# Summaries of Office of Science Facilities

## Under Construction and Proposed

March 27, 2026

## Office of Science (SC) National Laboratories

| | |
|---|---|
| AMES | Ames National Laboratory |
| ANL | Argonne National Laboratory |
| BNL | Brookhaven National Laboratory |
| FNAL | Fermi National Accelerator Laboratory |
| LBNL | Lawrence Berkeley National Laboratory |
| ORNL | Oak Ridge National Laboratory |
| PNNL | Pacific Northwest National Laboratory |
| PPPL | Princeton Plasma Physics Laboratory |
| SLAC | SLAC National Accelerator Laboratory |
| TJNAF | Thomas Jefferson National Accelerator Facility |

## Other Department of Energy (DOE) National Laboratories

| | |
|---|---|
| INL | Idaho National Laboratory |
| NLR | National Laboratory of the Rockies* |
| NETL | National Energy Technology Laboratory |
| SRNL | Savannah River National Laboratory |
| LANL | Los Alamos National Laboratory |
| LLNL | Lawrence Livermore National Laboratory |
| SNL | Sandia National Laboratories |

*Previously the National Renewable Energy Laboratory (NREL)

# Current Office of Science User Facilities

| | | |
|---|---|---|
| **Advanced Scientific Computing Research (ASCR) Computing Facilities** | | |
| ALCF | Argonne Leadership Computing Facility | ANL |
| ESnet | Energy Sciences Network | LBNL |
| NERSC | National Energy Research Scientific Computing Center | LBNL |
| OLCF | Oak Ridge Leadership Computing Facility | ORNL |
| **Basic Energy Science (BES) Light Sources** | | |
| ALS | Advanced Light Source | LBNL |
| APS | Advanced Photon Source | ANL |
| LCLS | Linac Coherent Light Source | SLAC |
| NSLS-II | National Synchrotron Light Source - II | BNL |
| SSRL | Stanford Synchrotron Radiation Light Source | SLAC |
| **BES Neutron Sources** | | |
| HFIR | High Flux Isotope Reactor | |
| SNS | Spallation Neutron Source | ORNL |
| **BES Nanoscale Science Research Centers** | | |
| CFN | Center for Functional Nanomaterials | BNL |
| CINT | Center for Integrated Nanotechnologies | SNL/LANL |
| CNMS | Center for Nanophase Materials Sciences | ORNL |
| CNM | Center for Nanoscale Materials | ANL |
| TMF | The Molecular Foundry | LBNL |
| **Biological and Environmental Research (BER)** | | |
| EMSL | Environmental Molecular Sciences Laboratory | PNNL |
| ARM | Atmospheric Radiation Measurement user facility | Multi-laboratory |
| JGI | Joint Genome Institute | LBNL |
| **Fusion Energy Sciences (FES)** | | |
| DIII-D | General Atomics | General Atomics |
| NSTX-U | National Spherical Torus Experiment Upgrade | PPPL |
| **High Energy Physics (HEP)** | | |
| | Fermilab Accelerator Complex | FNAL |
| FACET-II | Facility for Advanced Accelerator Experimental Tests II | SLAC |
| ATF | Accelerator Test Facility | BNL |
| **Nuclear Physics (NP)** | | |
| CEBAF | Continuous Electron Beam Accelerator Facility | TJNAF |
| FRIB | Facility for Rare Isotope Beams | Michigan State U. |
| RHIC | Relativistic Heavy Ion Collider* | BNL |
| ATLAS | Argonne Tandem Linac Accelerator System | ANL |

* RHIC completed user operations February 2026

# Under Development and Proposed SC Facilities

## Advanced Scientific Computing Research

### Energy Sciences Network 7 (ESnet7) [ASCR]

*ESnet7 will provide critical high performance network capacity and services enabling DOE requirements for AI-enabled integrated computational and data infrastructure, powering the Genesis Mission.*

- Capacity/resiliency enhancements to handle artificial intelligence (AI) and time-sensitive workflows securely and reliably.
- AI-integrated network operations, bridging network measurement and automation, with a foundation model for predictive analysis and automated outage remediation.
- In-network storage to speed data access and reduce network usage for datasets; in-network computing to precondition data in the network before reaching the data center.
- Advanced wireless infrastructure development for data acquisition from remote experiments.


ESnet7 will increase capacity and resilience to meet growing bandwidth demands, network management services assisted by artificial intelligence, in-network storage and computing, and more.

**Cost:** ~ $200-250M
**Timeline:** in pre-conceptual design; estimated completion in 2030

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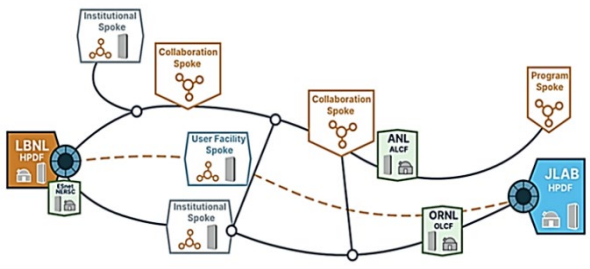
### High Performance Data Facility (HDPF) [ASCR]

*HPDF will provide high performance data services and infrastructure to support DOE's scientific user facilities, national laboratories, collaborations, and researchers, powering the Genesis Mission platform.*

- Enable scientists to integrate data catalogs, AI models, and computing resources into novel AI for Science and data analysis workflows, including AI services at scale.
- Hub facility hosts high up-time centralized, secure data management resources, including large scale storage optimized for AI for Science requirements.
- The heart of the Hub-and-Spoke model is a distributed, resilient, and extensible data fabric linking the HPDF Hub facility, ASCR high performance computing (HPC) facilities, commercial computing providers, and non-DOE partners.
- HPDF data lifecycle services, software tools, and technologies will support data capture, staging, processing, management, and archiving as a new capability powering the Genesis Mission.




Concept for hub-and-spoke model of centralized and distributed data infrastructure, including SC computing centers and resources (ESnet, ALCF, OLCF, NERSC), and more. The HPDF hub will be located at JLab with a secondary resilience site at LBNL.

**Cost :** ~ $300-500M
**Timeline:** in conceptual design; phased deployments with estimated completion in 2030

## Leadership Computing Facility (LCF) Upgrades [ASCR]

*LCF upgrades will meet ever growing demand for leadership-scale computing with modeling and simulation, AI and machine learning, and data analytics to serve broad research communities.*

**Oak Ridge Leadership Computing Facility 6 (OLCF-6)**

- Significantly increase leadership computational, data science, and AI capabilities.
- Expand with novel architectures to provide enhanced capabilities.
- Achieve improved performance efficiencies.
- Enable the Federal Information Security Modernization Act (FISMA) Moderate computing enclave for handling protected information.

**Argonne Leadership Computing Facility 4 (ALCF-4)**

- Will pursue innovations in hardware architectures to provide world-class AI training and inference capabilities for scientific applications.
- Focus on advancing scientific AI while simultaneously supporting high-precision modeling and simulation applications.
- Expand with novel architectures, including quantum, to provide enhanced capabilities.
- Achieve improved efficiencies.


OLCF-6 Discovery

ALCF-3 Aurora

SC led the development of first-of-a-kind national HPC resources for extreme-scale simulation, data, and AI applications, delivering the world's first exascale ($10^{18}$) supercomputers. OLCF-6 and ALCF-4 will continue to push the frontiers of extreme scale high-precision simulation and AI for science. In late 2025 DOE announced that OLCF-6 would bear the name *Discovery* and be delivered by HPE and AMD.

**Estimated cost/timeline:**

**OLCF-6**: $328M total project cost (TPC) and $493M (system); in construction, estimated deployment 2028, and completion 2029

**ALCF-4**: $300M TPC and $500M (system); in conceptual design stage, target completion 2031

## National Energy Research Scientific Computing Center-10 (NERSC-10) [ASCR]

*NERSC-10 will play a critical role in executing scientific workflows to support research programs across SC, expanding its current emphasis on modeling and simulation, AI training and inference, and data analytics to address the challenge of accessing and interacting with diverse HPC system resources.*

- Computation, storage, and networking designed to emphasize response time as well as system throughput and utilization.
- Tight integration of system components to enable high performance across workflow steps.
- Programmability to manage data, execute distributed code, and interact with system resources.
- Sophisticated orchestration using different types of scheduling across different resources.


