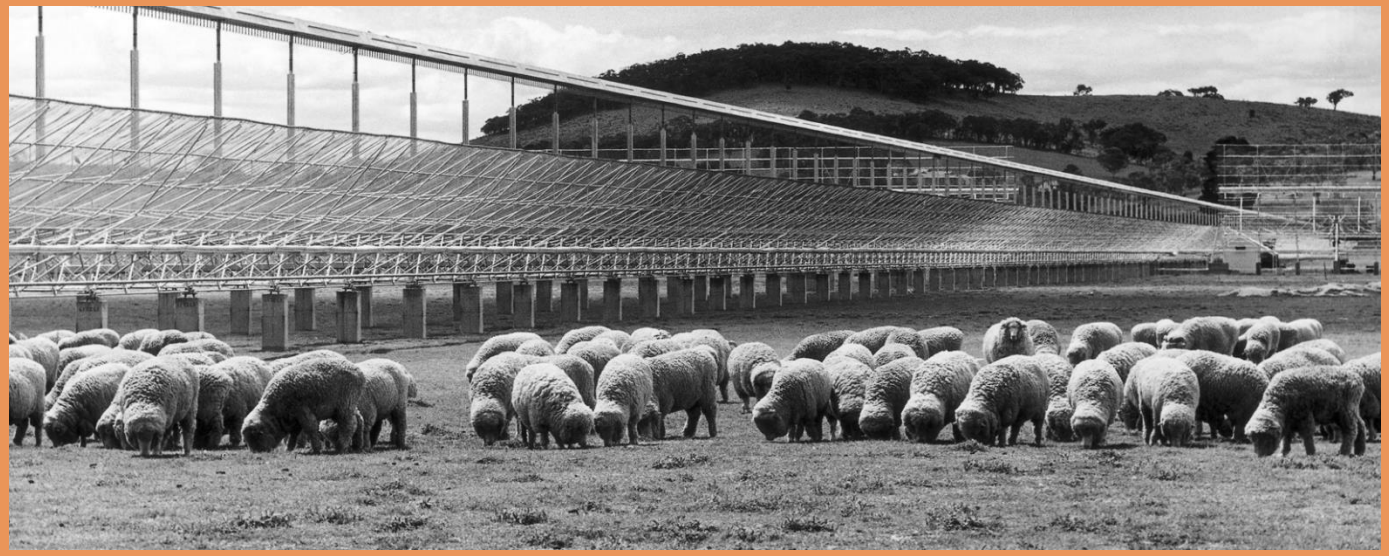
MSH and the MRC



FACULTY OF SCIENCE

Dick Hunstead, School of Physics
The University of Sydney

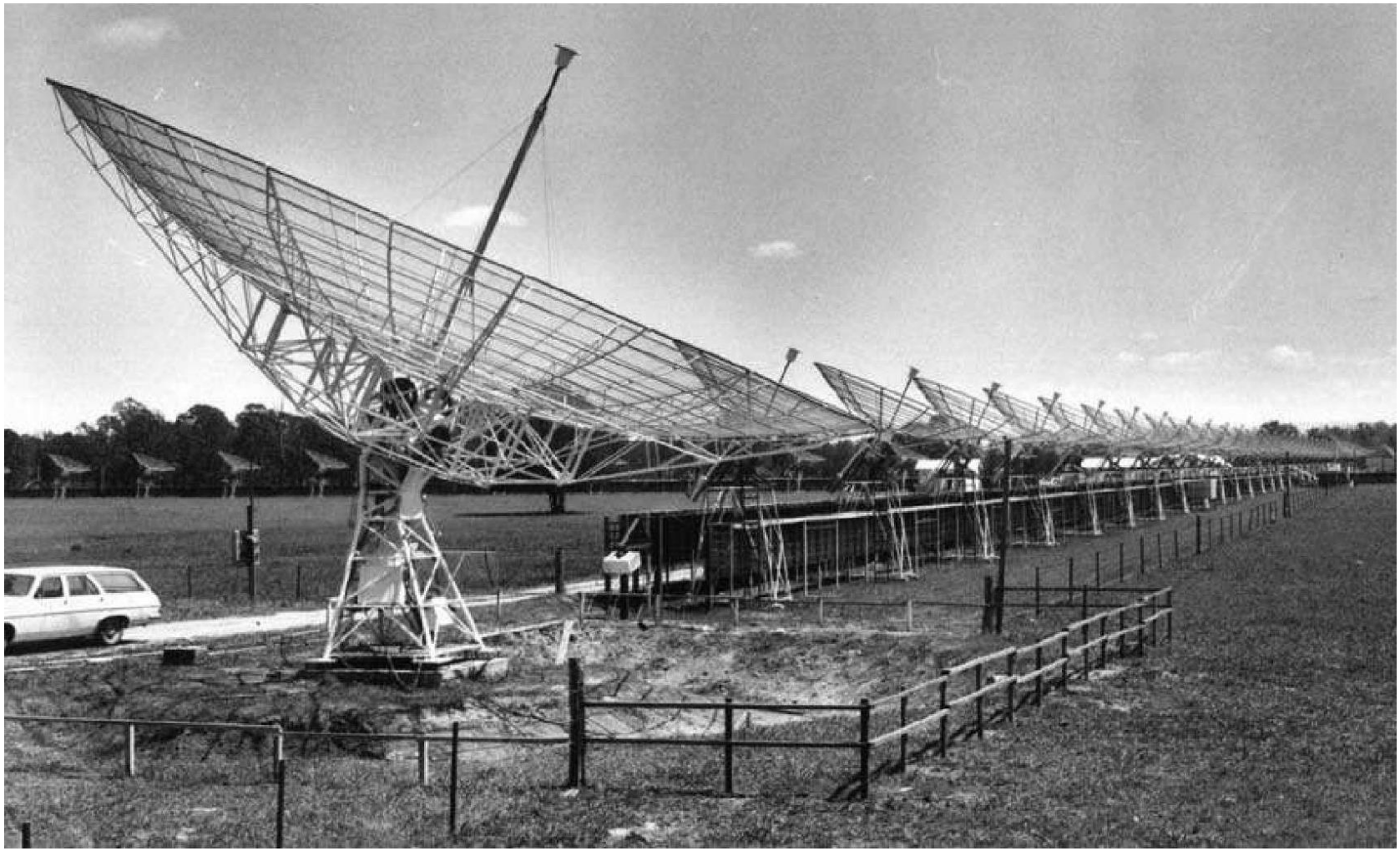
THE UNIVERSITY OF SYDNEY

The MSH surveys and the MRC

- Key players in radio astronomy in the 1950s, and how I became interested in radio astronomy at high school
- Mills, Slee and Hill southern surveys; Hydra-A variability
- Mills transition from Radiophysics → Sydney University, and the Molonglo Cross
- Molonglo Reference Catalogue; CTA 102 variability --- 1965 and 1972

