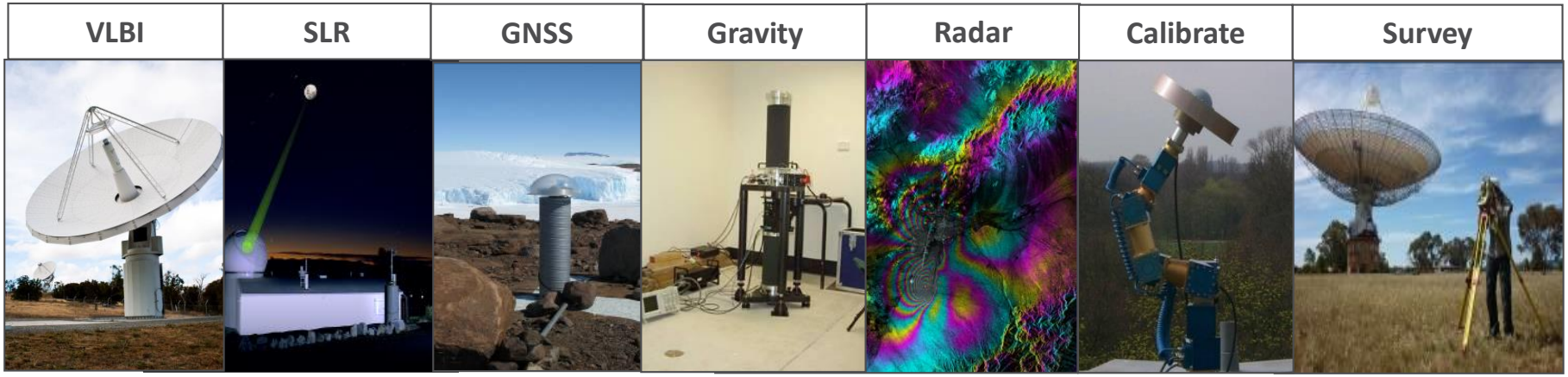
Local-Tie Survey Workflow.

