Workshop on the tuning of hadronic interaction models

Monday, 22 January 2024 - Thursday, 25 January 2024

University Wuppertal

Book of Abstracts

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Air shower predictions of QGSJET-III and model uncertainties for Xmax

Author: Sergey Ostapchenko[1]

[1] *Hamburg University, II Institute for Theoretical Physics*

Corresponding Author: sergey.ostapchenko@desy.de

I shall discuss new theoretical approaches implemented in the QGSJET-III Monte Carlo generator and present selected model results regarding secondary hadron production in hadron-proton and hadron-nucleus collisions. The predictions of the model for basic characteristics of proton-induced extensive air showers (EAS) will be compared to the ones of QGSJET-II and of other cosmic ray interaction models. In the second part of my talk, I shall concentrate on potential model uncertainties regarding predictions for EAS maximum depth.

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Strangeness enhancements and the muon excess in extensive air showers

Authors: Julien Manshanden[None]; Maria Vittoria Garzelli[1]; Guenter Sigl[2]; Sergey Ostapchenko[3]

[1] *II Institut fuer Theoretische Physik, Universitaet Hamburg*

[2] *Universität Hamburg*

[3] *Hamburg University, II Institute for Theoretical Physics*

Corresponding Authors: sergey.ostapchenko@desy.de, guenter.sigl@desy.de, maria.vittoria.garzelli@desy.de

Several high-energy cosmic-ray experiments have observed an excess of muons compared to theoretical expectations from air shower simulations based on standard hadronic interaction models. We investigate the potential of producing states of dense quark-gluon matter (so-called fireballs) to resolve the excess of muons on the ground for a given depth of the shower maximum. Adopting a phenomenological fireball model, we find that the inelasticity enhancement associated with the formation of a plasma state is in tension with data on the electromagnetic longitudinal shower development. We then restrict the fireball model to only enhance the strangeness produced in Standard Model hadronic interactions, and dub this model the strangeball model. Comparing with air shower measurements we find strangeball parameters that resolve the muon puzzle. Constraints from data on shower-to-shower fluctuations of the muon number require strangeness enhancements already at energies accessible to current-generation collider experiments. The strangeball
hypothesis leads to a 5–9% increase of the average fraction of energy retained in the hadronic cascade compared to predictions from current hadronic interaction models. A comparison with relevant measurements of the LHCf and LHCb detectors does not directly exclude this scenario, though the obtained tension with LHCb suggests a stringent test at 14 TeV.

Based mainly on Manshanden, Sigl and Garzelli, JCAP02 (2023) 017.

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Hadronic interactions in Angantyr

Author: Marius Utheim[None]

Corresponding Author: marius.utheim@cern.ch

In recent times, the Pythia event generator has been extended to feature simulations of generic hadron-nucleon interactions. In this talk, I present a further extension to hadron-ion interactions, which are of particular relevance for air showers where hadronic cascades interact with nuclei in the air.

The model has been validated against NA61/SHINE data. The model also has applications to the vector-meson dominance component of photo-induced processes, and in this context has been found to give a good description of HERA and ATLAS data.

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A RIVETing journey: Analysis Preservation and Generator Tuning in High Energy Physics

Author: Lars Kolk[1]

Co-author: Hans Dembinski [1]

[1] *TU Dortmund*

Corresponding Authors: lars.kolk@tu-dortmund.de, hans.dembinski@tu-dortmund.de

A RIVETing journey: Analysis Preservation and Generator Tuning in High Energy Physics

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EPOS4 overview

Author: Klaus Werner[1]

[1] *SUBATECH*

Corresponding Author: werner@subatech.in2p3.fr

EPOS4 overview

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Results and prospects of LHCf (cancelled)

Author: Hiroaki Menjo[1]

[1] *ISEE, Nagoya University, Japan*

Corresponding Author: menjo@isee.nagoya-u.ac.jp

LHCf is an LHC experiment designed to study high energy hadronic interaction for understanding cosmic-ray-induced air-shower development. LHCf measures the differential production cross-sections of neutral particles (photons, pi0, and neutrons) at the very forward region of collisions. In this talk, I will review LHCf results and discuss the prospects of ongoing analyses and future operation of pO collisions.

