The Early History of the VLA

Barry Clark

List of Topics

Origen of the idea of the VLA
Early design and proposal
The Green Bank Interferometer
Revised design and proposal
Beginning of construction to first fringes
Commissioning and beginning of observing

Acknowledgement: Material from pending book on the history of NRAO, by K. Kellermann and E. Bouton was used.

The Origins of the VLA
1950 - 1961

- Creation of the National Science Foundation in 1950
  - Law signed by President Harry S Truman
  - First grants awarded in 1952
- NRAO founded in 1957
  - Its mission was to support large instruments, beyond the scope of university researchers, comparable to instruments being built elsewhere in the world
    - A single dish antenna to take its place beside the Jodrell Bank 250 foot telescope
    - An interferometric array, comparable to several arrays then being constructed in Australia, England, and The Netherlands

The Origins of the VLA
1961-1964

- NRAO advisory panel reporting in 1961 notes need for high resolution observations
  - Also notes lack of radio astronomers with interferometer experience
- Dave Heeschen asks for development funds for a large interferometer array in 1962
- Memo by Cam Wade describes a conceptual design in 1963
- The first Decadal Review in 1964 noted that progress in radio astronomy required the construction of a large, high frequency interferometer array.

Design
1965 - 1967

- Design effort begins in 1965 under the leadership of George Swenson and Sandy Weinreb
- At the same time, an effort was launched at Green Bank to create an interferometer to learn the practicalities of interferometric observing. First fringes in 1964.
- Preliminary design report written in 1965
  - 37 antennas on a 3 armed wye
  - 11cm receivers at room temperature
  - 2.4 km baselines (10" resolution)
- Formal proposal was sent to the NSF in 1967

Design – Lessons from the GBI
1964 - 1969

- Replacement of chart recorder output with digital stepping recorder output in early 1965
- Addition of third antenna and implementation of computer control in 1967
  - Delays (switched lengths of cable) controlled by computer instead of special purpose device
  - Data written by computer with sampler sampling the three correlators.
  - Antenna motions under computer control
  - Switching circular polarizations for full stokes correlation with only one IF
- Demonstration of observations on a 35 km baseline in 1969.

Design and Prototyping
1972 - 1974

- Second decadal survey approves VLA as highest radioastronomy priority in 1972.
- Major review of previous design decisions
  - Receivers were to be cryogenic parametric amplifiers, with four receivers housed in a single cryostat
  - Data transmission to be by the newly developed TE01 mode waveguide
  - Local oscillator signals were to be transmitted by the same path
  - Correlators were to be digital
  - Computers for control and monitoring were to be an integral part of the design
- Choice of site as the Plains of San Augustine announced

Construction Begins
1972 - 1975

- Site ground breaking at the site in late 1972
- Antenna contract let in late 1974
- Antenna assembly begins in 1975

