

RHIC – Upgrades

Capital Projects and Accelerator Improvement Projects

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Content

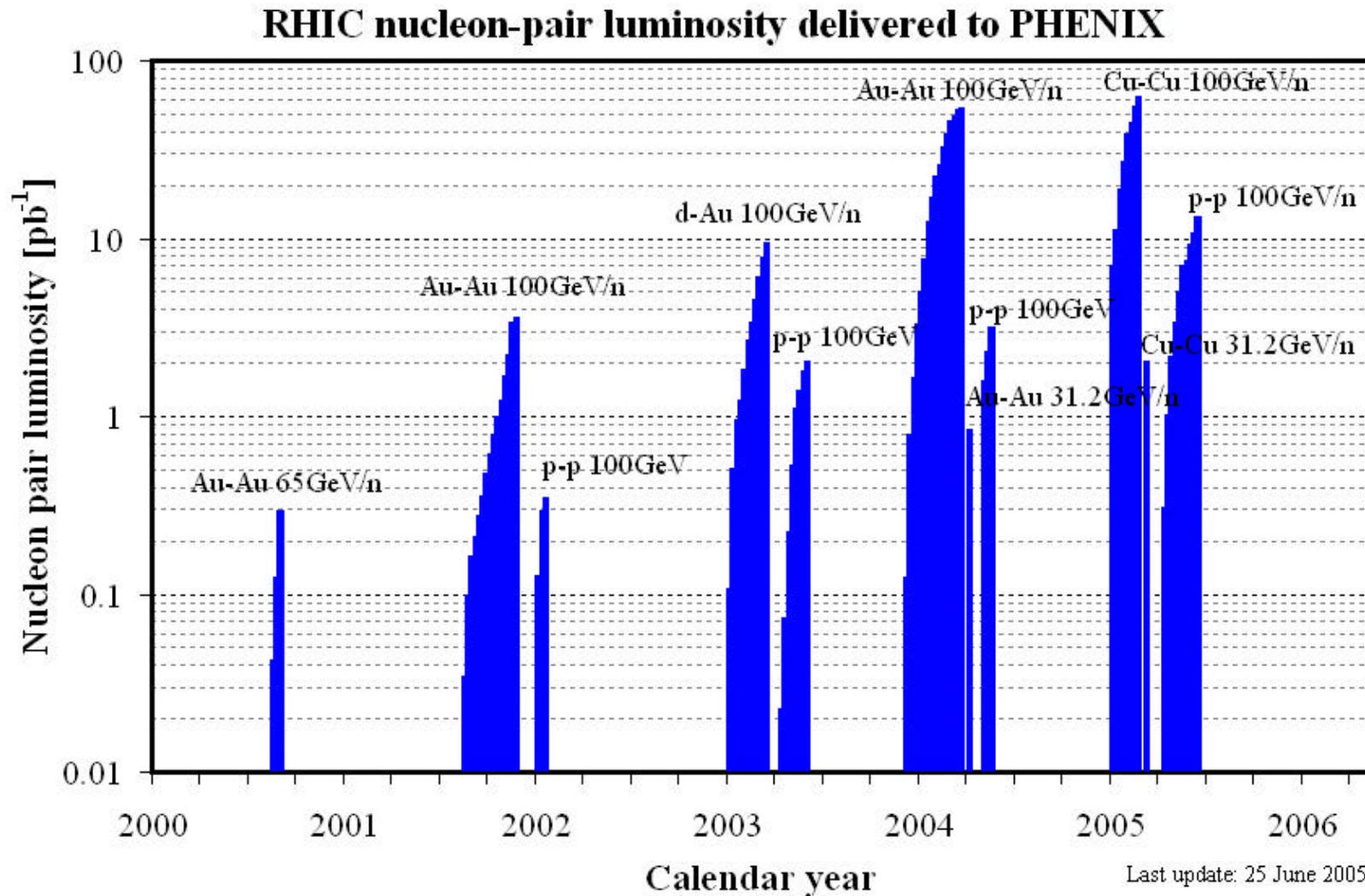
1. Current performance and Enhanced Design goals
2. Identified performance limits
3. Upgrade plans to address limits

RHIC and injector upgrades

1. Upgrades for more luminosity
2. Upgrades for more polarization
3. Upgrades for more time in store
4. Upgrades for power savings

RHIC luminosity evolution

Delivered luminosity increased by 2 orders of magnitude in 4 years.



