

6 Workshops and meetings

24th Symposium on Fusion Technology

The Warsaw University of Technology, Association member, achieved the status of the organizer of one of the most vital conferences dedicated to the fusion technology – namely SOFT conference.

The 24th Symposium on Fusion Technology was held on 11th-15th September 2006. It took place in the Palace of Culture and Science in the center of Warsaw, the Capital City of Poland. The objective of that conference was to exchange information on design, construction and operation of fusion experiments, and on the technology for present fusion machines, the next step and power plants. 618 participants from 25 countries: Austria, Belgium, Canada, China, Czech Republic, Finland, France, Germany, Hungary, India, Italy, Japan, Korea, Latvia, Poland, Portugal, Romania, Russia, Spain, Sweden, Switzerland, the Netherlands, UK and the US attended the conference. The biggest number of representatives came from Germany and France. The LOC invited 24 VIP guest featuring 2 most important persons in the field of fusion and ITER project i.e.: Norbert Holtkamp and Shinzaburo Matsuda.

The participants prepared their presentations and posters in English language on 1 of 10 of the following topics:

- A. Experimental Fusion devices
- B. Plasma Heating and Current Drive
- C. Plasma Engineering and Control
- D. Diagnostic, Data Acquisition and Remote Participation
- E. Magnets and power Supplies
- F. Plasma Facing Components
- G. Vessel/in-vessel Engineering and Remote Handling
- H. Fuel Cycle and Breeding Blankets
- I. Materials Technology
- J. Power Plants, Safety and Environment, Socio-economics and Transfer of Technology

The conference was organized by the Local Organizing Committee under supervision of International Organizing Committee. The complete list of all members is presented below.

International Organizing Committee

- K. J. Kurzydowski WUT, Warsaw, Poland (Chairman)
- N. Baluc CRPP-EPFL, Villigen, Switzerland
- A. Cardella IPP-CEC, Garching, Germany
- M. Chatelier CEA, Cadarache, France
- I. Cook UKAEA, Culham, UK
- J-L.Duchateau CEA, Cadarache, France
- F. Gnesotto RFX, Padua, Italy
- S. Gross FZK, Karlsruhe, Germany
- A. Kaye UKAEA, Culham, UK
- A. Möslang FZK, Karlsruhe, Germany
- S. Païdassi CEC, Brussels, Belgium

A. Pizzuto ENEA, Frascati, Italy
H. Tuomisto Fortum, Helsinki, Finland
H. Zohm IPP, Garching, Germany

Local Organizing Committee

K. Szawłowski (Chairman)
J. Blizzard (Co-worker of Scientific Secretary)
J. J. Bucki (Responsible for Web Site)
L. Ciupiński (Responsible for Industrial Exhibition)
E. Fortuna (Responsible for Satellite Meetings)
K. Konopka (Responsible for R&D Exhibition)
K. Kołys (Confernece Secretary)
M. Lewandowska (Responsible for Social Events)
K. Sikorski (Scientific Secretary)
T. Wejrzanowski (Co-worker of Scientific Secretary)

The conference programme consisted of: 8 Plenary Sessions (including Opening and Closing Ceremony, Round Table), 8 Oral Sessions, 4 Poster Sessions, Industrial Exhibition, R&D Exhibition and about 20 Satellite Meetings. The additional event of Mini Fusion Expo was organized at 141 Woloska Street in the building of Warsaw University of Technology. It was public-oriented, intended mostly for secondary school pupils.

The Opening Ceremony was honored by Pablo Fernandez Ruiz from the European Commission. The speeches were also delivered by Prof. Krzysztof Kurzydłowski Undersecretary of State and Dr Andrzej Gałkowski Head of the Reseach Unit of the Polish Association EURATOM-IPPLM.

The conference programme included 15 Invited Talks with the participation of the following speakers: Norbert Holtkamp, Jerome Pamela, Shinzaburo Matsuda, Felix Schauer, Mark Hendersson, Songtao Wu, Vanni Antoni, Manfred Glugla, Daniel Ciazynski, Maurizio Gasparotto, Jean-Philippe Girard, Rainer Lässer, Michael Kaufmann, David Ward, Karl Lackner.

