Stochastic Cooling in RHIC

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DOE RHIC S&T Review

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Outline

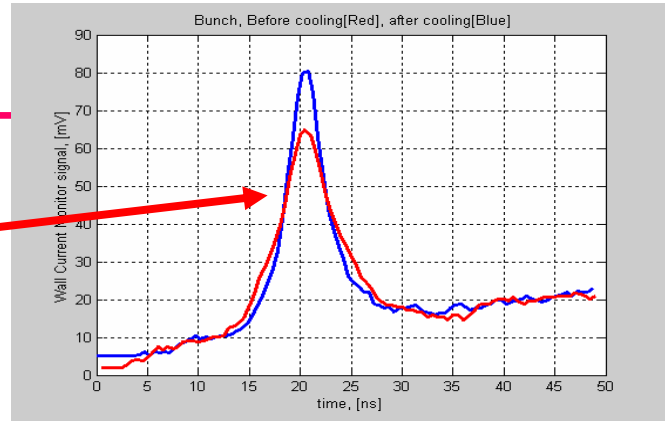
- Overall objective of stochastic cooling
- Progress Report, 2007 results
- Yellow operational this year
- Development in the Blue ring
- Plans
- R&D for cooling in the transverse plane
- Estimates of costs and schedules

Overall Objective (heretofore)

- Counteract IBS
- Keep the bunch in the bucket
- Increase integrated luminosity by 50% by extending store lifetime

Progress Report

- Last year: achieved cooling of test beam
- This year: 2007 goals



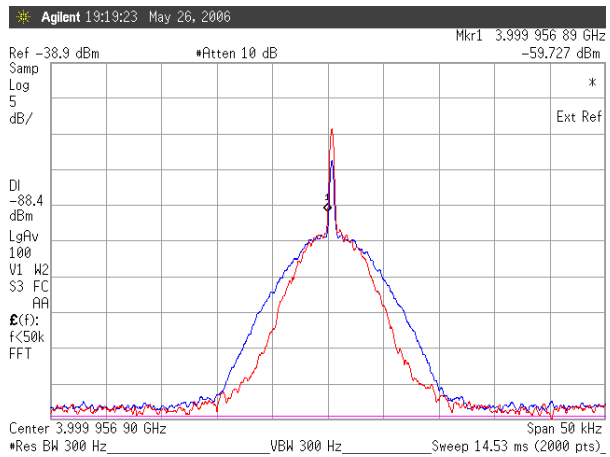
Bunch profile before (red) and after (blue) cooling, Wall Current Monitor

✓ In FY07 we will make the Yellow s.c. operational for gold beam

✓ For the Blue ring

- Install pick up and upgraded kicker (water cooled)
- Test "cutting the chord" with microwave link (70 GHz)

- After that comes cooling in the transverse planes
- Eventually s.c. will complement e-cooling by cooling the tails of the distribution



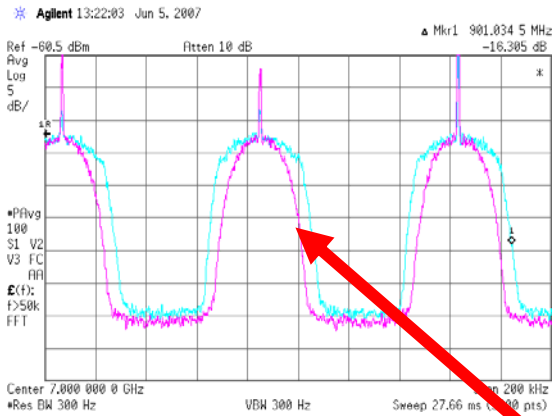
Schottky spectrum before cooling: blue trace

