The role of a prepulse in laser-driven ion acceleration (PIC simulations)

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Laser-driven ion beams have a great importance since high intensity pulsed lasers were developed. Many efforts were made in studying and manufacturing micro/nano-structured targets in order to both decrease beam divergence and/or increase beam charge and maximum ion energy and thus fulfill the requirements of foreseen applications such us laser-driven hadrontherapy, fast ignition of inertial fusion or pulsed radiolysis etc. Laser prepulse is being widely known and treated as unwanted feature in laser acceleration experiments. As a consequence of ablative pressure of blow-off plasma generated by a laser prepulse, a shockwave can penetrate into the target and thus destroy a micro/nano-structures on target front or even back side before the main pulse comes. This work introduces Particle-in-cell simulations performing physical situations when the laser prepulse is present. This includes firstly flat target(s) with generated layer of preplasma causing e.g. self-focusing and thus local increase of laser peak intensity and secondly scenario in which the laser prepulse causes an expansion of solid/cryogenic target up to near critical density and magnetic vortex field plays a role in ion acceleration. The optimal parameters for obtaining desired beam features or required scenario will be derived analytically. Part of the PIC results will be also compared to experimental data measured during laser-driven ion acceleration experiment at VULCAN laser (Rutherford Appleton Laboratory, UK) from cryogenic hydrogen ribbon.