

EFFECTS OF HIGH PLASMA DENSITY ON THE ELECTROMAGNETIC PROPERTIES OF SLOW WAVE CIRCUITS *

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The presence of background plasma in a slow wave circuit can change its electromagnetic properties and affect the interaction of an electron beam with the circuit. In particular, loading of a slow wave structure with a radially nonuniform background plasma of high density ($\omega_{\text{plasma}} \geq \omega_{\text{radiation}}$) can dramatically change the nature of the waves in the structure, leading to the formation of hybrid modes. These modes are hybrids of the plasma and the empty structure modes, with no analog in an evacuated system. Two C-band coupled cavity TWT (CCTWT) circuits and an X-band corrugated wall cavity were studied over a wide plasma density range. The radial profile and the absolute density of the background plasma were measured using a combination of a newly developed Langmuir-like probe and a small resonant cavity that measured the frequency shifts due to the plasma. For the corrugated cavity, resonant frequencies of both the TM_{01} and TM_{02} modes were measured over the density range $10^{10} < N_p < 10^{13} \text{ cm}^{-3}$. As a plasma density was increased, flattening of the dispersion (ω - k) diagram was observed up to $N_p = 2 \times 10^{12} \text{ cm}^{-3}$. At still higher densities, strong frequency upshifts were measured. Our calculation showed that both the flattening of the dispersion curves and the large frequency upshifts are associated with the formation of hybrid plasma-structure waves in the corrugated cavity.

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