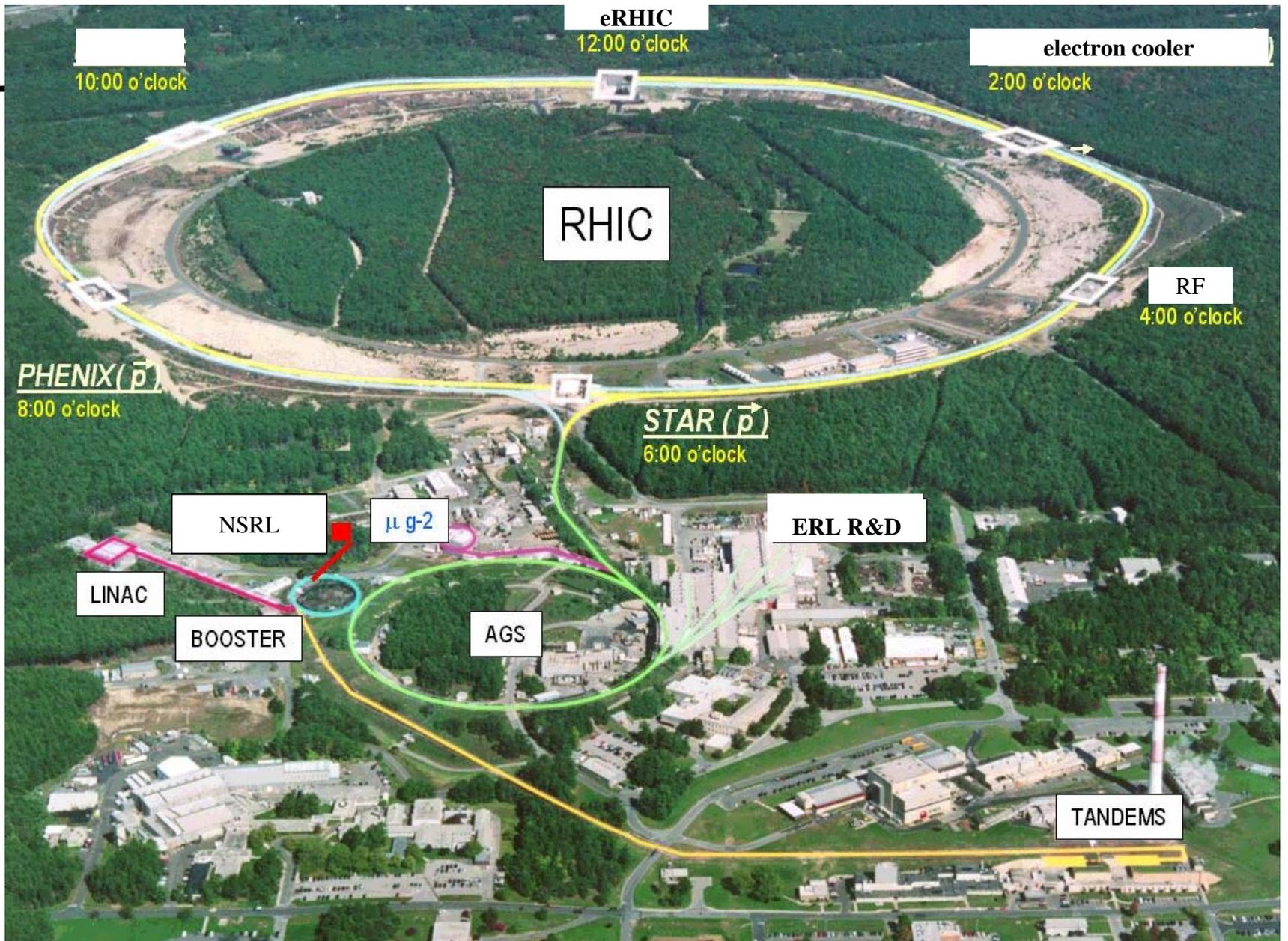

Collider-Accelerator Department Overview

Presented to

RHIC Facility Annual Science and Technology Review

Derek I. Lowenstein
July 18, 2007



FY2006 Nuclear Physics S&T Review Action Items

Recommendations

- Generate a risk assessment of the backlog of CE and AIP requests and submit to DOE by January 31, 2007.

Submitted to DOE as requested.

- An R&D plan for increasing machine luminosity should be generated which defines milestones, performance goals and deliverables, required resources, critical path and schedule contingency, in the context of what is needed for implementing the mid-term strategic plan and the proposed RHIC II. The plan should include 'checkpoints' that allow a re-evaluation of the design proposal at the critical planning points.

Submitted to DOE as requested.

C-A Department Statistics

COLLIDER-ACCELERATOR DEPARTMENT

Circa July 2007

Mission: “To develop, improve, and operate the suite of particle/heavy ion accelerators used to carry out the program of accelerator-based experiments at BNL; support of the experimental program including design, construction and operation of the beam transports to the experiments, plus support of detector and research needs of the experiments; to design and construct new accelerator facilities in support of the BNL and national missions. The C-A Department supports an international user community of over 1500 scientists. The Department performs all these functions in an environmentally responsible and safe manner under a rigorous conduct of operations approach.”

Staff: The Collider-Accelerator Department headcount is:

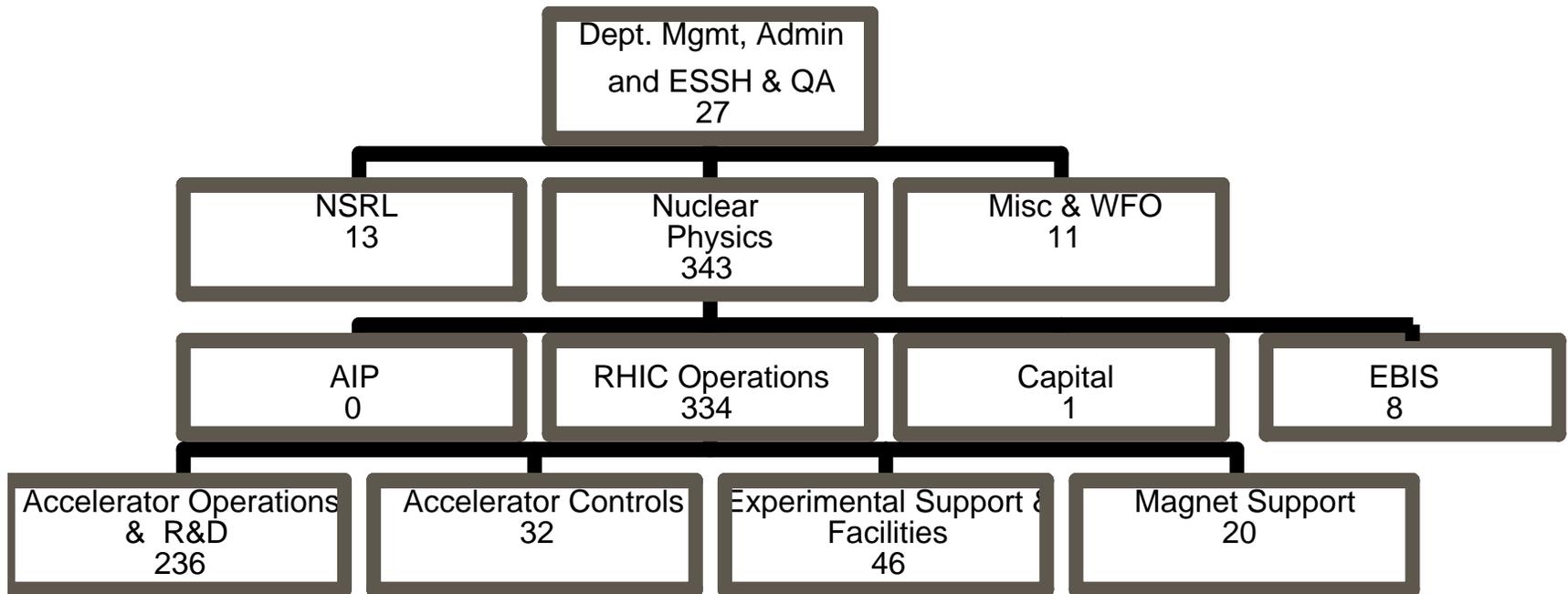
	<u>Total</u>	<u>NP*</u>	<u>EBIS</u>	<u>NSRL</u>	<u>OTHER</u>
Ph.D. Scientists	51	47	1	2	1
Postdoctoral Fellows	5	5	0	0	0
Engineers/Professional	126	115	4	4	3
Designers/Technicians	173	159	3	6	5
Admin./Clerical	<u>18</u>	<u>17</u>	<u>0</u>	<u>1</u>	<u>0</u>
Totals	373	343	8	13	9

*Does not include - ~ 20 Magnet Division employees charged to NP.

