Gyrotron Capabilities

With extensive expertise in the design, development, and construction of gyrotron microwave power sources, MPP is uniquely suited to provide high-power gyro devices for a variety of applications, including plasma heating, particle acceleration, high-resolution radar, non-lethal weapons, dynamic nuclear polarization enhancement for NMR spectroscopy, geothermal drilling, as well as industrial heating, curing, and sintering. In addition to offering gyrotron designs that have already been developed, MPP specializes in the development of customized designs to meet specific frequency, power and pulse duration requirements.

MPP has personnel with the skills and experience to ensure that every stage of the development process, from design to installation, is performed efficiently and effectively. MPP has the tools necessary to manufacture existing designs as well as to advance the state of the art. These resources include the computer codes used to generate new designs and analyze results, the facilities required to develop and test rf circuits, and the fabrication and test facilities needed to manufacture and validate high power gyro devices.

Historical Background

Since 1977, MPP has delivered over 185 gyrotrons and constructed more than 20 experimental vehicles, ranging in frequency from 8 GHz to 593 GHz at power levels up to 1.9 MW pulsed and 900 kW continuous wave (CW).

Throughout the past five decades, technological innovations have led to impressive advancements in the state-of-the-art for gyrotron designs. Chemical vapor deposition (CVD) diamond output windows have allowed development of CW sources at megawatt power levels. Internal quasi-optical mode converters allow whispering-gallery cavity modes in the gyrotron to be converted to Gaussian output beams with minimal diffractive loss. Incorporation of strengthened copper alloys in circuit and collector assemblies has allowed for robust operation and extended product lifetimes under high heat loads.

In addition to the production of gyrotron oscillators, MPP also specializes in the design and fabrication of gyro-amplifiers. These devices provide the high power, phase stability, and bandwidth required for coherent high-resolution radar systems and communication applications at millimeter-wave frequencies.

Milestones

2024: MPP shipped its 58th gyrotron for DNP/NMR spectroscopy applications, and its 253rd gyrotron (including oscillators and amplifiers) overall.

2024: MPP’s VGB-8198 gyro-TWT amplifier demonstrated the ability to produce 49 kW peak power with a bandwidth of 7.5 GHz around a center frequency of 95.75 GHz, while using a broadband internal converter to produce a Gaussian output beam.

2017: MPP shipped its first 593 GHz gyrotron, capable of CW operation with an output power of 50 W.

2016: MPP shipped its first multi-frequency gyrotron oscillator, the VGT-8141A, capable of producing either 500 kW at 104 GHz or 900 kW at 140 GHz.

2012: MPP shipped its first 527 GHz gyrotron, capable of CW operation with an output power of 25 W.

2010: MPP's VGB-8125 gyrotron produced over 1.4 MW at 95 GHz, with 51% efficiency, and over 1.9 MW at 40% efficiency, during short-pulse testing.

2007: The first public demonstration of the Air Force’s vehicle-mounted Active Denial System was held at Moody Air Force Base. This advanced non-lethal weapon system uses MPP’s VGB-8095 gyrotron to generate a 95 GHz, 100 kW beam which provides a safe but effective deterrent.

2005: At the Max Planck Institute for Plasma Physics in Greifswald, Germany, MPP’s VGT-8141, produced nearly 900kW of output power, at a frequency of 140 GHz, for 30-minute pulses.

2005: MPP’s VGB-8190 gyro-TWT demonstrated the ability to produce 2 kW peak power (0.8 kW average) with a bandwidth of 6.5 GHz around a center frequency of 95.5 GHz.

2000: MPP's VGB-8194 gyro-klystron demonstrated the ability to produce 100 kW peak power (10 kW average) with a bandwidth of 700 MHz at a frequency of 94 GHz. The same device was also operated at 1.05 GHz bandwidth at 40 kW peak power (4 kW average). Development of the VGB-8194 was funded by the Naval Research Laboratory.