Storage Systems and I/O Workshop 2018
Managing the Memory-Storage Continuum

Gaithersburg, MD

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Advanced Scientific Computing Research

DOE Office of Science

SSIO Workshop Organizers

- Co-chairs: Rob Ross and Lee Ward
- Organizing Committee:
  - Gary Grider
  - Scott Klasky
  - Glenn Lockwood
  - Kathryn Mohror
  - Brad Settlemeyer

- Pre-Workshop Report Contributors:
  - Phil Carns
  - Quincey Koziol
  - Matthew Wolf

- ORISE Workshop Coordinator: Deneise Terry
- ASCR Research Division Admin: Angie Thevenot

SSIO Workshop Charge

- As HPC architecture becomes more complex, the lines between what operating and runtime systems experts call *memory* and the emerging off-system storage hierarchy that includes solid state devices blur. These changes result is increased complexity for application developers and increased difficulty in managing the entire process for input and output. **A combination of rapid change in memory and storage technology and meeting the related requirements for the range of application classes using high performance computing (HPC) must drive the prioritization of essential new research activities in the SSIO area.** <u>**The goal of this day-and-a-half workshop is to identify technical requirements and basic and advanced research directions that will advance the field over the next 5-7 years.**</u>

Office of Science

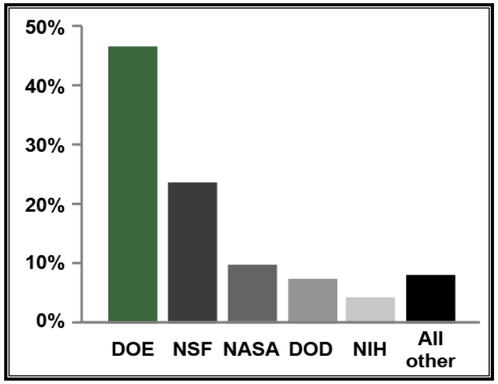
By the numbers

Shown is a portion of SLAC's two-mile-long linear accelerator (or linac), which provides the electron beam for the new Linac Coherent Light Source (~~LCLS~~) – the world's first hard x-ray, free-electron laser. For nearly 50 years, SLAC's linac had produced high-energy electrons for physics experiments. Now researchers use the very intense X-ray pulses (more than a billion times brighter than the most powerful existing sources) much like a high-speed camera to take stop-motion pictures of atoms and molecules in motion, examining fundamental processes on femtosecond timescales.

SC delivers scientific discoveries and tools to transform our understanding of nature and advance the energy, economic, and national security of the U.S.

Research

- Provides about half of the U.S. Federal support for basic research in the physical sciences;
- Supports about 19,000 Ph.D. scientists, graduate students, engineers, and support staff at over 300 institutions and 10 DOE national laboratories;
- Maintains U.S. and world leadership in high-performance computing and computational sciences;
- Continues to be the major U.S. supporter of physics, chemistry, materials sciences, and biology for discovery and for energy sciences.



Support for basic research in the physical sciences by agency.

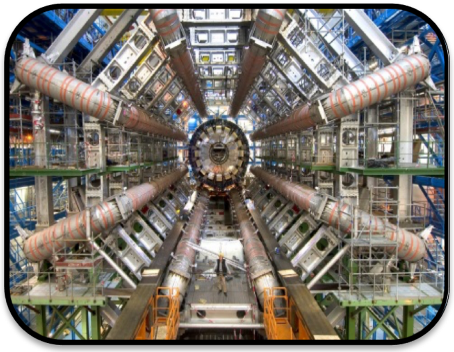
Source: *NSF Science and Engineering Indicators 2012*

Scientific User Facilities

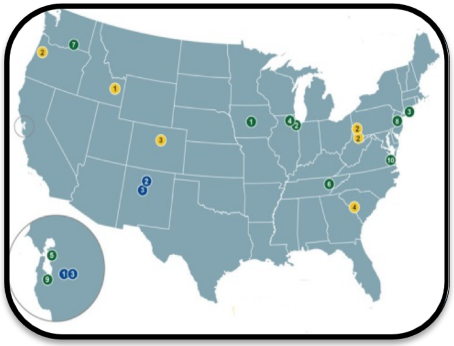
- SC maintains the world's largest collection of scientific user facilities (aka research infrastructure) operated by a single organization in the world, used by more than 31,000 researchers each year.

