Contribution ID: **5** Type: **Notebook talk**

Quantum machine learning for jet tagging at LHCb

Thursday 8 July 2021 18:10 (30 minutes)

At LHCb, b-jets are tagged using several methods, some of them with high efficiency but low purity or high purity and low efficiency. Particularly our aim is to identify jets produced by b and $\bar{b}$ quarks, which is fundamental to perform important physics searches, *e.g.* the measurement of the $b-\bar{b}$ charge asymmetry, which could be sensitive to New Physics processes. Since this is a classification task, Machine Learning (ML) algorithms can be used to achieve a good separation between b- and $\bar{b}$-jets: classical ML algorithms such as Deep Neural Networks have been proved to be far more efficient than standard methods since they rely on the whole jet substructure. In this work, we present a new approach to b-tagging based on Quantum Machine Learning (QML) which makes use of the QML Python library Pennylane integrated with the classical ML frameworks PyTorch and Tensorflow. Official LHCb simulated events of $b\bar{b}$ di-jets are studied and different quantum circuit geometries are considered. Performances of QML algorithms are compared with standard tagging methods and classical ML algorithms, preliminarily showing that QML performs almost as good as classical ML, despite using fewer events due to time and computational constraints.

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Session Classification: Plenary Session Thursday