

Office of Science Update

National Academy of Sciences
Board on Physics and Astronomy
April 30, 2025

Harriet Kung

Acting Director/Deputy Director for Science Programs



U.S. DEPARTMENT
of **ENERGY**

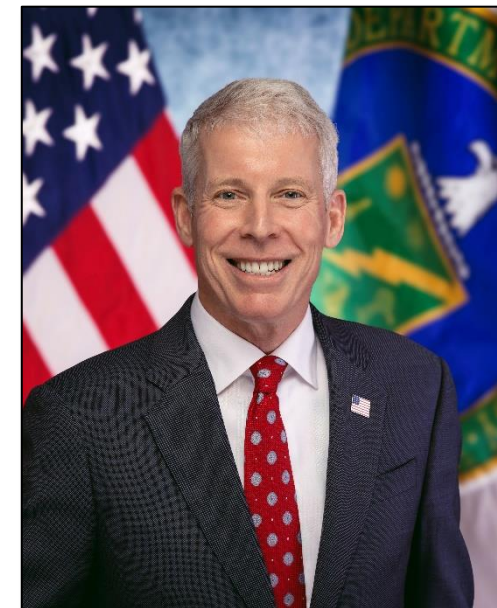
Office of
Science

[Energy.gov/science](https://energy.gov/science)

Secretarial Order – Feb. 5, 2025

Unleash Golden Era of American Energy Dominance

1. Advance Energy Addition, Not Subtraction
2. Unleash American Energy Innovation
3. Return to Regular Order on LNG Exports
4. Promote Affordability and Consumer Choice in Home Appliances
5. Refill the Strategic Petroleum Reserve (SPR)
6. Modernize America's nuclear stockpile
7. Unleash Commercial Nuclear Power in the United States
8. Strengthen Grid Reliability and Security
9. Streamline Permitting and Identify Undue Burdens on American Energy



Chris Wright

17th Secretary for U.S. DOE

2. Unleash American Energy Innovation:

- The Department's Research and Development (R&D) enterprise is the envy of the world. We must **focus our time and resources on technologies that will advance basic science, grow America's scientific leadership**, reduce costs for American families, strengthen the reliability of our energy system, and bolster America's manufacturing competitiveness and supply chain security. As such, the Department's R&D efforts will prioritize affordable, reliable, and secure energy technologies, including fossil fuels, advanced nuclear, geothermal, and hydropower.
- The Department must also **prioritize true technological breakthroughs - such as nuclear fusion, high-performance computing, quantum computing, and AI - to maintain America's global competitiveness**. To that end, the Department will comprehensively review its R&D portfolio. As part of that review, the Department will rigorously enforce project milestones to ensure that taxpayer resources are allocated appropriately and cost-effectively consistent with the law.





U.S. DEPARTMENT
of **ENERGY**

Office of
Science

Our Mission:

Deliver scientific discoveries and major scientific tools to transform our understanding of nature and advance the energy, economic, and national security of the United States.



More than **29,400** researchers supported at more than **300** institutions and **16** DOE national laboratories



Steward **10** of the 17 DOE national laboratories



Nearly **40,000** users of **28** Office of Science scientific user facilities



\$8.2B
(FY 24 enacted)



U.S. DEPARTMENT
of **ENERGY** | Office of
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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 Unique, World-Class Facilities

The Office of Science stewards a suite of scientific user facilities that provide the broad scientific community with world-leading capabilities for research - from physics, materials science, and chemistry to genomics and medicine.



AI Is A Major Initiative Within the Office of Science

Innovation and Competitiveness

Program Offices AI Pages

Community Resources

Artificial Intelligence for Science

- SC AI Initiative (<https://science.osti.gov/Initiatives/AI>). \$193M in FY25.
- Includes activities across SC, leveraging:
 - Sources of massive and/or complex science and engineering data from sensors, instruments, SC's national user facilities, and large-scale simulations
 - World-class high-performance computing (HPC) infrastructure
 - World-class high-performance network infrastructure
 - Exceptional workforce with large numbers of domain scientists, computer scientists, and mathematicians currently engaged in AI and related fields

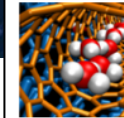
Program Offices AI Pages

The Office of Science develops and uses Artificial Intelligence and Machine Learning algorithms across a diverse research portfolio to continue to push the boundaries of scientific research and leverage massive amounts of data to encourage scientific breakthroughs.

The following describes SC program offices' support for AI research.



