RHIC and AGS Status and Plans for Run 12

RHIC and AGS Users Meeting

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6/20/11

Overview

- Run 11: goals and achievements
- OPPIS polarized source improvements
- AGS developments
  - Jump quads
- RHIC developments
    - Intensity: 9 MHz RF
    - Polarization: ramp tunes
    - Emittance (a setback)

Goal of the presentation is to report the 'highlight reel' for Run 11 developments and their applicability to Run 12 performance

See Haixin Huang's plenary session talk on Thursday for detailed report of Run 11 performance

RHIC Polarized Proton Parameters

Parameters	Goal	Achieved
Interaction points	6 8	6 8 (AnDY test at 2)
β* in blue [m]	0.65 0.65	0.8 0.6
β* in yellow [m]	0.65 0.65	0.65 0.63
Working points	ramp: (28.685, 29.675) Store: (28.69, 29.68)	Ramp: (28.680, 29.673) Store: (28.69, 29.68)
Luminosity/Week	18-32 pb^{-1}	25.4 pb^{-1} (the best, 4/5-12)
Polarization	50%	50*%
Peak bunch intensity (at store)	1.4×10^{11}	1.65×10^{11}
Peak luminosity	1.7×10^{32} $cm^{-2}s^{-1}$	1.6×10^{32} $cm^{-2}s^{-1}$

Tune/coupling feedback

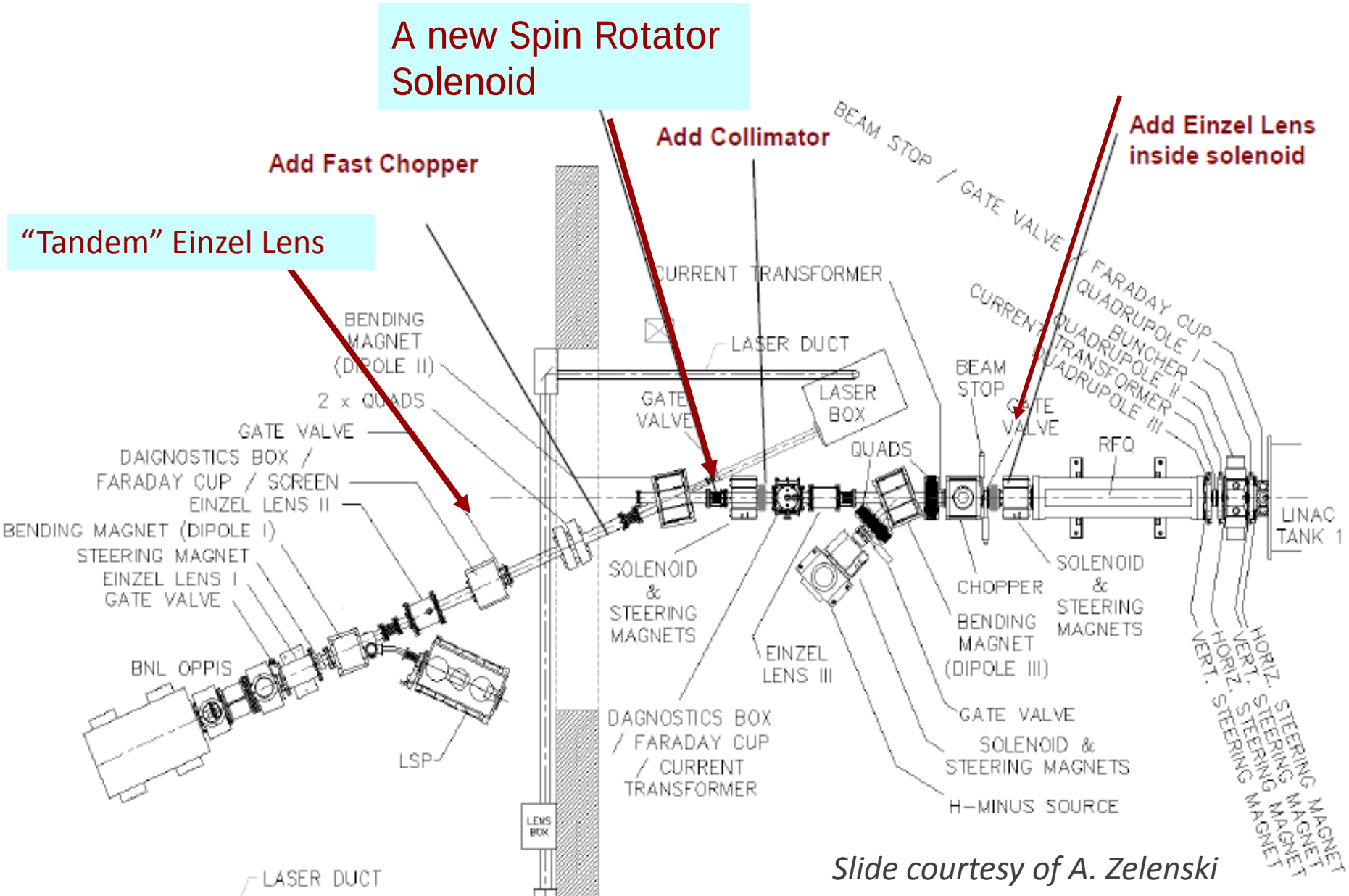
Tune jump + WP

9 MHz RF

*Average of jet polarization is 46% for both rings. Taking into account the polarization profile correction factor (R=0.2), The polarization seen by experimenters is boosted by Sqrt(1+R)=> 50%.

