



U.S. Department of Energy's  
Office of Science

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# Fusion Energy Sciences Program

American Physical Society  
Division of Plasma Physics

to the

University Fusion Association



**Dr. N. Anne Davies**  
Associate Director  
for Fusion Energy Sciences

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

*October 27, 2003*

# *Topics*

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- o Budget Update
- o OFES Organization
- o NRC Report/Response
- o ITER Negotiations
- o ITPA Status
- o Performance Measures
- o Solicitations
- o NCSX Status
- o Fusion Simulation Project
- o HEDP/Q2C Reports/Response
- o Other FESAC Charges
- o Plasma Science Decadal Study

## ***FY 2004 Fusion Energy Sciences Budget***

(\$ in Millions)

	FY 2002 <u>Actual</u>	FY 2003 <u>Cong.</u>	FY 2003 <u>Sept. Fin Plan</u>	FY 2004 <u>Cong.</u>
Science	134.3	136.2	136.2	138.1
Facility Operations	70.8	78.6	66.2	87.7
Enabling R&D	36.0	36.1	38.3	24.9
SBIR/STTR	<u>0.0</u>	<u>6.4</u>	<u>6.2</u>	<u>6.6</u>
<i>OFES Total</i>	<i>241.1</i>	<i>257.3</i>	<i>246.9</i>	<i>257.3</i>
DIII-D	50.9	55.6	51.5	56.7
C-Mod	17.6	22.3	19.2	22.7
NSTX	27.0	33.1	30.1	35.2
NCSX	5.4	11.8	11.7	16.7

# ***FY 2004 Fusion Energy Sciences Budget***

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(\$ in Millions)

## House Appropriations Committee

President's Request	257.3
ITER and FIRE	+ 4.0
Fusion Technology	+ 5.2
Advanced Design and Analysis	<u>+ 1.6</u>
House Mark	268.1
High Average Power Laser Research in NNSA	+ 25.0

## Senate Appropriations Committee

President's Request	257.3
Senate Appropriations Committee	257.3
“...within available funds, the Department should...redress the imbalance...”	
IFE Z Studies + 5.0 in NNSA	

## *FY 2004 OFES Budget*

### *Current Financial Plan for Continuing Resolution*

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- o \$257.0M (lowest of the three possible numbers) minus a Tax, plus the Senate constraints to “redress the imbalance”
- o Conference scheduled for October 29, 2003
- o Principles for Current Financial Plan Development
  - Minimize personnel disruptions
  - Support ITER Transitional Arrangements, modest effort on FIRE
  - Rebalance science and technology elements, to some extent
  - Continue NCSX project
  - Support for Fusion Science Centers Solicitations
  - Support National Lab portion of the successful NSF Science Center proposal lead by University of Wisconsin
  - Partially restore cuts to International Collaborations
  - Increase operation of facilities over FY 2003 level (~18 weeks)

