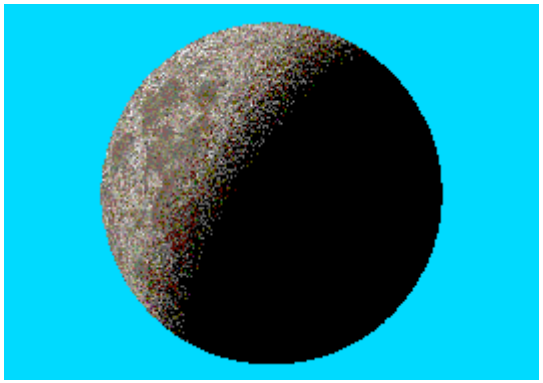
# The Dish:
# Fun things to notice in the movie

Donna Kubik



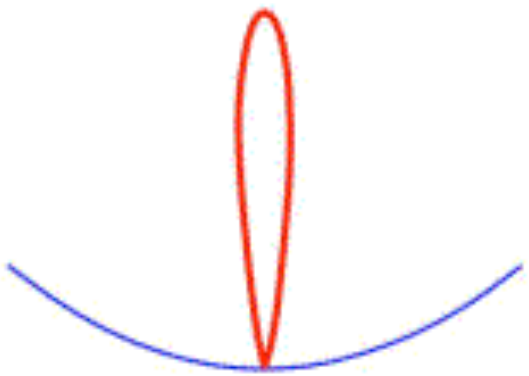
The 6 day old Moon as it appeared from Parkes on 21 July 1969.

Parkes tracking Apollo 11

# Apollo 11

- Six hundred million people, or one fifth of mankind at the time, watched Neil Armstrong's first steps on the Moon.
- Three tracking stations were receiving the signals simultaneously: CSIRO's Parkes Radio Telescope, the Honeysuckle Creek tracking station outside Canberra, and NASA's Goldstone station in California.
- The signals were relayed to Mission Control at Houston.
- During the first few minutes of the broadcast, NASA alternated between the signals from its two stations at Goldstone and Honeysuckle Creek, searching for the best quality images.
- When they switched to the Parkes pictures, they were of such superior quality, that NASA remained with the Parkes TV pictures for the remainder of the 2 1/2-hour telecast.

# Telescope beam



The telescope beam

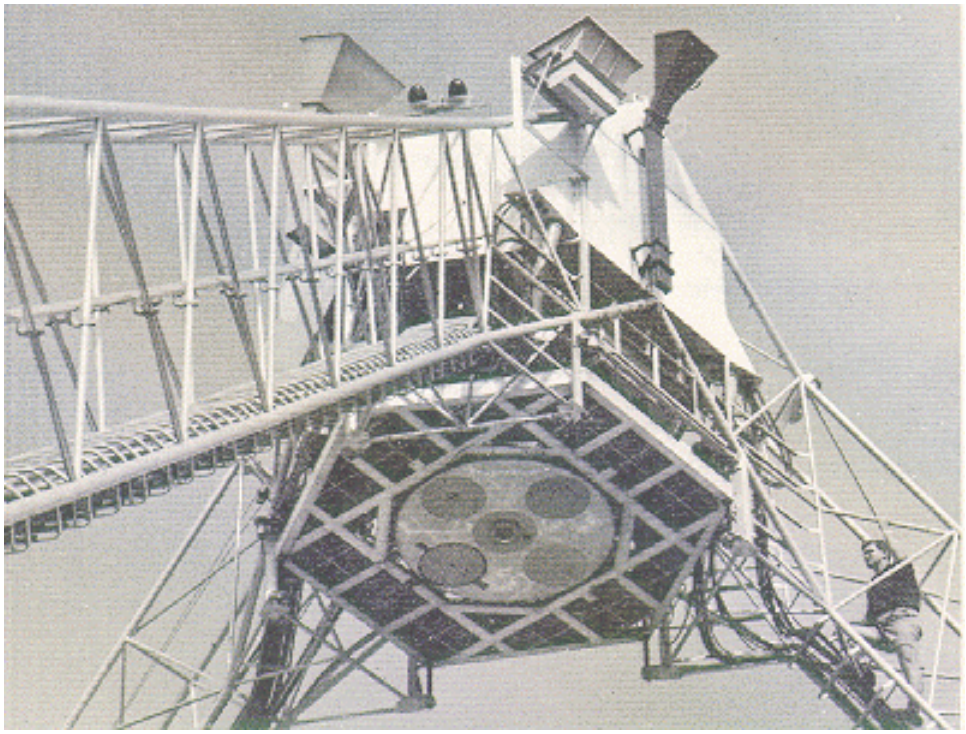
Apollo 11 used S-band

- The telescope beam defines the area of the sky from which the radio telescope receives radio waves
- The larger the telescope and the shorter the wavelength, the smaller the beam.
- Operating at S-band (2282.5 MHz, $\lambda$=13 cm) and with a diameter of 64-meter, the Parkes beam is about 9.2' FWHP
- So the Parkes beam is pretty narrow

# Telescope beam

- The horizon of the Parkes telescope is $29^{\circ}38'$ above the true horizon
- The cost in constructing a tower tall enough to allow the dish to tip fully to the true horizon would have been too great.
- On 21 July 1969, the Moon rose above the telescope's horizon at 1:02 p.m. (AEST).

