

3. International Collaboration on Helical Fusion Research – IEA Implementing Agreement for Cooperation in Development of the Stellarator-Heliotron Concept –

1 OVERVIEW

The world stellarator-heliotron community has been promoting international collaborations under the auspices of International Energy Agency (IEA) Implementing Agreement on “Development of the Stellarator-Heliotron Concept”. The present participating countries in this agreement are Australia, Germany, Japan, Russia, Spain, Ukraine and U.S.A. The Stellarator-Heliotron Executive Committee conducts arrangement of collaboration and endorses proposed activities. The 43rd Stellarator-Heliotron Executive Committee was held in St.Petersburg (Russia) in conjunction with the 25th IAEA Fusion Energy Conference. NIFS hosts the web page of this activity at <http://iea-shc.nifs.ac.jp/>. The summary of international collaboration on fusion research among helical systems is given in the following sections.

2 COORDINATED WORKING GROUP MEETING (CWGM)

During 2014, 13th CWGM was held to continuously facilitate the joint activities.

13th CWGM

The 13th Coordinated Working Group Meeting (CWGM13) was held from 26 to 28, February 2014 in Uji Campus of Kyoto University. The materials presented in this meeting are available at <http://ishcdb.nifs.ac.jp/> and http://fusionwiki.ciemat.es/wiki/Coordinated_Working_Group (→ CWGM13) for those of you having further interests. Below, you will find a brief summary of the meeting.

Three-dimensional (3D) Transport in divertors

Upon the proposal made in the last CWGM (12th in Padova), recent progresses were reviewed on the experimental identification and physics interpretation of 3D effects of magnetic field geometry/topology on divertor transport. This has passed the domestic (Japan) selection process towards the presentation in the coming 25th IAEA Fusion Energy Conference. Identification of key parameters for 3D effects should open new perspectives on divertor optimization for future reactors. Interactions between 3D structure of magnetic field, current in SOL/stochastic layer, parallel and perpendicular electric field should be systematically

clarified through diagnostics and modelling in a range of magnetic field configurations. Issues in formulating joint experiments, potential and current measurements, 2D temperature and density measurements, are discussed among HSX, LHD and TJ-II. Comparison with linear devices “without 3D effects” is also recommended to elucidate 3D effects in a comparative manner.

Impurity

Impurity issues have been raised in several CWGM meetings, but session has not been formed unfortunately. This time, the session is formed to re-activate discussions in framework of CWGM. Experiments for impurity transport are reported from LHD (intrinsic and TESPEL-induced) and TJ-II (broad range of materials, LiF to W). In TJ-II, TESPEL injection is now under consideration with a newly installed pellet injector. In-surface variation of electrostatic potential caused by ion drift-kinetic dynamics has been put forward as potentially important for radial impurity transport. TJ-II has identified asymmetries in C^{6+} impurity density and floating potential, for which comparisons with EUTERPE code result has been commenced. The importance of the impurity issues calls for coordinated actions both in experiments (Heliotron J, LHD and TJ-II) and simulations (FORTEC-3D, EUTERPE, fluid codes...) to assess the existence of in-surface potential variations and its contribution to radial impurity flux. R.Burhenn et al., published the joint paper on impurity issues in 2009 [“On impurity handling in high performance stellarator/heliotron plasmas”, Nuclear Fusion 49 (2009) 065005.]. The follow-up joint papers (further developments afterwards) can be formulated by re-activating joint activities in CWGM.

Highlights in experiments, invitation to joint experiment

The recent topics in Heliotron J device were reviewed. The plasma startup, the plasma parallel flow measurement and its comparison with neoclassical prediction, fast-ion driven MHD and related particle flux studies by using several probe systems, the external control of energetic-ion driven MHD instabilities by ECCD, the fast ion distributions in ICRF experiment, high density operation through HIGP (high intense gas puff) fueling and SMBI (supersonic molecular beam injection), transition to improved confinement in such a high density regime, etc. are emphasized to trigger proposal and discussions for joint experiments. From LHD, steady progresses of plasma

parameters (ion temperature, simultaneous high temperatures, and steady state operation) were reported. New diagnostics, high dynamic-range spectroscopic measurement of Balmer- α line, has facilitated quantitative understandings on the impacts of discharge-cleaning for producing high ion temperature plasmas. RMP experiments have fertilized 3D physics, such as the magnetic island dynamics (growth/healing), and observation of peaked pressure profile inside the magnetic island after the pellet deposition. A tentative schedule of deuterium experiment was also mentioned, along with the planning of upgrade of heating and diagnostics capability. Autoplot (advanced data viewer) and TASK3D-a (integrated transport analysis suite) were introduced, which should facilitate joint experiments. Invitation to 18th campaign (in 2014) were called.

Reactor/systems code

After the kick-off session in 10th CWGM (2012, Greifswald), interaction between systems codes (HELIOSCOPE and PROCESS) and physics modellings have been successfully enhanced. Plasma operation control scenario consideration has been progressing for FFHR-d1, in which a transport model based on LHD experiment has been employed. Coupling with the TASK3D (integrated transport analysis suite) is in preparation for consistency check (time evolution of equilibrium, heating along with plasma profiles). As for PROCESS, modules for plasma geometry, modular coils and island divertor have been developed and implemented. ITG transport model is deduced based on GENE simulation results, to be included. In such a way, the common development for these 2 reactor design activities is to implement further physics models. Benchmarking activities between these developments were proposed. However, it is too difficult, at this moment, because many modules depend on the individual design. Mutual information exchange and closer link to physics modellings are anticipated.

Flows and Viscosity, Transport

Flows and viscosity strongly depend on magnetic configurations, collisionality and radial electric field etc. Variety of magnetic configurations either within a single device or covering multi-devices provides wide variety of research subjects to be challenged in experiment, theories and simulations. In terms of neoclassical transport, the neoclassical poloidal viscosity analyses for LHD biasing plasmas, the validation of stellarator optimization via extended neoclassical simulations and dedicated experiment, parallel flow in Heliotron J NBI plasmas were reported. Benchmark of a bunch of neoclassical transport codes with (FORTEC-3D)/without non-local effects has been progressing through utilizing experimental data. Setting a standard case (like “Cyclone DIII-D base case” [C.M.Greenfield et al., Nucl. Fusion 37 (1997) 1215.]) for

this joint activity was proposed, utilizing the International Stellarator-Heliotron Profile Database. Uploading the simulation results was also suggested. Joint activities for the evaluation of expected potential variation on a flux surface (“ Φ_1 ”) based on EUTERPE and FORTEC-3D is planned in relation to the issue of the impurity transport. Neoclassical transport in tokamaks with 3D magnetic perturbation has also been progressing through collaborations among NIFS, PPPL and JAEA (Japan Atomic Energy Agency).

In addition to the neoclassical transport, correlations among flow, turbulence and transport were also discussed based on presentations from HSX (core density turbulence and plasma flows) and LHD (toroidal flows and turbulence, electromagnetic Gyrokinetic simulation in finite-beta plasmas). Because such issues have been rapidly evolving among several Stellarator-Heliotron devices, the establishment of a new session or identifying a new key person was proposed, to further activate collaborations on this topic.

Plasma startup

In Stellarator-Heliotron devices, current-free plasmas have been produced by 1st/2nd harmonic ECH or (in LHD) tangential NBI. No successful plasma startup by NBI only in mediums-size devices such as Heliotron J and TJ-II. Successful startup is required in W7-X. Reliable startup at low toroidal electric field is an important issue in superconducting tokamaks. These have been programmatically investigated in ITPA IOS (Integration Operation Scenario) topical group, and Heliotron J and TJ-II have contributed to it. Multi-device experiments and analyses have been made for detailed characterization of plasma startup, and better understanding for modelling. As the kick-off of this plasma startup session, (1) issues of plasma startup in Stellarator-Heliotron plasmas, (2) 2nd harmonic ECH breakdown in Heliotron J, LHD, WEGA and prediction for W7-X, (3) modeling of NBI startup in LHD and W7-AS and the possibility of plasma startup by NBI in W7-X, and (4) effects of Ohmic induced toroidal electric field were reported, all along with the modelling efforts. A joint paper on ECH breakdown has been in preparation.

Energetic particles, Alfvén eigenmodes

Database activity of Alfvén eigenmodes has been developing among H-1NF, Heliotron J and LHD. Data mining tool has been upgraded (updated clustering). Effects of ECH/ECCD on Alfvén eigenmodes have been programmatically investigated among Heliotron J, LHD and TJ-II. Among them, in Heliotron J, GAE (Global Alfvén eigenmode) has been targeted for comparison with TJ-II results, and it has passed domestic (Japan) selection process towards coming 25th IAEA Fusion Energy Conference as the

joint paper. Anomalous transport and loss of energetic particles by MHD instabilities are also the main topic (3 devices mentioned above). STELLGAP code has been upgraded to consider the coupling between shear Alfvén wave and acoustic wave. Beta-induced Alfvén eigenmodes (BAE) including EGAM (energetic particles-driven GAM), which are observed in many devices, will be examined by STELLGAP from the viewpoints of low frequency modes in gap caused by Alfvén and acoustic waves.

3D equilibrium

The programmatic validation and cross-benchmarking initiative for 3D equilibrium calculations (involving 11 codes from 6 institutions) was introduced. Stellarator symmetric tokamak equilibrium with small non-axisymmetric perturbations (ELM suppression experiments in DIII-D, shot 146058) allows participation of wide range of equilibrium codes. Calculations have found disagreement between VMEC and linearized tokamak codes, and the source of disagreement has not yet been resolved. Dedicated run day for scanning key plasma parameters and I-coil spectral scans is under planning to widen the database for guiding validation and cross-benchmarking. Joint activity utilizing Stellarator-Heliotron experiment was recommended. The big impacts of the toroidal current on the magnetic topology especially in low magnetic shear configurations were pointed out, and this issue has been systematically investigated in W7-X (VMC/EXTENDER, HINT2) and TJ-II (HINT2). Some of them will be reported as the plenary talk in the coming EPS (June 2014 in Berlin) by J.Geiger (IPP-Greifswald). Comparative studies on Heliotron J should be started. Helical core in RFP and 3D displacement for tokamaks are also emerging collaborative topics in 3D equilibrium.

International Stellarator-Heliotron Confinement and Profile Database (ISH-CDB, PDB)

The long history of ISH database was reviewed, in terms of the evolutions of global energy confinement scalings (ISS95, ISS04), and from CDB to PDB with equilibrium database. Re-examination of ι dependence in ISS04 ($\sim \iota^{0.41}$) was proposed exploiting the extended TJ-II data (wide scan of ι is available) for reducing collinearity of ι with geometrical parameters such as the aspect ratio. Extension of HSX data (recent 1T operation) was also proposed. Recent TASK3D extension in LHD has enabled to sequentially produce 0D data in CDB, so that registrations from LHD are foreseen. A.Kus (IPP-Greifswald), who has devotedly contributed for ISH-CDB and PDB, will retire this September. He has used the statistical analysis software, JMP. At this occasion, he prepares his scripts to be widely available as a basis for future extension. These will be uploaded in the ISH-DB web page. Trial of the statistical approach for deducing ion and

electron heat diffusivities for wide-range LHD plasmas (say, “LHD profile database”) was also introduced.

Framework of collaborations

Restructuring fusion activities in Europe, EUROFUSION, was explained along with the EFDA roadmap to the realization of fusion energy (<http://www.efda.org/wpcms/wp-content/uploads/2013/01/JG12.356-web.pdf>). Stellarators are part of roadmap, as an alternative approach, and to mitigate risks such as on steady-state operation and plasma startup. Focus is put on HELIAS line. It is mentioned that work on other helical concepts (heliotron, compact stellarators) will continue as a part of international collaborations. In this regard, CWGM is highly plausible in EUROFUSION activity. TJ-II experimental plans were introduced to emphasize that plans are very much aligned with EUROFUSION work programmes. SSOCG (Steady State Operation Coordination Group) activity was also introduced. This activity has been formulated by calling the participation of related IEA (International Energy Agency) Implement Agreements and national laboratories. Among 7 work packages, there is a “roadmap to SSO”, for which Stellarator-Heliotrons should contribute a lot. It was agreed to hold a brain-storming meeting (video-conference) between T.Mutoh (NIFS) and A.Dinklage (IPP) along with interested colleagues (such as the steady-state operation theme group in LHD). The outcome from that meeting will be reported in the next CWGM.

