National Radio Astronomy Observatory
Tucson, Arizona

September 25, 1987

NRAO TUCSON INTERNAL REPORT
No. 5

MEMORANDUM

To: Tucson Internal Report Series

From: P. R. Jewell

Subject: Season Startup System Tests, 1987 September 16 - 23

This memo summarizes the results of the system tests performed during 1987 September 16 - 23 to start the 1987-88 observing season. The test participants were D. Emerson, J. Lamb, H. Liszt, B. Turner, and myself. Many members of the staff spent long hours at the telescope during the tests; we thank these staff members and acknowledge R. Freund, B. Hill, and E. Stobie, in particular.

As planned the technical staff made major changes to the 12 m equipment configuration during the 1987 Summer Shutdown: the old PDP 11/40 control computer was replaced with the PDP 11/44 and that computer, the VAX analysis computer, and the synthesizer rack were moved to the new computer room. The move required extensive recabling. In addition, RWF, RHH, and EBS rewrote the 11/44-to-VAX link driver to include full handshaking and better error logging.

The objectives of the test session were as follows:

1. Find any bugs left from the major changes listed above;

2. Perform general system checks and make sure that all pieces of equipment and all observing modes were functional;

3. Measure telescope efficiencies and receiver sensitivities;

4. Conduct a full 3 mm pointing run, fit and install new pointing coefficients.

I. Tests of the New Hardware Configuration

The computer system performed remarkably well considering the magnitude of the changes. Even on the first day of the tests, the system was mostly free of errors. The most serious problem that we had was two prolonged episodes of LINK errors ("DATA TRANSMISSION ERROR"). On both occasions, we booted both the 11/44 and VAX computers but could not clear the error. On the second occasion, we powered both computers completely down but could still not clear the error. On the first occasion, the error went away after the operator performed a "SAVE SCAN." The second time the error finally went away after we wiggled cables and reseated cards on both the 11/44 and VAX link cards. The "fixes" were quite possibly just coincidences on both occasions. The problems seemed to occur after long lapses in observing and on the second occasion, the FORTH tape had to advance a long way to the EOF (taking 30 - 60 seconds).

We could not make the problem recur and at this point, it remains a mystery. RWF, EBS, and RHH installed more diagnostics and error logging in the link to help indentify the problem should it happen again. At this writing, the problem has not recurred in several days.

II. Equipment Checks

Most pieces of equipment were checked and found to be in proper operating condition. A few pieces of equipment deserve special mention.

a) The Andy Dowd Phase Advancer Box

A. Dowd installed a new piece of equipment to be used with spectral line beam switching that advances the subreflector switching phase so that it is in synchronism with the integrations in the 512 channel Multiplexer. The amount of the phase advance can be set from a front panel thumbwheel set (in milliseconds).

The box seemed to work fine. We set the phase advance to 26 ms by examining the waveforms on the oscilloscope. I tried to calibrate it on the sky, but at the time of the test I did not have a strong source to observe. The results were inconclusive, but for the record, I list them below.

Test Line: 115 GHz CO line in MIRA

Scan Type	Switch Rate	Advancer Setting	T_R*
PS	---	---	3.631 (.2005)
BSP	1.25	26	2.797 (.1997)
BSP	2.5	26	2.333 (.2102)
BSP	5.0	26	1.950 (.2061)
BSP	1.25	31	2.808 (.2452)
BSP	1.25	21	2.560 (.2320)
BSP	1.25	0	2.715 (.2251)

This test will have to be repeated in better weather, using a stronger line.

There is one problem with using the phase advancer that we should remedy as a high priority. When going between spectral line beam switching and continuum observing, the operator must remember to switch the external SIG/REF cables and set the Dowd box to 0 ms. This is certain to lead to error; I forgot to do it several times myself. Although Andy has left provision for the box to be controlled via the IEEE bus, a simple solution is to build a BNC switch box. The box need have only the 2 S/R inputs, a selector switch, and one BNC output for the S/R to the subreflector. This eliminates the need for the cable change and resetting the Dowd box. If the switch were manual, it would be an improvement over the present situation, but the switch should really be thrown by a TTL signal from the computer.

b) 3 mm Schottky Receiver

We used the 3 mm Schottky receiver (low frequency pair) for pointing and for a few miscellaneous observations. The receiver worked well. We did not get a chance to make detailed continuum sensitivity measurements, but the two polarization channels seemed to have similar sensitivities. We did measure noise temperatures at several frequencies across the band; these are tabulated below.

3 mm Schottky Noise Temperatures
(Low Frequency Pair)

Frequency (GHz)	Channel 1 Noise Temp.	Channel 2 Noise Temp.
70.0 (LO freq)	152	209
75.0	159	217
80.0	167	162
85.0[1]	262	238
90.0	203	180

[1]The 85 GHz measurement may have been a bad tuning.

We did have some difficulties with the Gunn oscillator in the receiver (2H23). I had trouble getting enough power in the 85 - 90 GHz range and on several occasions, it quit oscillating. To get it to oscillate again, you usually had to switch the voltage supply off and on.

c) The SIS Receiver

The SIS receiver worked well although the noise temperatures ran a bit higher (20 %) than James Lamb had measured in the lab. The receiver proved to be tricky to tune. A nominally good tuning (good rejection, reasonable peak in total power) can often turn out to give a terrible noise temperature (many hundreds of degrees).

It seems essential to assess the tuning with a hot/cold load, or in the least, with the vane and sky. A good tuning should give a Y factor (V_{hot}/V_{cold}) of about 2. If it is much less than that, something is wrong.

The cyrostat held helium for 4 days on its first fill but then ran out in 1 day on the next fill. In the second instance, we had a couple of power outages (including UPS failures) and were running at a lower temperature. James theorizes that one of these, probably the lower temperature (and different vapor pressure), caused the rapid boil off.