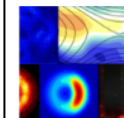
Advanced Scientific Computing Research supports efforts to develop new Scientific Machine Learning and Artificial Intelligence algorithms to enable scientific research. In addition, ASCR facilitates the development of the fastest supercomputers in the nation to support the use of AI and Deep Learning. [Read More](#)



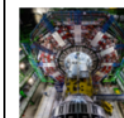
Basic Energy Sciences aims to advance the use of modern data science approaches to accelerate discovery in chemical and materials sciences and to maximize the production, analysis, and control of data generated at scientific user facilities. [Read More](#)



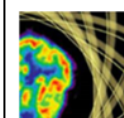
Biological and Environmental Research recognizes the potential of AI and has engaged the Earth and Environmental Systems Sciences Division (EESDD) to define what future framework is needed to harness AI for Earth system predictability and engaged the Biological System Sciences Division to advance new model formulations, analytics, and model data integration. [Read More](#)



Fusion Energy Sciences supports research into artificial intelligence and deploys these tools to predict key plasma phenomena; optimize active plasma control algorithms; provide plasma diagnostics; and develop data algorithms able to handle the amount and rate of data generated by fusion simulations and experiments. [Read More](#)



High Energy Physics supports fundamental research to understand how our universe works at its most fundamental level. HEP use AI techniques to transform research by harnessing DOE investments in experiments that produce massive datasets, improve operations at scientific user facilities, and development of new models and algorithms. [Read More](#)



Isotope R&D and Production increasingly leverages Artificial Intelligence in its R&D and isotope production activities to ensure a secure, domestic supply of isotopes that are of vital importance to the Nation. [Read More](#)



AI4SES Report

- AI for Science, Energy, and Security Report, released May 2023
- Created by a confederation of laboratories, informed by a series of workshops held in 2022
- Covers multiple AI approaches:
 - AI and Surrogate Models for Scientific Computing
 - AI Foundation Models for Scientific Knowledge Discovery, Integration, Synthesis
 - AI for Advanced Property Inference and Inverse Design
 - AI-Based Design, Prediction, and Control of Complex Engineered Systems
 - AI and Robotics for Autonomous Discovery
 - AI for Programming and Software Engineering
- Also covers crosscuts, including workflows, data, AI hardware, computing infrastructure, and workforce



<https://www.anl.gov/ai-for-science-report>

SC Roundtables: Transformational Science Enabled by AI

October 28-31 & November 7-8, 2024

Biosciences & environmental sciences (BER, BES)

Materials and chemical sciences (BES)

High energy & nuclear physics (HEP, NP, BES, FES)

Fabrication science (FES, BES, HEP, NP)

Fundamental energy research (BES, BER, FES)

User facility science and operations (All DOE-SC)

- Analogous to community input on “first science” for new/upgraded user facilities
- Participants identified Priority Research Opportunities for use of evolving AI capabilities to address the most significant challenges for each scientific theme
- Complements focus of ASCR AI workshops
- Follow-up to BER-ASCR February workshop: *Envisioning Frontiers in AI and Computing for Biological Research*



Leading Engagement with Leading AI Companies

- SC laboratories led the organization of the “1000 Scientist AI Jam”, partnering with OpenAI and Anthropic, and hosted by Argonne, Berkeley, Brookhaven, Idaho, Livermore, Los Alamos, Oak Ridge, Pacific Northwest, and Princeton Plasma Physics laboratories
- Scientists from across the entire DOE complex participated
- Collected hundreds of interactive AI conversations which can be used and analyzed to advance AI



Feb 28th, 2025



Secretary Wright visits ORNL during the AI Jam

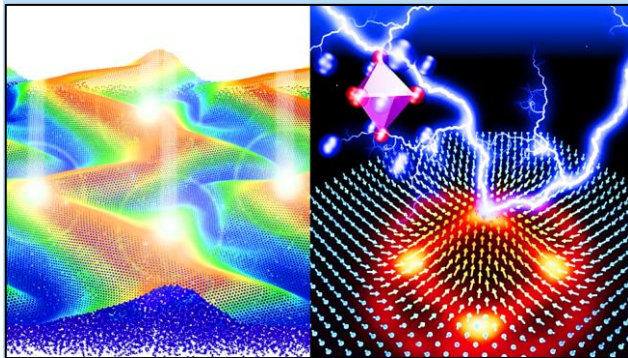


Scientists at ANL at the AI Jam.



Aurora opened to users in January and is delivering impactful science

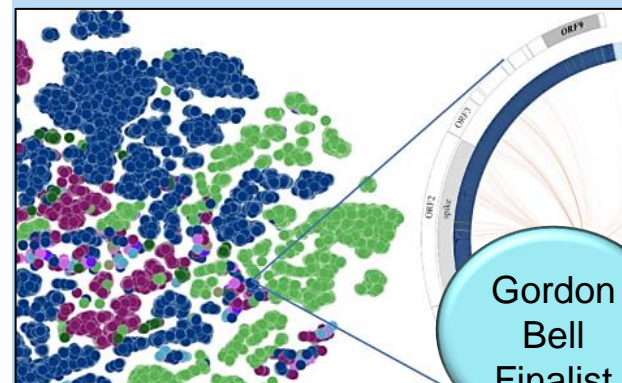
Advanced Quantum Materials



Advanced scalable manufacturing of quantum materials and ultrafast control of their emergent properties on demand using AI-guided simulations in tandem with state-of-the-art x-ray, electron-beam, neutron experiments at DOE facilities.

