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Numerical simulation of the propagation of short high-voltage pulses in dispersive coaxial lines

Abstract:

The efficiency of the x-ray beam is linked by the quality of the high-voltage pulses delivered by the emitting cathode. It is quite easy to achieve high quality requirements for the first pulse. However, it is a much more difficult for the next ones because their shapes are modified by the multiple bounces (oscillations) due to the previous voltage waves propagating in the transmission lines. In order to maintain high quality on successive pulses, reflections shall be limited. One proposed solution is changing current transmission lines by dispersive lines composed by thin semiconductor layers. With an attenuation rate in the right high-frequency band, bounces are minimized without disturbance of pulses shape (especially rise and fall edges).
This project aims to define the best design of these dispersive lines. The first stage is to study and to build electrical and electromagnetic models of well-known coaxial cables. Based on these models, the second stage is to define a first dispersive line and to validate it by experimentations.

Main results:

The project was started with the study of a RG58 coaxial cable. To build the model, impedance measurements (R, C, G) have been carried out on real samples. The radii of the different cable layers have also been measured. Then, these experimental values were implemented in CST Studio to computed the transmitted and reflected signals by this coaxial line.
Both figures on the right show a good correlation of the S-parameters (S11 and S21) returned by CST Studio (red curve) with those measured experimentally with a VNA on three different samples (blue curves). These results shall be confirmed by repeating this approach on other types of coaxial cables.