



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

## Update from the Office of Science

Basic Energy Sciences Advisory committee  
August 5, 2010

Dr. W. F. Brinkman  
Director, Office of Science  
U.S. Department of Energy  
[www.science.doe.gov](http://www.science.doe.gov)

# The Administration's S&T Priorities for the FY 2011 Budget

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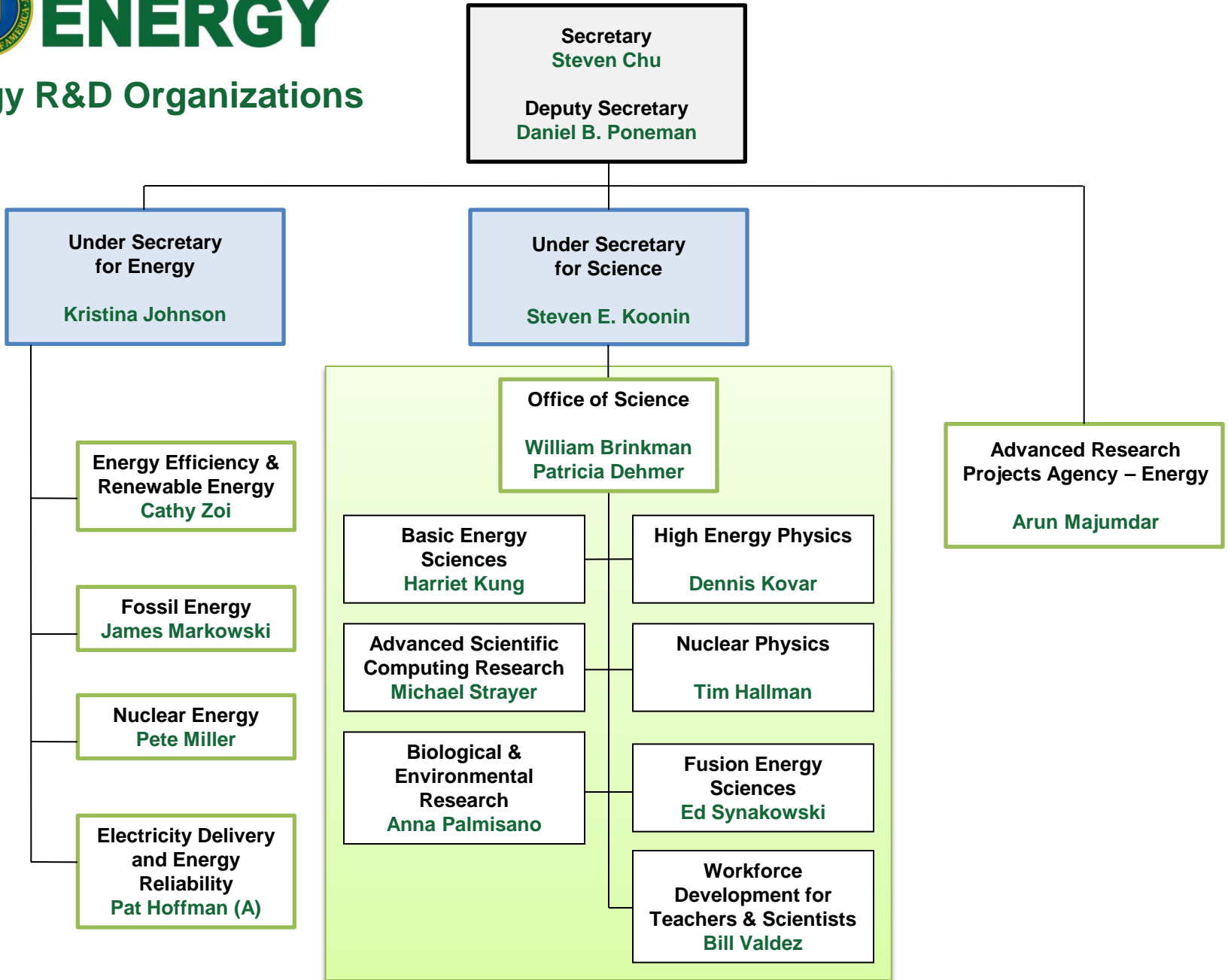
“When we fail to invest in research, we fail to invest in the future. Yet, since the peak of the space race in the 1960s, our national commitment to research and development has steadily fallen as a share of our national income. That’s why I set a goal of putting a full 3 percent of our Gross Domestic Product, our national income, into research and development, surpassing the commitment we made when President Kennedy challenged this nation to send a man to the moon.”

President Barack Obama  
September 21, 2009

[http://www.whitehouse.gov/the\\_press\\_office/Remarks-by-the-President-on-Innovation-and-Sustainable-Growth-at-Hudson-Valley-Community-College/](http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-on-Innovation-and-Sustainable-Growth-at-Hudson-Valley-Community-College/)



## Energy R&D Organizations



# Status of FY 2011 Budget Request and Appropriations

(dollars in thousands)

	FY 2010	Total Recovery Act	FY 2011						
	Current Approp.		FY 2011 Request to Congress	House Mark	House Mark vs. Request	Senate Mark	Senate Mark vs. Request		
<b>Office of Science</b>									
Advanced Scientific Computing Research.....	394,000	+161,795	426,000				418,000	-8,000	-1.9%
Basic Energy Sciences.....	1,636,500	+555,406	1,835,000				1,739,115	-95,885	-5.2%
Biological & Environmental Research.....	604,182	+165,653	626,900				614,500	-12,400	-2.0%
Fusion Energy Sciences.....	426,000	+91,023	380,000				384,000	+4,000	+1.1%
High Energy Physics.....	810,483	+232,390	829,000				820,085	-8,915	-1.1%
Nuclear Physics.....	535,000	+154,800	562,000				554,000	-8,000	-1.4%
Workforce Development for Teachers & Scientists.....	20,678	+12,500	35,600				21,000	-14,600	-41.0%
Science Laboratories Infrastructure.....	127,600	+199,114	126,000				126,000	—	—
Safeguards & Security.....	83,000	—	86,500				86,500	—	—
Science Program Direction.....	189,377	+4,600	214,437				208,000	-6,437	-3.0%
Small Business Innovation Research/Tech. Transfer (SC).....	107,351	+18,719	—				—	—	—
Subtotal, Science.....	4,934,171	+1,596,000	5,121,437	4,881,650	-239,787	-4.7%	4,971,200	-150,237	-2.9%
Earmarks.....	76,890	—	—	18,350	+18,350	—	40,800	+40,800	—
Small Business Innovation Research/Tech. Transfer (DOE).....	60,176	+72,775	—	—	—	—	—	—	—
Total, Science.....	5,071,237	+1,668,775	5,121,437	4,900,000	-221,437	-4.3%	5,012,000	-109,437	-2.1%



