



***New Zealand* eVLBI**

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Johannesburg

1/80



Radio Astronomical Observatory at Warkworth



New Zealand's North Island

Aotea Knoll

AUT Radio Telescope

Ohena Ridge

Auckland

Rotorua

North Island

Wellington



Warkworth

Radio quiet zone

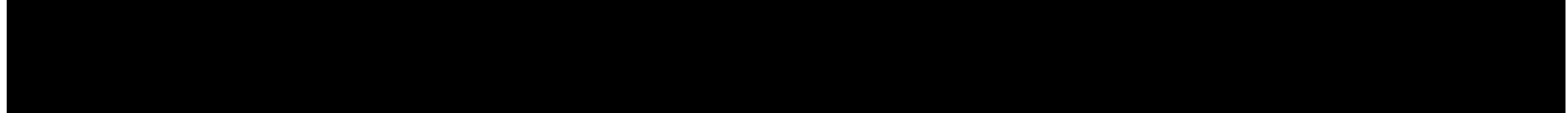
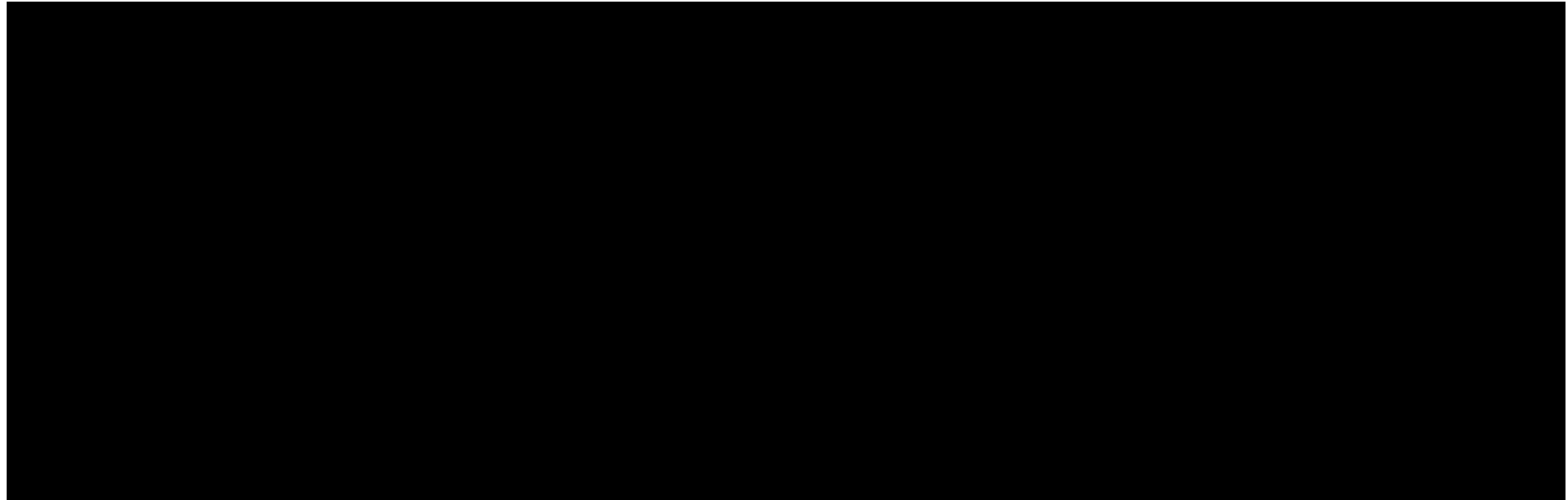
AUT Radio Telescope





GPS
Base
station





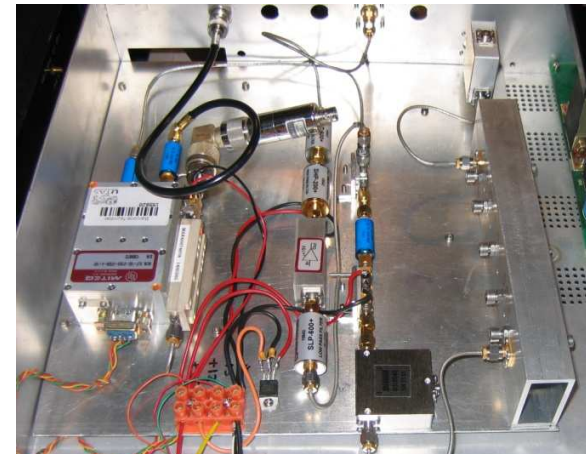
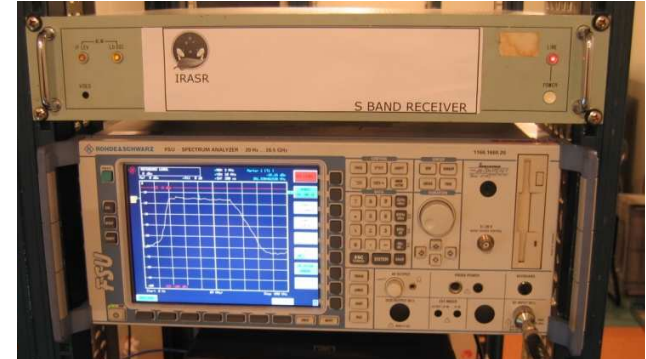




- Diameter: 12.1 m
- Manufacturer: Patriot/Cobham
- Shaped Cassegrain
- Slewing: 5 deg/s Az
1 deg/s El
- Surface: 0.35 mm (rms)
- Bands: S/X dual polarisation;
L-band ATNF feed +
Curtin recorder
New Prime focus L band feed
in design phase
- H-maser (Symmetricom MH2010)
- Mk5B+ , Mk5C:
- DBBC
- 1 Gbps International Connectivity

S/X Receiver

- Room temperature uncooled design
- SEFD – Single dish measures
 - ≈ 4000 Jy @ S Band
 - ≈ 4500 Jy @ X Band
- Thanks to Peter McCulloch and UTAS for generous assistance with receiver development!



