



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

**Fusion Energy Sciences
Program Update**

**Fusion Energy Sciences Advisory Committee
Gaithersburg, MD
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FY2009: Fusion Program Request Overview

- **ITER budget recovers to full funding**
- **Major facilities operations and research reduced**
 - Use large increases in FY 2008 to optimize utilization across two years
- **Some facility changes**
 - SSPX, QPS terminated
 - NCSX MIE continues, assuming successful rebaselining
- **Modest new initiatives**
 - Fusion Simulation Project started
 - Strategic Planning activity for long-term initiatives
 - Significant increase for joint program in HEDLP



Fusion Sciences Program is Confronting Significant Issues

- **FY2008 Budget and implications**
- **Support for ITER and the burning plasma program**
 - Integration of program vision
- **NCSX overruns and implications**
- **Lack of strategic plan to guide decisions**
- **Addressing most issues in a flat-budget climate, at best**
 - Distribution for mission elements
 - Multi-year planning, despite single-year funding
- **Personnel support at OFES**



FY 2009 Fusion Energy Sciences Congressional Budget Request Summary

***“Traditional” (WRONG)
Presentation:***

(\$ Millions)

	FY 2007 <u>Actual</u>	FY 2008 <u>Jan AFP</u>	FY 2009 <u>CONG</u>
Science	144.6	163.9	168.4
Facility Operations	146.3	100.8	301.9
Enabling R&D	<u>20.8</u>	<u>21.8</u>	<u>22.7</u>
OFES Total	311.7	286.5	493.1
DIII-D	56.7	61.7	58.1
C-Mod	22.3	25.1	23.2
NSTX	35.5	38.8	35.4
NCSX	16.6	16.6	20.3
ITER IPC	60.0	10.6	214.5
Non-ITER	251.7	275.9	278.6

***We all perpetuate the image of ITER being separate from the rest of the program;
need to change how we talk, even amongst ourselves!***



FY 2009 Fusion Energy Sciences Congressional Budget Request Summary

More Integrated Approach:

(\$ Millions)

	FY 2007 <u>Actual</u>	FY 2008 <u>CONG</u>	FY 2008 <u>Jan AFP</u>	FY 2009 <u>CONG</u>
Science	144.6	159.5	163.9	168.4
Facility Operations	146.3	247.5	100.8	301.9
Enabling R&D	<u>20.8</u>	<u>20.8</u>	<u>21.8</u>	<u>22.7</u>
OFES Total	311.7	427.8	286.5	493.1

Research:

Burning Plasma/Tokamak	85.7	89.7	93.8	88.1
Alternate Toroidal Configs	52.7	55.7	57.7	50.1
Plasma Science	28.7	25.6	29.5	38.4

MIE Projects:

ITER MIE	60.0	160.0	10.6	214.5
NCSX MIE	15.9	15.9	15.9	19.6



FY2009 Request: ITER Recovery Assumes Full Funding

- **FY 2008: U.S. ITER Project in survival mode**
 - Maintain minimal core team
 - Defer/curtail: cash contributions; design; R&D; hardware procurements
- **FY 2009: Full funding requested to fulfill commitments**
 - Pay cash contributions for FY2008 and FY2009
 - Reconstitute matrix of support FTE's
 - Resume design, R&D, and procurement activities
- **ITER cost and schedule under assessment**
 - CD-1 cost range (\$1.45 – 2.2B) approved December 2007
 - CD-2 (Performance Baseline) in FY2009 – 2010
- **Test Blanket Module decision due Spring 2008**
 - No ITER Project funding until construction of ITER is assured



