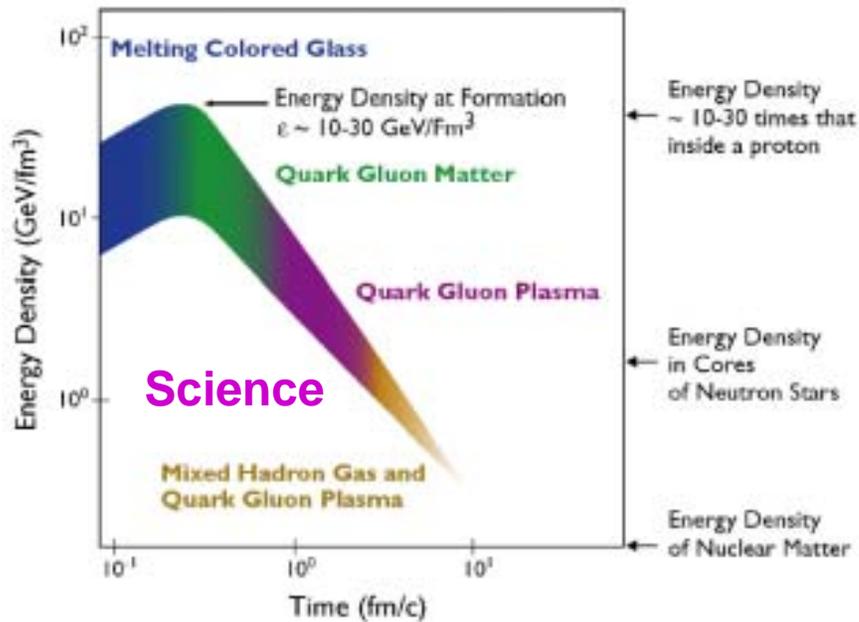


NSAC Subcommittee on Heavy Ion Physics Long Range View - BNL Outlook



Facilities

Thomas B.W. Kirk
Associate Laboratory Director
High Energy & Nuclear Physics

June 4, 2004

Plan of the Talk

- RHIC Science Vision
- RHIC Program Phases
- Role of Lattice Gauge Theory in RHIC Physics
- Activities to Advance the RHIC Program
- Laboratory Priorities
- Schedule of Upgrades – RHIC II & eRHIC

BNL Vision in Nuclear Physics

Office of Science Goal 5: “Explore Nuclear Matter – From Quarks to Stars”

- **Our Science Vision is driven by study of high energy density nuclear matter**
 - the discovery and characterization of **QGP*** is a fundamental area of knowledge for NP
 - other new phenomena (such as **CGC***) will emerge in this work to enrich nuclear physics
 - **Spin Physics** will soon grow rapidly as a productive area of nucleon structure advances
 - connecting **soft QCD** with QGP will be critically advanced by **lattice gauge theory**
- **RHIC, RHIC II, eRHIC and QCDOC provide unique tools for realizing our vision**
 - **RHIC** is already dominating world advances in the field of high energy density matter
 - continuing scientific evolution of the RHIC program will be enabled by the **RHIC II Project**
 - a unique program of relativistic nuclear structure (CGC) is provided by the **eRHIC Project**
 - lattice gauge theory computations will be strongly advanced by **QCDOC** supercomputers
- **Collaborative Research Groups at BNL and User Institutions power science**
 - BNL and RHIC institutions have built a strong experimental community to perform the work
 - BNL and **RBRC** have backed the RHIC experiments with a strong nuclear theory effort
 - lattice gauge theory research efforts are growing steadily at BNL and RBRC
 - BNL is building collaborations in accelerator design with MIT Bates, AEI and JLab

* QGP \Leftrightarrow Quark Gluon Plasma; CGC \Leftrightarrow Color Glass Condensate

RHIC Facility Evolution – Near Term RHIC

Office of Science Goal 5: “Explore Nuclear Matter – From Quarks to Stars”

