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

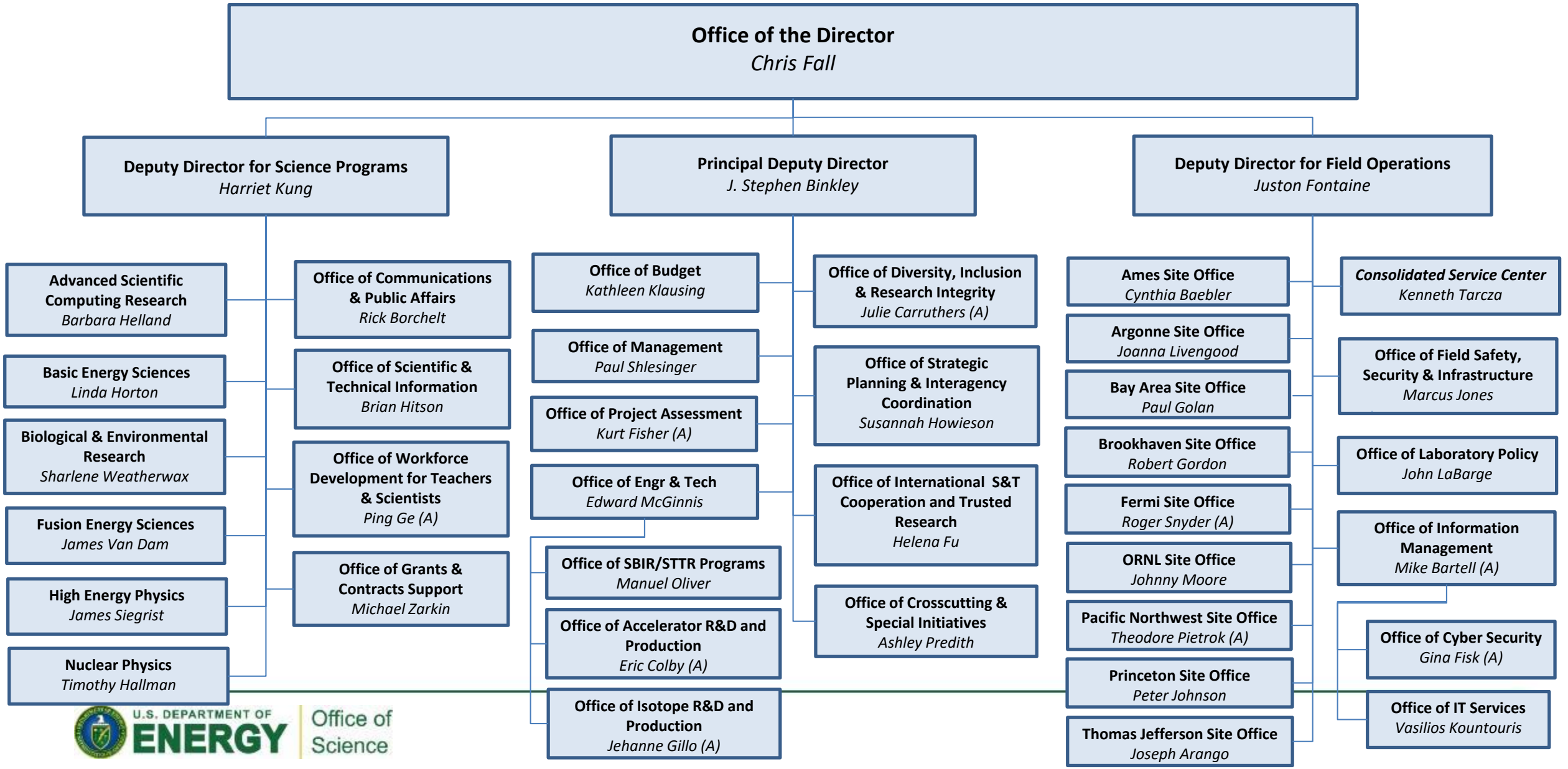
- Office of Science Reorganization
- FY 2021 President's Budget Request
- Long-range Planning – ASCR and BES Examples
- DOE COVID-19 S&T Response

