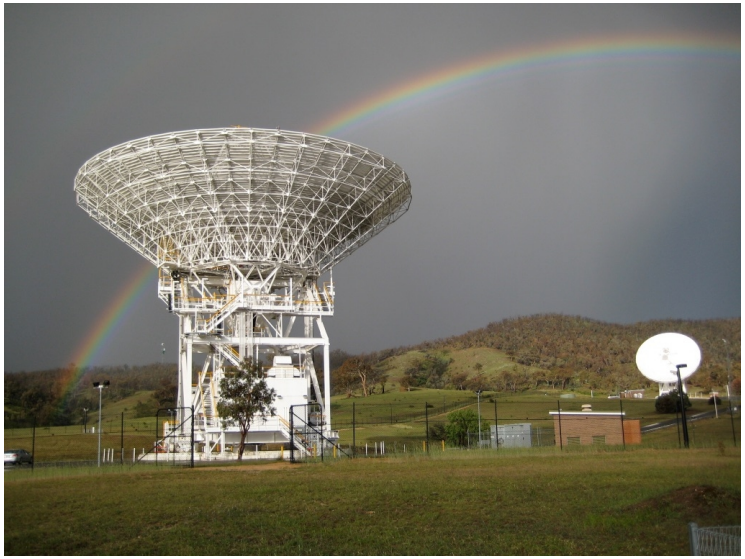
Australian Government
Geoscience Australia

Session: 3rd AOV Meeting – Canberra – November 2018

Indirect determination of the IVP of VLBI observing systems.

Ryan Ruddick



Reasons and Aim

- The integrity and strength of multi-technique reference frames, such as realisations of the International Terrestrial Reference Frame (ITRF), depend on the precisely measured and expressed local-tie connections at observatories with multiple space geodetic observing systems.

- A reference frame that is accurate to 1 mm with 0.1 mm/yr stability.

Terminology

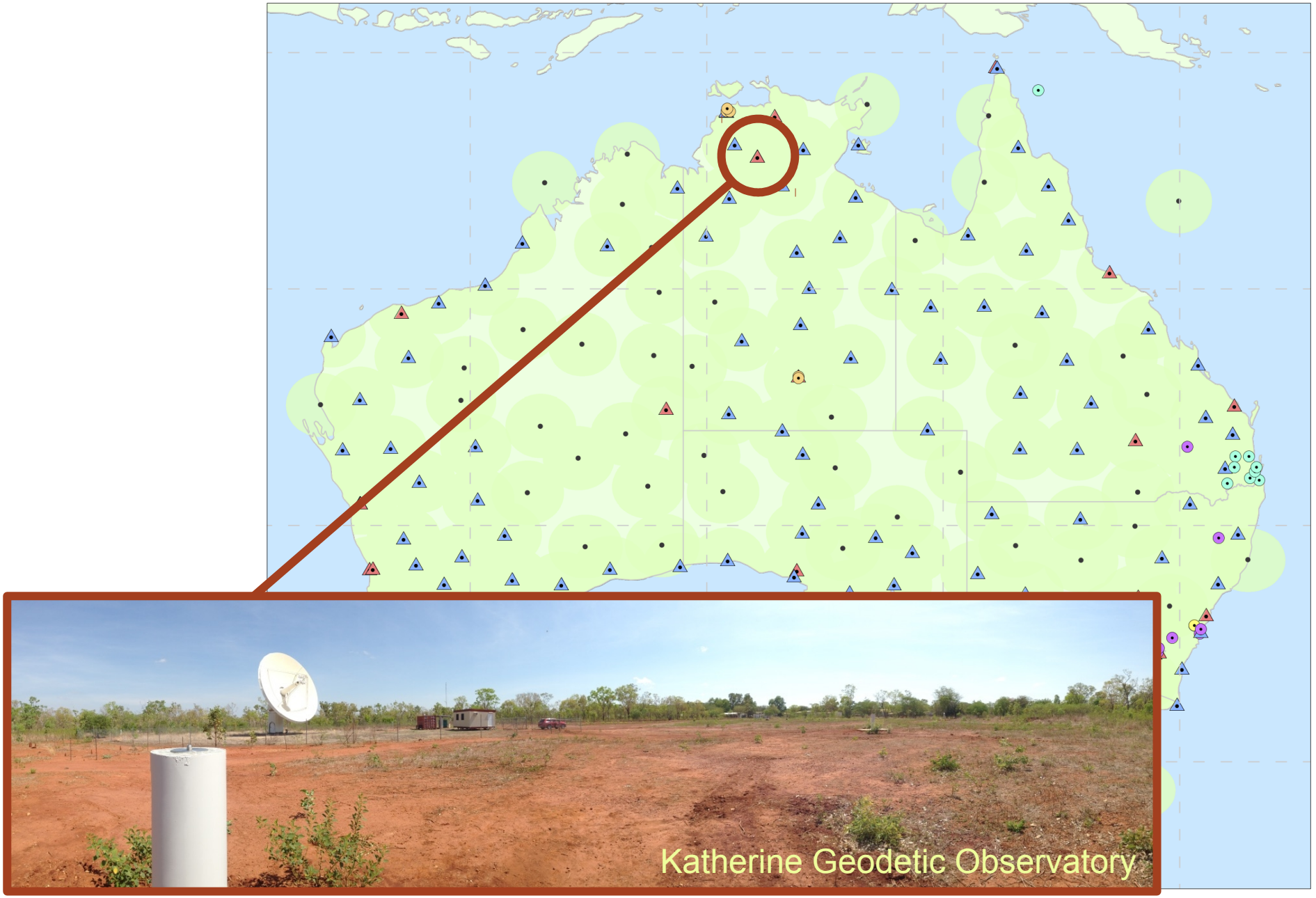
- Local ties are geometric vectors measured between reference points of different instruments, including the full covariance information in both temporal and spatial domain.

$$GRP \cup SM$$

- In this case the GRP is the system invariant point (IVP) for a standard VLBI telescope is described as the intersection of the azimuth axis with the common perpendicular of the azimuth and elevations axes.