The NERSC-10 supercomputer will bear the name of Nobel laureate Jennifer Doudna. DOE announced the contract award for *Doudna* to Dell, in partnership with NVIDIA and Vast, in 2025. The system will feature Dell's most advanced ORv3 direct liquid-cooled server technology and the NVIDIA Vera-Rubin GPU platform.

**Cost:** $150M (TPC) and $336M (system)
**Completion:** In construction, estimated deployment 2027, complete in 2029

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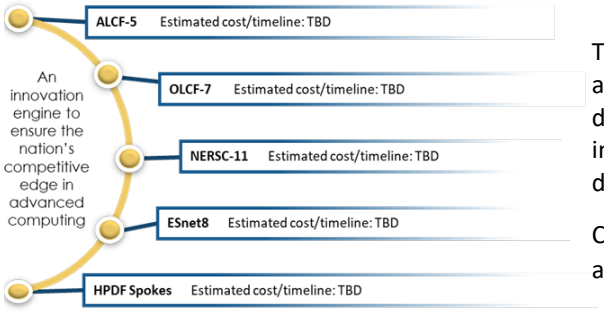
## Next-Generation ASCR Facilities Ecosystem [ASCR]

*The Next-Generation ASCR Facilities Ecosystem will continue its trajectory as the core high performance computing, data, and networking infrastructure powering the open science Genesis Mission platform.*

- Continuing the legacy of DOE HPC for U.S. competitiveness, will cultivate close partnerships with industry to deploy first-of-their kind high performance systems at scale.
- Fully operationalized Genesis Mission platform through the American Science Cloud continues to expand the range of automated instrumentation and data sources available to U.S. researchers.
- Quantum-HPC hybrid systems at scale bridging large scale HPC with early quantum hardware
- Novel advanced computing environments, such as neuromorphic and cryo-CMOS computing.
- End-to-end fully AI-enabled high performance network infrastructure.



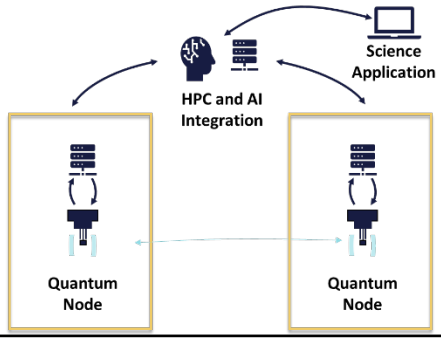

This Ecosystem will meet the requirements for advanced simulation, data science, and AI research. of dynamic innovation during a period of sustained, intense international competition for technological dominance in advanced computing and AI.

Cost range highly dependent on available technologies and market forces (~ $4-6B over five years)

## Quantum Supercomputing User Facility [ASCR]

*The Quantum Supercomputing User Facility will provide a flexible platform and laboratory infrastructure for development and deployment of multiple first-of-their-kind quantum computing systems.*

- Enable the integration of fault-tolerant, error corrected quantum processing units, classical high-performance computing, and AI supercomputing.
- Provide a unique combination of research infrastructure, including low-noise hybrid laboratory data center space, large-volume high-feedthrough cryocooled systems.
- Provide a technology-agnostic testing and enablement environment.
- Enable open, proprietary, and national security R&D scope, attracting industry, academic, national laboratory, and government users to develop benchmarks, algorithms, and software to execute scientific applications on quantum computers.




The Quantum Supercomputing User Facility will create a paradigm shift in computing by deploying a fault-tolerant, error corrected quantum computer and capitalizing on its convergence of with classical HPC and AI. It will solidify U.S. leadership in quantum computing and strengthen our ties with key partners

**Cost:** ~ $1,000M
**Timeline:** In planning, completion 2028

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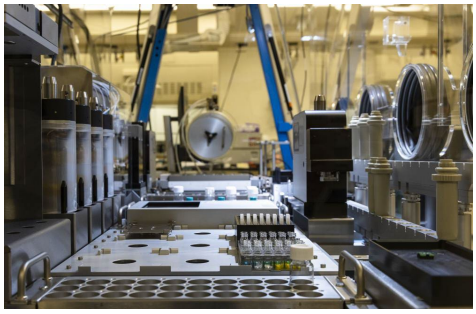
## User Facilities Automation Recapitalization [All SC Programs]

*The User Facilities Genesis Mission Recapitalization project will upgrade the laboratory automation, data acquisition, and networking infrastructure of the 24 experimental and observational User Facilities to fully AI-enabled infrastructure for the Genesis Mission.*

- Provide upgrades of lab-automation capabilities, including robotics and instrumentation, for AI-enabled experimental control.
- Provide local “edge” computing and storage for high data volume data acquisition triage.
- Provide local network upgrades for Terabit-scale data streaming to ESnet for access to large-scale HPC to enable Genesis Mission.
- Provide upgrades of remote-access data and workflow visualization systems for human-in-the-loop experiment control.
- Provide outfitting of sensors and controls for AI-enabled accelerator system operations.



Automated laboratories, such as ORNL’s Autonomous Chemistry Lab for Accelerated Materials Discovery and Innovation, require capital-intensive robotic systems tailored for complex research tasks. This project will recapitalize, reinvent, and reimagine experimental platforms at SC’s user facilities serving thousands of users.

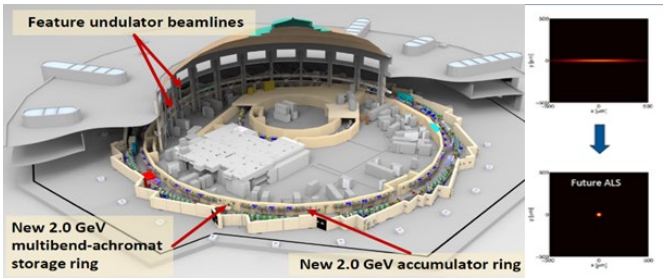
**Cost:** ~ $500M
**Timeline:** In planning, completion 2028

# Basic Energy Sciences

## Advanced Light Source Upgrade (ALS-U) [BES]

*The ALS-U at LBNL will deliver revolutionary new X-ray capabilities and build on more than two decades of ALS global leadership in soft X-ray science*.

- Installation of a new accumulator ring and a new multi-bend achromat electron storage ring to produce a more focused soft X-ray beam at least 100 times brighter than the current ALS
- Two new beamlines designed from the ground-up to take advantage of the enhanced characteristics of the X-ray beam
- Enables new opportunities for scientific discovery and technological innovation, including in the design of chemical reactions and leading-edge microelectronics devices and systems




The ALS-U project will replace the existing electron storage ring with a modern multi-bend achromat storage ring, install a new accumulator ring, and deliver several new beamlines designed to take full advantage of the new X-ray beam. ALS will deliver at least 100x improvement in brightness and significant enhancement in beam coherence.

**Cost:** ~ $980M (~60% funded)
**Timeline:** In construction, est. completion 2032

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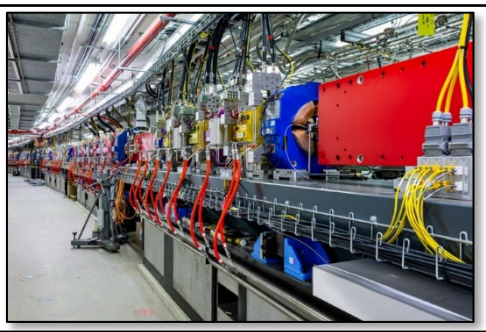
## Advanced Photon Source Upgrade (APS-U) [BES]

*The APS-U at ANL has delivered the world's most powerful hard X-ray synchrotron light source, with nearly 500x increased brightness and coherent flux.*

- The APS-U project, completed in January 2026, has achieved all its threshold key performance parameters and did so on budget and schedule.
- The project included replacement of the existing electron storage ring with a state-of-the-art multi-bend achromat ring, a suite of new and upgraded beamlines, and a new long beamline building that will house two beamlines designed to achieve focused nanoscale beams.
- The dramatically enhanced brightness and coherence of the X-ray beams will provide scientists, engineers, and technologists with world-leading capabilities to study complex systems, including devices, from the atomic to the macroscale with higher precision and at faster speeds.



