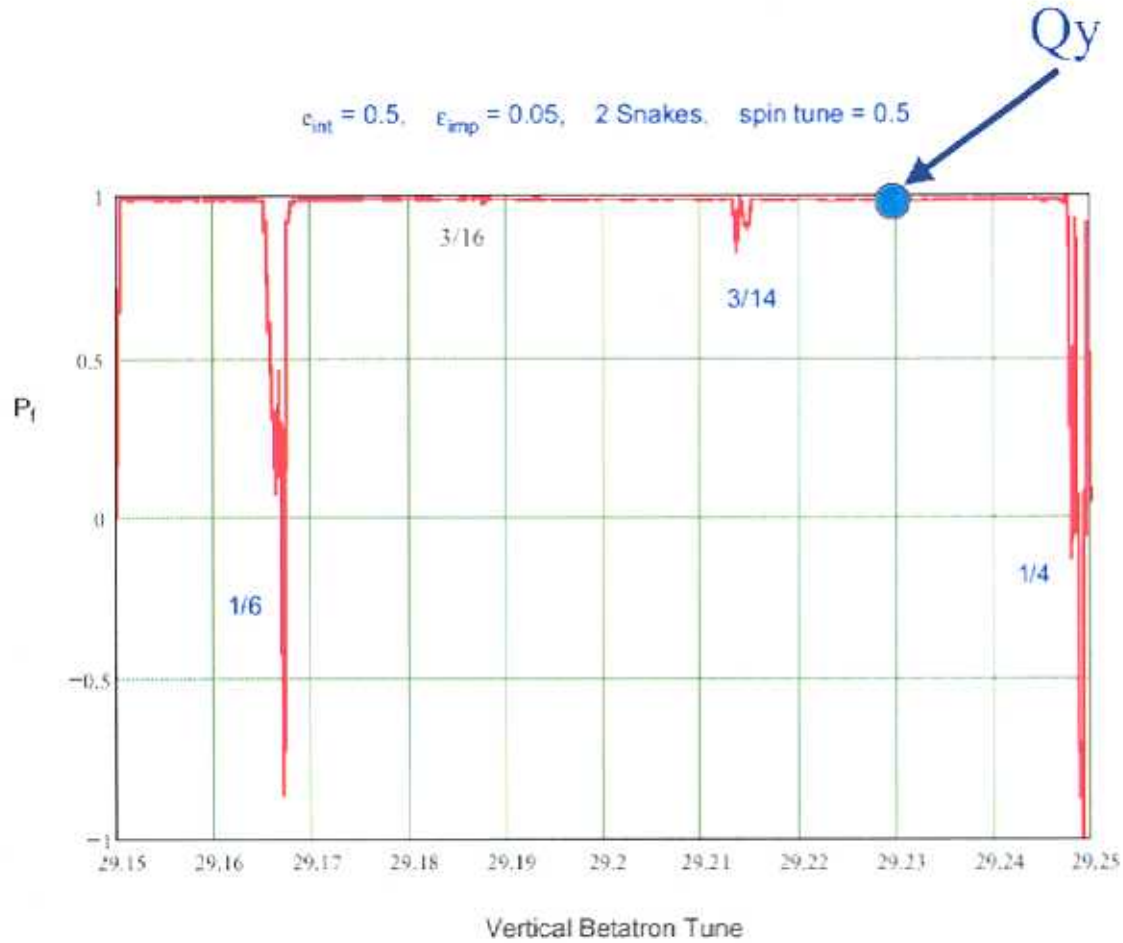
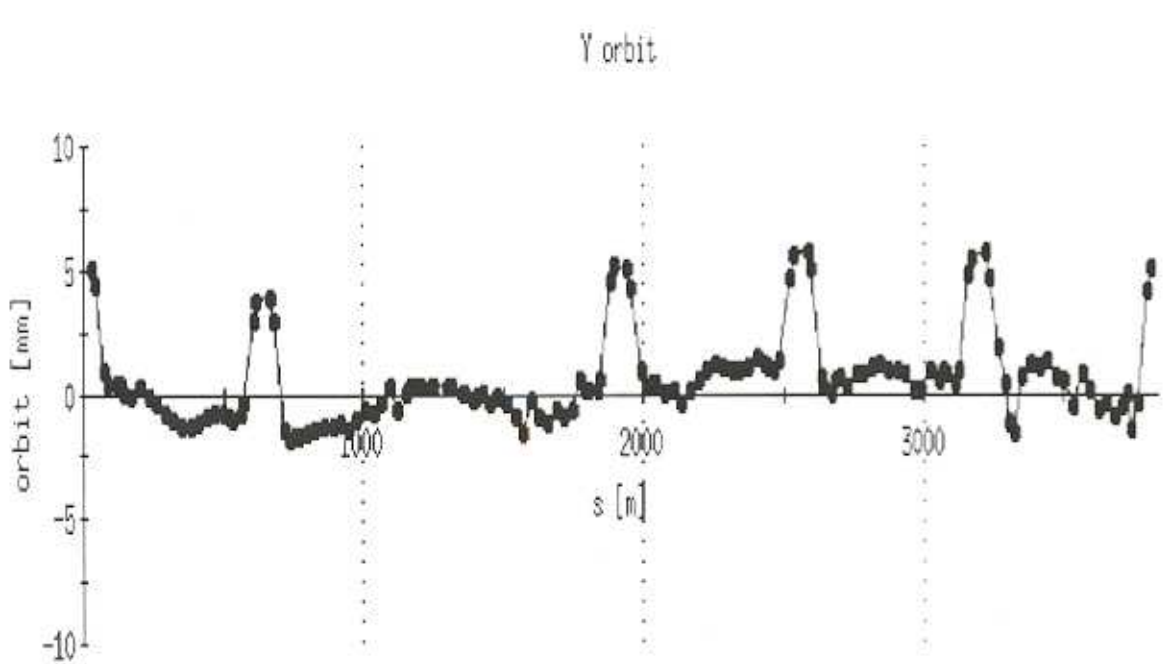
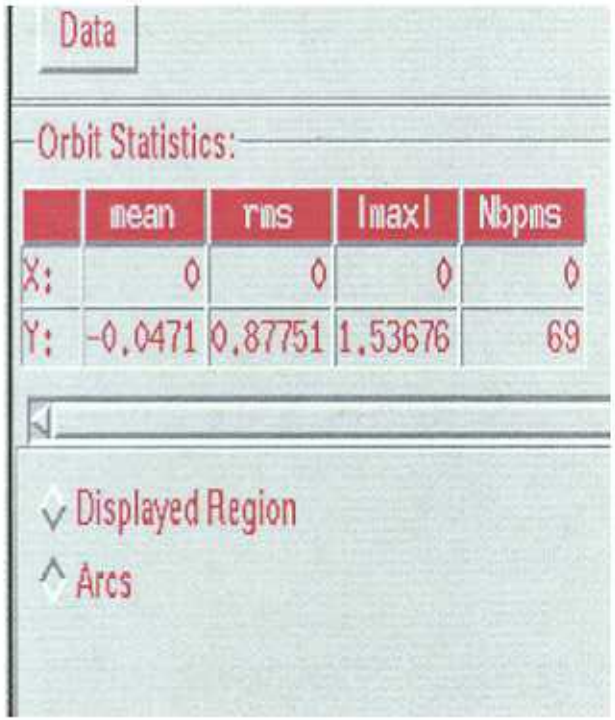


