Ongoing Development of a Gyro-TWT Test Stand up to 263 GHz at IHM

Max Vöhringer[1,3], Alexander Marek[2], Benjamin Bischofberger[1] Stefan Illy[1], Manfred Thumm[1,3], Chuanren Wu[1] and John Jelonnek[1,3]
[1]IHM, [3]IHE, Karlsruhe Institute of Technology (KIT), Kaiserstr. 12, 76131 Karlsruhe, Germany
[2]Fraunhofer FHR, Fraunhoferstr. 20, 53343 Wachtberg, Germany

ABSTRACT

The generation of high-power microwaves up to 263 GHz is of considerable interest for numerous applications, including communications, spectroscopy, and space situational awareness. To address this demand, a variety of different gyrotron travelling-wave tube (gyro-TWT) configurations have been developed over the past decades, including designs employing cylindrical [1], dielectrically loaded [2], quasi-optical [3], and helically corrugated [4] interaction circuits.

Despite their structural differences, all gyro-TWT variants share common features: All utilize the weakly relativistic electron cyclotron maser interaction principle [5], which enables the amplification of broadband input signals to power levels in the kilowatt range. Efficient operation necessitates a homogeneous axial magnetic field within the interaction region, a high-voltage power supply for electron beam acceleration, and an electron emitter capable of delivering the required beam current.

At IHM, the amplifier research activities are focused on gyro-TWTs employing a helically corrugated interaction region (HCIR), hereafter referred to as helical gyro-TWT [4]. The HCIR configuration facilitates second-harmonic electron cyclotron frequency operation, thereby reducing the required magnetic flux density by a factor of two.

This contribution presents the ongoing development of a dedicated test stand for gyro-TWTs and provides an overview of the critical components required for their experimental validation. Particular emphasis is placed on the requirements and design of the 5.5 T superconducting magnet to enable efficient operation of helical gyro-TWTs up to 263 GHz. The magnet features a variable magnetic field profile and a 50 mm diameter warm borehole, allowing for flexible operation of gyro-TWTs for different frequencies. In addition, an electron gun [6] capable of delivering axis-encircling beam currents of up to 1 A, as well as the new power supply providing up to 65 kV and 4 A, are described.

The presented components establish the basis for initial experimental investigation of helical gyro-TWTs and provide a versatile platform for future studies of a broad range of gyro-type devices.

References

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