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Maximizing the energy of laser-accelerated protons and ions within Target Normal Sheath Acceleration

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The Target Normal Sheath Acceleration mechanism is perhaps the most robust, and certainly the most studied, process by which protons and ions are accelerated to multi-MeV energies in ultra-intense laser-matter interactions. It is characterized by the generation of superstrong TV/m ambipolar electric fields in the relativistic electron sheath on the rear-surface of laser-irradiated thin foils, and the subsequent quasi-neutral plasma expansion driven by the electron thermal pressure. The maximum achievable ion energies should increase with increasing hot electron temperature and density, depending upon the laser pulse parameters and the geometry of the target and laser-plasma interaction. To date, proton energies of up to 67.5 MeV have been observed. In this talk, techniques to further increase the proton and ion energies from TNSA will be reviewed, with emphasis on experimental results from the FZD Draco Ti:Sa laser and with our collaboration partners working at several higher energy Nd:glass lasers world-wide. Scaling of the proton energy with the laser pulse energy and intensity, pulse length and contrast, and by variation of the target geometry and properties, such as thickness, transverse size, and by target shaping, will be discussed.