

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

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Presented to

**20th U.S. - Japan Executive Secretaries Meeting (ESM)**

By

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Office of Fusion Energy Sciences  
Office of Science  
Department of Energy

May 9, 2002  
(Televideo)

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

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**Excellent Science in Support of Attractive Energy**

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

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“Advance **plasma science, fusion science,** and  
**fusion technology**-- the **knowledge base** needed for an  
**economically** and **environmentally attractive** fusion  
energy source.,,



# *National Energy Policy*

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## National Energy Policy



Report of the  
National Energy Policy Development Group

May 2001

"The NEPD Group recommends that the President direct the Secretary of Energy to develop next-generation technology--including hydrogen and **fusion**."

## *Principal Science Appointments*

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- o On October 23, 2001 Dr. John Marburger became the Director of the Office of Science and Technology Policy and the Assistant to the President for Science and Technology
- o On January 6, 2002 the President nominated Dr. Raymond L. Orbach, Chancellor of the University of California at Riverside, to serve as the Director of the Office of Science.

## *Administration Emphasizes Management*

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“ . . . This administration strongly emphasizes good management for all Federal agencies, and The President’s Management Agenda will be applied to science as well as to other federally funded operations. The Agenda includes the principle that performance is an important basis for funding allocations, which implies that measures of performance are essential ingredients in the budget process . . . ,”

- J. Marburger at the American Astronomical Society, January 8, 2002

## *Realization of Management Emphasis*

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- o Program management is visible and prominent with Departmental leadership
- o Funding decisions are to be influenced by how well programs are managed
- o The Department is reviewing both
  - How investments are made (funding decisions)
  - How performance is measured and evaluated
- o The Department, working with OMB, is leading USG effort to develop performance measures for applied R&D, for application in FY2003

## *SC Advisory Committees are to Help SC Evaluate Performance Measurement.*

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- o SC has charged BESAC to examine SC's approach to performance measurement. BESAC has formed a subpanel comprised of 1 member from each SC Advisory Committee and 2-3 external participants with expertise in performance measurement. The subpanel will review
  - SC's current methods for performance measurement;
  - The appropriateness and comprehensiveness of the methods;
  - The effects on science programs; and
  - SC's integration of performance measures with the budget process as required by the Government Performance and Results Act.
- o Subpanel met January 24-25 in Washington D.C. A report on findings and recommendations can be found at:  
<http://www.sc.doe.gov/production/bes/BESAC/reports.html>

## *Three New Charges for FESAC*

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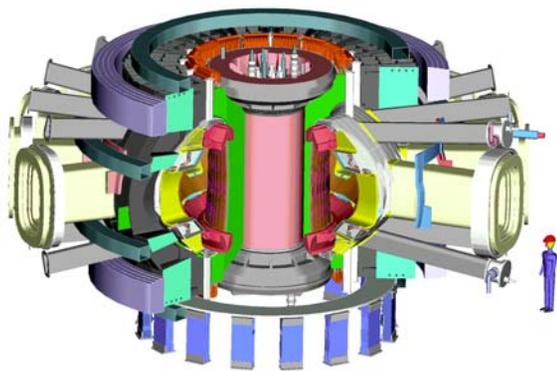
- o Build on Snowmass results to **recommend a strategy** for proceeding with a burning plasma experiment
- o Recommend roadmap for **joint initiative** between OFES and OASCR on integrated computational simulation and modeling
- o Consider whether to **broaden program scope** and **activities** to include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

# *Burning Plasma Physics*

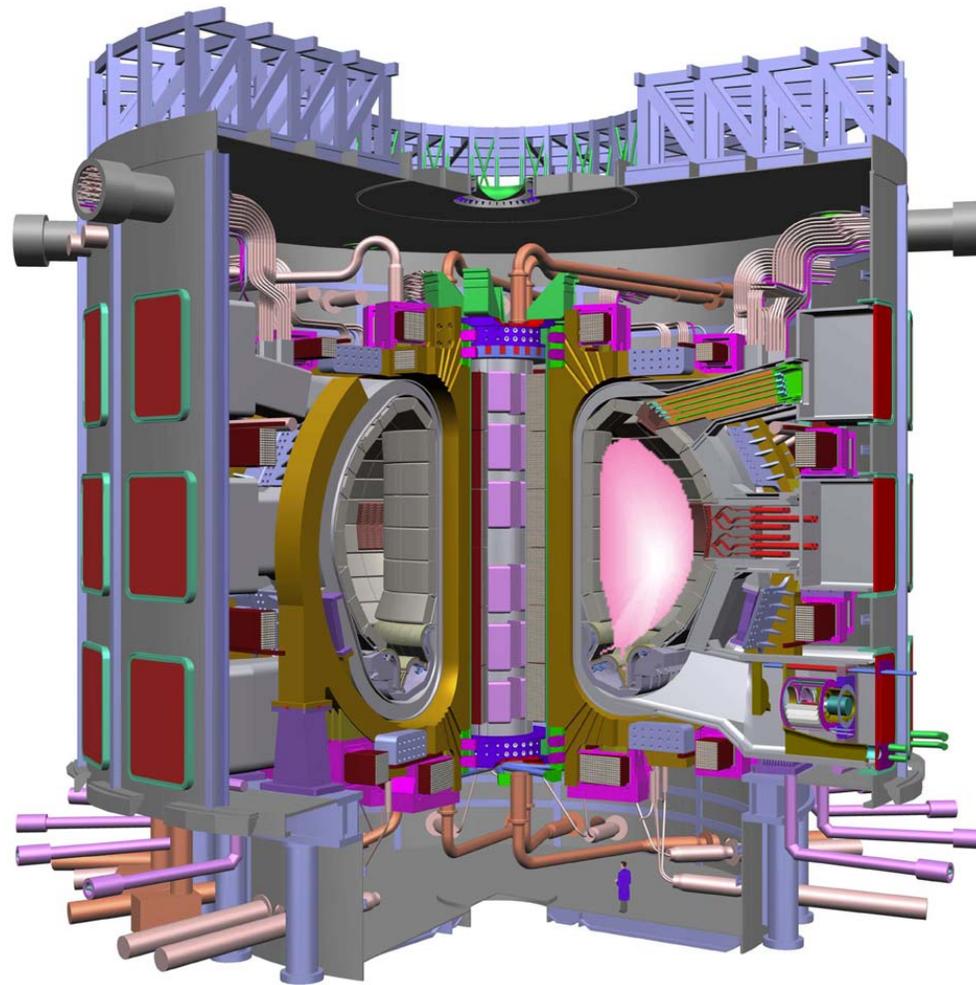
## *The Next Frontier*

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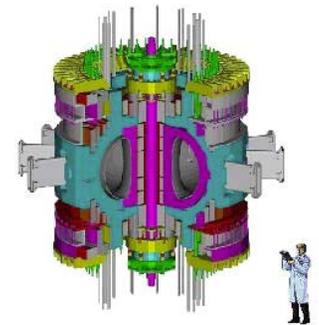
Three Options  
(Different Scales)



FIRE



ITER



IGNITOR

## *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

# *Mission and Priorities of DOE*

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## *Secretary Abraham, October 24, 2001*

Priority that deserves special mention.