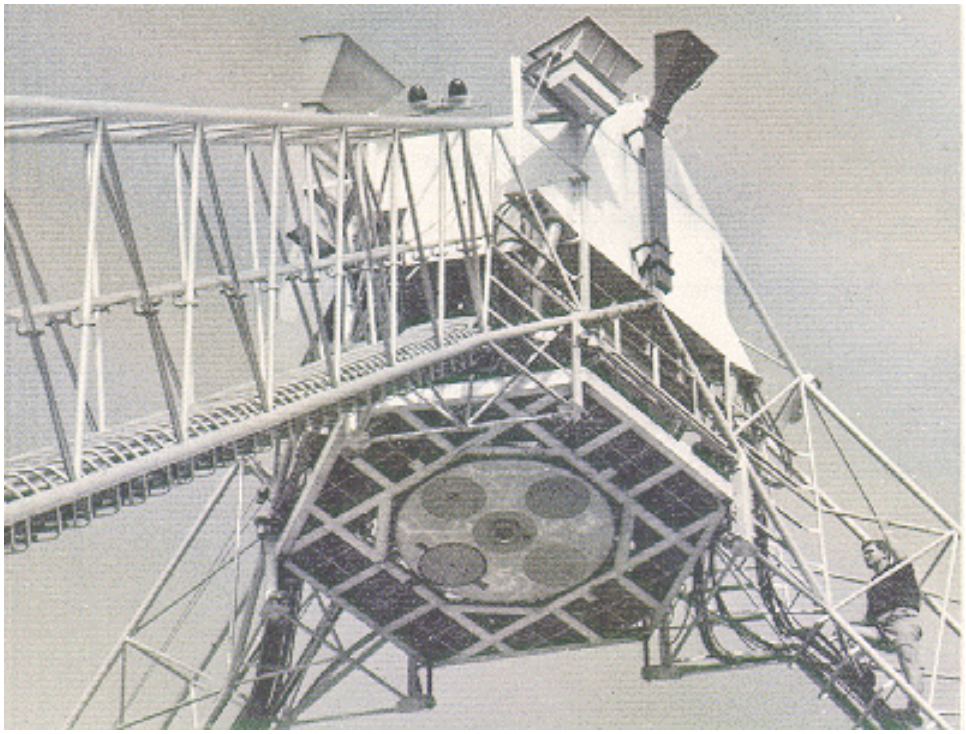
# On and off-axis receivers



- For Apollo 11, Parkes had two receivers installed in the focus cabin of the telescope
- One receiver was placed at the focus of the telescope, and the other was offset a small distance (1.2 or 1.43 deg)* in one of the four off-axis positions.

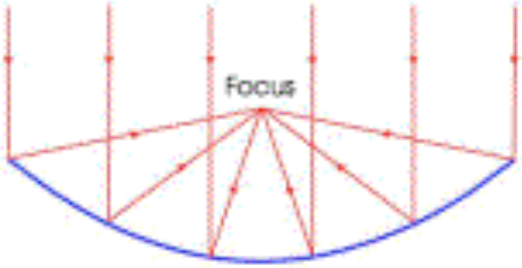
* The exact offset is not known

# On and off-axis receivers

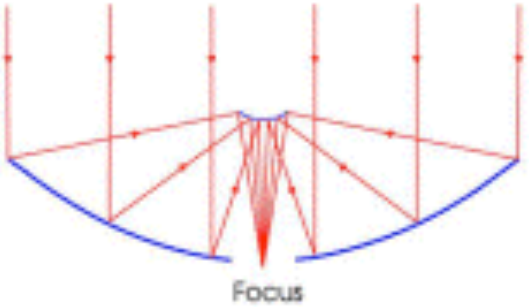


- In the movie, you'll see that they first picked up Apollo 11 using the off-axis receiver, because the Moon had not risen high enough to be seen at the prime focus
- Cliff says, "Offset feed!"
- As soon as the Moon has risen high enough to be seen with the prime focus receiver, Cliff says, "Switch back to main axis."

