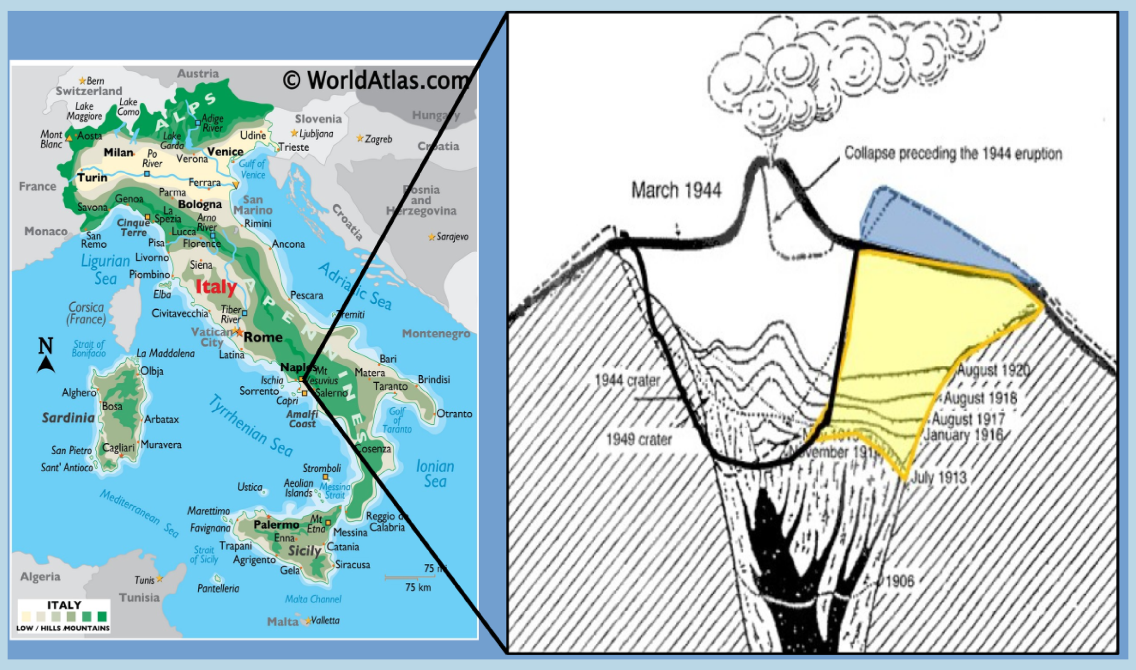
Status and first results of the MURAVES experiment at Mt. Vesuvius

Marwa Al Moussawi on behalf of the MURAVES Collaboration
marwa.almoussawi@uclouvain.be

