U.S. DEPARTMENT OF ENERGY | Office of Science

# On the program, vision, and budget for the fusion and plasma sciences


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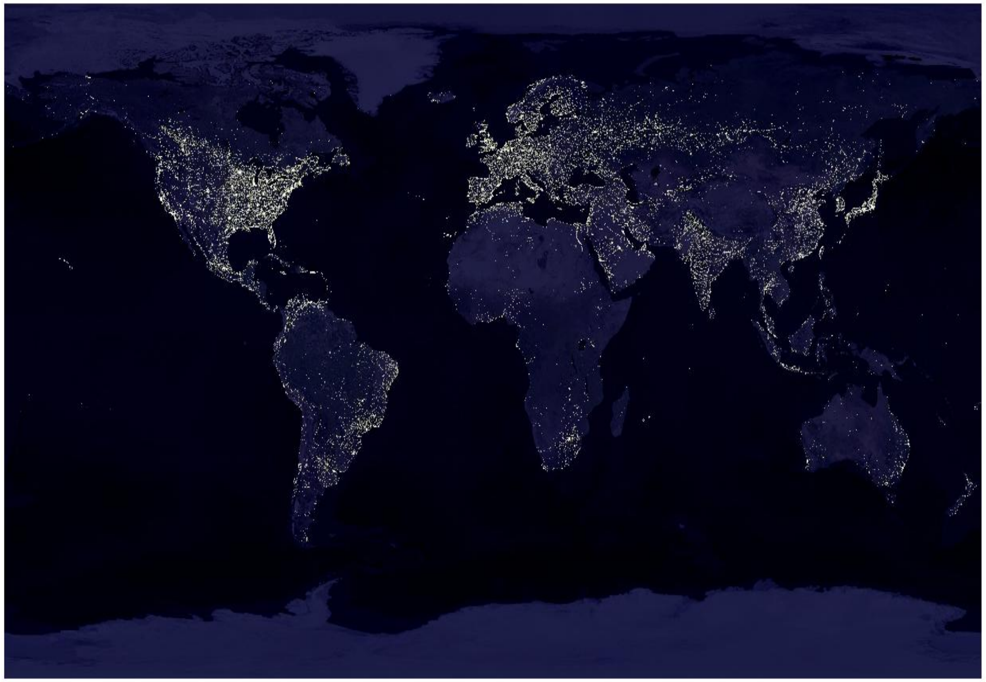
**For Fusion Energy Sciences**
**U.S. Department of Energy**


**Presented to the Fusion Energy Sciences Advisory Committee**

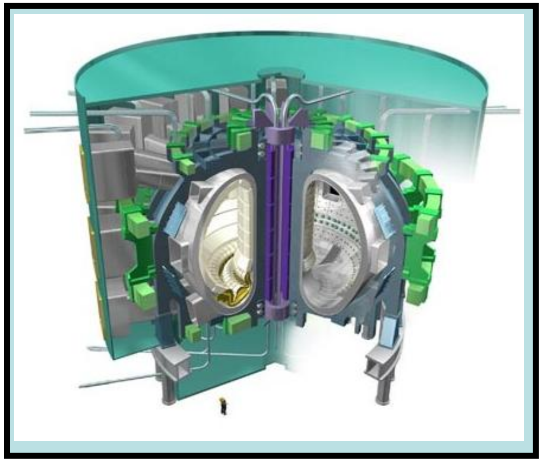
**February 28, 2012**

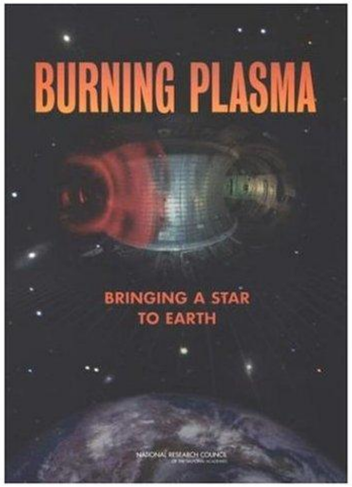
# The science at the heart of fusion energy is far-reaching and is poised for a transformation

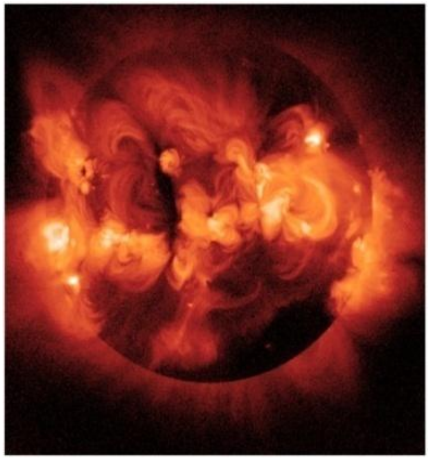


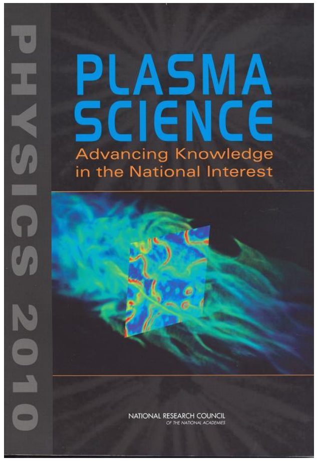
***Ambition**: Fusion contributes to energy and climate solutions by mid-century*

***Office of Science role**: Establish the plasma sciences broadly for fusion as well as discovery*







## *This proposal was developed with a long-term view for fusion and the plasma sciences, framed by Administration priorities for near-term payoffs*

- This budget was developed in part considering the Administration's high priority of investment in research relevant to clean energy with near-term payoff.

- With this as backdrop, the Administration affirms a strong commitment to ITER, recognizing its importance to fusion and potentially to the energy economy in the second half of this century, the U.S.'s leading scientific role in getting us to this point, and international commitments

- Cuts are realized in a large majority of the non-ITER part of the program. Exceptions are where modest increases are proposed in international research and materials

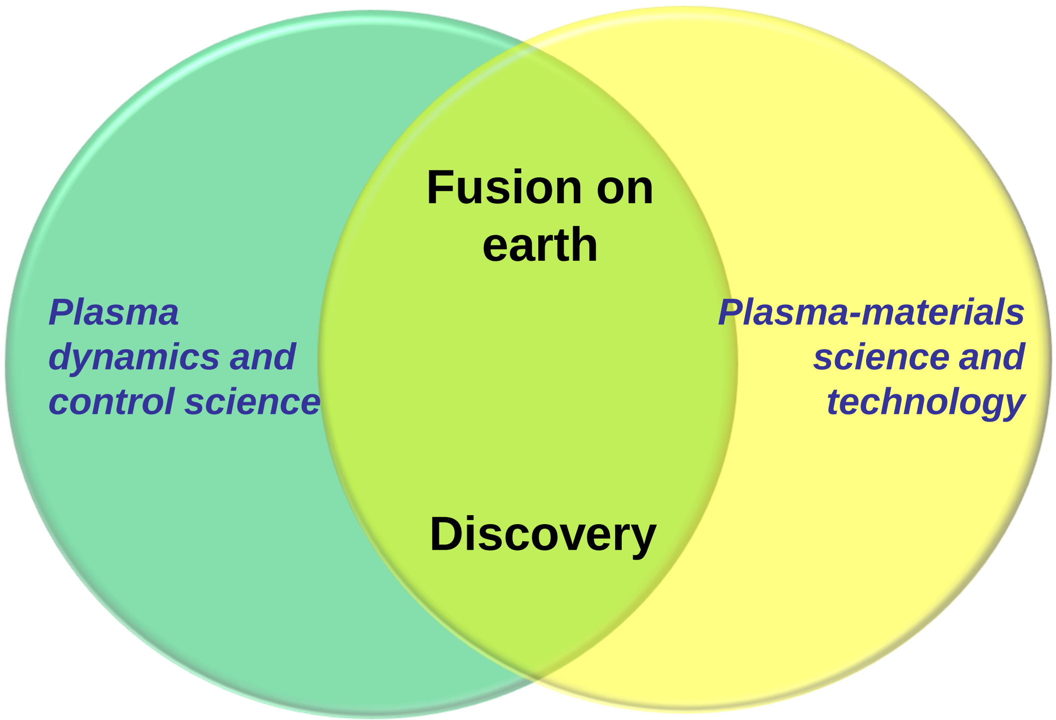
- With this proposal, a program structure is maintained that can lead to where we need to be in 10 years

# Fusion and plasma science elements are intimately linked

## Mission

**Priorities**

The mission of the Fusion Energy Sciences (FES) program 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 the study of the plasma state and its interactions with its surroundings.




- Advance the fundamental science of magnetically confined plasmas for fusion energy
- Pursue scientific opportunities and grand challenges in high energy density plasma science
- Support the development of the scientific understanding required to design and deploy fusion materials
- Increase the fundamental understanding of plasma science beyond burning plasmas

# FES research has been world leading in bringing us to a new era in fusion energy development

- After more than 50 years of research, fusion is ready to embark on the ultimate test – determining the scientific and technical viability of fusion on earth.

- ITER is the scientific vehicle for this test. It will enable the study of high gain fusion plasmas, fusion systems that release more energy than is required to initiate and control them.

- The U.S. has had a major, leading role in developing the scientific basis girding ITER, its design, and its operating scenarios.

- The FY'13 budget proposal is for a program that will be highly impactful for ITER construction, fusion research and the plasma sciences overall, preserves a structure that can effectively engage the world in the ITER era, and is fiscally responsible.

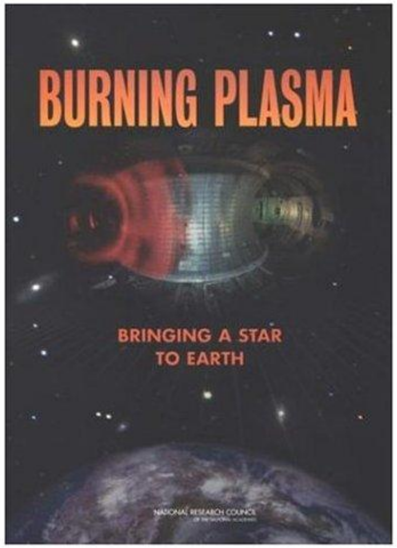
# *High-level considerations and budget overview*

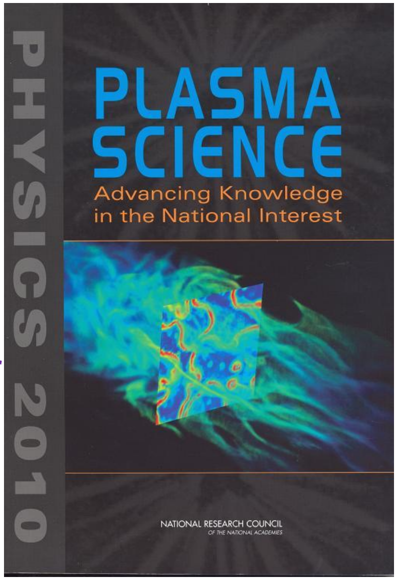
# Overarching consideration: where we need to be in ten years

- Total FES budget request is \$398.3M.

  Compare to \$401M appropriated in ‘12.

