Auger report to the LIP advisory

Ruben Conceição





LIP advisory, Lisbon, April 20th 2024

on behalf of the Auger-LIP group











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Auger data in a nutshell

- Increasingly coherent picture emerging from Auger Phase I data
 - Machine learning algorithms are boosting the event statistics
 - Unexpected astrophysical scenario?
- The mass composition determination is essential to rule out scenarios
- The post-LHC hadronic interaction models are unable to provide a consistent description of the measured showers











(A plethora of measurements to fully understand the shower)



1016

1017

Multi-hybrid shower events

10¹⁸

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1020

Calibration activities

Auger-LIP

• GN setup to evaluate WCD-SSD calibration

MARTA

EAS phenomenology

- Λ_{μ} vs. X_{max} is sensitive to hadronic interaction regimes of the first interaction
- Measurement of Λ_{μ} exploring **AMIGA** data (log $E \sim 17$) - LHC equivalent energies
- Measurement of the **shower** particles energy spectrum with a single **MARTA** station

- 0.1

0.9

- 0.8

- 0.7

- 0.6

- 0.5

- 0.4

0.3

Searches for neutral particles

Responsibilities: Task leader Air Shower Physics; Task leader Calibration (SD/SSD); Ombudsperson; Search committee for CB chair

Auger-LIP

 Under investigation the possibility to extend the detection of neutrino events to lower zenith angles

Outreach activities

5 Auger Masterclass events 16 institutions (6 outside Auger) 10 countries; 534 students

Strength

- The LIP team is relatively large, both in the number of members and competencies.
- FCT has a long-term commitment to the Portuguese participation in the Pierre Auger Observatory, which hopefully can be extended up to 2035. This assures the payment of the MoU.

Opportunities

- The group has a strong competence in extensive air shower The group's funding has been periodically renewed phenomenology, simulation, and calibrations using an RPC every two years through the Fund CERN application. hodoscope. Such places the group in a privileged position for the However, as time progresses, the stability and certainty of this funding source are gradually required collaboration activities upon entering Phase 2. • Visibility within the universities is increasing, which is an becoming more uncertain.
- opportunity to attract new students. Lecturing in the Master in Physics program at IST and participating in thematic schools is increasing the awareness of this field.

SWOT Analysis

Weakness

- The team has a modest number of master's and Ph.D. students, leading to a lack of workforce.
- The group's funding level is low for the number of team members. Resources are limited. Thus, missions for meetings and fieldwork in Argentina must be wisely chosen.

Threats

Acknowledgements

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REPÚBLICA PORTUGUESA

Backup Slides

Machine Learning - X_{max} from DNNs

Results: inclined muons

- WCD signal response for of $\theta \in [20^\circ; 50^\circ]$
- the percent level

Pierre Auger coll., JINST 15 (2020) 09, P09002

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12

Shower quantities

First interaction quantities

Gws and neutrinos - GW170817

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14

Auger Masterclasses @ IMC2024 participating institutions

Organized by people/institutions from:

the Pierre Auger Collaboration

other institutions

Back to the calibration with the RPC hodoscope

one of the Auger Prime detectors

The data acquisition system was also upgraded to cope with the new electronics board of the WCD and have a more robust/faster acquisition system

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The dawn of Machine Learning @ Auger

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- Both method have good resolutions comparable to those achieved with hybrid events
 A sector of the sect
- Algorithms highly dependent of simulations and might be picking up unknown less controlled shower characteristics
- \diamond It is vital to create strategies to achieve self consistent solutions \Rightarrow RPC hodoscope

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Extraction of Nmu from the WCD signal for vertical showers

Hybrid Technique (FD + SD)