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Radio Detection and its relevance for studying air shower physics

Author: Tim Huege[1]

[1] *Karlsruher Institut für Technologie*

Corresponding Author: tim.huege@kit.edu

Radio Detection and its relevance for studying air shower physics

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Pythia 8 Overview

Author: Torbjörn Sjöstrand[1]

[1] *Lund University*

Corresponding Author: torbjorn.sjostrand@fysik.lu.se

Pythia 8 Overview

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Measurements of Relevance for Cosmic-Ray Physics with NA61/SHINE

Author: Michael Unger[None]

Corresponding Author: michael.unger@kit.edu

Measurements of Relevance for Cosmic-Ray Physics with NA61/SHINE

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atmospheric flux calculations and LHC input

Author: Maria Vittoria Garzelli[1]

[1] *II Institut fuer Theoretische Physik, Universitaet Hamburg*

Corresponding Author: maria.vittoria.garzelli@desy.de

I discuss the calculations of atmospheric fluxes (prompt and conventional)
and LHC input useful for it.

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Models and Measurements of Antiproton Production for Cosmic-Ray Studies

Author: Thomas Pöschl[1]

[1] *CERN*

Corresponding Author: thomas.poeschl@cern.ch

Models and Measurements of Antiproton Production for Cosmic-Ray Studies

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Relevance of hybrid data to the tuning of hadronic interaction models

Author: Jakub Vícha[1]

[1] *FZU - Institute of Physics of Czech Academy of Sciences*

Corresponding Author: vicha@fzu.cz

Relevance of hybrid data to the tuning of hadronic interaction models

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MCPLOTS : MC validation resource based on volunteer computing

Authors: Anton Karneyeu[1]; Natalia Korneeva[2]; Peter Skands[2]

[1] *INR RAS*

[2] *Monash University*

Corresponding Author: natalia.korneeva@cern.ch

We present the MCPLOTS online resource for MC event-generator validations. The project is based on the RIVET analysis library and harnesses volunteer computing to generate high-statistics MC comparisons to data. Users interact with the resource via a simple web site, mcplots.cern.ch, where run cards, histogram points, etc, are all made easily available for download. The project has been structured to enable community-driven developments, and we discuss the computational back end, the web front end, and possibilities for further extensions and collaboration.

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CRPropa: overview and embedded hadronic interactions

Author: Leonel Morejon[1]

[1] *BUW*

Corresponding Author: leonel.morejon@uni-wuppertal.de

CRPropa 3.2, released recently, is the latest update in a continued effort to maintain and extend this open-source code well known in the cosmic-ray community. Originally aimed at simulating the ballistic propagation and interactions of Ultra-High Energy Cosmic Rays, today it can handle diffusive propagation of cosmic rays in a variety of magnetic fields, deal with stochastic cosmic ray acceleration, model electromagnetic cascades for gamma ray emission and transport, among other capabilities. Of special interest is the introduction of hadronic interactions to facilitate the treatment of cosmic ray interactions in the galaxy and within the sources. This talk provides an up-to-date overview of the code and details the recently implemented hadronic interactions.

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Chromo: An event generator frontend for particle and astroparticle physics

Authors: Anton Prosekin[1]; Hans Dembinski[2]; Anatoli Fedynitch[1]

[1] *Institute of Physics, Academia Sinica, Taipei, Taiwan*

[2] *TU Dortmund*

Corresponding Authors: antonpr@gate.sinica.edu.tw, hans.dembinski@tu-dortmund.de, anatoli@gate.sinica.edu.tw

Chromo: An event generator frontend for particle and astroparticle physics

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Status of nuclear-PDF analyses and prospects with light ions

Author: Petja Paakkinen[1]