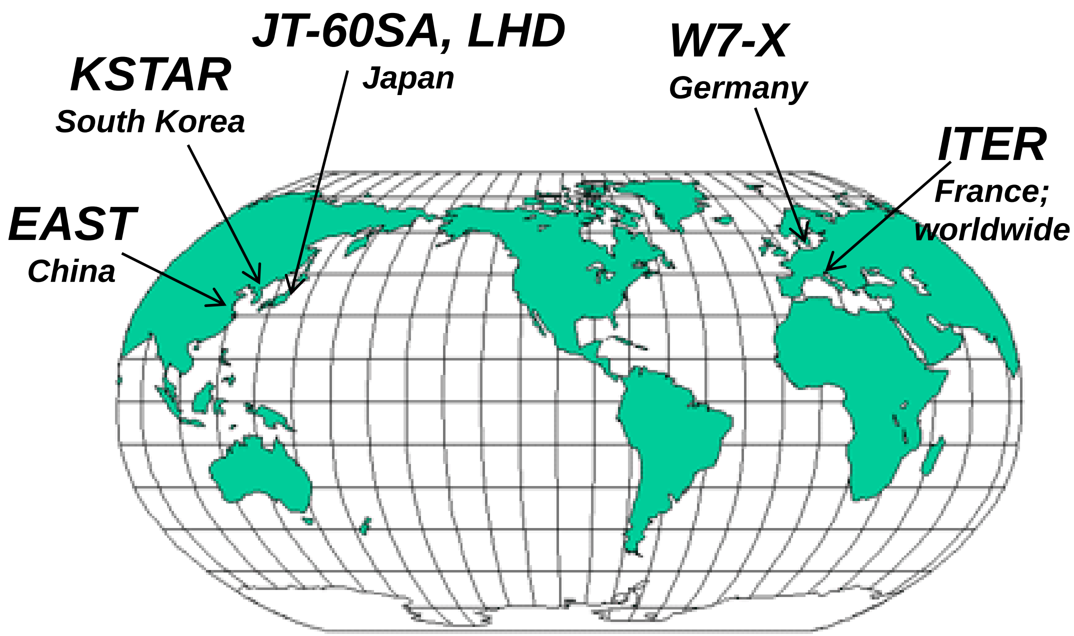
  - **The U.S. needs to lead in burning plasma science ➔** *Support ITER project at \$150M, an increase of \$45M over FY 12. Maintain DIII-D run time with no upgrades at this time. However, the Alcator C-Mod facility will cease operations in FY’13*
  - **Position the U.S. to assert leadership in present gaps ➔** *Modest increases in international opportunities on long-pulse facilities, both tokamak and stellarator. In materials science, continue support of the NSTX Upgrade project and DIII-D to enable an informed decision on an FNSF later this decade, and begin a modest initiative in materials science*
  - **Steward the broader plasma sciences ➔** *Overall FES Program structure is maintained as the non-ITER program faces an overall reduction of about 16%, including closure of the Alcator C-Mod program. Joint programs with NNSA and NSF in non-MFE research are maintained at a reduced level*



# The U.S. fusion program has to evolve if we are to retain a world leadership position in fusion: **new capabilities are emerging overseas**

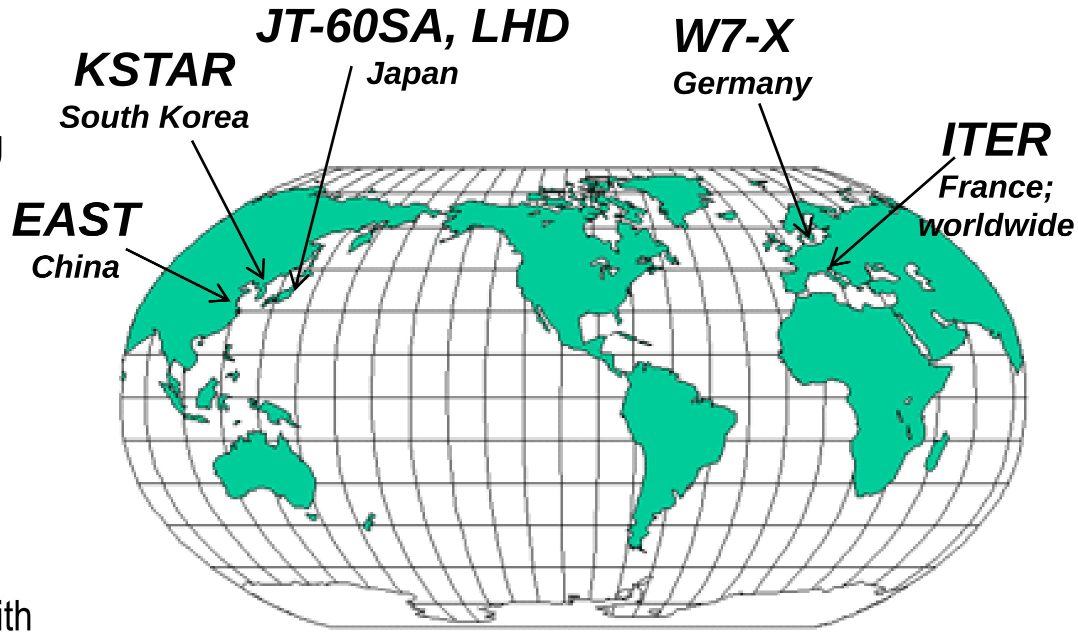
- In the next decade:
  - ITER will be constructed, and the frontier of burning plasma science will be there. Liken it to LHC in high energy physics – if the U.S. is not engaged, we will lose out.
  - First-of-a-kind, $B-class research facilities in magnetic fusion will be on line in Europe and Asia. The class of physics they will enable will include but extend beyond what U.S. facilities are capable of exploring. The U.S. domestic program can and must be sensibly levered to take advantage of these research resources.
  - The U.S. has a leadership opportunity in fusion materials science.




***This budget proposal makes steps in engaging these changes in a constrained budgetary environment***

# A leading challenge is engaging in this new global fusion enterprise in a manner that amplifies U.S. capabilities and brings home benefit

- What we have going our way in this budget that can make this happen
  - A student population of over 400 students
  - Outstanding facilities in DIII-D and NSTX-U
  - Viable core elements elsewhere, with leverage opportunities within the U.S.
  - A clearly defined gap in fusion materials
  - International research relationships at the emergent facilities that are strong and will enable growth
  - Materials science research opportunities with high potential for leverage with BES




- Examples of what we have to overcome
  - Loss of a major facility, Alcator C-Mod, with student education
  - Reductions in effort in nearly every area except international research and materials

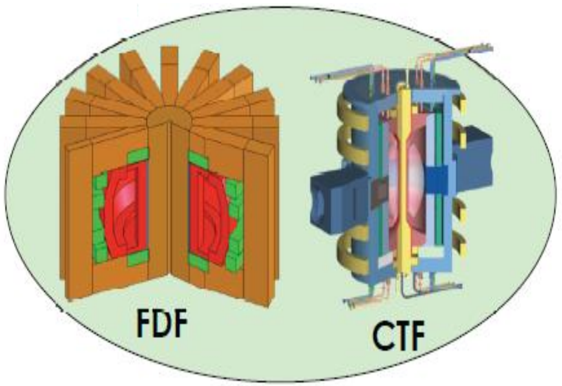
- Examples of what we can do to mitigate the effects of the losses
  - Increase student education opportunities at DIII-D and NSTX-U
  - Vigorously develop, and understand limits, of research opportunities overseas
  - Develop leverage with NNSA, BES, and ASCR

# *U.S. research has to evolve if we are to retain a world leadership position in fusion: **fusion materials science, and extracting fusion power***

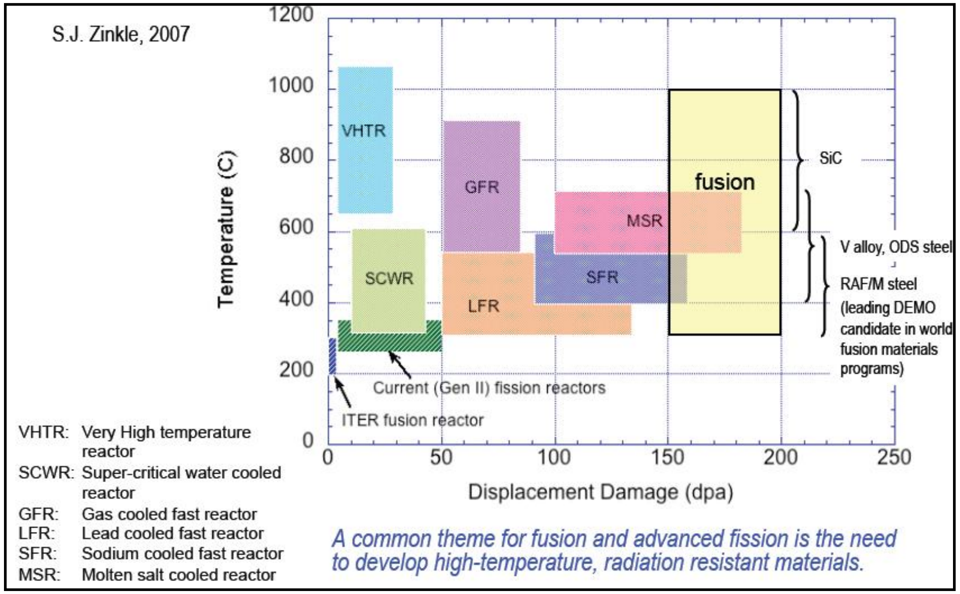
**FESAC "Priorities, Gaps, and Opportunities" report points to fusion materials as the next leading frontier to be mastered in parallel with ITER**

**To increase our impact in materials science, both nuclear and non-nuclear.**

- Lever common interests in MFE, IFE, NE, SC, NNSA
- Complementarity of DIII-D and NSTX-Upgrade will inform the decision on a Fusion Nuclear Science Facility later in this decade.
- Launch a prerequisite computational materials and beam line programs. Strong university role




