U.S. DEPARTMENT OF ENERGY | Office of Science

Application of Nuclear Science and Technology:

ANS&T Exchange Meeting
August 22-23, 2011
Rockville, MD

M. Farkhondeh

Program Manager
Advanced Technology Research and Development
DOE Office of Science
Office of Nuclear Physics

U.S. DEPARTMENT OF ENERGY | Office of Science

Contents:

- NP Mission Statement
- NP Facilities
- National Nuclear Data Center (NNDC)
- ANS&T Funding Opportunity Announcement
- Proposal Evaluations
- FY 2009 and 2010 FOA and funding,
- FY 2011 FOA and Funding
- Exchange Meeting Notes and Agenda

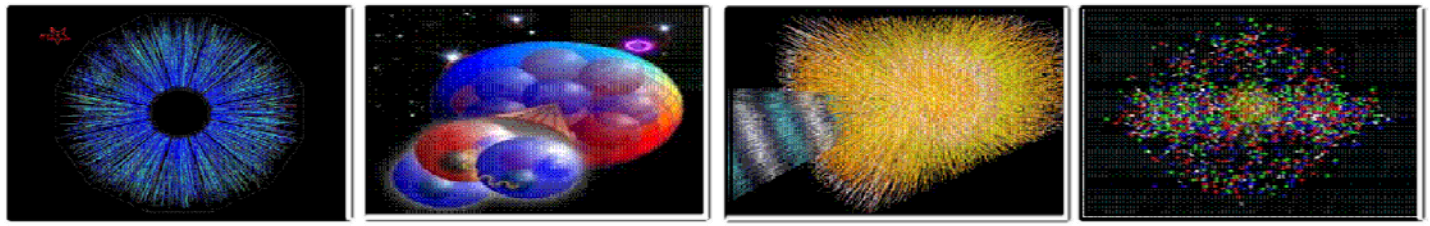
U.S. DEPARTMENT OF ENERGY | Office of Science

Nuclear Physics Program Mission

Mission: To discover, explore and understand all forms of nuclear matter; to understand how the fundamental particles, quarks and gluons, fit together and interact to create different types of matter in the universe, including those no longer found naturally

Priorities:

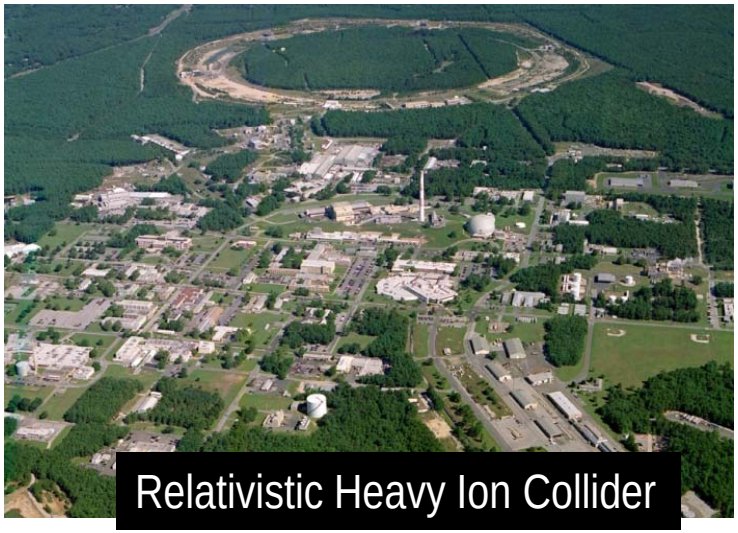
- To understand how quarks and gluons assemble into the various forms of matter and to search for yet undiscovered forms of matter
- To understand how protons and neutrons combine to form atomic nuclei and how these nuclei have emerged during the 13.7 billion years since the origin of the cosmos
- To understand the fundamental properties of the neutron and develop a better understanding of the neutrino
- To conceive, plan, design, construct, and operate national scientific user facilities; to develop new detector and accelerator technologies
- To provide stewardship of isotope production and related technologies to advance important applications, research and tools for the nation
- To foster integration of the research with the work of other organizations in DOE



U.S. DEPARTMENT OF ENERGY | Office of Science

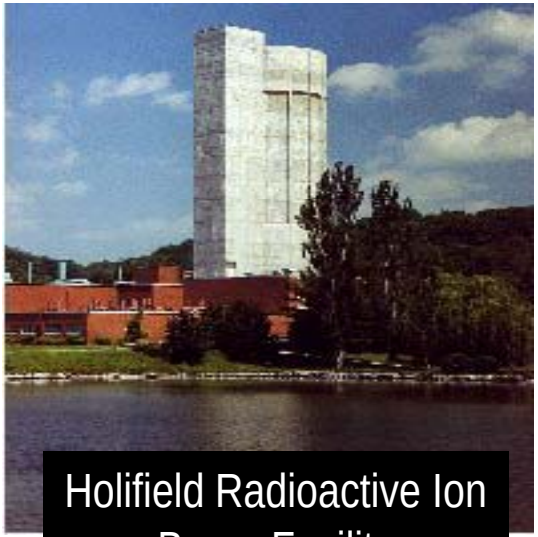
At Present NP Operates Four National User Facilities

"Microscopes" capable of groundbreaking research

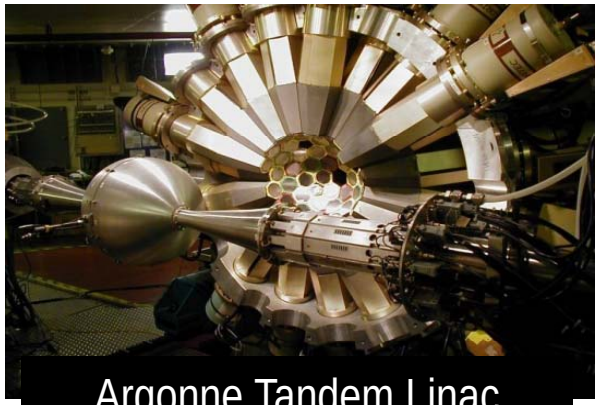


Relativistic Heavy Ion Collider

Continuous Electron Beam Accelerator Facility



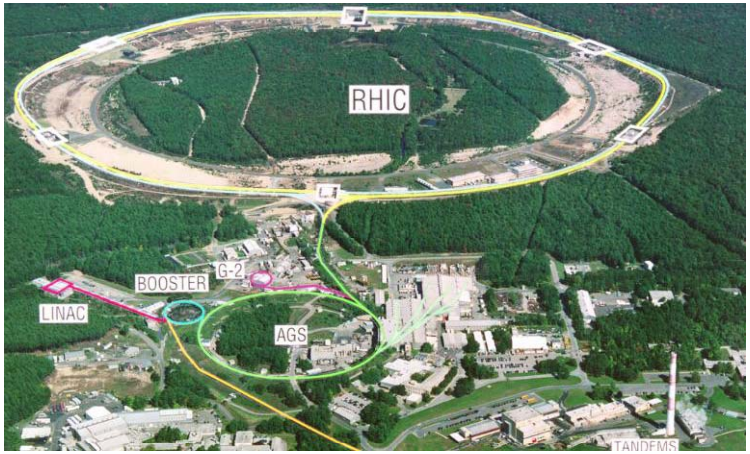
Holifield Radioactive Ion Beam Facility



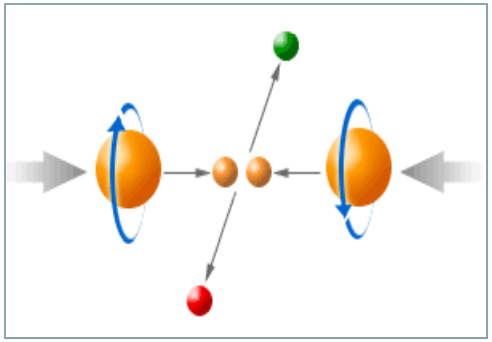
Argonne Tandem Linac Accelerator System

U.S. DEPARTMENT OF ENERGY | Office of Science

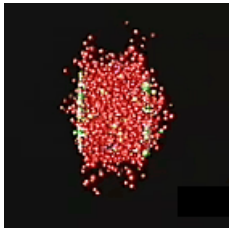
Relativistic Heavy Ion Collider (RHIC)

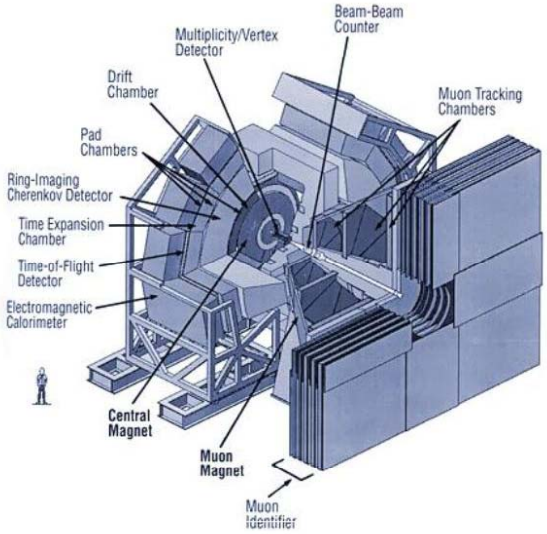


500 Gev P-P or 200 GeV/n Gold-Gold collider.



Polarized p-p collision





Inside the STAR Detector

PHENIX detector data

- 1st facility to clearly probe transition to quark-gluon matter; world's only polarized collider .
- To study the existence and properties of nuclear matter under extreme conditions, including that which existed at the beginning of the universe.