Fusion Energy Sciences FY 2009 Congressional Budget Request Detail

(\$ in thousands)	FY 2007	FY 2008	FY 2009		FY 2007	FY 2008	FY 2009
		Jan AFP	Cong			Jan AFP	Cong
Science				Enabling R&D			
DIII-D Research	24,531	27,060	26,249	Plasma Technologies (MFE)	13,531	13,391	13,351
C-MOD Research	8,267	9,600	9,030	Advanced Design (MFE)	2,544	2,600	4,573
International Collaborations	4,710	4,982	4,900	Materials Research (MFE)	4,679	5,800	4,791
Diagnostics	3,768	4,141	3,912				
Other	4,640	7,087	7,028	Total Enabling R&D	20,754	21,791	22,715
SBIR/STTR	0	7,417	7,282	Total Fusion Energy Sciences			
					311,664	286,548	493,050
Subtotal Tokamaks	45,916	60,287	58,401				
				<u>Recap</u>			
NSTX Research	14,608	16,730	16,163	DIII-D	56,669	61,660	58,060
Experimental Plasma Research	16,476	17,050	13,288	Alcator C-Mod	22,260	25,110	23,207
HEDLP	15,459	15,942	24,636	NSTX	33,525	38,830	35,437
MST Research	6,760	6,910	6,915				
NCSX Research	775	713	692	ITER Total MIE TPC (=TEC + OPC)	60,000	10,626	214,500
				NCSX MIE + Research	16,597	16,613	20,252
Subtotal Alternative Concepts	54,078	57,345	61,694				
Theory	23,732	24,486	24,283				
SciDAC	6,540	7,138	7,212				
Fusion Simulation Project	0	0	1,976				
General Plasma Science	14,306	14,648	14,869				
Total Science	144,572	163,904	168,435				
Facility Operations							
DIII-D	32,138	34,600	31,811				
Alcator C-Mod	13,993	15,510	14,177				
NSTX	18,917	22,100	19,274				
<i>Facility Ops times in weeks</i>	<i>13/15/13</i>	<i>18/15/15</i>	<i>10/11/11</i>				
NCSX MIE	15,822	15,900	19,560				
GPP/ GPE/ Other	5,468	2,117	2,578				
ITER MIE OPC	18,000	10,626	6,000				
ITER MIE TEC	42,000	0	208,500				
Total Facility Operations	146,338	100,853	301,900				



FY2009: Fusion Request Summary

- **ITER funding back on track**
 - CD-2 anticipated to define future profile
- **Major facility research and operations constrained**
 - Moderated by FY2008 increases
 - Coupled to NCSX/NSTX plan
- **Several modest starts for new initiatives**
 - FSP
 - Planning activities
 - HEDLP joint program with NNSA
- **Mainly status quo budget**
 - No major shifts, pending strategic planning developments



NCSX Cost Increases are a Burden on the Program

- **Significant cost & schedule increases**
 - Total Project Costs will be ~\$152M instead of \$102M with ~29 month delay in completion.
 - Many of the work packages have cost, or will cost, significantly more than the baseline estimates.
 - The cost of fabricating and assembling these complex, one of a kind components, to the stringent tolerances required was underestimated
 - Learning curve savings did not materialize as expected and costs remained higher than baseline estimates.
- **Implications are severe**
 - Credibility hit to the program as a whole
 - If we go forward, will need to eat the cost out of a ~ constant budget



NCSX Scientific/Programmatic Reviews

- **OFES and PPPL requested several reviews**
 - PPPL engineering assessment
 - SC Engineering (Lehman) review
 - PPPL external engineering assessment
 - FESAC science review
 - More to come...
- **FESAC review supported the science**
 - NCSX is the only U.S. device capable of examining the key stellarator issues in an integrated context.
 - Because of the quasi-symmetry and compactness of NCSX, it offers a similarity with tokamak science that is unmatched by any other stellarator.
 - Its resemblance to the tokamak should allow NCSX to illuminate several issues concerning symmetry and effects of symmetry-breaking on confinement.



Forces a Decision on Commitment to Stellarator Line of Research

- **NCSX offers potential for transformational science in the fusion program**
 - Inherently steady-state confinement system
 - Performance comparable to tokamak expected
 - Potential for robustness to disruptions; passive stability to internal/external modes
 - Broadens operational space for fusion
 - *E.g., high density operation with $\langle T \rangle$, alpha particle implications*
 - Mechanical complexity is a serious negative
- **Decision: request to bring NCSX into operation assuming present estimates reasonably hold**
 - Program has to move to the future
 - Implications on budget and planning, future directions for PPPL, etc.
- **Schedule for rebaselining request determined**
 - March - April: NCSX Integrated Team submits proposal for SC (Lehman) Review
 - May: Office of Engineering and Construction Management (OECM) External Independent Review (EIR)
 - June: Energy Systems Acquisition Advisory Board (ESAAB) review and decision



