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All-optical control of electron trapping in plasma channels[1] SERGUEI Y. KALMYKOV, BRADLEY A. SHADWICK, University of Nebraska - Lincoln, XAVIER DAVOINE, CEA, DAM, DIF, Arpajon, France — Generation of background-free, polychromatic electron beams using laser plasma acceleration in longitudinally uniform, mm-length dense plasma channels is demonstrated. Periodic self-injection and acceleration transfers up to 10 percents of the drive pulse energy to several 100-pC charge, GeV-scale-energy electron bunches, each having a few-percent energy spread. Negative chirp of the broad-bandwidth (up to 400 nm), few-Joule-energy driver reduces the nonlinear frequency red-shift, preventing rapid self-steepening of the pulse, whereas the channel suppresses diffraction of the pulse leading edge. The pulse thus remains uncompressed through electron dephasing, strongly reducing unwanted continuous injection [S. Kalmykov et al., New J. Phys. 14 (2012) 022025]. As a bonus, delayed self-compression of the driver extends the dephasing length, boosting electron energy to the GeV level. The number of the quasi-monoenergetic bunches, their charge, energy, and energy separation can be controlled by varying the channel radius and the acceleration length, whereas accumulation of the noise (viz. continuously injected charge) is prevented by the proper dispersion control via negative chirp of the pulse. These clean polychromatic beams can drive tunable, multi-color gamma-ray Compton sources.

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