Atmospheric Muon Flux Measurement Near Earth's Equatorial Line

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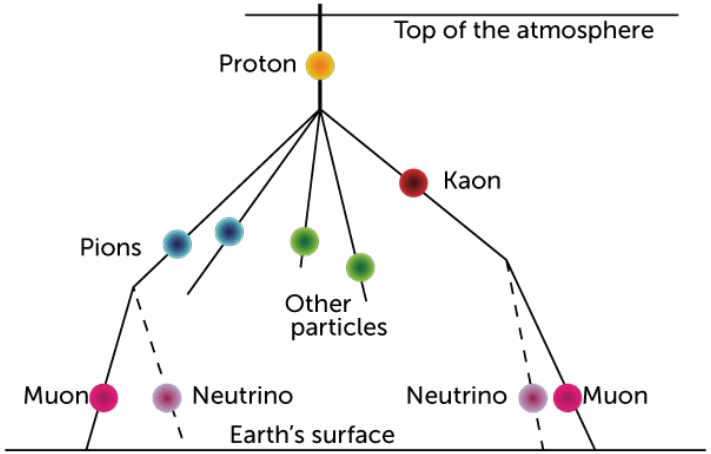
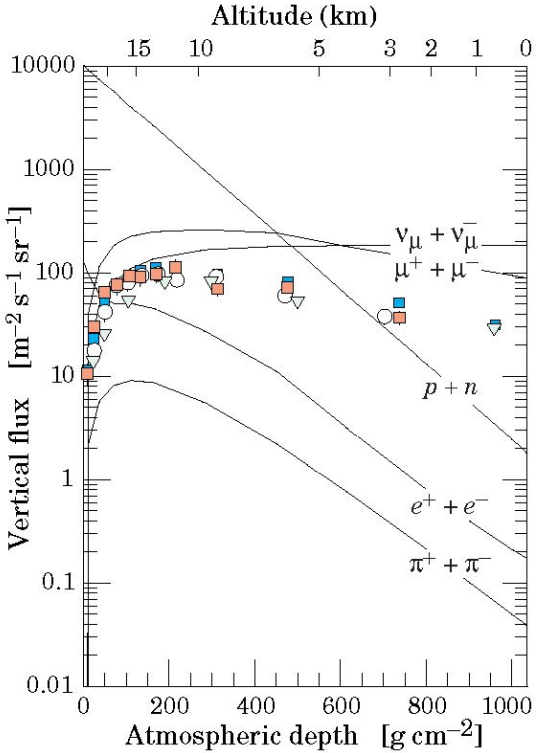
Atmospheric Muons



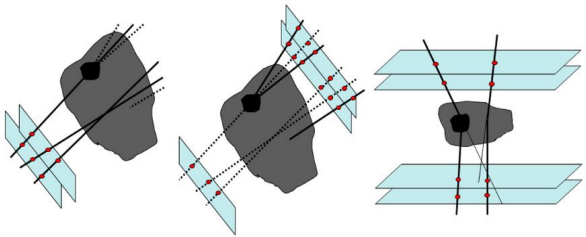


- ***Free Source of Radiation (No health hazard)***
- ***Higher flux at Sea Level***
- ***Lifetime*** *2.2μs. Relativistic factor γ≈20.*
  Travel 24 km (Produced at 15km height).
- ***Mass*** *~200me (Energy loss proportional to 1/m²).*

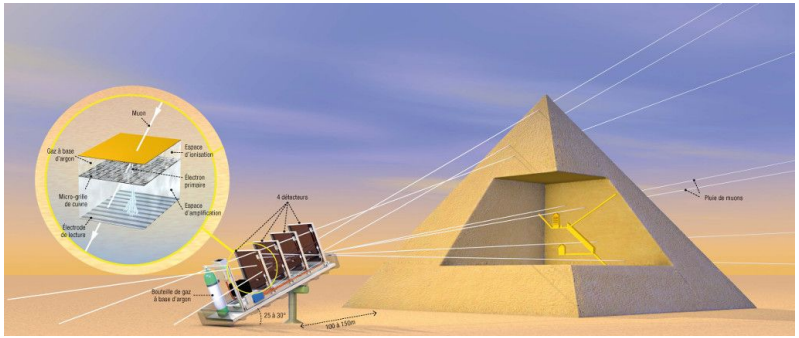
Muography

Muon Imaging

Muon flux with no target vs. Muon flux with a target

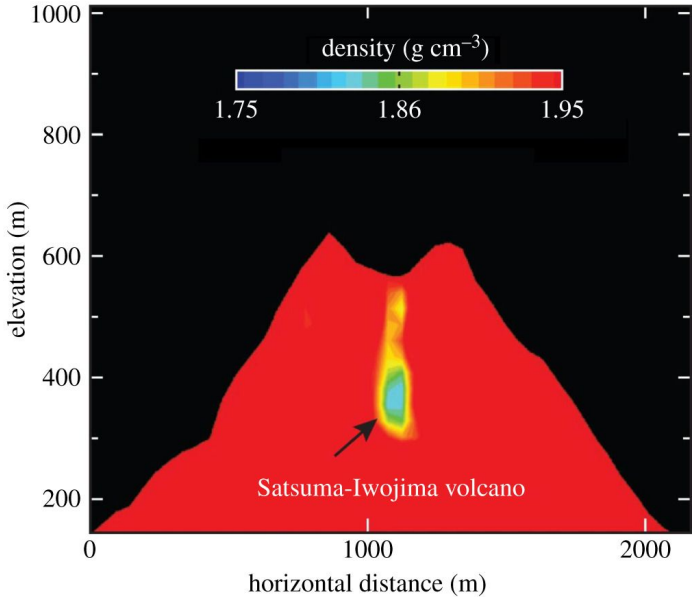


Transmission Scattering/Transmission



Applications In:

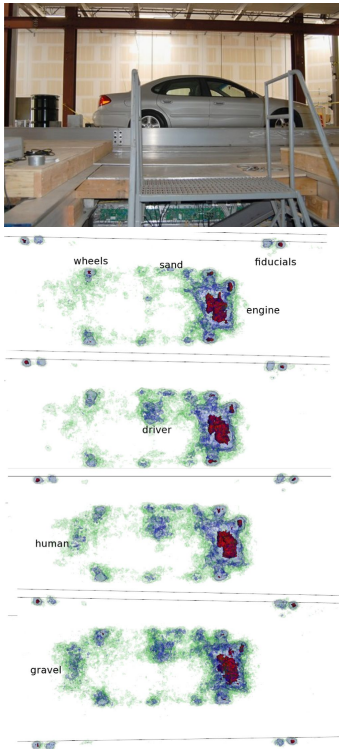
- *Archaeology*
- *Volcanology*
- *Civil Engineering*

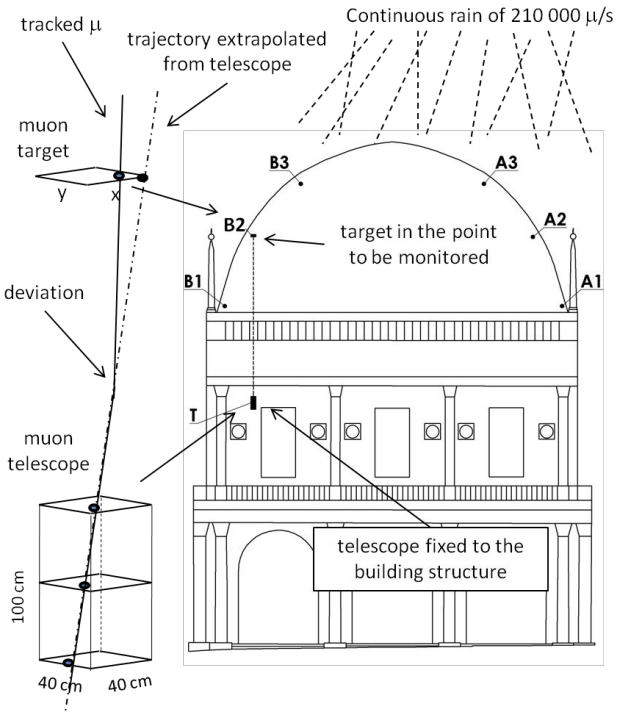


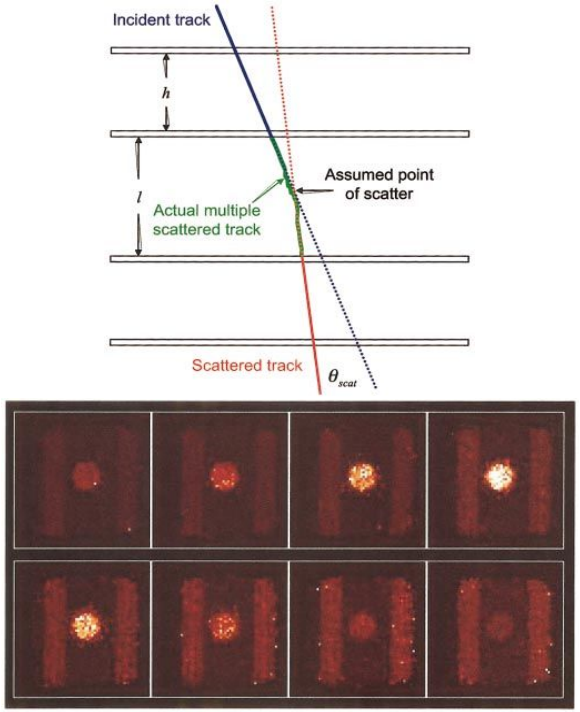
Alvarez, Anderson, et al. Search for Hidden Chambers in the Pyramids: The structure of the Second Pyramid of Giza is determined by cosmic-ray absorption. *Science* 1970 167, 832–839. https://doi.org/10.1126/science.167.3919.832.