# *FY 2004 Fusion Energy Sciences Budget*

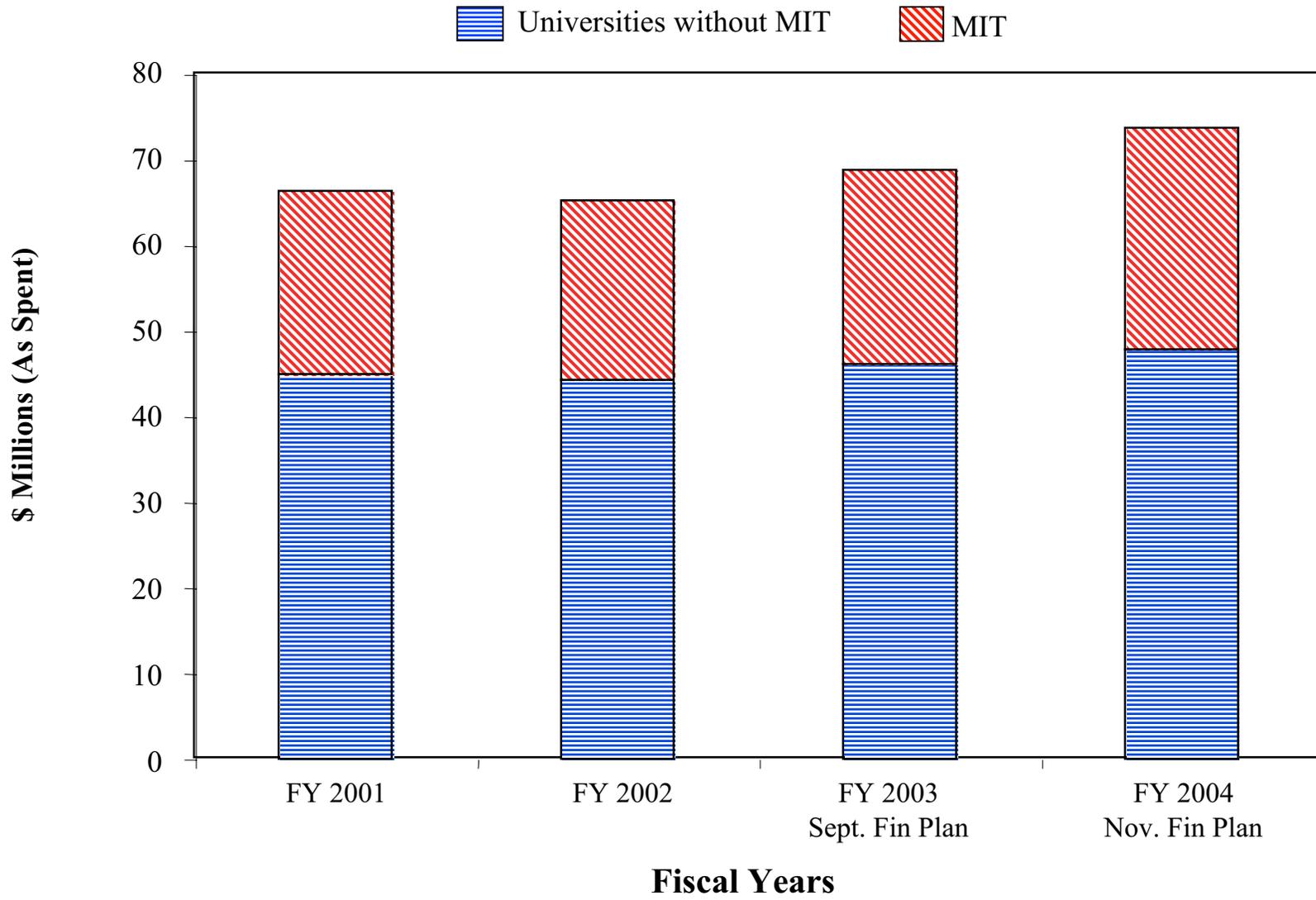
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(\$ in Millions)

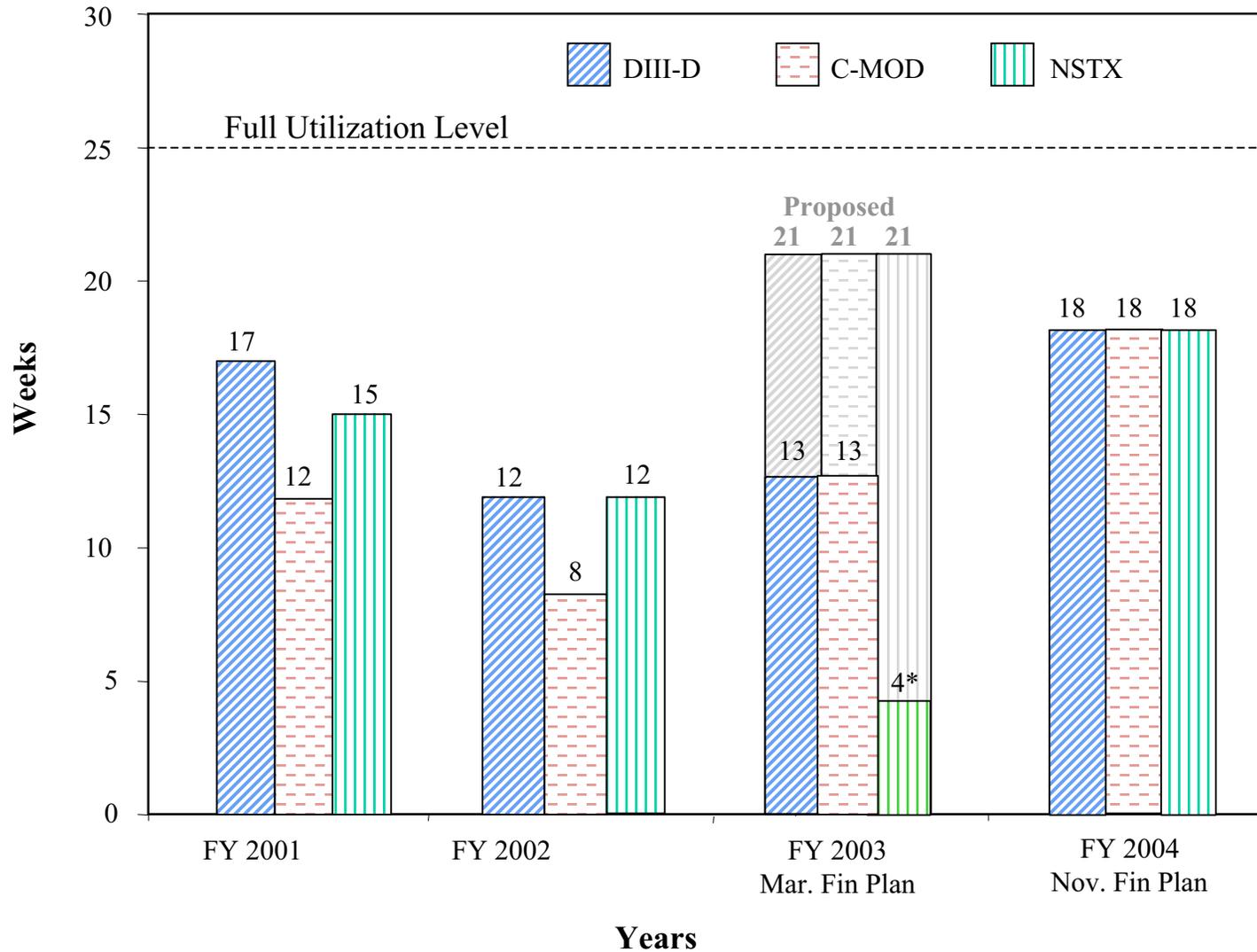
	FY 2004 <u>Cong.</u>	FY 2004 <u>Nov. Fin Plan</u>
Science	138.1	141.0
Facility Operations	87.7	81.2
Enabling R&D	24.9	28.2
SBIR/STTR	<u>6.6</u>	<u>6.6</u>
<i>OFES Total</i>	<i>257.3</i>	<i>257.0</i>
DIII-D	56.7	54.3
C-Mod	22.7	21.5
NSTX	35.2	33.5
NCSX	16.7	16.7

