Fast design codes for the simulation of the particle-field interaction in the interior of highly nonlinear gyrotron resonators are state of the art tools for gyrotron design [1,2]. While procuring their rapidity by making strong physical simplifications and approximations, the correctness of these assumptions is not known to be valid for all considered variations of the geometry and operation setup. Solving the self-consistent nonlinear Vlasov-Maxwell system without significant physical reductions, the transient 3D electromagnetic Particle-In-Cell (PIC) method [3] can provide better insights into these setups and beyond that can serve as validation tool for fast design codes.

We use a fully electromagnetic, transient, 3D PIC method based upon a high-order discontinuous Galerkin method [4] for the electromagnetic field in combination with high-order particle-pushing and high-order particle-field coupling techniques, to simulate a 30 GHz gyrotron resonant cavity. These novel high-order simulations provides new insights into the complex particle-field interaction, the azimuthal particle bunching in the beam and the microwave excitation.


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