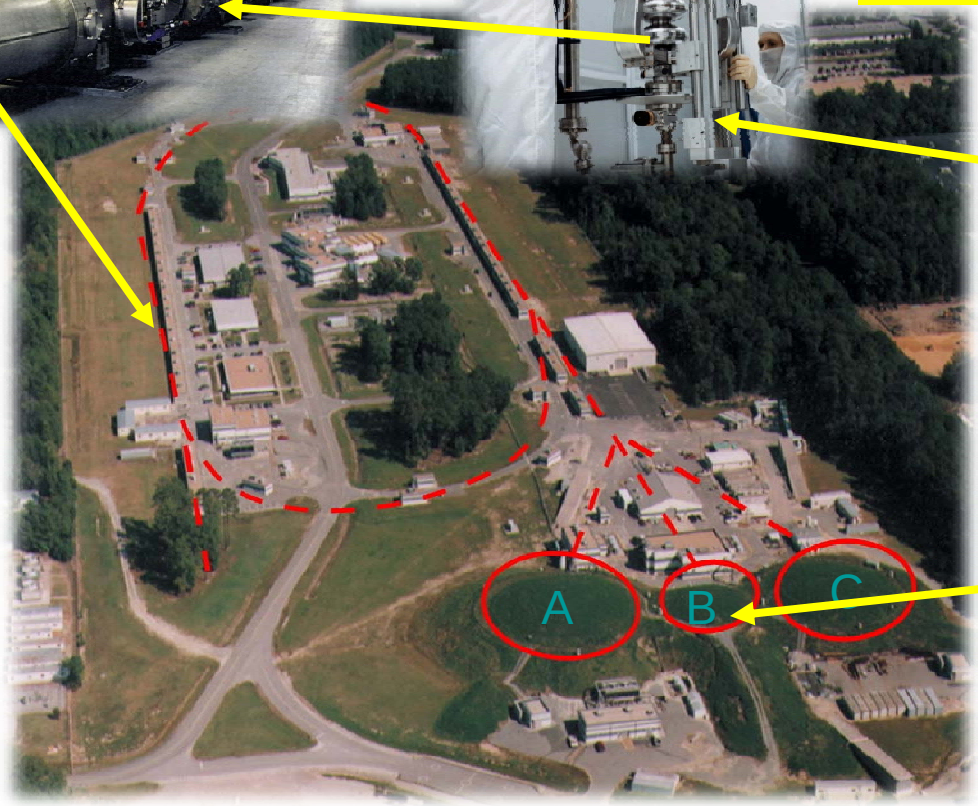
CEBAF at Jefferson Lab, a 6 GeV Electron Accelerator for Nuclear Physics with 12 GeV upgrade

World's Premier Facility for studies of:

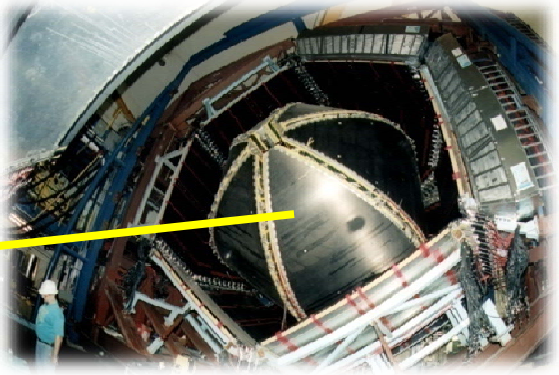
- Quark structure of matter
- Nuclear structure and weak interactions with polarized electrons

Cryomodules in the accelerator tunnel

Superconducting radiofrequency (SRF) cavities vertical testing.



An aerial view of the recirculating linear accelerator and 3 experimental halls.



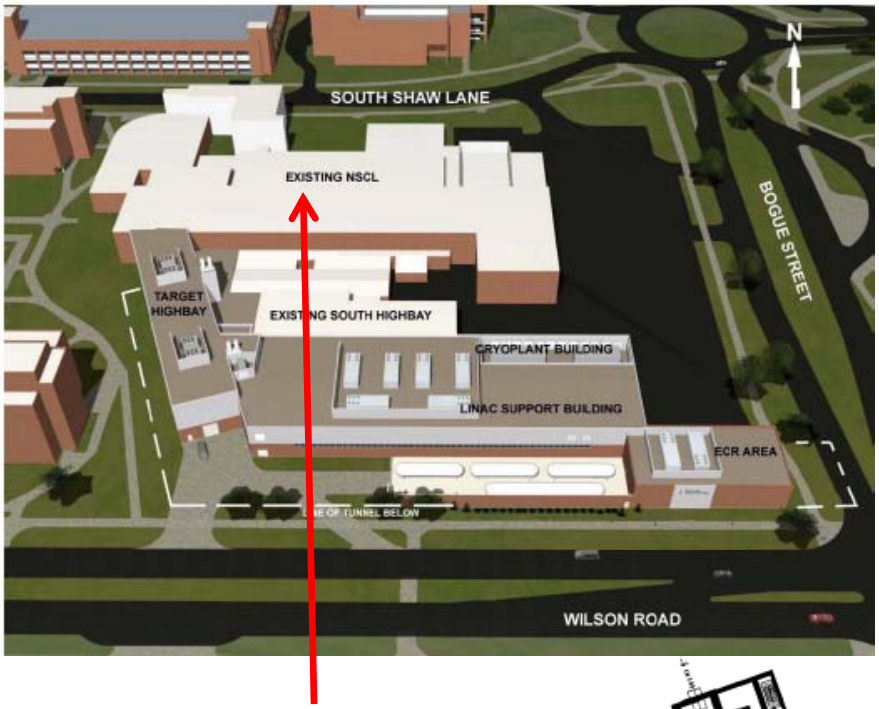
CEBAF Large Acceptance Spectrometer (CLAS) in Hall B

Curtsey, TJNAF

U.S. DEPARTMENT OF ENERGY | Office of Science

Facility for Rare Isotope Beams at MSU

A New "Microscope" to Study the Structure of Nuclei

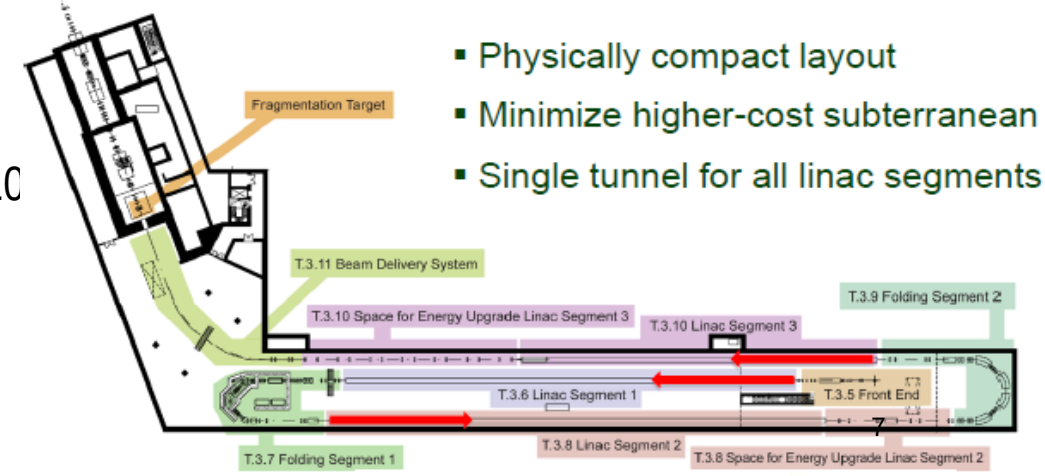


Existing NSCL Laboratory

- A 200 MeV/u, 400 kW super conducting accelerator
- A national user facility, to study the physics of nuclei, nuclear astrophysics, fundamental interactions, and **applications for society**

- Will cost approximately $600 M to establish. Construction is anticipated to begin in 2012 and completed by 2020

- Critical Decision-1, September 2010
- Steady progress towards Critical Decision-2 (performance baseline)



- Physically compact layout
- Minimize higher-cost subterranean structures
- Single tunnel for all linac segments

U.S. DEPARTMENT OF ENERGY | Office of Science

NP Isotope Program Mission

In 2009 the Isotope Production Program from DOE Office of Nuclear Energy was transferred to the Office of Science's Office of Nuclear Physics.

The mission of the DOE Isotope Program is three fold:

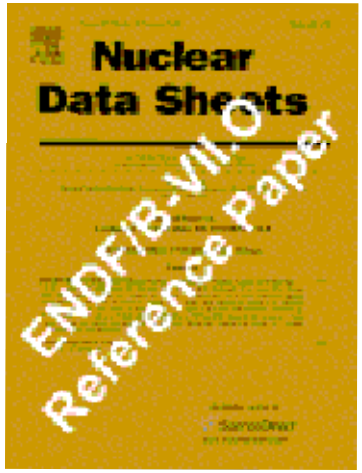
- Produce and/or distribute radioactive and stable isotopes that are in short supply, associated byproducts, surplus materials and related isotope services.
- Maintain the infrastructure required to produce and supply isotope products and related services.
- Conduct R&D on new and improved isotope production and processing techniques which can make available new isotopes for research and applications.