Office of Science at a Glance

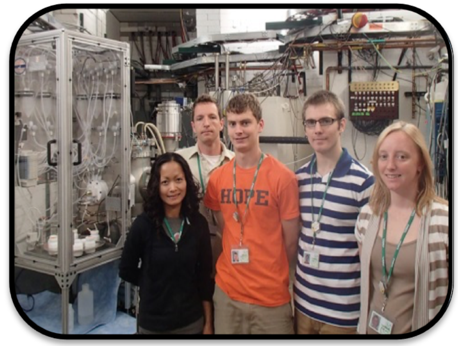
FY 2018 Request: $4.472B, (-16%)



Largest Supporter of Physical Sciences in the U.S.

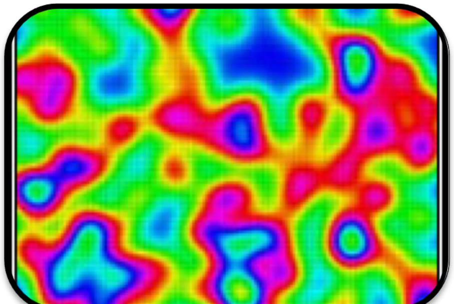


Funding at >300 Institutions including all 17 DOE Labs



> 20,000 Scientists Supported

>31,000 Users of 25 SC Scientific Facilities



Research: 42%

~40% of Research to Universities

Facility Operations: 36%

Seventeen DOE National Laboratories

Office of Science Laboratories

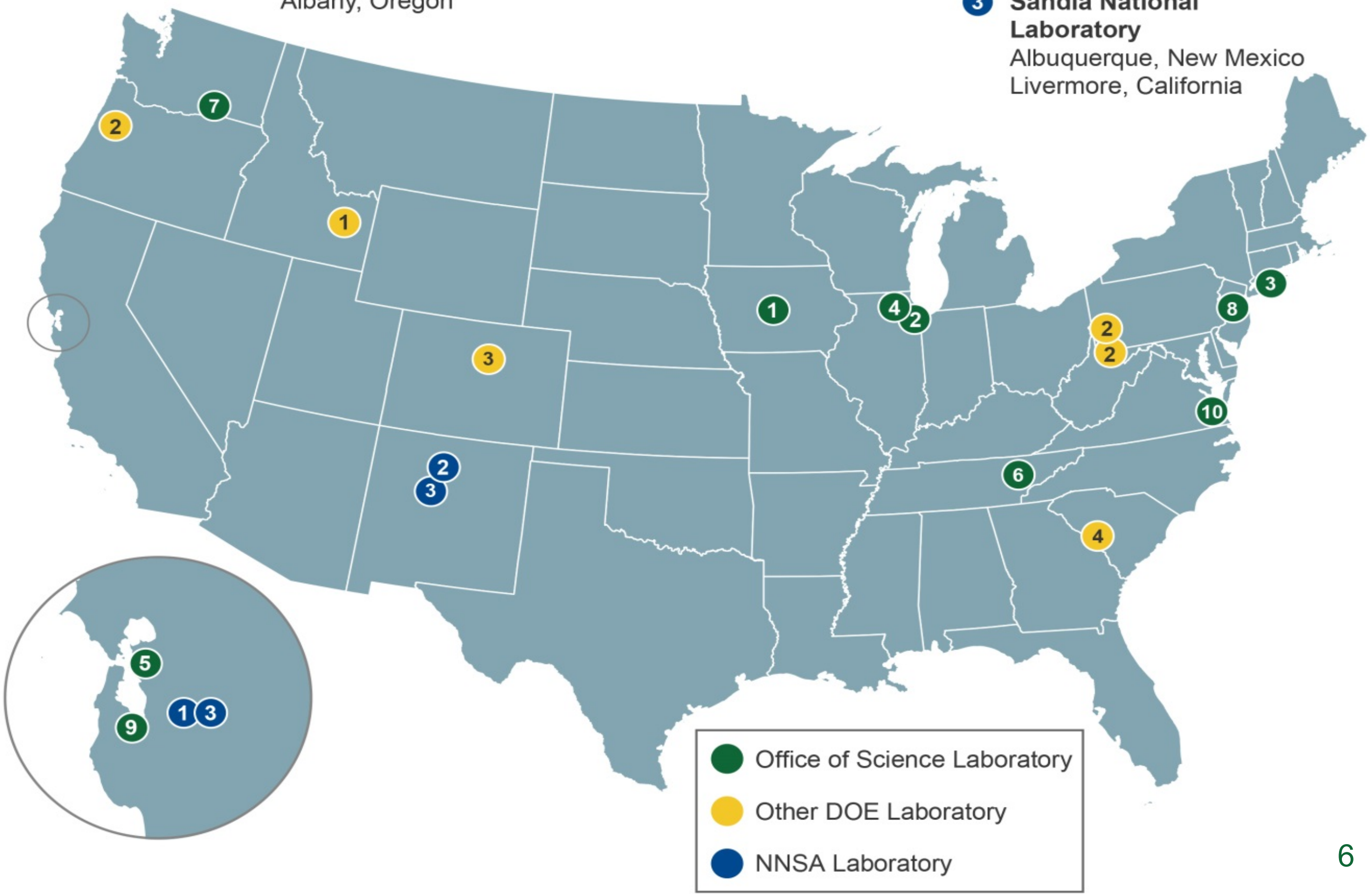
1. **Ames Laboratory**
   Ames, Iowa
2. **Argonne National Laboratory**
   Argonne, Illinois
3. **Brookhaven National Laboratory**
   Upton, New York
4. **Fermi National Accelerator Laboratory**
   Batavia, Illinois
5. **Lawrence Berkeley National Laboratory**
   Berkeley, California
6. **Oak Ridge National Laboratory**
   Oak Ridge, Tennessee
7. **Pacific Northwest National Laboratory**
   Richland, Washington
8. **Princeton Plasma Physics Laboratory**
   Princeton, New Jersey
9. **SLAC National Accelerator Laboratory**
   Menlo Park, California
10. **Thomas Jefferson National Accelerator Facility**
    Newport News, Virginia

