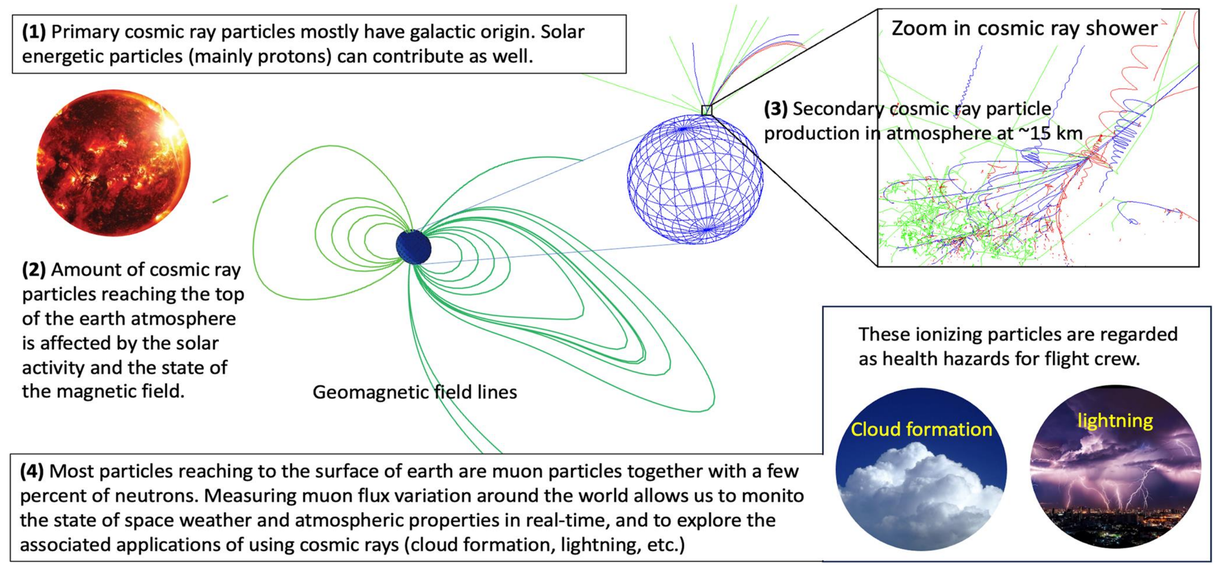
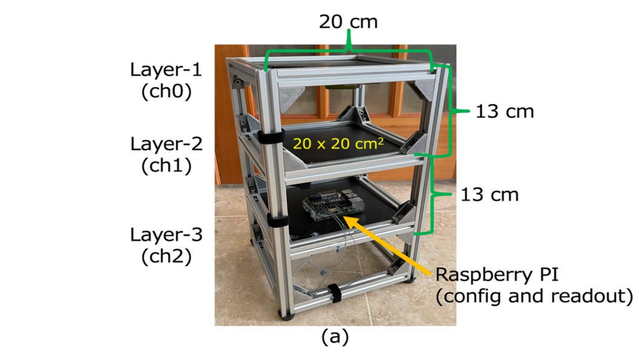
Global network of cosmic ray muon detectors for monitoring space and terrestrial weather- gLOWCOST

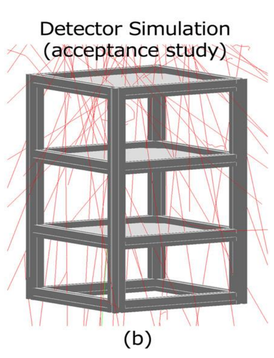
Interests of practical applications of cosmic ray measurements are growing world-wide, ranging from cosmic ray particle tomography, space and terrestrial weather monitoring, area-averaged soil moisture monitoring, to public health concerns with cosmic ray radiation exposure in fights.

