



The Jodrell Bank Story

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SKAO



Contents

- Lovell and the early days
- The drive for bigger telescopes
- Cosmic Rays and me
- The new generation of telescopes - MERLIN
- SKA and the future

Before JB: The Cloud Chamber



C T R Wilson 1911 original
(Cavendish Lab Cambridge)
Photo credit Rolf Kickuth
Visualise particle tracks

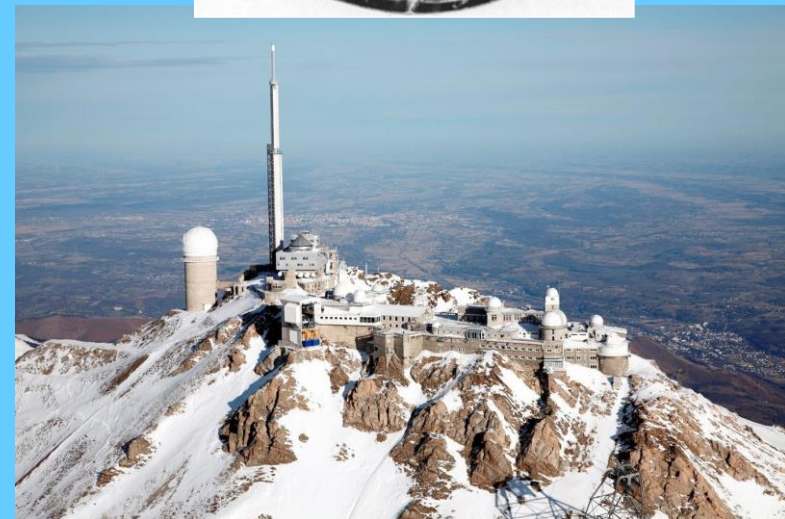
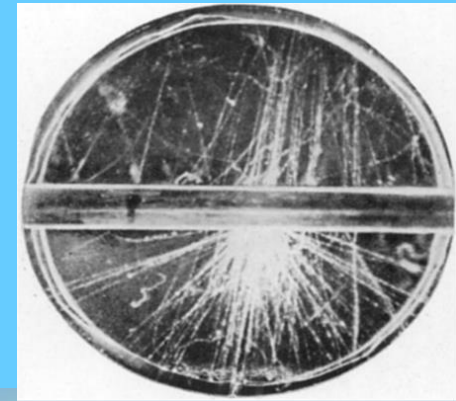


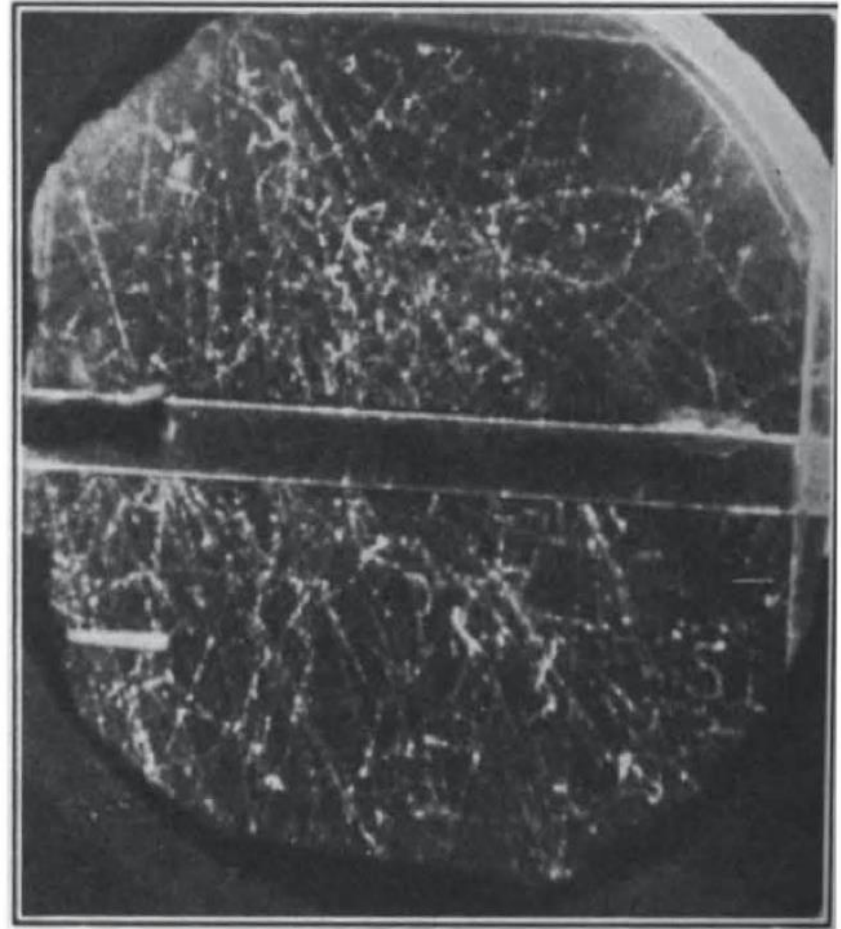
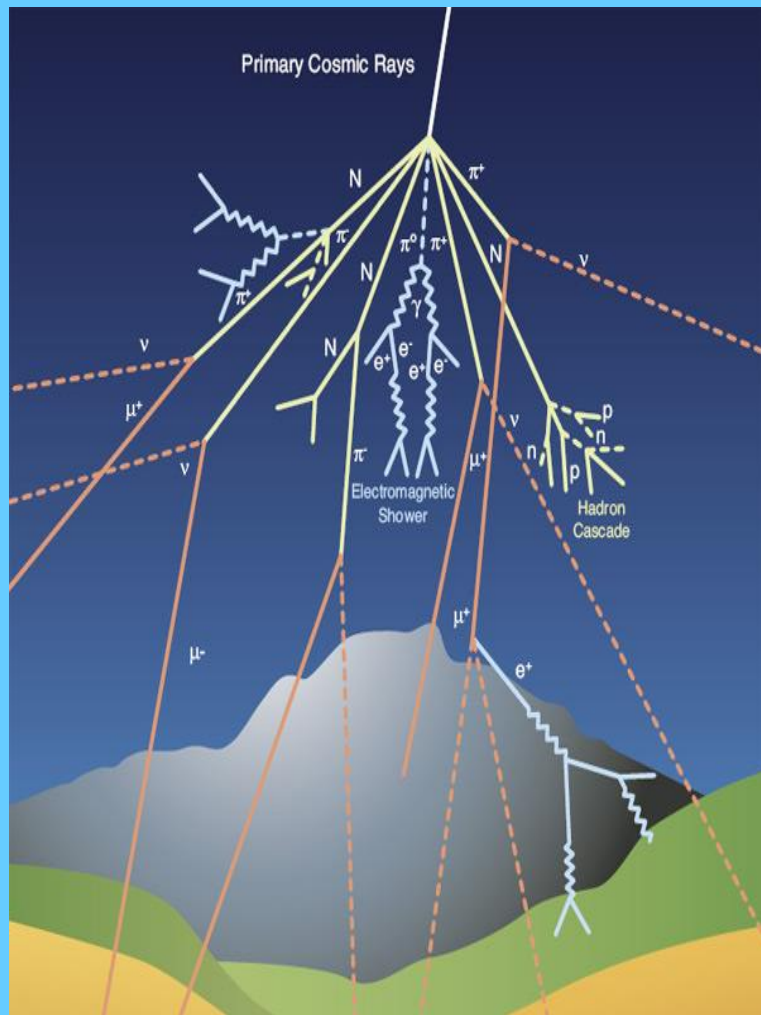
Patrick M. S. Lord Blackett Nobel prize 1948
Birkbeck 1933, Manchester 1937, Imperial
1953

Improved cloud chamber using a strong
spring so that it could be fired several
times per second

Sir Bernard Lovell

- A C B Lovell 1913-2012
- BSc Bristol 1934, PhD 1936 on thin metal films
- Manchester 1936 – worked with Blackett on cloud chambers to study cosmic rays. Designed a large magnet.
- August 1939 about to take a cloud chamber to The Pic Du Midi in France . Blackett advised him not to go!





