

Studies of ultrafast dynamics in substrate-free nanoparticles at ELI using Timepix3 optical camera

We present a novel application of the Timepix3 optical camera (Tpx3Cam) for investigating ultrafast dynamics in substrate-free nanoparticles at the Extreme Light Infrastructure European Research Infrastructure Consortium (ELI ERIC). The camera, integrated into an ion imaging system based on a micro-channel plate (MCP) and a fast P47 scintillator, enables individual time-stamping of incoming ions with nanosecond timing precision and high spatial resolution.

The detector successfully captured laser-induced ion events originating from free nanoparticles disintegrated by intense laser pulses. Owing to the broad size distribution of the nanoparticles (10–500 nm) and the variation in laser intensities within the interaction volume, the detected events range in occupancy from near-zero to extremely high—approaching the readout limits of the detector.

By combining time-of-flight and velocity map imaging (VMI) techniques, detailed post-processing and analysis were performed, allowing for the reconstruction of the three-dimensional ion momentum distributions. The results presented here focus on the performance of Tpx3Cam under high-occupancy conditions, which are of particular relevance to this study. These conditions approach the limitations imposed by the camera's readout capabilities and challenge the effectiveness of standard post-processing algorithms.

We investigated these limitations and associated trade-offs, and we present improved methods and algorithms designed to extract the most informative features from the data.

Workshop topics

Applications

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