§47. QUEST Plasma Measurement Using a Fast Video Camera

Nishino, N., Izuka, T., Mio, T. (Graduate School of Engineering, Hiroshima Univ.),
Zushi, H., Hanada, K., Yoshinaga, T., Honma, H. (RIAM, Kyushu Univ.)

QUEST (Q-shu University Experiment with Steady State Spherical Tokamak) is the middle sized ST machine in Japan and it is built to study the steady state operation for the next step machine of ST.

In the initial stage of QUEST project the measurement of the plasma shape and plasma position is very important to make the ST plasma steady, i.e. it is useful to adjust the coil currents and heating power to achieve the ST plasma equilibrium.

Two fast cameras were used to measure the plasma light with two-dimension. One is ULTIMA-SE (Photron Inc.), and the other is FX-K5 (Nac image technology). The start-up experiment was often used RF system of 8.2GHz, 200kW and Ohmic discharge (CS solenoid with cancellation coil). Figure 1 shows typical waveform at plasma start-up experiment.

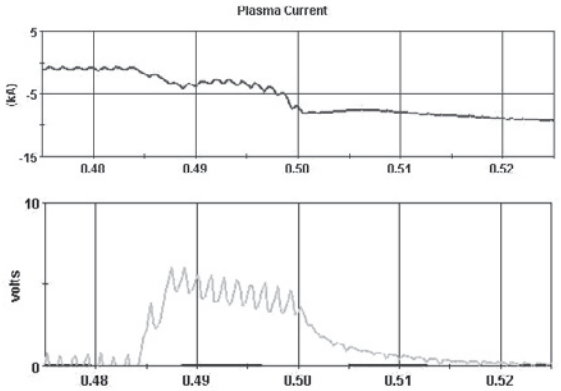

Fig.1 Waveform of plasma current at start-up (#1456)
Top: plasma current (downward)
Bottom: Volt*s (upward)

Ohmic current started at ~0.487s, but the plasma current did not rise simultaneously. The plasma current will rise at 0.495s and increase to ~5kA rapidly until 0.5s. After that it seemed that the plasma current was sustained by ohmic coil current because of Volt*sec consumption. In this shot RF power was constant during 0 to 0.6s, and the initial plasma was created by 2.45GHz RF. Therefore, the plasma current lasted to the end of RF, however, the current of several kA cannot obtained by RF only.

Figure 2 shows the fast camera images with 13500 frames per second (128x128pixels) at the same shot shown in Fig.1. Time marched left image to right image and upper column to lower column. First the bright emission was found near the CS (left image of the upper column), and this emission region enlarged and its figure seemed to be donuts (center image of the upper column). This donuts shape enlarged more (right image of the upper column), and it separate from CS with time (images of the lower column). The time of the last image is ~0.5s, and the current is almost peak value. In the images the closed flux surface was confirmed at least until 0.5s. In this experiment plasma shifted to the outer side due to the weak vertical field. These serious images gave us information on the plasma formation precisely. However, it was still questionable mechanism on the plasma current sustainment by RF after 0.52s, i.e. Volt*s of the ohimc coil was almost consumed. The clue might be the high energy electrons produced by RF. This should be resolved by X-ray detector.

Summary

It was very good season to get information on the plasma start-up and heating power adjustment. Using fast cameras is very powerful tool to understand the mechanism of the formation of plasmas at the initial stage. We have to research the formation and behavior of QUEST plasma with fast cameras and other measurement system. The combination of the Langmuir probe and fast camera is planned next year. Also, new coil power system enables us to sustain the plasma current up to 0.5s with ohmic current only. Therefore, it is hoped that the steady state ST plasma (first aim of QUEST) will be achieved.

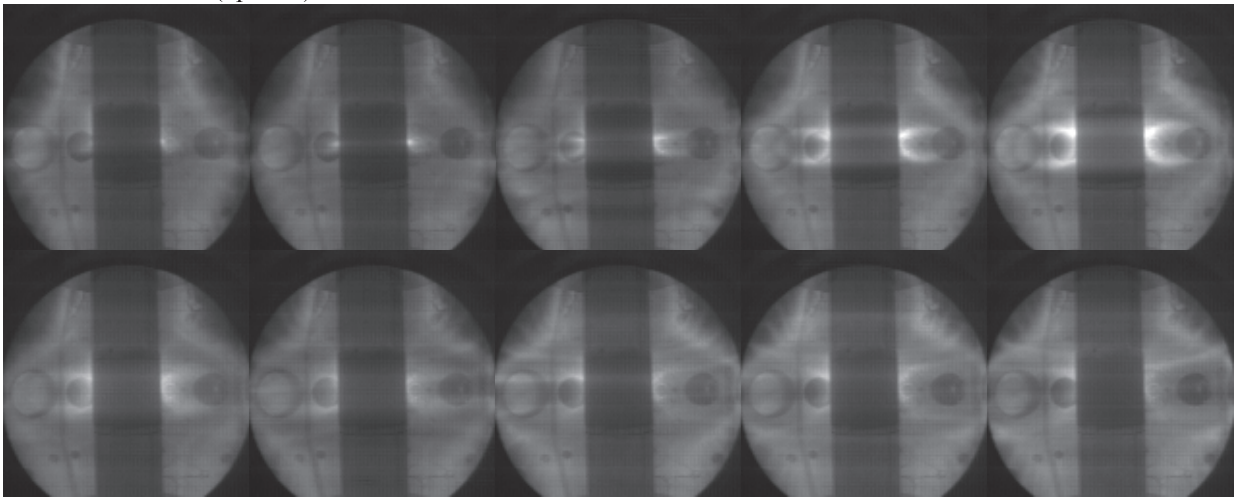

Fig.2 Camera images of the ohmic discharge with RF start up (#1456, initial time=0.498s, δt=222μs, time marches left to right images and upper column to lower column) The center stack (CS) can be seen in each image.