# Office of Science – House Mark

(dollars in Thousands)

	FY 2010 Approp.	FY 2011 Request	House	House vs. FY 2010 Approp.		House vs. Request	
SC, Total	4,903,710	5,121,437	4,900,000	-3,710	-0.1%	-221,437	-4.3%

- No details are available, no vote on bill scheduled
- Includes \$18,350 in Earmarks.
- Approximately the same as FY 2010.
- Ensures the United States' continued global leadership of basic science research and develops the fundamental knowledge necessary for the next generation of energy innovations.
- Investments in HEP pushes the edges of scientific knowledge and fosters our nation's world-leading scientists.
- Research in BES, FES, ASCR, NP, and BER build the foundation of knowledge that will enable us to transform our energy sector to be more secure and sustainable.



# Office of Science – Senate Mark

(dollars in Thousands)

	FY 2010 Approp.	FY 2011 Request	Senate	Senate vs. FY 2010 Approp.		Senate vs. Request	
SC, Total	4,903,710	5,121,437	5,012,000	+108,290	+2.2%	-109,437	-2.1%

- Includes \$40.8M in Earmarks, \$11M for Artificial Retina, \$15.4M for Nuclear Medicine research, \$100M to support EFRCs, \$16M for Fuels from Sunlight Energy Innovation Hub, \$22M for a new Batteries and Energy Storage Energy Innovation Hub, \$35M for EPSCoR, and \$5M for Graduate Fellowship.
- NP is down \$8M from request but has the nuclear medicine added
- Funding increase in FY 2011 will support initiatives to advance scientific understanding for new energy technologies.
- Concerned about LHC's planned shutdown; the Federal commitment to nuclear medicine research; cost increases and schedule delays related to the ITER project; and finding that the United States risks losing leadership and competitiveness in material science.

# FY 2001 Senate Markup Details for BES

<b>Basic Energy Sciences</b>			
(in whole dollars)			
	House	Senate	Conference
FY 2011 Request.....	\$ 1,835,000,000	\$ 1,835,000,000	\$ 1,835,000,000
Committee Mark.....	—	1,739,115,000	—
Change to Request.....		-95,885,000	
Congressional Direction:			
Energy Frontier Research Centers.....	—	-40,000,000 <sup>a/</sup>	—
Energy Innovation Hub-Batteries and Energy Storage.....	—	-12,020,000 <sup>b/</sup>	—
Energy Innovation Hub-Fuels from Sunlight.....	—	-8,300,000 <sup>c/</sup>	—
Methane hydrates research returned to FE.....	—	-17,517,000 <sup>d/</sup>	—
Advanced Engine Design delayed.....	—	-20,000,000 <sup>e/</sup>	—
Experimental Program to Stimulate Competitive Research (EPSCoR).....	—	+26,365,000 <sup>f/</sup>	—
Total Congressional Direction.....		-71,472,000	
Net unspecified program impact.....		-24,413,000	



# FY 2001 Markup Details for BES

<sup>a/</sup> \$100,000,000 is provided to support the 46 Energy Frontier Research Centers (\$40,000,000 below the request of \$140,000,000). The Senate Committee does not support the creation of new Energy Frontier Research Centers at this time.

<sup>b/</sup> The Senate Committee provides \$22,000,000 for a new Batteries and Energy Storage energy innovation hub (\$12,020,000 below the request of \$34,020,000).

<sup>c/</sup> The Senate Committee provides \$16,000,000 for the Fuels from Sunlight energy innovation hub (\$8,300,000 below the request of \$24,300,000).

<sup>d/</sup> The Senate Committee recommends no funding for a research program in gas ("methane") hydrates. \$17,517,000 was the request for this new research program as part of the total request for Geosciences Research of \$50,839,000. This program should remain in the Office of Fossil Energy, not the Office of Science.

<sup>e/</sup> The Senate Committee provides no funding for modeling of engine design. \$20,000,000 was the request for this new engine design as part of the total request for Chemical Physics Research of \$75,632,000.

<sup>f/</sup> \$35,000,000 is for the Experimental Program to Stimulate Competitive Research [EPSCoR] (\$26,365,000 above the request of \$8,635,000).

<sup>g/</sup> The Senate Committee provides \$1,587,515,000 for Research and \$151,600,000 for Construction.





# DOE Office of Science Graduate Fellowships

*The FY 2011 request doubles the number of graduate fellowships in basic science*

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## **\$10 million will be available in FY 2011 to fund about 170 additional fellowships**

**Purpose:** To educate and train a skilled scientific and technical workforce in order to stay at the forefront of science and innovation and to meet our energy and environmental challenges

### **Eligibility:**

- Candidates must be U.S. citizens and a senior undergraduate or first or second year graduate student to apply
- Candidates must be pursuing advanced degrees in areas of physics, chemistry, mathematics, biology, computational sciences, areas of climate and environmental sciences important to the Office of Science and DOE mission

### **Award Size:**

- The three-year fellowship award, totaling \$50,500 annually, provides support towards tuition, a stipend for living expenses, and support for expenses such as travel to conferences and to DOE user facilities.

### **FY 2010 Results:**

- 160 awards will be made this Spring with FY 2010 and American Recovery and Reinvestment Act funds.

