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Achieving competitive overall energy-transfer efficiency in a plasma accelerator

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Beam-driven plasma-wakefield acceleration has the potential to reduce the size and construction cost of large-scale accelerator facilities, by providing accelerating fields orders of magnitude greater than that of conventional accelerating structures. To keep the running costs affordable, high energy-transfer efficiency from the wall-plug to the accelerated bunch has to be demonstrated. For this, drive bunches must be efficiently produced, strong decelerating fields must be sustained for the drive bunches until their energy is depleted, and the resulting accelerating fields must be strongly beam loaded by the trailing bunches. Here we address the state-of-the-art in all three phases by reviewing the expected klystron efficiencies at future facilities, reporting on recent measurements performed at FLASHForward whereby 50% of the drive-beam energy is transferred to the wake, and laying the groundwork for how these results can be combined with previous record results in the transfer of energy from the wake to the accelerating beam. With this expected level of energy-transfer efficiency it is shown that plasma accelerators hold the potential to become competitive with conventional accelerators.

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Footnotes

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