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Building 919 floor stability

A. Pendzick

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Collider Accelerator Department

Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

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BROOKHAVEN NATIONAL LABORATORY
Associated Universities, Inc.
Upton, New York 11973

Experimental Planning and Support Division Technical Note

AGS/EP&S/Tech. Note No. 133

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A. Pendzick, F. Karl, J. Mills, J. Sullivan

Building 919 Floor Stability

The g-2 ring is to be installed in the old 80" Bubble Chamber high bay. The ring is approximately 50′ diameter, consists of 30° segments weighing 50 tons apiece and supported near their ends. Since the value of the muon magnetic moment depends heavily on knowing the effective field integral of the ring, a study was implemented to determine how the ring survey data varied with time and what factors may contribute to changes in the survey data.

919 Floor

The concrete floor of the old 80" bubble chamber consists of three different sections. The center section consists of 5′ thick concrete slab approximately 20′W x 60′L. The two outer sections consist of a 1′ thick slab approximately 20′W x 75′L. The sections have an expansion joint at their interface.

Method

The floor was loaded, simulating the ring, in 12-4′ x 5′ areas of 50 tons apiece. 12 elevation points were placed along the ring I.D. and 6 elevation points were placed along the ring O.D. Two diametrical distances were measured, one along the center slab and one across the three slabs (and 2 expansion joints). Additionally, thermocouples were placed in the floor in five places. Each position included a thermocouple close to the concrete surface and one approximately 12"-deep. All measurements were taken once a week from August 3, 1988 to February 22, 1989. Thus, we believe we went through a freeze-thaw cycle. We off-loaded the floor on March 15, 1989 and continued survey to look for rebound and load dampening effects.

Point #1 was used as the reference point and all elevations were measured relative to this point. A Wild N-3 level was set up on the ring center and 3-4 elevations were taken on each point, the average being recorded in the data. This method of data-taking has been statistically analyzed during AGS ring surveys and has been found to be accurate within ± .002". Diametrical distances are typically good to ± .0005" using a laser interferometer.

General Observations

1. The maximum positive excursion occurred in almost all points the week of December 6-13, with a drop in floor temperature. The maximum positive excursion was .020" in Point #13.

2. The maximum weekly change occurred at the same time.

3. The horizontal distance along the center slab tracked very well with temperature, with a maximum change of approximately .064".

4. The horizontal distance across the slabs varied by approximately .030", with the diameter *increasing* with an overall decrease in temperature.

5. The maximum weekly change in roll of .013" occurred between Points 7 and 17 on the thin slab. The thick slab did not fare much better with a maximum of .009" roll in two weeks.

6. Continued survey of the unloaded floor has shown that the excursions seen before the floor was loaded have come back. The load on the floor seems to damp out the vertical excursions.

g-2 Issues

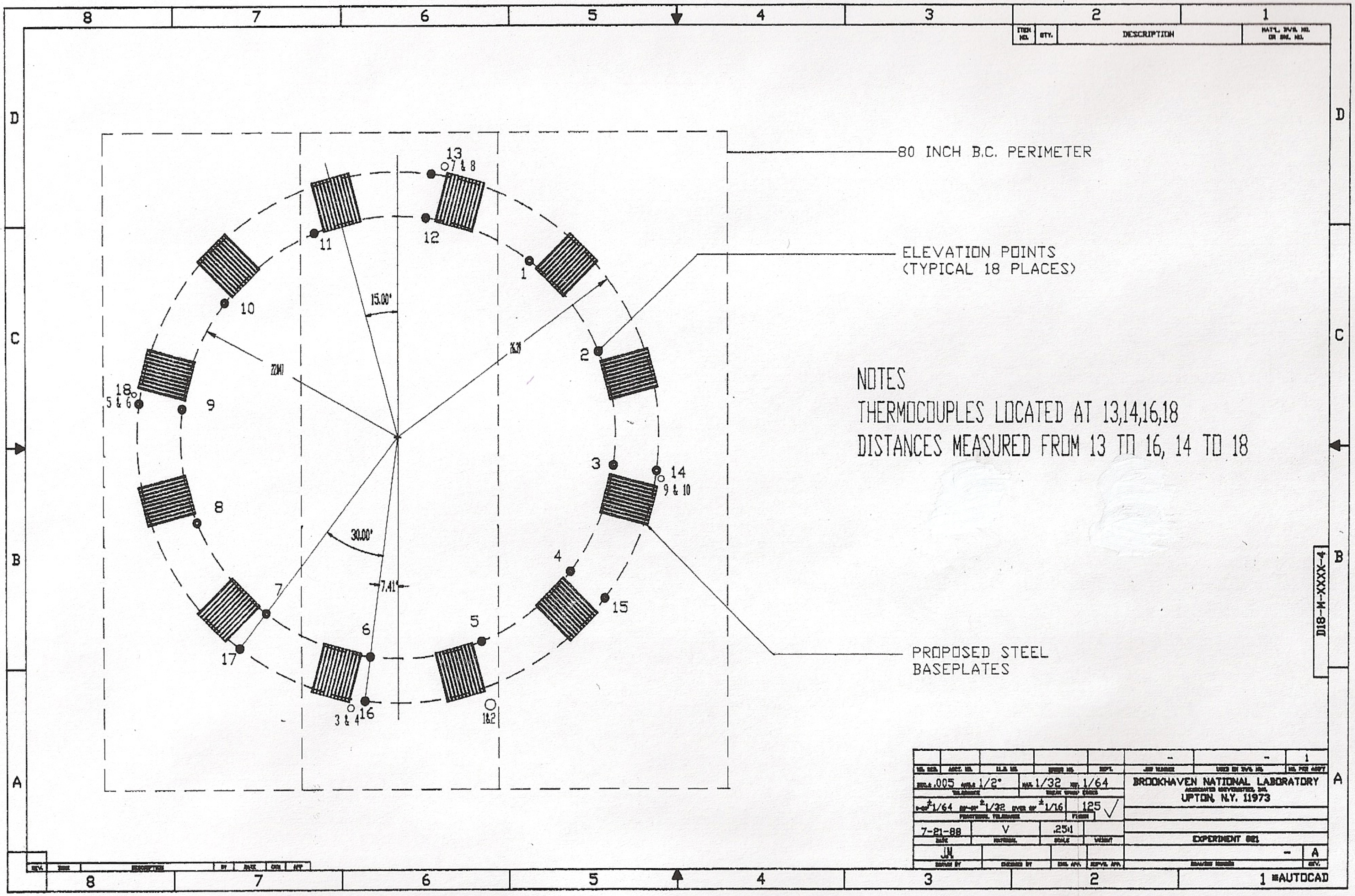
We have looked at the data to better understand how the g-2 ring will behave for pitch, roll and diametrical changes during an experimental run. For pitch we looked at the different inner elevations with time and produced a typical ring profile. For roll we looked at the difference in radial elevations with time. For diametrical changes we looked at the horizontal measurements vs time and temperature. To summarize these results:

Pitch: Maximum excursions will be .012" in one magnet.

