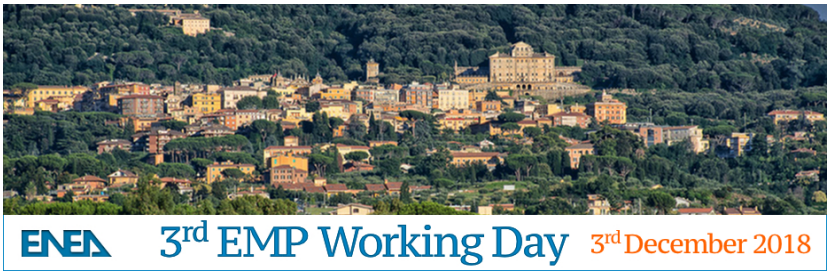

Contribution ID: **5** Type: **Oral Presentation**

Development of a low EMP proton source

Abstract

The targets that are used to produce high-energy protons with ultra-high intensity lasers generate a strong electromagnetic pulse (EMP). Several strategies are possible to mitigate that undesired side effect. In a recent publication [1], P. Bradford et al. report significant EMP mitigation by optimizing the material and the shape of the target stalk. They obtained a maximal 4.5 EMP amplitude ratio by using a spiral PTFE stalk instead of a regular stalk. We develop and test a different concept of EMP mitigation for a proton-target called the "bird-house". It consists in confining the EMP field in a finite volume and in dissipating the trapped electromagnetic energy with an electric resistor. A prototype was tested at the IFPILM institute's 10 TW 50 fs laser facility in Warsaw. The results were recently published [2]. The recorded average EMP mitigation ratio is about 20 for frequencies from 100 MHz to 6 GHz. The EMP mitigation ratio attains the level of 50 in the frequency range of 1 - 2 GHz where microwave emission is maximal. We measured the intensity of proton emission in two directions: along the laser propagation direction and along the edge of the proton beam. We observed that the "birdhouse" induces a two-fold increase of the intensity in the center of the proton beam and a two-fold reduction of the intensity on its edge. We did not observe any modification of the proton beam normalized spectrum. These obtained performances are encouraging but they have to be confirmed on a high-energy laser facility (> 100 J). For these energies, the real challenge for EMP mitigation solutions is to resist to the extremely high voltage between the target and the chamber that induces surface breakdown along the target stalk. By adjusting the "birdhouse" design, the EMP confinement strategy should be a lead to handle such a voltage.

Keywords:
Laser, electromagnetic pulse, mitigation, laser proton acceleration.

[1] P. Bradford, N. C. Woolsey, G. G. Scott, G. Liao, H. Liu, Y. Zhang, B. Zhu, C. Armstrong, S. Astbury, C. Brenner, P. Brummitt, F. Consoli, I. East, R. Gray, D. Haddock, P. Huggard, P. J. R. Jones, E. Montgomery, I. Musgrave, P. Oliveira, D. R. Rusby, C. Spindloe, B. Summers, E. Zemaityte, Z. Zhang, Y. Li, P. McKenna, and D. Neely, EMP control and characterization on high-power laser systems, High Power Laser Science and Engineering 6, e21 (2018)

[2] J. L. Dubois, P. Rączka, S. Hulin, M. Rosiński, L. Ryć, P. Parys, A. Zaraś-Szydłowska, D. Makaruk, P. Tchórz, J. Badziak, J. Wołowski, J. Ribolzi, and V. Tikhonchuk, Experimental demonstration of an electromagnetic pulse mitigation concept for a laser driven proton source,
RSI 89, 103301 (2018)

Primary author: JEAN-LUC DUBOIS, jean-luc (CELIA)

Co-authors: Dr RĄCZKA, Piotr (IFPILM); Dr HULIN, Sébastien (cea); ROSINSKI, marcin (IFPILM); Dr RYĆ, lesze (IFPILM); Dr PARYS, piotr (IFPILM); ZARAŚ-SZYDŁOWSKA, agnieszka (IFPILM); MAKARUK, Dominika (IFPILM); TCHÓRZ, przemyslaw (IFPILM); Dr BADZIAK, jan (IFPILM); Dr WOŁOWSKI, jerzy (IFPILM); RIBOLZI, jérôme (CEA); Prof. TIKHONCHUK, vladimir (CELIA / ELI-Beamlines)

Presenter: JEAN-LUC DUBOIS, jean-luc (CELIA)