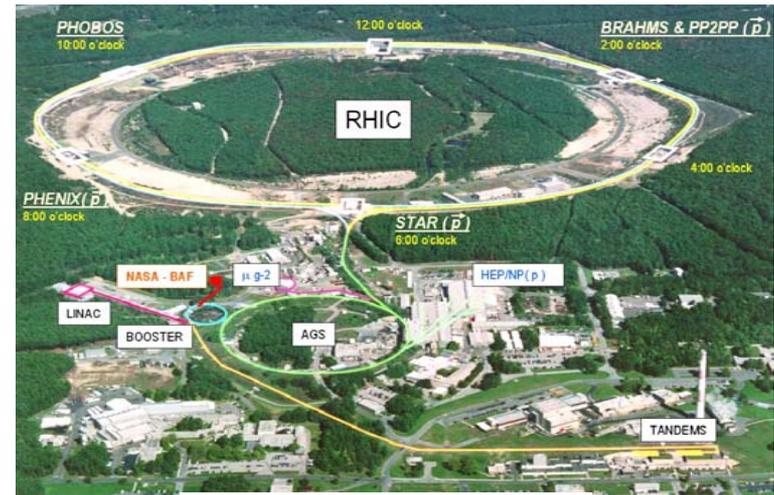
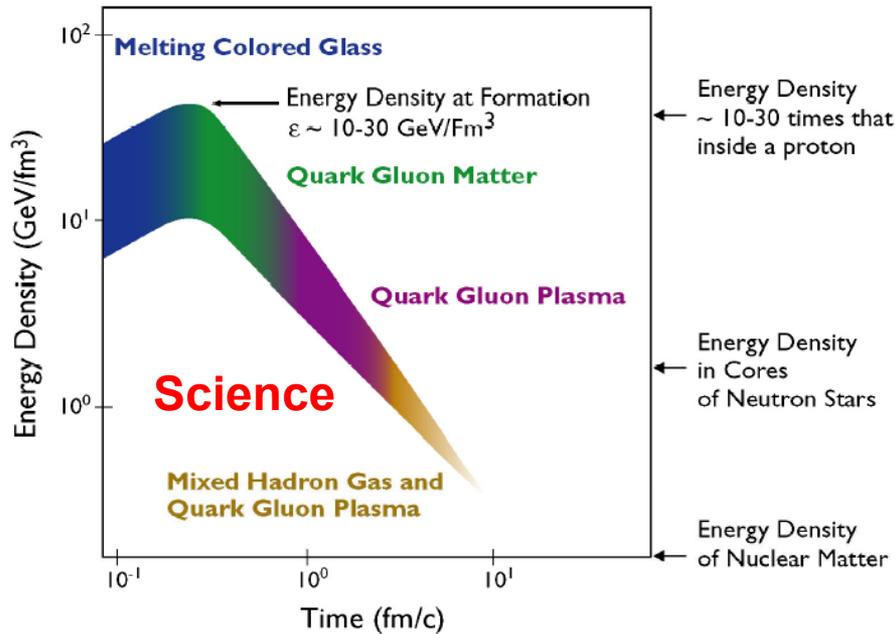


RHIC Program Overview – Director’s Perspective

Presented to

DOE-NP RHIC Science & Technology Program Review



Facilities

by
Thomas B.W. Kirk
Associate Laboratory Director of HENP

Upton, NY
June 30, 2004

Plan of the Overview Talk

- Charge to the Reviewers from DOE Nuclear Physics
- RHIC Physics Program at BNL – Core Competencies
- Past and Possible Future RHIC Physics Milestones
- Organization of BNL for the RHIC Program
- Communication Mechanisms with RHIC Users
- Program Highlights
- Future Directions of the RHIC Program
- BNL Responses to the 2003 RHIC S&T Review Action Items
- Safety
- ALD Priorities, Summary and Conclusions

Charge to the RHIC Program Reviewers

“...each panel member will be asked to evaluate and comment on:

- The quality, productivity, and significance of the laboratory’s scientific and technical accomplishments, particularly in the RHIC spin physics program, and the merit, feasibility and impact of the planned spin physics program [**Ludlam, Bravar, Bunce, Bland**]
- The effectiveness and reliability of accelerator operations and the planning for future facility upgrades in support of the planned research program and the impact of integration issues of other facilities on RHIC operations in support of the U.S. nuclear physics program [**Lowenstein, Bai, Fischer, Roser, Harrison**]
- The appropriateness and effectiveness of in-house core competencies needed to implement the planned future nuclear physics program [**Kirk, Ludlam, Lowenstein, Roser**]
- The effectiveness of management in implementing a balanced, prioritized and optimized program, and the implementation of a safe working environment [**Kirk, Roser**]
- The competence, creativity, and productivity of the facility scientific and technical staff in carrying out the above activities [**all presentations plus Committee judgement**]”

Jehanne Simon-Gillo’s letter to the Laboratory of June 17, 2004

Brookhaven National Laboratory Nuclear Physics Program

Mission Statement:

“Perform frontier research in theoretical and experimental nuclear physics; build, maintain and operate state of the art user facilities for nuclear physics; perform research and development work in accelerator science, experimental detector design and computing for NP; operate the National Nuclear Data Center and carry out construction projects in the NP area as assigned.”

