NPP's Role in

BSA Vision and Plans

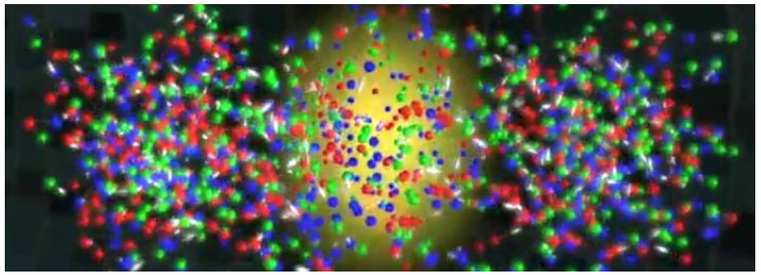
Presented by
Berndt Mueller

November 18, 2014

BROOKHAVEN SCIENCE ASSOCIATES
Charting a Path to Discovery

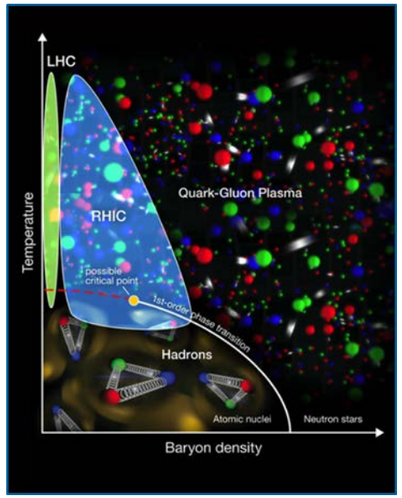
BSA Has Been Selected to Manage BNL for the Next 5 Years (with Possible Extensions up to 20)

- BSA: Deep and experienced partners with a strong commitment to the Lab
  - Fiduciary: Stony Brook University and Battelle
  - Distinguished Core universities: Columbia, Cornell, Harvard, MIT, Princeton, and Yale
- Impressive track record over 15 years: established excellent community relations, successful RHIC ops and the perfect fluid, successful NSLS ops: 2500 users per year, CFN, NSLS-II, significant improvements to safety record and infrastructure
- Exciting vision for the future that takes advantage of BNL's strengths and will have recognizable impact on DOE's mission
- Deep, proven and passionate management team, committed to the vision, to BNL and to each other

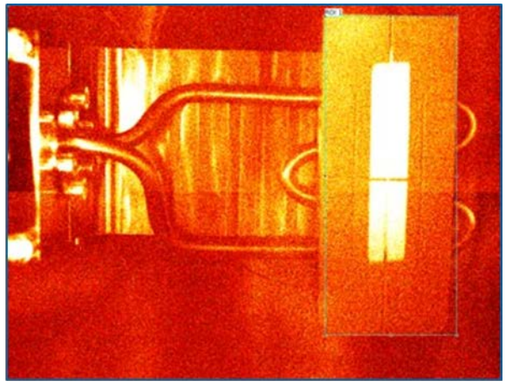


Strong Commitment of BSA and Partnership with NYS

- BSA: Strong commitment to BNL's future
  - Continued management expertise and access, both science and operations, from all partners: Continuous learning and improvement
  - SBU will double the number of Joint Appointments to 46 in the next ten years
  - Discovery Park Site Development
  - College Scholarships, STEM Education, Community Outreach, and Corporate Support
- BSA/New York State Partnerships
  - Energy storage at NSLS-II
  - Computational Science
  - Preparations for eRHIC



Discovery of the Perfect Fluid


First Light at NSLS-II

Novel Radiation Detectors

BSA's Vision in 2025

- **Vision:** Brookhaven is among the world's few pre-eminent science laboratories. BNL provides broad leadership in nuclear, photon, and energy sciences; conceives, builds and operates premier user facilities serving highly productive user communities; leads in the application of data sciences to enable discovery at those facilities; and accelerates DOE's mission in high energy physics, applied energy sciences, environmental/biological sciences and nonproliferation through focused, distinctive programs. The Laboratory operates at the highest levels of safety and efficiency, on a fully modernized campus.

- **Culture of Excellence:** This vision is based on BSA's core philosophy of simultaneous excellence in science, laboratory operations, and in community service.