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

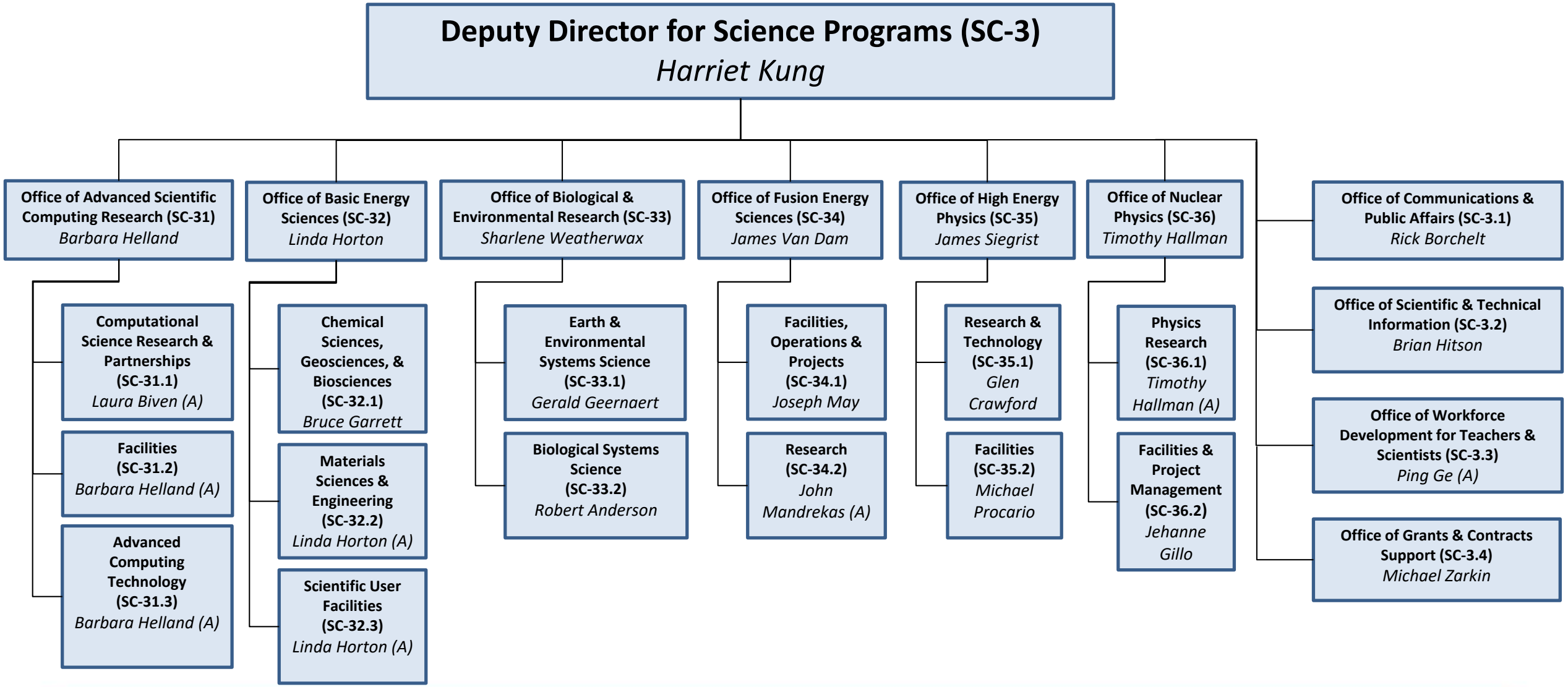
Effective 04/12/2020



U.S. DEPARTMENT OF ENERGY | Office of Science

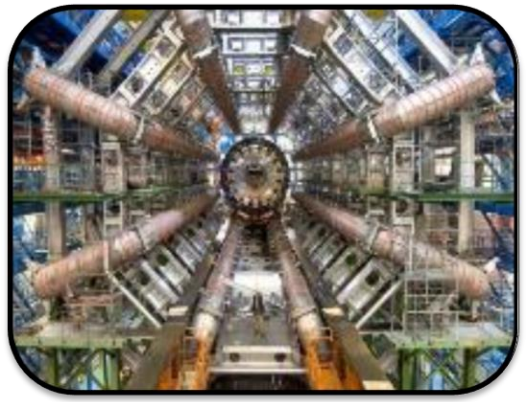
Deputy Director For Science Programs

Effective 04/12/2020



Office of Science at a Glance

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



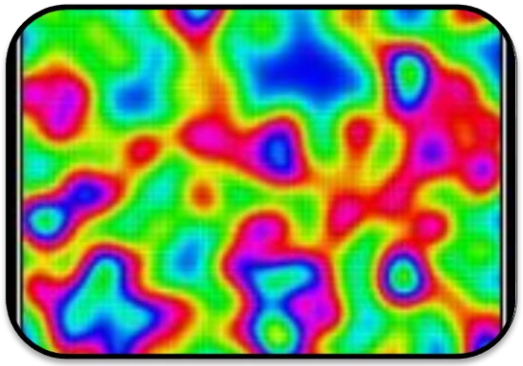
Largest Supporter of Physical Sciences in the U.S.

