Study on multi-ELVES in the Pierre Auger Observatory

Executive Summary

A. Vásquez-Ramírez[a] for the Pierre Auger Collaboration[b]

[a] Universidad Industrial de Santander, Escuela de Física, Carrera 27 Calle 9, Bucaramanga, Colombia

[b] Observatorio Pierre Auger, Av. San Martín Norte 304, 5613 Malargüe, Argentina

What is this contribution about?

We present the analysis of ELVES with more than one peak in their photo-traces, called multi-ELVES, detected at the Auger Observatory since 2014 with a dedicated trigger and a high temporal resolution of 100 ns.

Why is it relevant/interesting?

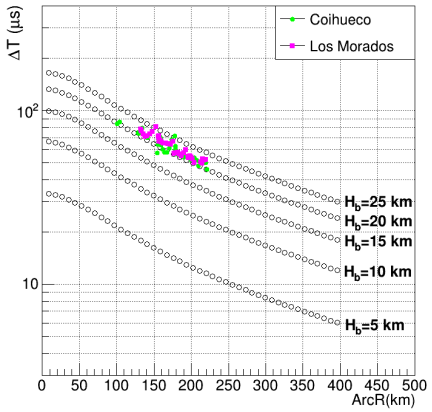
- The electromagnetic pulse (EMP) produced by lightning at a certain altitude (H_b) can produce ELVES with two peaks, and ΔT variation depends on H_b, as shown in fig. (a).
- Very few events detected in the period 2014-2020 can be explained by this mechanism.
- There is a frequent type of multi-ELVES with constant $\Delta T > 80\mu$s that does not follow this mechanism, as shown in fig. (b).

What has been done?

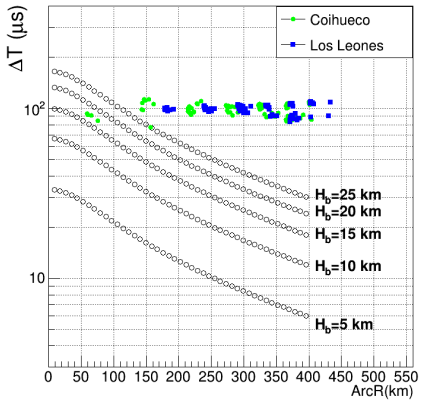
- Monthly distribution of ELVES and multi-ELVES with constant $\Delta T > 80\mu$s.
- Ratio (Q_{2tot}/Q_{1tot}) of the total light from the second peak (Q_{2tot}) respect to the first peak (Q_{1tot}).
- Peak current polarity distribution of the lightning that produced multi-ELVES (ME) (fig. (d)).

What is the result?

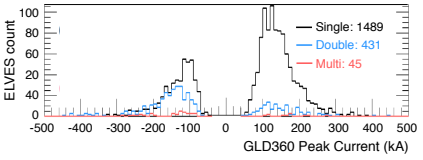
- The ratio of multi-ELVES with constant $\Delta T > 80\mu$s to total ELVES increases in April.
- Q_{2tot}/Q_{1tot} profile of multi-ELVES with constant $\Delta T > 80\mu$s is different from the Q_{2tot}/Q_{1tot} ground reflection mechanism multi-ELVES profile.
- The peak current distribution of the thunderstorm on April, 28, 2020 differs from the distribution obtained in the correlation of Auger data with the GLD360 (fig. (c).



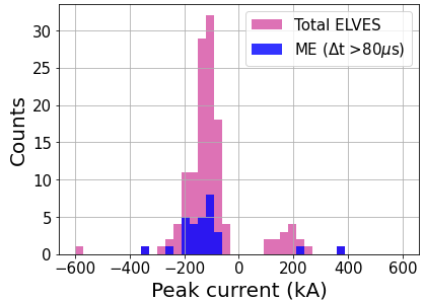
(a) Multi-ELVES candidate of EMP ground reflection mechanism.



(b) An example of a very frequent type of multi-ELVES with constant $\Delta T > 80\mu$s.



(c) Peak current distribution of Auger data correlated with the GLD360 in the 05/2017-12/2018 observation period.



(d) Peak current distribution of lightning inducing ELVES and multi-ELVES correlated with ENTLN and WWLLN data.