Machine Performance Overview: Au-Au

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Organization (an aside)

- Au-Au Run coordinator = K. Brown
  - Overall and weekly schedule
  - Reporting
  - Schedule tracking
- Two co-run coordinators
  - Todd Satogata & Angelika Drees
    - Dry run
    - Startup
    - 0.5 m Beta*
    - Ramp-up
    - Store development

Why 2 co-run coordinators?

- Run coordinator is a full time job. But I am now head of the Controls Systems – mostly a full time job.
  - Fortunately, Software and Hardware Systems have excellent leadership.
- The idea is simply to divide up the responsibilities and allow me to focus on the over-all schedule and goals.

Run Organization

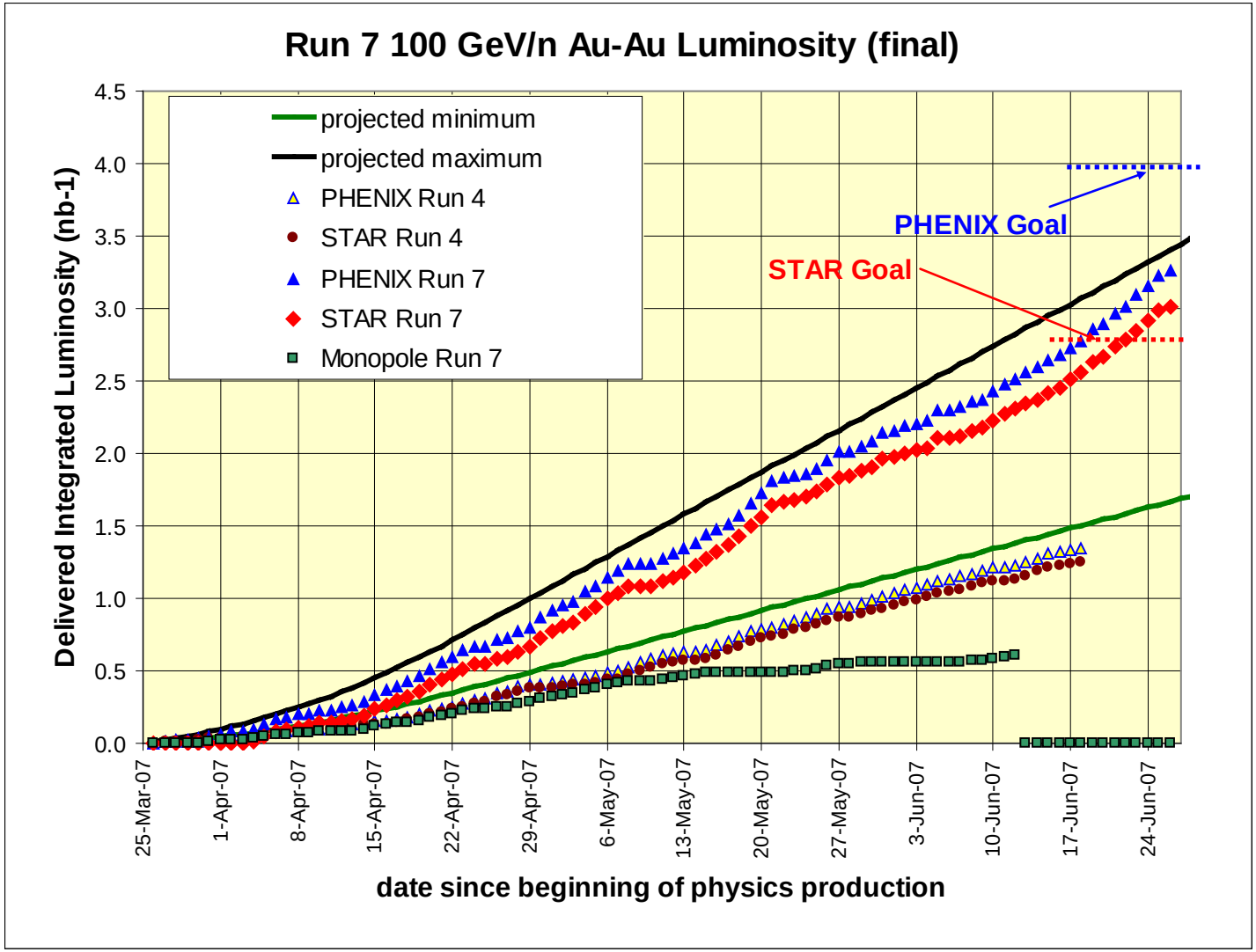
- start-up, ramp, and store development
  - Daily meeting at 9 am : Mon. – Fri.
    - need to schedule accesses and days activities
    - Set plan of the day
  - Day time for p.s. testing until ready for ramps
  - physics in 2 weeks (optimistic – shutdown work, LLRF) starting with 0.7 m beta* lattice
- Run coordinators meet daily at 4 pm (MCR)
  - 7 days/week (at least 1 RC will be in attendance)
  - With day and eve shift leaders
  - With mcr staff (OC's and available operators)
  - Review plan for over nights
  - Experimenters and Sched. Physicist are invited

Communication!

