Analysis of the quasi-optical output system of a $TE_{22,6}$ 118 GHz gyrotron

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I. Introduction

A quasi-optical output system for the $TE_{22,6}$ 118 GHz gyrotron of CEA Cadarache was designed years ago. Measurements show a double peak structure at the output window plane but simulations could not predict this behavior in the past [1].

II. Setup

The quasi-optical output system consists of a dimpled wall launcher and a set of three mirrors. The perturbation of the launcher's wall causes preshaping of the launcher's radiated field [2]. The first of the three mirrors has a quasi-elliptical shape which is used for athimuthal focussing of the radiated field from the launcher. The second mirror is plane and the third mirror is a parabolic one. Cold measurements of the output pattern show a double peak structures along the z-axis of the gyrotron whereas the simulation using our code based on the diffraction integral can not predict this behavior.

III. Analysis

After very intensive analysis together with cold measurements any production errors could be excluded. The first attempt was to optimize the launcher because wall currents on the cut could cause diffraction. The advanced design has much less currents on the cut and it focuses the output beam better. The complex Gauss content is 95.1%. Simulations again showed a Gaussian like peak in the window plane but the measurements still have an alike structure with a double peak.

Next we performed calculations to exclude reflections from the cut, captured modes and cavity-like behavior of the launcher. As this did not get any results the mirror system was the focus of the investigations. Measurements in different planes in between the mirrors showed patterns with a single peak as predicted by simulation. But in planes after the third mirror we could visualize the double peak structure by measurement. The spot looks different in each plane of course.

The first mirror has a quasi-elliptical shape which is optimized for the launcher's geometry. This can nearly be excluded as the cause of the double peak because the mirror has no curvature along the z-axis of the gyrotron. The second mirror is plane, so no effects other than changing the direction are possible. The third and last mirror has a parabolic shape with different curvature radii perpendicular and parallel to the gyrotron axis. The substitution of this mirror with one which is less focusing made the double peak structure change into a multi peak structure. First we could not predict this behavior. A different method of simulation, solving the electrical field integral equations numerically [3], which was up to now only used to calculate the launcher's output pattern was adapted. A full 3D modeling of the launcher and the three mirrors of this quasi-optical output system was performed. The results are in good agreement with the measured double peak structure.

IV. Conclusion

The complex quasi-optical output system was analyzed and the first full 3D-calculations of the launcher and the the three mirrors solving the electric field integral equations were performed.

References

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