Roll: Maximum roll will be .21 mrad; most magnets will roll in the same direction.

Diametrical distance: Expect a .030" contraction along the slabs while incurring a .020" expansion across the slabs.

Each of these issues is addressed separately in the following.

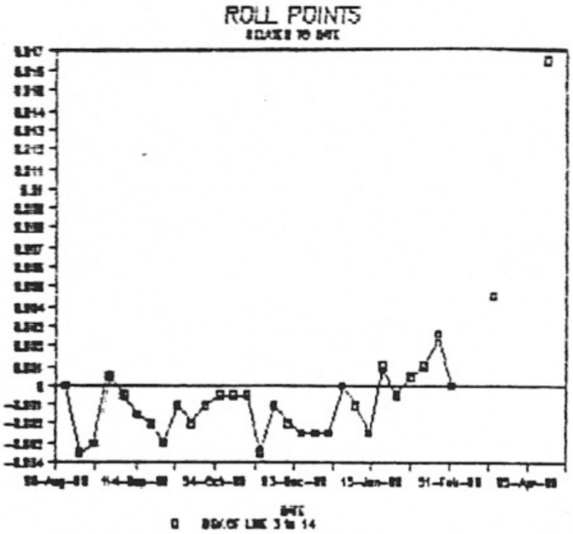

80 INCH B.C. PERIMETER
ELEVATION POINTS
(TYPICAL 18 PLACES)
PROPOSED STEEL
BASEPLATES
NOTES
THERMOCOUPLES LOCATED AT 13,14,16,18
DISTANCES MEASURED FROM 13 TO 16, 14 TO 18
15.00°
30.00°
7.41"
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
7 & 8
9 & 10
3 & 4
5 & 6
1&2
D18-M-XXXX-4
DESCRIPTION
BROOKHAVEN NATIONAL LABORATORY
UPTON, N.Y. 11973
.005
1/2°
1/32
1/64
125
7-21-88
V
.25:1
JN
EXPERIMENT 881
A
1 AUTOCAD

Roll

To estimate the amount of roll that may occur during a running period for the ring, we looked at the difference between two radial floor elevations approximately 60" apart. Two graphs are shown, one representing the best case and one the worst case; both occurred on the 12" slabs. The maximum roll of .013" occurred in one week. This could result in a .21 mrad radial tilt in two adjacent magnets. In general, the tilts occurred in the same direction (towards ring center) compounding the error due to roll. A possible reason for this may be due to the fact that the floor is vertically pinned by the building foundation along the perimeter.

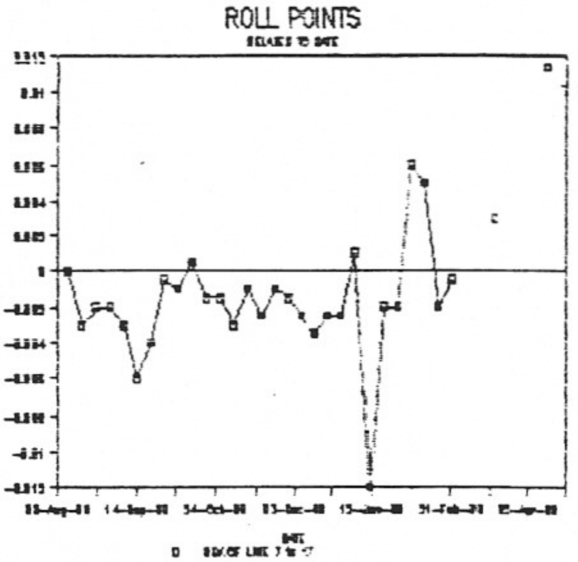
ROLL POINTS

DATE	POINT #3	POINT #14	DEVIATION
10-Aug-88	101.215	100.765	0.000
17-Aug-88	101.212	100.766	-0.004
24-Aug-88	101.212	100.766	-0.003
31-Aug-88	101.213	100.763	0.001
07-Sep-88	101.211	100.762	-0.001
14-Sep-88	101.214	100.766	-0.002
21-Sep-88	101.213	100.765	-0.002
28-Sep-88	101.210	100.763	-0.003
05-Oct-88	101.210	100.762	-0.001
12-Oct-88	101.210	100.763	-0.002
19-Oct-88	101.210	100.762	-0.001
26-Oct-88	101.210	100.761	-0.001
02-Nov-88	101.210	100.761	-0.001
09-Nov-88	101.210	100.761	-0.001
16-Nov-88	101.210	100.764	-0.004
23-Nov-88	101.217	100.769	-0.001
30-Nov-88	101.218	100.770	-0.002
07-Dec-88	101.214	100.767	-0.003
14-Dec-88	101.222	100.775	-0.002
21-Dec-88	101.219	100.772	-0.002
28-Dec-88	101.220	100.770	0.000
04-Jan-89	101.214	100.766	-0.001
11-Jan-89	101.217	100.770	-0.003
18-Jan-89	101.215	100.765	0.001
25-Jan-89	101.216	100.767	-0.001
01-Feb-89	101.212	100.762	0.001
08-Feb-89	101.216	100.765	0.001
15-Feb-89	101.217	100.765	0.002
22-Feb-89	101.216	100.767	0.000
01-Mar-89			
08-Mar-89			
15-Mar-89	101.220	100.766	0.004
22-Mar-89			
29-Mar-89			
05-Apr-89			
12-Apr-89	101.216	100.750	0.017