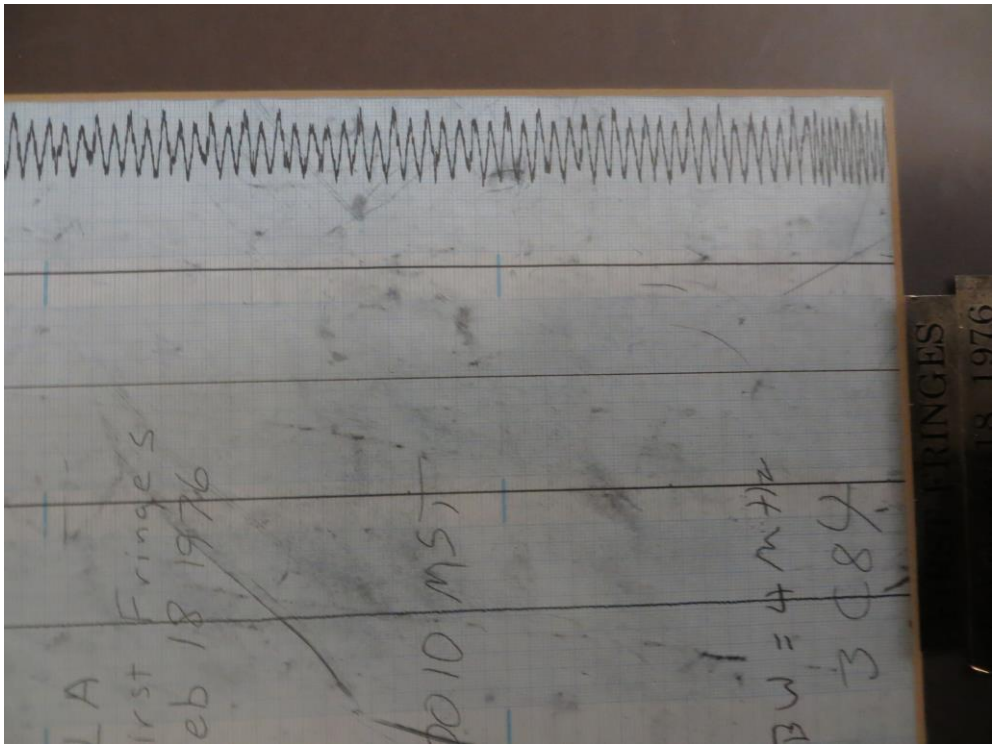
Commissioning – First Light
1975

- The antenna servo team built an interface from a calculator to the antenna servo system, to drive the antenna.
- A receiver package was installed and cooled and a detector was attached to a detector and connected to a chart recorder.

Commissioning – First Fringes
1976

- Antenna construction was phased to have two antennas built in the first year, so we could have an interferometer, four more in the second year, a year pause for fiscal reasons and to implement improvements based on experience.
- When the data transmission system could bring together data from the two antennas, an ad hoc analog correlator was improvised simply by making an analog adder for the bits output from the delay lines and detecting the result.
- To simplify the software requirements, we looked for first fringes with a reduced bandwidth (4 MHz), and the delay lines set to a fixed, precalculated value, and lobe rotators turned off.

