NATIONAL RADIO ASTRONOMY OBSERVATORY
SOCORRO, NEW MEXICO
VERY LARGE ARRAY PROJECT

VLA TEST MEMORANDUM NO. 122

ELEVATION EFFECTS AT 2 cm AND 1.3 cm

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Test observations at 2 cm and 1.3 cm on 1977 December 19 were analyzed for elevation effects. At the two high observing frequencies there are three effects which vary with elevation and cause a reduction in antenna amplitude as the elevation decreases: system temperature, atmospheric extinction, and dish efficiency. The data obtained at 2 cm and 1.3 cm were corrected for the first two effects and the resulting data should reflect the dish efficiency. The theoretical variation in efficiency with elevation is due to the rms dish surface errors due to gravitational deformation. The efficiency is a maximum at 50d elevation, and decreases toward higher and lower elevations. At 2 cm, the relative efficiency at 0d and 90d is 0.96. At 1.3 cm, it is 0.91. (These numbers from Peter Napier.)

The atmospheric absorption can be estimated from the variation of system temperature with zenith angle. The system temperature at any elevation is:

$$Tsys = Tsys(zenith) + a(zenith)*(secz-1)*300K$$

where "a" is the absorption coefficient. The values derived from the measured system temperatures are 1.3% at 2 cm, and 4.9% at 1.3 cm. Using these numbers, the data were corrected by multiplying by the quantity 1 + a*secz. Then ANTSOL was run with the fully corrected (system temperature and extinction) data, and the results are shown in the accompanying figures.

1.3 cm -- The amplitudes of antennas 4 and 8 follow roughly the pattern expected for the efficiency dependence, although the decrease in efficiency is larger than the expected value. Antenna 9 has a very steep fall-off toward low elevations, and antenna 7 shows little variation. Both channels A and C give consistent curves, which is some indication that this is truly an effect of the antenna.

2 cm -- Antenna 8 shows the expected pattern of efficiency, although the effect is still larger than expected. Antenna 9 shows a dramatic increase of amplitude toward low elevations, about a 30% increase from zenith to 10d. Antennas 7C and 4C also show increases toward low elevations. The data from antennas 7A and 4A were too noisy to allow determination of this effect. (The effect in antenna 9 shows up in the raw data itself, and the various corrections made only serve to make this behavior more pronounced.)

The ratio of the amplitudes at 10d and 90d elevation to that at the maximum of the curves is given in the following table.

RATIO OF ANTENNA AMPLITUDES

Antenna Efficiency Measurements at 1.3 cm

IF	10d/max	90d/max
4C	.80	.84
8A	.76	.79
8C	.73	.86
9A	.64	.91
9C	.69	.91
Predicted	.91	.91

Antenna Efficiency Measurements at 2 cm

IF	10d/max	90d/max
4C	.96	.87
8A	.92	.88
8C	curve approx. flat	
9A	curve has no maximum	
9C	curve has no maximum	
Predicted	.96	.96

At low elevations, neither focus nor pointing has been thoroughly investigated, and these two effects could be masking the efficiency measurements. More thorough testing and investigation of the focus and pointing at the high frequencies needs to be done to see if they might affect these results.

[redacted] 2 [redacted] - [redacted] D [redacted] x T [redacted] x [redacted]
↳ (1,3 ...)