RHIC – achieved and goal parameters

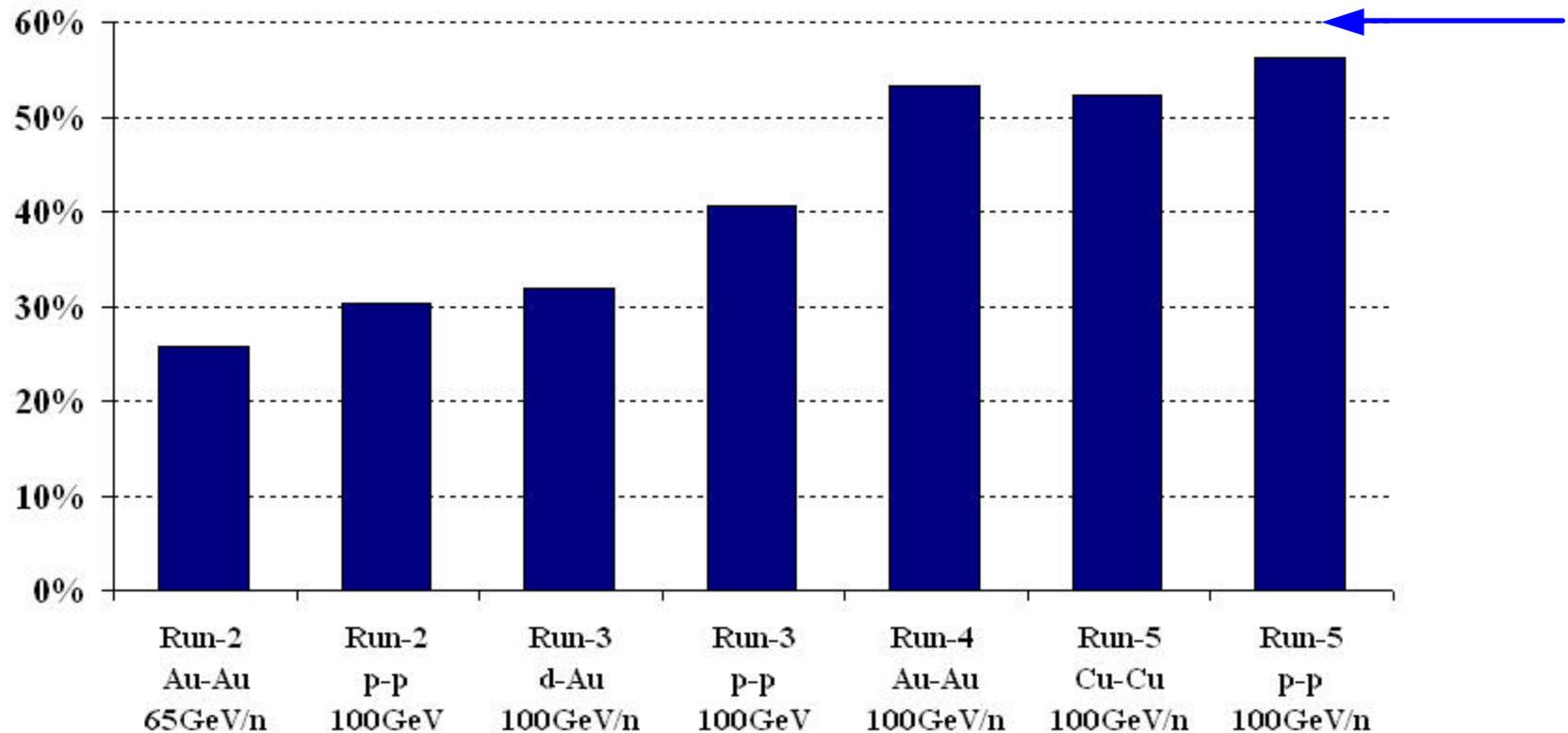
Mode	Pol.	No of bunches	Ions/bunch [10 ⁹]	β^* [m]	$L_{\text{store ave}}$ [cm ⁻² s ⁻¹]	L_{week}
Au-Au [Run-4]		45	1.1	1	5×10^{26}	$160 \mu\text{b}^{-1}$
Cu-Cu [Run-5]		37	4.5	0.9	0.8×10^{28}	2.4 nb^{-1}
d-Au [Run-3]		55	110/0.7	1	3×10^{28}	4.5 nb^{-1}
p↑-p↑ [Run-5]	47%	106	90	1	6×10^{30}	1.9 pb^{-1}
Au-Au enhanced design		56	1	2	8×10^{26}	$300 \mu\text{b}^{-1}$
p↑-p↑ enhanced design	70%	112	200	1	65×10^{30}	20 pb^{-1}

Improvements needed for Enhanced Design parameters:

- 2´ for heavy ion luminosity
- 10´ for polarized proton luminosity
- 1.5´ for polarization

