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High gradient IFEL acceleration and deceleration in strongly tapered undulators.

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Efficient coupling of relativistic electron beams with high power radiation in magnetic undulators lies at the heart of advanced accelerator and light source research and development. Recent inverse free electron laser experiments using strongly tapered undulators have demonstrated high-gradient (>100 MV/m) and high energy gain (> 50 MeV) acceleration of externally injected electrons, producing beams of high-quality (< 2 % energy spread and < 3 mm-mrad emittance). Using the tapering optimization principles developed for IFEL accelerators and taking into account the evolution of the radiation field along the interaction, it is possible to design strong tapering undulators where a large fraction of energy (> 50 %) may be transferred between the electrons and laser, enabling compact, high-current GeV accelerators and light-sources of unprecedented average and peak powers.

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