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	
Office of Science						
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	...	...	...	...
Total Budget Authority and Obligations, Office of Science	**6,585,000**	**6,585,000**	**7,000,000**	**5,837,806**	**-1,162,194**	**-16.6%**
SBIR/STTR (DOE)	...	123,254	...	...	...	...
Total, Office of Science	**6,585,000**	**6,708,254**	**7,000,000**	**5,837,806**	**-1,162,194**	**-16.6%**

Office of Science - FY 2021 Research Initiatives

New Research Initiatives

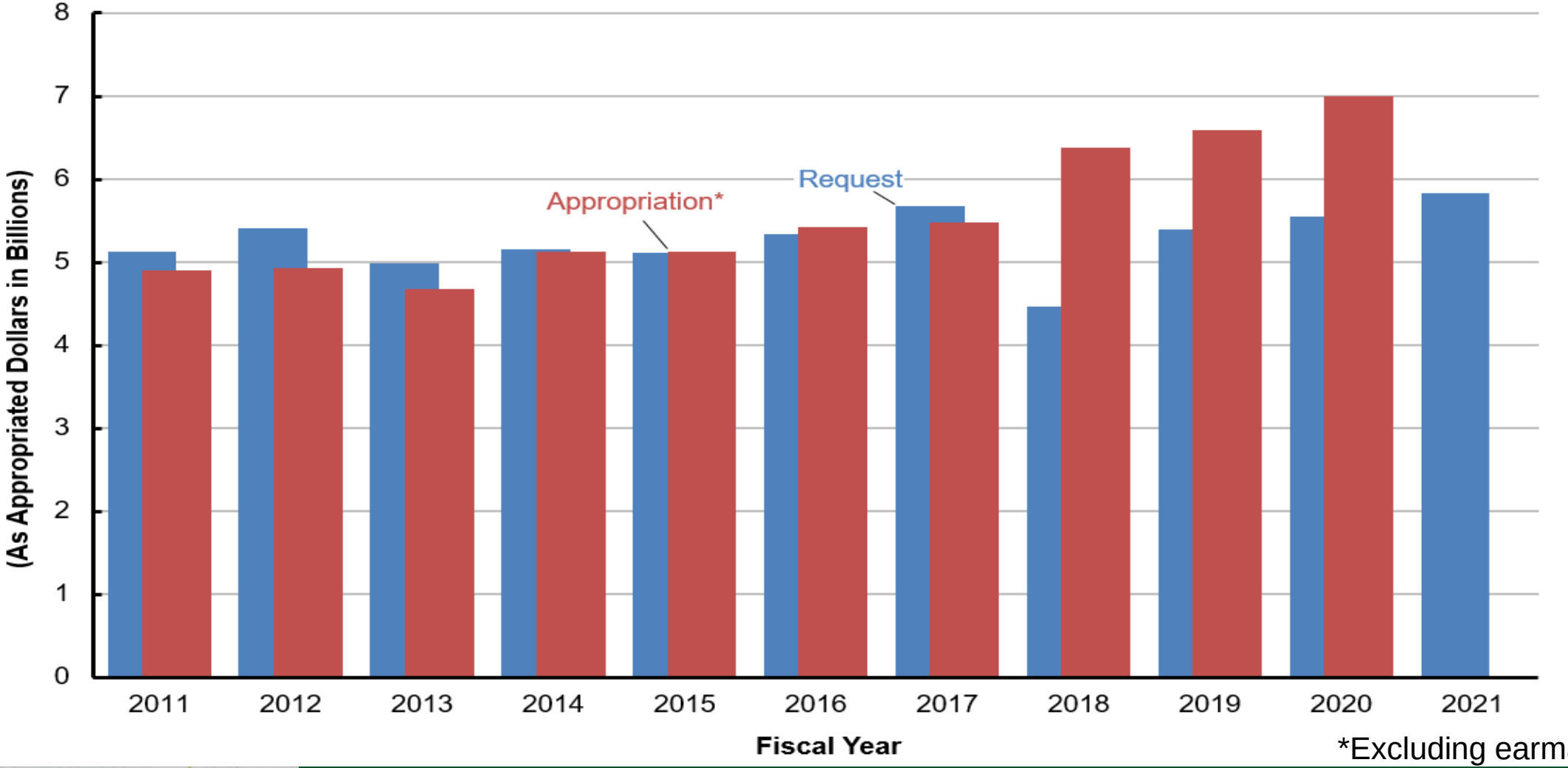
1. Integrated Computational and Data Infrastructure for Scientific Discovery
2. Next Generation Biology Initiative
3. Rare Earth / Separation Science Initiative
4. Revolutionizing Polymer Upcycling
5. Strategic Accelerator Technology Initiative
6. Data and Computational Collaboration with NIH

