Simulation of Cable SGEMP Interference in High-power Laser Facility

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Abstract**—**The system-generated electromagnetic pulse (SGEMP) on a cable inside the chamber of high-power laser facility is studied. Coaxial cables are essential for the signal transmission of diagnostic equipment. Strong X-ray pulse would be generated after a laser shooting and a current interference caused by cable SGEMP could be observed, which would be an important source of EMI. The problem was modeled and solved through a numerical simulation with the Monte Carlo method and finite-difference time-domain (FDTD) method.

Keywords- high-power laser facility; X-rays; cable SGEMP; finite-difference time-domain

I. INTRODUCTION

Researchers have conformed that there is a harsh working environment for diagnostics applied in high-power laser facilities[1-2]. Coaxial cables are essential for the signal transmission of electronic equipment and could be an important source of EMI, even with good electromagnetic compatibility (EMC) design. X-rays could penetrate into the inner conductor to excite or induce a large number of electrons, resulting in a current response, which is named as system-generated electromagnetic pulse (SGEMP) response. The cable SGEMP interference could superimpose on the real signal and cause severe impact on experiments. After the laser shooting, strong X-ray pulse would be generated in the target chamber through secondary reactions. Efforts have been made to predict the SGEMP during a nuclear explosion. However, evaluation of cable SGEMP interference in high-power laser facility is highly needed.

II. METHODS AND MODEL

A layered cable model was developed to simplify the complex physical process, as shown in Fig. 1. From inner to outside, each layer's radius is respectively 0.1 mm, 0.5 mm, and 0.7 mm. The Monte Carlo method are used to deal with the particle transport and calculate the distribution of deposited charges inside a cable, with the commercial software MCNP5. The finite-difference time-domain (FDTD) method is introduced to solve the Maxwell equations of EM-field on the dielectric layer.

III. SIMULATION RESULTS

A numerical simulation code was implemented by the computer with X-rays selected to be 10 keV of average energy and 4.2 J/cm^2 of total fluence, which approximates the experimental environment of the target chamber, and the length of cable selected to be 1 cm to save calculation time. The effects of some physical parameters were studied and a linear relationship between the cable length and peak current response was discovered. As shown in Fig. 2, the typical time-domain waveform of current response excited by cable SGEMP resembles that of X-rays and the peak value could reach 0.25 A/m. The simulation results could provide effective support for the anti-radiation design of cables in the high-power laser facility.

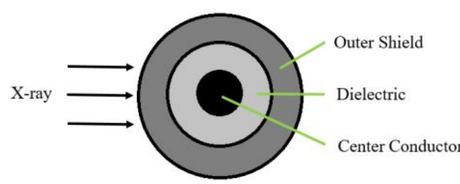

Figure 1. Illustration of the model.

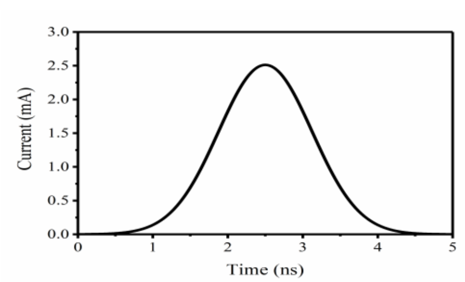

Figure 2. Waveform of the current response on the conductor.

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