



U.S. DEPARTMENT OF
ENERGY

OFFICE OF
SCIENCE

***Fusion Energy Sciences:
Innovative Confinement Concepts Program***

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Fusion Energy Sciences (FES) Mission

Mission

- The FES mission is to expand the fundamental understanding of matter at very high temperatures and densities and to develop the scientific foundations needed to develop a fusion energy source. This is accomplished by studying plasmas and their interactions with their surroundings under a wide range of temperature and density, developing advanced diagnostics to make detailed measurements of their properties, and creating theoretical and computational models to resolve the essential physics.

Program Priorities

- Advance the fundamental science of magnetically confined plasmas to develop the predictive capability needed for a sustainable fusion energy source;
- Pursue scientific opportunities and grand challenges in high energy density plasma science to explore the feasibility of the inertial confinement approach as a fusion energy source, to better understand our universe, and to enhance national security and economic competitiveness;
- Support the development of the scientific understanding required to design and deploy the materials needed to support a burning plasma environment; and
- Increase the fundamental understanding of plasma science beyond burning plasmas to include low temperature plasma science and engineering, to enhance economic competitiveness, and to create opportunities for a broader range of science-based applications.



Long-term (10-year) goals for scientific advancement to which FES is committed and against which progress can be measured

- **Predictive Capability for Burning Plasmas:** Progress toward 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 toward demonstrating enhanced fundamental understanding of magnetic confinement and improved basis for future burning plasma experiments through research on magnetic confinement configuration optimization.
- **High Energy Density Plasma Physics:** Progress toward developing the fundamental understanding and predictability of high energy density plasma physics.

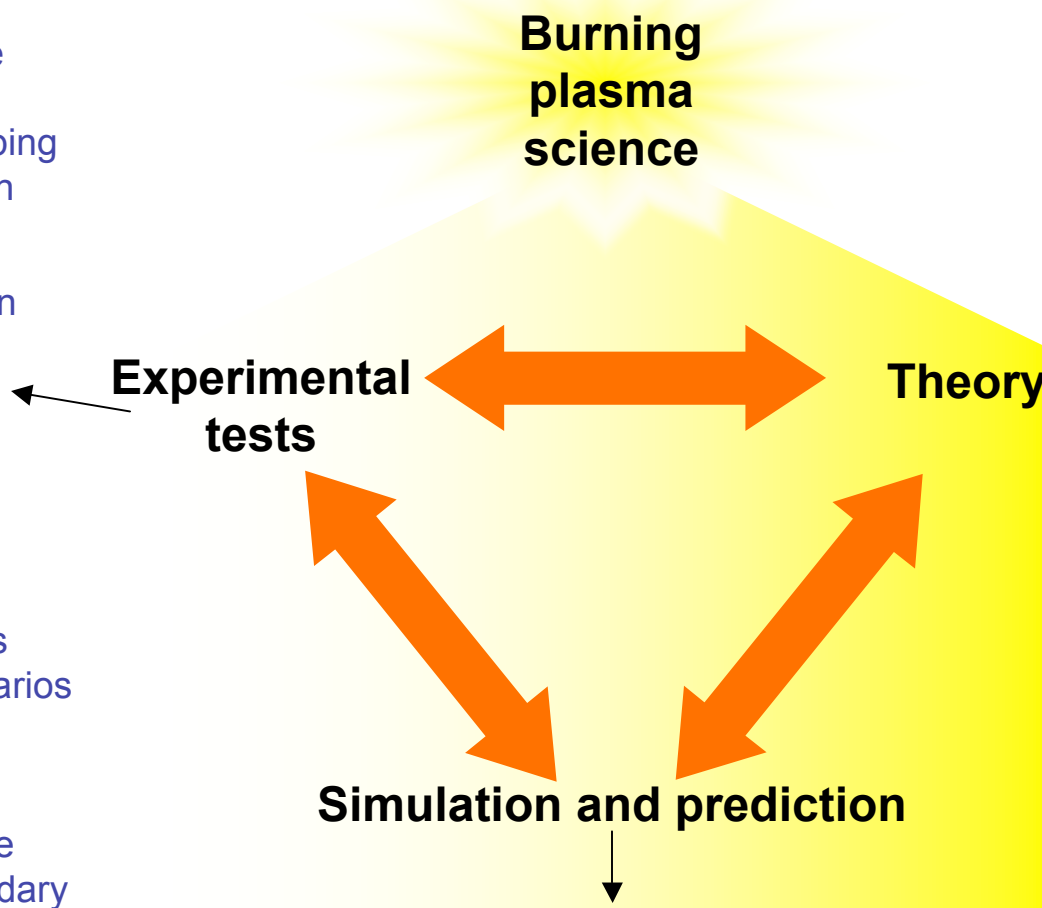
The ICC program supports two of the three FES Performance Measures.