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

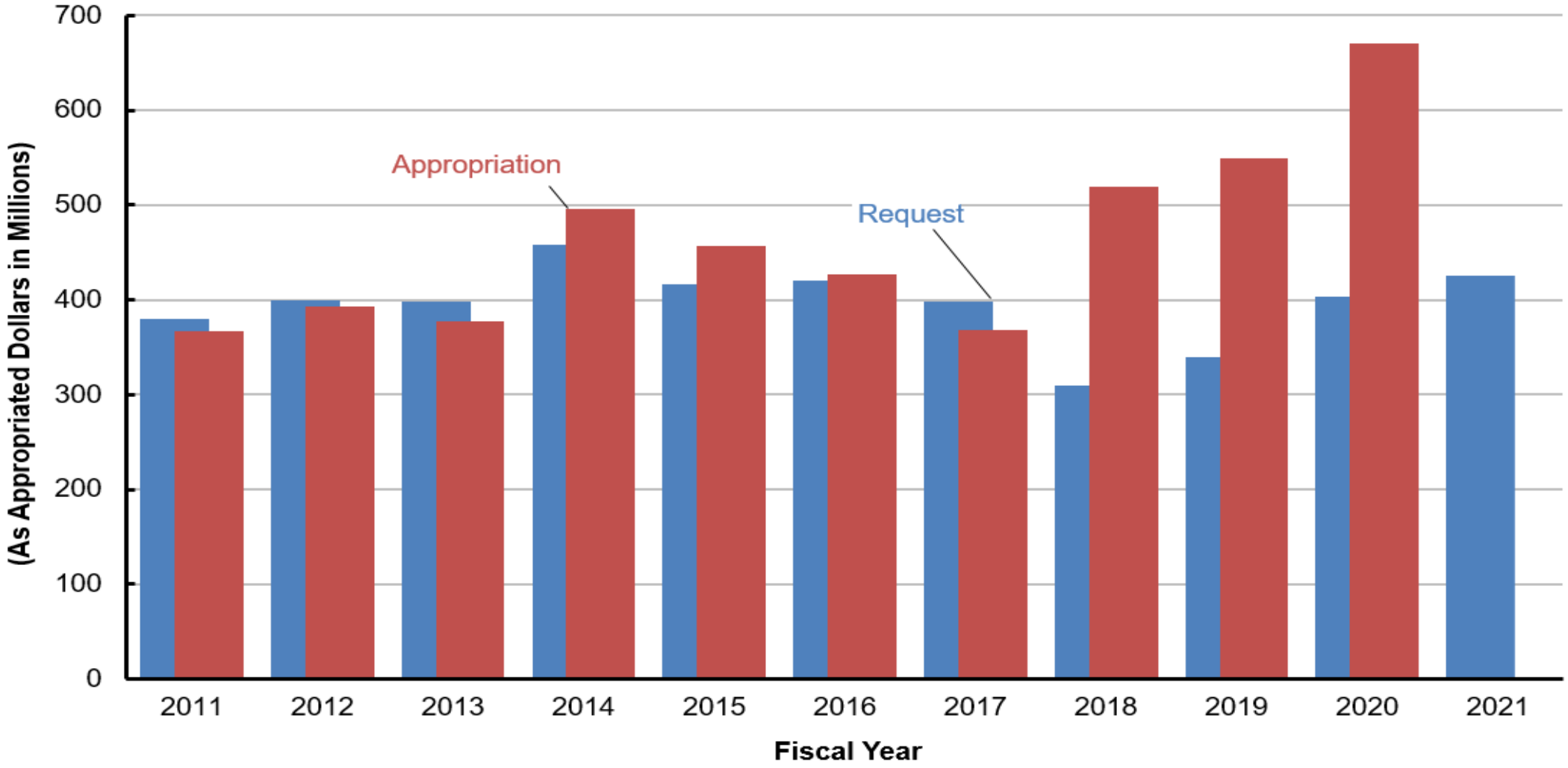
Office of Science

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.