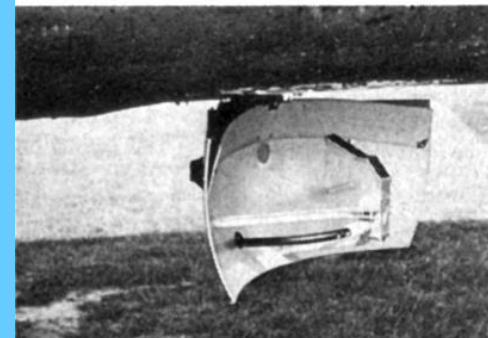
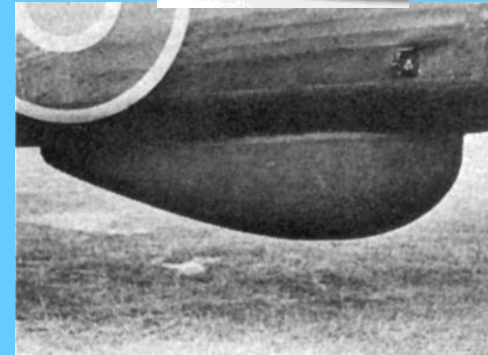
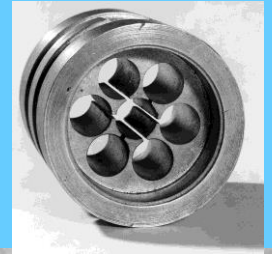
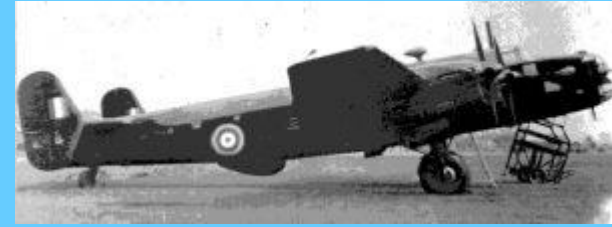
CLOUD CHAMBER PHOTOGRAPH OF AN EXTENSIVE COSMIC RAY SHOWER IN A MAGNETIC FIELD OF 800 GAUSS.

JÁNOSSY, L., LOVELL, A. 1938 Nature of Extensive Cosmic Ray Showers.

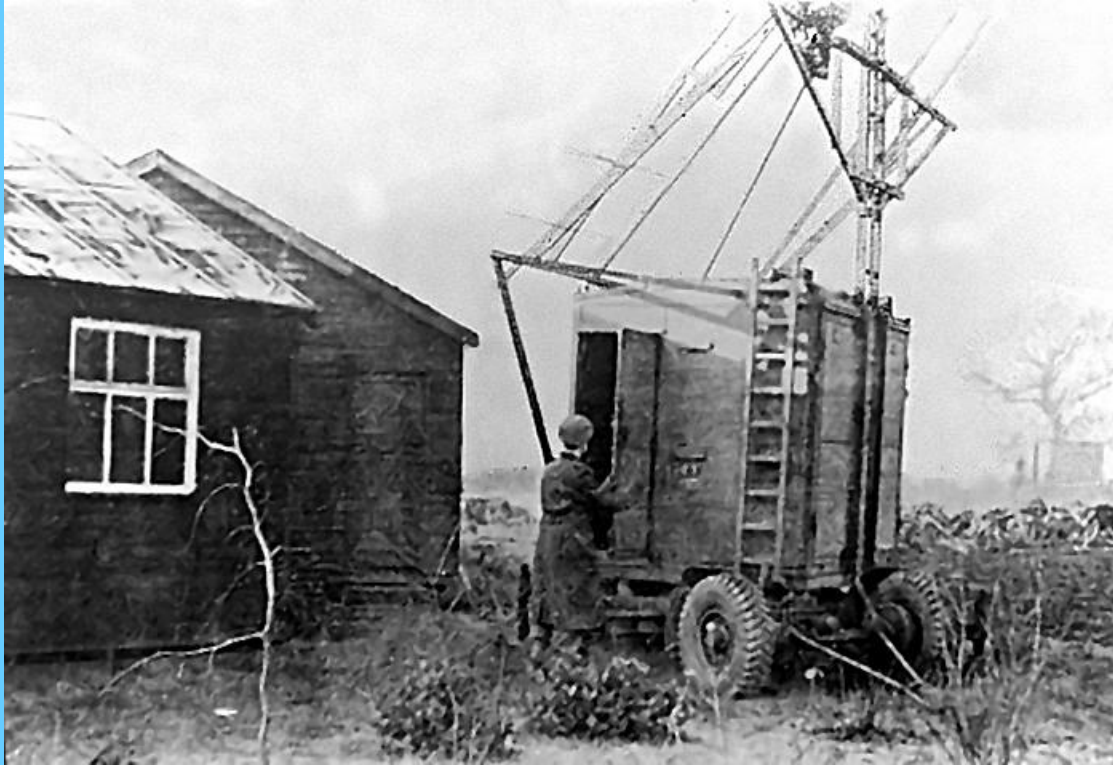
<https://www.auger.org/index.php/cosmic-rays/cosmic-ray-mystery>

Bernard Lovell and H2S

- 1939-1945 Worked on radar at TRE
- Led group that developed H2S airborne radar navigation system, initially at 9-cm wavelength using a magnetron
- Higher resolution H2X 3-cm radar system, still in use up to the 1982 on Vulcan bombers
- Hamburg
- U boat menace
- Paper on Cosmic Ray trail detection using radar?
- 1945 Back to academic life



December 1945 The Search for Cosmic Rays

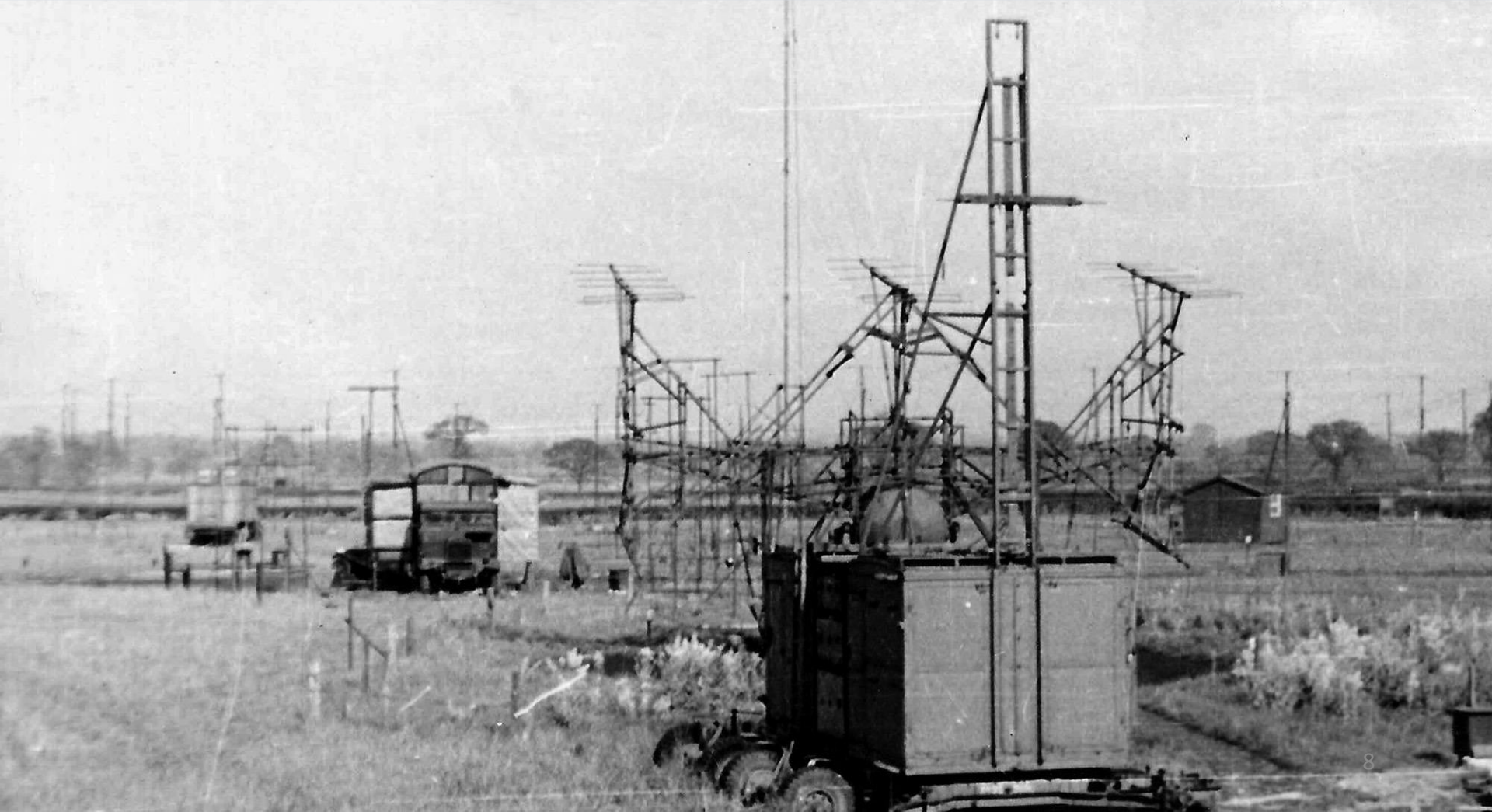


- First Echoes 14th Dec. Detected meteor trails instead.



