§70. Development of a Thomson Scattering System for the QUEST Spherical Tokamak Device

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QUEST is a spherical tokamak device aiming at steady state operation sustained by electron Bernstein wave. In order to obtain the electron temperature and electron density profiles of the QUEST plasmas, an efficient and compact Thomson scattering system has been developed. These profiles are necessary to estimate the slowing down time of the high energy electrons, which are believed to be the carrier of plasma current in QUEST. Furthermore, the electron density profile is necessary to study the RF wave propagation, mode conversion, current drive and heating.

In fiscal year 2014, an external laser control system has been developed. With the internal control system, the laser is fired with an internal timing (10 Hz), and it was difficult to follow a fast phenomenon, such as density evolution due to gas puff or compact torus injection. Figure 1 shows the schematic drawing of the external laser control system. Before the start of a discharge, laser is fired at 10 Hz by the synchronous circuit to warm up the laser and make it stable. At t = 0 s, a trigger from QUEST pulsar reset the circuit, and the laser timings are synchronized to the QUEST discharge sequence. Simultaneously, the fast oscilloscopes are triggered. Since the memory of the oscilloscopes are finite, the oscilloscopes are triggered at 10 Hz, and each scattering light is recorded. In order to confirm the laser firing and measurement timings, the trigger pulses to the oscilloscopes are deformed by the timing monitor circuit and fed to a slow digitizer. Using the external laser control system, we can set the measurement timing precisely. By measuring reproducible phenomena with slightly different laser firing timings, we can follow the fast phenomena with a high sampling rate much faster than the laser firing frequency of 10 Hz.

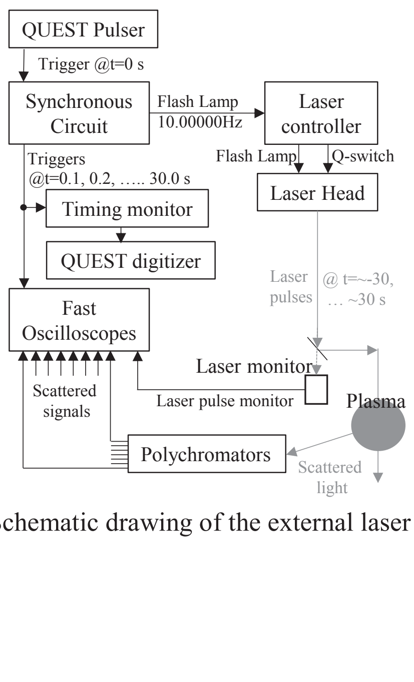

Fig. 1 Schematic drawing of the external laser control system.

Figure 2 shows the response of the plasma to gas puff. The plasmas were sustained by ECH (8.2 GHz, 40 kW), and the driven plasma current was 1.8 kA. Additional gas was injected at t = 5.0 s. The laser was fired at 3 different timings. From the figure we can see that the electron temperature and the density vary significantly within 0.3 s. Figure 3 shows the temperature profile and density profiles just before (t=4.91 s) and just after (t=5.11 s) the gas puff and during the recovering phase (t=5.51 s). The large effect at the inboard channel (R=340 mm) is probably due to the fact that the gas was injected from the inboard side.

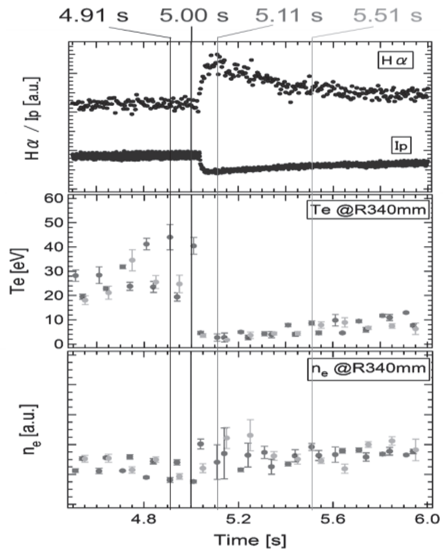

Fig. 2 Time evolution of the plasma current and Hα emission (a), the electron temperature (b) and the density (c) at R=340 mm, which is close to the inboard boundary.

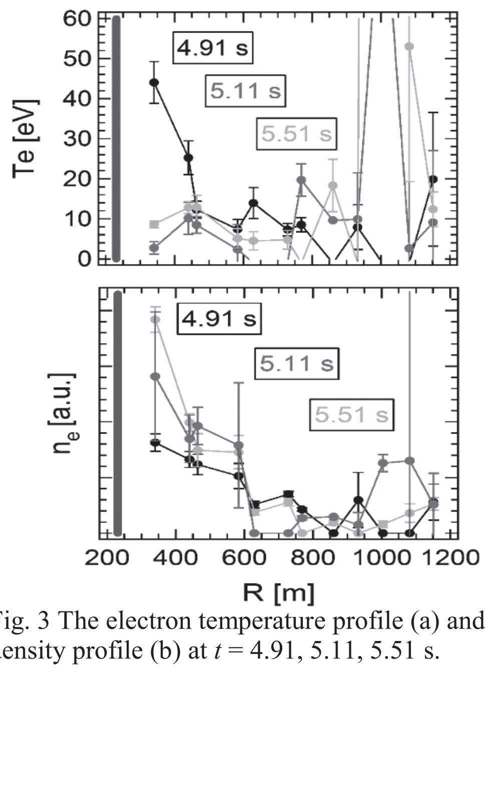

Fig. 3 The electron temperature profile (a) and the density profile (b) at t = 4.91, 5.11, 5.51 s.