§47. Fueling Scenario in LHD

Yamada, H., Sakamoto, R., Kato, S., Sudo, S., Yamazaki, K., Motojima, O.

Plasma fueling is one of primary technologies in fusion experiments. As plasmas have become hotter in the progressing larger experiments with long pulse duration, it has been widely recognized that present fueling are not necessarily compatible with next-generation experiments. Conventional but sophisticated fueling devices are in preparation in time with the initial experiment in LHD. Also LHD provides a good platform for examination of advanced and innovative techniques of fueling and pumping.

Gas puff is the most conventional as well as reliable technique. To prevent localized accumulation of neutrals, 9 gas inlets are distributed. Gas quality is controlled with the order of 10 ppb to keep impurity inventory in the plasma vacuum vessel as low as possible. Maximum flow rate is 300 Pa m^3/s for hydrogen. The characteristic response time of control is less than 50 ms. A gas puff device is also used for suppression of plasma current generation during coil-current dumping. In particular, large amount of argon gas is fed at the accident of coil quench.

A fueling pellet injector will be available in the second campaign of LHD experiment. Design concept of this device lies in high reliability and maintenance free since pellet injection is considered as a key element of fueling equivalent to gas puff. Conventional 10 -barrel pipe gun and closed cryogenic circuit have been adopted for this objective. Pellet size is available for 1.5mmϕ, 2mmϕ, 3mmϕ and 3.8mmϕ diameter, which provides 1.4×10^{20} to 3.5×10^{21} hydrogenic ions to LHD plasmas. Figure 1 shows the range of fueling drawn on the international pellet ablation database. Ablation process has been analyzed for typical LHD plasmas (see Fig.2). Except for low temperature plasmas with 1 keV, pellets cannot reached in the central region. High-field-side injection as an option is planned to improve deep penetration and efficient fueling.

Innovative research and development of compact torus injection has also been started for direct plasma fueling into the central region as well as drilling LHD plasma.

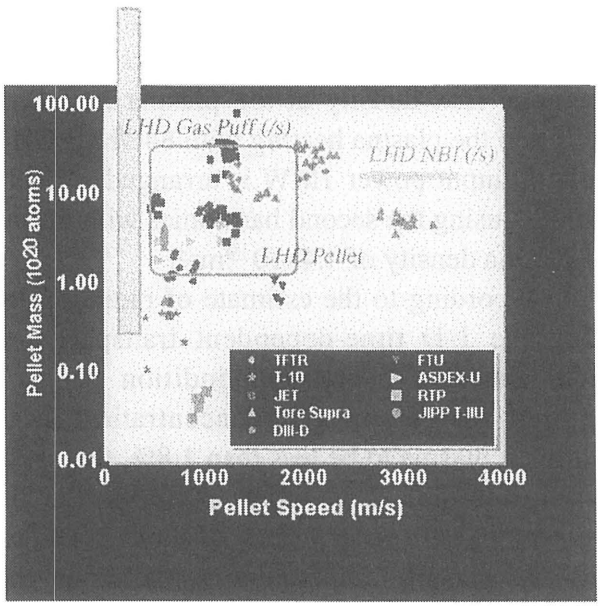

Fig.1 Fueling range of various schemes in LHD

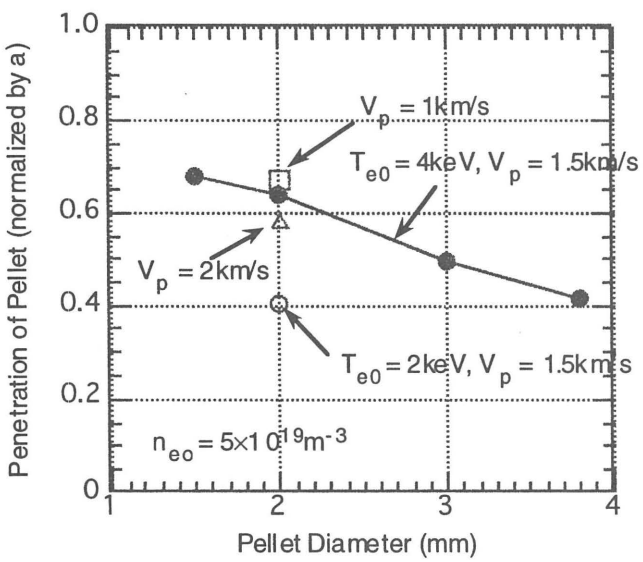

Fig.2 Penetration depth of pellet injection