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The Optimal use of Segmentation for Sampling Calorimeters

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One of the key design choices of any sampling calorimeter is how fine to make the longitudinal and transverse segmentation. To inform this choice, we study the impact of calorimeter segmentation on energy reconstruction. To ensure that the trends are due entirely to hardware and not to a sub-optimal use of segmentation, we deploy deep neural networks to perform the reconstruction. These networks make use of all available information by representing the calorimeter as a point cloud. To demonstrate our approach, we simulate a detector similar to the forward calorimeter system intended for use in the ePIC detector, which will operate at the upcoming Electron Ion Collider. We find that for the energy estimation of isolated charged pion showers, relatively fine longitudinal segmentation is key to achieving an energy resolution that is better than 10% across the full phase space. These results provide a valuable benchmark for ongoing EIC detector optimizations and may also inform future studies involving high-granularity calorimeters in other experiments at various facilities

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