NLSRT Memo No. 24

From: OUTBAX::VAX3::TCORNWEL 6-DEC-1988 14:38
To: PVANDENB,TCORNWEL
Subj: 300' replacement

Dear Paul,

Along with everyone and his brother, I thought that I should send you some comments on the 300' replacement. I shall try to concentrate on arguments which have not been made before.

I have heard a report on the GB meeting last week so I think I understand what the science is. It seems that with the possible exception of the nearby HI observations, all the science can be done with either a conventional big single dish or a very compact array. I do think that it is ridiculous to suggest building a very novel telescope of either type. This means that a 100m offset paraboloid is out! My feeling about the comparison between the two types of telescope is that, theoretically, both could do a good job. By this I mean that for the single-dish we would have to develop focal plane array technology substantially before it could compete with the array in imaging speed, data quality and the ability to correct certain errors like phasing and RFI. To take one example, selfcal for single dishes requires critically-sampled focal plane arrays, the like of which we will not be able to build reliably for at least a decade. Selfcal for arrays works now. Similarly, imaging (which is not a huge part of the science, but is important) is slightly more awkward with focal plane arrays than with a compact synthesis array. No doubt we can improve this but it will take time and effort. RFI rejection with a synthesis array will always be better, not because of fringe/delay descrimination which also exists for a single dish (it corresponds to different focal points--that's all), but because first, the elements can be build with very low sidelobes if desired, and second, we know exactly what the synthesized beam is at any point on the sky (WSRT can remove Cygnus A 50 degrees away--try that with a single dish). This does, however, require some development. Overall, the technology behind a compact array is conservative; we could build one now:

- 25 x VLBA dishes	= $40M, say
- Correlator from VLBA	= $5M, (ballpark)
- Computing	= $10-20M (do it right)
	$55-65M

Some other odd points in favor of an array which have not been raised before are:

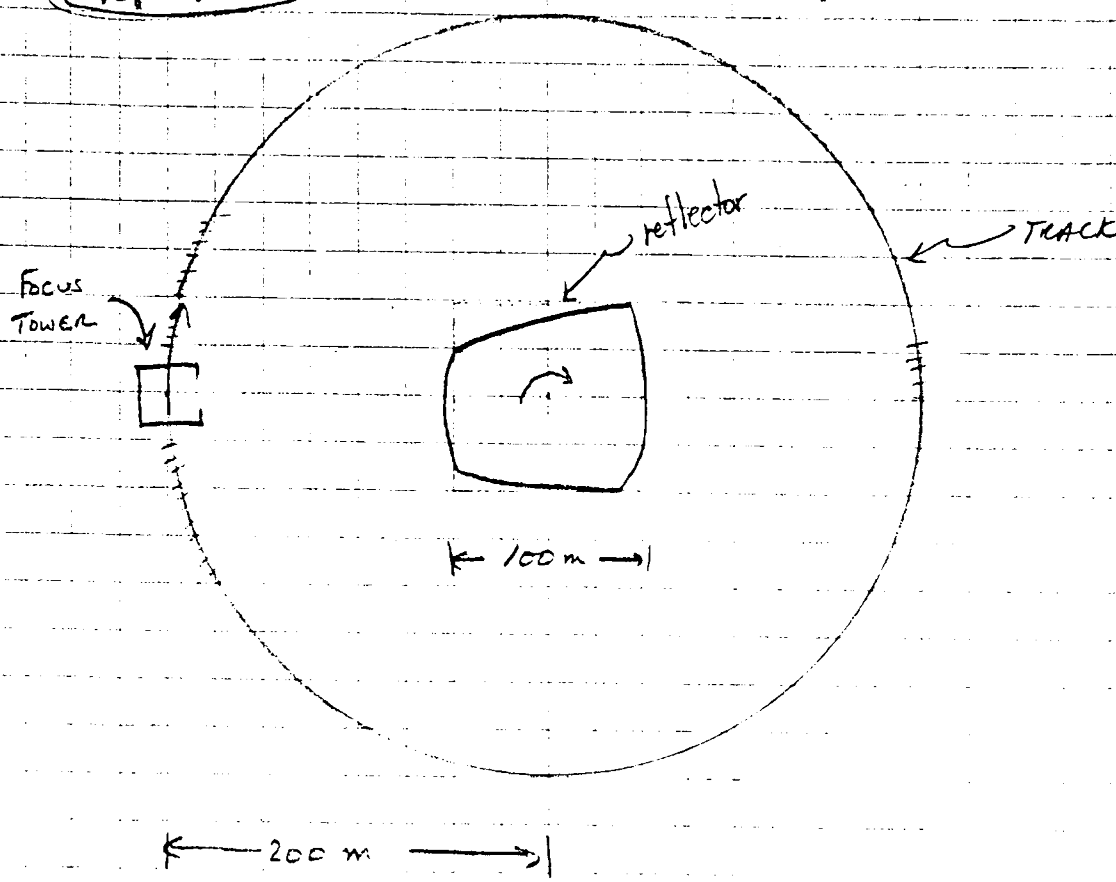
- It would give us an additional high frequency VLBA site even when the whole phased telescope is not used.
- It would be a good test bed for MMA techniques such as mosaicing. We would get good short-spacings for the VLA straightaway.

