15th International Workshop on Boosted Object Phenomenology, Reconstruction, Measurements, and Searches at Colliders

Contribution ID: **134** Type: **not specified**

AI based reconstruction for highly granular calorimeter for EIC

Tuesday, 1 August 2023 09:40 (20 minutes)

We deploy machine learning techniques to design the hadronic calorimeter for future Electron-Ion Collider (EIC). Tradition method of detector design relies on computationally expensive simulation using Geant4 package. Furthermore, the output of these simulations is not differentiable, and thus cannot be optimized using gradient-based technique. To overcome this hurdle, we are using generative models that can mimic the Geant4 simulation. These models will be differentiable enabling gradient-based optimization. Our detector design approach requires two interconnected components: a generator that mimics the detector, and reconstruction algorithm that uses output of detector to produce physics objects.

This presentation will be focused on AI based reconstruction of highly granular sampling hadronic calorimeter. The proposed Fe/Sc sampling calorimeter is based on SiPM-on-tile technology and capable of providing "5D" information of a shower, energy, position (x, y, and z), and time. For our study we are using the simulated showers from single particles (e-/π+).

Hadronic showers are particularly complex as the shower contain both an electromagnetic and hadronic component, each of which elicit a different detector response. We show how potentially learning from the shape of showers can improve the model performance in reconstructing the energy and polar angle of the incoming particle. Our AI based models have been proven to be more efficient and easier to adopt compared to the traditional approach. We will showcase the results of our AI based results for energy regression using the calorimeter cell information and compare them with the results obtained using more traditional approaches.

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Session Classification: Detectors