eNews

October 19, 2009 (Issue 37)

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Dear Burning Plasma Aficionados:

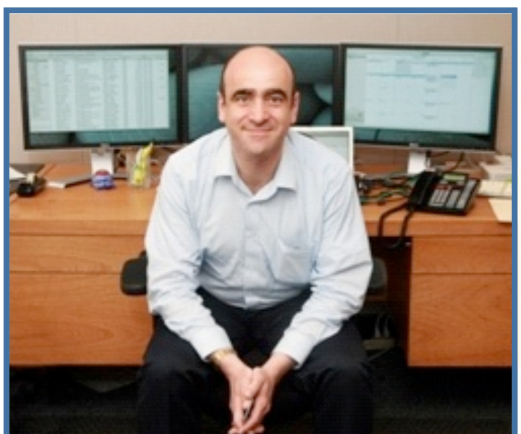
This newsletter provides a short update on U.S. Burning Plasma Organization activities. E-News is also available online at http://burningplasma.org/enews.html Comments on articles in the newsletter may be sent to the editor (Tom Rognlien trognlien@llnl.gov) or assistant editor (Rita Wilkinson ritaw@mail.utexas.edu).

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

Director's Corner by J. Van Dam

New Editor of *eNews*

As of this issue, Tom Rognlien will take over as the new Editor of *eNews*. We very much appreciate his willingness to assume this responsibility and look forward to his tenure. Tom replaces Raffi Nazikian, who did a tremendous job as the past Editor.

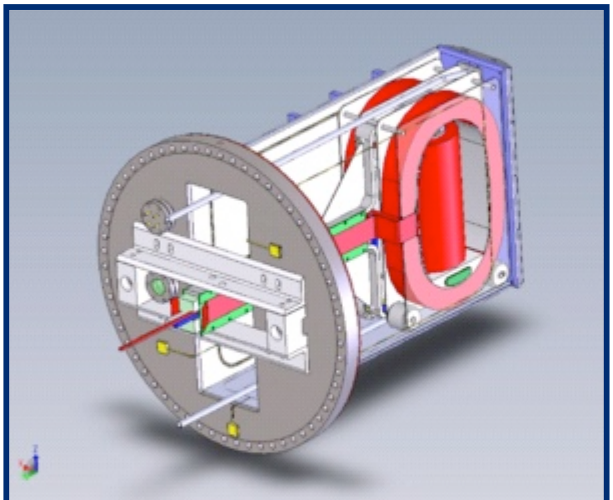


Raffi Nazikian
(courtesy of Elle Starkman, PPPL photographer)

Raffi began his service with the May 2007 newsletter (Issue #9), taking over from Ray Fonck, who had edited the newsletter himself while USBPO director. Raffi's final issue was the most recent one, September 2009. In total, he produced 28 newsletters, on a regular monthly schedule, which represents quite a bit of effort. As the editor, he applied his customary high level of enthusiasm, energy, and thoughtfulness. In my opinion, it is thanks to his excellent work with the newsletter that the subscription list has grown to 464 subscribers, exceeding the 307 regular membership of the USBPO. I might mention that I also have heard favorable comments from scientists outside the US who regularly read *eNews*. Thank you very much, Raffi!

More about TBM Simulation Experiments on DIII-D

The leaders of the Task Force on Test Blanket Module (TBM) Tokamak Physics Support of ITER are Mike Schaffer (GA) and Joe Snipes (ITER), with Deputy Chuck Greenfield (GA). An impressively large International Team has been set up, with 19 scientists from around the world (including three from US institutions other than General Atomics). Several planning meetings have already been held, and the experimental plan has been drafted. The TBM mockup has been completely fabricated, and the enclosure is now set up so that the TBM module can be inserted into the DIII-D machine without breaking vacuum. Hardware testing will occur for the next few weeks. The actual experiments will take place during November 9-20, 2009, which are the two weeks immediately following the APS-DPP Annual Meeting. You can follow the progress of this effort at http://fusion.gat.com/global/TBM2010. When the experimental campaign begins on November 9, however, the web site will be moved to a closed-access site.



TBM mock-up design features a poloidal magnetic field solenoid nested within a series pair of toroidal magnetic field racetrack main coils (*image courtesy of Mike Schaffer, General Atomics*)

Research Committee Meeting during APS-DPP Meeting

The leaders and deputy leaders of the ten USBPO topical groups, who together constitute the members of the Research Committee, will hold a face-to-face meeting (their first ever, since meetings are usually held by videoconference) on Monday, November 2, 2009, 12:30–2:00 PM, during the APS-DPP Meeting in Atlanta, GA. Scientists who serve as the US coordinators and deputy coordinators for the seven ITPA topical groups will also be invited to join this meeting, which will be held in the Inman Room (conference level of the Hyatt Regency Hotel).