Isotope Production Facility (LANL)

Brookhaven Linac Isotope Producer

U.S. DEPARTMENT OF ENERGY | Office of Science

National Nuclear Data Center (NNDC) At BNL



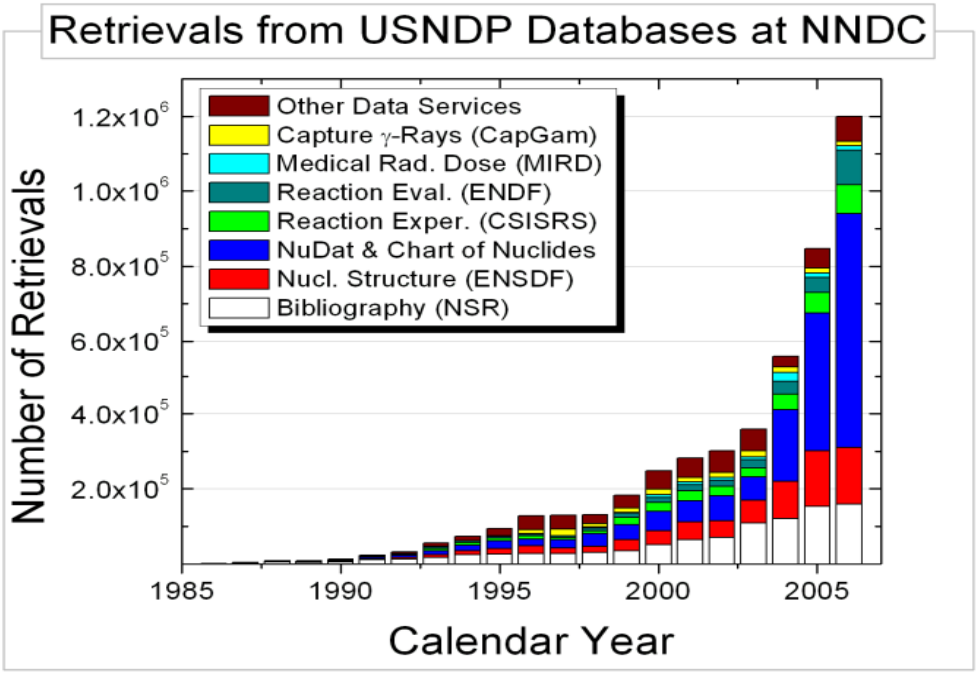
Evaluated Nuclear Data

USNDP:

- U. S. Nuclear Data Program (USNDP) evaluates, archives and disseminates information
- Information (nuclear properties/reaction cross sections) from nuclear physics research worldwide
- U.S. activities coordinated by the National Nuclear Data Center (NNDC) at BNL

Applications:

- Basic Nuclear Physics Research
- Accelerator Design
- Nuclear Medicine & Imaging
- Energy Generation
  - New reactors
  - Transmutation of waste
- National Security
  - Stockpile stewardship
  - Safeguards & nuclear management
  - Nuclear interrogation



U.S. DEPARTMENT OF ENERGY | Office of Science

Nuclear Data
Link Between Basic Science and Applications

Nuclear Science Community

- ✦microscopic experiments
- ✦(microscopic) theories
- ✦publications

Nuclear Data Community

- ✦compiles results of microscopic measurements
- ✦evaluates them and provides complete files of recommended values using nuclear theory modeling
- ✦archives and disseminates, bibliography, experimental data and recommended data files in readable format (ENDF, ENSDF)

- ✦ preservation of information worth billions
- ✦ development of nuclear reaction theory

Application Community

- ✦For R&D needs data:
  - •complete
  - •consolidated
  - •organized
  - •traceable
  - •readable
- ✦Validates data against integral measurements

Curtsey, NNDC

U.S. DEPARTMENT OF ENERGY | Office of Science

ANS&T Exchange Meeting

This is a two-day presentation meeting between the Principal Investigators (PIs) with 2009 and 2010 awards in Applications of Nuclear Science and Technology (ANS&T) supported by NP and American Recovery and Reinvestment Act ARRA funds, interested members of the NP community, NP Federal Program Managers, and Program Managers from other federal agencies with programmatic interests in ANS&T. The meeting today is designed to achieve the following goals:

- To provide a platform for the PI to present the status of their NP-supported grant work in ANS&T to the NP Program Managers, to interested people from the NP community, and to Federal Program Managers from other agencies.

- To provide an opportunity for NP to assess the progress made on each grant.

- To offer an opportunity to exchange information with the community and other federal agencies regarding each group's application work and capabilities.

- To provide the interested agencies with an opportunity to expand their awareness of potentially new capabilities in the field.

U.S. DEPARTMENT OF ENERGY | Office of Science

Basis of ANS&T Initiative

The primary goal of ANS&T initiative is to pursue forefront nuclear science research and development needed to achieve Nuclear Physics mission goals and that are also relevant to applications important to the Nation. Proposals that are solely based on pure research or pure application will not be considered for funding.

Areas of interest include but are not limited to:

a. Identification and development of approaches to the measurement of **nuclear data** needed for the nuclear energy industry and other applications;

b. Measurement of neutron cross sections and other relevant nuclear data such as decay properties, delayed neutrons, fission yields, photon production, etc., required for advanced reactor fuel cycles and other applications.

c. Development and **use of covariances and covariance matrices to support reactor and fuel cycle design** and other applications, and to identify priorities for cross section measurements and improved modeling of nuclear reactions.

d. Existing or **new instrumentation and accelerator design and development**, and analytical and computational methods that can be applied to nuclear forensics, handling of nuclear wastes, nuclear energy, national defense, medicine, environmental, space exploration, finance, commerce, radiation health physics, etc;

U.S. DEPARTMENT OF ENERGY | Office of Science

Proposal Evaluation

- **A Panel Review process is used for selection of proposals for award**

- **Criteria for Proposal Evaluation**
  - **Scientific and/or technical** merit of the proposed project – both the nuclear physics research and the application of that research;
  - The **Appropriateness of the proposed method** or approach;
  - The **Competency of the applicant's** personnel;
  - The adequacy of the **proposed resources**, and the reasonableness and appropriateness of the proposed **budget;** and
  - Any other factors relevant to the proposed project.

- **Program Policy Factors**

  a. The particular outstanding scientific opportunity in nuclear physics research afforded by the proposed research and its relevance to the **NSAC Performance Measures** and/or opportunities identified in the NSAC 2007 Long Range Plan;

  b. The **relevance** and impact of this opportunity on **applications and applied sciences**; and

  c. The opportunity for **training personnel** in key disciplines of nuclear science that are in short supply, such as nuclear chemistry and closely related disciplines, nuclear forensics, nuclear engineering, and radiation health science.

U.S. DEPARTMENT OF ENERGY | Office of Science

ANS&T Applications and Awards

FY 2009

- NP received over **200 applications** in FY 2009 in response to ANS&T FOA 09-13.
- Total funding available: **$22M** (~19M ARRA funding and ~3M from NP base)
- Following a panel review of the proposals a total of 22 proposals were selected for funding.

FY 2010

- Four additional proposals ranked highest from the remaining proposals were funded in FY10.
- Total funding available: **$3.7M**

The PI presentations in this meeting cover FY 2009 and 2010 awards

FY 2011

- NP received about **49 applications** in FY 2011 in response to ANS&T FOA 11-450
- Total funding available: **$3.2M**
- Following a panel review of the proposals , a total of 9 proposals were selected for funding.

Applications and Awards

FY 2009 ($22 M)	National Labs	University	Industry	Total
# of Applications	94	90	34+1	219
# of Awards	19	2	1	22

FY 2010 ($3.7 M)	National Labs	University	Industry	Total
# of Applications	-	-	-	-
# of Awards	4	1	0	5

FY 2011 ($3.2 M)	National Labs	University	Industry	Total
# of Applications	32	10	7	49
# of Awards	7	2	0	9

