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Probing Nanostructures for a Novel Inertial Fusion Energy Ansatz with X-rays from a Laser-Driven Plasma-Wakefield Accelerator

Nuclear fusion represents one of the most promising and at the same time challenging pathways toward a sustainable and reliable energy production. A novel inertial fusion concept proposes the use of nanostructured targets in the form of arrays of thin rods that are irradiated by high-intensity laser pulses. The resulting rapid electron expulsion triggers a Coulomb explosion that accelerates nuclei to high energies, potentially enabling efficient heating and compression of solid fusion fuel. Experimental validation of this approach is crucial, but the underlying dynamics unfold on femtosecond time scales and nanometer length scales, posing significant diagnostic challenges.

This work investigates the feasibility of probing these targets during the laser-target interaction using laser-driven plasma-wakefield accelerators for X-ray generation, delivering ultrashort and high-brightness pulses via either betatron radiation or inverse Compton scattering. We want to explore possibilities to use these radiation sources for small-angle X-ray scattering or coherent diffraction imaging to probe the interaction at the nano target.

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