Interoffice

NATIONAL RADIO ASTRONOMY OBSERVATORY

TUCSON, ARIZONA

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12 METER MILLIMETER WAVE TELESCOPE

MEMO No. 6

To: M. A. Gordon

From: B. L. Ulich

Subject: Modification of 36-foot surface

On December 21, 1977, Marty Tester and I adjusted the surface of the 36-foot telescope adjacent to the north and south feed legs. As you know, when we installed the new backup structure in February 1977, we had no means of conveniently (and economically) removing the feed support structure. Consequently, the weight of the feed legs produced depressions in the reflector when the old backup structure was removed. These depressions were preserved when the new backup members were subsequently installed. This procedure resulted in a thermally stable telescope which had a gain about 5% lower than the peak gain of the original structure. The average gain at all temperatures was considerably improved, however.

The purpose of the latest adjustment was to recover this loss by removing the depressions. We accomplished this by pointing the telescope toward the zenith, loosening the backup members in the elevation plane, pushing up on the feed leg attachment points underneath the reflector, and retightening the backup members. Lee King used his computer model of the telescope structure to calculate the force needed to produce the proper reflector deformation (2625 lbs.). Tony Hamed designed the two long rods which were bolted to the reflector with pin joints. One rod was fixed and rested on the dome floor. The other rod was positioned over a hydraulic jack, and a pressure gauge was used to monitor the upward force on the reflector. A dial indicator mounted on the base of the driving rod showed the vertical deflection. Figure 1 is a plot of the measured deflection versus force. It is quite linear on the way up, indicating that the deformations were elastic (as expected). When a force of 2625 lbs. was reached, the backup members were retightened. Then the jacking force was reduced. The open circles in Figure 1 represent the dial indicator readings on the way back down. It is apparent that an offset of 0.048 in. now exists. This means that the base of each of the north and south feed legs has been raised vertically by 0.024 in. (0.61 mm).

Table I presents radiometric data indicative of the telescope gain at 90 GHz. That the adjustment improved the telescope gain seems quite clear. The azimuth beamwidth did not change (as expected). The elevation beamwidth decreased by $3.7 \pm 1.9\%$. The aperture efficiency increased by $3.8 \pm 3.4\%$. The elevation beamwidth is in some ways a more accurate measure of the telescope performance since it only involves relative power measurements, whereas the aperture efficiency requires absolute power measurements at different times. The weighted mean of the two results is a gain increase of $3.7 \pm 1.7\%$. This is a significant improvement (and is consistent with the maximum possible increase of 5%). Data taken on 1/8/78 also showed that the residual astigmatism was 2 ± 1 mm, in excellent agreement with the value calculated at 10°C from the previously measured curve. Thus no feed leg shims are necessary.

The 36-foot telescope is now thermally stable and gravitationally stiff, and the feed leg depressions have been removed. The fundamental limitations to diffraction-limited performance are the small-scale surface errors due to imperfections in the original machining and the large-scale azimuth errors due to the feed leg accident. We are in a good position now to substantially improve the high frequency performance by correcting these errors. The most difficult task is to measure these residual surface errors. I believe the holographic method (using the COMSTAR satellite at 1 cm) is capable of producing an aperture phase error map of sufficient accuracy. Once a good map is obtained, the correction can be made in a straightforward manner either in the secondary mirror or in the primary reflector using aluminum tape.

