Performance Session Summary: Polarized Protons

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List of presentations

- Injector performance for pp:
  - Leif: AGS and source(OPPIS)
  - Deepak: emittance from LINAC and Booster
- RHIC performance:
  - Polarization: Bai
  - Orbit issues: Vadim
  - abort system: Leif
  - Collimator: A. Drees
- Polarimetry: Haixin
  - AGS and RHIC

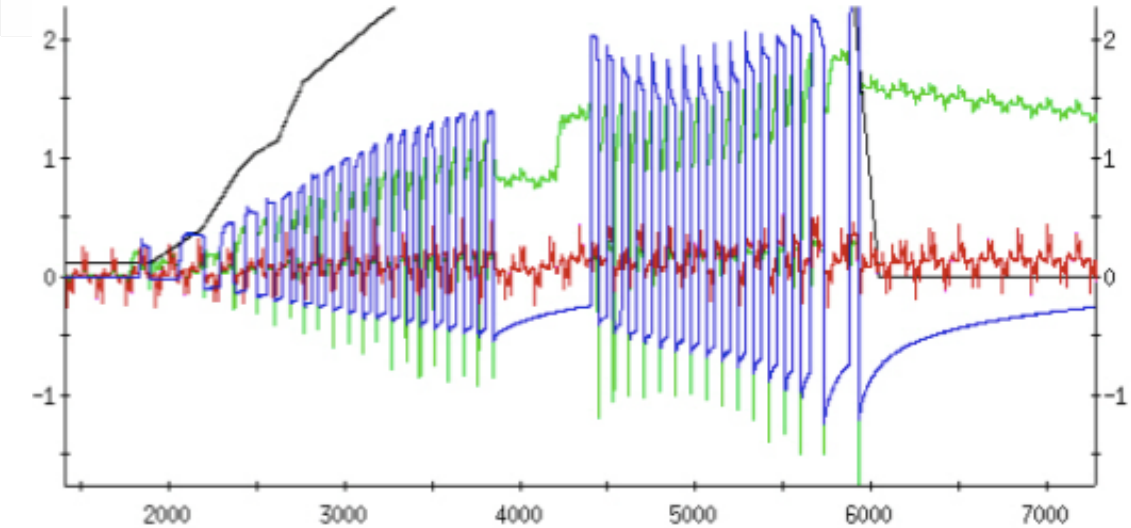
AGS and Source performance

- **Overall, polarization out of injectors stayed stable during the run unlike in the past polarization deteriorated close to the end of the run with no obvious reasons.**

- **The goal for polarized proton source upgrade during shutdown is to recover the 85% polarization as being demonstrated in the past.**

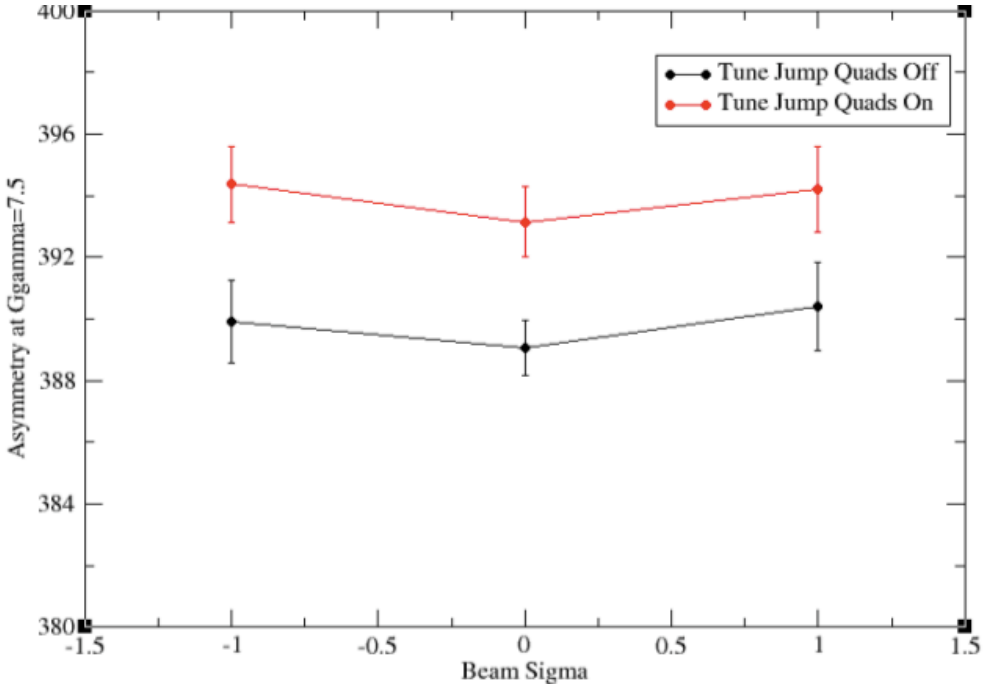
- In addition to provide stable polarized proton beams, the emphasis of this run is to commission the horizontal tune jump quads in the AGS. Two fast quads were installed during the run. The goal is to jump over a total of 82 horizontal resonances which are accounted for ~10-20% polarization losses during the acceleration in the AGS

