ADVANCED MODELING OF VACUUM ELECTRON DEVICES*

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ABSTRACT

The computer modelling and optimization now are critical components in the development of vacuum electron devices (VEDs) suitable for accurate prediction of device operation what can accelerate the design of new devices with improved performance. Advanced computer modeling can substantially reduce amount of experimentations and to be at the highest level called "First pass design success" [1], as the ultimate goal of numerical modelling. Through years the joint team from Naval Research Laboratory (NRL) and Leidos (former SAIC) developed variety of codes for modeling and design of VEDs. The codes are based on models that are commonly used to calculate beam particle motion in self-consistently evolving fields. We distinct between "First principles" (PIC) codes and "Parametric/Hybrid beam wave interaction" codes. The recent twin review papers [2-3] contain detailed description of approaches and algorithms implemented in the codes. First principles codes solve for the charged particle dynamics with minimal approximations. Parametric/Hybrid beam wave interaction codes essentially describe the same dynamics but solving a reduced set of equations, which is based on a number of physically proven simplifying approximations. This approach results in computational savings which make design and optimization more efficient. We are going to discuss advantages and limitations of both approaches for modleing of variety of VEDs such as gyrotrons, Helix based TWTs, klystrons, Multiple-Beam Klystrons (MBKs), and Coupled Cavity (CC) and Folded/Serpentine Waveguide (FW) Travelling-wave tube (TWT) Amplifiers. We also will discuss applicability of different NRL codes for optimization including advanced optimization based on adjoint approach what is developed recently.

References

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