



# ***U.S. Fusion Energy Sciences Program***

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Presented to

**Fusion Energy Sciences Advisory Committee**  
Gaithersburg, Maryland

By

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Office of Science  
Department of Energy

February 27, 2002

[www.fusion.doe.gov](http://www.fusion.doe.gov)

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***Excellent Science in Support of Attractive Energy***

# ***Secretary Abraham—DOE Priorities***

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From Priorities and Missions-Oct 24, 2001

- o Two priorities deserve special mention.
- o The first involves the unique technological contribution we can make to our energy and national security by finding new sources of energy. Whether it is fusion or a hydrogen economy, or ideas that we have not yet explored, I believe we need to leapfrog the status quo and prepare for a future that, under any scenario, requires a revolution in how we find, produce and deliver energy.
- o Success in this mission could well be one of the greatest contributions to our energy and national security for generations to come.
- o I intend, therefore, that this department take a leadership role in exploring how we can identify and use potentially abundant new sources of energy with dramatic environmental benefits.

# ***Secretary Abraham on Science***

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From FY03 Budget Rollout

- o “We will focus science on meeting the threat of weapons of mass destruction... We also want to use the talents nurtured by our science program to leapfrog today’s energy security problems by finding new sources of energy. And lastly, as the irreplaceable foundation for tomorrow’s security demands we need a strong physical science program—a program that is the seed for energy sources as yet undiscovered and for the technologies of national defense that will keep us secure.”
- o “Our science program will benefit from the kinds of policy and management reviews that have been successfully completed in other programs. This review, which will take place once our Director has been confirmed, will no doubt present new opportunities for this critical program, and reveal ways for our efforts in science to yield even greater benefits in the future.”

# *FY 2003 Fusion Energy Sciences Congressional Budget*

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	<u>FY 2001</u>	<u>FY 2002</u>	<u>FY 2003</u>
Science	131.4	137.7	142.5
Facility Operations	77.0	74.1	78.7
Enabling R&D	<u>33.6</u>	<u>35.7</u>	<u>36.1</u>
<i>OFES Total</i>	<i>242.0*</i>	<i>247.5</i>	<i>257.3</i>
DIII-D	51.9	50.9	55.6
C-Mod	18.0	17.6	22.3
NSTX	27.5	26.8	33.1
NCSX	4.3	4.0	11.8

