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# *Update and Outlook for the Fusion Energy Sciences*

E.J. Synakowski

Associate Director, Office of Science

Fusion Energy Sciences

For the University Fusion Associates

Town Hall Meeting

APS-DPP, Providence, RI

October 29, 2012



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## ***This has been an extraordinary year for fusion in the U.S.***

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- The budget was zero sum; ITER grows; non-ITER hit hard. You have asked, “What does this mean?”
- Tough decisions were made
- Commitment to ITER was affirmed at a very high level
- All in an extraordinary budget environment in Washington

*What follows is some context-setting, description of considerations, and elements of a path forward*



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But first:

- **The local:** FES business updates

Then, on the status and future of program

- **The past year and now**
- **The vision and planning**



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## ***FES has undergone a reorganization***

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- Two Divisions:

  - Research - Jim Van Dam, Division Director

  - New: Facilities, Operations, and Projects – Vacancy posted; closes on November 5.  
Senior Executive Service level

- This structure brings FES into alignment with the other offices in the Office of Science
- Facilities, Operations, and Projects Division will include facility operations formerly under the old Research Division, project construction, and US ITER Project construction
- Both Divisions will increasingly emphasize management Teams in FES to promote a topically aligned research and facility management approach

**Strategy and Budget  
Advisory Group**  
Division Directors  
Team leads  
Pamela Miller  
*Budget Formulation*

**Fusion Energy Sciences**  
**Associate Director, Office of Science**  
**Edmund Synakowski**  
Program Analyst: Pamela Miller    Administrative Specialist: Shahida Afzal    Chief of Staff: Gene Nardella

**Development**  
Sean Finnegan: *Sci Ed & Outreach*  
Sam Barish, *HBCU*  
Barry Sullivan, *SBIR*

**Research Division**  
**James W. Van Dam, Director**  
Program Analyst and Procurements: John Sauter  
Administrative Specialist: Marty Carlin    Administrative Specialist: Yvette Walker

**Facilities, Operations and Projects Division**  
**Edmund Synakowski, Acting Director**  
Administrative Specialist: Sandy Newton    International Agreement Administration: Debra Frame

**Theory and Simulation**  
**Simulation**  
John Mandrekas, Lead: *SciDAC, FSP, Theory*  
Sam Barish: *Validation Platforms, Stellarators*  
Sean Finnegan: *Theory, HEDLP*  
Steve Eckstrand: *NSTX, International*

**MFE Experimental Research Coordination**  
**ITER and AT Optimization**  
Mark Foster, Lead: *DIII-D, C-Mod*  
Steve Eckstrand: *NSTX, International Collaborations*  
Sam Barish: *Validation Platforms, Stellarators*

**Fusion Materials and Technology**  
**Materials Science and Enabling Technologies**  
Gene Nardella, Lead  
Peter Pappano: *Materials Science*

**Discovery Science and Joint Programs**  
**HEDLP and IFE science**  
Ann Satsangi, Lead: *HEDLP*  
Sean Finnegan: *HEDLP, Theory*

**U.S. ITER Project**  
John Glowienka: *ITER Program Manager, Contact Person*  
Tom Vanek: *Senior Policy Advisor, ITER, International Collaboration Agreements*  
Ed Stevens: *Enabling Technologies, MECI, ITER, ITER Test Blanket Modules*

**U.S. Domestic Research Construction Projects**  
Ed Stevens: *MECI, ITER, ITER Test Blanket Modules, Enabling Technologies*  
Barry Sullivan: *NSTX-U project, Enabling Technologies, ES&H*

**Theory and Experimental/Theory Coordination**  
John Mandrekas, Theory Lead  
Mark Foster, Experimental Lead  
Curt Bolton, *Physicist*  
Sean Finnegan: *Theory, HEDLP*  
Steve Eckstrand: *NSTX, International Collaborations*  
Samuel Barish: *Validation Platforms, Stellarators*  
Francis Thio: *Diagnostics, Validation Platforms*

