stellarator news

Published by Fusion Energy Division, Oak Ridge National Laboratory
Building 5700 P.O. Box 2008 Oak Ridge, TN 37831-6169, USA

Editor: James A. Rome Issue 130 February 2011
E-Mail: jar@ornl.gov Phone (865) 482-5643
On the Web at *http://www.ornl.gov/sci/fed/stelnews*

The Australian Plasma Fusion Research Facility upgrade

The "Super Science Initiative Scheme," announced in the 2009–10 Australian Budget, provided for a major infrastructure upgrade to the Facility, which is now known as the Australian Plasma Fusion Research Facility. This provides $7M to upgrade the H-1 facility infrastructure, including RF heating systems, vacuum quality, and diagnostics data access (to be covered in a future issue). In addition to consolidating and automating many existing diagnostics, new diagnostic instruments are being funded including a high-speed synchronous imaging camera, which produced the images shown in Fig. 1; spatially interferometric coherence imaging cameras to measure ion temperature and flow; and Thomson scattering. The development of such diagnostic tools, which it is hoped will ultimately be installed on the international fusion experiment ITER, was identified as a central plank of the "Strategy for Australian Fusion Science and Engineering" developed by the Australian ITER Forum in consultation with the Australian fusion community.

In addition to several technical and engineering staff recently appointed for the infrastructure upgrade, we have been joined by the Plasma Theory and Modelling Group, led by Prof. R. Dewar, and Future Fellow Dr. Matthew Hole. The Plasma Research Laboratory was also fortunate to attract Dr. Cormac Corr, who was recently awarded a Future Fellowship in the area of plasma-surface interactions. Cormac will play a leading role in the development of the Materials Diagnostic Test Facility, which is described below, following a brief description of two of the new diagnostics.

Synchronous imaging camera

An example of data from the new synchronous imaging camera is shown in Fig. 1. Images of plasma light were acquired in a stroboscopic manner, by gating the intensifier of a Princeton Instruments PI-MAX 3 camera with a phase-locked loop, synchronized with the magnetic fluctuations of a mode in the Alfvén range. The horizontal projections of intensity are similar to the profile of line-integrated density. This shows that under the right conditions, spectral line intensity can be used as a proxy for density fluctuation measurements. The advantage of this indirect approach is that acquisition can be automated, the camera can be moved to any port with a window and view dump, and it provides two-dimensional (2D) data.

Toroidal Mirnov array

To complement the two existing poloidal arrays, a toroidal/helical magnetic probe array has been installed, consisting of 16 sets of 3 mutually perpendicular coils housed inside a vacuum-tight thin stainless steel bellows (Fig. 2). The bellows is essentially transparent to magnetic field in the Alfvén frequency range and follows a toroidal helical path near the ring conductor. Proximity to the plasma produces large signal amplitudes, and traversal of regions of various magnetic curvature may enable ballooning and interchange modes to be distinguished.

More than 80 channels of Mirnov data are now connected to a new standalone D-tAcq DT132 2MS/sec 14 bit digi-

In this issue . . .

All opinions expressed herein are those of the authors and should not be reproduced, quoted in publications, or used as a reference without the author's consent.
Oak Ridge National Laboratory is managed by UT-Battelle, LLC, for the U.S. Department of Energy.