Figure 5.3: Vertical component of the polarization after acceleration through a strong intrinsic resonance and a moderate imperfection resonance shown as a function of the vertical betatron tune.

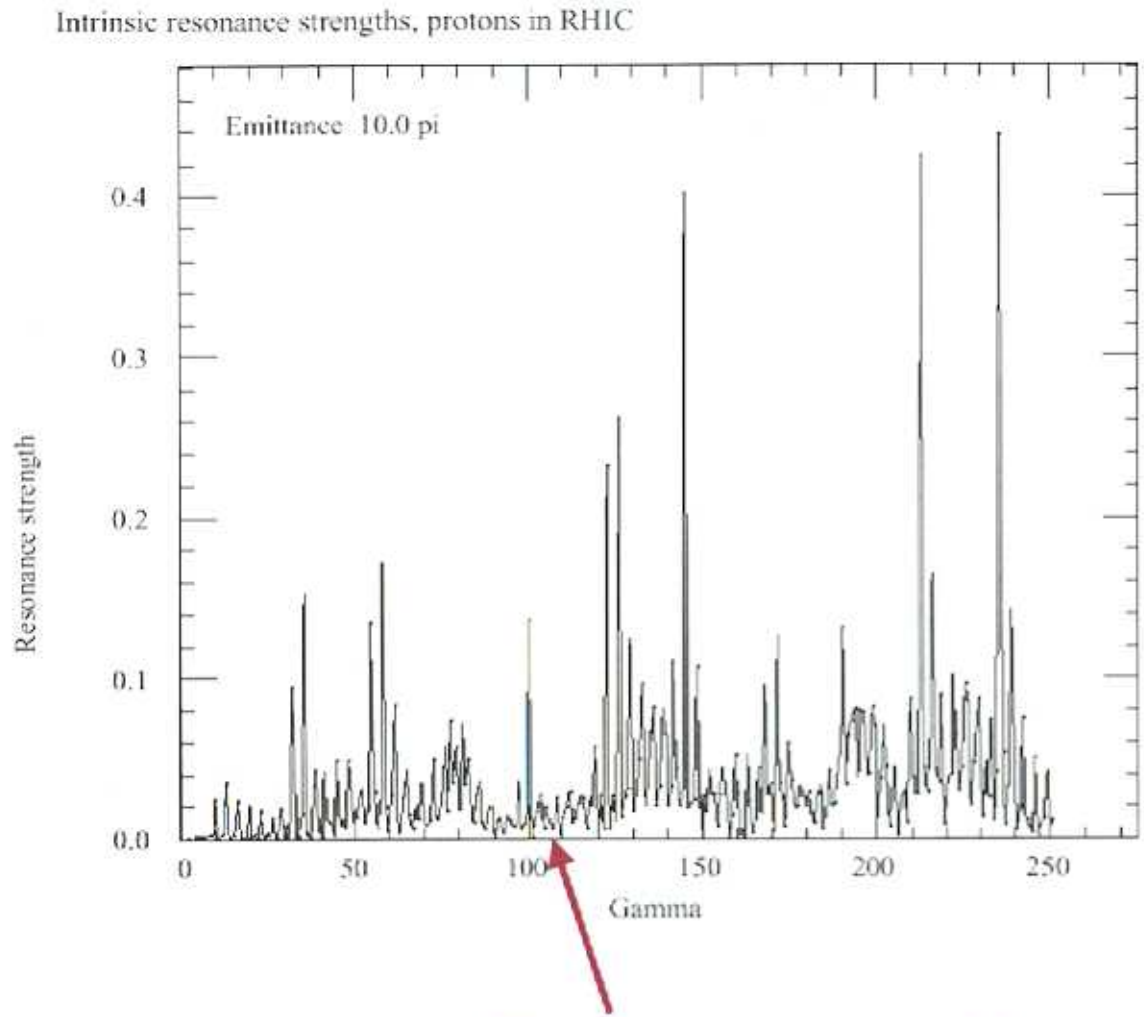
Ideal Blue orbit for polarized protons
(with vertical separation bumps included)





