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Transient gamma-ray sky with the future Cherenkov Telescope Array Observatory (CTAO) and validation tests with the NectarCAM camera

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The Cherenkov Telescope Array Observatory (CTAO) is going to consist of more than 60 telescopes in the northern and southern hemispheres, being the largest and most sensitive instrument to gamma rays from 20 GeV to 300 TeV. The arrays will be made of four Large-Sized Telescopes (LSTs) in the Northern Hemisphere, up to 23 Medium-Sized Telescopes (MSTs) distributed over both array sites for its core energy range, and up to 37 Small-Sized Telescopes (SSTs) in the Southern Hemisphere.

The flat-field flasher is a calibration device designed for NectarCAM, the camera that will equip the MSTs of the northern site of the CTAO. Positioned in the centre of the MST dish, 16 meters in front of the camera, the flasher emits short (FWHM < 5\,ns), uniform (2–4\%) light pulses at 390 nm to illuminate the entire focal plane. Accurate calibration is crucial for the optimal operation of NectarCAM, ensuring precise gain computation and mitigating differences in light-collection efficiency of the pixels of the camera. Using the flat-field flasher, two informations are obtained: the pixel gain and the relative efficiency between pixels. The flat-field coefficients are obtained to account for difference in signal between pixels of the camera, these coefficients are then applied within the camera to ensure a uniform response of a few percent across all 1855 pixels. To improve the precision of the computation of the flat-field coefficients, a signal distribution model is applied in order to correct for uncertainties on charge computation. Assuming the light-front shape to be 2D Gaussian, the required control of 2\% over the light front is achieved. Furthermore, the obtained light front parameters show good consistency with the results obtained at a dedicated test bench.

An accurate calibration of the cameras will be crucial for an unbiased reconstruction of gamma-ray energies and thus for the spectral studies of gamma-ray sources. Studies of Active Galactic Nuclei (AGN) constitute one of the Key Science Projects of the CTAO. The long-term monitoring of AGNs aims to measure their duty cycle and to constrain the location the gamma-ray emission regions within these sources. To achieve these scientific objectives within the allocated observation time, the observational program must be carefully optimized based on simulations. In this study, simulated CTAO observations were performed for a selected list of AGNs of interest. The resulting light curves were fitted and analyzed to estimate the excess variance, which serves as a criterion for identifying the most effective observational strategy among four considered scenarios. The ongoing work focuses on refining the selection of the optimal observation cadence and duration, using the flux distribution fitting to determine under which observational conditions different flux variability models can be reliably distinguished.

Auteur: MIKHNO, Anastasiia

Orateur: MIKHNO, Anastasiia

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