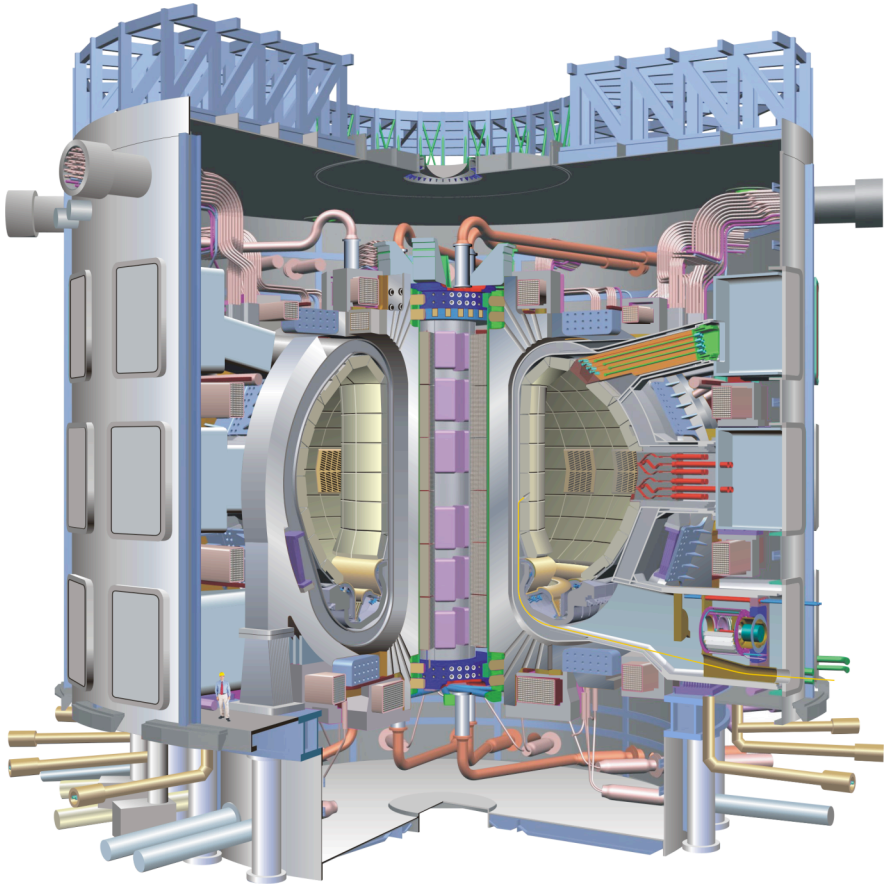
# USBPO Update & ITER Design Review Activities

**James W. Van Dam**
*US Burning Plasma Organization*
*US ITER Project Office*

**with input from:**

- USBPO Team
- US ITER Project Office
- US Design Review participants
- Virtual Laboratory for Technology
- OFES/USDOE
- ITER Design Review Coordinator

*FESAC Meeting (16-17 July 2007)*



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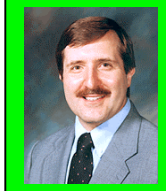
# Coordinating the US burning plasma effort

USBPO



**DOE Office of Fusion Energy Sciences**
R. Fonck, SC Assoc Director
Research Division
ITER and International Division

**US ITER Project Office**
N. Sauthoff, Director

**US ITER Chief Scientist**
(USBPO Director)

**US ITER Chief Technologist**
(VLT Director)

**ITPA**

**Virtual Laboratory for Technology**

**USBPO Council**
(14 members)

**USBPO Directorate**
Director
Deputy Director
Ass't Director for ITER Liaison
Research Committee

**US Burning Plasma Organization**

| | | | | |
|---|---|---|---|---|
| **Topical Group** MHD Stability | **Topical Group** Confinement/Transport | **Topical Group** Boundary | **Topical Group** Wave Interactions | **Topical Group** Energetic Particles |
| **Topical Group** Integrated Scenarios | **Topical Group** Fusion Engineering | **Topical Group** Modeling/Simulation | **Topical Group** Operation/Control | **Topical Group** Diagnostics |

# 1. USBPO update

# Diagnostics White Paper



- **USBPO Diagnostics Workshop (6-8 Feb 2007, San Diego)**
  - 50 onsite + 15 remote participants

- **Significant gap in US program**:
  - Need a funding mechanism in US program for development of innovative diagnostics for burning plasmas (ITER, companion experiments, DEMO)
  - USIPO supports in-kind procurement only for US-credited ITER diagnostics; some critical measurement needs are still unmet
  - Recent OFES diagnostics solicitation supports diagnostics for existing experimental facilities (but excludes burning plasma diagnostics for upcoming facilities)
  - *Diagnostics White Paper* (http://burningplasma.org/reference.html)

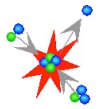
- **Proposed initiative (within existing OFES program)**:
  - Expansion to support development of short/long-term new burning plasma diagnostics
  - Integration of capabilities of burning plasma diagnostics into analysis/simulation codes and control systems
  - Execution of specific short-term tasks (e.g., assess “environmental” diagnostic issues, review ITER diagnostic systems of ITER Organization or other Parties, etc.)

