

New high spatial resolution optics for the DIII-D ECE radiometer

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A new high spatial resolution optical system for the horizontally viewing ECE heterodyne radiometer diagnostic on the DIII-D tokamak has been designed and is under construction for testing and installation in Spring 2006. The system measures second harmonic ECE in the frequency range of approximately 80-130 GHz and replaces the current long horn antenna. The optics system is extremely compact to accommodate limited space in the vacuum vessel and the in-vacuum components consist of a scalar horn and two mirrors. The design employs Gaussian beam optics throughout. Plasma emission is gathered by a focusing ellipsoidal mirror and the emission is then reflected off a plane mirror and focused into the scalar horn, which is coupled to the external waveguide. The horn is optimized to generate an antenna pattern which closely approximates a Gaussian beam over the required frequency range. The design emphasizes optimizing spot size over the entire second harmonic emitting region in the plasma, not a particular location. The system achieves a 3 dB spot size of less than 5 cm at the DIII-D magnetic axis and 6 cm at the edge, providing at least a factor of 2 improvement. Further improved localization is achieved by reducing the intermediate frequency bandwidth of the radiometer filters from 1 GHz to 500 MHz and for most conditions of interest Doppler broadening is the principle broadening mechanism. The net resulting radial resolution is also improved by at least a factor of two. Test measurements of system performance at 90 GHz will be presented and, if available, the first plasma data from DIII-D.