# Prime vs. Cassegrain focus

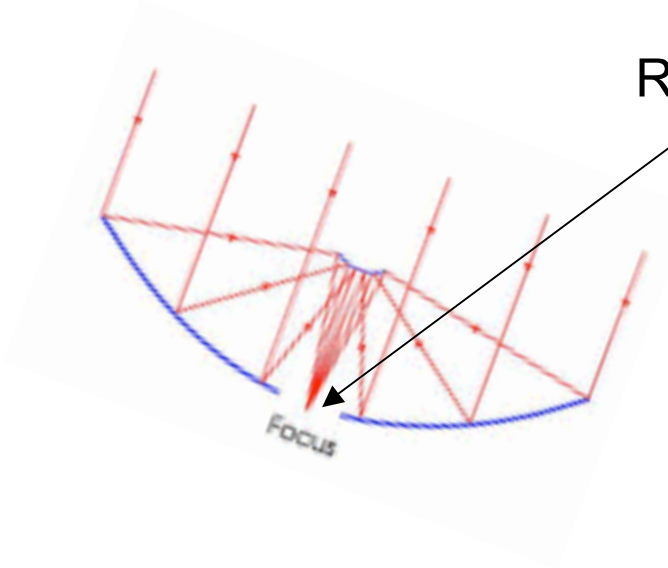



Prime focus




Cassegrain focus

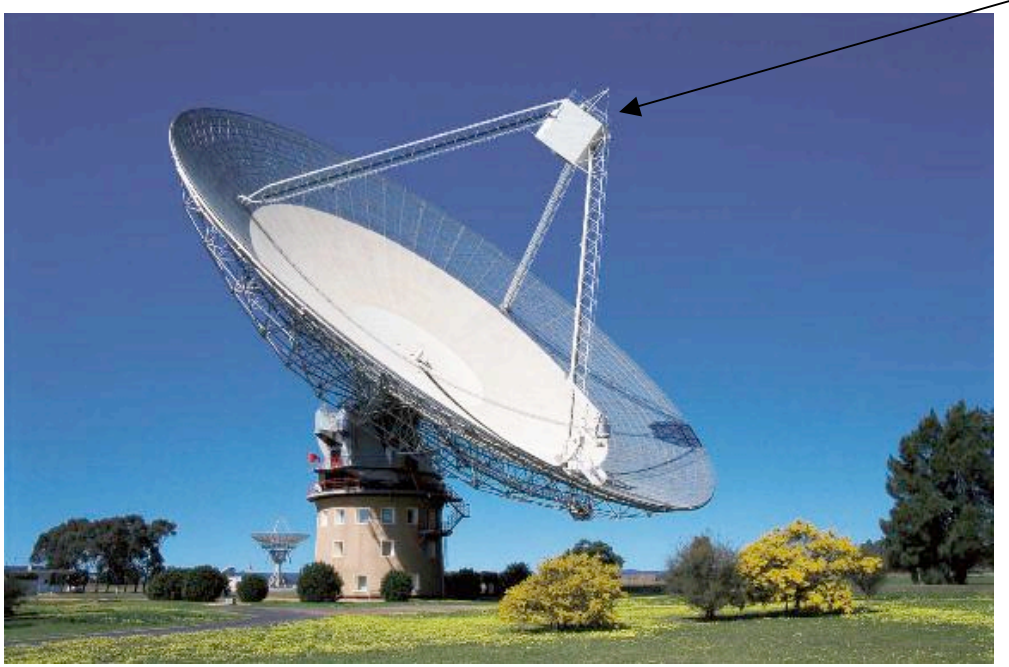
# Some radiotelescopes have a Cassegrain focus