BSA's Vision: Building a World-leading, Preeminent DOE Science Lab for the Future

- Leadership in nuclear physics, photon sciences and energy sciences
- Premier user facilities
- Accelerated BER, HEP, nonproliferation and applied energy missions
- Leadership in big data
- Enabled by renewed campus and safe/efficient operations

Critical Outcomes

- Understanding the origins of matter and mass
- Transformational discovery through synchrotron science
- *In operando* and *in situ* energy science leadership
- Leadership in data-driven discovery
- Renewed research campus that enables BNL's research mission
- Safe, efficient operations that ensure delivery of BNL's research mission

Brookhaven National Laboratory – Next 10 Years (SC Lab Plan)

Vision

To be the leading U.S. DOE, multi-program laboratory with recognized impact on national science needs

- Leadership in nuclear physics, photon sciences and selected areas of energy science
- Accelerate DOE missions in HEP, BER and national security
- Leadership in data-driven computational science

Mission

Utilize our world-class facilities and expertise to:

- Advance energy and environment-related basic research and apply them to 21st Century problems of critical importance to the Nation
- Advance fundamental research in nuclear and particle physics to gain a deeper understanding of matter, energy, space, and time

Strategy

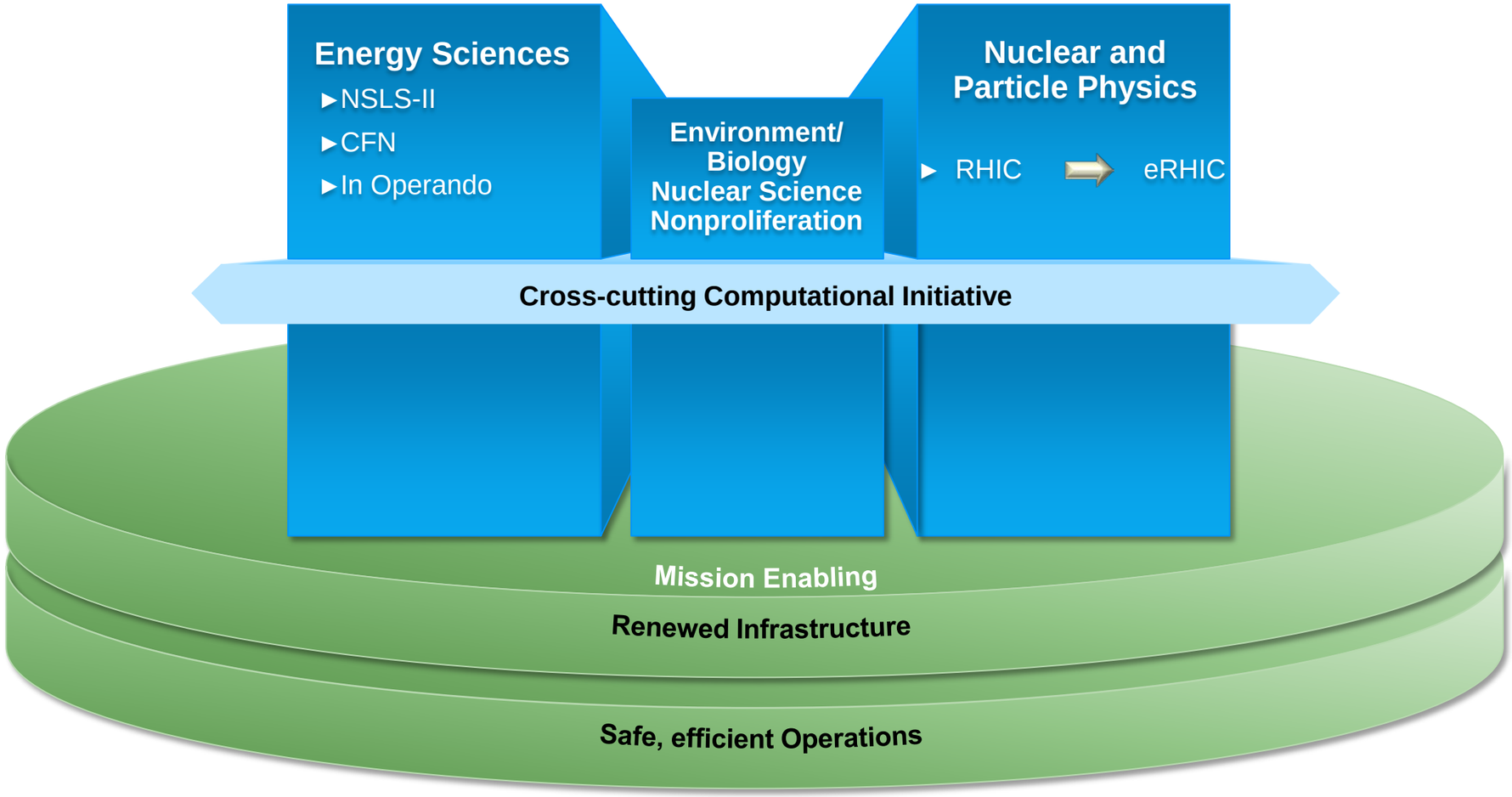
Position our major user facilities (**NSLS-II, CFN** and **RHIC → eRHIC**) for continued leadership roles

- Integrate our programs and facilities, including outreach to universities, industry, and other National Laboratories to enable us to solve complex problems of national importance

