High sensitivity Thomson spectrometry: analysis of measurements in high power picosecond laser experiments

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Thomson spectrometers (TS) are designed for revealing and differentiating protons from heavier ions in experiments of intense laser-matter interaction. The combination of electric and magnetic field allows deflecting ion species with different mass-to-charge ratio on different orbits. However, even small distortions of the device's internal fields can lead to a degradation of the measurement quality. Hence, TS are sensitive to both high electromagnetic pulses (EMPs) [1] and static charge accumulation caused by the interaction. Here we report on the analysis of data obtained with a TS designed to have a high sensitivity and a robust, optimized shielding against EMPs, even at short distances from the interaction point, where e.m. radiation is more intense [2,3]. The spectrometer was placed ~50 cm from the target during an experiment on the PHELIX laser at GSI (~180 J energy, >10^{20} W/cm^2 intensity, sub-ps laser pulses on solid targets). Despite the presence of strong EMPs (up to 100 kV/m at 1 m distance from the target), the TS was able to retrieve a good quality signal. Nevertheless, we show that the generation of fast electrons that enter the TS, may lead to internal electrostatic fields (in the tens of kV/m range). These induced fields alter the trajectory of the detected ions, making the interpretation and characterization of the particle species more difficult. This effect was analyzed with ad-hoc particle tracking simulations. This study is of high importance for the effective implementation of this type of high-sensitivity TS in experiments with PW-power lasers. *

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References

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