L Band Receiver

- ATNF supplied feed and receiver (Tasso).
Feed mounted at secondary focus
- Used for first observations with ASKAP 2010
and e-VLBI June 2011
- Recorder developed by Curtin used in first
ASKAP observations (Steven and Bruce)
- New Prime focus L band feed in design,
operational 1st quarter 2012

Frequency Standard

- Hydrogen Maser:
Symmetricom MH2010
 - 5, 10, 100 MHz outputs
 - Allan deviation

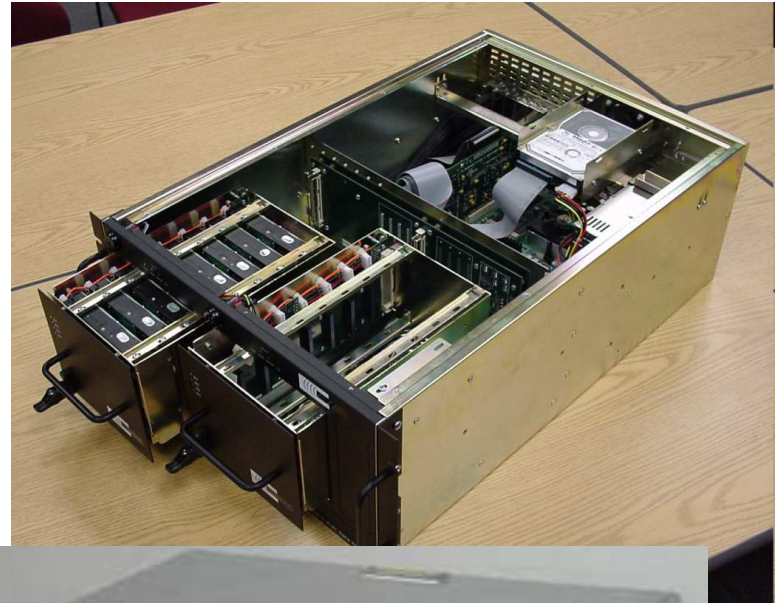
1s	2.0E-13
1000s	3.2E-15
Floor	3.0E-15
- Temperature stabilised room:
currently system holds
temperature to within 1 deg C



Digitiser + Recorders

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

- DBBC
 - Delivered Jan 2010



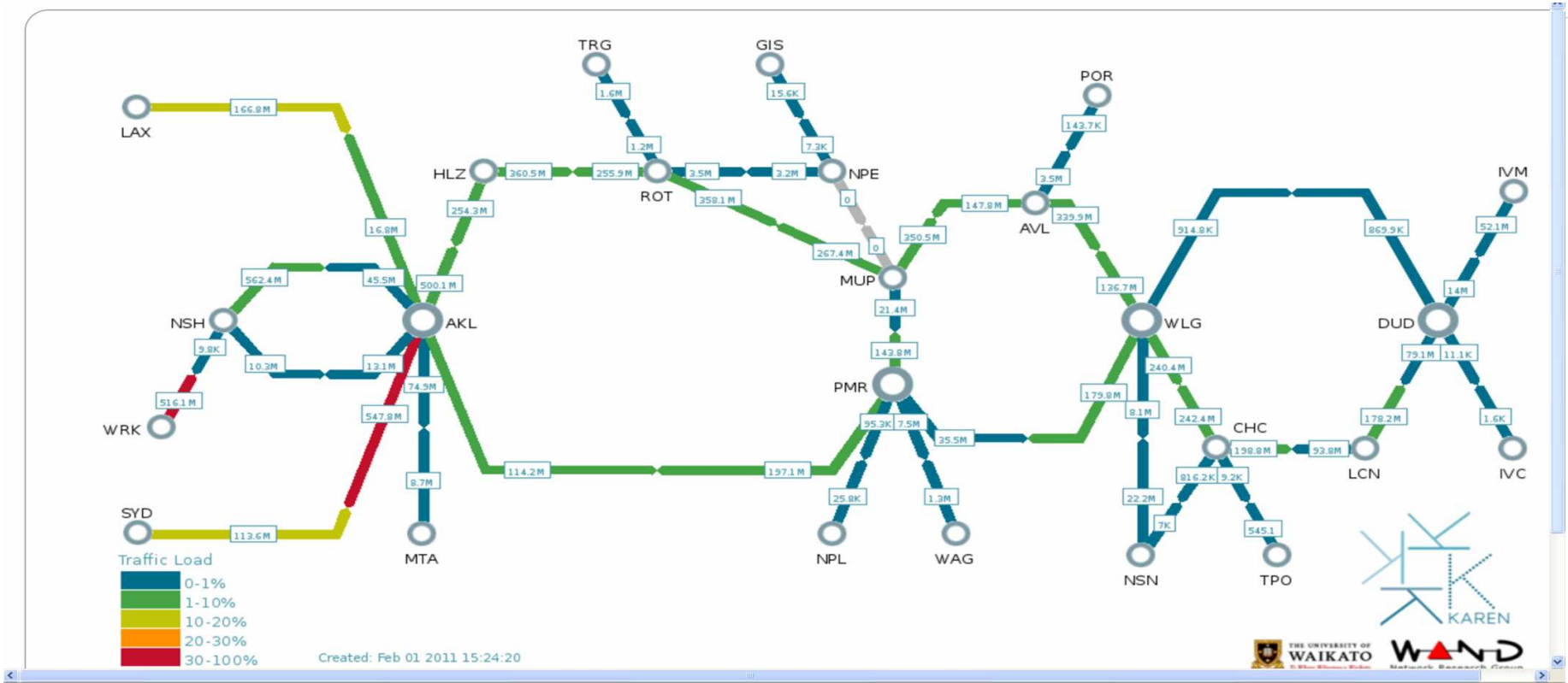
Integration of DBBC with Field System

- DBBC analogue power fed back to Field System pointing model
- Working on integrating DBBC channel/IF configuration into Field System schedules
- Stuart Weston, Ed Himwich, Gino Tuccari, Brian Corey

