New Zealand VLBI Developments

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1’st VLBI Technical Workshop
Haystack October 2012
Radio Astronomical Observatory
Warkworth New Zealand
The Hobo-Dyer Equal Area Projection

This map belongs to the family of Cylindrical Equal Area projections in which the rectangle and meridians form a rectangular grid. Other projections in this family include the Lambert, Gall, Behrmann, Eackward, and Peters projections. In the present case, the "spindles" is assumed to wrap around the globe and cut through it at 45° north and south. In order to preserve the equal area property the shapes of the landmasses become progressively flattened towards the poles, but shapes between 45° north and south are well preserved.
- Diameter: 12.1 m
- Manufacturer: Patriot/Cobham
- Shaped Cassegrain
- Slewing: 5 deg/s Az
  1 deg/s El
- Surface: 0.35 mm (rms)
- Receivers/feeds
  - S/X (dual circular pols)
  - L (1.1-1.8 GHz; prime focus)
- H-maser (Symmetricom MH2010)
- Mk5B+ , Mk5C
- DBBC 2 (4 IFs)
- 1 Gbps network connectivity
L Band Feed

• Designed and manufactured by Intertronic Solutions Canada – Peter Shields / Bill Imbriale

• Prime focus – have to remove subreflector to use
L Band Feed
Direct sky frequency to DBBC
Integration of DBBC with Field System

- DBBC digitised channel power measurements fed back to Field System pointing model
- DBBC channel/IF configuration integration with Field System completed
- Thanks to Ed Himwich
PositionNZ is LINZ’s Global Positioning System Active Control Network. Through this site you can download GPS 30 second RINEX files from the active control stations which you can use with remote GPS station data to determine precise positions in terms of New Zealand Geodetic Datum 2000. More

PositionNZ-RT – real-time data streams
Find out how to access real-time data from PositionNZ stations. more...

Text only version

Daily solutions for WARK

<table>
<thead>
<tr>
<th>East</th>
<th>North</th>
<th>Up</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
<td><img src="image3.png" alt="Graph" /></td>
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GPS coordinates and Telescope survey

- Determination of VLBI reference point
- PositioNZ: WARK
- RTK GPS

\[
\begin{align*}
X &= -5115324.5 \pm 0.1 \text{ m} \\
Y &= 477843.3 \pm 0.1 \text{ m} \\
Z &= -3767193.0 \pm 0.1 \text{ m}
\end{align*}
\]

- New survey Dec 2012
30 Metre – undergoing conversion

**Specs:**

Beam-waveguide cassegrain

Azimuth range: +/- 175 deg
(upgrade to +/- 270 deg)

Elevation range: 0 to 90 degrees

Slewing rate: 0.3 deg/s (both El and Az)

Surface: 0.6 mm \textit{rms}
Control system developed by Mark Godwin

Up-rated version of 12m Patriot Controller

COTS – Emerson Control Techniques
30 M optics + geometry

Figure 3-1. Cassegrain Antenna Geometry
Figure 1-1. Four-Reflector Primary Feed (YP-15412)
Frequency Standard distribution

300 m single mode fibre
Maser reference distribution over Single-mode fibre

Symmetricom 5115A Phase Noise tester

Fibre loop
The dead end!
Experimental Phase Cal
Frequency Standard

- Hydrogen Maser:
  Symmetricom MH2010
  - 5, 10, 100 MHz outputs
  - Allan deviation
    1s       2.0E-13
    1000s    3.2E-15
    Floor    3.0E-15

- Temperature stabilised room:
  currently system holds temperature to within 1 deg C

- Some signs of thermal instability from analysis of VLBI to Kashima 11m – Hiroshi Takiguchi
S/X Receiver

• Room temperature uncooled design
• SEFD – Single dish measures
  – ≈ 3600 Jy @ S Band
  – ≈ 4000 Jy @ X Band
Digitiser + Recorders

- Data recorders:
  - Mk 5 B+
  - Mk 5 C

- DBBC
  - 512 Mbps / 1024 Mbps
KAREN – Kiwi Advanced Research and Education Network

- 10 Gbps backbone linking Universities and Crown research Institutes
- 1 Gbps International connectivity to Australia and US as of Oct 2010
In 2011 eVLBI via KAREN has been demonstrated on several occasions, most recently for SKA 2011 in July this year. The AUT 12m antenna was one of six telescopes in this demonstration.

Sustained data rates of 512 Gb/s were achieved from Warkworth for real-time correlation.
KAREN connectivity

- Southern Cross Cables:
  - NZ – Australia: 2 Tbps
  - NZ – USA: 2 Tbps

- KAREN: Kiwi Advanced Research and Education Network
  - Inside NZ: 10 Gbps
  - NZ – Australia: 1 Gbps
  - NZ – USA: 1 Gbps

- Warkworth Observatory GigaPoP: connection to KAREN at 1 Gbps
KAREN connectivity - the future

- 2012: 10 Gbps
- 2014: 40 Gbps
- 2017: 80 Gbps
- 2022: 160 Gbps
Collaboration with Japan

• Establishment of the geodetic experiment environment
  – Ultra-rapid EOP measurement
  – Experimental PhaseCal thanks to NICT Kashima

Baseline length
Ww-Ts 8,105 km
Ww-K1 8,075 km

Ww-K1 (2012/4/17)
8,075.003546 km

Correlation processing
Bandwidth synthesizing
Data analysis
Primary surface alignment

- Surface alignment conducted by photogrammetric testing; rms ≈ 0.35 mm
- Plan RF holography on surface in future to confirm the photogrammetry results and further refine if possible