Contribution ID: **3001** Type: **not specified**

O3.402 Nonlinear wave-particle interaction in helix traveling-wave tubes using N-body simulations in time domain

Wednesday, 10 July 2019 12:25 (15 minutes)

See the full abstract here http://ocs.ciemat.es/EPS2019ABS/pdf/O3.402.pdf

Nonlinear synchronisation is a key process in wave-particle interaction [1], responsible for Landau damping as well as for the amplification in devices like traveling wave tubes and gyrotrons [2]. We investigate it using the finite-N approach from a self-consistent hamiltonian formalism [3]. This description is combined with a recent field decomposition [4] that allows drastic degree-of-freedom reduction while preserving conservation laws (from symplectic properties) for periodic waveguides. Those advantages enable fast time domain simulations compared to alternative particle-in-cell codes.
The model is assessed, with success, against a well-established frequency model in the linear regime [5], against nonlinear simulations [3] and against measurement from industrial TWTs [6]. Currently, our simulations handle non-sinusoidal fields (like multi-carriers). A specific formulation of this model is in preparation for helical waveguides.
Finally, we outline the occurence of the Abraham-Minkowski dilemma for waveguide amplifiers and plasmas [7]. This dilemma (well-known in dielectrics) highlights two different formulas for the momentum of light. For the wave-particle interaction, the dilemma resolution involves a non-negligible flowing momentum from Maxwell's electromagnetic stress.

References
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Presenter: MINENNA, D.F. (EPS 2019)

Session Classification: BSAP

Track Classification: BSAP