# ITER un-credited diagnostic R&D needs



| Measurement | Required R&D | Priority |
|---|---|---|
| Confined alpha particles | New or very greatly evolved techniques | High |
| Lost alpha particles | New or very greatly evolved techniques | High |
| Magnetics | Radiation effects | High |
| Optical diagnostics | Erosion/redeposition, cleaning/restoring mirrors | High |
| Dust | New techniques | High |
| Tritium inventory and retention | New techniques | High |
| Optical diagnostics | New self-calibration techniques | Intermediate |
| Instability features (core & edge plasma regions) | Soft X-ray | Intermediate |
| Fuel composition | Fast wave reflectometry | Intermediate |
| Tile erosion | New techniques | Intermediate |
| Impurities | New techniques | Intermediate |
| Core fluctuations | New techniques | Longer term |

# New subcommittee on long-range burning plasma program strategy



USBPO

- **Set up by USBPO Council in March**
  - Follow-on to 2006 USBPO report for OFES response to Energy Policy Act
  - Anticipates NRC review; will coordinate with FESAC panel

- **Some of the questions to be addressed:**
  - What is the US research agenda for ITER?
  - How will ITER promote progress toward making fusion a reliable and affordable source of power and how should this progress be assessed?
  - How does ITER relate to other elements of the US Fusion Energy Sciences program?

- **Subcommittee membership:**
  - Chair: E. Marmar
  - Members: S. Allen, M. Bell, C. Forest, S. Knowlton, F. Najmabadi, H. Neilson, M. Peng, P. Snyder, G. Tynan, N. Uckan, D. Whyte

# USBPO activities at APS/DPP07 Meeting



- **Special evening session (Tuesday, 13 Nov) on burning plasmas**
  - Featured speaker:  Dr. G. Janeschitz, “ITER Design Review”
- **Invited tutorial talk**
  - “The Scientific Challenge of Burning Plasmas” (J. Van Dam)
- **Additional**:
  - USBPO Council luncheon meeting
  - Topical Group get-togethers
  - USBPO to help organize mini-conference *First Microns of the First Wall*
  - Plan to distribute a list of talks and posters relevant to burning plasmas

# Other USBPO updates



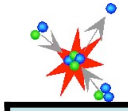
- **Wave-Plasma Interactions Topical Group Workshop**
  - 50 participants; held 9 May (following 17th Topical Conf on RF Power in Plasmas)
  - Focus: status of ICRF power lost in plasma edge versus absorbed into core region

- **Communications and organization:**
  - *USBPO eNewsletter*: published monthly (editor: R. Nazikian)
  - USBPO web site being converted to all-wiki format
  - New leadership for Integrated Scenarios Topical Group: C. Kessel (leader) + T. Luce (deputy) [USBPO Deputy Director C. Greenfield was the former TG leader]
  - Charter and Bylaws completed; considering amendment for foreign affiliate members

- **Participation in:**
  - Invited talk "How to Make a Big International Project Happen: Lessons from ITER" (April APS Mtg)
  - VLT-sponsored Test Blanket Module Workshop (30 May-1 June at ORNL)
  - ITPA-sponsored Topical Group Mtgs and the Coordinating Committee Annual Meeting

- **Publication of "Progress in the ITER Physics Basis" by the ITPA**
  - 9,000 downloads during first two weeks online (June special issue of *Nuclear Fusion*)