ITER Contributed Oral Session at APS-DPP Meeting

Please mark Thursday afternoon, November 5, 2009, on your calendars to attend the special session of contributed orals about “Research in Support of ITER.” The talks in this special ITER session are listed below; the associated abstracts may be viewed at
http://meetings.aps.org/Meeting/DPP09/SessionIndex2/?SessionEventID=110105.

Speaker	Title	Time
D. Campbell	ITER Research Plan	2:00-2:12 PM
M. Maraschek, et al.	Disruption mitigation and avoidance at ASDEX Upgrade	2:12-2:24 PM
M. Reinke	3-D radiation dynamics during gas jet mitigated disruptions on Alcator C-Mod	2:24-2:36 PM
N. Commaux ,et al.	Disruption mitigation experiments carried out on DIII-D	2:36-2:48 PM
S. Bozhenkov, et al.	JET experiments on massive gas injection	2:48-3:00 PM
J. Canik, et al.	NSTX ELM pacing and L-H threshold experiments for ITER	3:00-3:12 PM
T. Puetterich, et al.	Impurity behavior in the H-mode edge barrier: neoclassical transport and ELM flushing	3:12-3:24 PM
A. Huber, et al.	Impact of large type-I ELMs on plasma radiation in JET	3:24-3:36 PM
P. Politzer, et al.	Simulation of the ITER ramp-down scenario on DIII-D	3:36-3:48 PM
B. Lipschultz, et al.	Recovery of retained fuel through disruptions: implications for ITER	3:48-4:00 PM
J. Snipes, et al.	Physics requirements for the ITER plasma control system	4:00-4:12 PM
K. Hill, et al.	Development of a spatially resolving x-ray crystal spectrometer (XCS) for measurement of ion-temperature (Ti) and rotation velocity (v) profiles in ITER	4:12-4:24 PM
F. Durodie, et al.	On the JET ITER-like ICRF antenna and implications for the ICRF system for ITER	4:24-4:36 PM
C. Kessel, et al.	Simulations of ITER-like discharges on Alcator C-Mod	4:36-4:48 PM
E. Doyle, et al.	Progress in developing ITER operational scenarios on DIII-D	4:48-5:00 PM

Reports

Report from the "Marmar Panel" on Planning for US Participation in ITER

Jim Van Dam

Recently, a special panel organized by the USBPO Council to update planning for US scientific participation in the ITER project issued its report. Earl Marmar chaired the panel, hence, the shorthand name for this panel. The final version of the panel's report is available on the USBPO web site at http://burningplasma.org/reference.html (look in the section called "Fusion Policy").

Before describing the Marmar Panel report, let me briefly recall the chronology associated with its predecessor (the so-called EPAct Report), since these events led to the formation of the present panel.

- *July 27, 2005:* The Energy Policy Act (EPAct) from the U.S. Congress directed the Secretary of Energy to develop a plan, in consultation with the Fusion Energy Sciences Advisory Committee, for the participation of US scientists in ITER. The EPAct also required a review of the plan by the National Academies of Science.
- *February 16, 2006:* The Office of Fusion Energy Sciences requested that the US Burning Plasma Organization develop this plan in cooperation with the US fusion community.
- *June 7, 2006:* The EPAct Report entitled "Planning for US Fusion Community Participation in the ITER Program" was published by the US Burning Plasma Organization. The report had been prepared by the Energy Policy Act Task Force of the USBPO, consisting of 15 scientists from the US fusion community, chaired by Ray Fonck, USBPO director.
- *September 29, 2007:* The USBPO described its EPAct Report in an invited presentation to the Plasma Science Committee of the Board on Physics and Astronomy of the National Academies of Science. Subsequently the National Academies established the Committee to Review the US ITER Science Participation Planning Process (CRISPPP) and charged it with evaluating the 2006 EPAct Report from the USBPO.
- *December 14, 2007:* The CRISPPP committee held a meeting in Washington, DC. At this meeting there were invited presentations from ITER, Europe, Japan, and the US about national and international plans for scientific participation in ITER.
- *July 29, 2008:* The National Research Council of the National Academies of Science released a pre-publication version of the final report of the CRISPPP committee. The final publication version became available in early 2009. As reported in earlier issues of eNews, the CRISPPP report was fairly complimentary about the ITER planning process to date for ITER. It offered some recommendations and encouraged the use of metrics to assess progress.

