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Synthetic O-mode conventional reflectometry - an overview

J. Vicente [1], F. da Silva[1], E. Ricardo[1], S. Heuraux[2], T. Ribeiro[3], M. Hoelzl[3], J. Ferreira[1], J. Santos[1], G.D. Conway[3] and A. Silva[1]

[1] Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de Lisboa

[2] Institut Jean Lamour, University of Lorraine-CNRS

[3] Max-Planck-Institut für Plasmaphysik

e-mail (speaker): jvicente@ipfn.tecnico.ulisboa.pt

Conventional ordinary (O-mode) reflectometry has been employed in several fusion devices mainly to diagnose electron density profiles and fluctuations. Reflectometry diagnostics are also foreseen in future devices, such as ITER and DEMO, where plasma position and plasma shape are expected to be measured.

Synthetic reflectometry, through modeling and simulations, has made significant advances in recent years to either support the interpretation of data or to assess the performance of reflectometers in the next generations of tokamaks. In particular, the REFMUL* suite of finite-difference time-domain full-wave codes has been extensively used and continuously improved to carry out synthetic reflectometry studies. On one hand, improved numerical descriptions of plasmas obtained from turbulence and MHD codes (e.g. GEMR[1] or JOREK[2], respectively) have been integrated with REFMUL, which is state-of-the-art for 2D O-mode synthetic reflectometry[3]. On the other hand, a 3D full-wave code has also been developed to assess applications in future devices[4,5].

Here, the most significant results from both approaches are presented under a common understanding, where 2D and 3D O-mode versions from the REFMUL* family of codes are also benchmarked when possible. The limits and capabilities of reflectometry systems are highlighted when operating in realistic plasma scenarios, including high turbulence levels and non-linear edge localized mode (ELM) crashes. The merits and caveats of the technique are discussed in view of possible applications in future devices.

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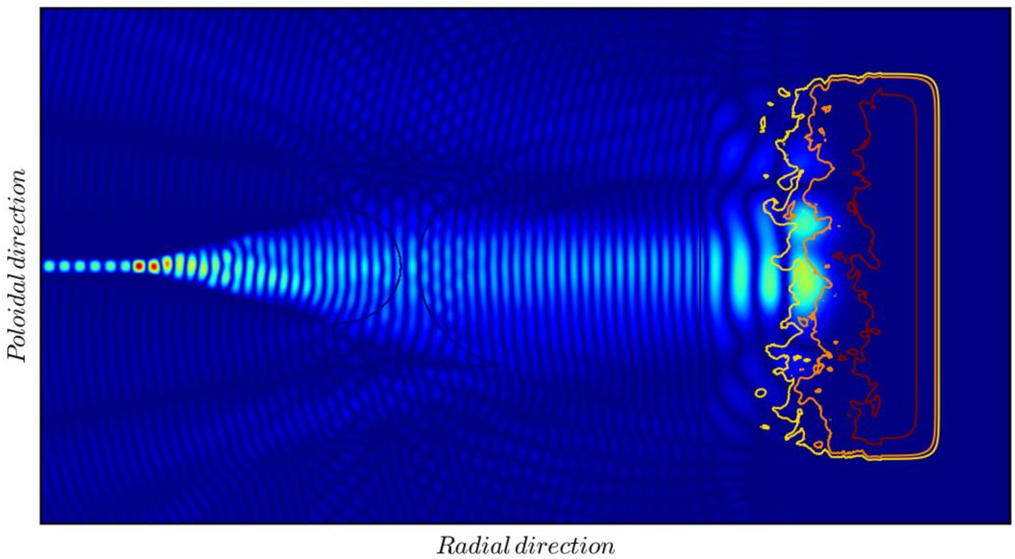

Figure 1. Snapshot of a 2D full-wave simulation (REFMUL) using an electron density map obtained from a plasma turbulence simulation (GEMR). Electric field amplitude and density contour are displayed at a given time instant.