

RHIC Machine Performance

Wolfram Fischer



RHIC & AGS Annual User's Meeting
12 May 2004

1. Enhanced luminosity goals
2. Progress in RHIC Run-4
 - Au-Au operation
 - Polarized proton operation
3. RHIC Run-5 Preparations
4. Summary

RHIC Enhanced Luminosity Goals:

(before e-cooling, about 2008)

- For Au-Au, average per store, 4 IRs

$$\mathbf{L = 8 \cdot 10^{26} \text{cm}^{-2} \text{s}^{-1}} \text{ at } 100 \text{GeV/u}$$

4× design
2× achieved

- For p↑-p↑ average per store, 2 IRs

$$\mathbf{L = 6 \cdot 10^{31} \text{cm}^{-2} \text{s}^{-1}} \text{ at } 100 \text{GeV}$$

$$\mathbf{L = 1.5 \cdot 10^{32} \text{cm}^{-2} \text{s}^{-1}} \text{ at } 250 \text{GeV}$$

with **70% polarization**

16× design
~5× achieved

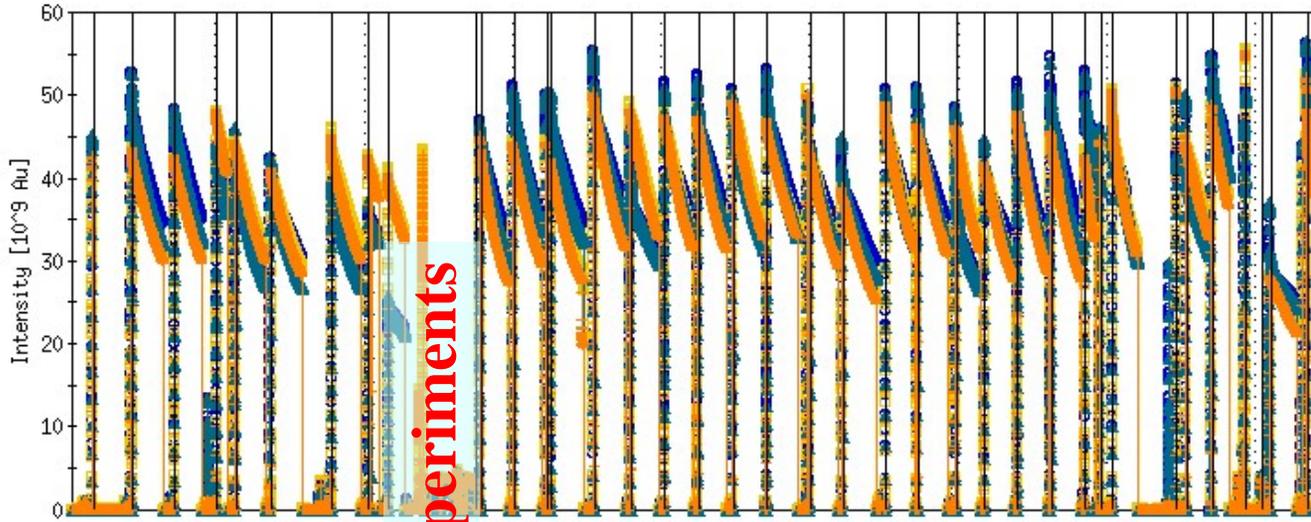
1× design
~2× achieved

Not yet at the
same time

Major achievements Au-Au:

