



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

Fusion Energy Sciences Program Update

**Fusion Energy Sciences Advisory Committee
Gaithersburg, MD
October 23-24, 2007**

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Topics

- Budget status
- ITER
- NCSX
- HEDLP Joint Program
- Issues and Plans

Note: Thank You to all who worked so hard on the three reports presented at this meeting!



FY 2008 Fusion Energy Sciences Congressional Budget Request

	(\$ Millions)		
	FY 2006	FY 2007	FY 2008
	<u>Actual</u>	<u>Sept AFP</u>	<u>CONG</u>
Science	148.7	144.6	159.6
Facility Operations	104.2	146.3	247.5
Enabling R&D	<u>27.8</u>	<u>20.8</u>	<u>20.8</u>
OFES Total	280.7	311.7	427.9
DIII-D	55.1	56.7	59.7
C-Mod	21.5	22.3	23.5
NSTX	34.2	33.5	36.1
NCSX	17.8	16.6	16.6
ITER	24.6	60.0	160.0
Non-ITER	256.1	251.7	267.9





FY 2008 Appropriations

- **House Mark**

- The Committee recommendation for fusion energy sciences is \$427,850,000, the same as the budget request, and reflecting the \$100,000,000 growth in the budget for ITER.
- The Committee does not support funding for a new program in High Energy Density Physics (HEDP) and provides no funds for this research area. (Resources for HEDP should be redirected to other programs).
- The Committee notes that major growth in support for ITER ... is affecting the overall funding picture for Fusion Energy Sciences and for the Office of Science as a whole. When direct funding for ITER is excluded, Fusion Energy Sciences increases by just 3.8 percent and the increase requested for the Office of Science, while still large, is 13.4 percent rather than 15.8 percent. If delays in ITER associated with international cooperation reduce the amount that can be spent on ITER in fiscal year 2008, the Committee directs the Office of Fusion Energy Sciences to invest the funds made available in Theory, materials research within Enabling R&D, Alternative Concept Experimental Research and operating time at the three U.S. user facilities rather than retaining the money for ITER and carrying it over to future fiscal years.

- **Senate Mark**

- Committee recommends \$427,850,000.
- High Energy Density Plasma Laboratory Program- The Committee is pleased that the Department has developed a multidisciplinary research program, which this Committee has been an advocate for the past several years. The Committee believes this program will provide greater interaction between the Office of Science researchers and the NNSA scientists and provide greater access to user facilities such as the Z machine, NIF and Omega. ...The Committee encourages the Department to increase their investment in this modest program to ensure its future success. The Committee supports the budget request of \$12,281,000 for the Office of Science. The Committee notes a similar amount has been included in the NNSA program.





FY2008 CR

- The Department is operating under a Continuing Resolution
 - CR in effect until November 16 unless Appropriations bill is passed sooner
 - “Standard” CR, i.e. no new starts, funding at FY 2007 level, etc.
- We have no info (or guesses!) on future FY 2008 funding expectations
- OFES expects no real impact on the program unless CR beyond March 1 is needed



ITER Status: Ratification Due

- Step 1 All ITER Parties have completed their process for final approval and acceptance of the ITER Agreement and have deposited their instruments of acceptance with the IAEA
- Step 2 Ratification scheduled for October 24, 2007 (a date created by a 30-day window following the last party's completion of the deposit of acceptance). **ITER Organization becomes legal entity.**
- Step 2b The U.S. will fulfill commitment for Privileges and Immunities through the International Organization Immunities Act Designation, which is well underway at the Department of State; anticipated for completion on or around October 24. All other Parties completed this commitment through their ITER Agreement process
- Step 3 Conduct First Formal Meeting of the ITER Council
- Advance tough issues
 - Finalize documentation under ITER Agreement
 - Begin planning for Spring Council Milestones/Decisions





ITER Design Review Activities

- ITER Organization's Design Review concluded by November 2007; U.S. views:
 - Result will be a “reference design” which will serve as the basis for much further work
 - Many Design Change Requests still under development to resolve key design issues in 2008
 - ITER Council will require a comprehensive baseline design and Integrated Project Schedule (with cost impacts) by mid-2008. This will be difficult – lots of work remains
 - Many thanks to USBPO, VLT, USIPO for guiding U.S. help in this!
- U.S. ITER Project is focused on helping complete the designs for US-supplied hardware as quickly as possible.
 - We are also providing ITER Organization with project management support





ITER - What's Coming Next?