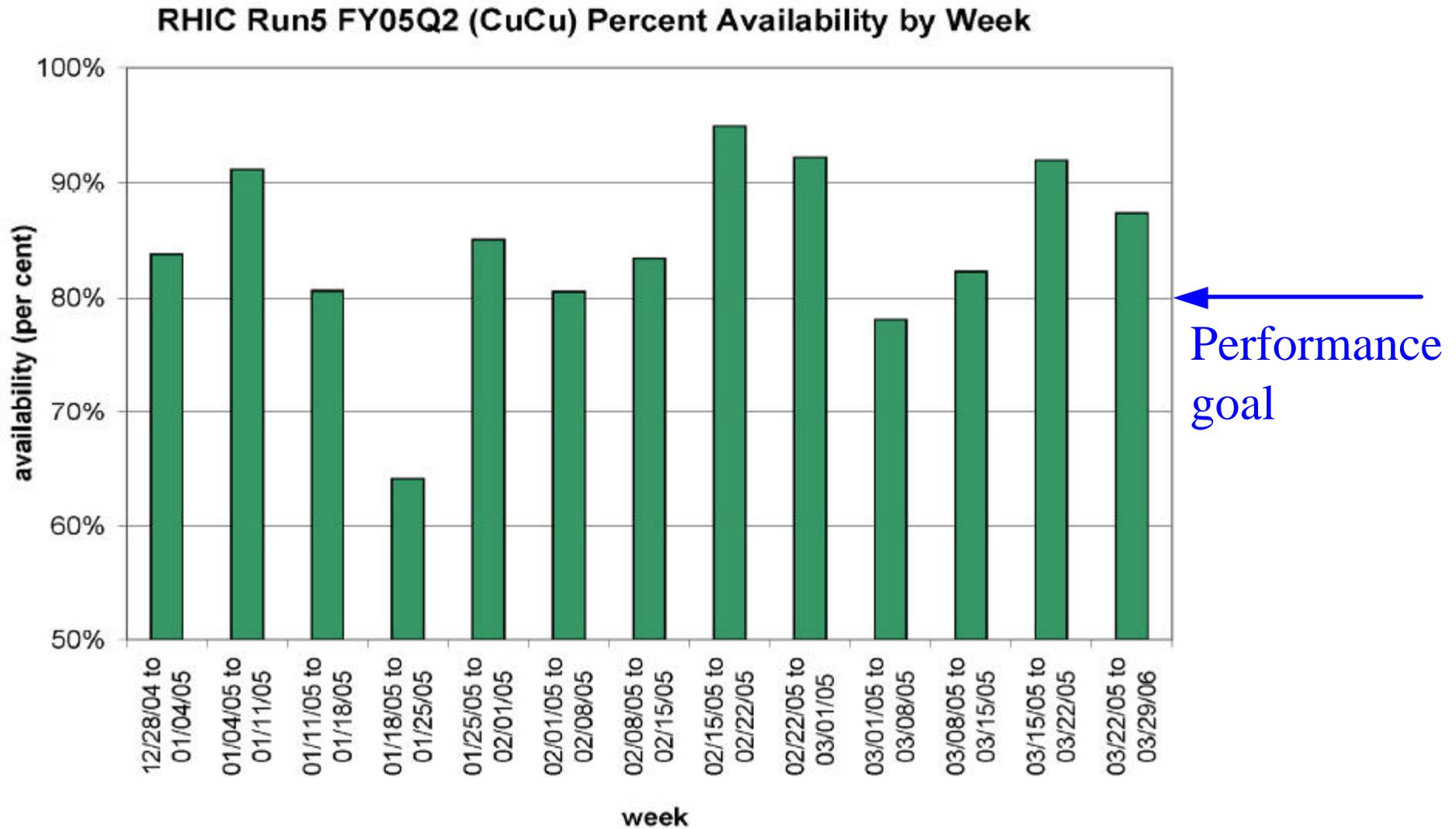
RHIC time in store

Goal 60% of calendar time (100h/week)

