GEODETIC ACTIVITIES AT UTAS AND CORRELATOR REQUIREMENTS

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AuScope VLBI

- AuScope VLBI network with the busiest geodetic antennas worldwide (235 experiments in 2015)
- 26m legacy antenna Ho
- AUSTRAL observing program
- Fully independent, from scheduling to analysis
BETTER RESULTS IN THE SOUTH

Baseline lengths from IVS R1 & R4 sessions [Plank et al., Adv Space Res 2015]

2012/1-2013/6

WRMS [mm]

length of baseline $10^3$ km
The addition of more southern stations has significantly improved the results!
AUSTRALS

Experiments with the AuScope array (Hb, Ke, Yg)
- Plus Ww, Ht, (Ho, Hh)
- 2011-2015: Aust02-74, AUST13, AUST14, AUST15/1, AUST15/2, AUG001-019, AUA001-008 → 160 sessions

Scheduling @ Vienna University of Technology

1 Gbps recording

Correlation @ Curtin University

Pre-analysis @ UTAS (fringe-fitting, Level1 DB)
Australas: Science

- Pre-VGOS observing
  - High recording rate, small and fast antennas
  - Remote operations, towards 24/7
  - Data logistics
- Scheduling
- Geodesy: improved baselines
- Astrometry: new sources, more sources
- Relativity
- Siblings (Hb+Ho, Ht+Hh)
SCHEDULING

- 1 Gbps (16x16 MHz IFs and 2-bit digitisation)
- 2 sub-networks
- Only strong sources (>0.8 Jy) – VieVS simulations
- Latest antenna SEFD levels
- 20” min. scan lengths
- Shorten ‘calibration time’

Results show a factor of ~2 improvement in baseline wrms.

[Lovell et al., Proc EVGA 2015]
INSTRUMENTAL EFFECTS?

- We have plenty of data which can now be studied
- E.g. instrumental effects on Tsys (J.F. Gruber)

X-band Tsys measurements of Hobart12 during the Austral experiments: jump coincides with recabelling event.
AUSTRAL ANALYSIS

- works for standard s/x.
Dynamic (VGOS) Observing

- Goal: more flexibility in the scheduling and adjustment to actual antenna capabilities

Simulation scenario:
Change in baseline repeatabilities when all observations of Hartrao are lost between

a) the original schedule is observed
b) the schedule was redone
**Dynamic Observing**

- Real time correlation?
- Regular (automated) fringe check
- Actual power levels / SEFDS
SIBLING TELESCOPE

Sibling Radio Telescopes for Geodesy:
Optimising the use of co-located VLBI telescopes in the southern hemisphere

How to operate a twin/sibling telescope? — scheduling!

Linking legacy and VGOS antennas

Improved analysis through common parameters
Sibling Radio Telescopes for Geodesy:
Optimising the use of co-located VLBI telescopes in the southern hemisphere
IONOSPHERE DISCREPANCIES

Cont14 / aust65:

- Huge (10 ns) discrepancies on Hb-Ho baseline (local RFI)
- Comparing redundant observations (Hb-Ke vs. Ho-Ke):
  - Large offsets (ambiguities ?)
  - 1 cm rms (30 ps)
  - Daily signal?

Difference in the ionospheric delays (ngs-files) of redundant observations to Hb & Ho.
HOBART TIE

The Hobart-Hobart baseline determined of 72 common VLBI sessions. The black line shows the mean calculated baseline length of 295.914 m, which is 4 mm off from the baseline determined in two local tie surveys.

[Plank et al., Proc EVGA 2015]
ANALYSIS

- New analysis options implemented in VieVS
- Combining zwd & gradients, clocks, station coordinates.
ANALYSIS

- New analysis options implemented in VieVS
- Combining zwd & gradients, clocks, station coordinates.

Improvements in baseline lengths of Cont14 when common parameters are constrained in the analysis.
Account for analysis of co-located antennas earlier?

- At the correlation level?
- In fringe fitting?

Twins should have same ambiguities.

Daily signal in ionosphere?
INTER-TECHNIQUE TIES

- High cadence time series (2011-2015) allows for a unique comparison between VLBI and GNSS baselines
- Inter-technique ties are a major issue for the ITRF
Discrepancies (radial, east, up) in the local tie between Yg (VLBI) and YAR3 (GPS).

- High consistency between sessions & networks (4-10 mm rms).
- We find systematic discrepancies of a few mm between local tie measurements and geodetic results.
**QUASAR STRUCTURE**

- Source structure simulator *(Shabala et al. JoG 2015)*
- Systematic displacements of several tens of μas, exceed tropospheric errors *(Plank et al. MNRAS 2015)*
- SI=3,4:
  Larger displacement for stronger secondary component close by.

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**Figure 5.** Simulated median source position offsets $d$ due to source structure using various two-component source models with nominal structure indices SI=2, 3, and 4 and a relative brightness of the second component between 0.05 and 0.35 of the main component. These are structure-only simulations.
**Source Structure**

- Amplitude versus frequency
  - For VGOS, the spectral index is important.
VLBI Satellite Tracking

- ‘Proof of concept’
- Single baseline
- L-band receivers
- GPS & GLONASS satellites
- 3 successful sessions (2-4 hours)
- From scheduling to analysis
SATELLITE TRACKING – HIGHLIGHTS:

- Combined scheduling (station-dependent vex-files) to satellites and quasars \( (A. \text{Hellerschmied, Vienna}) \)
- Correlation with DiFX, a priori model from VieVS \( (\text{Plank et al., JoG 2014}) \)
- Fringe fitting in AIPS
- Fringes in all 4 channels (GPS resp. GLONASS L1, L2)
- 5-30 ps rms over 5 minutes (per scan)
- Residuals +/- 10 ns at the moment (improvable)
Satellite Tracking

- **Flexibility in a priori model**
  - Detour via .im-files produced by calc
  - What is written there?
  - Moving source (satellite)?
- **Satellite model in DiFX?**
- **Visibility output into fourfit?**
- **Total delays?**
- **Time epoch?**
AREAS OF VLBI RESEARCH @ UTAS

- Future operations: towards VGOS
- AUSTRAL observing program:
  - Fully independent observing program.
  - Improvements through smart scheduling.
- Dynamic Observing
- Sibling telescopes
  - VGOS-legacy link
  - Sibling/Twin scheduling
  - Improved analysis
- Intra- & Inter-technique frame ties (VLBI & GNSS)
- Quasar structure
- VLBI satellite tracking in L-band
IVS

- VDIF -vsi=geo
- Get rid of difx2mark4
- WG: “future VGOS correlators
  - How fast?
  - “Seamless correlation process with minimum human intervention”
- Flexibility in pre-analysis steps (fourfit etc)
THANK YOU FOR YOUR ATTENTION!