NATIONAL RADIO ASTRONOMY OBSERVATORY

April 15, 1984

Memorandum

TO: 12-m Memo Series

FROM: J. M. Payne, C. J. Salter

SUBJECT: 12-m Telescope Calibration

We report the results of a short observing session made with the 12-m telescope on 12 Apr 1984. The observations were performed at 230 GHz using the rebuilt λ 1.3 mm two-channel mixer receiver. The performance of the receiver was evaluated, telescope pointing checked and the telescope characteristics as a function of elevation investigated (see 12-m Memo, J. M. Payne et al, 26 Mar 84).

a) λ 1.3 mm Receiver

The rebuilt λ 1.3 mm mixer receiver performed stably, having similar noise temperatures in each channel with an average value of 325K (DSB). After combination of the two channels, the noise ripple per unit time in continuum mode was about 5 Jy/sec outside the atmosphere.

b) Pointing

The pointing was checked via a set of measurements of the planets (Mars, Jupiter and Saturn) and the radio source 3C273 (Flux density, epoch 12 Apr 84 = 25.0 ± 1.5 Jy). The observations covered $130° \lesssim$ Azimuth $\lesssim 260°$; $16° \lesssim$ Elevation $\lesssim 60°$. Over this area, no change of thumbwheel offset was necessary. The r.m.s. deviations of measured positions were,

$$\sigma \text{ (azimuth)} = 3''.7; \ \sigma \text{ (elevation)} = 4''.0$$

The pointing offset between the two receiver channels was $< 2''$ in both azimuth and elevation.

c) Lateral Focus

Observations to determine the setting of the subreflector N-S translation stage, and the sensitivity of the gain to errors in this setting, were made between elevations 15° and 60°. Within the observational errors, the measured settings for the translation stage agreed with the values calculated by L. J. King

(12-m Memo No. 219), reproduced in Fig. 1.

A provisional 230 GHz gain-lateral displacement curve is shown in Fig. 2. The curve is a free-hand fit to the displayed data points, which were measured on Saturn at elevation = 44°. The axial focus was fixed throughout the measurement. We note that a 1 mm error in setting the translation stage results in a decrease of telescope gain by only 2-3% at 230 GHz.

d) Axial Focus

We investigated the movement of the axial focus of the telescope as a function of elevation using the normal 12-m FOCALIZE procedure. The observations were made at night and the ambient temperature did not vary by more than 2°C over the session.

The mean axial focus position of the two channels varies sysemmatically with elevation. This is shown as a function of sin (elevation) in Fig. 3. The straight line fit to the data is described by,

$$F_o = 37.5 + 2.8 \sin(\text{elevation}) \text{ mm} \quad (1)$$

This change of axial focus with elevation is considerably greater than predicted in 12-m Memo No. 219. In addition, there is a small difference in the axial focus positions of the two orthogonal linear polarizations, amounting to

$$\Delta F_o \text{ (Ch 1-Ch 2)} = 0.21 \pm 0.03 \text{ mm}$$

The detailed axial focus curve at 230 GHz for a given elevation is shown in Fig. 4. The half-power width of the curve is about 2.4λ, a value close to theoretical.

The gain-elevation curve at 223 GHz shown in Fig. 2 of 12-m Memo, 26 Mar 84, can be satisfactorily accounted for by the defocussing effects described above. On the occasion of these previous measurements, 27 Feb 84, the telescope was focussed at an elevation of 20°, with the N-S translation stage fixed at +1 mm. We have computed the expected gain-elevation curve using the elevation dependence of F_o from (1) and computing gain factors from Fig. 4, together with the effects of the fixed translation stage. This resultant curve shows good agreement with the measured values of gain-elevation. Observers having existing λ 1.3 mm data taken with the 12-m telescope could use a similar process to correct their data for gain-elevation effects caused by defocussing.

Within the next few days, computer control of both the axial and lateral focus with elevation will be implemented.

