United States
Burning Plasma Organization

Activities of the US Burning Plasma Organization

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Preparing for a "burning plasma era"

- U.S. Burning Plasma Organization (USBPO) was created in 2005 as a community-based entity
  - Mission: Advance the scientific understanding of burning plasmas and ensure the greatest benefit from burning plasma experiments by coordinating relevant U.S. fusion research with broad community participation
- Broad community participation:
  - Regular members (367 from 58 institutions)
  - Associate members (25 from 21 non-US institutions)
  - Council (12 members)
  - Research Committee (20) = leaders/deputy leaders of 10 Topical Groups
  - Directorate (5)
  - International Tokamak Physics Activity (ITPA): 49 Topical Group members + 3 Coordinating Committee members from the US

The USBPO organizes the US Fusion Energy Science community to support burning plasma research

Charles Greenfield (Director)
Amanda Hubbard (Deputy Director)
Nermin Uckan (Asst. Dir. for ITER Liaison)

USBPO Council:
Mark Koepke (Chair)
Chuck Kessel (Vice Chair)
10 at-large members

Research Committee made up of leaders and deputies of 10 Topical Groups

MHD & Macroscopic Plasma Physics	Integrated Scenarios
Pedestal and Divertor/SOL	Operations and Control
Fusion Engineering Science	Modeling and Simulation
Diagnostics	Confinement and Transport
Plasma-Wave Interactions	Energetic Particles

USBPO membership is open to any fusion researcher who joins one or more topical groups

USBPO Mission and activities

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Activities can be divided into three main elements:

1. **Communication:** *Ensuring that a broad community of interested and qualified researchers is well informed about and engaged in solving current burning plasma issues.*
2. **Coordination:** *When it is beneficial, coordinate and help prioritize US research on selected issues.*
   Actual research is done by FES-funded laboratories.
3. **Preparation:** *Prepare for operational phase of ITER, by encouraging broad, open participation and eventually helping form well qualified teams so US will maximize scientific benefit.*

Other USBPO activities…

- ITER Science and Technology Advisory Committee (STAC)
  - Advises ITER Council during twice-yearly meetings at ITER Headquarters
    - USBPO Director serves as one of five US participants along with R. Goldston (PPPL), E. Marmar (MIT), J. Rapp (ORNL), J. Van Dam (DOE)
  - USBPO organizes community briefings for US participants
- ITER International School scholarship program
  - 2014 topic was High Performance Computing
  - USBPO sent four students and four post-docs
- USBPO Director serves on ITPA Coordinating Committee along with S. Eckstrand (DOE) and R. Hawryluk (PPPL)
  - Advises DOE on US members and topical group leaders

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USBPO initiatives to disseminate information within the community

- Website: http://burningplasma.org
- Monthly eNews (distribution 566, both in and outside the United States)
  - Director's corner column, technical article, ITPA updates…
- Web seminars (estimated typical attendance ~70 people)
  - February 26: Todd Evans (GA)
    A Current Perspective on RMP ELM Mitigation
  - July 2: Chuck Kessel (PPPL)
    Fusion Nuclear Science Facility, What is it and What are the Plasma Requirements?
  - Sept 24: Rajesh Maingi (PPPL)
    Recommendations for ITER Operational Procedures and US ITER Team Formation and Management
  - Upcoming: Ned Sauthoff (Director, USIPO)
    ITER
- Contributed oral session at APS-DPP annual conference (next slide)
  - Town Meeting on ITER – not held every year… we plan to bring this back in 2015

"Research in Support of ITER"

Contributed oral session at APS-DPP (organized by USBPO)