The aperture efficiency of the SIS was good (48 % -- see below) and the beam was very nearly a circular Gaussian.

d) Filter Banks

The filter banks worked satisfactorily, in general, although the Red 1 MHz showed some strange glitches and baseline curvature on several occasions. We could not make this problem repeat. We are suspicious that temperature instabilities might be the culprit as the worst problems happened the day the control room air conditioner went out. The problems did happen at other times, however. Although the problems might not be related to the temperature, we should keep a watch for such problems and consider whether the control room air conditioning scheme and the open spaces at the ends of the racks are acceptable.

e) Weather Instruments

The dome chart recorder weather instruments (thermometer, hygrometer, and barometer) may not be in good calibration. The thermometer definitely appears to be reading about 5 F too low and the hygrometer calibration is also suspect. The calibration of all these instruments needs to be checked, and they should be moved outside. The conditions inside the dome are probably always different than the outside conditions, which are what we should be measuring. Dennis Chase has promised to look into these matters.

III. Observing Routines

We checked the operation of most of the common observing routines, including spectral line position switching, beam switching, and total power observations (single position and mapping), and continuum ON/OFFs and grid mapping. There were some initial problems with the way the link task was handling spectral line beam switching and total power observations, but EBS fixed these. By the end of the session, everything was functional.

IV. Efficiency Measurements and Beam Maps

Because of the system problems during the first few days and the terrible weather during the last few days of the session, we were able to make only a few of the efficiency measurements that we had intended to make. We were able to measure the aperture efficiency and make a beam map with the SIS receiver at 95 GHz. For the aperture efficiency, we measured 50 % in channel 1 and 46 % in channel 2. The beam maps (Figures 1 and 2) showed the beam to be a surprisingly good circular Gaussian: (Az, El) = (69" x 64"). Previous beam maps with the SIS and other receivers have shown a more significant azimuth elongation. The average beamwidth (66.5") is 1.23 lambda/D. Last season, the SIS sometimes showed very narrow beamwidths.

V. Pointing Measurements

As with the efficiency measurements, our pointing run was hampered first by system problems and then by bad weather. We were unable to collect enough data for a confident refitting of the primary pointing coefficients. Fortunately, the pointing from one year ago has held up very well. Figures 3 - 10 show the azimuth and elevation offsets plotted against cosine(el) for both the Schottky and SIS receivers. The Schottky receiver, for which we had the most data, showed an azimuth peak-to-peak scatter of about 21" and an elevation peak-to-peak scatter of about 16". I fitted for secondary pointing coefficients (azimuth encoder offset, collimation error, elevation encoder offset, and bend error) and installed them in the control computer (for both the Schottky [4 BAY] and SIS [1 BAY]).