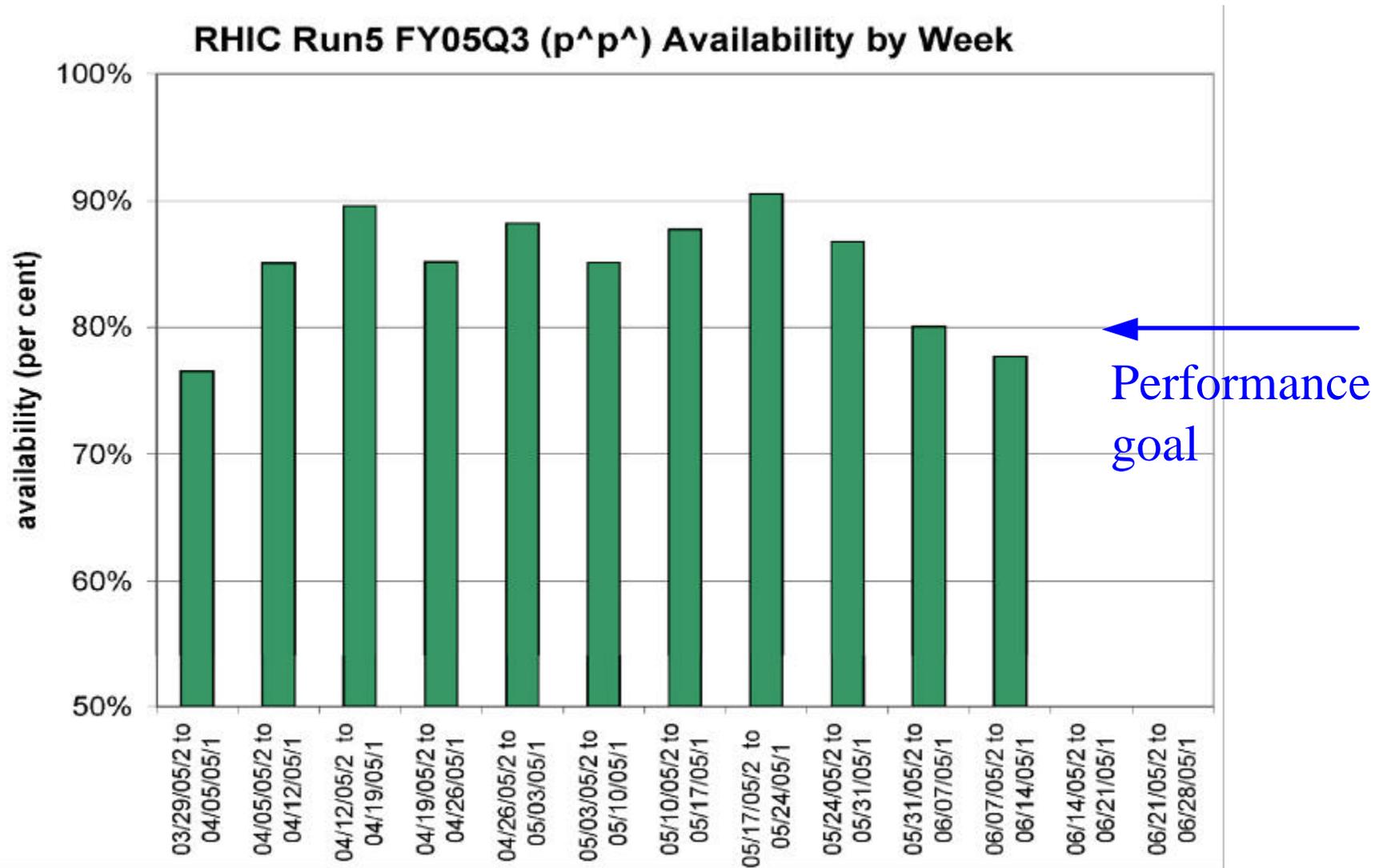


[time in store = time during which luminosity is delivered, not all usable by experiments, calendar time includes time for maintenance and accelerator physics experiments]

Run-5 Cu-Cu availability (DOE definition)



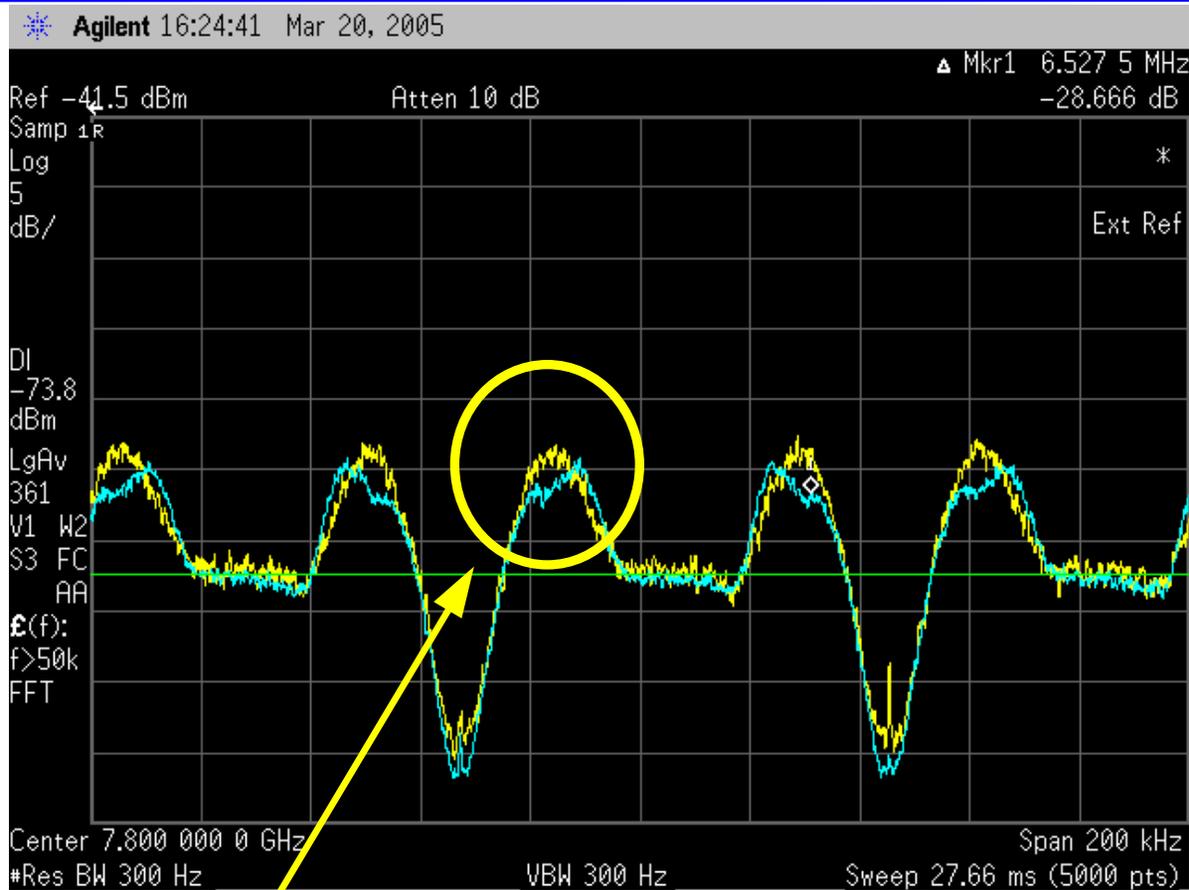
Run-5 p-p availability (DOE definition)