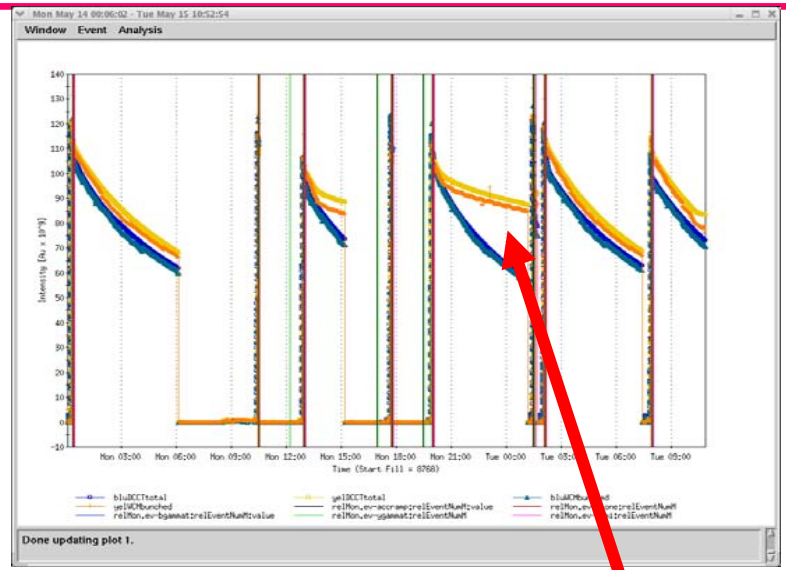
Spectrum after cooling: red trace

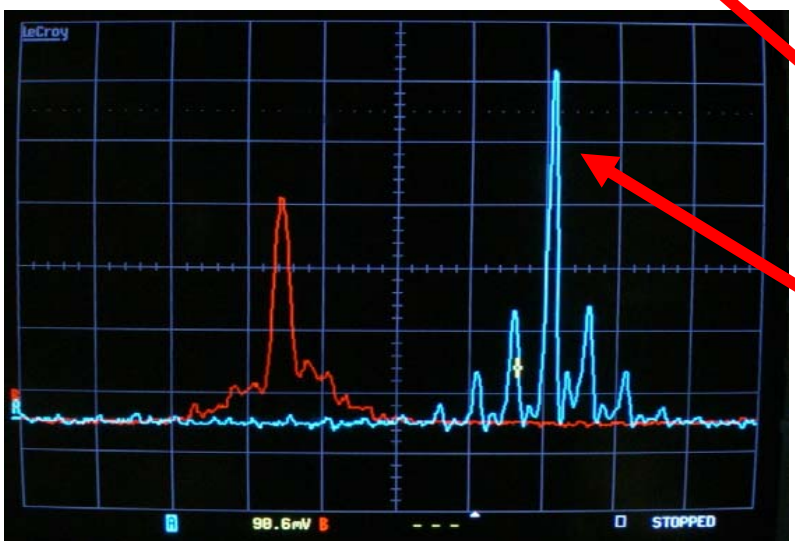
Yellow Operational this year

- Improvements over 2006
  1. New technology for fiber optics
  2. Two-turn cooling filter (stable cooling for large $\Delta P/P$)
  3. Automatic BTF with Network Analyzer
  4. Controls software
- Problems
  - EDFA (optical amplifier) failure
  - 4 microwave power amps failed
  - Mechanical drives got stuck

