Contribution ID: **36** Type: **Plenary**

Simultaneous multi-vertex reconstruction with a minimum-cost lifted multicut graph partitioning algorithm

Wednesday 11 October 2023 15:00 (25 minutes)

Particle physics experiments often require the simultaneous reconstruction of many interaction vertices. This task is complicated by track reconstruction errors which frequently are bigger than the typical vertex-vertex distances in physics problems. Usually, the vertex finding problem is solved by ad hoc heuristic algorithms. We propose a universal approach to address the multiple vertex finding in a dense environment through a principled formulation as a minimum-cost lifted multicut problem. The suggested algorithm is tested in a typical LHC environment with multiple pileup vertices produced by proton–proton interactions. The amount of these vertices and their significant density in the beam interaction region make this case a challenging testbed for the vertex-finding algorithms. To assess the vertexing performance in a dense environment with significant track reconstruction errors several dedicated metrics are proposed. We demonstrate that the minimum-cost lifted multi-cut approach outperforms heuristic algorithms and works well up to the highest pileup vertex multiplicity expected at the HL-LHC.

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Session Classification: Plenary