PI Aiichiro Nakano, University of Southern California

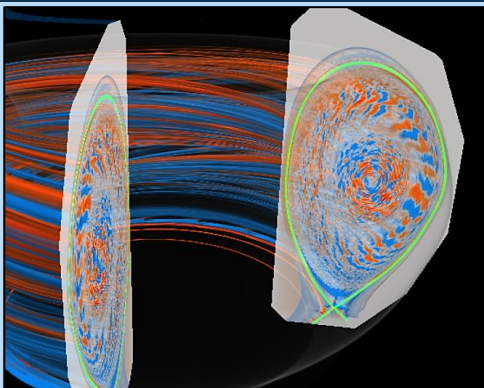
New Generation of Protein Discovery



Combined protein sequence data, experimental results, molecular simulations, and text narratives to provide detailed insights into properties with AI technologies. Scaled to large virus and bacterial genomes. Approach speeds up protein discovery for medicines, catalysts, and other applications.

PI Arvind Ramanathan, Argonne National Laboratory

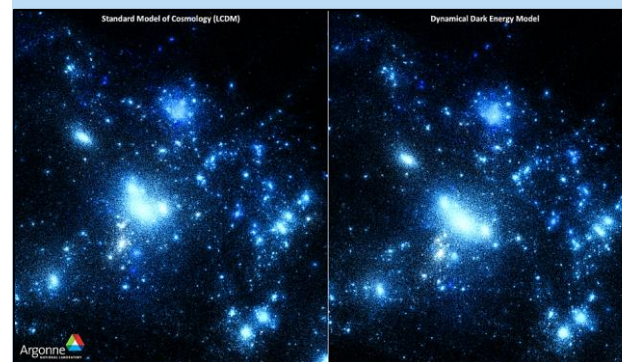
Designs for Fusion Power



Answered questions critical to design of fusion power plants with first-principles simulations providing insights into issues with power exhaust, including mitigating stationary heat-flux densities and avoiding unacceptably high transient power flow to material walls

PI CS Chang, Princeton Plasma Physics Laboratory

Dark Energy Discovery with DESI



Used Aurora to test ground-breaking observations from DESI that dark energy may not be constant. Simulations provide a key feedback to understand if observations are real or an artifact.

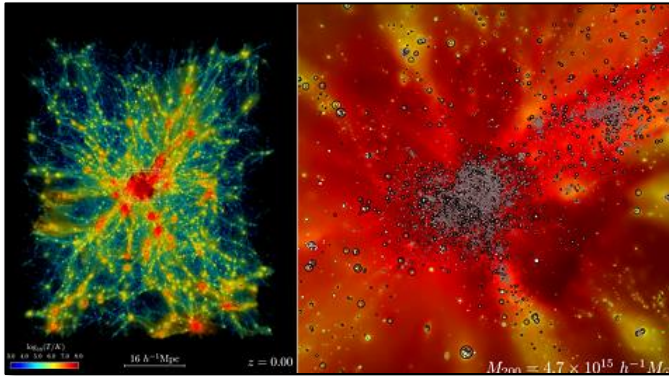
PI Katrin Heitmann, Argonne National Laboratory



OLCF Frontier is delivering impactful exascale science

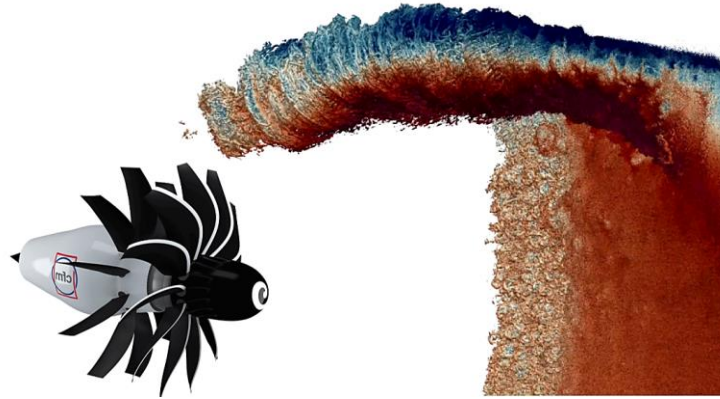
World's largest simulation of the expanding universe