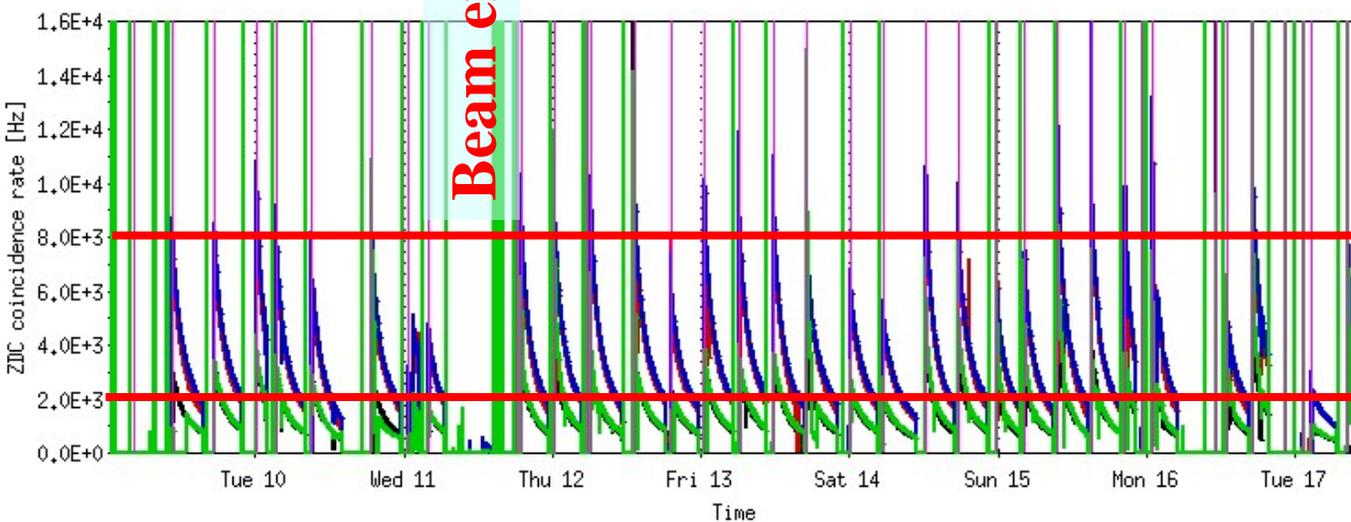
- Start-up/ramp-up in 4 weeks (1 week less than planned)
- Consistent high bunch intensity from injector ($\geq 10^9$ Au)
- Time in store increased to 53% (65% at 31.2GeV/u)
- Reliable, almost complete rebucketing into storage rf
- Steering and collimator setting time reduced to 10min
- Best 7 days delivered $179 \mu\text{b}^{-1}$ to Phenix (2x Run-2)
- Set-up for 31.2GeV/u run in less than 2 days

Week 9 Feb to 17 Feb [66% of calendar time in store]



