USBPO U.S. BURNING PLASMA ORGANIZATION

eNews

August 18, 2010 (Issue 46)

CONTENTS

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 trognlien@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 Jim Van Dam

Baseline Approval and Leadership Changes for ITER Organization

An Extraordinary ITER Council Meeting was held in Cadarache, France, on July 27 and 28. Several very important decisions were made at this meeting.

The ITER Council unanimously approved the ITER baseline as presented by the ITER Organization. In particular, at this meeting, the Council approved the Overall Project Schedule (OPS) and the Overall Project Cost (OPC). The Overall Project Schedule includes the four phases of construction, operation, deactivation, and decommissioning. The approved project schedule for ITER has First Plasma to be achieved by November 2019 and full Deuterium-Tritium Operation to begin in March 2027 (or earlier, in 2026, if the schedule can be optimized). Recall that the ITER Council had approved the Project Specifications at its 2nd Council Meeting (June 2008). Thus, all three elements of the ITER baseline—schedule, cost, and scope—have now been approved. This is a giant step forward.

Also at this Extraordinary Meeting, the ITER Council appointed Professor Osamu Motojima as the new Director-General of the ITER Organization, effective July 28, 2010. The press release from the Council meeting states: "Kaname Ikeda, who has led the ITER Organization

since November 2005, had earlier expressed his wish to resign at the moment the ITER baseline would be approved by the ITER Council."

Professor Motojima is well known to the international fusion community, having previously served as Director-General of the National Institute for Fusion Science (NIFS) in Japan during the period 2003-2009. The Large Helical Device (LHD), a world-class superconducting heliotron/torsatron magnetic confinement device, was constructed under his leadership at NIFS and has achieved superior operational performance. Before moving to NIFS in 1989, he was a professor at Kyoto University in the Plasma Physics Laboratory. His biography is available on the ITER web site. He had been a member of the ITER Council since 2007.

Professor Osamu Motojima
new Director-General, ITER Organization

The ITER Council also approved the new management structure of the ITER Organization that was presented by Prof. Motojima. *Science* magazine published an article on July 30 entitled "New Director Shakes Up Management of Fusion Project". According to the article, the position of Principal Deputy Director-General is eliminated in the new management structure. This position had been held by Dr. Norbert Holtkamp.

The most recent ITER Newsline (#142) has an article about the new Director-General giving an all-hands inaugural address to the entire ITER staff on July 29, with photographs.

Ambassador Ikeda and Dr. Holtkamp are to be heartily thanked and congratulated for their enormous efforts to bring the ITER project to the point where the baseline has now been approved and ITER is ready to move into its construction phase.

We look forward to the leadership of new Director-General Motojima and his management team as ITER moves ahead in fulfilling its mission of demonstrating the scientific and technological feasibility of fusion power.

IMEG Workshop

The Integrated Modeling Expert Group will hold its second meeting September 6-8, 2010, at the Chateau de Cadarache. A major focus of this IMEG meeting will be to preview a design for the ITER integrated modeling infrastructure. Contact Dr. Wayne Houlberg (ITER) for further details.

European Meeting on Disruptions

Two working groups of the European Fusion Development Activity (EFDA), one on data analysis and calibration techniques, and the other on feedback control for real-time applications, plan to hold a meeting that will discuss requirements on diagnostics and data analysis for disruption prediction, mitigation, and recovery strategies. The meeting will be held September 6 and 7 at the Culham Science Centre (UK). An invitation has been extended for US scientists to participate in this meeting. Please contact me if you are interested.

News about ITPA

As of August 5, the International Tokamak Project Activity (ITPA) has a new public web site. It is hosted by the ITER Organization and can be accessed from the ITER home page through the link in the left-hand column. Each ITPA topical group has its own public page, with announcements about meetings and lists of members, and also a private page. Previously, the Max-Planck Institute of Plasma Physics (Garching) had kindly hosted the ITPA web site.

