## Basic Energy Sciences

### Overview

Accelerating progress in critical and emerging technologies requires the discovery, design, and control of materials and chemical systems across wide scales of time and space. Such R&D drives innovation—in next-generation microelectronics and qubit platforms; in fusion, advanced nuclear fission, and enhanced geothermal energy; and in the critical minerals and materials needed for these technologies. The Basic Energy Sciences (BES) program addresses these needs through a broad portfolio of fundamental research and enabling capabilities that provide the discoveries needed to invent, develop, and deploy next-generation technologies. Through partnership with industry and other DOE programs, BES enables critical R&D to advance the promising nearer-term technologies.

The Department's Genesis Mission seeks to build the world's most powerful discovery platform by connecting the Nation's scientific infrastructure with purpose-built AI models and comprehensive datasets. The BES program provides an unmatched source of AI-ready data, as well as development of physics-informed AI-models that will leverage these data. Further, the scientific discoveries from BES-supported research and scientific user facilities are a primary source of new knowledge needed for the discovery platforms of the future.

Maintaining U.S. leadership requires fundamental research and next-generation tools to generate the knowledge needed for technology development critical to economic and national security. The BES mission is to support fundamental research to understand, predict, and control matter and energy at the electronic, atomic, and molecular levels. This research forms the basis for innovations in energy generation, conversion, transmission, and storage, as well as technologies for quantum information science, microelectronics, and critical minerals and materials. BES achieves this through sustained investment in leading-edge scientific research and stewardship of twelve world-class scientific user facilities.

The research disciplines that BES supports, touches virtually every aspect of energy resource production, conversion, transmission, and storage, providing a knowledge base for a secure, abundant, and affordable energy future. BES research similarly provides discoveries that advance innovation in microelectronics, QIS, and AI, and create the foundation of new knowledge required to invent the technologies of the future. This sustained mission-relevance of BES research is due to a long-standing, community-driven strategic planning process, resulting in a portfolio of investments balanced between discovery-oriented transformational basic research and use-inspired basic research.

BES scientific user facilities consist of complementary x-ray and neutron sources, and centers for nanoscale science. BES facilities probe systems at ultrahigh spatial, temporal, and energy resolution to investigate the critical functions of matter that provide answers to challenging science questions and insights on the scientific basis for new technologies. These facilities provide an unmatched source of data for AI model training under the Genesis Mission. Further, ongoing facility upgrades will dramatically increase data volumes and rates, and generate data that is currently inaccessible. BES has a long history of delivering major construction projects on time and on budget, and of providing reliable availability and support to users,[a] including rigorous community engagement in planning and performance assessment.

Exploiting scientific discoveries for future energy systems requires creation of new materials and chemistries using innovative synthesis and processing techniques to precisely define atomic arrangements, and discovery and design of chemical processes. These innovations, based on principles revealed by fundamental science and using experimental tools integrated with advanced computational, AI, and data science, enable better control of physical and chemical transformations and conversions of energy from one form to another. This generates

[a] https://www.gao.gov/assets/gao-08-641.pdf

knowledge for the development and improvement of energy-relevant technologies and industrial processes. BES research is further informed by practical technology challenges with findings disseminated to the community to translate federal investments to industrial impact and economic prosperity.

The grand challenge and use-inspired scientific research that is necessary to address National priorities requires a sustained and integrated ecosystem of scientists, engineers, and enabling capabilities. BES research and facilities provide a significant strategic advantage for the Nation to advance scientific frontiers while laying the foundation for future innovations that will sustain American scientific, technological, and energy dominance.

**Highlights of the FY 2027 Request**

The BES FY 2027 Request of $2,146.1 million is a decrease of $382.3 million below the FY 2026 Enacted level.

Research

Guided by strategic planning and current Departmental priorities, including the Genesis Mission, the Request underscores continued support for Energy Frontier Research Centers (EFRCs), National Quantum Information Science Research Centers (NQISRCs), and BES core scientific research programs. Continued funding for the Established Program to Stimulate Competitive Research (EPSCoR) will maintain support of institutions in U.S. states and territories that do not historically have large federally supported academic research programs, thereby enhancing research and user communities from across the Nation to ensure a strong scientific foundation in the BES ecosystem. The FY 2027 Request:

- Increases funding for artificial intelligence and machine learning (AI/ML) research in support of the Genesis Mission, accelerating fundamental discoveries, enhancing user facility operations, and advancing interpretation of massive data sets. As part of this portfolio, BES will emphasize efforts focused on AI/ML for science within the Theoretical Condensed Matter Physics and Computational and Theoretical Chemistry programs.
- Increases funding for QIS research, which includes a robust core research portfolio and contributions from selected EFRCs to complement the NQISRCs.
- Continues funding for critical minerals and materials (CMM) research to expand understanding of the role of rare earth elements, platinum-group elements, and other critical elements in determining the functional properties of materials and catalysts across different length scales, discover chemical processes and materials that can enhance recovery and reuse of critical elements, and develop fundamental knowledge of how best to reduce or eliminate the need for critical elements in chemical processes and energy technologies.
- Continues funding for the energy innovation hub program addressing basic scientific challenges in both the batteries and energy storage and fuels from sunlight areas. The hub program focuses on collaborative research to overcome key scientific barriers for major energy challenges that require large, multidisciplinary teams to provide the required science foundations and innovations.
- Continues funding for multi-disciplinary microelectronics research in which materials, chemistries, devices, systems, architectures, algorithms, and software are developed in a closely integrated, co-design approach. As part of this portfolio, the Microelectronics Science Research Centers (MSRCs) comprise a network of multiple team awards, with individual awards focused on a dimension related to a common research topic for each center. The multidisciplinary teams include researchers from national laboratories, universities, and industry. The Request will enable support for BES research awards that contribute to these cross-SC Research Centers.
- Continues funding for the highest priority research that provides foundational knowledge for the development of next-generation energy technologies.

Facility Operations

The Request balances support for user access with the need to ensure safe operations of five BES-supported x-ray light sources, two neutron sources, and five Nanoscale Science Research Centers (NSRCs). In support of the Genesis Mission, the Request provides continued support for development and implementation of novel AI-based approaches to facility operation and data analysis that enhances efficiency across the facility and within the user community. Preconceptual planning continues for beamline MIE projects.

Projects

Support continues for the Linac Coherent Light Source-II High Energy (LCLS-II-HE), Second Target Station (STS), and Cryomodule Repair and Maintenance Facility (CRMF) line-item projects. Funding is requested for the Advanced Light Source Upgrade (ALS-U) line-item project consistent with a new project baseline budget to be established in FY 2026. Funding for the NSLS-II Experimental Tools (NEXT)–III and High Flux Isotope Reactor (HFIR) Pressure Vessel Replacement (PVR) projects is deferred.

## Basic Energy Sciences
## Funding

(dollars in thousands)

| | FY 2025 Enacted | FY 2026 Enacted | FY 2027 Request | FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|---|
| **Basic Energy Sciences** | | | | |
| Scattering and Instrumentation Sciences Research | 81,396 | 68,324 | 16,772 | -51,552 |
| Condensed Matter and Materials Physics Research | 205,714 | 198,896 | 128,354 | -70,542 |
| Materials Discovery, Design, and Synthesis Research | 87,297 | 78,587 | 35,093 | -43,494 |
| Established Program To Stimulate Competitive Research EPSCoR | 25,000 | 25,000 | 25,000 | – |
| Energy Frontier Research Centers - Materials | 65,000 | 65,000 | 58,419 | -6,581 |
| Energy Earthshot Research Centers - Materials | 3,500 | – | – | – |
| Energy Innovation Hubs - Materials | 25,913 | 25,913 | 25,913 | – |
| Computational Materials Sciences | 13,492 | 4,000 | 3,683 | -317 |
| **Total, Materials Sciences and Engineering** | **507,312** | **465,720** | **293,234** | **-172,486** |
| Fundamental Interactions Research | 140,593 | 140,599 | 90,723 | -49,876 |
| Chemical Transformations Research | 114,658 | 100,861 | 42,577 | -58,284 |
| Photochemistry and Biochemistry Research | 99,710 | 86,009 | 30,848 | -55,161 |
| Energy Frontier Research Centers - Chemical | 65,000 | 65,000 | 60,151 | -4,849 |
| Energy Earthshot Research Centers - Chemical | 3,500 | – | – | – |
| Energy Innovation Hubs - Chemical | 20,758 | 20,758 | 20,758 | – |
| General Plant Projects - Chemical | 1,000 | 1,000 | 1,000 | – |
| Computational Chemical Sciences | 13,492 | 4,000 | 3,683 | -317 |
| **Total, Chemical Sciences, Geosciences, and Biosciences** | **458,711** | **418,227** | **249,740** | **-168,487** |
| X-Ray Light Sources | 778,865 | 867,675 | 868,226 | +551 |
| High-Flux Neutron Sources | 373,367 | 297,993 | 380,026 | +82,033 |
| Nanoscale Science Research Centers | 159,230 | 177,304 | 175,570 | -1,734 |
| Other Project Costs | 9,500 | 23,100 | 5,000 | -18,100 |
| Scientific User Facilities, Research | 67,800 | 45,624 | 30,541 | -15,083 |
| **Total, Scientific User Facilities (SUF)** | **1,388,762** | **1,411,696** | **1,459,363** | **+47,667** |
| **Subtotal, Basic Energy Sciences** | **2,354,785** | **2,295,643** | **2,002,337** | **-293,306** |
| **Construction** | | | | |
| 24-SC-10 HFIR Pressure Vessel Replacement (PVR), ORNL | 6,000 | 6,000 | – | -6,000 |
| 24-SC-12 NSLS-II Experimental Tools - III (NEXT-III), BNL | 5,500 | 5,500 | – | -5,500 |

(dollars in thousands)

| | FY 2025 Enacted | FY 2026 Enacted | FY 2027 Request | FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|---|
| 21-SC-10 Cryomodule Repair & Maintenance Facility (CRMF), SLAC | 20,000 | 20,000 | 7,800 | -12,200 |
| 19-SC-14 Second Target Station (STS), ORNL | 52,000 | 52,000 | 80,000 | +28,000 |
| 18-SC-12 Advanced Light Source Upgrade (ALS-U), LBNL | 50,000 | 50,000 | 50,000 | – |
| 18-SC-13 Linac Coherent Light Source-II-High Energy (LCLS-II-HE), SLAC | 100,000 | 99,343 | 6,000 | -93,343 |
| **Subtotal, Construction** | **233,500** | **232,843** | **143,800** | **-89,043** |
| **Total, Basic Energy Sciences** | **2,588,285** | **2,528,486** | **2,146,137** | **-382,349** |

**Basic Energy Sciences**
**Explanation of Major Changes**

| | (dollars in thousands) |
|---|---|
| | **FY 2027 Request vs FY 2026 Enacted** |
| **Materials Sciences and Engineering**<br>Research will continue to support fundamental scientific opportunities for materials innovations. Research priorities include energy technologies (e.g., nuclear fission, fusion, energy storage, and grid), microelectronics research (including the MSRCs), AI/ML, CMM, and QIS. The Request also includes funding for continued support of the EFRCs, the Batteries and Energy Storage Energy Innovation Hub, the NQISRCs, and EPSCoR. | **-$172,486** |
| **Chemical Sciences, Geosciences, and Biosciences**<br>Research will continue to support fundamental scientific opportunities for innovations in chemistry, geosciences, and biosciences. Research priorities include energy (e.g., geothermal, fuels and high commodity chemicals), AI/ML, QIS, microelectronics (including the MSRCs), and CMM. The Request also includes funding for continued support of the EFRCs, the NQISRCs, and the Energy Innovation Hub. | **-$168,487** |
| **Scientific User Facilities (SUF)**<br>The 12 BES user facilities will be supported in a manner balancing safe operation and user access. Continued facilities research priorities include accelerator and detector R&D and AI/ML. The Request also provides Other Project Costs (OPC) to support the STS project. | **+$47,667** |
| **Construction**<br>The Request provides continuing support for the LCLS-II-HE, STS, CRMF, and ALS-U projects. | **-$89,043** |
| **Total, Basic Energy Sciences** | **-$382,349** |

**Basic and Applied R&D Coordination**
As a program that supports fundamental scientific research relevant to many DOE mission areas, BES strives to build and maintain close connections with other DOE program offices. BES coordinates with DOE R&D programs through a variety of Departmental activities, including workshops, strategic planning activities, solicitation development, and program review, as elaborated below. BES also works closely with representatives from technology offices and the National Nuclear Security Administration on shared priorities established under the Department's Genesis Mission.

BES has robust interactions with DOE technology offices through formal and informal coordination activities. Historically, co-siting of research by BES and other DOE programs at the same institutions has facilitated close integration of basic and applied research. The DOE national laboratory system plays a crucial role in achieving this integration of basic and applied research.

BES program managers also participate in intra-DOE information exchange and coordination on solicitations and in program reviews and project selections. These activities facilitate cooperation and coordination between BES and other parts of DOE, notably the energy technology offices.

**Program Accomplishments**

- The Linac Coherent Light Source at SLAC National Accelerator Laboratory successfully deployed a new machine learning-based (ML-based) algorithm for automated emittance tuning of both the normal conducting and superconducting linacs. Facility operators were able to achieve a 2x improvement in beam emittance automatically with a 10x speed up in time relative to manual tuning (15-20 minutes vs. hours). The success of this ML-based approach will provide uses with improved signal quality in less experimental time, and will open the door to further operational improvements previously seen as inaccessible to facility operators.
- A team of university and DOE National Laboratory researchers discovered new fundamental physics in a class of materials called rare earth-based pyrochlores that offers exciting new opportunities for the development of quantum technologies. The team made two significant discoveries. First, they measured a rare phenomenon known as "electronic anisotropy" at the interface of two pyrochlores, presenting new opportunities to develop exquisitely sensitive quantum sensors. Second, they directly observed persistent, gapped magnon modes above the temperature at which long-range magnetic ordering is lost, challenging previous assumptions and offering new pathways to study spin liquids that hold promise for fault tolerant quantum computing.
- Researchers from a DOE National Laboratory and U.S. company made a breakthrough in the development of compact free electron lasers (FELs). The team demonstrated the ability to reliably and stably produce high energy, high brightness electron beams from a plasma and pass them through an undulator to produce a nearly 1000x exponential gain in FEL light. Realizing compact FEL systems based on plasma acceleration offers significant opportunity to expand the utilization of FELs for scientific discovery, as well as for industrial applications, including microelectronics fabrication.
- Researchers from a DOE National Laboratory and U.S. university discovered an unexpected "quantum echo" in superconducting niobium materials using advanced Terahertz (THz) spectroscopy techniques. Further, such THz radiation pulses could be used to encode, store, and retrieve quantum information within such superconducting niobium materials, offering new pathways to realize practical quantum information storage and processing.
- Researchers from a DOE National Laboratory-led Energy Frontier Research Center, have discovered a new, lower-cost solution to separating lithium from other elements in seawater and underground saltwater

reserves. The team's new membrane is based on a widely available, low-cost clay called vermiculate. Using their new process, the team separated the clay into ultra-thin layers and reassembled them into stacks supported by aluminum oxide pillars, helping the materials to avoid degradation in water. Lithium ion selectivity was enabled through introduction of sodium cations in the membrane, allowing for discrimination of other ions by both size and charge. Further development of this approach may enable recovery of other critical elements.

- The Advanced Photon Source (APS) at Argonne National Laboratory (ANL) measured a horizontal emittance of 33 picometers-radians, the lowest ever emittance measured at such a facility and approximately three times better than the previous record held by China's High Energy Photon Source. The measurements cemented the facility as the most advanced synchrotron X-ray light source in the world and underscored the success of the APS Upgrade project. The benefits of lower beam emittance, including improved signal-to-noise ratios, increased efficiency of beamtime, and expanded science opportunities, will yield new scientific discoveries across a broad range of areas critical to the nation, including microelectronics, quantum materials, energy storage, and medicine.
- Researchers from a DOE National Laboratory discovered "berkelocene," the first demonstration that the heavy element berkelium can be bonded with carbon. Electronic calculations of the highly symmetrical sandwich structure indicated that the berkelium atom at its center behaved in an unexpected manner, showing that actinides cannot be treated like lanthanides and providing new insights for the separation of complicated radioactive mixtures.
- A team of researchers from DOE National Laboratories and a large public company built novel tools for molecular screening. The collaboration leveraged software developed at one of the DOE laboratories to predict the 3D structure of metal complexes. The metal complexes represent an important class of chemistry explored in the dataset that is relevant to many fields in energy, biology, and materials science. The immense data generated can be used to train machine learning models at a fraction of time and cost. This work is potentially transformative for scientific discovery as these tools are open to the public and available to researchers who can use the data and models relevant to their own research.
- Researchers from a U.S. university discovered a new state of matter in rhombohedral graphene. At low temperatures, this material behaves as both a superconductor and a magnet. The material was found to host two superconducting states that can be switched using an applied magnetic field, which is only possible if the superconducting material has intrinsic orbital magnetism. The result strongly suggests a type of exotic superconductivity called chiral that has been hypothesized in a few complex materials but never observed in a naturally occurring material. This result increases the likelihood of achieving understanding and control of highly sought topological superconductivity, which could be revolutionary for error resistant quantum computing.

## Description

Materials are critical to nearly every aspect of energy generation, storage, transmission, and end-use, as well as numerous other critical technologies, including in the areas of quantum information science (QIS) and microelectronics. Materials limitations are often a significant barrier to longer lifetimes of infrastructure and devices, the introduction of new energy technologies, or improved energy efficiencies. The Materials Sciences and Engineering (MSE) subprogram supports research to provide the fundamental understanding and control of materials synthesis, properties, and functionality that will enable solutions to challenges in energy generation, storage, and use. The research explores the origin of macroscopic material behaviors; their fundamental connections to atomic, molecular, and electronic structures; and their evolution as materials move from nanoscale building blocks to mesoscale systems. At the core of the subprogram is experimental, theoretical, computational, and instrumentation research that will enable the predictive discovery, design, and characterization of new materials with novel structures, properties, and functions. To accomplish these goals, the portfolio includes three integrated research activities:

- Scattering and Instrumentation Sciences Research
- Condensed Matter and Materials Physics Research
- Materials Discovery, Design, and Synthesis Research

The Request continues the highest-priority fundamental research that supports the DOE mission, including the Genesis Mission, and establishes the foundational knowledge necessary to accelerate innovation to advance energy technologies, critical emerging technologies, and other national priorities. The portfolio emphasizes understanding of how to direct and control energy flow in materials systems over multiple time and length scales, and translation of this understanding to prediction of material behavior, transformations, and processes in challenging real-world systems. This will establish a foundational knowledge base for future advanced energy and information technologies, as well as industrial processes. The research supported explores a broad spectrum of materials science, including new frontiers of emergent materials behavior; utilization of nanoscale control; and metastable or far from equilibrium materials systems that enable novel materials design and advanced manufacturing.