Table courtesy of H. Huang

Source and Linac



Slide courtesy of A. Zelenski

AGS Tune Jump System

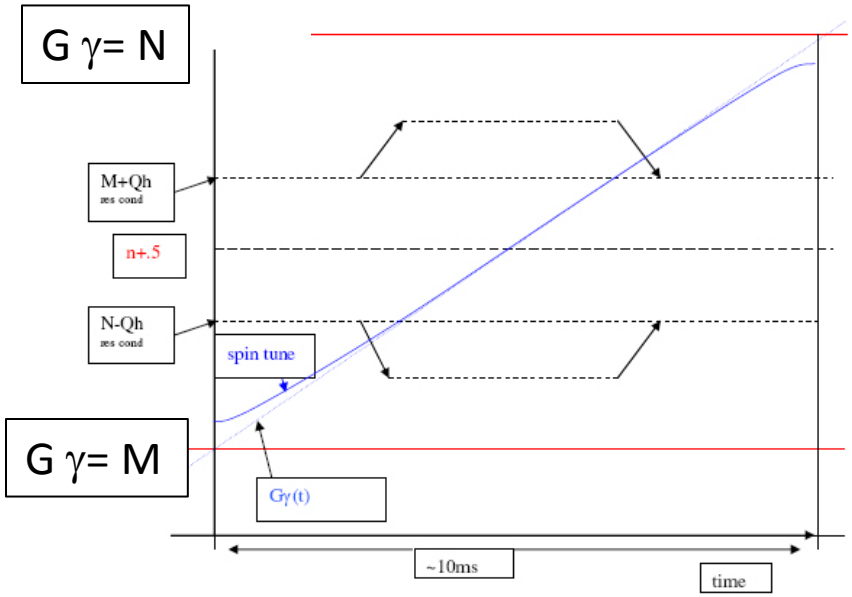
A pair of fast-pulse quads in the AGS designed to speed resonance crossing at the horizontal intrinsic resonances.

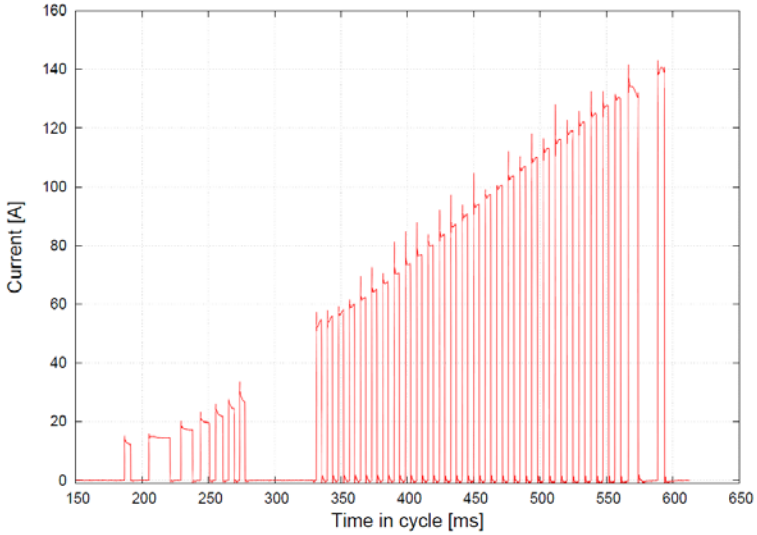
Made operational for all physics fills in Run 11.

Challenges

The time window for an accurate jump is ~200 us. Need to know horizontal tune and beam energy very precisely

There are 82 jumps, non-adiabatic with respect to vertical motion. Even a small increase at each jump results in appreciable emittance growth.





