



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

# **Office of Science Update**

## **Fusion Energy Sciences Advisory Committee**

Dr. Harriet Kung  
Deputy Director for Science Programs  
Office of Science  
U.S. Department of Energy

June 23, 2020

# Outline

- Office of Science Reorganization
- FY 2021 President's Budget Request
- Long-range Planning – ASCR and BES Examples
- DOE COVID-19 S&T Response

# Office of Science Reorganization

- Better aligns the organization to achieve strategic goals
- Mostly affects top levels of the organization
- Establishes the Principal Deputy Director position
- Eliminates the Deputy Director for Resource Management
- Minimal changes below the Deputy Director level
- Effective 4/12/2020

# Office of Science

Effective  
04/12/2020

**Office of the Director**  
*Chris Fall*

**Deputy Director for Science Programs**  
*Harriet Kung*

**Principal Deputy Director**  
*J. Stephen Binkley*

**Deputy Director for Field Operations**  
*Justin Fontaine*

**Advanced Scientific Computing Research**  
*Barbara Helland*

**Basic Energy Sciences**  
*Linda Horton*

**Biological & Environmental Research**  
*Sharlene Weatherwax*

**Fusion Energy Sciences**  
*James Van Dam*

**High Energy Physics**  
*James Siegrist*

**Nuclear Physics**  
*Timothy Hallman*

**Office of Communications & Public Affairs**  
*Rick Borchelt*

**Office of Scientific & Technical Information**  
*Brian Hitson*

**Office of Workforce Development for Teachers & Scientists**  
*Ping Ge (A)*

**Office of Grants & Contracts Support**  
*Michael Zarkin*

**Office of Budget**  
*Kathleen Klausung*

**Office of Management**  
*Paul Shlesinger*

**Office of Project Assessment**  
*Kurt Fisher (A)*

**Office of Engr & Tech**  
*Edward McGinnis*

**Office of SBIR/STTR Programs**  
*Manuel Oliver*

**Office of Accelerator R&D and Production**  
*Eric Colby (A)*

**Office of Isotope R&D and Production**  
*Jehanne Gillo (A)*

**Office of Diversity, Inclusion & Research Integrity**  
*Julie Carruthers (A)*

**Office of Strategic Planning & Interagency Coordination**  
*Susannah Howieson*

**Office of International S&T Cooperation and Trusted Research**  
*Helena Fu*

**Office of Crosscutting & Special Initiatives**  
*Ashley Predith*

**Ames Site Office**  
*Cynthia Baebler*

**Argonne Site Office**  
*Joanna Livengood*

**Bay Area Site Office**  
*Paul Golan*

**Brookhaven Site Office**  
*Robert Gordon*

**Fermi Site Office**  
*Roger Snyder (A)*

**ORNL Site Office**  
*Johnny Moore*

**Pacific Northwest Site Office**  
*Theodore Pietrok (A)*

**Princeton Site Office**  
*Peter Johnson*

**Thomas Jefferson Site Office**  
*Joseph Arango*

**Consolidated Service Center**  
*Kenneth Tarcza*

**Office of Field Safety, Security & Infrastructure**  
*Marcus Jones*

**Office of Laboratory Policy**  
*John LaBarge*

**Office of Information Management**  
*Mike Bartell (A)*

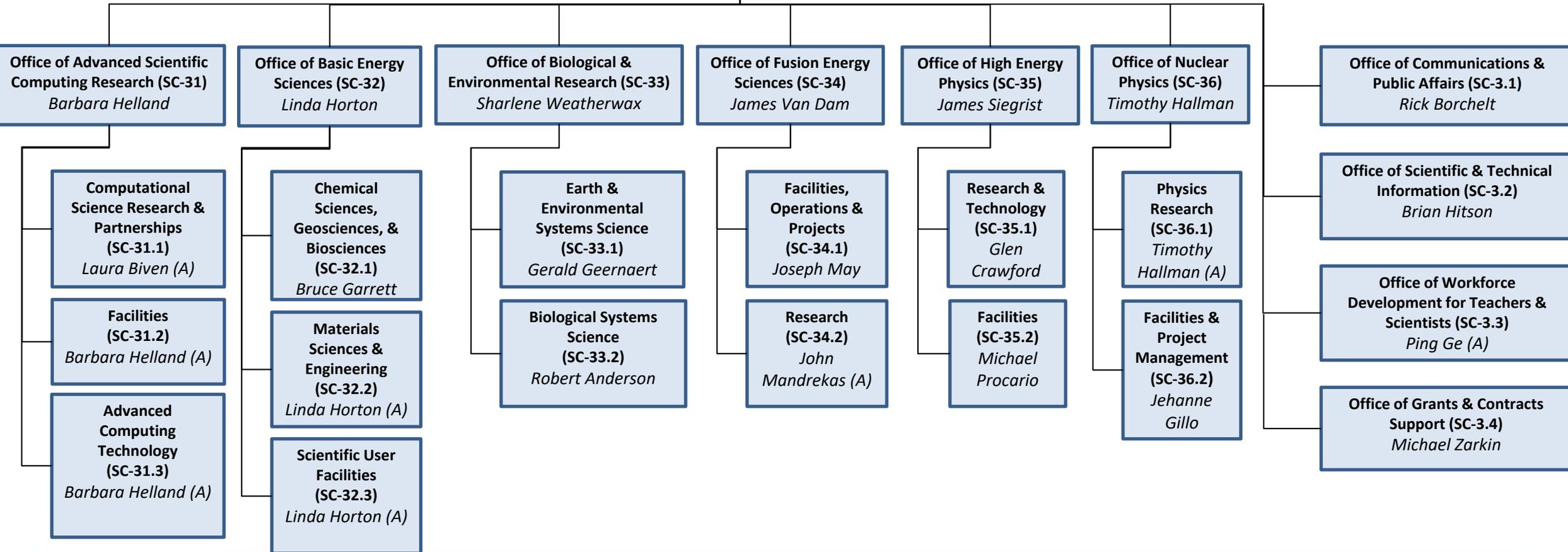
**Office of Cyber Security**  
*Gina Fisk (A)*