Tanaka Hiroyuki K. M. Japanese volcanoes visualized with muography. *Phil. Trans. R. Soc. 2018 A*.3772018014220180142 https://doi.org/10.1098/rsta.2018.0142

Other Applications







Left, Blanpied (2015), Material discrimination using scattering and stopping of cosmic ray muons and electrons: Differentiating heavier from lighter metals as well as low-atomic weight materials
Mid., Checchia (2016), Review of possible applications of Cosmic Muon Tomography. doi:10.1088/1748-0221/11/12/C12072
Right, Priedhorsky (2003), Detection of high-Z objects using multiple scattering of cosmic ray muons http://dx.doi.org/10.1063/1.1606536

Collaborations

[France]

DIAPHANE

Development and application of muon tomography for volcanology studies and monitoring

Tomography with Atmospheric Muons from Volcanoes (TOMUVOL)

Muon Radiography of Vesuvius (MURAVES)

Joint measurement of the transmittance of the inner structure of the Puy de Dôme in France (2018)

[Japan]

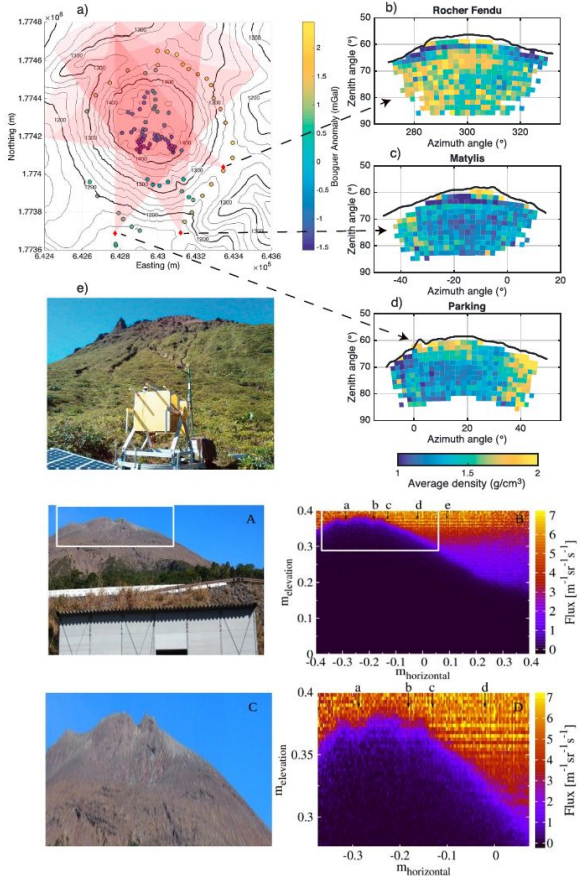
Sakurajima Muographic Observatory (SMO)

Aims to monitor the active volcano Sakurajima in Kyushu,Japan

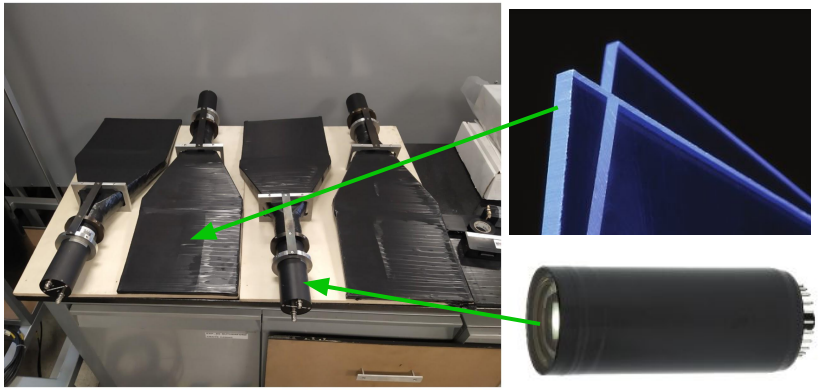
[Italy]

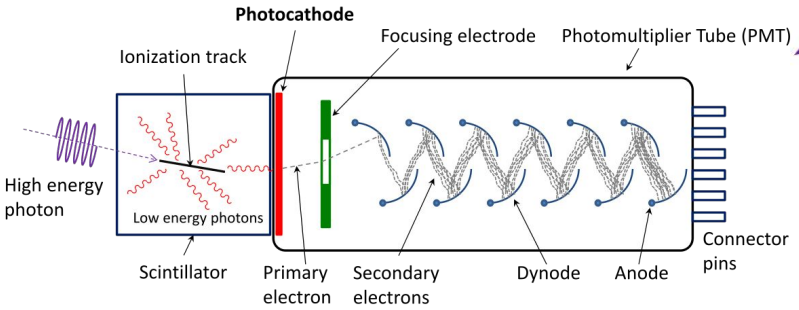
Muography of Etna Volcano (MEV)

Developing detectors intended for studying volcanoes in collaboration with geoscientists, engineers, and physicist