On Monday, Tuesday, Wednesday and Thursday participants presented their posters. Each day they have shown about 100 posters.

On Thursday 14th September there was Round Table discussion on “ITER Industrial Participation and Procurement”. The leader of the meeting was Francois D'Aubert. The discussion lasted 2 hours with the attendance of Marcel Gaube, Maurizio Gasparotto, Norbert Holtkamp, Angelo Airaghi and Herkko Plit.

An important part of the conference was the Industrial Exhibition which lasted from Monday 11th till Friday 15th September 2006 and gathered 20 European companies from 7 countries. The complete list of exhibitors is shown below. The biggest area was occupied by Group Areva, which was also the official sponsor of the conference.

ACCEL Instruments GmbH (Germany)
Air Liquide (France)
Alstom Magnets and Superconductors (France)
Ansaldo Ricerche S.p.A (Italy)
AREVA (France)
Babcock Noell (Germany)/ AGAN

BODYCOTE (Germany)
Comex Nucleaire/SNEF (France)
Dutch Scientific (The Netherlands)
EFET EWIV (Germany)
Hans Wälischmiller GmbH (Germany)
Grupo Jema (Spain)
LTCalcoli Sas (Italy)
LUVATA (Italy)
MAN DWE GmbH (Germany)
MKS Instruments Deutschland GmbH (Germany)
OCEM S.p.A (Italy)
Oxford Technologies Ltd. (UK)
PLANSEE SE (Austria)
Prizztech Oy/FinnFusion (Finland)
Regional Chamber of Commerce and Industry of Provence-Alps-Cote D'Azur-Corse (France)

Another exhibition was organized for R&D representatives. There were booths with exhibitors from 6 countries, namely:

Association Suisse EURATOM (Switzerland)
CEA Cadarache (France)
Consorzio RFX (Italy)
EFDA (Germany)
Elsevier (United Kingdom)
Forschungszentrum Karlsruhe (Germany)
ITER (Germany)
The Andrzej Sołtan Institute for Nuclear Studies (Poland)
The Institute of Plasma Physics and Laser Microfusion (Poland)
The Warsaw University of Technology (Poland)

All attendees were invited to take part in the Social Programme, which consisted of 4 events:

- Welcome Reception Cocktail organized on Monday 11th September 2006 in Warsaw Marriott Hotel
- Frederic Chopin Music Concert which took place on Wednesday 13th September 2006 in Warsaw Royal Castle and was performed by Polish world-famous pianist Ewa Poblocka.
- Organ Music Concert a parallel event on Wednesday 13th September 2006 in St. Anna' Church with the performance of talented young organist Bartosz Jakubczak
- Gala Dinner organized on Thursday 14th September 2006 in Warsaw University of Technology Main Aula with the jazz concert prepared by Bogdan Hołownia and first night of animated movie on SOFT.

Registration of participants and abstracts as well as all important information were on the web site.

The conference proceeding will be published by Elsevier in special issue 'Fusion and Design'.

The conference was finished with big success and was described in 'EFDA Fusion Newsletter' Vol 2006/3, Oct 15, 2006.

IEA Large Tokamak IA Workshop on “Edge Transport in Fusion Plasmas” 11-13 September 2006 Dom Polonii, Kraków, Poland

The Association was also the organizer of a workshop under International Energy Agency auspices – IEA Large Tokamak Workshop on Edge Transport in Fusion Plasmas. The workshop was held in Krakow, Poland from the 11th to 13th of September 2006, in the cultural center “Dom Polonii”. The first day (Monday) focused on edge turbulence with experimental results being reported in the morning session and theoretical work in the afternoon session. The second day (Tuesday) schedule was planned in a similar way (morning – experiment, afternoon – experiment) pertaining to edge localized modes or ELMs topic. The final day (Wednesday) contained a morning session dedicated to challenges in edge modeling with fluid codes, and an afternoon session comprising a plenary discussion followed by smaller working group discussions.

