

Development of Plasma Heating and Current Drive Systems for JT-60/U and JT-60SA

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JT-60U has developed and optimized operation concepts, and extended discharge regimes toward highly integrated performance in fusion reactor relevant plasma parameters. One of key factors to realize the high performance is to control actively profiles of plasma current, pressure, rotation and so on. Therefore, JT-60U has been equipped with several types of heating and current drive systems, such as ECRF, LHRF, ICRF, NBI systems, which work effectively as an actuator in plasma control system in addition to plasma heating and current drive. Recently, an effort for expanding the pulse duration more than 10s of the original specification has been made vigorously in the systems.

The ECRF system with output power of 4 MW at 110 GHz has been completed in 2005 using four 1 MW gyrotrons. The gyrotron has achieved 1 MW of output for 5s by suppressing the parasitic oscillation with SiC RF absorber built-in. The NBI system consists of negative ion based one (N-NBI) and positive ion based one (P-NBI), which have generated power of 5.8 MW at 400 keV of beam energy and 28 MW at 90 keV, respectively. In development work of N-NBI system, study of somewhat less withstanding voltage of the accelerator and excessive heat loads of its grids has been conducted. The LHRF system has 16 MW of output power with 16 high power klystrons at the frequency range of 1.74 to 2.23 GHz. It is useful to drive plasma current, in particular to control profile of the plasma current and to start up plasma current in a tokamak. Recently, development on carbon grill launcher has been concentrated because the tip of the launcher made of stainless steel has been damaged due to excessive heat loads such as plasma bombardment and RF breakdown. The performance of the launcher equipped with the carbon grills showed abilities as a high power LH launcher, for instance, moderate current drive efficiency. The ICRF system has 10 MW of generator output power at frequency range of 108 to 132 MHz, following improvement of the final amplifiers using the newly developed tetrode. RF power up to 7 MW at 116 MHz has been coupled to plasma.

JT-60SA project started in June 2007 as a combined project of JA-EU satellite tokamak programme under the Broader Approach Programme and JAEA's programme for national use. One of the features in JT-60SA project is extension of the plasma heating and current drive (H&CD) capability to 41 MW for 100s, involving improvement in the performance of the existing heating systems. The H&CD system consists of 24 MW/85 keV P-NBI and 10 MW/500 keV N-NBI systems, and 3 MW/110GHz and 4 MW/140GHz ECRF systems. The H&CD system will allow power densities in excess of those expected in ITER as well as capability to independently control heating, current and rotational profiles.

In this workshop, present status and future prospect of development on plasma heating and current drive systems for JT-60U and JT-60SA will be presented.