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Sharpening the sight of the MAGIC telescopes

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MAGIC Telescope

The Major Atmospheric Gamma Imaging Cherenkov (MAGIC) is a system of two imaging Cherenkov telescopes exploring the Universe by collecting gamma rays at energies above few tens of GeV. More precisely MAGIC collects the Cherenkov radiation generated from the extended air showers originated by cosmic rays impinging the atmosphere. The atmosphere is used like a calorimeter stopping the particles that arrive on earth surface. Among these, photons are a subdominant fraction, but given that they are not deflected by the magnetic fields filling the Universe at various scales, they can be used to trace back the source emitting them allowing astronomy at these energies and the astrophysical study of individual sources. The much more abundant charged cosmic rays act instead as an isotropical background that needs to be discriminated, mainly by the morphology of the shower images.



The Quest

Achieving the lowest possible energy threshold is crucial in order to detect sources characterized by a soft gamma-ray spectrum and/or far enough to suffer a significant extinction due to absorption of gamma rays against Extragalactic Background Light.

To improve the performance of MAGIC lowering the threshold a new trigger system called Sum Trigger (SumT) was installed. Together with the SumT a dedicated new image cleaning (NIC) algorithm that increases the fraction of low energy (meaning $E < 100$ GeV) events surviving the cleaning, at the price of some losses at high energies was necessary.

Acknowledgment

The main reason because I join this school is to learn/study new image cleaning techniques based on machine learning and to apply it on MAGIC. I hope in near future, Cherenkov Telescopes Array experiment data will be available for me to work on. Moreover I thank my supervisor Prof. Riccardo Paoletti for sending me to INIERI, my co-supervisor Giacomo Bonnoli for advice regarding research topic and my colleague and friend Lorenzo Bellizzi.

5th SUMMER SCHOOL ON INTELLIGENT SIGNAL PROCESSING FOR FRONTIER RESEARCH AND INDUSTRY

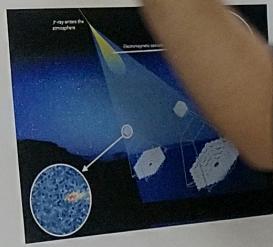
Wuhan University of Science & Technology Wuhan National Laboratory for Optoelectronics Digital PET Imaging Lab

The Idea

Sum T analysis led to development of an improved image cleaning optimization of the performance of the system below 100 GeV. Early analysis showed that this cleaning can also be successfully applied to data taken with standard tools. MAGIC gathered a large database of simulated images of sources where a very soft spectrum is concentrated only around the energy threshold. This is what is expected, but no signal was detected in this analysis. Thus, some solid detection was still missing.

already the first data, waiting only for the application of the improved analysis.

On the other hand, the computing is computation demanding in terms of storage and computation, leading to application to the whole database and to standard systems.



My work

I selected small data samples taken observing extragalactic sources expected to be detected only around the energy threshold, that were observed with standard trigger under good weather and technical conditions, and where hints of signal were found with standard analysis, but no firm detection. Applying NIC, significance of excess is measured as expected for a genuine signal. Cross-checks in order to exclude random fluctuations are enhanced by the new procedures, and that no fictitious signals are generated, are still in progress.

Large-matrix and applications

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Introduction

• Large-matrix calculations in particle physics

• Numerical methods for large matrices

• Application to particle physics

• Numerical methods for large matrices

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