AGS H Tune Jump Quads



- Tune jump system was tested
- Emittance blowup was minimized after orbit was corrected

- Test of H tune jump up to Gγ=7.5 showed encouraging results
- Future plan: make it operational
  - Automate the tunning of the jump pulse and timing
  - better calibration of timing and also HV.
  - Log all the related functions



AGS emittance issues

- Longitudinal emittance
  - Large shot-shot variation of longitudinal kick on the bunch
  - The longitudinal emittance growth is still dominated by the longitudinal mis-match between the AGS and RHIC
- Transverse emittance
  - Efforts in reducing beam size:
    - LINAC/LEBT
    - Reduce beta function at stripping foil of Booster injection
    - Booster scraping
  - However,
    - No strong experimental data to show the strong correlation of booster scraping and AGS final polarization
    - Does the emittance grow during AGS acceleration? If so, sources?
      - BtA understanding, modeling and machine studies
      - AGS model with snakes. How good is the model?

Measured Emittance after LEBT/MEBT upgrades

		Measured (w/o Scrapping)
• **At end of linac**		
H	5 π mm mrad (N, 95 %)	**4-5**
V	5 π mm mrad (N, 95 %)	**5-6**
• **At end of booster**		
assuming matched (we are matched),		
present booster lattice		
H	12 π mm mrad (N, 95 %), $\Delta\varepsilon_x$=7	**10-12**
V	8 π mm mrad (N, 95 %), $\Delta\varepsilon_y$=3	**8-11**
• With low beta lattice at injection (assuming matched)		
H /V	8 π mm mrad (N, 95 %), $\Delta\varepsilon_x$=3	**9-11**
V /H	7 π mm mrad (N, 95 %), $\Delta\varepsilon_y$=2	**6-7**
• With low beta lattice at injection with scrapping		
H /V	π mm mrad (N, 95 %),	**8-9** (Scrapping)
V /H	π mm mrad (N, 95 %)	**2.5-3** (Scrapping)

