Hartebeesthoek Radio Astronomy Observatory

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Abstract

This report summarises the current technical parameters of the HartRAO VLBI station. It also gives an overview of our geodetic VLBI activities during the last year and briefly describes our involvement with other space geodesy techniques. Current and envisaged upgrading to the antenna which should improve the performance of HartRAO as a VLBI station are discussed.

1. Geodetic VLBI at HartRAO

HartRAO is located north of Johannesburg, South Africa, in a valley of the foothills of the Witwaters mountain range. 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.

Figure 1. The 26 metre radio telescope. The antenna is located in a valley which shields it from terrestrial RFI.

2. Technical Parameters of the VLBI Telescope of HartRAO

The feed horns used for 13 cm and 3.5 cm are single polarised conical feeds. Both S and X bands have right hand circular polarisation. The RF amplifiers are cryogenically cooled HEMTS. The radio telescope is being upgraded, and we have recently (November 1998) replaced the hydraulic drive with an electric drive. A project has been launched to upgrade the perforated surface panels of the telescope to higher tolerance solid panels.

Table 1. Location and addresses of HartRAO.

Latitude	25.889° S
Longitude	27.686° E
Hartebeesthoek Radio Astronomy Observatory Geodesy Programme PO BOX 443 Krugersdorp, 1740, SOUTH AFRICA	
`http://www.hartrao.ac.za/geodesy/geodesy_index.html`	

The technical parameters of the radio telescope are summarised in Table 2.

Table 2. Technical parameters of the radio telescope of HartRAO for geodetic VLBI.

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	$25.914m$
focal length f	$10.886m$
f/d	0.424
surface contour of reflector	$\pm 2.0mm$
wavelength limit	2.5 cm
pointing resolution	0.001°
pointing repeatability	0.004°
X-band (standard $\nu = 8.580GHz, \lambda = 0.0349m$)	$8.180 - 8.980\,GHz$
T_{sys}	$65\,K$
S_{SEFD}	$1500\,Jy$
Point source	$17.1\,Jy/K$
3 dB beamwidth	0.092°
S-band (standard $\nu = 2.280GHz, \lambda = 0.1316$)	$2.210 - 2.344GHz$
T_{sys}	$40\,K$
S_{SEFD}	$1500\,Jy$
Point source	$9.7\,Jy/K$
3 dB beamwidth	0.332°
VLBI terminal type	Mark IV
recording media	thin tape only
Field System version	9.3.25
attended VLBI observations	24h, mode C

3. Staff Members Involved in VLBI

The Geodesy Programme draws some manpower from other programs at the observatory, particularly for technical maintenance and operations assistance. The staff members listed have direct VLBI responsibilities, but other staff are sometimes involved in supporting and maintenance roles.

Table 3 lists the HartRAO station staff who are involved in geodetic VLBI.

Table 3. Staff supporting geodetic VLBI at HartRAO.

Name	Background	Dedication	Function	Programme
Ludwig Combrinck	Geodesy	30%	Project Leader	Geodesy
Jonathan Quick	Astronomy	5%	Hardware/Software	Astronomy
William Moralo	Technical	30%	Operator	Geodesy
Peter Stocker	Technical	10%	Day Shift Operator	Electronics
Ferdie Nel	Technical	5%	Night Shift Operator	Electronics

4. Status of the HartRAO Geodetic VLBI Component

During the period of this report (1998 - March 1, 1999) HartRAO participated in several VLBI experiments which are listed in Table 4. We have been participating in VLBI experiments on a regular basis since 1986. Currently about 15 percent of available telescope time is allocated for geodetic VLBI. We have a Mark IV terminal and thin tape recorder. An S2 terminal is used for astronomical VLBI and SYOWA experiments.

Table 4. Participation of HartRAO in Geodetic VLBI experiments for the period 1998 to March 1, 1999.

Date	Exp.	Date	Exp.	Date	Exp.	Date	Exp.
1998-01-13	CA027	1998-01-27	CA028	1998-01-29	IS122	1998-02-12	IS123
1998-02-24	CA030	1998-03-10	CA031	1998-03-23	IS124	1998-03-24	CA032
1998-04-07	CA033	1998-04-13	IS125	1998-04-21	CA034	1998-05-05	CA035
1998-05-11	IS126	1998-05-19	CA036	1998-06-02	CA037	1998-06-15	IS127
1998-06-16	CA038	1998-06-30	CA039	1998-07-13	IS128	1998-07-14	CA040
1998-07-28	CA041	1998-08-11	CA042	1998-08-24	IS129	1998-08-25	CA043
1998-09-08	CA044	1998-09-22	CA045	1998-09-28	IS130	1998-10-05	IS131
1998-10-06	CA046	1998-11-17	CA049	1998-12-01	CA050	1998-12-07	IS133
1998-12-15	CA051	1998-12-29	CA052	1999-01-12	CA053	1999-01-26	CA054
1999-01-28	IS134	1999-02-01	CRF06	1999-02-04	COHIG4	1999-02-08	IS135
1999-02-09	CA055	1999-02-11	COHIG5	1999-02-15	CRF07	1999-02-18	COHIG6
1999-02-23	CA056						

Table 5. Table of eccentricities, VLBI telescope to SLR and GPS (HRAO) reference points.

Reference	Coordinate	Δ	σ (mm)
SLR	X	41.680	15.8
SLR	Y	-66.564	7.5
SLR	Z	-8.131	3.9
HRAO	X	90.236	15.8
HRAO	Y	-132.190	7.5
HRAO	Z	-34.704	3.9

Table 6. Table of Geodetic reference points, ITRF96 Epoch 1997, VLBI, SLR and GPS (HRAO).

Reference	Coordinate	Cartesian (m)	σ (m)	Velocity (m)	σ (m)
VLBI	X	5085442.780	0.006	0.0007	0.0009
VLBI	Y	2668263.483	0.005	0.0192	0.00101
VLBI	Z	-2768697.034	0.005	0.0164	0.0007
GPS	X	5085352.500	0.009	0.0007	0.0009
GPS	Y	2668395.681	0.007	0.0192	0.00101
GPS	Z	-2768731.692	0.006	0.0164	0.0007
SLR	X	5085401.135	0.101	0.0007	0.0009
SLR	Y	2668330.108	0.063	0.0192	0.00101
SLR	Z	-2768688.865	0.071	0.0164	0.0007

5. Future Plans

We are continuing our footprint survey, which has as its main purpose the determination of eccentricities between the GPS, VLBI and SLR reference points as well as the maintenance of a control network to enable stability monitoring of the site on a local scale. The current eccentricities between VLBI and SLR (Table 5) were determined using GPS (Combrinck & Merry 1997) and the SLR to GPS eccentricity values are from 1998 footprint results. We are processing HRAO in a 14 station regional (IGS) network and envisage having a permanent SLR (MOBLAS 6) operational by January 2000. This will strengthen colocation and with accurate eccentricities should tie the independent ITRF (Table 6) coordinates to a high degree of accuracy.

HartRAO has several upgrades in progress which will affect VLBI and general radio telescope performance. The main projects for 1999 are:

1. Upgrade of radio telescope surface.
2. Automation of dichroic.
3. Upgrade of S and X band receivers to dual polarisation.

References

[1] Combrinck W.L. and Merry, C.L. *Very long baseline interferometry antenna axis offset and intersection determination using GPS.* JGR, Vol.102, NO.B11, pages 24,741-24,743, 1997.