Polarization preservation

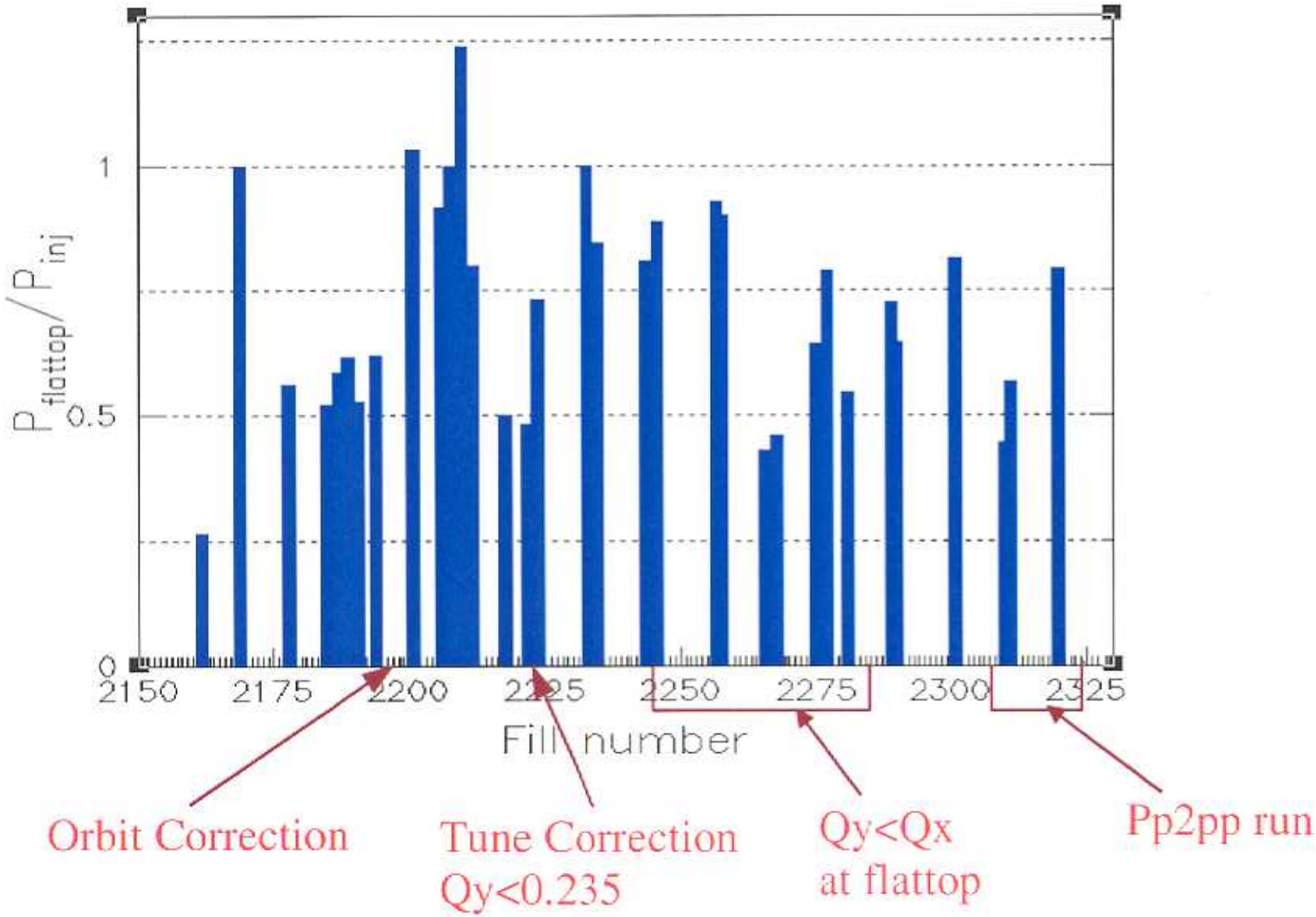
- The intrinsic resonances: 4 dangerous zones on the ramp
  - Special attention to the tunes and orbits at these zones
- Yellow polarization transmission was good the most of time
- Blue polarization transmission required more attention and periodical corrections
  - Mostly tune corrections



