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Tailored supersonic gas jets for laser plasma accelerators[1]
ROBERT MADDEN, MAHADEVAN KRISHNAN, BASTIAN BAUDISCH, BRIAN BURES, KRISTI WILSON-ELLIOT, Alameda Applied Sciences Corporation, PHILIP COLEMAN, Evergreen Hill Sciences — Petawatt class lasers have been used to demonstrate acceleration of electron bunches to ∼1-3GeV energy over distances of ∼10-30mm, an accelerating gradient of ∼100GeV/m. Present gas jets have lengths of only 2-4 mm at densities of 10^{19} cm^{-3}, sufficient for self trapping and electron acceleration to energies up to ∼150 MeV. Capillary structures 3 cm long have been used to accelerate beams up to 1 GeV. Several concepts have been suggested that use tailored gas density distributions to enhnace the laser plasma acceleration. Stepped profiles (high density followed by lower density) have been suggested in which the short and dense region acts as a nonlinear lens, followed by the lower density and long plateau in which background electrocn are trapped and accelerated by a nonlinear laser wakefield. Other profiles have been suggested to keep the electrons in phase with the wakefield and thereby increase energy and charge in the bunch. Such tailored gas profiles require innovative supersonic gas nozzles, the design of some of which are described. The nozzle flows are mapped using a laser interferometer. The non-axisymmetric density profiles demand multiple measurements at many angles around the azimuth and tomographic reconstruction techniques. S.Y. Kalmykov et al., Plasma Phys. Control. Fusion 53(2011). W. Rittershofer et al., PHYSICS OF PLASMAS 17, 063104, 2010.

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