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Optimization of a Folded Waveguide Traveling Wave Tube Using Impedance Matrices

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RF device design and performance are predicted using simulation. Fast design tools such as those that model beam dynamics in one dimension may be sufficient for initial design work or for RF devices where performance is not critical. However, in many cases these tools do not have the fidelity to meet performance objectives. Particle-In-Cell codes such as MAGIC can be used to model the complete device physics in 3D using Maxwell's equations but these simulation tools are computationally intensive and time consuming. The GPU code NEPTUNE [1] is a faster alternative to MAGIC but its computational time is still not insignificant. An alternative approach is presented using impedance matrices and Tesla-Z [2]. In this approach the impedance matrix for a folded waveguide traveling wave tube (FWTWT) is calculated using the Analyst 3D field solver. The impedance matrix is used in Tesla-Z [2] to predict tube performance. This approach is faster than PIC simulation, where the 3D fields are taken into account through the computation of the Z-matrix as opposed to a simplified or analytic model, and the particle dynamics are modeled in 2D. Ultimately, the Tesla-Z matrix approach is used within the Galaxy Simulation Builder (GSB) framework to optimize the FWTWT using the DAKOTA optimization library. The approach and optimization results are presented.

1. S. J. Cooke, I. A. Chernyavskiy, G. M. Stanchev, B. Levush and T. M. Antonsen, "GPU-accelerated 3D large-signal device simulation using the particle-in-cell code 'Neptune'," IVEC 2012, Monterey, CA, 2012, pp. 21-22.
2. I. A. Chernyavskiy T.M. Antonsen, Jr., J.C. Rodgers, A.N. Vlasov, D. Chernin, and, B. Levush, "Modeling Vacuum Electronic Devices Using Generalized Impedance Matrices,"IEEE Transactions on Electron Devices, Vol. 64, No. 2, pp. 536-542, Feb. 2017.

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