U.S. DEPARTMENT OF ENERGY | Office of Science

FY 2009 Proposal Awards

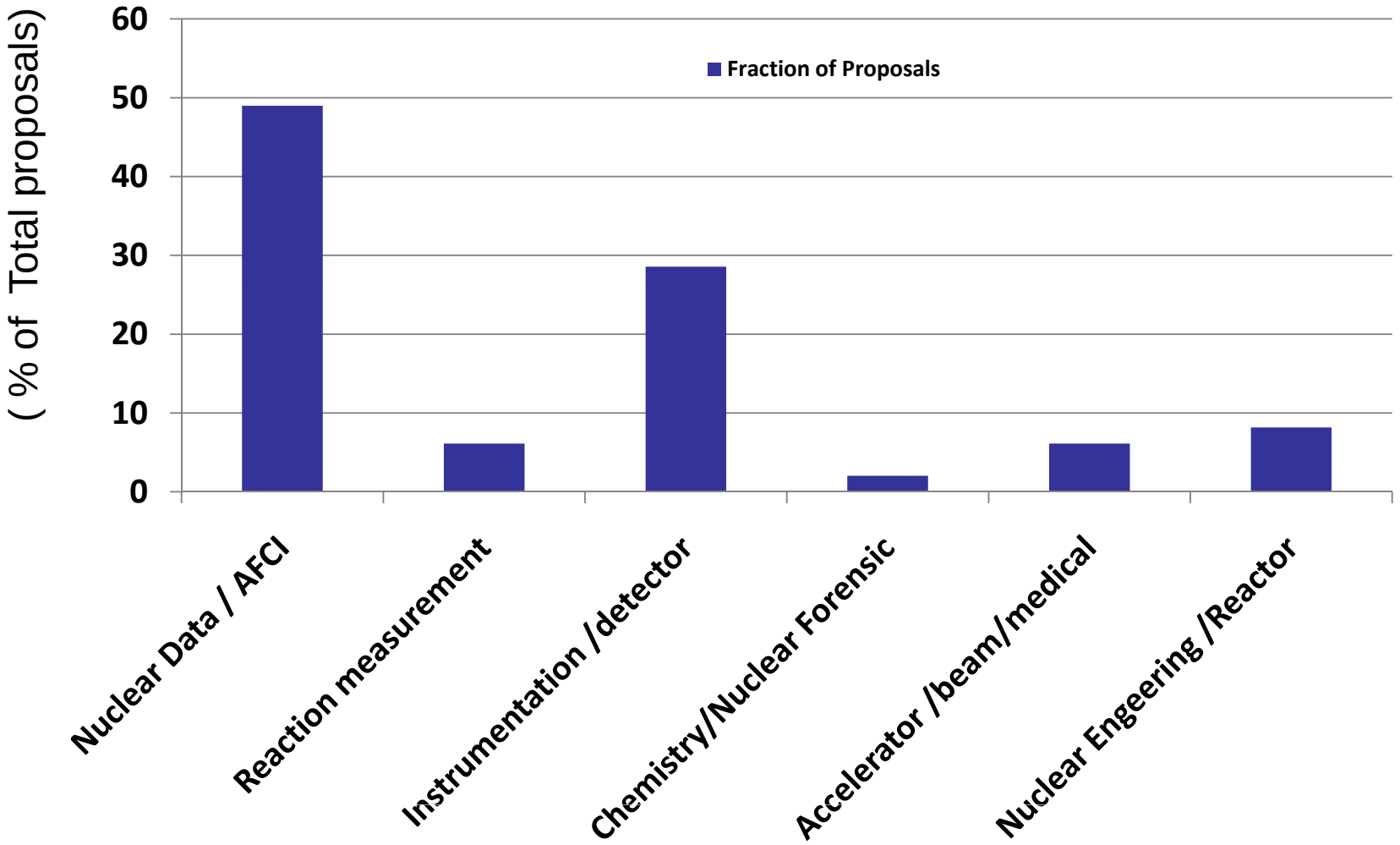
	FY 2009 funding of FOA 09-13, "Application of Nuclear Science and Technology"				
	Proposal Title	***Institutions***	***Principal Inv.***	***Duration (Years)***	***Funding ($k)***
1	Development of an Atom-Trap Detector to Analyze Rare Isotopes of Noble Gas	ANL	Zheng-Tian Lu	3	1300
2	Measurement and Evaluation of Actinide Neutron Cross Sections Relevant to Advanced Fuel	INL (Lead) /ANL	Youinou /Kondev and Pardo	3	1060 / 960
3	Transfer Reactions on Unstable Nuclei Science Applications	ORNL	Bardayan	3	1900
4	Neutron Cross Section Covariances for the ENDF/B-VII Library	BNL (Lead) /LANL	Oblozinsky /Talou	3	1400 / 1000
5	Construction, Optimization And First Experiments: Oak Ridge Isomer Spectrometer And Separator (Oriss)	Oak Ridge Associated U. (OAU)	Carter	3	1780
6	Total Absorption Spectrometer	ORNL	Grzywacz/ Rykaczewski	3	1580
7	Nuclear Reaction Modeling for Actinides	LANL (Lead) /LANL	Kawano /Younes	3	1005 / 695
8	New Approach for 2D Readout of GEM Detectors	MIT	Hasell	1	160
9	Single Crystal Large Volume Position Sensitive HPGe Detectors	ORNL	Radford	3	900
10	Use of Covariances in a Consistent Data Assimilation for Improvement of Basic Nuclear Parameters in Nuclear Reactor Applications: From Meters to Femtometers	INL (Lead) /BNL	Palmiotti /Herman	3	682 / 408
11	Beta-Decay Studies of Neutron-Rich Fission Products for Advanced Fuel Cycle Applications	ANL	Lister	3	2000
12	Improved Prompt and delayed Decay Specra for Advanced Fuels	LANL (lead) /LLNL	Hayes /Ching-Yen Wu	3	1098 / 592
13	Fiber Optic Based Thermometry System for Superconducting RF Cavities	MicroXact Incorporated	Kochergin	3	584
14	SRF Q0 Improvement Program	TJNAF	Myneni	2	684
15	Development Of A Suite Of Engineered Multi-Spoke Superconducting Cavities For Nuclear Physics, Light Sources, And Driven Systems Applications	ODU /TJNAF	Delayen /Mammosser	3	1448 / 1150

U.S. DEPARTMENT OF ENERGY | Office of Science

FY 2010 Proposal Awards

	FY 2010 funding of FOA 09-13, "Application of Nuclear Science and Technology"				
	Proposal Title	***Institutions***	***Principal Inv.***	***Duration (Years)***	***Funding ($k)***
1	Development of fast 3D gamma-ray imaging technologies for radiation treatment, nuclear physics and nuclear security	LBNL	Mihailescu	3	1026
2	Development of Field-Shaping Electrode Configurations for High-Resolution Semiconductor Radiation Detectors for Nuclear Sciences, Forensics, and Safeguards	LBNL	Vetter	3	1350
3	Application of Two Phase (Liquid/Gas) Xenon Gamma-Camera to the Detection of Special Nuclear Material and PET Medical Im	Yale /U Conn	McKinsey /Gai	1	342
4	Cross Section Measurement and Evaluation for Nuclear Applications	LBNL	Firestone	1	380
5	Micropattern Optical Sensors in Scintillian Counters	ORNL	Varner	3	650

FY11 FOA proposals in ANS&T
Total of 49 proposals



Presentation guidelines

➢We have a tight and busy agenda and **must stay on time** for each presentation.

➢ Sessions will **start sharply at the time stated** on the agenda. Please take your seat few minutes before the start of each session to allow the first presentation to begin on time.

➢ Make sure your presentation **file is uploaded on the display laptop** before the start of your session.

➢ **For Q&A sessions**, please make your comments /questions short and use the coffee breaks and lunch breaks for follow ups.

Total presentation (min)	Type of presentation	Presentation (min)	Q&A (min)	5 and 2 minutes warning @ (min)
30	Single PI	20	10	15 and 18
40	Collaboration	30	10	25 And 28
45	Keynote	35	10	30 and 33

Agenda page 1

DOE-NP ANS&T Exchange Meeting

AGENDA		Plaza I		1439.26
Day - 1: Monday, August 22, 2011		NUCLEAR DATA		
Time	**Dur.**	**Presentation Title**	**Speaker**	**Organization**
8:30 AM	10	Welcome and Introductory Remarks	Hallman/Gillo	DOE, NP
8:40 AM	30	ANS&T Program	Manouchehr Farkhondeh	DOE, NP
9:10 AM	40	Neutron Cross Section Covariances for the ENDF/B-VII Library [Collaboration]	Herman/Talou	BNL/LANL
9:50 AM	40	Use of Covariances in a Consistent Data Assimilation for Improvement of Basic Nuclear Parameters in Nuclear Reactor Applications: From Meters to Femtometers [*Collaboration*]	Palmiotti/Herman	INL/BNL
10:30 AM	**30**	**Coffee Break**		
11:00 AM	40	Nuclear Reaction Modeling for Actinides [Collaboration]	Kawano/Younes	LANL/LLNL
11:40 AM	45	**Keynote speaker - 1**	Giuseppe Palmiotti	INL
12:25 PM	**65**	**Lunch Break**		
1:30 PM	30	Transfer Reactions on Unstable Nuclei for Nuclear Science Applications	Bardayan	ORNL
2:00 PM	30	Beta-Decay Studies of Neutron-Rich Fission Products for Advanced Fuel Cycle Applications	Lister	ANL
2:30 PM	30	Decay studies of fission products with a new Modular Total Absorption Spectrometer (MTAS)	Rycaczewski	ORNL
3:00 PM	**30**	**Coffee Break**		
3:30 PM	30	Cross Section Measurement and Evaluation for Nuclear Applications	Firestone	LBNL
4:00 PM	40	Measurement and Evaluation of Actinide Neutron Cross Sections Relevant to Advanced Fuel Cycles via Accelerator Mass Spectroscopy [*Collaboration*]	Youinou/Pardo	INL/ANL
4:40 PM	40	Improved Prompt and Delayed Decay Spectra for Advanced Fuels [*Collaboration*]	Hayes-Sterbenz/Wu	LANL/LLNL
5:20 PM	**Adjourn**			

