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Dear Burning Plasma Aficionados:

This newsletter provides a short update on U.S. Burning Plasma Organization activities. E-News is also available online at <http://burningplasma.org/enews.html> Comments on articles in the newsletter may be sent to the Editor (Tom Rognlien troglien@llnl.gov) or Assistant Editor (Rita Wilkinson ritaw@mail.utexas.edu).

Thank you for your interest in Burning Plasma research in the U.S.!

Director's Corner by J. Van Dam

USBPO Talk at FPA Annual Meeting

At the recent Fusion Power Associates Annual Meeting (December 2-3, 2009, Washington, DC), Amanda Hubbard, Chair of the USBPO Council, presented a talk entitled "U.S. Burning Plasma Organization: Supporting U.S. Scientific Contributions to ITER," which can be found at (<http://burningplasma.org/reference.html>).

5th ITER Council Meeting

The ITER Council held its fifth meeting November 18-19, 2009, at Cadarache, France. The meeting began with an address from the French Minister for Research and Higher Education and the French State Secretary for European Affairs, which contained the following important statement:

The most recent project reviews have in effect revealed cost increases and the necessity of carefully taking into account possible technical unknowns. This is not surprising for a project of this scale, and must in no way be an obstacle to its development and its success in the long term. ITER, as we all know, is one of the most ambitious worldwide scientific programs of all times. Its success in demonstrating controlled nuclear fusion over the next decades could well change for the better the way we all live on Earth, and allow future generations to benefit from an abundant and nearly inexhaustible form of

energy that is respectful of our planet. What is at stake could affect every single person living on Earth, at a time when the world is preparing the Copenhagen Summit on climate change.



ITER Council meeting in the new conference center room at the Chateau de Cadarache
(photo courtesy of ITER Organization *Newsline* #108)

This Council meeting marked the end of terms of office for Chris Llewellyn Smith as Chair of the ITER Council, for Bob Iotti as Chair of the ITER Council Management Advisory Committee (MAC), and for Predhiman Kaw as Chair of the ITER Council Scientific and Technical Advisory Committee (STAC).

Former Vice-Chair Evgeny Velikhov (Russian Federation) was elected as the new Chair of the ITER Council. Yuanxi Wan (China) was appointed as the new Chair of the STAC, and Gyung-Su Lee (Korea) as the new Chair of the MAC.

Status of ITER

In a talk presented at the Fusion Power Associates Annual Meeting in December, Norbert Holtkamp (Principal Deputy Director-General of ITER) summarized the current status of ITER activities. He noted that at its November meeting, the ITER Council had difficulty accepting the baseline as presented, and that it had requested the ITER Organization and the Domestic Agencies to analyze the implications of implementing risk mitigation measures. The ITER Council also asked the ITER Organization and the Domestic Agencies to minimize any further schedule slip and present a realistic schedule that can be achieved by all ITER Members. The schedule will be submitted in February, and it is likely that the ITER Council will consider it at an interim Council meeting in March 2010. The schedule should optimize the phase between First Plasma and First DT Operation so as to shorten or maintain the 2026 DT date as much as possible. Dr. Holtkamp noted that baseline approval is expected in June 2010 including improvements and, in the meantime, it is essential to start all critical path components and especially the construction of the ITER buildings.

In his FPA talk, Dr. Holtkamp also mentioned the in-vessel coils for vertical stability and ELM mitigation, referring to their production and cost as issues. Let me comment that the STAC-7 report from the ITER Council's Science and Technology Advisory Committee recommended that category-1 chits from the in-vessel coils Conceptual Design Review should be resolved by the time of the Blanket Shield Module Conceptual Design Review that is planned in February 2010

and that, if unsuccessful, a new plan for vertical stability and/or ELM control should be presented at the next STAC meeting. However, the ITER Council did not act on the in-vessel coil recommendation from STAC. Also, the ITER Organization has not yet officially requested the ITER Council to approve the in-vessel coils. Because of the significance of ELM control for ITER, the USBPO recently circulated a request from the US ITER Project Office encouraging studies of mitigation methods in addition to that of resonant magnetic perturbation (RMP) coils.