The APS-U project replaced the current electron storage ring with a new multi-bend achromat storage ring (pictured), enabling a nearly 500x increase in brightness and coherence of the X-ray beam.

**Cost:** TPC $815M (fully funded)
**Timeline:** Project completed January 2026

## Linac Coherent Light Source II High Energy Upgrade (LCLS-II-H) [BES]

*The LCLS-II-HE project at SLAC builds on the success of the LCLS-II project to deliver an ultrafast, ultra-bright X-ray nanoscope capable of transformative insights in complex materials, chemical, and biological systems, as well as devices.*

- Increases the energy of the superconducting linac from 4 GeV to 8 GeV, offering users X-ray pulses in excess of 12 keV at up to 1 MHz.
- Initiates a new era of atomic-resolution structural dynamics measurements, enabling more effective and efficient design of catalysts; deeper insight into structure/function relationships of biomolecular systems for biotechnology; and greater understanding and control of non-equilibrium materials to realize advanced properties and greater device performance.
- The upgraded LCLS will provide world-unique training data for frontier AI models for science.

The LCLS-II-HE project extends the world-leading capabilities achieved following the successfully LCLS-II project, increasing the superconducting linac energy from 4 to 8 GeV and extending high repetition rate operation into the hard X-ray regime. This performance is achieved through the addition of two dozen new cryomodules to the superconducting linac (pictured).

**Cost:** $716M
**Timeline:** In construction; est. completion 2030

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## Proton Power Upgrade (PPU) [BES]

*The PPU project at ORNL enables delivery of more neutron flux to Spallation Neutron Source (SNS) beamlines and positions the facility for the future Second Target Station (STS).*

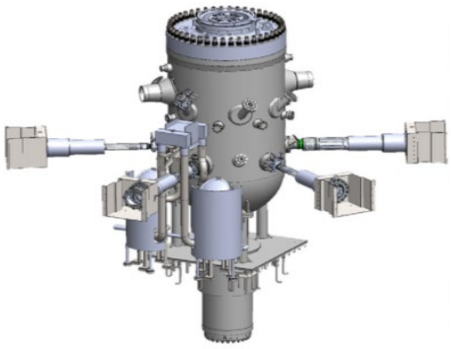
- Scheduled for early completion in late FY 2026.
- Increases the available power to 2.8 MW, with up to 2.0 MW to the SNS target—a nearly 40% increase—enabling new neutron experiments, in more extreme environments, and using smaller and less-concentrated samples.
- Provides up to 0.7 MW for the STS, a new source that will deliver the brightest low energy (“cold”) neutrons at the high repetition rates required for new structure and dynamics studies on systems of national importance, including quantum materials, polymers, and catalysts.

Upgrades to the linear proton accelerator at the SNS increased the available power to 2.8 MW, of which up to 2.0 MW will be used on target to increase neutron production. The 28 klystrons (red cylinders, pictured) provide the necessary high-power radio frequency energy required to accelerate the protons used for neutron spallation from the mercury target.
**Cost:** $272M (fully funded)
**Timeline:** In construction; completion late FY 2026

## High Flux Isotope Reactor Pressure Vessel Replacement (PVR) [BES]

*The PVR project at ORNL) will sustain and enhance HFIR's critical missions in neutron scattering, isotope production, neutron activation, and materials irradiation by redesigning and replacing the original reactor pressure vessel.*

- Replacement pressure vessel will include minor design changes that will significantly increase both thermal and cold neutron scattering capabilities with increased neutron beam quality and flux
- Will enable increased in-cycle access to irradiation positions for isotope production and materials irradiation, including neutron activation analysis
- Will realize significantly improved signal-to-noise ratios for all existing instruments
- Will be capable of accommodating an additional cold source in the future that could substantially increase both capacity and capability for discovery science



After six decades of operation, the pressure vessel at HFIR must be replaced to ensure continued service to critical missions in neutron scattering, isotope production, materials irradiation, and neutron activation.

**Cost:** ~$300M to $740M
**Timeline**: In design, est. completion late 2030s

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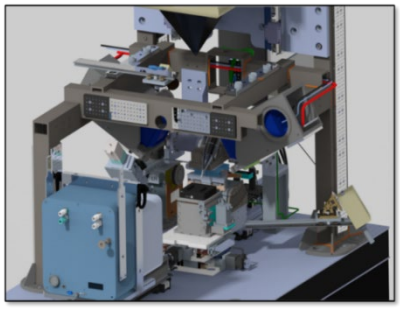
## Light and Neutron User Facility Capability Enhancements [BES]

*The design and installation of a suite of state-of-the-art end stations at beamlines across the light and neutron sources will close existing capability caps and provide novel experimental capabilities.*

- New capabilities will take advantage of upgraded facilities, including world-leading brightness and coherence of upgraded synchrotrons, superconducting X-ray free electron lasers (FELs), and neutron sources.
- Enhancements will enable new classes of experiments to reveal insights into materials and chemical processes that are currently unattainable to address national priorities, including energy research, microelectronics, critical materials, and quantum information science.
- New capabilities will enable breakthrough science for real-world, inhomogeneous functional materials and systems with structures spanning multiple length and time scales—ranging from the nanoscale to mesoscale and femtoseconds to weeks or months—under realistic operating conditions.



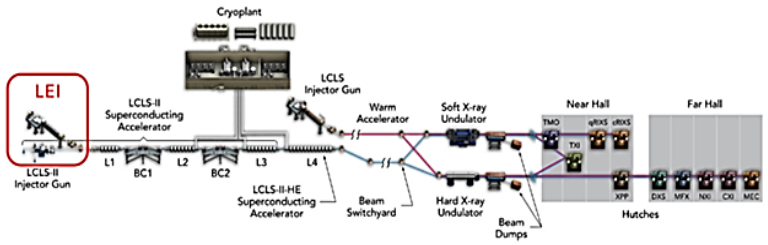
New instruments will be designed to provide new capabilities for the scientific community across the suite of X-ray light and neutron sources.

**Cost: ~**$25-50M/beamline
**Timeline:** In planning, ongoing through mid to late 2030s

## Linac Coherent Light Source – Low Emittance Injector (LCLS-LEI) [BES]

*The proposed LCLS-LEI project at SLAC will push LCLS to higher X-ray power and enable innovations for coherent imaging of the structure and dynamics of real-world materials, as well as chemical and biological systems in the environments in which they naturally operate.*

- Provides a superconducting electron source capable of driving the world's brightest X-ray laser.
- Facilitates model-free studies of structural dynamics, energy systems and quantum materials
- Enables a wide range of scientific applications, including novel metastable phases created by coherent light–matter interactions and local atomic arrangements in energy materials
- Allows for studies of bulk properties and samples in operando or in tailored sample environments, as well as simultaneous coupling with tailored transient stimuli




Layout of the Linac Coherent Light Source-II showing the location of LEI (red square) upstream of the superconducting linac.