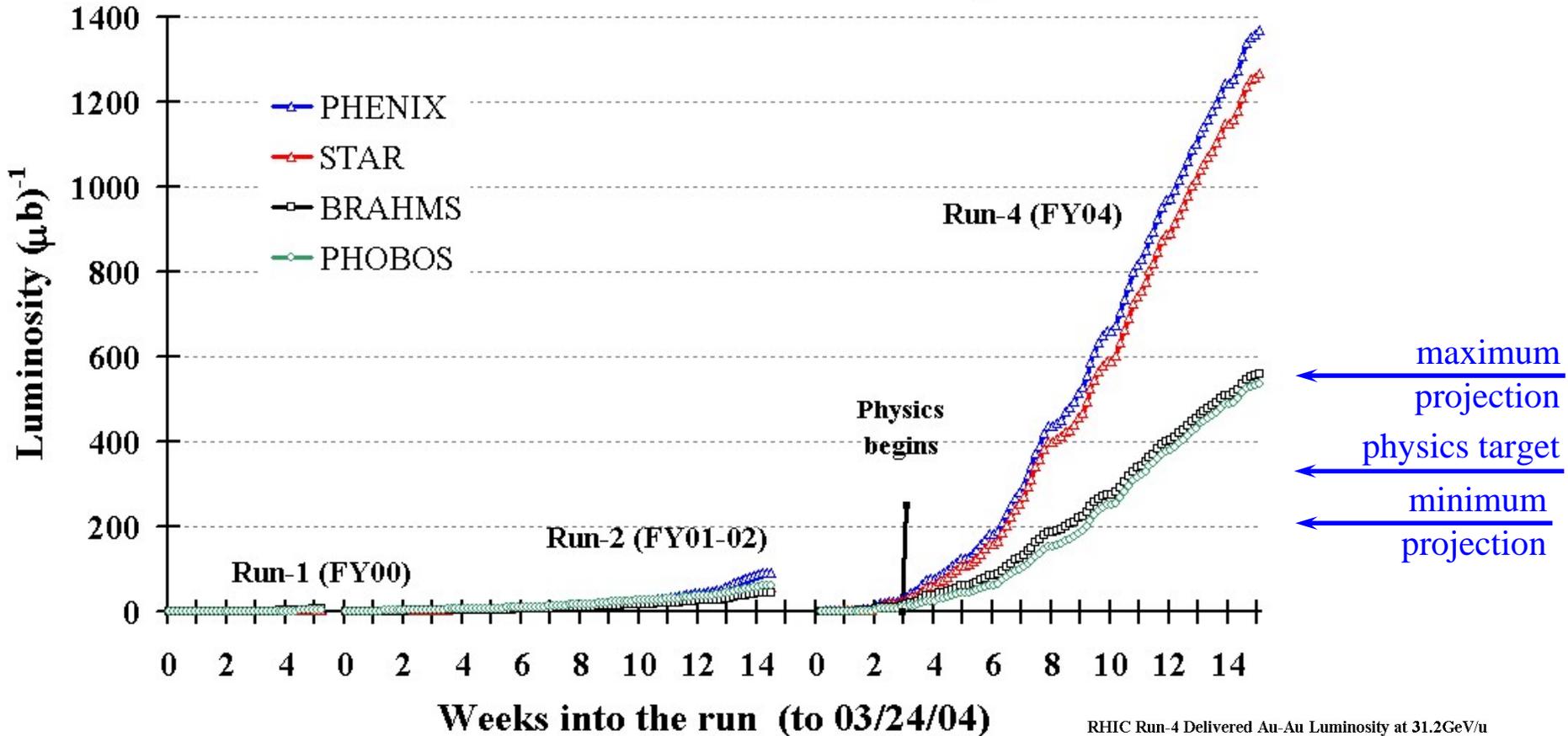
← 60e9 Au intensity

Beam experiments

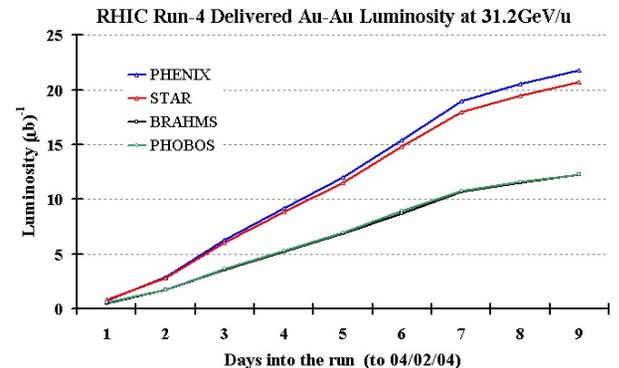


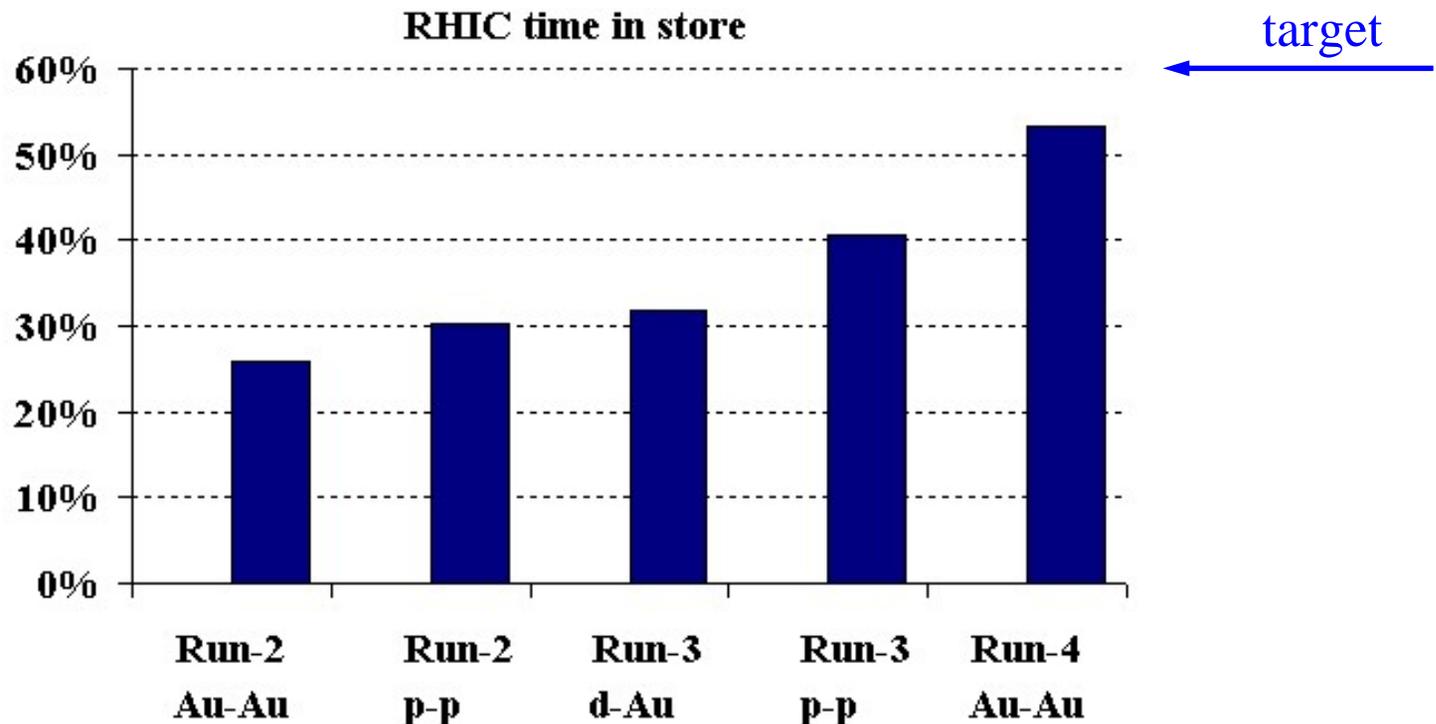
enhanced
luminosity
design
luminosity

RHIC Delivered Au-Au Luminosity at 100GeV/u



	100GeV/u (μb^{-1})	Relative to Run-4	31.2GeV/u (μb^{-1})
PHENIX	1370	15x	21.8
STAR	1270	21x	20.7
BRAHMS	560	13x	12.2
PHOBOS	540	7x	12.3





More time in stores through

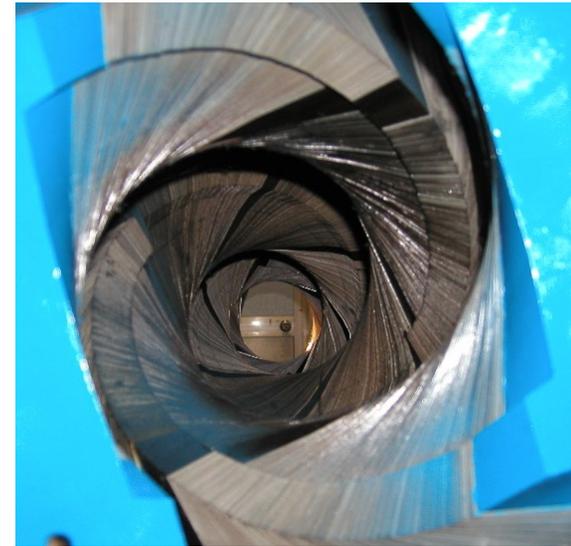
- Reduced number of quenches by 50% compared to Run-3 (several days)
- Eliminated ice-ball formation at corrector leads (several days)
- Better ramp maintenance, orbit correction after each ramp (several days)
- Resolved AtR cooling and software problems (~ 2 days)
- More reliable corrector power supplies (~ 2 day)
- Faster down ramps (1-2 days)

Major achievements $p\uparrow$ - $p\uparrow$:

(development run, until Friday morning)

Coordinators: H. Huang AGS
M. Bai RHIC

- New warm snake in AGS, increases polarization by $\sim 20\%$
- Max polarization from AGS 50%, consistently 40%
- Max polarization in RHIC 45%, consistently 35%
- Polarized H-jet commissioned
- Luminosity with 2 experiments $>10^{31}\text{cm}^{-2}\text{s}^{-1}$ (28 bunches, no polarization)
- Repeated stores with $P=35\%$, $L=5\cdot 10^{30}\text{cm}^{-2}\text{s}^{-1}$ initially (56 bunches, 4 experiments)



Goal:

- **Calibrate the RHIC p-Carbon polarimeters (store and injection)**
- **The Run-4 goal is to measure P_B to 10%**

