European gyrotrons for ITER

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Gyrotron is a microwave source whose operation is based on the stimulated cyclotron radiation of electrons oscillating in a static magnetic field. The radio frequency radiation is excited by gyrating electrons bunched near the phase in which they yield their energy to the high-frequency field. The phase bunching is due to the relativistic dependence of the electron mass on its velocity. This makes rotation of decelerated electrons faster and that of the accelerated ones slower. The typical frequency range of gyrotrons working at the fundamental harmonic is between 20-200 GHz.

Operating mode	$TE_{34,19}$
Frequency	170 GHz
RF output power	2 MW
Beam current	75 A
Accelerating voltage	90 kV
Velocity ratio	1.3
Cavity magnetic field	6.87 T
RF output efficiency	50%

European* gyrotron *design specifications

Powerful gyrotrons can be used to heat nuclear fusion plasma. In addition, they have found a wide utility in plasma diagnostic, plasma chemistry, radars, high-temperature processing of materials, extra-high-resolution spectroscopy, and medicine. However, the main application of gyrotrons is the electron cyclotron resonance heating in tokamaks and stellarators. For example, for its heating system with power up to 20 MW, the international thermonuclear experimental reactor (ITER) will need about 20 continuous wave ordinary gyrotrons at a frequency 170 GHz with output power per tube or about 10 coaxial gyrotrons with 2 MW output power per tube. Coaxial gyrotrons are developed only in Europe: at Karlsruher Institut für Technologie, Germany, and Ecole Polytechnique Fédérale de Lausanne, Centre de Recherches en Physique des Plasmas, Switzerland. Theoretical work is done also at the Institute of Solid State Physics, University of Latvia.

References

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