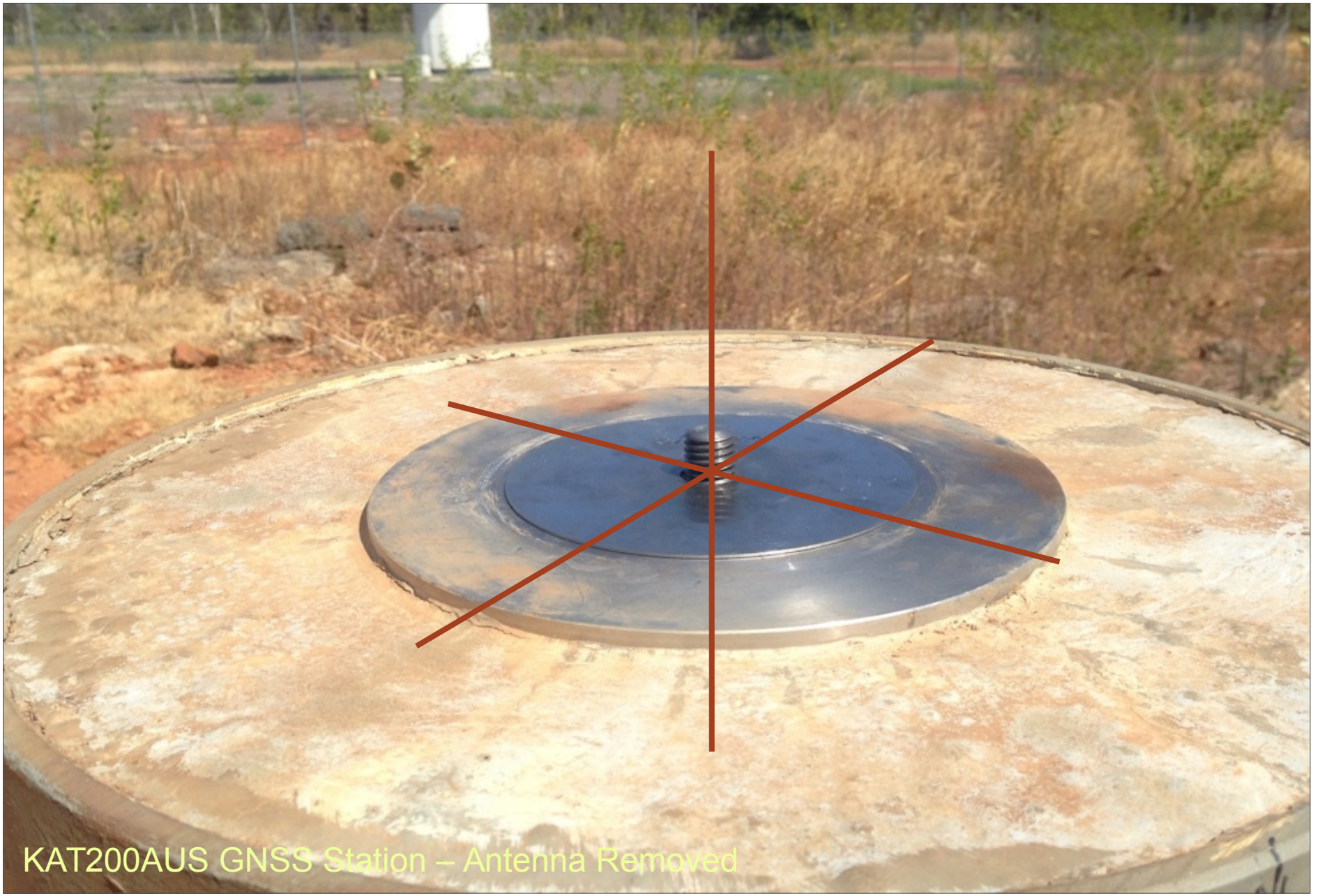
- In this case the SM is the conventional reference point of a standard GNSS antenna is the Antenna Reference Point (ARP).