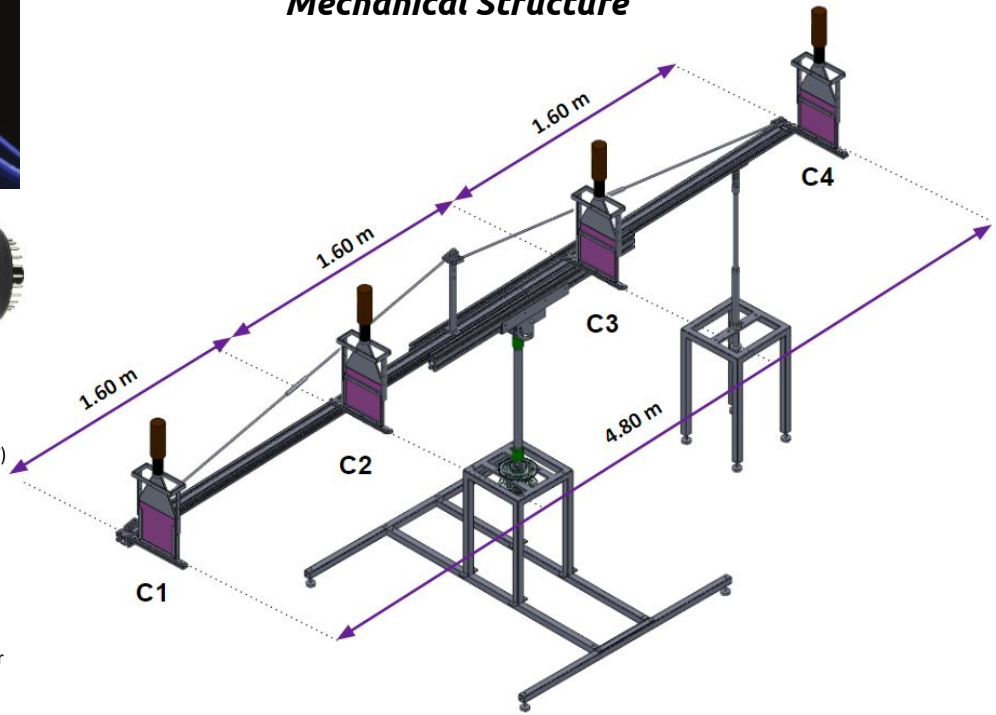
Muon Telescope (Uniandes)



