T 47: Cosmic Ray 2

Time: Tuesday 16:15–18:15 Location: T-H32

T 47.1 Tue 16:15 T-H32

The Underground Muon Detector in The Pierre Auger Observatory: calibration and characterization — •Marina Scornavacche[1,2], Federico Sánchez[1], Juan Manuel Figueira[1], and Markus Roth[2] for the Pierre Auger-Collaboration — [1]Instituto de Tecnologías en Detección y Astropartículas, Comisión Nacional de Energía Atómica, Buenos Aires, Argentina — [2]Institut für Astroteilchenphysik, Karlsruher Institut für Technologie, Karlsruhe, Deutschland

The Pierre Auger Observatory was designed to answer the key questions about the origin and composition of ultra-high energy cosmic rays. The Underground Muon Detector (UMD) is optimized to perform a direct measurement of the muon component of the air showers in the ankle-region of the energy spectrum. To estimate the number of muons, one of the most sensitive observables to the mass composition of primary cosmic rays, the UMD works in two complementary ways dubbed as binary (or counting) and ADC (or integrator) modes. The first relies on the amplitude of the signals, the latter on its charge. In this work, we will focus on the integrator mode, where the number of muons can be estimated once the average charge left by a single muon is known. In previous analysis, we showed how to calibrate the integrator based on simulations. Now we study evolution of the calibration data, including monitoring variables involved in the calibration process. We also perform comparisons between data and simulation results and report on most recent developments and interpretations.

T 47.2 Tue 16:30 T-H32

Compatibility of trigger and timing between the non-upgraded and the upgraded electronics of the Pierre Auger Observatory. — •Fabio Convenga for the Pierre Auger-Collaboration — Karlsruher Institut für Technologie (IAP), Karlsruhe, Germany

The surface detectors of the Pierre Auger Observatory are being upgraded by adding new detectors and replacing electronics.

The upgraded electronics, dubbed Upgraded Unified Board (UUB), is able to acquire data from the new detectors. It includes an improved GPS receiver, a higher sampling rate, and a more powerful logic capacity.

The new features of UUB made it possible to introduce new types of triggers. Despite this, to ensure backward compatibility, pre-upgrade triggers are implemented using digitally filtered and downsampled waveforms to simulate the triggering behavior in the non-upgraded stations.

The logic functionality of the UUB also includes a module for event timing. The fundamental architecture of this module is parallel to that used in non-upgraded electronics. The on-board software that manages the module is similar to that of the non-upgraded electronics, with minor modifications required for the new UUB hardware.

In this talk, we will present the first analysis on the compatibility of the triggering efficiency and timing focusing on two neighboring stations one with the non-upgraded electronics and the other with the UUB.

T 47.3 Tue 16:45 T-H32

Performance and Calibration of the Upgraded Surface Detector of the Pierre Auger Observatory — •Alexander Streich, David Schmidt, Darko Veberic, Markus Roth, and Ralph Engel for the Pierre Auger-Collaboration — Karlsruher Institut für Technologie (KIT), Karlsruhe, Deutschland

The AugerPrime upgrade defines the transition to the next measurement stage of the Pierre Auger Observatory and is rolled out among other things with the addition of new scintillation detectors on top of the water-Cherenkov detectors of the Surface Detector. These Surface Scintillator Detectors provide a complementary measurement of the secondary particles enabling the discrimination of the individual air shower components on an event-to-event basis. This leads to an significantly improved determination of the properties of the ultra-high energy cosmic rays, for example their mass composition. Besides the scintillation detectors, the electronics boards of each station will be replaced with an enhanced version with an increased signal resolution, a higher sampling frequency, as well as faster data processing. This presentation focuses on the analyses of the performance of these hardware components under the measurement conditions in the Observatory. Thereby, the general operation stability and hardware requirements are investigated. Additionally, the performance of the air shower reconstruction applied to the first array of AugerPrime stations is analyzed, including the necessary adaptations to the detector calibration procedure and the signal discrimination capability of the hybrid event detection utilizing the scintillation and Cherenkov detectors.

T 47.4 Tue 17:00 T-H32

Test of the front-end electronics of the AugerPrime Radio Detector* — Stephan Keller and •Julian Rautenberg for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

As part of the AugerPrime extension of the Pierre Auger Observatory each of the 1660 Surface Detector stations will be upgraded for the radio detection of air showers. The corresponding specialized front-end electronics has been developed within the collaboration for optimal performance in the cosmic ray detection. To ensure the quality of the electronics before deployment over the 3000 km^2 of the Observatory they are temperature cycled between -25 and 75 degree for 48 hours. At four temperatures their performance is repeatedly measured with a defined set of test-signal inputs. The setup to test the 2000 electronic boards will be presented together with the results of the first pre-production boards.

