Tu-4.

Ultrafast 25 keV backlighting for experiments on Z

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Sandia is operating 'Z', a 26 MA z-pinch facility to conduct experiments in the field of high energy density physics [1]. For several years this facility has utilized Z-Beamlet, a kJ/ns class laser system, to provide x-ray backlighting as a crucial diagnostic [2]. Due to the nature of the interaction between nanosecond laser pulses with matter, the efficiency of Z-Beamlet drops dramatically for x-ray energies beyond 6 keV, which does not longer suffice for a variety of experiments. In addition, several experiments require shorter pulses to freeze-frame fast processes.

To satisfy more demanding requirements of backlighting on Z, Sandia has built the Z-Petawatt laser, which can provide laser pulses of 500 fs length and up to 120 J (100TW target area) or up to 450 J (Z / Petawatt target area). While the new laser system had first successful experiments with stand-alone experiments such as novel intensity diagnostics [3] and proton acceleration [4], the main mission focuses on the generation of high energy X-rays, such as tin K_α at 25 keV in ultra-short bursts. Achieving 25 keV radiographs with decent resolution and contrast required addressing multiple problems such as blocking of hot electrons, minimization of the source, development of suitable filters, and optimization of laser intensity. Due to the violent environment inside of Z, an additional very challenging task is finding massive debris and radiation protection measures without losing the functionality of the backlighting system. We will present the first experiments on 25 keV backlighting including an analysis of image quality, X-ray efficiency and redundantly engineered machine safety measures.

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Tu-5.

Near-field enhanced electron acceleration from dielectric nanospheres in intense few-cycle laser fields

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The interaction of nanostructured materials with few-cycle laser light has attracted significant attention lately [1-3]. This interest is driven by both the quest for fundamental insight into the real-time dynamics of many-electron systems and a wide range of far-reaching applications, such as, e.g. ultrafast computation and information storage on the nanoscale and the generation of XUV frequency combs.

We investigated the above-threshold electron emission from isolated SiO_2 nanoparticles in waveform controlled few-cycle laser fields at intensities close to the tunneling regime [4]. The enhancement of the electron acceleration from the silica nanoparticles was explored as a function of the particle size (ranging from 50 to 147 nm) and the laser peak intensity (1 - $4{\cdot}10^{13}$ W/cm^2). Obtained cut-off values in the kinetic energy spectra are displayed in Fig. 1. The cut-off values show a linear dependence with intensity within the studied intensity range, with the average cut-off energy being 53 U_p, indicated by the black line. Quasi-classical simulations of the emission process reveal that electron rescattering in the locally enhanced near-field of the particle is responsible for the large energy gain. The observed near-field enhancement offers promising new routes for pushing the limits of strong-field phenomena relying on electron rescattering, such as, high-harmonic generation and molecular imaging.

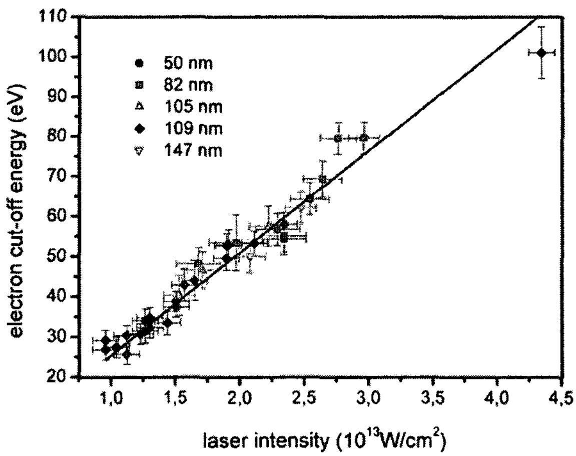

Fig. 1 Dependence of the cut-offs in the electron emission spectra from SiO_2 nanoparticles on laser intensity. Nanoparticles of different sizes are represented by different symbols as indicated in the legend.

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Tu-6.

QED studies using high-power lasers

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The event of extreme lasers, for which intensities above 10^{22} W/cm^2 will be reached on a routine basis, will give us opportunities to probe new aspects of quantum electrodynamics. In particular, the non-trivial properties of the quantum vacuum can be investigated as we reach previously unattainable laser intensities. Effects such as vacuum birefringence and pair production in strong fields could thus be probed. The prospects of obtaining new insights regarding the non-perturbative structure of quantum field theories shows that the next generation laser facilities can be an important tool for fundamental physical studies. Here we aim at giving a brief overview of such aspects of high-power laser physics.