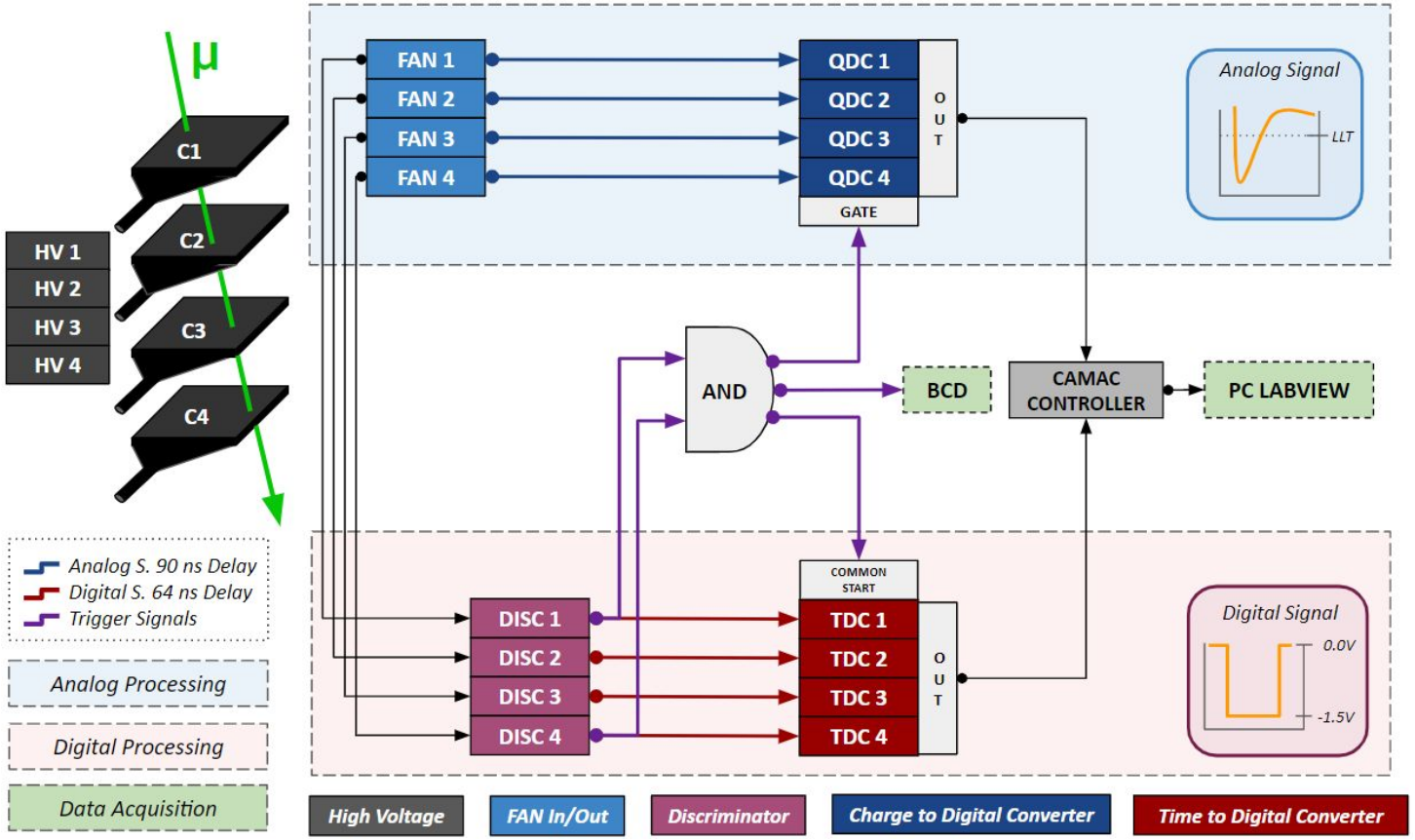


Photoelectric Effect

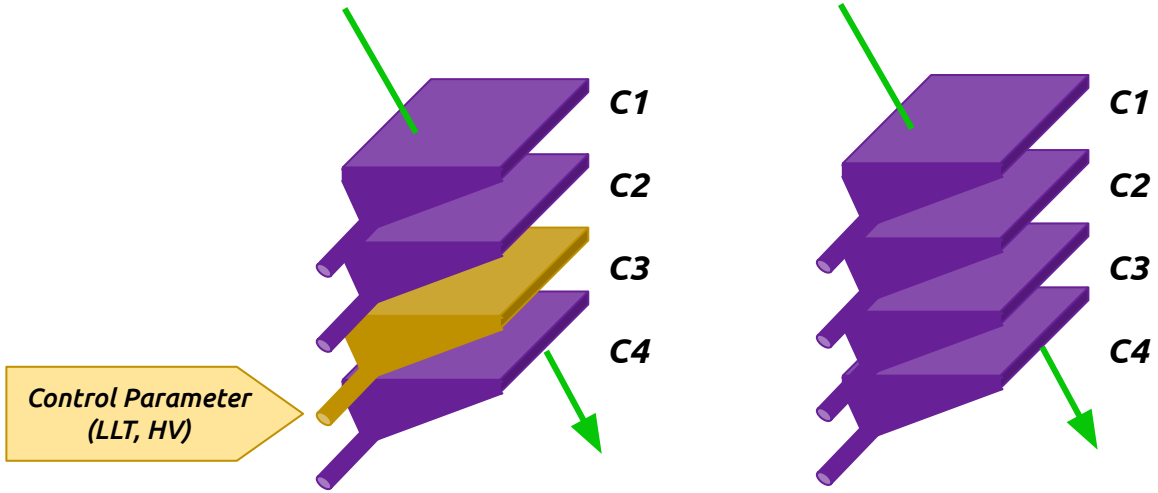
Mechanical Structure



Electronic System



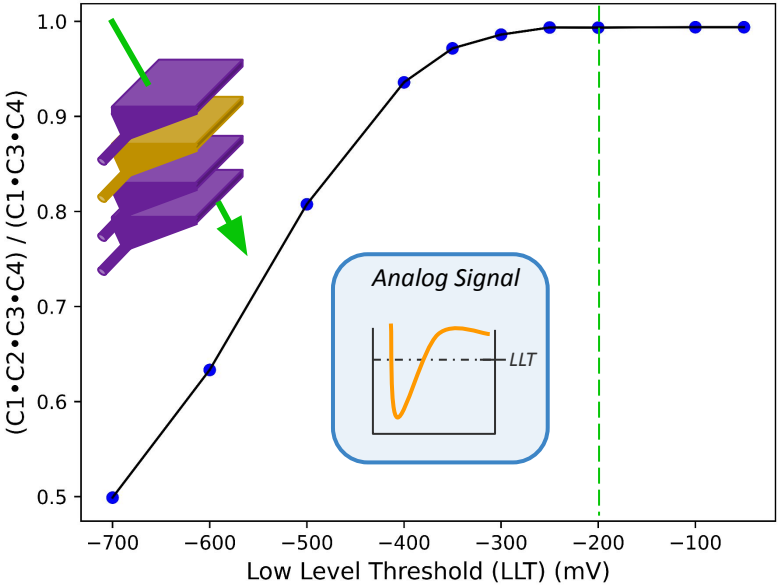
Detector Efficiency

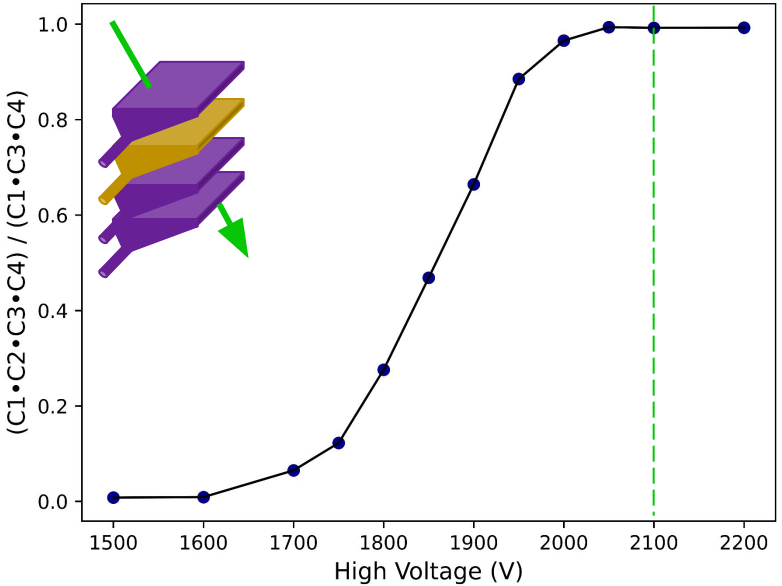


$C1 \cdot C2 \cdot C4$ $C1 \cdot C2 \cdot C3 \cdot C4$

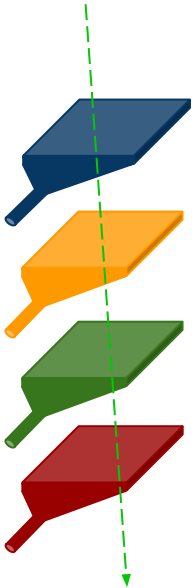
$$\text{Efficiency (C3)} = \frac{C1 \cdot C2 \cdot C3 \cdot C4}{C1 \cdot C2 \cdot C4}$$