Hobart 26m Telescope

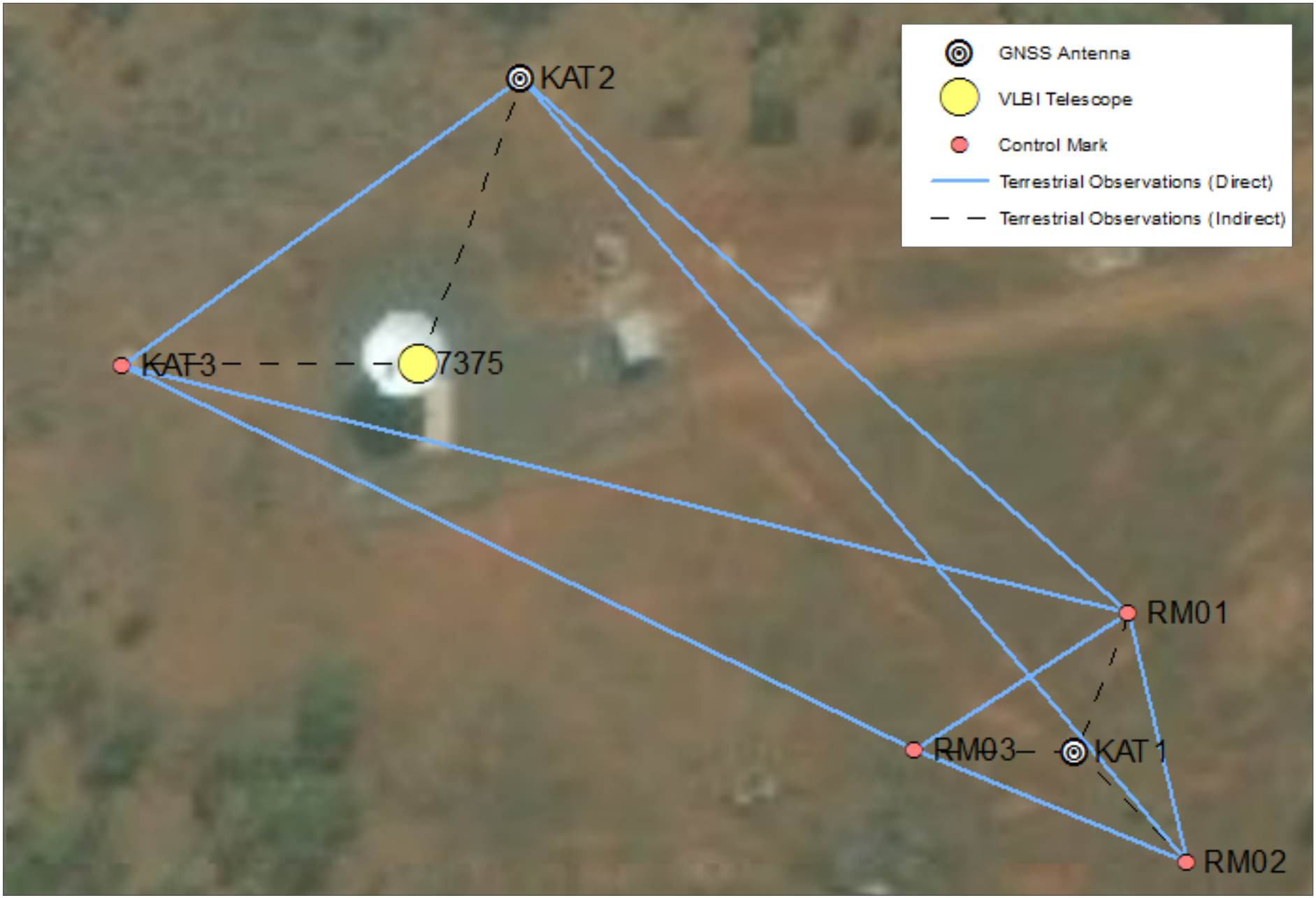


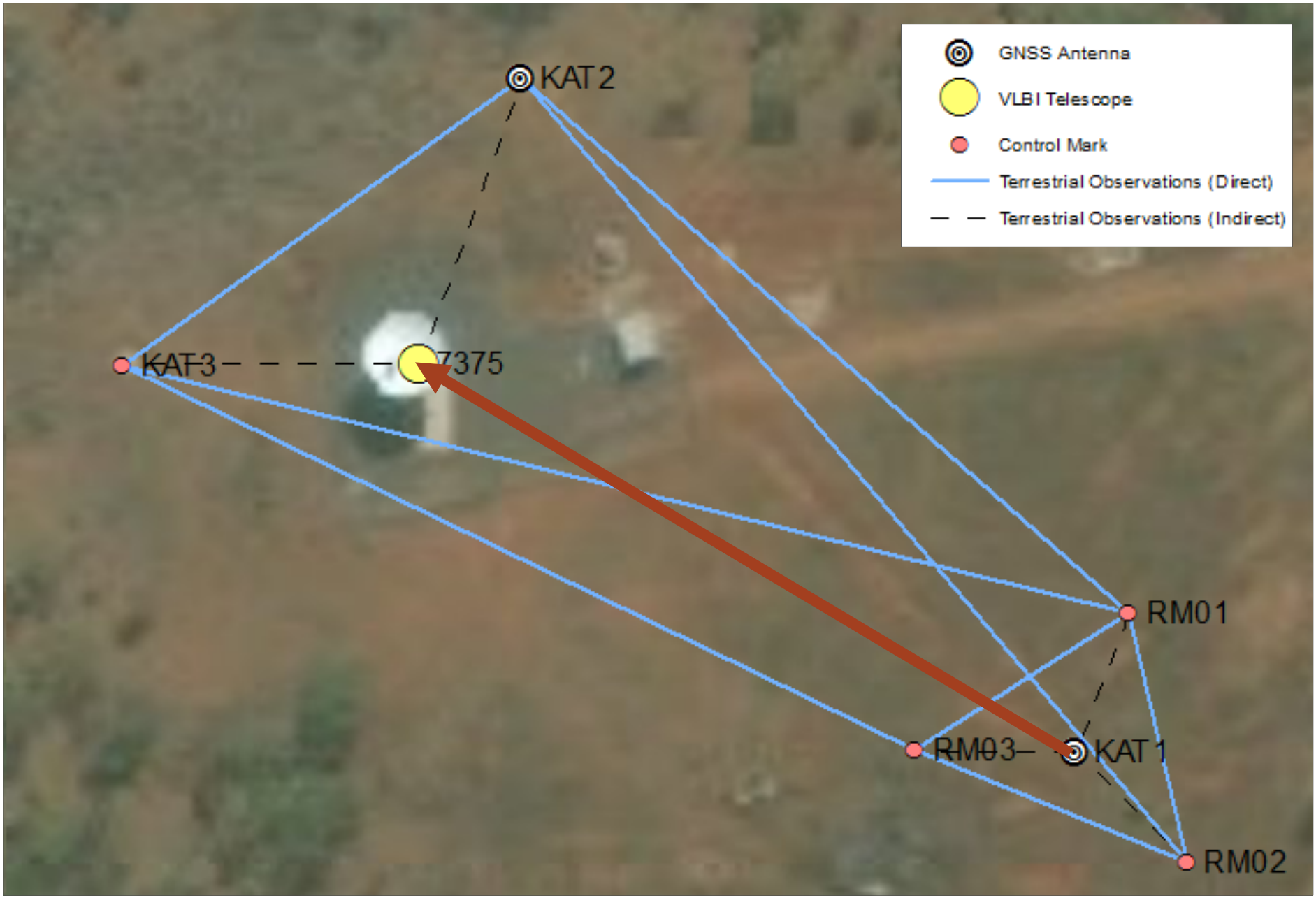
KAT100AUS GNSS Station – Radome Removed