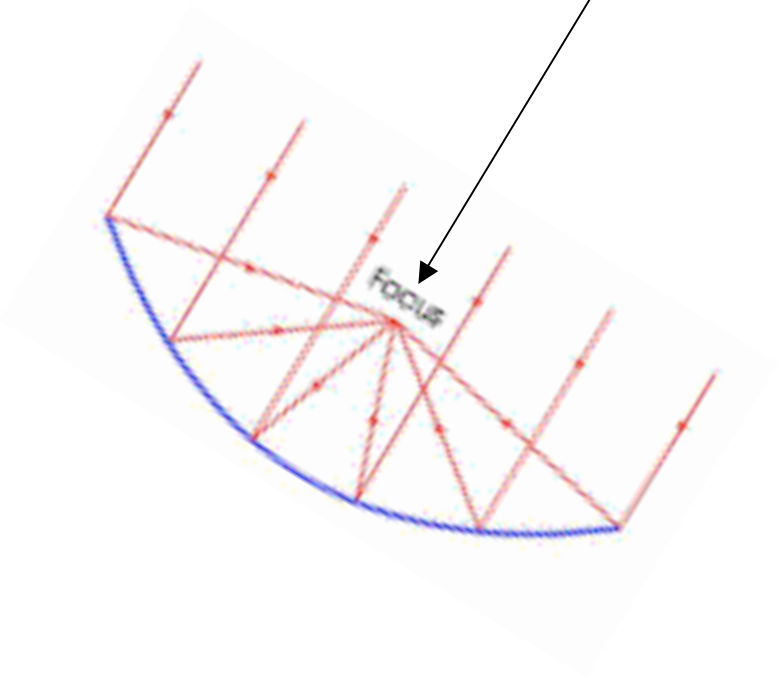

Receivers are here

VLBA telescope

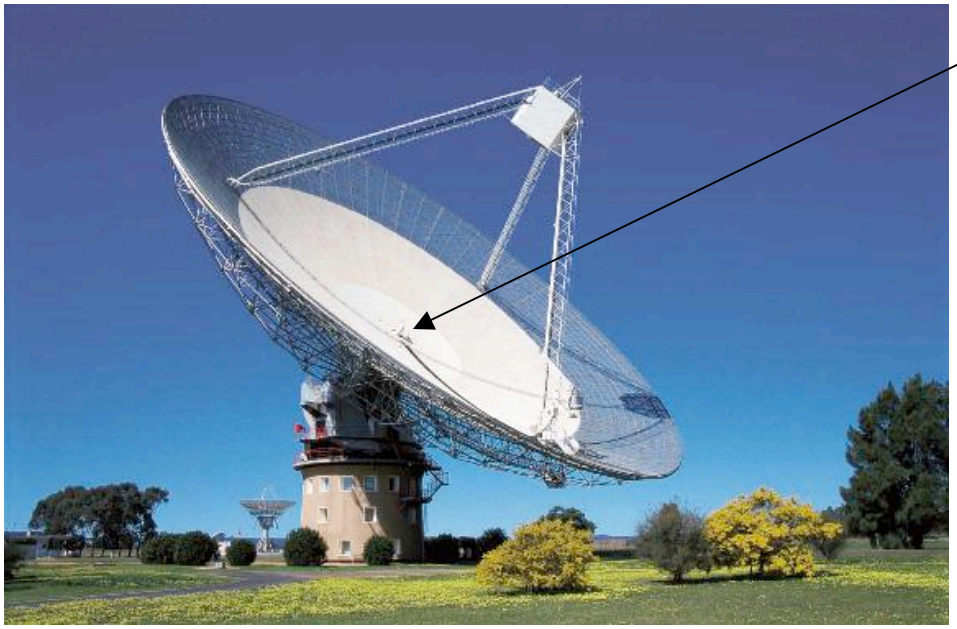
# Parkes is prime focus



Receivers are here

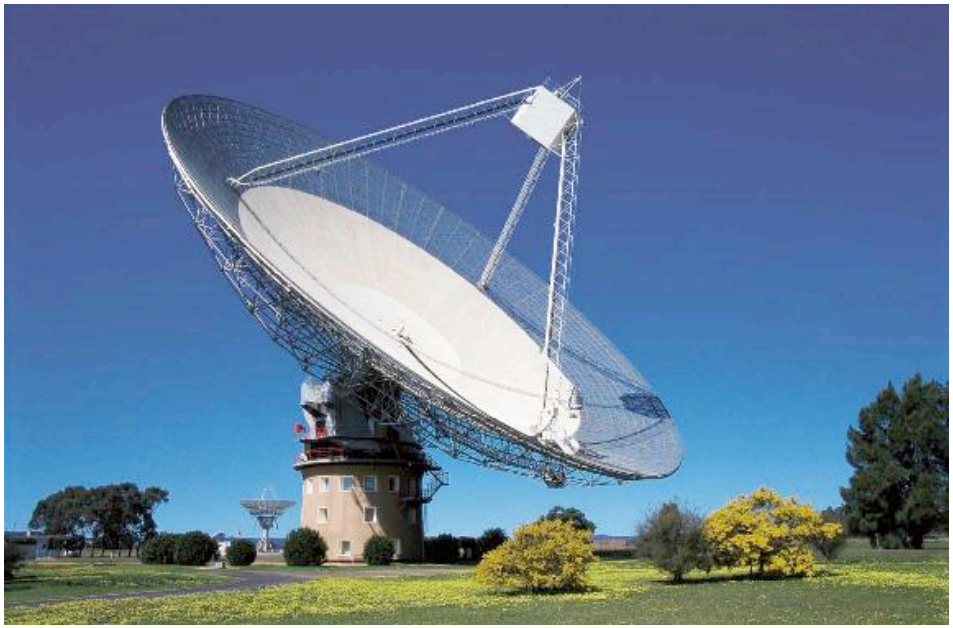


# Pointy thing



- Since the Parkes telescope is prime focus, I wondered what the pointy thing is in the center of the dish

# Pointy thing

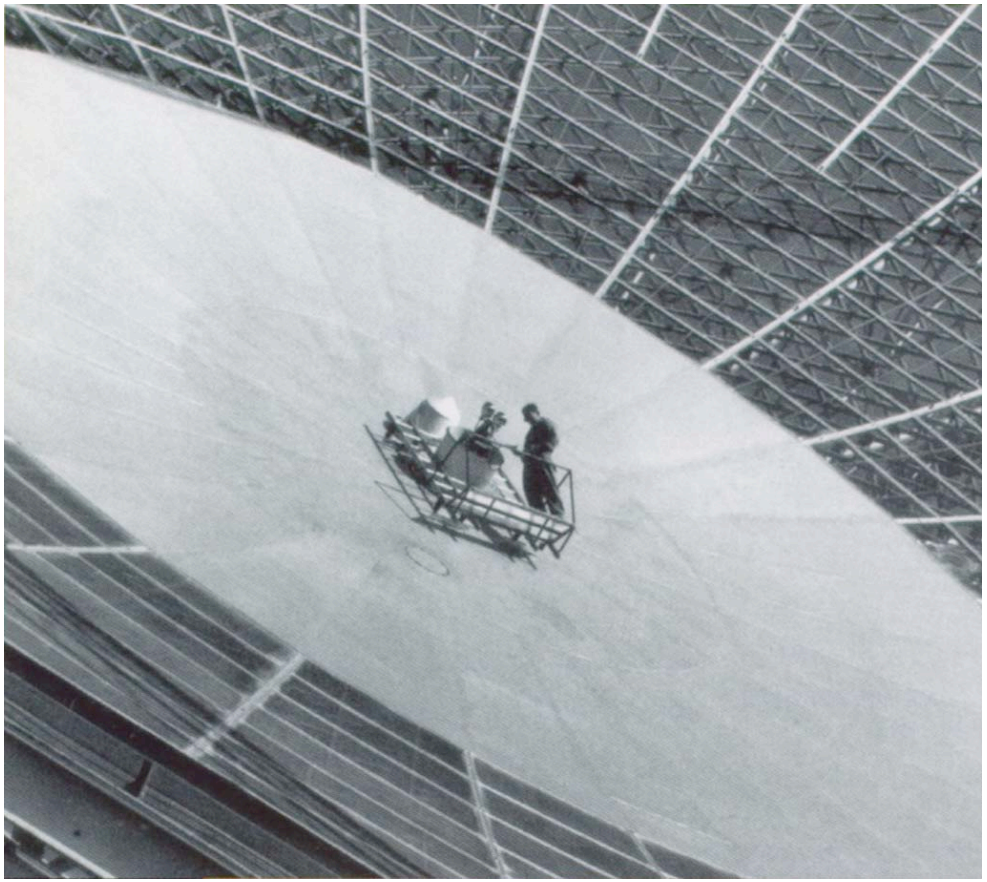


- According to Ron Ekers, the the director or Parkes,
- “The cone you see in the centre is just the cover of an optical instrument to measure the surface shape.
- It was enlarged at one time to reduce multiple reflections between the apex of the dish and the focus platform.
- If they are both flat, it acts like a Fabry-Perot and causes a spectral ripple in the received signal.”