**Office of IT Services**  
*Vasilios Kountouris*

# Deputy Director For Science Programs

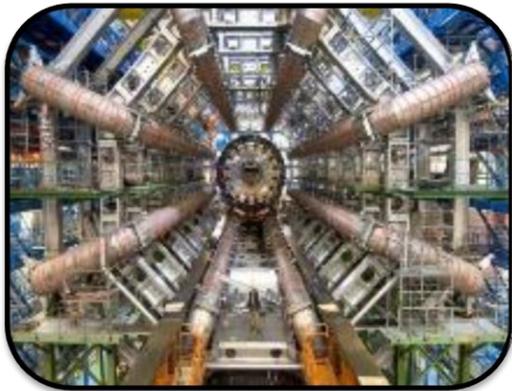
Effective  
04/12/2020

**Deputy Director for Science Programs (SC-3)**  
*Harriet Kung*



# Office of Science at a Glance

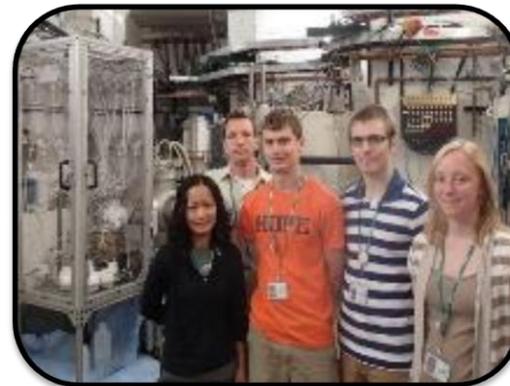
## FY 2020 Enacted: \$7.0B + \$99.5M (CARES Act)



Largest Supporter of Physical Sciences in the U.S.



Funding at >300 Institutions, including 17 DOE Labs



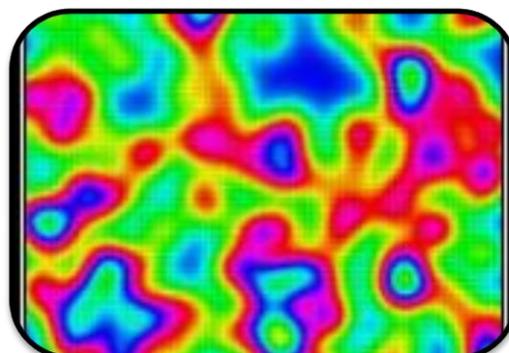
Over 23,000 Researchers Supported



Over 33,000 Users of 27 SC Scientific Facilities



~38% of Research to Universities



Research: 38.8%, \$2.7B



Facility Operations: 36.4%, \$2.5B



Projects/Other: 24.9%, \$1.7B

# Office of Science Guiding Principles

**FY 2019 Enacted: \$6.585B**

**FY 2020 Enacted: \$7.000B**

**FY 2021 Request: \$5.838B**

## Guiding Principles:

- The Office of Science's (SC) mission is to 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.
- The FY 2021 Request supports a balanced research portfolio, focused on cutting edge, early stage research and development, probing some of the most fundamental questions in areas such as: high energy, nuclear, and plasma physics; materials and chemistry; biological and environmental systems; applied mathematics; next-generation high-performance computing and simulation capabilities; and basic research for advancement in new energy technologies.
- The future of the Office of Science includes:
  - New research investments
  - Reduce deferred maintenance with upgrades/improvements to infrastructure

# FY 2021 SC President's Budget Request

(Dollars in Thousands)

