OFFICE OF SCIENCE UPDATE

Board on Physics and Astronomy
2023 Spring Meeting

Linda Horton, Andy Schwartz, Regina Rameika, Sharon Steph
Ceren Susut, Dorothy Koch, John Man

May 7

U.S. DEPARTMENT OF ENERGY

With Thanks to Dr. Berhe

- First earth scientist to lead the Office of Science (SC)
- Key Accomplishments:
  - Urban Integrated Field Labs
  - Fusion
  - Exascale Computing
  - SC Energy Earthshots
  - ITER Head of Delegation
  - International agreements
  - Broadening participation
    - Reaching a New Energy Sciences Workforce (RENEW)
    - Funding for Accelerated, Inclusive Research (FAIR)
    - Promoting Inclusive and Equitable Research (PIER) Plans
    - Community Outreach
- SC does business differently due to Dr. Berhe's visionary leadership

U.S. DEPARTMENT OF ENERGY | Office of Science

Driving Discovery Science for the Nation

Discovery science supported by the Office of Science builds the foundation for ensuring America's future prosperity and competitiveness by addressing its energy, environment, and national security challenges.

Fostering Great Minds and Great Ideas

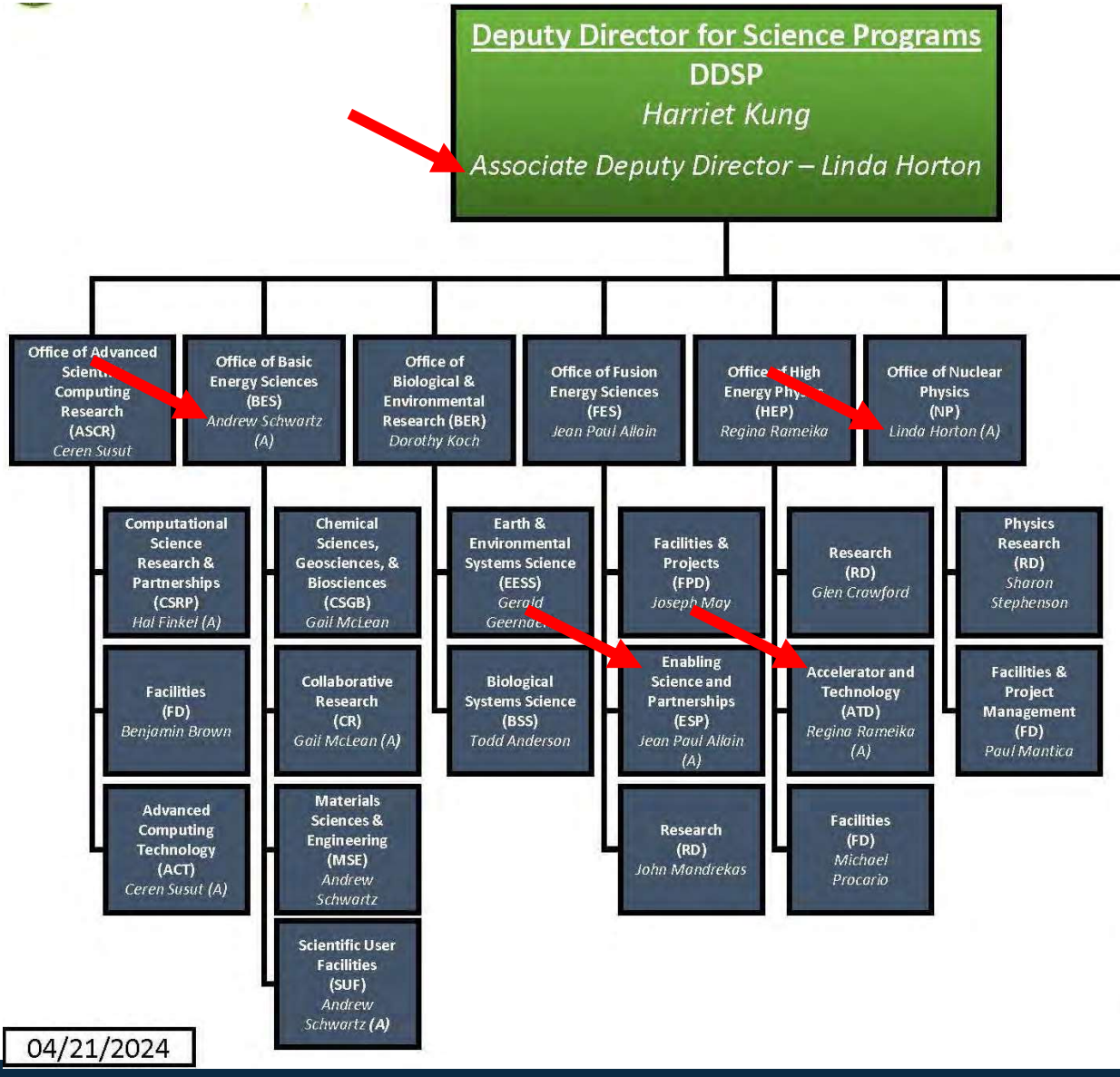
The Office of Science addresses the world's most challenging scientific problems, supporting innovation from America's brightest minds, across multiple disciplines, and at universities, DOE's national laboratories, and other research institutions.

Providing World-Clas

The Office of Scie
suite of scientifi
that provide the
community with
capabilities for r
physics, materia
chemistry to
advanced com
medic

Office of Science Realignment in the Deputy Director for Sc Programs Organization

- Associate Deputy Director
- Senior Advisor for Equity, Inclusion and Accessibility
- New Fusion Energy Sciences Division on Enabling Science and Partnerships
- New High Energy Physics Division on Accelerator and Technology



04/21/2024

Highlights from the FY 2024 Enacted Budget

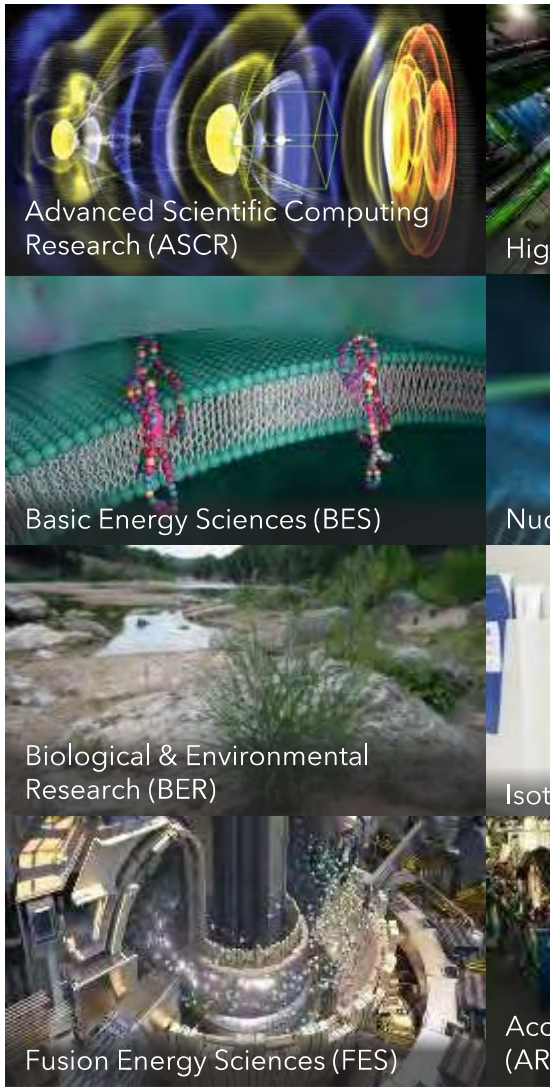
- FY 2024 Enacted: $8.24B, an increase of $140M over FY 2023 Enact
- Initiate Microelectronics Science Research Centers at $30M
- Initiate Fusion Innovation Research Engine (FIRE) Collaboratives at $
- SC Energy Earthshots reduced to $20M
- User facilities at 89% optimal operations
- "The Department is directed to provide not later than 90 days, and
  thereafter, a briefing on its actions to progressively move to fully fun
  research awards of $2,500,000 or less."

Office of Science - Guiding Principles for FY 2025 Re

FY 2023 Enacted : $8.1B
FY 2024 Enacted : $8.24B
FY 2025 Request : $8.583B

- The FY 2025 Request supports a balanced research portfolio, focused on cutting edge, early-stage R&D for discovery and use-inspired sciences. SC programs invest in basic research for the advancement of clean energy, to transform our understanding of nature, and to strengthen the foundation for S&T innovation.

- The Request includes:
  - Research investments
  - Moving towards optimal operations and upgrades to scientific user facilities
  - Upgrades/improvements to national laboratories infrastructure/utilities and reduce deferred maintenance



FY 2025 Request – Research Highlights

- Artificial Intelligence research (+$93.127M; $259M)
- Microelectronics (+$22M, $94.7M), including $45M for Microelec
  Science Research Centers
- U.S. Fusion Acceleration (+$18.8M), including the Fusion Innovat
  Engine (FIRE) collaboratives
- Climate Initiative ($20M)
- SC Energy Earthshots (+$95M; $115M)
- Broadening Participation & Workforce Development
  - Reaching a New Energy Sciences Workforce (RENEW) to increase particip
    non-R1 MSIs (+$68.6M; $120M)
  - Funding for Accelerated, Inclusive Research (FAIR) (+$31.6M; $64M)

Artificial Intelligence and Machine Learning

FY 2025 $259.0M, Δ=+$93.1M

DOE FASST (Frontiers in Artificial intelligence for Science, Security, and Technology) initiative – investing in transformative AI for science.

- AI for Science, including Scientific AI Foundation Models
  - AI to accelerate innovation for forefront science and for models trained on unique, highly-curated scientific datasets, including models that can *only* be trained on supercomputers
- AI Hardware Innovation
  - New AI algorithms and hardware co-design to improve energy efficiency by >100x, including dedicated AI hardware that leverages exascale software
- AI for User Facilities and Advanced Instrumentation/Technology
  - Optimized, self-driving, autonomous instruments/experiments and real-time data analysis, coupling experimental instruments to computing and AI resources
  - AI-enabled real time control of accelerators and detectors for optimal operational efficiency
- AI Tools for Design and Evaluation of Trustworthy AI Systems
  - New storage and archival tools for FAIR (Findable, Accessible, Interoperable, and Reusable) data and privacy-preserving algorithms to enable science using proprietary and sensitive data
- A diverse AI workforce
  - Leverage the broad and deep expertise of DOE's technical workforce, including skilled AI practitioners, to integrate AI across the science research community

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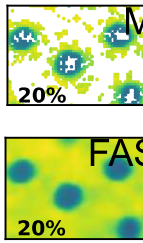


AI-driven
imaging – les

FY 2025 Request – Lab & User Facility Operatic Construction Highlights

- Scientific user facility operations, supporting 88% of operations (+$
- Upgrade core laboratory infrastructure, i.e. utilities and laboratory w through ongoing SLI infrastructure projects and General Plant Proje (+$31.7M; $50M)
- Support line-item construction and MIE projects
- Reduce backlog of deferred maintenance and improve obsolete inf at SC National Laboratories
- Continue the Laboratory Operations Apprentice Program (+$2M; $5
- SC fully funds Oak Ridge Nuclear Operations

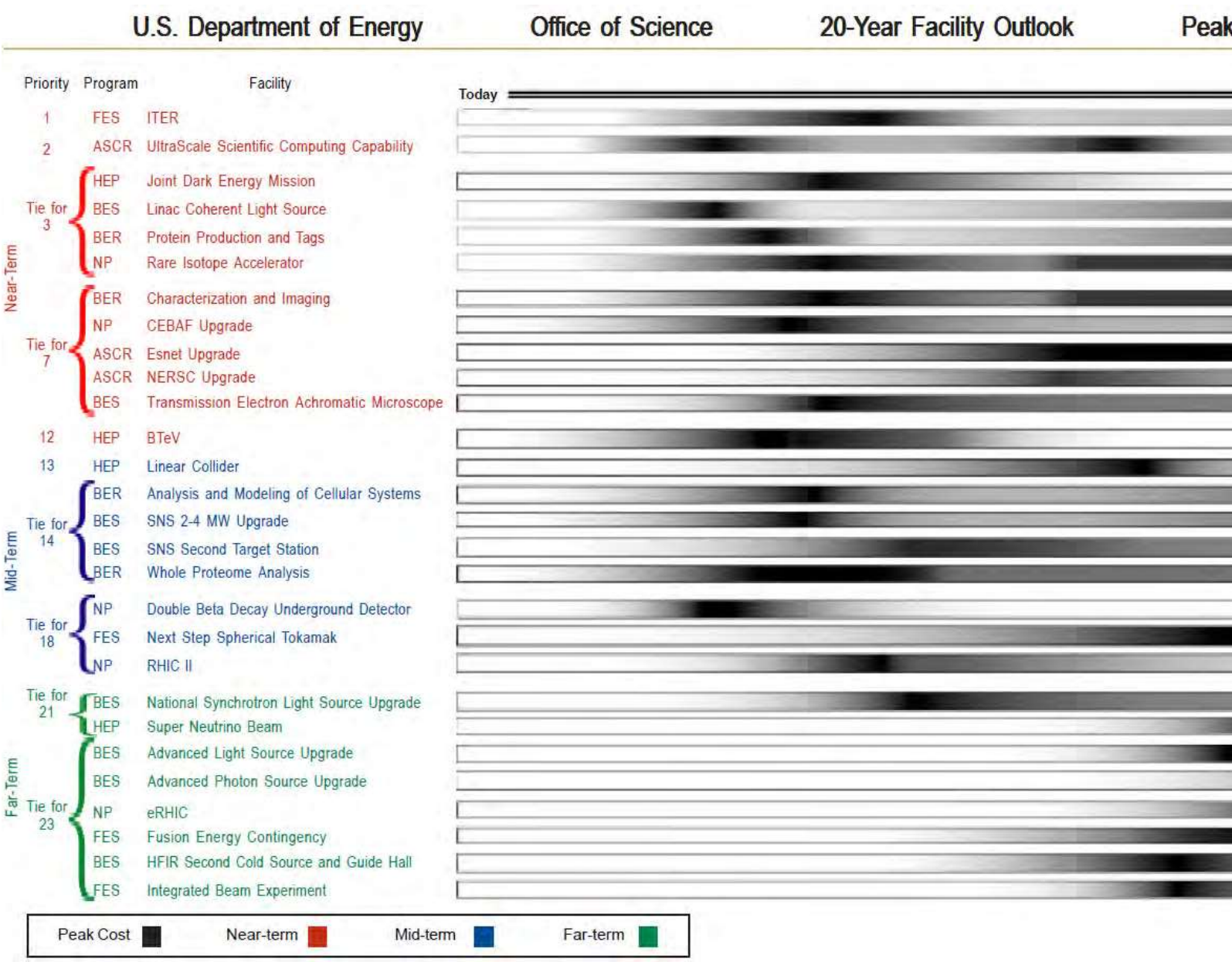
Current Advisory Charge: *2003 Facilities for the Future of Sc* established best practice of long-term planning and prioritiz