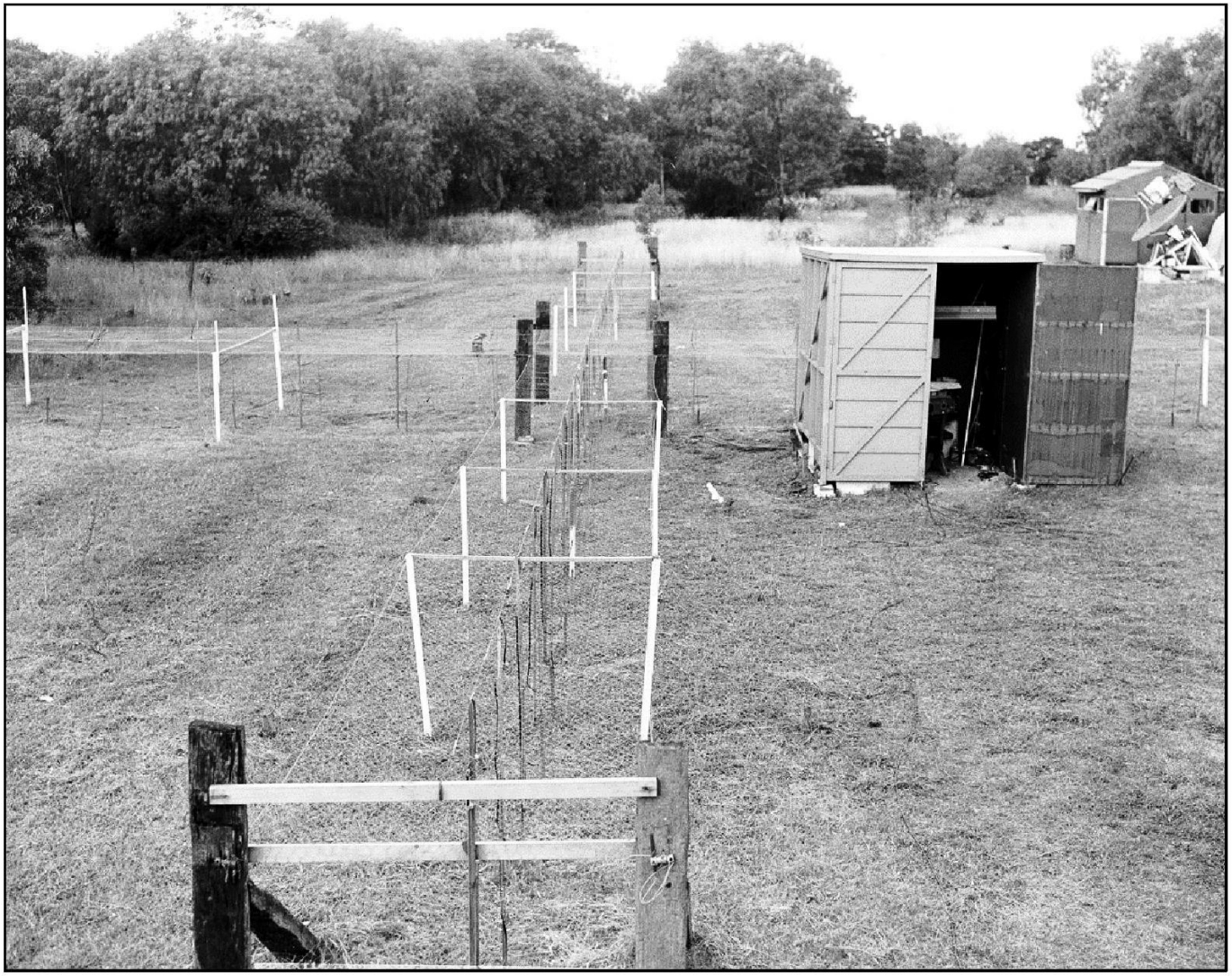
URSI , Sydney 1952

The Chris Cross at Fleurs

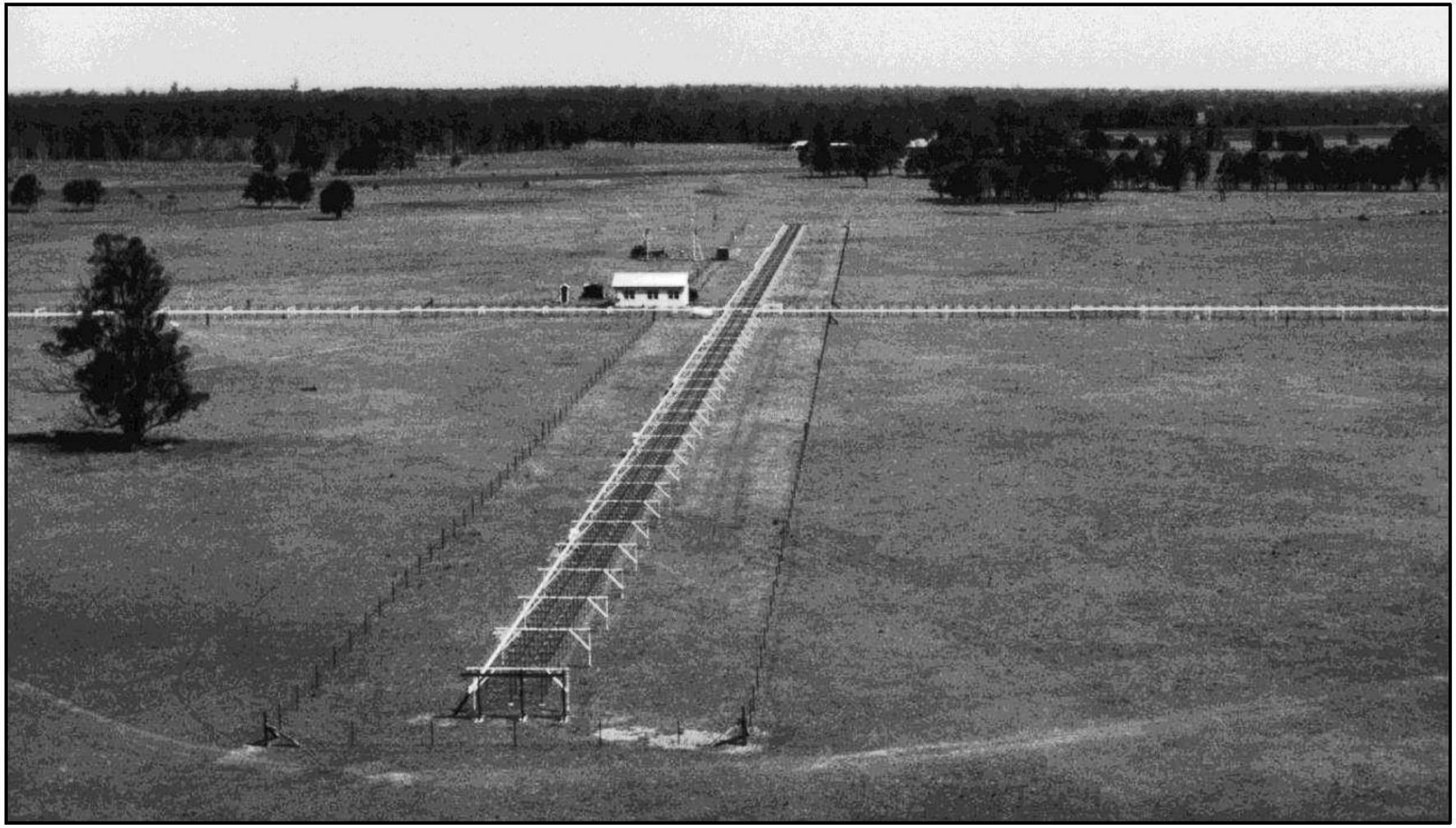


ATNF, Historic Photographic Archive, 9097-11

Prototype 36m Mills Cross



Original Mills Cross



Courtesy of ATNF Historical Photographic Archive: 3476-3 Image Date: 25 October 1954

Mills and Slee (1957)

- Precursor to the MSH survey: 383 sources RA 00-06h, Dec $+10^0$ to -20^0

- Their comparison between the preliminary Sydney and Cambridge 2C catalogues led to strong criticism of flaws in the Cambridge technique, and a long-standing souring of relationships between the two groups

- Three survey papers at 85.5 MHz were published in 1958, 1960 and 1961 covering the sky from $+20^0$ to -80^0, with 2270 sources above 7 Jy; resolution 48 arcmin FWHM. These surveys are still relevant today

Low frequency variability (Slee 1955)

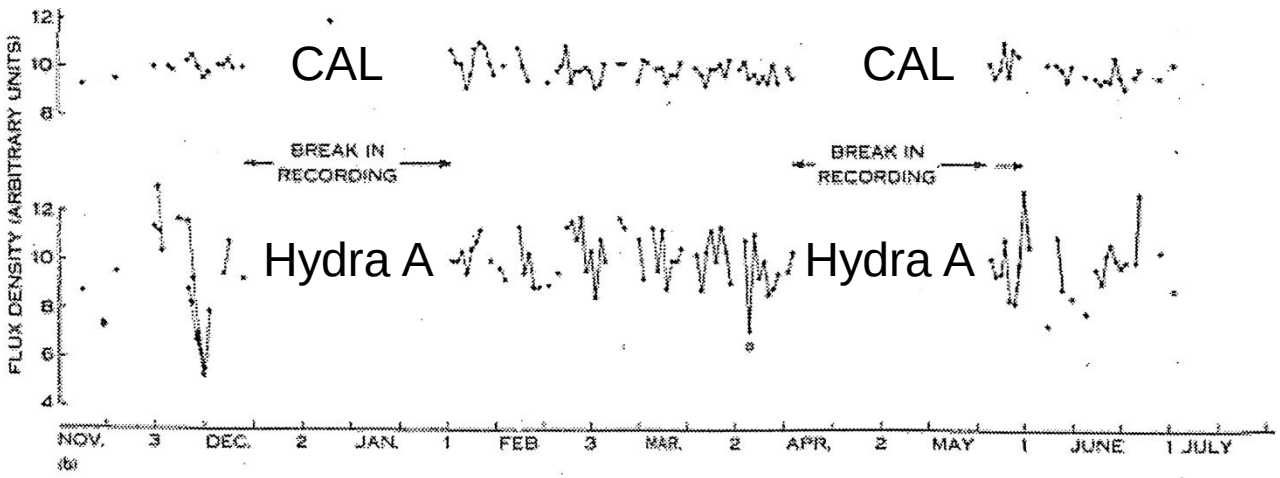


Fig. 4.—Plots of the daily observed intensities of Hydra-A and the comparison sources.