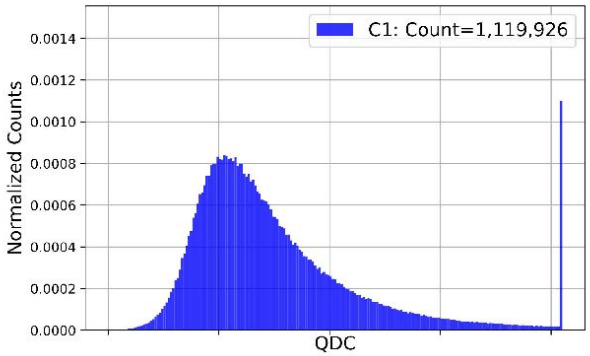
Optimal Operational Parameters

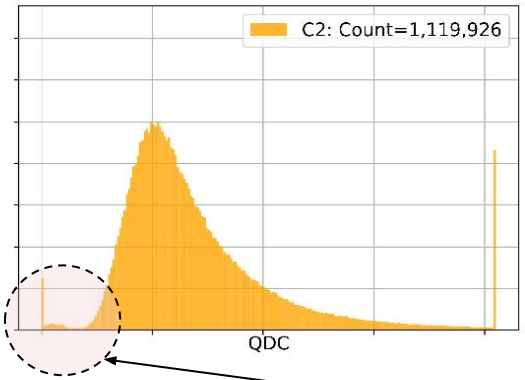


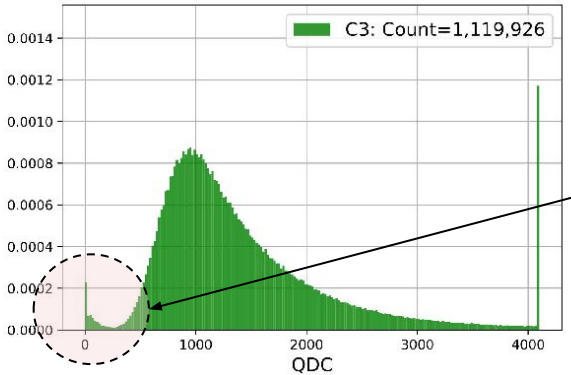


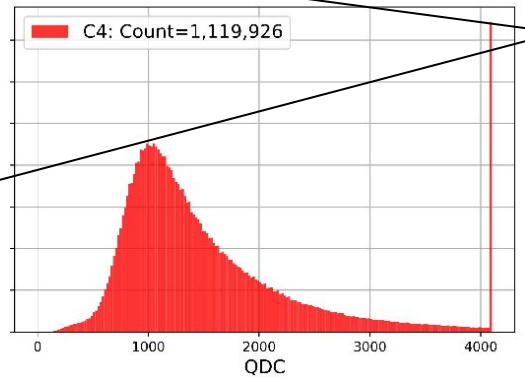
Detector Performance





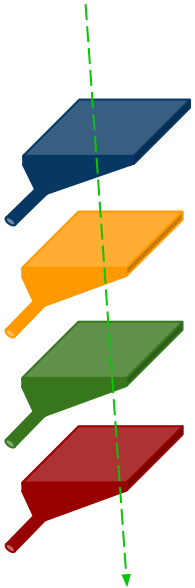


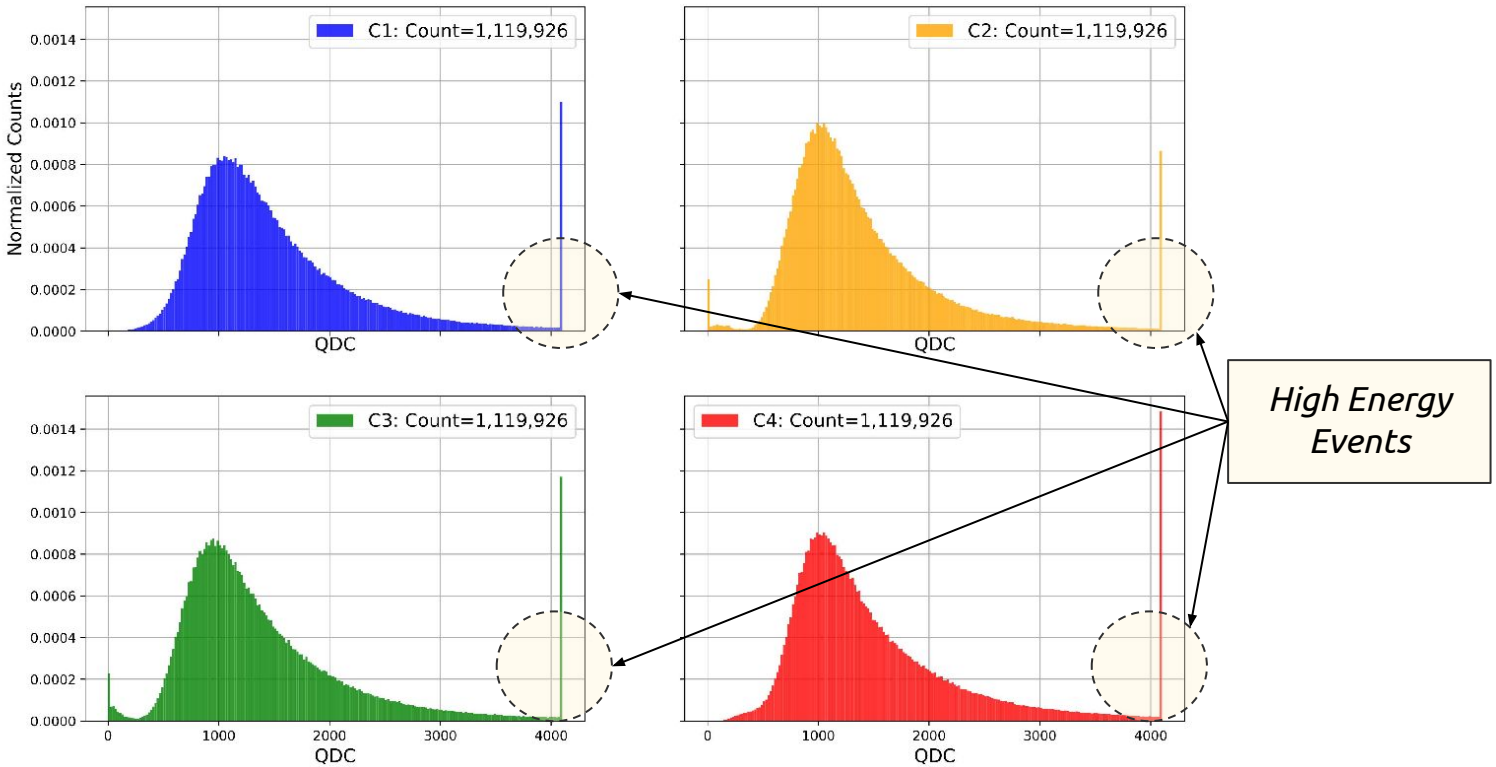




