

Research Result Report
ICRR Inter-University Research Program 2024

Research Subject: Study for Galactic CR origin using the ALPACA air shower array in Bolivia
Principal Investigator: Pedro Miranda
Participating Researchers: Pedro MIRANDA, Rolando TICONA, Hugo RIVERA, Martin SUBIETA, Mirko RALJEVICH (Universidad Mayor de San Andres) Yoshiki Tsunesada (Osaka Metropolitan University) Masato Takita, Takashi Sako, Munehiro Onishi, Kazumasa Kawata, Takashi Sako (ICRR, University of Tokyo)
Summary of Research Result : Our prime target of FY2024 was to complete the construction of the first muon detector, but due to a bureaucratic delay, the public call for the construction company opened in early FY2025. During this period, we received visits to the ALPACA site by several construction companies near La Paz city and listened interests from them. In the meantime, we continue the operation of the ALPAQUITA surface array. The depth of the moon's shadow exceeds 10 sigma as shown in Fig.1, which is consistent with the expected angular resolution of 1.1 degree at the mode energy of CR detections (several TeV). We implemented a counting operation mode with single, double, triple and quadruple coincidences of 97 surface detectors. In May 2024, at the time a CME passage, we observed a clear decrease of the CR intensity known as 'Forbush decrease' in the single counting rate (Any1) but not in double rate (Any2) as shown in Fig.2. The deficit timing coincides with the observations of the worldwide neutron monitor network and Global Muon Detector Network. Fig.3 shows a relation between the median rigidity and the FD

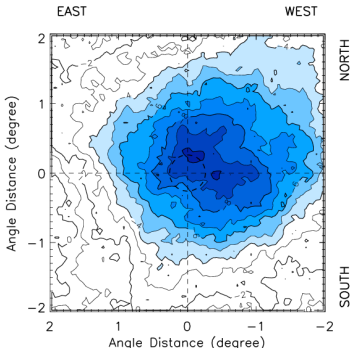


Fig.1 Deficit of the CR intensity around the moon (moon's shadow)

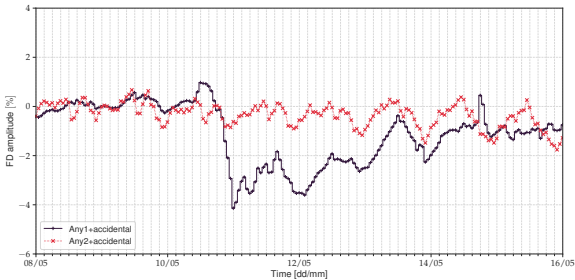


Fig.2 Counting rates single (Any1) and double (Any2) coincidence during a May 2024 CME passage

amplitude observed at various sites. Including the ALPAQUITA Any1 data, the results well align on a power law relation with a relatively hard index. Non detection of the ALPAQUITA Any2 contributes to constrain the possible simple extrapolation of the power law relation at a unique median rigidity.

So far, the area of the ALPAQUITA array (150mx150m) was enclosed by fence but it is extended to cover the full ALPACA area (320mx320m) as shown in Fig.4.

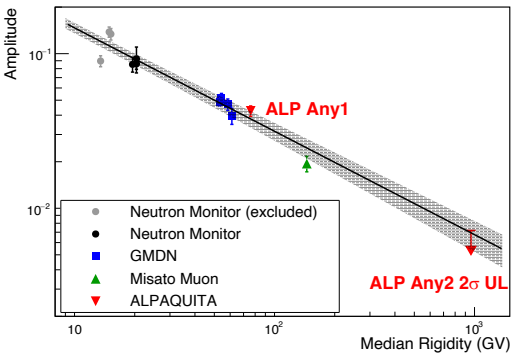


Fig.3 Amplitude of the FD as a function of median rigidity at each observation site.

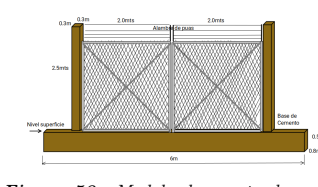
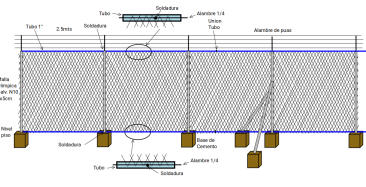


Fig.4 New fence enclosing the full ALPACA area.

Collaborating with the IIMETMAT (Institute of Metallurgical and Materials Research) of UMSA, we developed a procedure to produce lead plates to be placed on the ALPACA SDs as shown in Fig.5. Now a stable production is established.



Fig.5 Lead plate production in IIMETMAR, UMSA.