A 3D CAD model input pipeline for REFMUL3 full-wave FDTD 3D simulator

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The use of advanced simulation has become increasingly more important in the planning, design, and assessment phases of future fusion plasma diagnostics, and in the interpretation of experimental data from existing ones. The design cycle of complex reflectometry systems, such as the ones being planned for next generation machines (DTT, ITER and DEMO), relies heavily on the results produced by synthetic diagnostics, used for system performance evaluation and prediction, both crucial in the design process decision making. These synthetic diagnostics need realistic representations of all system components, to incorporate the main effects that shape their behavior. Some of the most important elements that are required to be well modelled and integrated in simulations are the wave launcher structures, such as the waveguides, tapers, and antennas, as well as the vessel wall structures and access to the plasma. The latter are of paramount importance and are often neglected in this type of studies. The procedure herein proposed uses CAD models of a given machine, together with parameterizable models of the launcher, to produce a description suited for FDTD 3d simulation, combining the accuracy of CAD design representations with the power of simulation. CAD model geometric descriptions, however, are incompatible with the ones used by standard FDTD codes. CAD software usually outputs models in a tessellated mesh while FDTD simulators use VOXEL descriptions. To solve this interface problem, we implemented a pipeline to automatically convert complex CAD models of tokamak vessel components and wave launcher structures to the VOXEL input required by REFMUL3, a full wave 3D Maxwell FDTD parallel code. To illustrate the full procedure, a complex reflectometry synthetic diagnostic for DTT was setup, converted and simulated. This setup includes 3 antennas recessed into the vessel wall, for thermal protection, one for transmission and reception, and two just for reception.