AGS Polarization Profiles

Jump quads properly timed and mistimed

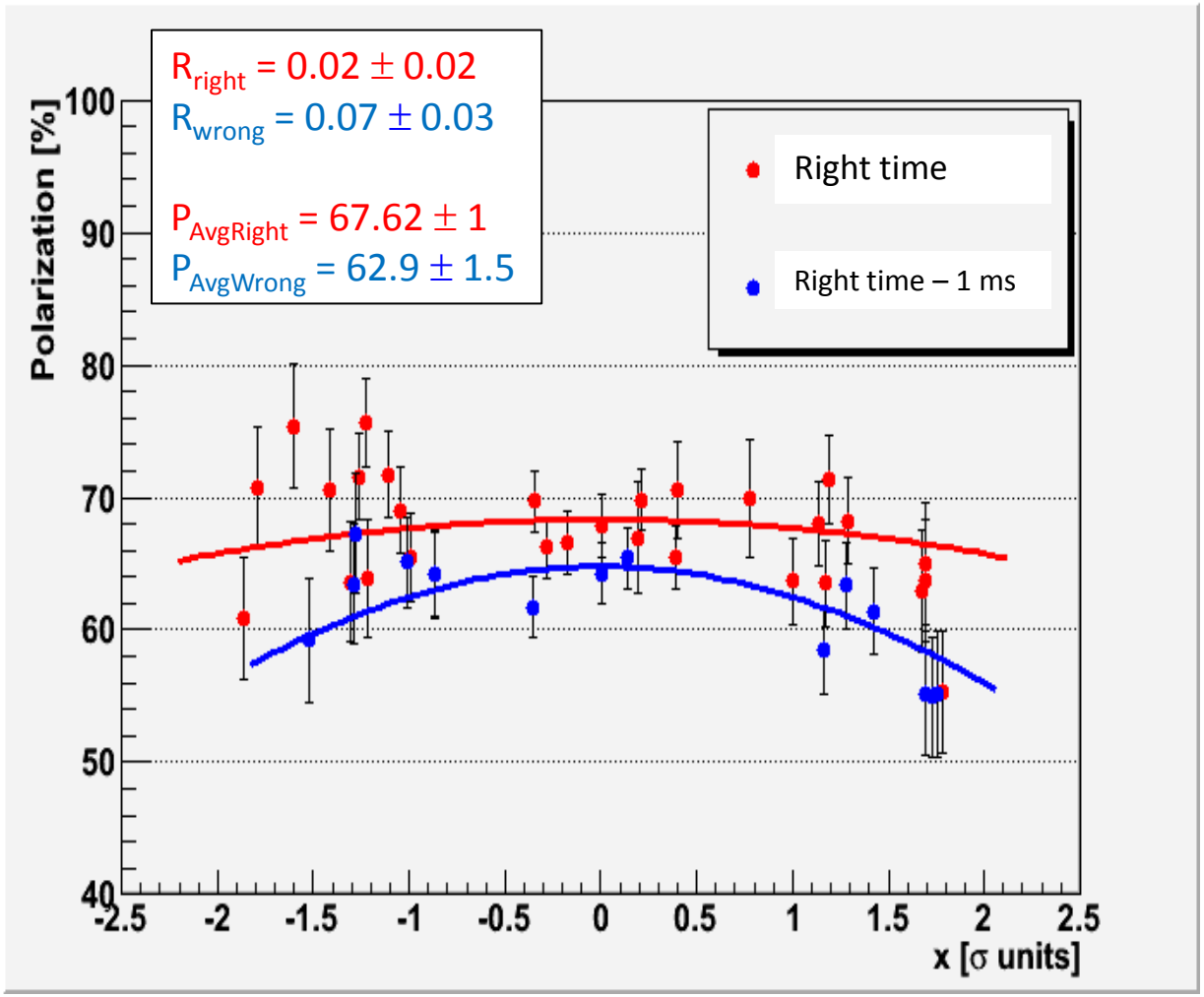
Jump quads created a 5% gain in average polarization at AGS extraction (at high intensity)

Measured R with the jump quads simply turned off (not shown) may be steeper than mis-timed case.

This implies that the 'right' time is not perfect.

