Contribution ID: **58**

Type: **Standard Talk**

# Accelerating Hadronic Calorimetry with Sparse Point-Voxel Convolutional Neural Networks

*Monday 25 September 2023 14:45 (15 minutes)*

Due to the stochastic nature of hadronic interactions, particle showers from hadrons can vary greatly in their size and shape. Recovering all energy deposits from a hadronic shower within a calorimeter into a single cluster can be challenging and requires an algorithm that accommodates the large variation present in such showers. In this study, we demonstrate the potential of a deep learning based algorithm based on a sparse point-voxel convolutional neural networks (SPVCNN) to perform hadronic calorimetry using Compact Muon Solenoid detector on the Large Hadron Collider with the hadron calorimeter and high granularity calorimeter. In particular, we focus on accelerating calorimeter reconstruction at HEP experiment calorimeters by offloading tasks to GPUs. By employing a modified object condensation loss, we train the network to group cell deposits into clusters while filtering out noise. We show that SPVCNN performs comparably to generic topological cluster-based methods in both pileup and no pileup scenarios, with the added advantage of acceleration using GPUs, and further algorithmic development with better datasets. This type of acceleration, as part of heterogeneous computing frameworks, will be crucial for the High-Luminosity Large Hadron Collider (HL-LHC). Our findings indicate that SPVCNN can provide efficient and accurate calorimetry solutions, particularly for high level trigger (HLT) applications with latency on the order of milliseconds.

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**Session Classification:** Contributed Talks

**Track Classification:** Contributed Talks