U.S. DEPARTMENT OF ENERGY | Office of Science

# Perspectives from DOE NP

Nuclear Science Advisory Committee Meeting

June 2, 2017

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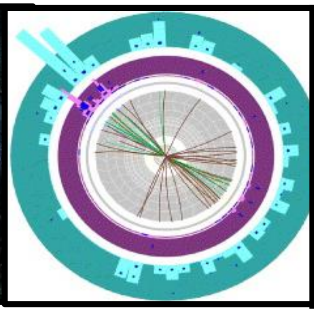
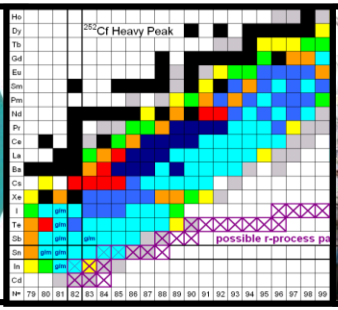
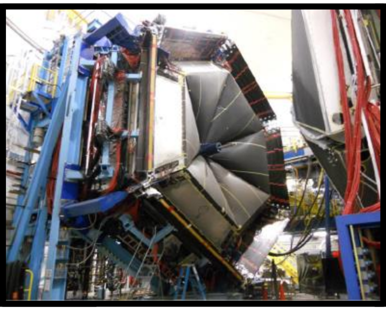
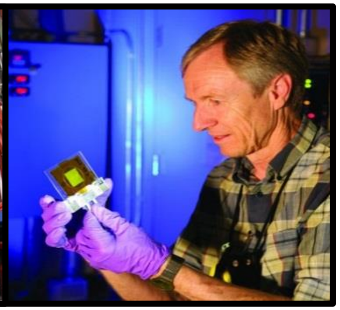
DOE Office of Science

What shall we talk about ? ☺

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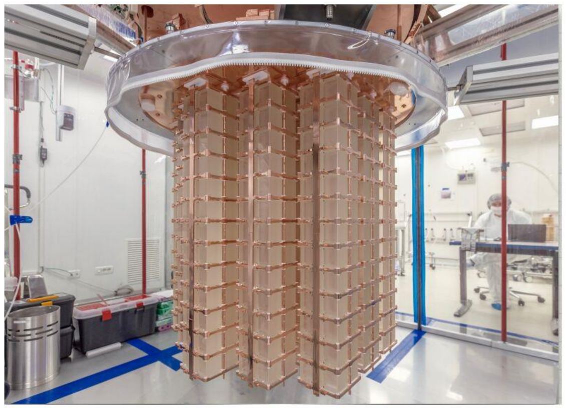
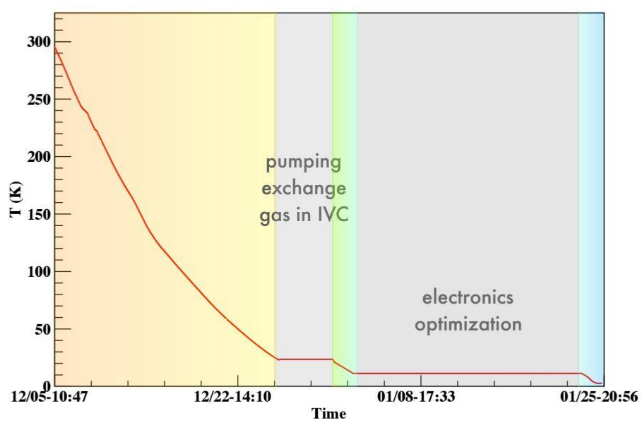
# CUORE: Start of Operations