1946: Moved north into a neighboring field

- Creates 'The Fairground'
- Range of radio antennas & projects studying meteors and the ionosphere
- Gathering of scientists & engineers



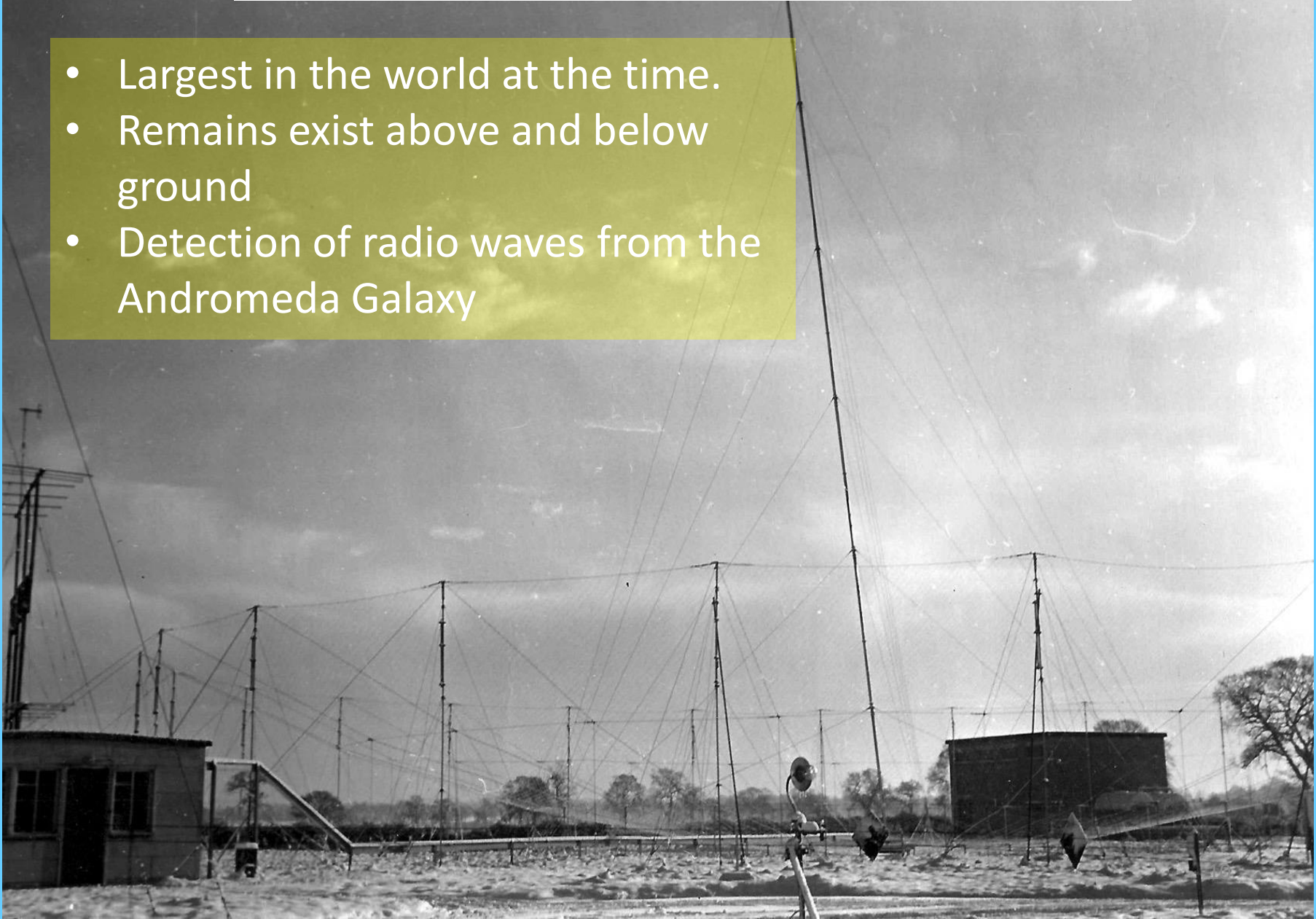
- Perhaps cosmic ray radar returns are weak? *
- Need a bigger aerial
- 218 ft transit telescope

** In fact very weak due to electron attachment to molecules in air – still not detected by radar!*



1947: 218-foot (66m) Transit Telescope

- Largest in the world at the time.
- Remains exist above and below ground
- Detection of radio waves from the Andromeda Galaxy

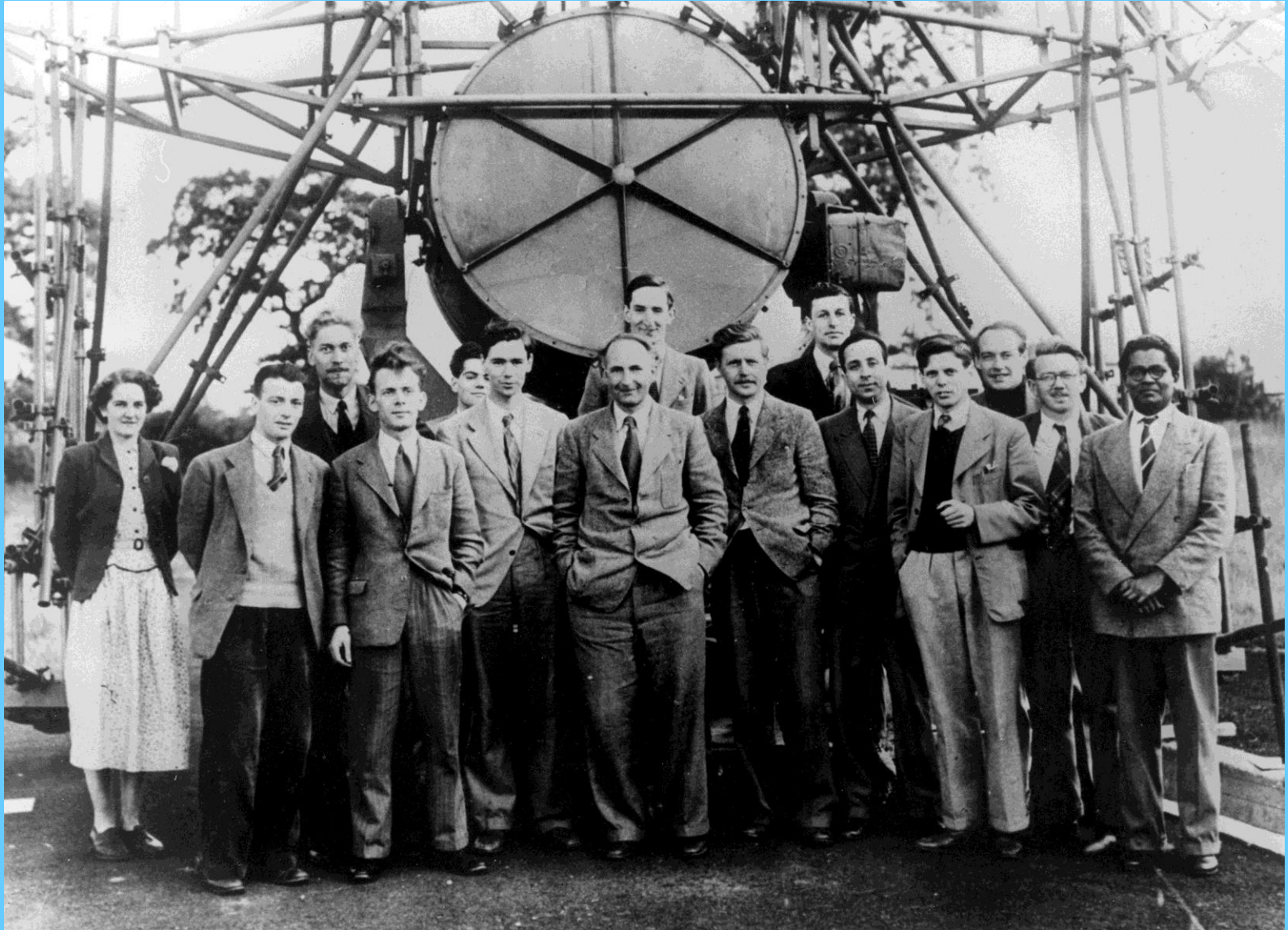


The Andromeda Galaxy M31 HB9!



