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Response of transition edge sensors to charged particle impacts and analysis technique for exotic atom X-ray spectroscopy

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The application of transition edge sensors (TESs) to exotic atom X-ray spectroscopy requires challenging techniques of measurement and analysis. We have developed them through the pionic and kaonic atom X-ray measurements with a 240-pixel TES array at hadron beamlines.

One of the important analyses is to investigate the charged particle impacts on the TES array. The energy deposits of charged particles on the array, especially on its silicon substrate, can cause small thermal cross-talk pulses in all TESs. The pileup of the thermal cross-talk and normal X-ray pulses degrades the energy resolution due to poor pulse-height estimation via optimal filtering.

Recently we have found the shorter record-length analysis for the piled-up pulses can improve the energy resolution (e.g., more than 1 eV at 6.9 keV). Generally, the optimal filtering for longer record-length pulses without pileup contamination results in better energy resolution. However, for the piled-up pulses, the benefit from cutting the pileup region is bigger than the degradation due to shorter records.

Here we will show the analysis details and the detector performance of the kaonic helium X-ray measurement at J-PARC (Ibaraki, Japan). We will discuss the influence of charged particle impacts on the TES array to the optimal filter, the pulse-height estimation, the background events, and the energy calibration. These analysis techniques and the characterization of TES response to charged particle impacts must be useful for future experiments at accelerator beamlines and space missions.

Less than 5 years of experience since completion of Ph.D

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