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## Detailed Phase Space Reconstruction from Accelerator Beam Measurements Using Differentiable Simulations

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Characterizing the phase space distribution of particle beams in accelerators is a central part of accelerator understanding and performance optimization. However, conventional reconstruction-based techniques either use simplifying assumptions or require specialized diagnostics to infer high-dimensional ( $> 2D$ ) beam properties. In this work, we introduce a general-purpose algorithm that combines neural networks with differentiable particle tracking to efficiently reconstruct high-dimensional phase space distributions without using specialized beam diagnostics or beam manipulations. We demonstrate that our algorithm reconstructs detailed 4D phase space distributions with corresponding confidence intervals in both simulation and experiment using a single focusing quadrupole and diagnostic screen. This technique allows for the measurement of multiple correlated phase spaces simultaneously, enabling simplified 6D phase space reconstruction diagnostics in the future.

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### Footnotes

### I have read and accept the Privacy Policy Statement

Yes

**Primary authors:** EDELEN, Auralee (SLAC National Accelerator Laboratory); MAYES, Christopher (SLAC National Accelerator Laboratory); RATNER, Daniel (SLAC National Accelerator Laboratory); WISNIEWSKI, Eric (Illinois Institute of Technology); POWER, John (Argonne National Laboratory); GONZALEZ-AGUILERA, Juan Pablo (University of Chicago); ROUSSEL, Ryan (SLAC National Accelerator Laboratory); KIM, Seongyeol (Argonne National Laboratory)

**Presenter:** ROUSSEL, Ryan (SLAC National Accelerator Laboratory)

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