1951 The 1st Professor of Radio Astronomy

A new science is born



Jodrell Bank Experimental Station

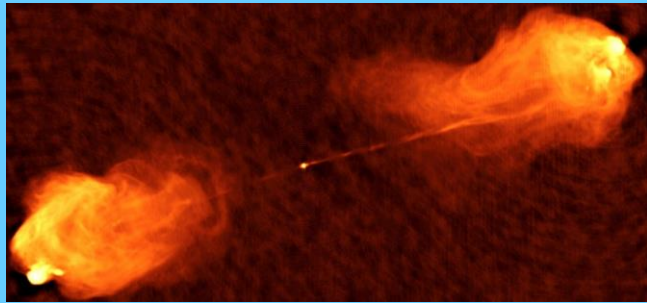


1950's: The first buildings constructed – maybe this is a long-term project...



Meanwhile Science carries on in the 1950's

'Double' structure of a radio galaxy discovered, using an interferometer -- remote aerials connected by radio links



Cygnus A Radio Galaxy

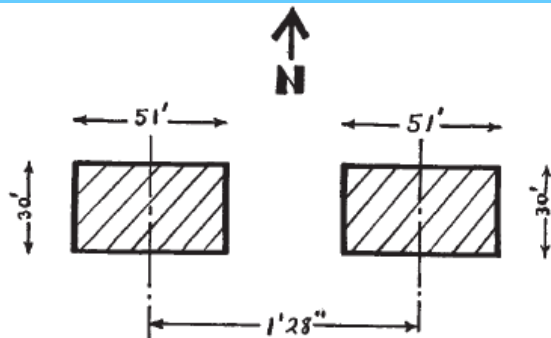
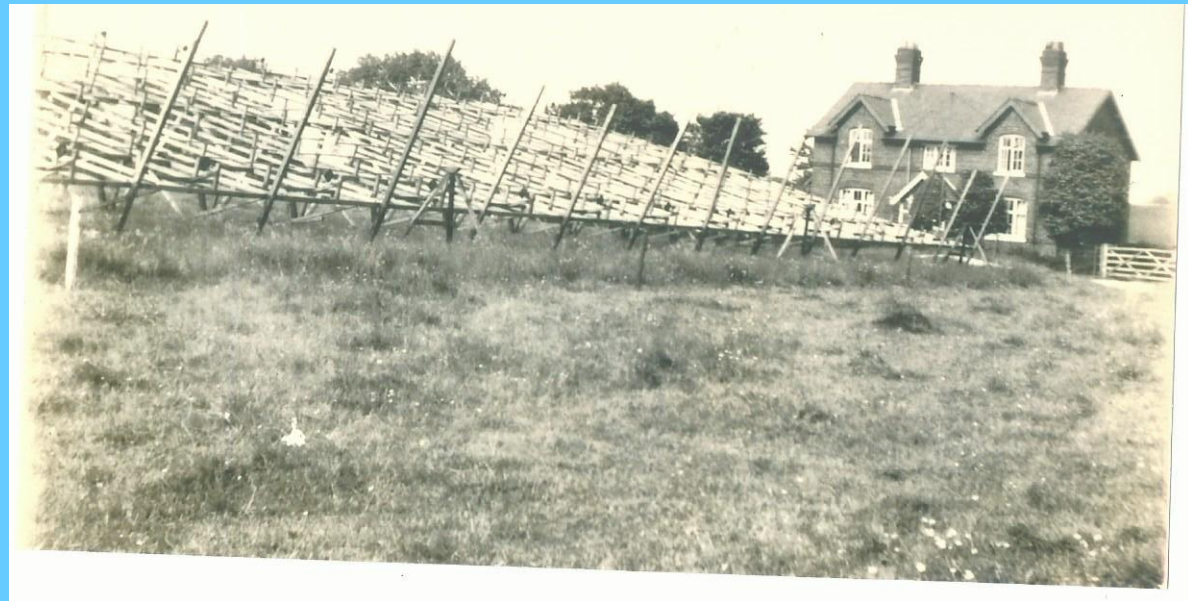


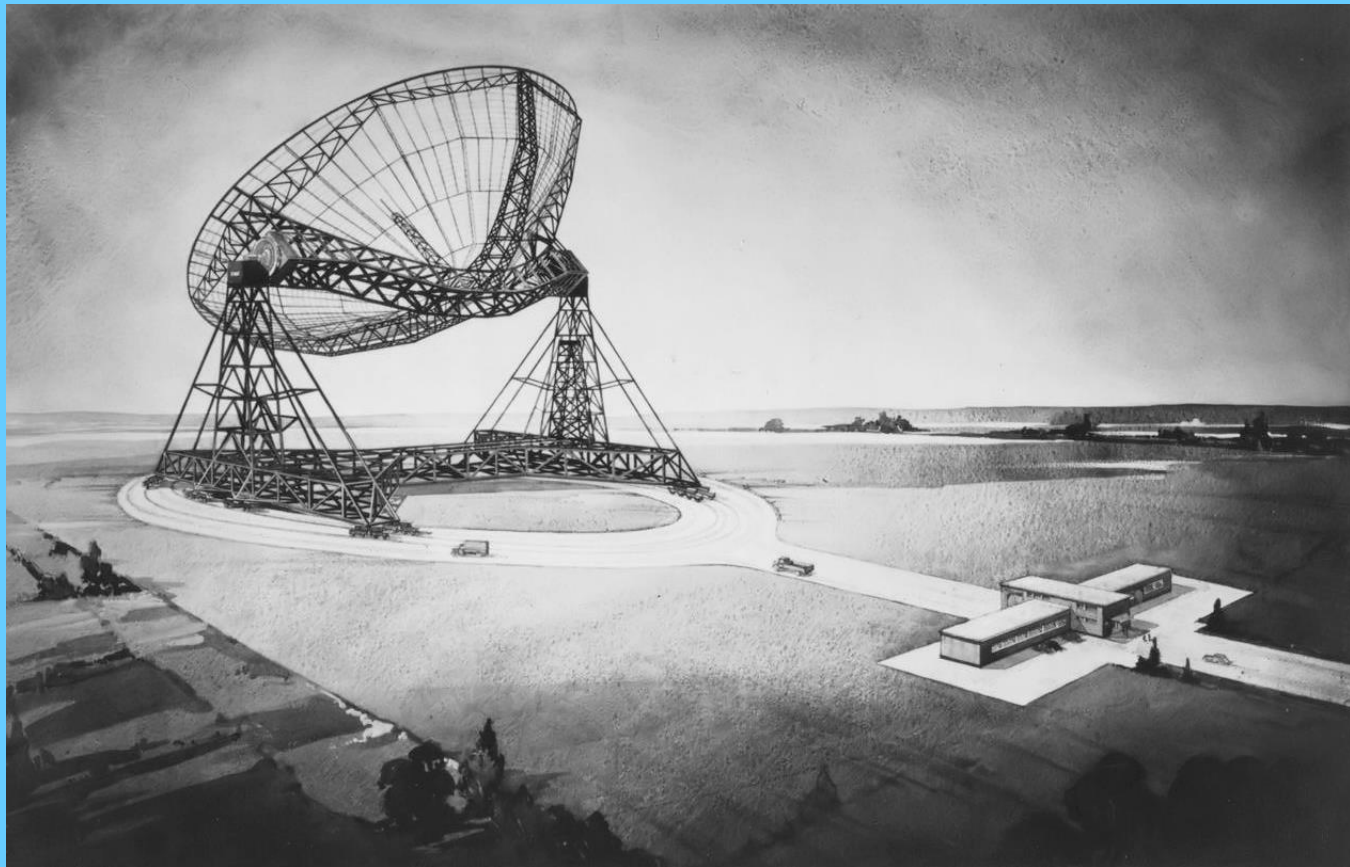
Fig. 2. Approximate intensity distribution of the extra-terrestrial radio source in Cygnus

