

§42. Study of Hydrogen Recycling and Neutral Particle Behavior in Spherical Torus Plasmas

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In magnetically confining plasma devices, investigation of hydrogen recycling and neutral transport is an important subject for understanding edge plasma behavior and for the estimation of particle confinement characteristics. In spherical torus plasmas, such as compact torus devices, the analysis of neutral transport becomes complex due to the three-dimensional configuration of the system. The objective of this study is to investigate the behavior of hydrogen recycling based on the $H\alpha$ line-emission measurement and 2-D image measurement using high-speed CCD camera in the spherical tokamak QUEST.

Figure 1 shows the schematic view of QUEST and the CCD camera mounted in front of the horizontal view port. The CCD camera (HAS-220, DITECT Inc.) captures 2-D plasma light-emission with the frame rate of 1 kHz. An interference filter with $H\alpha$ wave range is attached in front of a lens so that only $H\alpha$ -emission related to the neutral particles in the plasma can be observed.

The CCD camera is connected to the PC in the machine room. Three types of software (camera-control software, mouse-control software and image-view software) are installed in the PC. With the trigger signal, camera-control software starts to capture the 2-D images and save into the PC's memory. The mouse-control software automatically controls a mouse function. It automatically labels the 2-D images with a name of the plasma discharge number and saves into the hard disk. In Fig. 2, a captured picture obtained from PC display of the first shot in QUEST by the above monitoring system.

Figure 3 shows the time evolution of 2-D visible image of the QUEST plasma observed in the coil-current ramp-up experiment. In this experiment, the coil current of pf coil is gradually increased and the resultant change of the plasma parameter and its profiles are investigated. In each figure, the left side corresponds to the center stack (CS). In the beginning of the plasma start-up ($t = 0.774$ s), the light emission is localized near the equatorial plane and then expanded vertically together with the increase of the plasma current ($t = 0.894$ s). The light emission is diminished near the outer region along with the decrease of the plasma current and the plasma is shifted to CS ($t = 0.954$ s). It is considered that the closed magnetic surface is not established during this discharge.

A plasma monitoring system consist of high-speed CCD camera is installed on QUEST. By using this system, we

succeeded in observing the first plasma of QUEST and the behavior of the plasma was investigated. This results show that the 2-D image measurements is a powerful tool for the investigation of plasma motion and plasma edge behavior.

- 1) Y. Higashizono, Y. Nakashima, *et al.*, Jpn. J. Appl. Phys. **47**, No.5 (2008) 3615-3620.
- 2) Y. Nakashima, RIAM forum, June 6th, 2008. Kyushu Univ.

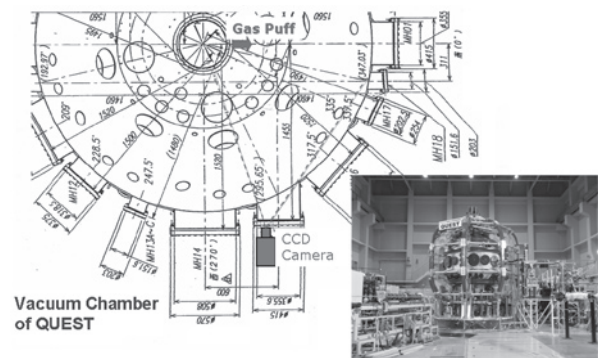


Fig. 1 Photograph of the CCD camera mounted in front of the horizontal view port of CPD.

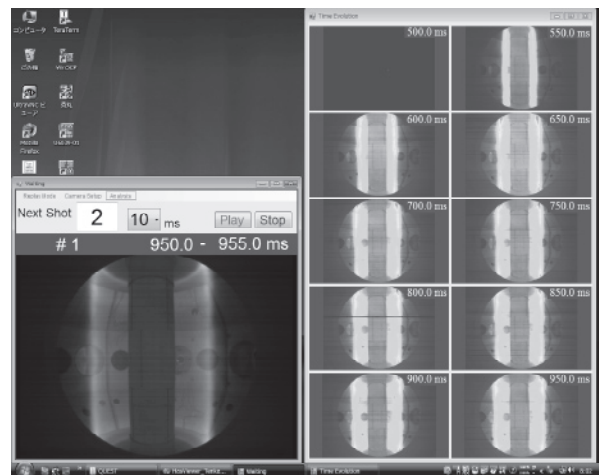


Fig. 2 A captured picture from the PC display of the first plasma of QUEST.

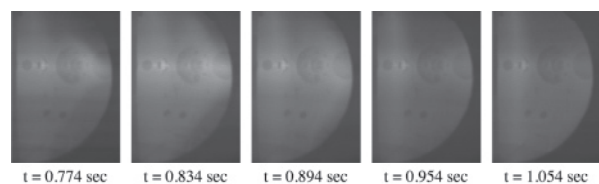


Fig.3 Time evolution of 2-D visible image of the QUEST plasma observed in the pf-coil current lamp-up experiment