The U.S. is a world leader in establishing the scientific basis for controlling burning plasmas

- U.S. facilities have complementary strengths in developing the science of fusion plasmas
- World leadership in detailed, controlled measurement of underlying plasma processes
- High impact on proposed burning plasma experiments and operating scenarios

Leading near-term goal: increase understanding of the physics of the boundary between the hot plasma and the first wall



- University and national laboratory
- Strong coupling with experiments
- Basis for massively parallel simulation

Leading near-term goal: Strengthen experimental validation of theories underpinning simulations

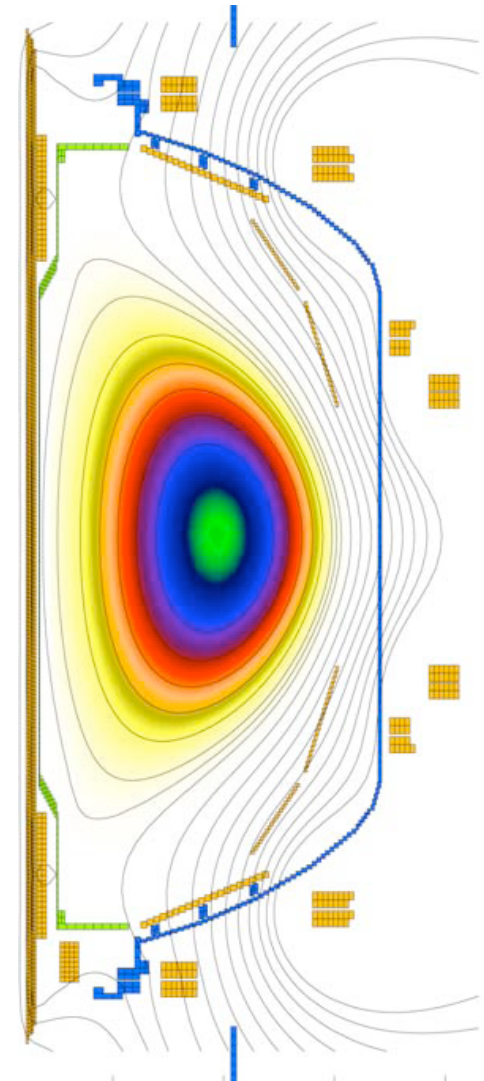
- A grand, multi-scale physics challenge
- Developing world leading simulation of burning plasmas

Leading near-term goal: initiation of multi-year Fusion Simulation Program



- **In magnetic fusion research, the Science subprogram addresses key science questions, such as:**
 - What are the physical processes that govern the behavior of plasmas, especially high temperature plasmas?
 - What limits the pressure in plasmas?
 - How do hot particles and plasma waves interact in the nonlinear regime?
 - What causes plasma transport?
 - How can high-temperature plasma and material surfaces co-exist?
 - How do you create, confine, heat, and control a burning plasma to make fusion power a reality?