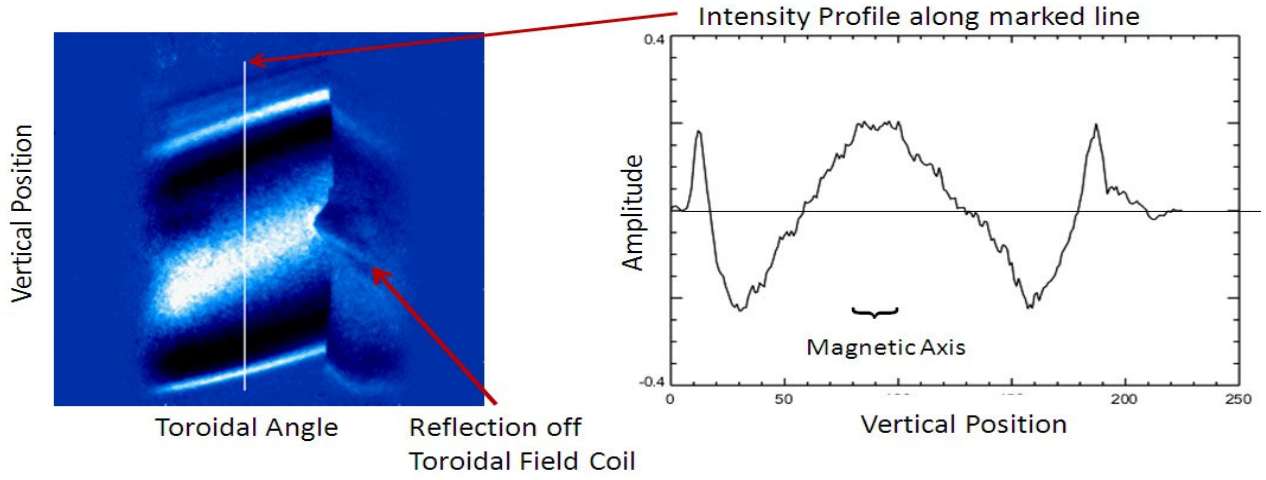


Fig. 1. At left: Phase-resolved side view of optical emission from MHD fluctuations in H-1 viewing between the toroidal field coils. At right: A vertical section along the line indicated shows an even mode structure ($m = 4$).

tiser system and preconditioned by a locally made programmable high gain filter/amplifier. A travelling wave mode in the Alfvén range of frequencies can be seen in the first data shown in Fig. 3, and it is clear that the mode is well sampled so that previous ambiguities in toroidal mode number can be resolved.

The Materials Diagnostic Development Facility (MDF)

A small linear device (Fig. 4) is under construction to provide a test bed specifically for developing and testing diagnostics for plasma-materials interaction under conditions relevant to the edge of fusion reactors. The device aims to achieve high plasma densities (~$10^{19}m^{-3}$ H^+) and power densities. Three different sources will be employed: an RF helicon wave source, an electron beam source and a plasma gun source. Recent results [1] show that plasma densities of ~$10^{19}m^{-3}$ can be achieved in hydrogen if helicon waves are launched into a tailored, increasing magnetic field. This will enable testing of advanced imaging and line diagnostics of the sheath, flows, and plasma-surface interactions including erosion on small samples placed in the high density region, and will benefit from synergistic links with a wide range of materials researchers in Australia.

An addition, the MDF will allow researchers to prepare experiments ultimately intended for larger international fusion materials facilities. A prototype will soon be operating with RF powers of several kilowatts and magnetic fields up to 0.15 T. The final device will be able to exploit the higher powers from H-1 systems.

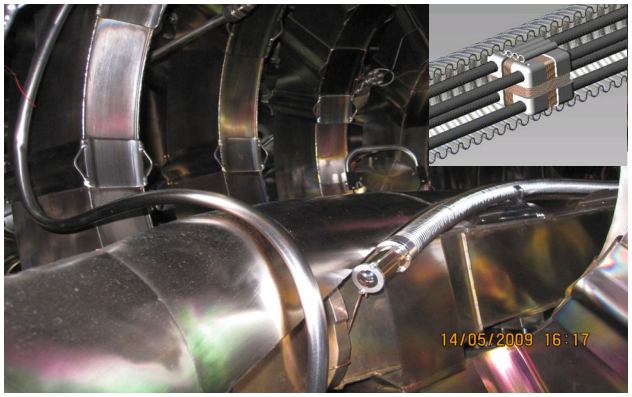


Fig. 2. The toroidal Mirnov array terminating in a special coil set enclosed in a metallized glass tube for high frequency response. The existing poloidal array is in the foreground (bean-shaped tube), and CAD detail of a coil set is inset.

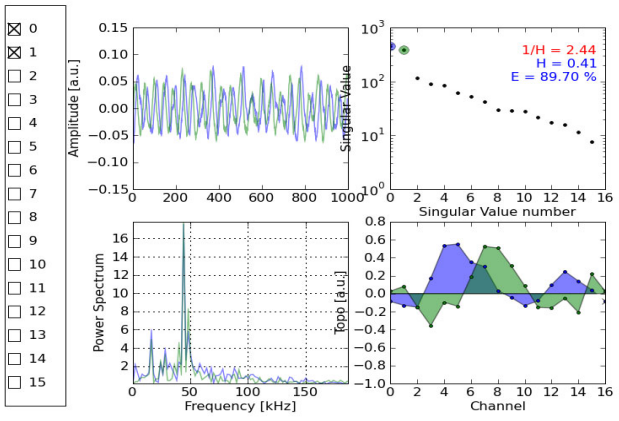


Fig. 3. First data from the new toroidal/helical Mirnov array in H:He plasma at 0.5 T. The s v (singular value) decomposition shows cosine and sine-like components, indicating a travelling wave with much higher toroidal resolution than previously achieved on H-1.

