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Energy recovery in filament-regime plasma wakefield acceleration of positron beams

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The filament regime is a promising candidate for the acceleration of positron beams in plasma because it is emittance-preserving and stable to transverse offsets [Diederichs et al, PRAB 25, 091304 (2022), Diederichs et al, PRAB 23, 121301 (2020]. Beam loading dynamics limit the maximum amount of energy that can be extracted from the wake by the trailing positron bunch. We explore efficiency enhancements through the use of an additional trailing electron recovery bunch using the HiPACE++ PIC code. We discuss potential experiments at the FACET-II facility as part of the E-333 experimental collaboration. We also provide a concept for a future collider facility that would accelerate positron bunches in the filament regime and use electron recovery beams as drivers of subsequent stages.

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