**Multilayer time-of-flight detector for real-time particle detection in laser-matter experiments**

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The detection of accelerated particles is a powerful method for getting information on the physics of intense laser-matter interaction, in both Inertial Confinement Fusion and Laser-Plasma Acceleration schemes. One of the important requirements nowadays is the capability to run diagnostics in real-time mode. Time-of-Flight (ToF) methodologies may allow accurate characterization of incoming accelerated ions, and are intrinsically real-time schemes. Unfortunately, they cannot supply discrimination on the species of the incoming ions, but only on their velocities. In some conditions, this limitation can be overcome by theoretical considerations or by the use of specific filtering foils. A promising technique can exploit the different ranges of ion species, as discussed in reference [1], for a scheme of several active ToF sensors placed in cascade. There, a single ion will undergo energy attenuation depending on both its energy and its species, traveling from one layer to the following one. The energies collected on each sensor can give real time characterization of number, energy and type of the incoming particles. In this work we describe a high-sensitivity ToF prototype detector that we have developed, consisting of three sensitive diamond sensors placed in cascade, in a structure with robust shielding to laser-generated electromagnetic pulses [2]. The sensors have different thicknesses and for each a different foil filter can be mounted, allowing for a high degree of adaptability of the structure to several possible experimental conditions and regimes of laser-matter interaction. The sensor thicknesses chosen for this first prototype took into account diamond robustness and device realization ease to demonstrate the actual capabilities of the adopted scheme. This choice is related to the energy range of incoming particles where the multilayer structure principles can be applied, as it will be discussed. This opens the field for future multilayer active structures for different particle energy ranges. In particular, details on the design, realization and test of the full structure on high intensity laser-matter experiment, will be given.a

[1] M. Salvadori, F. Consoli et al, Scientific Reports 11, 3071 (2021)

[2] F. Consoli et al, High Power Laser Science and Enginering 8, e22 (2020)

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