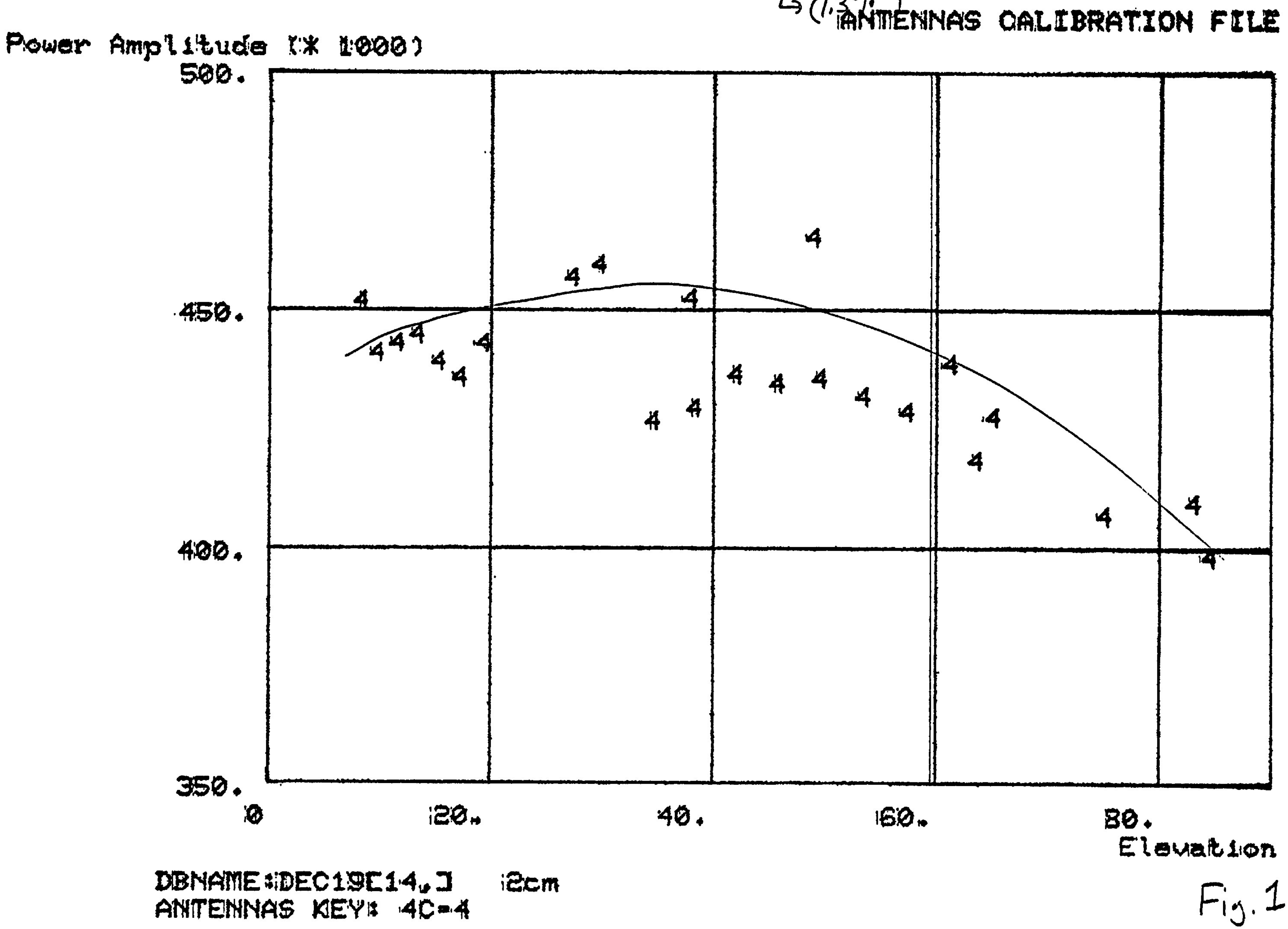


Fig. 1