At the end of the meeting, there raised a proposal, from A.Dinklage (IPP-Greifswald), to hold the next 14th CWGM in Europe. CWGM activity has been recognized in EUROFUSION (see, “Framework of collaborations”) as one of the international collaborative frameworks. It recommends holding the meeting, one in abroad and one in Europe, in a year. Based on recent increased interests on stellarator concept in Hungary and Poland, he will contact them for inquiring the possibility to hold the next CWGM in one of these 2 countries.

3 AUSTRALIA

3.1 International collaborations in 2014

The Australian Plasma Fusion Research Facility at the Australian National University houses the H-1 heliac and the MAGPIE linear device described below. H-1 is a three-period helical axis stellarator with a flexible magnetic topology that allows fundamental studies in plasma confinement and stability, turbulence and flows, and confinement transitions at moderate heating power. Because of its coil-in-tank construction, the device is an ideal test bed

for the development of advanced active and passive imaging diagnostic technologies from microwave through to optical frequencies. The MAGPIE materials interaction device shares this infrastructure.

2014 marked the completion of the infrastructure ~US\$7M upgrade under the Australian Government's Super Science Scheme. Enhancements to the Facility included a 2x200kW 4-20MHz RF heating system, the MAGPIE device, two discharge cleaning systems and other measures for impurity control, a number of multi-channel and imaging optical diagnostics, and a simple URL-based interface to data with consistency of access from simple browsing to detailed raw data. These will enable future growth of Australian capability in fusion science and engineering, and as a focus for collaboration within the Australian community, will support the development of world-class diagnostic systems for application to international facilities in preparation for ITER.

The performance of the new 21 channel imaging interferometer was improved by incorporating specially designed sub-millimetre structures on the interfaces of several components to reduce reflections. A three-view optical emission imaging system successfully acquired data in synchronism with the MHD signals from the Mirnov coils. Using CII light as a proxy for electron density, this provided excellent two dimensional data, and some three dimensional information. The operational range of the RF was extended to 4MHz, the lower limit of the new sources, to allow ion cyclotron heating of deuterium. This, along with the 21 channel interferometer has enabled magnetic field scans over a wider range to investigate the scaling of the dispersion properties of the observed MHD modes, with minimal variation in the RF heating mechanism.

As part of a longer term strategy that aims for an Australian involvement with ITER, upgrade funding has supported the development of a prototype linear, high power-density satellite device "MAGPIE", utilizing the H-1 heating, power and diagnostic systems. This is the first device in the Materials Diagnostic Facility, led by Dr. Cormac Corr and was developed in collaboration with Oak Ridge and the Australian Nuclear Science and Technology Organisation (ANSTO), to facilitate development of diagnostics for plasma wall interactions and for characterizing advanced high temperature materials. In collaborations with the Australian Nuclear Science and Technology Organisation, and several Australian and International Universities, materials including tungsten, its alloys, artificial diamond and carbon samples were exposed to the plasma to observe effects on both the plasma and the impinging plasma. Also, some of advanced material diagnostics available through the

Australian Synchrotron and the ANU positron facility were applied to fusion wall samples exposed by our international collaborators.

Other topics advanced in 2014 included diagnosis of complex plasma flows including kHz range fluctuations, and understanding the scaling of the most fusion-relevant plasma conditions achieved ($>10^{19}\text{m}^{-3}$) in helium and hydrogen. This will inform the design of a larger device for continuous operation.

The toroidal plasma activity was strongly endorsed in a review by an international panel with expertise spanning stellarator/heliotrons, tokamaks, theoretical and basic plasma physics and material interactions. The panel recommended the tenured appointment of two mid-career researchers.

Multilateral Collaborations

Work on the international collaboration on MHD and configuration studies under the IEA Implementing Agreement for Co-operation in Development of the Stellarator-Heliotron Concept focussed on automatic mode classification, searching for unusual mode structures, and full integration of auxiliary data from Heliotron J and LHD into the new version of the data mining analysis. The datamining techniques were able to find additional examples of recently discovered mode locking in LHD. 40,000 shots were examined in one day using the new server installed for international collaborators. On H-1, von Mises clustering was applied to new magnetic field and configuration scans, combining two poloidal arrays and the new 16 element, 3 axis helical arrays, and a joint grant proposal was submitted with Spanish and Japanese partner investigators.

One and two-dimensional coherence imaging (CI) systems developed by Prof Howard at ANU underpin collaborations with USA, and EU members. These include (EU) An imaging MSE system is installed on the ASDEX-U upgrade and first measurements obtained. The results have been validated against a standard multiple discrete channel polarimeter.

(US) With LLNL and General Atomics, application of Doppler CI systems for imaging flows in the DIII-D divertor and scrape-off-layer. A similar system has been deployed on the MAST divertor for tomographic reconstruction of divertor flows during L and H modes, and ELM events. First results were presented by Dr S Silburn at an invited talk at the High Temperature Plasma Diagnostics meeting in 2014.

Collaborations between ANU, IPP (J.Svensson), and the Culham Centre for Fusion Energy (L.C.Appel) have complementary stellarator and compact toroidal components. The project, which was supported by an Australian

International Science Linkages grant, aims to develop Bayesian techniques for the integration of various diagnostic data, building on pioneering development of the technique on W7-AS. Joint publications in 2014 included a review of the subject. In an application to H-1, Dr von Nessi and Michael began developing forward models for He line ratios, for application in a Bayesian inference framework for electron temperature and density estimation.

MRxMHD Equilibrium Code: Significant progress was demonstrated in a collaboration between the ANU (R. Dewar, M. Hole, G. Dennis, B. Blackwell, M. McGann, A. Gibson, G. Von Nessi), PPPL (S. Hudson), RFX-mod (Dr Dominique Escande, David Terranova) and CCFE (Prof. Richard Dendy) on the development of a new variational approach - multi region relaxed MHD (MRxMHD) for calculating 3D plasma equilibria with islands.

In 2014, Em. Prof R.L.Dewar spent 2 weeks at PPPL working with Dr. S.Hudson on theoretical issues related to development the new MRxMHD equilibrium code SPEC. Dr Dennis published two papers that extended the MRxMHD principle to include plasma flow and anisotropy. The formulation with plasma flow added constraints of flow helicity and toroidal angular momentum [Phys. Plasmas 21, 042501 (2014)], while the formulation with anisotropy added constraints of anisotropy plasma entropy and magnetic moment. A/Prof. Hole presented an invited talk on developments in both MRxMHD and anisotropy projects to the International Congress on Plasma Physics in October, and the IAEA Fusion Energy Conference in November. Prof. Dewar published calculations of plasmoid solutions of the Hahm-Kulsrud-Taylor equilibrium model, which illustrate how a magnetically sheared plasma slab driven by a resonant periodic boundary perturbation results in fully shielded (current sheet) and fully reconnected (magnetic island) responses. PhD student Craig Bowie, under the co-supervision of Prof. Richard Dendy, computed avalanche statistics from a sand pile model, and was able to reproduce characteristic waiting time statistics from JET experiments.

Collaborations with EU

An existing collaboration between C.Nührenberg and A.Koenies of IPP Greifswald, J.Bertram, R.Dewar, B.Blackwell, S.Haskey, J.Howard, M.McGann, G.Von Nessi, M.Fitzgerald and M.Hole of the ANU, which involves comparing the experimental observations of MHD activity with eigenvalue calculations using the CAS3D code and the wave-particle interaction code CAS3D-K, was expanded to commence work on continuum damping in 3D. In 2014, George Bowden spent three weeks at Greifswald funded by a DAAD grant between the Group of Eight research intensive Australian Universities and German Academic Exchange Service. During this time, he worked

with collaborator Axel Koenies to include continuum damping into ideal MHD code CKA. In October Michael Cole visited the ANU for three weeks to conduct drive calculations for H-1 scenarios using the CKA-EUTERPE code suite

In 2014 the burning plasma project focused on the formulation of stability for anisotropic plasmas, and the inclusion of anisotropy into continuum mode code CSCAS-A and global mode code MISHKA-A. A paper on the configuration changes in the presence of anisotropy and a review were published.

Collaborations with JAPAN

In addition to the multilateral datamining collaboration, the following were active in 2014: Drs. C. Michael, M.Yokoyama and K Tanaka on turbulence and transport.

Collaborations with USA

In addition to the multilateral MRxMHD collaboration, and the D3D divertor studies the following were active in 2014: A joint collaborative project with Oak Ridge National Laboratories (Dr Juergen Rapp and Dr Larry Owen) involves modeling of recycling in the MAGPIE device. The work was presented at the 21st International Conference on Plasma Surface Interactions in Controlled Fusion Devices in 2014.

ANU, PPPL, DIII-D and CCFE – The effect of 3D magnetic perturbations on edge plasma. Comprehensive parameter scans and experimental comparisons of the plasma response to a variety of applied 3D field structures, were performed with the MARS-F code, and correlated with outcomes such as ELM suppression to aid in understanding the underlying mechanism

Workshops and Conferences

Drs Blackwell and Hole presented papers which included the 3D computational collaboration at the IAEA Fusion energy conference in St Petersburg. Associate Prof. Hole represented Australia at the 53rd IFRC meeting and presented research highlights, described the successful Upgrade Launch of the Australian Plasma Fusion Research Facility, and circulated the fusion science strategic plan the Australian community released in July. The Council indicated growing support for more formal Australian participation in the International Tokamak Physics Activity.

In early December 2014 Prof. Howard chaired the Australian Institute of Physics Congress, hosted by the ANU, which attracted over 700 delegates from most areas of physics. The field of plasma physics was represented by a highly successful plenary lecture given by Prof. Steve Cowley (CEO of the Culham Centre for Fusion Energy),

and four oral and two poster sessions. Associate Prof. Hole and Dr Corr convened plasma lectures at a Summer School attended by ~70 prospective graduate students.

3.2 Future Research Plans

Enabled by the upgrade, configuration studies will focus on expanded configuration scans and magnetic field scans of Alfvén-driven instabilities. Multi-channel plasma density and polarization interferometers and multi-channel spectroscopic detectors will provide profile information for configuration studies and mode structure of Alfvénic instabilities. We hope to replace the original H-1 RF antenna with a design based on the new Uragan Alfvén antennas in collaboration with that group.

International collaboration on CI optical systems for spectro-polarimetric imaging will continue in 2015 and beyond. In the coming year, this work will embrace the following activities:

Following successful first data, a second Doppler imaging camera is planned for wide field of view divertor flow and temperature tomography on DIII-D.

Combined with fast, gated CCD cameras, newly developed passive spatial heterodyne CI systems will be deployed for synchronous detection of velocity distribution function perturbations associated with magnetic fluctuations in the H-1 heliac.

In future years we hope to deploy CI imaging systems for edge physics studies in the W7-X stellarator. The recent success of Doppler imaging on the DIII-D tokamak divertor is a valuable guide in future planning.

We are developing multiple-carrier spatial heterodyne CI systems that should allow extended capability for imaging of more complex spectral scenes and exploring Zeeman-assisted Doppler tomography of inhomogeneous magnetized plasma such as the tokamak divertor.

Utilizing the linear satellite device, we aim to trial imaging Stark effect and some new concepts in optical radar-based range sensing with the ultimate goal (subject to appropriate funding) to develop a prototype imager for monitoring tile erosion in high power fusion devices.

Under the expanded collaboration on the MRxMHD project the SPEC code will be applied to MAST with an RMP field, to investigate control of magnetic surfaces between different relaxed regions via external coils. In 2015 the burning plasma project will focus on computing the impact of anisotropy on global modes. A new postdoc, Dr Brett

Layden, has been appointed to compute wave-particle interactions using HAGIS in the presence of anisotropy, and thereby determine the impact of anisotropy on performance limiting global Alfvén eigenmodes.

The Australian Helic program at the ANU has produced several technological spin-offs that are now attracting support independent of the fusion program. These include technology for long distance, non-line-of-sight VHF digital wireless communications in rural Australia (the BushLAN project), and optical coherence imaging (CI) spectroscopy systems for use in process control in steel production. A demonstration of a new type of multiple path MIMO wireless communications technology to potential investors is near completion and has attracted interest from several quarters.

Finally, the Australian fusion science community will continue endeavours to secure funding to develop plasma fusion science in Australia, including prototype diagnostic concepts using the new capabilities of the H-1 facility for one or more plasma diagnostics for ITER. In 2014, the community released a new strategic plan, “Powering Ahead:” This replaced and updated the original 2007 fusion science strategic plan, taking into account funding developments over the intervening years and changes to research funding schemes.