- Numerous project management and technical meetings to be attended by OFES, USIPO and fusion community participants
- Numerous schedule-related workshops to be attended by USIPO WBs managers, in various areas of focus, including:
 - Machine Assembly
 - Magnets
 - Heating and Cooling Systems
 - Vacuum
 - Buildings
 - And more...
- Week of November 5, 2007
 - STAC November 5-7 – Cadarache
 - US representatives: Goldston, Milora, Taylor, Van Dam, Oktay
 - MAC November 7-8 – Cadarache (Bob Iotti, Chair, CH2MHill/DOE Idaho)
 - Chair: Iotti
 - US representatives: Baker, Hawryluk, Hoy, Sauthoff, (Moses)
 - CP November 9-10
 - US representatives: Harding, Vanek, Fonck, Hoy, Stevens, Glowienka
- November 27-28, 2007 – First formal ITER Council meeting
 - Advance tough issues (Baseline Design, Schedule, Cost & Impacts)
 - Finalize documentation under ITER Agreement
 - Begin planning for Spring Council Decisions
 - Representatives: Orbach, Harding, Fonck, Rottier (State Dept.)



National Compact Stellarator Experiment

- The science of plasma confinement with deep magnetic symmetry
 - Physics simplicity paid for with mechanical complexity
 - Stellarators solve critical problems for magnetic fusion
 - *Steady state without current drive*
 - *Stable without feedback control; No disruptions*
 - *Compact Stellarator: tokamak comparison, and may offer better economy*
- MIE funding problem
 - Projecting >\$40M, 2+year overruns
 - Fabrication, assembly costs underestimated
 - *Formidable technical challenges*
- Large overruns require re-evaluation
 - Impact on FES program, and SC





NCSX History

- In 2001, the Fusion Energy Sciences Advisory Committee (FESAC) endorsed NCSX “proof of principle” concept.
- Critical Decision (CD) 0, Approve Mission Need, was approved by OFES in May 2001.
- CD-1, Approve Alternative Selection and Cost Range, was approved in November 2002.
- CD-2, Approve Performance Baseline, was approved in February 2004, with a TEC of \$86.3 million and a completion date in May 2008.
- CD-3, Approve Start of Construction, was approved in September 2004, with a TEC of \$86.3 million and a completion date in May 2008.
- In response to budgetary constraints, OFES modified the funding profile and a new baseline was developed and approved by the Deputy Secretary in July 2005, establishing a TEC of \$92.4 million and a completion date of July 2009.
- Bottoms-up plan requested for December SC (Lehman) 2006 review. ~April 2007: uncovered considerably more work due for fabrication and assembly.





NCSX Decision Process

- Due process for decision on future direction
 - SC (Lehman Review) believes new proposed baseline is credible.
 - FESAC conducting scientific/programmatic review (this meeting)
 - External technical review of design-to-date due early Nov. 2007
 - OFES/SC will recommend either to re-baseline or cancel NCSX
 - Office of Engineering and Construction Management will conduct an External Independent Review if SC re-baselines.
- Re-baselining or cancellation decision impacts FY 2009 and later

TPC Funding (\$M)

	Prior FY	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	TOTAL
Current Baseline	\$50.9	\$17.0	\$15.9	\$15.9	\$2.3			\$102.0
Proposed Baseline	\$50.9	\$17.0	\$15.8	\$15.9	\$18.6	\$17.0	\$6.8	\$142.0*

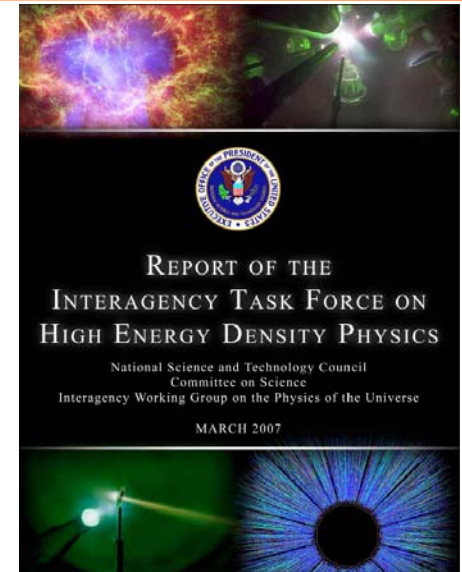
*Scope which was removed earlier may now be put back. This will increase TPC.





HEDLP Update

- Report of the interagency Task Force on HEDP has been released.
 - First International Conference in HEDP: with APS April Meeting 2008 in St. Louis, MO
- Increasing international interest in inertial fusion and ignition physics, and facilities for fast ignition
 - OMEGA EP (30 kJ long/5 kJ short)
 - FIREX-1 (10 kJ/10 kJ)
 - HiPER 3-year design phase (200 kJ/70 kJ)
 - An International Fast Ignition Committee (IFIC) formed to coordinate international research in fast ignition.
- Next step: FESAC charge to help map near- and mid-term program
 - MOU between OFES and NNSA is being drafted for use of FESAC as FACA advisory inputs for the Joint Program



Four Research Categories

- High energy density astrophysics
- High energy density NP
- **High energy density laboratory plasmas**
- Ultra-intense ultra-fast science





