J Ronney

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

May 5, 1995

MEMORANDUM

To: GBT Scientific Working Group

From: D. E. Hogg D.E. Hogg

Subject: Dynamic Analysis of the GBT

In February 1995 Ben Parvin and his group completed the first stage of an analysis of the dynamical response of the GBT to a step motion of one degree in azimuth. The analysis shows that the structure oscillates about the commanded position, and that it requires some tens of seconds for the oscillation to subside. In April 1995, at the request of Bob Hall, John Payne convened a study group in Tucson to examine the Parvin report and to recommend what actions should be undertaken.

The report by Parvin also looked at a step in elevation and found that cross-coupling from elevation to azimuth is not observed, due to the symmetry of the structural model. The pointing variations fall below 2 mdeg within 15 seconds.

The response to a wind which is steady at 6 m/s gusting to 7 m/s was also studied. With the wind coming from the most unfavorable aspect there is a deflection corresponding to a beam motion of about 11 arcsec, and a fluctuation of 8 arcsec rms due to the gusting. At a station 90 feet above the ground, winds of this speed are observed to occur less than two percent of the time (GBT Memo No. 126).

I plan to discuss the dynamic response of the telescope at the May 16 meeting of the GBT SWG. In preparation for this, I enclose the following documents:

1. John's report, now GBT Memo No. 127 (not included for those at NRAO).

2. Bob Hall's note which includes copies of two figures from Parvin's report. These figures are central to the discussion in Memo 127. The final report by Parvin is nearing completion but is not available for distribution yet.

3. A copy of Figure 14 from Parvin's report, showing the effects of a gusty wind striking the antenna from the most critical direction.

4. A figure Jay Lockman has made showing the loss of gain as a function of time and frequency which would be experienced if the structure oscillates as shown in Figure 9.

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

April 20, 1995

MEMORANDUM

To: Distribution

From: Robert D. Hall

Subject: Dynamic Pointing

The attached memorandum from John Payne, dated April 17, 1995, provides for your information a report on a recent GBT dynamic pointing meeting held in Tucson. As stated in this memo, a group was formed to investigate the results presented in the dynamic pointing analysis report and make recommendations to the project manager regarding the future course of action. This analysis shows oscillation of the telescope beam about the commanded position. The worst case response is shown in the attached figure 9 a,b, which is in the cross elevation direction. Also included is the elevation direction response (Figure 10 a,b) for comparison. I very much appreciate the efforts of the group which met to review the dynamic pointing.

The recommendations provided in the report are timely and valuable. They are presently being implemented. The surface accuracy of the GBT is estimated to be approximately 0.009 inches rms in Phase 3 operation. In view of this fact, the focus of the program will be directed towards achieving compatible pointing of the telescope. In addition, investigation of observing strategies adapted to the GBT mechanical constraints should be considered by the astronomical community.

1% damping
PI+feedforward controller with pre-processor
Antenna orientation 60 deg in EL
Acceleration limit 0.2 deg/sec^2
Rate limit 0.67 in AZ, 0.33 in EL