U.S. DEPARTMENT OF ENERGY | Office of Science

Agenda page 2

DOE-NP ANS&T Exchange Meeting

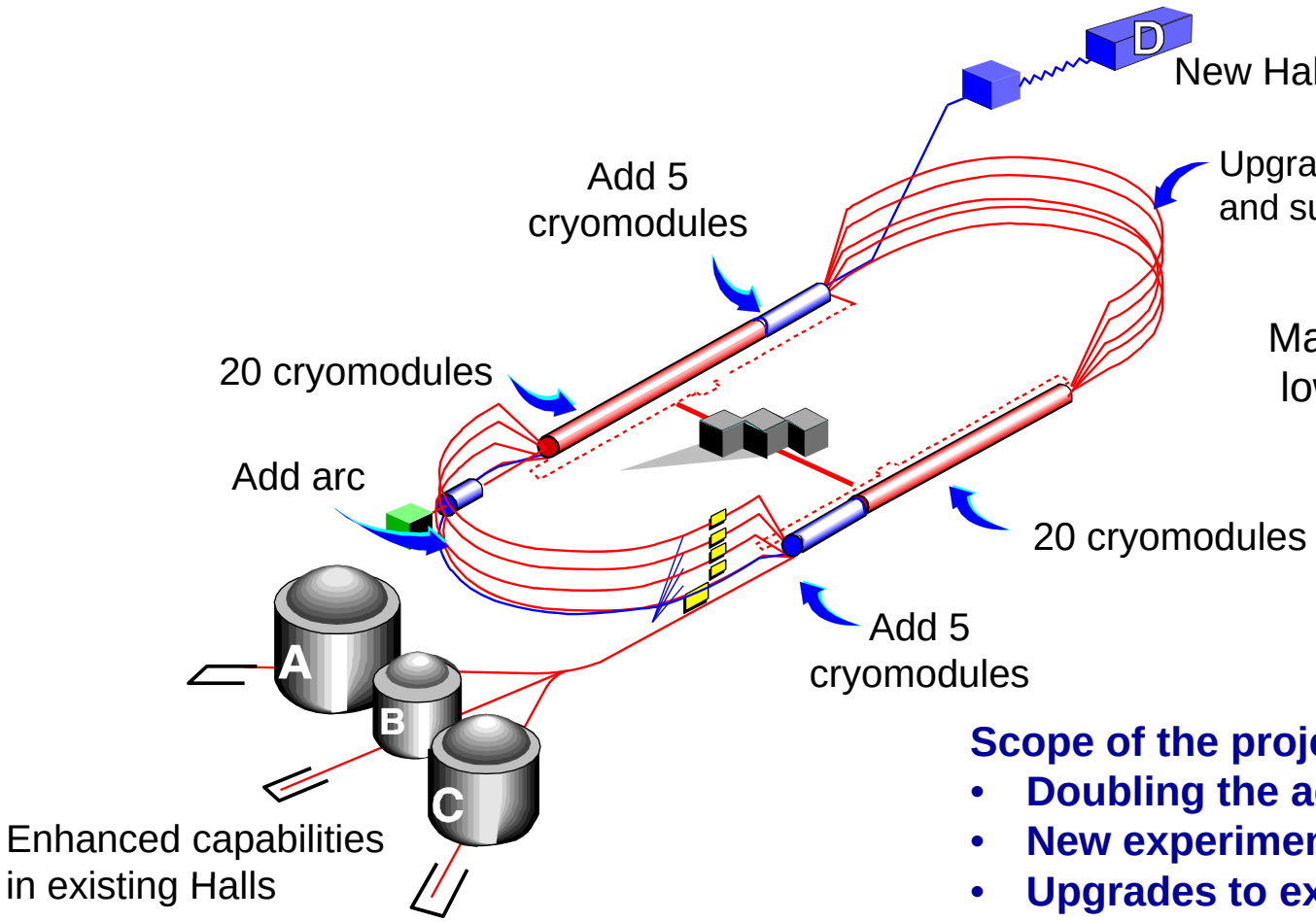
AGENDA		Plaza I		
Day - 2: Tuesday, August 23, 2010		INSTRUMENTATION		
Time	**Dur.**	**Presentation Title**	**Speaker**	**Organization**
8:30 AM	30	Development of an Atom-Trap Detector to Analyze Rare Isotopes of Noble Gas	Lu	ANL
9:00 AM	30	Construction, Optimization And First Experiments: Oak Ridge Isomer Spectrometer And Separator (ORISS)	Carter	ORAU
9:30 AM	40	Development of a Suite of Engineered Multi-Spoke Superconducting Cavities for Nuclear Physics, Light Sources, and Driven Systems Applications *[Collaboration]*	Delayen/Mammosser	ODU/TJNAF
10:10 AM	**30**	**Coffee Break**		
10:40 AM	30	SRF Q0 Improvement Program	Myneni	TJNAF
11:10 AM	30	Fiber Optic Based Thermometry System for Superconducting RF Cavities	Kochergin	MicroXact
11:40 AM	45	**Keynote speaker - 2**	**Lee Schroeder**	**TechSource-Inc./LBNL**
12:25 PM	**65**	**Lunch Break**		
1:30 PM	30	Fast 3D gamma-ray imaging technologies for radiation treatment, nuclear physics and nuclear security	Mihailescu	LBNL
2:00 PM	30	Single Crystal Large Volume Position Sensitive HPGe Detectors	Radford	ORNL
2:30 PM	30	Application of Two Phase (Liquid/Gas) Xenon Gamma-Camera to the Detection of Special Nuclear Material and PET Medical Imaging	Destefano/McKinsey	YALE
3:00 PM	**30**	**Coffee Break**		
3:30 PM	30	Development and applications of micropattern optical sensors to scintillation counters	Varner	ORNL
4:00 PM	30	Field-Shaping Electrode Configurations for High-Resolution Semiconductor Radiation Detectors for Nuclear Sciences, Forensics, and Safeguards	Vetter	LBNL
4:30 PM	30	New Approach for 2D Readout of GEM Detectors	Redwine/Hasell	MIT
5:00 PM	**15**	**Closing Remarks**		
5:15 PM	**Adjourn**			

Back up Slides

U.S. DEPARTMENT OF ENERGY | Office of Science

12 GeV CEBAF Upgrade Project

The energy of CEBAF is being upgraded to 12 GeV and a new experimental hall is being built



Maintain capability to deliver lower pass beam energies: 2.2, 4.4, 6.6….

Scope of the project includes:

- **Doubling the accelerator beam energy**
- **New experimental Hall and beamline**
- **Upgrades to existing Experimental Halls**

U.S. DEPARTMENT OF ENERGY | Office of Science

Isotope Program

- Produces, processes, packages and delivers isotopes that are in short supply
- Research and development of isotope production techniques and the production of research isotopes
- Serves a broad community of Federal agencies in addition to DOE—NIH, NIST, EPA, NNSA, DHS…
- Funding is from a combination of appropriations and sales—funds are deposited into the revolving fund which is externally audited annually.

Over 225 customer orders in FY2010

Over 415 shipments in FY2010

Six customers provided over 75% of sales

FY 10 Appropriations: $19.1M

FY 10 Sales: $21.7M

DOE Isotope Program History

Public Law 101-101 (1990), as modified by Public Law 103-316 (1995) created the Isotope Production and Distribution Program Fund (called a revolving fund) and allow prices charged to be based on costs of production, market value, U.S. research needs and other factors

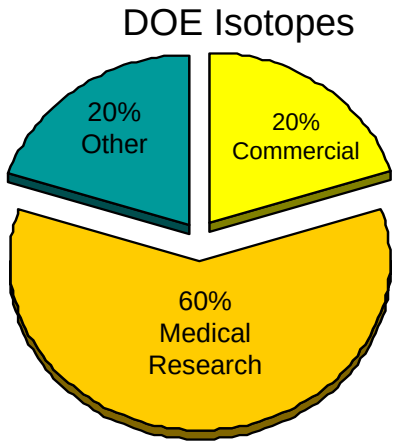
Prices for commercial isotopes are based on full cost. Prices for research isotopes are based on direct cost and may be partially subsidized

The DOE Isotope Program is new to the Office of Science

The Fiscal Year (FY) 2009 President's Request Budget proposed to transfer the Isotope Production Program from the Department of Energy (DOE) Office of Nuclear Energy to the Office of Science's Office of Nuclear Physics

Transfer become complete with Congressional Appropriation

Majority of isotopes produced are for medical community



U.S. DEPARTMENT OF ENERGY | Office of Science

Nuclear Physics

Discovering, exploring, and understanding all forms of nuclear matter

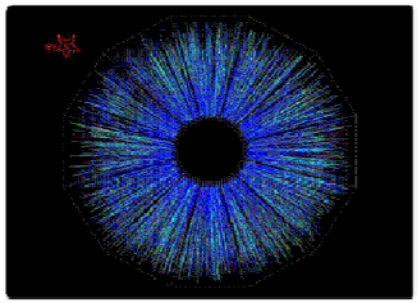
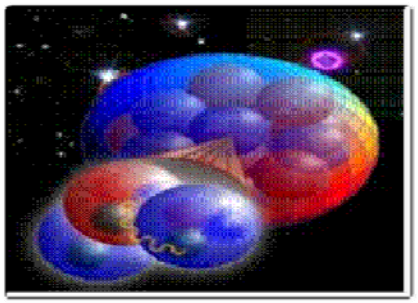
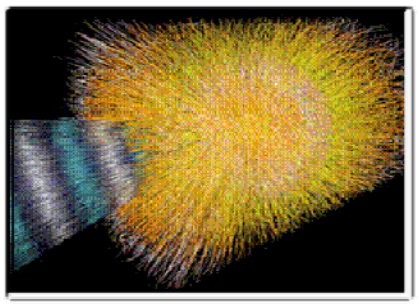
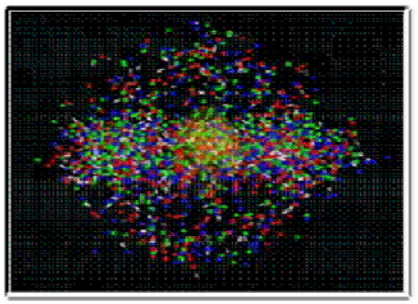
The Scientific Challenges:

Understand:

- The existence and properties of nuclear matter under extreme conditions, including that which existed at the beginning of the universe
- The exotic and excited bound states of quarks and gluons, including new tests of the Standard Model
- The ultimate limits of existence of bound systems of protons and neutrons
- Nuclear processes that power stars and supernovae, and synthesize the elements
- The nature and fundamental properties of neutrinos and neutrons and their role in the matter-antimatter asymmetry of the universe