All of the ITPA Topical Groups plan to hold meetings the week after the IAEA Fusion Energy Conference, six in Seoul, Korea, and one in Naka, Japan. If you are interested in attending any of these meetings, please contact the US coordinator for the respective topical group:Diagnostics (Rejean Boivin), Energetic Particles (Raffi Nazikian), Integrated Operation Scenarios (Chuck Kessel), MHD Stability (Ted Strait), Pedestal (Phil Snyder), SOL and Divertor (Bruce Lipschultz), and Transport and Confinement (Stan Kaye).

By the way, an article in the June 25 ITER *Newsline* provides a link to a video in which Dr. David Campbell, of the ITER Department of Fusion Science and Technology, describes the history of the ITPA and its activities.

Boars, not Bores

The Cadarache area in southern France, where ITER is located, has historically always had a large population of wild boars. According to ITER *Newsline* #45, four hunting parties are organized every year to regulate the wildlife population. When the CEA Cadarache Laboratory was constructed, its large campus was completely surrounded by a high-security fence—in spite (or perhaps because) of which, there are boars roaming the interior grounds of the laboratory. ITER *Newsline* #132 showed a sign posted at the ITER office building, warning staff members to close doors because of the wild boars. Sure enough, ITER *Newsline* #138, cleverly titled "Wild (office) life," had a photo of a boar inside the building. However, we reassure our readers that ITER scientists are not bores. (Blame the summer doldrums for this feeble humor.)

Neutral Beam Test Facility for ITER

At its meeting in November 2009, the ITER Council had approved a new Neutral Beam Test Facility as part of the baseline for the ITER project, due to the importance of developing high-energy negative-ion neutral beams for use on the ITER device. This facility will be constructed in Padua, Italy, next to the site of the Consorzio RFX laboratory. The facility will have two test stands, one for testing negative ion sources and one for testing a full-size, one-megavolt ITER neutral beam injector. ITER Members Europe, Japan, and India are contributing to this facility, and the National Research Council (CNR) of Italy will provide the building. Recently I visited the

RFX laboratory at the invitation of its director, Professor Piero Martin, who had been one of the lecturers at the recent 4th ITER International Summer School in Austin. Below is a photo that I took of the site for the Neutral Beam Test Facility.

Recent Presentations about Burning Plasmas

During the week of July 12-16, I presented three lectures about burning plasma physics at the International Advanced Workshop on the Frontiers of Plasma Physics, hosted by the International Centre for Theoretical Physics (ICTP) in Trieste, Italy. This institute, founded by Nobel Prize-winner Abdus Salam, is world-famous for its role in fostering advanced studies and research, especially for scientists from developing countries. My lecture notes are posted on the workshop's web page.

Recently, on August 2, I gave an invited keynote talk on "An Overview of ITER and US Efforts" at the Big Physics Symposium of the NIWeek Conference (Austin, TX.). This is an annual meeting hosted by National Instruments Corporation, which this year was attended by 4500 participants. (National Instruments was one of the major sponsors for the 4th ITER International Summer School.) The talk is posted on the USBPO Reference Files page (click on "Other USBPO Presentations").

ITER Postdoc from University of Alaska Fairbanks

Congratulations to Debasmita Samaddar, who recently received her Ph.D. in physics from the University of Alaska Fairbanks, and has accepted the offer of an ITER Postdoctoral Fellowship. For her thesis work, she demonstrated, contrary to what had been expected, that the "parareal" algorithm could indeed be applied for the parallelization in time of turbulence simulation codes. Her thesis advisor was David E Newman (UAF), and she also worked with Raul Sanchez and Lee Berry of ORNL. Debasmita is a citizen of India. She is the second Ph.D. graduate from a US university to be awarded an ITER Postdoc. The first was Matt Jewell, who was selected as an ITER Postdoc in the first competition, in 2008; he graduated from the University of Wisconsin in superconductivity and is currently pursuing research related to the qualification of the ITER Nb3Sn superconductors.