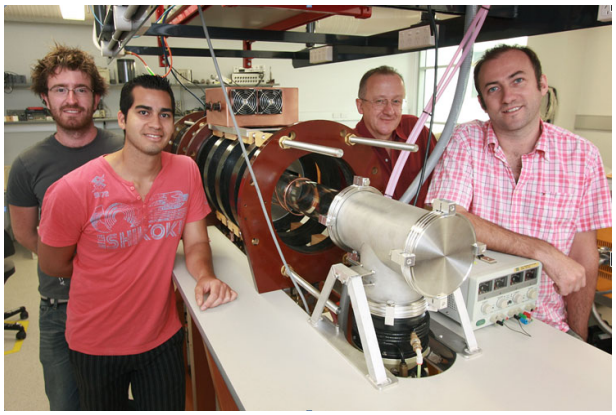


Fig. 4. The Materials Diagnostic Facility prototype device, showing the helicon antenna at the low-field end of the device. The target is placed at the far end (high-field region). L-R: Cameron Samuell, Juan Caneses, John Wach and Cormac Corr.

Reference

[1] Y. Mori, H. Nakashima, F. W. Baity, R. H. Goulding, Plasma Sources Sci. Technol. **13** (2004) 424–435.

Boyd Blackwell
Plasma Research Laboratory
Director, H-1 National Plasma Fusion Research Facility
Rm 431 Bldg 60, Research School of Physics and Engineering
The Australian National University
Canberra ACT 0200 Australia
E-Mail: Boyd.Blackwell@anu.edu.au
Telephone: 02 6125 2482

The 18th International Stellarator/Heliotron Workshop

Following discussions at the Princeton International Stellarator/Heliotron Workshop (ISHW) and the Daejeong IAEA meeting, it was decided that the next ISHW will be held jointly with the 10th Asia Pacific Plasma Theory Conference (APPTC) in Australia, from Sunday 29 January 2012 to Friday 3 February 2012. This timing avoids the congestion of conferences in November to early December 2011 and allows access to economical accommodation in Canberra (2 nights) and at the South Coast Conference Centre in Murramarang, http://www.murramarangresort.com.au/conferences.html

The weather in Canberra is usually hot and dry (average maximum 28°C, minimum 13°C). This is one reason why we have opted for the South Coast Conference Centre, which has a much better seaside climate, for the main part of the conference. Opening the conference in Canberra allows us access to an excellent theatre and to H-1, and allows us to simplify transport to the South Coast by hiring two buses, which will return delegates to Canberra after the conference. The accommodations at Murramarang are very reasonably priced for delegates who are willing to share a villa that has two completely separate bedroom and bathroom facilities and a common kitchen/living area.

It is anticipated that the conference will be largely conducted as a single session, with only some highly specialized topics in parallel sessions. The program committee will correspondingly be joint, breaking out for specialized sessions.

Topics will include:

- Basic plasma science (including laser plasmas and astronomical plasmas)
- Plasma theory, modeling, and numerical simulation
- Magnetic equilibria/stochastic fields/high beta
- Fast particle and high-energy physics
- D effects in tokamaks and RFPs
- Divertor and edge physics
- Transport, turbulence, and confinement improvement
- MHD equilibrium and stability
- Progress and technical reports
- General plasma theory, modeling, and numerical simulation
- Fusion materials/plasma-wall interaction/reactor materials/plasma-facing components
- Industrial applications of plasma technology
- Diagnostics

A second Announcement will be made in March with all information available at:
http://h1nf.anu.edu.au/PLASMA2012.

Contacts: Dr. Boyd Blackwell, Dr. Matthew Hole
E-mail: PLASMA2012@anu.edu.au

8th Coordinated Working Group Meeting, NIFS and Kyoto Univ., Japan

The 8th Coordinated Working Group Meeting (CWGM) to be held at the National Institute for Fusion Science (NIFS) 15–17 March 2011 followed by an extension meeting at Kyoto University on 18 March. The CWGM implements and coordinates international collaborations in stellarator-heliotron research. The work is intended to contribute to the International Stellarator-Heliotron Confinement and Profile Database [ISH-C(P)DB].