	FY 2019		FY 2020	FY 2021 President's Request	
	Enacted Approp.	Current Approp.	Enacted Approp.	President's Request	President's Request vs. FY 2020 Enacted
<b>Office of Science</b>					
Advanced Scientific Computing Research	935,500	910,031	980,000	988,051	+8,051 +0.8%
Basic Energy Sciences	2,166,000	2,105,873	2,213,000	1,935,673	-277,327 -12.5%
Biological and Environmental Research	705,000	680,246	750,000	516,934	-233,066 -31.1%
Fusion Energy Sciences	564,000	549,181	671,000	425,151	-245,849 -36.6%
High Energy Physics	980,000	955,905	1,045,000	818,131	-226,869 -21.7%
Nuclear Physics	690,000	669,888	713,000	653,327	-59,673 -8.4%
Workforce Development for Teachers and Scientists	22,500	22,500	28,000	20,500	-7,500 -26.8%
Science Laboratories Infrastructure	232,890	232,890	301,000	174,110	-126,890 -42.2%
Safeguards and Security	106,110	106,110	112,700	115,623	+2,923 +2.6%
Program Direction	183,000	183,000	186,300	190,306	+4,006 +2.2%
SBIR/STTR (SC)		169,376	...	...	... ..
<b>Total Budget Authority and Obligations, Office of Science</b>	<b>6,585,000</b>	<b>6,585,000</b>	<b>7,000,000</b>	<b>5,837,806</b>	<b>-1,162,194 -16.6%</b>
SBIR/STTR (DOE)	...	123,254	...	...	... ..
<b>Total, Office of Science</b>	<b>6,585,000</b>	<b>6,708,254</b>	<b>7,000,000</b>	<b>5,837,806</b>	<b>-1,162,194 -16.6%</b>

# Office of Science - FY 2021 Research Initiatives

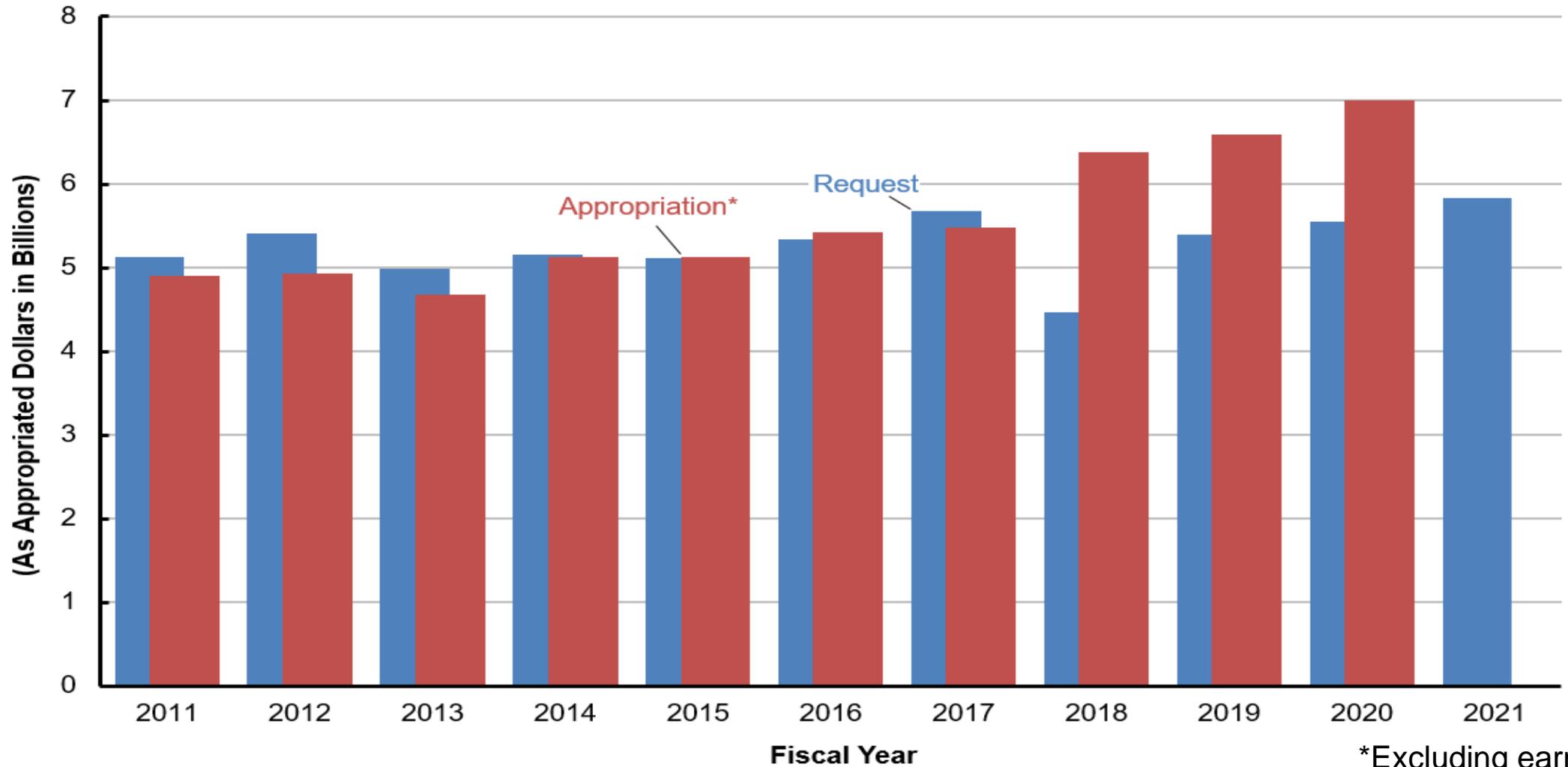
## New Research Initiatives

1. Integrated Computational and Data Infrastructure for Scientific Discovery
2. Next Generation Biology Initiative
3. Rare Earth / Separation Science Initiative
4. Revolutionizing Polymer Upcycling
5. Strategic Accelerator Technology Initiative
6. Data and Computational Collaboration with NIH