Enabled by renewed infrastructure and safe/efficient operations

6

The Laboratory Pillars

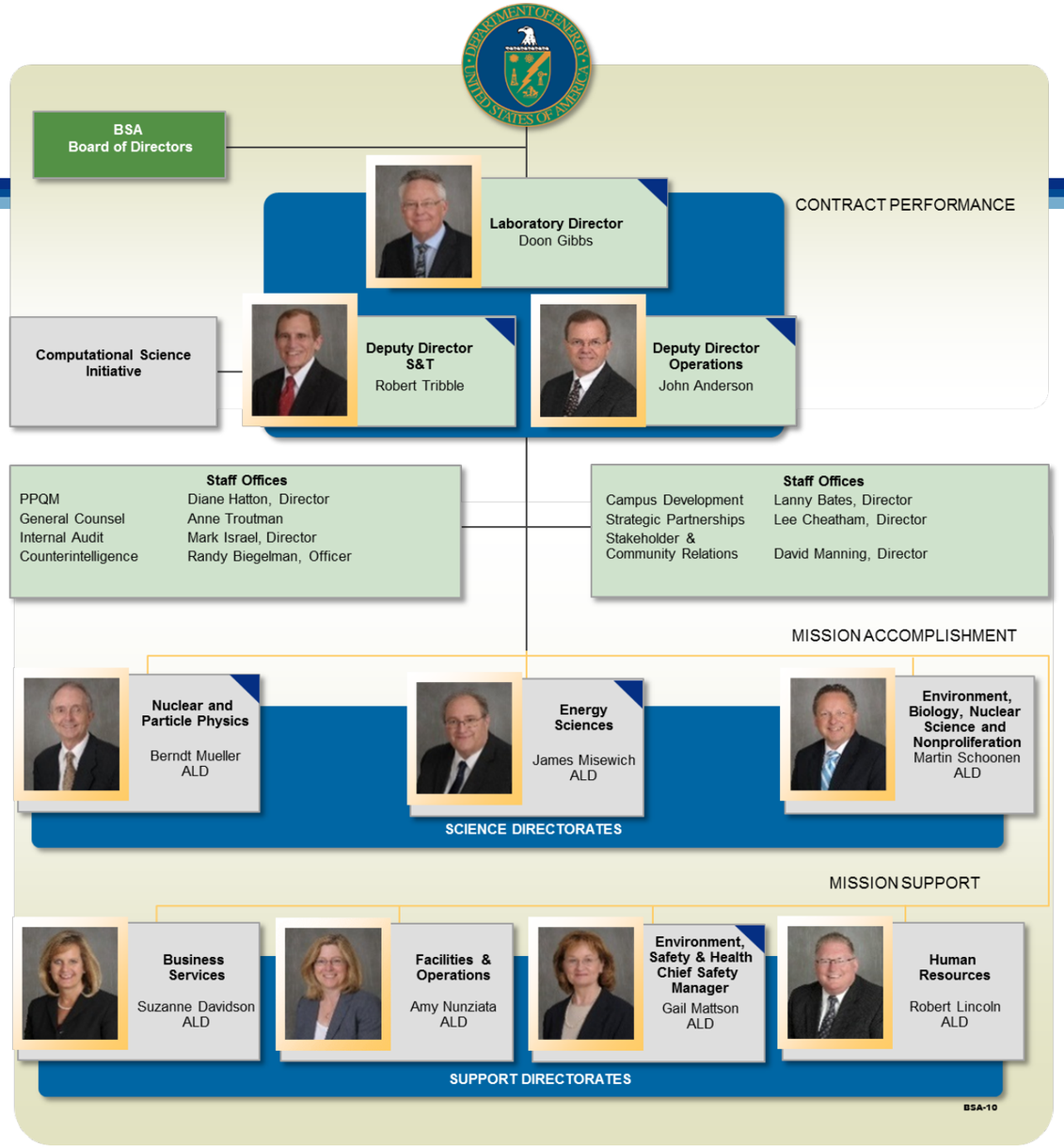


Our Organization Is Redesigned to Achieve Our Vision

- Integrated Energy Sciences Directorate (Feb. 1)
  - NSLS-II
  - CFN
  - Basic Energy Sciences
  - Applied Energy Sciences
- Environment, Biology, Nuclear Science and Nonproliferation (as this summer)
- Created Lab-level initiative in Computational Science: Big Data
- Consolidate Business Services and ITD
- Established three new staff offices
  - Campus Development
  - Strategic Partnerships
  - Planning, Performance and Quality Management

Benefits

- Clear leadership for each Critical Outcome
- Greater impact through consolidation
- New functionality without greater complexity



We Can Afford Our Vision, But It Will Require Commitment

- To achieve our goals in science, operations and infrastructure, including both the critical outcomes and additional program development, we will need to increase our investments over the next ten years.
- We propose a plan of growth and savings with targeted re-investment.
- Specifically, real growth by an average of about 2% each year combined with re-investment of at least half of the resulting increased indirects, implies we will meet our goals with room to spare.
  - Science ALDs have growth targets and will be accountable for them. They will be led by DDST.
  - All support/support ALDs and Staff Directors will be accountable for the savings, led by DDO.

