MULTI-FREQUENCY STABILITY ANALYSIS OF COUPLED CAVITY TWTS USING TESLA-CC*

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Spurious oscillations near edges of pass-bands due to periodicity ($\pi$ and $2\pi$) as well as edges due to manufacturing tolerance ($3\pi/2$) might develop in coupled cavity TWVs (CC-TWVs) and limit their performance. Modeling of spurious oscillations is a challenging computational task since the beam-wave interaction occurs at several frequencies simultaneously. In general, stability analysis is a non-linear problem since starting conditions for spurious oscillations might depend on input power at operating frequency.

We expanded the hybrid code TESLA-CC [1] to be capable of modeling of multi-frequency beam-wave interaction in CC-TWVs. The code is based on computationally efficient hybrid algorithm providing self-consistent solution of 3D equations of electron motion together with evolutionary equations for axially symmetric RF fields. The RF fields of the coupled-cavity structure are represented as a series of modes of equivalent Curnow circuit [2] expanded to multi-frequency case. The RF fields calculated by TESLA-CC inside the beam tunnel of the CC-TWT agree well with the fields calculated by 3D electromagnetic code ANALYST [3] for wide range of frequencies.

The 3D equations of electron motion are integrated at every time step in $d/dz$ with respect to the axial coordinate, $z$, for an initial ensemble of particles. The model for initial particles distribution has been developed to resolve the beam-wave interaction at the operating frequency and its temporal harmonics as well as at frequencies of spurious oscillations and combinational frequencies for limited number of particles. The code demonstrated promising agreement with the published examples of spurious oscillations in CC-TWVs.


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