Booster transmission efficiencies increased by ~ 15%

Pulse length

2008	400 μs
2009	300 μs

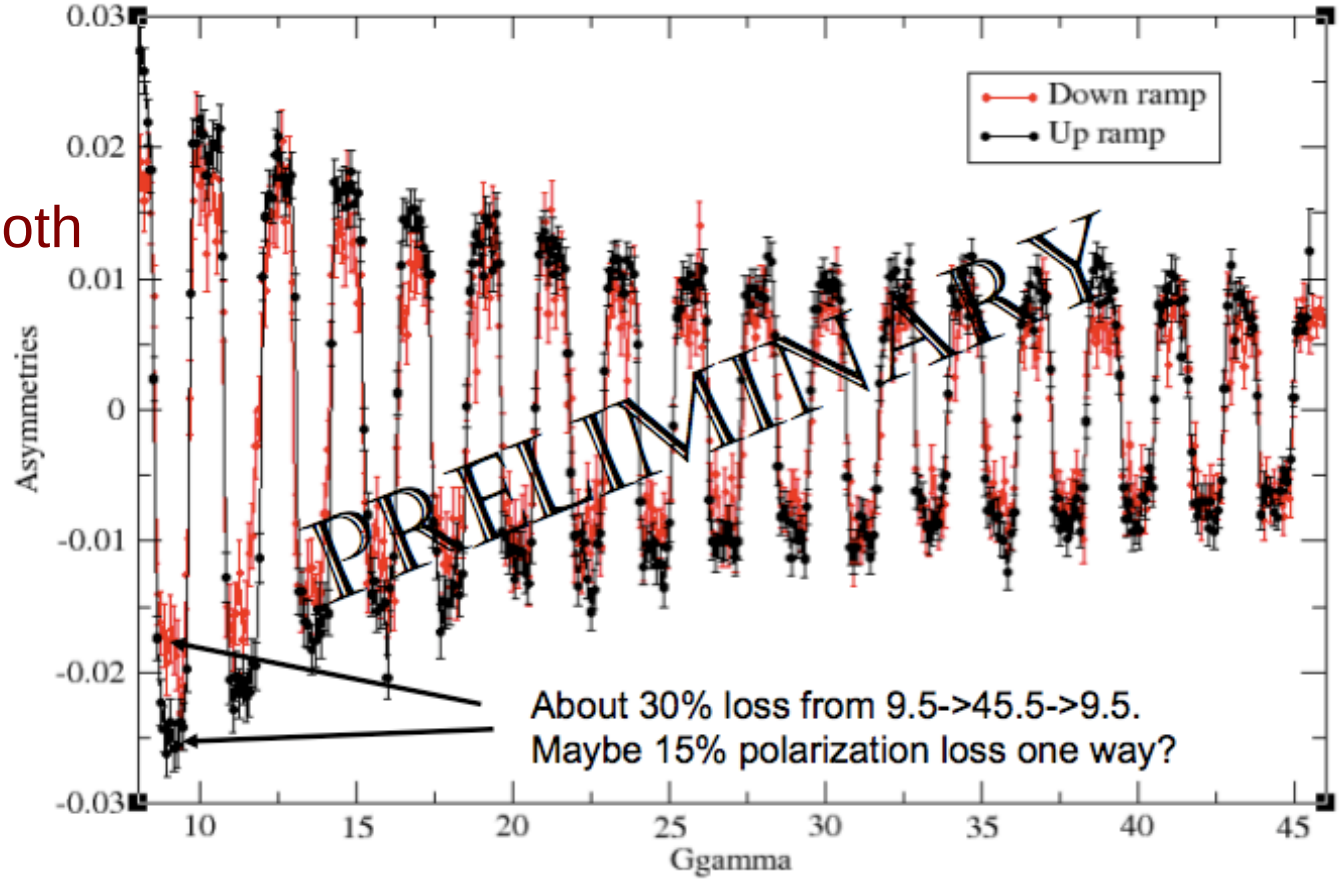
Emittance: LINAC and Booster

- Reduced linac output emittance by more than factor of two.
- Increased transmission efficiency from source to Tank 9 by 10-15%.
- **No impact on polarization due to new LEBT/MEBT configuration**
- Linac reliability > 97%
- Radiation due to losses were low every where.
- Changes next year and beyond
  - Reduce LEBT length for high intensity
  - Add Einzel lens to increase discrimination of molecular component
  - Reconfigured tank quad to reduce emittance by 20-25%
  - Incorporate Einzel lens inside 2nd solenoid to reduce depolarization
  - Add fast chopper in polarized LEBT
- New foil thickness and shape has increase the over all booster efficiencies (15%) and reduced emittance growth
- Modified booster lattice with low beta function at foil has reduce the emittance out of booster
- Want to reduce stamp foil size further
- **Contrary to general perception the average current on BLIP target for last several month was more than last year.**

Polarimetry: AGS CNI polarimeter

- Weekly dead layer correction to compensate the Si detector deterioration during the run
- Observed quick increase of leak current during the 1st few days seeing beam
- Observed polarization dependence on the AGS RF voltage.

First time to take polarization ramp measurements for both acceleration and decceleration!