The outline of each session is presented below.

In the Monday morning session (chaired by W. Fundamenski), S. Zweben presented a comprehensive overview on recent observations of edge turbulence with fast cameras, pointing out that turbulent structures in the edge are a sincere issue for ITER. Besides results he also reviewed available diagnostic methods for the edge and the emerging comparison with detailed turbulence calculations. J. Horacek reported on results from TCV on detailed investigations using probes of edge and SOL properties with good comparison to ESEL modeling. M. Hron showed recent results from the Czech tokamak CASTOR including biasing experiments in the SOL leading to improved confinement. The stochasticity in magnetic field lines at the ergodic divertor at TEXTOR and its impact heta and particle deposition was the topic of a talk by M. Jakubowski, depicting the relevance of the length of the ergodic field lines for heat deposition and the question of stochastic transport vs. collisional transport. First results and the construction on the FTU liquid Lithium limiter including observations of high density peaking at reduced Z_{eff} were presented by V. Pericoli-Ridolfini. P. Scarin reported on structures in the edge turbulence on RFX showing scalings in the structures and the spectra with density.

The Monday afternoon session (chaired by V. Naulin) dealt with theoretical progress made in edge turbulence simulations. B. Scott presented an overview of recent developments in edge turbulence codes and the requirements for energy transfer terms required for realistic numerical simulations. A.Kendl reported on the influence of magnetic field geometry on the turbulence, while T.Ribeiro presented first calculations showing the change of the turbulence characteristic from the drift wave type on closed magnetic field lines to interchange type on open field lines. T.S.Hahm showed the importance of turbulence spreading from the edge into the core and in general into stable regions. A.Nielsen presented ESEL simulations for JET showing fair agreement in predicting e-folding length and radial transport profiles, while stressing that corresponding ITER simulations will see a tenfold increase in computational resources.

In the Tuesday morning session (chaired by W. Fundamenski), K. Kamiya presented an overview of experimental observations of edge localized models (ELMs) in present day large tokamaks, including recent results on the effect of toroidal field ripple (varied with ferromagnetic insets) on ELM size on JT-60U. Peter Balan showed recent measurements for Reynolds stress and particle fluxes in the quiescent inter-ELM phases and compared these with numerical simulations of 2D SOL interchange turbulence for ASDEX Upgrade parameters. K. H. Finken reported on the Influence of the Dynamic Ergodic Divertor (DED) in the Textor tokamak on ELM behaviour, including the suppression of ELM activity at even moderate DED currents. S. Zweben, reporting for R. J. Maqueda who could not attend for personal reasons, showed High Speed Images of Edge Plasmas in NSTX; the images revealed an apparent continuum in intermittent activity and phenomenology of filamentary structures from ohmic through L-mode to ELMy H-mode conditions. E. Nardon discussed the simulations of ELM control by resonant magnetic perturbations (RMP) for ITER, including the expected response of the plasma

to the RMP as predicted by the non-ideal MHD code JOREK. The screening of the RMP due to toroidal rotation was suggested to explain the fall of the edge density with RMP in the DIII-D I-coil experiments. In the final talk, G.Kirnev reported on Investigation of nonlinear interactions of plasma fluctuations in the edge of the T-10 tokamak, showing a two wave decomposition of the observed fluctuations into several pairs of the frequency components (with frequencies f_1 and f_2) obeying the rule $f_1+f_2 = f_0$.