Ion luminosity limits

- **Dynamic pressure rise**
 - Conclusively determined to be caused by e-clouds
 - Beam pipes in warm sections are being replaced with NEG coated ones (AIP FY04)
 - Pre-pumping being installed in cold sections (AIP FY05)
- **Available bunch intensity**
 - Reliable high bunch intensity expected with EBIS
- **Emittance growth due to IBS**
 - R&D work for stochastic cooling
 - R&D work for electron cooling (I. Ben-Zvi)

Stochastic cooling test with Cu



- Plan to install a full longitudinal system in one ring for next year
- Longitudinal stochastic cooling may yield 50% luminosity increase for heavy ions
- Transverse stochastic cooling may be possible

Schottky signal suppression with Cu^{29+} ions
no cooling yet

M. Brennan, M. Blaskiewicz

Proton luminosity limits

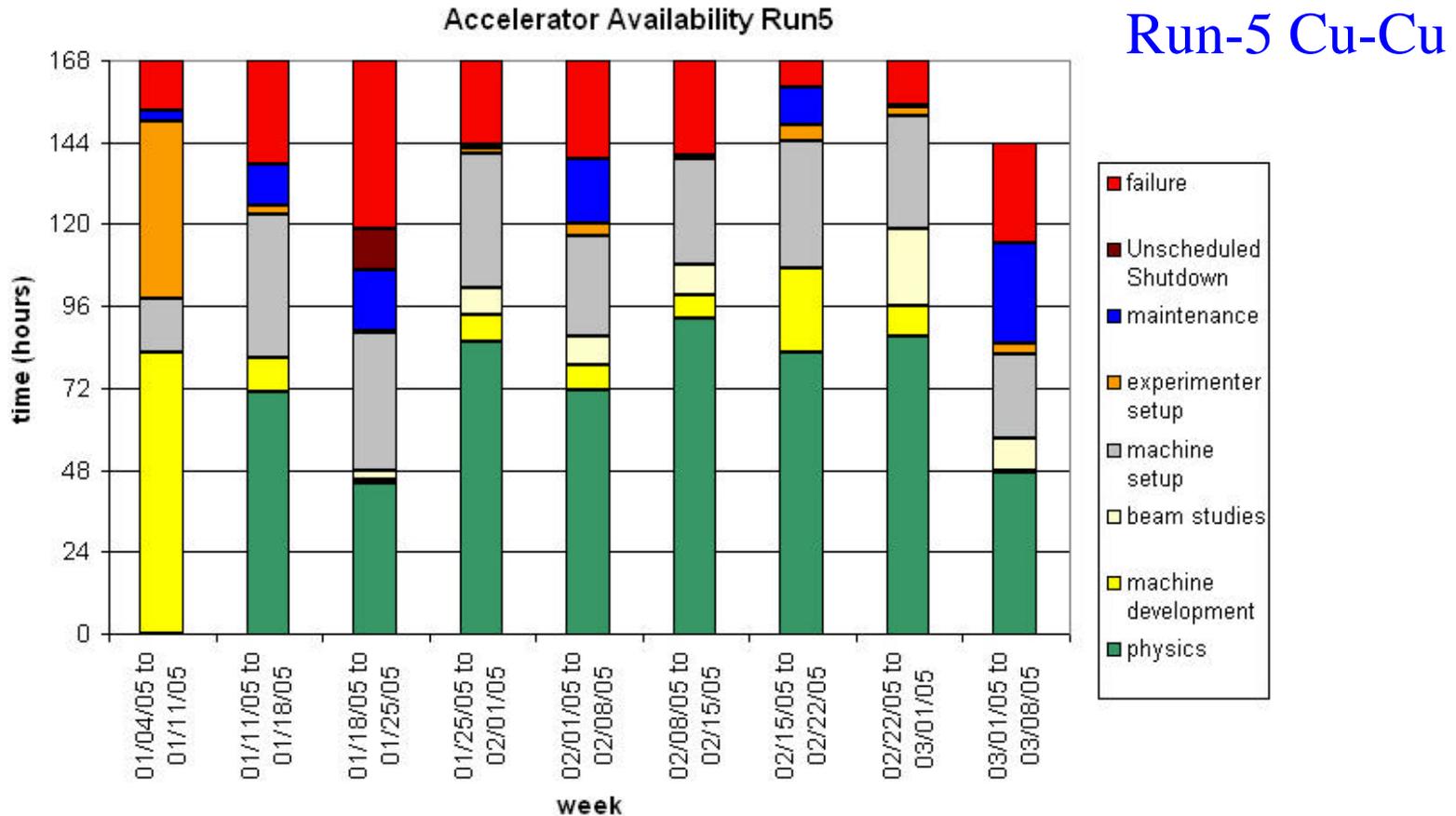
- Available bunch intensity
 - Constrained by polarization in AGS
 - Limit should be removed with AGS cold snake (AIP FY03/04)
- Beam-beam interaction
 - Leads to emittance growth
(detailed mechanism not fully understood)
 - Enhanced by other lattice nonlinearities
 - Enhanced by 10Hz orbit oscillations from triplet vibrations, work on orbit feedback design

