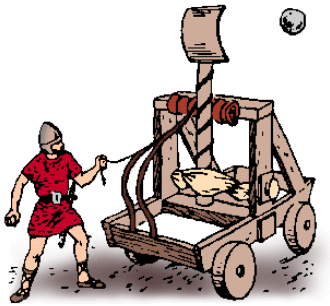
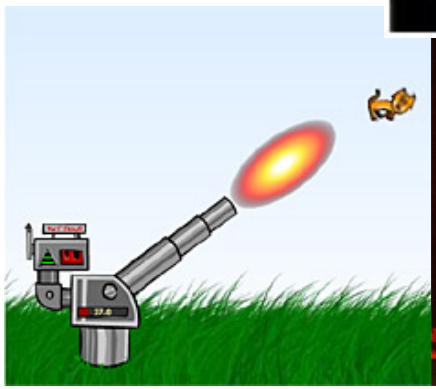
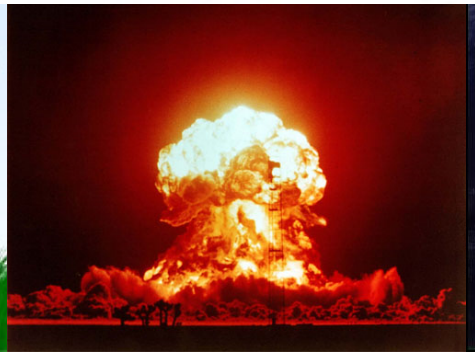
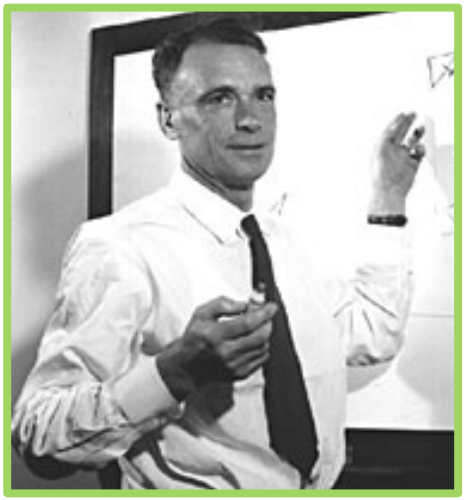
The NRAO – OVRO Wars





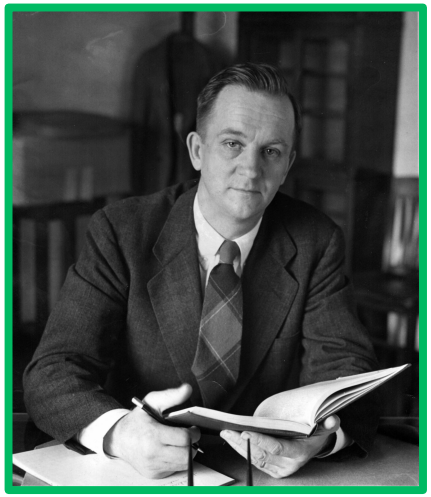


Taffy Bowen



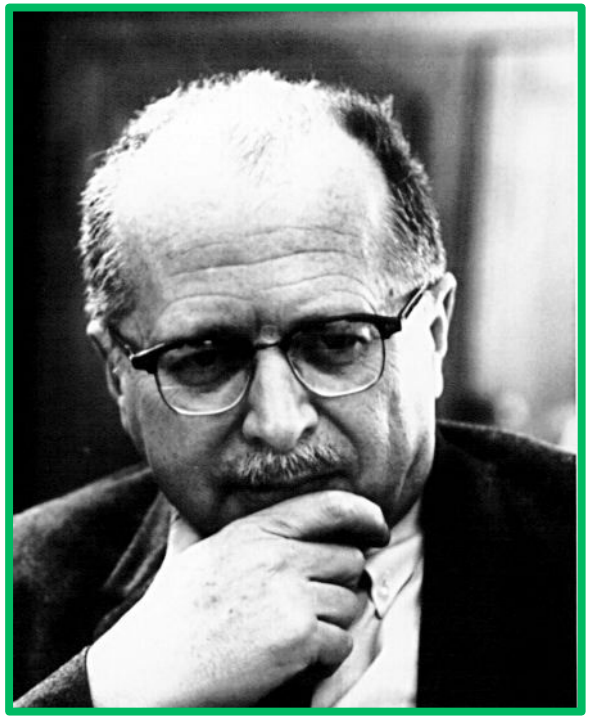
- Chief of CSIRO Radiophysics:
  - Pawsey, Bolton, Mills, Christiansen, Wild
- Ambitions to build a big dish
- Key figure in WWII radar (US liaison)
- 1951 visit to Caltech with DuBridge and Bacher at Caltech, Ira Bowen at Mt. Wilson/ Palomar
  - Urged radio astronomy facility: 200-250 ft antenna
  - Staffed by Australians (Bowen- Director , Bolton, etc.)
- Bowen received money from Carnegie & Rockefeller Foundations to build 210-ft antenna in Australia
- Planted idea of building a large Caltech radio telescope
- DuBridge consults Merle Tuve and Bart Bok

