# The effect experiments of CCD imaging system against high power electromagnetic pulse

Ping Wu, Cui Meng\* Key Laboratory of Particle & Radiation Imaging, Ministry of Education Department of Engineering Physics, Tsinghua University Beijing, China, 100084 p-wu16@mails.tsinghua.edu.cn

*Abstract*—High power electromagnetic pulse is one of threats inside laser target chamber, which could cause several effects of diagnostic equipment range from signal interference, data corruption to hardware damage. In this paper, a series of EMP experiments was carry out and a CCD imager system was chosen as vulnerable equipment. Several malfunction phenomena and a few of destruction cases were observed. The signal and imagers captured was processed and analyzed to explore the interference effects of EMP. The threshold and function relationship of device damage and image distortion was presented in this paper.

# Keywords: CCD imager; high power electromagnetic field; effect;

### I. INTRODUCTION

Electromagnetic Pulse (EMP) is a known issue for laser facilities, which could lead to the effects of diagnostic equipment range from signal interference, data corruption to hardware damage. However, the harsh environment inside laser target chamber is far more complicated, which

may include  $\gamma$ -ray, neutrons, metallic debris and other potential threat. In order to identify the effects caused by different environment factors, a separated and ideal experiment is designed to obtain the effects category and quantity data of imager system under EMP. In this paper, an experiment of different parts of imager system under several kinds of EMP sources was depicted. The quantity analysis of electronic interference and imager distortion was presented.

#### II. EXPERIMENT SETUP

In this paper, CCD imager was chosen as the typical example of diagnostic equipment. Consider both the simplification and integrality, a system constitutes by commercial CCD imager, AV data line, DAQ card and Image process terminal is build up as DUT. The incident HPEM field is excited by double-exponential high-voltage source and broadcasted by UWB(Ultra-wideband) antennas and GTEM (Gigahertz transverse electromagnetic wave) cell. Constituent parts of imager system were isolated or settled together against the incident pulse in different experiment settings to explore the effect contribution of those parts.



Fig. 1. Experiment setup of GTEM cell. (a) CCD imager was isolated and undergo radiation of EMP; (b) whole CCD imager system was undergo radiation of EMP.

# III. EXPERIMENT RESULT AND ANLYSIS

During the HPEM test, lots of malfunction phenomena and a few of destruction cases were observed. The destruction cases happen in the test of UWB in which field strength reaches up to 100 kV/m. The DAQ card kept inside shielded enclosure was still found burnout. Except for destruction cases, there are several malfunction and interference phenomena were observed, which include recording break, color distortion and row pixel flash. Image pixel grey level data was processed and at least 30% of pixel luminance distortion happened at the moment pulse incident. The minimum threshold of interference effects with different orientation is about 7 kV/m. the connection of interference effects and EMP environment describe factors will be further discussed.



Fig. 2. Pixel luminance distortion extract from time domain grey level analysis.

## REFERENCES

 Stathis P. Radiation and EMI effects in the NIF environment[J]. Nasa Sti/recon Technical Report N, 1994, 95.
Remo J L, Adams R G, Jones M C. Atmospheric electromagnetic pulse propagation effects from thick targets in a terawatt laser target chamber[J]. Applied Optics, 2007, 46(24):6166-75.