J. A. GEIBEL

MPS/Int./VA 62-7
20th February, 1962

TARGET FOR MEASUREMENT OF BEAM POSITION AND DIAMETER.

In order to measure beam position (vertical and radial) and beam diameter a set of two special target heads has been built. These targets, mounted on a normal target drive unit (fitted with modified, more accurate, stop contacts), are allowed to touch the beam in four directions at 45^{o}. The positions of interaction with the beam can be determined from the target radial position. Using derived empirical relationships, radial beam position Δr, vertical beam position Δz and beam diameter 2ρ can be obtained from the four readings of target radial position when the target is just touching the beam.

The results to date (in ss 05) show that fairly reliable measurements can be made provided the target is consuming less than 10 % of the whole beam. Attempts to measure the core of the beam, by absorbing more than 50 % of it, have been unsuccessful because of the effect on the beam orbit produced by energy loss of the protons in traversing the target.

Formulae and graphs for calculation of the above beam parameters from the four readings, and some results are given in this report.

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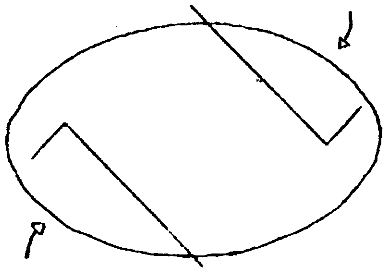
PS/3129

Calculation of Beam Position (radial Δr, vertical Δz) and Radius ρ.

1. Note which pair of target positions are being used

e.g. top int. / bot. ext.



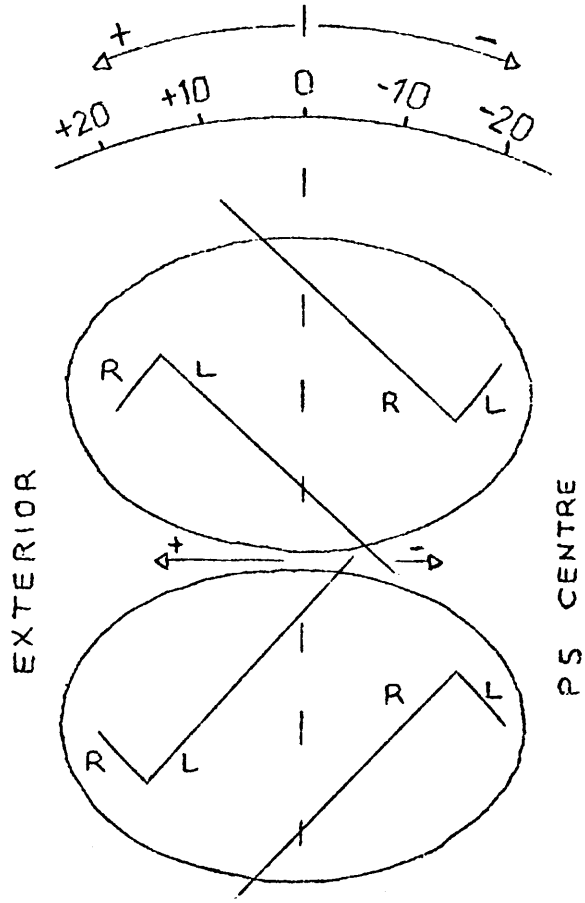
PS centre.

2. Obtain the four readings from the radial position meter, measured for a given interaction of the target with the beam in each case (e.g. 10 $^{o}/_{o}$, using Hereward current signal).

Let these readings be : top target TL, TR

bottom target BL, BR

where left (L) and right (R), and sign of the reading are defined on the radial position meter as shown.



3. Calculate

$$f(V) = \left[(TL - TR) - (BL - BR)\right]$$
$$f(\rho) = \left[(TL - TR) + (BL - BR)\right]$$
$$f(H) = \left[(TL + TR) + (BL + BR)\right]$$
$$f(\varepsilon) = \left[(TL + TR) - (BL + BR)\right]$$

4. From figure 1, read off the corresponding values of Δz and ρ using $f(V)$ and $f(\rho)$.

5. From these values of Δz and ρ, read off Δr^* from either figure 2 or 3, whichever is applicable (e.g. figure 3, left column in above example).

