The Green Bank Interferometer (GBI) in 1974

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The Green Bank Interferometer began operation in 1964 as a two element interferometer, intended both as a scientific instrument and as an instrument with which the NRAO staff could develop the techniques necessary for a large aperture synthesis telescope. It was soon realized that the science demanded a faster instrument with a more complete range of spacings, so an expansion to three elements was undertaken and completed in 1967. Subsequent developments involved adding radiometers at 1400 MHz and 8085 MHz, and adding the capability of doing observations in the HI line.

Figure 1: The three element Green Bank Interferometer.

This is the classic picture of the GBI shown in one of the commonly used configurations, with the movable antennas separated from the fixed 85-1 by distances of 1800 m and 2700 m. The control building is visible near the 85-3, the middle of the three antennas.

By 1967 the VLA concept envisioned a resolution of 1 arcsec at a wavelength of 11 cm, implying baselines of about 35 km in length. However, there was concern that the water vapor irregularities in the atmosphere over the array would introduce phase fluctuations which were so large as to preclude useful observations at centimeter wavelengths. One of the most forceful proponents of this view was Ryle, who with his student Hinder attempted to extrapolate the fluctuations observed with the One Mile telescope in Cambridge and concluded (Hinder & Ryle 1971,MNRAS,154,229) that it would indeed be challenging. That paper predicted that tropospheric irregularities would restrict the range of operating wavelengths for a baseline of 10 km to between 100 cm and 2 cm. The paper was published after we had the our results at long baselines, but their thinking was known to us well in advance of the paper.

What made the problem for us at the time was that the GBI, the one-mile telescope, and the Westerbork array all had maximum baselines of about 3 km. It was known that for a couple of hundred meters the phase was not bad, even at 8 GHz. It became much worse with longer baselines, but it was not known how rapid would be the deterioration beyond 3 km. Fortunately there was some reason for optimism. After all, the VLBI folks got fringes over much longer baselines in 1967, and later on (by 1971) were running regular synoptic observations between Texas, California, and Green Bank. Nonetheless, it seemed prudent in the planning of an expensive forefront instrument to at least demonstrate that one could make observations with reasonable phase stability over baselines of one hundred thousand wavelengths. Thus in 1967 we purchased a transportable 42-foot antenna to be used at sites remote from Green Bank by up to 35 km.

Figure 2: The 42-foot antenna.

This is the 42-foot deployed at one of the sites. I guess it is Spencer's Ridge, to the north by 11 km. The 42-foot fitted on one semi-trailer, and could be reassembled without the assistance of a large crane. It had a mesh surface, and thus worked only at 2695 MHz. The communications link is just barely visible behind the dish. The remote telescope was a self-contained unit, with control building on the trailer. The tank is the fuel supply for the generator.

In the earliest days two operators were required, one in Green Bank and one at the remote telescope. The operators were in constant communication with each other, using a part of link which transmitted the local oscillator signal and which brought the data back to the Interferometer Control Room. By 1969 the microwave link was expanded to include control signals and readouts, and the telescope could then be operated remotely.

The telescope was a success. In two papers (PASP 80: 273-280, 1968;

and IEEE Tr. Ant. Prop. 18: 375-379, 1970) John Basart and Barry Clark demonstrated that phase stable observations could be made over baselines of one hundred thousand wavelengths.

There is one anecdote I will use to close the saga of the 42-foot telescope. Peter Mezger, Bob Hjellming, with their colleagues Webster, Wink and Altenhoff, were interested in the structure on small angular scales of the very compact HII regions W3, DR21, W49, and Orion A. Observations of the first three proceeded well, but for economic reasons the declination range of the telescope was limited to 0 degrees to 60 degrees, and thus Orion lay out of reach. However, the operators were nothing if not ingenious, and it was arranged that the south end of the polar shaft would be dropped by seven degrees, just enough to enable Orion to be observed. Not only did the operators have to make the long trek at night to do the adjustment, but they had to remember that the declination readouts were all wrong during this period.

In 1969 the 42-foot telescope was moved to the Huntersville site, a distance of 35.2 km, and tests were made successfully at that site as well. For example, George Miley and collaborators (ApJL,159,L19, 1970) found a small component in the core of Virgo A using the 35 km baseline.

By 1971 it became clear that there was a lot of interesting science which could be done on these longer baselines if a better telescope was available. Accordingly, a contract was let with ESSCo for the design, fabrication, and delivery of a 45-foot portable antenna. It would have a solid surface, and could be used at both 2695 and 8085 MHz, and was thus well- matched to the GBI.