NCSX Continuation: Implications for NSTX

- **Paying for NCSX in a flat budget**
 - Completion and prep for Phase 3 research ops requires additional resources
 - Assume conclusion of the NSTX program in 2 years; can make case for a 3rd year of operation if funds materialize
- **NSTX Program Planning**
 - Importance of managing a smooth shutdown of facility
 - *Try to get max return for taxpayers*
 - OFES requested a plan to address the most critical ST science issues that can be carried out on NSTX during the next 2-3 years.
- **The U.S. is NOT abandoning its interests in the Spherical Torus**
 - Availability of comparable facility in MAST, with expected upgrades
 - Assuming pursuit of collaboration with MAST to address remaining issues
 - *OFES to facilitate collaborations as needs are defined*
 - Also exploit theory, computation, and smaller facilities (e.g., QUEST)



NSTX Priorities

- **Critical need to clearly specify unique scientific goals**
 - Complicated by ambiguity of long-term direction
 - ST community has responded very well in difficult circumstances
 - *NSTX team, NSTX PAC, ST Coordinating Committee*
- **Four areas of concentration proposed, in priority order:**
 - Increase and understand beam-driven current at lower n_e , v_*
 - *Next-step STs may require full NICD; low v_* yields increased CD*
 - Increase and understand H-mode confinement at low v_*
 - *Unique opportunity to examine electron confinement channel*
 - Demonstrate and understand non-inductive start-up and ramp-up
 - *Non-inductive ramp-up is necessary for an ST-CTF*
 - Sustain β_N and understand MHD near and above no-wall limit
 - *Operation near no-wall limit may be the baseline for next-generation ST*
- **High-risk, high-payoff approach taken for limited time window**
 - Density control via Lithium divertor
 - Add low-k turbulence diagnostic and enhance HHFW for $\langle T_e \rangle$



Overall Status of ITER

- **International**

- ITER Organization became a legal entity in October 2007 and 1st ITER Council meeting was held in November
- ITER Organization staffed to ~1/3 of full strength; employees are now under 5-year contracts
- ITER Council's S&T and Management Advisory Committees are operational and engaged. Financial Audit Board has been formed and will meet in March.
- Members' Domestic Agencies have all been formally established and are becoming operational (some faster than others)
- IO has just submitted the Preliminary Safety Report to the French regulatory authorities



Overall Status of ITER

- **International (continued)**

- Construction Site Preparations:
 - *Starting platform leveling*
 - *Excavation for Buildings to begin in early 2009*
- Design Review concluded, but there is urgent ongoing work to resolve a few key technical issues identified by STAC: ELM control, plasma vertical stability, disruption forces, which have implications for design of vacuum vessel, first wall, and poloidal field magnets.
- The first hardware Procurement Arrangements between IO and Domestic Agencies are being established.
- IO is developing a bottoms-up Integrated Project Schedule. Indications are that construction completion will slip to 2019 (including 1 year of contingency).



Overall Status of ITER

- **Domestic (US Contributions to ITER Project)**
 - FY 2008 Appropriation shortfall of ~\$150M has forced US ITER Project Office (USIPO) into survival mode with significant impacts:
 - *Cash contribution to IO deferred*
 - *Some matrixed staff at participating institutions reduced*
 - *All but highest priority design and R&D activities suspended*
 - *Long-lead procurements deferred (e.g., toroidal field magnet conductor material and fabrication, bulk steel for central solenoid magnet structure and fabrication)*
 - On the positive side, US will maintain support for its secondees at the IO, remain engaged in resolving the key technical issues identified by STAC, and participate in the activities of the ITER Council and its subsidiary bodies.