# *OFES University Research Funding*

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# Major Fusion Facilities Operating Times



\*NSTX operating time was reduced due to the failure of one of the magnetic coils in February. Operations are expected to begin again in February 2004.

# Office of Fusion Energy Sciences

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DIII-D Site Rep.

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## ITER & International Division

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**Sandy Newton**, Administrative Specialist (International)

**Francis Thio**

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**Chuck Fingfeld**

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**Arnold Kritz\***

Modeling and Simulation

**Sam Berk\*\***

Technology Leader, VLT, PFC,  
Plasma Chamber Sys, Materials

**T.V. George**

Heating and Fueling,  
SBIR/STTR, Facility Upgrades

**Warren Marton**◆

U.S. ITER Project Officer

**Curt Bolton**

Next Step Options, Theory  
Team Leader

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Atomic Physics, Theory, Basic  
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C-MOD, Theory

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NCSX Project Management,  
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**Sam Berk\*\***

ITER Technology Officer

**Steve Eckstrand**

NSTX, SciDAC, Fusion  
Simulation Project, Compact  
Stellarator, NCSX

**Erol Oktay\*\***

DIII-D, International Tokamaks

◆Principal Acting Director  
\*IPA (Lehigh Univ.)  
\*\*Dual Capacity  
( ) Area of Emphasis

+Does not necessarily reflect formal organization or position descriptions

# *Report of the NRC Burning Plasma Assessment Committee*

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- o Burning Plasma: Bringing a Star to Earth released September 24, 2003
- o Reviewed only Magnetic Fusion Energy
- o Major Conclusions
  - Burning Plasma experiment needed to advance fusion science--join ITER but reassess and move ahead if ITER fails
  - Cannot be done with flat budgets, augmentation is required
  - Program should focus on realistic opportunities
  - Community should identify and prioritize program elements needed for a *balanced* program within the context of a program that includes ITER

## *FESAC Charge on Prioritized Balancing*

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- o Identify major science and technology issues to be addressed in research campaigns through 2014
- o Prioritize the campaigns under three budget scenarios:
  - Current Level of \$257M plus inflation
  - Level authorized in current draft of 2003 Energy Bill plus inflation for later years
  - Level midway between these profiles
- o Assume that U.S. participation in ITER construction is separate funding
- o Plan balanced program with ITER as part of an integrated whole
- o Include Inertial Fusion and relevant aspects of High Energy Density Physics in developing balanced, prioritized program