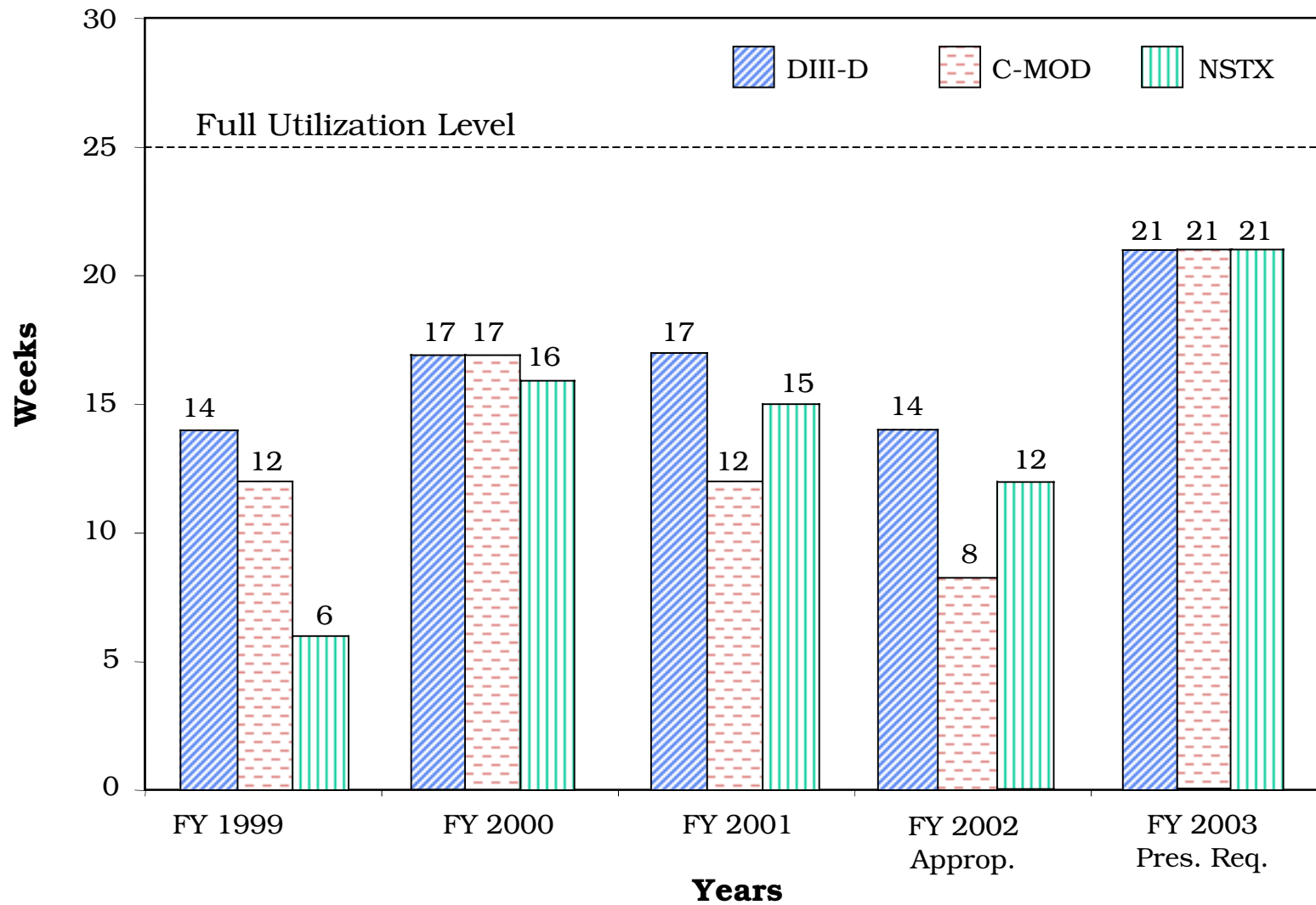
\*Without SBIR

## *FY 2003 FES Congressional Budget Highlights*

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- o Budget increase of \$9.8 million + TFTR D&D completion in FY 2002
- o Maintain research elements as close as possible to FY 2002 level
- o Increase operations at major facilities
  - Near doubling compared to FY 2002
  - Run each facility 21 weeks, 85% of full single shift operations
- o Initiate National Compact Stellarator Experiment project (\$11.8 million)
- o Pay housekeeping expenses
  - Complete TSTA clean up (\$3.0 million)
  - ORNL Fusion Energy Division move to X-10 (\$1.0 million in FY03)  
(Total Cost \$11M; OFES share \$4M over 3 years))