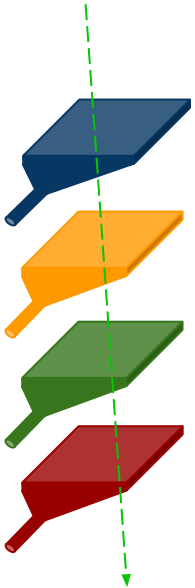
Low Energy Events

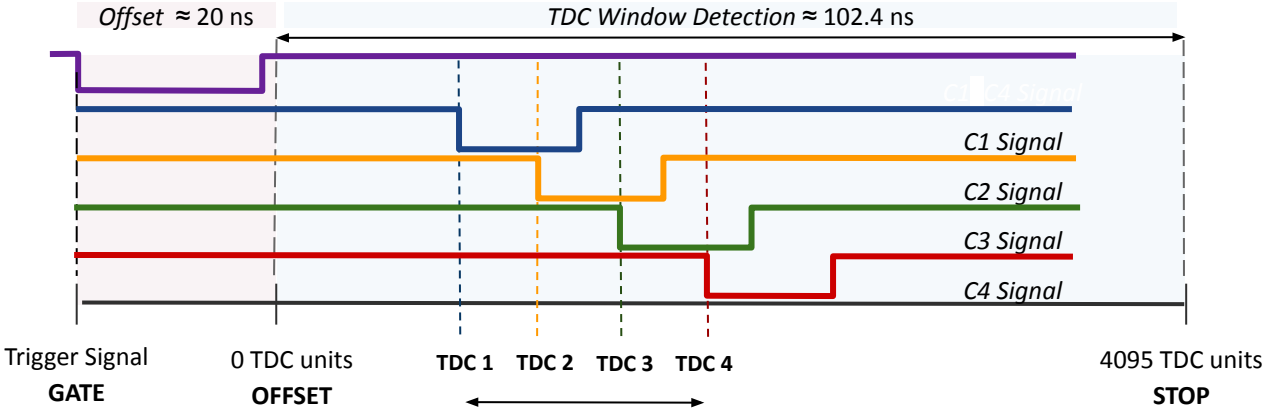
Detector Performance



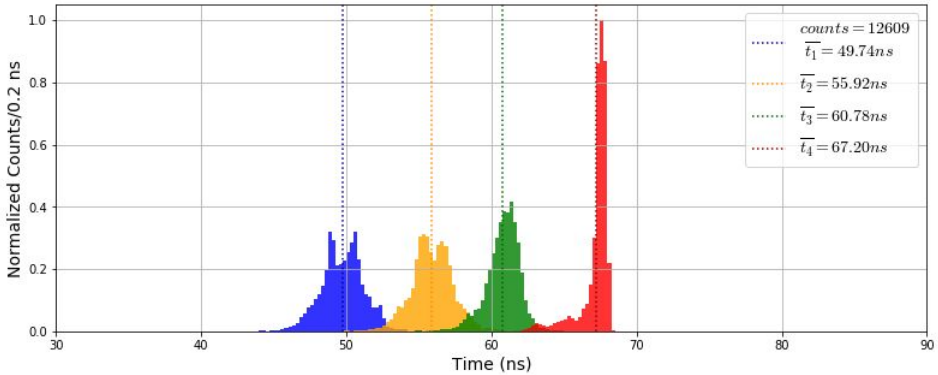


Detector Performance

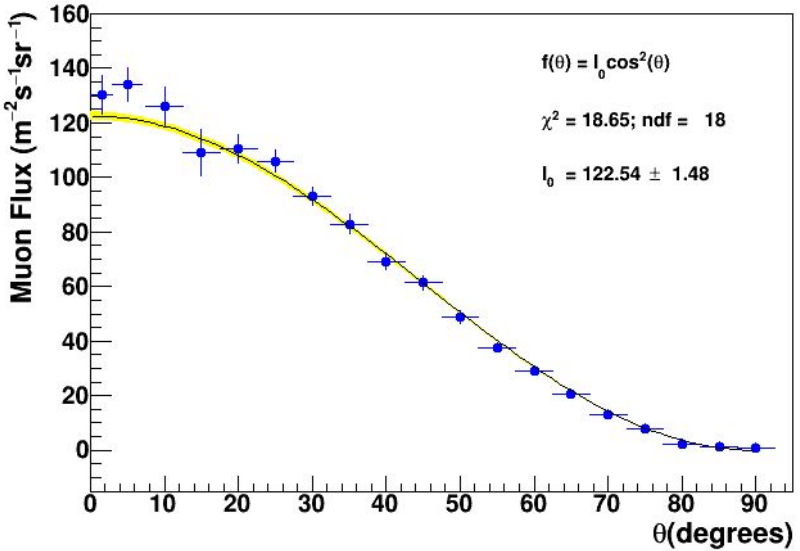


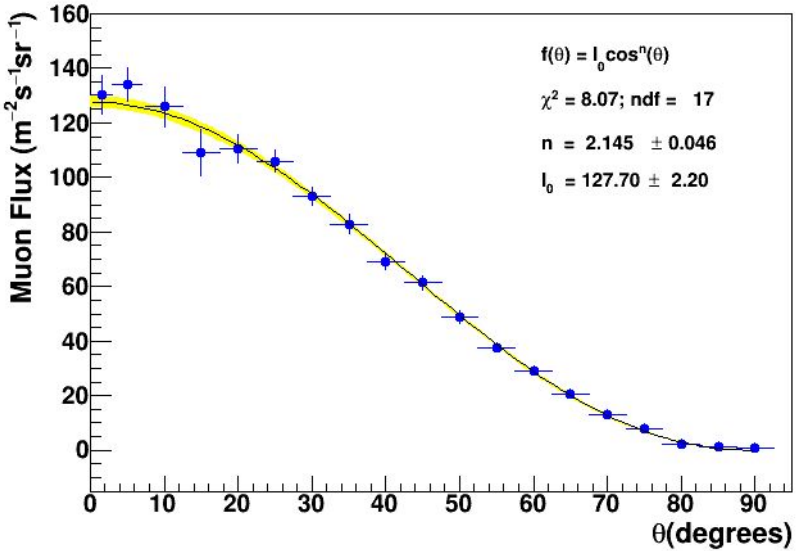