- Published in 2003, report provided a prioritized list of major scientific facilities for the next 20 years
  - Interim report highlighting progress released in 2007

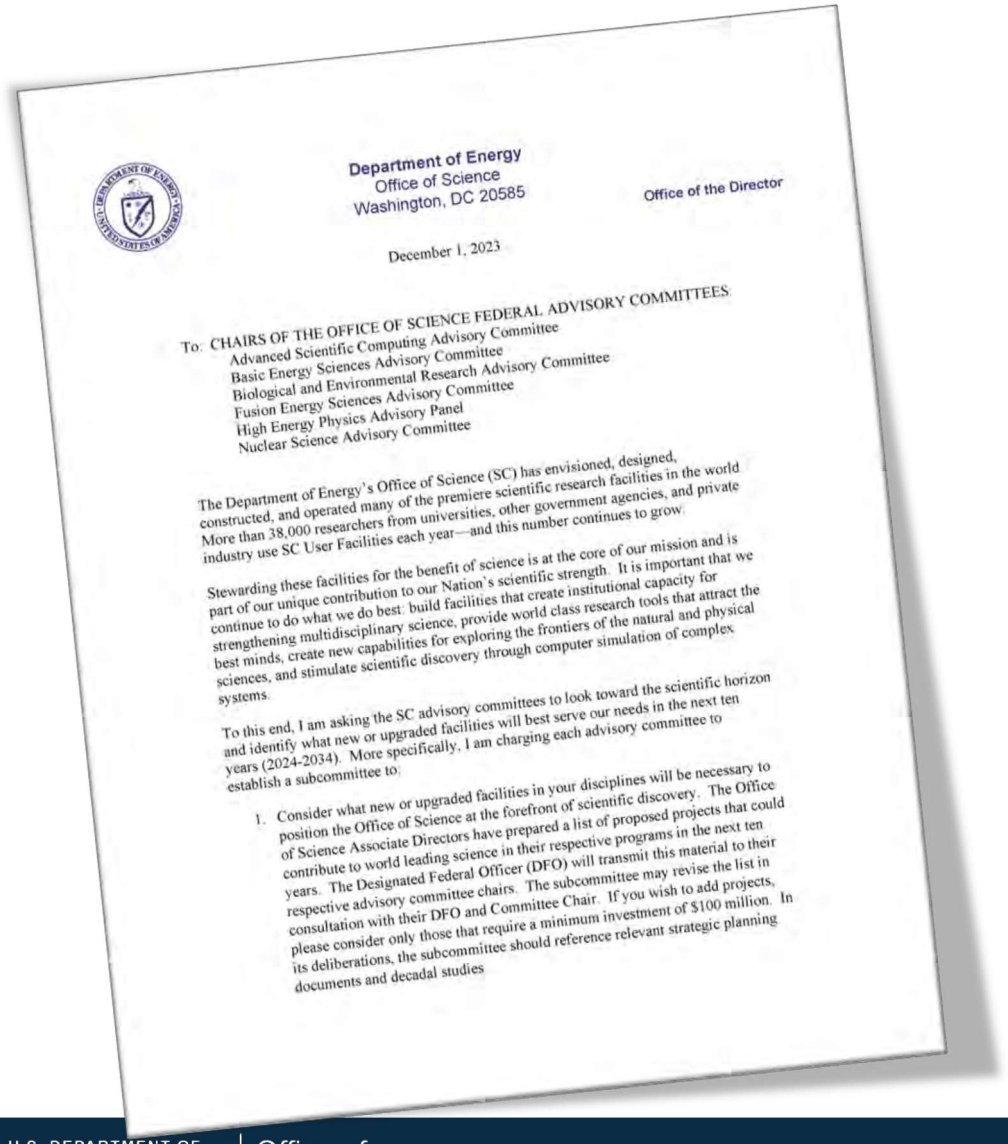
"We believe that the 20-year vision of future scientific facilities currently being developed in the Office of Science is outstanding and could have a far-reaching, positive effect on the Nation's leadership in science."

–Dr. Charles M. Vest, Chair of SEAB Task Force on the Future of Science Programs

2003 Report prioritized projects across scientific disciplines by focusing on world leadership, timeliness



Now is the time for an updated plan to advance U.
science & innovation leadership for the next decad



Department of Energy
Office of Science
Washington, DC 20585

Office of the Director

December 1, 2023

To: CHAIRS OF THE OFFICE OF SCIENCE FEDERAL ADVISORY COMMITTEES
Advanced Scientific Computing Advisory Committee
Basic Energy Sciences Advisory Committee
Biological and Environmental Research Advisory Committee
Fusion Energy Sciences Advisory Committee
High Energy Physics Advisory Panel
Nuclear Science Advisory Committee

The Department of Energy's Office of Science (SC) has envisioned, designed, constructed, and operated many of the premiere scientific research facilities in the world. More than 38,000 researchers from universities, other government agencies, and private industry use SC User Facilities each year—and this number continues to grow.

Stewarding these facilities for the benefit of science is at the core of our mission and is part of our unique contribution to our Nation's scientific strength. It is important that we continue to do what we do best: build facilities that create institutional capacity for strengthening multidisciplinary science, provide world class research tools that attract the best minds, create new capabilities for exploring the frontiers of the natural and physical sciences, and stimulate scientific discovery through computer simulation of complex systems.

To this end, I am asking the SC advisory committees to look toward the scientific horizon and identify what new or upgraded facilities will best serve our needs in the next ten years (2024-2034). More specifically, I am charging each advisory committee to establish a subcommittee to:

1. Consider what new or upgraded facilities in your disciplines will be necessary to position the Office of Science at the forefront of scientific discovery. The Office of Science Associate Directors have prepared a list of proposed projects that could contribute to world leading science in their respective programs in the next ten years. The Designated Federal Officer (DFO) will transmit this material to their respective advisory committee chairs. The subcommittee may revise the list in consultation with their DFO and Committee Chair. If you wish to add projects, please consider only those that require a minimum investment of $100 million. In its deliberations, the subcommittee should reference relevant strategic planning documents and decadal studies

- SC Director Berhe charged ea advisory committee to form subcommittee to assess list of facilities from Associate Direct
- Assessment on:
  - The potential to contribute to w leading science in the next deca
  - The readiness for construction.
- Assessments due to Advisory Committees in May 2024
- SC leadership will gather inpu develop a prioritized strategy facility investments for next de

OFFICE OF SCIENCE BY THE NUMBERS

Delivering scientific discoveries and major scientific tool
transform our understanding of nature and advance the
economic, and national security of the United States

6 CORE SCIENCE PROGRAMS

- Advanced Scientific Computing Research
- Basic Energy Sciences
- Biological and Environmental Research
- Fusion Energy Sciences
- High Energy Physics
- Nuclear Physics

3 ENGINEERING AND TECHNOLOGY OFFICES

- Accelerator Research and Development and Production
- Isotope Research and Development and Production
- Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)

5 NATIONAL QUANTUM INFORMATION SCIENCE RESEARCH CENTERS

ACROSS ITS 10 NATIONAL LABS, OFFICE OF SCIENCE MAINTAINS APPROXIMATELY

24 MILLION
SQUARE FEET OF SPACE

1,600
BUILDINGS

38,000
ACRES OF LAND OWNED

SUPP RESE SPAN

1
D
NATION

5
STATES
PUERTO
WASHIN

>3
UNIVERS
HIGHER-
INSTIT

STEWARDS 10 DOE NATIONAL LABORATORIES

3
World-Leading Supercomputers

ESTIMATED RESEARCHERS SUPPORTED

11,100 Permanent PhDs

3,400 Postdoctoral Associates

5,200 Graduate Students

9,700 Other Scientific Personnel

OVER 39,500 USERS AT 28 OFFICE OF SCIENCE FACILITIES

10
SITE OFFICES

1
CONSOLIDATED SERVICE CENTER

OVER 100 NOBEL PRIZES

$8.1 BILLION
OVERALL OFFICE OF SCIENCE BUDGET

$918 MILLION
USER FACILITY CONSTRUCTION

$281
SC
LABOR
INFRAS

Basic Energy Sciences

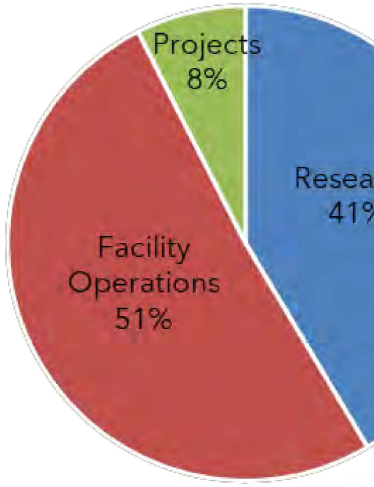
Andy Schwartz, Acting Associate Director

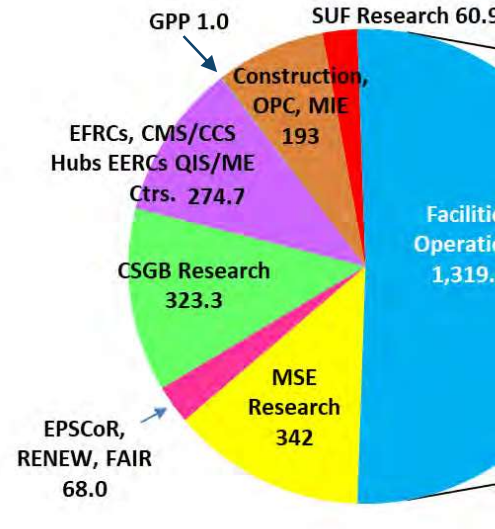
U.S. DEPARTMENT OF ENERGY | Office of Science

Energy.gov/

FY 2025 Request: $2,582.3M (-$43.3M or 1.65% below FY 202

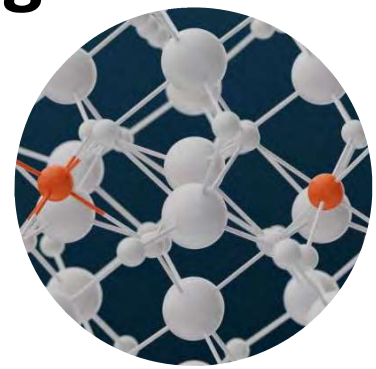
- **Research programs** (Δ = -$18.1M) continues support for core research and crosscutting initiatives, including:
  - Artificial Intelligence/Machine Learning (AI/ML)
  - Microelectronics
  - DOE Energy Earthshots
  - Multi-disciplinary, Multi-institutional Team Science
  - Broadening Participation (i.e., RENEW, FAIR, EPSCoR)
- **Scientific user facilities** (Δ = +$81.4M) supports:
  - Operation of 12 user facilities at 90% of normal operations.
  - Facilities R&D (e.g., AI/ML, accelerator and detector R&D)
- **Construction/MIE Projects** (Δ = -$106.6M) continues support for major projects (e.g., LCLS-II-HE, STS)



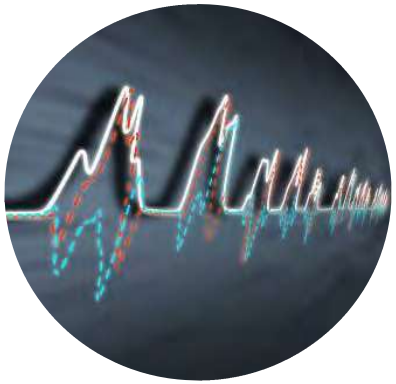


BES Artificial Intelligence and Machine Learning

(+$17.4M, 60% above FY 2024 Enacted)



- AI for Science
  - Accelerate scientific discovery and realize broader insights from shared datasets
  - Develop surrogate models for expensive or time-constrained experiments
  - Learn from multi-modal, sparse, and/or noisy data
- AI for User Facilities
  - Guided by BES Roundtable on Producing and Managing Large Scientific Data with AI/ML
  - Enhance efficiency of facility operations and design of experiments
  - Transform real-time analysis of data
  - Predict and mitigate instrument/facility down time (e.g., use of digital twins)
  - Enable self-driving, autonomous instrumentation and experiments

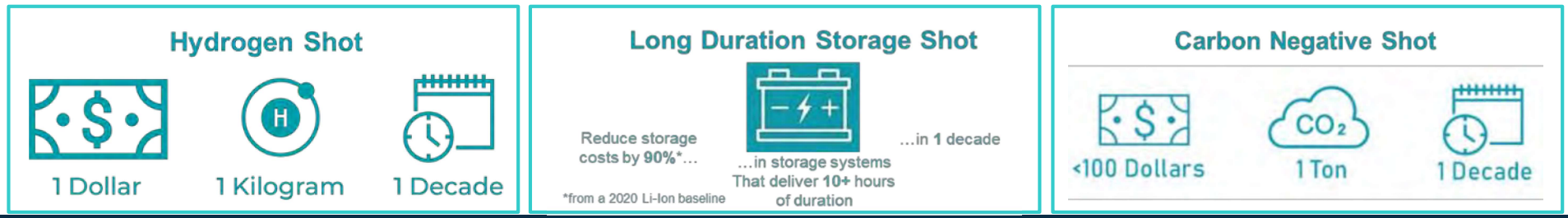


BES Advanced Microelectronics (+$5M above FY 2024 Enac

- Support for SC Microelectronics Science Research Centers will comprise a network of multiple team awards
  - Each Center will be made up of individual team awards that focus on research required for a co Center goal
  - Multidisciplinary teams will include researchers from universities, national laboratories, and in
- Continues coordinated SC support for multi-disciplinary research to accelerate the innovation and advancement of microelectronic technologies in a co-design ecosyste
- Includes fundamental research on materials, chemistries, processing, isotopes, devic systems, architectures, algorithms, and software
- Builds on capabilities at SC user facilities for computation, fabrication, and characteri
- Provides foundational knowledge for development of next-generation technologies i computing, communications, sensing, and power
- This basic research complements later-stage investments being made by other agenc through the CHIPS Act

BES SC Energy Earthshots (+$45M above FY 2024 Enacted) – Includes All Energy Earthshots

- Increases investments in fundamental research to accelerate breakthroughs required to address challenges for the stretch goals of the DOE Energy Earthshots
  - Eight Energy Earthshots have been announced; New for FY 2024 and 2025 are the Affordable Home and Clean Fuels/Products Energy Shots
- Continues the Energy Earthshot Research Centers (EERCs) established in FY 2023
- Advances foundational knowledge and state-of-the-art capabilities in experimental, theoretical, and computational sciences needed to realize new approaches and solutions
- Large, multi-investigator, multi-disciplinary national laboratory-led teams
- Close coordination with the Energy Technology Offices and existing research consortia/demonstration projects to enhance cross-office research cooperation
- EERCs are complemented by small group awards focused on use-inspired fundamental research to address knowledge gaps that limit achievement of the Energy Earthshot goals



FY 2025 Team Science Continues

BES will continue support of team science research centers/awards that core research program advances in and are critical to clean energy and innovation.

