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Update and Outlook for the Fusion Energy Sciences Program

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Fusion Energy Sciences

Fusion Power Associates Annual Meeting

Washington, D.C.

December 5-6, 2012



Outline of talk

- *FES Updates*
- *ITER Project*
- *Regarding the past year*
- *Moving forward*
- *Kudos*



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FES and US fusion “business” updates

Fusion Energy Sciences

Associate Director, Office of Science

Edmund Synakowski

Program Analyst
Pamela Miller

Administrative Specialist
Shahida Afzal

Chief of Staff
Gene Nardella

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

Research Division

James W. Van Dam, Director

Administrative Specialist
Marty Carlin

Administrative Specialist
Yvette Walker

Program Analyst and
Procurements
John Sauter

Facilities, Operations and Projects Division

Director search is underway (EJS, Acting Director)

Administrative Specialist
Sandy Newton

International Agreement Administration
Debra Frame

Development

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

Theory and Simulation

Simulation

John Mandrekas, Lead:
SciDAC, FSP, Theory

Sam Barish: *Validation Platforms, Stellarators*

Sean Finnegan: *Theory, HEDLP*

Steve Eckstrand: *NSTX, International*

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*

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*

FNSF Science Basis

Steve Eckstrand, Lead: *NSTX, International Collaborations*

Samuel Barish: *Validation Platforms, Stellarators*

Mark Foster: *DIII-D, C-Mod*

Gene Nardella: *Materials, Technology*

3D topologies

Samuel Barish, Lead,: *Validation Platforms, Stellarators*

Steve Eckstrand: *NSTX, International*

Mark Foster: *DIII-D, C-Mod*

Fusion Materials and Technology

Materials Science and Enabling Technologies

Gene Nardella, Lead

Peter Pappano: *Materials Science*

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*

Discovery Science and Joint Programs

HEDLP and IFE science

Ann Satsangi, Lead:
HEDLP

Sean Finnegan: *HEDLP, Theory*

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. 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*

U.S. Facility Operations

Steve Eckstrand, Lead:
NSTX, International Collaborations

Mark Foster: *DIII-D, C-Mod*

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 |



Recent major fusion meetings

■ **10th ITER Council Meeting**

Hosted by the US in Washington, DC, June 20-21, 2012

■ **24th IAEA Fusion Energy Conference**

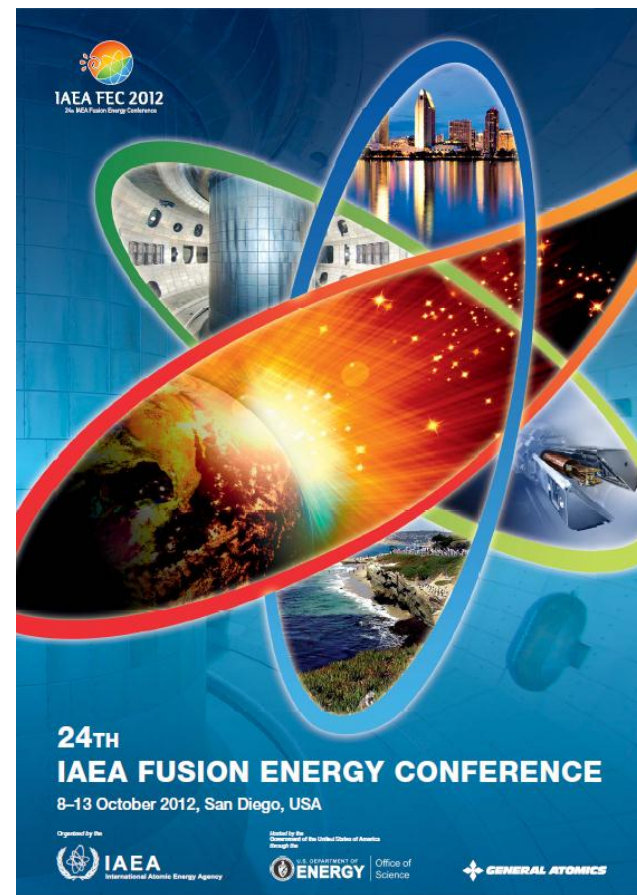
Hosted by the US in San Diego, CA, October 8-13, 2012

■ **Six ITPA topical group meetings**

Also hosted by the US in San Diego, the week after the IAEA Fusion Energy Conference

■ **IAEA DEMO Programme Workshop**

Hosted at UCLA Oct 15-18, 2012





The community made an impressive showing at the IAEA meeting in San Diego

- **A great deal of gratitude is extended to General Atomics for their highly successful hosting of this event**

- **Another signature of US research strength: *both* post-deadline talks awarded to US research teams**
 - State-of-the-art Neoclassical Tearing Mode Control in DIII-D Using Real-Time Steerable Electron Cyclotron Current Drive Launchers – Egeman Kolmen
 - Initial Snowflake Divertor Physics Studies on DIII-D – Steven Allen



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ITER Project



10th ITER Council Meeting was held in the U.S. in June in DC

The participants to the Tenth ITER Council Meeting stand together in the Ronald Reagan Building in Washington, D.C., on Thursday, 21 June.