**Candidate geometries for a fusion nuclear materials science facility. Down-select late this decade**

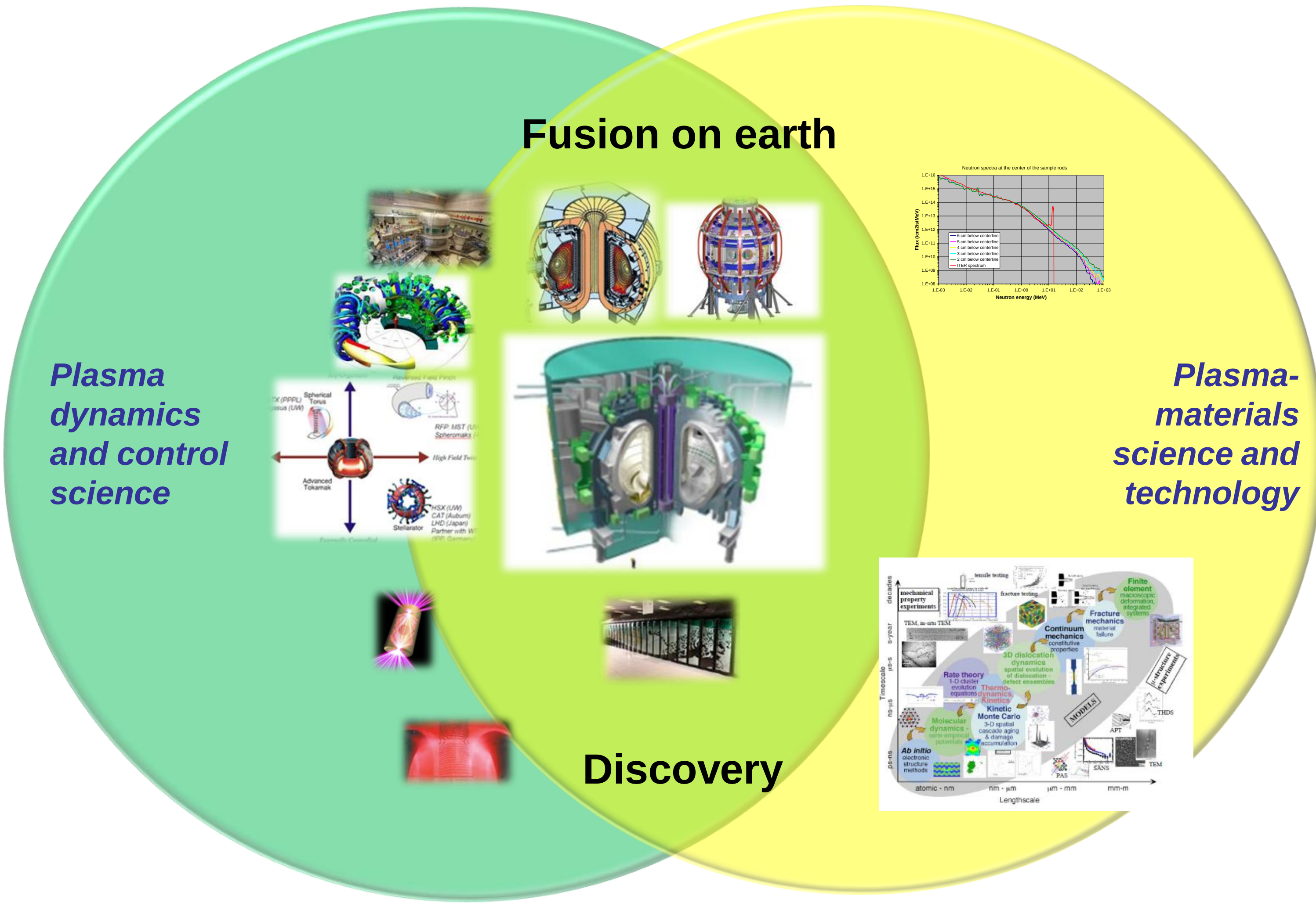



*A common theme for fusion and advanced fission is the need to develop high-temperature, radiation resistant materials.*

- Note, from the narrative:

  "The U.S. remains committed to the scientific mission of ITER, while maintaining a balanced research portfolio, and will work with ITER partners to accomplish this goal."

# Ultimately, the U.S. fusion's path forward will be expressed in terms of scientific elements and will include changes of emphasis



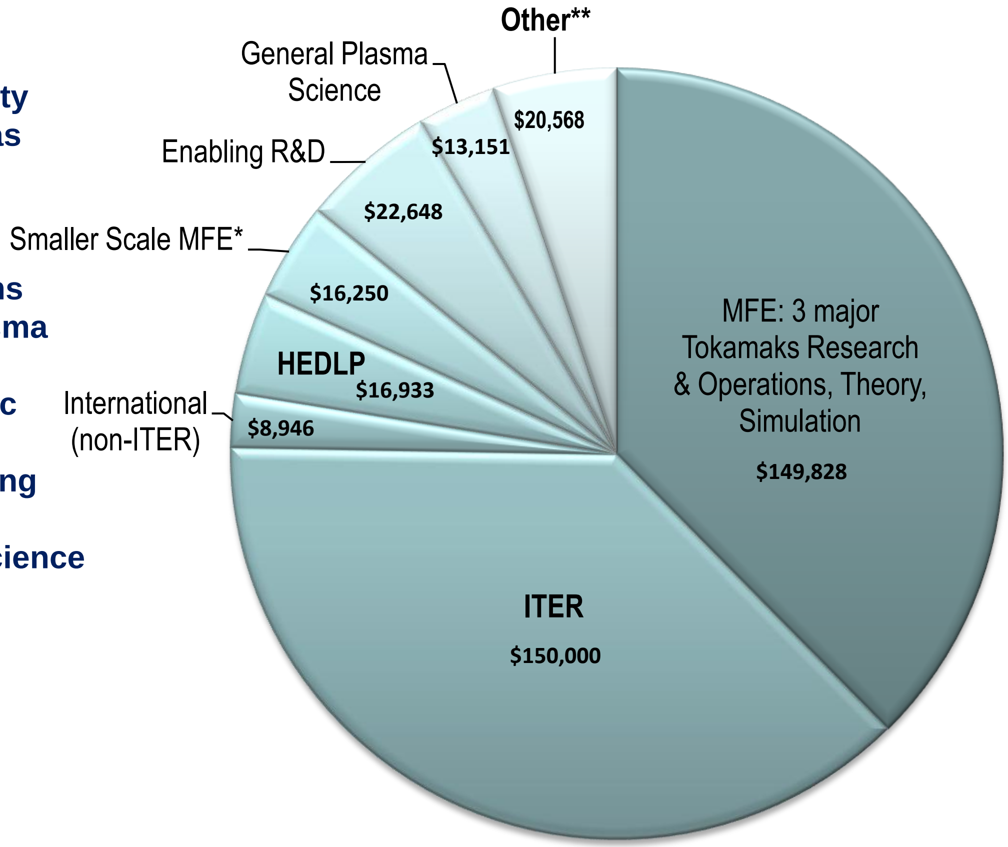

- Burning plasma science and stewarding broader plasma science will be key elements, but program scope may have to be reduced for lower funding level scenarios

- Major domestic facilities will still engage in plasma dynamics and control, but will shift focus towards challenging metrics relevant to fusion materials science

- Leverage between domestic and international research opportunities in MFE will become even more important in tough budget times, if the U.S. is to obtain access to the leading scientific questions in the next decade

# FY 2013 FES Congressional Request ($398.324M)

**Research: $154,200M**
- DIII-D, C-Mod, NSTX
- International Collaborations
- High Energy Density Laboratory Plasmas (HEDLP)
- Outreach and Education
- Validation Platforms (Experimental Plasma Research (EPR))
- Madison Symmetric Torus (MST)
- Theory and Modeling
- SciDAC
- General Plasma Science
- Diagnostics
- SBIR/STTR



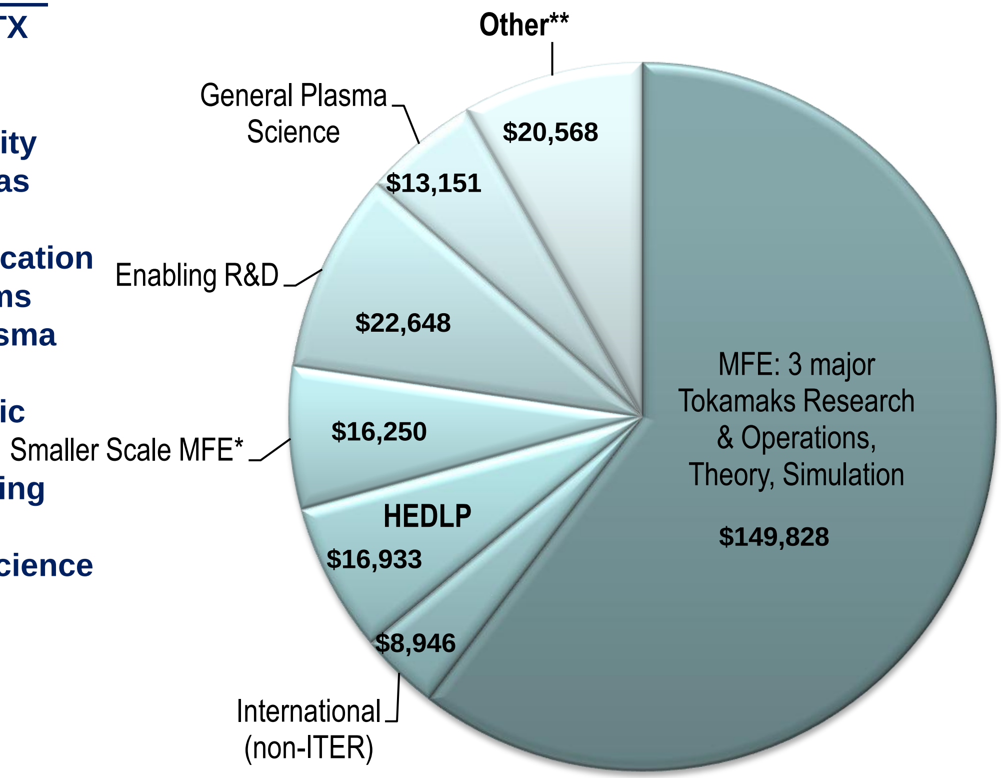

**Facility Operations: $221,476M**
- ITER at $150M
- 10 weeks of DIII-D Operations
- 0 run weeks of Alcator C-Mod Operations due to shutdown
- 0 run weeks of NSTX Operations due to upgrade
- NSTX Major Item of Equipment (MIE) Upgrade project
- General Plant Projects (GPP)/General Purpose Equipment (GPE)/Infrastructure

**Enabling R&D: $22,648M**
- Plasma Technology
- Advanced Design
- Materials Research

*Smaller Scale MFE includes Validation Platforms (EPR) and MST
**Other includes SBIR/STTR, GPP/GPE/Infrastructure, Outreach, Education & Diagnostics

# FY 2013 FES Congressional Request ($398.324M): Non-ITER

**Research: $154,200M**
- DIII-D, C-Mod, NSTX
- International Collaborations
- High Energy Density Laboratory Plasmas (HEDLP)
- Outreach and Education
- Validation Platforms (Experimental Plasma Research (EPR))
- Madison Symmetric Torus (MST)
- Theory and Modeling
- SciDAC
- General Plasma Science
- Diagnostics
- SBIR/STTR




**Facility Operations: $71,476M**
- 10 weeks of DIII-D Operations
- 0 run weeks of Alcator C-Mod Operations due to shutdown
- 0 run weeks of NSTX Operations due to upgrade
- NSTX Major Item of Equipment (MIE) Upgrade project
- General Plant Projects (GPP)/General Purpose Equipment (GPE)/Infrastructure

**Enabling R&D: $22,648M**
- Plasma Technology
- Advanced Design
- Materials Research

*Smaller Scale MFE includes Validation Platforms (EPR) and MST
**Other includes SBIR/STTR, GPP/GPE/Infrastructure, Outreach, Education & Diagnostics

