§7. Getting High-Beta Profile Data in LHD for Extrapolation to FFHR-d1

Miyazawa, J., Goto, T., Sakamoto, R., Motojima, G., Morisaki, T., Masuzaki, S., Suzuki, Y., Suzuki, C., Sagara, A.

The reactor core plasma design for FFHR-d1 is being carried out using the Direct Profile Extrapolation (DPE) method [1]. To obtain the better plasma properties in the reactor, high-beta profile data are needed. In the 15th cycle LHD experiment in 2011, we have tried to obtain high-beta profile data at two magnetic configurations of 1) B_Q = 57 % and γ_c = 1.254 at R_{ax} = 3.70 m, and 2) B_Q = 100 % and γ_c = 1.20 at R_{ax} = 3.60 m, in collaboration with the LHD project.

The former is the magnetic configuration similar to that in FFHR-d1, where two poloidal magnetic coils called the IS coils in LHD are omitted to maximize the maintenance port [2]. Then, the averaged plasma cross section becomes vertically elongated. From the experimental results, the vertical elongation was shown to be effective for Shafranov shift mitigation. Furthermore, the effective plasma volume in the vertically elongated configuration given by the "*tsmap*" becomes 10 – 20 % larger than those in the standard configuration of B_Q = 100 %, where the averaged plasma cross section is circular. Because of these effects, the parameter C_{exp*} used in the DPE method [1], which can be used as a measure of the plasma performance and the smaller C_{exp*} is the better, also becomes smaller in the vertically elongated configuration. The smallest C_{exp*} has been obtained at R_{ax} = 3.70 m (Fig. 1). This might presumably be reflecting to the better confinement property in the inward shifted configurations.

The latter configuration with γ_c = 1.20 is also a strong candidate for FFHR-d1, since the plasma aspect ratio becomes high and the blanket space can be increased compared with γ_c = 1.254. The Shafranov shift is strongly mitigated in this configuration (Fig. 2(a)). However, the effective plasma volume becomes smaller due to the smaller plasma minor radius (Fig. 2(b)). Furthermore, the achievable density and beta are lower than those in the normal configuration of γ_c = 1.254 (Fig. 2(c)). The reason of this is not understood yet. At least, however, the small plasma volume might be increased by the vertical elongation. The experiments at the γ_c = 1.20 configuration with vertical elongation are being planned for the 16th cycle LHD experiment.

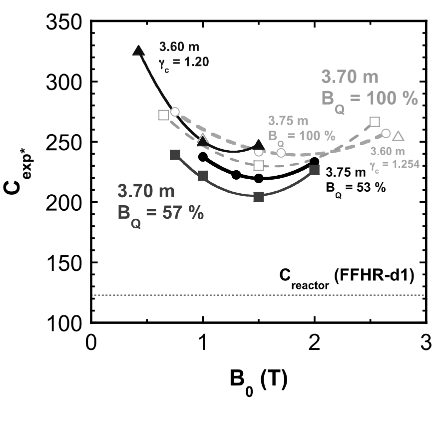

Fig. 1. Relation between C_{exp*} and B_0 in various magnetic configurations.

1) J. Miyazawa, et al., Fusion Eng. Des. **86** (2011) 2879.
2) J. Miyazawa, et al., Ann. Rep. NIFS (2011) 23.

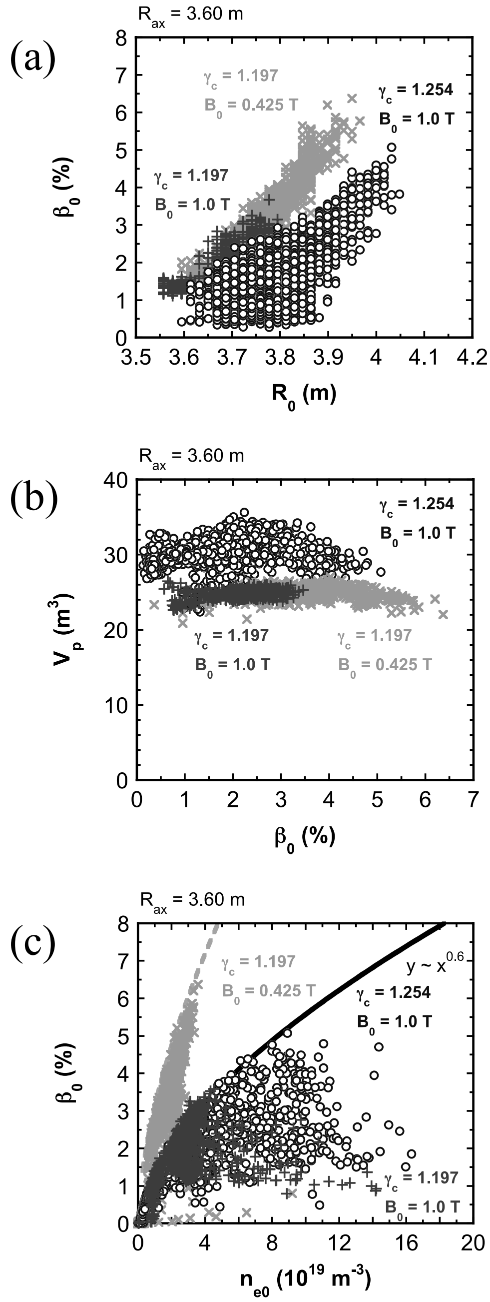

Fig. 2. Relations between (a) the magnetic axis position, R_0, and the central beta, β_0, (b) β_0 and the effective plasma volume, V_p, (c) n_{e0} and β_0. Open circles denote γ_c = 1.254 while plusses and crosses denote γ_c = 1.20. The curves in (c) denote the gyro-Bohm type parameter dependence of $\beta_0 \propto n_{e0}^{0.6} B_0^{-1.2}$.