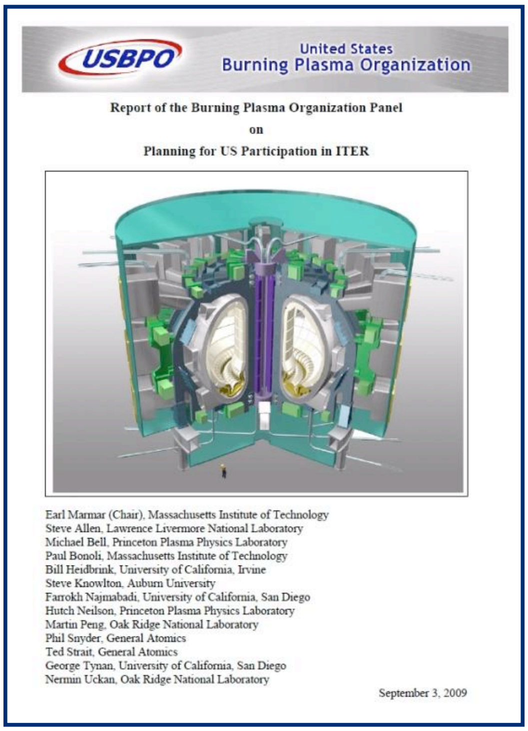
In parallel with these events, the USBPO Council continued to be actively involved in pushing forward further development of the planning for US participation in ITER. After having received the EPAct Report from the Department of Energy in August 2006, the US Congress had requested additional information. The USBPO Council discussed this request at its December 2006 meeting and subsequently, at its meeting in February 2007, determined to set up a new panel that would update and amplify these plans. Earl Marmar, a member of the Council, agreed to chair this panel. The 13 members of the panel represented a spectrum of US fusion institutions and areas of scientific expertise. Several of the panel members were also Council members. It was helpful that one of the panel members (Michael Bell) was simultaneously serving as a member of the ITER Research Plan international working group.

Dr. Marmar gave regular updates about the progress of the panel at subsequent meetings of the USBPO Council. Also, his report about this panel's work was one of the presentations at the December 2007 meeting of the CRISPPP committee.

The “Marmar Panel” structured its report to answer the following three questions:

1. What is the US research agenda for ITER?
2. How will ITER promote progress toward making fusion a reliable and affordable source of power and how should this progress be assessed?
3. How does ITER relate to other elements of the US Fusion Energy Sciences program?

Essentially, these are the same three questions that were asked in the 2005 Energy Policy Act of Congress and given an initial response in the 2006 USBPO EPAct Report. The Marmar Panel report has now provided an updated response, with a fresh perspective in terms of scientific theme areas: plasma macro-stability, waves and energetic particles, multi-scale transport, plasma boundary interfaces, fusion engineering science, and integrated burning plasma science. For each of these theme areas, the panel provided responses to the three over-arching questions.


USBPO United States Burning Plasma Organization

Report of the Burning Plasma Organization Panel on Planning for US Participation in ITER

Earl Marmar (Chair), Massachusetts Institute of Technology
Steve Allen, Lawrence Livermore National Laboratory
Michael Bell, Princeton Plasma Physics Laboratory
Paul Bonoli, Massachusetts Institute of Technology
Bill Heidbrink, University of California, Irvine
Steve Knowlton, Auburn University
Farrokh Najmabadi, University of California, San Diego
Hutch Neilson, Princeton Plasma Physics Laboratory
Martin Peng, Oak Ridge National Laboratory
Phil Snyder, General Atomics
Ted Strait, General Atomics
George Tynan, University of California, San Diego
Nermin Uckan, Oak Ridge National Laboratory

September 3, 2009

The panel presented its final report at the September 8, 2009, Council meeting, where it was adopted as an official USBPO report. Dr. Marmar and the other panel members—Steve Allen, Michael Bell, Paul Bonoli, Bill Heidbrink, Steve Knowlton, Farrokh Najmabadi, Hutch Neilson, Martin Peng, Phil Snyder, Ted Strait, George Tynan, and Nermin Uckan—were heartily thanked by the Council for their excellent work in preparing this report.

