§44. Behavior of Neutral Particle and Recycling in Spherical Torus Plasmas

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Investigation of behavior of neutral particle transport is important subject for evaluating particle and energy transport in torus plasmas. In particular, edge plasma – neutral interaction is much interesting subject from the viewpoint of long-lasting and steady state plasma production. QUEST is a medium sized spherical tokamak device whose chamber height is 2.8 m and radius is 1.4 m. The diameter of the CS is 0.4 m. The major (R) and minor radii of the plasma are 0.68 m and 0.4 m, respectively. Eight toroidal field (TF) coils produce the toroidal magnetic field, Bt ~0.25 T at R ~0.64 m. PF coils are used to create the vertical field, Bv. The magnetic field for plasma confinement is optimized by adjusting the TF and PF. The plasma discharge is sustained using hydrogen gas puffing and ECH by 8.2 GHz klystrons.

Figure 1 shows the photograph of the horizontal viewing port of QUEST vacuum chamber and the image fiber system with a medium-speed camera. This system consists of two-branched image fiber, CCD camera (HAS-220, DITECT INC.) and relay lens. The object side of the fiber is separated, which enables to observe the different image of the plasmas simultaneously. The frame speed of the medium-speed camera is 500 fps. An interference filter that transmits 75% of light at wavelengths from 650 nm to 690 nm is attached between the set of relay lens so that only Hα -light (656.3 nm) can be observed in the plasma. The camera is connected to a PC in the QUEST machine room. Two-dimensional images are captured during the QUEST experiment just after the PC in the machine room receives a trigger signal, which is synchronized with the start-up of the coil current. In Fig.2, Hα image obtained from the QUEST plasma.

Figure 3 shows Hα images captured by the medium-speed camera. Figure 3(a) shows the vertically extended plasma near the CS at 0.398 s. The slab structure is attributed to plasma production in the fundamental harmonic region by 8.2 GHz ECH. In Figs. 3(b) at 0.406 s and (c) at 0.414 s, the topology of these emission profiles changes and the emission peak shifts to the outer side. Figure 4 shows the time evolution of Ip and a contour plot of the medium-speed camera image data, which is extracted in the radial direction of the one vertical point indicated by a dotted line in Fig. 3(b), respectively. As these graph shows, the plasma current changed repeatedly, and the radial position of Hα emission correspondingly shifted at the inner($R < 1.0$ m) and outer($R > 1.0$ m) regions. Interestingly, both cycles were completely the same. When Hα emission had a peak in the inner region, Ip became higher than the Hα emitted in the outer position.

1. H. Zushi, et al. 22th IAEA Fusion Energy Conf. EX/P4-12 (13-18 October 2008, Geneva, Switzerland).
2. Y. Higashizono et al. Proc. 7th General Scientific Assembly of the Asia Plasma and Fusion Association, (October 27-30 2009,Aomori, Japan).

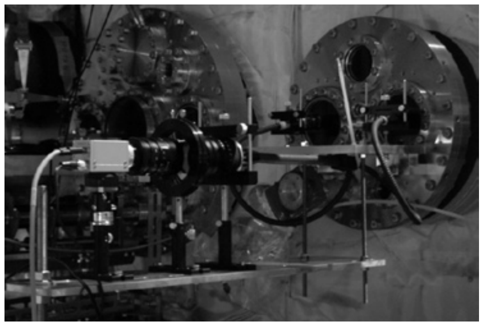

Fig. 1 Photograph of the medium-speed camera and imaging fiber system.

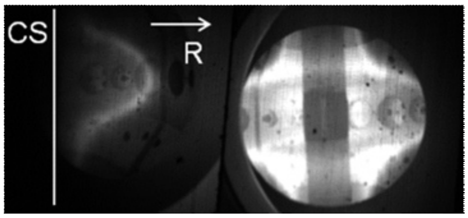

Fig. 2 Hα image of the QUEST plasma

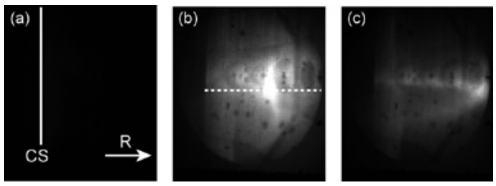

Fig. 3 Hα image of the QUEST plasma

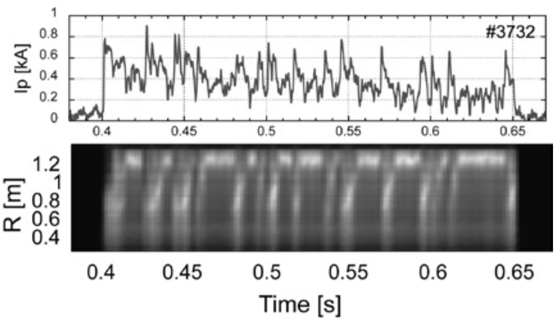

Fig. 4 Time evolution of Ip and contour plot in radial direction of Hα emission captured by medium-speed camera.