Polarized Proton Run Summary

Christoph Montag

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Goals (in a nutshell)

- STAR:
  1. Unpolarized comparison data for d-Au
  2. Transverse (vertical) spin running
- PHENIX:
  1. 250 GeV (did not happen)
  2. Transverse (radial) spin running
  3. Machine development towards higher luminosity

Goals (cont.)

- RHIC:

  1. Satisfy all customers in terms of physics running

  2. Machine development towards higher luminosity in Run-9 and beyond

$\Rightarrow$ High expectations, conflicting goals – and only six weeks of running!

The short, sad life of the near-integer working point

Motivation:

- In Run-6, performance was beam-beam limited. With working points on opposite sides of the diagonal, the beam above the diagonal inevitably suffered.

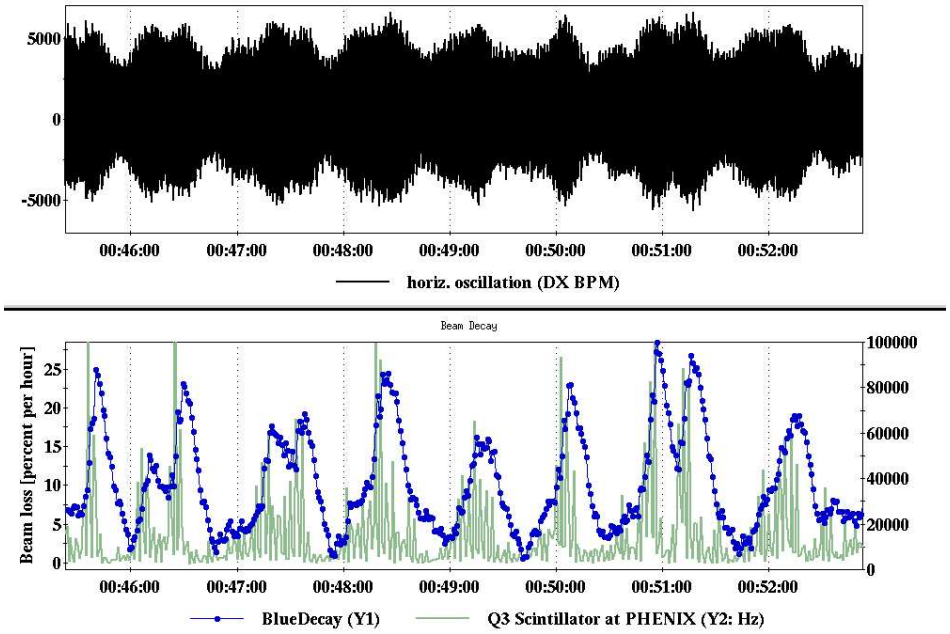
- To overcome this, a new (better) working point was necessary.

- Best candidate: near-integer (.96/.95).

Known challenges:

- β-beat scales as $1/\sin(2\pi Q)$.
- Orbit distortion scales as $1/\sin(\pi Q)$.
- 10 Hz beam-beam offset (= modulated orbit distortion) increases – but we have a dedicated feedback for that.

Blue beam decay and orbit jitter – perfect correlation!



High beam decay causes background – too much for experiments. Abandoned after one week.

Back to Run-6 configuration

- Reloaded pp28 as pp83.
- Two-person shifts for shorter start-up time.
- Colliding beams within 24 hours!
- Increased injected bunch intensity up to 1.84e11 (Blue)/ 1.76e11 (Yellow).
- No hard beam-beam limit observed. Both beams are below the diagonal.

- RHIC ramp is an "intensity filter" – as in Run-6.

- Higher beam-beam parameter needs to come from smaller emittances.

- Yellow injection efficiency deteriorates towards the end of the run – X/Y-arcs never get enough attention during start-up.

- Need faster feedback on lumi (Vernier scan analysis).

Polarization

- Polarization was significantly lower than in Run-6.
- AGS performance lower than in Run-6. Initially injection on-the-fly, later returned to Run-6 configuration to improve performance.
- Poor Yellow polarization transmission (≈ 75 percent).
- Insufficient time to really diagnose the problem - ramp polarization measurements, chromaticity measurements require a significant amount of time, which time is extremely precious during a short run.