NPR Report about Fusion Research

On July 27, National Public Radio aired a report called "Experts Fuss Over Cost of Nuclear Fusion Research." One of the interviews in the report was with Dr. Michael Zarnstorff, Deputy Director of Princeton Plasma Physics Laboratory and former Vice Chair of the USBPO Council. The written transcript and an mp3 audio file download of the report can be accessed at the NPR web site.

Notices from DOE Office of Fusion Energy Sciences

For the information of our *eNews* readers, there are currently two job openings posted in the Office of Fusion Energy Sciences, both of which are relevant to burning plasma science:

- ***Research Division Director***
- ***Director for the ITER and International Division***

USBPO Topical Group Highlights

The Fusion Engineering Science Topical Group seeks to facilitate U.S. efforts to resolve issues in existing and future fusion devices through improved design and construction of components (leaders are Richard Nygren and Larry Baylor). This month's research highlight from Dennis Youchison and colleagues describes the substantial components that are needed to prevent overheating of the wall in ITER.

Two-phase Heat Transfer in the ITER Enhanced-Heat-Flux First Wall

D.L. Youchison, M.A. Ulrickson, and J.H. Bullock (Sandia National Laboratories)

Enhanced radial transport and the effect of ELMS in ITER may increase local first wall (FW) heat loads to as much as 5 MW/m^2 and a design for enhanced heat flux (EHF) modules that may cover roughly 40% of the first wall design is under consideration. To provide adequate cooling to the 8-mm-thick beryllium armor with sufficient safety margin for transients such as ELMS and mild disruptions, the EHF concept incorporates hypervapotrons, developed for cooling klystron tubes in the early 1970s, into the first wall at select locations. Figure 1 shows a shaped first-wall module, a hypervaportron "finger" and a cross sectional mesh view for the simulations described later. The water flow goes across the teeth in a hypervaportron and at high heat loads, localized boiling in the space between the teeth pushes vapor into the main flow where it re-condenses. Traditional forced convection, boiling and critical heat flux correlations developed in the power industry cannot be applied here because the (assumed) fully developed flow conditions seldom exist in this complex geometry, and others who have recently investigated flow in hypervapotrons for ITER have not treated the issue of heat transfer with two-phase flow [1,2].

In this news note, we describe recent advances using a commercial computational fluid dynamics (CFD) code, Star-CCM+, to analyze the two-phase flow analysis in the ITER first wall [3] and explain the fundamentals of the boiling model and the capabilities of the code to model not only nucleate boiling, but also transition and film boiling leading to critical heat flux (CHF) and melting of the heatsink. This is necessarily a transient analysis and uses an implicit, unsteady solver and time steps on the order of 10 ms with 10 to 16 inner iterations. While there is some understanding of basic processes involved, quantitative simulation requires that six parameters be determined by comparison to relevant experimental data. Failure to replace the default values for these parameters results in unrealistically high heat transfer from nucleate boiling,

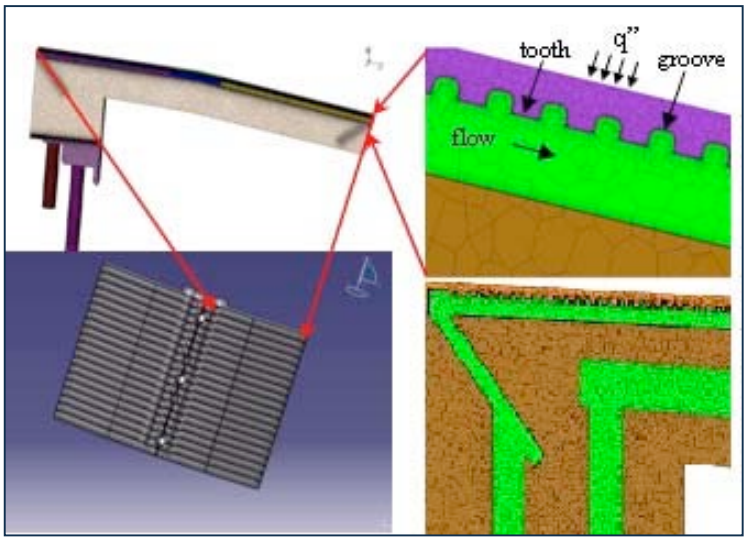

Fig. 1. A 40-finger first-wall panel highlighting a single hypervaportron finger and a cross-section showing the CuCrZr wall (purple) under the Be armor, the coolant channel, and the polyhedral computational mesh. Incident heat flux is denoted as q".