Mt. Vesuvius

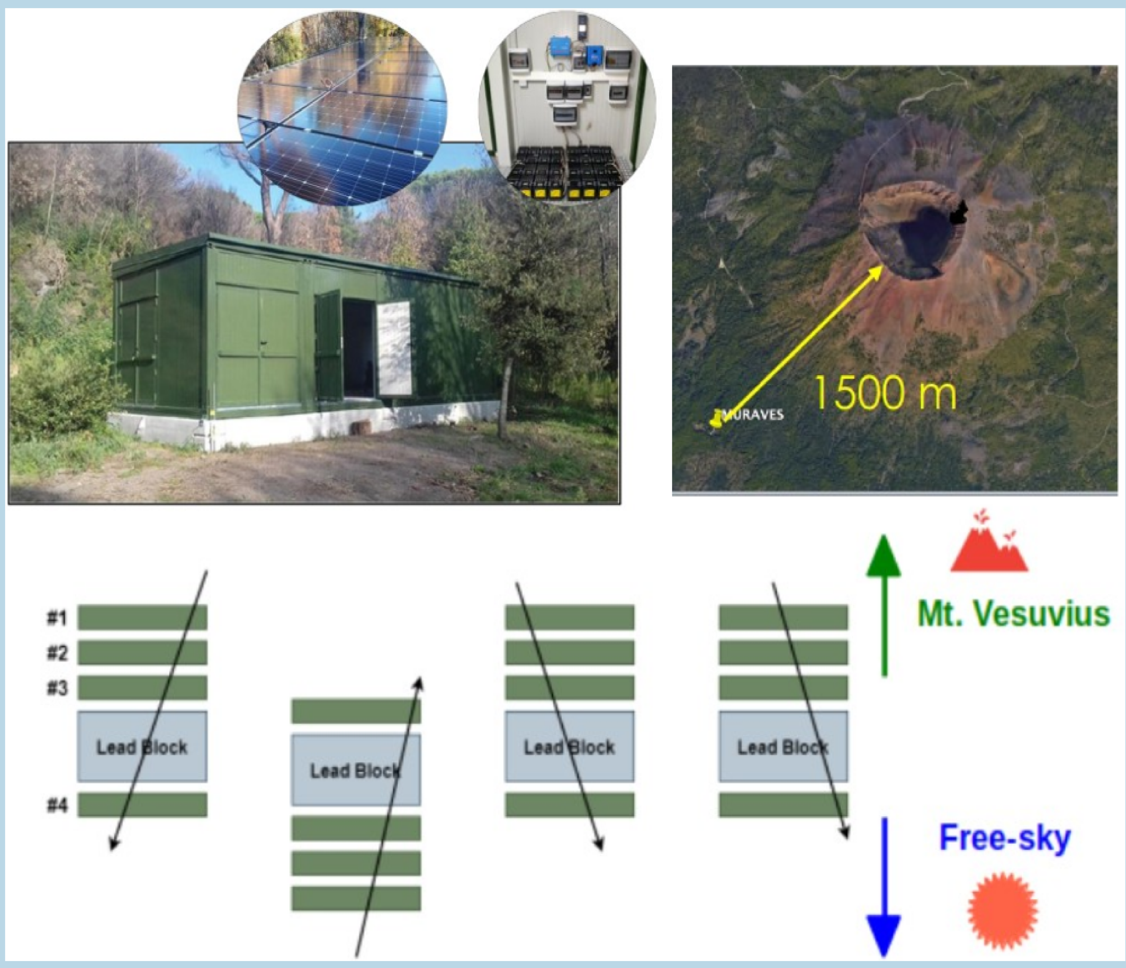
One of the most dangerous active volcanoes, located in the south of Italy near the city of Naples, with more than half a million people living in its high-hazard zone.



Over time, Mt. Vesuvius has undergone drastic changes in morphology due to its activity. Recent eruptions in its last period of activity caused the collapse of its caldera and the formation of the current crater. The summit cone is believed to have a layered structure of materials with different densities, which MURAVES aims to study.

MURAVES @ Mt. Vesuvius

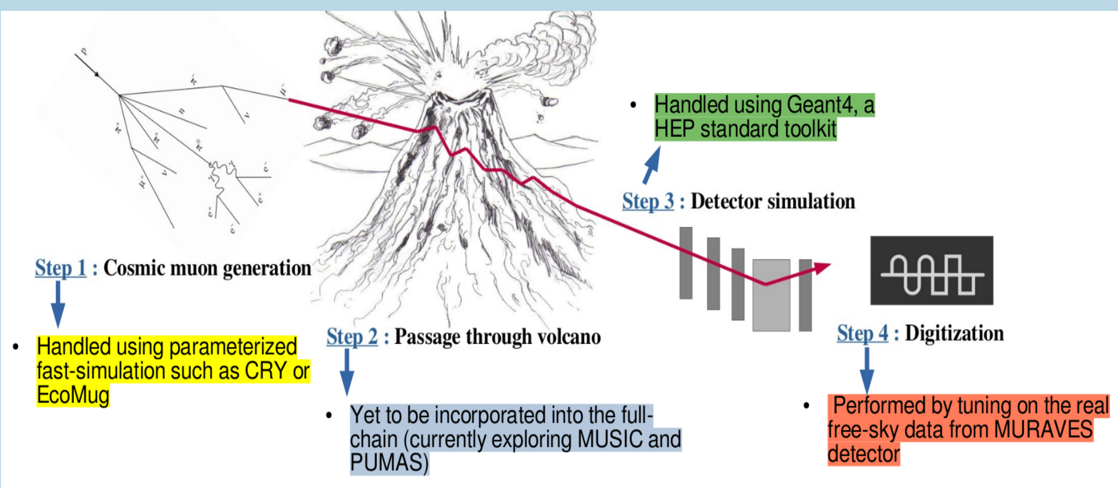
The 3 MURAVES telescopes are housed inside a container located @ 1500m away from the crater summit. The electric power is supplied by a solar panel system on the container roof connected to an array of batteries.