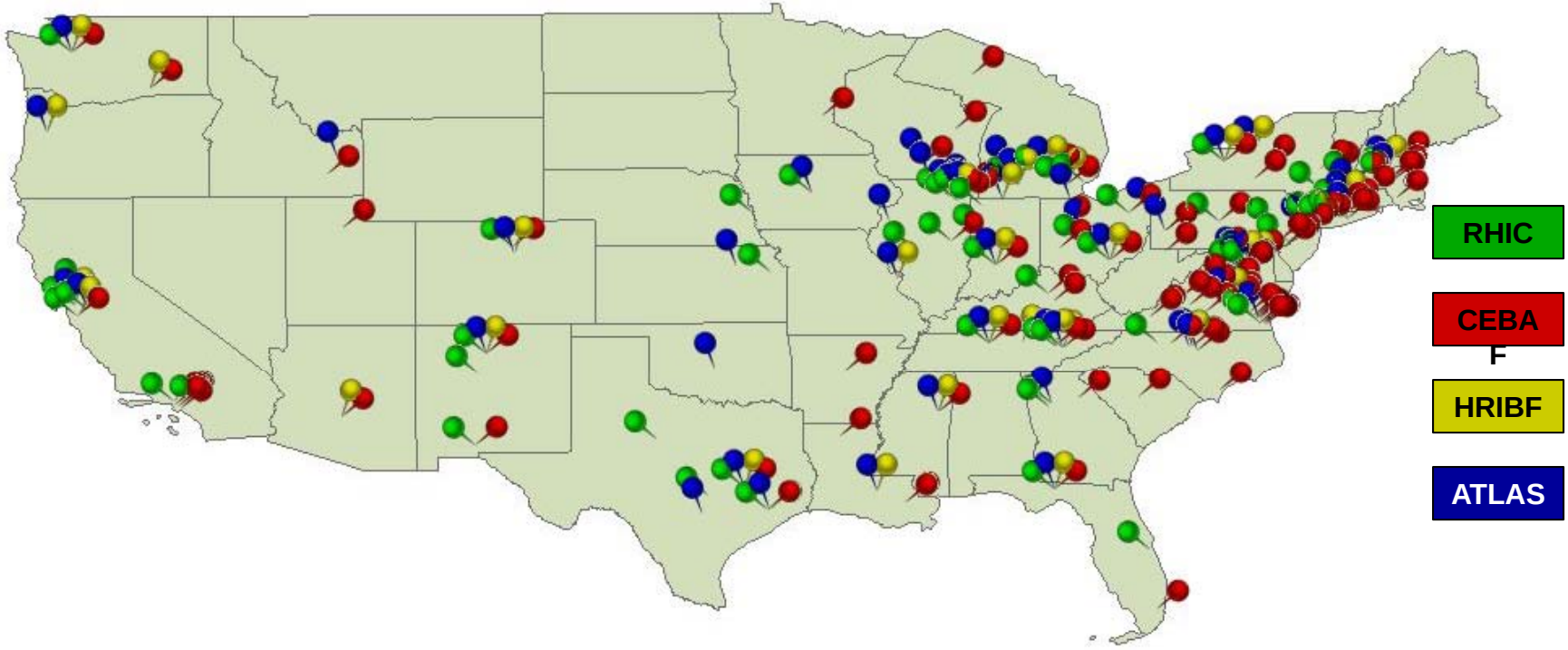
FY 2012 Highlights:

- 12 GeV CEBAF Upgrade to study exotic and excited bound systems of quarks and gluons and for illuminating the force that binds them into protons and neutrons.
- Design of the Facility for Rare Isotope Beams to study the limits of nuclear existence.
- Operation of three nuclear science user facilities (RHIC, CEBAF, ATLAS); closure of the Holifield Radioactive Ion Beam Facility at ORNL.
- Research, development, and production of stable and radioactive isotopes for science, medicine, industry, and national security.

U.S. Institutions Conducting Research at Nuclear Physics National User Facilities

Approximately 1,900 U.S. users from 32 states and the District of Columbia

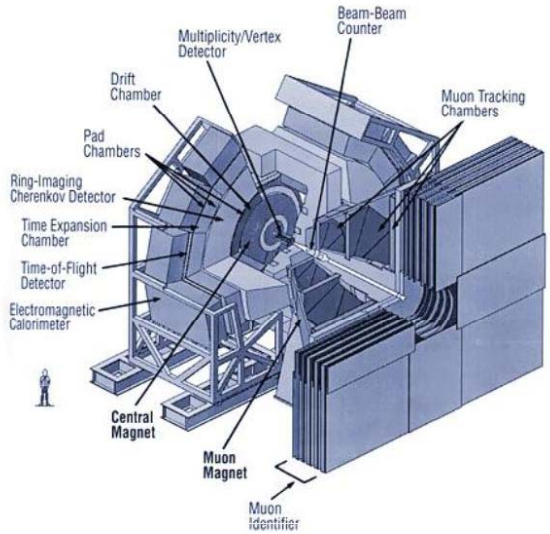


NP supports a scientific workforce of approximately 2,900 FTE's to carry out operations and research at the National User Facilities and related programs

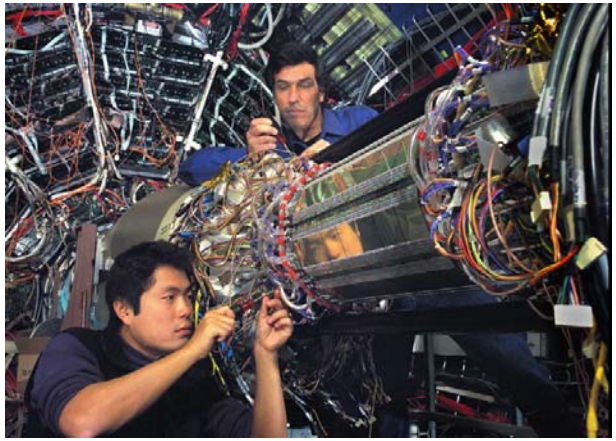
HRIBF is closed as a national user facility in FY 2012, and users will be transitioned to other parts of the program where possible. When FRIB comes on line, the Nuclear Physics program will gain the current NCSL/FRIB user community.

U.S. DEPARTMENT OF ENERGY | Office of Science

STAR Detector at RHIC



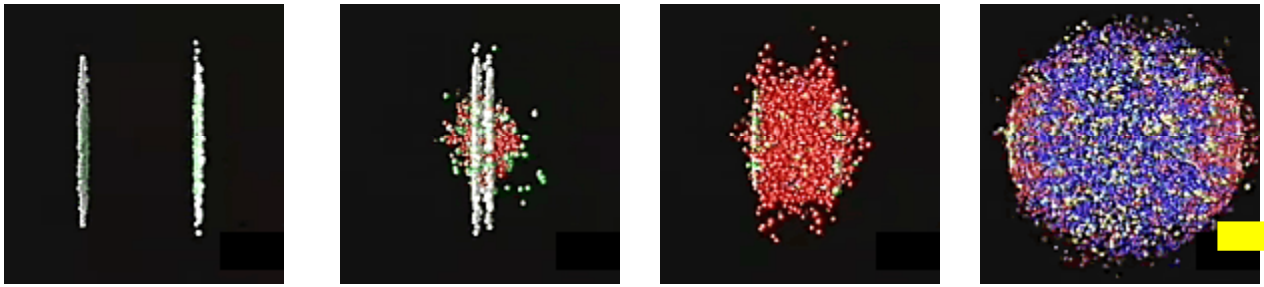
Inside the STAR Detector

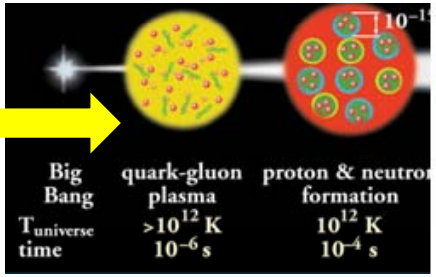


Inside the STAR Detector

End view of a collision of two 30 GeV gold beams in the STAR detector at RHIC.

Collisions create quark-gluon plasma that existed microseconds after the Big Bang.





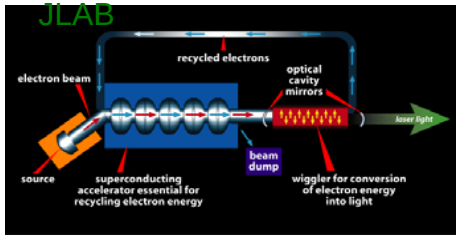
Ion-Ion Collision: If conditions are right, the collision "melts" the protons and neutrons and, for a brief instant, liberates their constituent quarks and gluons. Just after the collision, thousands more particles form as the area cools off. Each of these particles provides a clue as to what occurred inside the collision zone. Physicists sift through those clues for interesting information.

