§57. Experiments of the Plasma Current Start-up by Ohmic and RF in QUEST

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1. Introduction

In a spherical tokamak (ST) a larger plasma current can be flown with the larger safety factor in the lower magnetic field compared to a high aspect ratio tokamak. This is favorable to achieve ignition. However as the flux of the central solenoid (CS) is limited, it is difficult to ramp up large plasma current. In addition, the divertor coil current has the same direction of the plasma current, its induction reduces the plasma current. Therefore, careful operation is necessary in a ST with the small CS flux.

In this fiscal year, the CS flux to obtain the plasma current of 40 kA is experimentally compared in the divertor and limiter operations with the same major radius, which keeps the plasma external inductance identical.

2. Inner and outer divertor operation with 40 kA

Inner and outer divertor series connected operation was first tried for comparison. Figure 1 shows the OH discharge waveform with divertor for the plasma current of 40 kA. Near the current peak, the central plasma position is around 0.8 m, the CS current is changed from -8 to -2 kA, with the difference of ΔI_{CS}=6 kA. The initial divertor coil current was -1 kA, and increased to -1.9 kA to reduce the reverse induction.

Plasma flux surface calculated by EFIT code are shown in Fig. 2 (Dr. Xia in SWIP) at the peak plasma current. It is seen that the divertor configuration has been generated.

3. Limiter discharge with 40 kA

For comparison, the limiter discharge with the identical major radius were produced as shown in Fig. 3 by adjusting CS, and vertical field. The plasma current of 40 kA was induced by the difference of the CS coil current was ΔI_{CS}=5.5 kA.

Thus, the divertor operation needs more CS flux to achieve the plasma current. In the inner divertor operation, CS flux to achieve 40 kA were just between these values, because the reverse induction effect from the inner divertor coil is weaker. This result may imply that snowflake divertor is better suitable to induce the lager plasma current than super-X divertor.

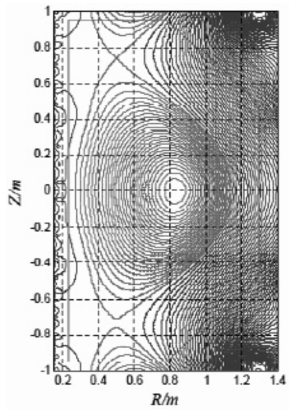

Fig. 2. The preliminary reconstructed magnetic flux surface by the EFIT using 12 flux loops at t=1.39 s. (#17050).

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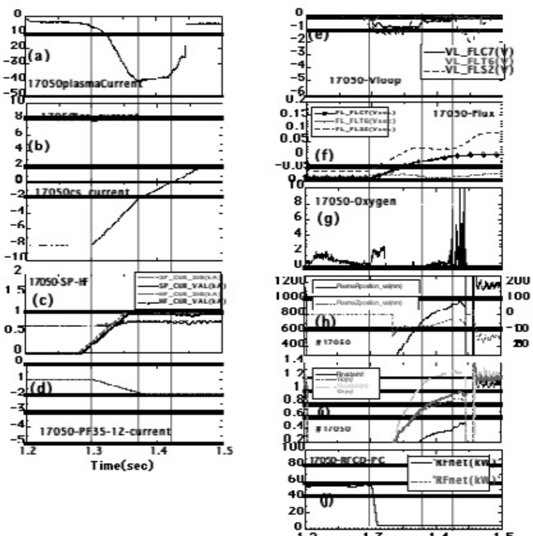

Fig.1. The plasma current evolution in ohmic discharge with the PF35-12 divertor like operation. (#17050) (a) Plasma current (b) CS current with B-coik current, (c)PF26 vertical shaping coil current and PF17 vertical field coil current, (d) PF35-12 divertor coil current, (e) loop voltage measured at three locations, (f) measured fluxes at three locations, (g) oxygen impurity line, (h) horizontal and vertical positions of the plasma center, (i) the plasma edge positions, and (j) 8.2 GHz RF power.

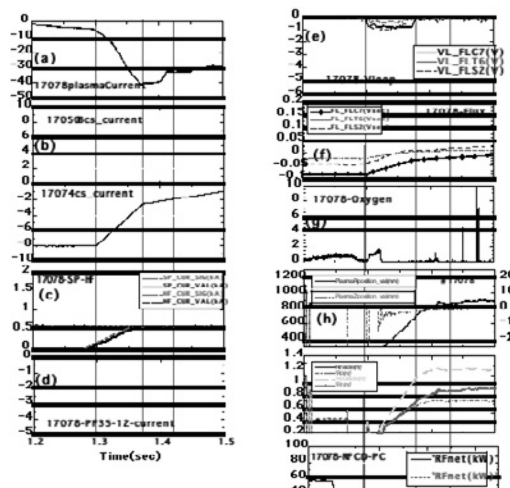

Fig. 3. The plasma current evolution in ohmic discharge with the limiter operation. (#17078) (a)-(i) are the same as in Fig. 1. (Note: The timing of RF should be corrected by 0.1 s due to time recording error.)