4 concrete platforms and lead walls, for 3 detector configurations pointing towards Mt.Vesuvius and 1 collecting open-sky reference data.

Simulation chain

Performing a full Monte Carlo simulations chain for the MURAVES experiment and comparing the resulting data is essential in order to image a target and explore the different impacts of experimental limitations.

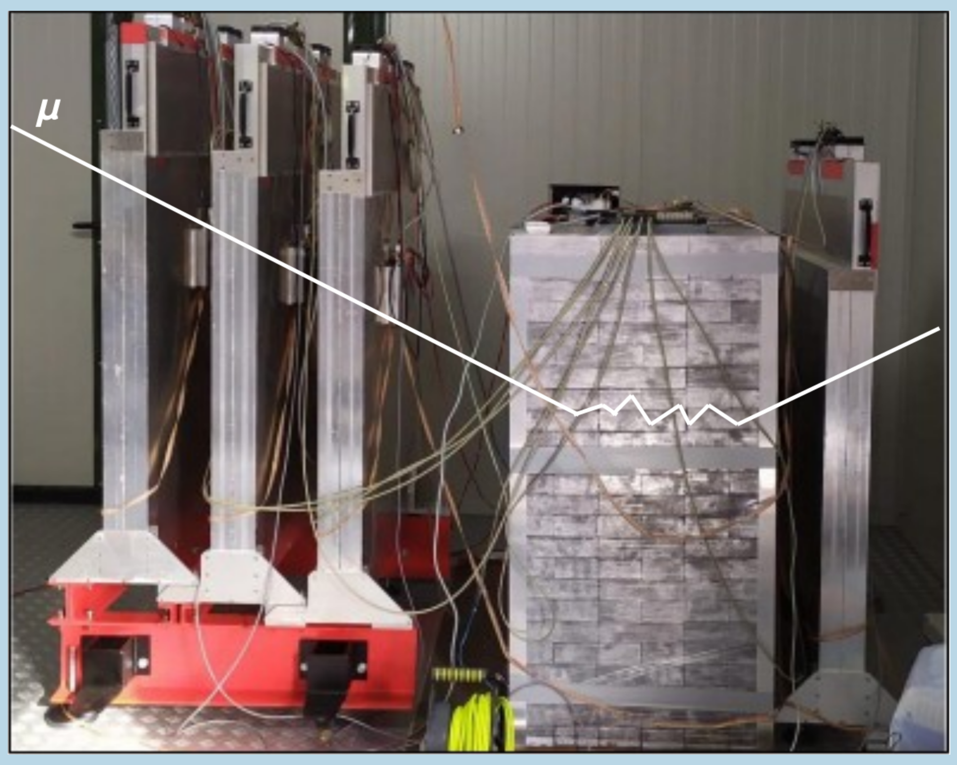


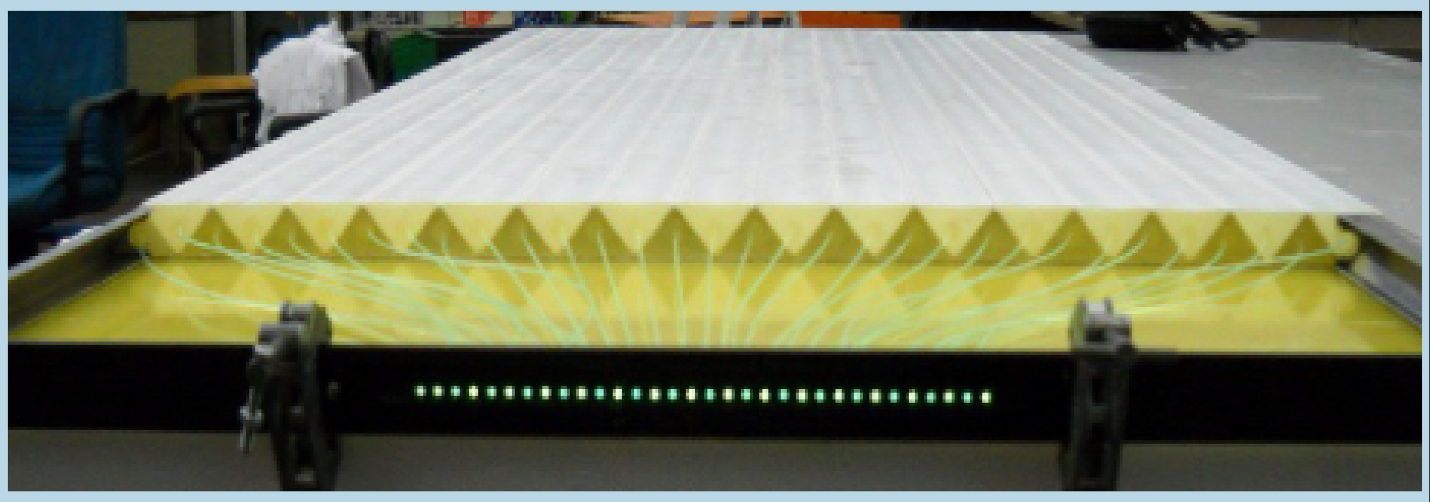
References

1. M. D'Errico, "The MURAVES Experiment: A Study of the Vesuvius Great Cone with Muon Radiography", Journal of Advanced Instrumentation in Science, vol. 1 (2022), 273.
2. M. Al Moussawi, "The Simulations Chain of the MURAVES Experiment", Journal of Advanced Instrumentation in Science, vol. 1 (2022) , 303.
