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Dynamic x-ray imaging of laser-driven nanoplasmas

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A major promise of current x-ray science at free electron lasers is the realization of unprecedented imaging capabilities for resolving the structure and ultrafast dynamics of matter with nanometer spatial and femtosecond temporal resolution or even below via single-shot x-ray diffraction. Laser-driven atomic clusters and nanoparticles provide an ideal platform for developing and demonstrating the required technology to extract the ultrafast transient spatiotemporal dynamics from the diffraction images. In this talk, the perspectives and challenges of dynamic x-ray imaging will be discussed using complete self-consistent microscopic electromagnetic simulations of IR pump x-ray probe imaging for the example of clusters. The results of the microscopic particle-in-cell simulations (MicPIC) enable the simulation-assisted reconstruction of corresponding experimental data. This capability is demonstrated by converting recently measured LCLS data into a ultrahigh resolution movie of laser-induced plasma expansion. Finally, routes towards reaching attosecond time resolution in the visualization of complex dynamical processes in matter by x-ray diffraction will be discussed.