Search for $K_{S(L)}^0 \rightarrow 4\mu$ at LHCb

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Analysis Overview

- Highly constrained by phase space (very low background)
- $K_S^0$ escapes the detector acceptance
- No existing measurements
- Follows the scheme of $K_S^0 \rightarrow \mu^+\mu^-$ [1]

Analysis Strategy

- 2016-2018 LHCb data
- $K_{S(L)}^0$ coming from PV
- Blind analysis
- Control mode: $K_S^0 \rightarrow \pi^+\pi^-$

\[ \mathcal{B}(K_{S(L)} \rightarrow 4\mu) = a N_{\text{sig}} / N_{\text{norm}} \]

\[ \alpha = 2 \times 10^{-12} \]

- $\mathcal{B}(K_S^0 \rightarrow \pi^+\pi^-) \sim 70\%$
- $N_{\text{norm}}$ is obtained after a soft selection
- $K_L^0 \rightarrow 4\mu$ contributions are neglected when studying $K_S^0 \rightarrow 4\mu$ and vice versa

Background contributions

- Main contributions are combinatorial
- Can be random tracks disguised as $K^0 \rightarrow 4\mu$ candidates
- Can also be tracks originated in inelastic collisions with the material
- BDT classifier removes most of the background

Results and prospects

- No significant signal observed
- First upper limits set for both decays (at 90% C.L.):

\[ \mathcal{B}(K_S^0 \rightarrow 4\mu) < 5.1 \times 10^{-12} \quad \text{and} \quad \mathcal{B}(K_L^0 \rightarrow 4\mu) < 2.3 \times 10^{-9} \]

- Most stringent limit at LHC so far
- Expect to gain an order of magnitude after LHCb Upgrade I

References