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Accurate, quasi-3D modeling of single-beam and multiple-beam klystrons and iots by the Tesla-family of large-signal codes

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Klystrons and IOTs are widely used in accelerators as high-power RF sources. Development and optimization of klystron and IOT designs is aided by the use of different simulation tools, including highly efficient large-signal codes. We present an overview of the advances in the code development and modeling using Naval Research Laboratory (NRL) set of TESLA-family of large-signal codes, suitable for the modeling of single-beam and multiple beam klystrons (MBKs) and IOTs. Original 2.5D large-signal algorithm of the code TESLA*was developed for the modeling of klystrons based on (relatively) high Q resonators and is applicable to the multiple-beam devices in an approximation of identical beams/beam-tunnels. Parallel extension of TESLA algorithm (code TESLA-MBenabled an accurate, quasi-3D modeling of multiple-beam devices with non-identical beams/beam-tunnels. Added into TESLA algorithm procedure for proper treatment of 'slow' and 'reflected' particles***enabled accurate modeling of high-efficiency klystrons and contributed into the development of klystron with 80% efficiency. Recently developed more general TESLA-Z algorithm***** is based on the impedance matrix approach and enabled accurate, geometry-driven large-signal modeling of devices with such challenging elements as multiple-gap cavities and filter-loading. Examples of applications of TESLA-family of codes to the modeling of advanced single-beam and multiple-beam klystrons and IOTs will be presented.

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Footnotes

*A.N. Vlasov, et al., IEEE TPS, vol. 30, no. 3, pp.1277-1291, June 2002.I.A. Chernyavskiy, et al., IEEE TED, vol. 54, no.6, pp.1555-1561, June 2007.***I.A. Chernyavskiy, et al., IEEE TPS, vol. 36, no. 3, pp.670-681, June 2008.M. Read, T. Haberman, A. Jensen, R.L. Ives, 22nd IVEC, 2021.***I.A. Chernyavskiy et al., IEEE TED, vol. 64, no. 2, pp. 536-542, Feb. 2017.

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Primary author: CHERNYAVSKIY, Igor (Naval Research Laboratory)

Presenter: CHERNYAVSKIY, Igor (Naval Research Laboratory)

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