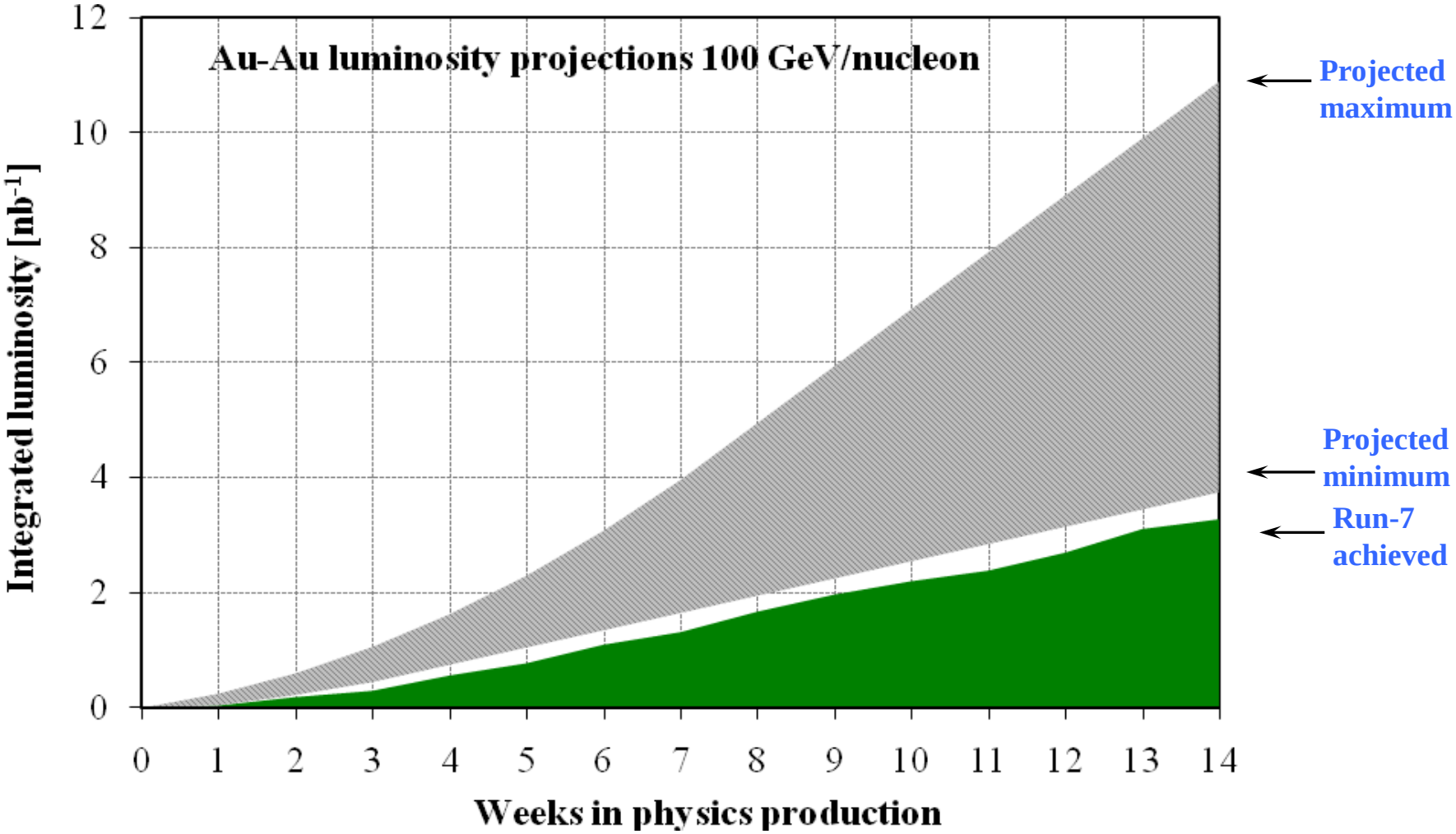
- **Listening = that's everyone's job**
- **Morning meetings during startup (9 am)**
  - I will assume people have read the logs
  - A short summary of the day, because somebody will give me hard time about not getting to read the log!
  - plan of the day (accesses and machine development).
  - Unless under very stressful circumstances = the meeting will not exceed 30 minutes (Max.)
  - People must be respectful – or else!
  - Don't expect me to do this for the entire run. Won't happen. Ends when steady physics is running.
  - Format: reports from SP, Experiments, then make plan.