TABLE 2

RELATIONSHIP BETWEEN SIGNAL-TO-NOISE RATIO AND ACCURACY OF INTENSITY MEASUREMENTS

Source	Signal-to-noise Ratio	% Standard Deviation
Hydra-A	10	12·2
Virgo-A	15	5·3
Taurus-A	10	6·0
Centaurus-A ..	30	6·1

Low frequency variability

- Slee (1955)… “the large reductions in the Hydra-A intensity … cannot be explained by any well-known ionospheric effect. However, in view of the small angular size of the source compared with the comparison sources , it is possible that ionospheric effects may be more severe.”

- Pisareva (1958): Abstract --- “We discuss the possible explanation of intensity variations of the discrete radio source Hydra A in terms of diffraction [by] nonuniformities in interstellar and interplanetary ionized gas.”
- … “dimension of these nonuniformities is ~10^6 km and they are at a distance of about 10^9 km from the earth, and thus belong to the solar system.”
- Cited by Hewish et al. (1964) in describing the phenomenon of IPS

Hydra –A at 74 MHz (Lane et al 2004)

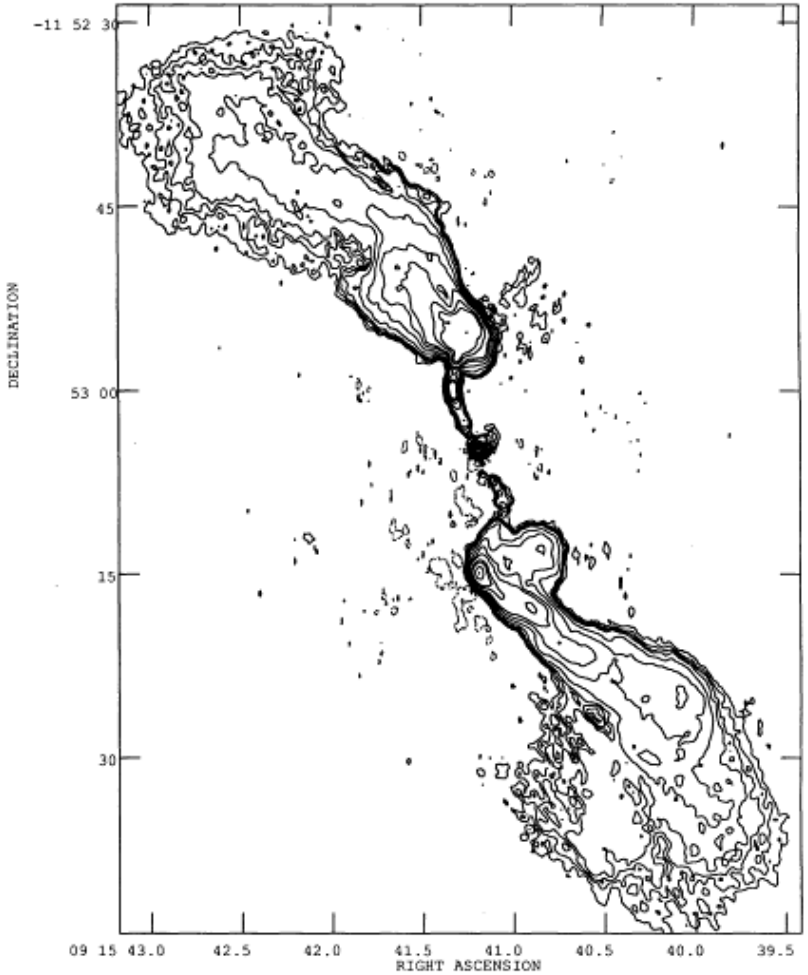


FIG. 1.—Total intensity distribution of Hydra A at 4635 MHz from A-, A/B-, B-, C-, and D-configuration data at 0″.6 resolution. Contour levels are at −3.7, −1.5, 1.5, 2.7, 3.7, 5.1, 10, 21, 37, 51, 103, 154, 311, and 466 mJy arcsec^{-2}, with negative contours shown as dashed lines.

Original peg marking the Parkes site

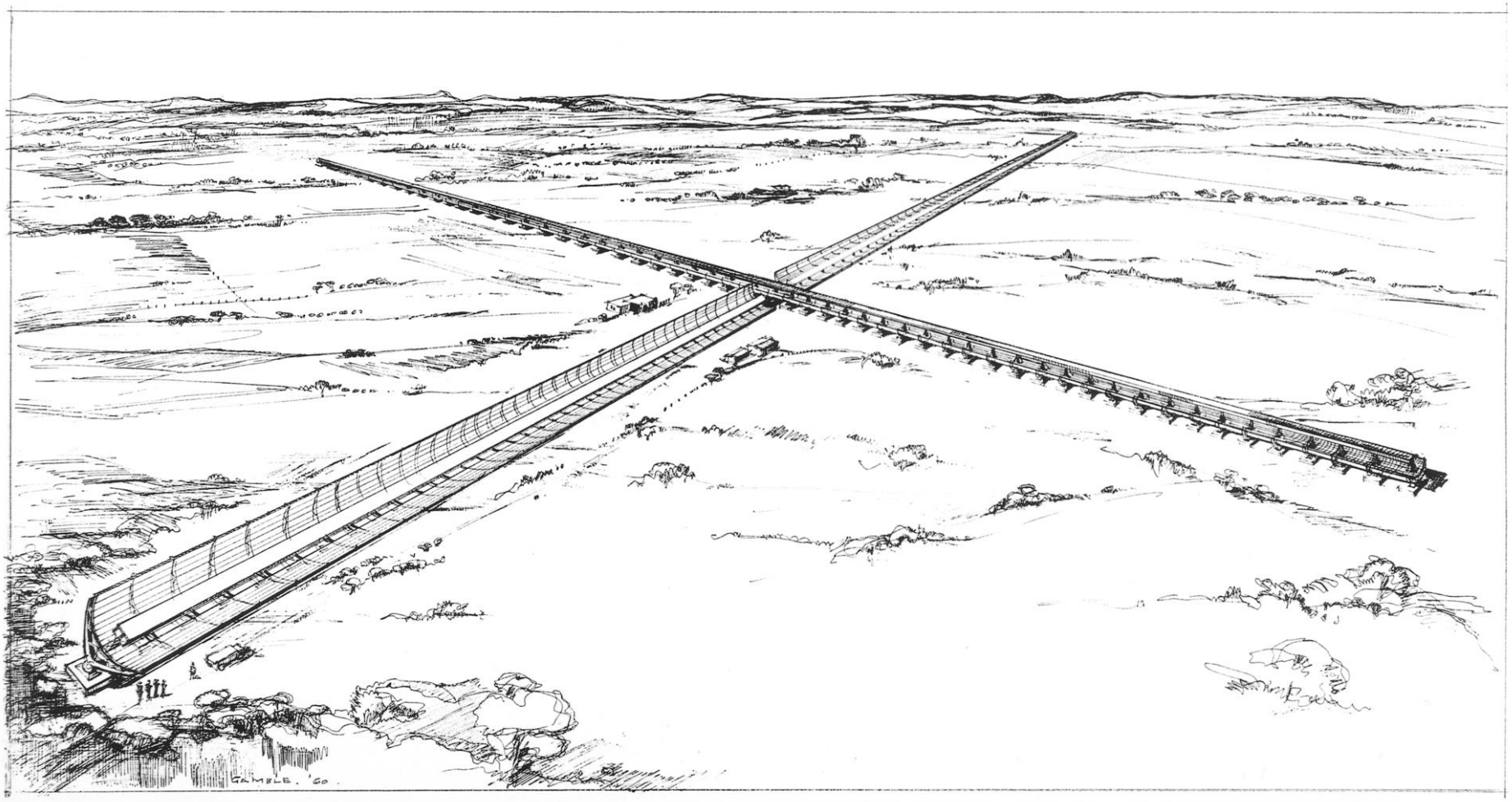
March 1958

Mills (2006)