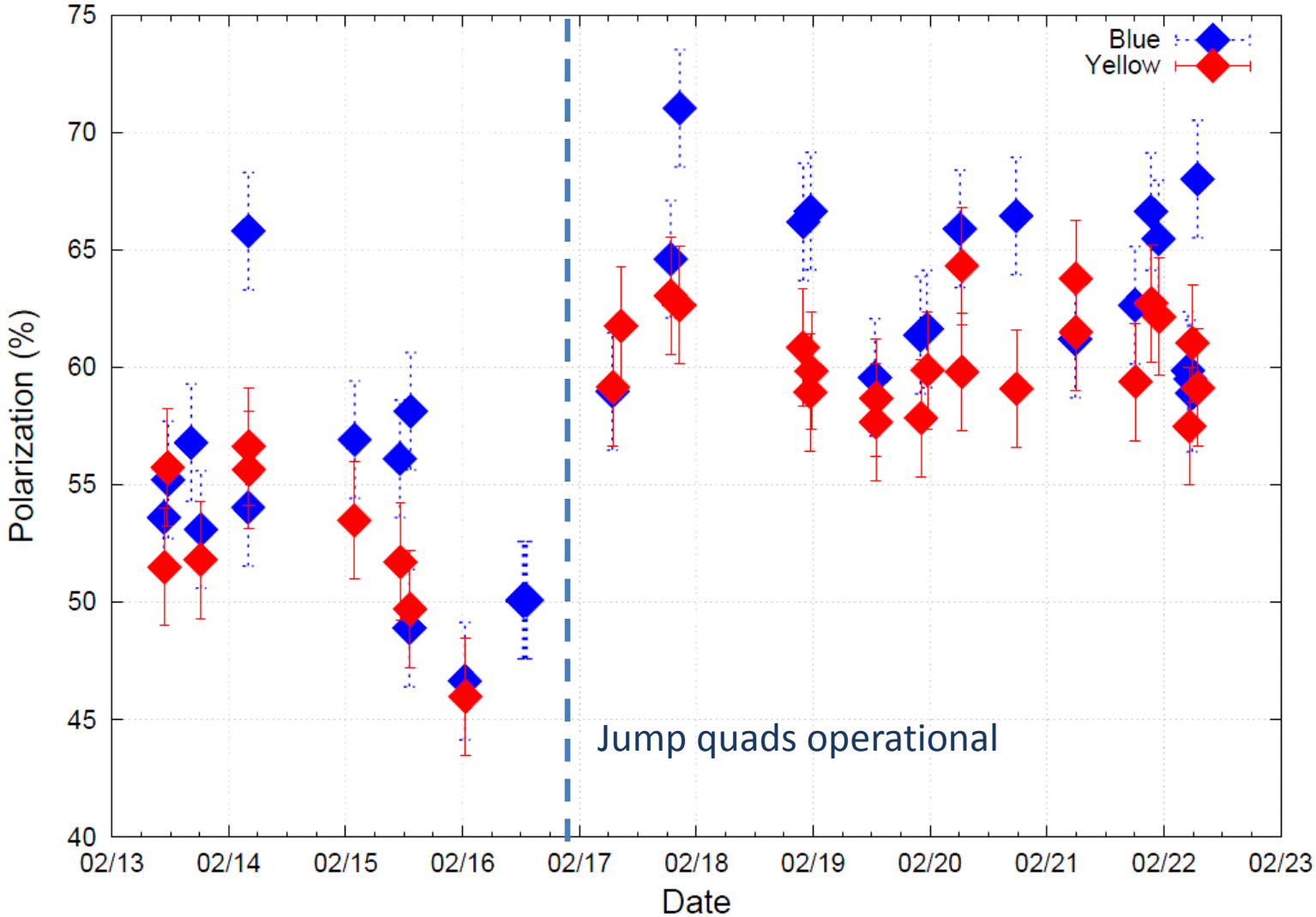
Beam conditions from turning jump quads off is are not identical, the difference might be accounted for by something other than resonance jumping.

In run 12, more beam-based measurements of resonance timing will be tried.



RHIC Injection Polarization

Measured with pC at RHIC injection energy, prior to physics fills



AGS Polarimetry in Run 11

- New target drives
  - Reproducible motion
  - Horizontal targets available
- New electronics
  - Current sensitive (instead of charge sensitive) pre-amps
- New detectors
  - 45 deg Hamamatsu
- Fast online analysis tested
  - Data collection takes ~5 minutes, data analysis took ~5 minutes
  - Analysis can now take a few seconds.

RHIC Beam Intensity

9 MHz RF

Using 9 MHz RF removed a Run 9 limit on the intensity (largely in yellow)

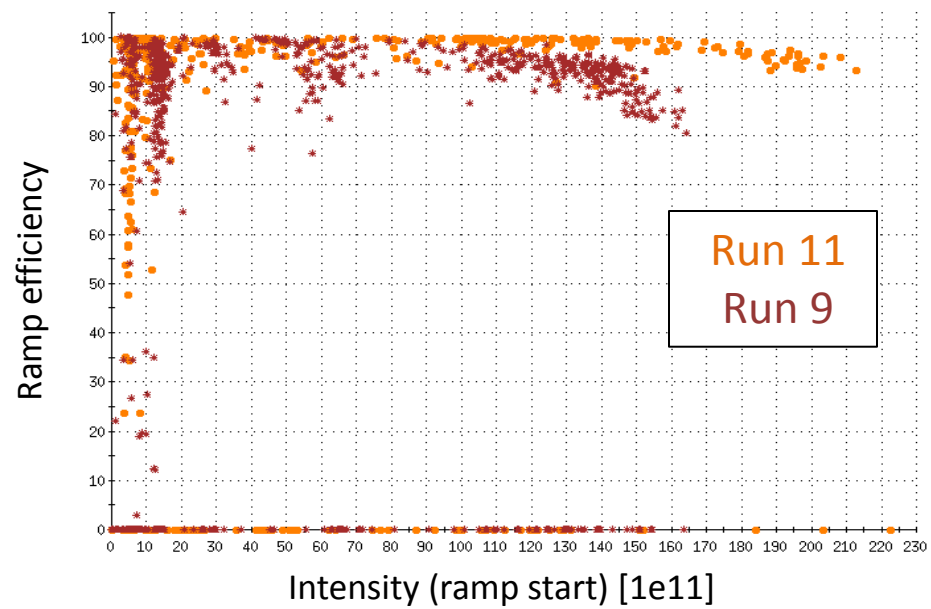
The 9 MHz system was in development for most of the run and only available for operation for part of Run 11.