- **A major goal of the *Science* subprogram is developing a predictive understanding of fusion plasmas in a range of plasma confinement configurations, and developing the basis for controlling the underlying processes.**

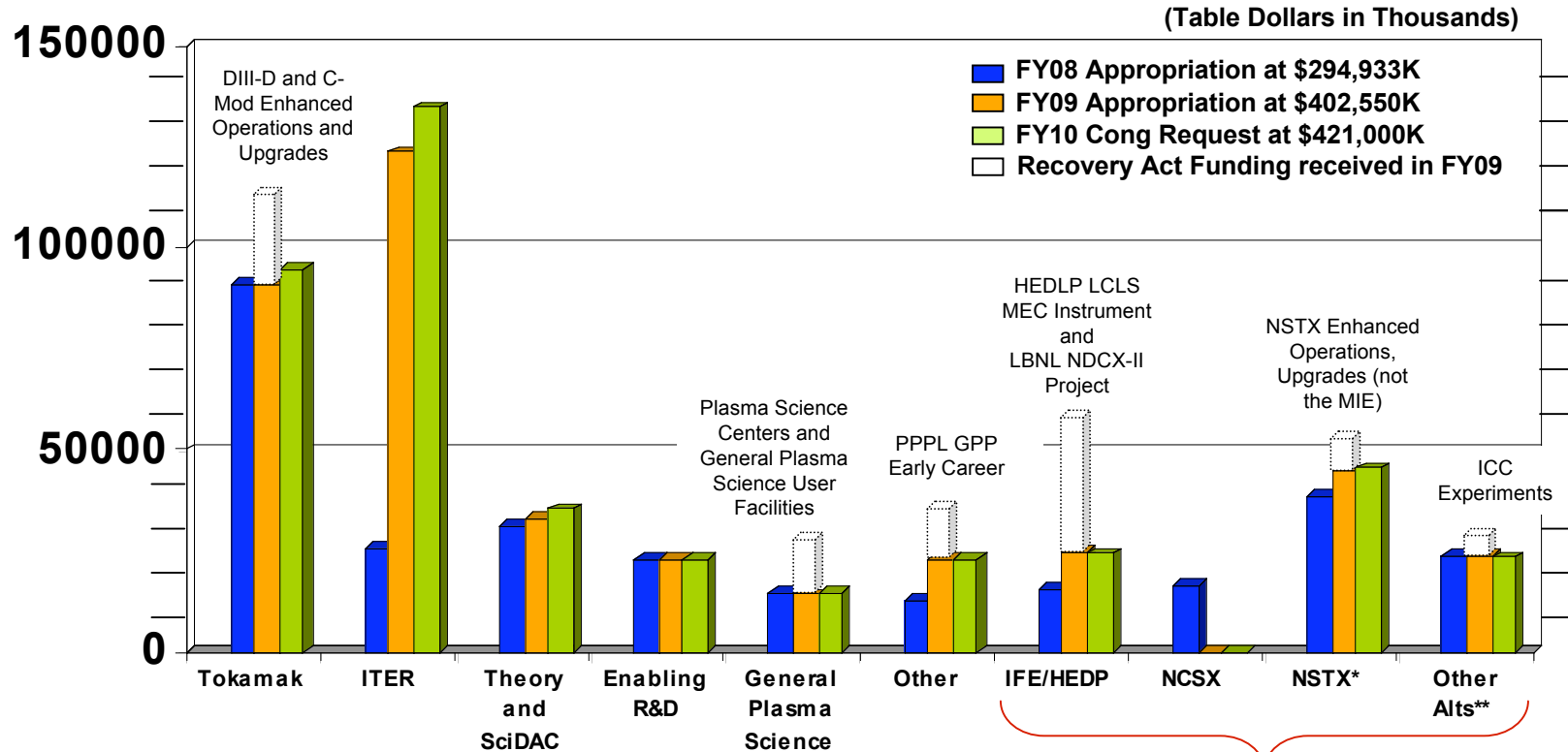




- **The National Spherical Torus Experiment (NSTX)**
- **The Madison Symmetric Torus (MST)**
- **The Concept Exploration (CE) Program of Magnetic ICCs, which consists of 26 projects including:**
 - Stellarator
 - Spheromak
 - Field Reversed Configuration
 - Spherical Torus
 - Open System
 - Resistive Wall Mode
 - Levitated Dipole
 - Z-Pinch
 - Inertial Electrostatic Confinement
 - Simulation Center