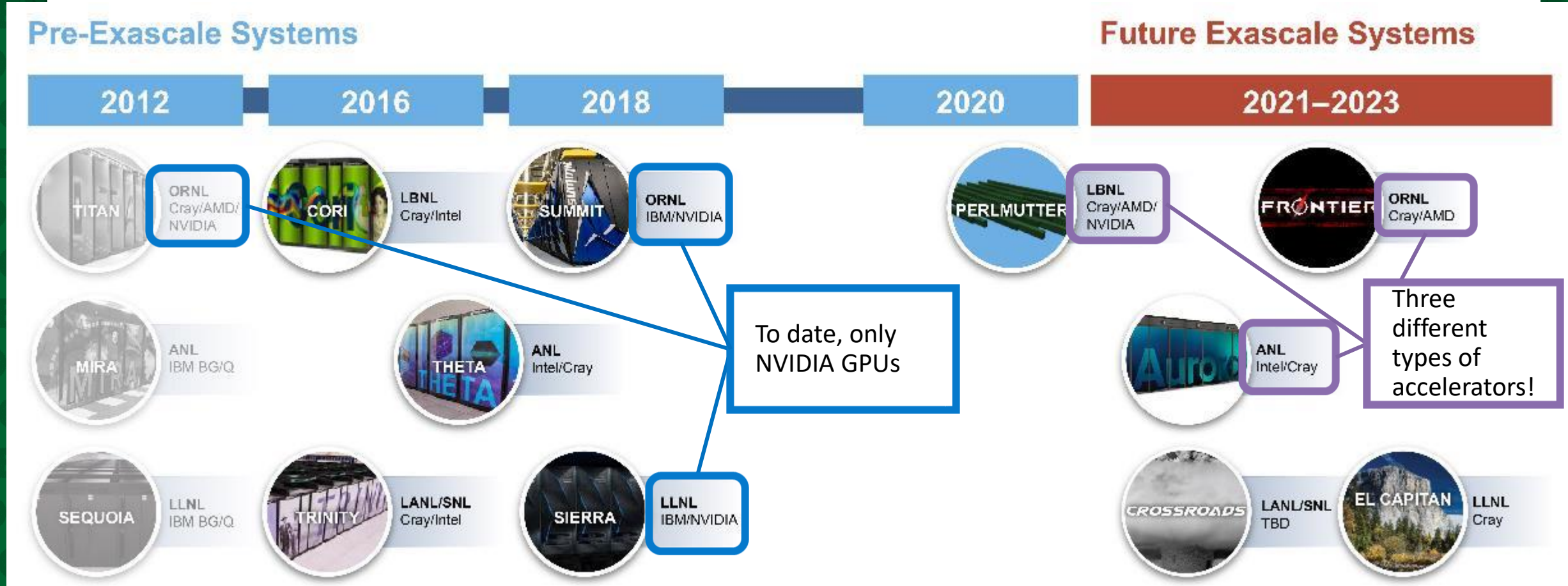
Subcommittee Members	Subcommittee Members
Baalrud, Scott [2]	Lasa, Ane [2]
Betti, Riccardo	Ma, Tammy [1]
Carter, Troy (CHAIR) [1]	Maingi, Rajesh [1]
Cary, John	Schaffner, David [2]
Ellis, Tyler	Schmitz, Oliver
Foster, John	Shumlak, Uri [2]
Geddes, Cameron	Snead, Lance
Gleason, Arianna [2]	Solomon, Wayne [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

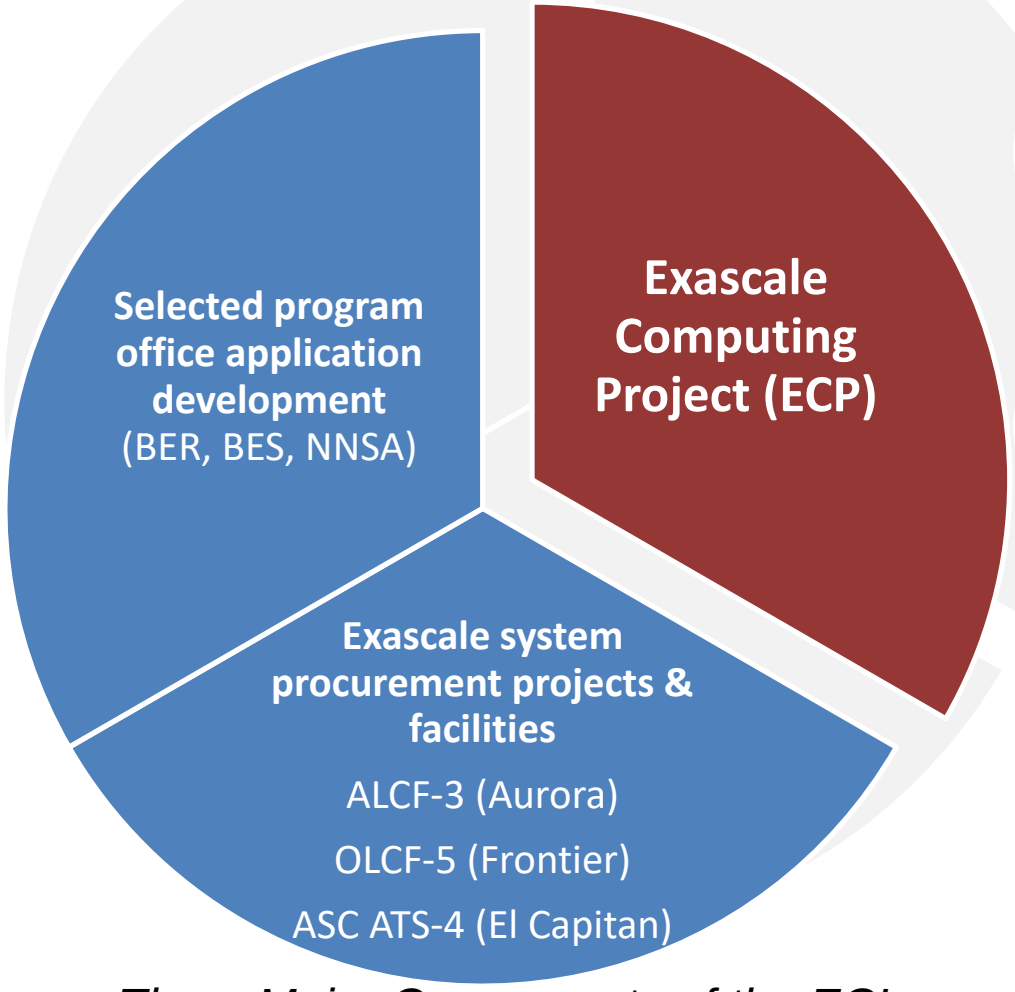
[2] Community Program Planning Committee member

