Polarization Transmission Efficiency on the Ramp

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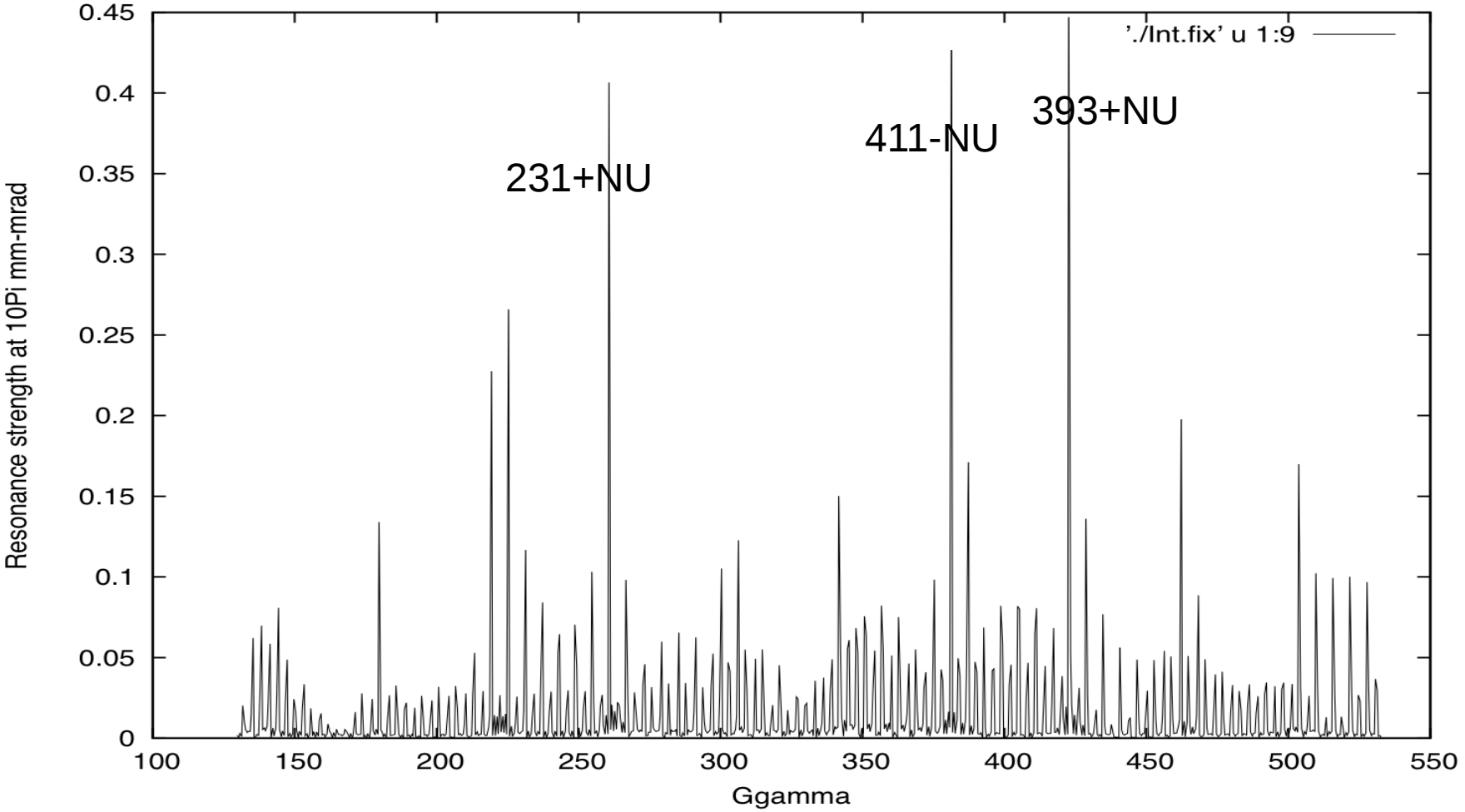
Outline

- Overview of Losses during RHIC energy Ramp
  - Predicted versus Measured
- e-lens lattice versus FY12 lattice
  - Predicted versus Measured
  - Tracking
- Losses on Rotator Ramp
- Beam lifetime

Overview of Resonances on RHIC ramp



How did we do?

