

SARAO Hartebeesthoek - Overview

Roelf Botha

SA Geodesy Working Group Workshop 2026 - 30 September 2026



SARAO
South African Radio
Astronomy Observatory



1960

**Construction Started on the 85' Antenna
for JPL/NASA Deep space missions.**











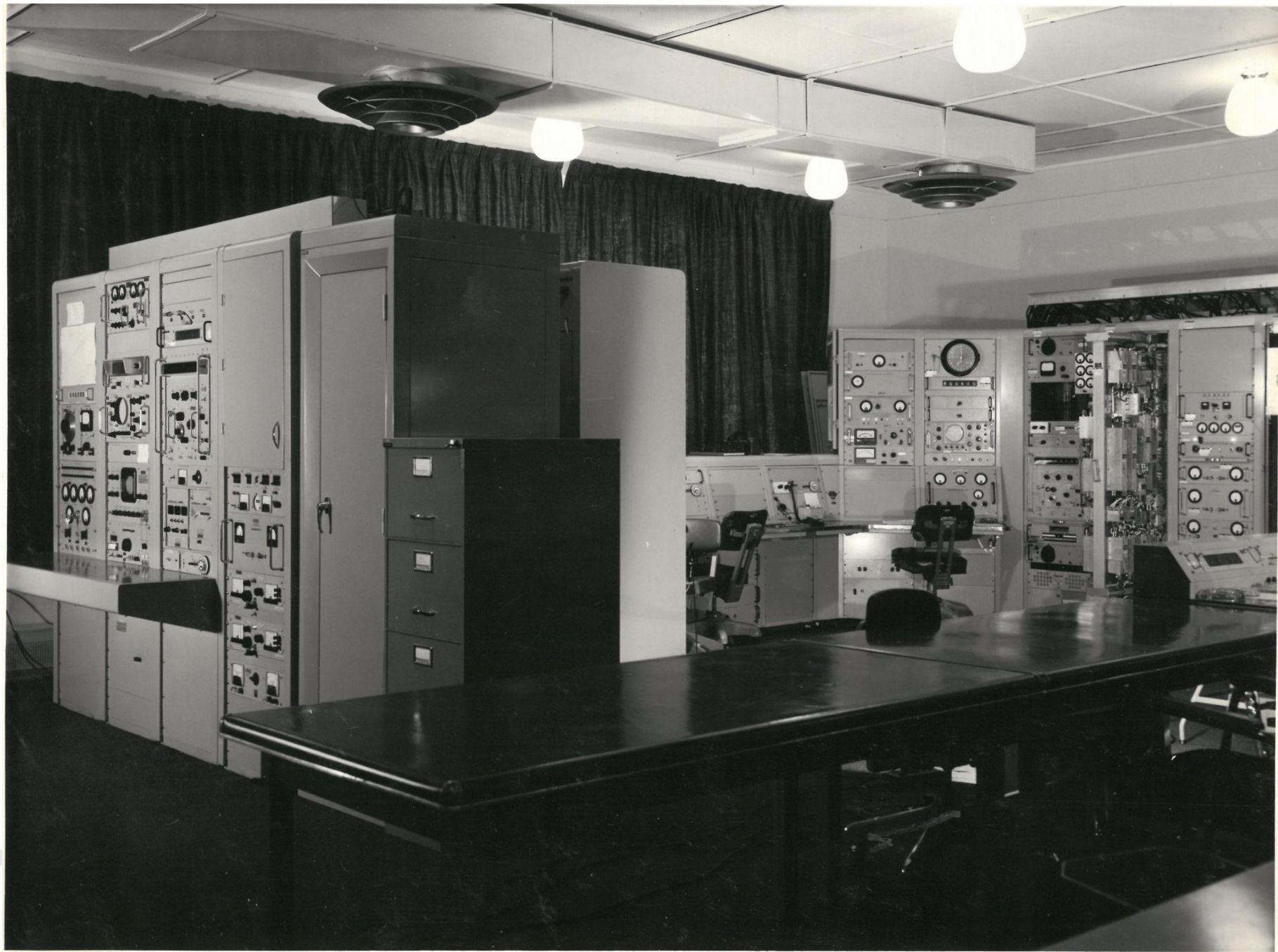




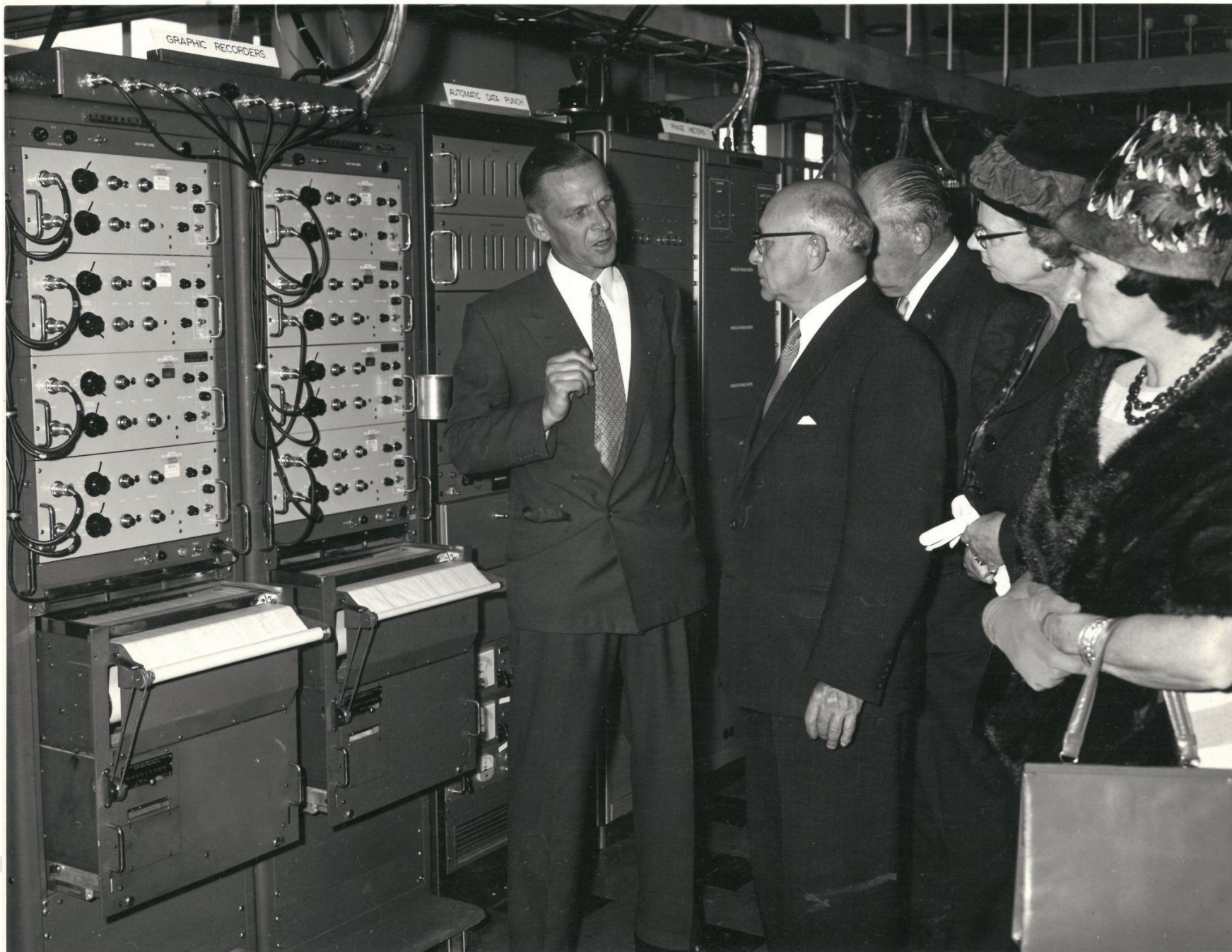






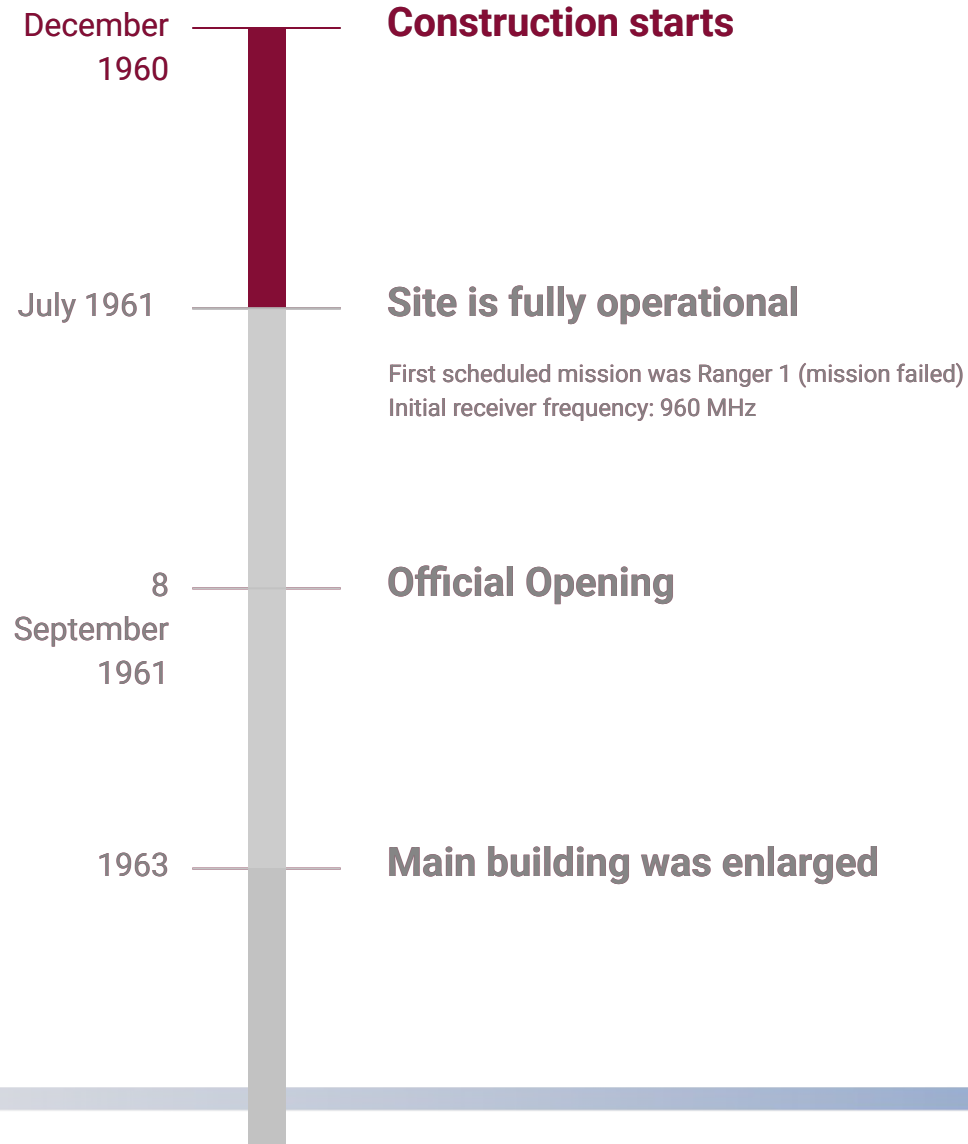












1964

26m antenna converted