**Cost**: TBD
**Timeline**: In planning, R&D; est. completion TBD

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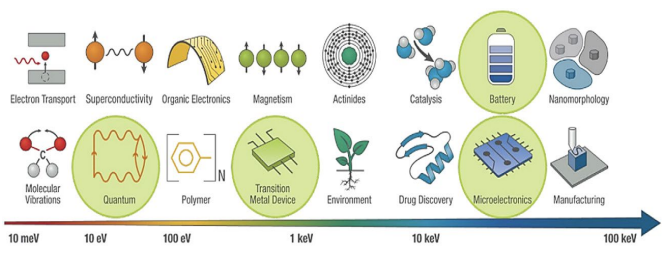
## National Synchrotron Light Source-II Experimental Tools – III (NEXT-III) [BES]

*NEXT-III will develop 8-12 beamlines to enhance NSLS-II (BNL) capabilities for a wide range of applications, including energy generation/storage/utilization, microelectronics, QIS, and biology.*

- First four new beamlines include: the *Advanced Nanoscale Imaging* and *Tender X-Ray Nanoprobe* beamlines (new imaging capabilities with larger fields of view, faster scan rates, and broader energy range); the *High-Resolution X-Ray Powder Diffraction* beamline (fast [<1 minute] operando or *in situ* experiments at super-high resolution, a capability currently not available in the U.S.); and the *Quantitative Cellular Tomography* beamline (cellular processes across length/time scales)
- Project allows selection of future beamlines based on technological advances and community need
- Project addresses both capacity needs in the X-ray science community and new capability development to tackle future science and technology challenges of national importance



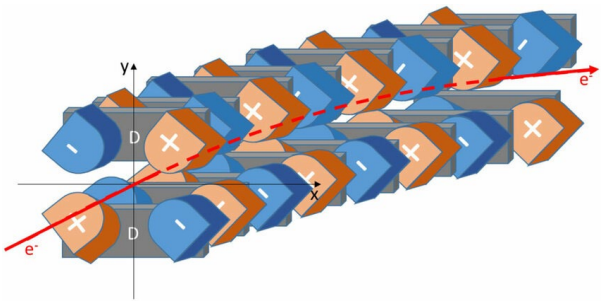

This project will increase NSLS-II's ability to leverage different photon energies suitable for characterizing a diverse array of materials, processes, and scientific phenomena.

**Cost**: ~ $300-500M
**Timeline**: In design, est. completion mid-2030s

## National Synchrotron Light Source-II Upgrade [BES]

*The NSLS-II upgrade at BNL would provide the highest brightness across a very broad energy range, from soft to hard X-rays, as well as unmatched, world-leading performance in the tender X-ray regime.*

- Would transform NSLS-II into the ultimate diffraction-limited, medium-energy synchrotron light source, with dramatically increased brightness and a full suite of transformative capabilities.
- Would enable new, unique techniques and advanced multimodal capabilities for exploring phenomena on multiple length, energy, and time scales, from microseconds to weeks.
- Would provide leading performance in the 1 to 10 keV energy range (i.e., tender X-rays) unmatched by any existing or planned facility in the world.
- The BNL-designed Triple Complex Bend Achromat lattice would enable world-record beam emittance and significantly reduced energy consumption (5x relative to NSLS-II).




A schematic of the Triple Complex Bend Achromat lattice technology being developed for a future National Synchrotron Light Source-II upgrade.

**Cost:** TBD
**Timeline:** R&D; est. completion TBD

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## Spallation Neutron Source Second Target Station (STS) [BES]

*The STS at the SNS (ORNL) will be a next-generation, short-pulse, cold neutron source with a suite of unique neutron scattering instruments designed to take advantage of unparalleled peak brightness and the long wavelength of cold neutrons.*

- Will accelerate progress in quantum materials for computing and sensors, structural materials for reactors and turbines, protein complexes for the bioeconomy, and other S&T challenges.
- Will be a next-generation, short-pulse, cold neutron source with peak brightness 20x higher than the first target station and several times brighter than other planned neutron sources worldwide.
- Ability to study systems dynamically over broad length- and timescales.
- Leverages the nearly finished Proton Power Upgrade (PPU) project, which increases the power of the SNS accelerator to 2.8 megawatts (MW).

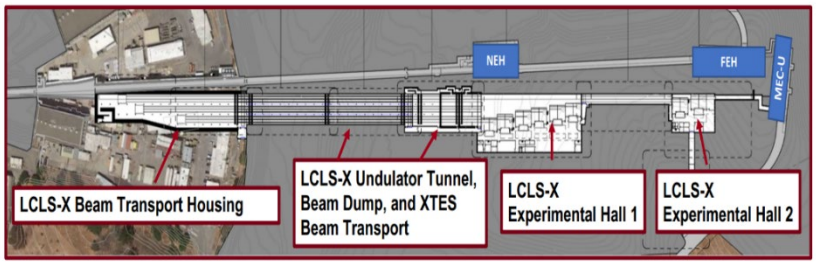
Once completed, STS (shown highlighted here in an artist's rendering) will provide a peak brightness beyond that of other neutron sources worldwide.

**Cost**: ~ $1.8-3.0B
**Timeline**: In design; est. completion 2039

## Linac Coherent Light Source-X (LCLS-X) [BES]

*The LCLS-X concept represents the next big leap in X-ray Free Electron Lasers (XFELs), the first so-called "3rd generation" XFEL, fully leveraging investments in the superconducting linac to dramatically increasing the opportunity for transformative science.*

- Drive up to 10 specialized XFELs and dozens of instruments to realize, for the first time, synchrotron-like parallel experimentation.
- Develop specialized instruments for each individual XFEL, targeting high priority science areas.
- Establish new capabilities to probe operating devices in 4D, capture detailed information on chemical structure in transient species, and transform materials synthesis and manufacturing.
- Increase by orders of magnitude the volume and velocity of AI-ready scientific data for model training, discovery science, and technological innovation.




Schematic of the LCLS-X concept supporting up to 10 specialized XFELs and dozens of tailored beamlines for the Nation's scientific priority areas.

**Cost:** TBD
**Timeline:** R&D/concepts being developed; est. completion TBD

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## Next Generation Characterization Facility [BES]

*A large-scale AI-enabled characterization facility designed to tackle the Nation's premier science challenges beyond 2035.*

- Will leverage future technology in accelerators, detectors, controls, and analysis to push the frontiers of energy, intensity, and control of X-ray, neutron, and/or electron probes.
- Infrastructure designed to meet the needs of the scientific community for decades beyond 2035—from a distributed network of smaller-scale capabilities to a single integrated facility.
- Potential for multi-modal approaches featuring varied and customizable tools tailored to meet specific scientific and industrial needs.
- Designed from the ground up for AI-assisted and autonomous and closed-loop experimentation to accelerate discovery and innovation.

A visual representation of the potential for a next-generation characterization facility designed to answer future science questions through the utilization of many probes of matter (e.g., X-ray photons, neutrons, and electrons). [Generated with Google Gemini]

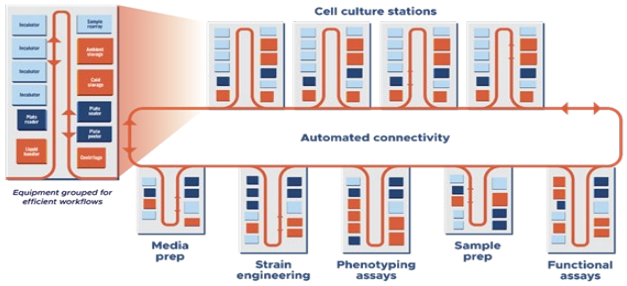
**Cost:** TBD
**Timeline:** Concepts being developed; est. completion TBD

# Biological and Environmental Research

## Microbial Molecular Phenotyping Capability (M2PC) [BER]

*The M2PC project is designing and constructing an automated laboratory system and space to culture and characterize microbes at a massive scale to speed organism design for biotechnology innovation.*

- Enables assessment of variations in the observable characteristics of microorganisms under a range of growth conditions.
- Advances understanding of concerted activity of interacting microbes in microbial communities.
- Provides critical functional knowledge in microbial sciences, underpinning advances supporting U.S. biotechnology leadership, including biomanufacturing, environmental remediation, and biogeochemical cycling.
- Capable of automated microbial culturing and characterization, through integrated computational analyses and agentic AI to quickly adjust workflows and experimental processes.



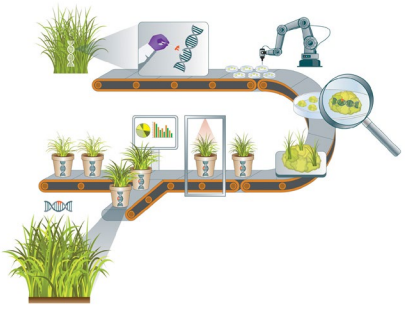

The M2PC project will offer an integrated suite of automated, high-throughput phenotyping and analytical tools to gain functional knowledge of microbes and microbial communities.