4 EU

4.1 GERMANY

4.1.1 International collaborations in 2014

Collaborations with EU

- 1) P. Cottier (CEA Cadarache) to IPP Greifswald, 10.01. – 14.01.2014
- 2) H. Smith (IPP) to Chalmers Göteborg (Sweden), 28.02. – 09.03.2014
- 3) P. Helander (IPP) to CCFE Culham (GB), 08.03. – 16.03.2014
- 4) A. Könies (IPP) to ENEA (Italy), 10.03. – 15.03.2014
- 5) P. Helander (IPP) to Uni Aalto (Finland), 19.03. – 21.03.2014
- 6) H. Oosterbeek (Eindhoven University of Technology) and Y. Ma (ITER) to IPP, 24.03. – 26.03.2014
- 7) S. Marsen (IPP Greifswald) visited CCFE Culham, 12.05. – 23.05.2014
- 8) J. Connor (CCFE Culham) to IPP Greifswald, 15.05. – 28.05.2014
- 9) D. Pacella (ENEA, Italy) to IPP Greifswald, 20.05. – 22.05.2014
- 10) S. Akäslompolo and T. Kurki-Suonio (TEKES, Finland) to IPP Greifswald, 26.05. – 28.05.2014

- 11) P. Holmval (Chalmers Göteborg) to IPP Greifswald, 31.05. – 31.10.2014
- 12) M. Kubkowska, A. Czarnecka and E. Pawelec (IPPLM, Poland) to IPP Greifswald, 08.06. – 14.06.2014
- 13) M. Preynas (IPP Greifswald) visited CEA Cadarache, 16.06. – 20.06.2014
- 14) J.-P. Traverre (CEA, France) to IPP Greifswald, 23.-27.06.2014
- 15) S. Newton (CCFE Culham) to IPP Greifswald, 01.07. – 05.07.2014
- 16) J.-P. Traverre (CEA, France) to IPP Greifswald, 06.07. – 09.07.2014
- 17) S. Schmuck (CCFE Culham) to IPP Greifswald, 07.07. – 11.07.2014
- 18) R. Zagorski (IPPLM, Poland) to IPP Greifswald, 13.07. – 26.07.2014
- 19) G. Pelka (IPPLM, Poland) to IPP Greifswald, 13.07. – 09.08.2014
- 20) E. Sanchez (CIEMAT) to IPP Greifswald, 27.07. – 02.08.2014
- 21) M. de Baar (FOM Institute DIFFER and Eindhoven University of Technology) to IPP Greifswald, 28.07. – 30.07.2014
- 22) P. Helander (IPP) to CEA Cadarache (France), 08.08. – 10.08.2014
- 23) F. Manke (Imperial College London) to IPP Greifswald, 18.08. – 27.09.2014
- 24) O. Marchuk (Forschungszentrum Jülich) to IPP Greifswald, 01.09. – 05.09.2014
- 25) G. Plunk, J. Proll and P. Xanthopoulos (IPP) to University Lisbon (Portugal), 11.09. – 18.09.2014
- 26) H. Peraza (University Carlos III Madrid) to IPP Greifswald, 14.09. – 25.10.2014
- 27) A. Mollen (Chalmers Göteborg) to IPP Greifswald, 14.09. – 26.09.2014
- 28) M. Kubkowska, L. Ryc, J. Kaczmarczyk, W. Figacz and I. Ksiazek (IPPLM, Poland) to IPP Greifswald, 28.09. – 03.10.2014
- 29) W. Kernbichler (ÖAW, Austria) to IPP Greifswald, 12.10. – 25.10.2014
- 30) B. Carvalho (TECNICO, Portugal) to IPP Greifswald, 02.11 – 06.11.2014
- 31) T. Szabolics (WIGNER, Hungary) to IPP Greifswald, 09.11. – 05.12.2014
- 32) G. Cseh, T. Szepesi and G. Kocsis (WIGNER, Hungary) to IPP Greifswald, 16.11. – 05.12.2014
- 33) W. Cooper and J. Faustin (EPFL, Switzerland) to IPP Greifswald, 18.11. – 21.11.2014
- 34) M. Mantsinen (BSC, Spain) to IPP Greifswald, 18.11. – 21.11.2014
- 35) A. Mollen (Chalmers Göteborg) to IPP Greifswald, 07.12. – 19.12.2014
- 36) Collaboration with NCBJ in Swierk, Poland for the

construction and installation of the NBI heating system, numerous visits between IPP, NCBJ and industry

Collaborations with Japan

- 1) E. Winkler (IPP Greifswald), delegation to NIFS, 01.01. – 31.12.2014
- 2) S. Nishimura (NIFS) to IPP Greifswald, 17.02. – 27.02.2014
- 3) A. Kus (IPP Greifswald) visited Kyoto University and NIFS, 24.02. – 07.03.2014
- 4) A. Dinklage (IPP Greifswald) visited Kyoto University, 25.02. – 01.03.2014
- 5) G. Kawamura (NIFS) to IPP Greifswald, 03.03. – 06.03.2014
- 6) H. Tanaka (NIFS) to IPP Greifswald, 03.03. – 08.03.2014
- 7) Y. Suzuki (NIFS) to IPP Greifswald, 24.03. – 28.03.2014
- 8) N. Marushchenko (IPP Greifswald) visited NIFS, 14.04. – 16.04.2014
- 9) N. Marushchenko (IPP Greifswald) visited Kyoto, 17.04. – 18.04.2014
- 10) F. Wagner (IPP) visited Kyushu University, 21.-28.05.2014
- 11) Y. Suzuki (NIFS) to IPP Greifswald, 27.06. – 04.07.2014
- 12) G. Kawamura (NIFS) to IPP Greifswald, 17.06. – 04.07.2014
- 13) S. Murakami (NIFS) to IPP Greifswald, 29.06. – 03.07.2014
- 14) M. Yokoyama (NIFS) to IPP Greifswald, 30.06. – 18.07.2014
- 15) H. Yamaguchi (Kyoto University) to IPP Greifswald, 07.09. – 20.09.2014
- 16) T. Stange (IPP Greifswald) visited Kyoto University and NIFS, 03.11. – 22.11.2014
- 17) M. Krychowiak (IPP Greifswald) visited NIFS, 03.11 – 14.11.2014
- 18) Y. Feng (IPP Greifswald) visited NIFS, 03.11. – 15.11.2014

Collaborations with Russia

- 1) M. Mikhailov (Kurchatov Institute Moscow) to IPP Greifswald, 03.03. – 18.04.2014
- 2) M. Mikhailov (Kurchatov Institute Moscow) to IPP Greifswald, 14.10. – 12.12.2014
- 3) F. Wagner (IPP) visited St. Petersburg State Polytechnical University, 14.09. - 21.09.2014

Collaborations with USA

- 1) J.P. Allain, D. Curreli and D. N. Razic (University of Illinois) to IPP Greifswald, 12.01. – 13.01.2014
- 2) B. Faber (University of Wisconsin, Madison) to IPP

- Greifswald, 19.01. – 30.01.2014
- 3) G. Wurden (LANL) to IPP Greifswald, 02.-08.02.2014
 - 4) J. Proll (IPP Greifswald) to PPPL, 24.03. – 31.05.2014
 - 5) H.-S. Bosch, T. Klinger, T. Sunn Pedersen (IPP Greifswald) visited University of Wisconsin, Madison (Wisconsin, USA), 06.-12.04.2014
 - 6) D. Gates and N. Pablant (Princeton Plasma Physics Laboratory) to IPP Greifswald, 21.04. – 26.04.2014
 - 7) J. Loizu (IPP Greifswald) to PPPL, 28.04. – 31.12.2014
 - 8) J. Proll (IPP Greifswald) to University of Madison, 11.05. – 17.05.2014
 - 9) G. Wurden (LANL) to IPP Greifswald, 11.06.-01.08.2014
 - 10) J. Hudson (University Auburn, USA) to IPP Greifswald, 15.06. – 18.06.2014
 - 11) R. Prater (General Atomics), D. Andruczyk and D. Curreli (University of Illinois) to IPP Greifswald, 29.06. – 19.07.2014
 - 12) P. Fflis (University of Illinois) to IPP Greifswald, 06.07. – 12.07.2014
 - 13) D. Andruczyk (University of Illinois) to IPP Greifswald, 31.08. – 20.09.2014
 - 14) A. Press (University of Illinois) to IPP Greifswald, 01.09. – 12.09.2014
 - 15) P. Fflis (University of Illinois) to IPP Greifswald, 07.09. – 19.09.2014
 - 16) F. A. Volpe (Columbia University) to IPP Greifswald, 21.09. – 23.09.2014
 - 17) D. Gates and S. Lazerson (Princeton Plasma Physics Laboratory) to IPP Greifswald, 28.09. – 03.10.2014
 - 18) J. Proll (IPP Greifswald) to PPPL, 29.09. – 07.12.2014
 - 19) G. Wurden (LANL) to IPP Greifswald, 10.-23.10.2014
 - 20) D. Gates and N. Pablant (Princeton Plasma Physics Laboratory) to IPP Greifswald, 08.12. – 12.12.2014

Participation in joint projects

International stellarator/heliotron profile data base

Contributions from A. Dinklage, A. Kus, C. Beidler, H. Maaßberg, S. Marsen

ITPA diagnostics

- 1) R. König: 26th Meeting of the ITPA Topical Group on Diagnostics, Pohang University of Science and Technology, 19. - 22.05. 2014
- 2) R. König: 27th Meeting of the ITPA Topical Group on Diagnostics, ITER IO, Cadarache (France), 03.11. - 07.11.2014

ITPA confinement and transport

Contributions from M. Jakubowski and A. Dinklage (3D working group within the ITPA Transport and Confinement group, TC24)

M. Jakubowski, ITPA conference, Boston (Massachusetts, USA), 07.-13.04.2014

ITPA Fast Particles

- 1) A. Könies and M. Cole: 12th ITPA Energetic Particle Physics TG Meeting, Madrid (Spain), 30.03. – 03.04.2014
- 2) A. Könies: 13th ITPA Energetic Particle Physics TG Meeting, Padua (Italy), 20.10. – 24.10.2014

4.1.2 Plans for 2015

The 20th International Stellarator–Heliotron Workshop will take place in Greifswald 05.10.– 09.10.2015 with an expected 150 participants from across the world.

Planning stellarator/heliotron theory

- 1) J. Geiger plans to go to NIFS to work on 3D MHD equilibrium problems
- 2) J. Proll plans visit PPPL to collaborate on gyrokinetic theory for stellarators
- 3) A. Könies will participate in the 14th ITPA EP Meeting in Princeton, and in the 15th such meeting, whose location has not yet been decided.
- 4) J. Loizu plans to spend several months at PPPL to work on MHD equilibrium theory

Spectroscopic diagnostics

- 1) I. Ksiazek (Institute of Physics, Opole University, Opole) plans several visits (each about 1-2 weeks) to IPP Greifswald in the frame of the cooperation concerning the development of the C/O-monitor diagnostic for W7-X.
- 2) A. Langenberg plans to visit Alcator C-Mod for impurity diagnostic experiments using x-ray imaging spectrometer and a multi-energy x-ray camera.

Collaboration with NIFS

- 1) J. Baldzuhn plans to visit NIFS for pellet experiments (2 weeks)
- 2) A. Dinklage plans to visit NIFS for particle transport experiments (2 weeks)
- 3) F. Warmer: collaboration in systems code studies

Neutron diagnostics

Mutual visits (about 1 - 2 per year, each about for 2-3 days) in the frame of collaboration with PTB Braunschweig on the neutron counter system for W7-X are planned to discuss the progress, data analysis, MCNP calculations and the work plan of the project (involving R. Burhenn, W. Schneider).

Microwave diagnostics

H. Oosterbeek (Technical University of Eindhoven) + student(s) will visit IPP: Measurement of microwave stray

radiation in the W7-X vessel.

October-28 November).

ITPA confinement and transport

- 1) Contributions from M.Jakubowski and A.Dinklage chairs the 3D working group within the ITPA Transport and Confinement group.

ITPA diagnostics

- 1) R. König: 26th Meeting of the ITPA Topical Group on Diagnostics, Pohang University of Science and Technology, 19. - 22.05. 2014, Contributions on: Effect of neutral gas background pressure on Bolometer signals, and on Using SWCNTs for ECRH stray radiation protection of optics.
- 2) R. König: 27th Meeting of the ITPA Topical Group on Diagnostics, ITER IO, Cadarache (France), 03.11. - 07.11.2014, Presentation: Overview of the diagnostics sets available in the first Operation Phases of Wendelstein 7-X and of the EUROfusion contributions and on ECRH stray radiation protection of diagnostics

Collaboration with USA

M. Krychowiak plans to visit University of Wisconsin-Madison for 1-2 weeks to work on the development of atomic models of helium and neon for the helium beam diagnostic.

