§6. Observation of Plasma Termination Processes at the End of Long Pulse Discharges in LHD

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In the Large Helical Device (LHD), long pulse discharge experiments have been performed mainly with ICRF by hydrogen minority heating in helium plasmas. In many cases, LHD plasmas in the long pulse discharges were suddenly terminated under conditions where the plasmas had been almost stably sustained.[1)]

In order to investigate the termination processes of the long pulse discharges, two fast framing cameras were newly installed in tangential ports and upper ports for monitoring the plasma behavior and plasma-surface interactions on divertor plates in the vacuum vessel in addition to standard video rate (30fps) CCD cameras for monitoring plasma discharges equipped at totally 23 different ports.

In the last experimental campaign (the 17th cycle), a long pulse plasma discharge had been successfully sustained for about 48 minutes by modifying ICRF antennas, introducing a newly designed ICRF antennas, and improving gas fueling control system, etc. The average electron temperature and density sustained in the long pulse discharge were about 2keV and $1.2\times10^{19}m^{-3}$, respectively. The total heating power injected from ICRF and ECRH antennas was about 1.2MW.

Figure 1 (a) is an image of the LHD plasma viewed from an outer port (5-O) at the end of the long pulse discharge taken with the standard CCD camera. It shows that there are many flight paths of incandescent dusts released from a lower divertor region in the inboard side of the torus (4-I) with sparks. Figure 1 (b) is an image of the plasma observed with the fast framing camera installed in an upper port (4.5-U) at the end of this discharge, which proves that a large amount of small dusts were released from the lower and inner divertor region (4-I). The observations with the fast framing camera clearly shows that the dusts released from the divertor region penetrated into the maim plasma and caused radiation collapse, which finally led to termination of the long pulse plasma discharge.

Long pulse plasma discharges with high heating power (>3MW) were also tried in the last experimental campaign. Plasma had been successfully sustained for about 220 seconds with abrupt termination of the discharge. Figure 2 gives the tangential image of the LHD plasma viewed from a tangential port (6-T) at the end of the long pulse discharge. A fast framing camera installed in the tangential port observed the drop of a large sized melted dust from an upper area inside of the vacuum vessel. The camera clearly took the plasma termination process by the drop of the large sized dust.

The above two observations taken with the fast framing cameras can contribute to finding the reason for the termination of the long pulse discharges and to extending the plasma duration time in LHD.

1) Mutoh, T. et al.: Nucl. Fusion **53** (2013) 063017.

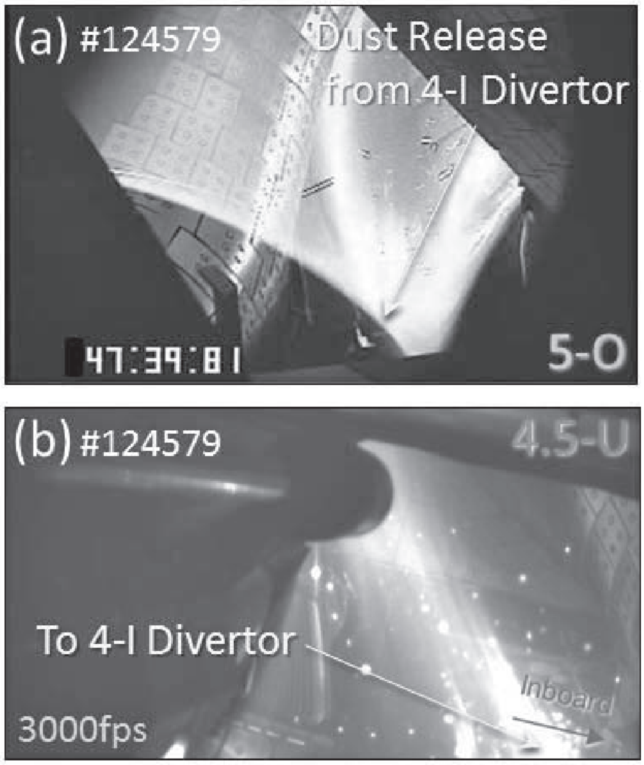

Fig. 1. Image of a LHD plasma viewed from an outer port (5-O) at the end of a long pulse discharge taken with a standard video rate CCD camera (a), an image taken with a fast framing camera installed in an upper port (4.5-U) at the end of the discharge (b).

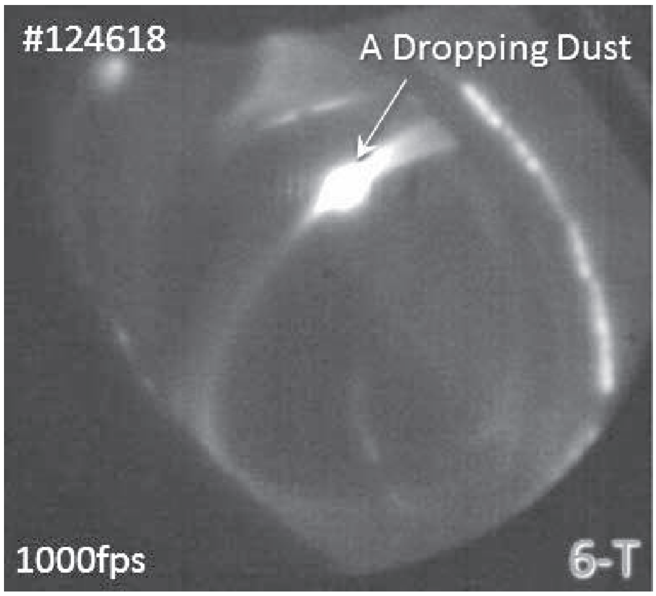

Fig. 2. Tangential image of a LHD plasma observed from a tangential port (6-T) taken with a fast framing camera at the end of a long pulse discharge in high heating power operation.