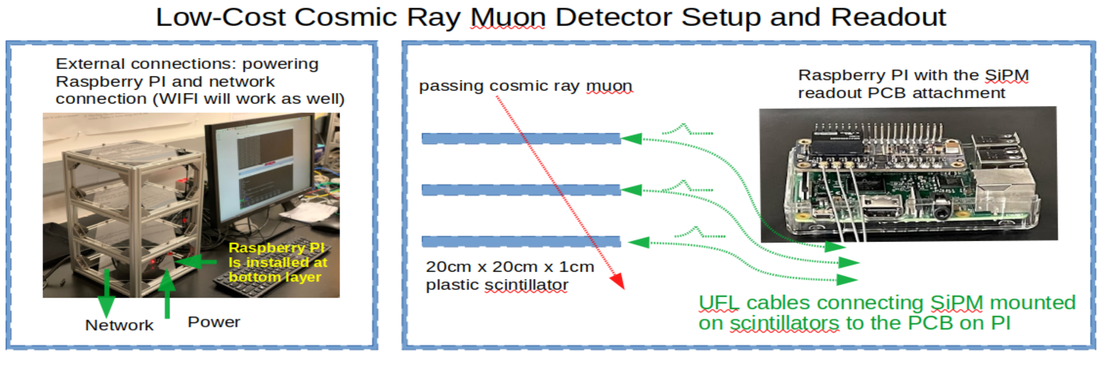
State-of-the-art portable muon particle detector has been developed by the Nuclear Physics Group at Georgia State University. This marks the beginning of a long-term effort by the team to build **a global network of such affordable and low-maintenance CR muon detectors for monitoring space and terrestrial weather.** This network could become a significant asset for statistical and case studies of muon flux variations preceding and happening during space weather event.

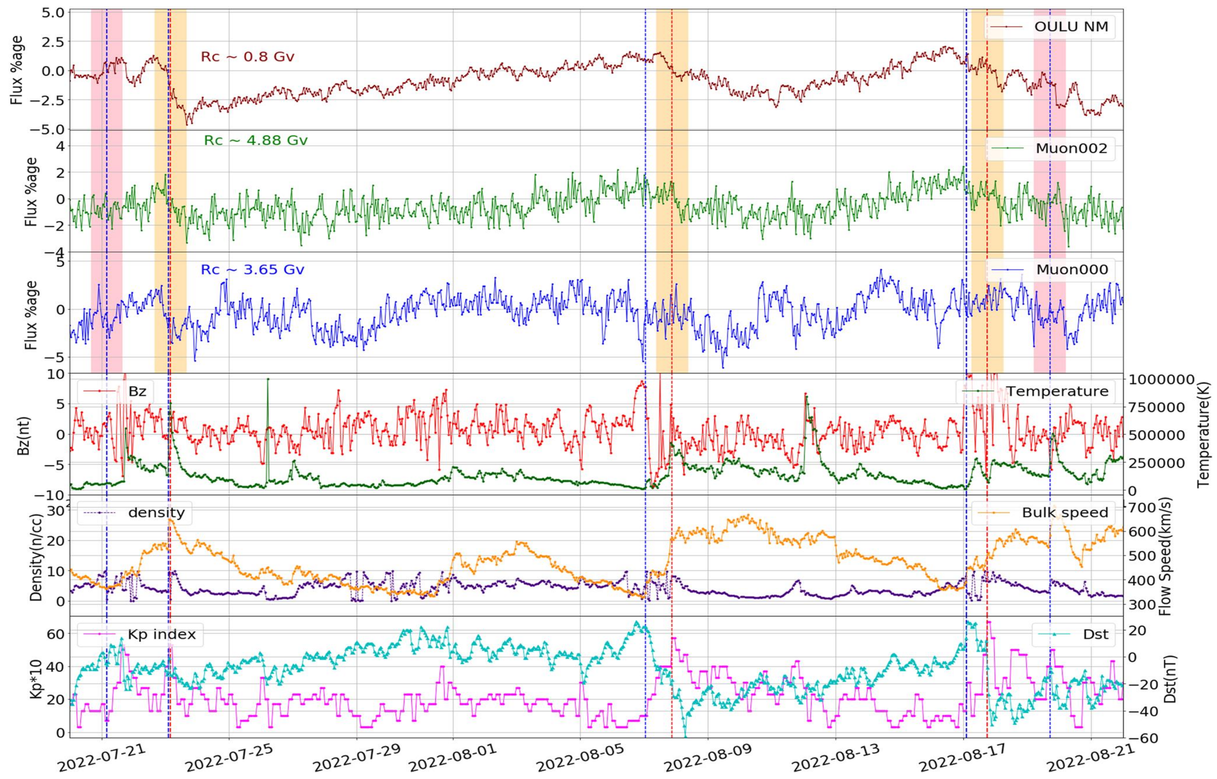
Desktop cosmic ray (CR) muon detector design: (a) CR muon detector dimension and configuration; the baseline muon detector setup with the adjacent scintillator layers 13 cm apart (b) Detector acceptance study using GEANT4 simulation toolkit.