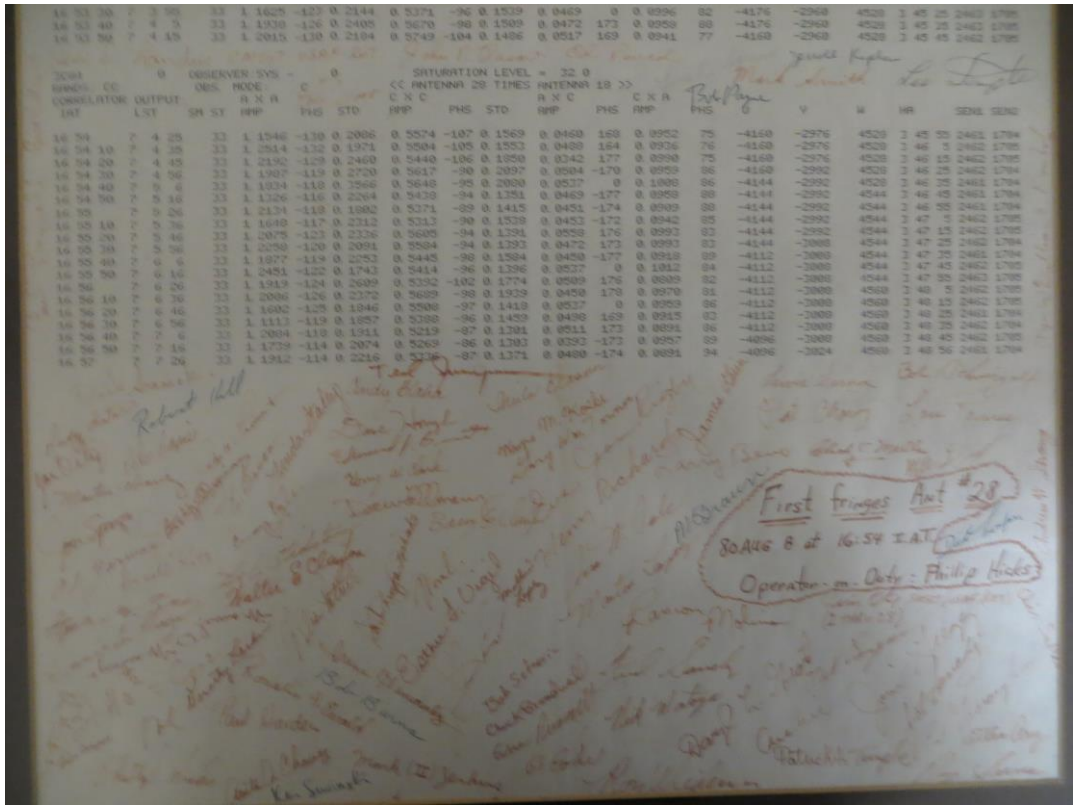
Commissioning – First Fringes
1976



- The delay lines were part of an interim correlator, and full use of that correlator was soon enabled.

Commissioning – Fringe Display
1976

- A listing of amplitude and phase for each baseline



Commissioning – Multiple Antennas
1977

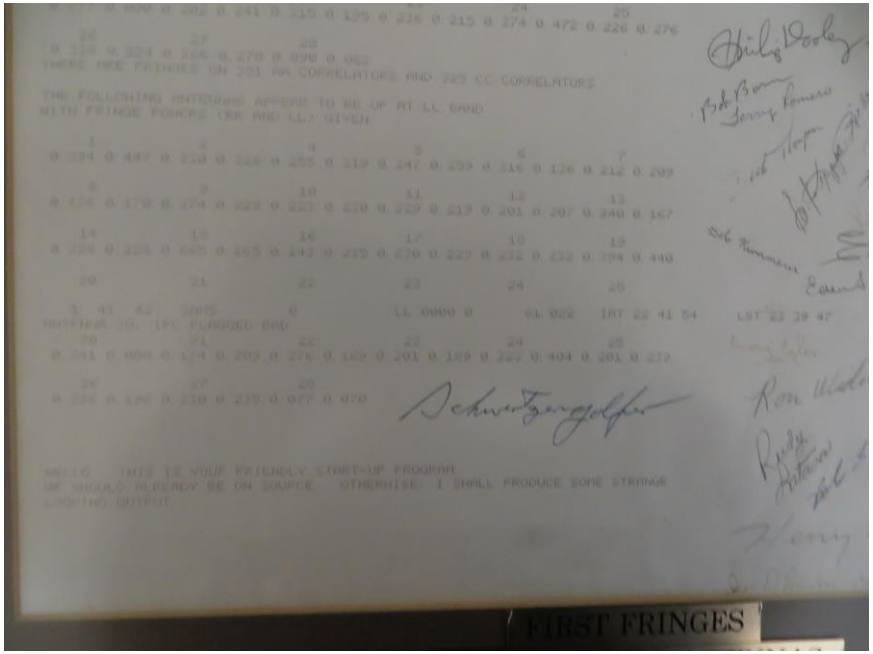
- With the second group of antennas, the six antenna array opened new avenues of commissioning, and also became scientifically interesting.