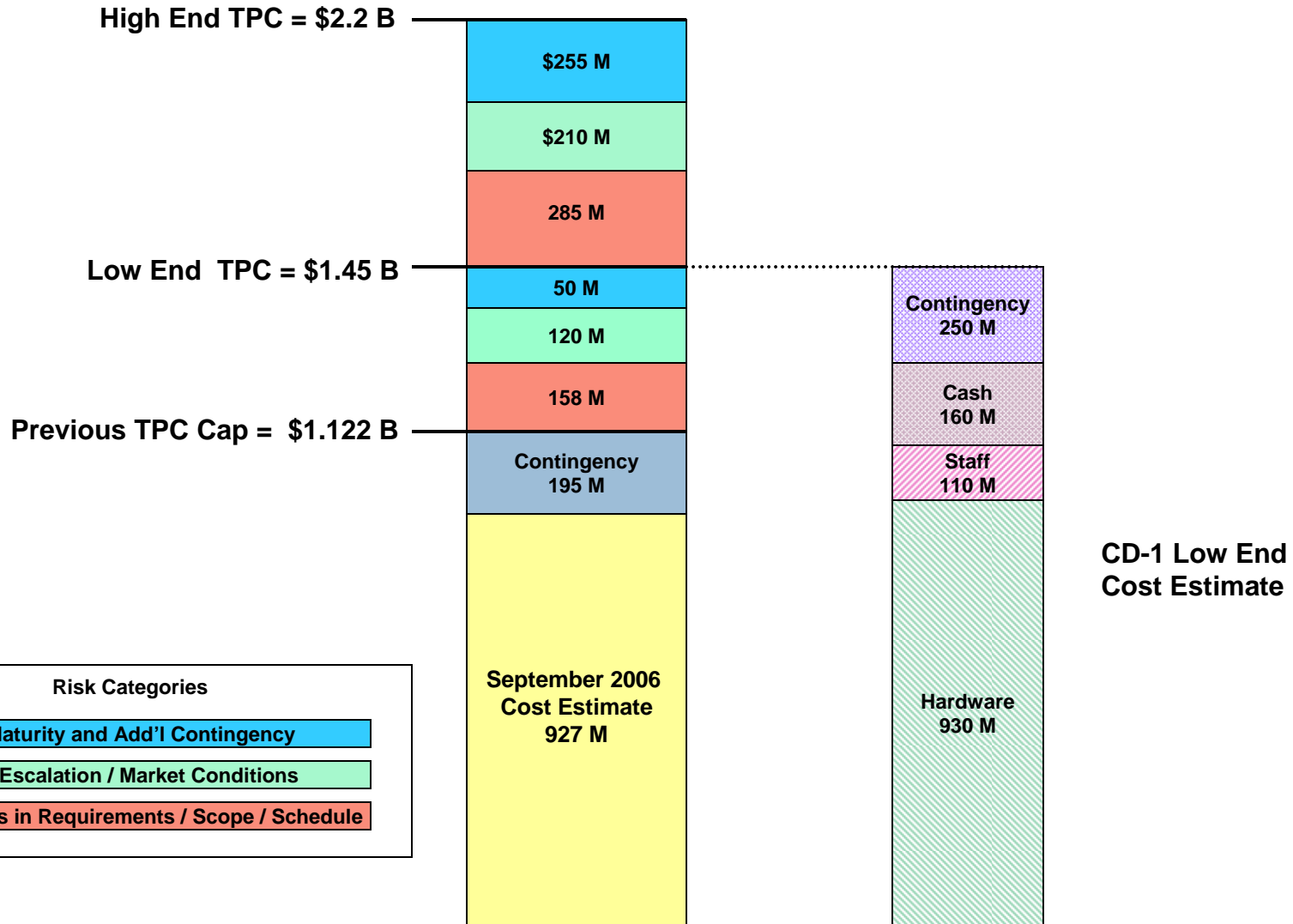


Overall Status of ITER

- **Domestic (continued)**
 - Achieved Critical Decision 1 (Approve Alternative Selection and Cost Range) in January 2008. Total Project Cost range set at \$1.45B - \$2.2B based on analysis of risks and present market environment. This range supercedes the previous OMB cap of \$1.122B.
 - Critical Decision 2 (Approve Performance Baseline) is projected to occur in FY 2009-10 depending on how soon the IO can establish their own baselines for the entire construction phase of ITER



CD-1 TPC Range for US ITER Project





ITER Test Blanket Module Program

- **ITER Organization has an ad-hoc planning group for TBM program**
 - Requesting all partners to declare their intentions for TBM participation by late March 2008
- **Our options are limited due to financial and planning constraints**
 - The U.S. does not plan to be 1 of the 3 TBM Port Masters, nor 1 of the 6 TBM Concept Leaders. For budgetary reasons, we will not lead any effort to design and build a TBM for installation on ITER.
 - The U.S. has agreed to pay its 9.1% share (< \$10M) of the added civil infrastructure costs to accommodate an ITER TBM Program.
 - The U.S. will not make further financial commitments for TBM involvement until ITER construction is more assured.
- **The U.S. is reserving the option to be a future collaborator in design, R&D, fabrication, and testing of one or more TBM concepts.**
 - Any future involvement and commitment by the U.S. will be consistent with ITER's to-be-developed TBM Program Plan, which is itself part of the ITER Research Plan. These Plans will be reviewed by STAC and MAC, and approved by the ITER Council.



