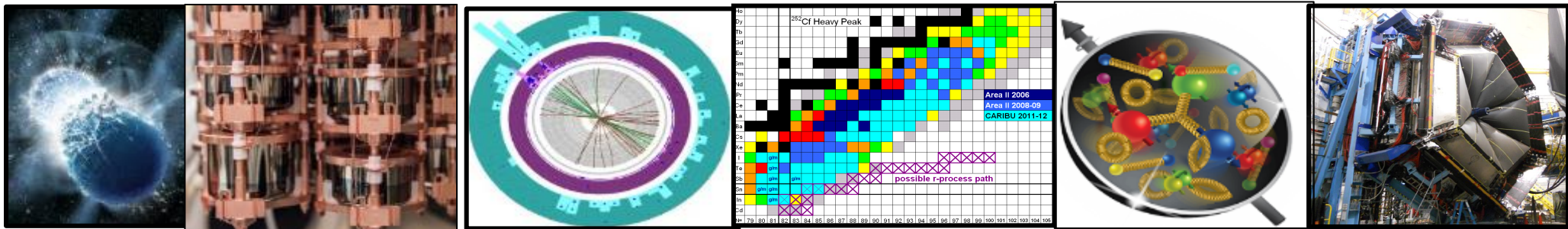


Perspectives from DOE Nuclear Physics

APS Topical Group on Hadron Physics
April 12, 2023

Dr. T. J. Hallman
Associate Director of the Office of Science
for Nuclear Physics

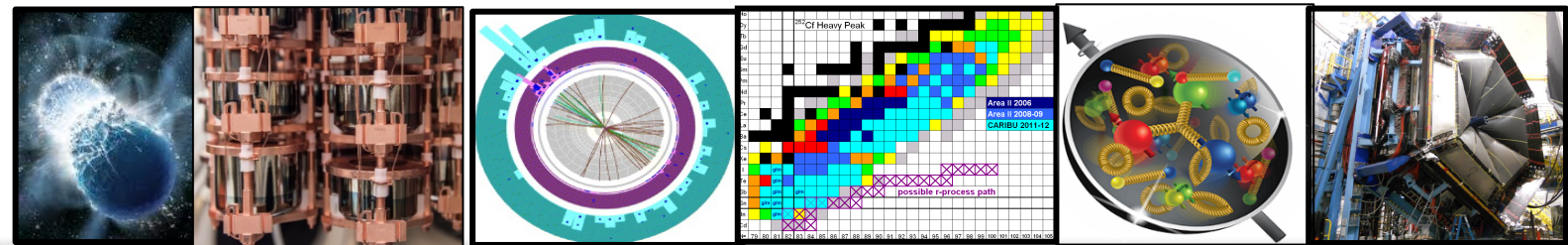


Nuclear Physics

Discovering, exploring, and understanding all forms of nuclear matter

Understanding why matter takes on the specific forms observed in nature and how that knowledge can benefit energy, commerce, medicine, and national security, by:

- Mapping the quantum cosmos inside the proton using the future **Electron-Ion Collider**
- Discovering the properties of the novel quark-gluon plasma **RHIC, LHC**
- Exploring the mechanism underlying the confinement of quarks and gluons via **CEBAF and RHIC**
- Searching for new exotic particles and violations of nature's symmetries at **CEBAF, FRIB, ATLAS**
- Determining the limits of nuclear existence and how are heavy elements made via **FRIB and ATLAS**
- Discovering if the neutrino its own anti-particle or if the neutron's precise properties point to new physics via **Neutrino-less Double Beta Decay and Neutron Electric dipole Moment**
- Exploring the strong force in many-body systems via **SciDAC, Core Research, QIS/QC, AI/ML**
- Advancing Nuclear Data for Space, Energy, and Research through **Nuclear Data and AI/ML**



NP is the Federal Steward of U.S. Nuclear Physics Research

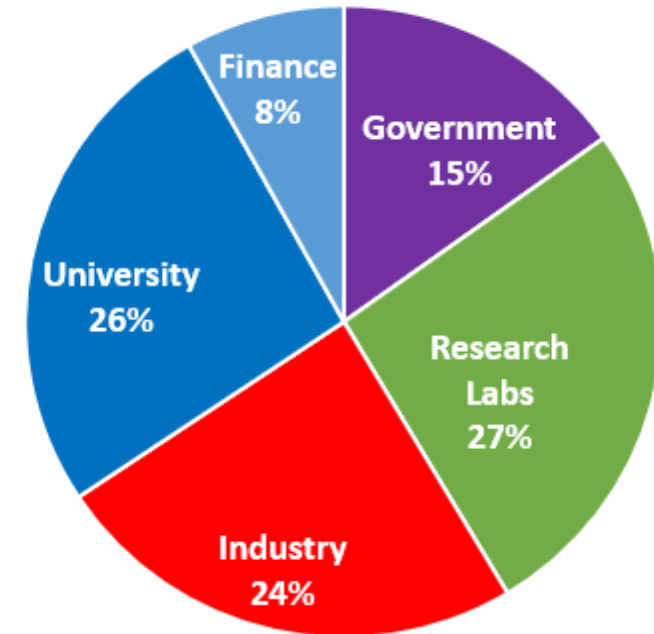
NP supports ~ 95% of the nation's investment in basic research in nuclear physics in the U.S.

It is responsible for Strategic Planning, Funding, and Implementation

Goals and Deliverables:

- Knowledge
- Leadership class facilities
- New technology
- A highly-trained, diverse workforce capable of supporting DOE & other missions

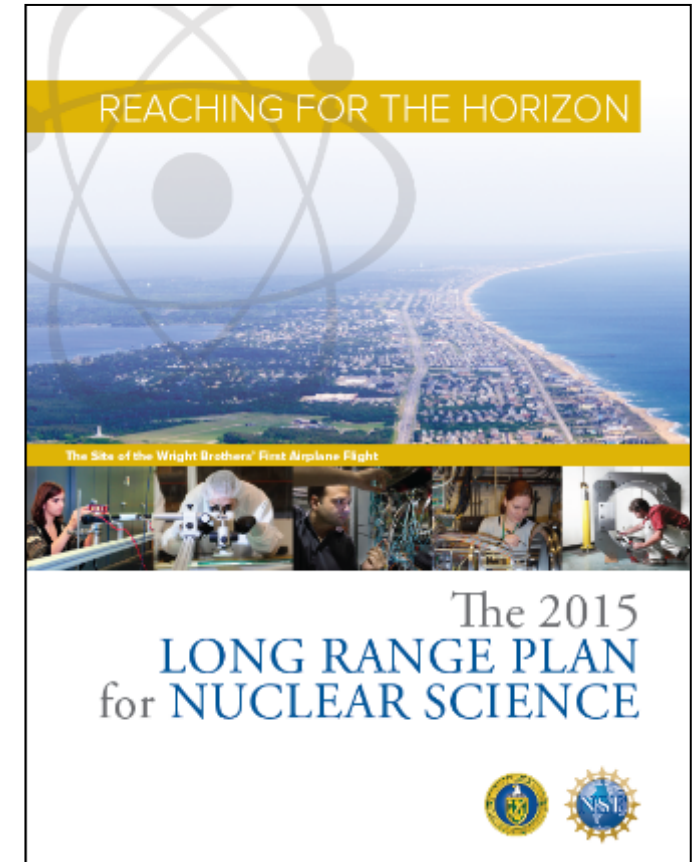
Where NP PHDs go



U.S. science, commerce, medicine, defense —all benefit, in part, from a stable level of sustained competence, capability, capacity, and leadership in nuclear physics; NP is the U.S. steward responsible for reliably delivering that benefit

The High-Level NP Work Plan

1. Operate and get science out from the Relativistic Heavy Ion Collider (RHIC), the Continuous Electron Beam Accelerator Facility (CEBAF), the Argonne Tandem Linac Accelerator System (ATLAS) and the Facility for Rare Isotope Beams (FRIB)
2. Make progress on a U.S.-led ton-scale neutrino-less double beta decay experiment.
3. Start construction of a high-energy high-luminosity polarized electron-ion collider (EIC)
4. Implement smaller scale instrumentation to take advantage of facility capabilities



The work plan centers on NP's mission to understand all forms of nuclear matter to benefit energy, commerce, medicine, and national security. A new Long Range Plan is in development by NSAC.