### **FY 2011 Application Process:**

- Funding Opportunity Announcement issued in Fall 2010
- Awards made in March 2011

# Office of Science Early Career Research Program

*Investment in FY 2011 will bring 60 new scientists into the program*

**\$16 million will be available in FY 2011 to fund about 60 additional Early Career Research Program awards at universities and DOE national laboratories.**

**Purpose:** To support individual research programs of outstanding scientists early in their careers and to stimulate research careers in the disciplines supported by the Office of Science

**Eligibility:** Within 10 years of receiving a Ph.D., either untenured academic assistant professors on the tenure track or full-time DOE national lab employees

**Award Size:**

- University grants \$150,000 per year for 5 years to cover summer salary and expenses
- National lab awards \$500,000 per year for five years to cover full salary and expenses

**FY 2010 Results:**

- 69 awards funded via the American Recovery and Reinvestment Act
- 1,750 proposals peer reviewed to select the awardees
- 47 university grants and 22 DOE national laboratory awards
- Awardees are from 44 separate institutions in 20 states

**FY 2011 Application Process:**

- Funding Opportunity Announcement issued in Spring 2010
- Awards made in the Second Quarter of 2011

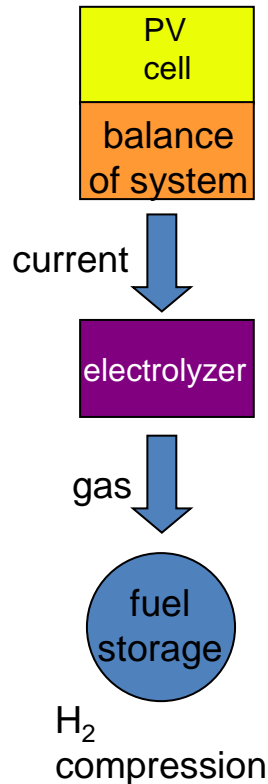
[http://www.science.doe.gov/SC-2/early\\_career.htm](http://www.science.doe.gov/SC-2/early_career.htm)



# Prospects for Solar Fuels Production

## What We Can Do Today

\$12/kg H<sub>2</sub> @ \$3/pW PV  
(BRN on SEU 2005)



High capital costs

We do not know how to produce solar fuels in a cost effective manner.

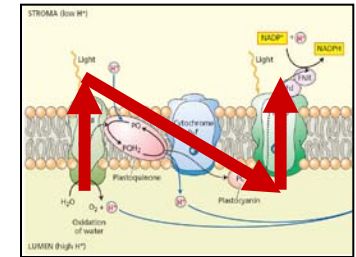
## Two Limits

Low capital costs

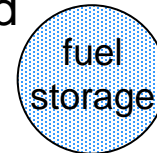
Chemists do not yet know how to photoproduce O<sub>2</sub>, H<sub>2</sub>, reduce CO<sub>2</sub>, or oxidize H<sub>2</sub>O on the scale we need.

## Ultimate Goal

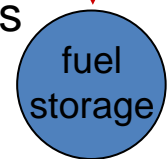
solar microcatalytic energy conversion



liquid



gas



compression

# Award of the “Fuel From Sunlight” Hub

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- Winning team led by Cal Tech and LBNL
- Other institutions involved:
  - SLAC National Accelerator Laboratory
  - Stanford University
  - UC Berkeley
  - UC Santa Barbara
  - UC Irvine
  - UC San Diego
- Professor Nate Lewis leader
- Looking for a factor of 10 over nature
- Strong push to integrate processes to form a complete system

# FY 2011 Energy Innovation Hub for Batteries and Energy Storage

*Addressing science gaps for both grid and mobile energy storage applications*

The Administration's Energy Plan has two goals that require improvements in the science and technology of energy storage:

- Solar and wind providing over 25% of electricity consumed in the U.S. by 2025
  - 1 million all-electric/plug-in hybrid vehicles on the road by 2015
- 
- **Grid stability and distributed power require innovative energy storage devices**
    - Grid integration of intermittent energy sources such as wind and solar
    - Storage of large amounts of power
    - Delivery of significant power rapidly
  
  - **Enabling widespread utilization of hybrid vehicles requires:**
    - Substantially higher energy and power densities
    - Lower costs
    - Faster recharge times

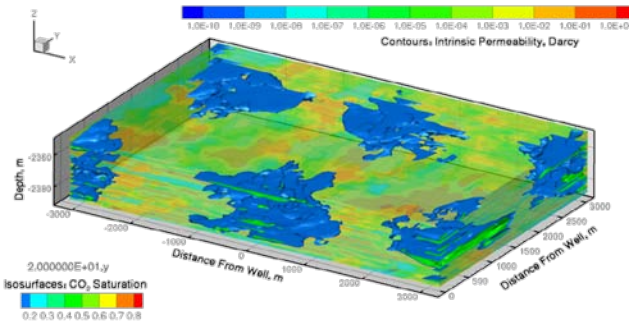


# Exascale Initiative

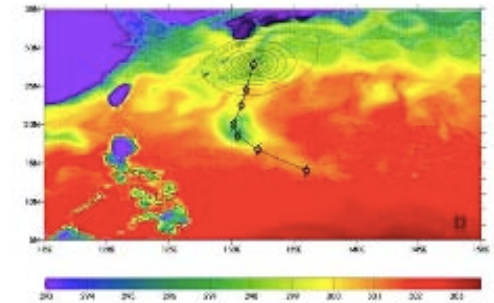
**The Goal:** *“Provide the United States with the next generation of extreme scale computing capability to solve problems of National importance in Energy, the Environment, National Security, and Science”*

## Why do Exascale?

- Environment
- Energy
- National Security
- Science and Innovation
- American Competitiveness