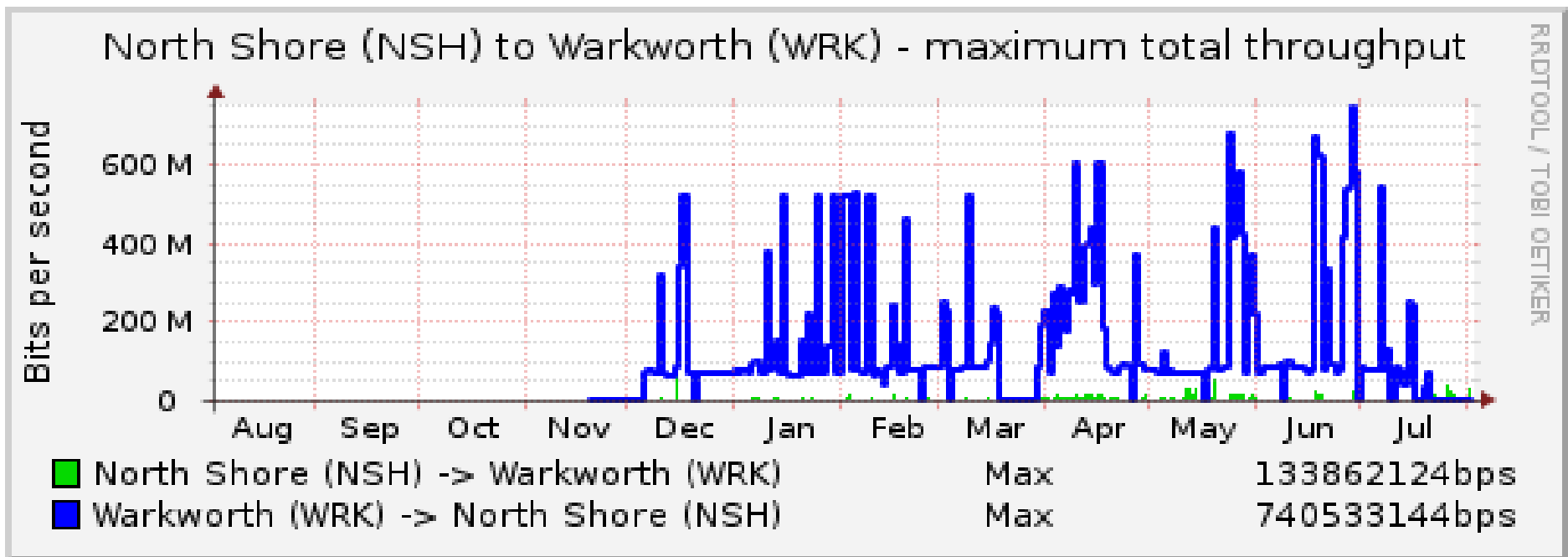
S/X VLBI Performance

- Correlated SEFD (IVS C1111)
 - S band : 5000 Jy
 - X band : 4500 Jy

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

Professor John Raine, Chair of KAREN:

“SKA-like real-time observations are a great achievement by New Zealand and Australian researchers. KAREN which provides the data network for New Zealand’s research institutions intends to be an anchor tenant on a new international cable that, if built, will provide international connectivity of 40 Gbps by 2014, scaling through 80Gbps in 2017 to 160 Gbps by 2022 – more than enough to link the New Zealand and Australian parts of SKA.”

- 2012: 10 Gbps**
- 2014: 40 Gbps**
- 2017: 80 Gbps**
- 2022: 160 Gbps**

Network Protocols and Connectivity Status

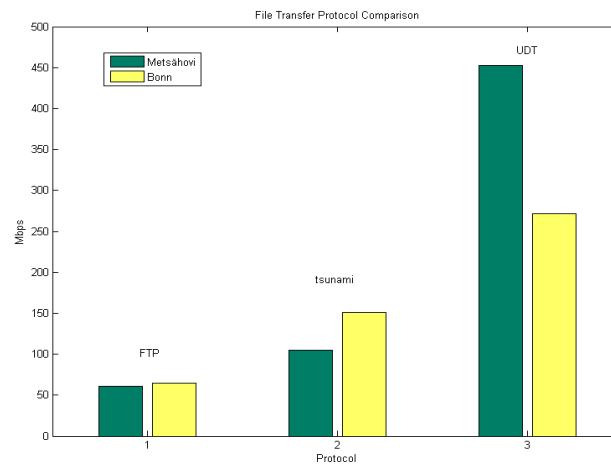
Destination	Protocol		Command	Date
CSIRO (Australia)	UDP	Tsunami, UDT	ssh	01/04/2010
Bonn (Germany)	UDP	Tsunami, UDT	ssh	01/06/2010
JIVE (Netherlands)	UDP	-	iperf	27/07/2010
Metsähovi (Finland)	UDP	Tsunami, UDT	ssh	21/07/2010
USNO (United States)	UDP	-	ssh, iperf	15/01/2011
GSI (Japan)	UDP	Tsunami, UDT	ssh, iperf	10/01/2011

With the connection of Warkworth to the KAREN network, some preliminary tests were undertaken to establish connectivity.

Also initial comparison of protocols was conducted to look for a solution as from New Zealand many hops are involved and FTP becomes inefficient.

Early Data Transfer Results

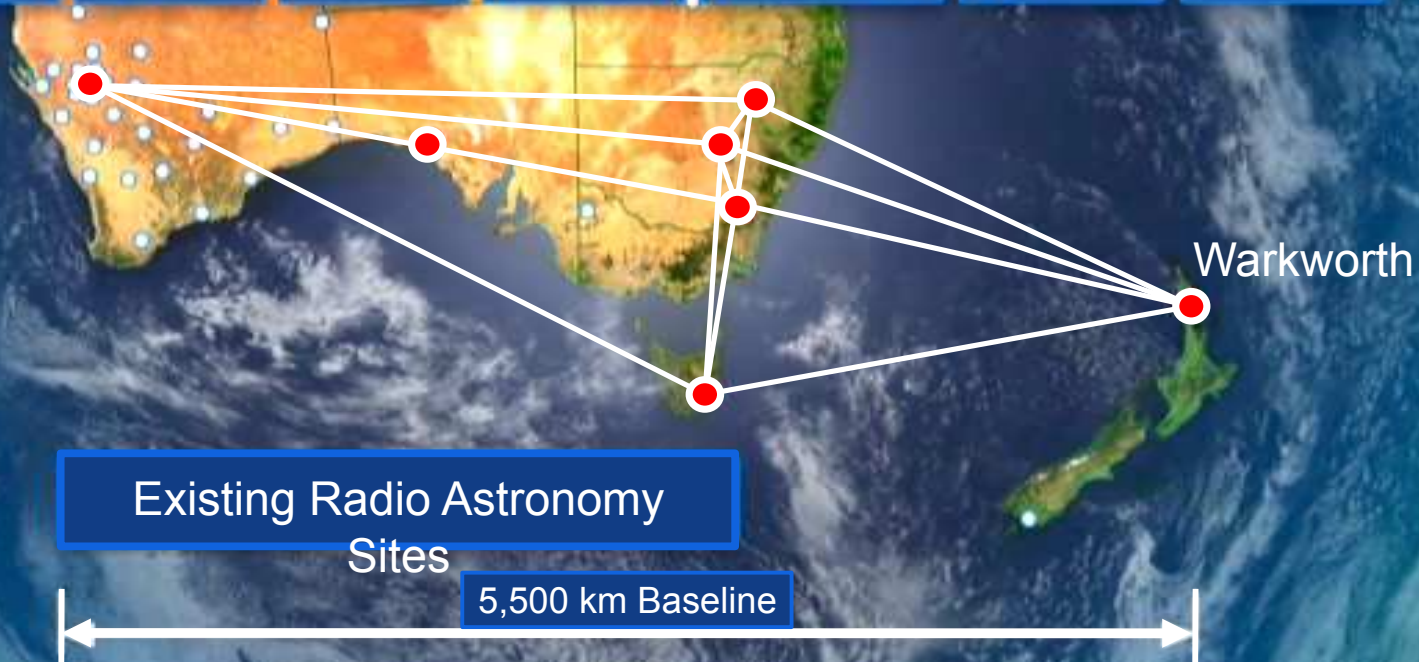
Route	Protocol	Bytes	Time(s)	Throughput (Mbps)
AUT – Bonn	ftp	65G	8016	65
AUT – Metsähovi	ftp	3.1G	432	61
AUT – Bonn	tsunami	65G	3466	151
AUT – Metsähovi	tsunami	65G	4979	105
AUT – Bonn	UDT	65G	1920	273
AUT – Metsähovi	UDT	65G	1157	453



