

The U.S. Burning Plasma Program

by

C.M. Greenfield

Deputy Director, US Burning Plasma Organization

Presented at

**Fusion Power Associates Annual Meeting and Symposium
Livermore, California**

December 3, 2008



<http://burningplasma.org>

US FES community is actively preparing for the burning plasma era

- **Organization of the community for burning plasma research**
 - US Burning Plasma Organization (created 2005): currently 283 registered members from 46 institutions + 8 international Assoc Members
 - Virtual Laboratory for Technology; ITPA; US ITER Project Office
- **Technical participation in ITER design studies**
 - Design Review (25% of world-wide effort)
 - STAC Issues (36%)
- **Strategic planning for burning plasma science**
 - EAct Report (2006): USBPO & DOE response to 2005 Energy Policy Act
 - NRC Decadal Survey Report by the “Plasma 2010 Panel” (2007)
 - FESAC “Greenwald Panel” Long-Range Strategic Plan for MFE (2007)
 - Research Needs Workshop (June 2009) to propose initiatives



Outline

- **How work is organized**
- **Technical contributions to preparations for ITER**



Outline

- **How work is organized**
- Technical contributions to preparations for ITER



The ITER Design Review was not a model for future collaboration

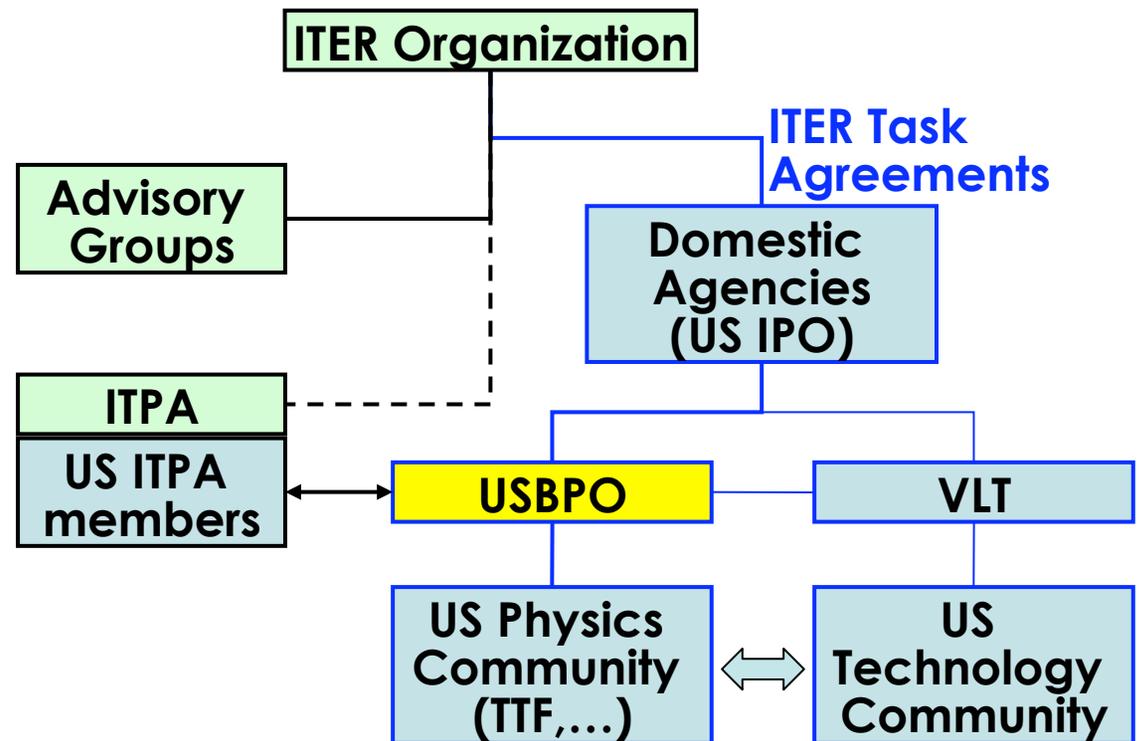
- **Need for rapid turnaround on design issues**
- **No clearly established channels for assignment of tasks**
- **Lots of confusion**
- **But... it worked!**
 - BPO helping to organize the US community
 - Success would not have been possible without an enthusiastic community and supportive institutional and OFES leadership
- **Lessons learned**
 - Informal cooperation between interested scientists does work - this should not be discouraged
 - Clearly established channels of communication and authority are needed to address “official” ITER issues
- **Design review process was a diversion from how we envisioned the USBPO working**



How ITER support research gets done

- **Various channels**

- “Official” requests from ITER Organization come through the Domestic Agency (i.e., IO to USIPO to USBPO)
 - Task Agreements
 - With or without ITER Credit
- Other tasks may come through the ITPA (now under ITER auspices) as Joint Experiments etc.
- Voluntary work by Members' base programs
- Self-generated USBPO tasks