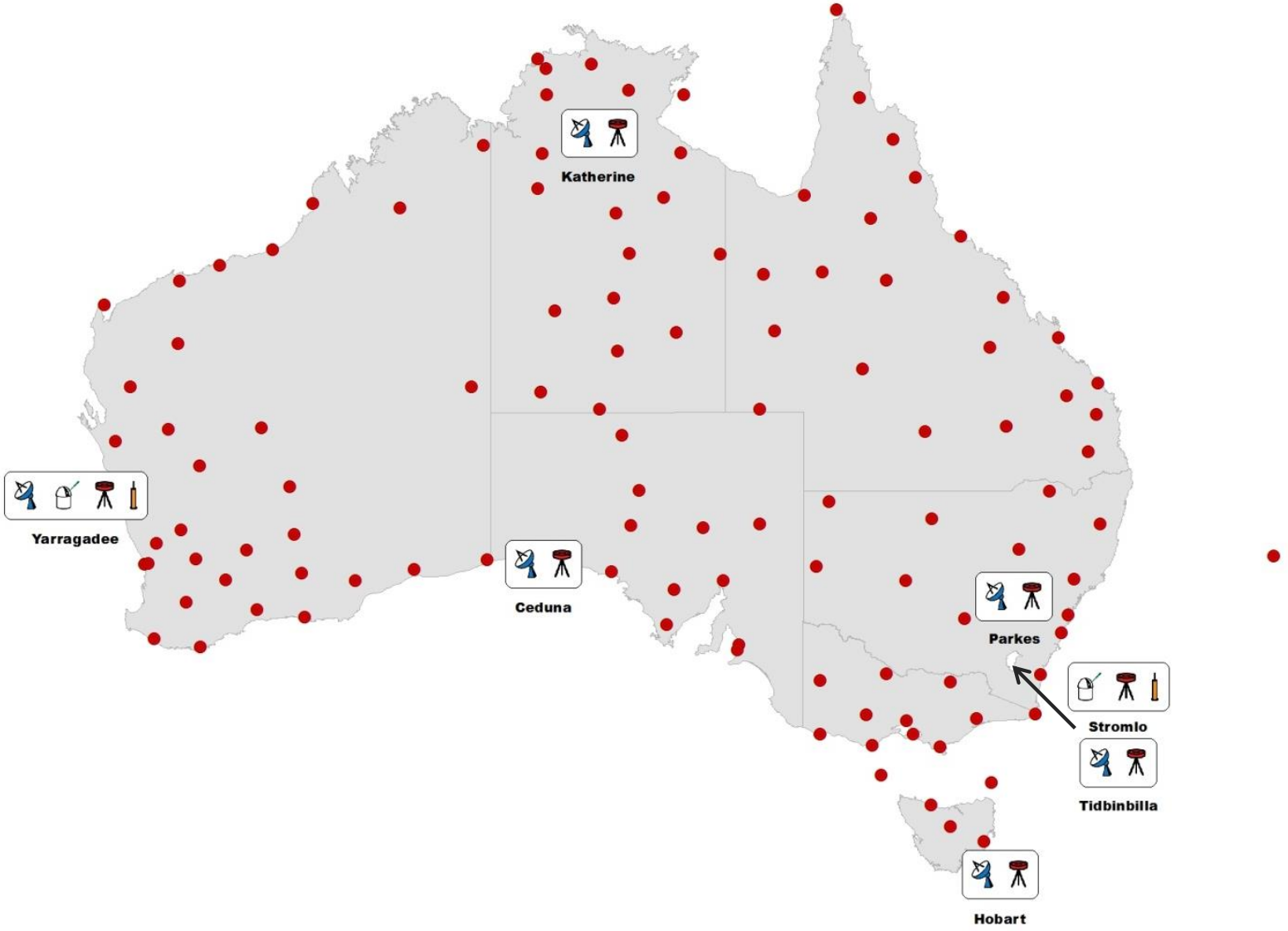
Gary Johnston, Ryan Ruddick

Geodetic Capability



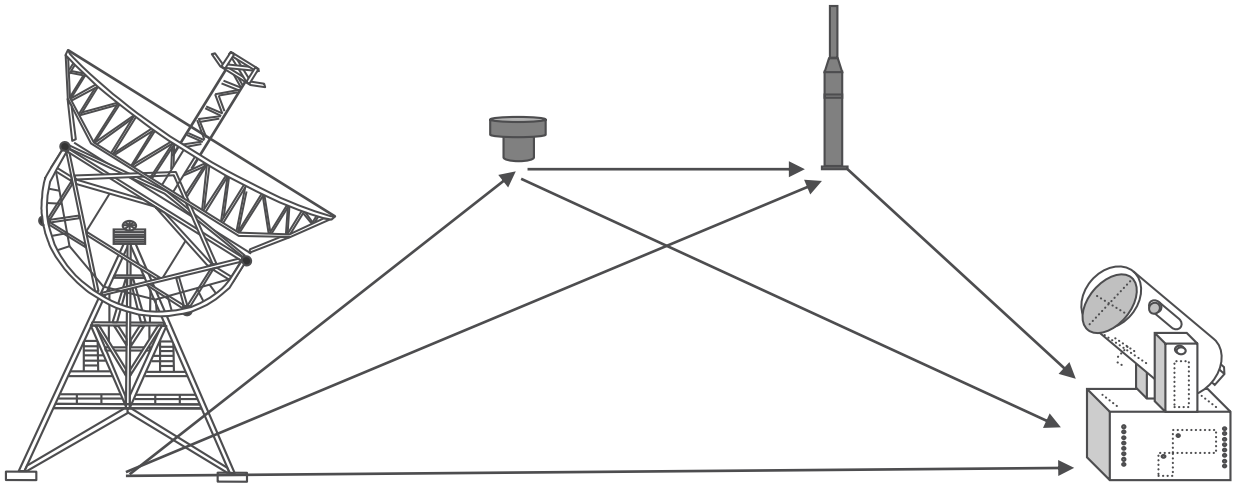
- Provides data to the International community for ITRF production
- Undertake technique and application research
- Provide national coordination
- Developing National Positioning Infrastructure
- Developing Satellite Based Augmentation System