Research activities in quantum materials emphasize the development of systems that realize unique properties required for QIS technologies. Materials science for microelectronics provides the advances needed for future computing, sensors, detectors, and communication critical for energy and for leadership in advanced research. An increasingly important aspect of materials research is the development and use of artificial intelligence/machine learning (AI/ML) and data science techniques to enhance the utility of both theoretical and experimental data for predictive design and discovery of materials. The MSE subprogram supports the development of advanced characterization tools, instruments, and techniques that can access a wide range of space and time scales, especially in combination and under operando conditions to analyze non-equilibrium materials, conditions, and excited-state phenomena. In addition to a multifaceted portfolio of single-investigator and small-group research projects, the MSE subprogram supports multi-investigator, multi-disciplinary team-science research modalities, including Energy Frontier and Microelectronics Science Research Centers, Energy Innovation Hubs, Computational Materials Sciences, and the National QIS Research Centers (NQISRCs). This subprogram also includes the DOE Established Program to Stimulate Competitive Research (EPSCoR) program to broaden investments in foundational science and early-stage energy research for U.S. states and territories that do not historically have large federally supported academic research programs.

Scattering and Instrumentation Sciences Research
This activity supports innovative techniques and instrumentation development for advanced materials science research with scattering, spectroscopy, and imaging using electrons, neutrons, and x-rays, including development of science to understand ultrafast dynamics. These techniques provide precise and complementary information about the relationship among structure, dynamics, and properties, and are critical in advancing understanding and discovery of novel quantum materials, including materials for next-generation systems to advance microelectronics and QIS. The tools and capabilities developed in this activity are broadly applicable to other fields, including chemistry, biology, and geoscience. The unique interactions of electrons, neutrons, and x-rays with matter enable a range of complementary tools with different sensitivities and resolution for the characterization of systems at length- and time-scales spanning many orders of magnitude. Included is the use of cryogenic environments to evaluate properties only occurring at low temperatures and to learn about processes and interfaces in materials damaged by the probes used to characterize them. In parallel with the development of advanced instrumentation, application of novel data science approaches, including those leveraging AI/ML, to improve the collection, processing, and analysis of very large data sets is critical to ensuring optimal use of such instruments in support of the Genesis Mission.

Condensed Matter and Materials Physics Research
This activity supports fundamental experimental and theoretical research to discover, understand, and control novel phenomena in solid materials. These electronic, magnetic, optical, thermal, and structural materials make up the infrastructure for innovative energy advances, accelerator and detector technologies for SC facilities, and microelectronics and QIS. This activity supports research to understand the role of critical materials in determining material properties and functionality, so that they can be reduced or eliminated from key energy technology supply chains.

Experimental research in this activity emphasizes discovery and characterization of materials' properties that have the potential to be exploited for new technological functionalities. Complementary theoretical research aims to explain such properties across a broad range of length- and time-scales. Theoretical research also includes development and integration of predictive theory and modeling for the discovery of materials with targeted properties. Advanced computational and data science techniques, including AI/ML, are enabling knowledge to be extracted from large materials databases of theoretical calculations and experimental measurements. This activity supports the development of such databases, the computational tools that can take advantage of them, and innovative physics-guided AI approaches to accelerate discovery in support of the Genesis Mission. This activity continues to emphasize understanding and control of quantum materials. The research advances the fundamental understanding of electronic, magnetic, thermal, and optical properties relevant to energy-efficient microelectronics and QIS. Specifically, the MSE subprogram's dedicated QIS portfolio supports fundamental research with potentially transformative impact on the development and characterization of qubit platforms for future quantum computing, sensing, and communication systems. Activities also emphasize research to understand how materials respond to temperature, light, radiation, corrosive chemicals, and other environmental conditions.

In FY 2027, BES will continue to partner with other SC programs in the NQISRC program. NQISRC research supported by the MSE subprogram includes theory of materials for quantum applications in computing, communication, and sensing; device science for next-generation QIS systems; and synthesis, fabrication, and characterization of quantum materials. BES will also continue to partner with other SC programs on activities to support multi-disciplinary basic research to accelerate the advancement of microelectronic technologies in a co-design innovation ecosystem, where the design of materials, devices, architectures, and algorithms are integrated as part of a single R&D pipeline.[b] BES contributes to the SC Microelectronics Science Research Centers (MSRCs) program, a portfolio of awards that support research in energy efficiency for microelectronics

[b] https://science.osti.gov/-/media/bes/pdf/reports/2019/BRN_Microelectronics_rpt.pdf

or their operation in extreme environments. Materials, chemistries, devices, systems, architectures, algorithms, and software are being developed in tandem.

Materials Discovery, Design, and Synthesis Research
This activity supports the predictive design, discovery, and development of new materials with desired properties, which is the engine that drives science frontiers and technology innovations. It aims to grow and maintain U.S. leadership in materials discovery by investing in advanced synthesis capabilities and by coupling these with state-of-the-art user facilities and advanced computational capabilities at DOE laboratories, generating scientific knowledge that is foundational to the BES mission.

The FY 2027 Request continues support of materials discovery and synthesis research to understand the unique properties of critical materials, with the goal of reducing their use. Understanding the science of synthesis will enable the design of new systems that are easier to efficiently convert into similar products with comparable or enhanced complexity, functionality, and value. The activity also supports fundamental research in solid-state chemistry to enable discovery of new functional materials and the development of new crystal growth methods and thin film deposition techniques to create complex materials with targeted structure and properties. In addition to research on chemical and physical synthesis processes, the portfolio includes research to understand how to use bio-mimetic and biology-inspired approaches to design and synthesize novel materials with some of the unique properties found in nature. The activity supports the development of new AI/ML-based approaches aimed at accelerating materials discovery and enabling scalable, automated synthesis with real-time adaptive control in support of the Genesis Mission.

Established Program to Stimulate Competitive Research (EPSCoR)
The DOE EPSCoR program funds fundamental and early-stage research that supports DOE's science and energy mission in states and territories with historically lower levels of federal academic research funding. The program emphasizes research that will improve the capability of designated states and territories to conduct nationally competitive fundamental and early-stage energy-related research; jumpstart research capabilities through workforce development in energy-related areas; and build beneficial relationships between scientists and engineers in the designated jurisdictions and DOE laboratories. Managed by BES, funding for the EPSCoR program is distributed among the six major research programs within SC.[c] Annual EPSCoR funding opportunities alternate between research performed in collaboration with the DOE laboratories and larger-team implementation awards. The FY 2027 program is planned to emphasize Implementation awards to establish larger, multi-investigator teams that will develop research capabilities, including investment in instrumentation, in EPSCoR jurisdictions. The technical scope will focus on the research topics supported by SC program offices and early-stage energy research broadly. The program will continue to support other SC programs, including the Early Career Research Program.

Energy Frontier Research Centers
The EFRC research modality brings together the skills and talents of teams of investigators to combine discovery science and energy-relevant basic research whose scope and complexity is beyond what is possible from single-investigator or small-group awards. These multi-investigator, multi-disciplinary centers aim to accelerate basic research to enable transformative scientific advances and uncover new and innovative solutions to the most difficult problems in materials sciences. EFRCs supported in this subprogram focus on the design, discovery, synthesis, characterization, and understanding of novel, solid-state materials that generate and convert energy; the understanding of materials and processes foundational for electrical energy storage; quantum materials and QIS; microelectronics; and materials for future nuclear energy. The development and application of novel AI/ML-based tools and techniques for scientific discovery throughout the EFRC portfolio

[c] Per direction in the explanatory statement accompanying the FY 2023 Consolidated Appropriations Act

contributes to the Department's Genesis Mission. The FY 2027 Request continues support for EFRC awards made in prior fiscal years.

Energy Innovation Hubs

The Batteries and Energy Storage Energy Innovation Hub program will continue to tackle forefront, basic scientific challenges for next-generation electrochemical energy storage. Hubs focus on collaborative research to overcome key scientific barriers for major energy challenges that require large, multidisciplinary teams to provide the required science foundations and innovations. The Request will continue to support the Batteries and Energy Storage Energy Innovation Hub.

Computational Materials Sciences

This program has focused on research leading to computational codes and associated experimental/computational databases for the design of materials with advanced functionalities. This included development of new ab initio theory, contributing the generated data to databases; advanced characterization and controlled synthesis to provide the data to validate computational predictions; and design of computational codes to take advantage of DOE's world-leading exascale high-performance computers.

In FY 2027, the program will continue to focus on the development of novel AI/ML-based tools and techniques for accelerated scientific discovery in support of the Genesis Mission. Support for the maintenance and further development of high value, widely used software previously developed under the program may be considered based on program priorities.

## Activities and Explanation of Changes

(dollars in thousands)

| FY 2026 Enacted | | FY 2027 Request | Explanation of Changes FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|
| **Materials Sciences and Engineering** | **$465,720** | **$293,234** | **-$172,486** |
| Scattering and Instrumentation Sciences Research | $68,324 | $16,772 | -$51,552 |
| Funding continues to focus on the development and use of advanced characterization tools to extract information on multiple length and time scales. Advanced instrumentation research is applied to a breadth of national priorities, including QIS, microelectronics, critical minerals, energy science, and advanced industrial processes. | | The Request will continue to focus on the development and use of advanced characterization tools to extract information on multiple length and time scales. Advanced instrumentation research will be applied to a breadth of national priorities, including QIS, microelectronics, critical minerals, energy science, and advanced industrial processes. | Reductions will be based on programmatic priorities. |
| Condensed Matter and Materials Physics Research | $198,896 | $128,354 | -$70,542 |
| Funding continues to emphasize the understanding and control of the fundamental properties of materials that are central to their functionality in a wide range of clean energy-relevant technologies. Exploration of quantum materials remains a high priority, specifically the role they play in microelectronics, accelerators, and QIS. The program continues to partner with other SC program offices in the NQISRCs and the MSRCs. Additional investments expand support for research to leverage AI/ML to accelerate materials discovery and characterization in support of the Genesis Mission. | | The Request will continue to emphasize the understanding and control of the fundamental properties of materials that are central to their functionality in a wide range of energy-relevant technologies. Exploration of quantum materials remains a high priority, specifically the role they play in microelectronics, accelerators, and QIS. The program will partner with other SC program offices in the NQISRCs and the MSRCs. Investments will continue support for research to develop and leverage AI/ML to accelerate materials discovery and characterization in support of the Genesis Mission. | Reductions will be based on programmatic priorities. |

(dollars in thousands)

| FY 2026 Enacted | FY 2027 Request | Explanation of Changes FY 2027 Request vs FY 2026 Enacted |
|---|---|---|
| Materials Discovery, Design, and Synthesis Research $78,587 | $35,093 | -$43,494 |
| Funding continues support for the design, discovery, and synthesis of novel forms of matter with desired properties and functionalities with an emphasis on advancing the fundamental science relevant to future industrial processes and energy technologies, as well as developing and implementing novel AI-based techniques to accelerate synthesis and characterization in support of the Genesis Mission. Research on bio-mimetic and biology-inspired materials is relevant to energy technologies as well as other national priorities such as critical minerals and materials. | The Request will continue support for the design, discovery, and synthesis of novel forms of matter with desired properties and functionalities with an emphasis on advancing the fundamental science relevant to future industrial processes and energy technologies, as well as developing and implementing novel AI-based techniques to accelerate synthesis and characterization in support of the Genesis Mission. Research on bio-mimetic and biology-inspired materials is relevant to energy technologies as well as other national priorities such as critical minerals and materials. | Reductions will be based on programmatic priorities. |
| Established Program to Stimulate Competitive Research (EPSCoR) $25,000 | $25,000 | $ — |
| Funding continues to support fundamental science and early-stage R&D, including research that underpins DOE energy technology programs. FY 2026 funding supports State-National Laboratory Partnership awards. Investment continues in early career research faculty from EPSCoR-designated jurisdictions and in co-investment with other initiatives. | The Request will continue to support fundamental science and early-stage R&D, including research that underpins DOE energy technology programs. FY 2027 will emphasize Implementation awards to establish larger, multi-investigator teams that develop research capabilities, including investment in instrumentation, in EPSCoR jurisdictions. Investment will continue in early career research faculty from EPSCoR-designated jurisdictions and in co-investment with other initiatives. | Funding will focus on Implementation awards, with the aim to improve the capability of designated states and territories to conduct sustainable and nationally competitive fundamental and early-stage energy-related research. |

(dollars in thousands)

| FY 2026 Enacted | | FY 2027 Request | Explanation of Changes FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|
| Energy Frontier Research Centers | $65,000 | $58,419 | -$6,581 |
| Funding provides the third year of support for four-year EFRC awards that were made in FY 2024. In addition, BES will recompete awards made in FY 2022, with emphasis on a broad range of topics relevant to energy and other national priorities. | | The Request will provide the final year of support for four-year EFRC awards that were made in FY 2024 and the second year of support for four-year awards made in FY 2026. | Technical emphasis for the EFRC program will continue to include new research directions that cut across BES programmatic efforts, as well as those identified in recent strategic planning activities related to energy, QIS, microelectronics, and other national priorities. |
| Energy Innovation Hubs | $25,913 | $25,913 | $ — |
| Funding supports the fourth year of funding for Batteries and Energy Storage Hub award initiated in prior years through an open competition. | | The Request will support the Batteries and Energy Storage Hub award initiated in prior years. | No change. |
| Computational Materials Sciences | $4,000 | $3,683 | -$317 |
| The CMS activity supports the development of AI-based tools and techniques for materials discovery and characterization in support of the Genesis Mission. Support for the maintenance and further development of high value, widely used software previously developed under the program may be considered based on program priorities. | | The CMS activity will continue to develop AI-based tools and techniques for materials discovery and characterization in support of the Genesis Mission. Support for the maintenance and further development of high value, widely used software previously developed under the program may be considered based on program priorities. | Fundamental research will target AI for accelerated scientific discovery to support the goals of the Genesis Mission. |

## Description

Development of innovative energy technologies relies on understanding and ultimately controlling transformations of energy among forms and conversions of matter across multiple scales starting at the atomic level. The Chemical Sciences, Geosciences, and Biosciences (CSGB) subprogram supports research to discover fundamental knowledge of chemical reactivity and energy conversion foundational to energy-relevant chemical processes, such as catalysis, synthesis, separations, and light-driven chemical transformations. The research addresses how physical and chemical phenomena at the scales of electrons, atoms, and molecules—including quantum phenomena—control complex and collective behavior of macroscopic-scale energy and matter conversion systems. Fundamental knowledge developed through this subprogram can enable science to tailor chemical transformations with atomic and molecular precision and achieve predictive understanding of complex chemical, geochemical, and biochemical systems.

To address these challenges, the portfolio includes coordinated research activities in three areas:

- Fundamental Interactions Research
- Chemical Transformations Research
- Photochemistry and Biochemistry Research.

The Request continues the highest-priority fundamental research that supports the DOE mission, including the Genesis Mission, and provides foundational knowledge that can advance affordable, reliable, and secure energy technologies. Research will discover and develop chemical processes that are energy and atom efficient and increase understanding of the phenomena relevant to QIS. This fundamental science can lead to new approaches for industrial processes, innovations in microelectronics, and reduced dependence on critical materials and minerals. Fundamental biochemistry will discover principles that could enable biomimetic and biohybrid energy systems and guide development of new biotechnologies. Integration of artificial intelligence/machine learning (AI/ML), data science, and computational chemistry will provide tools and infrastructure needed for shared data repositories and accelerated discovery and characterization of complex chemical systems.

The CSGB subprogram supports a multifaceted portfolio of single-investigator and small-group research projects as well as multi-investigator, multi-disciplinary team-science research including Energy Frontier and Microelectronics Science Research Centers, Energy Innovation Hubs, Computational Chemical Sciences, and the National QIS Research Centers (NQISRCs).

<u>Fundamental Interactions Research</u>

This activity emphasizes structural and dynamical studies of atoms, molecules, and nanostructures to understand their interactions in full quantum detail. Research is conducted at the boundary of chemistry and physics to understand reactive chemistry in the gas phase, in condensed phases, and at interfaces. This activity provides leadership for ultrafast chemistry and advances ultrafast tools and approaches to probe and control chemical processes. It supports theory and computation for accurate descriptions of molecular reactions and chemical dynamics, optimal use of exascale computing facilities, and potential application of future quantum computers to computational quantum chemistry. In support of the Genesis Mission, this activity supports AI/ML efforts that can advance use of exascale or quantum computing hardware to simulate chemical systems and processes for fundamental discovery as well as methods to accelerate the analysis of complex experimental data. It also supports a program of QIS research at the intersection of chemistry, quantum physics, and information theories that can advance foundational understanding of quantum information control in complex molecular systems. This fundamental research can lay the foundation for the chemical design principles needed to realize next-generation quantum technologies in computing, sensing, and communication.

In FY 2027, BES will continue as a partner in the NQISRC program. The research in this portfolio will advance state-of-the-art science and technology to realize the full potential of quantum-based applications and pave the path to quantum computing in the longer term. BES will also continue to partner on microelectronics research to unravel complex mechanisms of chemical reactions at interfaces to inform design and synthesis of new materials and chemical processes.[d] As part of this portfolio, the Microelectronics Science Research Centers (MSRCs) comprise a network of multiple team awards, with individual awards focused on a dimension related to one of two common research topics for each Center—energy efficiency or extreme environments. The multidisciplinary teams include researchers from universities, national laboratories, and industry and are developing chemistries, materials, devices, systems, architectures, algorithms, and software in a co-design innovation ecosystem.

Chemical Transformations Research

This activity seeks fundamental knowledge of chemical reactivity, matter and charge transport, and chemical separation and stabilization processes foundational to development of affordable and reliable energy technologies. Fundamental research in this activity spans catalysis science, separation science, heavy element chemistry, and geosciences to advance mechanistic understanding of charge transport and reactivity, catalytic efficiency and selectivity, critical materials recovery, conversion of energy resources, and chemistry in subsurface and aqueous systems important in chemical processes.