Bowen's recreation 29 Sep 1961

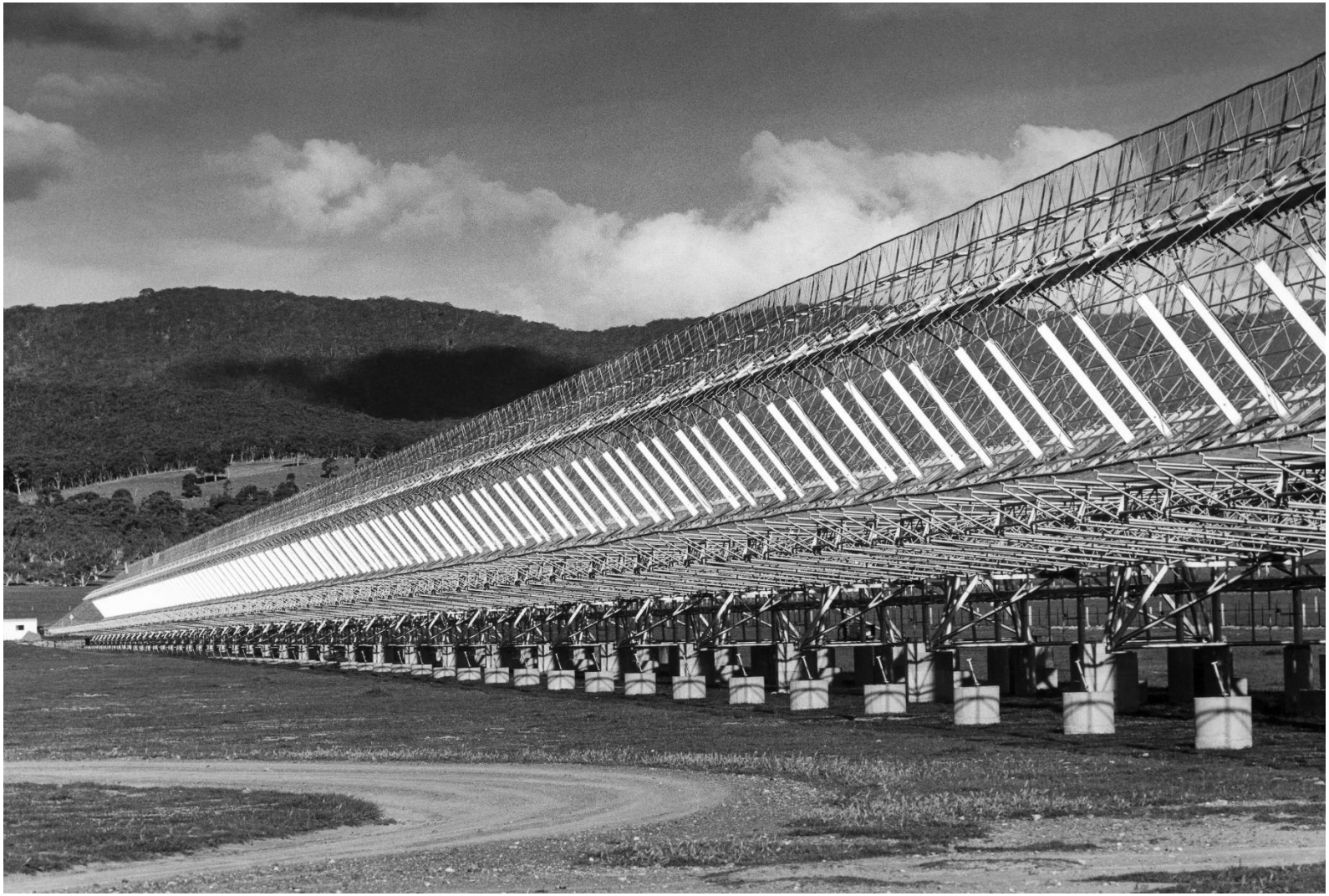
Courtesy of the ATNF Photographic Archive B6586