"The US is committed in the project," stated Steven Chu, United States Secretary of Energy (right) as the tenth ITER Council began on 20 June in Washington, DC. Next to Chu: Council Chair Hideyuki Takatsu, speaking; ITER Director-General Osamu Motojima; and, right to left, deputies Rem Haange, Rich Hawryluk and Carlos Alejaldre. 9



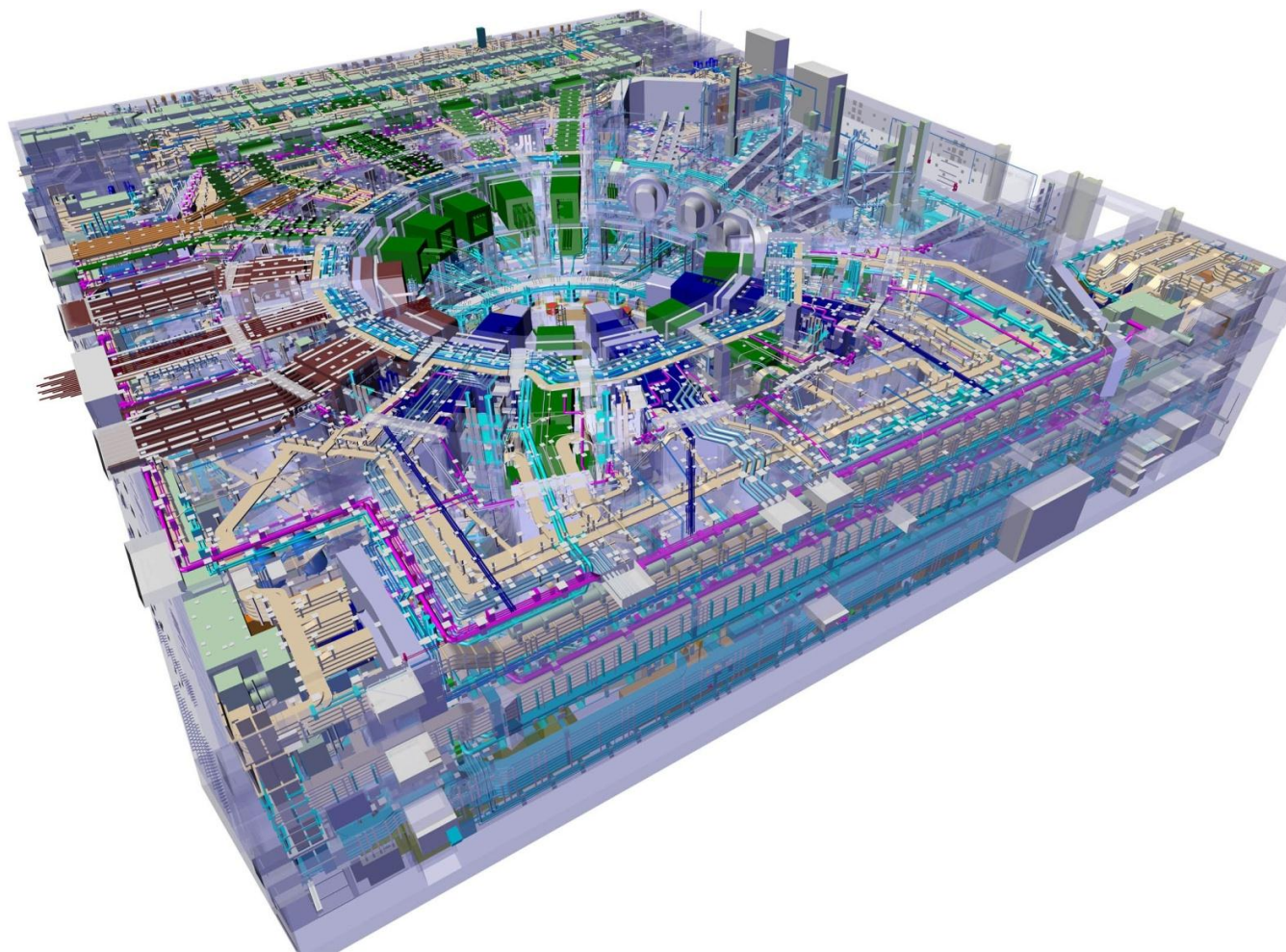
11th ITER Council Meeting was held last week in Cadarache



