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 122 Octobert 2009
E-Mail: jar@ornl.gov Phone (865) 482-5643
On the Web at *http://www.ornl.gov/sci/fed/stelnews*

Introduction of the Coordinated Working Group Meeting for Stellarator/Heliotron Studies

The Coordinated Working Group Meeting (CWGM) for Stellarator/Heliotron Studies has been active since its first meeting in Kyoto in September 2006. The main long-term goals of CWGM activity are to identify critical issues for helical systems, to perform thorough and critical assessment of data, and to define a database for system/reactor studies. These goals can be achieved by obtaining comprehensive, complementary, and deductive perspectives that can provide highly reliable extrapolations. Helical system research, by exploiting the diversity of the three-dimensional (3D) nature of magnetic configurations, provides the best opportunity to achieve this through joint comparative studies. The CWGM offers an appropriate forum to accomplish these goals. As shown in Fig. 1, CWGM meetings have typically been held in between the major international conferences, such as the IAEA fusion energy conference (IAEA-FEC) and the international stellarator/heliotron workshop (ISHW), to facilitate collaborative research documented in joint papers. More than 10 joint papers originating from CWGM activity have been presented at such conferences, and seven joint papers will be presented at the 17th ISHW in Princeton, NJ, USA. (For reference, the joint papers presented at IAEA-FEC are listed at the end of this article.)

The CWGM activity is briefly introduced here with the hope of getting more researchers interested and involved, resulting in the broadening of the activity and the expansion of the database for future development.

Helical system research has a long history of programmatic international collaborations. One of the formalisms supporting such collaborations is the IEA Implementing Agreement for Cooperation in the Development of the Stellarator Concept, concluded by the Stellarator Executive Committee (SEC) on 2 October, 1992.

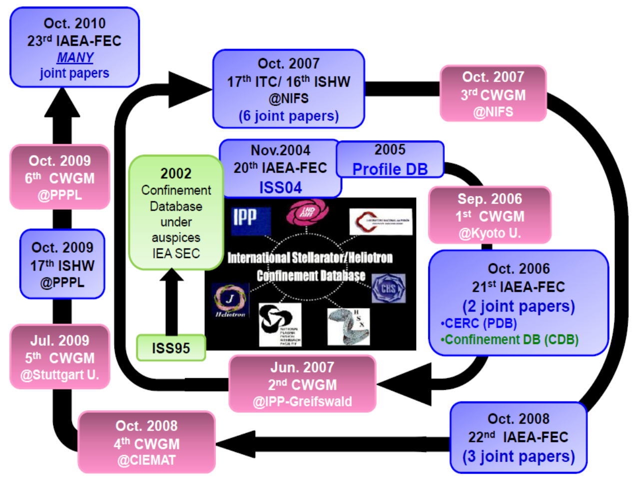

Fig. 1. Evolution of the CWGM activity.

Extensive collaborations based on the body of data arising from multiple devices have led to what may be regarded as a landmark achievement, the International Stellarator Scal-

In this issue . . .

ing 1995 (ISS95) [1]. The International Stellarator/Heliotron **Confinement** DataBase (ISH-**C**DB) activity acquired the "official" auspices of the above agreement in 2002. Since new helical devices such as Heliotron J, HSX, LHD, and TJ-II (in alphabetical order) came into operation after the derivation of the ISS95, a second phase of ISH-CDB activity was launched, to be able to explore a wider range of configurations and plasma parameter space. The effective helicity, as the configuration-dependent quantity, was introduced to produce the ISS04 [2]. The trend, of better energy confinement in the case of smaller effective helicity, is recognized through intermachine comparison and even in configuration scan experiments in one device.

As detailed profile information about plasma parameters has become routinely available, qualitative upgrade of the database activity to include profile information is possible and expected. More physics-based discussions can be anticipated with this upgrade. One particular example was selected as its prototype project: plasmas having a peculiarly steep electron-temperature gradient in the core region, commonly obtained in CHS, LHD, TJ-II and W7-AS (in alphabetical order) with centrally focused electron cyclotron heating (ECH). The significance of the electron root of the radial electric field in the core region was recognized through comparative studies. This is a physics mechanism peculiar to helical systems, and not the case in tokamaks. Based on this clarification, those plasmas were denoted as core electron-root confinement (CERC) [3], highlighting their physics background. After this project's presentation at the 15th International Stellarator Workshop (Madrid, 2005), discussions among interested volunteers [coordinated mainly by Prof. H. Yamada (NIFS) and Dr. A. Dinklage (IPP-Greifswald)] led to an agreement to launch a programmatic collaboration on profile database activity, the International Stellarator/Heliotron **Profile** DataBase (ISH-**P**DB]). Meanwhile it was agreed to initiate "working-basis" meetings as the supporting body of ISH-C/P DB activities and to facilitate joint collaborations. This is the origin of the CWGM.