Author	Institution	Title
S. Lisgo	ITER	Time-resolved kinetic modelling of ELM-induced tungsten influx in ITER
T. Eich	ASDEX-U	Revisited ELM divertor heat load scaling to ITER with JET and ASDEX Upgrade data
P. Stangeby	U. Toronto	Power deposition on the DIII-D inner wall limiter
P. Valanju	U. Texas	X-Divertors on ITER - with no hardware changes
B. LaBombard	MIT	High resolution edge plasma profiles in L and H-mode
T. Biewer	ORNL	Perspectives on the Final Design Review process from the US ITER DRGA team
R. Hawryluk	PPPL	Control of Plasma Stored Energy for Burn Control Using DIII-D In-Vessel Coils
C. Paz-Soldan	GA	Progress in Understanding DIII-D Low Input Torque ITER Baseline Scenario Stability
Y. In	KSTAR	Steady-state ELM-suppressed H-modes from KSTAR to ITER and beyond
E. Schuster	Lehigh	Physics-model-based Current Profile Control in DIII-D
M. Lanctot	GA	Control Solutions for High Performance in ITER with Test Blanket Modules
S. Wukitch	MIT	ICRF Compatibility with high Z metallic walls: Source and transport studies of conventional and field aligned ICRF antennas
D. Smithe	Tech-X	Modeling the ITER ICRF Antenna with Integrated Time Domain RF Sheath and Plasma Physics
R. Granetz	MIT	Runaway electrons and disruption mitigation
N. Commaux	ORNL	Rapid Shutdown using Large Neon Shattered Pellet in DIII-D

USBPO input to the FESAC Strategic Priorities Panel advocated for research supporting a successful ITER

- **C.M. Greenfield (USBPO Director):**
  Positioning the US to Play a Leading Role in and Benefit from a Successful ITER Research Program
- **T. Biewer (Leader, USBPO Diagnostics Topical Group):**
  A Burning Plasma Diagnostic Technology Initiative for the US Magnetic Fusion Energy Science Program

Feedback from the panel indicated that this input was very influential in their recommendations

Excerpts from Greenfield's presentation…

Activities are needed in three broad areas

Efforts in three areas must be prioritized to make ITER a success both in meeting its technical objectives and in moving forward the US Domestic Fusion program:

Make ITER succeed

1. **Inform ITER design decisions**
   The US is a strong contributor, and in some areas a clear leader, in ongoing research supporting ITER's design during construction. These activities are supported by ongoing US tokamak research, but rely on the availability of adequate resources and run-time.

2. **Prepare for leading roles in the ITER research program**
   The US is among the leaders in ongoing fusion science research that will prepare scientists to play leading roles in scientific exploitation of ITER, and US tokamak capabilities are world-leading in increasing fidelity to expected burning plasma conditions.

3. **Prepare the US to make use of the results of the ITER research program**
   A successful ITER research program along with progress in fusion nuclear science will provide much of the needed basis to proceed to a fusion DEMO. To position the US to benefit from ITER and proceed toward energy development requires continued strong domestic programs in tokamak physics, materials, and fusion nuclear science.

Position the US to benefit from the ITER Research Program

Current research is already addressing these areas

What are we asking you to endorse:

- The assets we have in hand are already world-leading in many ways that provide critical information for ITER
- Preparing for a successful ITER depends most strongly on our continuing to assign high priority to the needed research within the present programs
  - Run-time, upgrades, people,…
- Many of the initiatives being proposed to the panel will provide valuable new capabilities that enhance our probability of success
  - Tokamak upgrades for improved fidelity to ITER conditions
  - Computational capabilities for more advanced modeling and simulation
  - Technology developments both to contribute to ITER and to learn from ITER
- Continue to leverage our unique capabilities by partnering with international experiments with complementary capabilities