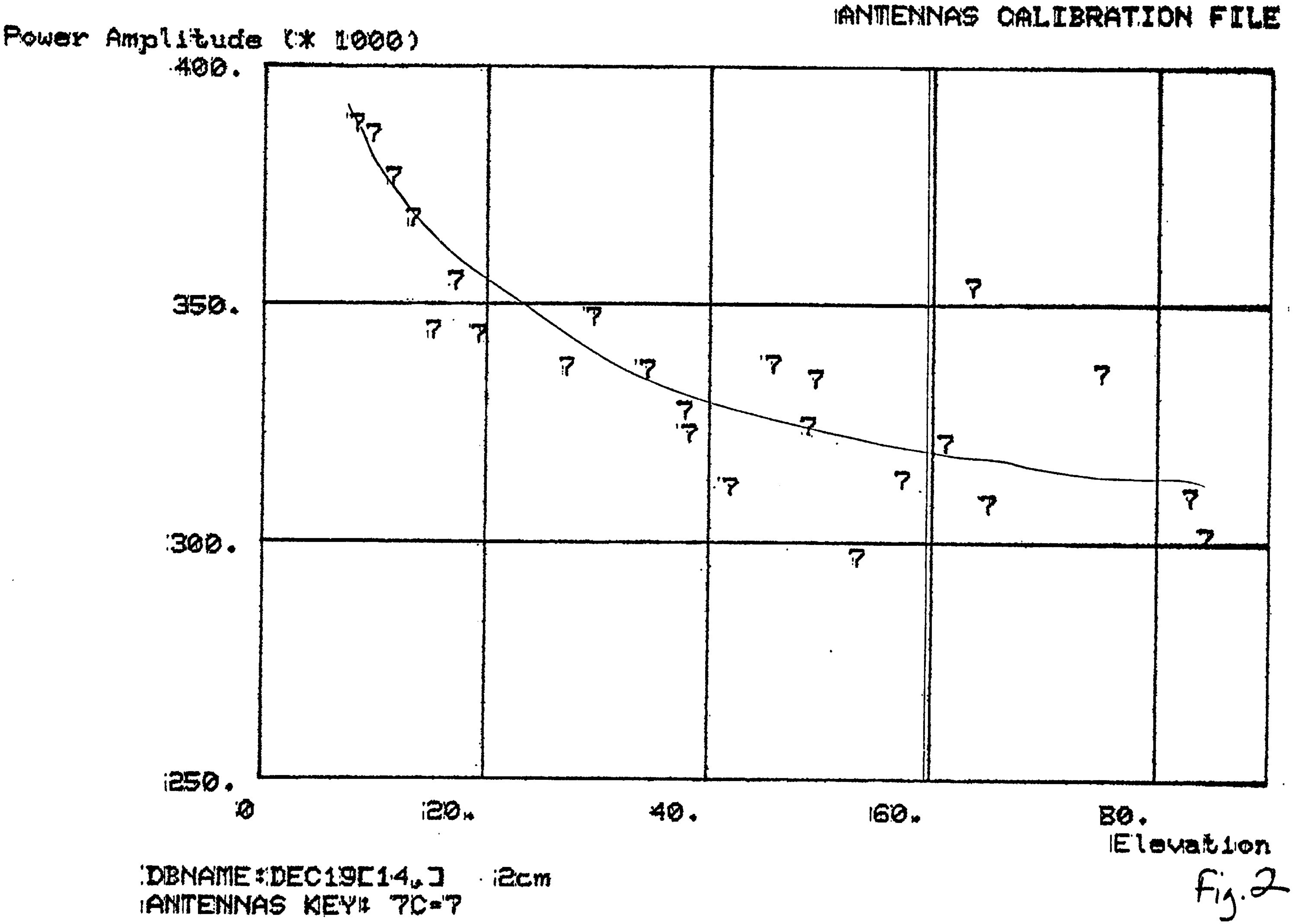
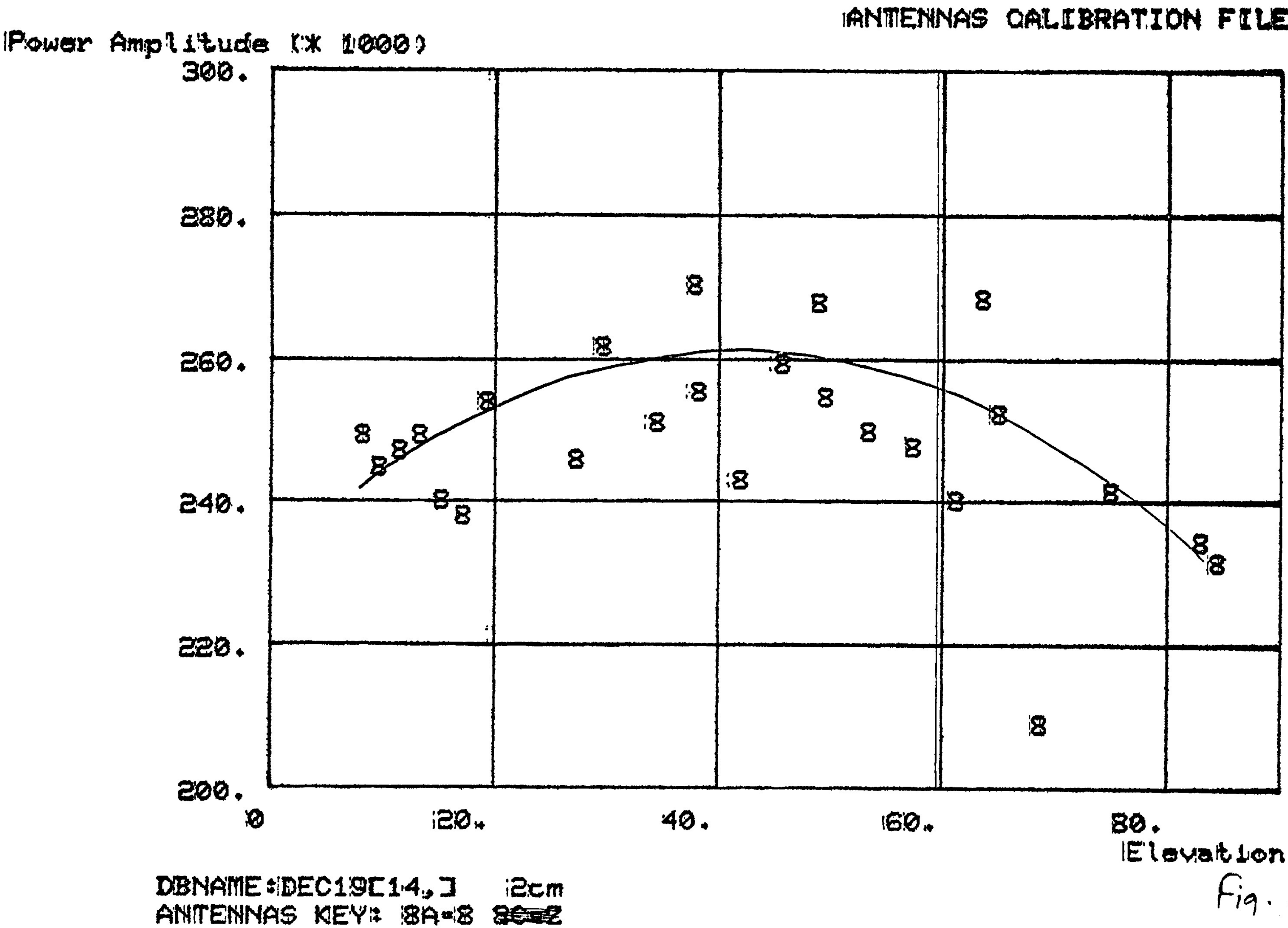