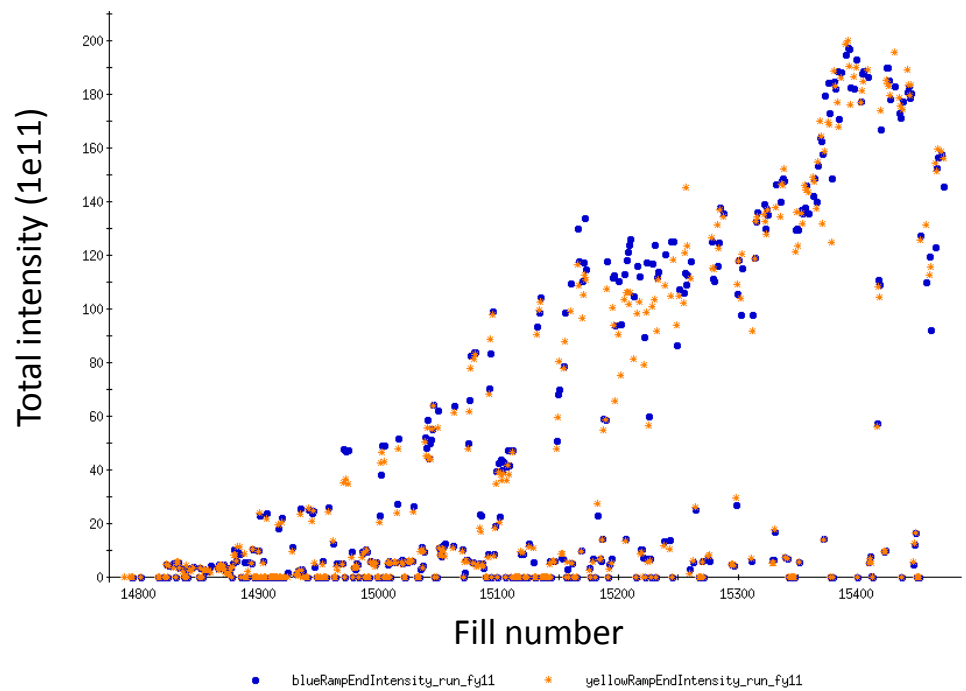
Achieved 1.65e11/bunch at store.

Ramp up

In Run 11 *every* ramp used orbit and tune feedback. Chromaticity feedback only during startup.

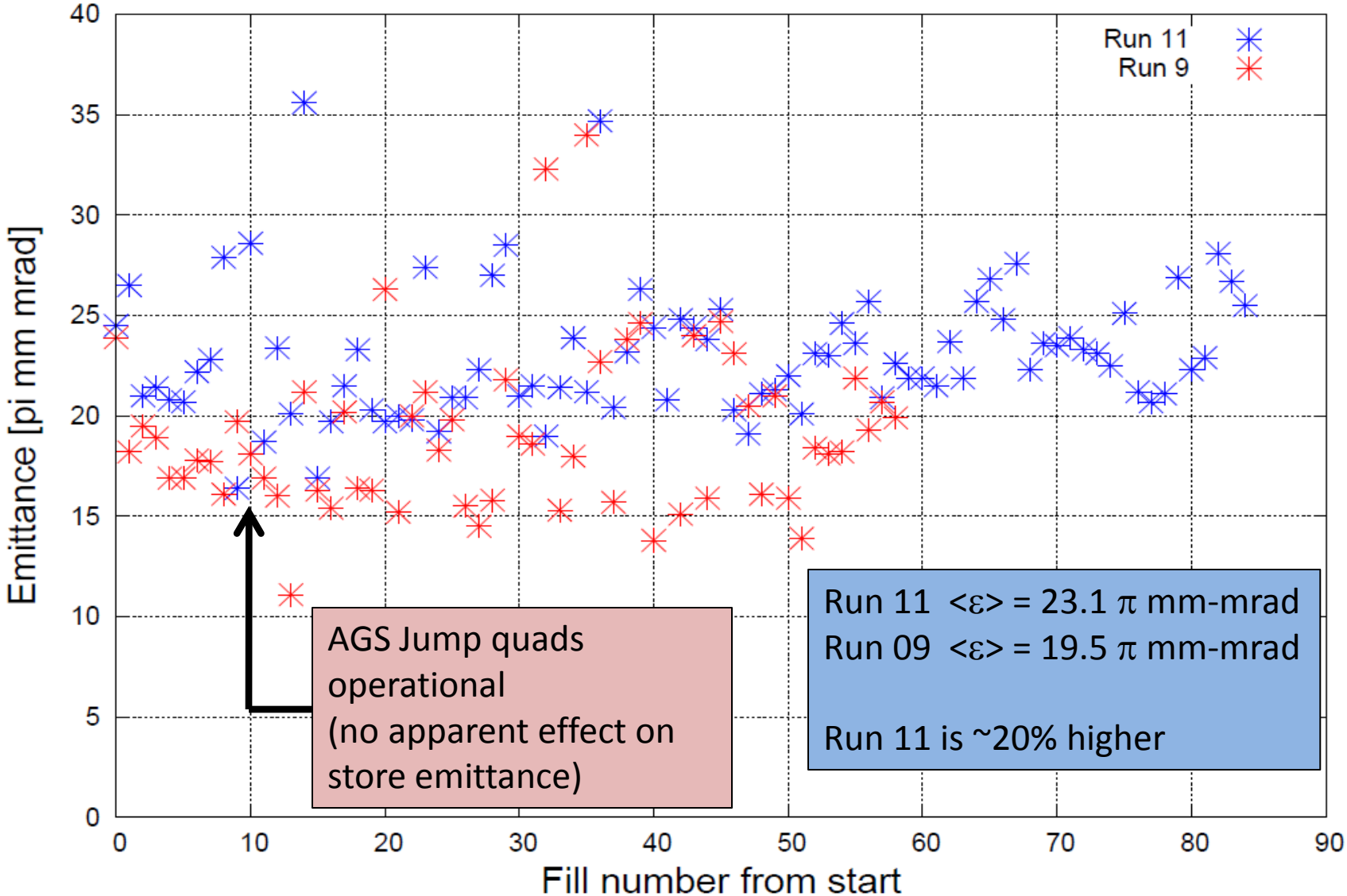
The intensity 'ramp up' strategy could change to take advantage of this. Get to 'physics' faster. How much faster?





