Run-9 Accelerator

Christoph Montag, BNL

RHIC & AGS Users' Meeting

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Run-9 timeline

- 2 Feb, cool-down to 4.5 degrees begins
- 7 Feb, beam injected into Blue ring,
- 9 Feb, 2 week "Setup" mode begins (0.5 weeks early)
- 7 Feb, first collisions at $\sqrt{s} = 500\,\mathrm{GeV}$ $\vec{p}-\vec{p}$ (2.3 weeks into run - a record!)
- 17 Mar experiments in Physics mode
- 13 April, end of 250 GeV $\vec{p}-\vec{p}$ physics run (3.9 weeks)

- 15 April, begin setup with beam for 100 GeV $\vec{p} - \vec{p}$
- 20 April, 100 GeV $\vec{p} - \vec{p}$ physics run begins (8 days early)
- 26 June, begin set-up for pp2pp
- 3 July, Run-9 ends

Thomas-BMT Equation

$$\frac{\mathrm{d}\vec{S}}{\mathrm{d}t} = \vec{\Omega} \times \vec{S} = -\frac{e}{\gamma m}\left[G\gamma \vec{B}_{\perp} + (1+G)\vec{B}_{\parallel}\right] \times \vec{S}$$

Spin tune $Q_s = G\gamma$: number of spin precessions in one orbital revolution

As a result, preserving polarization gets more difficult at higher energies

Depolarizing Resonances

Two types of depolarizing resonances:

1. Imperfection resonances

$$G\gamma = k, \qquad k \quad \text{integer}$$

   Driven by vertical closed orbit distortions

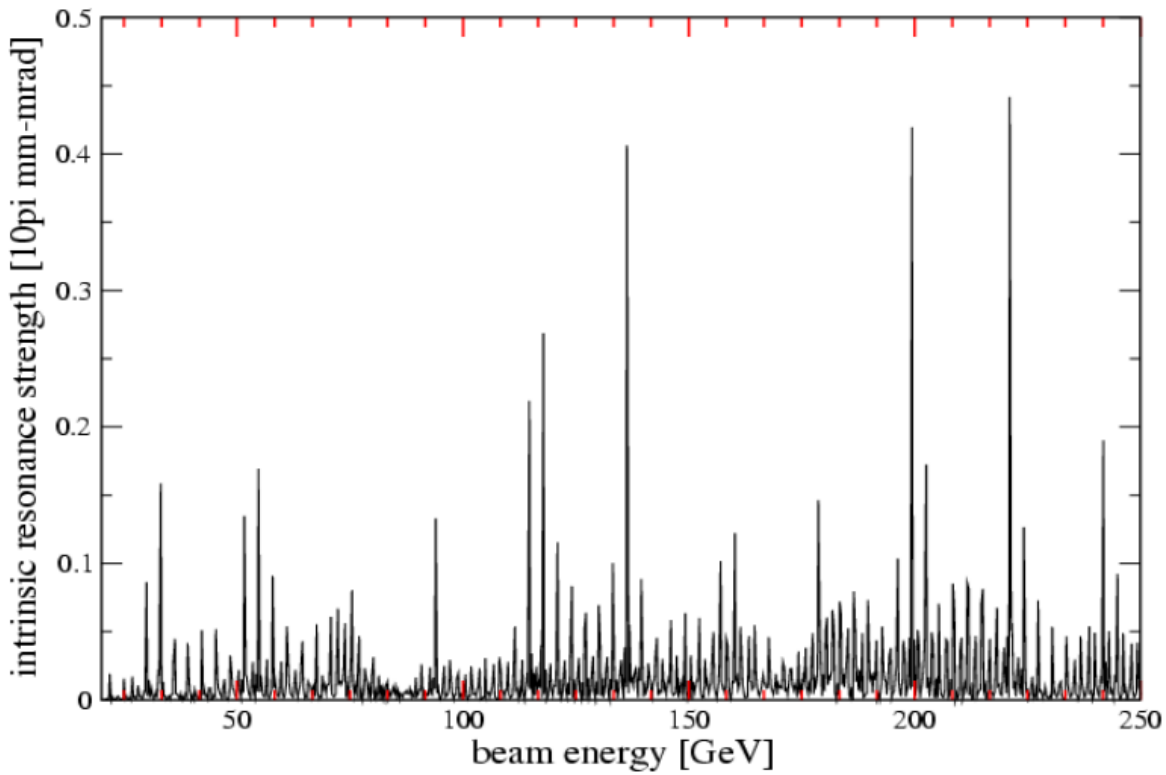
2. Intrinsic resonances

$$G\gamma = kP \pm Q_y,$$

   P machine periodicity, Q_y vertical tune