ANTENNAS CALIBRATION FILE
Power Amplitude (* 1000)
400.
350.
300.
250.
0
20.
40.
60.
80.
Elevation
DBNAME:DEC19[14,] 2cm
ANTENNAS KEY: 7C=7

Fig. 2


ANTENNAS CALIBRATION FILE
Power Amplitude (* 1000)
300.
280.
260.
240.
220.
200.
0
20.
40.
60.
80.
Elevation
DBNAME:DEC19[14,] 2cm
ANTENNAS KEY: 8A=8
Fig. 3

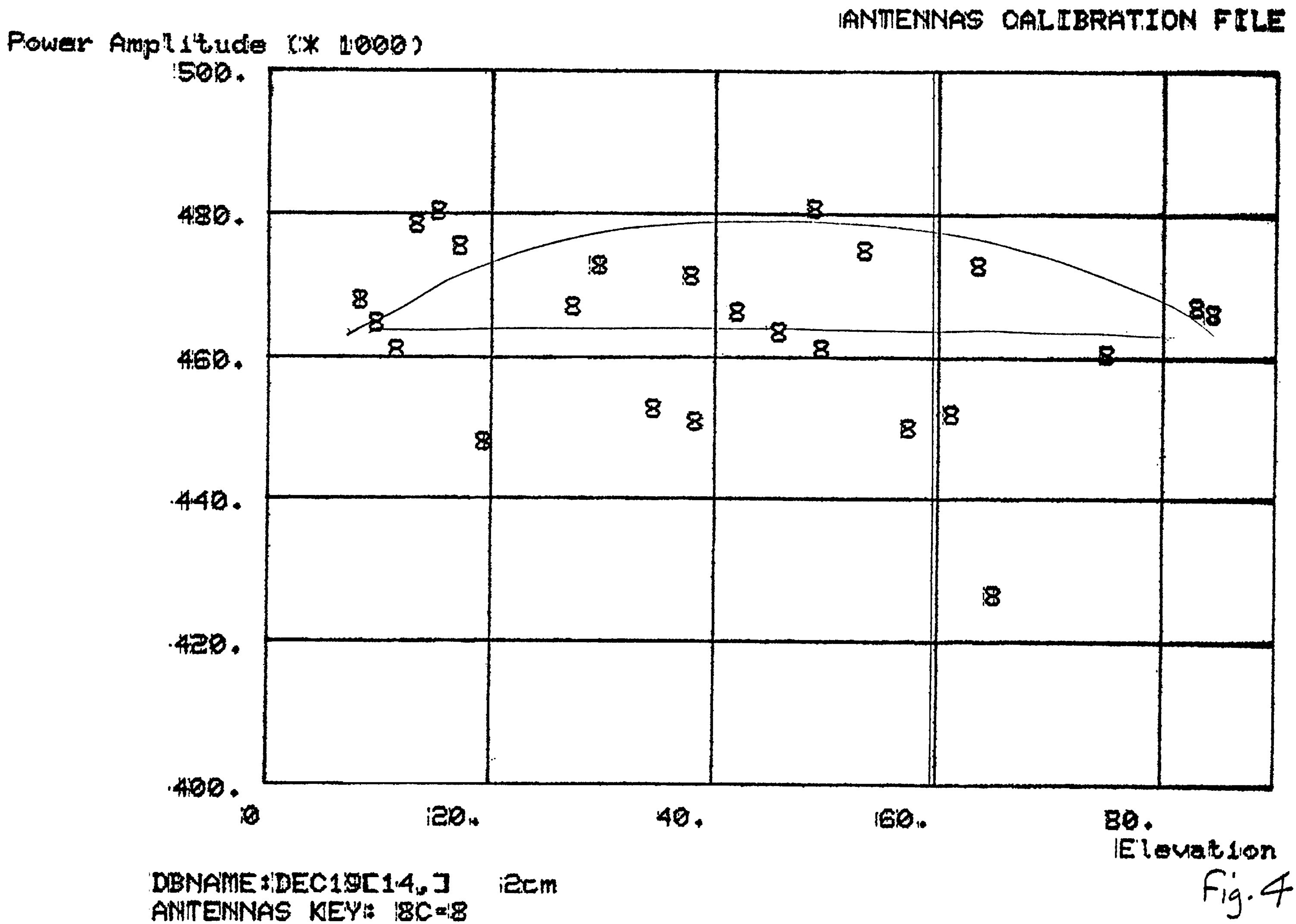

ANTENNAS CALIBRATION FILE
Power Amplitude (* 1000)
500.
480.
460.
440.
420.
400.
0
20.
40.
60.
80.
Elevation
DBNAME:DEC19[14,]   2cm
ANTENNAS KEY: 8C=8

Fig. 4

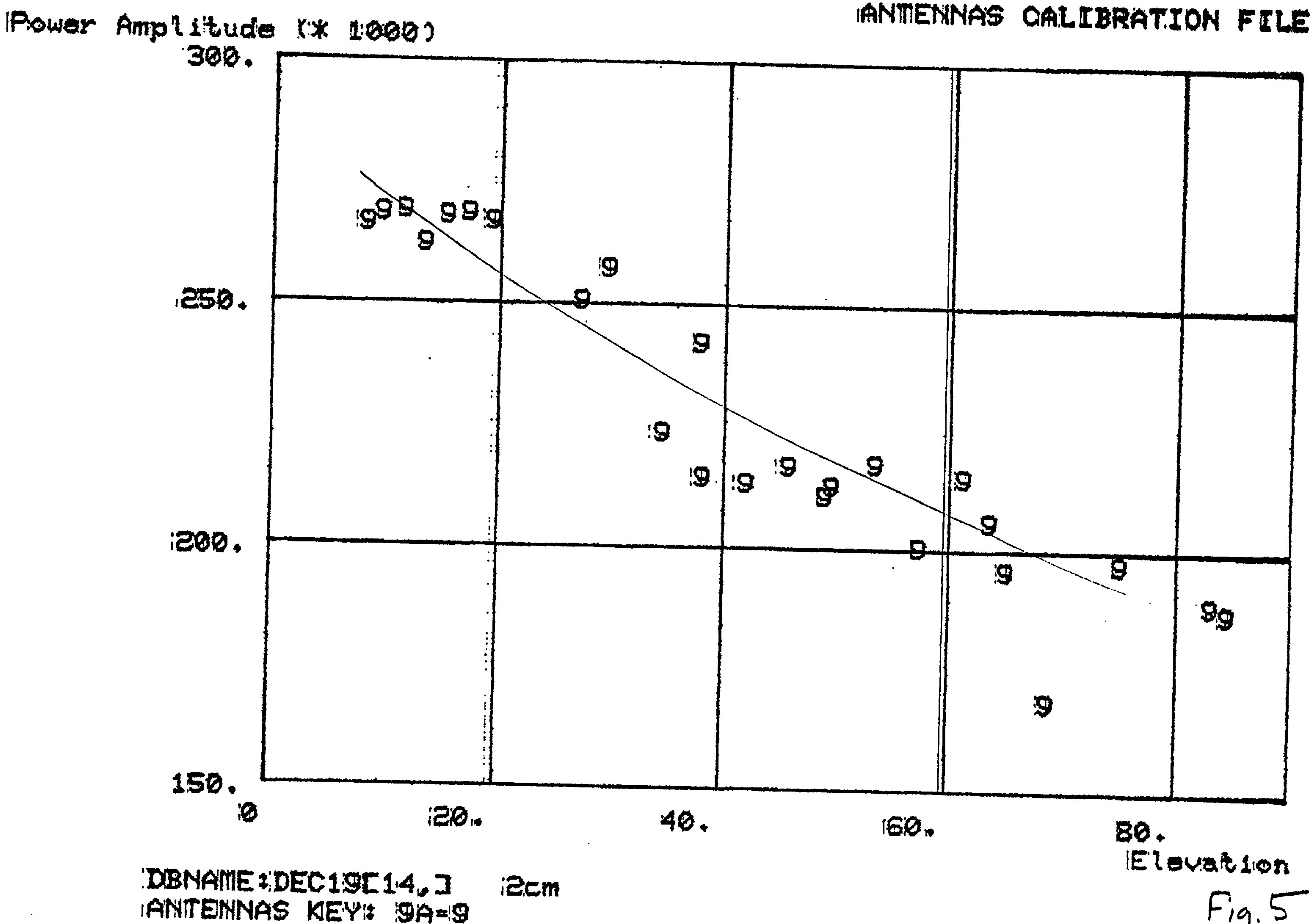

Power Amplitude (* 1000)
ANTENNAS CALIBRATION FILE
300.
250.
200.
150.
0
20.
40.
60.
80.
Elevation
DBNAME:DEC19[14,] 2cm
ANTENNAS KEY: 9A=9

