Introduction to Office of Nuclear Physics and Program Mission

Office of Nuclear Physics (NP)

Virtual Office Hour

March 4, 2023

https://science.osti.gov/np/officehours

U.S. DEPARTMENT OF ENERGY | Office of Science

Energy.gov/science

Office of Science Code of Conduct

- The DOE Office of Science (SC) is fully committed to fostering safe, diverse, equitable, and inclusive work, research, and funding environments that value mutual respect and personal integrity. The Office of Science expects the members of the scientific communities engaged in SC-sponsored activities to conduct themselves in a manner that is respectful, ethical, and professional.

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The DOE policies and procedures for the prevention of discrimination and harassment:

https://science.osti.gov/SW-DEI/DOE-Diversity-Equity-and-Inclusion-Policies/DOE-Policies-Prohibiting-Discrimination-and-Harassment

Office of Nuclear Physics (NP)

Mission

Discover, explore, and understand all forms of nuclear matter

Oversees

- ~95% of the nation's investment in basic research in nuclear physics in the US
- Research groups: 9 National Laboratories, 93 Universities

Responsible for strategic planning, funding, and implementation of nuclear physics basic research programs in the US

Functions and Goals

- Maintain vibrant research programs
  - Ground-breaking research and discoveries in nuclear physics
  - Applications critical for national need
- Safe and efficient operations of four national user facilities and other accelerator-based labs
- Construction of new facilities and instruments to maintain US leadership
- Develop a highly trained, diverse workforce in nuclear physics as part of the national core competency

Open Funding Opportunity Announcement (FOA)

- **Heavy Ions** (Hot and dense nuclear matter) Experiment programs at Relativistic Heavy Ion Collider (RHIC), Large Hadron Collider, Future Electron-Ion Collider (EIC)
- **Medium Energy** (Hadron structure, hadron spectroscopy, cold Quantum Chromodynamics (QCD)) Experiments at Continuous Electron Beam Accelerator Facility (CEBAF), Polarized protons at RHIC, Triangle University Nuclear Lab (TUNL), Fermilab, Future EIC
- **Nuclear Structure and Nuclear Astrophysics** (Low energy nuclear interactions, nucleosynthesis) Experiments at Argonne Tandem Linac Accelerator System (ATLAS), TUNL, Facility for Rare Isotope Beams (FRIB), 88-Inch Cyclotron, Nuclear Labs in Universities
- **Fundamental Symmetries** (Fundamental symmetries in nuclear reactions, neutrino-nuclear interactions, beta decays) Experiments at FRIB, CEBAF, Neutrinoless Double Beta decay experiments
- **Theoretical Nuclear Physics** (Theoretical underpinning to support above subprograms and to advance new ideas for experimental investigations)

Targeted FOA

- **Quantum Information Science (QIS)** (Research in three broad areas intercept with : Quantum Chromodynamics (QCD), Nuclei and Nuclear Astrophysics, Fundamental Symmetries.)
- **Nuclear Data** (Collection, evaluation, and dissemination of nuclear data), joint FOA by interagency working group
- **Accelerator Physics** (Technology for accelerators of electrons, protons and heavy ions)
- **Artificial Intelligence / Machine Learning (AI/ML)** (applications in nuclear physics research: simulation, data acquisition/analysis, accelerator and detector controls/optimization)
- **Computational Nuclear Physics** (Includes two separate FOAs below)
  - Scientific Discovery Through Advance Computing (SciDAC), partnership with Office of Advanced Scientific Computing Research (ASCR)
  - Nuclear Physics Topical Collaborations

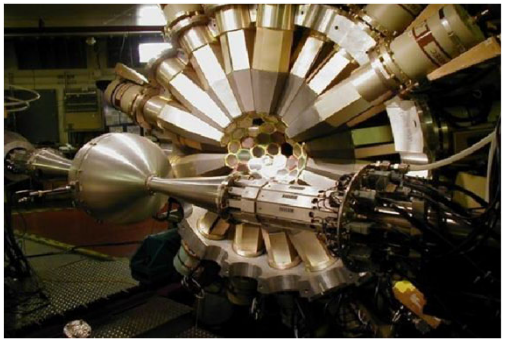
NP Participates in Office of Science FOAs

- **Early Career Research Program**
  Outstanding Early Career Scientists at Universities, National Laboratories, and Office of Science User Facilities
- **SBIR/STTR**
  Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)
- **Funding for Accelerated, Inclusive Research (FAIR)**
  Mutually beneficial relationships between minority serving institutions and emerging research institutions with partner institutions to perform basic research
- **Reaching a New Energy Sciences Workforce (RENEW) Initiative**
  Internships, training programs, and mentor opportunities for historically underrepresented groups
- **Office of Science Graduate Student Research (SCGSR) Program**
  Supplemental funds for PhD thesis research at a host DOE laboratory/facility