Science Critical Outcomes - Expanded

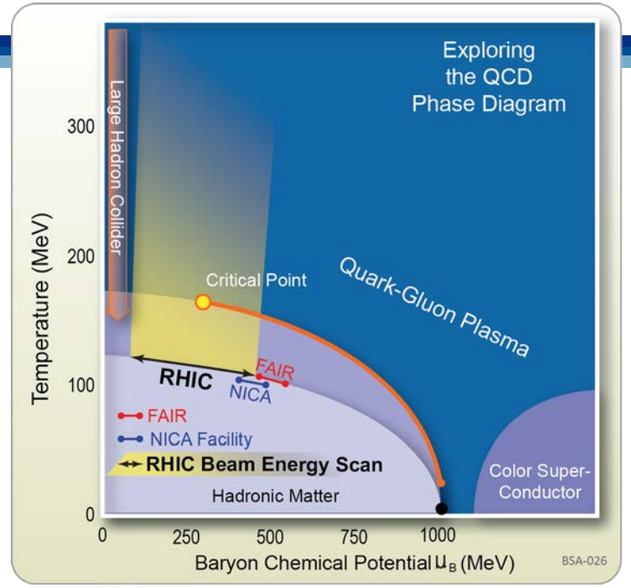
Critical Outcomes	Programs and Facilities Leveraged	Breakthrough Science	DOE Sponsor
Origins of Matter and Mass	RHIC and eRHIC	• Quantum Chromodynamics (QCD) Phase Diagram • Gluon Nature	Office of Nuclear Physics (ONP)
Transformation of Synchrotron Science	NSLS-II with full set of beamlines	• X-rays for nanoscale imaging • In situ studies with unprecedented resolution	Office of Basic Energy Sciences (BES)
In operando/in situ Energy Science	NSLS-II and Center for Functional Nanomaterials (CFN) integrated for topical area	• Catalysts at work • Real batteries in charge/ discharge • Complex materials in situ	BES; Energy Efficiency and Renewable Energy (EERE); Advanced Research Projects Agency-Energy (ARPA-E)
Data-driven Discovery	Computing Center and Facilities	• Real time data analysis • Complex modeling • Very large data volume storage and distribution	Advanced Scientific Computing Research (ASCR); ONP; High-Energy Physics (HEP); BES, Biological and Environmental Research (BER)

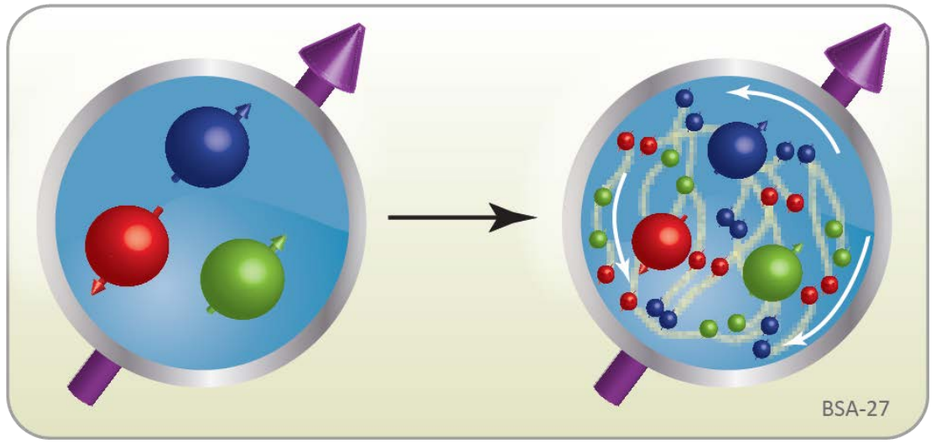
BNL LEADERSHIP

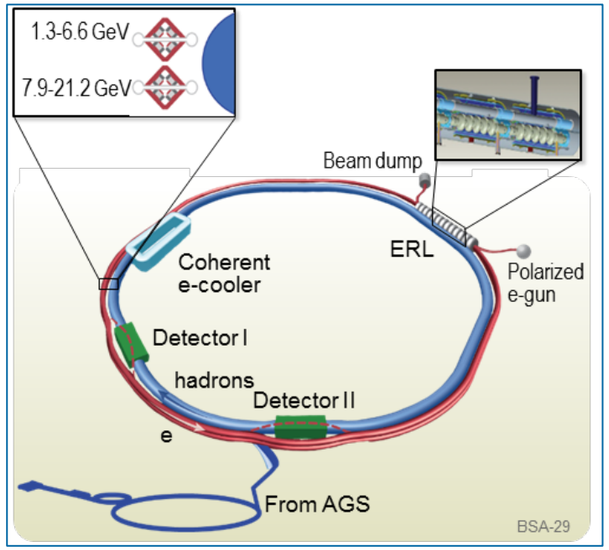
Critical Outcome 1: Origins of Matter and Mass