Fig. 5

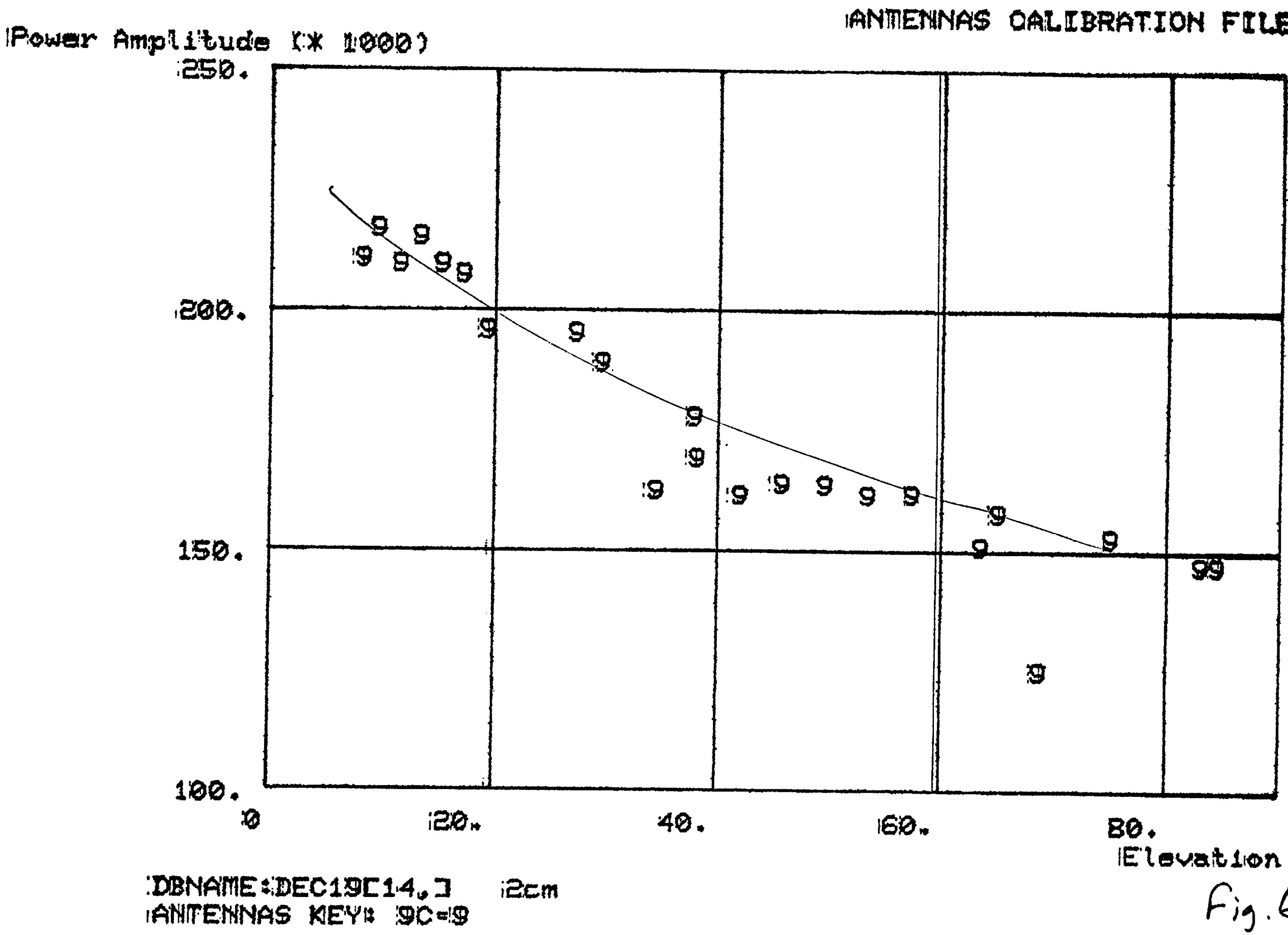
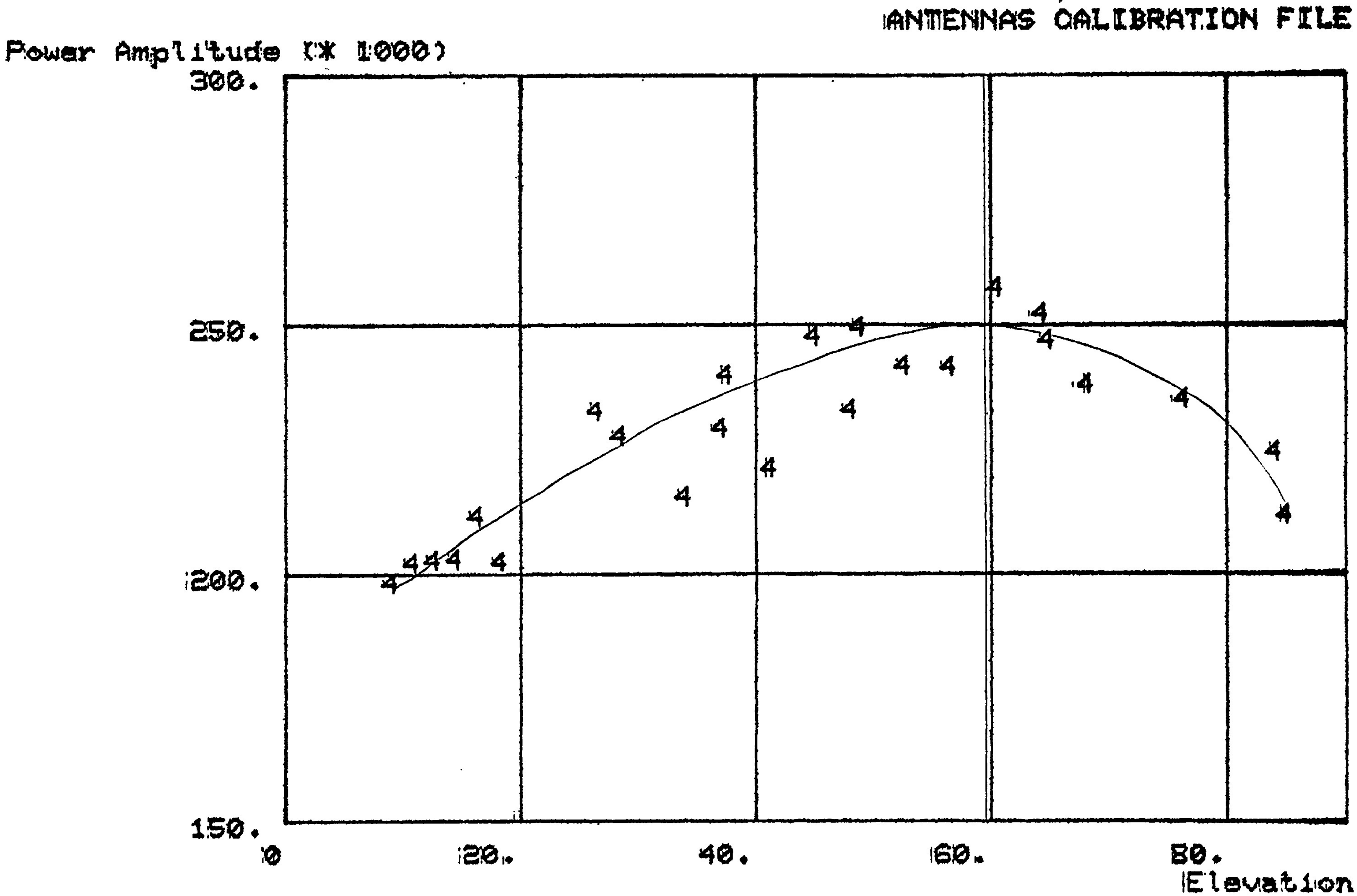