Run 10: What to expect.

Run 7 Integrated Luminosity



Run 10 Luminosity Projections



From W. Fischer (2008) Retreat Talk

Upgrades for Au-Au luminosity

Main limits: IBS, transition instabilities

- Reduction in β* (from 80cm to 50cm, +70%)
- Lattice with reduced IBS (+25%)
- Blue longitudinal stochastic cooling (+15%)
- Transverse stochastic cooling(+400%)
- Transverse damper / scrubbing (+40%)

RHIC 56 MHz SRF (+30-50%)

Run 10 Luminosity Improvements

1. Longitudinal stochastic cooling both rings
2. Transverse stochastic cooling will be commissioned in the vertical plane, both rings
   - Highly coupled lattices will cool both planes
3. β^* reduced to 0.5 m
4. Separate γ_{tr} for two rings (lesson from d-Au run)
5. IBS Suppression lattice for both rings
6. Efforts (transverse and longitudinal) to improve transition crossing
7. Smaller Longitudinal Emittance (AGS)
8. New LLRF (improve Luminosity?)

Stochastic Cooling

Mike Brennan & Mike Blaskiewicz

Reconfiguration for FY10

- Up to now we have only cooled one of the six possible phase space planes (Yellow longitudinal)
  - The Blue longitudinal systems has only seen deuterons and protons
  - For FY10 we will have systems for cooling 4 planes (longitudinal and vertical in both rings)
    - We expect some cooling to be transferred from vertical to horizontal via betatron coupling
    - Cooling in the transverse plane will make longitudinal cooling more difficult because smaller emittance enhances IBS
    - See Blaskiewicz talk for luminosity projections
- Therefore even the Yellow longitudinal system will be new this year
  - To go beyond halo cooling we jettison the two-turn filter
  - Add another microwave link to cut the chord
  - Extend the frequency range to 9 GHz (like Blue)
- We have to build another original kicker machine for Blue vertical
  - Same microwave cavities as Yellow vertical but new concept for the opening mechanism
  - A new concept is called for so that we can efficiently build kickers for the horizontal cooling system
  - This effort is underway thanks to the stimulus funding
- We have also run out of Tevatron pickups
  - The longitudinal systems (Blue and Yellow) will use a new concept
  - Longitudinal is easier, therefore no motion in vacuum is required
  - The new concept is based on commercial waveguide-to-coax transitions
  - Tested this year at Blue pickup

Commissioning Plans

1. Initial checkout of pickups and microwave links
   - Beam at injection with reasonable lifetime
   - Some ring access likely (pickup electronics)
2. Real checkout needs beam at store
   - Need small beam size to close devices to small aperture
   - Rebucketed beam to get 5 ns bunches
   - Need reliable BPMs at Q4s
   - Set up software to read PIN diodes
3. Precise adjustment of pickup-to-kicker delays needs beam at store (six bunches is hard to see the gap)
4. We need to establish reference BTFs for each cavity (4 x16) for all four planes
   - One plane per shift is optimistic
   - The interaction between planes is something new. It likely will require iterating these reference BTFs
   - Commission the software that stabilizes these BTFs
5. Testing and refining TAPE sequences will be on-going as other systems come on line
   - rebucketing
   - Collimation
   - Orbit correction
   - Backgrounds/vacuum
   - We want to switch on cooling as early as possible in a store
6. Ring access will require some priority during commissioning (!)
7. A WILD GUESS……we would have all four systems running three weeks after we have stable beam at store

From my notes

- initial check out of pickups and microwave links as soon as there is beam, but can't close the pickups at injection.
- real checkout occurs when there is steady beam at store.
- Key dry run activity, testing the tape sequences
- expect all four systems will be running (not optimized) three weeks after steady stores.
- *Need stable beam during the day shift*

New RHIC LLRF

Kevin Smith

(with slight format editing by K.Brown)