# FY 2013 FES Budget Proposal Summary

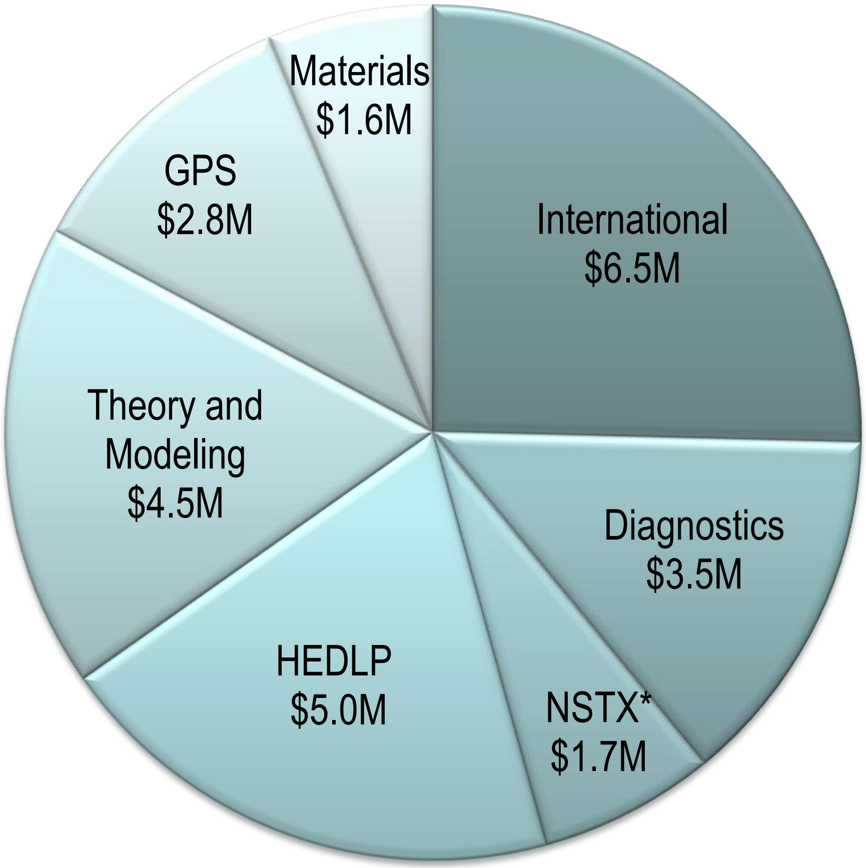
**Fusion Energy Sciences**
**FY 2013 Congressional Budget**
(Budget Authority in thousands)

| | FY 2011 Actual | FY 2012 Approp | FY 2013 Request |
|---|---|---|---|
| **Science** | | | |
| DIII-D Research | 30,716 | 30,300 | 26,703 |
| C-Mod Research | 10,056 | 10,454 | 8,396 |
| International Research | 6,105 | 7,435 | 8,946 |
| Diagnostics | 4,115 | 3,519 | 3,519 |
| Other | 8,085 | 11,919 | 9,193 |
| NSTX Research | 16,107 | 17,549 | 16,836 |
| Experimental Plasma Research | 17,745 | 11,000 | 10,500 |
| HEDLP | 25,727 | 24,741 | 16,933 |
| MST Research | 7,005 | 6,000 | 5,750 |
| Theory | 25,663 | 24,348 | 20,836 |
| SciDAC | 7,057 | 8,312 | 6,556 |
| General Plasma Science | 14,810 | 16,780 | 13,151 |
| SBIR/STTR | - | 8,326 | 6,881 |
| **Total, Science Research** | **173,191** | **180,524** | **154,200** |

| | FY 2011 Actual | FY 2012 Approp | FY 2013 Request |
|---|---|---|---|
| **Facility Operations** | | | |
| DIII-D | 35,699 | 38,319 | 33,260 |
| C-Mod | 17,518 | 18,067 | 7,848 |
| NSTX | 32,559 | 32,134 | 29,393 |
| Other, GPE, and GPP | 4,568 | 975 | 975 |
| MIE: U.S. Contributions to ITER Project | 80,000 | 105,000 | 150,000 |
| **Total, Facility Operations** | **170,344** | **194,495** | **221,476** |
| **Enabling R&D** | | | |
| Plasma Technology | 14,501 | 13,911 | 11,666 |
| Advanced Design | 2,752 | 4,337 | 1,611 |
| Materials Research | 6,469 | 7,729 | 9,371 |
| **Total, Enabling R&D** | 23,722 | 25,977 | 22,648 |
| | | | |
| **Total, Fusion Energy Sciences** | **367,257** | **400,996** | **398,324** |

# *Funds will be available through solicitations in FY2013*

**Total available in solicitations is $26M**




Labs, universities, and industry R&D groups may compete for all solicitations except:

- NSTX Research—Labs only in FY13
- Theory/Modeling—Universities and industry groups in FY13

# *On ITER*

*The driving force*

*International project construction and status*

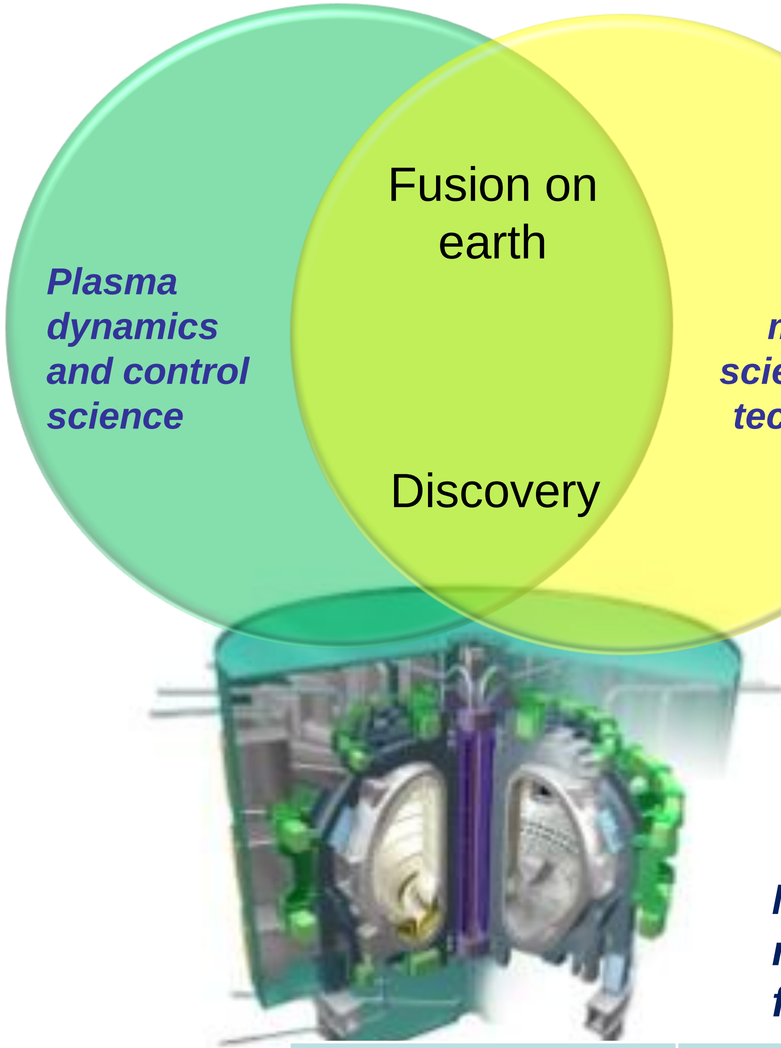
*International commitments*

*U.S. obligations, US. ITER Project performance, and impact on the international ITER schedule*

# *ITER is the keystone for establishing the scientific and technological feasibility of magnetic fusion energy*

***ITER will advance every element of the FES program, and will be the world's first entry into Burning Plasma Science***

***The scientific question of how to optimize the plasma distribution function in a burning plasma is at the center of ITER's plasma science***




Will create the world's first sustained self-heated plasma: numerical goal of Q = 10, pulsed, 500 MW; Q = 5 steady-state.

U.S. research has had a defining impact on ITER design and operating scenarios

Designs will be completed with industry input for the majority of U.S. hardware needed for first plasma

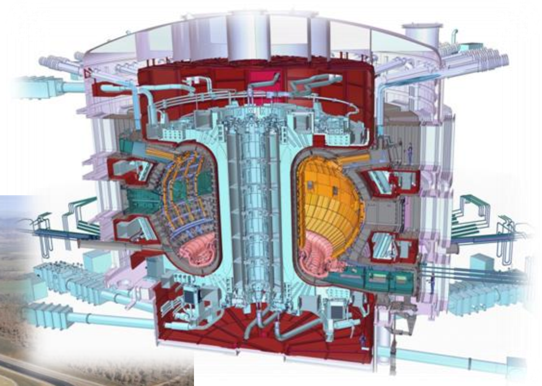
***Many technologies will be at reactor scale, or will enable first studies at reactor scale***

| | FY2012 Enacted | FY2013 Proposed |
|---|---|---|
| ITER Project | $105M | $150M |

# *International Organization management changes have made an enormous positive impact*

*Poloidal winding building construction*

**The ITER Device**



*Site construction* ***is underway***

***New project leadership, instituted with U.S. leadership***

*Director General Motojima*

*Rich Hawryluk (*

*Rem Haange*

Facing the main entrance to the ITER site, the ITER Headquarters building will be the window to the ITER project for the world, Sept 2011.

*Headquarters Building*

# Overarching considerations regarding ITER

*“Why does the ITER project need to grow in such a challenging budget?”*

- ITER is the capstone of over 50 years of research in magnetic fusion. This time is critical for its success, and for fusion’s success
- The project is moving out smartly in construction, and the U.S. needs to keep pace to the best of its ability. Now and the coming years is when contracts need to be placed so that ITER construction can be completed on time.
- The U.S. is at the very edge of having a negative impact on the international schedule at a time when the other Members have demonstrated extraordinary commitment. Further reductions in the U.S. ITER budget will yield an international schedule slip with unpredictable consequences on the political front, and will add to costs for everyone.

# The demonstration of international commitment to ITER during extraordinary times has been exceptionally strong

| Member | Comments |
|---|---|
| China | Highly committed to ITER and fusion overall. Their plan to aggressively invest in fusion requires ITER success, including schedule success. Expressed interest in fusion comes from highest levels of government, including a visit by China's President and Vice Premier to their leading fusion laboratory. |
| European Union | They are in for 45% of the cost. The EU recently committed to **$1.3B additional Euro of ITER funding to a total of $2B Euros over the next two years, despite extraordinary financial times**. They have recently forged a deal with JA to trade in-kind contribution obligations to help entire project stay on schedule discussions. |
| India | They fight hard every year for their budget in a complex process, but outward indications of support are very strong. They see ITER is a vehicle for advancing their whole fusion R&D enterprise. |
| Japan | **Their FY'12 funding of $224M has been approved**. **This is more than a 3-fold increase in funding over FY'11, despite the earthquake and tsunami.** |
| Russia | Cash is in-hand, and they are eager to spend and get on with the project fully and to stay on schedule |
| South Korea | Strong commitment; Eager to demonstrate industrial capabilities. Catalyzing trade of obligations between EU and JA. Strident about sticking to schedule. |

# A significant portion of U.S. ITER funding is spent with U.S. industry, universities, and national labs

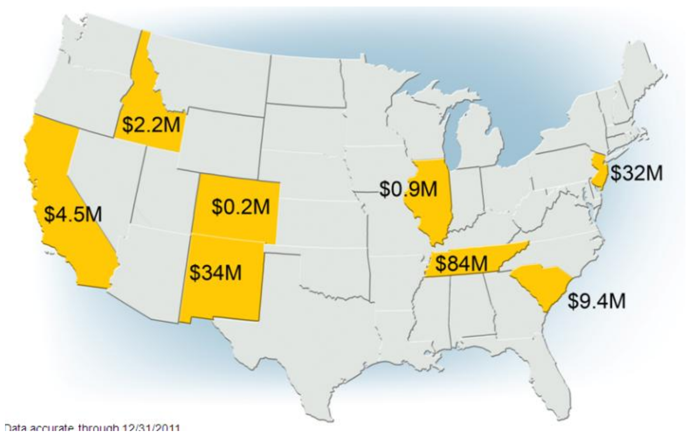
Funding in FY12 will be utilized to:

- allow the US to progress as needed to remain a viable partner in this collaboration
- retain or create jobs in >300 industries and universities and 8 National Laboratories in 37 states
- provide US industry experience with advanced manufacturing techniques

**Funding to DOE Labs**

**March 2006 – December 2011**

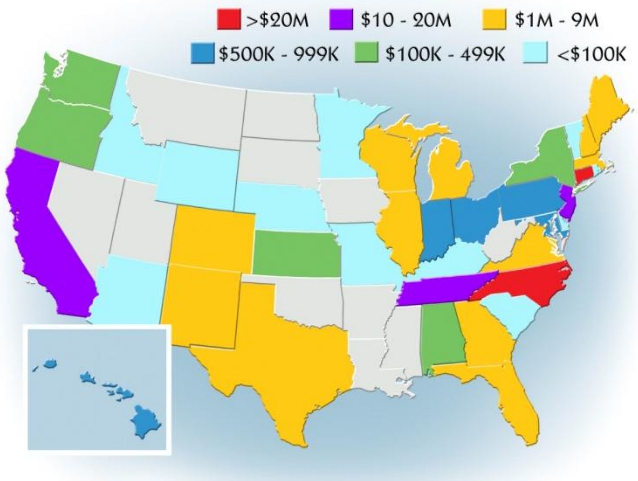
**Total ~$168M**




**Funding to Industries and Universities**

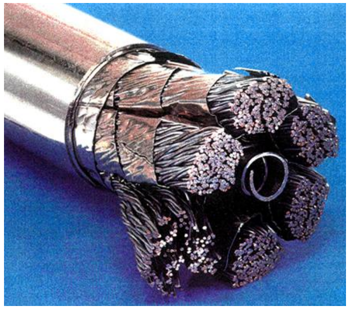
**March 2006 – December 2011**

**Total ~$171M**




**Attracting business**

- **The EU has let a contract to Oxford Instruments for its superconducting strand ($58M; New Jersey)**
- **Luvata Connecticut s supplying US TF strand to the EU ($26M)**



***An understandable concern is: can the U.S. program be impactful with the proposed reductions in the non-ITER budget, and are we positioning ourselves to get good scientific return during the ITER era?***

***The view of FES and Office of Science regarding these questions is "yes," but there is loss, and near-term choices will be important***

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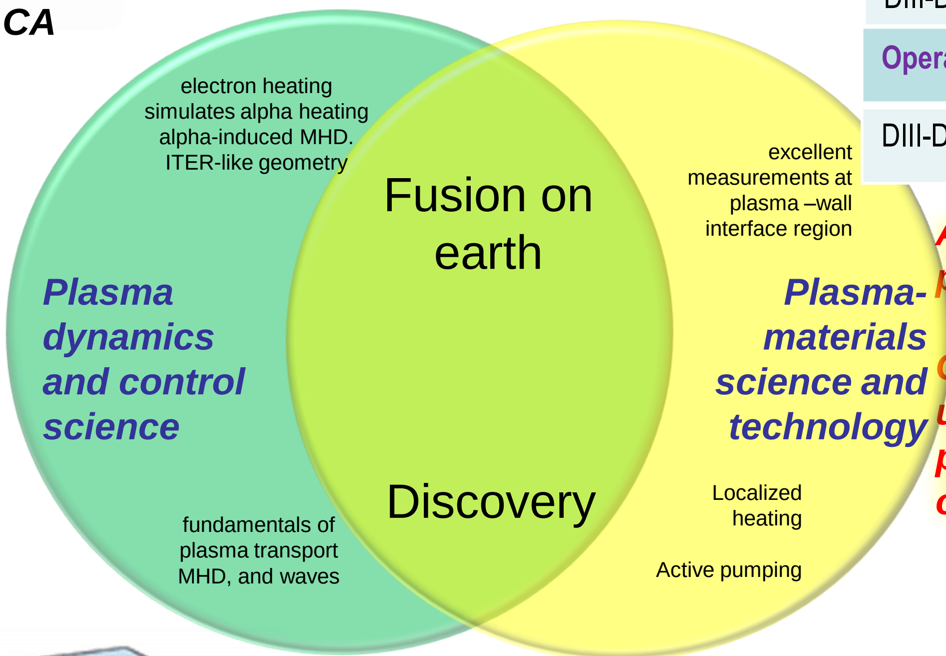
# *DIII-D has had an enormous influence on establishing a scientific understanding and optmization of magnetically confined plasmas*

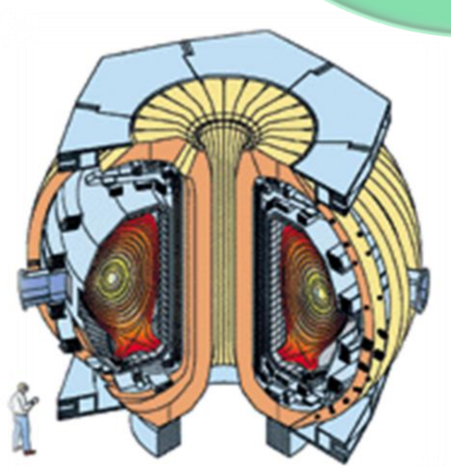
***General Atomics, La Jolla, CA***

| Research | FY2012 Enacted | FY2013 Proposed |
|---|---|---|
| DIII-D | 30,300 | 26,703 |
| **Operations** | **FY'12 Enacted** | **FY'13 Proposed** |
| DIII-D | 38,319 | 33,260 |



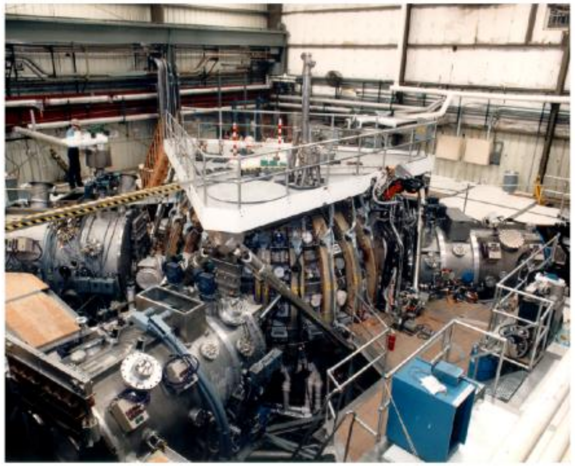

***A leader in the transformation of fusion plasma science to a predictive enterprise***

***Collaboration value extremely high: universities at ground level of program planning and execution. High impact on overseas research***



DIII-D research is at the heart of plasma dynamics and control: it forms the basis of many research scenarios and control tools for ITER and reactors

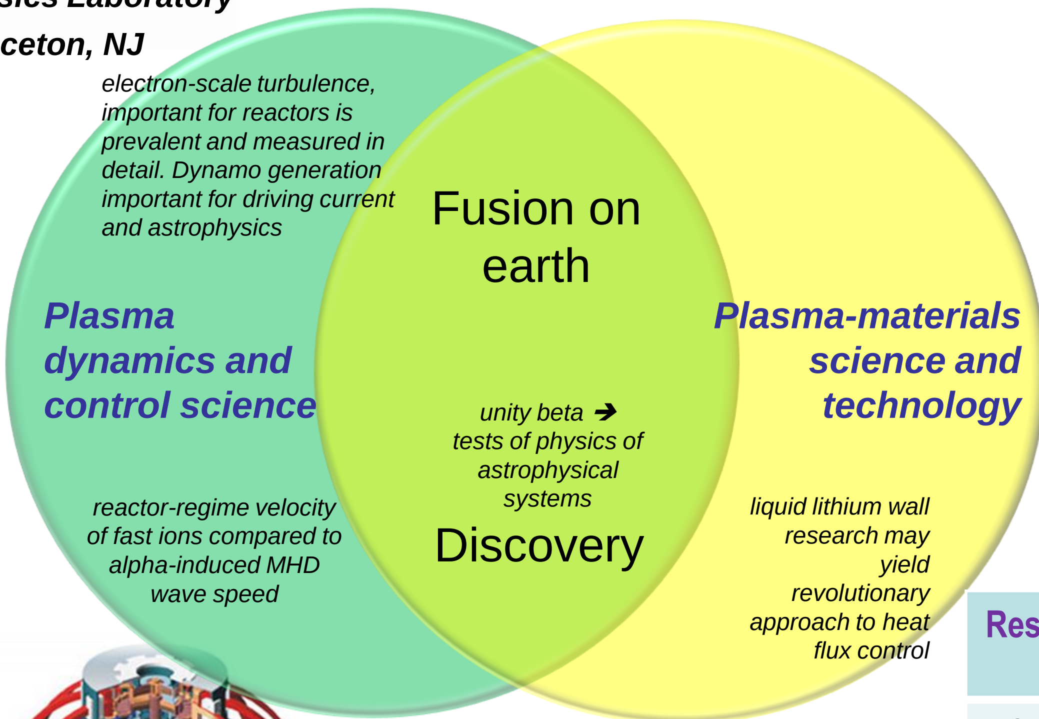
The Operations funding reduction will halt all major facility upgrades and defer system refurbishments, but still allow for 10 weeks of operation in FY2013.



## The commitment to the National Spherical Torus Experiment Upgrade is high

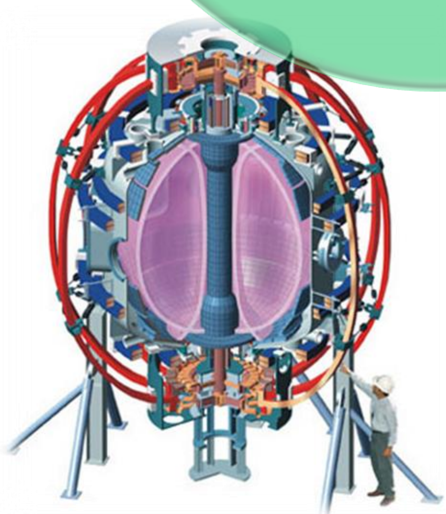
***Princeton Plasma Physics Laboratory***

***Princeton, NJ***




***NSTX compact, low aspect ratio geometry***
***➔candidate for materials volume neutron source***
***➔ tests of toroidal effects on transport, waves, and MHD***

***High plasma pressure/magnetic pressure***
***➔ transport important to a burning plasma is highlighted***
***➔Validation platform for astrophysics***



**NSTX Upgrade is on track for project completion on time**

| Research | FY2012 Enacted | FY2013 Proposed |
|---|---|---|
| NSTX | 17,549 | 16,836 |
| **Operations** | **FY2012 Enacted** | **FY2013 Proposed** |
| NSTX | 15,004 | 6,593* |
| **Construction Projects** | **FY2012 Enacted** | **FY2013 Proposed** |
| NSTX Upgrade | 17,130 | 22,800 |