- Energy Frontier Research Centers – Continued support for 4-year awards from FYs
- Energy Earthshot Research Centers – Continued support for 4-year awards from FY
- Fuels from Sunlight Energy Innovation Hub Program – Renewal of two awards initia
- Batteries and Energy Storage Energy Innovation Hub Program – Continued suppor based on FY 2023 recompetition.
- National QIS Research Centers – Recompetition/renewal of funding for SC QIS Cer FY 2020.
- Computational Chemical and Materials Sciences – Continued support focusing on software that takes advantage of SC leadership class computers.
  - FY 2025 recompetes Computational Chemical Sciences, placing a priority on transitionir and use of software from the Exascale Computing Project.

BES Engagement in SC Programs to Broaden Particip

RENEW (+$13M above FY 2024 Enacted; $23
Reaching a New Energy Sciences Workforce:

- Internships for emerging research institutions a minority serving institutions

FAIR (continues at $20M)
Funding for Accelerated, Inclusive Research

DOE EPSCoR (continues at $25M BES +$10M
Established Program to Stimulate Competitive

- BES manages the cross-SC-funded progra promote geographically inclusive, equitab

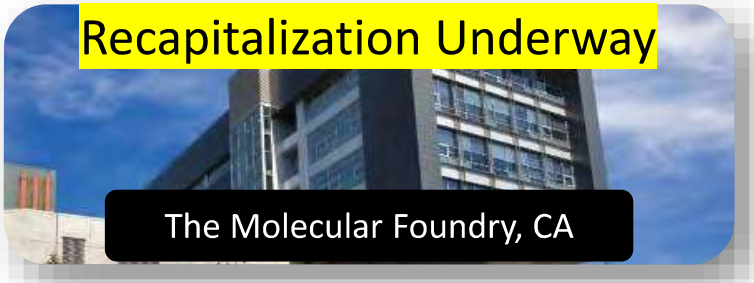
US DOE Basic Energy Sciences User Facilities

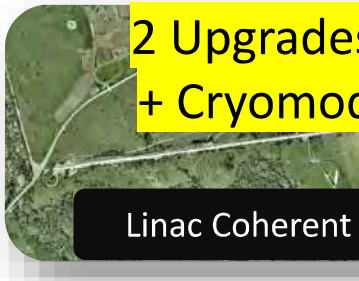
5 X-ray Light Sources
5 Nanoscale Science Research Centers
2 Neutron Sources

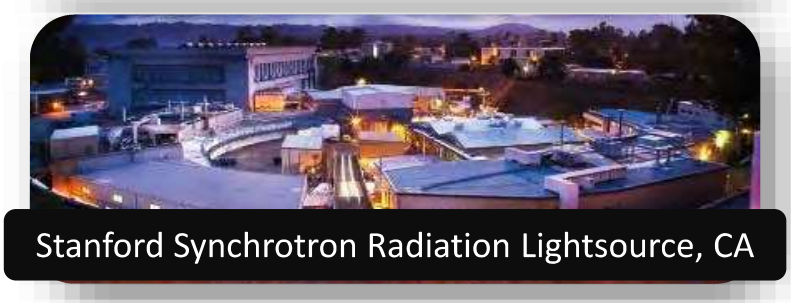
FY 2025 Request Highlights – BES User Facilities

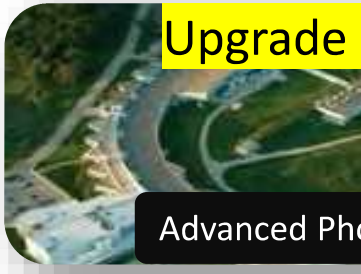
- In FY 2025, the proposed increase to BES facilities (+$84.3M above FY 202
  would support facilities at 90% of funding level required for normal operati
  baselined to account for new capabilities coming on-line following upgrad
  maintenance, inflation, supply chain costs, staffing support, and remote ope
- The FY 2025 Request continues support for the following projects:
  - NSLS-II Experimental Tools-III (NEXT-III)
  - High Flux Isotope Reactor Pressure Vessel Replacement (HFIR-PVR)
  - Linac Coherent Light Source-II High Energy (LCLS-II-HE)
  - Spallation Neutron Source Second Target Station (STS)
  - Cryomodule Repair & Maintenance Facility (CRMF)
- While no funding is requested for Major Items of Equipment (MIE), prelimin
  for future MIEs for beamlines for the Advanced Light Source, Advanced Ph
  and Stanford Synchrotron Radiation Lightsource would be supported.

BES User Facilities: Operating and Maintaining 12 World-leading Capa









Update: BRN for Accelerator-Based Instrumentatio

The brochure for the Workshop *Basic Research Needs for Accelerator-Based In* is available on the BES website.
https://science.osti.gov/-/media/bes/pdf/brochures/2024/24-G00737-BRN-ABI-brochure-Final.pdf

Five priority research directions to revolutionize accelerator-based instrumentation have been developed:

- Realize next-generation capabilities that achieve theoretical performance limits
- Tailor and control beams with unprecedented precision and speed to probe complexity in matter.
- Accelerate advanced modeling, real-time feedback, fully-integrated co-design, and physical-digital fusion.
- Lead innovation in new materials, system design, and advanced fabrication as a foundation for integration of technologies in accelerator-based facilities
- Understand Scientific Mechanisms that limit system performance and utilization

High Energy Physics

Regina Rameika, Associate Director

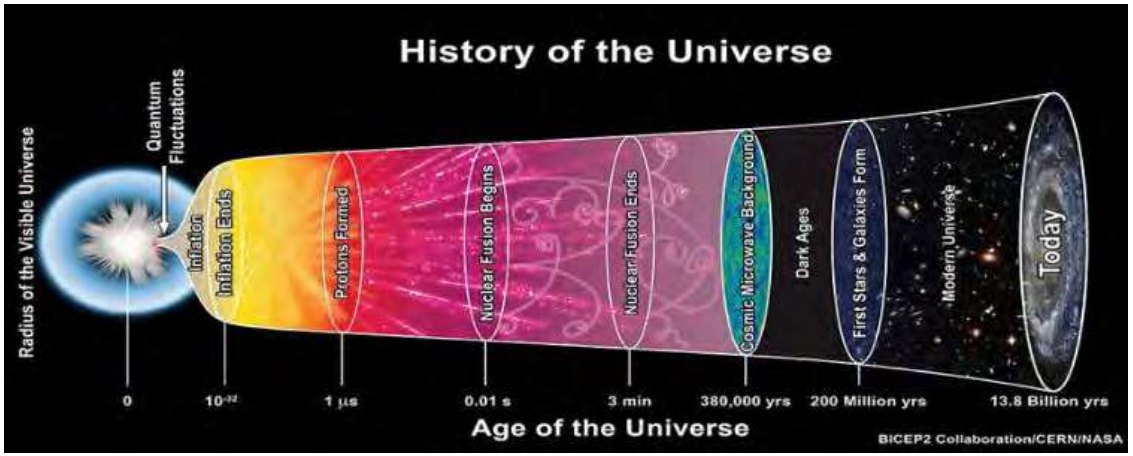
U.S. DEPARTMENT OF ENERGY | Office of Science

Energy.gov/

Office of High Energy Physics (HEP) Mission

Understanding how the universe works at its most fundamental level

- Discover the elementary constituents of matter and energy
- Probe the interactions between them
- Explore the basic nature of space and time



- HEP studies the smallest pieces of matter and the forces that govern them
  - Investigates nature of the universe immediately after the Big Bang
  - Explores physics at energies not common for past 13.8 billion years
  - Connects particles of early universe to cosmos as we see it today

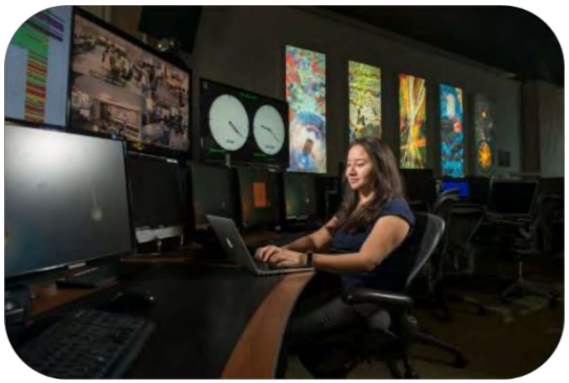
Collide

High Energy Physics (HEP)

Understanding the how the universe works at its most fundamental level

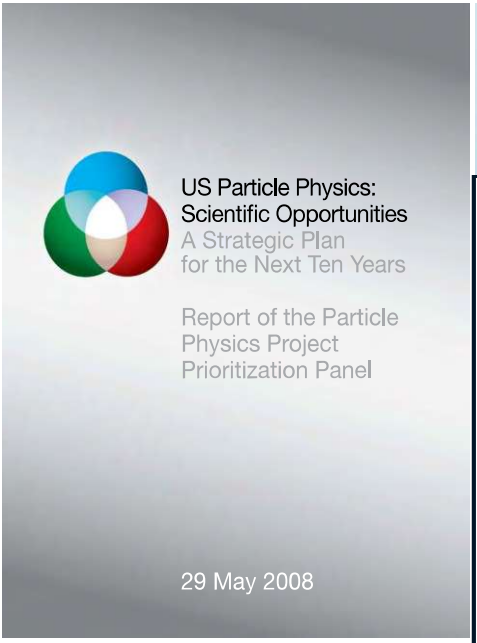
Office of Science supports HEP to carry out this mission through experiments on the Er
Intensity and Cosmic Frontier by:

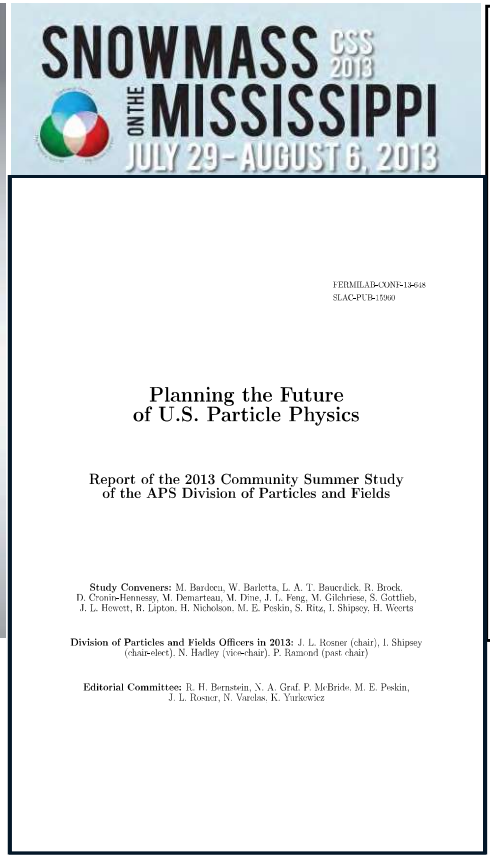
- building projects that enable discovery science
- operating facilities that provide the capability to perform discovery science
- supporting a balanced research program that produces discovery science

