



U.S. DEPARTMENT OF
ENERGY

Office of
Science

FY 2016 Budget Request to Congress for DOE's Office of Science & More

March 2015

Dr. Patricia M. Dehmer
Acting Director, Office of Science

<http://science.energy.gov/sc-2/presentations-and-testimony/>

Office of Science

By the numbers

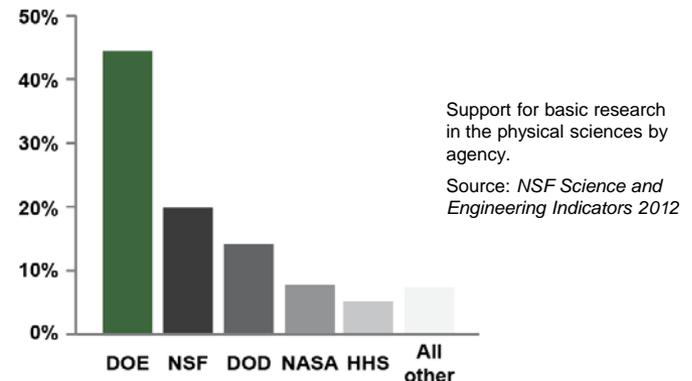


Shown is a portion of SLAC's two-mile-long linear accelerator (or linac), which provides the electron beam for the new Linac Coherent Light Source (LCLS) – the world's first hard x-ray, free-electron laser. For nearly 50 years, SLAC's linac had produced high-energy electrons for physics experiments. 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

- Support for 47% of the U.S. Federal support of basic research in the physical sciences;
- ~22,000 Ph.D. scientists, grad students, engineers, and support staff at >300 institutions, including all 17 DOE labs;
- U.S. and world leadership in high-performance computing and computational sciences;
- Major U.S. supporter of physics, chemistry, materials sciences, and biology for discovery and for energy sciences.



Scientific User Facilities

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



U.S. DEPARTMENT OF
ENERGY

Office of
Science

Office of Science FY 2016 Budget Request to Congress

(Dollars in thousands)

	FY 2014 Enacted Approp. (prior to SBIR/STTR)	FY 2014 Current Approp.	FY 2015 Enacted Approp.	FY 2016 President's Request	FY 2016 President's Request vs. FY 2015 Enacted Appropriation	
Advanced Scientific Computing Research	478,093	463,472	541,000	620,994	+79,994	+14.8%
Basic Energy Sciences	1,711,929	1,662,702	1,733,200	1,849,300	+116,100	+6.7%
Biological and Environmental Research	609,696	593,610	592,000	612,400	+20,400	+3.4%
Fusion Energy Sciences	504,677	495,855	467,500	420,000	-47,500	-10.2%
High Energy Physics	796,521	774,920	766,000	788,000	+22,000	+2.9%
Nuclear Physics	569,138	554,802	595,500	624,600	+29,100	+4.9%
Workforce Development for Teachers and Scientists	26,500	26,500	19,500	20,500	+1,000	+5.1%
Science Laboratories Infrastructure	97,818	97,818	79,600	113,600	+34,000	+42.7%
Safeguards and Security	87,000	87,000	93,000	103,000	+10,000	+10.8%
Program Direction	185,000	185,000	183,700	187,400	+3,700	+2.0%
SBIR/STTR (SC)	.....	128,539	.....	.....	.....	.....
Subtotal, Office of Science	5,066,372	5,070,218	5,071,000	5,339,794	+268,794	+5.3%
SBIR/STTR (DOE)	.....	64,666	.....	.....	.....	.....
Subtotal, Office of Science	5,066,372	5,134,884	5,071,000	5,339,794	+268,794	+5.3%
Use of Prior Year Balances (SBIR)	.....	-3,846	.....	.....	.....	.....
Rescission of Prior Year Balances	.....	.....	-3,262	.....	+3,262	-100.0%
Total, Office of Science	5,066,372	5,131,038	5,067,738	5,339,794	+272,056	+5.4%



FY 2016 SC Budget Request by Category

Dollars in Thousands

Construction

- BES: Linac Coherent Light Source-II continues and is in its peak funding year (\$200,300K).
- FES: ITER – support for the USIPO, IO, and hardware fabrication continues (\$150,000K).
- HEP: Long Baseline Neutrino Facility (\$20,000K for PED); Muon to Electron Conversion (\$40,100K).
- NP: FRIB continues and is at the peak of its funding profile (\$100,000K); accelerator commissioning and detector construction of the CEBAF 12 GeV upgrade continue (\$12,000K).
- SLI: Materials Design Lab at ANL (\$23,910K); Photon Science Lab Building at SLAC (\$25,000K); Integrative Genomics Building at LBNL (\$20,000K).
- Also in SLI: “Infrastructure Support” increases by \$31,100K for top priorities identified as part of the Campus Strategy discussions, for electrical upgrades at ANL and SLAC and for facility improvements at FNAL.