- o Unique contribution we can make to our energy and national security by finding new sources of energy—**whether fusion or hydrogen economy or ideas not yet explored**—we need to leapfrog status quo and prepare for future requiring revolution in how we find, produce and deliver energy
- o Not simply because of the many usual reasons, but because success in this mission could well be one of the greatest contributions to our energy and national security for generations to come
- o The Department should take this leadership role

# ***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.”

# ***Excerpts from Secretary Abraham's Speech at the Conference of G8 Energy Ministers***

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May 2, 2002, Detroit, Michigan

“Advanced technology, and the contributions of science, play a critical role in our future energy plans. Along with promising innovations such as hydrogen fuel cells, the President is anxious to accelerate fusion power as a realistic source of energy.

We are now engaged in serious consultation here in the United States and around the world on how best to pursue a fusion program.

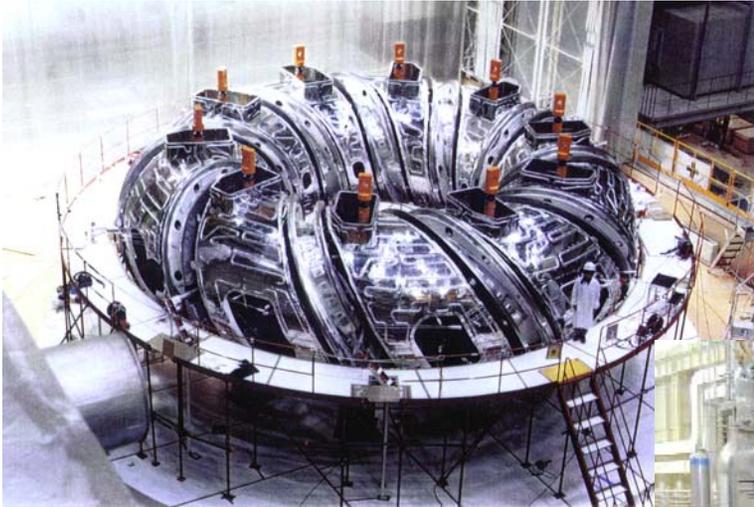
President Bush is particularly interested in the potential of the international effort known as ITER and has asked us to seriously consider American participation.

This major international effort will answer a critical scientific question: Can a fusion reaction--the kind of reaction that powers the sun--be harnessed here on earth for the benefit of all mankind?.,

The whole text can be found at:

<http://www.energy.gov/HQDocs/speeches/2002/mayss/PublicEnergyForu>

# Major International Facilities

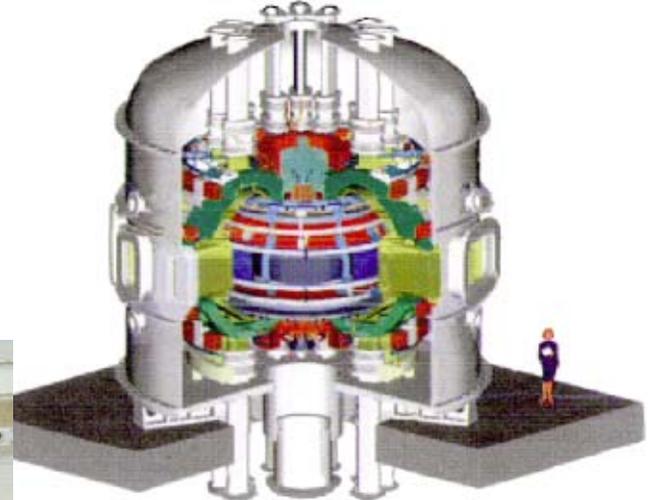


Large Helical Device (LHD)

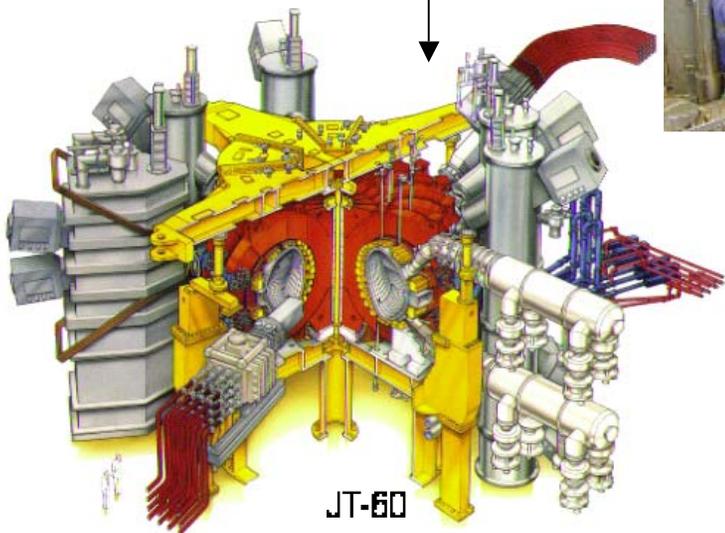
Japan



ITER Central Solenoid  
Model Coil



K-STAR (Korea)



JT-60



Joint European Torus (JET)