ROLL POINTS

DATE	POINT # 7	POINT #17	DEVIATION
10-Aug-88	100.083	99.774	0.000
17-Aug-88	100.079	99.773	-0.003
24-Aug-88	100.083	99.776	-0.002
31-Aug-88	100.080	99.773	-0.002
07-Sep-88	100.082	99.776	-0.003
14-Sep-88	100.081	99.778	-0.006
21-Sep-88	100.080	99.775	-0.004
28-Sep-88	100.079	99.771	-0.001
05-Oct-88	100.080	99.772	-0.001
12-Oct-88	100.086	99.776	0.001
19-Oct-88	100.080	99.772	-0.002
26-Oct-88	100.079	99.772	-0.001
02-Nov-88	100.080	99.774	-0.003
09-Nov-88	100.080	99.772	-0.001
16-Nov-88	100.080	99.774	-0.003
23-Nov-88	100.085	99.777	-0.001
30-Nov-88	100.087	99.779	-0.001
07-Dec-88	100.085	99.779	-0.002
14-Dec-88	100.096	99.791	-0.003
21-Dec-88	100.093	99.786	-0.002
28-Dec-88	100.091	99.784	-0.002
04-Jan-89	100.088	99.778	0.001
11-Jan-89	100.078	99.781	-0.012
18-Jan-89	100.086	99.779	-0.002
25-Jan-89	100.088	99.781	-0.002
01-Feb-89	100.085	99.770	0.006
08-Feb-89	100.092	99.778	0.005
15-Feb-89	100.088	99.781	-0.002
22-Feb-89	100.090	99.781	-0.001
01-Mar-89			
08-Mar-89			
15-Mar-89	100.091	99.779	0.003
22-Mar-89			
29-Mar-89			
05-Apr-89			
12-Apr-89	100.086	99.765	0.012