Warkworth joining LBA



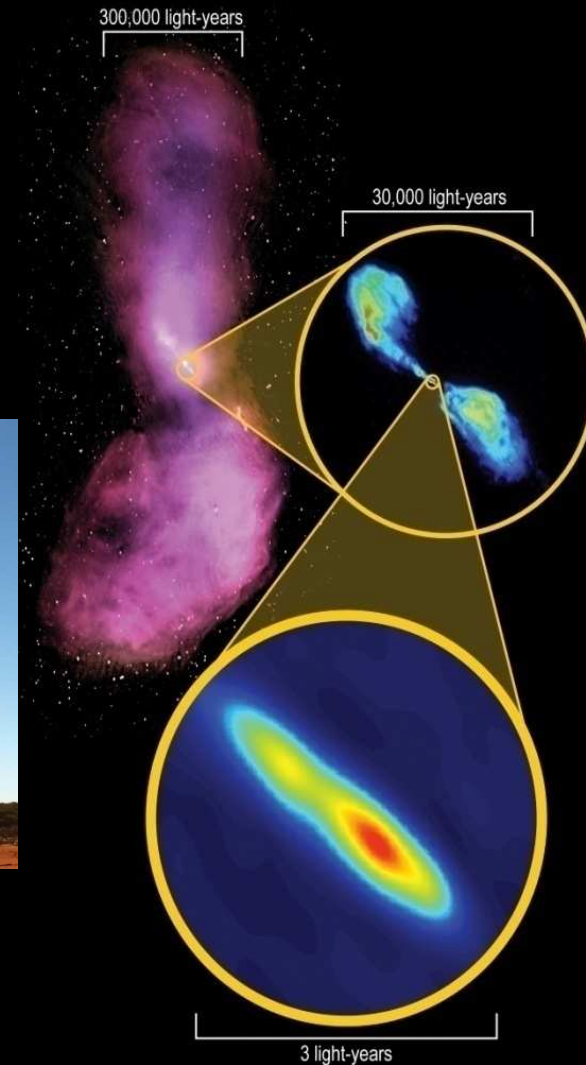
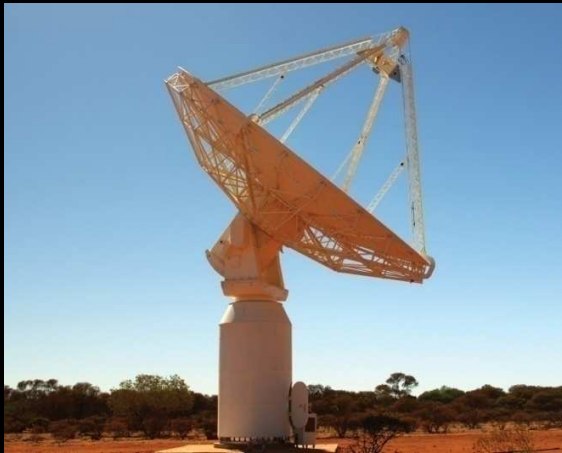
ASKAP--LBA--NZ VLBI, April-May 2010



Credit: Brian Boyle/CSIRO/ANZSKA

Radio galaxy Centaurus A

ASKAP antenna



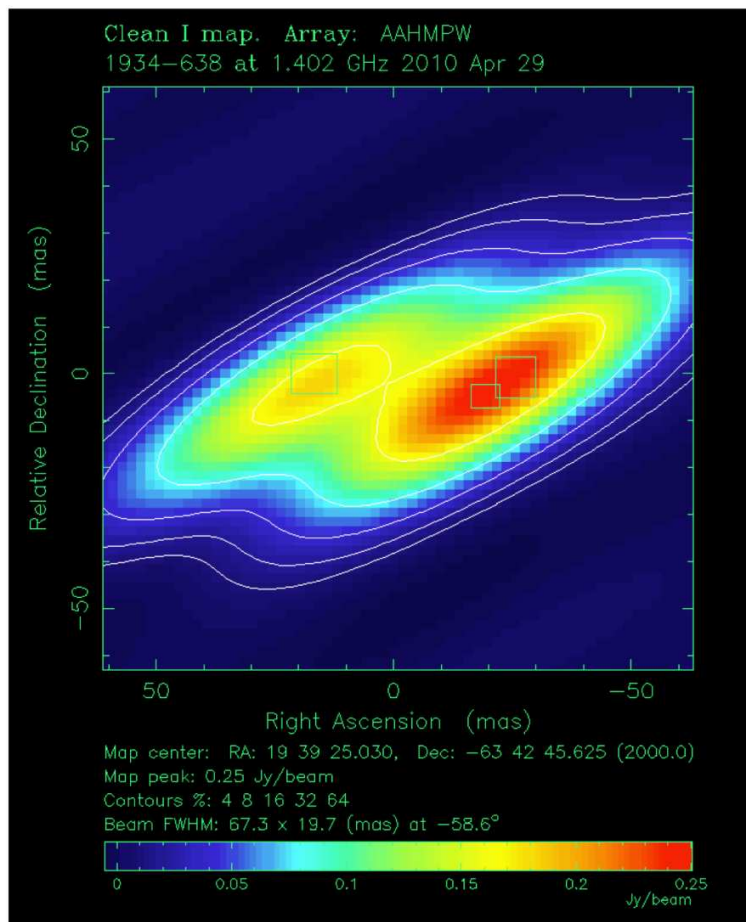
NZ radio telescope



Image credit – Whole galaxy: I. Feain, T. Cornwell & R. Ekers (CSIRO/ATNF); ATCA northern middle lobe pointing courtesy R. Morganti (ASTRON); Parkes data courtesy N. Junkes (MPIfR). Inner radio lobes: NRAO / AUI / NSF. Core: S. Tingay (ICRAR) / ICRAR, CSIRO and AUT

