RECENT ADVANCES IN THE TESLA-FAMILY OF 2.5D LARGE-SIGNAL ALGORITHMS FOR THEIR APPLICATIONS TO THE MODELING OF KLYSTRONS AND TWTS*

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ABSTRACT

The developed in the US Naval Research Laboratory (NRL) TESLA-family of 2.5D large-signal codes [1-6] is based on a set 4 highly accurate and efficient algorithms. The codes currently are widely used by the Vacuum Electronics (VE) industry and US companies as computational tools capable to model linear-beam amplifiers, including klystrons, MBKs, IOTs, EIKs and TWTs. These codes, being capable to produce the same level accuracy of solutions as the Particle-in-cell (PIC) codes, are far less demanding on computer resources and memory, while allowing fully 2D modelling of the VE amplifiers on a single core of the modern CPUs. To meet the challenges of the fast progressing area of VE amplifiers, we continue to extend and improve all TESLA algorithms to enable modelling of increasingly advanced and complex structures and designs. For example, recent trend in development of TWTs based on increasingly “open” Serpentine Slow-Wave Structures (SWSs) required extension of the code TESLA-FW algorithm to take into account potential effects of inter-gaps “coupling” [7]. Another part of our activity involves extension of the applicability of TESLA algorithms with their applications to high-power microwave (HPM) amplifiers: recent improvements in the klystron code TESLA algorithm enabled accurate modelling of the experimental relativistic klystron [8]. More general algorithm of the code TESLA-ZM [6] enabled geometry-driven large-signal modelling of a wide variety of VE amplifiers, including klystrons and TWTs. Recent extension of this algorithm enabled linear (“zero-drive”) stability analysis of the TWTs [9]. Following the previously completed study [10], ongoing development of the code TESLA-ZM algorithm targets modelling of such challenging phenomena as large-signal instabilities, including Drive-Induced Oscillation (DIO) [11]. We will present an overview of these developments and demonstrate results of application of newly improved and extended TESLA algorithms to the modelling of variety of experimental amplifiers.

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