6. Calculate the radial position of the beam

$$\Delta r = \frac{f(H)}{4} + \Delta r^*$$

7. The measured accuracy of Δr is given by $[f(\varepsilon) - \Delta\varepsilon]$ where $\Delta\varepsilon$ is read from either figure 4 or 5 (using Δz and ρ).

<u>Example</u> :

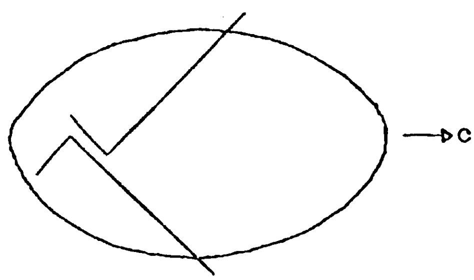
(a) From a graphical model, a beam of 5.5 mm radius (circular section) at a position $\Delta r = -15$ mm, $\Delta z = 5$ mm has the following co-ordinates

TL	TR
BL	BR

+8.0	-36.2
-2.0	-28.5

using two exterior targets.

Hence, in this case



and $f(V) = (+44.2) - (26.5) = -17.7$

$f(\rho) = (+44.2) + (26.5) = +70.7$

$f(H) = (-28.2) + (-30.5) = -58.7$

$f(\varepsilon) = (-28.2) - (-30.5) = +2.3$

From figure 1,

$$\Delta z = +5.0 \text{ mm}$$

$$\rho = 5.9 \text{ mm}$$

From figure 2 (bottom), $\Delta r^{*} = -0.6$ mm

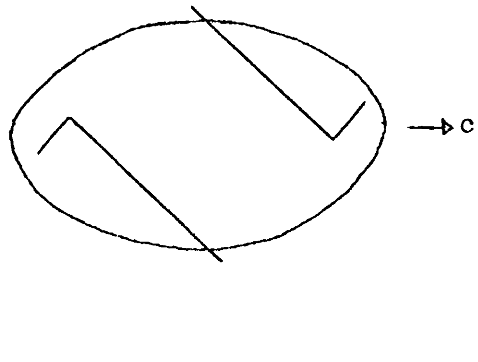
$$\Delta r = -\frac{58.7}{4} - 0.6 = -15.3 \text{ mm}$$

From figure 5; $\Delta\varepsilon = +2.2$. Therefore $[f(\varepsilon) - \Delta\varepsilon] = +0.1$ mm

(b) Target top int.) bot. ext. ($\Delta r = -5$ mm, $\Delta z = -2.5$ mm, $\rho = 5.5$ mm

