§21. Overdense Plasma Production by the Use of Whistler Mode

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Plasma production with the conventional ECRH (ordinary mode) is limited by the density limit that is determined with the cut-off frequency. On the other hand the whistler mode 1,2), which propagates along a magnetic field with right-hand circular polarization, does not suffer such restriction, so that this mode has a possibility to produce a plasma which density is about 100 times as high as the cut off density.3) In this program we have studied the possibility of over dense plasma production with the whistler mode in the Tohoku University Heliac (TU-Heliac) 4) and plan to apply to LHD in the next step.

We have successfully produced an ECH plasma which density is 2~4 times of cut-off density in TU-Heliac. We designed a new rectangle horn antenna for our small ECR heating system (f = 9.75 GHz, Pmax = 5 kW) in order to try to excite the whistler mode. The old horn antenna was placed along the perpendicular direction of the magnetic field at a high field side. On the other hand, the new one is set to align with the parallel direction of the magnetic field at the same high field side.

Figure 1(a) and (b) show the radial profiles of the electron density and the electron temperature for the old antenna (open circles) and for the new one (solid circles). The density and temperature profiles are measured with the triple probe which is placed 180 degree in toroidal angle away from the antenna. The line density is also measured with the 50 GHz microwave interferometer and we always verify the density profiles measured with the triple probe. Working gas is He (p = 2.3×10^{-3} Pa). The broken line in Fig.1(a) shows the cut off density $n_e = 1.18\times10^{12}$ cm^{-3}. In the old antenna case the maximum density near the magnetic axis is almost equal to the cut off density and can not exceed 1.3 times of this cut off density in any operating conditions in TU-Heliac. Whereas Fig.1(b) shows that the electron temperature for the new antenna is 60~70% of that in the old antenna case, it is clear from Fig.1(a) that the densities for the new antenna exceed the cut-off density by a factor of 2~4. The simulation of this experiment and the optimization of the antenna by means of the ray trace calculation are in progress.

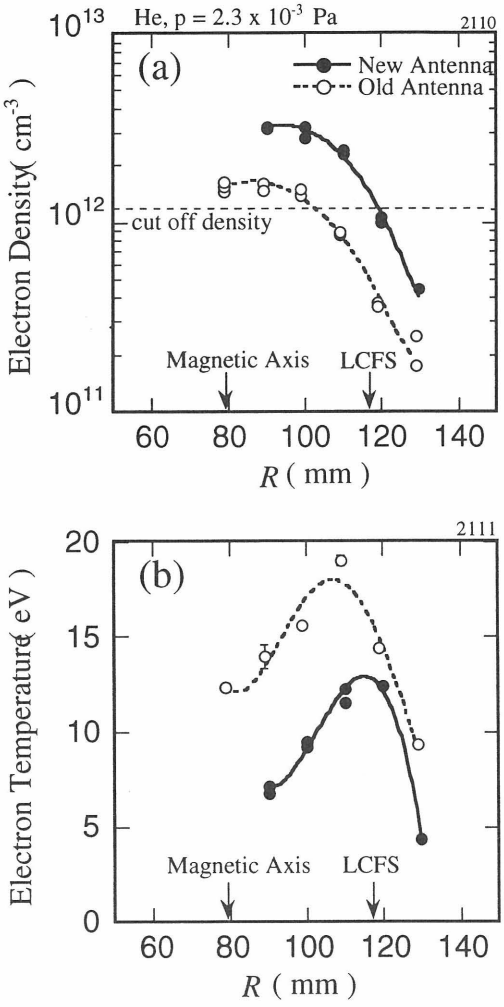

Fig.1 Radial profiles of (a) the electron density and (b) the electron temperature measured with the triple prove.
The magnetic axis is at 79 mm and the LCFS is at 117 mm as indicated by arrows.

References
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