Collaboration on ECRH, ECCD and ECE Plans 2015

K.Nagasaki (Kyoto University) will visit Greifswald for the Joint research program "Optimization of high power ECRH application to helical fusion plasma confinement systems"

4.2 SPAIN

4.2.1 International collaborations in 2014 using TJ-II at CIEMAT

Collaborations with Russia

- 1) S. Perfilov (November-December) of the HIBP Kurchatov Institute team was visiting CIEMAT to investigate the structure of plasma potential and plasma fluctuations in TJ-II and the commissioning of the second HIBP system where secondaries have been successfully detected by the end of 2013.
- 2) Collaboration with General Physics Institute, Moscow on the characterization of the plasma reflected power on gyrotron performance. A final compilation of the experimental results as well as a conclusive data analysis have been carried out during 2014. The results will be sent for its publication. The visiting scientists of GPI involved have been: K. Sarksyian (8-22 May), V. Borzosekov (26 May-26 June), D. Malakhov (14 November-12 December), N. Kharchev (29

Collaborations in Europe

Germany

- 1) Participation in Eurofusion (S1/S2) programme in the field of theory and modeling on Neoclassical transport and gyrokinetic simulations. J.L. Velasco and D. López Bruna have participated in an inter-machine validation study of neoclassical transport modelling in medium to high density stellarator-heliotron plasmas.
- 2) E. Sánchez spent one week in Greifswald working on gyrokinetic simulations.

Portugal

- 1) C. Hidalgo was visiting IST (November) to study the influence of the isotope effect on plasma confinement and fluctuations in the ISTTOK tokamak.
- 2) C. Silva was visiting CIEMAT (December) to continue our collaboration on edge studies (edge turbulence, asymmetries and transport studies and diagnostic development including RFA and probes) during 2014.

Italy

- 1) D. López-Bruna was visiting RFXmod (November) to discuss the electromagnetic nature of plasma filaments in TJ-II.
- 2) Collaboration with M. Spolaore, E. Martines and the RFXmod team to participate on edge diagnostic development and measurements in TJ-II including the design, development of electromagnetic probes and characterization of the electromagnetic nature of plasma filaments in TJ-II.

Bulgaria

T. Popov was visiting CIEMAT (November) to investigate non-Maxwellian electron distribution functions in the plasma boundary region and the influence of plasma ECRH and NBI heating.

Romania

F L Tabares and D Alegre visited the laboratories of Dr Dinescu at Magurele in the frame of the collaboration on tungsten plasma nitriding as PFC for fusion devices.

The Netherlands

D Alegre visited DIFFER and run experiments in Pilot PSI in the frame of collaboration on tungsten nitrides for PFCs.

Collaborations with USA

- 1) E. Hollmann (USCD) was visiting CIEMAT (1 week, June 2014) working on parallel / radial impurity transport studies and role of Z.
- 2) Álvaro Cappa was invited to join the experiments on

the impact of ECRH on Alfvén Eigenmodes that were performed in the DIII-D tokamak in June. He spent one week in the General Atomics facilities in San Diego from June 9th to June 14th.

- 3) F Tabares was visiting the U of Illinois, Urbana, for the fabrication of LISn alloys

Collaborations with Ukraine

- 1) The Heavy Ion Beam Probe team (A.Kozachek and A.Zezhera, leaded by L. Krupnik, Institute of Plasma Physics, National Science Center “Kharkov Institute of Physics and Technology”, Kharkov) has been involved in the characterization of radial electric fields and plasma fluctuations in the TJ-II stellarator during 2013 experimental campaign. The development of the second HIBP system has been finalized and installed (injector and analyzer) in TJ-II with on-going commissioning activities in 2014.
- 2) F. Tabarés was visiting IPP Kharkov to discuss the QSPA project and contribute to the wall conditioning of Uragan 2M.

Collaborations with Japan

- 1) J.L. Velasco visited NIFS during March to discuss on the comparison between two neoclassical approaches (FORTEC-3D and DKES) for TJ-II and LHD.
- 2) F L Tabarés visited NIFS in order to plan the collaboration on the implementation of a supersonic He beam for Ti studies as well as in the characterization of 3-D effects in the plasma boundary of stellarators.

Participation in Joint Projects

Stellarator-Heliotron working groups and ITPA

The 13th Coordinated Working Group Meeting (CGWM) was held in Kyoto in February 2014. Several researchers from CIEMAT participated in the presentation and discussions in several areas such as divertor physics, impurity transport, flows and viscosity, energetic particles (remote) and scientific collaboration framework (remote).

The 12th meeting of the ITPA Energetic Particles Physics Topical Group was held in Madrid (April 2014). CIEMAT participation in the meeting was mainly focused in the influence of ECRH on the Alfvén Eigenmodes observed in the TJ-II stellarator. CIEMAT scientists have been also directly involved in the ITPA (T&C and Integrated Operational Scenarios meetings) and activities along 2014. The ITPA energetic particles meeting will be held in Madrid (31 March - 4 April). E. Ascasisbar was attending the ITPA Integrated Operational Scenarios meeting (MIT, April / Cadarache October); C. Hidalgo was attending the 12th ITPA Transport and Confinement meetings (April-2013, MIT, US).

4.2.2 Plans for 2015

The main research activity of Euratom – Ciemat association will remain on concept improvement development and on the fusion technology programme with special emphasis on all the different aspects of fusion materials technology. In addition, we will strengthen and continue with our long standing tradition to extend our physics studies to different confinement concepts (tokamak / stellarators), looking for common clues as a fundamental way to investigate basic properties of magnetic confinement beyond any particular concept.

The following research areas are foreseen in the 2015 research programme:

- 1) Stellarator physics: confinement data-base, neoclassical transport, magnetic topology, stellarator optimization and magnetic configuration effects on confinement. These activities are carried out within the framework of the Implementing Agreement for Co-operation in Development of the Stellarator-Heliotron Concept.
- 2) Plasma diagnostic development and engineering: Diagnostic developments for TJ-II will continue and in a wider context for ITER (with emphasis on reflectometry, VIS-IR spectroscopy) and W7-X (reflectometry, impurity transport physics, fuelling and interplay between large and short scale radial electric fields) as well a supersonic He beam for Ti edge profile measurements in LHD.
- 3) Plasma heating (NBI, ECRH) and their role on fast particles driven modes.
- 4) Physics of advanced confinement scenarios: transport barrier physics, isotope effect, impurity transport and stability (including the role of magnetic well and density limit).
- 5) Theory and modelling of plasma transport, stability and equilibrium with emphasis on island dynamics and breaking of nested surface topology (3-D effects) and Gyrokinetic theory.
- 6) Validation activities of stellarator-specific transport models will continue at TJ-II in collaboration with NIFS and IPP Greifswald.
- 7) Plasma – wall studies, exploring plasma-wall interaction scenarios with Li coating and CPS Li-liquid limiter concepts in the search for a candidate material (Li/Sn/Ga) that offers all the required properties.
- 8) Data acquisition, control and advanced data analysis techniques.

Collaborations with Russia

A. Melnikov and L. Eliseev and members of the HIBP Kurchatov Institute team will visit CIEMAT to investigate the structure of plasma potential in ECRH and NBI plasmas

(in Lithium coated wall conditions) and measurements using two HIBP systems for zonal flows experiments in the core plasma region.

Collaborations in Europe

Germany

- 1) E. Sánchez will visit Greifswald (Germany) to work on gyrokinetic theory.
- 2) A. Alonso, J. L. Velasco and I. Calvo will visit Greifswald to discuss ongoing impurity studies including role of poloidal asymmetries and underlying mechanisms.
- 3) T. Estrada, E. Blanco, B. van Milligen, A. de la Peña and L. Pacios will visit Greifswald for the installation and commissioning of the Doppler reflectometry, and its control and data acquisition system. In addition, T. Estrada and E. Blanco will be involved in the first W7-X operation campaign (OP1.1).

Portugal

- 1) C. Silva and I. Nedzelskiy will visit CIEMAT to continue our collaboration on edge studies using arrays of Langmuir probes, Retarding Field Analyzers (RFA) and reflectometry.
- 2) C. Hidalgo will visit IST to study the influence of the isotope effect on plasma confinement and fluctuations in the ISTTOK tokamak

Italy

- 1) Collaboration with M. Spolaore / E. Martinez and the RFXmod team to participate on edge diagnostic development and measurements of electromagnetic turbulence and isotope physics in TJ-II.
- 2) C. Hidalgo will visit RFXmod to study the influence of the isotope effect on plasma confinement and fluctuations in the RFXmod Reversed Field Pinch.

United Kingdom

Calvo will visit the University of Oxford to work on gyrokinetic theory and optimized stellarator concepts.

The Netherlands

Exposure of Li to PILOT-PSI PSI plasma

Slovenia

Recombination constants for H atoms on lithium

Czech Republic

Implementation of a He beam diagnostic in COMPASS for edge characterization.

Collaborations with USA

- 1) E. Hollmann (USCD) will visit CIEMAT (June 2015)

to work on impurity transport studies in TJ-II.

- 2) Collaboration with U. Illinois Urbana (Dr Ruzic) on Sn/Li alloys for fusion

Collaborations with Ukraine

- 1) L. Krupnik and HIBP team will visit TJ-II for investigation of the structure of radial electric fields using HIBP diagnostic (Institute of Plasma Physics, National Science Center “Kharkov Institute of Physics and Technology). The second HIBP system has been design for long-range correlation studies (zonal flows) full operation is foreseen in 2015.
- 2) F.LTabares. Collaboration on QSPA and PWI issues in Uragan 2M

Collaborations with Japan

- 1) Collaboration on fast particle physics with Japanese institutions will continue. Joint experiments will be performed in TJ-II on March 2015. The visiting scientists likely to be involved will be K. Nagaoka (NIFS), S. Yamamoto (Kyoto Univ.). T. Ido (NIFS) and A. Shimizu (NIFS).
- 2) Based on the TJ-II experience with the pellet injector developed by ORNL, we plan to explore the viability of TESPEL system developed by NIFS (N.Tamura et al).
- 3) M. Shoji (NIFS) will visit CIEMAT (March) to discuss recent results on edge transport studies using fast visible cameras in TJ-II / LHD.
- 4) C. Hidalgo will visit NIFS to participate in the Workshop on the strategy of stellarator / heliotron research (March)
- 5) J.L. Velasco will visit NIFS in order to discuss on experimental results and neoclassical simulations with the code FORTEC-3D
- 6) F. Castejón and D. López-Bruna will visit NIFS to perform experiments on magnetic topology and island dynamics.
- 7) A. Alonso will visit NIFS to participate in the discussion of asymmetries as possible causes of the outward impurity convection in LHD.
- 8) Supersonic He beam for Ti profile reconstruction in LHD (Dr Morisaki)
- 9) Exposure of liquid Li to ELMS loads in the MCPG device (Dr Kikuchi)

International stellarator/heliotron working groups / ITPA

Ciemat staff will participate in the forthcoming CWGM and ITPA meetings to be held along 2015.