Co-ordinates

+10.5	-20.5
+15.2	-24.5



Hence $f(V) = -8.7$

$f(\rho) = +70.7$

$f(H) = -19.3$

$f(\varepsilon) = -0.7$

From figure 1, $\Delta z = -2.4$ mm, $\rho = 5.5$ mm

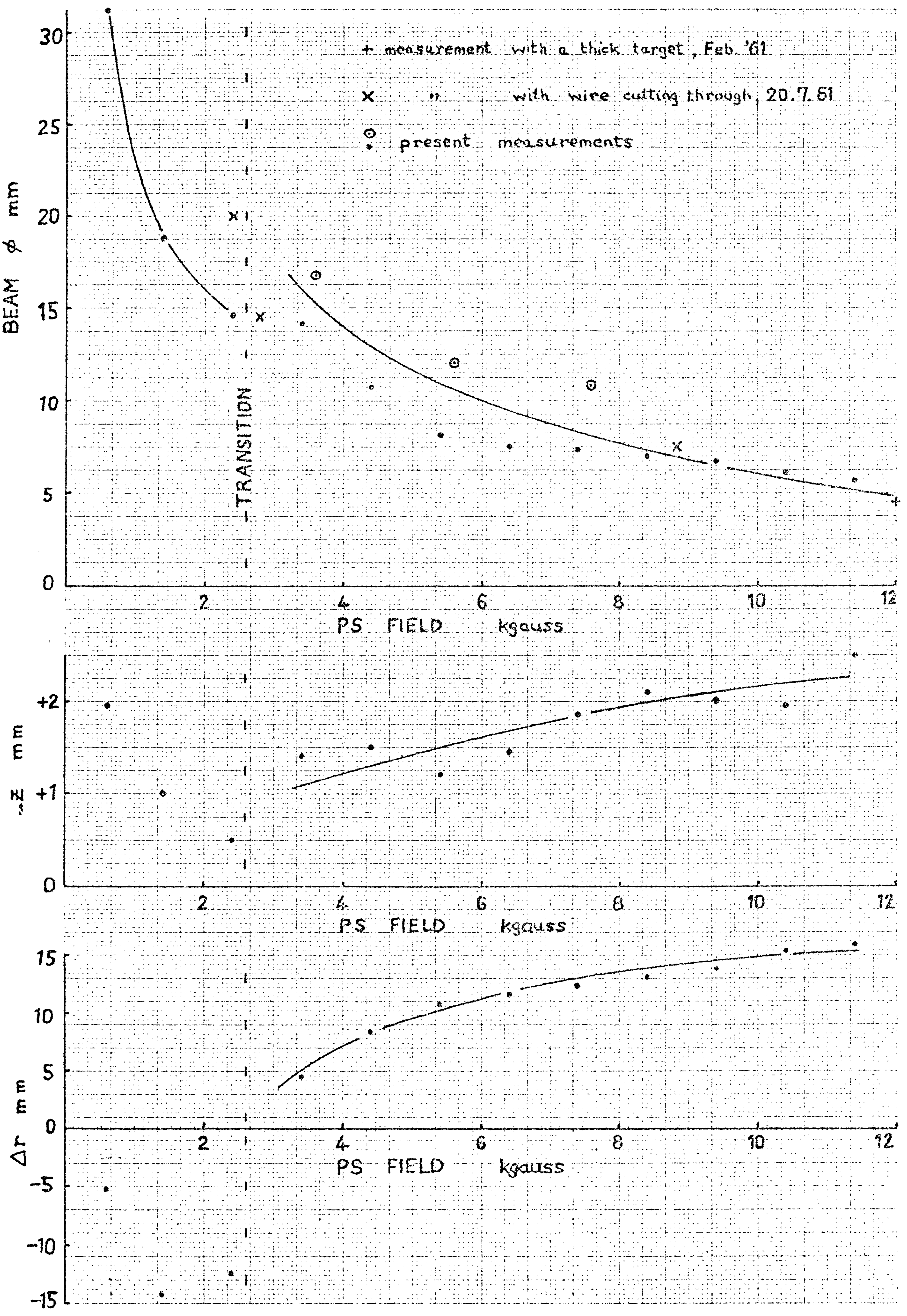
From figure 3, $\Delta r^{*} = -0.23$ mm, therefore $\Delta r = -5.0$ mm

From figure 4, $\Delta \varepsilon = -2.0$ mm, therefore $\left[f(\varepsilon) - \Delta \varepsilon\right] = +1.3$ mm

Distribution : (open)

Scientific Staff of Machine Division P.S.
Target Group

/rf
PS/3129


+ measurement with a thick target, Feb. '61
× " with wire cutting through, 20.7.61
⊙ • present measurements
BEAM ϕ mm
TRANSITION
PS FIELD kgauss
-z mm
Δr mm

