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# Contrast Dependence of Laser-Driven Proton Acceleration

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Laser-driven proton acceleration to high kinetic energies has great potential for applications in e.g. time-resolved radiography or in high-dose radio-biology. To date, however, a strong discrepancy remains between theoretical predictions of the maximum proton energies (Eprot) and the experimental results. Furthermore, a tremendous progress in laser development did not lead to a dramatic improvement of Eprot, which suggests principally limiting physical processes that need to be investigated in detail. For this reason, we carried out an experimental study on the POLARIS laser facility of the Eprot-scaling with laser energy, which was varied by more than one order of magnitude and with different levels of temporal intensity contrast. The results show a clear increase of the scaling exponent with reduced pre-plasma scale lengths from a root-like up to a linear Eprot scaling, which occurs for a scale length of $L \leq 2\mu m$. This is most likely induced by laterally recirculating hot electrons enhancing the rear-surface electric field. Furthermore, we see a clear limitation of Eprot, whereby a further increase of the laser energy does not lead to a further increase of Eprot. This, we attribute to stopping of hot electrons inside the target due to the onset of two-stream-instabilities.

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