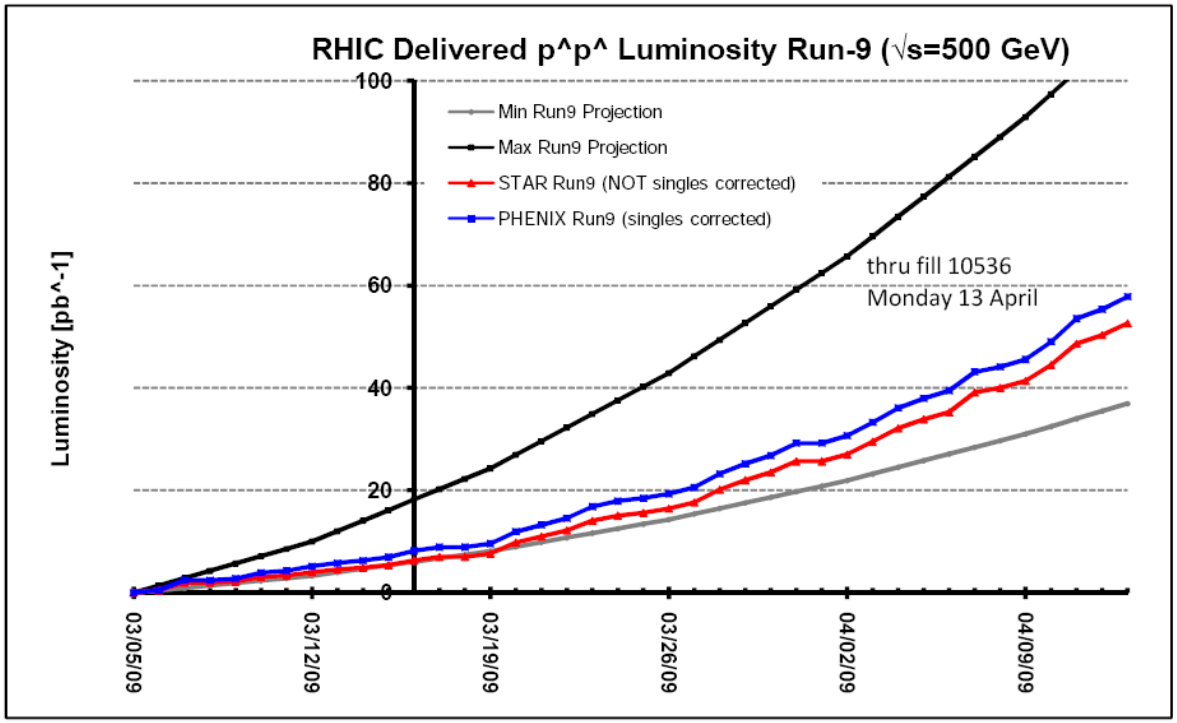
Overcome by Siberian Snakes

Intrinsic spin resonances up to 250 GeV

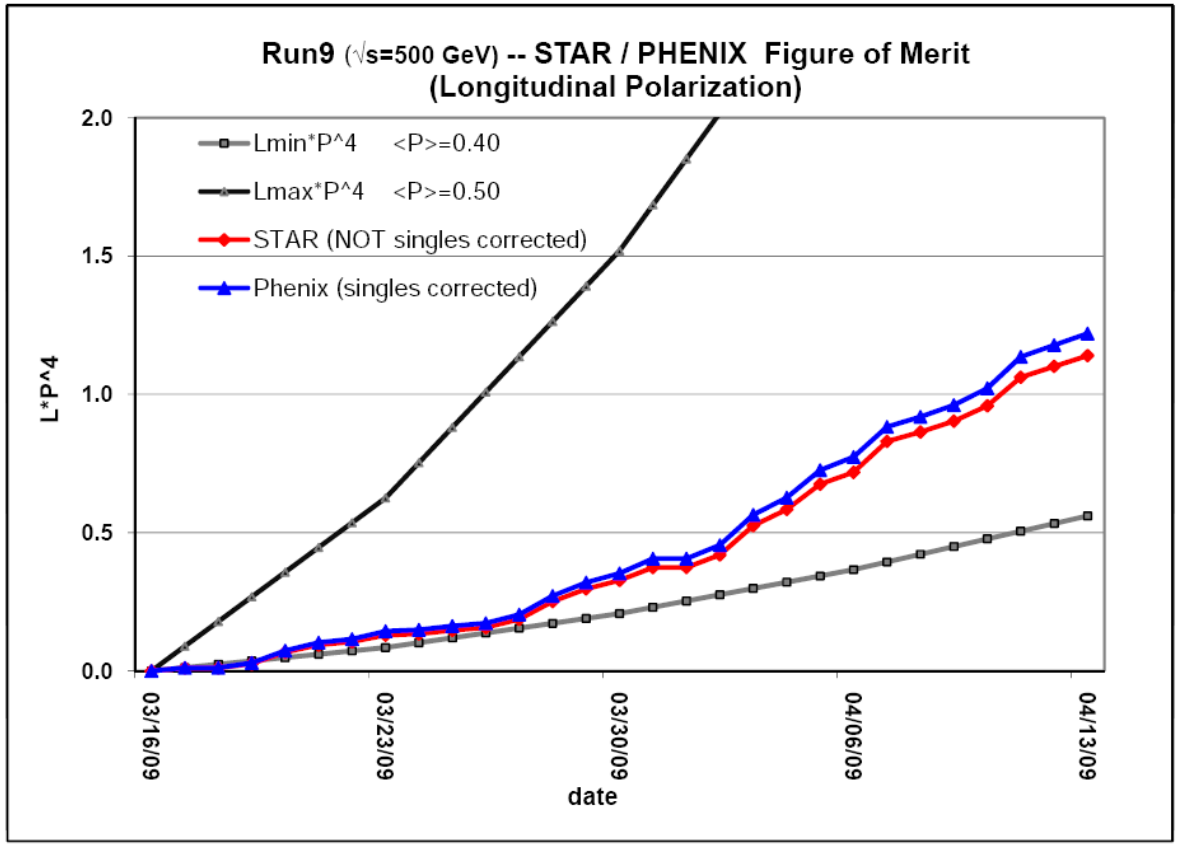


Beyond 100 GeV, resonances are more than factor 2 stronger

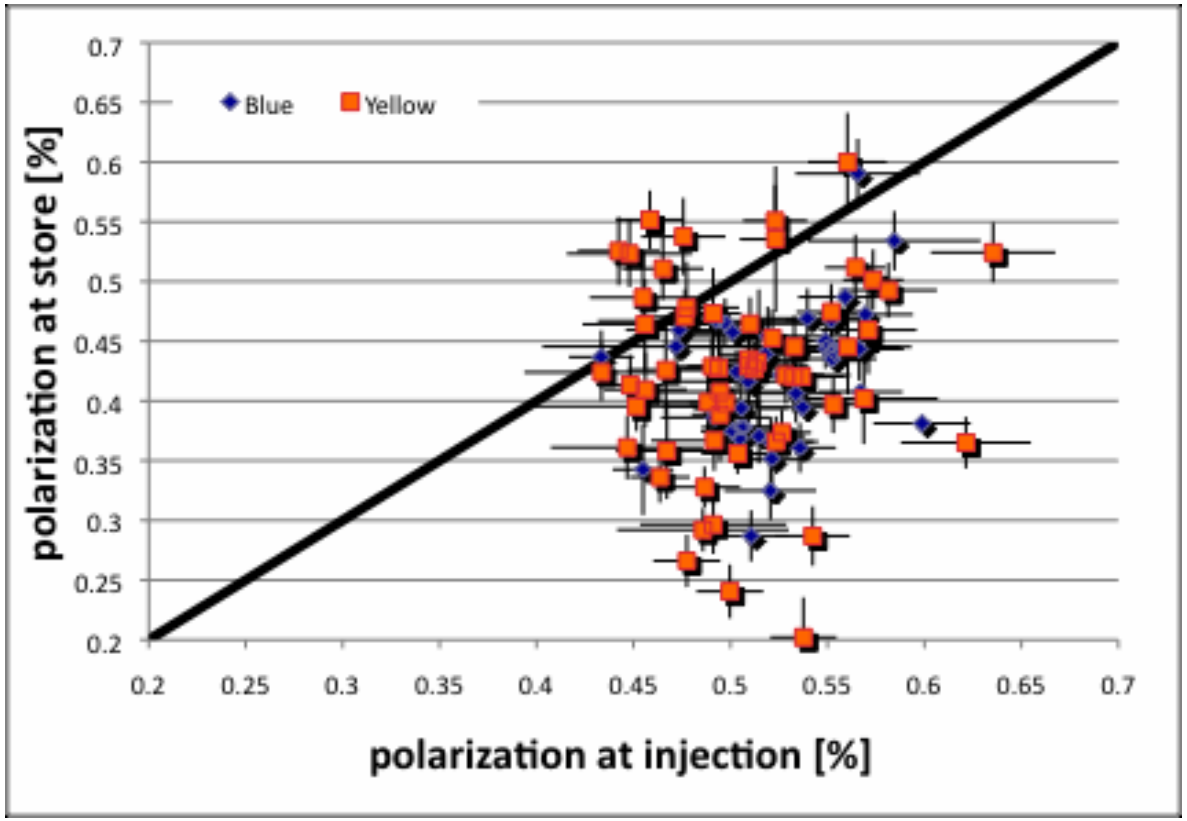