5 JAPAN

5.1.1 International collaborations by NIFS

Collaborations with EU

- 1) M. van Berkel (Eindhoven University of Technology) visited NIFS (N. Tamura) from November 21, 2013 November 20, 2014 with a JSPS Postdoctoral Fellowship to join the LHD experiments regarding a electron heat transport.
- 2) M.Brombin (Consorzio RFX) visited NIFS (Y.Takeiri) from 13 to 31 Jan. 2014 for collaborations on NBI.
- 3) G.Serianni (Istituto Gas Ionizzati CNR) visited NIFS (Y.Takeiri) from 13 to 24 Jan. 2014 for collaborations on NBI.
- 4) H.Nakano (NIFS) visited Institute of ionized gas (IGI) from January 27th to February 21th, 2014 to discuss on the joint experiments performed in negative hydrogen ion sources at NIFS and IGI.
- 5) P.Veltri (Consorzio RFX) visited NIFS (Y.Takeiri) from 31 Jan. to 27 Feb. 2014 for collaborations on NBI.
- 6) G.Kawamura (NIFS) visited Forschungszentrum Julich from 3 to 15 Feb. 2014 to discuss on impurity transport simulation modeling.
- 7) G.Kawamura (NIFS) visited Max-Planck-Institut fur Plasmaphysik Greifswald from 2 to 8 Mar. 2014 to discuss on plasma simulation modeling of a linear device.
- 8) J.M.Garcia-Regaña (IPP) visited NIFS (S.Satake) from 3 to 13 Feb. 2014 for collision operator in neoclassical transport code.
- 9) P.Agostinetti (Consorzio RFX) visited NIFS (Y.Takeiri) from 9 to 27 Feb. 2014 for collaborations on NBI.
- 10) K.McCarthy, J.L.Velasco and F.L.Tabares (CIEMAT) visited NIFS (M.Yokoyama, N.Tamura, M.Kobayashi and S.Satake) from 3 to 7 Mar. 2014 for discussions on collaboration issues in the framework of CWGM.
- 11) A.Kus (IPP) visited NIFS (M.Yokoyama) from 3 to 7 Mar. 2014 for joint work on International Stellarator-Heliotron Database.
- 12) K.Nagaoka (NIFS) visited Ciemat (Madrid) from 9th March to 16th March, 2014 to join TJ-II experiments on the energetic particle driven MHD modes and the effect of ECH on the mode stability.
- 13) N.Tamura (NIFS) visited CIEMAT from to March 11, 2014 to March 22, 2014 to discuss the installation of the TESPEL injector on TJ-II device for promoting a collaborative research on the impurity transport in helical plasmas.
- 14) D.Moseev (IPP) visited NIFS (K.Tanaka) from 9 to 23 Mar. 2014 to discuss on the collective Thomson scattering measurement.
- 15) C.J.Ham and T.C.Hender (Culham Center for Fusion Energy) visited NIFS from 10 to 14 Mar. 2014 to attend the ITPA MHD meeting.
- 16) G.Pautasso (IPP) visited NIFS from 10 to 14 Mar. 2014 to attend the ITPA MHD meeting.
- 17) P.Martin (Consorzio RFX) visited NIFS from 10 to 14 Mar. 2014 to attend the ITPA MHD meeting.
- 18) A.Portone (Fusion for Energy Spain) visited NIFS from 10 to 14 Mar. 2014 to attend the ITPA MHD meeting.
- 19) C.Abellan (ICFO-The Institute of Photonic Sciences, Spain) visited NIFS (S.Satake) from 24 to 28 Mar. 2014 for tests of random parameter generator for its application.
- 20) M.Shoji (NIFS) visited to CIEMAT in Spain from 16 to 24th, March, 2014 to attend a dust trajectories observation experiment in the TJ-II and to discuss on the future international collaboration plan between NIFS and CIEMAT.
- 21) L.Antonio and M.Tomáš (Institute of Physics AS, Czech Republic, HiLASE Project) visite NIFS (R.Yasuhara) on 18 Apr. 2014 for discussions on laser for Thomson Scattering system.
- 22) T.Micolas (Institut de Recherche sur la Fusion Magnétique, IRFM) has stayed NIFS from 25 Apr. 2014 (to 24 Apr. 2016) to promote MHD simulations in LHD.
- 23) H.Yamada (NIFS) visited IPP-Greifswald in May 2014 for discussions on collaborations between NIFS and IPP.
- 24) K.Ikeda (NIFS) stayed at IPP-Garching from 19 May to 30 Nov. 2014 to study negative hydrogen behavior in RF negative hydrogen ion source for NBI.
- 25) K.Y.Watanabe (NIFS) visited Carlos III University from 25 May to 15 June, 2014 for collaborations on saturation mechanism of interchange modes.
- 26) M.Klaus (IPP) visited NIFS (H.Sugama) from 27 to 30 May 2014 for discussions on numerical scheme based on fluid and kinetic models.
- 27) C.Suzuki (NIFS) stayed at University College Dublin (Ireland) from 31 May to 9 Nov. 2014 for collaborations on atomic-molecular process. (During this stay, he also attended W7-X/LHD Joint Collaboration Workshop (Greifswald) and International Conference on atomic-molecular data and its application (Jena University))
- 28) P.Innocente (Consorzio RFX) visited NIFS (T.Morisaki) on 2 Jun. 2014 for discussions on fueling and plasma-wall interaction.
- 29) S.Satake (NIFS) visited CIEMAT, Spain from 2 to 20 June, 2014 to discuss with J. L. Velasco about inter-code verification and validation of neoclassical transport simulation for helical plasmas, and prepared

an oral presentation concerning the collaboration at 41th EPS conference on plasma physics.

- 30) S. Satake (NIFS) visited IPP-Garching, Germany from 29 June to 12 July, 2014 to discuss with J. M. Garcia-Regaña about inter-code verification and validation of neoclassical transport simulation for helical plasmas
- 31) M.Kobayashi (NIFS) attended 41st EPS and EMC3 Workshop (Berlin) from 22 to 29 June 2014.
- 32) G.Kawamura (NIFS) visited Berlin from 25 to 27 Jun. 2014 to attend a workshop on development of EMC3-EIRENE code.
- 33) K.Tanaka, I.Yamada, R.Seki, T.Kobayashi and S.Okamura (NIFS) attended 41st EPS (Berlin) in Jun. 2014.
- 34) M.Yokoyama (NIFS) visited Max-Planck Institute for Plasma Physics (Greifswald) from 29 June to 20 July to attend the LHD/W7-X Joint workshop and to discuss/work on the extension of International Stellarator-Heliotron Profile Database and on statistical analysis of database.
- 35) K.Ida (NIFS) attended 41st EPS (Berlin) and W7-X/LHD Joint Collaboration Workshop (IPP-Greifswald) from 22 Jun. to 5 Jul. 2014.
- 36) B.J.Peterson (NIFS) attended 41st EPS (Berlin) and W7-X/LHD Joint Collaboration Workshop (IPP-Greifswald) from 18 Jun. to 6 Jul. 2014.
- 37) G.Kawamura (NIFS) visited Max-Planck-Institut für Plasmaphysik Greifswald from 30 Jun. to 6 Jul. 2014 to attend a workshop on W7-X and LHD collaborations.
- 38) Y.Yoshimura (NIFS) visited IPP-Greifswald from 1 to 3, July 2014 to discuss on the collaboration between NIFS and IPP.
- 39) S.Masuzaki, T.Tokuzawa, I.Yamada, H.Tsuchiya and K.Saito attended W7-X/LHD Joint Collaboration Workshop from 1 to 3 Jul. 2014, held in IPP-Greifswald.
- 40) H.Sugama and M.Nunami (NIFS) visited CIEMAT from June 28 to July 6, 2014 to attend the Gyrokinetic Theory Working Group Meeting and discuss gyrokinetic theory and simulation of turbulent transport in toroidal plasmas.
- 41) U.Czarnetzki (RUB, Germany) visited NIFS (S.Yoshimura) from 5 to 10, Aug. 2014 to discuss the collaborative research on plasma spectroscopy using optical vortex laser.
- 42) S.Toda (NIFS) attended Varenna Workshop Theory of Fusion Plasmas (Italy) from 30 Aug. to 7 Sep. 2014.
- 43) T.Goto (NIFS) visited CCFE from 1 to 5, Sep, 2014 to discuss on the improvement of the cost model in systems codes.
- 44) T.Kobayashi (NIFS) attended EU-US Transport Taskforce 2014 (Culham Centre for Fusion Energy) from 7 to 13 Sep. 2014.
- 45) K.Ichiguchi (NIFS) visited University of Carlos III in Madrid, Spain from 8 to 12 September, 2014 to discuss the MHD simulation with Dr. B.A.Carreras.
- 46) K.Ichiguchi (NIFS) attended 17th International Congress on Plasma Physics held in Lisbon, Portugal, from 15 to 19 September, 2014.
- 47) S.Yoshimura (NIFS) visited the Instituto Superior Técnico, Lisbon, Portugal to attend the 17th International Congress on Plasma Physics (ICPP2014) from 13 to 21, Sep. 2014. He gave a poster presentation entitled "Intermittent Generation of Localized Higher Electron Temperature Regions in a Weakly-Ionized Electron Cyclotron Resonance Plasma"
- 48) M.Kisaki (NIFS) visited Consorzio RFX from 14 to 29 Sep. 2014 for collaborations on beam physics.
- 49) Y.Takeiri (NIFS) visited IPP-Garching from 5 to 12 Oct. 2014 to attend the 4th International Symposium on Negative Ions, Beams and Sources NIBS2014.
- 50) H.Nakano (NIFS) joined the 4th International Symposium on Negative Ions, Beams and Sources held at Garching, Germany on October 6th to 10th, 2014.
- 51) K.Saito (NIFS) visited San Sebastian, Spain from 29, Sep to 3, Oct, 2014 to attend 28th Symposium on Fusion Technology.
- 52) S.Hamaguchi (NIFS) attended SOFT2014 (Spain) from 27 Sep. to 5 Oct. 2014.
- 53) A.Komori, K.Ida, I.Yamada and H.Tsuchiya (NIFS) attended ICPP 2014 (Lisbon, Portugal) in Sep. 2014.
- 54) K.Tsumori, H.Nakano and M.Kisaki (NIFS) visited IPP-Garching from 5 to 12 Oct. 2014 to attend the 4th International Symposium on Negative Ions, Beams and Sources NIBS2014.
- 55) K.Saito, H.Tamura, Y.Hishinuma and J.Yagi (NIFS) attended 29th Symposium on Fusion Technology (Spain) from 27 Sep. to 5 Oct. 2014.
- 56) N.Ashikawa (NIFS) is staying at IPP-Garching from 26 Oct. 2014 to 31 Jan. 2015 to investigate of hydrogen/deuterium retentions and influences of helium bombardments on ferritic steels
- 57) K.Ichiguchi (NIFS) visited Carlos III University (Spain), and then attended ICPP2014 (Portugal) from 11 to 20 Oct. 2014.
- 58) M.Osakabe (NIFS) attended ITPA Energetic Particles (Consorzio RFX, Padova, Italy) from 21 to 25, Oct. 2014
- 59) D.Kato (NIFS) visited International Centre for Theoretical Physics, Trieste, Italy, from 3 to 7, Nov, 2014 to attend and give the invited talk in 2014 Joint ICTP-IAEA Conference on Models and Data for Plasma-Material Interaction in Fusion Devices.

- 60) S.Okamura (NIFS) visited Max-Planck Society Administrative Headquarter (Germany) and Wien University (Austria) from 25 to 30 Nov. 2014.
- 61) O.Slezak (Institute of Physics AS, Czech Republic, HiLASE Project) visited NIFS (R.Yasuhara) from 6 Oct. to 12 Nov. 2014 for discussions on laser for Thomson Scattering system.
- 62) J.Geiger (Max-Planck Institute fuer Plasmaphysik, Germany) visited NIFS (Y. Suzuki) from 3rd to 22nd November 2014 to discuss applications of HINT2 code to Wendelstein 7-X.
- 63) P. Vincenzi (Consorzio RFX) is staying NIFS (M.Osakabe, M.Yokoyama) from 3 Nov. 2014 to 16 Jan.2015 for improving and applying integrated transport code, TASK3D-a.
- 64) Y. Feng (IPP, Greifswald) visited NIFS (M.Kobayashi) from 3 Nov. 2014 to 14 Nov. 2014 to discuss on the edge modeling of LHD with EMC3-EIRENE.
- 65) T.Stange (IPP) visited NIFS (Y.Yoshimura) from 17 to 22 Nov. 2014 for collaborations on RF heating.
- 66) K.Maciej (IPP) visited NIFS (T.Morisaki) from 4 to 14 Nov. 2014.

Collaborations with Russia

- 1) **The 25th IAEA Fusion Energy Conference was held in St.Petersburg from 13 to 18 Oct. 2014.** A.Komori, H.Yamada, A.Sagara, T.Mutoh, K.Ida, M.Kobayashi, W.Hao, H.Miura, T.Seki, M.Yokoyama, S.Sudo, M.Yoshinuma, Y.Narushima, S.Sakakibara, S.Ohdachi, T.Kobayashi, I.Murakami, M.Shoji, K.Mukai, A.Ishizawa, G.Kawamura, D.Kato, A.Itoh, X.Du, M.Nunami, Y.Suzuki, K.Ichiguchi, Y.Todo, K.Nagaoka, T.Shimozuma, M.Osakabe, H.Kasahara, N.Yanagi (including individual list below) participated from NIFS.
- 2) I.Tolistikhina (P.N. Lebedev Physical Institute) visited NIFS (D.Kato) from 3 to 7 Feb. 2014 for atomic process on W impurity in plasmas.
- 3) S.Konovalov, V.Lukash and V.Pustovitov (Kurchatov Institute) visited NIFS from 10 to 14 Mar. 2014 to attend the ITPA MHD meeting.
- 4) S.Kubo (NIFS) attended 9th International Workshop on Strong Microwaves and Terahertz waves (Nizhny Novgorod Applied Physics Institute) from 23 Jul to 1 Aug. 2014.
- 5) V.N.Leonid (Budker Nuclear Physics Institute) visited NIFS (K.Tanaka) from 15 Sep. to 18 Oct. 2014 for discussions on diagnostics development for turbulence fluctuations based on CO2 laser.
- 6) S.Sudo (NIFS) discussed with I. Viniar (PELIN, Russia) about the collaboration on the TECPEL activity for LHD, and discussed with V. Sergeev (State Polytechnical University, St. Petersburg, Russia) about

the collaboration on the NIOS system for LHD during the IAEA-FEC 2014 conference (13-18 October 2014) at St. Petersburg.

