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Generation and acceleration of electron bunches from a plasma photocathode

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Fundamental improvements of the quality, and stability of the electron output of plasma wakefield accelerators are required to realize key applications such as hard X-ray FELs and lepton colliders [1]. Here we report on the first realization of a plasma photocathode [2], in which a spatiotemporally synchronized laser beam is used to release tunnel-ionized electrons inside an electron beam driven wakefield. This concept decouples injection from wakefield excitation and opens a regime of ultralow emittance and ultrahigh brightness [3] due to localized injection. Details of the experimental SLAC FACET “E-210: Trojan Horse PWFA” programme are presented, including innovations which allow to successfully address key challenges of spatiotemporal injection and plasma control. This proof-of-concept milestone [4] has been realized in 90° geometry and under significant experimental constraints. Improvements of setup and experimental boundary conditions allow exploring the full range and quality of electron output, and its stability. An analysis of stability and quality reach expected from upcoming realizations of the scheme are presented.

[1] <https://arxiv.org/abs/1904.09205> UK PWASC Roadmap

[2] PRL 108, 035001 (2012)

[3] Nat. Comm. 8,15705 (2017)

[4] Generation and acceleration of electron bunches from a plasma photocathode, Nat. Phys., accepted (2019)

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