250 GeV delivered luminosity



250 GeV delivered Figure-of-Merit

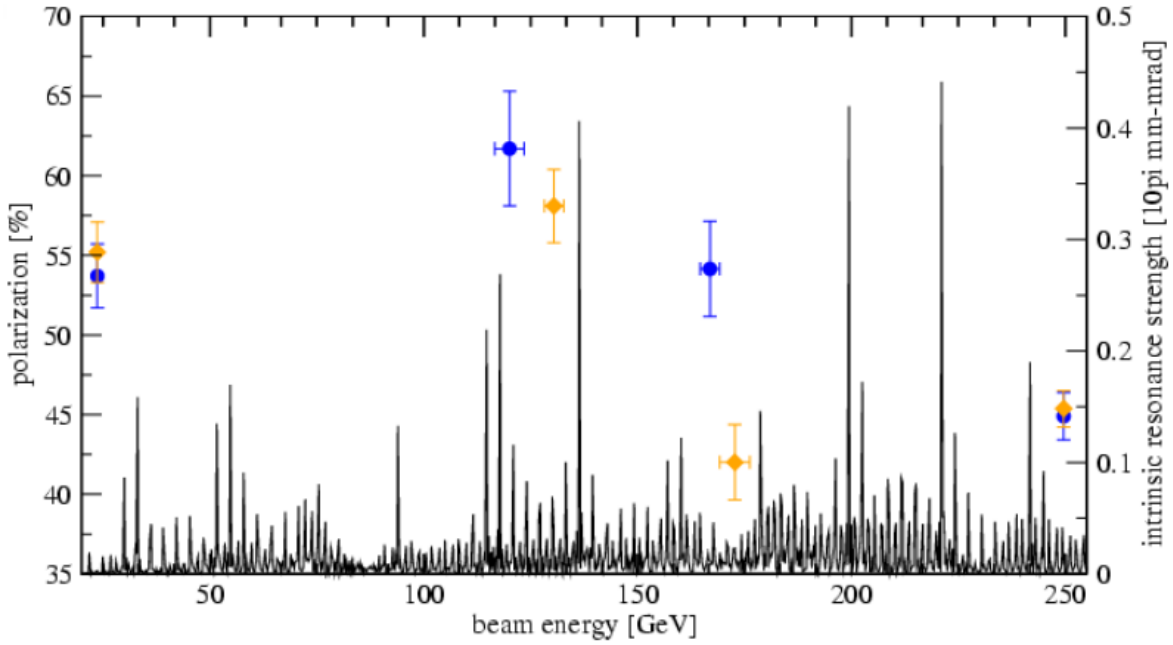


Store polarization vs. injected polarization



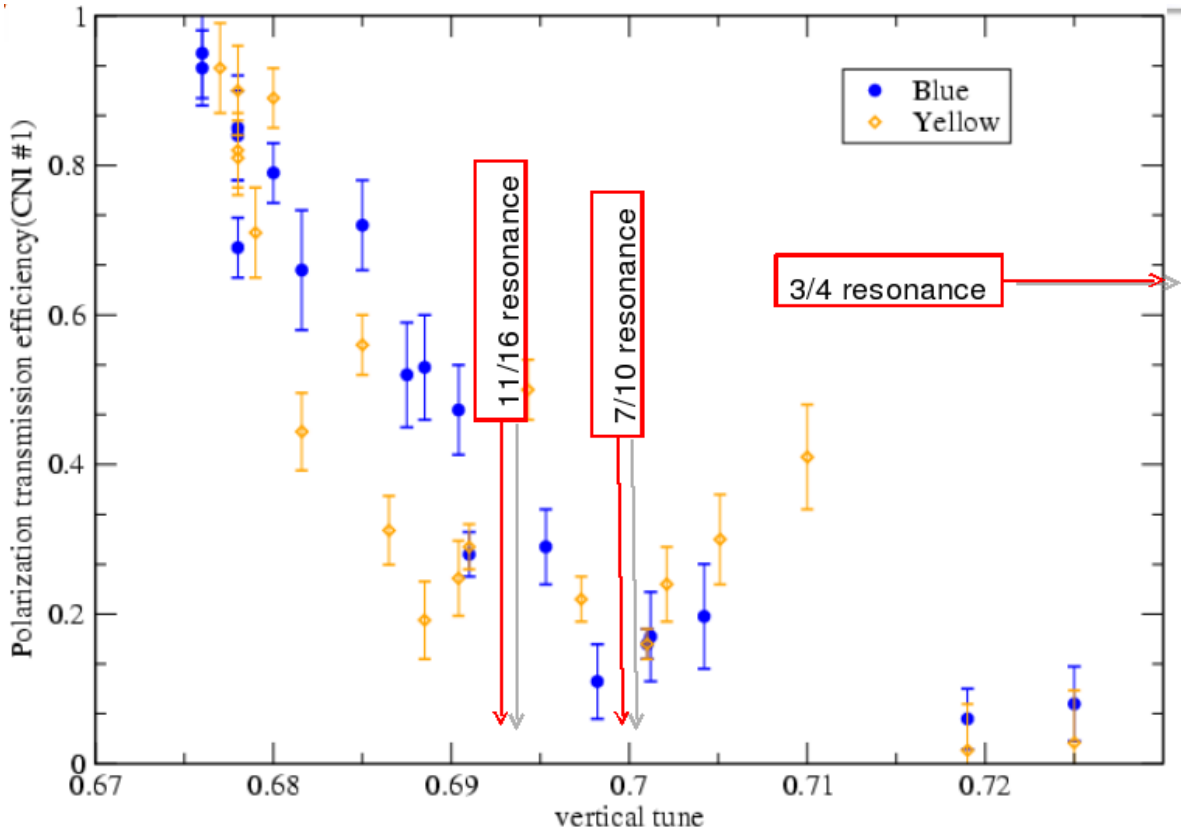
Average polarization at store is 42 %, vs. 50 % at injection