Polarization limits

Polarization limited by

- Source
 - Upgraded with sc solenoid in FY05 (80% → 85%)
- AGS
 - Installed cold snake (55% → goal of 75%)
[AIP phase I and II, FY03 and FY04]
- Orbit in RHIC
 - Upgrading BPM system, orbit control
[capital project FY04]

Time in store limits



- Still possible to reduce failures, maintenance, machine set-up, and machine development time
- Expect small gains in all areas

Power consumption reduction

- Plan to install a new cold turbine (FY05 AIP)
 - Power savings of up to 1.5MW
(current steady-state cryo consumption is 7MW)
 - Increased refrigeration capacity leading to shorter cool-down times at the beginning of a run and during quench recovery
- FY05 AIP funds may not be enough for completion
- Planned completion date: September 2006

RHIC and injector upgrades – Capital projects and AIPs

FY2004

- Capital projects total: \$1.2m
 - RHIC BPM electronics relocation → Completed
 - **Replace LINAC cooling tower (I of II)** → Expected completion 2005
 - Operations disk server upgrade → Completed
 - Nitrogen Pneumatic Controls Upgrade (II of II) → Completed
 - RF test equipment → Completed
 - RHIC polarimeter readout upgrade → Completed
 - AGS ring fire alarm system (II of III) → Expected completion 2005
- AIP total: \$2.9m
 - AGS helical Siberian snake (II of II) \$1.1m → Completed
 - RHIC refrigerator controls upgrade \$0.5m → Completed
 - **RHIC warm pipes vacuum (NEG) \$1.2m** → Expect completion 2006

AGS helical Siberian snake

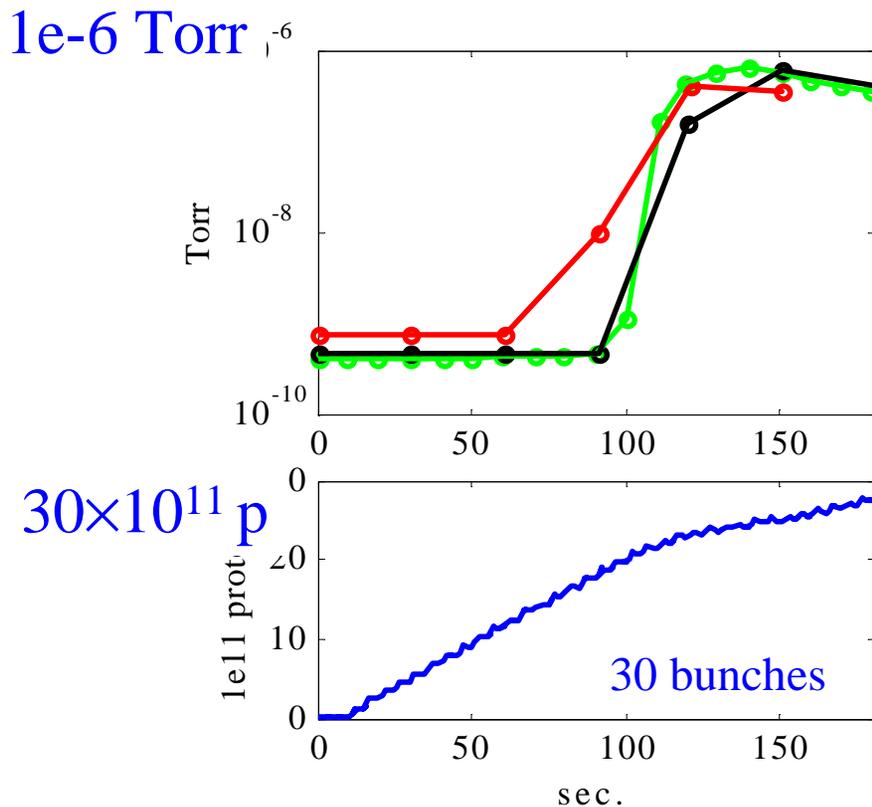
- Most complex magnet ever built by SMD
- Installed during Run-5
- First commissioned in Run-5
- Critical component to reach polarization and luminosity goals in polarized proton operation