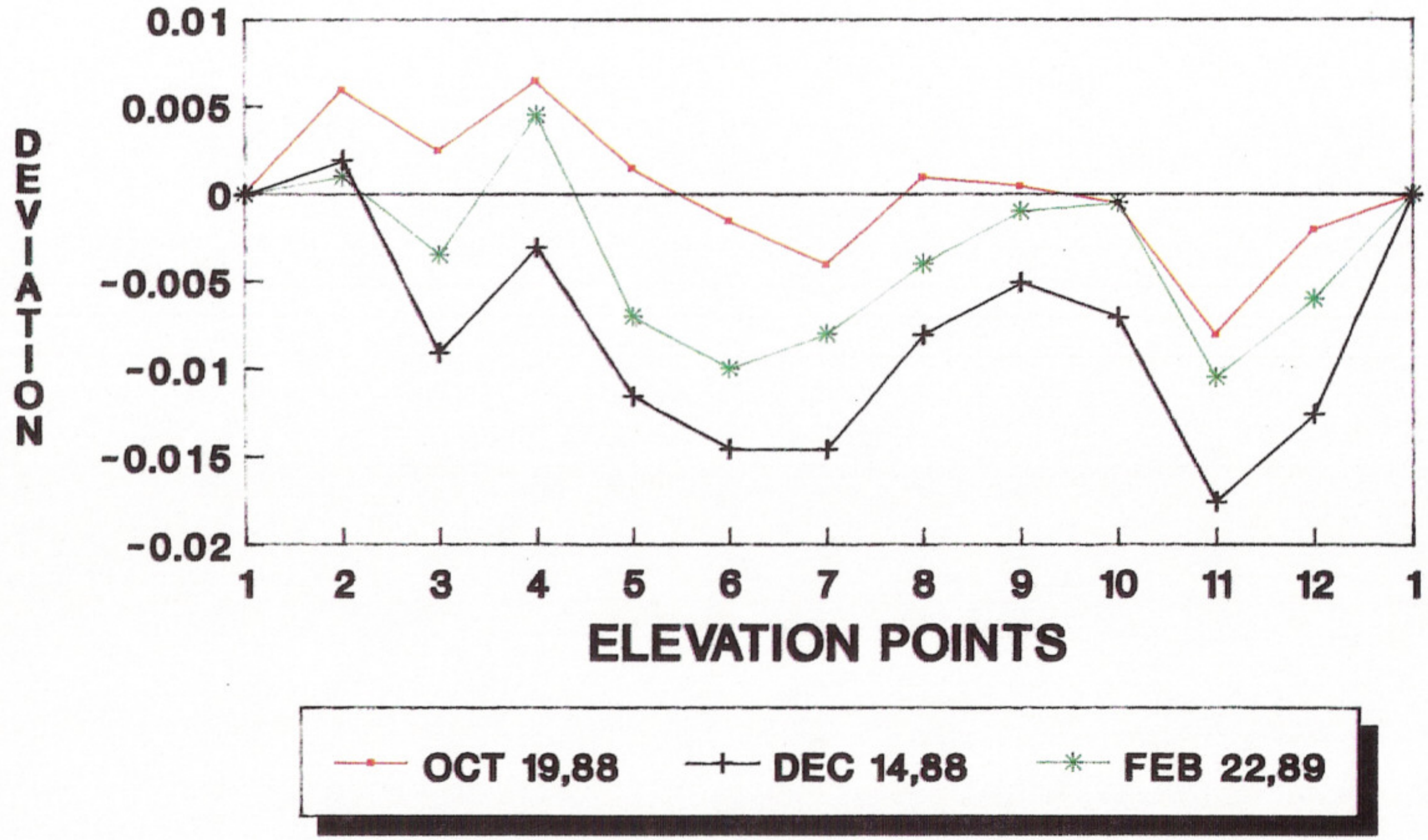


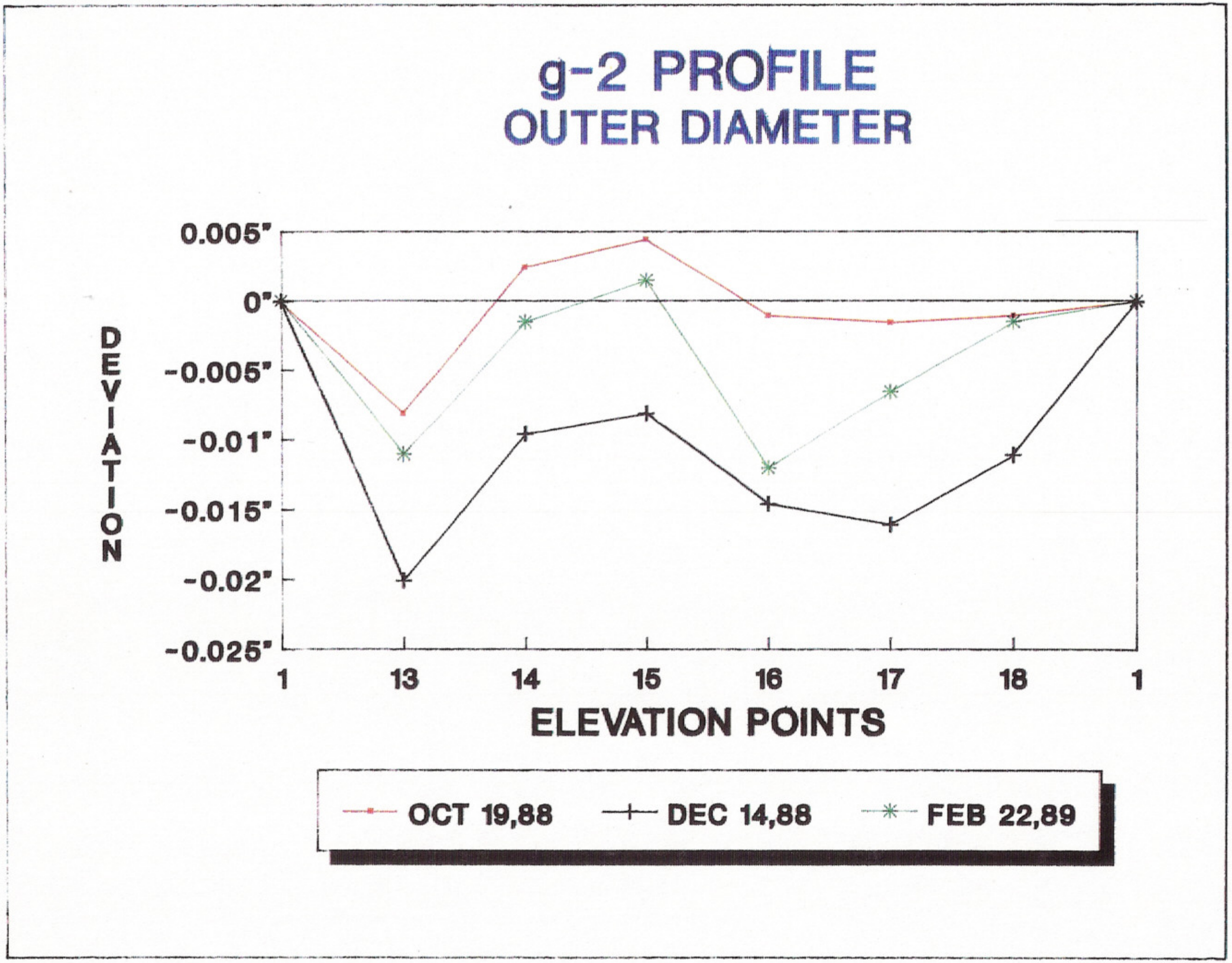
Pitch

To estimate the amount of pitch one would expect during a run, we picked three dates: October 19, December 14, and February 22, and produced a typical ring profile around the inner 12 points and outer 6 points. All elevations were normalized to zero on August 3, 1988. Note that the largest excursions occurred for both inner and out points in December.

Since each inner elevation point is the best representation of pitch in an individual magnet, we use this data for comparisons. The worst case was between points 4 and 5 on February 22, with .012" pitch. December had two cases of .011" pitch between points 2 and 3, and 10 and 11.

