Skewed World of Plasma-wave Modeling: Challenges and Solutions using Unconditionally Stable FDTD Methods

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Electron plasma-waves within confined electron gas systems have been demonstrated to be applicable for terahertz devices such as, detectors, emitters, mixers, modulators among others. A rather challenging aspect of these terahertz devices is related to performance prediction and phenomenological understanding using accurate numerical models. These models include modeling of electron gas regions and surrounding media. Therefore, these must account for finer mesh in 2DEG regions and yet demonstrate time efficiency. The issue is further complicated at terahertz frequencies, where electron plasma-waves become dominant and electromagnetic as well as electronic (electron transport) modeling is needed. Thus, a multiphysics as well multiscale numerical model is desired, which is time-efficient and accurate at the same time.

In this talk, we will develop fast Finite Difference Time Domain based numerical models that solve above issues, while providing accurate phenomenology and performance predictions. The presented algorithms use 'unconditional stability' to reduce the simulation times, and at the same time combine iterative strategies to attain accuracy. Therefore, they attain sweet spot of time and accuracy, reducing the overall simulation times by a factor of 2 or more. In the talk, we will develop these algorithms from basics, in tutorial styled presentation, while also presenting interesting phenomenological observations within single and multiple 2D electron gas systems.