# Development of RF wave simulation using the open source MFEM library

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The finite element method (FEM) can handle complicated computational geometry and its mathematical formulation is suitable for modeling cold plasma wave propagation, in which the dielectric response to the RF electric field is local. Indeed, FEM has been widely used to analyze the propagation of RF waves in antenna and edge regions [1]. One can readily build such an RF wave simulation code nearly out-of-box, using the scalable open-source FEM library MFEM (http://mfem.org) and Petra-M (Physics equation translator for MFEM). This paper reports application of MFEM/Petra-M to model various types of RF wave antennas including the field-aligned ICRF antenna on Alcator C-Mod, proposed DIII-D HFS LHCD launcher, and capcacitivily coupled comb-line antenna for LHCD. MFEM/Petra-M has been successfully coupled with the TORIC core spectrum solver to solve RF wave problem in entire tokamak plasma poloidal cross-section self-consistently [2-4]. We will also discuss including advanced physics models such as the mode-conversion to Bernstein waves and RF rectified sheath BC [5].

[1] S. Shiraiwa et al., Physics of Plasmas 17, 056119 (2010)

[2] S. Shiraiwa, J. C. Wright, et al., Nucl. Fusion 57, 086048 (2017)

[3] J. Wright and S. Shiraiwa, EPJ Web of Conferences 157, 02011 (2017)

[4] S. Shiraiwa, J. C. Wright, et. al., EPJ Web of Conferences 157, 03048 (2017)

[5] H. Kohno and J.R. Myra Computer Physics Communications 220 (2017) 129–142

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