U.S. DEPARTMENT OF ENERGY | Office of Science

CEBAF at JLab provides polarized 6 GeV electron beams

ccelerator Core Competencies

SNS SC RF cavities at JLAB



Developed most powerful FEL

Single crystal Niobium gives promise for high gradients for acceleration (ILC)

World's Premier Facility for studies of:

- **Quark structure of matter**
- **Nuclear structure and weak interactions with polarized electrons**

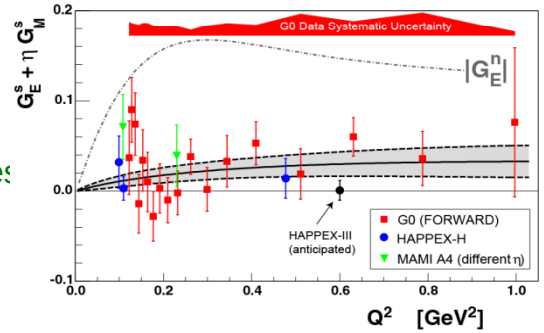
Core Competencies utilized by others

- SRF cavities for SNS
- Improvements in cryogenics (efficiencies
- FEL and ERL for USN/USAF
- SRF cavities for FRIB
- SRF cavities for ILC R&D
- Technology transfer

CEBAF Jefferson Laboratory

Premier NP User Facility

- User community of ~1300
- Outstanding science



- Nucleon weak coupling
- Quark structure of the nucleor
- Quark flavor masses

Technology Transfer

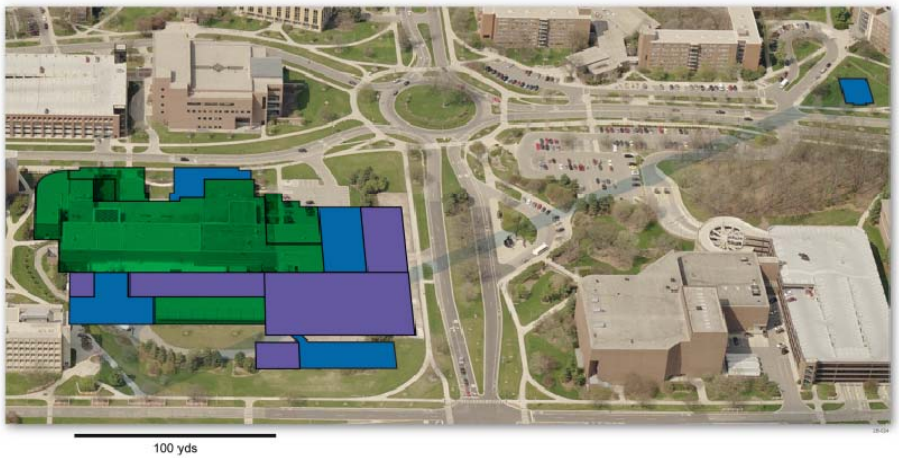
Dilion Gamma Camera used in scanning for breast cancer

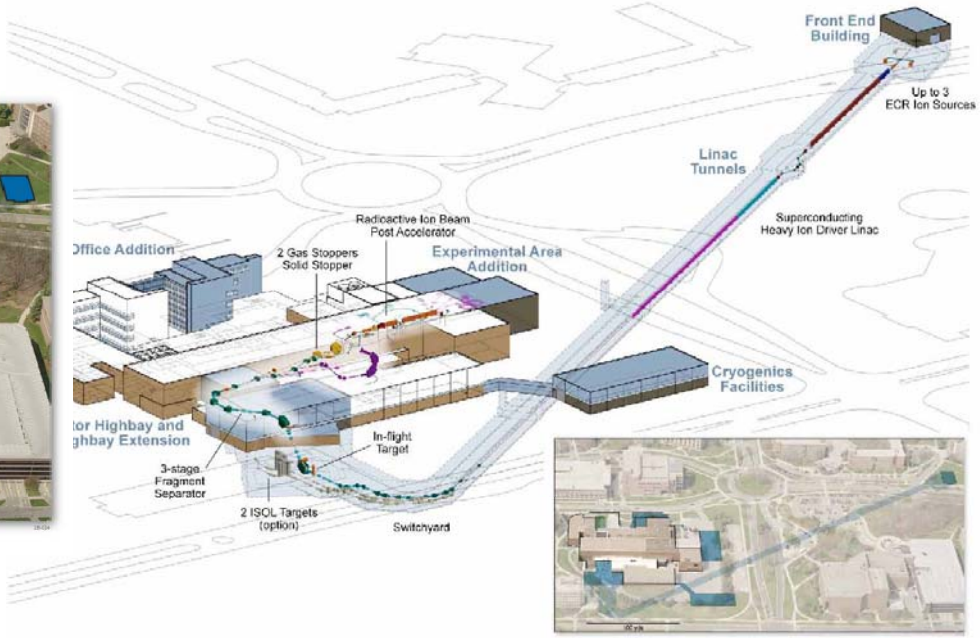
U.S. DEPARTMENT OF ENERGY | Office of Science

FRIB

Facility for Rare Isotope Beam (FRIB)

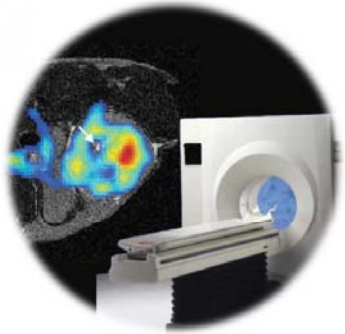
at Michigan State University,
Funded by DOE ~$550M, to be ready for science in 10 years.





FRIB: Using rare isotope beam to study the following questions:

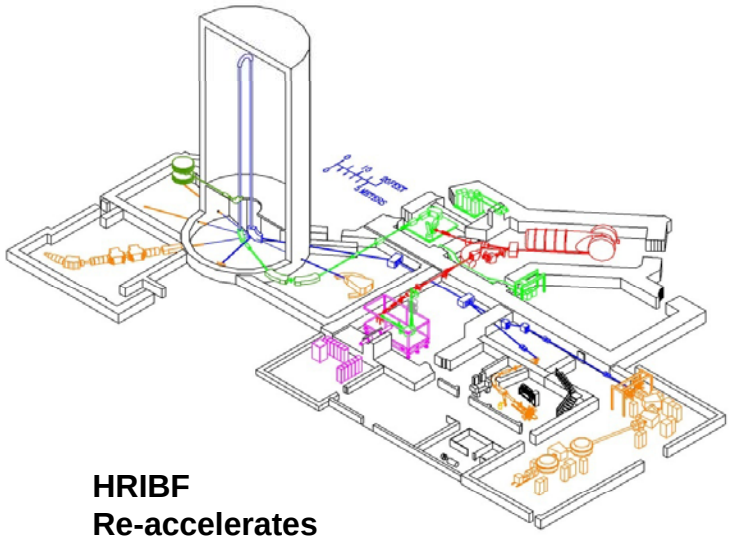
- How are the elements from iron to uranium created?
- How do stars explode?
- What is the nature of neutron star matter?



ATLAS and HRIBF Provide Stable and Radioactive Beams

- Capabilities:
  - ATLAS: stable beams (1<A<238) with energies > 8 MeV/u
  - HRIBF: >175 radioactive ion beams with energies above the Coulomb barrier for Sn
- Programs:
  - ATLAS: NS at the proton drip line, N=Z and heavy nuclei; CNO cycle breakout and cosmogenic gamma-ray emitters; precision mass measurements
  - HRIBF: delayed proton decay, NS at the proton drip line, closed-shell neutron rich nuclei; CNO cycle breakout, *rp* - and *r*-processes
- New Capabilities:
  - ATLAS: CARIBU source of complementary RIBs; HELIOS spectrometer for reaction studies with RIBs in reverse kinematics; Canadian Penning Trap for precision mass measurements
  - HRIBF: High Power Target Laboratory and Injector for Radioactive Ion Species 2; new endstation for study of rare isotopes including beta-delayed neutron decay; ORRUBA spectrometer for proton reactions with rare isotope beams (in collaboration with

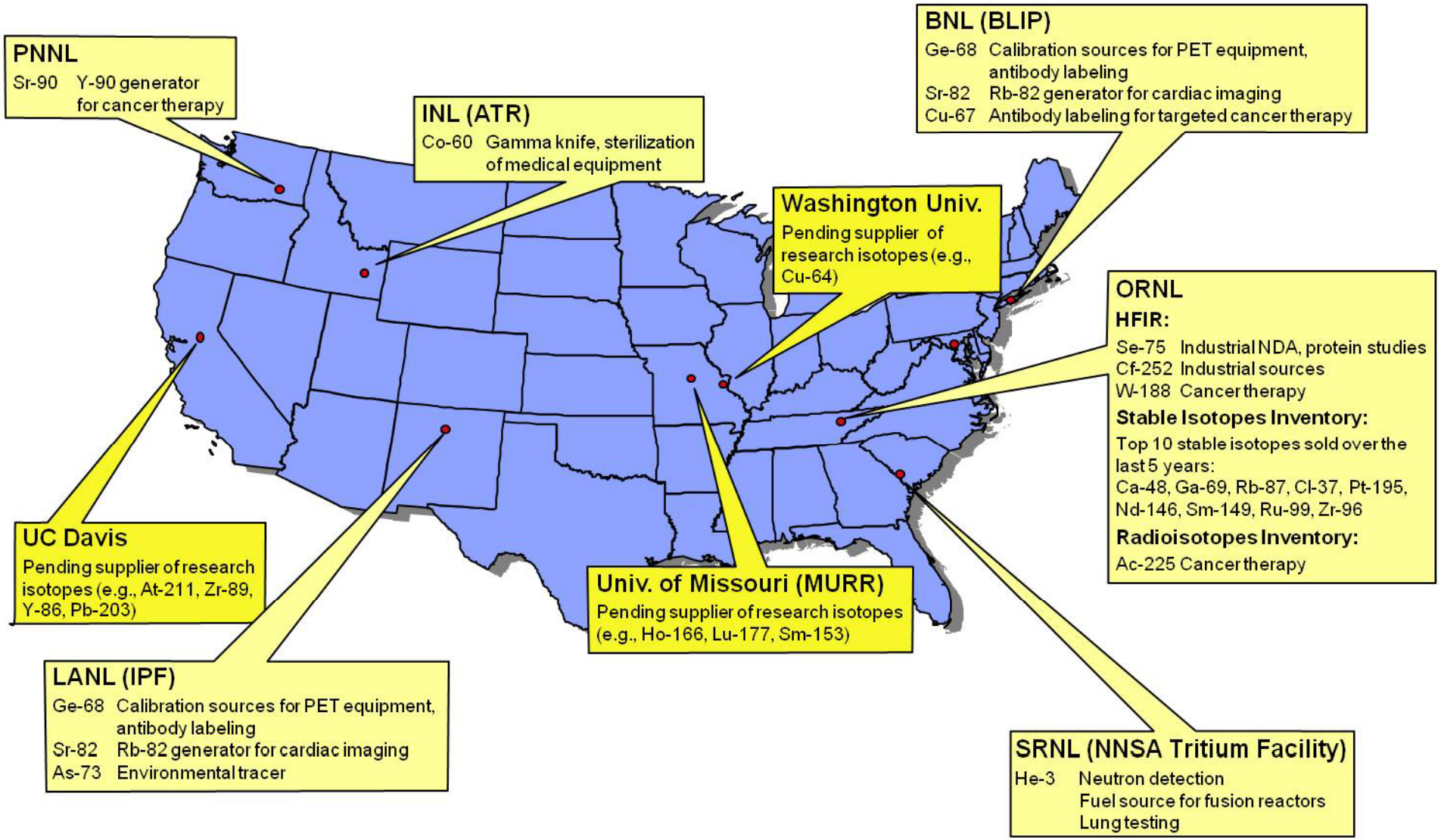
- User Community:
  - ~700 users including international and NSF-supported researchers
- Core Capabilities:
  - ATLAS: Superconducting Radiofrequency technology for heavy ion accelerators; gas cell heavy ion catchers
  - HIRIBF; development of ISOL technology for radioactive ion beams