NP - FY 2024 President's Request

(dollars in thousands)

	FY 2022 Enacted	FY 2023 Enacted	FY 2024 Request	FY 2024 Request vs FY 2023 Enacted		FY 2024 Request vs FY 2022 Enacted	
Nuclear Physics							
Medium Energy, Research	53,404	59,083	55,555	-3,528	-5.97%	+2,151	+4.03%
Medium Energy, Operations	142,709	149,834	141,930	-7,904	-5.28%	-779	-0.55%
Total, Medium Energy Physics	196,113	208,917	197,485	-11,432	-5.47%	+1,372	+0.70%
Heavy Ion, Research	46,505	46,149	47,454	+1,305	+2.83%	+949	+2.04%
Heavy Ion, Operations	183,943	182,087	176,195	-5,892	-3.24%	-7,748	-4.21%
Heavy Ion, Projects	25,013	20,000	2,850	-17,150	-85.75%	-22,163	-88.61%
Total, Heavy Ion Physics	255,461	248,236	226,499	-21,737	-8.76%	-28,962	-11.34%
Low Energy, Research	73,935	77,651	78,409	+758	+0.98%	+4,474	+6.05%
Low Energy, Operations	107,831	128,579	127,624	-955	-0.74%	+19,793	+18.36%
Low Energy, Projects	17,400	23,940	9,259	-14,681	-61.32%	-8,141	-46.79%
Total, Low Energy Physics	199,166	230,170	215,292	-14,878	-6.46%	+16,126	+8.10%
Theory, Research	57,260	67,873	77,142	+9,269	+13.66%	+19,882	+34.72%
Total, Nuclear Theory	57,260	67,873	77,142	+9,269	+13.66%	+19,882	+34.72%
Subtotal, Nuclear Physics	708,000	755,196	716,418	-38,778	-5.13%	+8,418	+1.19%
20-SC-52 Electron Ion Collider (EIC), BNL	20,000	50,000	95,000	+45,000	+90.00%	+75,000	+375.00%
Subtotal, Construction	20,000	50,000	95,000	+45,000	+90.00%	+75,000	+375.00%
Total, Nuclear Physics	728,000	805,196	811,418	+6,222	+0.77%	+83,418	+11.46%

- ▶ The FY 2024 Request for \$811.4 million supports high priority efforts and capabilities in fundamental nuclear physics research; operations, maintenance, and upgrades of scientific user facilities; and projects

The Nuclear Physics Program Supports...

- ▶ Ground-breaking research and discoveries
 - ▶ E.g., First observation of the direction production of matter/anti-matter from an intense electro-magnetic field; discovery that natural radiation frustrates quantum coherence time essential for quantum computing
- ▶ Safe and highly efficient operation of four world-leading national user facilities with complimentary capabilities to maintain U.S. leadership in Nuclear Physics
- ▶ The construction of new tools (e.g. the Electron-Ion Collider) to maintain U.S. dominance in nuclear physics and a trained nuclear/accelerator physics workforce through the century
- ▶ Pioneering programs in RENEW, FAIR, EPSCOR to ensure the future NP workforce is fully capable of leveraging the entirety of diverse intellectual capital in the United States
- ▶ Applications critical for national needs through Nuclear Data, ACCELERATE, QIS, AI/ML, and Microelectronics

FY 2024 President's Request Highlights - NP

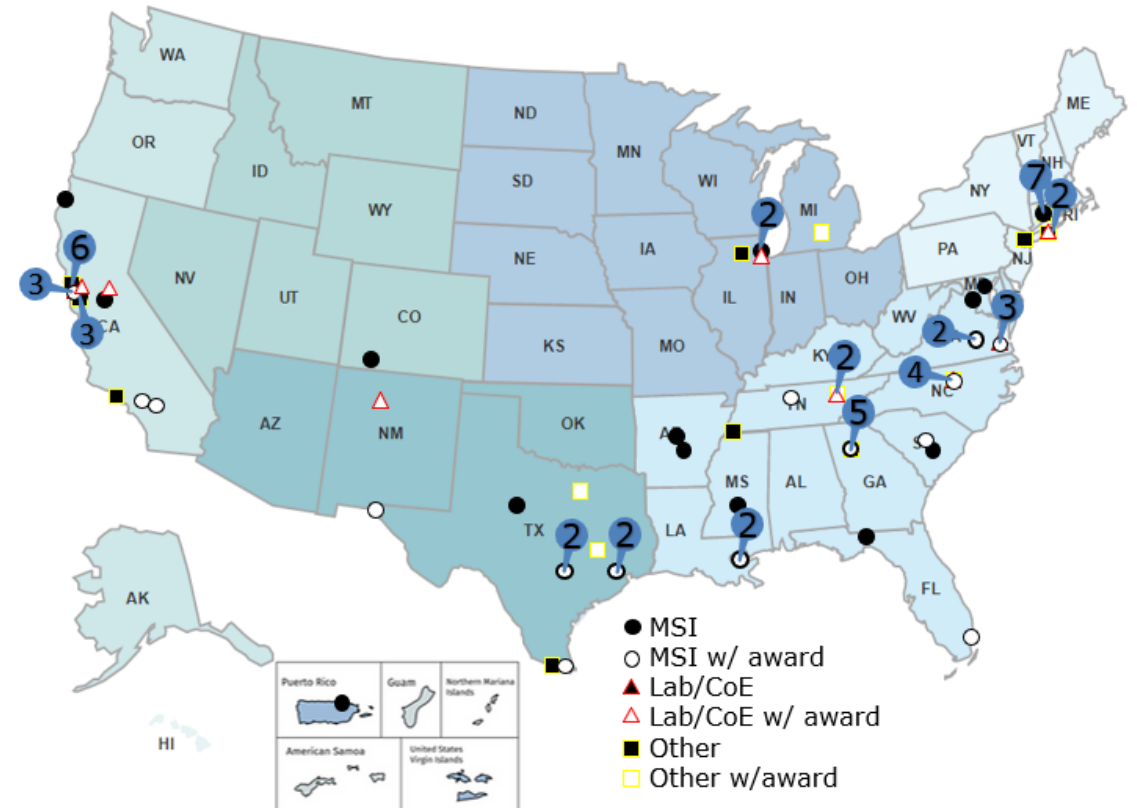
- ▶ FRIB begins its third year of science research studying atomic number nuclei near the limit for nuclear existence, and initiating a world leading campaign of fundamental symmetries measurements
- ▶ NP User Facilities (RHIC, CEBAF, ATLAS, and FRIB) are all at or above 90% optimal budget
- ▶ The Electron-Ion Collider vets a list of CD3a long lead procurements and makes finalizes preparations for CD-2 Review, Approve Performance Baseline. EIC A/E design is begun subject to funding.
- ▶ sPHENIX continues science research at RHIC to determine the novel properties of the quark-gluon plasma
- ▶ LEGEND-200 continues initial search for new physics via the slowest rare decay ever attempted
- ▶ A ton-scale neutrino-less double beta decay experiment finalizes preparation for a CD-1 review, "Approve Alternatives Selection and Cost Range"
- ▶ The Gamma Ray Energy Tracking Array (GRETA) MIE and MOLLER are fully funded at the FY 2023 Request, and construction continues in accordance with their technically driven schedules
- ▶ The High Rigidity Spectrometer for FRIB continues construction
- ▶ NP investment in the AI/ML cross-cutting research continues and RENEW and EPSCOR investment increases
- ▶ NP makes highly impactful awards in the new cross-cutting initiatives in Funding for Accelerated Inclusive Research (FAIR) and Accelerate Innovations in Emerging Technologies (Accelerate)

