UPGRADE OF THE MUON DETECTOR AT THE SOUTHERN SPACE OBSERVATORY

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ABSTRACT

The Brazilian muon detector, part of the Global Muon Detector Network (GMDN), was installed in 2002 at the Southern Space Observatory (SSO/INPE) in São Martinho da Serra. Since its installation, the detector has undergone several upgrades to enhanced sensitivity, stability, and data quality. The most recent upgrade, carried in collaboration with Shinshu University (Japan), involved the replacement of the old acquisition system with a new, high perfomance electronics system provided by our Japanese partners. This modernization significantly improved the detector directional resolution, and the counting rate stability, enabling more precise measurements of cosmic ray flux and solar modulation effects such as Forbush Decreases. Data produced are transmission to the GMDN ensures coordinated global observation, strengthening Brazil role international space weather monitoring and Sun-Earth connection studies

INTRODUCTION

- Cosmic rays are key for studying space weather and Sun–Earth interactions [1].
- The Global Muon Detector Network (GMDN) provides worldwide monitoring of cosmic-ray variations [2].
- Brazil plays a strategic role due to its geographical location within the network

INSTRUMENTATION

- The Muon Detector at the Brazilian Southern Space Observatory (SSO) measures the flux of secondary cosmic rays produced when high-energy cosmic rays interact with Earth's atmosphere.
- These detectors are typically scintillator-based, where cosmic ray-induced muons produce light that is detected by photomultiplier tubes (PMTs). Currently, the total area covered is 28 m^2, and the detector is multidirectional, with 119 directional channels, as shown in Figure 1.
- The SSO is located in Southern Brazil (Table 1) and is part of a network that monitors cosmic ray intensity. By detecting of the passage of the solar – interplanetary structures. The observatory helps in studying space weather impacts on Earth's atmosphere.

