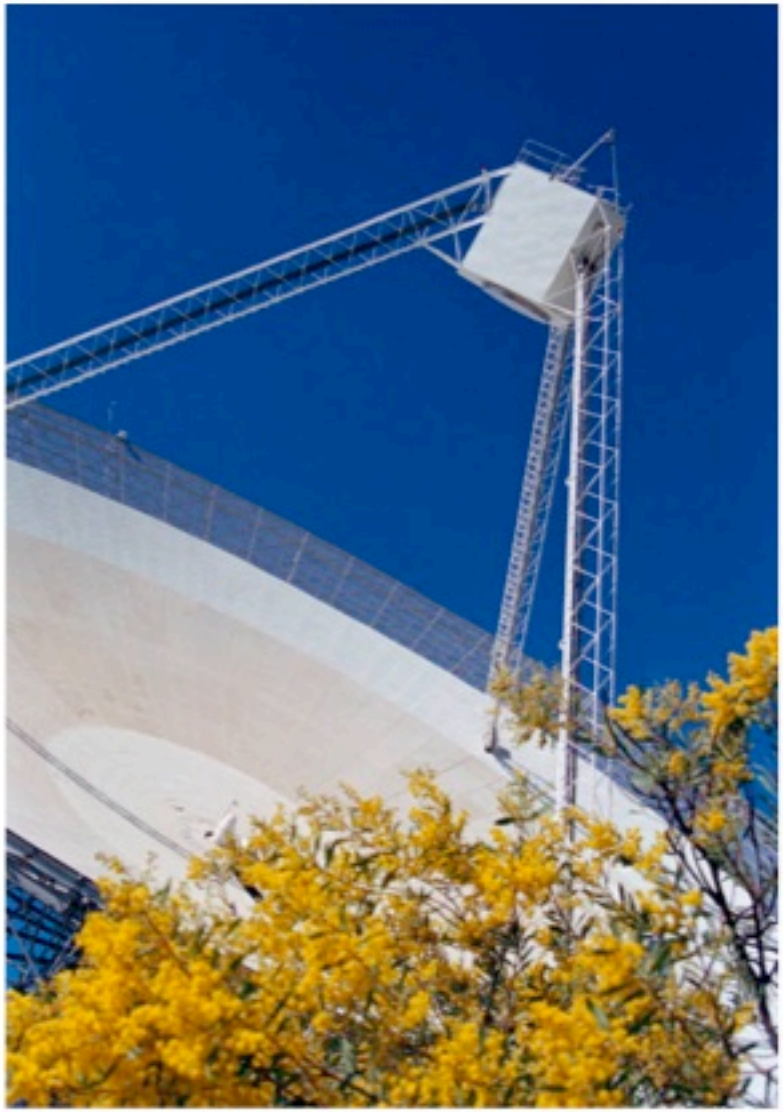
www.csiro.au

The History of Parkes Observatory

John M. Sarkissian
Operations Scientist
21 September 2009

CSIRO

The CSIRO Parkes Telescope



"One of the world's great research instruments"

The CSIRO Parkes Telescope

Conceived by Edward "Taffy" Bowen in 1954.

The best all round instrument was a large, fully-steerable dish antenna

Funding the Project

1. $250,000 from the Carnegie Corporation
2. $250,000 from the Rockefellar Foundation
3. Equal matching funds from the Australian Government
4. Additional $107,000 from Rockefellar Foundation
5. $55,000 Private Australian Donations

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Vannevar Bush

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Dean Rusk

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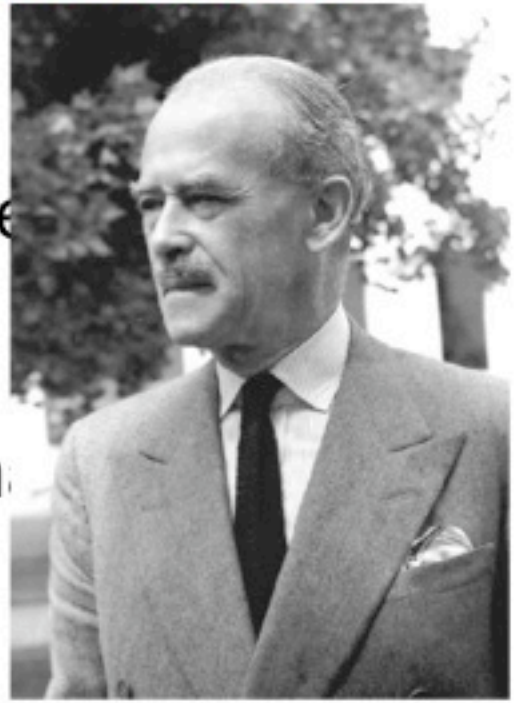

Richard Casey

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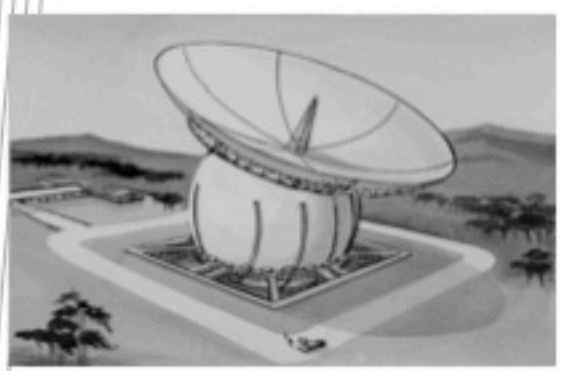
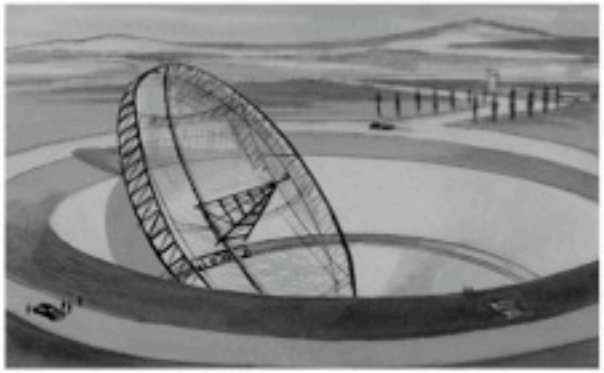
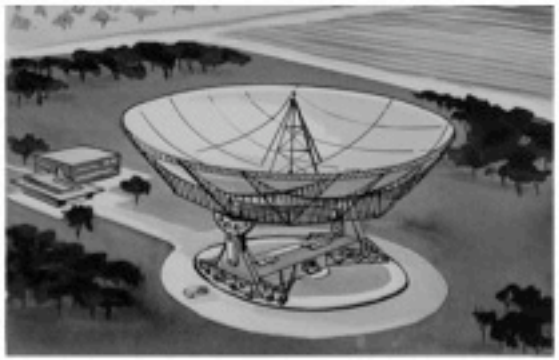
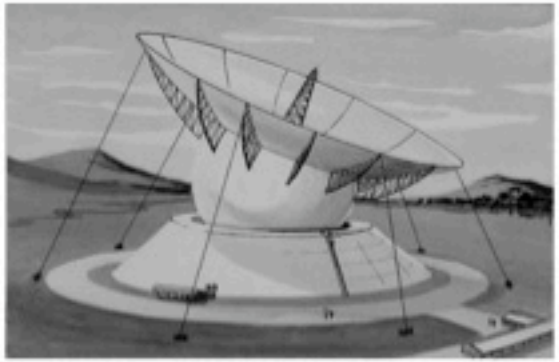
Early Concepts



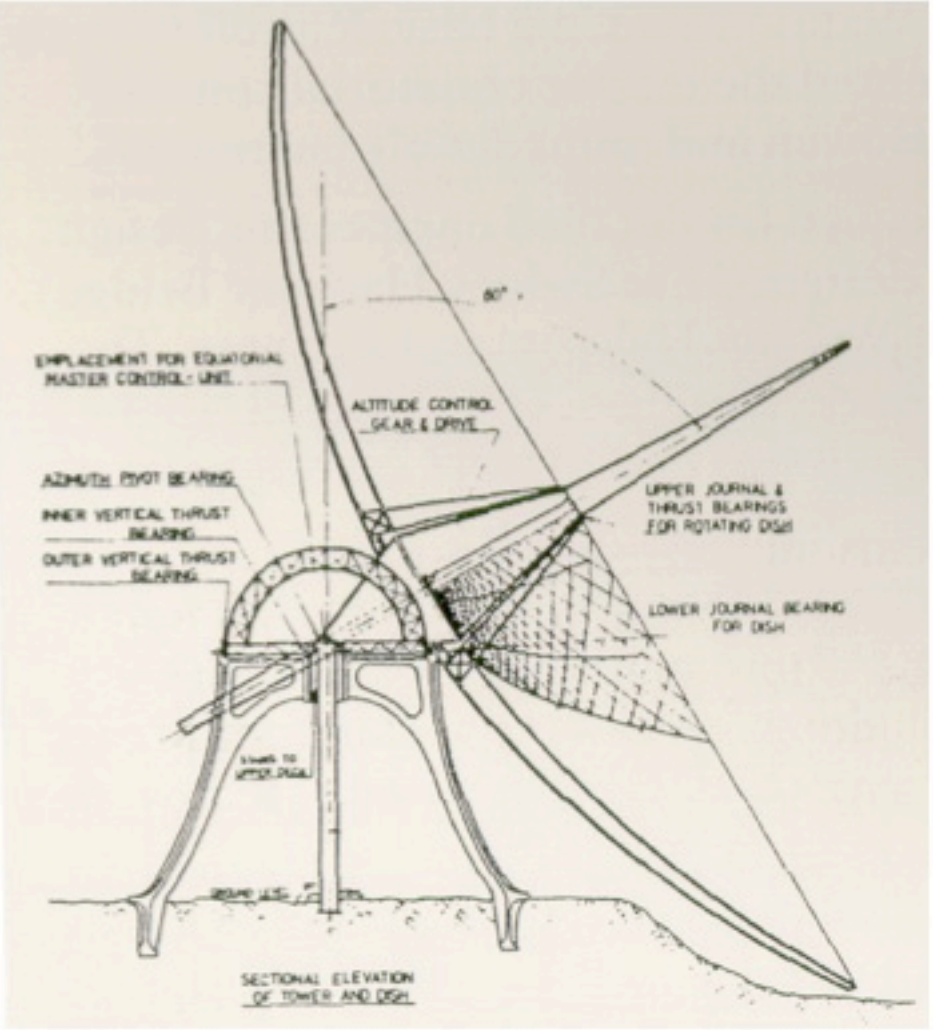






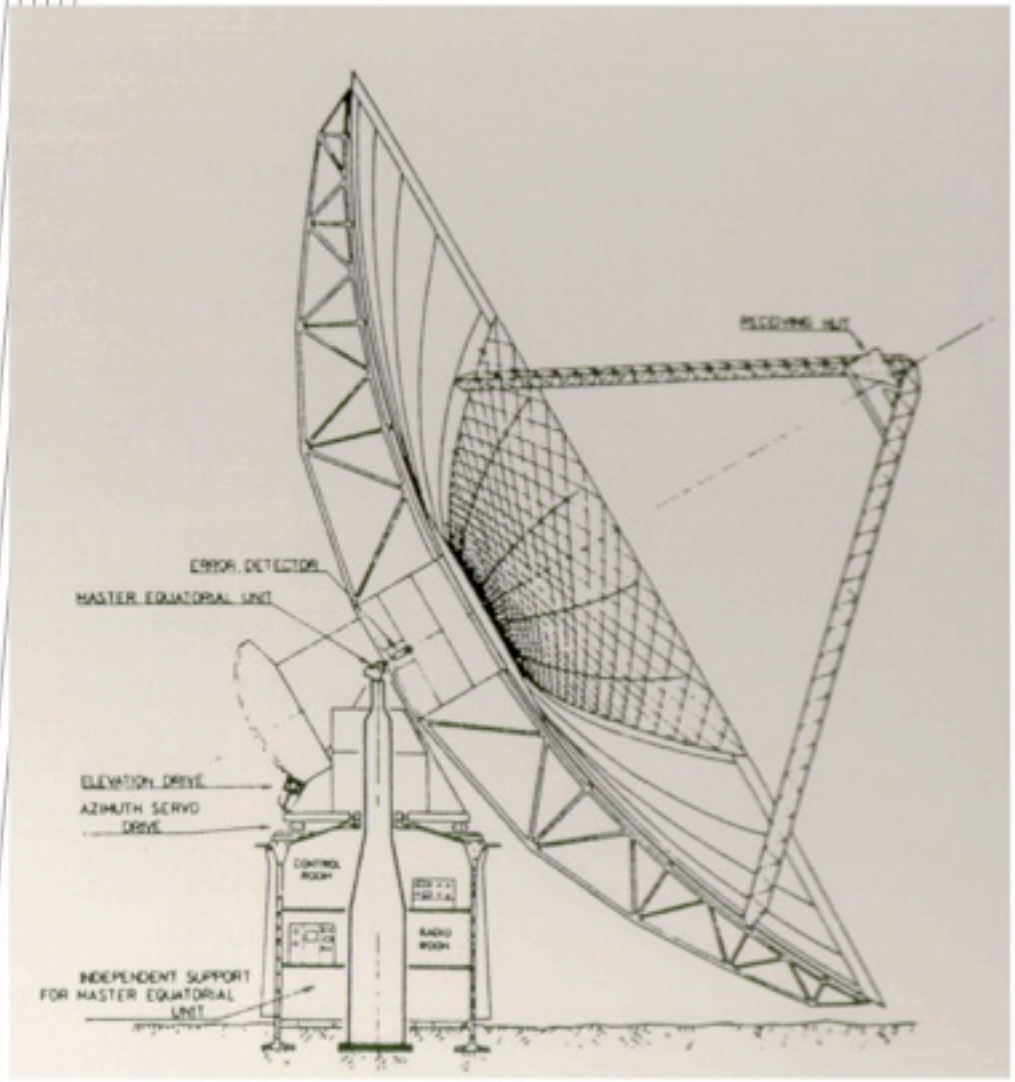
Barnes Wallis

Chief Engineer of Metropolitan-Vickers



CSIRO

Final Design



CSIRO Engineer, **Harry Minnett**, supervised the design and drive system from 1956-59

30° elevation limit

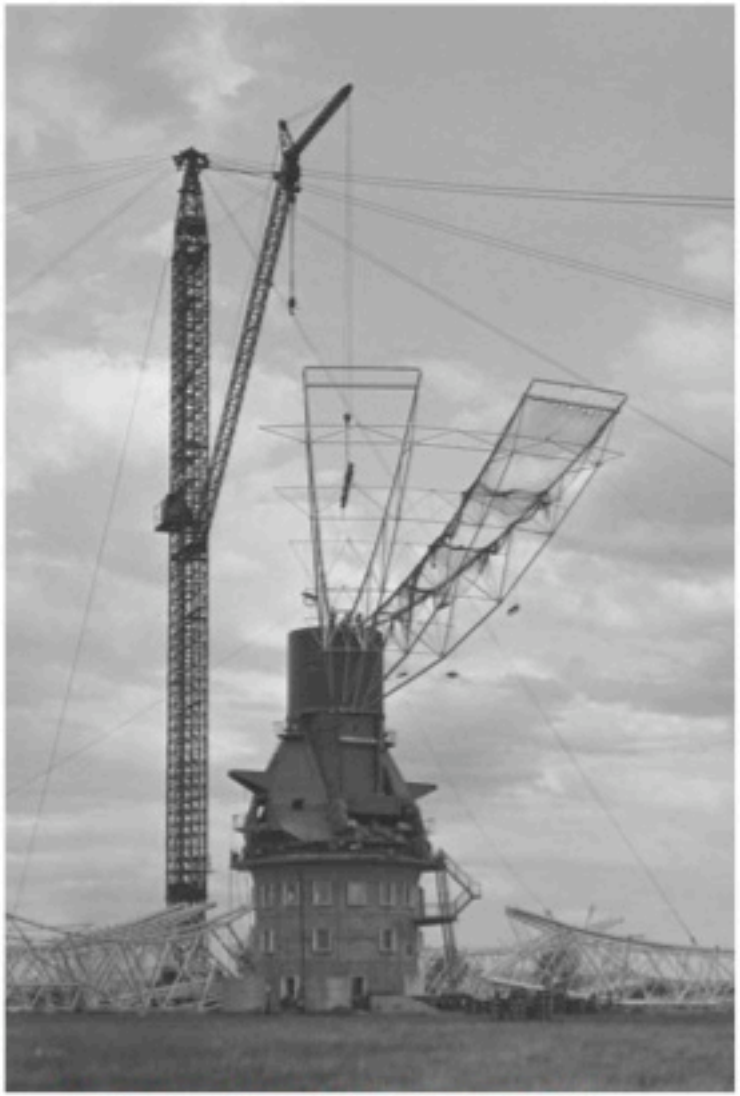
Construction 1959-61

Construction 1959-61

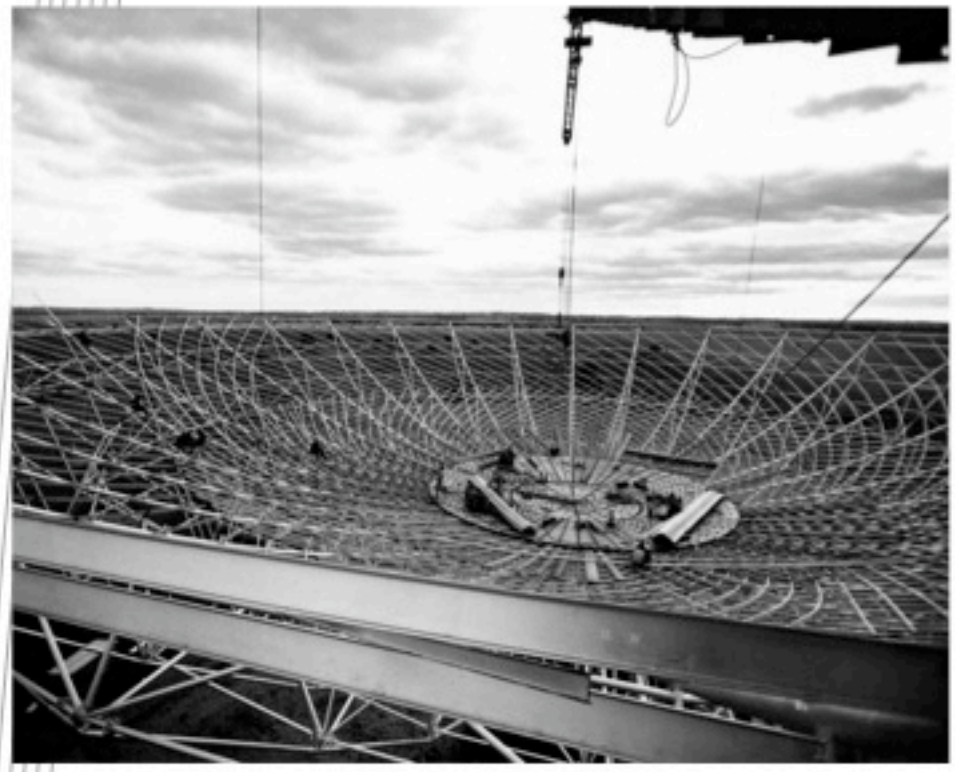
Parkes was chosen as the site because of the ***lack of radio interference***

Construction 1959-61

Construction 1959-61



Construction 1959-61



Construction 1959-61

Commissioning - October 1961

First Tip of the Dish - 1961

Official Opening
31 October 1961

John Bolton Appointed First Director

John Bolton appointed as the first Director of Parkes Observatory

Innovative Design features

The Master Equatorial (ME)

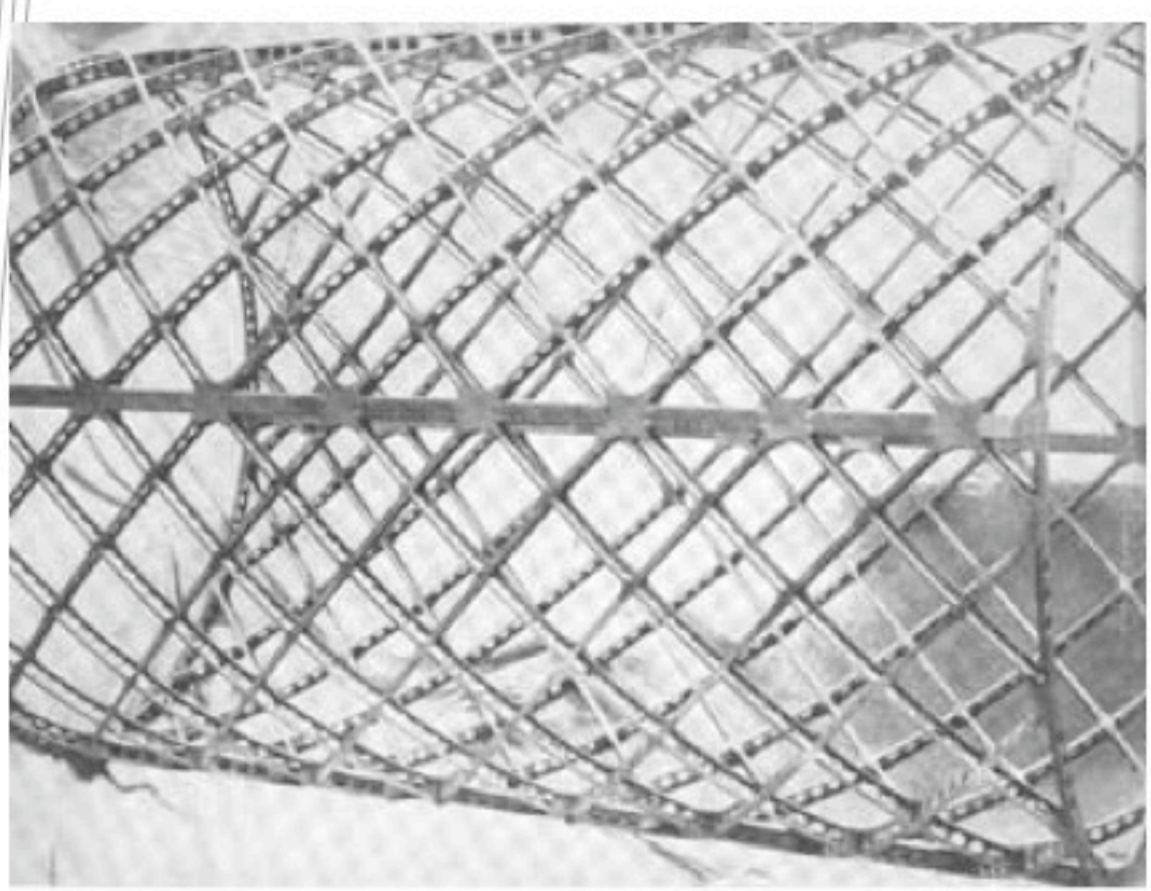
The dish is slaved to the ME via a servo loop

Innovative Design Features

Spiral Purlins

Based on a Barnes Wallis design for his airship hulls

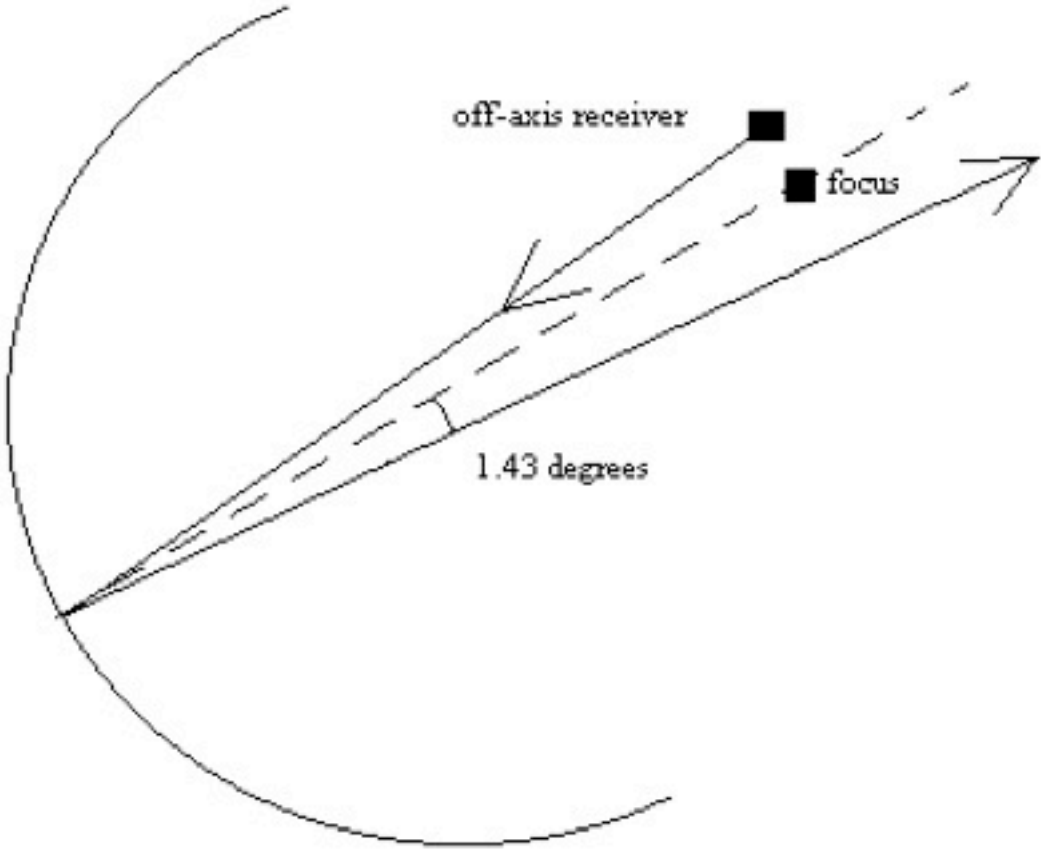
Innovative Design Features



Spiral Purlins

Based on a Barnes Wallis design for his airship hulls

Innovative Design Features



Feed Rotator

Off-axis feed has an offset beam

Space Missions

1. Mariner 2 – 1962
2. Mariner 4 – 1965
3. Apollo Missions – 1969-72
4. Voyager 2 Uranus – 1986
5. Halley's Comet (Giotto) – 1986
6. Voyager 2 Neptune – 1989
7. Galileo Jupiter – 1996-97
8. ACP (Mars) – 2003-04
9. Huygens - 2005

Space Missions

PIONEER 4

6 March 1959

Flew past the Moon at a record distance of 654,860 km

JPL/NASA could not communicate with it

The Early Years

JPL needed largest possible antenna

1. 6–12 dB improvement over existing 26 metre array, that is, 60 – 80 metre class antennae
2. Optimum performance at 2200 MHz (surface accuracy)
3. Pointing accuracy of 1.2 minutes of arc
4. Slew rates of ~10°/min