• Science Goals

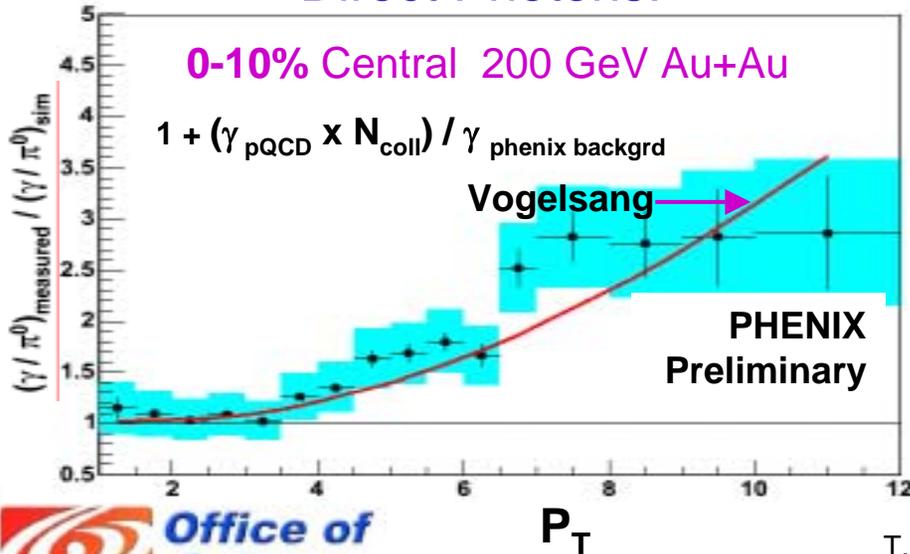
- discover and characterize Quark Gluon Plasma (**QGP**)
- determine the gluon’s role in the spin of the proton

• RHIC Detector Goals

- upgrades for new capabilities
- consolidation into 2 detectors

Direct Photons!

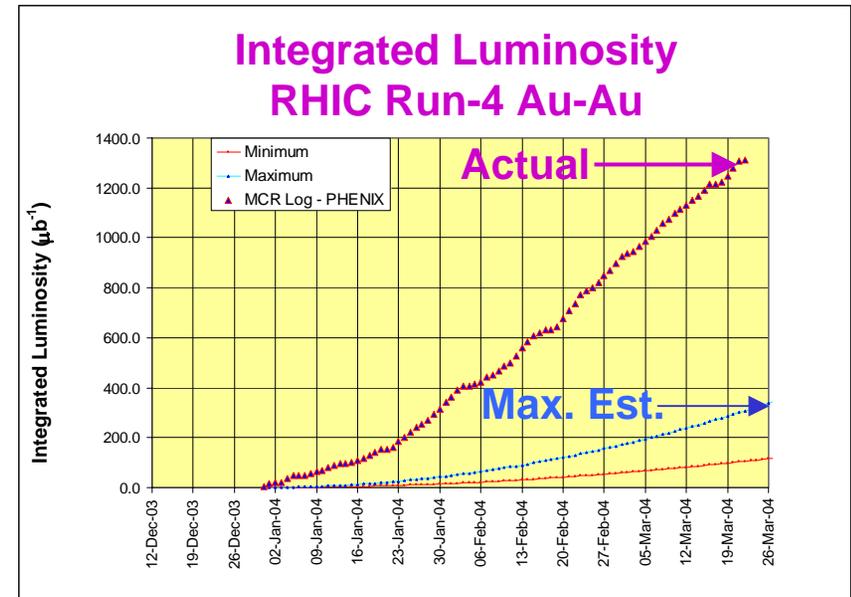
0-10% Central 200 GeV Au+Au



• RHIC Machine Goals

- increase injector intensity
- achieve 70% beam polarization
- RHIC II & eRHIC R&D
- **EBIS**

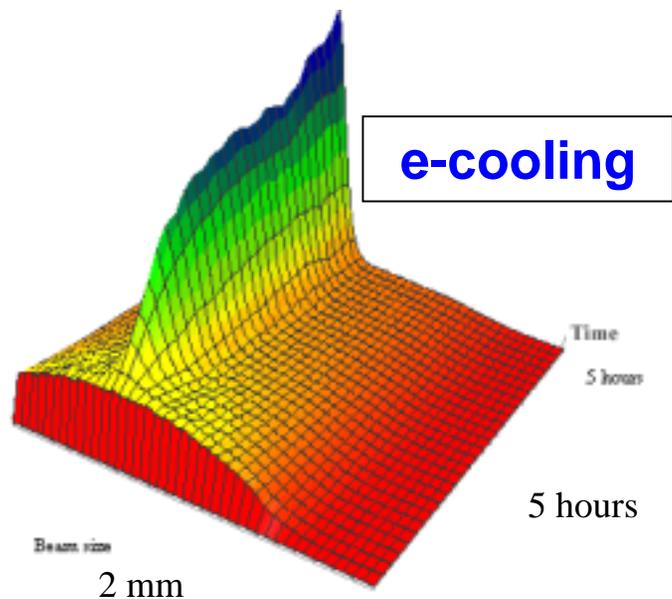
• LGC: 10 Tflops QCDOC



RHIC Facility Evolution – RHIC II

Office of Science Goal 5: “Explore Nuclear Matter – From Quarks to Stars”

