Proposition d'un Projet de Recherche en Laboratoire

Titre : **Thermal Testing and Performance Analysis of NectarCAM camera for the Cherenkov Telescope Array Observatory**

Laboratoire d'accueil : LLR

Mots clés : Tests thermiques / Python / CTAO / NectarCAM / camera / instrumentation

Nature : Expérimental/Numérique

Accueil d'un binôme possible : Oui

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Résumé :
Overview: Gamma rays are highly energetic particles, spanning a wide range of energies from MeV (mega-electron volts) to TeV (tera-electron volts). Since gamma rays cannot penetrate Earth's atmosphere, space-based observatories are typically required to detect them. However, very high-energy (VHE) gamma rays, in the range of 100 GeV to 100 TeV, interact with the atmosphere and produce secondary particles that generate Cherenkov light—light that ground-based telescopes can detect. This is where instruments like Imaging Atmospheric Cherenkov Telescopes play a crucial role.
The Cherenkov Telescope Array Observatory (CTAO) is a cutting-edge facility designed to detect VHE gamma rays. It will be located at two sites: La Palma in the Northern Hemisphere and Chile in the Southern Hemisphere. CTAO is an international collaboration involving 150 institutions across 25 countries and 1,500 scientists. It will be ten times more sensitive than current gamma-ray instruments. The observatory will consist of three types of telescopes: Large Size Telescopes (LSTs), Medium Size Telescopes (MSTs), and Small Size Telescopes (SSTs). The camera for the MST telescope is called NectarCAM.

Project Goal: NectarCAM is currently under construction and being tested at CEA in the Paris region. One of the key tests is the thermal test, which evaluates how the camera performs at different temperatures. The goal of this thesis is to assist in these tests by using tools developed at Laboratoire Leprince-Ringuet to analyze the data. The student will work with raw data collected by NectarCAM at various temperature settings. Through this analysis, they will assess how the camera's performance changes with temperature and evaluate its reliability under extreme conditions. These findings will help ensure the camera is robust enough to operate in the environments where the CTAO will be located.

Project Outline:

- **Introduction to Gamma-ray Astronomy and CTAO:**
    - Overview of gamma rays and their detection methods.

    - Explanation of Cherenkov light and how it helps us detect VHE gamma rays.
    - Overview of the different types of telescopes in the CTA, focusing on the Medium Size Telescopes (MST) and the functionalities and operational modes of the NectarCAM camera.
- **Thermal Testing Data:**
    - Learn how to access and select data from remote grids.
    - Develop Python scripts to visualize and filter the data.
- **Data Analysis:**
    - Use calibration and analysis tools to evaluate the camera's performance under varying temperatures.
    - Investigate potential improvements to the calibration and analysis tools.
- **Results and Implications:**
    - Interpret the test results to determine whether the camera can handle extreme temperature changes.
    - Discuss how this data will be used to enhance the final design and ensure reliable performance in La Palma.

Expected Outcome: A detailed assessment of NectarCAM's performance under various temperature conditions, along with recommendations for any necessary adjustments to improve its robustness.