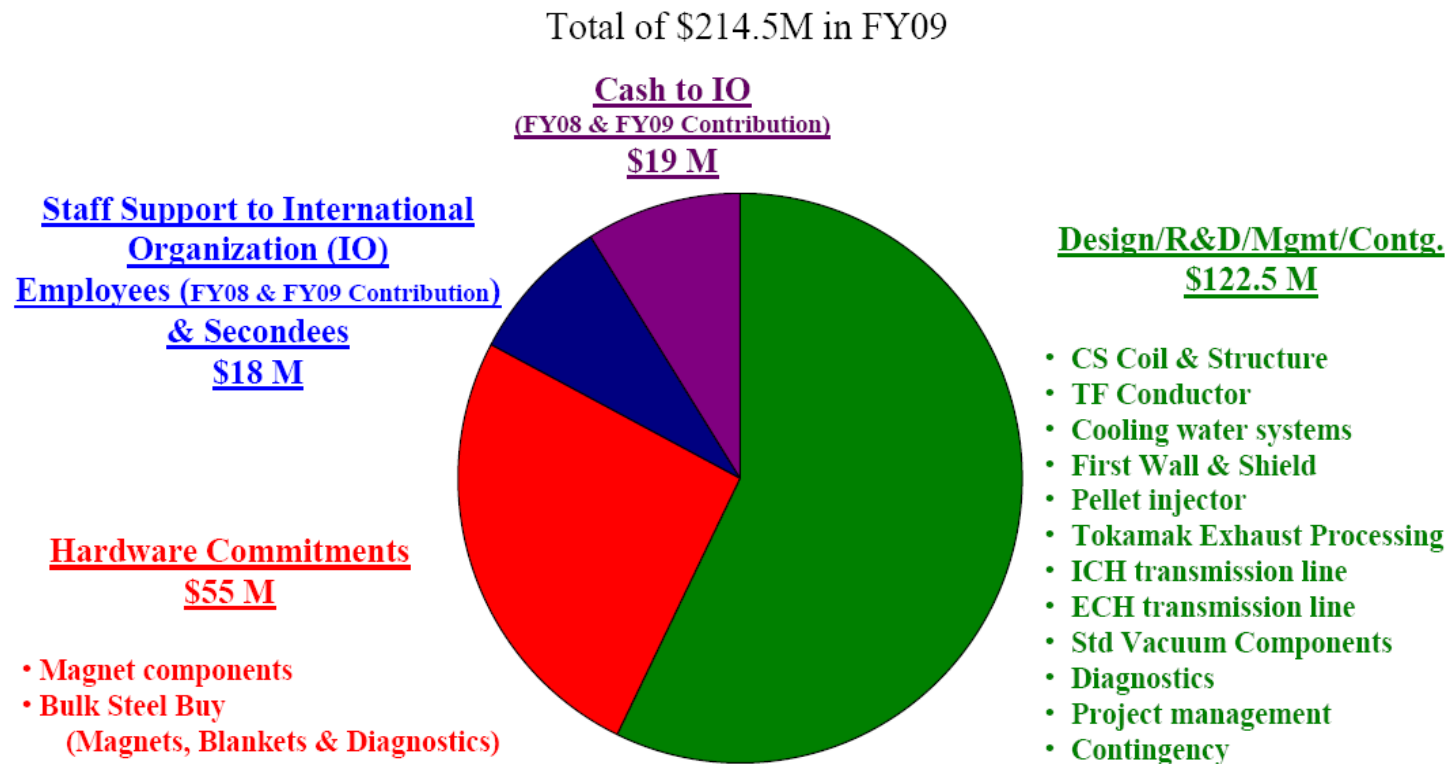
FY 2009 ITER Budget Request

- **President's FY 2009 Budget Request calls for \$214.5M**
 - Consistent with previous funding projections
 - Enables U.S. to meet 2008 – 09 cash commitments to the IO
 - USITER staffing will be reconstituted
 - Permits US design and R&D activities to move forward, and allows long-lead hardware procurements to be initiated