In support of this mission, the Laboratory operates large user facilities (AGS and RHIC) and carries on an in-house program of research in theoretical and experimental nuclear physics. Support of RHIC computing is provided by the RHIC Computing Facility at BNL. The National Nuclear Data Center is based at BNL. The work of the NP Program is also supported through the expertise of BNL’s Instrumentation Division, a Lab-wide development organization reporting to the ALD-HENP.

Direction of the NP Program:

The Associate Laboratory Director of High Energy and Nuclear Physics directs this program. The work of the NP program is carried out in the Physics, Chemistry, ES&T and Collider-Accelerator Departments and in the Superconducting Magnet and Instrumentation Divisions.

RHIC Related BNL Core Competencies

- **Operation and upgrade of forefront user facilities for NP experiments**
 - *RHIC facility (a unique collider facility for heavy-ion and polarized proton beams)*
 - AGS Complex (highest intensity proton synchrotron in the world, off in FY03)
- **Performance of a world class, in-house program of basic research in theoretical and experimental nuclear physics**
 - *five experimental groups of key value to forefront efforts at RHIC*
 - *a theoretical group of broad capability with productive links to particle physics*
 - close collaboration with the RIKEN BNL Research Center to enhance research
 - productive collaboration in the SNO neutrino experiment
 - maintenance and improvement of the National Nuclear Data Center at BNL
- **Performance of a leading R&D effort in the development of advanced accel. & detector concepts and computing support for NP research**
 - *continued improvement of the RHIC-AGS complex using AIP and other funding*
 - *development (with Instrumentation Division) of novel particle detectors*
 - operation & development of the RCF for support of RHIC computing

Program elements addressed in this review shown in *red italics*



PHOBOS
10:00 o'clock

12:00 o'clock

BRAHMS & PP2PP (\vec{p})
2:00 o'clock

RHIC

4:00 o'clock

PHENIX (\bar{p})
8:00 o'clock

STAR (\bar{p})
6:00 o'clock

NASA - BAF

μ g-2

HEP/NP (p)

