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Particle Tracking with Noisy Intermediate-Scale Quantum Computers

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Particle track reconstruction poses a key computing challenge for future collider experiments. Quantum computing carries the potential for exponential speedups and the rapid progress in quantum hardware might make it possible to address the problem of particle tracking in the near future. The solution of the tracking problem can be encoded in the ground state of a Quadratic Unconstrained Binary Optimization. In our study, sets of three hits in the detector are grouped into triplets. True triplets are part of trajectories of particles, while false triplets are random combinations of three hits. By approximating the ground state, the Variational Quantum Eigensolver algorithm aims at identifying true triplets. Different circuits and optimizers are tested for small instances of the tracking problem with up to 23 triplets. Precision and recall are determined in a noiseless simulation and the effects of readout errors are studied. It is planned to repeat the experiments on real hardware and to combine the solutions of small instances to address the full-scale tracking problem.

Significance

We present a comprehensive study to tackle small instances of the particle tracking problem at an ATLAS-like detector using the Variational Quantum Eigensolver algorithm

References

Experiment context, if any

ATLAS, LHC

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