Energy Bill Profile

FY 2004	\$335M
FY 2005	\$349M
FY 2006	\$362M
FY 2007	\$377M
FY 2008	\$393M

## *Status of ITER Negotiations*

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- o Negotiations at many levels, ongoing since November 2001, to develop an international agreement for ITER
- o High-level decision-making process now established and working
- o Meetings discuss: site, key personnel, procurement allocation, and cost sharing, all in high-level, small groups
- o Negotiations could be concluded by turn of year
- o First high level meeting held in June, 2003, including KO, now 7 parties: CA, CN, EU, JA, KO, RF, and US
  - First indications of positions on key points shared
  - Substantial progress made toward implementation of ITER
- o Second high level meeting held in October, 2003
  - Further progress on many issues

## *Common Message from Second High Level Meeting—Under Development*

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- o All seven parties present
  - CA still awaiting its governmental decision on funding
- o Procurement Allocation recommendations well received
  - US ‘basket’ still requires export control review here
- o Construction cost sharing moving toward resolution
  - Sensitive negotiating point
  - Operation costs and sharing requiring further work
  - Need further clarification of costs as well as sharing
- o Decommissioning costs and sharing requiring further work
  - Need further clarification of costs as well as sharing
- o Plan for completing text of agreement considered
  - US striving to complete its review of all legal points
- o Reinforced intention to complete all essential issues by December, 2003
  - Stiff challenge, but many parties under severe pressure to complete negotiations this year

## *ITER Organization*

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- o OFES
  - Restructured Office has two Divisions
    - Research Division (John Willis)
      - Includes:
        - Erol Oktay, US ITER Science Officer
        - Sam Berk, US ITER Technology Officer
    - ITER/International Division (Michael Roberts)
      - Warren Marton, US ITER Project Officer
      - Debra Frame, International Administrator

## *ITER Organization* (continued)

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- o US Fusion Community
  - Presently have US ITER Planning Officer
    - Ned Sauthoff, PPPL, with Deputy--Charles Baker, UCSD
  - OFES preparing to hold competition to organize US ITER Project Office at existing national laboratory
- o Internationally
  - International Team now headed by Yasuo Shimomura
  - OFES seeking nominees for Senior Management positions

# *Status of the International Tokamak Physics Activity (ITPA)*

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- o The ITPA is developing and documenting the physics basis for burning tokamak plasmas
  - High Priority Research Topics for 2004 were refined by several ITPA Topical Physics groups and the ITPA Coordinating Committee recently at GA
  - The ITPA is updating the Tokamak Physics Basis for publication in the Summer of 2004
  - The ITPA and the IEA tokamak collaborations are planning joint experiments to address the ITPA's high priority R&D topics
- o The ITPA, which started in September 2001 and built on the previous ITER Physics Expert Groups, was extended for another two years to July 2005
  - China has joined the ITPA
  - The future relationship between ITER Transitions Activity (ITA) and the ITPA is being refined in the ITER negotiations
- o We have re-established the ITPA team in the OFES in order to enhance the integration of ITPA into the OFES programs
  - We expect that the community involvement in the ITPA and ITER Physics are covered by your program funds and university grants
- o Visit the ITPA website <http://itpa.ipp.mpg.de/> to see annual reports, organizational structure, and meeting schedules

# *Leadership of U.S. ITPA Topical Physics Groups*

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More than 100 Scientists in the U.S. are Active in Topical Groups

	<b>Leader</b>	<b>Co-Leader</b>	<b>OFES Contact</b>
Transport Physics	Ed Doyle (UCLA)	Ed Synakowski (PPPL)	Curt Bolton
Confinement DB & Modeling	Wayne Houlberg (ORNL)	Jim DeBoo (GA)	Steve Eckstrand
Pedestal & Edge Physics	Tony Leonard (GA)	Amanda Hubbard (MIT)	Arnold Kritz
Divertor & Scrape-Off Layer	Bruce Lipschultz (MIT)	Peter Stangeby (GA/LLNL)	Chuck Finfgeld
Steady State & Energetic Part.	Cynthia Phillips (PPPL)	Ron Prater (GA)	Erol Oktay
MHD, Disruption & Control	Ted Strait (GA)	Steve Jardin (PPPL)	Rostom Dagazian
Diagnostics	Dave Johnson (PPPL)	Rejean Boivin (GA)	Darlene Markevich

# ***OFES Performance Measures***

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FESAC has reviewed these Performance Measures and the comments of FESAC members have been included

## **Long Term Indicators**

### **Predictive Model for Burning Plasmas**

Progress in developing a predictive capability for key aspects of burning plasmas using advances in theory and simulation benchmarked against a comprehensive experimental database of stability, transport, wave-particle interaction, and edge effects.