producing surface temperatures hundreds of degrees lower than measured values, and an inability to predict catastrophic failure resulting from film boiling. We used high heat-flux data from mock-up tests at the Efremov Institute in Russia and Sandia's Plasma Materials Test Facility to obtain a detailed design tool for the hypervaportons in ITER.

In some more detail, the CCM+ code uses the Rohsenow nucleate boiling model in an Eulerian multi-phase approach to the conservation of momentum and energy in the Navier-Stokes equation similar to codes like Fluent and CFX [4]. Two of the parameters, C_{qw} and C_{ew}, adjust coefficients in the Rohsenow model for the surface heat flux due to boiling:

$$q_{bw}=\mu_l h_{lat}\sqrt{g(\rho_l-\rho_v)/\sigma}\left(\frac{C_{p_l}(T_w-T_{sat})}{C_{qw}h_{lat}Pr_l^{n_p}}\right)^{3.03}$$

where μ_l, $\mathbf{C}_{Pl}$, ρ_l, and Pr_l are the dynamic viscosity, specific heat, density, and Prandtl number of the liquid phase, n_p is the Prandtl number exponent (1.7 by default). Also, g is gravity, ρ_v is the vapor density, σ is the surface tension coefficient at the liquid-vapor interface, T_w is the wall temperature, and C_{qw} is an empirical coefficient varying with the liquid-surface combination. A third parameter determines the vapor mass generation rate over the area covered by nucleation sites by setting the fraction of boiling heat flux used for creation of vapor bubbles. Other adjusted parameters include the heat transfer between water vapor bubbles and the surrounding sub-cooled liquid, the exponent in the Prandtl number in the Rohsenow model, and the Schmidt turbulence number that controls the magnitude of local turbulence generated by bubble departure at the wall. The final parameter, the volume-of-fluid (VOF) a parameter, determines at what vapor fraction to transition from nucleate boiling to film boiling at the wall allowing a seamless transition in CCM+ to the VOF technique wherein we track the liquid/vapor interface.

This approach is also a good example of the "design-by-analysis" approach available to support the technology necessary for a burning plasma machine. By tracking the evolving vapor film that acts as a thermal insulating layer under the heated surface, we also obtain accurate temperature profiles through the wall and can determine if the situation is quasi-stable leading to a steady state temperature distribution or one in which the vapor film progressively covers more of the wall leading to dryout and possible melting of the wall (burnout).

Figure 1 illustrates the computational mesh used for our simulations, and Figure 2 shows the dramatic variation of calculated convective heat transfer coefficient through the finger with various flow regimes. The flowing liquid comes in from the left and the forced-convection-dominated heat transfer coefficient is highest at the bottom of the teeth (a) where the flow velocity is highest. In the grooves the velocity is almost zero resulting in little heat transfer. However, during nucleate boiling, the grooves (b) have the highest heat transfer coefficients decreasing dramatically when a vapor film forms (c).