ECP / Argonne National Laboratory



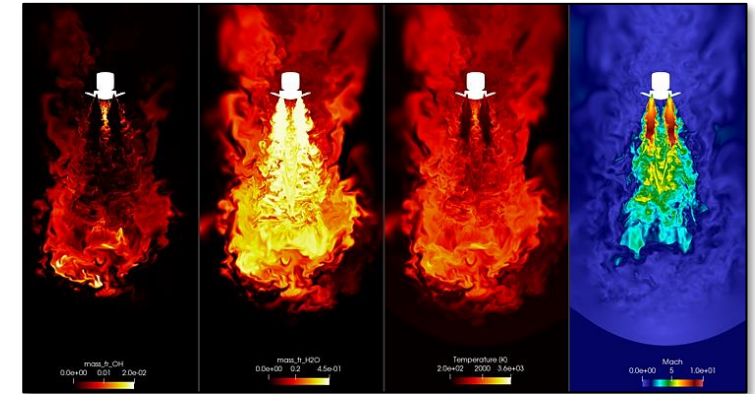
Flight-scale aero-acoustic simulations for jet engine design only possible at the exascale

ALCC / GE Aerospace



First detailed simulation of retro-propulsion human-scale Mars lander descent

INCITE / NASA Langley Research Center



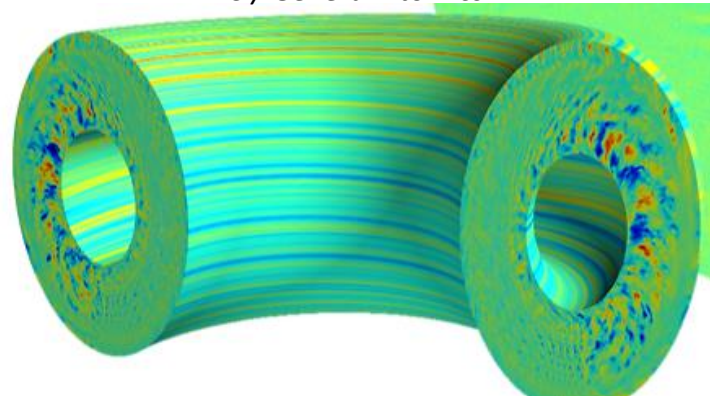
AI-training of Large Language Model for protein design

ECP / Argonne National Laboratory



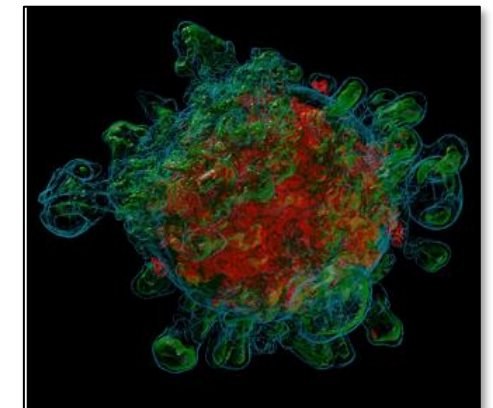
Bridging simulation and data analysis of DIII-D fusion plasma turbulence in unprecedented detail