# Major Fusion Facilities Operating Times



# *A New Initiative in Innovative Confinement Concepts*

## *National Compact Stellarator Experiment (NCSX)*

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**Fusion Science opportunity:** flexibility in...

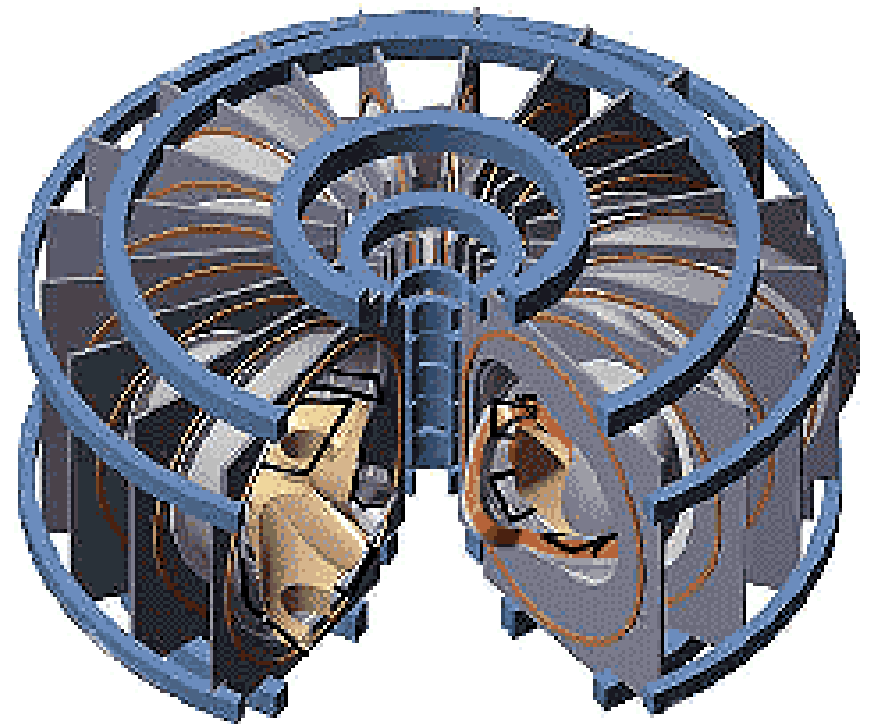
- o 3D plasma shape
  - o Rotational transform and flow shear
  - o Helical ripple
- ⇒ advances toroidal physics understanding

**Fusion Energy vision:** steady state with...

- o No need for current drive or feedback control of instabilities
- o Tokamak-like power density
- o No disruptions

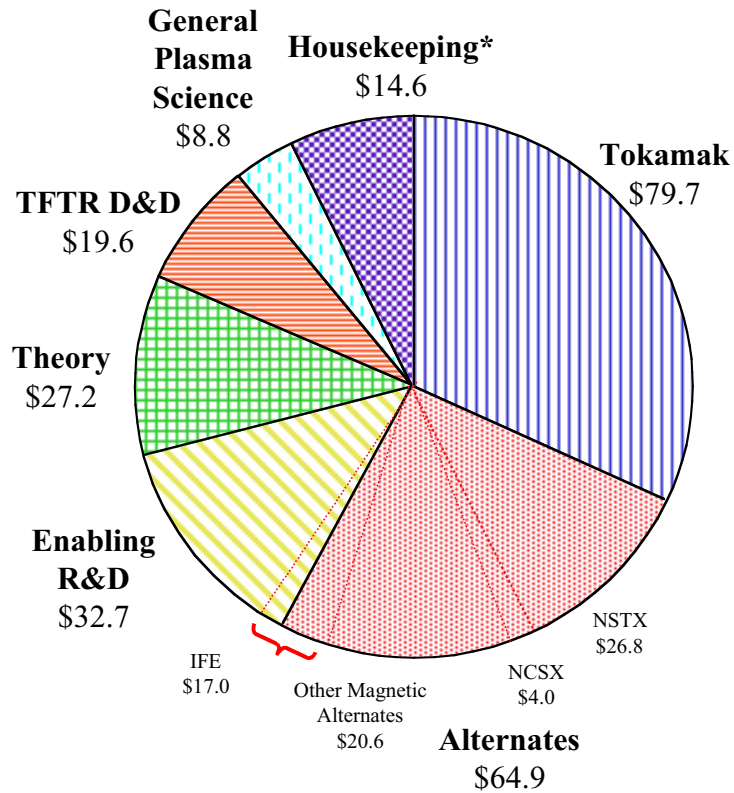
**Project plan...**

- o Conceptual design review: May, 2002
- o Fabrication: FY 2003-2007
- o Preliminary cost estimate: approx. \$69M (as-spent)

