Measurement of the DIII-D ECH Transmission Line Losses

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The DIII-D ECH System has six transmission lines connecting the gyrotrons to the launchers on the DIII-D vacuum vessel. Each line uses a 31.75 mm diameter evacuated corrugated aluminum waveguide, which is designed to transmit 110 GHz HE_{11} mode at very low loss. The six lines vary in length from 60 and 100 meters. Each line also incorporates specialized waveguide components, such as power monitor miter bends, polarizers (mounted in a pair of miter bends), pumpouts, switches, isolation valves, dummy loads, and miter bends. The total number of miter bends vary from seven to fourteen per line, with the longest waveguide runs having the most miter bends. This system is very similar to the transmission line system proposed for ITER other than that ITER will operate at 170 GHz and use 63.5 mm diameter waveguide.

Using rf theory the anticipated losses in the waveguide and components can be calculated. The estimated losses are: 1% (-0.04 dB) for a standard miter bend, mainly mode conversion loss, 1.5% (-0.07 dB) for polarizing miter bends (two per waveguide line), and 2%/40 m length (-0.09 dB) for the waveguide. For the six DIII-D transmission lines the anticipated transmission efficiencies were estimated to be 80% to 90%, with the highest performing transmission line being the shortest one with the fewest miter bends. However the measurements to date found transmission efficiencies were 70% to 76%, significantly below expectations. Measurements will continue on the transmission line components in order to get a better definition of where the excess losses are generated. These measurements and their influence on ITER will be reported at the workshop.