## Ongoing Research Initiatives

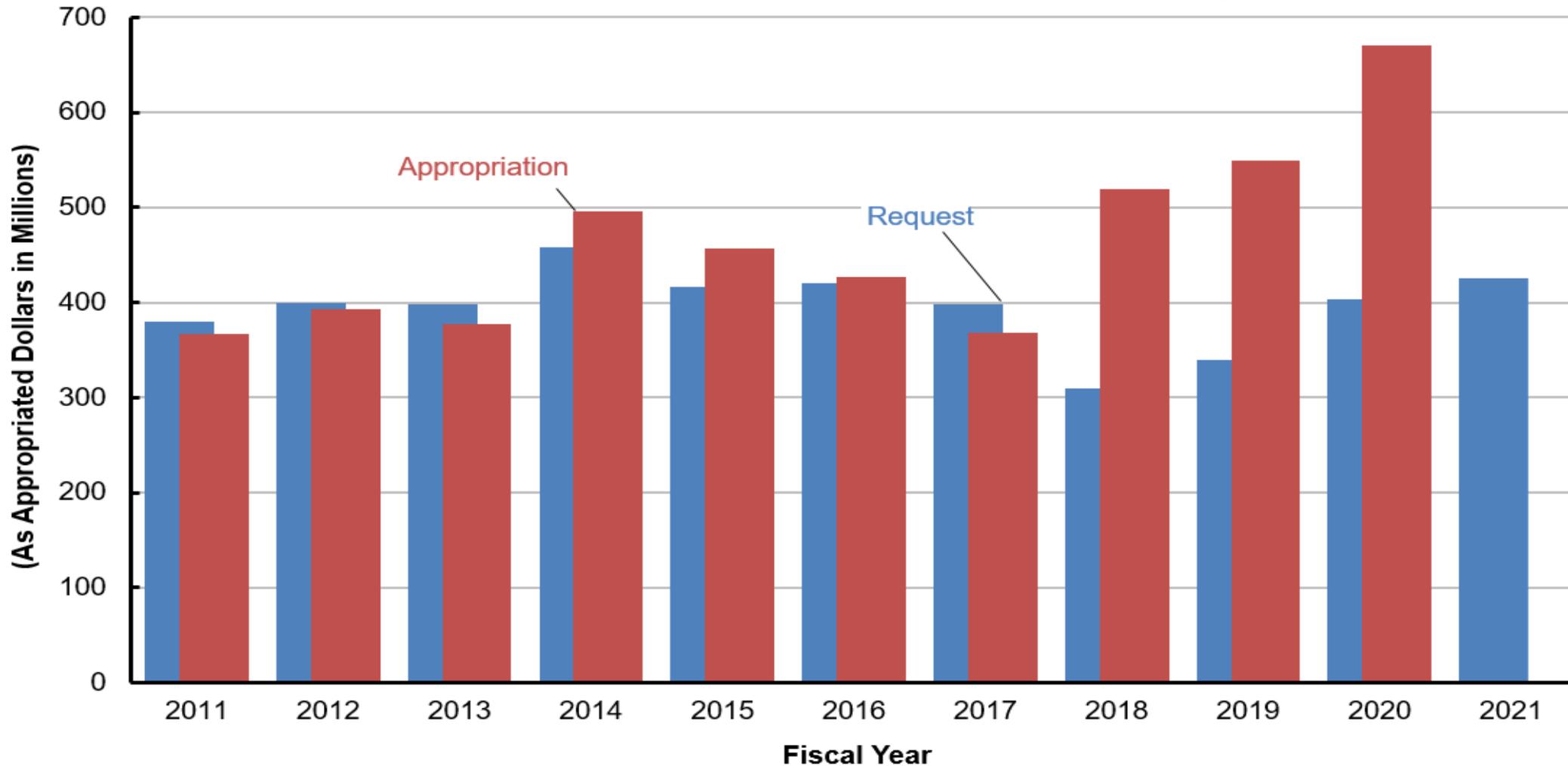
1. Artificial Intelligence and Machine Learning
2. Biosecurity
3. DOE Isotope Initiative
4. Exascale Computing Initiative
5. Microelectronics Innovation
6. Quantum Information Science
7. U.S. Fusion Program Acceleration

# Office of Science Request vs. Appropriation History\*



\*Excluding earmarks

# Fusion Energy Sciences Request vs. Appropriation History



# FES Long-Range Planning activity

## Charge scope

Provide recommendations on the priorities for an optimized FES program over the next ten years (FY 2022-2031) under three scenarios, with the FY 2019 enacted budget for the FES program as the baseline.