g-2 PROFILE
INNER DIAMETER




g-2 PROFILE
OUTER DIAMETER
0.005"
0"
-0.005"
-0.01"
-0.015"
-0.02"
-0.025"
DEVIATION
1
13
14
15
16
17
18
1
ELEVATION POINTS
OCT 19,88
DEC 14,88
FEB 22,89

Horizontal Movement

Points 16 to 13 are located along the center slab. On page 12, the horizontal movement is plotted vs two surface temperature probes. There is a clear relationship between temperature and length. Using this data to calculate the coefficient of expansion on concrete

$$\alpha = \frac{\Delta d}{d\Delta t} = \frac{.062''}{(648'')(20K^\circ F)} = 4.78 \times 10^{-6} \frac{in}{in\ ^\circ F}$$

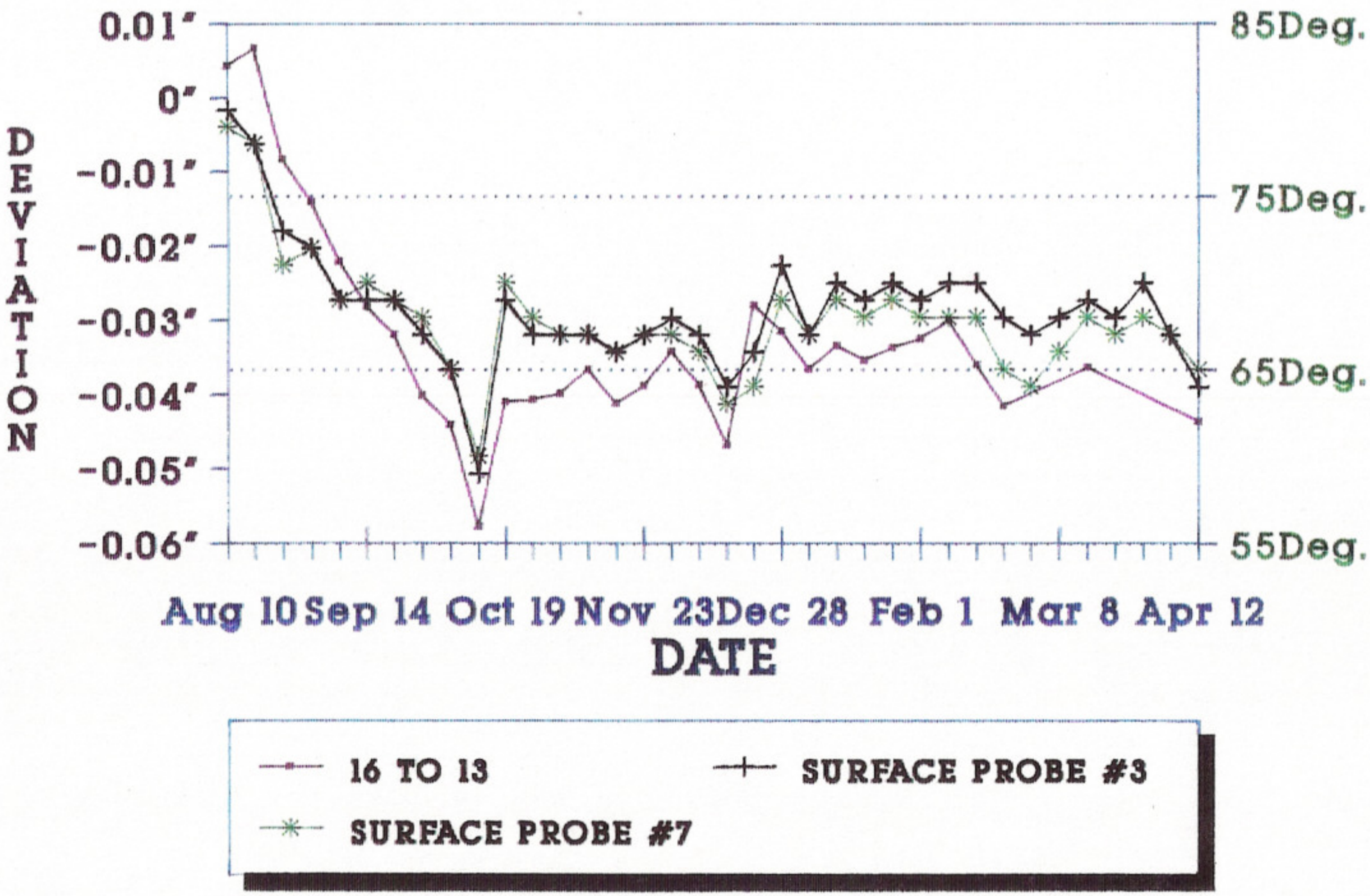
This agrees fairly well with published data of $6 \times 10^{-6} \frac{in}{in\ ^\circ F}$.