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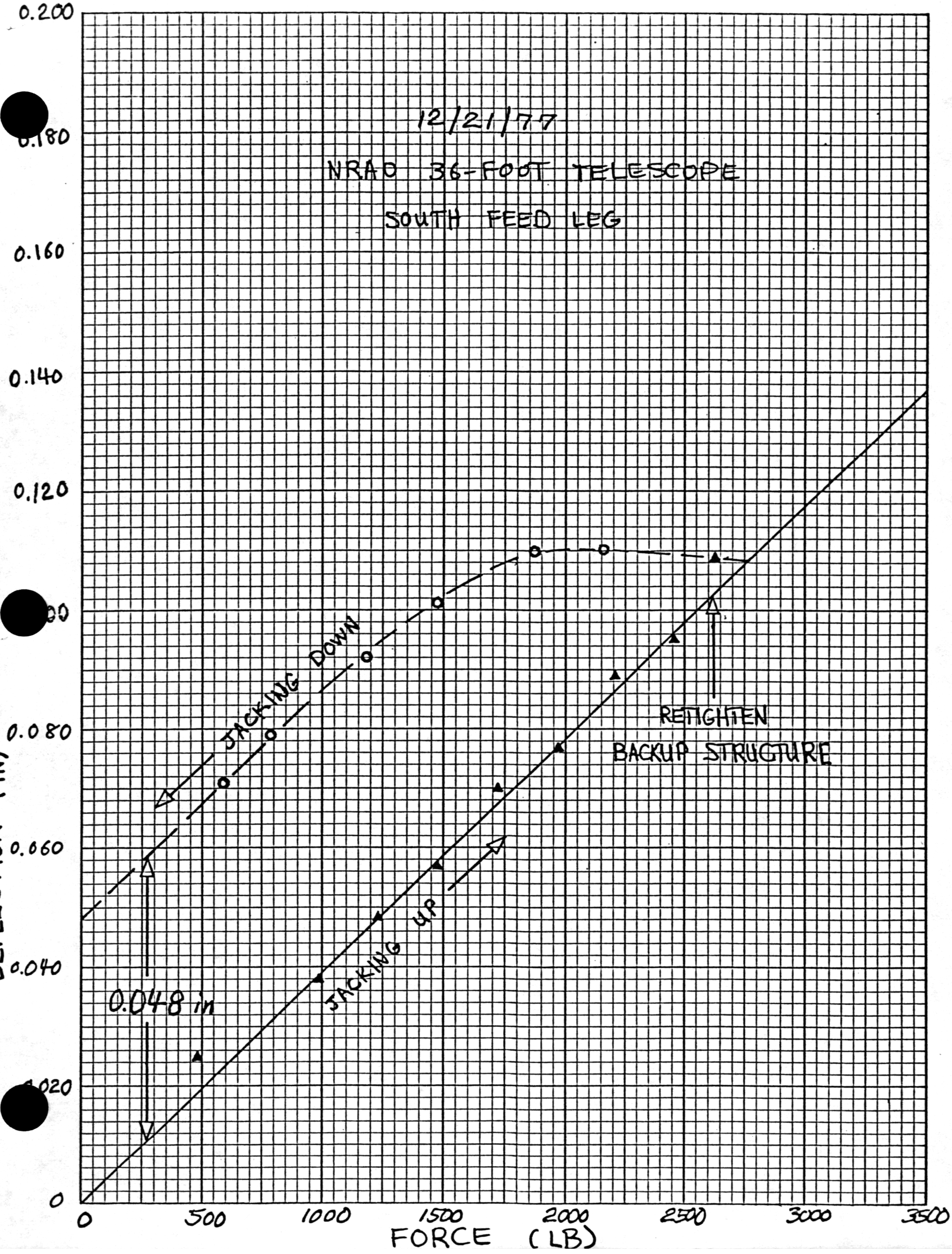
FIGURE 1



12/21/77
NRAO 36-FOOT TELESCOPE
SOUTH FEED LEG
JACKING DOWN
JACKING UP
RETIGHTEN
BACKUP STRUCTURE
0.048 in
DEFLECTION (IN)
FORCE (LB)
0.200
0.180
0.160
0.140
0.120
0.080
0.060
0.040
0.020
0
0
500
1000
1500
2000
2500
3000
3500

TABLE I

90 GHz RADIOMETRIC DATA

DATE	HPBW AZ (")	HPBW EL (")	APERTURE EFFICIENCY (%)	NOTES
12/20/77	81.9 ± 1.1	76.6 ± 1.1	31.7 ± 0.9	Before adjustment
12/21/77	82.3 ± 1.1	72.9 ± 1.1	32.0 ± 0.9	After adjustment
1/8/78	80.7 ± 1.1	74.9 ± 1.1	33.8 ± 0.9	Astigmatism = 2 ± 1 mm
12/21/77 and 1/8/78	81.5 ± 0.8	73.9 ± 0.8	32.9 ± 0.6	Average of data after adjustment