The Early Years

JPL needed largest possible antenna

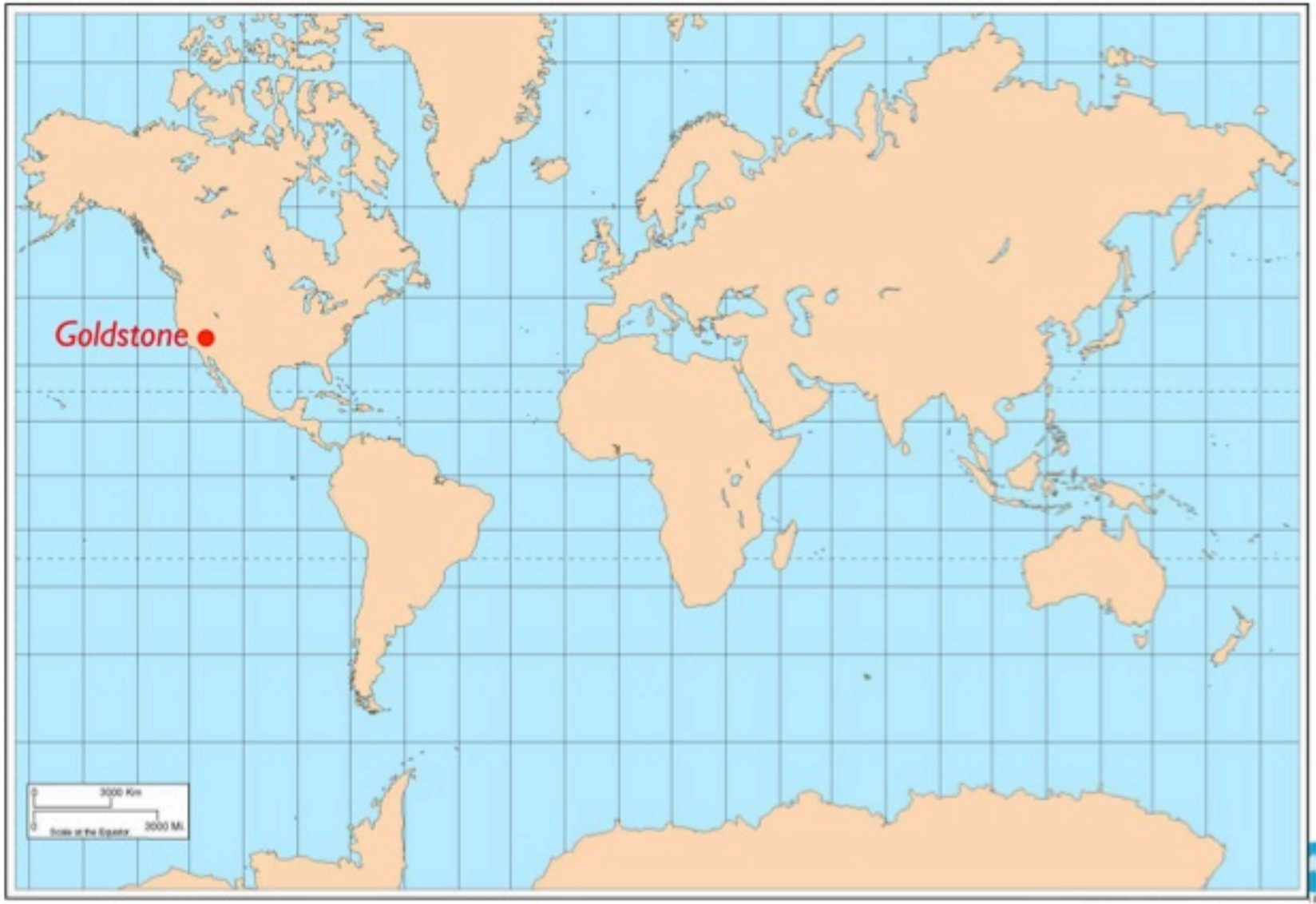
These requirements matched Parkes very closely

The Early Years

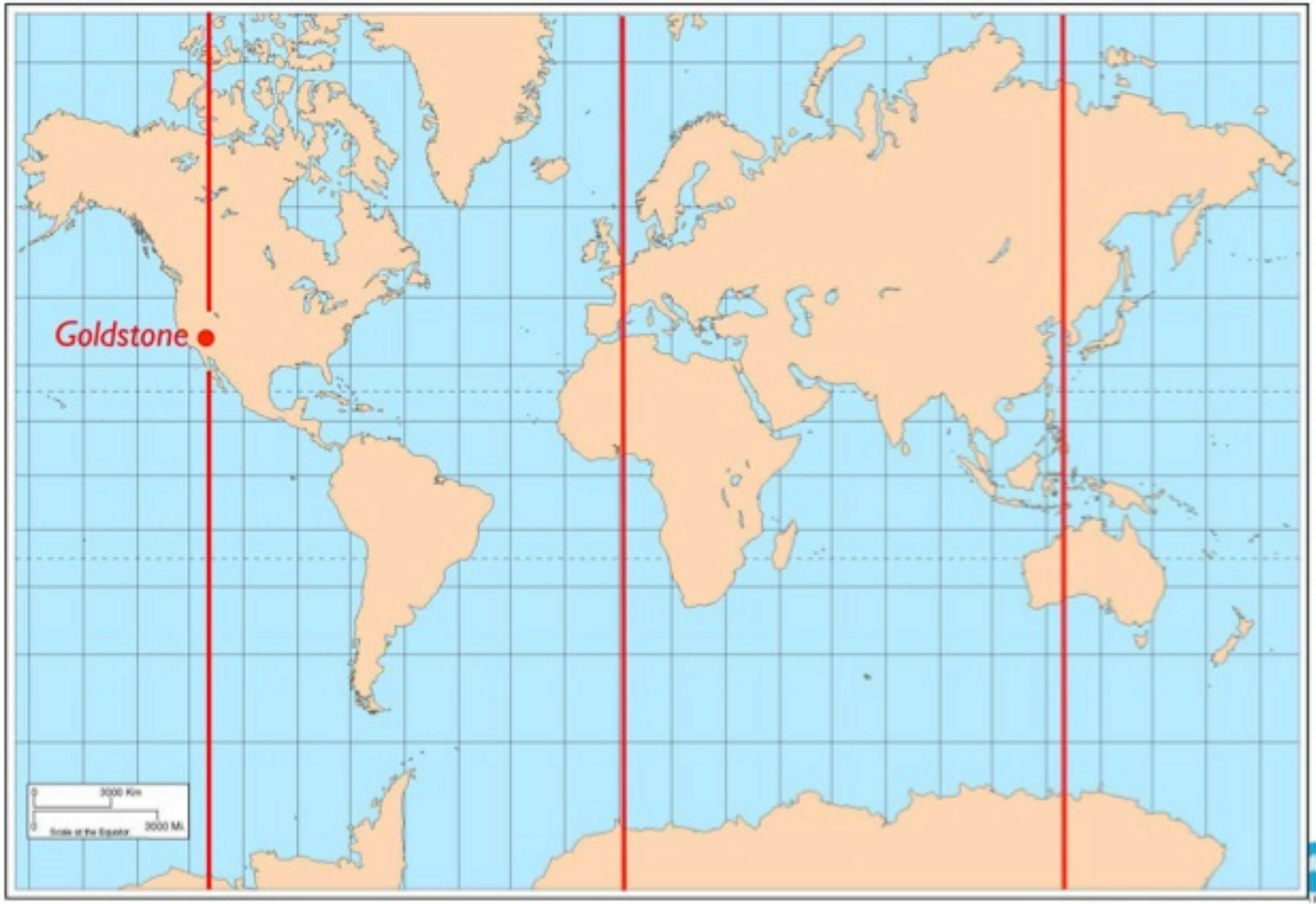
From 1959-61 : Cooperative Space Exploration Program proposed

Occasional use of Parkes for data acquisition of a short term nature where an extremely strong and reliable signal was required

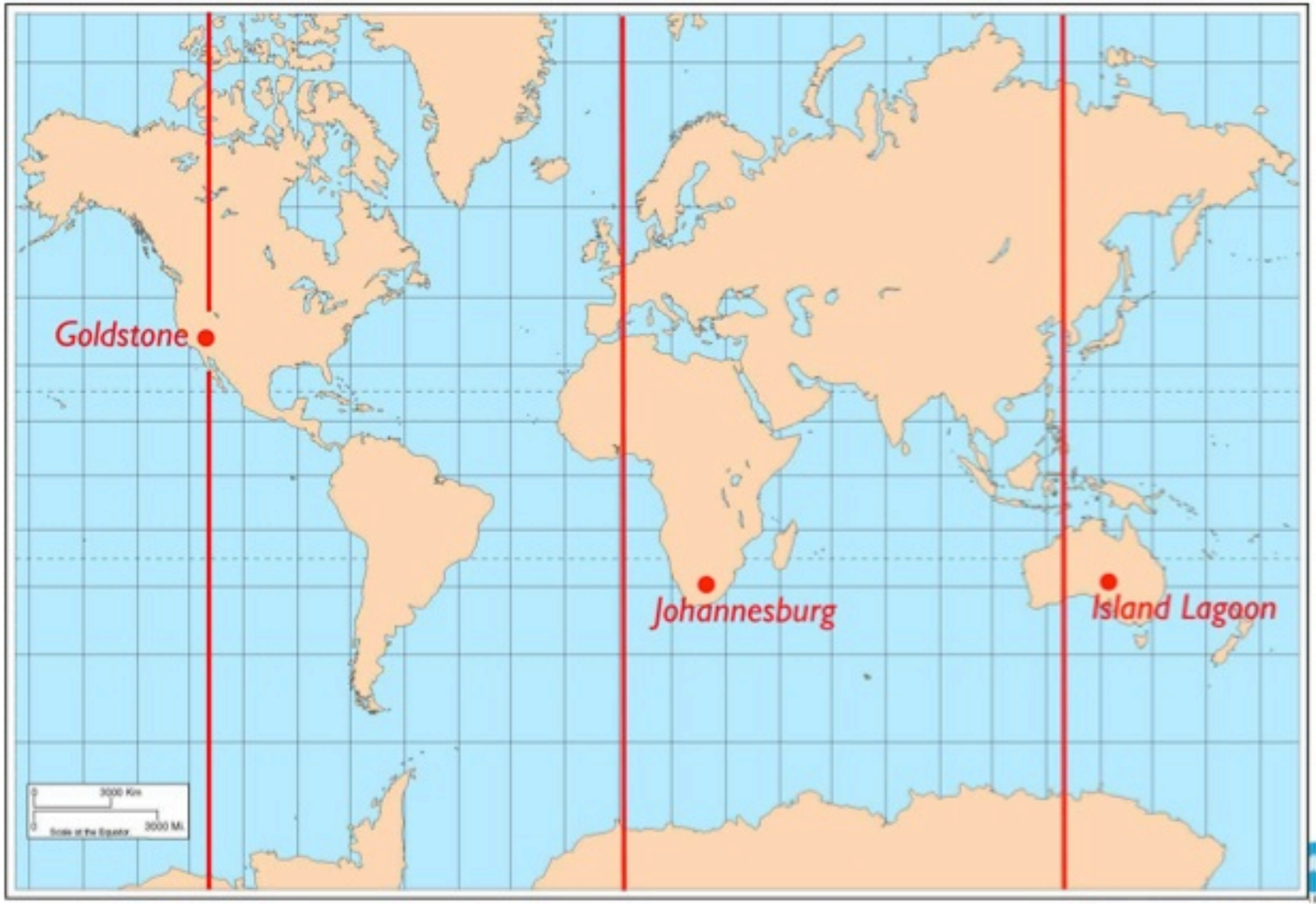
The DSIF and DSN



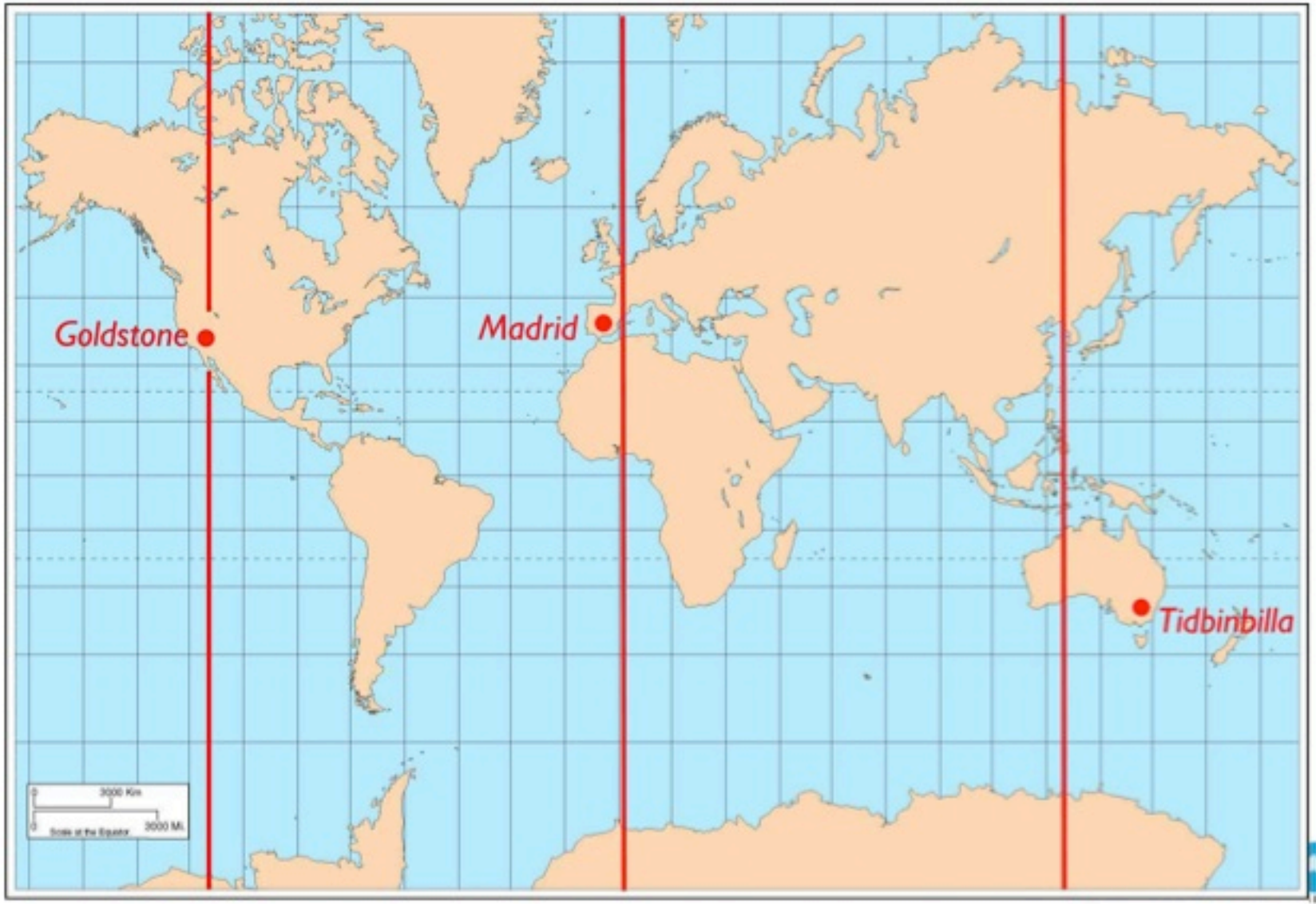
The DSIF and DSN



The DSIF and DSN



The DSIF and DSN



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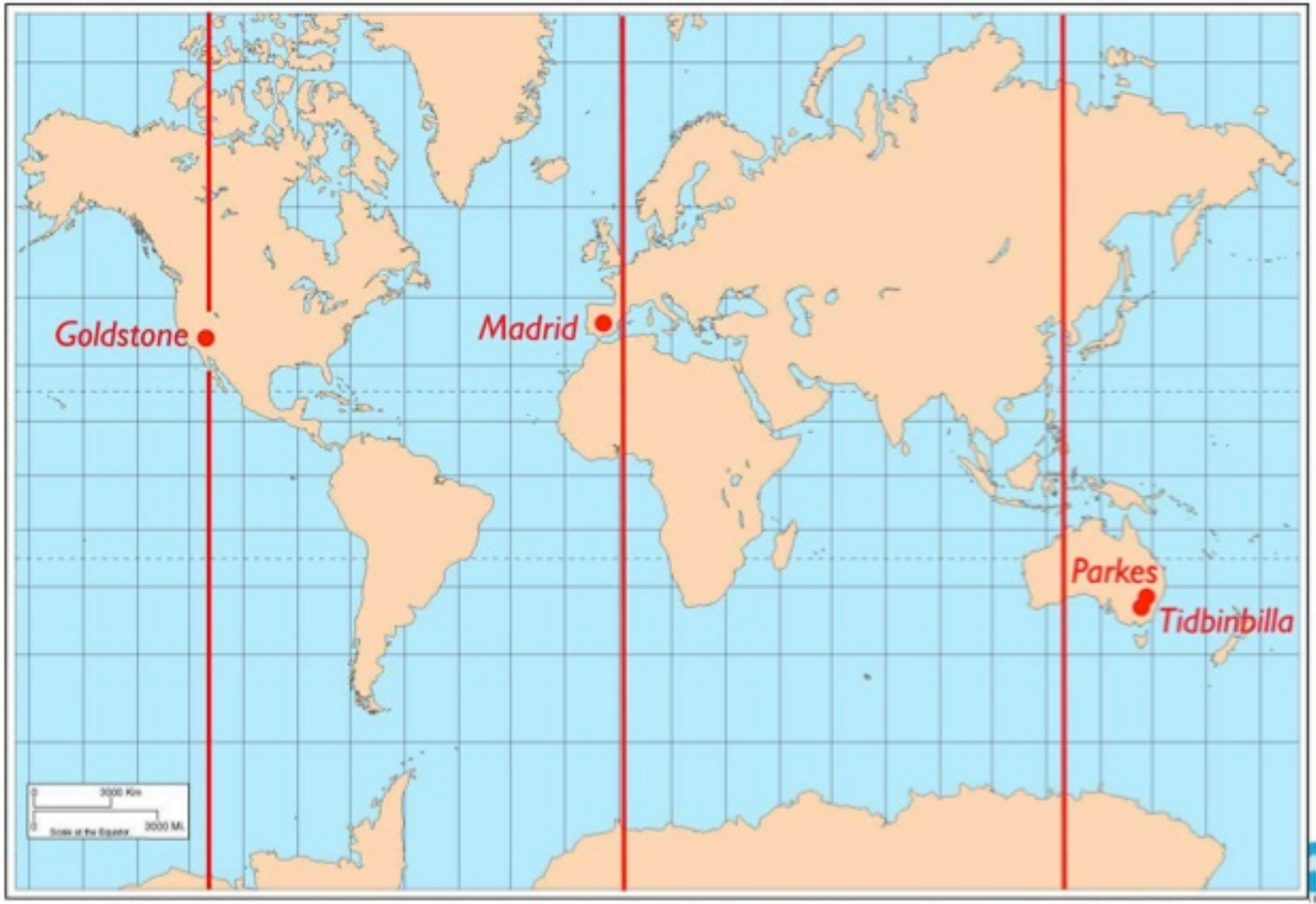


NASA Research Grant: NsG-240-62

1. CSIRO Participated in feasibility studies and specification reviews of the JPL antennas

2. Harry Minnett appointed Officer-in-Charge of advanced antenna design to head the study

NASA Research Grant: NsG-240-62

3. Determine detailed performance parameters of the Parkes Telescope as regards:
    a) structural behaviour
    b) characteristics of the drive system
    c) radio frequency performance
    d) vibration characteristics
    e) measurements of dish shape in the zenith and tilted positions

NASA Research Grant: NsG-240-62

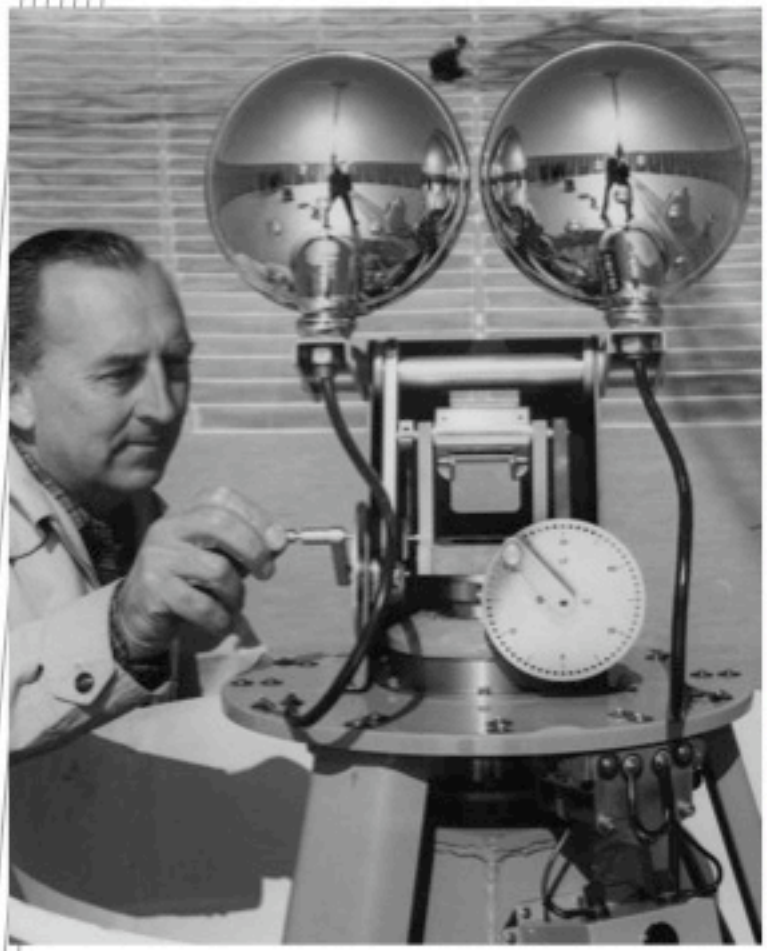
This information was considered to be of critical importance in the design and construction of the JPL antennas

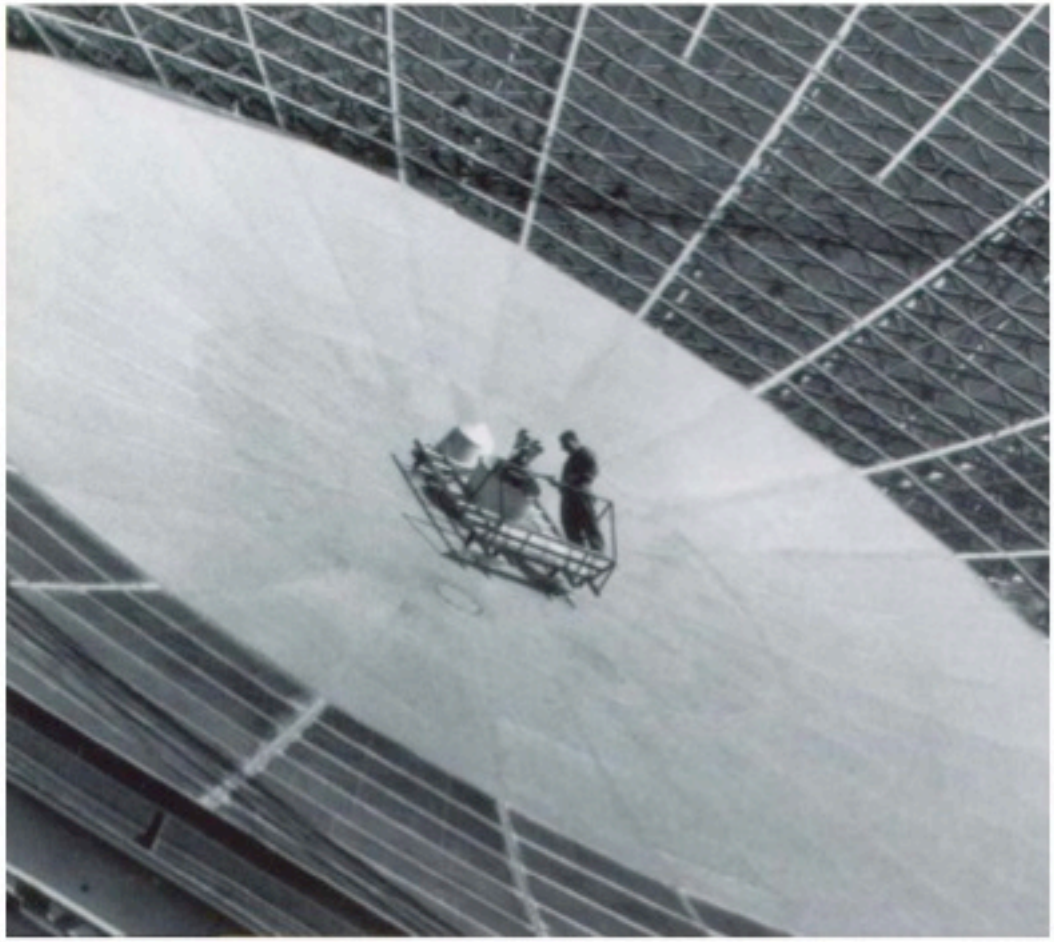
The Parkes 64 metre dish became the model for the DSN antennas

