§7. Ballooning Mode Stability of H-mode Plasmas with an Outward-shifted Configuration

Ohdachi, S.

Edge transport barrier is formed by H-mode transition in LHD. While the low amplitude edge localized modes (ELMs) just after the H-mode transition are observed in the inward-shifted configurations, H-mode without ELMs are obtained in outward shifted configurations, e.g., Raxis = 3.9m[1)]. The electron density increases linearly in this ELM-free H-mode phase and a large scale ELM terminates the H-mode. It is important to understand the cause of the difference in the ELM behavior with inward/outward shifted configurations in order to form a stable edge transport barrier. Among the several candidate to explain the difference, MHD stability is investigated in this study. The beta profile is shown in Fig. 1. It is clear that pressure gradient in the ETB region is increased after the H-mode transition. In LHD, the pressure driven modes, such as the interchange mode and the ballooning mode, are possible candidates for ELMs. Since it is known that the high-n ballooning mode is unstable in the outward shifted configurations [2)] even when the interchange mode is stable, stability analysis of the ballooning mode by Hn-Bal code [3)] is made.

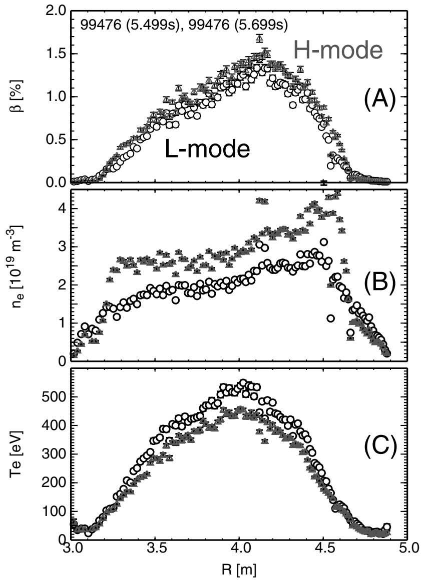

Fig. 1: *Profiles of the L-mode(circle) and H-mode(triangle) plasma are compared. The plasma beta, the electron denstiy and the electron temperature profile is shown in (A), (B) and (C), respectively*

The profile just before a giant ELM is analyzed (Fig.1(A) triangles). The preset magnetic axis is 3.9m and the toroidal magnetic field is -0.9T. The ideal ballooning mode is found to be stable in this condition. The growth rate start to increase when the pressure profile is multiplied by a factor of 4 (in Fig .2(A) and (D)). Finite value of the growth rate is expected in the edge region where the ELM activities take place. However, needed pressure gradient for the ballooning modes is much larger than the experimental one. Giant ELMs thus cannot be explained by the ideal ballooning mode. Further stability analysis including the resistivity is needed to understand the mechanism of the giant ELMs.

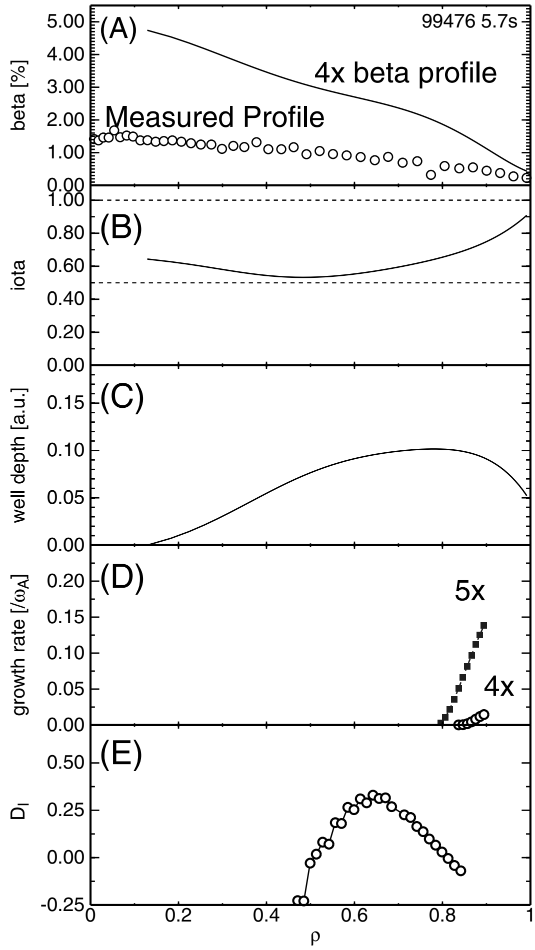

Fig. 2: *The measured beta profile (circles) and the assumed profile which is multiplied by four (solid line) (A), the iota profile (B), the well depth(C), the growth rate of the ballooning mode with 4 times(open circle) and 5 times (closed square) case (D) and the mercier condition D_I (E) are shown.*

1) K. Toi, et.al., "Role of Low-Order Rational Surfaces in Transport Barrier Formation on the Large Helical Device. ", in Proc. of 23th IAEA Fusion Energy Conference Daejeon, Korea, 2010, Post Deadline, EX/C

2) S. Ohdachi, et. al, Contrib. Plasma Phys. **50**(2010)552.

3) N. Nakajima, et. al, Fusion. Sci. Tech. **51**(2007)79