A 2 MW, 170 GHz Coaxial Cavity Gyrotron

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In experiments performed on a 165 GHz coaxial cavity gyrotron operated in the $TE_{31,17}$ mode the feasibility of manufacturing a 2 MW, CW gyrotron has been demonstrated. Problems specific to the coaxial arrangement have been investigated and information relevant for an industrial realization of a high power coaxial gyrotron has been obtained.
The power loading at the collector surface limited the pulse length to about 20 ms because no sweeping of the electron beam has been provided. By extending the pulse length above about 10 ms a strong increase of the current to the insert appeared rapidly thus limiting the operating performance. In detailed investigations it has been found that the effect is due to a built up of a Penning discharge inside the technical part of the electron gun. Very recently it has been demonstrated experimentally that the occurrence of the Penning discharge can be suppressed by a suitable modification of the gun geometry which avoids trapping regions for electrons.
Based on the results, the development of a 2 MW, CW coaxial gyrotron at 170 GHz for ITER, started in cooperation between European laboratories (FZK Karlsruhe, CRPP Lausanne and HUT Helsinki) together with an industrial partner. The $TE_{34,19}$ mode has been selected as operating cavity mode. In order to keep the amount of microwave stray radiation low a quasi optical RF output coupler with an advanced launcher and three mirrors has been designed. To verify the design of the electron gun, the cavity and the RF output system, the existing 165 GHz coaxial gyrotron is under redesign for operation at 170 GHz. The cavity and the RF output coupler will be identical as suggested for the industrial tube. This will allow to investigate the RF generation and mode competition as well as the efficiency of the RF output system and the amount of the stray radiation under practically relevant conditions. The new design of the electron gun avoids regions in which electrons can be trapped. Thus the built up of a Penning discharge is not expected. The maximum magnetic field of the FZK gyrotron magnet of only 6.667 T requires a reduction of the operating voltage from 90 kV to 80 kV. The experimental results will be reported and the design will be discussed.

ICOPS$_{2003}$

International Conference on Plasma Science

Abstract Submitted for the 30th IEEE International Conference on Plasma Science
June 2-5, 2003
Jeju, Korea

Abstracts should be submitted by e-mail using this MS Word file.

Subject Topic__ Fast Wave Devices___________
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Subject Number___2.2___________________

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Abstract must be received no later than Jan. 18, 2003

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