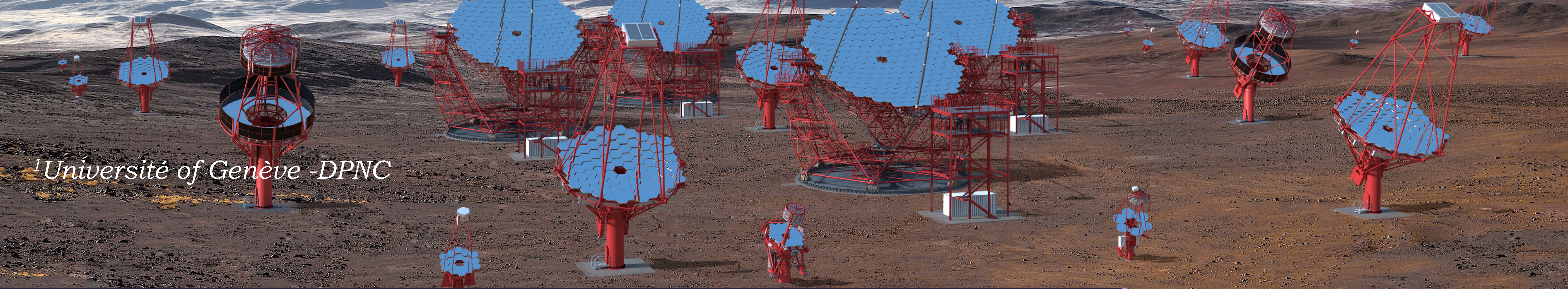
Trigger rate studies with LST-1 prototype

Mykhailo Dalchenko[1], Andrii Nagai[1]
for the UNIGE DPNC group

[1]Université of Genève -DPNC



ABSTRACT

In-depth analysis and comparison of simulated and observed trigger rates provides a good verification on the correctness of the telescope simulation. Presented method uses the full simulation of cosmic rays induced showers with the large size telescope prototype (LST-1) which is installed at the Roque de los Muchachos Observatory, La Palma, Spain. It compliments the results obtained with the analysis of detected muons. Good agreement achieved through entire range of scanned trigger threshold points.

LST trigger logic

The pixels of the LST camera are grouped in modules consisting of 7 pixels each at the front-end electronics level. In order to produce a trigger decision, analog trigger sum concept is employed. The signals from neighboring modules are combined in a trigger sector and the total signal level is required to reach a preset threshold. Three modes of module selection for triggering are supported, as shown on Fig. 1. In a given study, Mode 3 configuration is used.

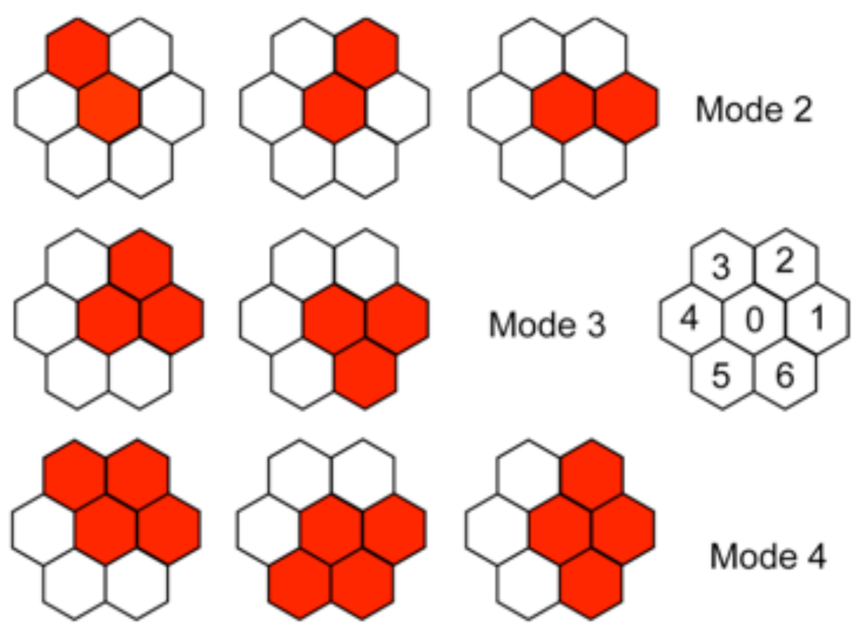


Fig. 1: An illustration of module combinations around a given central module. The single hexagon represents a module consisting of seven pixels.

