The Hartebeesthoek Radio Astronomy Observatory's (HartRAO) 26m and 15m radio telescopes regularly participate in astrometric and geodetic VLBI sessions. The 26m suffered a critical bearing failure in 2008 and returned to operations in 2010 after repair. The 15m was built as SKA prototype during 2007 and converted to an operational geodetic VLBI antenna during 2012. It officially joined geodetic VLBI operations in 2013. In 2014 antenna axis offsets (AO) of both the 26m and 15m were estimated using the Vienna VLBI Software (VieVS). A discrepancy was found to exist between previously determined AO values for the 26m (from ground surveys as well as from analysis with other VLBI analysis software packages before bearing repair) and the values obtained with VieVS in 2014 from geodetic VLBI sessions before and after bearing repair. Additional geodetic VLBI sessions are analysed using VieVS to estimate the AO of both the 26m and 15m antennas and also to determine the local tie between them. Possible seasonal variations in AO as well as baseline length between the 26m and 15m are investigated. Possible displacement of the antennas due to an earthquake occurring in the vicinity of HartRAO during 2014 is also investigated. A local site tie was performed during the early part of 2014. Should results from this ground survey become available, a comparison will be made with VieVS determined values.

### HARTRAO 26m

- Equatorially mounted Cassegrain radio telescope built by Blaw Knox in 1961
- VLBI reference point: intersection of fixed axis (HA) with perpendicular plane containing moving axis (Dec)
- Serves as reference point for co-location of SLR and GNSS stations on-site and as reference datum for South Africa's surveying system
- 3 October 2008: critical failure of south polar bearing
- After bearing repair. Additional geodetic VLBI sessions are analysed using VieVS to estimate the AO of both the 26m and 15m antennas and also to determine the local tie from analysis with other VLBI analysis software packages before bearing repair
- 11 August 2010: first post repair geodetic session
- 11 October 2012: first geodetic session (as part of commissioning)
- As many as possible geodetic sessions off-loaded to quick-slewing, all-sky seeing 15m

### HARTRAO 15m

- alt-az radio telescope built as SKA prototype during 2007
- VLBI reference point: intersection of fixed (azimuth) axis with perpendicular plane containing moving (elevation) axis
- Converted to operational geodetic VLBI antenna during 2012
- 10 March 2014: first geodetic session (as part of commissioning)
- As many as possible geodetic sessions off-loaded to quick-slewing, all-sky seeing 15m

### AXIS OFFSET COMPARISON

- When telescope’s rotation axes do not intersect, VLBI reference point is point represented by intersection of fixed axis with perpendicular plane containing moving axis; causes delays (geometric and dry troposphere); has to be considered for VLBI results.

### SEASONAL VARIATION

<table>
<thead>
<tr>
<th>Month/Season</th>
<th>26m dAO</th>
<th>15m dAO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec-Jan-Feb (Summer)</td>
<td>17.30 ± 1.67 mm</td>
<td>7.09 ± 2.12 mm</td>
</tr>
<tr>
<td>Mar-Apr-May (Autumn)</td>
<td>5.77 ± 1.97 mm</td>
<td>1.41 ± 2.22 mm</td>
</tr>
<tr>
<td>Jun-Jul-Aug (Winter)</td>
<td>13.25 ± 1.56 mm</td>
<td>6.67 ± 2.37 mm</td>
</tr>
<tr>
<td>Sep-Oct-Nov (Spring)</td>
<td>12.03 ± 1.06 mm</td>
<td>6.02 ± 2.47 mm</td>
</tr>
</tbody>
</table>

### BASELINE

<table>
<thead>
<tr>
<th>Month</th>
<th>26m dAO</th>
<th>15m dAO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep - Feb</td>
<td>13.14 ± 0.91 mm</td>
<td>7.11 ± 3.78 mm</td>
</tr>
<tr>
<td>Mar - Aug</td>
<td>9.749 ± 1.23 mm</td>
<td>3.74 ± 1.64 mm</td>
</tr>
</tbody>
</table>

### FURTHER INVESTIGATION REQUIRED

- Discrepancy in VieVS estimate for 26m axis offset values before and after bearing repair
- Seasonal variation of antenna axis offset: large deviation in values for autumn months (Mar-Apr-May) compared to other months as well as large difference in values between 6 months of Spring/Summer and 6 months of Autumn/Winter for both antennas
- Station position before and after earthquake (magnitude 5.5) of 4 August 2014 occurring within 100 km from site.