All of the talks presented at the Fusion Power Associates meeting, including that of Dr. Holtkamp, can be found at <http://fusionpower.org> (click on Annual Meetings and Symposia).

ITER Physics Task Agreements

The ITER Organization recently published a new Physics Task Agreement solicitation for an independent verification of blanket first-wall surface shaping. To quote the description of the work being requested:

Following the 2007 ITER design review, the blanket system is being redesigned. One aim of the redesign is to provide handling capability of plasma parallel heat loads. The first wall is shaped to form self-protecting poloidal limiters. This allows reducing or eliminating high heat loads on the lateral sides of FW panels due to port openings or assembly misalignment. In addition, it is intended to use the first wall as plasma limiter during start-up and ramp-down.

This shaping is done while conserving the current BM segmentation. Each FW panel is individually shaped so that the poloidal limiter configuration is obtained. This shaping is calculated following a rationale leading to a given recess of the panel edges. The magnitude of the recess needs to be independently checked.

The design should aim at staying within the allowable limits derived from the ITER requirements during steady state situations and minimizing damage during off-normal transient events.

Groups who are interested in this new solicitation should contact Wayne Steffey (steffeyrw@ornl.gov) at the US ITER Project Office.

During the past year, 13 proposals were submitted from the US for the 16 Physics Task Agreements that had been issued to date. According to the US ITER Project Office, US proposals were approved for approximately half of them, specifically, for the following Physics Task Agreements:

- Study of error fields using ideal perturbed equilibrium code
- Study of control of plasma current, position and shape
- Self-consistent simulations of plasma scenarios
- Benchmarking and update of TSC codes and simulations of ITER disruptions/VDEs scenarios
- Task on the error fields measurements without plasma
- Task on the error fields measurements using plasma response
- Task for self-consistent transport simulations of plasma scenarios with fixed-boundary equilibria
- Task for edge magnetic field structure for ELM control in ITER and associated power/particle fluxes to plasma-facing components

TBM Simulation Experiments

A preliminary report entitled "Initial Report on the ITER Test Blanket Mock-up Experiments on DIII-D" has been prepared by Joe Snipes (ITER) and the International TBM Team, which summarizes the experimental observations from the recent campaign. Based on control room observations, the applied perturbation appears to have had little impact on plasma performance.

Much additional analysis remains to be done, however, and the detailed results will be reported in refereed publications. This experimental effort was initiated by a request by the ITER Organization, was strongly endorsed by the DIII-D Program Advisory Committee, and was supported by the US Office of Fusion Energy Science. Broad international support was valuable in developing and carrying out the experiment. The coil set was designed, built, installed and tested in less than six months, thanks to efforts and dedication of the design team and operations group. The experiments were carried out by an International Team, composed of researchers from the ITER Members. The team worked very well together in developing the experimental plan and executing it. In particular, Mike Schaeffer, Joe Snipes, and Chuck Greenfield provided leadership and direction for this effort.

ITER Postdoctoral Fellowships

Applications are being accepted for Principality of Monaco/ITER Postdoctoral Fellowships for 2010. Applicants should be about ready to finish their Ph.D. degrees or have received such a degree no earlier than January 1, 2007. The purpose of these postdoctoral positions is the development of excellence in research in fusion science and technology within the ITER framework. For more complete information and application forms, please refer to the web site for the fellowships at <http://www.iter.org/Pages/Monaco2010.aspx>. The deadline for applications is February 7, 2010.

In the poster (on the left), try to read what is written in the sand on the beach.