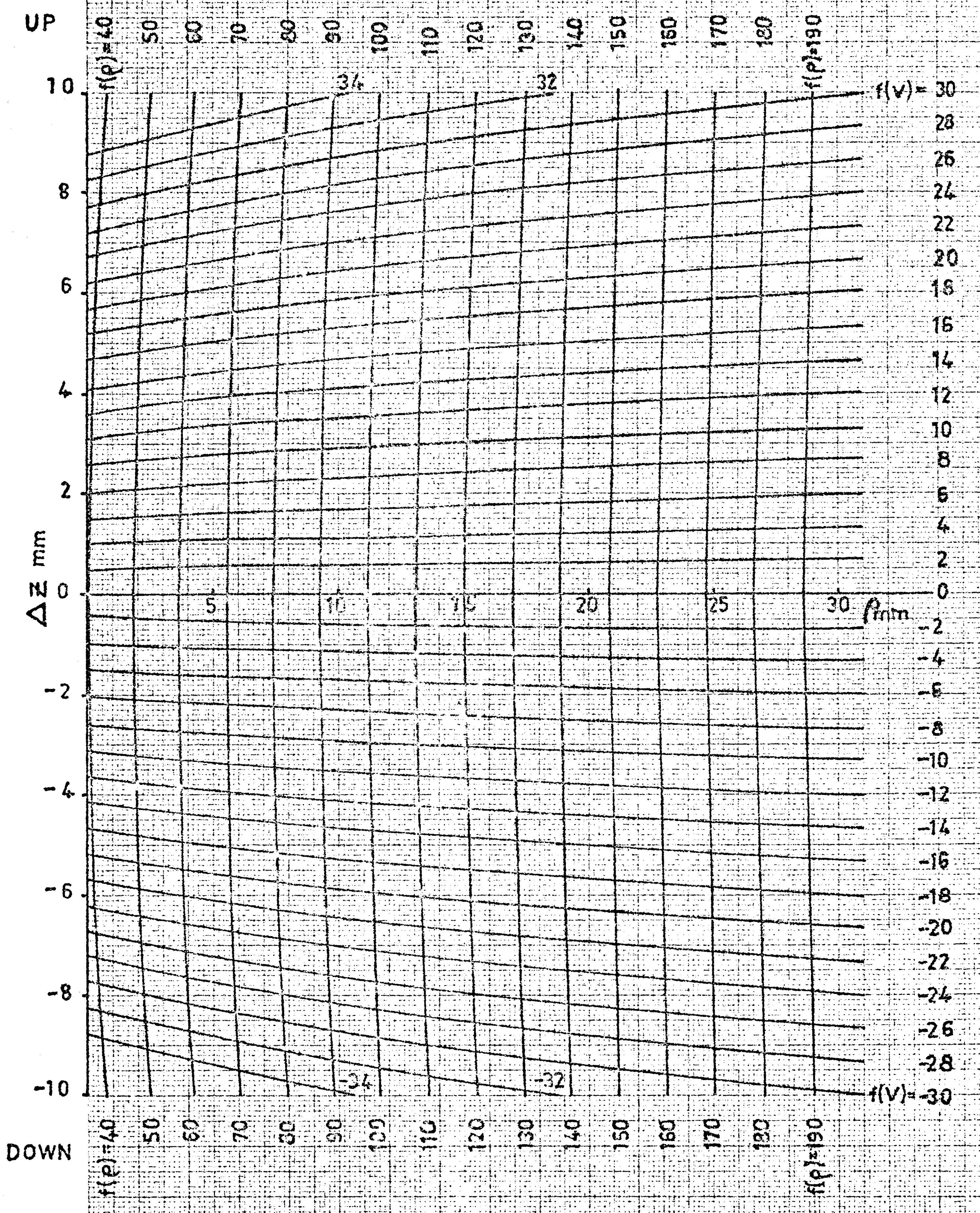

UP
DOWN
Δz mm
ρ mm
f(ρ)=40
f(ρ)=190
f(V)= 30
f(V)=-30
34
32
-34
-32
10
8
6
4
2
0
-2
-4
-6
-8
-10
5
10
15
20
25
30

