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Measurement of the number of muons near the shower core using MARTA engineering array

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As particles coming from space with center-of-mass energies up to 400 TeV (well above the limits of current man-made accelerators), the Ultra High Energy Cosmic Rays detected at the Pierre Auger Observatory are currently one of the most important research objects in Astroparticle physics.

In recent works, it has been demonstrated that the muon number distribution at the ground can be used to probe the first few, very high energy interactions of a shower, which would allow us to obtain information on the primary's source and acceleration mechanisms. Yet, currently most cosmic ray experiments don't directly measure the muon content in an Extensive Air Shower (EAS), but rather estimate through shower features due to the incapability of the detectors to distinguish the muon content from the electromagnetic component of the shower.

The Muon Array with RPCs for Tagging Air Showers (MARTA) is a hybrid detector design with the purpose measuring the muon content in an EAS. The main idea is to place a Resistive Plate Chamber (RPC) under a water-Cherenkov Detector (WCD) in order to shield it from the showers' electromagnetic content.

An implementation of MARTA has already been installed at the Pierre Auger observatory and is currently being used as an R&D project to test MARTA's viability to directly measure the muon content in a shower.

The purpose of my thesis project is then to use the MARTA simulation framework to test the possibility of measuring the number of muons near the shower core, where the contamination due to the electromagnetic component is at its highest making it so that current studies with this engineering array cannot probe this region. I will then develop a new RPC configuration mode based on linking the total charge in a pad to the number of particles crossing it at a given time which, combined with other strategies such as defining fiducial areas, may allow us to recover the important shower region.

A successful implementation would allow us to study the important shower core region for the first time.

Author: FREITAS, Milton

Presenter: FREITAS, Milton