§2. Finite β Effects on 3D MHD Equilibrium of TEXTOR Tokamak with External Perturbed Field

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In most of situations, tokamak equilibria are analyzed as axisymmetry (2D) systems. The nature of this symmetry gives many advantages for its analysis. However, as realistic tokamaks have discreteness of the toroidal field coils, this discreteness yields the toroidal field ripples (TF ripples) and, strictly speaking, realistic tokamaks could not be axisymmetric configurations. In previous work, we pointed out the significance of 3D effects, which are effects of plasma equilibrium currents along rippled field lines[1)].

On the other hand, in recent tokamak experiments, it is noted that stochastic filed lines reduce strong heat load driven by the edge localize mode (ELM) on the divertor plate. Stochastic field lines are produced by the external helical perturbation and it is called the Dynamic Ergodic Divertor (DED). From the viewpoint of high-β stellarator equilibrium, 3D effects on the stochastic field are very important because finite-β perturbed field produces further stochasticity in the peripheral region. However, in present analyses of DED, 2D MHD equilibrium superimposed vacuum helical perturbed field was still used. In order to consider effects of DED to ELM, considerations of finite-β MHD equilibrium and the impact of 3D effects are critical and urgent issue.

In this study, the fully three-dimensional (3D) equilibrium of TEXTOR tokamak is solved numerically and finite-β effects are studied. For this study, we use a 3D MHD equilibrium code HINT2[2)], which is widely used to analyze the 3D equilibrium of helical system plasmas. Since HINT2 uses the real coordinate system, HINT2 can treat magnetic island and stochastic field in the computational domain.

Figure 1 shows a puncture map of magnetic field lines obtained from 2D equilibrium superposed vacuum external perturbation with m/n=6/2 mode. Chains of magnetic islands appear and field lines become stochastic in the peripheral region. Figure 2 shows a puncture map of magnetic field lines obtained from HINT2. This means the equilibrium is fully 3D. Island chains appear in same positions and phases. However, significant differences appear. That is, the width of islands is larger than 2D case and the stochasticity in the edge does not appear. Clear closed surfaces are kept in the edge. The verification of 3D effects is next subject.

1) Suzuki, Y. et al. : Nucl. Fusion **43** (2003) 406
2) Suzuki, Y. et al. : Nucl. Fusion **46**, (2006) L19

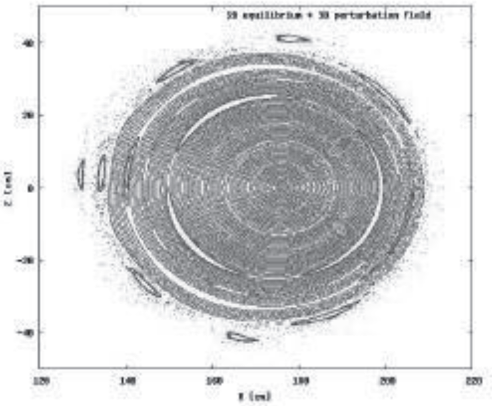

Fig. 1. Puncture map of magnetic field lines of TEXTOR with m/n=6/2 external mode. The field is 2D MHD equilibrium superposed vacuum external field.

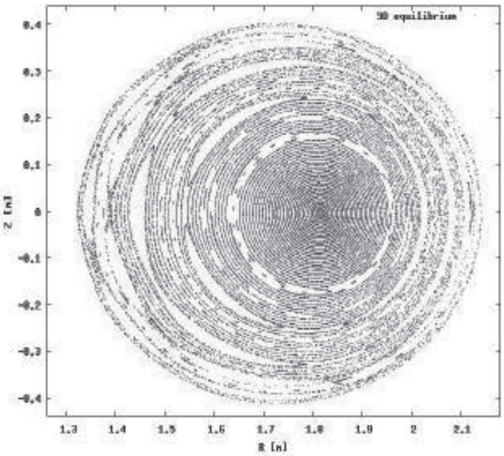

Fig. 2. Puncture map of magnetic field lines of TEXTOR with m/n=6/2 external mode. The field is 3D MHD equilibrium obtained from HINT2.