NASA Research Grant: NsG-240-62

Mike Jeffrey's and Harry Minnett performing vibration tests

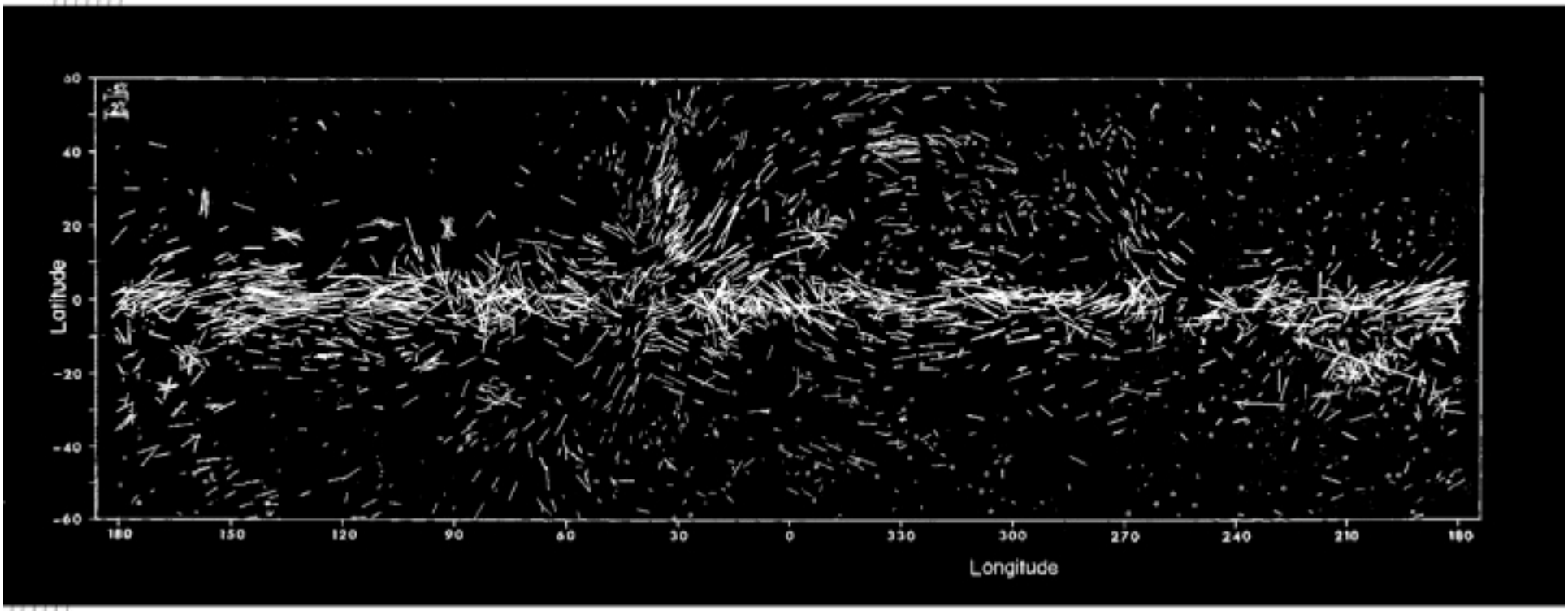
NASA Research Grant: NsG-240-62





Surface deformation measurements as a function of tilt angle

1962: The Galactic Magnetic Field



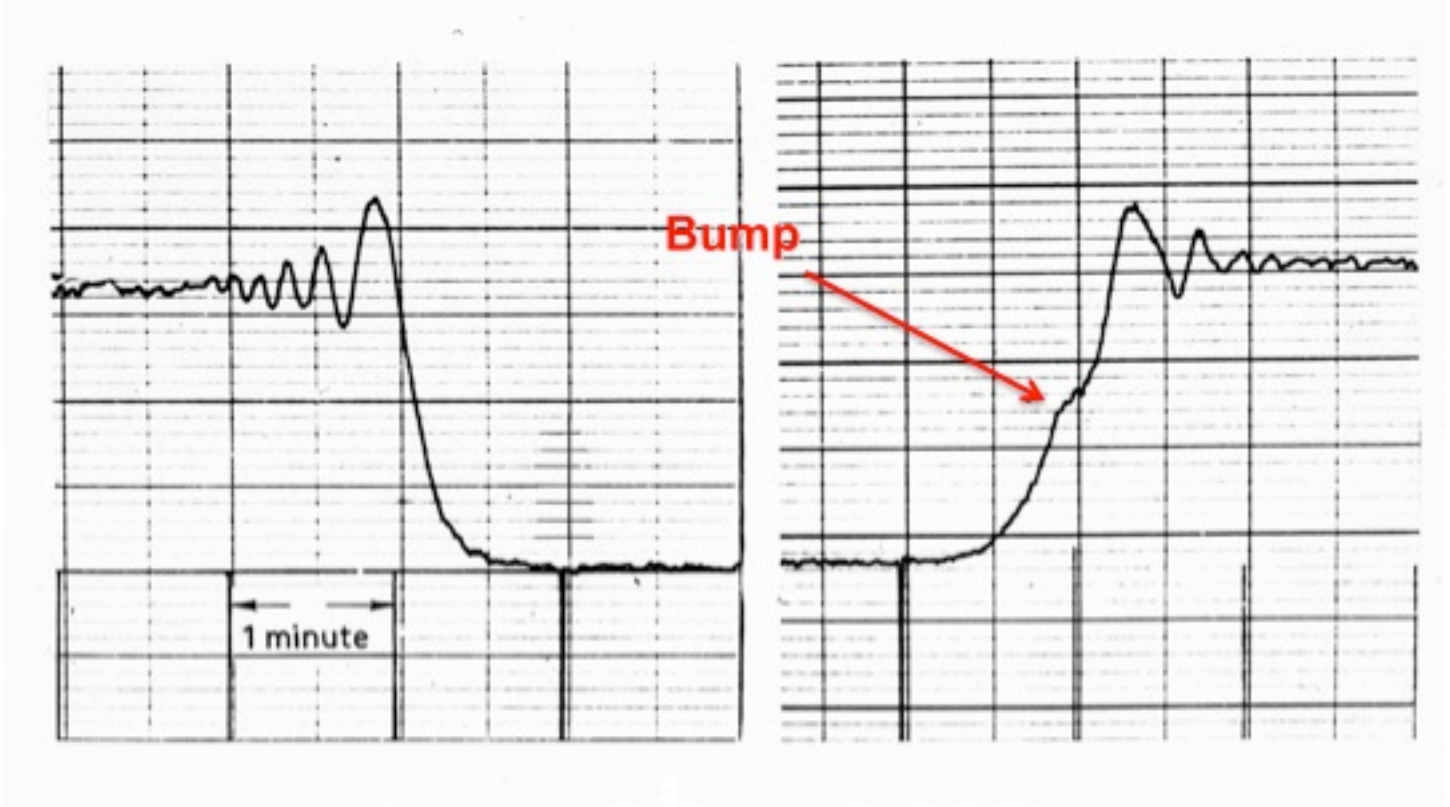
Faraday Rotation: Easter 1962

Magnetic Field is millions of times weaker than the Earth's

CSIRO

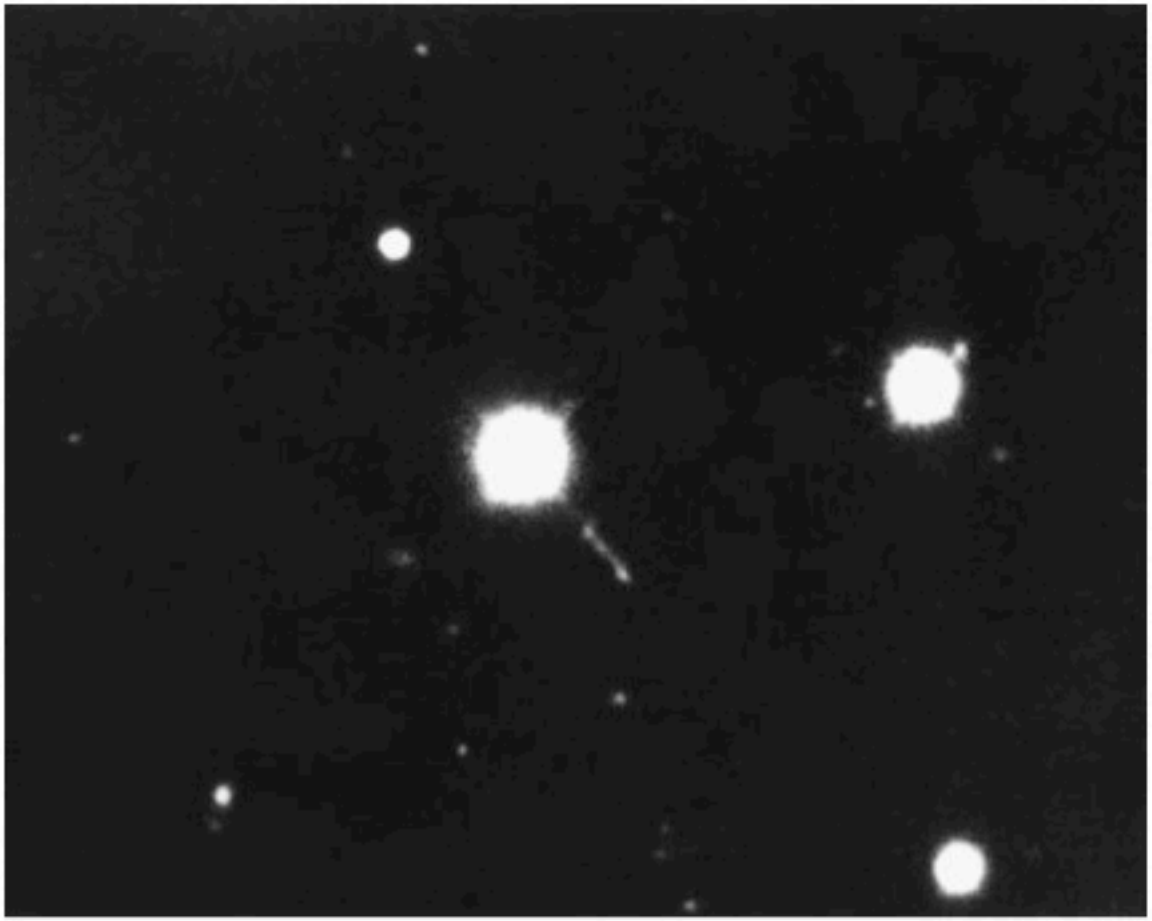
Lunar Occultation

The First Quasar: 3C273



Lunar Occultation: August 1962

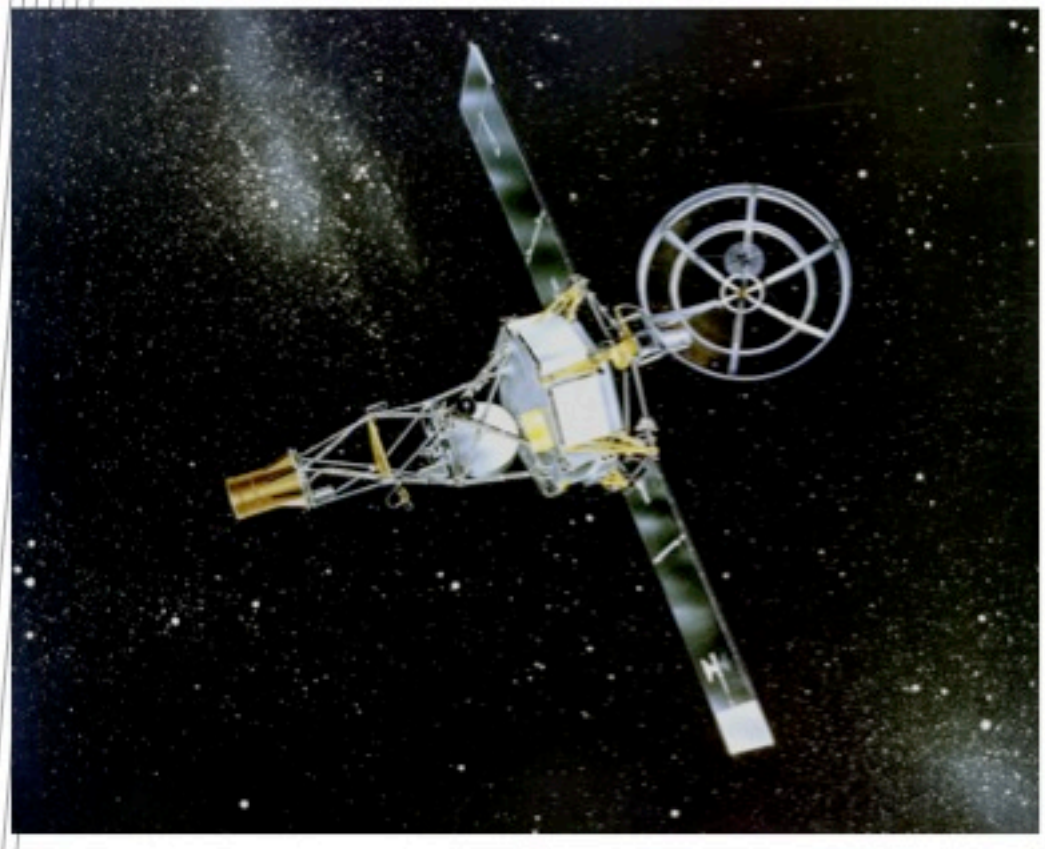
One of the most distant objects



Martin Schmitt from Mt Palomar identified it as very distant

Mariner 2

First interplanetary space probe



Flew by Venus on
14 December 1962

Flew within 34,762 km
of the surface

Mariner 2

A simple experiment measuring

1. Spacecraft position
2. Signal level
3. Doppler frequency

Establish the technique and measure the performance of a 64 metre antenna

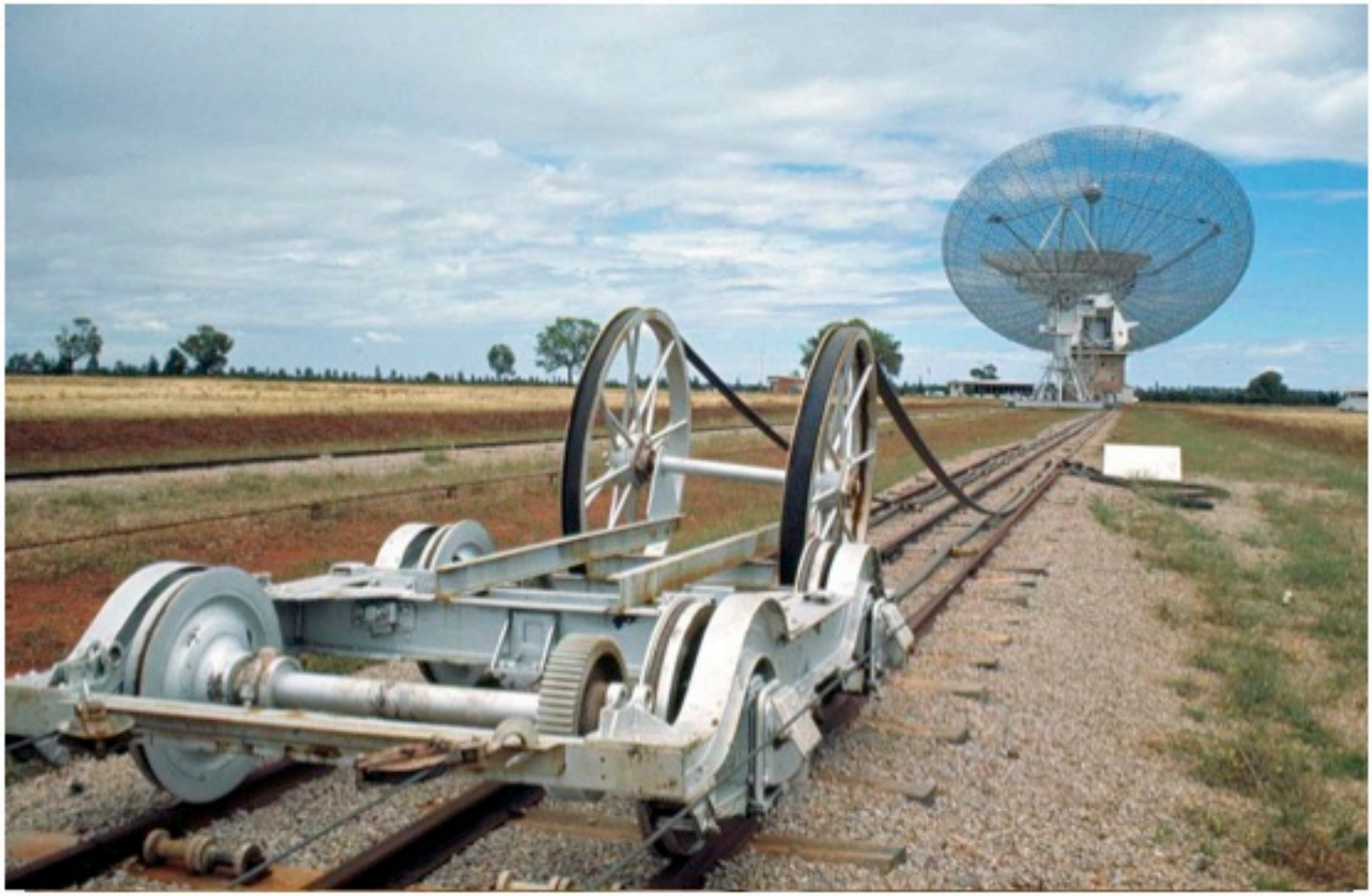
Costs covered by NASA research grant

Mariner 2

Doug Cole

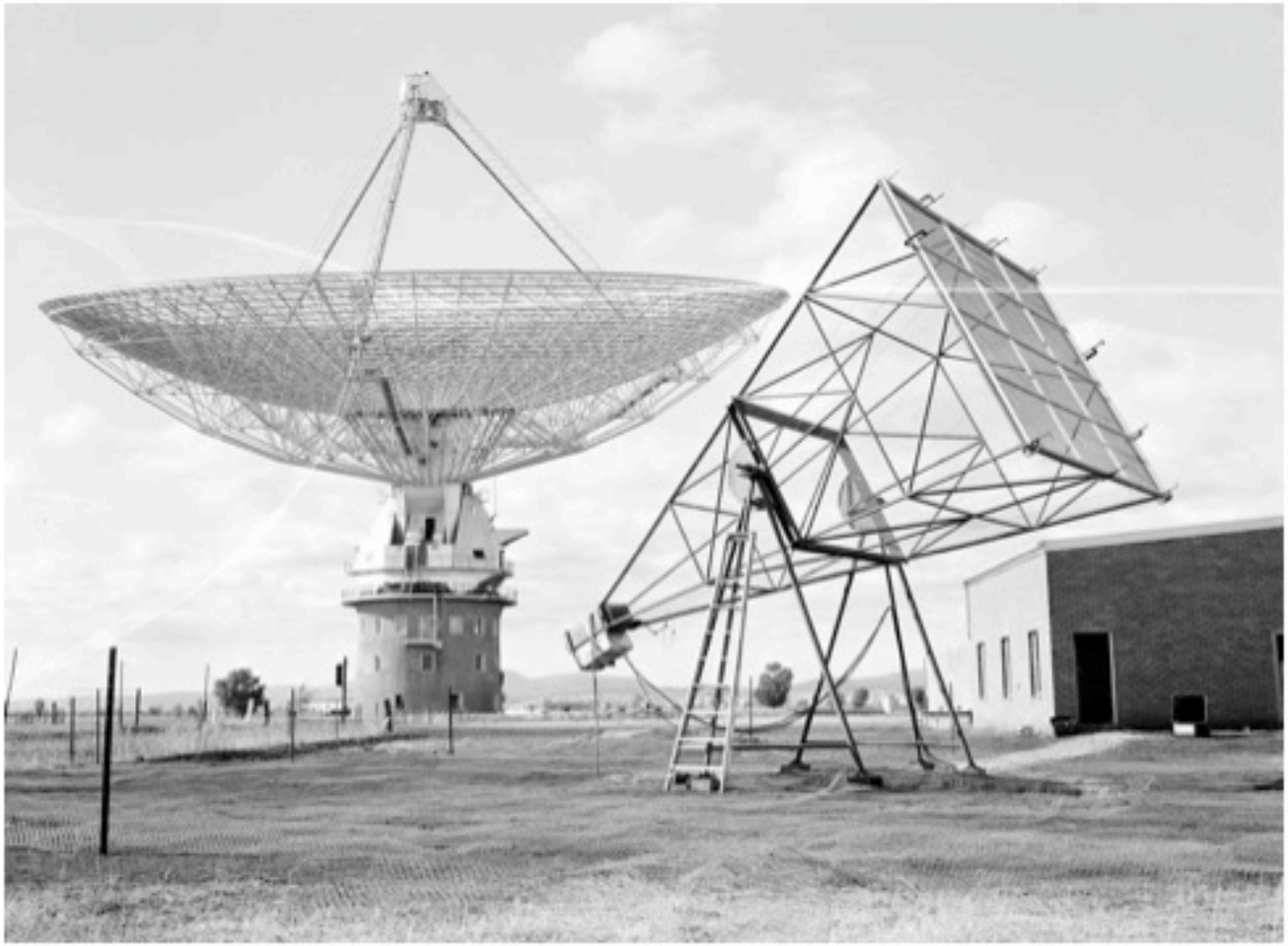
Tracked it for two weeks from
20 December 1962 to 3 January 1963

18m Kennedy Antenna - 1963



Real-time two element interferometer

The Goobang Horn – 1963-1965



Galactic Background Radiation at 400MHz

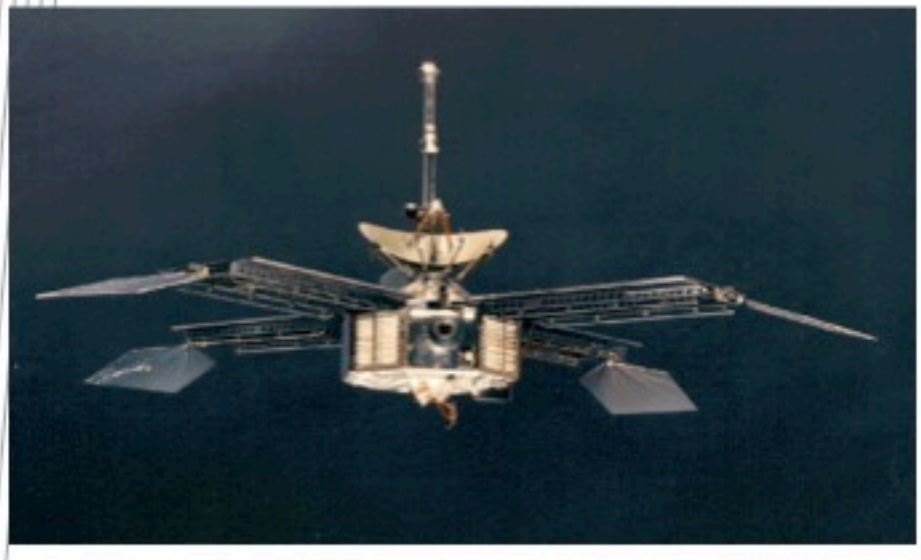
Mariner 4

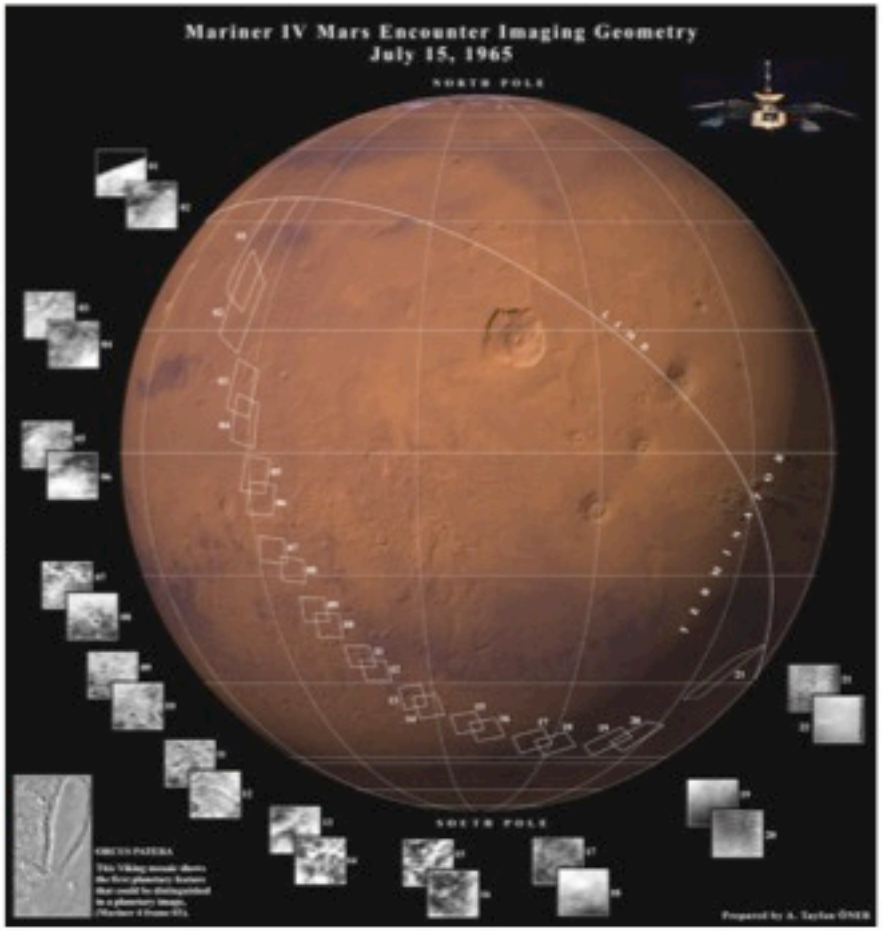
By Mariner 4, the Goldstone 64 metre dish was still one year from completion

Parkes was approached to provide a 64 metre antenna to act as backup for the DSIF

Costs were covered by the NASA research grant

Mariner 4





Flew by Mars on 15 July 1965

Closest approach was 9,846 km

Mariner 4

S-Band transmitter centred on 2300 MHz

8 bits-per-second data rate, and the receiver had just an 11 Hz bandwidth

15 July occultation observation on horizon

Telemetry recordings - 8 July to 27 August

Mariner 4 – Images of Mars

22 images taken of Martian surface

Parkes data was ***3dB better*** than from existing DSIF network

Parkes data combined with others to produce improved images of Martian surface

Mariner 4 – Images of Mars

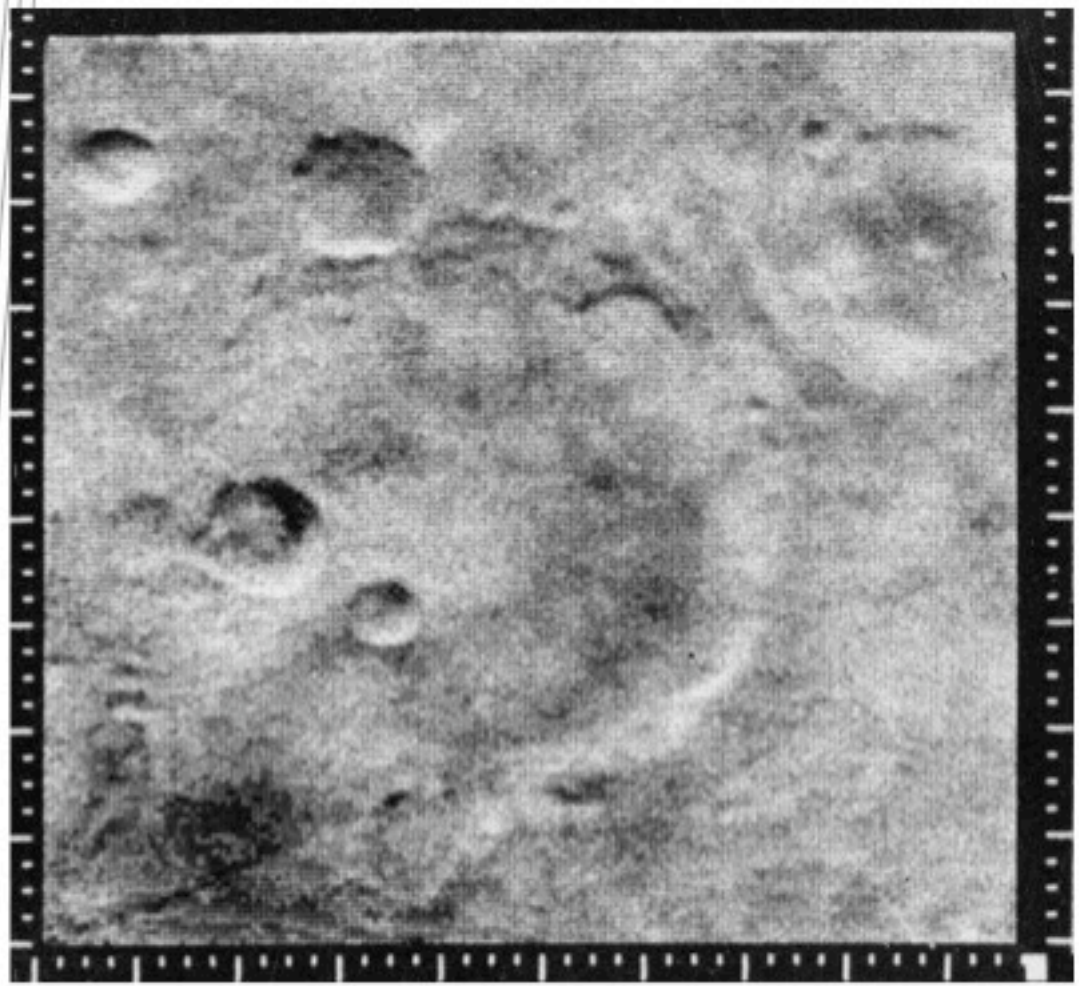


Image 11 was the best

Astronomers were disappointed!