- Due to the short run, there were simply not enough ramps to scan various parameters (tunes, snake currents, snake angles,...) systematically.

- Cross-calibration of various polarimeters (CNI, Jet, Experiments, AGS) needed to detect polarization losses early.

- Two-beam mode at the Jet should help to get results much faster due to simultaneous measurement of both beams.

β^*-squeeze

- Several attempts during APEX and Machine Development to squeeze to $\beta^* = 0.68\,\mathrm{m}$.

- Each and every time, we almost made it operational – but not quite. Reasons: Lack of time, human error,...

- Achieved so far: 56 bunches at store.

- Backgrounds are as low as for $\beta^* = 1.0\,\mathrm{m}$.

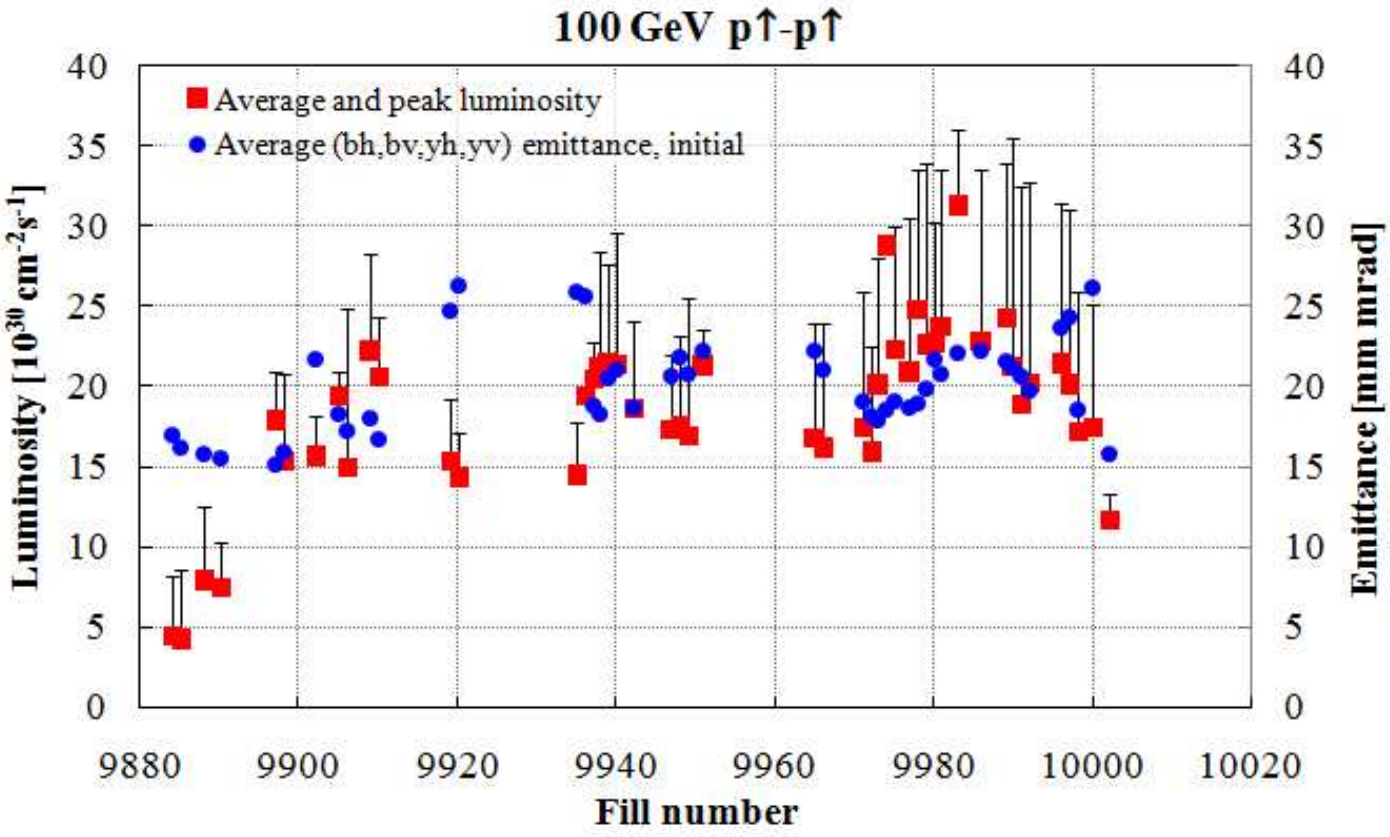
- Lifetime at store requires nonlinear chromaticity correction.