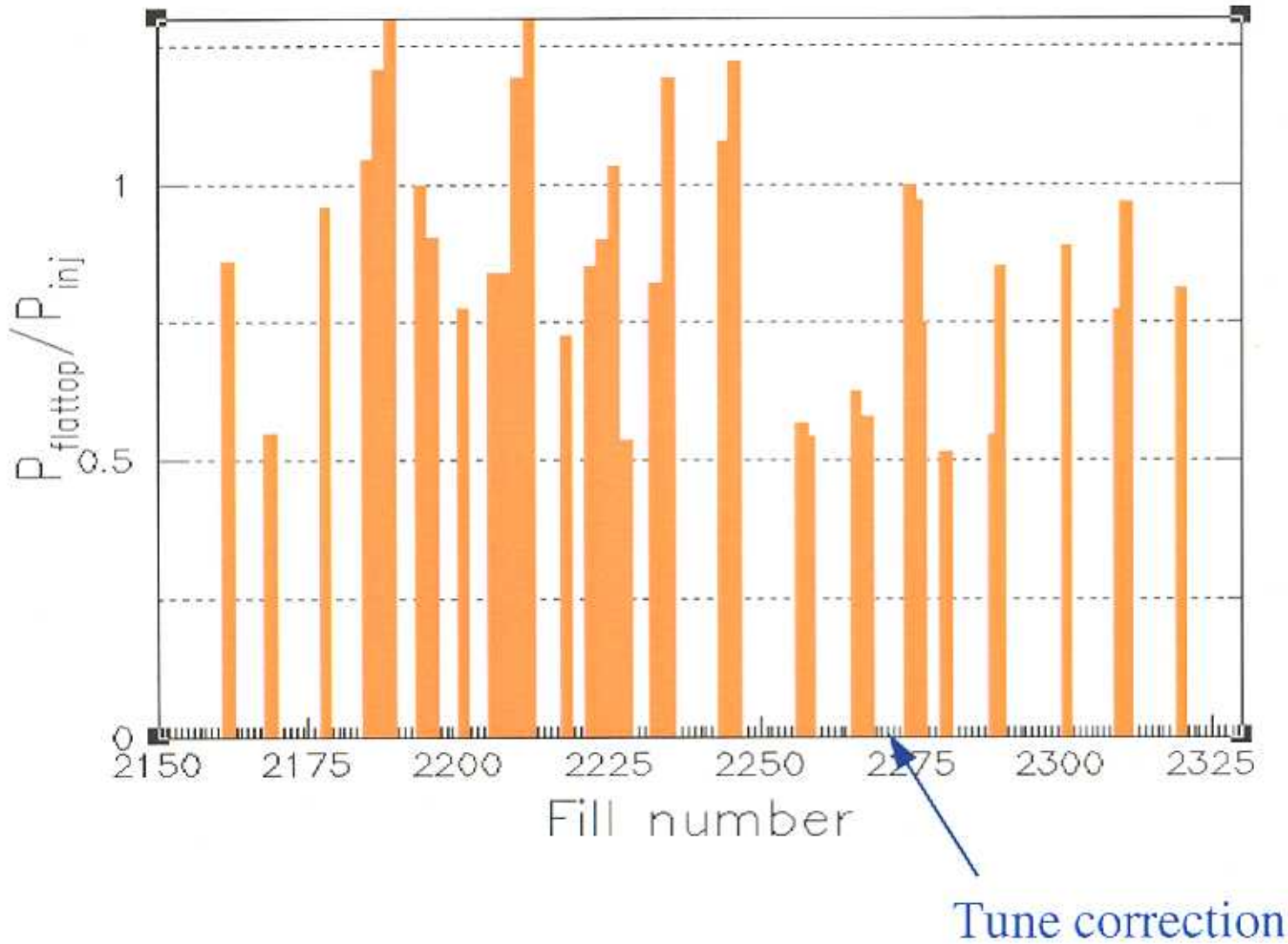
The flattop energy this run

Note that the emittance was more than 2 times larger this run with the resonance strength increasing as the square root of the vertical emittance

Blue polarization transmission on the ramps



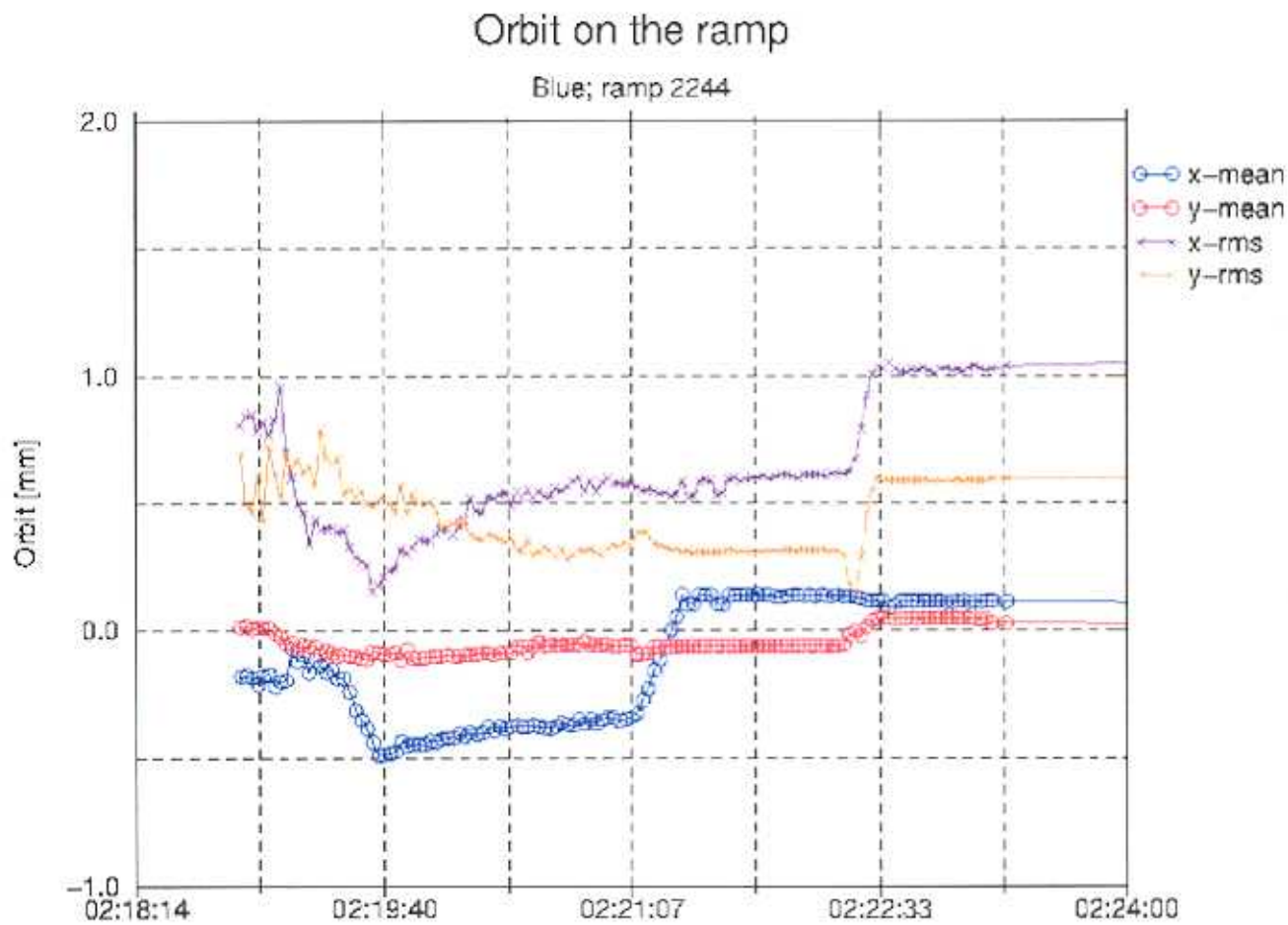
Yellow polarization transmission on the ramps