Co-Located Observatories in Australia



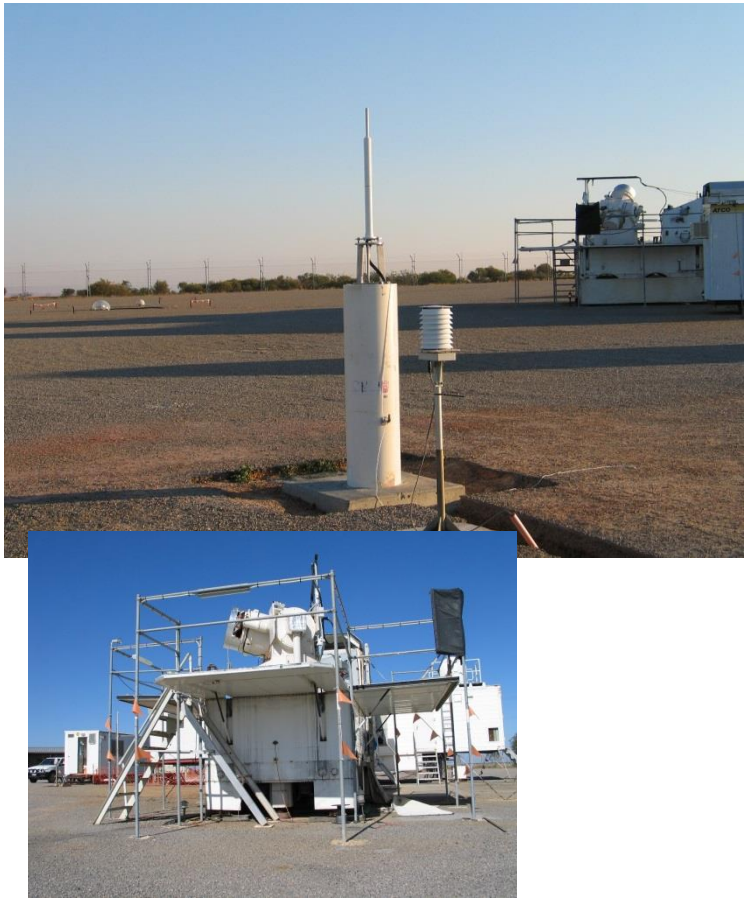
Co-located observatories

SLR and VLBI observing systems generally co-located with GPS/GLONASS, DORIS and terrestrial network survey marks