Other DOE Laboratories

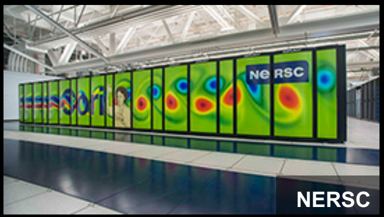
1. **Idaho National Laboratory**
   Idaho Falls, Idaho
2. **National Energy Technology Laboratory**
   Morgantown, West Virginia
   Pittsburgh, Pennsylvania
   Albany, Oregon
3. **National Renewable Energy Laboratory**
   Golden, Colorado
4. **Savannah River National Laboratory**
   Aiken, South Carolina

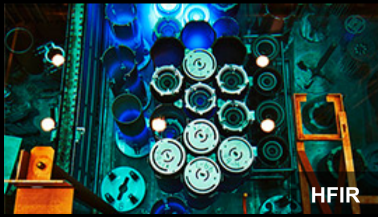
NNSA Laboratories

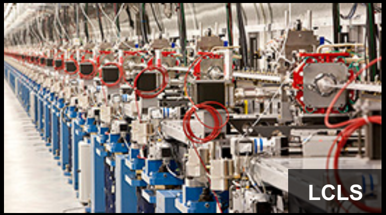
1. **Lawrence Livermore National Laboratory**
   Livermore, California
2. **Los Alamos National Laboratory**
   Los Alamos, New Mexico
3. **Sandia National Laboratory**
   Albuquerque, New Mexico
   Livermore, California