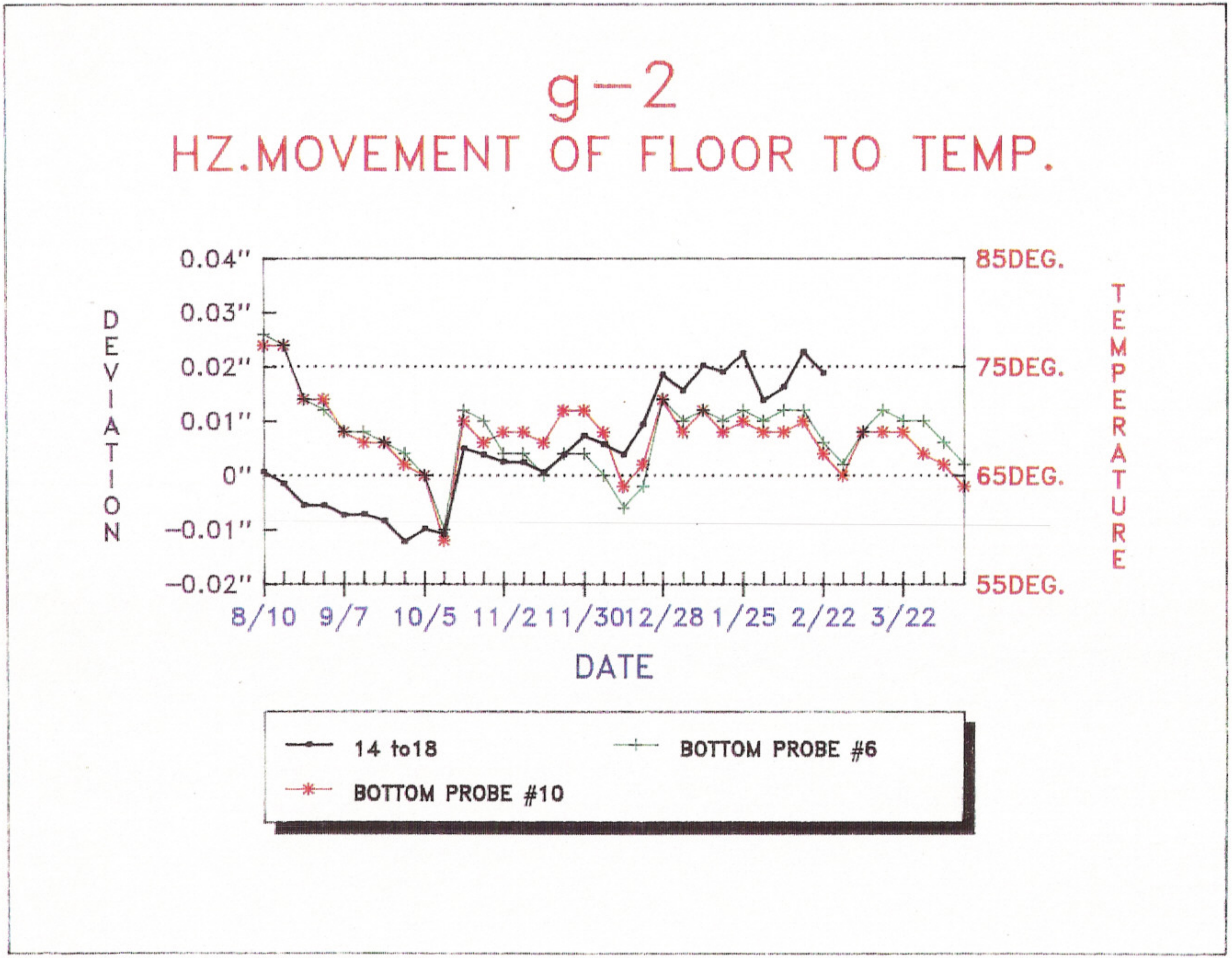
Points 14 to 18 are located across the slabs and 2 expansion joints. On page 13, the horizontal movement is plotted vs two bottom temperature probes. Temperature and movement are still clearly related, but nonlinear and overall, there is an *increase* in distance for a decrease in temperature. This should not occur if you assume the slabs expand and contract from their centers and the expansion joints are functional. If you assume the outer slabs are pinned to the crane columns, the diameter would increase with a decrease in temperature. There is some evidence that this is happening, but it cannot be confirmed by calculations.

The maximum excursion between the two measured diameters is about .050". This occurred on October 12, 1988 and the late winter of 1989.

g - 2

HZ.MOVEMENT OF FLOOR RELATED TO TEMP.




g-2
HZ.MOVEMENT OF FLOOR TO TEMP.
0.04"
0.03"
0.02"
0.01"
0"
-0.01"
-0.02"
DEVIATION
85DEG.
75DEG.
65DEG.
55DEG.
TEMPERATURE
8/10
9/7
10/5
11/2
11/30
12/28
1/25
2/22
3/22
DATE
14 to18
BOTTOM PROBE #6
BOTTOM PROBE #10