Beyond that I have nothing more to say about the technical arguments for a compact array. Darrel's memo of last week summarizes these very well. I agree whole-heartedly that there is no scientific compromise in building a compact array, and there are a great number of advantages. We could build a single dish, but, compared to the array, it would be rather poor in a number of areas.

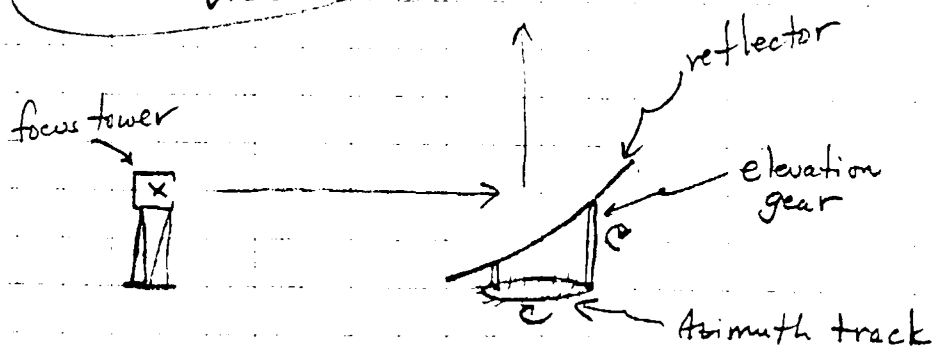
Putting aside the technical arguments, it seems to me that there are a

South

Top View



Side View



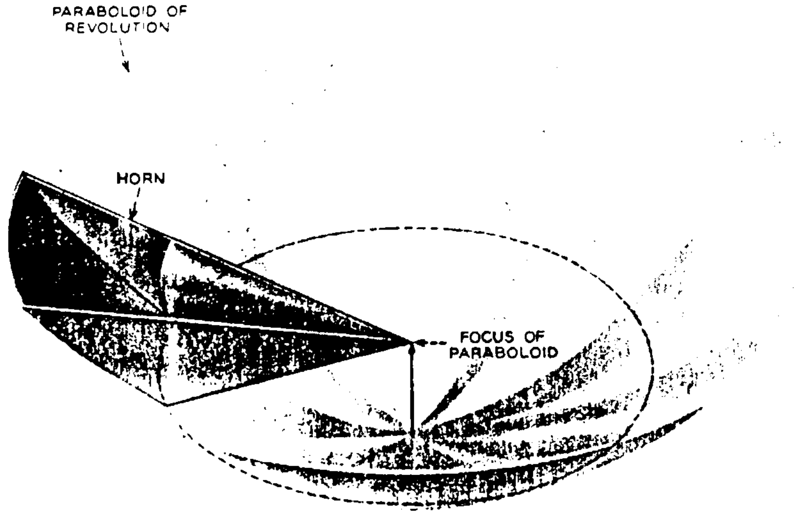


Fig. 1 — Sketch showing relationship of horn-reflector antenna to a paraboloid of revolution.

