Contribution ID: **30** Type: **Poster**

Competition between Increasing and Decreasing Effects of the Afterpulsing Rate of PMTs during Night-Sky Observations

Wednesday 20 November 2024 19:52 (5 minutes)

Photomultiplier tubes (PMTs) are crucial in photon-counting experiments due to their high detection efficiency and low noise levels. A key application is in imaging atmospheric Cherenkov telescopes (IACTs), which observe Cherenkov light from air showers triggered by high-energy gamma and cosmic rays. They are also employed in the Large-Sized Telescopes (LSTs) and the Medium-Sized Telescopes of the Cherenkov Telescope Array Observatory (CTAO), the latest-generation IACTs currently under construction. The LSTs are optimized for relatively low-energy observations, particularly in the range of 20 GeV to 150 GeV, requiring PMTs with extremely low false-signal pulsing rates to avoid data acquisition issues. Currently, only the first LST (LST-1) is in operation among the CTAO telescopes.

Afterpulsing in PMTs, caused by ionized gas molecules from accelerated electrons (mainly triggered by night-sky photons), generates false signal pulses. To address this, CTAO and Hamamatsu Photonics K.K. developed novel PMTs (R11920-100 for LST-1 and R12992-100 for subsequent telescopes) with an exceptionally low afterpulsing rate of less than 2 × 10ˆ-4 per photoelectron input.

However, the afterpulsing rate increases over time due to atmospheric molecules, particularly helium, penetrating the tube. This increase, measured at roughly 3 × 10ˆ-5 per year, could degrade the LSTs'energy threshold over their 20-year operation. Conversely, we found that the afterpulsing rate decreases when PMTs are operated under high voltage with light exposure, a condition naturally met during IACT observations.

In 2023, we removed several PMTs from LST-1. These tubes were installed shortly before or after the telescope's first light at the end of 2018. Our laboratory measurement showed no increase in afterpulsing compared to pre-installation measurements from 2015, suggesting that the decreasing effect quickly cancels the increasing one during operation. In this talk, we report detailed results and discuss the mechanisms behind this behaviour.

Do you need a VISA letter for traveling to Canada ?

No

Primary authors: KIYOMOTO, Takuto (Saitama University); NAGAYOSHI, Tsutomu (Saitama University); SAKURAI, Shunsuke (Japan); Dr TAKAHASHI, Mitsunari (ISEE, Nagoya University); YAMAMOTO, Tokonatsu (Konan University)

Co-authors: DONINI, Alice (INAF); INOME, Yusuke (ICRR, The University of Tokyo); KOBAYASHI, Yukiho (ICRR, The University of Tokyo); MAZIN, Daniel (ICRR, The University of Tokyo); MIRZOYAN, Razmik (Max--Planck-Institute for Physics); NOZAKI, Seiya (Max-Planck-Institute for Physics); OHOKA, Hideyuki (ICRR, The University of Tokyo); Dr OKUMURA, Akira (ISEE, Nagoya University and KMI, Nagoya University); SAITO, Takayuki (ICRR, The University of Tokyo); TAKEISHI, Ryuji (ICRR, The University of Tokyo); TESHIMA, Masahiro (ICRR, The University of Tokyo and Max-Planck-Institute for Physics); FOR THE CTAO LST PROJECT

Presenter: Dr TAKAHASHI, Mitsunari (ISEE, Nagoya University)

Session Classification: Poster Session

Track Classification: Applications: Astroparticles, Astrophysics and Astronomy