Geologic sequestration

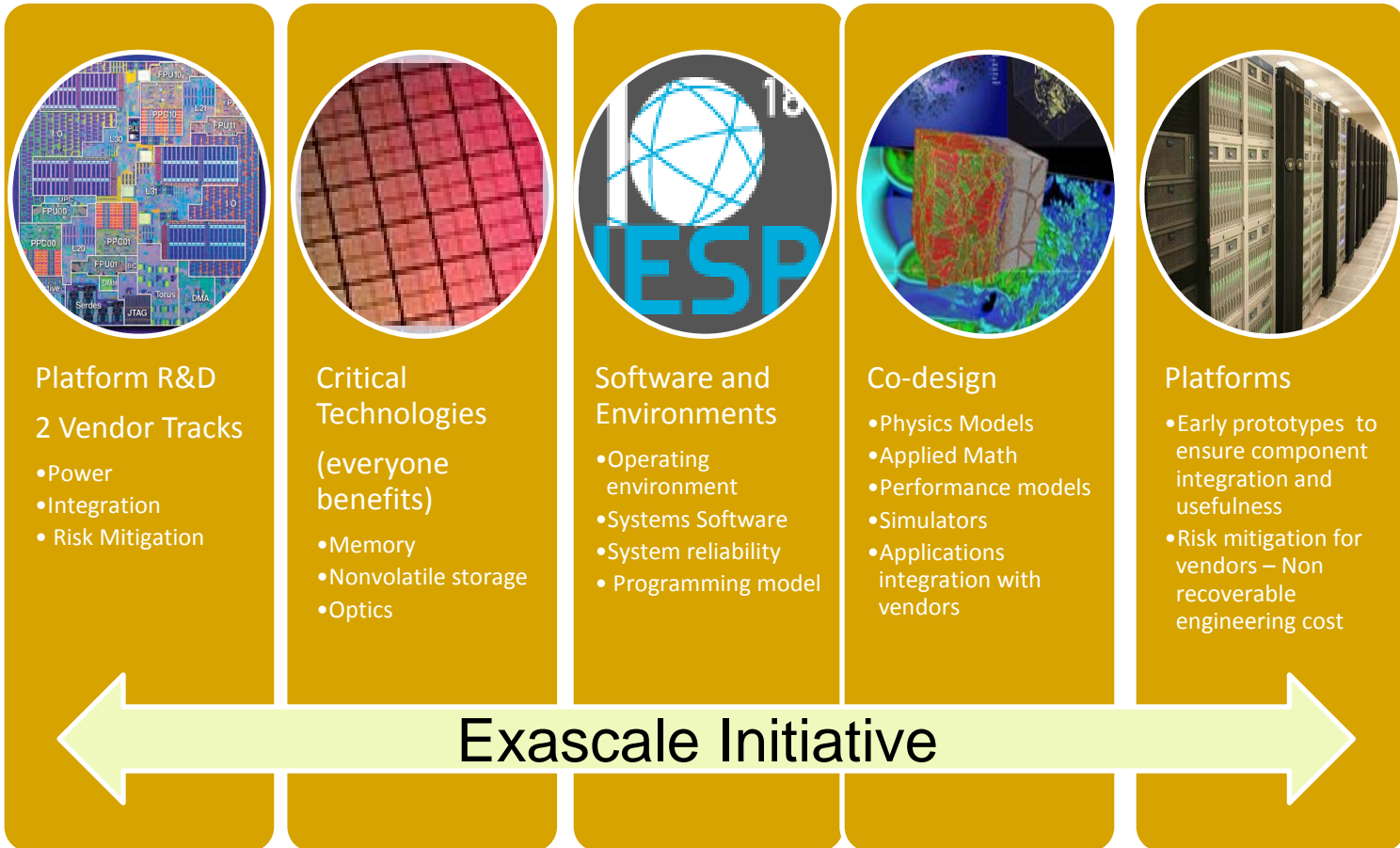


*Massive Earth System Model ensembles*  
(e.g. decadal forecasts, extreme weather)



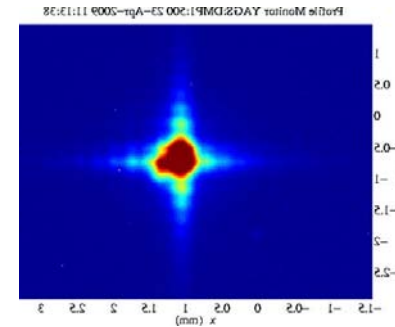
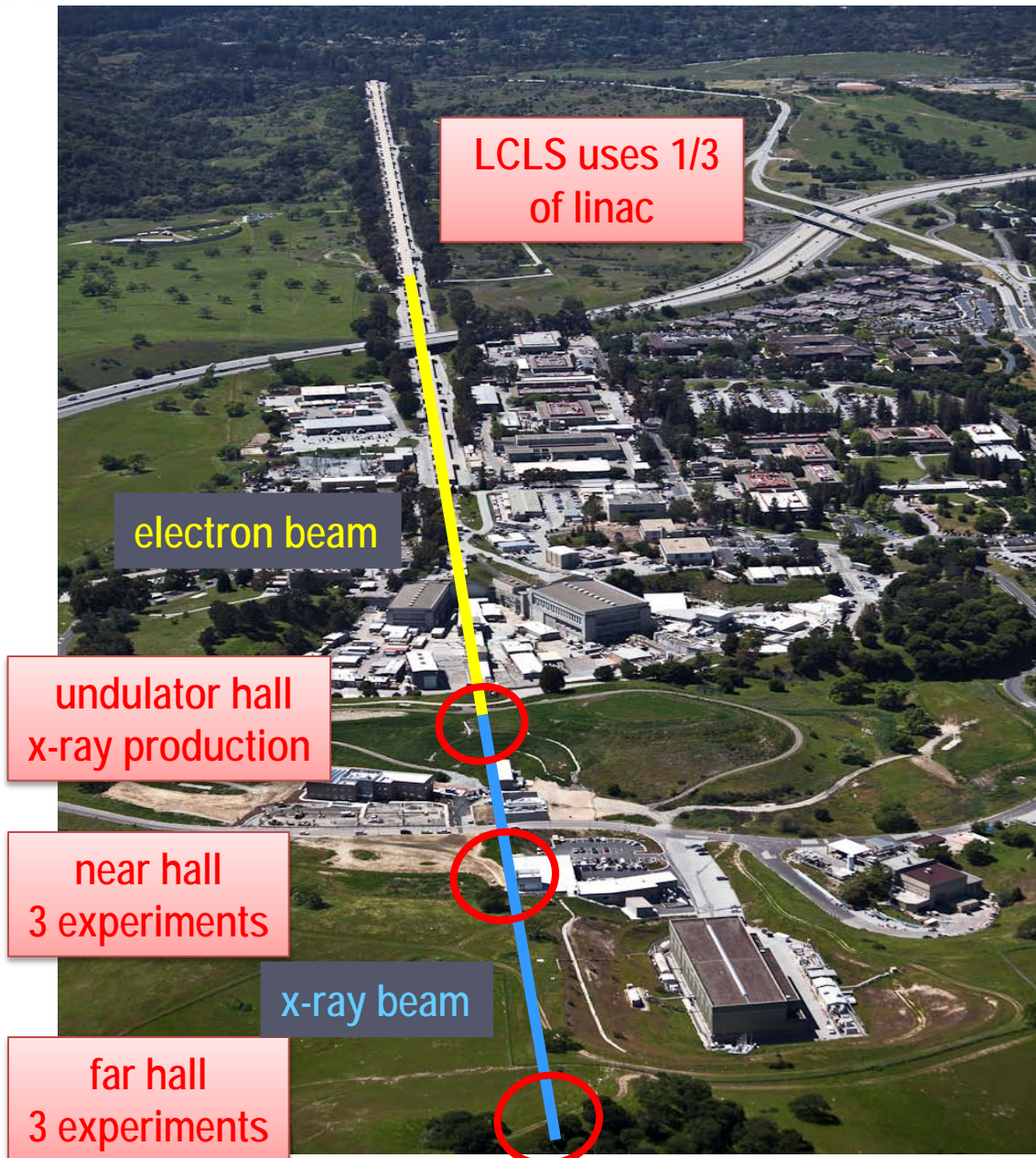