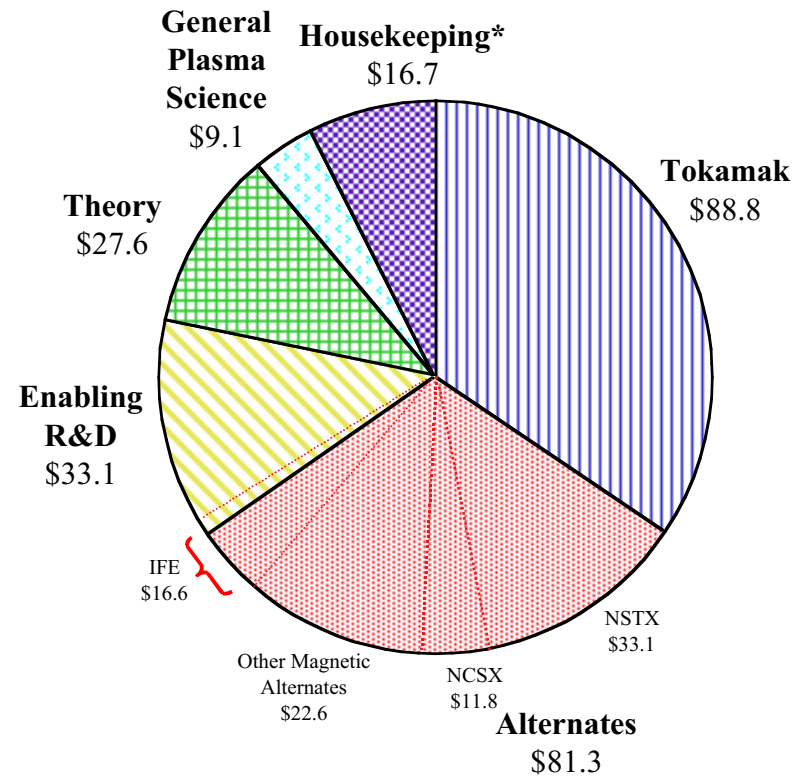


# *Fusion Energy Sciences Budget*

FY 2002  
December Financial Plan  
**\$247.5 M**



FY 2003  
Congressional  
**\$257.3 M**



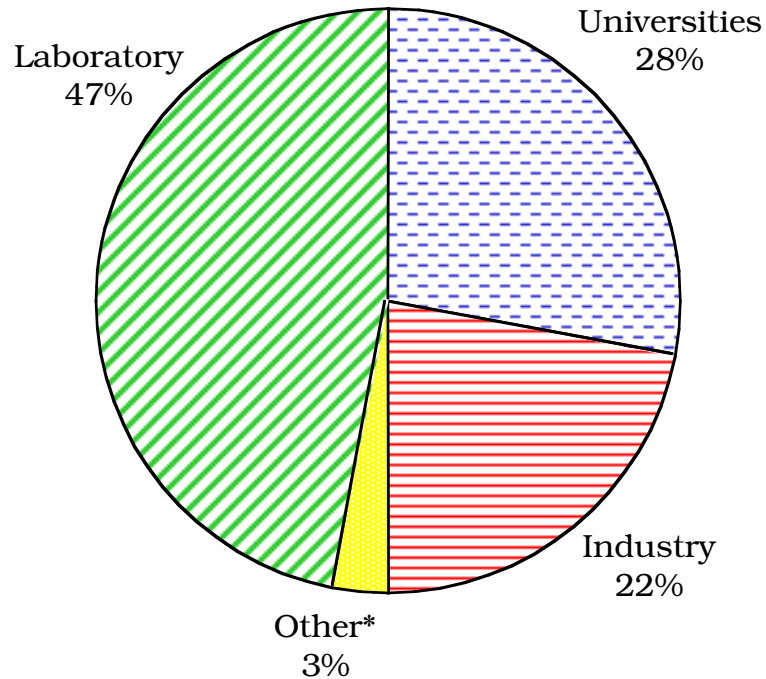
\* Housekeeping includes SBIR/STTR, GPE/GPP, TSTA cleanup, D-Site caretaking at PPPL, HBCU, Education Outreach, ORNL Move and Reserves



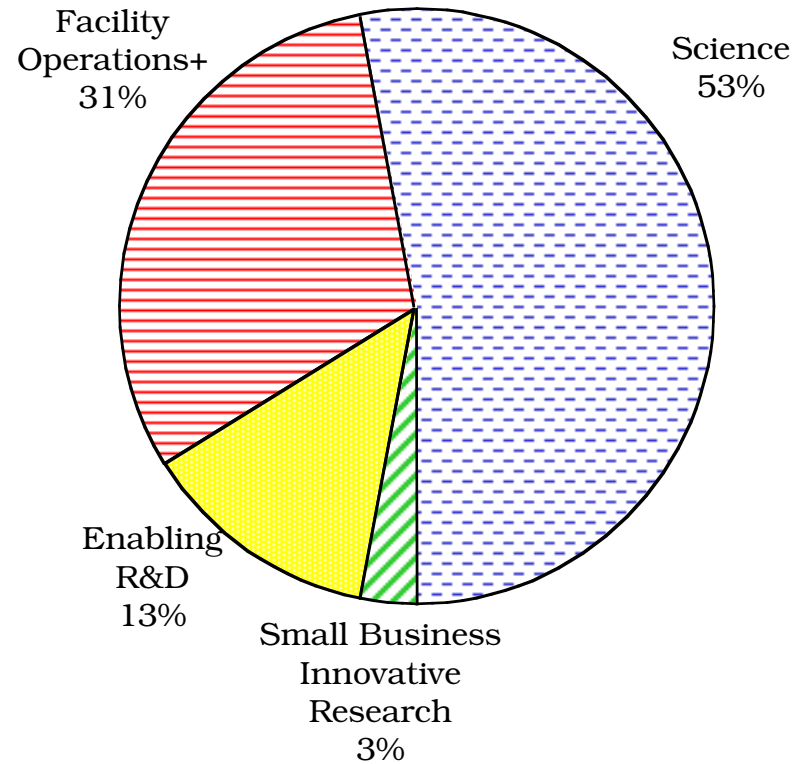
# *Fusion Energy Sciences Funding Distribution*