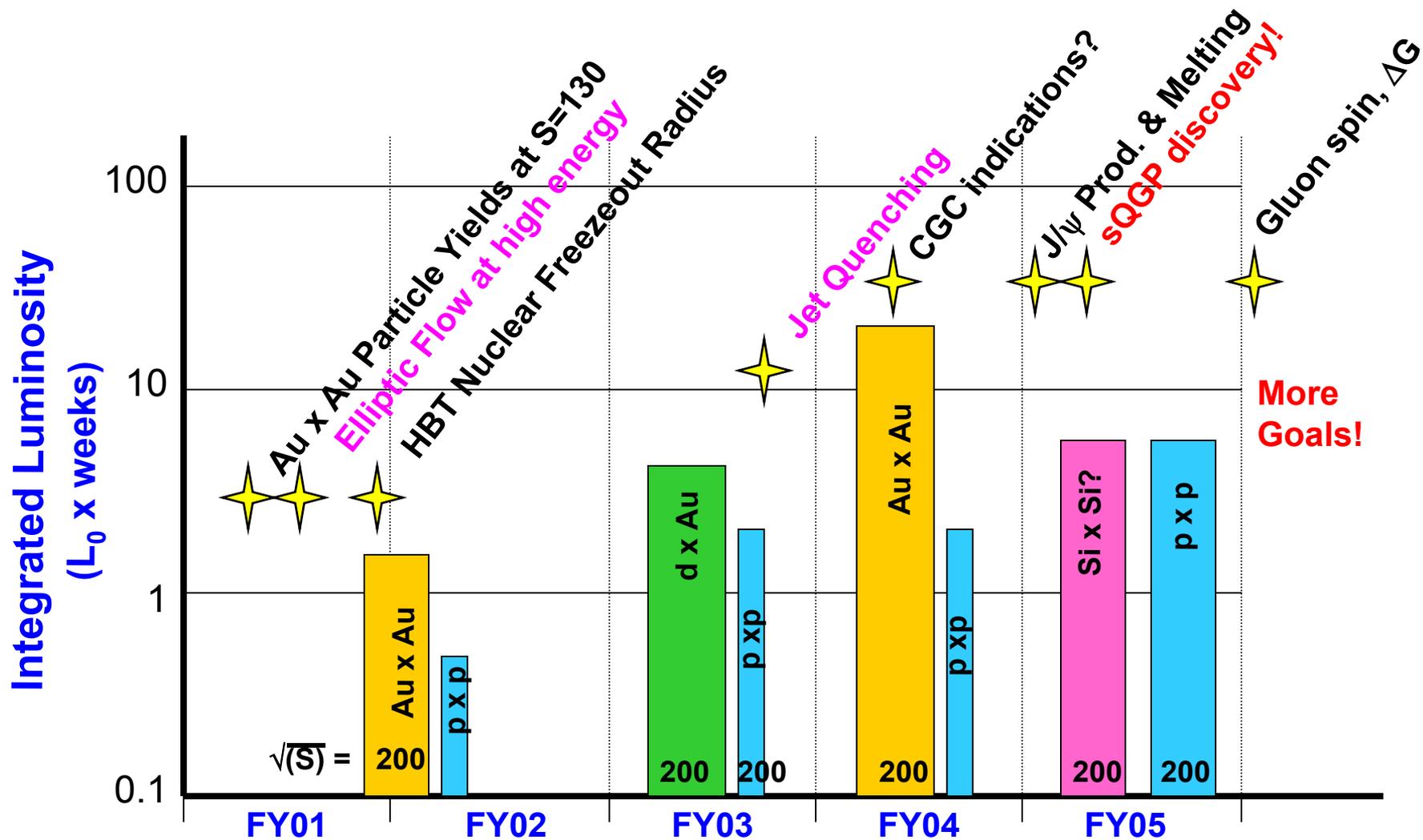
LINAC

BOOSTER

AGS

TANDEMS

Past & Possible Future RHIC Physics Milestones



1 RHIC Wk = 3.0×10^5 secs

Fiscal Year

T. Kirk
June 30, 2004

$L_0 = 2.0 \cdot 10^{26} \text{ cm}^{-2} \text{ sec}^{-1}$, AuAu @ 200

$L_0 = 5.0 \cdot 10^{30} \text{ cm}^{-2} \text{ sec}^{-1}$, p↑p↑ @ 200

$L_0 = 1.0 \cdot 10^{28} \text{ cm}^{-2} \text{ sec}^{-1}$, SiSi @ 200

Elements of the BNL RHIC Physics Program

• The RHIC-AGS Accelerator Complex at BNL

- RHIC-AGS is the *flagship DOE user facility* at BNL
- RHIC is the *top HI facility in the world* until at least 2008 (LHC at CERN)
- AGS remains the *highest intensity proton synchrotron* in the world

• RHIC and AGS Experiments at BNL

- the 4 RHIC collider detectors *cover the gamut of first-generation RHIC physics*
- these detectors are *well-suited to spin physics* with polarized proton beams
- RHIC serves a current total of over 1000 NP users from all over the world
- proposals for future RHIC and AGS experiments are in prospect (RSVP et al)

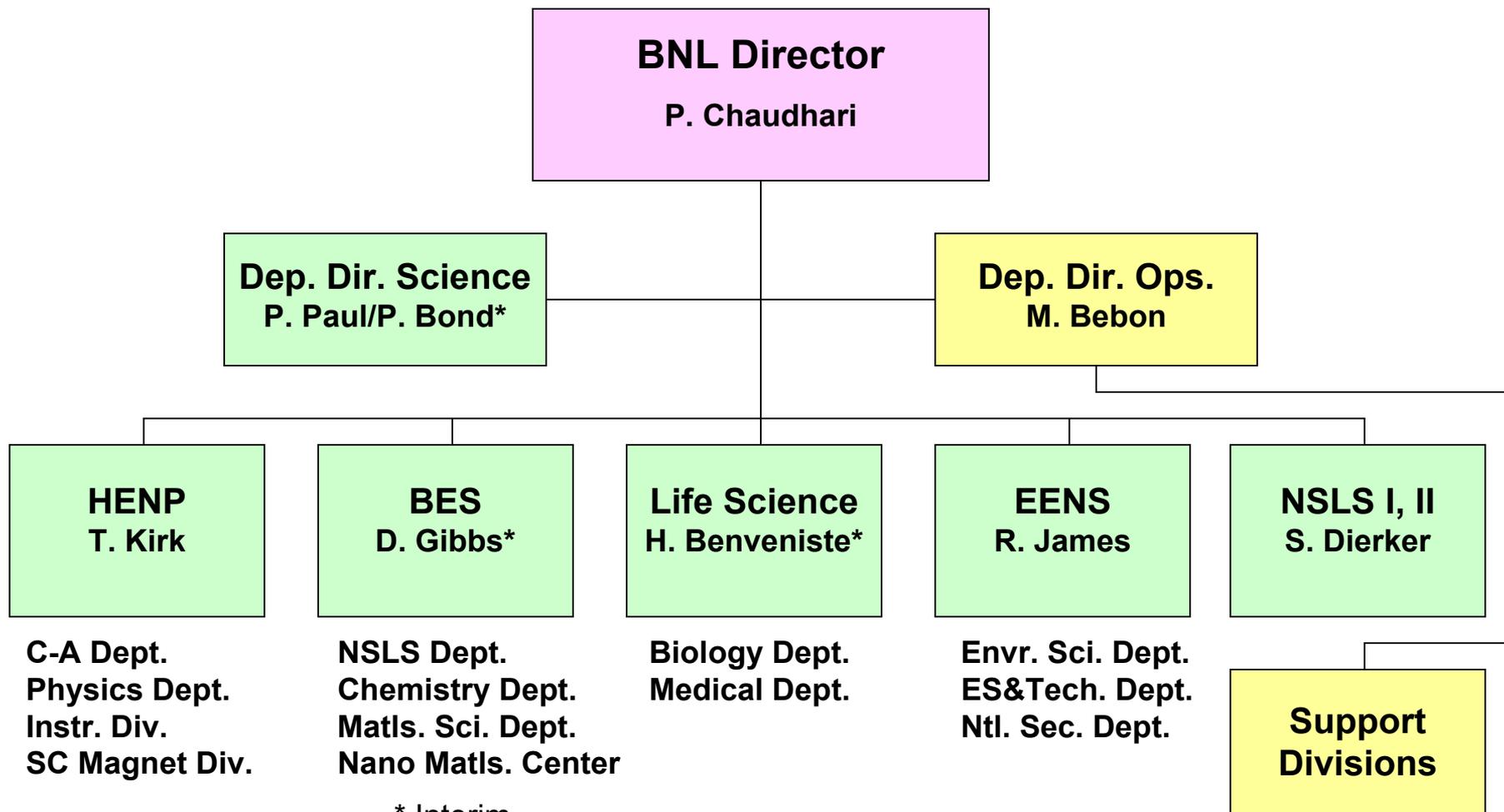
• RHIC-Related Nuclear Physics Research

- 5 experimental and 1 theoretical RHIC-related physics research groups at BNL
- Riken BNL Research Center contributes strongly to theory and spin physics
- *QCDOC supercomputer* for *Lattice Gauge Physics* approved -10 Tflops peak

• BNL's Instrumentation Division

- Nuclear Physics is a *prime beneficiary of BNL's Instrumentation Div.*
- RHIC upgrade technologies under development for PHENIX & STAR

BNL Science Organization



C-A Dept.
Physics Dept.
Instr. Div.
SC Magnet Div.