Lattice (before LLRF fix)	Avg Jet Pol. *	Avg. CNI Ramp Eff. **	Avg R ratio **
Blue e-lens	47.7± 0.7%	0.8202+- 0.0059	0.2381
Blue FY12	42.7% ± 0.8%	0.7805+- 0.0089	0.3129
Yellow e-lens	44.1% ± 0.8%	0.8324+- 0.0064	0.2447
Yellow FY12	50.0% ± 0.9%	0.8469+- 0.0105	0.2452

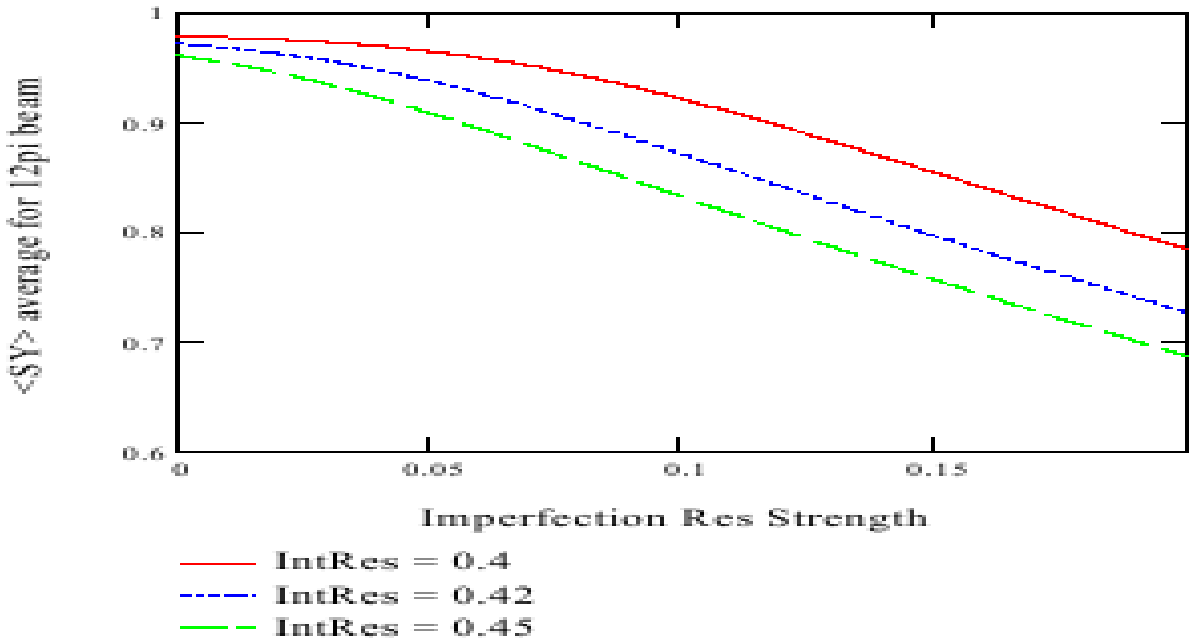
Lattice (after LLRF fix)	Avg Jet Pol. *	Avg. CNI Ramp Eff. **	Avg R ratio **
Blue FY12	51.7 %± 0.3%	0.8842+- 0.0057	0.1287
Yellow FY12	55.1%± 0.4%	0.8834+- 0.006	0.1403

* Jet Number Courtesy H. Huang ** CNI Ramp Eff. Courtesy D. Smirnov

Polarization Loss In RHIC cycle

- These numbers are at times debated a lot. Under good conditions we have seen:
  - Average Jet number of 57% over 16 fills
  - The injection 65%
  - This means we have about 88% efficiency on a good day. This agrees with CNI efficiency numbers. So for those fills where we fall below 57% probable causes are:
    - Emittance
    - Rotator Ramp losses
    - Lifetime during collision

Looking at predicted losses on Energy Ramp compared for 12pi beam (extrapolate from tracking).