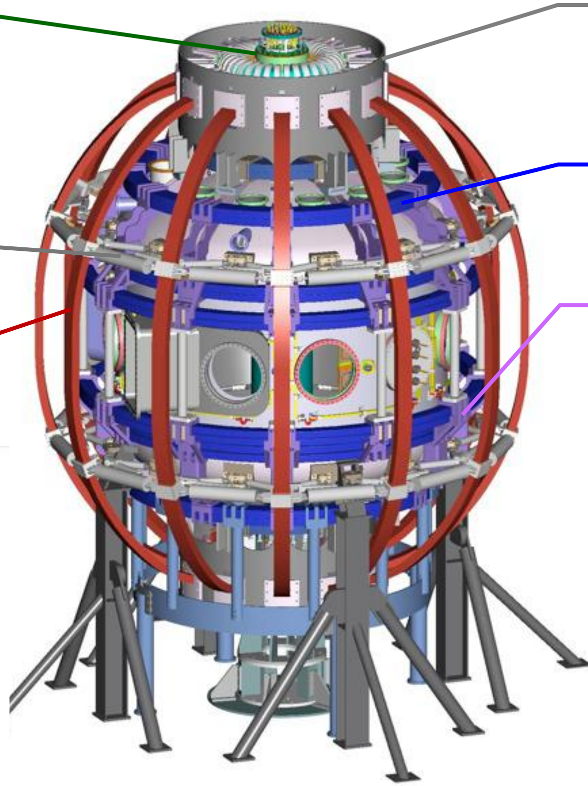
# *Workscope of the NSTX upgrade*

**Increase toroidal field: 0.5T > 1.0T**
**Increase pulse length: 1.0 s > 5 s**
**Increase plasma current: 1 MA > 2 MA**
**Increase NB heating: 5-9MW > 10-18MW**

**New solenoid**
**Inner TF bundle, TF joint, OH & inner PF coils**

**Upgraded TF coil support structure**

**Existing outer TF coils**

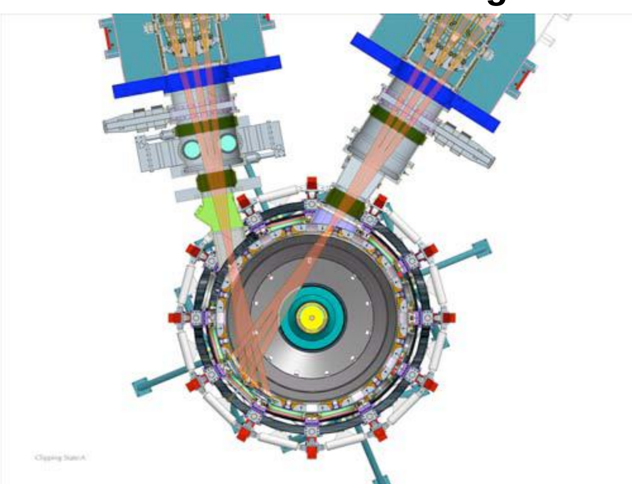


**Reinforce umbrella structure**

**Exst'g outer PF coils – 6 total**

**New PF coil support structure**

**Second NBI** **Existing NBI**



**Also…modify coil power system, protection system & ancillary support systems**

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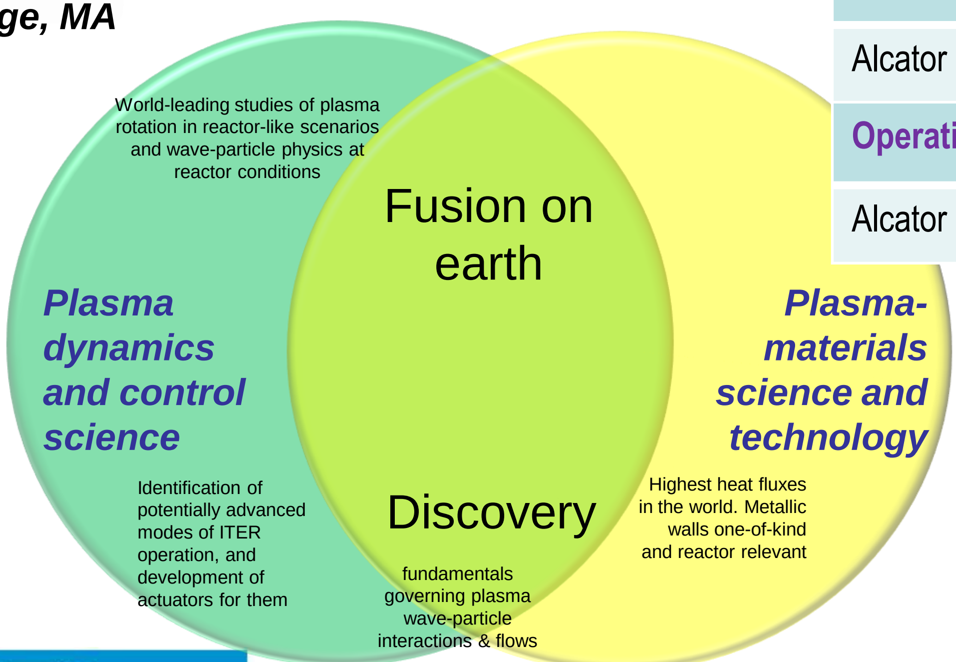
# Alcator C-Mod closes in FY2013. It has been a test-bed for materials science and wave physics relevant to advanced reactor scenarios

***MIT, Cambridge, MA***



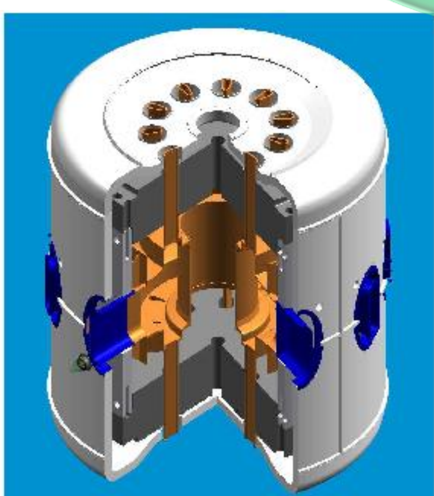

| Research | FY2012 Enacted | FY2013 Proposed |
|---|---|---|
| Alcator C-Mod | 10,454 | 8,396 |

| Operations | FY2012 Enacted | FY2013 Proposed |
|---|---|---|
| Alcator C-Mod | 18,067 | 7,848 |

- The Alcator C-Mod facility is shut down in FY2013. No operations will be conducted and the funding will provide for the safe shutdown of the facility.

- FY2013 will see analysis of data taken in FY2012 and publication the results. A transition of research staff into collaborative activities on other domestic and international experiments will begin.

FES will work with MIT regarding student impacts, enabling those in their last stage of research to finish, and supporting relocation of those in the middle of their research projects

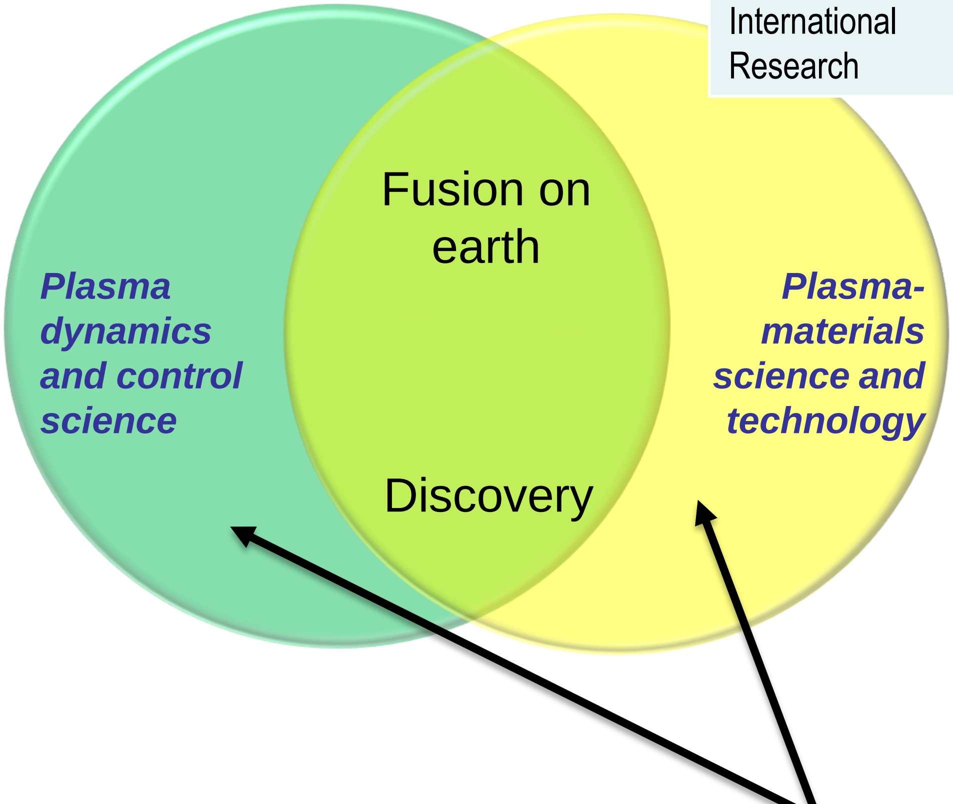


# We need to grow our internationally based research efforts

| Research | FY2012 Enacted | FY2013 Proposed |
|---|---|---|
| International Research | 7,435 | 8,946 |

***How we respond with labs and universities in the next decade will be a major factor determining our place on the world stage***

***These efforts will define our work approach on ITER.***




**First-of-kind superconducting tokamaks (based on U.S. designs) now in China (EAST, Hefei) and South Korea (K-STAR, Daejeon). Also superconducting stellarators (Japan and Germany). China, South Korea, and Germany have offered the U.S. a leadership seat at their program governance table.**

**U.S. teams, formed by national labs, private industry, and universities, will participate on-site and with remote data centers**

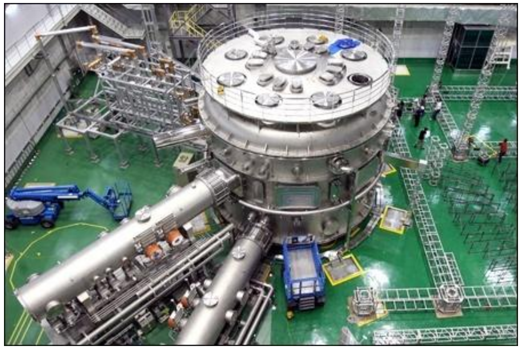
***Major unique scientific opportunities need to fill fusion gaps and teach us how to engage internationally for ITER***

FESAC input will be considered in developing the details and approach

**This will lead to a research team model to be implemented on ITER**

# *Emergent opportunities for plasma control research, with superconducting magnetic technology, reside overseas*

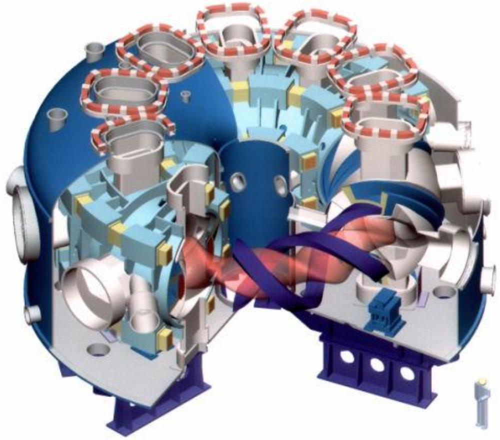
***K-STAR***
***Daejeon, S. Korea***
***Goal: 300 s pulse 2 MA***

