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Generation of an ultrashort GeV proton bunch in an instability-free regime by a single-cycle laser pulse

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Prompted by the possibility to produce high energy, single-cycle laser pulses with tens of Petawatt (PW) power, we have investigated laser-matter interactions in the few optical cycle and ultra relativistic intensity regimes. A particularly interesting instability-free regime for ion production was revealed leading to the efficient coherent generation of short (femtosecond) monoenergetic ion bunches with a peak energy greater than GeV. Of paramount importance, the interaction is absent of the Rayleigh Taylor Instabilities and hole boring that plague techniques such as target normal sheath acceleration and radiation pressure acceleration.

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