- High P_T & heavy quark measurements will extend our characterization of **QGP** through very rare processes
- Polarized W-production leads to a deep understanding of nucleon spin

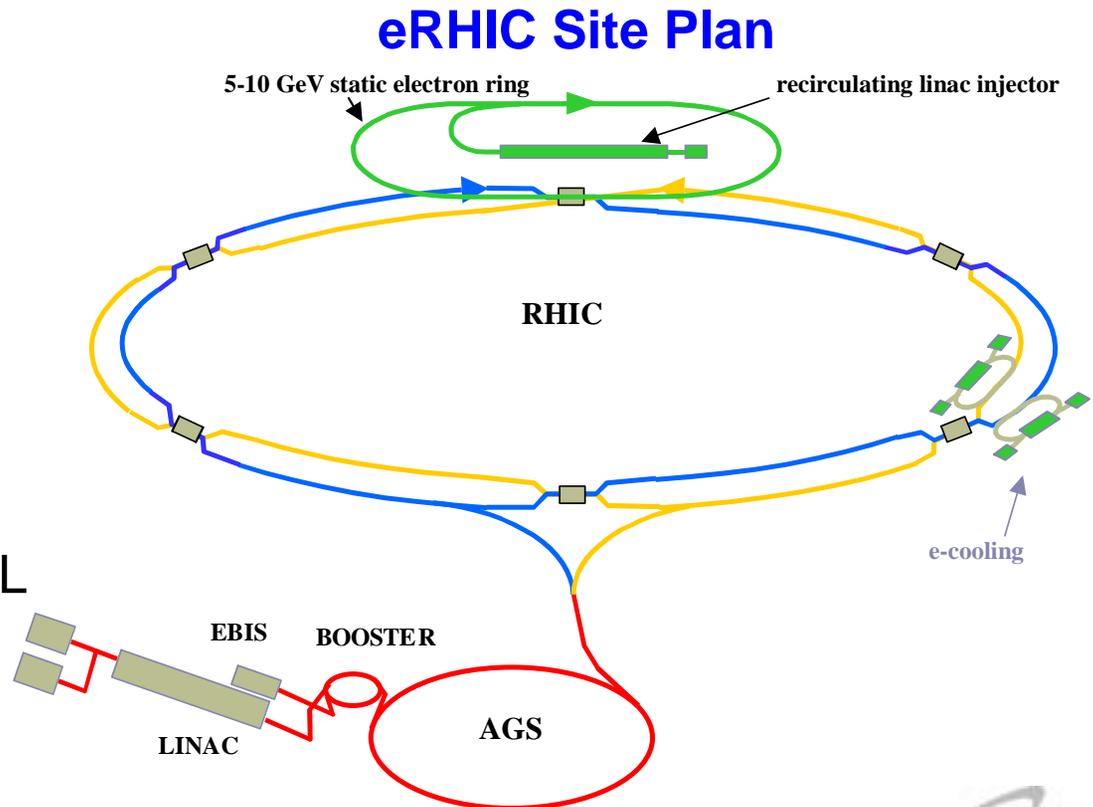


- Upgraded STAR and PHENIX Detectors, increased rate and technical reach
- Electron cooling at full-energy in RHIC enables **10X** increase in *average Luminosity*
- Continuous evolution of Lattice Gauge Physics and supercomputing at BNL

RHIC Facility Evolution – RHIC II

Office of Science Goal 5: “Explore Nuclear Matter – From Quarks to Stars”

- eRHIC uniquely enables the discovery and characterization of Color Glass Condensate (**CGC**), a unique Bose condensate of **gluonic matter**, plus the extension of **gluon polarization** measurements to “**wee X**”
- eRHIC requires upgrade of the existing RHIC facility (10 GeV e-ring plus a new experimental detector)
- a strong NP community is already well-started in both physics and machine R&D to move eRHIC forward
- MIT-Bates partners with BNL in eRHIC; HERA physicists and others will join in