# ***OFES FY 2002 Budget Status***

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Request

House

Senate

\$248,495,000

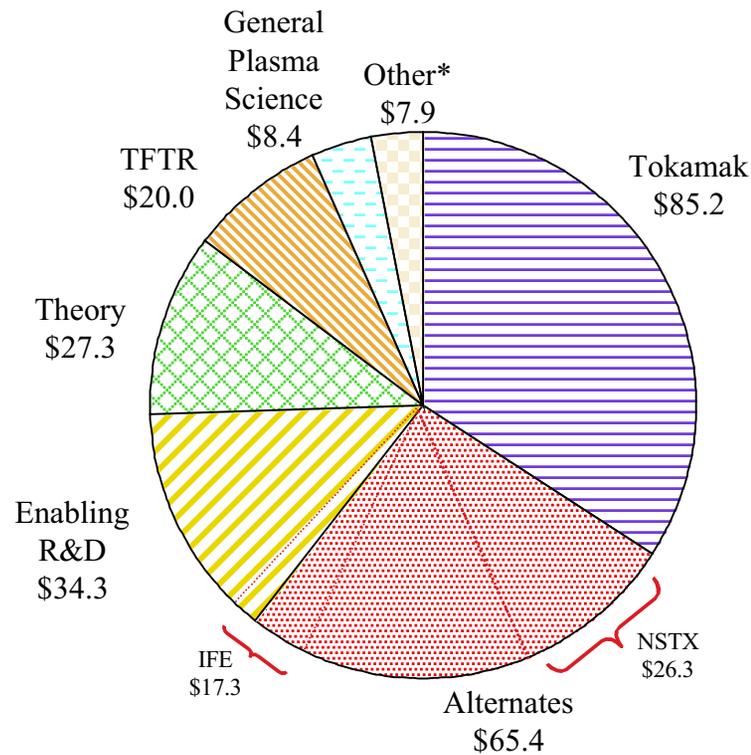
\$248,495,000

\$248,495,000

# *Fusion Energy Sciences Budget*

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FY 2002  
Congressional

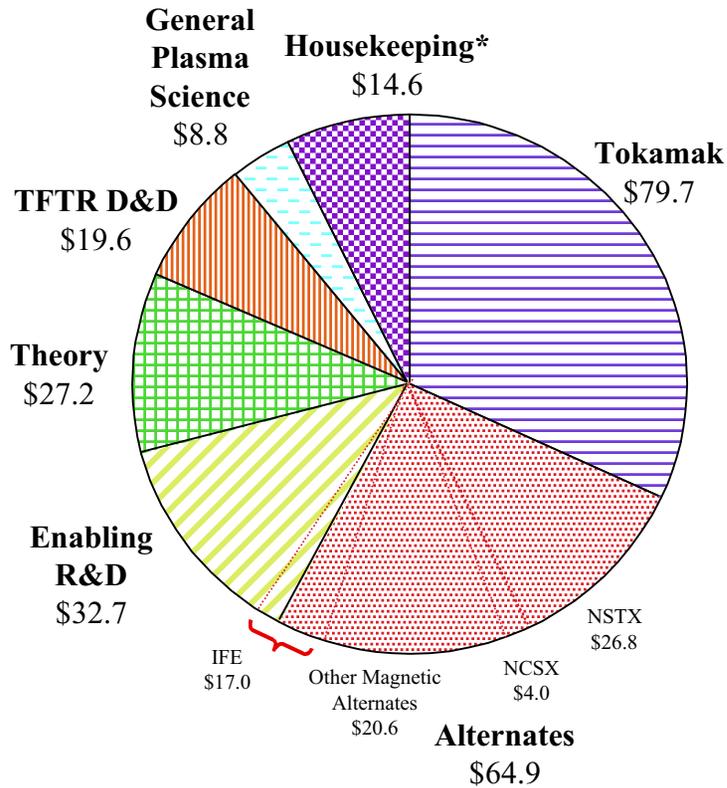


**\$248.5 M**

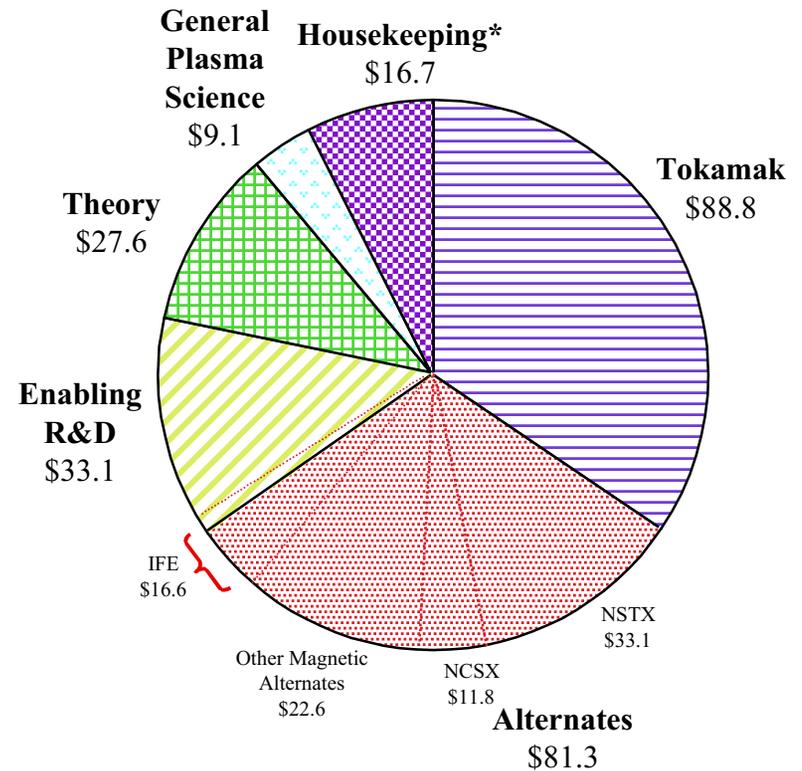
\*Waste Management  
SBIR/STTR  
GPP/GPE

# *Fusion Energy Sciences Budget*

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



FY 2003  
Congressional  
**\$257.3 M**



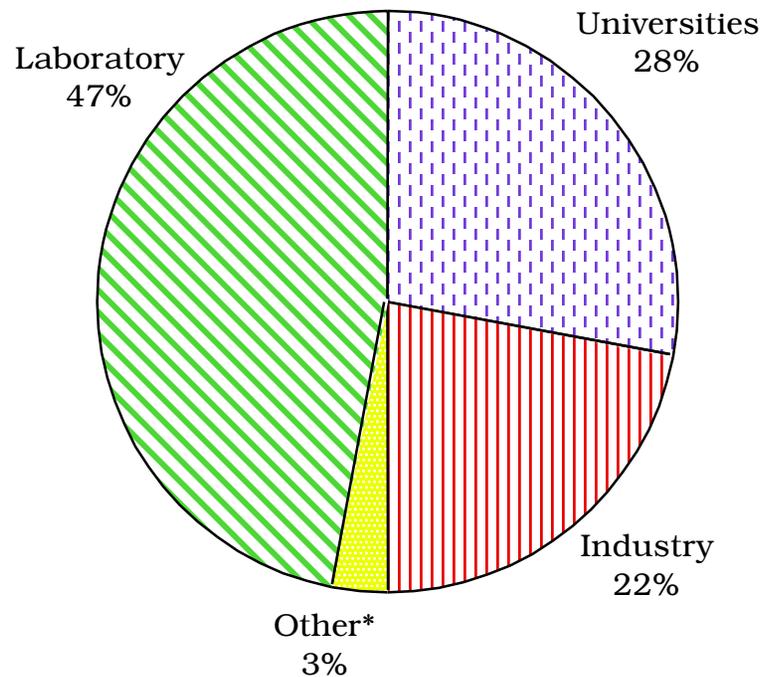
\* Housekeeping includes SBIR/STTR, GPE/GPP, TSTA cleanup, D-Site caretaking at PPPL, HBCU, Education Outreach, ORNL Move and Reserves

# *Fusion Energy Sciences Funding Distribution*

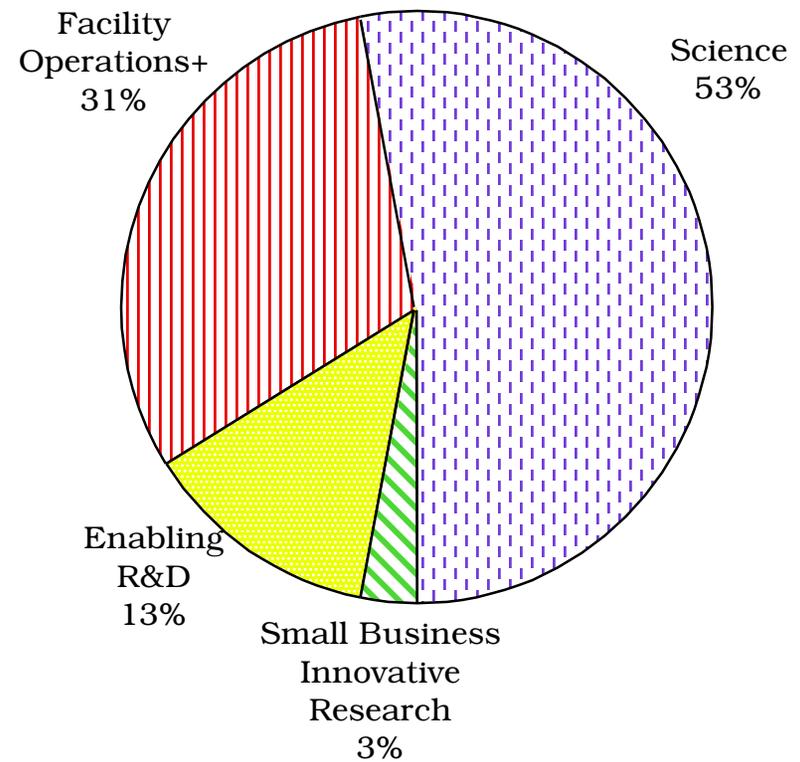
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FY 2003 President's Request  
\$257.3M

