

# Study on Reconstruction of Vacuum Magnetic Surface in QUEST

M. Ishiguro, K. Hanada<sup>a</sup>, K. Nakamura<sup>a</sup>, O. Mitarai<sup>b</sup>, H. Zushi<sup>a</sup>, H. Idei<sup>a</sup>, M. Sakamoto<sup>a</sup>,  
M. Hasegawa<sup>a</sup>, Y. Higashizono<sup>a</sup>, Y. Takase<sup>c</sup>, T. Maekawa<sup>d</sup>, Y. Kishimoto<sup>d</sup>, S. Kawasaki<sup>a</sup>,  
H. Nakashima<sup>a</sup>, A. Higashijima<sup>a</sup>

*IGSES, Kyushu Univ., Kasuga, 816-8580, Japan*

*<sup>a</sup>RIAM, Kyushu Univ., Kasuga, 816-8580, Japan*

*<sup>b</sup>Inst. of Industrial Sci. and Tech. Reseach, Tokai Univ., Kumamoto 862-8652, Japan*

*<sup>c</sup>Department of Complexity Sci. and Eng., Univ. of Tokyo, Kashiwa 277-8561, Japan*

*<sup>d</sup>Graduate School of Energy Science, Kyoto Univ., Kyoto 606-8501, Japan*

ishiguro@triam.kyushu-u.ac.jp

In tokamak devices, the magnetic field to keep equilibrium of plasma should be generated inside the vacuum vessel by the external coils. To avoid the inductive current on the vacuum vessel, which is eddy current, the electrical insulation have been installed in the vacuum vessels of tokamaks to keep high impedance. However, it is difficult to isolate the vacuum vessel in spherical tokamaks (STs) because of narrow space of central post region. Therefore the consideration of the equilibrium including the eddy current on the vacuum vessel should be done. In QUEST, which is the ST device in Kyushu University, the measurement of vacuum magnetic field was executed to confirm the accuracy of the reconstruction of magnetic flux inside the vacuum vessel.

In this study, four methods of calculation (a), (b), (c) and (d) are used to reconstruct the magnetic surface. Each method has different technique to estimate the eddy current. During the plasma experiments, the only magnetic data on the vacuum vessel is used in the magnetic reconstruction and it is difficult to confirm the accuracy of reconstruction of the magnetic surface inside the vacuum vessel. This time, the magnetic flux was measured on the wall and inside the vacuum vessel using flux loops, and the measured values were compared with the values calculated by the four methods with the data measured on the wall.

In the method (a) and (b), vacuum vessel is considered as the assembled body of loop segment of conductor. In the method (a), eddy current in each segment is calculated by solving the circuit equation numerically. In the method (b), eddy current is estimated by the loop voltage measured by the flux loop on the wall and the resistance of the segment of vacuum vessel [1]. In the method (c) and (d), virtual coils are set out of the vacuum vessel in calculation and the current of virtual coils is determined to satisfy the

measured flux values on the wall of vacuum vessel. In the method (c), virtual coils are set at the positions of PF coils. In the method (d), the virtual coil is set around vacuum vessel and the number of virtual coil is same as the number of flux loops on the wall. The measured and calculation results are shown in the Fig.1. From this figure, the most accurate method of the reconstruction of magnetic surface is method (c).

[1] D. A. Gates, J. E. Menard, and R. J. Marsala, Rev. Sci. Instrum. 75, 12, pp5090-5093 (2004)

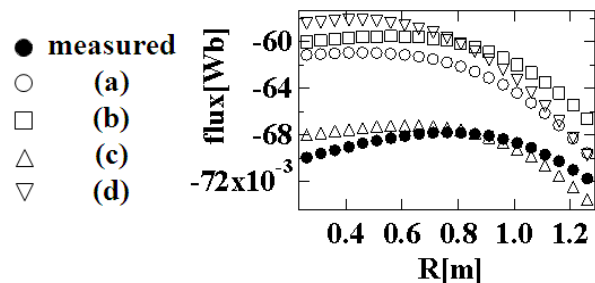


Fig. 1. The comparison between measured flux and calculated flux using four methods

Horizontal axis shows the radius of flux loop set on the mid plane. Vertical axis shows the flux value.