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Kaon physics at LHCb: recent results and Run 3 prospects

The LHCb detector is a single-arm forward spectrometer optimized to study heavy hadrons containing b and c quarks. Owing to the high collision energy and forward geometry of the LHC, strange hadron production occurs with cross-sections orders of magnitude larger than heavy-flavor production, allowing LHCb to also perform a rich program in strange physics. In this regard, the latest LHCb searches using Run 1 and Run 2 data for rare kaon decays, such as $K^0_S \to \mu^+\mu^-$, $K^0_S \to \mu^+\mu^-\mu^+\mu^-$ and $K^0_S \to \pi^+\pi^-\mu^+\mu^-$ are presented. The LHCb Upgrade I introduced major updates, notably a fully software-based trigger system and upgraded detectors designed to handle an instantaneous luminosity five times higher than previous runs. These enhancements also provide a significant improvement for physics analyses needing low-pT reconstruction. In Run 3, these improvements should enable high trigger efficiency for hadronic and multi-body kaon decays. New data analyses currently underway are expected to provide enhanced sensitivity to these rare channels, paving the way for more stringent upper limits and probing potential physics beyond the Standard Model.

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