In the FY 2027 Request, this activity will continue to investigate transformative approaches for energy. Research will focus on discovery and design of catalytic and separation processes and provide fundamental knowledge of subsurface processes such as mineralization, crack propagation, and rock fracture to foster innovation in the use of the subsurface for energy generation and storage. Research will also address critical minerals and materials with a focus on approaches for resource identification and extraction, selective separation, and substitution of critical elements. Research will also examine quantum phenomena enabled by rare earth elements and actinides. AI/ML approaches will be emphasized to accelerate the generation of scientific knowledge foundational to the BES mission and its role in realizing the goals of the Genesis Mission.

Photochemistry and Biochemistry Research

This activity supports fundamental research on the molecular mechanisms of capture and conversion of light energy into chemical energy in both natural and man-made systems, providing a model system for studies of energy conversion and quantum phenomena relevant to critical materials and radiation chemistry. It integrates research at the interface of chemistry, physics, and biology and plays a leadership role for basic research on natural photosynthesis and photochemistry. Such research can inspire new strategies for energy conversions and inform development of innovative energy technologies, including how elements in critical materials can be reduced or even eliminated without negatively affecting energy conversion efficiency. To understand energy conversion across spatial and temporal scales, research explores charge transport and redox interconversion of atoms and small molecules important in production of commodity and specialty chemicals and fuels. Research also examines ionizing radiation effects and radiation chemistry which can provide insights for nuclear reactor design, remediation, and fuel-cycle separation as well as other chemical transformations.

In the FY 2027 Request, the activity will continue to focus on molecular-level understanding of biochemical, biophysical, and photochemical processes to enhance energy conversions. Research will aim to discover and design chemical processes, complex structures, and bio-inspired and biohybrid systems and approaches to advance affordable energy technologies, including microelectronics. Studies will continue on reducing use of critical and rare earth elements in catalysts and light absorbers and on radiation chemistry, including growing the scientific workforce. This activity will also continue research to understand quantum phenomena such as

[d] https://science.osti.gov/-/media/bes/pdf/reports/2019/BRN_Microelectronics_rpt.pdf

coherence in natural and artificial systems, providing insights for enhancing energy conversion and potentially inspiring materials development for QIS. AI/ML-based methods will be supported to accelerate discovery of chemistries and new materials for energy conversion and to identify and characterize biochemical and biophysical processes based on large, complex datasets in support of the Genesis Mission.

Energy Frontier Research Centers

The EFRC research modality brings together the skills and talents of teams of investigators to combine discovery science and energy-relevant, basic research whose scope and complexity are beyond what is possible from single-investigator or small-group awards. These multi-investigator, multi-disciplinary centers aim to accelerate basic research to enable transformative scientific advances and uncover new and innovative solutions to the most difficult problems in chemical sciences, geosciences, and biosciences. EFRCs supported in this subprogram focus on the design, discovery, characterization, and control of chemical, biochemical, and geological processes for improved electrochemical conversion; the understanding of catalytic chemistry and biochemistry that is foundational for production of fuels and chemicals and for separations; QIS; nuclear energy and the chemistry of waste processing; and the advanced characterization of the Earth's subsurface. The development and application of novel AI/ML-based tools and techniques for scientific discovery throughout the EFRC portfolio contributes to the Department's Genesis Mission. The FY 2027 Request continues support for EFRC awards made in prior fiscal years.

Energy Innovation Hubs

Energy Innovation Hubs focus on collaborative research to overcome key scientific barriers for major energy challenges that require large, multidisciplinary efforts. The Fuels from Sunlight Hub program addresses both new directions and long-standing fundamental science challenges in fuels generation identified in the report from the Liquid Solar Fuels Roundtable.[e] The Request will continue support for the two Hub projects recommended for renewal following external peer review of renewal proposals in FY 2025.

The two Fuels from Sunlight Hub awards will continue to conduct fundamental research on key scientific challenges for fuels production that uses light energy, water, and carbon dioxide as the only inputs to reduce or replace critical and rare earth elements. AI/ML methods and laboratory automation will continue to be developed and used for discovery of materials for energy conversion and in support of the Genesis Mission.

Computational Chemical Sciences

This program has supported basic research to develop validated, open-source codes and associated experimental/ computational databases for modeling and simulation of complex chemical processes and phenomena that can take advantage of today's exascale high-performance computers. Research has supported establishment of a publicly accessible website[f] of open source, robust, validated, user-friendly software that captures the essential physics and chemistry of relevant chemical systems. The broader research community and industry are using these codes/data to accelerate U.S. chemical research.

In FY 2027, the program will continue to focus on development of novel AI/ML-based tools and techniques for accelerated scientific discovery and in support of the Genesis Mission. Support for the maintenance and further development of high value, widely used software previously developed under the program may be considered based on program priorities.

General Plant Projects

General Plant Projects funding provides for minor new construction, other capital alterations and additions, and improvements to land, buildings, and utility systems to maintain the productivity and usefulness of DOE-owned facilities and to meet requirements for safe and reliable facilities operation.

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[e] https://science.osti.gov/-/media/bes/pdf/reports/2020/Liquid_Solar_Fuels_Report.pdf
[f] https://ccs-psi.org/

## Activities and Explanation of Changes

(dollars in thousands)

| FY 2026 Enacted | FY 2027 Request | Explanation of Changes FY 2027 Request vs FY 2026 Enacted |
|---|---|---|
| **Chemical Sciences, Geosciences, and Biosciences $418,227** | **$249,740** | **-$168,487** |
| Fundamental Interactions Research $140,599 | $90,723 | -$49,876 |
| Funding continues to develop innovative ultrafast approaches, with emphasis on use of x-ray free electron lasers; determine how reactive intermediates affect reaction pathways; and characterize quantum phenomena underlying QIS. Research funding is targeting the understanding and control of interfacial chemical conversion mechanisms and quantum phenomena to advance novel energy technologies for improved energy capture and conversion and microelectronics. The program continues to partner with other SC program offices for the NQISRCs and the MSRCs. Additional investments expand support for research to leverage AI/ML to accelerate discovery and characterization in support of the Genesis Mission. | The Request will continue to develop innovative ultrafast approaches, with emphasis on the use of x-ray free electron lasers; determine how reactive intermediates affect reaction pathways; and characterize quantum phenomena underlying QIS. Research will also target the understanding and control of interfacial chemical conversion mechanisms and quantum phenomena to advance novel energy technologies for improved energy capture and conversion and microelectronics. The program will partner with other SC program offices for the NQISRCs and the MSRCs. Investments will continue support for research to develop and leverage AI/ML to accelerate discovery and characterization in support of the Genesis Mission. | Reductions will be based on programmatic priorities. |
| Chemical Transformations Research $100,861 | $42,577 | -$58,284 |
| Funding continues fundamental research to understand catalytic mechanisms for thermo- and electro-chemical conversions and to develop atomically precise synthesis of catalysts important for affordable and reliable energy. Research in separation science | The Request will continue fundamental research to understand catalytic mechanisms for thermo- and electro-chemical conversions and to develop atomically precise synthesis of catalysts important for affordable and reliable energy. Research in separation science will | Reductions will be based on programmatic priorities. |

(dollars in thousands)

| FY 2026 Enacted | FY 2027 Request | Explanation of Changes FY 2027 Request vs FY 2026 Enacted |
|---|---|---|
| continues to focus on innovative mechanisms for high-efficiency chemical separations and processes. Heavy element research continues to advance understanding of actinide speciation and reactivity and f-electron systems. Geosciences research continues to reveal subsurface phenomena that can be foundational to new energy technologies. Research continues to advance the separations and extraction of rare earth elements from complex and dilute mixtures and the development of alternative approaches to reduce use of critical elements. AI/ML and data science approaches will be leveraged across the activity to accelerate discovery and characterization in support of the Genesis Mission. | continue to focus on innovative mechanisms for high-efficiency chemical separations and processes. Heavy element research will continue to advance understanding of actinide speciation and reactivity and f-electron systems. Geosciences research will continue to reveal subsurface phenomena that can be foundational to new energy technologies. Research will continue to advance the separations and extraction of rare earth elements from complex and dilute mixtures and the development of alternative approaches to reduce the use of critical elements. AI/ML and data science approaches will be developed and leveraged across the activity to accelerate discovery and characterization in support of the Genesis Mission. | |
| Photochemistry and Biochemistry Research $86,009 | $30,848 | -$55,161 |
| Funding supports research on physical, chemical, biophysical, and biochemical processes of light energy capture and conversion which could inspire technology innovations for affordable and reliable energy. Biological and chemical studies examines the role of quantum phenomena in energy conversion. Biochemical studies can provide insights for bio-inspired and biohybrid systems with desired functions and properties and new strategies for artificial photosynthesis, energy conversions, and biotechnology. Solar fuels research continues to address molecular mechanisms of photon capture, charge transport, product selectivity, and reduced critical element use in | The Request will continue research on physical, chemical, biophysical, and biochemical processes of light energy capture and conversion which could inspire technology innovations for affordable and reliable energy. Biological and chemical studies will examine the role of quantum phenomena in energy conversion. Biochemical studies will provide insights for bio-inspired and biohybrid systems with desired functions and properties and new strategies for artificial photosynthesis, energy conversions, and biotechnology. Solar fuels research will address molecular mechanisms of photon capture, charge transport, product selectivity, and reduced critical element use in catalysts. AI/ML | Reductions will be based on programmatic priorities. |

(dollars in thousands)

| FY 2026 Enacted | | FY 2027 Request | Explanation of Changes FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|
| photoabsorbers and catalysts. AI/ML and data science methods continue to be integrated across the activity to accelerate discovery and characterization in support of the Genesis Mission. | | and data science methods will continue to be developed and integrated across the activity to accelerate discovery and characterization in support of the Genesis Mission. | |
| Energy Frontier Research Centers | $65,000 | $60,151 | -$4,849 |
| Funding provides the third year of support for the four-year EFRC awards that were made in FY 2024. In addition, BES will recompete awards made in FY 2022, with emphasis on a broad range of topics relevant to energy and other national priorities. | | The Request will provide the final year of support for the four-year EFRC awards that were made in FY 2024 and the second year of support for the four-year awards made in FY 2026. | Technical emphasis for the EFRC program will continue to include new research directions that cut across BES programmatic efforts, as well as those identified in recent strategic planning activities related to energy, QIS, microelectronics, and other national priorities. |
| Energy Innovation Hubs | $20,758 | $20,758 | $ — |
| Funding continues support for the Hub awards made in FY 2025 to further advance research efforts on solar fuels generation for affordable and secure energy. | | The Request will continue support for the Hub awards renewed in FY 2025 to further advance research efforts on fuels generation for affordable and secure energy. | Fundamental research will continue to target innovative artificial photosynthesis approaches for fuels generation to reduce or replace critical materials used in catalysts. |
| Computational Chemical Sciences | $4,000 | $3,683 | -$317 |
| The CCS activity supports the development of AI-based tools and techniques for discovery and characterization in the chemical sciences in support of the Genesis Mission. Support for the maintenance and further development of high value, widely used software previously developed under the program may be considered based on program priorities. | | The CCS activity will continue support to develop AI-based tools and techniques for discovery and characterization in the chemical sciences in support of the Genesis Mission. Support for the maintenance and further development of high value, widely used software previously developed under the program may be considered based on program priorities. | Fundamental research will target AI for accelerated scientific discovery to support the goals of the Genesis Mission. |

(dollars in thousands)

| FY 2026 Enacted | | FY 2027 Request | Explanation of Changes FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|
| General Plant Projects | $1,000 | $1,000 | $ — |
| Funding supports minor facility improvements at Ames National Laboratory. | | The Request will support minor facility improvements at Ames National Laboratory. | No change. |

**Description**

The Scientific User Facilities subprogram supports the operation of a geographically and technically diverse suite of major research facilities that provide unique tools to thousands of researchers from universities, industry, and government laboratories to advance a broad range of scientific domains and technology areas that are critical to DOE's mission and to many other National priorities. The BES user facilities portfolio consists of a complementary set of intense x-ray sources, neutron scattering facilities, and research centers for nanoscale science. These facilities allow researchers to probe materials in space, time, and energy with the resolution to interrogate the inner workings of matter to help understand the fundamental aspects of the natural world. Operated on an open access, competitive, merit review basis, scientists from every state can utilize the facilities' capabilities and sophisticated instrumentation. The 12 BES scientific user facilities collectively contribute to important scientific results across basic and applied research in chemistry, physics, geology, materials science, environmental science, biology, and biomedical science that can lead to the discovery and design of advanced materials and novel chemical processes with broad societal impacts. In FY 2024, more than 13,000 scientists and engineers in many fields of science and technology used BES scientific facilities.

The Department's Genesis Mission aims to build the world's most powerful scientific platform for discovery by connecting the Nation's scientific infrastructure with purpose-built AI models and comprehensive data sets. The 12 BES-stewarded user facilities are an unmatched source of the AI-ready data necessary to realize this vision, conducting hundreds of experiments simultaneously around the clock. These experiments are generating vast quantities of raw experimental data that must be stored and analyzed to translate the data into information to yield answers to important scientific questions. The data challenges continue to grow as new capabilities and advanced detector technologies come online. Data science and AI/ML methods coupled with advanced computing hardware are required to address these challenges and get the highest value data from user experiments. There are also AI/ML opportunities to improve the efficiency and reliability of accelerator and instrument operations. The Request continues support for the research needed to realize these opportunities in AI/ML, in alignment with the goals of the Genesis Mission.

Maintaining world-leading capabilities is crucial for international competitiveness as advances in tools and instruments often drive scientific discovery. Major upgrades to BES facilities are supported through line-item construction and Major Items of Equipment (MIEs), including support for new and upgraded x-ray and neutron experimental stations and forefront nanoscience instrumentation. The subprogram also supports research in accelerator and detector development to explore technology options for the next generations of x-ray and neutron sources that will keep BES accelerator-based facilities at the forefront.

The FY 2027 Request supports user facilities' operational budget requirements determined by the user facilities. Base requirements for operations continue to increase due to the steady rise in the cost of staff, utilities, maintenance, and materials; evolution of remote use; increased data and computational costs; and the transition of new capabilities from facility upgrades to operations. Funding will require a careful balance to meet costs to ensure safe operations and user access.

X-Ray Light Sources

X-rays are an essential tool for studying the structure of matter and have long been used to see things that visible light cannot resolve. X-rays are critical tools for assessing dynamics as materials, chemistries, and biological systems evolve. Large-scale light source facilities have vastly enhanced the utility of existing x-ray techniques and have given rise to entirely new ways to do experiments that are not otherwise feasible with conventional x-ray machines. Owing to their broadly tunable wavelengths, coherence, ultrafast pulses, and polarization control, light source facilities are incisive probes for advanced research.

BES operates five light sources, including a free electron laser, the Linac Coherent Light Source (LCLS) at SLAC, and four storage ring-based sources—the Advanced Light Source (ALS) at LBNL, the Advanced Photon Source (APS) at ANL, the Stanford Synchrotron Radiation Light Source (SSRL) at SLAC, and the National Synchrotron Light Source (NSLS)-II at BNL. BES provides funding to support facility operations, technical support, computational tools for data analysis, and user program administration, which are made available to all researchers with access determined via peer review of user proposals. All facilities are multidisciplinary and have extensive outreach efforts to ensure that researchers have fair and equitable access regardless of their research focus, geographical location, or institutional size. In support of the Genesis Mission, all light source facilities are actively developing AI/ML tools to both optimize facility operations and provide enhanced scientific capabilities to users. Upgrade projects are underway for the APS, ALS, and LCLS to ensure ongoing world leadership for these facilities. The initial suite of seven beamlines at NSLS-II in FY 2015 has expanded to 29 beamlines with three under construction and room for about 30 more. To adopt the most up-to-date technologies and provide the most advanced capabilities, BES has a phased approach to new beamlines at NSLS-II, as was done for other BES facilities. The NSLS-II Experimental Tools-II (NEXT-II) MIE project, started in FY 2020, provides three best-in-class beamlines to support the needs of the U.S. research community. In FY 2024, planning and conceptual design funds were provided for NEXT-III, a line-item construction project to deliver the next cadre of beamlines. The Request supports continued preliminary planning for future beamline MIEs.

High-Flux Neutron Sources

BES supports two neutron sources at ORNL, the High Flux Isotope Reactor (HFIR) and the Spallation Neutron Source (SNS). Neutron sources are used to understand the factors that determine the properties and functions of matter and provide foundational insights for development of new materials and molecules with desired functionality. Thermal and cold neutrons are unique tools for the study of atomic-scale structure and dynamics. The wavelength and energy of neutrons are similar to interatomic distances and elementary excitations in materials, allowing atomic-resolution studies of structure and an investigation of material dynamics. As they carry no charge, neutrons can assess bulk properties. Critically, neutrons can discriminate different isotopes of the same element, making them a unique probe to resolve, for example, the location of hydrogen atoms in organic and biological materials via isotope substitution of deuterium for hydrogen. In addition, their magnetic moments allow investigation of magnetism, important for electronic technologies and systems.

HFIR generates neutrons via fission. It operates at 85 megawatts and provides state-of-the-art facilities for neutron scattering, isotope production, materials irradiation, and neutron activation analysis. It is the world's leading production source of elements heavier than plutonium for medical, industrial, and research applications. There are 12 neutron scattering beamlines in the user program at HFIR, which include state-of-the-art instruments for spectroscopy, diffraction, imaging, and small angle scattering. Operations funding in the FY 2027 Request will continue to support efforts to replace the beryllium reflector at HFIR.

SNS produces neutron beams using an accelerator to generate proton pulses that strike a mercury target. As a result of impacts, cascades of neutrons are produced in a process known as spallation. It is the world's brightest pulsed neutron facility and presently offers 19 beamlines. This is a world-leading suite of instruments for very high-resolution spectroscopy and diffraction, reflectometry, spin echo, and small angle spectrometers. Demand is strong for SNS instruments (3.6x oversubscribed) across a very broad range of scientific disciplines and technology areas. Current construction projects at SNS focus on maintaining world-leadership for neutron scattering.

At both HFIR and SNS, investments will advance data science, AI/ML, and computing hardware to support experiment planning, data analysis, and operational efficiency of the accelerator, reactor, and beamlines, in support of the Genesis Mission.

Nanoscale Science Research Centers

Developments at the nanoscale are foundational for delivery of remarkable scientific discoveries that transform our understanding of energy and matter. The Nanoscale Science Research Centers (NSRCs) provide the tools and capabilities for experimental and computational research that lead to technological innovations, new experimental tools, and new computational and modelling capabilities. NSRCs comprise a suite of unique tools and platforms, as well as expert scientific staff that enable and advance probing, manipulating, and assembling single atoms, clusters of atoms, and molecular structures for transformative science providing the foundation for the development of next-generation technologies.