The strategic planning activity—to encompass the entire FES research portfolio (namely, burning plasma science and discovery plasma science)—should identify and prioritize the research required to advance both the scientific foundation needed to develop a fusion energy source, as well as the broader FES mission to steward plasma science.

Subcommittee Members	Subcommittee Members
Baalrud, Scott [2]	Lasa, Ane [2]
Betti, Riccardo	Ma, Tammy [1]
Carter, Troy (CHAIR) [1]	Maingi, Rajesh [1]
Cary, John	Schaffner, David [2]
Ellis, Tyler	Schmitz, Oliver
Foster, John	Shumlak, Uri [2]
Geddes, Cameron	Snead, Lance
Gleason, Arianna [2]	Solomon, Wayne [2]
Holland, Chris [2]	Trask, Erik [1]
Humrickhouse, Paul [2]	Waelbroeck, Francois
Kessel, Chuck [1]	White, Anne [1]

[1] FESAC member      FESAC chair (Don Rej) is ex officio

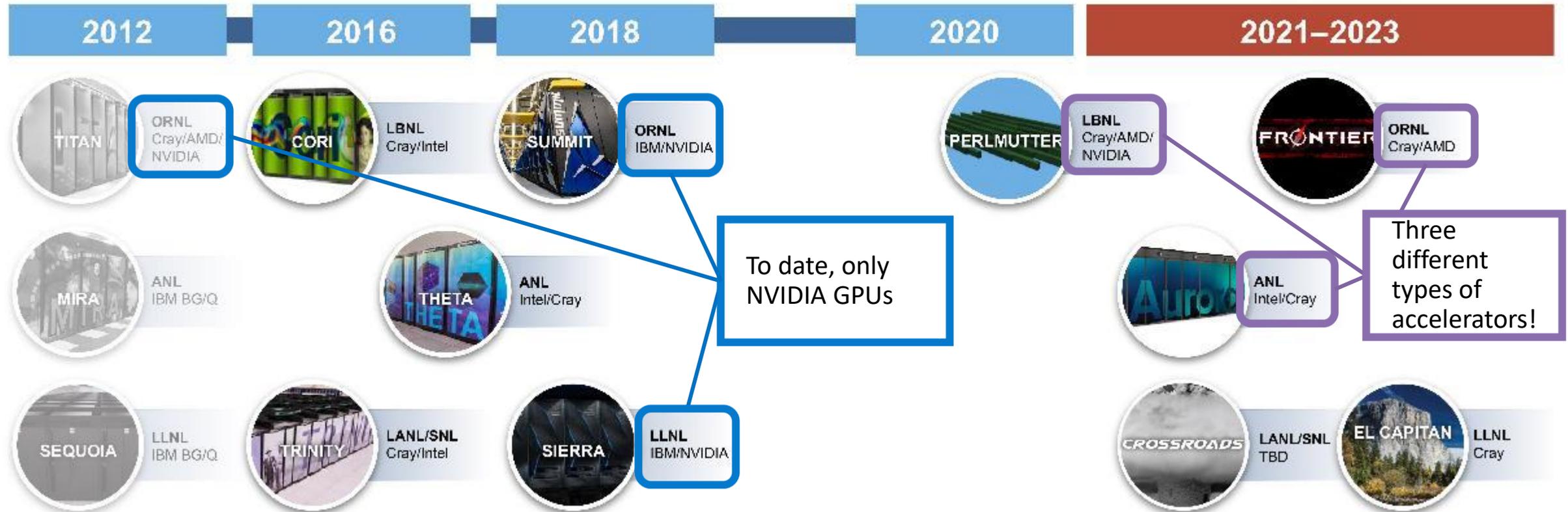
[2] Community Program Planning Committee member