of the low-noise features of the maser amplifier. An effective noise temperature of about 2°K has been measured for the horn-reflector type of antenna.[4]

II. MECHANICAL DESCRIPTION OF THE ANTENNA

Fig. 2 is a photograph of the horn-reflector antenna erected on the Crawford Hill site of the Holmdel Laboratory and used in the Project Echo experiment.* To permit the antenna beam to be directed to any part of the sky, the antenna is mounted with the axis of the horn horizontal. Rotation about this axis affords tracking in elevation while the entire assembly is rotated about a vertical axis for tracking in azimuth. The antenna is about 50 feet in length, the radiating aperture is approximately 20 by 20 feet, and the weight is about 18 tons. The structure was designed to survive winds of 100 miles per hour.

The elevation structure, both horn and reflector, is constructed of aluminum. The elevation wheel, 30 feet in diameter, supports all radial loads and rotates on rollers mounted on the base frame. All axial or thrust loads are taken by a large ball bearing at the apex end of the horn. The horn proper continues through this bearing into the equipment cab. Here is located a tapered transition section from square to round waveguide, a rotating joint, and waveguide take-offs which provide for the simultaneous reception of either two orthogonal linearly polarized signals or two circularly polarized signals of opposite sense. The ability to locate the receiver equipment at the apex of the horn, thus eliminating the loss and noise contribution of a connecting line, is an important feature of this antenna.

* Although this antenna was designed and constructed by the Bell System as part of its research and development program, it was operated in connection with Project Echo under Contract NASW-110 for the National Aeronautics and Space Administration.

The triangular base frame is constructed of structural steel shapes. It rotates on wheels about a center pintle ball bearing on a track 30 feet in diameter. The track consists of stress-relieved, planed steel plates which were individually adjusted to produce a track flat to about $\frac{1}{64}$ inch. The faces of the wheels are cone-shaped to minimize sliding friction. A tangential force of about 100 pounds is sufficient to start the antenna in motion.

The horn flares at an angle of 28°. As can be seen in Fig. 1, the antenna is generated by swinging the side projection through this angle. Thus the two sides of the horn are flat surfaces, while the front and back surfaces are sections of cones. There are several advantages to this type of construction: right-angle sections can be used for the corners of the horn; the reflector can be constructed of identical longitudinal sections;

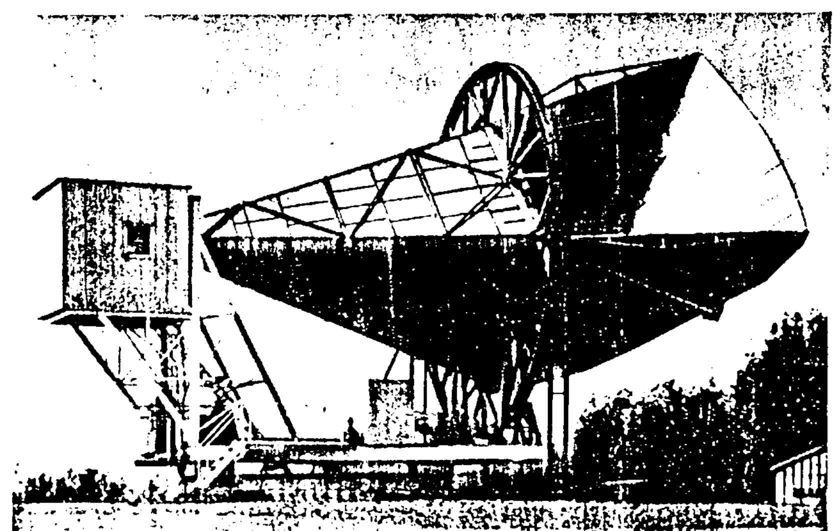


Fig. 2 — Horn-reflector antenna used in Project Echo experiment.