

Overview

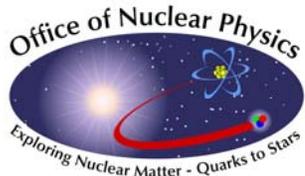
DOE-NP Annual S&T Review of RHIC

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(interim)

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Structure of this Review

TODAY

- Laboratory perspectives, vision
- Collaboration reports, outlook
- Accelerator performance and evolution

TOMORROW

- A: Accelerator R&D and upgrades
- B: BNL Research Program: Theory/Lattice Groups
Experimental Groups, RHIC Computing Facility
- Polarimetry, Instrumentation, Safety, Users' perspective

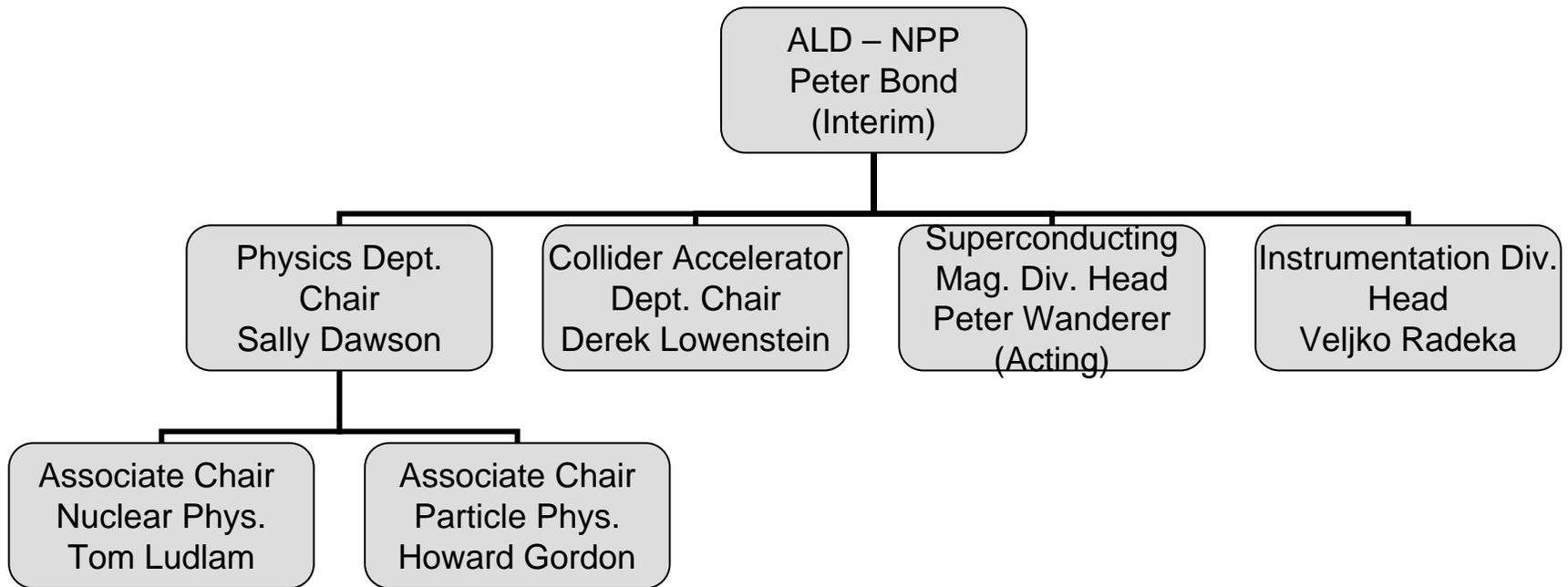
Value of the review to BNL

- S&T Review of the overall RHIC Program
 - but also BNL-specific performance in Research and Operations
- Evaluate typical problem of a host laboratory
 - Balancing research and “customer” support
- A key piece of this review for us -- how well do we achieve this balance ?
- Is our planning sensible and credible ?

Topics

- BNL Organization
- Core competencies at BNL
- Response to last year's review
- RHIC overview and the roles of BNL
- Some accomplishments of the RHIC program
- Priorities, vision, outlook for the RHIC program
- BNL overhead contributions to NP program

Nuclear and Particle Physics Directorate



- NPP: 2 Departments, 2 Divisions, ~730 FTEs total (various funding types)
- PHOBOS scientists moved to Physics from Chemistry in new group
- Some non-RHIC NP-funded activities
 - LEGS (done), neutrino (Chemistry), NNDC (Energy Sci & Tech Dept)
- Total FY07 BNL NP Budget Authority ~\$170M (includes "landlord" funding) - RHIC specific \$152M (incl EBIS)

Recent Changes

- Steve Vigdor will arrive as the new Associate Lab Director for Nuclear and Particle Physics (Sept)
- Michael Ernst has been in place as the Head of RHIC/ATLAS computing since February. Bruce Gibbard did a wonderful job in building the organization and facility
- 100-teraflops Blue Gene computer is in place courtesy of New York State – called New York Blue
- With completion of PHOBOS and BRAHMS those groups have been downsized and reformed into a new group. Some effort devoted to STAR and PHENIX and some to proposed LHC ATLAS HI effort.