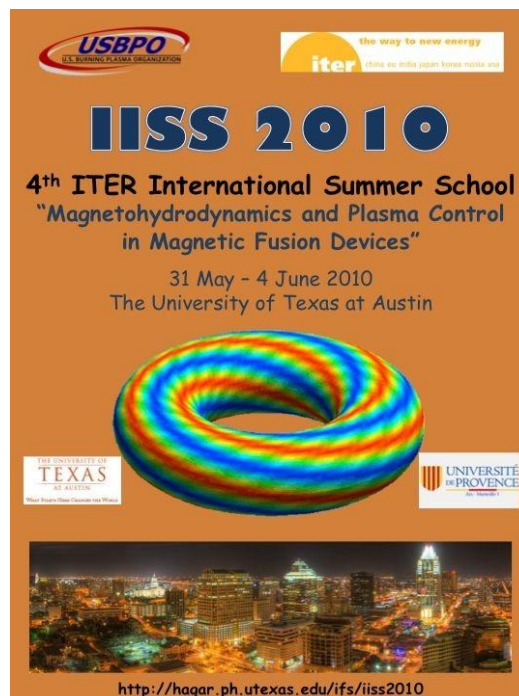


ITER International Summer School

The 4th ITER International Summer School (IISS 2010) will be held on the campus of the University of Texas at Austin, May 31-June 4, 2010. The USBPO will be a sponsor for holding this school in the US. The theme for the 2010 school, as determined by the IISS Steering Committee chaired by ITER Director-General Kaname Ikeda, will be "Magnetohydrodynamics and Plasma Control in Magnetic Fusion Devices." The lecturers for the school will be experts drawn from the ITER Member countries. Housing for student participants will be provided in a new university residence hall. A web site (still evolving) for the school is <http://w3fusion.ph.utexas.edu/ifs/iiss2010/>.

Registration will begin early next year. Students from around the world are encouraged to participate. If necessary, assistance with obtaining a visa will be provided.

Previous ITER International Summer Schools were held in Cadarache, France (<http://147.94.187.232/>) 2007, in Kyushu, Japan in 2008 (<http://sannygw.riam.kyushu-u.ac.jp/IISS2008/>), and again in Cadarache in 2009 (<http://sites.univ-provence.fr/iterschool/index.html>). The purpose of these schools is to prepare young researchers to



master the current and anticipated challenges of magnetic fusion devices, and to spread the global knowledge required for a timely and competent exploitation of the ITER physics potential. The lectures and other activities are designed for advanced graduate students, postdoctoral researchers, and young scientists.

U.S. Congressional Hearing on Fusion

On October 29, the House Committee on Science & Technology, Subcommittee on Energy and Environment, held a hearing entitled "The Next Generation of Fusion Energy Research." It was the first Congressional hearing on fusion energy in thirteen years. Witnesses who testified were Edmund Synakowski (DOE/OFES), Stewart Prager (PPPL), Thom Mason (ORNL), Riccardo Betti (Rochester), and Raymond Fonck (Wisconsin).

The press release about this hearing is available at:

<http://science.house.gov/press/PRArticle.aspx?NewsID=2672>

Video of the testimony can be viewed online at:

<http://science.edgeboss.net/wmedia/science/scitech09/102909.wvx>

Written transcripts are available at:

http://science.house.gov/publications/hearings_markups_details.aspx?NewsID=2653

End-of-Year Greetings

At the end of this column, coming at the end of the calendar year, we wish all of you Seasons Greetings.

Reports

First meeting of the ITER Integrated Modeling Expert Group

Written by Don Batchelor (ORNL)

The ITER Integrated Modeling Expert Group (IMEG) has been formed to provide the necessary coordination between the ITER Organization (IO) and the ITER Members in developing a comprehensive suite of Integrated Modeling tools and the necessary associated infrastructure. The technical responsibilities encompass definition of the program to support ITER modeling needs and development of a comprehensive modeling capability to meet the full range of project demands. An initial meeting of the IMEG members and a subset of the ITER Fusion Science and Technology Department (FST) took place in Cadarache, France, June 23-26. In addition to presentations relating to the status of the Integrated Modeling programs of the Partners, the core part of the meeting was formed around open discussions of a set of documents and presentations describing the scope and charter for the ITER Integrated Modeling program, the near term program plans, and a draft set of ITER modeling standards and guidelines.

Members of the ITER staff have produced an initial version of a document describing the "ITER Integrated Modeling Programme" and its primary requirements. The charter of this program is quite broad. It should support ITER during the design phase including design assessments, scenario development, and development of plasma control algorithms. And it will support operations including experiment planning, real time modeling, and data post processing. A major activity will be the establishment of an Integrated Modeling Analysis Suite of codes (IMAS). In the short-to-intermediate term and during the establishment of IMAS, the plan is to exploit existing stand-alone codes in IO and Domestic Programs in a structured way with an aim toward longer-term integration.