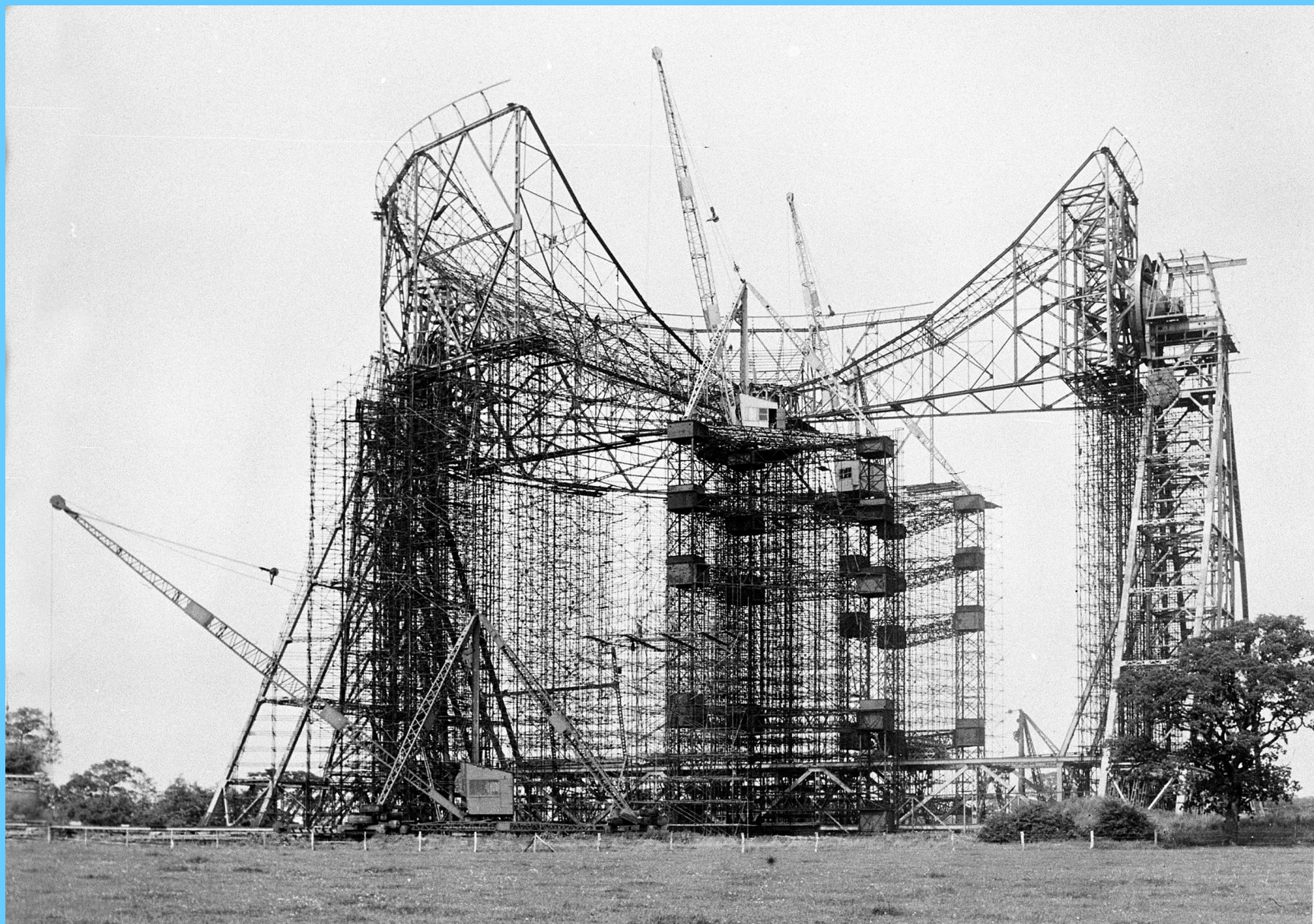


Daisy Bank farm

Jennison and Das Gupta 1953, 1956

Plans for the Mk I Radio Telescope







1957



The Control Room analogue computer 1957- 1968



October 1957 Sputnik 1

- 1st Oct First movement of new telescope
- Crash installation of radar at 120 and 36 MHz
- 12 Oct launch of Sputnik satellite
- Launch rocket detected by the Mk1 – ICBM
- MOD woke up! Finance problems began to be resolved



Jodrell in the News

- Tracking of deep space probes in late 50's and early 60's
- JB no. 9 in Russian nuclear target list
- US Able and Pioneer 3 and 4 projects
- Russian Luna probes
- Professor Quatermass!
- Collaborating with the US and Russia at the same time during the cold war!
- Mean the science carried on

The problem of the unresolved sources - radio stars?



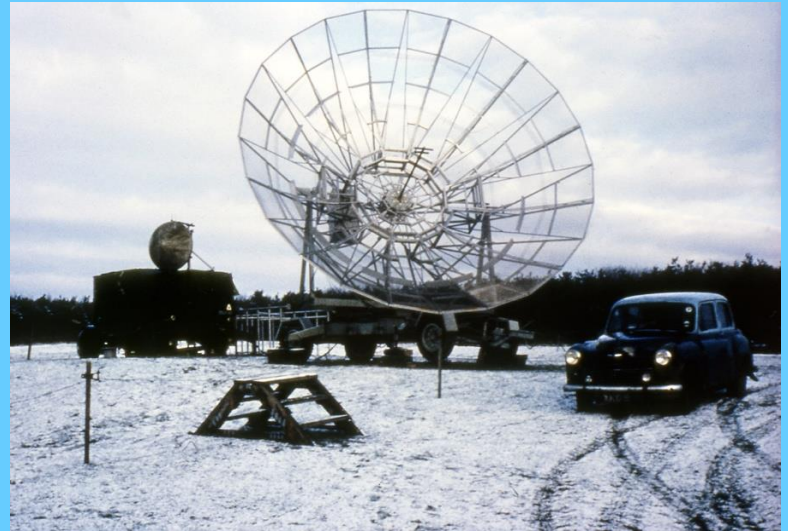
Sir Bernard Lovell



Henry Palmer

Discovery of Quasars in 1960's

- Compact radio sources, < 1 arc sec
- High resolution needed to study
- A radio telescope 100 km in diameter?
- Use interferometers. Pioneered at Cambridge and Jodrell in 1950's
- Palmer developed use of microwave links
- What are these compact objects?
- Optically identified with very distant objects billions of light years away.
- Quasi-Stellar objects -- Quasars. Often double in structure
- Radio jets!



