U.S. DEPARTMENT OF ENERGY | Office of Science

FY 2015 Budget Request to Congress for DOE's Office of Science

March 14, 2014

Dr. Patricia M. Dehmer
Acting Director, Office of Science
www.science.energy.gov

Office of Science FY 2015 Budget Request to Congress

(Dollars in thousands)

	FY 2013 Current (prior to SBIR/STTR)	FY 2013 Current Approp.	FY 2014 Enacted Approp.	FY 2015 President's Request	FY15 President's Request vs. FY14 Enacted Approp.	
Advanced Scientific Computing Research	417,778	405,000	478,093	541,000	+62,907	+13.2%
Basic Energy Sciences	1,596,166	1,551,256	1,711,929	1,806,500	+94,571	+5.5%
Biological and Environmental Research	578,294	560,657	609,696	628,000	+18,304	+3.0%
Fusion Energy Sciences	385,137	377,776	504,677	416,000	-88,677	-17.6%
High Energy Physics	748,314	727,523	796,521	744,000	-52,521	-6.6%
Nuclear Physics	519,859	507,248	569,138	593,573	+24,435	+4.3%
Workforce Development for Teachers and Scientists	17,486	17,486	26,500	19,500	-7,000	-26.4%
Science Laboratories Infrastructure	105,673	105,673	97,818	79,189	-18,629	-19.0%
Safeguards and Security	77,506	77,506	87,000	94,000	+7,000	+8.0%
Program Direction	174,862	174,862	185,000	189,393	+4,393	+2.4%
Subtotal, Office of Science	**4,621,075**	**4,504,987**	**5,066,372**	**5,111,155**	+44,783	+0.9%
Small Business Innovation Research/Technology Transfer	...	176,208	...	...	...	...
Use of Prior Year Balances	...	...	...	...	...	...
Total, Office of Science	**4,621,075**	**4,681,195**	**5,066,372**	**5,111,155**	+44,783	+0.9%

Highlights of the FY 2015 SC Budget – Research

Research: New investments in research underpinning next-generation computing and in the development of computational models for disciplinary computing.

ASCR **Increased research investments in exascale and data-intensive science** in Applied Mathematics, Computer Science, and R&E Prototypes, including work in the representation, analysis, visualization, and management of extreme-scale data from simulations and experiments; also in processors, memory, and data flow leading to the development of exascale systems.

BES **Computational materials sciences** will combine theory, modeling, and computer science to develop new community codes for the design of functional materials—that is, materials that "function" by responding to external stimuli such as pressure, temperature, electric/magnetic fields, or chemical changes in their environment. Teams will address topics such as catalysis, superconductivity, and materials in high fields. Validation and verification of materials codes will involve experiments using SC facilities to probe materials at fast time scales (e.g., LCLS) and with near-atomic resolution (synchrotron x-ray sources, neutron scattering sources, electron-beam microscopy sources) under a variety of conditions.

Highlights of the FY 2015 SC Budget – Facility Ops

Facility operations: Most of the scientific user facilities operate at or near optimal levels—including the Leadership Computing Facilities and the light sources that together host more than half of all users at the facilities.

ASCR

- **NERSC and the Leadership Computing Facilities at ANL and ORNL** operate optimally. NERSC moves to the Computational Research and Theory Building at LBNL. Funds for the LCFs support the preparation of planned 75-200 petaflop upgrades in the FY 2017-2018 timeframe.

BES

- **4 Light Sources, 2 Neutron Scattering Sources,** and **5 Nanoscale Science Research Centers** operate optimally. **NSLS-II** transitions to operations and **NSLS-I** ceases operation. With **SNS** operating at full power and nearly fully instrumented, operations at the **Lujan Neutron Scattering Center** cease.

FES

- **NSTX** operates for an 18-week run following the 3-year-long upgrade.
- **DIII-D** operates for a 15-week run.
- **Alcator C-Mod** operates for a 5-week run.

