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A Machine-learning-based Local Calibration for Topological Cell Clusters in the ATLAS Calorimeters

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The basic signals in the ATLAS calorimeter are clusters of topologically connected cell signals. These 'topo-clusters' provide signal features that are sensitive to the differences between electromagnetic and hadronic shower developments. These features are presently used for a local hadronic calibration of these clusters employing a sequence of scale factors retrieved from binned multi-dimensional lookup tables with some observed inefficiencies related to the binning and the corresponding loss of correlations. A new machine-learning-based calibration trains a deep neural network to learn the response of the topo-clusters at the basic signal scale. The resulting predicted response is then the basis of the (smooth) calibration function applied cluster by cluster. First results are shown for the obtained signal linearity and resolution, all at the local level of topo-clusters. In addition, successful network designs and configurations are discussed and motivated by aspects of calorimeter signal formation, the incoming energy flow in jets and environmental conditions like pile-up at the proton-proton collisions at the LHC. This new local calibration promises improved performance in jet substructure reconstruction as well as jet tagging, for both jets reconstructed with the calorimeter only and with particle flow objects.

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