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Towards a better understanding of cosmic showers: design study of a spectrometer to measure forward charm production at the LHC

Abstract: There is a consolidated belief that the study of astrophysical phenomena could allow a significant step forward in understanding the origin and evolution of our Universe. In particular, the study of matter (cosmic rays and neutrinos) and radiation (gamma rays) of very-high energies ejected during these extraordinary events seems to be of paramount importance to answer cosmological questions. Unfortunately, due to the low flux of particles reaching the Earth, ~km^{3} detectors are required to collect a statistically significant amount of data to have relevant information. For this reason, these detectors are most-likely to be built on-Earth rather than outside of the atmosphere and therefore have to face the large amount of background coming from hadronic production at the atmosphere-level. It is then essential to have a detailed knowledge of the set of processes occurring when a CR-particle impacts the atmosphere: when experimental observations are not available (both at astronomical detectors and at particle colliders), theoretical predictions are needed. In this context, I give a series of motivations why and where the theoretical models are thought to fail, affecting the most recent observations (IceCube, Auger, etc...) and I propose a measurement to be done around the LHC beams with the best possible acceptance in a kinematical region never covered so far in a collider.