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JUPITER SCAN 852

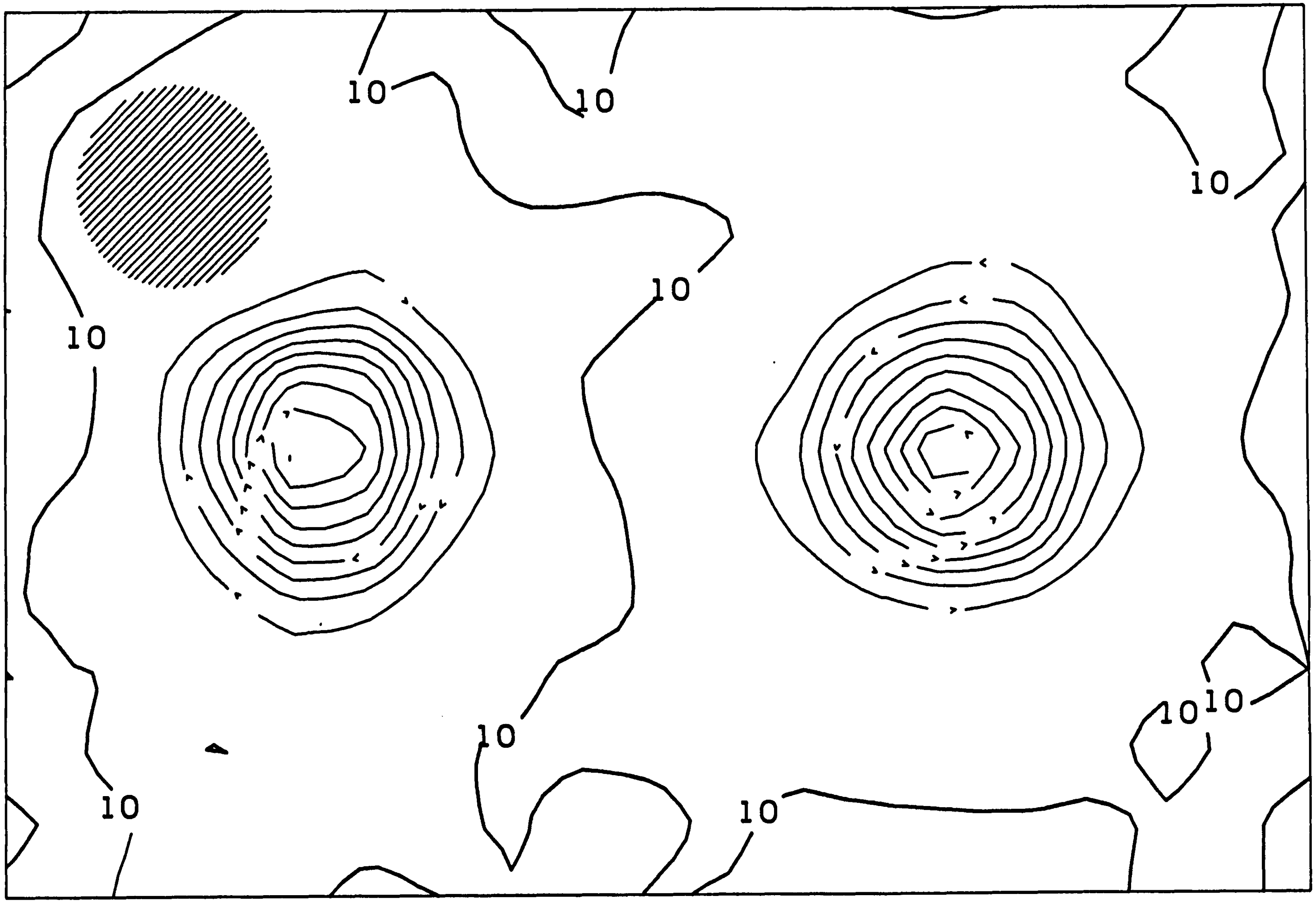
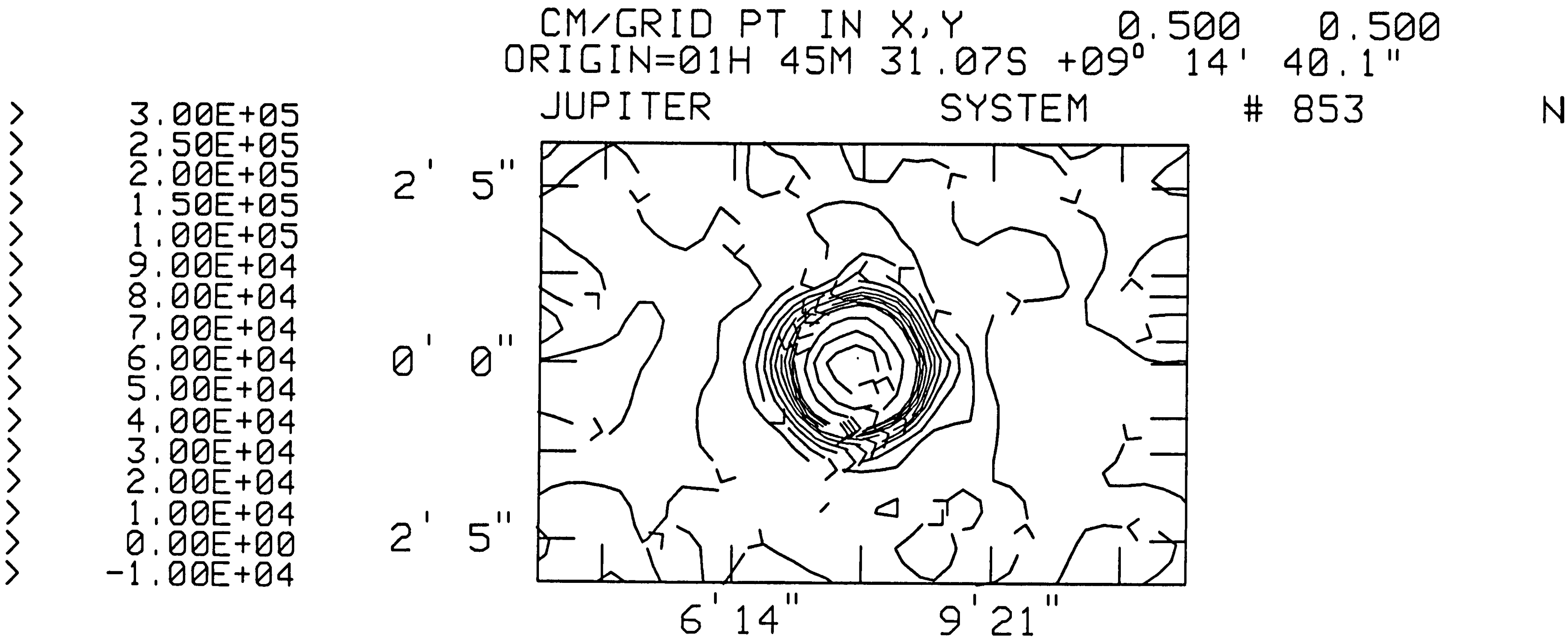


FIG. 1 — Dual beam map of Jupiter using the SIS receiver at 95 GHz (18 Sep 1987)

Fig. 2 — Restored 95 GHz SIS map of Jupiter (18 Sep 87)
(See Figure 1 for unrestored version).