[1] *University of Jyväskylä*

Corresponding Author: petja.k.m.paakkinen@jyu.fi

Status of nuclear-PDF analyses and prospects with light ions

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Introduction and overview of the UrQMD model for p+A and A+A reactions

Author: Marcus Bleicher[1]

[1] *Uni Frankfurt*

Corresponding Author: bleicher@itp.uni-frankfurt.de

This talk provides an introduction into the Ultra-relativistic Quantum Molecular Dynamics model (UrQMD). UrQMD is a well established transport approach to simulate hadron-hadron, hadron+nucleus

and nucleus+nucleus reactions at beam energies starting from 1 GeV to center-of-mass energies of a few hundred GeV. UrQMD has been well tested against a wide range of accelerator data for various collision systems and allows to obtain a full momentum distribution of all final state particles.

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LHCb colliding-beam measurements for astroparticle physics

Author: Michael Schmelling[None]

LHCb colliding-beam measurements for astroparticle physics

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Air shower genealogy

Author: Maximilian Reininghaus[None]

Co-authors: Ralph Engel [1]; Tanguy Pierog [2]

[1] *Karlsruhe Institute of Technology (KIT)*

[2] *KIT, IAP*

Corresponding Authors: ralph.engel@kit.edu, m@reininghaus.tech, tanguy.pierog@kit.edu

genealogical studies of EM and hadron/muon EAS component with CORSIKA 8 and comparisons with Heitler-Matthews model

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Welcome

Corresponding Author: kampert@uni-wuppertal.de

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Tuning of event generators with accelerator and astroparticle experiments

Corresponding Author: hans.dembinski@tu-dortmund.de

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Summary and final remarks on the workshop

Corresponding Authors: hans.dembinski@tu-dortmund.de, kampert@uni-wuppertal.de

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Sibyll-2.3d and SIBYLL-STAR

Corresponding Author: friehn@lip.pt

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EPOS-LHCR

Corresponding Author: tanguy.pierog@kit.edu

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CORSIKA 8 overview

Corresponding Author: asandrock@uni-wuppertal.de

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MCEq for atmospheric lepton flux calculation

Corresponding Author: anatoli@gate.sinica.edu.tw

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Overview on UHECR interactions

Corresponding Author: ralph.engel@kit.edu

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The role of direct muon measurements in Auger

Corresponding Author: markus.roth@kit.edu

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KASCADE

Corresponding Author: andreas.haungs@kit.edu

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WHISP

Corresponding Author: lorenzo.cazon@usc.es

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Fixed target experiments at the LHC: SMOG and SMOG2 at LHCb

Corresponding Author: graziani@fi.infn.it

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Tuning in the far forward region for FASER

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Tuning of Pythia 8 for simulations of UHECR induced air showers

Corresponding Author: gaudu@uni-wuppertal.de

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Tuning with Bayesian methods

Corresponding Author: michael.windau@tu-dortmund.de

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IceTop observables for tuning

Corresponding Author: dennis.soldin@utah.edu

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IceCube observables for tuning

Corresponding Author: mirco.huennefeld@tu-dortmund.de

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Modified Hadronic Interactions in CORSIKA 7

Corresponding Author: ebr@fzu.cz

Ulrich et al. have shown already in 2011 that changing the cross-section, elasticity and multiplicity of hadronic interactions at very high energies with respect to the standard hadronic interaction models has a direct impact on predicted depths of the shower maxima and numbers of muons at ground. We have expanded this work from the original 1D implementation in CONEX to full 3D simulations in CORSIKA, allowing us to quantify the effects of the modified interactions on other observables. We find that satisfying the latest constraints from the Pierre Auger Observatory on the number of muons at 1000 meters from the shower axis and depth of shower maximum simultaneously is challenging, but possible within a reasonable space of modifications.

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ALICE measurements for tuning

Corresponding Author: antonin.maire@cern.ch

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About train driver's strike

Corresponding Author: hans.dembinski@tu-dortmund.de