RHIC Overview

- 7 coupled accelerators
- Nucleus -nucleus collider from 10-200 GeV/nucleon
Symmetric or asymmetric species
- Polarized p-p collisions up to 500 GeV
- Capabilities unique world-wide



Core Competencies at BNL

- **Design, construct, and operate extraordinary facilities**

RHIC complex

- **Advanced concepts of accelerators, detectors, magnets, and instrumentation**

Upgrades to RHIC and its detectors, SMD, Instrumentation Division

- **Tera (peta)-scale computing**

RCF, QCDOC, BlueGene

- Synchrotron radiation science and technology
- Imaging expertise

Last Year Issues

- Action Items from last year's S&T Review
 - Evaluate the risks associated with the backlog of Capital Equipment and Accelerator Improvement Projects at RHIC
 - Submitted - you will hear a talk on this
 - BNL should develop a Research and Development plan for increasing the machine luminosity (RHIC II) that includes milestones, deliverables resources and critical path and schedule contingency consistent with the mid-term plan
 - Submitted - you will hear a talk on this

The Roles of BNL (Operations)

Operations

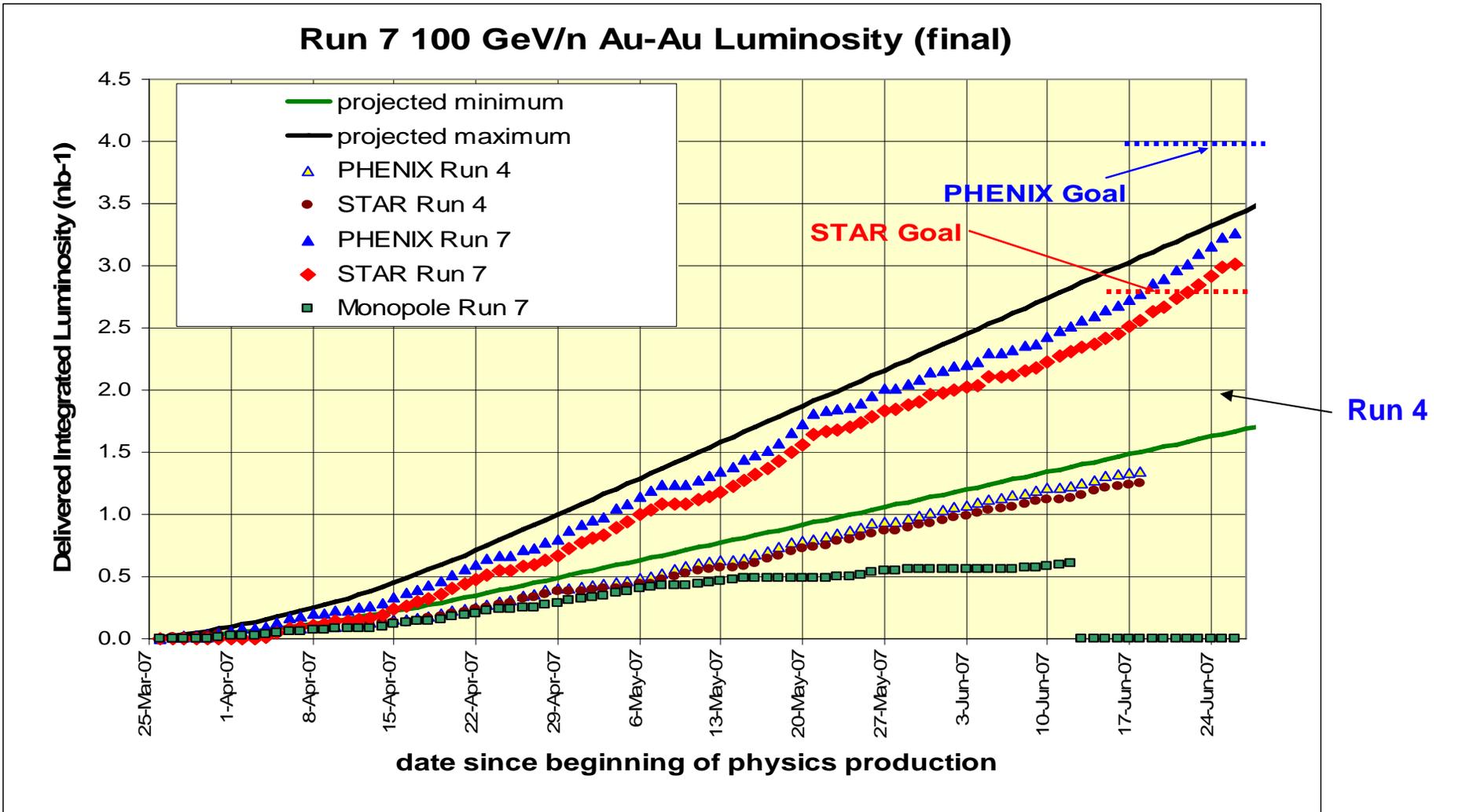
- RHIC has met and often exceeded expectations each year for integrated luminosity with HI and p polarization.
- This year despite late budget from Congress
 - HI integrated luminosity exceeded Run 4 by factor of 2.5
 - Demonstrated stochastic cooling and low energy run
- Developments continue with HI and polarized p beams
- Continually evaluate operations efficiency and make improvements
- BNL C-AD and Physics play major roles in detector operations
- RHIC Computing Facility has been extraordinary
 - recorded 800 TB of data in Run 7

The Roles of BNL (Research)