# Measuring the surface shape

- Harry Minnett and his specially designed camera for measuring the dish shape
- The camera was located where the “pointy thing” is now.

# Measuring the surface shape



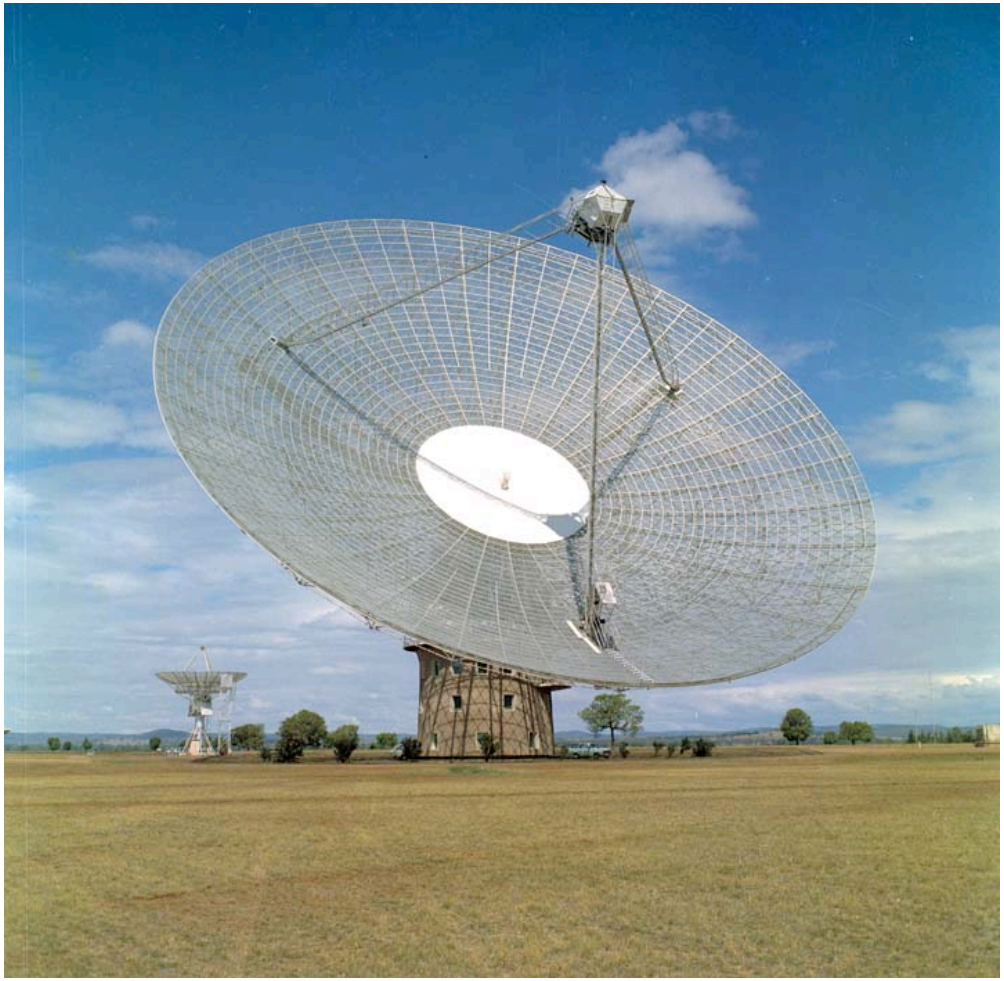
- Measuring the surface error with Harry Minnett's specially designed camera

