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Non-relativistic top quarks at the LHC

Collision events resulting in a top and an anti-top quark ($t\bar{t}$) provide a sensitive probe of phenomena beyond the Standard Model, such as additional neutral Higgs bosons or axion-like particles. Moreover, they provide an ideal test bed to study quantum phenomena, such as spin entanglement, at the TeV scale and in a system of fundamental quarks. Recently, special attention has been drawn to top quarks close to the kinematic threshold for $t\bar{t}$ production ($m_{t\bar{t}} \sim 2m_t$), where the top quarks carry only a very small Lorentz boost and their dynamics can be described by non-relativistic QCD. In this region, the $t\bar{t}$ system is not only maximally entangled but may also form a –so far only hypothetical –quasi-bound state, which it may be possible to observe with the current LHC datasets. Current reconstruction mechanism for top quarks are not optimised for this kinematic region where typically one of the top quarks is not on-shell. Improved reconstruction algorithms are needed for precision measurements and searches for new phenomena close to the kinematic threshold.

In this project, we will investigate the use of different ML techniques (DNNs, transformers) to improve the reconstruction accuracy –and hence resolution of kinematic variables of interest –close to the kinematic threshold. The performance will be measured in simulated $t\bar{t}$ events and compared to that of established reconstruction algorithms optimised for the full kinematic regime.

Special Qualifications

Python

DESY Site

Hamburg

Group

FH-ATLAS

Project Category

B1. Physics data analysis and performance (software-oriented)

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