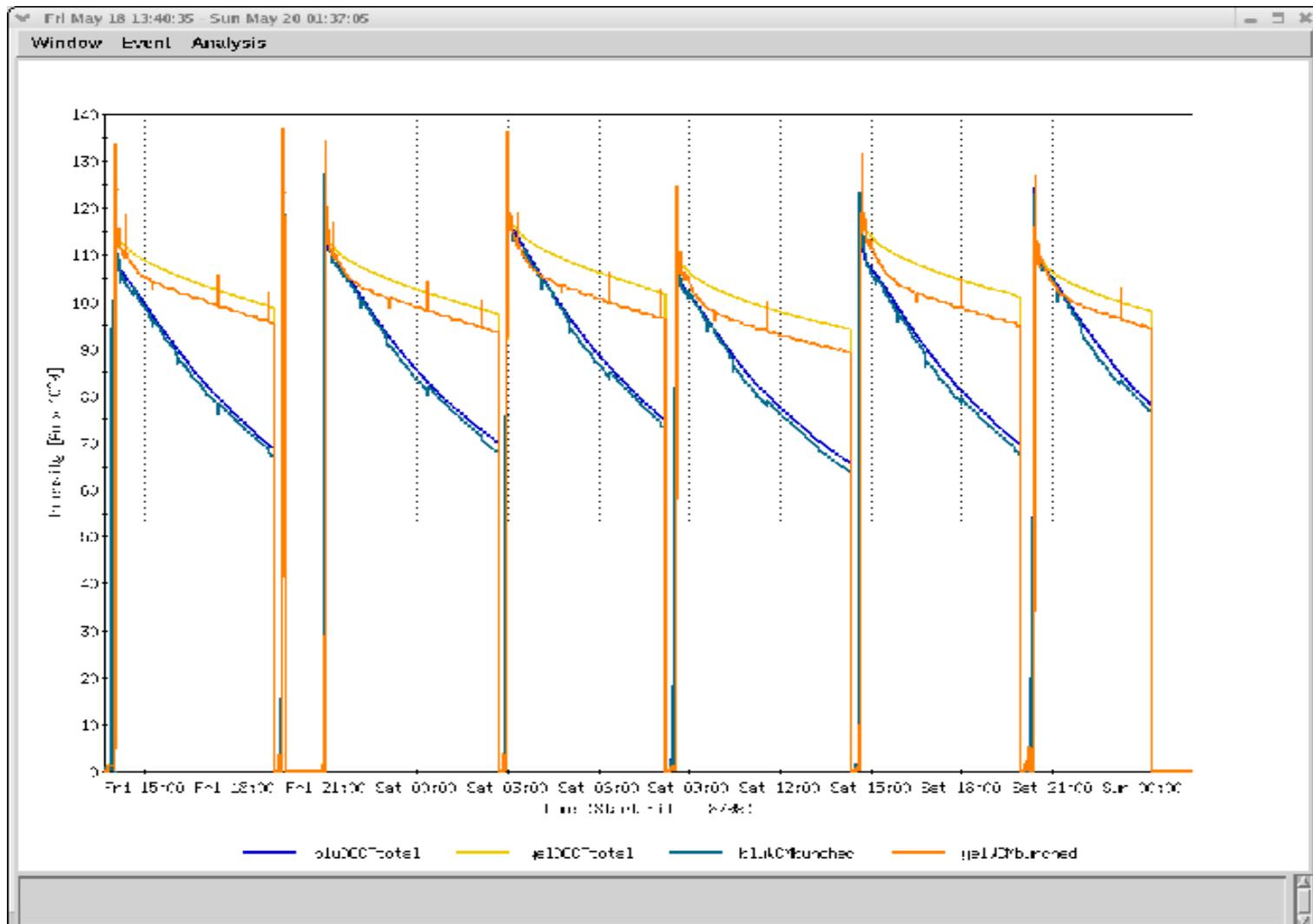
Research

- BNL plays leadership roles in research *and* detector operations
 - BNL group presentations tomorrow
- HI research will be reviewed in 2008 with other labs
- Nuclear Theory (2005) and Spin groups (2006) were reviewed in comparison with other labs
 - Both have synergy with very successful RIKEN-BNL Research Center (10th anniversary of RIKEN support for people and hardware): another major positive impact on RHIC from Japan is US/Japan program
 - Theory quality outstanding, but some concern with perception of “relevance” to experimental program and DOE goals – we believe that has been addressed – (two presentations, theory and lattice gauge, tomorrow)
 - Spin group “outstanding” – look to increase manpower, address polarimetry issue (talks today and tomorrow)
- Forefront experimental and theoretical research at BNL is vital to outstanding operations at RHIC