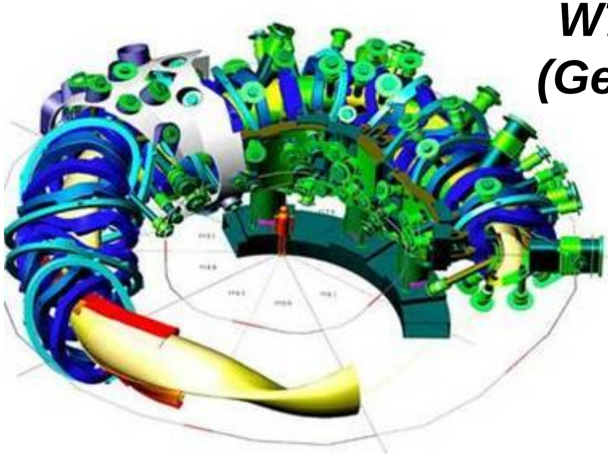


***EAST***
***Hefei, China***
***Goal: 1000 s 1 MA***

***The U.S. DIII-D control system has been implemented on K-STAR and EAST devices***

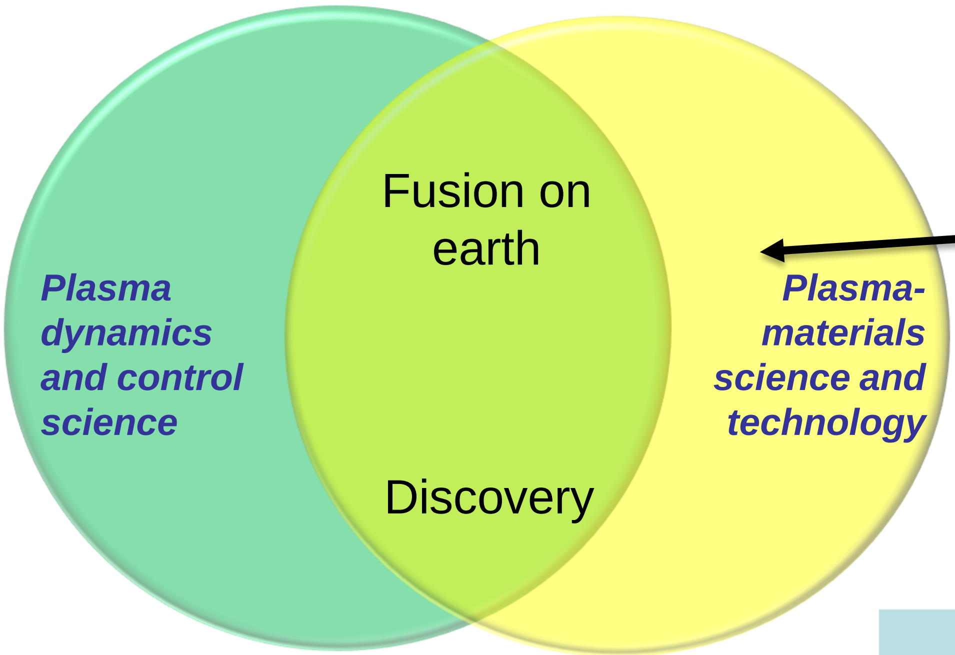
***LHD stellarator (Japan – operating)***





***W7-X stellarator (Germany – 2014)***

# Enabling technologies is being directed towards a materials science emphasis




**FESAC Greenwald panel report, "Priorities, Gaps, and Opportunities (2007)" pointed to the needs and opportunities for the U.S. in fusion materials science, including closing the fuel cycle and harnessing fusion power.**

**A FESAC panel report at the end of February will inform FES's strategy for moving forward in this area**

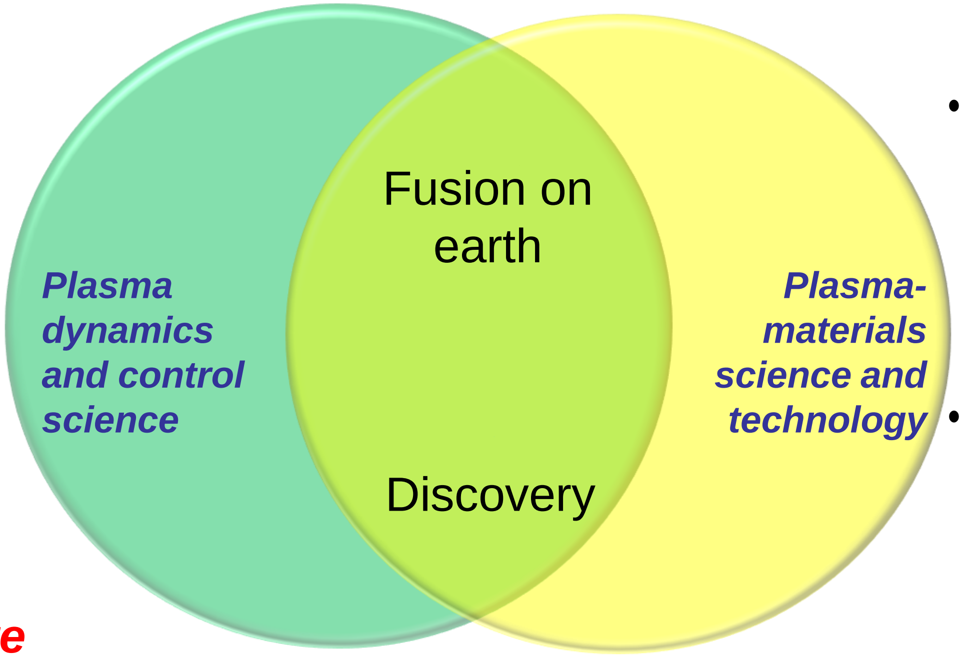
- An initiative in fusion materials research is proposed
- The level of support for design studies of future facilities and for the Virtual Laboratory for Technology (VLT) will be reduced.
- The level of support for advanced technologies for future facilities will be reduced.

| | FY2012 Enacted | FY2013 Proposed |
|---|---|---|
| Plasma Technology | 13,911 | 11,666 |
| Advanced Design Studies | 4,337 | 1,611 |
| Materials Research | 7,729 | 9,371 |
| Total Funding, Enabling R&D | 25,977 | 22,648 |

# Advances in validated simulation are critical for fusion's future success

***How we use validated simulation as instruments of scientific discovery is a great question for science overall.***

***How we execute our simulation efforts in terms program governance, including the relation between universities and labs, is critical.***



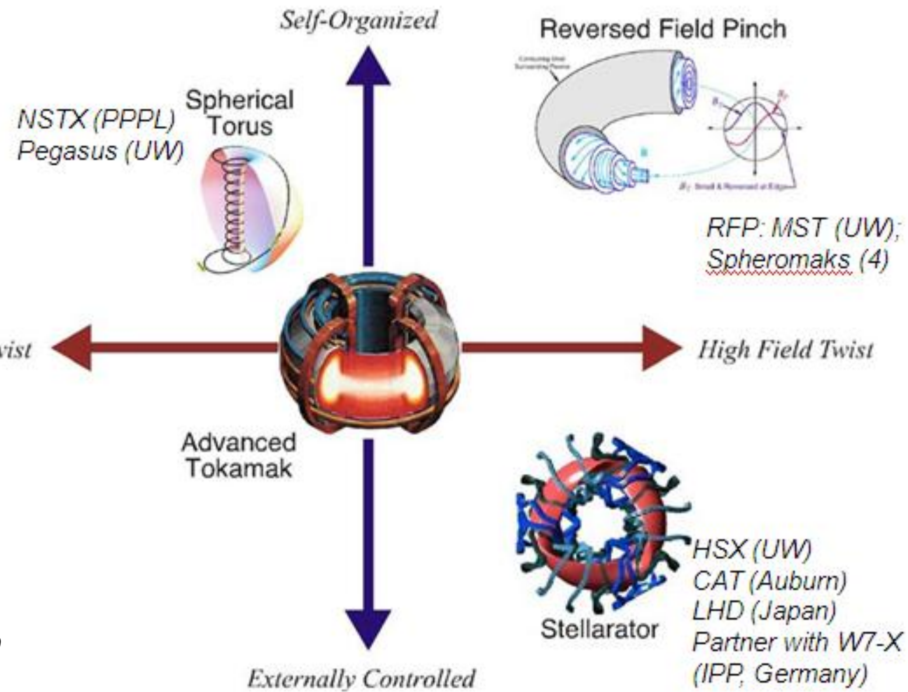

| | FY2012 Enacted | FY2013 Proposed |
|---|---|---|
| Theory and modelling | 24,348 | 20,836 |
| SciDAC | 8,312 | 6,556 |

- Theory and computation is an important element of every aspect of the fusion and plasma sciences
- In FY2013, the scope of the Theory program will be narrowed
- SciDAC: the scope and balance of the portfolio will be maintained, but fewer Centers may be selected for an award following the FY2012 recompetition of a significant portion of the FES SciDAC program.

# Experimental Plasma Research Portfolio and MST are nearly flat-funded

| | FY'12 Enacted | FY'13 Proposed |
|---|---|---|
| Madision Symmetric Torus | 6,000 | 5,750 |
| Experimental Plasma Research | 11,000 | 10,500 |

- All concepts are smoothly connected in magnetic geometry
- → alpha particle physics studied on ITER can be bridged to alternate configurations

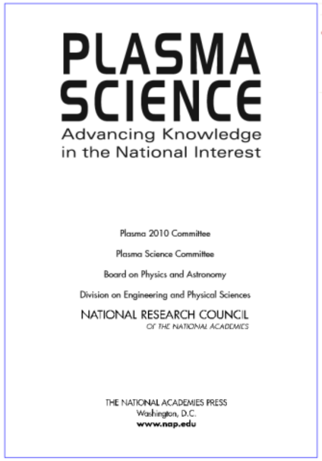


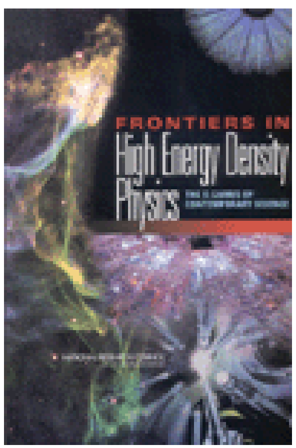

***From EPAct plan***

***Major elements of the U.S. magnetic configuration portfolio***

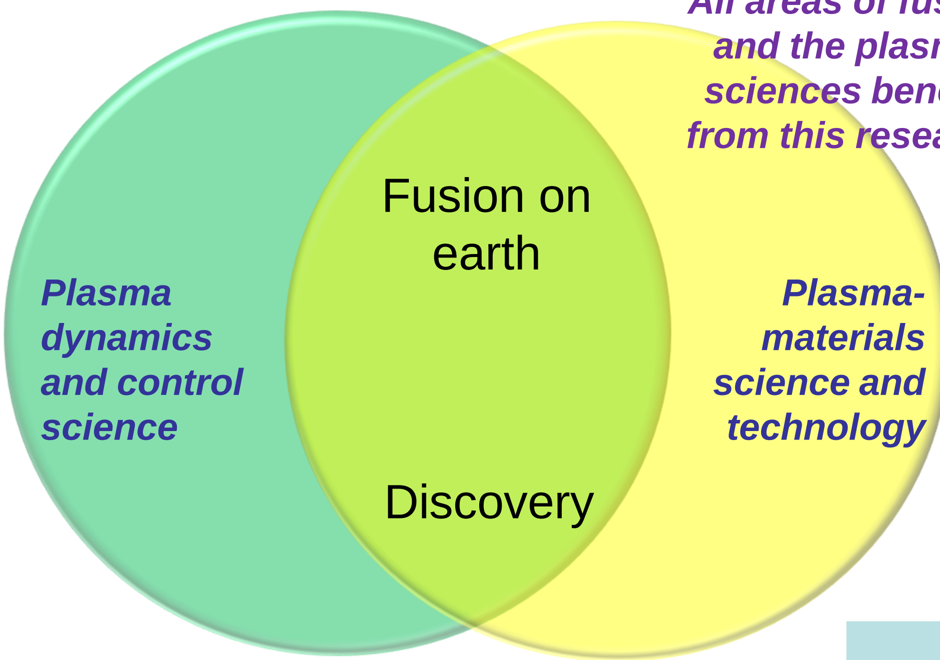
- Maintains critical level of effort to enable connections between non-tokamak and tokamak configurations
- Validation and verification emphasis maintained
- National lab/university teaming among confinement concepts is being developed to address questions of universal importance to magnetic fusion

# General Plasma Science and HEDLP portfolios emphasize discovery and the science of inertial fusion energy




*All areas of fusion and the plasma sciences benefit from this research*




***University-national lab partnership in joint program with NSF***

***Joint Program with NNSA nurtures emergent field of High Energy Density Laboratory Plasma physics***

***FES Plasma Science Centers enable focused collaboration between universities on range of topics relevant to fundamental science and industry***

| | FY2012 Enacted | FY2013 Proposed |
|---|---|---|
| High Energy Density Laboratory Plasma physics | 24,741 | 16,933 |
| | **FY2012 Enacted** | **FY2013 Proposed** |
| General Plasma Science | 16,780 | 13,151 |

- HEDLP program specifics will be informed by the outcome of a competitive merit review of much of the program in FY2012 and FY2013, the forthcoming NRC Inertial Fusion Energy (IFE) study report and the Department's response to it, and programmatic priorities.