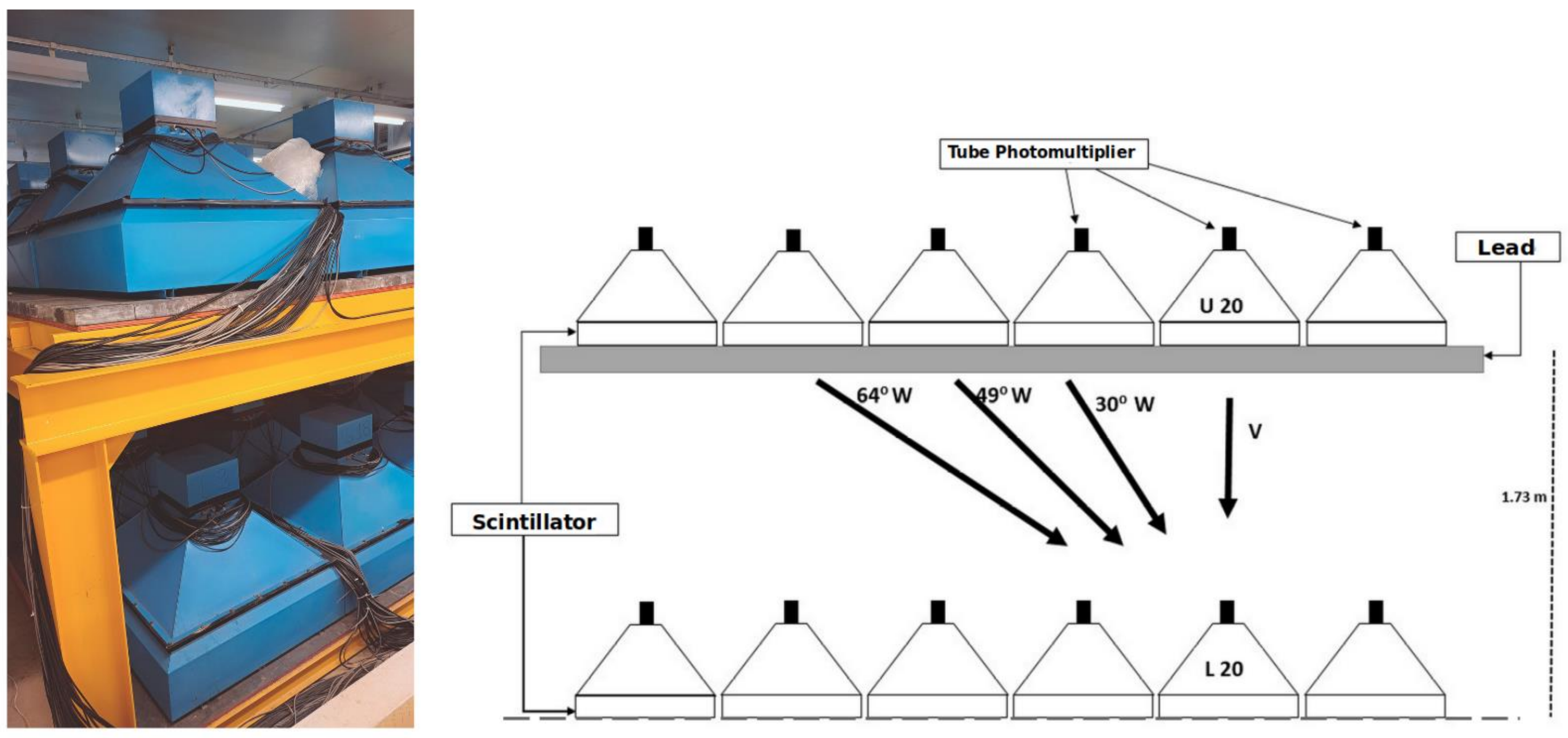

Fig. 1. Muon particles detectors of the two layers (a), and the muon detector system (b).

Localization	Latitude	Altitude	Longitude	Cutoff Rigidity
São Martinho da Serra, Brazil	-29° 32' 16.80" S	488 m	-53° 51' 18.00" W	Effective: 8.854 GV Upper = 9.162 GV Lower = 8.01 GV

Table 1. Geographic and Magnetic characteristics of SSO Muon detector

RECENT UPGRADE

Most recent upgrade, in collaboration with Shinshu University (Japan):

- Replacement of the old acquisition system.
- Integration of new high-performance electronics.
- Improved counting rate stability and directional resolution.
- Increase in area

In the Figure 2 present the old electronic (a) used in the muon detector, the new electronic part (b), and (c) is the pulse indicative of the correct work of the new electronic (square signal toward FPGA and deep signal muon spectrum)

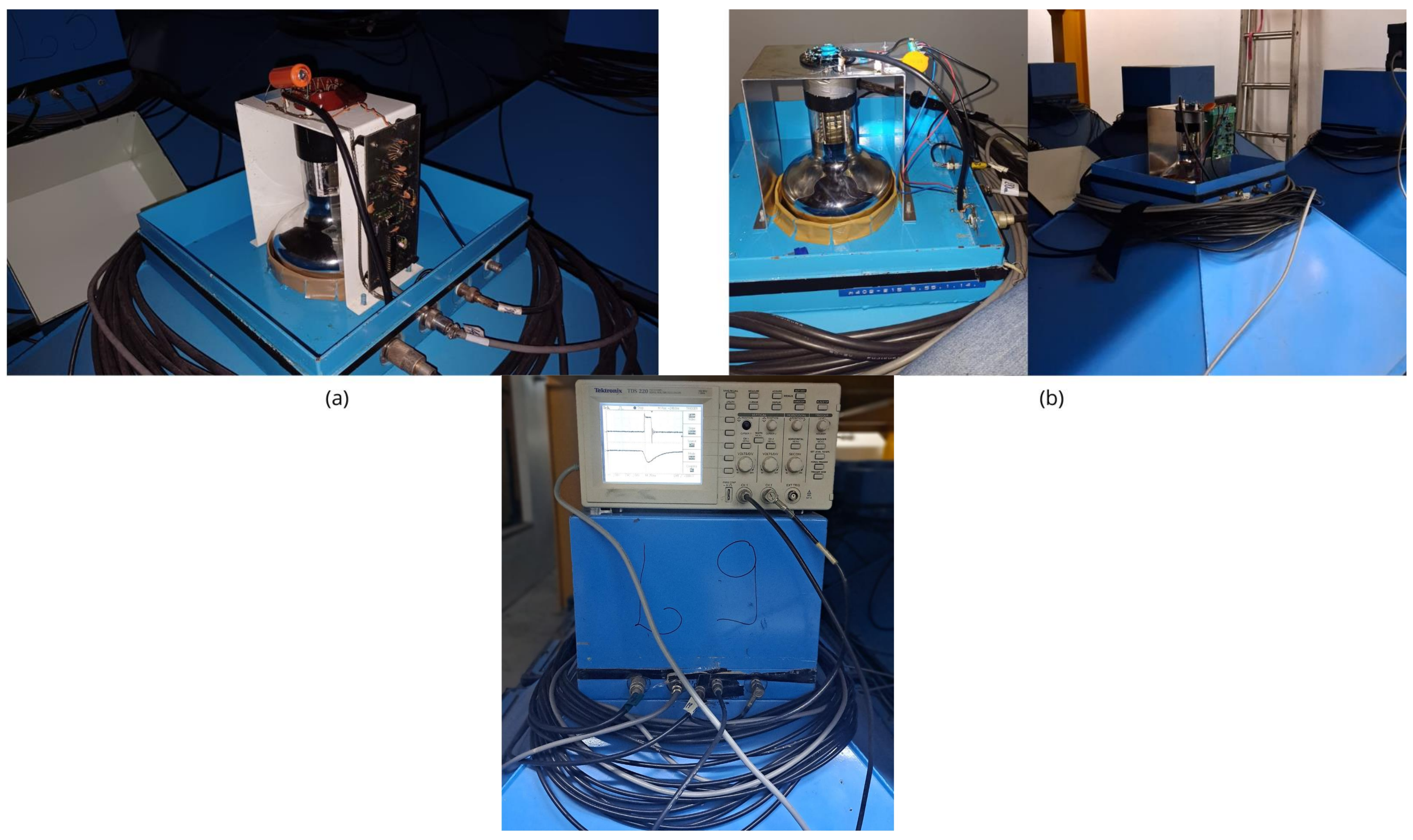

Fig. 2. Old electronic (a), new electronic system (b), and (c) pulse indicative.