FES Budget Distribution



- FY09 Appropriations and the Recovery Act provided new opportunities
- FY10 Highlights:
 - Full funding for ITER
 - Increases continued for Fusion Simulation Program and NSTX Major Item of Equipment Upgrade
 - Increases provided for Facility Operations
- Planning – maximize resources in FY09 and FY10 to begin building a robust program to include support for initiatives, full support for ITER, and new activities (starting in FY11) as made possible through strategic and budgetary planning

Alternates

*Includes NSTX Upgrade

**Includes: Experimental Plasma Research and Madison Symmetric Torus



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EXPERIMENTAL PLASMA RESEARCH (ICC) BUDGET

FY 2009 Appropriation	16,975
FY 2010 Appropriation	16,765
FY 2011 President's Request	16,765

(\$ in thousands)



ARRA FUNDING FOR ICC PROJECTS

- All ICC projects and ICC-related HBCU projects (28 total) were invited to submit three- to five-page requests for supplemental funding in the Spring of 2009.
- Emphasis was on hardware improvements - such as diagnostics, heating systems, spectrometers, and data acquisition systems.
- The 23 requests received were subjected to an external peer review.
- The 16 most meritorious requests were chosen for funding in October 2009, for a total of \$4868K.
- Award sizes ranged from \$40K to \$952K.
- After submission of a short supplemental proposal (which was reviewed briefly by FES), funding allocations were made for most projects. This process should be completed soon.



RENEW REPORT KEY FINDINGS ON ICC'S

- **“The Spherical Torus Program is now poised to generate the knowledge base to confidently construct and operate a low-A Fusion Nuclear Science and Technology component testing device, and to aggressively pursue improvements to advance the ST for energy production.”**
- **The quasi-symmetric stellarator is “a transformational concept, offering a timely, effective solution to the challenges of severe, transient events and control in steady-state, high-pressure plasmas.”**
- **Research on the reversed-field pinch, spheromak, and field-reversed configuration “broadens the scientific approach to grow and validate fusion science over a wide range of plasma conditions and enhances the opportunity for scientific discovery and innovation in toroidal confinement.”**

FES appreciates the excellent work of the fusion community on ReNeW. It has been a valuable resource in planning for the fusion program.



- **Open to all labs and “non-labs.”**
- **All current ICC projects are eligible to compete for funding beginning in FY 2011.**
- **Funding for all current ICC university grants is scheduled to end in FY 2010.**
- **Support should be requested for up to three years.**
- **Up to \$11.2 M of FY 2011 funds are expected to be available to support non-lab research.**
- **Up to \$5.6 M of FY 2011 funds are expected to be available to support lab research.**
- **Award sizes are expected to range from \$50K to \$1700K per year.**
- **Pre-applications are required for non-labs.**



- Issue “Date” – Late February, early March 2010
- Pre-Applications Due – Four weeks after issue date
- Applications Due – Five weeks after pre-applications due