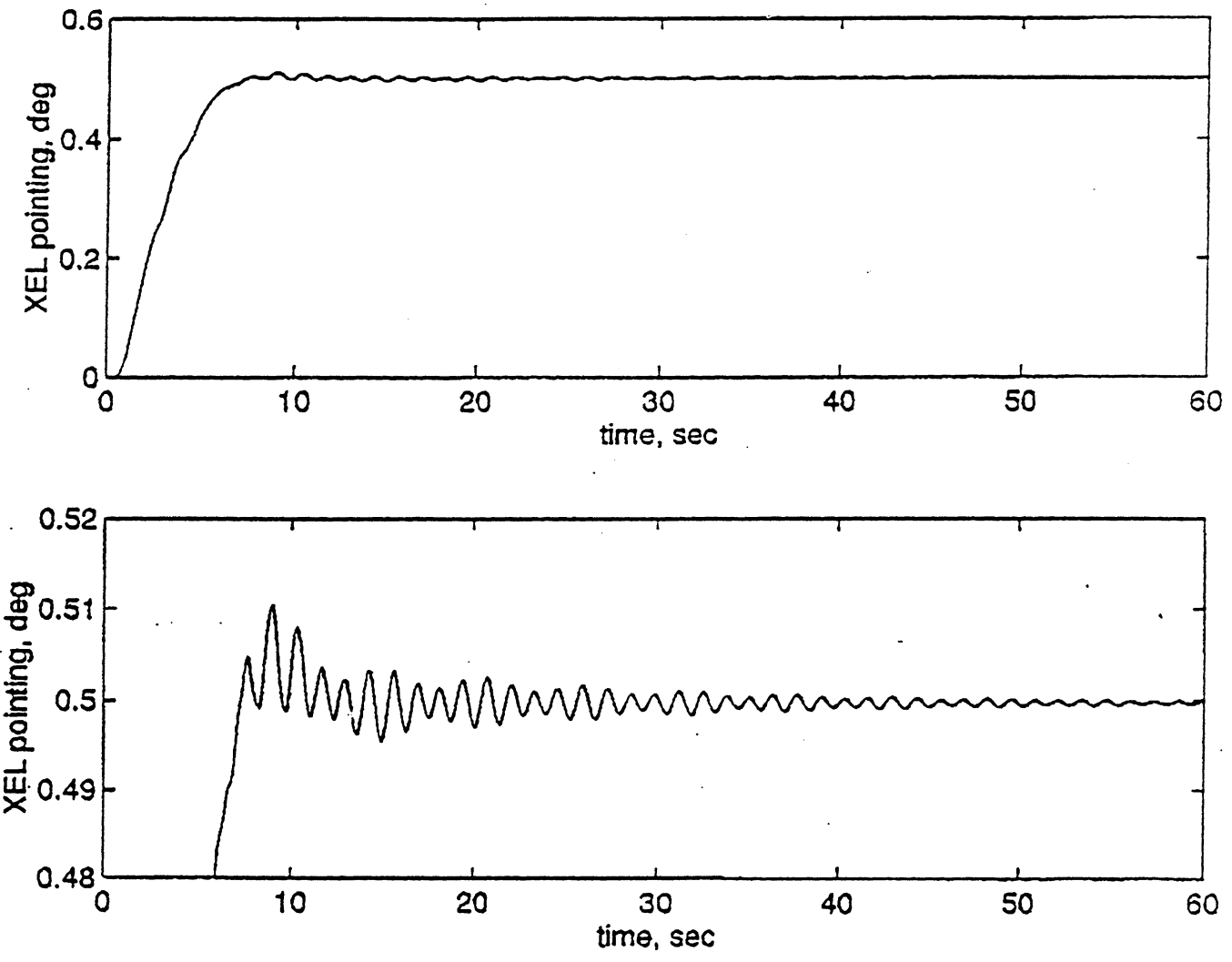

Fig.9a,b Antenna XEL beam response to 1 deg step in AZ: for steady state XEL pointing=AZ encoder × cos(EL position)

Fig.9 a,b

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Rate limit 0.67 in AZ, 0.33 in EL

