Development and Performance of a Low Mass In-Beam Charged Particle Detector for the KOTO Experiment

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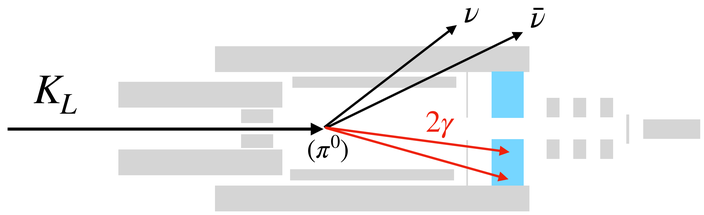
1. KOTO Experiment @J-PARC

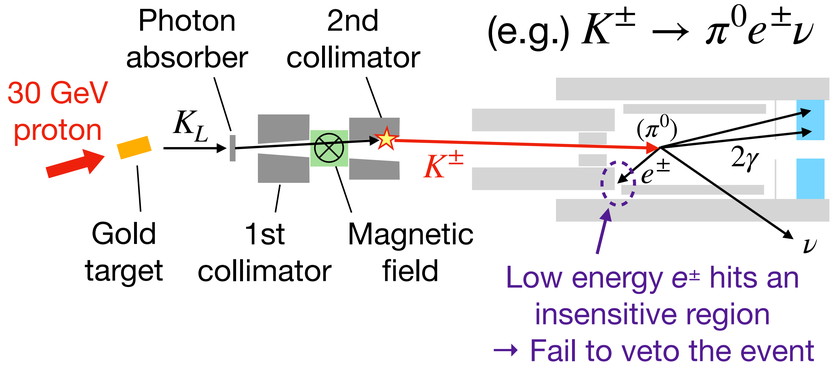
Search for new physics via $K_L \to \pi^0\nu\bar{\nu}$

- Direct CP Violation
- $BR_{SM}(K_L \to \pi^0\nu\bar{\nu}) = 3.0 \times 10^{-11}$
- Signal : $(\pi^0 \to)\ 2\gamma + Nothing$ (veto det. / EM calorimeter)



2. Charged Kaon Background

(e.g.) $K^\pm \to \pi^0 e^\pm \nu$



In the analysis of the data collected in 2016-2018, #BG by K± was 0.87 events (largest BG). (PhysRevLett.126.121801)

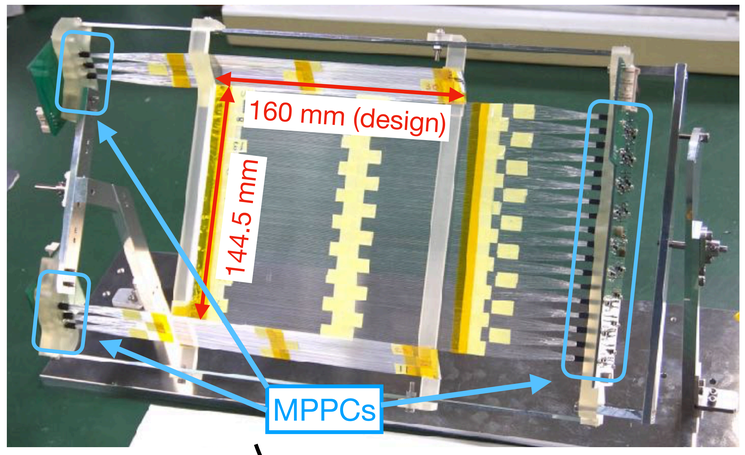
⟶ corresponds to ~20 events at the SM sensitivity

3. New Detector

to veto K± backgrounds

Upstream Charged Veto (UCV)

- 0.5mm square scintillating fibers
- Readout by silicon photo-sensors (MPPC)

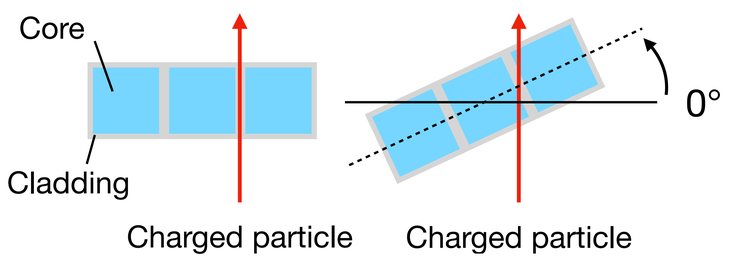


Installed here (Dec. 2020)

Beam

(not only K_L, but also γ, n, etc)

Key feature…less inefficiency by rotation

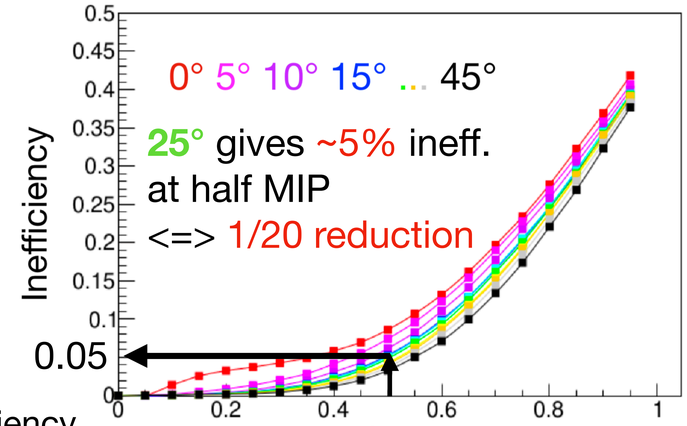


4. Performance

Before installation,

Electron beam test @ELPH (Tohoku Univ.)

Purpose: To measure inefficiency and decide the optimal angle



Inefficiency = $\frac{\#\text{events below threshold}}{\text{total \#events}}$

=> Set the angle to 25° suppressing neutron interactions.

Currently the detector is working at J-PARC to collect data.

5. Summary

- K± made the largest background in the previous dataset collected in 2016-2018.
- Developed a new detector to veto K± BG.
- #BG by K± will be reduced to ~1 event level at the SM sensitivity.