New compact laser-based high energy particles sources

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With the advent of high intensity short pulse lasers the compact acceleration of electrons and ions to high particle energies has become a rapidly growing field of research.
Specifically, the quest for high energy ions and secondary radiation for applications like material research or even cancer treatment has been going on for some years. Recently using high contrast short pulse lasers and the concept of relativistic transparency a breakthrough has been achieved with respect to ion energy and the production of neutrons. Using the 200 TW TRIDENT laser at Los Alamos National Laboratory (LANL) and the 400 TW laser PHELIX at Helmholtzzentrum für Schwerionenforschung - GSI in Darmstadt we have achieved proton energies well exceeding 100 MeV and intense pulses of neutrons in recent experiments [1].
Our first short-pulse laser-driven neutron source, powerful enough for radiography is operating in the relativistic transparency regime. Based on the mechanism's advantages, a laser-driven deuteron beam is used to achieve a new record in laser-neutron production, in numbers, energy and directionality. Thus using short pulse lasers, it is now possible to use the resulting hard x-rays and neutrons of different energies to radiograph an unknown object and to determine its material composition, including the first demonstration of laser-driven neutron resonance spectroscopy. Our data matches the simulated data for our test sample [2].
We report on results showing relativistic transparency on thin foil targets, ion beams from solid hydrogen targets and the successful injection into ion optical systems for further applications [3]

[1] M. Roth et al., Phys. Rev. Lett., **110**, p. 044802 (2013)

[2] D. Jung et al., Physics of Plasmas **20**, 056706 (2013)

[3] S. Busold et at., Phys. Rev. ST Accel. Beams 16, 101302 (2013)