Planned FY 2024 NP Research Horizons

- ▶ Search for anomalous atomic electric-dipole moments at FRIB as a signal of new physics using laser trapped isotopes
- ▶ Search for anomalous parity violation in electron scattering as a signal of new physics using MOLLER at JLAB
- ▶ Search for the next superheavy nucleus ($A = 120$) at the LBNL 88 inch cyclotron
- ▶ Understanding the equation of state of the quark-gluon plasma using sPHENIX at RHIC
- ▶ Expanding the boundary of present knowledge of how heavy elements are produced in the cosmos via never-before-produced heavy neutron-rich nuclei at FRIB
- ▶ Discovering ways to suppress the effects of natural radiation on quantum coherence times
- ▶ Quantum step improvement in rare search capability via AI/ML pattern recognition software
- ▶ Significantly advancing imaging technology for the physical sciences.
- ▶ Reducing the limit on the neutrino mass by a factor of 5.

NP Helped Pioneer An Early Initiative As Part of SC's Development of RENEW

- ▶ 110 NP traineeship award recipients include:
 - ▶ 18 MSIs,
 - ▶ 10 other colleges/universities,
 - ▶ 5 DOE laboratories
- ▶ MSI award recipients include:
 - ▶ 9 Hispanic Serving Institutions (HSIs),
 - ▶ 8 HBCUs,
 - ▶ 5 Asian/Native American, and Pacific Islander Serving Institutions (AANAPISI),
 - ▶ 1 Predominantly Black Institution (PBI)

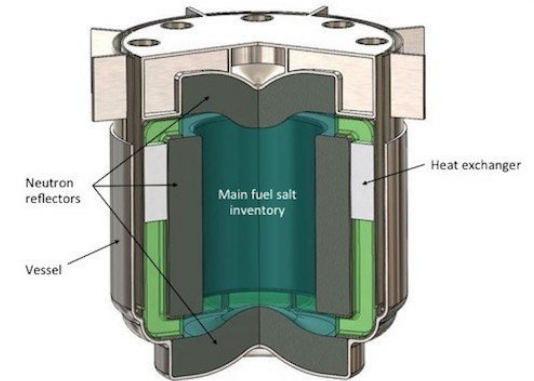


Other institutions on the map are involved in the traineeship program as recruitment sites (38), Co-Is (9), and/or hosts (7).

Of the funds awarded, ~ 70% went to MSIs, MSI faculty, or MSI students. About 50% of trainees awarded continued on to Graduate Programs in Science or Engineering

NP Broader Impacts & Applications For Other Missions: Nuclear Data

- ▶ NP is providing new and updated nuclear data to existing customers
 - ▶ Working to identify impactful nuclear data needs and leverage resources
 - ▶ Ex: Data for next generation molten salt reactors with DOE/NE, ARPA-E
- ▶ NP is reaching out to new nuclear data application customers
 - ▶ Electronics protection (NASA, Missile Defense Agency, Federal Aviation Administration)
 - ▶ Human safety (NASA [spaceflight], NIH [ion beam therapy])
 - ▶ Advanced reactors (ARPA-E, NASA)
- ▶ NP is exploring a mechanism for Rapid Response Nuclear Data
 - ▶ Many federal agencies have projects with nuclear data shortfalls
 - ▶ USNDP is investigating a process where performers can submit requests for urgent, high impact nuclear data needs



Summary of 2024 PR Changes Relative to FY 2023 Enacted

Research

FY 2022 Enacted	FY 2023 Enacted	FY 2024 PR
<p>Core research in Medium Energy, Heavy Ions, and Theory is increased by 7.5% from FY21 Enacted. The Fundamental Symmetries and Nuclear Structure and Nuclear Astrophysics portfolios are increased by 10.5% over FY21 Enacted.</p>	<p>Core Research in Medium Energy, Heavy Ions, Nuclear Theory, Fundamental Symmetries and Nuclear Structure and Nuclear Astrophysics is ~6.1% above the FY22 Enacted Level.</p>	<p>Core Research in Medium Energy, Heavy Ions, Nuclear Theory, Fundamental Symmetries and Nuclear Structure and Nuclear Astrophysics is ~flat with the FY23 Enacted Level.</p>
<p>LHC M&O commitments are met.</p>	<p>LHC M&O commitments are met.</p>	<p>LHC M&O commitments are met.</p>
<p>FRIB Research is increased.</p>	<p>FRIB Research is increased.</p>	<p>FRIB Research is increased.</p>
<p>nEDM supported significantly below planned profile.</p>	<p>nEDM is supported below the planned profile at \$1M for the GPP effort for minor construction.</p>	<p>nEDM is supported below the planned profile at \$1M for the GPP effort for minor construction.</p>
<p>SciDAC funding is increased to support SciDAC-5 (+ \$600k).</p>	<p>SciDAC is modestly reduced by from the FY22 Enacted.</p>	<p>SciDAC is modestly increased from the FY23 Request to support SciDAC-5 activities.</p>
<p>Nuclear Data increased \$2.8M from FY21 Enacted to support the expansion of experimental efforts.</p>	<p>Nuclear Data is flat with the FY22 Enacted level.</p>	<p>Nuclear Data is modestly increased above the FY23 Enacted level.</p>
<p>Accelerator R&D held flat with the FY21 Enacted level.</p>	<p>Accelerator R&D is reduced by 4.5% from the FY22 Enacted.</p>	<p>Accelerator R&D is flat with the FY23 Enacted.</p>