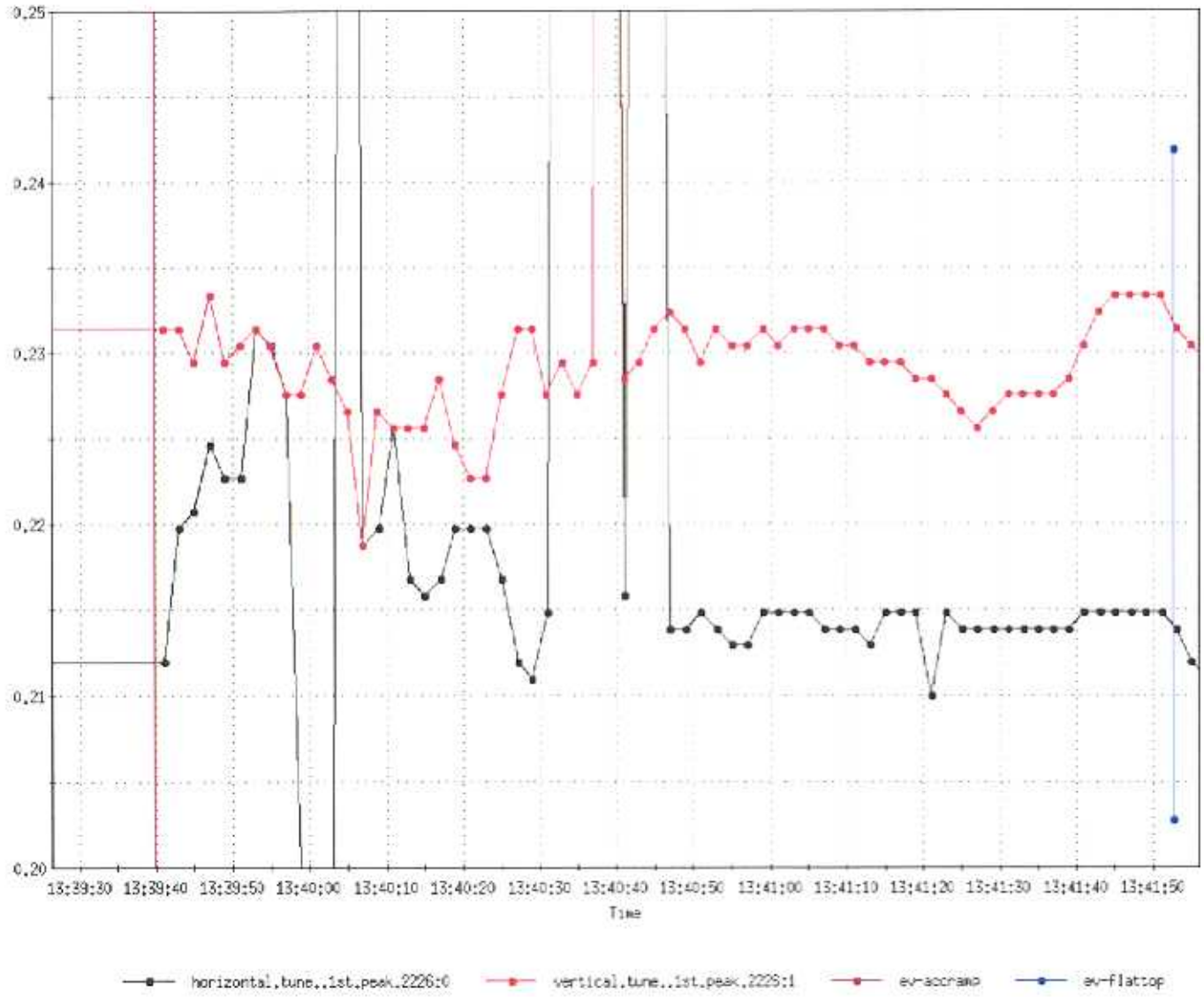
The empirical rules for the ramp:

- Keep the vertical tune below 0.235
  - Total polarization loss when Qy exceeded 0.245 at the end of the ramp was observed
- Horizontal tune + coupling might be important too
- Keep the orbit rms below 1mm
  - Blue depolarization was observed with the horiz.orbit rms higher than 1.5 mm
- The polarization deterioration at the store was observed when the vertical and horizontal tunes were switched in Yellow.
  - Qy close to 3/14 resonance