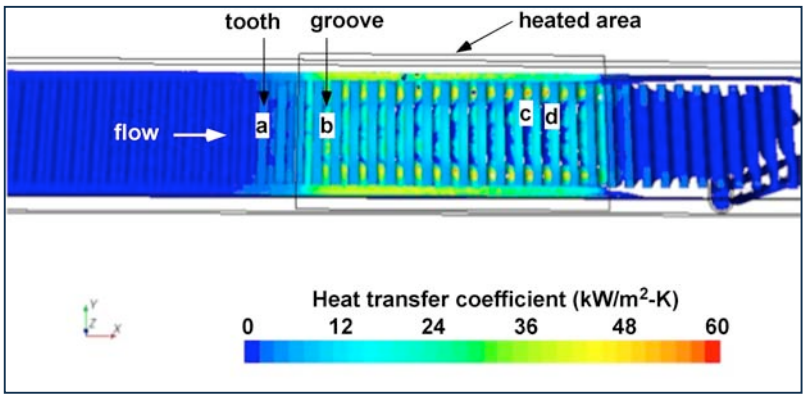

Fig. 2. Calculated convective heat transfer coefficient near critical heat flux conditions as viewed from the top at the CuCrZr/water interface. a) sub-cooled, b) nucleate boiling, c) film boiling and d) sub-cooled regimes.

CFD analysis not only provides the designer with important information about the flow distribution in multi-phase problems, but also accounts for the large disparity in cooling efficiency between various flow regimes. In addition, the model allows us to optimize the teeth height and pitch to maximize cooling in both sub-cooled forced convection and nucleate boiling. The new advances in the CCM+ boiling physics provides new insights into hypervapotron operation under these conditions, e.g., the function of the side slots in vapor removal, and also provides an indicator when departure from nucleate boiling is imminent, and the CHF limit is near. This type of predictive capability will lead to a robust design for the enhanced heat flux first wall for ITER capable of surviving many off-normal conditions.

References

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2. J.M. Milnes and D. Drikakis, "Qualitative assessment of RANS models for hypervapotron flow and heat transfer," Fus. Engr. Des. **84** 7-11, 1305-1312 (2009).
3. Star-CCM+ Version 5.04.006 User Guide, CD-adapco Inc., New York, NY, USA (2010).
4. D.L. Youchison, M.A. Ulrickson, J.H. Bullock, "A Comparison of Two-Phase Computational Fluid Dynamics Codes Applied to the ITER First Wall Hypervapotron," *IEEE Trans. On Plasma. Science* **38** 7, 1704-1708 (2010).

This work was supported by the US ITER Project Office at Oak Ridge National Laboratory. Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

REPORTS

Summary of the 4th Meeting of the ITPA Energetic Particle Physics Topical Group in Garching, Germany

R. Nazikian (Princeton Plasma Physics Laboratory)

The fourth Energetic Particle ITPA meeting was held in Garching, Germany on April 26-28, 2010 and included over thirty speakers with several remote participants from the US and the EU. The meeting was divided into four topical areas; linear and nonlinear benchmarking of Alfvén eigenmode codes, ITER fast particle diagnostics and 3-D magnetic-field effects on fast ion confinement.

1. Linear benchmarks

Significant progress has taken place since the first ITPA meeting on the linear benchmarking of toroidal Alfvén eigenmode (TAE) spatial structure and damping. The analysis of damping rates was used to compare with experimental damping rate measurements on JET. It was found that full gyrokinetic codes generally predicted higher damping rates than perturbative MHD codes in cases with no continuum damping. The gyrokinetic codes contain a more self-consistent description of the coupling of the Alfvén eigenmodes to kinetic Alfven waves. The linear gyrokinetic calculations were more consistent with the experimental observations of higher damping rates in JET plasmas

where continuum damping was avoided. Interestingly, analysis with the LIGKA code (IPP, Garching) showed that very high-resolution electron density profile measurements are needed in order to determine the role of edge continuum damping. Plans were discussed for drafting an IAEA paper on the linear benchmark analysis.

2. Non-linear benchmarks

A nonlinear benchmark study was performed for an analytical large-aspect-ratio tokamak equilibrium. The objective of the benchmark study was to compare the nonlinear simulations against linear TAE eigenmode calculations. Several codes were used in the benchmark study. The main result was that all of the codes identified the most unstable mode as a nonperturbative energetic particle mode (EPM) rather than the TAE. In addition, not all the codes could identify the TAE when the instability drive was below the EPM threshold. For this reason, it was decided that the nonlinear benchmark should be performed against a linear nonperturbative eigenmode calculation. The results of the comparison between the nonperturbative linear and nonlinear codes will be presented at the next ITPA meeting.

