Design Studies of a 42 GHz, 200 kW, CW Gyrotron Operating in the $TE_{0,3}$ Mode witl

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Abstract : *In this work, the design studies on a 200 kW, CW gyrotron operating in the $TE_{0,3}$ mode with axial output collection has been presented. Such a device will be used for electron cyclotron resonance heating of plasmas in a small experimental tokamak. Cold cavity design and self-consistent calculations are carried out and power and efficiencies are computed. In addition, a triode type magnetron injection gun has also been designed with a compression ratio of around 14-15. The nominal beam parameters are chosen to give a moderate to low velocity spread. True beam information from gun computations is used for self-consistent and time-dependent simulations. Besides, for CW operation, one has to test the performance of the device by running multi-mode, time-dependent, self-consistent simulations for power and efficiencies during the start-up and space charge neutralization periods. The initial results are indicating that an output power of well over 250 kW, CW, can be achieved at 42 GHz with $TE_{0,3}$ as the operating cavity mode. Further investigations to consolidate the engineering design aspects (EDA) are in progress.*

Table-I: Design Data & Goals

Frequency	42 GHz
Output Power	» 200 kW, CW
Beam Current	» 10 A
Beam Voltage	» 65 kV
Magnetic Field at the Interaction	» 1.61-1.62 T
Beam velocity Ratio	» 1.3-1.4
Efficiency	» 35 %
Peak-wall Losses	< 2 kW/cm^2
Over-all Losses	< 8 %
Output Type	Vertical Extraction

Introduction :

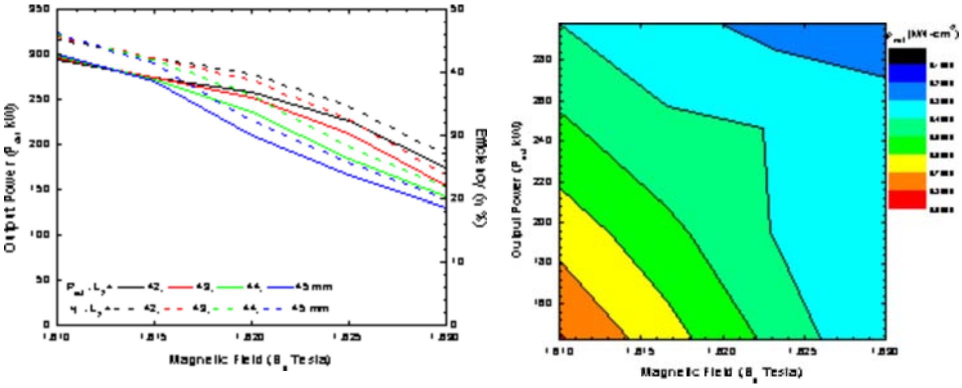
Gyrotrons and their variations, popularly known as gyro-devices, a

The studies on the RF-behavior of such a technical device have jus

Design Studies :

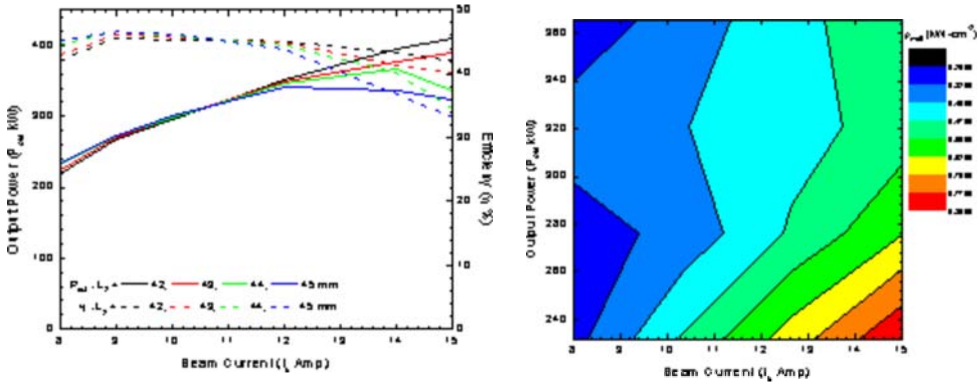
The given frequency corresponds to a wavelength of 7.143 mm. Fo

After the mode selection process, the cold cavity design and the calculation of the RF-behavior are carried out. The cavity is a standard three section structure with an input taper and a uniform mid-section followed by an output uptaper. Parabolic smoothing of the input and output tapers is carried out to reduce unwanted mode conversion at sharp transitions. The beam-wave interaction takes place in the uniform mid-section where the RF-fields reach peak values. The uptaper with nonlinear contour connects the cavity with output waveguide section. The optimum cavity design is carried out by computing the power and interaction efficiencies in cold cavity and self-consistent approximations for various parameters until a satisfactory cavity design compatible with the design goals such as efficiency, wall losses, output power etc. is obtained. Design studies of a triode-type MIG and magnetic guidance system are also carried out. The true beam information and magnetic field data obtained from these calculations are used to study the RF-behavior of this specific gyrotrons. By suitably choosing a three-section weakly tapered conventional cavity geometry with Q_{Diff} » 850, the cold cavity design and the computation of the RF-behavior are carried out. The initial results of the single mode self-consistent calculations are shown in Figures. 1-2. The results of the studies on RF-behavior are quite promising.



(a) (b)

Fig. 1: (a) Power-Efficiency Calculations by varying the magnetic field for various cavity mid-section lengths. The other parameter



(b) (b)

Fig. 2: (a) Power-Efficiency Calculations by varying the beam current for various cavity mid-section lengths. The other parameters

Concluding Remarks :

We have presented design studies and RF-behavior of a 200 kW, CW gyrotron operating in the $TE_{0,3}$ mode and with vertical outpu

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