An Advanced Highly Automated Test System for the Verification of Quasi-Optical Gyrotron Components

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ABSTRACT

Gyrotrons are RF microwave sources used for fusion plasma applications. These vacuum tubes are currently the only sources for Electron Cyclotron Resonance Heating and Current Drive (ECRH&CD) in fusion devices. The excitation of the high-order main operating mode in the gyrotron cavity and the separation of this mode from the different possible competing modes is challenging. The same issue exists at the low-power test system to validate the quasi-optical components of the gyrotron. Nevertheless, the availability of such a test system is vital for the gyrotron design and validation. Particularly, the launcher, which converts the rotating high-order operating mode into a linearly-polarized Gaussian mode, is the critical component here. The previous test set-up at Karlsruhe Institute of Technology included a mode generator with manual tuning for the excitation of the operating mode. The excitation of the correct operating mode was an extremely time consuming task, which was not always successful. Additionally, that set-up allowed the measurement of operating modes up to frequencies of 170 GHz only.

In this work, a new test system, allowing the automated adjustment of several critical parameters by an advanced computer controlled system is presented. This system has been validated using a $TE_{28,8}$-mode cavity operating at 140 GHz, relevant to the gyrotrons used at the stellarator W7-X in Greifswald, Germany [1], and the newly designed $TE_{28,10}/TE_{36,12}$-mode cavity operating at 140/175 GHz, respectively, which is being considered in view of a possible upgrade of the W7-X gyrotrons[2]. The latter cavity to be used in the mode generator has been designed using a scattering matrix code [3]. The measurement results of the fabricated cavities are in very good agreement with the simulations. During this work, a new method was developed for finding the correct mode, which provides a time saving of up to 90 %.

References

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