

# Quantum Entanglement in Top Quark Pairs in the Lepton+Jets Final State

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Quantum entanglement is a fundamental prediction of quantum mechanics and the experimental achievements with electrons and photons were recognised by the Nobel Prize in Physics 2022. At the LHC, quantum entanglement can be observed in top quarks, testing quantum mechanics at high energies. Therefore, a sensitivity study for a possible measurement of quantum entanglement in the top quark pair production in the lepton+jets final state is presented.

The angular separation between the decay products of the top quarks can act as an indicator of quantum entanglement, when the two top quarks are produced near threshold. The two strongest spin analysers in this final state are the charged lepton and the down type quark which is accessed via  $c$ -tagging. The result is then compared to parton level predictions using a calibration curve. As the biggest challenge for this analysis, the parton shower systematic uncertainty, comparing Powheg+Pythia 8 to Powheg+Herwig 7.13 predictions, is discussed.

The study is performed with ATLAS Monte Carlo simulations under Run 2 conditions.

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