ASKAP & NZ VLBI of 1934-638

Normal LBA at 1.4 GHz



LBA with NZ and ASKAP

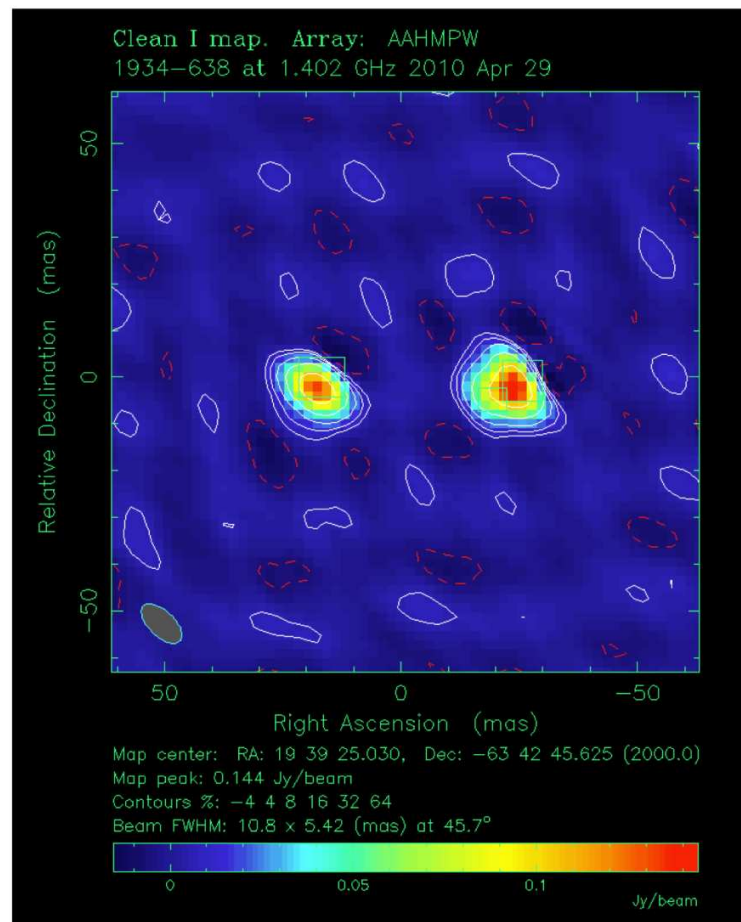
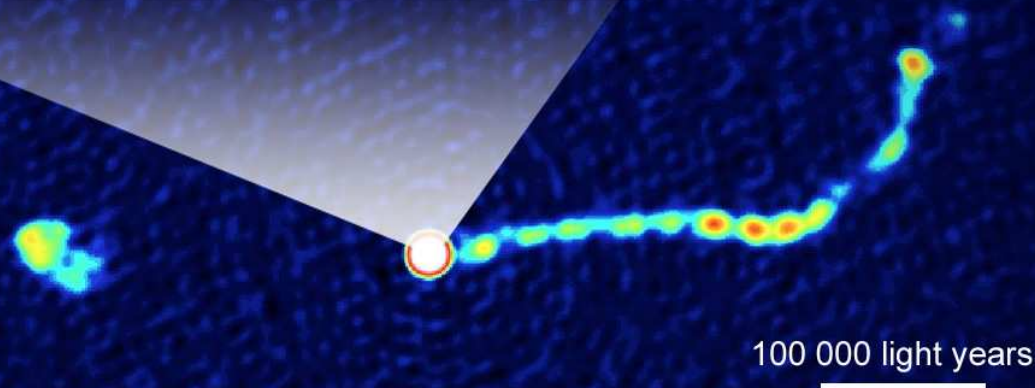
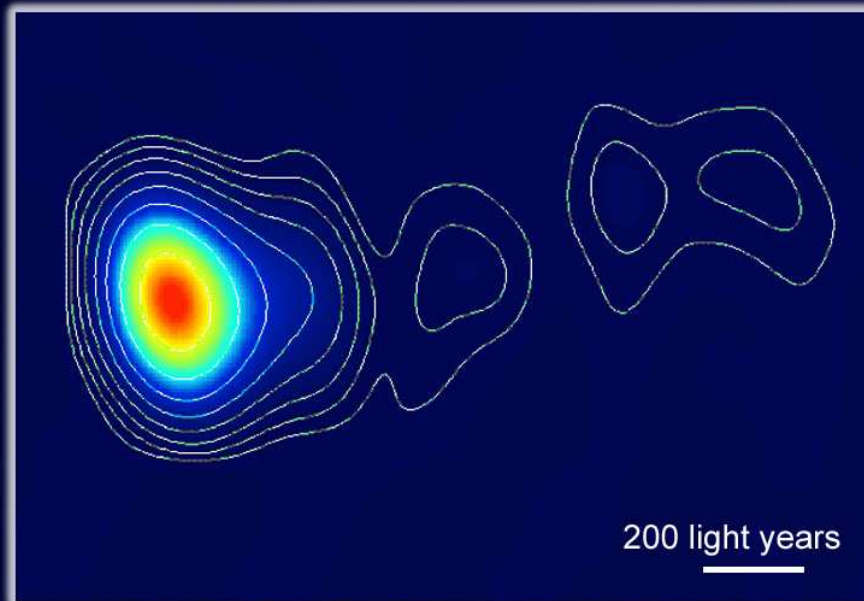


Image credit: Steven Tingay
(see also Tzioumis et al. AJ, 140, 2010)

The 1st real-time eVLBI ASKAP—LBA—NZ June 2011



The 1st real-time eVLBI ASKAP—LBA—Warkworth June 2011



Quasar PKS 0637-752
Image credit: S.Tingay et al.