# Resurfacing

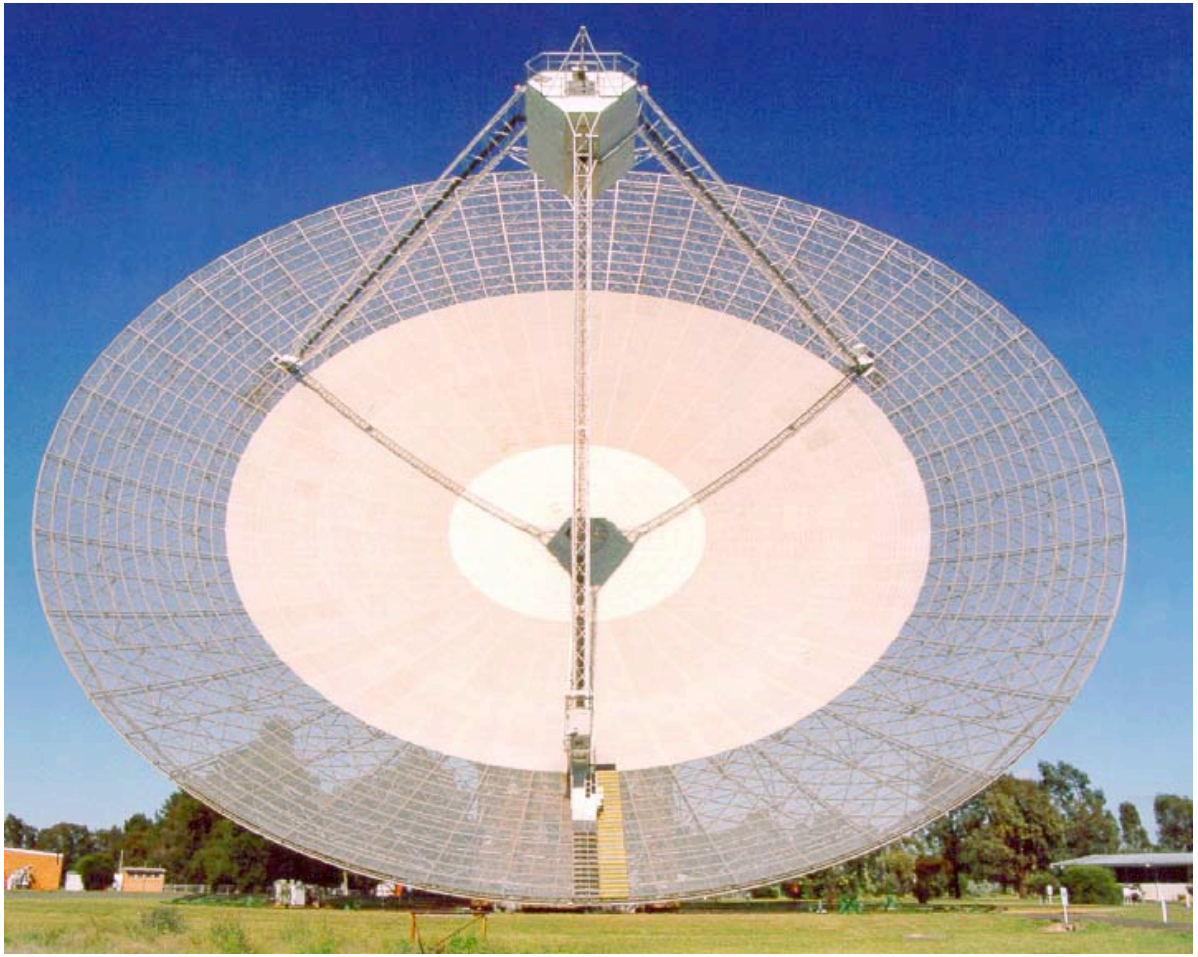
- The surface of the dish in the movie (today) looks a bit different than it really did in 1969.
- The telescope has been resurfaced several times to increase sensitivity and to receive at higher frequencies
- The surface error (accuracy of antenna surface and shape) should be less than 1/20 wavelength to keep losses to less than 30%