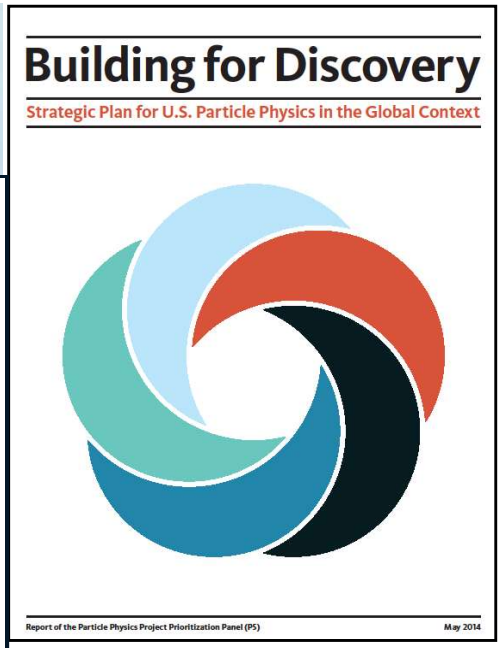


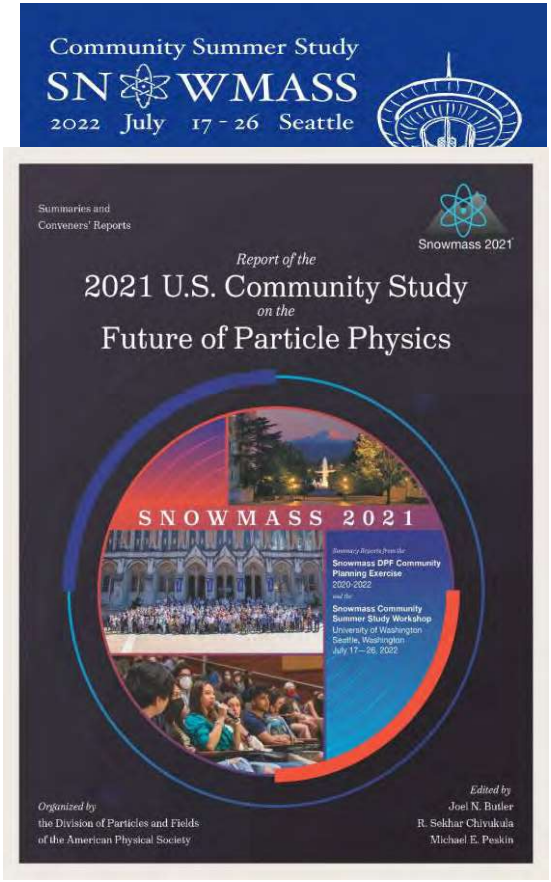

U.S. Particle Physics Strategic Planning Process

2008 → 2014 → Snowmass 2021 → PPPP → 2023

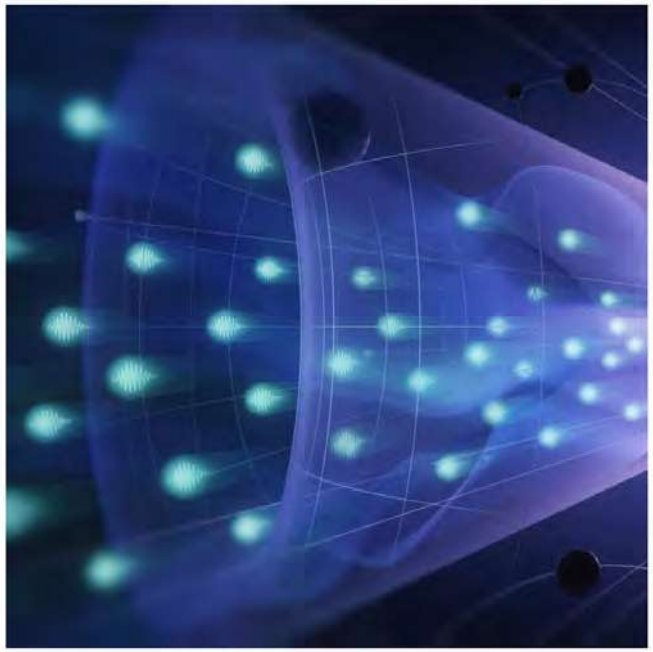








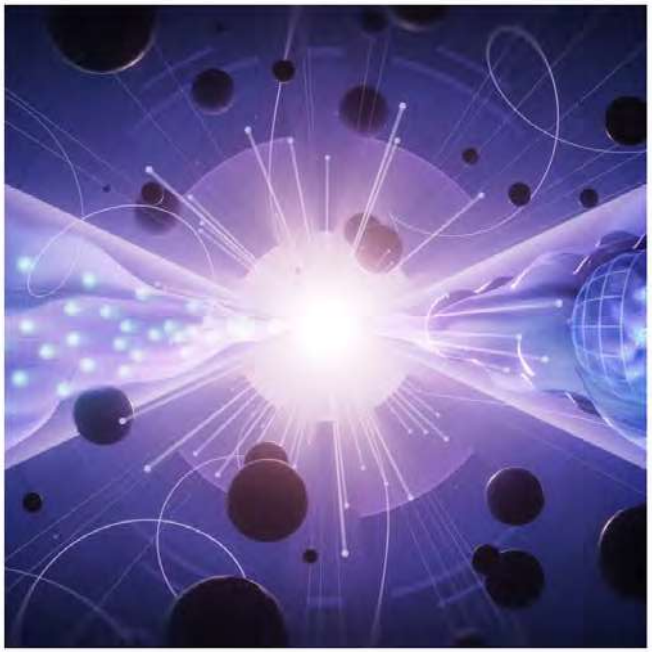
P5 2023 Science Drivers



Decipher the Quantum Realm

Elucidate the Mysteries of Neutrinos

Reveal the Secrets of the Higgs Boson



Explore New Paradigms in Physics

Search for Direct Evidence of New Particles

Pursue Quantum Imprints of New Phenomena

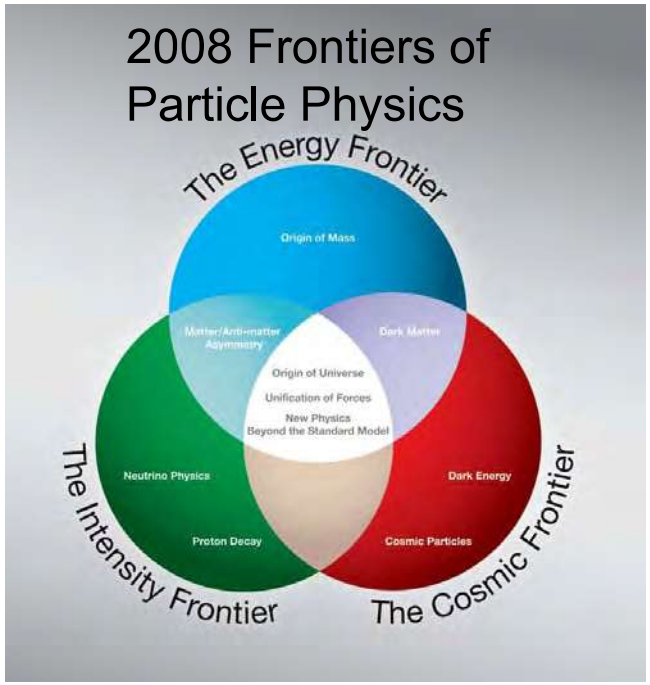
Illuminate the Hidden Universe

Determine the Nature of Dark Matter

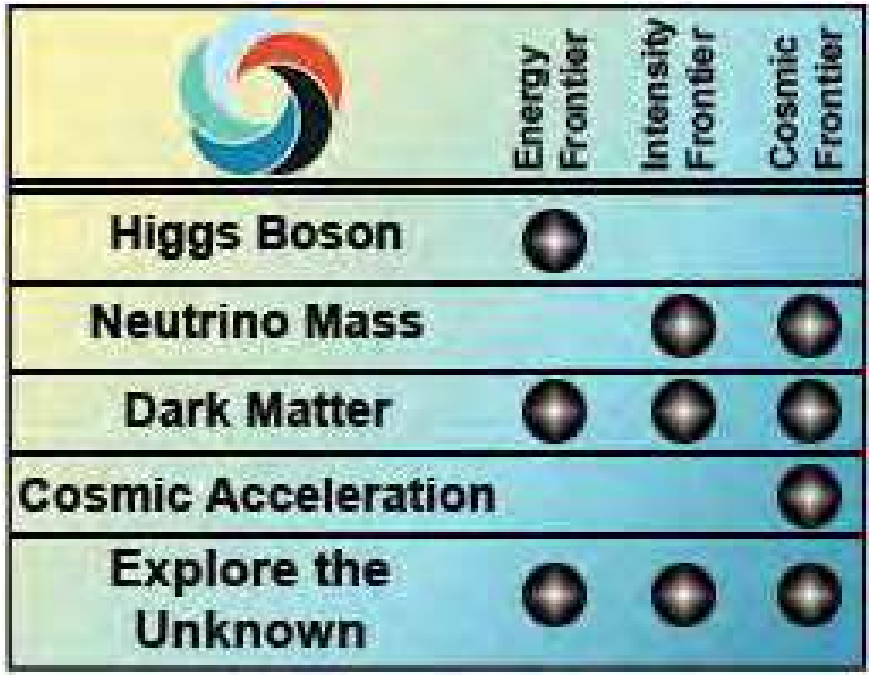
Understand What Drives Cosmic Evolution

Evolution of the key questions in particle physics

2008 Frontiers of Particle Physics



2014 Science Drivers



2023 Science D

Office of High Energy Physics at a Glance

FY 2024 Enacted: $1.2B

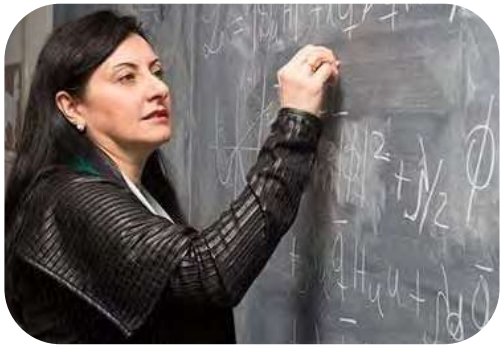
Largest Supporter (~**85%**) of Particle Physics in the U.S.

Funding at >**180** Institutions, including 12 DOE Labs

[Snowmass, July 2022, Seattle]
Over **1,120** Ph.D. Scientists and **515** Grad Students Supported