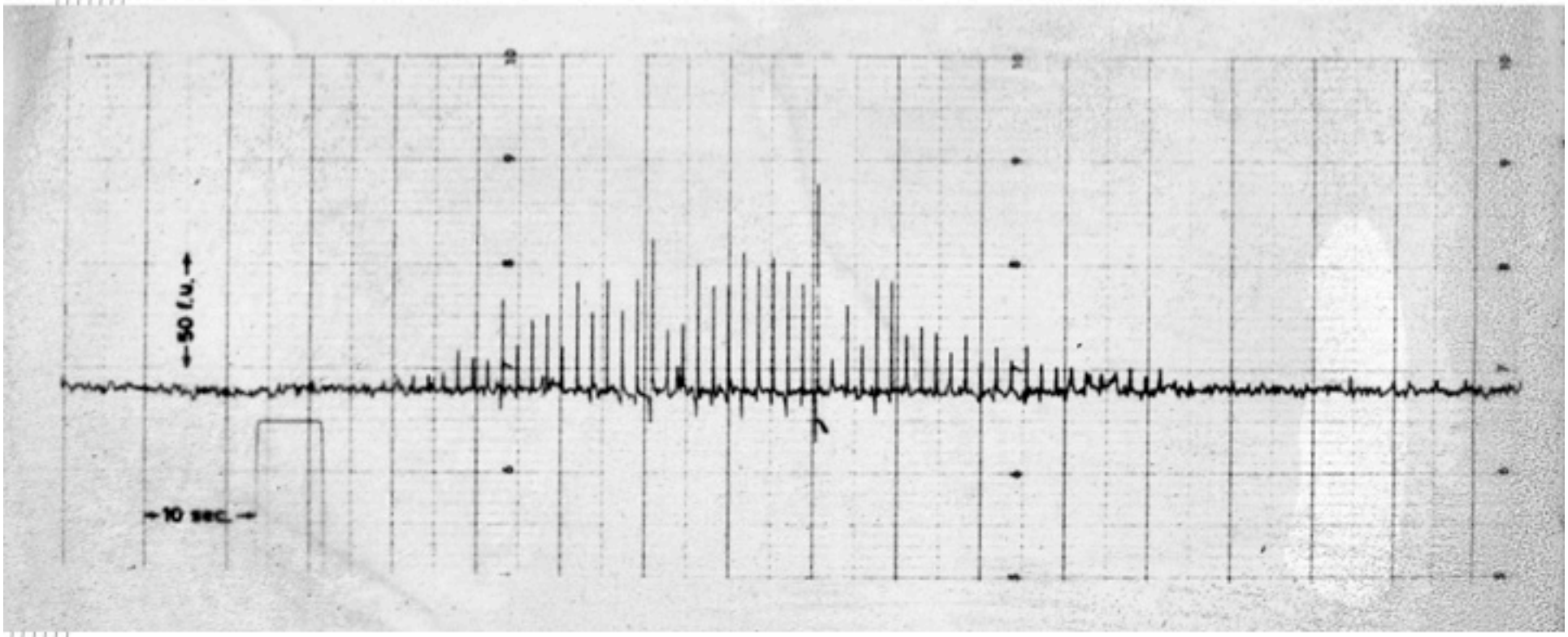
64 metre antennas delayed

In May 1966 the Goldstone 64 metre dish was completed

Budget cutbacks delay the other two antennas

PDP9 Computer - 1968

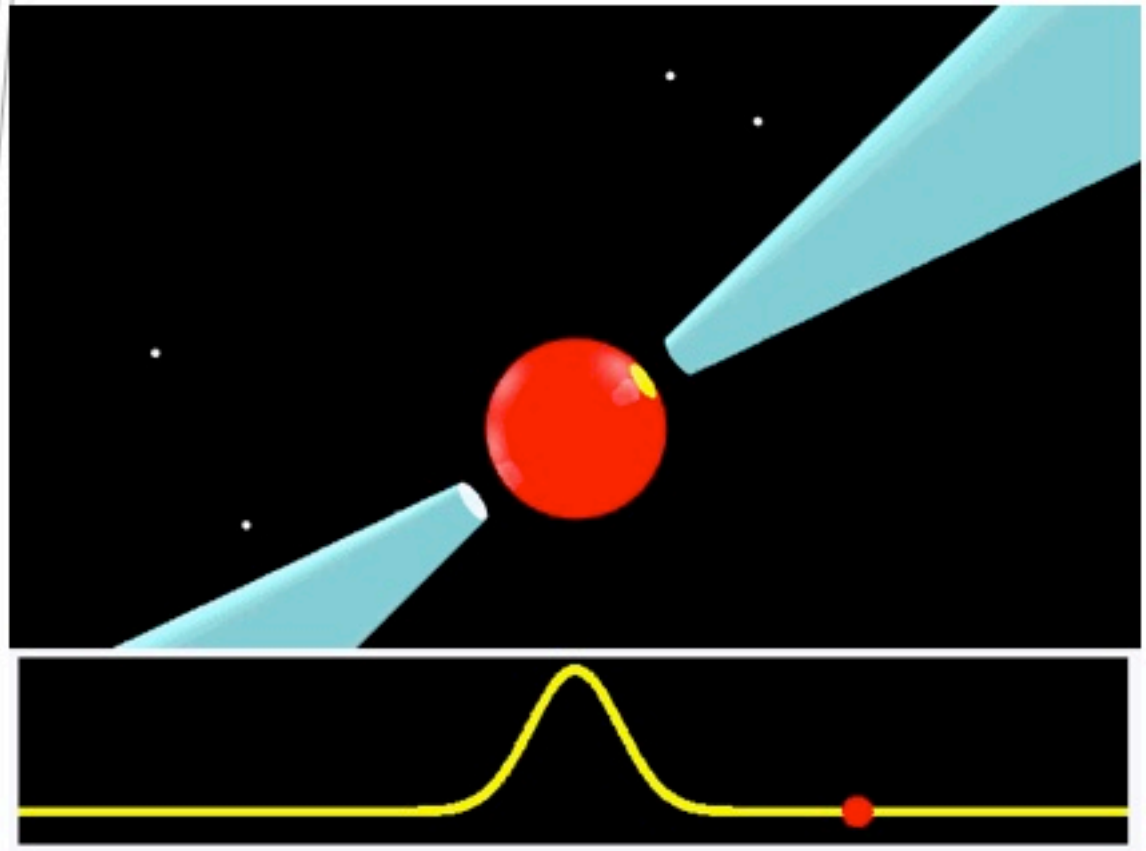
Pulsars at Parkes – 8 March 1968



CP1919 (B1919+21) Robinson and Wielebinski

Pulsars at Parkes – $50 Note

Pulsars



~ 1800 known

Normal Pulsars:
P = 0.05 – 8.5 seconds

MSP:
P = 1.5 - 30 ms

~ 170 known

~3/4 found at Parkes

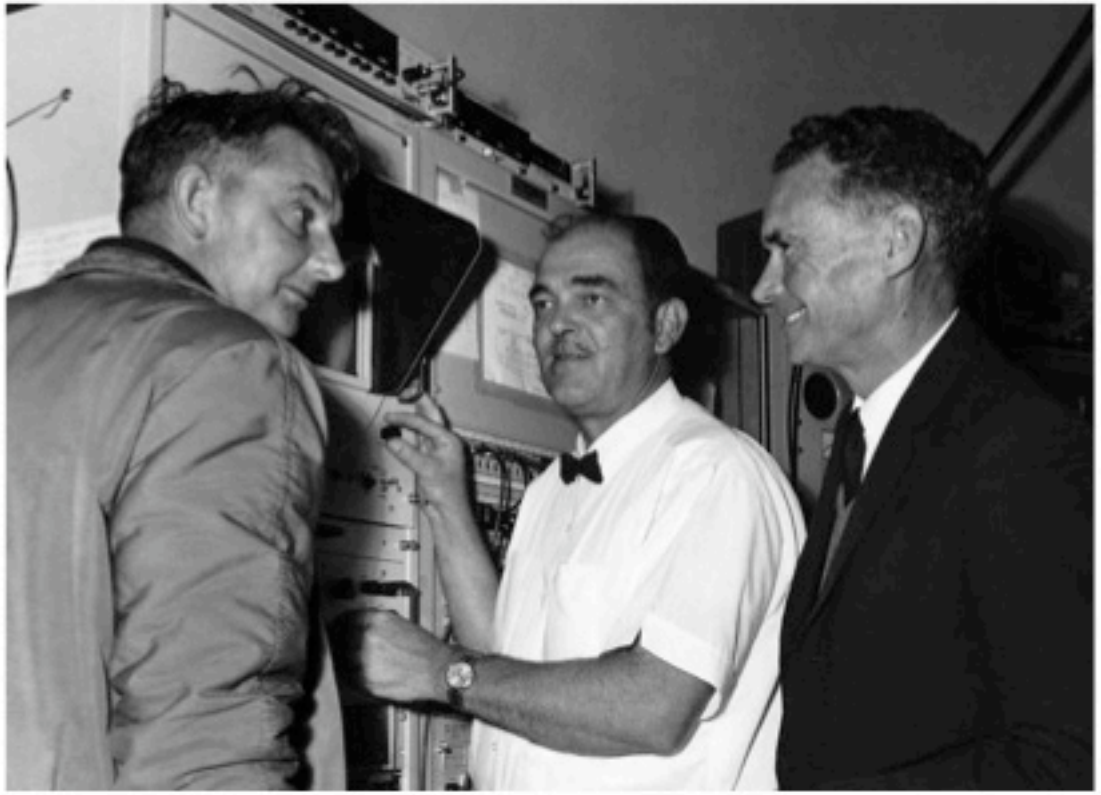
Apollo 11 – An Invitation to Dinner

In October 1968, John Bolton was asked to make Parkes available for the Apollo 11 mission

Because human lives were at risk, both he and Taffy Bowen agree

Dinner was at the home of Bob Leighton -
"Feynman, Leighton and Sands"

Apollo 11



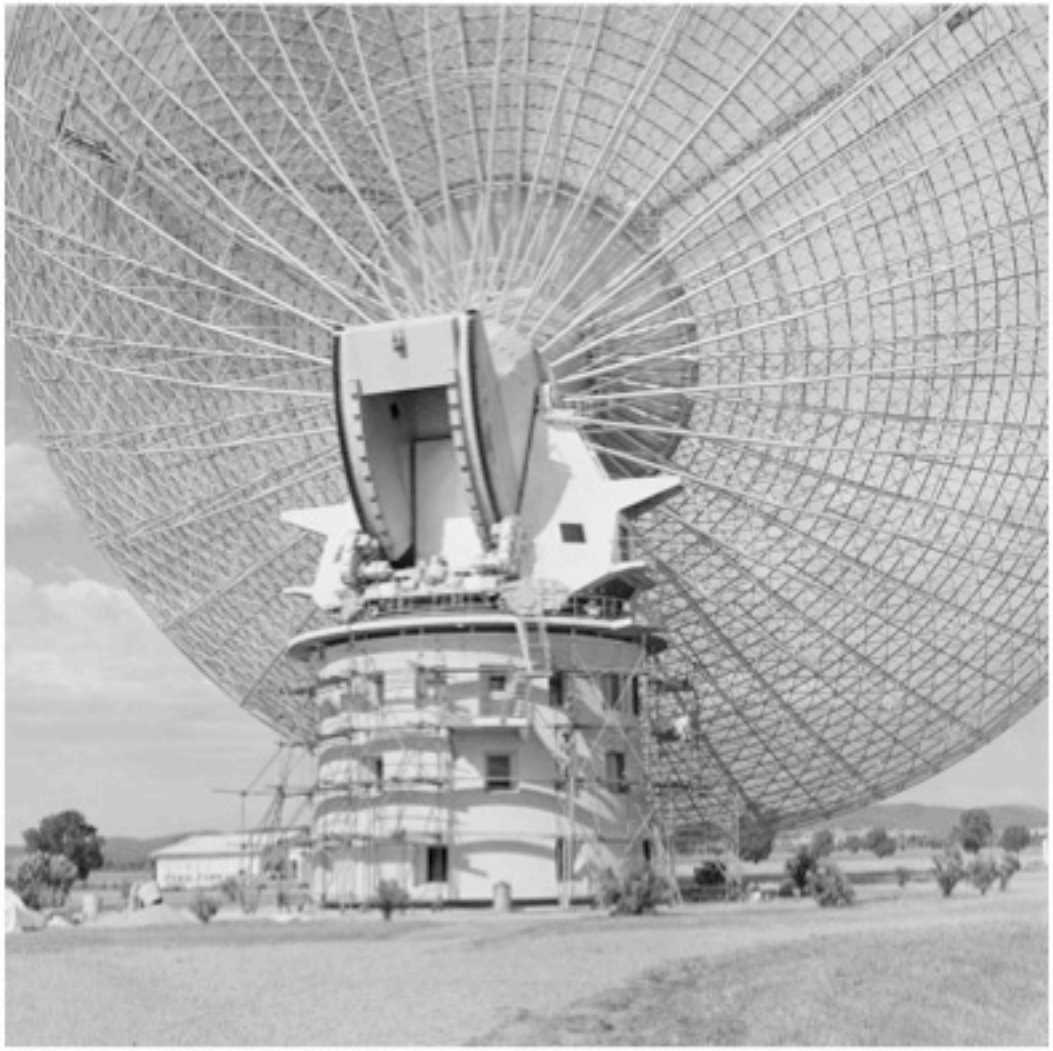
"The CSIRO Radiophysics Division agrees to support the Apollo 11 mission"

Apollo 12

1. Landing was to occur during the Parkes-Honeysuckle Creek viewing period

2. Contract specified that the money's would go toward the "re-skinning" of the dish

Apollo 12 – Strengthening the Tower



Apollo 12

The Parkes Apollo 12 Crew

Apollo 12

Bruce Window and crew with equipment from the *"USNS Vanguard"*

Apollo 12

John Bolton

Apollo 13

"Houston, we have a problem"

Apollo 13

"Houston, we have a problem"

Apollo 13

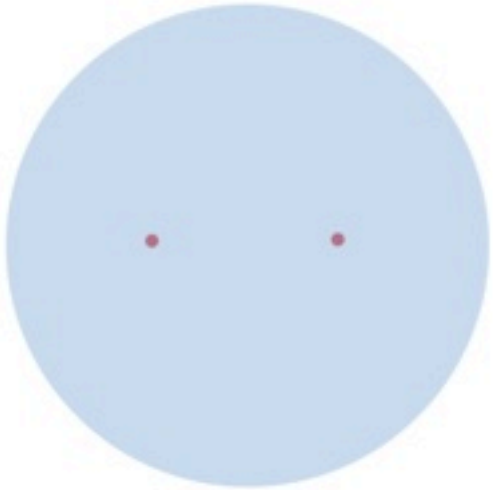
1. Little power aboard the Apollo spacecraft
2. Fast dumps of data
3. Interference from the Saturn third stage transmitter
4. Parkes had a narrow beamwidth

Apollo 13

SIV-B
Third Stage

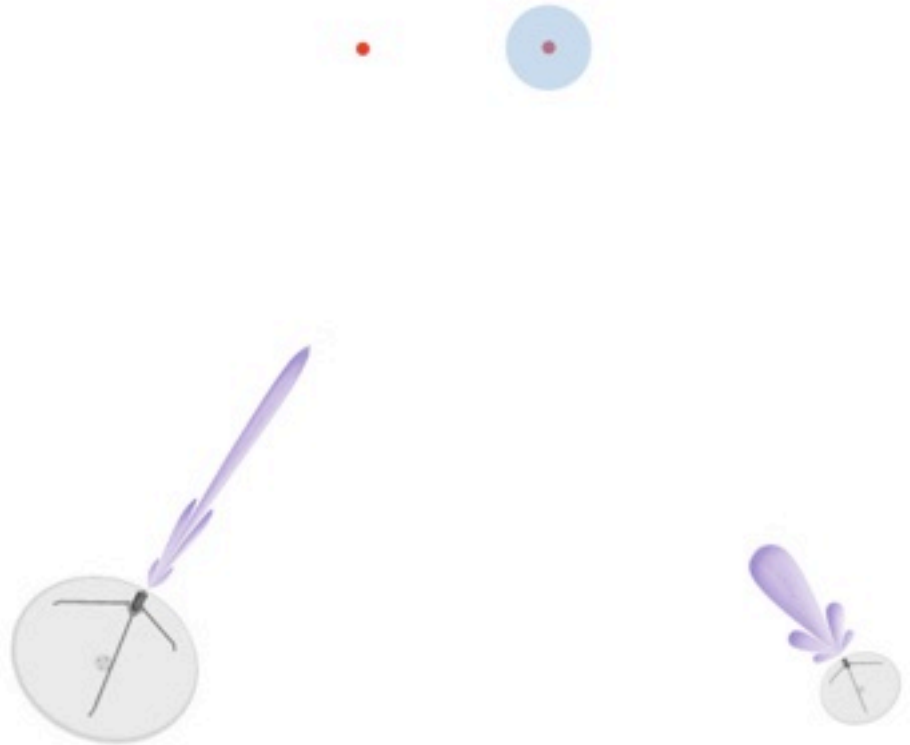
The *"Aquarius"*

Apollo 13



Apollo 13

Apollo 13



Apollo 13

Tracking Apollo 13 at the Moon

Apollo 13

As a gesture of goodwill to the United States, CSIRO Chairman, Dr. Frederick White, decided that the CSIRO would assume the costs of bringing the Parkes telescope into commission.

Resurfacing the Dish - 1970

Replacing the inner 37 metres with perforated aluminium panels

Resurfacing the Dish - 1970

Replacing the inner 37 metres with perforated aluminium panels

Resurfacing the Dish - 1970

Replacing the inner 37 metres with perforated aluminium panels

Apollo 15

Panoramic control room scene

Apollo 15

Apollo 15

Molecular Astronomy – Early 1970's

Collaboration with Monash University Chemists – Ron Brown and Peter Godfrey

1971 – Thioformaldehyde (HCHS)

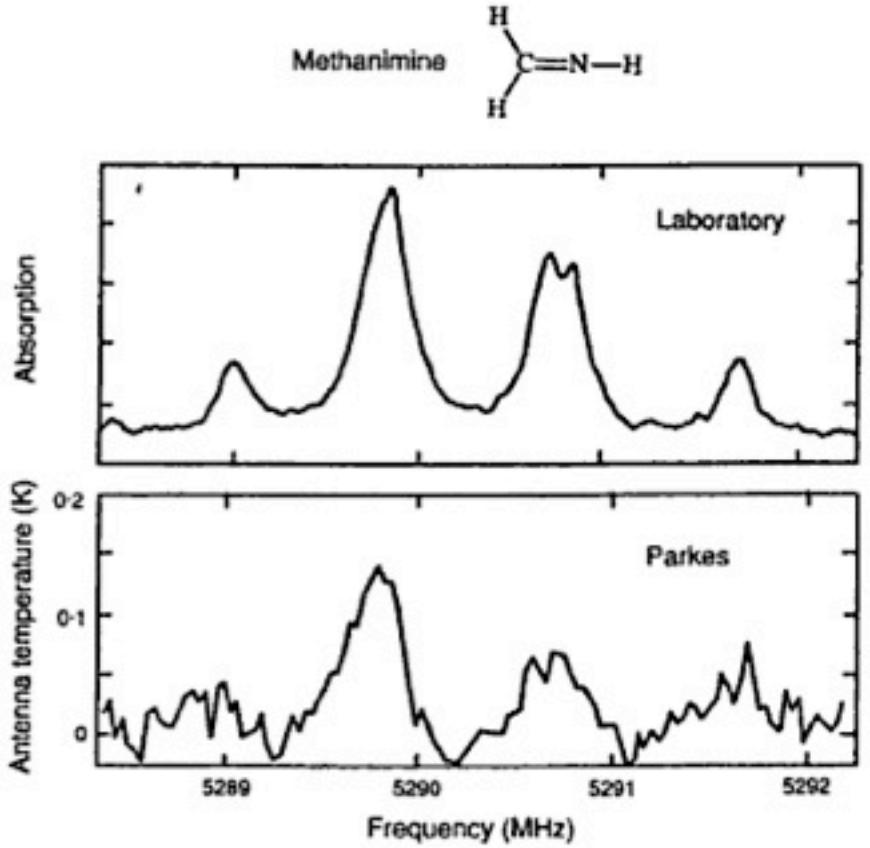
1972 – Methanimine (CH_2NH) found in Sagittarius B2

1972 – Methyl Formate ($HCOOCH_3$)

1972 – Vinyl Cyanide (CH_3CHCN)

1973 – Methylamine (CH_3NH_2) found in Sagittarius and Orion

Molecular Astronomy - 1971



The pair of records that led to the discovery of interstellar methanimine in May 1972. The laboratory spectrum of the molecule measured at Monash University (above) matches closely with the spectrum of the source Sagittarius B2 recorded shortly after at Parkes.

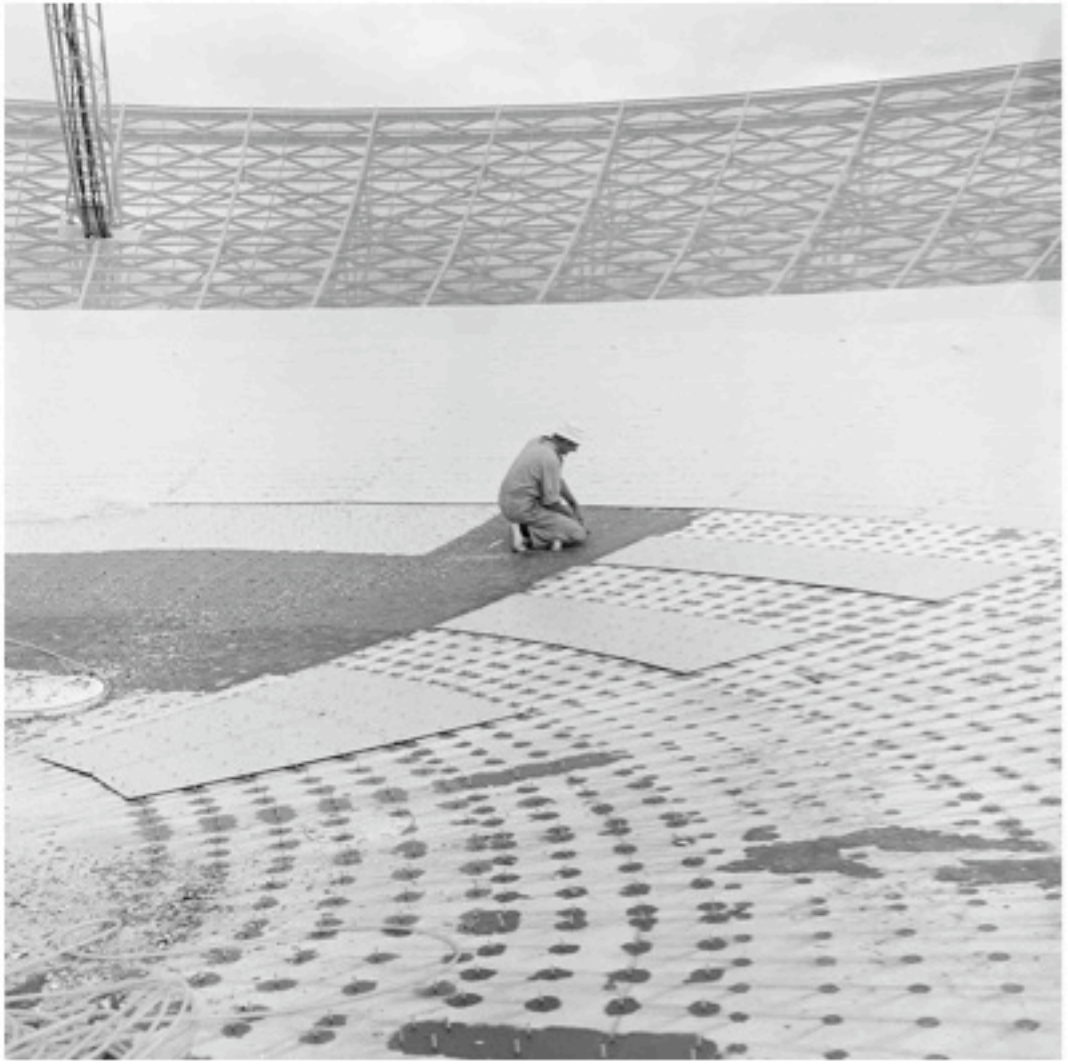
Molecular Astronomy

In 1973 Brian Robinson proposed that a new 25m antenna be built for millimetre wave astronomy (~2mm) either at Parkes or Culgoora. The cost would be about $3 million.