Strategy

- Complete the RHIC mission: focus on measurements that can provide critical information on the extraordinary properties of the QGP
  - Its nature as a near-perfect fluid
  - Its static and dynamical color response functions
- Transition from RHIC to eRHIC
  - Carry out precision studies of the contribution of gluons to the structure of the proton and other nuclei
  - Explore the mechanism by which they generate 99% of the mass of all visible matter





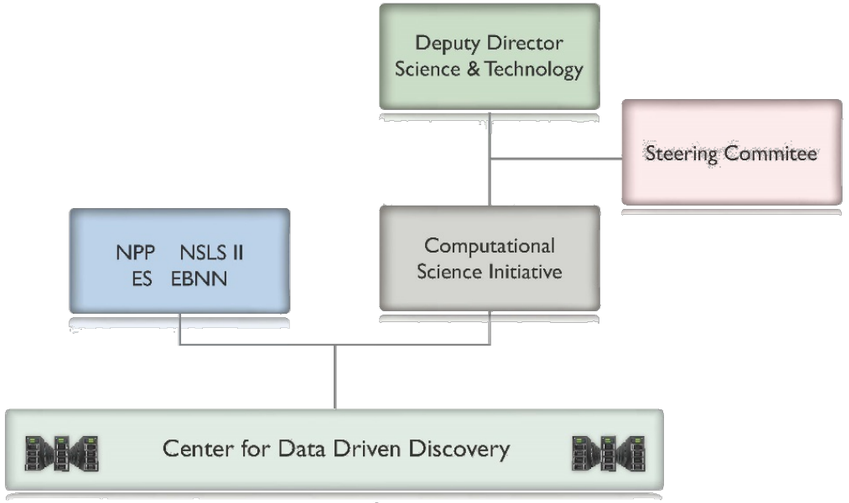


Critical Outcome 4 – Data Driven Science

Working Together to Change Computation

Computational Science Initiative

NPP BES EBC



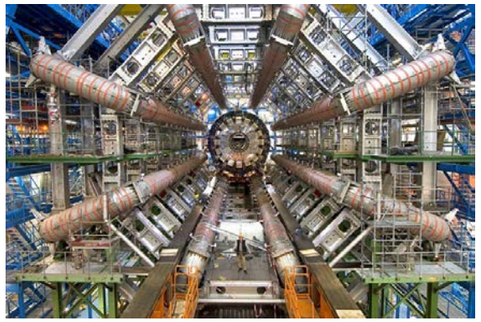
CD^3

Expanded Role for Computational Sciences Initiative Critical Outcome

People	Facilities	Programs and Investments
► Select new Director for initiative/CD^3 ► Assemble strong team from existing staff and new hires ► Double the number of joint appointments with partner universities ► Establish Steering Committee to provide oversight and guidance	► Leverage existing capabilities to develop CD^3 ► Reconfigure building 725 to house initiative and CD^3 ► Upgrade network and storage for extended user access	► Secure DOE, BSA, and New York State investments to support growth ► Develop and expand partnerships to leverage additional capabilities and resources

Expand BNL's Scientific Impact Beyond the Four Critical Outcomes

- High Energy Physics
  - Perform LHC/Higgs boson experiments
  - Expand on ATLAS detector and computer analysis capability
  - Participate in search for neutrino CP violation
  - Deliver LSST sensor and play a leading role in LSST dark energy research
  - Develop state-of-the-art instrumentation and detectors
- Biological and Environmental Research
  - Energy systems operation informed by local climate/meteorology
  - Develop sampling, imaging, computing to improve climate models
  - Investigate plant-based carbon capture systems
  - Improve plant biofuel production



Core Facility Revitalization Will Enhance Science Capabilities

Critical projects to revitalize core capability for the next decade of BNL science