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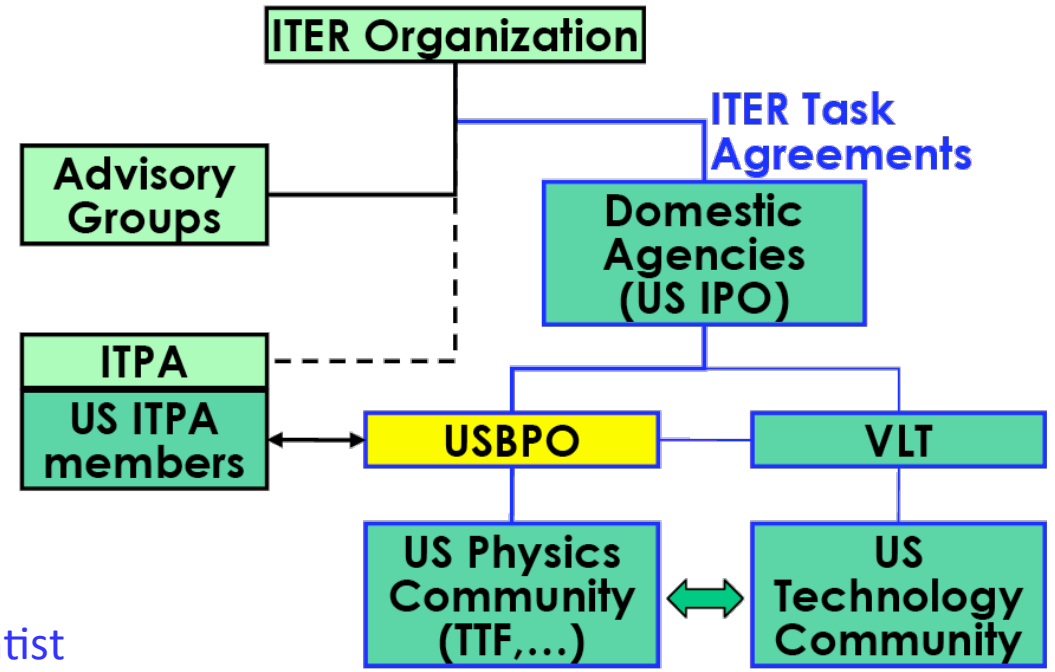
USBPO Role in ITER Support

- US ITER Project Office
  - US Domestic Agency for ITER
  - Provides hardware & technical contributions
- USBPO
  - Coordinates US burning plasma research, to advance scientific understanding & ensure greatest benefit from ITER
  - USBPO Director is also the US ITER Project Office Chief Scientist