NSLS Dept.
Chemistry Dept.
Matls. Sci. Dept.
Nano Matls. Center

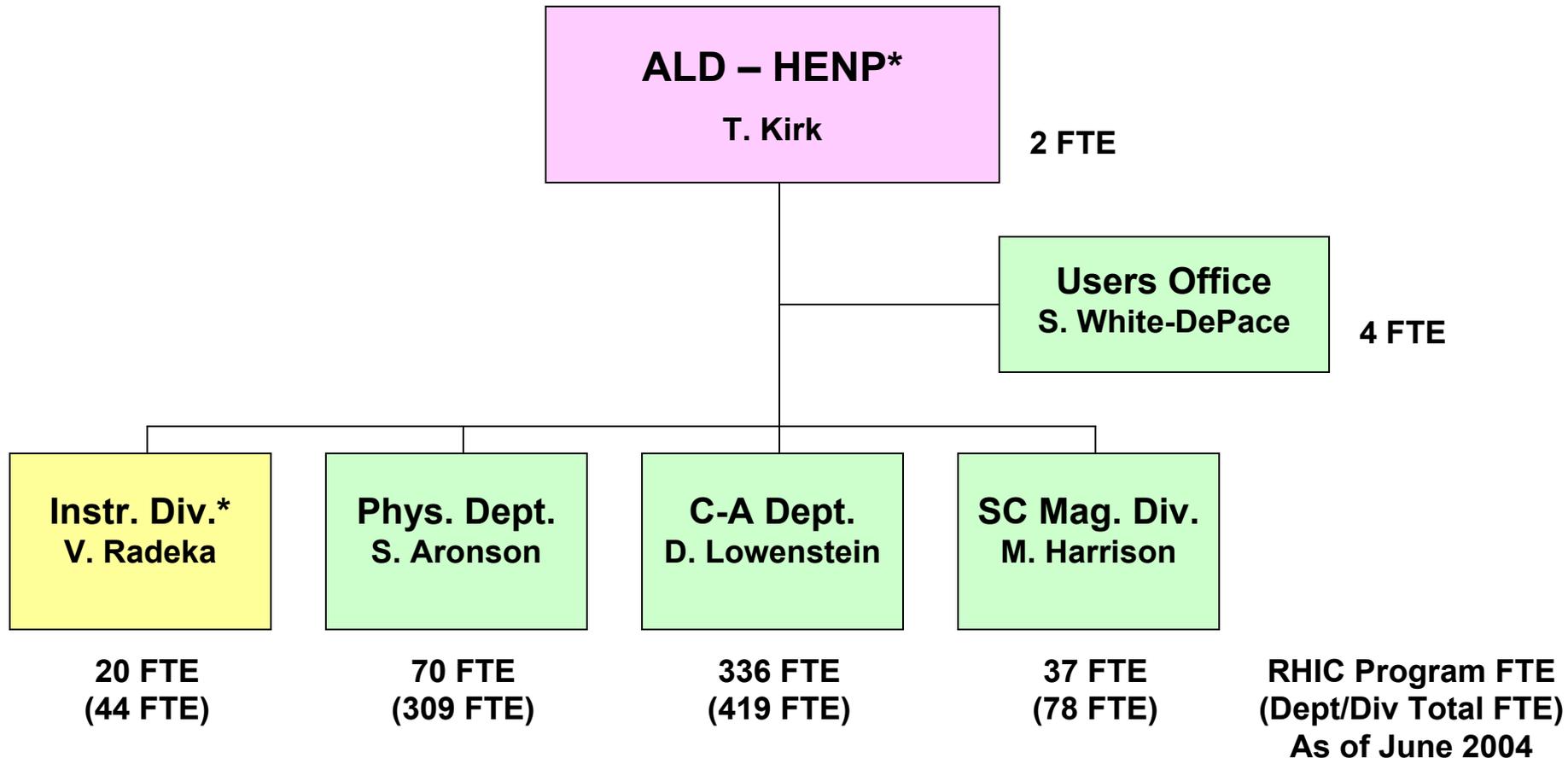
Biology Dept.
Medical Dept.

Envr. Sci. Dept.
ES&Tech. Dept.
Ntl. Sec. Dept.