A strong level of coordination with, and involvement of, the Domestic Programs are foreseen, as well as working with the ITPA for the R&D associated with the development and validation of computational physics models, and general assessments of their implications for ITER. The document puts emphasis on the establishment of proper software engineering methodologies

as documentation, verification and validation standards, installation and acceptance testing procedures, and regression testing procedures for core elements.

A second document discussed covered “ITER Integrated Modeling Standards and Guidelines.” The component structure that is foreseen for IMAS requires consistency in the definitions of interfaces, parameters, variables, data structures, etc. Such consistency must certainly be enforced for all in-house elements of the IMAS. But because the ITER Members are expected to augment this in-house suite with supplemental components (e.g., developmental, more advanced, simplified, or just alternative), it is recommended that the members also adopt these standards and guidelines as appropriate. The document outlines standards for: code documentation, units and coordinates, data structures, and coding practices. In addition, guidelines for the procedures to be applied in qualification, verification, and validation are presented. There was also consideration of guidelines to protect intellectual property rights related to the integrated modeling program.

Finally there was discussion of the near-term plan for integrated modeling at ITER. It is expected to continue along two parallel threads: first, establishment of a database structure currently proposed to be based on an MDSplus installation. Initially, this structure could use existing ITPA databases (CDBM and Pedestal Groups) as a template. As part of the initial activity, modeling elements currently used by FST staff will be included while more formal “in house” tools tied into the database structure are being developed. The current modeling activities are focusing on more short-term design issues. This activity could be further supplemented with external analyses channeled through the ITPA, partially motivating the choice of the database structure.

In parallel, a somewhat longer-term activity aimed at developing the IMAS as a unified platform for ITER’s internal simulation needs is to be developed. Planning and assessment for this activity need to start now, although actual implementation and detailed structuring will ramp up on a slightly slower pace. The presentations suggested a range of short-term activities: an engine for solving transport equations, data management and communication of data between engine and components, workflow management, and grid and HPC computing. Since several of the ITER partners’ domestic programs have active integrated modeling efforts, a set of workshops or the establishment of an IMEG working group was raised as possible mechanisms to bring the partners’ experiences to bear in more direct ways on the development.

The IMEG made a number of specific suggestions for restructuring and augmenting the ITER program description and standards and guidelines documents. The documents primarily focused on the development of predictive modeling, however, it was clear from discussions with the ITER staff that the ITER Organization also expects the Integrated Modeling Program to provide the tools needed for data analysis, interpretation and control algorithm development. This broader scope needs to be reflected in the documents.

A recurring theme throughout the June meeting centered on the IMEG group trying to understand what are the most pressing short-term issues faced by the ITER Integrated Modeling Program. It was suggested that a more clearly laid out schedule and prioritization of near-term modeling tasks needed by ITER be developed. It was agreed that this should be made as part of the ITER Fusion Science and Technology Division (FST) work plan. In particular, FST is charged to urgently provide a suite of first-use cases for IMEG to structure planning activities.

The IMEG report has been entered into the ITER Document Management (IDM) system as ITER_D_2UWY75, and can be accessed by anyone with an ITER account.

Summary of FY09 Joint Facility Milestone Report on Particle Control and Fuel Retention

Written by Steve Allen (LLNL), Charles Skinner (PPPL), and Dennis Whyte (MIT)

The goal of this DOE milestone was to identify the fundamental processes governing particle balance by systematically investigating, across facilities, the impact of divertor geometries, particle exhaust capabilities, and wall materials. Alcator C-Mod operates with high-Z metal walls, NSTX is pursuing the use of lithium surfaces in the divertor, and DIII-D continues operating with all graphite walls. Experiments, analysis, and modeling were carried out at the three facilities. Significant progress was made toward better characterizing particle control and fuel retention in tokamaks. The facilities worked closely together to share and implement ideas on particle measurement techniques in order to best compare results across facilities using different wall materials. The facilities coordinated implementation of particle balance experiments using both the “static” and “dynamic” measurement method. The static technique is highly accurate, but lacks time resolution, whilst the dynamic technique provides time-resolved fuel retention, but can be prone to uncertainty in exhaust rates.