Polarization measurements on the ramp



Polarization is preserved up to 100 GeV, drops at depolarizing resonances between 100 and 250 GeV

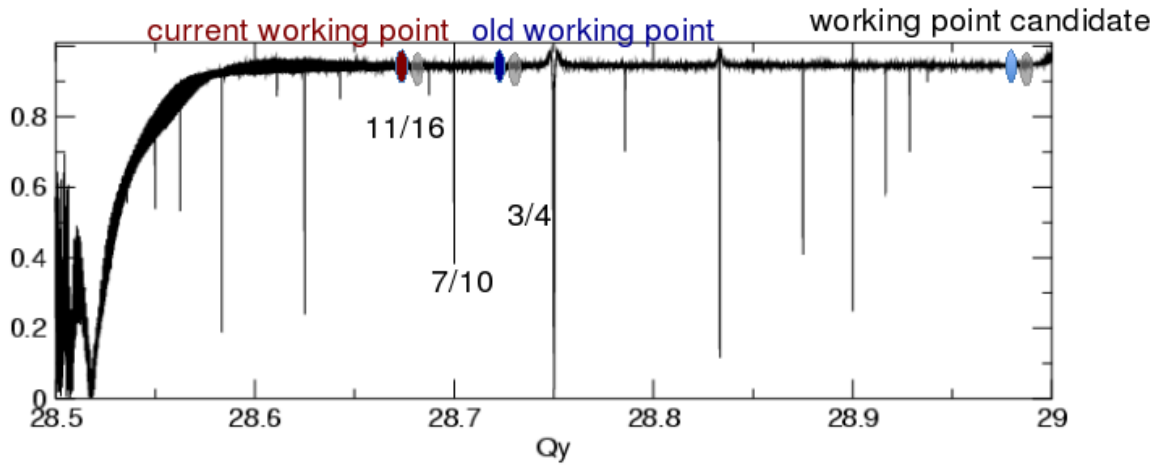
Ramp tune scan for polarization transmission



