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Kaon-Scatter Introduced Backgrounds in the KOTO Experiment

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The KOTO experiment is a particle physics experiment located in J-PARC, Japan, aiming to explore physics beyond the Standard Model by measuring the branching ratio of the $KL \rightarrow \pi^0 \nu \bar{\nu}$ decay. This decay has not yet been observed. The branching ratio predicted by the Standard Model of $(3.0 \pm 0.3) \times 10^{-11}$ and the current experimental upper limit established by KEK E391a is 2.6×10^{-8} .

The signal of $KL \rightarrow \pi^0 \nu \bar{\nu}$ decay has the signature of two photons on the calorimeter with no signal on the veto detectors. It also has a large transverse momentum due to missing neutrinos. Kaons that decay outside the beam line with final product of two photons, such as $KL \rightarrow \gamma \gamma$ and $KL \rightarrow \pi^+ \pi^- \pi^0$, can appear to have large transverse momentum due to kaon scattering and beam interaction with the detectors. These off-axis kaon decay events can impact the upper limit of $KL \rightarrow \pi^0 \nu \bar{\nu}$ branching ratio. Aluminum targets located at the upstream of the KOTO detector and inside the decay-volume were used to study kaon beam profile, which provided off-axis kaon decay vertex information. The beam profile provided insights on background contributions to the signal. Studies on the kaon beam profile and background identification from kaon scattering will be presented in this talk.

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