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SOFT: Single-Optics 4D phase space Tomography via double-rotated 2D measurements

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Detailed knowledge of high-dimensional phase space distributions is crucial for predicting and controlling the evolution of intense beams. Conventional beam tomography techniques require measurements under multiple beamline configurations, introducing reconstruction errors due to transport nonlinearities and model uncertainties while complicating the beamline design. This paper introduces SOFT (Single-Optics Four-dimensional Tomography) , a novel technique that reconstructs the complete 4D distribution using measurements from a single beamline setting. SOFT conducts 2D phase space scans with two independently rotatable slits to extract otherwise inaccessible cross-plane information. We present a rigorous proof demonstrating SOFT's ability to acquire sufficient data for full 4D reconstruction. Physics-informed analytical tools based on 4D geometry were developed to optimize the design and minimize measurement errors. SOFT's efficacy is validated through simulations, and the status of the prototype experiment is discussed.

Footnotes

Funding Agency

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Yes

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