FY 2003 President's Request  
\$257.3M

Institution Types



Functions

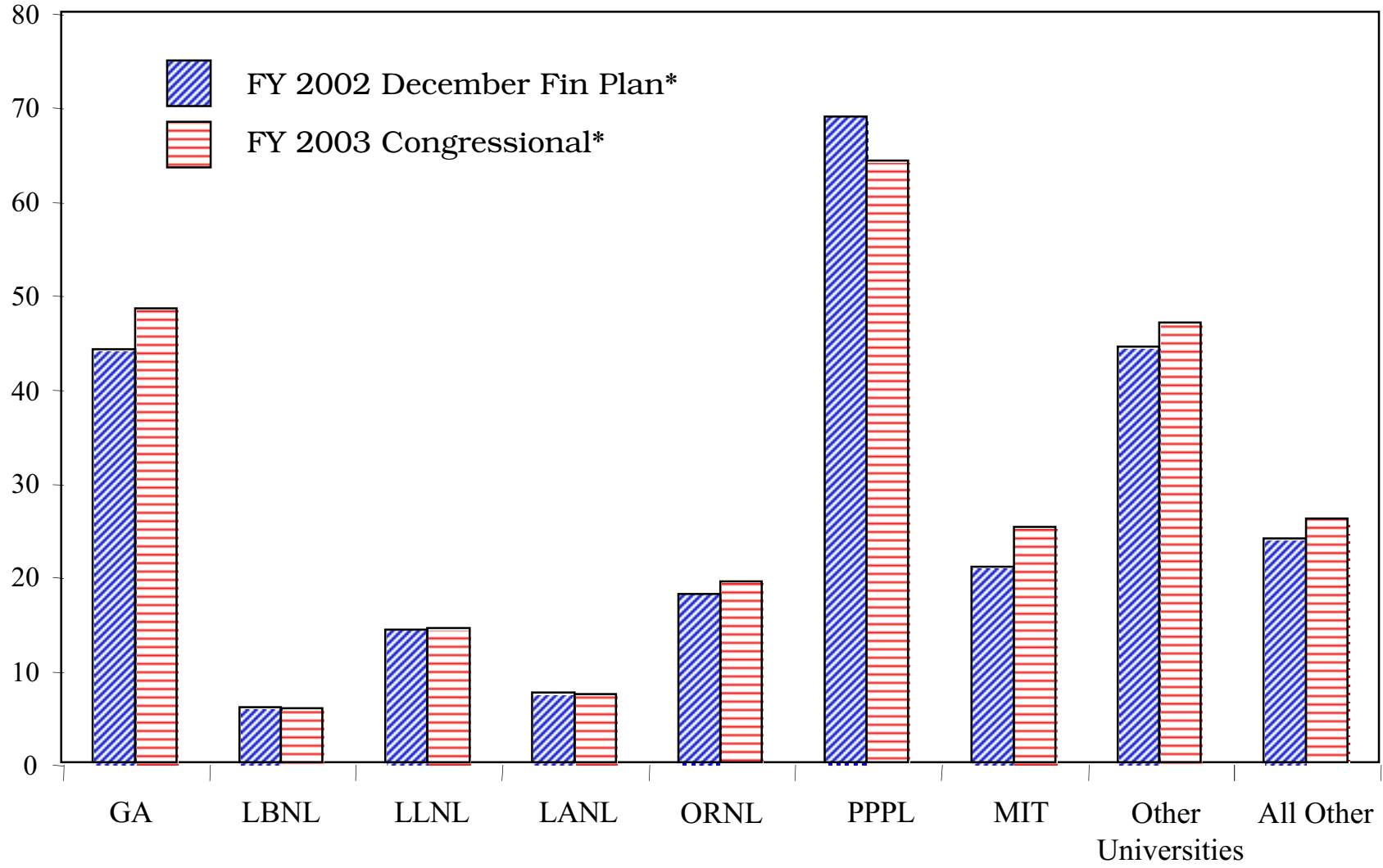


\*NSF/NIST/NAS/AF  
Undesignated

+Includes NCSX Project

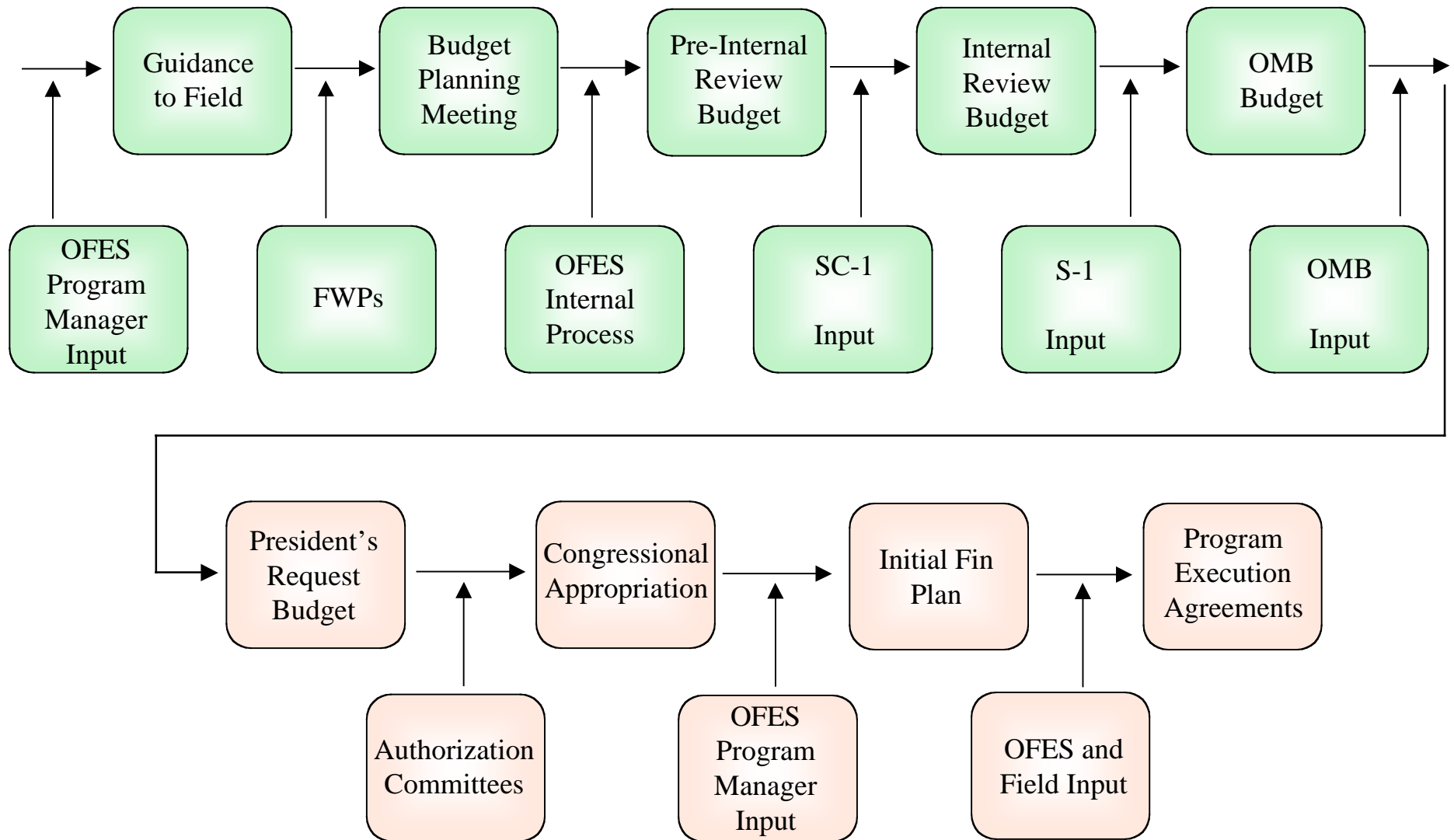
# Fusion Energy Sciences Funding by Institution

(\$ in Millions)



\*With SBIR/STTR Included

# Budget Formulation Process



## *Why Program Execution Agreements (PEA)*

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- o Administration focusing on "grading" performance
- o PEAs close the budget planning cycle
- o We will work with the community to improve the process

