15 GeV Low Energy Run

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RHIC/AGS Users Meeting 2014

Energy Choice

- Experiments requested Au-Au collisions halfway in-between 5.75 and 9.8 GeV/n - energies where RHIC ran in 2010

- 7.5 GeV/n would be too close to transition energy in AGS, $\gamma_t = 8.5$

- Limited RF frequency tuning range in RHIC limits beam energy range

- Lowest possible energy without harmonic number change is 7.3 GeV/n

Beam-beam Effect

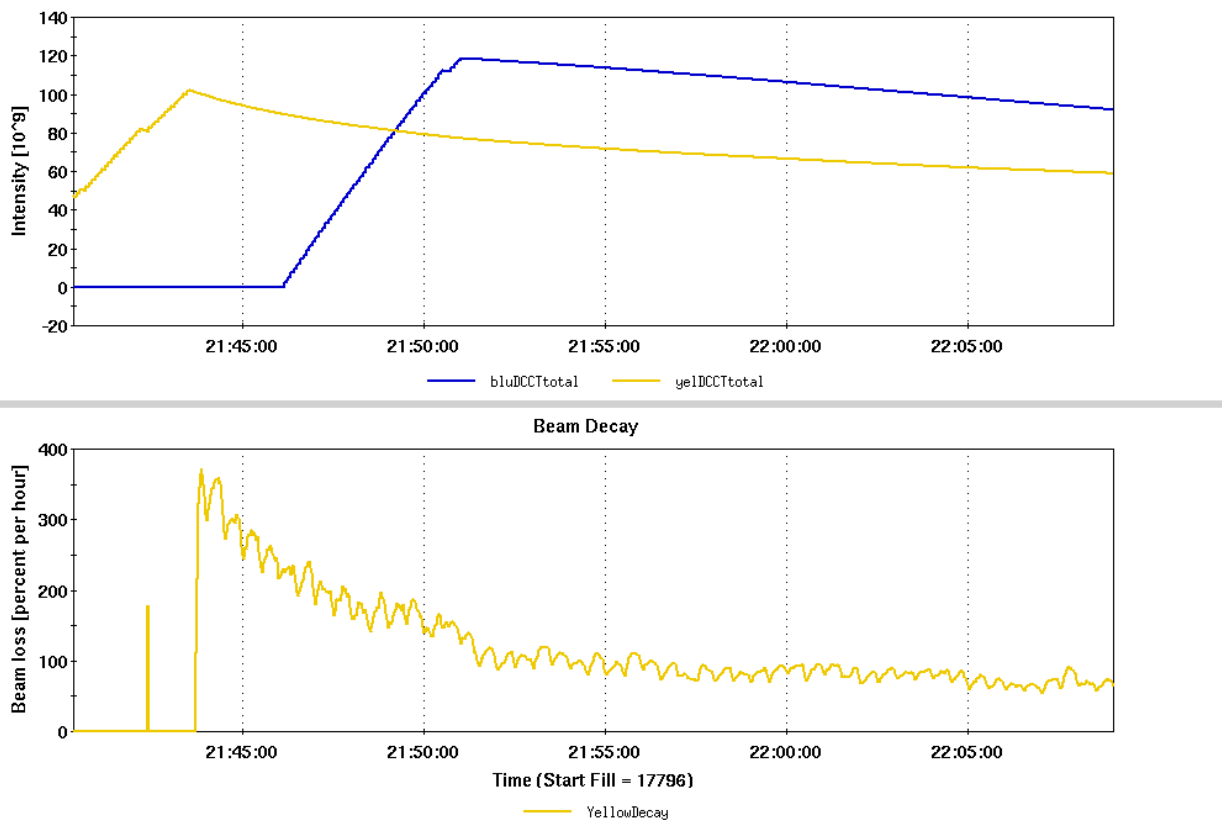
- During earlier low energy runs in 2010, strong beam-beam effects were observed in the presence of large ($\Delta Q_{\mathrm{sc}} \approx 0.05$) space charge tune shift that limited the beam lifetime significantly

- Tunes in 2010 were set to $(Q_x, Q_y) = (.13, .12)$

- Near-integer tunes should be better because they provide largest tune space between nonlinear resonances