Figure 3: The 45-foot antenna. This view is of the antenna at the Huntersville site.

The control room was an auxiliary trailer, as I remember. The communications tower had to be high to give a line-of-site, and even so it wasn't sufficient. The signal had to be relayed using the large flat mirror on the hill above the 140-foot.

The antenna was delivered in the late summer of 1972 to Green Bank. Outfitting was completed by December 1972, and then it underwent extensive testing. Eventually it was moved to the Huntersville site.

Figure 4: The 45-foot antenna coming to Green Bank.

For long distance moves the antenna had to be dismantled, placed on two trailers, and assembled at the site using a small portable crane. We did not move it often.

In July, 1973 fringes were successfully measured. (Figure 5).

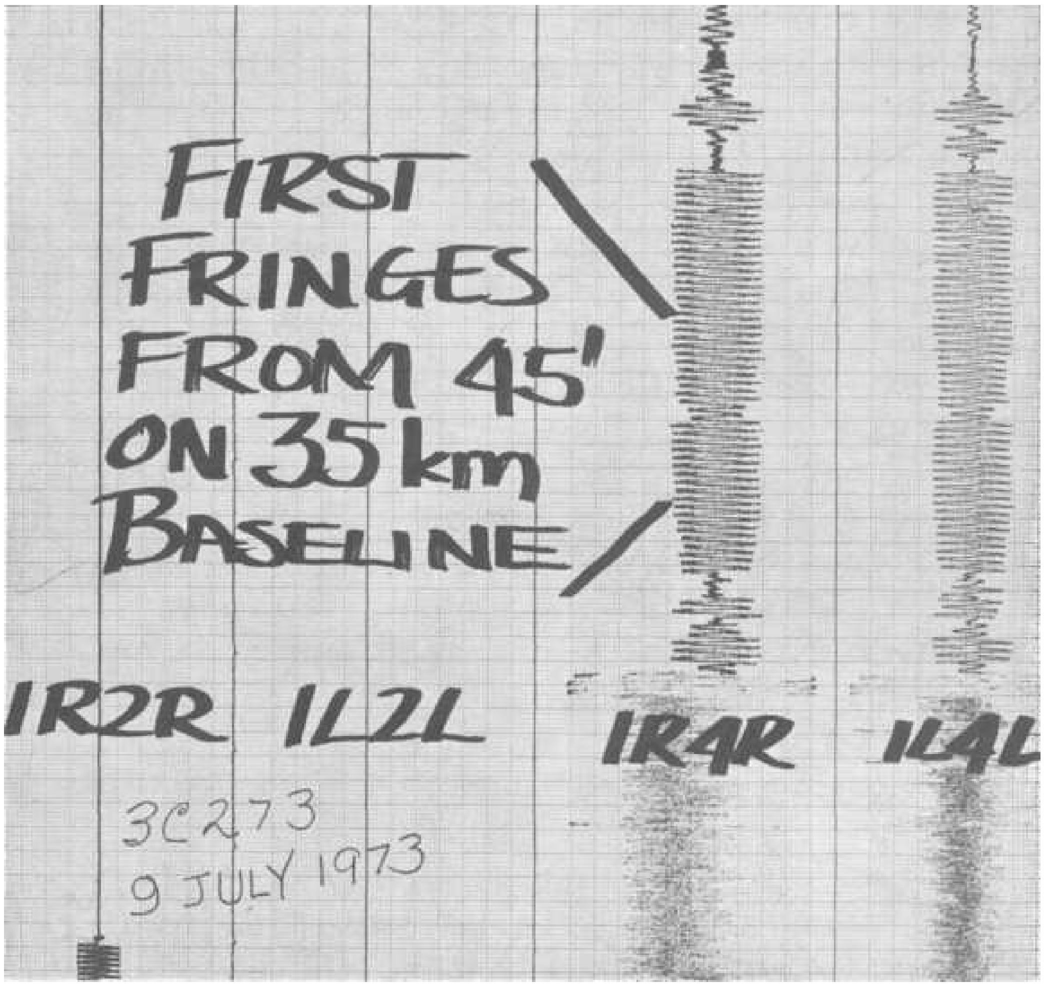

Figure 5: First fringes with the 45-foot at 35 km.

In the little note in the Observer (Volume 14, No. 4, page 8; August 1973) which Bruce Balick wrote on the occasion of obtaining fringes he commented that there were a number of proposals in the queue which requested the long baseline, and that one of the first that was to be scheduled was by Balick and Brown, to study certain hot sources of emission found in the galaxy using the 42-foot.

And the rest is history.