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T 47.5 Tue 17:15 T-H32

CRPropa 3.2 — an advanced framework for high-energy particle propagation in extragalactic and galactic spaces — •Julien Dörner for the CRPropa-Collaboration — Theoretische Physik IV, Ruhr University Bochum, Bochum, Germany — RAPP-Center at Ruhr University Bochum, Bochum, Germany

The landscape of high- and ultra-high-energy astrophysics has changed in the last decade, largely due to the inflow of data collected by large-scale cosmic-ray, gamma-ray, and neutrino observatories. At the dawn of the multimessenger era, the interpretation of these observations within a consistent framework is important to elucidate the open questions in this field. CRPropa 3.2 is a Monte Carlo code for multimessenger simulations of high-energy particles and their secondaries. With this new version, the framework is now extended to more than extragalactic propagation opening up the possibility to more astrophysical applications, like Galactic cosmic-ray and local source modeling.

In this talk, we will show some of these new aspects that can be applied with CRPropa 3.2. It will include simulations of high-energy particles in diffusion dominated domains and self-consistent, fast modelling of electromagnetic cascades and interactions with customized photon fields. With the new CRPropa 3.2 version several technical updates and improvements were implemented, which will be presented in the talk.

T 47.6 Tue 17:30 T-H32

Testing the Starburst Galaxy and Active Galactic Nuclei correlation result for Pierre Auger Observatory with CRPropa simulations* — •wilson namasaka — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal, Germany.

Intermediate scale anisotropies in the distribution of Ultra-High Energy Cosmic Rays (UHECRs) arrival directions can be associated with two prominent classes of extragalactic gamma-ray sources detected by Fermi-LAT. In most recent study, a correlation between the arrival direction of cosmic rays at energies above 38 EeV for starburst galaxies (SBG) and 39 EeV for active galactic nuclei (AGN) was reported by the Pierre Auger Collaboration with a significance of 4.5σ and 3.1σ, respectively. The cosmic ray excess models for these sources used an angular smearing parameter to fit the observed arrival direction distribution in an optimization scan.

The viability of this angular smearing using CRPropa is investigated in this research, to test whether the results of the Pierre Auger Observatory can be reproduced by the deflections expected due to magnetic fields. The five strongest gamma-ray sources in both the Fermi-LAT AGN and SBG catalogs based on flux weight have been selected. In this talk, results from the simulations and expected angular deflections

shall be presented.

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T 47.7 Tue 17:45 T-H32

Extending CRPropa with hadronic interactions for in-source propagation of UHECRs* — •Leonel Morejon — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

CRPropa is a versatile Monte Carlo code for the propagation of Ultra-High Energy Cosmic Rays (UHECRs). Part of its strength is the possibility to combine it with user code to provide additional functionality. For example, it has been employed with post-simulation computations to study sources where hadronic interactions are of interest. However, when such interactions are too important, like may be the case in certain bursting sources, this type of approach is inconsistent.

This contribution reports on the ongoing effort to extend CRPropa with the inclusion of hadronic interactions. The approach involves exposing hadronic modelling softwares (*e.g.* EPOS-LHC, SYBILL, QGSJet) to the main code, and thus, make them available to all users natively (*i.e.* no need for additional coding). The result is a new module within CRPropa that computes hadronic interactions in runtime, along with the other interactions in the code. The performance of this new module is profiled and simple case studies are selected to illustrate its use.

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T 47.8 Tue 18:00 T-H32

Advances in parallelization of cosmic rays simulations in CORSIKA 8 — •Antonio Augusto Alves Junior, Pranav Sampathkumar, and Ralf Ulrich for the CORSIKA 8-Collaboration — Institute for Astroparticle Physics (IAP) - KIT

Advances in the parallelization of CORSIKA 8, which is being developed in modern C++17 and is designed to run on multi-thread modern processors and accelerators, are discussed.

Aspects such as out-of-the-order calculations, generation of high quality random numbers and fast task scheduling and submission on massively parallel platforms are highlighted, followed by presentation of preliminary performance measurements.

Finally, the design choices and integration into CORSIKA 8 are presented, together with some basic examples.