Transverse Emittance at Store

Calculated from collision rate, average both planes, both rings



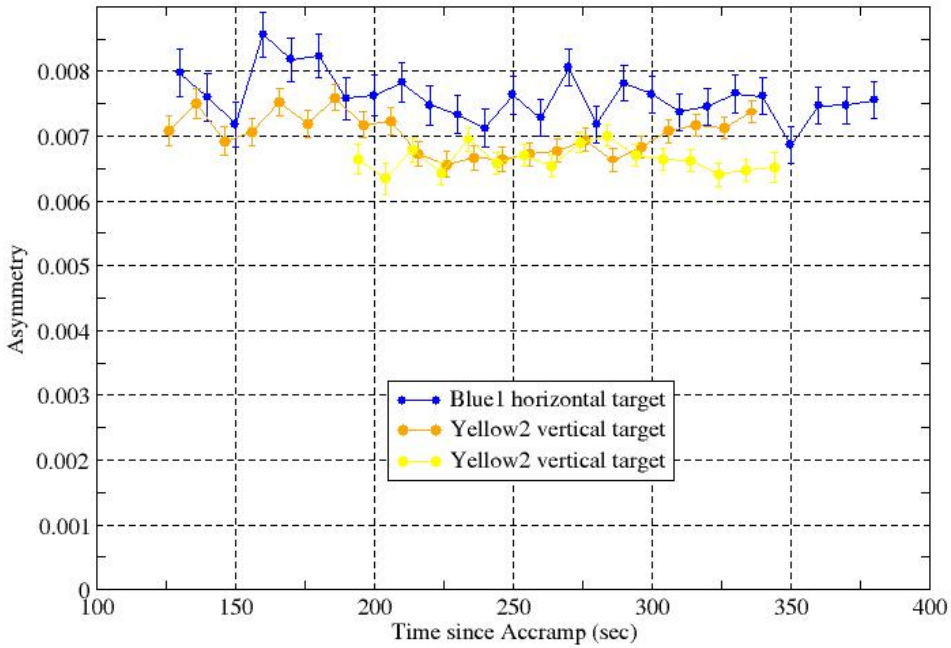
Polarization Transmission in RHIC

Acceleration of beam from

100 GeV to 250 GeV and *back to* 100 GeV suggests 10 % (absolute) polarization loss between 100 and 250 GeV.

The mechanism for the remaining loss is not well-understood and continues to be studied with tracking.

Not a clear step down at the location of an identifiable resonance



Possible RHIC Polarization Loss Mechanisms

- Spin tune spread from snake D' mismatch
  - D' adjusted ramp was not implemented during fy11
- Transverse coupling during the ramp
- 10 Hz orbit oscillations
- Closed orbit errors
  - Orbit feedback makes control to target orbit, as defined by BPMs exceptional (~ tens of microns)
  - BBA effort continues to align BPM measurements to (select) quadrupole centers
  - 'True' offsets (deviation from planar accelerator) invisible except to survey

