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Quantum entanglement and Bell inequality violations at Future Linear Colliders

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Quantum entanglement and Bell inequality violations—cornerstones of quantum mechanics—have traditionally been investigated in low-energy experimental settings. Recently, these fundamental phenomena have begun to be explored in the high-energy domain of particle physics, where colliders offer a powerful new platform for studying quantum correlations. In this talk, we discuss how colliders can serve as unique laboratories for testing quantum phenomena, particularly through quantum state tomography techniques. We present recent results on the detection of entanglement and Bell inequality violations in processes such as WW and ZZ diboson production, as well as tau-lepton pair production, illustrating the potential of Future Linear Colliders to probe the quantum structure of fundamental interactions.

Author: GABRIELLI, Emidio (CERN PH-TH)

Presenter: GABRIELLI, Emidio (CERN PH-TH)

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