T 85: Cosmic rays III

Time: Thursday 16:30–19:00 Location: L-3.002

T 85.1 Thu 16:30 L-3.002

Muon studies with IceTop data — •Donghwa Kang for the IceCube-Collaboration — Karlsruher Institut für Technologie (KIT)

IceTop is the surface component of the IceCube Neutrino Observatory at the geographical South Pole. It is designed to measure the air showers of cosmic ray with energies from PeV up to EeV. In general it is reasonable to assume that the muon signal becomes significant for a large distance from the shower axis, since they are overwhelmed by the signal from electromagnetic components at close to the shower axis. Considering the charge signal distribution, a parameter sensitive to the muon content was defined and estimated, which is the sum of the charge signals divided by the total number of tanks and the area of the tanks at a fixed distance from the shower axis. In this talk the estimated muon parameter based on the charge distribution will be presented. Its dependence of the high-energy hadronic interaction models will be discussed as well.

T 85.2 Thu 16:45 L-3.002

Insight into physical parameters of hadronic interactions — •Isabel Goos[1,2,3], Xavier Bertou[2,4], and Tanguy Pierog[3] for the Pierre Auger-Collaboration — [1]Universidad Nacional de San Martín, Buenos Aires, Argentina — [2]CONICET — [3]Institute for Nuclear Physics, Karlsruhe Institute of Technology, Karlsruhe, Germany — [4]CNEA

The Pierre Auger Observatory is a hybrid detector designed to detect extensive air showers initiated by cosmic rays with energies above 3×10^{17} eV. Monte Carlo simulations are used to study the relationship between properties of the primary cosmic ray and features of the resulting air shower which ultimately provides the observables accessible in the observatory. In these simulations an anti correlation between the number of muons N_μ and the depth X_{max} of maximum development of the air shower was observed. The main explanation is that the more energy is taken by neutral pions, the deeper the shower develops (higher X_{max}) and the less energy is left for charged pions which decay into muons (lower N_μ). However, this anti correlation presents a spread that is still to be understood. It is expected to give insight into physical parameters related to the hadronic interactions at very high energies. Searching for these parameters is particularly interesting since they are not accessible with current accelerator experiments. In this talk we present the current results on the search of the relationship between the X_{max}-N_μ anti correlation and some physical parameters describing aspects of hadronic interactions.

T 85.3 Thu 17:00 L-3.002

Muon deficit in air shower simulations estimated from AGASA muon measurements — •Flavia Gesualdi[1,2], Alberto Daniel Supanitsky[1], and Alberto Etchegoyen[1] — [1]Instituto de Tecnologías en Detección y Astropartículas (CNEA, CONICET, UNSAM), Centro Atómico Constituyentes, San Martín, Buenos Aires, Argentina — [2]Karlsruhe Institute of Technology, Institute for Nuclear Physics (IKP), Germany

Understanding the origin of ultra-high energy cosmic rays is still a challenge. The average composition as a function of primary energy is a key information to elucidate the origin of these very energetic particles. The most sensitive observables to the mass composition are the atmospheric depth of the shower maximum and the muon content of the showers. In this work, direct measurements of the muon density at 1000 m from the shower axis observed by the Akeno Giant Air Shower Array (AGASA) are analysed. The selected events have zenith angles $\theta \leq 36^\circ$ and energies in the range $18.83 \leq \log_{10}(E_R/\mathrm{eV}) \leq 19.46$. These are compared to the predictions corresponding to proton, iron, and mixed composition scenarios obtained by using the high-energy hadronic interaction models EPOS-LHC, Sibyll2.3c, and QGSJetII-04. A muon deficit in air shower simulations is observed: The muon density obtained from AGASA data is greater than the one obtained in the mixed composition scenario by a factor of 1.49 ± 0.11 (stat)±0.17 (syst), 1.54 ± 0.12 (stat) $\pm$ 0.18 (syst), and 1.66 ± 0.13 (stat) $\pm$ 0.20 (syst) for EPOS-LHC, Sibyll2.3c, and QGSJetII-04, respectively.

T 85.4 Thu 17:15 L-3.002

Unfolding of the energy spectrum of stopping muons in IceCube — •Hubertus Kaiser and Jan Soedingrekso for the IceCube-Collaboration — TU Dortmund, Dortmund, Germany

The investigation of neutrinos and their origin is one of the main objectives of IceCube Neutrino Observatory. A classification of measured events into atmospheric muons and neutrinos is essential, as most events are of atmospheric nature and form the background in the search for extragalactic neutrino sources. Therefore an accurate selection of atmospheric muons and a precise determination of their energy spectrum provide the basis for further analysis. This talk gives insights into the selection of single stopping muons using machine learning algorithms and how their energy spectrum can be unfolded.

T 85.5 Thu 17:30 L-3.002

Leading HE Muon Measurements using Machine Learning Techniques — •Johannes Werthebach for the IceCube-Collaboration — TU Dortmund

The prompt component of the cosmic ray flux can be determined by analysing the energy spectrum of single atmospheric muons. A sufficiently pure sample of these muons can be obtained with the IceCube detector. Extracting such a sample is challenging, due to IceCubes geometric restrictions. Using machine learning techniques is one possible solution. This talk presents a machine learning based approach.