The US was a leader in establishing domestic frameworks to perform ITER technical tasks



The US Burning Plasma Organization

Jim Van Dam (Director)
Chuck Greenfield (Deputy Director)
Nermin Uckan (Assistant Director for ITER Liaison)

Council:
Amanda Hubbard (Chair)
Mike Zarnstorff (Vice Chair)
+10 members at large

Executive Committee
members in red

Research Committee made up of Topical Group Leadership

MHD, Macroscopic Plasma Physics
Chris Hegna, Ted Strait

Integrated Scenarios
Chuck Kessel, Tim Luce

Boundary
Dennis Whyte, Tom Rognlien

Operations and Control
David Humphreys, David Gates

Fusion Engineering Science
Nermin Uckan, Richard Nygren

Modeling and Simulation
Don Batchelor, Jon Kinsey

Diagnostics
Steve Allen, Jim Terry

Confinement and Transport
Edward Doyle, John Rice

Plasma-Wave Interactions
Cynthia Phillips, Steve Wukitch

Energetic Particles
Raffi Nazikian, Donald Spong

ITPA

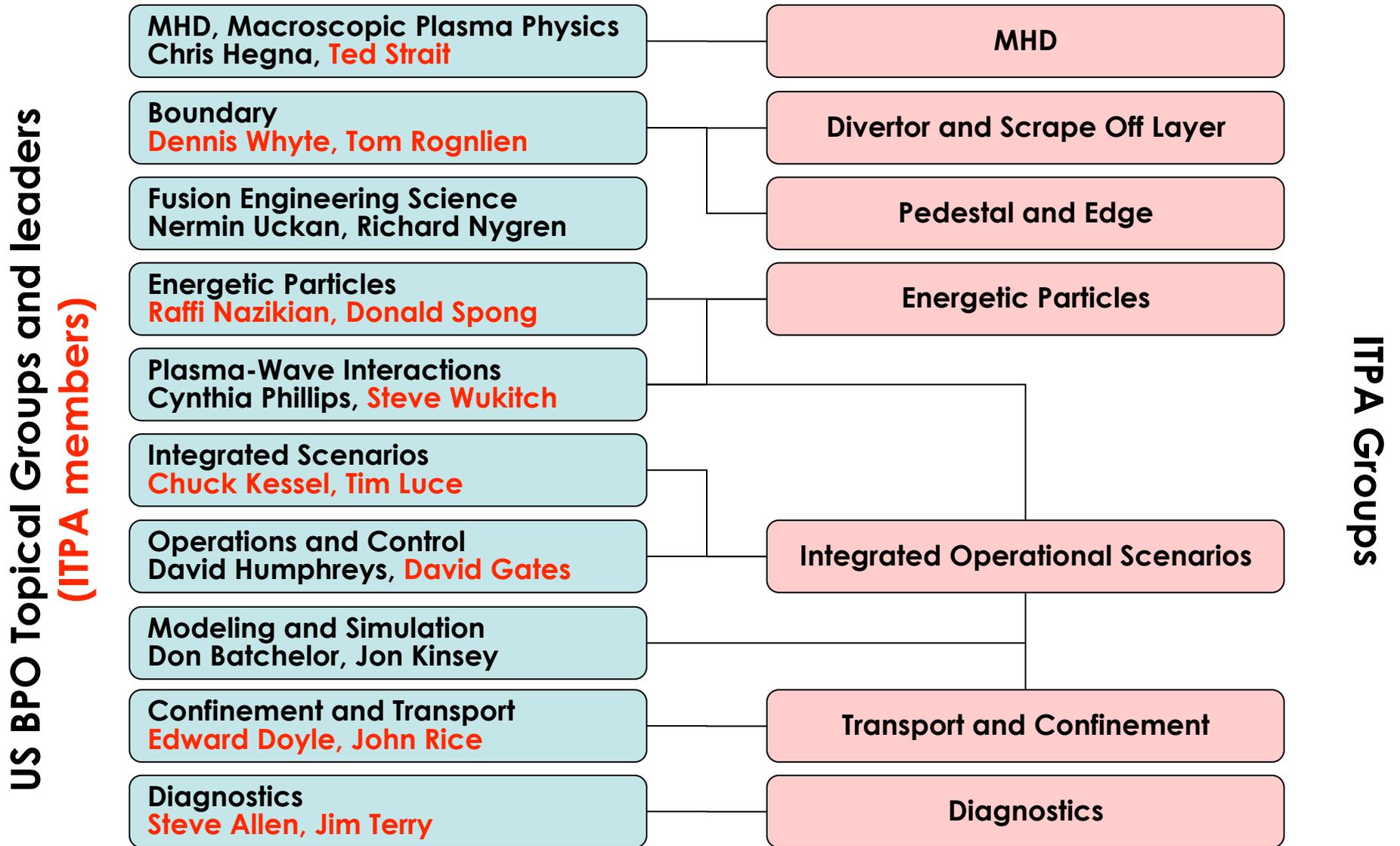


US actively contributes through ITPA

- **Internationally: ITPA is now under auspices of ITER**
 - Topical Groups are formulating research tasks in response to ITER R&D requests
 - International joint experiment annual planning meeting (Dec 11-13, 2008, at MIT)
 - US leadership for 7 Topical Groups (recently revised): 3 chairs & 1 deputy chair
- **Within the US: ITPA has been integrated with USBPO**
 - Strong overlap of USBPO and ITPA US topical group leaders and coordinators
 - Dissemination of information from ITPA meetings
 - Reports at USBPO Research Committee meetings; summaries published in eNews (USBPO monthly electronic newsletter); planning to use web seminars to inform the community about ITPA meetings
- **US participates in Topical Group meetings**
 - All topical groups met recently
 - As before, non-ITPA members may participate in the twice/year TG meetings
- **US participates in ITPA Coordinating Committee meetings**
 - US CC members = R. Stambaugh (CC chair), E. Oktay, N. Sauthoff, J. Van Dam
 - 9 US participants at June '08 CC Mtg (of 28); US scientists presented 4 of 7 TG reports