GPS coordinates

- Determination of VLBI reference point



- PositionNZ: WARK
- RTK GPS



X = -5115324.5 +/- 0.1 m
Y = 477843.3 +/- 0.1 m
Z = -3767193.0 +/- 0.1 m
March 2010

Antenna's centre survey:
- Real-time kinematic GPS
- Tie vector from GPS station

GPS



Credit: Neville Palmer

VLBI reference point

- VLBI
 - L-band only

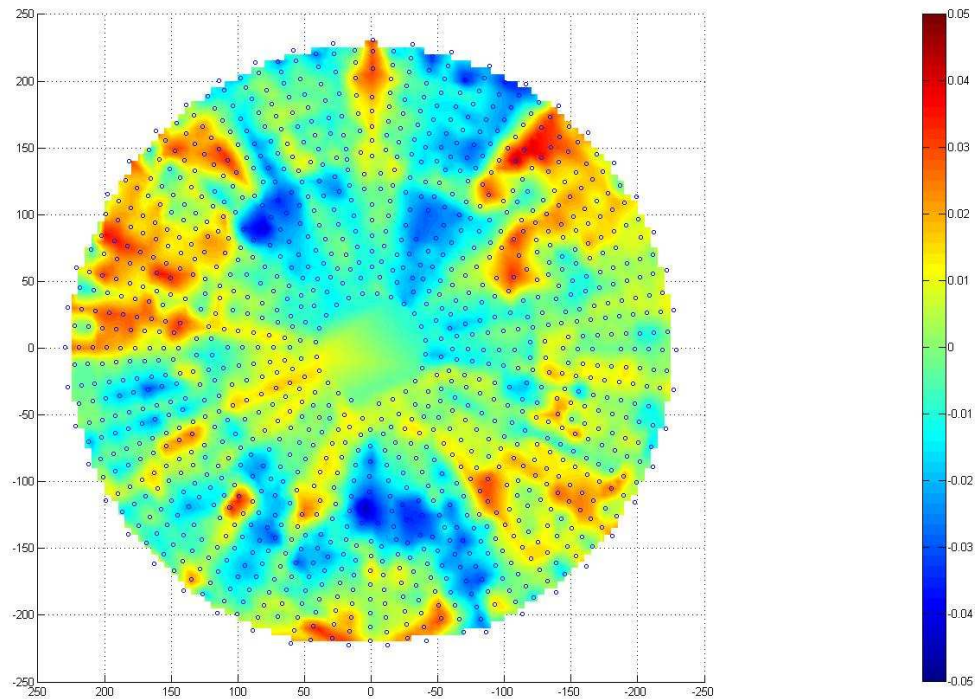


$X = -5115325.55 \pm 0.10 \text{ m}$
 $Y = 477842.95 \pm 0.05 \text{ m}$
 $Z = -3767194.41 \pm 0.09 \text{ m}$
May 2010

Petrov et al., 2011

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





Specs:

Beam-waveguide
cassegrain

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

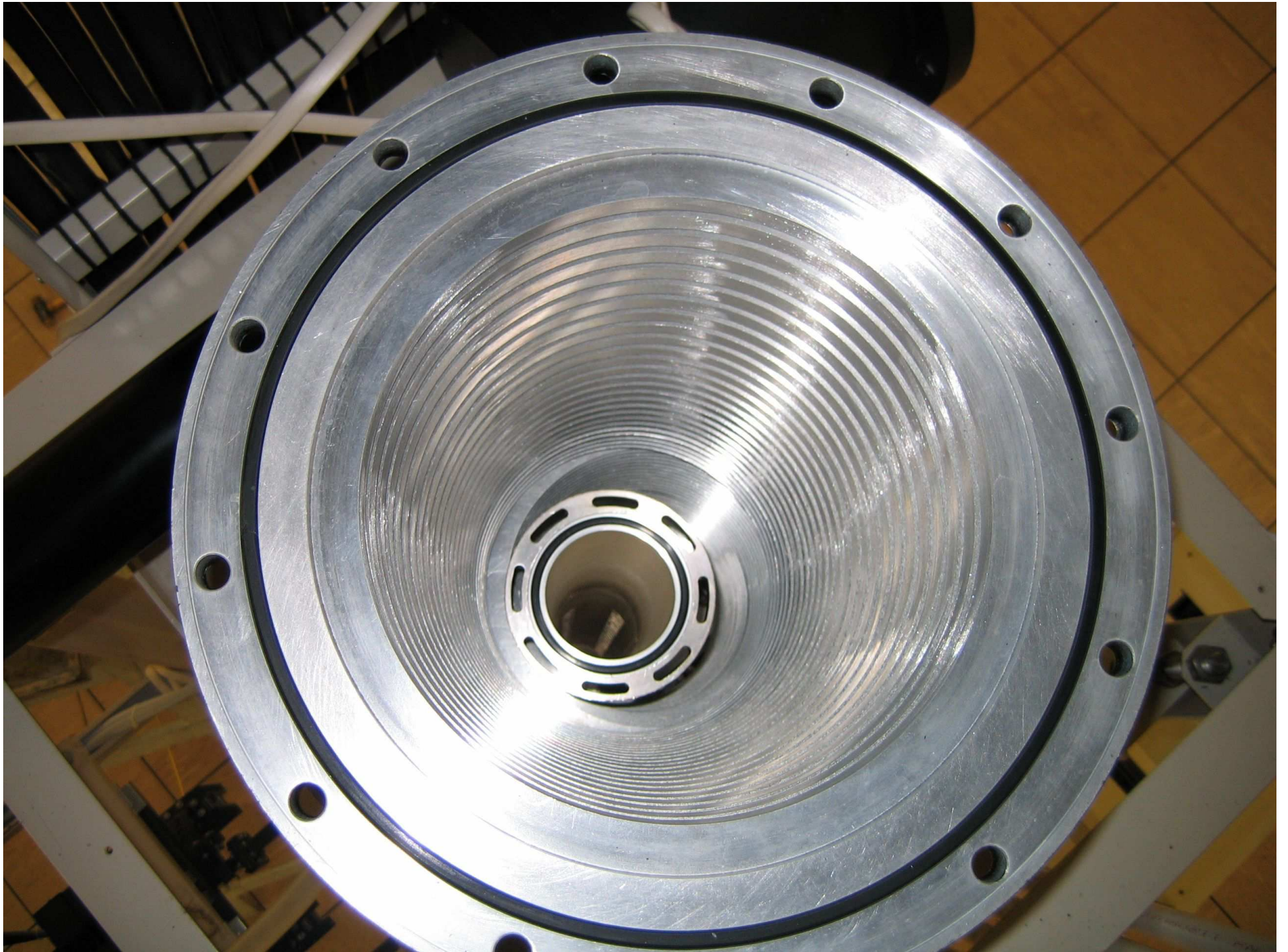
Elevation range:
0 to 90 degrees

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

Surface: 0.6 mm rms







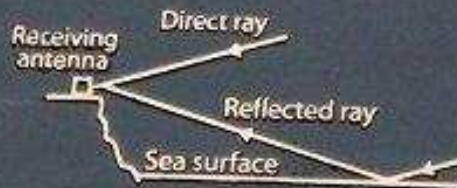
The Cosmic Noise Expedition

From this site in August 1948, two pioneering radio astronomers, John Bolton and Gordon Stanley, from the Council for Scientific and Industrial Research in Sydney, determined for the first time the source of radio waves from outside our solar system. The astronomical world was astonished by this surprising opening of a new window on the universe

The expedition gathered data at Pakiri on the east coast, then moved to this World War II Radar Station. Success was ensured because of a reliable electricity supply for their trailer-mounted sea-cliff interferometer (used at 100 MHz) and a west-facing horizon from the high cliffs.