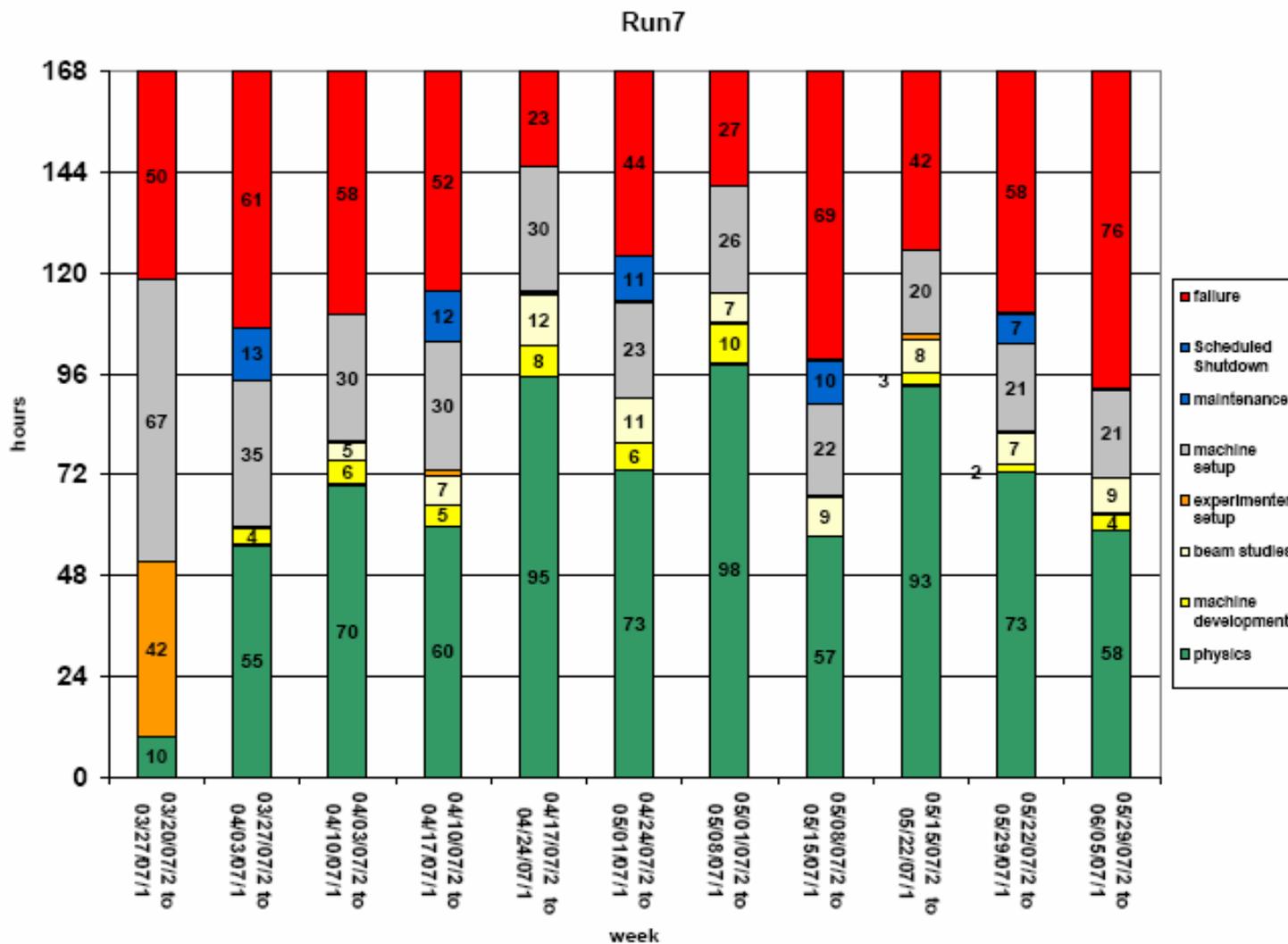
RHIC Today



Longitudinal Stochastic Cooling Works !!



Run 7 Reliability an Issue



Progress this year on other issues

- Test of how low in energy RHIC can run – in a very short run were able to see some Au-Au collisions at 4.6 GeV/A per beam – well below top energy of SPS heavy-ion collisions. Will allow energy scan to search for critical point.
- Electron Beam Ion Source (EBIS) has CD-3 and DOE funding ! NASA funding was already in place so moving ahead for FY2011 operation (looking for ways to “catch up” time due to funding delays)
 - Will not hear a specific presentation on this as DOE review in September

RHIC Program to date

- Seven spectacularly successful annual runs
 - Physics discoveries: a new state of matter (top physics story of 2005)
 - Scores of refereed papers, thousands of citations
 - Machine performance meeting and exceeding goals
- Au+Au (Run 4) published articles, continuing analysis
 - Significant, and surprising, suppression and flow effects seen for heavy quark particles (via non-photon electrons)
 - First measurements of J/psi suppression at RHIC
- Cu+Cu (Run 5) published articles, continuing analysis
 - Precise studies of jet suppression, flow, and hydro behavior vs. system size and shape
- Polarized p+p (Runs 5-6) published articles, continuing analysis ---
 - Results from two-spin asymmetries indicate small value of delta-G (gluon spin contribution).
- Large Au-Au data sample (Run 7) being analyzed

Detailed talks on these today and breakout session

Near term Plans

Exploit the scientific opportunities at RHIC

- Enormous gains in knowledge will continue to be made in A+A and Spin programs with near term upgrades and incremental improvements
 - Luminosity, polarization
 - Au-Au energy range down to 10 GeV
 - Polarized p-p energy range up to 500 GeV
 - DAQ, particle ID, η coverage
- Ability to collide asymmetric species, d-A, is vital
- Optimized operations continually being evaluated
 - Running time vs. investment (for efficiency and the future)

Mid term plan and status

■ EBIS

- increase the range of ion species available and improve operations efficiency - **under way**

■ RHIC II

- e-cooling to increase the HI luminosity - **R&D ongoing**
- Science case for RHIC II has been made in working group white papers led by user community - **external validation early FY08 ?**