CWGMs have the character of a working meeting. The sessions are organized around a well-specified working goal. Proposals for sessions are welcome at any time; the realization of a session, however, depends on the availability of time slots and its importance for joint collaborations. CWGM and its related database activities have been conducted under the auspices of the IEA Implementing Agreement for Cooperation in Development of the Stellarator-Heliotron Concept (http://iea-shc.nifs.ac.jp/).

A tentative list of topics is:

- Stellarator-heliotron H-mode survey
- High-beta, MHD physics
- Magnetic island/iota/shear
- Validation of transport models
- Edge turbulence database
- Energetic particles (to be established, but still in negotiation)
- Joint experiments: Proposals/planning

If you are interested in attending the meeting/receiving information, please contact the local organizer.

Masayuki Yokoyama, Local organizer
E-mail: yokoyama @LHD.nifs.ac.jp)

International Energy Agency Implementing Agreement for Cooperation in Development of the Stellarator-Heliotron Concept: Web page

Multilateral research collaborations in our stellarator-heliotron community have been extensively developed in the framework of the International Energy Agency (IEA) Implementing Agreement (IA) for Cooperation in the Development of Stellarator-Heliotron Concept (concluded on 2 October 1992).

In accordance with the IEA's initiative to have Web pages for its IAs (for fusion-related IAs, please see http://www.iea.org/techno/technologies/fusion.asp), we have opened our IA's Web page at

http://iea-shc.nifs.ac.jp/.

Currently, the following links have been arranged:

- Contracting Parties (including links to major contributing institutions)
- History of International Stellarator-Heliotron Workshop
- Coordinated Working Group Meeting (CWGM) [jointly hosted by IPP site and NIFS site]
- *Stellarator News*
- Executive Committee Annual Report to the Fusion Power Coordination Committee [FPCC, http://www.iea.org/about/FPCC.asp]
- Written Agreement (amended as of 14 October 2009)
- "About the IEA," where you can find the brief introduction of the IEA and its link with the Implementing Agreement

The Web page is managed by NIFS which represents the current Chair party. Contents will be updated according to your cooperation. Please send comments, suggestions and materials to

iea-shc@LHD.nifs.ac.jp

It would be appreciated if you could include a link to our Web page on your institution Web page, to enhance its visibility and to heighten awareness of this IA.

Hiroshi Yamada
National Institute for Fusion Science
Secretary to Stellarator-Heliotron Executive Committee, IEA-Implementing Agreement

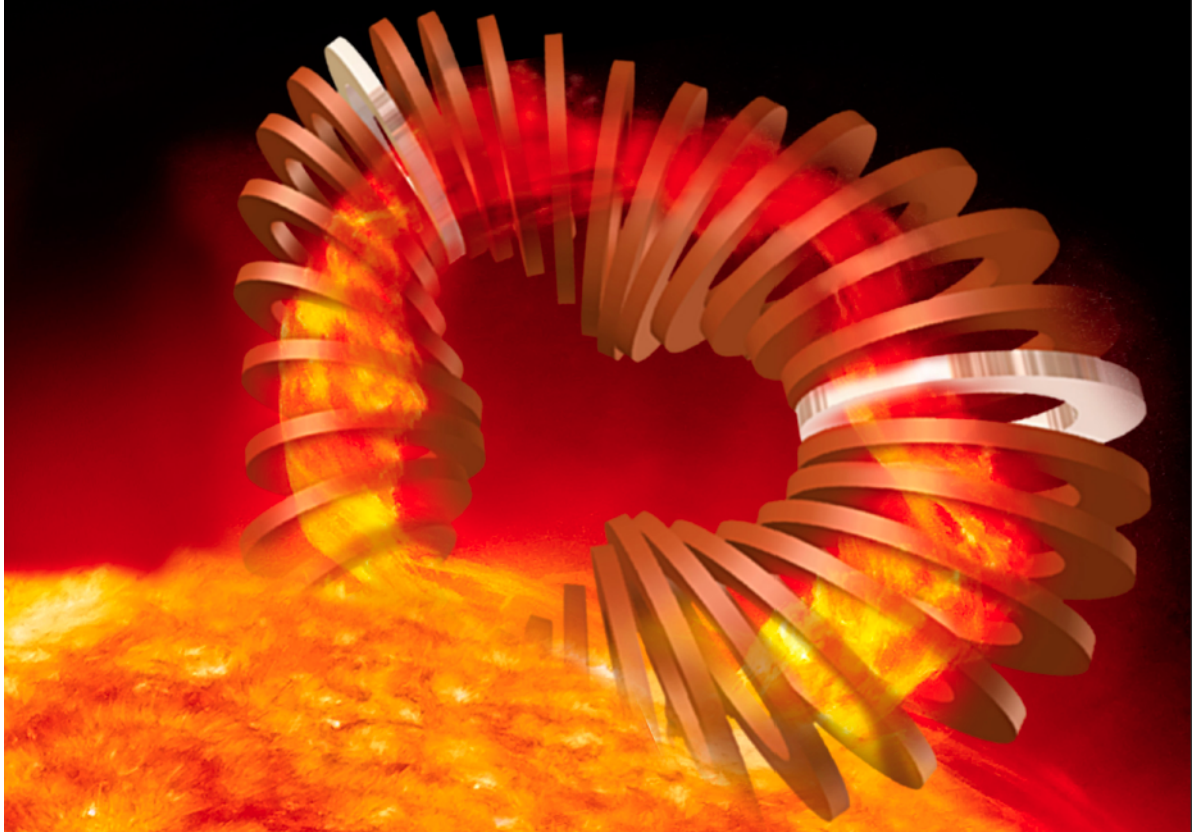
18th Joint International Stellarator/Heliotron Workshop and 10th Asia Pacific Plasma Theory Conference

