# 26aE05P

# 三次元MHD平衡計算コードHINT2における境界条件の影響
# Influence of boundary condition in three-dimensional calculation code HINT2

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Since tokamaks are usually regarded as the axisymmetric devices, the 2D MHD equilibrium analyses have been carried out in tokamak plasmas by the VMEC code. However, some external factors such as Toroidal Field (TF) ripple and Resonant Magnetic Perturbation (RMP) field create the non-axisymmetric fields. For equilibrium analysis of tokamaks including such non-axisymmetric 3D effects, we usually use the vacuum approximation that a vacuum helical perturbed field due to RMP coils is superimposed on a 2D MHD equilibrium. The previous study [1] shows that the vacuum approximation is good approximation. However, the vacuum approximation does not include the effect of the magnetic field produced by plasmas on the equilibrium. This 3D effect cannot be ignored completely especially in high-β plasmas. Therefore, consistent 3D equilibrium calculation of non-axisymmetric tokamaks is an important work.

The HINT2 code [2], three-dimensional MHD equilibrium calculation code, is widely used to analyze the equilibrium of helical plasmas. The HINT2 can calculate equilibrium condition by iterating two relaxation steps: the pressure relaxation step (step-A) and the field relaxation step (step-B). In contrast to the VMEC code, the HINT2 code can calculate the equilibrium condition without assumption of the existence of nested flux surfaces. Thus, the HINT2 code can be applied to the calculation of the equilibrium including magnetic islands and stochastic region. However, the HINT2 code assumes fixed normal component of the magnetic field at the computational boundary. Few influences of that boundary condition have been predicted in Large Helical Device (LHD) [3]. But this boundary condition is not suitable for the equilibrium analysis in plasma with large current such as tokamak plasmas because the magnetic field near the boundary is changed by plasma current.

For those reasons, we apply the Virtual Casing Principle (VCP) for the calculation of the magnetic field on the boundary in tokamaks. In the VCP, we assume the “virtual casing” between the plasmas and the external conductors. Then, we can introduce the surface currents and the magnetic surface charges on the casing that cancel the external field by plasma and coil currents. By using them, we can calculate the external field by plasma currents and the internal field by coil currents without a detailed calculation of the precise structure due to those currents. In our study, the VCP will be used only to compute the external field from plasma currents.

In this study, we will include the new boundary condition obtained by the VCP into the HINT2 code. Comparison of the equilibrium field obtained by the “new HINT2 code” which includes the boundary condition to that by the conventional HINT2 code is now under investigation. Furthermore, application to the equilibrium calculation of tokamak plasmas and comparison to other equilibrium calculation codes such as the VMEC code are planned.

**References**

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[2] Y. Suzuki et al. : Nucl. Fusion 46(2006) L19-24
[3] H. Kamiuttanai et al. : “Influence of boundary condition in three-dimensional MHD calculation code HINT2” Plasma Conference 2014 18PB-055