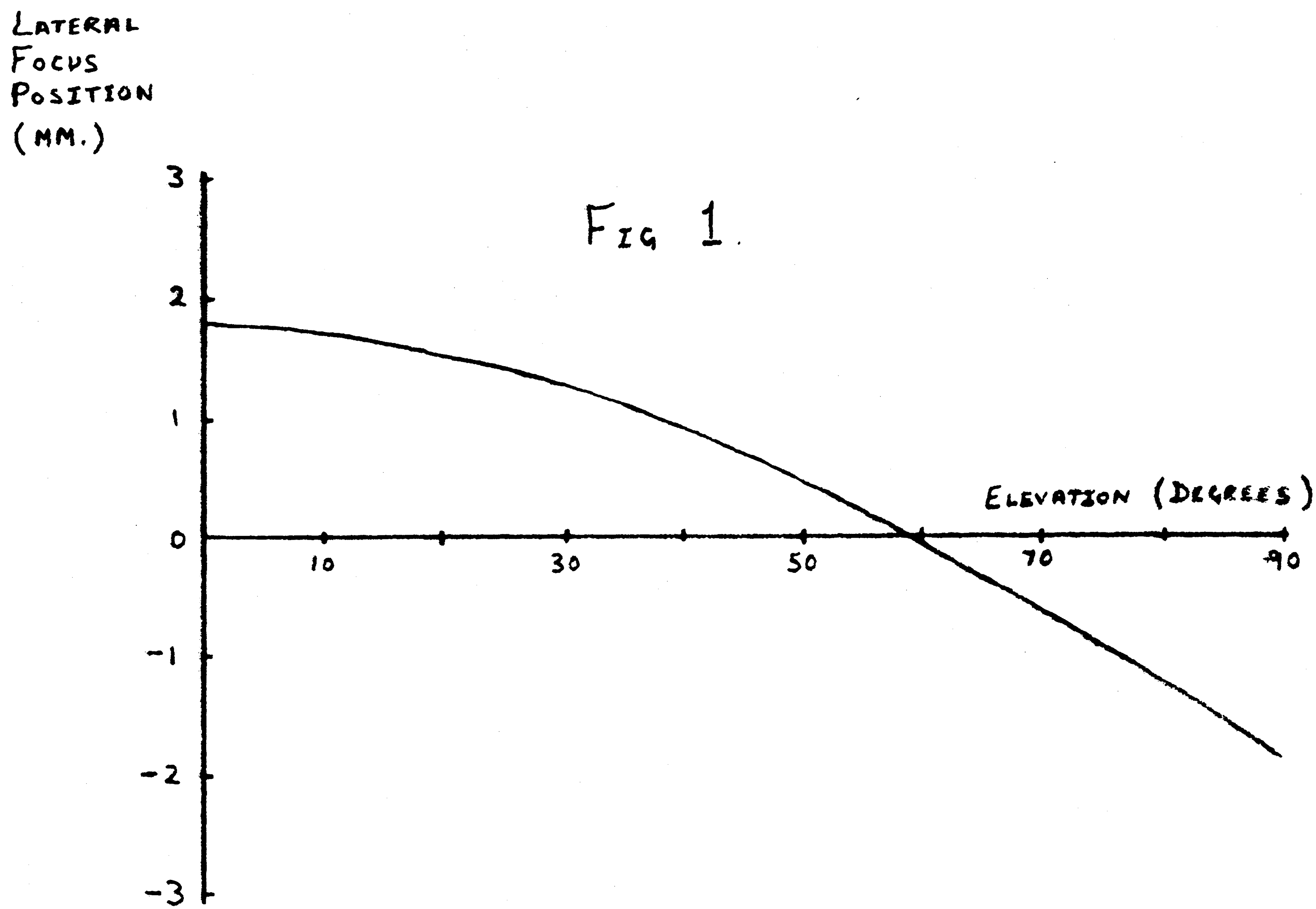

LATERAL
FOCUS
POSITION
(MM.)
3
2
1
0
-1
-2
-3
ELEVATION (DEGREES)
10
30
50
70
90

FIG 1.