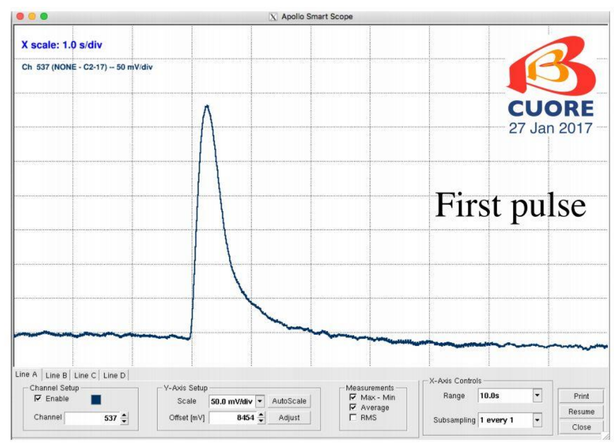
CUORE detectors installed



- Milestones:
  - Tower installation: Jul-Aug 2016
  - Cryostat closeout: Nov 2016
  - Cooldown: Dec-Jan 2016
  - Commissioning and initial performance optimization: Jan-May 2017
  - First science run: May 2017
- Cryostat performs very well: base T < 7 mK
- >95% of detectors operational
- Expect to report on first data in the Summer 2017

Cooldown Dec 2016-Jan 2017



# Additional Science News

**From:** "Clayton, Steven" <sclayton@lanl.gov>
**Subject: New neutron lifetime result from UCNtau**
**Date:** May 30, 2017 at 12:59:15 PM MDT

Hello,

Over Memorial Day weekend, the UCNtau collaboration unblinded results from the 2016-17 and 2015-16 LANSCE run cycles at a collaboration meeting, and prepared a first physics result for the experiment with uncertainty approximately equal to the previous most precise neutron lifetime measurement, and that is the first sub-1-second-precision neutron lifetime measurement that did not require a systematic correction large compared to its stated uncertainty…. We are working on rapid publication of this result…We also unblinded the 2015-16 data set and found agreement with the 2016-17 result, giving us confidence in both results considering the widely varying run conditions of numerous data subsets.

In addition, we have a publication that was just released today about the experimental method: "A new method for measuring the neutron lifetime using an in situ neutron detector," 30 May 2017, in Review of Scientific Instruments (Vol.88, Issue 5). It may be accessed via the link below:
http://scitation.aip.org/content/aip/journal/rsi/88/5/10.1063/1.4983578

# One Important Take-Away

Delivering exciting discoveries, important scientific knowledge and technological advances is what we do.

We need to stay focused and continue to deliver these outcomes for the nation

# Budget News

# NP FY 2018 President's Request

## (Dollars in thousands)

| | FY 2016 Enacted Approp. | FY 2016 Current w/SBIR-STTR[a] | FY 2017 Enacted Approp. | FY 2018 President's Request | FY 2018 Request vs. FY 2016 Current w/SBIR-STTR[a] | |
|---|---|---|---|---|---|---|
| **Medium Energy Nuclear Physics** | | | | | | |
| Research | 37,802 | 34,411 | 36,585 | 25,316 | -9,095 | -26.4% |
| Operations (TJNAF) | 98,670 | 99,672 | 99,168 | 88,598 | -11,074 | -11.1% |
| SBIR/STTR and Other | 19,321 | 18,457 | 21,546 | 16,253 | -2,204 | -11.9% |
| **Total, Medium Energy Nuclear Physics** | **155,793** | **152,540** | **157,299** | **130,167** | **-22,373** | **-14.7%** |
| **Heavy Ion Nuclear Physics** | | | | | | |
| Research | 35,822 | 36,036 | 37,369 | 20,943 | -15,093 | -41.9% |
| Operations (RHIC) | 172,088 | 172,088 | 174,538 | 164,738 | -7,350 | -4.3% |
| **Total, Heavy Ion Nuclear Physics** | **207,910** | **208,124** | **211,907** | **185,681** | **-22,443** | **-10.8%** |
| **Low Energy Nuclear Physics** | | | | | | |
| Research | 51,383 | 54,263 | 55,717 | 33,033 | -21,230 | -39.1% |
| GRETA | … | … | 676 | 200 | +200 | ... |
| Operations | 27,402 | 27,402 | 23,499 | 19,222 | -8,180 | -29.9% |
| **Total, Low Energy Nuclear Physics** | **78,785** | **81,665** | **79,892** | **52,455** | **-29,210** | **-35.8%** |
| **Nuclear Theory** | | | | | | |
| Theory Research | 38,033 | 37,616 | 36,475 | 27,749 | -9,867 | -26.2% |
| Nuclear Data Activities | 7,742 | 8,022 | 7,572 | 5,537 | -2,485 | -31.0% |
| **Total, Nuclear Theory** | **45,775** | **45,638** | **44,047** | **33,286** | **-12,352** | **-27.1%** |
| **Isotope Development and Production for Research and Applications** | | | | | | |
| Research | 6,033 | 6,329 | 9,829 | 5,307 | -1,022 | -16.1% |
| Operations | 15,304 | 15,304 | 16,526 | 14,304 | -1,000 | -6.5% |
| Stable Isotope Production Facility (SIPF) | … | … | 2,500 | 1,500 | +1,500 | ... |
| **Total, Isotope Production and Applications** | **21,337** | **21,633** | **28,855** | **21,111** | **-522** | **-2.4%** |
| **Subtotal, Nuclear Physics** | **509,600** | **509,600** | **522,000** | **422,700** | **-86,900** | **-17.1%** |
| **Construction** | | | | | | |
| 14-SC-50 Facility for Rare Isotope Beams, MSU | 100,000 | 100,000 | 100,000 | 80,000 | -20,000 | -20.0% |
| 06-SC-01 12 GeV CEBAF Upgrade, TJNAF | 7,500 | 7,500 | … | … | -7,500 | -100.0% |
| **Total, Construction** | **107,500** | **107,500** | **100,000** | **80,000** | **-27,500** | **-25.6%** |
| **Total, Nuclear Physics** | **617,100** | **617,100** | **622,000** | **502,700** | **-114,400** | **-18.5%** |