Satellite Laser Ranging Facilities

Mount Stromlo



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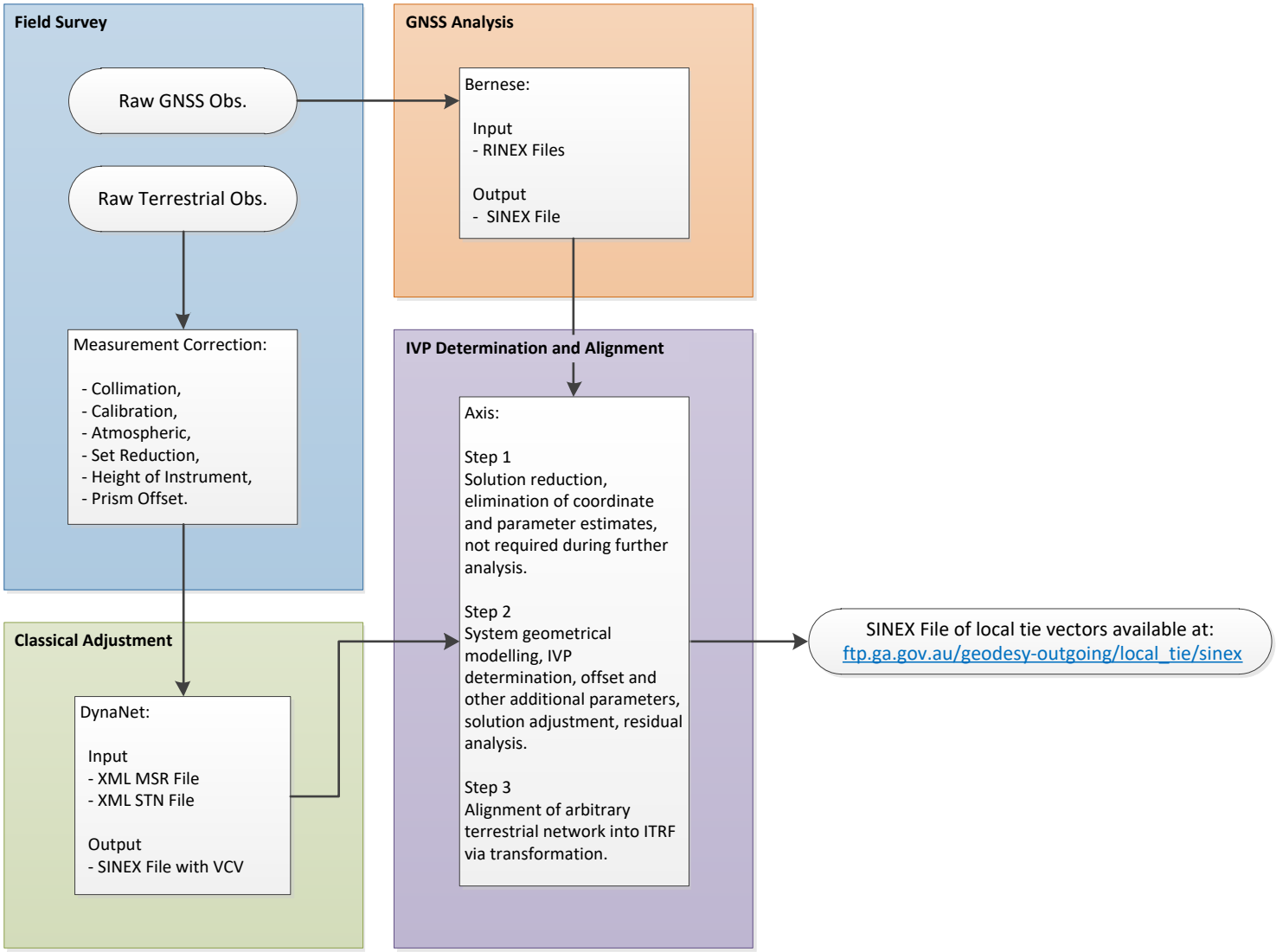
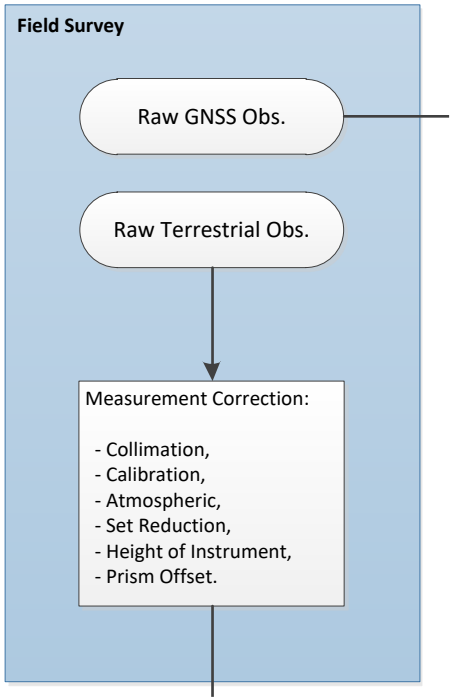
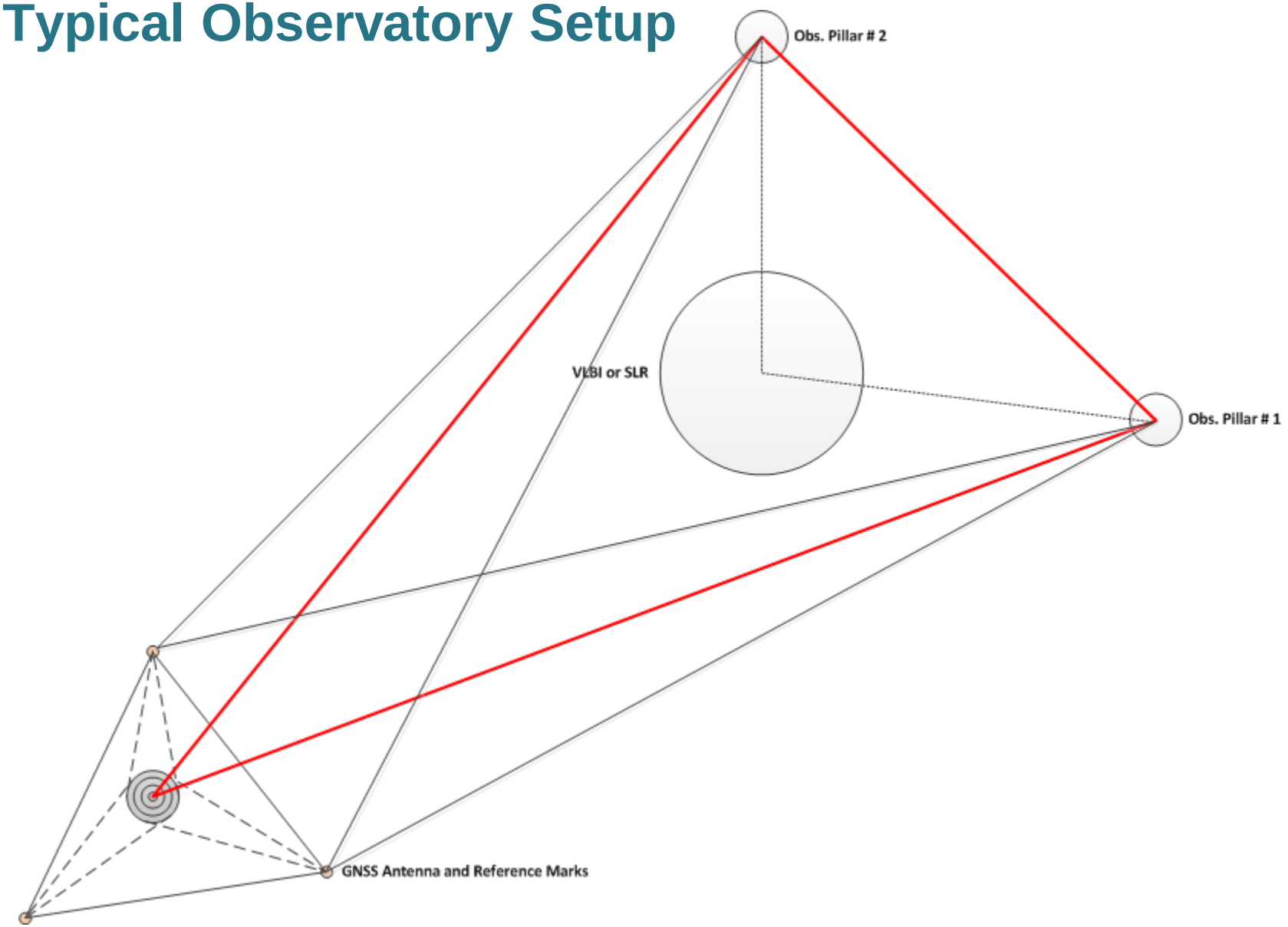
Local Tie Workflow