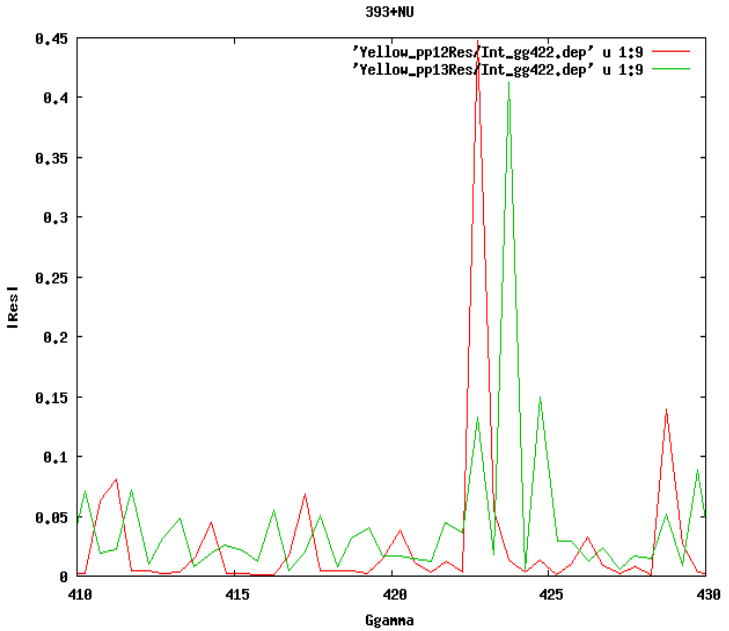


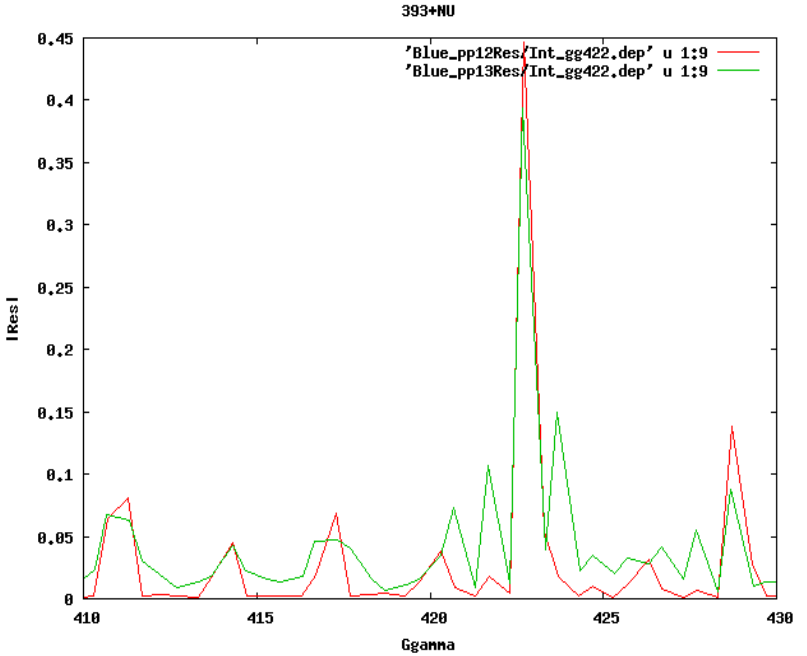
Estimates of efficiency up the Energy Ramp for FY12 Lattice:

Pol(0.445 ,0.03)-Pol(0.426 ,0.03)-Pol(0.4 ,0.03) = 0.872

Estimated crossing each of the three strong Intrinsic resonances and integrating out to 3 sigma we get 87%. If we drop down to 2 sigma this become 94%. Also these response functions are for Qy tunes = 0.673. (Need to build for 0.671).
Probably the baseline is higher than 87% (low coupling and high tunes)