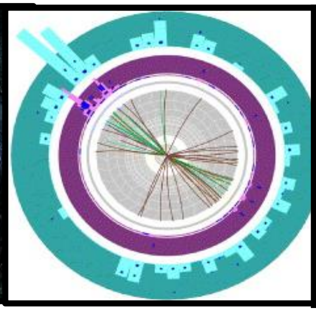
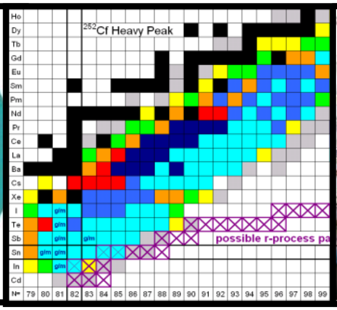
*[a]The FY 2016 Enacted column printed in the FY 2018 Congressional Budget Justification (President's Request) includes SBIR/STTR funding in the program lines and reflects programmatic updates through the end of the fiscal year.*

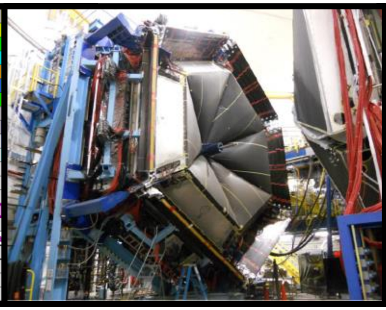
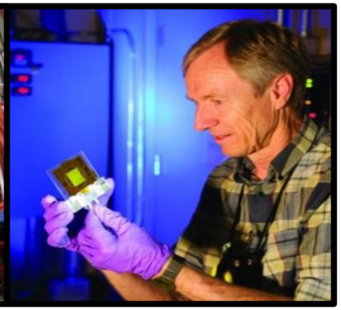
One feature of the FY 2017 enacted appropriation is that all research lines were put at the level of the FY 2017 President's Budget Request

Since the overall bottom-line was less than the FY2017 PBR, other lines had to be reduced accordingly

# The FY 2018 Request for Nuclear Physics

- Decreased funding for **research** focuses resources on the most critical areas of nuclear science research
- Operations at **RHIC** are supported for 10 weeks in FY 2018. Beam time in FY 2018 is combined with planned operation in FY 2019 to explore the properties of the quark gluon plasma first discovered there and to enable studies of spin physics
- The **12 GeV CEBAF Upgrade,** completed in FY 2017, begins its scientific program with a 10 weeks run, promising new discoveries and an improved understanding of quark confinement.
- Operations at **ATLAS** are supported, continuing to provide high-quality beams of all the stable elements up to uranium as well as selected beams of short-lived nuclei.
- Construction continues on the **Facility for Rare Isotope Beams** following a rebaseline of the project reflecting reduced construction funding in FY 2018**.** The **Gamma-Ray Energy Tracking Array (GRETA)** MIE is continued to exploit the scientific potential of FRIB.
- Fabrication continues on the **Stable Isotope Production Facility (SIPF)** to produce enriched stable isotopes, a capability not available in the U.S. for almost 20 years.