Resurfacing in the early 70's

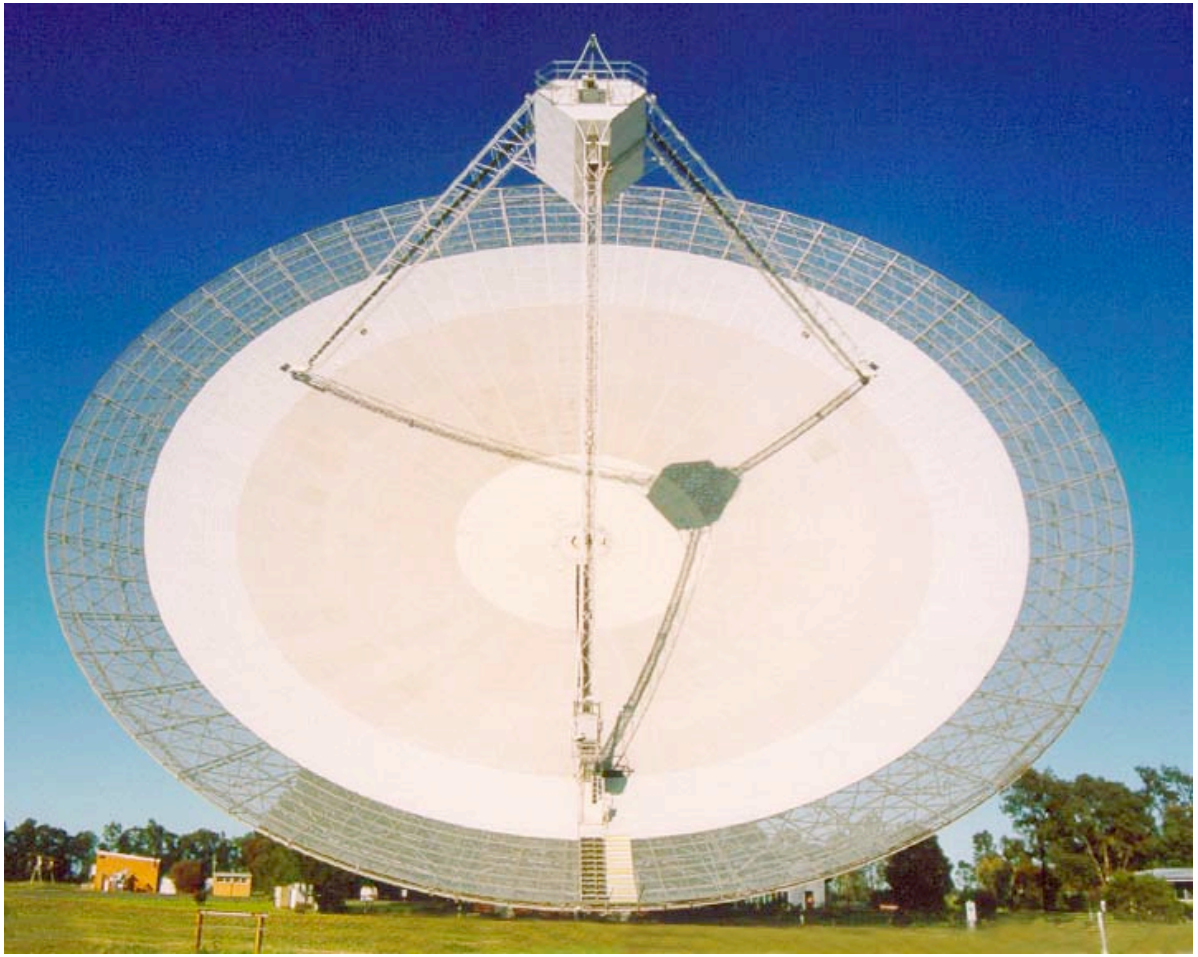
# The surface in1969



# Before 2003 upgrade

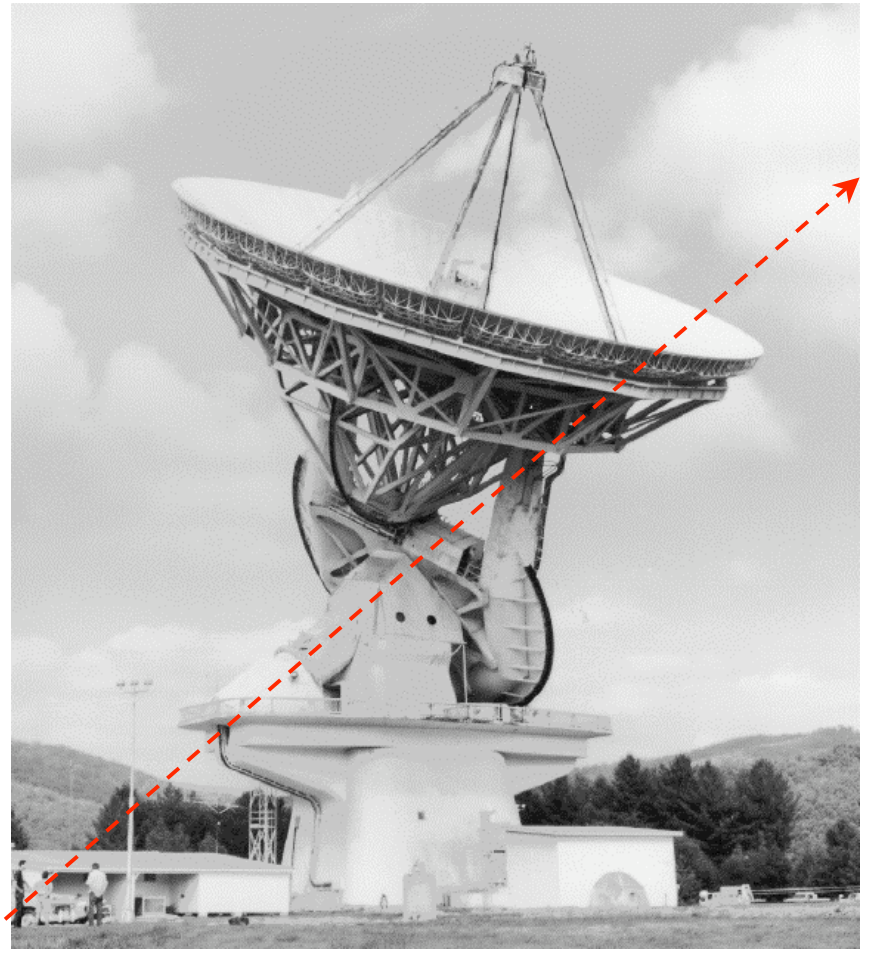


# After 2003 upgrade



# Alt-az vs. equatorial

- The 64-meter Parkes telescope has an altitude-azimuth (alt-az) mount
- It is easier to support a big, heavy telescope with an alt-az mount than with an equatorial mount
- I think the largest equatorial-mount dish is the 140-foot telescope at Greenbank.