FES / General Atomics

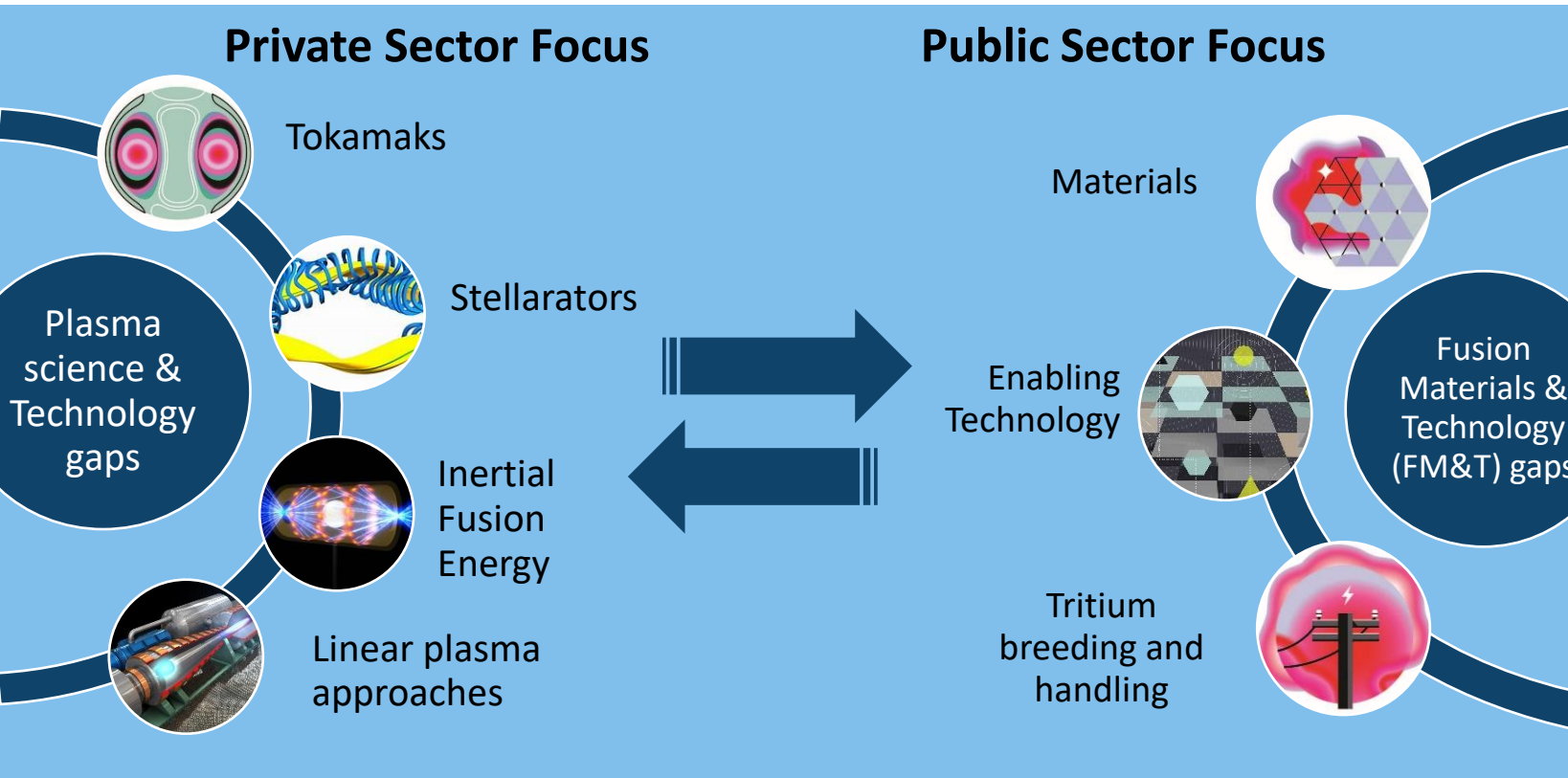


Revealing origins of heavy elements from stellar supernova

ECP / Lawrence Berkeley Laboratory



Understanding of fusion and plasma science is critical for development of a fusion power industry

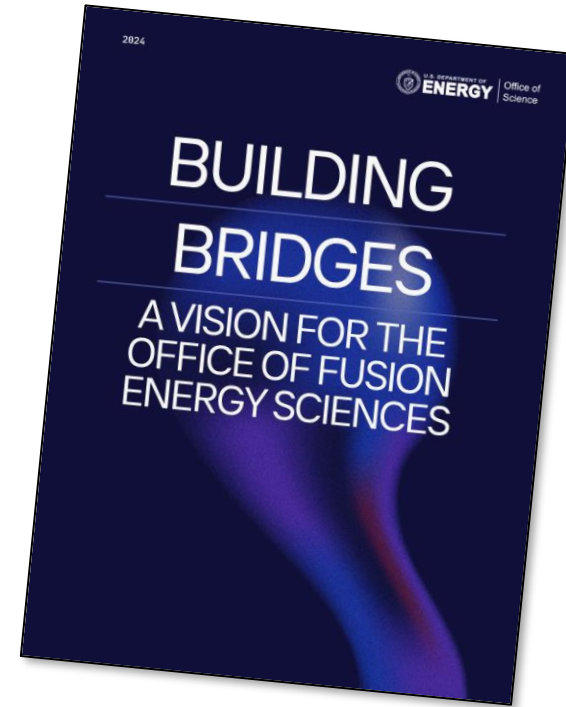


1. **Align** current assets to close remaining plasma science and FM&T gaps
2. **Establish** the Public-Private Consortium Framework for Fusion Energy to leverage regional local/state govt support with private sector to build needed testing facilities
3. **Prepare** the path towards credible Fusion Pilot Plant designs by late 2020s

Future outlook: prioritize construction of small, medium and large-scale FM&T facilities in the U.S.

