On the use of the Gabor Transform to Study the Instability Growth Time in Vircators

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Abstract—This paper proposes the use of the Gabor transform to determine the instability growth time in the signal produced by a Vircator. We'll describe the theory and parametrization of the Gabor transform and we'll apply it to a signal radiated by a vircator. The results will be compared with more traditional methods based on dimensional analysis and with other wavelet-based methods.

Keywords: Gabor transform, Instability growth time, Reflex triode

I. Introduction

In a High- power source, the instability growth time (T_{gt}) can be defined as the rate from the beginning of radiation (linear stage) to the non-linear saturation stage [1]. A preliminary estimate of the instability growth time is important when designing high-current generators, since the total beam duration must substantially exceed *T.* Otherwise, the generation simply will not have time to develop.

In this paper, we propose the use of the Gabor transform applied to the radiated electric field in order to estimate the instability growth time. This transform, named after Dennis Gabor, is a short-time Fourier transform representing a time function in time and frequency simultaneously. [2]

II. Methodology

We'll use the Discrete Gabor Transform (DGT) applying the methodology presented in [2]. In DGT, a Gaussian window will be multiplied by the function in time domain, and the resulting will be transformed using a classical Fast Fourier transform. The result will be plotted in a time-frequency diagram, where the magnitude of the frequency component will be expressed as a color code.

The DGT can be expressed by

$$s(t) = \sum_{m=-\infty}^{\infty} \sum_{n=-\infty}^{\infty} C_{m,n} h_{m,n}(t) \qquad (1)$$

where $C_{m,n}$ are the Gabor coefficients and $h_{m,n}(t)$ is the synthesis function, as in reference [2].

III. Experiment setup

The experimental setup is similar to the one presented in [4]. The radiated electric field *E(t)* was measured from a Reflex Triode and it's shown in Figure 1. The Gabor transform of *E(t)* is shown in Figure 2.

As it can be seen in Figure 2. there are two modes: parasitic mode and basic mode. The basic mode, containing most of the energy, occurs from 3.2 GHz to 3.4 GHz. The instability growth time can determined from the figure is around (~70 ns), which coincides with the theoretical results.

A Continuous Wavelet Transform (CWT) and Wavelet Synchrosqueezed Transform (WSST) were also computed. It was concluded that DGT is sharper and more precise than the other wavelets. Also, in DGT, the oscillation modes can be observed easily.

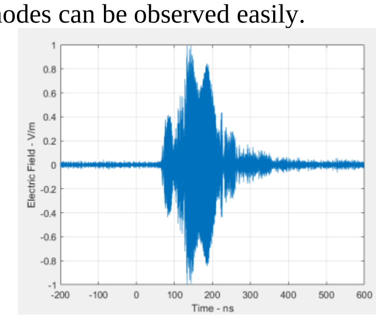

Figure 1. Normalized electric field

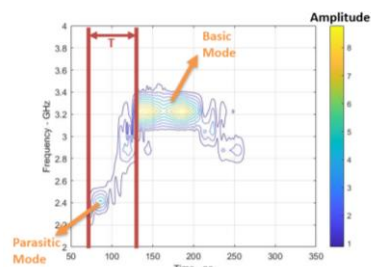

Figure 2. Gabor transform

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