

## Gyrotron Capabilities

With extensive expertise in the design, development, and construction of gyrotron microwave power sources, CPI 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 nuclear magnetic resonance systems, as well as industrial heating, curing, and sintering. In addition to the gyrotron designs that have already been developed, CPI also specializes in the development of customized designs to meet specific frequency, power and pulse duration requirements.

CPI's years of experience in the development of gyro-devices include the simulation codes used to optimize new designs, the cold-test facilities required to validate RF circuit designs, and the facilities needed to manufacture and test high-power gyro-devices. Most importantly, CPI has personnel with the skills and experience to ensure that every stage of the process, from design to installation, is performed efficiently and effectively.

## Milestones

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

2010: CPI'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 CPI'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, CPI's VGT-8141, produced nearly 900kW of output power, at a frequency of 140 GHz, for 30-minute pulses.

2005: CPI'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: CPI'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.

## [subheader]Historical Background[/subheader]

Since 1977, CPI has delivered over 185 gyrotrons and constructed more than 20 experimental vehicles, ranging in frequency from 8 GHz to over 527 GHz at power levels up to 1.9 MW pulsed and 900 kW continuous wave (CW).

In 1975, CPI was chosen by the Oak Ridge National Laboratory to study devices capable of producing hundreds of kilowatts of CW power output at frequencies in the 100 GHz range. The study resulted in the award of a contract to CPI for the production of a 200 kW CW gyrotron at 28 GHz. Since the completion of the program in 1980, gyrotron oscillators have been designed, developed, and shipped at many other frequencies. Technological innovations have led to impressive advancements in the state-of-the-art. 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.

Funding by the Department of Energy led to the development of a successful product line of 1 MW, 110 GHz long-pulse gyrotrons (VGT-8110) and a new, enhanced-efficiency version capable of producing up to 1.3 MW (VGT-8115).

In addition to the production of gyrotron oscillators, CPI also specializes in the design and fabrication of gyro-amplifiers using the cyclotron resonance principle. These devices, called gyro-klystrons or gyro-TWTs (depending on the type of beam-to-RF interaction employed), provide the high power required for coherent radar and communication applications at millimeter-wave frequencies. CPI has shipped 13 gyro-amplifiers in addition to fabricating 13 experimental gyro-amplifier prototypes.

**Please contact CPI BMD to assist you with your gyrotron needs.**

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