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# High Power Testing of Water-cooled Waveguide for ITER ECH Transmission Lines

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ITER ECH transmission lines have challenging-to-meet transmitted waveguide mode purity requirements, pushing individual subcomponents towards strict manufacturing tolerances. In addition, most ECH components will require active cooling to remove heat generated by microwave losses, even those with very high transmission efficiencies. To meet these two particular challenges, several new components were built and tested under high power ITER-like conditions. One component is a 4.2 meter water-cooled 63.5-mm diameter corrugated 170 GHz waveguide assembly, the straightest and longest corrugated waveguide built to date. The assembly consists of two sections of corrugated waveguide and a precision joint formed by aligning the sections using information from a scanning coordinate measurements machine. Other components include a short expansion joint capable of +/- 5 mm change in length, and water-cooled waveguide sections which may be used for gyrotron commissioning transmission lines. The testing of these items occurred at the JAEA Gyrotron Test Facility using gyrotron pulses of 450 kW at 170 GHz for 300 seconds. A transmission line was constructed of the new components, with water cooling provided by JAEA. Overall power absorption per unit length of waveguide was measured for each water-cooled component by monitoring the temperature rise of the water. The maximum water temperature rise through all components is less than 4 degrees Celsius. The microwave losses are consistent with previous measurements taken of an uncooled transmission line using infrared camera data of waveguide exterior surfaces. Analysis shows that the power absorbed per unit length for the various waveguide components are dependent on location in the transmission line with respect to high order mode generators, such as miter bends. Far from miter bends, the absorption is 250 W/m. The highest absorption, 700 W/m, occurs for a short section of waveguide between two bends, where both miters contribute decaying higher order modes. The waveguide components demonstrate suitability for supporting ITER ECH transmission power levels of 1.5 MW at 170 GHz.

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