Contribution ID: **14** Type: **not specified**

End-To-End Latent Variational Diffusion Models for Unfolding LHC Events

Wednesday 8 November 2023 16:30 (15 minutes)

High-energy collisions at the Large Hadron Collider (LHC) provide valuable insights into open questions in particle physics. However, detector effects must be corrected before measurements can be compared to certain theoretical predictions or measurements from other detectors. Methods to solve this inverse problem of mapping detector observations to theoretical quantities of the underlying collision, referred to as unfolding, are essential parts of many physics analyses at the LHC. We investigate and compare various generative deep learning methods for unfolding at parton level. We introduce a novel unified architecture, termed latent variation diffusion models, which combines the latent learning of cutting-edge generative art approaches with an end-to-end variational framework. We demonstrate the effectiveness of this approach for reconstructing global distributions of theoretical kinematic quantities, as well as for ensuring the adherence of the learned posterior distributions to known physics constraints. Our unified approach improves the reconstruction of parton-level kinematics as measured by several distribution-free metrics.

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Session Classification: Measurements & Observables