Additional support ~ 14 FTEs are purchased as Laboratory assigned trades.

Collider - Accelerator Department

(Programmatic Heads 391)*



*Reflects Head data circa May 2007

Dept Mgmt, Admin, ESSH&QA is 24 manyears

C-AD Program Areas (2007)

RHIC

- Au -Au operations

Tandem

- Commercial Users

Linac

- Isotope production (DOE NE)

Booster

- NASA Space Radiation Laboratory (NSRL)

Projects

- EBIS (DOE / NASA)

R&D

- ERL / electron cooling (DOE / US Navy)
- LARP (DOE HEP)
- Joint neutrino source R&D effort with FNAL (DOE HEP) continues
- NSLSII CD1 design (DOE BES) completed

CRADA

- Rapid cycling medical synchrotron (NanoLife Sciences)

FY2007 (to date)

Funding (\$M):

<u>Fund Type</u>	<u>DOE NP</u>	<u>EBIS</u>	<u>NSRL</u>	<u>Other</u>	<u>Totals</u>
DOE Operating	108.5			.7	109.2
DOE Equipment	1.0				1.0
DOE Construction/AIP	2.1	5.1			7.2
WFO				5.1	5.1
NASA	<u>. </u>	<u>1.0</u>	<u>6.7</u>	<u>. </u>	<u>7.7</u>
Totals	111.6	6.1	6.7	5.8	130.2

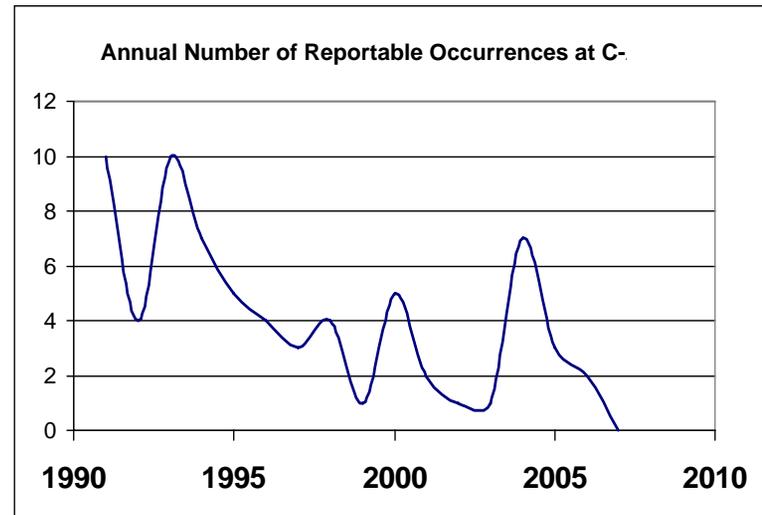
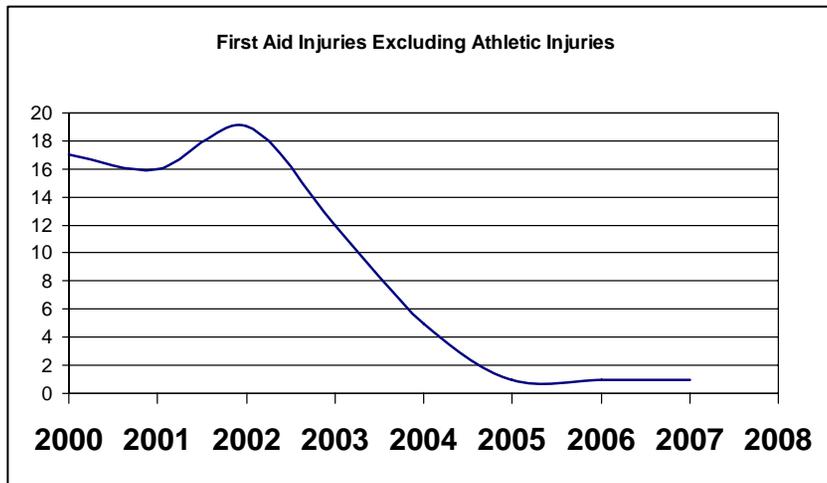
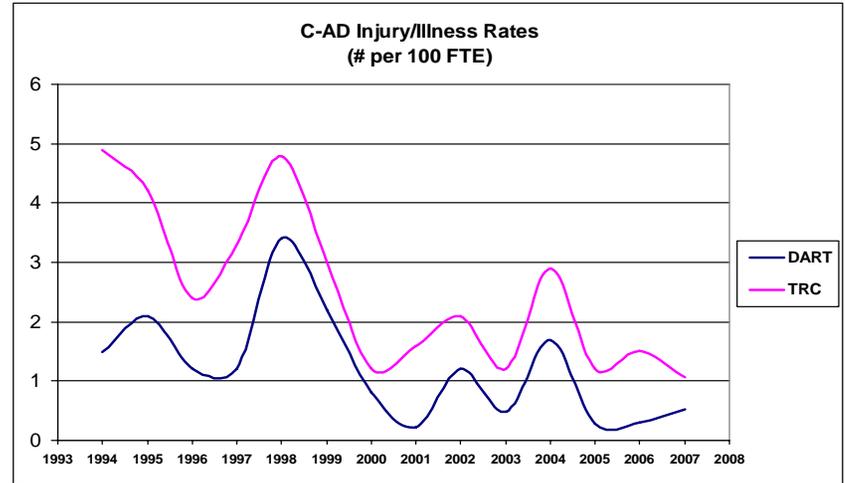
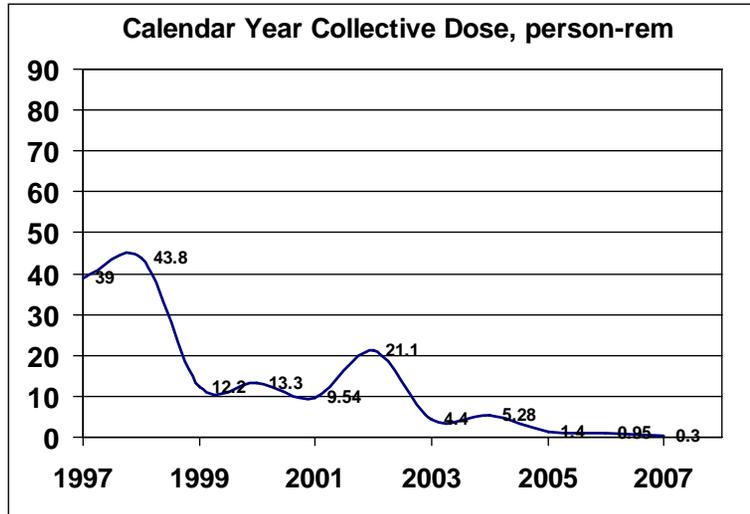
**Distribution of FY 06-09
Capital Equipment/AIP Funds (\$K)**