Summary of 2024 PR Changes Relative to FY 2023 Enacted

Initiatives

FY 2022 Enacted	FY 2023 Enacted	FY 2024 PR
QIS increased to \$10.9M.	QIS is flat with FY22 Enacted.	QIS is flat with FY23 Enacted (\$10.9M).
AI/ML Initiative support flat with FY21 Enacted (\$4M).	AI/ML is increased to \$8M (+\$4M)	AI/ML is flat with the FY23 Enacted (\$8M).
Three new initiatives are supported: <ul style="list-style-type: none"> Reaching a New Energy Sciences Workforce (RENEW) - \$3M Accelerator Science and Technology - \$1M Microelectronics - \$518k 	Two of the FY22 Enacted new initiatives are supported in FY 2023: <ul style="list-style-type: none"> Reaching a New Energy Sciences Workforce (RENEW) - \$6M (+\$3M) Microelectronics - \$518k Accelerator Science and Technology Initiative is paused 	Initiatives are continued in FY 2024: <ul style="list-style-type: none"> Accelerate Innovations in Emerging Technologies - \$4M Microelectronics - \$518k Accelerator Science and Technology Initiative is paused
	Two new cross cutting initiatives are supported: <ul style="list-style-type: none"> Funding to Accelerated, Inclusive Research (FAIR) - \$2M Accelerate Innovations in Emerging Technologies - \$4M 	The FAIR and RENEW initiatives are increased: <ul style="list-style-type: none"> Reaching a New Energy Sciences Workforce (RENEW) - \$11.5M (+\$5.5M) Funding to Accelerated, Inclusive Research (FAIR) - \$5M (+\$3M)

Summary of 2024 PR Changes Relative to FY 2023 Enacted

Facility Operations and Projects

FY 2022 Enacted	FY 2023 Enacted	FY 2024 PR
<p>Facility operations supported at >90% of optimal.</p> <ul style="list-style-type: none"> - RHIC operates 20 weeks (90 % maximum) - CEBAF operates 31 weeks (90 % optimal) - ATLAS operates 39 weeks (93 % optimal) - FRIB operates 12 weeks (100% of optimal) 	<p>All NP user facilities operate at >90% of optimal in FY 2023.</p> <ul style="list-style-type: none"> - RHIC operates 25 weeks (96 % optimal) - CEBAF operates 33 weeks (96 % optimal) - ATLAS operates 40 weeks (96 % optimal) - FRIB operates 26 weeks (99% of optimal) 	<p>All NP user facilities operate at roughly 90% of optimal funding in FY 2024.</p> <ul style="list-style-type: none"> - RHIC operates 20 weeks (94 % optimal funding) - CEBAF operates 27 weeks (88 % optimal funding) - ATLAS operates 39 weeks (94 % optimal funding) - FRIB operates 24 weeks (91% of optimal funding)
<p>FRIB Operations increased, but still slightly below planned levels (\$77M in PR vs \$82M planned)</p>	<p>FRIB Operations increased to near optimal level.</p>	<p>FRIB Operations slightly reduced, and below optimal levels (\$96.2M in Request vs \$102.4M optimal)</p>
<p>EIC construction at TEC of \$20M and OPC of \$24.8M in annual appropriation, and TEC of \$128.24M and OPC of \$10M in the Inflation Reduction Act.</p>	<p>EIC construction at TEC of \$50M and OPC of \$20M</p>	<p>EIC construction at TEC of \$95M and OPC of \$2.9M</p>
<p>Ongoing Major Items of Equipment are supported with both the annual appropriation and Inflation Reduction Act funds:</p> <ul style="list-style-type: none"> - GRETA above baseline level (\$16.7M) - SPHENIX at baseline level in final year (\$0.2M) - MOLLER above planned level (\$36.2M) - TSNLDBD at \$8.4M - HRS at \$34.84M 	<p>Ongoing Major Items of Equipment:</p> <ul style="list-style-type: none"> - GRETA at optimal level, providing the project with the final year of funding (\$15.5M) - MOLLER receives the final \$4M of planned TEC funding - TSNLDBD at \$1.44M TEC - HRS at \$3M TEC 	<p>Ongoing Major Items of Equipment:</p> <ul style="list-style-type: none"> - GRETA and MOLLER at received full TPC amount in FY 23 Request. Progress continues, but no new funding requested in FY24. - TSNLDBD at \$3M TEC - HRS at \$6.3M TEC

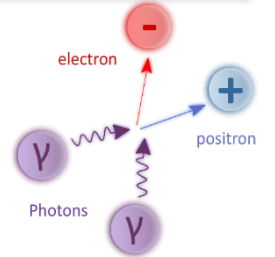
NP - Research Initiatives

(dollars in thousands)

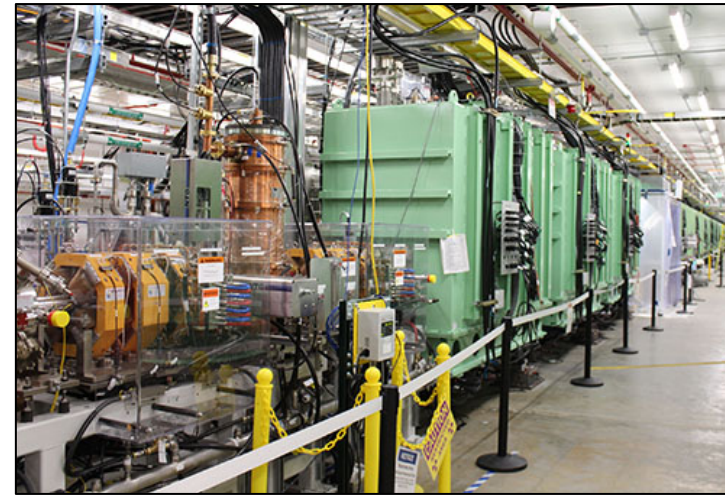
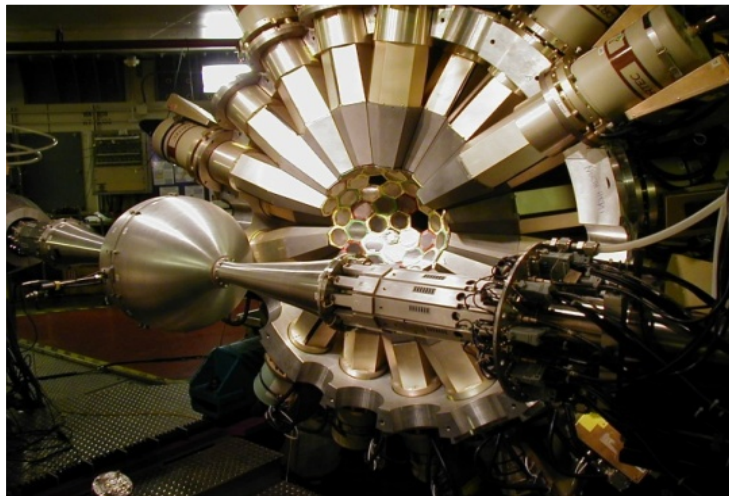
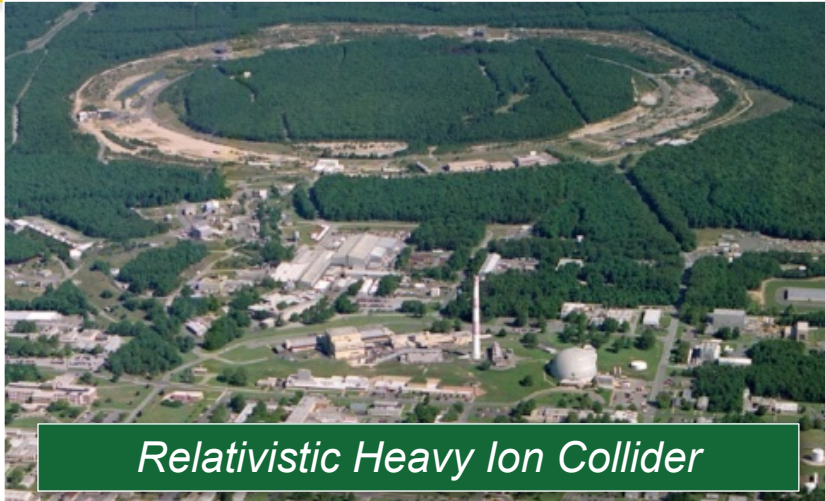
	FY 2022 Enacted	FY 2023 Enacted	FY 2024 Request	FY 2024 Request vs FY 2023 Enacted		FY 2024 Request vs FY 2022 Enacted	
Nuclear Physics (NP)							
Accelerate Innovations in Emerging Technologies	–	4,000	4,000	–	–	+4,000	–
Accelerator Science and Technology Initiative	1,037	–	–	–	–	-1,037	-100.00%
Artificial Intelligence and Machine Learning	4,000	8,000	8,000	–	–	+4,000	+100.00%
Funding for Accelerated, Inclusive Research (FAIR)	–	2,000	5,000	+3,000	+150.00%	+5,000	–
Microelectronics	518	518	518	–	–	–	–
Quantum Information Science	10,866	10,866	10,866	–	–	–	–
Reaching a New Energy Sciences Workforce (RENEW)	3,000	6,000	11,500	+5,500	+91.67%	+8,500	+283.33%
Total, Research Initiatives	19,421	31,384	39,884	+8,500	+27.08%	+20,463	+105.37%