7/10 resonance is very broad; 2/3 leads to beam loss

Poor polarization transmission above 0.7

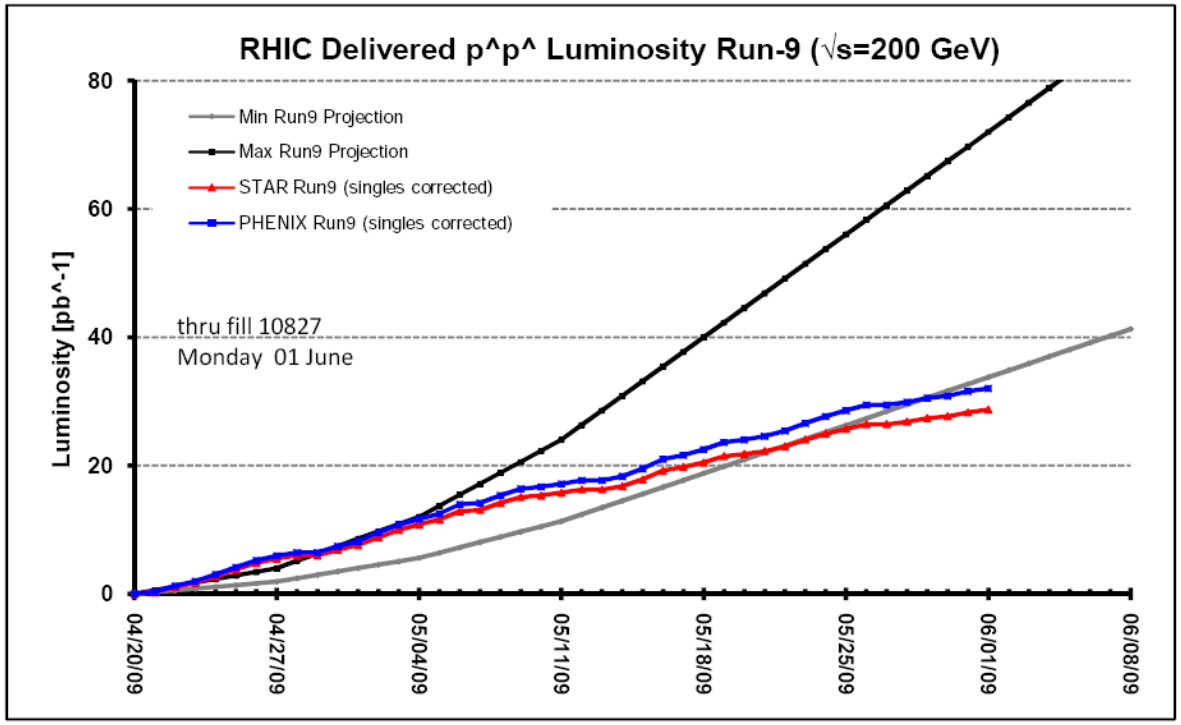
RHIC working point candidates



Largest space between depolarizing resonances is near the integer; also preferred for beam-beam

Luminosity running at near-integer tunes currently prevented by 10 Hz orbit oscillations due to mechanical triplet vibrations