	FY 06	FY 07	FY 08	FY 09
B&R Code: KB-02-02-01-1	Actual	Actual	Planned	Planned
<u>Facility Base Capital Equipment</u>	<u>\$622</u>	<u>\$1,000</u>	<u>\$1,000</u>	<u>\$1,400</u>
AGS Ion Pump Control Upgrade		500		
RHIC/AGS Low Level RF Upgrade	200	200		
RF Test Equipment	202	170	200	150
Booster Power Supply Interfaces	120			
LEBT and MEBT Modification for Polarized Protons	100			
Block house for rf test stand		130		
RHIC collimation upgrade			400	
RHIC storage rf windows			200	
Booster and AGS access control system			200	150
Westinghouse stator insulation				600
AGS roughing pumps and vacuum gauges				500
<u>AIP</u>	<u>\$1,500</u>	<u>\$2,100</u>	<u>\$2,100</u>	<u>\$3,700</u>
AGS MMPS Transformer Replacement & Ripple Reduction	1,000	900		
RHIC Stochastic Cooling	500	500		
MCR consolidation and upgrade		500	800	1,200
RHIC cryo control system upgrade		200	500	
Electron cooling in AGS			800	700
Transverse stochastic cooling				900
Electron lenses in RHIC				700

Accelerator R&D Effort

	FY2005	FY2006	FY2007	FY2008	FY2009
	\$M	\$M	\$M	\$M	\$M
e-cooling (DOE NP) (MS)	2.0	2.0	2.0	2.0	
e-cooling (other) (labor,MS)	2.8	4.3	4.6	2.0	1.0
stochastic cooling (labor,MS)	0.5	0.5	0.5	0.5	
eRHIC (labor,MS)	0.3	0.5	1.0	3.0	4.0
EBIS (labor, MS)	0.3	0.4			
Machine Operations Development (labor, machine time)	3.8	4.0	4.1	4.2	4.4
FFAG (labor)	0.1	0.1	0.1		
Total (all sources)	10.0	11.8	12.3	11.7	9.4
Total (DOE NP)	7.2	7.5	7.7	9.7	8.4