# DOE Roadmap to Exascale Systems

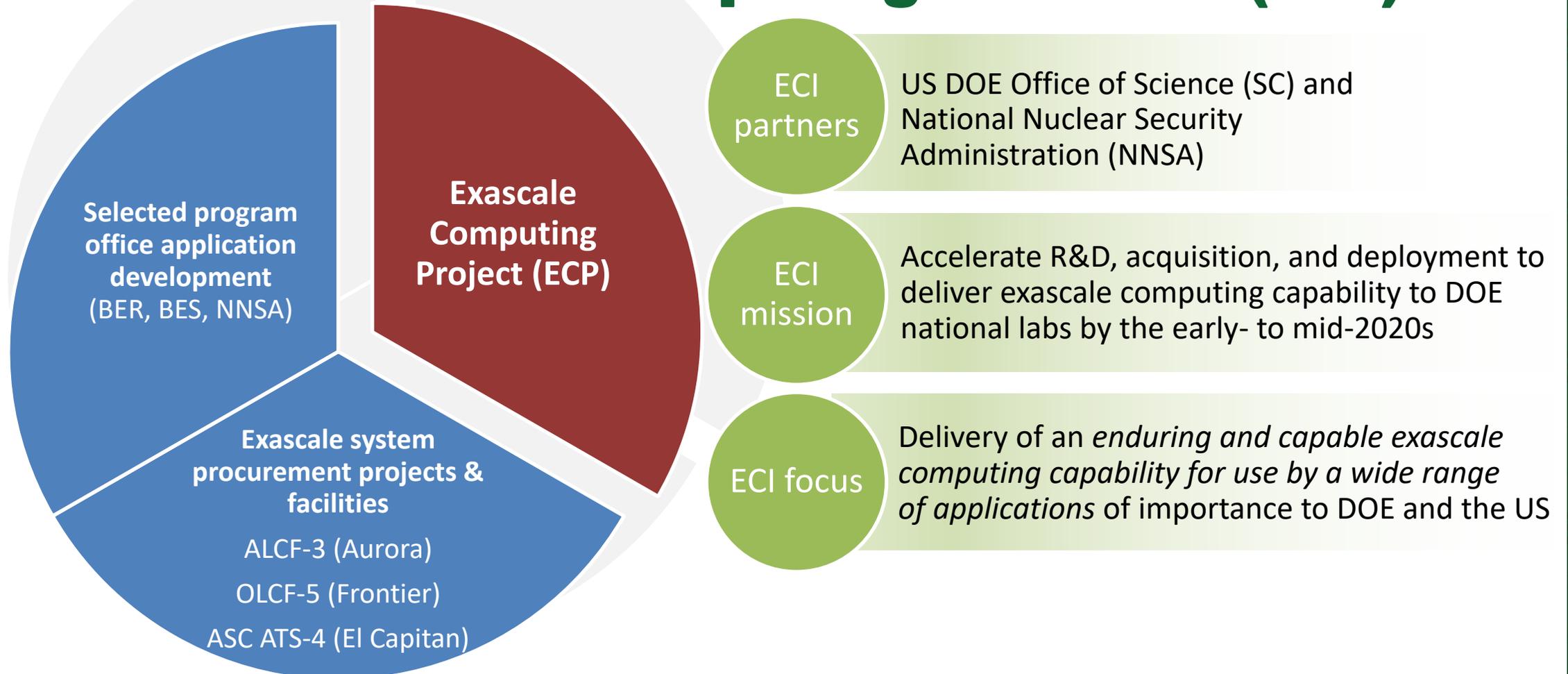
An impressive, productive lineup of *accelerated node* systems supporting DOE's mission

## Pre-Exascale Systems

## Future Exascale Systems



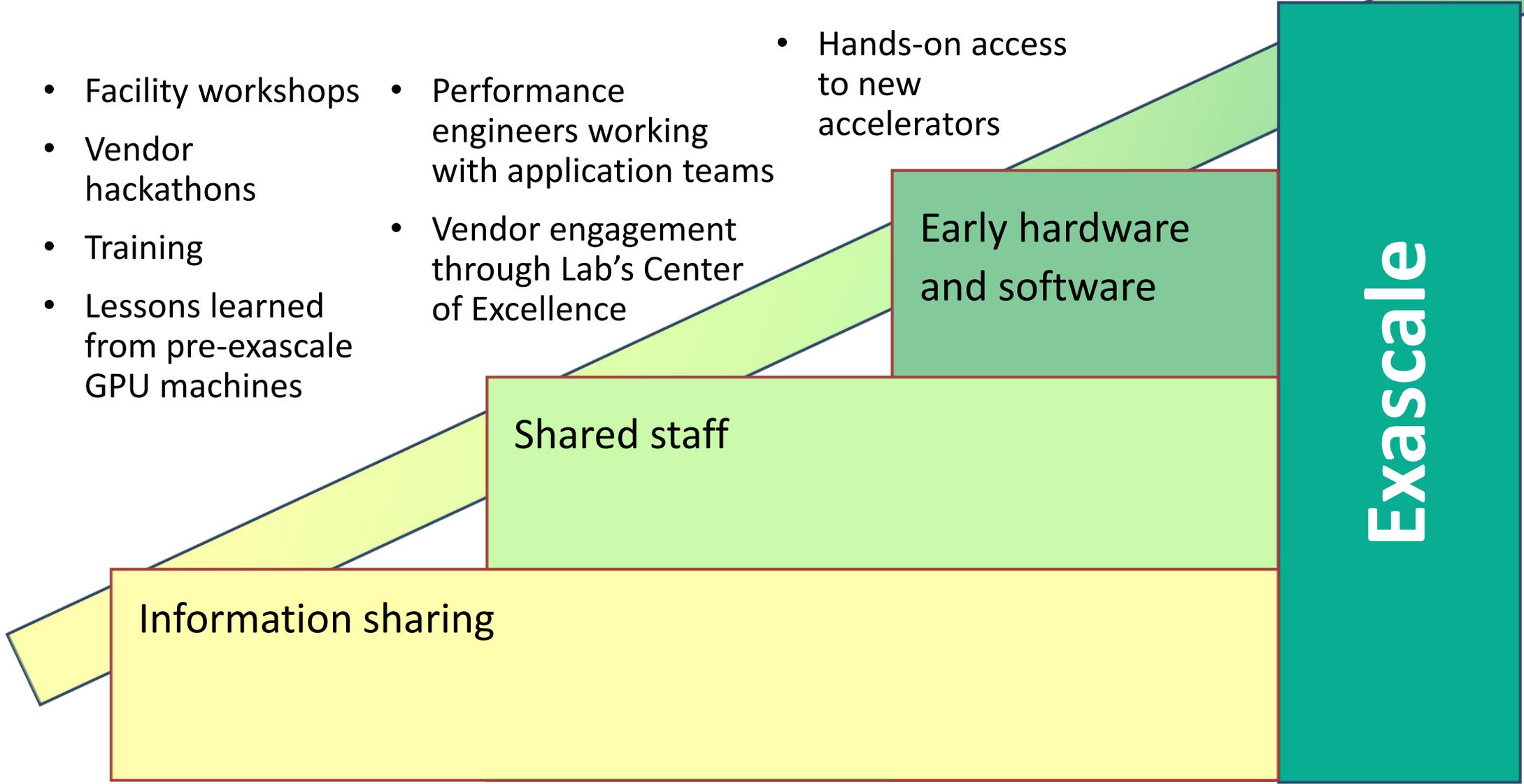
# DOE Exascale Program: The Exascale Computing Initiative (ECI)



