Advanced time-of-flight diagnostics for real-time characterization of ions accelerated by high energy lasers

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Time-Of-Flight (TOF) methods are very effective to detect ions accelerated in laser-plasma interactions, but they show significant limitations when used in experiments with high energy and intensity lasers, where both high-energy ions and remarkable levels of ElectroMagnetic Pulses (EMPs) in the radiofrequency-microwave range are generated.
In this work an advanced diagnostic technique for the characterization of protons accelerated by intense laser-matter interactions with high-energy and high-intensity lasers has been implemented.
The proposed method exploits and improves the advantages given by TOF technique coupled to Chemical Vapor Deposition diamond detectors and features high sensitivity, high energy resolution and high radiation hardness. Thanks to the optimization of the acquisition system and to the careful setup of the TOF line, high signal-to-noise ratios in environments heavily affected by remarkable EMP fields have been achieved.
Various types of diamond structures and electrode layouts have been tested and their performances characterized for application as detectors to be employed in TOF lines.
A novel procedure to retrieve a calibrated proton spectrum from the performed measurements is here also proposed and discussed.

The developed technique has been applied for detecting laser-plasma accelerated particles produced in different application scenarios and in the most variable laser-matter interaction conditions where it has been proven to be effective in reducing the EMP noise and in enhancing the dynamic range*.

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