2. TEXTOR Collaboration

The framework of the TEXTOR Implementing Agreement has been discussed in consideration of rearrangements with other IEA agreements. However, research in the field of plasma-wall interaction is of increasing importance for the fusion community in view of the urgent R&D needs for ITER, and also plasma-wall interaction is seen as a key research area on the way towards the realization of steady state fusion power facilities. As a result, the TEXTOR Implementing Agreement was extended for period of five years from 1 January 2008 to 31 December 2012. The main focus will be put on the key research issues such as erosion, deposition, tritium retention, life time and steady state. The international workshop on "TEXTOR and PWI" was held in October and the strong collaboration between Japan and TEXTOR groups was requested for further integration and coordination of research on world wide scale. All the activities in this fiscal year are summarized in the following table. Highlights in some of individual programs are described in this report

Test limiter experiments in TEXTOR

Carbon deposition and mixed layer formation on tungsten surfaces in TEXTOR test limiter experiments by varying surface conditions such as surface roughness (R_a: 10 nm ~1 mm), temperature (300 °C ~ 900 °C), and initial surface carbon concentration (0 ~ 0.6) were made. These results are valuable for understanding carbon deposition and re-erosion behavior on actual surfaces of tungsten.

The experiments were performed under TEXTOR standard Ohmic discharge conditions (I_P = 350 kA, B_t = 2.25 T, $n_e = 2.5 \times 10^{19}$ m^{-3}, D-plasma). Tungsten samples were installed on a graphite roof limiter and positioned with the nearest end 1-2 cm behind the LCFS. Several samples including a reference sample (R_a ~10 nm, pure W) were simultaneously exposed to the edge plasma. Characterization of carbon deposition layers and mixed material layers was made by various surface diagnostics such as NRA with 2.5 MeV $^3He^+$ for the carbon and deuterium surface density and colorimetry for the thickness of carbon deposition layers.

The results are summarized as follows: Rough surface increased the carbon deposition efficiency significantly. Carbon deposition was suppressed at elevated temperatures (more than 520 °C), while deposition occurred around 300 °C. Deuterium retention was observed only in the carbon deposition layer. The carbon deposition behavior strongly depends on initial surface carbon concentration.

Japanese Participation in 2007-2008

Subjects	Participants	Term	Key Persons *etc.*
1. PSI studies with test limiters	Y. Ueda (Osaka Univ.) M. Fukumoto (Osaka Univ.)	07. 9. 16 - 9. 23 07. 9. 16 - 9. 23	Y. Ueda/ V. Philipps
2. Tangential X-ray Camera	S. Ohdachi (NIFS)	08. 3. 6 - 3. 14	K. Toi / H. R. Koslowski
3. Tritium Measurement	Y. Torikai (Toyama Univ.)	07. 9. 29 - 10.7	M .Matsuyama /V. Philipps
4. DED experiments	T. Shoji (Nagoya Univ.) A. Tsushima (Yokohama National Univ.)	07. 12. 2 - 12. 17 07. 12. 5 - 12. 17	T. Shoji / K. H. Finken
5. Millimeter-Wave Imaging	N. Ito (Kyushu Univ.)	08. 3. 30 - 4. 6	A. Mase/ A. J. H. Donne
6. H recycling			M. Sakamoto/ K. H. Finken
7. Collective scattering of mm waves	K. Tanaka (NIFS) S. Kubo (NIFS)	07. 6. 14 - 7. 9 07. 9. 8 - 9. 16	K. Tanaka / Westerhov / H. Bindslev
8. International WS on TEXTOR and PWI	U. Samm (FZJ) K. H. Finken (FZJ) M. Lehnen (FZJ) K. Sugiyama (IPP)	07. 10. 10 - 10. 13 07. 10. 10 - 10. 13 07. 10. 10 - 10. 20 07. 10. 4 - 10. 14	N. Noda / U. Samm
9. He measurements In LHD			H. Funaba/ M. Lehnen

DED experiments

Collaboration experiments with Dynamic Ergodic Divertor (DED) are continued. The Japanese experimental plan is to study the excitation and suppression of Alfven eigenmodes (AEs) in DED magnetic configuration. An rf current (100kHz-1MHz, 4A) is applied on DED coil (3/1 and 6/2 modes) and the excitation of AEs including TAE are observed on the coil impedance and Mirnov signals. The coil impedance and excited rf magnetic fields by Mirnov coils are measured for various parameters of plasma density, B_t and DC DED coil current. The change of DED coil impedance due to the excitation of TAE is analyzed theoretically. Moreover, suppression of AEs induced by rf current on DED for the Ohmic plasma (I_p = 400 kA, B_t = 2.25 T, n_e~$2x10^{19}$ m^{-3}) is observed when the small error field is introduced by DC DED coil current (~500A). These results are interested in connection with the control of TAE in nuclear burning plasmas.