Polarized Hydrogen Gas Jet Target

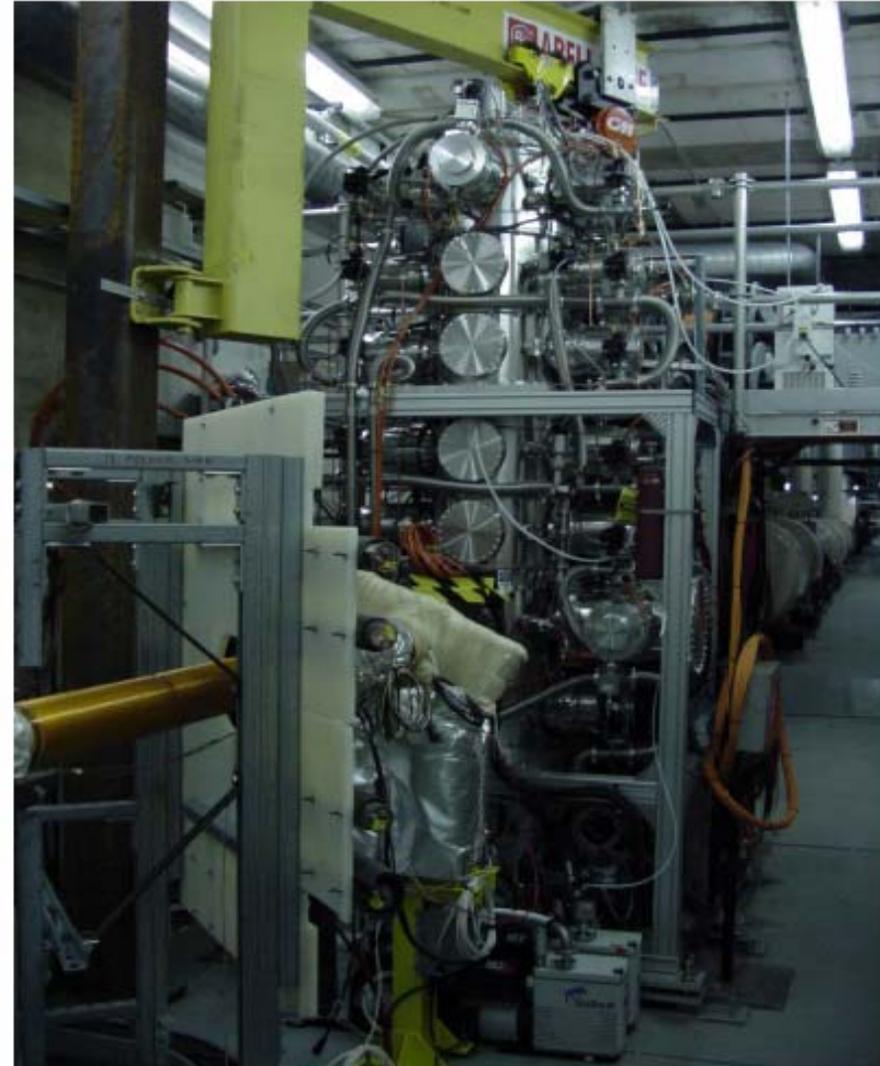
thickness of $> 10^{12}$ p/cm²

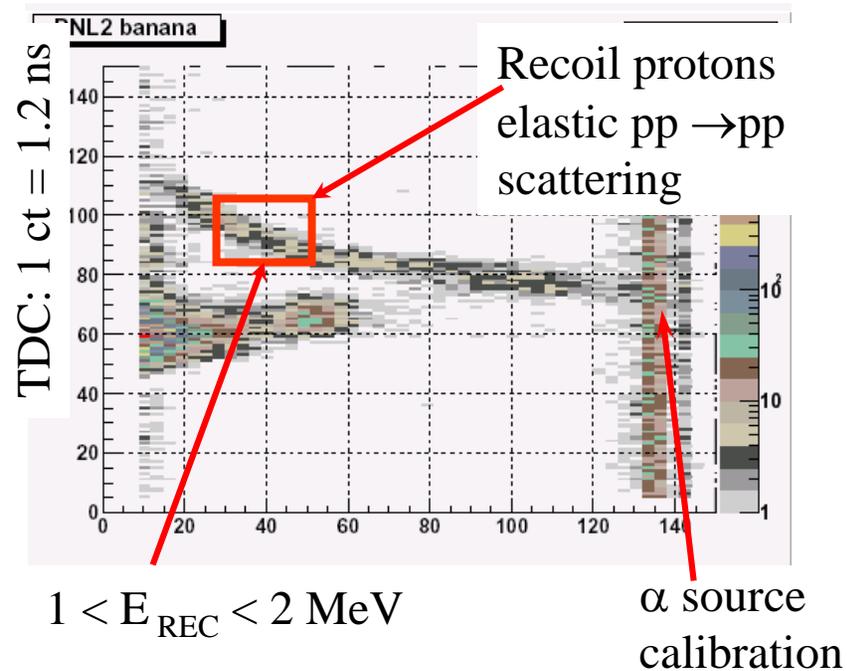
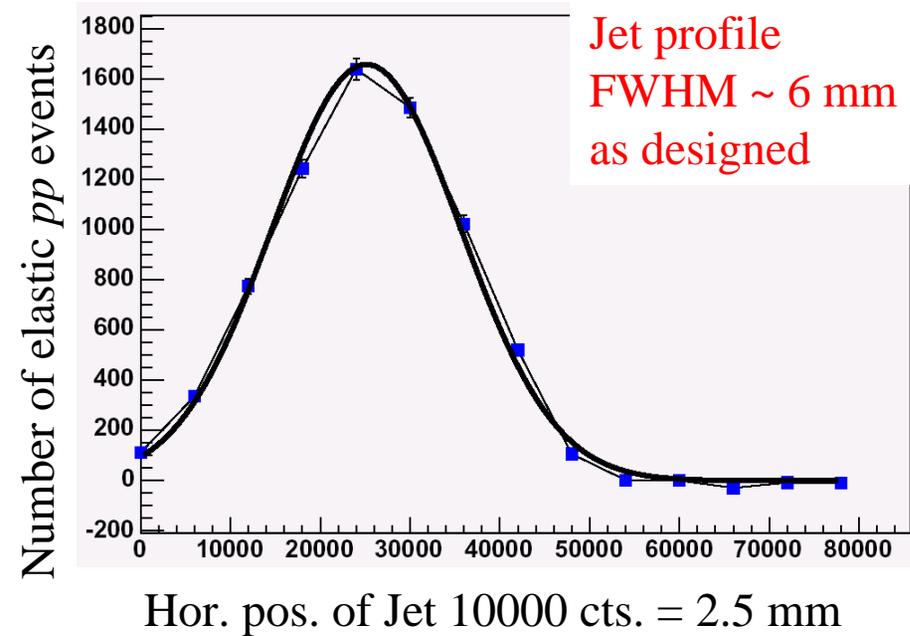
polarization $> 90\%$ (~95% !)