Red herrings

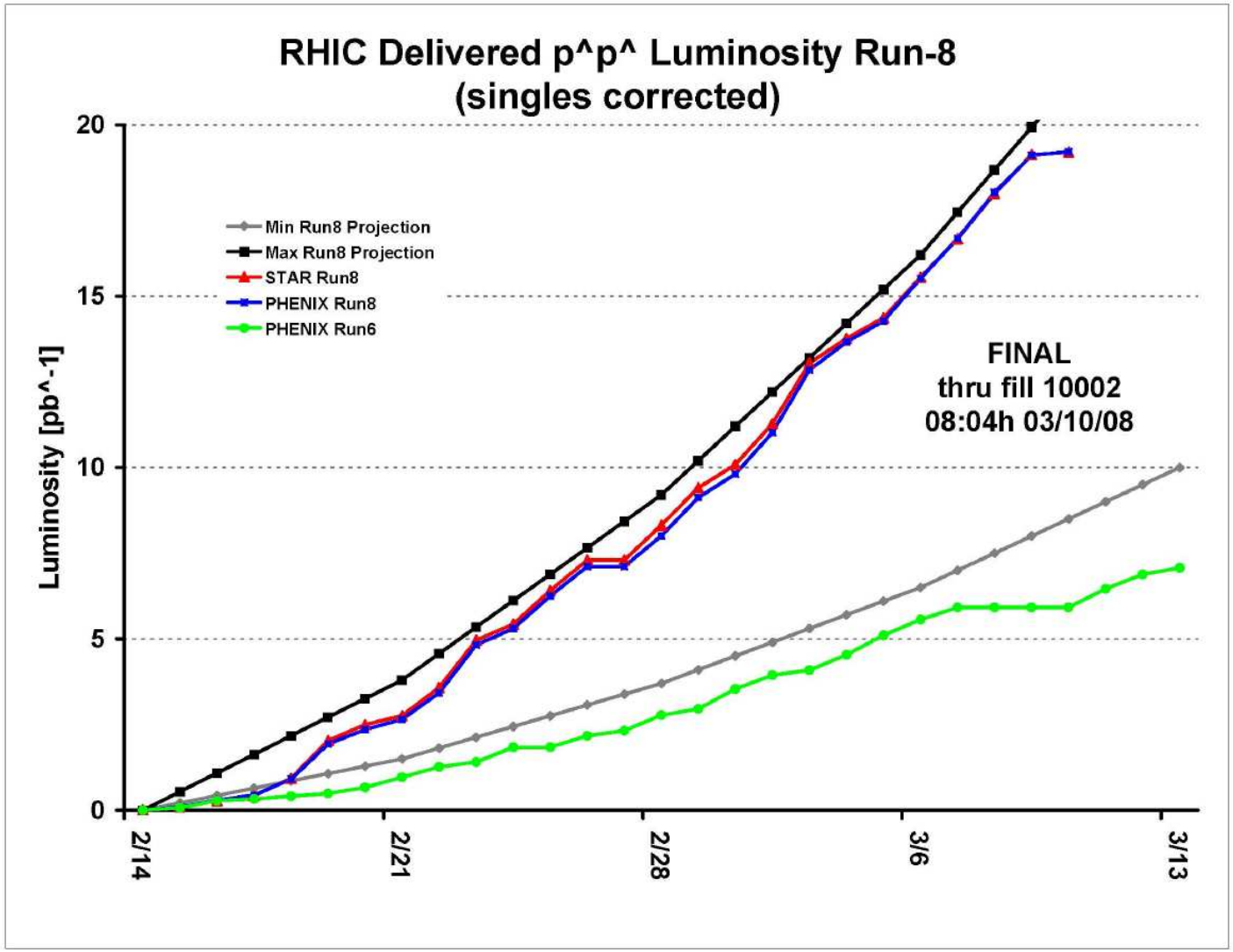
- "Emittance blow-up due to long-range beam-beam effects on the ramp"
  – struggled for almost a week, spent hours on cogging on the ramp, worked on tune separation, abandoned PHENIX rotator ramp.
  Turned out to be poor injection kicker timing.

