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Four dimensional calorimetry with both-side readout of the CsI calorimeter in the $K_L \to \pi^0 \nu \bar{\nu}$ search

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The aim of the KOTO experiment [1] is the first observation of $K_L \to \pi^0 \nu \bar{\nu}$ which is sensitive to CP-violating new physics beyond the standard model (SM). The experimental signature is only two photons from the π^0. To detect this simple signature, the KOTO detector consists of a pure cesium iodide (CsI) calorimeter and hermetical veto counters. The calorimeter is made of 50 cm long CsI crystals stacked in a cylinder of 1.9 m diameter. Each crystal is read out with a PMT. $K_L \to \pi^0 \nu \bar{\nu}$ is a rare decay: its SM prediction of the branching fraction is $(3.0 \pm 0.3) \times 10^{-11}$. One of the major backgrounds is caused by a single neutron generating two clusters in the calorimeter. We are developing multiple countermeasures to reject such events. One of the methods is to distinguish photon clusters from neutron clusters with the depth of their interactions in the CsI crystals. To this end, we plan to install 4000 silicon photomultipliers (SiPMs) on the front surface of the crystals, and locate the depths of interactions by measuring the timing difference between SiPMs and PMTs on the back surface of the crystals.

I will report:
1) beam test results on the neutron rejection power of this method,
2) expected background suppression in the KOTO experiment, and
3) effect of expected radiation damage on the SiPM.

Reference
[1] J. K. Ahn *et al.*, Prog. Theor. Phys. 021C01 (2017).

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