The Plan For Run 10

- RHIC LLRF
  - *Start RHIC with new LLRF System ready to fully commission.*
  - Integrate quad mode damping from the start.
    - One example of the flexibility of the new system.
    - "Readily expandable, flexible, obsolescence resistant, ready spares. Example: Once new system is stable, new quad mode damper functionality is readily subsumed and current "external" implementation goes away." (RHIC Retreat 2008)
  - Begin commissioning of "Cavity Controllers" during the Au run.
    - Provide independent drive for each cavity, eliminate existing IQ modulators.
    - In the fullness of time add tuning loop, phase and amplitude stabilization, monitoring …

LLRF Commissioning plan

- This (LLRF) remains a commissioning effort and we will need machine time

	Post Retreat Clarification Edit Conservative	Optimistic
♦ Blue Injection, Timing Setup, Injection Correction, Capture • Testing and debugging of BTB Phase Detector	1 x 12 Hrs	1 x 12 Hrs
♦ Blue Acceleration, Transition Crossing, Store Cogging Testing, Rebucket Testing • Testing and debugging of BTB Phase Detector, Feedback DSP, DAC Firmware	2 x 12 Hrs	1 x 12 Hrs
♦ Yellow Injection, Timing Setup, Injection Correction, Capture • Ditto Blue.	1 x 12 Hrs	0.5 x 12 Hrs
♦ Yellow Acceleration, RTR Synchro, Transition Crossing • RTR Synchro loop moves from analog to digital	1 x 12 Hrs	0.5 x 12 Hrs
♦ Collision Cogging, Rebucketing • Rebucket gymnastic is a new implementation, simpler in hardware.	1 x 12 Hrs	1 x 12 Hrs
♦ Quad mode damping • Completely new implementation, embedded in new hardware (firmware)	1 x 8 Hrs	1 x 8 Hrs
	80 Hours	56 Hours

Note: Original estimate for the Run 9 Start-Up commissioning was 96 Hours = 8 x 12 Hrs. See Dejan's Meeting, 12/22/2008.

We actually took less than 20 hours in the two Run 9 commissioning development days. So the benefit of those days has been realized both in terms of the upgrade effort proper, and in required commissioning time.

BBQ and Tune Feedback

Michiko Minty

II Tune/Coupling Ramp Development Summary

ramp	date	commissioning hours to first replay ramp	# ramps to first replay ramp	comment
250 GeV 0.7 m beta*	02/14-16/09	6 (blue) + 5 (blue + yellow)	12	(ramps for LLRF commissioning not counted)
100 GeV 0.7 m beta*	04/16/09	3 (blue + yellow)	4	followed by 6 more hours tuning orbits by OPS using tune/ coupling feedback
100 GeV 20 m beta*	06/29/09	3 (blue + yellow)	5	
250 GeV near-integer tune	06/11/09	3 hours setup 2 hours to full energy (blue + yellow) 4 additional hours (tune mode)	(7 ramps, no replay)	8 ramps total to first replay
(same)	06/24/09	0 hours	1	
(same)	07/04/09	0 hours	1	

From my notes

- A number of improvements in software development - expect improved performance.
- number of ramps to establish a ramp using replay has gotten to just a few
- So once BBQ is debugged and working, only need 3 to 5 ramps to establish an efficient ramp.
- Orbit control during ramp is needed, especially at transition!
- System is mature enough, now, to allow operators to run
- Plan to have BBQ and tune feedback on 1st Ramp!

Lattice Plans

Steve Tepikian

Lattice plans for 100 GeV Au run

- IBS suppression lattice
- Crossing γ_T
- $0.5m$ β^* for Phenix and Star
- The β^* squeeze

- The IBS-suppression lattice is operational
- Separating γ_T between rings requires development
  - Chromaticity swing through γ_T needs further study
- Low $\beta^* = 0.5m$ is achievable

From my notes

- How close to 0.5 m beta* depends on p.s. limits (no changes!, so perhaps can only get to 0.6 m).
- How good are current to strength conversions = needs to spend time looking at it. (how do we improve the transfer functions? magnet division)
- is there a fall-back? (there will be!)
- pi-mode of the IBS lattice?
- Dynamic beta-squeeze? Certainly something to try during ther run.
- Without the IBS lattice we can only get to 0.7 beta*.