3. V. Niess, "The PUMAS library", Computer Physics Communications 279 (2022) 108438.

MURAVES: MUon RAdiography of VESuvius

The MURAVES setup consists of 3 muon hodoscopes (or "telescopes"), each made of 4 XY tracking stations of 1m^2 active area, distributed along a length of $\sim 2m$, with a 60cm-thick lead wall between 3rd and 4th station.



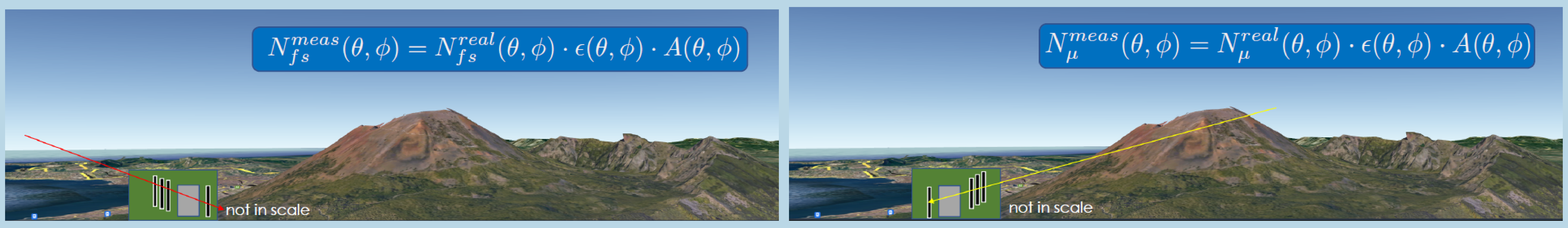


Every tracking station is made of 2 adjacent, orthogonally oriented arrays of scintillator bars, with each array consisting of 2x 32 triangularly shaped bars glued together in a roughly 50cm wide half-plane. Every scintillator bar is read out individually via a SiPM connected to a wave-length fiber embedded through the center of each bar.