Recent Impactful Accomplishments

- ✓ Discovery that ionizing radiation reduces coherence time for entangled quantum states
 - Need new quantum materials or/and underground Quantum Computing
- ✓ First known observation of the Breit-Wheeler two-photon process at RHIC
 - Confirmation of Quantum Electro-Dynamic (QED) process; possibility of e^+e^- pair production via lasers
- ✓ Discovery that heavy nuclei have a neutron skin (CEBAF)
 - New constraints on neutron star radii and their equation of state
- ✓ Implementation of dynamical fermions and the real pion mass in Lattice QCD
 - Major advance in fidelity of Lattice Quantum Chromodynamics calculations
- ✓ Initiation of the FRIB science program
 - Opening a new frontier to understand heavy element production in cosmos
- ✓ Integration of AI technology at CEBAF to make it more fault tolerant
 - Test-bed for use of Artificial Intelligence in accelerator control and optimization



The Four World-Leading National User Facilities NP Stewards



Are “Microscopes” with Complementary Resolving Power

The Newest SC User Facility: the Facility for Rare Isotope Beams



- FRIB construction started in 2013 and finished in 2022, on cost and ahead of schedule
- FRIB was constructed by DOE (\$635M) and Michigan State University (\$94.5M) under a unique Cooperative Agreement
- Now complete, FRIB provides access to 80% of all isotopes predicted to exist in nature

	PYs	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	DOE Total	MSU	TOTAL
FRIB Funding Profile	318,000	100,000	97,200	75,000	40,000	5,300	635,500	94,500	730,000

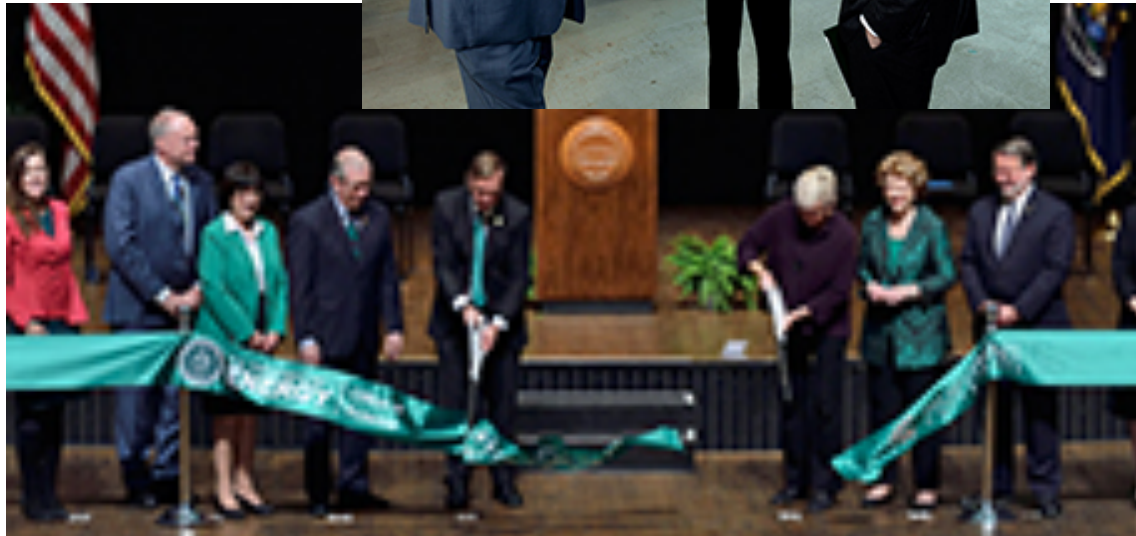
- Secretary Granholm and MSU President Stanley “Cut the Ribbon” declaring FRIB open for scientific research on May 2, 2022
- On May 19, 2022, first scientific results on isotopes never-before produced in sufficient quantity for scientific study are awaiting publication

NP Highlight: The Opening of a New Horizon for Scientific Discovery



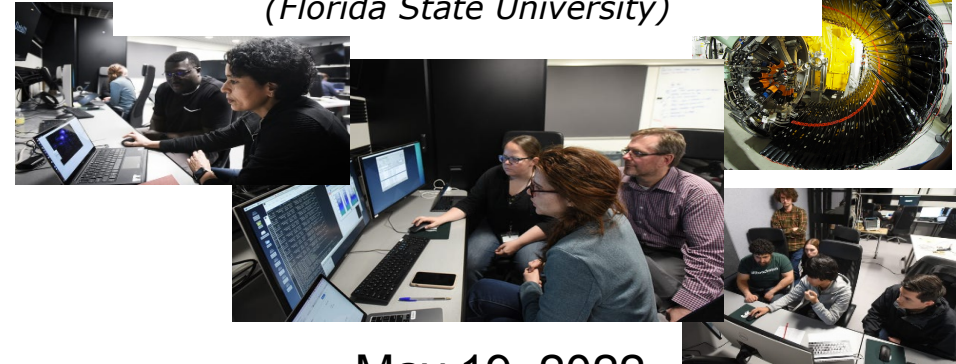
Secretary Granholm at the
FRIB Ribbon Cutting

