§54. Accelerated Compact Toroid Injection into the Spherical Tokamak CPD Device

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CT injection experiment has been conducted on the Compact Plasma wall interaction experimental Device (CPD) in Kyushu University to study on advanced fuelling into ST plasmas. However the fuelling process is not clear yet. Understanding the process is one of the critical issues for practical application of CT injection on reactor-grade tokamaks. We have recently focused on the investigation of dynamics of CT plasmoids in the penetration process on the ST device. Thus, for simplicity, CT injection into toroidal or vertical vacuum magnetic fields has been conducted.

In the experiment, the UH-CTI of a CT injector has been installed perpendicularly to the magnetic axis on the midplane of CPD. We have initially observed behavior of CT plasmoid and its trailing plasma injected into toroidal and vertical fields by using a fast camera (HPV-1, 1μs x 100 frames). The visible images were obtained. In Fig.1(a) for CT injection in vacuum without the magnetic fields, a frame of the movie data shows that CT plasma reaches the W-limiter wound around the center stack (CS) of CPD, while, in Fig.1(b) for that in a vertical magnetic field, a CT plasmoid is grazing by the right side of the limiter. When the direction of the magnetic field is from the bottom to the top of CPD, the CT plasmoid shift is right. In the opposite vertical field, the shift is left. Although such a CT shift motion has been observed in previous experiments on a tokamak device, the shift direction has depended on the toroidal fields. We also monitored increase in temperature due to impact of a CT on the target plate (SUS) installed in CPD to investigate the CT trajectory and the CT kinetic energy. Figure 2 shows trace of the peak point in the isothermal diagram on the target (at R =230 mm). The IR images were taken from the angle-A with the IR camera (TVS-700, 8-14 μm). Results indicates that CT shifts from y = 0 to 39 mm with increase of a toroidal field from 0 to 261G on the target plate. We measured rise in temperature due to CT impact on the target plate from the angle-B, and then estimated the heat deposition at 44 J, which is less than 10 % of the whole CT kinetic energy. The loss of the CT kinetic energy seems to occur during the CT penetration. These quantitative analyses will be following to understand CT fuelling process and optimize CT injection.

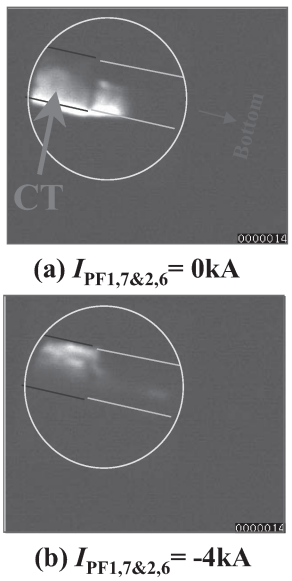

Fig. 1 Visible images of a CT penetrating into a vacuum without and with a vertical magnetic field.

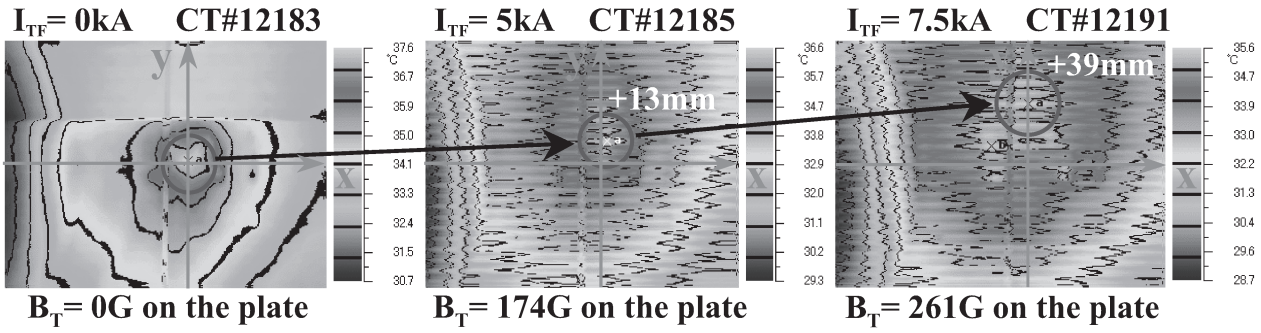

Fig.2 Observed IR images due to CT impact on the target plate.
These images are taken from the angle-A. The target plate is positioned at R = 230 mm.