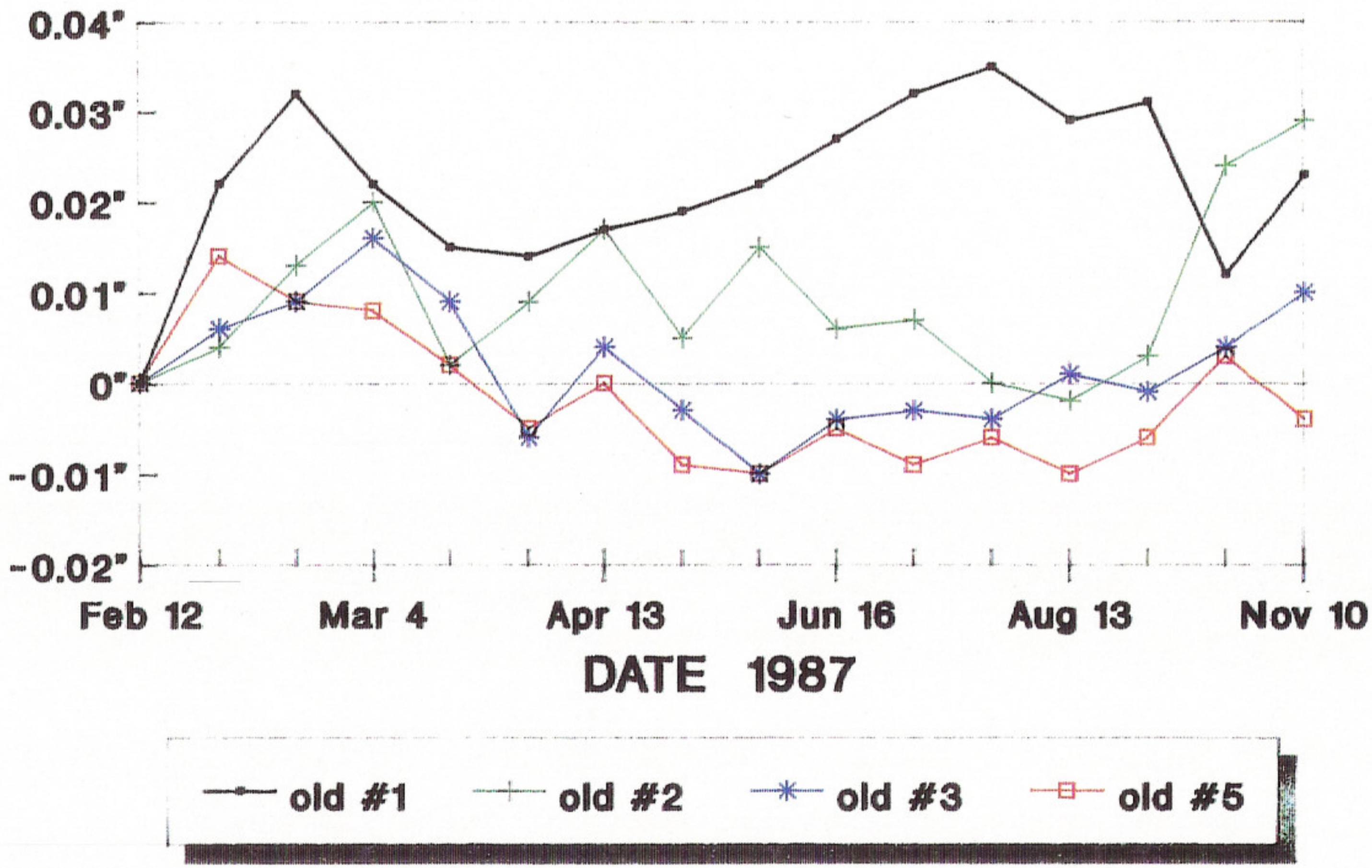
Load Dampening Effects

The following graphs seem to indicate there is an elevation dampening effect due to the simulated load of the g-2 ring on the concrete floor. Graph #1 illustrates the vertical excursion of 4 elevation points before the floor was loaded. Graph #2 represents a typical point with load (note change in scale). Graph #3 represents unloaded data to date using the same points used for the loaded data.

There is a clear indication that the load on the floor dampens the vertical excursions.

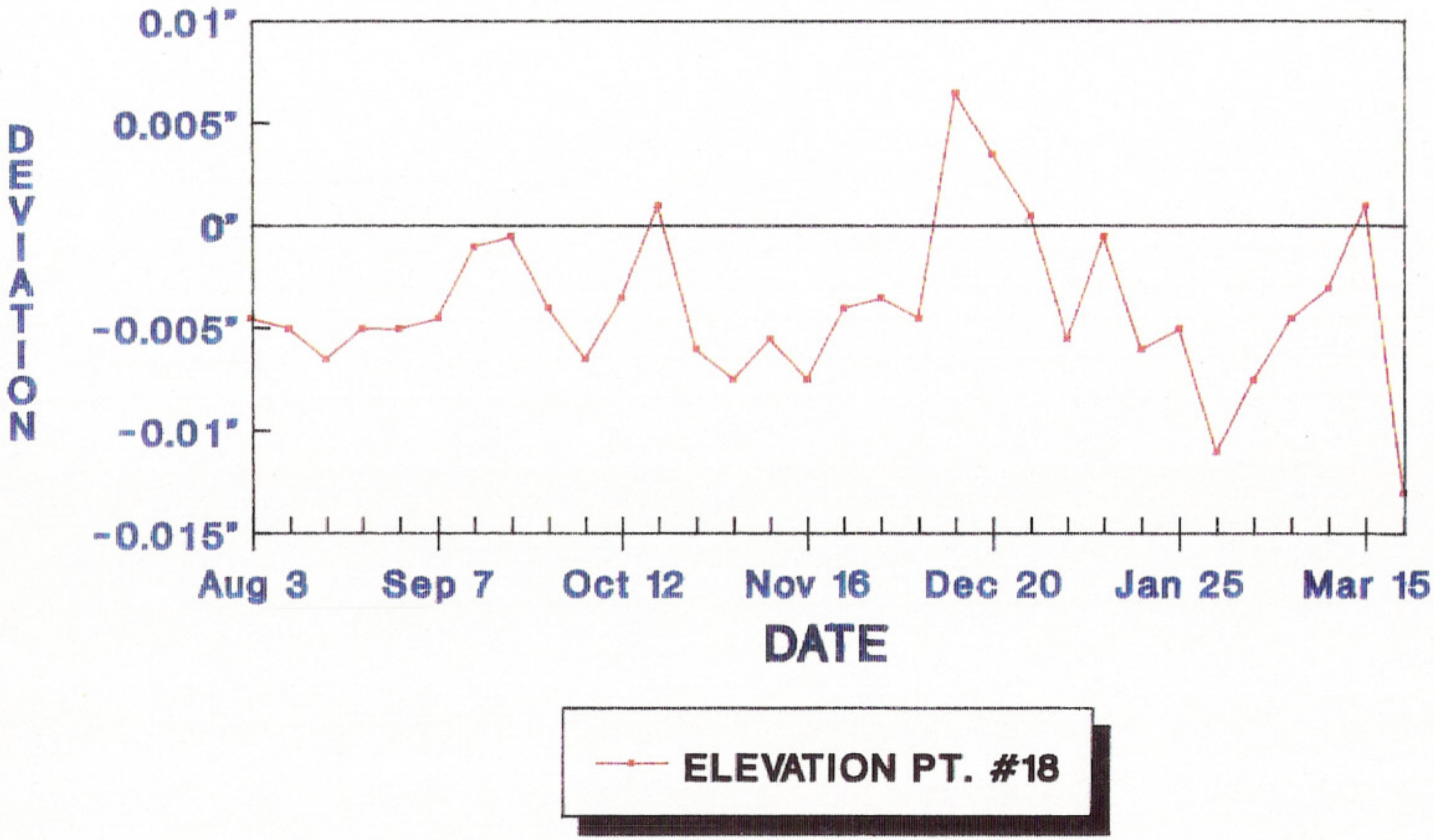
The last 3 graphs relate the elevation of a point to temperature. We make no comment on a relationship between the two.

