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デタッチプラズマにおけるプラズマ応答磁場の振舞
Behavior of plasma response field in detached plasma

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In the recent LHD experiment, the resonant magnetic perturbation (RMP) has been utilized to establish the detached plasma [1] which is one of candidates to prevent the divertor heat load. The behavior of plasma response field has been investigated from the view point of the magnetic island dynamics [2]. The purpose of this study is to investigate the detailed behavior of plasma response field and its dependence of plasma parameters for detached plasmas. Here, an important parameter, the phase shift (Δθ), should be noted that the Δθ is defined as the phase difference between the plasma response field and RMP. When the phase shift is in-phase (Δθ = 0), the magnetic island grows whereas the magnetic island is suppressed when that is anti-phase (Δθ = πrad). Figure 1 shows a typical waveform of a discharge transiting to detached state in a magnetic configuration with RMP. When the plasma becomes to detached state, the Hα signal oscillates and electron density slightly drops. Before the transition, the Δθ gradually moves to positive direction corresponding to ion-diamagnetic direction and finally, the Δθ reaches -0.3πrad (Fig.1 (c)). Waveforms of Δθ just before detachment are summarized in Fig.2 in which the values of Δθ when the plasma is detached are indicated by circle. It should be noted that each times for detachment are discrete but the threshold of Δθ = -0.3πrad seems to be a robust value. To compare the dispersion of Δθ and other parameters (plasma β and collisionality ν), we summarize them as shown in Fig. 3. The β and ν are widely dispersed when the detached plasma is produced (white circles in Fig.3). Both states (detach/attach) coexist in the same wide region of β = 0.08 - 0.17% and ν = 0.18 - 0.44. This implies that the phase difference Δθ can be an index to predict the appearance of detachment plasma. From the viewpoint of magnetic island dynamics, the growth of magnetic island is required to produce detached plasmas. The different critical Δθ has been observed in the other magnetic configuration. That reason will be clarified in the future.

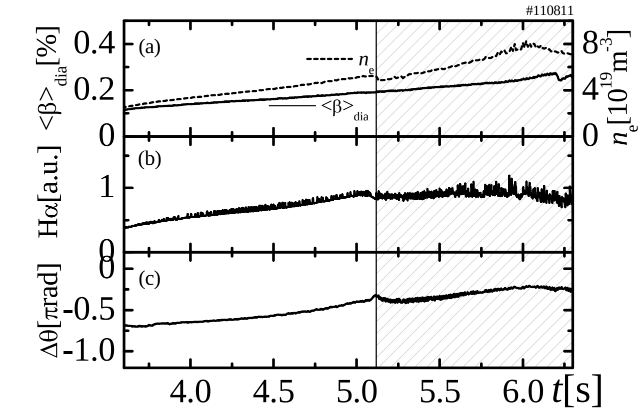

Fig.1 Time evolution of (a) β and n_e, (b) Hα and (c) phase shift Δθ. Plasma transits from attached to detached state at t=5.117s. Detached phase is shown by hatched region.

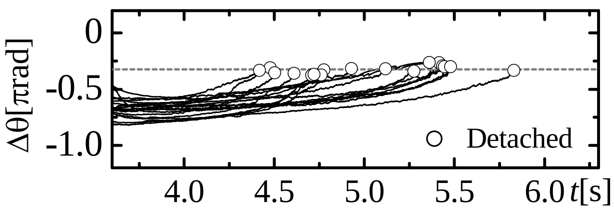

Fig.2 Time evolution of phase shift Δθ of multi shots. The values of Δθ when plasmas transit to detached state are shown by circle.

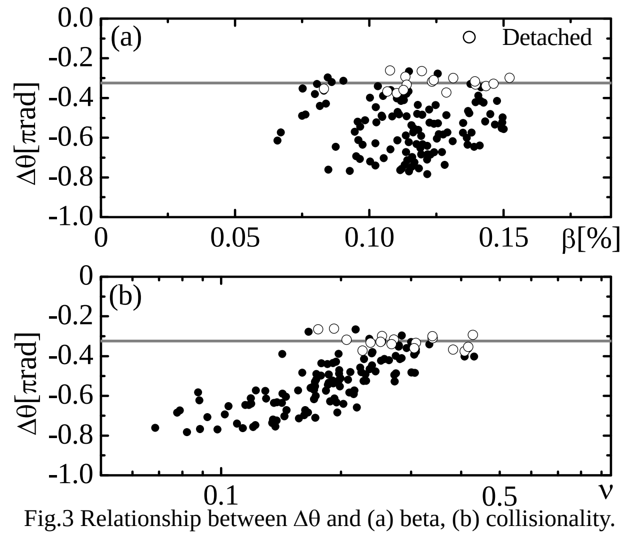

Fig.3 Relationship between Δθ and (a) beta, (b) collisionality.

Reference
[1] M. Kobayashi, et al. Phys. Plasmas **17** 056111 (2010)
[2] Y. Narushima, et al., Nucl. Fusion **51** 083030 (2011)