Beam orbit rms/mean along the ramp



Betatron tunes on the ramp (Blue)

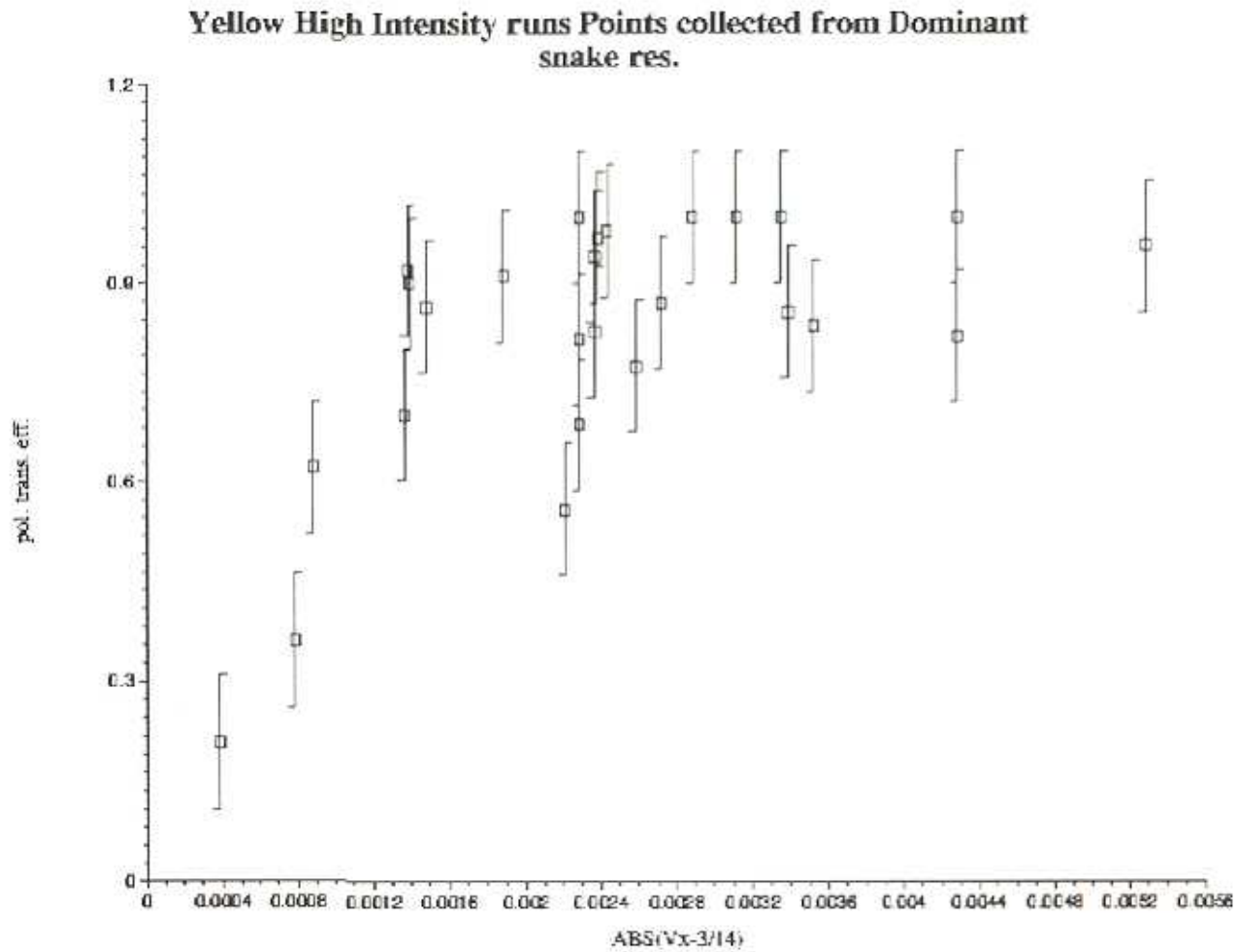


The Polarization Analysis

- The search for correlations between the polarization and tunes, orbits, coupling, emmittances is underway
  - The horiz. tune should be kept away from 3/14 (V.Ranjbar)
  - Was Blue worse than Yellow because of different emmittances? Or the goal orbits?
  - The Blue orbit more critical than Yellow
- The spin (SPINK) tracking to reproduce observed depolarizing effects and to study them (A.Luccio)