Four world-leading national user facilities

Relativistic Heavy Ion Collider (RHIC)
Brookhaven National Lab, Upton, NY

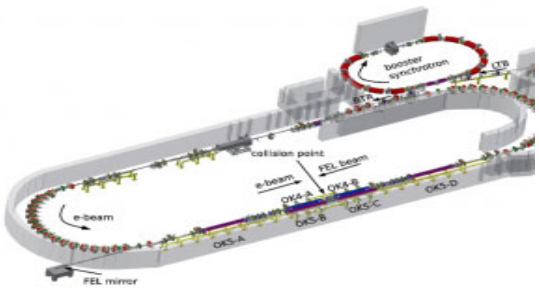
Continuous Electron Beam Accelerator Facility (CEBAF)
Jefferson Lab, Newport News, VA



Argonne Tandem Linac Accelerator System (ATLAS)
Argonne National Lab, Argonne, IL

Facility for Rare Isotope Beams (FRIB)
Michigan State Univ., East Lansing, MI

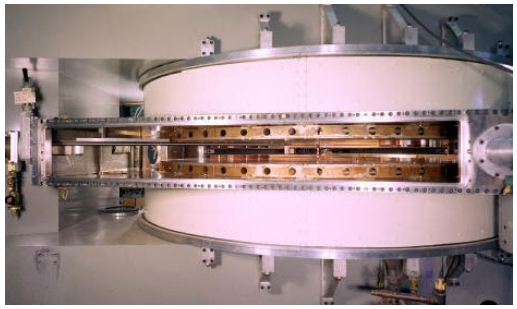
Other Accelerator-based Labs



Triangle Universities Nuclear Laboratory (TUNL)
Duke University, Durham, NC

Center for Experimental Nuclear Physics and Astrophysics (CENPA)
University of Washington, Seattle, WA

Texas A&M University Cyclotron Institute
College Station, TX

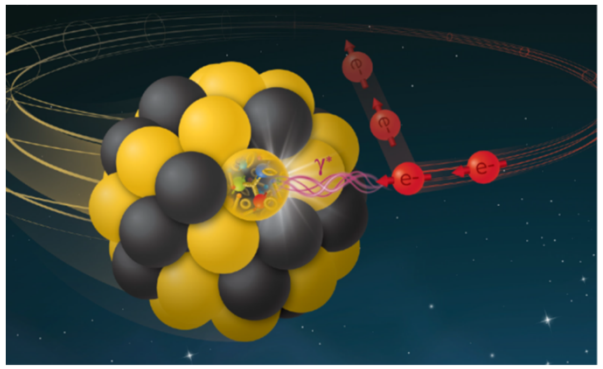


88 Inch Cyclotron Lab
Berkeley, CA

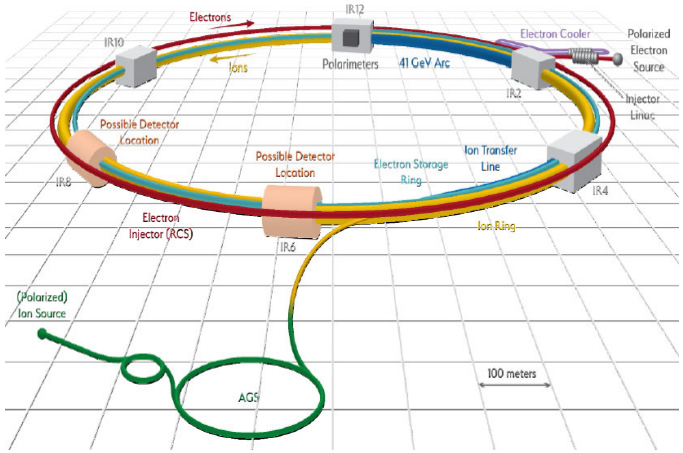
New Facilities Construction

Electron-Ion Collider – the next super high-power, high-energy microscope:

Spin and 3-D quark gluon structure of a nucleon, parton distributions in a nucleus, gluon saturation, quark gluon hadronization, new precision studies in intensity frontier



Located at Brookhaven National Lab, being built in partnership with Jefferson Lab

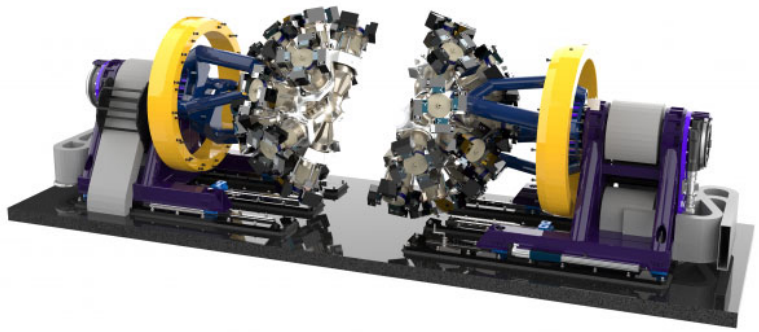


Status: Critical Decision (CD) 3A
Estimated Cost: $1.7B - $2.8B
Anticipated completion: FY2035

Major Items of Equipment (1)

Gamma-Ray Energy Tracking Array (GRETA)

