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Quantum GAN for fast shower simulation

High-energy physics relies on large and accurate samples of simulated events, but generating these samples with GEANT4 is CPU intensive. The ATLAS experiment has employed generative adversarial networks (GANs) for fast shower simulation, which is an important approach to solving the problem. Quantum GANs, leveraging the advantages of quantum computing, have the potential to outperform standard GANs.

Considering the limitations of the current quantum hardware, we conducted preliminary studies utilizing a hybrid quantum-classical GAN model to produce downsampled 1D(8 pixels) and 2D(64 pixels) calorimeter average shower shapes on quantum simulators. The impact of quantum noise is also investigated on the noisy simulator, and the performance is checked on the real quantum hardware.
After producing the average shower shape, we implemented a new generator model to produce the actual shower image with event fluctuation.

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