Slant Range Tests of Quadrant Detector

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Abstract.

Further tests on a Quadrant Detector system suitable for measuring movement of the GBT feed arm are given in this report. The tests show that, at the intended range of operation atmospheric effects will not be a limitation.

Introduction.

Concern has arisen in recent years over the possibility of pointing errors induced by feed arm vibration. The pointing of the GBT is very sensitive to lateral movements of the subreflector, the sensitivity being around 5 arc seconds per mm.

GBT Memo #127 recommended the accelerated development of a system to monitor movement of the GBT arm. GBT Memo #144 outlined a development program which called for tests of atmospheric effects as soon as possible. GBT Memo #149 gave results over a vertical path of 34 meters which were encouraging in that the atmospheric effects were small enough to not impose a limitation on the intended application.

This Memo gives results over a slant range of 70 meters, the intended range of operation, and shows that, at least during conditions appropriate to observations at high frequencies, that the atmospheric effects will not significantly degrade the accuracy of the proposed system.

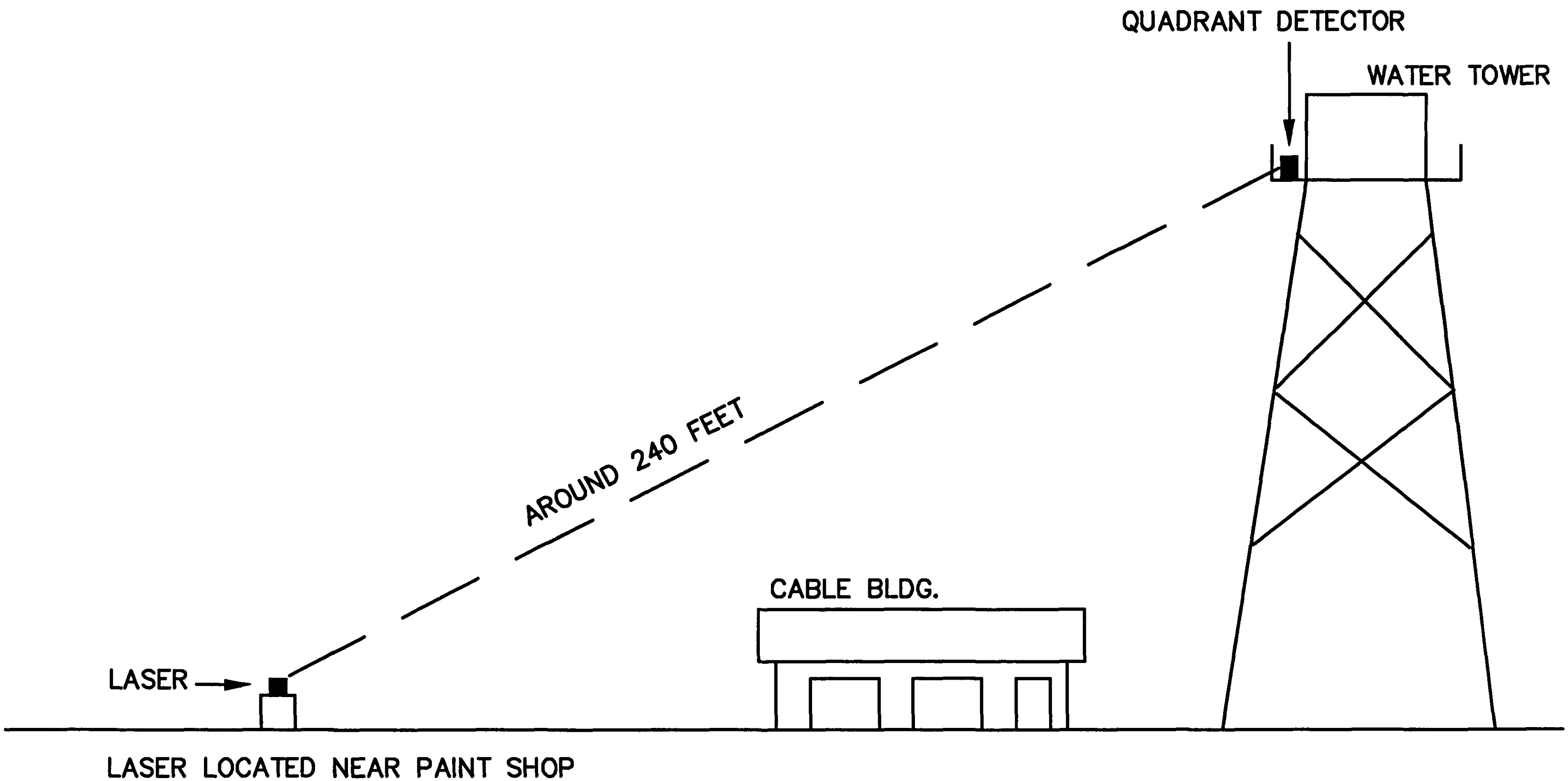
The System.