DOE Roadmap to Exascale Systems

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



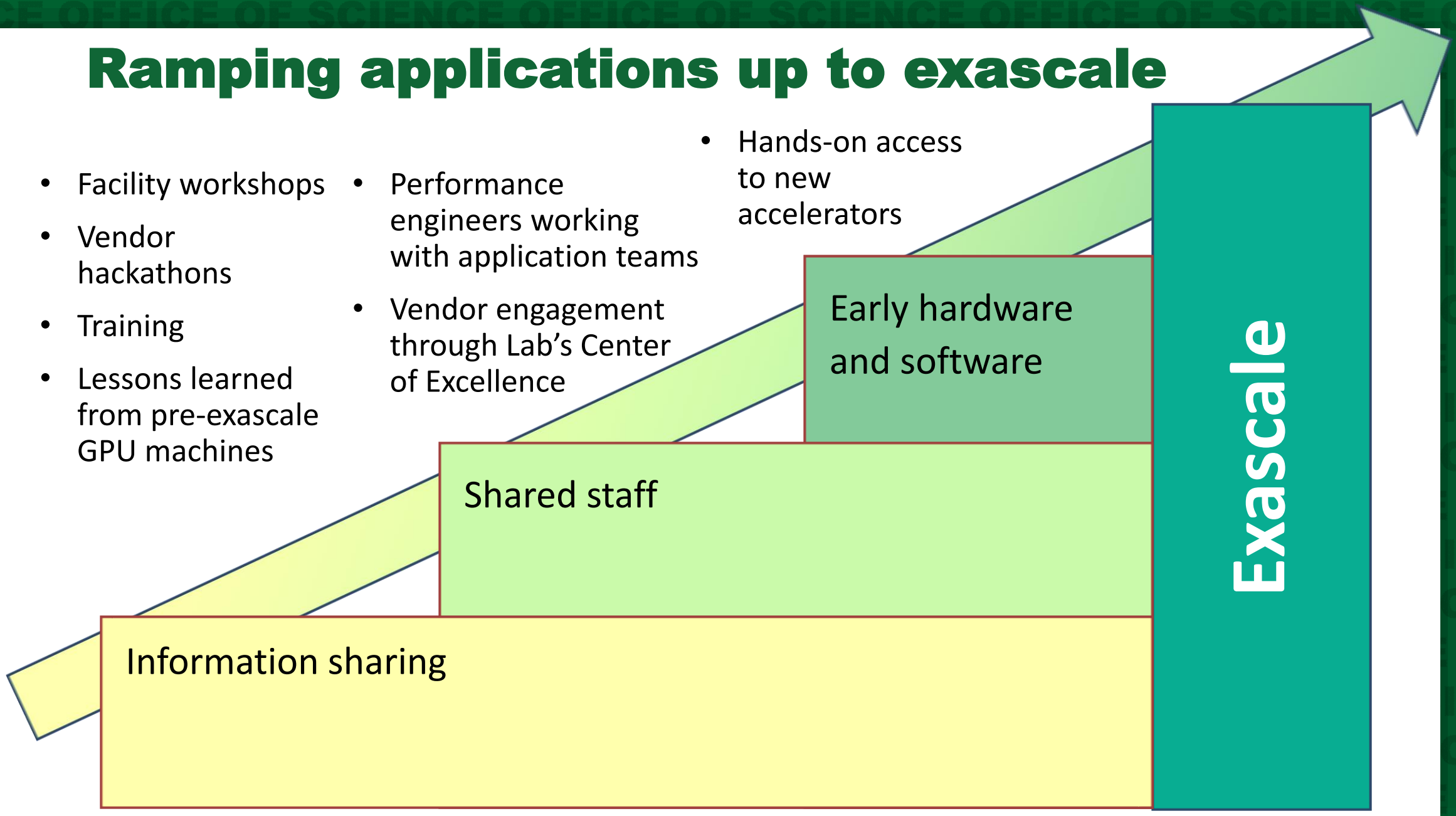
DOE Exascale Program: The Exascale Computing Initiative (ECI)