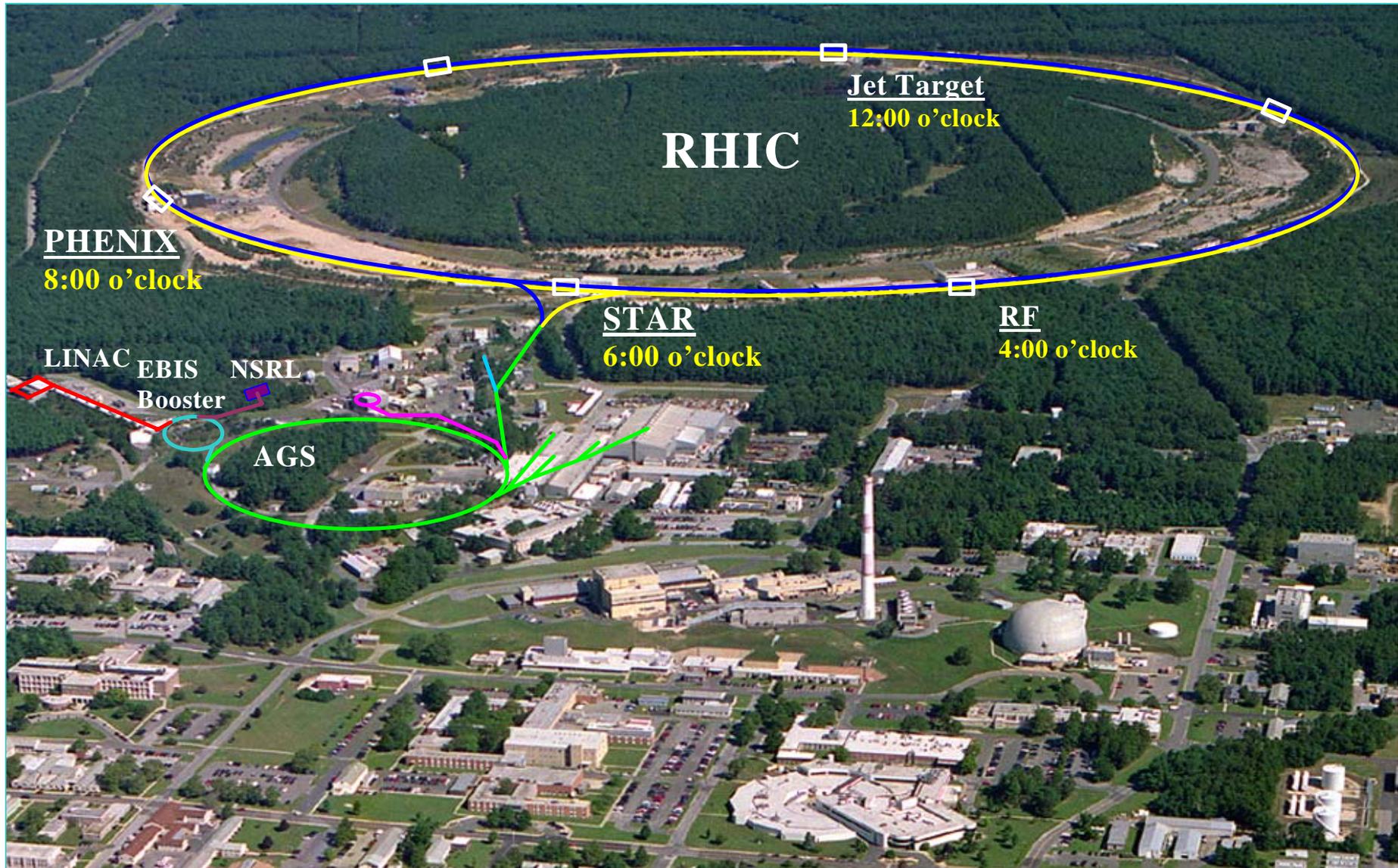
■ Detector upgrades to take advantage of these capabilities **ongoing**

Detailed plan is proceeding although slowed by funding issues

■ Theory , including lattice gauge, is also key to progress

- 100Tflops BlueGene computer has just been added

With EBIS the operation (and RHIC photo) will change
(2 experiments, no tandems nor 1800 ft transfer line)



Longer Term Plan

Evolve RHIC into a more comprehensive QCD laboratory

- A 10GeV electron accelerator is added to RHIC
- A new detector is added

Address the compelling questions in QCD revealed by the discoveries at RHIC – the steps

- **Involve the RHI, Spin and DIS communities in articulating the future science of RHIC and eRHIC**
- **convince the Nuclear Physics community of the outstanding science afforded by**

$$A + A, p + A, \vec{p} + \vec{p}, \vec{e} + \vec{p}, e + A$$

- **address the technical, funding and political issues**

RHIC → RHIC II / eRHIC (QCDLab)