Sunday 29th January 2012 to
Friday 3rd February 2012.
ANU, Canberra (29th Jan - 31st Jan) /
Murramarang, NSW (31st Jan. - 3rd Feb.)

First Announcement

Topics include:

* Basic Plasma Science (including Laser Plasmas and Astronomical Plasmas)
* Plasma Theory, Modeling and Numerical Simulation
* Magnetic equilibria / stochastic fields / high beta
* Fast particle and high energy physics
* 3D effects in tokamaks and RFPs
* Divertor and edge physics
* Transport, turbulence and confinement improvement
* MHD equilibrium and stability
* Progress and technical reports
* General Plasma Theory, Modeling and Numerical Simulation
* Fusion materials/plasma wall interaction/reactor materials/plasma facing components
* Industrial Applications of Plasma Technology
* Diagnostics

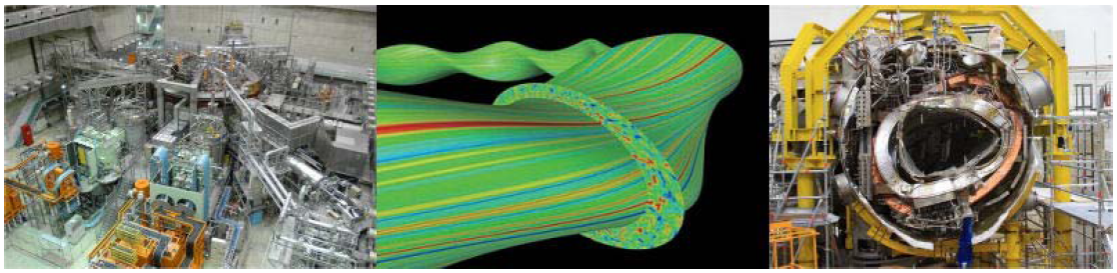


Co-Chairs:
Dr Boyd Blackwell (ISHW): boyd.blackwell@anu.edu.au
Dr Matthew Hole (APPTC): matthew.hole@anu.edu.au

Australian National University

www.h1nf.anu.edu.au/ISHW2012 www.h1nf.anu.edu.au/APPTC2012

Co-operation in Development of Stellarator-Heliotron Concept



Objective

The objective of the co-operation is to improve the physics base of the Stellarator-Heliotron concept and to enhance the effectiveness and productivity of research and development efforts rlated to the Stellarator-Heliotron concept by strengthening co-operation among Agency member countries.

Scope

The co-operative programme to be carried out by the Contracting Parties within the framework of this Agreement shall consist of the following activities:

1. Exchanges of information;
2. Assignment of specialists to the facilities or research groups of the Contracting Parties;
3. Joint planning and co-ordination of experimental programmes in selected areas;
4. Workshops, seminars and symposia;
5. Joint theoretical, design and systems studies;
6. Exchanges of computer codes; and
7. Joint experiments.

Contracting Parties

International Stellarater-Heliotron Workshop

CWGM (IPP site)

CWGM (NIFS site)

Stellarator News

Annual Report

Written Agreement

About the IEA

The Stellarator-Heliotron IA Web page at http://iea-shc.nifs.ac.jp/.