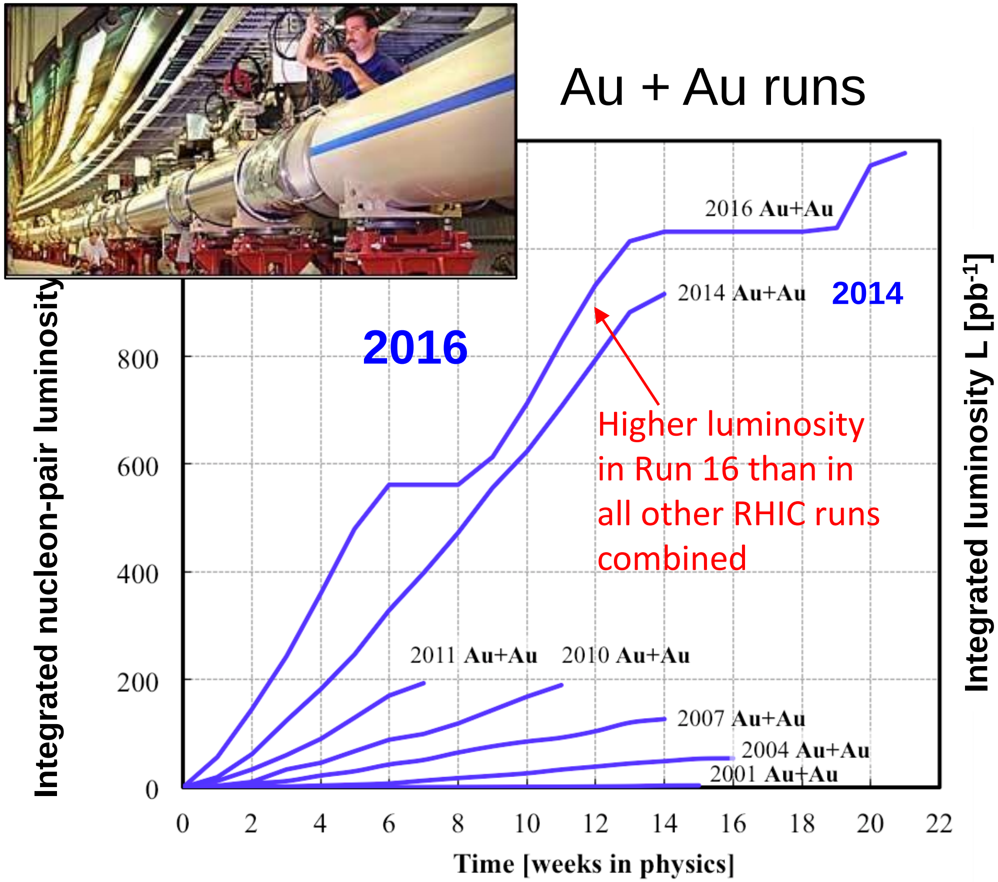
# FY 2018 Reductions to Research

Targeted Cuts to

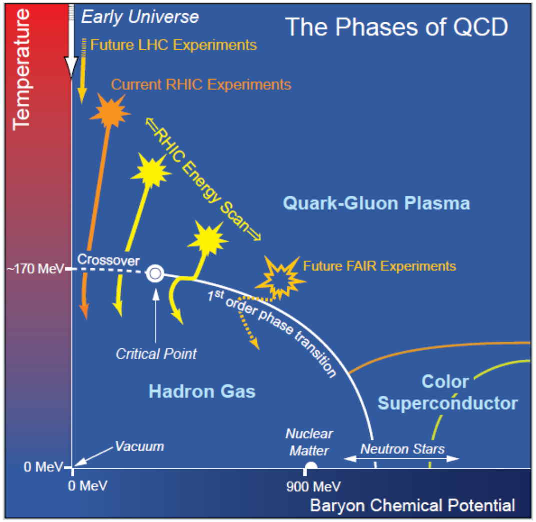
- RHIC Spin Program
- LHC Heavy Ion Program
- The MIT Research and Engineering Center
- New ECA awards in FY 2018