# ITPA meetings during 2007





| TOPICAL GROUP | LOCATION | DATE | COMMENT |
|---|---|---|---|
| Diagnostics | Princeton, USA | 26-30 Mar | |
| Transport Physics | Lausanne, Switzerland | 7-10 May | |
| Confinement Database & Modeling | | | |
| Pedestal and Edge | Garching, Germany | 7-10 May | |
| SOL & Divertor Physics | | | |
| Steady State Operation | Daejeon, Korea | 9-11 May | Before IAEA TCM on Steady State Operation |
| MHD | San Diego, USA | 21-24 May | |
| Coordinating Committee | Cadarache, France | 18-20 June | |
| Transport Physics | Naka, Japan | 1-3 Oct | After H-Mode Workshop (26-28 Sept, Tsukuba) |
| Confinement Database & Modeling | | | |
| Pedestal and Edge | | | |
| MHD | Garching, Germany | 11-12 Oct | After IAEA TCM on Energetic Particles (8-10 Oct) |
| Steady State Operation | Garching, Germany | 15-17 Oct | |
| Diagnostics | Chengdu, China | 29 Oct–2 Nov | |
| SOL & Divertor Physics | Toledo, Spain | 7-10 Jan 2008 | In conjunction with PSI paper selection meeting |
| IEA/ITPA Joint Expt Planning | Abingdon, UK | 29-30 Nov | |



*Provided by R. Stambaugh*

# 2. ITER Design Review activities

# Goals of ITER Design Review



- **Create a new Baseline Design 2007 that:**
  - Confirms or re-defines the physics basis and requirements for the project
  - Is the basis for procurement of long-lead items (vacuum vessel, magnets, buildings)
  - Provides input for Preliminary Safety Report
  - NOTE: Components/systems to be procured at later date, as well as issues with lower priority, will be examined later

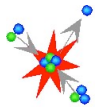
- **Establish ITER design decisions in detail on a broad basis**
  - Thus the fusion community and the Parties take ownership of the project

- **Broaden the knowledge basis into the Parties**
  - Essential for successful procurement of ITER components in-kind
  - Domestic Agencies will provide technical “coaching” of industry and Quality Assurance