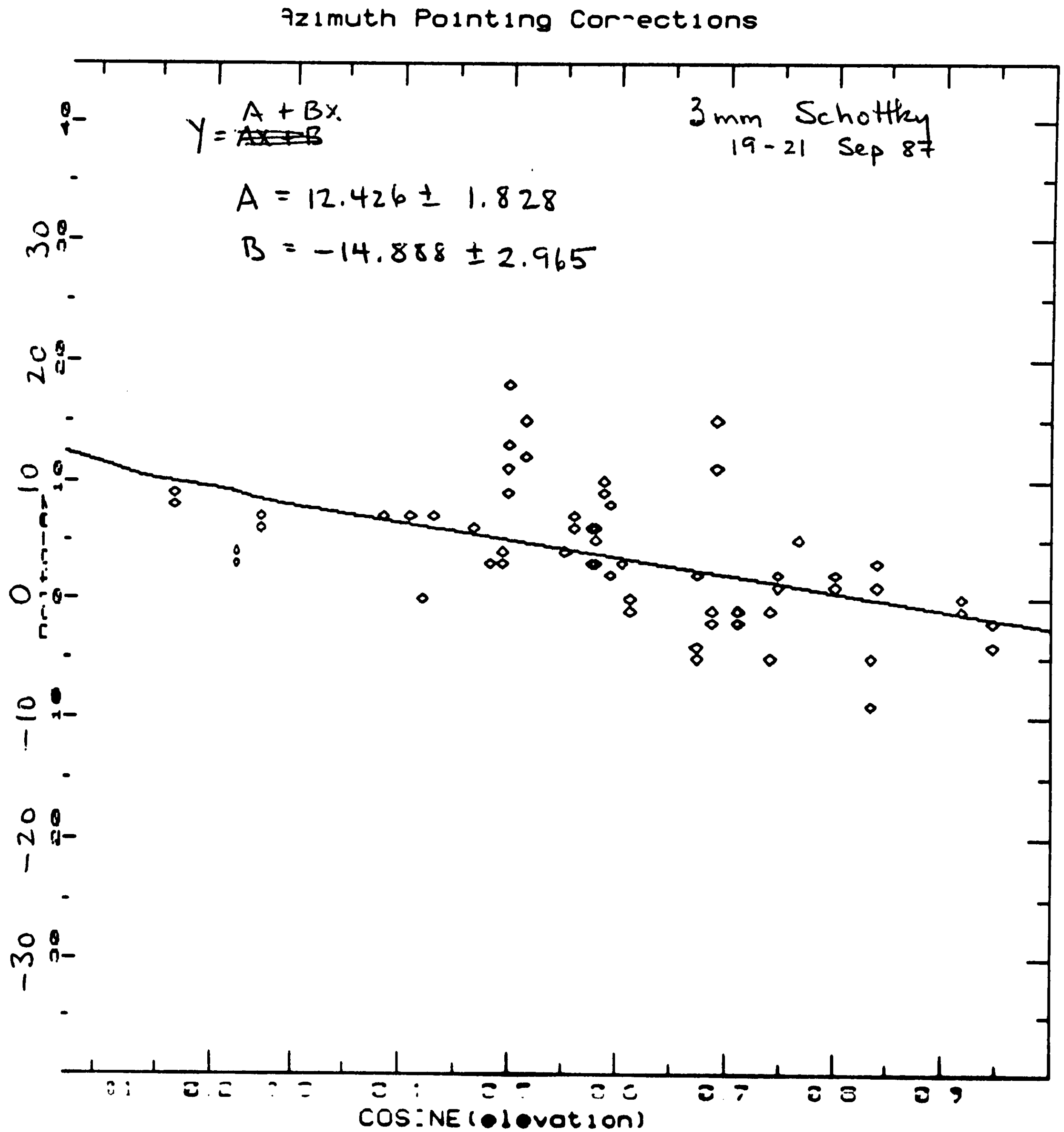


FIG. 3 ΔAz_{thumb} vs cos(E)

3mm Schottky Rx.