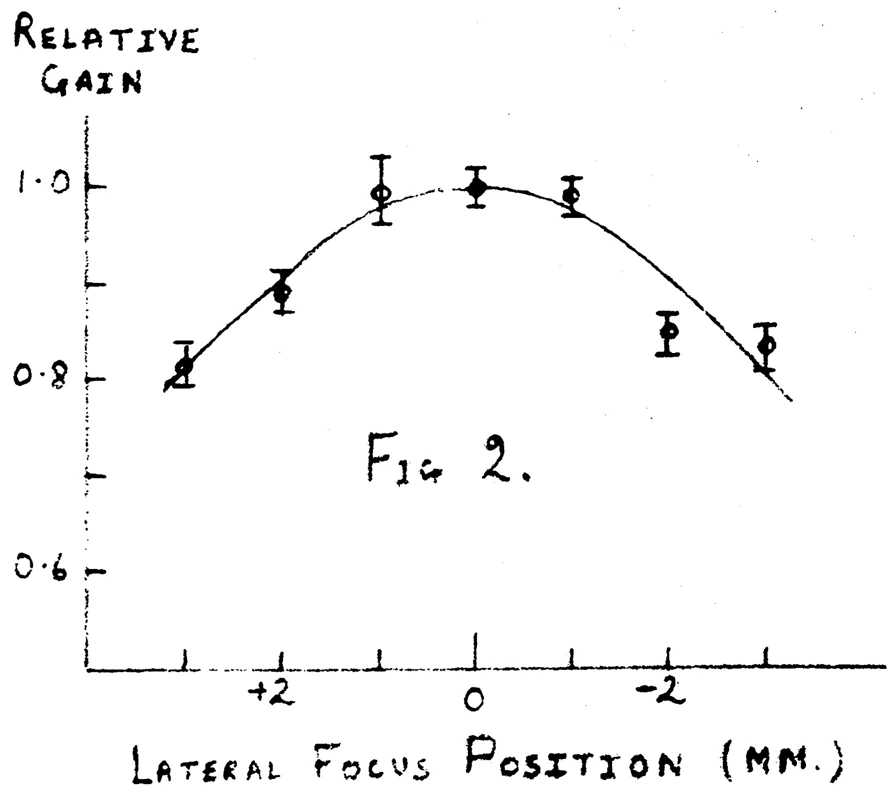
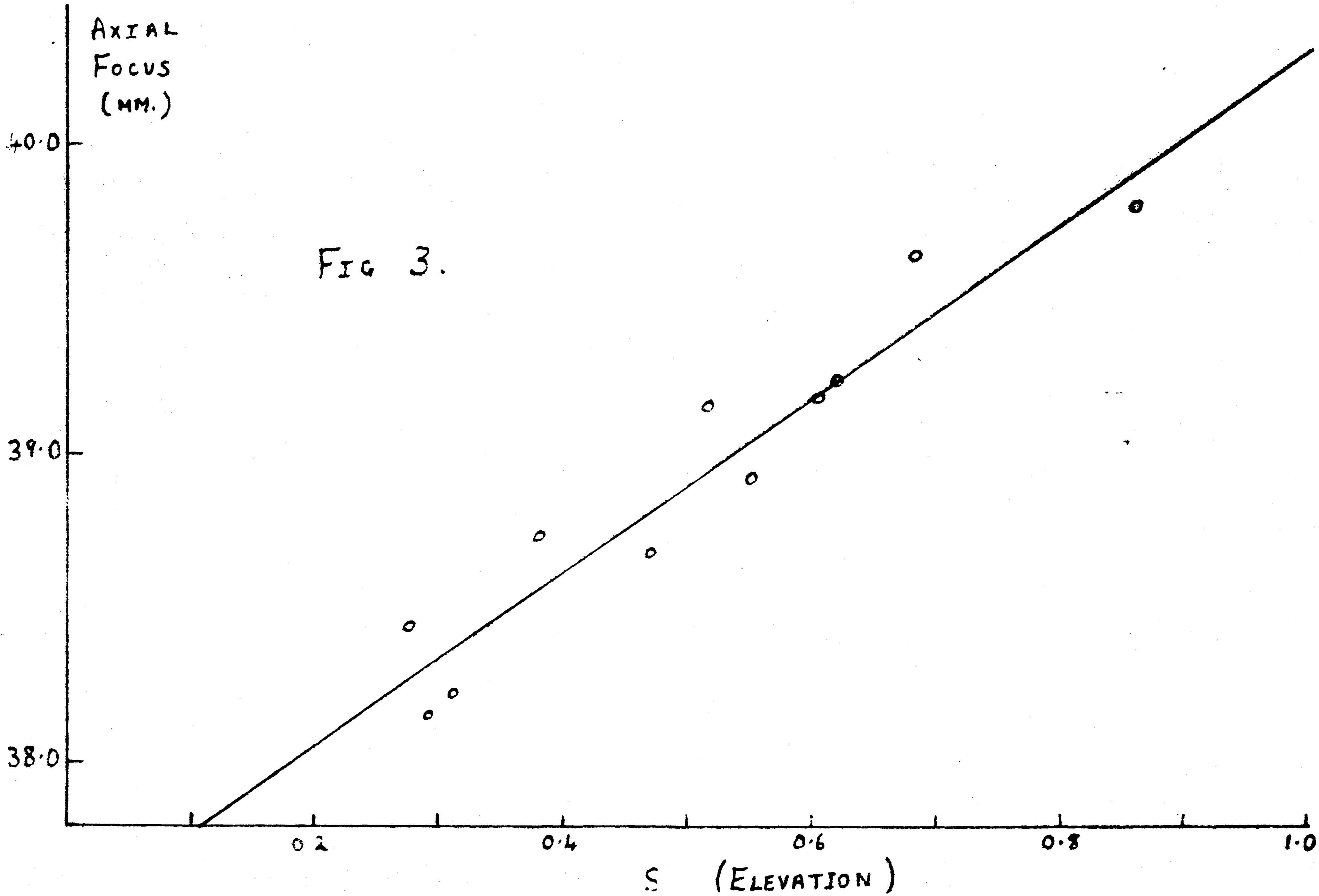


FIG 2.