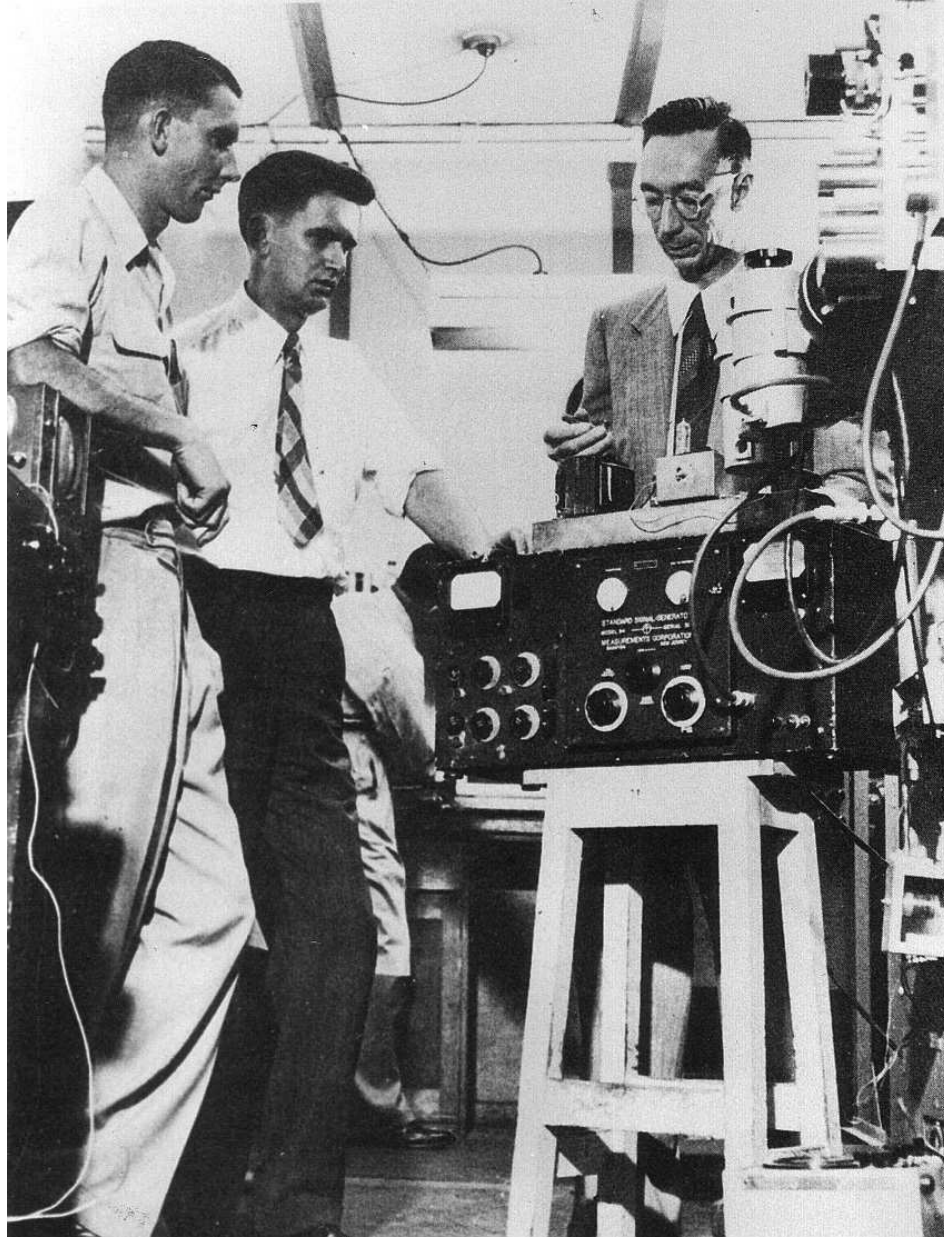
Bolton and Stanley identified radio signals from three 'radio stars' - Taurus A, Centaurus-A and Virgo-A. Taurus-A is the remnant of the famous Crab Nebula, a supernova which exploded in 1054 AD. The other two sources of 'cosmic noise' are associated with galaxies outside the Milky Way.

