Dynamic Simulation of Mode Selective Extended Interaction Cavity for Wideband, High Power Gyrotron Applications

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In order to build compact high power gyro devices, the following critical issues must be addressed first: To reduce magnet weight, operating gyrotron at cyclotron harmonic is essential. As a result of weaker harmonic interaction, long interaction length and high beam current must be utilized. These factors introduce severe mode competition problem. Furthermore, in order to avoid breakdown at the waveguide wall, the TE_{0n} mode with high n number is preferred.

To extend the interaction length and to alleviate the mode competition problem, the scheme which was actively pursued to accomplish these goals in the eighties is to connect two cavities with different radii by a gradual taper. The respective radius is chosen so that the cutoff frequency of both desired modes is the same. However, the above scheme is unable to completely eliminate the mode competition problem. For example, to use the TE_{01}/TE_{04} mode, the TE_{21}/TE_{24} combination can still pose a threat if a high beam current is required. We propose to use tapers with absorptive axial gaps to connect three cavities together ($TE_{02}/TE_{03}/TE_{04}$). In doing so, the interaction length is further extended and $m\neq0$ are suppressed. The absorptive gaps disrupt the wall current flowing azimuthally. Since the TE_{0n} mode does not induce any wall current, the presence of the gaps will not affect its performance.

We have carried out dynamic simulations of the proposed device. Simulation results show that three cavities couple together only if parameters are chosen properly and the field is peaked at the last cavity. After further optimization, we plan to place the proposed cavity as the output cavity of a inverted gyrotwystron. The bandwidth and output power of such a device will be investigated.

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