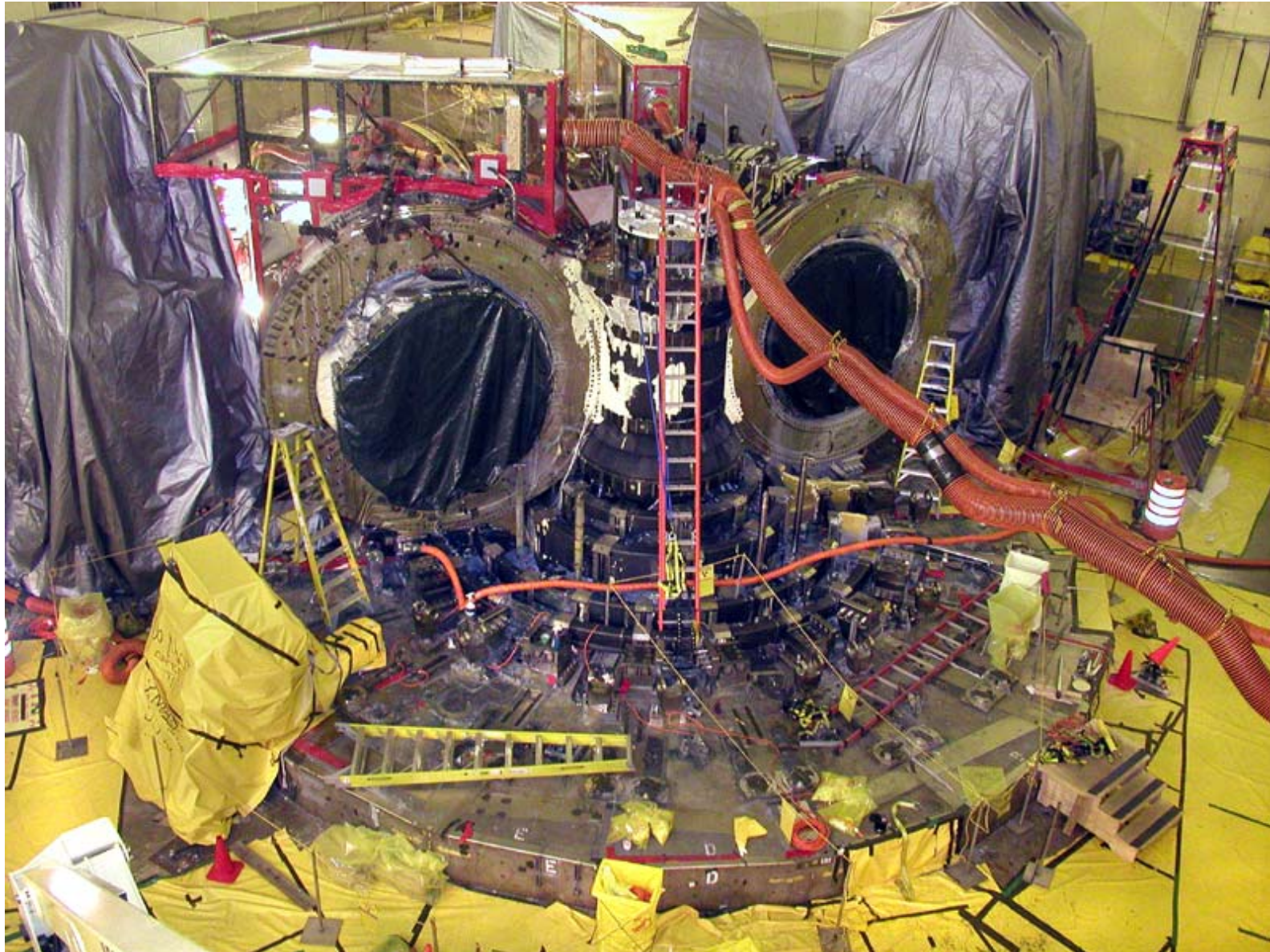
## *Status of TFTR D&D Project*

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- o **On schedule** for completion by end of FY 2002
- o **Within planned cost**
- o **Nearing end of most challenging phase**--cutting and removal of vacuum vessel segments and shipping to waste depository
  - All cuts completed
  - 6 of 10 segments have been shipped
  - This phase is scheduled for completion by March 31
- o Several major **activities remain** to be completed

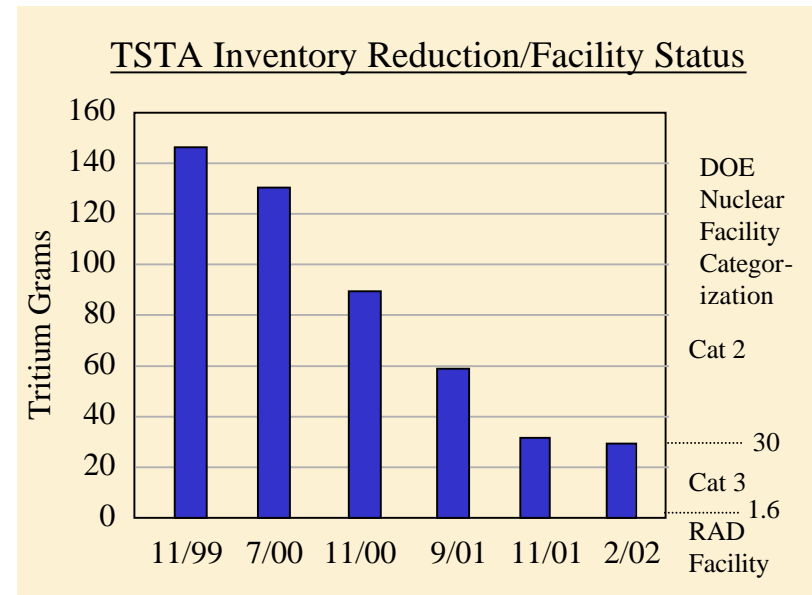
# *TFTR D&D Project*

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# *Status of Tritium Systems Test Assembly (TSTA) Stabilization Project*

- o In November 1999, DOE determined that TSTA had completed its mission and LANL should begin the process of preparing TSTA for transfer to the Office of Environmental Management (EM).
- o DOE-JAERI Collaborative Program at TSTA completed in June 2001
- o EM requires that TSTA be stabilized (i.e. all tritium/hazardous materials are removed, only surface contamination remains) and that funding be provided to cover surveillance and maintenance until D&D can be completed
- o SC plans to transfer TSTA to EM in mid-FY03
- o Recent (2/14/02) review indicated that LANL is making excellent progress, but many difficult and hazardous activities still remain



# *Tritium Systems Test Assembly (TSTA)*

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## *Safety is Key Element in Fusion*

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- o Doing work safely is essential for the FES program
- o PPPL, GA, ORNL have devoted much energy to assuring safety in research and operations
- o Universities are encouraged to seek help in assessing their own lab safety
  - GA worked successfully with UCLA in 2001 on assuring lab safety
  - The assessment help will be provided at no cost to the universities
  - UFA will publicize this in upcoming Newsletter

## *Results of Diagnostics Competition*

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- o Thanks to proposers, reviewers, panel members
- o Proposals submitted
  - 32 from universities and industry (1 non-U.S.)
  - 7 from labs
- o Resulted in funding at the historical ratio
  - 11 grants (85%)
  - 4 lab programs (15%)
- o FY 2002 funding is being provided for orderly closeout of programs not being renewed
- o Results will be posted on the web

## *Results of Diagnostics Competition*

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- o Process resulted in institutional impacts
  - Lost 4 universities
  - Lost 2 labs (1 did not submit)
  - Gained 1 new lab
- o Distribution of diagnostic efforts
  - 9 programs on large tokamaks
  - 4 programs on innovative confinement concepts
  - 4 programs on tokamaks in Europe