**Cost:** $122M
**Timeline:** in construction, planned completion 2031

## Plant Transformation Capability (PTC) [BER]

*The PTC will revolutionize genome editing technologies for a wide variety of plants to advance a range of biotechnology innovations.*

- Aims to substantially improve and automate genetic modification of plants with new, efficient plant transformation capabilities, leveraging AI for data processing, automated workflows and design.
- A vital plant-focused biodesign component of DOE's multi-scale biotechnology capabilities, from genomics to microbes to plants.
- Has strong community and interagency support for providing access to new methods that will greatly enhance agriculture, industry and other areas of U.S. competitiveness in plant biotechnology.
- Scientific advances pioneered by PTC will train a new workforce in plant biotechnology.



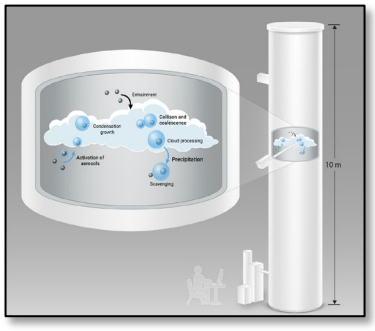
The PTC, designed to be part of the Joint Genome Institute (JGI), will dramatically accelerate plant bioengineering for a variety of beneficial purposes, such as production of fuels, chemicals and materials from domestic feedstocks.

**Cost:** ~ $80-120M
**Timeline:** early design, estimated completion 2032

## Drizzle, Aerosol, and Cloud Observation Chamber (DRACO) [BER]

*DRACO will be a new unique laboratory designed for controlled research and testing of cloud, aerosol, and precipitation microphysical processes.*

- A world-leading, in size and design, convection cloud chamber that will observe the full range of cloud droplet growth processes from droplet activation to precipitation formation.
- Advanced instrumentation and measurement capabilities and high-resolution numerical simulation capability for enhancing the predictive abilities of DOE models for informing energy solutions.
- AI-driven experiments will capture ephemeral phenomena, track growth events and inform fundamental theoretical constructs.
- Guest instrument space and flexible design/construction for future instrumentation needs to enable support of evolving atmospheric physics and chemistry research.




DRACO, a project for the Atmospheric Radiation Measurement (ARM) Facility, will enable the scientific community to study fundamental principles governing complex coupled physical, chemical, and turbulent processes central to atmospheric aerosol–cloud–precipitation interactions and critical to improving projections of water availability and severe weather risks to energy infrastructure.

**Cost:** ~ $100M
**Timeline:** early design, estimated completion in 2033

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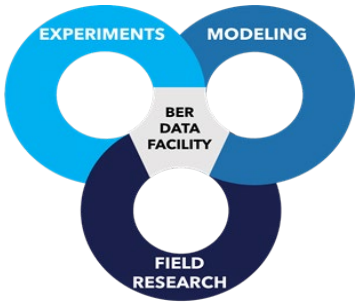
## Biological and Environmental Research Data Center [BER]

*A federated data science ecosystem to deliver curated, open, AI-ready data, integrated analytics and models, to accelerate scientific discovery for advance biotechnology, environment and energy.*

- Harmonize multiple BER data repositories in an interoperable distributed network, providing AI-ready data, and using AI-driven integration, management, and model verification.
- Synthesize new knowledge and develop innovative computational methods for advancing next-generation integrated models for biology, environment, and biotechnology innovation.
- Interconnect data and related modeling and experimental capabilities across a hierarchy of scales and complexity as needed for breakthrough scientific insights.
- Provide a national data asset and potential hub for collaboration across the U.S., in line with the vision of the National Security Commission on Emerging Biotechnology Report (NSCEB 2025).




The BER Data Center's centralized approach will advance application of AI-based discovery interconnected with the other BER research modalities: modeling, field, experiment, and process research.

**Cost:** ~ $190M
**Timeline:** in planning, estimated completion in 2034

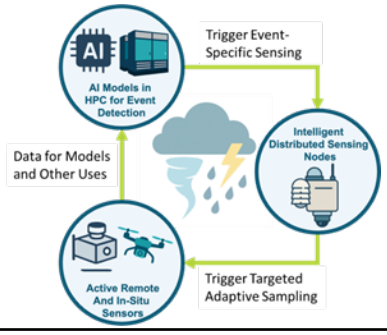
## Integrated Mobile Field Facility [BER]

*Advanced "intelligent" network of automated field instruments and sensors to capture targeted real-time phenomena for genotype to phenotype, vegetation, atmosphere and soil dynamics.*

- Builds on DOE's mobile field and sampling capabilities and networks to add AI-driven autonomous mobile platforms for plant phenotype identification, rhizosphere, soils, vegetation, feedstocks, critical mineral detection, atmosphere and hydrology in an integrated fashion.
- Advanced network of drones, instruments and sensors, facilitating comparison of the open environment with controlled laboratory experiments.
- AI-driven integration of data collection with digital twins and other models for adaptive sampling in which sensing strategies evolve dynamically in response to observational indicators.

Unique and leading-edge approach to efficiently capture complex and dynamic phenomena in the field, to advance science, detect critical minerals and support energy infrastructure and biotechnology.

**Cost:** TBD
**Timeline**: In planning, completion date TBD

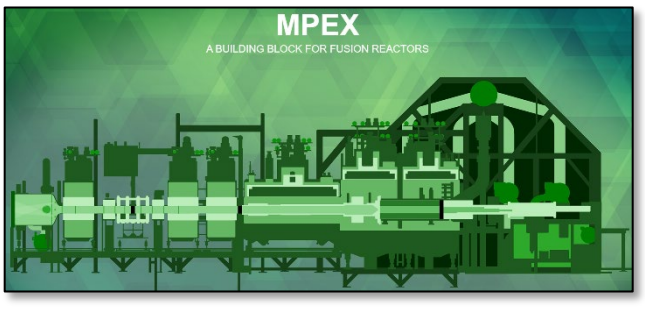



# Fusion Energy Research

## Material Plasma Exposure eXperiment (MPEX) [FES]

*MPEX is a next-generation linear plasma research facility being developed at ORNL to recreate fusion edge and divertor conditions by generating high-density, high-temperature plasmas for exposing candidate materials to fusion-like particles and heat fluxes.*

- MPEX will advance the science of plasma–material interactions (PMI) and materials discovery, providing critical foundations for viable fusion energy systems.
- MPEX will enable researchers to understand how extreme conditions affect the divertor—considered the power and particle exhaust system of a fusion reactor.
- To achieve these goals, MPEX is being developed in collaboration with ORNL's capabilities in plasma physics, radio frequency heating, and high heat flux engineering.



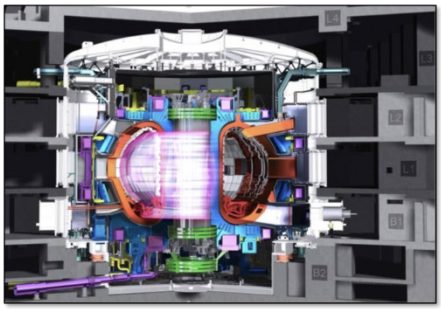

MPEX capability: steady-state, high-density, high-heat-flux plasmas for controlled exposure of fusion materials for pilot plants.

**Cost :** $201M (89% funded)
**Timeline:** In construction, operation in 2027

## U.S. Contributions to ITER [FES]

*ITER provides critical knowledge and operational experience for fusion energy development.*

- ITER will deliver the foundational science for fusion by advancing the understanding of sustained burning plasma, plasma in which heating from fusion reactions dominates over external heating.
- ITER will offer long-pulse, plasma operations and extensive diagnostic tools to explore burning plasma regimes and address the research and development needs across U.S. fusion sectors.
- ITER technology, operations, fuel-cycle, licensing know-how, and data provide essential inputs for fusion system development and fusion supply chains.
- The U.S. has received 60% credit for its contributions to the construction of ITER with remaining deliverables scheduled by 2033, including central solenoid, cool water system, and fuel pellet injectors.