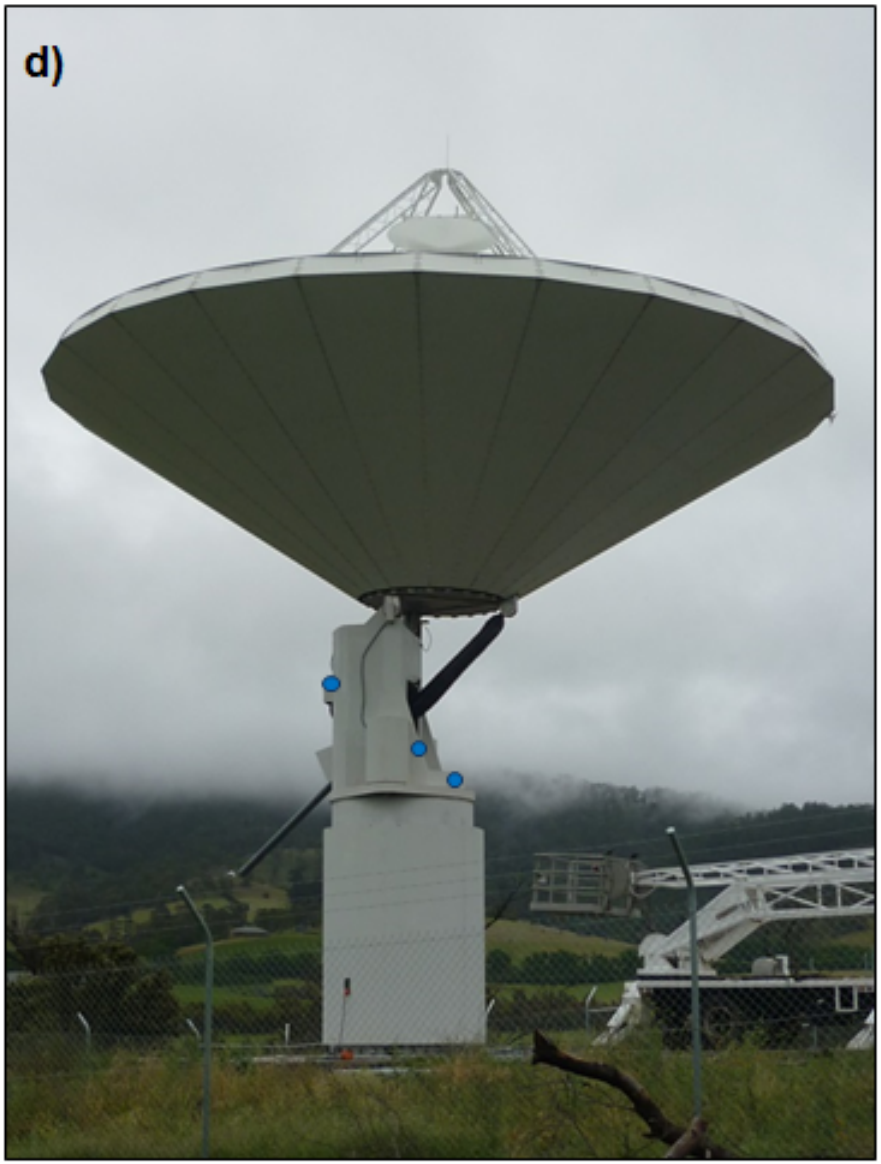
KAT200AUS GNSS Station – Antenna Removed



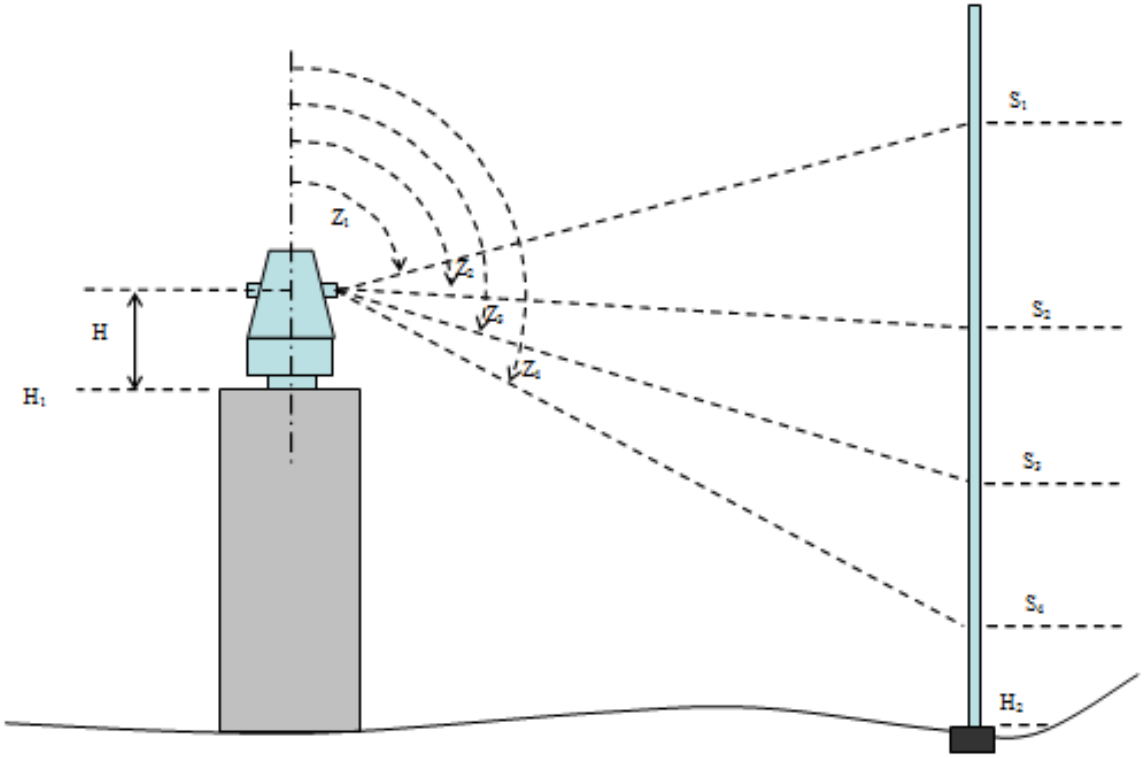
KAT200AUS GNSS Station – Antenna Removed