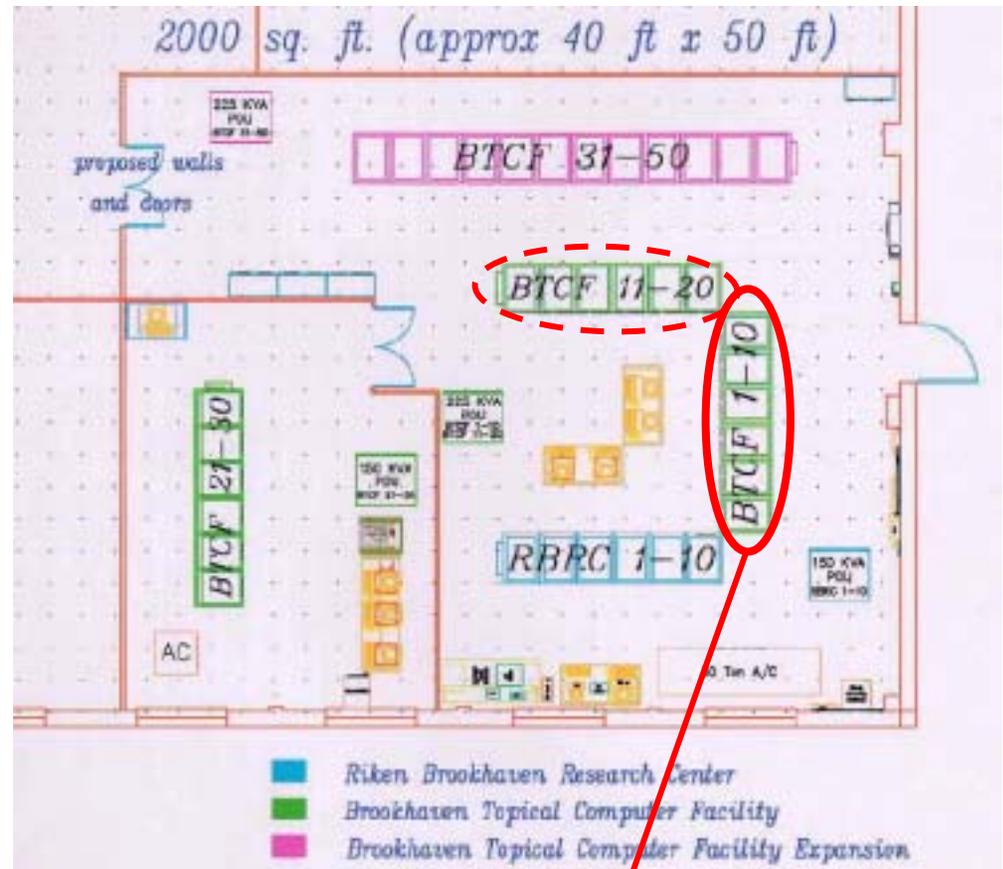
T. Kirk
June 4, 2004

Lattice Gauge Center at BNL

- 512 QCDOC nodes are currently operating successfully with LGP codes and show full functionality
- Columbia Univ., RBRC and BNL will commission the 10 Tflops RBRC and UKQCD machines at BNL
- DOE NP and HEP are co-funding a 10 Tflops QCDOC at BNL



QCDOC daughter board



**10 Tflops (peak)
QCDOC module**

BNL Activities to Reach our Goals

- **BNL engages in diverse planning activities**
 - we believe *BNL aligns well* with DOE's 2004 "**Office of Science – Strategic Plan**"
 - the RHIC community participates in the **Nuclear Physics Long Range Plan** activities
 - each RHIC Collaboration has produced its own future physics planning document
 - a **20-year BNL Plan** was produced by BNL for use by DOE and the Laboratory
 - workshops have been held over a three year period to develop the eRHIC science potential
 - advice and counsel on long range planning for NP at BNL was provided by the **BNL PAC**
 - BNL physicists (along with others) are exploring the HI capabilities of ATLAS at LHC
 - this review inaugurates NSAC's assessment of world research capabilities in HI physics
- **BNL competes in advocacy forums for future facilities in Nuclear Physics**
 - RHIC II/eRHIC earned a top ranking from the 2003 NSAC Future Facilities Panel
 - **RHIC II** & **eRHIC Projects** are included in the "**Facilities for the Future of Science**" Plan
 - RHIC ^L **upgrade** is advocated in OSTP's "**Physics of the Universe**" 2004 Strategic Plan
 - the lattice gauge power of **QCDOC** has competed successfully with a 'clusters' approach
- **BNL conducts forward-looking programs of accelerator and detector R&D**
 - *electron cooling and photocathode research* will determine the enabling path to RHIC II
 - *SC solenoid magnet R&D* will show how to align the electron and ion beams for cooling
 - RHIC Collaborations are pursuing a focused R&D effort for *new detector capability*
 - eRHIC collaborators are studying *detector concepts integrated with collider optics*