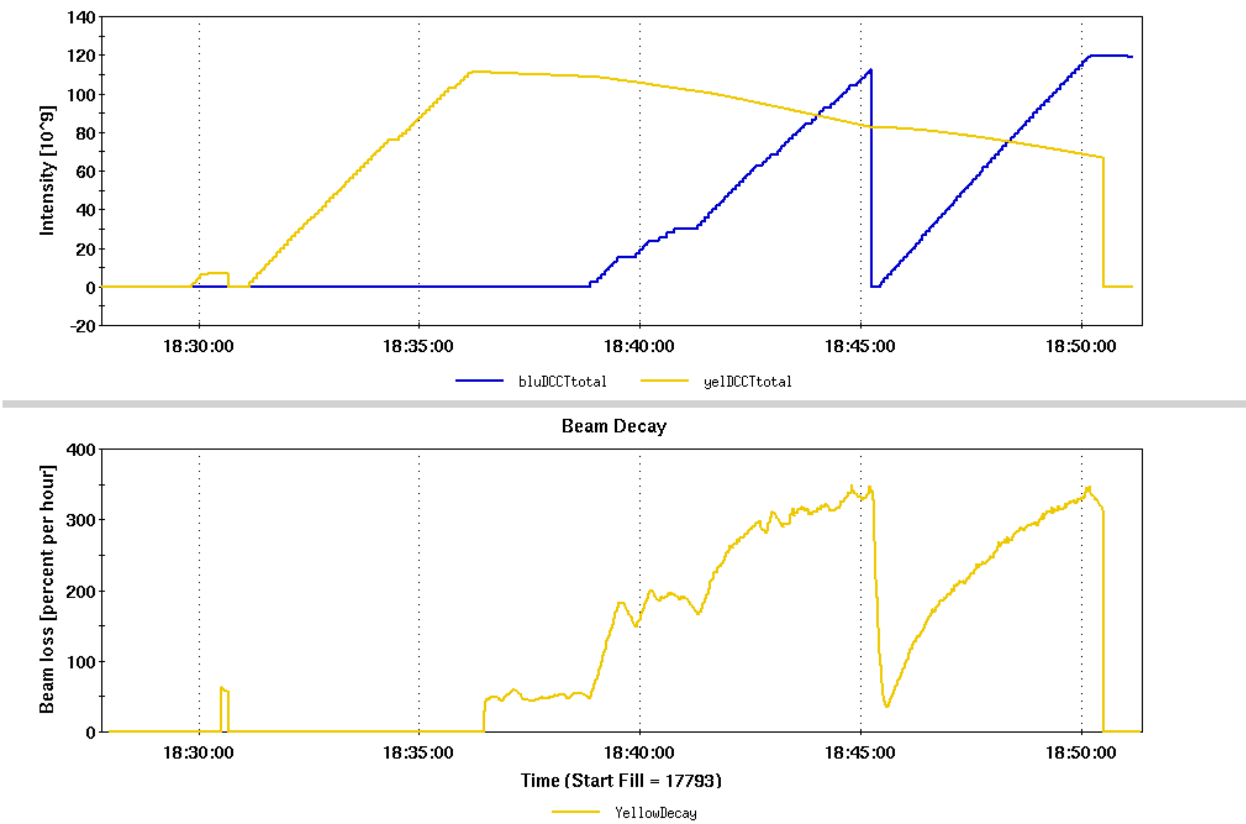
- Beam experiments at injection energy as well as simulation studies suggested that near-integer tunes are indeed better

Yellow beam decay during injection of Blue beam at (.095,.085)



At near-integer tunes, Yellow beam decay is unaffected by Blue beam

Yellow beam decay during injection of Blue beam at (.13,.12)



At FY2010 tunes, Yellow beam decay increases significantly when Blue beam is injected

Orbit Correction and Collision Steering

- RHIC dipole correctors are equipped with 50 A bipolar power supplies

- 12-bit controls, so one bit corresponds to 24 mA

- At 7.3 GeV/n, 24 mA provide a 6 μrad orbit angle

- Orbit bumps are no longer closed due to coarse corrector resolution, especially in IRs where dipole correctors in triplets at high β are used