HEP

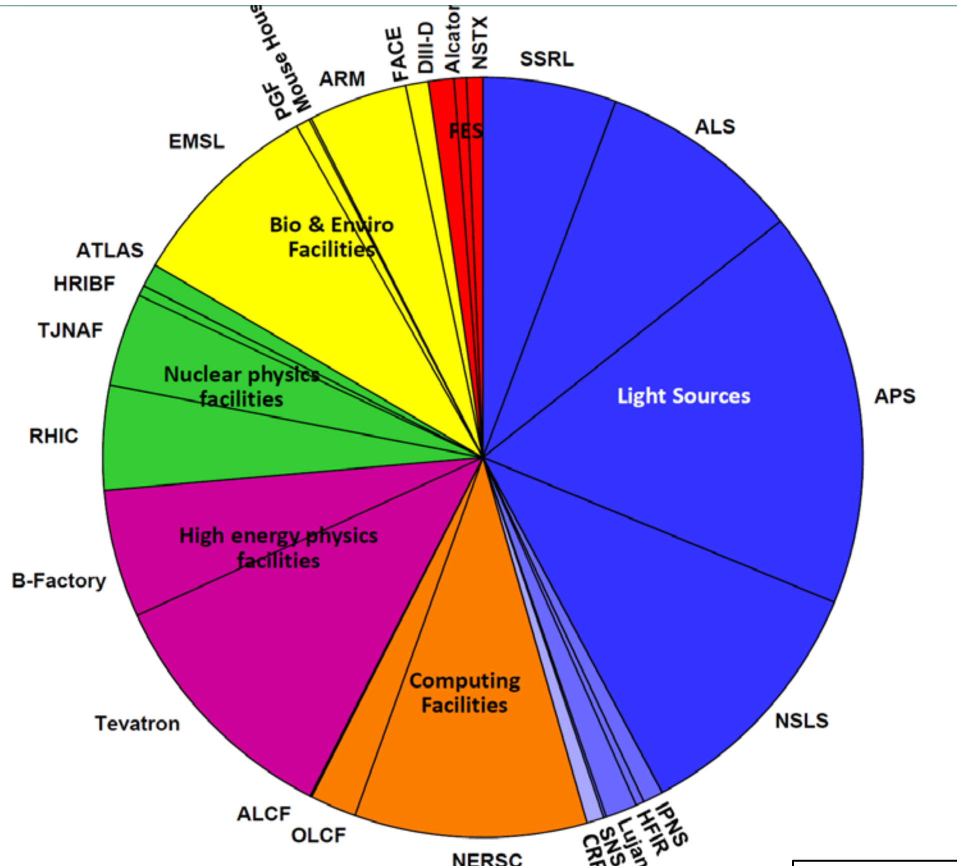
- The **Fermilab Accelerator Complex** operates to support experiments such as **NOvA, Minerva, MicroBoone, MINOS**