**FNSF Science Basis**  
Steve Eckstrand, Lead: *NSTX, International Collaborations*  
Samuel Barish: *Validation Platforms, Stellarators*  
Mark Foster: *DIII-D, C-Mod*  
Gene Nardella: *Materials, Technology*

**Ed Stevens: Enabling Technologies, MECI, U.S. ITER Project Cost and Schedule, ITER Test Blanket Module**  
Al Opdenaker: *Advanced Design*  
Barry Sullivan: *Enabling Technologies, NSTX-U project, ES&H, SBIR/STTR*

**General Plasma Science**  
Ann Satsangi: Lead, *FES/NSF Joint Program, General Plasma Science*  
Nirmol Podder: *General Plasma Science, Low Temperature Plasmas, MST*  
Sean Finnegan: *General Plasma Science*

**U.S. Facility Operations**  
Steve Eckstrand, Lead: *NSTX, International Collaborations*  
Mark Foster: *DIII-D, C-Mod*

**3D topologies**  
Samuel Barish, Lead: *Validation Platforms, Stellarators*  
Steve Eckstrand: *NSTX, International*  
Mark Foster: *DIII-D, C-Mod*



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## *You've responded to many solicitations for FY 2013 funding*

| Solicitation  | Date Issued     | Proposals Due      | Current FY 2013 \$ available (Final amount depends on Appropriations) | FES Point of Contact(s)                    |
|---|-----------------|--------------------|---|--|
| <i>Theoretical Research in Magnetic Fusion Energy Science</i>   | March 27, 2012  | May 31, 2012       | \$4.5M/yr   | John Mandrekas                             |
| <i>Collaborative Research in Magnetic Fusion Energy Sciences on International Research Facilities</i>               | April 16, 2012  | June 21, 2012      | \$6M/yr   | Steve Eckstrand                            |
| <i>Laboratory Opportunities in Basic Plasma Science</i>   | May 11, 2012    | July 16, 2012      | \$1.4M/yr   | Nirmol Podder                              |
| <i>Diagnostic Systems for Magnetic Fusion Energy Sciences</i>   | June 22, 2012   | August 14, 2012    | \$3M/yr   | Francis Thio                               |
| <i>Collaborative Research in Magnetic Fusion Energy Sciences on the National Spherical Torus Experiment Upgrade</i> | July 18, 2012   | September 26, 2012 | \$1.7M/yr   | Steve Eckstrand                            |
| <i>High Energy Density Laboratory Plasma Science for Inertial Fusion Energy</i>                                     | June 22, 2012   | October 1, 2012    | \$5M/yr   | Ann Satsangi, Sean Finnegan                |
| <i>NSF/DOE Partnership in Basic Plasma Science and Engineering</i>  | On going        | October 5, 2012    | \$2M/yr   | Nirmol Podder, Ann Satsangi, Sean Finnegan |
| <i>SBIR/STTR Phase I</i>  | August 13, 2012 | October 16, 2012   | TBD   | Varies, depends on proposal area           |
| <i>High-Energy-Density Laboratory Plasma Science</i>  | August 13, 2012 | November 16, 2012  | \$2M/yr   | Sean Finnegan, Ann Satsangi                |
| <i>Office of Science Early Career Research Program (Required Pre-proposals due by September 6, 2012)</i>            | July 20, 2012   | November 26, 2012  | TBD   | Varies, depends on proposal area           |
| <i>Research in Innovative Approaches to Fusion Energy Sciences</i>  | Spring 2013     | TBD                | FY 2014 Funding (TBD)   | Sam Barish                                 |



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## ***ITER is looking for strong candidates for two important positions***

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- Rich Hawryluk is returning to the US as planned. The community owes him a great debt of gratitude.
- His position is as head of the Department for Administration, one of three departments that reports to the Director General
- Another high level position is for the Director of the Directorate for CODAC, Heating, and Current Drive. This person will report to Rem Haange, who reports to the DG
- Both are extremely important positions, and provide an opportunity for the US. Your support in identifying candidates, including yourselves, will be appreciated.
- The vacancies close on November 15, so the clock is ticking



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*Regarding the past year*



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## ***The budget that the Administration negotiated evoked big concerns in the fusion community***

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- Zero sum; ITER grows; non-ITER hit hard. You have asked, "What does this mean?"
- Tough decisions were made
- But yet a strong Administration commitment to ITER was affirmed.

