ISR-MA/BA/rh

18th November 1971

# ISR RUNNING-IN

## Run 119 - 3 November 1971 - 15.00 to 18.00 h (parasitic)

## Ring 2 - p = 22.465 GeV/c - 20 bunches

### Relation between beam potential and pressure in SS 432

This run was a continuation of run 109. Due to the fact that Ring 1 has been baked out completely, the straight section SS 333 used in run 109 showed no pressure bump. Therefore, Ring 2 was chosen; SS 416 was originally used because its geometry is very pure and two vacuum gauges are available, which is necessary to interpret quantitatively the experiment (the dynamic vacuum equation is of second order*); unfortunately, there was practically no pressure rise in that region; so, it was abandoned for SS 432 which exhibited a higher pressure but just one gauge was recorded and in a last stack the correlation between beam position (or potential) and pressure was clearly confirmed in spite of a fast decay of the intensity.

### 1st stack

VG 416.7 and VG 416.1 were connected to the recorders. A stack was made with its centre at + 11 mm. A 4.03 A intensity was reached and the low energy tail was scraped. A small rise of pressure was noticed on both vacuum gauges. Moving the beam did not show any influence on the pressure.

### 2nd stack

In order to increase the pressure, a higher intensity (4.835 A) of the beam was obtained by stacking up to + 28 mm.

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* ISR running-in: On the dynamic vacuum equation
13th September 1971 by E. Fischer, E. Jones
G. Lewin

The pressure rise was still poor in VG 416.7 and this gauge was disconnected and replaced by VG 432.8 which indicated a $1.4 \times 10^{-9}$ Torr pressure. With a 3.3 A intensity, a small pressure variation could be noticed by displacing the beam 30 mm inwards.

3rd stack

The conditions of the second stack were reproduced but the the shutter was operated without the scraper. A beam current of 5 A was reached but, at the same time, the pressure rose from $10^{-9}$ to $10^{-6}$ Torr in SS 432 while the pressure in VG 416.7 increased from $3.10^{-10}$ to $5.10^{-8}$ Torr. It was too late to refill the ring and the beam was left despite its bad lifetime. The centre of the stack in the vicinity of VG 432.8 was about 21 mm outside; the RF scan showed that the centre of space charge was a little outside. The beam was displaced and the effect of these movements on the pressure is represented in Fig. 1. The drops in current are probably due to 5th order resonances because the bumps change the Q's and the working line. The variations of pressure per Ampere vs beam position as plotted in Fig. 5 show the existence of a maximum near to the centre line.

Calculation of the beam potential

The beam potential V (x, y) derives from the Poisson's equation

$$\Delta V = \frac{\rho}{\varepsilon_o} .$$

This equation has no analytical solution when the beam is off-centred in the vacuum chamber. A numerical computation was carried out with a bi-dimensional relaxation programme which basically uses the same routines as those of MARE. The model is described in Fig. 2. The x-axis is a Neumann's boundary where $\frac{\partial V}{\partial y} = 0$. V = 0 on the circumference. The mesh size is $5 \times 1$ mm$^2$.

The assumptions for the space charge are those used in luminosity measurements: rectangular cross-section whose width is 35 mm and height is the effective height, i.e. 7 mm, the density is uniform and corresponds to a 3.8 A intensity. In fact, the program could be refined without difficulty by imposing on the space charge a radial distribution conforming to the RF scan. Figs. 3 and 4 represent the variation of the potential vs x and y, respectively; a is the abscissa of the centre of the beam and $x_m$ the abscissa of the maximum of V (x, 0).

Some calculations are in preparation with an elliptic chamber which could replace circular chambers in long straight sections if pressure bumps remain at higher intensities even after a complete bake-out.

## Conclusion

The present experiment has confirmed that the rate of outgasing depends strongly on the energy of the ions which hit the wall since a variation of 40 volts in the potential of the centre of the beam causes a variation of pressure of more than a factor 10.