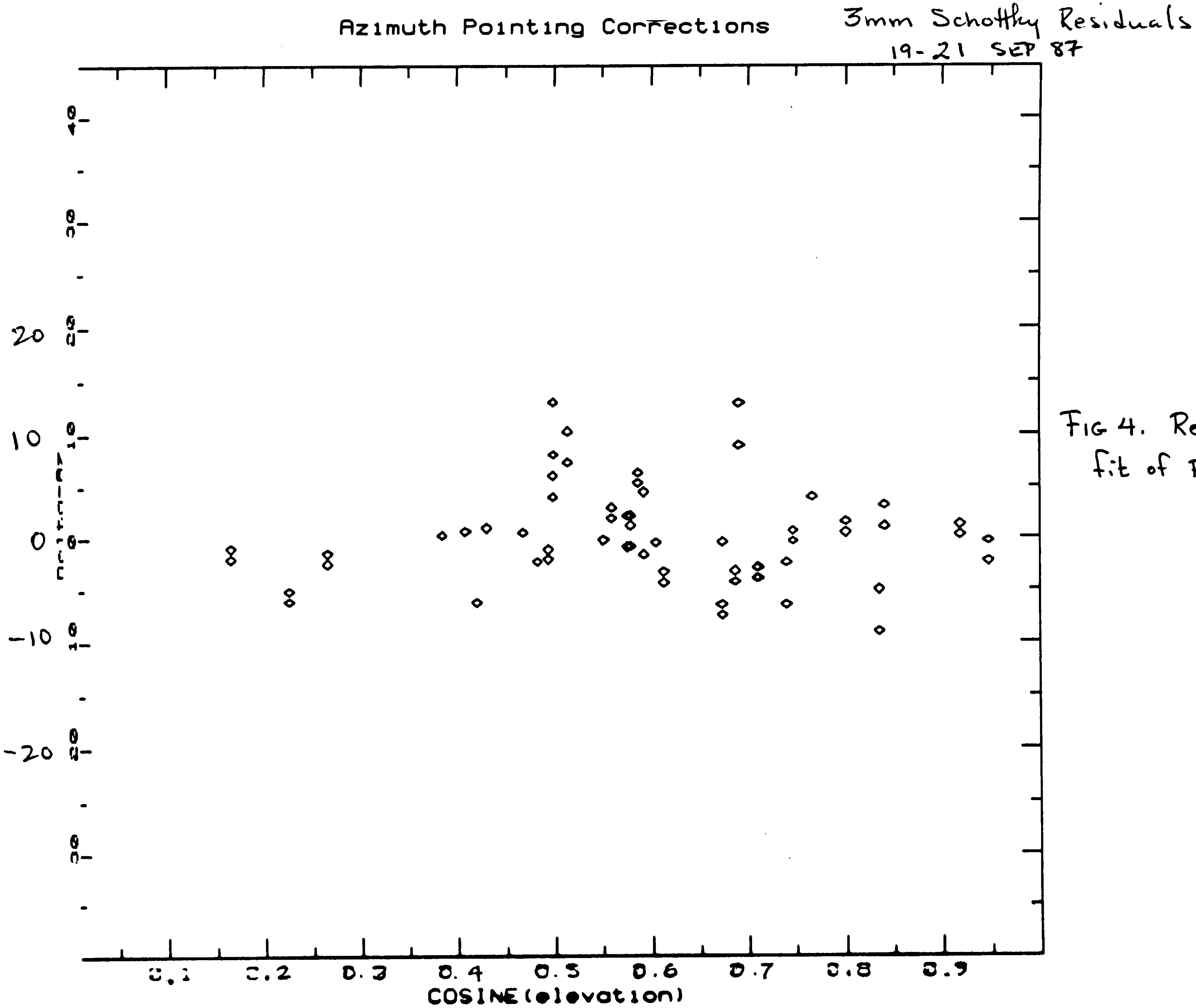


FIG 4. Residuals for fit of Fig. 3

Elevation Pointing Corrections

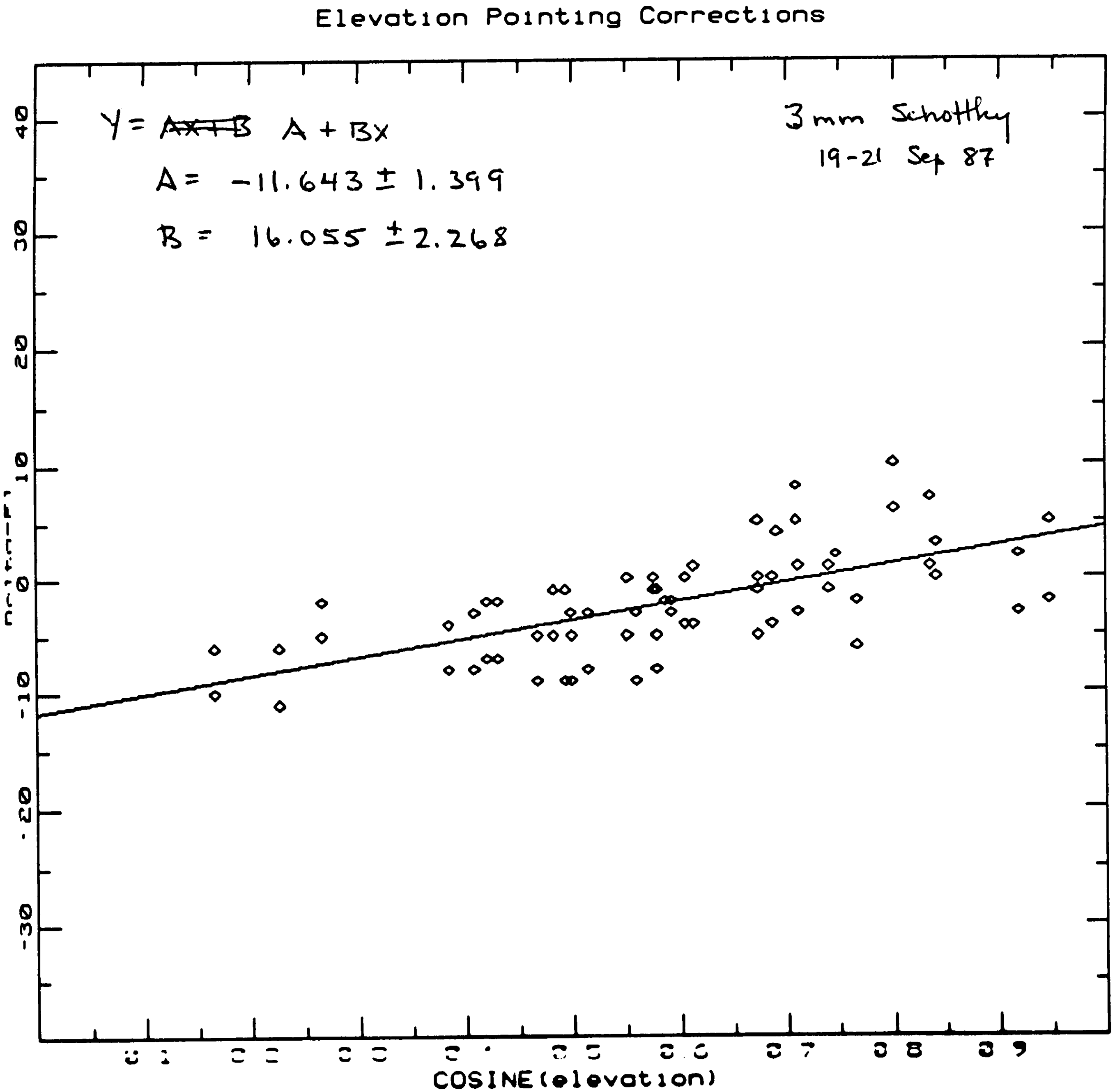


