

From ITER to DEMO: Towards Multi-Purpose Multi-MW Gyrotrons Operating above 200 GHz

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ABSTRACT

Electron cyclotron heating and non-inductive current drive (EC H&CD) in DEMO and future Fusion Power Plants require multi-megawatt gyrotrons operating in continuous-wave at multiple possible frequencies. Current drive is needed for plasma stabilization and in steady state tokamaks for maintaining the toroidal plasma current. Currently, the gyrotron R&D assumes operating frequencies at 170, 204 and 238 GHz.

The modular, single-frequency 170 GHz 2 MW TE_{34,19}-mode coaxial-cavity short-pulse pre-prototype gyrotron was recently modified to push the coaxial-cavity technology from short pulse operation towards longer pulses [1]. In parallel, a theoretical investigation of a possible upgrade of the existing tube towards the operation at higher frequencies was started. It shall allow the operation in the new 10.5 T superconducting (SC) magnet of the FULGOR gyrotron test stand at KIT [2]. The target is the first operation of the coaxial-cavity pre-prototype at 204 GHz and 238 GHz (window transmission maxima). Simulations show, that increasing the distance emitter – centre of cavity by 30 mm is required for a first proof of concept. This is done by modifying the anode of the existing diode gun to get the additional 30 mm length. In the second step, major gyrotron key components like the gun, coaxial-cavity with non-linear up-taper and insert are modified for a proper operation having RF output powers of 2.63/2.04 MW with interaction efficiencies of 37.8/34.5 % at the operating frequencies of 170/204 GHz, respectively. In addition, the quasi-optical output system will be modified to increase the Gaussian mode content of the output beam from 96.6/91.6 % to 97.6/96.7 % at 170/204 GHz, respectively. The manufacturing process of the components will start soon.

In parallel, the upgrade of the measurement setups towards an operation above 200 GHz are ongoing. The two major upgrades which will be presented are, firstly, the proper excitation of very high order modes using an advanced mode generator, and, secondly, the upgrade of the existing frequency measurements system.

Topic: Vacuum Electronic and Discharge Devices and their Applications – Microwave Tubes (Gyrotron)

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References

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