RECENT RESULTS

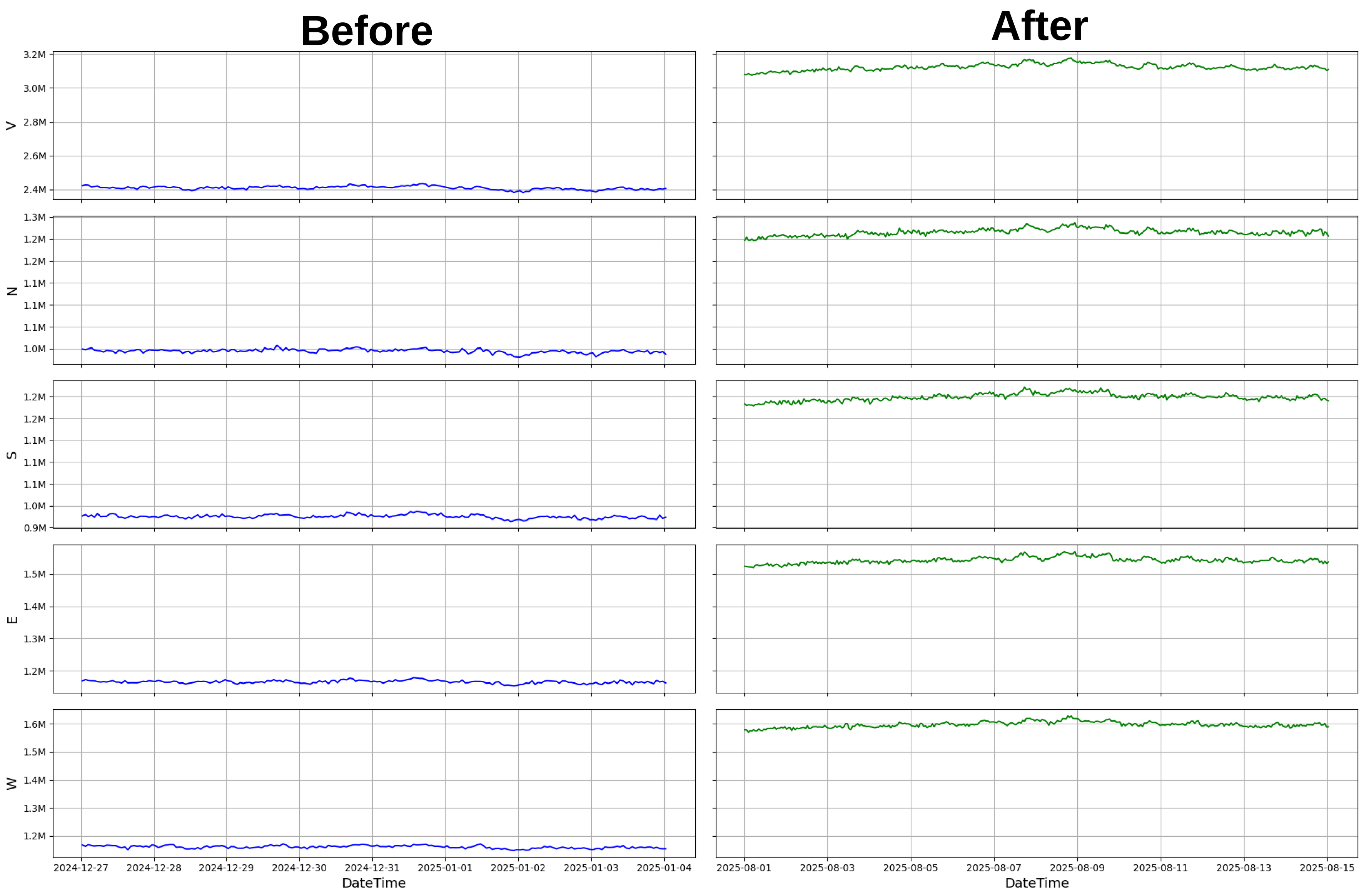

Fig. 3. Before and After upgrade of the cosmic rays flux using different directions

SUMMARY

- The Brazilian detector has become a crucial node of the GMDN.
- Ongoing modernization strengthens Brazil's role in global space weather monitoring.
- Results provide essential data for international studies of the Sun, solar wind, and their effects on the Earth's magnetosphere

REFERENCES

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