Time of Flight (ToF) ≈ 16 ns

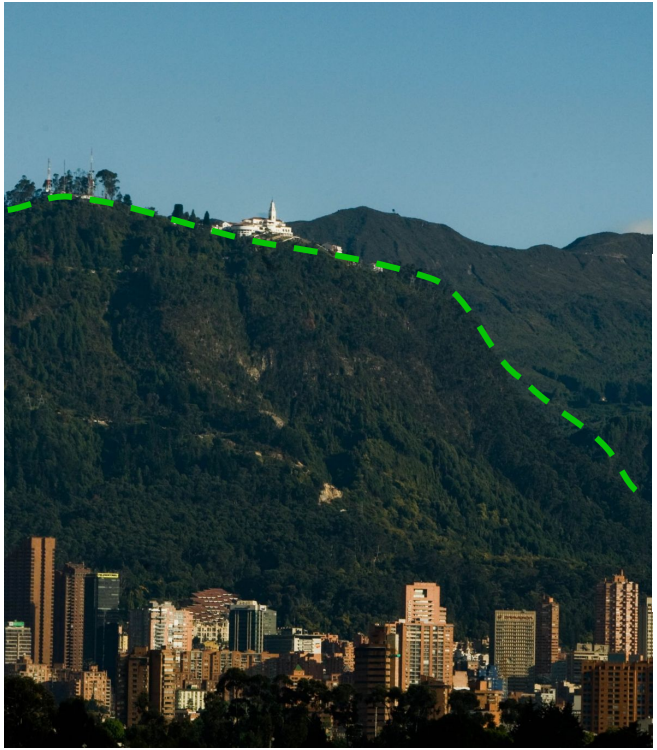


Muon Flux vs. Zenith Angle

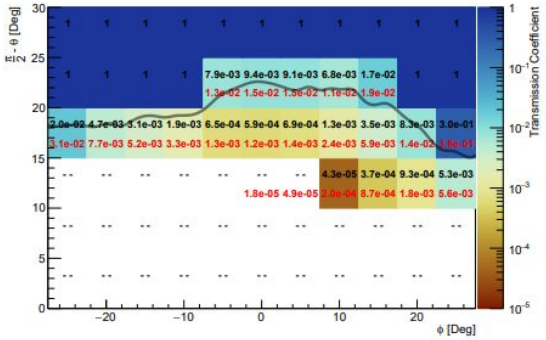




What 's Next?



CORSIKA Simulation Density Mapping of Monserrate



Further Information

Open Access Article

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