A general reduction of 24.5% across all research lines

# RHIC Machine Performance Continues to Set New Records




- In FY 2018, RHIC operates for 10 weeks. Beam time in FY 2018 is combined with planned operation in FY 2019 to improved operational efficiency.
- The FY 2018 request supports data taking to confirm the explanation of never-before-seen phenomena in quark gluon plasma formation and preparations to search for a critical point between the phases of nuclear matter.




- Consistently high facility availability ( ~ 85%)
- No other facility worldwide, existing or planned, rivals RHIC in science reach and versatility as a heavy ion collider. It is the only polarized proton collider in the world.

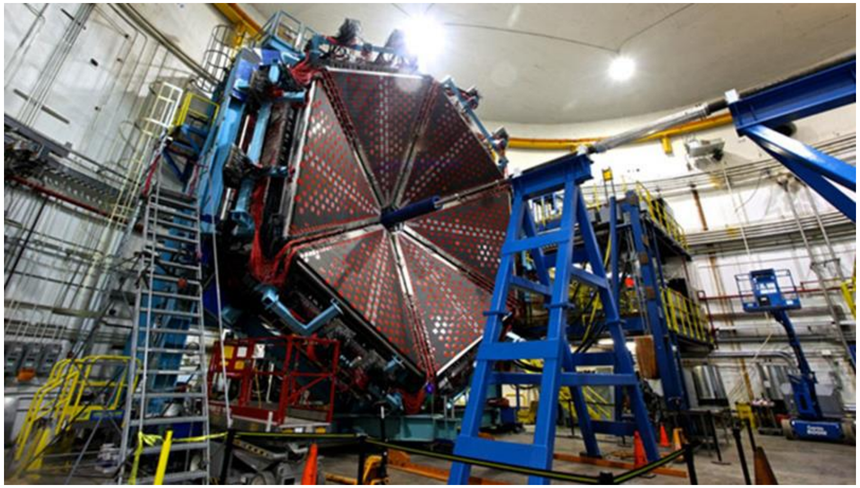
# Continuous Electron Beam Accelerator Facility

**CEBAF operates for 10 weeks in FY 2018**

**12 GeV CEBAF Upgrade Science Program is initiated:**

- The CEBAF science program restarts its first science data taking operations following the completion of the 12 GeV Upgrade.
- While concurrent operation of the 4 experimental halls is constrained by resources, sequential data taking in the four experimental halls, including the recently constructed Hall D, gets underway.

Hall D Solenoidal Spectrometer



Hall B Time of Flight Detector

**With the completed 12 GeV CEBAF Upgrade, researchers begin experiments to:**

- Search for exotic new quark-anti-quark particles to advance our understanding of the strong force.
- Find evidence of new physics from sensitive searches for violations of nature's fundamental symmetries.
- Gain a microscopic understanding of the internal structure of the proton, including the origin of its spin, and how this structure is modified when the proton is inside a nucleus. begin

# Facility for Rare Isotope Beams is > 77% Complete

FRIB will increase the number of isotopes with known properties from ~2,000 observed over the last century to ~5,000 and will provide world-leading capabilities for research on:

Nuclear Structure

- The limits of existence for nuclei
- Nuclei that have neutron skins
- Synthesis of super heavy elements

Nuclear Astrophysics

- The origin of the heavy elements and explosive nucleo-synthesis
- Composition of neutron star crusts

Fundamental Symmetries

- Tests of fundamental symmetries, Atomic EDMs, Weak Charge

This research will provide the basis for a predictive model of nuclei and how they interact.