The Eleventh ITER Council convened on 28-29 November 2012 at ITER Headquarters. The Council noted the strong measures that have been taken by the ITER Organization and the Domestic Agencies to realize strategic schedule milestones and to develop new corrective measures for critical systems. The next ITER Council meeting is scheduled to take place in Japan in June 2013.



ITER tokamak complex



The heart of the ITER facility will be the Tokamak Complex, comprising the Tokamak Building, the Diagnostic Building, and the Tritium Plant. The seven-story Complex, measuring 118 m by 80 m and towering 57 m above the platform, will contain more than 30 different plant systems, including cooling systems and electrical power supplies, all having physical as well as functional interfaces. 11



ITER site

17,000 cubic metres of concrete went into the 1.5 metre-thick basemat slab, which was completed on 22 December 2011. The retaining walls were completed mid-March 2012.

November 2012 ITER Council Meeting will be held in the new Headquarters building



Staff will move in to the ITER Headquarters building this fall.
Photo: ITER Organization



The seismic pit of the Tokamak Complex is part of the common foundation for the Tokamak, Tritium and Diagnostic Buildings. Photo: ITER Organization



In June 2012, visitors tour the Poloidal Field Coils Building.
Photo: ITER Organization

Winding/assembly of 5 PF coils will begin in late 2012 in this 257-meter-long building



ITER is looking for strong candidates for two important positions

- **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 DDG Rem Haange, who reports to the Director General

- **The vacancies closed on November 15.**



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Regarding the past year



The budget that the Administration negotiated evoked concerns in the fusion community

- **Zero sum—ITER grows; non-ITER hit hard.**
 - The community has asked, “What does this mean?”

- **Tough decisions were made**

- **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



Affirming the commitment to ITER: what has mattered

- **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**



The budget decisions emphasized maintaining impactful, balanced portfolio

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 in MFE
 - In other words, not collapse the program to MFE-only science
- **The role of continuing and future escalation,** and how to maximize flexibility in coming years in light of the prospect that future non-ITER budgets are flat at best
- **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**



***If status quo is maintained for budgets,
we will lose if we don't make changes***

- **Buying power is being eroded annually by inflation. We see reductions in numbers of people, operations/capabilities, and research. This must be balanced with the need to conduct all activities in a safe manner.**
- **At least one scientific field (i.e. biomedical research and development price index) shows buying power is eroded faster than the normal measure (i.e. consumer price index) of inflation.**



Moving forward

There is an ongoing FESAC activity to assess MFE priorities

- **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**
 - Recently learned that FACA subpanels must also operate under the federal Conflict of Interest regulations
- **We appreciate that the panel is striving to grapple with the big picture**



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

- 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...



The charge that FESAC has been asked to consider

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.



Where we need to be in 10 years, in MFE

Vision elements:

- **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
- **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.
- **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
- **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



