Motivations and context

- In the next years, LHC detectors will face significantly increased luminosities
- We have developed deep neural network (DNN) algorithms to identify primary and secondary vertices in pp collisions in this high pile-up environment

Previous models (hybrid FC+CNN) architecture and performances


- Here we report new results from a novel approach based on a Graph Neural Network (GNN) model

Original hybrid ML approach to finding primary vertices

- **poca-ellipsoids**: the positions and error ellipsoids at tracks positions of closest approach to the beamline.
- **target histograms**: proxies that are Gaussian distributions whose heights and widths reflect the expected PV resolutions
- Hybrid model is trained to predict distributions similar to the target histograms
- Heuristic algorithms extract PV positions from the predicted histograms

Hybrid model architecture

- **Inputs**
  - Fully Connected layers
  - UNet layers
- **Outputs**
  - 8x160 bin hist
  - 6 Fully Connected layers building 9 (x100) output channels (x480dim)
  - U-Net layers summing the 8 contributions per bin to construct final predicted histogram

Graph building for GNN implementation

- Data preparation is a crucial step when building input graphs

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**Summary:**

- **GNN** models appear quite versatile where similar models achieve good performances for different tasks (tracking vs PV finding)
- GNN and hybrid models achieve similar intrinsic physics performance
- ...but only partial overlap meaning both models did not learn exactly the same relations from identical input data!