

## 2. TEXTOR Collaboration

Importance of plasma-surface interactions (PSI) is common understanding among the IEA partners and scientists/engineers working on tokamaks and helical devices. From this viewpoint, discussion on the framework of the TEXTOR Implementing Agreement is still on going. More intimate cooperation to the ITPA topics group has been requested. Subject oriented rearrangement is desirable, but not yet agreed upon. More stable operation was realized in this fiscal year. Significant experimental data have been obtained in some research subjects. The third workshop on "Stochasticity in Fusion Plasmas (SFP-3)" was held in March. Five Japanese scientists attended to this workshop and 9 papers were presented based on results of the collaborations.

### DED experiments

Collaboration experiments with Dynamic Ergodic Divertor (DED) are continued. According to a proposal of the Japanese team, experiments on excitation of Alfvén eigenmodes (AEs) have been carried out. RF current (100kHz-1MHz, 4A) has been applied on DED coil (6/2 mode) and compared the coil impedance with theoretical calculation for AEs. Excitation of MHD modes (probably AEs) are observed on the Mirnov signal and the coil

impedance. Effect of the field ergodization by DC DED current on AEs is studied by superimposing rf current on DED coil. Indications of the suppression of the AEs by the field are obtained preliminary.

### PSI studies related with test limiters

The new roof limiter made by isotropic graphite was fabricated and tested. The most important feature of it is local heating capability. The small heater module (~40 mm x 30 mm) with a BN plate heater was embedded in the roof limiter. The surface temperature of the heated plate can be raised up to about 800 °C. This limiter was brought to TEXTOR to test its adaptability to the limiter lock system. The surface temperature of the local heated plate was raised to more than 700 °C in the TEXTOR vacuum chamber without any vacuum problem. This temperature was beyond the peak temperature of chemical sputtering of graphite. In 2007 (Japanese fiscal year) collaboration, plasma exposure experiments will be planned.

<sup>13</sup>C marked ethylene gas was puffed through a small hole in a tungsten limiter to investigate atomic processes in edge plasmas and subsequent redeposition of carbon and hydrocarbon ions. The spectral lines of C<sub>2</sub>H<sub>x</sub> and CH<sub>x</sub> molecular line, CII, CIII were observed.

### Japanese Participation in 2006-2007

Subjects	Participants	Term	Key Persons etc.
1. PSI studies with test limiters	T. Tanabe (Kyushu Univ.) Y. Ueda (Osaka Univ.)	07. 3. 11 - 3. 17 07. 3. 11 - 3. 18	T. Tanabe / V. Philipps
2. Tangential X-ray Camera	S. Ohdachi (NIFS)	07. 3. 11 - 3. 16	K. Toi / H. R. Koslowski
3. Tritium Measurement	M. Matsuyama (Toyama Univ.)	06. 7. 8 - 7.15	M. Matsuyama / V. Philipps
4. DED experiments	T. Shoji (Nagoya Univ.) T. Shoji (Nagoya Univ.) K. Toi (NIFS) Y. Kikuchi (Univ. of Hyogo) K. N. Satoh (Kyushu Univ.)	07. 1. 7 - 1. 17 07. 2. 26 - 3. 4 07. 3. 3 - 3. 9 07. 3. 4 - 3. 9 07. 3. 6 - 3.12	T. Shoji / K. H. Finken
5. Millimeter-Wave Imaging			A. Mase/ A. J. H. Donne
6. H recycling	M. Sakamoto (Kyushu Univ.)	07. 2. 28 - 3. 9	M. Sakamoto/ K. H. Finken
7. Edge Plasma Diagnostics	A. Tsushima (Yokohama National Univ.)	07. 1. 7 - 1. 17	A. Tsushima / S. Jachmich
8. He measurement in LHD			H. Funaba/ M. Lehnen
9. Development of PFM Executive Committee Meeting	N. Noda (NIFS) Y. Nakamura (NIFS)	07. 2. 26 - 3. 4 07. 2. 28 - 3. 4	N. Noda/ J. Linke

The gas-puff experiments with  $^{13}\text{CH}_4$  was also made for the similar plasma (standard ohmic discharges) to compare the results. The detailed analysis will be made in future.