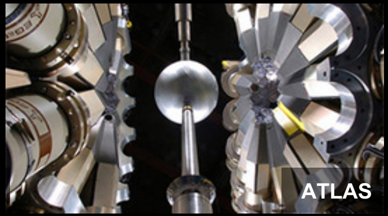


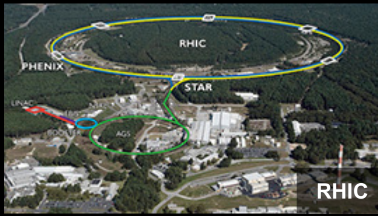
FY 2016
28 user facilities

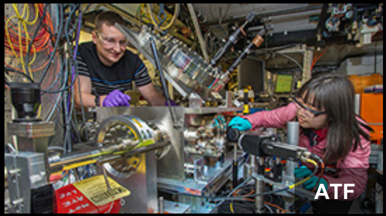






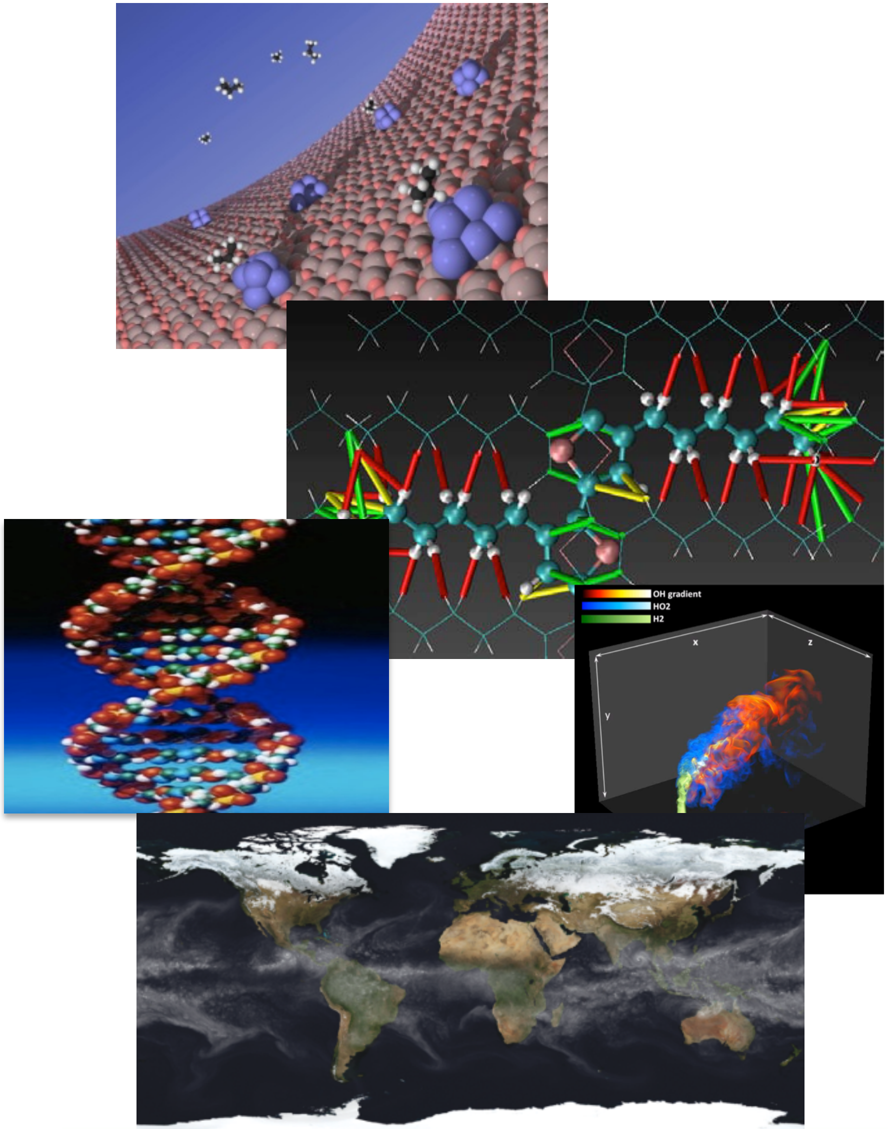






U.S. DEPARTMENT OF
ENERGY
Office of Science

ASCR Investment Priorities



- **Exascale –** conduct research and development, and design efforts in hardware software, and mathematical technologies that will produce exascale systems for science applications
- **Facilities –** acquire and operate more capable computing systems, from multi-petaflop through exascale computing systems that incorporate technologies emerging from research investments
- **Large Scientific Data –** prepare today's scientific and data-intensive computing applications to migrate to and take full advantage of emerging technologies from research, development and design efforts
- **Begin R&D for post-Moore Era**

Things We Ask of You

- **Think about challenges, not about solutions. Where should research investments focus to make significant advances in capability and usability?**

- **Think about what science needs over the next 5-7 years,** not about your own research agenda**.**

- **Try to stay present in the moment.**

- **Help to make sure that we capture the important ideas and include them in the workshop report.**

Thank you!

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