The five NSRCs are the Center for Nanoscale Materials (CNM) at ANL, the Center for Functional Nanomaterials (CFN) at BNL, the Molecular Foundry (MF) at LBNL, the Center for Nanophase Materials Sciences (CNMS) at ORNL, and the Center for Integrated Nanotechnologies (CINT) at SNL and LANL. Each center has complementary expertise and capabilities for synthesis and assembly; theory, modeling, and simulation; imaging and spectroscopy; and nanostructure fabrication and integration. Selected thematic areas include quantum materials, next generation semiconductors, nanoscale photonics, catalysis, and soft/biological materials. These facilities include clean rooms, nanofabrication resources, one-of-a-kind signature tools, custom advanced instrumentation laboratories, and unique AI/ML and data science analytical capabilities, in support of the Genesis Mission. Each NSRC is co-located with other scientific user facilities and/or complementary capabilities, enabling users to more easily take advantage of these additional world-leading experimental and computational resources. Operating funds ensure cutting-edge research capabilities, technical support, and administration of the user program, which serves academic, government, and industry researchers.

Going forward, the NSRCs will continue to spearhead the development of flexible infrastructure and enabling capabilities for materials synthesis, device fabrication, metrology, modeling, and simulation. Investments will focus on evolving these capabilities to address the most pressing national needs, including QIS and next-generation microelectronics. Coordination across the NSRCs will grow to support development of cross-cutting, mutually beneficial techniques and facilitate access to complementary instrumentation.

Other Project Costs

Total project cost (TPC) is comprised of total estimated cost (TEC) and other projects costs (OPC). TEC includes post-Critical Decision (CD)-1 costs for engineering; the acquisition of equipment; and construction/fabrication. OPC represents all other costs incurred during the initiation and definition phase for planning, conceptual design, conceptual design, research, and development, and during the execution phase for startup and commissioning. OPC is always funded via operating funds.

Major Items of Equipment

BES supports MIE projects to ensure continual development and upgrade of scientific facility capabilities, by fabricating upgraded and new stand-alone instruments and capabilities at X-Ray Light Sources, High-Flux Neutron Sources, and NSRCs.

Research
This activity supports research from conceptual studies of accelerator physics and instrumentation to their translation into components or techniques that improve BES user facilities and maintain international competitiveness. Production of beams with increased average flux/brightness and detection tools responsive to high beam intensities are required components for the advancement of light and neutron sources. Research on superconducting undulators will focus on increasing magnetic fields and eliminating liquid helium use. Higher beam availability is needed to respond to the increasing number of facility users, requiring research on techniques to support multiple beamlines simultaneously. Detectors require higher computational capabilities per pixel, improved readout rates, radiation hardness, and better energy and temporal resolutions. Higher neutron-flux capabilities at the SNS demand tight control of beam losses and detectors designed for advanced neutron imaging. BES coordinates with the SC Offices of High Energy Physics and Nuclear Physics on crosscutting accelerator research and technology areas. BES accelerator R&D research is informed by recent workshops.[g] Investments will continue to support development of data science methods and AI/ML-enabled tools to address data and information challenges in support of the Genesis Mission.

[g] https://science.osti.gov/-/media/bes/pdf/brochures/2024/24-G00737-BRN-ABI-brochure-Final.pdf

**Activities and Explanation of Changes**

(dollars in thousands)

| FY 2026 Enacted | | FY 2027 Request | Explanation of Changes FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|
| **Scientific User Facilities (SUF)** | **$1,411,696** | **$1,459,363** | **+$47,667** |
| X-Ray Light Sources | $867,675 | $868,226 | +$551 |
| Funding supports operations at five BES light sources (LCLS, APS, ALS, NSLS-II, and SSRL). Development of AI/ML-enabled capabilities for computational techniques, and data analysis methods continues. | | The Request will support operations at five BES light sources (LCLS, APS, ALS, NSLS-II, and SSRL). Development of AI/ML-enabled capabilities for computational techniques, and data analysis methods will continue. | Funding will support LCLS, APS, ALS, NSLS-II and SSRL operations, accounting for inflation, supply chain costs, staffing support, remote operations, and costs for operation of new/upgraded capabilities. |
| High-Flux Neutron Sources | $297,993 | $380,026 | +$82,033 |
| Funding supports operations at SNS and HFIR (including ongoing funding for maintenance of HFIR with the beryllium reflector replacement). Development of AI/ML-enabled capabilities for computational techniques, and data analysis methods continues. | | The Request will support operations at SNS and HFIR (including ongoing funding for maintenance of HFIR with the beryllium reflector replacement). Development of AI/ML-enabled capabilities for computational techniques, and data analysis methods will continue. | Funding will support operations for SNS and HFIR, accounting for inflation, supply chain costs, staffing support, remote operations, and costs for operation of new/upgraded SNS capabilities. |
| Nanoscale Science Research Centers | $177,304 | $175,570 | -$1,734 |
| Funding provides funding for five NSRCs (CFN, CNM, CNMS, MF, and CINT). The NSRCs continue to develop infrastructure and capabilities to maintain world-leading synthesis, device fabrication, characterization, modeling, and simulation. | | The Request will provide funding for five NSRCs (CFN, CNM, CNMS, MF, and CINT). The NSRCs will continue to develop infrastructure and capabilities to maintain world-leading synthesis, device fabrication, characterization, modeling, and simulation. | Funding will support operations for the five NSRCs, accounting for inflation, supply chain costs, staffing support, remote operations, and other costs. |

(dollars in thousands)

| FY 2026 Enacted | | FY 2027 Request | Explanation of Changes FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|
| Other Project Costs | $23,100 | $5,000 | -$18,100 |
| Funding supports OPC for the LCLS-II-HE project at SLAC, the HFIR PVR project at ORNL, and the NEXT-III project at BNL. | | The Request will support OPC for the STS project at ORNL. | OPC will support conceptual design and planning for the STS project at ORNL. |
| Research | $45,624 | $30,541 | -$15,083 |
| Funding supports high-priority research activities for accelerators, detectors, and applications of AI/ML and other data science techniques to accelerator optimization, control, prognostics, and data analysis to help advance the goals of the Genesis Mission. Research emphasizes transformative advances in accelerator science and technology that lead to significant improvements in very high brightness and high current electron sources and in high intensity proton sources. | | The Request will support high-priority research activities for accelerators, detectors, and development and application of AI/ML and other data science techniques to accelerator optimization, control, prognostics, and data analysis to help advance the goals of the Genesis Mission. Research will emphasize transformative advances in accelerator science and technology that lead to significant improvements in very high brightness and high current electron sources and in high intensity proton sources. | Funding will support investment in future accelerator and detector technologies to continue to provide the world's most comprehensive and advanced accelerator-based facilities for scientific research. Funding will continue investments in data science and AI/ML methods and tools to address data and information challenges at the BES user facilities, including accelerator control and experiment automation with real time data analysis. |

*Note:*

- *As part of the FY 2026 Appropriation, the High-Flux Neutron Sources received $150,000,000 in prior year funds not included in the FY 2026 Enacted table above.*

**Description**

Accelerator-based x-ray light sources, accelerator-based pulsed neutron sources, reactor-based neutron sources, and nanoscale science research centers are essential user facilities that enable critical DOE mission-driven science, including research in support of next-generation energy technologies and other critical and emerging technologies (e.g., in quantum information science, microelectronics, and critical minerals) vital to U.S. economic and national security. These user facilities provide the academic, laboratory, and industrial research communities with the tools to fabricate, characterize, and develop new materials and chemical processes to advance basic and applied research across multiple scientific disciplines. Funding for the construction of new user facilities and upgrades to existing user facilities are essential to maintaining U.S. scientific leadership.

<u>21-SC-10, Cryomodule Repair & Maintenance Facility (CRMF), SLAC</u>

The CRMF project will provide a much-needed capability to maintain, repair, and test superconducting radiofrequency (SRF) accelerator components. These components include but are not limited to superconducting RF cavities and cryomodules that make up the new superconducting accelerator being constructed by the now complete LCLS-II project and ongoing LCLS-II-HE project, high brightness electron injectors, and superconducting undulators. The facility will provide for the full disassembly and repair of the SRF cryomodule; the ability to disassemble, clean, and reassemble the SRF cavities and cavity string; testing capabilities for the full cryomodule; and separate testing capabilities for individual SRF cavities. To accomplish this, the project requires a building of up to 21,000 gross square feet to contain the necessary equipment, tools, and fixtures, as well as a control room, clean rooms, and liquid helium distribution system. The project received CD-1, Approve Alternative Selection and Cost Range, on October 11, 2023, with a current TPC range of $70,000,000–$98,000,000, but is actively being re-evaluated due to current construction market conditions. A CD-3A, Approve Long Lead Procurements, is expected in 3Q FY 2026.

<u>19-SC-14, Second Target Station (STS), ORNL</u>

The STS project will expand SNS capabilities for neutron scattering research by exploiting 0.7 MW of the 2.8 MW SNS accelerator proton beam power enabled by the Proton Power Upgrade (PPU) project. The STS will provide high brightness, cold neutrons complementary to the first target station (FTS). Instruments will feature advanced neutron optics, optimized geometry, and high resolution, advanced detectors, enabling new research opportunities in quantum materials, materials science and engineering, chemistry and catalysis, soft matter and polymers, and biological systems. The project received CD-1, Approve Alternative Selection and Cost Range, on November 23, 2020, establishing the approved TPC range of $1,800,000,000–$3,000,000,000. A combined CD-2/3, Approve Performance Baseline and Approve Start of Construction, is expected in 4Q FY 2026.

<u>18-SC-13, Linac Coherent Light Source-II-High Energy (LCLS-II-HE), SLAC</u>

The LCLS-II-HE project will expand the capabilities of the LCLS to maintain U.S. leadership in ultrafast and ultrabright x-ray science. The project will increase the energy of the superconducting linac from 4 GeV to 8 GeV and thereby expand the high repetition rate operation (1 million pulses per second) into the hard x-ray regime (5-12 keV). This will transform the community's ability to interrogate and advance understanding of complex matter at the atomic scale on ultrafast time scales with elemental specificity relevant to real world systems, including quantum materials, functional materials, catalysts, and biological molecules. The project received a combined CD-2/3, Approve Performance Baseline and Approve Start of Construction, on September 19, 2024, establishing a TPC of $716,000,000. CD-4, Approve Start of Operations, is expected 2Q FY 2028.

18-SC-12, Advanced Light Source Upgrade ALS-U, LBNL

The ALS-U project will upgrade the existing ALS facility by replacing the existing electron storage ring with a new electron storage ring based on a multi-bend achromat lattice design, which will provide a soft x-ray source that is up to 1,000 times brighter and with a significantly higher coherent flux fraction. ALS-U will leverage two decades of investments in scientific tools at the ALS by making use of the existing beamlines and infrastructure. ALS-U will ensure that the ALS facility remains a world leader in soft x-ray science. The project received CD-3, Approve Start of Construction, on November 10, 2022, with an original Total Project Cost (TPC) of $590,000,000. The ALS-U project is currently working towards rebaselining, which will establish a new TPC and schedule no later than 3Q FY 2026. CD-4, Approve Project Completion, is currently expected 4Q of FY 2030.

## Activities and Explanation of Changes

(dollars in thousands)

| FY 2026 Enacted | | FY 2027 Request | Explanation of Changes FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|
| **Construction** | **$232,843** | **$143,800** | **-$89,043** |
| 21-SC-10, Cryomodule Repair & Maintenance Facility (CRMF), SLAC | $20,000 | $7,800 | -$12,200 |
| Funding supports the continuation of activities required to secure a combined CD-3A approval and initiation of Long-lead Procurements (LLPs), expected in 3Q FY 2026. | | The Request will support ongoing construction of the building and conventional facilities and initiate procurement of key technical systems and facilitate procurement activities for the cryogenic system. | Final funding for this project is requested in FY 2027. |
| 19-SC-14, Second Target Station (STS), ORNL | $52,000 | $80,000 | +$28,000 |
| Funding continues the activities, focusing on the highest priority accelerator and target designs in parallel with advancing long lead procurement activity for civil construction site preparation upon associated CD approvals. | | The Request will support planning, R&D, design, engineering, prototyping, fabrication, procurement, and testing to advance the highest priority activities with emphasis on the target monolith, bunker, and associated controls system designs. | Funding will advance progress on the STS project. |
| 18-SC-13, Linac Coherent Light Source-II-High Energy (LCLS-II-HE), SLAC | $99,343 | $6,000 | -$93,343 |
| Funding continues the construction and installation contracts, complete the pre-staging activities, and start installation activities during the year-long LCLS Dark Time in FY 2026. | | The Request will continue planning, R&D, design, engineering, prototyping, and testing, procurement, and construction to advance the highest priority activities with the emphasis on continuing the construction and installation contracts, including the infrastructure systems for cryogenic transfer lines, cryomodules, safety systems, and the experimental hutch. | Final funding for this project is requested in FY 2027. |

(dollars in thousands)

| FY 2026 Enacted | FY 2027 Request | Explanation of Changes FY 2027 Request vs FY 2026 Enacted |
|---|---|---|
| 18-SC-12, Advanced Light Source Upgrade ALS-U, LBNL $50,000 | $50,000 | $ — |
| Funding advances installation of the Accumulator ring in the tunnel and the beamline front end engineering and system engineering as well as begin preparation activities for the dark time Storage Ring installation. | The Request will enable continued planning, design, engineering, prototyping, and testing to advance the highest priority activities with emphasis on Accumulator Ring commissioning, production of the Storage Ring rafts, completing the beamline front-end engineering, and advancing beamline systems engineering. | Funding will advance progress on the ALS-U project. |

## Basic Energy Sciences
## Capital Summary

(dollars in thousands)

| | Total | Prior Years | FY 2025 Enacted | FY 2026 Enacted | FY 2027 Request | FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|---|---|---|
| **Capital Operating Expenses** | | | | | | |
| Capital Equipment | N/A | N/A | 29,590 | 47,693 | 79,783 | +32,090 |
| Minor Construction Activities | | | | | | |
| General Plant Projects | N/A | N/A | 10,900 | 46,361 | 33,039 | -13,322 |
| Accelerator Improvement Projects | N/A | N/A | 19,605 | 60,427 | 88,562 | +28,135 |
| **Total, Capital Operating Expenses** | **N/A** | **N/A** | **60,095** | **154,481** | **201,384** | **+46,903** |

## Capital Equipment

| | (dollars in thousands) | | | | | |
|---|---|---|---|---|---|---|
| | **Total** | **Prior Years** | **FY 2025 Enacted** | **FY 2026 Enacted** | **FY 2027 Request** | **FY 2027 Request vs FY 2026 Enacted** |
| **Capital Equipment** | | | | | | |
| Major Items of Equipment | | | | | | |
| Total, MIEs | N/A | N/A | – | – | – | – |
| Total, Non-MIE Capital Equipment | N/A | N/A | 29,590 | 47,693 | 79,783 | +32,090 |
| **Total, Capital Equipment** | **N/A** | **N/A** | **29,590** | **47,693** | **79,783** | **+32,090** |

*Note:*
- *The Capital Equipment table includes MIEs with a Total Estimated Cost (TEC) > $10M.*

## Minor Construction Activities

(dollars in thousands)

| | Total | Prior Years | FY 2025 Enacted | FY 2026 Enacted | FY 2027 Request | FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|---|---|---|
| **General Plant Projects (GPP)** | | | | | | |
| GPPs (greater than $5M and $34M or less) | | | | | | |
| Technical and Storage Space | 9,528 | – | – | 9,528 | – | -9,528 |
| SLAC, SSRL, B120 Expansion for Beamline Upgrade | 27,700 | – | – | 1,700 | 26,000 | +24,300 |
| SLAC, LCLS, Far Experimental Hall | 25,000 | – | – | 25,000 | – | -25,000 |
| Spallation Neutron Source Sample Environmental Building | 8,594 | – | – | 8,594 | – | -8,594 |
| HFIR Helium Recovery System | 539 | – | – | 539 | – | -539 |
| Total GPPs (greater than $5M and $34M or less) | 71,361 | N/A | – | 45,361 | 26,000 | -19,361 |
| Total GPPs $5M or less | N/A | N/A | 10,900 | 1,000 | 7,039 | +6,039 |
| **Total, General Plant Projects (GPP)** | **N/A** | **N/A** | **10,900** | **46,361** | **33,039** | **-13,322** |
| **Accelerator Improvement Projects (AIP)** | | | | | | |
| AIPs (greater than $5M and $34M or less) | | | | | | |
| DISCOVER, Spallation Neutron Source | 5,000 | – | – | – | 5,000 | +5,000 |
| 3rd Harmonic Cavity, National Synchrotron Light Source-II | 10,600 | – | – | 5,300 | 5,300 | – |
| New SAX/WAX Beamline, LBNL | 9,390 | 1,890 | – | 7,500 | – | -7,500 |
| ALS Beamline Readiness | 6,000 | – | – | 6,000 | – | -6,000 |
| ALS Front End Readiness | 6,000 | – | – | 6,000 | – | -6,000 |
| HFIR HBRR MANTA | 8,525 | – | – | 753 | 7,772 | +7,019 |
| HFIR HBRR MARS | 14,855 | – | – | 1,282 | 13,573 | +12,291 |
| LOB 742 #1 National Synchrotron Light Source II at BNL | 21,158 | – | – | – | 21,158 | +21,158 |
| Total AIPs (greater than $5M and $34M or less) | 81,528 | 1,890 | – | 26,835 | 52,803 | +25,968 |
| Total AIPs $5M or less | N/A | N/A | 19,605 | 33,592 | 35,759 | +2,167 |
| **Total, Accelerator Improvement Projects (AIP)** | **N/A** | **N/A** | **19,605** | **60,427** | **88,562** | **+28,135** |
| **Total, Minor Construction Activities** | **N/A** | **N/A** | **30,505** | **106,788** | **121,601** | **+14,813** |

*Notes:*

- *GPP activities $5M and less include design and construction for additions and/or improvements to land, buildings, replacements or addition to roads, and general area improvements. AIP activities $5M and less include minor construction at an existing accelerator facility.*
- *The Total funding for the 3rd Harmonic Cavity (AIP) project is $5,300,000. This project, originally requested in FY 2024, has been deferred until FY 2027.*