RHIC warm pipe vacuum upgrade

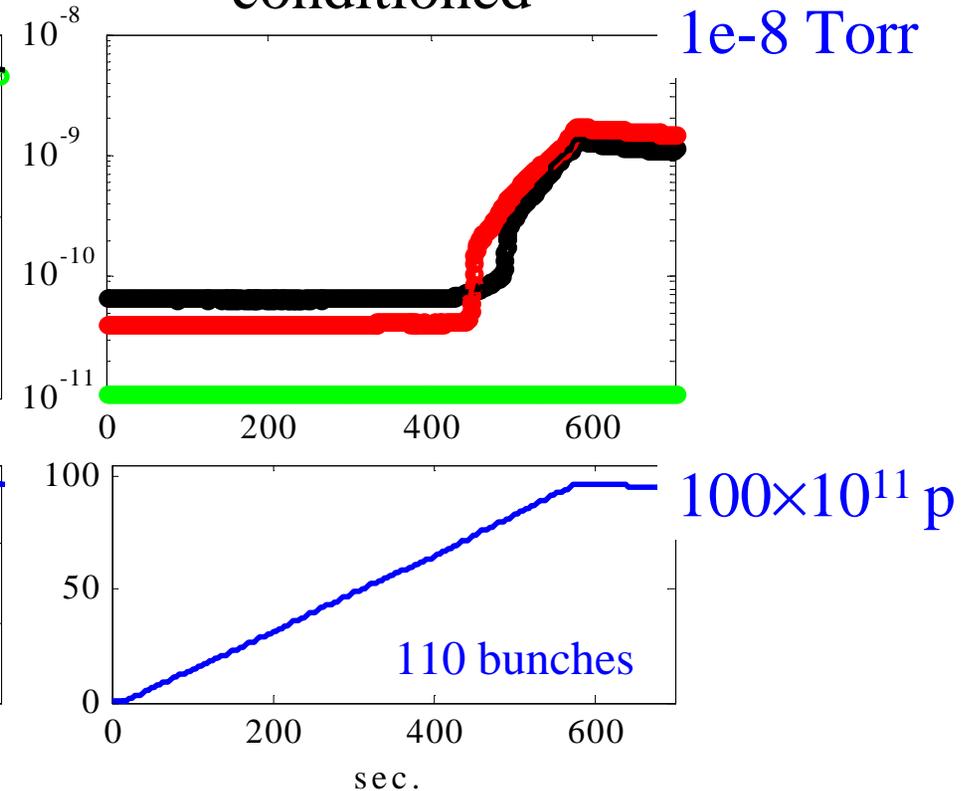
2002

unbaked stainless



2005

NEG coated stainless,
conditioned



Injection of 1×10^{11} proton bunches, 3 buckets spacing, same location.