Facility Operations

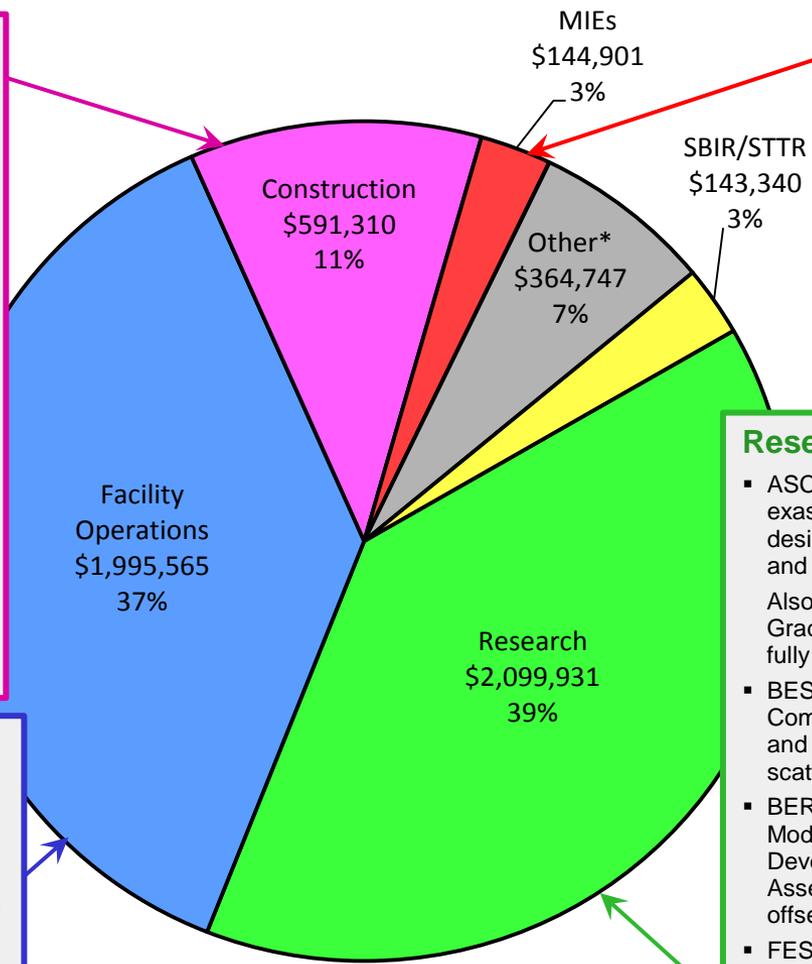
- ASCR, BER, BES, HEP: Facilities operate at or near to optimal, >98%.
- FES: NSTX resumes operations for 14 weeks; DIII-D operates for 12 weeks until shutdown for installation of upgrades; Alcator C-Mod operates for 5 weeks prior to final shutdown at the end of FY 2016.
- NP: RHIC operates 22 weeks, same as in FY 2015 and has funding for capital equipment and spares; ATLAS operates 37 weeks; CEBAF is supported for continued machine development and commissioning of beam to Halls B and C.

Major Items of Equipment

- BES: Advanced Photon Source Upgrade (APS-U) (\$20,000K) and NSLS-II Experimental Tools (NEXT) (15,500K).
- HEP: LHC Detector Upgrades (ATLAS and CMS) (\$9,500K each); Large Synoptic Survey Telescope camera (LSSTcam) (\$40,800K); Muon g-2 (\$10,200K); LUX-ZEPLIN (\$9,000K); SuperCDMS-SNOlab (\$2,000K); Dark Energy Spectroscopic Instrument (DESI) (\$5,300K).