Polarimetry: RHIC CNI polarimeter

- A lot of upgrades
  - adding an additional polarimeter for both rings to allow polarization measurements with both H and V targets as well emittance measurements
  - Added more targets
  - However, this also led to a slower start of the polarimeter during the 250 GeV

- Less operational issues for MCR due to the improvement of the application as well as the 2nd polarimeter

- Remaining issues
  - Rate problems
  - Polarization ramp measurement
  - System glitches:
    - Wrong start/stop position
    - AC unit failure
  - More and more emphasis on providing offline analysis after the online measurements

Polarimetry: RHIC H Jet polarimeter

- Slow start as well due to various system problems
- Operated in two beam mode which worked well
- Even though this is designed to the polarimeter to calibrate CNI, it had been used as reliable polarization measurement for physics stores during the run. So, for future, if this is going to the case, one needs to address the issues in manpower and stability of operations.

RHIC polarization: Status

- Using CNI measurements and assuming the current analyzing power used at injection
- Polarization was preserved up to 100 GeV in Blue ring and about ~10% polarization loss was observed in Yellow ring. No noticeable polarization deterioration during store in both rings
- About 75% polarization transmission efficiency was achieved during RHIC 250 GeV run. Polarization ramp measurements showed polarization was lost beyond 100 GeV.
- Significant polarization deterioration during store was observed especially in Blue. This led to less than 40% average polarization of physics stores.
- The polarization as function of vertical tune near 0.7 indicates that 90% polarization transmission efficiency can be achieved if beam can be accelerated with vertical tune below 0.675
- Development of accelerating pp at near integer tune didn't yield better polarization, or polarization transmission efficiency as unexpected

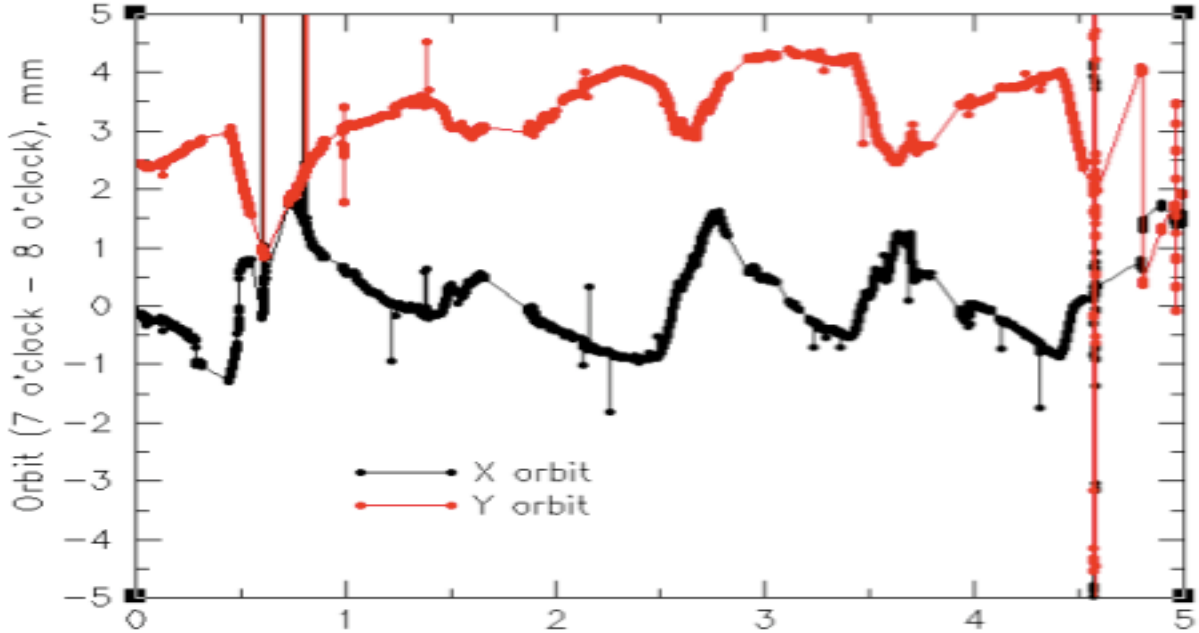
RHIC polarization: plan for >50%

- Explore the possibility of accelerating pp in the tune box of 0.67 and 0.675 beyond 250 GeV. The work point from injection to 100 GeV stays above 0.7. This requires to minimize the glitch of ps for main quadrupoles and main dipoles.
- Detailed data analysis of polarization lifetime during 250 GeV run to really/fully understand why this is very sensitive to the Blue rotator setting at PHENIX
- Revisit spin tracking. Use the experimental data from the run to benchmark the spin codes.
- Extensive spin tracking to explore
  - Why the near-integer working point didn't yield higher polarization at 250 GeV?
  - Is 0.3mm rms orbit distortion enough for avoiding depolarization beyond 100 GeV?
  - Eplore the best working point for pp acceleration