3. ITER diagnostics

A discussion took place concerning ITER diagnostics. Joe Lister (remote participation) pointed out that there is a table of energetic particle measurement requirements for ITER that should be finalized in May. The priority for such measurements will be determined according to how important the measurement is for machine protection and basic plasma control.

There was also a discussion on the possibility of lost alpha-particle detectors, however it was made clear that such measurements are technically very challenging as the detectors must be located in regions of high heat flux. However, progress was made on the design of a collective scattering system for monitoring the core population of alpha particles. It was shown that the optimal frequency microwave frequency is below the fundamental cyclotron resonance in order to minimize the noise from electron cyclotron emission on the detected signal.

4. 3-D effects on fast ion confinement

With the consideration of Resonant Magnetic Perturbations (RMP) for the suppression of ELMs and the use of ferritic Test Blanket Modules (TBM) for ITER, attention was given to the effect of these 3-D field perturbations on the loss of alpha particles and neutral beam ions in ITER. A presentation on the effect of RMP showed that 1 MeV beam ions could be strongly affected by an toroidal mode number n=4 RMP, however further investigation is needed to understand why the losses are so sensitive to the value of n. The effect of magnetic islands on alpha loss was also addressed. Finally, the results of TBM experiments on DIII-D were presented. The expected carbon tile heating on the TBM was compared to thermocouple measurements and found to be in good agreement.

The next meeting of the ITPA Energetic Particle Working Group will take place in Seoul, Korea, Oct. 18-20, the week following the IAEA FEC meeting.

Summary of the 4th Meeting of the ITPA Integrated Operating Scenarios Topical Group in Princeton, NJ

C. Kessel (Princeton Plasma Physics Laboratory)

The 4th ITPA-IOS meeting was held at Princeton Plasma Physics Laboratory April 20-23, 2010. There were 35 participants with 14 EU colleagues participating remotely due to the volcano in Iceland. The presentations and discussions focused on issues and results from the ongoing IOS Joint experiments, which are as follows:

IOS-1.1	ITER demo discharges
IOS-1.2	Study of impurity seeding effects
IOS-2.2	Ramp-down of plasma current from a discharge with magnetic safety factor $q_{95} = 3$
IOS-3.1	Plasma-beta limit for advanced tokamak (AT) regimes with ITER recommended q-profile
IOS-3.2	Define access conditions to get to steady state
IOS-4.1	Access conditions for hybrid operating scenario with ITER-relevant restrictions
IOS-4.2	Dependence of transport on ratio of gyroradius to radial profile scale length (ρ^*) and stability in hybrid scenarios
IOS-5.2	Maintaining ion cyclotron resonance heating (ICRH) coupling in expected ITER regimes
IOS-5.3	Assessment of lower hybrid (LH) current drive at high density for extrapolation to ITER advanced scenarios
IOS-6.1	Modulation of actuators to qualify real-time profile control methods for hybrid and steady state scenarios
IOS-6.1	Internal inductance controller with primary voltage and additional heating
IOS-6.3	Control of experimentally simulated burning plasma

The ITER Organization participants gave reports on ITER research needs and ITER inductive scenario modeling. Demo discharges, ramp-down, and impurity seeding experiments were reported from JET, DIII-D, ASDEX-Upgrade, and Alcator C-Mod. JET/DIII-D identity experiments were reported on the ρ^* dependence in hybrid discharges. Final reports on the electron cyclotron heating (ECH) assisted plasma start-up were reported by ASDEX-Upgrade.

Comparison of transport models in the current ramp-up phase of experiments were presented, and will be reported at the IAEA FEC meeting in October. Benchmarking of ITER steady state scenarios is continuing, and reports of steady state and hybrid simulations for ITER were made. The ICRF code benchmark is ongoing, identifying relevant scenarios, showing agreement in deuterium/tritium with He^3 minority ions for the baseline scenario. Work was reported on techniques for maximizing the loading for the ICRF antenna. LH results were reported demonstrating the strong reduction in non-thermal electrons as the density rises above $1x10^{20}$ /m^3 on C-Mod and the Frascati Tokamak Upgrade (FTU). Modeling of the LH on C-mod was reported using GENRAY/CQL3D. The commissioning of the new passive/active multi-junction (PAM) LH launcher for current drive on Tore Supra was reported, showing steady 2.75 MW for 78 s.

