Measurement of EMP environment inside target chamber of SG-III

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Abstract—ShenGuang-III (SG-III) is the most advanced laser fusion research plant in China. To accomplish the EMC design of the devices inside the chamber of SG-III, the transient magnetic field inside the chamber is measured and investigated in this paper. Two kinds of B-Dot sensor are used in the experiments. Also, anti-radiation shielding of sensor is considered in the measuring setup. At last, a typical waveform is illustrated and some preliminary conclusions are given.

Keywords-SG-III; EMC; magnetic field; measurement; B-Dot; anti-radiation

I. INTRODUCTION

SG-III is the most advanced laser fusion research plant in China. It focuses on the development of clean energy, research of fusion reaction physics, etc. As shown in Fig. 1, radiation effect, electromagnetic pulse (EMP) caused by the movement of the electrons, and system generated EMP (SGEMP) exist in the target chamber of SG-III [1]. EMP is the background EM environment affecting all the diagnostic devices placed in the chamber. Because of the broad bandwidth and high amplitude of EMP, electromagnetic compatibility of the diagnostic devices inside the chamber is difficult. Necessary measurement and understanding of the EM environment is required for EMC design of the diagnostic devices. So the magnetic field inside the target chamber of SG-III is investigated. At last, a typical measured magnetic field waveform is given.

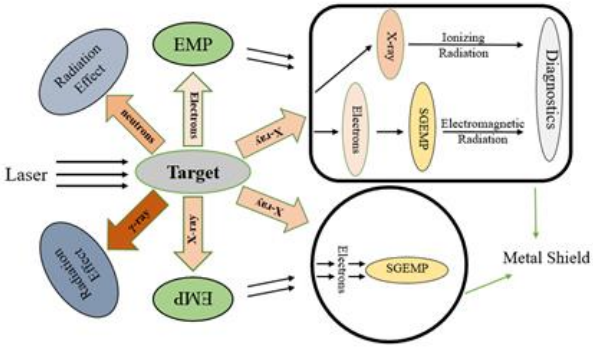

Fig. 1. Complex electromagnetic environment generated in the chamber of SG-III

II. SETUP OF MEASURING THE TRANSIENT MAGNETIC FIELD

The magnetic field is measured with B-Dot sensor. It is a kind of passive differential magnetic field sensor. The structure we use is Moebius Strip Loop. The advantages lie in rapid response, wide bandwidth, simple structure and the abilities to measure high-amplitude field and reduce the common-mode noise. Further, to expand the frequency bandwidth, a modified Moebius Strip Loop is also used in the design of senor structure [2]. As a consequence, the sensors contain two kinds of bandwidth, which are 1GHz and 300 MHz, separately. All the sensors are designed and manufactured by the laboratory of Tsinghua University Electromagnetic Pulse Environment and Effect.

Different from the regularly used B-Dot sensors, considering the ionizing radiation environment inside the chamber, the sensors used here are also designed to be anti-radiation. HDPE (high density polyethylene) material is used to reduce the effect of ionization radiation, including X-ray, gamma ray, and neutron. And the material will not distort the EM field which is to be measured.

III. RESULT AND CONCLUSION

A typical measured waveform is shown in Fig. 2. The blue line represents the original signal of B-Dot, whereas the red line represents the integration of the original signal, which is the resumed magnetic field waveform. It can be seen that the magnetic field is an oscillatory pulse. The time scale is about 100 ns. Analyze the frequency spectrum with FFT in Matlab, it can be obtained that the highest frequency of magnetic field can approach about 600 MHz. Also, through comparing the waveforms in different direction, it can be concluded that the vertical magnetic field strength dominates.

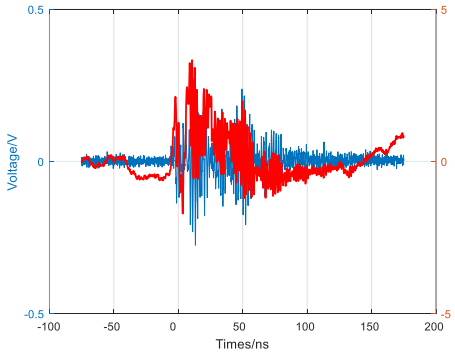

Fig. 2. Typical measured magnetic field waveform

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