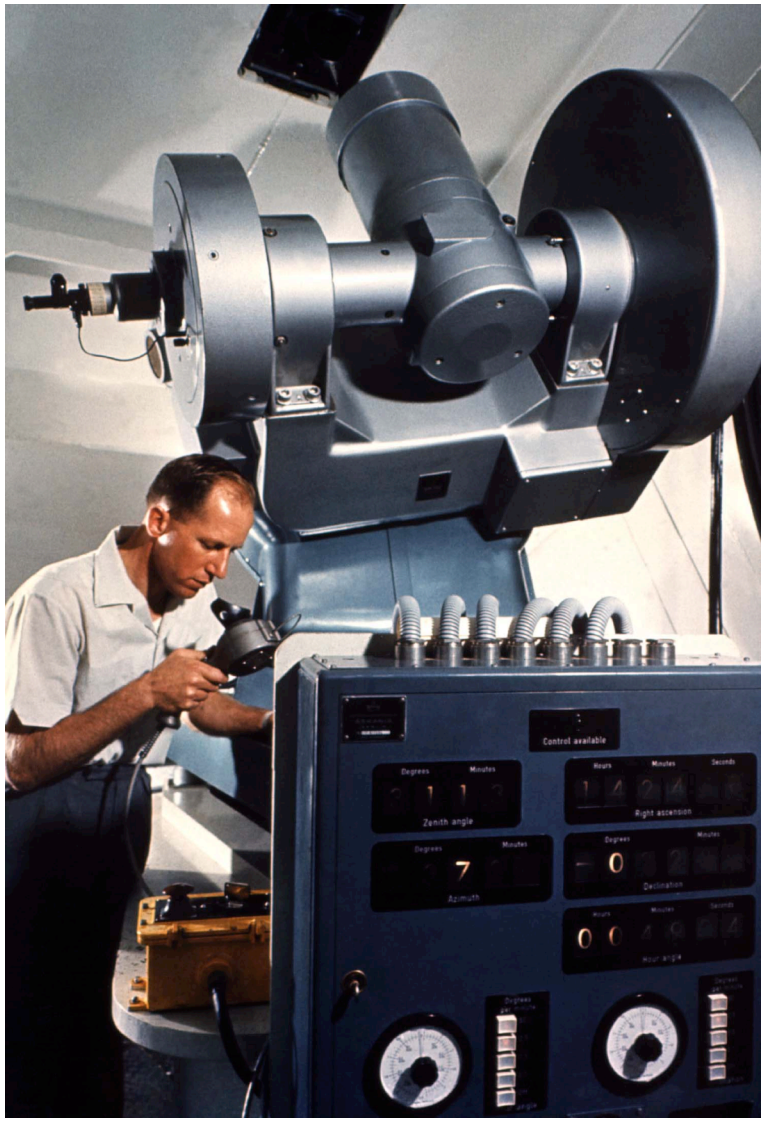

140 ft at Greenbank, WV

# Alt-az vs. equatorial

- The disadvantage of an alt-azimuth mounting arises when tracking celestial objects across the sky
- The dish must move in two axes at varying rates, whereas an equatorial system moves only in one axis at the constant sidereal rate.
- When the Parkes telescope was designed in the 1950s, high speed computers capable of performing the rate calculations were not available.

# Master equatorial

- The problem was solved by the incorporation of a "master equatorial" telescope.

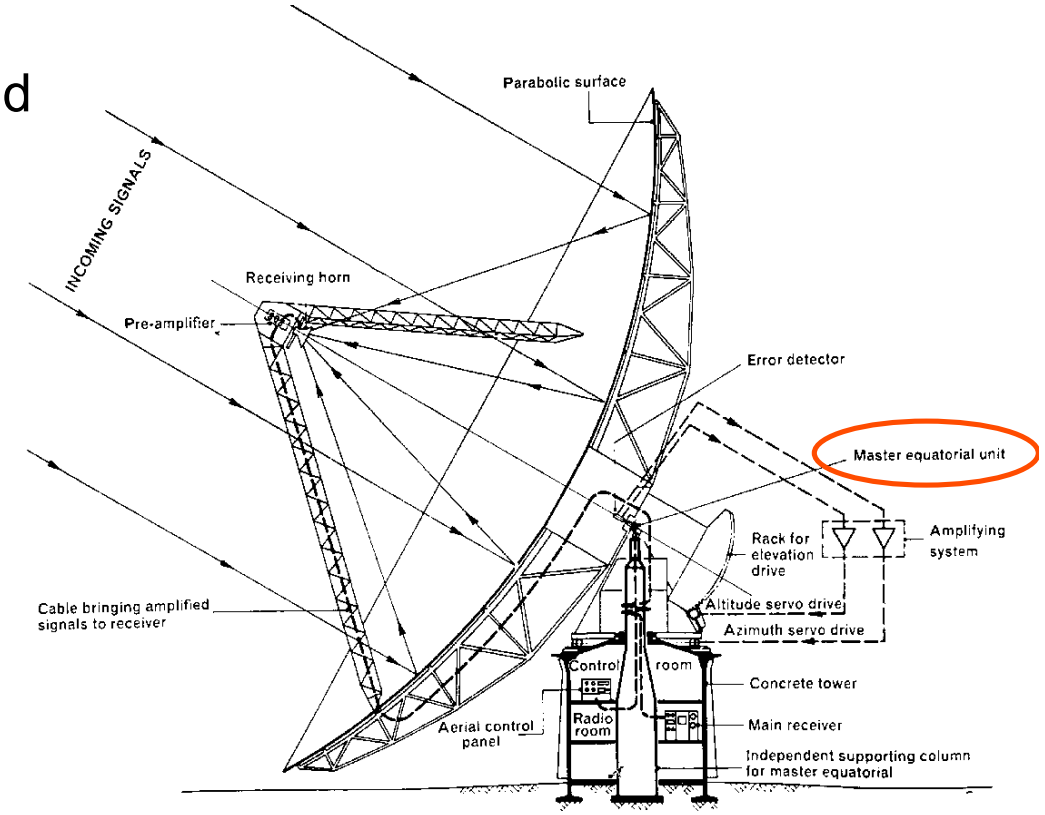



Jim Roberts and the master equatorial

# Master equatorial (ME)

- The master equatorial (ME) telescope is situated at the intersection of the azimuth and zenith axes

- The master equatorial telescope tracks the object across the sky, and the dish follows by minimizing the misalignment between it and the telescope by means of an error detector system.



# Master equatorial (ME)

- In the movie, after Glenn explains Goldstone and Parks to Janine using the soccer ball, Janine asks if the computer moves the dish. Glenn says, “Mitch does that. Then the master eq….”, and then he’s interrupted by the NASA guy.

- In the movie, soon after the Classical Gas scene, you’ll hear Cliff say to Mitch, “Switch to ME.”