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Generation, detection, mitigation and potential applications of laser-generated electromagnetic pulses

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The generation of electromagnetic fields of remarkable intensity in the radiofrequency-microwave range is commonly observed in experiments where high energy and high power lasers interact with matter. These transient electromagnetic pulses (EMPs) depend on laser energy and intensity [1]. They can carry a significant portion of the incoming laser energy and be so powerful to represent a potential serious danger for any electronic device placed inside or even outside the experimental vacuum chamber. For this reason, the understanding of the origin and the mitigation of these electromagnetic fields is of primary importance for the operation of the existing laser facilities for inertial confinement fusion and laser-plasma acceleration. Of course, EMPs represent an even more severe issue for future laser facilities with higher energy and power. On the other hand, they can be constructively used for a large number of promising applications.

Several mechanisms are now recognized as sources of these EMP fields [2]. The main one is associated with the target positive charging caused by the fast-electron emission due to the laser-plasma interaction. This fast charging induces high neutralization currents from the conductive walls of the vacuum chamber [1-3]. It is possible to act on the target holder with the purpose to minimize this current [1,4].

The complex picture of the field distribution within the experimental chamber strongly depends on the physical localization and on the characteristics of each of the source processes, but is also affected by the expanding plasma and particle beams emitted from the target [3,5]. An up-to-date presentation of the problems related to generation, detection and mitigation of the strong electromagnetic pulses created in the interaction of high-power, high-energy laser pulses with different types of solid targets will be here given. This will include the activities on the EMP topic performed by the main international research centers active in this field.

References

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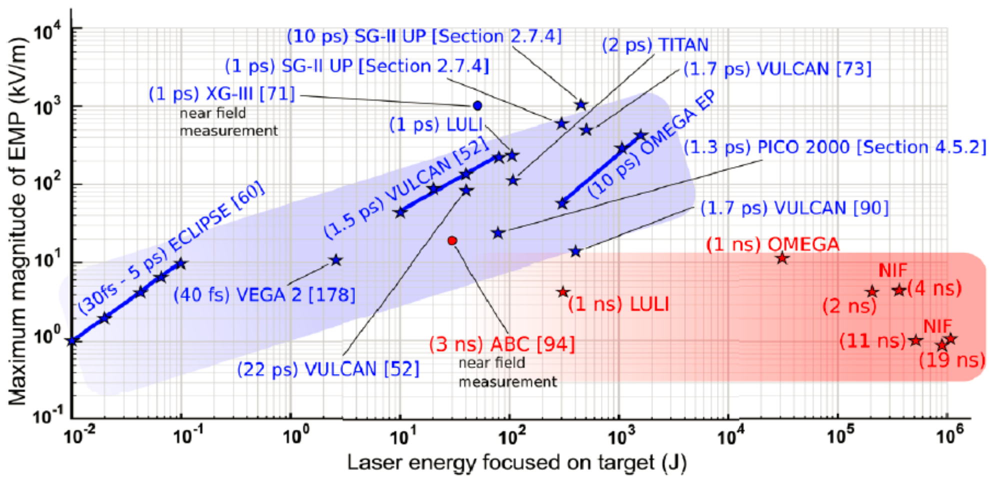

Figure 1. Set of the measured amplitudes of EMP signals at different laser installations [1]. Blue and red zones outline the data obtained with ps and ns laser pulses, respectively. All data were normalized to the reference distance of 1 m from the source.