Cross-Section of the ITER Tokamak. The tokamak will be the largest device of its kind in the world, with a plasma volume of 840 $m^3$. It will be nearly 30 m tall, weigh 23,000 tons, and consist of an estimated one million parts.

**Cost:** ~$6.5B (to US)
**Timeline:** In construction, operations in 2034

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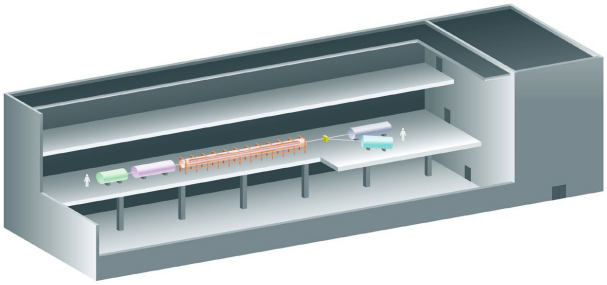
## Fusion Prototypical Neutron Source (FPNS) [FES]

*FPNS will provide critical knowledge needed to enable the development of materials that can tolerate the extreme conditions of neutron irradiation and plasma exposure sustained in a fusion power plant.*

- FPNS will uniquely address fundamental scientific and engineering questions required for developing materials in a fusion-relevant environment, including microstructure and phase stability, radiation and neutron embrittlement, transmutation effects, and irradiation creep.
- Will uniquely address whether materials retain adequate properties and integrity at neutron damage levels greater than 20 to 50 displacements per atom (dpa) in a fusion neutron environment.
- Will examine engineering science issues of material lifetime limits at higher irradiation exposures and will generate the engineering data needed to design and deploy commercial fusion devices.



Concept of a potential FPNS implementation. The FPNS will help develop the materials needed and determine the lifetime limits and fundamental evolution of fusion materials under irradiation,. This information will inform both the designers and regulators of fusion power plants.

**Cost:** Federal share <$750M
**Timeline:** In planning, completion TBD

## Integrated Blanket and Fuel Cycle Test Facility (IBF-CTF) [FES]

*IBF-CTF is a proposed integrated test facility to de-risk fusion blanket and fuel-cycle technologies using prototypical neutron and tritium environments at component and system scale.*

- Enables testing of breeding blanket materials and components under fusion-relevant neutron irradiation.
- Provides integrated tritium production, processing, and closed-loop handling at pilot-plant-relevant throughput.
- Addresses science and technology gaps not covered by other domestic or international facilities.
- Supports maturation of higher technology readiness level (TRL) blanket and fuel-cycle technologies needed for fusion pilot plants.

The IBF-CTF will be a critical tool in establishing the scientific foundation to harness fusion power by developing the blanket technology which is necessary to breed the tritium fuel and allows the heat of the burning plasma to be transferred to a steam generator for production of electricity.

**Cost:** ~ $650M (federal share)
**Timeline:** In planning, completion TBD

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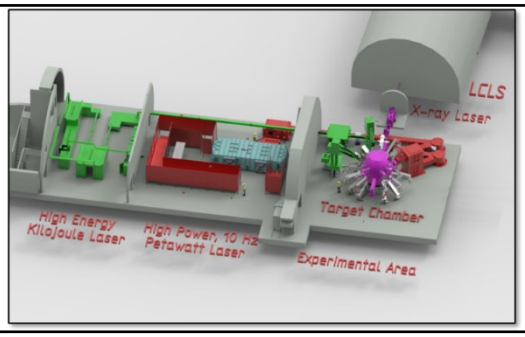
## Matter in Extreme Conditions Petawatt Upgrade (MEC-U) [FES]

*MEC-U will be a world-leading facility for high-energy-density science that will advance the fundamental science of matter at extreme temperatures and densities.*

- MEC instrument at the Linac Coherent Light Source (LCLS) will combine a high-power optical laser with a hard X-ray beamline to study the transient behavior of matter in extreme conditions.
- MEC-U will inform aspects of inertial fusion energy technology development, providing opportunities to gain experience with high-intensity and high-repetition rate laser experiments and to test materials for radiation damage.
- The facility creates synergies across astrophysics, fusion energy, and materials science, as well as national security, and will offer broad capabilities for high-spatial and -temporal measurements.



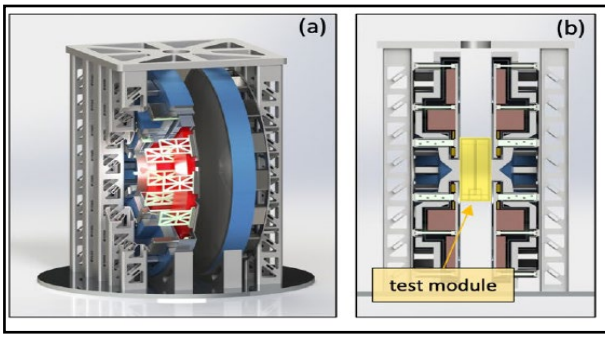

Conceptual design for MEC-U which includes a kilojoule laser, a 10 Hz 150J laser, and an experimental area.

**Estimated cost:** ~ $350M-$450M
**Timeline:** In planning, estimated completion 2034

## Blanket Component Test Facility (BCTF) [FES]

*BCTF is a proposed test facility to mature fusion blanket components and subsystems through controlled testing prior to integration into fusion pilot plants.*

- BCTF will focus on components and materials surrounding the plasma to capture fusion energy, reduce neutron and gamma fluxes, and shield sensitive components essential for plant operations.
- The facility enables testing in non-nuclear environments, with pathways to nuclear testing, to address key gaps in thermal management, materials compatibility, tritium control, and MHD effects.
- Modular design supports iterative testing and risk reduction before system-level integration.
- BCTF ensures blanket components are ready for seamless integration with plasma-facing systems and the broader fusion facility.




Blanket Component Test Facility concept: a) a potential superconducting magnet assembly for test modules b) the location of the test module relative to the magnet coils, in cross section

**Estimated cost:** ~ $100M (federal share ~>25%)
**Timeline:** In planning, estimated completion TBD

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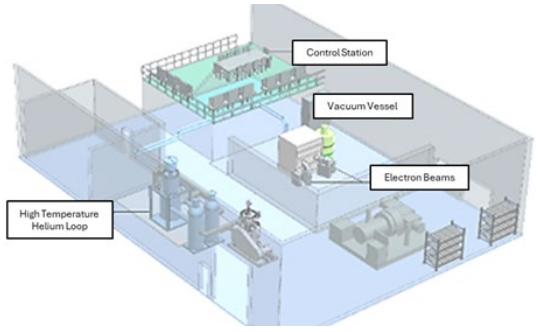
## Nuclear High Heat Flux (NHHF) Test Facility [FES]

- The NHHF facility will provide a national capability to evaluate how materials react under synergistic extreme heat loads in a fusion device.
- NHHF de-risks plasma-facing components, which experience the harshest conditions in fusion energy devices, via application of plasma and heat incidence on neutron irradiated samples.
- NHHF requires sophisticated hot cell technology that enables component-scale and sample-scale synergistic irradiation with in-operando measurement capability.
- Materials development and testing is necessary to deploy fusion power plants that can manage compounding effects on thermo-mechanical, surface, and interface properties to maximize mean-lifetime-to-failure and manage hydrogen isotope transport.



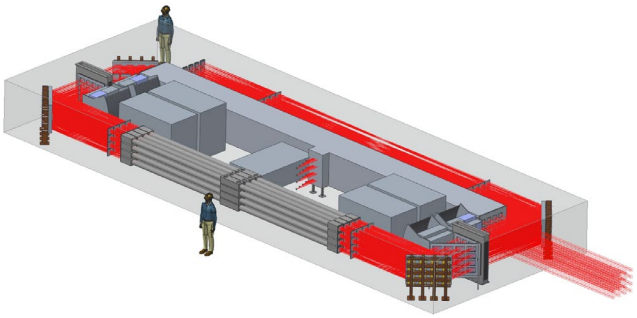

This high heat flux testing facility could take the form of an upgrade to MPEX by adding a heat flux capability. The facility must handle sub-component and coupon-scale materials at steady-state and transient heat loads.