- 7) K.Nagaoka (NIFS) visited St. Petersburg from 12th Oct. to 20th Oct. 2014 to participate in the IAEA Fusion Energy Conference and make an oral presentation on the integration of ion and electron ITBs in the LHD.
- 8) A.Komori (NIFS) attended 25th IAEA Fusion Energy Conference and the 43rd Executive Committee Meeting of the IEA Stellarator-Heliotron Implementing Agreement from 12 to 19, Oct. 2014 (St.Petersburg, Russia).
- 9) H.Yamada (NIFS) attended 25th IAEA Fusion Energy Conference and the 43rd Executive Committee Meeting of the IEA Stellarator-Heliotron Implementing Agreement from 12 to 19, Oct. 2014 (St.Petersburg, Russia)
- 10) S.Kubo (NIFS) attended 25th IAEA Fusion Energy Conference and the SSOCG-4 from 12 to 19, Oct. 2014 (St.Petersburg, Russia).
- 11) T.Mutoh (NIFS) attended 25th IAEA Fusion Energy Conference, SSOCG-4 and the 43rd Executive Committee Meeting of the IEA Stellarator-Heliotron Implementing Agreement from 12 to 20, Oct. 2014 (St.Petersburg, Russia).
- 12) M.Yokoyama (NIFS) attended 25th IAEA Fusion Energy Conference and the 43rd Executive Committee Meeting of the IEA Stellarator-Heliotron Implementing Agreement from 12 to 20, Oct. 2014 (St.Petersburg, Russia).

Collaborations with USA

- 1) H.Miura (NIFS) visited the Institute for Fusion Studies, University of Texas at Austin from Feb. 9 to March 31, 2014 to study for numerical simulations of plasma in a heliotron device, by making use of the sabbatical leave system of NIFS.
- 2) S.Yoshimura (NIFS) visited PPPL and the University of Wisconsin-Madison to discuss basic plasma experiments related with magnetic reconnection and dynamo effects from 16 to 23, Feb. 2014. He gave a seminar presentation on intermittent local electron flux in a linear ECR plasma
- 3) A.Bader (Univ. Wisconsin-Madison) visited NIFS (M.Kobayashi) from 3 to 7 Mar. 2014 for discussions on divertor simulations.
- 4) H.Tsuchiya (NIFS) visited University of California, San Diego on 2014.3.3 to discuss the startup of collaboration study.
- 5) C.Deng (Univ. Wisconsin-Madison) visited NIFS (K.Nagaoka) on 4 Mar. 2014 to discuss on plasma flows and collaborations between NIFS and UW.

- 6) H.Tsuchiya (NIFS) visited Oak Ridge National Laboratory on 2014.3.5 to discuss the startup of collaboration study.
- 7) H.Tsuchiya (NIFS) visited Princeton Plasma Physics Laboratory on 2014.3.7 to discuss the startup of collaboration study.
- 8) M.Okabayashi (PPPL), M.J.Lanctot and E.J.Strait (General Atomics), R.Granetz (MIT), F.L.Waelbroeck (U.Texas), J.J.Koliner (U.Wisconsin) visited NIFS from 10 to 14 Mar. 2014 to attend US-Japan Workshop and the ITPA MHD meeting.
- 9) K.Tanaka (NIFS) attended ITPA Transport and Confinement (MIT) from 9 to 13 Apr. 2014.
- 10) S.Ohdachi (NIFS) visited General Atomics from 8 to 19 May 2014 for collaborations on DIII-D.
- 11) R.Yasuhara (NIFS) visited Univ. Wisconsin from 21 to 25 May 2014 for discussions on Thomson scattering diagnostics.
- 12) K.Ogawa (NIFS) visited Atlanta from 1 to 5 June, 2014 to present the design of a neutron profile monitor diagnostics in LHD.
- 13) T.Oishi (NIFS) visited Atlanta, USA from 1 to 5 June, 2014 to participate the 20th Topical Conference on High-Temperature Plasma Diagnostics (HTPD 2014).
- 14) K.Mukai (NIFS) participated in 20th Topical Conference on High Temperature Plasma Diagnostics (HTPD 2014) in Atlanta (USA) from 1 to 7, June, 2014 to present "Improvement of an infrared imaging video bolometer with a semi-tangential view in LHD"
- 15) T.Akiyama (NIFS) attended HTPD2014 (Intercontinental Hotel Buckhead) from 1 to 8 Jun. 2014 to give an invited talk.
- 16) S.Kubo, A.Shimizu, K.Ogawa and S.Kamio (NIFS) attended HTPD2014 from 1 to 7 Jun. 2014.
- 17) M.Goto (NIFS) attended 22nd emission profile workshop (Tennessee Univ.) from 1 to 8 Jun. 2014.
- 18) M. Ono (PPPL) visited NIFS from June 2, 2014 to June 3, 2014 to discuss a future plan of the collaborative research between helical plasma (LHD) and spherical torus plasma (NSTX-U).
- 19) A.S.Sabau (ORNL) visited NIFS (M.Tokitani) on 3 Jun. 2014 for discussions on heat-load tests.
- 20) D.Nishijima (UCSD) visited NIFS (S.Masuzaki) from 5 to 6 Jun. 2014.
- 21) J.W.Van Dam (DOE) visited NIFS (S.Masuzaki) on 14 Jul. 2014 for discussions on recent research in NIFS and future collaborations with US-institutions.
- 22) A.Y.Pankin (Tech-X Corporation) stayed NIFS from 16 Jun. to 16 Sep. 2014 as a JIFT visiting professor (contact: M.Yokoyama) for implementing uncertainty-quantification scheme in TASK3D-a.
- 23) S.Imagawa and Y.Hishinuma (NIFS) attended Applied Superconducting Conference 2014(Chalotte) from 10 to 16 Aug. 2014.
- 24) K.Tanaka (NIFS) visited General Atomics from 24 Aug. to 7 Sep. 2014 for US-Japan collaboration.
- 25) J.B.Caughman and C.H.Lau (ORNL) visited NIFS (S.Kubo) on 16 Sep. 2014 for discussions on RF heating physics.
- 26) T.Shimozuma, H.Kasahara and T.Ii (NIFS) attended Japan-US-Europe workshop on RF heating technology (Sedona, USA) from 21 to 26 Sep. 2014.
- 27) K.Ogawa (NIFS) visited PPPL from 29 Oct. to 9 Nov. 2014 for discussions on spatial profile measurement of fusion reaction.
- 28) S.Yoshimura (NIFS) visited the New Orleans Marriott Hotel, New Orleans, LA, USA to attend the 56th Annual Meeting of the American Physical Society Division of Plasma Physics (APS-DPP 2014) from 26 Oct. 2014 to 2, Nov. 2014. He gave a poster presentation entitled "Plasma Spectroscopy Using Optical Vortex Laser".
- 29) K.Ida, S.Morita, S.Sakakibara, H.Sugama and S.Toda (NIFS) attended 56th APS-DPP from 26 Oct. to 2 Nov. 2014.
- 30) S.Ohdachi (NIFS) attended 56th APS-DPP and 19th US-Japan MHD Workshop (New Orleans) from 26 Oct. to 7 Nov. 2014.
- 31) K.Ogawa (NIFS) visited Princeton Plasma Physics Laboratory from 30 Oct. to 7 Nov., 2014 to discuss the neutron calibration method in NSTX-U and get the knowledge to do the neutron calibration in LHD.
- 32) S.Hudson (PPPL) visited NIFS (Y. Suzuki) from 3rd to 11th November. He studied the chaotic coordinate system in non-axisymmetric tori and its application to the LHD. This collaboration result was reported at 24th International Toki Conference (Toki, Japan, Nov. 2013). Future plans are also discussed.
- 33) Y.Hirooka (NIFS) visited PPPL for collaboration and then attended TOFE2014 from 6 to 15 Nov. 2014.
- 34) A.Sagara and T.Muroga (NIFS) attended 21st Topical Meeting on the Technology of Fusion Energy (TOFE) from 9 to 15 Nov. 2014 (USA).
- 35) J.W.Ahn (Oak Ridge National Laboratory, USA) visited NIFS (M.Kobayashi) from 6 to 13 Dec. 2014 to join the experiments on divertor foot print in LHD.
- 36) D.Nishijima (UCSD) visited NIFS (M.Tokitani) from 12 to 26 Dec. 2014 for joint experiment on LHD.

5.1.2 Plans for 2015

- 1) I.Yamada (NIFS) will attend the 1st EPS Plasma Diagnostic conference (Frascati, Italy) from 14 to 17, April, 2015.
- 2) I.Yamada (NIFS) will attend the 42nd EPS Plasma Physics conference (Lisbon, Portugal) from 22 to 26, June, 2015.

- 3) Y.Suzuki (NIFS) will visit General Atomics (San Diego, USA) February 2015 to discuss 3D MHD modeling of tokamaks with resonant magnetic perturbation. These collaboration results will be reported at EPS2015 (Lisbon, Portugal, Jun. 2015)
- 4) Y.Suzuki (NIFS) will visit Max-Planck Institute fuer Plasmaphysik (Greifswald, Germany) and Forschungszentrum Juelich GmbH (Juelich, Germany) in March 2015 to discuss 3D MHD equilibrium calculation of Wendelstein 7-X. These collaboration results will be reported at ISHW2015 (Greifswald, Germany, Oct. 2015)
- 5) Many NIFS researchers will attend the 20th International Stellarator-Heliotron Workshop (Oct. 2015, Greifswald)

5.1.3 Collaborations by the Heliotron J team at Kyoto University

Collaborations with EU

- 1) S.Yamamoto visited CIEMAT on 9 to 17 March, 2014. He numerically analysed shear Alfvén spectra including Alfvén continua and discrete eigenfunctions of TJ-II plasma by using 3D numerical code “STELLOGAP” and “AE3D” with Francisco Castejón. He adjusted the parameters in numerical codes to analyse MHD equilibrium and magnetic field spectra in Boozer coordinate for the codes “STELLOGAP” and “AE3D” with Antonio López Fraguas.
- 2) S. Ohshima visited CIEMAT, Spain on March 9th-17th, 2014 for discussion of the joint experiment conducted in 2013 regarding the structural change of turbulence and long-range correlation observed with Langmuir probes. In this year, we discussed further analysis results for the response of long-range correlation to the radial electric field, which support a theoretical prediction for the relationship between long range correlation and neoclassical viscosity.
- 3) Nikolai Marushchenko visited Kyoto University on April 17th and 18th, 2014. He conducted a collaboration research on ECH/ECCD physics with K. Nagasaki. They have been developing a ray tracing calculation code “TRAVIS” for the Heliotron J device to calculate the EC power deposition and EC driven current efficiency. The TRAVIS code was also applied to an interferometer system of Heliotron J to calculate the beam trajectory for designing the transmission system.
- 4) Torsten Stange (Postdoctoral fellow, Max-Planck Institute) visited Kyoto University from Nov. 4 to Nov. 17, 2014. Concerning plasma production, non-resonant heating using 2.45GHz microwaves in stellarator/heliotron devices, he joined the Heliotron J experiment. He measured gamma rays produced by

high-energy electrons during 2.45GHz microwave heating, and scanned the amount and timing of gas puffing to optimize the plasma production using NBI, and compare with a simulation. He also made a presentation of recent research activities on plasma production using 2.45GHz and 70GHz microwaves in the WEGA stellarator.

