# Hartebeesthoek Radio Astronomy Observatory (HartRAO)

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**Abstract**

HartRAO, the only fiducial geodetic site in Africa, participates in VLBI, GPS and SLR global networks. This report provides an overview of our geodetic VLBI activities during 2004. The status of the 26m radio telescope surface upgrade is reported. In order to meet future requirements of geodetic VLBI, we have initiated the first steps towards founding a new space geodetic station which will cater to new developments and challenges as addressed by VLBI2010 and future requirements of GPS and SLR/LLR.

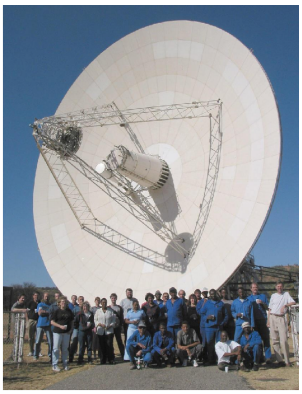

Figure 1. Staff celebrating in front of newly resurfaced telescope which the Director had just "launched" with champagne.

## 1. Geodetic VLBI at HartRAO

Hartebeesthoek is located 65 kilometers north-west of Johannesburg, just within the provincial boundary of Gauteng, South Africa. The nearest town, Krugersdorp, is 32 km distant. The telescope is situated in an isolated valley which affords protection from terrestrial interference. HartRAO uses a 26-metre equatorially mounted Cassegrain radio telescope built by Blaw Knox in 1961. The telescope was part of the NASA deep space tracking network until 1975 when the facility was converted to an astronomical observatory. The telescope is co-located with an SLR station (MOBLAS-6) and an IGS GPS station (HRAO). HartRAO joined the EVN as an associate member during 2001. Astronomical and geodetic VLBI have been allocated equal shares (15% each) of telescope time.

## 2. Technical Parameters of the VLBI Telescope of HartRAO

The feed horns used for 13 cm and 3.5 cm are dual circularly polarised conical feeds. The RF amplifiers are cryogenically cooled HEMTS. Tables 1, 2 and 3 contain the technical parameters of the HartRAO radio telescope, its receivers and recording systems. Our Mark 5 recording unit

has been run in Mk5A mode since mid-May and has been used in the majority of experiments since then.

Table 1. Antenna parameters.

| **Parameter** | **HartRAO-VLBI** |
|---|---|
| Owner and operating agency | HartRAO |
| Year of construction | 1961 |
| Radio telescope mount | Offset equatorial |
| Receiving feed | Cassegrain |
| Diameter of main reflector $d$ | $25.914\,m$ |
| Focal length $f$ | $10.886\,m$ |
| Focal ratio $f/d$ | 0.424 |
| Surface error of reflector | $< 1.0\,mm$ |
| Wavelength limit | $< 2.5\,cm$ |
| Pointing resolution | $0.001^\circ$ |
| Pointing repeatability | $0.020^\circ$ |

Table 2. Receiver parameters with dichroic reflector (DR), used for simultaneous S-X VLBI, off or on.

| **Parameter** | **X-band** | **S-band** |
|---|---|---|
| $T_{sys}$ (DR off) $(K)$ | 60 | 44 |
| $T_{sys}$ (DR on) $(K)$ | 70 | 50 |
| $S_{SEFD}$ (DR off) $(Jy)$ | 684 | 422 |
| $S_{SEFD}$ (DR on) $(Jy)$ | 1330 | 1350 |
| Point source sensitivity (DR off) $(Jy/K)$ | 11.4 | 9.6 |
| Point source sensitivity (DR on) $(Jy/K)$ | 19 | 27 |
| 3 dB beamwidth $(^\circ)$ | 0.092 | 0.332 |

Table 3. VLBI recording systems.

| **Parameter** | **HartRAO-VLBI** |
|---|---|
| VLBI terminal | MKIV |
| VLBI recorder | Mark5A, MarkIV, S2 |

## 3. Staff Members Involved in VLBI

Table 4 lists the HartRAO station staff who are involved in geodetic VLBI. Jonathan Quick (VLBI friend) has continued to provide technical support for the Field System as well as for hardware problems.

Table 4. Staff supporting geodetic VLBI at HartRAO.

| Name | Function | Programme |
|---|---|---|
| Ludwig Combrinck | Programme Leader | Geodesy |
| Jonathan Quick | Hardware/Software | Astronomy |
| Marisa Nickola | Logistics/Operations | Geodesy |
| William Moralo | Operator | Geodesy |
| Pieter Stronkhorst | Operator | Geodesy |
| Attie Combrink | Operator | Geodesy |
| Gert Agenbag | Operator | Geodesy - student |
| Roelf Botha | Operator | Geodesy - student |
| Sakia Madiseng | Operator | Geodesy - student |
| Mojalefa Moeketsi | Operator | Geodesy - student |
| Sandile Ngcobo | Operator | Geodesy - student |
| Vasyl Suberlak | Operator | Geodesy - post doctoral researcher |

## 4. Current Status

During 2004 HartRAO participated in 56 experiments (Table 5), compared to 58 in the previous year, which utilised the telescope time allocated to geodetic VLBI to its fullest extent. The antenna surface upgrade is continuing - new surface panels have been aligned optically using theodolite and steel tape, with a night alignment taking place on 2-3 September (see Figures 2, 3 and 4); the subreflector was realigned on 8-10 October. After completion of the night alignment, we will use microwave holography to determine the overall shape of the dish, making use of a 12 GHz transmitter on a geostationary satellite as a reference signal. Based on the results of the holography, individual panels will be adjusted to obtain the best overall surface shape.

Table 5. Geodetic VLBI experiments HartRAO participated in during 2004.

| Experiment | Number of Sessions |
|---|---|
| R1 | 30 |
| T2 | 6 |
| CRDS | 6 |
| OHIG | 4 |
| SYOWA | 4 |
| CRF | 4 |
| RDV | 2 |
| Total | 56 |

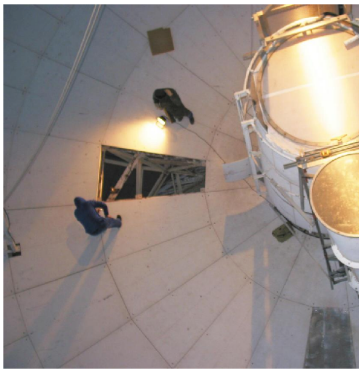

Figure 2. Night alignment of the 26-m antenna new surface panels; Cassegrain cone and 18 cm feed horn seen from top; theodolite reference target mounted beneath (removed) panel.

Figure 3. Jaques Grobler operating the theodolite located in the "elephant base" during the night alignment.

Figure 4. Jonathan Quick adjusts one of the mounting bolts.

## 5. Future Plans

We have started initial steps towards the development of a new integrated Space Geodesy Facility which will support SLR, LLR, VLBI and GPS as well as host other earth science instrumentation. This will mean the construction of a new site, development and implementation of new state of the art equipment and will place the southern hemisphere and especially Africa securely in the space geodesy arena for the next several decades. We would like to invite possible participants in this venture to contact us. The Geodesy Programme is an integrated programme, supporting VLBI, SLR and GPS and is active in several collaborative projects with GSFC, JPL, GFZ (Potsdam) and local institutes.