Institution Types



Functions

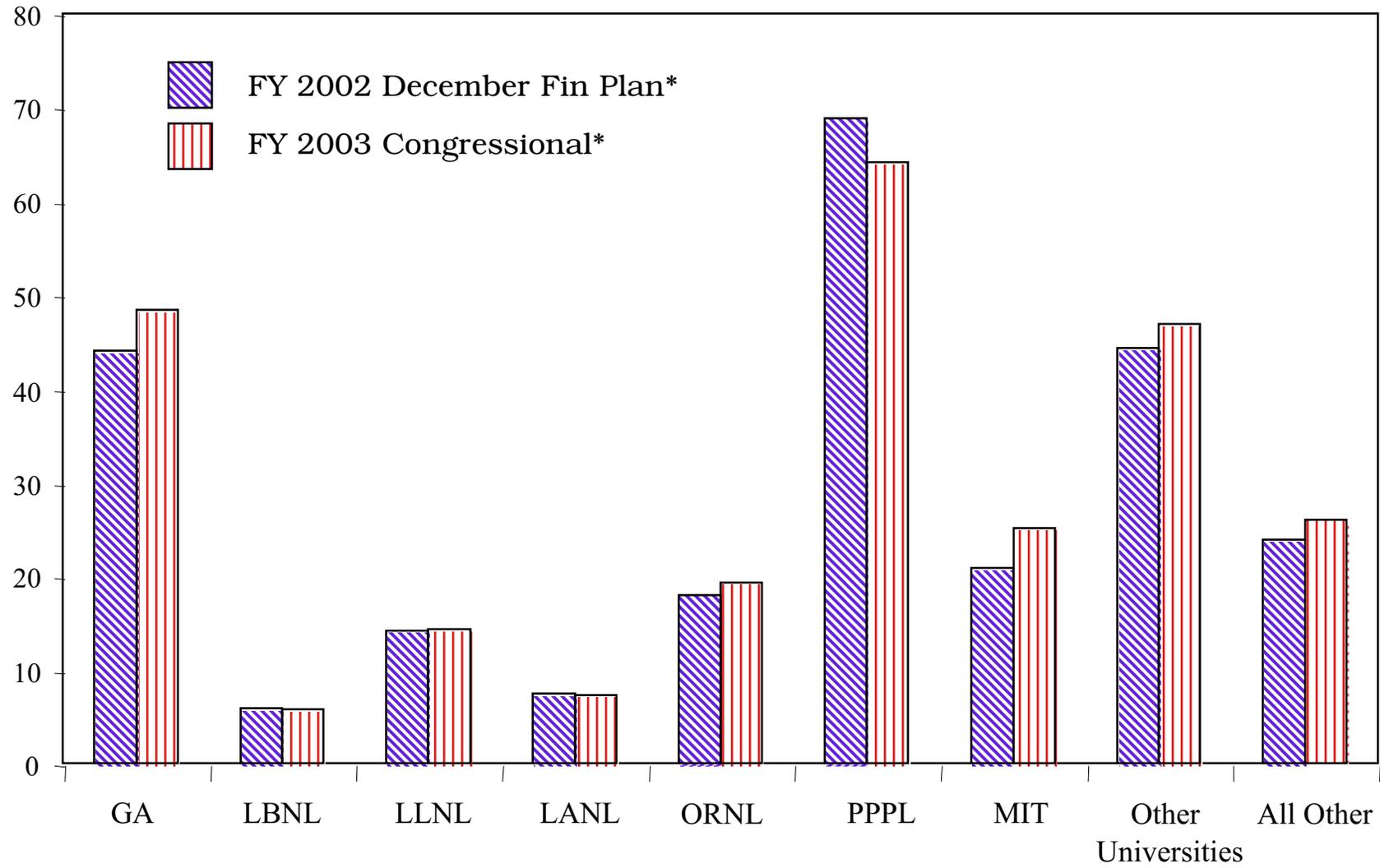


\*NSF/NIST/NAS/AF  
Undesignated

+Includes NCSX Project

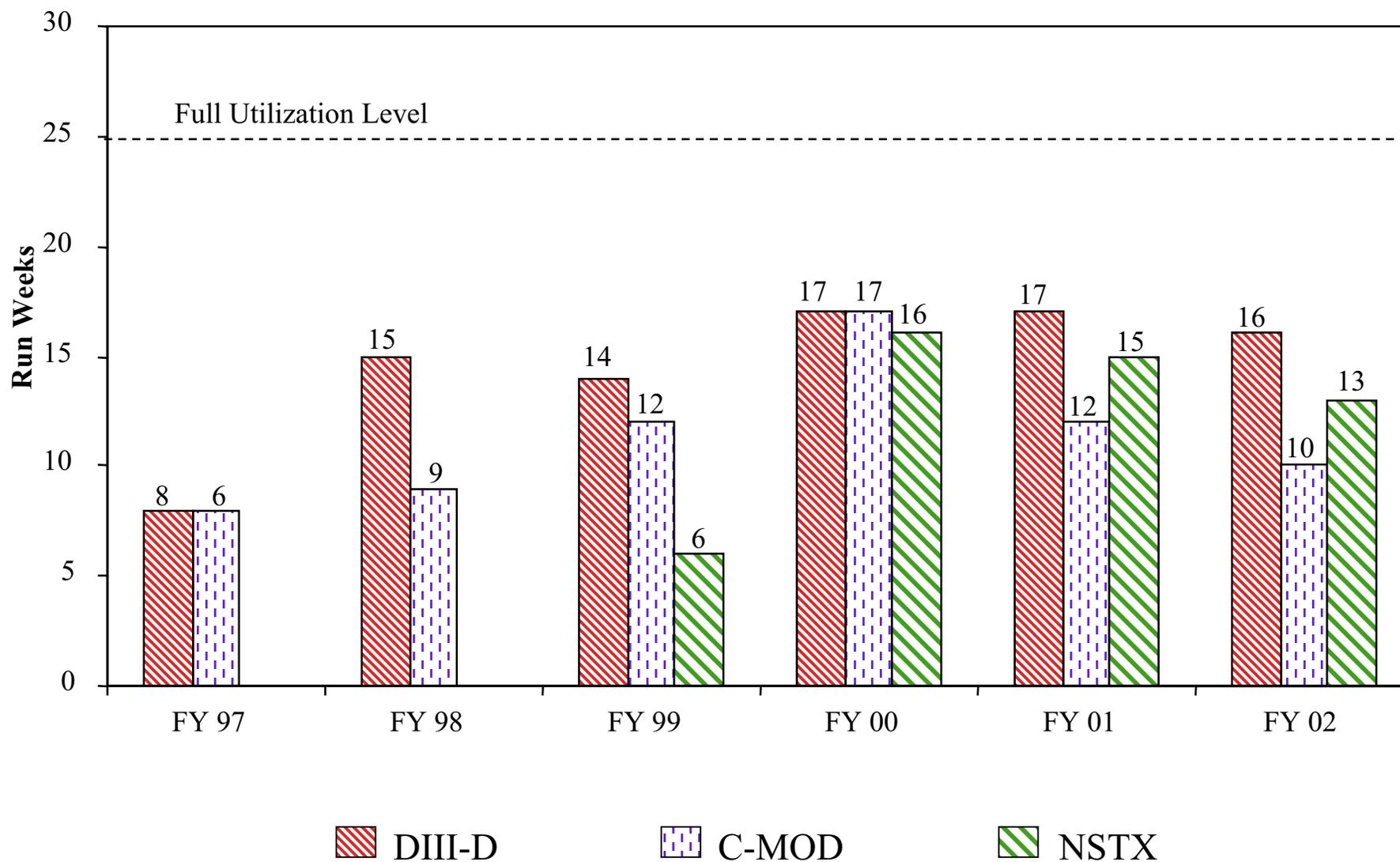
# Fusion Energy Sciences Funding by Institution