FIGURE 1

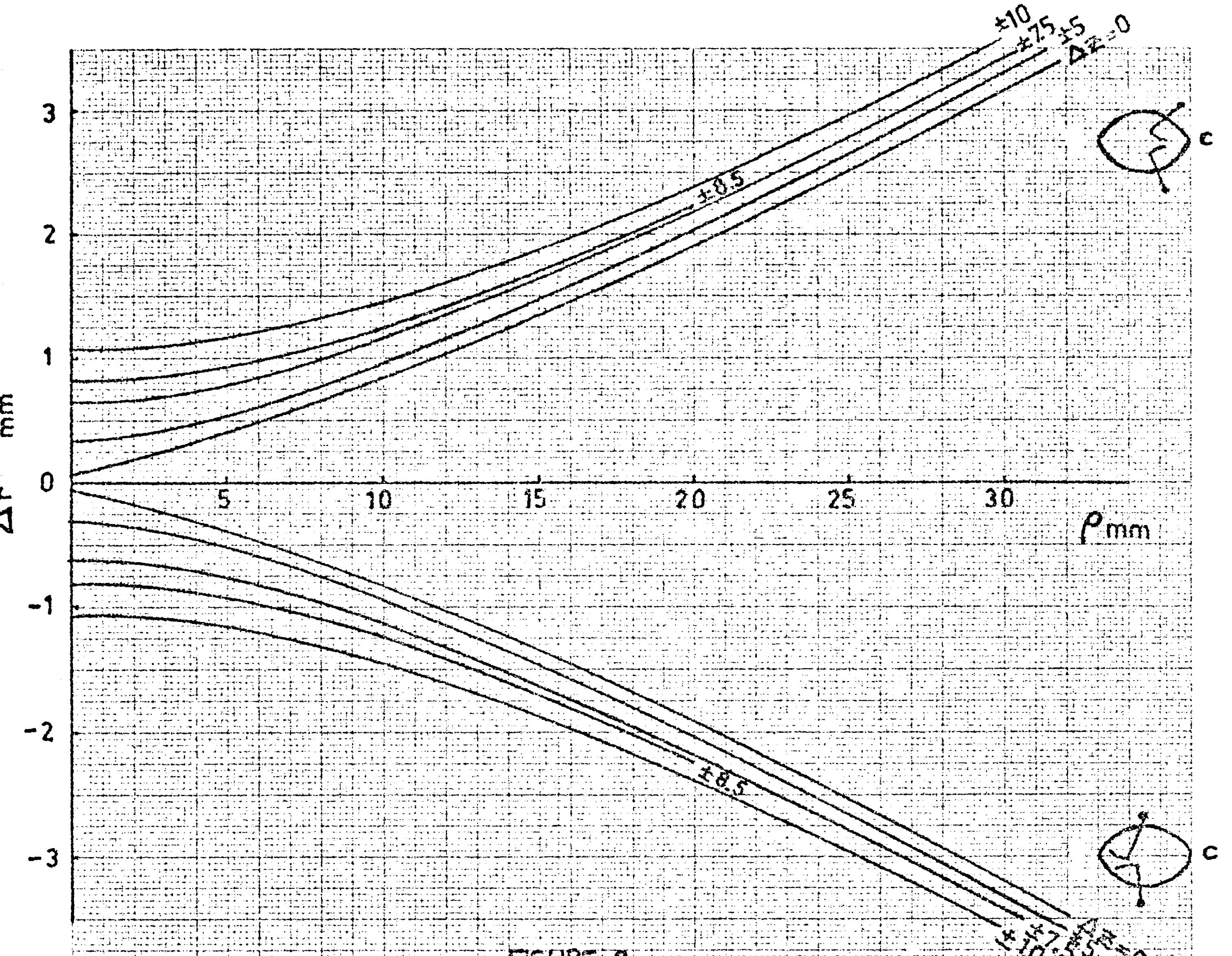


