Contribution ID: **24** Type: **Oral**

Characterization of SiPM Optical Crosstalk and its Resin Thickness Dependence

Tuesday, 27 November 2018 12:05 (20 minutes)

Silicon photomultipliers (SiPMs) are widely used in many applications in medical imaging, particle physics, and high-energy astrophysics owing to their high photon detection efficiency, high charge resolution, compactness, and low voltage. It is known, however, that so-called optical crosstalk (OCT), which generate secondary infrared photons in the micro silicon cell that fired first, can worse the SiPM charge resolution. This is because the secondary photons can be accidentally detected by surrounding micro cells. As a result, the trigger threshold in fast photon pulse detectors such as atmospheric Cherenkov telescopes needs to be increased and less bright photon events can be lost. In our previous study (Asano et al. 2017), we found that the OCT rates of single channel SiPMs have resin thickness dependence, which may be explained by photon propagation inside the protection resin coating. In the present study we simulated this photon propagation with a dedicated ray-tracing simulation model, and it is compared with our measurements. We also measured the OCT rate of multi-channel SiPMs, resulting in a discovery of "neighboring-pixel OCT," in which OCT photons are propagated into neighboring pixels. We report our single- and multi-channel SiPM OCT measurements and comparison with ray-tracing simulations.

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Session Classification: Tuesday morning