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Laser-Ion-Acceleration using Water Droplets and Optical Probing

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In order to gain more insights into laser driven ion acceleration experiments it is advisable to probe the laser target interaction, for example with an optical probe. Water droplets are ideal targets for this purpose, because the laser illuminated and the rear surface can be imaged simultaneously. However, strong light emission from the plasma typically outshines the probe.
To overcome this we used in our experiment the frequency doubled main pulse of the JETI 40 laser system at 400 nm while using a broadband optical probe centered around 750 nm. This gave us the opportunity to select a spectral region in which the plasma emission was weakest. Using this method, we could observe the hydrodynamic expansion of a water droplet hit by the laser pulse on a picosecond timescale. Although this is not directly related to ion acceleration, which takes place on a femtosecond timescale, the geometrical form of the expansion could be related to the maximum proton energy. Additional measurements of the proton beams' spatial profile have been performed which show strong density modulations likely connected to modulated electric or magnetic fields at the target's rear side, which will be investigated with the help of simulations.

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