

Advanced Electromagnetic Analysis of the ITER ECH Transmission System

The ITER Electron Cyclotron Heating system will provide 20 megawatts of power for plasma heating and current drive. The US is responsible for the design and implementation of the 24 transmission lines that connect the one megawatt 170-GHz gyrotrons to the launchers / antennas at the ITER tokamak. The transmission lines are 63.5-mm-diameter corrugated aluminum circular waveguides that are capable of very low loss. However, excitation of higher order modes in the lines can lead to enhanced losses, which are undesirable both due to the reduction in transmitted power and to a concern over possible overheating of components. Research conducted at MIT in collaboration with the ITER Project at ORNL has produced a new theory of the modes in these oversized corrugated waveguides. The modes have been formulated in terms of linearly polarized eigenmodes of the guide (so called LPMN modes), which provide a superior description of the modes excited by the linearly polarized gyrotron beam. Using this new theory, the losses in the ITER transmission lines have been accurately estimated. Low power tests at MIT and high power tests at JAEA in Japan have validated the theory. The results of the new theory have been used to specify the output mode purity of the gyrotrons as a single Gaussian mode that must match to the fundamental waveguide HE₁₁ mode with an accuracy of at least 95%. These advances should lead to a more reliable and robust ECH system for ITER.