§77. High Density ST Plasma Production by CT Injection in QUEST

Fukumoto, N., Nagata, M., Kikuchi, Y. (Univ. Hyogo),
Mitarai, O. (Tokai Univ.),
Hanada, K. (Kyushu Univ.)

Compact torus (CT) injection experiment has been conducted in the QUEST device. CT injection has been proposed as an advanced fueling method for fusion reactors. Central CT penetration into a magnetically confined plasma requires that a CT kinetic energy density should exceed the magnetic energy density of the toroidal field at the plasma center. The QUEST is designed for a spherical tokamak (ST) confinement at the toroidal field B_T= 0.25 T for a steady-state mode (B_T= 0.5 T for a pulse mode). The CT injector (UH-CTI) installed on the QUEST has a sufficient performance to penetrate into the tokamak plasma at B_T= 0.8 T. The injector can thus deposit fuel particles deeply in an ST plasma. The primary aim of the experiment is to produce a high-density ST plasma by CT injection fueling. The experiment is also planned to explore possibilities to control CT penetration depth and particle deposition point by varying CT parameters, to study interaction between a high-temperature plasma and a CT plasmoid (magnetic reconnection, helicity conservation, excitation of waves), and to investigate ability of CT injection to assist ST plasma current start-up.

In this fiscal year, CT injection experiment was conducted to optimize the conditions for effective and efficient fueling in ST plasmas. Plasma responses to a CT injection has been observed in OH ST plasmas with RF power injection. The CT injector is typically operated at the charging voltages of 17 kV and 25 kV for the CT formation and acceleration banks respectively. After CT injection an plasma current remains at more than 90% in an ST plasma. The non-disruptive CT injection is successfully obtained. In ST plasmas, electron temperature and density profiles can be observed by the Thomson scattering system developed by Drs. Takase and Ejiri group (the University of Tokyo). The scattering location is roughly the opposite side of the CT injection port as shown in fig.1. The Thomson system uses 1064 nm Nd:YAG laser operated in the Q-switched mode at 10 Hz. The trigger system is set up to synchronize the actions of the Thomson and the CT injector systems to observe electron temperature and density profiles for any time after CT injection. A measured radial density profile is shown in fig.2. The profile becomes more peaked immediately after CT injection and the peak density increases by almost three times. This indicates that a CT plasmoid penetrates deeply into an ST plasma, and the particles are deposited in the plasma core. The total deposited particles are estimated at 2.0×10^{18}. The number is, however, less than a predicted one due to CT injection. In the CT experimental setup, an extra drift tube (0.52 m in length) is installed between the QUEST and the CT injector. The presence of the tube might affect the CT plasma parameters, resulting in loss of CT fueling. In the experiment, it is also found that although the internal clock of the Thomson laser system has sufficient accuracy for a 10Hz operation, it is not the order of microsecond required to investigate the fast CT fueling process. The external clock of the laser system and the trigger system need micro-second accuracy to measure a density profile change due to CT injection. We have prepared the more accurate systems to synchronize the actions of the CT injection and the Thomson scattering. By using the modified Thomson system, we intend to perform the CT injection experiment mainly in OH ST plasmas to optimize CT parameters and QUEST conditions for effective and efficient fueling

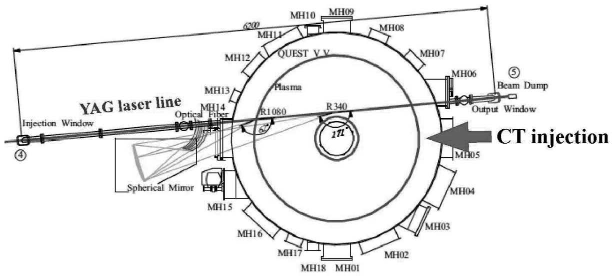

Fig.1. Arrangement of the Thomson scattering system and CT injection on QUEST

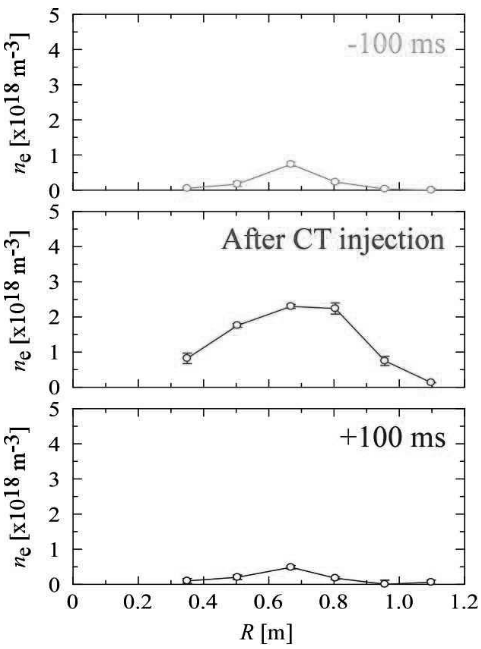

Fig.2. Density profile responses to a CT injection.