Magnetic Fusion Energy Sciences Program Evolving to New Phase

- Entering a time of transition to the ITER/Burning Plasma Era
 - Past decade: consolidation & redirection, with excellent scientific progress
 - Next decade: to a major step(s) in state-of-the-art in fusion science?
- Must start addressing growing issues in the program
 - What should the domestic program look like?
 - How can we capture a qualitatively new level of sciences in the domestic program?
 - What are the compelling science and technology issues?
 - What are the opportunities in which the US can take a world leadership role?
 - What must we do to effectively steward plasma physics and HEDLP?
- What are elements of a 5, 10, and 20-year strategic plan?
 - MFE driven by mission-related science needs
 - Plasma sciences must be more generally defined
- Looking forward to opportunities/gaps subpanel discussions ...
- Need to define a dynamic evolution in research and facilities





Directions for Next 5 Years

- Support ITER construction and organization development
 - Support burning plasma physics and engineering to prepare for ITER experiments
- Accelerate development of fusion energy sciences towards world leadership in most promising thrust areas during the ITER era
 - Initiate program(s) to provide world-class domestic facilities
 - Establish coordinated computation, theory and experimental campaigns to develop integrated simulation capabilities
 - Expand focus to confront new challenges in the burning plasma environment
 - Develop and integrate emerging ideas for improving fusion concepts
- Strengthen stewardship of plasma science and high energy density laboratory plasmas (HEDLP)
 - Provide focus area of Federal support for basic and mission-oriented plasma sciences
 - Support evolution of HEDLP through period of ignition science; plot course for increasing emphasis on IFES after NIF ignition demonstration
- Need to examine distribution of resources for each element



Issues for the Next 5 Years

- Chronic/Existing Issues
 - Using and upgrading major facilities
 - Support of fundamental theory program
 - Restoration of engineering science and materials to adequate levels
 - Support for plasma physics and HEDLP / Inertial Fusion Energy Sciences
 - Support for diagnostic development
 - Inflation and the cost of doing business
 - Workforce demographics
 - Support for International Collaborations
- Capturing Opportunities => New Initiatives/Issues
 - Low-temperature plasma physics (NRC Plasma 2010)
 - Design next-step facility(ies) in the US
 - Fusion Simulation Project
 - Momentum towards IFES/HEDLP from NIF campaign
 - ITER Research Program and Upgrades
 - *E.g., Test Blanket Module (TBM) program for ITER*



OFES Internal Planning 5 Year Budget Plan at Time of FY 2008 Congressional Budget Request

	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
	Sept AFP	CONG				
ITER TPC	60,000	160,000	214,500	209,321	181,964	130,000
NCSX MIE	15,900	15,900	2,264			
All Other	243,050	251,950	270,768	286,927	297,948	310,933
FES Total	318,950	427,850	487,532	496,248	479,912	440,933

- Baseline guidance: ITER construction + ~constant \$ Research and Ops
 - Need strong case for any addition...
 - Show added value to program goals
- Not corrected for NCSX variations, but envelope ~fixed
 - *Beginning in FY 2010 NCSX was to run only on odd years and NSTX only on even years.
- Identify and address pressing needs within this envelope





There is Urgency to Develop 5-20 year Vision and Plan

- Planning is an evolving process; never complete
- But, need general plan for budget planning soon
 - Near-term for budget process; can have ambiguities
 - Longer-term to set program directions more firmly
- OFES: internal 10-year planning exercise
 - Work off wealth of community studies (e.g., latest FESAC studies)
 - Pursue contributions from research community members
 - Consider white-papers, short-term workshop(s) if needed
- Merge and develop as more extensive community discussion evolves
 - Workshops as needed
 - FESAC subpanel studies