*Provided by G. Janeschitz*

# ITER Design Review timeline



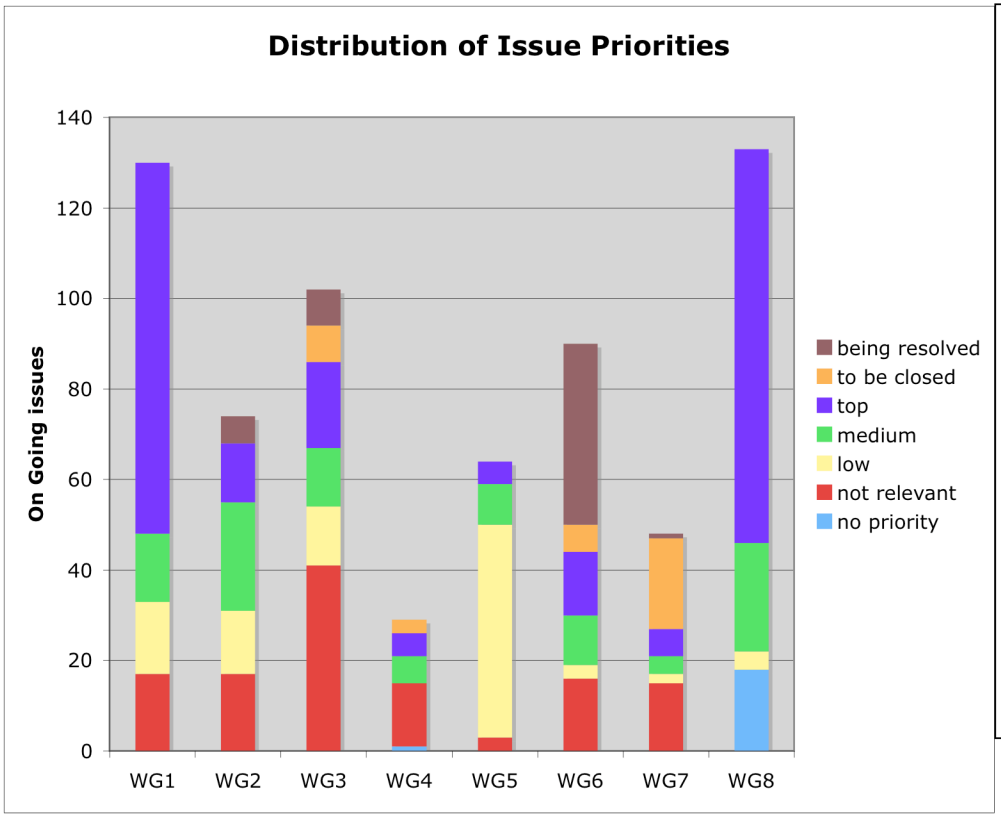


| | | |
|---|---|---|
| **2006** | **September** | Call for Issue Cards |
| | **December** | 8 Design Review Working Groups formed, to address Issue Cards |
| **2007** | **March** | List of US experts, effort estimates, and priorities for tasks of Working Group 1—discussed with US program leaders; sent by USIPO to Design Review WGs and ITER IO |
| | **March** | ITER IO guidance about PT resource allocations for design review |
| | **May** | WG1 subtask leaders contact US and international experts for work |
| | **June 15** | OFES Guidance Letter in response to OMB decision |
| | **July 6** | Revised list of US experts/effort/tasks provided to USIPO, which initiated paperwork with US institutions for work packages |
| | **July 16-19** | First set of Design Change Request decision meetings |
| | **Sept 11-14** | Second set of Design Change Request decision meetings |
| | **November 29** | Baseline Design 2007 to be presented to ITER Council |

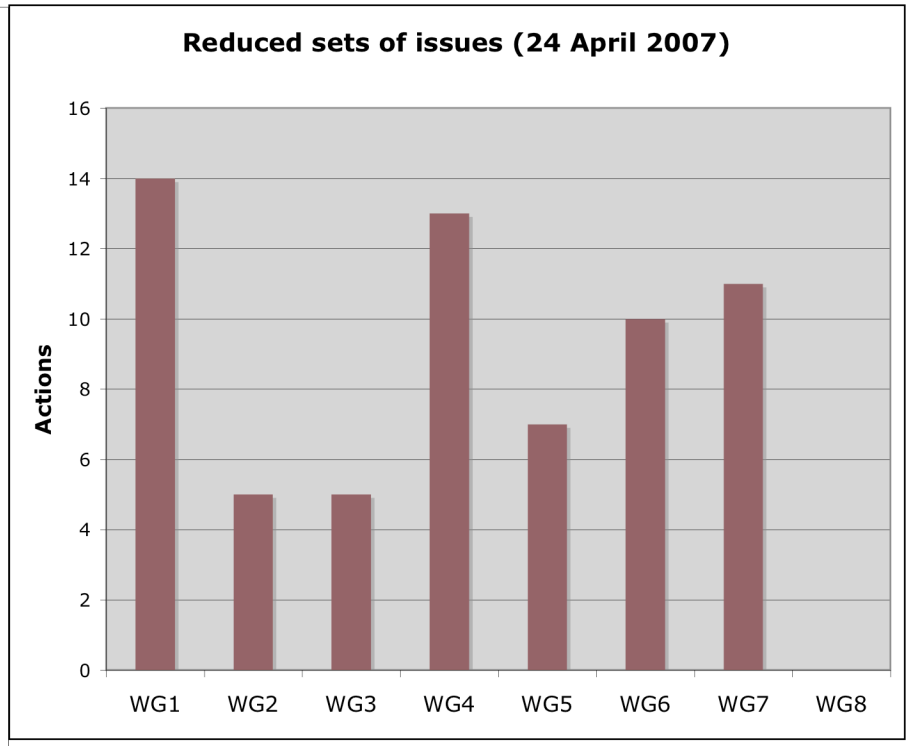
# ITER Issues



*Figures provided by G. Janeschitz*




**Issues were prioritized**
(dark blue = highest priority)




**Top priority issues (+ a few others) were combined into fewer number of issues covering same range of problems: thus, now 65 issue "families"**

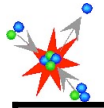
# Design Review is being performed by 8 Working Groups



| WG# | WG Name | Chair | IO Representative |
|---|---|---|---|
| WG 1 | Design Requirements & Physics Objectives | P. Thomas | D. Campbell |
| WG 2 | Safety & Licensing/Security | J-P Perves | J-P Girard |
| WG 3 | Site & Buildings | C. Strawbridge | J. Sovka |
| WG 4 | Magnets | M. Huguet | N. Mitchel |
| WG 5 | Vacuum Vessel & Interfaces | Songtao Wu | K. Ioki |
| WG 6 | Heating & Current Drive | J. Jacquinot | A. Tanga |
| WG 7 | Tritium Plant | D. Murdoch | M. Glugla |
| WG 8 | In-vessel components | I. Mazul | M. Pick/C. Lowry |

- **Participation**
  - WGs 1-8 involve approximately 150 members
  - Work packages have been agreed with the Parties, thus adding ~160 more persons
  - Estimate require extra PT resources of 82.4 PPY from the 7 Parties in 2007

