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Quantum Entanglement discovery in top quark events and perspectives into future colliders

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In quantum mechanics, a system is said to be entangled if its quantum state cannot be described as a simple superposition of the states of its constituents. If two particles are entangled, we cannot describe one of them independently of the other, even if the particles are separated by a very large distance. When we measure the quantum state of one of the two particles, we instantly know the state of the other. The information is not transmitted via any physical channel; it is encoded in the correlated two-particle system. The talk will discuss CMS results in the top quark production region with data provided by the Large Hadron Collider (LHC) at CERN. Results confirm the observation of entanglement in top quark events, even in presence of hypothetical top quark bound states, and providing a new quantum probe to the inner workings of the Standard Model. The talk concludes with an outlook on LHC perspectives into the 2040's and prospects at other proposed future colliders.

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