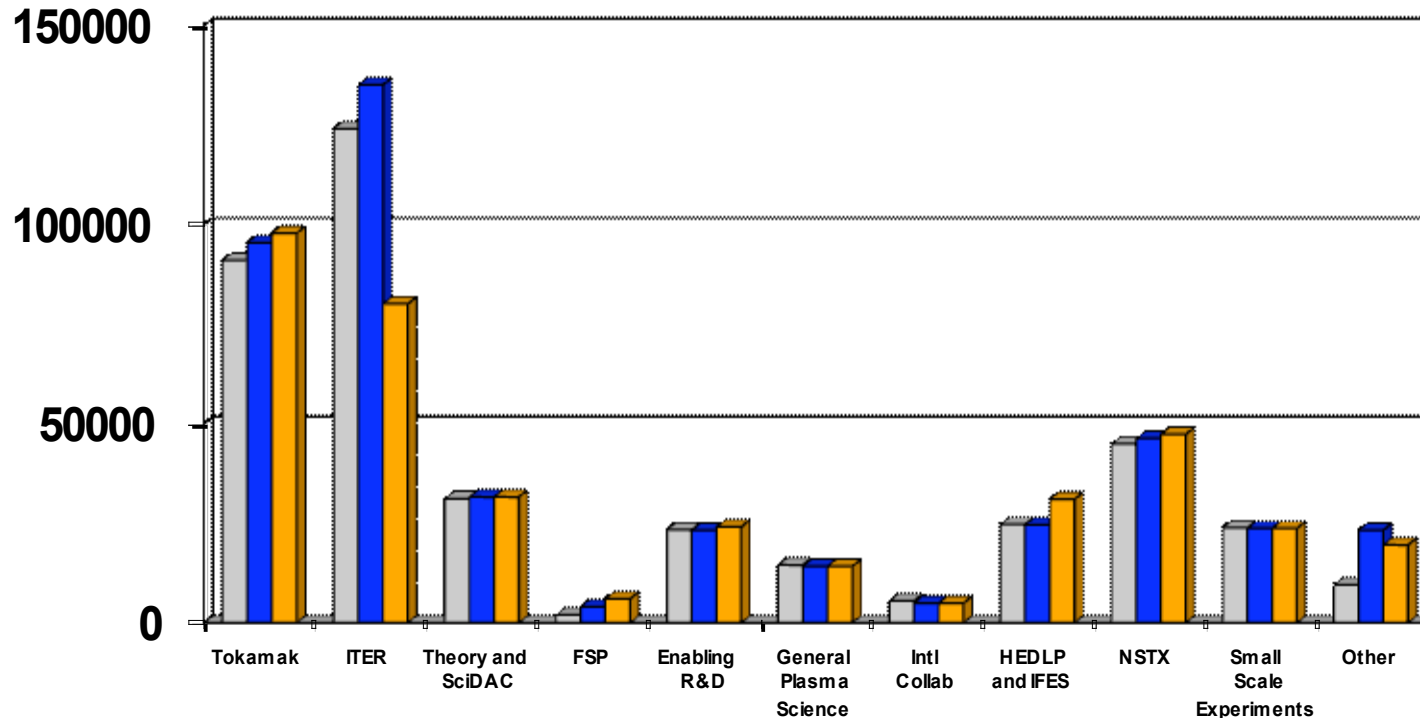
- **As the world program enters the burning plasma era, ICC research should migrate toward investigations of the physical framework that will govern the dynamics and control of the self-organized burning plasma state in future toroidally-confined plasmas.**
- **Research that can help increase the scientific understanding of magnetic confinement and has the potential to improve the tokamak concept is an important focus area. Examples include research that can address critical problems that hinder the tokamak concept, such as plasma disruption, heat load on components, and operational and maintenance complexity.**
- **Proposals for research on the large facilities (DIII-D, Alcator C-Mod, NSTX , and MST) are excluded.**
- **Proposals on Inertial Fusion Energy Sciences and High Energy Density Plasma Physics are also excluded.**



- **Emphasis will be placed on the linkage between prediction and measurement for scientific leverage in testing the theories and scaling the phenomena that are relevant to future burning plasma systems.**
- **Key program issues include:**
 - Initiation and increase of plasma current
 - Dissipation of plasma exhaust power
 - Symmetric-torus confinement prediction
 - Stability, continuity, and profile control of low-aspect-ratio symmetric tori
 - Quasi-symmetric and 3D shaping benefits to toroidal confinement performance
 - Divertor design for 3D magnetic confinement configurations
 - The plasma-materials interface
- **Compared to previous ICC solicitations, increased emphasis will be placed on those proposals that have the most promise of making such linkages and addressing the key issues.**



- **Another priority is carry out experiments in regimes relevant to the mainline magnetic confinement and materials science efforts in order to help validate theoretical models and simulation codes, thus supporting the FES goal to develop an experimentally-validated predictive capability for magnetically-confined fusion plasmas.**



FY'11 budget

- supports most program areas at the FY 2010 level
- reduces ITER funding to \$80M with understanding of \$40M carryover
- increases provided for Fusion Simulation Program and NSTX MIE Upgrade
- increases provided for DIII-D and Alcator C-Mod Facility Operations
- increase provided for HEDLP