To Cassegrain system. New receiver operated at 2290 MHz

1968

Next phase of major structural upgrades

1971

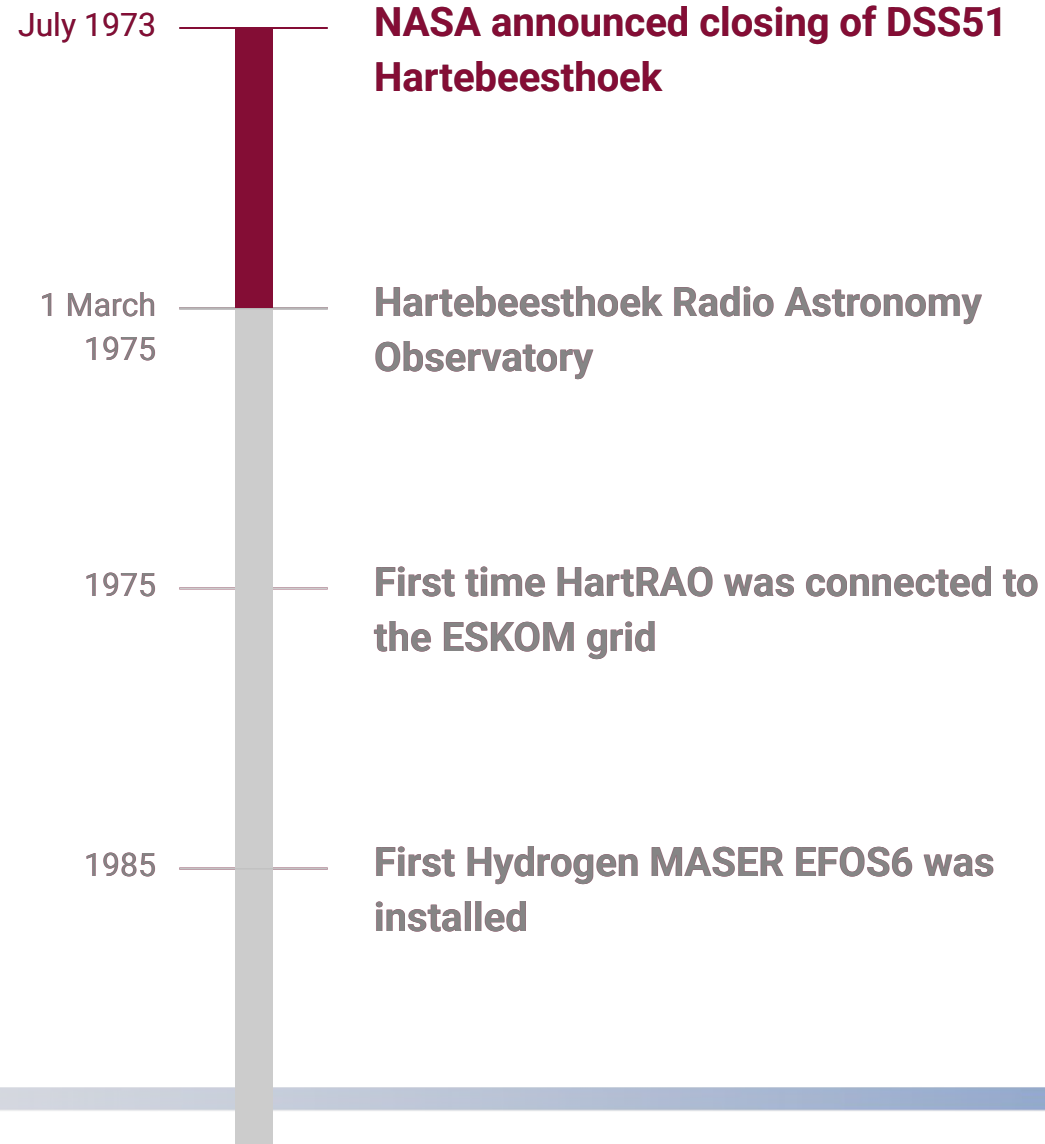
First inter continental VLBI

Between South Africa (HartRAO) and Australia

July 1971

Apollo 15

The only Apollo mission supported from DSS51 Hartebeesthoek



1996

NASA GPS Reference station: HRAO



From: Comparison of Site Velocities Derived from Collocated GPS, VLBI and SLR Techniques at The Hartebeesthoek Radio Astronomy Observatory (Comparison of Site Velocities) - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Geodetic-instruments-collocated-at-HartRAO-South-Africa-In-the-distance-15-m-VLBI_fig1_260906766 [accessed 30 Sept 2026]

Addition during 2021: HRAX



1999

**NASA Moblas6
Satellite Laser Ranger**



The MOBLAS-6 Satellite Laser Ranger

During 2008 October the laser system received a major upgrade.



