OPTIMIZED ANTENNA SYSTEM FOR LOW POWER TESTING OF THE QUASIOPTICAL TRANSMISSION LINE AT TJ-II EXPERIMENT

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ABSTRACT

In this paper we present a high performance antenna system to carry out low power testing of the main parameters of the quasioptical transmission line system for Electron Cyclotron Resonance Heating (ECRH) at TJ-II experiment under construction in Madrid. The system uses a practically pure Gaussian Beam at 53.2 GHz obtained by means of an optimized corrugated horn launcher. The main goal of the system is to make low power measurements of the beam waveguide by means of a simulation of the gyrotron beam size. Previous experience of both teams in the Millimeter Wave Plasma Heating has been very useful for the design.

INTRODUCTION

The TJ-II stellerator is a medium-size (R_0 = 1.5 m, $\langle a_p \rangle$ = 0.2 to 0.25 m, B_0 = 1 T) helical-axis stellerator which is under construction at the Asociación Euratom-Ciemat para Fusión site in Madrid [1]. Two quasioptical transmission lines have been designed to launch the millimeter wave power. One will launch the X-Mode linearly polarized and another a mode with oblique angle and elliptically polarized. Each transmission line is feed by a Gycom (Nizhny Novgorod, Russia) gyrotron of 400 kW, 0.5 sec pulse length at 53.2 GHz, and the gyrotron output field is in the free space TEM_{00} mode.

The beamwaist from the output of the gyrotrons is 18 mm in X and Y planes and after reflections on the focusing mirrors system we reach a value of 32 mm (for the beamwaist) at the plasma center. The first transmission line whose construction parameters were given in [2] has been constructed at the Ciemat and, therefore, the low power testing of the line performance will be realized shortly.

ANTENNA SYSTEM DESCRIPTION

Low power testing of the quasioptical transmission line is desirable in order to minimize the high power microwave exposition risk on the people that perform the high power measurements. Then, a low power beam that can simulate the emergent gyrotron beam, can be very attractive.

The optimized horn has an initial up taper with increasing derivative where an additional corrugation depth tapering is superimposed from half free space wavelength to quarter wavelength. The radius at the output of this section is 24.28 mm and 190 mm length.The next part is a straight waveguide corrugated at quarter wavelength of 50 mm length that cannot be avoided in the beam formation process. Finally another up taper corrugated at the same quarter free space wavelength of 200 mm length and 37.16 mm radius is added.

Numerical simulation of this horn has been realized by means of mode matching and scattering matrix code together with a far field calculation. The conversion efficiency to the gaussian beam in both E and H planes is 98.6 % , the beam waist between 17.8 and 18.5 mm , the position of beamwaist relative to the horn output 15 mm, the approximated antenna gain between 28.6 and 29.1 dB, the cross polarization level - 53 dB and the reflected power lower than a value of 0.12 %.

The construction of such a component is quite complicated and we are considering in a very serious way the electroforming techniques due to the difficulties encountered to construct it by classical numerical control methods.

Experimental measurements as described in [3] employing a sensitive receiver are expected in next weeks to verify the theoretical statements.

CONCLUSION

An optimized measurement system based upon a non linear corrugated horn which generates the same beamwaist as the gyrotron is presented. The beam waveguide efficiency will be measured and the launched beam properties studied.

REFERENCES

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