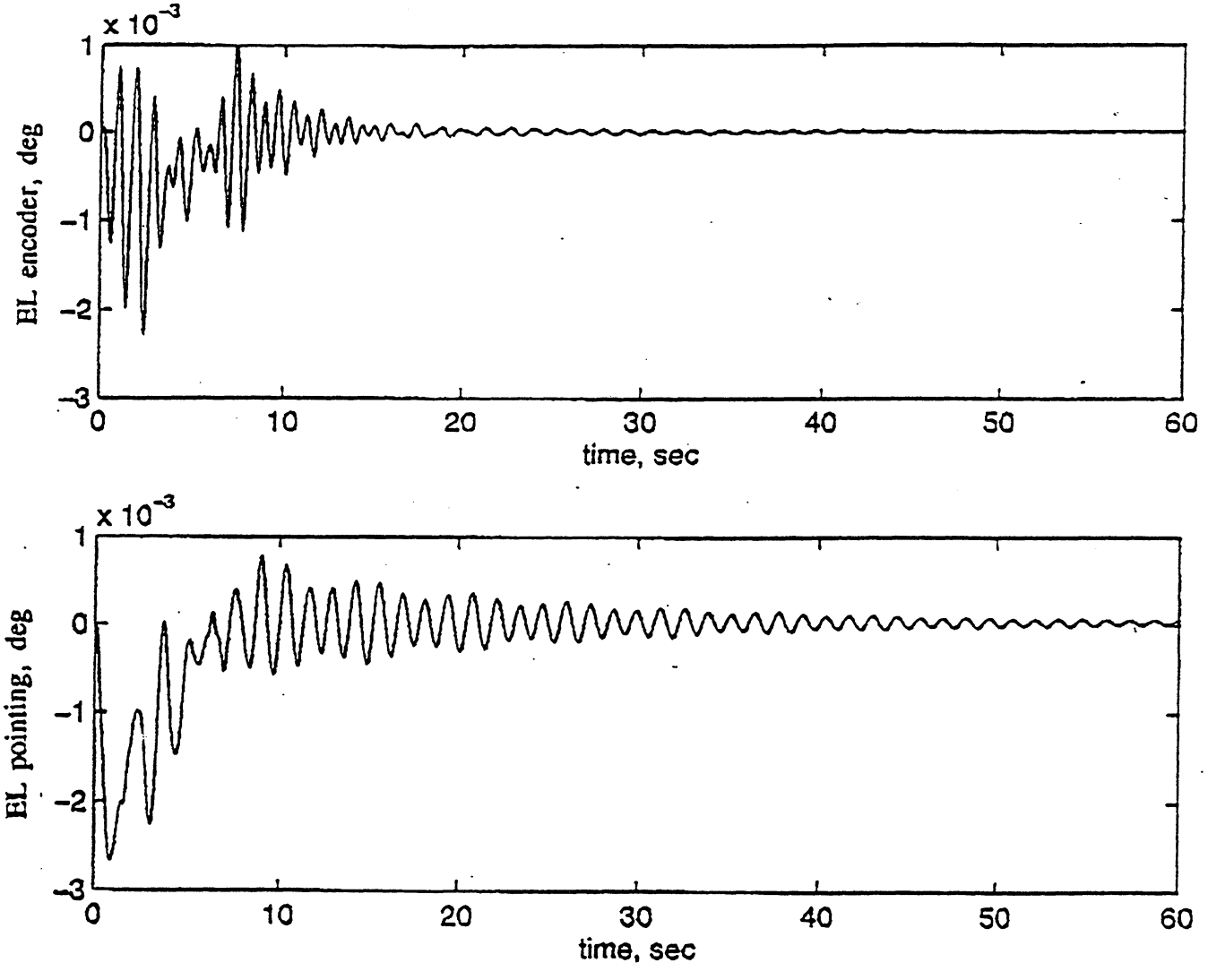


Fig.10a,b Antenna EL encoder and EL beam responses to 1 deg step in AZ.

