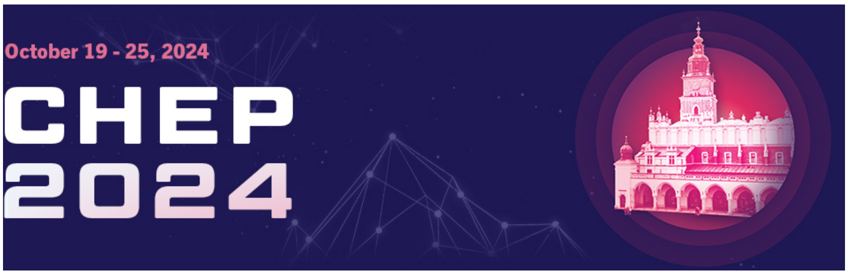

Contribution ID: **516** Type: **Talk**

Energy-efficient graph-based algorithm for tracking at the HL-LHC

Thursday 24 October 2024 17:45 (18 minutes)

Graph neural networks represent a potential solution for the computing challenge posed by the reconstruction of tracks at the High Luminosity LHC [1, 2, 3]. The graph concept is convenient to organize the data and to split up the tracking task itself into the subtasks of identifying the correct hypothetical connections (edges) between the hits, subtasks that are easy to parallelize and process efficiently, for example using GPUs.

We will describe an algorithm that benefits from the graph advantages, but instead of using neural networks, it consists of direct geometric comparisons of neighboring edge pairs, testing the hypothesis of both edges corresponding to the same particle, to build up hit triplets and track candidates. The compatibility of edge pairs is tested based on two observables: the η direction, and an estimator of the transverse momentum of the particle hypothetically associated with each edge. Before this step, the tracking algorithm includes graph construction with a modified version of the Module Map method described at [2]. In this Module Map version, the hits are organized in a two dimension map of the modules in the longitudinal detector plane (r, z), and next the edges are built based on a list of possible connections, in combination with a $\Delta\phi$ cut. At each module, the hits are ordered based on their ϕ position, which serves to significantly reduce the combinatorics when applying that $\Delta\phi$ cut.

We will present the track reconstruction performance of this algorithm, estimated using the Open Data Detector [4], as well as its computing efficiency. For this tracking chain executed in a single CPU core, the time required to process an HL-LHC $t\bar{t}$ event with 200 pp interaction pileup per bunch crossing is of the order of a second, which makes it a rather energy efficient tracking algorithm. This is the processing time from the collection of reconstructed hits to the track candidates, targeting primary particles with transverse momentum above 1 GeV. The algorithm is highly parallelizable; executed on a GPU, the processing time is expected to decrease at least by one order of magnitude.

[1] S. Farrell et al., Novel deep learning methods for track reconstruction, 2018, arXiv: 1810.06111 [hep-ex], url: https://arxiv.org/abs/1810.06111.
[2] C. Biscarat et al., Towards a realistic track reconstruction algorithm based on graph neural networks for the HL-LHC, EPJ Web Conf. 251 (2021) 03047, url: https://doi.org/10.1051/epjconf/202125103047.
[3] H. Torres et al. on behalf of the ATLAS Collaboration, Physics Performance of the ATLAS GNN4ITk Track Reconstruction Chain, Proceedings of the CTD 2023, ATL-SOFT-PROC-2023-047, url: http://cds.cern.ch/record/2882507.
[4] https://gitlab.cern.ch/acts/OpenDataDetector.

Author: TORRES, Heberth (L2I Toulouse, CNRS/IN2P3, UT3)

Presenter: TORRES, Heberth (L2I Toulouse, CNRS/IN2P3, UT3)

Session Classification: Parallel (Track 3)

Track Classification: Track 3 - Offline Computing