First Test of modified Intrinsic resonance in RHIC

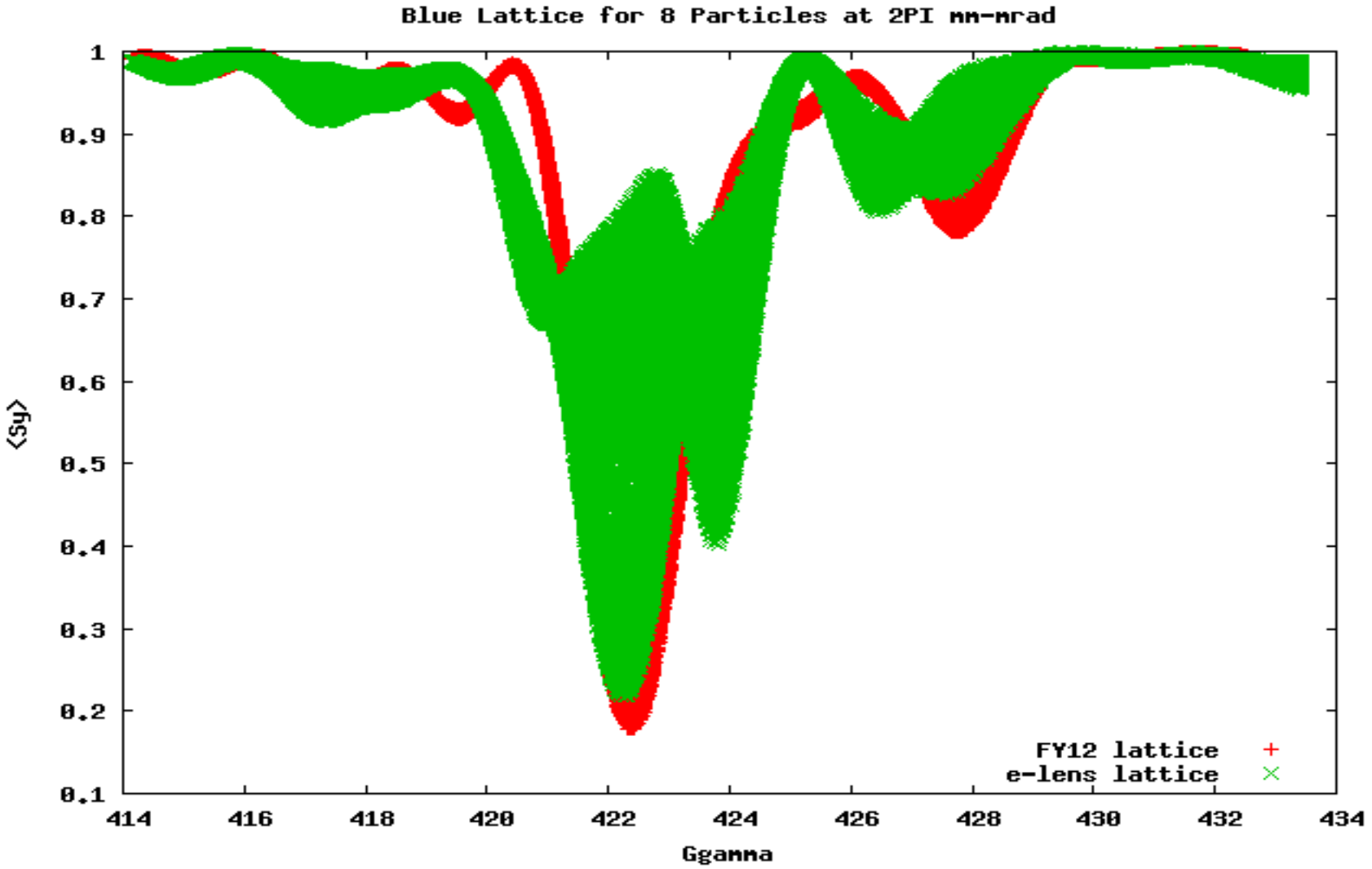




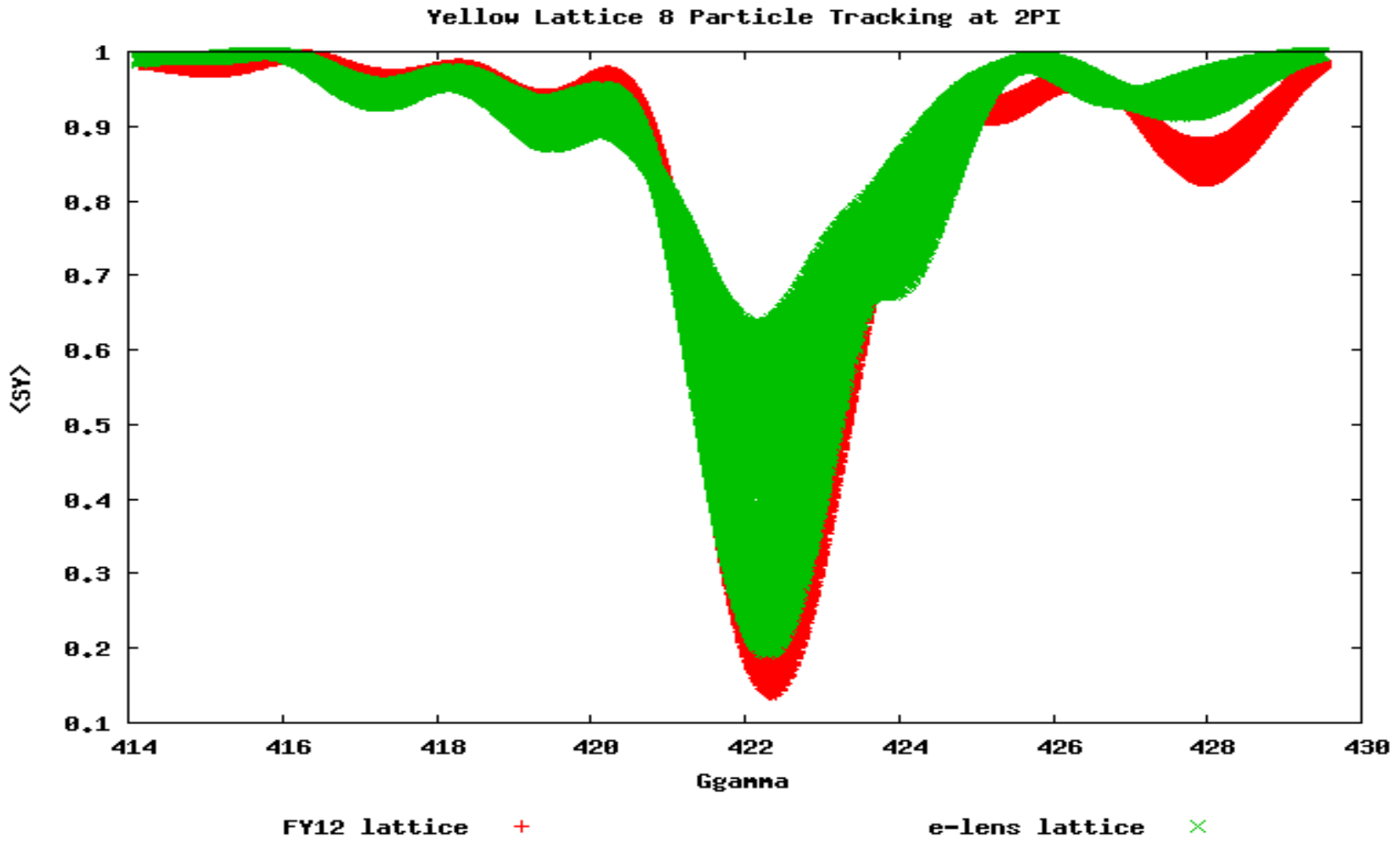
Reduced Resonances by 10 to 14%

Resonances	Blue (new-old)	Yellow (new-old)
231+NU	-0.0387	-0.0415
411-NU	-0.06134	-0.0655
393+NU	-0.05347	-0.0347

Blue E-lens tracking no errors.



Yellow E-lens tracking no errors



Challenges with Tracking:

- There were issues tracking large amplitude particles in UAL-SPINK and TEASPINK.
- Still studying this problem but I now believe it is related to the radius of convergence for these integrators
- I was initially worried that there might be 'new' spin dynamics issues with the unique phase of the e-lens lattice. Maybe overlapping of the secondary intrinsic resonance.

Predictions for e-lens lattice

- Based on Intrinsic resonance strength at 16pi

Lattice	231+NU res.	411-NU res	393+NU res	Qy (actual)	Efficiency Qy=0.673 Predicted/actual
Blue e-lens	0.361	0.365	0.392	0.673	0.857/0.82
Blue FY12	0.4	0.426	0.445	0.671	0.64/0.78
Yellow e-lens	0.359	0.361	0.41	0.671	0.83/0.83
Yellow FY12	0.4	0.426	0.445	0.671	0.64/0.84

What would the model predict if we ran e-lens lattice with 12pi emittances?
Blue = 0.943 and Yellow = 0.936 compared with 0.87 predicted (and delivered) for the FY12 lattice

Losses on Rotator Ramp

- Aside from Emittance this was the other large source of store polarization variability. Dominated losses for FY12 lattice runs.
  - Set up with the 5 mm bump at STAR slew spin tunes from 0.5 to 0.478
  - Oscillating due to poor control over the orbit at collisions.
  - Sensitive to tunes.
  - Still under study Mei will say more about this in her talk.
  - Hopefully this won't be an issue for future runs.

Conclusion

- Losses on the ramp dominated by the three large Intrinsic resonances
- With the e-lens lattice we had opportunity reduce the strength of these resonance
  - Effect was obscured by the larger emittances during the e-lens run
  - For Blue there seems to be observable effect when controlling for emittance.
  - For Yellow there didn't seem to be an observable difference. (maybe masked by coupling or other effects?)