# Exascale Initiative Major Components

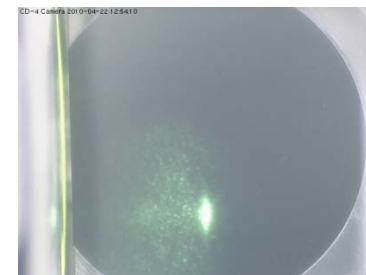


# Linac Coherent Light Source or "LCLS" at SLAC

## The World's First X-ray Laser



First X-rays:  
~ 1 PM PDT  
4/15/2009

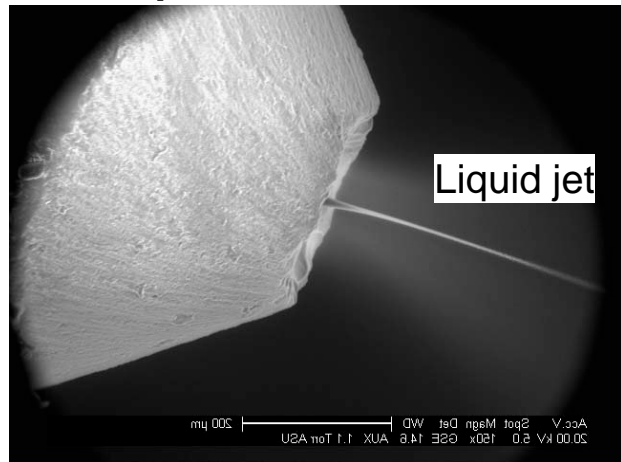


Detection of  
X-ray at Far  
Hall ~ 1 PM  
PDT 4/22/2010

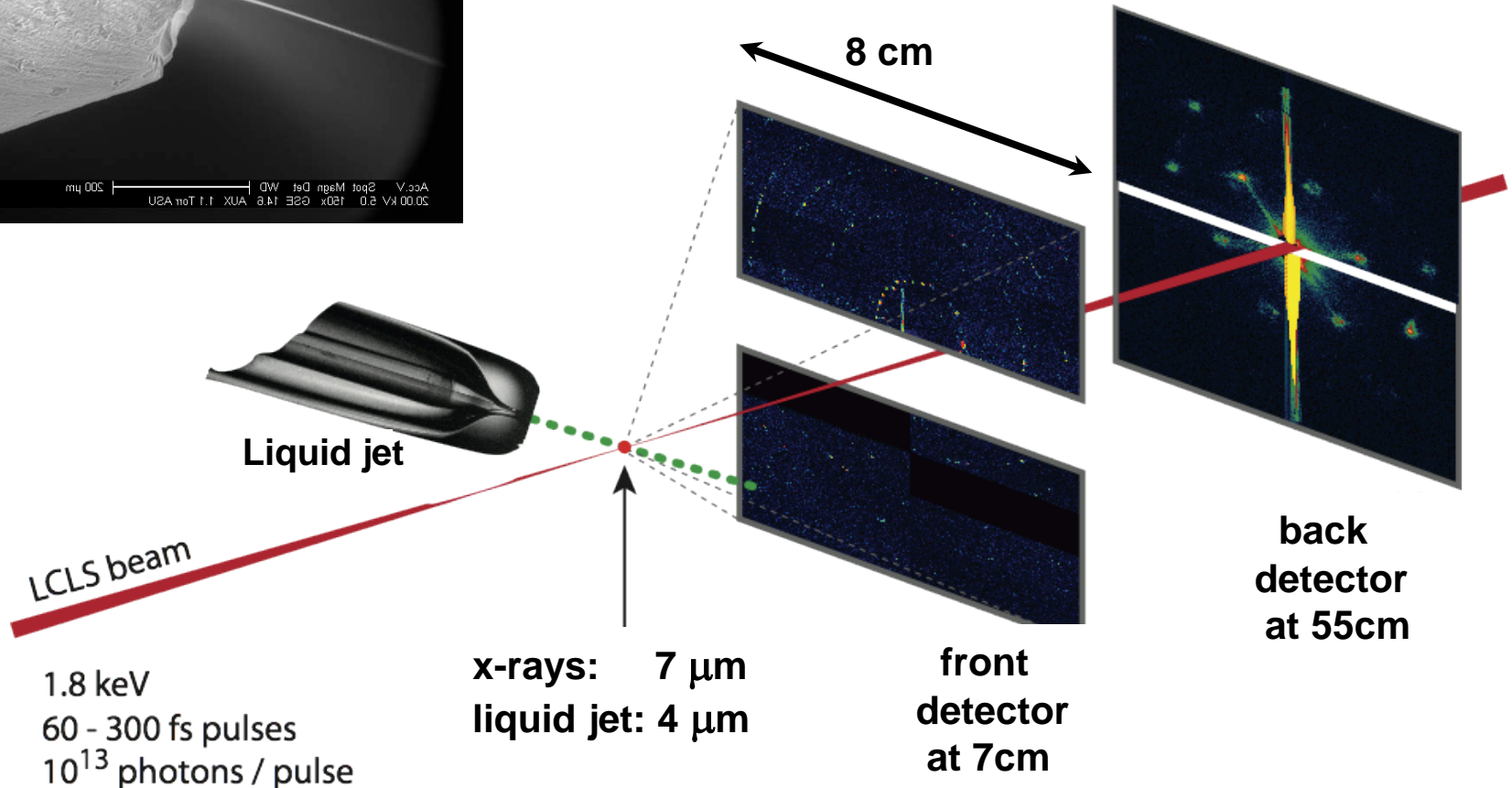