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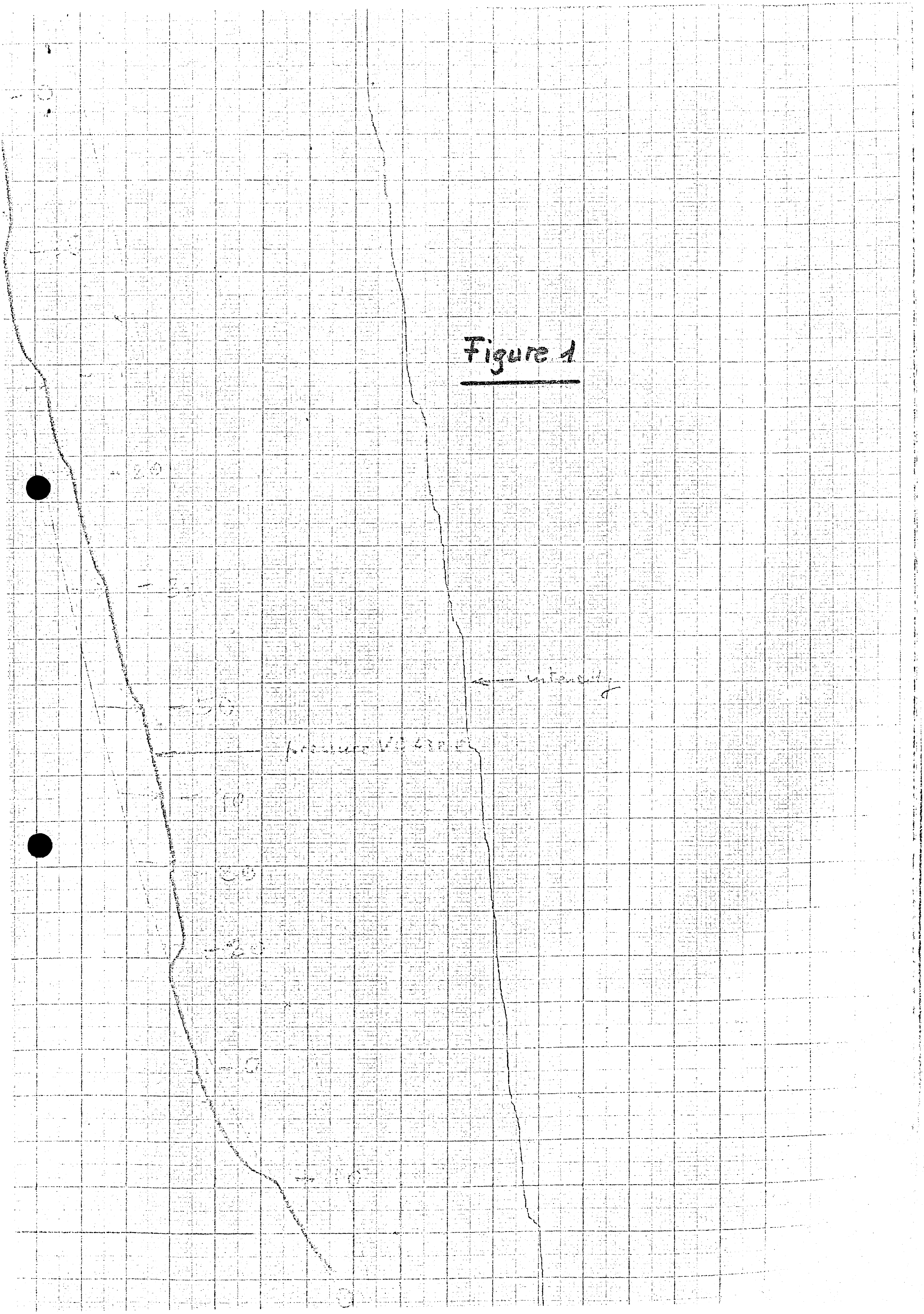
## Figure 1