Support Divisions

* Interim

BNL - HENP Organization Chart



* G&A supported organization

BNL HENP Program Advisory Committee

Stanley Brodsky

Stanford Linear Accelerator Center

Sarah Dawson

Brookhaven National Laboratory

Gerald T. Garvey

Los Alamos National Laboratory

Donald Geesaman

Argonne National Laboratory

Miklos Gyulassy

Columbia University

Wick Haxton

University of Washington

Robert Jaffe

Massachusetts Institute of Technology

Berndt Mueller

Duke University

Jack Sandweiss, Chairman

Yale University

RHIC Communications

BNL communicates with its RHIC users and other communities in many venues. Here, we list the current communications modes in use:

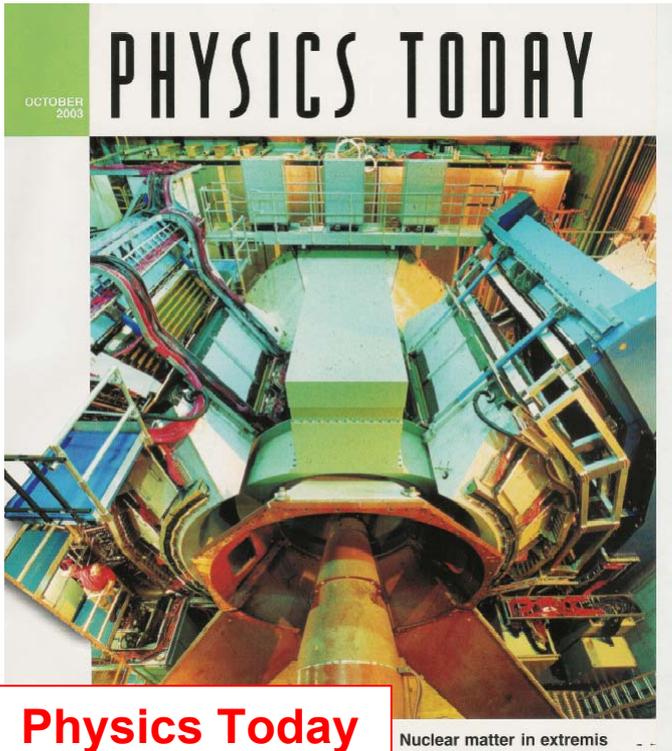
- **The web is the main venue for communication of facility/user information**
 - <http://www.bnl.gov/physics/>
 - <http://www.bnl.gov/userscenter/>
 - <http://www.agsrhichome.bnl.gov/>
 - <http://www.inst.bnl.gov/henp/>
 - <http://www.inst.bnl.gov/>
 - <http://www.bnl.gov/magnets/>
- **RHIC experiments maintain up to date publ/preprint lists on their web pages**
- **Time meetings and user status meetings are held weekly during RHIC runs**
 - running experiments representatives attend and participate in decision-making
 - C-AD staff leaders and managers report day to day status and actions
- **BNL organizes physics and upgrade workshops for new RHIC directions**
- **RHIC-AGS Users Group and Exec. Comm. interact with BNL management**
- **The long term RHIC program responds to user proposals and PAC advice**
- **The ALD-HENP meets monthly with RHIC Spokespersons on current issues**
- **RHIC-AGS Users Office and BNL Quality of Life Committee respond to needs**

Recent NP Program Highlights

- Drs. Jie Wei and Vladimir Litvinenko named *APS Fellows*
- Record breaking *RHIC Au-Au data run* yielded huge experimental data sets
- *Polarized proton beams* in RHIC improved performance in many ways
- *QM2004* in Oakland was dominated by RHIC results
 - reports from 4 RHIC experiments with important evidence for QGP
 - BRAHMS data suggests first observation of CGC effect
 - four articles in NYT plus coverage in numerous science venues
- 10 Tflops *QCDOC Supercomputer* funded for Lattice Gauge Physics at BNL
- RBRC sponsored a stimulating forum on *RHIC physics results* in May
- RHIC II and eRHIC appear in DOE's *Future Facilities Plan* – Nov 2003
- BNL's future program noted favorably in two high-level policy documents:
 - "Physics of the Universe", a Feb 2004 OSTP Strategic Plan advocates the RHIC II luminosity upgrade among its "Next Steps for Future Investments"
 - "Quantum Universe", a May 2004 HEPAP report includes RHIC as a 'major facility' "...whose primary physics goals align most directly with the report's nine questions"

RHIC publishes physics... and makes news!

BRAHMS: 4 Phys. Rev. Lett.;
PHOBOS: 9 Phys. Rev. Lett.
PHENIX: 18 Phys. Rev. Lett.
STAR: 25 Phys. Rev. Lett.



**Physics Today
 October 2004**

QM2004

THE NEW YORK TIMES, TUESDAY, JANUARY 20, 2004

Science Times

Like Particles, 2 Houses of Physics Collide

By JAMES GLANZ

MARCELLUS *What, has this thing appear'd again to-night?*
 BARNARDO *I have seen nothing.*
 — "Hamlet," Act I, Scene 1

OAKLAND, Calif., Jan. 14 — A bland and bulky conference center in this city's fog-bound downtown was transformed in recent days into the Elsinore of particle physics. The ghost that continually appeared, disappeared and appeared again during a scientific meeting was not the shade of a murdered king but a puff of primordial matter with an otherworldly name: the quark-gluon plasma.

This drama, like the original, involved not only a clash of great forces but also what some saw as betrayal and a measure of revenge. It drew in a pair of renowned

Blast From the Past

Smashing the nuclei of gold atoms at nearly the speed of light may — or may not — have produced a flash of quark-gluon plasma, which probably last existed in large amounts just after the Big Bang.

Brookhaven National Laboratory

**New York Times
 Jan 20, 2004**

Science, Chronicle of Higher Ed., Oakland Tribune, SF Chronicle, CERN Courier + 3 NYT

The process inside the collider:

- 1 PAIRS OF GOLD NUCLEI ACCELERATED TO NEAR LIGHT SPEED
- 2 COLLISION
- 3 POSSIBLE INSTANT OF QUARK-GLUON PLASMA
- 4 PARTICLES FLUNG OUT. Their paths are examined for signatures of quark-gluon plasma.