Parting of the ways…



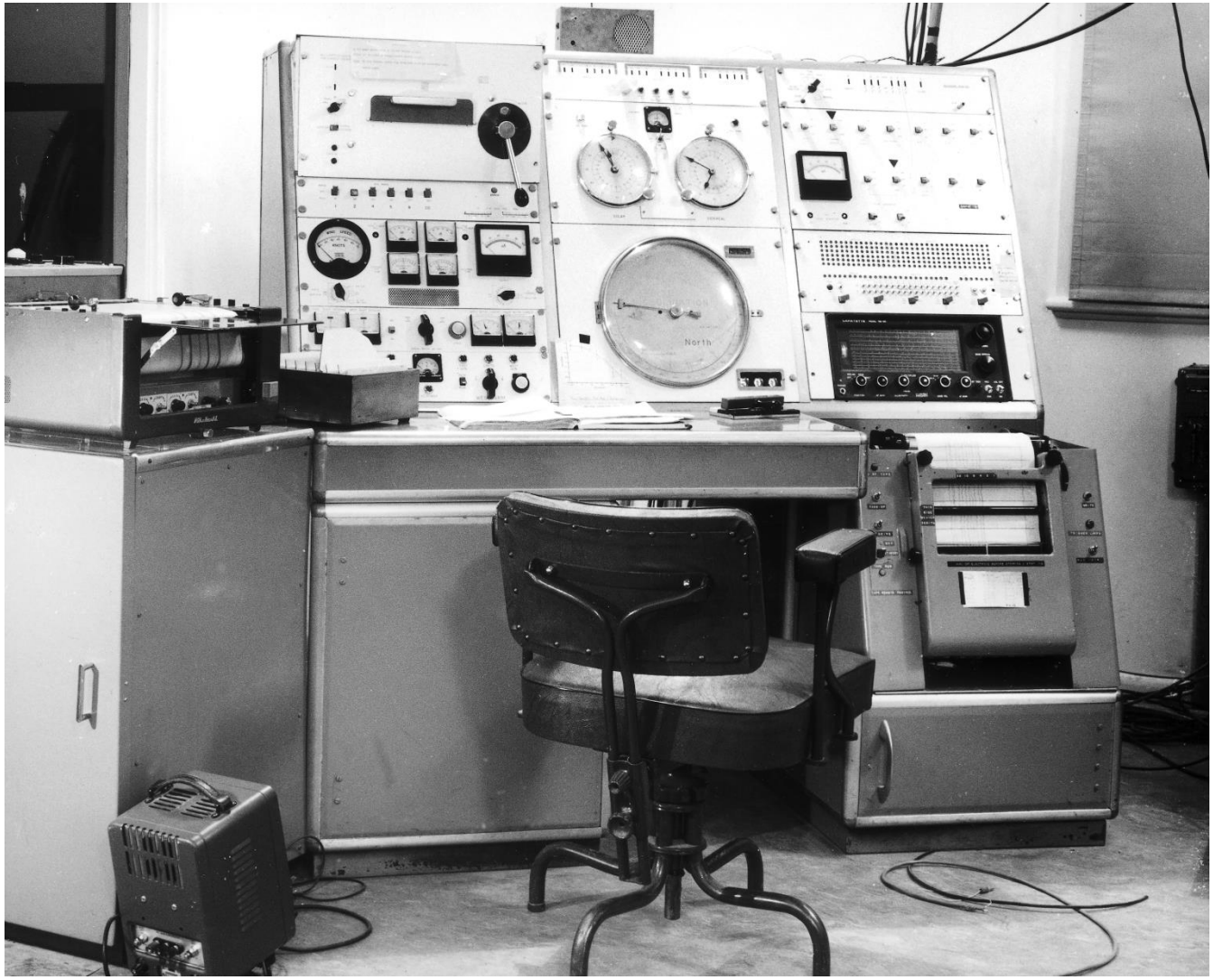
Molonglo construction begins…

East-west arm complete…

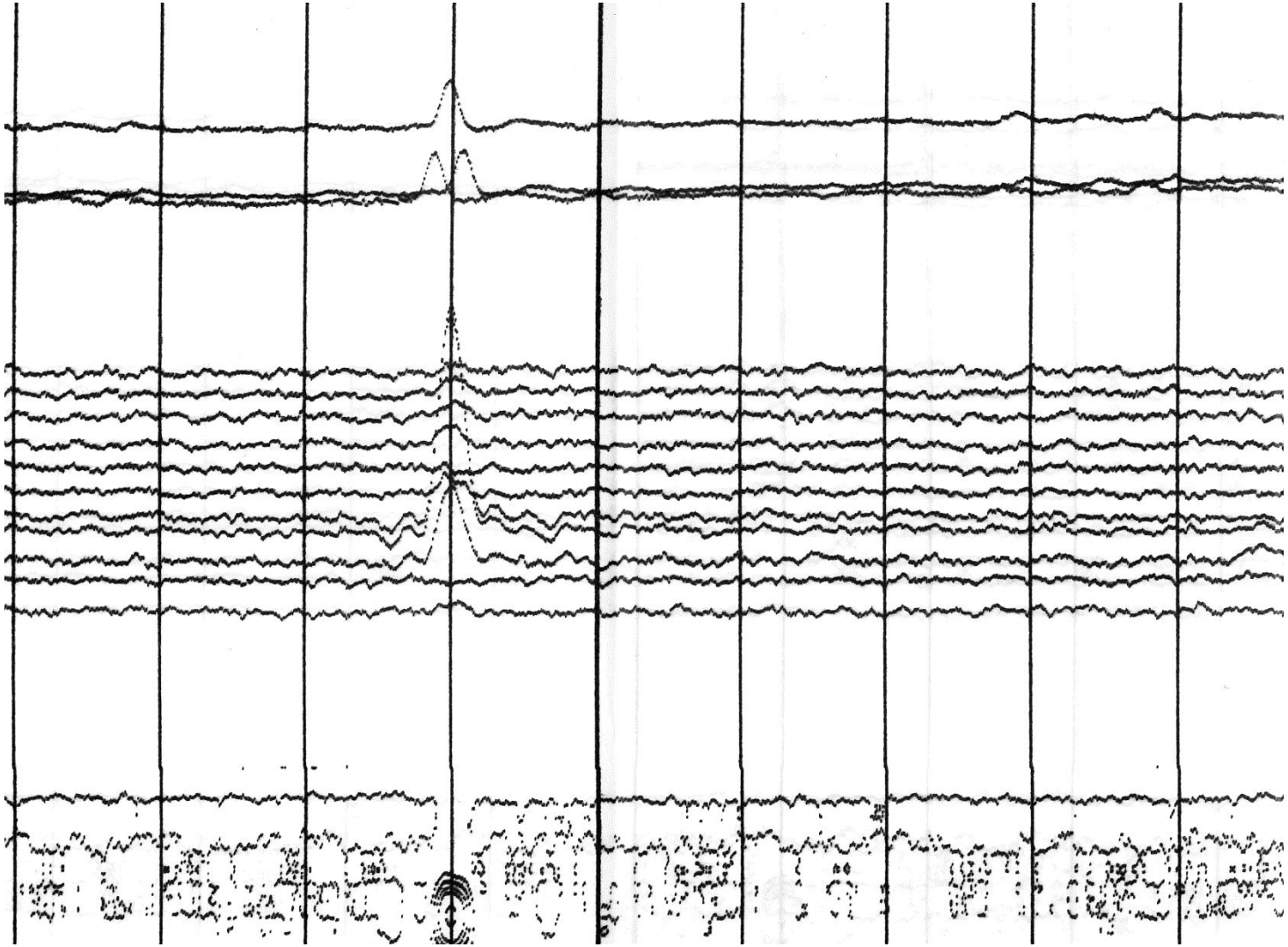


Official opening: 19 Nov 1965

Control room in the 1960s



Fax chart



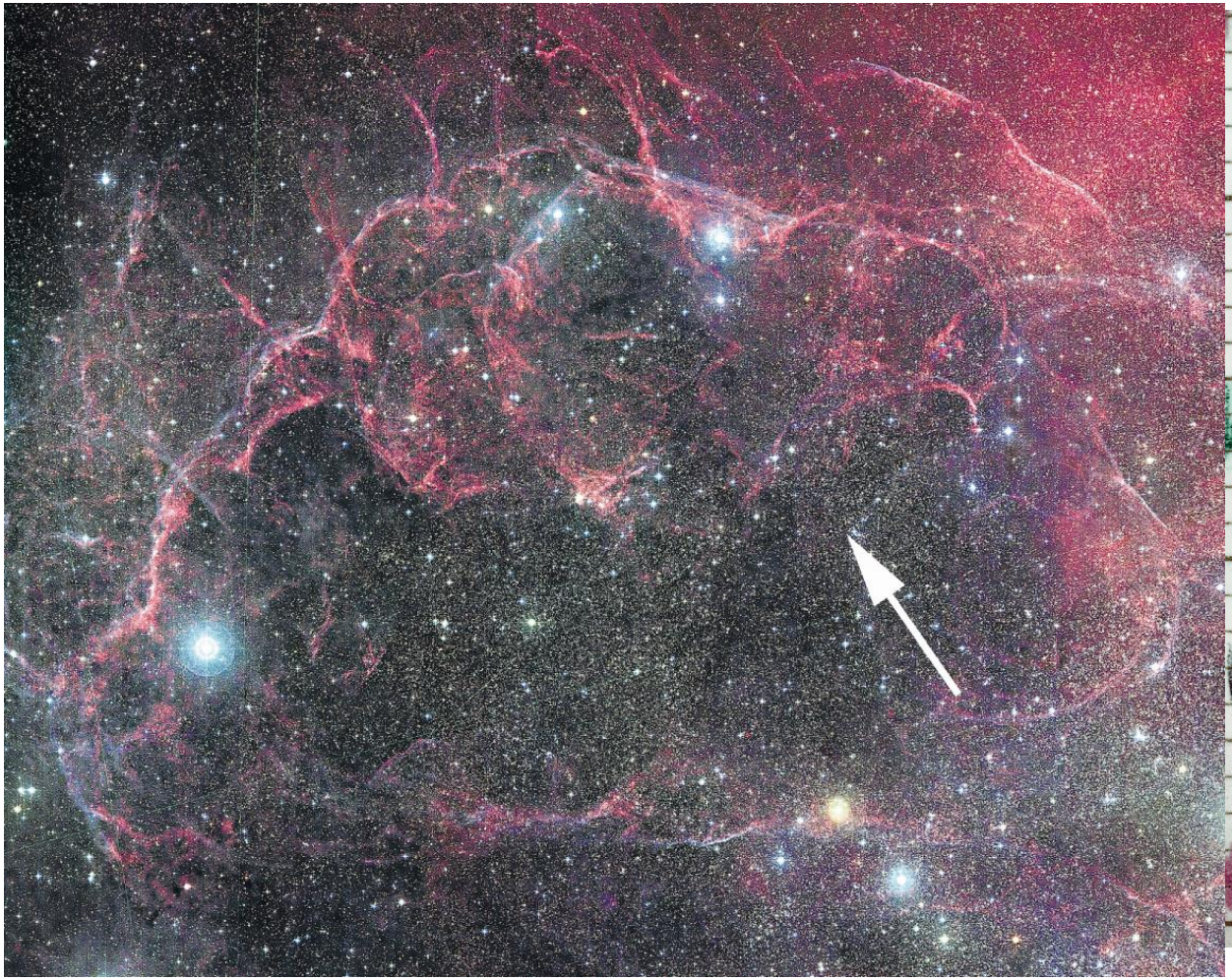
3 EWTP beams

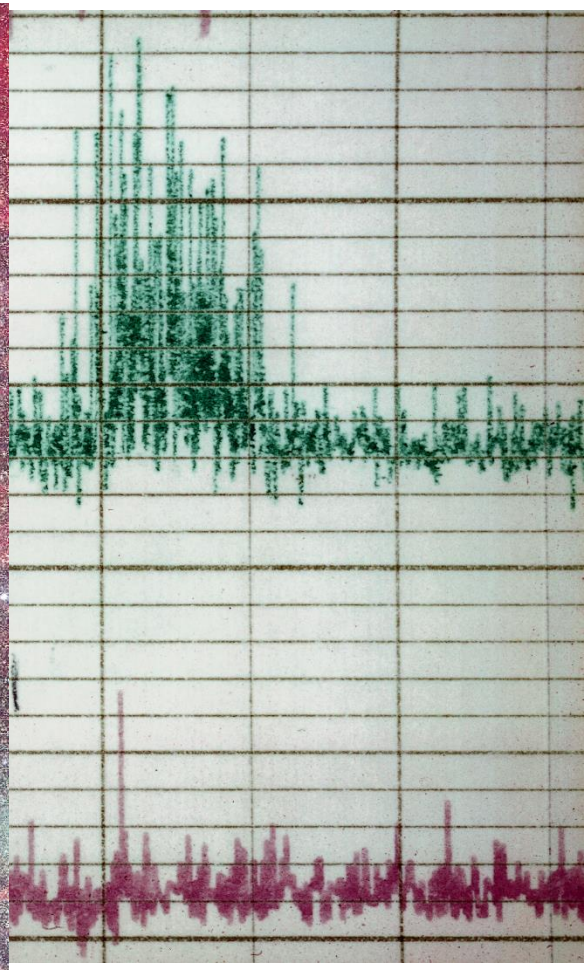
11 NS beams

Real time contours

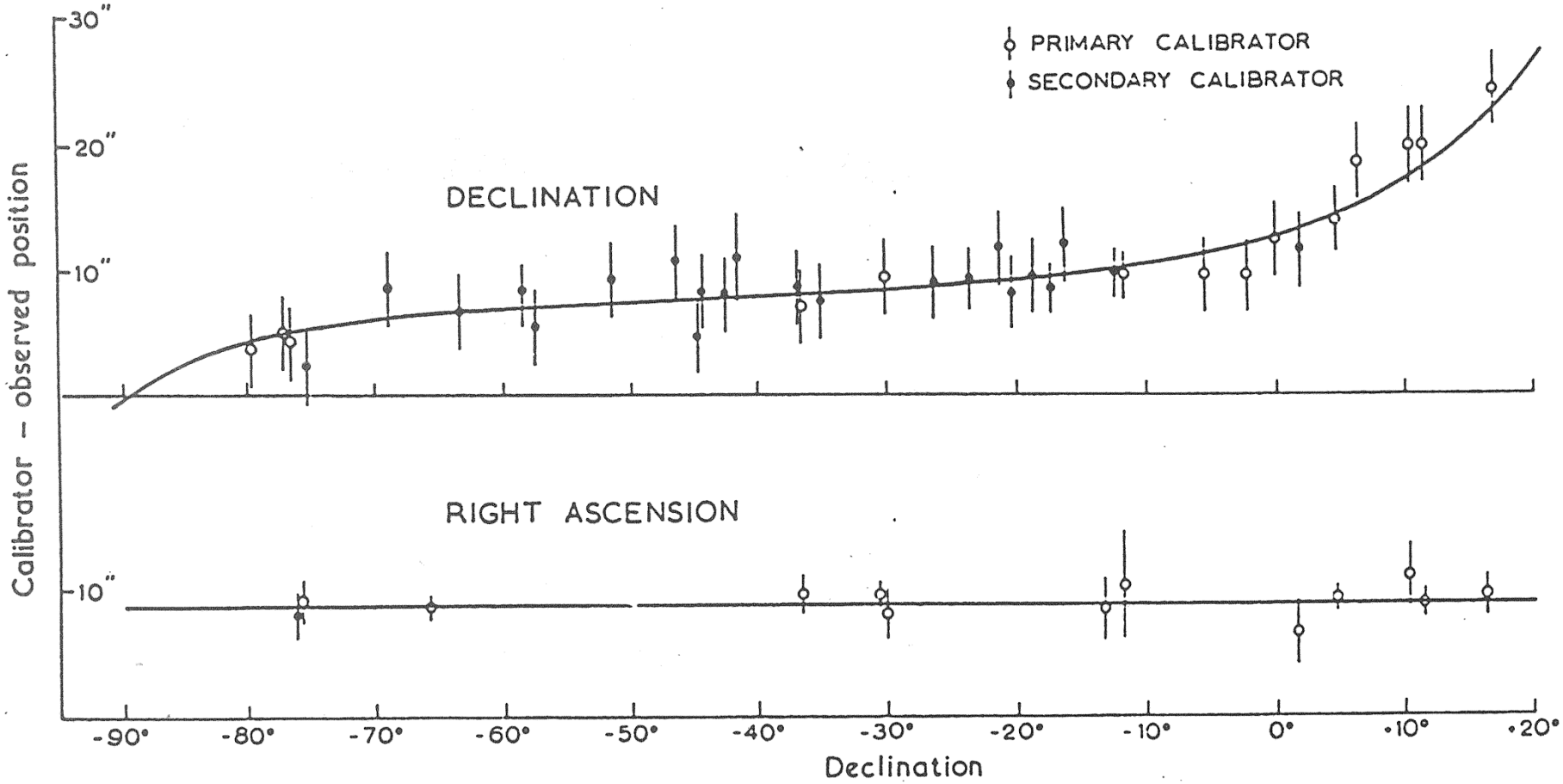
Discovery of the Vela pulsar

› Large, Vaughan & Mills 1968

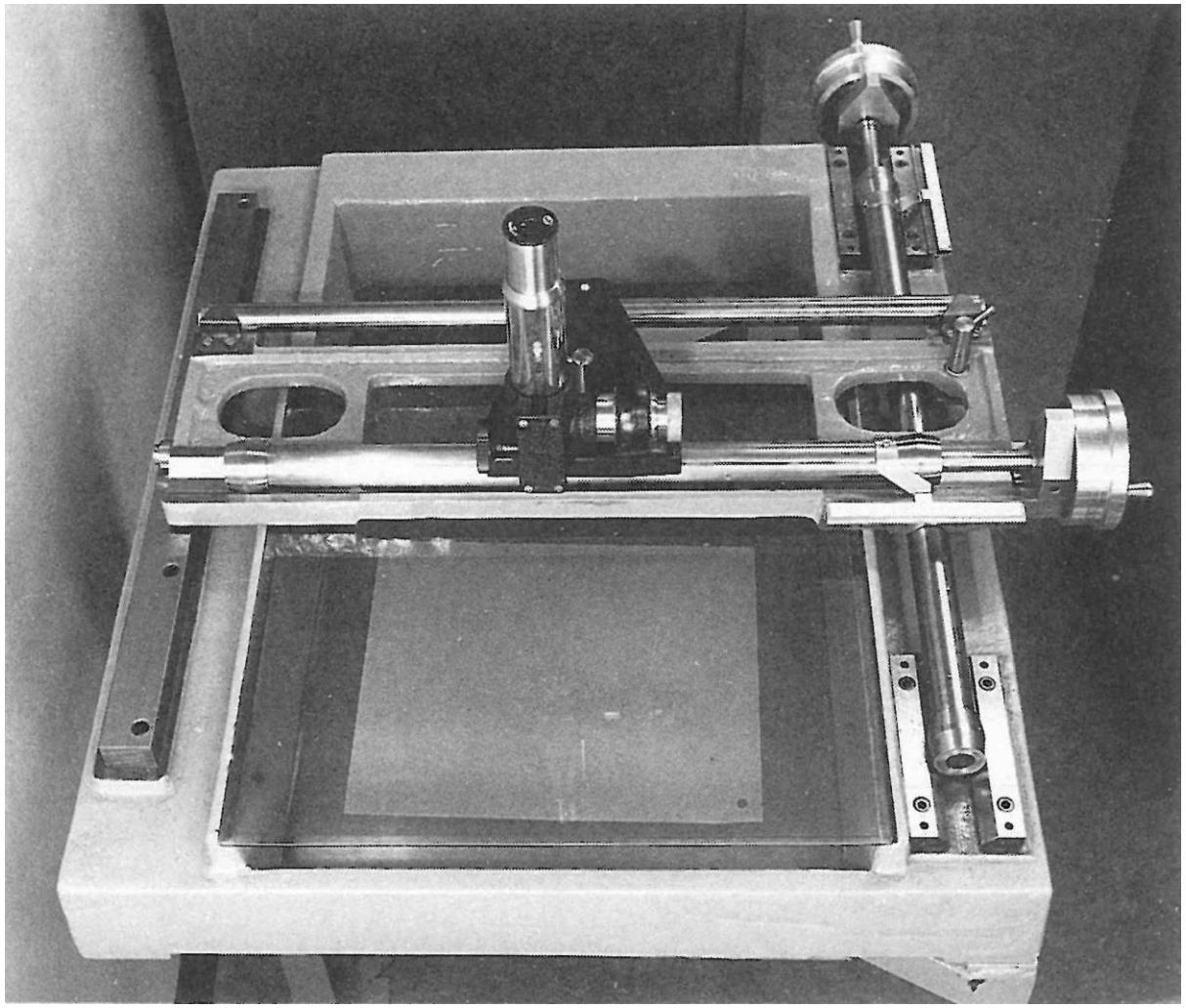




Molonglo Cross calibration curve

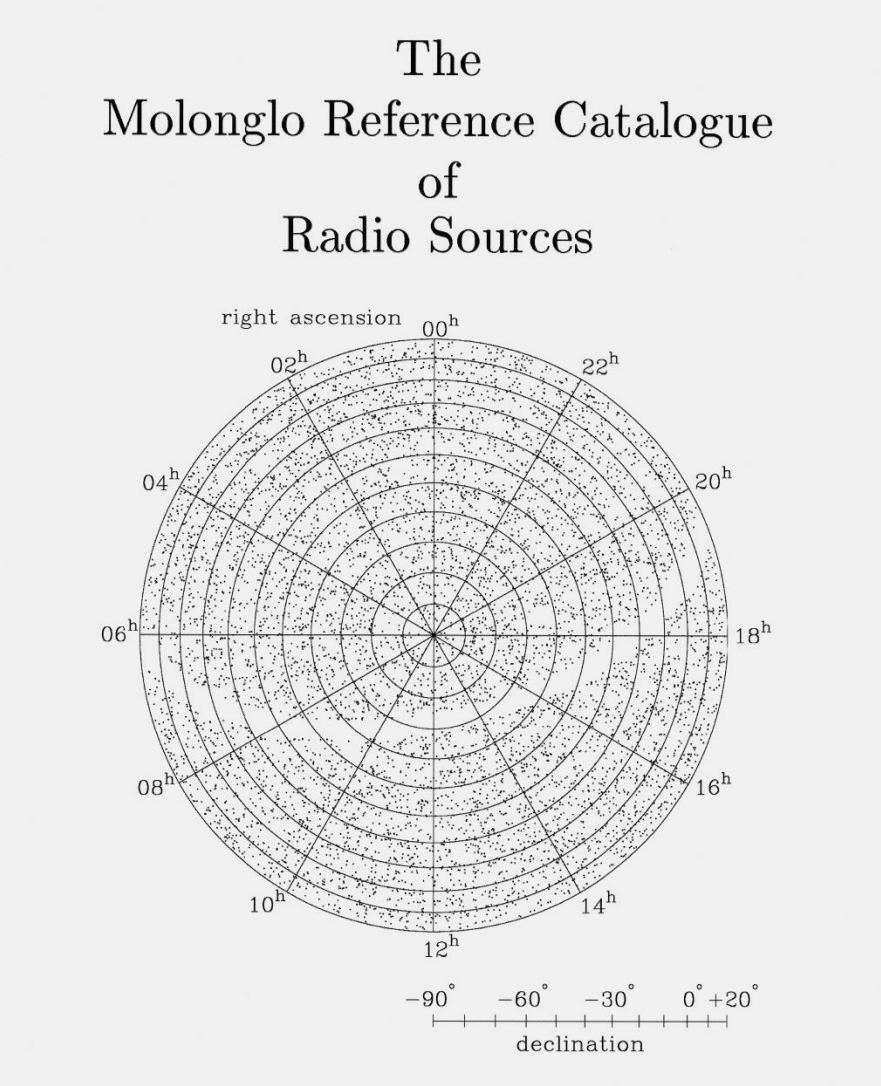


Two-coordinate measuring machine



Design: NML Construction: John Horne Photo: Bob Shobbrook

Molonglo Reference Catalogue



- 408 MHz
- 12141 sources
- S>0.95 Jy
- Dec -85^0 to +18.5^0
- |b| > 3^0

- N.B. MSH had 2270 sources

Key players 1960--1985

Bernie Mills

Alec Little

The saga of CTA 102 (B2230+11)

(A Brief History of Radio Astronomy in the USSR. Ed. S.Y.Braude et al, Springer 2012)

Sholomitkskii Shklovskii Kardashev