Determination of Instrument Height



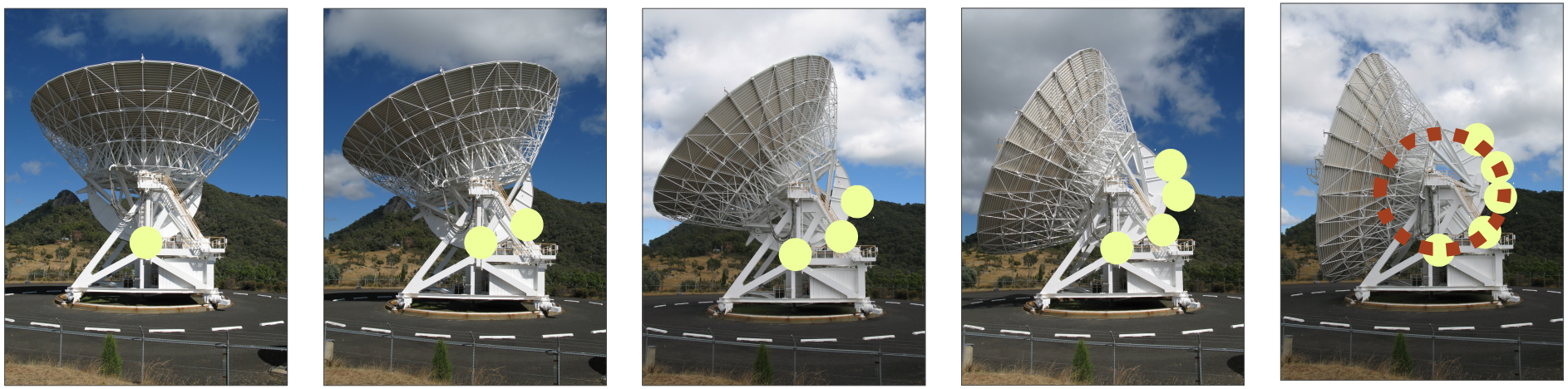
$$H = \frac{S_2 \cot Z_1 - S_1 \cot Z_2}{\cot Z_1 - \cot Z_2} - (H_1 - H_2)$$

Figure 8: *Total station instrument heighting technique, where S_n are staff readings; Z_n are zenith angles (Rueger & Brunner, 1981).*

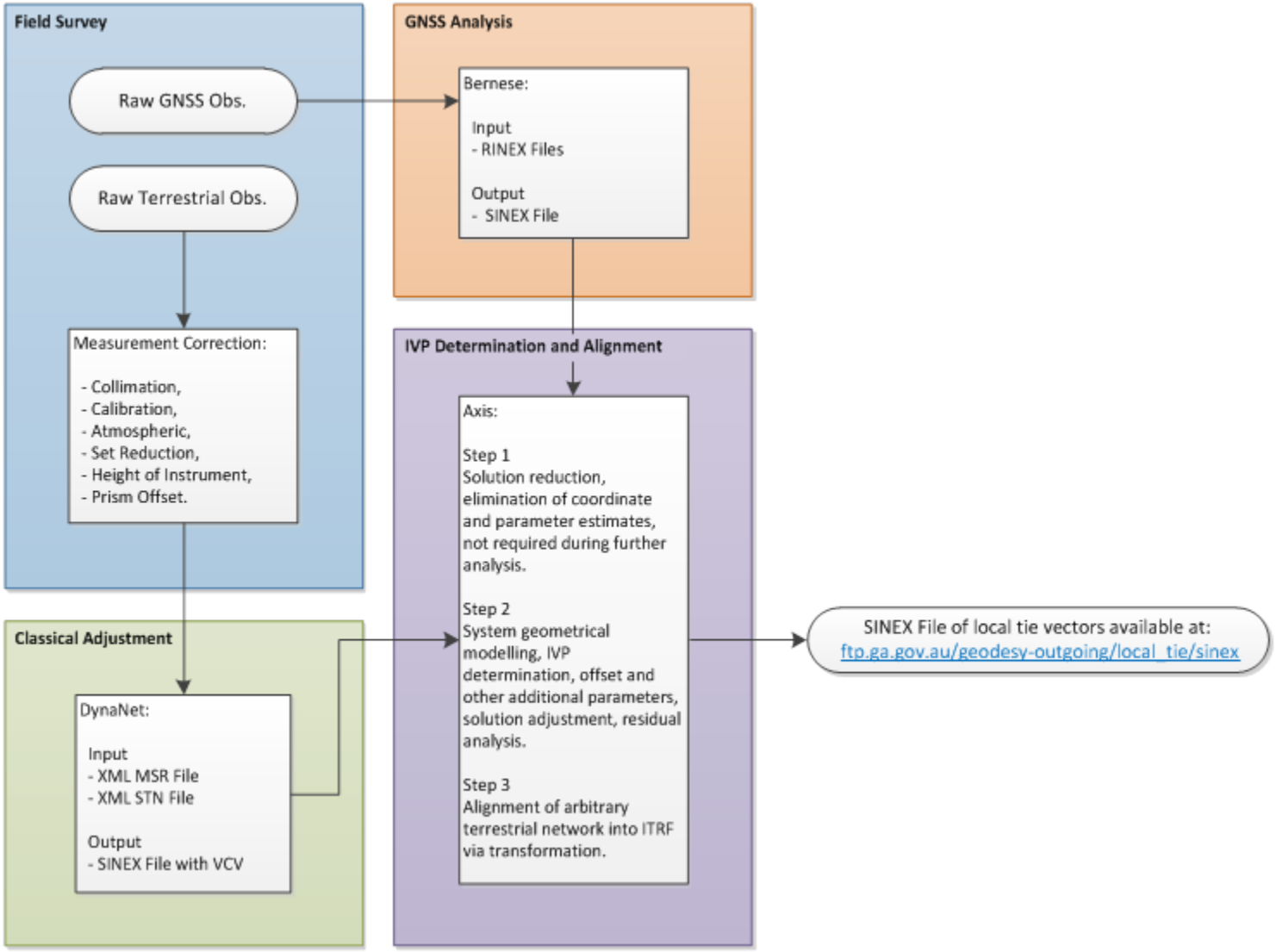
IVP Survey Technique

- Telescope moved through its full range of axis at regular increments for both azimuth and elevations axes.
- Observations are made from two standpoints.
- Targets scribe a circular arc.
- Intersect circles to determine IVP.