2006

XDM/15m Antenna









2015

VGOS















CVCU

Front-end
under
construction

Dewar window &
external cover

IR filter

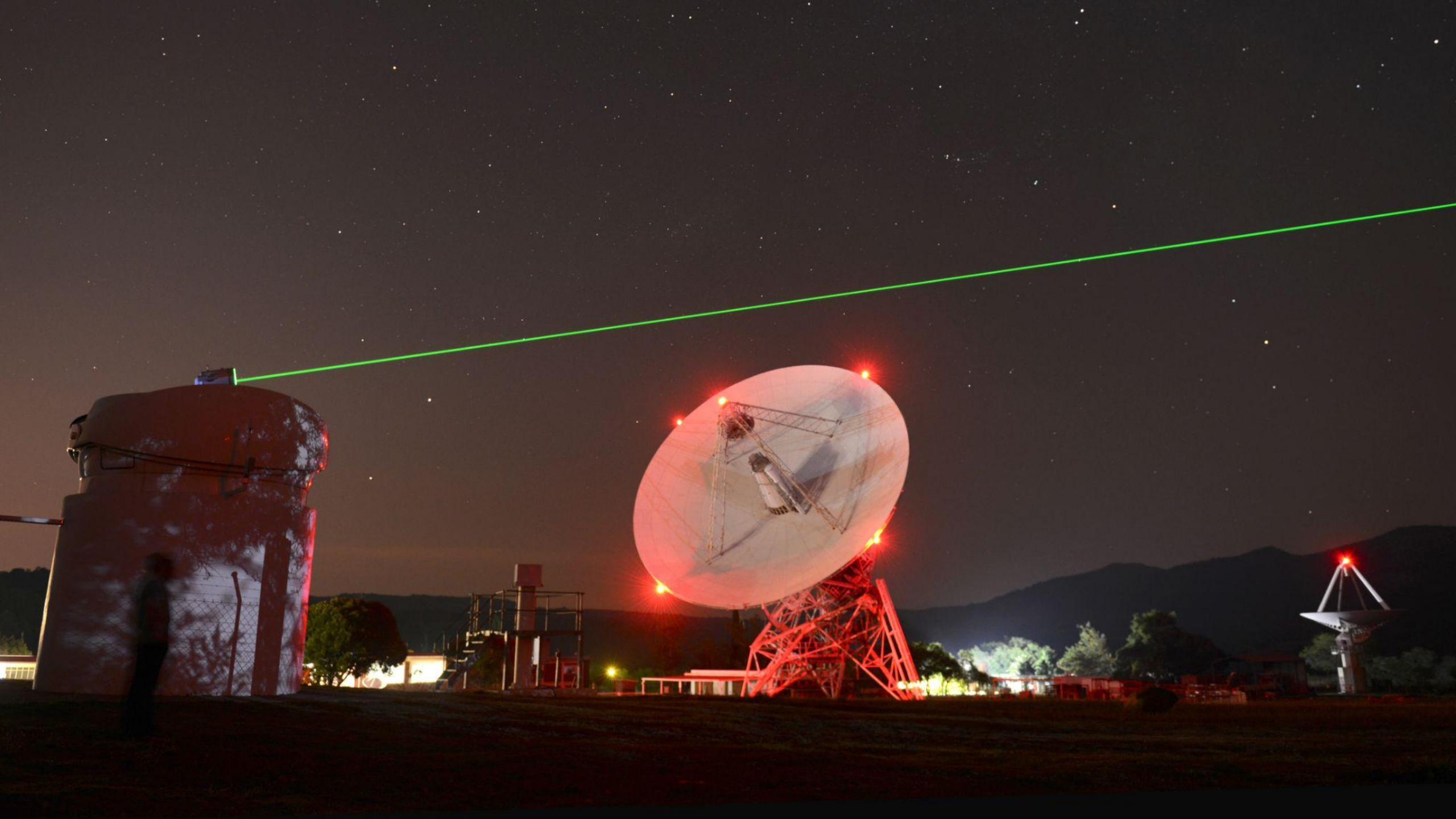
Radiation
shield

In 2013/14, the Hartebeesthoek facility was successfully awarded funding by the Department of Science and Technology for the construction of the VGOS telescope. Telescope construction started in 2016/17, with the final receiver system installed during 2020. The first successful VLBI fringes were obtained on 24 July 2024. The telescope commissioning continued, with acceptance into the international VLBI Service on 17 July 2025



2016

**Russian Sazhen-TM+OWS
Satellite Laser Ranger + GNSS**



What do we do...