In 1963 Nikolai Kardashev proposed that the then-unidentified radio source could be evidence of a Type II or III extraterrestrial civilization on the Kardashev scale.[2] Follow-up observations were announced in 1965 by Gennady Sholomitskii, who found that the object's radio emission was varying;[5] a public announcement of these results on April 12, 1965, caused a worldwide sensation.[6] The idea that the emission was caused by a civilization was rejected when the radio source was later identified as one of the many varieties of a quasar.[2]

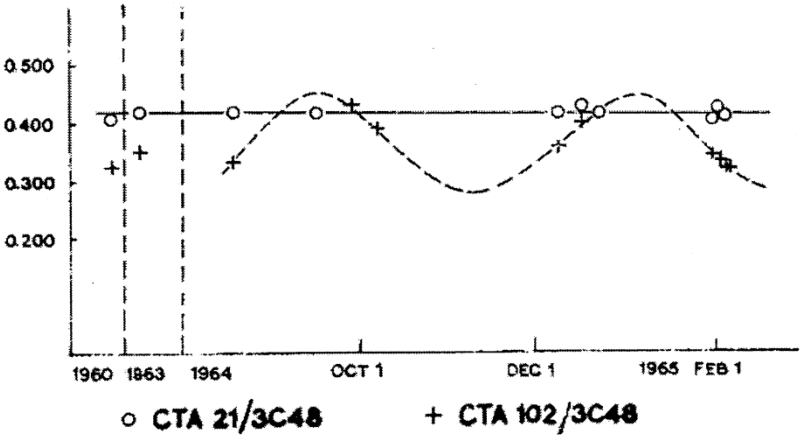
CTA 102 is one of the two great false alarms in the history of SETI, the other being the discovery of pulsars, specifically PSR B1919+21, which are rotating neutron stars.

The American folk rock band The Byrds whimsically reflected the original view that CTA-102 was a sign of extraterrestrial intelligence in their song "C.T.A.-102" from their 1967 album Younger Than Yesterday.[7]

COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
NUMBER 83

Konkoly Observatory
Budapest
27 February 1965

