

Fortaleza Station Report for 2021 and 2022

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Abstract This is a brief report about the activities carried out at the Fortaleza Geodetic Observatory (FGO), Rádio Observatório Espacial do Nordeste (ROEN), located in Eusébio, CE, Brazil, during the period from January 2021 until December 2022.

1 General Information

The Rádio Observatório Espacial do Nordeste, ROEN, also known as Fortaleza Geodetic Observatory, FGO, located at INPE facilities in Eusébio, nearly 30 km east of Fortaleza, Ceará State, Brazil, began operations in 1993. Geodetic VLBI and GPS observations are carried out regularly, as contributions to international programs and networks. ROEN/FGO is part of the Brazilian space geodesy program, which was initially conducted by CRAAE (a consortium of the Brazilian institutions Mackenzie, INPE, USP, and UNICAMP) in the early 1990s. The program began with antenna and instrumental facilities installation sponsored by the U.S. agency NOAA and the Brazilian Ministry of Science and Technology's FINEP agency.

ROEN/FGO is currently coordinated by CRAAM, The Center of Radio Astronomy and Astrophysics, Engineering School, Mackenzie Presbyterian University, São Paulo, in agreement with the Brazilian National Space Research Institute, INPE. The activities are carried out under an Agreement of Cooperation

signed between NASA—representing research interests of NOAA and USNO—and the Brazilian Space Agency, AEB, which has been extended until August 2023. Discussions are currently underway for a ten-year extension including new possible partners. Under the auspices of the NASA-AEB Agreement, a contract was signed between NASA and CRAAM, Mackenzie Presbyterian Institute and University to partially support the activities at ROEN/FGO. In 2019 the contract was renewed for five more years.

The counterpart of the operational costs, staff, and support of infrastructure are provided by INPE and by Mackenzie.



Fig. 1 14.2-m radio telescope.

1. Universidade Presbiteriana Mackenzie, CRAAM and INPE, Rádio Observatório Espacial do Nordeste

2. National Aeronautics and Space Administration, NASA

2 Main Instruments

The largest instrument at ROEN is the 14.2-m radio telescope on an alt-azimuth positioner. It is operated at S- and X-bands, using cryogenic radiometers. The system is controlled by the Field System, Version 9.11.19. Observations are recorded with a Mark 5A system and transmitted through a high speed network either to the correlators in U.S. (WACO and Haystack) or to Bonn in Germany or to Shao in China at rates about 300 Mbps.

For this, a 1 Gbps link has been available since 2007. It integrates and is sponsored by the Brazilian Research Network — RNP.

One Sigma-Tau hydrogen maser clock standard is operated at ROEN. GPS monitoring is performed within a cooperative program with NOAA (USA). A Septentrio PolarRx5 receiver was installed at the station and operates continuously. The collected data are provided to the NOAA/IGS center and to the Brazilian IBGE center. ROEN has all basic infrastructures for mechanical, electrical, and electronic maintenance of the instrumental facilities.



Fig. 2 The 14.2-m antenna set down off the pedestal for bearing replacement activity.

3 Staff

Dr. Jean-Pierre Raulin is the current coordinator of the geodesy program. The coordination receives support from the São Paulo office at CRAAM/Instituto and Universidade Presbiteriana Mackenzie, with administrative support from Valdomiro M. S. Pereira and Lucíola Russi.

The Fortaleza Station facilities and geodetic VLBI and GPS operations are managed on site by Eng. Adeildo Sombra da Silva (CRAAM / Mackenzie) and the technicians Francisco Renato de Abreu (CRAAM / Mackenzie), Emerson Costa (CRAAM / Mackenzie), and Kelvin de Oliveria (CRAAM / Mackenzie).

4 Current Status and Activities

4.1 Azimuth Bearing Replacement

In November of 2020, the FGO 14.2-meter antenna bearing failed after ten years of operations. Intertronic-

Calian (ISI) completed a failure analysis to identify the root cause of the bearing failure. Based on the results of the failure analysis, ISI developed specifications for an improved bearing that provides extended life. There were delays in getting access to a vendor to manufacture the bearing, with the main contributor to the delay being the pandemic and associated supply chain issues. Once the manufacturing of the bearing started, the antenna's gearboxes, electrical motors, torque limiters, and other auxiliary equipment were replaced or refurbished by the FGO staff. Upon receipt of the new bearing, the old bearing was replaced with the new bearing by Revtech in February 2023. Both NASA and ISI-Calian were onsite to support the replacement activities.

All the auxiliary equipment was installed and tested. The signal chain was installed. The FGO staff tested the antenna's slewing and pointing. The pointing and slewing models were updated. The FGO 14.2 m was placed back into operations in May 2023.

4.2 New VGOS Antenna Construction

The new VGOS 12-m system build began in early 2021. ISI has the manufacturing of the 12-m antenna, and the factory acceptance test will be in September 2023. MIT has started the build of the signal chain. The FGO signal chain build will include the new generation ROACH-2 digital backends. The digital backend systems digitize and timestamp the incoming radio signals before they are sent on to other components for recording and analysis. Peraton is providing the meteorological sensors, networking equipment, the monitoring/archival element, and a time/frequency element that includes a new Hydrogen Maser Clock. NVI is providing the Field System that will include the capability of automatically handling schedules and an improved communications capability between VLBI stations and communication & coordination centers. KBR developed designs for all the modifications to the FGO infrastructure needed to support the new 12-m VGOS system. The modifications include a new generator and an uninterruptible power supply (UPS) set that will service both the 12-m and 14.2-m antennas. KBR also provided designs for an antenna foundation, an access road for the new 12-m antenna, and modifications to the operations building to support the new maser clock and other technical equipment.

Mackenzie University is implementing the modifications to the FGO infrastructure. Earthscope is providing three new GNSS antennas/receivers. The SGNOG, Space Geodesy Project's network operations center, will provide enhanced display capabilities to increase the overall situation awareness for the FGO station. This will include station operational status, network management, and alert displays that will enable the local operations team, support elements, and NASA managers to effectively respond to changes to the FGO operational environment.

The FGO station will be ready for commissioning/operations as early as January 2025.

4.3 VLBI Observations

In the years of 2021 and 2022, Fortaleza did not participate in any geodetic VLBI sessions.



Fig. 3 Site plan for 12-m VGOS construction.

4.4 Operational and Maintenance Activities

The summary of activities performed in the period is listed below:

1. Evaluation of the azimuth bearing failure: NASA/Intertronics Inc. performed a failure analysis.
2. Producing new requirements for extending the bearing lifespan.
3. Procurement and hiring of companies to design and manufacture the bearing.
4. Procurement and hiring of companies to perform the bearing replacement work.
5. Refurbishment of gearboxes, electrical motors, torque limiters, and brakes of antenna drives.
6. Supporting the Revtech company activities during the bearing replacement work along with NASA and Intertronics Inc. staff.
7. Procurement and hiring of contractors to perform geotechnical and topographical surveys for the design of the new VGOS telescope.
8. Providing support to the KBR team at the site on the new VGOS system design.
9. Operation and maintenance of geodetic GPS (NOAA within the scope of the NASA contract).

4.5 GPS Operations

The IGS network GPS receiver operated regularly at all times during 2021 and 2022. Data were collected and uploaded to an IGS/NOAA.

5 Future Plans

FGO expects to return to the IVS geodetic VLBI schedule in May 2023.

All efforts are being made to implement the designed site constructions and modifications on time to make the facilities ready for the installation within 2023, then have the VGOS system fully operational up to early 2025, according to the schedule.