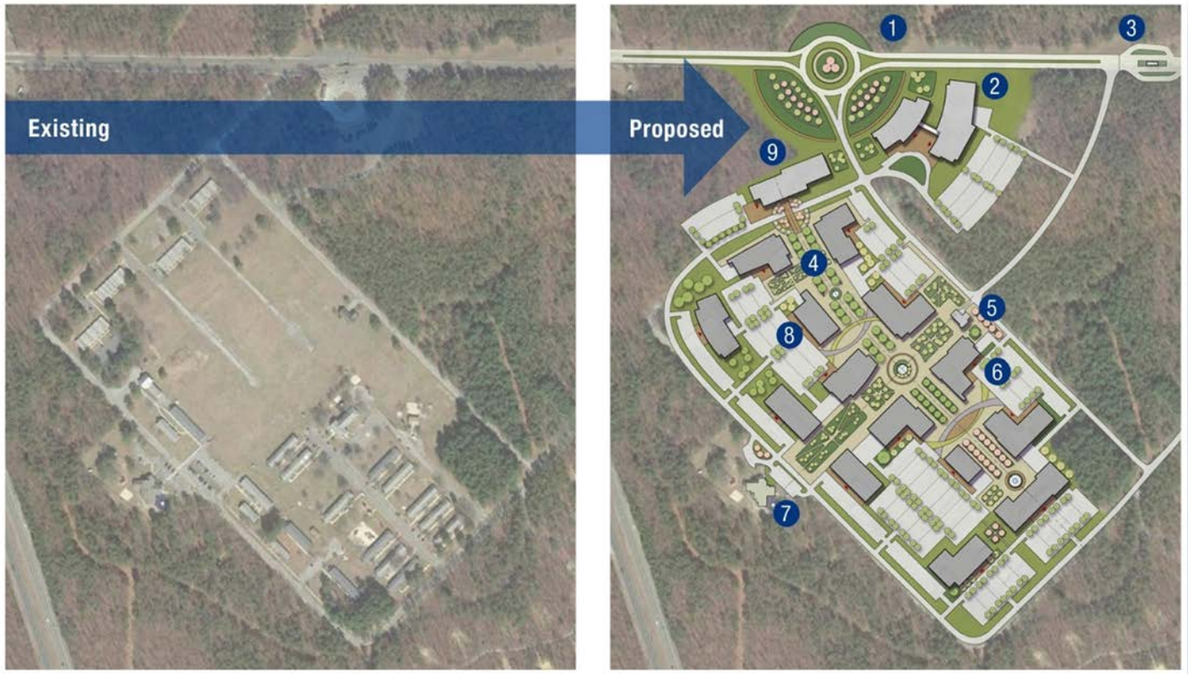
CFR-I ~ Integrated Sciences Center

- Scope: Repurpose B/725 (NSLS-I) as a key Laboratory multi-purpose facility
- Renovate 60-80KGSF to achieve a mission-critical computing capability for a focus on data intensive needs of NSLS-II/eRHIC
- Cost Estimate: $40 Million
- Leverages the significant utility infrastructure made available by transfer of operations to NSLS-II
- Reuse of B/725 enables significant near term footprint reduction

CFR-II ~ Accelerator Science & Technology Center

- Scope: Renovate B/911 for accelerator science and technology
- Completes a comprehensive facility modernization of 55-70 KGSF (bldg. enclosure, interiors & building infrastructure)
- Cost Estimate: $30 Million
- B/911 serves as main office & control room for RHIC, NSRL & BLIP
- Supports RHIC, eRHIC, ATF, and a broad range of accelerator science programs

Discovery Park: Unique Partnership with DOE and GSA



Previously Developed Site | Proposed Improvements

- The existing apartment complex is well beyond useful life and provides excellent opportunity for redevelopment
- BNL has a robust housing business that can transfer to a new private housing operation
- Other public-private partnership opportunities include contemporary administration space, guest and visitor processing, and technology partnerships space

Development Possibility

- 40 acres
- 730,000 Gross SF
- 1,000 - 1,500 occupants

Conceptual Features

1. Traffic circle / roundabout
2. Lab Entrance Facility
3. New security gate
4. Office Buildings
5. International House
6. AEGIS
7. Child Development Center
8. Technology partnerships space
9. Visitor/user/guest housing

GSA Targeted Asset Review (TAR) nearly complete

Current NPP Program Scope and Goals

- Relativistic Heavy Ion Collider
  - Complete the RHIC scientific mission
  - Develop EIC science case and machine design
- Medical Isotope Program
  - Execute national isotope production plan, upgrade BLIP, ^{225}Ac research
- NASA Space Radiation Laboratory
- Energy Frontier
  - LHC Run-2 and ATLAS Phase 1 upgrade, Accelerator Test Facility
- Intensity Frontier
  - Support FNAL program and position BNL in LBNF
- Cosmic Frontier
  - LSST sensor construction; dark energy research

16

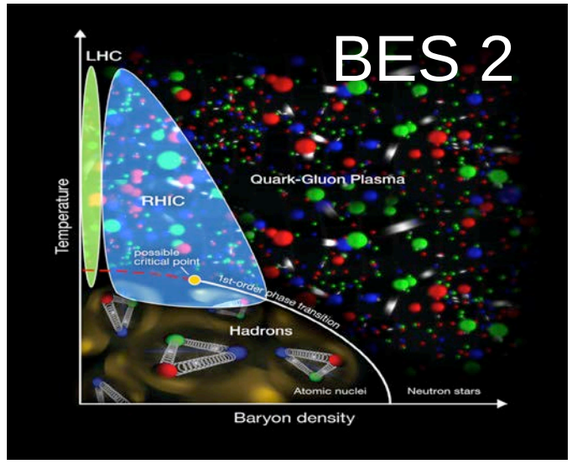
Completing the RHIC Science Mission

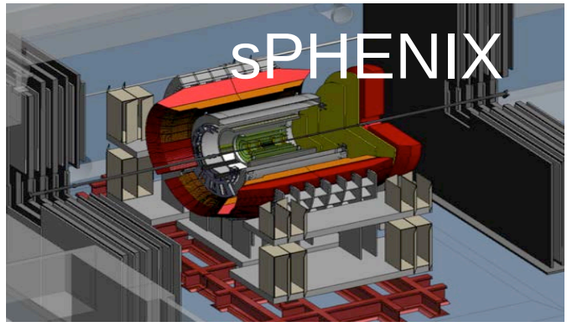
Status:

- RHIC-II configuration is now complete
  - 3-D stochastic cooling
  - Vertex detectors in STAR (HFT) and PHENIX

Plan: Complete the RHIC Mission in 3 campaigns

- **2014-16:** Heavy flavor probes of the QGP
  - Install low energy e-cooling in 2017
- **2018/19:** Precision scan of the QCD phase diagram
  - Install sPHENIX upgrade in 2020
- **2021/22:** Elucidate the internal structure of the quark-gluon plasma
  - RHIC shutdown and transition to eRHIC in 2023/24

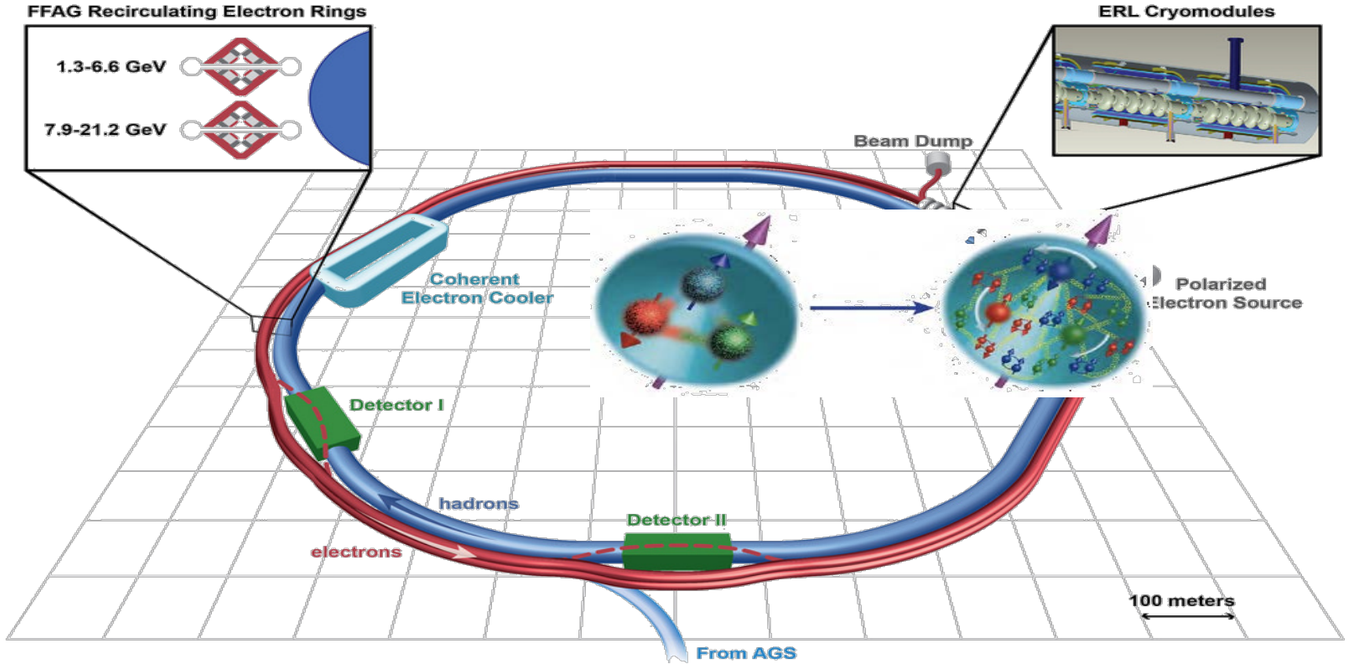


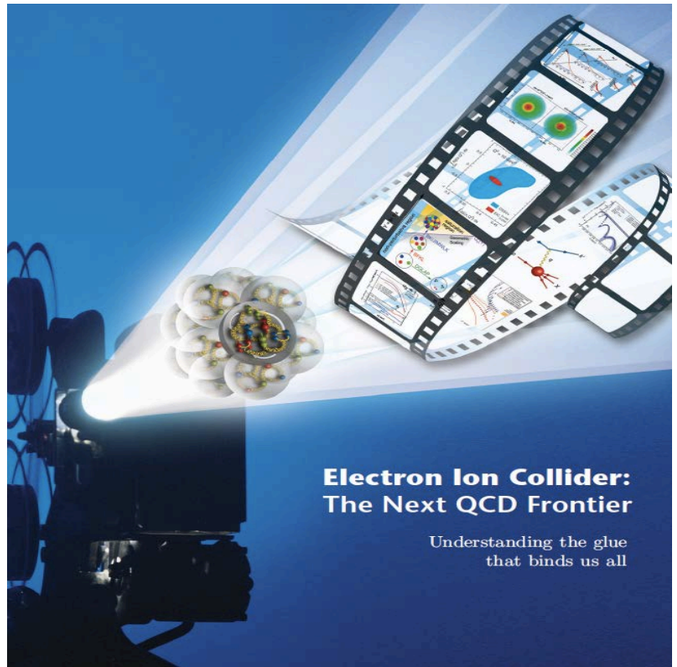


eRHIC: The Electron-Ion Collider at BNL

eRHIC will combine several innovative, cost-effective accelerator concepts:

- World's first Linac-ring collider
- Coherent electron cooling for record high beam brightness
- Energy Recovery Linac (ERL) reduces power consumption from 1 GW to 20 MW
- Fixed field alternating gradient (FFAG) arcs propagate beams with multiple energies





Partnerships

- Cornell University
  - eRHIC Prototype (ERL + FFAG recirculating arcs)
  - Prospect of NSF funding through Cornell
- Jefferson Lab
  - EIC science case
  - EIC detector and accelerator R&D
- RIKEN
  - RIKEN-BNL Institute; “Brain” project
  - sPHENIX upgrade
- Other partnerships
  - CCNU Wuhan: STAR, eRHIC
  - Jülich/KAIST: pEDM
  - INTEL/Columbia: HPC Code Center

19

New Investments: eRHIC

- Investment in eRHIC accelerator and detector R&D:
  - eRHIC Prototype (opportunity of joint venture with Cornell)
  - Coherent electron cooling - Proof of Principle
  - 422 MHz SRF Cavity for ERL - Prototype
  - Multi-beam beam position monitors
- Infrastructure upgrades to provide modern and energy efficient facilities for eRHIC construction
  - Completion of state-of-the-art SRF tech facilities in building 912
  - Completion of modern tech facility in building 924 to allow for necessary consolidation and demolition of a number of unsustainable, inefficient and very old buildings

New Investments: HEP