The Tuesday afternoon session (chaired by T. Rognlien) dealt with progress in the theory and simulations of ELMs. G. Huysmans presented an overview talk in which he described several approaches at modeling the ELM. Non-ideal MHD codes were shown to be fairly successful in modeling the early non-linear phase of the ELM evolution. X-point geometry and plasma dissipative effects were shown to be important in this context. O. E. Garcia presented dynamical simulations of isolated blobs and ELM filaments in SOL plasmas based on electrostatic interchange dynamics. He showed that it is demonstrated that such plasma filaments develop dipolar vorticity and electrostatic potential fields, resulting in rapid radial acceleration and formation of a steep front and a trailing wake. A.H.Kritz discussed the Modeling of ELM Dynamics in ITER. He addressed the important question of integrated modeling of ELMy H-mode discharges, namely how much plasma and current density is removed during each ELM crash. Non-ideal MHD simulations using the NIMROD code indicate the formation of ELM filament structures, which are observed in many existing tokamak experiments, in marginally stable ITER equilibria. Differences between ELM dynamics for ELMs triggered by ballooning instabilities and by peeling instabilities are described. M.Tokar discussed modeling of mechanisms responsible for ELM mitigation by external magnetic field perturbations. He demonstrated that through non-linear interaction, leading to the generation of side bands which suck energy from the main mode, such perturbations can raise the threshold of MHD instabilities. D.Kalupin presented simulations of the effect of pulsed gas puffing as a trigger for the ETB formation, using the 1-D transport code RITM. The results indicate that the turbulent transport is transiently suppressed by the shear of the radial electrical field, which emerges at the plasma edge due to the formation of the steep pressure gradient driven by the gas injection. Finally, P.Belo discussed the effect of the edge transport barrier on impurity transport using the 2D transport code EDGE2D. She found that the decrease in the deuterium puff level lead to an increase in the parallel classical thermal force, such that the sum of the parallel friction and thermal forces was directed away from the divertor region allowing impurities to concentrate in the plasma core.

In the Wednesday morning session (chaired by V. Naulin), was devoted to numerical approaches to edge modeling. R. Schneider presented an overview on current challenges in edge modeling pointing out the successes in edge modeling over the last decade, but also lasting complex questions that need addressing in an integrated way. He showed the scope of edge modeling from molecular dynamics simulations via kinetic and gyrokinetic calculations to the more ubiquitous fluid models. He also called for integrated modeling as is happening in other engineering and physics fields with well defined measures for quality assessment and code integration. C. S. Chang presented the SciDAC program on integrated simulation of edge transport in fusion plasmas and showed first results from the full f gyrokinetic XGC-1 PIC code. He called for an integrated approach to turbulence and neoclassic in the edge as conventional neoclassical theory often breaks down for the SOL. Coupling of the code to an MHD code is underway. T. Rognlien presented the progress on a continuum gyrokinetic code for edge plasmas and results from early physics benchmarks from modules of the code. H. Kawashima reported on JT60U/JT-60SA simulations and development of a integrated SOL/divertor code in JAEA. An effort to integrate particle and fluid codes for the edge is underway. Results on sputtering and divertor pumping were presented. Kalentiev presented results from different numerical approaches to 3D transport modeling of fusion devices, focusing on three competitive codes under development for W7-X. One problem being the mapping of a complex, evolving magnetic field structure to a usable and computational beneficial numerical grid. J. Brooks considered sputtered impurity edge plasma transport modeling for ITER parameters and the spatial distribution of sputtered material from the ITER wall. Large uncertainties in the material redeposition properties were reported. The concluding discussion session on Wednesday afternoon was chaired by W. Fundamenski, V. Naulin and R. Zagórski.

Topics of the previous days were taken up in a vivid discussion on the convergence of large scale MHD models towards fluid turbulence models. The need for better benchmarking of codes was stressed as the need for development and maintenance of larger code projects. It was agreed that some progress will be made on the inclusion of atomic physics into transport codes and the coupling of these to turbulence codes. The experimental side has benefited from better diagnostics in the edge, with a clear call for improved spatiotemporal diagnostics and quantification of fast camera data.

LIST OF PARTICIPANTS

- EU:** Balan Petru (Innsbruck University)
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The Sixth International Workshop and Summer School

“Towards Fusion Energy – Plasma Physics, Diagnostics, Spin-offs”

Kudowa Zdrój, Poland, September 18–22, 2006

The 6th edition of the International Workshop and School “Towards Fusion Energy – Plasma Physics, Diagnostics, Spin-Offs” was, as in the past years, held in charming Kudowa Zdrój (formerly Bad Kudowa in pre-war Niederschlesien) from 18 to 22 September. This summer school is organized every year by The Association EURATOM/Institute of Plasma Physics and Laser Microfusion (IPPLM, Warsaw, Poland) and the International Centre for Dense Magnetised Plasmas (ICDMP) together with its Czech Branch in Prague.

