

(3) Physics and Engineering of LHD Torus and Heating Systems

Following collaborative works are performed this fiscal year along this line:

- R&D of LHD

R&D related to LHD includes following three topics:

- **Development for coating/jointing of tungsten on structure materials and evaluation of heat loading property, Tokunaga, K. (RIAM Kyushu Univ.)** Material properties of tungsten are investigated from the view point of coating/jointing to the structural material and heat loading properties. Several coating/jointing methods including HIP are tested and issues to be investigated are clarified.
- **R&D of high energy gamma-ray imaging system with tandem accelerator, Taniike, A. (Kobe Univ.)** Gamma-ray imaging system for detecting the distribution of energetic particle loss site emanating from DT and/or DD reaction have been proposed and tested using 1.7MeV tandem accelerator at Kobe Univ. The results show that the high energy escaping helium from burning plasma can be diagnosed well diagnosed by this method.
- **Overview of the Improvements of Data Analysis Environment, Emoto, M. (NIFS)** User-friendly environment to analyze the LHD experimental data is developed based on python data visualization tool. *AutoAna* system executes the updated analysis programs from necessary analysed data sets in chain, shot by shot. This system are developed and started service in LHD.

- R&D of Heating Devices

R&D related to heating devices are executed for the upgrading the present on going devices and advanced concept development for the near and long term system. Here, topics are categorized into ECH, ICH and NBI.

- ECH & ICH

Main efforts are focused on developing and realizing the new idea to upgrade and perform high performance monitoring the ECH & ICH system in LHD. These ideas are applicable in general ECH & ICH systems and actually applied or can be applied also to JT-60 SA,

QUEST *etc.*. Conventional workshops related to the high frequency covering from micro-wave to tera-Hz-wave were held and discussed up-to-date technology in this area.

- * **Development of CW High Power Transmission Line Component, Kubo, S. (NIFS)**
- * **Method of Mode Content Analysis Using Measured Signals by a Millimeter-wave Beam Position and Profile Monitor, Shimozuma, T. (NIFS)**
- * **Development of power and polarization monitor for EC wave, Makino, R. (NIFS)**
- * **Development of polarizers optimized for low ohmic loss and any polarization state in ECRH, Tsujimura, T. I. (NIFS)**
- * **Bloch Wave Cavity in Millimeter and Sub-MillimeterWave Regions, Ogura, K. (Niigata Univ.)**
- * **Direct Control of Magnetic Reconnection by Localized ECH and NBI Heating, Ono, Y. (Univ. Tokyo)**
- * **Technology Related to High Power Micro-, Millimeter- and TeraHertz-Waves, and Its Application to Plasma Heating and Diagnostics, Idei, H. (Kyushu Univ.)**
- * **Workshop on "Development and reactor application of ICRF heating device", Mutoh, T. (NIFS)**

- NBI

In the R&D of NBI system, main efforts are put on understanding the physical mechanisms of caesium seeded negative ion source and development of diagnostic and simulation method necessary for this purpose. The other important topics is related to the production of D⁻ beam and RF ion source.

- * **Overview of physics-based investigation of behaviors of charged particles in caesium seeded negative ion source for NBI, Tsumori, K. (NIFS)**
- * **Cs density measurement in arc driven negative ion source by means of laser absorption spectroscopy, Kisaki, M. (NIFS)**
- * **Flow of H⁻ ions in a Cs-seeded negative hydrogen ion source for NBI, Geng, S., (SOKENDAI)**

- * A New Measurement Method of Negative-Hydrogen Ion Temperature Measurement with Cavity Ring-down Technique, Nakano, H. (NIFS)
- * Development of Electric Field Measurement with Saturated-Absorption Spectroscopy for Negative-Hydrogen Ion Source Sasaki, K.*et al.*(Hokkaido Univ.)
- * Balmer- α Line Spectrum Measurement of LHD 1/3 Ion Source Plasma Wada, M. (Doshisha Univ.)
- * Integrated Modeling of Negative Hydrogen (H^-/D^-) Ion Production, Extraction and Acceleration in a Large Negative Ion Source for Neutral Beam Injection System Hatayama, A.(Keio Univ.)
- * Negative Ion Formation from Molecular Hydrogen Beam Injection onto a Complex Surface Sasao, M. (Doshisha Univ.)
- * Cs-free Negative Ion Production inside the Extraction Aperture of Plasma Grid Oohara, W. (Yamaguchi Univ.)
- * A Design Study of Photodetachment with Faraday Cup technique on NIFS Research and Development Negative Ion Source, Matsumoto, Y. (Tokushima-Bunri Univ.)
- * Electron transports at extraction region in a hydrogen negative ion source Matsumoto, Y.(Tokushima-Bunri Univ.)
- * Research and Development of Very Small Diameter, High-Density RF Plasma for Utilization of Negative Ion NBI, Shinohara, S.(Tokyo Univ.Agric.&Tech.)

(Kubo, S.)