VARIABILITY OF THE RADIO SOURCE CTA - 102



Rebuttal of CTA102 variability

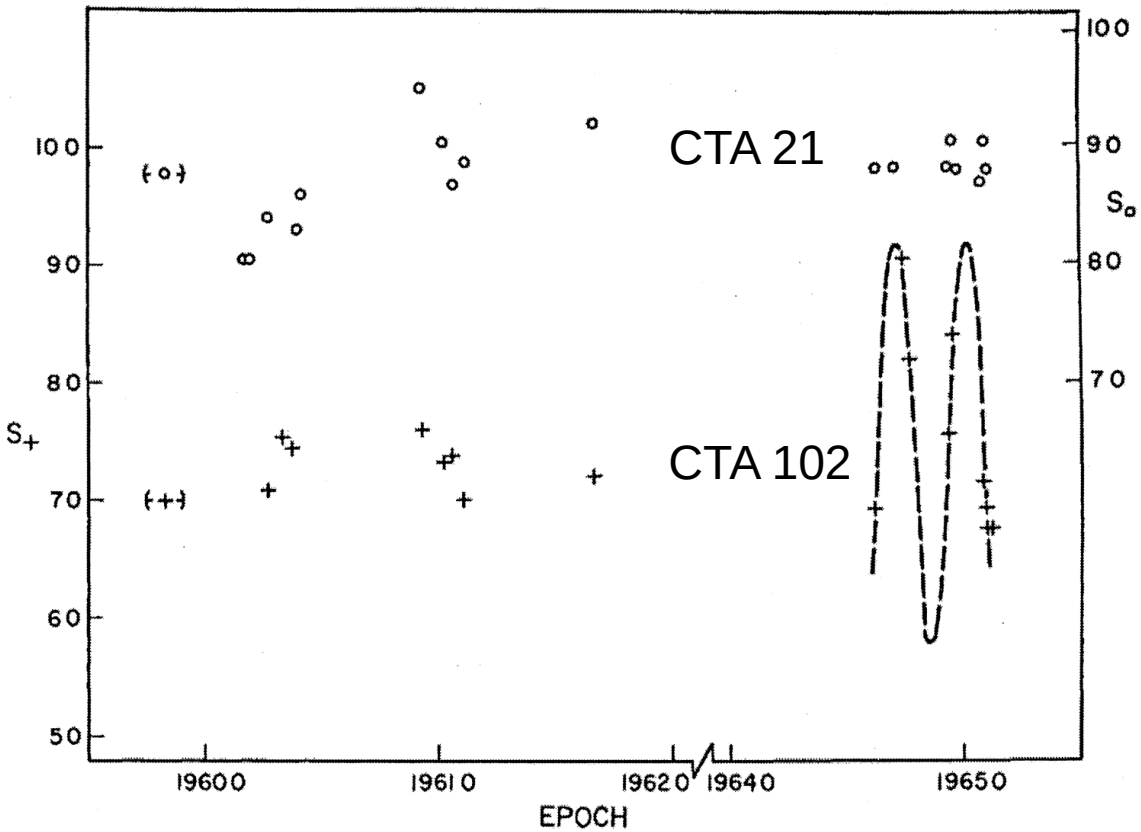


FIG 1 —Measured intensities of CTA 102 (*crosses* and intensity scale on left) and of CTA 21 (*circles* and scale on right). For comparison we have plotted on the right the data and suggested light-curve of Sholomitskii (1965). Units are 10^{-26} W m^{-2} $(c/s)^{-1}$.

Observer	Wavelength
Sholomitskii	32 cm
Maltby/Moffet	31 cm
Caswell/Wills	170 cm
Terzian	49 cm
Nicolson	13 cm

CTA 102 revisited

Hunstead to Jauncey, 28 Jan 1972:

In the course of my redetermination of PB gain curve, I came across a few sources with notable differences in flux density between observing sessions. Most of these sources are known variables at high frequency. However, the most convincing case for significant variability is none other than CTA102 You may remember the stir caused by Sholomitskii in 1965

Jauncey to Hunstead, 11 Feb 1972:

I'm going to go through our old 430 records looking for more 2230+11 results and hopefully we may turn up something useful there.