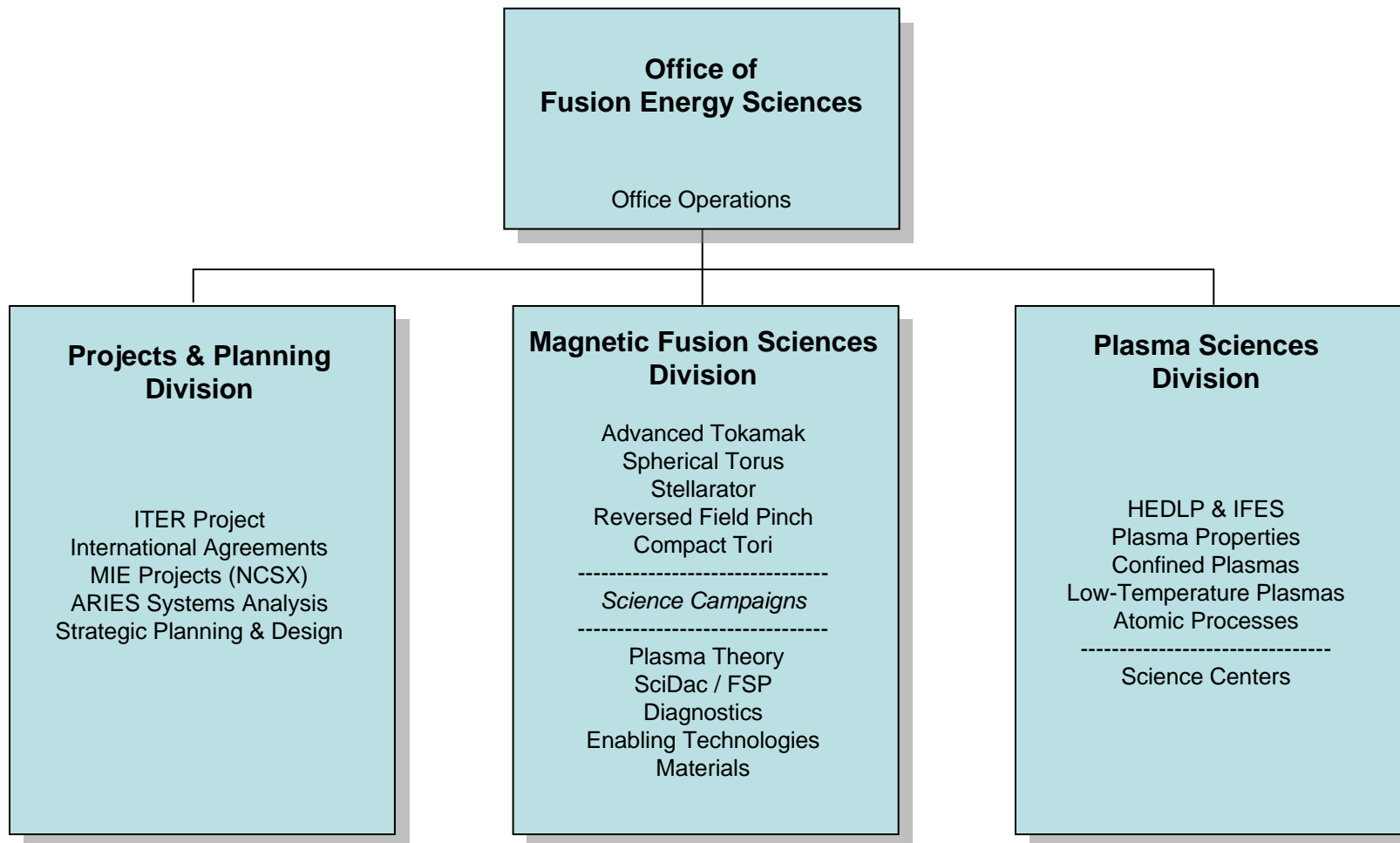


Some Needed Planning Activities...

- Identify scientific challenges and opportunities
 - Develop prioritized list of compelling initiatives
- Possible workshop topics and/or charge areas for FESAC
 - HEDLP & IFES (w/NNSA)
 - *Next 10 years: before and after NIF ignition campaign*
 - Alternate investigations in MFES
 - *Role in ITER era*
 - Plasma Sciences
 - *NRC Plasma 2010 follow-up*
 - Fusion materials and engineering sciences
 - *Framing underlying scientific issues and technical challenges*
 - Next major domestic initiative or facility
- Long term
 - Consolidation and distribution into an integrated program plan
- Other issues coming up
 - Targeted follow-up to Opportunities
 - Governance of national facilities
 - Integration of Universities in national programs
 - *FESAC or UFA...*



Draft, Conceptual OFES Organization



- Organize via concepts/topical areas rather than specific facilities
- Cross-cut with coordinated campaigns on identified priority issues





OFES Staffing Plans

- General needs independent of changes to organizational structure
- FY 2007:
 - Recruited a Physical Scientist and an Admin Support person to OFES
- FY 2008: (pending CR end)
 - Fill division head positions (2/3)
 - Recruit three technical staff members and one program assistant to OFES
 - Recruit one technical staff member and one program assistant to DOE ITER Project Office at Oak Ridge



FESAC Membership

- Generally expect to turn over 1/3 membership every two-year cycle
 - Term up to six years max
- Need to expand representation in FESAC
 - HEDLP joint program
 - Stewardship of Plasma Science
- Planning to start transition of FESAC membership
 - Starting process to find new members
 - Coordinating with FESAC Chair
 - Welcoming suggestions and nominations



Summary

- Waiting for info on budget and CR
- ITER is becoming a real, legal entity
 - Design review process making progress, but challenges...
- NCSX resolution due soon
- Program and OFES structure under consideration
- Multi-tiered planning process needed
 - Address increasing demands on budget
 - To coordinate with FESAC
 - Short-term and long-term