# Early Studies at LCLS: Nanocrystals in Water Microjet

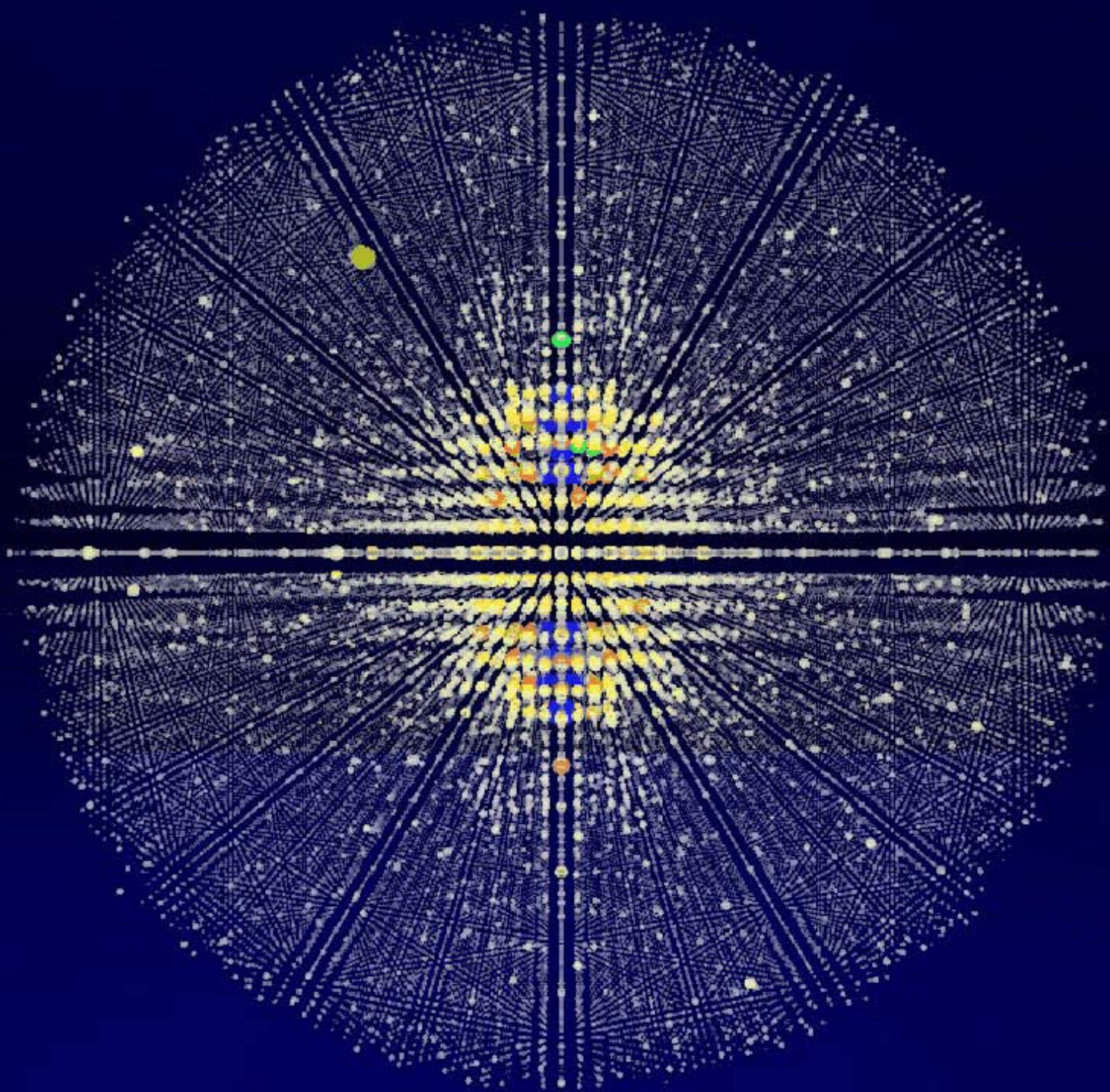
John Spence et al. ASU



Spokesperson: **Henry Chapman et al.**  
collaboration of  
Center for Free Electron Laser Science DESY  
Arizona State University, Max Planck CFEL  
ASG, SLAC, LLNL, CBST, Uppsala University