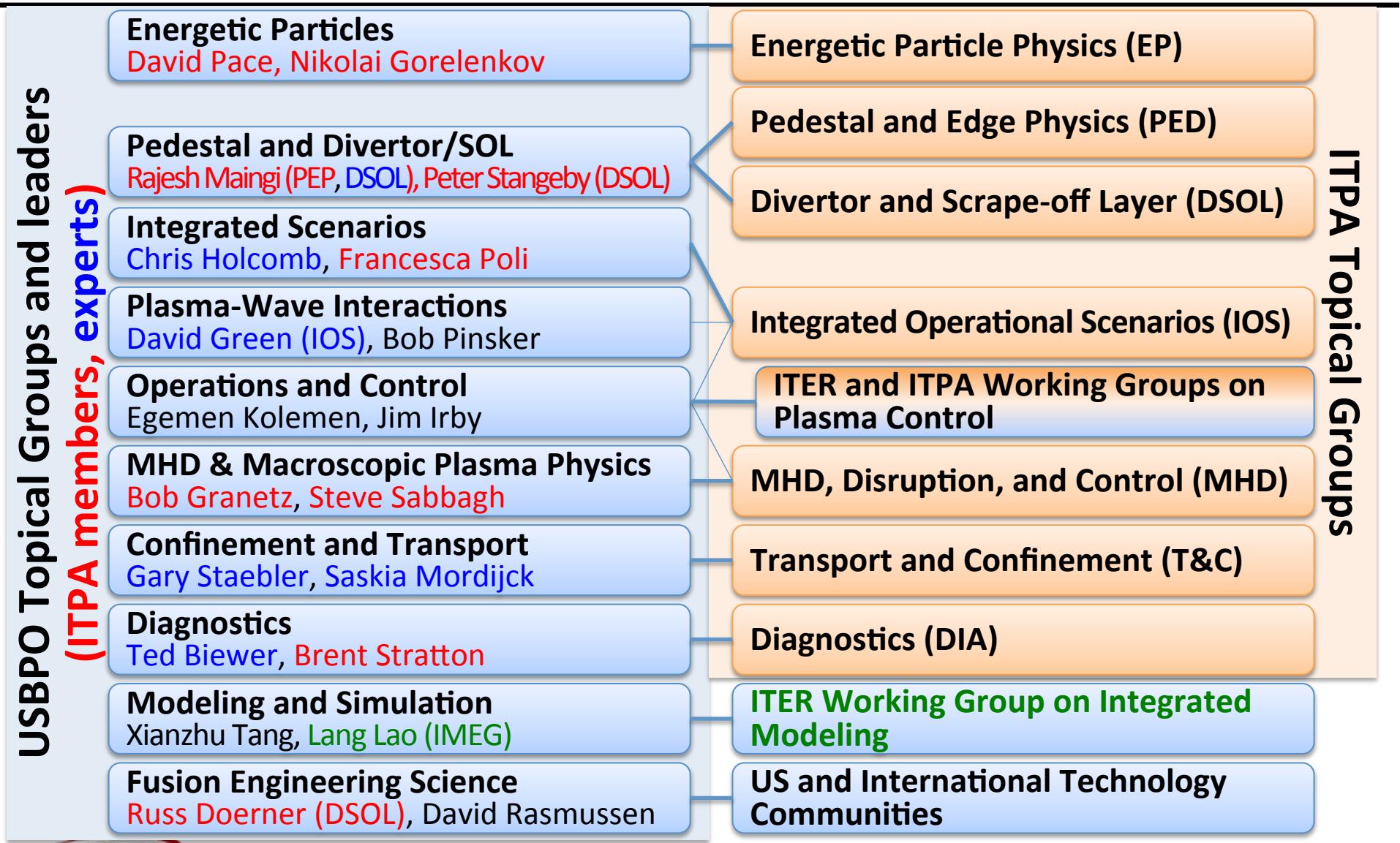
- International Tokamak Physics Activity (ITPA)
  - Under auspices of ITER Organization, acts as interface between ITER and worldwide burning plasma physics community
  - Addresses ITER's physics needs
    - Example: First tungsten divertor

USBPO-ITPA Integration

- USBPO is national base for US international activities in ITPA
  - Acts as community arm of US ITPA representation
- Coordination role
  - Publicize ITPA meetings
  - Reports back to US community via eNews and web seminars
  - Recommend US members for ITPA topical groups
- But… US ITPA participants have strong ties to individual research programs – broader coordination is not always needed

ITPA

The USBPO Topical Groups are strongly linked to ITPA Topical Groups and other burning plasma stakeholders



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Task Groups have been formed to address issues of special importance to the USBPO membership

- Disruption Task Group (Valerie Izzo, Bob Granetz)
  - Near term: Coordinating US research supporting ITER DMS specification
  - Longer term: Address disruption prediction and avoidance
- Modes of collaboration with ITER (Rajesh Maingi)
  - Nearing completion: Develop a US community vision of how we would like to work with ITER; anticipates later discussions among all ITER parties
  - Output: Recommendations on ITER operational procedures and US ITER team formation and management
- We are always seeking further opportunities to contribute
  - Under consideration
    - What physics can ITER do?
    - Burning plasmas beyond ITER, e.g. a Fusion Nuclear Science Program
  - Important to take into account: Where can USBPO "add value?"
    - If we can't make things better… stay out of the way!