T 85.6 Thu 17:45 L-3.002

Analysis of photon-like airshowers measured by the Pierre Auger Observatory — •Jannis Pawlowsky for the Pierre Auger-Collaboration — Bergische Universität Wuppertal

The Pierre Auger Observatory is the largest experiment measuring ultra high energy cosmic rays. It is sensitive to the type of the primary particle because of their different shower development in the atmosphere. This yields the experiment the most sensitive detector for photons and neutrinos at energies above the EeV range.
For this search of photons, the full duty cycle of the Surface Detector is used. The detectors are sensitive to separate the electromagnetic and hadronic shower component by the lateral distribution of the station signals as well as shape of the signals. Based on this, observables are combined in a principal component analysis resulting in a photon-like parameter. In this, the distributions for hadrons and photons are well separated. Using a threshold corresponding to 50% photon detection efficiency photon candidates can be selected. Applied to the full dataset, candidates in the tail of the data-distribution have been found.
Testing a hadron hypothesis, protons with the event-geometry of the candidates have been simulated to study the effect of the shower-to-shower fluctuations. A small fraction of simulated hadronic showers is further studied for their specific properties that are responsible for the photon-like air shower development. First results for the characterization of the photon-like hadronic showers are presented.
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T 85.7 Thu 18:00 L-3.002

Using the Leptonpropagator PROPOSAL for air shower and underground experiments — •Jan Soedingrekso and Mirco Hünnefeld — TU Dortmund

The lepton propagator PROPOSAL is a simulation library to efficiently propagate leptons and high energy photons through large volumes of media. To study the effect of systematic uncertainties of the cross-sections on the propagation, e.g. the muon energy or the secondary distribution, multiple cross-section parametrizations are implemented. PROPOSAL is mainly used and optimized for the muon propagation in the Cherenkov neutrino astronomy experiment IceCube, but is also used in radio neutrino astronomy simulations.

In this talk, the current status of the library and new opportunities for its usage in air shower and underground experiments are shown.

T 85.8 Thu 18:15 L-3.002

Recent developments in CORSIKA 8 — Tanguy Pierog[1], •Maximilian Reininghaus[1,2], Felix Riehn[3], and Ralf Ulrich[1] — [1]Karlsruher Institut für Technologie, Karlsruhe, Deutschland — [2]Instituto de Tecnologías en Detección y Astropartículas, Buenos Aires, Argentinien — [3]Laboratório de Instrumentação e Física Experimental de Partículas, Lissabon, Portugal

CORSIKA 8 is a next-generation framework for Monte Carlo simulations of air showers currently under development. In this contribution we present recent developments of the project, mainly concerning the propagation of the hadronic and muonic components of air showers. Furthermore we compare simulation results obtained from CORSIKA 8 to other codes, including CORSIKA 7, CONEX and MCEq.

T 85.9 Thu 18:30 L-3.002

Extension of the simulation library PROPOSAL to propagate electromagnetic shower components — •Jean-Marco Alameddine, Jan Soedingrekso, and Maximilian Sackel — TU Dortmund, Dortmund, Germany

PROPOSAL is a Monte Carlo simulation library, usable both in C++ and via a python wrapper, used to describe the propagation of highly energetic particles. These particles can, for example, be induced by atmospheric air showers or produced from interactions of astrophysical high-energy neutrinos with matter, observed with experiments such as the IceCube Neutrino Observatory. Previous versions of PROPOSAL focused on a precise description of muon and tau propagation. In a recent update, both photon propagation and a more precise description of electron and positron propagation were implemented as well. This allows PROPOSAL to be used as a propagator for electromagnetic shower particles, for example in the upcoming eight version of the extensive air shower simulation framework CORSIKA. In this talk, the recent update of PROPOSAL is presented with a focus on the physical description of the new processes as well as comparisons with alternative propagation models such as EGS.

T 85.10 Thu 18:45 L-3.002

PROPOSAL as a tool for the calculation of electromagnetic and muonic energy losses — •Maximilian Sackel, Jean-Marco Alameddine, and Jan Soedingrekso — Technische Universität Dortmund, Dortmund, Germany

For cosmic rays experiments, precise simulations of the various components of a particle shower are of high importance. Both the muonic and the electromagnetic component of an air shower can be propagated with the lepton propagator PROPOSAL. The initial concept was to calculate the energy losses of muons in large volume media with constant density. For the propagation of the muonic and electromagnetic shower components through inhomogeneous densities, modifications are needed that preserve the modularity to new interactions and parameterizations. Fast propagation is ensured by the use of interpolation tables, whereby the number of calculated tables is kept as small as possible by parameterizing the density distribution of the media. On the basis of the air shower simulation program CORSIKA a concept is shown how stochastic and continuous interaction points can be calculated with the library PROPOSAL for the use in a custom simulation.