Interoffice

NATIONAL RADIO ASTRONOMY OBSERVATORY

TUCSON, ARIZONA

April 17, 1980

To: M. S. Roberts

From: M. A. Gordon

Subject: A new surface for the 36-ft telescope?

1. Background:

Since the 36-ft telescope was put into service, the NRAO technical staff has worked to improve its sensitivity and productivity. The areas of endeavor include

1. Receiver development
2. Data acquisition and analysis
3. Feed design
4. Improvement to the primary reflector
5. Sunshade and environmental conditions.

They have been successful in every area except the primary reflector. The attempts to measure the reflector figure and subsequently to correct defects by adding aluminum foil were unsuccessful. Although the reason for the failure is unknown, I believe that the thermal flexure of the dish is very large from one day to the next.

Figure 1 shows the aperture efficiency as a function of frequency. These measurements were all made at prime focus by Ned Conklin and Bobby Ulich. The data suggests that the 36-ft surface can be modeled by a randomly rough surface of RMS error 140μm.

Also shown on Figure 1 are horizontal bars marking the atmospheric windows through which we can operate on Kitt Peak, at least some of the time. We now have receivers up to 2-mm, and expect to have receivers operating in the 1-mm window within the next year. As you can see, the reflector is not terribly efficient in the 1-mm window.

Figure 2 shows the atmospheric transmission over Kitt Peak as a function of frequency and of precipitable water vapor. Note that the 1-mm window is usable at Kitt Peak during the non-summer months. Submillimeter bands, through which we hope to operate at Mauna Kea, are almost always unusable from Kitt Peak on a predictable basis. (Please note that this figure shows zenith transmission only.)

The reflector appears to be the limitation to operation in the 1-mm window at Kitt Peak.

2. A New Surface:

In the interim before the 25-m telescope is completed, the performance of the 36-ft telescope could be improved by a "bolt-on" new reflector. I've looked into 2 possibilities: a commercial surface from ESSCO, and a Leighton dish from Caltech.

a) ESSCO. This firm can supply a 10-11 m reflector by December 1980. They would cut down their standard 13.6 m (like the UMASS dish) to whatever size would fit our mount. They believe that they could achieve an RMS error of 100μm and a focal ratio of about 0.5. The stiff characteristic of ESSCO's box beam construction would permit use in our astrodome. The quadrupod would be changed to permit a simple bolting on of our Stirling Mount. Price: ∿ $300K.

b) Leighton Dish. Bob Leighton's dish factory produces reflector surfaces faster than they can be instrumented in the Owens Valley or installed on Mauna Kea. His 4th dish, known as dish #3 because the prototype was counted as 0, will be finished within a month or so. (It takes 14 months to produce a dish.) Because they won't be able to use it for a year or more, he is interested in loaning it to us in return for some unspecified consideration. Quite possibly the loan could be permanent. The RMS error will probably be less than 50μm. (See Figure 1 for its 1-mm performance). Cost: uncertain.