3C273 Merlin image
Davis et al. 1990's

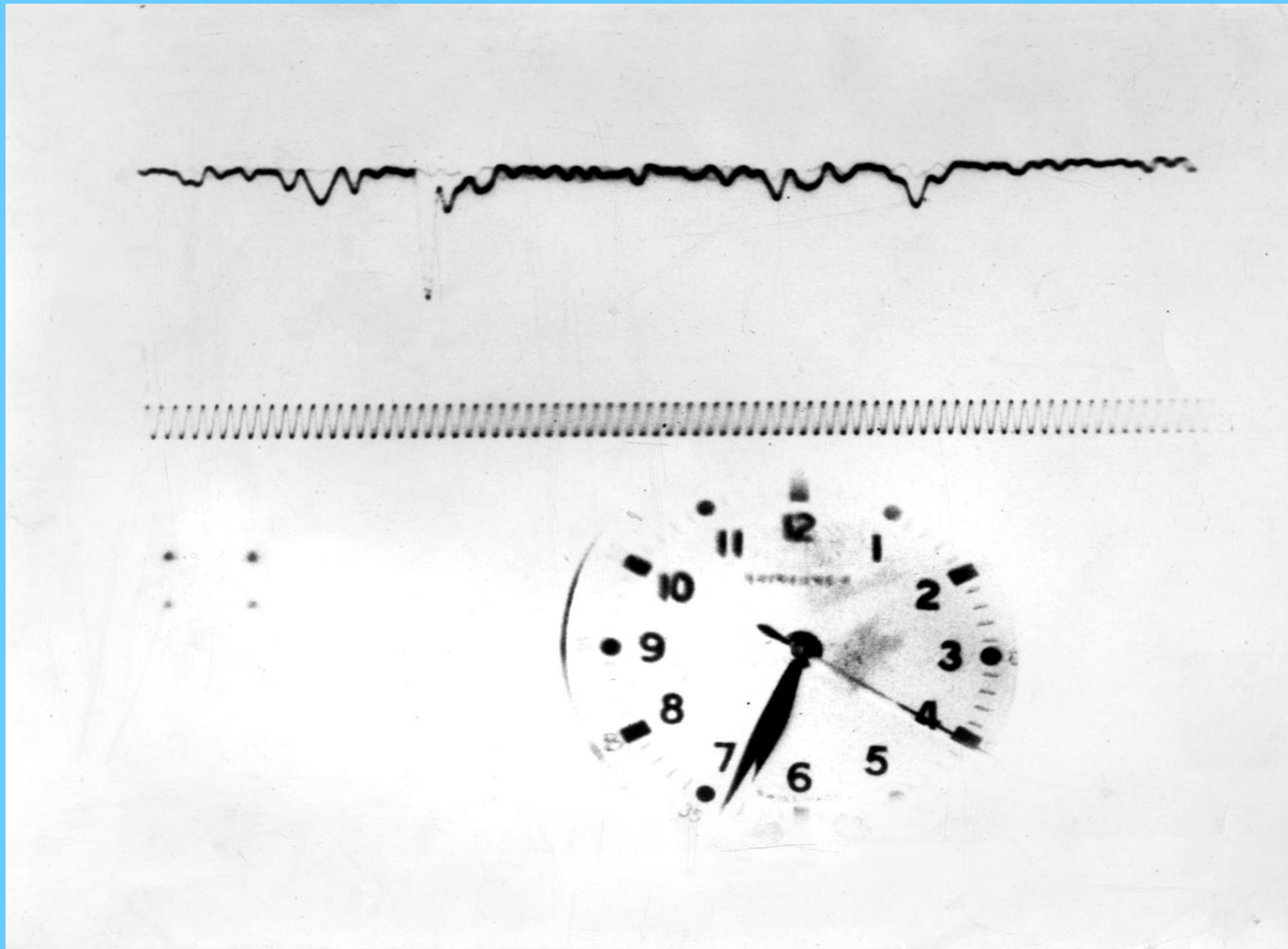
Cosmic Rays and me

- 1960's Problems with metal fatigue on the big telescope - elevation bearings cracking
- New support structure needed, telescope out of action
- New projects? Cosmic Rays again?
- John Jelley – Harwell – passive detection?
- Experiment at Jodrell 1965. I joined in 1966
- Project ended 1971

John Jelley (Harwell) wrote to Graham Smith (JB) suggesting
we looked at radio emission from CR again (Askaryan charge excess)

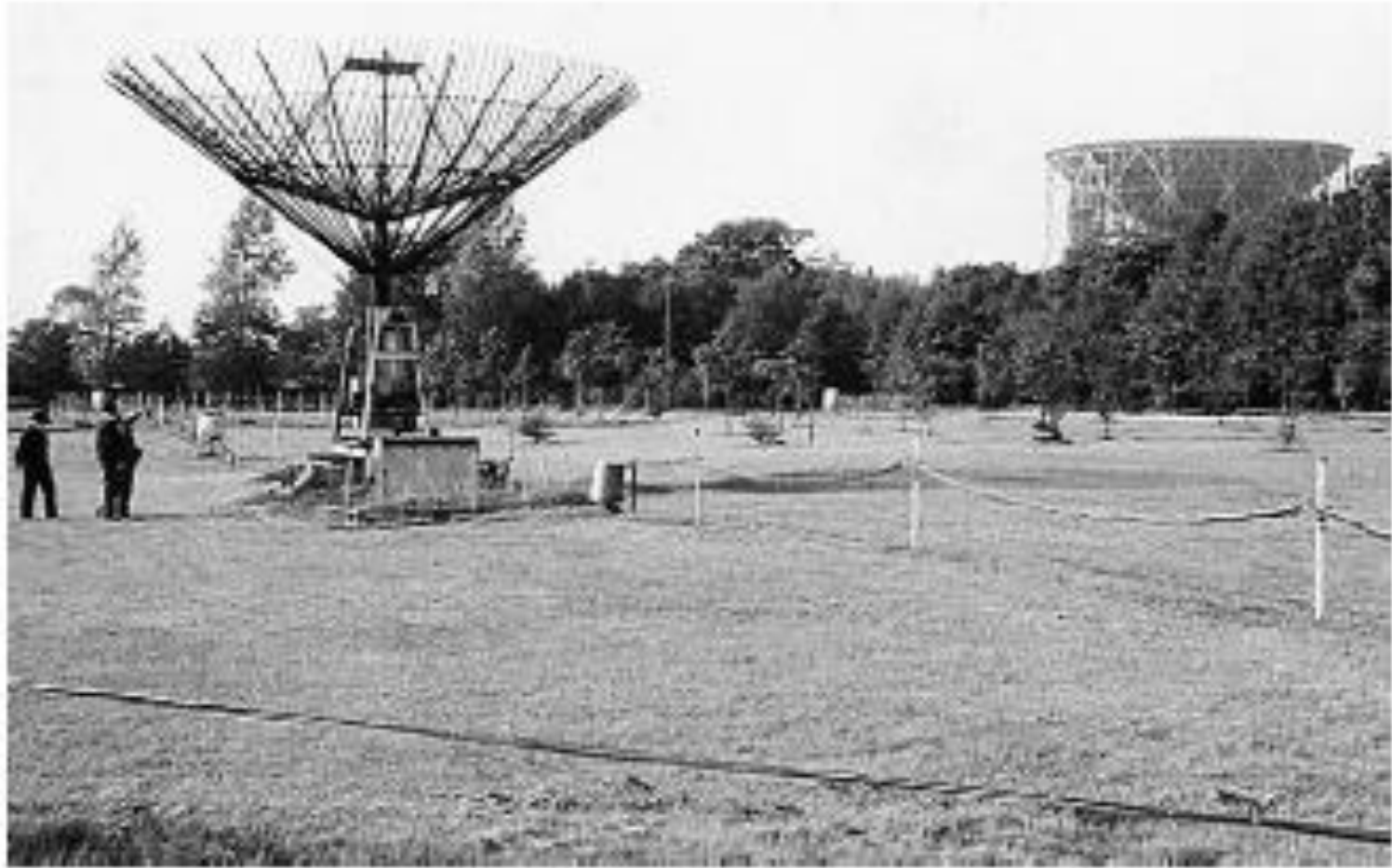


Blackett's Field ~1965, Porter MSc



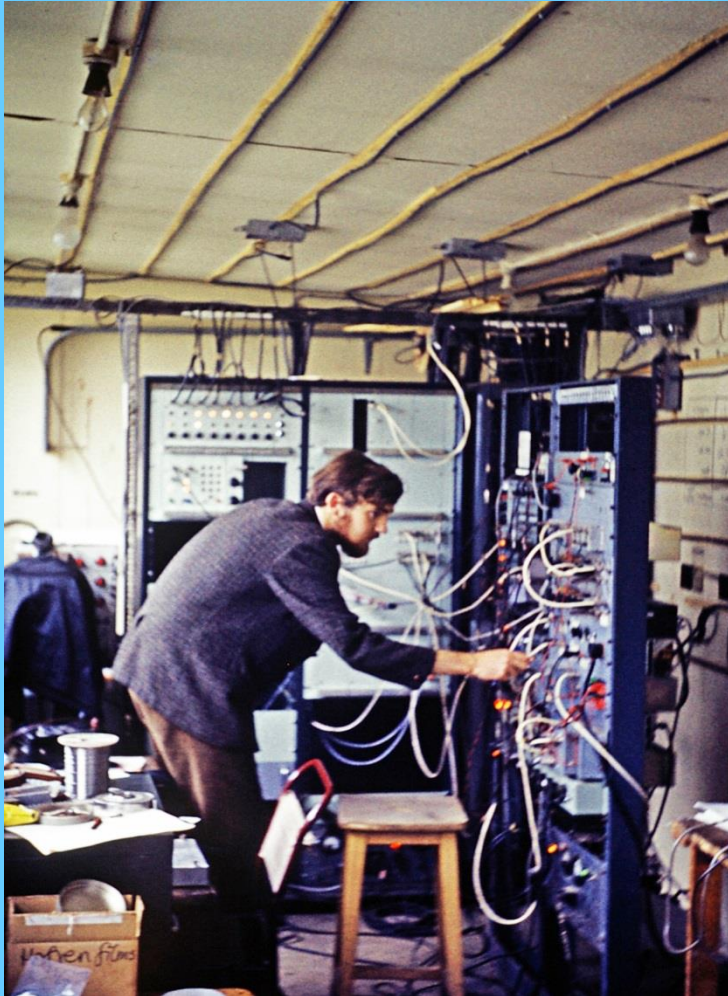
Jelley et al Nature 1965, R. A. Porter MSc Thesis 1967,
Radiation generated by the shower itself.