no depolarization from beam wake fields

Use a Silicon recoil spectrometer to measure

- The left-right asymmetry A_N in pp elastic scattering in the CNI region to $\Delta A_N < 10^{-3}$ accuracy
- Transfer this to the beam polarization



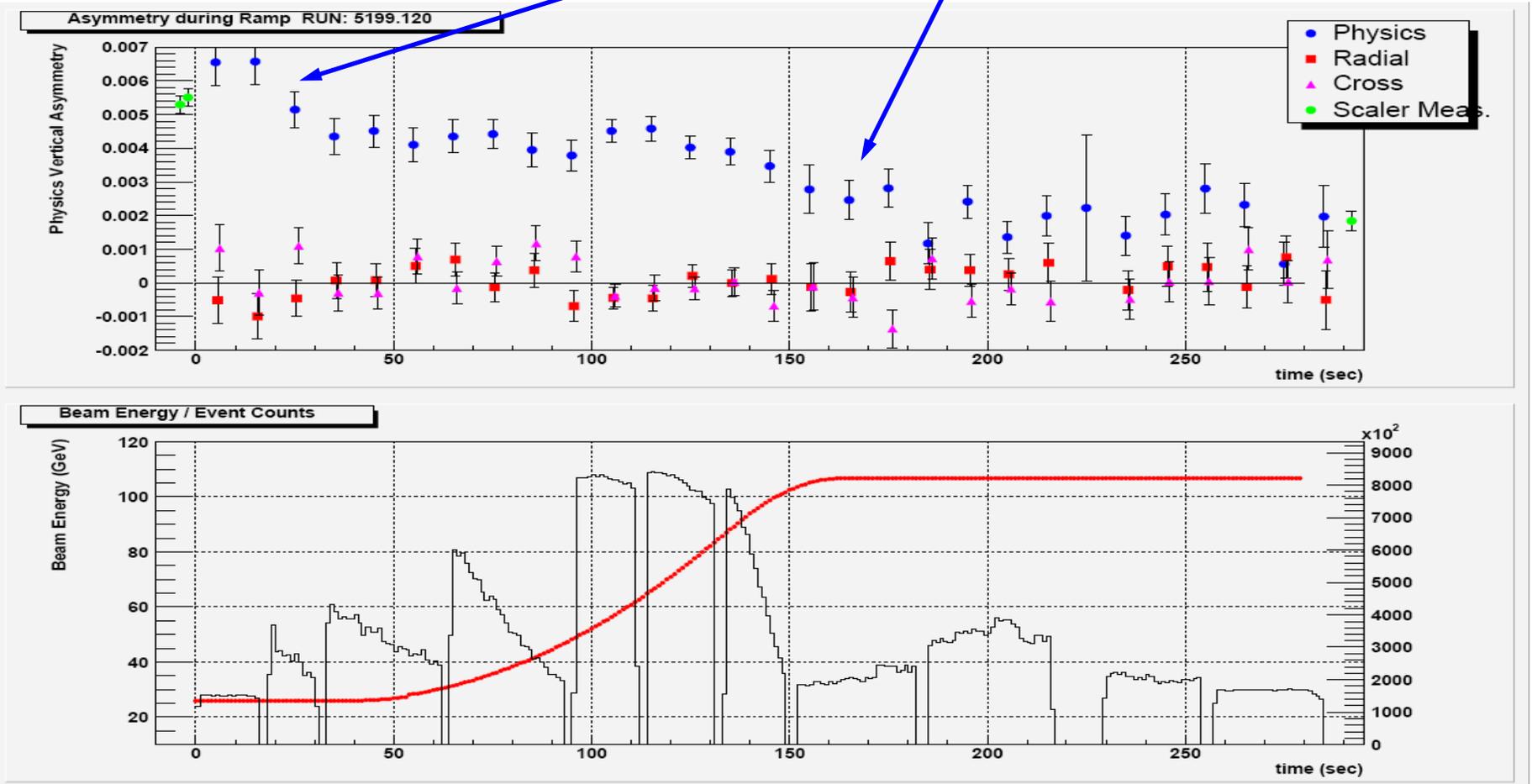


Data collected so far in this run:

- 100 GeV $\sim 440,000$ events at the peak of the analyzing power
($\sim 2 \times 10^6$ total useful pp elastic events) $\rightarrow \Delta P/P < 10\%$
- 24 GeV $\sim 120,000$ events at the peak of the analyzing power
($\sim 5 \times 10^5$ total useful pp elastic events) $\rightarrow \Delta P/P < 20\%$

Polarization measurement along ramp