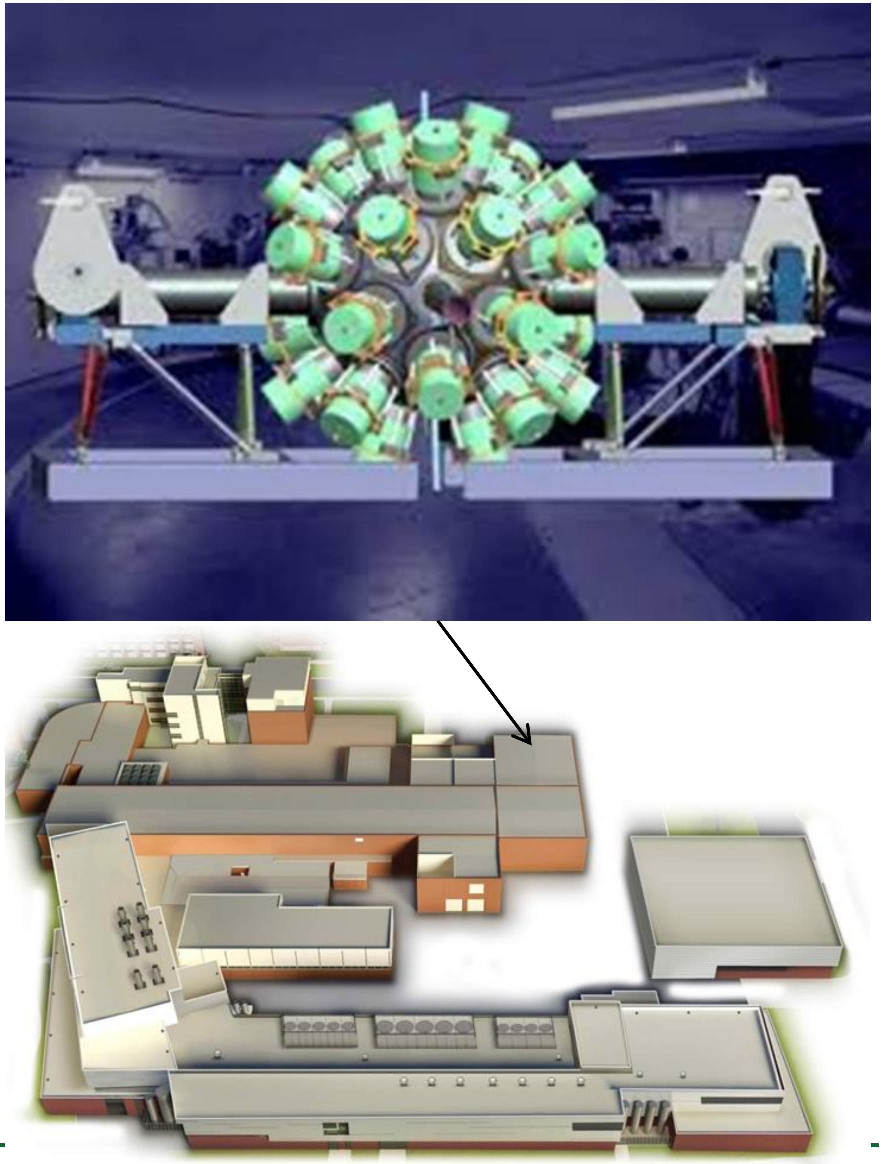
FRIB is rebaselined in FY2018 to reflect reduced construction funding

**The FY2018 Request supports:**

- Completing work on the fabrication and assembly of the cryogenics plant and distribution system.
- Remaining major procurements; fabrication, assembly and installation of technical systems including cryo-modules and experimental systems.
- Completing the commissioning of the FRIB ion source, and beginning the commissioning of the linear accelerator (linac) system.