May 2, 2022

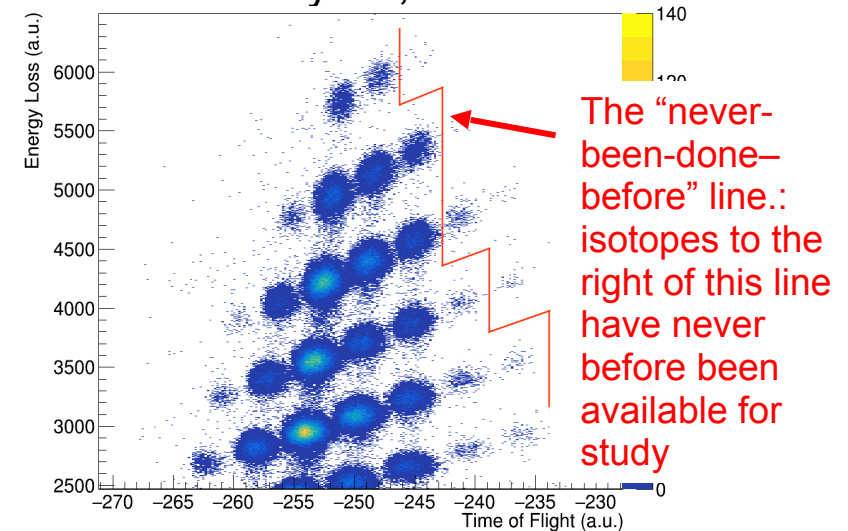


FRIB Experiment E21062

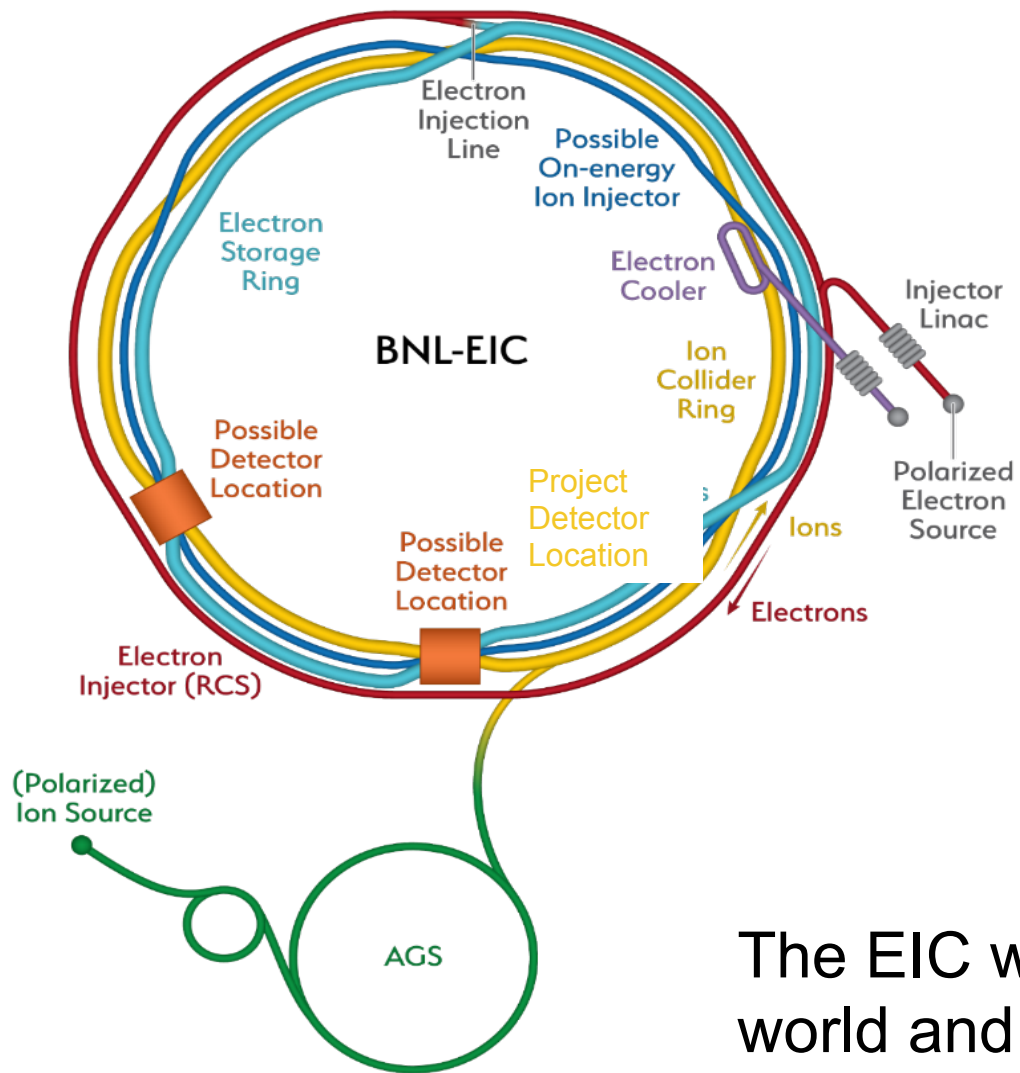
Spokespersons: *J. Allmond (ORNL), H. Crawford (LBNL), B. Crider (Mississippi State University), R. Grzywacz (University of Tennessee Knoxville) and V. Tripathi (Florida State University)*



May 19, 2022



Constructing Capability to Maintain World Leadership Throughout The Century: the Electron-Ion Collider









Recent Progress

Successful OPA Progress Review 1/ 2023

Significant Project staffing increases via IRA

Pursuing Long Lead (CD3a) followed by CD-2

-  Hadron Storage Ring
-  Hadron Injector Complex
-  Electron Storage Ring
-  Electron Injector Synchrotron
-  Electron Cooler
-  Possible On-energy Hadron Injector Ring