(\$ in Millions)



\*With SBIR/STTR Included

# Major Fusion Facility Use



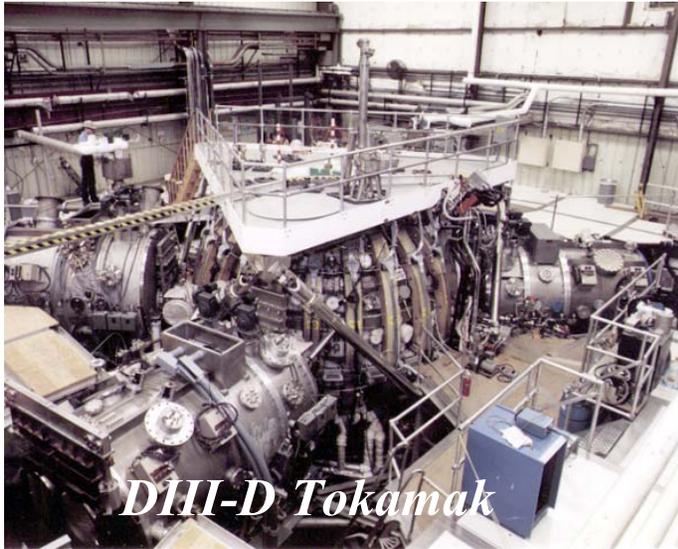


## *Safety is Key Element in Fusion*

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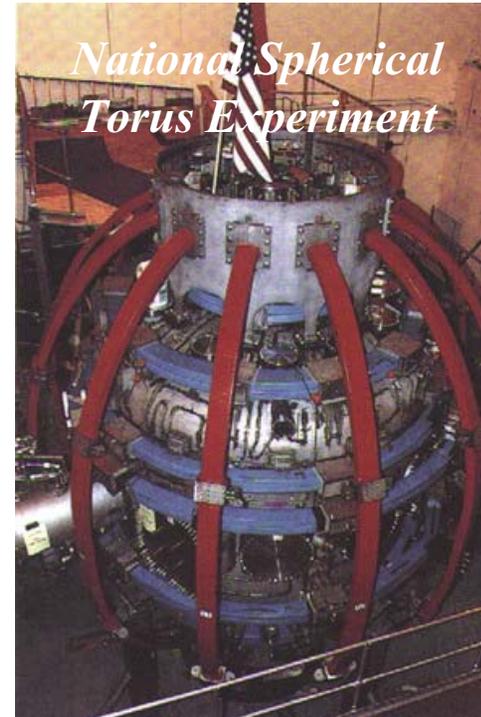
- o Doing work safely is essential for the FES program
- o PPPL, GA, ORNL have devoted much energy to assuring safety in research and operations
- o Universities are encouraged to seek help in assessing their own lab safety
  - GA worked successfully with UCLA in 2001 on assuring lab safety
  - The assessment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