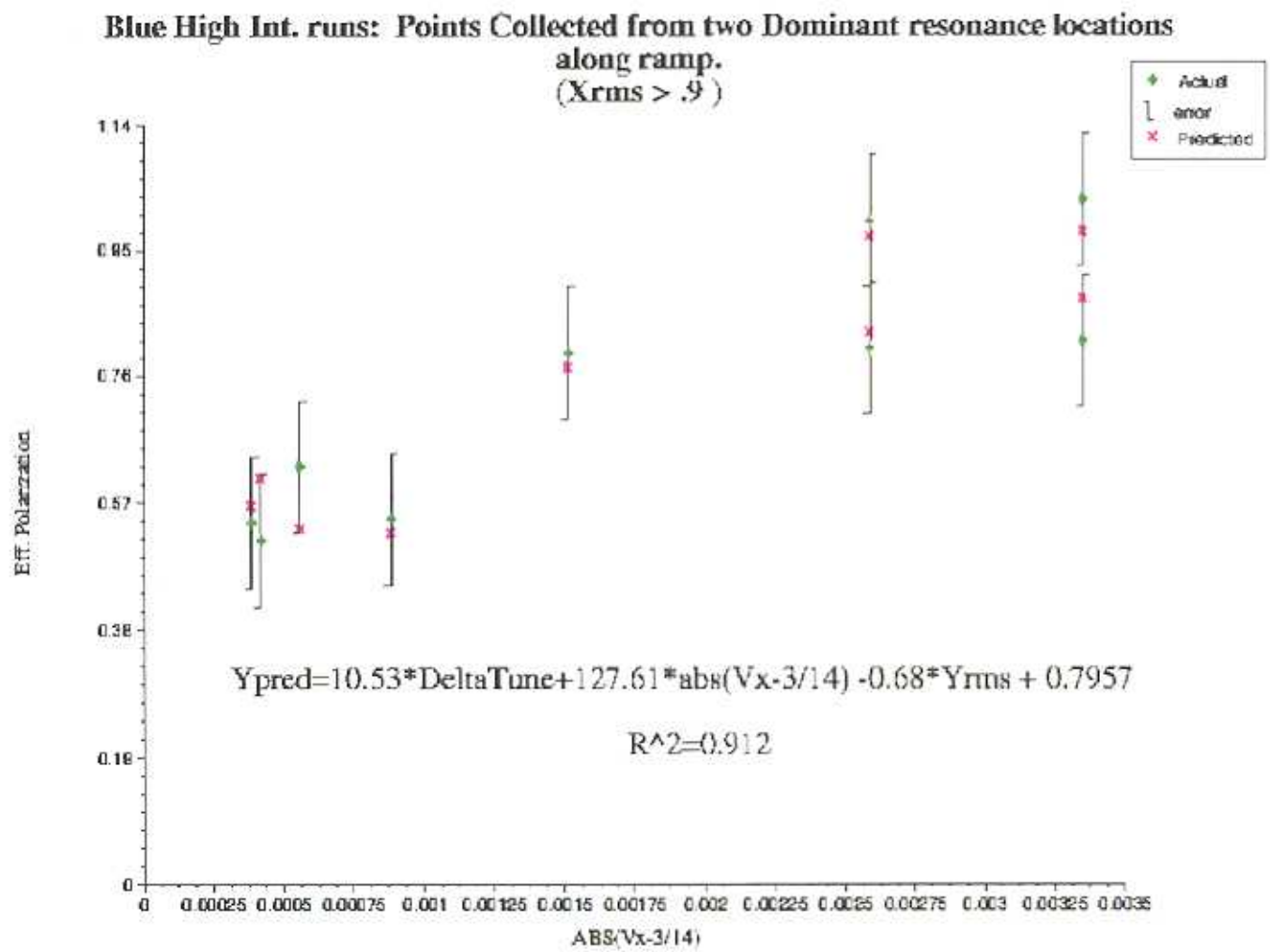
The run data shows depolarisation by 3/14 resonance caused by coupling inYellow

(V.Ranjbar)