# *A Possible Outline for a Workshop on Energy Security*

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## Fossil Energy

### **Petroleum**

Reserves  
Production  
Issues  
Basic research needs

### **Natural Gas**

Reserves  
Production  
Issues  
Basic research needs

### **Coal**

Reserves  
Production  
Issues  
Basic research needs

### **Other (oil shale, tar sands, gas hydrates, etc.)**

Reserves  
Production  
Issues  
Basic research needs

## Nuclear Energy

Reserves  
Production  
Issues  
Basic research needs

## Renewable Energy

### **Solar electric; solar photochemical, and solar thermal**

Production  
Future potential  
Issues  
Basic research needs

### **Wind**

Production  
Future potential  
Issues  
Basic research needs

### **Geothermal**

Production  
Future potential  
Issues  
Basic research needs

### **Biomass, biofuel, biofeedstock**

Production  
Future potential  
Issues  
Basic research needs

### **Hydroelectric**

Production  
Future potential  
Issues  
Basic research needs

### **Other (tides, ocean thermal, etc.)**

Future potential  
Issues  
Basic research needs

## Hydrogen

Sources  
Production  
Future potential  
Issues  
Basic research needs

## Fusion Energy

Issues  
Basic research needs

## Electrical Energy

Production  
Energy sources  
Generation, transmission, and storage  
Current technologies  
Future technologies  
Basic research needs

## Consumption

### **Transportation**

On board energy sources  
Current  
Future  
Primary fuel efficiency  
Current  
Future  
Basic research needs

### **Residential**

Energy sources  
Current  
Future  
Efficiency  
Current  
Future  
Basic research needs

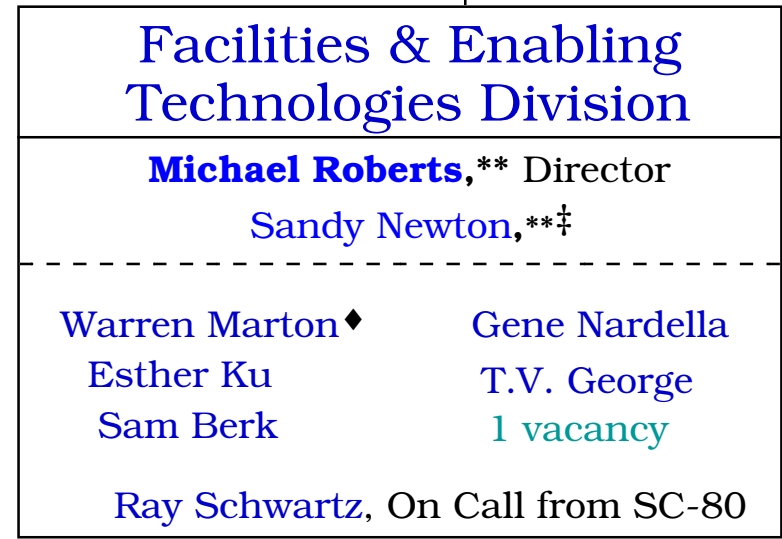
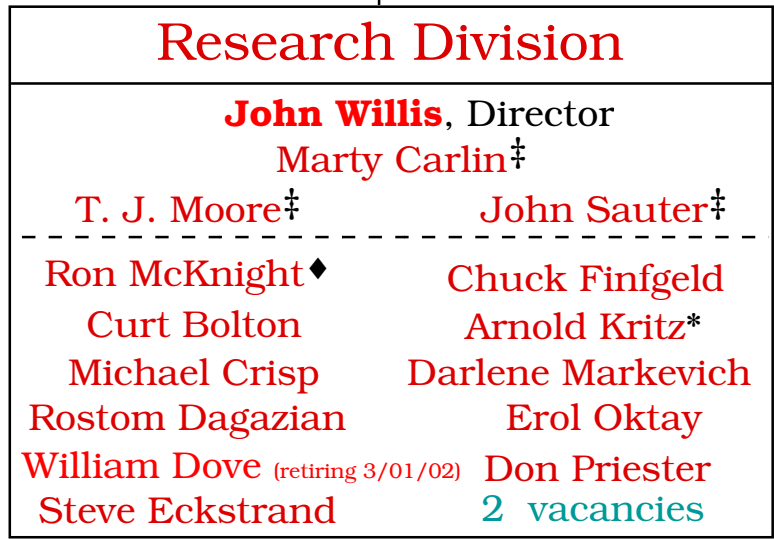
### **Commercial**

Energy sources  
Current  
Future  
Efficiency  
Current  
Future  
Basic research needs

### **Industry**

Energy sources  
Current  
Future  
Efficiency  
Current  
Future  
Basic research needs

# Office of Fusion Energy Sciences



♦Principal Acting Director

\*On Assignment (Lehigh Univ.)

