Contribution submission to the conference SMuK 2023

Track reconstruction of charged particles using a 4D quantum algorithm — Arianna Crippa[1,2], Lena Funcke[3,4], Tobias Hartung[5], Beate Heinemann[1,6], Karl Jansen[1], Annabel Kropf[1,6], Stefan Kühn[1], Federico Meloni[1], •David Spataro[1,6], Cenk Tüysüz[1,2], and Yee Chinn Yap[1] — [1]Deutsches Elektronen-Synchrotron DESY — [2]Humboldt-Universität zu Berlin — [3]Universität Bonn — [4]Massachusetts Institute of Technology — [5]Northeastern University, London — [6]Albert-Ludwigs-Universität Freiburg

Reconstructing tracks in future colliders can be challenging for several reasons. For example, there may be a large number of particle tracks or a high background rate. Therefore, new reconstruction techniques need to be developed and existing ones refined. Quantum algorithms are believed to offer an advantage in computation time in combinatorial tasks such as track reconstruction. By formulating the tracking task as Quadratic Unconstrained Binary Optimization (QUBO), the task can be solved with quantum computers. For the first time, a time component is integrated into QUBO to enable 4D tracking, reducing background rates effectively. Results of an initial implementation are presented for a setup similar to the positron tracking system of LUXE, an experiment planned at DESY and Eu.XFEL. Peak occupancies of up to 100 hits/mm^2 are expected in the initial phase of LUXE. To demonstrate the transferability of this approach, results are also presented for a barrel-shaped muon collider detector geometry, where lower peak occupancy but large background is expected.

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