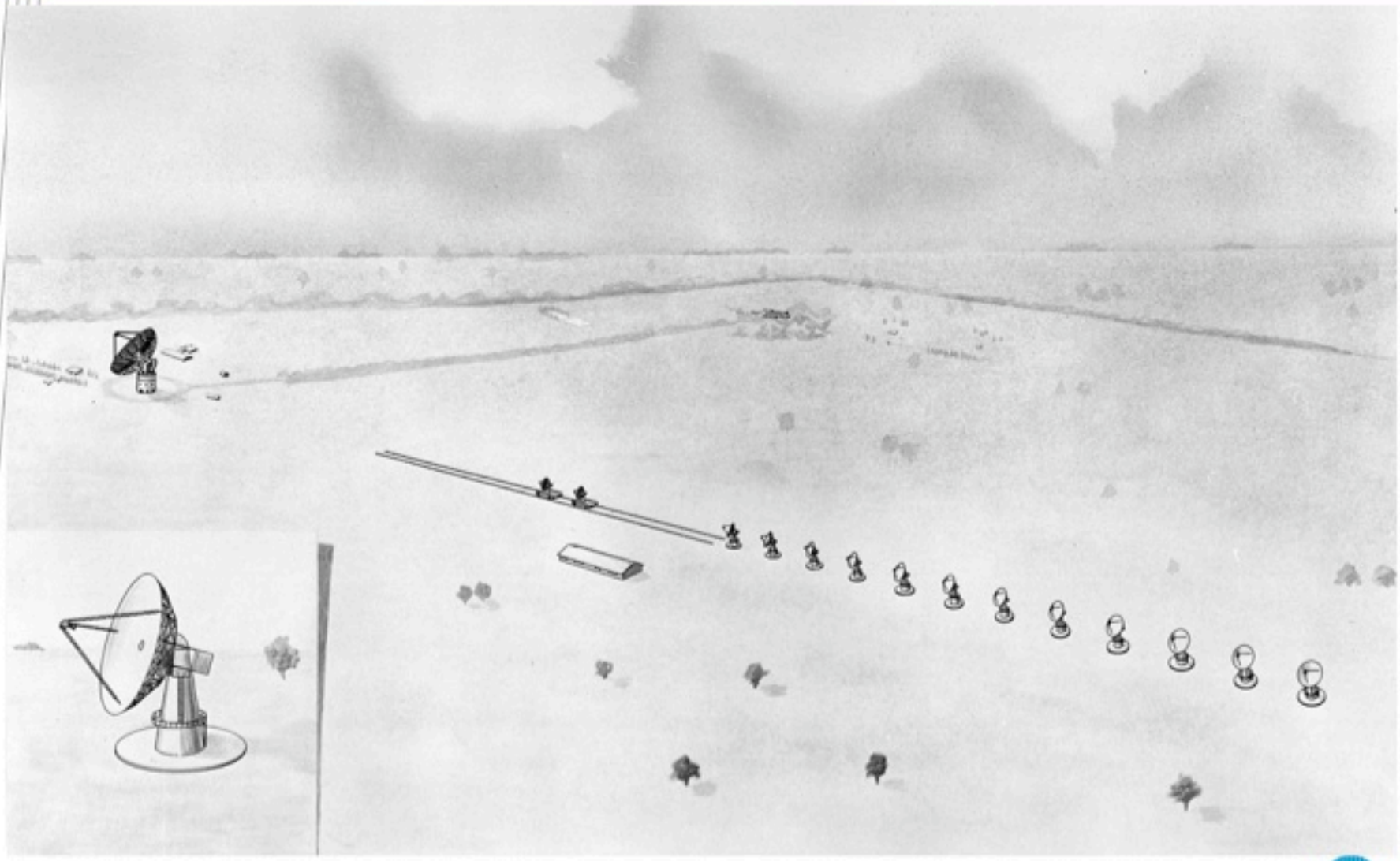
A vote was taken of all Radiophysics staff and the large synthesis telescope (later known as the compact array) won out.

Instead, in 1975 the inner 17m of the Parkes telescope was re-skinned for operation down to 5mm.

17m Upgrade - 1975



The TEST Project – Late 1970's



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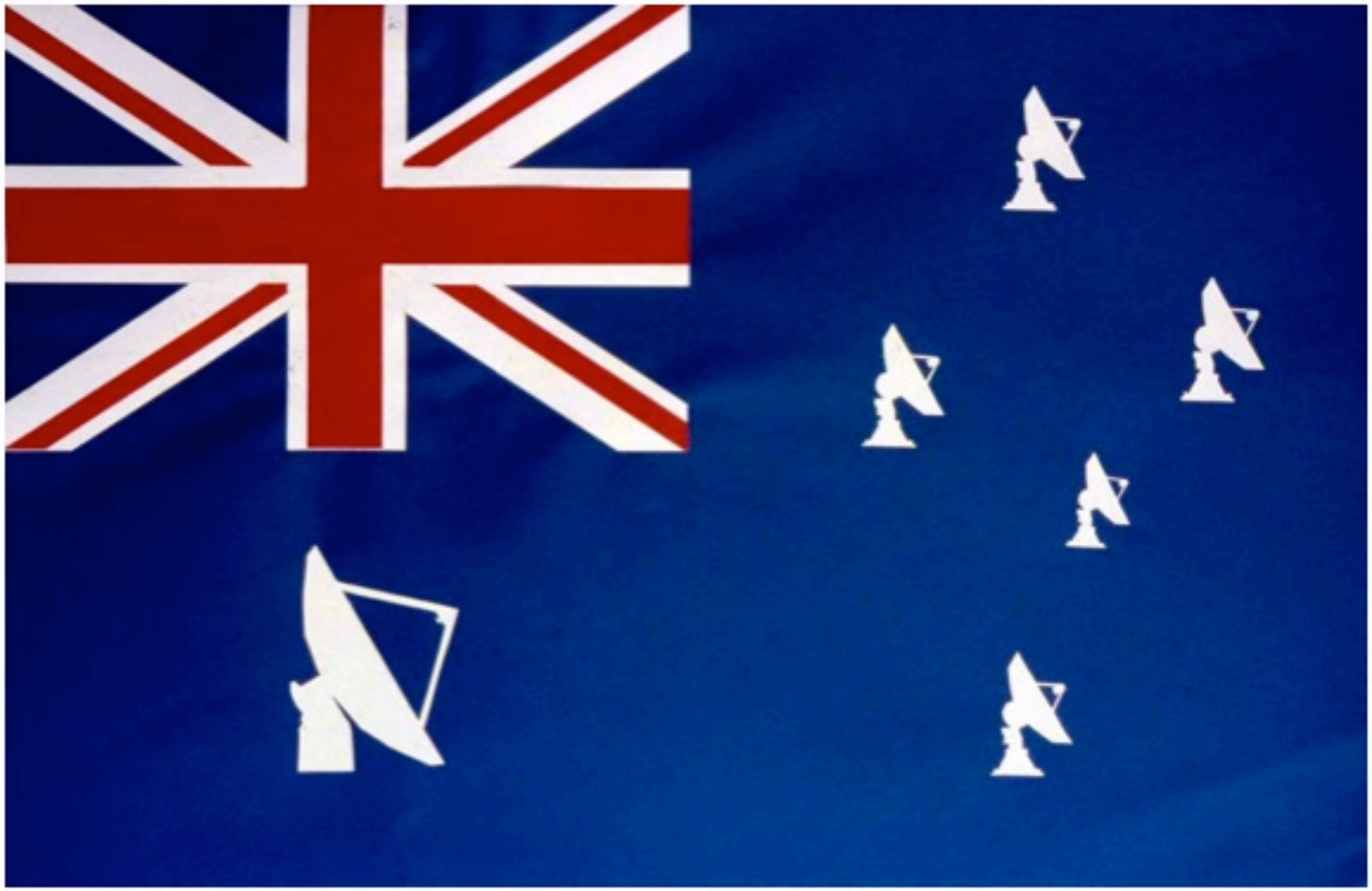
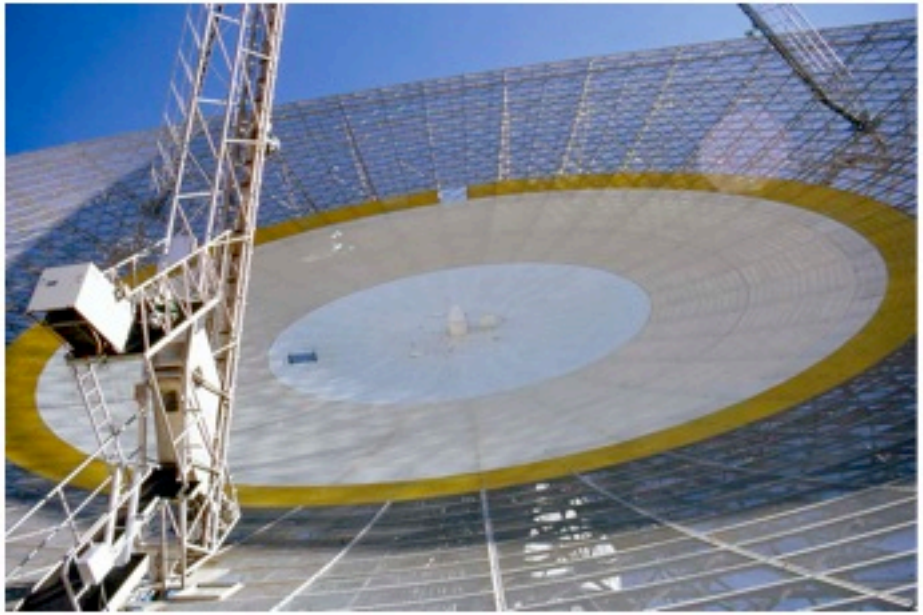


Modernisation – 1984

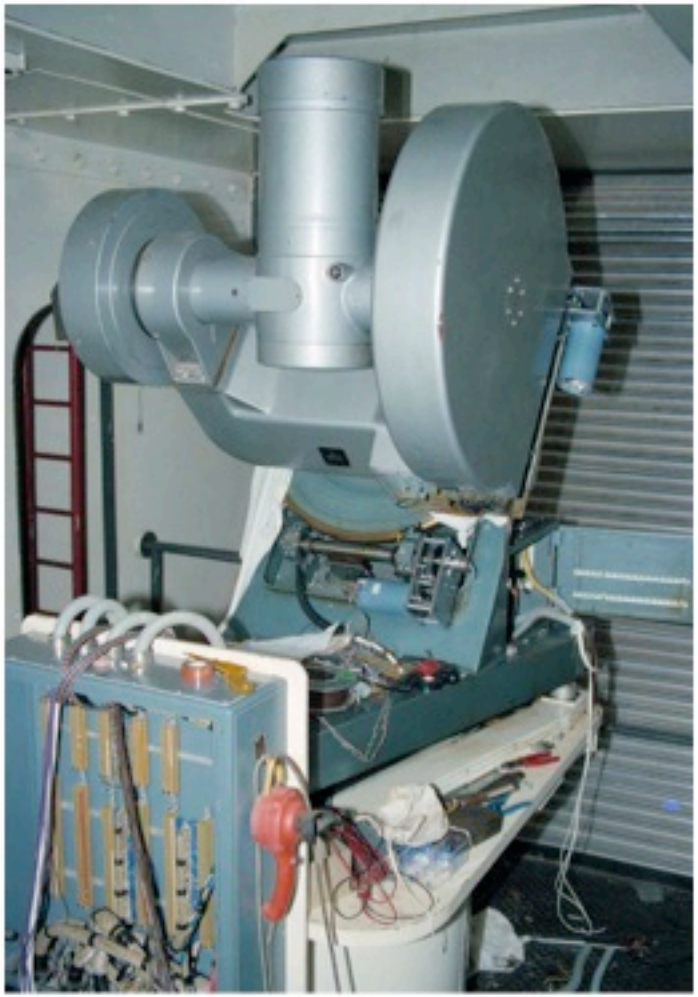


Reskinning the surface to 45m

Modernisation – 1984

Replacing the Old Control Desk

Modernisation – 1984



The Master Equatorial Upgraded

Modernisation – 1984

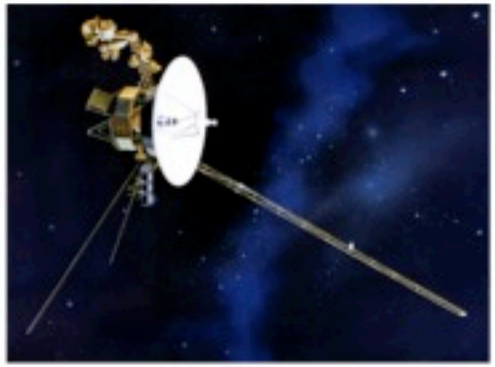
Refurbishing the Zenith Axis Gears

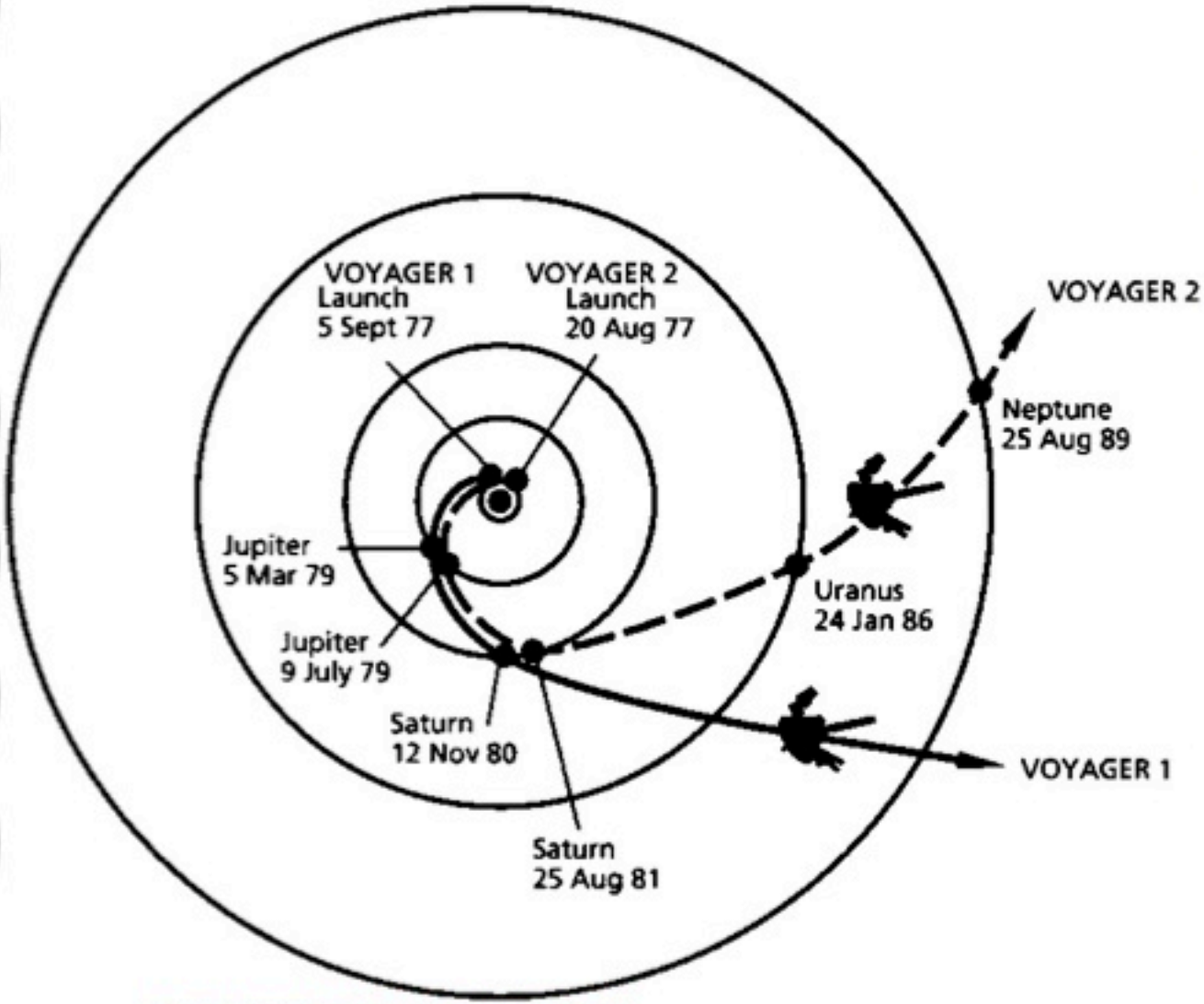
Modernisation – 1984

Refurbishing the Zenith Axis Gears

Modernisation – 1984

Voyager 2 – The Grand Tour





Voyager 2: Uranus – January 1986

Parkes was originally to be used as a backup for the 64 metre dish at Tidbinbilla.

But by linking the Parkes and Tidbinbilla dishes, the sensitivity was doubled.

$2 million duplex, microwave link installed to combine the signals in real-time.