# Major U.S. Magnetic Fusion Facilities



*DIII-D Tokamak*

**General  
Atomics**  
Doublet III  
Started  
Operations  
In 1978



*National Spherical  
Torus Experiment*

**Princeton  
Plasma  
Physics  
Laboratory**  
Torus started  
Operations in  
1999

**Massachusetts Institute of Technology**  
C-MOD Started Operations  
in October 1991



*Alcator C-MOD*

**Princeton  
Plasma  
Physics  
Laboratory**  
Fabrication:  
FY 2003-2007



*National Compact  
Stellarator Experiment*

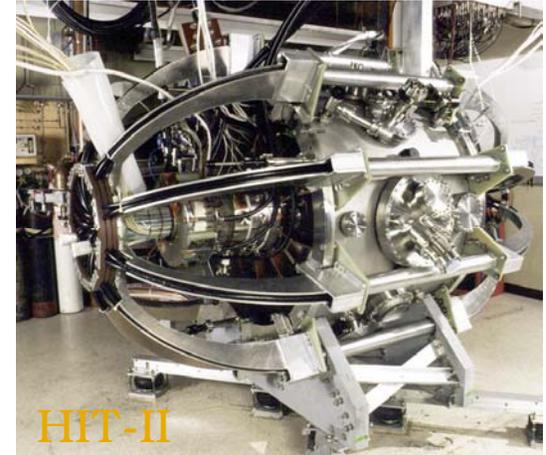
# *Innovative Confinement Concepts*



**Compact Auburn Torsatron becoming  
Compact Toroidal Hybrid**  
Auburn University, Auburn Alabama



**Levitated Dipole Experiment**  
Columbia University/Massachusetts  
Institute of Technology



**Helicity Injected Torus-II Experiment**  
University of Washington, Seattle



**Sustained Spheromak  
Plasma Experiment**  
Lawrence Livermore National Laboratory



**Electric Tokamak**  
University of California, Los Angeles



**Helically Symmetric Experiment**  
University of Wisconsin, Madison

# *National Compact Stellarator Experiment (NCSX)*

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

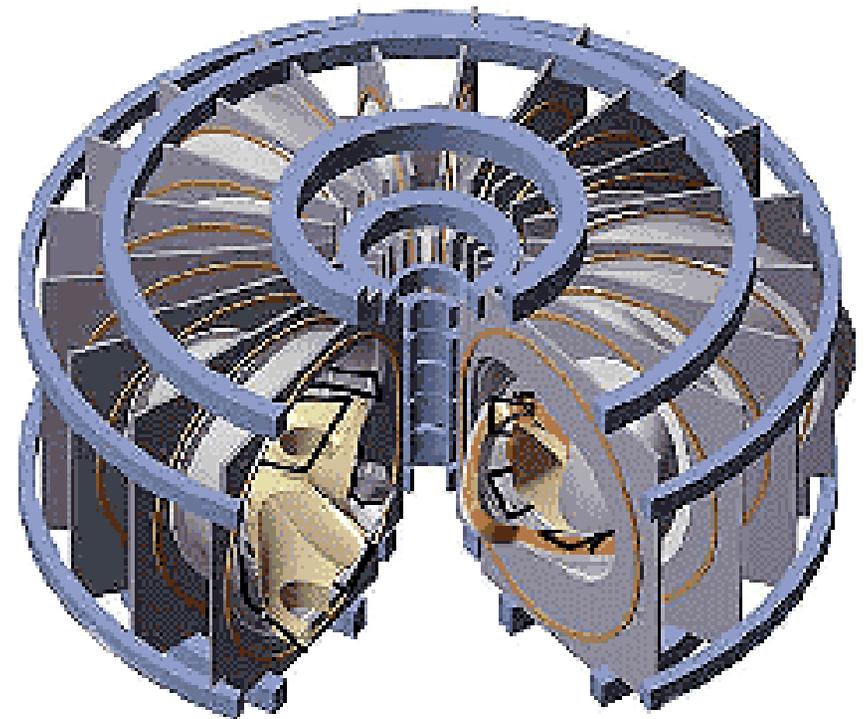
- o 3D plasma shape.
  - o Rotational transform and flow shear.
  - o Helical ripple.
- ⇒ advances toroidal physics understanding.

**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...**

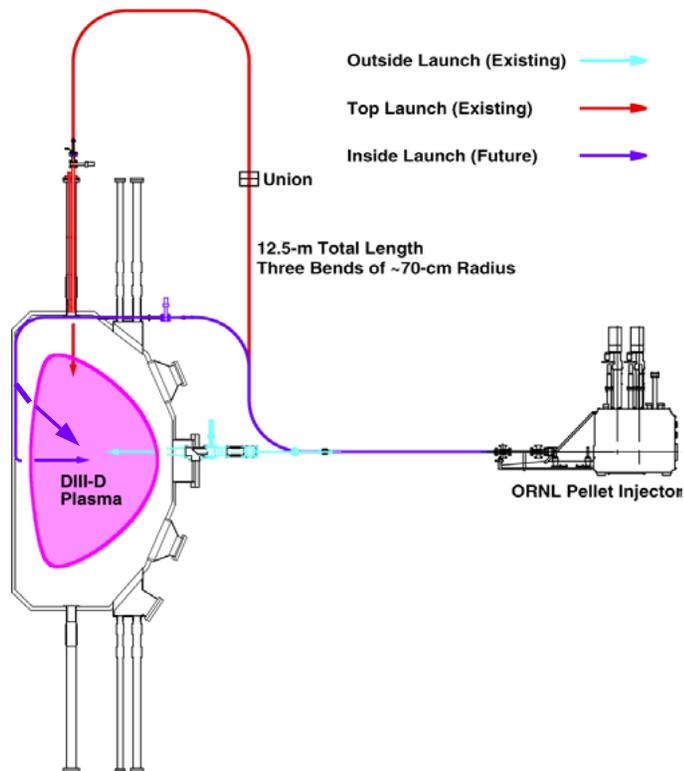
- o Conceptual design review: May, 2002
- o Fabrication: FY 2003-2007
- o Preliminary cost estimate: approx. \$69M (as-spent)



# Enabling Technologies Program

100 GHz Gyrotron Tube (1MW power in 1 second pulse) for Plasma Heating and Control

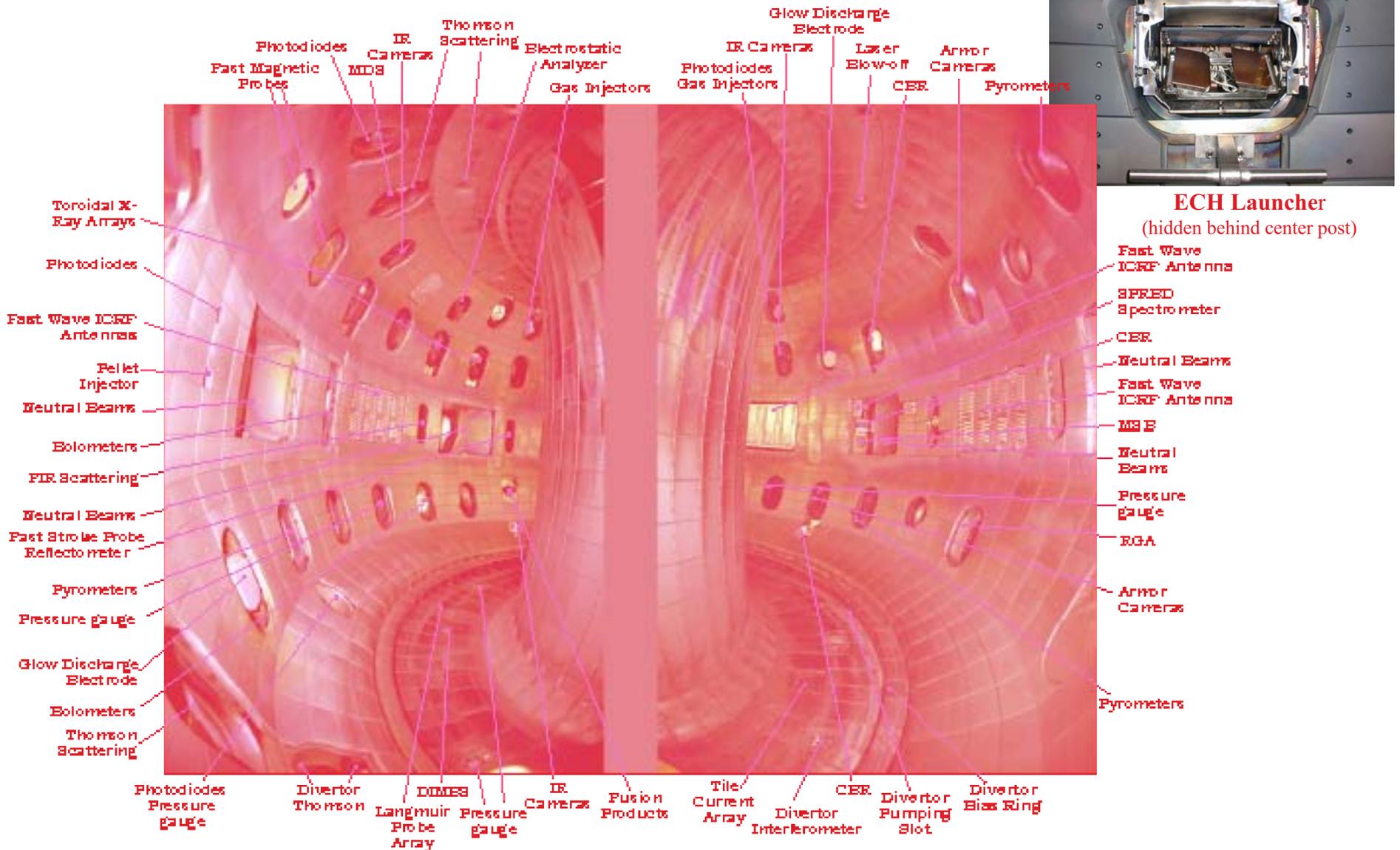
Pellet Injector in DIII-D for Plasma Fueling