# Gamma-Ray Energy Tracking Array (GRETA)

- The  FY 2018 Request continues the Gamma Ray Energy Tracking Array (GRETA) Major Item of Equipment (MIE) initiated in FY 2017, a premiere gamma-ray tracking device that will exploit the new capabilities of FRIB.
- GRETA was identified by NSAC as an instrument that will "revolutionize gamma-ray spectroscopy and provide sensitivity improvements of several orders of magnitude."
- GRETA will advance the rare-isotope science at FRIB and investigate reactions of importance for nuclear structure and nuclear astrophysics.
- FY 2018 Request: $0.2M
  Est. Total Project Cost: $52M-$67M
- The estimated cost and schedule will be re-evaluated in the context of funds available in the FY 2018 budget



# Stable Isotope Production Facility (SIPF)

- The FY 2018 Request initiates the Stable Isotope Production Facility (SIPF) MIE, which restores domestic capability lacking since 1998:
  - Renewed enrichment capability that will benefit nuclear and physical sciences, industrial manufacturing, homeland security, and medicine.
  - Nurtured U.S. expertise in centrifuge technology and isotope enrichment, useful for a variety of peaceful-use activities.
  - Capability to address U.S. needs for high priority isotopes needed for research, feedstock material for Mo-99 production, and more.
  - Removes U.S. dependence on off-shore suppliers of of enriched stable isotopes

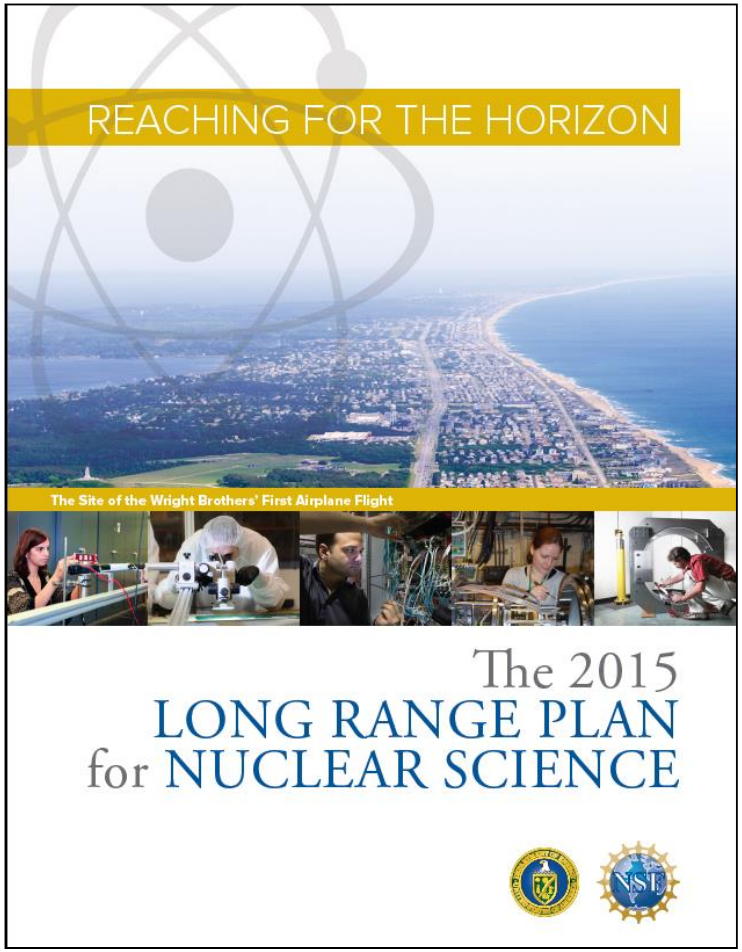
Stable Isotope Pilot Production Facility at ORNL

- Responds to the Persistent Recommendation of the Nuclear Science Advisory Committee for Isotopes (NSACI)
  - 2009 Recommendation: “Construct and operate an electromagnetic isotope separator facility for stable and long-lived radioactive isotopes.”
  - 2015 Long Range Plan: “We recommend completion and the establishment of effective, full intensity operations of the stable isotope separation capability at ORNL.”

# The 2015 Long Range Plan for Nuclear Science

Recommendations:

1. Capitalize on investments made to maintain U.S. leadership in nuclear science.
2. Develop and deploy a U.S.-led ton-scale neutrino-less double beta decay experiment.
3. Construct a high-energy high-luminosity polarized electron-ion collider (EIC) as the highest priority for new construction following the completion of FRIB.
4. Increase investment in small-scale and mid-scale projects and initiatives that enable forefront research at universities and laboratories.