Voyager 2: Uranus – January 1986

11/12 GHz microwave link

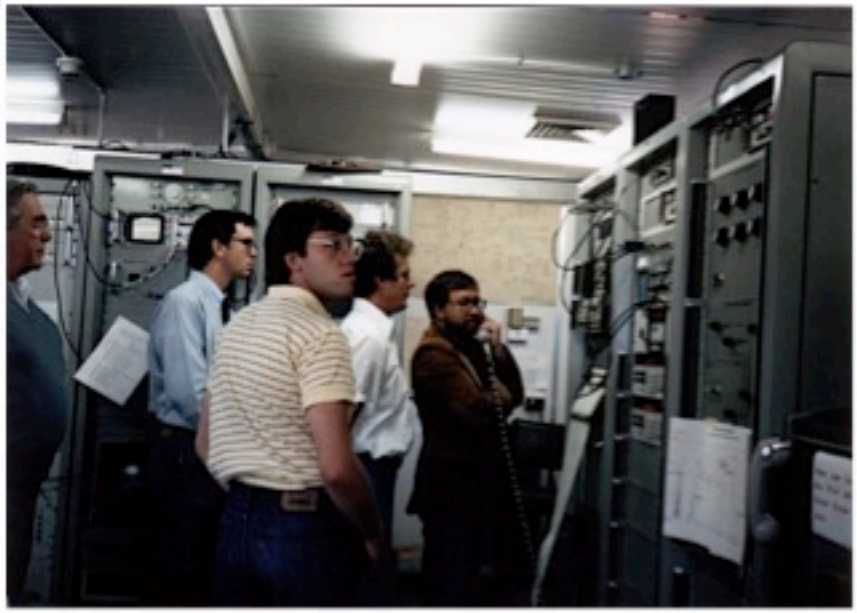
Voyager 2: Uranus – January 1986

NASA Hut

Voyager 2: Uranus – January 1986

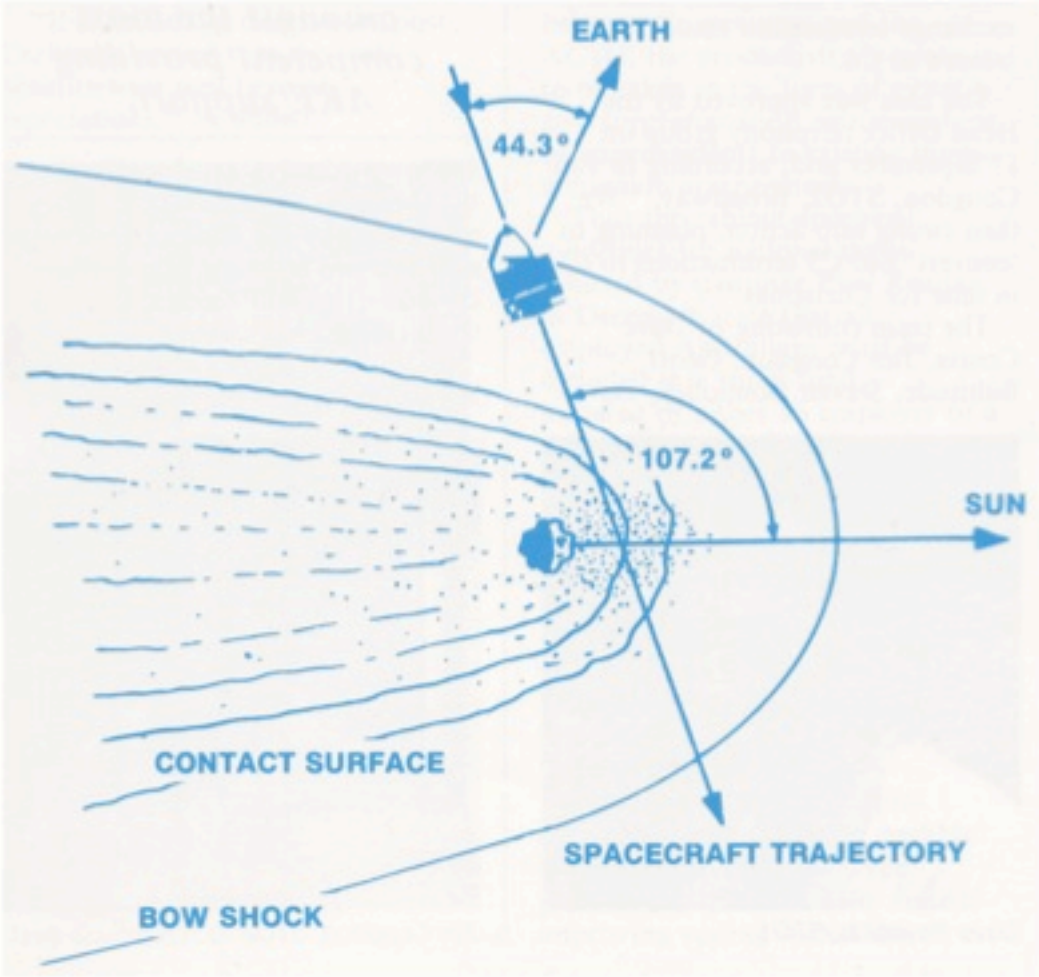
CSIRO

Voyager 2: Uranus – January 1986



Watching the encounter with Miranda

Missions: Giotto: Once in a Life-Time



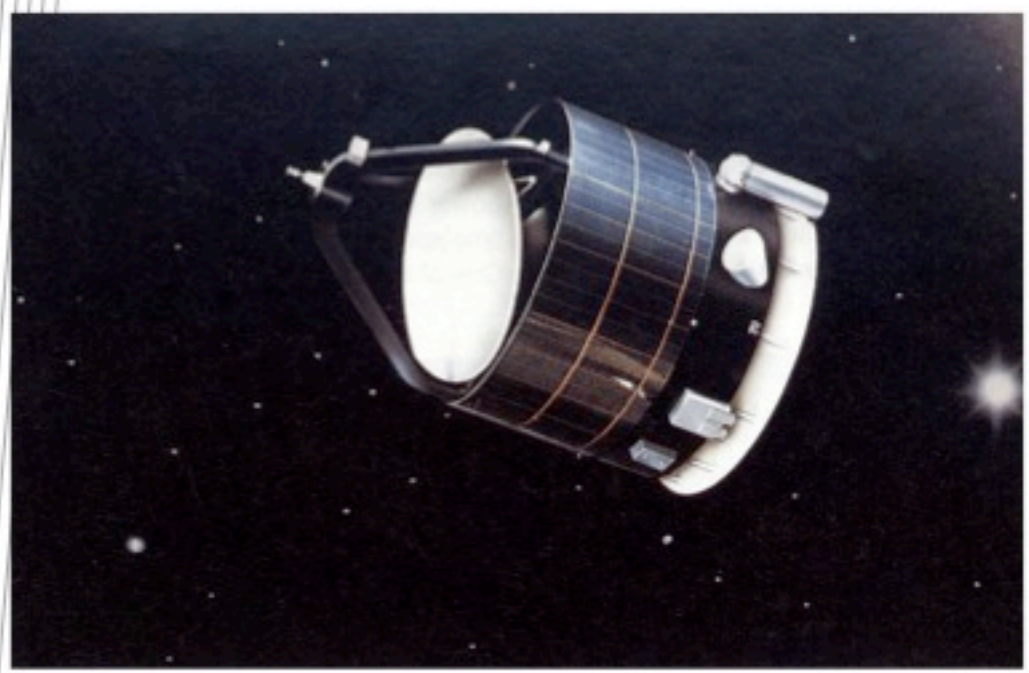
World-wide Media Interest

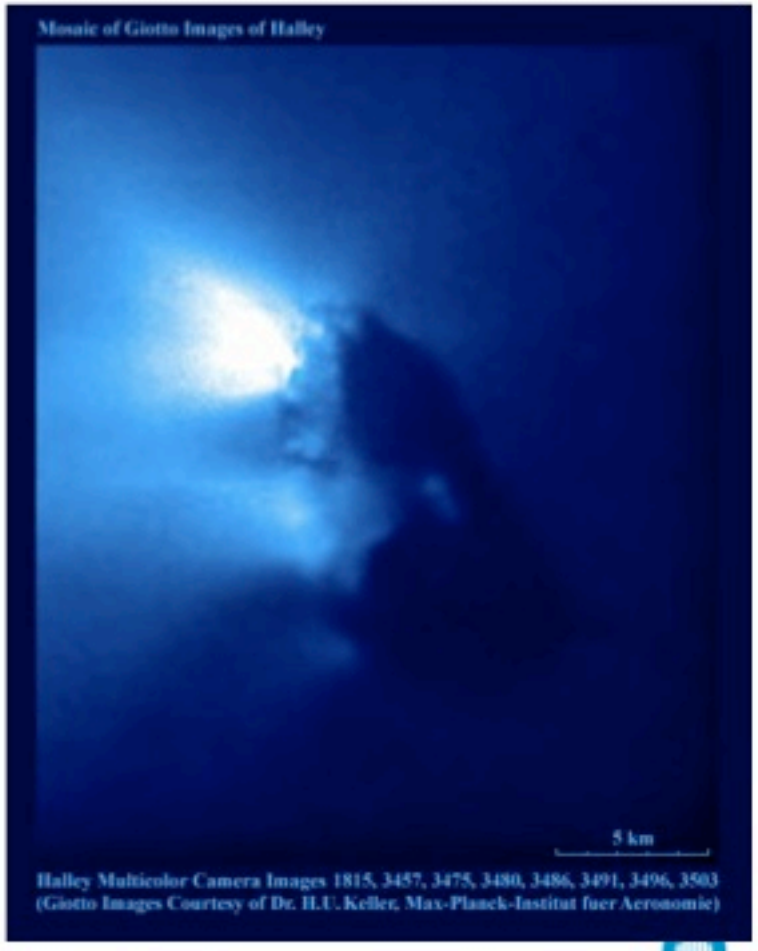
Boris Smeds at Parkes in 1986 for

ESA's Giotto mission

Missions: Giotto: Once in a Life-Time

The *"Dirty Snow-ball"* confirmed

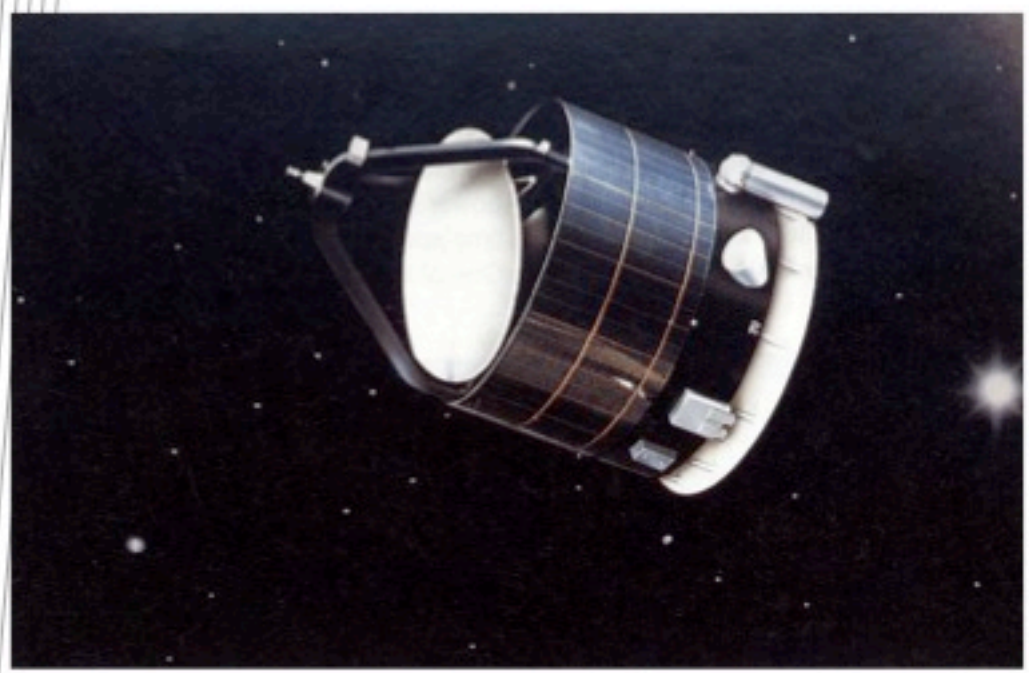


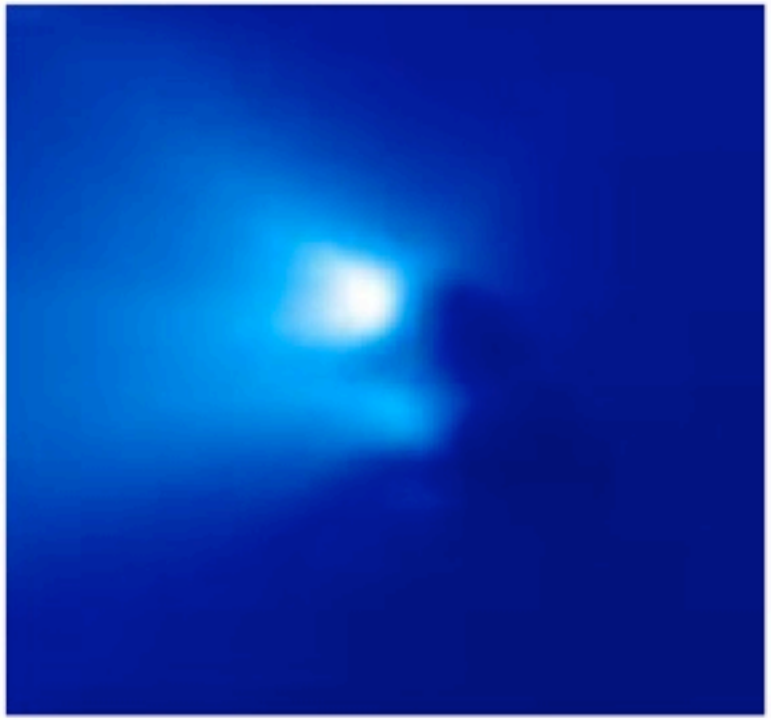


CSIRO

Missions: Giotto: Once in a Life-Time

The *"Dirty Snow-ball"* confirmed





Missions: Giotto: Once in a Life-Time

Celebrations

Voyager 2: Neptune – August 1989

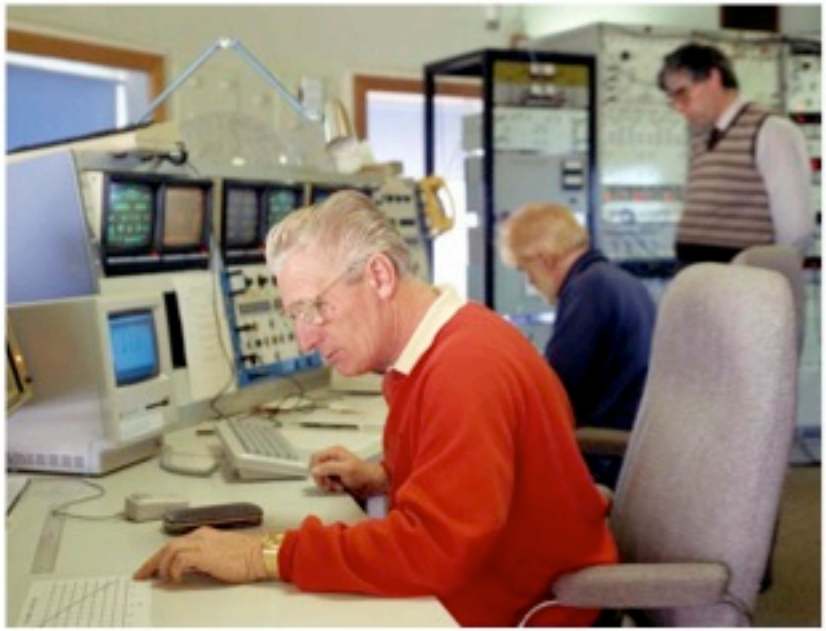
Robina Otrupcek

Terry Williams

Voyager 2: Neptune – August 1989

The Tidbinbilla Crew in the NASA Hut

Voyager 2: Neptune – August 1989

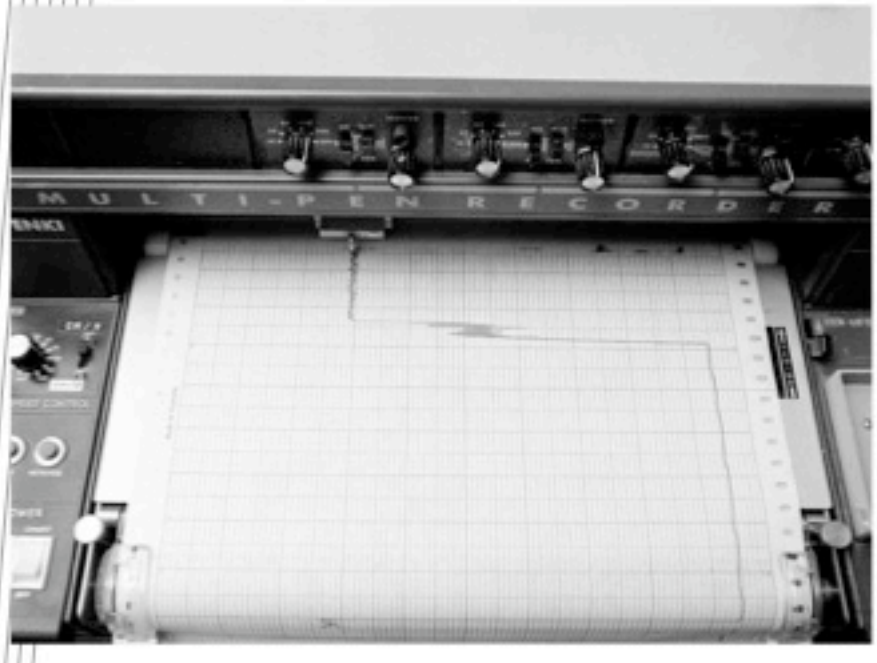


All hands on deck

Voyager 2: Neptune – August 1989

The moment of closest approach

Voyager 2: Neptune – August 1989



Celebrations

Project Phoenix - 1995

Six month Stay

A Year with Galileo

18 October 1989

A Year with Galileo

High gain antenna fails to unfurl

Bit rate down from 134,000 bps to just ***10 bps***

A Year with Galileo

Fortunately it takes 6 years to reach Jupiter

Link or *"array"* dishes to increase bit rate to 160 bps

Salvage 70% of the science planned

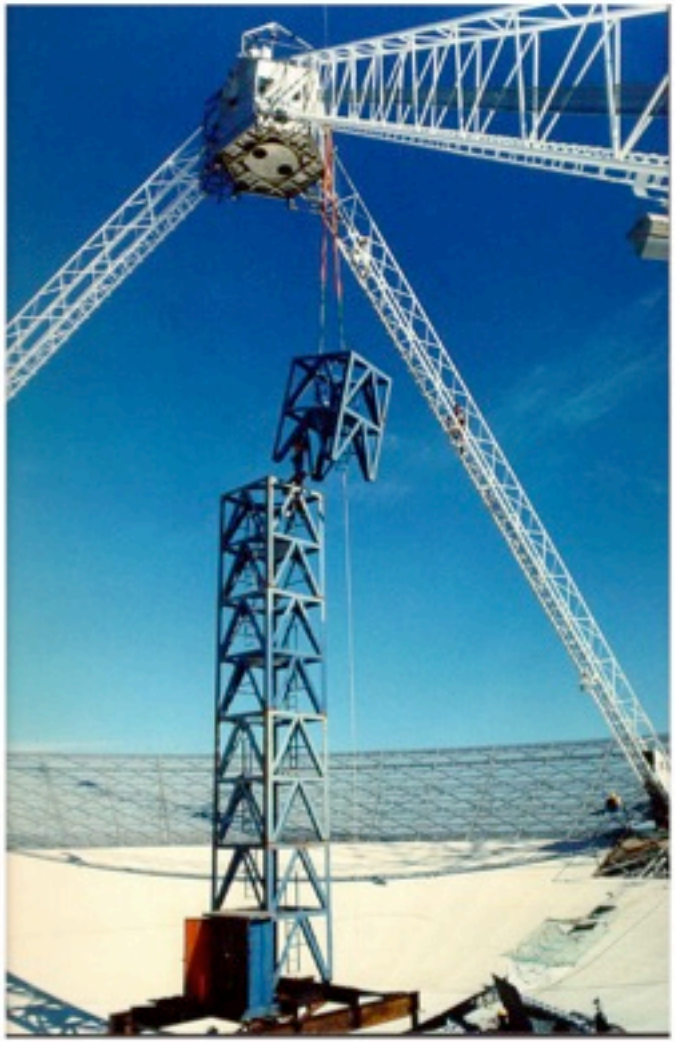
A Year with Galileo

Parkes contracted to track the spacecraft for one year

Dish needs to be upgraded with new, larger focus cabin

A new very sensitive S-band receiver built

A Year with Galileo



A Year with Galileo

A Year with Galileo

A Year with Galileo

A Year with Galileo

New focus cabin is twice the size of the old one

Greater *"frequency agility"*

A Year with Galileo

Cryogenically cooled S-band receiver

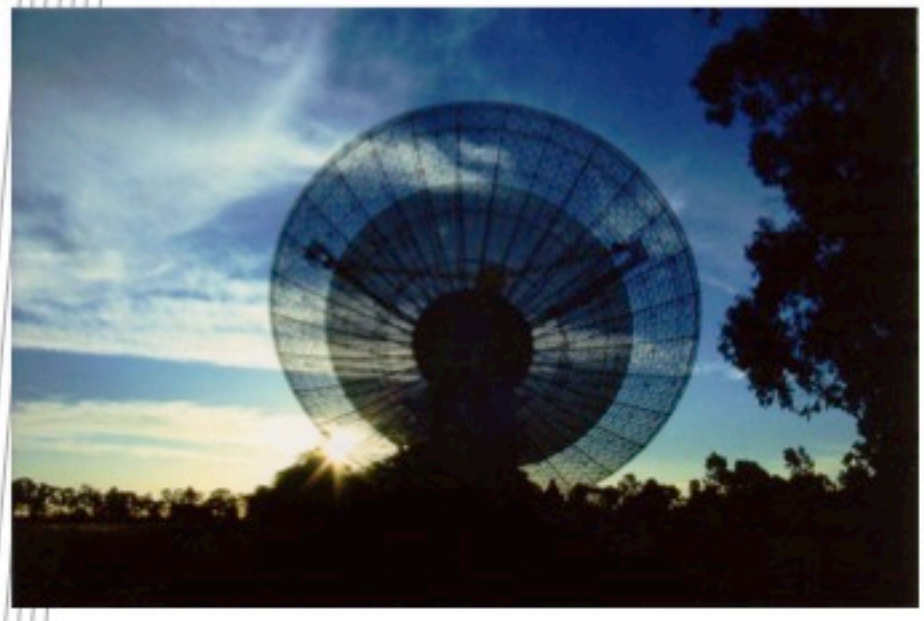
A Year with Galileo

Official Opening with Dr Ed Stone

A Year with Galileo

CSIRO

A Year with Galileo



Tracking Galileo

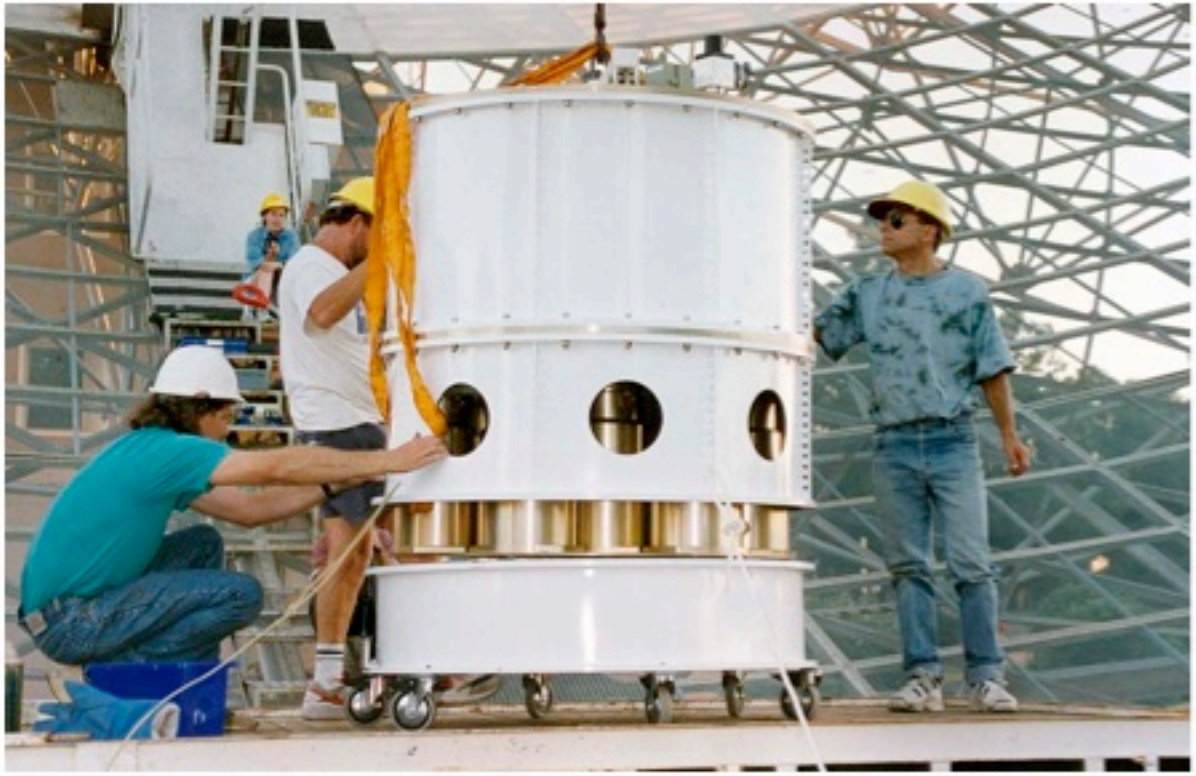
28 October 1996 to 6 November 1997

CSIRO

A Year with Galileo

96.95% uptime!

The 20cm Multi-Beam Receiver: A Rebirth



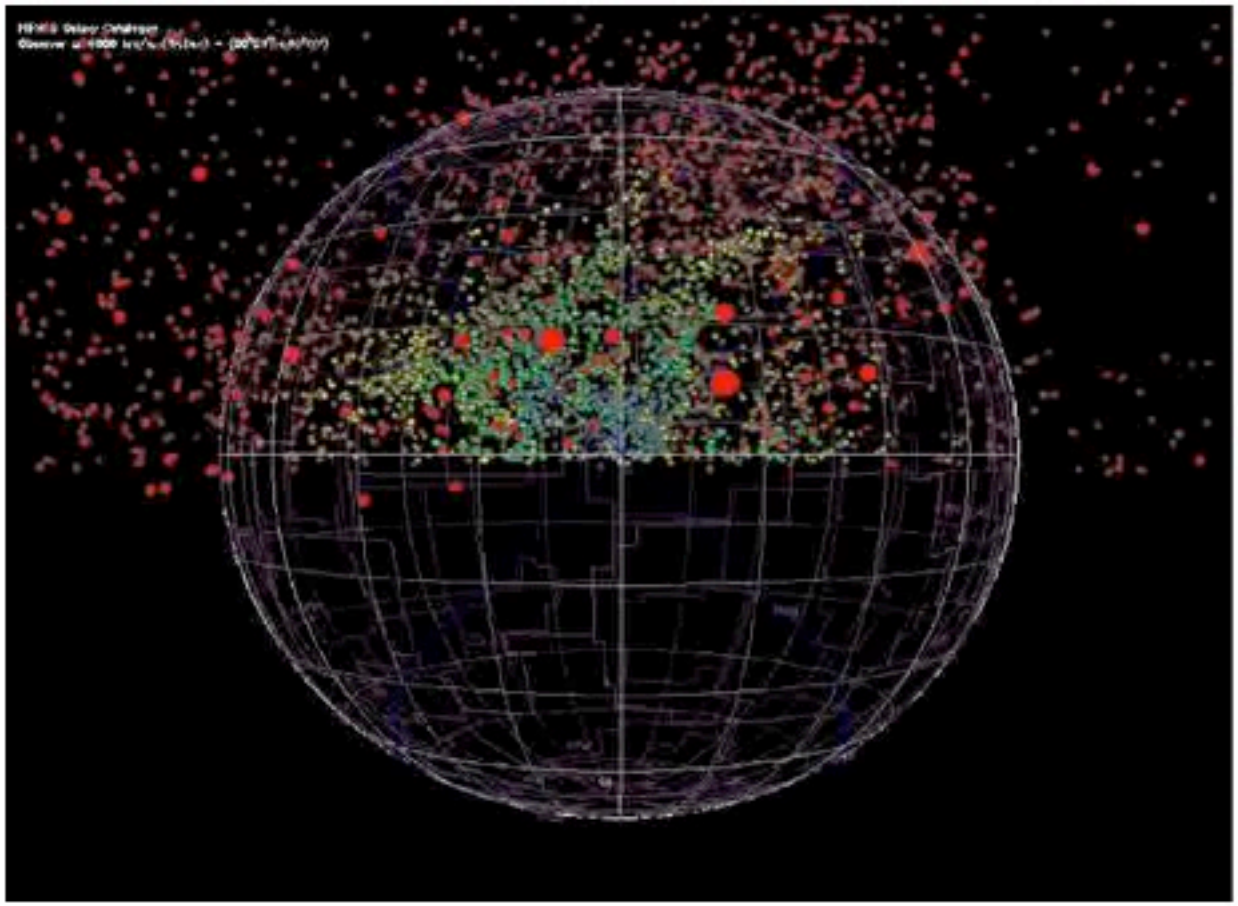
The Legacy of Galileo

The 20cm Multi-Beam Receiver

21cm

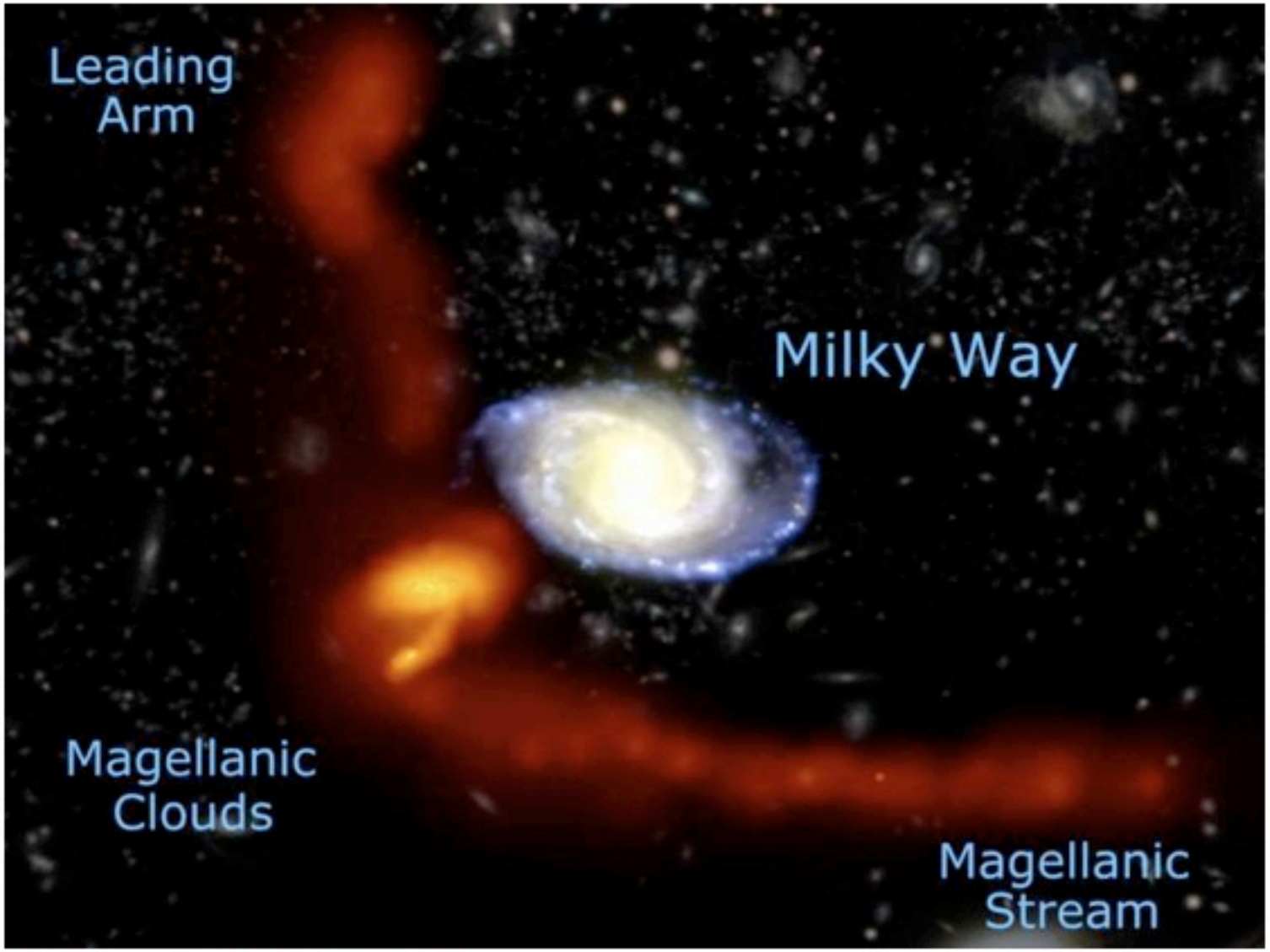
Frequency range:	1.23-1.53 GHz
Bandwidth:	300 MHz
Tsys:	23.5 K
Sensitivity:	1.7 Jy/K
Polarisation:	26 x L
FWHP:	14’

HIPASS Survey – 1997-2001



The HIPASS Movie by Mark Calabretta

HIPASS Survey – 1999



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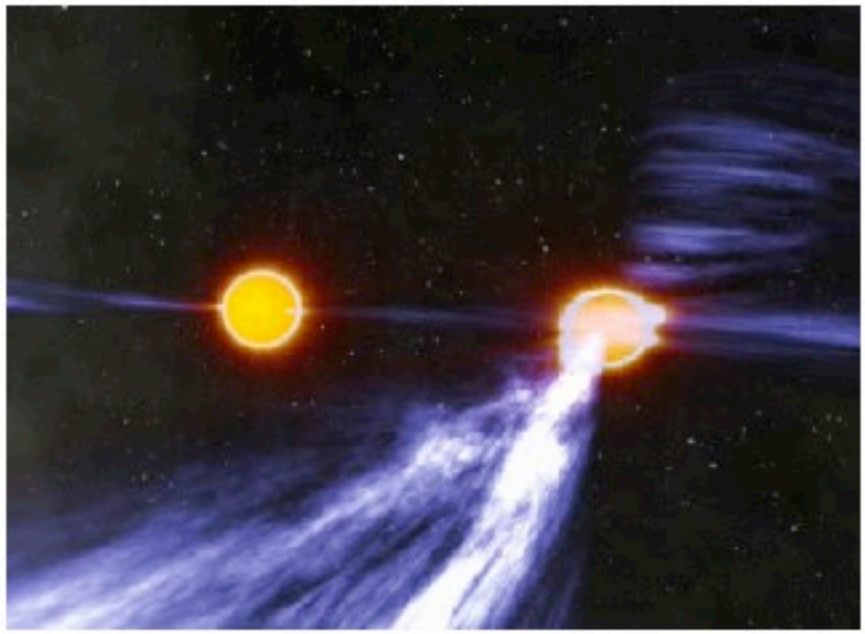
Pulsars

The Double Pulsar: J0737-3039



A Pulsar = 22.7 msec

B Pulsar = 2.7 sec

Orbital Period of 2.4 hours.