- 5) Alvaro Cappa (CIEMAT, Spain) submitted a paper entitled “Second harmonic ECRH breakdown experiments in the TJ-II stellarator” to Nuclear Fusion Journal, which is related to plasma breakdown using 2nd harmonic X-mode ECH in TJ-II. K. Nagasaki discussed plasma production mechanism with him and is a co-author of this paper.
- 6) Discussions with W7 team (IPP) were kept along the same line as in 2013.
- 7) Collaborations with CIEMAT were continued along the same lines as in 2013.

Collaborations with Australia

Discussions with H-1 team (ANU) were kept along the same line as in 2013.

Collaborations with US

- 1) Chuanbao Deng (Honorary fellow, University of Wisconsin, USA) visited Kyoto University from Feb. 23 to March 6, 2014 for collaboration research on relationship between flow and turbulence in advanced helical systems such as the Heliotron J and HSX devices. He has been developing a diagnostic for density fluctuation measurement in HSX using a technique of microwave interferometry. He has reported broadband turbulent fluctuation that correlates with plasma density gradient and flow. C.B. Deng and S. Kobayashi discussed the experimental data of the density fluctuation by BES and plasma flow obtained by CXRS in Heliotron J.
- 2) K. Nagasaki will discuss reflectometer system and its application to measurement on density profile and density fluctuation with K. Likin and D. Anderson (U. Wisconsin).
- 3) Discussions with the HSX (Wisconsin Univ.) team and CTH (Auburn Univ.) team, groups of ORNL and PPPL, etc.) were kept along the same line as in 2013.

Collaborations with Ukraine

Discussions with Kharkov team about the collaboration in U-2M project were kept along the same line as in 2013.

Collaborations with Russia

Discussions with Kurchatov Institute related to development of advanced stellarator/heliotron systems were kept along the same line as in 2013.

Others

- 1) Kyoto University hosted the 13th Coordinated Working Group Meeting (CWGM) held at Kyoto University on February 26th-28th, 2014. About 30 people attended the meeting, including Aaron Bader, Chuanbao Deng (Univ. Wisconsin), Allan Reiman (PPPL), Andreas Dinklage, Andreas Kus, Melanie Preynas, Dorothea Gradic, Felix Warmer, Robert Wolf (IPP), Enrique Ascasibar, Kieran McCarthy, Jose-Luis Velasco, Arturo Alonso, Alvaro Cappa, Francesco L. Tabares (CIEMAT) on site or through internet. They discussed database analysis for confinement and plasma profiles, three dimensional transport in divertor, impurity transport, reactor/system code, transport analysis related to flow and viscosity, plasma production, energetic-particle-driven MHD modes, three dimensional equilibrium and collaboration structure
- 2) T. Mizuuchi, S. Kobayashi, S. Yamamoto and S. Ohshima attended 25th Fusion Energy Conference held at Saint Petersburg, Russia on October 13th-18th, 2014. They presented recent experimental results on Heliotron J, especially high-density plasma sustainment using novel fuelling methods, toroidal flow measurement concerning neoclassical transport, stabilization of energetic-particle-driven MHD instabilities using ECCD and measurement of turbulence and structure at edge region using Langmuir probes. They discussed the future collaboration research with researchers from TJ-II, W7-X, H-1 and HSX.
- 3) A new gas fuelling by high-intense gas puffing (HIGP) was successfully applied to ECH/NBI plasma in Heliotron J. The core electron density reached $1 \times 10^{20} \text{ m}^{-3}$. The collaboration of fuelling control studies are being discussed with TJ-II team and NIFS.

5.1.4 Plans for 2015

- 1) The Heliotron group will participate in next international stellarator/heliotron workshop which is planned to be held at Greifswald, Germany in 2015.
- 2) Gavin Weir (Univ. Wisconsin) will join the Heliotron J group from January, 2015 for one year as a post-doctoral fellow, supported by JSPS. He will be engaged in experimental study on anomalous electron heat transport using an ECE radiometer.
- 3) Francesco Volpe and his PhD student plan to visit Kyoto University for collaboration research on the EBE diagnostic. He will develop a polarizer to measure the polarization of O-mode emitted from a Heliotron J plasma.
- 4) Manuel Garcia-Munõz (University of Sevilla, Spain) plan to visit at Kyoto University for research collaboration on the energetic ion driven MHD

instabilities and their effect on energetic ion confinement in both tokamaks and stellarator/heliotron plasmas.

- 5) Plasma fluctuations and structural formation at core and edge regions will be continued to be measured with using diagnostics including a beam emission spectrometer, a reflectometer, SX array, Langmuir probes and fast CCD cameras under collaboration with CIEMAT, IPP and Stuttgart University and domestic universities.
- 6) Confinement improvement of particle, momentum and energy, especially the role of toroidal and poloidal rotation, will be investigated by controlling particle fuelling method and magnetic field configuration under collaboration with Kharkov Institute and CIEMAT.
- 7) Confinement control of high-energy particles by using the optimized field configuration based on the quasi-isodynamic concept will be examined through Heliotron J NBI/ICRF experiments.
- 8) Internal transport barrier will be experimentally investigated in Heliotron J, which is observed in low-density ECH plasmas. The necessary conditions for forming the internal transport barrier will be clarified, and will be compared with
- 9) MHD instabilities such as interchange instabilities and Alfvén Eigenmode instabilities in low-magnetic shear configurations will be studied from the viewpoint of magnetic island control and suppression of energetic-ion loss under collaboration with CIEMAT and IPP.
- 10) Research on NBI start-up using 2.45GHz microwaves will be continued for high-beta experiments and physics study of plasma production under collaboration with IPP.
- 11) ECCD experiments using 2nd harmonic 70GHz X-mode will be performed for control of MHD instabilities through rotational transform modification under collaboration with IPP, CIEMAT and NIFS.
- 12) Electron Bernstein heating/current drive and Electron Bernstein emission diagnostics are prepared for overdense plasma heating and electron temperature profile measurement under collaboration with IPP and Columbia University.
- 13) Particle and heat transport control of edge plasmas will be investigated with regard to divertor optimization.
- 14) Kyoto University and NIFS made an application of Joint research projects related to ECRH and ECCD physics and technology between Germany and Japan to Japan Society for the Promotion of Science. If approved, personal exchange including researchers and students will be performed.

6 RUSSIA

25th IAEA Fusion Energy Conference (FEC2014) was held in St. Petersburg from 13 to 18 October 2014. (Hosted by the Government of the Russian Federation through the State Atomic Energy Corporation ROSATOM)

Collaborations with Germany

- 1) M. Mikhailov (Kurchatov Institute Moscow) to IPP Greifswald, 03.03. – 18.04.2014
- 2) M. Mikhailov (Kurchatov Institute Moscow) to IPP Greifswald, 14.10. – 12.12.2014
- 3) F. Wagner (IPP) visited St. Petersburg State Polytechnical University, 14.09. - 21.09.2014

Collaborations with Spain

- 1) S. Perfilov (November-December) of the HIBP Kurchatov Institute team was visiting CIEMAT to investigate the structure of plasma potential and plasma fluctuations in TJ-II and the commissioning of the second HIBP system where secondaries have been successfully detected by the end of 2013.
- 2) Collaboration with General Physics Institute, Moscow on the characterization of the plasma reflected power on gyrotron performance. A final compilation of the experimental results as well as a conclusive data analysis have been carried out during 2014. The results will be sent for its publication. The visiting scientists of GPI involved have been: K. Sarksyian (8-22 May), V. Borzosekov (26 May-26 June), D. Malakhov (14 November-12 December), N. Kharchev (29 October-28 November).

Collaborations with Japan

- 1) I.Tolistikhina (P.N. Lebedev Physical Institute) visited NIFS (D.Kato) from 3 to 7 Feb. 2014 for atomic process on W impurity in plasmas.
- 2) S.Konovalov, V.Lukash and V.Pustovitov (Kurchatov Institute) visited NIFS from 10 to 14 Mar. 2014 to attend the ITPA MHD meeting.
- 3) S.Kubo (NIFS) attended 9th International Workshop on Strong Microwaves and Terahertz waves (Nizhnij Novgorod Applied Physics Institute) from 23 Jul to 1 Aug. 2014.
- 4) V.N.Leonid (Budker Nuclear Physics Institute) visited NIFS (K.Tanaka) from 15 Sep. to 18 Oct. 2014 for discussions on diagnostics development for turbulence fluctuations based on CO₂ laser.
- 5) S.Sudo (NIFS) discussed with I. Viniar (PELIN, Russia) about the collaboration on the TECPEL activity for LHD, and discussed with V. Sergeev (State

Polytechnical University, St. Petersburg, Russia) about the collaboration on the NIOS system for LHD during the IAEA-FEC 2014 conference (13-18 October 2014) at St. Petersburg.

Collaboration with Kurchatov Institute, Moscow, Russia

- 1) Dr. L.I. Krupnik and HIBP team (IPP NSC KIPT) in collaboration with Dr. A.V. Melnikov and T-10 team (Kurchatov Institute).
- 2) Joint development of two kinds of the probing beam diagnostics for new tokamak T-15. (two HIBP systems and Injection of the neutral atoms Li0 and Na0).
- 3) Investigation of the nature of Tl ion emission and increase intensity of the probing beam.
- 4) Study of the plasma potential and density and their fluctuations by upgraded HIBP system in regimes with high plasma density. Comparative study of the GAMs (and AEs) behavior in the T-10 tokamak and TJ-II stellarator during ECR heating with high intensity heavy ion probing beam.

7 UKRAINE

Institute of Plasma Physics of the National Science Center “Kharkov Institute of Physics and Technology” of the NAS of Ukraine (IPP NSC KIPT, NASU)

7.1 International collaborations of the NSC KIPT in 2014

Multilateral Collaboration

V.V.Nemov, S.V.Kasilov, V.E.Moiseenko, V.N.Kalyuzhnyi in collaboration with W.Kernbichler, A.F.Martitsch (**Technische universität Graz, Austria**) and O.Agren (**Angstrom Laboratory, Uppsala University, Uppsala, Sweden**) investigated the confinement of high energy ions for a stellarator type trap DRAGON

Collaboration with Technische Universität Graz, Austria

Direct computations of high energy particle losses in optimized stellarators solving the guiding center drift equations in real-space coordinates. (V.V.Nemov, S.V.Kasilov in collaboration with W.Kernbichler).

Collaboration with CIEMAT

Dr. L.I.Krupnik et al (IPP NSC KIPT) in collaboration with Dr. C. Hidalgo and TJ-II team (CIEMAT).

- 1) Designing, manufacturing and installation new modification of the emitter-extraction system in the probing beam injector of the first HIBP system.
- 2) Tuning of the second HIBP system.

Collaboration with Kurchatov Institute, Moscow, Russia
Dr. L.I. Krupnik and HIBP team (IPP NSC KIPT) in collaboration with Dr. A.V. Melnikov and T-10 team (Kurchatov Institute).

- 1) Joint development of two kinds of the probing beam diagnostics for new tokamak T-15. (two HIBP systems and Injection of the neutral atoms Li0 and Na0).
- 2) Investigation of the nature of Tl ion emission and increase intensity of the probing beam.
- 3) Study of the plasma potential and density and their fluctuations by upgraded HIBP system in regimes with high plasma density. Comparative study of the GAMs (and AEs) behavior in the T-10 tokamak and TJ-II stellarator during ECR heating with high intensity heavy ion probing beam.

Collaboration of with Technische Universität Graz, Austria and Max-Planck-Institut für Plasmaphysik, Greifswald, Germany

V.V.Nemov, S.V.Kasilov and V.N.Kalyuzhnyj continued collaboration aiming the application of NEO-2 to study efficiency of ECCD in tokamaks and stellarators.

7.2 Plans for 2015

Collaboration with Technische universität Graz, Austria

Study of collisionless high energy ion losses in stellarator magnetic fields produced by 3D plasma equilibrium codes.

Collaboration with Spain (CIEMAT, Madrid)

- 1) Upgrade of the first HIBP system for identity of two systems.
- 2) Tuning and start experiments with the second HIBP system.
- 3) Study of the plasma potential and electron density during ECR and NBI heating in different magnetic configurations and regimes of device operation. Study of the plasma potential evolution and its fluctuations (Alfven and non-Alfven modes) in two cross-sections of plasma column in combined NBI/ECRH plasmas by two HIBP systems on TJ-II stellarator.

Collaboration with Russian Kurchatov Institute, Moscow

- 1) Development, production and delivery of the upgraded emitter and extractor block of the accelerator of thallium ions for tokamak of T-10.
- 2) Carrying out joint experiments on receiving a long focusing beam with a high density of ionic current – $300 \mu\text{A} / \text{cm}^2$
- 3) Study of the plasma potential and density and their fluctuations by upgraded HIBP system in regimes with high plasma density. Comparative study of the GAMs (and AEs) behavior in the T-10 tokamak and TJ-II

stellarator during ECR heating with high intensity heavy ion probing beam.