[Fermilab Acceler
Over **2,345**
2 SC Scientifi

~**30%** of Research to Universities

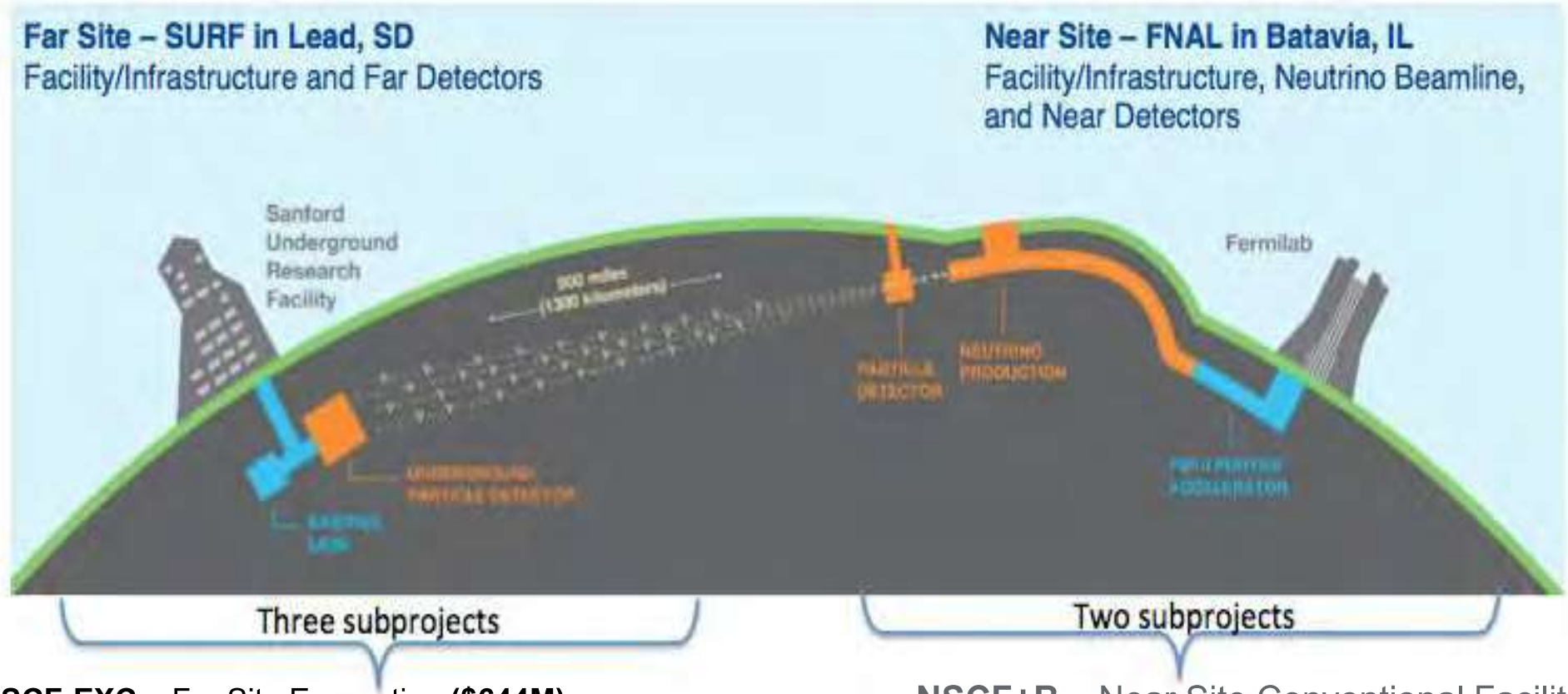


Research:
36%, $426.3M

[Vera Rubin Observatory, Chile]
Facility Operations:
29%, $348.5M

[LBNF/DUNE Cave
Projec
35%, $42

LBNF/DUNE-US Project



LBNF

- Deep (1.5 liquid detec
- A lon neutr wide

DUNE

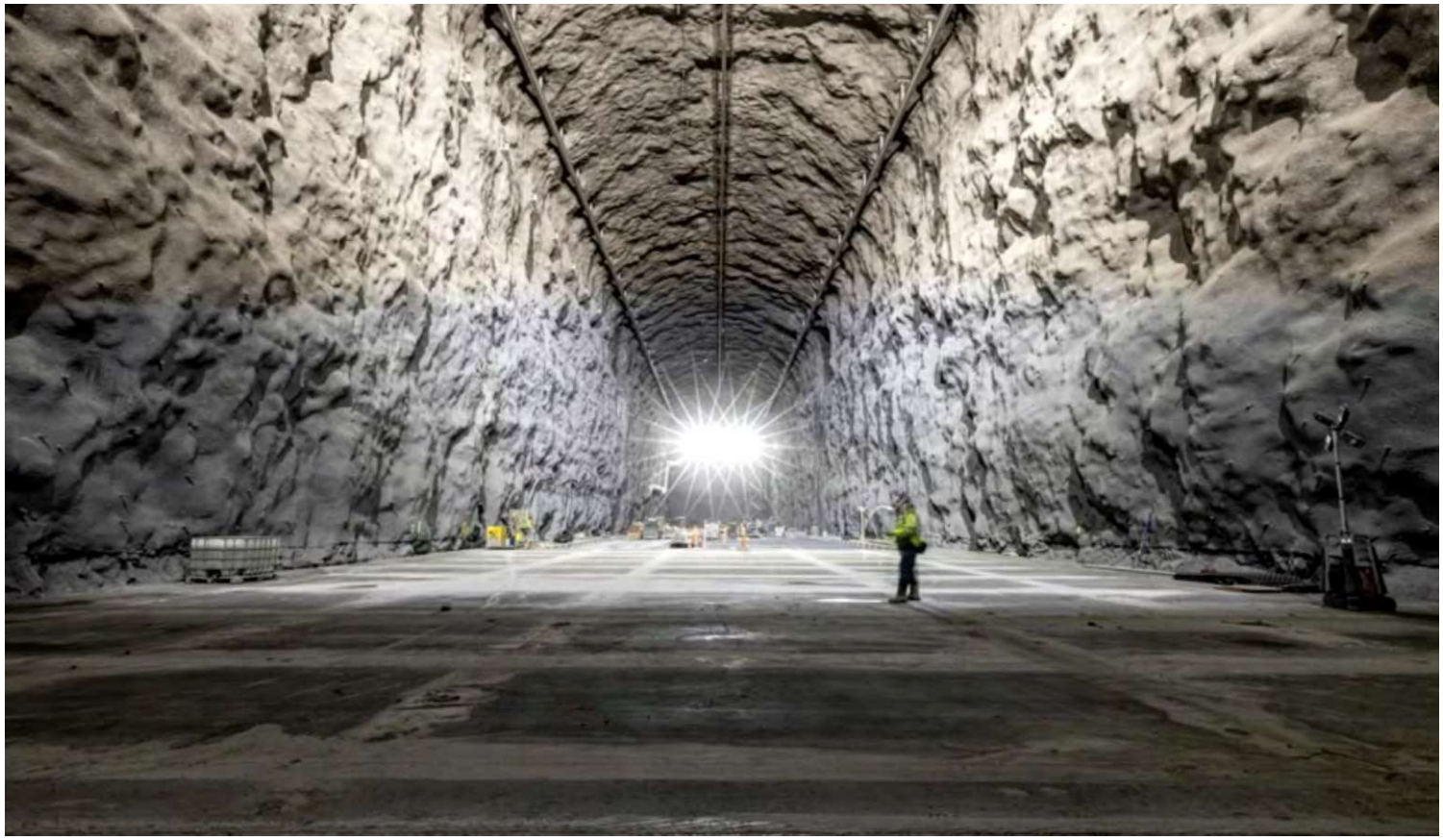
- Two F (~24
- A Nea functio detect

- **FSCF-EXC** – Far Site Excavation **($644M)**
- **FSCF-BSI** – Far Site Building & Site Infrastructure **($211M)**
- **FDC** – Far Detectors and Cryogenic Infrastructure **($1,119M)**

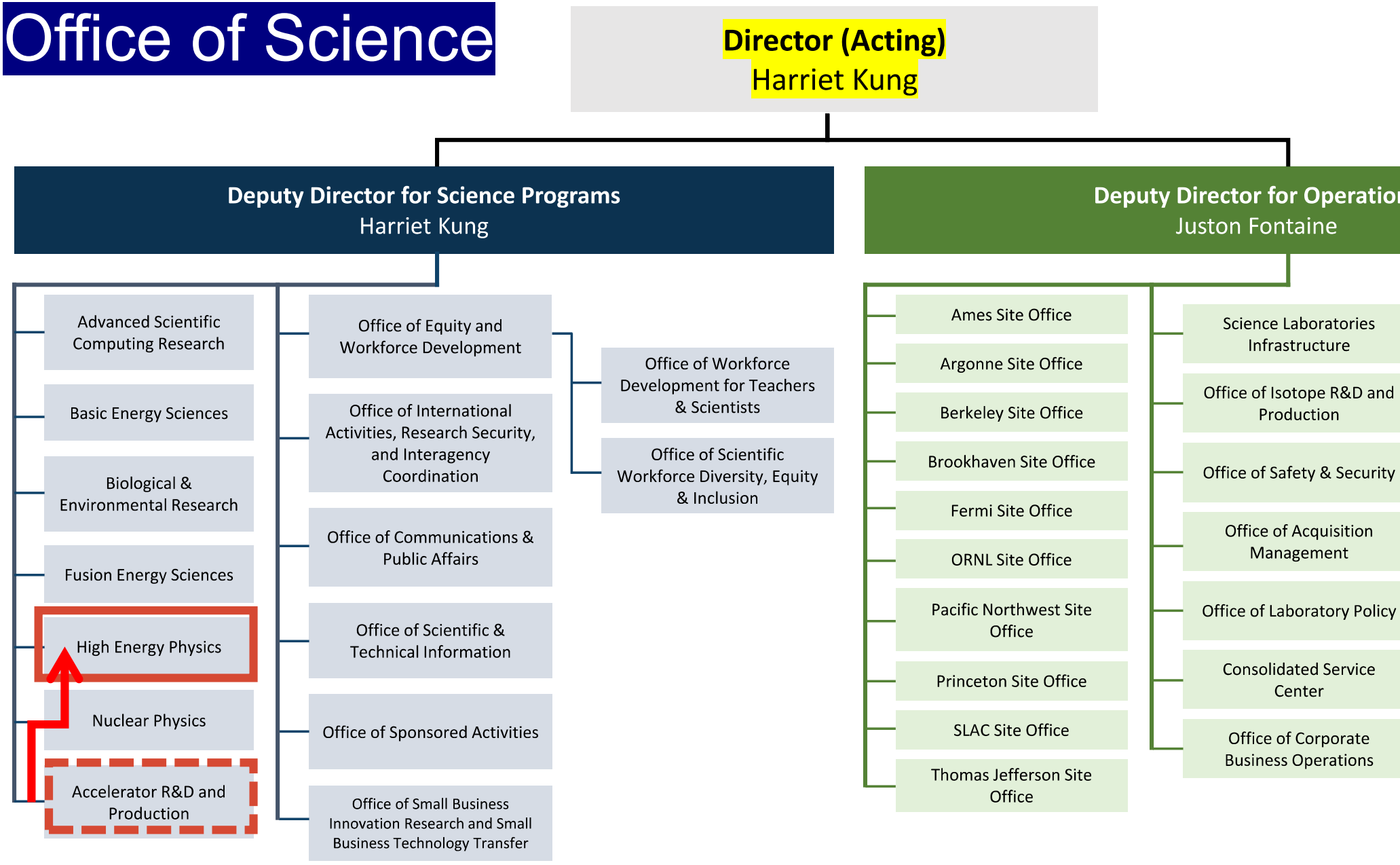
- **NSCF+B** – Near Site Conventional Facilities + Beamline **($1,103M)**
- **ND** – Near Detectors **($200M)**

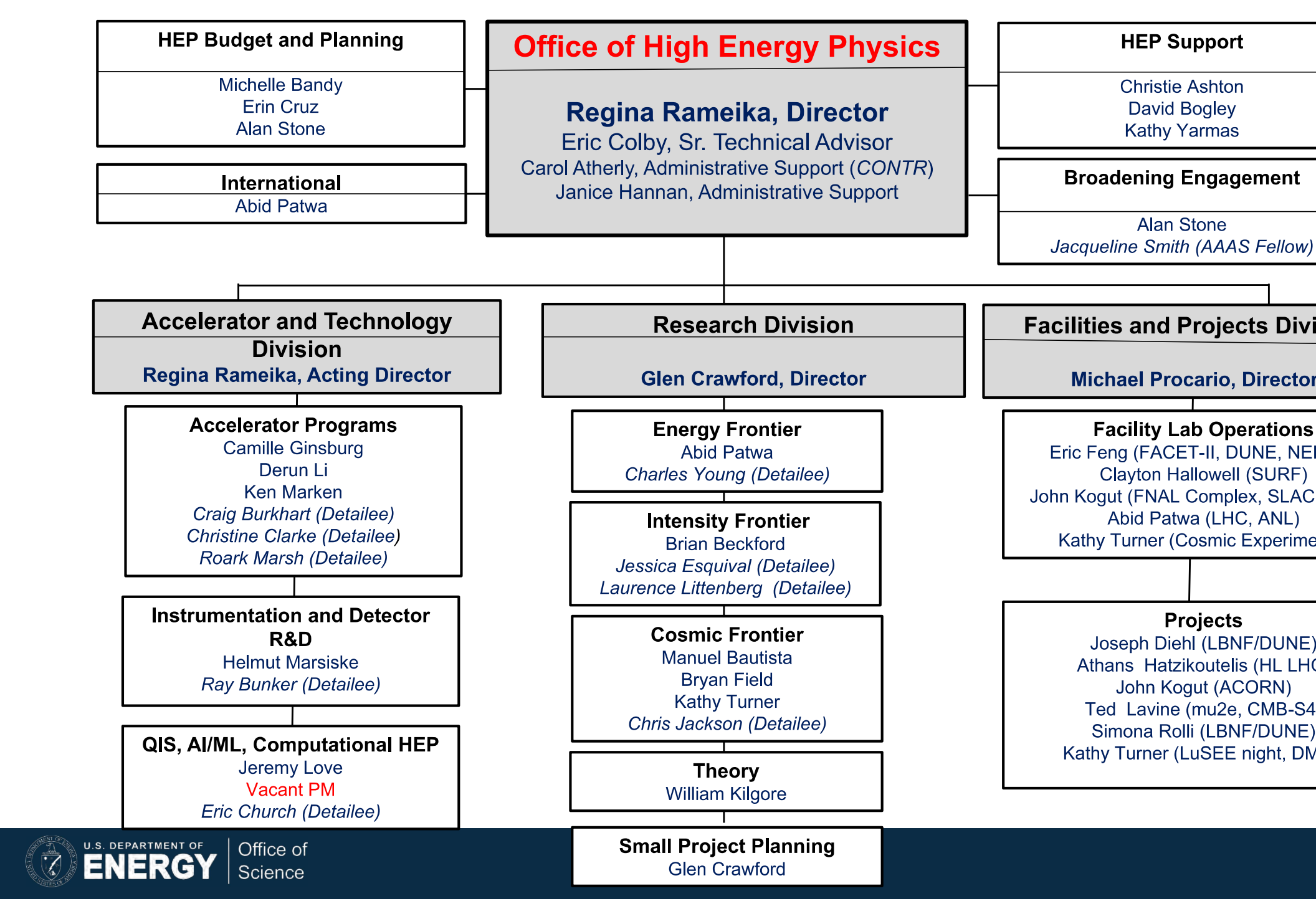
LBNF Cavern excavation at SURF : Complete!

