

§5. Mirror Synthesis by Phase Retrieval Basing on IR Camera Measurements of Output Power Profile from a Gyrotron

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A matching optics unit (MOU) is a one of the most important component among the constitutions of ECH system for fusion devices. Improvement of the coupling efficiency of a gyrotron power to a transmission line such as a corrugated wave guide increases the effective power available for plasma heating, and raises the purity of transmitted mode, and reduces power losses in the transmission lines, and also suppresses some arcings induced by incomplete couplings. The MOU normally consists of several mirrors, absorbing structure of diffractive millimeter waves, and RF-shielded box. Output power profile can be modified to a Gaussian beam profile at the wave guide mouth by the mirrors to optimize the coupling efficiency.

MIT group has been developing the computer codes of phase retrieval only from measured data of field amplitude at several positions and of mirror synthesis. In collaboration with MIT we have been designing a new MOU for an 84 GHz gyrotron in LHD ECH-system.

Figure 1 shows an IR (Infrared) camera image which was taken on the paper screen of 84.5mm apart from the gyrotron window. The output profile of this gyrotron (CPI #2R) has a very complex structure, but Gaussian beam profile with a given beam waist is required at the entrance of HE₁₁ corrugated wave guide.

The measuring configuration of IR images is shown in Fig. 2. The phase retrieval code analyzes two or three images and reconstructs the RF-field, which includes both its amplitude and phase, at the other position. By using the retrieved field at one mirror position and the given field at another mirror position, the mirror surface shapes are determined. Figure 3 shows an example of the mirror surface calculated by the above method. Main part of the shape focuses the beam and the subtle wavy structure

around the center seems to adjust the phase.

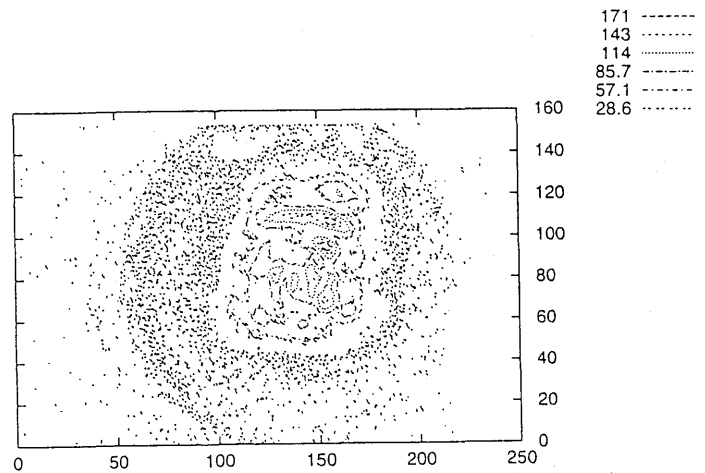


Fig. 1 Typical IR image of the RF power profile which was taken as temperature rise of a screen material. The distance from the window disk is 84.5mm.

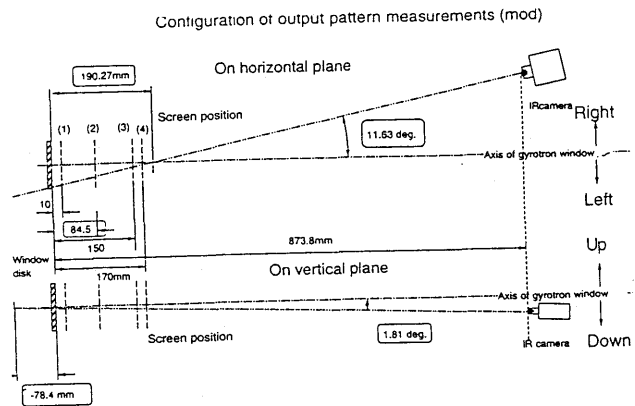


Fig. 2 Configuration of output pattern measurements from a gyrotron window.

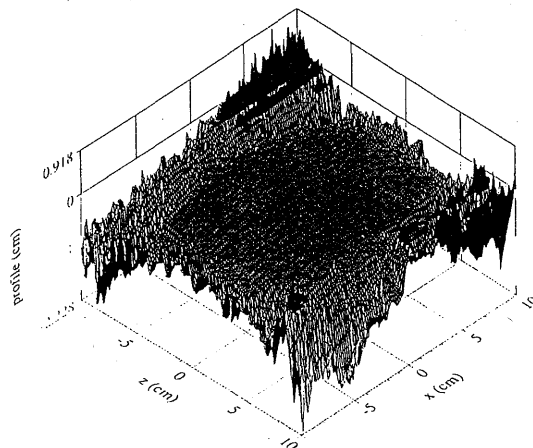


Fig. 3 An example of the surface shape of the synthesized mirror determined by the phase retrieval from the IR camera data.