§62. 2-D PSD Diagnostic System Measuring the Pellet Trajectory in LHD Plasmas

Hoshino, M. (Nagoya Univ.), Sakamoto, R., Yamada, H., Kumagai, K. (Grad. Univ. Adv. Stud.), Kumazawa, R., Watari, T.

The pellet penetration depth evaluated from H_α line emissions without spatial resolutions in the Large Helical Device (LHD) can be partly explained by the NGS ablation model [1]. However, a deflection of the pellet trajectory due to the rocket effect which pellets undergo an anisotropic heating of energetic particles by the neutral beam injection (NBI) has been observed [2]. This causes the variation of the position where the pellet ablates and consequently leads to an error on the estimation of the penetration depth. Therefore, diagnostics which enables the position detection with high time and spatial resolutions [3] is required for accurate comparison of the experimental observation with the result of the theoretical ablation model. The system of the position sensitive detector (PSD) diagnostics is installed to obtain 2-D experimental data of the pellet trajectory in NBI heated plasmas.

The PSD is set on the chamber connecting the pellet injector and the outer port of LHD as shown in Fig. 1. The light emission of pellet ablation from the plasma is detected by using the mirror which reflects and bends up the light, and the light through the H_α filter is focused to the acceptance surface of the PSD by the lens. The viewing angle is 6° and the subsequent view of this system is a circle of ~40 cm in diameter at the last closed surface of the vacuum magnetic configuration in LHD plasmas. After installing the PSD chamber, the alignment is assessed to correct the installation error. There is the misalignment of the angle of ~1.5° at the maximum. The initial pellet trajectory and the real position of the PSD axis are useful for precise estimation of the penetration depth. On experiments for the calibration, it is also confirmed that the PSD detects the position of the light of 1 cm in diameter within the error of a few centimeters at the maximum.

The signal of H_α line emissions in the pellet fueled experiment # 70848 is compared with the total of four PSD outputs as shown in Fig. 2(a). The start time of the ablation can be estimated by assuming the location of the last closed surface of the vacuum magnetic configuration in LHD plasmas and the unchanged pellet velocity measured before the injection. Pellet penetration depth assessed by 1-D H_α signal is 0.58 m, where the pellet velocity and the duration of the ablation are 1185.43 m/s and 0.49 ms, respectively. The pellet trajectory on the discharge is measured by PSD diagnostics as shown in Figs. 2(b1)-(b3). The initial trajectory of pellets is represented by an arrow. The PSD output which is different from the behavior of H_α signal in Fig. 2(a) must not be also used as identified by dashed lines. Since the tangential neutral beam #1 toward the counter direction is only injected to LHD plasmas, the deflection of the pellet to the same direction is demonstrated in Fig. 2(b2). This conclusion supports the experimental results using the fast camera on LHD [4]. The problem that the initial position of pellet ablation is misaligned on the direction of X_{PSD} and Y_{PSD} in Figs. 2(b2) and 2(b3) may be also derived by shifts of the barycenter of the light spot due to the X point in the viewing field of the PSD. The time response being a present issue on this system must be also improved by converting the amplifier of the PSD in the future study.

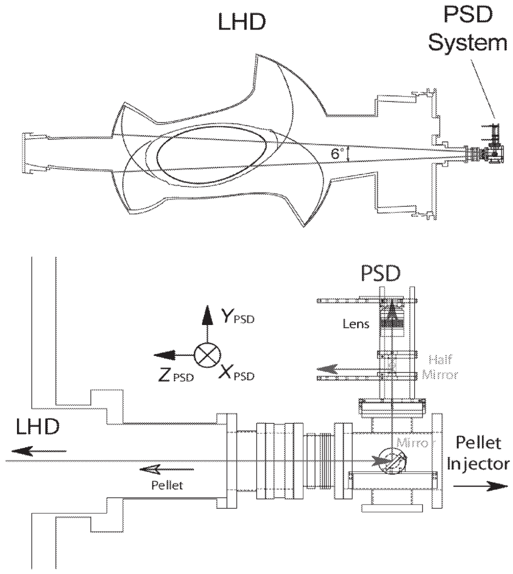

Fig. 1 Viewing field of the PSD and schematic diagram of the PSD system installing in LHD.

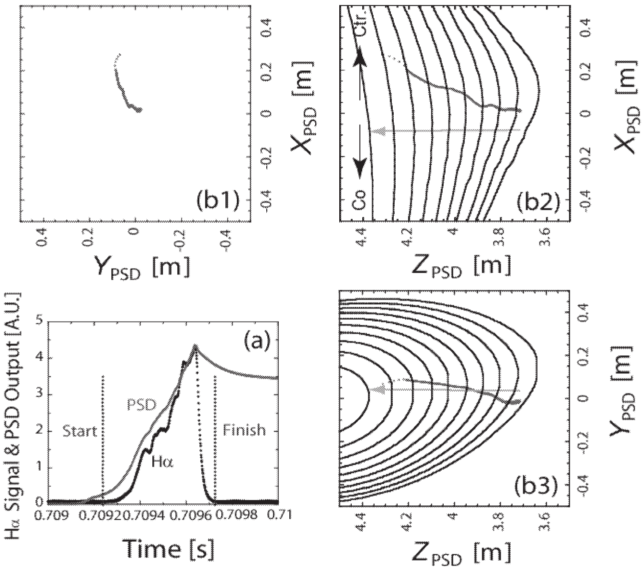

Fig. 2 In the LHD experimental shot #70848, (a) comparison with H_α signal and the total of PSD outputs, and the pellet trajectory observed by the PSD in (b1) X-Y, (b2) X-Z, (b3) Y-Z plane.

Reference

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