Study on the instability growth time in high-current radiation sources with explosive-emission cathodes

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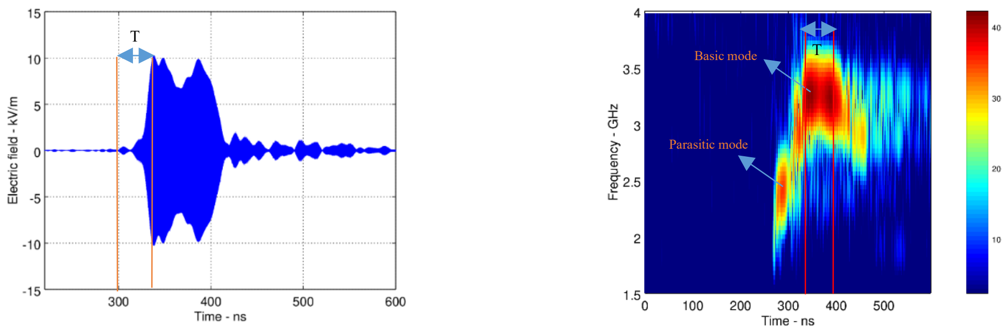
This paper studies the influence of explosive electron emission on the instability growth time (T) in high current radiation sources. Caused by explosive electron emission, the ecton structure of high-current electron beams determines the spectral density of the electric current in vacuum diodes. Knowledge of the spectral density opens the possibility of finding the typical value of the instability growth time. The theoretical results have predicted an instability growth time of around 50 ns. This was compared with the experimental results obtained in the case of a reflex triode. The experimental setup of this study is similar to the one reported in [1].

In order to analyze the experimental data, two approaches are adopted: first, the measured time-domain radiated electric field is transformed to frequency-domain applying the Fast Fourier Transform. Then, the spectrum is filtered and smoothed. Finally, the filtered signal is transformed back to time-domain using the Inverse Fourier Transform. Result is presented in Figure 1 (a). The Gabor transform is applied to the time-domain electric field signal in order to determine the frequency instability behavior. A summary of the frequency content of the signal using the Gabor transform is presented in Figure 1 (b) where the parasitic mode and the basic mode are depicted.



(a) (b)

Figure 1: (a) Filtered signal (b) Gabor transform of the measured signal

The instability growth time was measured from the linear stage to the non-linear stage in time-domain signal. In the case presented in Figure 1 (a), the measured instability growth time is T≈70 ns. On the other hand, a value T=70 ns was obtained from the basic mode duration in the Gabor transform, Figure 1 (b). As it can be seen both theoretical and experimental results are in close agreement. The discrepancy between both results (~20ns) can be attributed to the presence of parasitic modes in microwave oscillations and to time-varying properties of high-voltage pulse applied to the microwave source. Also, it should be noted that there is a significant uncertainty associated with the determination of the start of generation due to the presence of noise in the measuring equipment where it becomes possible to identify the signal when the field deviates noticeably from the background noise.

References

[1] V. Baryshevsky, "Experimental Study of an Axial Vircator With Resonant Cavity," *IEEE Transactions*, vol. 43, no. 10, p. 3507.