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Laser-driven Swift Ion Bunches

My group at the Chair for Medical Physics at the LMU Munich investigates the acceleration of ion bunches through the interaction of laser pulses at relativistic intensities with plasmas. Over the last 15 years, Laser-ION (LION) acceleration has been the focus of intense research, which I will review in my talk. Our main objective is to realize viable sources for applications in radiation physics, material science, chemistry, biology and medicine. Currently, we establish the Centre for Advanced Laser Applications (CALA), which will feature a laser system able to provide 20 fs short laser pulses with peak power of up to 3 Peta-Watt.

This talk will provide information on the ultrafast processes that lead to the acceleration of ions to kinetic energies from a few to 10s of MeV per nucleon. I will highlight challenges and limits of our current understanding and explain latest break-through demonstrations. The difficulty of advancing laser-driven ion acceleration into integrated laser-driven ion acceleration systems (ILDIAS) mainly originates from the fact that in the focus of a PW-laser pulse, the light intensities rise from the damage threshold of solid matter ($\sim 10^{13} \text{W/cm}^2$) via relativistic intensities (10^{18}W/cm^2) to the maximum intensity ($10^{20} \dots 10^{22} \text{W/cm}^2$) within a few 10s of picoseconds. The actual acceleration phase in electric fields of the order $\text{MV}/\mu\text{m}$ happens within a few 10s of femtoseconds. This extraordinary acceleration though enables unique characteristics of ion bunches to be exploited. I will explain three recent examples that range from sub-picosecond resolved ion induced dynamics in solids to the generation of soundwaves in water on the microsecond scale.

CV: Jörg Schreiber received his Diploma in physics on studies with high power laser pulses at the University of Jena. After completing his PhD-studies and a short post-doctoral phase on laser-driven ion acceleration at the Ludwig-Maximilians-University (LMU) and the Max-Planck-Institute for Quantumoptics (MPQ) in Garching, he investigated relativistic plasma physics as a DAAD-PostDoc-fellow at the Imperial College in London. On his return to Germany, he accepted a position at the MPQ as team leader for laser-ion acceleration, particularly to realize the first ion-cell-irradiation study. Since 2011, Jörg Schreiber is associated Professor at the chair of medical physics of the LMU. Amongst his responsibilities is the installation and the realization of laser-driven sources at the Center for Advanced Laser Applications (CALA).