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The atmospheric muons flux measured with the Large Volume Detector for 24 years

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The Large Volume Detector, hosted in the INFN Laboratori Nazionali del Gran Sasso, is triggered by atmospheric height energy muons (E_μ>1 TeV), which are produced in the decay of short-lived charged mesons in the extensive air showers, at a rate of ~ 0.1˜Hz.
The data collected over almost a quarter of century (1994-2017), the longest ever exploited by a single instrument, allows for the accurate long-term monitoring of the muon intensity underground. This is relevant as a study of the background in the Gran Sasso Underground Laboratory (minimal depth 3100 m w.e.), which hosts a variety of long-duration and low-background detectors aimed to search for rare events as supernova neutrinos and dark matter.

The muon flux intensity measured with LVD, $\mathrm{I}_\mu = (3.35 \pm 0.0005^{\mathrm{stat}} \pm 0.03^{\mathrm{sys}}) \times 10^{-4}\ \mathrm{m}^{-2}\mathrm{s}^{-1}$, is modulated with the effective temperature due to seasonal temperature variations in the stratosphere. We quantify such correlation, $\alpha_{\mathrm{T}} = 0.94 \pm 0.01^{stat} \pm 0.01^{sys}$, by using temperature data from the European Center for Medium-range Weather Forecasts for the LNGS Laboratory in agreement with other measurements at the same depth. We also investigated the spectral content of the time series by means of the Lomb-Scargle and Singular Spectrum Analysis techniques. This yields the clear evidence of a 1-year periodicity, as well as the indication of others, both shorter and longer, suggesting that the series, as expected, is not a pure sinusoidal wave.

In this contribution we will report on the results of the time series analisys and we will describe the methods to select muon-like events, to compute the effective temperature and to calculate the detector exposure.

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