DiMES probe in DIII-D provides data on plasma material interactions



# DIII-D Diagnostic and Heating Systems



## *General Plasma Science*

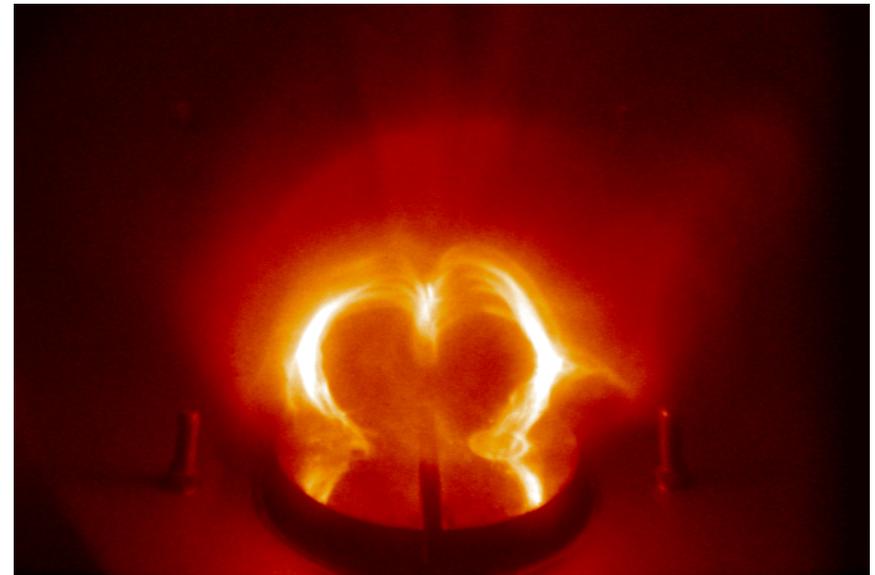
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Since its inception, there have been  
15 Plasma Physics Junior Faculty  
Development Program Awards (+1 in  
cooperation with NSF)



**Dense Z Pinch**  
University of Nevada-Reno

There are presently 34 NSF/DOE  
grants under the partnerships in  
Basic Plasma Science and  
Engineering Awards



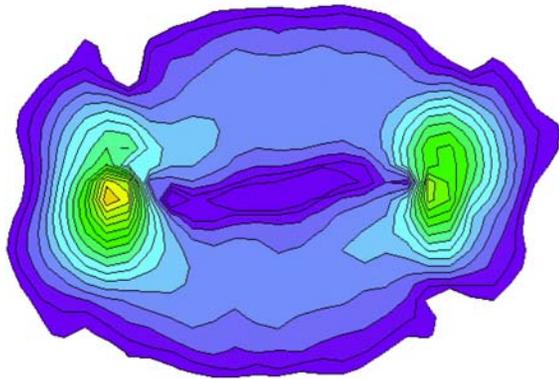
**Laboratory Simulation of  
Solar Prominences**  
California Institute of Technology

# *Scientific Discovery Thru Advanced Computing*

## Three Principal Projects

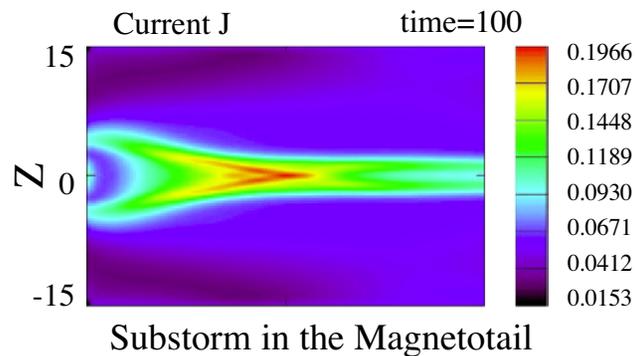
### Terascale Atomic Physics

Auburn, Rollins, ORNL



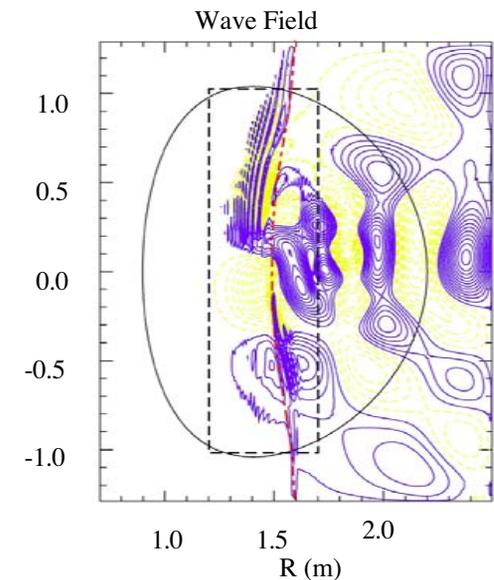
### Magnetic Reconnection Code

U. Iowa, U. Chicago, U. Texas



### Computation of Wave Plasma Interactions

ORNL, PPPL, MIT,  
Lodestar, CompX



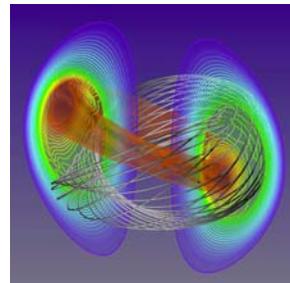
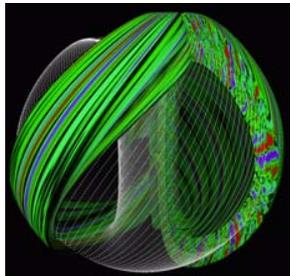
## Two Pilot Projects

### Plasma Microturbulence

LLNL, GA, PPPL, U.  
Maryland, U. Texas,  
U. Colorado, UCLA

### Extended MHD Modeling

PPPL, SAIC, U. Wisconsin,  
NYU, U. Colorado, MIT, Utah  
State U., GA, LANL, U. Texas