The Quadrant Detector used in these tests is described by M. Valente in a document that is an appendix to Memo #143. A laser diode is used to generate a collimated beam that is projected over the range of interest and is intercepted by a quadrant detector. Small movements in two orthogonal directions, each perpendicular to the direction of propagation, are sensed by the quadrant detector along with its associated electronics. The frequency response of the system is from DC to around 100Hz. The geometry used in this series of tests is shown in Figure 1. Again the water tower in Green Bank was used to establish a path between the transmitter and receiver, this time over a slant path of 70 meters. The two orthogonal outputs from the quadrant detector were sampled 2700 times over the course of one minute and the average and RMS values calculated. Ten minutes later another measurement was taken.

Results

A typical result is shown in Figure 2. The scale of the measurements is 1.5 microns per millivolt so the fluctuations vary from 30 microns during the night to a peak value of 300 microns during the middle of the day. Measurements with an accelerometer mounted on the tower suggest that at least part of the measured fluctuations may be due to movements of the tower caused by daytime traffic in the area. An accelerometer record is shown in Figure 3. Although it would be interesting to attempt to separate mechanical movements from the atmospheric effects it was not judged to be a wise use of manpower in view of the fact that the combined effects were of such an amplitude as not be a serious limitation during nighttime observations. Memo #144 quoted the expected turbulence induced fluctuations at this range to vary from 15 microns(weak turbulence) to 920 microns (strong turbulence) with 73 microns given as the value for "medium" turbulence. The measured values fall nicely in this range and it seems a reasonable expectation that the values in the GBT will be similar or even less than those measured. In view of these results the compensation scheme mentioned in Memo #144 will not be pursued and work will start immediately on the detailed design and construction of the system outline in Memo #144.

FIGURE 1



NRAO

NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGULAR ±0°30'
FRACTIONAL ±1/64
2 PLACE DECIMAL ±.01
3 PLACE DECIMAL ±.005
DIMENSIONS ARE IN INCHES