Recent Changes in Fusion

- Created new **Enabling Science and Partnerships** division
 - Position SC FES for building key fusion technology facilities
- Established **Milestone Program** with 8 fusion startup companies (e.g. CFS, Tokamak Energy, and more)
- Created **innovation engines** with national laboratories, universities, and industry to resolve S&T gaps
 - New awards for Fusion Innovation Research Engine (FIRE) Collaboratives will be announced soon; initiated investments in inertial fusion energy
- Issued **Public-Private Consortium Framework** (PPCF) request for information for fusion energy anchored by regional hubs
- Developing national **Fusion S&T Roadmap** aligned with industry to guide SC FES program
 - “How” and “when” of closing S&T gaps to industry-led, government-enabled Fusion Pilot Plant(s) –To be released by 2025 Q2



<https://www.energy.gov/sites/default/files/2024-06/fes-building-bridges-vision.pdf>



High Energy Physics Highlight:

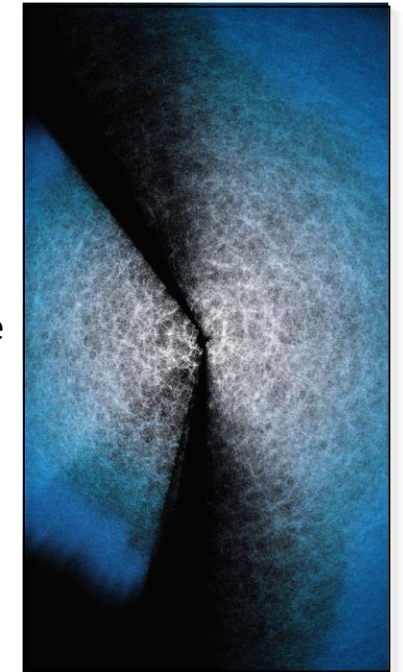
Dark Energy Spectroscopic Instrument (DESI)

- Measures spectra of 5,000 galaxies simultaneously (up to 100,000 each night) to build 3D map of the universe, enabling measurement of how the acceleration of the expansion of the universe has evolved over cosmological time and a determination of the nature of Dark Energy
- SC/HEP supported design and fabrication of instrumentation and data systems and now supports the instrumentation and telescope operations operations, data collection, processing and analysis
- LBNL leads all DESI efforts, with participation from 70 US and international institutions

- DESI's March 2025 Dark Energy cosmology results (using 3 years of data) indicate that the Universe isn't just accelerating – it may be changing how it accelerates
- The precision measurement shows a preference for a dynamic Dark Energy rather than Einstein's cosmological constant
 - *Does General Relativity not hold at larger distances or is it due to something else?*



DESI maps distant objects to study dark energy. The instrument is installed on the NSF's Mayall Telescope, shown here beneath star trails. (Credit: KPNO/NOIRLab/NSF/AURA/B. Tafreshi)



DESI's 3-year map of ~ 40 million galaxies (we are at the center). Note the structure, with regular spacing and clumping of galaxies.



Nuclear Physics Highlight

- Exploring all forms of nuclear matter by pursuing research in three key areas:
 - Quantum Chromodynamics:
Accelerator Facilities (RHIC, TJNAF)
 - Nuclear Structure & Nuclear Astrophysics:
Accelerator Facilities (FRIB, ATLAS@ANL)
 - Fundamental Symmetries:
Decay-based experiments like KATRIN
- These key areas are supported by cross cutting efforts in nuclear theory, nuclear data, computing, QIS, and AI/ML
- *April 2025 Highlight:* Best neutrino-mass information ever obtained from a direct, laboratory measurement, upper limit of <0.45 electron volts at 90% confidence

Physicists narrow down neutrino's
mysterious mass **nature**



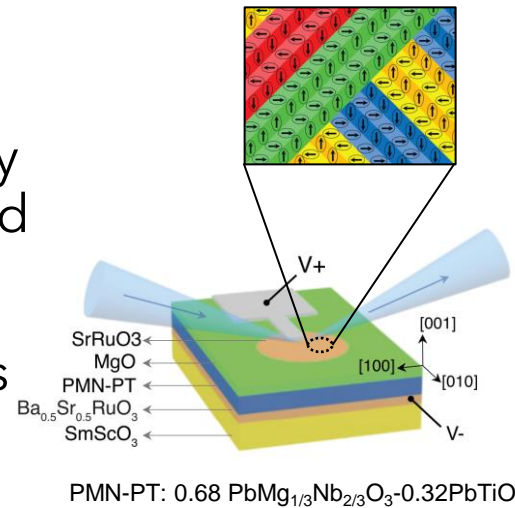
Karlsruhe Tritium Neutrino Experiment (KATRIN) in Germany.

