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The analysis of a rare deep extensive air shower using Top-Down reconstruction chain

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The Top-Down reconstruction chain is a Monte Carlo simulation framework designed to reconstruct extensive air showers while addressing the observed muon discrepancy—the excess of muons in data compared to simulations. We apply this method to a rare event detected by the Pierre Auger Observatory, notable for its exceptionally large depth of shower maximum. This rare event may even suggest exotic physics. To analyze its probability of being a hadron or photon, we try to reconstruct it using the Top-Down chain. The analysis has shown the need for modifications of the procedure: increasing the number of simulations, introducing additional quality cuts, and others. We present the reconstructed event that best matches the observations and analyze the top matches to quantify the muon discrepancy. Finally, we assess the likelihood of the primary particle being a hadron or photon.

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