Plasma-photonic response to electron-beams as a versatile tool for plasma accelerators

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Particle accelerators based on plasma wakefields are one of the most promising technologies under development to generate highly relativistic lepton beams for high-energy physics research or as compact drivers of light sources. So far, particle acceleration by energies of 7.8 GeV [7] and 42 GeV [6] were achieved in singular plasma accelerator stage. However, to reach TeV energies for future particle colliders as envisioned e.g. in the European strategy for particle physics [2] this technology will be drastically up-scaled, which might require tens or hundreds of subsequent plasma accelerator stages all operating in unison. Along this path comes the need for compact diagnostics that do not add to the overall accelerator footprint. In the past, energy transferred from an electron beam to the plasma could be successfully linked to an increase in recombination light yield [1]. By combining a strong plasma response with the femtosecond ionization dynamics of short laser pulses, a precise timing diagnostic could be established and allowed to dial-in timing-critical experiments such as e.g. plasma cathodes [3, 4, 5]. These results indicate that the plasma response towards a particle beam can be a powerful tool to monitor the performance of plasma accelerators when properly modeled. We report on recent experiments conducted at the CLARA accelerator at the Daresbury Laboratory [8] in which we demonstrated and calibrated a compact plasma-light based diagnostic enabling a feedback system. We will present results of the study and discuss their relevance towards multistage plasma accelerators.

References

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