IMPROVED ELECTRON BEAM SIMULATIONS FOR HIGH-POWER GYROTRON BEAM TUNNELS

J. Gr. Pagonakis[1], *J. L. Vomvoridis*[1]

[1]National Technical University of Athens, School of Electrical and Computer Engineering, 9 Iroon Polytechniou st., GR 15773, Greece

pagon@central.ntua.gr

We present a new approach for electron beam simulations of a high-power gyrotron beam tunnel with the finite element method. This approach is based on (i) the generation of a dynamic mesh which can be adapted to the shape of the beam, and (ii) the representation of the space charge of the beam through continuous functions.

In the trajectory and self-consistent beam simulation codes, which use finite element method for the electric field calculation, such as, the two-dimensional code *DAPHNE* [1] and the three-dimensional code *ARIADNE* [2], the adaptation of the mesh to be denser in the region of the electron beam is static, since it is performed at most once before each iteration. In addition, the space charge of the electron beam is represented by delta functions at all intermediate positions of the simulation electrons. These techniques cause some inaccuracies in the electric field calculation in the beam region, and consequently in the calculation of the beam characteristics, i.e. the average value and the dispersion of parallel and transverse velocity, the ratio of velocities α, the radius and the width of the beam, etc. Such inaccuracies are impossible to confront with the use of a denser mesh, due to the increased presence of empty elements (i.e., without space charge) in the beam region, while the use of more simulation electrons is limited by computing time and memory.

To confront this difficulty a code is developed which focuses on the improvement of the electric field calculation in the beam region. In particular, a dynamic curvilinear quadrilateral and automatic mesh generator, which can adapt its elements to the beam shape, is incorporated in the code facilities, to separate the elements inside the beam and the elements outside the beam. This results in a more accurate calculation of the strong variation of the electric field at the ends of the beam. On the other hand, the space charge of the beam is determined by continuous functions which are defined by the trajectories of two successive macroelectrons. This technique achieves the exclusion of uncharged elements in beam region irrespectively of the density of the mesh.

References

[1] T. M. Tran, D. R. Whaley, S. Merazzi, R. Gruber, "*DAPHNE*, a 2D axisymmetric electron gun simulation code", 6th EPS-APS Int. Conf. on Phys. Comp., Lugano, Switzerland, 1994.

[2] J. Gr. Pagonakis, J. L. Vomvoridis, "The self-consistent 3D trajectory electrostatic code *ARIADNE* for gyrotron beam tunnel simulation", 29th Joint Int. Conf. on Infr. and Millimeter Waves and 12th Int. Conf. on Terahertz Electronics, Karlsrue, Germany, pp. 657-658, 2004.

* Work supported by and performed for the Association Euratom-Hellenic Republic (funded by the Euratom Fusion Programme and the Secreteriat for Research and Technology, Greece), in co-operation with CRPP (Lausanne). The contents of this paper are the sole responsibility of the authors and do not necessarily represent the views of the European Commission or its Services.