Planning for US participation in ITER is, of course, constantly evolving, and so we should look at the Marmar Panel report and its predecessor, the EPAct Report, as living documents that are to be periodically updated and refreshed. Similarly, the ITER Research Plan document of the ITER Organization has already gone through two versions, and preparation of a third is projected for early next year.

As noted, the Marmar Panel report is available on the USBPO web site, and I strongly encourage everyone to read it. The report is well written and insightful. For the convenience of our *eNews* readers, the introductory summary from the report is quoted below. (Note that some of the theme areas express opinions about recommendations on priority research.)

Executive Summary reproduced from the
Report of the Burning Plasma Organization Panel on Planning for US Participation in ITER

A. Macrostability

1. High level objectives in the macrostability science area are: to maximize fusion performance through understanding and control of instabilities that can limit plasma pressure or energy confinement in a burning plasma; to develop the scientific basis to understand and control instabilities that could limit the lifetimes of plasma facing materials.

2. ITER will access unique plasma regimes, not accessible in any present day device. With regard to stability, the most important of these are: the large Lundquist number, the small normalized gyro-radius, the significant, isotropic high energy ion population, and the significant effects of self-heating on the plasma pressure and current density profiles.

3. Existing magnetic confinement devices allow development and testing of the fundamental models for stability, which will ultimately be validated on ITER. They provide versatile, cost effective test beds for assessing new theories, control methods and stability issues. The theory and modeling program

provides models of stability and control for the burning plasma regime, and will provide the necessary links from ITER to a fusion power plant.

B. Waves and Energetic Particles

1. Key ITER goals include: achieving high levels of performance of plasma heating and current drive systems essential to obtaining and maintaining high-gain plasmas; evaluating the technology of reliable RF antennas located at the edge of burning plasmas, to achieve reliable coupling and performance over long durations; validating the physics understanding plasma heating and current drive in fusion plasmas for multiple RF techniques and for NBI heating; validating self-consistent models for the dominant effects of the fusion alpha particle population, including heating, instability drive, and fast particle transport.

2. ITER is the only planned fusion facility with dominant self-heating, offering the first opportunity to test actual alpha-particle production, transport and heating rates. ITER is uniquely positioned to evaluate the self-consistent non-linear effects of Alfvén wave turbulence on the alpha particle distribution. RF power will provide the majority of core heating required to initiate the fusion burn, and will be required to stabilize the ITER plasmas to access high performance regimes.

3. Highest priorities for US research in plasma wave heating and current drive for ITER include: improving understanding of RF coupling for Ion Cyclotron Heating (ICH) and Electron Cyclotron Heating (ECH); developing integrated models of RF propagation, absorption and energetic particle interaction; assessing auxiliary current drive and current profile control using waves in the Lower Hybrid range of frequencies; evaluating ECH/ECCD for stabilization of current-driven instabilities. For energetic particle science, high priority research includes: determining requirements and options for Alfvén wave diagnostics; understanding levels and effects of prompt loss of high energy alphas caused by magnetic ripple and by Alfvénic instabilities; evaluating the overall stability of ITER plasmas with energetic alphas, neutral beam ions, and RF-heated ions.

C. Multi-Scale Transport

1. Key objectives in transport research include: making the first studies of confinement properties in reactor-scale plasmas, across all accessible operational regimes, including baseline H-mode, small/no Edge Localized Mode (ELM) regimes, and advanced hybrid and non-inductive regimes; evaluating the non-linear effects on confinement and stability as the plasmas become predominantly self-heated; comparing turbulence and transport in reactor-scale plasmas with first-principles simulations; evaluating thermal stability at high Q.

2. Measures of success in resolving transport issues on ITER include: demonstrating that potentially detrimental transport effects which may arise in the burning plasma regime can either be avoided or controlled; demonstrating control of plasma conditions and fusion power production in a confined, burning plasma; demonstrating that first principles computational models are capable of accurately predicting/reproducing the behavior of burning plasmas.

3. The development of experimental and diagnostic techniques, and of plasma scenarios in existing facilities, will be applied to ITER to improve prospects for success. The results will motivate new experimental studies in existing facilities to prepare for ITER operation. Critical transport related investigations that will advance during ITER construction include: transport in plasmas with dominant electron heating; transport barrier trigger mechanisms and evolution; bulk plasma rotation in the absence of external torque drives; verification and validation of plasma turbulence simulations.