Depolarization, later eliminated

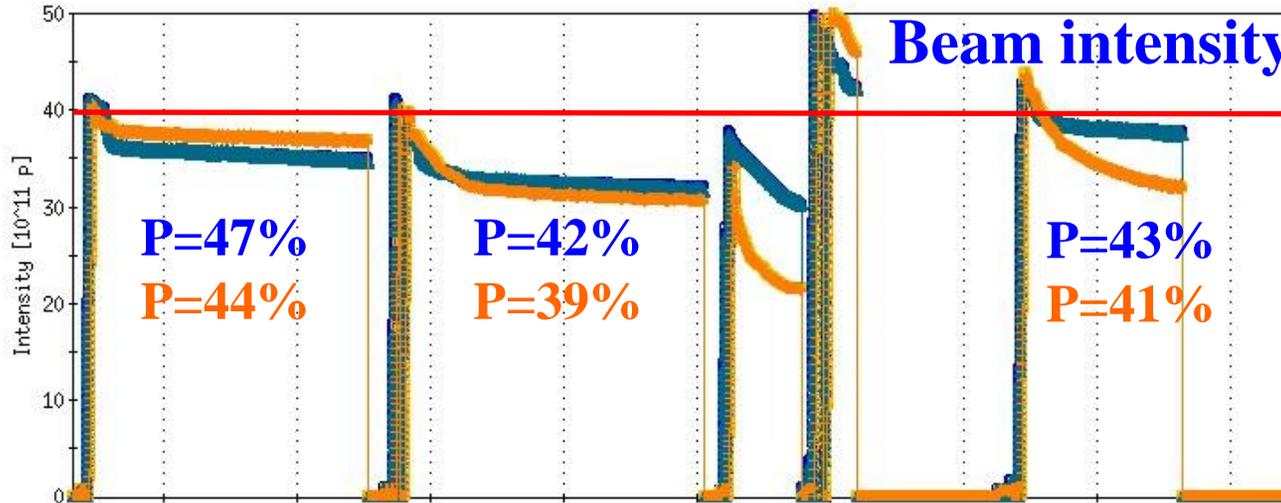


- More instantaneous luminosity & less background
 - Vacuum system upgrade (→10-50% more luminosity)
(PHOBOS, BRAHMS, STAR, ~150m warm beam pipes)
 - Possibly bunch merge for polarized protons in AGS
 - Improved machine model
 - Additional vertical collimators
- More time in store (→ about a day/run or more for each item)
 - Reduction of Quench Link Interlocks (beam induced, other)
 - Increase radiation resistance of electronics
 - Faster down ramps
 - Increased corrector power supply reliability
 - Better lead flow control
 - Beam Position Monitor system improvements
 - Various software improvements