- In GPS, commitments to NSF/DOE interagency activities will be maintained. Program balance of the laboratory GPS projects will be critically reviewed through competitive peer review.

# *On program planning*

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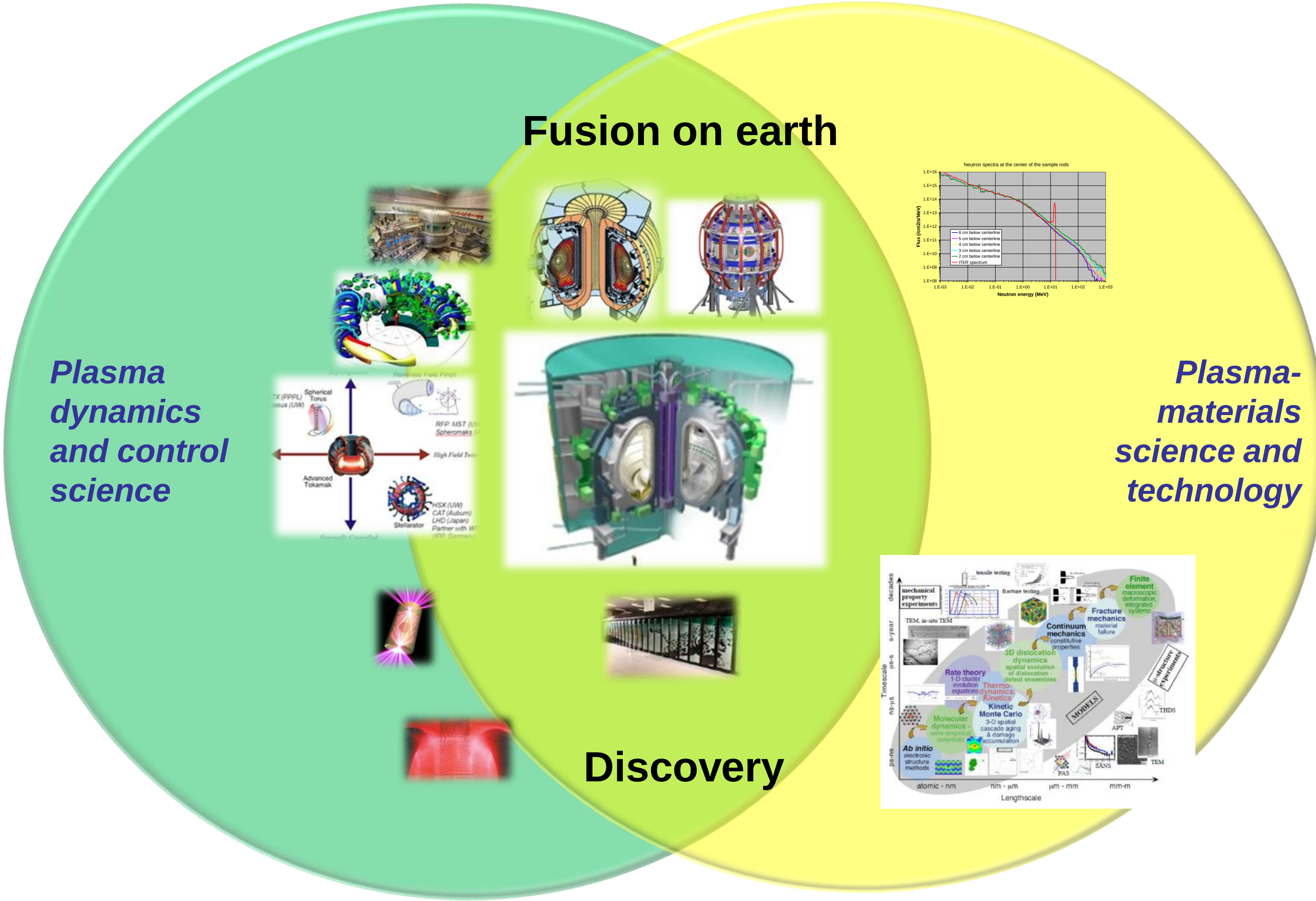
# Ultimately, the U.S. fusion's path forward will be expressed in terms of scientific elements and will include changes of emphasis




- Burning plasma science and stewarding broader plasma science will be key elements, but program scope may have to be reduced for lower funding level scenarios

- Major domestic facilities will still engage in plasma dynamics and control, but will shift focus towards challenging metrics relevant to fusion materials science

- Leverage between domestic and international research opportunities in MFE will become even more important in tough budget times, if the U.S. is to obtain access to the leading scientific questions in the next decade

# *FES is developing a strategic plan, to be presented to Congress in December 2012*

- *Mandated by legislative language accompanying the FY'12 appropriation*
- *Technical community input is needed*
- *What we have in hand includes ReNeW reports, the "Priorities, Gaps, and Opportunities" analysis, and FESAC's new input on international research and fusion materials science.*

# On gathering input and developing the report

- *FES will present a charge to FESAC to seek advice in time to be impactful. A charge or charges is/are being developed, and your thoughts on this will be welcome*

- *Timing: clarification on a couple of fronts will be beneficial*
  - *the Administration approach to ITER and the domestic program*
  - *the House and Senate marks this year*

- *Input from individuals on programmatic concerns and possible future structures is welcome at any time*

- *Plan will be developed by FES and shared with FESAC for comment, likely in the fall of ‘12*

# In developing a fusion program strategic plan, overarching considerations will include…

- The nurturing of a domestic program that enables a high degree of leverage and influence in the world, and will engage ITER in as scientifically constructive a manner as possible, with a high return for the U.S.

- Such a program must include a vigorous international component if U.S. scientists are to have access to research questions that will remain inaccessible within the U.S. alone.

- The development of a capability to make major contributions in fusion materials science and harnessing fusion power

- A priority of maintaining program breadth if budgets permit, noting that the prospect of further non-ITER program reductions may make it impossible to maintain present program scope.

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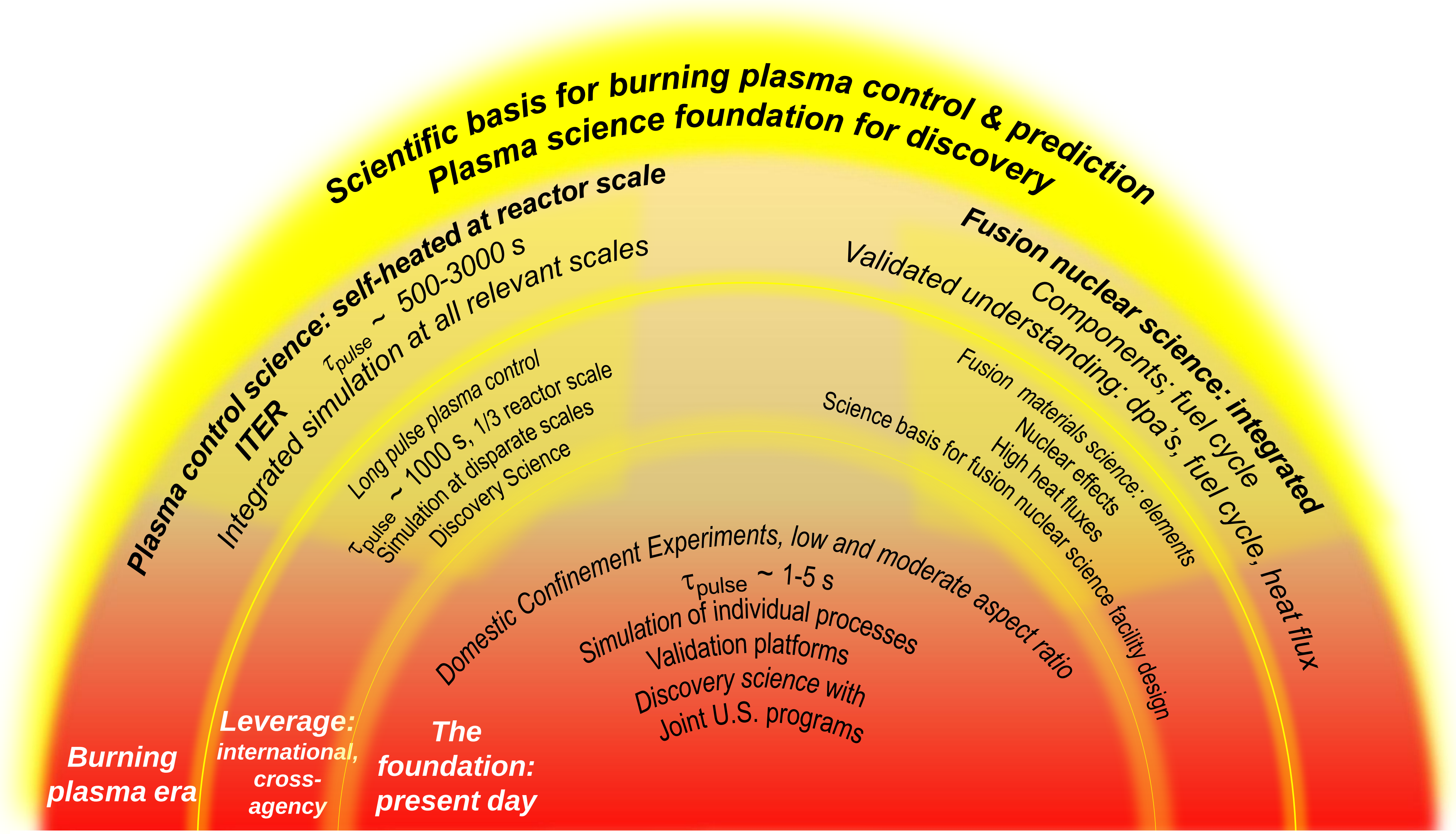
# Establishing the scientific basis for fusion requires strong domestic research and leverage across national and institutional boundaries



# *Thank you*