Orbit variation and feedback

- Slow orbit variations(24 hours):
  - Reproducibility of ramp orbit as well as the orbit stability during the store which is very critical to the collimator setup
  - Currently: orbit correction every 0.5 hour and only apply ramp orbit correction in certain time windows.

Orbit variation at IP8



- Fast orbit variation(10 Hz):
  - From triplet vibration. Affects the collision as well as ramping with near-int working point

Correction schemes for stable orbit

- Slow orbit variation
  - Propagation of orbit corrections at injection through ramp
  - feedback system: using correctors in IP4 or 6(12) correctors from IPs.
  - Local 3-bump at collimator to keep the orbit at collimator drifted away

- Fast orbit variation
  - Mechanically damp the triplet vibration:
    - P. Thieberger et al
  - Local orbit feedback system worked, but couldn't eliminate the orbit variation at triplets
  - Currently, a global orbit feedback system was proposed for run10. ~4 magnets(air-cored) at IRs with the filtered data of existing BPMs
    - Vadim, Michiko, Rob, …

RHIC abort/dump system

- Observed magnet quench during a clean beam dump at 250Gev. Both raising voltage and widening the abort gap were tried. Didn't eliminate the problem. Indication of the limit of present abort system: combination of the present kicker strength(chosen between the required voltage and less pre-fire) as well as the distance between the kicker and the dump as well as Q4

- This observation seems to be in agreement with A. Stevens' calculation

- Current plan for upgrading the system is to revisit A. Stevens' calculation(Kin Yip) to explore what's the gain of changing the configuration of the abort/dump system
  - Increase the distance from the circulating beam of the initial impact on the C-C absorber
  - Stronger kicker. Increase the voltage or add another module