Disruption Task Group

- USBPO DTG formed to coordinate US research toward ITER's Disruption Mitigation System (DMS)
  - DMS will be ITER's most pressing scientific issue for the next few years
  - All three major US facilities are active in developing physics basis
  - US responsible for delivering system (but specification to come from IO)
- Activities of the USBPO DTG
  - Coordinate 2014-2015 National Campaign (DIII-D, C-Mod, NSTX-U) on disruptions
    1. Study 3D and 0D aspects of locked mode mitigation
    2. Measure effect of extrinsic asymmetry (poloidal location of injector) on VDE mitigation
    3. Disruption avoidance & H-mode recovery after locked-mode
  - Create a framework for participation by broader community explicitly including theory community
  - Later: Address disruption prediction and avoidance

Modes of collaboration with ITER

Purpose of Study

- Chapter 1: Advise ITER Organization on US Device experimental procedures
  - Make recommendations for ITER procedures directly to IO
  - *Timely because CODAC decisions being made now; IO requested input on what activities need to be supported*
- Chapter 2: Advise FES on US ITER team formation and management
  - Highlight issues for three classes of participants: universities, national labs, and industry
  - Consider scale of effort and possible role of various organizations (ITER Project Office, BPO, etc.)
  - Identify data access and storage issues
- *The Task Group did not intend to come up with a position on which technical areas the US should focus*
- Draft report available at: https://www.burningplasma.org/resources/PDFS/taskgroups/BPO_ITER_Participation_FullReport_DRAFT%2022Sep2014.pdf

Final report anticipated January, 2015

The US Burning Plasma Community is addressing many key ITER R&D issues

Not always explicitly coordinated by the USBPO – here I am speaking as a representative of the US Burning Plasma Science community

1: Inform ITER design decisions

The ITER design is sufficiently advanced that construction is underway, but there are numerous technical issues that must be addressed to reduce risk when ITER operates

- ✓ Develop and qualify disruption prediction, avoidance, and mitigation techniques
- ✓ Prepare a physics basis for ELM control and ELM-free operating scenarios that can be extrapolated to ITER
- ✓ Extend current plasma control techniques to be effective in the burning plasma environment
- ✓ Develop standards for acceptable error fields and techniques to measure and correct them
- Qualify candidate heating and current drive upgrades for ITER steady-state scenarios
- *Be prepared to take up other issues as they arise during construction*

Work to address these issues is ongoing, but will require continued effort in the coming years

✓ US is a leader

2: Prepare for leading roles in a successful ITER research program

Plasmas produced in ITER will differ in important ways from those we can produce today. Improved understanding of how to extrapolate from current research will be important for reducing risk in the ITER research program.

- ✓ Advance the capability to simulate ITER plasmas using validated models
  - *Need to simulate each condition before attempting in ITER*
- ✓ Understand energetic particles and energetic particle driven instabilities
  - *Today's fast ions are a proxy for alpha particles in ITER*
- ✓ Develop plasma-based solutions for controlling heat flux on ITER's divertor
  - *Geometric variation (within constraints of ITER design) and divertor seeding for detachment*
- ✓ Develop and qualify ITER inductive and noninductive operating scenarios
  - *Scenarios must integrate core and edge solutions including high-Z materials and without large ELMs*
- Develop techniques to understand and mitigate damage to tungsten surfaces from helium plasmas in the non-nuclear phase and helium ash in the DT phase

We must develop and maintain a high quality scientific workforce who can represent the US program within the ITER Team

✓ US is a leader

USBPO U.S. BURNING PLASMA ORGANIZATION

3: Prepare the US to make use of the results of the ITER research program

- Maintain strong domestic programs in tokamak physics, materials, technology and fusion nuclear science throughout and in parallel with ITER research program
- The consequences of allowing the domestic program to shrink significantly in favor of ITER would be crippling to the post-ITER development of fusion as an energy source

Our mission will continue, but the specifics will evolve

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- Supporting successful completion of the ITER project (defined as providing a facility that is ready and able to carry out a successful research program) is our highest priority
  - Operational issues (e.g. operating scenarios) will eventually displace design issues (e.g. DMS) as we get closer to the transition to experimental operations
- Fusion Nuclear Science Program may be a consideration for USBPO in the future
- Roles of the USBPO
  - Use topical groups or form task groups to organize specific tasks
  - Facilitate the flow of information both to each other and outside the community
  - When USBPO involvement won't make things better, stay out of the way (e.g. ELM control and mitigation)
- The US FES community has been enthusiastic and effective in supporting ITER and the transition of our field to burning plasma science in general