CTA 102 revisited

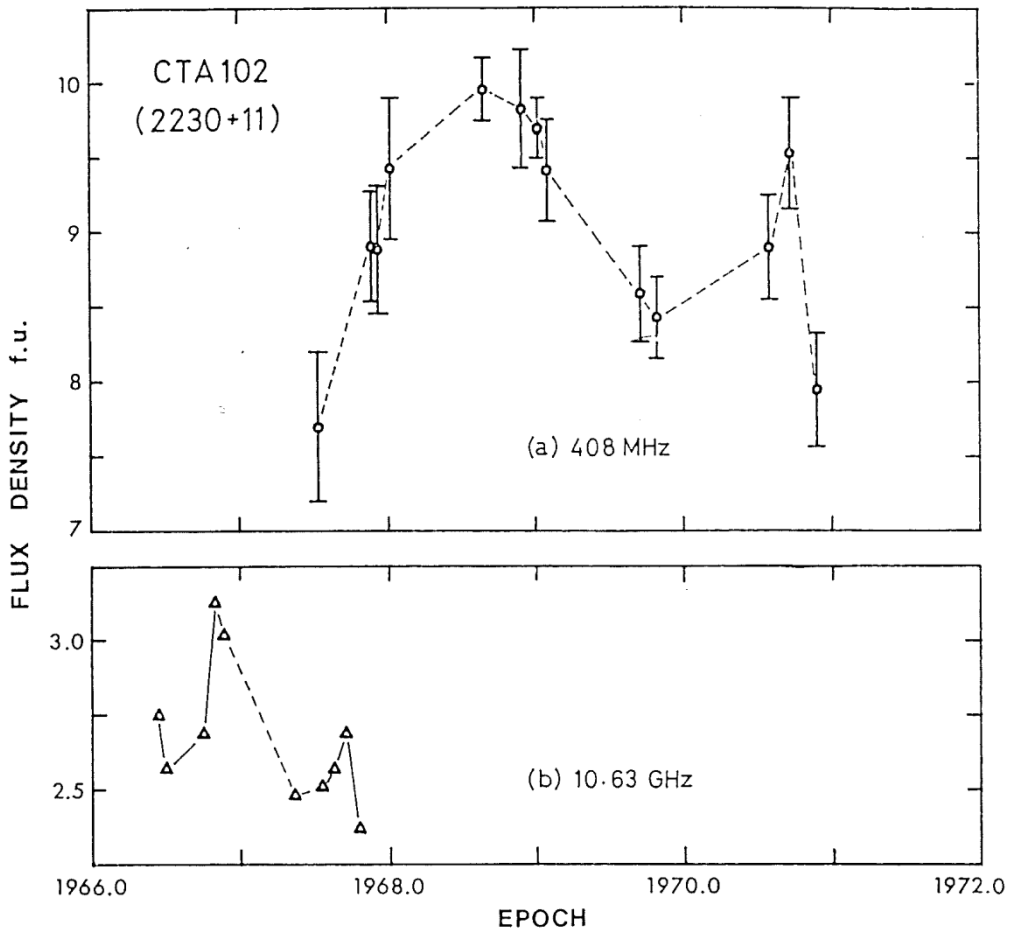


FIG. 4. Variations in the flux density of CTA 102 (2230 + 11) at (a) 408 MHz and (b) 10.63 GHz (Medd, Locke and Andrew 1968).

3C 454.3 variability

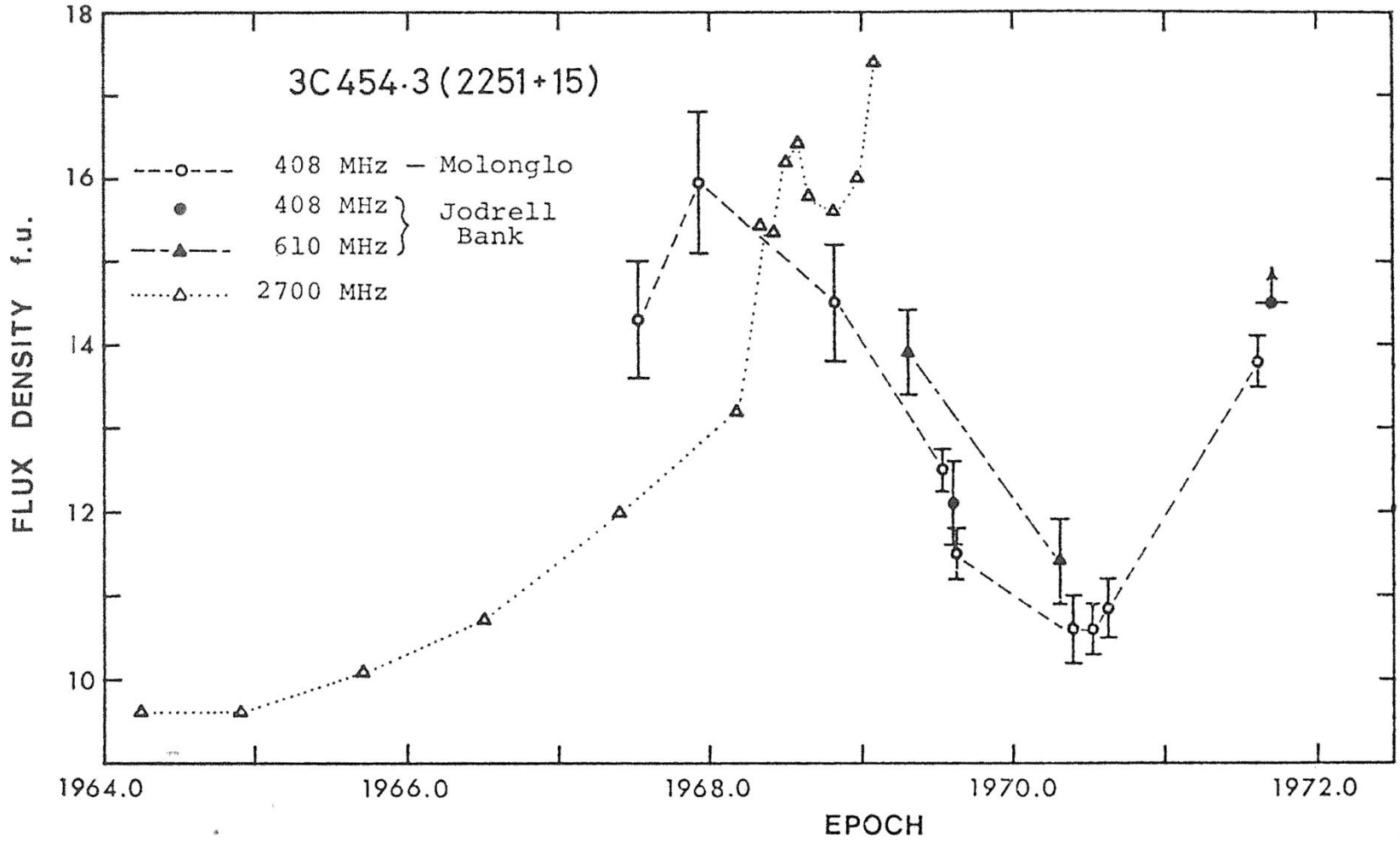
Conway to Hunstead, 30 Mar 1972:

Bob Munro, Dave Stannard and I have been greatly interested in your letter and graph of 3C 454.3. It is very encouraging to find that the 1969.5 point, which we started by thinking might have changed because of systematic errors, is in fact spot on your graph.

Jauncey to Hunstead, 03 Apr 1972:

You mentioned that, in addition to CTA 102, you have some other ~~optical~~ radio variables at 408 MHz. I would be very interested in comparing these with our measurements at 318/430/606. In particular, I'm pretty sure that we have found 3C 454.3 variable at 318 MHz.

3C 454.3 variability



What causes the variability?

- Slee (1955)… “the large reductions in the Hydra-A intensity … cannot be explained by any well-known ionospheric effect. However, in view of the small angular size of the source compared with the comparison sources , it is possible that ionospheric effects may be more severe.”

- Hunstead (1972): “The situation therefore appears to present a choice among three possibilities….[all unlikely]”
- … “There remains the further possibility that the variations are not intrinsic to the sources themselves but arise from slow scintillations due to the interstellar or intergalactic medium…”

Final question

When variability due to refractive scintillation has now been well confirmed at frequencies around 300-400 MHz, why have MWA and LOFAR found so few variables?