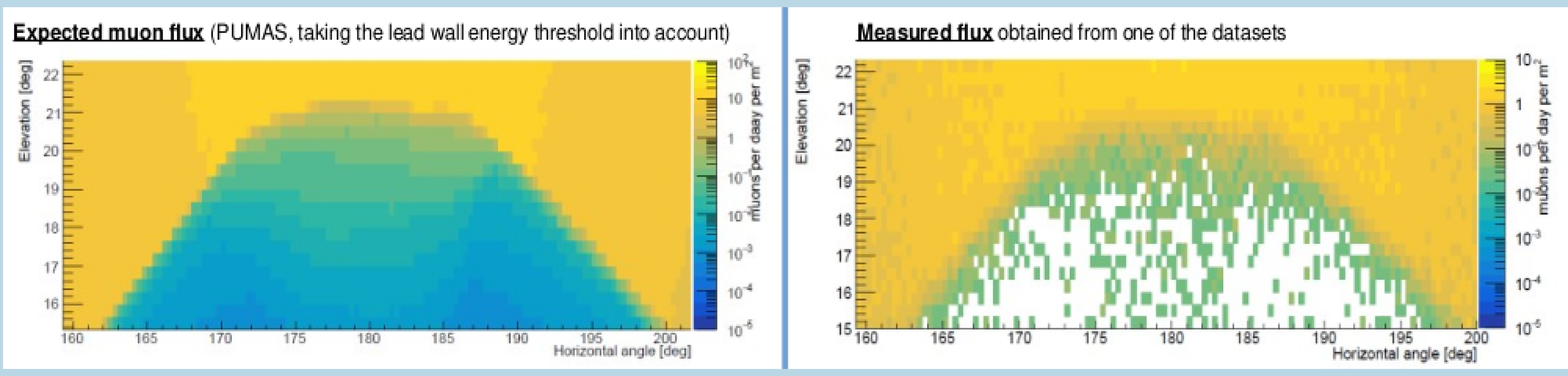
Measurement principle and initial datasets

The experiment aims at mapping the mean density of the matter crossed by muons in the traversal of the volcano, through the measurement of the muon flux that reaches the detector as a function of zenith (θ) and azimuth (ϕ). Its ratio with the muon flux measured in reference data (i.e. with the muon tracker pointing to open sky in the opposite direction) gives a muon transmission map:

$$T_{exp}(\theta,\phi) = \frac{N_{\mu}^{meas}}{N_{fs}^{meas}} = \frac{N_{\mu}^{real}}{N_{fs}^{real}} = \frac{\int_{E_{min}(\rho)}^{\infty} N_{\mu}(E)\,dE}{\int_{E_0}^{\infty} N_{\mu}(E)\,dE} \quad (1)$$