C-AD ESH Performance – Long Term



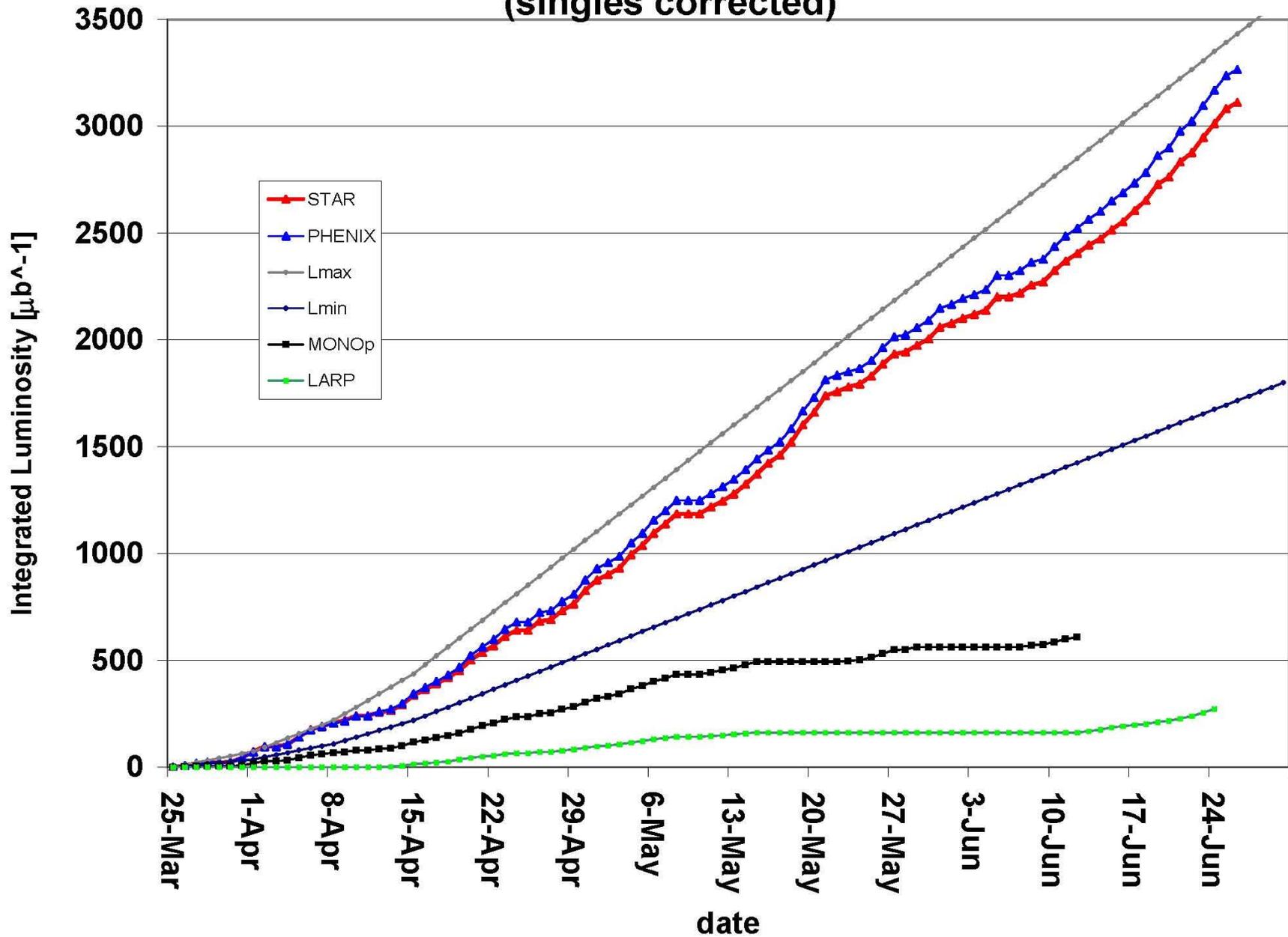
RHIC Performance

RHIC Au-Au Highlights

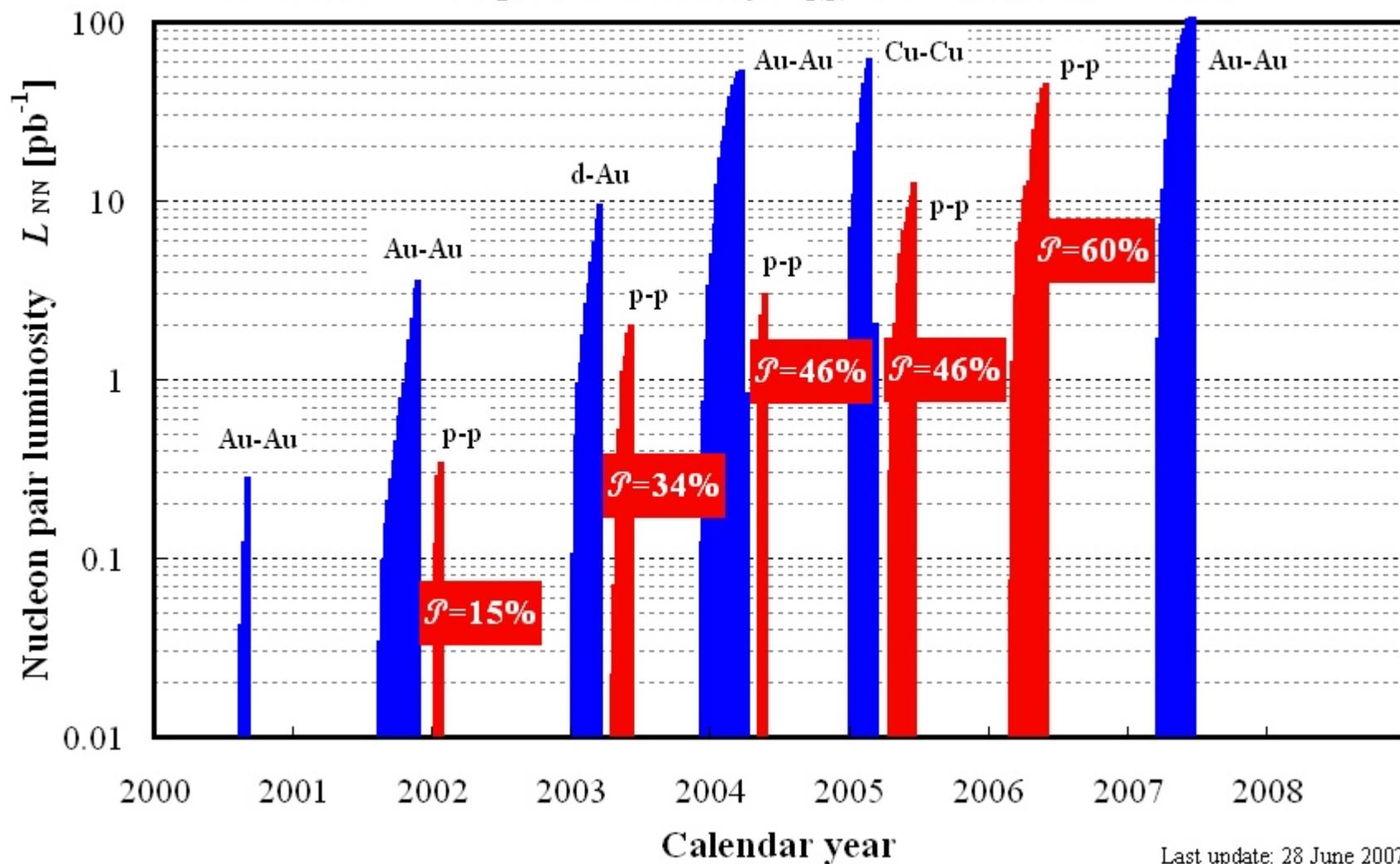
100x100 GeV/nucleon for PHENIX, STAR, and MonoPole (test)

- start-up/ramp-up time of 2 weeks (1/2 week less than planned)
- increased number of bunches from 45 to 103, 1.1×10^9 /bunch
- average store luminosity increase 2.5 x Run4 (exceeded Enhanced Design goal of $8 \times 10^{26} \text{cm}^{-2} \text{s}^{-1}$), $12 \times 10^{26} \text{cm}^{-2} \text{s}^{-1}$ with usual peak of 30×10^{26}
- longitudinal stochastic cooling operational in Yellow ring (15-20% luminosity enhancement)
- time in store was 48% of calendar time (53% in Run-4)
 - availability was 71%, down from 79% in FY2006
- 4.6x4.6 GeV/nucleon established
 - collisions (events seen by STAR), luminosity measured

Run7 RHIC AuAu Integrated Luminosity for Physics (singles corrected)