DOE-SC Goals

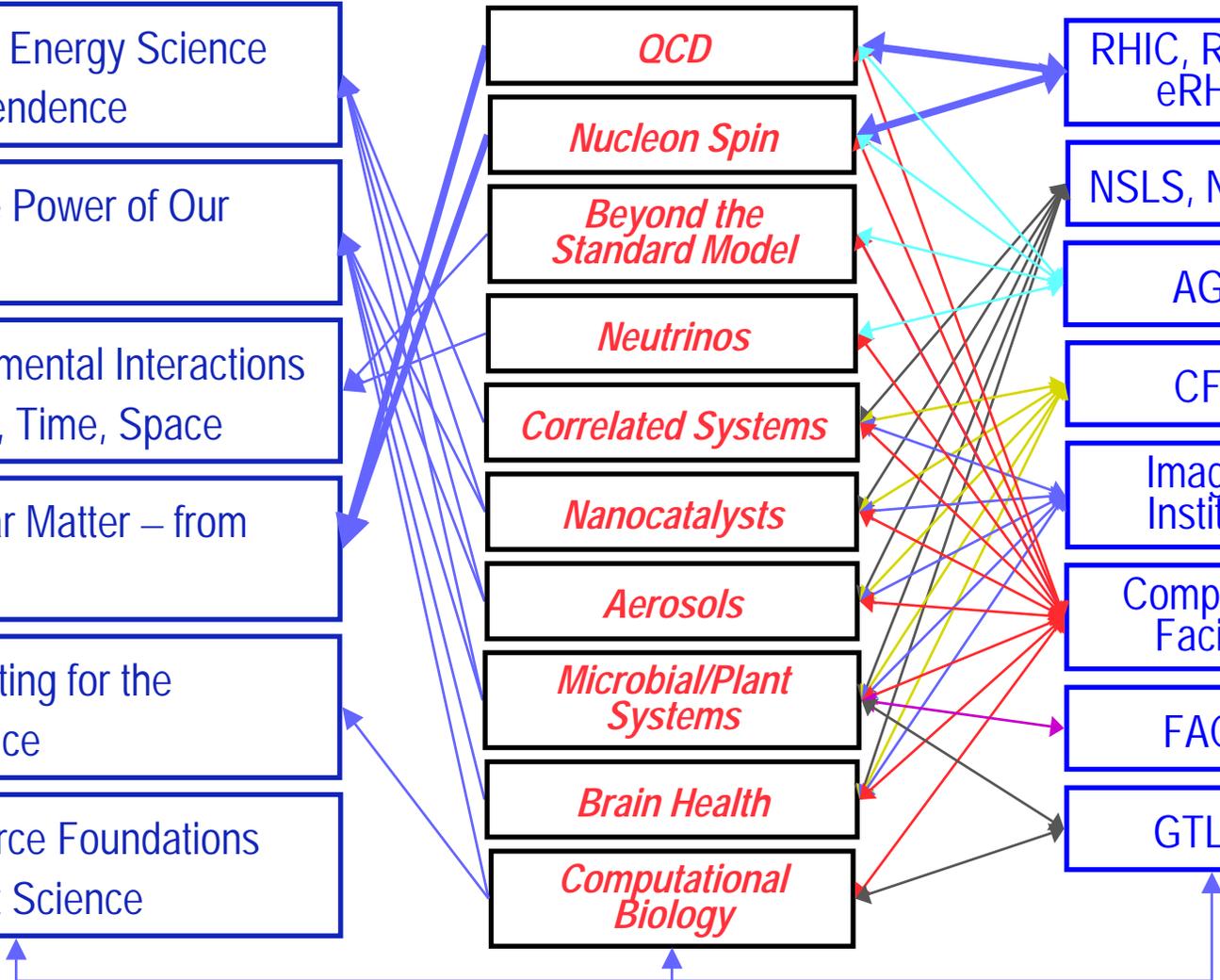
- 1. Advance Basic Energy Science for Energy Independence
- 2. Harnessing the Power of Our Living World
- 4. Explore Fundamental Interactions of Energy, Matter, Time, Space
- 5. Explore Nuclear Matter – from Quarks to Stars
- 6. Deliver Computing for the Frontiers of Science
- 7. Provide Resource Foundations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