- Radio Astronomy**
- Space Geodesy**

Radio Astronomy + VLBI

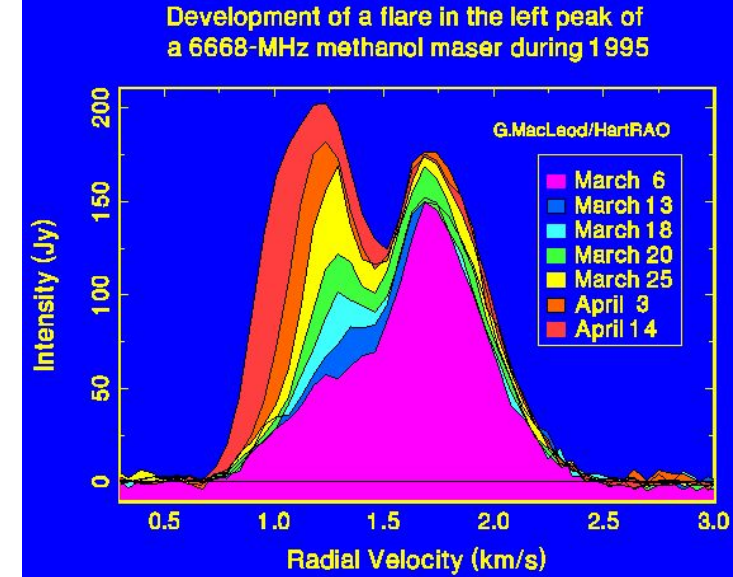
Radio Astronomy

- Single dish
- Maser monitoring
- Pulsar observation

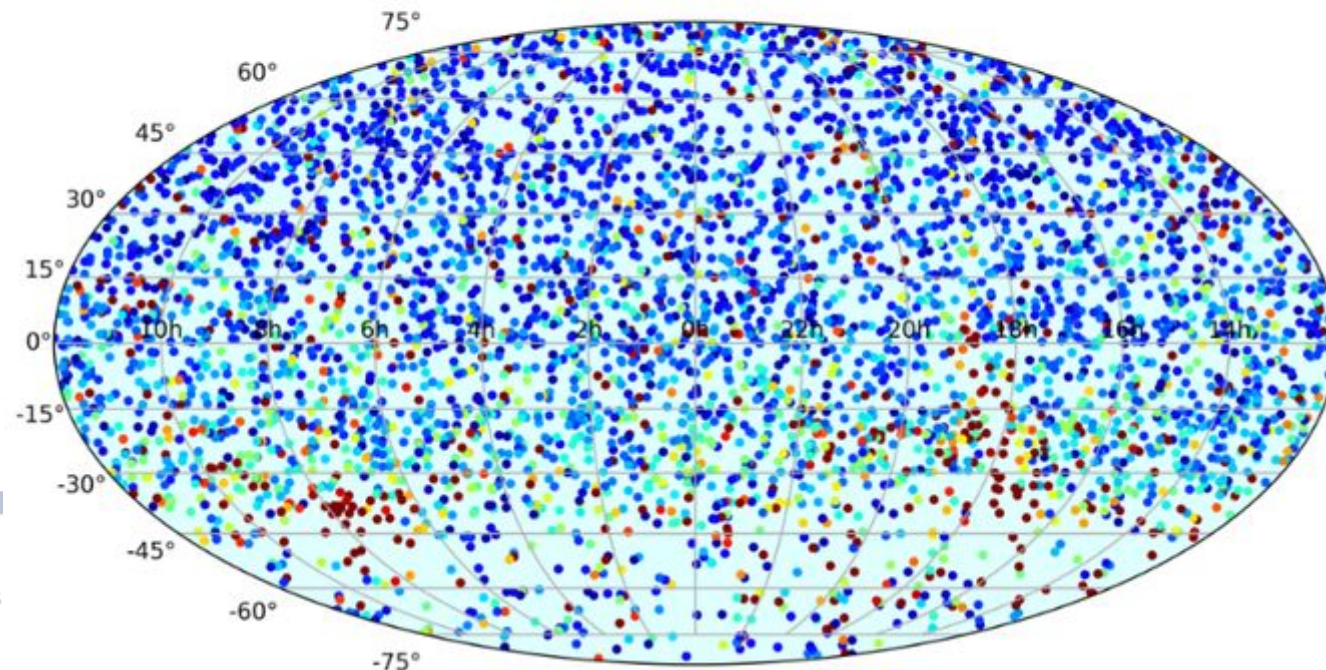
Very Long Baseline Interferometry

Participate in international networks:

- Source Structure
- International Celestial Reference Frame
- International Terrestrial Reference Frame



ICRF-3
most precise position catalog in astronomy today



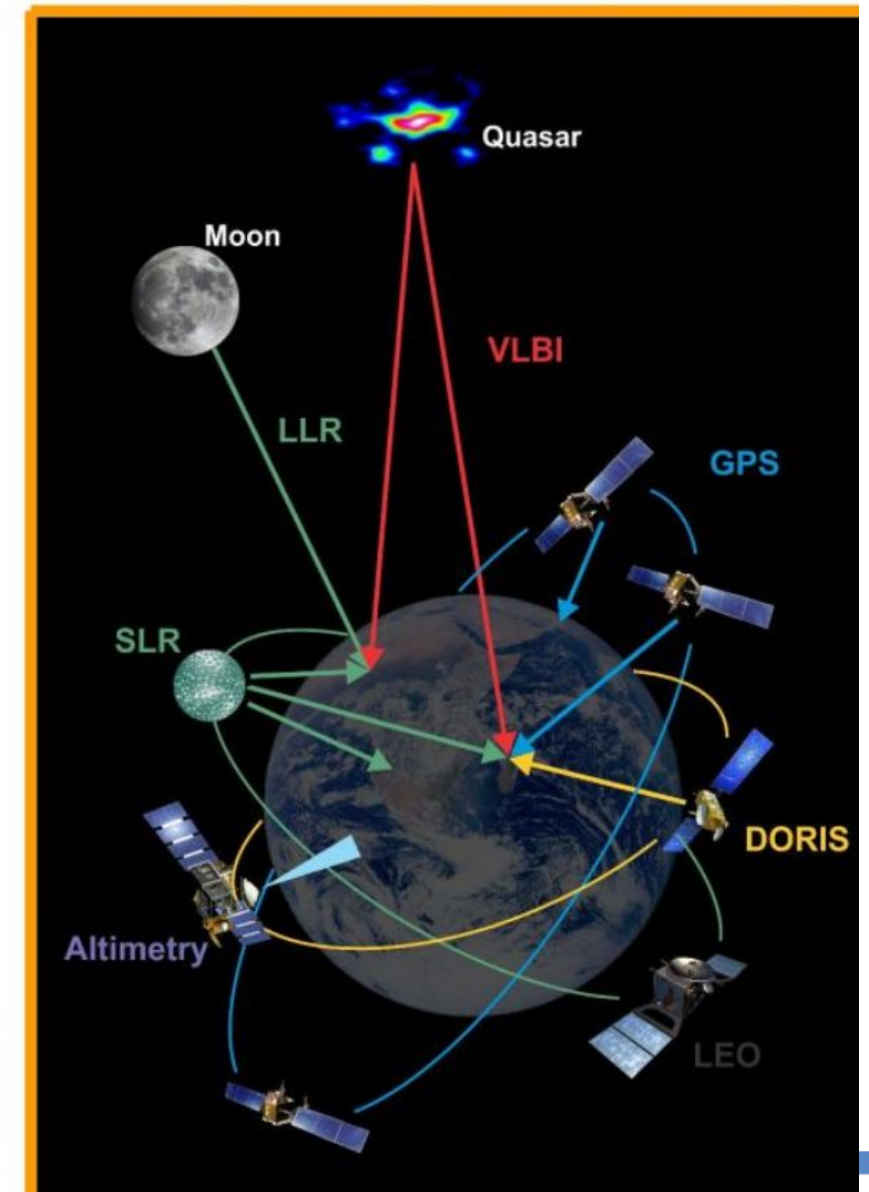
Space Geodesy - Fundamental Site

Various techniques, like:

- Global Navigation Satellite Systems:
 - Global Positioning System (GPS)
 - Global Orbiting Navigation Satellite System (GLONASS)
 - The European Navigational System (Galileo)
 - Chinese Satellite Navigational System "Compass" (Beidou)
- Very Long Baseline Interferometry (VLBI)
- Laser Ranging to satellites and the Moon (SLR and LLR)
- Doppler Orbitography and Radio-positioning (DORIS)
- Local automated Site-tie
- Geo-physical measurements: seismicity, gravity, meteorological data

These techniques are used both separately *and in conjunction* with each other in Geodesy

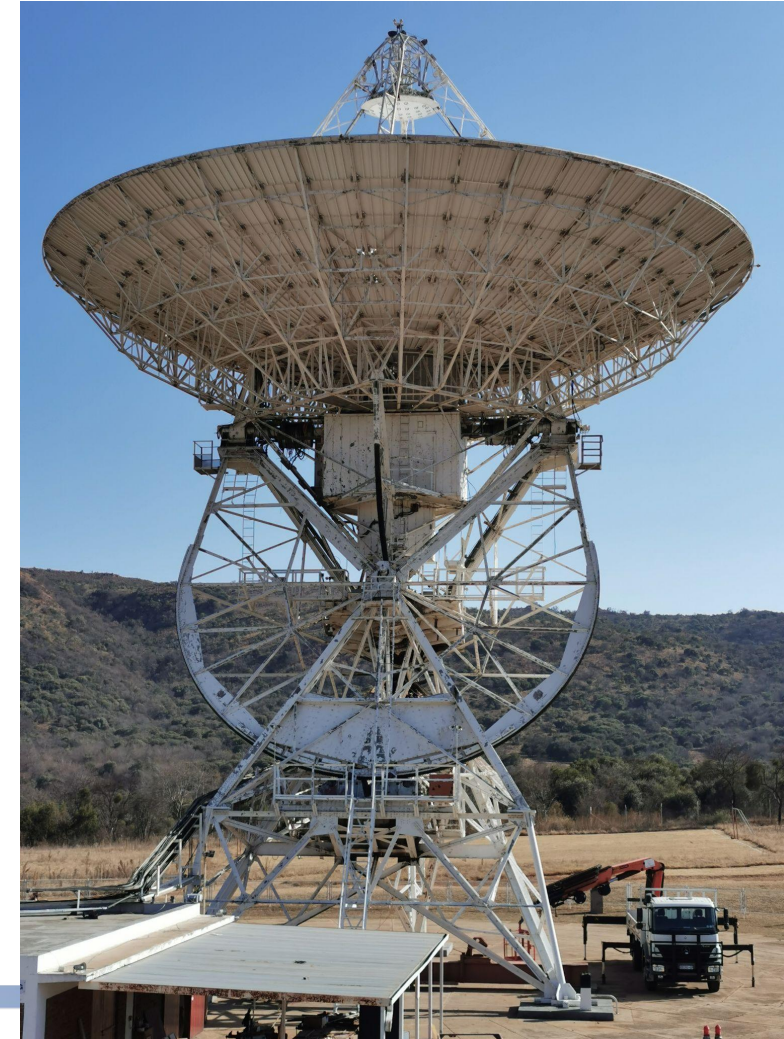
COLLOCATION



Engineering

Primarily ensuring that the antennas and scientific support equipment are operational 24/7

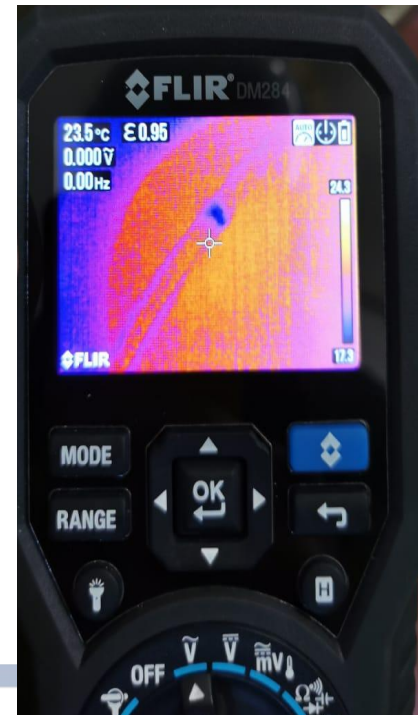
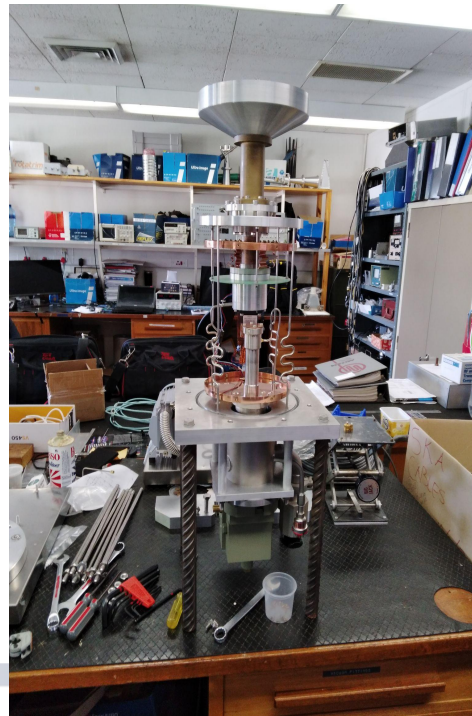
- Currently 3 antennas, ~2 maintenance periods for each per year
- Small team < 10
 - Mechanical workshop (manual machines, lathes, milling machines, ...)
 - Microwave lab (VNAs, spectrum analysers, ...)
 - Electronics lab