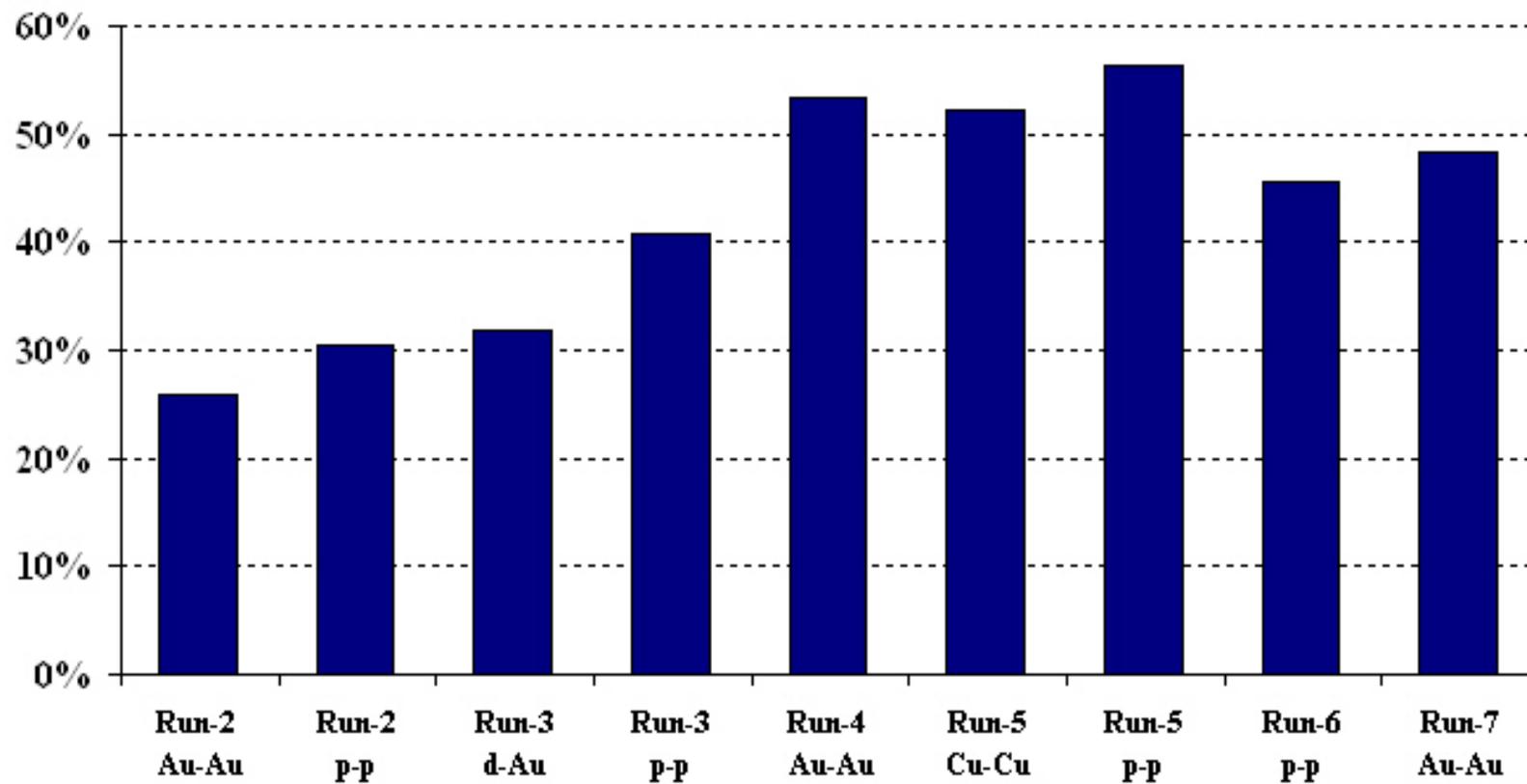


RHIC nucleon-pair luminosity L_{NN} delivered to PHENIX

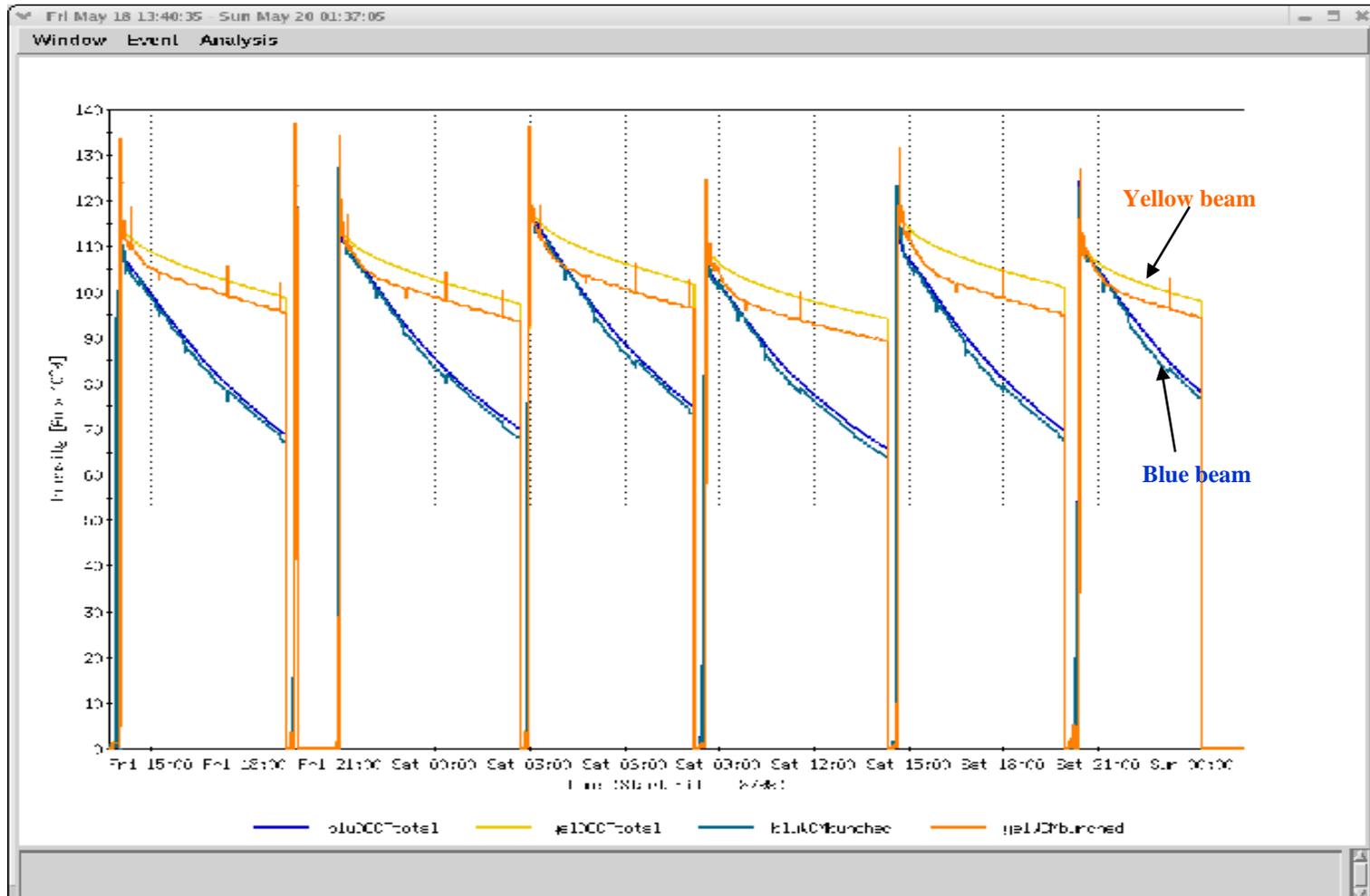


Last update: 28 June 2007

RHIC time in store



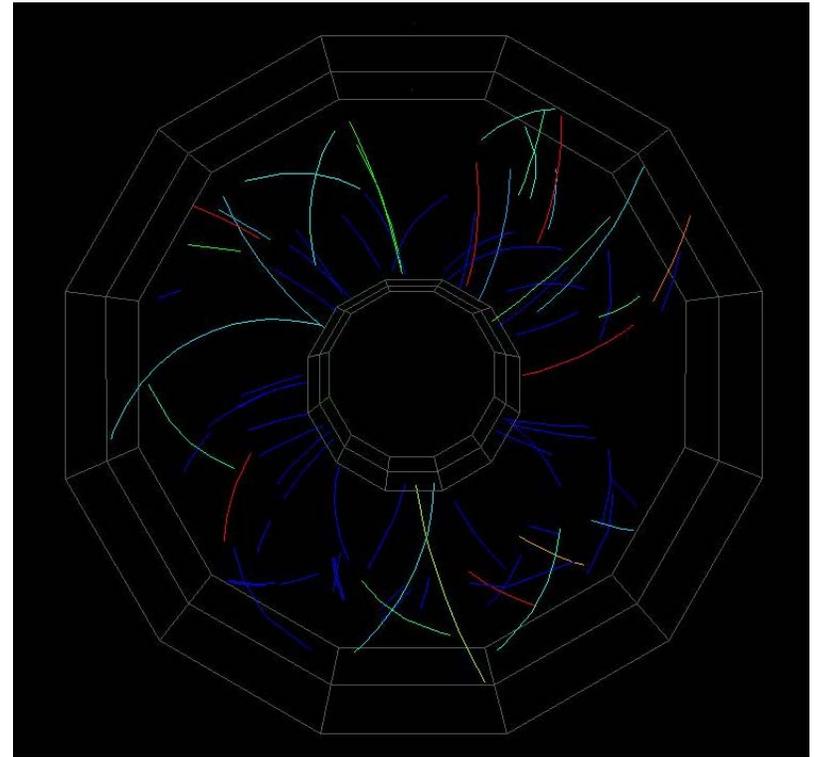
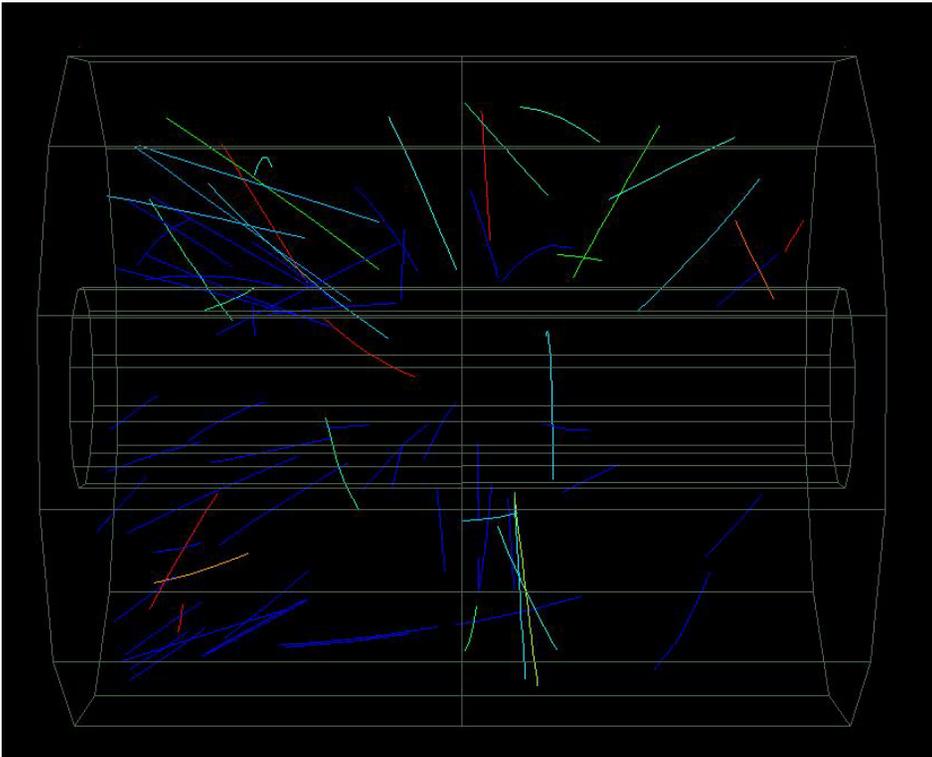
Longitudinal Stochastic Cooling