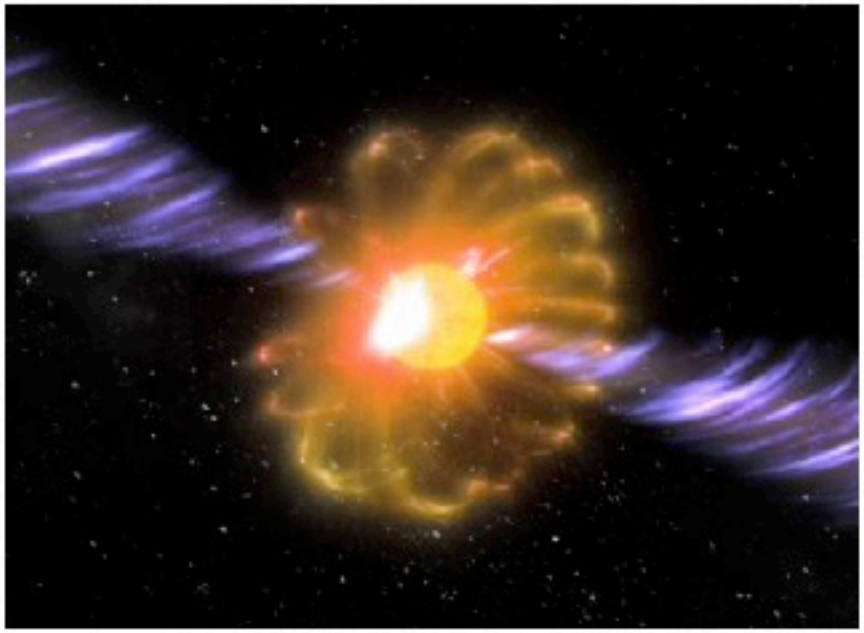
Separation = 800,000 km

The Orbit is shrinking by 7mm/year

Will coalesce in 85 million years

Burgay et al. NATURE 2003 and Lyne et al. Science 2004

The First Radio Magnetar

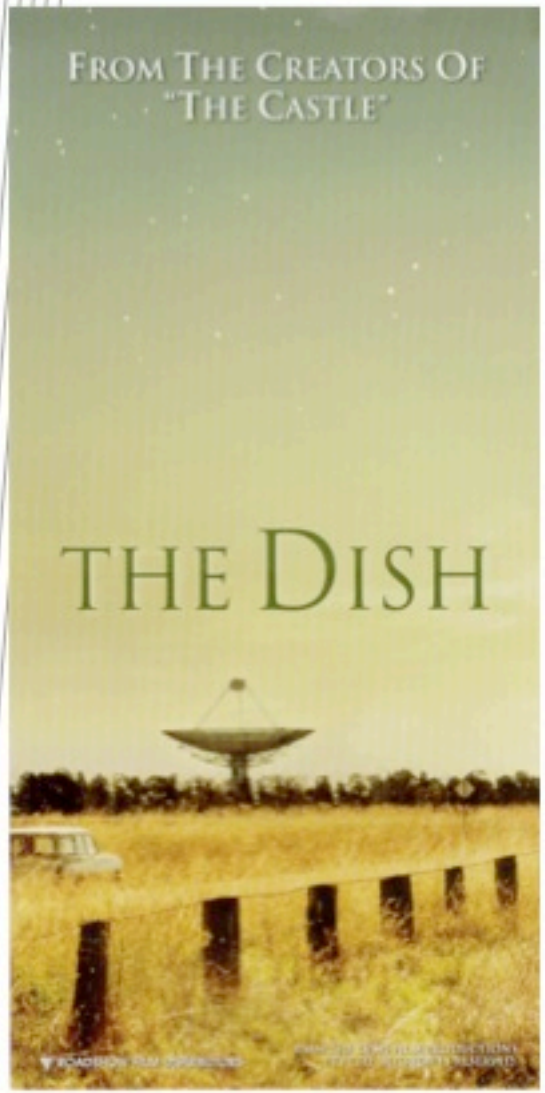


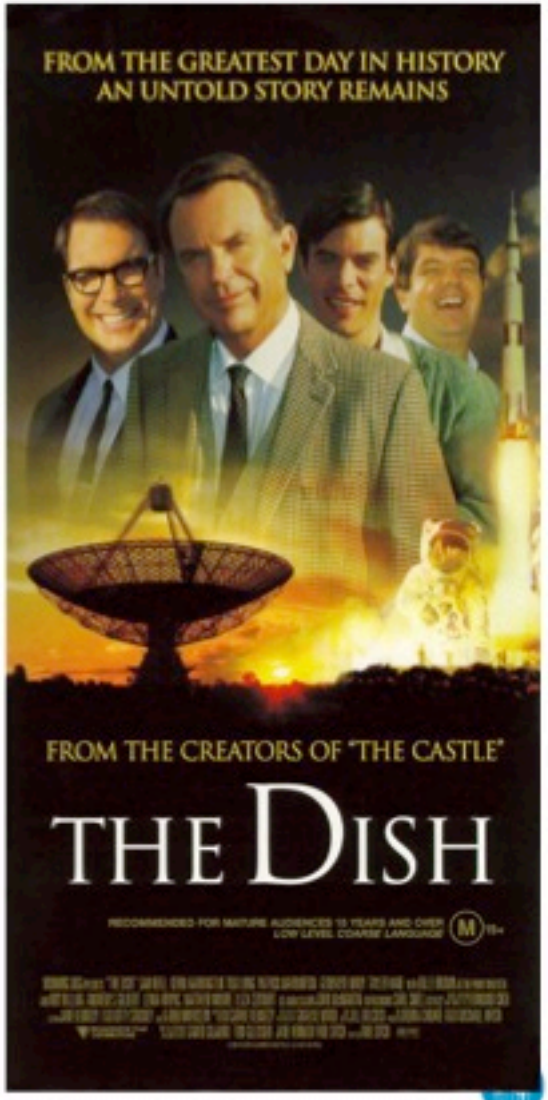
Strongest magnetic field of any known star in the Universe

Has a Period of 5.54 sec

Camilo et al. NATURE 2006

The DISH - 2000





Movie Star

Other movies featuring The Dish in cameo roles

Asset Contention Period – 2003-04

Congestion at Mars

1. Mars Global Surveyor
2. Mars Odyssey
3. Mars Exploration Rovers (MER)
4. Mars Express (Beagle 2)
5. Nozomi (Hope)

Asset Contention Period – 2003-04

Plus many more

1. Stardust
2. Deep Impact
3. Genesis
4. Cassini
5. Voyager 2
6. SERTF (IR Telescope)

Asset Contention Period – 2003-04

To augment the capabilities of the DSN at Tidbinbilla, Parkes was contracted to provide an extra receiving capability

This freed Tidbinbilla to concentrate on those spacecraft requiring two-way communication

ACP - Contract

1. Resurface the dish to 54 metres

2. Provide new 8.4 GHz X-band receiver

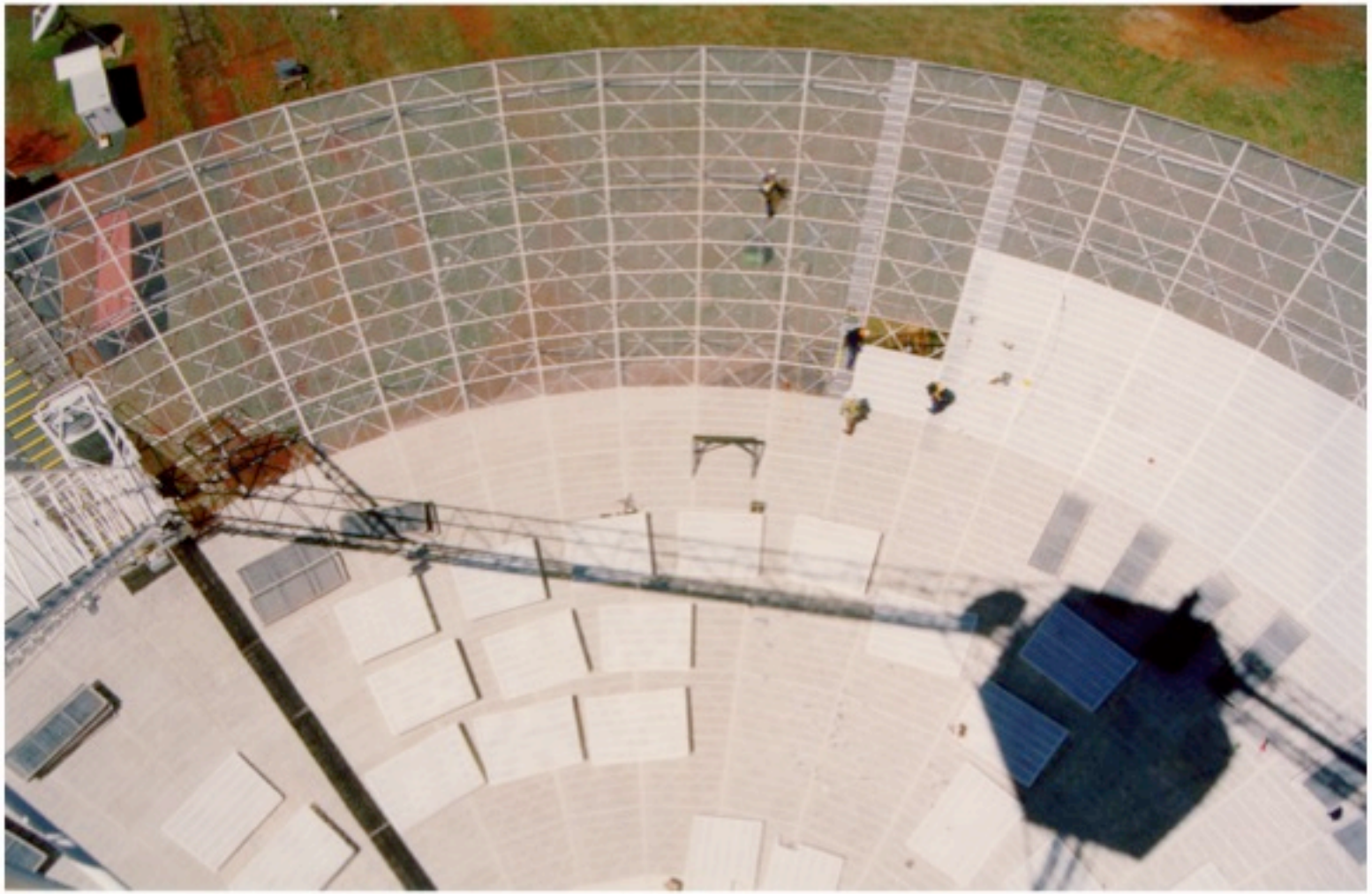
3. Daily track spacecraft for a 4 month period

Surface Upgrade

Surface Upgrade

Surface Upgrade

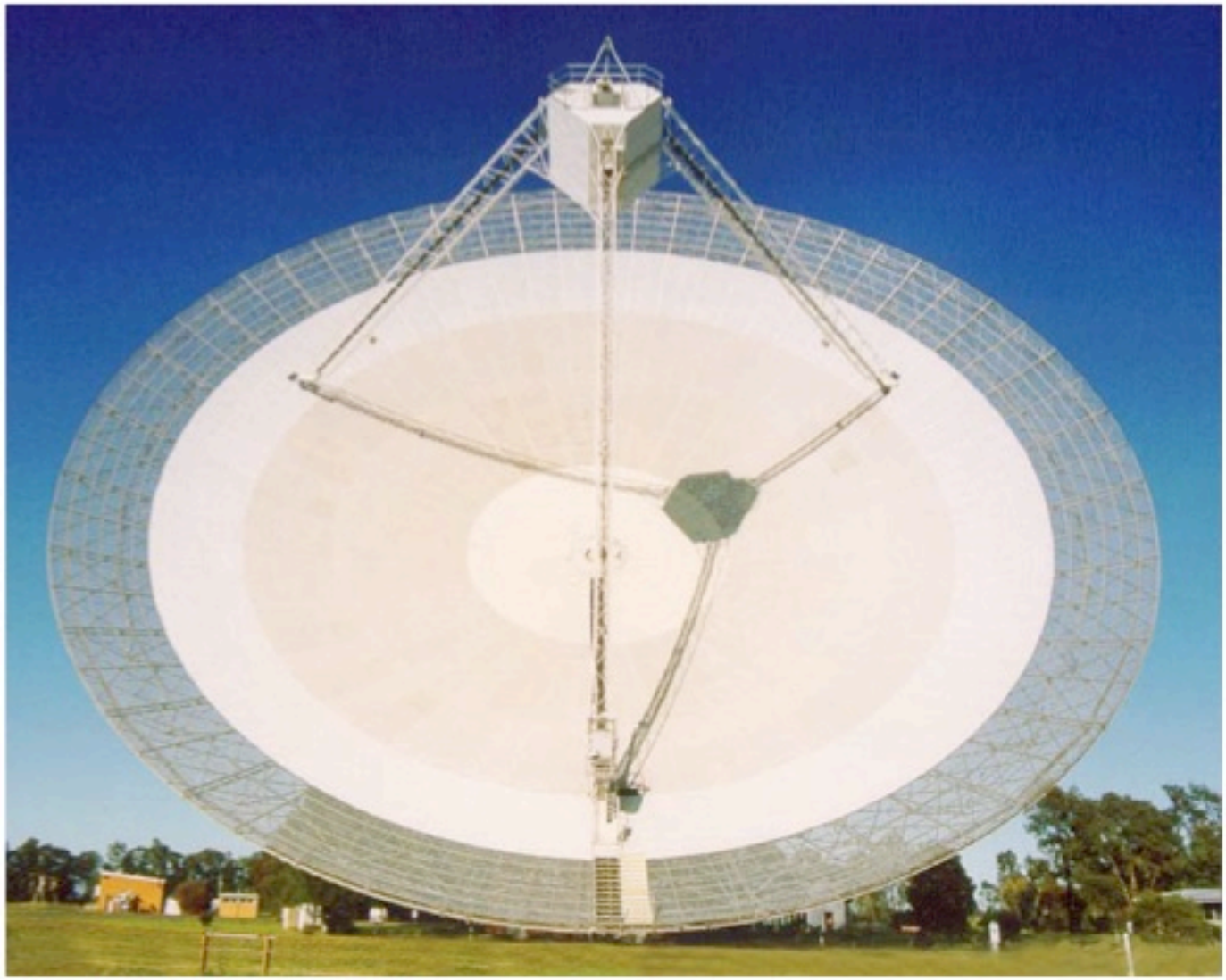
Surface Upgrade



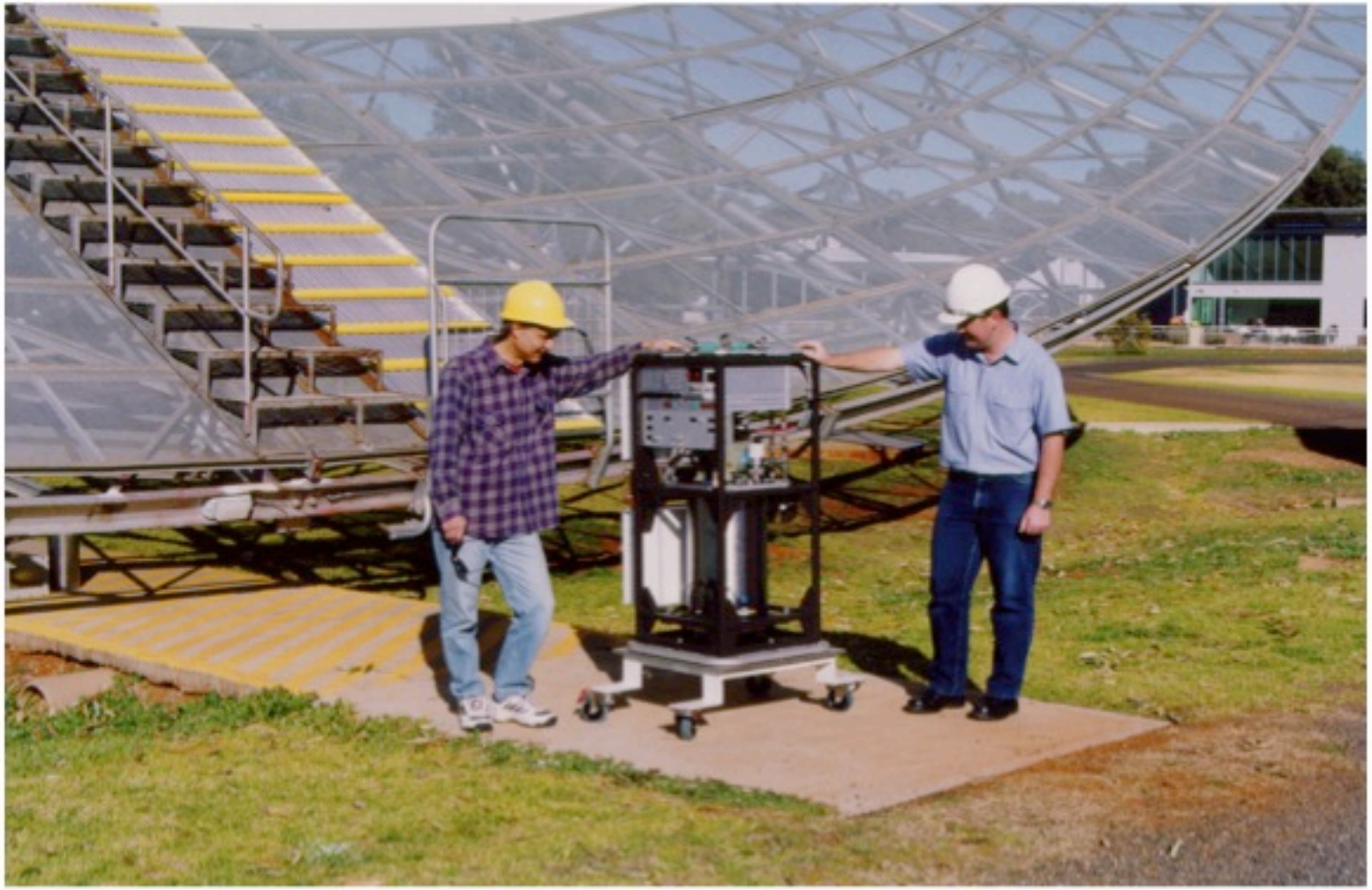
Surface Upgrade

Surface Upgrade

Surface Upgrade



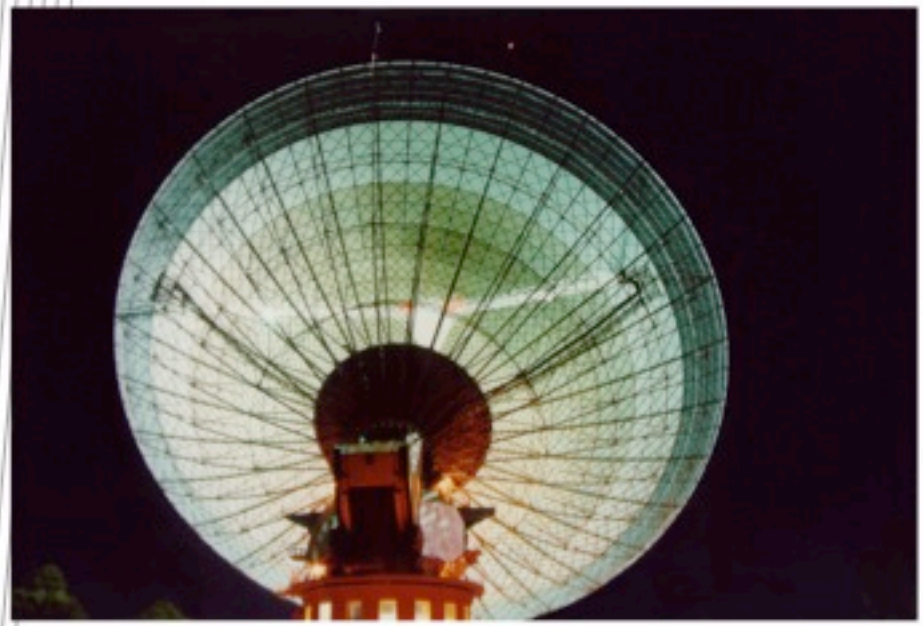
X-Band Receiver



X-Band Receiver

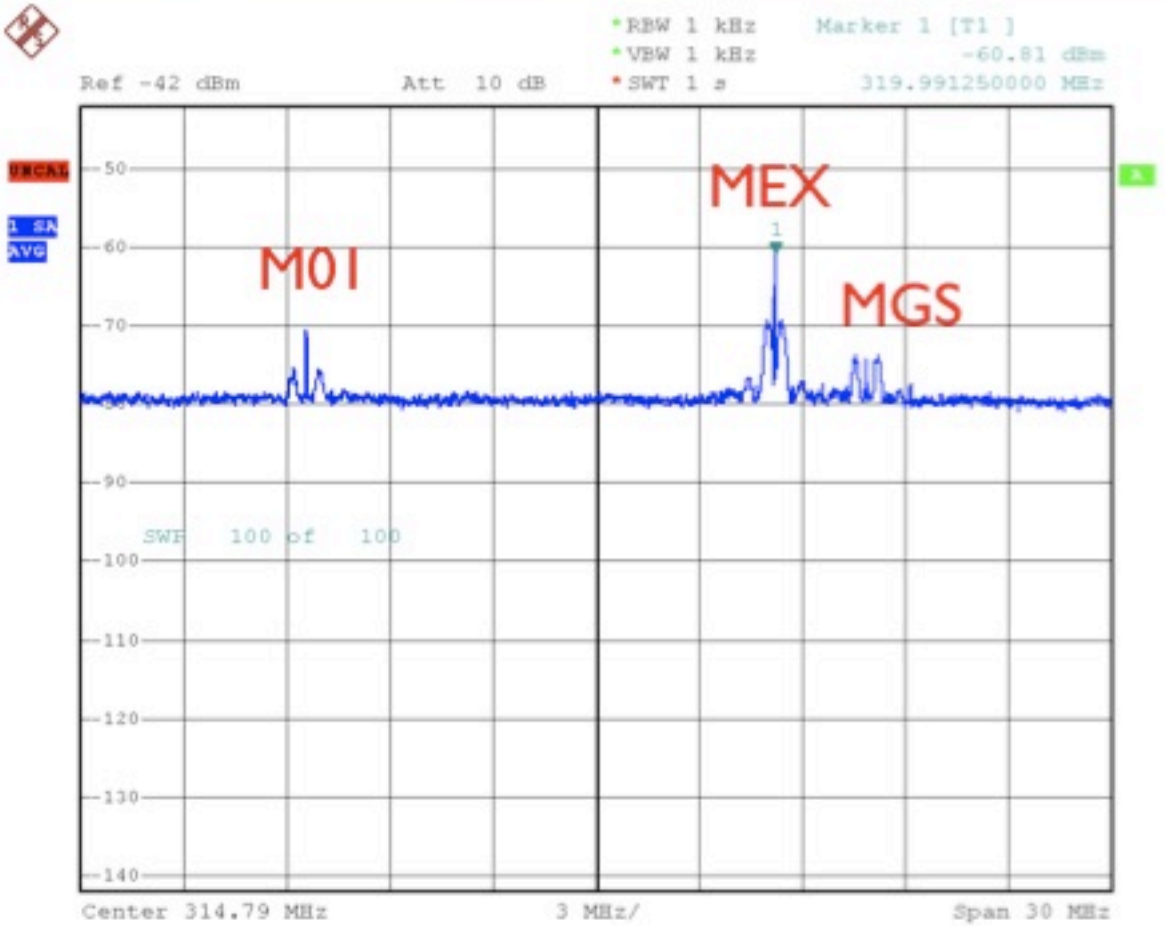
The ACP

Tracking period from
3 November 2003 to 22 February 2004



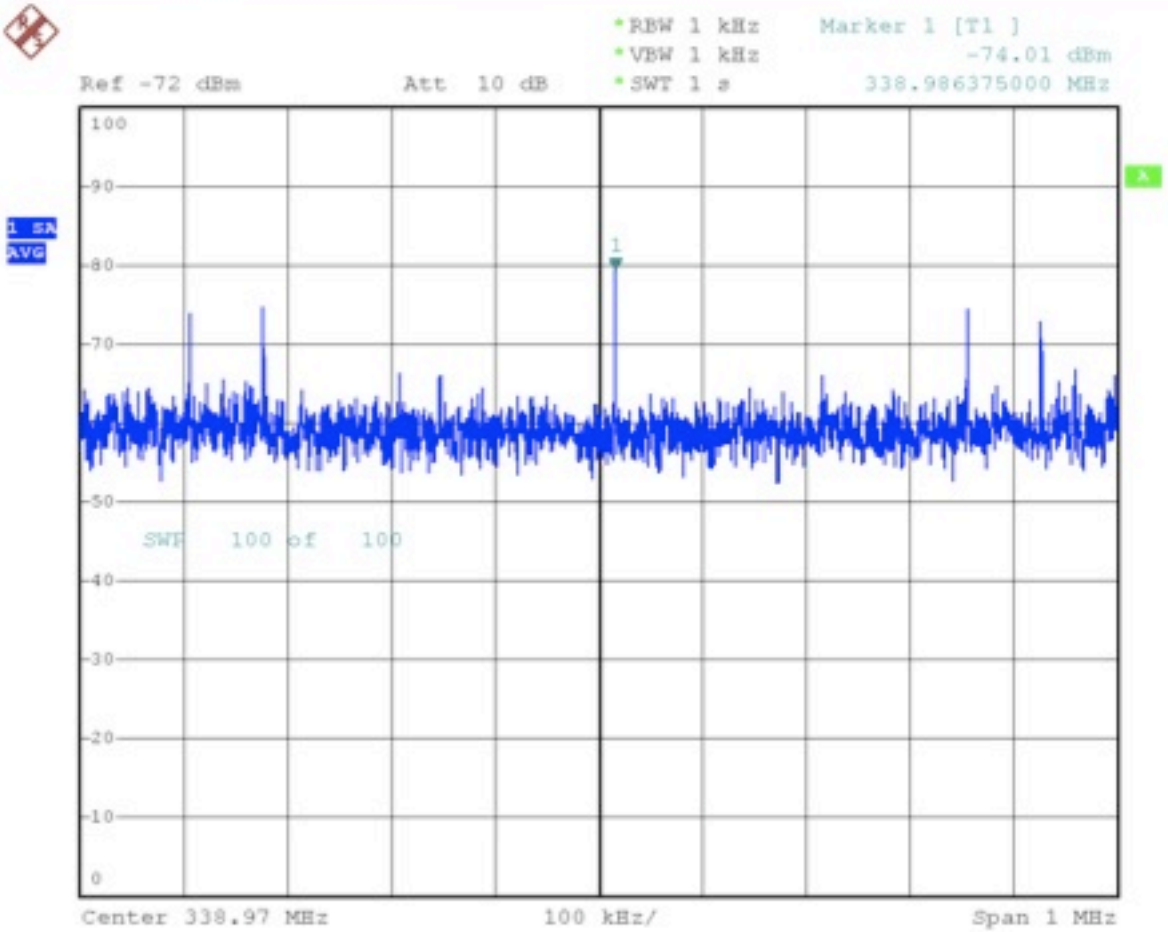
Tracked mainly Voyager 2 and MGS

Mars – Family Portrait



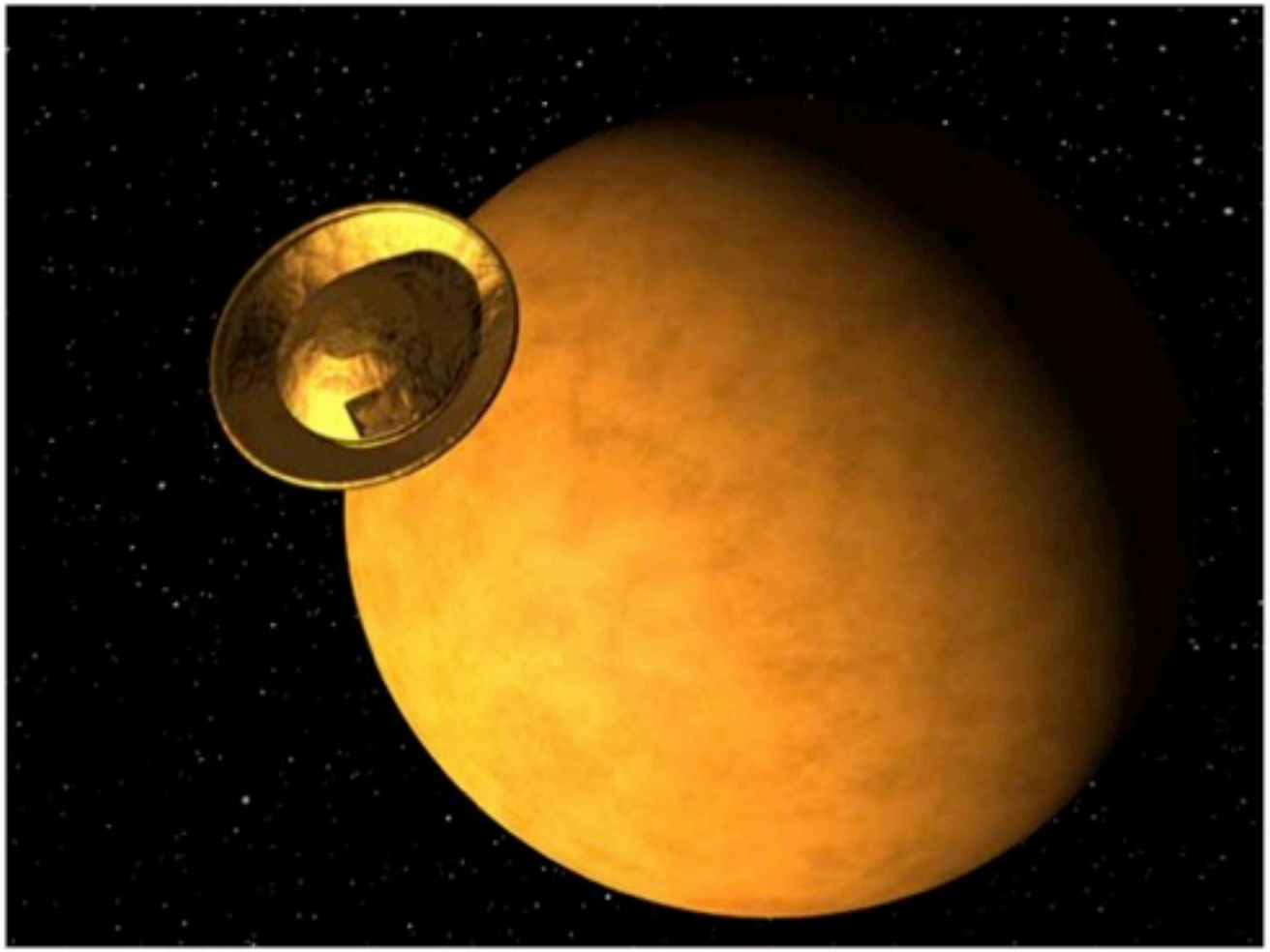
21 January 2004

MER Spirit – A Signal Lost



21 January 2004

Huygens



Trouble loomed!