FIGURE 2

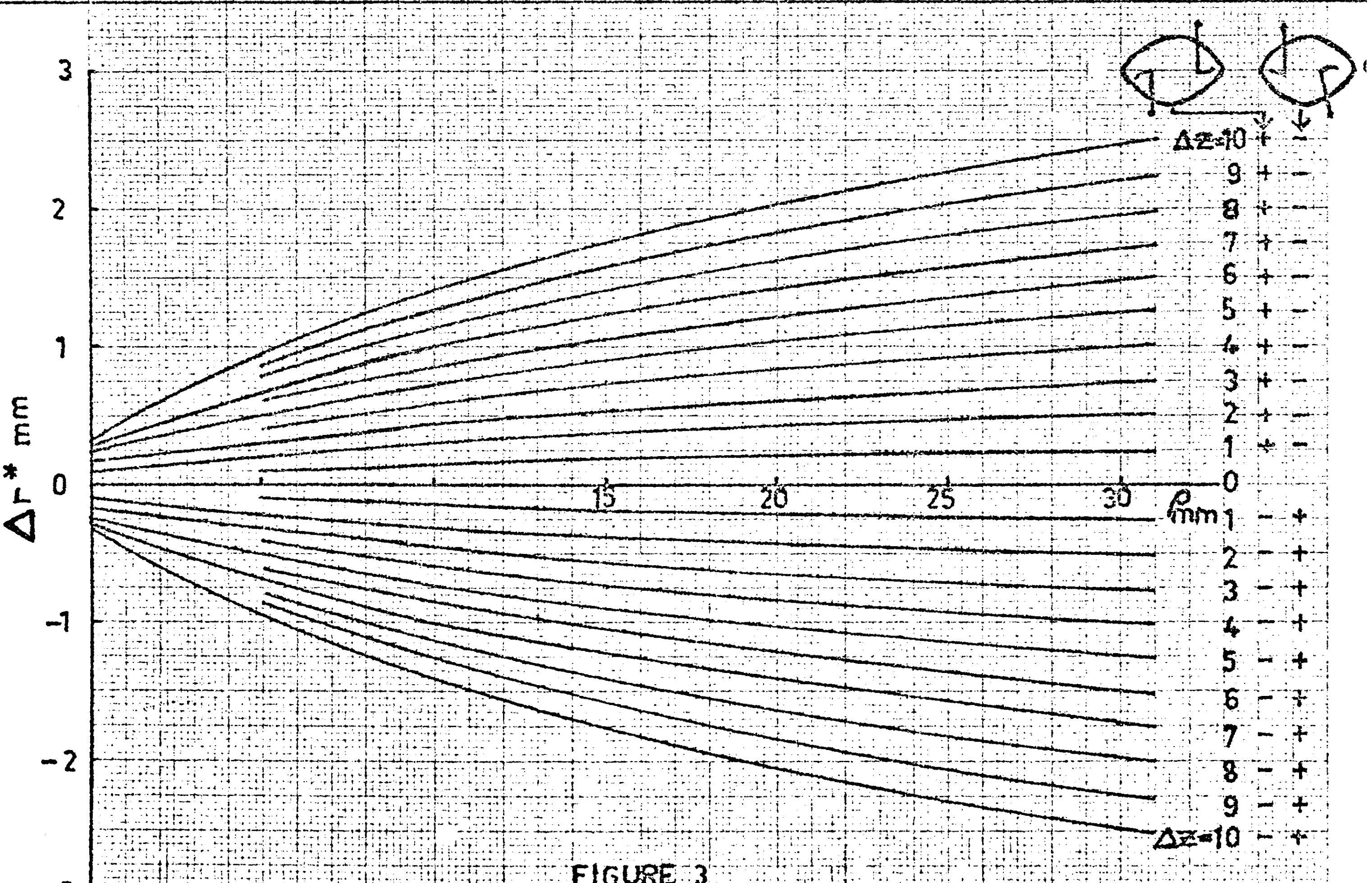


