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2D full-wave and 3D beam-trace modelling of Doppler reflectometry response in realistic geometry

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This contribution reports the conclusions of a lengthy modelling study (cf. previous reports [1]) using 2D full-wave (IPF-FD3D) and 3D beam-tracing (Torbeam) codes, on the behaviour, and in particular the physical and spectral resolutions, of microwave Doppler reflectometry / backscatter diagnosis of fusion plasmas. Using a large database (including simulation spatial weighting-functions & instrument response to test density perturbations) of ASDEX Upgrade tokamak configurations covering a broad range of magnetic equilibria shape, plasma density and probing beam geometry in O & X-mode wave polarization with upper and lower cutoffs, a set of generic empirical models for the principle diagnostic sensitivities & associated error-bars have been distilled. These models require only easily obtainable experimental plasma & wave parameters, such as the permittivity scale length, wavelength, refractive index and beam spot size etc. There have been significant refinements in the models over previous database fits [1], which, are now supported by new theory considerations. Comparisons have also made between the 2D full-wave parameter models and similarly distilled diagnostic models from 3D beam-tracing. Beam tracing provides an alternative, and more experimentally accessible, approach to modelling the diagnostic behaviour. Finally, new results and models have also been obtained on the diagnostic back-scattered power sensitivity. This opens the discussion on the need for fully 3D full-wave simulations and their potential benefits.

[1] G.D.Conway et al. Proc. 12th Intl. Reflectometer Workshop, Julich (2015) and Proc. 14th Intl. Reflectometer Workshop, Lausanne (2019)

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