S.Y. Zhang

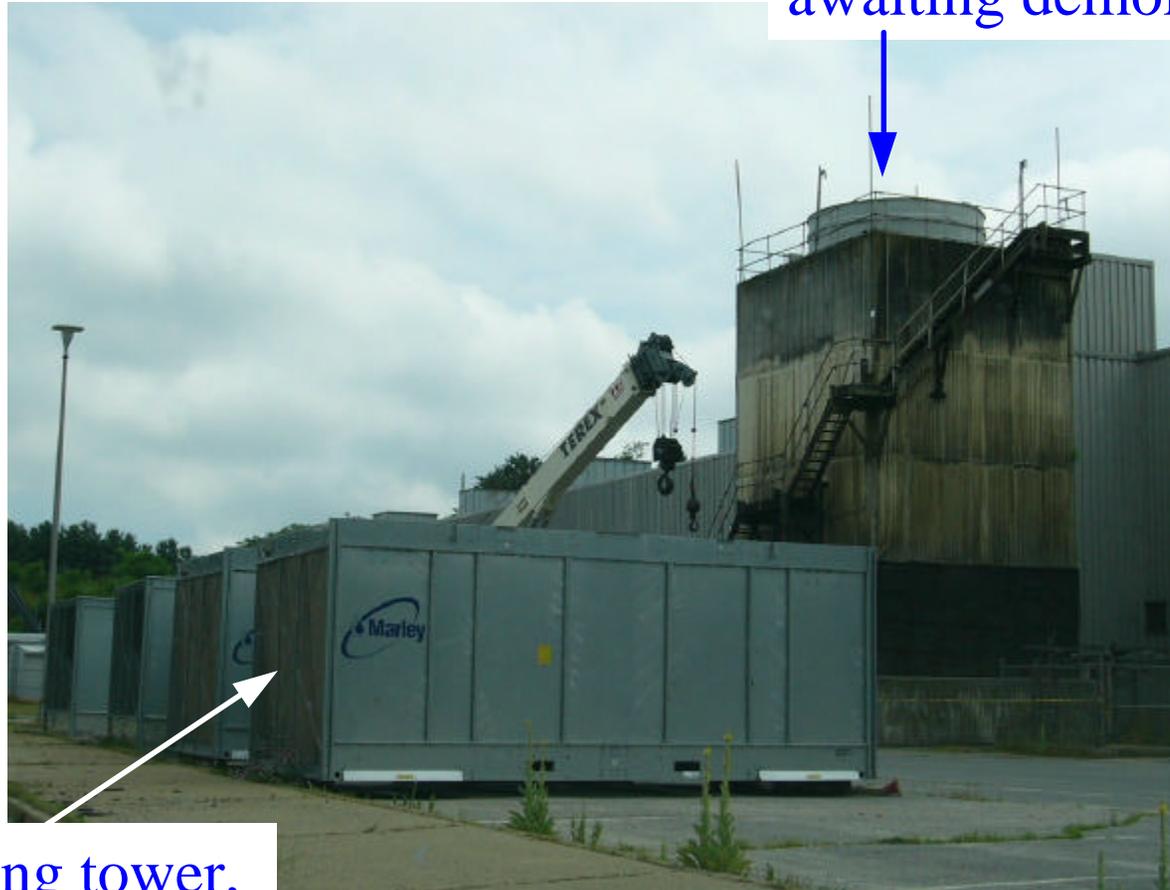
RHIC and injector upgrades – Capital projects and AIPs

FY2005

- Capital projects total: \$1.2m
 - AGS ion pump control upgrade (I of II) → Started
 - Replace LINAC cooling tower (II of II) → Expected completion 2005
 - AGS and RHIC low level rf (I of III) → Started
 - RF test equipment → Started
 - AGS ring fire alarm system (III of III) → Started
- AIP total: \$3.1m
 - **AGS MMPS transformer (I of II) \$1.9m** → In bidding process
 - RHIC cryogenic cold turbine \$0.8m → In bidding process
 - RHIC cold bore vacuum upgrade \$0.4m → Started

LINAC cooling tower

Old LINAC cooling tower,
awaiting demolition



New cooling tower,
awaiting completion

AGS Transformer Yard

Siemens Motor-Generator



Old AGS MMPS transformer

- built in 1969
- single point of failure

RHIC and injector upgrades – Capital projects and AIPs

FY2006 projection

- Redirection toward EBIS construction: \$2m
- Capital projects total: \$1.1m
 - AGS ion pump control upgrade (II of III)
 - AGS and RHIC low level rf (II of III)
 - Windows for RF storage system
 - RF test equipment
 - RHIC service buildings and tunnel environment
- AIP total: \$1.4m
 - AGS MMPS transformer (II of II): \$1.4m

→ Expected completion 2006/07

RHIC and injector upgrades – Capital projects and AIPs

FY2007 projection

- Redirection toward EBIS construction: \$2m
- Capital projects total: \$1.1m
 - AGS ion pump control upgrade (III of III)
 - AGS and RHIC low level rf (III of III)
 - RF test equipment
 - RHIC service buildings and tunnel environment
- AIP total: \$1.4m
 - RHIC stochastic cooling \$1.4m
 - Would like to move this to 2006 to increase luminosity

RHIC and injector upgrades – Capital projects and AIPs

FY2008 projection

- Redirection toward EBIS construction: \$2m
- Capital projects total: \$1.2m
 - Replacement of obsolete controls equipment
 - RHIC cryo computer upgrade
 - RHIC broadband amplifiers
 - RHIC service buildings and tunnel environment
- AIP total: \$1.5m
 - AGS roughing pumps \$0.5m
 - Westinghouse Motor-Generator Stator Insulation \$0.5m
 - Cooling tower 1 replacement and water main \$0.5m

Summary

- Enhanced Design goals 2008 require
 - 2× heavy ion luminosity
 - 10× polarized proton luminosity
 - 1.5× store polarization
 - Increase of time in store by 8h/week
- Limiting effects are identified
- Upgrade plans exist to address limits
- Progress currently constrained by
 - Available manpower (especially during shut-downs)
 - Available upgrade funds