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Optical Spectra as a Wakefield Diagnostic for Laser-Plasma Accelerators[1] SATOMI SHIRAISHI, CARLO BENEDETTI, ANTHONY GONSALVES, KEI NAKAMURA, BRIAN SHAW, THOMAS SOKOLLIK, JEROEN VAN TILBORG, CAMERON GEDDES, CARL SCHROEDER, CSABA TOTH, ERIC ESAREY, WIM LEEMANS, Lawrence Berkeley National Laboratory, LOASIS PROGRAM TEAM — Laser diffraction and pump depletion represent two fundamental limitations to the acceleration lengths of laser-plasma accelerators (LPAs). The diffraction can be mitigated using a capillary discharge waveguide to optically guide the laser. However, the laser pulse can oscillate transversely if it does not match the guiding condition. This mismatched guiding leads to inefficient coupling of laser energy into the plasma. The efficiency of the coupling can be estimated through optical spectra. As the laser pulse excites plasma waves, the spectrum is red-shifted and modulated. We present optical spectral analysis comparing experimental data with simulation. The spectral analysis is a non-destructive diagnostic of laser energy depletion and accelerating field. These measurements will be critical in staged LPAs. Measurement of laser energy depletion helps us determine an optimal length for each LPA module and the amplitudes of excited waves allows us to estimate the potential energy gain from the module for an externally injected electron beam. These studies contribute to improved control of LPAs and greater reliability.

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