ICaRO: a new cosmic ray detector at Izaña Atmospheric Observatory

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Abstract

A twin detector of ORCA, the cosmic ray detector operating at Juan Carlos I Spanish Antarctic Base, is foreseen to be installed at Izaña Atmospheric Observatory (IZO) during the second part of 2021. IZO belongs to the State Meteorological Agency of Spain (AEMET) and it is located at the top of a mountain plateau in Teide volcano at Tenerife Island ($28°18'N$, $16°29'W$, 2373 m a.s.l.) at vertical cut-off rigidity of 11.5 GV. ICaRO (Izaña Cosmic Ray Observatory) is composed of a BF3-based 3NM64 (ICRO), 3 bare BF3 counters (ICRB). The neutron monitor is complemented by a muon telescope sharing a common room in a single stack. The muon telescope follows the MITO approach, and thus is composed of two scintillator layers, Top and Bottom. It is able to provide muon counting rate and muon impact points on the scintillator layers. MITO's layers are 1.365 m apart with the two BF3 sets, ICRO and ICRB, in between. As such, the lead surrounding ICRO acts as filter for particles traversing throughout Top and Bottom. ICaRO will provide counting rates of neutrons in two energy thresholds, muon counting rate and muon incoming directions throughout the detector volume.

Introduction

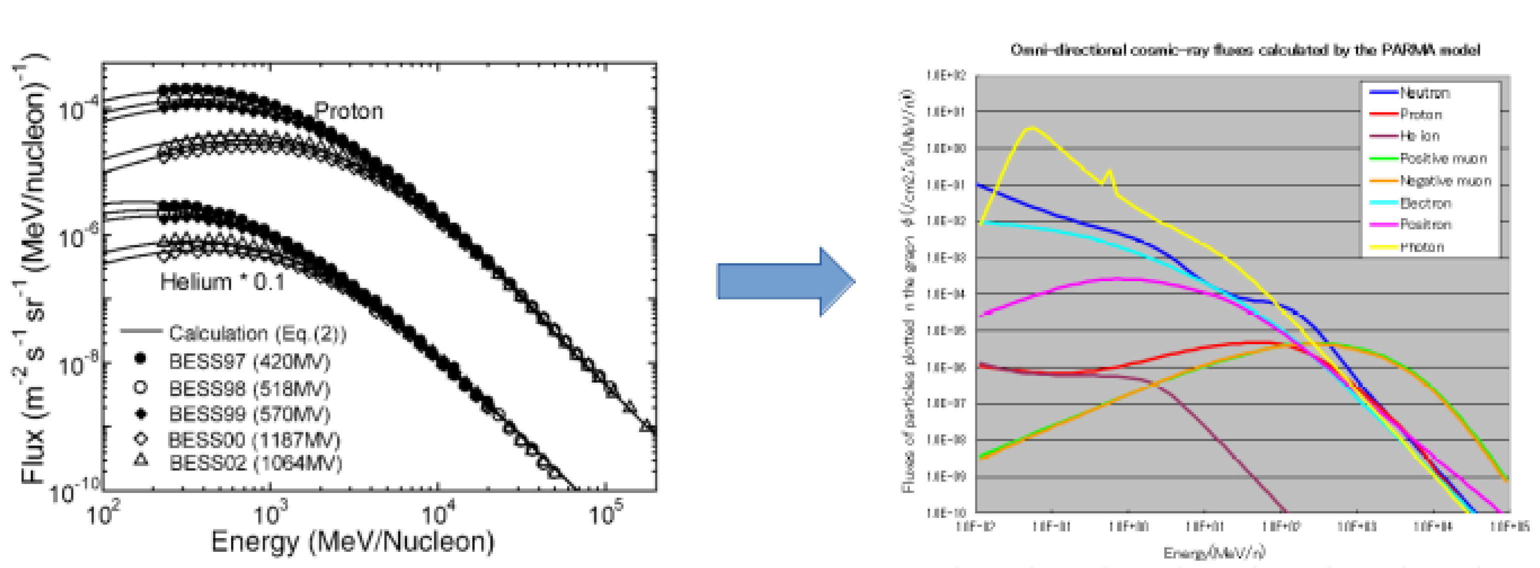

Figure 1:Primary and Secondary cosmic ray at Tenerife Island vertical [1].

Cosmic rays (CR) are atomic nuclei accelerated to relativistic energies in explosive processes in stars, supernovae and supernova remnants, and active galaxy nuclei. From their sources, they travel through the galaxy, cross the heliosphere, and finally reach the Earth bringing information about the sources that produce them, the interstellar and interplanetary medium they pass through. Once they arrive at Earth, they interact with the atmosphere producing a cascade of secondary cosmic rays that can be detected by ground-level instruments.