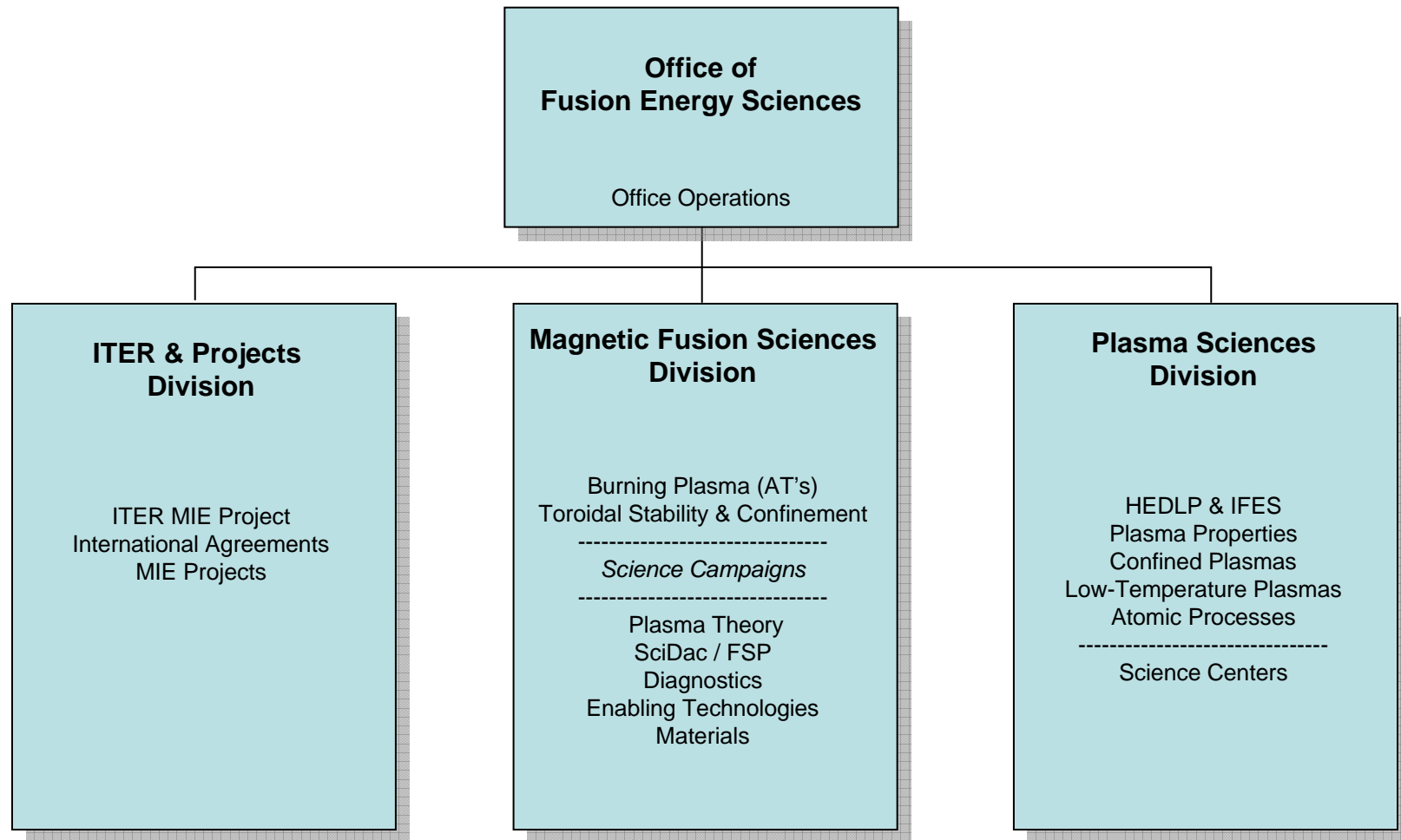
FY 2009 ITER Budget Request

- **President's FY 2009 Budget Request calls for \$214.5M**
 - Consistent with previous funding projections
 - Mostly recoups the ground lost in FY 2008