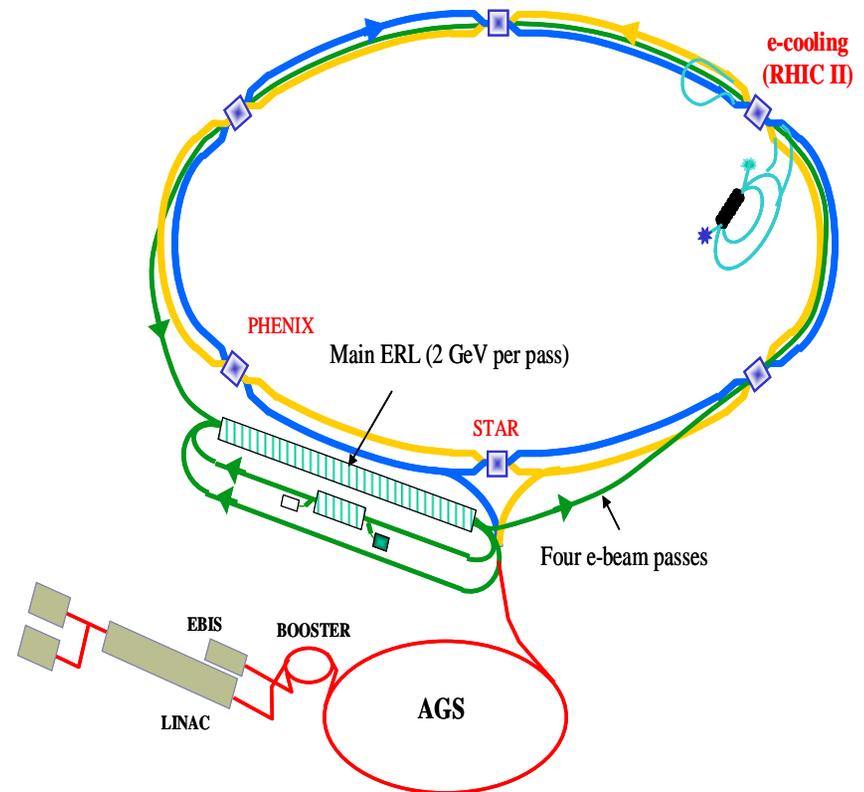
■ RHIC II

- An additional increase in average luminosity (beyond near term incremental increases)
- Detector enhancements

■ eRHIC

- Electron ring or linac added
- New detector

Critical technologies (principally electron cooling and Energy Recovery Linac) enable both RHIC II and eRHIC. Higher integrated luminosity through longer luminosity lifetime



2007 NSAC LRP Recommendations

Bullet #4 (out of 4)

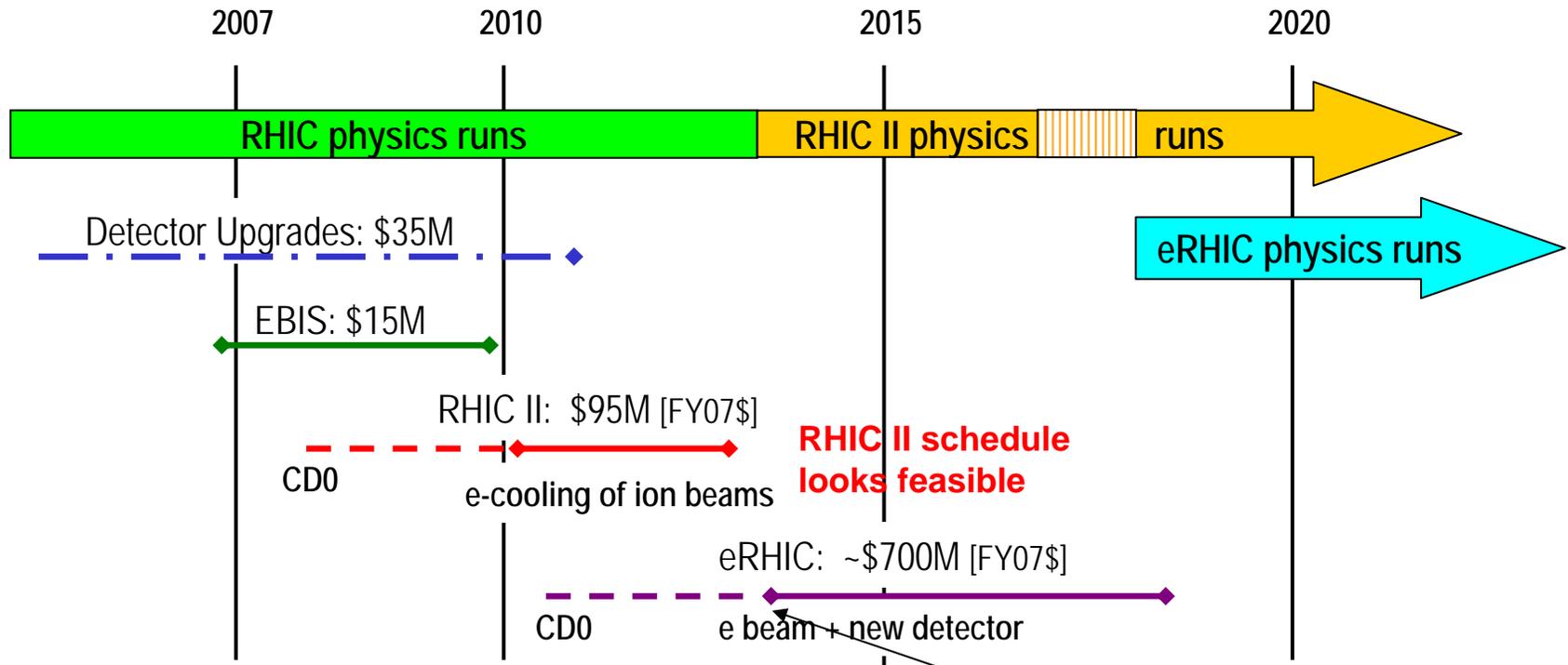
- The experiments at the Relativistic Heavy Ion Collider have discovered a new state of matter at extreme temperature and density—a quark-gluon plasma that exhibits unexpected, almost perfect liquid dynamical behavior. *We recommend implementation of the RHIC II luminosity upgrade, together with detector improvements*, to determine the properties of this new state of matter.



