§6. Development of Tranport Code for LHD SOL/divertor Plasma and Neutrals

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Extension of the calculation mesh of EMC3-EIRENE code[1, 2] with divertor legs of Large Helical Device (LHD) has been achieved in this work. The code is a three-dimensional fluid code to simulate parallel and perpendicular plasma transport with neutrals and calculate stational distributions self-consistently. Plasma simulation of boundary plasmas of LHD was launched for edge plasma without divertor legs to reduce difficulties arising in making a calculation mesh on outer region of plasma. That is reasonable assumption to focus on transport in edge region because width of the legs is enough thin to assume weak interaction of plasma and neutrals inside legs. However, that is not the case with closed divertor configuration introduced in 80% of toroidal sections from the experimental campaign in 2012. Neutral compression caused by baffle plates[3, 4] leads to strong recycling and localized plasma source in the legs. Extension of simulation region with the legs is necessary to simulate global transport of plasma and neutrals.

In order to realize edge/divertor simulation in closed divertor configuration, extended EMC3-EIRENE and calculation meshes have been developed. The difficulty due to large distortion of cells in the mesh of legs has been overcome by splitting regions into edge-, leg- and vacuum-regions. The simulation area of EMC3 is restricted to those with long connection length. The rest regions, i.e. vacuum regions, has no dependence on magnetic field structure and hence purely geometrical approach is employed to make mesh covering them.

Figure 1 is a simulation result of electron temperature in the case of inward-shifted configuration with 8MW heating power. Electron density of $2 \times 10^{19}/m^3$ is assumed at the inner boundary. Open divertor configuration is applied. Bohm condition is applied at divertor plates, which locate at the tips of the legs. Physical quantities in edge and leg regions are seamlessly connected each other without numerical discontinuity. The distribution of plasma source is shown in Fig. 2. Large ion flux leads to high recycling flux at the inner side of the divertor and hence large plasma source is observed. On the other hand, much less recycling takes place at the outer divertor. The same tenency was observed in H_α light in experiments.

Figure 3 gives comparisons of simulation results with open and closed divertor configurations. We note that the closed divertor geometry is not exactly the same as actual device and the improvement of simulation modeling is on going work. The results suggest higher plasma density in the leg and outer edge regions. Electron temperature becomes lower, which is not shown here. These differences are interpretated by difference in neutral transport. The closed configuration confines neutrals effectively and leads to higher neutral density in leg plasma. That causes large plasma source due to ionization and hence higher electron density. Since the input power is kept constant, the electron temperature becomes lower.

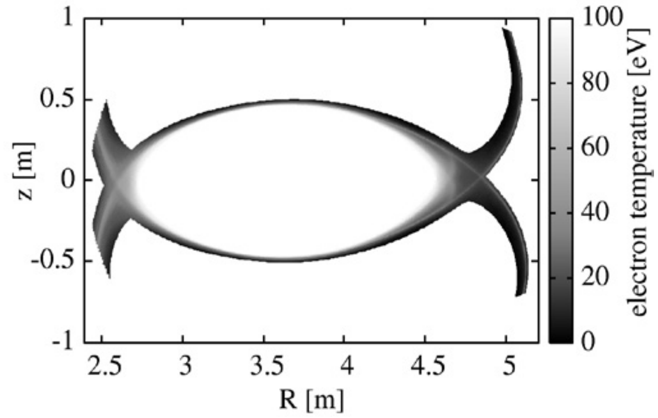

Fig. 1: Electron temperature distirubiton in the holizontally erongated cross setion.

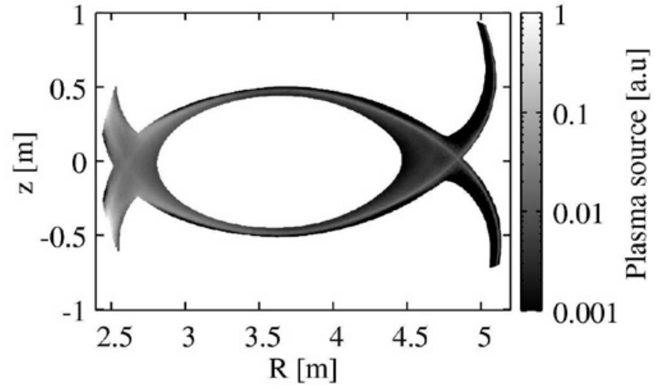

Fig. 2: Distirubution of plasma source calcurated from plasma density temperature and neutral density.

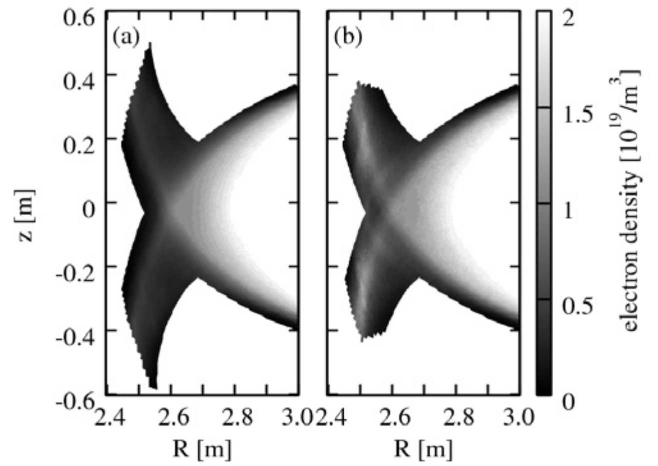

Fig. 3: Comparisons of electron density between (a) open and (b) closed divertor configurations.

1) Y. Feng *et al.*, Contrib. Plasma Phys., **44** (2004) 57
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3) M. Shoji *et al.*, Nucl. Mater., **390–391** (2009) 490
4) S. Masuzaki *et al.*, Plasma Fus. Res., **6** (2011) 1202007