### He Partial pressure measurement in LHD

Penning gauge developed in TEXTOR is applied to Large Helical Device (LHD). Partial pressure has been measured for hydrogen (H), helium (He) or noble gases (Ne, Ar etc.) in the vacuum vessel. Signal of the penning gauge spectroscopy was improved to be about 3 times larger compared to that of last year due to the installation of a new short cross tube and by the improvement of the optics. The temporal behaviour of the intensity of  $H_\alpha$  was obtained during the ICRF conditioning discharges. The  $H_\alpha$  intensity increased after each ICRF pulse in the helium operating gas. The neutral pressure in RF heated long-pulse discharges were quite low. This result is consistent with the measurements of the fast ion gauge or another penning gauge which is used under normal operation.

### Millimeter-Wave Imaging Diagnostics

A 140 GHz frequency-selective-surface (FSS) band-stop filters have been fabricated using electro-fine-forming (EF2) technique in Kyushu Hitachi Maxell Ltd. The evaluation shows large rejection and outstanding angle insensitivity. The filter is now installed in the TEXTOR-ECEI (electron cyclotron emission imaging) system operated by UCD-PPPL and FOM group to protect the mixer arrays from spurious ECRH power. The 16<sup>th</sup> International Toki Conference was held in Toki, Japan during 5-8 December, 2006. The topics of the conference are advanced plasma diagnostics and imaging science in the various fields. The presentations on TEXTOR microwave imaging diagnostics were the most important and attractive among all.

### Tritium analysis with BIXS

To examine changes in the amount and depth profile of tritium retained on the surface and in the bulk of metallic materials which were exposed to high-level tritium gas, techniques of BIXS and chemical etching were applied. The samples used were thin plates of stainless steel type 316: one was mechanically polished by fine alumina powders (described as POL-Sample), and the other was the as-received state without any treatments (described as AR-Sample). These samples were exposed to high-level tritium gas under given conditions. It was found by BIXS and chemical etching of the samples that the tritium concentration was not uniform in SS316 and remarkably high tritium concentration was observed in surface layers irrespective of difference in surface structure. Surface enrichment of tritium is due to the effects of peculiar surface layers formed in the atmosphere. In addition, tritium inventory in POL-Sample was about three times

greater than that in AR-Sample, indicating that absorption rate of tritium is strongly dependent on the surface conditions of a sample. However, it was seen that desorption rate of tritium did not depend on the surface structure and it was obeyed by a diffusion rate of tritium in the bulk. Namely, it was suggested that the tritium atoms dissolved in metallic materials can be removed by only thermal treatments.

### Tangential Camera

In this fiscal year, a new type of the device has been developed, tangentially viewing VUV telescope using the multi-layer mirror for the visualization of the MHD instabilities. The soft x-ray system we used so far had the advantage that the photons it detects are in the same energy range as those emitted by the plasma. The drawback is, that no lenses are available in this energy range and we have to use a pinhole. Then the time and the space resolution are coupled. To improve the time resolution is then only possible if we increase the diameter of the pinhole together with the detector. The size of the detector is, however, limited by their availability; moreover, the camera becomes larger and needs more space on the experiment.

For longer wavelength, the first optical components would be mirrors made of Mo-Be multi-layers, which can reflect photon of 13.5nm. The carbon VI line (13.5~nm) falls into this energy range. The reflectivity of the material is up to 65% and the mirrors available are close to the theoretical limit. The CVI-line ( $n=4-2$ ) has been identified by the VUV spectrometer on LHD. Therefore it may be expected to observe with the camera patterns in the boundary of fusion devices. If it is necessary to look further into the plasma, the charge exchange emission ( $\text{H}^0 + \text{C}^{+6} \rightarrow \text{H}^+ + \text{C}^{+5*}$ ) is available.

Inverse-Schwarzschild type mirror optical system was adopted with a magnification of 1/60. From the dispersion of the spot diagram, the spatial resolution of the system is estimated; it is as small as 3mm in the middle of the viewing field. Thought, in the real experiment, the signal is a line integrated one, up to poloidal mode numbers  $m = 10$  can be resolved in numerical simulations. We had discussed the possibilities to install it on the TEXTOR device. At the present, there is no suitable port to be installed. We continue the experiments at the Large Helical Device and wait for the opportunity for the experiments at the TEXTOR.

### Other possible collaborations in future

A possible new collaboration program is proposed on beam probe diagnostics in LHD. The TEXTOR group has experiences and instrumentation relating to He beam probe, with which edge electron density and temperature are obtained simultaneously. Interests on stochastic edge structures in DED and LHD are expressed from both sides. More detail will be discussed in 2007.

(Noda, N.)