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LASER ACCELERATORS SYSTEMS TO MIMIC SPACE CONDITIONS

Abstract

Outside of the Earth atmosphere, beside the lack of Earth-like ‘ambient conditions’ as pressure and ambiance oxygen content, cosmic rays represent a considerably issue which has to be considered for almost all kind of space mission. Ionizing radiation represents a threat both for life and for electronics and other sensitive devices, used in any space mission, therefore, safety testing on biological materials and devices before sending them in a mission is a key step for any space exploration project, step not always easy to perform.

Recent advances in high-power laser systems has allowed development of laser accelerator systems, which could accelerate particles to relativistic energies and generate so called ‘ionizing radiations’. Acceleration processes are produced by an ultra-short high-power laser beam, interacting with a target. Target is usually a gas target or an ultra thin solid (metallic) target, and the interaction takes place in vacuum. Such a laser-matter interaction is usually accelerating first the electrons, which in the case of a solid target could further extract and accelerate protons and even ions and further accelerate them. Such acceleration (and deceleration) processes will generate strong electromagnetic pulses (EMP), X-ray and even Gamma-ray (in some particular conditions). Cumulating these mixture of vacuum conditions and different types of ionizing radiations we could actually try to mimic extra-atmospheric conditions and potentially use them to test a device reliability in space conditions.

In the present work CETAL- 1 PW laser with a pulse duration of 35 fs, focused on a gas target was used for accelerating electrons. We have monitored associated radiation doses and we have compared them with the space conditions. Absorbed dose measured by gafchromic films was giving values of up to 16 mGy per pulse at a distance of about 1 m from the laser target interaction point (focus spot). Such doses of combined X-ray, accelerated electrons, (with energies up to few hundreds of MeV), accompanied by EMP (in the range of hundreds of MV/m) generated in a 10-5 mb air ambient pressure could relatively conveniently mimic orbital, Lunar or Mart’s surface conditions. While real space condition are usually having several times smaller doses than our maximal generated values, dose control could be achieved both by controlling laser parameters but also by controlling the ionizing radiation types mixture, through

the measurement position point, within the laser acceleration setup. Some spatial distribution of doses and potential mixed radiation options are also presented.