FUSION STUDIES IN JAPAN

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In New Strategic Energy Plan decided by Cabinet in April 2014, The Government of Japan declares steady promotion of nuclear fusion development activities, including the ITER project, which is being implemented through international cooperation, and the Broader Approach Activities from the long-term viewpoint. In addition, the MEXT (Ministry of Education, Culture, Sports, Science and Technology) has decided to prioritize four research areas; i.e., Tokamak, Helical, Laser and Fusion Engineering. The Government is promoting fusion energy development with a step-by-step program, and now Third Phase Basic Program, which aims to achieve self-burning plasmas and to set forth key elements of R&Ds for a DEMO reactor, is in progress. ITER is assigned as a core device in this third phase basic program. According to the Procurement Arrangement between IO and JADA, key components such as superconducting coil have been successfully fabricated. A joint JA-EU fusion research and development project called Broader Approach (BA) activities has been conducted since 2007, so as to establish a technological basis for DEMO as well as to play supporting and complementary roles for the ITER Project. In Rokkasho site IFERC(International Fusion Energy Research Center) and IFMIF/EVEDA projects have been implemented. The IFERC project covers DEMO design and R&Ds coordination. Prototype accelerator and liquid lithium loop have been developed in IFMIF/EVEDA project. In Naka site a superconducting device JT-60SA is just in assembly so as to start plasma operation by 2019. In addition to these tokamak research activities, Large Helical Device (LHD), which has intrinsic advantage and engineering capability of steady-state operation, has been promoted in NIFS.

Laser fusion research has been strongly supported along with magnetic fusion in Japan, and Osaka University is steadily promoting FIREX-I project in order to demonstrate scientific feasibility of fast ignition concept. In 2014 four beam lines of LFEX, which has a capability of high contrast 2PW laser, have been assembled, and commissioning experiments has started. Key issues for efficient fast heating more than 10% might be generation and transport of laser-produced electron beam. High pulse contrast experiments have successfully demonstrated the generation of moderate energy electron beam, and laser-driven capacitor-coil target experiments have been conducted to generate kilo-Tesla magnetic field for the beam convergence. Reactor design is quite important so as to assess the development goal with overall consistency for laser fusion reactors. Based on fast ignition concept, KOYO-F with wetted wall and FALCON-D with dry one have been designed, and engineering key issues such as high repetition laser, final optics and chamber wall have been pointed out. To mitigate technical gap between present device and commercial reactor, experimental plant LIFT was proposed in 2015.

Looking ahead to beyond-ITER project, discussion on organized framework for implementation throughout Japan towards establishment of technology bases for development of DEMO has been initiated in Japan, and several key problems such as divertor, blanket and so on have been identified for urgent R&D issues. Although DEMO is designed based on tokamak device, some of R&D issues are common to other concepts. For example, pulse heat load to divertor due to disruption in tokamak plasmas might be similar to that of chamber wall in laser fusion reactors. Synergetic R&Ds between magnetic and inertial fusion research might be important and effective to accelerate fusion reactor development.