Fig 5. ΔEL_{thumb} vs cos(E)
3mm S

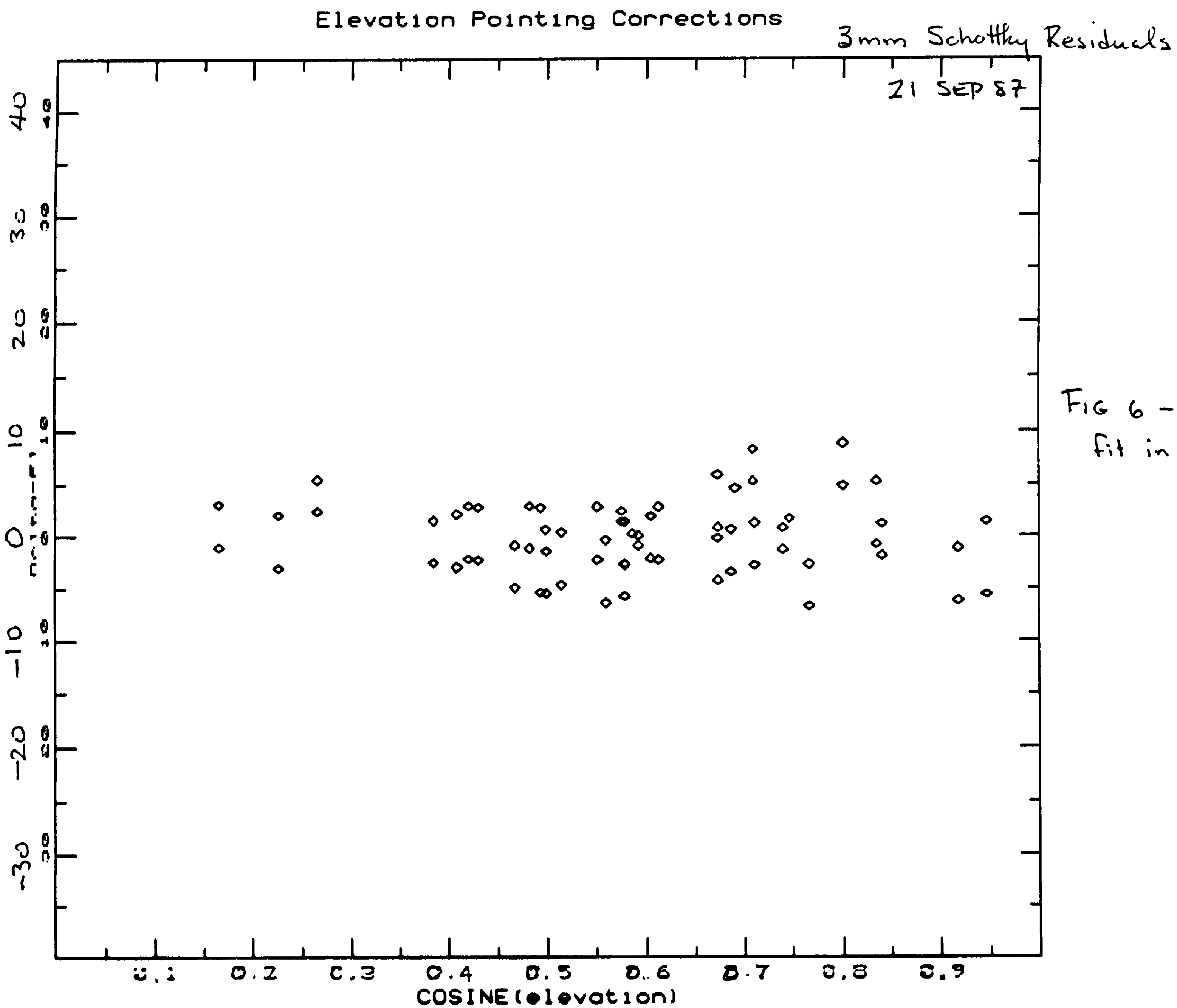


Fig 6 – Residuals from fit in Fig. 5

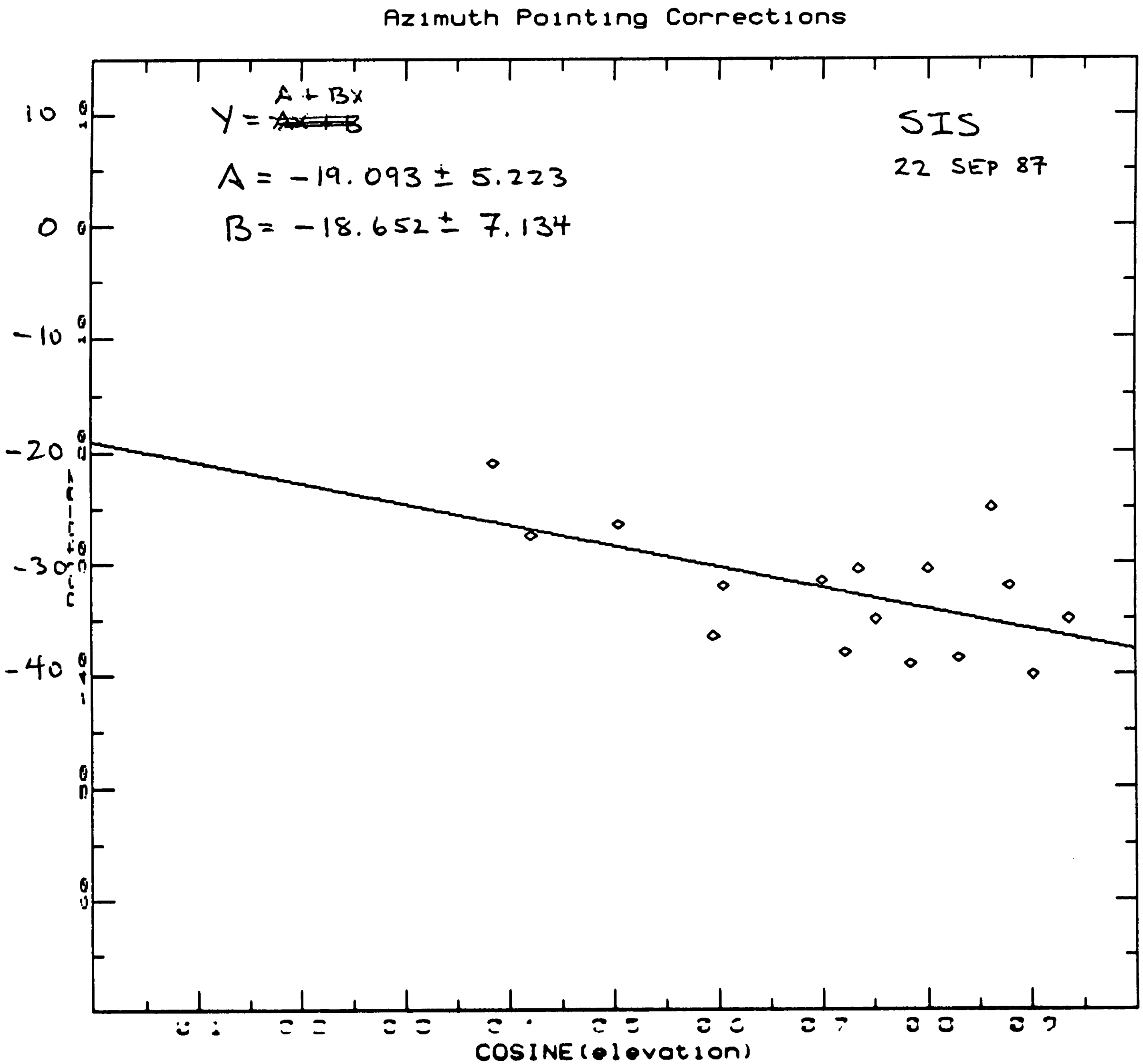


