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Investigation of parameter dependence of density profile peaking for H-mode positive magnetic shear plasmas in JT-60U

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For the purpose of realizing a future nuclear fusion plant by magnetic confinement devices, a density profile shape is one of the important factors in terms of plasma confinement and stability. Density profiles of ELMy H-mode plasmas in the several magnetic confinement devices were being peaked with decreasing collisionality [1-4]. In addition, as a toroidal rotation increases in a counter-current direction by fast ion losses due to a toroidal field ripple, the electron density profiles were peaked [1]. Scaling studies of the density peaking factor were performed in JET and ASDEX upgrade [2-4]. These studies showed that the density peaking factor had a dependence on the collisionality at ρ = 0.5, the NBI particle flux at ρ = 0.5, and a ratio of ion temperature ($T_i(\rho = 0.5)$) to electron temperature ($T_e(\rho = 0.5)$). Here, ρ is the normalized minor radius. Parameter dependence of the peaking factor should be investigated in various devices in order to evaluate the dependence in wide parameter space and understand a mechanism in determining the density profile of tokamak plasmas.

In previous study of JT-60U, the dependence of the peaking factor ($n_e(\rho = 0.2)/< n_e >$) on collision frequency for the dataset I in ref. [1] was investigated as shown in Fig. 1(a). Here, ν_{eff} indicates a ratio of the electron–ion collision frequency to the curvature drift frequency and $< n_e >$ is the volume averaged electron density. In ref. [4], the dependence of ν_{eff} on the peaking factor had an inflection point at $\nu_{eff} \sim 0.5$. In the range of $\nu_{eff} > 0.5$, the collisionality dependence of the peaking factor is weak. This tendency was also observed in fig. 1(a). On the other hand, a variation of density peaking factor from 1.4 to 1.8 was observed in a narrow ν_{eff} region, ν_{eff} = 0.2 - 0.4. One of the reason for the variation is the toroidal rotation as reported in ref. [1]. As can be seen in Fig. 1(b), however, the variation cannot be explained only by the toroidal rotation. These plasmas were heated by NBI of which absorption power (P_{NBI}^{abs}) were 7 - 8 MW. Thus, the difference of particle flux among these shots was considered to be small. Therefore, we investigated the plasma parameters, which cause the change of the density peaking factor, for the plasma with ν_{eff} = 0.2 - 0.4 and V_T (ρ = 0.2) = 0 - 100 km/s.

Figure 2 (a) shows a relation between the peaking factor and T_i/T_e evaluated at ρ = 0.5 in order to compare the tendency of the parameter dependence on the peaking factor with those in JET and ASDEX Upgrade. The peaking factor in this dataset shows a dependence on T_i/T_e. In this dataset, normalized beta value (β_N) also shows a dependence of the peaking factor as shown in Fig. 2 (b). The peaking factor of the plasma with the same β_N is quite similar. However, the present dataset was small to conclude the level of dependence of T_i/T_e, β_N and the other parameters on the peaking factor. Therefore, the dataset will be expanded.

In this presentation, by including additional data of JT-60U, the parameter dependence of the peaking factor for H-mode positive magnetic shear plasma will be shown and discussed.

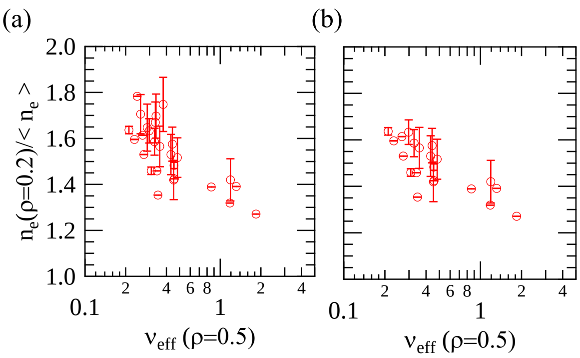

Fig. 1. (a) Collisionality dependence of peaking factor[1]. (b) Extracted data with co-current direction of toroidal rotation V_T (ρ = 0.2) = 0 - 100 km/s from Fig.1(a).

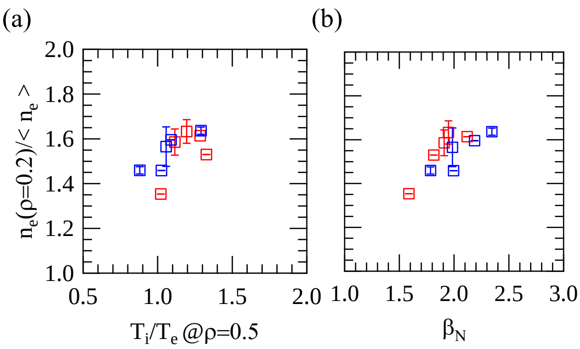

Fig. 2. Examples of the relation between the peaking factor and (a) T_i/T_e evaluated at ρ = 0.5, and (b) β_N. Red and blue markers indicate low and high triangularity, respectively.

References
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