Fig.10 a,b

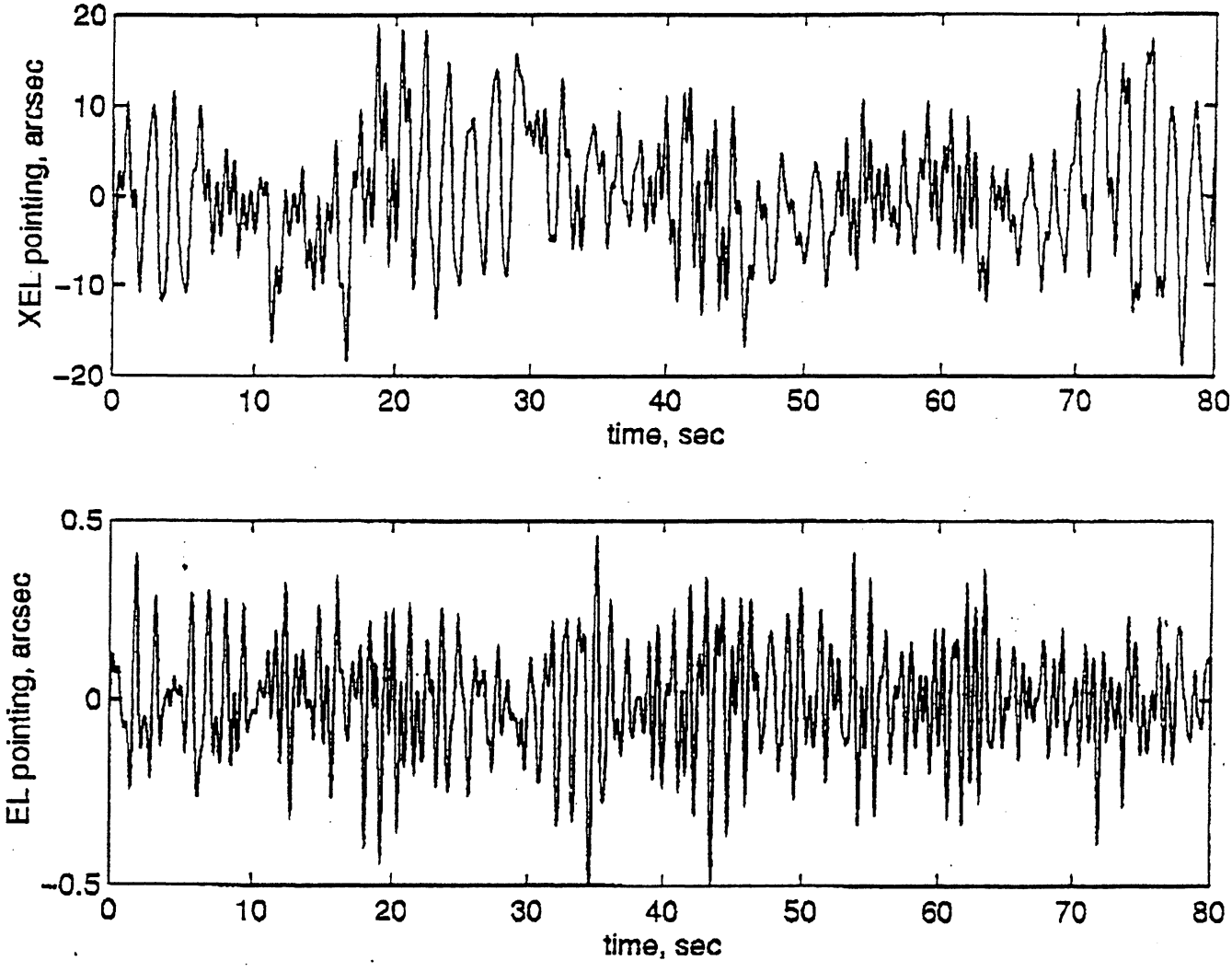
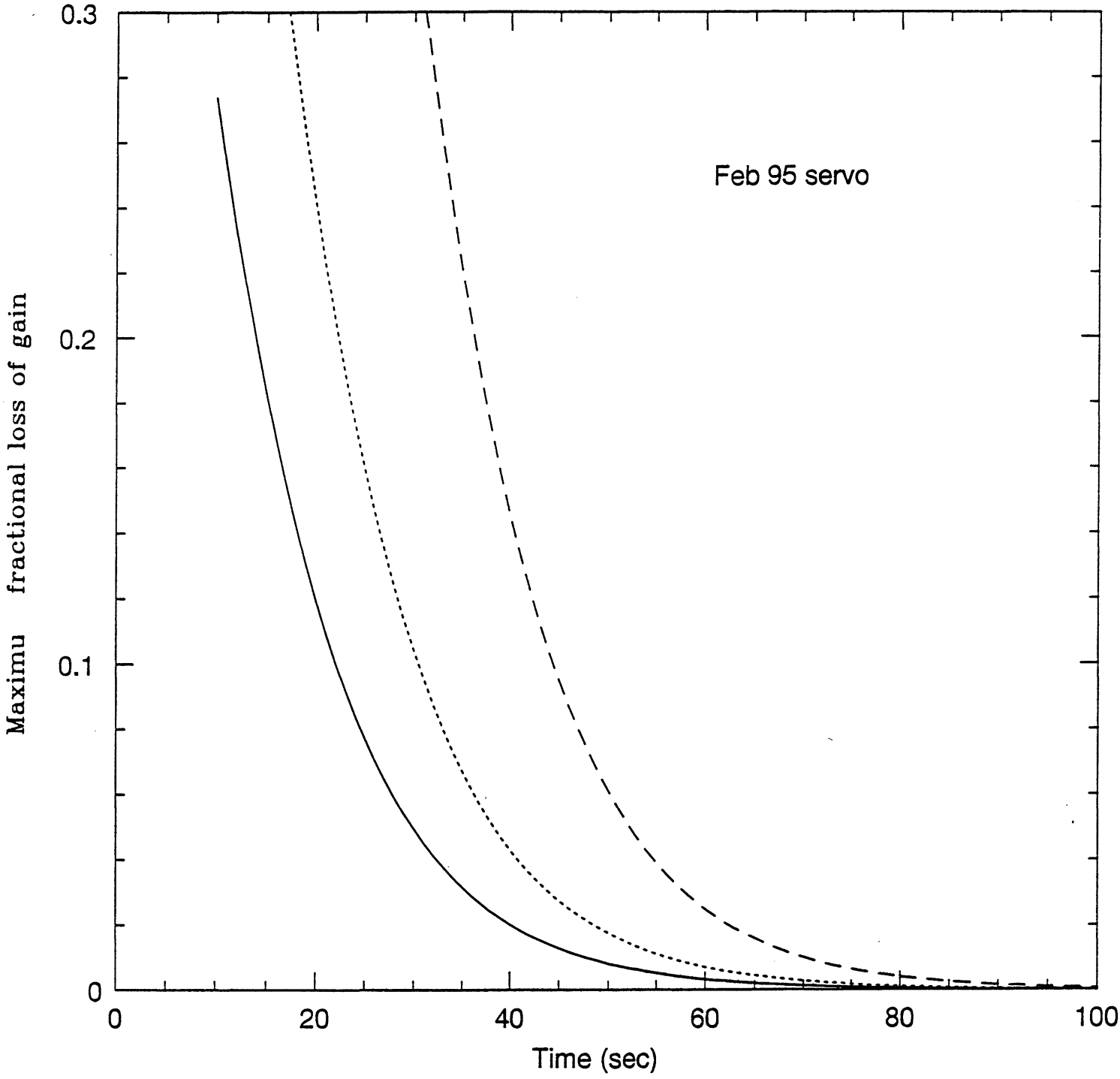


Fig.14a,b Antenna pointing responses to 7 m/s (15.6 mph) gusting.
Wind direction along elevation axis, elevation position 60 deg.
XEL pointing=7.9 arcsec, EL pointing=0.16 arcsec.

Fig.14 a,b


15, 22, 42 GHz
Feb 95 servo
Maximu fractional loss of gain
0.3
0.2
0.1
0
0
20
40
60
80
100
Time (sec)