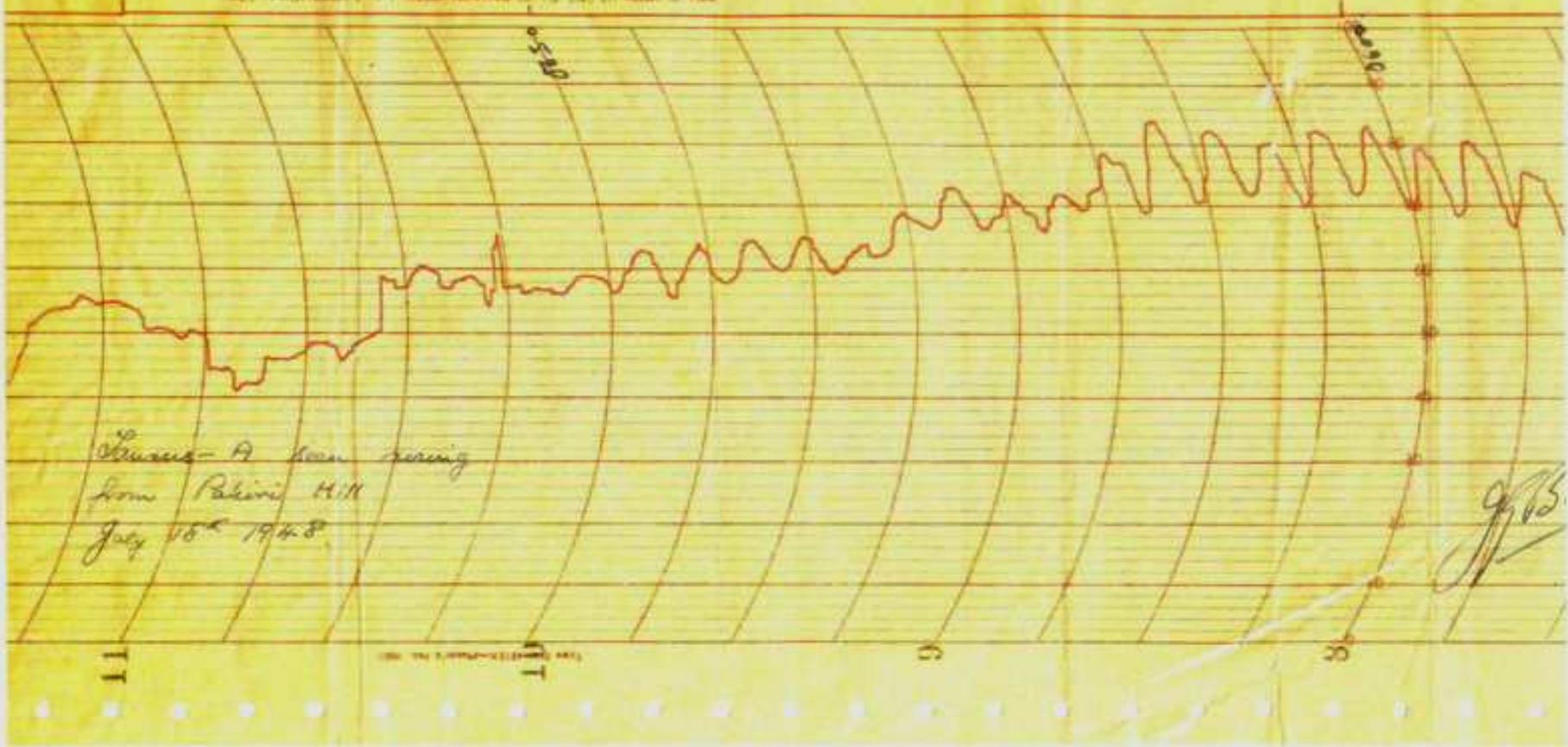
Modern radio astronomy made a big leap forward with this discovery at Piha and this is acknowledged with this marker unveiled on 28th January 2011 by Auckland Council.



Auckland Council

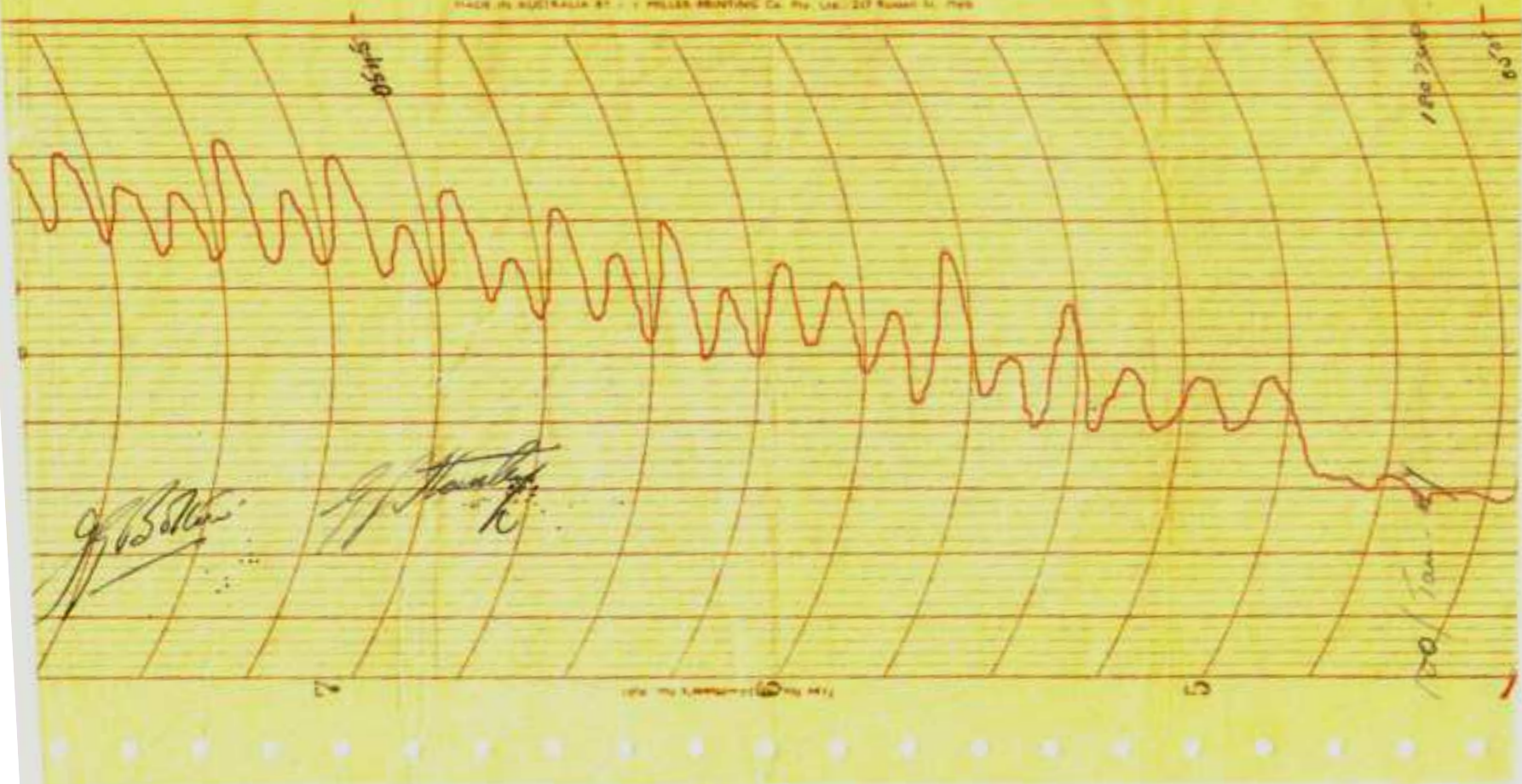






Stanzas - A scan recording
 from Palmetto Hill
 July 18th 1948

greenwood. b. CCE



Greenwood. C. C. C.



Thank you!