**Cost:** ~ $200M
**Timeline:** In planning, estimated completion TBD

## Inertial Fusion Energy Beamlet Testbed (IFE-BT) [FES]

*IFE-BT will advance IFE and accelerate its commercialization, building on recent fusion ignition achievements, by maturing driver, target, and injection technologies.*

- The facility will be instrumental in bridging technological gaps across key areas of IFE development.
- It will specifically address challenges in designing and operating high-performance drivers, refining target physics for optimal energy gain, and developing target tracking and injection systems.
- IFE-BT will offer a novel test bed designed to bridge science and technology gaps across various domains and achieve fuson pilot plant-scale driver performance, wall-plug efficiency, and repetition rates.



IFE-BT concept: IFE-BT will address challenges in designing and operating high-performance drivers at FPP-scale.

**Cost:** ~ $200-300M (Federal Share ~>25%)
**Timeline:** In planning, estimated completion TBD

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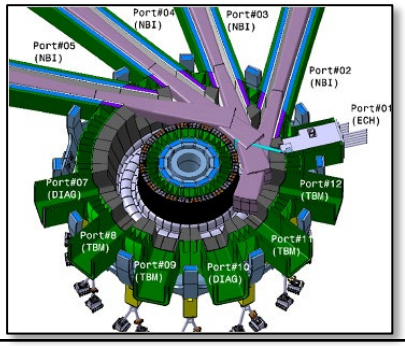
## Volumetric Neutron Source (VNS) [FES]

*A VNS is required for integral-effect irradiation testing of components or subcomponents necessary to the successful commercialization of fusion energy.*

- Enables performance testing and qualification of complex components, including tritium breeding blankets, in configurations representative of those anticipated for fusion pilot plants.
- Supports measurement, build-up, and control of tritium inventories under sustained neutron flux.
- Can be integrated with facilities such as IBF-CTF or BCTF to enable system-level testing of blanket and fuel cycle technology to ensure deployment readiness.
- Addresses critical gaps in fusion nuclear testing not accessible with existing neutron sources, with specific gaps dependent on broader infrastructure choices.




The European approach to a VNS, shown to the left, involves a neutral beam-driven tokamak used to generate volumetric neutrons. Numerous U.S. approaches are under consideration.

**Cost:** ~ $500-1,500M (depending on approach) (Federal Share ~>25%)
**Timeline:** In planning, estimated completion TBD

# High Energy Physics

## Proton Improvement Plan II (PIP-II) [HEP]

*PIP-II will deliver higher-power proton beams to the neutrino-generating target at FNAL, which will enable ground-breaking discoveries in neutrino physics.*

- The project involves the design and construction of a new superconducting radio-frequency proton linear accelerator, along with enhancements to existing accelerator infrastructure to accommodate increased beam intensity.
- Some key accelerator components and the cryoplant are being provided through international, in-kind contributions.
- On track to begin operations in late 2029, PIP-II will enhance reliability and increase the performance of the Fermilab Accelerator Complex.

PIP-II will replace the 50-year-old proton source and increase the reliability and intensity of proton beams used to drive LBNF/DUNE and other experiments.

**Cost:** $978M (76% funded)
**Timeline:** in construction, first beam by late 2029

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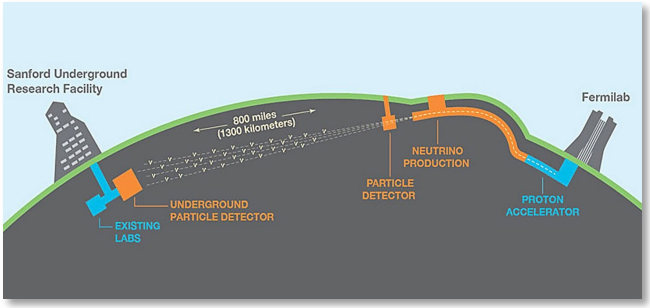
## Long Baseline Neutrino Facility/Deep Underground Neutrino Experiment and Supporting Infrastructure (LBNF/DUNE) [HEP]

*LBNF/DUNE will be the world's premier facility for neutrino physics, unlocking some of the universe's great mysteries by using the highest-energy beam of neutrinos and state-of-the-art particle detectors.*

- Determine whether neutrinos could be the reason the universe is made of matter.
- Look for subatomic phenomena to potentially realize Einstein's dream of the unification of forces.
- Watch for neutrinos emerging from an exploding star, perhaps witnessing birth of a neutron star or a black hole.
- Solidify U.S. leadership in discovery science and strengthen our ties with key partners.
- Five subprojects have been developed, including excavation (Far Site); buildings and site infrastructure (Far Site); detectors and cryogenics (Far Site); conventional facilities and beamline (Near Site); and near detector (Near Site)




DUNE will send the world's most intense neutrino beam hundreds of miles through Earth's crust from Fermi National Accelerator Laboratory in Batavia, Illinois (Near Site), to the Sanford Underground Research Facility (Far Site) in Lead, South Dakota.

**Cost**: ~ $3,277M (62% funded)
**Timeline:** in construction, completion 2034

## Deep Underground Neutrino Experiment – Phase 2 Detectors and Supporting Infrastructure [HEP]

*Critical upgrades which will enable DUNE to establish whether CP violation exists in the neutrino sector.*

- Three possible projects make up a second phase of a two-part strategy for constructing the Long Baseline Neutrino Facility / Deep Underground Neutrino Experiment
  - Accelerator Complex Evolution Main Injector Ramp and Target (ACE-MIRT) at Fermilab
  - Third DUNE Far Detector (FD3)
  - DUNE More Capable Near Detector (MCND)
- Full sensitivity CP violation measurement envisioned by the 2014 P5 process (at 5σ significance) will be possible

Installation of the NP02 protoDUNE detector, upgrades to the Fermilab Accelerator Complex, and upgrades to the near detector, and a third detector in the existing cavern at SURF.

**Cost:** ~ $1,000M
**Timeline:** R&D phase, estimated completion TBD

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## U.S. Contribution to Future Energy Frontier Collider [HEP]

*The next Energy Frontier Collider in the world is planned to be a high-energy electron-positron collider at CERN: The Higgs Factory. U.S. contributions to the particle accelerator and detector technologies that will be required for this state-of-the-art project will be critical to its success.*

- The discovery of the Higgs boson at the CERN Large Hadron Collider in 2012 was a major milestone in particle physics, receiving a Nobel Prize. The next frontier is to understand the role of the Higgs with precision measurements at a dedicated Higgs Factory.
- Fundamental questions include: Is the recently discovered Higgs boson only the first one in a new family of particles? Is the Higgs boson an elementary particle or composite of smaller constituents?
- The U.S. made key contributions to the LHC accelerator and detectors; innovations needed for the Higgs Factory will drive progress in critical technology areas such as AI and microelectronics.

**Future High-Energy Collider**. For decades, U.S. scientists have contributed significantly to large international high energy physics projects. That leadership is expected to continue with possible future colliders, such as the Higgs Factory proposed for CERN. Shown here is the envisioned 90.7-km underground tunnel. [Courtesy CERN]

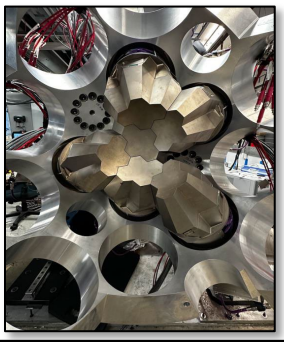
**Cost:** ~ $1,000M
**Timescale:** R&D phase, completion after 2030

# Nuclear Physics

## Gamma Ray Energy Tracking Array (GRETA) [NP]

*GRETA will provide world-unique opportunities to advance rare isotope science and investigate reactions of critical importance for nuclear astrophysics.*

- GRETA will have an unprecedented combination of full sphere solid-angle detector coverage with high efficiency, excellent energy and position resolution, as well as high peak-to-total ratio and polarization sensitivity.
- GRETA is a mobile scientific instrument that will be deployed at U.S. accelerator facilities and will reveal new details on the structure and behavior of atomic nuclei.
- GRETA includes high purity, segmented germanium detectors, cryostats, electronics, and mechanical support for placement and operation of the array.