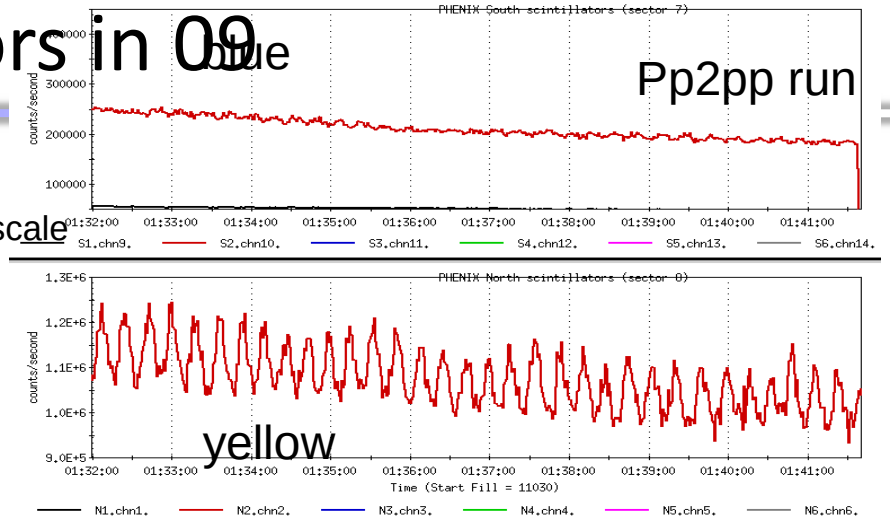
Collimators in 09

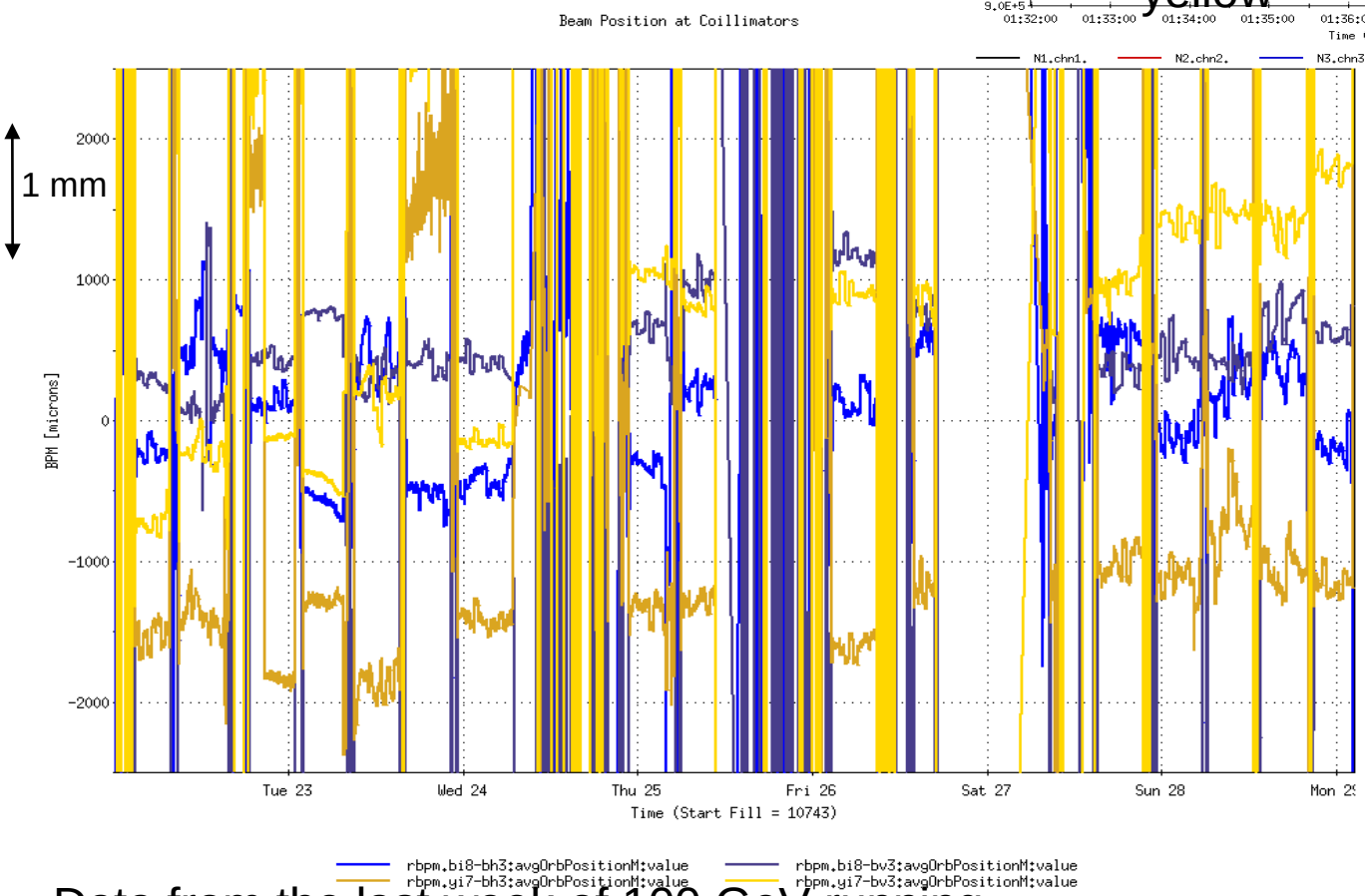
- Collimators worked as expected
  - 250 GeV
    - Very high rates, but normalized not higher than in 08
    - Backgrounds inside PHENIX shielding are collision dominated (there are some open questions under study)
  - 100 & 250 GeV
    - Orbit control in collimator area is an issue
      - A few stores were lost because of bad positions
    - 20 sec noise affects yellow (slow background growth)
      - Affected mostly pp2pp
- We are looking into relocating collimators to another IR (simulations in progress)

Collimators in 09

Problems:
irreproducible orbits for positioning
orbit drifts during the store
erratic automatic orbit corrections
20 sec (10 Hz?) noise, mostly in yellow