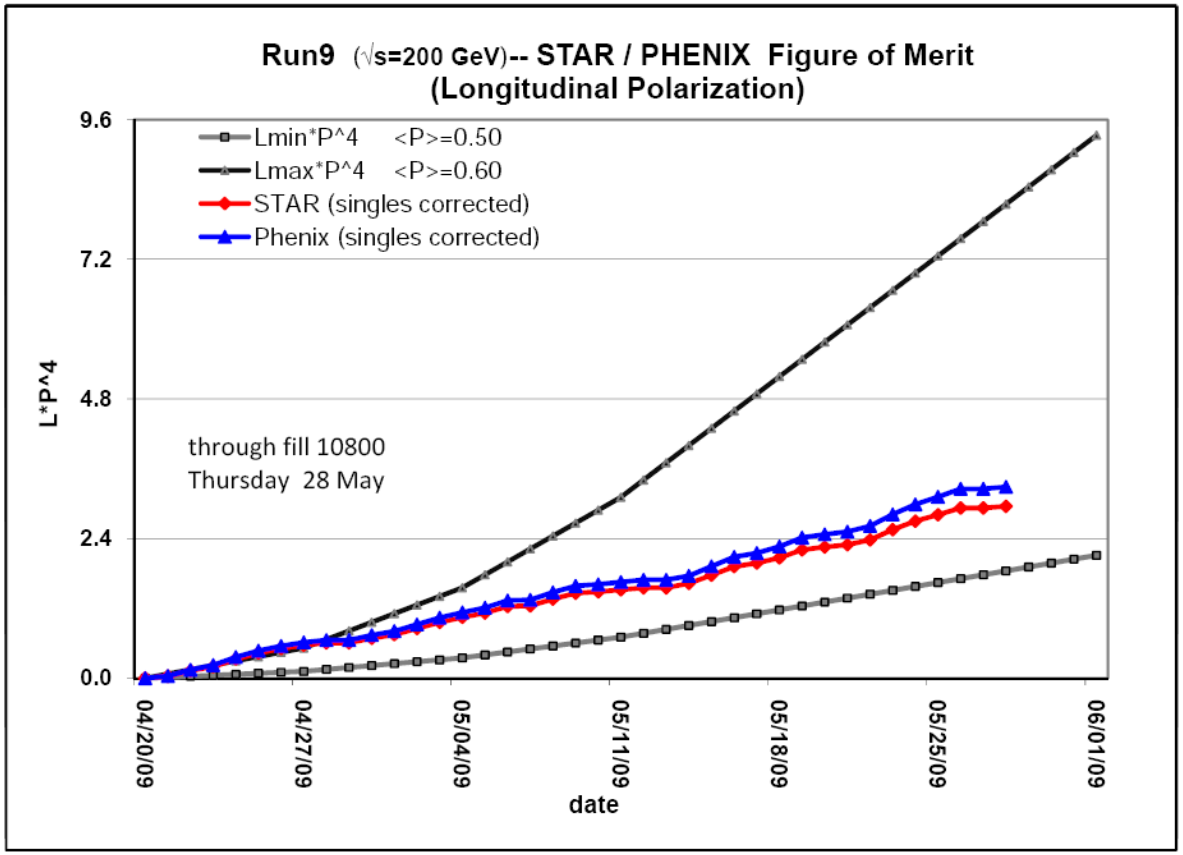
100 GeV delivered luminosity



$\beta^* = 0.7\,\mathrm{m}$, vs. $1.0\,\mathrm{m}$ in Run-8

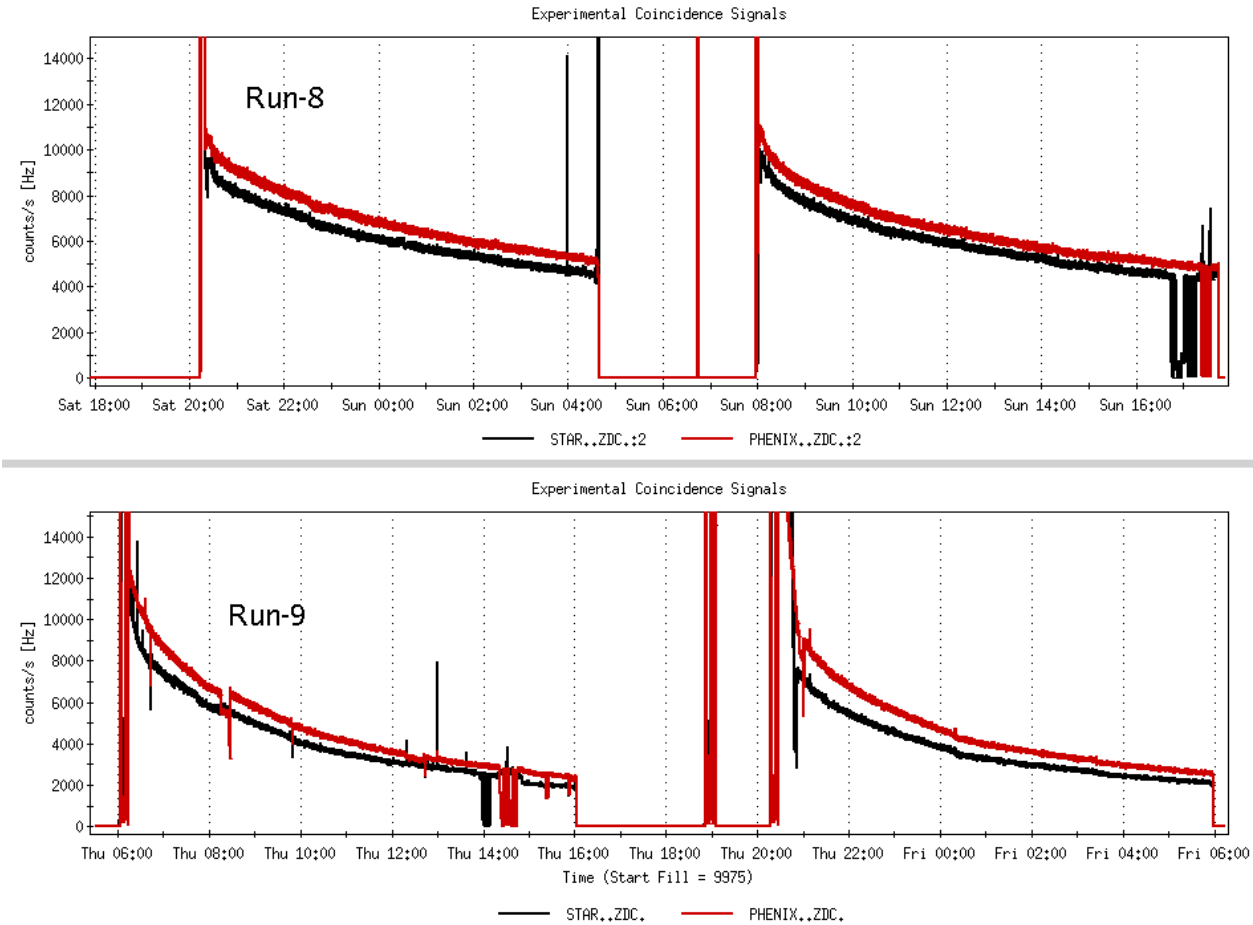
Reached Run-8 luminosity performance from the start