North Cavern



Office of Science




HEP Budget and Planning
Michelle Bandy
Erin Cruz
Alan Stone
International
Abid Patwa
Office of High Energy Physics
Regina Rameika, Director
Eric Colby, Sr. Technical Advisor
Carol Atherly, Administrative Support (CONTR)
Janice Hannan, Administrative Support
HEP Support
Christie Ashton
David Bogley
Kathy Yarmas
Broadening Engagement
Alan Stone
Jacqueline Smith (AAAS Fellow)
Accelerator and Technology Division
Regina Rameika, Acting Director
Accelerator Programs
Camille Ginsburg
Derun Li
Ken Marken
Craig Burkhart (Detailee)
Christine Clarke (Detailee)
Roark Marsh (Detailee)
Instrumentation and Detector R&D
Helmut Marsiske
Ray Bunker (Detailee)
QIS, AI/ML, Computational HEP
Jeremy Love
Vacant PM
Eric Church (Detailee)
Research Division
Glen Crawford, Director
Energy Frontier
Abid Patwa
Charles Young (Detailee)
Intensity Frontier
Brian Beckford
Jessica Esquival (Detailee)
Laurence Littenberg (Detailee)
Cosmic Frontier
Manuel Bautista
Bryan Field
Kathy Turner
Chris Jackson (Detailee)
Theory
William Kilgore
Small Project Planning
Glen Crawford
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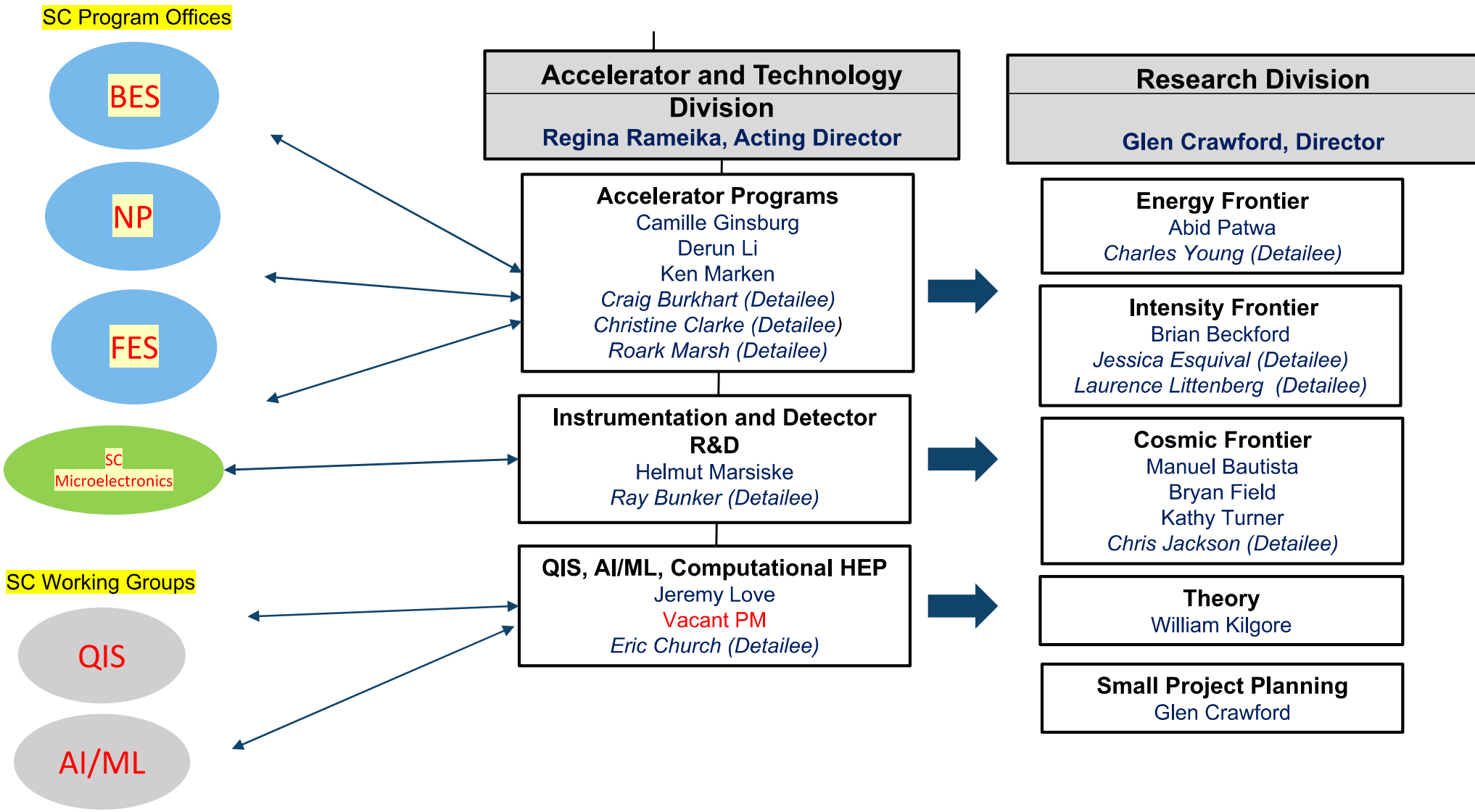
Michael Procario, Director
Facility Lab Operations
Eric Feng (FACET-II, DUNE, NE
Clayton Hallowell (SURF)
John Kogut (FNAL Complex, SLAC
Abid Patwa (LHC, ANL)
Kathy Turner (Cosmic Experime
Projects
Joseph Diehl (LBNF/DUNE)
Athans Hatzikoutelis (HL LH
John Kogut (ACORN)
Ted Lavine (mu2e, CMB-S4
Simona Rolli (LBNF/DUNE)
Kathy Turner (LuSEE night, DM
U.S. DEPARTMENT OF ENERGY
Office of Science

Introducing the Accelerator and Technology Divisio



Nuclear Physics

Sharon Stephenson, Physics Research Division Director

U.S. DEPARTMENT OF ENERGY | Office of Science

Energy.gov/

DOE Nuclear Physics Program

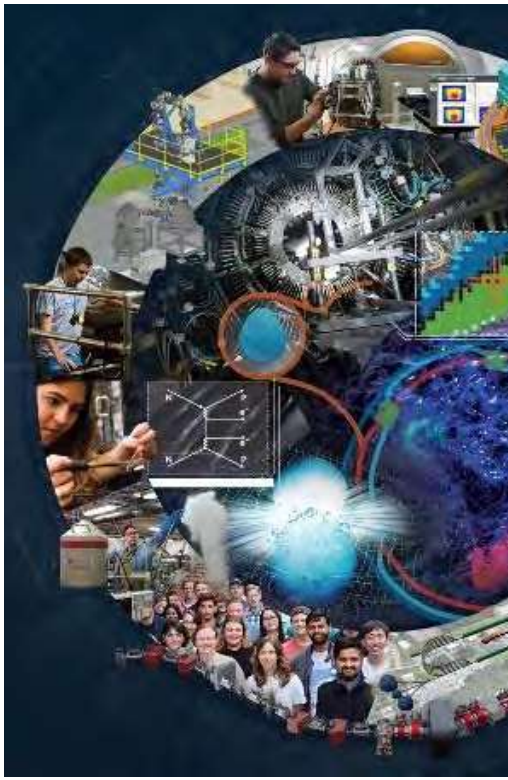
Understanding why matter takes on the specific forms observed in nature and how that knowledge can benefit energy, economic, and national security

- **Quantum Chromodynamics**: Mapping the inside of the proton; Discovering the properties of quark-gluon plasma; and Exploring mechanisms underlying confinement of quarks and gluons
- **Fundamental Symmetries**: Searching for new exotic particles and violations of nature's symmetries
- **Nuclei and Nuclear Astrophysics**: Determining the limits of nuclear existence and how heavy elements are made in stars
- **Neutrino-less Double Beta Decay**: Discovering if the neutrino is its own anti-particle or if the neutron's precise properties point to new physics
- **Nuclear Theory**: Exploring the strong force in many-body systems
- **Nuclear Data**: Curation of accurate nuclear data for space, energy, and research

The New NSAC Long Range Plan: A New Era of Dis

Capitalize on the extraordinary opportunities for scientific discovery made possible by the substantial and sustained investments of the United States. We must draw on the talents of all in the nation to achieve this goal.

We reaffirm the exceptionally high priority of the following two investments in new capabilities for nuclear physics. The Electron–Ion Collider (EIC), …will elucidate the origin of visible matter in the universe and significantly advance accelerator technology… Neutrinoless double beta decay experiments have the potential to dramatically change our understanding of the physical laws governing the universe.



As the highest priority for new *experiment* construction…, lead an international consc
undertake a neutrinoless double beta decay campaign.

We recommend the expeditious completion of the EIC as the highest priority for *facil*

Capitalize on the unique ways nuclear physics can advance discovery science and app
society.

Four World-Leading National User Facilities Driving

Relativistic Heavy Ion Collider

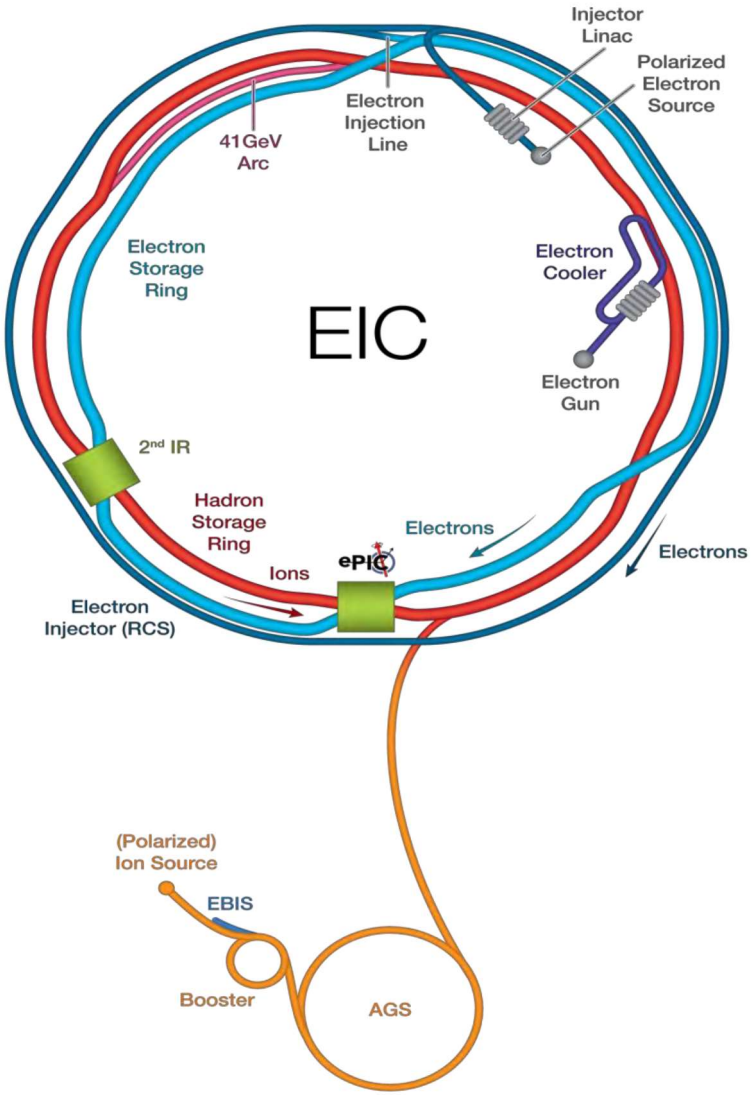
Continuous Electron Beam Accelerator Facili

Argonne Tandem Linac Accelerator System

Facility for Rare Isotope Beams

"Microscopes" with Complementary Resolving Power

Top Priority for New Facility Construction in the 2023 Lo Plan: Expedient Completion of the Electron-Ion Col



The EIC will be the most advanced accele world and the only new collider built for will maintain US leadership in accelerator

Status:

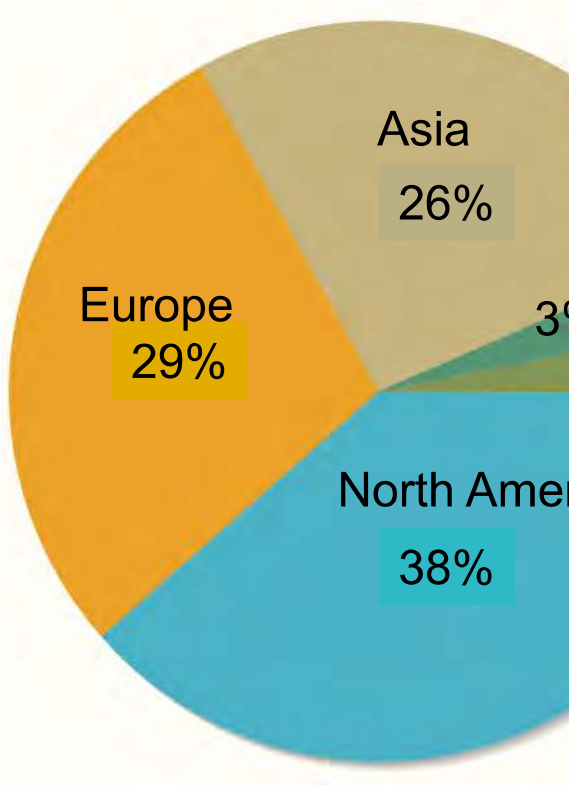
- CD-3A approved March 2024
  - ~$90M in procurements to reduce
- Project continues to support prelimina engineering & design and execution o procurements
- Pursuing additional long lead procure (CD-3B) followed by CD-2

The Electron-Ion Collider is International at

EIC Users Group Formed in 2016
EICUG.ORG

Status April 2024:

- Collaborators **1491**
- Institutions **291**
- Countries **40**



International Contributions to the Electron-Ion C

- The EIC Project is envisioning international contributions to the EIC approximately $100M, and contributions to the accelerator of appro $50M
  - 100% of these contributions have been notionally identified by international partners and interest continues to grow
- Two entities established to coordinate EIC in-kind contributions
  - EIC Advisory Board – Meets quarterly and provides guidance and the BNL Director on the design and construction of the EIC acce facility and on the efforts to establish partnerships with institution collaborating on the facility
  - EIC Resource Review Board (RRB) – Meets twice per year and pro coordination among the different funding partners during both t detector development and construction phase of the project and the operations of the experiments that follow

NP Projects Status

Project	Location	Status	Cost
Construction Projects			
Electron-Ion Collider (EIC)	BNL	CD-3A	$1.7B to $2.8B (Est)
Major Items of Equipment			
Gamma Ray Energy Tracking Array (GRETA) [FF]	LBNL	CD-2/3	$58.3M (TPC)
Measurement of Lepton-Lepton Electroweak Reactions (MOLLER) [FF]	TJNAF	CD-3A	$45.8M to $56.6M (Est)
High Rigidity Spectrometer (HRS)	MSU	CD-1	$85.0M to $111.4M (Est
Ton Scale Neutrinoless Double Beta Decay (TS-NLDBD) Program	TBD	CD-0	$215M to $250M (Est)

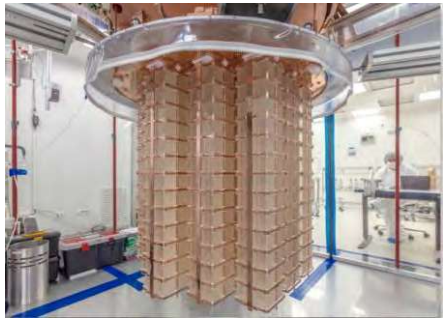
FY 2023 Enacted	FY 2024 Enacted	FY 2025
EIC at TEC of $50M and OPC of $20M	**EIC** at TEC of $95M and OPC of $2.9M	**EIC** at TEC of $110M and
GRETA at optimal level, providing the project with the final year of funding ($15.5M) **MOLLER** receives the final $4M of planned TEC funding **TS-NLDBD** at $1.44M TEC **HRS** at $3M TEC	**GRETA** and **MOLLER** received full TPC amount in FY23 Request. Progress continues, but no new funding requested in FY24. **TS-NLDBD** at $3M TEC **HRS** at $3M TEC	**GRETA** and **MOLLER** rece amount in FY23 Request. F but no new funding reque **TS-NLDBD** at $2M TEC **HRS** at $3.3M TEC

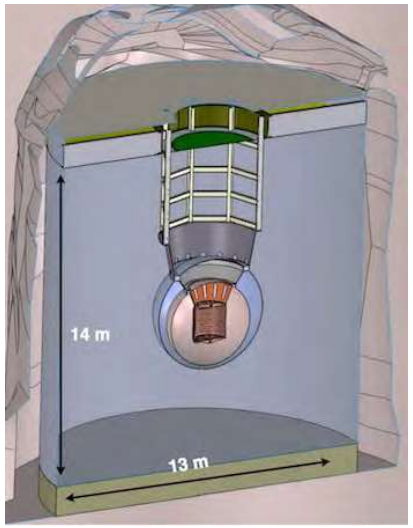
Top Priority for New Experiment Construction
2023 Long Range Plan : Neutrinoless Double Bet

- Between IRA funding and NP Program Funding, ~$20M has been allocated since 2020 to explore three technologies: LEGEND 1000, nEXO, and CUPID; supporting conceptual design and R&D
- Significant resources are required from international partners to realize more than one ton-scale experiment
- The inability to procure isotopes from countries of concern is being addressed and there is engagement with alternate vendors
- A working group has been established and charged with defining an organizational framework for a Virtual Global DBD Observatory
- A 3rd DBD international summit is being planned for spring 2025

Three Proposed Technologies

- Scintillating bolometry (**CUPID**, ^{100}M Li_2Mo_4 crystals)
- Enriched ^{76}Ge crystals (**LEGEND-1**0 charge, point contact detectors)
- Liquid Xenon TPC (**nEXO**, light via S ionization)





Potential Partners:
Italy, Canada, and Germany

Summary

- NP continues to steward the world-leading nuclear physics program, de new science and operating unique user facilities with the support of an outstanding workforce.
- The Electron-Ion Collider (EIC) Project continues to progress, now at CD- Lead Procurement). Support from annual appropriations is essential to m timely progress and enable an efficient workforce transition from the Re Heavy Ion Collider.
- The FY 2025 Request will balance support for the highest priority efforts capabilities in fundamental NP research and projects with robust (at nea of optimal budget) support of user facility operations, maintenance, and upgrades of NP National User Facilities.