ANTENNAS CALIBRATION FILE
Power Amplitude (* 1000)
250.
200.
150.
100.
0
20.
40.
60.
80.
Elevation
DBNAME:DEC19[14.]   2cm
ANTENNAS KEY: 9C=9

Fig. 6

[redacted]

↳ (4.9%)



DBNAME:DEC19[14,] 1.3cm
ANTENNAS KEY: 4C=4

Fig. 7

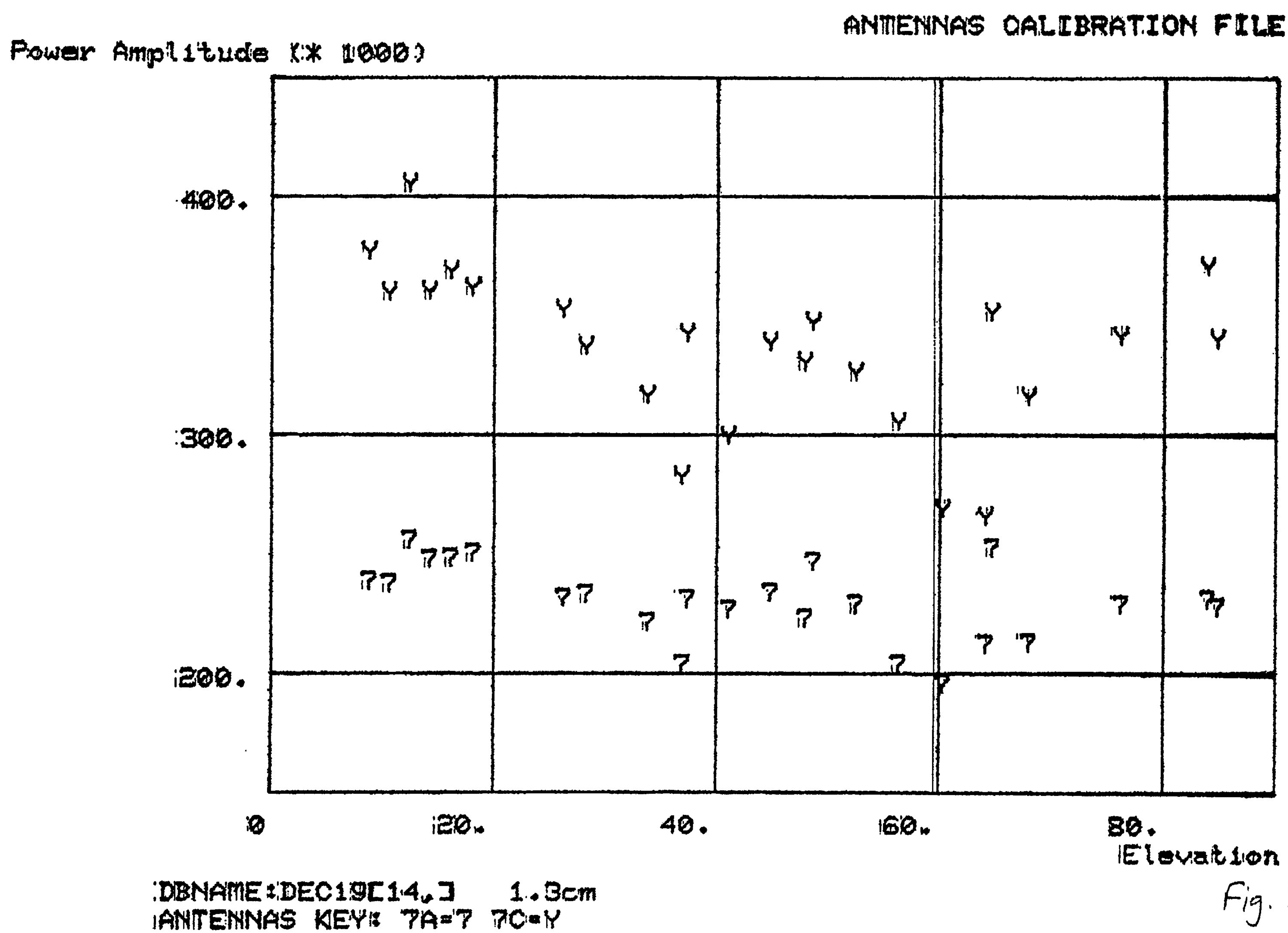

ANTENNAS CALIBRATION FILE
Power Amplitude (* 1000)
400.
300.
200.
0
20.
40.
60.
80.
Elevation
DBNAME:DEC19[14.]   1.3cm
ANTENNAS KEY: 7A=7 7C=Y