Merle Tuve



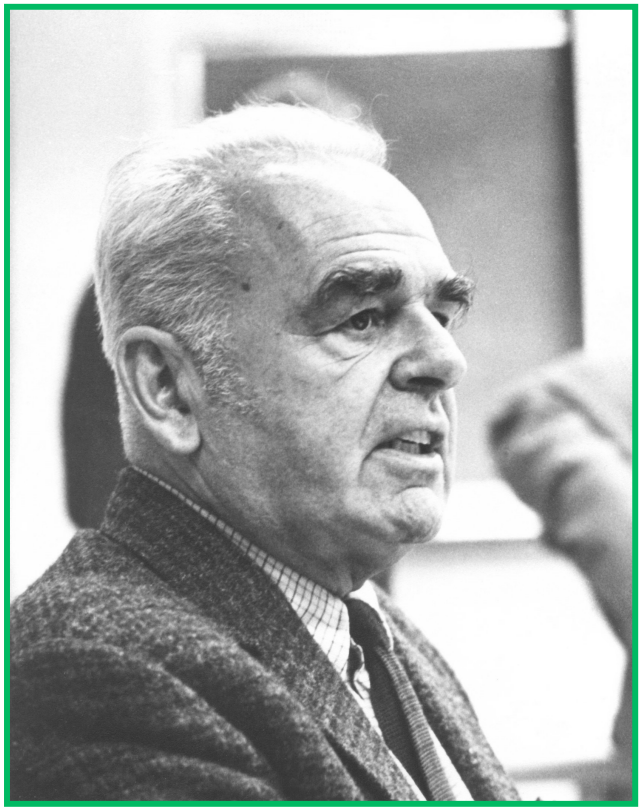
- Ran radio astronomy program at DTM
- Developed ionospheric sounding technique
- Invented the proximity fuse.
- Offered position of NSF Director
- First chair, NSF Radio Astronomy Panel
- Agreed to help DuBridge organize Wash. meeting, Jan 1954

Jesse Greenstein



- Started astronomy at Caltech
- First trained astronomer to pay attention to radio astronomy
- Organized Jan 1954 Radio Astronomy symposium
- Chair of 1970 NAS "Greenstein Committee"

Bart Bok



- Harvard Professor
- Started first academic radio astronomy program in U.S.
- Received first NSF radio astronomy grant for 24-ft antenna.
- Organized radio astronomy meeting in Boston Dec 26/27, 1953

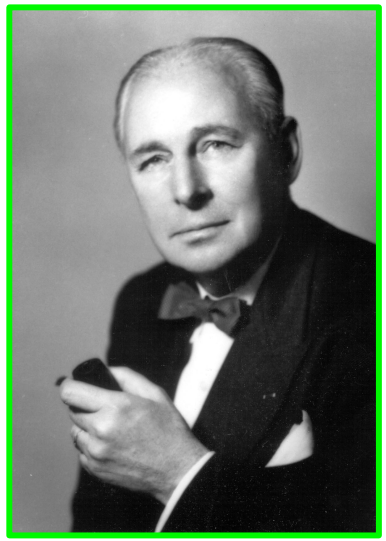
Two Key Conferences held with two weeks of each other