D. Plasma-Boundary Interfaces

1. Key objectives in plasma boundary research for ITER include: developing models of the edge transport barrier region (the pedestal), benchmarked against existing experimental data; developing, implementing and testing ELM control strategies; measuring and modeling Scrape Off Layer (SOL) parameters, including power widths at the midplane and divertor, and extrapolating to ITER; characterizing plasma wall interactions to guide the selection of plasma facing components for ITER; assessing plasma facing component performance on ITER.

2. ITER will provide a unique combination of low collisionality and high-density reactor conditions in the H-mode pedestal and scrape-off layer, providing critical tests of transport and turbulence understanding. The ITER SOL is a unique test bed for detachment physics, with high opacity for both neutrals and radiation. ITER will provide important tests of our understanding of tritium retention and removal.

3. Near-term priorities for US plasma boundary research which contribute to ITER include: understanding pedestal structure and dynamics and ELMs, including the development and application of 2D transport and 3D MHD simulations; improving models for divertor detachment, and through iterative comparison with experiment, developing a predictive capability for the ITER scrape-off layer; comparing erosion, deposition and power handling for different candidate wall materials, including carbon and refractory metals.

E. Fusion Engineering Sciences

1. Priority US areas for fusion technology development from ITER include: validating the performance of power-plant scale superconducting magnets; developing and assessing steady-state actively cooled heating and current drive systems, operating in a high flux neutron environment; developing of fueling, pumping and fuel processing/tritium technologies; developing and applying of tools for real-time control of plasma parameters, including density, pressure, and current density, in the presence of strong self-heating with a significant population of high energy alphas; developing plasma diagnostics for the harsh neutron environment; developing nuclear monitoring and safety systems that will be needed for licensing of future fusion devices; evaluating the effects of tritium-breeding blanket modules on plasma operations.

2. ITER will provide a unique high neutron flux test-bed for assessing fusion technologies. Plasma support technologies developed for ITER should be directly applicable to future fusion devices including power plants. Information obtained during the construction, commissioning and operational phases of ITER will allow further optimization.

3. The majority of the engineering resources in the US Fusion Energy Sciences program are currently focused on developing and fielding plasma support technologies and plasma-facing components for ITER. Targeted testing of components, such as plasma facing divertor components, is carried out on the existing facilities. Diagnostic development is a significant element of the US program, and many of these developments have direct applicability to ITER.

F. Integrated Burning Plasma Science

1. The primary goal for US participation in ITER is to understand integrated burning plasmas which will require: producing and studying non-transient (pulse length >> energy confinement time) high Q ($Q \geq 10$) D-T plasmas; accessing and optimizing advanced quasi-steady-state scenarios, including partially inductive hybrid and fully non-inductive scenarios; developing alternative operational scenarios which could lead to smaller or less technically demanding DEMO devices. Key issues involved in reaching these goals will include: accessing the H-mode in initial hydrogen and/or helium plasmas; the physics of confinement physics at a scale characterized by small ion gyro-radius normalized to machine size; understanding stability and plasma-wall interactions under burning conditions.

2. ITER is the only planned magnetic confinement experiment capable of producing high fusion gain, and thus represents a major step toward making fusion a practical energy source. Success on ITER will provide specific design information and confidence in key extrapolations to proceed to a next-step DEMO facility.

3. A major long-term goal of the US fusion energy sciences research program is development of a validated, comprehensive simulation capability. During the ITER construction phase, progress toward this goal will include integration of simulation capabilities through the Fusion Simulation Project to provide predictions for ITER, which will ultimately be validated against ITER experimental results. This effort should contribute strongly to the ITER Organization’s plans to develop integrated modeling

capabilities during the ITER construction phase with the help of the ITER members' research programs.

Many important topics will be the subject of active research on existing and new tokamaks during ITER construction including: investigating hybrid scenarios and fully non-inductive scenarios with significant bootstrap current; developing methods and predictive capability for real-time current profile control using heating and current drive actuators; developing in medium-scale tokamaks reliable disruption avoidance and/or mitigation schemes and control of potentially adverse plasma-wall interactions.

The greatest lasting value of the ITER project will be the scientific knowledge gained to help provide the predictive capability needed to design practical fusion reactors.

Summary of the Third Meeting of the ITPA Energetic Particles Topical Group 24-25 September 2009, Kiev, Ukraine

Jim Van Dam

The new (since last year) Energetic Particles Topical Group of the International Tokamak Physics Activity (ITPA) held its third meeting recently in Kiev, Ukraine, September 24 and 25, 2009. This topical group meeting conveniently followed the biennial IAEA Technical Committee Meeting on Energetic Particles held the preceding three days of the same week in the same location (http://www.kinr.kiev.ua/TCM/index.html). The local host for both meetings was Dr. Yaroslav Kolesnichenko of the Institute for Nuclear Research, National Academy of Sciences of Ukraine.