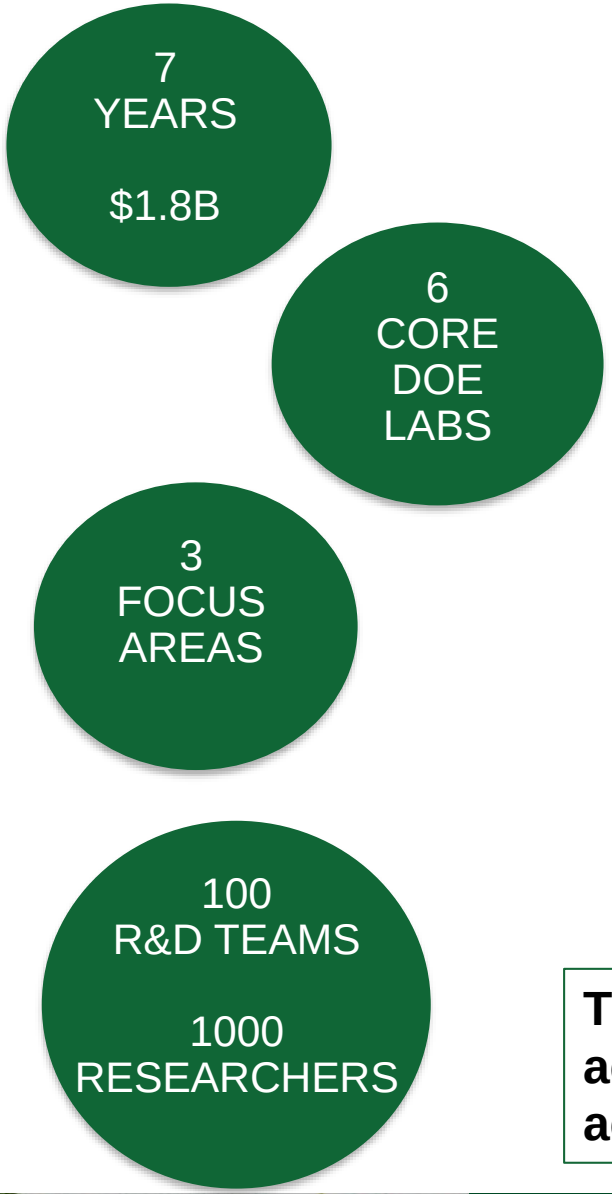
Three Major Components of the ECI

ECI partners	US DOE Office of Science (SC) and National Nuclear Security Administration (NNSA)
ECI mission	Accelerate R&D, acquisition, and deployment to deliver exascale computing capability to DOE national labs by the early- to mid-2020s
ECI focus	Delivery of an *enduring and capable exascale computing capability for use by a wide range of applications* of importance to DOE and the US