The venue for the Summer School was the Hotel Bristol in Kudowa Zdrój. A total of 14 invited lectures on various aspects of plasma physics and controlled thermonuclear fusion were given in this week. In addition, students attending the school gave 21 oral presentations.

The invited lectures covered general talks on magnetic and inertial confinement, plasma diagnostics, plasma facing components, detailed physical aspects of various fusion devices (stellarators, tokamaks and plasma focus), an overview of research on small tokamak devices, and a glance at the future of magnetic fusion research with overviews on JET and ITER. Lecturers were drawn from fusion research laboratories across Europe, from the European Commission and from leading plasma physics research groups at Institutes and Universities in Europe.

The students gave very well prepared presentations on their own work, and their talks covered research results from PF-1000 (Plasma Focus 1000, International Centre for Dense Magnetised Plasmas, Warsaw, Poland), Uragan U-3M torsatron (Kharkov Institute of Physics and Technology, Kharkov, Ukraine), gas dynamic trap (GDT, Budker Institute, Academy of Sciences, Novosibirsk), CASTOR tokamak (Institute of Plasma Physics, Prague). In addition talks were given on the reinstallation of the COMPASS tokamak from UKAEA-Culham to IPP Prague, research results from the X-ray crystal spectrometer at JET, theoretical studies in plasma physics at the University of Szczecin and studies on capillary discharges and laser generated pulsed plasmas.

The atmosphere at the summer school was as every year very stimulating. The students actively participated in questions after the talks, and there were continuous discussions with the invited speakers during coffee break, lunchtime or free evening time. A competition was held for the three best oral presentations given by the students. The quality of the presentations was generally very good, and gave the members of the jury a difficult time to make a final selection. After some discussion, the jury awarded the first prize to Francesco Caridi (from the Dipartimento di Fisica, Università di Messina, Messina, Italy) for his lecture “Neutral and ion energy distributions from laser-generated pulsed plasmas”, second prize to Andriy Velyhan (from the Institute of Physics - ASCR, Prague, Czech Republic) for his presentation “Measurement of spatial distribution of neutron emission on Plasma Focus Device PF-1000 with the use of thermoluminescent dosimeters” and the third prize to Agata Czarnecka (from the Institute of Plasma Physics and Laser Fusion, Warsaw, Poland) for her talk “Relative calibration of the X-ray crystal spectrometer at JET”. The prizes consisted in typical beautiful regional craftwork, and should provide a lasting memory to the prize-winners for their participation in the summer school.

Participation in the Euratom Fusion Training Scheme: W7-X Superconducting Magnet System: Fabrication and Testing “W7-X SC MAGNETS”.

A Ph.D. student at Warsaw University of Technology, Mr. Paweł Czarkowski, is participating in the W7-X SC Magnets Project. He is one out of 4 participants of this Euratom training activity. Each of the participants has his/her own task in the scope of the common topic which is manufacturing/assembling/operation/modeling of fusion reactors' superconducting magnets. The task of Mr Czarkowski consists of modelling of W7-X relevant parts using Finite Element Method. His activities are supervised by tutors from Warsaw University of Technology, more precisely the team also participating in the EURATOM-IPPLM P9 project, and IPP Greifswald - Systemtechnik department, where Mr. Paweł Czarkowski is an employee.

Presently, his main task, in the scope of the activity, is analysis of influence of the strain due to wedges welding on behavior of central support elements. This task demands a broad knowledge of main support structure of W7X which is provided by IPP Greifswald team. Mr. Czarkowski has also other minor task, all of them related with support structure of W7X.

Since the start of the project he has spent more-or-less equal time in IPP and WUT, with 2-3 weeks intervals. The project is still in its starting phase and substantial lectures and visits are planed to take place in near future.