§14. Design of Transmission System for 400 GHz Collective Thomson Scattering on LHD

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In FIR center, Univ. of Fukui, sub-THz frequency-range gyrotrons have been developed, and 400 GHz high-power pulse gyrotrons are now being developed.[1-3] Until last year, a feasibility study of a 400 GHz gyrotron as a collective Thomson scattering (CTS) source had been investigated for LHD high density plasma of 10^{20} m^{-3}.[4] In result, it was found that the CTS in this frequency range is very attractive for LHD plasma. The CTS condition is satisfied for large scattering angle larger than 90 degrees, which provides good spatial resolution. The sub-THz wave does not suffer from refraction due to cutoff in plasma of the order of 10^{20} m^{-3}as shown in Fig. 1. Moreover, it is almost free from cyclotron absorption since its frequency is much higher than harmonics of the cyclotron frequency. Therefore, the background ECE is at a very low level.

This year, a transmission system, which delivers the sub-THz electromagnetic beam to the plasma in the vacuum vessel of LHD, was investigated. It is assumed that the electromagnetic wave oscillated in the gyrotron is delivered from the gyrotron into the vacuum vessel through waveguides with a diameter of 31.75 mm. Some mirrors will be installed in the vacuum vessel, and they control the direction of the propagation beam and the beam size. Figure 1 shows the plane including a propagation beam from the final mirror to the scattering point. The spot size of the beam at the scattering point is assumed to be 20 mm. The distance between the final mirror and the scattering point is 2350 mm. When a Gaussian beam is assumed, the beam radius at the final mirror is 35 mm. And it is difficult to match radius of the beam radiated from the 31.75 mm waveguide to this radius directly, because of the limited space of the vacuum vessel. Then, we designed the transmission system including four mirrors. One example is shown in Fig. 2. The first three mirrors are plane and the fourth mirror controls the beam size.

1) T. Saito et al., The Joint 33rd International Conference on Infrared and Millimeter and Terahertz Waves, 1209 (2008).
2) T. Notake et al., Plasma Fusion Res. **4**, 011 (2009).
3) T. Saito et al., The Joint 34th International Conference on Infrared and Millimeter and Terahertz Waves, 09030089 (2009).
4) Y. Tatematsu et al., The Joint 33rd International Conference on Infrared and Millimeter and Terahertz Waves, 1281 (2008).

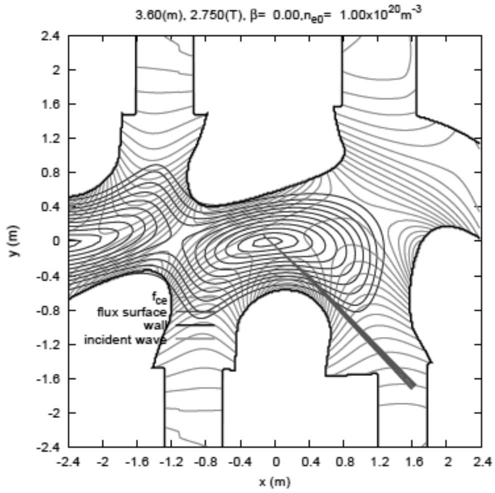

Figure 1: Ray tracing in LHD plasma with density of 10^{20} m^{-3} for frequency of 400 GHz.

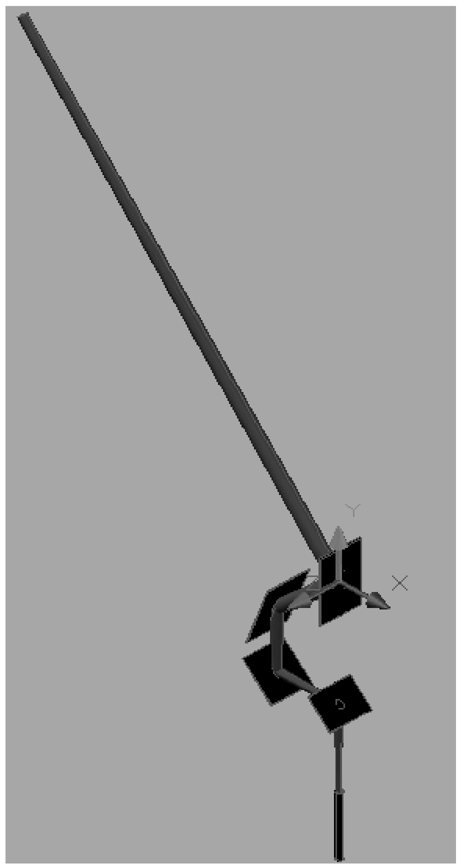

Figure 2: One example of designed transmission system in the LHD vacuum vessel.