Contribution ID: **3** Type: **Talk (in-person)**

Air Showers Simulations to Produce Technological Results

Tuesday 6 September 2022 09:20 (20 minutes)

Atmospheric radiation is mainly produced during the interaction of high energy cosmic rays with the atmosphere. After the first interaction of these primary cosmic rays, a series of radiative and decay processes generate a collective process known as Extensive Air Shower (EAS), with up to 10 secondary particles per primary per GeV at the altitude of the maximum development, and continue evolving up to reach the ground level.

Bearing this in mind, calculating the atmospheric radiation background is a very complex and demanding task. This computation is originated from the integration of all the secondary particles produced by the complete and modulated flux of cosmic rays that impinge on the atmosphere. For doing this we developed ARTI [1], a computational framework that takes advantage of the state-of-the-art radiation propagation and interaction codes, such as CORSIKA [2] and Geant4 [3], to trustworthily estimate the expected flux of radiation at any place in the World under real-time evolving atmospheric and geomagnetic conditions [4]. We are also capable to include the impacts produced during the sudden occurrence of transient astrophysical phenomena. As these calculations require a vast amount of computational resources, several approaches were adopted, such as the recent development of OneDataSim [5], a virtualized application to run ARTI on high-performance computing and cloud-based environments.

In this work, we show some of the implications and technological applications of our research, including results related to the precise calculation of the expected muon flux at underground laboratories, the mining prospecting and volcanoes risk assessment in muography, some new applications for precision agriculture and personal safe ward, and even how we are able to predict the occurrence of silent and non-silent errors at the new exascale supercomputers centres.

In addition, some results will be shown for the future ANDES underground laboratory. Thus, regarding the study of high energetic secondary particles at the tens of TeV scale for this lab background calculations and the expected flux of muons for muography geophysical applications, the expected flux over an integration time of 1 year at different altitudes of the ANDES mountain profile will be presented.

In all those cases, the accuracy and statistical significance of previous results have been extended by using these new resources.

References

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Acknowledgments

This work has been partially funded by the Spanish Ministry of Science, Innovation, and Universities CODEC-OSE project (RTI2018-096006-B-I00) and the Comunidad de Madrid CABAHLA project (S2018/TCS-4423), both with European Regional Development Fund (ERDF). It also profited from funding received by the H2020 co-funded project European Open Science Cloud - Expanding Capacities by building Capabilities (EOSC-

SYNERGY, No. 857647). Simulations carried out made also use of the computing facilities provided by CETA-CIEMAT and CIEMAT.

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