The main highlights of the joint work are:

1. Static and dynamic particle balance measurement techniques were successfully carried out on all three facilities (Alcator C-Mod, DIII-D, and NSTX) with generally good agreement between the two techniques. This establishes a powerful and accurate set of tools to study particle balance across the three devices despite their significant differences in configuration and wall materials.
2. In DIII-D and C-Mod dynamic particle balance showed a very consistent trend, namely, that the wall retention rate of fuel was very close to zero when the plasma reached a stationary condition in current flattop with density feedback control and divertor cryo-pumping. This similarity is despite the very different plasma-facing materials used: graphite/carbon in DIII-D and refractory metals (molybdenum and tungsten) in Alcator C-Mod. This result could be encouraging for longer pulsed divertor plasmas with strong divertor pumping, such as ITER.
3. In contrast, NSTX finds a constant large rate of positive fuel retention, i.e., net pumping, by the wall during flattop. It is unclear if this difference is due to differences with Spherical Torus plasma transport, non-stationary density, and/or the lack of divertor cryo-pumping. Furthermore NSTX finds only small differences in retention between graphite and lithium-coated surfaces, although lithium clearly reduces the recycling of fuel from the plasma-facing components. Ex-situ analysis of material samples from NSTX illuminates important surface chemistry processes that are occurring with the lithium coatings and the underlying graphite/carbon. These insights help explain NSTX results with respect to fuel absorption and release.
4. Dynamic particle balance indicates that wall fuel retention rates are strongest in the beginning phases of the discharge, and this phase typically leads to net wall retention when considered over the entire discharge in these modest pulse-length devices (1-5 seconds). Because the shot-averaged retention rates can be dominated by transient phases, such as plasma startup, the implications for very long-pulse devices, such as ITER and eventual reactors, remain uncertain.

The material summarized here is taken from the more detailed report by the research staffs at Alcator C-Mod, DIII-D, and NSTX, which is available at http://www.science.doe.gov/ofes/FES_Joule_2009_Joint_Final.pdf.

Summary of the Meeting of the ITPA Topical Group on MHD Stability Culham, UK, October 6-9, 2009

Written by Abhijit Sen (India), Ted Strait (GA), and Yuri Gribov (IO)

The ITPA Topical Group on MHD Stability held its third meeting at the Culham Science Center, Abingdon, UK on October 6-9, 2009 in conjunction with the IEA Large Tokamak Cooperation Workshop (W70) on “Key ITER Disruption Issues”.

This meeting was structured to devote maximum time and attention to the various outstanding scientific issues of disruptions in tokamaks and their implications for ITER design and operation, including:

- (1) radiation asymmetries during disruption mitigation
- (2) sideways forces from halo current asymmetries
- (3) improvements to the disruption database to include halo current data
- (4) development of improved numerical models for halo currents
- (5) limiter heat loads during vertical displacement events (VDEs)
- (6) the quantities and species of gas needed to suppress runaways by massive gas injection and the resulting current quench rates
- (7) other possible control measures for runaway electrons, including resonant magnetic perturbations and killer pellets

In the session devoted to other high priority issues for ITER, a broad spectrum of presentations were made following a brief recap from the ITER IO on the present status and future work to be done on these issues. These topics include control and avoidance of neoclassical tearing modes, resistive wall modes, sawteeth and magnetic error-field effects. The meeting also discussed progress on the IEA-ITPA Joint Experiments related to many of these urgent research issues.

Several new working groups (WG) were formed to address some of the most urgent issues for ITER in a more focused and time-limited manner. These new groups are as follows:

WG-1: Waveforms of current in error field correction coils

Chair: A. Garofalo

Scope: Determine waveforms of current in ITER error field correction coils that should be used for design of the coil power supplies (on-load voltage) and for analysis of AC losses in these superconducting coils.