Research

- ASCR: There is a significant increase for the exascale initiative to support for HPC vendors to design and develop exascale node technologies and systems. ($\Delta = +\$86,895K$).
Also in ASCR: The Computational Science Graduate Fellowship is restored at \$10,000K to fully fund a new cohort!
- BES: Increases for EFRCS ($\Delta = +\$10,000K$), Computational Materials Sciences ($\Delta = +\$4,000K$), and mid-scale instrumentation for ultrafast electron scattering ($\Delta = +\$5,000K$).
- BER: Increases for Climate and Earth System Modeling with largest increase for Climate Model Development & Validation and Integrated Assessment. ($\Delta = +\$18,730K$). Some decreases offset the increases.
- FES: Research continues in all areas. Increase for GPP for PPPL in support of NSTX-U operations. HEDLP is reduced, but the Matter in Extreme Conditions end station at LCLS remains fully funded.
- HEP: Research funding is nearly flat with FY 2015 and supports scientific results from operating experiments and R&D for future projects.
- NP: Research increases by more than 8% to support high-priority work.



*Other includes GPP/GPE amounts for BES, GPP for FES, Other (DOE/SC/Fermi/Lawrence) for NP, WDTS, SLI non-construction funding, S&S, and Program Direction.



U.S. DEPARTMENT OF
ENERGY

Office of
Science

FY 2016 SC Budget Request by Category

Dollars in Thousands

Research

- ASCR: There is a significant increase for the exascale initiative to support for HPC vendors to design and develop exascale node technologies and systems. ($\Delta = +\$86,895\text{K}$).
Also in ASCR: The Computational Science Graduate Fellowship is restored at \$10,000K to fully fund a new cohort!
- BES: Increases for EFRCs ($\Delta = +\$10,000\text{K}$), Computational Materials Sciences ($\Delta = +\$4,000\text{K}$), and mid-scale instrumentation for ultrafast electron scattering ($\Delta = +\$5,000\text{K}$).
- BER: Increases for Climate and Earth System Modeling with largest increase for Climate Model Development & Validation and Integrated Assessment. ($\Delta = +\$18,730\text{K}$). Some decreases offset the increases.
- FES: Research continues in all areas. Increase for GPP for PPPL in support of NSTX-U operations. HEDLP is reduced, but the Matter in Extreme Conditions end station at LCLS remains fully funded.
- HEP: Research funding is nearly flat with FY 2015 and supports scientific results from operating experiments and R&D for future projects.
- NP: Research increases by more than 8% to support high-priority work.

FY 2016 SC Budget Request by Category

Dollars in Thousands

Facility Operations

- ASCR, BER, BES, HEP: Facilities operate at or near to optimal, >98%.
- FES: NSTX resumes operations for 14 weeks; DIII-D operates for 12 weeks until shutdown for installation of upgrades; Alcator C-Mod operates for 5 weeks prior to final shutdown at the end of FY 2016.
- NP: RHIC operates 22 weeks, same as in FY 2015; ATLAS operates 37 weeks; CEBAF is supported for continued machine development and commissioning of beam to Halls B and C.