1967



David Fegan 1967 from Fegan, D. J., NIM PA 662 supp 1, 2012

1966-1970 RES PhD
on radio emission from cosmic rays



1968 in Balckett's Hut



1970

Blackett's Hut 2020



~1972 – The MK IA



1970's -80's MERLIN an imaging machine



Jodrell Bank



Tabley



Knockin



Cambridge



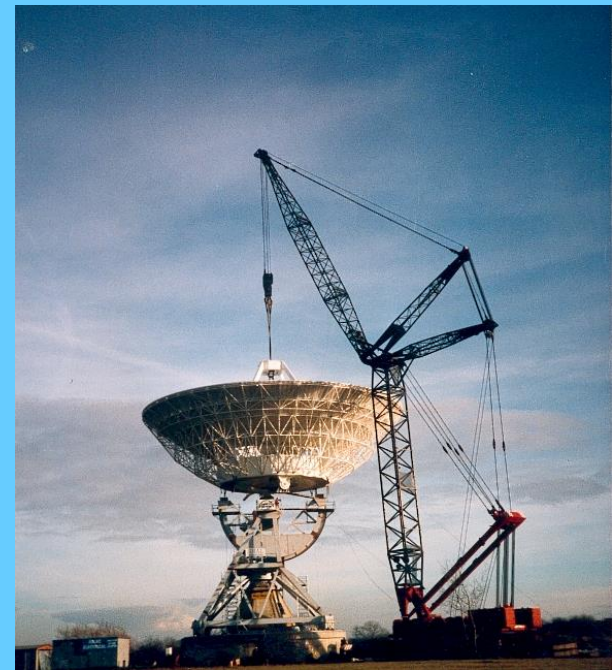
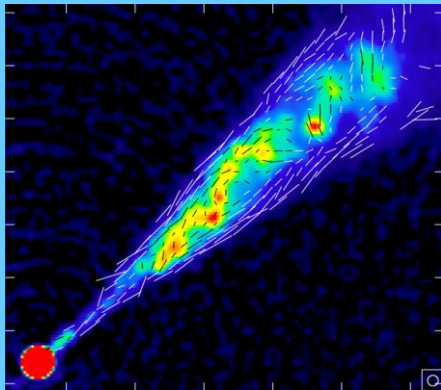
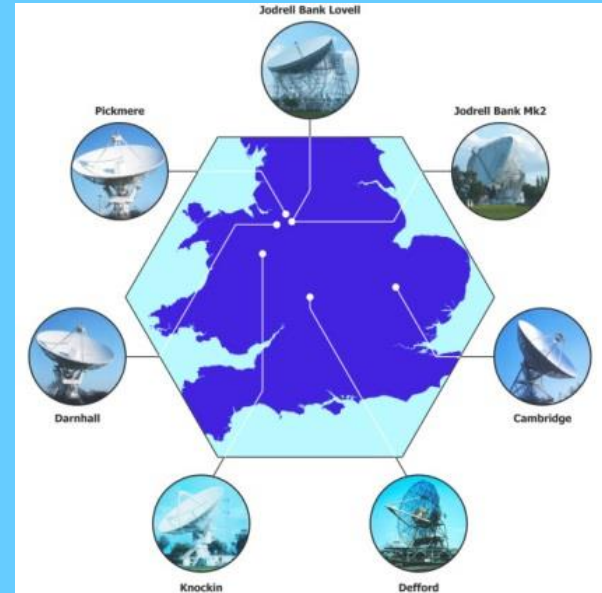
Darnhall



Defford

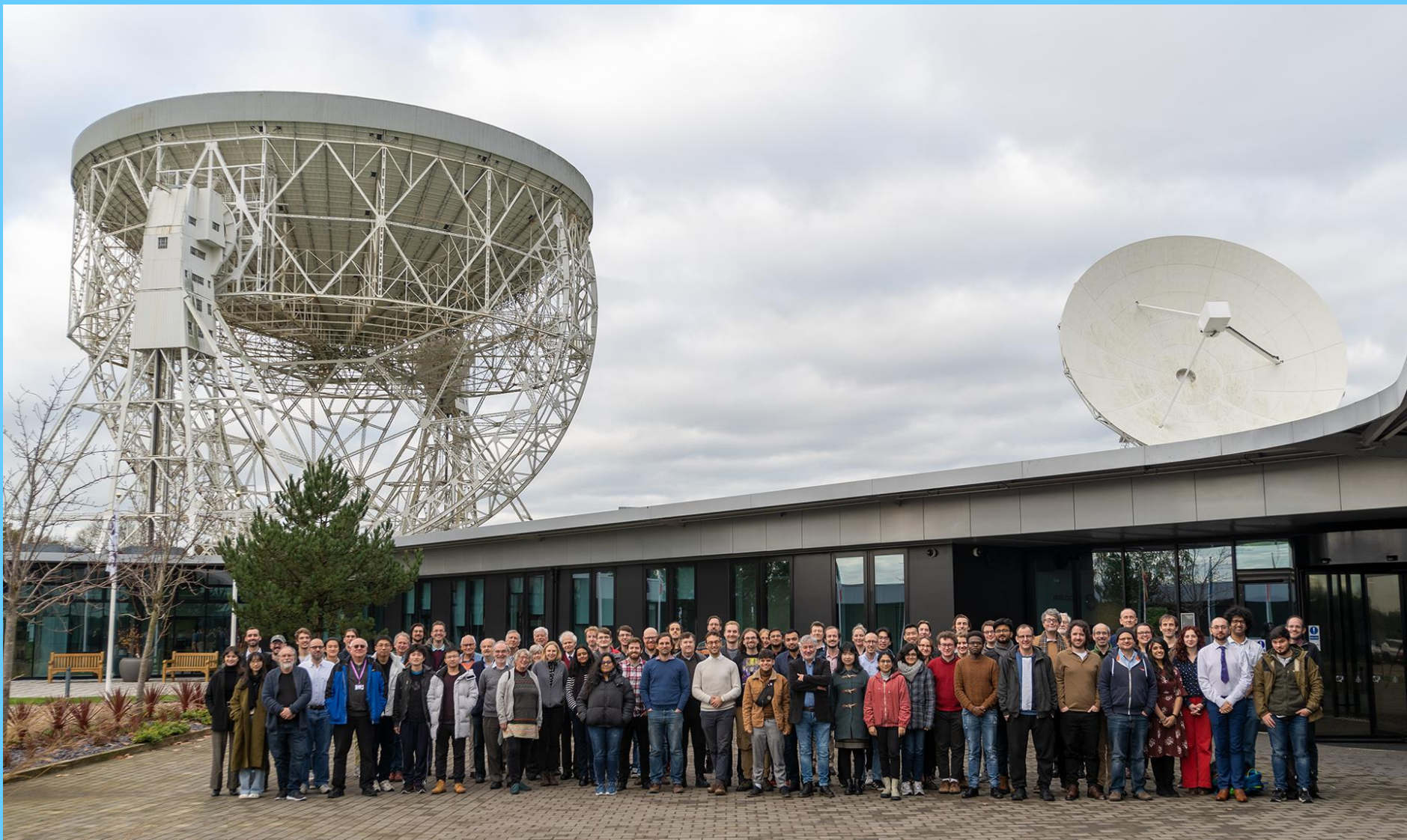
e-MERLIN 1990 --

- New receivers
- Wide band fibre links
- 32-m Cambridge telescope 1990
- New wide bandwidth correlator 2000
- Still running and being developed further



The Present 2022





The Future

- The Square Kilometre Array SKA (Hydrogen!)
- E-MERLIN upgrade, L-Bass, RHINO, Simons Observatory etc.