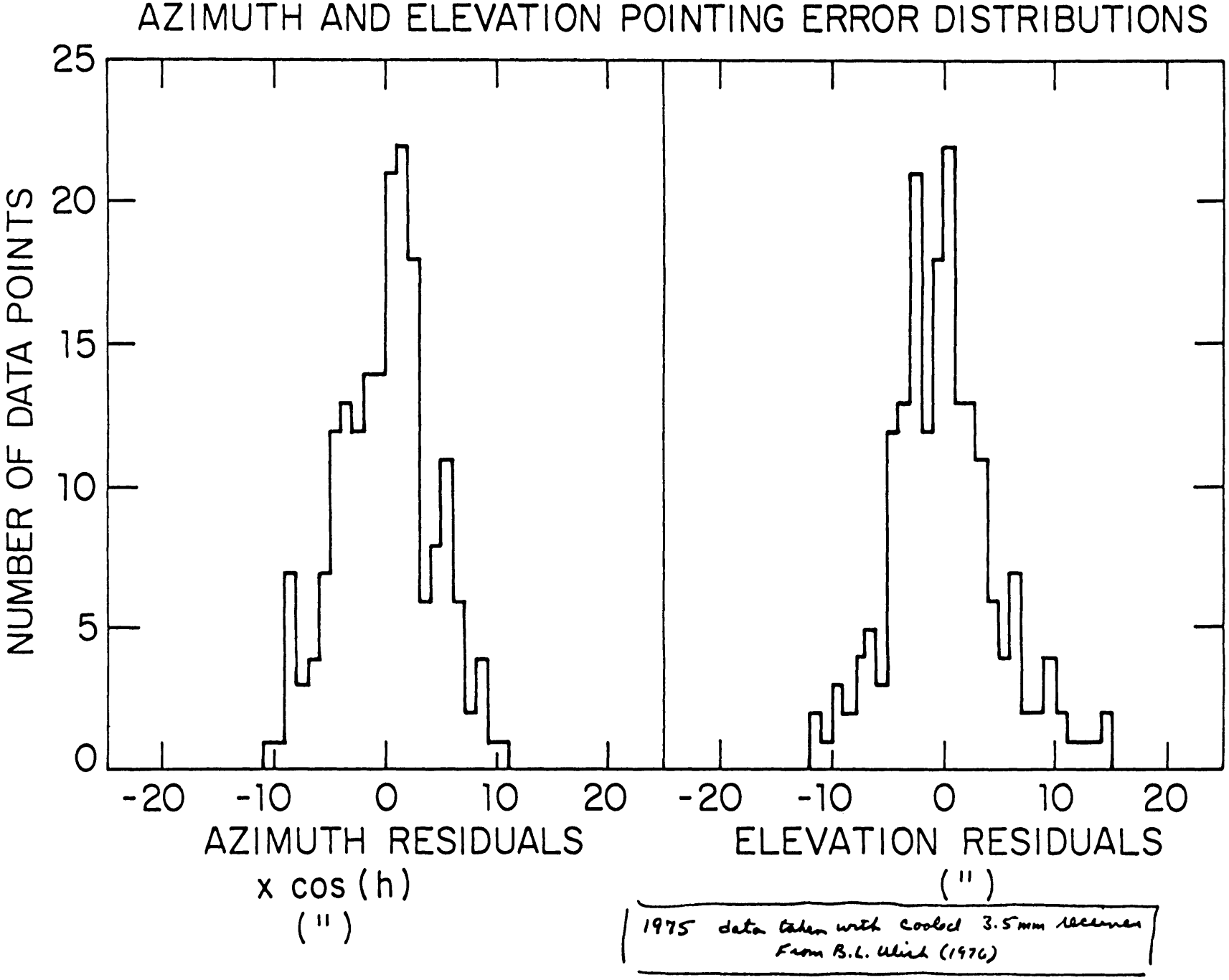
In either case, we will have to change our optics to accommodate our receivers. John Payne feels that we can get by in the 3, 2, and 1-mm bands by simply installing a smaller subreflector. To minimize diffraction effects at longer wavelengths, he would install a larger subreflector and new lenses. Cost: ∿ $5K.

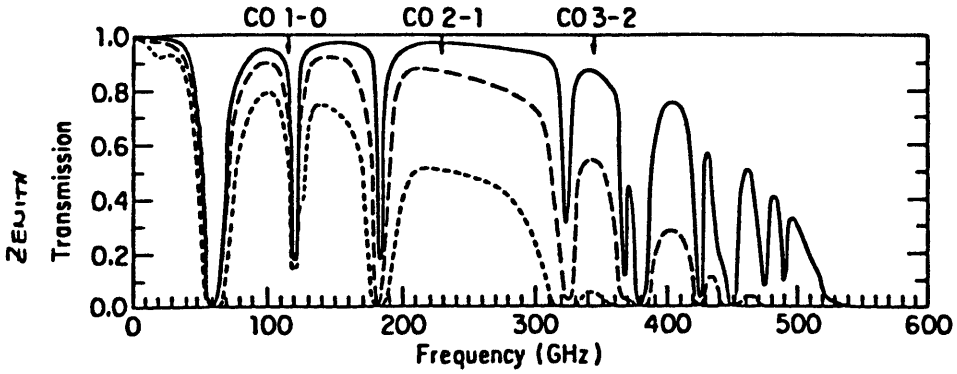
I do not know much about the difficulties of mounting either dish. Tony Hamed has made rough calculations regarding weight and balance of the Leighton dish number 0 on our mount, when we considered this change some years ago.

The pointing is another unknown. Many hard statements have been made by Ulich regarding the pointing error of the 36-ft. Some of these are contradictory. All that I'm certain of is that the pointing is variable and that Leighton's dish won't worsen the pointing.

c: H. Hvatum
J. M. Payne

FIGURE 1


AZIMUTH AND ELEVATION POINTING ERROR DISTRIBUTIONS
NUMBER OF DATA POINTS
25
20
15
10
5
0
-20
-10
0
10
20
AZIMUTH RESIDUALS
x cos (h)
(")
ELEVATION RESIDUALS
(")
1975 data taken with cooled 3.5mm receiver
From B.L. Ulich (1976)



—— 1mm water vapor (4000m alt.)
--- 4mm water vapor (3000m alt.)
..... 15mm water vapor (Sea level)

KITT PEAK
non-summer

FIGURE 2

(FROM VOLUME 2 OF 25-m PROPOSAL)