The Earth as a global detector

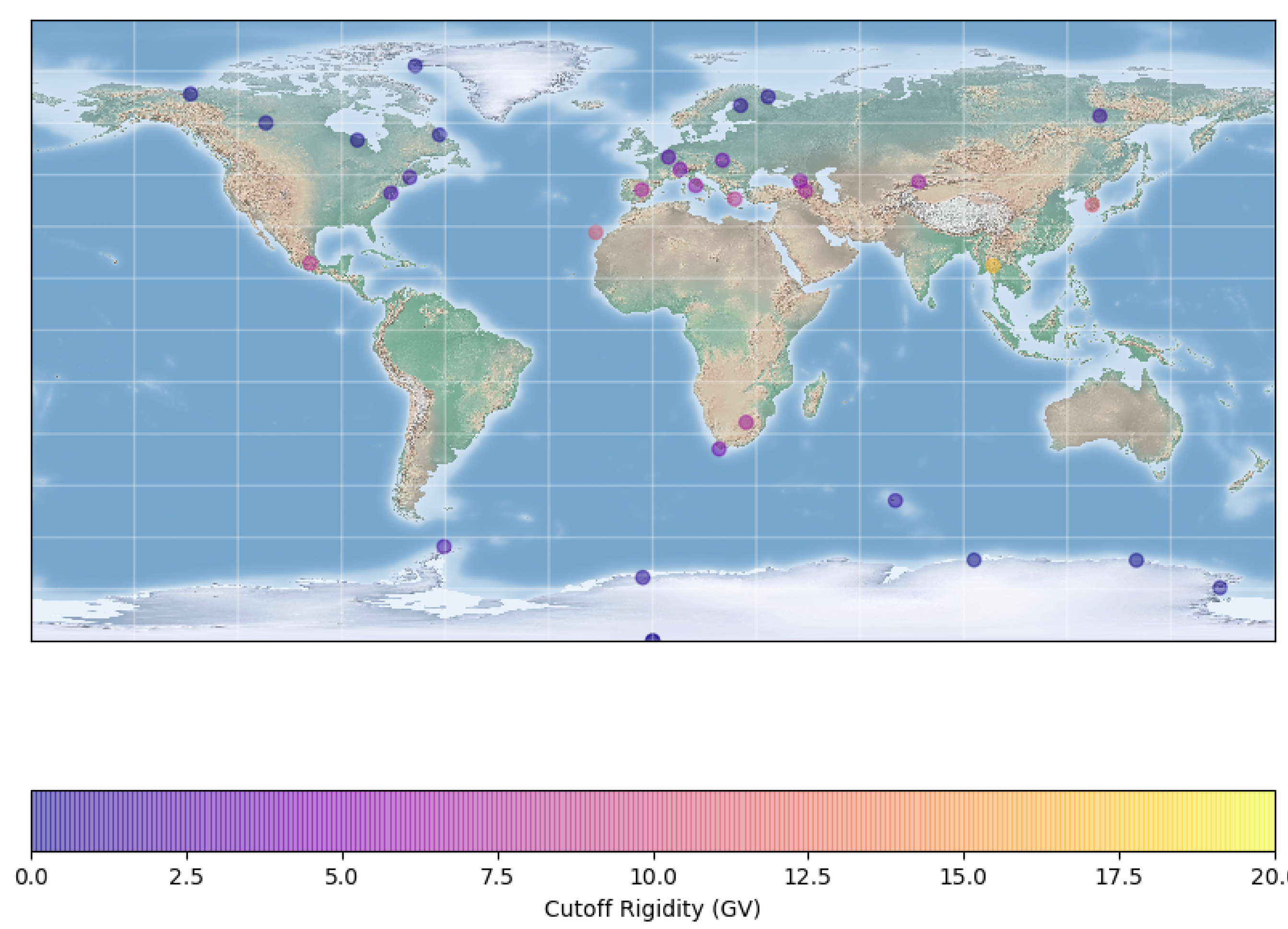

Figure 2:Neutron monitor global distribution. Color bar shows vertical cutoff rigidity range.

The location of a given detector determines the minimum energy needed for a cosmic ray to produce an observable cascade at the detector position. The magnitude that characterizes this is the vertical cutoff rigidity of the station. This makes desirable the global coverage of comparable detectors to ensure detection at different energy thresholds and to cover different regions of the sky. The neutron monitor data base (NMDB) provides access to neutron monitor measurements from stations around the world (`http://www01.nmdb.eu/`).

