Optimization of Gyrokylystron Efficiency

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ABSTRACT

In this paper, the optimization of gyrokylystron efficiency is investigated by employing a two-step procedure. As a first step, the prebuncher is analyzed using a small signal approximation, since the cavity(ies) here serve mainly to modulate slightly the velocities of the electrons, which will be bunched in the field-free drift section(s). It is found that the electrons entering the energy extraction cavity can be characterized entirely by only two dimensionless parameters: a bunching parameter $q$ and a relative phase $\psi$. The numerical simulation of the extraction cavity, based on the nonlinear pendulum equations describing the interaction between the electrons and the rf field, supplemented by the initial conditions specified by $q$ and $\psi$, constitutes the second step. The final result of this two-step analysis is the efficiency, $\eta_{\perp,\text{opt}}$, optimized with respect to $q$, $\psi$ and the magnetic detuning parameter $\Delta$. This efficiency depends only on the normalized cavity length $\mu$ and the normalized rf field $F$ of the energy extraction section. The efficiency as well as the conditions required to attain this optimum ($q_{\text{opt}}$, $\Delta_{\text{opt}}$, and $\psi_{\text{opt}}$) are presented as contour plots on the ($F, \mu$) plane and can be used efficiently to design gyrokylystrons of any frequency and output power.