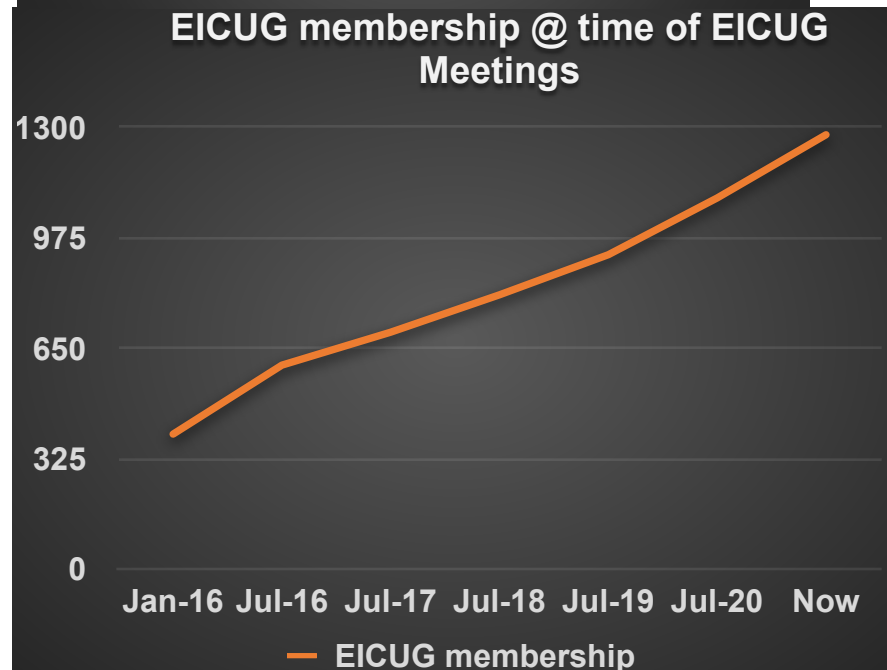
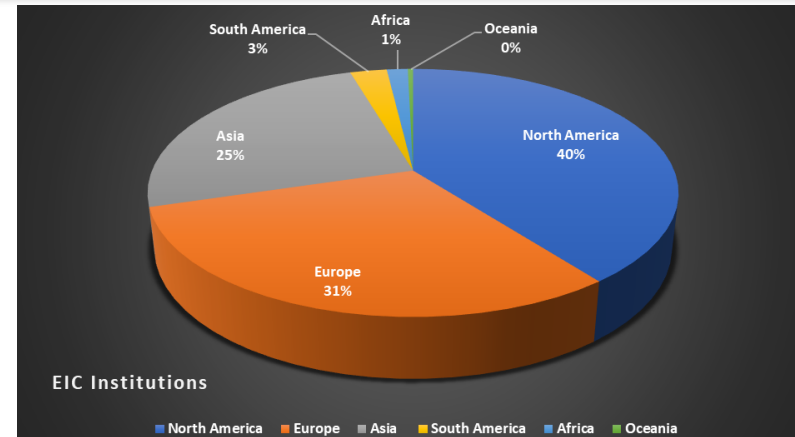
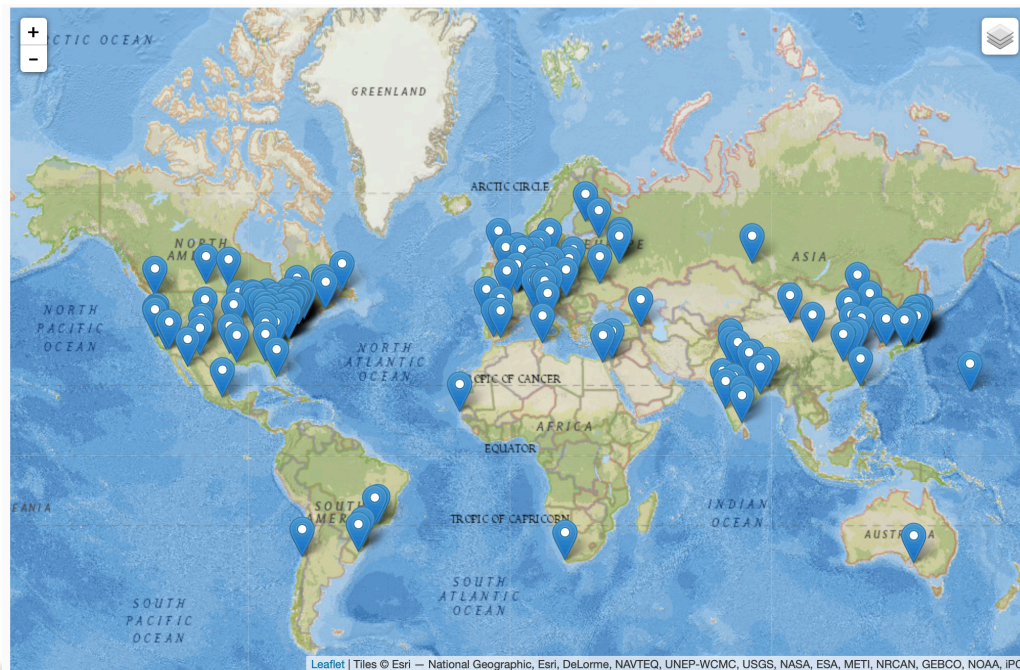
The EIC will be the most advanced accelerator in the world and the only new collider built for decades. It will keep US capability in accelerators physics number one

The EIC is International At Its Core

EIC Users Group Formed in 2016 EICUG.ORG

Status January 2023:

- Collaborators 1379
- Institutions 269
- Countries 36



And the Governance is Being Envisioned Accordingly

The EIC Advisory Board

Name	Affiliation
Stuart Henderson, Chair	TJNAF, USA
Diego Bettoni	INFN, Italy
Paul Kearns	ANL, USA
Mike Lamont	CERN, Switzerland
Reynald Pain	IN2P3/CNRS, France
Franck Sabatié	CEA, France
Nigel Smith	TRIUMF, Canada
Mark Thomson	STFC, United Kingdom
Mike Witherell	LBNL, USA

Laboratory and National Program Leaders from Around the World

International Contributions to the Electron-Ion Collider

- ▶ The EIC Project is also envisioning international contributions to the EIC detector of approximately \$100M, and contributions to the accelerator of approximately \$50M
 - ▶ About half of these contributions have already been notionally identified by international collaborators
- ▶ The body being established to coordinate such contributions in analogy with the way this is handled at CERN is a Resource Review Board (RRB), the first meeting of which will occur next month (April 2023)

First EIC Resource Review Board To Discuss International Contributions

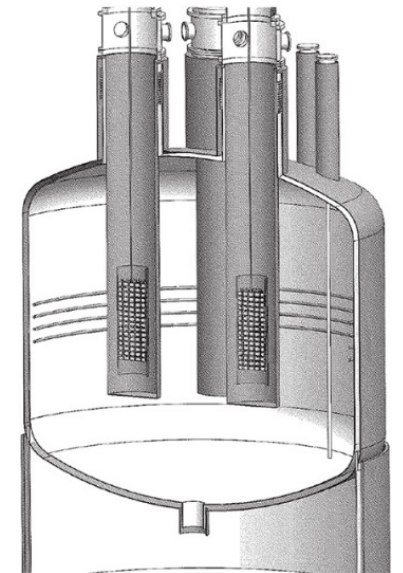
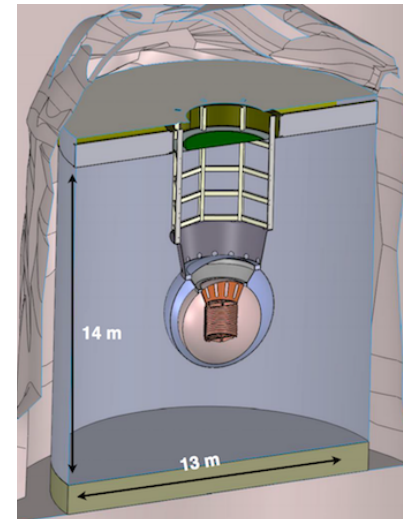
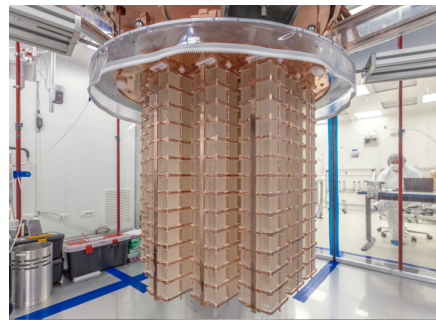
Name	Affiliation	Country	Funding Agency/PI
Hayotsyan, Sargis	State Science Committee of Armenia	Armenia	Funding Agency
Samson, Claire	Canada Foundation for Innovation (CFI)	Canada	Funding Agency
Vyřinka ,Marek	Ministry of Education, Youth and Sports	Czech Republic	Funding Agency
Sabatie, Franck	Institut de Recherche sur les Lois Fondamentales de l'Univers (Irfu-SPhN), CEA-Saclay	France	Funding Agency
Grasso, Marcella	IN2P3/CNRS	France	Funding Agency
Lucotte, Arnaud	IN2P3/CNRS	France	Funding Agency
Bettoni, Diego	Instituto Nazionale de Fisica Nucleare (INFN)	Italy	Funding Agency
Nania, Rosario	Instituto Nazionale de Fisica Nucleare (INFN)	Italy	Funding Agency
Moon, Young Kun	Research Promotion Division at the Ministry of Science and ICT	Korea	Funding Agency
Gaczyński, Mateusz	Department of Innovation and Development, Ministry of Science and Higher Education	Poland	Funding Agency
Ka, Oumar	Cheikh Anta Diop University	Senegal	N/A
Nxomani, Clifford	National Research Foundation	South Africa	Funding Agency
Blaire, Grahme	UK Science and Technology Facilities Council (STFC)	United Kingdom	Funding Agency
Hiscock, Jenny	UK Science and Technology Facilities Council (STFC)	United Kingdom	Funding Agency
Hallman, Timothy	DOE Office of Nuclear Physics	United States	Funding Agency