- "Blue abort kicker timing shift causes dirty dumps"
  – after a power dip, beam losses due to instability at Blue injection pulled the permit. Dumps looked dirty. A comparison of Blue and Yellow abort kicker timing showed 200 nsec difference. Injection tuning results in dirty dump alarms. 12 h downtime.
  Misinterpretation of timing measurements and alarm messages – human error.

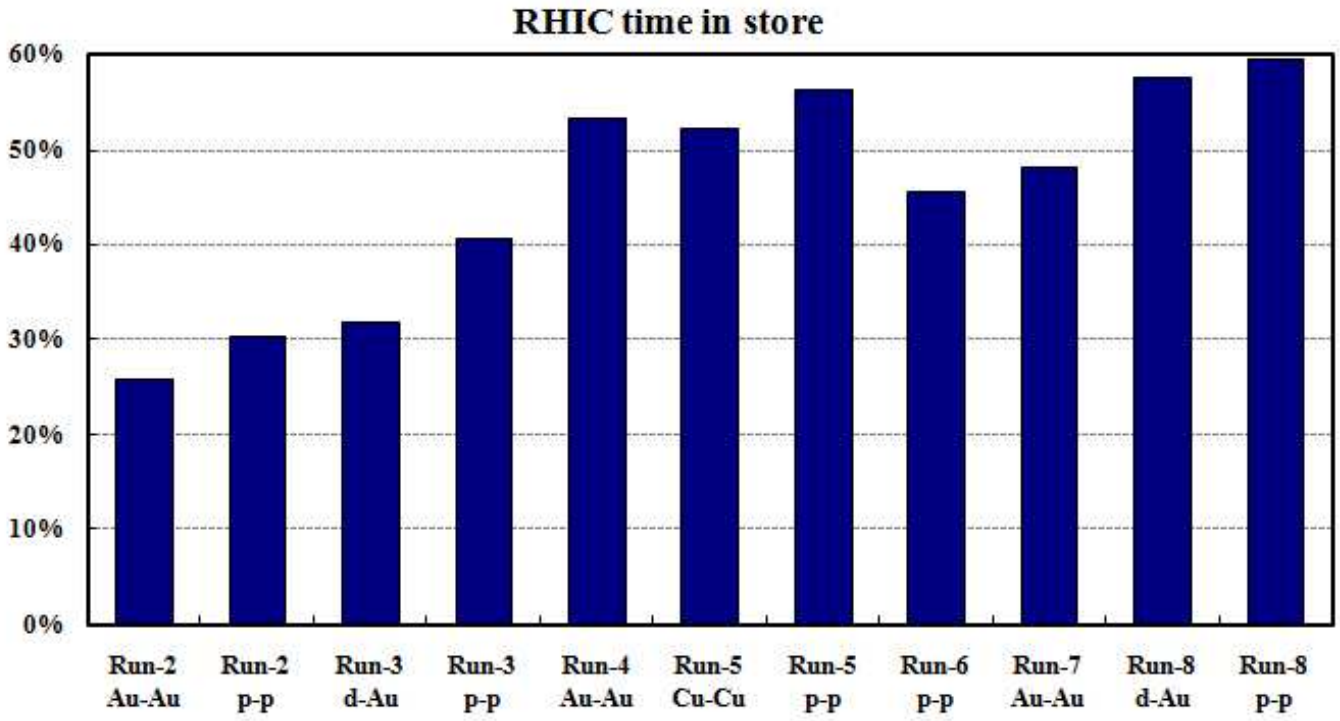
Some statistics



Courtesy Wolfram Fischer



Courtesy Peter Ingrassia



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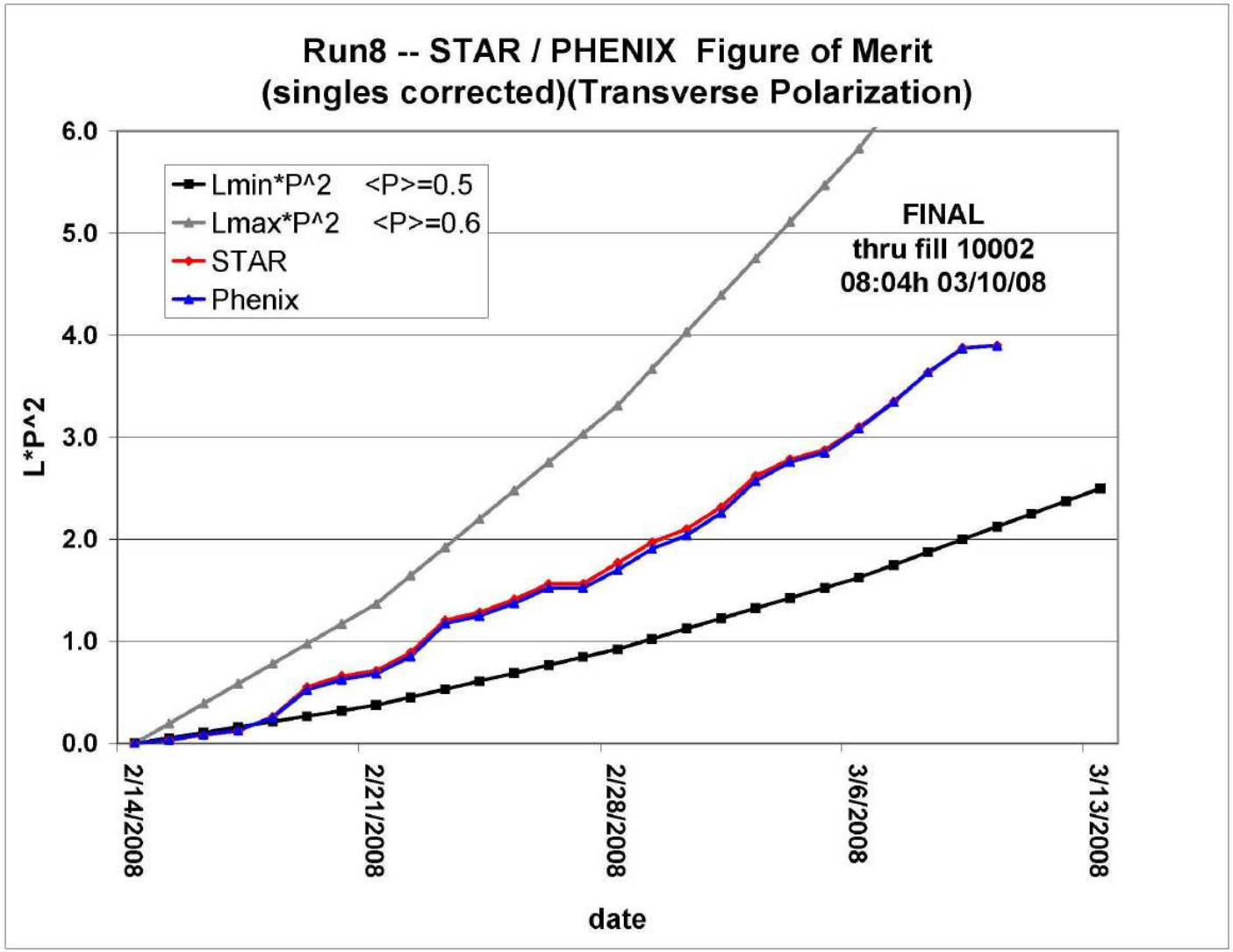