### **Configuration Optimization**

Progress in demonstrating enhanced fundamental understanding of magnetic confinement and improving the basis for future burning plasma experiments through research on magnetic confinement configuration optimization.

### **Inertial Fusion Energy and High Energy Density Physics**

Progress in developing the fundamental understanding and predictability of high energy density plasma physics, including potential energy producing applications.

## ***OFES Performance Measures*** (continued)

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### **FY 2005 Targets**

#### **Facility Operations**

Average achieved operation time of the major national fusion facilities as a percentage of the total planned operation time. (*Efficiency Measure*)

#### **FY 2005 Construction**

Cost-weighted mean percent variance from established cost and schedule baselines for major construction, upgrade, or equipment procurement projects.

## *Summary of 2003 Theory Solicitation*

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- o 39 proposals received
- o 16 proposals funded with total funding of \$6 M--all rated very good or better
- o 6 new PIs funded--good proposals combined with a modest growth in theory funding
- o 4 proposals get 4 year grants as a result of getting excellent rating by all reviewers and OFES theory team

## *ICC Review and Decision 2003: Summary*

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- o A total of 39 proposals were reviewed (12 of which are for renewals)
- o Based upon the reviews, the proposals are ranked in bands as “equals”  
(Blue – funded, Green – limited funding, Red – Not funded)

	Non National Labs	National Labs
“Excellent”	3 renewals	1 renewal, 1 new
“Very-Good-to-Excellent”	5 new	3 renewals
“Very Good”	3 renewals	1 new
“Good-to-Very-Good”	2 new	2 renewals (1 yr)
“Good”	8 new	1 new
“Poor”	2 renewals (closeouts), 8 new	

- o Clearly there are opportunities for more funding
- o More details are available at the ICC Community Meeting after the UFA

## *Fusion Science Center (FSC) Initiative*

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Recommendation of the National Research Council Report “An Assessment of the Department of Energy’s Office of Fusion Energy Sciences Program”

- o *“Several new centers, selected through a competitive peer-review process and devoted to exploring the frontiers of fusion science, are needed for both scientific and institutional reasons.”*
- o Strong educational component
- o Centers should sponsor multidisciplinary workshops and summer school

## *FSC Initiative Description*

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- o Focus of Center is on areas of fundamental importance to Fusion Plasma Science
- o \$2 Million in FY 2004 Funding for FSC
  - Host institution is expected to provide at least 15% cost sharing
  - Center expected to host workshops and summer schools
- o Grant duration of 5 years with possible 5 year renewal
- o Center will be a University based Center of Excellence with possibility of up to 20% of funding going to a National Laboratory(s) partner