NP

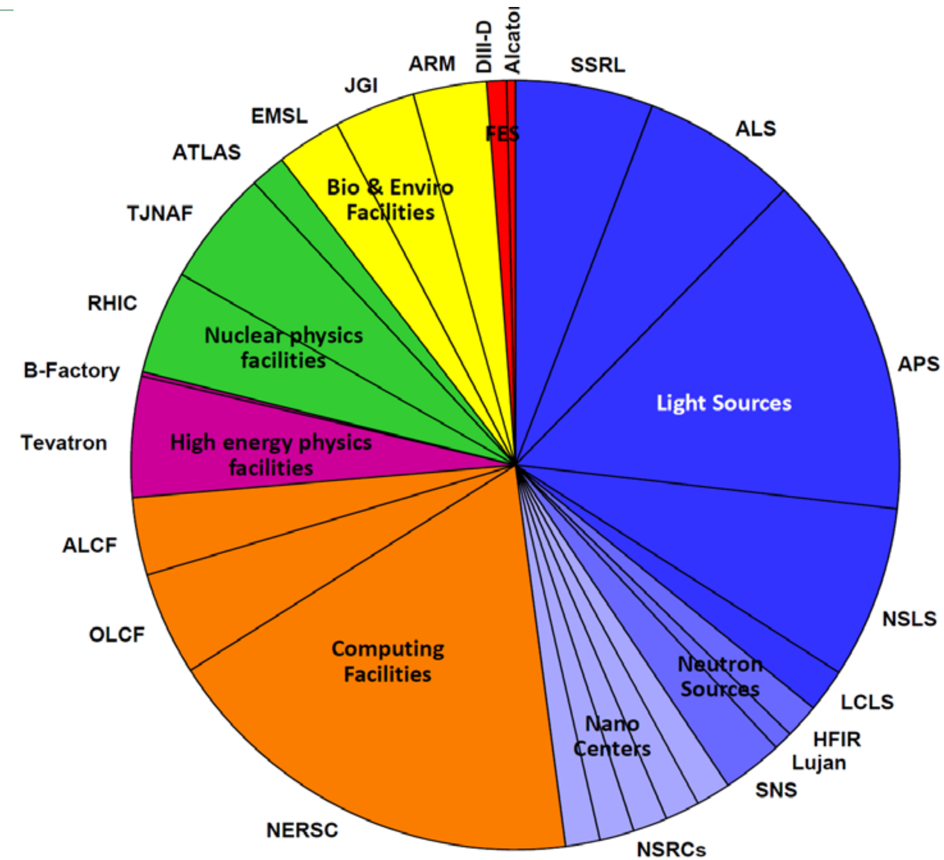
- **RHIC** operates for 22 weeks, the same as FY 2014.
- **ATLAS** operates at 95% of optimal.

Distribution of Users at the ~30 SC Facilities

2007
~20,000 users



2013
~28,000 users



Basic Energy Sciences
Advanced Scientific Research Computing
High Energy Physics
Nuclear Physics
Biological & Environmental Research
Fusion Energy Sciences

Highlights of the FY 2015 SC Budget – Construction

Construction: Several large projects are nearing successful completion, on time and within budget; new projects are initiated to address science and infrastructure needs.

BES
- **NSLS-II** is transitioning from early operations to full operations; construction funding ended in FY 2014. The planned CD-4 date is June 2015.
- **LCLS-II** is in its second year of construction.