Fig 7 — ΔAz_{thumb} vs $\cos(E)$

SIS Rx

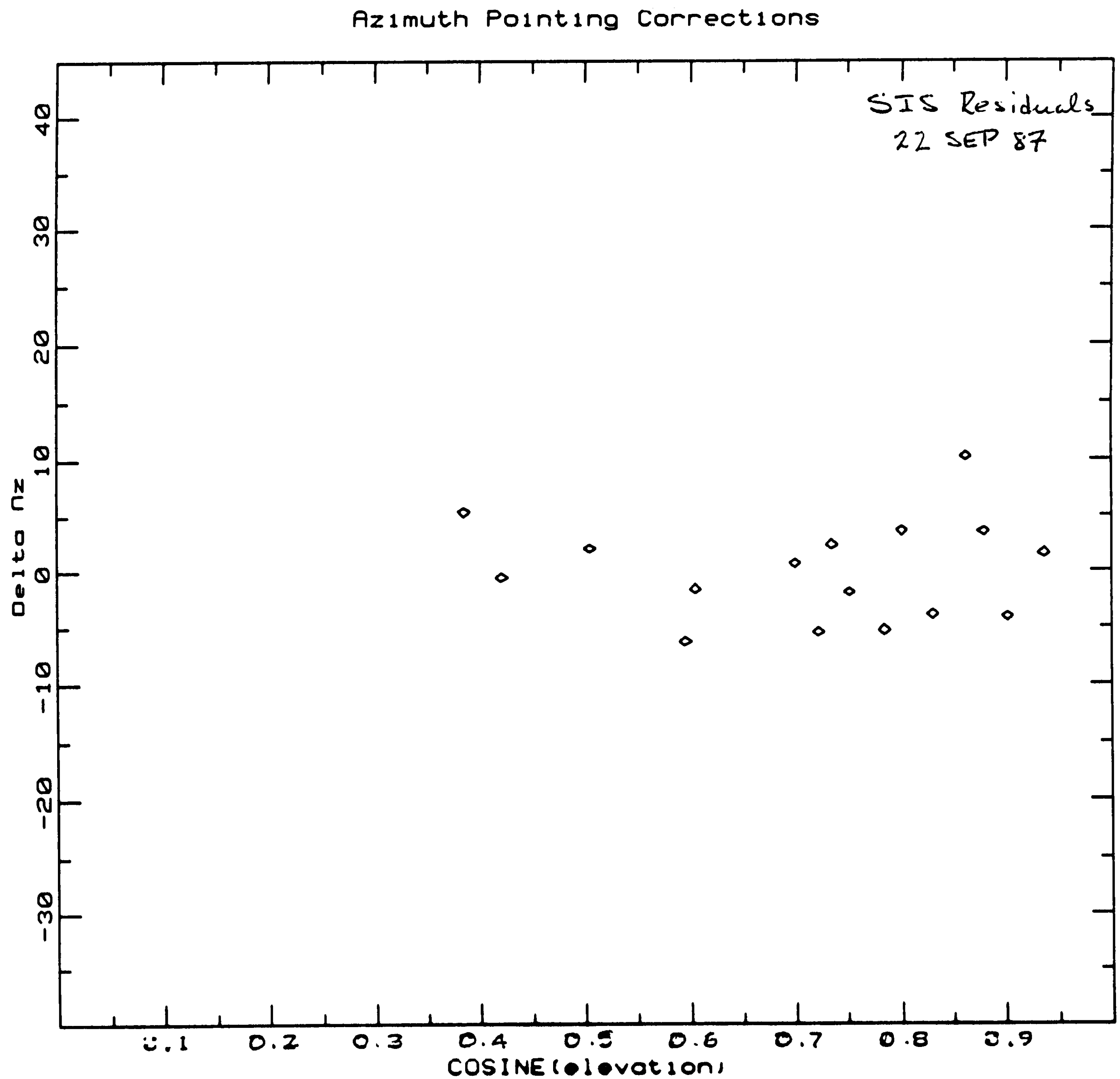


FIG. 8 – Residuals of ΔAz_{thumb} vs. cos(E)