Tritium measurement by BIXS in decontamination

The potential application of β-ray-induced X-ray spectrometry (BIXS) as an analytical tool for the characterization of stainless steel waste was investigated. Stainless steel type 316 (SS316) specimens were loaded with tritium (0.6% T in D) at 573 K and 1.2 kPa over a total period of up to 5 hours. Depth profiles of the loaded specimens were obtained by chemical etching as well as BIXS. Complementary measurements by BIXS delivered tritium concentrations not only on the surface but also in the stainless steel bulk. Tritium on the surface was obtained by purging argon across the specimen holder and measuring the characteristic Ar(Kα) X-rays at 2.9 keV, induced by the β-rays of tritium. The results show that except for the surface, where the tritium concentration is comparatively high, most of the tritium is distributed homogeneously within the bulk. The data reveal a rapid decrease in tritium surface concentration over the first 200 hours; thereafter the decrease rate stabilizes at considerably lower values. This phenomenon can be understood in terms of a progressive and relatively rapid depletion of subsurface tritium; the concentration of tritium in the deep bulk undergoing a much slower change. The tritium measurement by BIXS is able to apply in the process of tritium decontamination.

Millimeter-Wave Imaging Diagnostics

By using an improved MIR (microwave imaging reflectometry) system, a new MHD mode with equally separated higher harmonics has been observed in the LHD plasma in the case of perpendicular ion heating. The mode appears as the density and magnetic fluctuations with the fundamental frequency of 1-10 kHz, which is much lower than the typical frequencies of Alfven eigenmodes. The mode is destabilized by both the high-energy ion and the pressure gradient at the rational surface. A frequency-selective-surface (FSS) band-stop filters, dual-dipole antennas for imaging array, and electronically-controlled beam shaping/steering phased array antennas (PAAs) have been fabricated using electro-fine-forming (EF2) microfabrication technology with collaboration among UCD, FOM, and Kyushu Univ. The devices are being applied to TEXTOR, LHD, and DIII-D.

Tangential Camera

We are developing a new type of the device, tangentially viewing VUV camera for the visualization of the edge MHD instabilities. It is basically a telescope using 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. In order to interpret the VUV radiation images, we have ported impurity transport code IONEQ, which has been developed by Dr. A. Weller. Thereby, we started to simulate the 2-dimensional image of the edge instabilities in the LHD device and the TEXTOR tokamak. We continue the experiments at the Large Helical Device, and HL-2A in china and wait for the opportunity for the experiments on the TEXTOR

Collective Thomson scattering for Ti measurement

Tanaka visited TEXTOR Julich, ASDEX-U IPP Garching, RISO National laboratory Denmark and Ruhr-Universitat Bochum during 2007/6/14~2007/7/9. The purpose of this visit is to get information and have a discussion about collective Thomson scattering (CTS) to measure bulk and tail ion distribution. Tanaka plans to install CTS in LHD. RISO group experienced CTS fro many years. The CTS was installed CTS system on TEXTOR and ASDEX-U. On TEXTOR, CTS has provided physics data. On ASDEX-U, CTS is under commissioning phase. RISO group showed CTS system on TEXTOR and ASDEX-U. Tanaka had a presentation about feasibility of CTS in LHD. From discussion with RISO group, the brief plan of CTS in LHD was made. In LHD presently available 77GHz Gyratron should be used, because power is high enough (~200kW) and pulse length is long enough (~5sec). The magnetic filed should be set around 2T on the magnetic axis. The fundamental (2.75T) and second harmonic (1.375T) resonance layers are very close to edge. So, effect of ECE radiation will be small. Although, the fundamental second harmonic resonances are out of last closed flux surface on TEXTOR and ASDEX-U, however, when density and temperature was high (~$1x10^{19}m^{-3}$,1 keV) in the scrape off layer region, ECE noise disturbed CTS signal a lot. It was suggested that careful setting of magnetic filed and plasma positioning are extremely important to get good enough signal noise ratio.

(Nakamura, Y.)