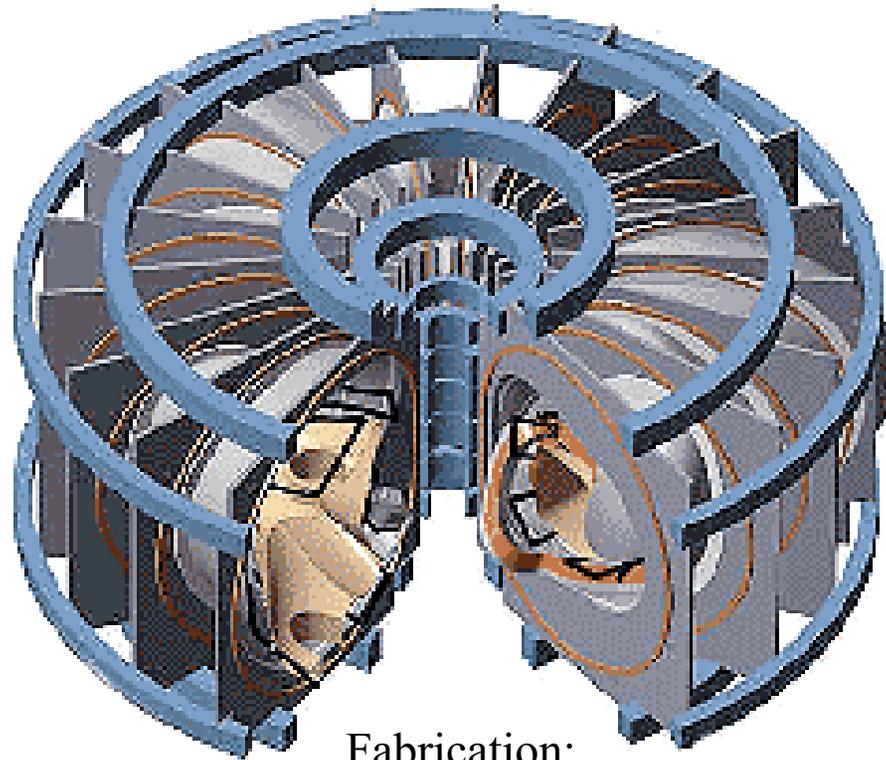
## *Phased Review Process*

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- o Federal Register Notice in August 15, 2003
- o October 15, 2003 Letter of Intent Requested, but not required
- o November 15, 2003 receipt of Preliminary Applications for review by panel
- o January 15, 2004 Full Applicants are selected from Preliminary Applications
- o March 1, 2004 Deadline for receipt of Full Applications
- o April, 2004 Panel Review of Full Applications, including oral presentation by proposed key FSC participants
- o May 2004 FSC Awards

# *National Compact Stellarator Experiment (NCSX)*

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Fabrication:  
FY 2003-2007

Partnership between  
Princeton Plasma Physics Laboratory and Oak Ridge National Laboratory

## *National Compact Stellarator Experiment (NCSX)*

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- o Project started on April 1, 2003. Delayed 6 months due to the FY 2003 continuing resolution
- o NCSX Stellarator Core Systems (i.e. Modular coils, vacuum vessel) are technically challenging. Industry involved early in project for these critical systems
- o Project has completed (10/7-9/03) an independent review to determine whether the project was ready to establish its performance baseline cost and schedule (Critical Decision 2) and proceed to final design. The review team concluded it was ready
- o Current project proposal is to complete construction in September of 2007 at a cost of \$81M
- o DOE will now conduct (week of November 16) its reviews (Lehman review and Office of Engineering Construction Management External Independent Review) to determine whether we believe the project is ready to be baselined

## *Initiation of Fusion Simulation Project (FSP)*

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- o FESAC identified Comprehensive simulation capability as a critical program element for the future
- o FSP – complex project with challenging goals
  - Planning FSP in advance of project initiation is essential
- o Planning committee appointed
  - Doug Post** (LANL), **Chair**; **Don Batchelor** (ORNL); **Randy Bramley** (Indiana U.); **John Cary** (U. Colorado); **Ron Cohen** (LLNL); **Phil Colella** (LBNL); **and Steve Jardin** (PPPL)
  - Provide initial planning for implementation of FSP
  - Consider issues of organization and management structure
- o Committee will seek broad input from fusion, applied math and computer science communities
- o FSP will be a multi-institutional community project
  - Fraction of funding at a single institution will be limited

***Center for Magnetic Self-Organization  
in Laboratory and Astrophysical Plasmas at U. Wisconsin-Madison***

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- o An NSF Physics Frontier Center, a partnership with OFES
- o Goal: advance physics of magnetic self-organization common to laboratory plasmas and astrophysics
- o Teams laboratory plasma physicists and astrophysicists
- o Involves 4 experiments (MST, MRX, SSPX, SSX)
- o Involves theorists, computation scientists, and astrophysicists at Chicago, Princeton, SAIC, UW