Five CWGMs have been held to date (the sixth one will be held in Princeton on 16 October 2009), as shown in Fig. 1. In Table 1, some facts along with the topics discussed are summarized. Although detailed discussion of each topic is not described here, presentation materials can be obtained through the NIFS web site, http://www.nifs.ac.jp/en/index_cat04.html [DATABASE → International Stellarator/Heliotron Confinement/Profile Database (ISH-C/P DB)]. Based on the voluntary nature of contributions, not all the topics have been continuously discussed, and the contributors may vary from time to time. However, the CWGM has evolved by identifying a person in charge from each device/institution on each possible topic, to support steady progress towards completeness.

Along with the progress of individual topics related to critical issues in helical systems (and for tokamaks in many cases), issues on reactor scenarios (such as HSR [4] and FFHR [5]) and collaborations in technology fields were also discussed at the fourth meeting, to develop concrete action plans for system/reactor studies. Agreement was reached to launch physics assessments of reactor scenarios utilizing the ISH-C/P DB.

One of the advanced capabilities of the stellarator/heliotron community, computational tools that deal rigorously with the 3D nature of magnetic configurations, can be also extensively applied to critical issues in the tokamak community. One example would be the quantitative understanding of the impacts of induced ergodization of the edge field structure on edge-localized mode (ELM) behavior [6]. The CWGM has provided suitable opportunities to

Table 1. Some topics of previous CWGM meetings.

#	Place	Date	# attendants (on record)[1]	Remarks: Topics discussed etc. (alphabetical order unless underlined)
1	Kyoto University	19–22, September 2006	41	ISS04(CDB)→PDB, possible topics on collaborations, Joint Meeting with Kinetic Theory in Stellarators
2	IPP-Greifswald	4–6, June 2007	26	Edge/3D divertor, high beta, impurity, iota/shear, momentum transport, neoclassical (NC) transport
3	NIFS	23–24, October 2007	34	Current drive (CD), edge/3D divertor, flow/momentum transport, high beta, high performance, impurity, iota/shear, NC, technical issues of DB, transport codes
4	CIEMAT	20–22, October 2008	29	Reactor, collaboration on technology, 3D effects, CD, data access, edge/3D divertor, high beta, impurity, iota/shear, transport codes, turbulent transport codes (→ passed to discussions in expert group)
5	Stuttgart Univ.	6–8, July 2009	29	H mode and ELM, turbulence studies (experiment), usage of PDB, data access, high beta, iota/shear, 3D effects

[1] On-site/video participants may not be counted.

discuss strategic ways to reach out to the tokamak community, and to deepen the understanding of helical systems as an essential element of toroidal confinement.

Possible linkages to the International Tokamak Physics Activity (ITPA) were also discussed at the 5th CWGM. (For details, see for example http://itpa.ipp.mpg.de/.) Due to a kind of "top-down" selection of issues in the case of ITPA, it was pointed out that programmatic linkage of CWGM to ITPA might not be plausible, at least at this moment. However, people working on helical systems who want to contribute to the ITPA can utilize the CWGM to verify their results in a more comprehensive manner (i.e., not device-specific) to increase the impact of their results. For this purpose, inputs from the ITPA members appointed from the stellarator community (to each topical group) to CWGM are highly appreciated to provide cross-fertilization in both meetings.

The collection of profile data has been extended to construct the profile database (PDB). The PDB has been jointly hosted by IPP and NIFS, in a similar manner to the confinement database (CDB). The web site is http://xanthippe.ipp-hgw.mpg.de/ISS/public/index.html (IPP) and http://ishpdb.nifs.ac.jp/index.html (NIFS). Currently, the data are stored according to the physics topics, such as CERC, high beta, high performance, and H mode. The time trace of the shot, profile information (in figures as well as in Ufiles [7], which are compatible with the international multi-tokamak profile database [8]), and some key profiles [e.g., radial electric field (measurement/calculations) for CERC cases] are stored. In principle, published data are stored for public use. The number of profile data sets has been gradually increased to make it more comprehensive. Anyone wishing to contribute data may contact Dr. A. Kus (IPP-Greifswald) and/or H. Funaba (NIFS), who are in charge of managing the database.

Meanwhile, associated configuration (equilibrium) data are now intended to be stored, so that people who are interested in applying their computational codes to experimental profiles can do so. So far, only a few examples have been provided [e.g., high-beta shots from W7-AS, by Dr. J. Geiger (IPP-Greifswald)]. Those who voluntarily check the database availability and send comments are encouraged in order to realize a user-friendly database. The registered profiles on ISH-PDB can also be utilized as a test bed, similar to the Cyclone DIII-D base case [9], with the equilibrium information commonly used by a number of different computational codes.

A poster introducing the CWGM and associated database activity will be presented at the 17th ISHW in Princeton. You all are very welcome to join the activity to make it more extensive and comprehensive to achieve its long-term goals.