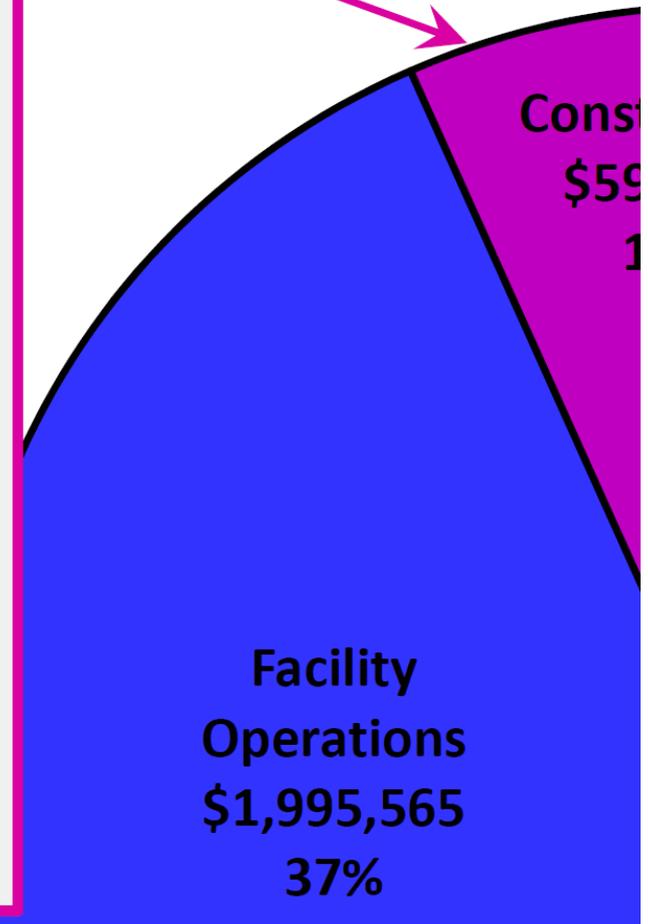


FY 2016 SC Budget Request by Category

Dollars in Thousands

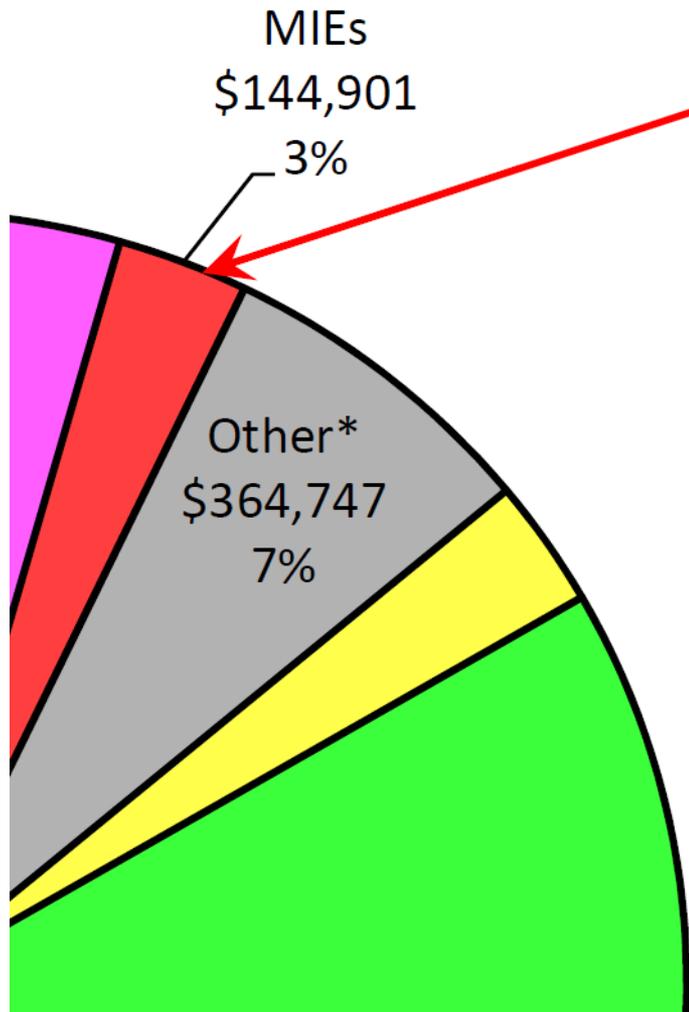
Construction

- BES: Linac Coherent Light Source-II continues and is in its peak funding year (\$200,300K).
- FES: ITER – support for the USIPO, IO, and hardware fabrication continues (\$150,000K).
- HEP: Long Baseline Neutrino Facility (\$20,000K for PED); Muon to Electron Conversion (\$40,100K).
- NP: FRIB continues and is at the peak of its funding profile (\$100,000K); accelerator commissioning and detector construction of the CEBAF12 GeV upgrade continue (\$12,000K).
- SLI: Materials Design Lab at ANL (\$23,910K); Photon Science Lab Building at SLAC (\$25,000K); Integrative Genomics Building at LBNL (\$20,000K).