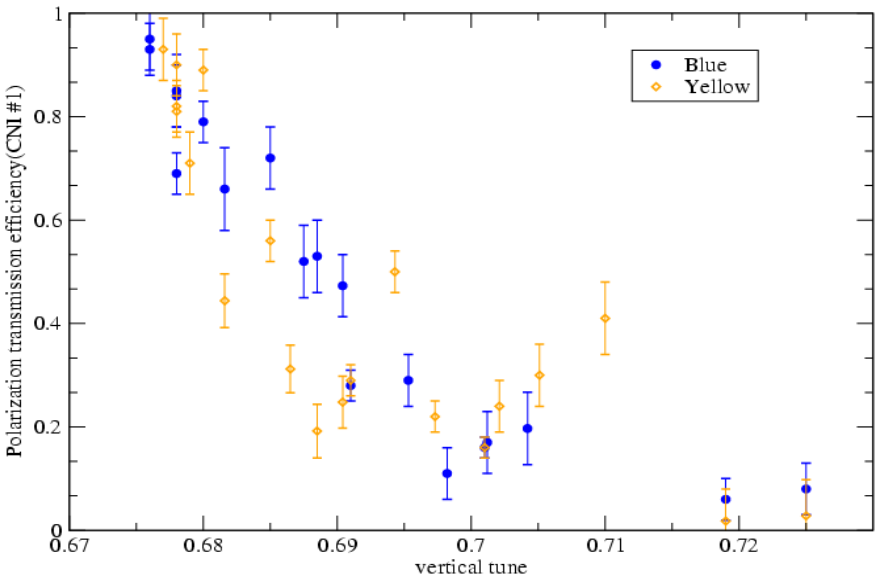
Ramp coupling

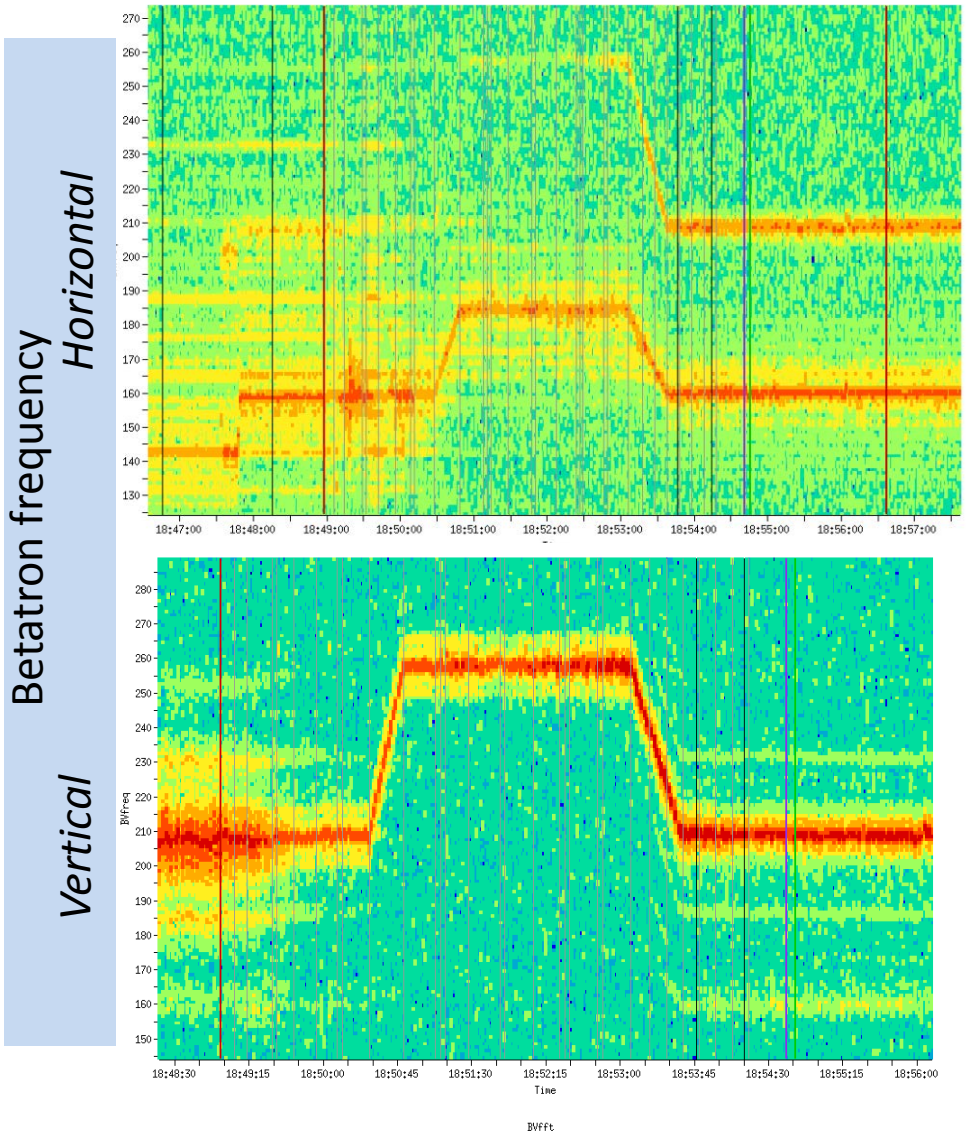
Horizontal spectrum shows strong vertical line

Horizontal frequency also shows up in the vertical spectrum (but not so strongly.