Field Survey



Typical Observatory Setup



Classical Adjustment (DynaNet)

- A rigorous, high performance network adjustment application,
- Specifically to estimate 3D station coordinates and uncertainties from both small and extremely large geodetic networks,
- Supports a diverse range of measurement types,
- Simultaneous (traditional) and phased adjustment modes,
- Automatic segmentation or extremely large networks in an efficient manner,
- Phased adjustments designed to use multi-core processors,
- Results achieved from phased adjustment mode are identical to simultaneous adjustment results, but estimated in a fraction of the time.

IVP survey technique

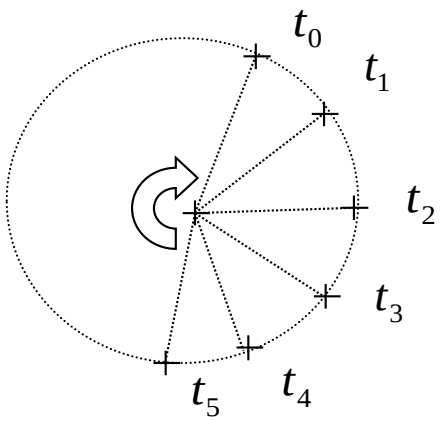
- Indirect measurement approach
- Terrestrial observations (Total station)
- Highly over-determined ground network
- Attach a number of targets on the telescope structure and observe as the telescope is moved through several rotational sequences
- Targets observed from multiple instrument stations
- Space geodetic observations (GNSS) used to align survey from local to global frame

IVP survey technique

Telescope moved through its full range of motion:

- Azimuth (held fixed in elevation)
- Elevation (held fixed in azimuth)

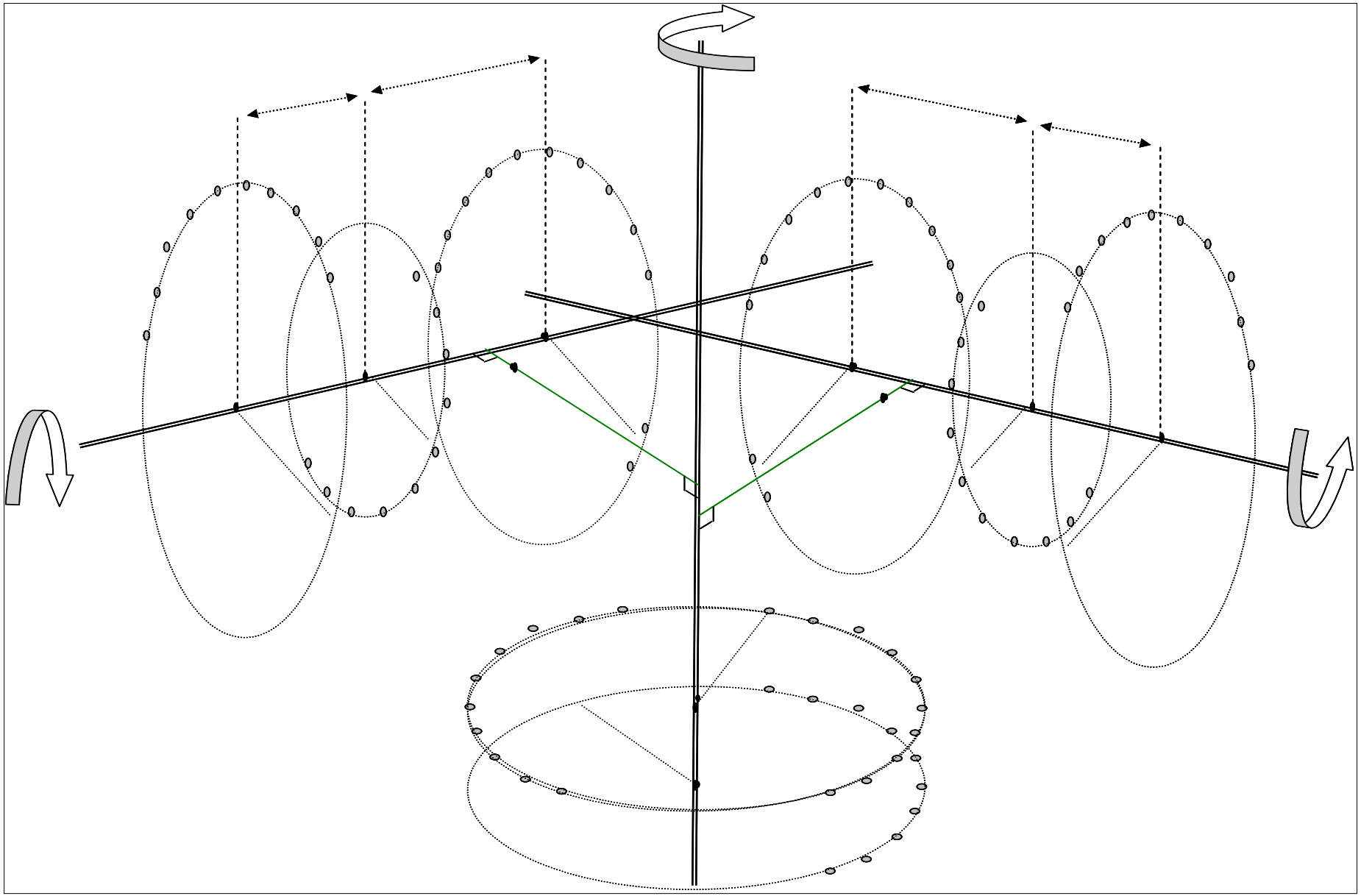
Telescope rotated at incremental steps (10º-20º)