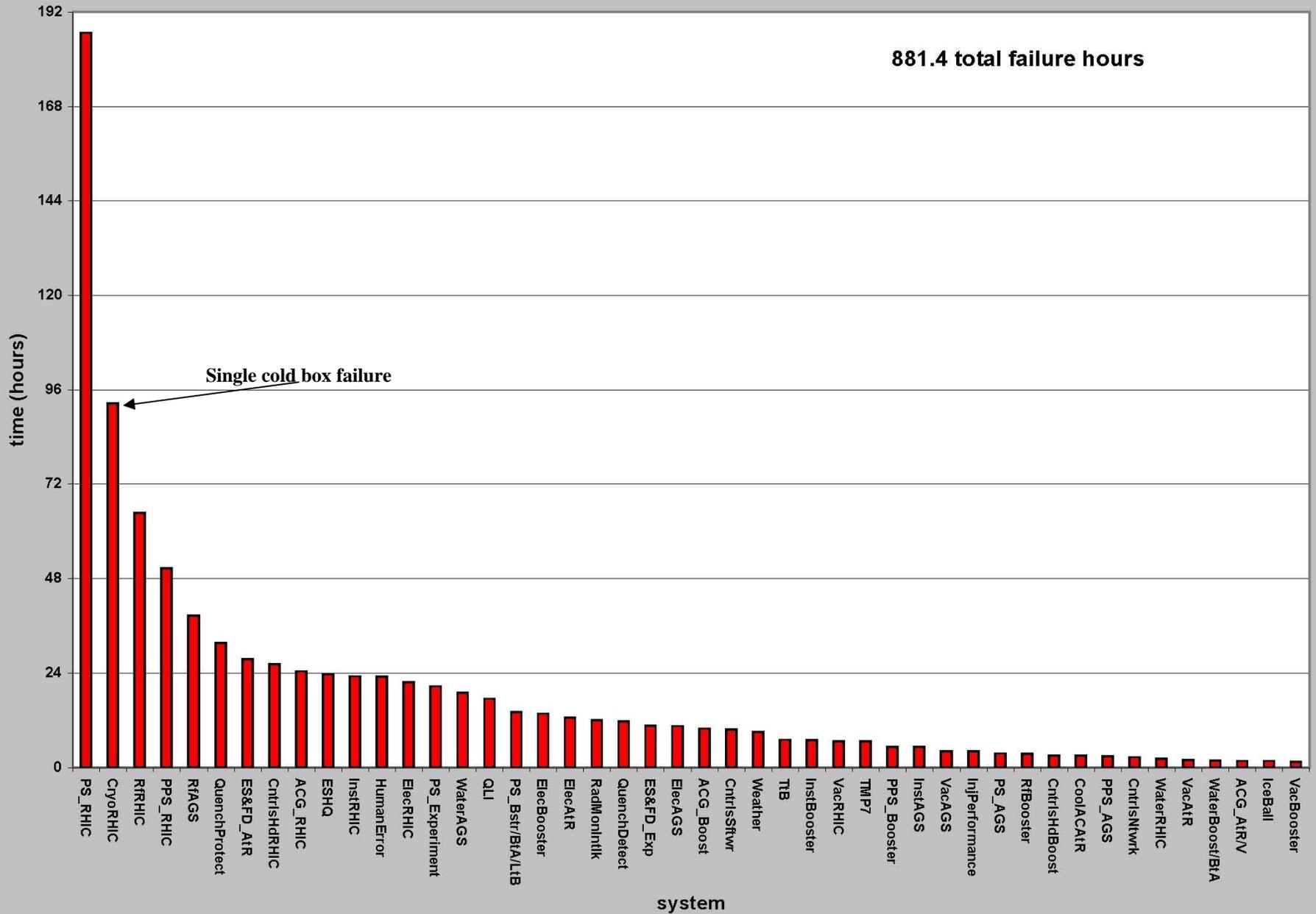
**RHIC did a one day Low Energy Commissioning Run.
Star commissioned triggers and took a small amount of data**

STAR TPC image of root(s) = 9.2 GeV Au-Au Collision

Taken June 7, 2007.

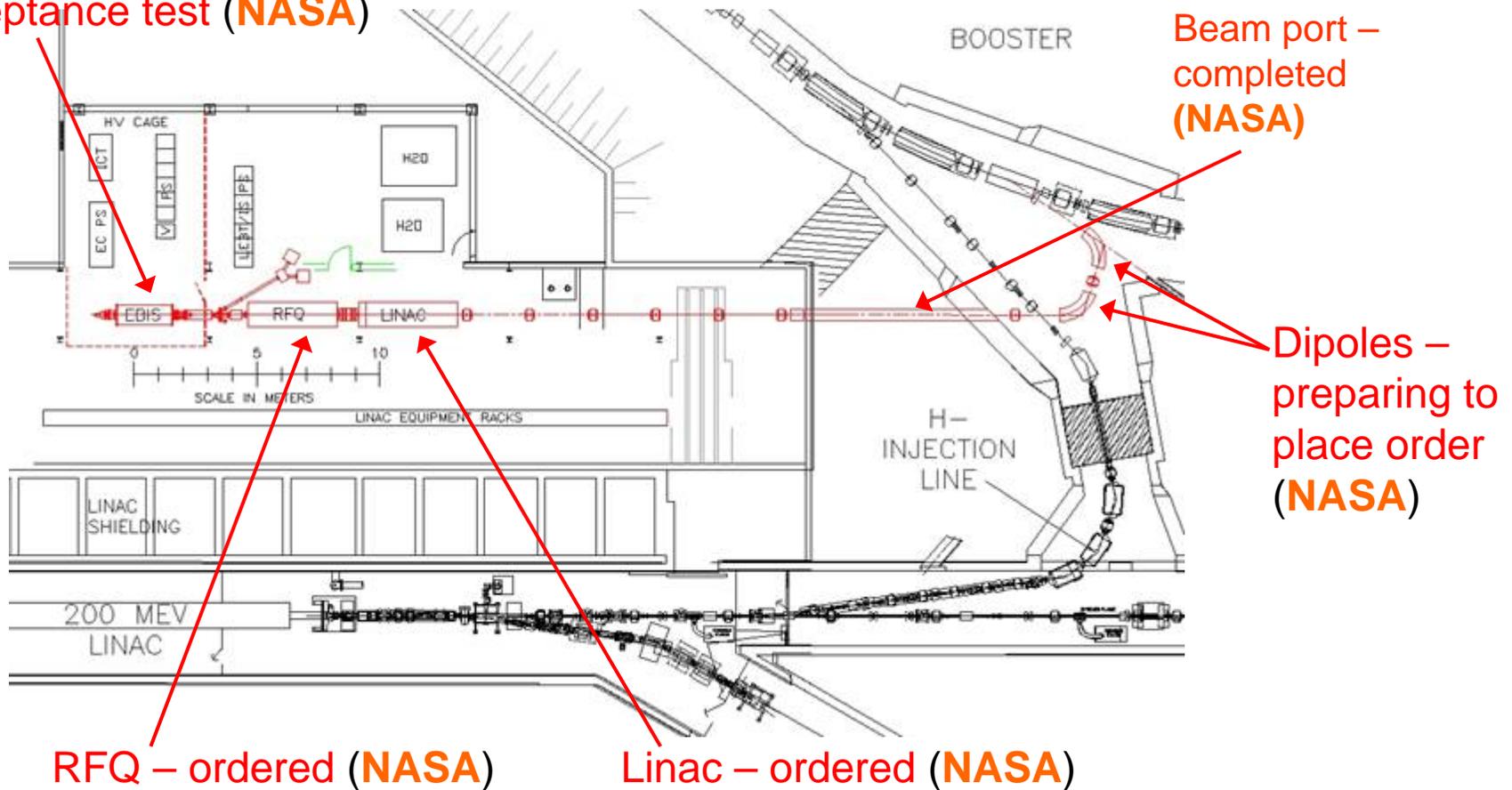


Run 7 Failures by system (to 6/26)



EBIS Injector System

EBIS SC solenoid – July 07
acceptance test (**NASA**)



EBIS Project History

August, 2004: CD-0 Approval – Mission need

July, 2005 – Technical, Cost, Schedule, & Management review (NASA & DOE)

September, 2005 – DOE CD-1 approval - Alternative Selection and Cost Range

May, 2006 – Technical, Cost, Schedule, & Management Review (NASA & DOE)