FY 2016 SC Budget Request by Category

Dollars in Thousands

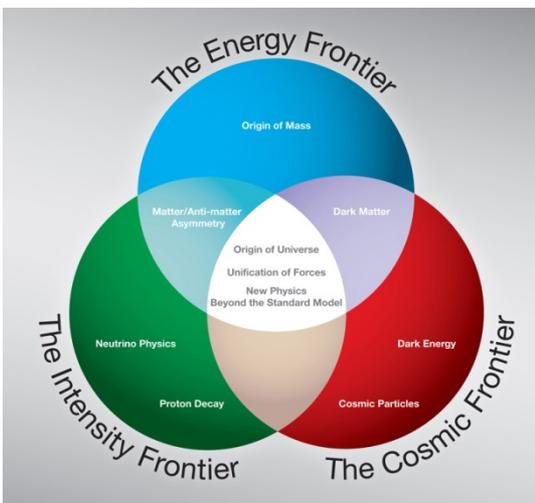


Major Items of Equipment

- BES:
 - Advanced Photon Source Upgrade (APS-U) (\$20,000K);
 - NSLS-II Experimental Tools (NEXT) (15,500K).
- HEP:
 - LHC Detector Upgrades (ATLAS and CMS) (\$9,500K each);
 - Large Synoptic Survey Telescope camera (LSSTcam) (\$40,800K);
 - Muon g-2 (\$10,200K);
 - LUX-ZEPLIN (\$9,000K);
 - SuperCDMS-SNOlab (\$2,000K);
 - Dark Energy Spectroscopic Instrument (DESI) (\$5,300K).



HEPAP/P5 Reports, 2008 and 2014



- Use the Higgs boson as a new tool for discovery
- Pursue the physics associated with neutrino mass
- Identify the new physics of dark matter
- Understand cosmic acceleration: dark energy and inflation
- Explore the unknown: new particles, interactions, and physical principles.

BESAC Light Source Report, 2013

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

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

In a January 2, 2013 letter, then Director of the DOE Office of Science (SC), Dr. William Brinkman, asked the Basic Energy Sciences Advisory Committee (BESAC) to provide him with objective, independent advice in the following areas:

- Assessment of the grand science challenges that could best be explored with current and possible future SC light sources. The assessment should cover the disciplines supported by Basic Energy Sciences (BES) and other fields that benefit from intense light sources.
- Evaluation of the effectiveness of the present SC light source portfolio to meet these grand science challenges.
- Enumeration of future light source performance specifications that would maximize the impact on grand science challenges.
- Prioritized recommendations on which future light source concepts and the technology behind them are best suited to achieve these performance specifications.
- Identification of prioritized research and development initiatives to accelerate the realization of these future light source facilities in a cost effective manner.

It is important to note that the Future Light Source charge was provided to BESAC shortly after the Office of Science requested BESAC to provide a prioritization of the BES existing and planned major facilities. In the BESAC facilities prioritization report provided to the Office of Science on March 21, 2013, BESAC made the clear statement that *"the BESAC urges DOE to aggressively pursue a new future light source with unprecedented beam characteristics and thus unprecedented opportunities for world-leading science"*.

The BESAC facilities prioritization report, in concert with the outstanding success story of construction and early experiments of the Linac Coherent Light Source sets the stage for the present discussion and report.

Executive Summary

The world leadership that the U.S. has provided in accelerator-based x-ray light source user facilities over the last 40 years has generated broad and far-reaching advances in diverse fields of science and technology. The unprecedented success of the U.S. x-ray light sources, under the stewardship of BES, has resulted in an extensive international activity in the development of innovative, and ever more advanced x-ray sources for discovery science and technological development. In spite of the present intensely

The report dramatically altered plans for new/upgraded light sources at ANL, LBNL, and SLAC – affecting APS (ANL), NGLS (LBNL), ALS (LBNL), and LCLS (SLAC).