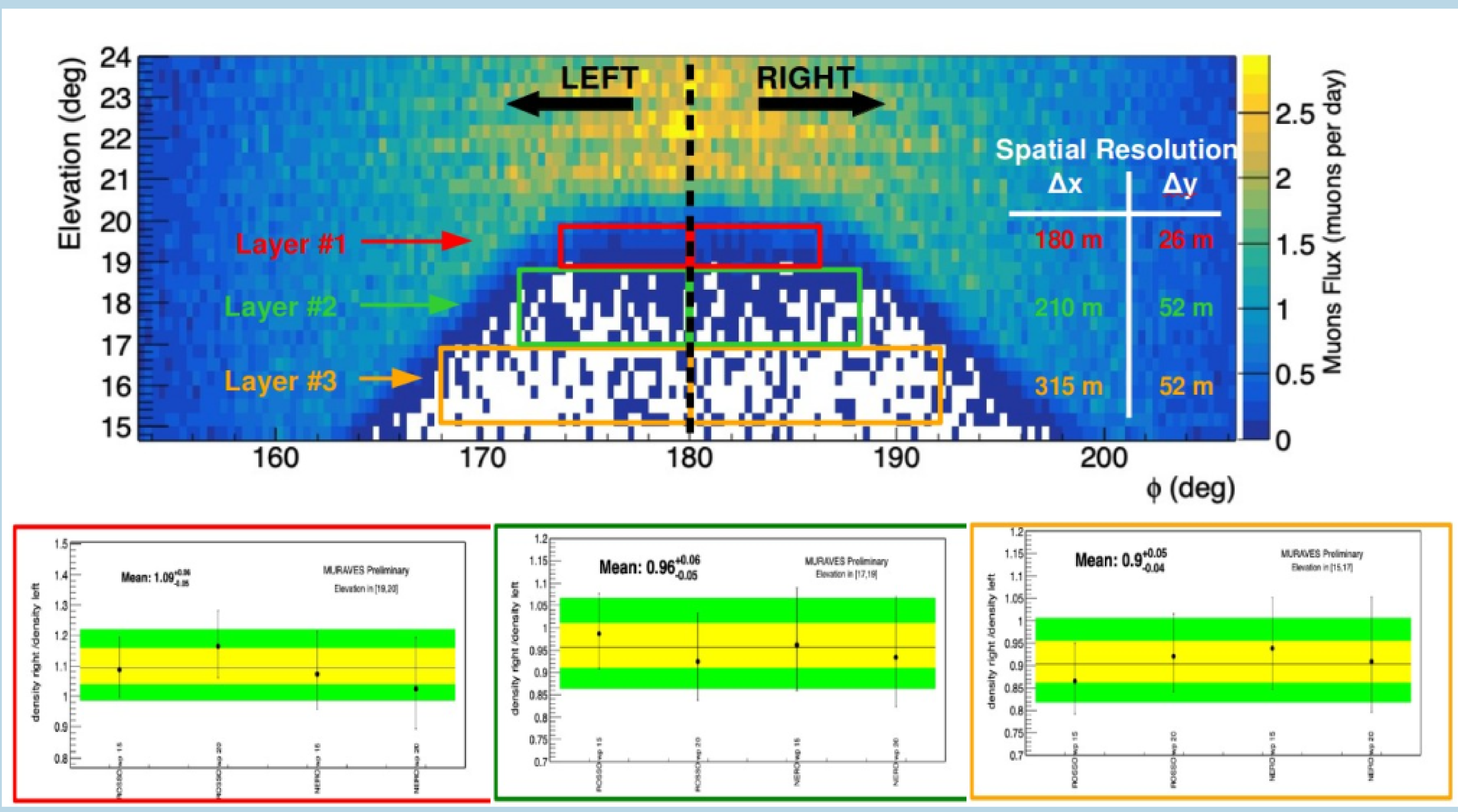
Preliminary analysis based on initial datasets (1-2 months of exposure time) from 2 out of 3 telescopes, each operated at two different working points corresponding to 2 SiPM temperature settings.



The measured flux obtained from these datasets is consistent with the expected muon flux evaluated using the PUMAS muon transport code.

Preliminary results

The visible cone was divided into 3 regions, further subdivided in left and right parts in order to measure possible asymmetries between the slopes of the volcano. A measurement of the density asymmetry (ρ_{right}/ρ_{left}) is obtained, indicating density asymmetry variations between different layers. More data are being accumulated, and a thorough assessment of possible biases is ongoing.



Acknowledgements

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