Fig. 8

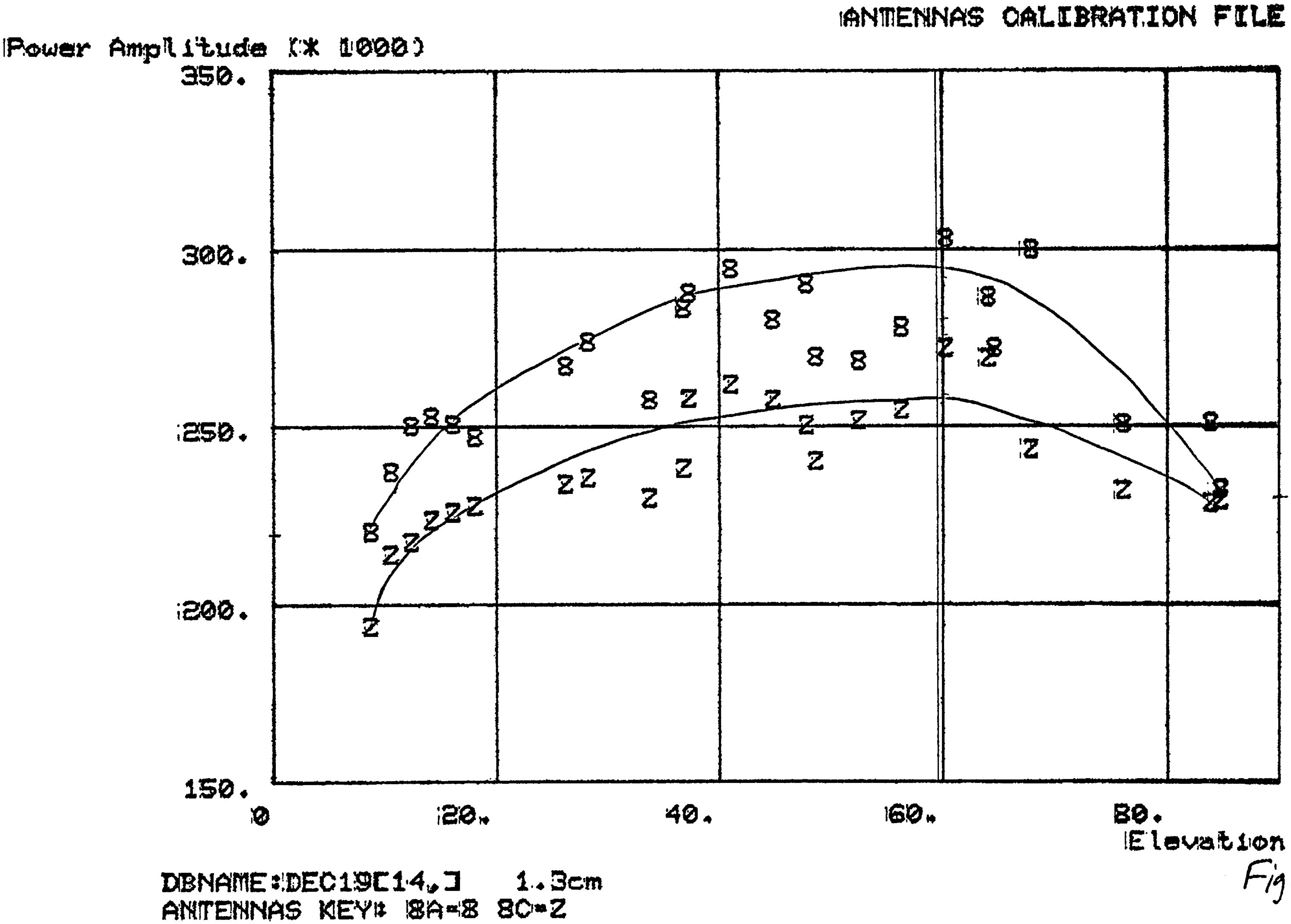

ANTENNAS CALIBRATION FILE
Power Amplitude (* 1000)
350.
300.
250.
200.
150.
0
20.
40.
60.
80.
Elevation
DBNAME:DEC19[14,]   1.3cm
ANTENNAS KEY: 8A=8 8C=Z