- *The Total funding for the SAX/WAX Beamline (AIP) project is $9,000,000. This project, originally requested in FY 2024, has been deferred with revised scope until FY 2026.*
- *The Total funding for the NSLS-II Technical and Storage Space (GPP) project is $9,528,000. This project, originally requested in FY 2025, has been deferred until FY 2026.*
- *The SLAC B120 Expansion for Beamline Upgrade (GPP) project originally requested in FY 2025 has been delayed. Design efforts are requested in FY 2026.*
- *The Total funding for the Far Experimental Hall (GPP) project is $28,400,000. This project, originally requested in FY 2025, has been deferred until FY 2026.*
- *The Total funding for the HFIR Helium Recovery System (GPP) project is $7,440,000. Design efforts are requested in FY 2026.*
- *The Total funding for the ALS Beamline Readiness (AIP) project is $7,500,000. Design efforts will be fully funded in FY 2025 and the remaining funds are requested in FY 2026.*
- *The Total funding for the ALS Front End Readiness (AIP) project is $7,500,000. Design efforts will be fully funded in FY 2025 and the remaining funds are requested in FY 2026.*
- *The Total funding for the HFIR HBRR MANTA (AIP) project is $8,525,000. Design efforts are requested in FY 2026 and the remaining funds are requested in FY 2027.*
- *The Total funding for the HFIR HBRR MARS (AIP) project is $14,855,000. Design efforts are requested in FY 2026 and the remaining funds are requested in FY 2027.*

(dollars in thousands)

| | Total | Prior Years | FY 2025 Enacted | FY 2026 Enacted | FY 2027 Request | FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|---|---|---|
| **24-SC-10, HFIR Pressure Vessel Replacement (PVR), ORNL** | | | | | | |
| Total Estimated Cost (TEC) | 16,000 | 4,000 | 6,000 | 6,000 | - | -6,000 |
| Other Project Cost (OPC) | 27,000 | 12,000 | 5,000 | 10,000 | - | -10,000 |
| **Total Project Cost (TPC)** | **43,000** | **16,000** | **11,000** | **16,000** | **-** | **-16,000** |
| **24-SC-12, NSLS-II Experimental Tools - III (NEXT-III), BNL** | | | | | | |
| Total Estimated Cost (TEC) | 13,556 | 2,556 | 5,500 | 5,500 | - | -5,500 |
| Other Project Cost (OPC) | 18,100 | 5,500 | 4,500 | 8,100 | - | -8,100 |
| **Total Project Cost (TPC)** | **31,656** | **8,056** | **10,000** | **13,600** | **-** | **-13,600** |
| **21-SC-10, Cryomodule Repair & Maintenance Facility (CRMF), SLAC** | | | | | | |
| Total Estimated Cost (TEC) | 88,800 | 41,000 | 20,000 | 20,000 | 7,800 | -12,200 |
| Other Project Cost (OPC) | 5,700 | 5,700 | - | - | - | - |
| **Total Project Cost (TPC)** | **94,500** | **46,700** | **20,000** | **20,000** | **7,800** | **-12,200** |
| **19-SC-14, Second Target Station (STS), ORNL** | | | | | | |
| Total Estimated Cost (TEC) | 1,930,727 | 208,700 | 52,000 | 52,000 | 80,000 | +28,000 |
| Other Project Cost (OPC) | 69,273 | 52,845 | - | - | 5,000 | +5,000 |
| **Total Project Cost (TPC)** | **2,000,000** | **261,545** | **52,000** | **52,000** | **85,000** | **+33,000** |
| **18-SC-12, Advanced Light Source Upgrade (ALS-U), LBNL** | | | | | | |
| Total Estimated Cost (TEC) | TBD | 562,000 | 50,000 | 50,000 | 50,000 | - |
| Other Project Cost (OPC) | TBD | 28,000 | - | - | - | - |
| **Total Project Cost (TPC)** | **TBD** | **590,000** | **50,000** | **50,000** | **50,000** | **-** |
| **18-SC-13, Linac Coherent Light Source-II-High Energy (LCLS-II-HE), SLAC** | | | | | | |
| Total Estimated Cost (TEC) | 684,000 | 478,657 | 100,000 | 99,343 | 6,000 | -93,343 |
| Other Project Cost (OPC) | 32,000 | 27,000 | - | 5,000 | - | -5,000 |
| **Total Project Cost (TPC)** | **716,000** | **505,657** | **100,000** | **104,343** | **6,000** | **-98,343** |
| **Total, Construction** | | | | | | |
| **Total Estimated Cost (TEC)** | **N/A** | **N/A** | **233,500** | **232,843** | **143,800** | **-89,043** |
| **Other Project Cost (OPC)** | **N/A** | **N/A** | **9,500** | **23,100** | **5,000** | **-18,100** |
| **Total Project Cost (TPC)** | **N/A** | **N/A** | **243,000** | **255,943** | **148,800** | **-107,143** |

*Note:*
- *The project is currently working on a new cost and schedule analysis that will inform a new baseline TPC in FY 2026.*

## Basic Energy Sciences
## Scientific User Facility Operations

The treatment of user facilities is distinguished between two types: TYPE A facilities that offer users resources dependent on a single, large-scale machine; TYPE B facilities that offer users a suite of resources that is not dependent on a single, large-scale machine.

(dollars in thousands)

| | FY 2025 Enacted | FY 2025 Current | FY 2026 Enacted | FY 2027 Request | FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|---|---|
| **Scientific User Facilities - Type A** | | | | | |
| **Advanced Light Source** | **118,439** | **119,665** | **133,698** | **126,617** | **-7,081** |
| Number of Users | 1,550 | 1,609 | 776 | 820 | +44 |
| Achieved Operating Hours | – | 2,583 | – | – | – |
| Planned Operating Hours | 2,768 | 2,768 | 1,850 | 1,515 | -335 |
| **Advanced Photon Source** | **201,758** | **201,758** | **224,442** | **213,956** | **-10,486** |
| Number of Users | 2,736 | 2,140 | 4,400 | 3,280 | -1,120 |
| Achieved Operating Hours | – | 4,809 | – | – | – |
| Planned Operating Hours | 4,774 | 4,774 | 4,000 | 4,100 | +100 |
| **National Synchrotron Light Source II** | **158,134** | **158,134** | **189,038** | **191,730** | **+2,692** |
| Number of Users | 2,500 | 2,330 | 1,840 | 1,968 | +128 |
| Achieved Operating Hours | – | 4,783 | – | – | – |
| Planned Operating Hours | 4,900 | 4,900 | 4,000 | 4,100 | +100 |
| **Stanford Synchrotron Radiation Light Source** | **69,000** | **69,000** | **86,120** | **92,465** | **+6,345** |
| Number of Users | 1,900 | 1,529 | 14,520 | 1,558 | -12,962 |
| Achieved Operating Hours | – | 5,106 | – | – | – |
| Planned Operating Hours | 5,116 | 5,116 | 4,080 | 4,100 | +20 |
| **Linac Coherent Light Source** | **231,534** | **235,534** | **234,377** | **243,458** | **+9,081** |
| Number of Users | 1,000 | 1,092 | 800 | 820 | +20 |
| Achieved Operating Hours | – | 7,053 | – | – | – |
| Planned Operating Hours | 7,500 | 7,500 | 4,360 | 4,510 | +150 |
| **Spallation Neutron Source** | **230,741** | **225,741** | **153,213** | **211,163** | **+57,950** |
| Number of Users | 1,082 | 1,059 | 743 | 1,701 | +958 |
| Achieved Operating Hours | – | 4,364 | – | – | – |
| Planned Operating Hours | 4,329 | 4,329 | 3,956 | 4,100 | +144 |
| **High Flux Isotope Reactor** | **142,626** | **147,626** | **144,780** | **168,863** | **+24,083** |
| Number of Users | 403 | 399 | 442 | 882 | +440 |
| Achieved Operating Hours | – | 1,383 | – | – | – |
| Planned Operating Hours | 2,250 | 2,250 | 2,924 | 2,296 | -628 |
| **Scientific User Facilities - Type B** | | | | | |

(dollars in thousands)

| | FY 2025 Enacted | FY 2025 Current | FY 2026 Enacted | FY 2027 Request | FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|---|---|
| **Center for Nanoscale Materials** | **32,445** | **32,445** | **36,367** | **35,765** | **-602** |
| Number of Users | 885 | 1,001 | 830 | 820 | -10 |
| **Center for Functional Nanomaterials** | **27,663** | **27,663** | **30,130** | **30,161** | **+31** |
| Number of Users | 750 | 739 | 701 | 693 | -8 |
| **Molecular Foundry** | **39,273** | **39,273** | **46,529** | **46,253** | **-276** |
| Number of Users | 1,150 | 1,135 | 1,132 | 1,118 | -14 |
| **Center for Nanophase Materials Sciences** | **30,743** | **30,743** | **34,013** | **33,820** | **-193** |
| Number of Users | 850 | 957 | 689 | 681 | -8 |
| **Center for Integrated Nanotechnologies** | **29,106** | **29,106** | **30,265** | **29,571** | **-694** |
| Number of Users | 1,100 | 949 | 913 | 902 | -11 |
| **Total, Facilities** | **1,311,462** | **1,316,688** | **1,342,972** | **1,423,822** | **+80,850** |
| Number of Users | 15,906 | 14,939 | 27,786 | 15,243 | -12,543 |
| Achieved Operating Hours | – | 30,081 | – | – | – |
| Planned Operating Hours | 31,637 | 31,637 | 25,170 | 24,721 | -449 |

*Note:*

- *Percent optimal operations defines what is achieved at this funding level. This includes staffing, up-to-date equipment and software, operations and maintenance, and appropriate investments to maintain world leadership.*

## Scientific Employment

| | FY 2025 Enacted | FY 2026 Enacted | FY 2027 Request | FY 2027 Request vs FY 2026 Enacted |
|---|---|---|---|---|
| Number of Permanent Ph.Ds (FTEs) | 5,530 | 4,930 | 3,890 | -1,040 |
| Number of Postdoctoral Associates (FTEs) | 1,510 | 1,290 | 880 | -410 |
| Number of Graduate Students (FTEs) | 2,340 | 1,990 | 1,320 | -670 |
| Number of Other Scientific Employment (FTEs) | 3,520 | 3,250 | 2,850 | -400 |
| **Total Scientific Employment (FTEs)** | **12,900** | **11,460** | **8,940** | **-2,520** |

*Note:*
- *Other Scientific Employment (FTEs) includes technicians, engineers, computer professionals and other support staff.*

**21-SC-10, Cryomodule Repair & Maintenance Facility (CRMF), SLAC**
**SLAC National Accelerator Laboratory, SLAC**
**Project is for Design and Construction**

## 1. Summary, Significant Changes, and Schedule and Cost History

**Summary**

The Cryomodule Repair and Maintenance Facility (CRMF) project will provide a much-needed capability to maintain, repair, and test superconducting radiofrequency (SRF) accelerator components. The FY 2027 Request for the CRMF project at SLAC National Accelerator Laboratory is $7,800,000 of Total Estimated Cost (TEC) funding. This project has a preliminary Total Project Cost (TPC) range of $70,000,000 to $98,000,000. This cost range encompasses the most feasible preliminary alternatives as of CD-1 approval in FY 2024. As the design of this project has matured, the current preliminary TPC estimate for this project of $94,500,000 is being evaluated considering current construction market conditions.

**Significant Changes**

CRMF was initiated in FY 2021. The most recent DOE Order 413.3B approved Critical Decision (CD) is CD-1, Approve Alternative Selection and Cost Range, which was approved on October 11, 2023. On March 27, 2025, the Secretary of Energy issued a memorandum amending the project TPC thresholds in DOE Order 413.3B, resulting in the delegation of the CRMF project to the SLAC laboratory director. As the design has matured and cost estimates have grown, consistent with materials and labor inflation in the region, the $94,500,000 TPC estimate may not contain sufficient contingency for covering the remaining risks.

FY 2025 funding supported the completion of design work for the construction scope, including the building and conventional facilities, while advancing the designs and specifications for the technical systems including the superconducting radiofrequency (SRF) equipment, controls, and cryogenics capabilities. The FY 2026 Enacted supports the next building construction phase including the issuing of the Request for Proposals (RFP) and initiation of the construction contract. CD-3A will be requested in FY 2026 for Long-lead Procurement (LLP) of cryogenic, safety, and radio frequency equipment and systems. The FY 2027 Request will support ongoing construction of the building and conventional facilities and continue planning, design, engineering, prototyping, testing, fabrication, and installation to advance the highest priority activities with emphasis on initiating procurement of key technical systems and facilitating procurement activities for the cryogenic system.

A Federal Project Director, certified to Level II, has been assigned to this project.

**Critical Milestone History**

| Fiscal Year | CD-0 | Conceptual Design Complete | CD-1 | CD-2 | Final Design Complete | CD-3 | CD-4 |
|---|---|---|---|---|---|---|---|
| FY 2027 | 12/6/19 | 8/24/23 | 10/11/23 | 1Q FY 2027 | 4Q FY 2026 | 1Q FY 2027 | 3Q FY 2030 |

**CD-0** – Approve Mission Need for a construction project with a conceptual scope and cost range; **Conceptual Design Complete** – Actual date the conceptual design was completed (if applicable); **CD-1** – Approve Alternative Selection and Cost Range; **CD-2** – Approve Performance Baseline; **Final Design Complete** – Estimated/Actual date the project design will be/was complete(d); **CD-3** – Approve Start of Construction; **D&D Complete** – Completion of D&D work; **CD-4** – Approve Start of Operations or Project Closeout.

| Fiscal Year | Performance Baseline Validation | CD-3A |
|---|---|---|
| FY 2027 | 1Q FY 2027 | 3Q FY 2026 |

**CD-3A** – Approve Long-lead Procurement (LLP) of cryogenic, safety, and radio frequency equipment and systems

**Project Cost History**

(dollars in thousands)

| Fiscal Year | TEC, Design | TEC, Construction | TEC, Total | OPC, Except D&D | OPC, Total | TPC |
|---|---|---|---|---|---|---|
| FY 2026 | 20,700 | 68,100 | 88,800 | 5,700 | 5,700 | 94,500 |
| FY 2027 | 21,100 | 67,700 | 88,800 | 5,700 | 5,700 | 94,500 |

*Note:*
- *This project has not received CD-2 approval; therefore, funding estimates are preliminary.*

## 2. Project Scope and Justification

**Scope**

The preliminary scope of the CRMF project is to construct a building equipped with clean rooms, high pressure rinsing capabilities, handling tools, and fixtures to support the repair, maintenance, and testing of SRF linear accelerator (linac) components. These components may include, but are not limited to, SRF cavities and cryomodules, future capabilities for high brightness electron injectors, and superconducting undulators. The requirements will be further refined as the project matures.

**Justification**

Through two BES construction projects at SLAC, LCLS-II (completed) and LCLS-II-HE (well underway), SC is making over $1,800,000,000 of capital investment in those projects with improved SRF linac performance to support researchers advancing the scientific discovery and technology development missions of DOE. The LCLS-II project provided a 4 GeV SRF-based linear accelerator containing 35 SRF cryomodules (CMs) to accelerate the electrons. The LCLS-II-HE project will increase the energy of the superconducting linac to 8 GeV by providing an additional 23 SRF CMs of a similar design to those installed by the LCLS-II project but operating at a higher accelerating gradient. SLAC has partnered with Fermi National Accelerator Laboratory (FNAL) and the Thomas Jefferson National Accelerator Facility (TJNAF) to provide the accelerating CMs. The specialized CM fabrication, assembly, and test capabilities are currently available at FNAL and TJNAF, but not at SLAC. Therefore, to make any repairs, SLAC must send the CMs cross country back to either FNAL or TJNAF at an increased risk of damage, cost, and schedule delays. This situation also requires that either FNAL or TJNAF have the maintenance facility capacity and trained personnel available when needed. Historically, these facilities are actively working on CMs for other SC projects, and maintenance or repairs typically require scheduling 6 to 12 months in advance.

The CRMF is designed to meet these challenges by providing SLAC with the capability to repair, maintain, and test the cryomodules and components that make up the upgraded LCLS superconducting linac.

The project is delegated to the SLAC laboratory director to manage and will be executed using a tailored approach defined in the preliminary project execution plan (PPEP) while maintaining best practices and principles in DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*.

