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Spectrally resolved wavefront measurement of ultrashort laser pulses

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We present a novel and experimentally simple method for measuring the multispectral wavefronts of ultrashort laser pulses. IMPALA, or Iterative Multispectral Phase Analysis for LAsers, relies on only standard optical elements and a pinhole mask, allowing for the extraction and retrieval of multiple monochromatic wavefronts from a single polychromatic intensity image [1]. By algorithmically isolating the contribution of different colors to the measured speckle pattern, IMPALA enables the user to forgo expensive optics and convoluted experimental setups while probing the spatio-spectral behavior of the beam in a single shot. Additional rotations of the mask can be used to improve the spatial resolution of the wavefronts. We conducted proof-of-principle experiments at the Laboratoire d'Optique Appliquée (LOA) using a 30 fs laser. We successfully retrieved the correct amount of pulse front tilt (PFT) introduced in a controlled way by misaligning the compressor. In another experiment, we retrieved the pulse-front curvature (PFC) induced by a lens. With its mask modifications, IMPALA can be optimized for a wide array of ultrashort, high-intensity laser systems. A number of the world's most powerful and sophisticated laser facilities are working to implement IMPALA as a new diagnostic.

[1] S. Smartsev et al, Opt. Lett. 49, 1900-1903 (2024)

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