# §1. Overall Examination of Tritium Transfer and Thermofluid Control in Fusion System

Okuno, K. (Shizuoka Univ.), Ueda, Y. (Osaka Univ.), Terai, T. (Univ. Tokyo), Kunugi, T. (Kyoto Univ.), Hatano, Y. (Toyama Univ.), Kimura, A. (Kyoto Univ.), Hasegawa, A. (Tohoku Univ.), Sagara, A., Muroga, T.

Recent fusion reactor designs require a high degree of performance for the first wall, blanket and recovery systems, for the purpose of enabling high efficiency energy production with advanced safety features and environmental benignancy. Toward the development of such systems, focused researches on the subjects extending over some component elements are required, as well as on specific subjects to each component element for its advancement. The fusion energy system is regarded as a system for producing and recovering tritium and heat. Thus its advancement particularly requires mechanism-based development of controlling technology for tritium transportation across the component elements, and for thermofluid of breeder/coolants which are responsible for recovery of tritium and heat.

Jpan-USA Fusion Cooperation Program in FY2001 to 2006 (JUPITER-II Program [1]) has aimed at establishing key technologies and their integration for some advanced blanket concepts. The results of the project showed feasibility of some materials performance under irradiation, compatibility of the candidate materials with breeder/coolant, and controllability of tritium and thermofluid in the blanket. However, the project did not cover tritium behavior in the environments of neutron irradiation and/or circulation of breeders/coolant, which are specific to fusion energy systems. In addition, since the tritium transfer and thermofluid control are common to the first wall and recovery systems, integration and advancement of component systems taking the overall system into account are necessary. Although most of the issues for the first wall, blanket and recovery systems are common to Magnetic Fusion Energy (MFE) and Inertial Fusion Energy (IFE) systems, there are some issues specific to MFE or IFE systems, which need to be investigated as efficiently as possible by the use of common research facilities.

The objectives of the next program (TITAN Program, FY2007-2012) are to show feasibility of self-consistent MFE and IFE systems through development of necessary technologies and their integration for tritium and thermofluid control throughout the first wall, blanket and recovery systems, and advancement of system design based on the construction of integration model. The following researches are proposed, as the new development, based on the achievements of JUPITER-II and relevant domestic research.

(1) Tritium and mass transfer in first wall, blanket and recovery systems.

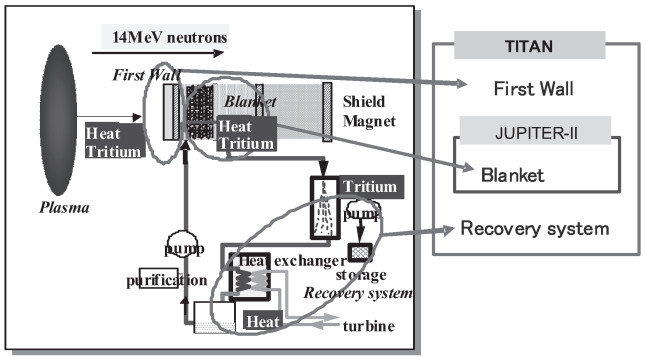


Fig. 1 Schematic illustration of the energy and tritium extraction system of fusion reactors. Also shown are the component system JUPITER-II and TITAN Projects cover.

(2) Interaction of tritium with materials under irradiation and its effects on materials performance.

(3) Thermofluid of liquid breeder/coolants under magnetic field, and construction of integrated model for MFE and IFE systems.

Fig. 1 illustrate the energy and tritium extraction system of fusion reactors. Also shown in the figure are the component system JUPITER-II and TITAN Program cover. As is seen in Fig. 1, the heat and tritium are transported continuously throughout the core plasma, first wall, blanket and heat exchange and tritium recovery systems. Although development of the respective component, including very advanced options, were carried out in the past programs, consistency of the components with respect to the overall tritium and heat control was not examined, and this is the major purpose of TITAN Program.

Based the present NIFS collaboration framework, extensive efforts were made to analyse the key feasibility issues throughout the first wall, the blanket and the recovery systems and decided the focal points of the collaboration activities in FY2007 and 2008. Also carried out was to review the domestic research activity relating with the subject of TITAN, and complementary roles of domestic and international collaboration researches were defined.

[1] Summary Report of Japan-US Joint Project (JUPITER-II) (FuY 2001-2006), eds. K. Abe, A. Kohyama, S. Tanaka, T. Muroga, C. Namba, S.J. Zinkle and D.K. Sze, NIFS-PROC-71 (March 2008, NIFS)