Modeling activities are being organized like joint experiments, forming groups, contact, and spokespersons. A number of IAEA papers are being pursued from the IOS group, with initial outlines presented. There is ongoing interaction with the Transport and Confinement group on current ramp-up and ramp-down modeling.

The next ITPA IOS meeting will be the week following the IAEA FEC2010 meeting, Oct. 18-21 in Seoul, Korea.

Announcements

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

Upcoming Burning Plasma Events

2010 Events

Aug 30-Sept 3
Theory of Fusion Plasmas Joint Varenna-Lausanne International Workshop
Varenna, Italy

Sept 6-7 NEW
EFDA Workshop on Disruption Prediction, Mitigation, and Avoidance
Culham Science Centre, Oxfordshire, UK

Sept 6-8
Integrated Modeling Expert Group Meeting
Cadarache, France

Sept 7-10
3rd EFDA Transport Topical Group Meeting combined with the
15th EU-US Transport Task Force Meeting
Cordoba, Spain

Sept 27-Oct 1
26th Symposium on Fusion Technology (SOFT2010)
Porto, Portugal

Oct 11-16
23rd IAEA Fusion Energy Conference
Daejeon, Korea

Week of Oct 18-20
ITPA Energetic Particles Topical Group Meeting (in conjunction with IAEA FEC)
S. Korea

Week of Oct 18-20
ITPA Transport and Confinement Topical Group Meeting (in conjunction with IAEA FEC)
S. Korea

Week of Oct 18-21
ITPA Divertor and SOL Topical Group Meeting (in conjunction with IAEA FEC)
S. Korea

Week of Oct 18-21
ITPA Integrated Operation Scenarios Topical Group Meeting (in conjunction with IAEA FEC)
S. Korea

Week of Oct 18-21
ITPA MHD Topical Group Meeting (in conjunction with IAEA FEC)
S. Korea

Week of Oct 18-20
ITPA Pedestal and Edge Physics Topical Group Meeting (in conjunction with IAEA FEC)
S. Korea

Week of Oct 18-22
ITPA Diagnostics Topical Group Meeting (in conjunction with IAEA FEC)
Japan

Oct 24-29
9th International Conference on Tritium Science and Technology
Nara, Japan

Nov 7-11
19th Topical Meeting on the Technology of Fusion Energy (TOFE 2010)
(embedded with 2010 ANS Winter Meeting)
Las Vegas, NV USA

Nov 8-12
52nd Annual Meeting of the APS Division of Plasma Physics
Chicago, IL USA

Nov 15-17, 2010
15th Workshop on MHD Stability and Control: "US-Japan Workshop on 3D Magnetic Field Effects in MHD Control"
Madison, WI USA

Dec 1-2, 2010
Fusion Power Associates Meeting
Washington, DC USA

Dec 15
IEA-ITPA Joint Experiments Planning Meeting
Videoconference

2011 Events

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

May 2-4, 2011 NEW
2011 International Sherwood Fusion Theory Conference
Austin, TX USA

May 15-19, 2011
15th International Conference on Emerging Nuclear Energy Systems (ICENES)
San Francisco, CA USA

June 26-30, 2011
38th IEEE International Conference on Plasma Science (ICOPS) and the 24th Symposium on Fusion Engineering (SOFE)
Chicago, IL USA

Oct 16-21
15th International Conference on Fusion Reactor Materials (ICFRM-15)
Charleston, SC USA

Directories of Other Plasma Events

IEEE Directory of Plasma Conferences
Fusion Ignition Research Experiment (FIRE) Physics Meetings

Please contact the administrator with additions and corrections.