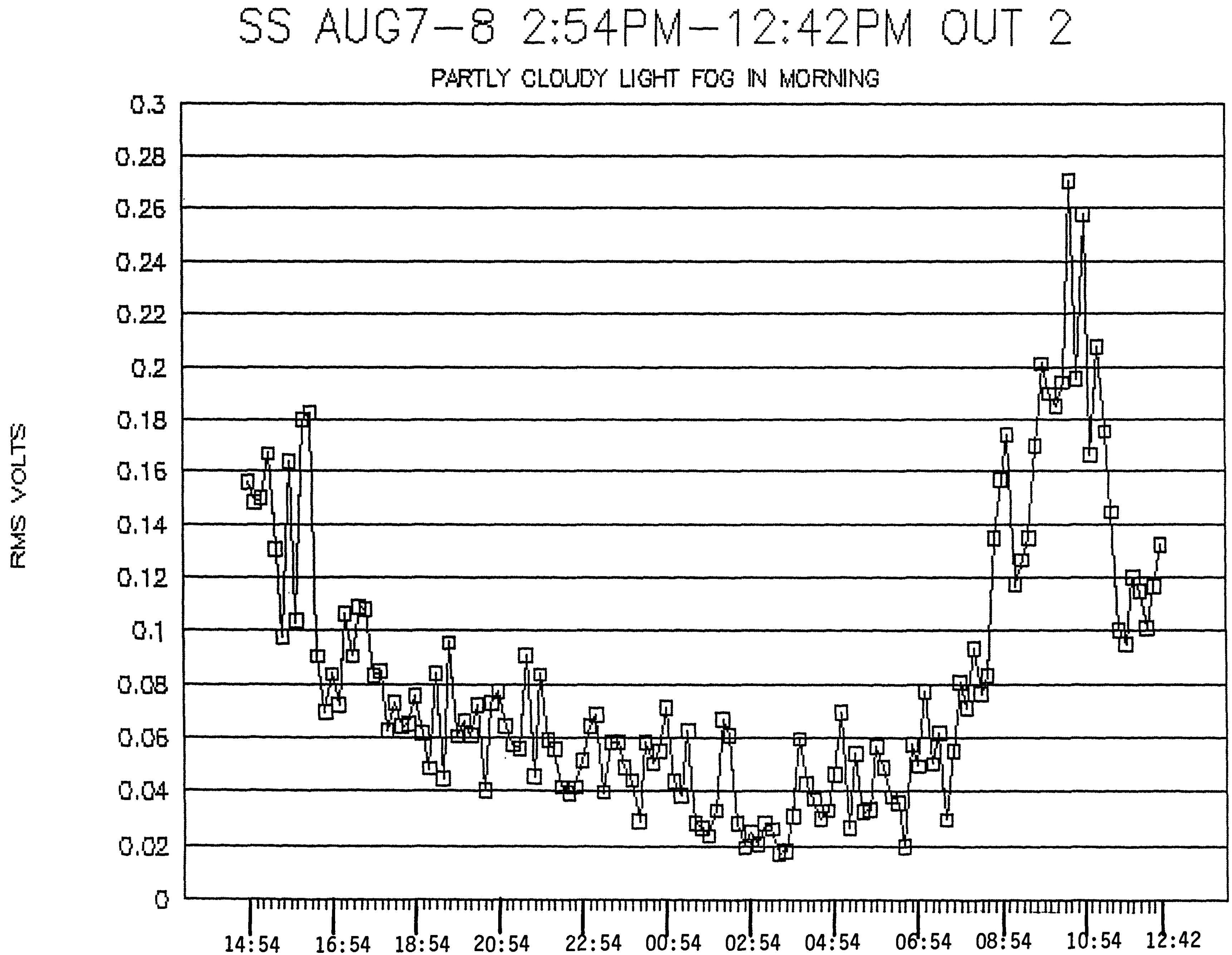
PROJECT/TITLE: GBT
QUADRANT DETECTOR SLANT SHOT VIEW

DESIGNED	D. SCHIEBEL	DRAWN	D. SCHIEBEL	CHECKED	
SCALE	NONE	MATERIAL		FINISH	
FILE	C:\NETACAD\DWG\QDSS	SHEET	1 OF 1	REVISION	X