## *Inertial Fusion Energy*

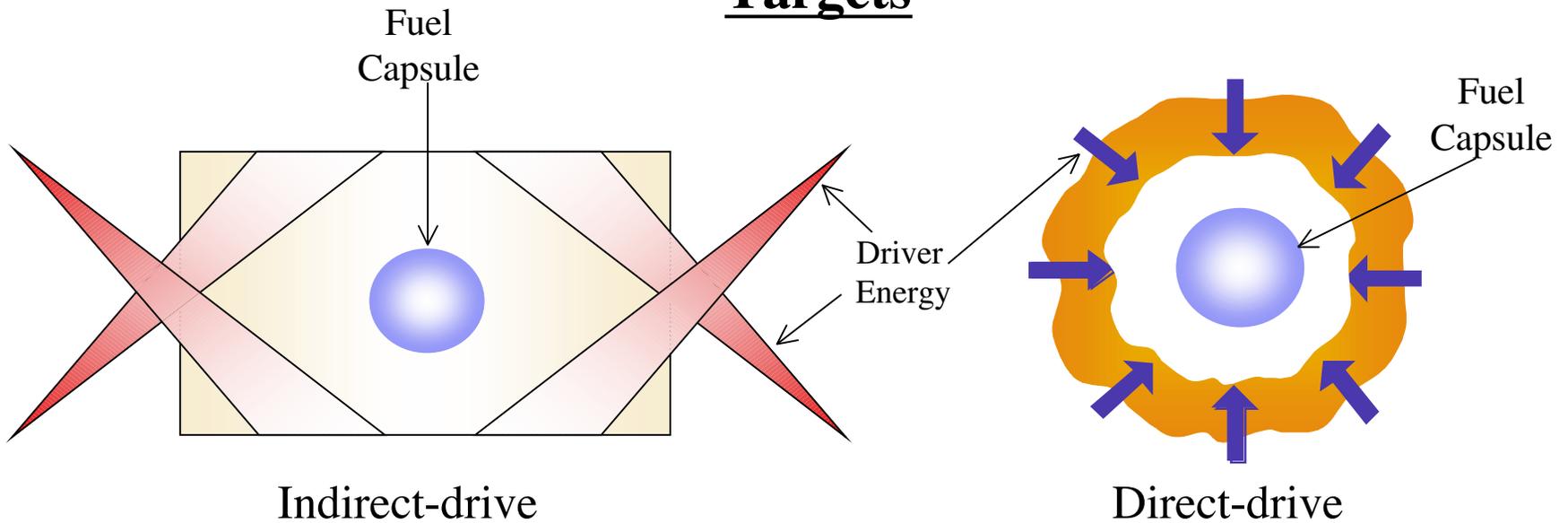
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- o Defense Programs **conducting high energy density physics** using OMEGA, and NIKE lasers; National Ignition Facility under construction; results are used by Science in designing energy producing targets
- o SC developing **components** for energy applications, especially accelerator-based driver and target chamber technologies
- o Developing **international collaboration** through bilateral agreements

# *Inertial Fusion Energy Options*

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## Targets



## Drivers

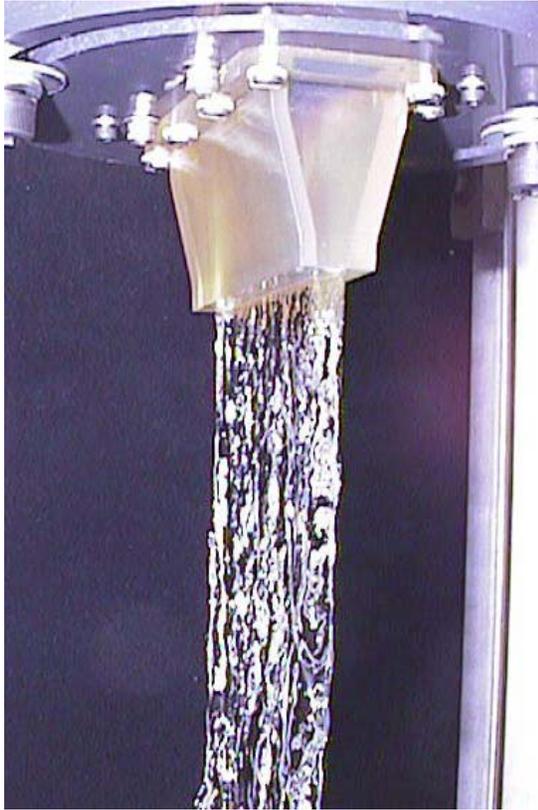
Heavy Ions

KrF Laser

Diode Pumped Solid State Laser

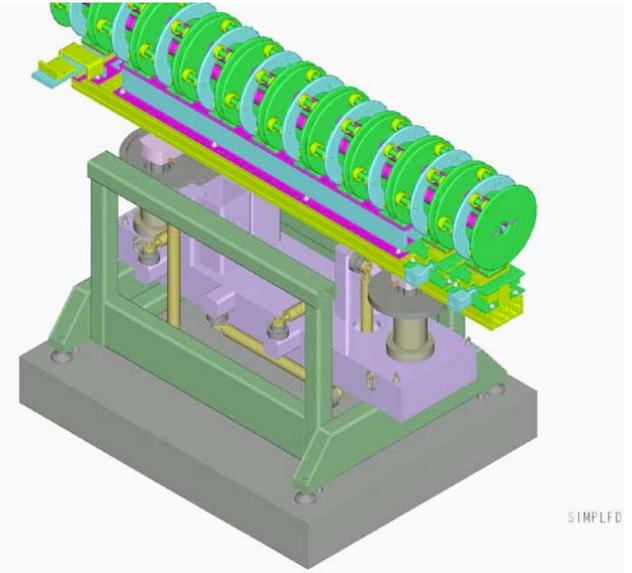
# *Inertial Fusion Energy Experimental Facilities*

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**Liquid wall chamber  
protection flow  
experiment**  
Georgia Tech

**Quadrupole Focusing  
Assembly for New  
Heavy Ion Beam  
Experiments**  
(Under construction at  
Lawrence Berkeley  
National Lab)



**Multi-beam  
Transport  
Experiment**  
Lawrence Berkeley  
National Lab

*Progress Report on ITPA*  
*(International Tokamak Physics Activity)*

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U.S.-Japan Executive Secretaries  
Televideo Meeting  
May 9, 2002

# ***ITPA Objective***

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- o Cooperation in development of physics basis of burning tokamak plasmas
  - Includes databases, modeling, analysis, and workshops
  - Provides access to all relevant databases, including ITER, for all participants
  - ITER Physics now a part of broader ITPA

# *ITPA Progress in FuY 2001*

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- o First Coordinating Committee meeting held at Naka, Japan in September 2001
  - Initiated ITPA implementation
  - Chairs/Co-Chairs selected for Coordinating Committee and Topical Groups
- o Second Coordinating Committee meeting held at San Diego, U.S. in March 2002
  - Reviewed Progress, Topical Group Charters, etc.
  - Included stellarator physics in ITPA
- o Several Topical Group Meetings were held
  - Gifu, Japan - September 2001
  - St. Petersburg, Russia – November 2001
  - San Diego, U.S. – March 2002
  - Princeton, U.S. – March 2002
- o Next Topical Group and Coordinating Committee meetings in France and Germany after the IAEA FEC 2002 meeting

## *ITPA Web Page Established*

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- o EU has kindly established a web-page for ITPA:  
<http://www.aug.ipp.mpg.de/itpa/>
- o Provides information on
  - ITPA charter, membership, structure
  - Topical Group activities, reports, and meeting schedules
  - World tokamak programs through linkages

## *Summary*

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- o The progress with ITPA has been very gratifying in this short period of time
- o Very good interaction among the world tokamak community, now extending to stellarators
- o Seven technical papers, produced by ITPA Topical Groups will be presented at the IAEA FEC 2002 in Lyon, France