Commissioning – Adding Antennas 1977-1980

- As antennas were added to the array, their placement was not optimized for imaging
  - Long baselines had a priority, to make sure we would have phase stable operation
  - Other antennas were placed for convenient access

Commissioning – Multiple Antennas
1977

- Source flux resolved onto individual antennas



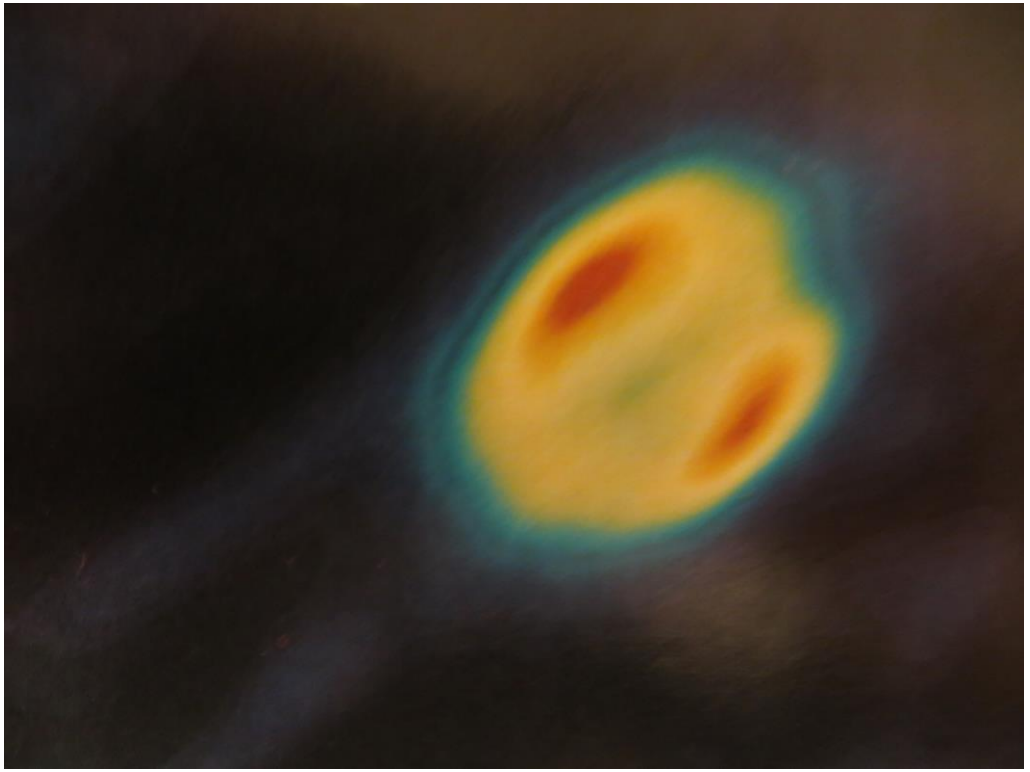
- This sort of real-time display has been invaluable in both commissioning and in maintaining array health.

Commissioning - Calibration
1977

- Solving for the antenna phase calibrates the atmosphere
  - Phase is relative. Assuming zero phase for a 'reference antenna' ties it down. If the reference antenna misbehaves, complications ensue
  - We were uncertain how to interpolate phase between calibrator observations.
  - Calibrator lists had to be generated and maintained.
- Watching the cross polarized correlations rotate with parallactic angle sorts out antenna "polarization leakage terms" from source polarization.
- Software to calculate and apply these corrections had to be written and verified.

Commissioning - Images
1978

- Bruce Balick from the University of Washington spent a sabbatical quarter at the VLA making an image of a planetary nebula.



Commissioning - Spectroscopy
1978

- Initial commissioning was done in continuum mode as the interim correlator had no spectroscopic capability
- The final correlator was delivered in late 1978
  - This correlator was designed to be flexibly switched between continuum and spectral line observations
  - It was a recirculating correlator, so the number of channels depended on the bandwidth being analysed – 16 channel for a 50MHz band, 32 for a 25 MHz band, etc.
  - The initial software supported 128 channels maximum, sufficient of commissioning activities.
  - Spectral baseline stability was found to be limited to propagation effects in the waveguides to be of order one percent.

Operations
1980

- Antennas were moved into a standard VLA configuration for the first time in July 1980.
- Array was dedicated in October 1980.

www.nrao.edu
science.nrao.edu
public.nrao.edu

The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.