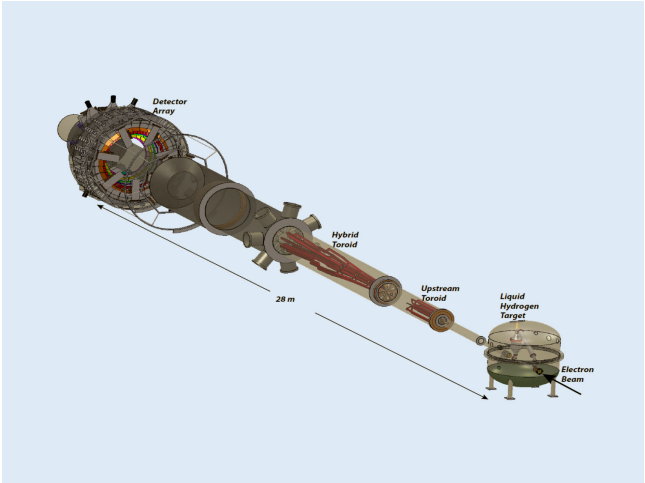
Key instrument at FRIB
Expected completion: 2028



Measurement of a Lepton-Lepton Electroweak Reaction (MOLLER)

Measure parity-violating asymmetry in polarized electron-electron (Møller) scattering

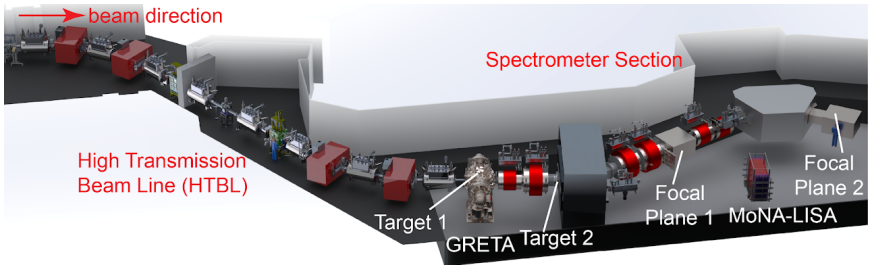
Locate : Jlab
Expected completion: 2028



Major Items of Equipment (2)

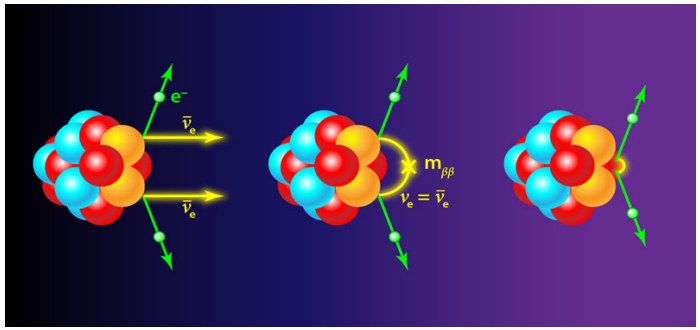
High Rigidity Spectrometer for FRIB (HRS)

Centerpiece for fast-beams program at FRIB
Expected completion: 2029



Ton-Scale Neutrinoless Double Beta Decay experiments

- Large Enriched Germanium Experiment for Neutrinoless ββ Decay One Tonne (LEGEND-1000)
  Expected Completion: 2035
- next Enriched Xenon Observatory (nEXO)
  Expected completion: 2034
- Cryogenic Underground Observatory for Rare Events Upgrade with Particle Identification (CUPID) (TBD)



Nuclear Physics Workforce

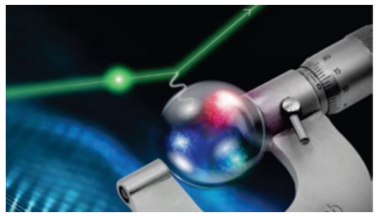
~ 852 Faculty & Lab Res Staff
~ 391 Post-docs
~ 630 Graduate Students
~ 900 Lab technical/admin
~ 150 Undergraduate Students

Research Groups
- 9 National Laboratories
- 93 Universities

Approximately 3000-4000 scientists (0.001% of the U.S. population) are trained and working in nuclear science, providing highly specialized skills and knowledge to support medicine, commerce, national and homeland defense, and basic research.

Research Highlights

Another Piece of the Proton Radius Puzzle



New value for the proton radius produced using the first new method in half a century for measuring proton size via electron scattering.

How Large Are Neutron Stars

Data from the first observation of a neutron star collision combined with modern nuclear theory narrow the range of neutron star radii.

Isotope Discovery Continues: Mendelevium-24

With the discovery of this new, lightest isotope of Md, researchers have observed 17 isotopes in total, including 12 discovered at LBNL.

More information about NP
https://science.osti.gov/np

Upcoming Virtual Office Hours

Monday, April 1 at 3pm ET:

Proposal Life Cycle

Monday, May 6 at 3pm ET:

Post-Award Actions: Annual Reports

Information available at:

https://science.osti.gov/np/officehours