- Dec 26/27 1953 (Sat/Sun): $(AAAS)^2$ meeting, Boston
- Jan 4-7, 1954: Washington Conference on Radio Astronomy,
  - Organized by NSF, Caltech, Carnegie Institution (DTM) – NSF funded
  - SOC: Greenstein (Chair), SOC-Bok, Weisner, Tuve
  - Attended by about 75 people from universities, government, and industry including Alfven, Mills, Bowen, Brown, Smith, Hoyle, Van de Hulst, Covington, and (Reber).
  - See JGR, 59, 149-201 (1954) extensive summary of proceedings

These two meetings provided the catalyst which set the ball rolling to establish a major US radio astronomy facility

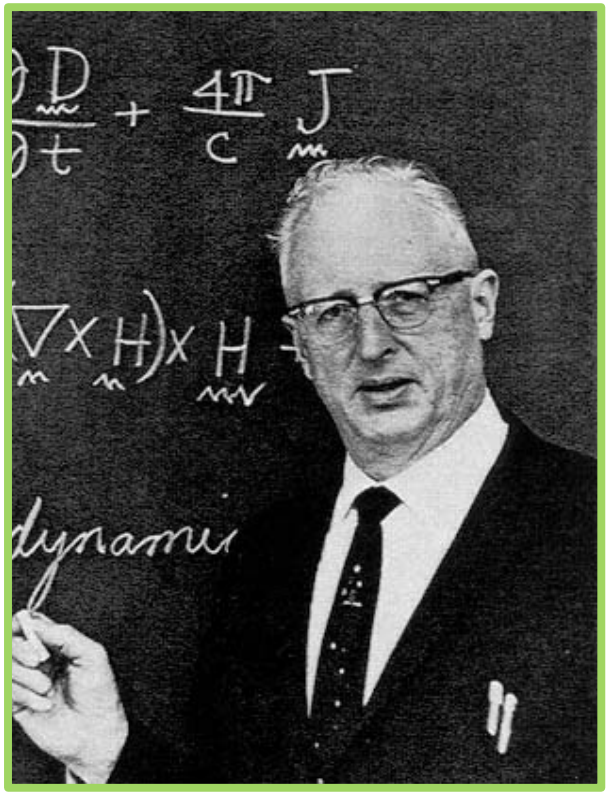
Initiated discussions among the Washington-Harvard-MIT power dealers (Stratton, Weisner, Menzel, Bok, Hagen, and **Loyd Berkner**)

Lloyd Berkner
Science policy czar



- EE Student of Prof. Curtis Jansky at U. Minn.
- Antarctic Explorer (Berkner Island)
- Amelia Earhart communications support
- Ionospheric studies and Radio astronomy at DTM
- Helped to establish NATO
- UFO investigator (Majestic 12)
- PSAC (Eisenhower)
- AGU President
- IGY Organizer
- ICSU President – Created COSPAR
- November 22, 1963, Dallas, Texas
- 1951 – 1960: President of AUI
- Understood that the new NSF might be a good source of money.
- Suggested that Donald Menzel appraise status of radio astronomy recommend direction for U.S.

Donald Menzel



- Director of HCO
- Background in physics/spectroscopy
- Remembered Grote Reber's 1936 letter to Shapley

Survey of Potentialities of Cooperative Research in Radio Astronomy, Donald Menzel -- April 13, 1954

- Radio astronomy "encompasses most of astronomy
  - Galactic, extragalactic, solar, planetary studies, HI, OH, D,
- Suggested AUI study feasibility of a national radio astronomy facility with 600-ft dish
- RFI free site

"I hope this is the beginning of a new important era in radio astronomy"

John Hagen

- Head radio astronomy program at NRL
- Chair of URSI Commission J
- Chair AUI Radio Astronomy Advisory Panel
- Wanted AUI to build a big (300-600-ft) telescope and wrote:
  - *"interferometers and arrays are not acceptable at centimeter wavelengths."*
  - *Claimed that a 150-ft would delay the real goal*

AUI/Hagan plan fought by Merle Tuve

- Argued for university based management
  - *"Very high priority, probably ahead of anything else, must be given to the support of existing activities in radio astronomy at universities."*
  - Wrote *"A very large dish (250-600-ft) is a project of uncertain value," and "I see no value in a telescope capable of operation at less than 10 cm."*
  - *"No investigators qualified in radio astronomy are connected with AUI."*
  - *"NSF money should go to active research astronomers, not to physicists, engineers, or administrators".*
  - AUI plan for 600-ft: a *power bid by people who love to manage things*
- Julius Stratton: *Never have so many thought so differently on so few matters*