*Three Major Components of the ECI*

# Ramping applications up to exascale

- Facility workshops
- Vendor hackathons
- Training
- Lessons learned from pre-exascale GPU machines
- Performance engineers working with application teams
- Vendor engagement through Lab's Center of Excellence
- Hands-on access to new accelerators



7  
YEARS  
\$1.8B

6  
CORE  
DOE  
LABS

3  
FOCUS  
AREAS

100  
R&D TEAMS  
1000  
RESEARCHERS

## ECP by the Numbers

A seven-year, \$1.8B R&D effort that launched in 2016

Six core DOE National Laboratories: Argonne, Lawrence Berkeley, Lawrence Livermore, Los Alamos, Oak Ridge, Sandia

- Staff from most of the 17 DOE national laboratories take part in the project

Three focus areas: Hardware and Integration, Software Technology, Application Development

More than 100 top-notch R&D teams

Hundreds of consequential milestones delivered on schedule and within budget since project inception

**The ultimate success of ECP will be determined by the technical achievements of the applications as well as community acceptance of the ECP software stack**

# BES Community Consensus Building Guided by BESAC

**BESAC Report on Facility Upgrades**

Approved by the Basic Energy Sciences Advisory Committee on June 9, 2016

**Report of the BESAC Subcommittee on Future X-ray Light Sources**

Approved by the Basic Energy Sciences Advisory Committee on July 25, 2013

Facility Upgrade	Science Impact on Mission	Readiness for Construction
Advanced Photon Source Upgrade (APS-U)	Absolutely Central	Ready to initiate construction
Advanced Light Source Upgrade (ALS-U)	Absolutely Central	Ready to initiate construction
Linac Coherent Light Source-II High Energy Upgrade (LCLS II-HE)	Absolutely Central	Ready to initiate construction
Spallation Neutron Source Proton Power Upgrade (PPU)	Absolutely Central	Significant scientific/engineering challenges to resolve before initiating construction
Spallation Neutron Source Second Target Station (STS)	Absolutely Central	Significant scientific/engineering challenges to resolve before initiating construction

# BESAC Report on Facility Upgrades

Project	ANL APS-U	LBNL ALS-U	ORNL SNS PPU	ORNL SNS STS	SLAC LCLS-II	SLAC LCLS-II-HE
<b>Proposed Project</b>	Hard X-ray ~Diffraction Limited 6 GeV MBA Ring	Soft X-ray ~Diffraction Limited 2 GeV MBA Ring	Proton Power Upgrade to 2.8 MW (W Target) 1.3 GeV SC Linac	High Resolution Neutron Science; Second Target Station	High Rep-Rate, Soft X-ray FEL, 4 GeV SC Linac	High Rep-Rate, Medium Energy X-ray FEL, 8 GeV SC Linac
<b>Current Status of Facility</b>	APS is operational since 1996; ring will be replaced	ALS is operational since 1993; ring will be replaced	SNS Linac is operational since 2006 at 0.94 GeV	SNS is operational since 2006	LCLS is operational since 2010; LCLS-II is under construction	LCLS is operational since 2010; LCLS-II is under construction
<b>Worldwide Competition</b>	 EU ESRF  Germany PETRA3,4  Japan SPRING-6  China HEPS	 Sweden MAX-IV  Brazil SIRIUS  CH SLS-II	 EU ESS  Japan JPARC  China CSNS  UK ISIS	 EU ESS  Japan JPARC  China CSNS  UK ISIS	 EU XFEL  Japan SACLA  Korea PAL XFEL  CH Swiss FEL	 EU XFEL  China SCLF
<b>Status Q3/20</b>	CD-3	CD-1/CD-3A	CD-1/CD-3B	CD-0	CD-3	CD-1/CD-3A
<b>FY20 Approp</b>	✓	✓	✓	✓	✓	✓

# DOE broad capabilities for addressing COVID-19 crisis

- Light and neutron sources
- Nanoscience centers
- Computational resources
- People with deep expertise relevant to:
  - Testing
  - Antiviral drug discovery
  - Vaccine discovery
  - Supply chain bottlenecks
  - Modeling and understanding disease spread
  - Molecular and structural biology

**HOW DOE AND OUR LABS ARE COMBATING COVID-19**

**UNDERSTANDING THE STRUCTURE –**  
DOE scientists are studying the components of the virus so we can determine how to fight it.