Each ITPA group has connections with one or more US BPO Topical Groups



Outline

- How work is organized
- **Technical contributions to preparations for ITER**



US strongly contributed to ITER Design Review

- **Design Review working groups**

- The US submitted numerous Issue Cards (via USIPO, USBPO, ITPA, VLT, etc.)
- 24 US official participants in the 8 Working Groups
- 160 additional scientists worldwide were involved through IO-DA work packages
 - Of this, 25% of the effort was contributed by the US
 - Example: ~100 scientists from >10 US institutions (and Canada) contributed to Working Group #1 (Design Requirements & Physics Objectives)
- Numerous US reports were submitted
 - Examples: 15 reports from DIII-D; PFC reports from MIT; PPPL reports on PF system; disruption mitigation requirements paper; etc.

- **Integrated Design Review meetings**

- US scientists participated in both meetings (July and Sept 2007) and made presentations for Design Change Requests



US community is actively addressing STAC Issues

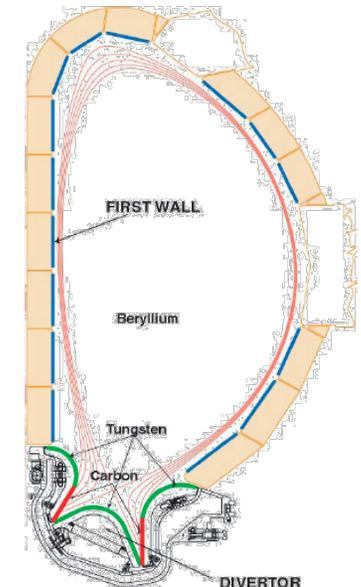
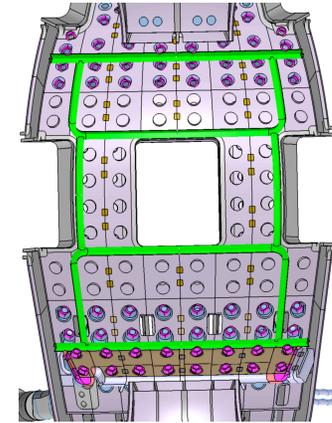
- **STAC Issues working groups**
 - US contributing 36% of total effort

Topic	Title	IO, US, & other DA leaders
T01	T01.a. Vertical stability T01.b. Shape control / poloidal field coils T01.c. Flux swing in OH operations & CS	D. Campbell, D. Humphreys (1.a), C. Kessel (1.b-c), G. Saibene (EU)
T04	ELM control	G. Johnson, R. Hawryluk, G. Janeschitz
T05	Remote handling	A. Tesini, B. Nelson, C. Damiani (EU)
T06	Blanket manifold remote handling	G. Johnson, M. Hechler, G. Federici (EU)
T07	First wall strategy (divertor armor)	M. Merola, M. Hechler, G. Federici (EU)
T08	Capacity of 17 MA discharge	D. Campbell, J. Wesley
T09	Cold coil test	P. Weng, J. Miller, M. Huguet (EU)
T10	Vacuum vessel / blanket loading condition	G. Sannazzaro, B. Nelson, G. Federici (EU)
T11	Test blanket modules strategy	V. Chuyanov, B. Nelson, L. Giancarli (EU)
T12	Hot cell design	M. Benchikhoun, B. Nelson, E. Di Pietro (EU)
T13	H&CD strategy, diagnostics, research plan	D. Bora, E. Synakowski, J. Jacquinet (EU)