WG-2: Guideline for optimization of distribution of ferritic inserts

Chair: M. Schaffer

Scope: Determine guidelines to optimize the distribution of ferritic inserts between the ITER toroidal field coils, considering the trade-off between minimization of toroidal-field ripple in the regular sectors of shielding blocks and low toroidal mode-number error fields caused by the ferromagnetic inserts in the toroidally irregular sectors.

WG-3: Power requirements for ECRH and ICRF control of sawteeth

Chair: I. Chapman

Scope: Assess power requirements for ECRH and ICRF to control sawteeth.

WG-4: Diagnostic requirements for MHD stability control

Chair: (to be determined)

Scope: Determine requirements of diagnostics used for MHD stability control (sawteeth, neoclassical tearing modes, resistive wall modes, etc.) The present requirements for ITER diagnostics should be revised by this WG.

WG-5: Halo currents caused by disruptions

Chair: V. Riccardo

Scope: Develop an improved halo-current-width model in order to improve 2D code calculations. Update guidelines for the upper limits of the relative halo current magnitude, I_h/I_{p0} , and the toroidal peaking factor, $TPF \times I_h/I_{p0}$, based on the new database activity. Here I_h and I_{p0} are the halo and core plasma currents, respectively.

WG-6: Sideways forces on vacuum vessel and magnets caused by disruptions

Chair: T. Hender

Scope: Assess existing models (sink/source and kink theory-based models) in comparison with existing experimental databases to confirm the possible maximum sideways force and its detailed characteristics expected in ITER.

The next meeting of the MHD Stability group is proposed to be at NIFS, Toki, Japan on March 8-12, 2010 (subject to final confirmation and approval by the ITPA Coordinating Committee). It is expected that the meeting will be held in conjunction with a US-Japan MHD workshop.

📣 Announcements

Submit BPO-related announcements for next month's eNews to Tom Rognlien at trogli@llnl.gov.

Upcoming Burning Plasma Events

2010 Events

January 18-21

[Workshop on Opportunities in Plasma Astrophysics \(WOPA\)](#)

Princeton, USA

February 16-19

[Innovative Confinement Concepts Workshop \(ICC 2010\)](#) abstracts due **12/4/09**

Princeton, USA

Week of 22 March

ITPA Transport & Confinement Topical Group Meeting

Oxfordshire, UK

Spring

ITPA IOC Topical Group Meeting

Princeton, New Jersey USA

April 12-15

[16th Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Resonance Heating](#)

Sanya, China

April 13-16

[U.S. Transport Task Force Workshop](#) (abstracts due Feb. 4)

Annapolis, Maryland USA

April 13-16

[International Conference on Plasma Diagnostics](#)

Pont-à-Mousson, France

April 19-21

[Sherwood Fusion Theory Conference](#) (abstracts due Feb. 26)

Seattle, Washington USA

May 16-20

18th ITPA Diagnostics & HTPD Topical Group Meetings

Wildwood, New Jersey USA

May 19-21

STAC-8

Cadarache, France

May 24-28

[19th International Conference on Plasma Surface Interactions](#) (abstracts due Nov. 20)

San Diego, California, USA

May 31-June 4

[4th ITER International Summer School](#)

Austin, Texas USA

June 21-25

[37th European Physical Society Conference on Plasma Physics](#)

Dublin, Ireland

Sept 27-Oct 1

[26th Symposium on Fusion Technology \(SOFT2010\)](#)

Porto, Portugal

Oct 11-16 **UPDATED NOTE DATE CHANGE**

23rd IAEA Fusion Energy Conference

Daejeon, Korea

Oct 24-29

[9th International Conference on Tritium Science and Technology](#)

Nara, Japan

Fall

ITPA Transport and Confinement Topical Group Meeting (following IAEA)

South Korea

Fall
ITPA IOC Topical Group Meeting (following IAEA)
South Korea

Fall
ITPA Diagnostics Topical Group Meeting (following IAEA)
Japan

2011 Events

Spring
ITPA Transport & Confinement Topical Group Meeting (following US/EU TIF)
San Diego, California USA

Please contact [the administrator](#) with additions and corrections.