Contribution ID: **262** Type: **Oral Presentation**

EX/8-1: 3D Plasma Response to Magnetic Field Structure in the Large Helical Device

Friday, 12 October 2012 08:30 (20 minutes)

In the LHD experiments, the volume averaged beta value was achieved to 5% in the quasi-steady state. For such high-beta plasmas, the change of the magnetic field structure is expected. Since the magnetic field of the LHD is intrinsically 3D structure, the plasma current flowing along 3D field lines drives perturbed field to break nested flux surfaces for the vacuum field, so-called the "3D plasma response". This is an important and critical issue in stellarator and heliotron researches. Understanding of the nature of stochastic field lines is also a critical issue for application of the Resonant Magnetic Perturbation in tokamaks. To study theoretically the impact of 3D plasma response to the magnetic field, 3D MHD equilibrium was studied using a 3D MHD equilibrium calculation code without assumption of nested flux surfaces. In that study, magnetic field lines in the peripheral region become stochastic and expanding due to increasing beta then the plasma volume in the inside of the last closed flux surface shrinks. However, the connection length of stochastic field lines is still longer than the electron mean free path. That means the change of the effective plasma boundary by the 3D plasma response.

To study the 3D plasma response, the radial electric field, Er, is measured in the peripheral region. The positive electric field appears in the region and that suggests the boundary between opened and closed field lines. The position of appearing positive Er is the outside of the vacuum boundary. A 3D MHD modeling predicts the expanding of the effective plasma boundary by the 3D plasma response. The position of appearing strong Er is almost comparable to expanded plasma boundary of the modeling. That is, the 3D plasma response is identified in the LHD experiments.

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Session Classification: 3D Equilibrium & High Beta Physics

Track Classification: EXS - Magnetic Confinement Experiments: Stability