SIS Rx

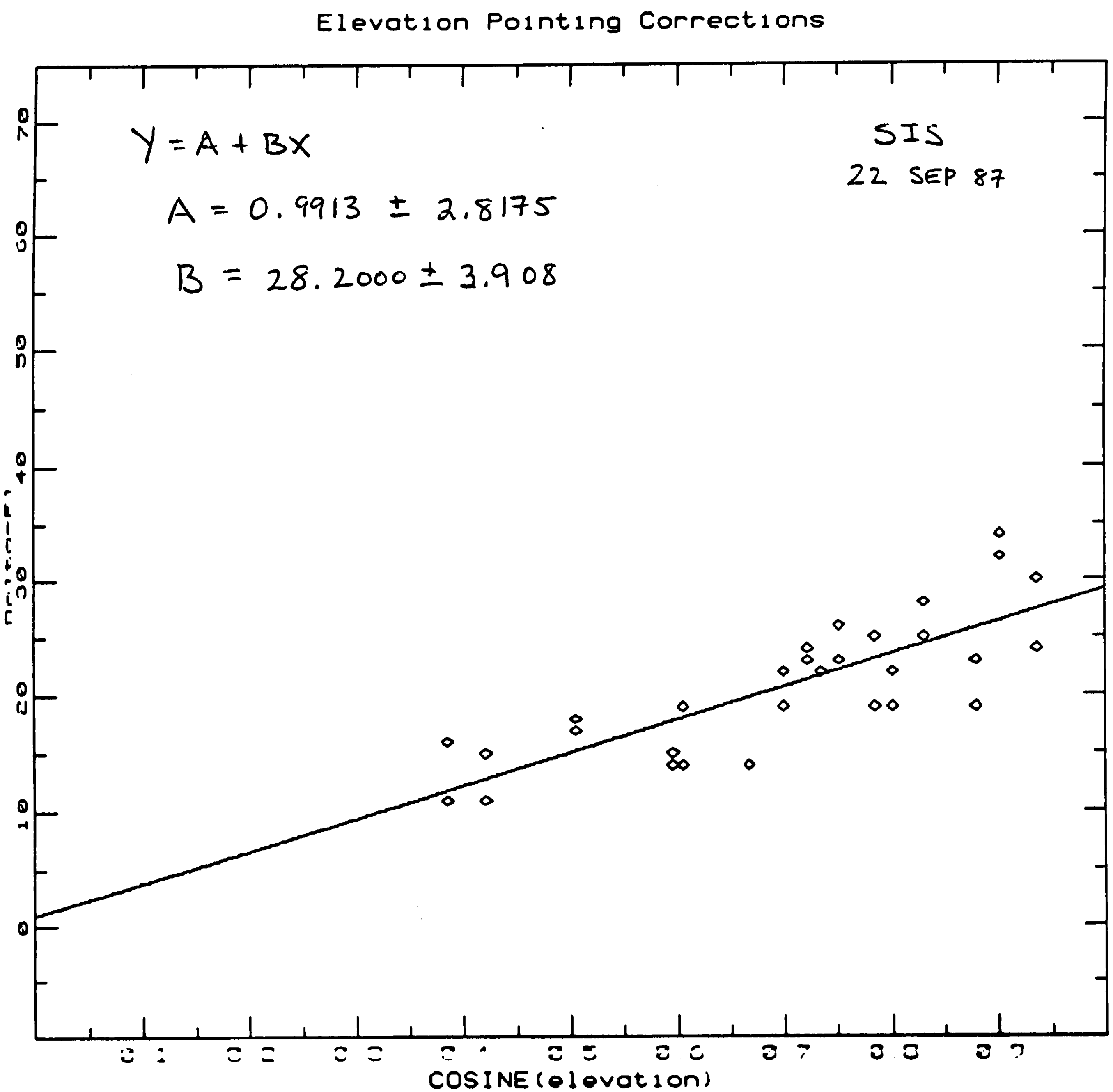


FIG. 9 —
ΔEL_{thumb} vs cos(E)
SIS Rx

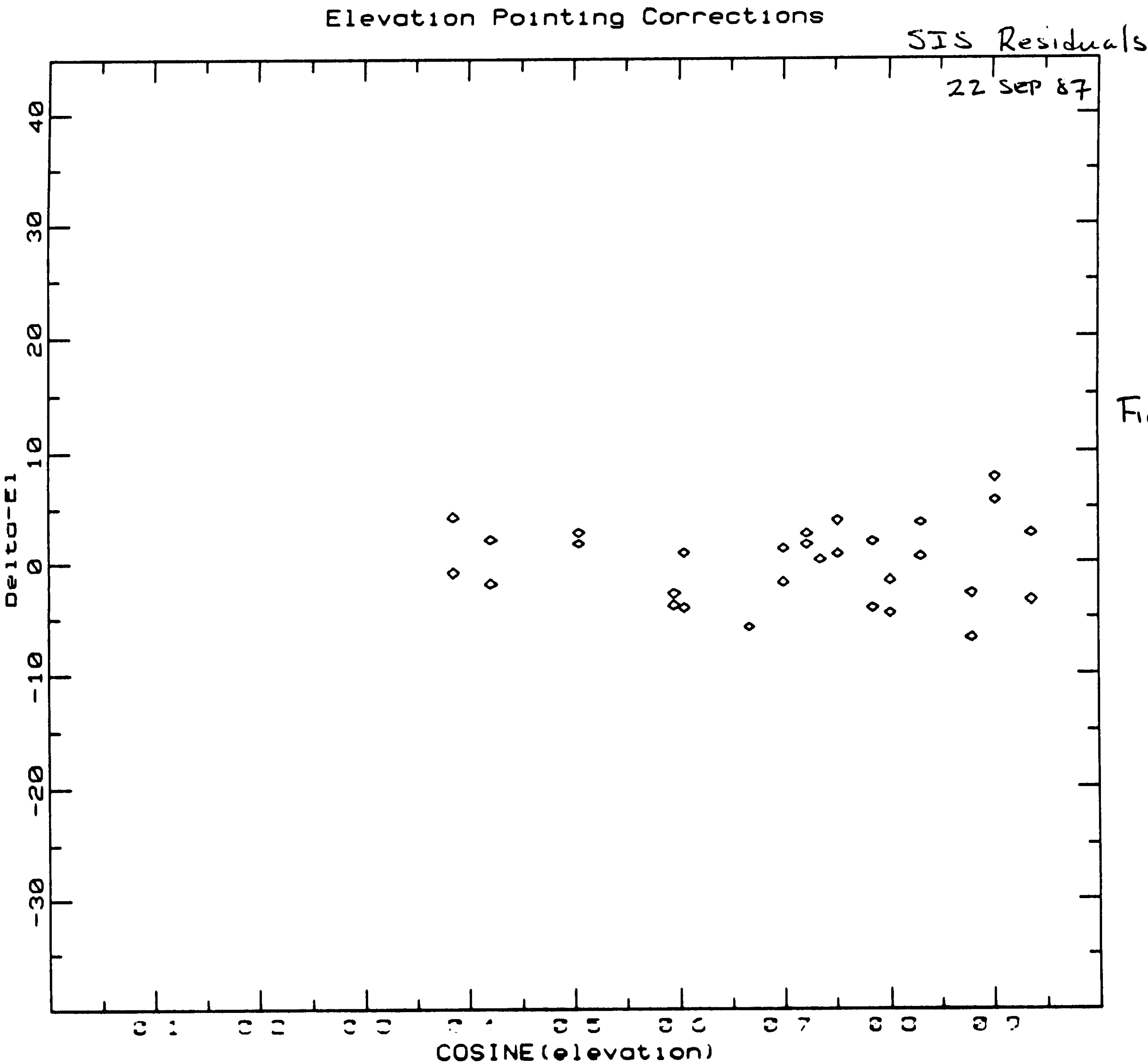


Fig. 10 – Residuals from Fit in Figure 9.