Key Performance Parameters (KPPs)

The KPPs are preliminary and may change as the project continues towards CD-2. At CD-2 approval, the KPPs will be part of the approved performance baseline. The Threshold KPPs represent the minimum acceptable performance that the project must achieve. The Objective KPPs represent the desired project performance. Achievement of the Threshold KPPs will be a prerequisite for approval of CD-4, Project Completion.

| Capability | Threshold | Objective |
|---|---|---|
| Disassembly, repair, and re-assembly of a 1.3 gigahertz (GHz) cryomodule | Install CM assembly tooling and ISO 4 Cleanroom | Same as threshold |
| 1.3 GHz cavity qualification tests in CM | One 7 kilowatt (kW) Solid State Amplifier (SSA) installed with controls and safety systems operational | Eight 7kW SSA installed |
| High-pressure-rinsing (HPR) of 1.3 GHz cavity | Space for High-Pressure Rinse (HPR) | Installation of HPR and ultrapure water systems |
| Cryogenic cooling | Delivery of sufficient 4.5 kelvin (K) liquid Helium (LHe) to sustain 100W of heat load at 2 K for 8 hours | Delivery of sufficient 4.5 Kelvin LHe to sustain 250W of heat load at 2 K for 8 hours |
| Infrastructure | 18,000 GSF building | 21,000 GSF building |
| Infrastructure for testing of 1.3 GHz cavity & cryomodule | Shielded enclosure and 880 GSF dedicated area for vertical test stand equipment and construction of two vertical pits | Same as threshold |
| Area for SRF-related equipment | Space for ISO 4 cleanroom and CM assembly workstations | Additional space for future SRF shielded enclosure |

**3. Financial Schedule**

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | | |
| Design (TEC) | | | | |
| Prior Years | 2,540 | 2,540 | — | — |
| Prior Years - IRA Supp. | 18,560 | 18,560 | — | 5,954 |
| FY 2025 | — | — | — | 7,398 |
| FY 2026 | — | — | 2,540 | 5,208 |
| **Total, Design (TEC)** | **21,100** | **21,100** | **2,540** | **18,560** |
| Construction (TEC) | | | | |
| Prior Years | 18,460 | 18,460 | — | — |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | | |
| Prior Years - IRA Supp. | 1,440 | 1,440 | — | — |
| FY 2025 | 20,000 | 20,000 | — | — |
| FY 2026 | 20,000 | 20,000 | 25,388 | 1,440 |
| FY 2027 | 7,800 | 7,800 | 36,533 | — |
| Outyears | — | — | 4,339 | — |
| **Total, Construction (TEC)** | **67,700** | **67,700** | **66,260** | **1,440** |
| Total Estimated Cost (TEC) | | | | |
| Prior Years | 21,000 | 21,000 | — | — |
| Prior Years - IRA Supp. | 20,000 | 20,000 | — | 5,954 |
| FY 2025 | 20,000 | 20,000 | — | 7,398 |
| FY 2026 | 20,000 | 20,000 | 27,928 | 6,648 |
| FY 2027 | 7,800 | 7,800 | 36,533 | — |
| Outyears | — | — | 4,339 | — |
| **Total, Total Estimated Cost (TEC)** | **88,800** | **88,800** | **68,800** | **20,000** |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Other Project Cost (OPC)** | | | | |
| Prior Years | 5,000 | 5,000 | 3,089 | – |
| Prior Years - IRA Supp. | 700 | 700 | – | 700 |
| FY 2025 | – | – | 8 | – |
| FY 2027 | – | – | 6 | – |
| Outyears | – | – | 1,897 | – |
| **Total, Other Project Cost (OPC)** | **5,700** | **5,700** | **5,000** | **700** |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Project Cost (TPC)** | | | | |
| Prior Years | 26,000 | 26,000 | 3,089 | – |
| Prior Years - IRA Supp. | 20,700 | 20,700 | – | 6,654 |
| FY 2025 | 20,000 | 20,000 | 8 | 7,398 |
| FY 2026 | 20,000 | 20,000 | 27,928 | 6,648 |
| FY 2027 | 7,800 | 7,800 | 36,539 | – |
| Outyears | – | – | 6,236 | – |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Project Cost (TPC)** | | | | |
| **Total, TPC** | **94,500** | **94,500** | **73,800** | **20,700** |

**4. Details of Project Cost Estimate**

(dollars in thousands)

| | Current Total Estimate | Previous Total Estimate | Original Validated Baseline |
|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | |
| Design | 20,100 | 17,000 | **N/A** |
| Design - Contingency | 1,000 | 3,700 | **N/A** |
| **Total, Design (TEC)** | **21,100** | **20,700** | **N/A** |
| Construction_No_Detail | 38,900 | 31,700 | **N/A** |
| Equipment | 27,000 | 22,600 | **N/A** |
| Construction Contingency | 1,800 | 13,800 | **N/A** |
| **Total, Construction (TEC)** | **67,700** | **68,100** | **N/A** |
| **Total, TEC** | **88,800** | **88,800** | **N/A** |
| *Contingency, TEC* | *2,800* | *17,500* | ***N/A*** |
| **Other Project Cost (OPC)** | | | |
| OPC, Except D&D | 740 | N/A | **N/A** |
| Conceptual Planning | 500 | 500 | **N/A** |
| Conceptual Design | 2,805 | 2,800 | **N/A** |
| Start-up | 500 | 1,200 | **N/A** |
| OPC - Contingency | 1,155 | 1,200 | **N/A** |
| **Total, Except D&D (OPC)** | **5,700** | **5,700** | **N/A** |
| **Total, OPC** | **5,700** | **5,700** | **N/A** |
| *Contingency, OPC* | *1,155* | *1,200* | ***N/A*** |
| **Total, TPC** | **94,500** | **94,500** | **N/A** |
| ***Total, Contingency (TEC+OPC)*** | ***3,955*** | ***18,700*** | ***N/A*** |

**5. Schedule of Appropriations Requests**

(dollars in thousands)

| Fiscal Year | Type | Prior Years | FY 2025 | FY 2026 | FY 2027 | Outyears | Total |
|---|---|---|---|---|---|---|---|
| FY 2026 | TEC | 41,000 | 20,000 | 20,000 | — | 7,800 | 88,800 |
| | OPC | 5,700 | — | — | — | — | 5,700 |
| | TPC | 46,700 | 20,000 | 20,000 | — | 7,800 | 94,500 |
| FY 2027 | TEC | 41,000 | 20,000 | 20,000 | 7,800 | — | 88,800 |
| | OPC | 5,700 | — | — | — | — | 5,700 |
| | TPC | 46,700 | 20,000 | 20,000 | 7,800 | — | 94,500 |

*Note:*
- *This project has not received CD-2 approval; therefore, funding estimates are preliminary.*

### 6. Related Operations and Maintenance Funding Requirements

| | |
|---|---|
| Start of Operation or Beneficial Occupancy | 3Q FY 2030 |
| Expected Useful Life | 25 years |
| Expected Future Start of D&D of this capital asset | 3Q FY 2055 |

Related Funding Requirements
(dollars in thousands)

| | **Annual Costs** | | **Life Cycle Costs** | |
|---|---|---|---|---|
| | **Previous Total Estimate** | **Current Total Estimate** | **Previous Total Estimate** | **Current Total Estimate** |
| Operations, Maintenance and Repair | 5,500 | 5,500 | 137,500 | 137,500 |

### 7. D&D Information

At this stage of project planning and development, SC is planning to construct a new building up to 21,000 gross square feet as part of this project.

| | **Square Feet** |
|---|---|
| New area being constructed by this project at SLAC | 21,000 |
| Area of D&D in this project at SLAC | — |
| Area at SLAC to be transferred, sold, and/or D&D outside the project, including area previously "banked" | 21,000 |
| Area of D&D in this project at other sites | — |
| Area at other sites to be transferred, sold, and/or D&D outside the project, including area previously "banked" | — |
| Total area eliminated | — |

### 8. Acquisition Approach

The CRMF Project will be sited at SLAC and is being acquired under the existing DOE M&O contract with Stanford University. SLAC has delivered several large construction projects and research facilities and has the requisite expertise to successfully deliver CRMF. SLAC, with support from partner laboratory expert staff, will complete the design of the technical systems. The acquisition of the CRMF building will be based on the design-bid-build methodology. Selected subcontracted vendors, pre-qualified with the necessary capabilities, will fabricate the technical equipment. SLAC will competitively bid and award all contracts based on best value to the government.

SC and the M&O will draw from the lessons learned from other SC projects and other similar facilities in planning and executing the CRMF project. SC will evaluate the M&O contractor's performance through the annual laboratory performance appraisal process.

**19-SC-14, Second Target Station (STS), ORNL**
**Oak Ridge National Laboratory, ORNL**
**Project is for Design and Construction**

## 1. Summary, Significant Changes, and Schedule and Cost History

**Summary**

The STS project will design and build a new, very high brightness cold[h] neutron scattering capability to maintain U.S. competitiveness in providing world-leading neutron scattering user facilities. STS will offer unique beamlines to advance our understanding of the fundamental aspects of the natural world. The FY 2027 Request for the STS project is $80,000,000 of Total Estimated Cost (TEC) funding. This project has a preliminary Total Project Cost (TPC) range of $1,800,000,000 to $3,000,000,000. This cost range encompasses the most feasible preliminary alternatives. The current preliminary TPC estimate is $2,000,000,000 based on the most current revised scope, notional funding profile, and schedule.

**Significant Changes**

STS was initiated in FY 2019. The most recent DOE Order 413.3B approved Critical Decision (CD) is CD-3A, Approve Long Lead Procurements (LLPs), which was approved on June 24, 2025. The project continues to face schedule and cost challenges due to increasing construction costs in the local market and has worked with the program on the Key Performance Parameter (KPP) and scope refinements to keep within the $2,000,000,000 preliminary TPC point estimate. The preliminary TPC is subject to change with adjustments in the annual funding levels.

FY 2025 funding continued planning, R&D, design, engineering, prototyping, and testing to advance the highest priority activities with emphasis on key project scope for the accelerator, bunker, target assembly, shielding, moderator reflector assembly, and conventional facilities, including initiating site preparation for the conventional facilities. The FY 2026 Enacted supports continuation of FY 2025 activities to further advance the final designs in readiness for CD-2, *Approve Performance Baseline* and CD-3 *Approve Start of Construction* for the conventional civil construction and all the technical systems except for the beamline scope. The STS science advisory board will provide recommendations on the highest priority instrument concepts for inclusion in the project for further development. The FY 2027 Request will support planning, R&D, design, engineering, prototyping, fabrication, procurement, and testing to advance the highest priority activities with emphasis on the target monolith, bunker, and associated controls system designs. Site preparation, completed in FY 2027, will enable construction of the proton transport tunnel and the target and instrument building. Procurements, including the accelerator magnets, will be evaluated based on sufficient funding beyond what is needed for construction.

A Federal Project Director, certified to level III, has been assigned to this project.

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[h] Neutrons can be described based on their wavelength and energy. Cold neutrons have lower energy (below 25 meV) and longer wavelengths (>0.2 nm) than thermal neutrons. Cold neutrons are best for characterizing materials with large atomic/molecular structures, such as polymers, biological materials, and magnetic materials. The wavelength of cold neutrons is similar to the activation energies for many solid-state excitations, molecular relaxations, and dynamic processes.

## Critical Milestone History

| Fiscal Year | CD-0 | Conceptual Design Complete | CD-1 | CD-2 | Final Design Complete | CD-3 | CD-4 |
|---|---|---|---|---|---|---|---|
| FY 2027 | 1/7/09 | 4/30/21 | 11/23/20 | 4Q FY 2026 | 1Q FY 2032 | 4Q FY 2026 | 3Q FY 2040 |

**CD-0** – Approve Mission Need for a construction project with a conceptual scope and cost range; **Conceptual Design Complete** – Actual date the conceptual design was completed (if applicable); **CD-1** – Approve Alternative Selection and Cost Range; **CD-2** – Approve Performance Baseline; **Final Design Complete** – Estimated/Actual date the project design will be/was complete(d); **CD-3** – Approve Start of Construction; **D&D Complete** – Completion of D&D work; **CD-4** – Approve Start of Operations or Project Closeout.

| Fiscal Year | Performance Baseline Validation | CD-3A |
|---|---|---|
| FY 2027 | 4Q FY 2026 | 06/24/25 |

**CD-3A** – Approve Long-Lead Procurements for the Construction Management/General Contractor (CM/GC) to perform site preparation for conventional civil construction.

## Project Cost History

(dollars in thousands)

| Fiscal Year | TEC, Design | TEC, Construction | TEC, Total | OPC, Except D&D | OPC, Total | TPC |
|---|---|---|---|---|---|---|
| FY 2026 | 263,520 | 1,660,400 | 1,923,920 | 76,080 | 76,080 | 2,000,000 |
| FY 2027 | 285,222 | 1,645,505 | 1,930,727 | 69,273 | 69,273 | 2,000,000 |

*Note:*
- *This project has not received CD-2 approval; therefore, funding estimates are preliminary.*

### 2. Project Scope and Justification

## Scope

The STS project will design and build the new cold neutron scattering facility that comprises four primary elements: the neutron target and moderators; the accelerator systems; the instruments; and the conventional facilities. Costs for acceptance testing, integrated testing, and initial commissioning to demonstrate achievement of the KPPs are included in the STS scope. STS will be located in unoccupied space east of the existing SNS First Target Station (FTS). The project requires approximately 230,000 square feet of new buildings, making conventional facility construction a major contributor to project costs. The conventional facilities have been consolidated and the footprint reduced to lower the construction cost and shorten the schedule.

**Justification**
BES supports two world-class neutron scattering facilities, the HFIR and the SNS, with the SNS FTS among the world's brightest pulsed neutron scattering facilities providing thermal neutron capability.[i] Currently, the U.S. lacks domestic capacity for research with lower energy, longer wavelength cold neutrons. Filling this gap is critical to maintaining U.S. competitiveness in world-leading neutron scattering research. The STS project will design and build a new world-leading, peak brightness, cold neutron source. The STS will provide an initial set of unique, world-class instruments that will address major scientific challenges that are currently difficult or impossible to conduct at existing facilities. This includes unlocking breakthroughs in quantum materials, biomaterials, soft matter and polymers, materials under extreme conditions and in non-equilibrium environments, enhancing advanced manufacturing, and improving efficiency of catalytic transformations within chemical manufacturing, all of which are enabling for U.S. energy dominance.

The STS will use the high-power proton beam from the SNS proton linac to strike a solid tungsten target to produce neutrons that illuminate geometrically optimized compact moderators, yielding cold neutron beams with unparalleled peak brightness for instruments. The STS project will use 0.7 MW of the 2.8 MW accelerator proton beam power enabled by the PPU project. STS is designed to operate at 15 pulses/second simultaneously with FTS by using one out of every four proton pulses to produce cold neutron beams. FTS will operate at 45 pulses/second. An initial set of world-class instruments to support the refined science case will enable new research opportunities and unprecedented levels of performance. STS will fill the capability gap that is emerging with upgrades and construction of new facilities worldwide.

The closest operational competitor facility is J-PARC in Japan, which became the brightest pulsed cold neutron source with a recent power upgrade. The CSNS in China has lower peak and average brightness but offers resolution flexibility with its optimized pulse length. The European Spallation Source (ESS), a long-pulse facility under construction in Sweden, is expected to provide neutrons by 2027 with an initial ramp-up to a proton beam power of 2 MW at 14 pulses/second by ~2028. With a designed power of 5 MW, ESS will not achieve the anticipated STS world-leading peak brightness. However, it will be highly competitive with its unique, bi-spectral capability that allows instruments to simultaneously use neutrons from both cold and thermal moderators, world-leading average brightness, and ultimate resolution flexibility. Therefore, STS, with its unmatched capabilities, would fill a capability gap in the context of other facilities worldwide.

The project is being conducted in accordance with the project management requirements in DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*.

Key Performance Parameters (KPPs)
The KPPs are preliminary and may change as the project continues towards CD-2. At CD-2 approval, the KPPs will be baselined. The Threshold KPPs represent the minimum acceptable performance that the project must achieve. The Objective KPPs represent the desired project performance. Achievement of the Threshold KPPs will be a prerequisite for approval of CD-4, Project Completion.

[i] Thermal neutrons have higher energy (at and above 25 meV) and shorter wavelengths (<0.2 nm) than cold neutrons. The wavelength of thermal neutrons is similar to the interatomic distances in materials, making them ideal for engineering materials, imaging, and determination of crystal structures.

| Performance Measure | Threshold | Objective |
|---|---|---|
| Demonstrate independent control of the proton beam on the two target stations | Operate beam to FTS at 45 pulses/s, with no beam to STS. Operate beam to STS at 15 pulses/s, with no beam to FTS. Operate with beam to both target stations 45 pulses/s at FTS and 15 pulses/s at STS. | Same as threshold. |
| Demonstrate proton beam power on STS at 15 Hz with FTS at 2MW at 45 pulses/s | 100 kW beam power | 700 kW beam power |
| Demonstrate STS neutron brightness | Peak brightness of 2 x $10^{13}$n/cm$^2$/sr/Å/s at 5 Å | Peak brightness of 2 x $10^{14}$n/cm$^2$/sr/Å/s at 5 Å |
| Beamlines transitioned to operations | 3 beamlines successfully passed the integrated functional testing per the transition to operations parameters acceptance criteria. | ≥ 3 beamlines successfully passed the integrated functional testing per the transition to operations parameters acceptance criteria. |

## 3. Financial Schedule

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | | |
| Design (TEC) | | | | |
| Prior Years | 151,000 | 151,000 | 84,474 | — |
| Prior Years - IRA Supp. | 42,700 | 42,700 | — | 42,700 |
| FY 2025 | 17,000 | 17,000 | 43,226 | — |
| FY 2026 | 24,452 | 24,452 | 35,989 | — |
| FY 2027 | — | — | 21,000 | — |
| Outyears | 50,070 | 50,070 | 57,833 | — |
| **Total, Design (TEC)** | **285,222** | **285,222** | **242,522** | **42,700** |
| Construction (TEC) | | | | |
| Prior Years | 15,000 | 15,000 | — | — |
| FY 2025 | 35,000 | 35,000 | 5,303 | — |
| FY 2026 | 27,548 | 27,548 | 29,635 | — |
| FY 2027 | 80,000 | 80,000 | 73,000 | — |
| Outyears | 1,487,957 | 1,487,957 | 1,537,567 | — |
| **Total, Construction (TEC)** | **1,645,505** | **1,645,505** | **1,645,505** | **—** |
| Total Estimated Cost (TEC) | | | | |
| Prior Years | 166,000 | 166,000 | 84,474 | — |
| Prior Years - IRA Supp. | 42,700 | 42,700 | — | 42,700 |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | | |
| FY 2025 | 52,000 | 52,000 | 48,529 | — |
| FY 2026 | 52,000 | 52,000 | 65,624 | — |
| FY 2027 | 80,000 | 80,000 | 94,000 | — |
| Outyears | 1,538,027 | 1,538,027 | 1,595,400 | — |
| **Total, Total Estimated Cost (TEC)** | **1,930,727** | **1,930,727** | **1,888,027** | **42,700** |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Other Project Cost (OPC)** | | | | |
| Prior Years | 52,845 | 52,845 | 40,180 | – |
| FY 2025 | – | – | 4,540 | – |
| FY 2026 | – | – | 3,832 | – |
| FY 2027 | 5,000 | 5,000 | 498 | – |
| Outyears | 11,428 | 11,428 | 20,223 | – |
| **Total, Other Project Cost (OPC)** | **69,273** | **69,273** | **69,273** | **–** |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Project Cost (TPC)** | | | | |
| Prior Years | 218,845 | 218,845 | 124,654 | – |
| Prior Years - IRA Supp. | 42,700 | 42,700 | – | 42,700 |
| FY 2025 | 52,000 | 52,000 | 53,069 | – |
| FY 2026 | 52,000 | 52,000 | 69,456 | – |
| FY 2027 | 85,000 | 85,000 | 94,498 | – |
| Outyears | 1,549,455 | 1,549,455 | 1,615,623 | – |
| **Total, TPC** | **2,000,000** | **2,000,000** | **1,957,300** | **42,700** |

## 4. Details of Project Cost Estimate

(dollars in thousands)

| | Current Total Estimate | Previous Total Estimate | Original Validated Baseline |
|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | |
| Design | 253,902 | 248,220 | **N/A** |
| Design - Contingency | 31,320 | 28,300 | **N/A** |
| **Total, Design (TEC)** | **285,222** | **276,520** | **N/A** |
| Construction_No_Detail | 1,198,600 | 1,128,120 | **N/A** |
| Construction Contingency | 446,905 | 519,280 | **N/A** |
| **Total, Construction (TEC)** | **1,645,505** | **1,647,400** | **N/A** |
| **Total, TEC** | **1,930,727** | **1,923,920** | **N/A** |
| *Contingency, TEC* | *478,225* | *547,580* | ***N/A*** |
| **Other Project Cost (OPC)** | | | |
| R&D | 19,743 | 5,632 | **N/A** |
| Conceptual Design | 29,142 | 36,644 | **N/A** |
| Start-up | 14,313 | 18,588 | **N/A** |
| OPC - Contingency | 6,075 | 15,216 | **N/A** |
| **Total, Except D&D (OPC)** | **69,273** | **76,080** | **N/A** |
| **Total, OPC** | **69,273** | **76,080** | **N/A** |
| *Contingency, OPC* | *6,075* | *15,216* | ***N/A*** |
| **Total, TPC** | **2,000,000** | **2,000,000** | **N/A** |
| ***Total, Contingency (TEC+OPC)*** | ***484,300*** | ***562,796*** | ***N/A*** |

## 5. Schedule of Appropriations Requests

(dollars in thousands)

| Fiscal Year | Type | Prior Years | FY 2025 | FY 2026 | FY 2027 | Outyears | Total |
|---|---|---|---|---|---|---|---|
| FY 2026 | TEC | 208,700 | 52,000 | 52,000 | — | 1,611,220 | 1,923,920 |
| | OPC | 52,845 | — | — | — | 23,235 | 76,080 |
| | TPC | 261,545 | 52,000 | 52,000 | — | 1,634,455 | 2,000,000 |
| FY 2027 | TEC | 208,700 | 52,000 | 52,000 | 80,000 | 1,538,027 | 1,930,727 |
| | OPC | 52,845 | — | — | 5,000 | 11,428 | 69,273 |
| | TPC | 261,545 | 52,000 | 52,000 | 85,000 | 1,549,455 | 2,000,000 |

*Note:*
- *This project has not received CD-2 approval; therefore, funding estimates are preliminary.*

## 6. Related Operations and Maintenance Funding Requirements

| | |
|---|---|
| Start of Operation or Beneficial Occupancy | 3Q FY 2040 |
| Expected Useful Life | 25 years |
| Expected Future Start of D&D of this capital asset | 3Q FY 2065 |

Related Funding Requirements
(dollars in thousands)

| | Annual Costs | | Life Cycle Costs | |
|---|---|---|---|---|
| | **Previous Total Estimate** | **Current Total Estimate** | **Previous Total Estimate** | **Current Total Estimate** |
| Operations, Maintenance and Repair | 59,000 | 59,000 | 1,475,000 | 1,475,000 |

The numbers presented are the incremental operations and maintenance costs above the existing SNS facility without escalation. The estimate will be updated and additional details will be provided after CD-2, Approve Performance Baseline.

