THE 110 GHz GYROTRON SYSTEM ON DIII-D: GYROTRON TESTS AND PHYSICS RESULTS

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The DIII–D tokamak has installed a system with three gyrotrons at the 1 MW level operating at 110 GHz. Physics experiments on electron cyclotron current drive, heating, and transport have been performed. Good efficiency has been achieved both for on-axis and off-axis current drive with relevance for control of the current density profile leading to advanced regimes of tokamak operation, although there is a difference between off-axis ECCD efficiency inside and outside the magnetic axis. Heating efficiency is excellent and electron temperatures up to 10 keV have been achieved. The gyrotron system is versatile, with poloidal scan and control of the polarization of the injected rf beam. Phase correcting mirrors form a Gaussian beam and focus it into the waveguide. Both perpendicular and oblique launch into the tokamak have been used. Three different gyrotron designs are installed and therefore unique problems specific to each have been encountered, including parasitic oscillations, mode hops during modulation and polarization control problems. Two of the gyrotrons suffered damage during operations, one due to filament failure and one due to a vacuum leak. The repairs and subsequent testing will be described. The transmission system uses evacuated, windowless waveguide and the three gyrotrons have output windows of three different materials. One gyrotron uses a diamond window and generates a Gaussian beam directly. The development of the system and specific tests and results from each of the gyrotrons will be presented. The DIII–D project has committed to an upgrade of the system, which will add three gyrotrons in the 1 MW class, all using diamond output windows, to permit operation at up to ten seconds per pulse at one megawatt output for each gyrotron.