The Administration recognizes the challenges that big projects present across the sciences in this era of constrained budgets.



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## ***Affirming the commitment to ITER: what has mattered***

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- The recognition that burning plasma science is the critical new frontier for fusion
- The readiness of the tokamak to strike for burning plasma science, so that fusion can be assessed and have an impact as soon as possible
- The readiness of the US to execute its project construction responsibilities smartly and responsibly
- The recognition that ITER science is informed by, and informs, a wide range of domestic research, and that the US can lead in ITER research
- The commitment the US has made to our international partners



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## ***Emphasized in the budget decisions: maintain an impactful, balanced portfolio***

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Considerations in developing the non-ITER portion of the budget, given the budget constraints:

- **Retaining program balance:** ensuring viable enterprises in HEDLP and General Plasma Science, as well as MFE
- **Retaining elements to execute the FES vision** for burning plasma science, long pulse steady-state research, and fusion materials science
- **Size of the budget challenge**



## ***Regarding concerns of young scientists... I received a letter (1)***

An open letter to Dr. Edmund Synakowski, the Associate Director of the DOE Office of Science for the Office of Fusion Energy Sciences:

This is a letter in response to the DOE Office of Fusion Energy Sciences (OFES) FY13 budget proposal; a letter from young research scientists and professors, those “under 40”, who have committed themselves to careers in plasma & fusion science.

Dr. Vyacheslav Lukin, Naval Research Laboratory  
Prof. Anne White, Massachusetts Institute of Technology  
Dr. Scott Baalrud, Los Alamos National Laboratory  
Dr. Aaron Bader, University of Wisconsin – Madison  
Dr. Jessica Baumgaertel, Los Alamos National Laboratory  
Dr. Igor Bepamyatnov, University of Texas at Austin  
Dr. Carrie Black, Oak Ridge Associated Universities  
Dr. Joshua Breslau, Princeton Plasma Physics Laboratory  
Dr. Daniel Casey, Lawrence Livermore National Laboratory  
Prof. Paul Cassak, West Virginia University  
Prof. Jason Cassibry, University of Alabama in Huntsville  
Dr. Christopher Crabtree, Naval Research Laboratory  
Dr. Gian Luca Delzanno, Los Alamos National Laboratory  
Dr. Ahmed Diallo, Princeton Plasma Physics Laboratory  
Dr. Ilya Dodin, Princeton Plasma Physics Laboratory  
Dr. Arturo Dominguez, Massachusetts Institute of Technology  
Dr. Mikhail Dorf, Lawrence Livermore National Laboratory  
Dr. Seth Dorfman, University of California, Los Angeles  
Dr. Rebekah Evans, Oak Ridge Associated Universities  
Dr. Raymond Fermo, Boston University  
Dr. William Fox, University of New Hampshire  
Prof. Kai Germaschewski, University of New Hampshire  
Dr. Brian Grierson, Princeton Plasma Physics Laboratory  
Dr. Ammar Hakim, Princeton Plasma Physics Laboratory  
Dr. Jeremy Hanson, Columbia University  
Dr. David Hatch, Max Planck Institute for Plasma Physics – Garching  
Dr. Christopher Holcomb, Lawrence Livermore National Laboratory  
Dr. Nathan Howard, Massachusetts Institute of Technology  
Prof. Gregory Howes, University of Iowa  
Dr. Yi-Min Huang, University of New Hampshire  
Dr. Jerry Hughes, Massachusetts Institute of Technology  
Dr. Grigory Kagan, Los Alamos National Laboratory  
Dr. Noam Katz, University of Wisconsin – Madison  
Dr. Deepak Kumar, Johns Hopkins University  
Dr. Matt Landerman, Massachusetts Institute of Technology  
Dr. LiWei Lin, University of New Hampshire  
Dr. Yijun Lin, Massachusetts Institute of Technology  
Dr. Yi-Hsin Liu, Los Alamos National Laboratory  
Prof. Alan Lynn, University of New Mexico  
Dr. Kenneth Marr, Naval Research Laboratory  
Dr. Eric Meier, Lawrence Livermore National Laboratory  
Prof. Saskia Mordijck, College of William and Mary  
Dr. Nicholas Murphy, Smithsonian Astrophysical Observatory  
Dr. Mark Normberg, University of Wisconsin – Madison  
Dr. Matthew Reinke, Massachusetts Institute of Technology  
Dr. Syun'ichi Shiraiwa, Massachusetts Institute of Technology  
Dr. Andrei Simakov, Los Alamos National Laboratory  
Dr. Artem Smirnov, Tri Alpha Energy, Inc.  
Dr. David Smith, University of Wisconsin – Madison  
Dr. Sterling Smith, General Atomics  
Dr. Bhuvana Srinivasan, Los Alamos National Laboratory  
Kelsey Tresemer, Mechanical Engineer, Princeton Plasma Physics Laboratory  
Dr. Alexander Tronchin-James, Lawrence Livermore National Laboratory  
Prof. Francesco Volpe, Columbia University  
Dr. Gregory Wallace, Massachusetts Institute of Technology  
Dr. Graham Wright, Massachusetts Institute of Technology  
Prof. Alexander Wurm, Western New England University  
Prof. Sethivoine You, University of Washington  
Dr. Howard Yuh, Nova Photonics, Inc.