The FY 2018 Request supports progress in important aspects of the 2015 LRP Vision

# Things to Bear in Mind

- Budget discussions that NP engages in must be factual only without commentary.
- There are no scenarios which avoid significant impacts to all current NP supported operations and research
- The decisions made are owned by the AD and issues should be directed to him.
- An attempt was made to preserve “core” areas of NP’s mission and the tools which enable them, even though they are also impacted.
- Both the Executive and the Legislative branches must agree on whatever the FY18 budget will be. The answer may not be known for a while and it will be challenging to try to remain prepared for the full range of possibilities. An attempt was made to take that into account.
- At the requested budget level there will be significant RIFs and that is unavoidable. The size of these reductions can be different FTE-wise at Labs and universities because of the differing cost of doing business at the two types of institutions and method of operations.
- At FY 2018 request level it will not be possible to continue to execute on the full scope of the 2015 Long Range Plan

# Other DOE NP News Items

- Selections have been made for proposals submitted in response to the $0\nu\beta\beta$ R&D FOA released August 29,2016
- The recommendations of the Jones panel are being folded into planning for accelerator R&D related to a possible Electron-Ion Collider
- A new lab-only FOA has been published by the Interagency Working Group established on Nuclear Data to assess the possibility of some additional investment in targeted experiments with great leverage for enhancing nuclear data
- FRIB Theory alliance continues to progress
- 12 GeV upgrade and FRIB construction continue to be on track
- A Statement of Mission has been established for the MIT Research and Engineering center
- The 2017 ECA process is progressing
- Selections in progress for SciDAQ4

# Next Formal Step on the EIC Science Case is Continuing

**THE NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE**
Division on Engineering and Physical Science
Board on Physics and Astronomy
**U.S.-Based Electron Ion Collider Science Assessment**

***Summary***

The National Academies of Sciences, Engineering, and Medicine ("National Academies") will form a committee to carry out a thorough, independent assessment of the scientific justification for a U.S. domestic electron ion collider facility. In preparing its report, the committee will address the role that such a facility would play in the future of nuclear science, considering the field broadly, but placing emphasis on its potential scientific impact on quantum chromodynamics. The need for such an accelerator will be addressed in the context of international efforts in this area. Support for the 18-month project in the amount of $540,000 is requested from the Department of Energy.

"U.S.-Based Electron Ion Collider Science Assessment" is now getting underway. The Chair will be Gordon Baym. The rest of the committee, including a co-chair, will be appointed in the next couple of weeks. The first meeting is being planned for January, 2017

# The Outlook Today

- The U.S. has unquestioned world leadership in experimental QCD research. CEBAF and RHIC are both unique and at the "top of their game" with compelling "must-do" science in progress or about to start. Long term, the future of QCD science is pointing to the need for an electron-ion collider.

- There is a wealth of science opportunity near term at ATLAS, and longer term at FRIB which will be world leading. NP is beginning to position the low energy experimental community to take full advantage of FRIB. The Theory Alliance (and support for theory in general) is also crucial.

- A very high priority for the NP community is U.S. leadership in the science of neutrino-less double beta decay.

  - A specific challenge will be ensuring essential R&D for candidate technologies is completed in the next 2-3 years prior to a down-select for a ton-scale experiment

- Research and production efforts to meet the Nation's need for isotopes in short supply are being strengthened; re-establishing U.S. capability for stable isotopes will be a major advance and will help address community concerns in this area documented in the 2009 and 2015 NSACI Strategic Plans

# The Outlook Three Months From Today

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It’s a process informed by information gathering

# A Long Tradition of Partnership and Stewardship

There has been a long tradition in Nuclear Science of effective partnership between the community and the agencies in charting compelling scientific visions for the future of nuclear science.

Key factors:

1) Informed scientific knowledge as the basis for recommendations and next steps
2) Mutual respect among scientific sub-disciplines
3) Commitment to the greater good of nuclear science as a discipline
4) Meticulously level playing field leading to respect for process and outcomes
5) Deep appreciation for the wisdom of Ben Franklin