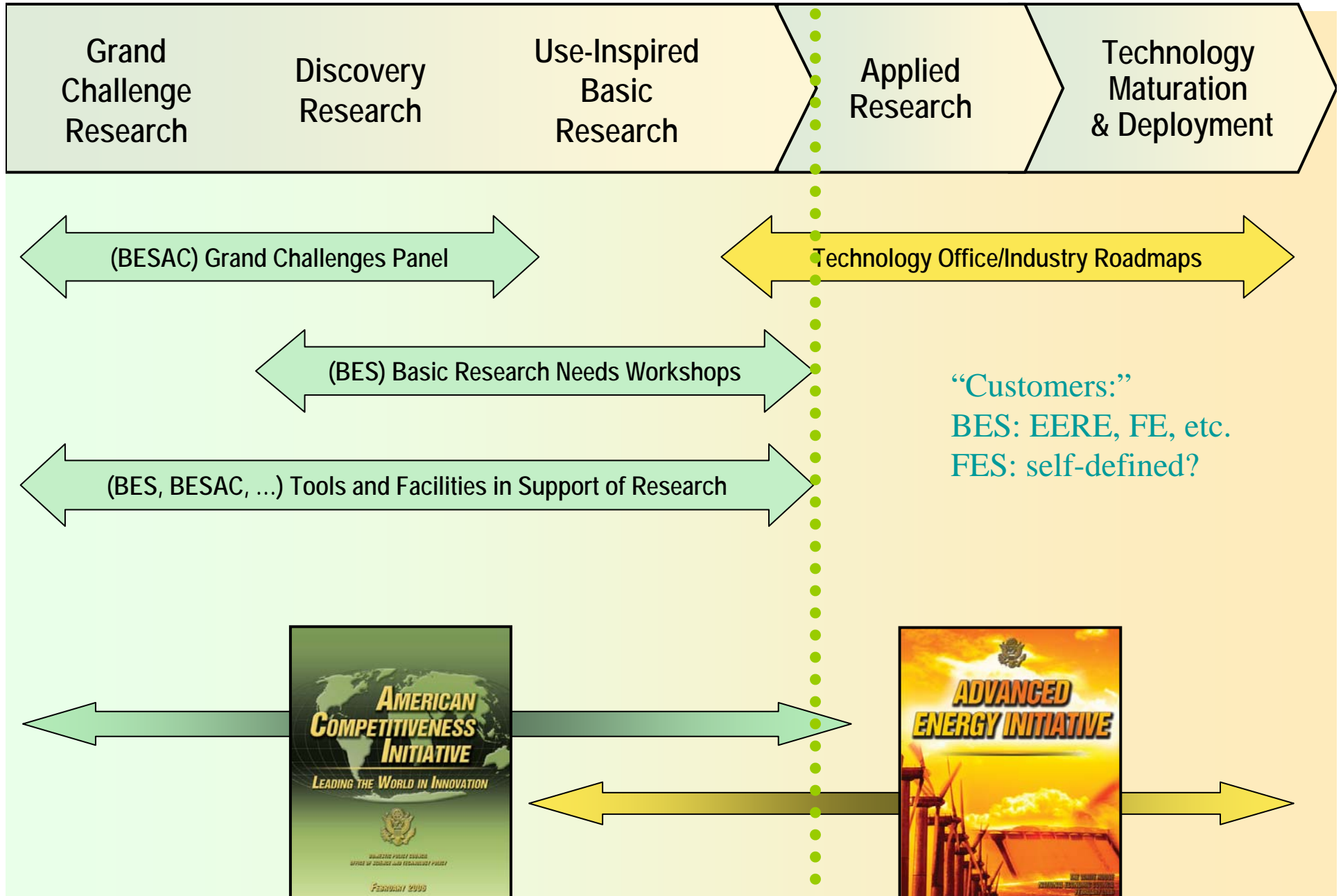


Draft, Conceptual OFES Organization



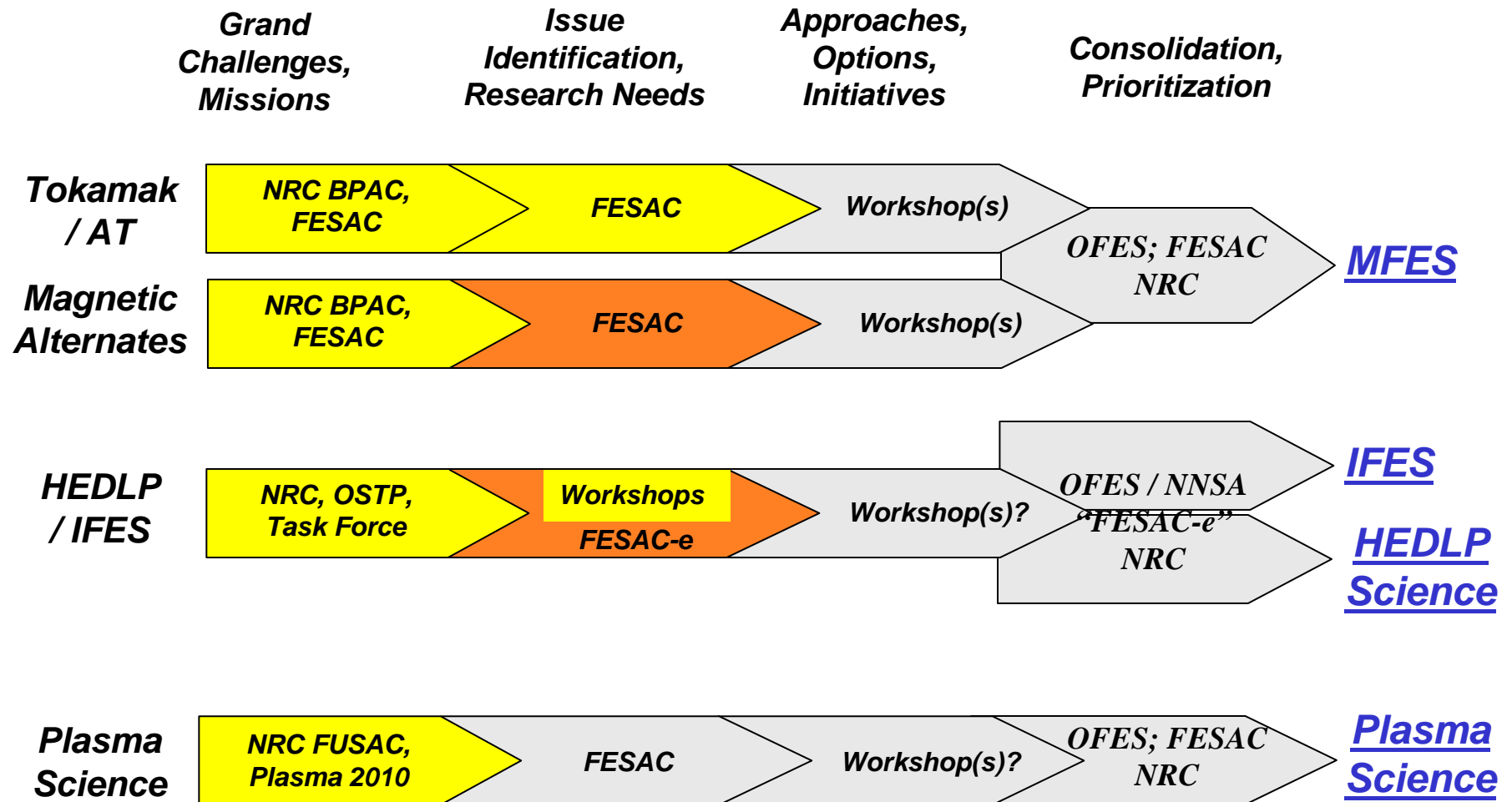
- Organize MFES Div as integrated toroidal confinement program
- ITER is the next major facility in the integrated march to the burning plasma regime
- Cross-cut with coordinated campaigns on identified priority issues

BES: Continuum of Research, Development, and Deployment





Planning for OFES Science Research Programs





Outreach and Communications

- **Need to improve our communications and outreach to sponsors, colleagues, etc.**
- **OFES working to improve communications activities**
 - Establish a crosscutting group (labs, universities, industry) to identify improvements for addressing the outreach and communications needs for the fusion program
 - *Composed of Public affairs professionals; technical support from research community*
 - Help develop a more integrated voice and consistent message about the fusion program, its priorities – present and future
 - Gain increased interest in, confidence of and support for the Fusion Energy Sciences program
- **Improved communications, presentations, web site, etc.**



OFES Staff Openings

- **The following openings will be advertised soon**
 - Management, Leadership Team
 - *Division Director for ITER & International Division (SES)*
 - *Division Director for MFE Sciences Division (SES)*
 - *Division Director for new Plasma Sciences Division (IPA)*
 - Technical Staff
 - *3 openings for physicists/engineers, etc.*
 - *Potential for a few IPAs*
 - Support Staff
 - *2 openings for program assistants*
- **Critically important that community helps us find good candidates to lead the program!**



Summary

- **We all need to work hard to encourage support for the FY2009 budget request**
 - We are way overdue for reframing our language to emphasize the integrated nature of the program!
- **The FY 2009 request puts FES on a positive trajectory**
 - Restores ITER as our burning plasma program facility
 - Constrained in ability to participate in TBM program for now
- **Research and ops funding continues to be tight**
 - The FY2009 request is mainly status quo, with hooks...
 - *Small wedges for future directions*
 - NCSX overruns force painful decision to wind down NSTX
 - *Important to bring to successful closure*
- **Need to continue dialog to develop robust plan for the ITER era - next few decades**