Transition

Christoph Montag

Improvements to Transition Crossing

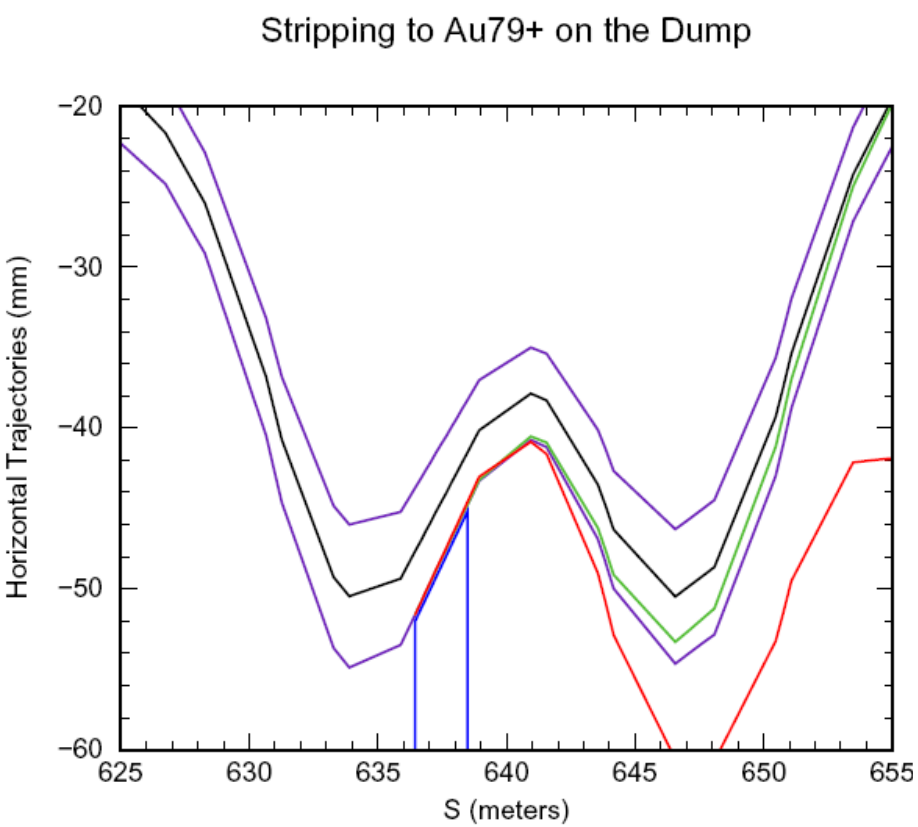
- Chromaticity jump
  - Using RHIC's 8 sextupoles families, chromaticity jump can be modified
  - Tested at in injection during Run-8
- Longitudinal quadrupole oscillations
  - Longitudinal quad mode damper in LLRF
- Radial feedback in Yellow
  - Yellow RF is tied to Blue master and cannot compensate for small field errors (radial offsets)
  - Adjust Yellow dipole field instead, based on BPMs
- Different γ_t in the two rings
- Alternative method to separate γ_t – new idea, to be further investigated