Unnumbered bullet

We recommend the allocation of resources to develop accelerator and detector technology necessary to lay the foundation for a polarized Electron Ion Collider. The EIC would explore the new QCD frontier of strong color fields in nuclei and precisely image the gluons in the proton.

A Long Term View of RHIC



RHIC II schedule looks feasible

Possible technically, but is too optimistic for other reasons

Legend:

- R&D
- ◀—▶ Construction
- .-.-.-> Multiple small projects

CD0: DOE Critical Decision, mission need

RHIC II Issues

- Obviously must go through the DOE CD process
- Options on how to reduce RHIC II costs –
 - RHIC infrastructure can use AIP, CE and operating funds, instead of construction funds
 - Putting the cooler in the RHIC ring enclosure eliminates any civil construction
 - Eliminate the need for a separate He refrigerator
 - Shorten a few runs or not run for a year (not more)
 - discussion with many people - experiments, machine, DOE

Perhaps replace e-cooling with some new developments
Very recent R&D has indicated transverse stochastic cooling might provide substantial luminosity improvement (talk tomorrow)

BNL funding support for NP

■ Some examples

- Instrumentation Division (talk tomorrow)
- LDRD
- Program Development funding
- Postdoc/Goldhaber Fellow subsidy
- Physics Dept overhead
- RIKEN-BNL Research Center (RBRC) space
- Royalty

The amounts change year by year

Then there are Lab efforts to keep costs under control, e.g.

- negotiation of power rates that reduced expected \$100/MWhr to \$70/MWhr

Summary

- RHIC's success has made BNL a world center for
 - Heavy Ion Physics
 - Spin Physics
 - Nuclear Theory (high T , high ε , high E , low x)
 - Accelerator science
- Compelling mid-term program for science
 - New detector capabilities, higher luminosity and polarization
- A clear (*non-trivial!*) path leading to a broad ranging QCD laboratory

This path has ***discovery potential*** every step of the way!

Backup

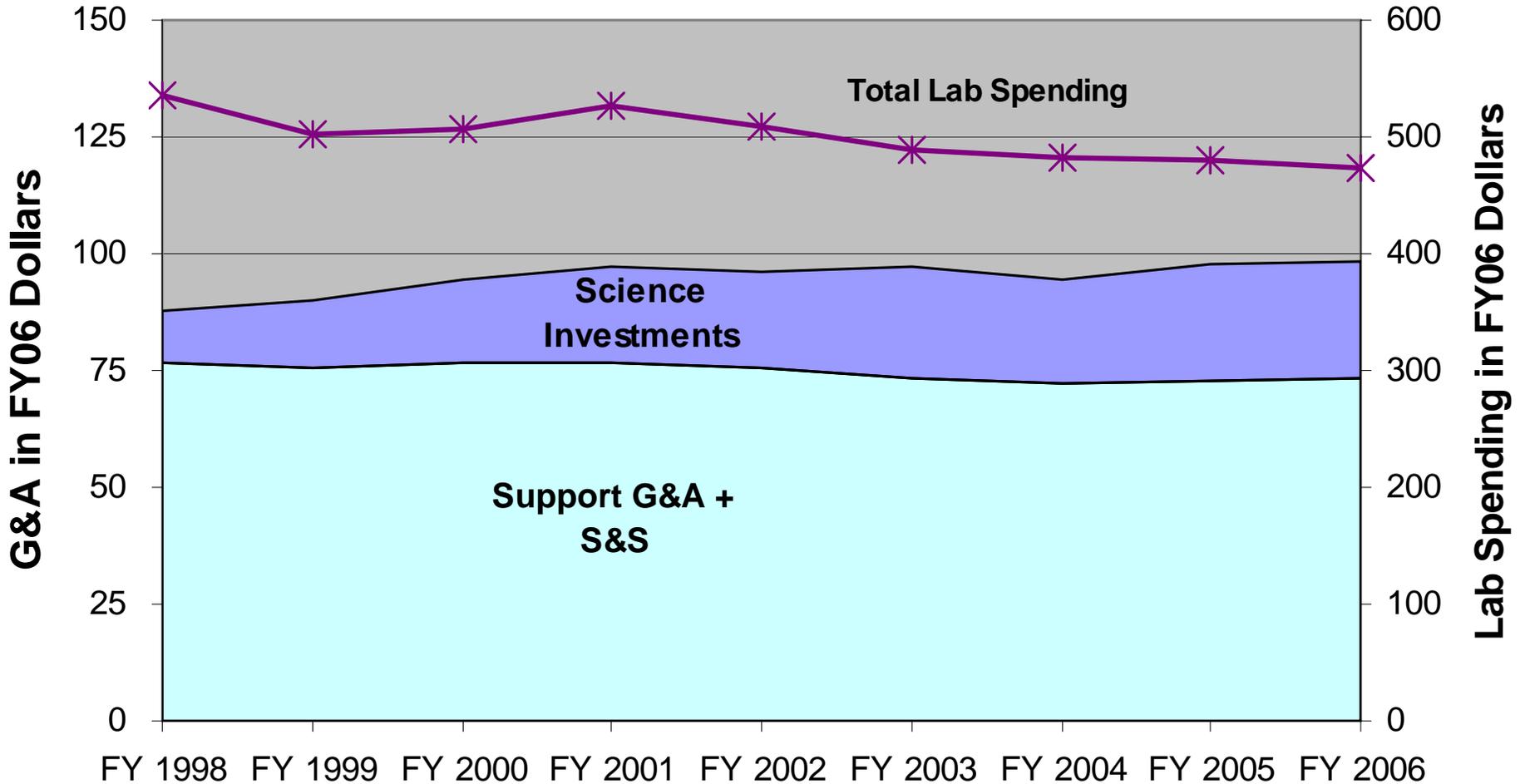


BNL NP FY2007 Budget

TOTAL OPERATING	146,848,000
TOTAL CONSTRUCTION	5,120,000
TOTAL EQUIPMENT	6,900,000
TOTAL AIP	2,100,000
TOTAL GPE	2,733,000
TOTAL GPP	6,550,000
TOTAL NUCLEAR PHYSICS	170,251,000