## ***Regarding concerns of young scientists... I received a letter (2)***

The US plasma & fusion program must be in a position to understand and expand upon these new physics insights. The vibrant *domestic program* must be maintained and nurtured, so that today's graduate students and postdocs can become experienced scientists and leaders 15 years from now. Instead, the Administration's FY13 OFES budget redirects 1/6<sup>th</sup> of the FY12 domestic spending to the ITER project. If this trend continues, within the next two years hundreds of scientists and engineers at some of the premier US institutions will be laid off. In the long run, this will lead to *the permanent loss of some of the brightest young minds* from the US plasma & fusion program, and likely from the academic and research community altogether.

...

The “under 40” crowd, those expected to lead our field in the ITER era, respectfully request:

*Do not let the world-leading US plasma & fusion science program weaken in comparison to our partners and competitors. Instead, let us capitalize on the taxpayers' domestic R&D and ITER investments. Let us build a stronger and broader program to advance knowledge in basic plasma & fusion science and to prepare the US scientific workforce for the burning plasma era.*

**Concerns expressed:**

***ITER swallowing the domestic program***

**Need identified:**

***Maintaining an exciting, broad program that includes and goes beyond fusion***



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***The vision – moving forward***

***The FESAC Rosner Panel***



## ***There is an ongoing FESAC activity to assess MFE priorities***

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- Charge was issued in mid-April
- FESAC set up a subpanel to address the charge. Bob Rosner, chair. They've had three meetings (two with public comment), several conference calls, will have more...
- The charge is a difficult one, albeit very important
- The difficulty is compounded by the need for the panelists to set aside institutional concerns and deal with the big picture.
- We appreciate that the panel is striving to grapple with the big picture

What follows includes what I described to the Rosner Panel in the inaugural meeting in July