These activities are partly supported by NIFS (National Institute for Fusion Science) and NINS (National Institutes of Natural Sciences) under the project "Formation of International Network for Scientific Collaborations." We appreciate the sincere efforts of Dr. B. Peterson (NIFS) at proofreading the English.

References

[1] U. Stroth et al., Nucl. Fusion **36** (1996) 1063.

[2] H. Yamada et al., Nucl. Fusion **45** (2005) 1684.

[3] M.Yokoyama et al., Fusion Sci. Technol. **50** (2006) 327.

[4] H. Wobig et al., Nucl. Fusion **43** (2003) 889.

[5] A.Sagara et al., Fusion Eng. Design **81** (2006) 2703.

[6] See e.g., T. E. Evans et al., Nucl. Fusion **48** (2008) 024002.

[7] See e.g., http://w3.pppl.gov/~pshare/help/ufiles_manual_toc.html

[8] The ITER 1D Modelling Working Group, Nucl. Fusion **40** (2000) 1955.

[9] A. M. Dimits et al., Phys. Plasmas **7** (2000) 969.

Joint papers presented at IAEA-FEC from the CWGM activity:

20th IAEA-FEC (2004)

H.Yamada et al., Nucl. Fusion **45** (2005) 1684.

21st IAEA-FEC (2006)

M. Yokoyama et al., Nucl. Fusion **47** (2007) 1213.

A. Dinklage et al., Nucl. Fusion **47** (2007) 1265.

22nd IAEA-FEC (2008)

Y. Feng et al., Nucl. Fusion **49** (2009) 095002.

R. Burhenn et al., Nucl. Fusion **49** (2009) 065005.

A. Weller et al., Nucl. Fusion **49** (2009) 065016.

M. Yokoyama, on behalf of the collaborators in CWGM activity
National Institute for Fusion Science
322-6 Oroshi, Toki 509-5292, Japan
E-mail: yokoyama@LHD.nifs.ac.jp

Itoh Project Prize in Plasma Turbulence 2009 awarded to Tim Happel (EURATOM-CIEMAT)

At the 36th European Physical Society (EPS) Conference on Plasma Physics (Sofia, Bulgaria, 29 June–3 July 2009), the Itoh Project Prize in Plasma Turbulence 2009 was awarded to Tim Happel (EURATOM-CIEMAT) for his work on "Perpendicular plasma velocity and radial electric field profiles measured by Doppler reflectometry in the stellarator TJ-II."

This was the fifth time that Professor Sanae-I. Itoh, in agreement with the conference organizers and with the help of *Plasma Physics and Controlled Fusion* (PCCF, published by the Institute of Physics), has offered the Itoh Project Prize in Plasma Turbulence to students presenting a poster at the conference. (Please visit the PPCF web site for previous winners.) The winner is given the chance to visit Kyushu University in Japan for one week, including flights and living expenses.

The competition was very successful with many excellent candidates. Each candidate had to make a presentation of at least 15 minutes and the final choice was very difficult. After enthusiastic discussion, the selection committee for 2009 (S.-I. Itoh, G. Bonhomme, S. Chapman, K. Itoh, U. Stroth) chose T. Happel as the winner.

Fig. 1. Tim Happel (left) is announced as the winner by Prof. Sanae-I. Itoh.

Two students also received high commendations from the judges:

Alessandro Casati, EURATOM-CEA Cadarache, "Turbulence in Tore-Supra plasmas: measurements and validation of nonlinear simulations"

Christian Theiler, EPFL, "Study of filament motion and their active control."

Congratulations to these students and thank you to all entrants.

Fusion wiki at CIEMAT

A new Fusion Wiki has started at:

http://www-fusion.ciemat.es/fusionwiki/

The goals of the wiki are described in some detail in the "About FusionWiki" section; however, in the spirit of a wiki, these are open to discussion, as is any of the material included.

The TJ-II page is at:

http://www-fusion.ciemat.es/fusionwiki/index.php/TJ-II

For more information, contact

Boudewijn van Milligen
E-mail: boudewijn.vanmilligen@ciemat.es

U.S. Stellarator Engineering Metrics peer review posted

The U.S. stellarator R&D program has the following milestone: "Issue report on engineering metrics for stellarator complexity, for use in targeting simpler designs, September, 2009." Here "metrics" is interpreted to include design criteria, guidelines, limits, constraints, etc., as long as they are specific enough to be incorporated into stellarator design tools and processes. In fiscal year 2009, the first year of the study, the goal was to make progress in documenting metrics that could be tested in design studies the following year. Tom Brown leads the effort to achieve this milestone. The purpose of this peer review was to communicate progress and utilize the technical expertise of a broader group before finalizing the milestone report. The report is posted at

http://nsdr.pppl.gov/meetings/aug20PeerRev/Stel_MetricsRev.pdf