§57. Experiments of Fuelling by CT Injection on QUEST

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Compact toroid (CT) injection for deep fuelling in a fusion reactor has been proposed. Then CT injection experiment has been planned to study on advanced fuelling into spherical tokamak plasmas on QUEST. The CT injector of UH-CTI (the former HIT-CTI), the power supplies and the related equipment were moved to the Advanced Fusion Research Center in Kyusyu University in FY2005. Since then, CT injection had been conducted on the compact PWI experimental device of CPD to study dynamics of CT plasmoid in the penetration process and also to trial CT plasma exposure on wall materials.

The ST device of QUEST was designed to be operated at B_T= 0.25 T for a steady-state mode (B_T= 0.5 T for a pulse mode). Here, in simple theory, the required kinetic energy density of the CT plasma for injection in QUEST is less than 25% of that in JFT-2M at B_T= 1 T. The UH-CTI injector has a sufficient performance to be utilized as a fueller for ST plasmas on QUEST. Thus deep CT penetration is readily achievable. The CT injection experiment has been planned for the following purposes; 1.Exploration of possibilities to control CT penetration depth and particle deposition point by varying CT parameter, and the technological establishment for deep fuelling, 2.Research on interaction between a high-temperature plasma and a CT plasmoid (magnetic reconnection, helicity conservation, excitation of waves), 3.Investigation of ability of CT injection to assist ST plasma current start-up, 4.Attempt to drive plasma flow by tangential CT injection on poloidal or toroidal planes in ST.

In this year, in order to launch the CT experiment, the UH-CTI injector was removed from CPD and installed on QUEST as shown Fig.1. The injector was set up perpendicularly on the magnetic axis on the midplane. The lower docking stage for the CT injector had been fixed up in the last year. We also evaluated arrangement of the power supplies on the laboratory floor to prevent a decline in performance of CT formation and acceleration. In the power supply units, total inductance of the discharge cables has a considerable influence on discharge currents to form or accelerate CT plasmas. The units are optimized, each having 24 coaxial cables with 12-m long. While, for the power supply units for a bias poroidal coil and gas puff valves, the 50-m-long cables are acceptable. Therefore the power supply units for CT formation and acceleration were moved and set nearby the CT injector. Moreover the unit 1 should be put on top of the unit 2 owing to limited footprint. However the setting did not meet the quake-resistance standards. We need to provide a seismic strengthening structure for the piled-up units, and then have prepared that. The unit 1 still remains in the original location.

Measurement systems in CT injection experiments have been also prepared. A laser interferometer has been designed to measure density increment in QUEST. The density in a CT plasmoid ejected from the CT injector can be high of the order of 10^{21} m^{-3}. The increment is much higher than a predicted density of 1×10^{19} m^{-3} in an ST plasma with a plasma current of 100 kA. After these preparations, we intend to install the CT injector on QUEST and conduct the initial test of CT injection in the next fiscal year.

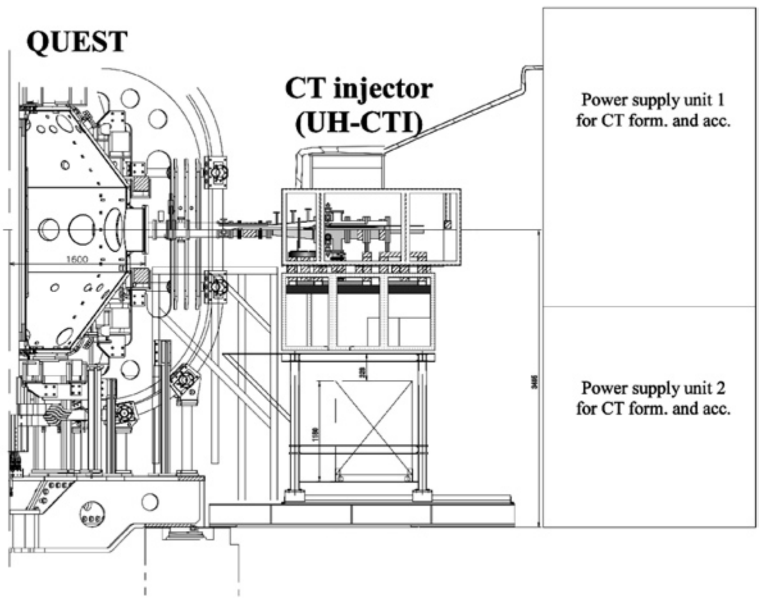

Fig. 1 Rendering of UH-CTI installed on QUEST and the power supply units for CT formation and acceleration.