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Analysis of neutral long-lived kaons reconstruction efficiency via a missing 4-momentum method at Belle II experiment

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In this report, we present a method for the reconstruction of neutral long-lived kaons (K_L^0) using Monte Carlo simulations of the Belle II detector at the SuperKEKB accelerator in Tsukuba, Japan. The detector's nearly 4π hermetic coverage, layered subdetector structure, and the precisely known initial kinematics of the $e^- e^+$ collisions provide a unique environment for the study of flavor physics via decays of B mesons, D mesons, and tau leptons.

Due to their long lifetime and primarily hadronic interactions, K_L^0 mesons are notoriously difficult to reconstruct. They often penetrate the inner tracking systems without leaving a trace and may only leave partial energy deposits in the Electromagnetic Calorimeter (ECL) or hits in the K_L^0 and Muon detector (KLM). While these subdetectors can capture a fraction of K_L^0 interactions, their overall reconstruction remains a significant challenge for many Belle II analyses.

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