### 7. D&D Information

The new area being constructed in this project will not replace existing facilities.

| | Square Feet |
|---|---|
| New area being constructed by this project at ORNL ........................................................ | ~230,000 |
| Area of D&D in this project at ORNL .............................................................................. | — |
| Area at ORNL to be transferred, sold, and/or D&D outside the project, including area previously "banked" ........................................................................................................ | ~230,000 |
| Area of D&D in this project at other sites ......................................................................... | — |
| Area at other sites to be transferred, sold, and/or D&D outside the project, including area previously "banked" ........................................................................................................ | — |
| Total area eliminated ........................................................................................................ | — |

### 8. Acquisition Approach

Based on the DOE determination at CD-1, ORNL is acquiring the STS project under the existing DOE M&O contract.

The M&O contractor prepared a Conceptual Design Report for the STS project and identified key design activities, requirements, and high-risk subsystem components to reduce cost and schedule risk to the project and expedite the startup. The necessary project management systems are fully up to date, operating, and are maintained as an ORNL-wide resource.

ORNL will design and procure the key technical subsystem components. Some technical system designs will require research and development activities. Preliminary cost estimates for most of these systems are based on SNS operating experience and vendor estimates, while some first-of-a-kind systems are based on expert judgement. Vendors and/or partner labs with the necessary capabilities will fabricate the technical equipment. ORNL will competitively bid and award all subcontracts based on best value to the government. SC will evaluate the M&O contractor's performance through the annual laboratory performance appraisal process.

SC and the M&O will draw from lessons learned from other SC projects and other similar facilities in planning and executing the STS project.

**18-SC-12, Advanced Light Source Upgrade (ALS-U), LBNL**
**Lawrence Berkeley National Laboratory, LBNL**
**Project is for Design and Construction**

## 1. Summary, Significant Changes, and Schedule and Cost History

**Summary**

The FY 2027 Request for the ALS-U project is $50,000,000 of Total Estimated Cost (TEC) funding. The project has a baselined Total Project Cost (TPC) of $590,000,000. Since the TPC was established at CD-2, Approve Performance Baseline, on April 2, 2021, the project has experienced significant cost and schedule escalation because of factors both external and internal to the project. As a result, the Department is preparing for a rebaseline of the project, which is currently planned for no later than 3Q FY 2026.

**Significant Changes**

The ALS-U was initiated in FY 2018. The most recent DOE Order 413.3B approved Critical Decision (CD) is CD-3, Approve Start of Construction, approved on November 10, 2022. This Construction Project Data Sheet (CPDS) is an update of the FY 2026 CPDS and does not include a new start for FY 2027.

Independent project reviews (IPR) carried out by the DOE Office of Project Assessment in November 2023 and May 2024 identified significant challenges impacting project performance. Following an internal laboratory assessment and subsequent external Director's review in November 2024, the lab concluded that the project was on a trajectory to exceed its current baseline. The analysis identified multiple issues that have been validated by a root cause analysis. A revised bottom-up cost and schedule baseline will be assessed and validated with independent project reviews occurring in early calendar year 2026 to inform, with confidence, the rebaseline evaluation and decision in 3Q FY 2026.

The FY 2025 funding supported advancing the remaining Accumulator Ring procurements and the Storage Ring final designs. The first article raft and sector mockup will advance as necessary precursors for pre-staging and assembly of the Storage Ring rafts. The FY 2026 funding advances key activities, such as the first article raft and sector mockup, necessary precursors for pre-staging and assembly of the Storage Ring raft assemblies, cable plant installation, Accumulator Ring electrical installation, and beamline front end and system engineering. Vacuum system components will be procured, in preparation for the dark time Storage Ring installation. The FY 2027 Request will enable continued planning, design, engineering, prototyping, installation, and testing to advance the highest priority activities with emphasis on Accumulator Ring commissioning, production of the Storage Ring rafts, completing the beamline front-end engineering, and advancing beamline systems engineering as the project continues progressing toward completion.

A FPD certified to Level III has been assigned to this project, with Level IV certification in progress.

## Critical Milestone History

| Fiscal Year | CD-0 | Conceptual Design Complete | CD-1 | CD-2 | Final Design Complete | CD-3 | CD-4 |
|---|---|---|---|---|---|---|---|
| FY 2027 | 9/27/16 | 4/30/18 | 9/21/18 | 4/2/21 | 1Q FY 2027 | 11/10/22 | 4Q FY 2030 |

**CD-0** – Approve Mission Need for a construction project with a conceptual scope and cost range; **Conceptual Design Complete** – Actual date the conceptual design was completed (if applicable); **CD-1** – Approve Alternative Selection and Cost Range; **CD-2** – Approve Performance Baseline; **Final Design Complete** – Estimated/Actual date the project design will be/was complete(d); **CD-3** – Approve Start of Construction; **D&D Complete** – Completion of D&D work; **CD-4** – Approve Start of Operations or Project Closeout.

| Fiscal Year | Performance Baseline Validation | CD-3A |
|---|---|---|
| FY 2027 | 4/2/21 | 12/19/19 |

**CD-3A** – Approve Long-Lead Procurements includes Accumulator Ring equipment on the critical path necessary for installation.

*Note:*

- *The ALS-U project is currently working towards a rebaseline in FY 2026 that will establish a new cost and schedule estimate. The current cost and schedule estimates shown are those established at CD-2.*

## Project Cost History

(dollars in thousands)

| Fiscal Year | TEC, Design | TEC, Construction | TEC, Total | OPC, Except D&D | OPC, Total | TPC |
|---|---|---|---|---|---|---|
| FY 2026 | 134,340 | 427,660 | 562,000 | 28,000 | 28,000 | 590,000 |
| FY 2027 | TBD | TBD | TBD | TBD | TBD | TBD |

*Note:*

- *The ALS-U project is currently working towards a rebaseline in FY 2026 that will establish a new cost and schedule estimate. The current cost and schedule estimates shown are those established at CD-2.*

### 2. Project Scope and Justification

## Scope

The ALS-U project will upgrade the existing ALS facility by replacing the existing electron storage ring with a new electron storage ring based on a multi-bend achromat (MBA) lattice design to provide a soft x-ray source that is an increase in brightness of up to 100 times over the current ALS—and to provide a significantly higher fraction of coherent light in the soft x-ray region (approximately 50-2,000 electronvolts [eV]) than is currently available at ALS. The project will replace the existing triple-bend achromat storage ring with a new, high-performance storage ring based on a nine-bend achromat design. In addition, the project will add a low-emittance, full-energy accumulator ring to the existing tunnel inner shield wall to enable on- and off-axis, swap-out injection and extraction into and from the new storage ring using fast kicker magnets. The new source will require upgrading x-ray optics on existing beamlines with some beamlines being realigned or relocated. The project adds two new undulator beamlines that are optimized for the novel science made possible by the beam's new high coherent flux. The project intends to reuse the existing building, utilities, electron gun, linac, and booster synchrotron equipment currently at ALS. Prior to CD-2, the scope was increased to include radiation shielding and safety-mandated seismic structural upgrades to the ALS facility. With an aggressive accelerator design, ALS-U will provide the highest coherent flux covering the entire soft x-ray regime (up to a photon energy range of about 3.5 keV) of any existing or planned storage ring facility worldwide.

**Justification**

At this time, our ability to observe and understand materials and material phenomena in real-time as they emerge and evolve is limited. Soft x-rays (approximately 50 to 2,000 eV) are ideally suited for revealing the chemical, electronic, and magnetic properties of materials, as well as the chemical reactions that underpin these properties. This knowledge is crucial for the design and control of new advanced materials that address the challenges of new energy technologies.

Existing storage ring light sources lack a key attribute that would revolutionize x-ray science: stable, nearly continuous soft x-rays with high brightness and high coherent flux—that is, smooth, well organized soft x-ray wave fronts. Such a source would enable 3D imaging with nanometer resolution and the measurement of spontaneous nanoscale motion with nanosecond resolution—all with electronic structure sensitivity.

Currently, BES operates advanced ring-based light sources that produce soft x-rays. The NSLS-II, commissioned in 2015, is the brightest soft x-ray source in the U.S. The ALS, completed in 1993, is competitive with NSLS-II for x-rays below 200 eV but not above that. NSLS-II is somewhat lower in brightness than the Swedish light source, MAX-IV, which began user operations in 2017 and represented the first use of a Multi-Bend-Achromat (MBA) magnet lattice design to dramatically increase the brightness in a light source facility. Neither NSLS-II nor ALS make use of the newer MBA lattice design. Switzerland's SLS-2 (an MBA-based design that began user operations in late 2025) will be a brighter soft x-ray light source than both NSLS-II and MAX-IV. These international light sources, and those that follow present a significant challenge to the U.S. light source community to provide competitive x-ray sources to domestic users until the ALS upgrade is complete.

Neither the NSLS-II nor ALS soft x-ray light sources possess sufficient brightness or coherent flux to provide the capability to meet the mission need in their current configurations.

The existing ALS is a 1.9 GeV storage ring operating at 500 milliamps (mA) of beam current. It is optimized to produce intense beams of soft x-rays, which offer spectroscopic contrast, nanometer-scale resolution, and broad temporal sensitivity. The ALS facility includes an accelerator complex and photon delivery system that can provide the foundations for an upgrade that will achieve world-leading soft x-ray coherent flux. The existing ALS provides a ready-made foundation, including conventional facilities, a $500,000,000 scientific infrastructure investment and a vibrant user community of over 2,500 users per year already attuned to the potential scientific opportunities an upgrade offers. The facility also includes extensive (up to 40) simultaneously operating beamlines and instrumentation, an experimental hall, computing resources, ancillary laboratories, offices, and related infrastructure that will be heavily utilized in an upgrade scenario. Furthermore, the upgrade leverages the ALS staff, who are experts in the scientific and technical aspects of the proposed upgrade.

In summary, the capabilities at our existing x-ray light source facilities are insufficient to develop the next generation of tools that combine high resolution spatial imaging together with precise energy resolving spectroscopic techniques in the soft x-ray range. To enable these cutting-edge experimental techniques, ALS-U is designed and being constructed to be a world-leading facility in soft x-ray science by delivering ultra-bright source of light in the soft x-ray regime with the high coherent x-ray flux required to resolve nanometer-scale features and interactions, and to allow the real-time observation and understanding of materials and phenomena as they emerge and evolve. Developing such a light source will ensure the U.S. has the tools to maintain its leadership in soft x-ray science and will significantly accelerate the advancement of the fundamental sciences that underlie a broad range of emerging and future energy applications.

The project is being conducted in accordance with the project management requirements in DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets.*

Key Performance Parameters (KPPs)
The Threshold KPPs approved at CD-2 represent the minimum acceptable performance that the project must achieve. The Objective KPPs represent the desired project performance. Achievement of the Threshold KPPs will be a prerequisite for approval of CD-4, Project Completion.

| Performance Measure | Threshold | Objective |
|---|---|---|
| Storage Ring Energy | ≥ 1.9 GeV | 2.0 GeV |
| Beam Current | > 25 mA | 500 mA |
| Horizontal Emittance | < 150 pm-rad | < 85 pm-rad |
| Brightness @ 1 keV[a] | $> 2 \times 10^{19}$ | $\geq 2 \times 10^{21}$ |
| New MBA Beamlines | 2 | ≥ 2 |

[a] Units = photons/sec/0.1% BW/mm2/mrad2

### 3. Financial Schedule

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | | |
| Design (TEC) | | | | |
| Prior Years | 134,340 | 134,340 | 130,975 | — |
| FY 2025 | — | — | 3,365 | — |
| **Total, Design (TEC)** | **134,340** | **134,340** | **134,340** | **—** |
| Construction (TEC) | | | | |
| Prior Years | 331,060 | 331,060 | 164,336 | — |
| Prior Years - IRA Supp. | 96,600 | 96,600 | — | 95,034 |
| FY 2025 | 50,000 | 50,000 | 57,183 | 1,566 |
| FY 2026 | 50,000 | TBD | TBD | — |
| FY 2027 | TBD | TBD | TBD | TBD |
| Outyears | TBD | TBD | TBD | TBD |
| **Total, Construction (TEC)** | **TBD** | **TBD** | **TBD** | **TBD** |
| Total Estimated Cost (TEC) | | | | |
| Prior Years | 465,400 | 465,400 | 295,311 | — |
| Prior Years - IRA Supp. | 96,600 | 96,600 | — | 95,034 |
| FY 2025 | 50,000 | 50,000 | 60,548 | 1,566 |
| FY 2026 | 50,000 | TBD | TBD | — |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | | |
| FY 2027 | TBD | TBD | TBD | TBD |
| Outyears | TBD | TBD | TBD | TBD |
| **Total, Total Estimated Cost (TEC)** | **TBD** | **TBD** | **TBD** | **TBD** |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Other Project Cost (OPC)** | | | | |
| Prior Years | 28,000 | 28,000 | 23,560 | – |
| FY 2026 | – | – | 4,440 | – |
| **Total, Other Project Cost (OPC)** | **28,000** | **28,000** | **28,000** | **–** |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Project Cost (TPC)** | | | | |
| Prior Years | 493,400 | 493,400 | 318,871 | – |
| Prior Years - IRA Supp. | 96,600 | 96,600 | – | 95,034 |
| FY 2025 | 50,000 | 50,000 | 60,548 | 1,566 |
| FY 2026 | 50,000 | TBD | TBD | – |
| FY 2027 | TBD | TBD | TBD | TBD |
| Outyears | TBD | TBD | TBD | TBD |
| **Total, TPC** | **TBD** | **TBD** | **593,400** | **96,600** |

*Note:*

- *The ALS-U project is currently working towards a rebaseline in FY 2026 that will establish a new cost and schedule estimate. The current cost and schedule estimates shown are those established at CD-2.*
- *The FY 2027 Request includes $50M for the ALS-U project. This funding will not be reflected in the table until a new CD-2 baseline is approved.*

## 4. Details of Project Cost Estimate

(dollars in thousands)

| | Current Total Estimate | Previous Total Estimate | Original Validated Baseline |
|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | |
| Design | 117,778 | 117,778 | 92,967 |
| Design - Contingency | 16,562 | 16,562 | 38,778 |
| **Total, Design (TEC)** | **134,340** | **134,340** | **131,745** |
| Construction_No_Detail | 159,338 | 159,338 | 142,165 |
| Equipment | 172,938 | 172,938 | 161,449 |
| Construction Contingency | 95,384 | 95,384 | 126,641 |
| **Total, Construction (TEC)** | **427,660** | **427,660** | **430,255** |
| **Total, TEC** | **562,000** | **562,000** | **562,000** |
| *Contingency, TEC* | *111,946* | *111,946* | *165,419* |
| **Other Project Cost (OPC)** | | | |
| R&D | N/A | N/A | 8,241 |
| Conceptual Planning | 10,261 | 10,261 | 2,000 |
| Conceptual Design | 14,100 | 14,100 | 12,100 |
| Start-up | 1,000 | 1,000 | 2,000 |
| OPC - Contingency | 2,639 | 2,639 | 3,659 |
| **Total, Except D&D (OPC)** | **28,000** | **28,000** | **28,000** |
| **Total, OPC** | **28,000** | **28,000** | **28,000** |
| *Contingency, OPC* | *2,639* | *2,639* | *3,659* |
| **Total, TPC** | **590,000** | **590,000** | **590,000** |
| ***Total, Contingency (TEC+OPC)*** | ***114,585*** | ***114,585*** | ***169,078*** |

*Note:*

- *The ALS-U project is currently working towards a rebaseline in FY 2026 that will establish a new cost and schedule estimate. The current cost and schedule estimates shown are those established at CD-2.*

## 5. Schedule of Appropriations Requests

(dollars in thousands)

| Fiscal Year | Type | Prior Years | FY 2025 | FY 2026 | FY 2027 | Outyears | Total |
|---|---|---|---|---|---|---|---|
| FY 2026 | TEC | 562,000 | 50,000 | 50,000 | TBD | TBD | TBD |
| | OPC | 28,000 | — | — | TBD | TBD | TBD |
| | TPC | 590,000 | 50,000 | 50,000 | TBD | TBD | TBD |
| FY 2027 | TEC | 562,000 | 50,000 | 50,000 | TBD | TBD | TBD |
| | OPC | 28,000 | — | — | TBD | TBD | TBD |
| | TPC | 590,000 | 50,000 | 50,000 | TBD | TBD | TBD |

*Note:*

- *The ALS-U project is currently working towards a rebaseline in FY 2026 that will establish a new cost and schedule estimate. The current cost and schedule estimates shown are those established at CD-2.*
- *The FY 2027 Request includes $50M for the ALS-U project. This funding will not be reflected in the table until a new CD-2 baseline is approved.*

## 6. Related Operations and Maintenance Funding Requirements

| | |
|---|---|
| Start of Operation or Beneficial Occupancy | 4Q FY 2030 |
| Expected Useful Life | 25 years |
| Expected Future Start of D&D of this capital asset | 4Q FY 2055 |

Related Funding Requirements
(dollars in thousands)

| | **Annual Costs** | | **Life Cycle Costs** | |
|---|---|---|---|---|
| | **Previous Total Estimate** | **Current Total Estimate** | **Previous Total Estimate** | **Current Total Estimate** |
| Operations, Maintenance and Repair | 71,500 | 71,500 | 2,597,500 | 2,597,500 |

## 7. D&D Information

At this stage of project planning and development, SC anticipates that there will be no new area being constructed in the construction project.