<https://doi.org/10.1126/science.adq9592>

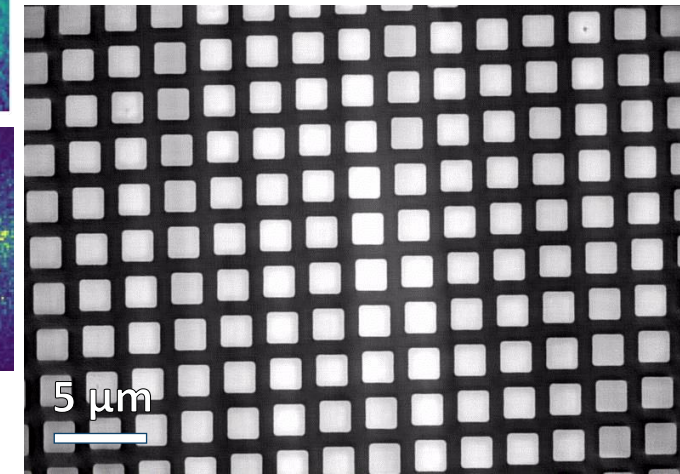
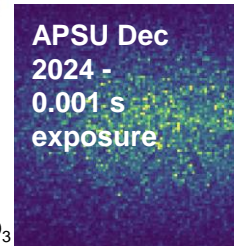
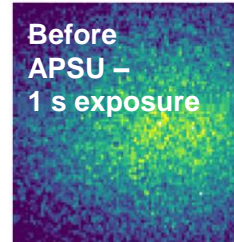


Basic Energy Sciences Highlight: Advanced Photon Source (APS) Upgrade

- Upgraded APS is the brightest synchrotron light source in the world, increasing brightness by 500 times compared to the previous facility
- Five (of 7) new and 15 substantially upgraded experimental stations are already in the user program or being commissioned
- New generation of experiments is made possible by the increase in X-ray brightness (e.g., better focusing, coherent imaging)
- Use of Leadership Class Computing at the ALCF is essential for near real-time science



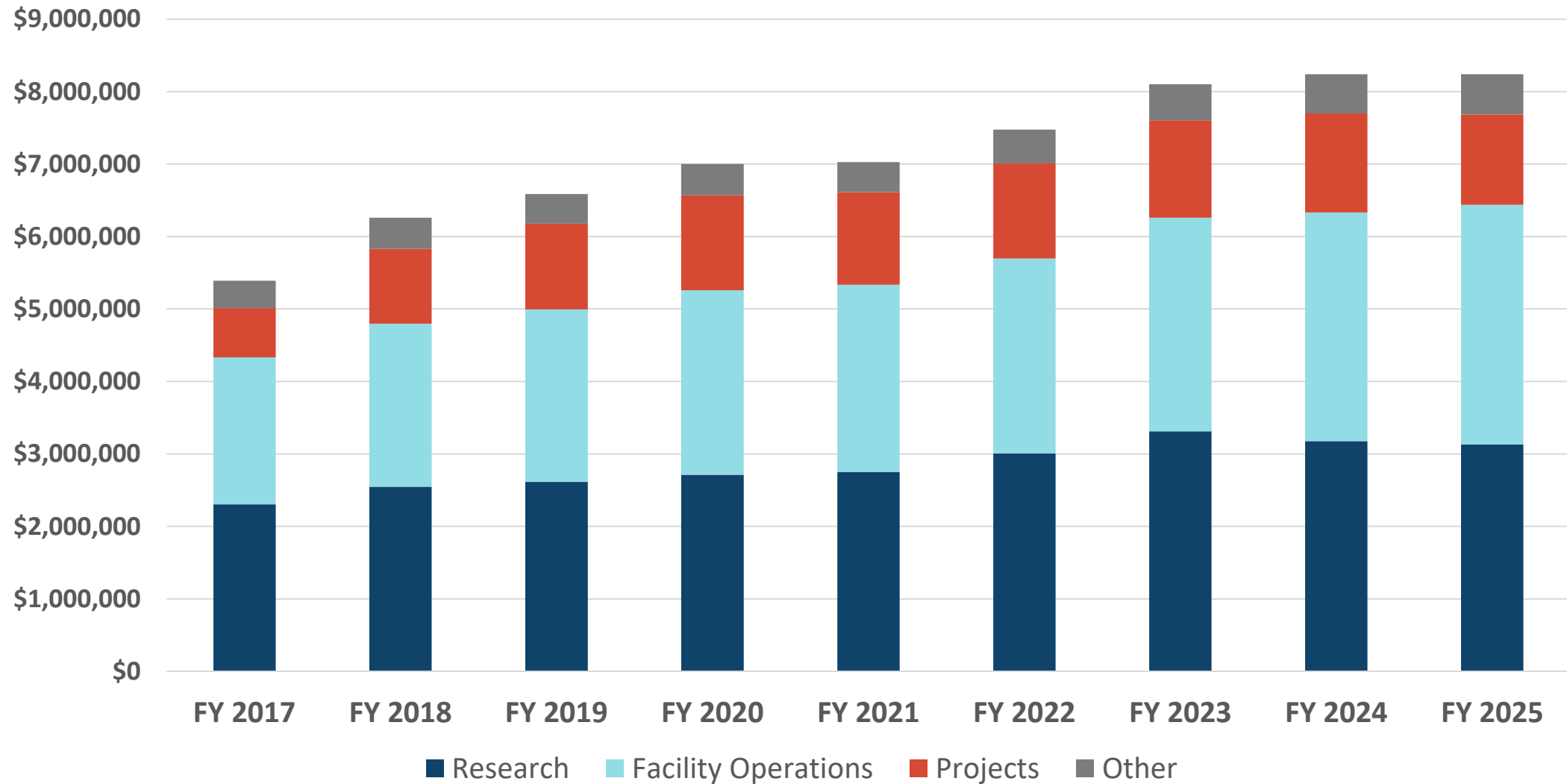
10^3 faster data collection of relaxor ferroelectrics using X-ray Photon Correlation Spectroscopy