Fig 3.



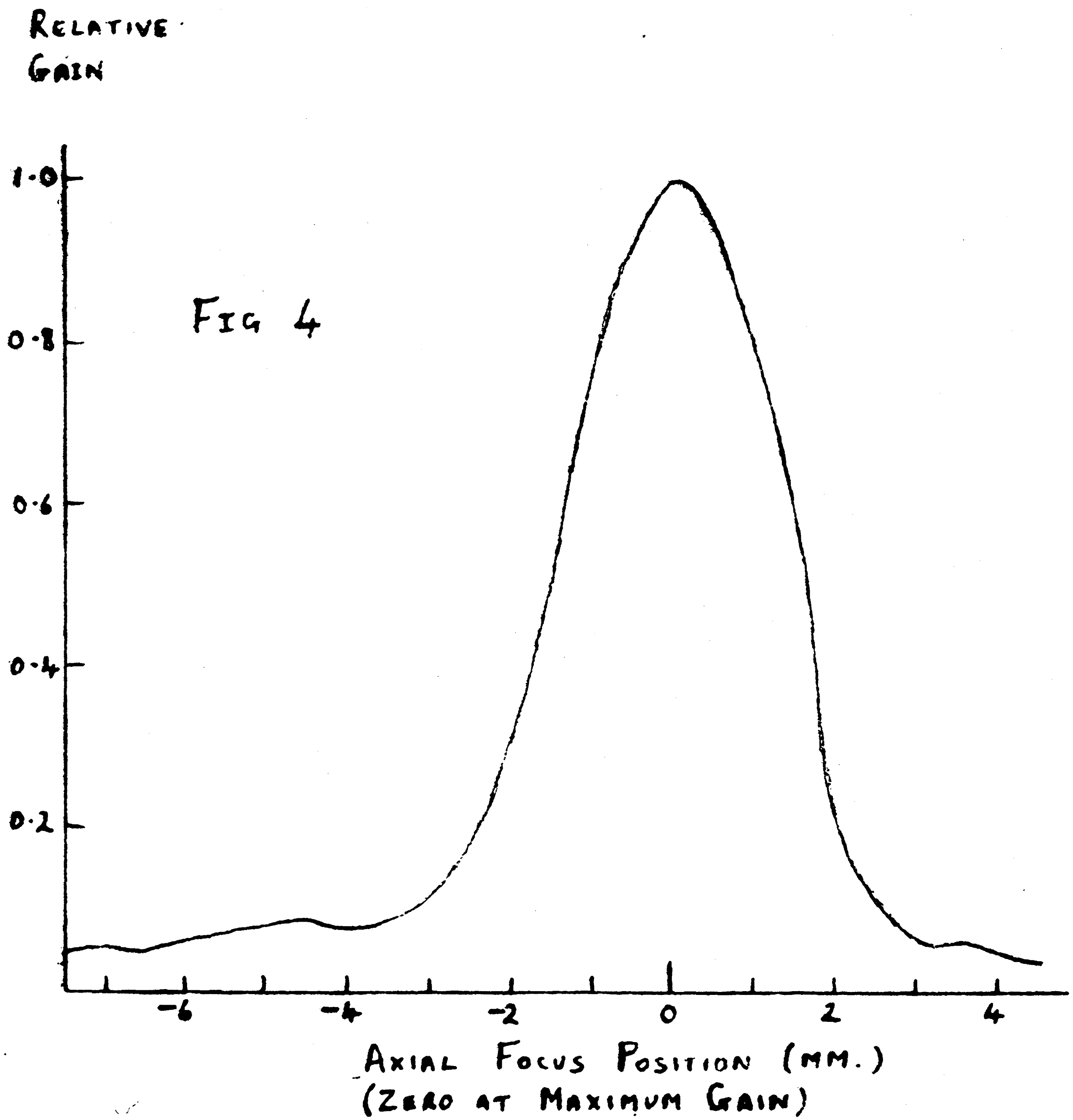

Relative
Gain
1·0
0·8
0·6
0·4
0·2
-6
-4
-2
0
2
4
Axial Focus Position (mm.)
(Zero at Maximum Gain)

Fig 4