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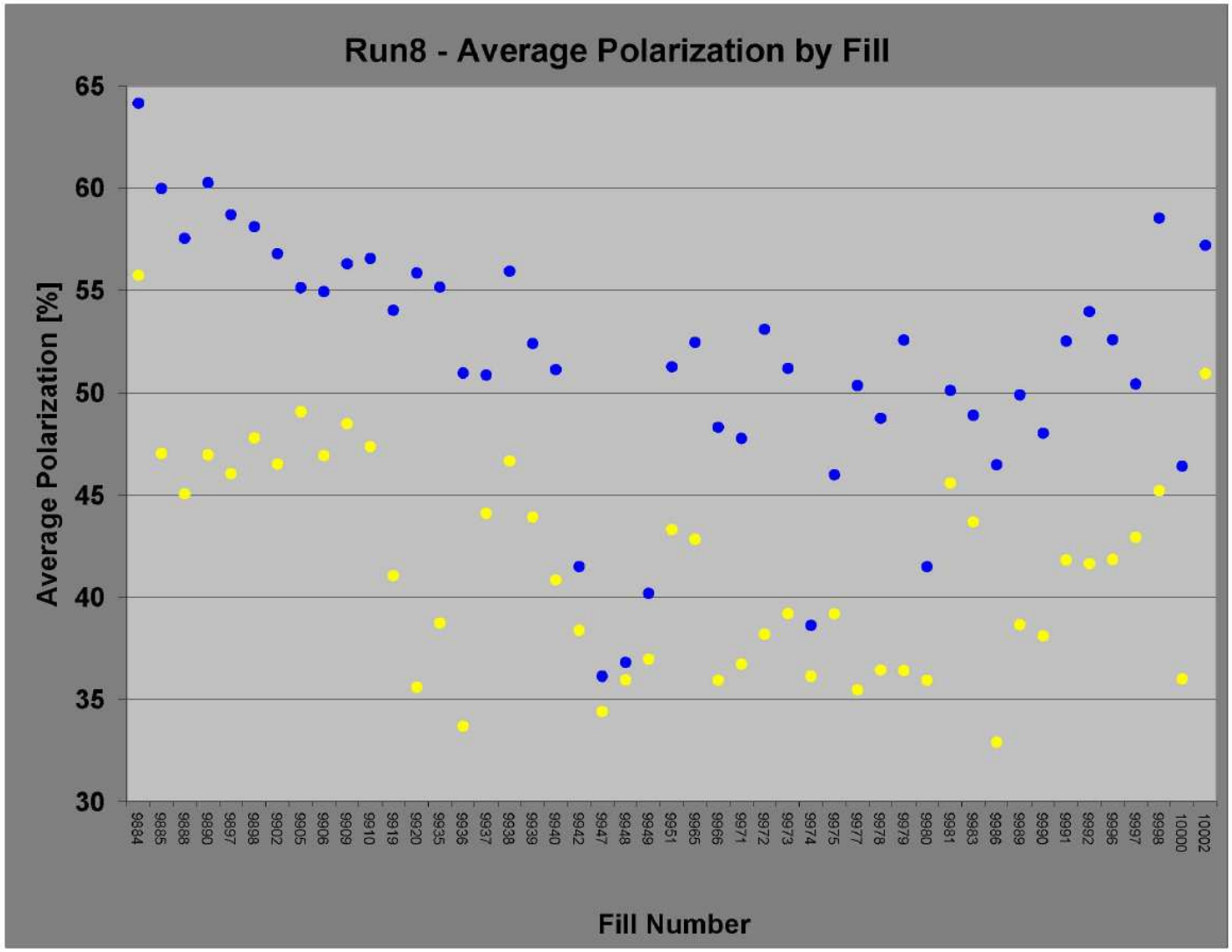

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Conclusion

- After two years, it was certainly important to run protons at all.
- Goals on delivered luminosity and FOM were met according to projections. However, PHENIX did not get radial polarization.
- Time in store reached a new record: $(60 - \epsilon)$ percent.
- Six weeks are too short to make real progress.
- β^*-squeeze was an important development towards higher luminosity in Run-9.