The organizers for the ITPA Topical Group Meeting were its Leader, Dr. Sibylle Günter; Deputy Leader, Dr. Kouji Shinohara; and ITER Organization Deputy Leader, Dr. Sergei Putvinski. This article for eNews is based on the meeting summary written by the organizers.

The Topical Group Meeting began with a discussion of the reference ITER database for energetic particle modeling. Proposals to improve the database included the addition of more detailed wall geometry, maximum available heat loads in various wall regions, magnetic field interpolation routines, neutral beam injection (NBI) geometry, fast particle distribution function for ion cyclotron minority heating, ranges of profiles and time slices for the current ramp-up phase, and descriptions of the models used for the database entries.

The next six presentations were concerned with code verification/validation benchmark exercises. These were focused on two tests defined prior to this meeting: (a) to compare linear growth rates and nonlinear saturation levels for an $n = 4$ TAE instability and (b) to calculate the damping of toroidal Alfvén eigenmodes (TAE) in comparison with JET experiments that had measured frequencies and damping rates for $n=3$, 5, and 6 modes. Theoretical results were reported from six energetic particle simulation codes that had been applied to these test problems. Reasonable agreement among codes and with experiment is being obtained, although detailed dependences on elongation, fast ion pressure, central safety factor, etc., are still being investigated.

Several presentations at the meeting focused on the effect of plasma micro-turbulence on energetic particles. New measurements on DIII-D of NBI slowing down of fast ions and anomalous redistribution at large heating powers were reported. Consistency has been found between diffusion coefficients from simulations and those found from NBI current driven experiments on ASDEX Upgrade. Also, electromagnetic transport of alpha particles in ITER has been studied.

Other topics considered at the meeting were nonlinear saturation of TAE modes when drag-by collisions are taken into account, current driven by alpha particles, fast ion losses induced by 3D effects, and new developments in TAE experiments.

One of the final items on the agenda was a discussion of plans for joint experiments. The topical group decided to propose three such experiments at the annual IEA/ITPA Joint Experiments Meeting, to be held December 15 and 16, 2009, in Daejeon, Korea. The three experiments are

1. damping rate measurements, which would be a continuation of an existing joint experiment,
2. effect of drag at resonance, and
3. fast ion turbulent transport.

The topical group also had a general discussion about the importance of investigating marginal stability for fast ion distributions and the effect of ELMs (i.e., increased anomalous diffusion coefficients in the pedestal region for short times).

The meeting concluded with a report about ideas for energetic particle-related studies in connection with the Test Blanket Module mock-up experiments to be performed on DIII-D for ITER during November 9-20, 2009, and also a report about US future plans for energetic particle research as described in the recent Research Needs Workshop report.

The full agenda for this topical group meeting, the meeting summary, and the talks that were presented are available at the ITPA web site: Go to http://itpa.ipp.mpg.de/, click on Topical Groups (left-hand sidebar), click on Energetic Particles (06-Oct-2009), and then click on 3rd meeting of the ITPA-TG.

Announcements

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

Upcoming Burning Plasma Events

2009 Events

Oct 18-23
21st International Conference on Magnet Technology (MT-21)
Hefei, China

Oct 20-23
3rd ITPA Integrated Operation Scenarios Topical Group Meeting
Frascati, Italy

Nov 2-6
51st APS-DPP Meeting
Atlanta, Georgia USA

Nov 9-11
14th Workshop on MHD Stability and Control
Princeton, New Jersey USA

Nov 15-19
ANS Winter Meeting
Washington, DC USA

Dec 2-3
Fusion Power Associates Annual Meeting
Washington, DC USA

Dec 8-11
The 19th International Toki Conference (ITC19)
Ceratopia Toki-City, Gifu, Japan

Dec 14-17
ITPA SOL & Divertor Topical Group Meeting
San Diego, California USA

2010 Events

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 EC Meeting
China

April 13-16
Transport Task Force
Annapolis, Maryland USA

April 13-16
International Conference on Plasma Diagnostics
Pont-à-Mousson, France

April 19-21
Sherwood Fusion Theory Conference
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
Plasma Surface Interactions
San Diego, California, USA

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

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

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