HRIBF
Re-accelerates
Rare Isotope Beams

U.S. DEPARTMENT OF ENERGY | Office of Science

Broaden portfolio of production capabilities



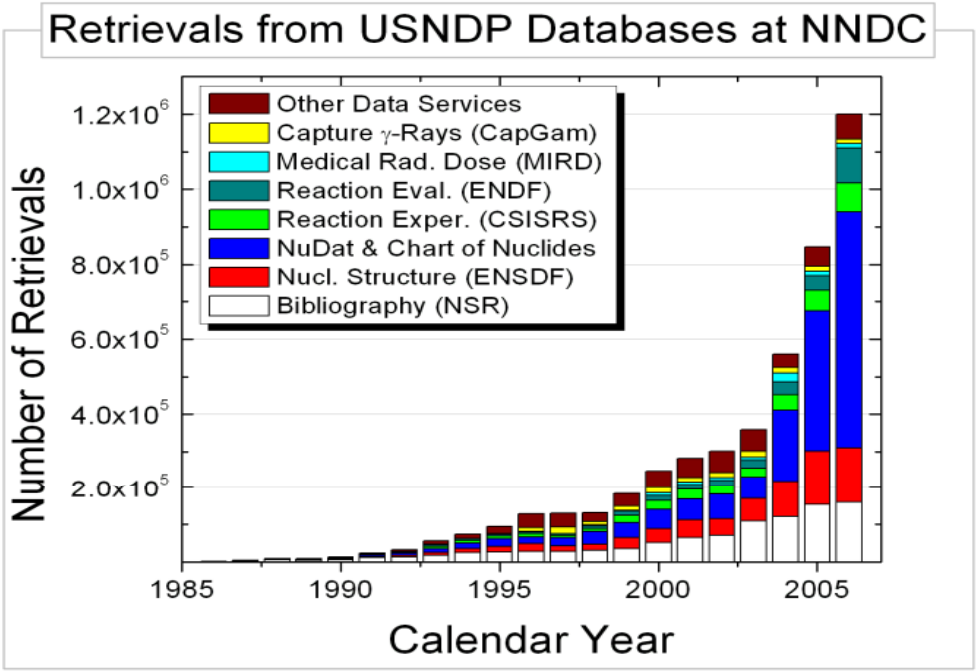
New Production Solicitation released in May 2011

Nuclear Data are used for many applications

- U. S. Nuclear Data Program (USNDP) evaluates, archives and disseminates information
- Information (nuclear properties/reaction cross sections) from nuclear physics research worldwide
- U.S. activities coordinated by the National Nuclear Data Center (NNDC) at BNL

Applications:

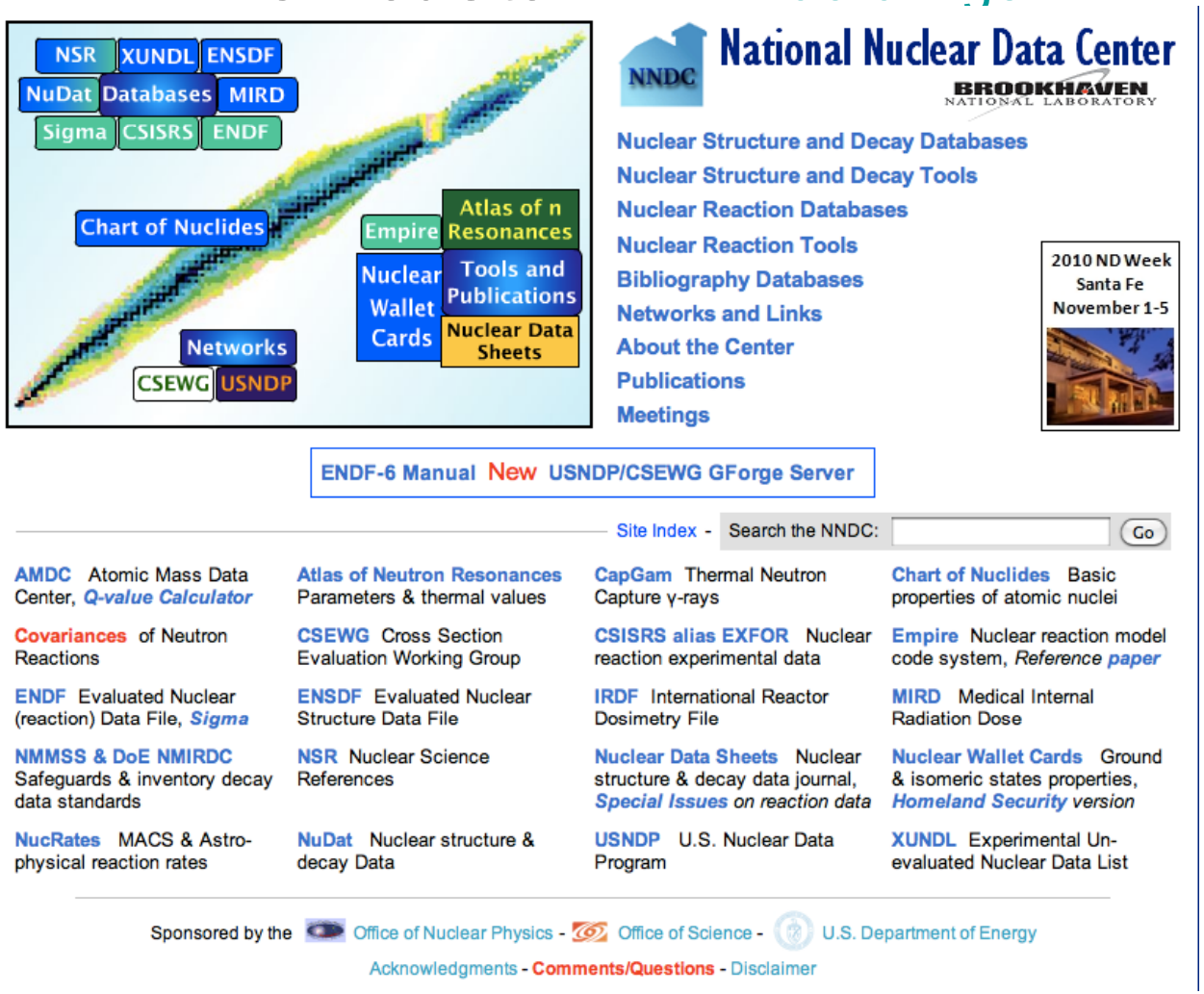
- Basic Nuclear Physics Research
- Accelerator Design
- Nuclear Medicine & Imaging
- Energy Generation
  - New reactors
  - Transmutation of waste
- National Security
  - Stockpile stewardship
  - Safeguards & nuclear management
  - Nuclear interrogation



U.S. DEPARTMENT OF ENERGY | Office of Science

Nuclear data dissemination

NNDC Web site www.nndc.bnl.gov



RHIC at BNL - Heavy Ion Beams and High Energy Polarized Protons

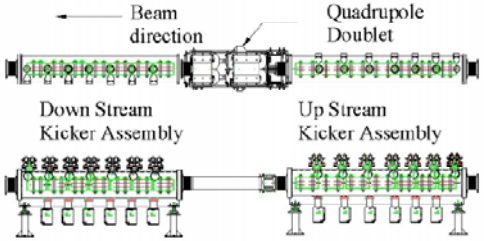
Capabilities used by others

BLIP (Isotopes) NSRL (NASA)

Tandem van de Graff
(SEU, micro-filter)

Accelerator Core Competencies

- Synchrotron and component for SNS
- Magnets for LHC
- ERL for USN
- Designs for medical synchrotrons



Fast kicker system designed and built for the SNS

World's Premier Facility for studies of:

- Hot, dense nuclear matter
- Structure of the proton

Unique Capabilities utilized by Others

- NASA (NSRL)
- NP Isotopes (BLIP)
- NASA, others (SEU, commercial)

Core Competencies utilized by others

- Synchrotron for SNS
- Magnets/Tier I Center for LHC
- USN work for ERL
- Technology transfer

RHIC Brookhaven National Laboratory

Premier NP User Facility

- User community of ~1200
- Outstanding Science

- "Perfect" QGP liquid
- Connection to string theory
- Proton's spin (gluons)

Instrumentation Core Competency

- World-class Instrumentation Group
- Awake Animal Imaging
- Micro-electronics/detectors for PET
- etc.

Awake animal imaging