Establishing the National Observatory

- AUI and NSF Advisory/Steering Committees
  - Acrimonious discussions about management
  - Discussed many telescope designs up to a 600-ft dish
  - Decided on first building 140-ft dish
  - Alt-Az/equitorial mount debated (HA range ± 7 hours)
- NSF stipulated site should be with 300 miles of Washington
  - Travel time for north-east radio astronomers
  - Balance optical astronomy largely based in California
  - Berkner appoints Site Selection Committee:
  - Sites in VA, WVA, Tenn evaluated
    - RFI testing done by Jansky & Baily Inc.
  - Dec 1955, Green Bank site chosen by AUI
- Aug 1956: WV Zoning Act passed – National Radio Quiet Zone
- March, 1956 AUI acquires purchase options for 6,200 acres
- But NSF buys land in GB
- July, 1956 Congress appropriates $ 3.5M for NRAO

Signing of contract between AUI and NSF November 17, 1956

Radio Astronomy at Caltech

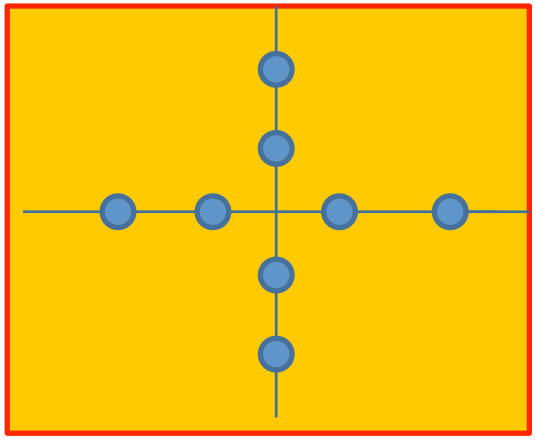
- 1955 John Bolton and Gordon Stanley go to Caltech
  - OVRO staffed by physicists and engineers (students & postdocs)
  - Patron Saint – Arnold Shostak
  - 2-element interferometer: λ ~20 cm
- OVRO - premier radio observatory in US (world)
  - Radio source structure, polarization, spectra
    - Moffet, Maltby, Morris, Seielstad, Kellermann
  - Radio Source optical identifications
    - Bolton, Baade, Minkowski, Matthews, Schmidt, Sandage
    - 3C 295 (z=0.46)
    - Quasars (3C 48, 3C 273)
  - Jupiter radiation belts (Morris, Rad)
  - Two component interstellar medium (Clark, Rad)
  - Galactic studies - Wilson
  - Instrumental Leaders
    - centimeter interferometry
    - Spectral line interferometry
    - Phase calibration
- Missed opportunity – Aperture Synthesis

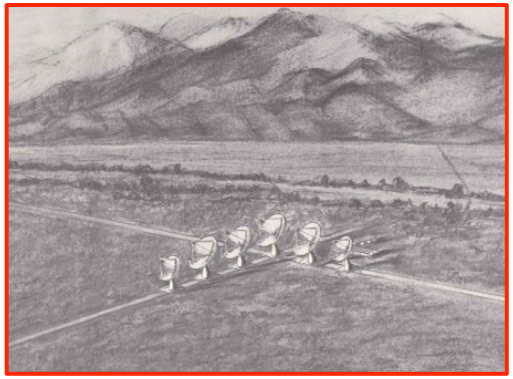
NRAO falters

- Lot's of money
- Staff -first US (Harvard) trained radio **astronomers**
  - Dave Heeschen, Frank Drake, Kochu Menon, Cam Wade, Bill Howard
  - Little experimental expertise
- Can't find a director
  - Greenstein, Bok, Goldberg
  - Struve becomes Director after long search
- 140-ft - Construction problems
  - AUI management by Committee in New York
  - Neither AUI nor NSF had experience in managing big contracts
    - Design flaws
    - Both AUI and NSF were far from Green Bank
    - Strikes at Contractor plant
    - Brittle steel ended up as shielding at Brookhaven or buried
  - Lloyd Berkner resigns as AUI President
  - 140-ft dedicated Oct 13, 1965
  - Jodrell 250-ft, Parkes 210-ft, Haystack 120-ft already in operation
  - Over budget (under-costed) $14M (originally $1.2M)
  - 140-ft had illustrious career primarily due to
    - excellent instrumentation
    - wise management
    - broadly based user community