## ***The charge FESAC is asked to consider***

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1. With the focus on research that supports burning plasma science and that addresses critical challenges for long-pulse/steady-state operation including plasma-wall interactions and materials, prioritize among and within the FY2013 elements of the non-ITER magnetic fusion portion of the Fusion Energy Sciences program. Assume funding at the FY2013 Presidential budget request level of effort, and that a sustained investment in the US ITER project will extend over much of this decade. New elements may be inserted into the prioritization after FY2013, with an accompanying adjustment in priorities.
2. Considering the same focus as in (1), again prioritize the elements of the non-ITER part of the magnetic fusion portion of the FES program, but assume a restoration of the budget to the 2012 level for that part of the program. New elements may be inserted in the prioritization after FY2013.
3. Prioritize the elements of a U.S. program that has a substantially enhanced emphasis on fusion materials science. Consider the five year period following the roll-off in ITER project construction funding. Assume that the roll-off allows a 50 percent increase in the non-ITER magnetic fusion level of effort during that 5-year period over that in the FY2013 budget, and that research on fusion materials science and harnessing fusion power will capture much of this increase.



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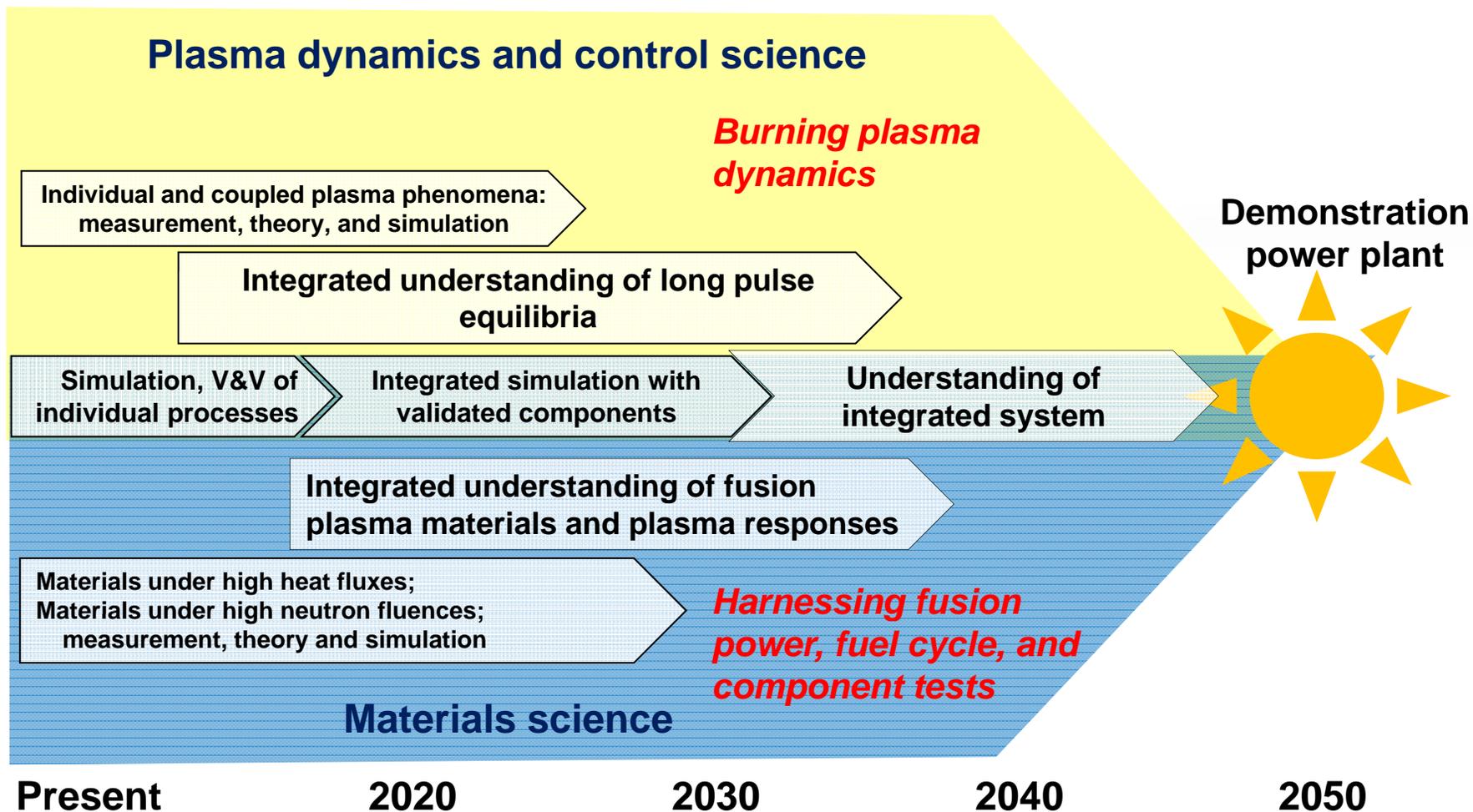
## ***Where we need to be in 10 years, in MFE***