September, 2006 – DOE Independent Project Review

September 29, 2006 – DOE CD-2 approval (Performance Baseline), and CD-3 approval (Construction Start)

April 2007 - DOE construction funding start

September 19-20, 2007 – DOE/NASA Annual Review

EBIS DOE and NASA funding profiles

Total

	FY 05	FY 06	FY 07	FY 08	Total
R&D	0.5	0.7	-	-	1.2
CDR	0.2	-	-	-	0.2
PED/EDIA	-	1.98	0.12	-	2.1
Cons	0.5	2.4	5.0	7.6	15.5
Pre-Ops	-	-	-	0.3	0.3
TEC	0.5	4.38	5.12	7.6	17.6
TPC	1.2	5.08	5.12	7.9	19.3

DOE Contribution

	FY 05	FY 06	FY 07	FY 08	Total
R&D	0.5	0.1			0.6
CDR	0.2				0.2
PED/EDIA		1.98	0.12		2.1
Cons			5.0	6.6	11.6
Pre-Ops				0.3	0.3
TEC		1.98	5.12	6.6	13.7
TPC	0.7	2.08	5.12	6.9	14.8

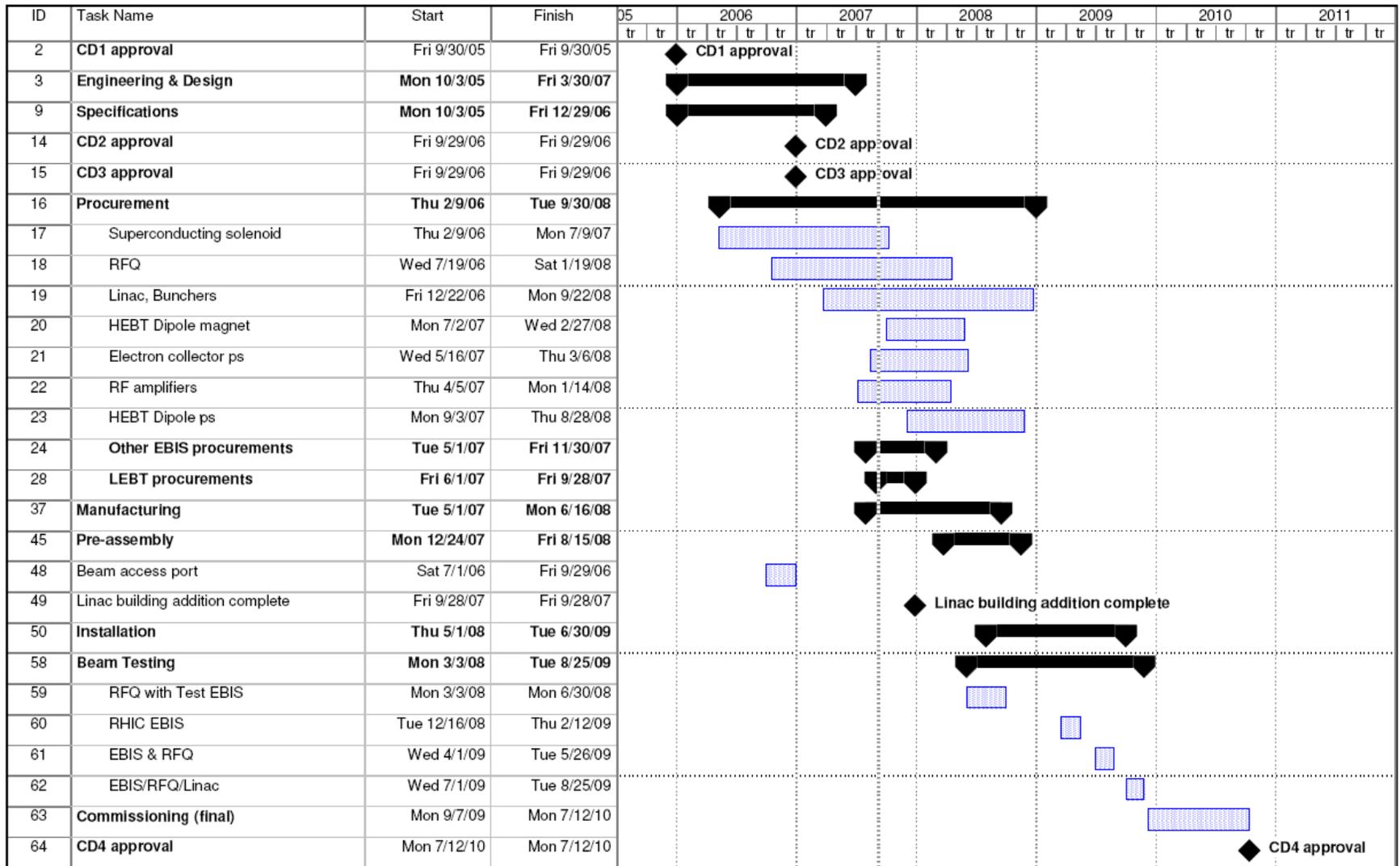
2.4 M\$ of DOE \$
shifted from
FY'07 to FY'08

NASA Contribution

	FY 05	FY 06	FY 07	FY 08	Total
R&D		0.6			0.6
CDR					-
PED/EDIA					-
Cons	0.5	2.4	1.0	1.0	3.9
Pre-Ops					-
TEC	0.5	2.4	1.0	1.0	3.9
TPC	0.5	3.0	1.0	1.0	4.5

Early arrival of NASA
FY'08 funds.

Current EBIS Project Schedule



R&D

C-AD R&D

Focus on 3 main areas for RHIC, RHICII and eRHIC

● Luminosity and polarization performance

- Heavy ion stochastic cooling (DOE, BNL) - See Brennan presentation
 - Longitudinal yellow system is operational, longitudinal blue is under construction
 - Transverse systems are under design
 - Complements electron cooling. Too early to judge whether matches electron cooling performance
- ERL and electron cooling (BNL, US Navy, AES) - See BenZvi presentation
 - FY2008 will be the time that the hardware comes together
- Other luminosity enhancements (NP) - See Roser presentation

● Source development

- EBIS
 - Under construction
- Polarized He³
 - Work has begun at BNL
- Polarized electron gun
 - Funding MIT

● eRHIC design

- eRHIC design (MIT-Bates, Novosibirsk, JLab). See Vladimir Litvinenko presentation
 - Focus on linac-ring design. ERL will be required.
 - Polarized electron gun (funding MIT)
 - Magnet prototype (LDRD)

Electron cooling R&D (see Ben Zvi presentation)