Need for a Radio Imaging Array

- John Bolton - 1960
  - 8 x 200-ft antennas
- 1961 Pierce Committee
  - Need for resolution $\leq$ 1 arc min
  - Synthesis Array
- NRAO
  - 1955 Bob Dicke letter
  - Autumn 1961 internal NRAO discussions
  - Joe Pawsey - "pictures" better than 1 arc min
  - July 1962 Pawsey Memo (ignored Caltech)
  - Sept 7, 1962 formal start of VLA Project
  - 1964 George Swenson becomes Project Manager
- Caltech 1962 OVA Proposal to NSF
  - 4 x 125-ft plus 2 x 90-ft antennas





OVA vs. VLA

- 1964: Whitford report – Supported Arrays (OVA then VLA)
- 1965: 1st VLA report {$\theta \sim 10$”; 37 elements}
- 1966: Revised OVRO proposal
  - 7 x 120-ft antennas
- JAN 1967: VLA Proposal {36 x 25m elements; $\theta \sim 1$”; DR = 100}
- Aug 1967: 1st Dicke Committee
  - OVA, Arecibo upgrade, Arecibo +, VLA (studies)
  - George Swenson replaced by Hein Hvatum
- June 1969: Re-revised OVRO Proposal to 2nd Dicke Com. (spectroscopy)
- August 1969: 2nd Dicke Committee no priorities
- 1969 Greenstein Committee convened
- 1971: OVI - 2 x 130-ft antennas (NASA &NSF?) (Descoped OVA)
- 1972: Greenstein Committee - VLA

Congress "Acts"

- $3M Design funds available in FY1973
- 1974 NSF House Auth: $10M for c ruction
- House Appropriations VLA deleted
  - *The stars will be still b ears*
- New Mexico ontoya (Senate Appro airplane
- Se D bill including $10M
- Hou iate compromise on $5M – VLA built

4 proposals – Caltech
one 130-ft antenna
turned attention to VLBI and mm astronomy

Building the VLBA

- 1974 Charlottesville VLBI meeting
  - US VLB Network (Caltech) – NUG/Consortium
  - Dedicated Array (NRAO)
- VLBA program
  - 1977 Intercontinental Radio Tele
  - Competition with VLA and cope
  - Jan 1980, Pasaden
  - Caltech/JPL S tinental Radio Telescope
- Oct, 19 n Bank shootout
- Dec esign Study (not a proposal)
- Field mittee Report: a VLBA highest priority
- May 1983, NRAO VLBA Proposal; Caltech withdraws
- FY 1984 VLBA Design funds available
- FY 1985 VLBA Construction begins

Caltech forced to abandon VLBI and concentrate on mm astronomy

Why did NRAO Prevail?

- NRAO poster child for NSF – "NSF cannot let NRAO down"
- University allegiance is primarily to its own staff
- Sound technical design credible costing
- Inevitable slide to "big science.?"

Caltech Deserters

- Clark (student)
- Kellermann (student)
- Fomalont (student)
- Griesen (student)
- Sramek (student)
- Romney (student)
- Purcell (student)
- Greg Taylor (student)
- Debra Shepherd (postdoc)
- Tod Hunter (student)
- Walker (postdoc)
- Wroble (postdoc)
- Ekers (post doc)
- Seielstad (student/staff)
- Shostak (student)
- Wooten (student)
- Myers (student)
- Lo (student/faculty)
- Claire Chandler (postdoc)

Miller Goss

Sources

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  - Papers of Dave Heeschen
  - NRAO/AUI records, minutes, and correspondence
- Carnegie/DTM Archives
- Huntington Library Archives, papers of Ira Bowen
- Caltech Archives: Papers of Jesse Greenstein
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- Wall Street Journal, November 1, 1973
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- NSF Pierce and Dicke Committee Reports
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