Trigger scan data processing

Trigger scan is produced per each trigger sector individually. For this, the threshold on all the trigger sectors except the one under scan is raised to maximum value and the rate is recorded per each trigger threshold value. This procedure is then repeated for each module. The resulting rates are presented at Fig. 2, left. The individual sector curves shows large spread in the trigger threshold offset which must be accounted for. The trigger rate is driven by the night sky background contribution at low thresholds and by cosmic ray induced Cherenkov showers at higher thresholds.

These two parts of the curve are fitted with exponential functions for each trigger sector. The value of threshold at the intersection of these exponents reflects the individual offsets of trigger comparator for each sector. The offsets are accounted for by shifting the individual sectors intersection points to their average value. Corrected for the offsets plot is shown on Fig. 2, right.

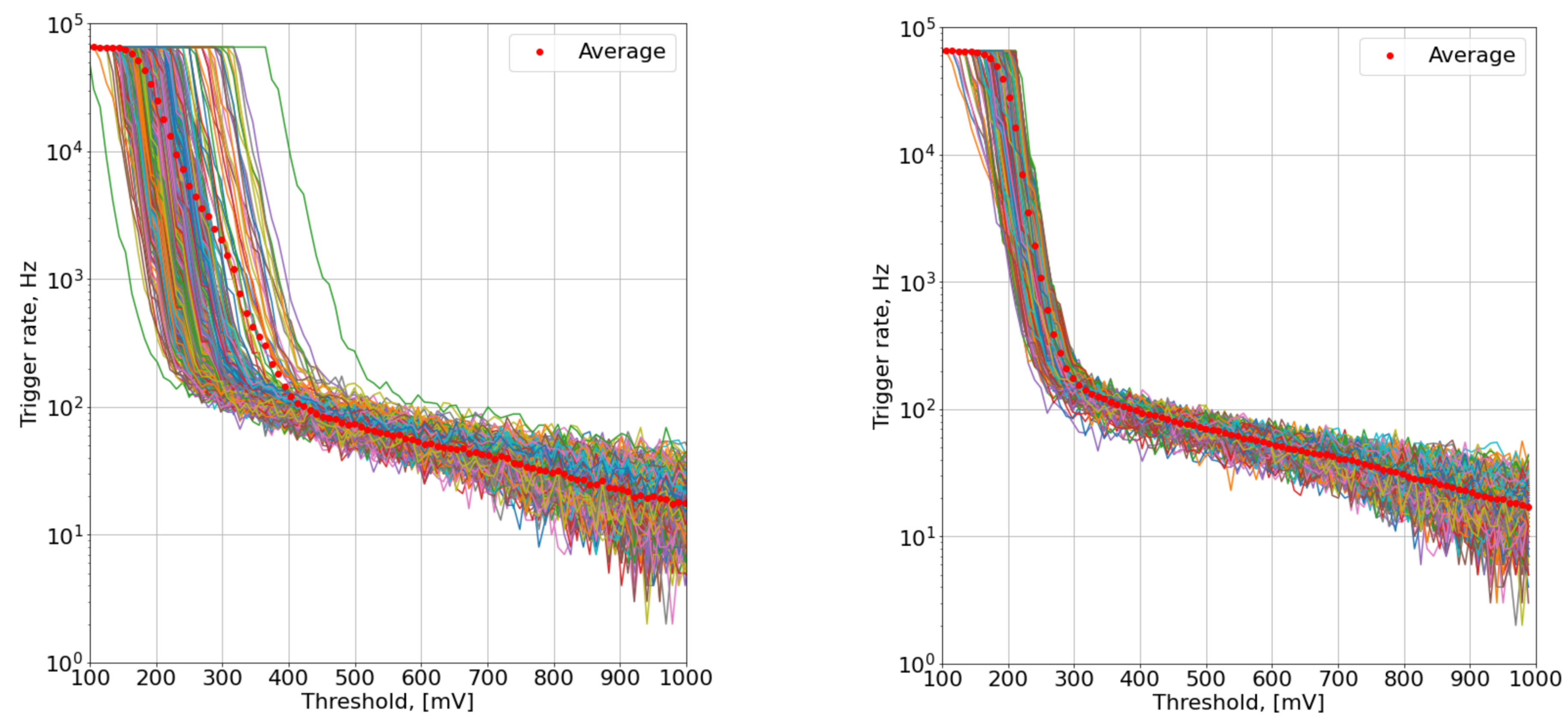


Fig. 2: Individual trigger sector rates and their average as a function of applied trigger threshold before the threshold offset correction (left) and after (right).