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- **Elements of a vision for 2021:**
  - **ITER Research** - The U.S. has a strong research team hitting the ground on a completed ITER project in Cadarache. This team is capable of asserting world leadership in burning plasma science
  - **Fusion materials science** - The U.S. has made strides in fusion materials science and passed critical metrics in tokamak and ST operations with national research teams. It is prepared to move beyond conceptual design of a fusion nuclear science facility
  - **Extend the reach of plasma control science and plasma-wall interactions-** U.S. fusion research has successfully levered international research opportunities in long pulse plasma control science, plasma-wall interactions, and 3-D physics.
  - **Validated predictive capability-** The U.S. is a world leader in integrated computation, validated by experiments at universities and labs. Such computation should be transformational, as it must reduce the risks associated with fusion development steps



*What I have argued for in the Administration regarding fusion per se: two major thrusts need to be pursued to demonstrate practical fusion power on a relevant time scale*



*Path to fusion demonstration:  
scientific thrusts a la ReNeW*



## ***Opportunities for leverage need to be an important consideration in FES planning***

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- Reasons are many:

- FES cannot afford to live in scientific and political isolation if it is to continue to be as impactful as it has been. We need other communities to have a stake in our success.

- The scientific questions are too deep to ignore the insights of other communities

- Budgetary pressures imply that smart partnering will be supported within the Administration and on the Hill

- We already do much leveraging, but the opportunities go beyond what we do now

- FES/BES in materials

- US domestic and international MFE long pulse and PMI

- FES/NNSA in HEDLP

- FES/NSF in General Plasma Science

- FES/ASCR in computing



***FESAC is being asked to give advice that FES and SC will consider in developing a congressionally mandated plan***

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- The plan FES will develop will consider the priorities identified as input, but FESAC is not being asked to craft a plan per se  
Nonetheless, where we need to be in ten years is a critically important consideration.
- FESAC is being asked to consider MFE only, and not weigh the merits of MFE vs. general plasma science or vs. HEDLP and IFE, for example.
- All manner of contributors to MFE science are up for discussion: the roles of large facilities, university scale research, both large and small, the role of massively parallel computing and V&V now and a decade from now, how to best lever the emergence of international facilities, leverage possibilities elsewhere in the Administration, more...



## **Some perspectives on U.S. fusion and planning**

- *Maintaining the status quo – managing the elements we have if our spending power remains flat – is itself a risky path with guaranteed consequences*
- *The competition in the Office of Science is intense. Programs that grow are programs that promote change*
- *Scientific and intra-DOE isolation is a risky attribute that FES has lived with, both scientifically and politically. But smart leverage through partnerships can change this*
- *Scientifically: Our challenges are too deep, and the stakes are too high, to not use resources outside of our immediate sphere that could help advance the fusion cause.*
- *Politically: No one will help you fight for research dollars and defend you if they don't have a shared interest in and respect for your program*



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***Thank you***