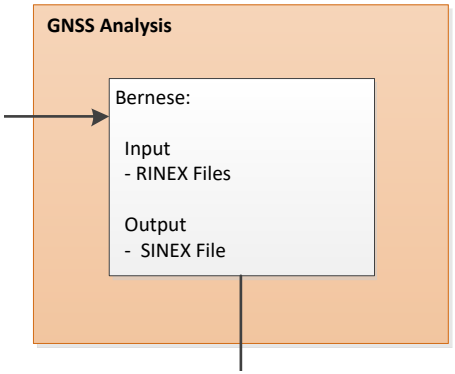
perfectly circular arc

IVP Determination (AXIS)

- Software developed at Geoscience Australia,
- Rigorous least squares analysis to determine the system IVP,
- Input adjusted target coordinates and VCV,
- Apply various geometrical models, which include:
  - Targets scribe a perfect circular arc,
  - Target observed multiple times scribes circle of equal radius,
  - Normal vectors forced to be parallel,
  - Circle centres lie along same line,
  - Offset distance between axes remains constant,
  - IVP coordinate estimates remain constant.



GNSS Analysis (Bernese)



- The GNSS observations made on the observation pillars are processed against the ITRF coordinates of the local CORS sites, generally due to the short baselines we have been using an L1 only solution.
- Results are output in a SINEX file

Time Series results

Local topocentric vectors between the fundamental reference mark (AU45 / STR2) and the SLR system IVP from the local surveys undertaken since the station was rebuilt after the fires in 2003. The most recent survey compares below the millimetre level with the previous survey. The spread between all of the surveys is better than 2 mm.

AU45 to …	East	North	Up	Vector	Model
7825	-24.9530	2.0063	2.4991	GNSS → SLR	2014
7825	-24.9531	2.0066	2.4997	GNSS → SLR	2009
7825	-24.9523	2.0069	2.5005	GNSS → SLR	2006
7825	-24.9541	2.0069	2.4984	GNSS → SLR	2003

Local topocentric vectors between the fundamental reference mark (AU45 / STR2) and the DORIS reference mark from the local surveys undertaken since the station was rebuilt after the fires in 2003. The most recent survey compares at the millimetre level with the previous survey. The spread between all of the surveys is better than 2 mm. The DORIS beacon was changed before the 2006 survey was undertaken.

AU45 to …	East	North	Up	Vector	Model
MSPB	-15.8572	6.1394	2.4305	GNSS → DORIS	2014
MSPB	-15.8578	6.1399	2.4314	GNSS → DORIS	2009
MSPB	-15.8569	6.1419	2.4327	GNSS → DORIS	2006
MSPB	-15.8559	6.1438	2.4380	GNSS → DORIS	2003

Future Improvements

- Improved alignment of surveys to the global reference frame
- Better Management of Survey epoch vs ITRF reference epoch
- Complete re-observation program over coming years

Technique Improvements

- Structural (gravitational sag) and thermal deformation models on Radio Telescopes
- Multi GNSS antenna calibrations using Robot
- In-situ Calibration of GNSS Antenna
- SLR bias estimation

Conclusion

- Inter-technique local ties are a key contribution to ITRF development
- Survey technique is well developed and relatively easy to undertake
- Repeatability ~ 2mm easily achieved
- Technique specific biases appear to be the main contributor to remaining error
- SLR systems should be designed with Reflector mount engineered into the telescope.
- Collocated observatories should be designed with instrument standpoints built in the correct places