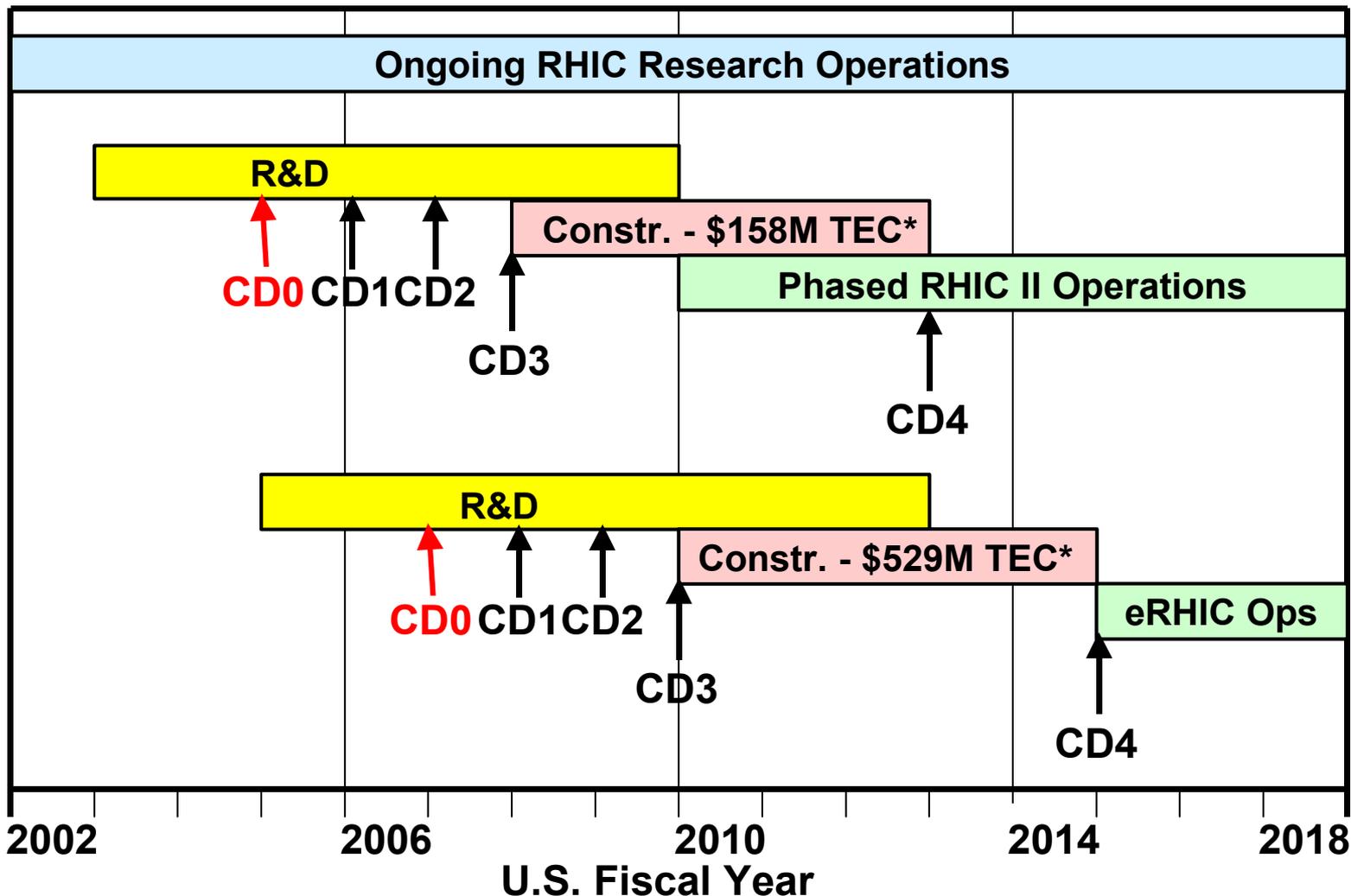
RHIC Future Directions

- **RHIC Facility Evolution** ⇒ **“Facilities for the Future of Science”, DOE Office of Science, Nov. 2003**
“RHIC II – This upgrade will provide a 10-fold increase in the luminosity (collision rate) of the RHIC, enabling scientists to create and study atomic particle collision events that happen only rarely, and to explore states of matter believed to have existed during the first moments after the Big Bang.”
- **BNL-RHIC Facility planning** ⇒ **“Twenty Year Planning Study for the RHIC Facility”, BNL, December 31, 2003**
- **“Quarks to the Cosmos”** ⇒ **“Physics of the Universe”, OSTP, Feb 2004**
“DOE and NSF will develop a scientific roadmap for the luminosity upgrade of RHIC in order to maximize the scientific impact of RHIC of HED physics.”
- **BNL large facilities - technically limited construction schedules**
 - RSVP, accelerator modifications plus beams & detectors [FY05 – FY09]
 - RHIC II luminosity upgrade, accelerator & detectors [FY08 – FY12]
 - Very Long Baseline Neutrino Oscillations [FY07 – FY10]
 - eRHIC facility, electron ring and new detector [FY10 – FY14]
- **BNL Priorities for the RHIC Program** ⇔ **DOE On-Site Review, April 2004**
 - RHIC QCD and Spin Physics head Laboratory priority list

