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LHDにおける輸送解析のための磁気座標マッピングシステムの構築
Development of Magnetic Coordinate Mapping System for Transport Analysis in LHD

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In magnetically confined torus plasma experiments, it is essential for data analysis (e.g., precise determination of transport coefficients) to express measured electron temperature/density profile in magnetic coordinates, which are mapped from real coordinates by specifying an appropriate equilibrium. Because direct reconstruction of three-dimensional (3D) equilibria in helical systems is generally time-consuming unlike tokamaks, it is more reasonable approach to choose a proper equilibrium best-fitted to the experimental data from the equilibrium database constructed in advance. In this work, we have constructed a new large-scale equilibrium database in order to perform automatic post-shot magnetic coordinate mapping following the experimental sequence of shots in the Large Helical Device (LHD).

This database consists of numerous free-boundary 3D LHD equilibria calculated using VMEC code in the seven-dimensional input parameter space including external coil currents, pressure/toroidal current, and their peaking factors. The input parameters are selected so as to cover all experimentally achievable conditions, and divided into 5 to 13 mesh points. A block diagram of the entire system is displayed in figure 1. Once users designate the seven input parameters as well as a position in terms of three components in real cylindrical coordinates (R, Z, Φ), the inverse mapping solver brings back the magnetic coordinates (e.g., effective minor radius) corresponding to the real coordinates by referring to VMEC output files. Output parameters are automatically interpolated when intermediate values in the parameter space mesh are given, and automatically extrapolated when real coordinates are outside the calculation boundary. In addition, we have prepared an additional Line-of-Sight (LOS) database which tabulates pre-calculated mapping results along several frequently used lines of sight such as Thomson scattering diagnostic, which realizes faster mapping process.

We have developed an automated system to map profile data into magnetic coordinates in each time slice by minimizing the inboard/outboard asymmetry of the electron temperature or the pressure profile by referring to the LOS database. We have also developed interface programs to give the experimental temperature/density profile to several numerical codes for transport analysis, neutral beam power deposition, and ray tracing. These tools enable us to analyze fast temporal evolution of transport, and to construct large-scale experimental database of transport analysis by calculating a number of shots automatically. This database is expected to make large contribution from LHD to the international stellarator/heliotron profile database.

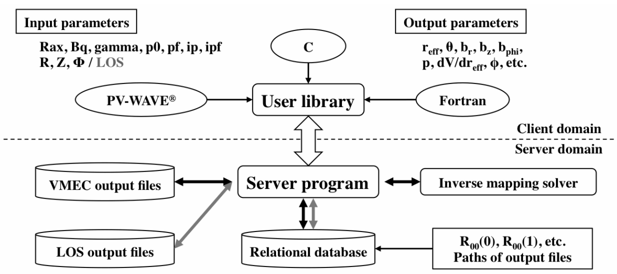

Fig. 1: Block diagram of the mapping system. Information on positions can be given by real cylindrical coordinates or name of the LOS.