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# Recent progress in the RF modeling activities

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This paper reports the recent progress in the RF modeling capability developed at PPPL. First, an introduction of the Petra-M code which is an integrated FEM full-wave simulation framework, will be given describing the main features of this tool and its capability to simulate RF in fusion plasmas and beyond, together with the excellent code benchmark agreement found in comparison with different RF antenna tools. The Petra-M code enables a while device approach to the RF physics including high fidelity simulation of RF antenna, surrounding PFCs, and plasma geometry. Using the 3D full wave RF fields thus calculated, we shown an example of RF propagation with an application to high harmonic fast wave in NSTX-U plasmas with 3D high geometrical fidelity in terms of antenna and device geometries [1,2]. We then shown a numerical approach to evaluate the RF induced rectified sheath potential developing around an RF actuator and plasma facing components (PFCs) with the WEST ICRF 3D high geometrical fidelity [3]. The study also shows that far RF sheath effects can play an important role particularly in the case of weak single pass damping (a 2D example is shown in Figure 1. The role of 2D/3D density fluctuations and 3D edge filaments in the RF propagation is also investigated [4,5]. Finally, a new method to incorporate the plasma kinetic effects suitable for a finite element method will be shown [6]. This approach includes all-order finite Larmor radius effects while considering only the second order derivatives and it has been implemented in the Petra-M framework. A demonstration of this new approach will be presented in solving the O-X-B mode-conversion of the electron Bernstein wave in a non-relativistic Maxwellian plasma.

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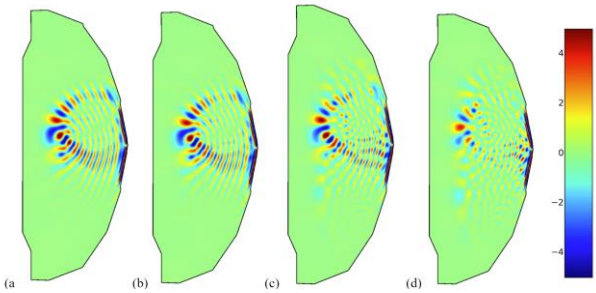


**Figure 1**. $E_z$ component of the wave electric field evaluated by Petra-M assuming a cold plasma with an additional collision and $n_{ø}$=12: No fluctuation (a), Fluctuation amplitude A=0.1 (b), A=0.5 (c), and A=1.0 (d) with A the amplitude of the edge density fluctuations.