DATE: 9/4/96

DRAWING NO.: XXXXXXXXXX

FIGURE 2


SS AUG7-8 2:54PM-12:42PM OUT 2
PARTLY CLOUDY LIGHT FOG IN MORNING
RMS VOLTS
0.3
0.28
0.26
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
14:54
16:54
18:54
20:54
22:54
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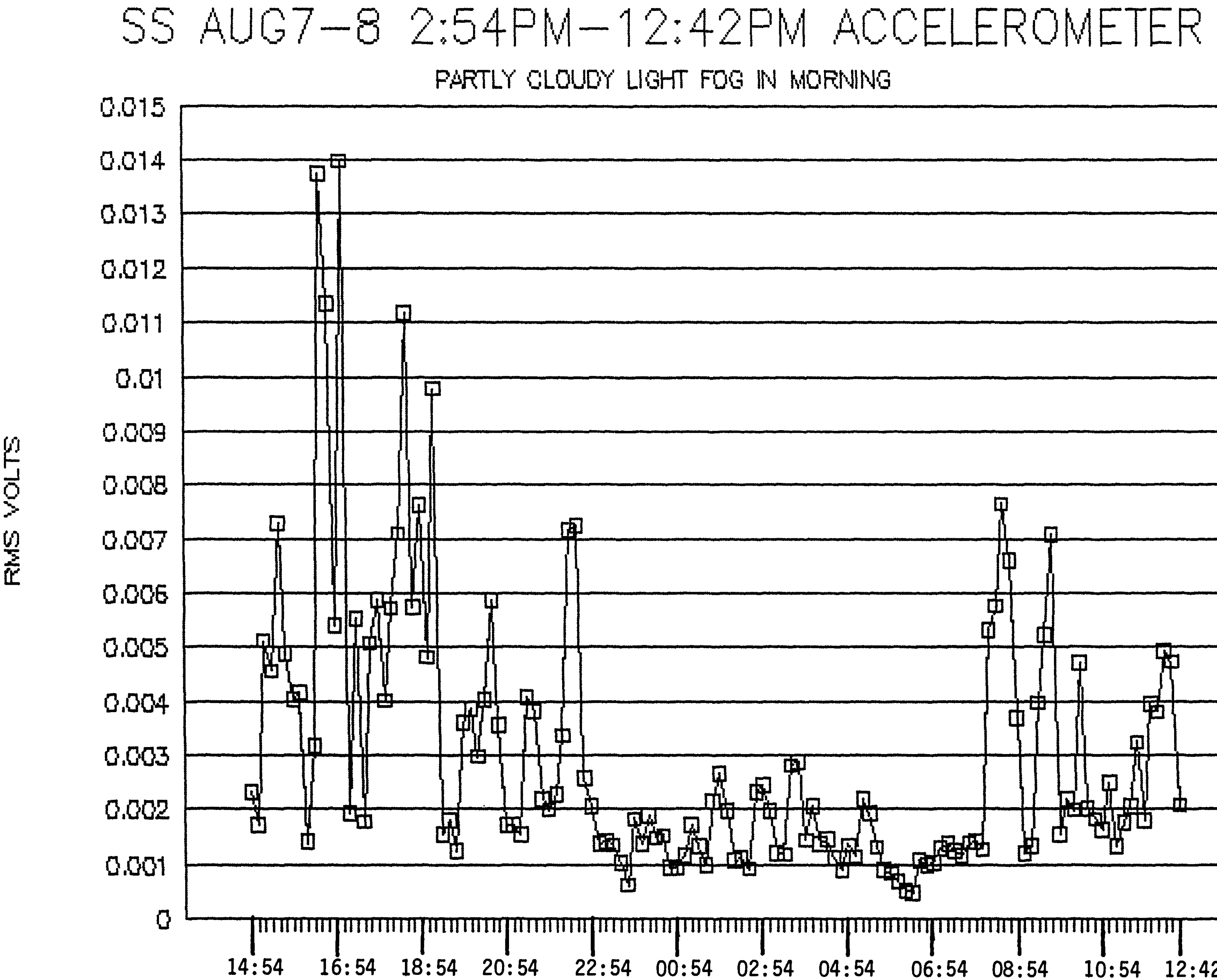
02:54
04:54
06:54
08:54
10:54
12:42

FIGURE 3



SS AUG7-8 2:54PM-12:42PM ACCELEROMETER
PARTLY CLOUDY LIGHT FOG IN MORNING
RMS VOLTS
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0.014
0.013
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
14:54
16:54
18:54
20:54
22:54
00:54
02:54
04:54
06:54
08:54
10:54
12:42