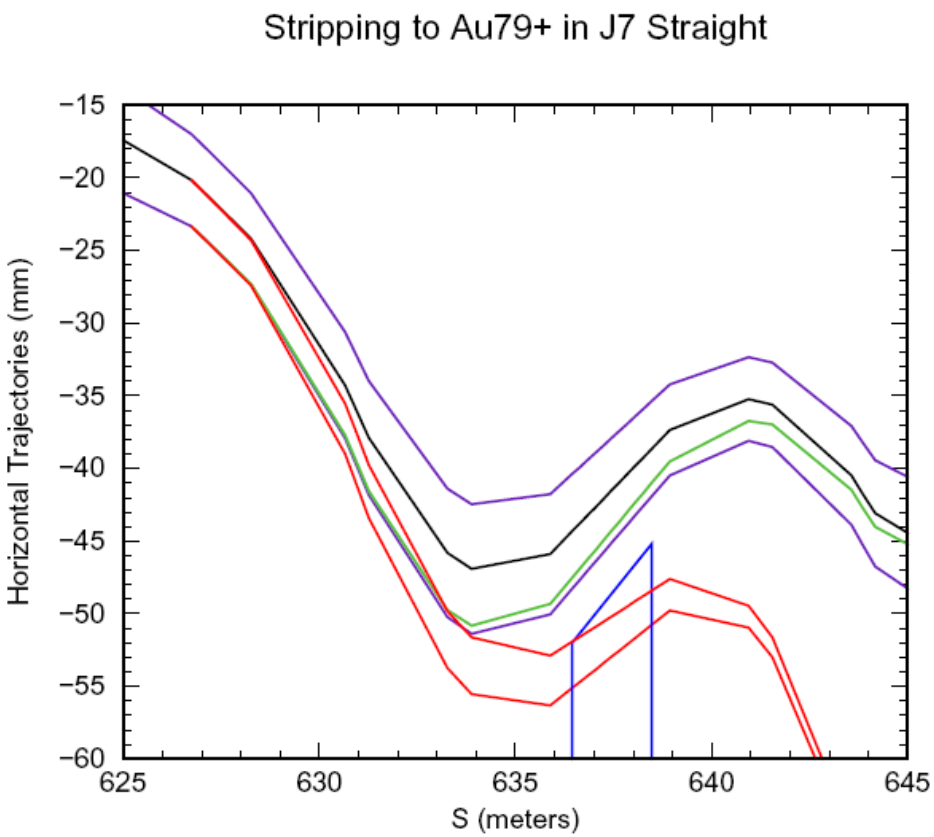
AGS Beam Dump

Kip Gardner

L.A. Ahrens, "AGS Au77+ Beam Dumping (making holes in the vacuum chambers)", RHIC Retreat 2008.

The focus of the current presentation is our proposal to put gold beam into the dump by stripping to Au79+ in the J7 straight.





Improved Longitudinal Emittance

Eduard Pozdeyev

From my notes

- Largely repeat of Retreat ’08 talk, but now included IBS predictions.
- Main problem was emittance growth during 3 to 1 merge in AGS. Fixed.
- Main benefit is low energy running in RHIC (get down to 0.1 eV-sec, now – was 0.3)
- Real problem is growth on RHIC ramp - growth at injection from IBS is small (20 - 30 %), while the growth on the ramp is x2.

Low Energy Au Run

Todd Satogata

2010 Run Planning

- Do we run low energy Au-Au in 2010? Plan for success…
  - …but requires guidance/decision from management
- PHENIX prefers a run above injection energy
  - Planning is straightforward for operations in this regime
- STAR prefers a run near $\sqrt{s_{NN}}$=7.7 GeV, E=3.85 GeV
  - h=369 will satisfy this and provide collisions at both experiments
  - Must resolve radiation safety concerns: run later rather than earlier
  - Take advantage of improvements in AGS Au longitudinal emittance
  - No top-off, modest setup times per energy (days)
  - Swap defocusing sextupole leads (1+ shift) below $\sqrt{s_{NN}}$=9.3 GeV
  - β^*=10m lattice, optimize apertures (IR, abort kickers)
  - Collimation setup

2010 Run Planning

- From $\sqrt{s_{NN}}$ = 9 GeV 2008 experience and expected tuning improvements
  - Assumes 75% time in physics during running time
  - Event rates scale as γ^3 below injection, γ^2 above injection ($\sqrt{s_{NN}}$ = 21.2 GeV)
- Assumes STAR run plan to initially explore near $\sqrt{s_{NN}}$ = 7.7 GeV
- $\sqrt{s_{NN}}$ = 12 GeV precludes optimized luminosity at both experiments
- Also desire 3-5 days development time for electron cooling projections

$\sqrt{s_{NN}}$ [GeV]	μ_B [MeV]	<Event Rate> [Hz]	Days/ Mevent	# events	# beam days (phys+setup)
5.0	535	0.55	28	5M	140+5
6.1	470	1.0	15	5M	75+4
7.7	405	2.0	7.6	5M	38+3
8.6	370	3.0	5.0	5M	26+2
12	295	--	--	--	--
18	210	>30	0.5	5M	3+1
28	145	>60	<<1	5M	1+2 (ramp)

2010 Operations?

(Swap sextupole leads)

Energies loosely from K. Rajagopalan ("Can We Discover the QCD Critical Point at RHIC?", 2006)

From my notes

- Expect to get clearance for low energy running by start of February, 2010.
- PHENIX - maybe want a crossing angle ?
- Running above normal injection energy can occur before February.

Run 10 Au-Au Goals

No of bunches	= 103
Ions/bunch [10^9]	= 1.1 (>1.2)
β^*[m]	= 0.5 m
Emittance[mm]	= 17-35 (smaller?)
L_{peak} [$cm^{-2}s^{-1}$]	= 50×10^{26}
$L_{store\ avg}$[$cm^{-2}s^{-1}$]	= 28×10^{26}
L_{week}	= 1 nb^{-1}
Time in Store	= 60 %