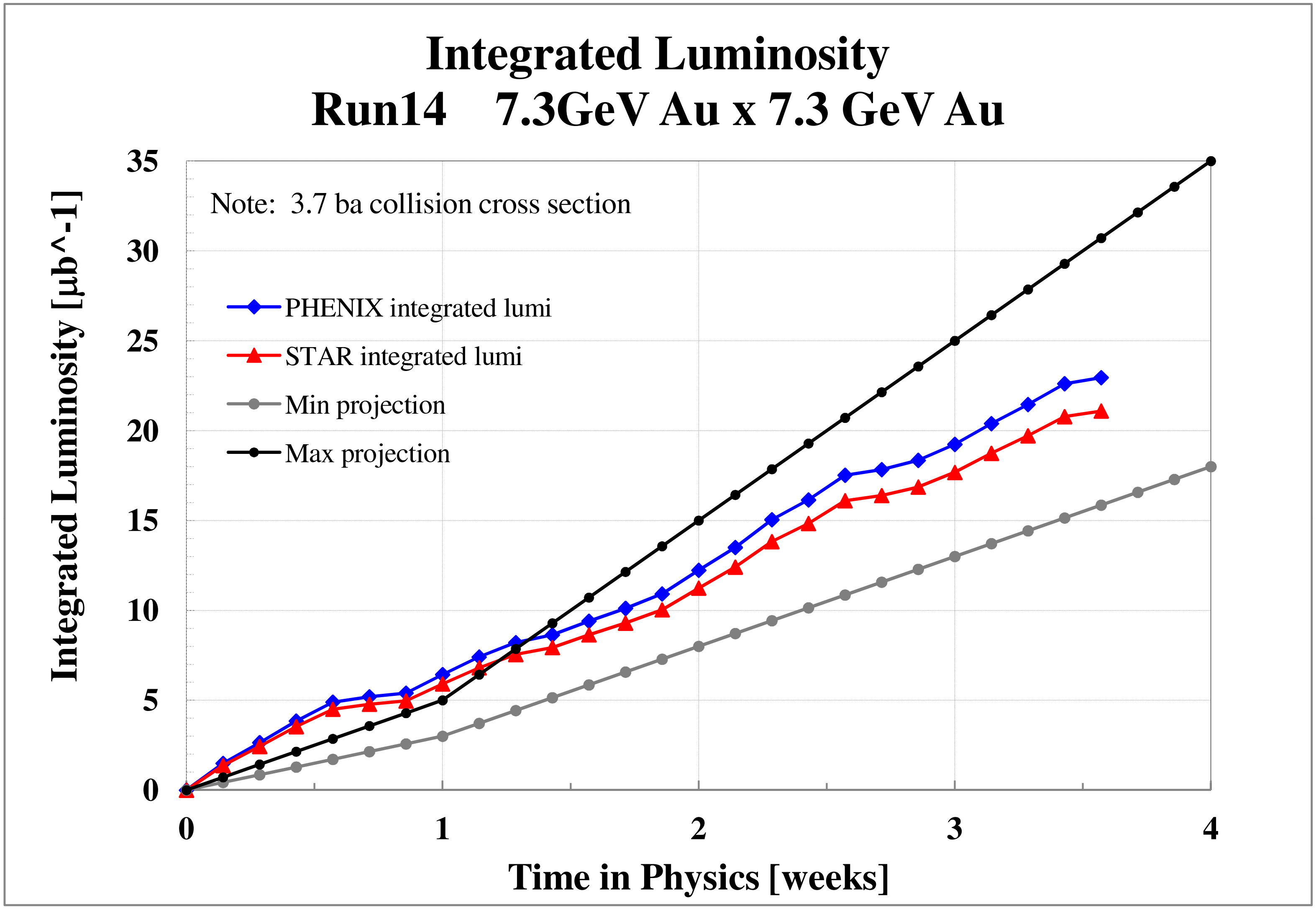
- Solution for future runs: Upgrade critical correctors to 16-bit, or use correctors at lower β for IR steering

Luminosity Performance

Machine parameters achieved during the low energy run

no. of bunches/ring	111
ions per bunch	$1.1 \cdot 10^9$
$\beta*$	3.5 m
rms emittance	1.7 μm
L_{peak}	$1 \cdot 10^{26}$ cm^{-2}sec^{-1}
$L_{\text{store avg}}$	$0.2 \cdot 10^{26}$ cm^{-2}sec^{-1}
integrated luminosity per week	8.1 μb^{-1}
store length	1 h, later 45 min
time in store	57% of calendar time

Low energy run had to be extended by one day to com-npensate for time lost due to Siemens motor generator failure



Exceeded integrated luminosity goal of 20 μb^{-1}

Other Accomplishments

- AGS main magnet slow feedback at flattop
- Continuous gap cleaning to avoid kicking unbunched beam in abort gap into STAR
- Installation of a prototype internal target at STAR, 2.05 m from the IP, with 20 mm aperture radius
- Special optics in IR2 for future low-energy electron cooling, with $(\beta_x, \beta_y) = (34\,\mathrm{m},\ 14\,\mathrm{m})$ in the Blue ring, and $(\beta_x, \beta_y) = (13\,\mathrm{m},\ 49\,\mathrm{m})$ in the Yellow ring

Summary

- Beam energy was modified to 7.3 GeV/n instead of 7.5 GeV/n due to constraints from AGS transition energy and RHIC RF frequency range

- Three days cool-down to 4 K

- Physics run started after 9 days of set-up

- Near-integer working point to reduce beam-beam effect

- Luminosity goals for both STAR and PHENIX were met during 3 week run