- ATLAS Phase 2 Upgrade
  - Co-investment (with DOE) in Si strip detector design and test facility
  - Current estimated project scope: $100M ($28M at BNL) plus $55M contingency
- High-Luminosity LHC Upgrade
  - Maintain High-T_c and Direct Wind capabilities in SMD
- Long Baseline Neutrino Facility
  - Position BNL as Major Participating Institution in LBNF
- ATF Upgrade
- Proton EDM Experiment
  - Develop concept for pEDM experiment (collaboration with FZ Jülich, KAIST, Liverpool)

21

Other Opportunities

- HP/HT Computing
  - Core role of RACF and PAS in new BNL-wide computing effort
  - HPC Code Center (w/ Columbia, SUB, INTEL)
- Accelerator Applications (examples)
  - Fixed field alternating gradient (FFAG) beam transport for light-weight medical gantry
  - Ultra-Fast Electron Diffraction (UED) device using SRF cavities as surrogate X-ray FEL.
- SC Magnet Applications
  - FFAG, SMES
- Instrumentation
  - New technologies for eRHIC, ATLAS, and Photon Sciences (photocathodes, detectors, etc.)
  - ASICs: Integration with detectors (“experiment on a chip”)

22

NPP – Growth opportunities I

Opportunity for growth - describe	Magnitude (million $)	Probability	Fiscal Years
NP: Magnets/testing for FRIB	$1M	75%	FY15-16
NP: eRHIC	$750M+	65%	FY17-25
HEP: FCC magnet R&D	$15M	75%	FY16-25
HEP/NP: proton EDM	$25M	25%	FY17-22
HEP: HL-LHC upgrade	$40M	90%	FY18-22
HEP: ATLAS Phase 2 upgrade	$35M	90%	FY18-22
HEP: Next generation LSST	$20M	50%	FY20-25
ASCR: PanDA++	$30M	50%	FY16-20

23

NPP – Growth opportunities II

Opportunity for growth - describe	Magnitude ($'s & FTE's)	Probability	Fiscal Years
BES: muSR	$50M	20%	FY17-22
BES: small scale X-ray FEL (UED)	$10M	40%	FY16-20
FUS: neutron materials test facility	$50M	20%	FY17-22
DOE NE: ADS R&D	$5M	10%	FY16-20
WFO: FFAG medical gantries	$5M	30%	FY16-20
WFO: medical RCS prototype	$10M	10%	FY16-20
WFO: e-beam water purification	$2M	20%	FY16-20
WFO: Laser ion source	$2M	20%	FY16-20

24