## *Focused Materials Workshop*

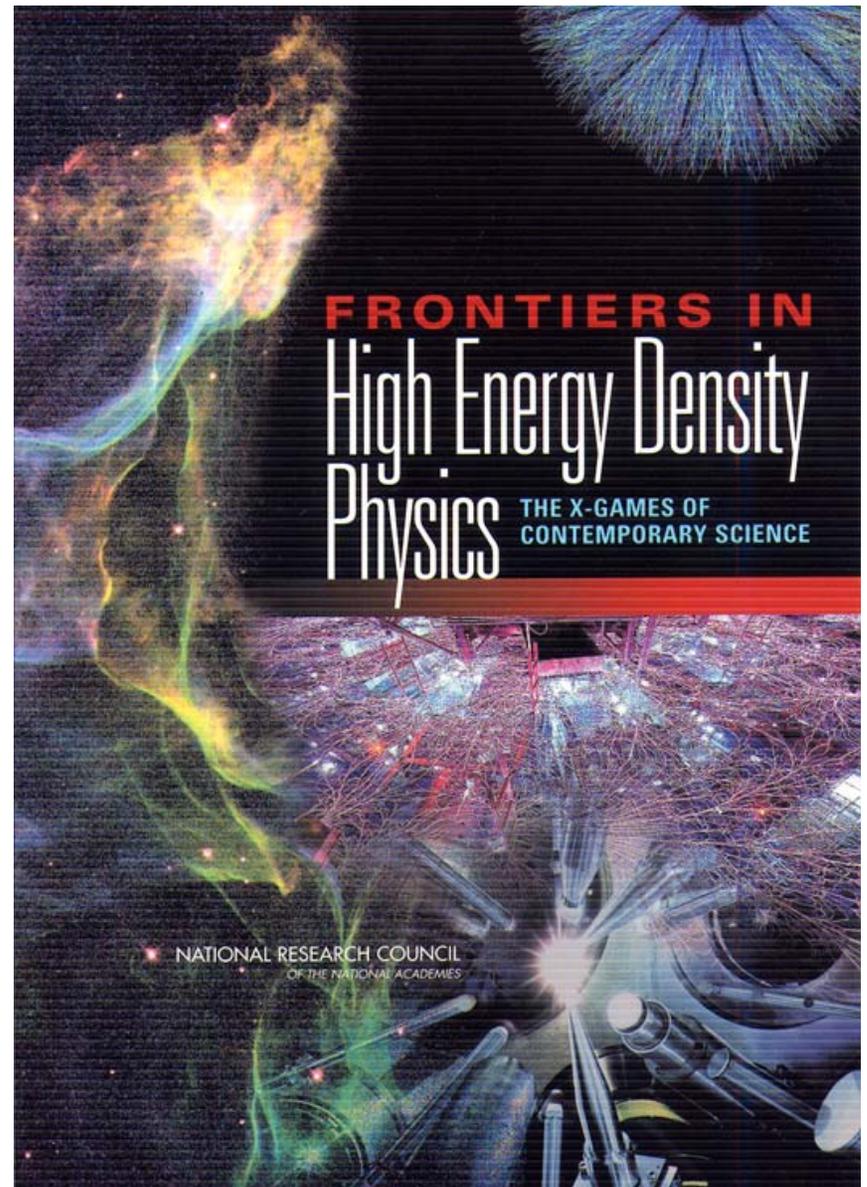
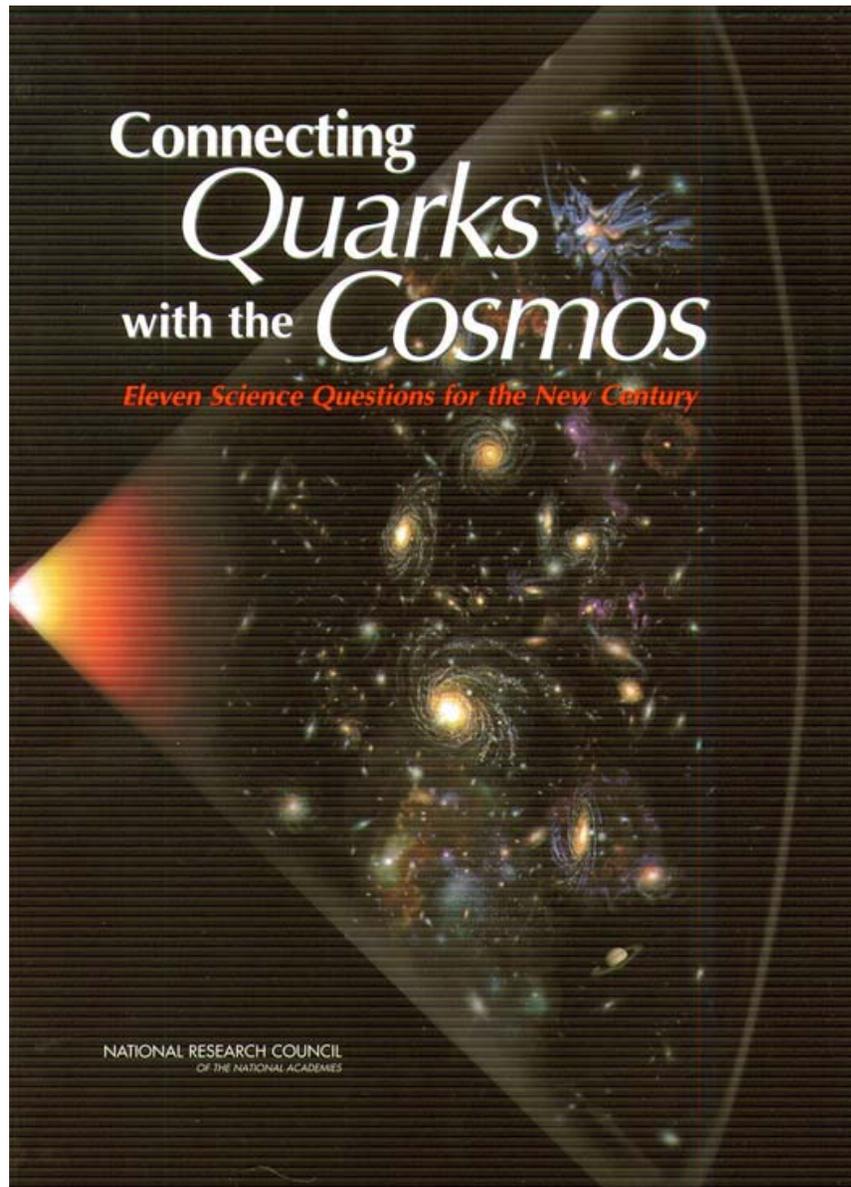
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Can DOE establish a better strategy for developing materials for use in a harsh radiation environment?