FIGURE 3

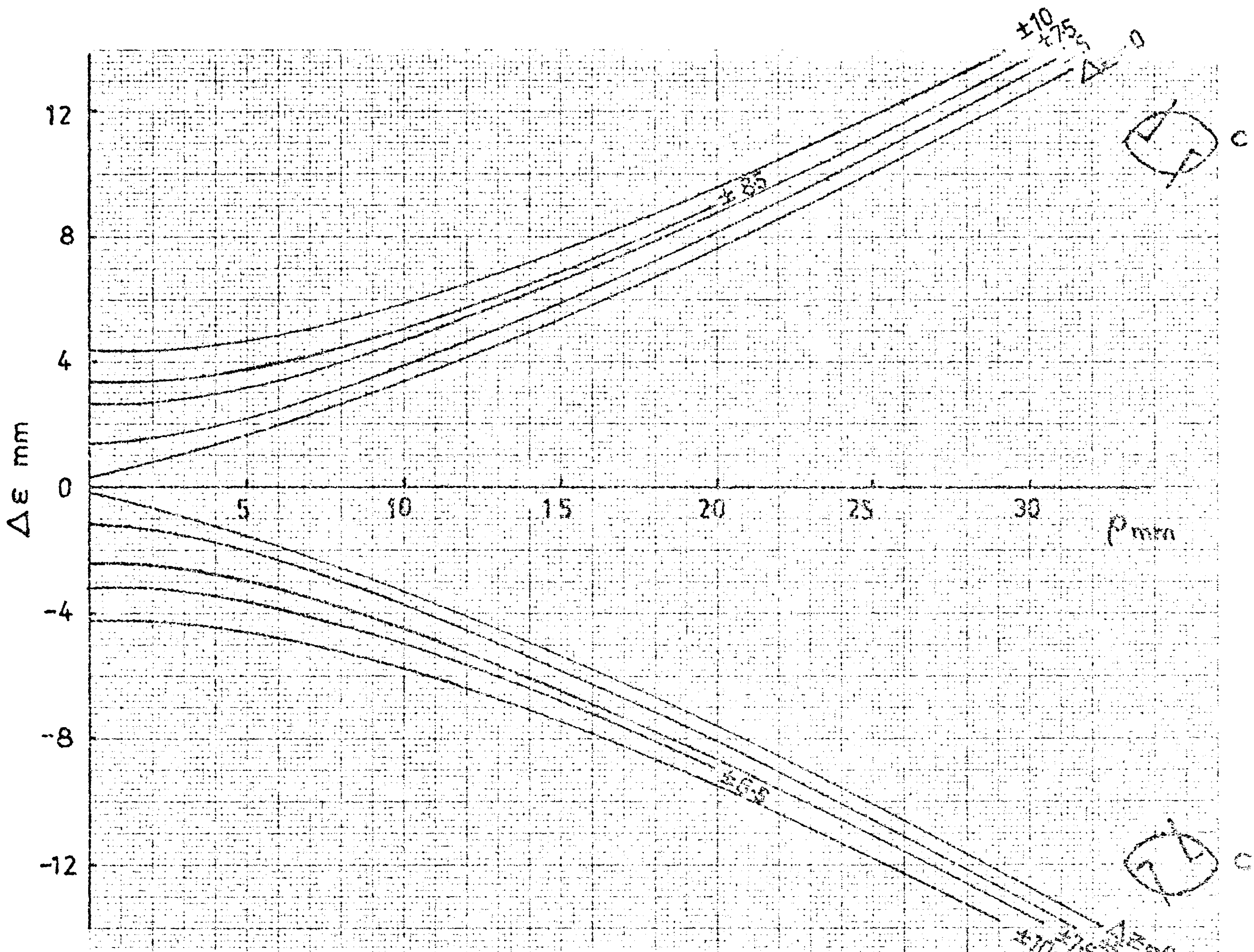


FIGURE 4

