Electromagnetic emissions at LMJ-PETAL facility: understanding, mitigation and measurement.

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The LMJ-PETAL is a large-scale facility that combines high energy nanosecond laser beams (300 kJ/3 ns in 2022) and high-power picosecond beam (400 J/0.6 ps in 2021). A combination of these beams is able to generate MV/m electromagnetic pulses (EMP) in GHz domain in the interaction chamber that may produce equipment failures, diagnostic damages, and spurious signals in detectors. The main mechanism of EMP generation is due to the return current through the target holder, induced by electron ejection from the laser-irradiated target [1]. However, other processes may also strongly contribute to the electromagnetic emissions [2].

The upgrade of PETAL up to energy of 1 kJ cannot be achieved without an efficient EMP mitigation strategy. By performing in-situ measurements on smaller-scale laser facilities and multiphysics, multiscale large scale numerical simulations, we further improved the understanding EMP generation processes and developed an efficient mitigation device [3]. We present in this paper a new resistive and magnetic target holder designed to reduce the current discharge. It is tested and validated in experiments showing the robustness and efficiency of this device at kJ energies.

Moreover, we present two recent advances in the understanding of EMP generation and detection: First, a THz emission makes a significant contribution to the signal when the main EMP source is efficiently mitigated. Second, the discharge current a few cm from the target can be measured with a good precision 4 m away from the target in the experiment chamber. This observation, validated by PIC simulations and near field measurements, may lead to a new efficient hot electron diagnostic.

References

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