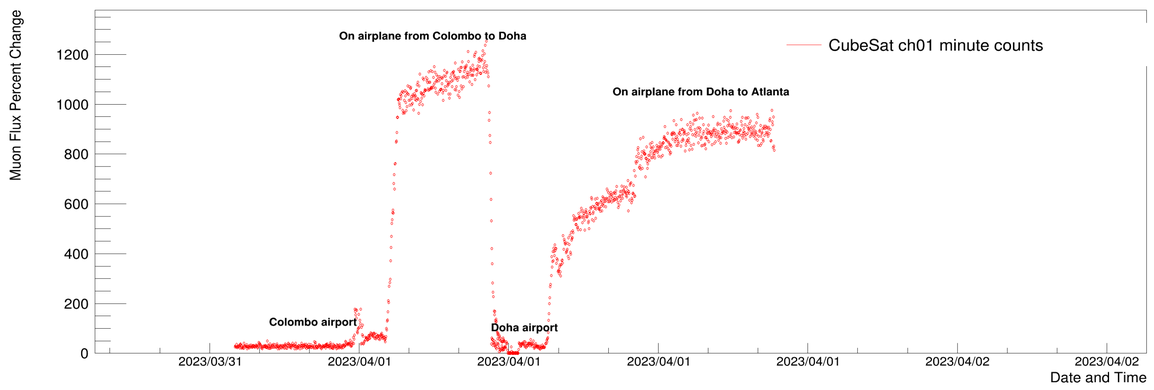


Typical detector setup at a given site. A minimum site requirement is a small desk, power and network connection. (right) Low-cost detector readout. The scintillation light generated by a passing muon particle is collected by silicon photomultipliers and the electrical signals are sent to the PCB mounted on a Raspberry Pi.

Time series of pressure and temperature corrected cosmic ray flux percentage changes and the space parameters from 2022-07-20T00:00 UT to 2022-08-22T00:00 UT. The vertical red dashed line within the shaded bars marks the times of the geomagnetic storm, while vertical blue lines mark the Interplanetary Coronal Mass Ejection shocks.

Cosmic Ray **Flux Measurement on Flight** from Colombo (Sri Lanka) to Atlanta (USA). Cosmic ray muon flux was recorded using a cubeSat prototype detector (3 scintillator stack, 9cm x 9cm x 1cm).

A Growing Network of Cosmic Ray Muon Detectors



A growing list of participating institutions:

Georgia State University, USA
University of Belgrade, Serbia
University of Oulu, Finland
Institute of Astronomy and National Astronomical Observatory, Bulgaria
University of Montenegro, Montenegro
Georgia Institute of Technology,, USA
Northwestern Polytechnic University, China
Tsinghua University, China
Uva Wellasa University, Sri Lanka
Muthoot Institute of Technology, India
Astronomical Observatory Zagreb, Croatia

We are looking for many more institutions to join this effort!

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Some of the recent publications:

- Mubashir, A., Ashok, A., Bourgeois, A. G., Chien, Y. T., Connors, M., Potdevin, E. et al. (2023). Muon flux variations measured by low-cost portable cosmic ray detectors and their correlation with space weather activity. *Journal of Geophysical Research: Space Physics*, 128, e2023JA031943. https://doi.org/10.1029/2023JA031943
- He, X., Butler, C., Syed, S. et al.(2021). Development and Production of Modular Cosmic Ray Telescopes}",
  "*Proceedings of 37th International Cosmic Ray Conference ICRC2021), 395,1257.* *https://doi.org/10.22323/1.395.1257*
- Chen N., Chen S., He W., He X. and Wei T.,(2021) Advanced Readout Electronics System for Portable Cosmic Ray Muon Detection," in *IEEE Transactions on Instrumentation and Measurement*, vol. 70, pp. 1-11, Art no. 2002711, https://doi.org/10.1109/TIM.2020.3043108

2nd International Workshop on Applications of Cosmic Ray Measurements
(WACR 2024)
11th - 14th March 2024
at Georgia State University, Atlanta, GA, USA
In-Person (with Virtual option)

The workshop is intended as an opportunity to share the knowledge and the most recent progress with the cosmic ray measurements and analysis within the community and with other interested scientists, policy makers, and industry representatives. The main objectives of this workshop are (1) to initiate efforts in the deployment of a low-cost and reliable cosmic ray detector network (with multiple sensors in each detector) to monitor cosmic ray flux variation in real-time on a global scale, and (2) to strengthening international coordination and cooperation, as well as interpretation of cosmic ray data with a focus on new research results and findings.

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