■ **Reasons are many:**

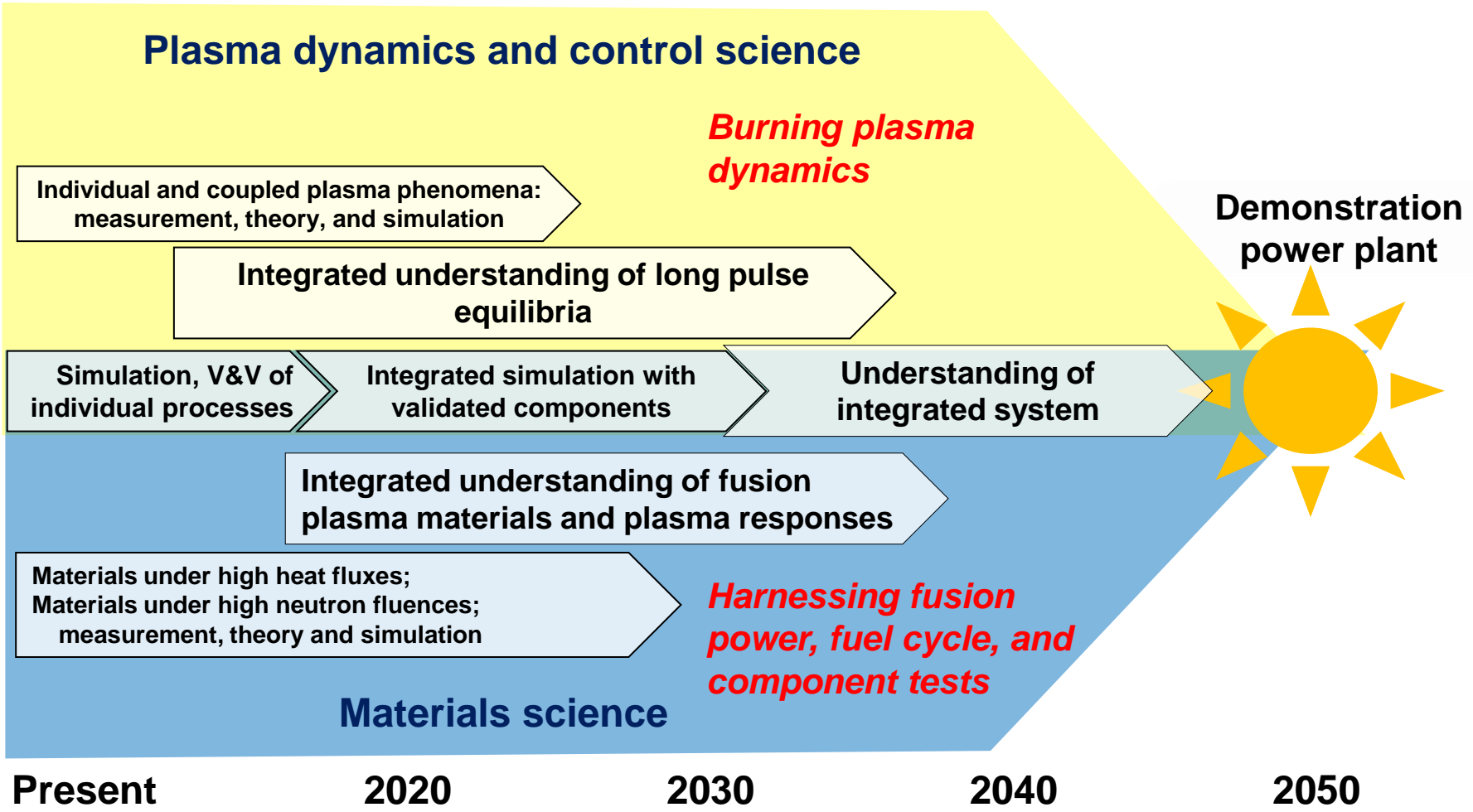
- FES cannot afford to live in scientific and political isolation if it is to continue to be as impactful as it has been. We need other communities to have a stake in our success.
- The scientific questions are too deep to ignore the insights of other communities
- Budgetary pressures imply that smart 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



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



Kudos



E.O. Lawrence Award



Riccardo Betti of the University of Rochester received E. O. Lawrence Award (2012)

Citation: *“Riccardo Betti will be honored for a series of impactful theoretical discoveries in the physics of inertial confinement fusion including seminal transformative work on thermonuclear ignition, hydrodynamic instabilities and implosion dynamics, and the development of innovative approaches to ignition and high energy gains”.*

Professor Betti received the E. O. Lawrence Award in the area of Fusion and Plasma Science during a ceremony hosted by Secretary of Energy Steven Chu on May 21.

In addition to his research in inertial confinement fusion, Prof. Betti has in parallel maintained a strong theoretical research effort in magnetic confinement fusion, with well-known papers on energetic particle physics, tokamak equilibria with toroidal flow, and macroscopic instabilities such as the resistive wall mode. He is the director of the Fusion Science Center for Extreme States of Matter, funded by the Office of Fusion Energy Sciences..



Nuclear Fusion journal prize



2012 Prize to Patrick Diamond (UCSD/NFRI):
Non-diffusive transport transport of momentum
and origin of spontaneous rotation in tokamaks

2011 Prize to Hajime Urano (JAEA):
Dimensionless parameter dependence of H-
mode pedestal width using H and D plasmas in
JT-60U

▪ **Awarded annually (since 2006) to recognize outstanding work published in *Nuclear Fusion***

- ✓ Selected by Board of Editors, based on citation record and scientific impact
- ✓ Past awardees: **Luce** (2006), Angioni (2007), **Evans** (2008), **Sabbagh** (2009), **Rice** (2010)
- ✓ 5 of 7 awards so far have gone to U.S. scientists (highlighted in red)





Thank you