Engineering

In-house upgrades, repairs, innovation, solutions

- Electronics
- Control
- Radio frequency
- Mechanical
- Vacuum systems
- Helium
- Cryogenic
- Design and fabrication
- Everything in between



Development, Training, Support

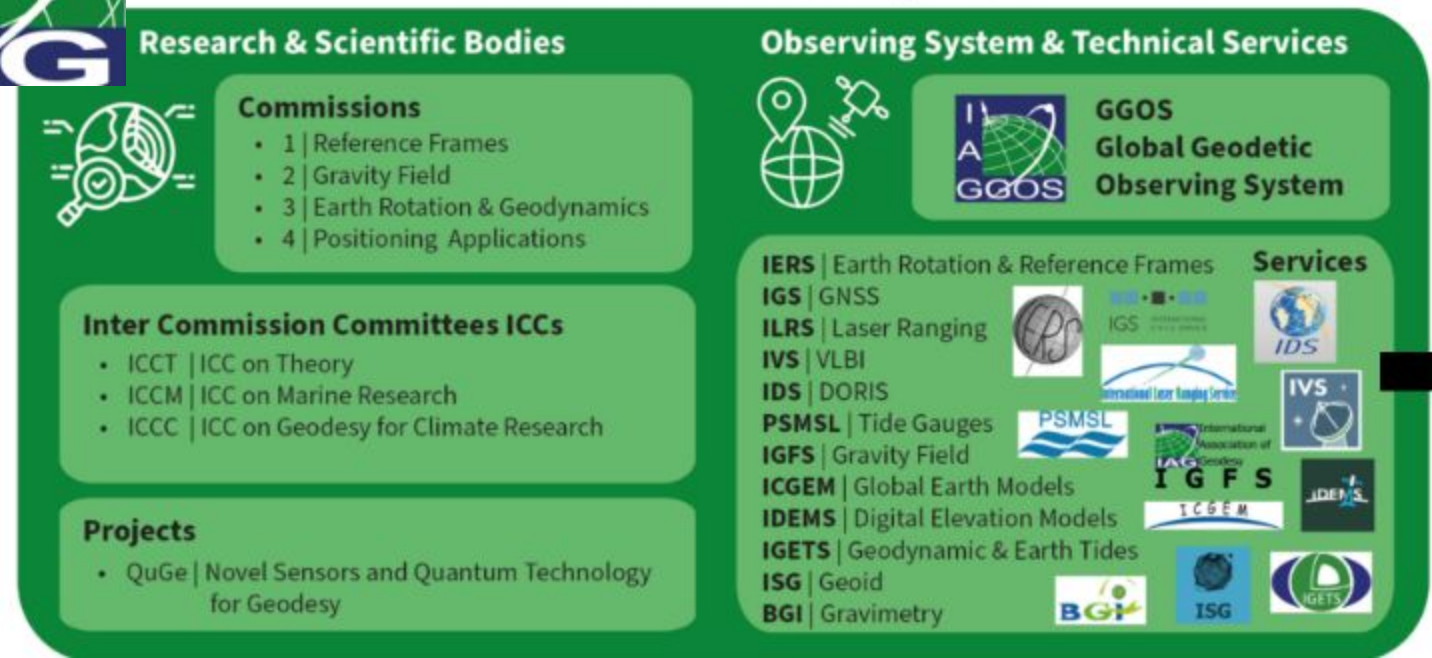
Development in Africa through Radio Astronomy

- DARA training (2 week RA module) 2 times a year for 20 African students
- PhD + MSc students (local + foreign universities)



Collaboration + Support

- International VLBI Service
- International Laser Ranging Service
- International GNSS service
- European VLBI Network
- SA National Space Agency - TT&C



Thank you for visiting our site...



Interactions

Group Photograph at 26m (weather dependent)

Main groupings:

- Engineering + Workshops (Pieter Stronkhorst)
- Radio Telescopes and VLBI (Jon Quick)
- SLR, GNSS + Site Tie (Roelf Botha)
- Any other interests (Simpfiwe Madlanga)

Please be ready to depart at 11:30 - 11:35