The SKA- a transformative large radio telescope

- The Habitable Universe
(The Sun, Solar System, Exoplanets, Astrochemistry, SETI, Star and planet formation])
- The Nearby Universe
(Galactic Structure, Evolved Stars, Feedback within Galaxies, Magnetism)
- The Distant Universe
(Cosmic Dawn/EoR, Dark Matter, Dark Energy, acceleration, Star formation, AGN, high-Z galaxies, Cosmic Web, Magnetism)
- The Energetic Universe
(Radio transients, Pulsars, FRBs, Black Hole Mergers, TDEs, SN, Multi-messenger Astrophysics)

SKA-MID South Africa 0.3—25 GHz



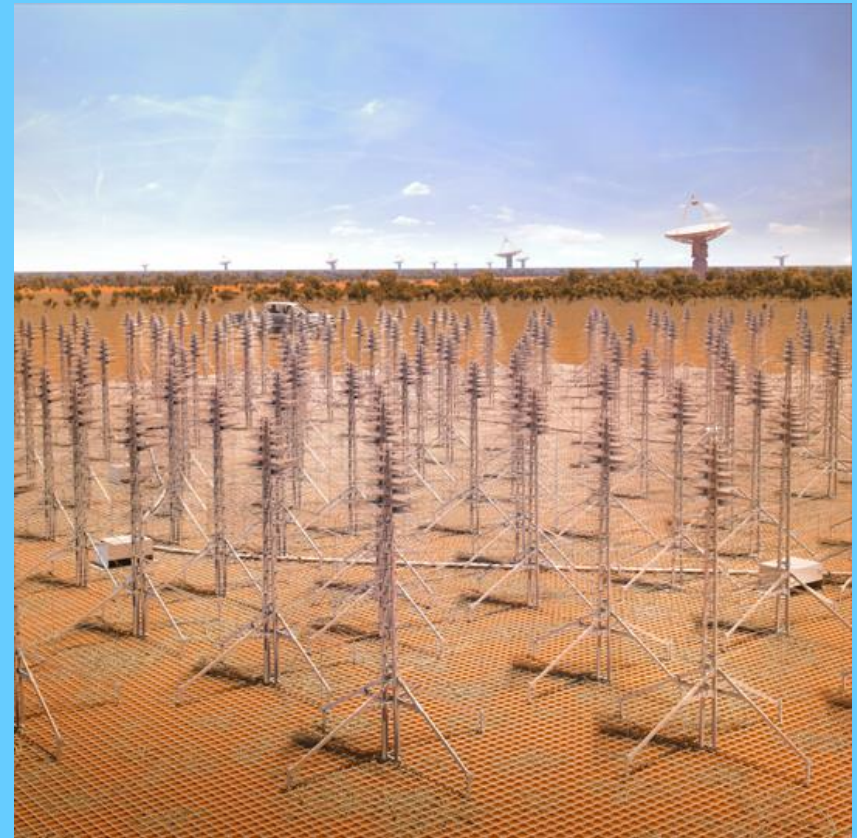
SKA1_MID

197 Dishes including:

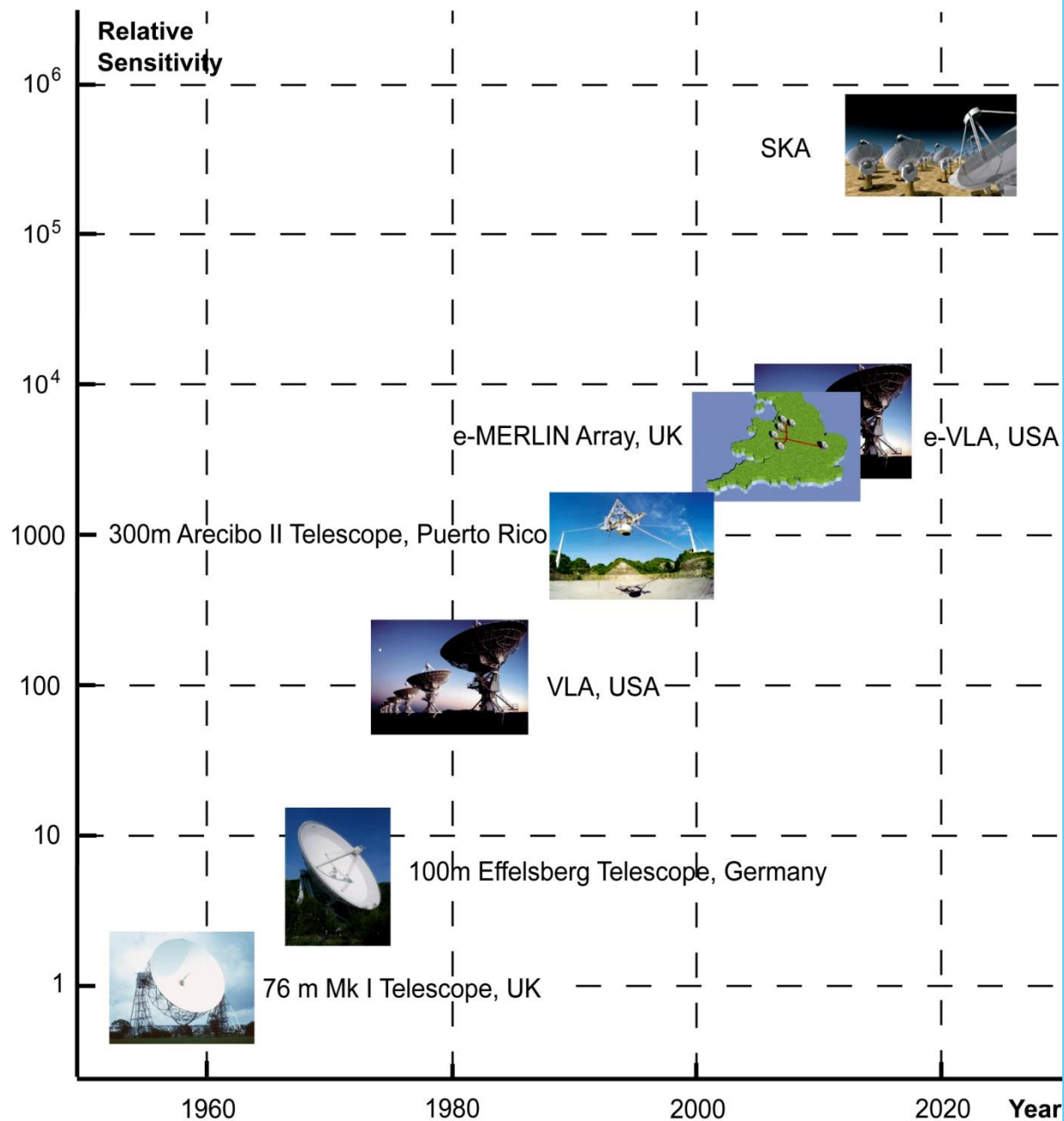
64 x MeerKAT dishes

133 x SKA dishes

SKA-LOW Australia 50-350 MHz

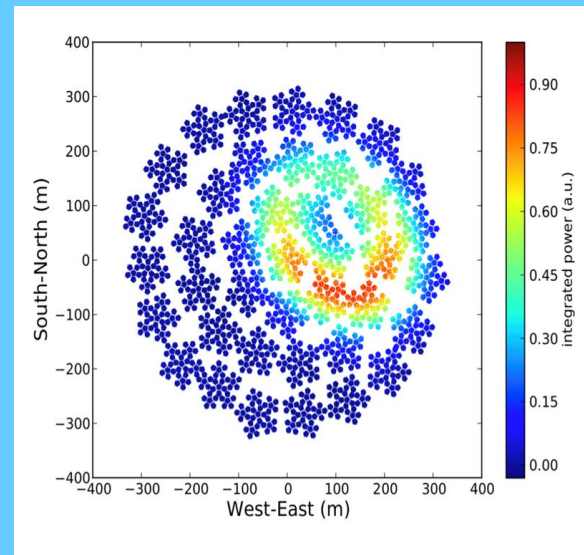


SKA1_LOW
131000 Low Frequency
Antennas



Cosmic Rays are back at Jodrell:

- Developing particle detectors to be used as a trigger so that the radio emission can be recorded
- Prototype at Metre Wavelength Array (MWA) at Murchison W. Australia
- 8 detectors currently being built at JBO
- Use the radio to find the composition
- Plan – eventually install 200 detectors at the SKA-Low – just need money!



Conclusions

- Jodrell Bank had an intriguing past and a high involvement with public interest
- Now a UNESCO World Heritage site
- <https://www.jodrellbank.net/>
- An exciting future with the development of new and existing telescopes
- The Mkl --Aka The Lovell telescope still a world leader (you can't beat collecting area)
- New mega project, the SKA has started construction!