Comparison between data and simulation

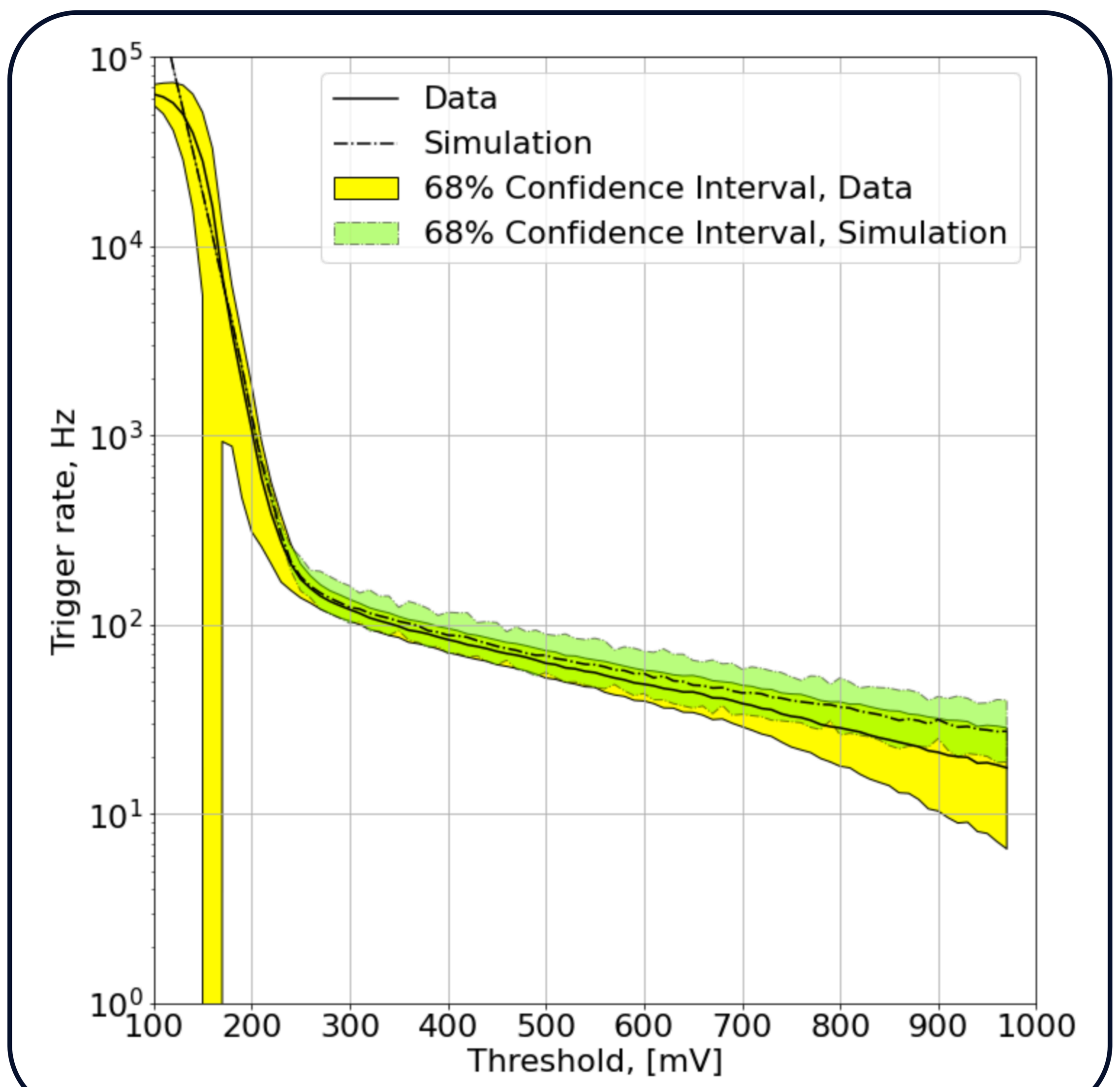


Fig. 3: Comparison between simulated and measured trigger rates as a function of the applied trigger threshold. Blue and orange bands represent 68% confidence interval for data and simulation

We simulate the cosmic ray induced showers interaction with the telescope and compute the differential trigger rate probability as a function of primary particle energy. Then it is convoluted with the observed cosmic ray spectrum. On top of this we add the simulated trigger rate produced by the night sky background. We show, that with the most up to date simulation parameters of the telescope, such as overall transmission efficiency and parameters of photomultipliers, a good agreement between the simulated and observed rates is achieved. Small discrepancy observed above the threshold value of 500 mV is attributed to a limited statistics both in data and simulation for such high-energy events and is well within the statistical errors.

ACKNOWLEDGEMENTS
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www.cta-observatory.org/consortium_acknowledgments

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