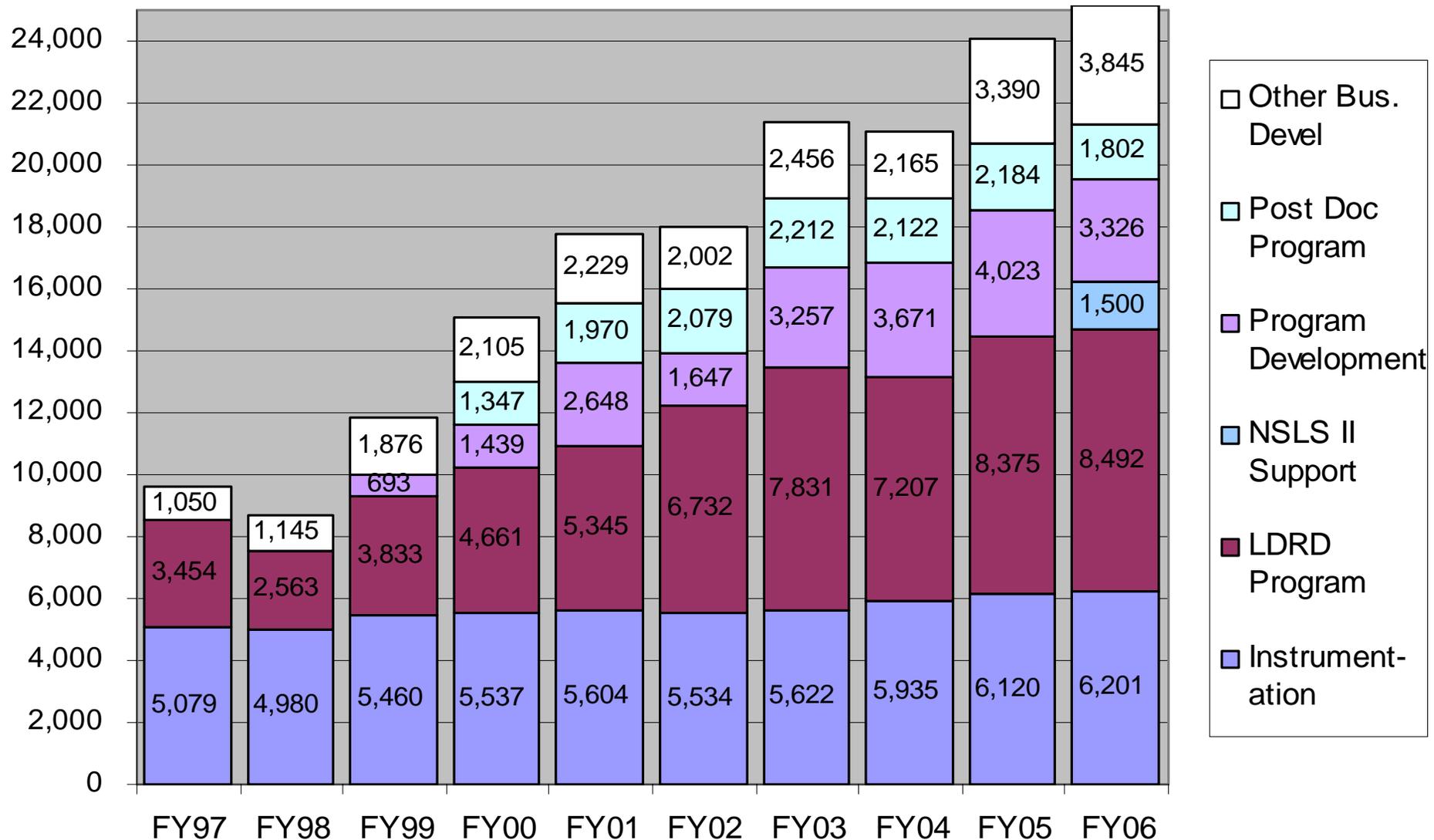
History of BNL G&A Cost in FY06 Dollars

Corrected for Direct Funding of Safeguards & Security Beginning in FY01



BNL Investments In Business Development

Thousands



BNL support to NP for FY07

- Instrumentation Division -- \$2M
- LDRD -- \$ 1.6M
- Program Development funding -- 0
- RIKEN-BNL Research Center (RBRC) -- \$0.46M
- Postdoc/Goldhaber Fellow subsidy -- \$0.23M
- Physics Dept overhead -- \$0.4M
- Magnet Division space subsidy -- \$0.45M
- Royalty -- \$0.6M

The amounts change year by year

Over the last 3 years the total of these items has varied from about \$3.8M to about \$5.8M