Why Canary Islands?

- Cover a gap into the NMDB [2]
- Its height and cutoff rigidity make it an observation site of solar neutrons
- Izaña Atmospheric Research Center (IARC)
- Güimar Geomagnetic Observatory (GGO)
- Observation of cosmic rays, atmosphere conditions and magnetospheric status

Izaña Cosmic Ray Observatory (ICaRO)

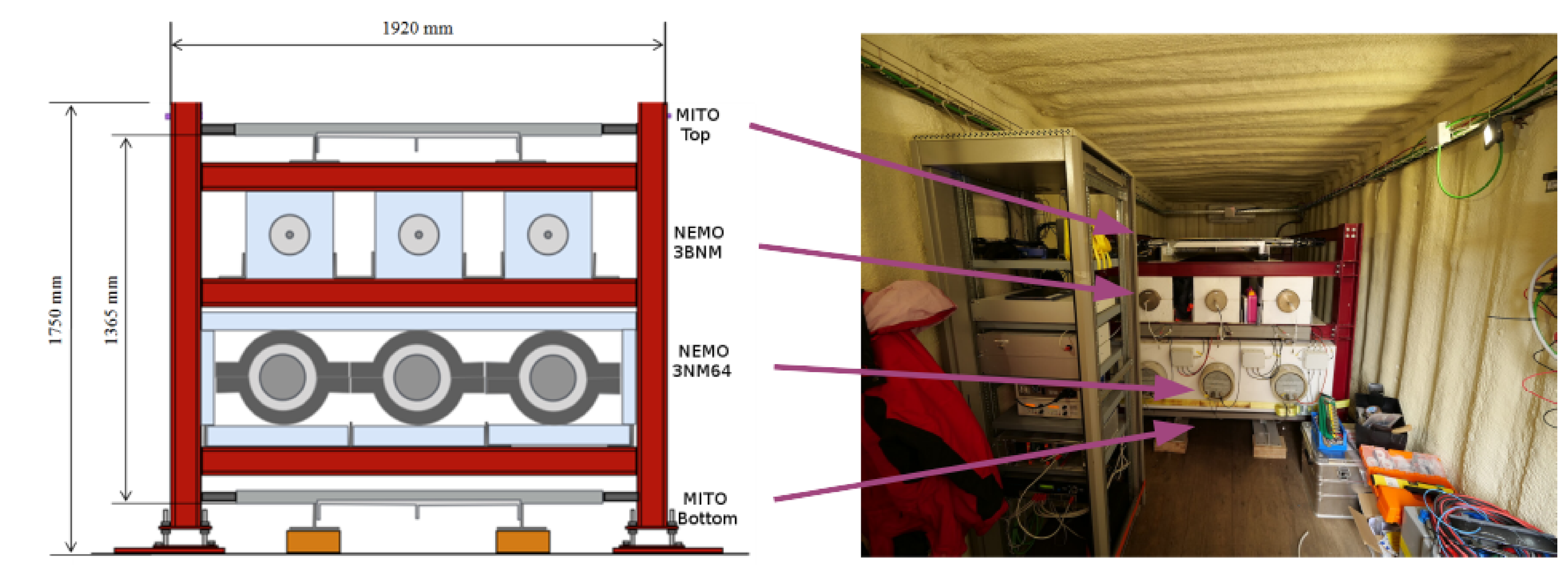

Figure 3:ICaRO design and ORCA (ICaRO's twin at Antarctica).

ICaRO will measure neutron and moun counting rates, and muon incident direction thanks to two instruments, NEMO and MITO. Both instruments share a common structure which keeps the relative position of their different elements.

Conclusion

A new cosmic ray detector, ICaRO, will be installed along the second part of 2021 at Izaña Atmospheric Research Center. Its location, $28°18'N$, $16°29'W$, 2373 m a.s.l. at a vertical cut-off rigidity of 11.5 GV makes it an ideal detector to study, cosmic rays and solar activity, the cosmic ray-atmosphere-magnetosphere interaction and solar neutrons.

References

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[2] A. A. Artamonov, G. A. Kovaltsov, A. L. Mishev, and I. G. Usoskin. *J. Geophys. Res. Space Phys.*, 121(1):117–128, 2016.

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Data of neutron monitors has been downloaded from NMDB page: `http://www.nmdb.eu/nest/`. Thanks to the project PID2019-107806GB-100, funded by Ministerio de Ciencia e Innovación.

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