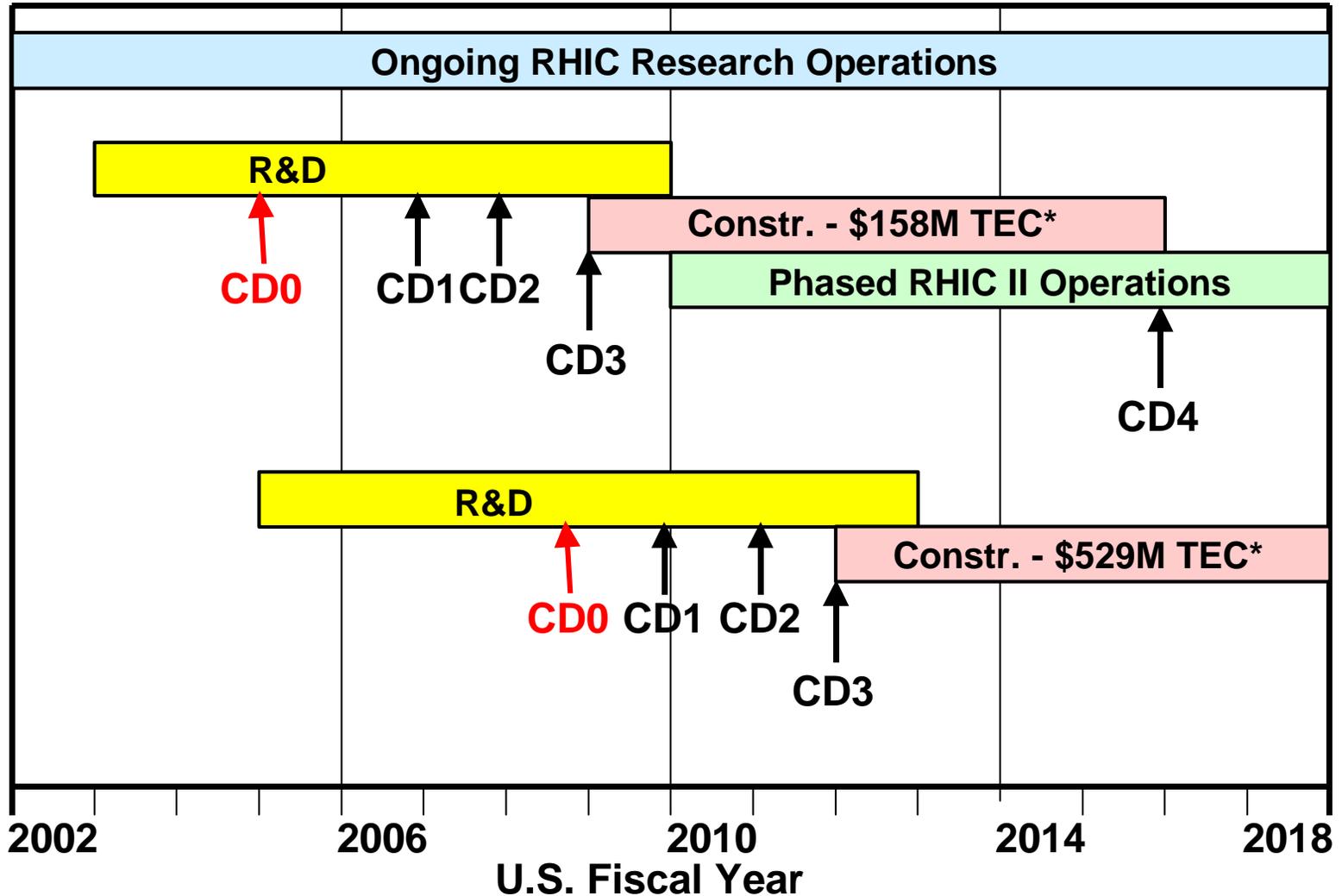
- RHIC, RHIC-II, eRHIC
- NSLS, NSLS-II
- AGS
- CFN
- Imaging Institute
- Computing Facility
- FACE
- GTL IV



RHIC Upgrade Schedules for 2004 Inst. Plan Rev.

