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Optimizing Entanglement and Bell Inequality Violation in Top Anti-Top Events

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When a top and an anti-top are produced at colliders their spins are correlated. Furthermore, when the top and anti-top system is interpreted as a quantum state, the system can exhibit entanglement and can violate Bell's inequality. Treating the system as a quantum state requires using the same axes to measure the top and anti-top spins in all events. In practice, most studies allow the axes to vary event-by-event, such that observables are angular-averaged. This averaging introduces a dependence on the spin axes that were chosen. In this work, we show that the basis which diagonalizes the spin-spin correlations is optimal for maximizing spin correlations, entanglement, and the violation of Bell's inequality. Since detecting violations of Bell's inequality will likely require the full dataset of the high-luminosity run of the Large Hadron Collider, optimizing detection is crucial.

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