**MODELING EPIDEMICS –**  
DOE scientists use previous experience they gained modeling Smallpox, Anthrax and Ebola spread to understand how COVID-19 might behave.

**SCREENING DRUGS –**  
Our supercomputers are allowing us to expedite testing, screen more than 8,000 drug compounds and found 77 have potential to fight against COVID-19... what took days on Summit would take months with a MacBook.

**COORDINATING AND EXPANDING ACCESS FOR COVID-19 RESEARCH –**  
DOE made a nationwide call to the scientific community to utilize our state-of-the-art facilities and technologies to understand and combat COVID-19 together.

**ENERGY.GOV**

# National Virtual Biotechnology Laboratory (NVBL)

<https://science.osti.gov/nvbl>

- **Consortium of 17 DOE National laboratories**
- **Takes advantage of DOE user facilities**
- **Initial activities include:**
  - Epidemiological and logistical support
  - Addressing supply chain bottlenecks by harnessing advanced manufacturing
  - Medical therapeutics: computational drug discovery and structural biology
  - Innovations in testing capabilities
  - New project in understanding fate and transport of virus in the environment

# Epidemiology: Modeling COVID-19 Spread

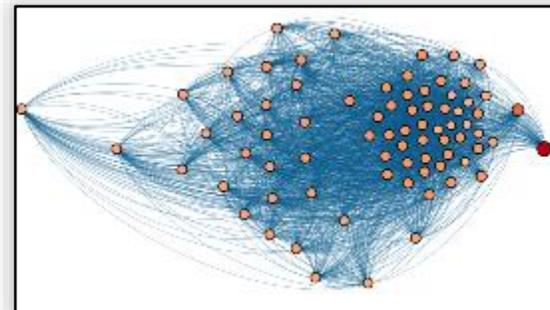
Lead: Budhu Bhaduri

Laboratories: ANL, LANL, ORNL, SNL

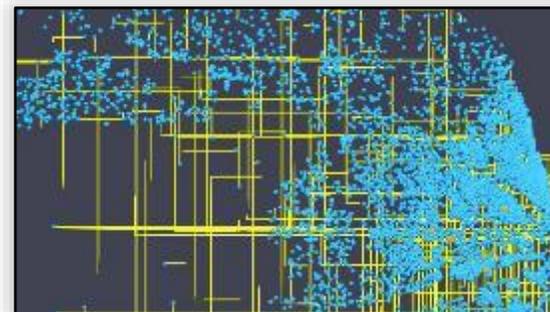
- Developing an integrated COVID-19 pandemic monitoring modeling and analysis capability
- Taking advantage of DOE's leadership computing capabilities
- Builds on scalable data and computing, spatial demography/ human dynamics research, and economic and risk modeling



Where are people located?  
With whom?



Who is infecting whom?  
Who may be infected?



Where are people going, coming from?

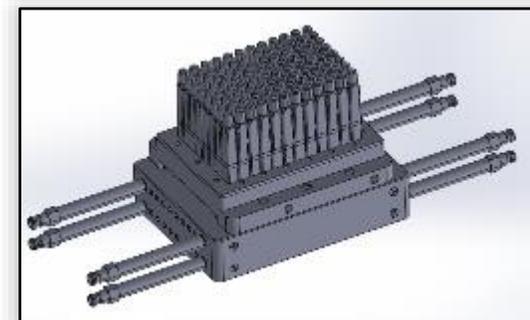
# Advanced Manufacturing for Medical Supplies

**Lead: Lonnie Love**  
**Laboratories: All 17**

- The rapid spread of COVID-19 has resulted in significant supply chain issues
- DOE leadership in materials, manufacturing, modeling, and characterization is being leveraged to design and prototype products
  - Addressing alternative materials and approaches for rapid mass production, including new processing and tooling approaches
- **NVBL focus areas:**
  - Masks/respirators (ORNL lead)
  - Ventilators (INL lead)
  - Consumables (LLNL lead)



Tubes and swabs



Testing plates:  
~500,000 needed per week



# Molecular Design to Inform Medical Therapeutics

**Lead: Marti Head**

**Laboratories: ANL, BNL, LANL, LBNL, LLNL, ORNL, PNNL, SLAC, SNL**

- COVID-19 has no approved medical therapeutic interventions beyond palliative care
- DOE capabilities are being applied to accelerate scientific discovery for therapeutics targeting SARS-CoV-2
  - Supercomputing and AI
  - Materials characterization at light and neutron sources
  - Nanoscience research

