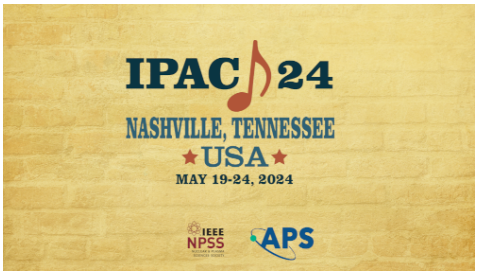

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Fast 6-dimensional phase space reconstructions using generative beam distribution models and differentiable beam dynamics

Tuesday, 21 May 2024 16:00 (2 hours)

Next-generation accelerator concepts, which hinge on the precise shaping of beam distributions, demand precise diagnostic methods capable of reconstructing beam distributions with 6-D phase spaces. However, the characterization of 6-D beam distributions using conventional techniques necessitates hundreds of measurements, using hours of valuable beam time. Novel diagnostic techniques are needed to reduce the number of measurements required to reconstruct detailed, high dimensional beam features for precision beam shaping applications. In this study, we present a novel approach to analyzing experimental measurements using generative machine learning models of 6-D beam distributions and differentiable beam dynamics simulations. We demonstrate in simulation that using our analysis technique, conventional beam manipulations and diagnostics can be used to reconstruct detailed 6-D phase spaces using as few as 20 beam measurements with no prior training or data collection. These developments enable detailed, high dimensional phase space information to be obtained for precision control and improved understanding of complex accelerator beam dynamics.

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