- o Led by BES, including OFES and NE
- o ORNL is organizing a Fission-Fusion International Workshop for the Spring 2004 to address this question and develop a roadmap
- o Objective is to determine if the combination of advances in high-end computing with existing (i.e. fission reactors) and near term (i.e. spallation neutron source) facilities, can lead to development of reliable and experimentally validated modeling and simulation tools for the design and performance of advanced nuclear materials
- o This workshop will bring together an outstanding group of both domestic and foreign material and modeling/computing experts. Many experts will be from outside of the world's fusion community

# *National Research Council Reports*

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## *High Energy Density Physics (HEDP)*

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- o Two NRC studies (Turner's "Connecting Quarks with the Cosmos", Davidson's "Frontiers in High Energy Density Physics") urge a national, multi-agency program in HEDP
  - An emerging field amenable to laboratory studies relevant to interpreting astrophysical observations and other applications of national importance
- o NSF is leading an interagency working group to develop a science driven roadmap for a balanced, comprehensive program in HEDP
- o NNSA plans to construct two high-energy petawatt (HEPW) lasers at Omega, and seeking to implement HEPW capabilities at Z and NIF without impacting the NIF schedule
- o DOE and NSF are called upon to strengthen the university activities in the HEDP field

## *FESAC Charge on Workforce Development*

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- o OFES has long-standing interest in education and training of scientists and engineers needed to support program goals
- o Situational Analysis
  - Aging workforce
  - Steady number of graduates enrollment in fusion science
  - Decreasing number of graduates in fusion technology
  - U.S. participation in ITER
  - Working toward fusion electricity in latter part of 21st Century
- o Key Issues
  - Current workforce status (age, skills mix, skill level)
  - Workforce needs
  - Suggestions for ensuring needed workforce (within control of OFES)
- o Report due January 1, 2004

## *FESAC Charge on Inertial Fusion Energy*

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- o “Carry out a review to assess status of IFE program”
- o Both SC and Defense Programs support this review
- o Topics to be addressed
  - Status and quality of science and technology for each IFE approach
  - Science issues for each approach and how they contribute to the long-range potential of IFE
  - Impact that fast ignition may have on IFE
  - Potential contribution of IFE program elements to the field of High Energy Density Physics
- o Approaches to be considered
  - Heavy ion beam drivers
  - Laser drivers
  - “Z”
- o Final report by “early 2004”

## *Committee of Visitors*

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- o Modeled on the NSF approach and prototyped by BES for SC
- o Plan to use FESAC Panels
- o All Program Areas to be reviewed over 3 year period
  - Theory and Computation (FY 2004)
  - Confinement Innovation and Basic Plasmas Science (FY 2005)
  - Tokamak Research and Enabling Technologies (FY 2006)

## *Committee of Visitors* (continued)

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- o Bill Nevins from LLNL will Chair
- o Scope of the Panel's work
  - Work with OFES to establish COV procedures and processes
  - Assess efficiency and quality of processes used to
    - Solicit, review, document proposal actions
    - Establish consistency of award decisions with respect to program goals
    - Monitor projects and programs
  - Comment on how awards process has affected
    - Breadth, quality and balance of portfolio
    - National and international standing of program elements
- o Schedule
  - November 13-14 meet at DOE/OFES offices
  - Preliminary Briefing to FESAC on November 18
  - Panel report by mid-December

## *Possible Statement of Work for NRC Decadal Study*

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1. Assess the progress and achievements of plasma science over the past decade.
2. Identify the new opportunities and the compelling science questions for plasma science, frame the outlook for the future, and place the field in the context of physics as a whole.
3. Evaluate opportunities and challenges for the applications of plasma science to fusion and other fields.
4. Offer guidance to the government research programs and the scientific communities aimed at realizing these opportunities and challenges.

# **We Need Help!!!!**

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Are you or somebody you  
know willing to come to the  
Office of Fusion Energy  
Sciences as an IPA  
appointment for 1-2 years?