Advanced Scientific Computing Research

Ceren Susut, Associate Director

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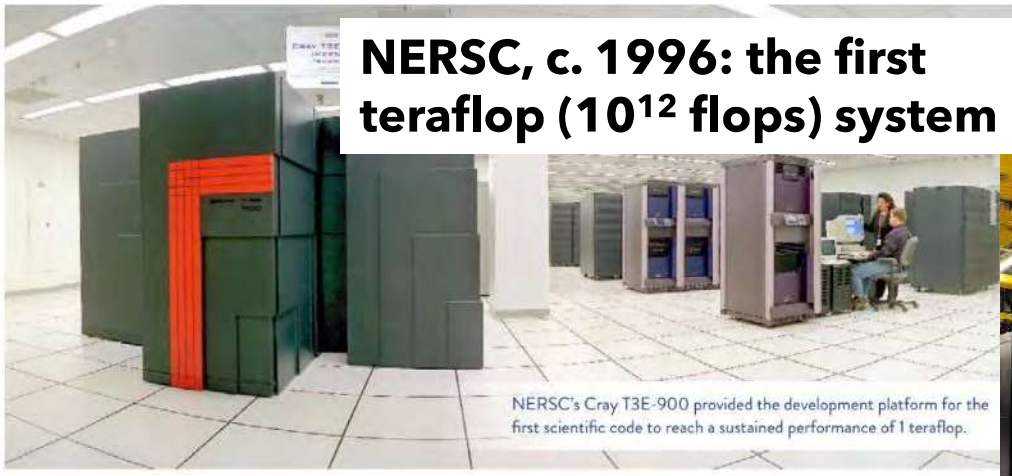
Energy.gov/

ASCR – over 70 years of Advancing Computational

Beginnings: During the Manhattan Project, John Von Neumann advocated for the creation of a Mathematics program to support the continued development of applications of digital computing

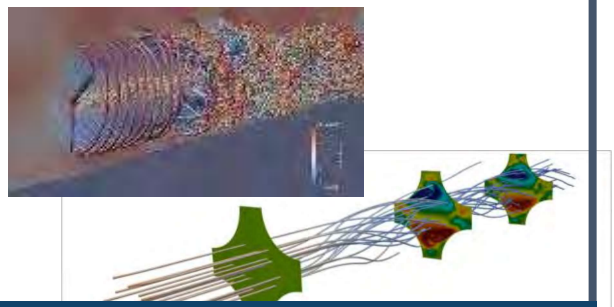
Over 40+ years, ASCR has a rich history of investment in computational science and applied mathematics research, and revolutionary computational and network infrastructure.



FY 2023 Enacted	FY 2024 Enacted	FY 2025 President's Request
$1,068M	$1,016M	$1,153M

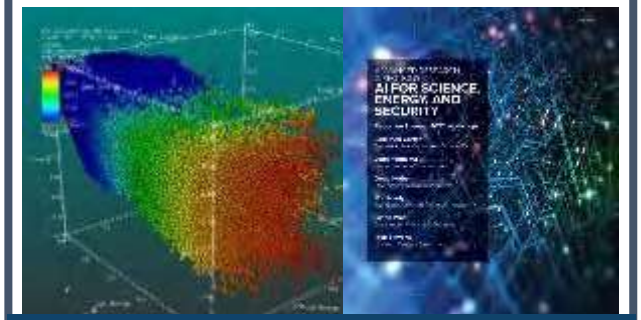
ASCR Research Responds to Critical Technology T

Advanced Modeling, Simulation, and Visualization



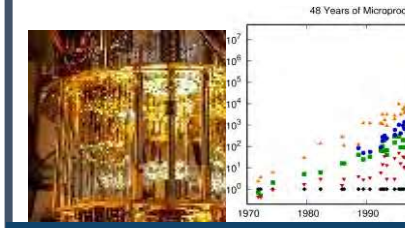
Empowering Science Through Fundamental Research

Frontier AI & Data



Creating Trustworthy and Energy Efficient Frontier AI

Heterogeneous, D Co-Designed, Efficient Compu Algorithr



Transforming Funda of Computing

Software Complexity for Increased Versatility

Enhancing Scientific Programming

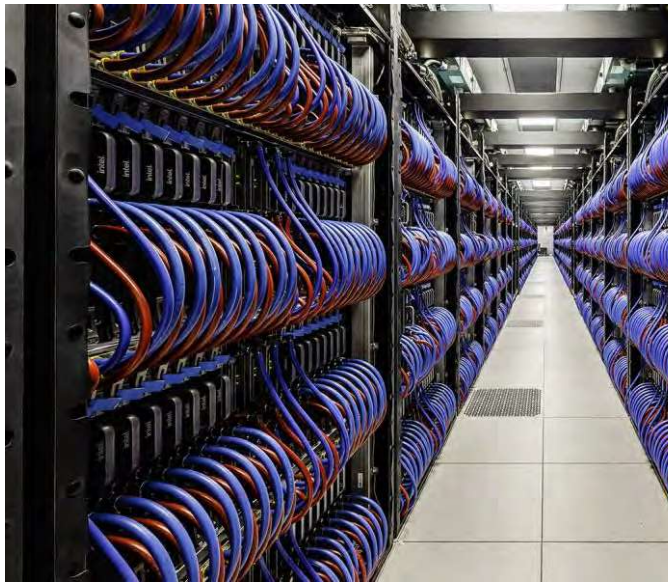
High-Performance Computing and Networking Experiments, Exascale and the Edge

Accelerating Science from Exascale to the Edge

ASCR Facilities: Major systems

OLCF
Frontier

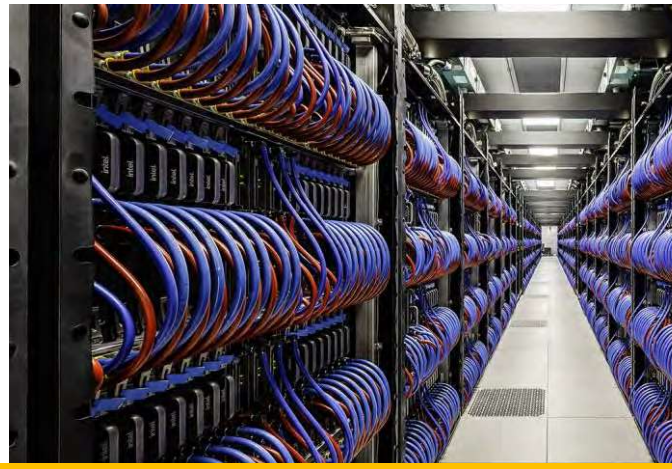
ALCF
Aurora



NERSC
Perlmutter

ASCR Facilities: Major systems

OLCF Frontier



Each ASCR Facility is an Innovation Er

NERSC Perlmutter

ASCR Launched The Exascale Science E

Le

Leadership in computational capability

Leadership in energy efficiency

A New Science Era: Exascale Today Enables the AI o Tomorrow

Long-term investments in applied mathematics and computer science enabled exascale.

MPICH2

R&D 100

2005

TOP500 #1

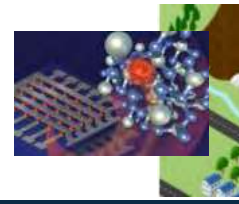
GREEN 500 #2

HPL-MxP #1

Frontier and Aurora #1 and #2 on the Top500, **lead the world in computational capability**, and is also **#2 in the world in energy efficiency**, and is **#1 in the world for AI capability**.

The exascale and A era will lead to dra to predict extreme impacts on the ele weather and clima

and will ac design and clean-ener create a be



ASCR contributions to the NAIRR Pilot

- **OLCF Summit:** To provide computational resources to the research community in support of President Biden's Executive Order, DOE extended operations of ORNL's Summit supercomputer through October 2024 to support the NAIRR Pilot and other high priority DOE research projects.
- **ALCF AI Testbed**: NAIRR Pilot users may apply to access the ALCF AI Testbed, a resource platform supporting AI and data-centric workloads on next-generaiton AI hardware.
- DOE national laboratory experts are sharing knowledge and participating in community-driven AI software and AI user outreach activities.
- DOE is participating in the federal NAIRR Pilot Program Management Office.

DOE, with NIH, is co-leading the NAIRR Secure Pilot to inform design of NAIRR Secure:

- DOE is expanding its efforts in trustworthy and responsible AI research and will showcase ORNL's CITADEL framework as an example of research infrastructure to enable researchers to safely and securely process protected data at scale.
- DOE is expanding its research efforts under its Biopreparedness Research Virtual Environment (BRaVE) program with a new project that will leverage generative AI to create a high-quality set of synthetic pathology reports. This effort builds on a longstanding partnership between DOE, the National Institutes of Health, the U.S. Department of Veterans Affairs, and the Centers for Disease Control and Prevention.

More information is available at https://nairratdoe.ornl.gov/

Recent DOE AI EO Activities

Launched on February 26

NSF and DOE Establish a Research Coordination Network Dedicated to Enhancing Privacy Research

FEBRUARY 26, 2024

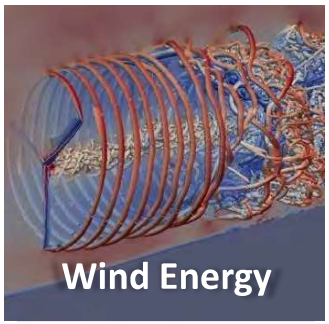
https://www.energy.gov/cet/office-critical-and-emerg

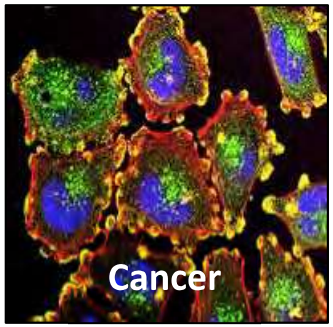
AI-ready workforce. The U.S.
orts thousands of AI learnin
rtunities across the country

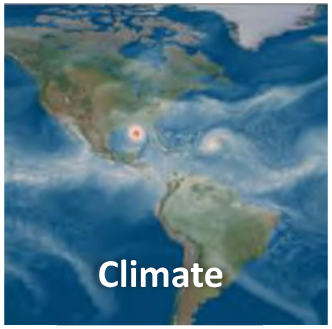
Office of Science » NSF and DOE Establish a Research Coordination Network Dedicated to Enhancing Privacy Research

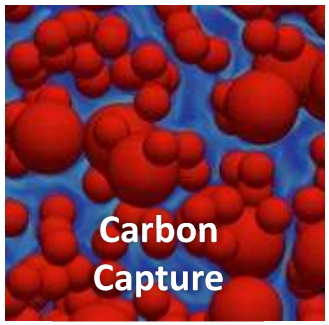
In response to the rapidly evolving landscape of data collection and analysis driven by advances in artificial intelligence, the U.S. National Science Foundation (NSF) and the U.S. Department of Energy (DOE) have established a Research Coordination Network (RCN) dedicated to advancing privacy research and the development, deployment and scaling of privacy enhancing technologies (PETs). Fulfilling a mandate from the "**Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence**," the initiative advances the recommendations in the ***National Strategy to Advance Privacy-Preserving Data Sharing and Analytics*** to move towards a

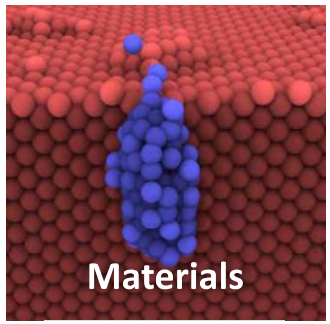
The breadth of exascale-ready applications is indicative of a se computing abilities for DOE and the Nation