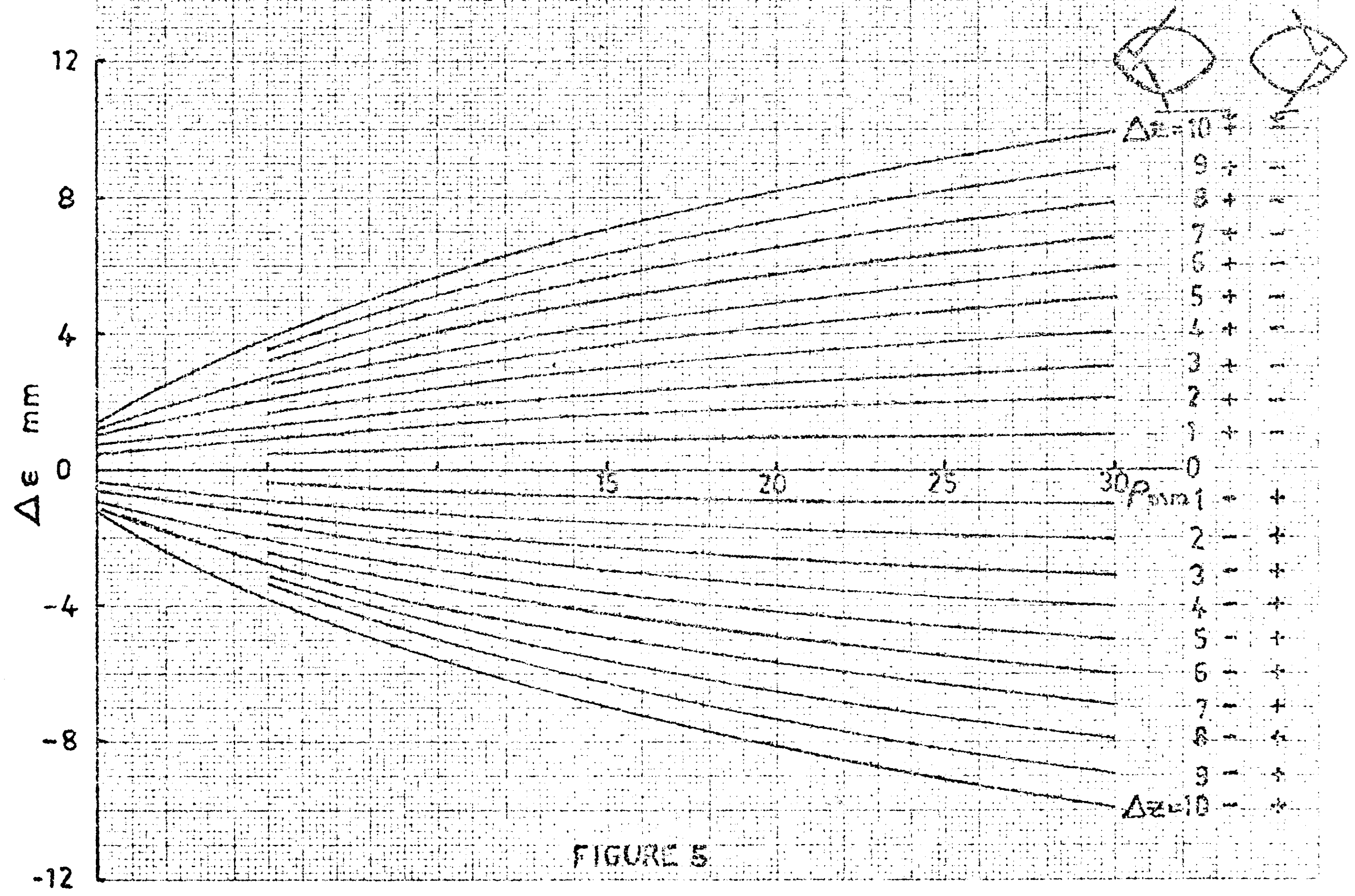


FIGURE 5