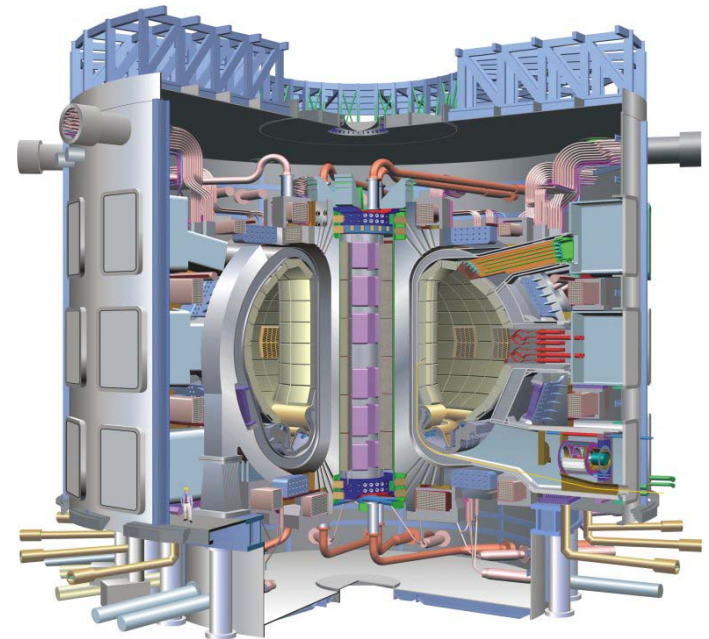






# ITER

- ITER (Latin for “the way”) is a first of a kind major international research collaboration on fusion energy.
- U.S. is a 9.09% partner.
- ITER Goals
  - Designed to produce 500 MW of fusion power ( $Q \geq 10$ ) for at least 300-500 seconds
  - *Burning plasma* dynamics and control
    - U.S. emphasizes the value of ITER, its flexibility, and its diagnostics as a scientific instrument: develop a predictive capability of the burning plasma state
  - Will optimize physics and integrate many of key technologies needed for future fusion power plants
- The *Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project*, entered into force in October 2007 for a period of 35 years.



ITER Tokamak – Cross Sectional View





# ITER Background

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- The ITER Organization (IO), located at Cadarache, France, has been established as an independent international legal entity comprised of personnel (~400) from all of the Members.
- Like all non-host Members, the U.S. share for ITER's construction is 1/11<sup>th</sup> (9.09%) of the total value estimate.
  - roughly 80% will be in-kind components manufactured largely by U.S. industry and beyond that, the United States has agreed to fund 13% of the cost for operation, deactivation, and decommissioning.
  - At Critical Decision 1 (January 2008), the Total Project Cost (TPC) range for the U.S. share of the Construction Phase was estimated to be \$1.45-2.2 B



# ITER Status

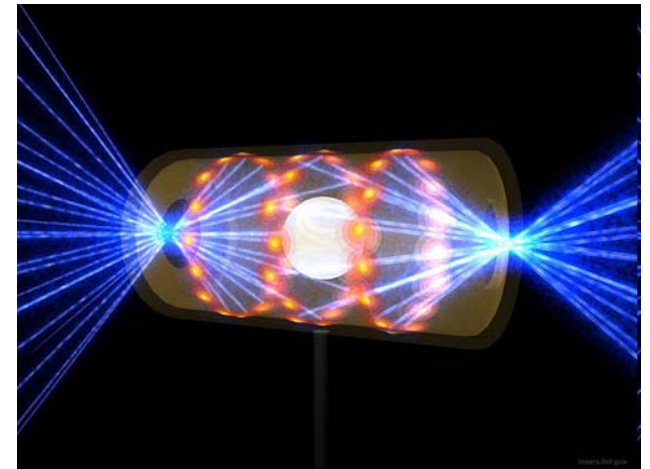
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- Over the past year a scope, schedule and cost analysis has been completed.
- The EU and Japan agreed that if the EU gained approval for the additional funding they required to allow them to commit to the overall ITER project cost and schedule, the Japanese would agree to a change in the DG position. SC led effort in brokering this agreement and in helping the EU find ways to accelerate their schedule
- Dr. Osama Motojima (Japan) is the new DG. He led highly successful LHD stellarator construction (superconducting) and research institution in Japan.
- EU funding outlook now positive even amidst overall EU financial chaos. Their delegation is optimistic that EU is poised to commit €6.6 B.
  - Represents a €600M decrease over the previous estimated costs.
  - Cost management imperative for all parties. US ITER Project Office (ORNL) undergone Lehman Reviews of project operations (February and July; favorable).
- Acceptance of ITER cost, schedule, and baseline, and leadership change occurred in late July Extraordinary Council meeting.



# Inertial Fusion Energy: Nearing Ignition

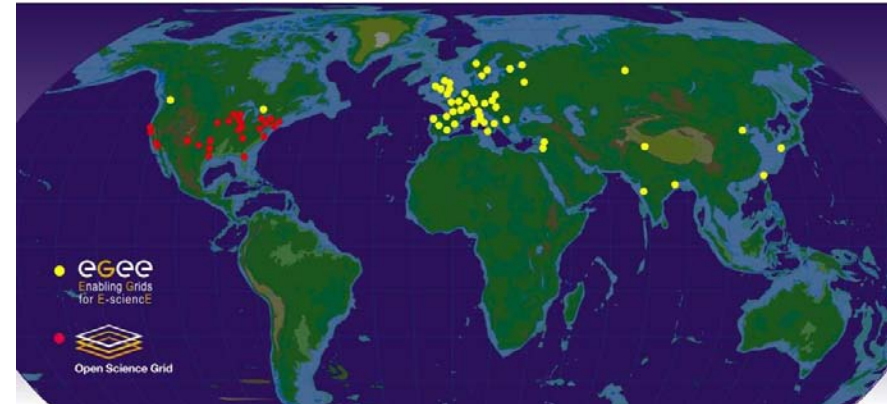
- The newly completed National Ignition Facility – the world’s most powerful laser system – recently began full operations
- NIF is on track to achieve the first laboratory demonstration of “ignition” or net energy gain



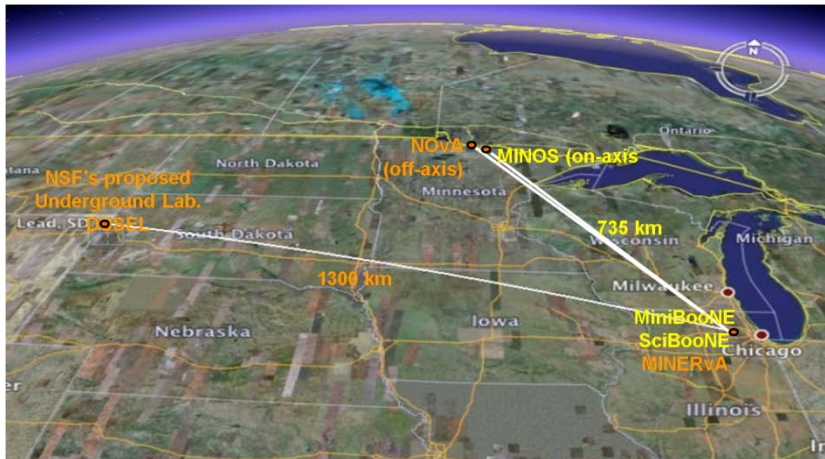
# The U.S. High Energy Physics Program

*The U.S. is uniquely positioned for a world-leading program in neutrino physics*

The U.S. is a critical and strategic partner in global scientific collaborations that push the boundaries of High Energy Physics. The U.S. has developed components for the Large Hadron Collider at CERN and hosts centers for data analysis.