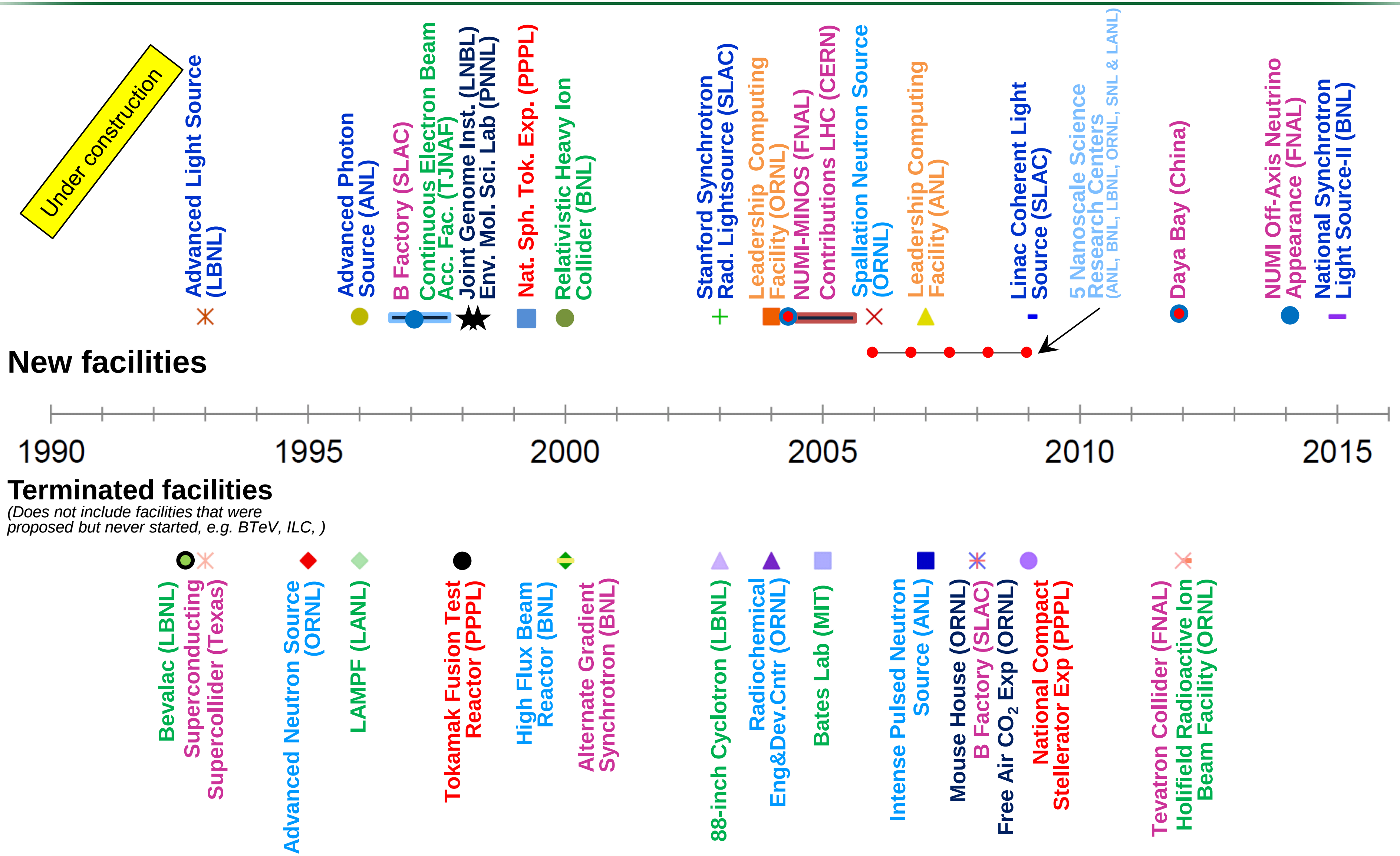
FES
- **ITER** funding supports continuation of in-kind hardware, cash contributions to the IO, and the USIPO.

HEP
- **NOvA** is in its first full year of early operations; the planned CD-4 date is November 2014.
- **Muon to Electron Conversion Experiment** continues construction. The planned CD-2 date is 4Q FY 2014.
- **Long Baseline Neutrino Experiment** continues R&D.

NP
- **12 GeV CEBAF Upgrade** is nearing completion. Activities at TJNAF focus on beam development and commissioning of the new machine.
- **Facility for Rare Isotope Beams** is in early civil and technical construction.

SLI
- **Science and User Support Building at SLAC** completes construction.
- **Infrastructure Improvements at PPPL; Materials Design Laboratory at ANL; Photon Sciences Laboratory Building at SLAC; Integrative Genomics Building at LBNL** all are initiated, with the PPPL project fully funded.

A Summary of Terminated and New Major Facilities 1990-2015



U.S. DEPARTMENT OF ENERGY | Office of Science

BESAC Report on "Future X-Ray Light Sources" and the DOE Actions

REPRISE
Snippets from the briefings to stakeholders of the BESAC Light Source Report

Patricia Dehmer
Acting Director, Office of Science

Harriet Kung
Director, Office of Basic Energy Sciences

Jim Murphy
Director, BES Scientific User Facility Division

Charge to BESAC on X-ray Light Sources

- On January 2, 2013, Bill Brinkman, then the Director of the Office of Science, issued a charge to the Basic Energy Sciences Advisory Committee (BESAC).
- The charge requested:
  - An **assessment of the grand science challenges** that could best be explored with current and possible future SC light sources.
  - An **evaluation of the effectiveness of the present SC light source portfolio** to meet these grand science challenges.
  - An **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.
- John Hemminger, the Chair of BESAC, served as Chair of a 22 member Subcommittee, which used previous BESAC and BES reports and new input from the x-ray sciences communities to formulate findings and recommendations.
- The final report was accepted by BESAC on July 25, 2013.