Non-destructive 3D lens-less imaging of a microchip at the nanoscale (video)

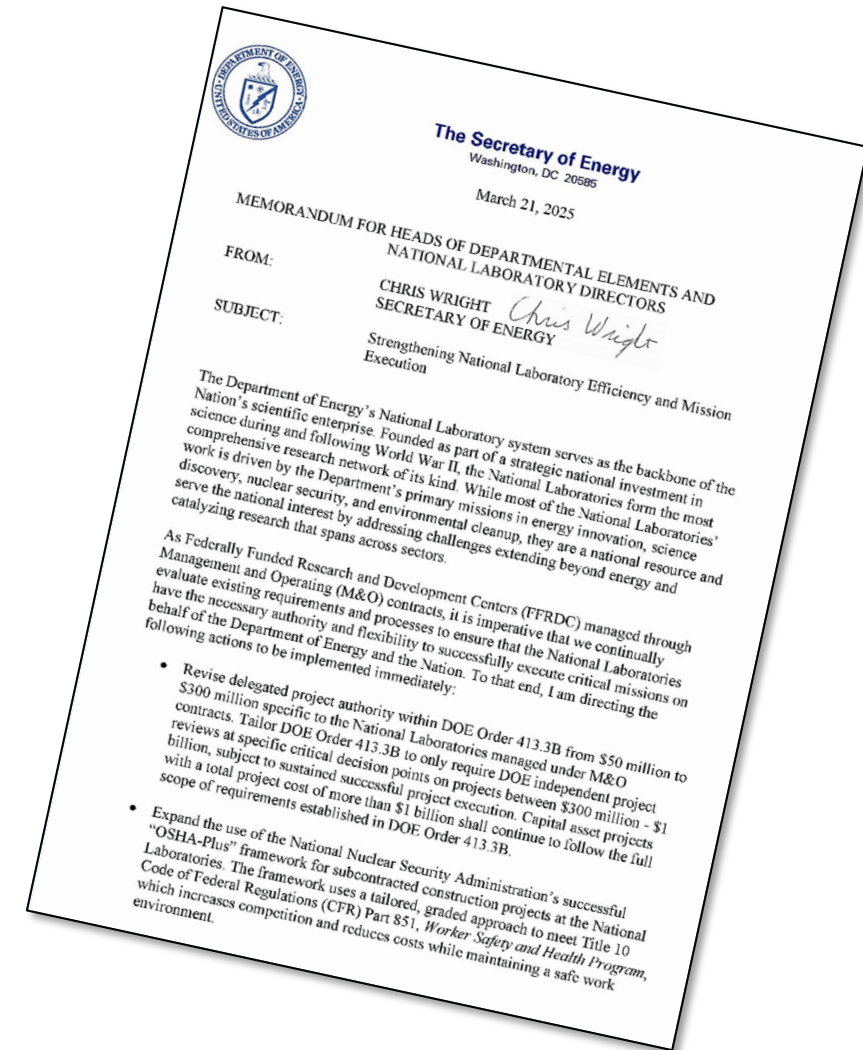


Office of Science Budget



First 100 Days: Strengthening National Laboratory Efficiency and Mission Execution

- DOE Secretary Wright has recognized that National Laboratories are the “backbone” of the National Scientific Enterprise
- Directed several actions to improve effectiveness and flexibility of National Laboratory operations
- Simplifying the execution of construction projects with a value of <\$300M and use of OSHA safety standards are core to these actions
 - Use of commercial approaches for construction will increase the number of companies willing to compete for contracts
 - Delegate project leadership, including reviews of progress, to the laboratory, to accelerate schedules and reduce costs
 - Continue high level oversight by the site offices and programs to ensure the safe delivery of the agreed upon project scope, on time, and within agreed upon funding
 - Impacts over half of the science-driven construction projects



<https://www.energy.gov/articles/secretary-wright-acts-remove-red-tape-accelerate-mission-execution-americas-national>



THANK YOU!