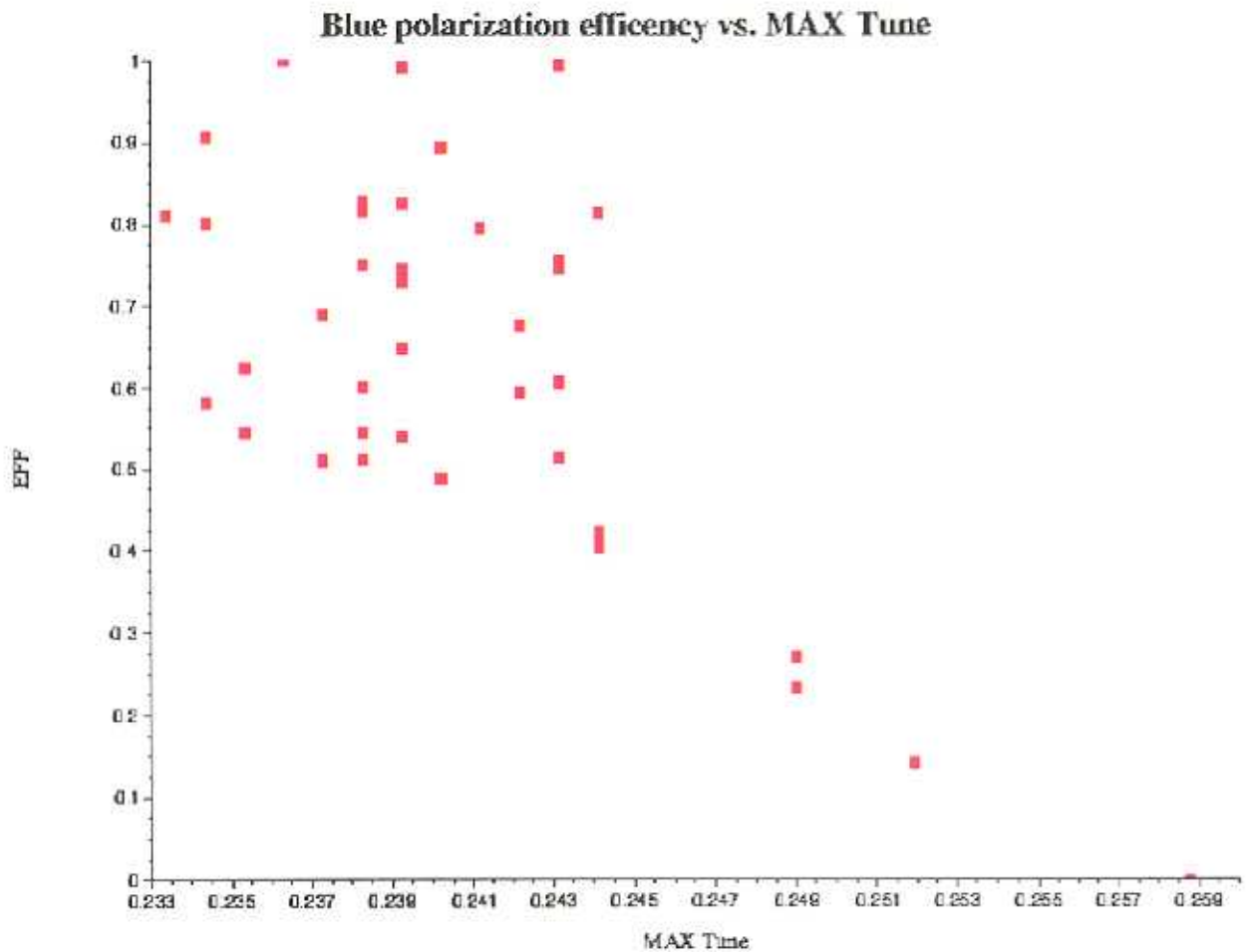


Blue data for the 3/14 resonance
The resonance was not so pronounced as in Yellow

(V.Ranjbar)

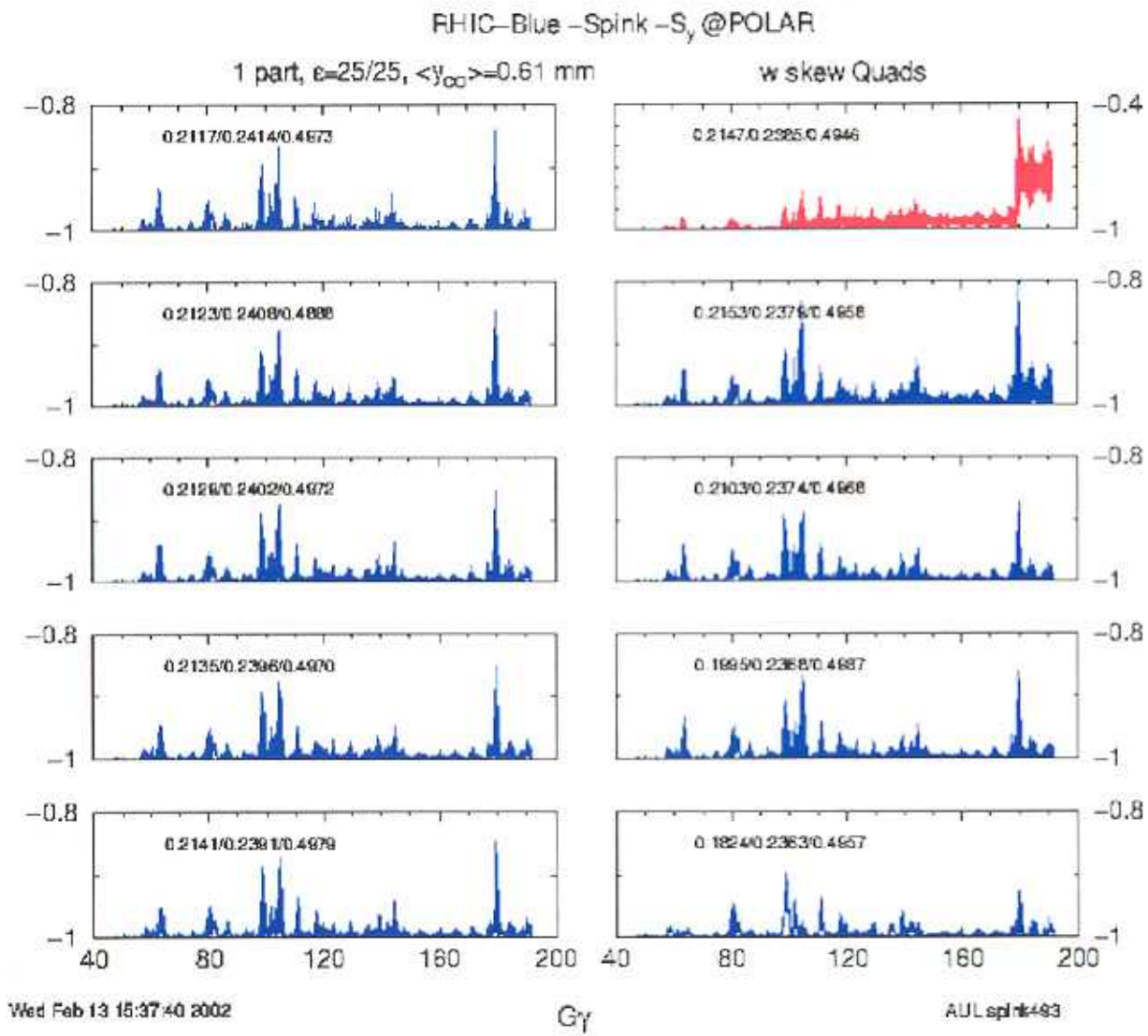


¼ spin resonance (with vertical betatron tune) (V.Ranjbar)



SPINK modeling of 3/14 resonance in the presence of betatron coupling

(A.Luccio)



Next Run

- Higher energy–> stronger resonances
- The goal orbit needs to be revisited
  - Newly measured misalignment data
  - Analysis of the corrector strengths
  - Coupling and dynamic aperture from the ideal orbit going off center in quads and sextupoles.
- Better beam control on the ramp would be necessary
  - Tune feedback
  - Improved orbit correction (below 0.4mm rms)
  - Coupling control on the ramps