100 GeV delivered Figure-of-Merit



Above minimum projections due to average polarization of 56%, as measured by Hydrogen Jet

Typical stores during Run-8 and Run-9

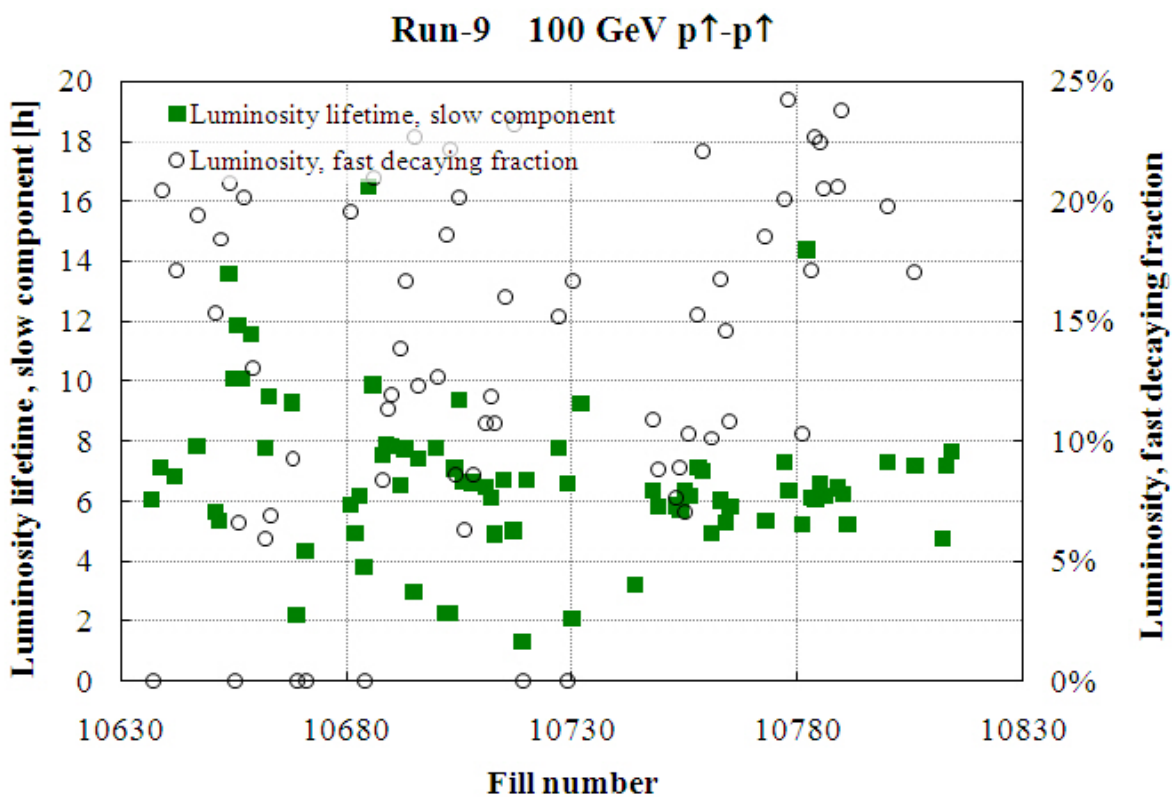


Significantly shorter luminosity lifetime than in Run-8.

Systematic tests

- Fewer bunches, 84 instead of 109
- Low bunch intensity, $1.0 \cdot 10^{11}$
- Constant RF voltage at store
- Larger β^*, 80 cm instead of 70 cm

Luminosity lifetime vs. fill number



Systematic tests started at store 10764

No effect on luminosity lifetime

Priority study items

- Polarization transmission to 250 GeV with a near-integer working point.
  $\rightarrow$ To be studied in APEX next week

- Cause of poor luminosity lifetime at 100 GeV.
  $\rightarrow$ Reverted to last year's ramp earlier this week. No significant improvement due to poor Blue lifetime.

Summary

- Polarized protons at 250 GeV was significant new development
- Preserving polarization to 250 GeV more difficult than expected, and needs to be studied
- For only a few weeks of running, this is a great success
- Luminosity lifetime is the greatest challenge at 100 GeV
- Studies are ongoing to determine the cause of this poor lifetime