## 8. Acquisition Approach

Based on the DOE determination at CD-1, LBNL is acquiring the ALS-U project under the existing DOE Management and Operations (M&O) contract.

The ALS-U project identified key design activities, requirements, and high-risk subsystem components to reduce cost and schedule risk to the project and expedite the startup. The necessary project management systems are fully up-to-date, operating, and are maintained as a LBNL-wide resource.

LBNL has partnered with BNL for design and procurement of all required power supplies. Technical system designs required research and development and prototyping activities that are now near completion. Cost estimates for the remaining work have been updated by acquiring recent vendor quotes as part of CD-3 approval. All subcontracts are being competitively bid and awarded based on best value to the government. The M&O contractor's performance is being evaluated through the annual laboratory performance appraisal process.

Lessons learned from other SC projects and other similar facilities are being exploited fully in planning and executing ALS-U.

**18-SC-13, Linac Coherent Light Source-II-High Energy (LCLS-II-HE), SLAC**
**SLAC National Accelerator Laboratory, SLAC**
**Project is for Design and Construction**

## 1. Summary, Significant Changes, and Schedule and Cost History

**Summary**

The LCLS-II-HE project will expand the capabilities of the LCLS to maintain U.S. leadership in ultrafast and ultrabright x-ray science. The project will increase the energy of the superconducting linac from 4 GeV to 8 GeV and thereby expand the high repetition rate operation (one million pulses per second) into the hard x-ray regime (5-12 keV). The FY 2027 Request for the LCLS-II-HE project is $6,000,000 of Total Estimated Cost (TEC) funding. The Total Project Cost established at the combined CD-2/3 is $716,000,000.

**Significant Changes**

The LCLS-II-HE project was initiated in FY 2019. The most recent DOE Order 413.3B approved Critical Decision (CD) is a combined CD-2/3, Approve Performance Baseline/Approve Start of Construction, which was approved on September 19, 2024. The phased long-lead procurements were enabled by the investment of the Inflation Reduction Act (IRA) funds. CD-4 is projected for 2Q FY 2028.

FY 2025 funding supported continued engineering, R&D, and injector gun prototyping; and initiated CD-3C, Approve Long-lead Procurements of cryogenic system components and early construction of vertical transfer line penetration through the linac structure for delivery of cryogens, and cryogenic distribution system and controls instruments required for installation during the year-long down time. The FY 2026 Enacted will continue engineering, R&D, and prototyping for the superconducting radiofrequency electron gun; cryomodule and solid state amplifier production and delivery; continued CD-3C procurements advancing the cryogenic distribution systems; and initiating the low-emittance injector tunnel infrastructure; and initiating construction/installation contracts. The FY 2027 Request will enable continuation of the planning, R&D, design, engineering, prototyping, testing, procurement, and construction to advance the highest priority activities with the emphasis on continuing the construction and installation contracts, including the infrastructure systems for cryogenic transfer lines, cryomodules, safety systems, and the experimental hutch. Installation activities continue during the year-long LCLS downtime and commissioning the new beamline.

A Federal Project Director, certified to Level IV, has been assigned to this project.

**Critical Milestone History**

| Fiscal Year | CD-0 | Conceptual Design Complete | CD-1 | CD-2 | Final Design Complete | CD-3 | CD-4 |
|---|---|---|---|---|---|---|---|
| FY 2027 | 12/15/16 | 3/23/18 | 9/21/18 | 09/19/24 | 3Q FY 2026 | 09/19/24 | 2Q FY 2028 |

**CD-0** – Approve Mission Need for a construction project with a conceptual scope and cost range; **Conceptual Design Complete** – Actual date the conceptual design was completed (if applicable); **CD-1** – Approve Alternative Selection and Cost Range; **CD-2** – Approve Performance Baseline; **Final Design Complete** – Estimated/Actual date the project design will be/was complete(d); **CD-3** – Approve Start of Construction; **D&D Complete** – Completion of D&D work; **CD-4** – Approve Start of Operations or Project Closeout.

| Fiscal Year | Performance Baseline Validation | CD-3A | CD-3B | CD-3C |
|---|---|---|---|---|
| FY 2027 | 09/19/24 | 5/12/20 | 1/27/23 | 7/2/24 |

**CD-3A** – Approve Long-Lead Procurements for cryomodule associated parts and equipment.
**CD-3B** – Approve Long-Lead Procurements for SRF Injector cryogenic systems, Cryo Distribution Box, Optics for Experimental Systems, Controls Systems.
**CD-3C** – Approve Long-Lead Procurements of cryogenic system distribution and controls, beamline optics, and Early Limited Construction including drilling vertical penetration into the accelerator housing for delivery of cryogens into the tunnel.

**Project Cost History**

(dollars in thousands)

| Fiscal Year | TEC, Design | TEC, Construction | TEC, Total | OPC, Except D&D | OPC, Total | TPC |
|---|---|---|---|---|---|---|
| FY 2026 | 68,000 | 616,000 | 684,000 | 32,000 | 32,000 | 716,000 |
| FY 2027 | 67,300 | 616,700 | 684,000 | 32,000 | 32,000 | 716,000 |

## 2. Project Scope and Justification

**Scope**

The LCLS-II-HE project's scope increases the superconducting linac energy from 4 GeV to 8 GeV by installing additional cryomodules in the first kilometer of the existing linac tunnel. The electron beam, generated by a superconducting electron source, will be transported to the existing undulator hall to extend the x-ray energy to 12 keV and beyond. The project will also modify or upgrade existing infrastructure (process cooling water, power, electrical) in the last sector of the linac tunnel and the x-ray transport, optics, and diagnostic and safety systems. It will provide new or upgraded instrumentation to augment existing and planned capabilities.

**Justification**

International developments in X-ray facilities will challenge LCLS's world leadership position. The Shanghai Advanced Research Institute XFEL in Shanghai, China, called SHINE, will match the high pulse rate for continuous operation and have double the electron energy enabled by the LCLS-II project, which allows production of shorter (i.e., harder) x-ray wavelength pulses compared to LCLS. The European X-ray Free Electron Laser (XFEL) at DESY in Hamburg, Germany has a higher electron energy than LCLS, and recent plans could extend the European XFEL from a pulsed operation mode to continuous operation. The continuous operation improves the stability of the electron beam and provides uniformly spaced pulses of x-rays or, if desired, the ability to customize the sequence of x-ray pulses provided to experiments to optimize the measurements being made. The European XFEL began operations in 2017, and SHINE is estimated to begin user operations in 2027. Both facilities will create a profound capability gap compared to LCLS.

In the face of this challenge to U.S. scientific leadership, extending the energy reach of x-rays beyond the upper limit of the current LCLS superconducting linac (5 keV) is a high priority. This expanded range to 12 keV will allow U.S. researchers to access x-ray wavelengths as short as one Ångstrom and probe earth-abundant elements for novel catalysts used for electricity, fuel, and chemical production. It also allows the study of strong spin-orbit coupling that underpins many aspects of quantum materials, and it reaches the biologically important selenium k-edge, used for protein crystallography.

The ability to observe and understand the structural dynamics of complex matter at the atomic scale, at ultrafast time scales, and in operational environments is critical to the nation's R&D enterprise and its ability to develop advanced materials for new energy technologies. To achieve this objective, DOE needs a hard x-ray source capable of producing high energy ultrafast bursts with full spatial and temporal coherence at high repetition rates. This capability cannot be provided by any existing or planned light source.

The LCLS-II project was completed successfully in October 2023 and LCLS began operation in November 2023. The LCLS-II project was the first step in addressing the capability gap described above. With this upgrade, LCLS is currently the premier XFEL facility in the world at photon energies ranging from 200 eV up to approximately 5 keV. The cryomodule technology is a major advancement from prior designs that will allow continuous operation up to 1 MHz.

The LCLS-II cryomodules have consistently performed beyond expectations, providing the technical basis to double the electron beam energy. The LCLS-II-HE project adds the additional acceleration capacity necessary to double the electron beam energy of the superconducting linear accelerator (linac) from 4 GeV to 8 GeV. The LCLS-II-HE upgrade will meet the mission need by providing world leading experimental capabilities for the U.S. research community by extending the energy into the hard x-ray regime (from 5 keV to 12 keV and beyond).

The project is being conducted in accordance with the project management requirements in DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*.

Key Performance Parameters (KPPs)
The threshold KPPs approved at CD-2 represent the minimum acceptable performance that the project must achieve. The Objective KPPs represent the desired project performance. Achievement of the Threshold KPPs will be a prerequisite for approval of CD-4, Project Completion.

| Performance Measure | Threshold | Objective |
|---|---|---|
| Superconducting linac electron beam energy | 7 GeV | $\geq$ 8 GeV |
| Electron bunch repetition rate | 93 kHz | 929 kHz |
| Superconducting linac charge per bunch | 0.02 nC | 0.1 nC |
| Photon beam energy range | 250 to 8,000 eV | 250 to 12,800 eV |
| High repetition rate capable, hard X-ray end stations | $\geq$ 1 | $\geq$ 2 |
| FEL photon quantity ($10^{-3}$ BW) | $5x10^8$ @ 8 keV (10x spontaneous) | $10^{10}$ @ 12.8 keV (20 mJ) |

## 3. Financial Schedule

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | | |
| Design (TEC) | | | | |
| Prior Years | 67,300 | 67,300 | 52,081 | — |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | | |
| FY 2025 | — | — | 12,176 | — |
| FY 2026 | — | — | 3,043 | — |
| **Total, Design (TEC)** | **67,300** | **67,300** | **67,300** | **—** |
| Construction (TEC) | | | | |
| Prior Years | 321,357 | 321,357 | 200,706 | — |
| Prior Years - IRA Supp. | 90,000 | 90,000 | — | 52,735 |
| FY 2025 | 100,000 | 100,000 | 97,061 | 30,609 |
| FY 2026 | 99,343 | 99,343 | 181,607 | 6,656 |
| FY 2027 | 6,000 | 6,000 | 46,658 | — |
| Outyears | — | — | 668 | — |
| **Total, Construction (TEC)** | **616,700** | **616,700** | **526,700** | **90,000** |
| Total Estimated Cost (TEC) | | | | |
| Prior Years | 388,657 | 388,657 | 252,787 | — |
| Prior Years - IRA Supp. | 90,000 | 90,000 | — | 52,735 |
| FY 2025 | 100,000 | 100,000 | 109,237 | 30,609 |
| FY 2026 | 99,343 | 99,343 | 184,650 | 6,656 |
| FY 2027 | 6,000 | 6,000 | 46,658 | — |
| Outyears | — | — | 668 | — |
| **Total, Total Estimated Cost (TEC)** | **684,000** | **684,000** | **594,000** | **90,000** |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Other Project Cost (OPC)** | | | | |
| Prior Years | 27,000 | 27,000 | 13,456 | – |
| FY 2025 | – | – | – | 6,000 |
| FY 2026 | 5,000 | 5,000 | 3,216 | – |
| FY 2027 | – | – | 8,736 | – |
| Outyears | – | – | 592 | – |
| **Total, Other Project Cost (OPC)** | **32,000** | **32,000** | **26,000** | **6,000** |

(dollars in thousands)

| | Budget Authority (Appropriations) | Obligations | Costs | IRA Supp. Costs |
|---|---|---|---|---|
| **Total Project Cost (TPC)** | | | | |
| Prior Years | 415,657 | 415,657 | 266,243 | – |
| Prior Years - IRA Supp. | 90,000 | 90,000 | – | 52,735 |
| FY 2025 | 100,000 | 100,000 | 109,237 | 36,609 |
| FY 2026 | 104,343 | 104,343 | 187,866 | 6,656 |
| FY 2027 | 6,000 | 6,000 | 55,394 | – |
| Outyears | – | – | 1,260 | – |
| **Total, TPC** | **716,000** | **716,000** | **620,000** | **96,000** |

*Note:*

– *In FY 2021, the Office of Science reprogrammed $19,343,211.24 of prior year funds from this project to support the LCLS-II project at SLAC. The Prior Year Budget Authority in the table above reflects this reprogramming. Also in FY 2021, a total of $10,000,000 in current year and prior year funding was reprogrammed to the LCLS-II-HE project and additional funds were included in the outyears to maintain the project profile.*

## 4. Details of Project Cost Estimate

(dollars in thousands)

| | Current Total Estimate | Previous Total Estimate | Original Validated Baseline |
|---|---|---|---|
| **Total Estimated Cost (TEC)** | | | |
| Design | 66,539 | 65,000 | 65,000 |
| Design - Contingency | 761 | 3,000 | 3,000 |
| **Total, Design (TEC)** | **67,300** | **68,000** | **68,000** |
| Construction_No_Detail | 281,000 | 268,000 | 506,000 |
| Site Preparation | 20,000 | 2,000 | **N/A** |
| Equipment | 262,460 | 236,000 | **N/A** |
| Construction Contingency | 53,240 | 110,000 | 110,000 |
| **Total, Construction (TEC)** | **616,700** | **616,000** | **616,000** |
| **Total, TEC** | **684,000** | **684,000** | **684,000** |
| *Contingency, TEC* | *54,001* | *113,000* | *113,000* |
| **Other Project Cost (OPC)** | | | |
| R&D | 5,000 | 5,000 | **N/A** |
| Conceptual Planning | N/A | 1,000 | 6,000 |
| Conceptual Design | 14,600 | 12,000 | 12,000 |
| Start-up | 9,200 | 8,000 | 8,000 |
| OPC - Contingency | 3,200 | 6,000 | 6,000 |
| **Total, Except D&D (OPC)** | **32,000** | **32,000** | **32,000** |
| **Total, OPC** | **32,000** | **32,000** | **32,000** |
| *Contingency, OPC* | *3,200* | *6,000* | *6,000* |
| **Total, TPC** | **716,000** | **716,000** | **716,000** |

(dollars in thousands)

| | Current Total Estimate | Previous Total Estimate | Original Validated Baseline |
|---|---|---|---|
| ***Total, Contingency (TEC+OPC)*** | ***57,201*** | ***119,000*** | ***119,000*** |

## 5. Schedule of Appropriations Requests

(dollars in thousands)

| Fiscal Year | Type | Prior Years | FY 2025 | FY 2026 | FY 2027 | Outyears | Total |
|---|---|---|---|---|---|---|---|
| FY 2026 | TEC | 478,657 | 100,000 | 99,343 | — | 6,000 | 684,000 |
| | OPC | 27,000 | — | 5,000 | — | — | 32,000 |
| | TPC | 505,657 | 100,000 | 104,343 | — | 6,000 | 716,000 |
| FY 2027 | TEC | 478,657 | 100,000 | 99,343 | 6,000 | — | 684,000 |
| | OPC | 27,000 | — | 5,000 | — | — | 32,000 |
| | TPC | 505,657 | 100,000 | 104,343 | 6,000 | — | 716,000 |

*Note:*

– *In FY 2021, the Office of Science reprogrammed $19,343,211.24 of prior year funds from this project to support the LCLS-II project at SLAC. The Prior Year Budget Authority in the table above reflects this reprogramming. Also in FY 2021, a total of $10,000,000 in current year and prior year funding was reprogrammed to the LCLS-II-HE project and additional funds were included in the outyears to maintain the project profile.*

## 6. Related Operations and Maintenance Funding Requirements

| | |
|---|---|
| Start of Operation or Beneficial Occupancy | 2Q FY 2028 |
| Expected Useful Life | 25 years |
| Expected Future Start of D&D of this capital asset | 2Q FY 2053 |

Related Funding Requirements
(dollars in thousands)

| | Annual Costs | | Life Cycle Costs | |
|---|---|---|---|---|
| | Previous Total Estimate | Current Total Estimate | Previous Total Estimate | Current Total Estimate |
| Operations, Maintenance and Repair | 21,500 | 21,500 | 537,500 | 537,500 |

The numbers presented are the incremental operations and maintenance costs above the LCLS-II facility without escalation. The estimate will be updated and additional details will be provided after CD-2, Approve Project Performance Baseline.

## 7. D&D Information

At this stage of project planning and development, SC anticipates no new area will be constructed for this project.

## 8. Acquisition Approach

Based on the DOE determination at CD-1, SLAC is acquiring the LCLS-II-HE project under the existing DOE M&O contract.

SLAC has completed the requirements for baselining the project and LCLS-II-HE has received CD-2/3 approval. The necessary project management systems are fully operating and are maintained as a SLAC-wide resource.

SLAC is partnering with other laboratories for design and procurement of key technical subsystem components. Technical system designs require research and development activities. Preliminary cost estimates for these systems are based on actual costs from the LCLS-II project and other similar facilities, to the extent practicable. The M&O contractor is fully exploiting recent cost data in planning and budgeting for the project. SLAC or partner laboratory staff will complete the design of the technical systems. SLAC or subcontracted vendors with the necessary capabilities will fabricate the technical equipment. All subcontracts will be competitively bid and awarded based on best value to the government. SC will evaluate the M&O contractor's performance through the annual laboratory performance appraisal process.

SC and the M&O will draw from lessons learned from the LCLS-II project and other similar facilities in planning and executing the LCLS-II-HE project.