\*\*Dual Capacity

‡Support Staff

## *Three New Charges for FESAC*

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- o Build on Snowmass results to **recommend a strategy** for proceeding with a burning plasma experiment
- o Recommend roadmap for **joint initiative** between OFES and OASCR on integrated computational simulation and modeling
- o Consider whether to **broaden program scope** and **activities** to include non-electric applications of intermediate term fusion devices

## *Burning Plasma Physics*

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- o Establish a high-level panel to use Snowmass results to recommend a strategy for pursuing burning plasma physics experiments
  - Show how ITER could fit into U.S. program if we decide to participate
  - Show how FIRE or IGNITOR would fit into U.S. program if we do not join ITER
- o Panel
  - All interested FESAC members
  - Program leaders from major institutions
  - Selected others
- o Report by September 2002
- o NRC will review FESAC Recommendations by end of 2002

# *Integrated Simulation and Modeling*

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- o Provide a roadmap for a joint initiative with OASCR
  - A 5-6 year program, costing about \$20 million
  - Use the improved computational models developed by the base theory program
  - Significantly improve simulation and modeling capabilities
- o Panel members
  - FESAC members
  - Experts recommended by ASCAC
- o Obtain fusion community input using workshops
  - Current status
  - Vision for simulation of toroidal confinement systems
  - New theory and math needed
  - Computer science needed
  - Computational infrastructure
  - Validation and use
- o Summary report by July 15, 2002

**Final roadmap recommendation by December 1, 2002**



## *Non-Electric Applications*

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- o Realizing the vision of fusion electricity requires long-range development effort
- o Past studies have explored ways to use fusion to meet other needs not requiring the levels of physics and technology understanding needed for electricity production
  - Hydrogen production
  - High-energy neutrons for many uses, i.e. waste transmutation
- o FESAC consider if program should be broadened to include non-electric applications of intermediate fusion devices
  - What are promising opportunities
  - What steps are needed to include these opportunities in program
  - What are the possible negative impacts and mitigation strategies
- o Report by January 2003

# ***FESAC Membership***

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- o Current FESAC membership terms are scheduled to expire on August 18, 2002. We are going to **request an extension until the end of the year** for the sake of continuity in dealing with the burning plasma experiments issue
- o We request that **current members contact Al Opdenaker** to indicate whether they are interested in continuing to serve
- o We request that anyone wishing to serve or wishing to suggest someone who might serve contact Al Opdenaker

[albert.opdenaker@science.doe.gov](mailto:albert.opdenaker@science.doe.gov)

**301-903-4927**

# *International Progress on ITER*

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Negotiations under way:

- o First meeting, Toronto, November 8-9
  - Senior level delegations
  - Lay out a work plan
  - Establish working group
- o Second meeting, Tokyo, January 22-23
  - Review first drafts of key documents
  - Accelerate working group activities
- o NEXT MAJOR STEPS:
  - Japan and EU--decide to offer site candidates
    - Cabinet level discussion with decisions expected in the next few months
  - Reach consensus on site, roles, organization, etc
- o Third meeting, Moscow, April 23-24: possible site offers
- o Fourth meeting, Cadarache, June 5-6: possible consensus

In U.S., Secretary Abraham responded to Congress on ITER:  
"expect to complete initial review in next few months"

# Background

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## *"Housekeeping"*

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	<u>FY 2002</u>	<u>FY 2003</u>
TSTA	3.0	3.0
D-Site	0.0	0.5
HBCU	0.8	0.9
Education Outreach	1.2	1.6
ORNL Move	0.0	1.0
SBIR	6.0	6.0
STTR	0.4	0.4
Kritz	0.2	0.0
GPP/GPE	1.5	1.5
Reserves		
OFE	0.9	0.9
SC-1	<u>0.6</u>	<u>0.6</u>
<i><b>Total Housekeeping</b></i>	<i><b>14.6</b></i>	<i><b>16.7</b></i>

## *"All Other"*

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	<u>FY 2002</u>	<u>FY 2003</u>
ANL	1.7	1.5
Air Force	0.5	0.5
INEEL	2.3	2.4
NRL	0.2	0.2
ORISE	0.4	0.8
PNNL	1.3	1.6
SNL/A	2.4	2.5
SNL/L	0.6	0.7
WSR	0.1	0.0
Industry	2.8	2.8
NIST	0.4	0.4
NSF	1.1	0.9
NAS	0.1	0.1
Reserves	3.8	5.3
SBIR/STTR	<u>6.4</u>	<u>6.4</u>
<i><b>Total Other</b></i>	<i><b>23.9</b></i>	<i><b>26.0</b></i>

## *Safety is Key Element in Fusion*

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- o Most publicly understandable aspect of our work
- o PPPL has devoted much energy to safety this year
  - EH Assessment--resulted in better appreciation of PPPL's best practices and areas for needed improvement
  - Surprising spate of injuries and a near-miss--resulted in serious, lab-wide inward look at what needed to be improved
- o ORNL (Madia) has devoted much energy as well
  - Spate of accidents (outside of Fusion)
  - Madia has prepared a safety video with his sincere concerns
  - Lab-wide stand-downs to address key issues, including complacency
- o PPPL, GA, ORNL, etc. prepared to assist university labs
  - In 2001, UCLA (Abdou) invited GA to assess lab safety
    - GA recommended, and UCLA carried out, full range of safety improvements
  - Universities encouraged to invite labs to help them
    - Voluntary basis, no cost to universities, should be not liability for this advice
  - UFA (Jarboe) will likely include this invitation in upcoming Newsletter

# *Fusion Energy Sciences Budget by Institution*

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(\$ in Millions)

<u>Institution</u>	<u>FY 2002 Dec Fin Plan</u>	<u>FY 2003 Congressional</u>
General Atomics	44.1	48.3
Lawrence Berkeley National Lab	5.9	5.8
Lawrence Livermore National Lab	14.3	14.4
Los Alamos National Lab	7.4	7.3
Oak Ridge National Laboratory	17.9	19.3
Princeton Plasma Physics Lab	68.8	64.1
Massachusetts Institute of Technology	20.9	25.2
Other Universities	44.3	46.9
All Other	<u>23.9</u>	<u>26.0</u>
<b><i>Total</i></b>	<b><i>247.5</i></b>	<b><i>257.3</i></b>