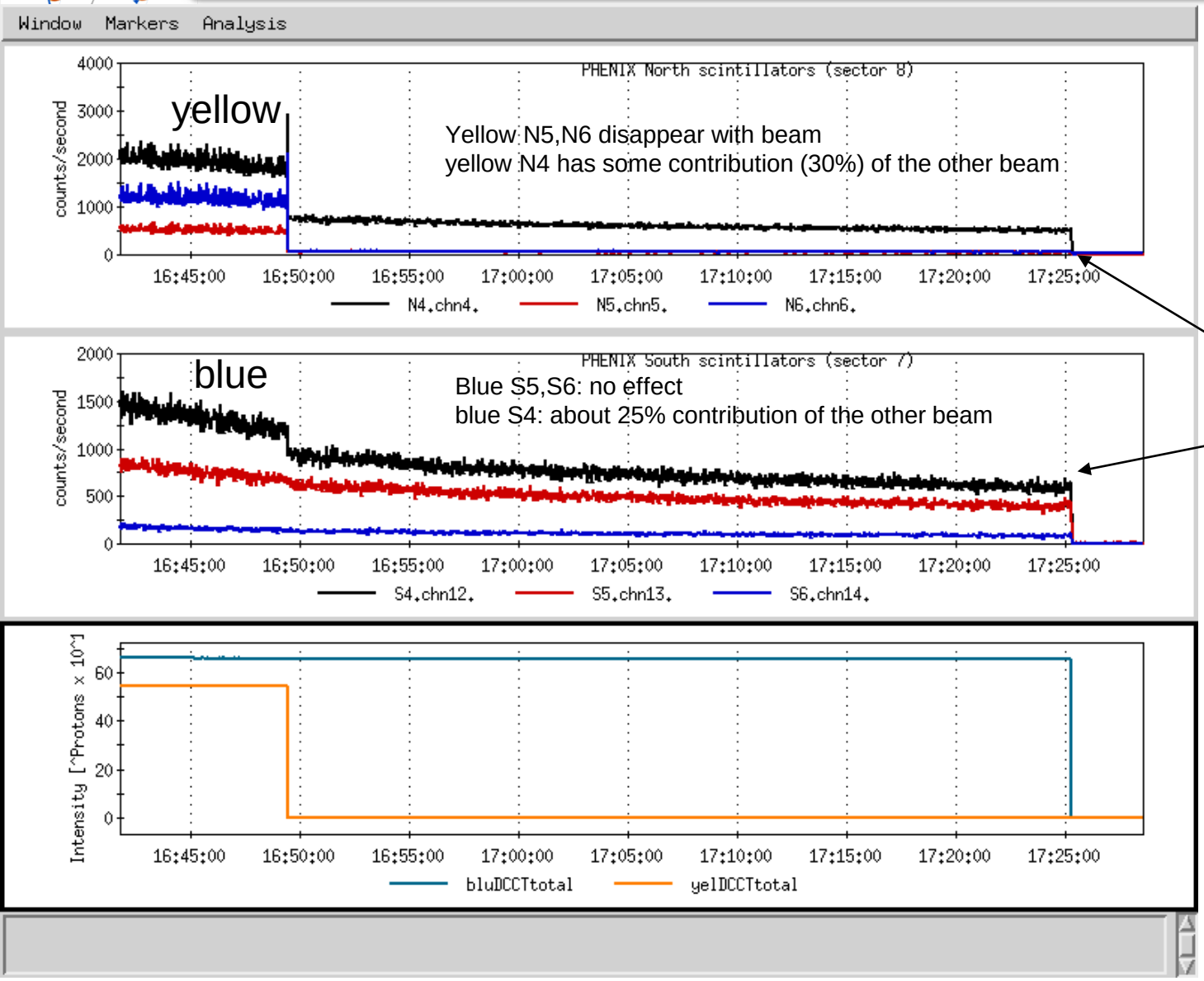
same scale





Data from the last week of 100 GeV running.

250 GeV: PHENIX inside scintillators



- There is some rate behind the MuID panels that comes from the tunnel, indicated by S5, S6 and N5, N6
- The most "forward" counter, N4 and S4, get about ¾ of their rate from upstream (tunnel, triplet), this is the amount that remains in the yellow counter and vanishes from the blue counter
- Some part, about ¼, is coming from the other beam: through the IR or caused locally?
- This contribution seems restricted to an area very close to the beampipe