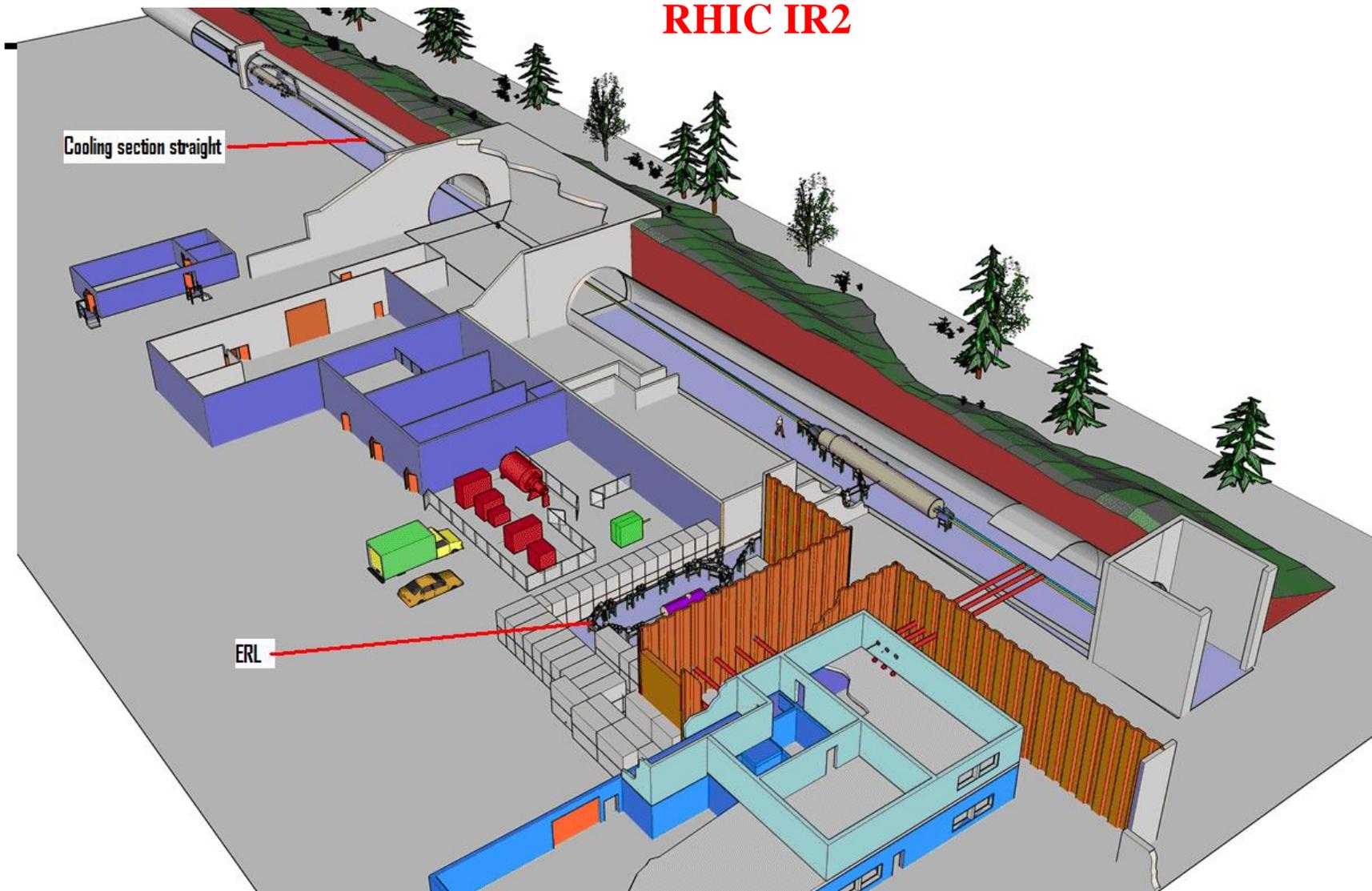
Progress to date:

- Significant progress, 23 papers at PAC07
- R&D plan was submitted as requested
- Feasibility established through simulations and benchmarking
- Risk-reduction R&D in progress
- R&D ERL on track for start of commissioning February 2009
- Navy added \$1.792M direct and \$0.8M in kind to the \$2M from DOE
- DOE SBIR added \$0.96M

Expected progress:

- 5-cell high-current cavity successfully tested vertically, horizontal test at BNL in 2/08
- 1 MW klystron installed, ready for acceptance test this summer
- Photocathode preparation chamber delivered end 7/07
- Laser to be delivered 12/07
- Many components fabricated
- ERL assembled 1st half 2008
- Injection installed 2nd half 2008

RHIC IR2



Issues

- Beam availability not yet to maximum projection
 - Power supply failures are the major problem
 - Suncraft power supply sent to outside engineering firm for evaluation
 - Costs to ameliorate are not yet known
 - Cryogenic system was a single failure
- Increased support for accelerator R&D
 - We are clearly supportive of the ONP FY2009 initiative to broaden an increase accelerator r&d across the university and laboratory community
 - eRHIC focus including polarized electron source r&d at MIT
- Delayed FY2007 EBIS funding of \$2.4M + NASA early funding has slid the completion date by 4 months
- Buildup of GSO to minimize annual congressional budgetary inactions effecting running schedule

C-AD Accelerator Physics Students (2002-2007)

Student	Mentor	Comments
Lin, Fanglei	Bai, Mei	Current Ph.D. Student
Chang, Xiangyun	Ben-Zvi, Ilan	Post Doc at C-AD
Calaga, Rama	Ben-Zvi, Ilan	Post Doc at LARP (CERN/BNL)
Grimes, Jacob	Ben-Zvi, Ilan	Just finished MS; looking for job
Wu, Qiong	Ben-Zvi, Ilan	Current Ph.D. Student
Hammons, Lee	Litvinenko, Vladimir	Current Ph.D. student
Longhi, Emily	Litvinenko, Vladimir	Accelerator Scientist at Diamond light source
Roychowdhury, Samadrita	Litvinenko, Vladimir	Researcher at Xerox Corp.
Chalut, Kevi	Litvinenko, Vladimir	Post Doc at Duke Univ.
D'Imperio, Nicholas	Luccio, Alfredo	Current Ph.D. Student
Ranjbar, Vahid	MacKay, Waldo	Post Doc at TechX Corp.
Kanesue, Takeshi	Okamura, Masahiro	Current Ph.D. Student
Tamura, Jun	Okamura, Masahiro	Current Ph.D. Student
Cardona, Javier	Peggs, Steve	Prof. of Physics, Bogota, Colombia
Fliller, Ray	Peggs, Steve	Post Doc at Fermilab
Iriso, Ubaldo	Peggs, Steve	Post Doc at CELLS light source, Barcelona, Spain
Tang, Chunmei	Peggs, Steve	Stay-at-home mom
Warner, Arden	Peggs, Steve	Physicist, Accelerator Div., Fermilab
Hao, Yue	Ptitsyn, Vadim	Current Ph.D. Student
Takano, Junpei	Roser, Thomas	Post Doc at KEK

FY 2007 Awards and Publications

FY 2007 Awards (to date)

- BNL Science & Technology Award – M. Blaskiewicz, January 2007
- BNL Engineering Award – G. McIntyre, A. Pendzick, January 2007
- BNL Brookhaven Award – S. LaMontagne, January 2007
- Brookhaven Town Honor – F. Pilat, March 2007
- 2007 Environmental Stewardship Award – J. DeBoer, J. Scaduto, April 2007
- DOE Pollution Prevention Star Award – V. LoDestro, J. Scott, W. Shaffer, B. Briscoe, April 2007
- AAAS Fellow – D. Lowenstein, November 2006
- FY 2007 Publications and invited talks (to date)
 - 98 publications
 - 24 journals, 20 refereed
 - 73 conference proceedings
 - 1 report
 - Approx. 10 invited talks

C-AD Accelerator Community Leadership Positions

- Chair, Particle Accelerator S&T, IEEE NPSS: I. Ben Zvi
- Co-Chair, DOE Accelerator Safety Order Working Group: E. Lessard
- USPAS Program Advisory Com. and APS DPB Nominating Com.:
V. Litvinenko
- Chair, US Particle Accelerator School Board of Governors: D. Lowenstein
- Program Leader, US LARP: S. Peggs
- Member, APS DPB Nominating Committee: F. Pilat
- Past-Chair, APS Division of Particles & Beams Executive Com.: T. Roser
- Editor, ICFA Beam Dynamics Newsletter and CSNS Project Head: J. Wei
- Chair, SNS Accelerator Readiness Review team: E. Lessard
- + others serving on DOE, NNSA, NSF, CERN, RAL, GSI, J-PARC committees and reviews

Summary

.FY2007 delivered luminosity goals were met, resulting in another excellent year.

.RHIC average store luminosity increased by 2.5 over previous Au run. Now at 1.5 over enhanced design luminosity goal and 6 over design specification.

.Challenge #1 is to increase the availability to provide even more luminosity and improved availability in FY2008.

.Challenge #2 is to reach RHICII specifications at minimal cost.

.Challenge #3 is to minimize the technical risks for eRHIC