g-2 ELEVATIONS
BEFORE LOADING

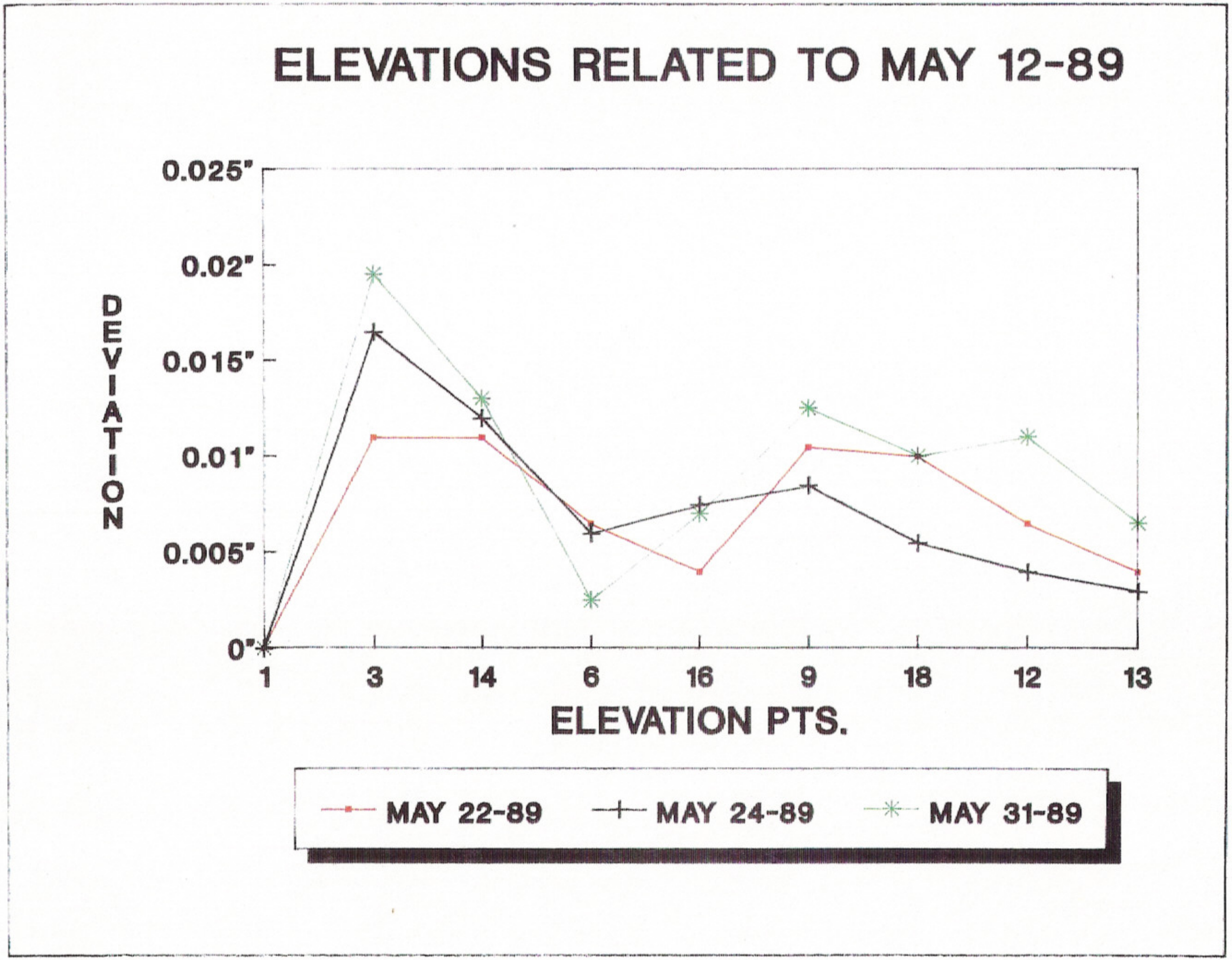


#1

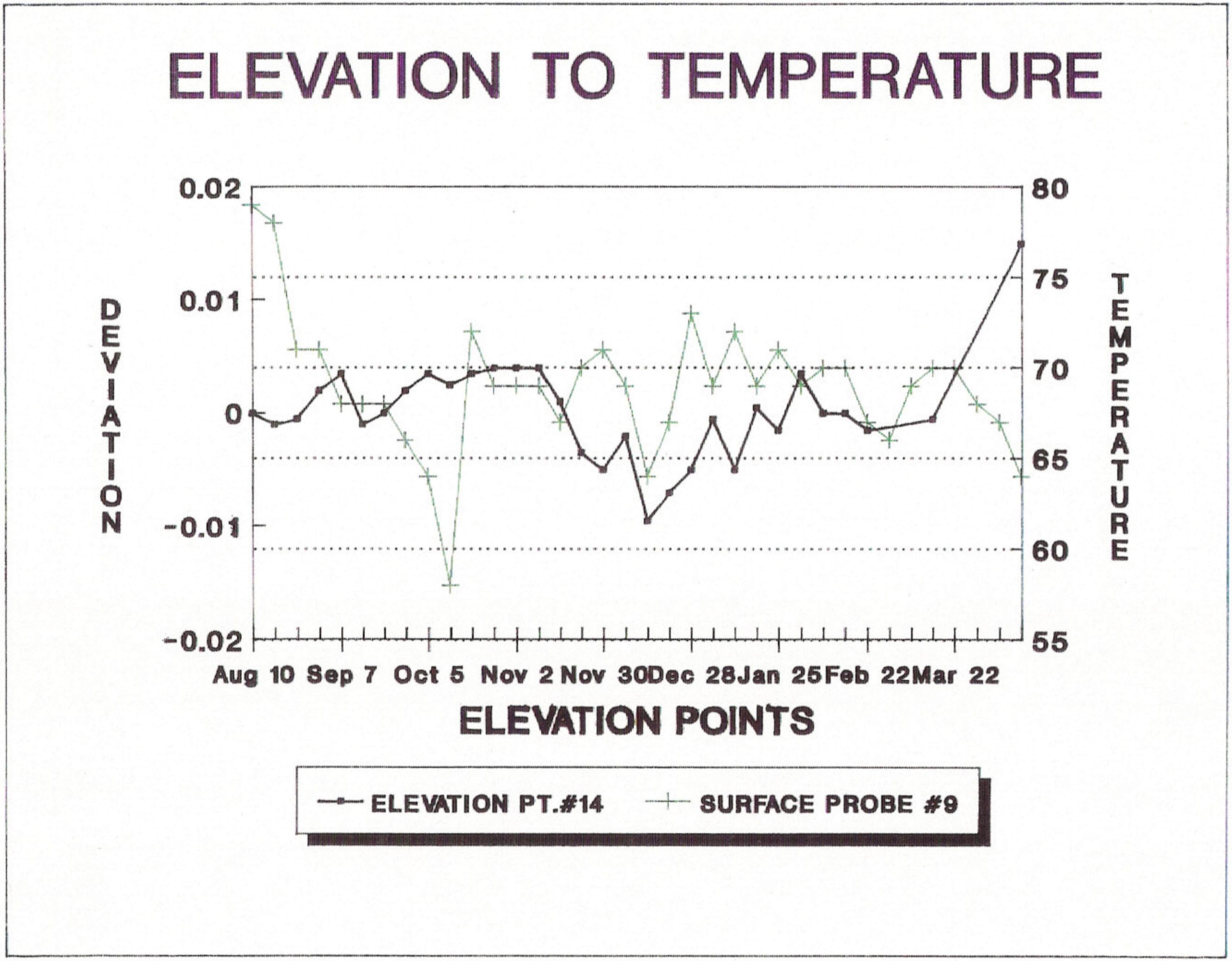
g - 2
ELEVATIONS RELATED TO DATE

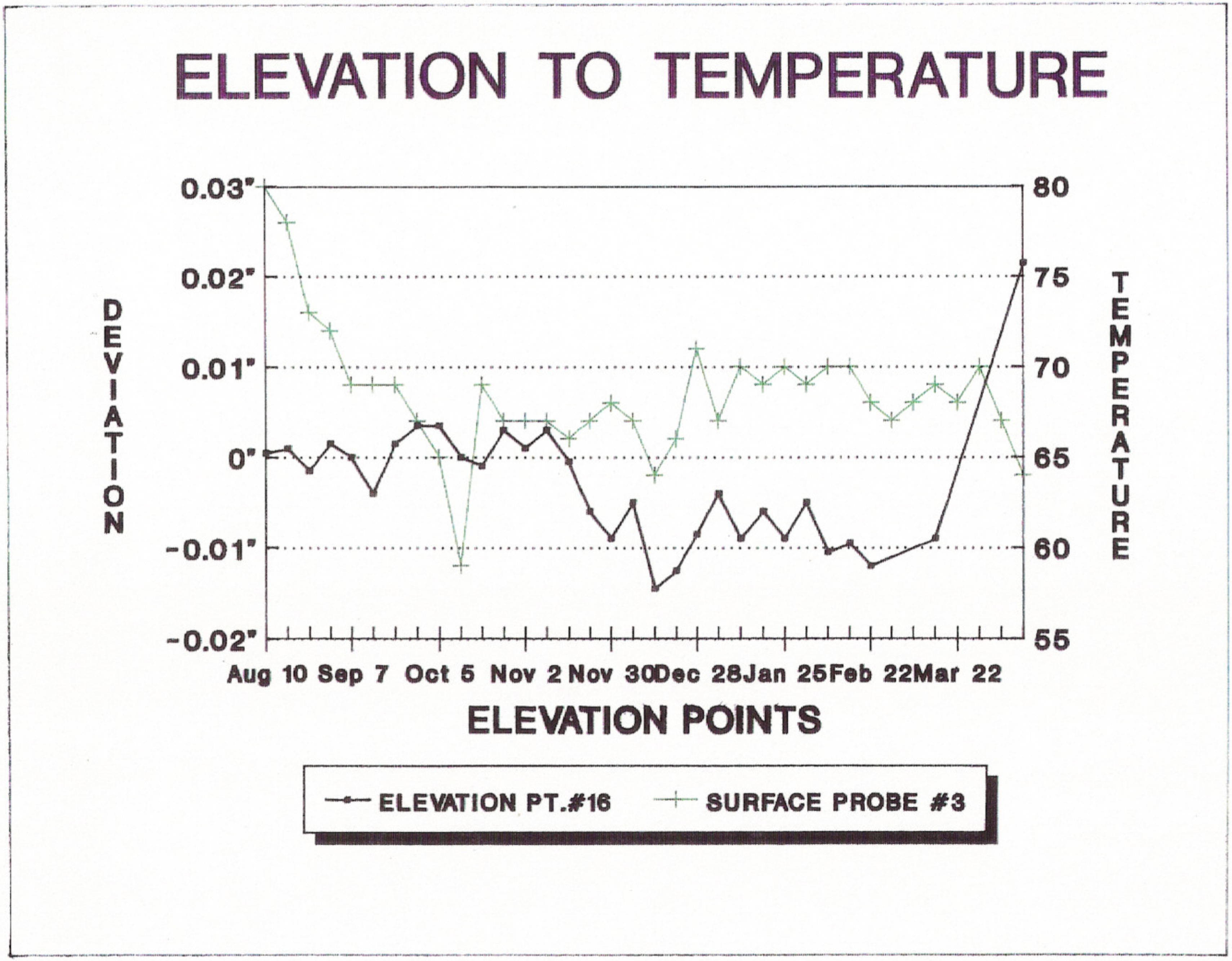


#2


ELEVATIONS RELATED TO MAY 12-89
DEVIATION
0.025"
0.02"
0.015"
0.01"
0.005"
0"
1
3
14
6
16
9
18
12
13
ELEVATION PTS.
MAY 22-89
MAY 24-89
MAY 31-89

#3


ELEVATION TO TEMPERATURE
DEVIATION
0.02
0.01
0
-0.01
-0.02
TEMPERATURE
80
75
70
65
60
55
Aug 10 Sep 7 Oct 5 Nov 2 Nov 30 Dec 28 Jan 25 Feb 22 Mar 22
ELEVATION POINTS
ELEVATION PT.#14
SURFACE PROBE #9



ELEVATION TO TEMPERATURE
0.03"
0.02"
0.01"
0"
-0.01"
-0.02"
DEVIATION
80
75
70
65
60
55
TEMPERATURE
Aug 10 Sep 7 Oct 5 Nov 2 Nov 30Dec 28Jan 25Feb 22Mar 22
ELEVATION POINTS
ELEVATION PT.#16
SURFACE PROBE #3

ELEVATION TO TEMPERATURE