GRETA's first experimental campaign will be at the Facility for Rare Isotope Beams at Michigan State University, where the new device will be used to explore how stars form heavy elements, to test the limits of the nucleus, and to probe hundreds of new isotopes.

**Cost:** $58.3M (fully funded)
**Timeline:** construction underway, completion 2027

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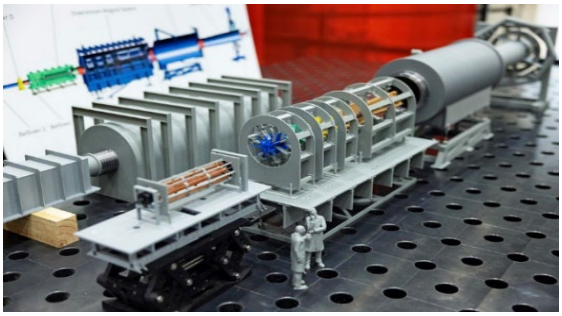
## Measurement of a Lepton-Lepton Electroweak Reaction (MOLLER) [NP]

*The MOLLER instrument will measure parity violating asymmetries in electron-electron scattering at an unprecedented level of precision. Even small departures from the theoretical value could signal the presence of physics not accounted for in the Standard Model.*

- The high sensitivity of the MOLLER instrument will make it a significant component of the global strategy to discover, at low energy, signatures of a variety of physics that could escape detection at the Large Hadron Collider.
- MOLLER will be sited in Hall A at TJNAF and will make use of the high-power electron beam from the Continuous Electron Beam Accelerator Facility.
- MOLLER consists of a polarized target, spectrometer, tracking detectors, integrating detectors, data acquisition and infrastructure modifications.



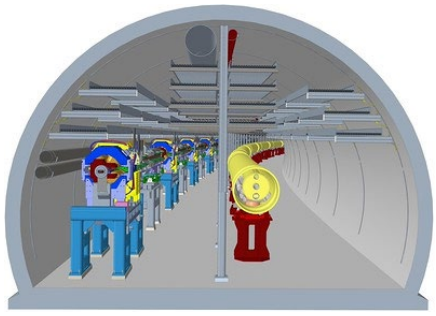
MOLLER will measure a key symmetry property with unprecedented precision through Møller scattering in collisions between two electrons.

**Cost:** $48.66M (fully funded)
**Timeline:** In construction, estimated completion 2028

## Electron-Ion Collider (EIC) [NP]

*EIC will elucidate the origin of visible mass in the universe, provide insights relevant to the physical properties of matter, and significantly advance accelerator science and technology.*

- The EIC will study the particles emitted when the polarized electrons and protons from EIC's two intersecting circular accelerators collide head-on at the center of a multi-layered detector.
- EIC design will reuse existing ion sources, a heavy-ion pre-accelerator chain, a superconducting magnet ion storage ring, and other infrastructure at Brookhaven National Laboratory to maintain affordability.
- AI will contribute to all phases of the EIC, from design to future operations, where optimization of such a large-scale experiment is a complex problem characterized by multiple parameters.



EIC will provide unprecedented ability to discover how the mass of everyday objects is dynamically generated by the interaction of quark and gluon fields inside protons and neutrons.

**Cost:** ~$3,000M (20% funded)
**Timeline:** Design underway, estimated completion 2036

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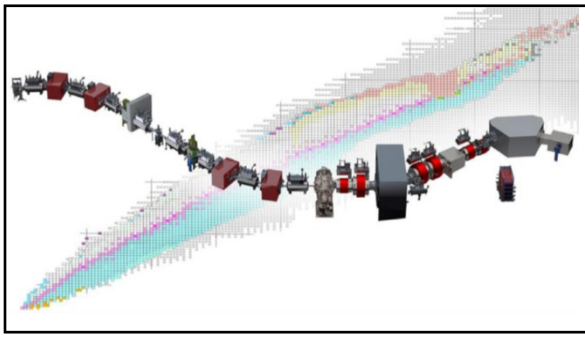
## High Rigidity Spectrometer (HRS) [NP]

*HRS will address long-standing questions in nuclear structure, nuclear matter, and nuclear astrophysics.*

- HRS will substantially increase scientific reach and productivity at the Facility for Rare Isotope Beams, enabling highly sensitive experiments even with very small sample sizes.
- HRS will be executed in two subprojects: the 41-m long High-Transmission Beam Line and the 34-m long Spectrometer Section. Both subprojects include the construction of superconducting dipole and quadrupole magnets to transport and separate the rare isotope beams.
- The superconducting magnets that compose HRS optimize the study of neutron-rich atomic nuclei (i.e., many more neutrons than protons), that are critical to understanding how protons and neutrons assemble in the atomic nucleus as well as formation of the heaviest elements in stars.



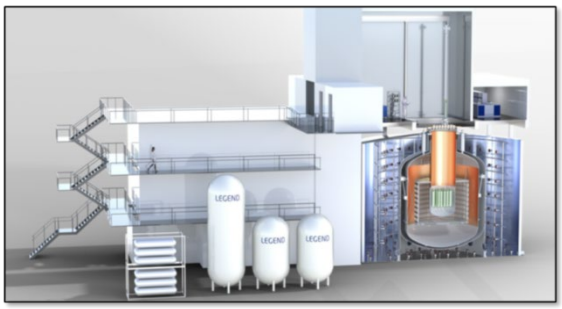
Experiments with HRS will reveal insights into the strong nuclear force that governs the formation of a broad range of element-specific isotopes and their application in fields such as medicine, energy, and national security.

**Cost:** ~$150M (40% funded)
**Timeline:** In construction, estimated completion 2033

## Large Enriched Germanium Experiment for Neutrinoless Double Beta Decay One Tonne (LEGEND-1000) [NP]

*Positive detection of double beta decay from LEGEND-1000 would profoundly impact the understanding of the universe by demonstrating that an excess of matter over antimatter can indeed be created in microscopic processes.*

- LEGEND-1000 will address two of the most important questions in fundamental physics today:
  - What physics is responsible for non-zero neutrino masses?
  - Are neutrinos their own antiparticles (a so-called Majorana particle)?
- LEGEND-1000 will use established technology, employing encapsulated detectors enriched in Germanium-76 at the "ton-scale" to allow a measurement of this rare decay within a decade.
- LEGEND-1000 will be located at the deep underground laboratory in Gran Sasso, Italy and will be an international effort with expected significant contributions from the U.S., Italy, and Germany.



The LEGEND-1000 experiment has the potential to unravel the mysteries surrounding neutrinos.

**Cost:** ~ $ 527M
**Timeline:** In planning, estimated completion 2040

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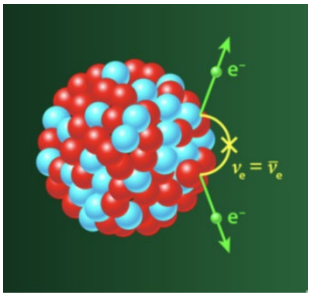
## Ton-Scale Neutrinoless Double Beta Decay [NP]

*Mounting additional ton-scale experiments in addition to the LEGEND-1000 experiment, using complementary technical approaches, will provide a path to confirm neutrinoless double beta decay.*

- The rare process of neutrinoless double beta decay is expected to be revealed by a few detectable events in a ton-scale detector over a ten-year measurement period.
- Experiments utilizing different enriched isotopes and measurement techniques from LEGEND-1000 are envisioned, e.g., bolometry with enriched molybdenum-1000 crystals and liquid xenon-136 contained in a time projection chamber. These experiments will also involve international partners.
- Confirmation of neutrinoless double beta decay would have profound consequences for understanding how the universe contains so much more matter than antimatter.




Neutrinoless double beta decay is predicted to be of the order of $10^{28}$ years, which drives the need to mount multiple ton-scale experiments to confirm observation of this rare and critically important nuclear process.

**Cost:** ~ $500M
**Timeline:** Research underway on concepts, estimated completion 2043.