BESAC Grand Challenges, 2015

BESAC DRAFT

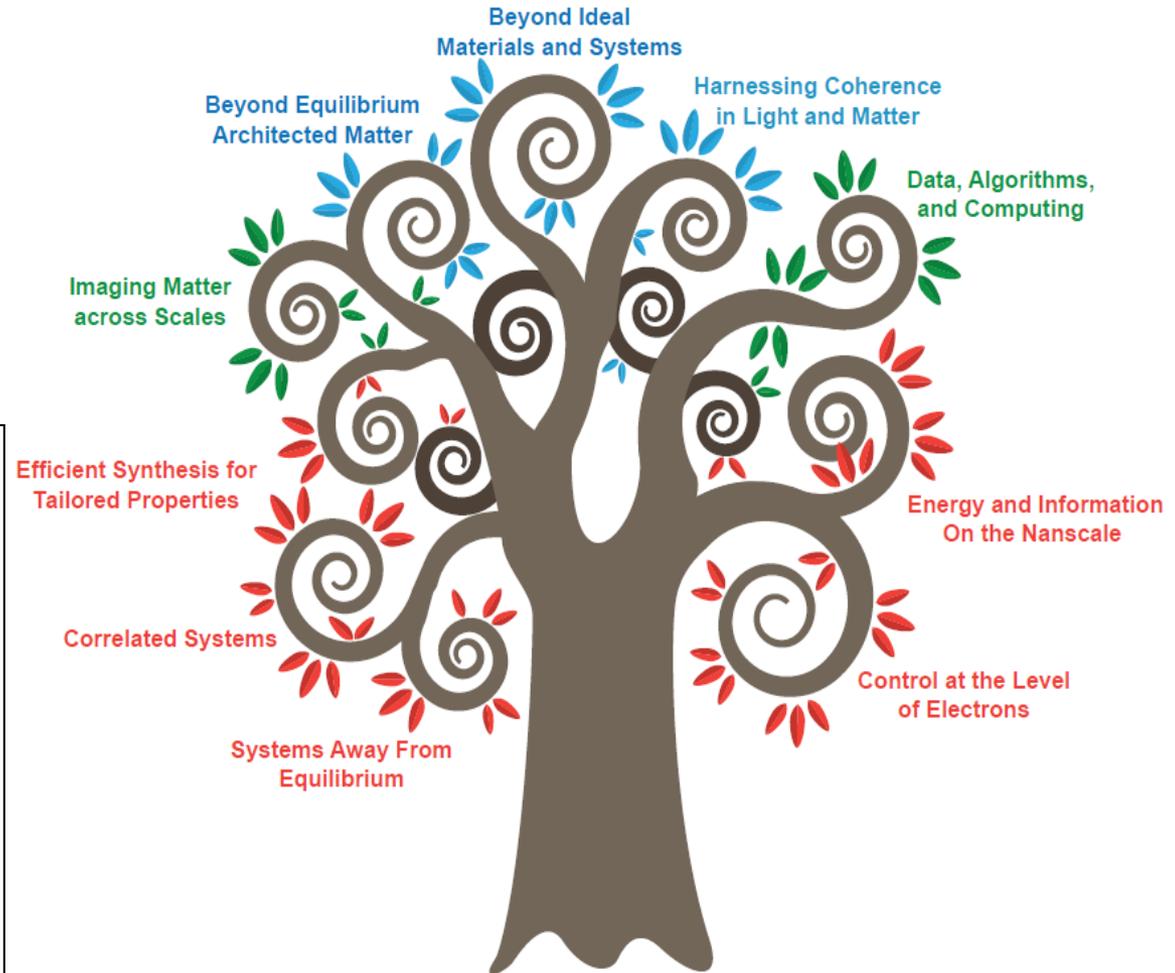
Do Not Circulate

A Report from the Basic Energy Sciences Advisory Committee

CHALLENGES AT THE FRONTIERS OF MATTER AND ENERGY:

Transformative Opportunities for Discovery Science

- ▶ **Mastering Hierarchical Architectures and Beyond-Equilibrium Matter**
- ▶ **Beyond Ideal Materials and Systems: Understanding the Critical Roles of Heterogeneity, Interfaces and Disorder**
- ▶ **Harnessing Coherence in Light and Matter**
- ▶ **Revolutionary Advances in Models, Mathematics, Algorithms, Data, and Computing**
- ▶ **Exploiting Transformative Advances in Imaging Capabilities Across Multiple Scales**



Instrumentation, Synthesis, People, Resources

FESAC 2014

Pat's take aways: Five areas of importance emerge.

- First, massively parallel computing with the goal of validated whole-fusion-device modeling will enable a transformation in predictive power, which is required to minimize risk in future fusion energy development steps.
- Second, materials science as it relates to plasma and fusion sciences will provide the scientific foundations for greatly improved plasma confinement and heat exhaust.
- Third, research in the prediction and control of transient events that can be deleterious to toroidal fusion plasma confinement will provide greater confidence in machine designs with stable plasmas.
- Fourth, continued stewardship of discovery at the plasma science frontier that is not expressly driven by the energy goal will address frontier plasma science issues underpinning great mysteries of the visible universe and will help attract and retain a new generation of plasma/fusion science leaders.
- Fifth, FES facilities will be kept world-leading through robust operations and regular upgrades.