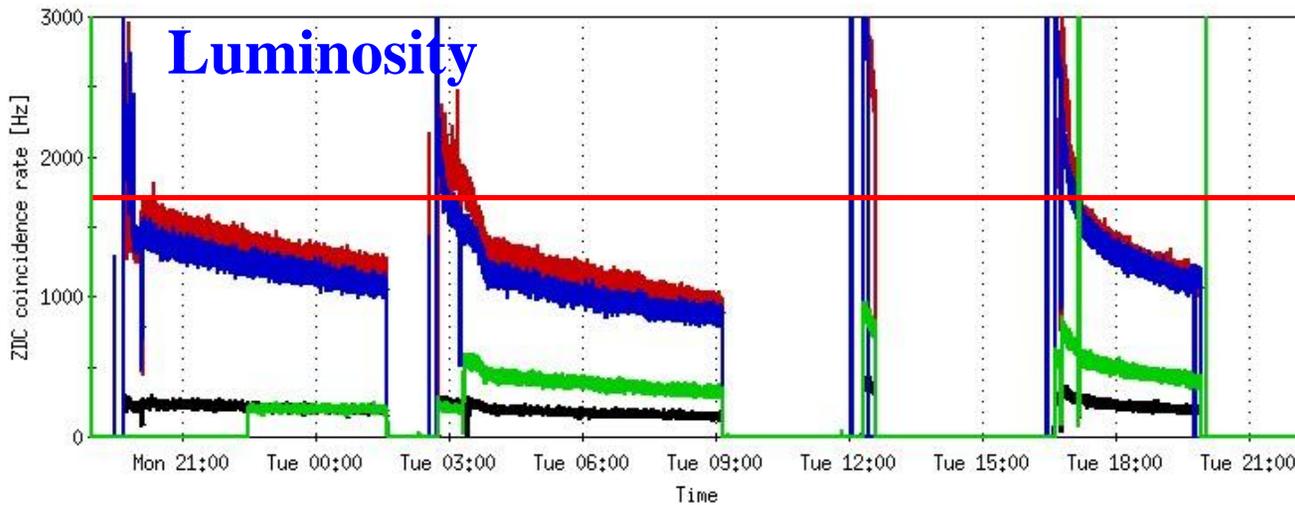
For likely species scan in Run-5:

- Consider Si^{14+} and Fe^{26+} , Ni^{28+} , Cu^{29+}
- Performance similar to Au^{79+} in Run-4 with
 - 10^{11} or more charges per bunch possible
 - Luminosity improvements due to vacuum upgrade, and reduced intra-beam scattering
- All above species are possible, preference for intensity/reliability of injector performance:
 1. Si^{14+}
gas stripping
 2. Ni^{28+} , Cu^{29+}
2-3x Fe intensity at Booster
 3. Fe^{26+}

Repeated stores with polarized beam



$40 \cdot 10^{11} p$ in 56 bunches



$L = 5 \cdot 10^{30} \text{cm}^{-2} \text{s}^{-1}$

- **Significant progress in Run-4 (FY04)**
 - Integrated Au-Au luminosity increased 15× compared to Run-2
 - Less than 2 days set-up for lower Au energy run
 - 1st measurements with polarized H jet target (store and injection)
 - Demonstrated viability of long polarized proton run (repeated stores with P=35%, $L=5 \cdot 10^{30} \text{cm}^{-2}\text{s}^{-1}$ initially)
- **Preparations for Run-5 (FY05) under way**
 - Substantial vacuum upgrade for more luminosity, many other efforts
 - Ions lighter than Au can be prepared for RHIC
 - AGS cold snake to be finished for Run-5 (probably not used for production)
- **Beyond Run-5: Enhanced Luminosity Goals** (before e-cooling)
 - For Au-Au, average per store, 4 IRs
 $L = 8 \cdot 10^{26} \text{cm}^{-2}\text{s}^{-1}$ at 100GeV/u 2× achieved
 - For p↑-p↑ average per store, 2 IRs
 $L = 6 \cdot 10^{31} \text{cm}^{-2}\text{s}^{-1}$ at 100GeV 5× achieved
 $L = 1.5 \cdot 10^{32} \text{cm}^{-2}\text{s}^{-1}$ at 250GeV 2× achieved
 with **70% polarization**