Technically Limited RHIC Upgrade Schedules

RHIC II
DOE-NP

eRHIC
DOE-NP



* Estimates in FY 2004 Dollars

DOE-SC Goals

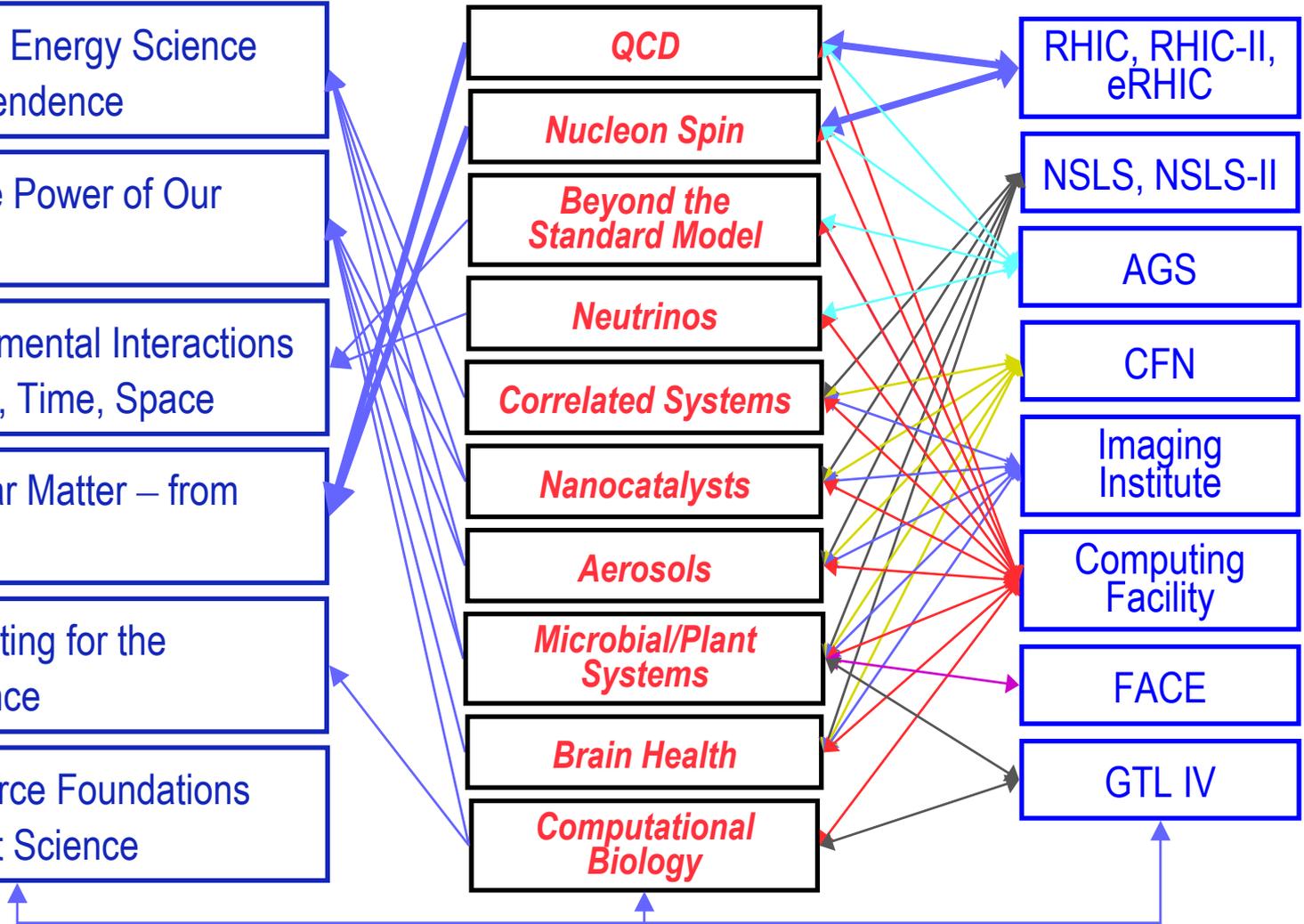
- 1. Advance Basic Energy Science for Energy Independence
- 2. Harnessing the Power of Our Living World
- 4. Explore Fundamental Interactions of Energy, Matter, Time, Space
- 5. Explore Nuclear Matter – from Quarks to Stars
- 6. Deliver Computing for the Frontiers of Science
- 7. Provide Resource Foundations that Enable Great Science

BNL Leadership Themes

- QCD*
- Nucleon Spin*
- Beyond the Standard Model*
- Neutrinos*
- Correlated Systems*
- Nanocatalysts*
- Aerosols*
- Microbial/Plant Systems*
- Brain Health*
- Computational Biology*

BNL Facilities (\$\$)

- RHIC, RHIC-II, eRHIC
- NSLS, NSLS-II
- AGS
- CFN
- Imaging Institute
- Computing Facility
- FACE
- GTL IV



BNL Response to 2003 Review Action Items

“1) BNL should develop a prioritized 5-year and a long-term 10-year strategic plan that optimally exploits the RHIC accelerator and detectors, especially during the next 5-years before the heavy ion program begins at the LHC, paying particular attention to the integration of the beam schedule, the scientific program, risks and the available resources. The plan should include milestones, timelines and the provision to monitor progress. A copy should be submitted to DOE by December 31, 2003.”