Yellow operational this year: Results



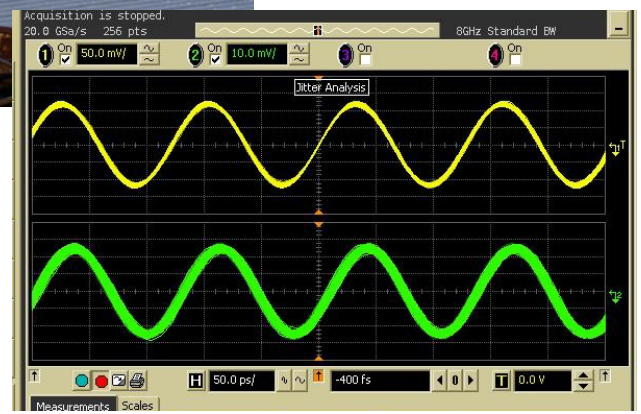


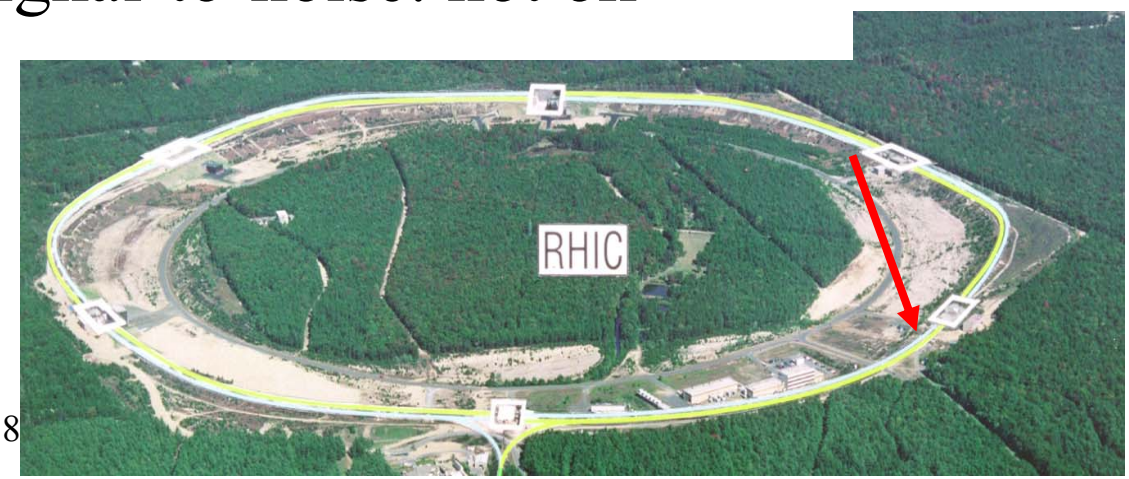


- Cooling stops debunching and
- Increases peak current
- Losses approach burn-off rate

Development in Blue ring

- Microwave link (70 GHz)
  - Cooling the core
  - Higher frequency>more particles
  - Installed and tested with beam
- Timing w.r.t beam: ok
- Stabilized with pilot tone: ok
- Signal-to-noise: not ok





10 sec sample @ 8 GHz

Blue: new kicker vacuum vessel

- 50 % failure of rf feedthrus after baking
- Mechanical design for movement contains the same design flaw as Yellow

Plans

- Yellow
  - Fix mechanical failures: in sito
  - Improve operations interface
  - Operate with the same parameters as FY07 for gold in the Yellow ring
- Blue
  - Complete blue system and test with low intensity deuteron test bunch
  - Use the microwave link to cut the chord
    - Frequency, 6-9 GHz
    - One-turn delay cooling filter, cooling to higher peak current
    - Test calculations with no IBS; cooling rate versus temperature

R & D for Transverse Cooling

- Design new pickups
  - We've used up all the equipment from the TEVATRON
  - Location of the pickups in the lattice is open question
- Develop fiber optic filter for betatron spectrum
- Design new vacuum vessel
  - Better reproducibility of kicker frequencies
  - Develop "build to print" design
    - Building a table-top prototype to test components and concepts
    - Can we "build to print" transverse kicker cavities?

Estimates of Costs and Manpower

- **Materials**, (direct costs) ~ 1 M$ per plane
  x,y,blue,yellow = 4 planes in all
  - Low level = 200 k$
  - Kickers = 290 k$
  - Pickups = 320 k$
  - Controls = 175 k$
- **Manpower** , FTE(in addition to on-going support from; Beam Components, RF, Controls, Engineering and design)
  - Mechanical engineer……1
  - Designer……1
  - Mechanical tech……....2
  - Electronics tech……1
  - Software developer……..…1
- **Additional costs** to augment rf system (56 MHz)
  - Very rough guess = 4 M$

Possible Schedule
"pull out all stops" scenario

- Build one transverse plane for yellow or blue to install in the fall of 2008
- Achieve simultaneous cooling in longitudinal and one transverse plane some time before the end of the run
- Optimal location and number of pickups is under study.
  - May be necessary to have pickup(s) in the cold section
  - This would challenge the schedule

