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Parametric Dependence of Microwave Beam Broadening by Plasma Turbulence

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See attached abstract for full details.
To inject power for heating or current drive, the RF beams must traverse the turbulent layer of plasma at the edge of the tokamak. In this layer, the density fluctuation level can reach 100 % of the background density, and the plasma fluctuates on length scales similar to that of the wavelength used for power injection. These density fluctuations scatter incident microwaves, resulting in an overall broadening of the beams which can significantly impact the efficiency of the device. We are therefore seeking to develop a predictive capability of this broadening for current and future tokamaks.
We simulated a microwave beam propagating through a turbulent layer of plasma using the 2D full-wave cold plasma code EMIT-2D. We conducted a series of pairwise parameter scans to determine whether the dependence on each parameter is separable from the others. The parameters we considered were background plasma density, fluctuation amplitude, turbulence correlation lengths in the radial and poloidal direction, thickness of the turbulence layer, and microwave beam waist. We found two pairs of parameters that are not separable: the radial and poloidal correlations lengths, and the fluctuation level and background density. All other dependencies are separable. With this data, we aim to develop an empirical formula, making predictions of the effect possible in microseconds of processing time, instead of the hours required for full-wave simulation.

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