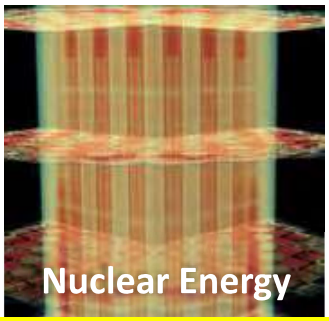


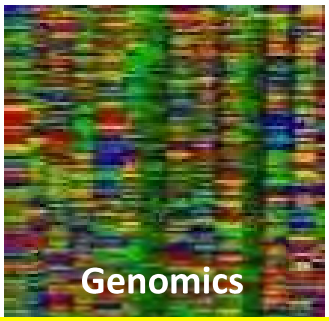


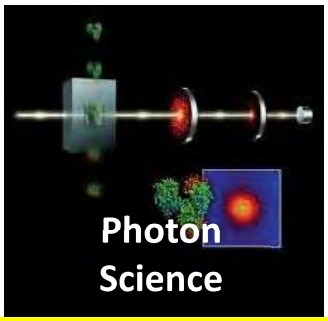


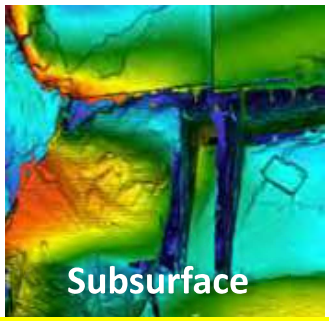


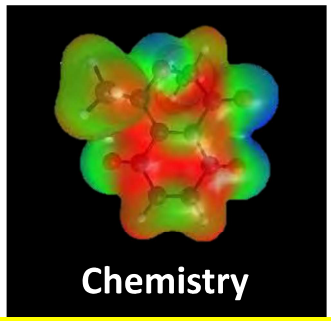


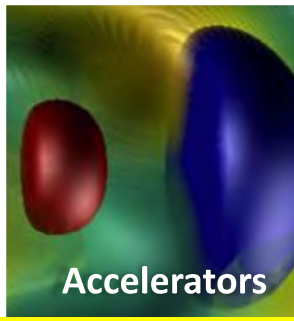




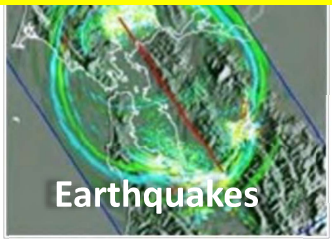


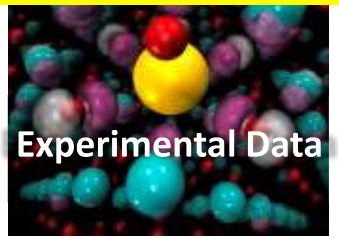


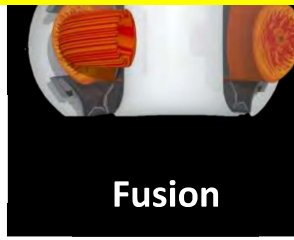




DOE must and will continue pushing Innovation i







Biological and Environmental Research

Dorothy Koch, Associate Director

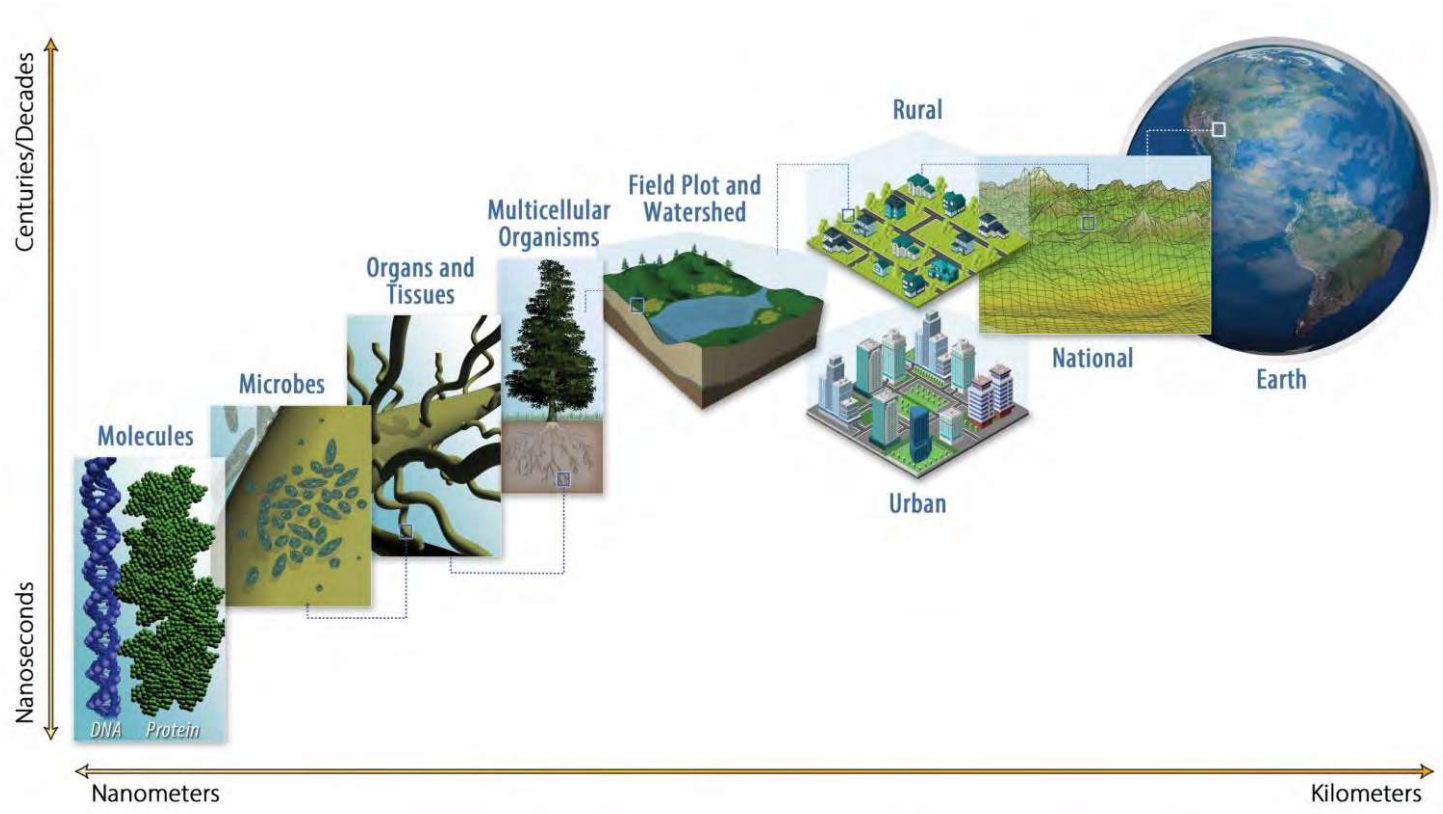
U.S. DEPARTMENT OF ENERGY | Office of Science

Energy.gov/

Biological and Environmental Research

Predictive understanding of complex biological, Earth, and environmental system
clean energy and climate innovation

FY 2023 Enacted	FY 2024 Enacted	FY 2025 President's R
908,685	900,000	945,225



- Genome-enabled bi
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  energy, carbon mana
  biotechnology for bi
  bioproducts and bio
- Earth and environme
  research to characte
  and predict feedbac
  Earth and energy sys
  to global scales.
- Enable innovation ar
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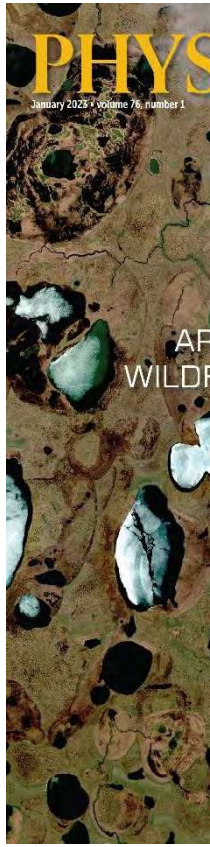
  urban integrated fiel

Physics Today



DOE Office of Science

Biological and Environmental Research

Dorothy Koch, Associate Director

Biological Systems Science

- Genomic Science
  - Microbes, microbial communities
  - Plants
  - Biosystems design
  - Bioenergy Research Centers
- Biomolecular Characterization and Imaging Science

Earth & Environmental System

- Atmospheric System Research
- Environmental System Science (terrest
- Climate – Earth - Human System Mode

BER User Facilities: EESSD and BSSD

Atmospheric Radiation Measurement (ARM) user facility

ARM deploys instruments at fixed and varying locations around the globe for obtaining continuous field measurements of clouds, aerosols, precipitation, radiation, surface properties & the atmospheric state since 1992

Environmental Molecular Sciences Laboratory

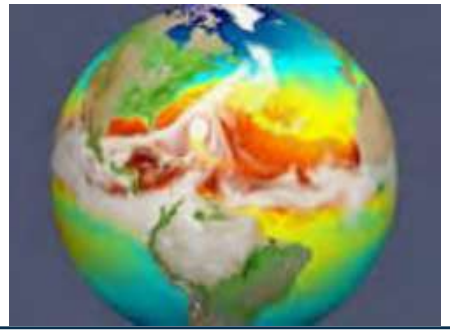
EMSL provides capabilities to understand physical, chemical, and intra- and inter-cellular processes and interactions.

Joint Genome Institute

JGI provides advanced genome sequencing, data and analysis for bioenergy, carbon cycling and biosequestration, and biogeochemical processes. It is the leading provider of plant, fungal, algal, & microbial community genomes and genomic analyses.

Earth and Environmental Systems Modeling

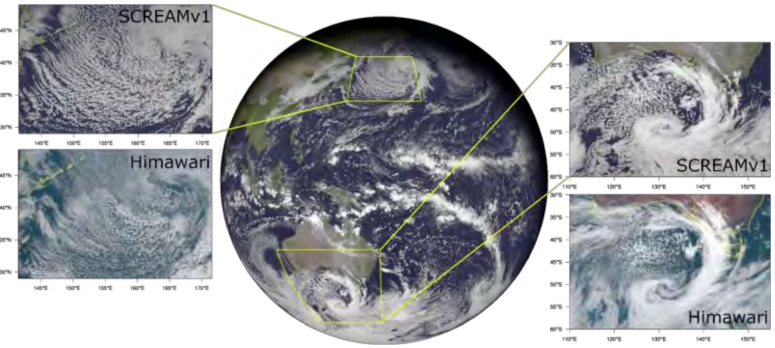
E3SM Energy Exascale Earth System Model



DOE's flagship climate model is the highest resolution prediction capability in the world and is the only model that includes details of infrastructures, urban systems, and economics

AI4

Developmer
models with
to reduce ur



SCREAM: E3SM ultra-high resolution runs on DOE's Exascale co the 1 SYPD barrier at cloud resolving resolutions, and run on bo NVIDIA GPUs

Winner for the 2023 ACM Gordon Bell Prize in Climate Modelin

Taylor et al, SC '23: Proceedings of the International Conference for High Performance Co Storage and Analysis, 2023, https://doi.org/10.1145/3581784.3627044.

Applications: The capabilities help address high priority climate challenges and contribute to the

Frontier Science for the Bioeconomy, Workshop Series

Microbial Design for a Developing Bioeconomy

How do we accelerate our ability to harness and leverage the diver metabolic potential of microbes as a platform to efficiently produce bioproducts, and biomaterials?

Microbiome Research: Engineering Microbial Comm

How do we harness the behavior of microbiomes and to manipulat microbial solutions to challenging bioeconomy and environmental

Resilient Bioenergy Crop Production

How do we predict and improve both plant and plant microbiome r changing environment to optimize biomass feedstock production?

Plant Design for a Developing Bioeconomy

How do we understand and transform bioenergy plants into advan that generate clean, renewable, and sustainable biofuels, bioprodu biomaterials?

Low Dose Radiation Research

Developing an integrated portfolio combining computational and experimenta research to understand the effects of low dose radiation on cells, tissues and organs/organoids and bridge gaps with human epidemiological observations.

- BER Advisory Committee report (2024), also drawing from NASEM and other reports.
- Utilize unique DOE capabilities (user facilities, AI/ML computation, analysis capabilities).
- Support National Laboratory and academic-led projects in low dose radiation research.
- CHIPS and Science Act assigns DOE the role to convene multiple agencies to address low dose research challenges.

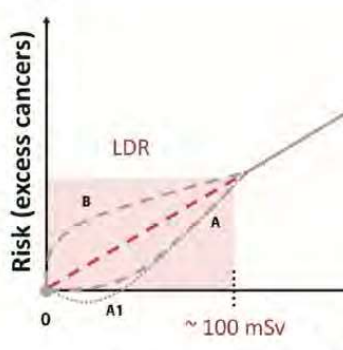


Fig. 1.2. The Linear No-Thresho
assumes a linear correspondenc
exposure and excess cancer risk
mSv; shaded in red). Alternative
is greater (B) or lower (A) or has

Opportunities for FY 2025

ENERGY earthshots
U.S. DEPARTMENT OF ENERGY

- Energy Earthshot Research Centers continue at the DOE Labs while research opportunities within Academia increase ($30.0M)

URBAN CLIMATE-ENERGY SCIENCE

- The 4 Urban Integrated Field L launched in FY2023 (Baltimore Arizona, Chicago) are enhance

- Enhance research on climate science with a new climate initiative foc climate-energy predictability of America's rural regions ($20.0M), wit role for emerging research institutions and underserved HBCU and communities.
- Expand Reaching a New Energy Sciences Workforce (RENEW) ($13.0 for Accelerated, Inclusive Research (FAIR) ($10.0M) with scope acros
- Expand the network of Climate Resilience Centers ($10.0M)

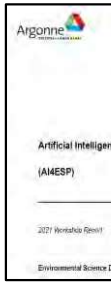
Artificial Intelligence (AI) and Quantum

Examples of BER AI activities:

- Genomic and metagenomic annotation analysis
- Predict cellular metabolic network dynamics influenced by changing environment
- Design of new of biological systems
- Energy Exascale Earth System Model (E3SM) component surrogates; E3SM initialization
- Better predict future climate and extreme weather likelihood
- Optimize multi-model solutions for physical and human/energy components
- Data for training, quality-control, gap-filling and analysis of facility data
- Digital twins

BER quantum activities:

- Novel approaches for biological imaging, e.g. quantum entanglement for non-destructive imaging of biological samples



THANK YOU!

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