BNL submitted “Twenty Year Planning Study for the RHIC Facility” to DOE ONP on December 31, 2003.

“2) In order to guarantee continued physics output, RHIC management should set a minimum performance goal that will be achieved with high priority. Furthermore, an effort should be made to improve the “up time” beam fraction from 20% to a value that is more comparable to other collider accelerators.”

BNL collaborated with DOE ONP on Performance Measures for the FY04 Run and exceeded all three performance measures; the measures included an availability of 80.4% of scheduled physics collision time.

“3) The replacement of the tandems by an EBIS source has merit and DOE and BNL are encouraged to implement this.”

BNL has submitted a request to DOE ONP for approval of the EBIS Project; DOE is now preparing a CD0.

BNL Response to 2003 Review Action Items (Cont.)

“4) Construction and installation of a strong Siberian snake in the AGS should proceed expeditiously to improve the proton polarization. A long-term schedule with realistic goals and milestones for the polarized proton program needs to be developed.”

BNL is constructing a cold snake for AGS; installation December 2004 (Mei Bai talk)

“5) Given its importance for future operations and future projects, R&D of electron cooling should be pursued.”

BNL R&D is in progress on electron cooling (Thomas Roser talk).

“6) BNL should explore the feasibility of mounting a joint effort with other national laboratories to ensure the availability of new and remanufactured linac power amplifier tubes.”

BNL has ordered and expects to receive new/reconditioned 7835 power tubes from Burle Industries this year. (Wolfram Fischer talk)

“7) Staffing levels for the local support groups should be at least maintained at present strength, or preferably strengthened to ensure an optimal operation of the RHIC.”

BNL has not maintained staff because DOE research funding levels are below inflation on Long Island.

“8) The RHIC/AGS UEC is encouraged to continue its effort to ensure that the composition of RHIC/AGS Users Executive Committee reflect the interests of foreign users. The DOE should assist in any way it can to promote the case for having reasonable visa and security regulations for non-US laboratory users.”

The RHIC-AGS Users Executive Committee has taken positive steps to increase the representation of non-U.S. users on the UEC.

Safety

- **Safety is a priority at BNL before all programmatic considerations**
 - employees, users and visitors must be secure against injury at BNL
 - safety at BNL is a line management responsibility, starting with the director
 - indications of injury 'clusters' are the subject of intense study and result in explicit actions for mitigation and elimination (laser safety, rigging, etc.)
- **Safety in the HENP Departments and Divisions is a primary focus**
 - all potentially hazardous circumstances and activities are evaluated for safety implications and subject to *Enhanced Work Planning*
 - safety discussions are *mandatory at least once per week* in all HENP meetings or in some alternate forum
 - lost work days are closely tracked, displayed prominently and discussed as safety topics in group forums
 - HENP departments and divisions have better than DOE average safety records
- **Safety in the RHIC-AGS Facility engages all users**
 - all persons working in the RHIC experiments must receive appropriate training for their level of responsibility
 - RHIC-AGS training is tracked and training renewed on a prescribed cycle

ALD Priorities for the RHIC Program

(in decreasing order)

- **RHIC must run for colliding beam data every year**
 - the goal is 37 weeks/yr, of which at least 30 are for experiments
 - HI/p \uparrow mix will be driven by Beam Use Proposals & PAC recommendations
 - a nominal beam mix, averaged over time, will be 2/3 HI, 1/3 p \uparrow p \uparrow
- **RHIC research requires strengthening of funding support**
 - BNL and collaborating universities are both critically under-funded
- **RHIC will require continuous upgrade/capital improvements**
 - AIP funding requires a funding level of \$5M/yr or greater
 - facility capital funding for accelerator maintenance requires \$1M/yr
 - special projects requiring more will result in competitive proposals to DOE
- **PHENIX and STAR will require continuous upgrade/cap actions**
 - the facilities capital equipment level needed for RHIC detectors is ~\$5M/yr
 - computing support in RCF will require \$2M/yr to meet data processing needs
 - competitive research capital equipment funds of ~\$5Myr likely to be proposed
- **Other AGS/RHIC experiments will be accommodated as possible**
 - RHIC 4-hour stores allow up to 20hrs/day for AGS fixed-target physics (RSVP)

Priorities are applied in the most program-effective manner, not in simple series order.

ALD Conclusions and Summary

- **RHIC has been scientifically productive**
 - data from the Au-Au run of FY04 exceeded integrated luminosity predictions
 - DOE performance measures for the FY04 run were all exceeded
 - theoretical analysis and interpretation has been fully active and engaged
 - **54 PRL publications** to date; a growing number of longer papers in progress
- **RHIC and its experiments have begun planning upgrades**
 - e-Cooling R&D is underway in the C-AD
 - PHENIX and STAR have embarked on their upgrade R&D paths and have completed and submitted proposals for their first near-term upgrade projects
- **Funding for the RHIC Facility is expected to improve in FY 2005**
 - RHIC facility funding expected to reach 31 cryo/24 physics weeks in FY05
 - RHIC research funding levels for Labs and universities continues to be tight
 - **R&D** for RHIC facility evolution continues in FY04 at an improving level
- **Viable & competitive future directions for RHIC have been identified**
 - the RHIC luminosity upgrade path is well-matched to developing HI physics
 - the **RHIC II** upgrade is noted and endorsed in high-level policy documents
 - the **eRHIC** facility will provide unique new physics in the longer-term future