90º 70º 50º 30º 10º



Processing Workflow



Axis Software

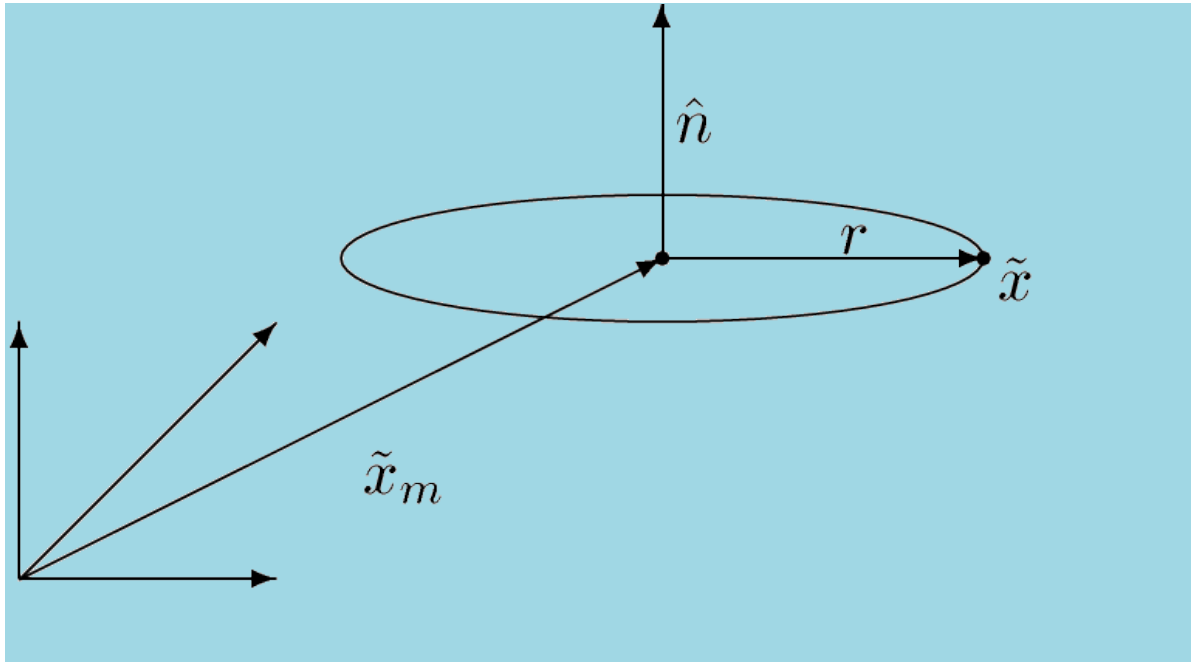
- Developed at Geoscience Australia
- ftp://ftp.ga.gov.au/geodesy-outgoing/local-tie/axis/

- Rigorous least squares analysis to determine the system IVP.
- Input adjusted targets and full VCV.
- Apply geometrical constraints to determine axes.
  a. Targets scribe a prefect circular arc.
  b. Targets observed multiple times have the same radius.
  c. Normal vectors are forced to be parallel.
  d. Circle centres are forced to lie along the same line.

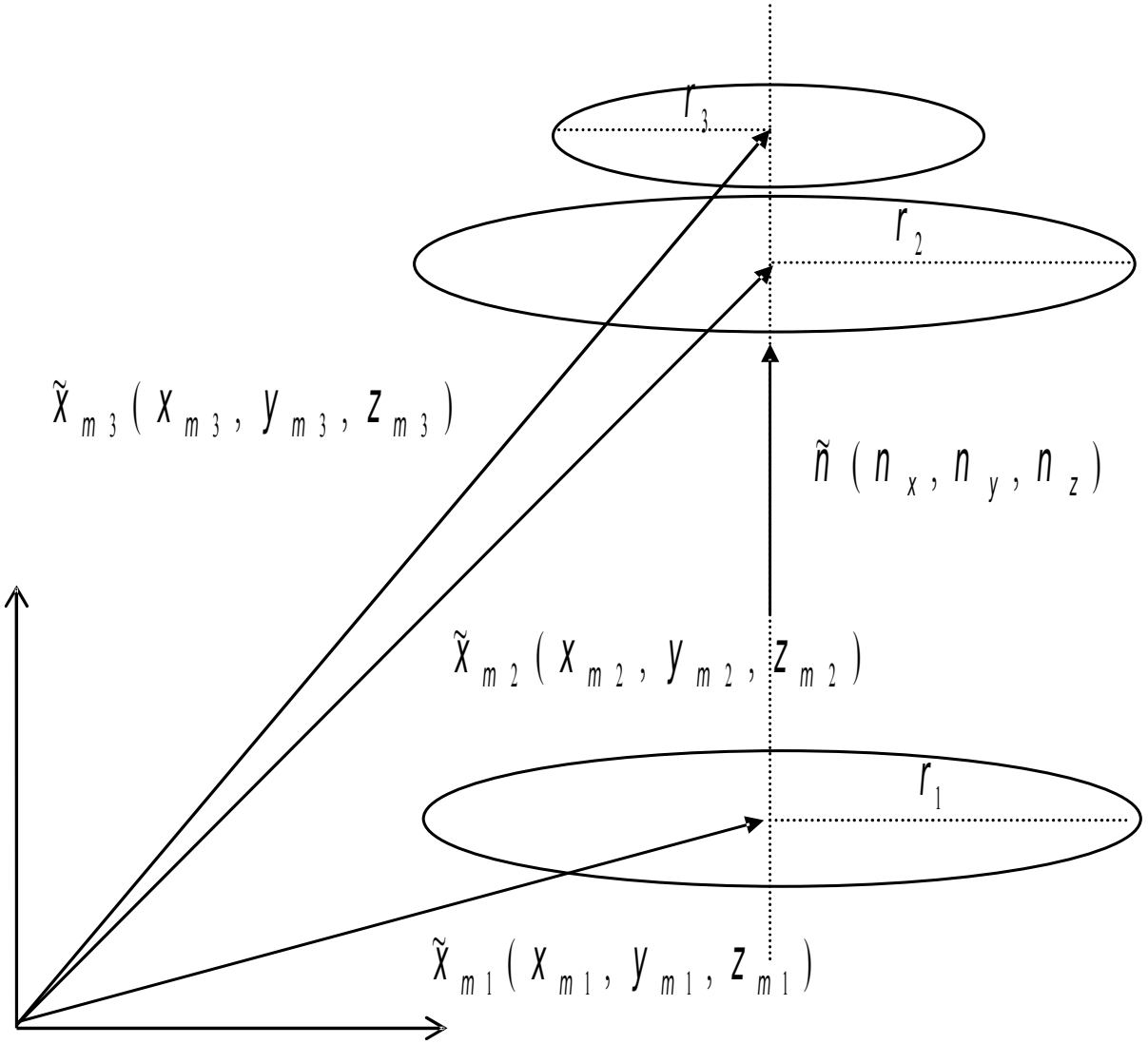
Circles

Circles are defined by 7 parameters:

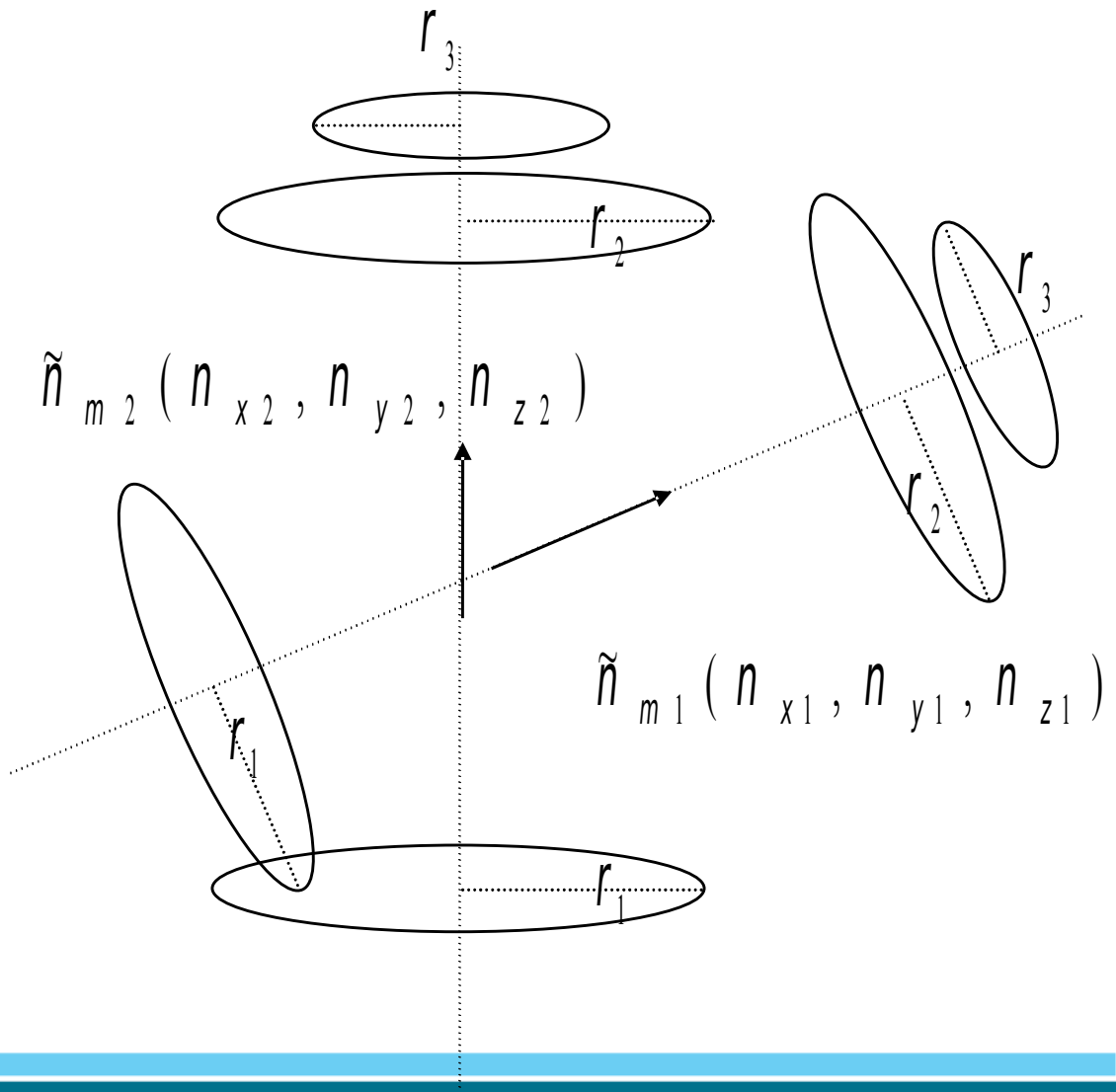
- Circle centre (3 parameters, dx, dy, dz).
- Unit normal vector (3 parameters, nx, ny, nz).
- Circle radius (1 parameter, r)