Huygens

Boris Smeds

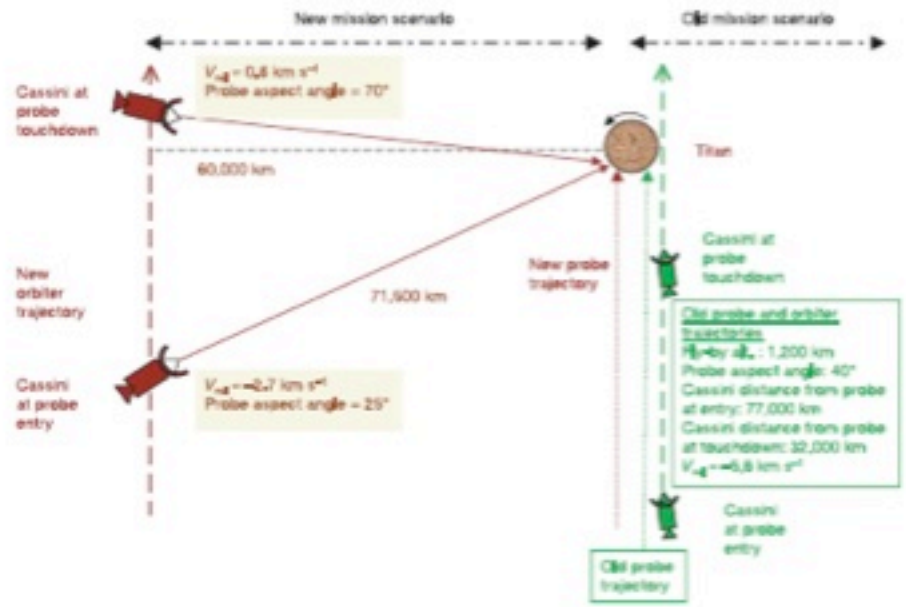
In 2000, Boris Smeds found that the Huygens receiver onboard Cassini could not track the Doppler shift of Huygens' signal and decode the data stream correctly.

Huygens

The solution was to reconfigure the descent profile so that it was more orthogonal to the Cassini mothercraft in order to reduce the Doppler shift (relative velocity).

The landing date was changed from November 2004 to 14 January 2005.

Huygens



New Descent Profile

Huygens

Huygens will transmit at two frequencies with two antennae for redundancy

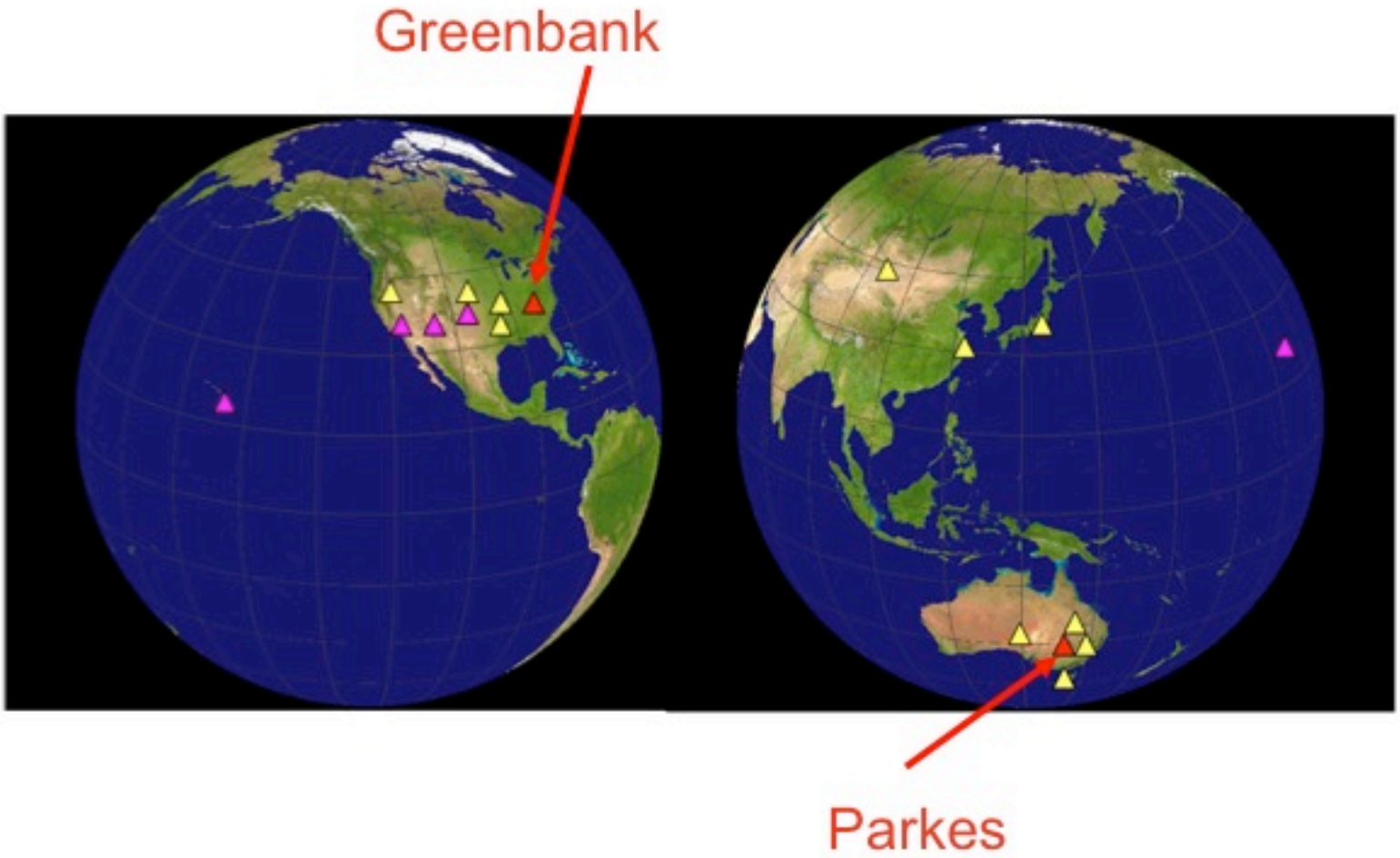
1. 2040 MHz (channel A)
2. 2090 MHz (channel B)

Huygens

It was realised that the antennae on Huygens would be pointing just 30° from Earth

JIVE organised a VLBI network around the Pacific Rim to track the weak channel A signal and pin-point the position of Huygens to within just 1km.

Huygens – VLBI Network



Huygens – Doppler Wind Experiment

In late 2004, NASA/JPL asked if they could piggyback the DWE on the Parkes observations.

Parkes agreed!

Huygens – The Schedule

1. Huygens was scheduled to enter the atmosphere of Titan at 8:18 pm (AEST) with Greenbank to observe it.

2. At 8:32 pm the parachute was to be deployed.

3. At 10:12 pm it set at Greenbank

Huygens – The Schedule

1. At 10:29 pm it rises at Parkes.

2. At 10:33 pm it was scheduled to land.

3. The batteries should last about 1 hour before expiring.

4. Titan sets at Parkes at 1:56 am (~3.5 hours after landing).

Huygens

Prelude – A Rainbow over the dish

Huygens

Preparing for the track - testing

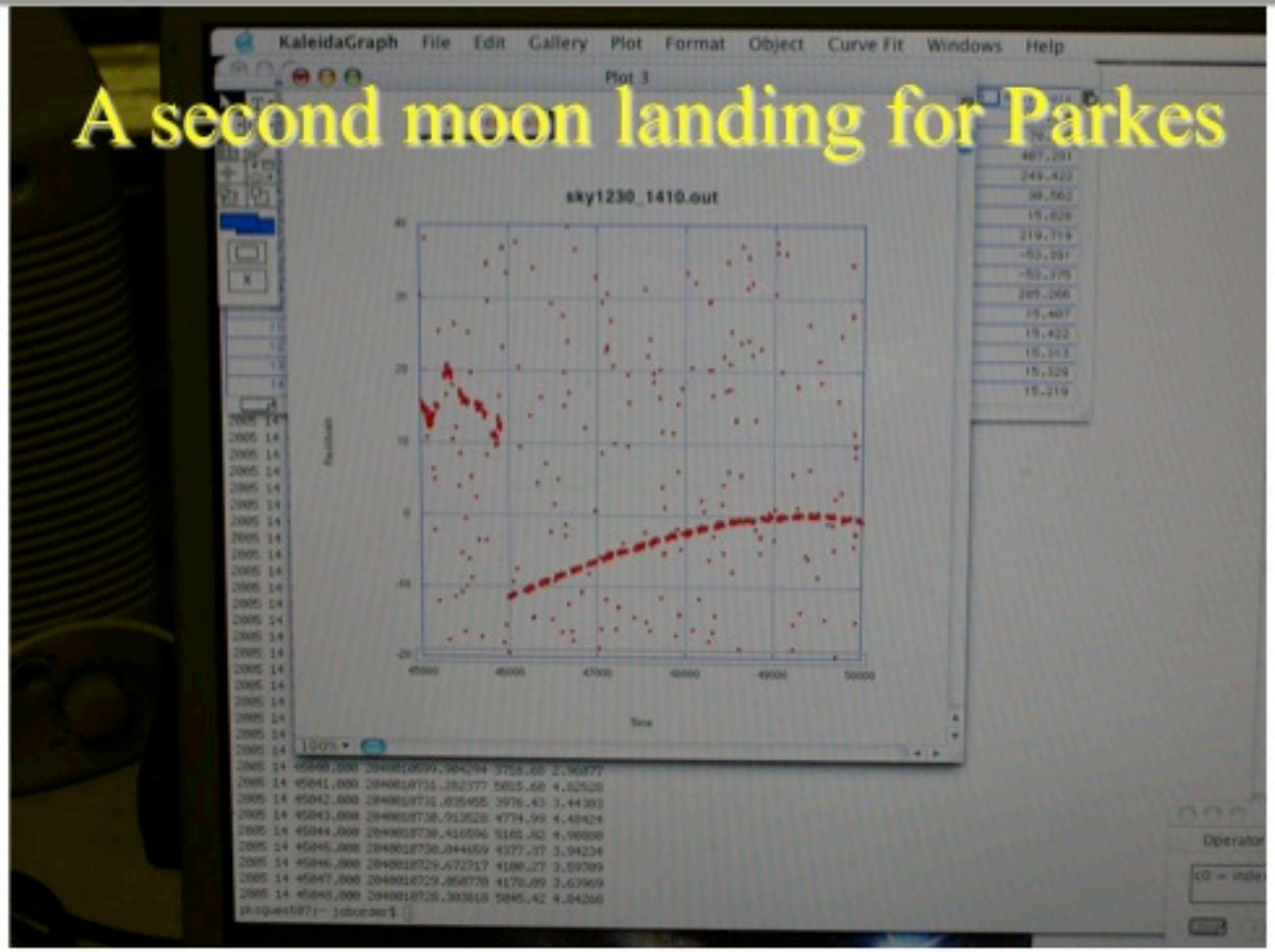
Huygens

Dr John Reynolds checking levels and the pointing of the dish

Huygens

Right on schedule Parkes detects the signal at 10:29 pm

Huygens



The Huygens has landed!

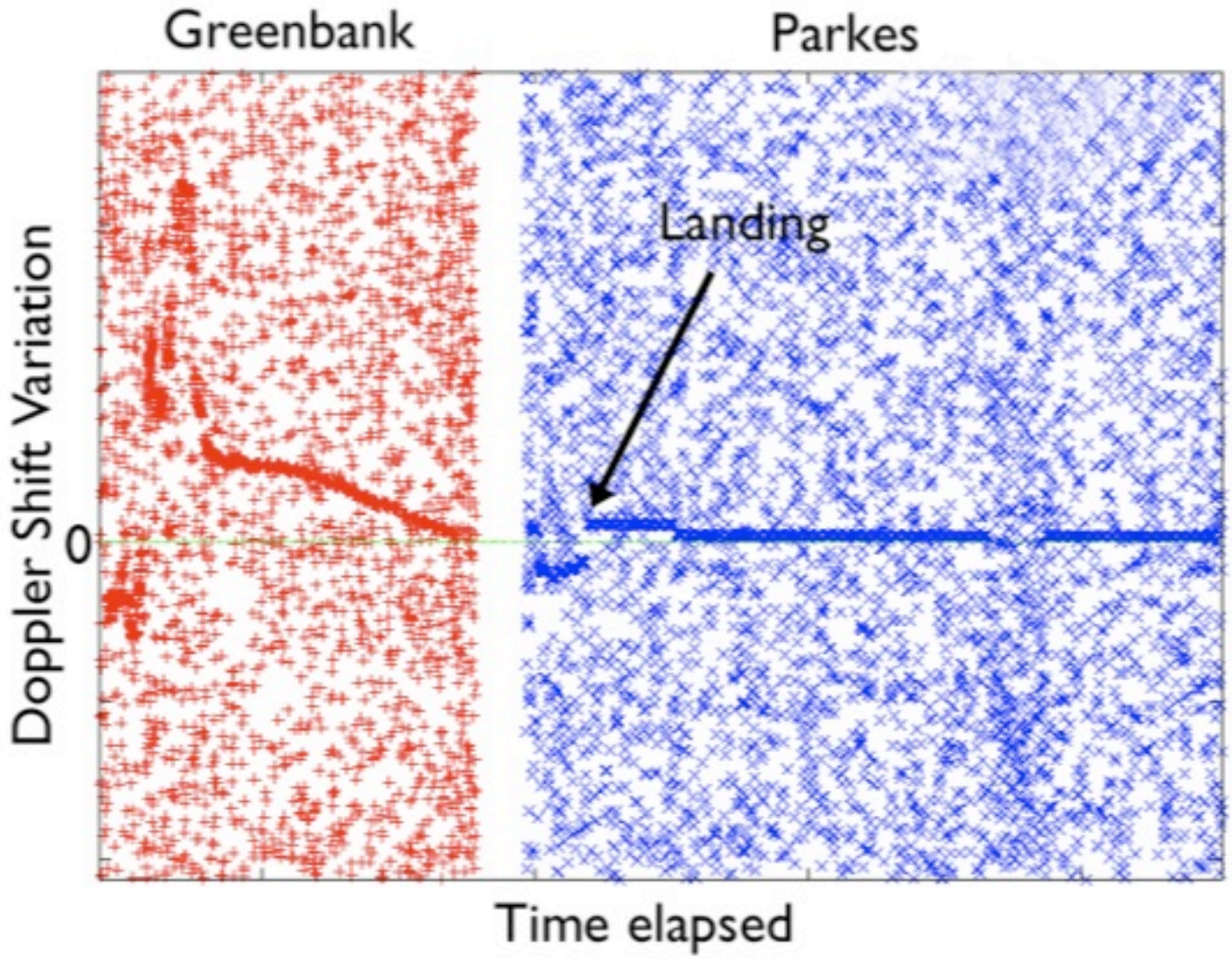
Huygens

Tracking Huygens at transit ~ 00:00am

Huygens

1. In reality, the landing was delayed with the landing occurring sometime between 10:45 and 10:46 pm – 12 to 13 minutes late!
2. The signal was 4dB stronger than expected (2.5 times).
3. The batteries lasted much longer - until Titan set at Parkes.

Huygens


Greenbank
Parkes
Landing
Doppler Shift Variation
0
Time elapsed

Huygens

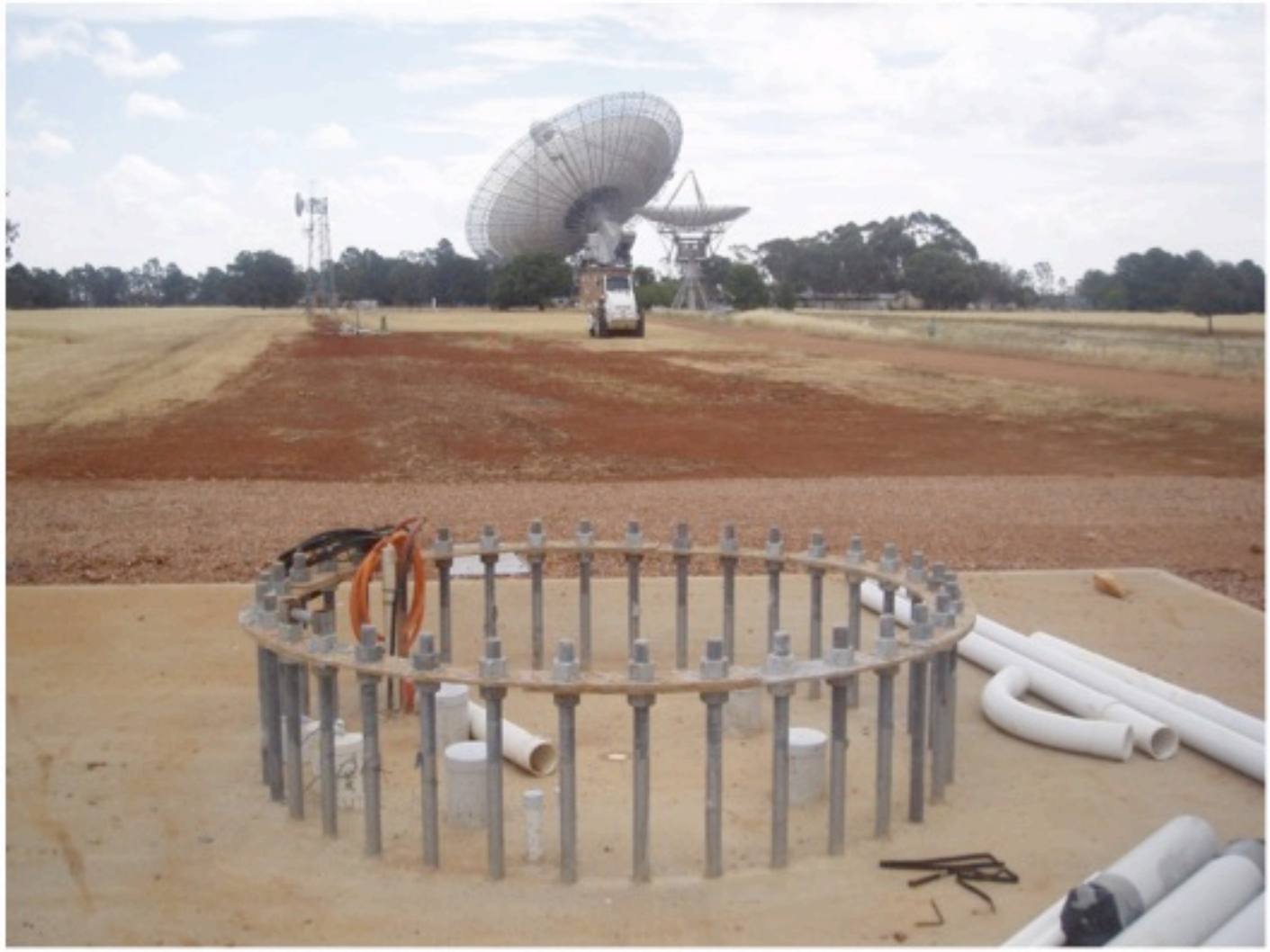
1. The channel A receiver on board Cassini was not swicthed on - only ½ of the data was received.

2. The Greenbank-Parkes data was now vital for the success of the DWE.

It pays to eavesdrop sometimes

- Sami Asmar

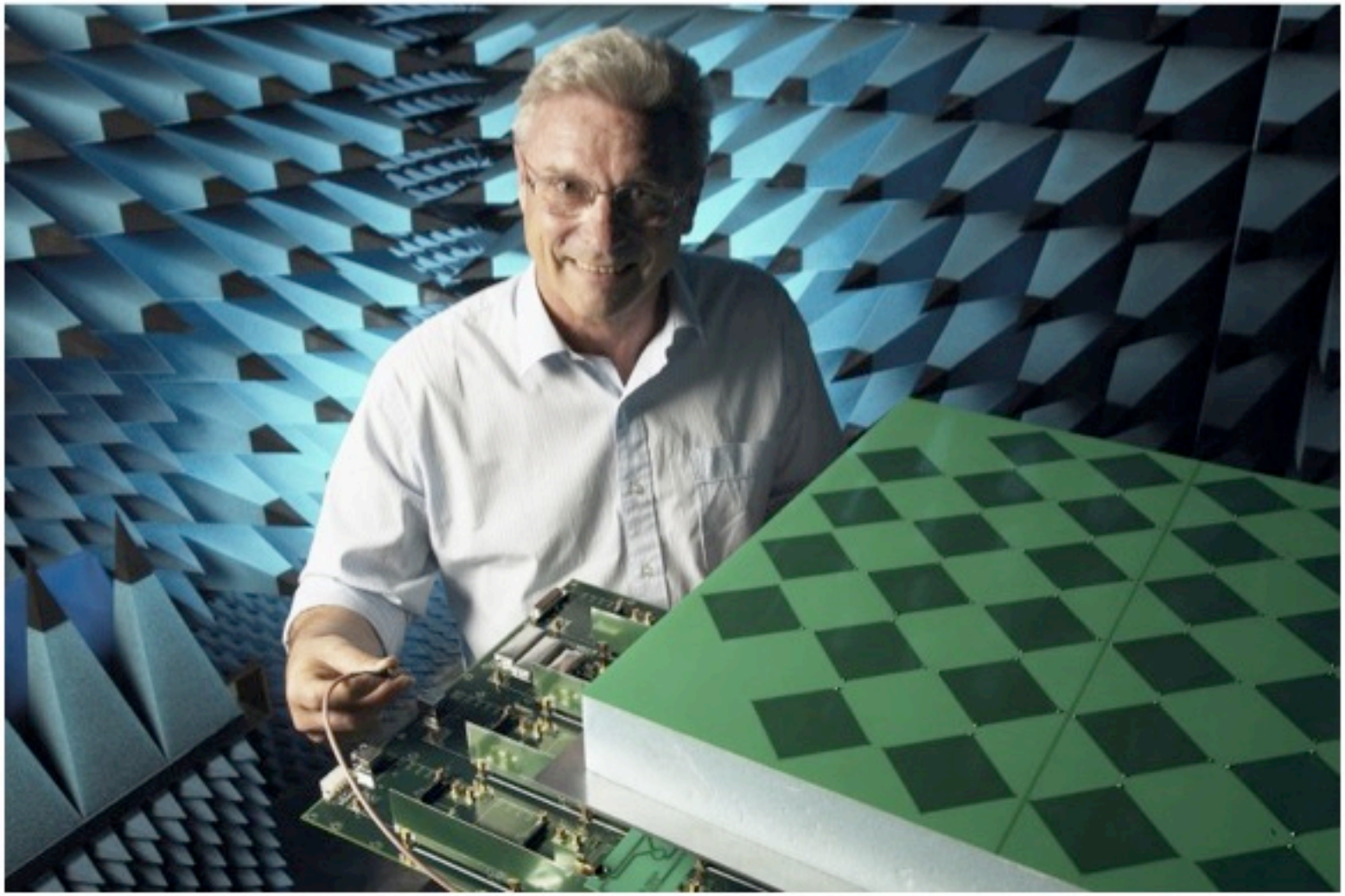
The ASKAP Test Bed Antenna



The ASKAP Test Bed Antenna

The ASKAP Test Bed Antenna

The Focal Plane Array (FPA)



The FPA mounted at the focus

The ASKAP Test Bed Antenna

The ASKAP Team

The Dawn of a New Era

The Dawn of a New Era

The Dawn of a New Era

CSIRO

Parkes

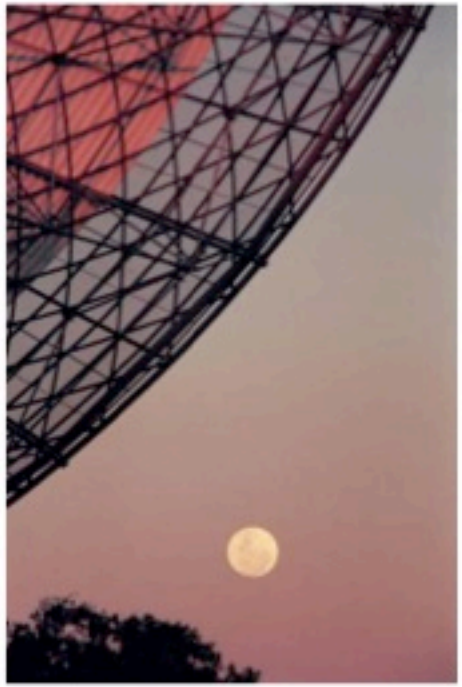
" ... the search for truth is one of the noblest aims of mankind and there is nothing which adds to the glory of the human race or lends it such dignity as the urge to bring the vast complexity of the Universe within range of human understanding."

E.G. "Taffy" Bowen

Chief of the CSIRO Radiophysics Laboratory

Inauguration of the Parkes Telescope

Tuesday, 31 October 1961.



CSIRO

CSIRO Parkes Observatory, ATNF
John M. Sarkissian
Operations Scientist

Phone: (02) 6861-1700
Email: John.Sarkissian@csiro.au
Web: www.parkes.atnf.csiro.au/people/sar049/

Thank You

www.csiro.au

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