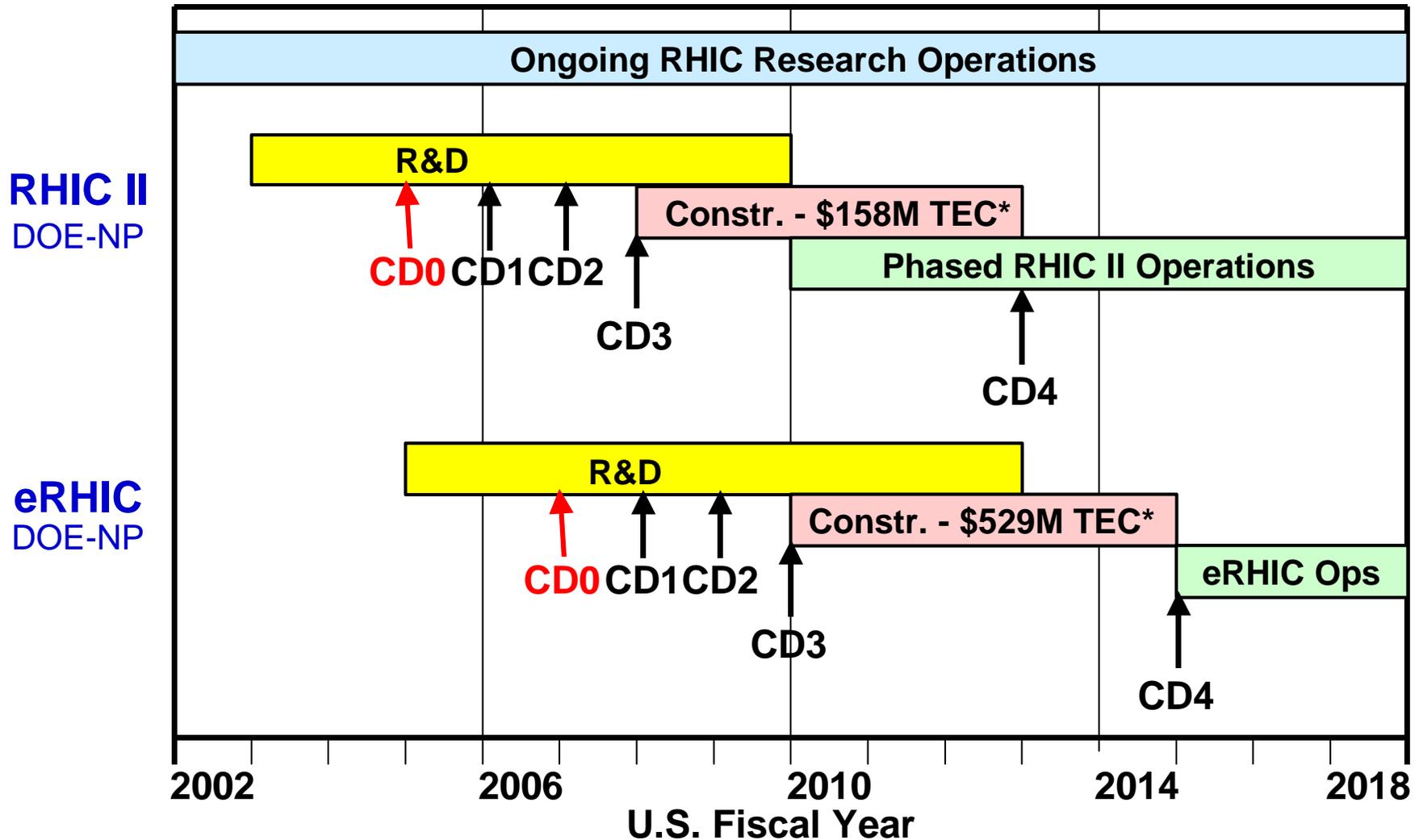
RHIC II
DOE-NP

eRHIC
DOE-NP



* Estimates in FY 2004 Dollars

Technically Limited RHIC Upgrade Schedules

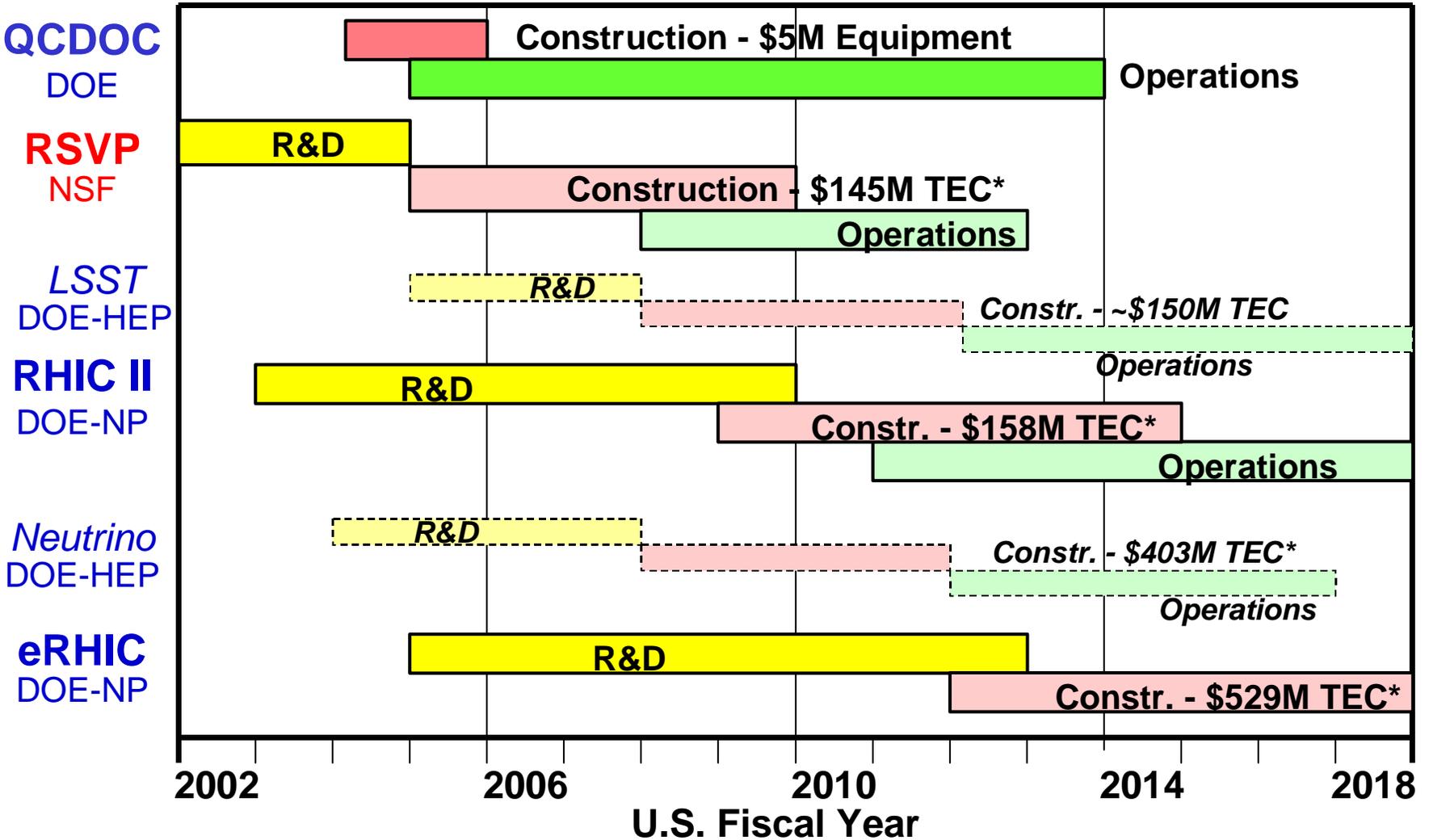


* Estimates in FY 2004 Dollars

Connections to DOE Critical Milestones

- **CD0 – Approve Mission Need for RHIC II and eRHIC**
 - **RHIC II** & **eRHIC Projects** are included in the **"Facilities for the Future of Science"** Plan
 - RHIC ^L **upgrade** is advocated in OSTP's **"Physics of the Universe"** 2004 Strategic Plan
 - The **2004 NSAC Subcommittee on Relativistic Heavy Ions** could meet the DOE's "Mission Need Independent Project Review" criterion for the RHIC II CD0
 - the 2005(?) **Nuclear Physics Long Range Plan** could meet DOE's "Mission Need Independent Project Review" criterion for the eRHIC CD0
 - many planning documents exist to assist DOE's ONP in creating the required documents needed to meet the **"CD0 Critical Decision Prerequisites"** for RHIC II and eRHIC
- **CD1 and CD2 - Approve Preliminary and Performance Baselines**
 - we believe the many criteria for CD1 And CD2 could be met in the FY05-06 time frame for RHIC II and in the FY07-09 time frame for eRHIC
- **CD3 and CD4 – Approve Start of Construction and Project Closeout**
 - the projections we make for CD3 and CD4 for RHIC II and eRHIC reflect a **success-oriented and technically limited plan** that BNL and the RHIC collaborations believe could be realized; the effects of R&D delays and/or funding limitations are not addressed in the milestones we display for this review

BNL HENP Facility Initiatives



* Estimates in FY 2004 Dollars