# Tasks of Working Group #1 (DR&PO)



USBPO

| Task | Title | Leaders (+IO) | IO | CN | EU | JP | KO | IN | RF | US | Sub-totals | Issue Cards |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Project develop. plan | Kamada | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 24 | |
| 2 | Sensitivity studies | Stambaugh | 6 | | 11 | 4 | | | | 13 | 34 | 1 |
| 3 | Ripple requirements | Thomas | | | 5 | 5 | | | 2 | 2 | 14 | 4 |
| 3a | Ripple from TBMs | Thomas | | | 1 | | | | | | 1 | |
| 4 | Disruption, VDE | Sen | | | 2 | 2 | | 2 | | 2 | 8 | 7 |
| 5 | Choice of PFC | Lackner | 1 | 1 | 5 | | 1 | 1 | | 5 | 14 | 22+19 |
| 6 | Tritium breeding blanket | Lackner | | | 1 | | | | | | 1 | 3 |
| 7 | Startup scenarios | Saibene | 2 | | 24 | | | 12 | 24 | 12 | 74 | 6 |
| 8 | RWM/ELM control coils | Hawryluk | | | 10 | 1 | | | | 18 | 29 | 8 |
| 9 | Gas loads (ELM, disrupt) | Hawryluk | 1 | | 1 | | | | | 2 | 4 | 5 |
| 10a | Reliability (definition) | Chiocchio, Kaye | 1 | | 2 | | | | | | 3 | 3 |
| 10b | Reliability (execution) | Chiocchio, Kaye | 12 | | 6 | | | | | 6 | 24 | |
| 11 | Maintenance (cryostat) | GS Lee | 5 | | | | 1 | | | | 6 | 1 |
| 12 | Heating & current drive | Stambaugh | 10 | | | 5 | | | | 3 | 18 | 11 |
| | Totals (# persons) | | 41 | 4 | 71 | 20 | 5 | 18 | 29 | 66 | 254 | 88 |

# OFES Guidance Letter



- **Work requested by IO (via WG leaders) eligible for USIPO support**
  - All Parties' efforts in the Design Review are voluntary (no ITER credit).
  - Parties and IO reach agreement on tasks, performers, and deliverables. Each Party responds to IO's task request with its proposal of performers.
  - Pool of US performers (non-members of ITER Project) had been identified by USBPO, VLT, and USIPO.
  - Performer effort should exceed *de minimis* level (2-3 weeks) .
  - USIPO will issue work packages for major performers for tasks.

- **Ongoing broader ITER-related research not included**
  - E.g., joint experiments and general burning plasma research of ITPA

- **Estimated 15-20 FTEs through end of CY 2007 (plus int'l travel)**

# Current status of US proposed work



- **USBPO recently recommended enhancements of effort:**
  - Vertical stabilization requirements for range of operating scenarios
  - Gas fueling/pumping requirements with pellet pacing for ELM control
  - Disruption, VDEs, and runaways

- **Work/funding packages are currently being set up by USIPO**
  - Activity descriptions, deliverables, costs (including FTMS foreign travel)
  - Performers to report progress on periodic basis

# First set of Design Change Request decision meetings this week



- **Very important meetings**
  - Half-day sessions with each of the 8 Design Review Working Groups
  - To be attended by WGs 1-8 leaders/representatives, ITER Organization management, and PT leaders/representatives

- **Examples of WG-1 design change requests:**
  - First draft of ITER research plan
  - First results of sensitivity study on performance versus main parameters
  - Start-up scenarios and stability, for PF coil modifications
  - Ripple requirements
  - Exchange of the first wall
  - Heating and current drive requirements: start-up set
  - RWM and ELM control requirements and specification

- **Second set of Design Change Request meetings in September**



*Provided by G. Janeschitz*

# Example: ELM control and RWM coils



- **Techniques for active control of ELMs appear essential to ITER mission**
  - Requirement Change to be proposed at the July DCR meetings
- **Resistive Wall Mode control would enhance steady-state and technology testing aspects of ITER mission**
  - Suitable coil solution for ELM control could be adapted to RWM control needs
- **Two internal coil options (blanket interface and port-plug) have been identified and are being analyzed**
  - Key issue is engineering feasibility; US engineers have been participating in a scoping study
- **US researchers and engineers have worked closely with WG 1 members, EU researchers, and the IO**



*Provided by R. Hawryluk*

# Concluding comments



- **The ITER Design Review effort is geared up**
  - Working to successfully overcome “growing pains” related to communication needs and PT/national programmatic differences
- **US needs to learn how to respond to IO work requests**
  - Recent highly specific request via a fixed-cost contract
- **A comprehensive Design Review will lead to the best facility possible to achieve ITER’s mission**
  - The US is making all reasonable efforts to ensure the success of the ITER Project and protect US interests by supporting the Design Review with appropriate expertise and effort