The tasks planned for study at IPP NSC KIPT in 2015

URAGAN-3M

- 1) Optimization of RF-discharge plasma in U-3M torsatron.
- 2) Studies of plasma flow properties in the helical divertor of the Uragan-3M torsatron in different regimes of RF plasma production and heating. Studies of peripheral plasma characteristics.
- 3) A search for optimum regimes of RF plasma heating in the Uragan-3M torsatron with using the three-half-turn antenna.
- 4) Investigation of RF pre-ionization with the small frame antenna at Uragan-3M device.
- 5) Study of MHD activity of RF-discharge plasma in U-3M torsatron.
- 6) Investigation of toroidal non-uniformity of edge plasma turbulence in the Uragan-3M torsatron.
- 7) Further investigation of the high energy particles behavior in Uragan-3M RF plasmas.
- 8) Investigation of parametric instability at the periphery of plasma confinement volume in Uragan-3M.
- 9) Clearing up the mechanism of suppression of run-away electrons by supplying voltage to the RF antenna.
- 10) Study of energy characteristics of run-away electrons by means of Cherenkov detectors (in cooperation with Institute of Plasma Physics and Laser fusion, Warsaw, Poland)

URAGAN-2M

- 1) First measurements of plasma parameters via HIBP diagnostic (electric plasma potential) in Uragan-2M.
- 2) Evaluation of radial plasma density profiles using dual polarization interferometry for the U-2M plasmas.

PLASMA MODELLING

- 1) Development of a self-consistent multi-ion species model for RF plasma production (in collaboration with LPP ERM/KMS, Belgium).
- 2) Making calculations of neutron distributions in stellarator-mirror fusion-fission hybrid.

8 UNITED STATES

International collaborations in 2014

Collaborations with EU

- 1) J.P. Allain, D. Curreli and D. N. Razic (University of Illinois) to IPP Greifswald, 12.01. – 13.01.2014
- 2) B. Faber (University of Wisconsin, Madison) to IPP Greifswald, 19.01. – 30.01.2014

- 3) G. Wurden (LANL) to IPP Greifswald, 02.-08.02.2014
 - 4) J. Proll (IPP Greifswald) to PPPL, 24.03. – 31.05.2014
 - 5) H.-S. Bosch, T. Klinger, T. Sunn Pedersen (IPP Greifswald) visited University of Wisconsin, Madison (Wisconsin, USA), 06.-12.04.2014
 - 6) D. Gates and N. Pablant (Princeton Plasma Physics Laboratory) to IPP Greifswald, 21.04. – 26.04.2014
 - 7) J. Loizu (IPP Greifswald) to PPPL, 28.04. – 31.12.2014
 - 8) J. Proll (IPP Greifswald) to University of Madison, 11.05. – 17.05.2014
 - 9) G. Wurden (LANL) to IPP Greifswald, 11.06.-01.08.2014
 - 10) J. Hudson (University Auburn, USA) to IPP Greifswald, 15.06. – 18.06.2014
 - 11) R. Prater (General Atomics), D. Andruczyk and D. Curreli (University of Illinois) to IPP Greifswald, 29.06. – 19.07.2014
 - 12) P. Fflis (University of Illinois) to IPP Greifswald, 06.07. – 12.07.2014
 - 13) D. Andruczyk (University of Illinois) to IPP Greifswald, 31.08. – 20.09.2014
 - 14) A. Press (University of Illinois) to IPP Greifswald, 01.09. – 12.09.2014
 - 15) P. Fflis (University of Illinois) to IPP Greifswald, 07.09. – 19.09.2014
 - 16) F. A. Volpe (Columbia University) to IPP Greifswald, 21.09. – 23.09.2014
 - 17) D. Gates and S. Lazerson (Princeton Plasma Physics Laboratory) to IPP Greifswald, 28.09. – 03.10.2014
 - 18) J. Proll (IPP Greifswald) to PPPL, 29.09. – 07.12.2014
 - 19) G. Wurden (LANL) to IPP Greifswald, 10.-23.10.2014
 - 20) D. Gates and N. Pablant (Princeton Plasma Physics Laboratory) to IPP Greifswald, 08.12. – 12.12.2014
 - 21) E. Hollmann (USCD) was visiting CIEMAT (1 week, June 2014) working on parallel / radial impurity transport studies and role of Z.
 - 22) Álvaro Cappa was invited to join the experiments on the impact of ECRH on Alfvén Eigenmodes that were performed in the DIII-D tokamak in June. He spent one week in the General Atomics facilities in San Diego from June 9th to June 14th.
 - 23) F Tabares was visiting the U of Illinois, Urbana, for the fabrication of LISn alloys
- dynamo effects from 16 to 23, Feb. 2014. He gave a seminar presentation on intermittent local electron flux in a linear ECR plasma
- 3) A.Bader (Univ. Wisconsin-Madison) visited NIFS (M.Kobayashi) from 3 to 7 Mar. 2014 for discussions on divertor simulations.
 - 4) H.Tsuchiya (NIFS) visited University of California, San Diego on 2014.3.3 to discuss the startup of collaboration study.
 - 5) C.Deng (Univ. Wisconsin-Madison) visited NIFS (K.Nagaoka) on 4 Mar. 2014 to discuss on plasma flows and collaborations between NIFS and UW.
 - 6) H.Tsuchiya (NIFS) visited Oak Ridge National Laboratory on 2014.3.5 to discuss the startup of collaboration study.
 - 7) H.Tsuchiya (NIFS) visited Princeton Plasma Physics Laboratory on 2014.3.7 to discuss the startup of collaboration study.
 - 8) M.Okabayashi (PPPL), M.J.Lanctot and E.J.Strait (General Atomics), R.Granetz (MIT), F.L.Waelbroeck (U.Texas), J.J.Koliner (U.Wisconsin) visited NIFS from 10 to 14 Mar. 2014 to attend US-Japan Workshop and the ITPA MHD meeting.
 - 9) K.Tanaka (NIFS) attended ITPA Transport and Confinement (MIT) from 9 to 13 Apr. 2014.
 - 10) S.Ohdachi (NIFS) visited General Atomics from 8 to 19 May 2014 for collaborations on DIII-D.
 - 11) R.Yasuhara (NIFS) visited Univ. Wisconsin from 21 to 25 May 2014 for discussions on Thomson scattering diagnostics.
 - 12) K.Ogawa (NIFS) visited Atlanta from 1 to 5 June, 2014 to present the design of a neutron profile monitor diagnostics in LHD.
 - 13) T.Oishi (NIFS) visited Atlanta, USA from 1 to 5 June, 2014 to participate the 20th Topical Conference on High-Temperature Plasma Diagnostics (HTPD 2014).
 - 14) K.Mukai (NIFS) participated in 20th Topical Conference on High Temperature Plasma Diagnostics (HTPD 2014) in Atlanta (USA) from 1 to 7, June, 2014 to present "Improvement of an infrared imaging video bolometer with a semi-tangential view in LHD"
 - 15) T.Akiyama (NIFS) attended HTPD2014 (Intercontinental Hotel Buckhead) from 1 to 8 Jun. 2014 to give an invited talk.
 - 16) S.Kubo, A.Shimizu, K.Ogawa and S.Kamio (NIFS) attended HTPD2014 from 1 to 7 Jun. 2014.
 - 17) M.Goto (NIFS) attended 22nd emission profile workshop (Tennessee Univ.) from 1 to 8 Jun. 2014.
 - 18) M. Ono (PPPL) visited NIFS from June 2, 2014 to June 3, 2014 to discuss a future plan of the collaborative research between helical plasma (LHD) and spherical torus plasma (NSTX-U).
 - 19) A.S.Sabau (ORNL) visited NIFS (M.Tokitani) on 3

Collaborations with Japan

- 1) H.Miura (NIFS) visited the Institute for Fusion Studies, University of Texas at Austin from Feb. 9 to March 31, 2014 to study for numerical simulations of plasma in a heliotron device, by making use of the sabbatical leave system of NIFS.
- 2) S.Yoshimura (NIFS) visited PPPL and the University of Wisconsin-Madison to discuss basic plasma experiments related with magnetic reconnection and

- Jun. 2014 for discussions on heat-load tests.
- 20) D.Nishijima (UCSD) visited NIFS (S.Masuzaki) from 5 to 6 Jun. 2014.
 - 21) J.W.Van Dam (DOE) visited NIFS (S.Masuzaki) on 14 Jul. 2014 for discussions on recent research in NIFS and future collaborations with US-institutions.
 - 22) A.Y.Pankin (Tech-X Corporation) stayed NIFS from 16 Jun. to 16 Sep. 2014 as a JIFT visiting professor (contact: M.Yokoyama) for implementing uncertainty-quantification scheme in TASK3D-a.
 - 23) S.Imagawa and Y.Hishinuma (NIFS) attended Applied Superconducting Conference 2014(Chalotte) from 10 to 16 Aug. 2014.
 - 24) K.Tanaka (NIFS) visited General Atomics from 24 Aug. to 7 Sep. 2014 for US-Japan collaboration.
 - 25) J.B.Caughman and C.H.Lau (ORNL) visited NIFS (S.Kubo) on 16 Sep. 2014 for discussions on RF heating physics.
 - 26) T.Shimozuma, H.Kasahara and T.Ii (NIFS) attended Japan-US-Europe workshop on RF heating technology (Sedona, USA) from 21 to 26 Sep. 2014.
 - 27) K.Ogawa (NIFS) visited PPPL from 29 Oct. to 9 Nov. 2014 for discussions on spatial profile measurement of fusion reaction.
 - 28) S.Yoshimura (NIFS) visited the New Orleans Marriott Hotel, New Orleans, LA, USA to attend the 56th Annual Meeting of the American Physical Society Division of Plasma Physics (APS-DPP 2014) from 26 Oct. 2014 to 2, Nov. 2014. He gave a poster presentation entitled "Plasma Spectroscopy Using Optical Vortex Laser".
 - 29) K.Ida, S.Morita, S.Sakakibara, H.Sugama and S.Toda (NIFS) attended 56th APS-DPP from 26 Oct. to 2 Nov. 2014.
 - 30) S.Ohdachi (NIFS) attended 56th APS-DPP and 19th US-Japan MHD Workshop (New Orleans) from 26 Oct. to 7 Nov. 2014.
 - 31) K.Ogawa (NIFS) visited Princeton Plasma Physics Laboratory from 30 Oct. to 7 Nov., 2014 to discuss the neutron calibration method in NSTX-U and get the knowledge to do the neutron calibration in LHD.
 - 32) S.Hudson (PPPL) visited NIFS (Y. Suzuki) from 3rd to 11th November. He studied the chaotic coordinate system in non-axisymmetric tori and its application to the LHD. This collaboration result was reported at 24th International Toki Conference (Toki, Japan, Nov. 2013). Future plans are also discussed.
 - 33) Y.Hirooka (NIFS) visited PPPL for collaboration and then attended TOFE2014 from 6 to 15 Nov. 2014.
 - 34) A.Sagara and T.Muroga (NIFS) attended 21st Topical Meeting on the Technology of Fusion Energy (TOFE) from 9 to 15 Nov. 2014 (USA).
 - 35) J.W.Ahn (Oak Ridge National Laboratory, USA) visited NIFS (M.Kobayashi) from 6 to 13 Dec. 2014 to join the experiments on divertor foot print in LHD.
 - 36) D.Nishijima (UCSD) visited NIFS (M.Tokitani) from 12 to 26 Dec. 2014 for joint experiment on LHD.
 - 37) Chuanbao Deng (Honorary fellow, University of Wisconsin, USA) visited Kyoto University from Feb. 23 to March 6, 2014 for collaboration research on relationship between flow and turbulence in advanced helical systems such as the Heliotron J and HSX devices. He has been developing a diagnostic for density fluctuation measurement in HSX using a technique of microwave interferometry. He has reported broadband turbulent fluctuation that correlates with plasma density gradient and flow. C.B. Deng and S. Kobayashi discussed the experimental data of the density fluctuation by BES and plasma flow obtained by CXRS in Heliotron J.
 - 38) K. Nagasaki will discuss reflectometer system and its application to measurement on density profile and density fluctuation with K. Likin and D. Anderson (U. Wisconsin).

(Komori, A., Yamada, H., Yokoyama, M.)