Ramping applications up to exascale



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

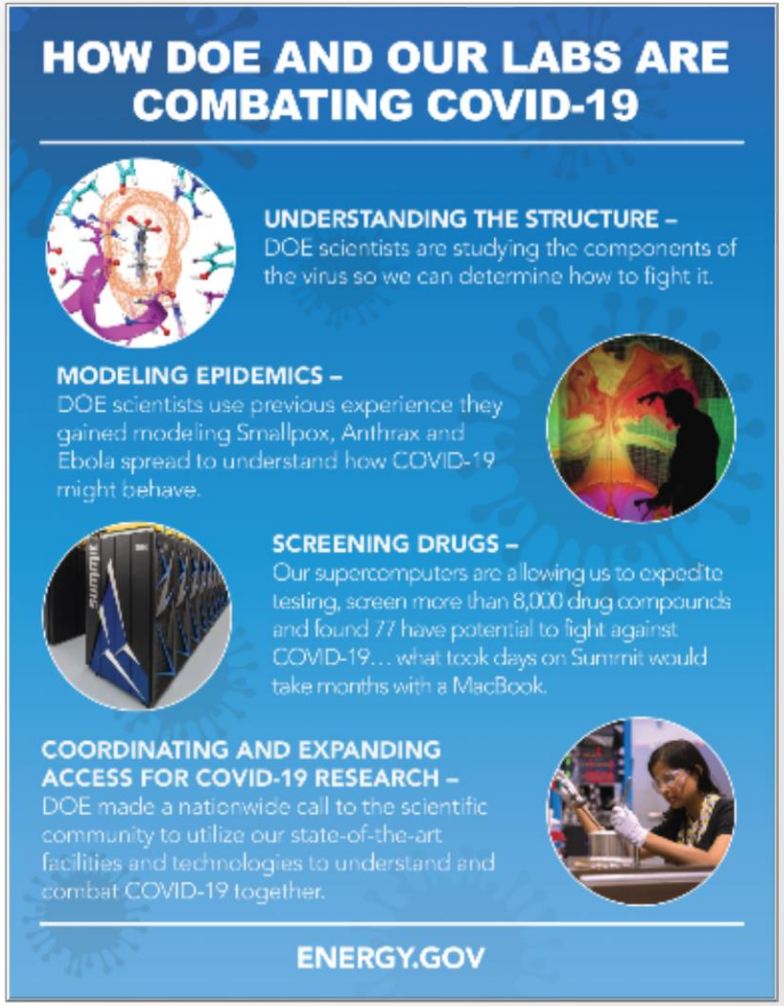
Facility Upgrade	Science Impact on Mission	Readiness for Construction
Advanced Photon Source Upgrade (APS-U)	Absolutely Central	Ready to initiate construction
Advanced Light Source Upgrade (ALS-U)	Absolutely Central	Ready to initiate construction
Linac Coherent Light Source-II High Energy Upgrade (LCLS 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
Proposed Project	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
Current Status of Facility	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
Worldwide Competition	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**
Status Q3/20	CD-3	CD-1/CD-3A	CD-1/CD-3B	CD-0	CD-3	CD-1/CD-3A
FY20 Approp	✓	✓	✓	✓	✓	✓

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



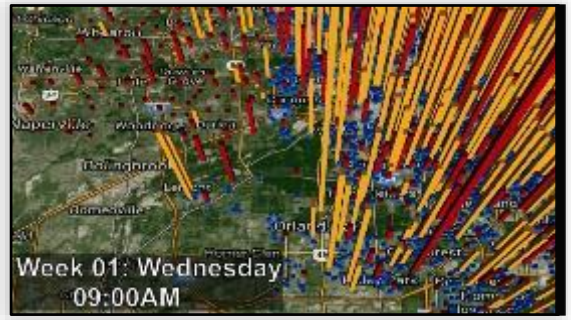
- **Consortium of 17 DOE National laboratories**
- **Takes advantage of DOE user facilities**
- **Initial activities include:**
  - Epidemiological and logistical support
  - Addressing supply chain bottlenecks by harnessing advanced manufacturing
  - Medical therapeutics: computational drug discovery 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

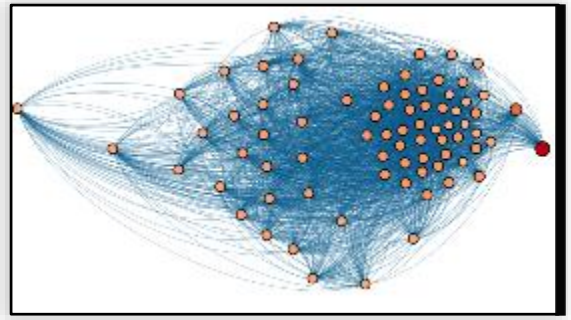
Laboratories: ANL, LANL, ORNL, SNL

- 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



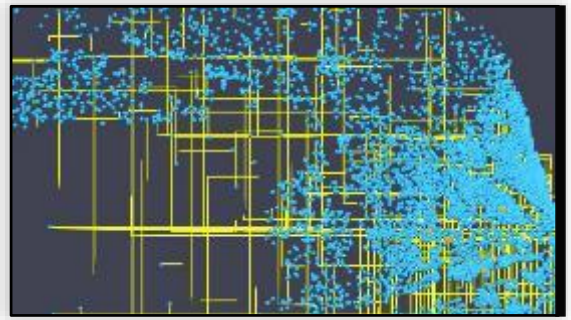
Where are people located?

With whom?



Who is infecting whom?

Who may be infected?



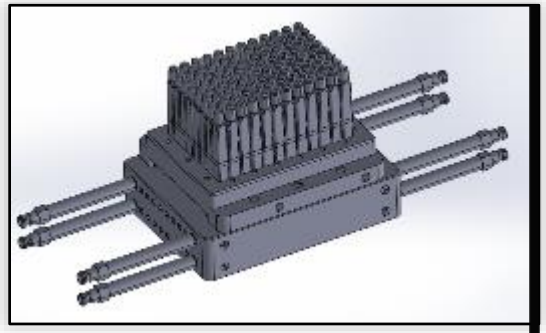
Where are people going, coming from?

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