Vertical spectrum also show sidebands

Polarization transmission is strongly dependent on vertical frequency (tune)



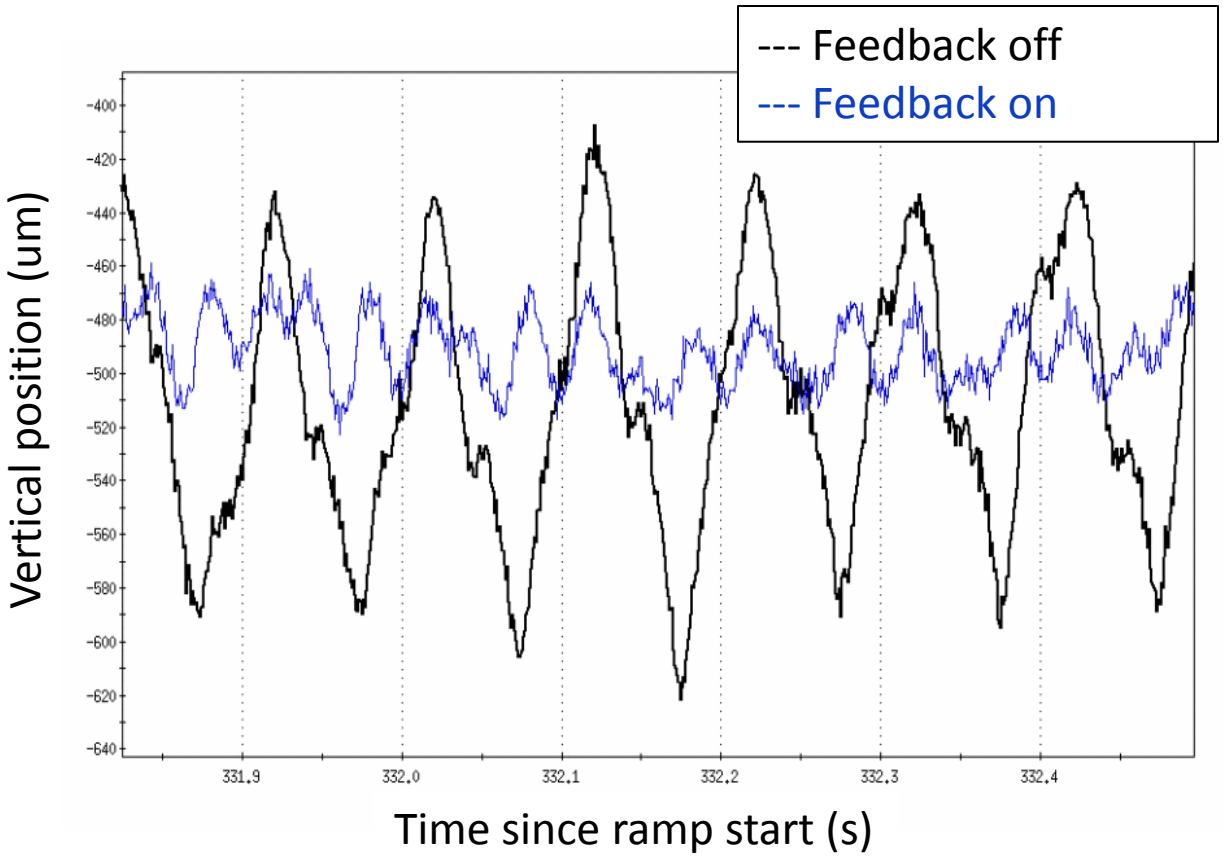


Orbit oscillations at 10 Hz

Mechanical vibration of triplet quads causes transverse position oscillations. Horizontal change is of order 2-3 mm, but 200 um (peak-to-peak) in vertical

Feedback routinely used at store through Run 11, demonstrated effective only at the end of Run 11 during the heavy ion run.

Does the feedback work at the proton synchrotron tune (with 9 MHz RF)?



Run 12 Operational Plan of Attack

- Begin with Run 11 conditions
  - Better source polarization ~83%
  - Examine coupling conditions at RHIC injection, ramp and store and adjust feedback parameters as necessary
  - Employ 10 Hz feedback on the ramp (possible conflict with 9 MHz cavity)
  - Aggressive ramp-up of intensity
  - Switch to D’ ramp

- Operational experience with jump quads in the AGS allows for faster turnaround between changes to machine configuration and calculation of new jump times.
  - Allows for a free hand tuning for intensity and emittance.
  - Given the polarization profile, decreased emittance should itself contribute to a gain in polarization.

- Faster online AGS polarization analysis should allow higher statistics and help fine-tune the jump quad system.

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β* in yellow [m]	0.65 0.63	0.65 0.65
Working points	Ramp: (28.680, 29.673) Store: (28.69, 29.68)	Ramp: (28.680, 29.673) Store: (28.69, 29.68)
Luminosity/Week	25.4 pb^{-1} (the best, 4/5-12)	40 pb^{-1} (max)
Polarization	50%*	55%
Peak bunch intensity	1.65×10^{11}	1.65×10^{11}
Peak luminosity	1.6×10^{32} $cm^{-2}s^{-1}$	2.0×10^{32} $cm^{-2}s^{-1}$

*Average of jet polarization is 46% for both rings. Taking into account for the polarization profile correction factor (R=0.2), The polarization seen by experimenters is boosted by Sqrt(1+R)=> 50%.