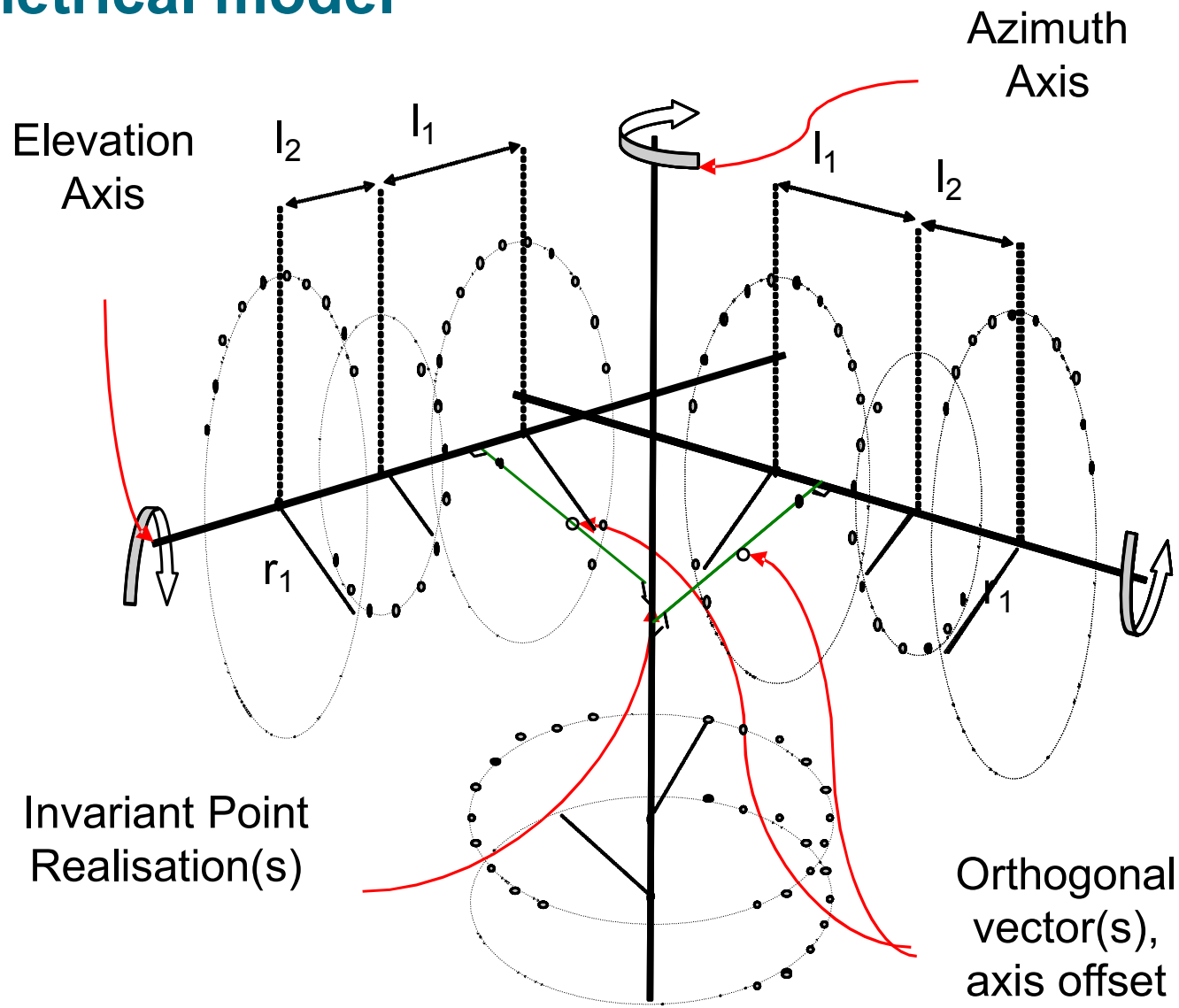
Constraint on unit normal vector

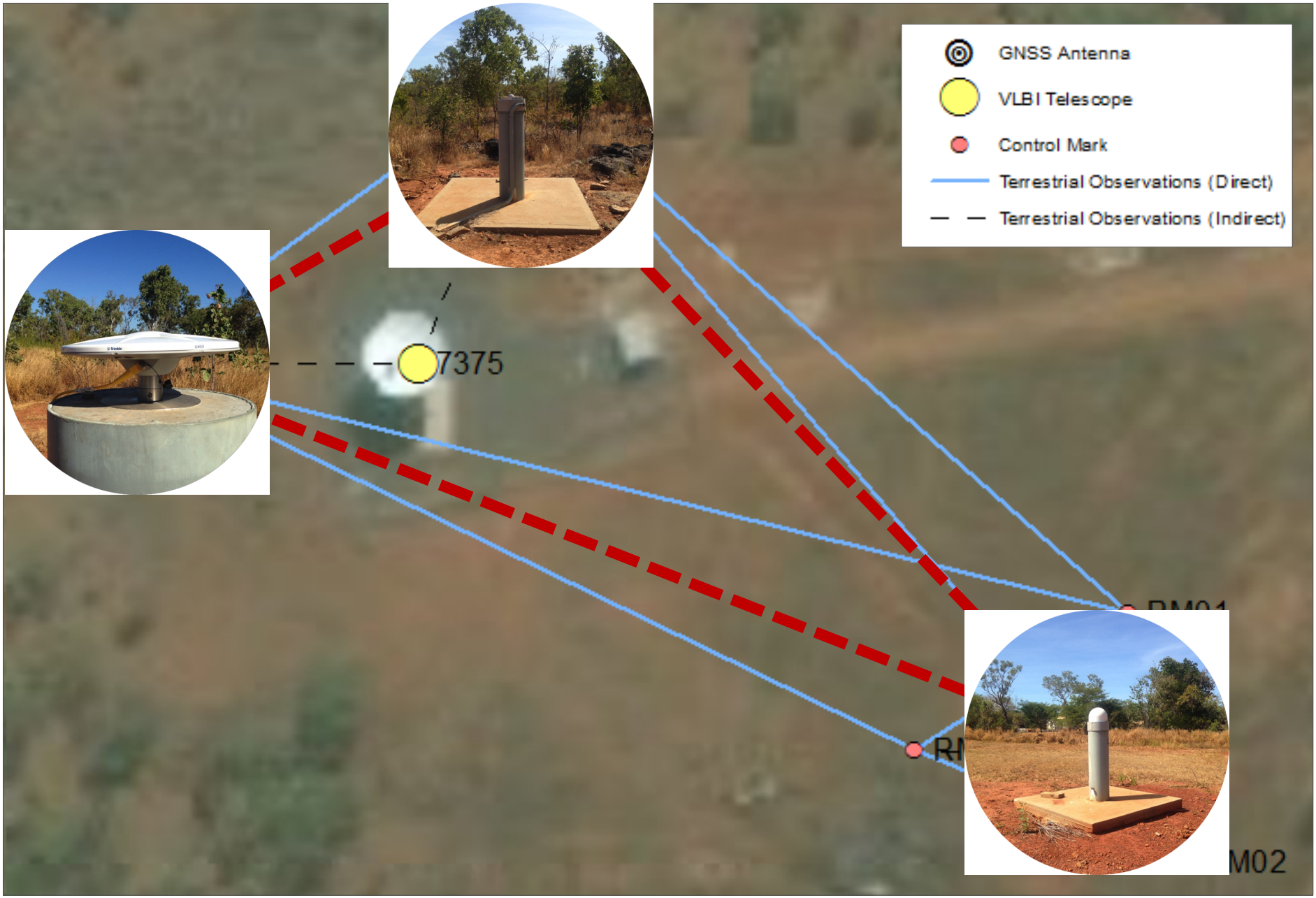


Constraint on target radius



Geometrical model





Results

KAT1 to 7375	de	dn	du
2010	97.1717	-59.3554	-4.9592
2014	97.1718	-59.3563	-4.9590
Difference	**0.1 mm**	**0.9 mm**	**0.2 mm**
ITRF2014 Discrepancy	-1.7 mm	-2.3 mm	3.9 mm

Open Questions

- Gravitational sag on the telescope.
- Thermal expansion.
- Influence of the local geoid variations.