BEAM WAVEGUIDE FOR ECRH AT TJ-II

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ABSTRACT

In this paper we present the main parameters of the transmission line system for Electron Cyclotron Resonance Heating (ECRH) for the TJ-II experiment at the Asociación Euratom Ciemat para Fusión in Madrid. This heating system is based on two quasioptical transmission lines carrying 400 kW and 0.5 sec. of pulse length each line and operating at the frequency of 53.2 GHz. The principal parameters of the designed mirrors and those of the guided beams are given in this paper. The first transmission line has already been built at the Ciemat workshop, the second one is under construction.
INTRODUCTION

The TJ-II stellerator is a medium-size \( R_0 = 1.5 \text{ m}, \langle \rho \rangle = 0.2 \text{ to } 0.25 \text{ m}, B_0 = 1 \text{ T} \) helical-axis stellerator which is under construction at the Asociación Euratom-Ciemat para Fusión in Madrid [1]. In the initial stage, plasma breakdown and heating will be produced by an ECRH system operating at near the second harmonic resonance (53.2 GHz).

Electron Cyclotron Resonance Heating is one of the most serious candidates for magnetically Confined Nuclear Fusion experiments. For the next generation of fusion machines (ITER) the requirements on generators, transmission lines and power supplies are defining practically the state of the art of these technologies as discussed in [2, 3 and 4].

In the case of the TJ-II experiment, we will employ two quasioptical transmission lines designed to launch the millimeter wave power in the linearly polarized X-Mode and for the second transmission line the power will be launched obliquely and elliptically polarized. Each transmission line is fed by a 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 (by means of an internal quasioptical mode converter) having about 5 to 6 % of unwanted mode content. The tubes will be constructed by the company GYCOM (Nizhny Novgorod, Russia).

The gyrotrons are powered (100 kV, 30 A) by means of an advanced regulated high voltage power supply (RHVPS) using solid state DC-DC converters to take advantage of the high frequency (4 kHz) commutation and neglecting the use of the usual ignitron crowbar system as explained in more detail in [5].

The first quasioptical transmission line uses a set of 8 focusing mirrors and the second one includes an additional mirror inside the TJ-II vessel (9 mirrors). Both transmission lines have 6 cylindrical mirrors coupled in pairs for machining simplicity and the rest are typical double curvature mirrors.

TRANSMISSION LINES DESIGN

The design of quasioptical transmission lines where millimeter waves are transmitted as Gaussian Beams (by means of the TEM\(_{00}\) free space fundamental mode) has been a well established topic since 1960, but the application to ECRH has appeared only recent.