Status of The Other Priority of the 2015 Long Range Plan for Nuclear Science: Neutrinoless Double Beta Decay

- ▶ Between IRA funding and NP Program Funding, approximately \$12.8 M allocated to the three technologies being explored LEGEND 1000, nEXO, and CUPID since FY 2020.
- ▶ Additional resources provided by international partners
- ▶ Inability to procure isotopes from Russia is having a severe, existential impact
- ▶ The next DBD international summit is April 27, 2023 at SNOLab in Canada.
- ▶ NP is thinking about options to demonstrate a proof-of-principle isotope procurement test

Three Proposed Technologies

- Scintillating bolometry (**CUPID**, ^{100}Mo enriched Li_2Mo_4 crystals)
- Enriched ^{76}Ge crystals (**LEGEND-1000**, drifted charge, point contact detectors)
- Liquid Xenon TPC (**nEXO**, light via SiPM, drifted ionization)



Potential Partners:
Italy, Canada, and Germany

Snapshot of the Status of NP Projects

Project	Location	Status	Cost	CPI	SPI	CD-4	Operation cost plan
Construction Projects							
Facility for Rare Isotope Beams (FRIB) *	MSU	CD-4	\$730M	1.00	1.00	6/2022	Included in NP budget formulation
Electron-Ion Collider (EIC)	BNL	CD-1	\$1.7B to \$2.8B			Q4 FY33	RHIC operations funds redirected to EIC project recovered for EIC operations
Major Items of Equipment							
Gamma Ray Energy Tracking Array (GRETA) ^{FF}	LBNL	CD-2/3	\$58.3M	1.00	1.01	4/2028	Mostly covered by host laboratory operations experimental support
Super Pioneering High Energy Nuclear Interaction Experiment (SPHENIX) *	BNL	PD-4	\$26.5M	1.00	1.00	12/2022	Covered by RHIC operations experimental support
Measurement of Lepton-Lepton Electroweak Reactions (MOLLER) ^{FF}	TJNAF	CD-1	\$45.8M to \$56.6M			Q4 FY27	Covered by TJNAF operations experimental support
<i>High Rigidity Spectrometer (HRS)</i>	<i>MSU</i>	<i>CD-1</i>	<i>\$85.0M to \$111.4M</i>			<i>Q2 FY29</i>	<i>Covered by FRIB operations experimental support</i>
Ton Scale Neutrinoless Double Beta Decay (TS-NLDBD)	TBD	CD-0	\$215M to \$250M			TBD	TBD

Blue (*) indicates “Completed”, green (FF) “Fully Funded”, and purple italic “Substantially Funded”

NP Outlook

- ▶ In FY 2024, NP continues stewardship of a world-leading program in nuclear physics that delivers new science, operates unique leadership user facilities, supports and enhances a diverse workforce, and delivers impactful applications
- ▶ The EIC Project is making steady progress, towards CD3a (Long Lead Procurement), and the next DOE gateway CD-2 (Approve Performance Baseline). Although not yet baselined, increased support from annual appropriations is essential to enable timely progress and a smooth transition of workforce from the Relativistic Heavy Ion Collider in FY 2025.
- ▶ The FY 2024 Request is greatly appreciated, allowing NP National User Facilities to operate at or above 90% of optimal funding
- ▶ NP Research funding allows for a compelling program of science but continues to be constrained due to the priority of increased funding for FRIB Operations and EIC construction

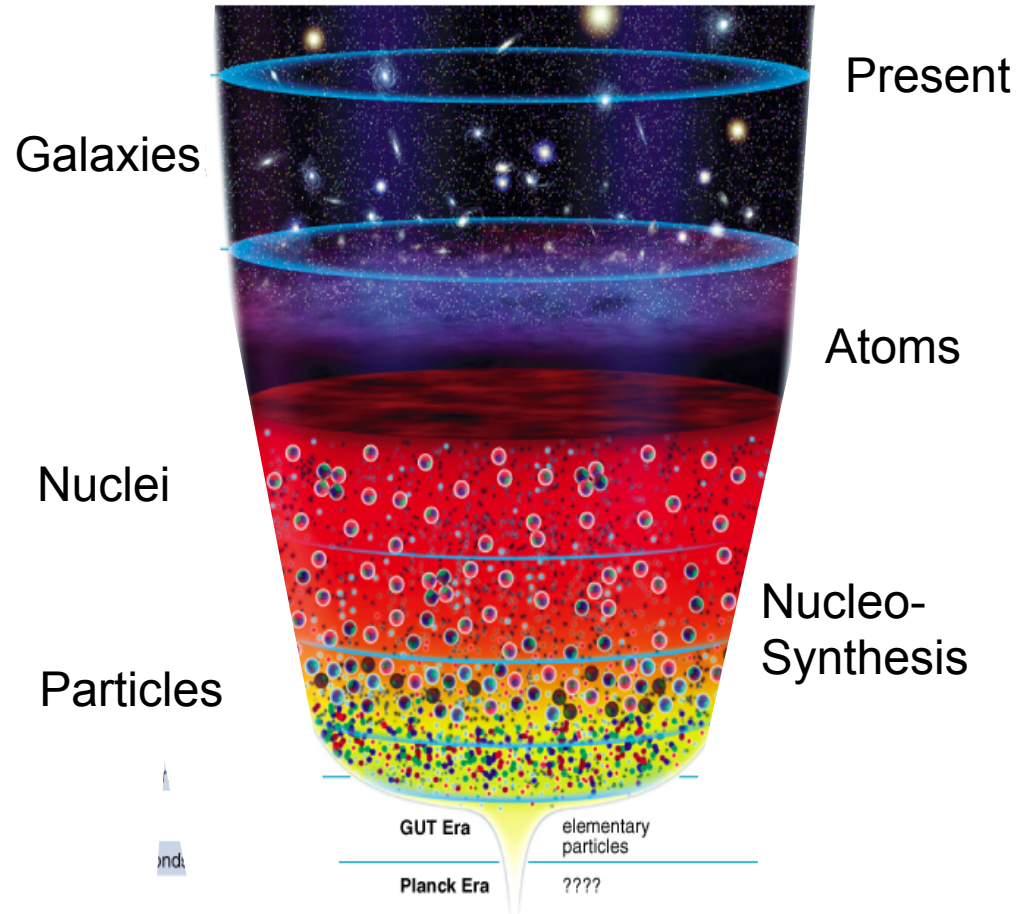
Additional Information

Present Day

NP
Discovery
Horizon



Evolution of the Universe



The vast range of time (μsec to 13.8B years) and physical scales (quarks to galaxies) requires “microscopes” of varying, complementary resolving “powers”