Examples of how US is actively contributing to address high-priority ITER physics research needs

- **ELM control and mitigation**
 - RMP coil international design group for ITER (US leader and participants)
- **Disruption/runaway electron mitigation**
 - 5 US (out of 25) scientists participated in July workshop on runaway electrons
 - New USBPO task on disruption mitigation & radiation patterns
- **Plasma-facing materials**
 - Joint US program FY09 milestone on hydrogen retention
 - High-Z PFCs in C-Mod, O bake in DIII-D, Li studies in NSTX
 - USBPO task force on PFCs (coordinate with VLT)



More high-priority ITER physics research needs

- **Scenario development**

- US provided extensive design studies on PF system (start-up, flux swing, vertical stability): reported at 2008 IAEA Fusion Energy Conference
- USBPO task force on Heating & Current Drive mix

- **Diagnostics**

- ITER 2007 working group on diagnostics (chaired by US scientist)
- USBPO workshop on ITER diagnostics (Feb '07): led to ITER Diagnostics Needs White Paper, submitted to OFES, reported to FESAC (Nov 2008)



Other US contributions to ITER

- **US is positioned to contribute to ITER integrated modeling needs**
 - US has strong base program in simulation/modeling/theory (e.g., SciDAC projects and Fusion Simulation Project)
 - US scientists attended 1st ITER Integrated Modeling Workshop (Sept 2007)
 - ITER plans to set up Integrated Modeling Advisory Group, based on efforts in Members' domestic programs (Houlberg talk at ITER town mtg at 2008 TTF Mtg)
 - Paper on V&V by USBPO TG and TTF (published in *Phys Plasmas* 2008)
- **Additional USBPO tasks underway or being initiated**
 - EAct Report follow-up study (almost completed)
 - Support for continued development of ITER Research Plan
 - Test Blanket Modules task group



US ITER-related contributions reported at recent conferences

- **US scientists presented papers in the ITER session at the 2008 IAEA Fusion Energy Conference:**
 - 2 oral papers (out of 9)—one was the overall review of Design Review and STAC Issues work activities
 - 5 poster papers (out of 40 from IO and 7 Members)
 - 3 poster papers (out of 11) about ITPA research results for ITER
- **2008 APS-DPP Annual Meeting**
 - Oral contributed talk session on work related to ITER design and STAC issues
 - Special evening Town Meeting on ITER (also held one last year)



Ways whereby US participation in ITER is being communicated to fusion community

- **USBPO annual report (posted on web site)**
- **USBPO eNews**
 - Monthly issues, sent to 432 subscribers from 80 institutions (2X the membership)
- **Program leaders**
 - Fusion Facilities Coordinating Committee and Transport Task Force discussions
 - Plan to hold periodic videoconference consultations with US program leaders and OFES, to coordinate resources



NRC favorably assessed US participation in ITER

- **NRC Committee to Review US ITER Science Participation Planning Process**
 - CRISPPP meeting in Dec 2007 to review EPAAct Report: presentations from US (OFES, USIPO, VLT, USBPO) and also from ITER, Japan, and European Union
- **Statements from CRISPPP Report**
(<http://www7.nationalacademies.org/bpa/CRISPPP.html>)
 - The 2006 DOE plan for US participation in ITER is operating and has proven effective in beginning to coordinate US research activities and the development of the ITER program. US scientists have been well engaged in the planning for ITER....
 - The US ITER research program is at least as organizationally and technically mature as that of the other ITER participants....
 - An important consideration not reflected in the current DOE plan for US participation in ITER is...dissemination of information on and the results of ITER research activities to the broader scientific community.
 - To accomplish the US planning goals and facilitate the further development of the DOE plan...the USBPO should continue to be an essential point of communication, and serve as a home team to encourage broad cooperation and collaboration among all US participants in the ITER project.



US Fusion Energy Sciences community is actively contributing to ITER

- **Community organization is facilitating US contributions**
 - USIPO, USBPO, VLT work together with each other and with scientists, technologists, and institutions
 - ITPA is tightly coupled with these groups through the USBPO
- **ITER design and operational plans are undergoing continued development**
 - US will continue to provide strong scientific input
- **Next frontier for fusion energy science is to study burning plasmas**
 - The ITER facility—an unprecedented model for big-science international collaboration—will advance the development of fusion into this exciting new regime
 - Strategic planning for US participation in ITER will continue to evolve