Network sites of the Open Science Grid and Enabling Grids for E-scienceE used for transmitting experimental data from the LHC to scientists worldwide.



The NuMI beamline provides the world's most intense neutrino beam for the MINOS experiment and proposed NOvA and LBNE experiments

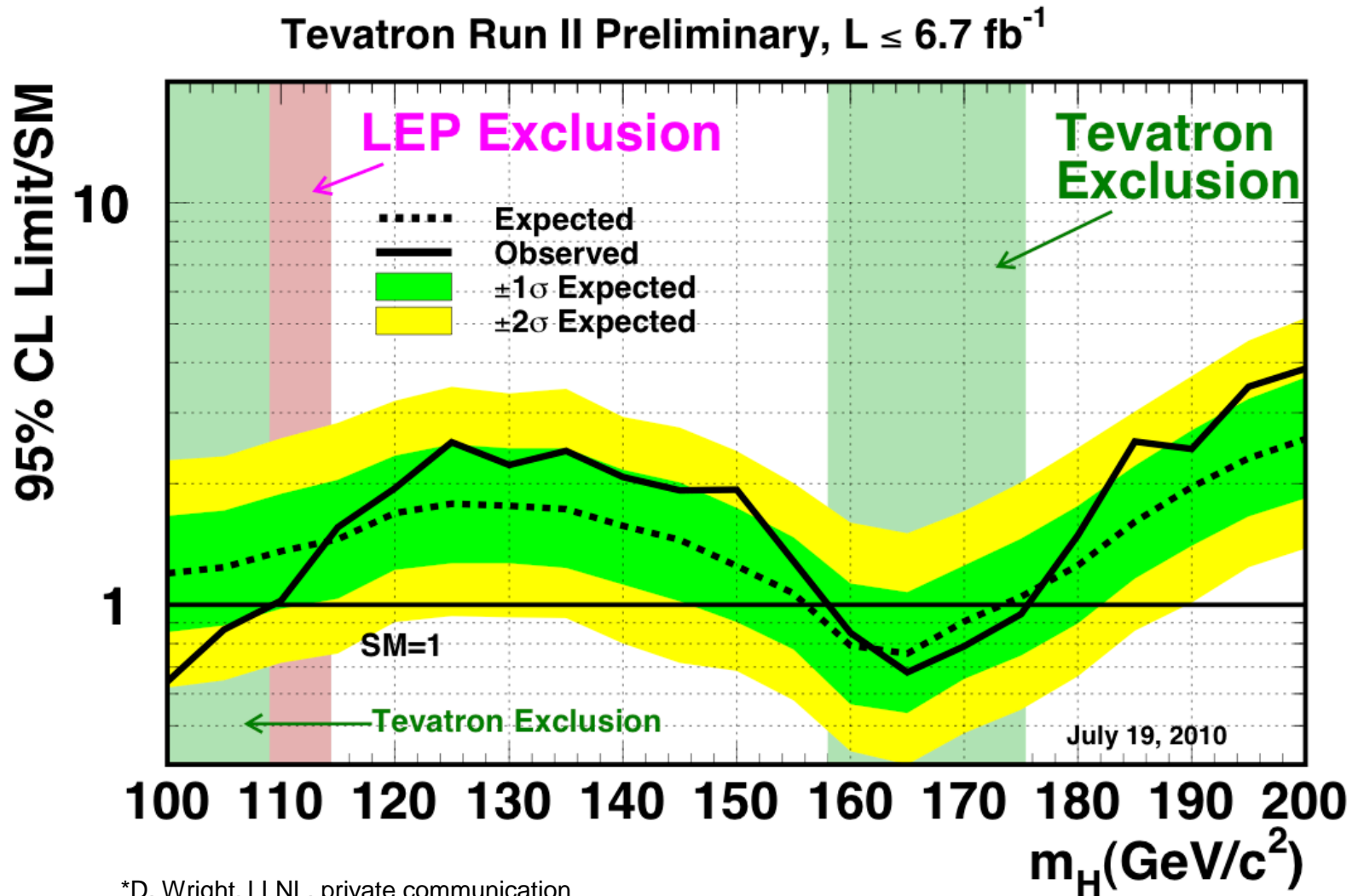
At home, HEP builds on its investments in tools and facilities to capture the unique opportunities of neutrino science. These opportunities are fundamental to the science of particle physics.

**At the heart of the DOE HEP program is the *NuMI beamline* at Fermilab, the world's most intense neutrino source, which serves MINERvA and MINOS and will support NOvA and the proposed LBNE (+\$12,000K, HEP, initiated in FY 2011).**





# Progress Toward the Higgs Particle\*



\*D. Wright, LLNL, private communication





# Accelerator Technology – Is it good enough?

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- Long term waste storage needs dominated by actinides
- Fast Spectrum Reactors can burn actinides but require chemical processing
- Accelerator Driven Systems would allow the reduction of the actinides and burning of the spent fuel without chemical processing

**Question is can accelerators be built with ~50MW of power in the beam and can associated targets be constructed**



# SBIR

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- Continuous need for enhancing small businesses
  - DOE-wide SBIR program is managed by SC
  - It is not a small program ~\$150M/yr
  - Steps are being taken to strengthen program
- 
- **Moved up to report to Deputy SC Director**
  - **Enhancing office to make it more effective**
  - **Strengthening involvement of DOE executive management**

