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All-optical control on acceleration length to optimize laser wakefield acceleration

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One of the experimental configurations of interest, to verify the theories of strong-field quantum electrodynamics (SF-QED), is the collision of multi GeV electron beam with an ultra-intense laser pulse. Such sophisticated experiments also require strong theoretical support, more specifically simulation support, not only at the designing stage of the experiment but also after the experiment to understand the results.

For such experiments, to produce a multi-GeV electron beam, we are exploring various interesting concepts, such as, all optical-dual-staged laser wakefield acceleration [1], and transitional laser-plasma electron acceleration (Transition from laser to electron beam-driven wakefield acceleration). We here discuss some of the possible ways to extend the acceleration length of electron bunch beyond the single-stage LWFA, without compromising the beam quality.

We extend the discussion on acceleration beyond the single-stage LWFA by proposing an all-optical dual-stage LWFA, staged with co-propagating two-colour laser pulses in a plasma medium. After the depletion of the leading fundamental laser pulse that initiates self-injection and sets up the first-stage particle acceleration, the subsequent second-harmonic laser pulse takes over the acceleration process and accelerates the electron bunch in the second stage over a significantly longer distance than in the first stage.

References

[1] **V B Pathak**, H T Kim, J Vieira, L O Silva and C H Nam, Scientific Rep., **8**, 11772 (2018).