BESAC – Findings

- At the present time, the U.S. enjoys a significant leadership role in the x-ray light source community. This is a direct result of the successes of the major facilities managed by BES for the U.S. This leadership position is due to the science successes of the storage ring facilities and the particularly stunning success of the first hard x-ray free electron laser, the Linac Coherent Light Source (LCLS). **However, it is abundantly clear that international activity in the construction of new diffraction limited* storage rings and new free electron laser facilities will seriously challenge U.S. leadership in the decades to come.**

- **The U.S. will no longer hold a leadership role in such facilities unless new unique facilities are developed** as recommended by the BESAC facilities prioritization report.

** To upgrade an existing storage ring to one that is diffraction limited will require the replacement of the entire lattice to greatly reduce the electron source size and angular divergence in order to maximize the x-ray beam brightness.*

BESAC – Recommendations

- **For free electron lasers:** In spite of the present intensely competitive environment, an exciting window of opportunity exists for the U.S. to provide a revolutionary advance in x-ray science by developing and constructing an unprecedented x-ray light source. This new light source should provide **high repetition rate**, **ultra-bright, transform limited**, **femtosecond x-ray pulses** over a **broad photon energy range** with **full spatial and temporal coherence**. **Stability** and **precision timing** will be critical characteristics of the new light source.
    - The best approach for a light source would be a linac-based, seeded, free electron laser.
    - The linac should feed multiple, independently tunable undulators each of which could service multiple endstations.
    - The new light source must have pulse characteristics and high repetition rate to carry out a broad range of "pump probe" experiments, in addition to a sufficiently broad photon energy range (~0.2 keV to ~5.0 keV).

- **For storage rings:** At best the present plans for upgrades of U.S. storage rings will leave the U.S. behind the international community in this area of x-ray science. BES should ensure that U.S. storage ring x-ray sources reclaim their world leadership position. **This will require a careful evaluation of present upgrade plans to determine paths forward that will guarantee that U.S. facilities remain at the cutting edge of x-ray storage ring science.**

SC/BES Response to BESAC Recommendations

Project	Project prior to BESAC report	Project after BESAC report
Linac Coherent Light Source II (LCLS-II) SLAC	Incorporate an additional 1 km of the existing 3 km linac; add a new electron injector and 2 new undulators. Major construction required for a new tunnel and experimental hall. Status: Completed CD-0 and CD-1. CD-2 on hold pending BESAC recommendations. TPC = approx. $400M + instruments.	SC directed SLAC to consider incorporating the BESAC recommendations into the LCLS-II project. SLAC proposed a modified LCLS-II: use 1 km of the existing 3 km linac tunnel to add a new 4 GeV superconducting linac; add a new electron injector; and 2 new undulators to produce the world leading high rep rate FEL in the 0.2-5 keV photon energy range. No construction required; no new instruments required. Cost = very approx. $900M.
Advanced Photon Source Upgrade (APS-U) ANL	Upgrade of >20 beamlines; addition of new insertion devices; generation of 2 picosecond x-ray pulses; 50% increase in ring current. Status: Completed CD-0 and CD-1. CD-2 on hold pending BESAC recommendations. TPC = approx. $400M.	SC directed ANL to consider incorporating diffraction limited storage ring technology into APS-U. ANL proposed a multi-bend achromat lattice in the existing tunnel; a doubling of the ring current; new insertion devices & beamlines that will boost the ring brightness by 10^2-10^3 to position APS as the world's brightest hard x-ray storage ring. Cost = very approx. $550M.
Next Generation Light Source (NGLS) LBNL	High rep rate soft x-ray free electron laser facility based on a superconducting linac and 3 undulators. Status: Completed CD-0. Further CDs on hold pending BESAC recommendations. TPC range = $0.9-1.5B.	SC directed LBNL to consider whether NGLS could be modified at reasonable cost to include an expanded energy range. After consideration, LBNL terminated the NGLS project.