IEEE Quantum Week 2021 Workshop: Quantum Computing for High-Energy Physics

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Book of Abstracts

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Quantum algorithm for the classification of supersymmetric top quark events

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The search for supersymmetric particles is one of the major goals of the Large Hadron Collider (LHC). Supersymmetric top searches play a very important role in this respect, but the unprecedented collision rate to be attained at the next high luminosity phase of the LHC poses new challenges for the separation between any new signal and the standard model background. Quantum computing techniques may yield an efficient solution for this problem. In this talk, I will present a novel application of a binary classification based on quantum annealing machine learning to discriminate a stop signal from the background, and its implementation in a quantum annealer machine. This approach together with the pre-processing of the data with principal component analysis may yield better results than conventional multivariate approaches.

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First implementation of Quantum Machine Learning algorithms for b-jet tagging at LHCb

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The identification of jets coming from heavy-flavor quarks, namely bottom and charm quarks, is an important and non-trivial task at the LHC experiments. The classification of jets coming from bottom and anti-bottom quarks at the LHCb experiment would allow to perform physics measurements, such as the forward-central charge asymmetry, to constrain the Standard Model predictions and/or find possible signals of New Physics. While recently Machine Learning algorithms have played an important role in exploiting the jet substructure, there is room for improvement in the jet identification by exploiting the particles correlations. In this paper, we present a brand new approach to identify the charge of jets produced by bottom quarks, based on Quantum Machine Learning techniques. Data are embedded in a quantum circuit through a quantum feature map, a training procedure is performed, and the measurement of final state observables is mapped to a binary classification label. The models are trained and evaluated using LHCb Open Data obtained from LHCb simulations and the tagging performance is compared with the Muon Tagging algorithm used so far at LHCb, and a classical Deep Neural Network model.

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Introduction

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