Ultra-low-emittance electron bunches from a laser-plasma accelerator measured using single shot X-ray spectroscopy\(^1\) C.G.R. GEDDES, G.R. PLATEAU, M. CHEN, C. BENEDETTI, E. ESAREY, A.J. GONSALVES, N.H. MATLIS, K. NAKAMURA, C.B. SCHROEDER, S. SHIRAIISHI, T. SOKOLIK, J. VAN TILBORG, CS. TOTH, T.S. KIM, M. BATTAGLIA, W.P. LEEMANS, LBNL, D.B. THORN, TH. STOEHLKER, EMMI Darmstadt, S. TROTSENKO, Helmholtz Jena — Single-shot spectroscopic measurements of betatron X-rays are reported, and used to infer the transverse bunch size of both broadband sub-100 MeV and low-energy-spread 0.5 GeV electron beams produced by a laser-plasma accelerator. The measurements use semiconductor detector arrays, and spectra are obtained via single pixel absorption and cluster techniques. By matching the X-ray betatron spectra to analytical and numerical models of betatron radiation, the electron bunch radius inside the plasma is estimated to be \(\sim 0.1\mu m\). Combined with simultaneous electron spectrum and divergence measurements, the normalized transverse emittance is estimated to be as low as 0.1 mm mrad, consistent with three-dimensional particle-in cell simulations. This emittance is lower than previously measured, important for applications including gamma sources and colliders.

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