Fig. 9

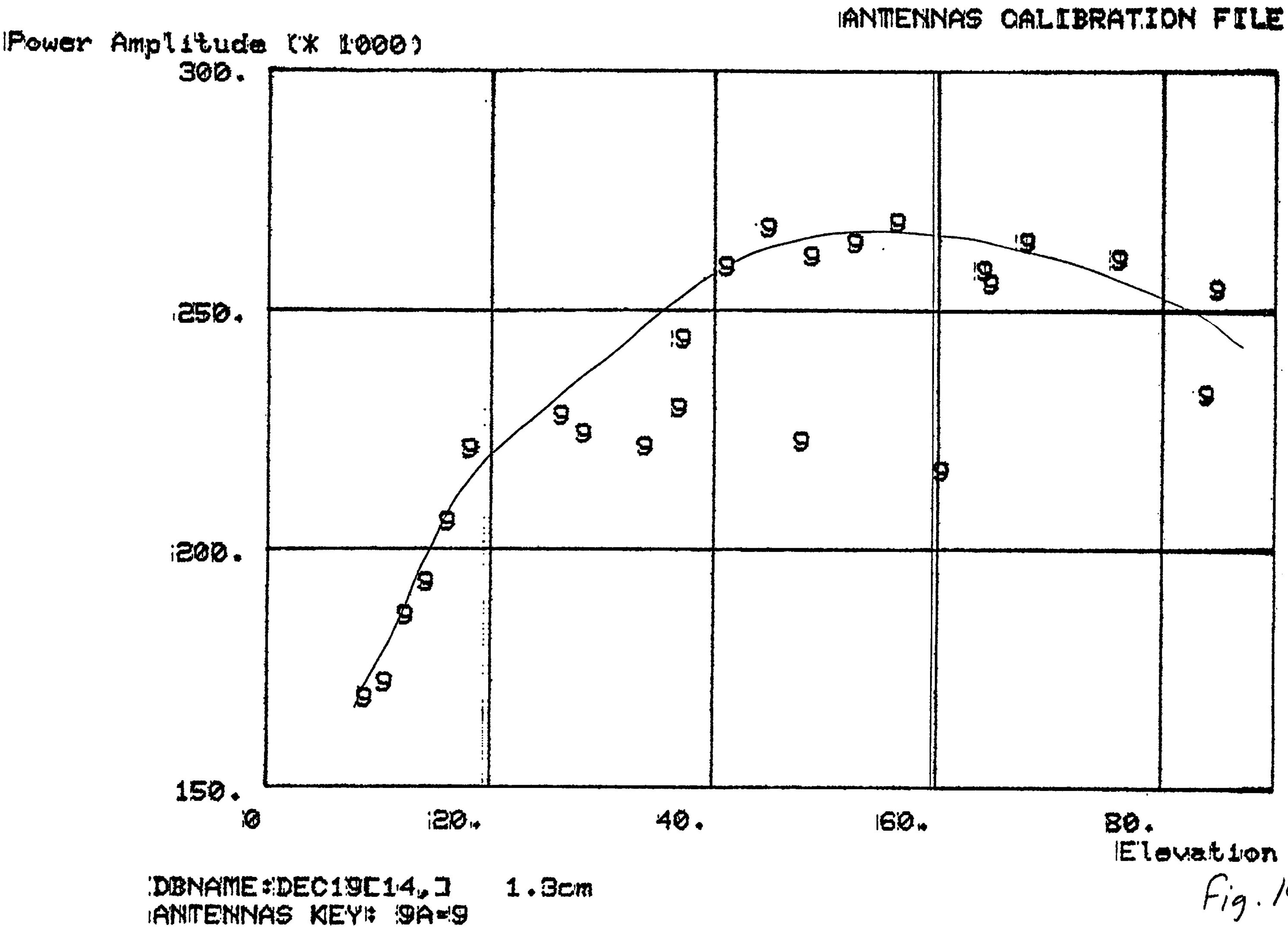
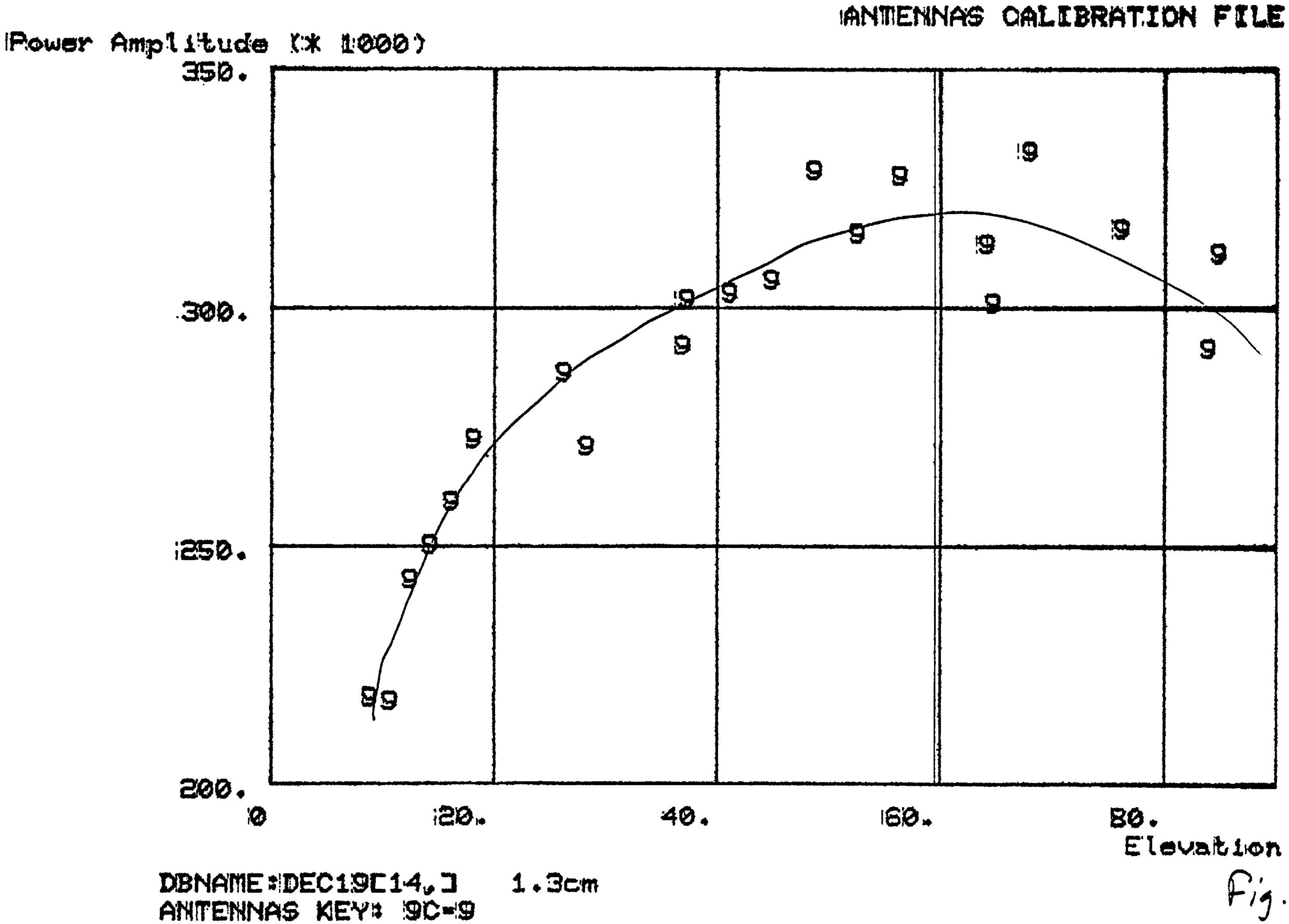

ANTENNAS CALIBRATION FILE
Power Amplitude (* 1000)
300.
250.
200.
150.
0
20.
40.
60.
80.
Elevation
DBNAME:DEC19[14,]   1.3cm
ANTENNAS KEY: 9A=9

Fig. 10



ANTENNAS CALIBRATION FILE
Power Amplitude (* 1000)
350.
300.
250.
200.
0
20.
40.
60.
80.
Elevation
DBNAME:DEC19[14.]   1.3cm
ANTENNAS KEY: 9C=9

Fig. 11