§40. Effect of MHD Instabilities on Confinement Performance in Helical Plasmas

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In the LHD low-beta discharges, the dependence of the energy confiment performance on the plasma paramter is reproduced by the ISS04(International Stellarator Scaling 2004) model [1] which has the similar dependence with the gyro-reduced Bohm model. It is found that an factor, f_{ren}, which is different in the each magnetic configuration, should be introduced to be quantitatively reproduced though the ISS04 scaling is valid for the various helical plasmas. On the contrary, in the LHD discharges with a large range of beta value, it is reported that the dependence of the confiment performance on the plasma paramter is different from that of the ISS04 model, the reason of which is because the transport is governed by the anomalous transport induced by the resistive interchange instability[2, 3]. The characteristics of the MHD instability of the Heliotron-J plasmas is quite different from that of the LHD because the properties of the magnetic configuration like the magnetic shear and the magnetic hill/well depth is quite different in the both plasmas. The main purpose of this works is to verify the above hypothesis on the dependence of the confinement performance on the beta through the analysis of the confinement performance of the high beta Helioteron-J plasmas with and without MHD instabilities.

Before the analysis, we are developing and updating the analysis tool based on the 2.0 dimensional local heat transport analysis tool, TASK4LHD, which was developed for the LHD[4]. In Fig.1, the contents of the analysis tool. The main updating parts is as the follows: (1) The MHD equilibrium database for the mapping the measurement locations between the real coordinates and a magnetic coordinates is constructed by the HINT code. (2) The magnetic coordinates for the mapping in the NBI deposition profile estimation is based on the VMEC calculation. The reason for the first updating is as the follows: the VMEC free-boundary version, which is used to calculate the LHD MHD equilibrium database, cannot well calculate the MHD equilibrium of Heliotron-J, especially in the peripheral region because the shape of the magnetic surface is much more complicated than that of the LHD. HINT code needs the much larger calculation resource than the VMEC free boundary version. On the other hand, a magnetic coordinate is efficient to distribute the pressure profile based on that defined by the flux quantity. Then, after the MHD equilibrium is calculated, the mapping database is made by the VMEC fix boundary version, whose boundary condition is given from the HINT results. The reason for the second updating is as the follows: the Boozer coordinates is commonly used to calculate the particle orbit because the usage leads to the reduction of the calculation resources. On the contrary, it is much easier to distribute the density and temperature in the real coordinate based on those defined by the flux quantity because the magnetic surface is too complicated, and the direct 3 dimensional interpolation procedure is necessary to map them. On the contrary, in VMEC coordinates, the definition of the toroidal angle is exactly same with that in the real coordinates, where the 2 dimensional interpolation procedure is enough. Here it should be noted that the Boozer coordinates are still used to calculate the particle orbit.

We are analyzing the local heat transport for the discharge shown in Fig.2[5], which is maintained by NBI, and the configuration is so-called "standard" in Heliotron-J experiment group. The beta values at a time slice indicated by ② in the Fig.2 is twice larger than that by ① because the density increases due to the gas-puffing. Now we are comparing the transport properties in between ① and ② cases.

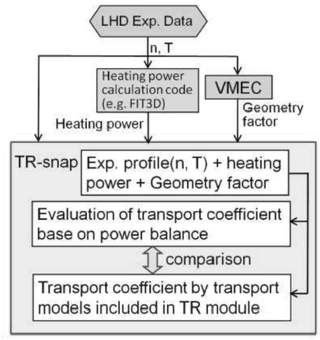

Fig.1 The architecture of TASK4LHD.

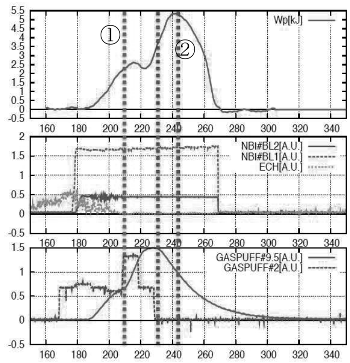

Fig.2 A sample-discharge's waveform.

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[2] H.Funaba et al., Plasma Fus. Res. 8, 022 (2008).
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