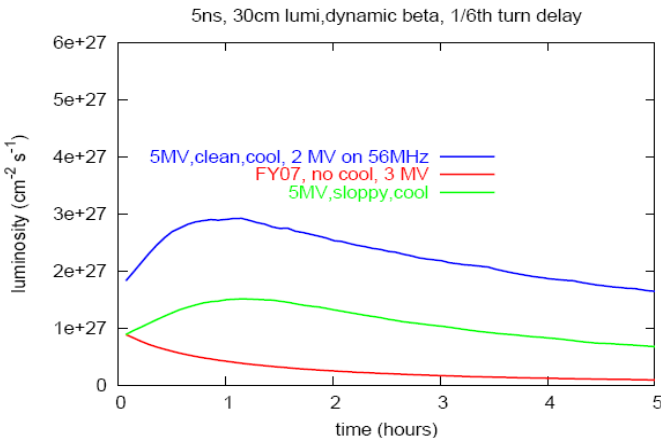
Simulations of cooling (with burn off)

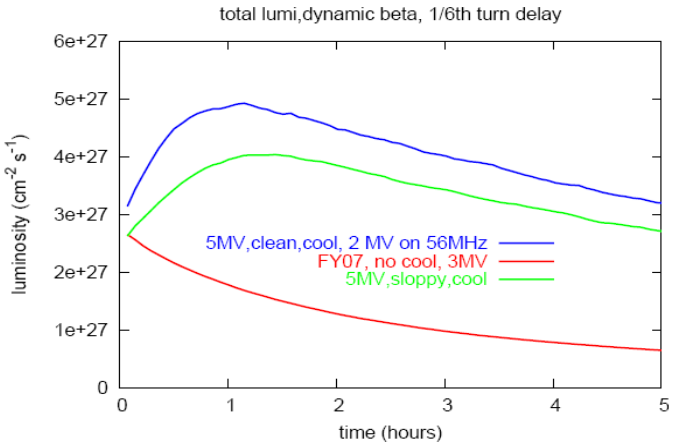
by Mike Blaskiewicz

Vertex cuts

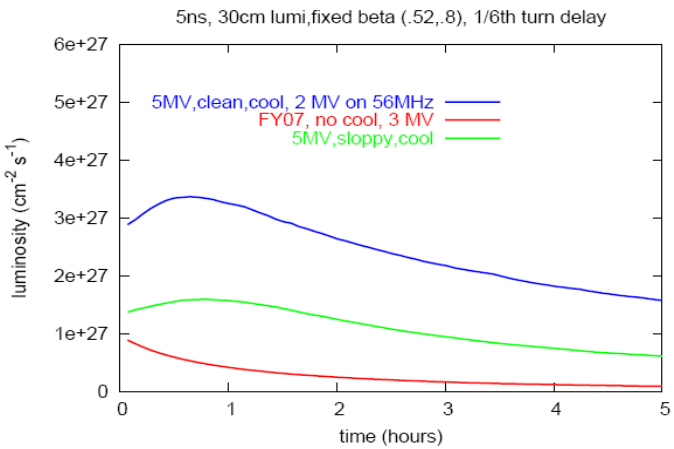
Total luminosity

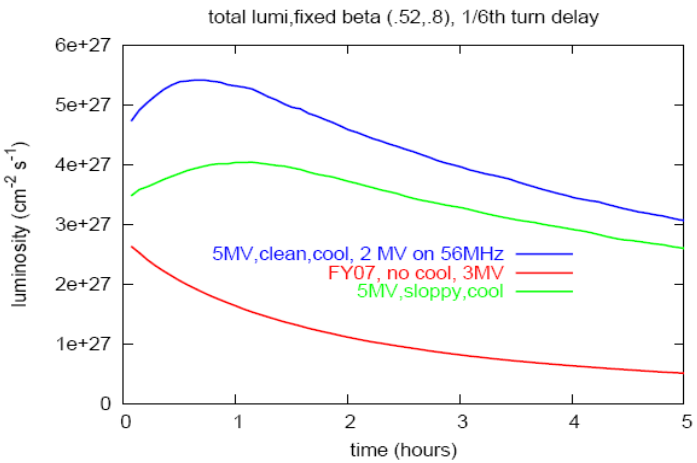
Dynamic beta*





Fixed beta*





Conclusions

- Stochastic cooling has been added to the capabilities of RHIC
- This is the first successful application of cooling in a high energy collider
- Expanding cooling to the transverse planes will likely enhance the luminosity of RHIC for heavy ions by a factor of 4