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Observation of Optical Bullets formed in Laser-driven Plasma Bubble Accelerators P. DONG, S.A. REED, S.A. YI, S. KALMYKOV, G. SHVETS, Department of Physics, University of Texas at Austin, N.H. MALIS, Lawrence Berkeley National Laboratory, C. MCGUFFEY, S.S. BULANOV, V. CHVYKOV, G. KALINTCHENKO, K. KRUSHELNICK, A. MAKSIMCHUK, T. MATSUOKA, A.G.R. THOMAS, Center for Ultrafast Optical Science, University of Michigan, V. YANOVSKY, M.C. DOWNER, Department of Physics, University of Texas at Austin — Laser-driven plasma "bubble" electron accelerators, a nonlinear regime of the laser wakefield accelerator, have produced collimated, nearly monoenergetic relativistic electron beams up to 1 GeV energy in millimeter acceleration lengths. To date the bubble's spatio-temporal structure has been accessible only from intensive computer simulations based on estimated initial conditions. Here we demonstrate direct, non-invasive, single-shot visualization of bubbles in plasmas of density $n_e > 10^{19}$ cm^{-3}, whether or not the bubbles produce relativistic electrons, by observing "bullets" of light that the bubble trap, focus and compress from co-propagating probe pulses. We correlate these bullets with relativistic electrons that the bubble captured and accelerated. Frequency Domain Holography (FDH),used previously to visualize weakly nonlinear sinusoidal wakes in plasmas of density $n_e < 0.6 \times 10^{19}$ cm^{-3}, are tweaked to work in this high density regime.

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