A single photo-electron calibration system for the NectarCAM camera of the Cherenkov Telescope Array Medium-Sized Telescopes

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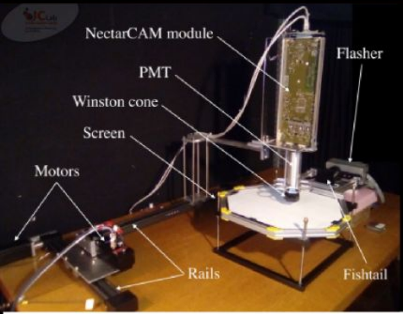
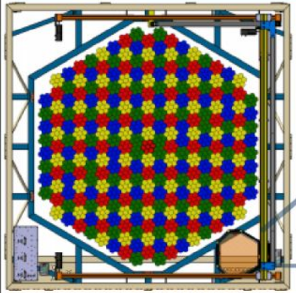
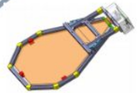
This contribution aims to introduce the single photo-electron (SPE) system designed to calibrate the camera of the Medium-Sized Telescopes of the Cherenkov Telescope Array (CTA). This system will allow us to measure accurately the gain of the camera's photodetection chain and to constrain the systematic uncertainties on the energy reconstruction of gamma rays detected by CTA.

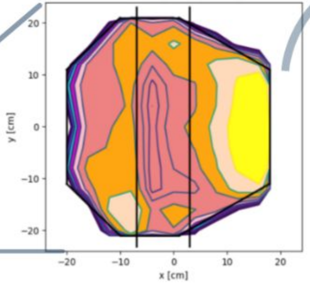


1. TEST BENCH

Homogeneity test is done in a dark room set up in IJCLab [1]. The calibration system consists of a 10 mm flat octagonal block of PMMA screen, a fishtail light guide with groove and a light box. The screen is painted with a high reflective material based on Titanium oxide. Using the motors, a PMT is moved over the screen.

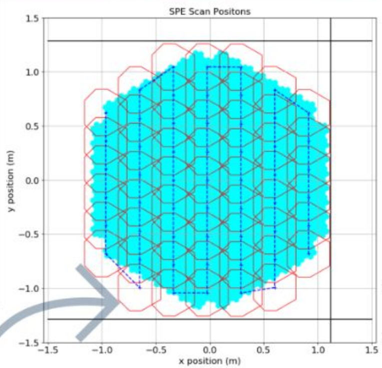






2. SCREEN CONFIGURATION

The homogeneity map measures the light intensity over the screen. The black lines mark the different regions of the screen which are painted with layers of different thickness to allow for homogeneous spreading of the light. Contours enclose area of the screen ranging from half down to a tenth of the maximum screen emissivity.

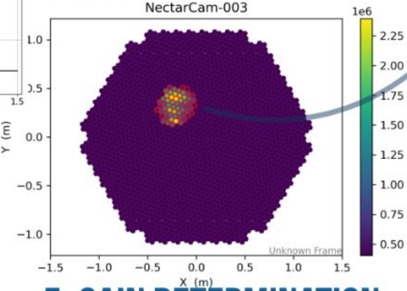


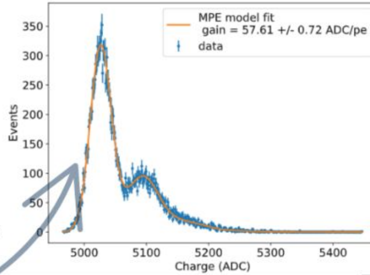
3. SCAN OPTIMISATION

The time taken to calibrate the camera depends on the vertical and horizontal movement of screen. The screen positions are shown using red outlines, the path of the screen as dotted line. The limit of the motors are signified by the black lines. The velocity and acceleration of motors result in 55 scan positions with scanning time ranging from 17 to 28 minutes.

4. CALIBRATION RUN

Data acquired from Mini NectarCAM camera installed on the MST [2] prototype telescope in Adlershof has been analysed using Ctapipe [3]. The charge of each event reconstructed after pedestal subtraction for every pixel around the peak is shown.





5. GAIN DETERMINATION

The charge distribution is modelled by a multi p.e. spectrum accounting for a two-gaussian SPE response [4] and the pedestal level. The first peak corresponds to pedestal (zero photon) and subsequent peaks correspond to photo-electrons induced by the screen emission. We obtain a mean gain of 56 ADC/p.e. and associated standard deviation of 2.1 ADC/p.e over the mini camera.

6. OUTLOOK

We describe the SPE system designed for NectarCAM camera of MST of CTA, which will be used to study the response of each PMT. Data acquired by SPE system integrated in mini camera have been analysed to identify pixels which are illuminated by the screen to allow for quick determination of gain. Data acquired with the fully equipped camera may yield gain better than 4%.

References

[1] Barbara Biasuzzi et al. "Design and characterization of a single photoelectron calibration system for the NectarCAM camera of the medium-sized telescopes of the Cherenkov Telescope Array". In:Nucl.Instrum.Meth.A(2020)

[2] Thomas Tavernier, Jean-François Glicenstein, and François Brun.Status and performance results from NectarCAM – a camera for CTA medium sized telescopes. 2019. arXiv:1909.01969 [astro-ph.IM].[3]

[3] Karl Kosack et al.cta-observatory/ctapipe: v0.11.0. Version v0.11.0. May 2021

[4] Sami Caroff et al. "Determination of the single photo-electron spectrum and gain measurement for the Cherenkov Telescope Array camera NectarCAM". In:Optics for EUV, X-Ray, and Gamma-Ray Astronomy IX. International Society for Optics and Photonics. SPIE, 2019.

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