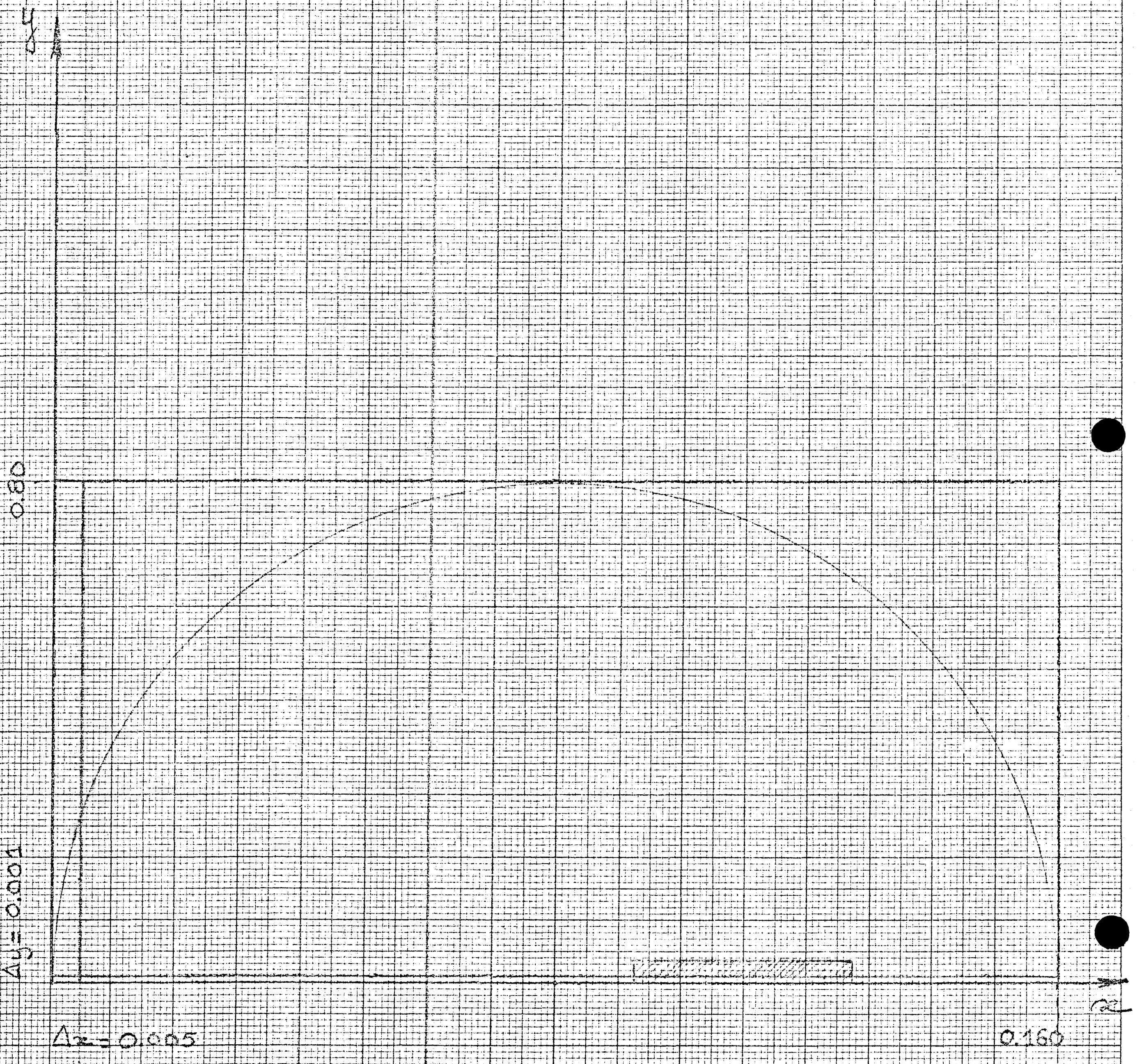
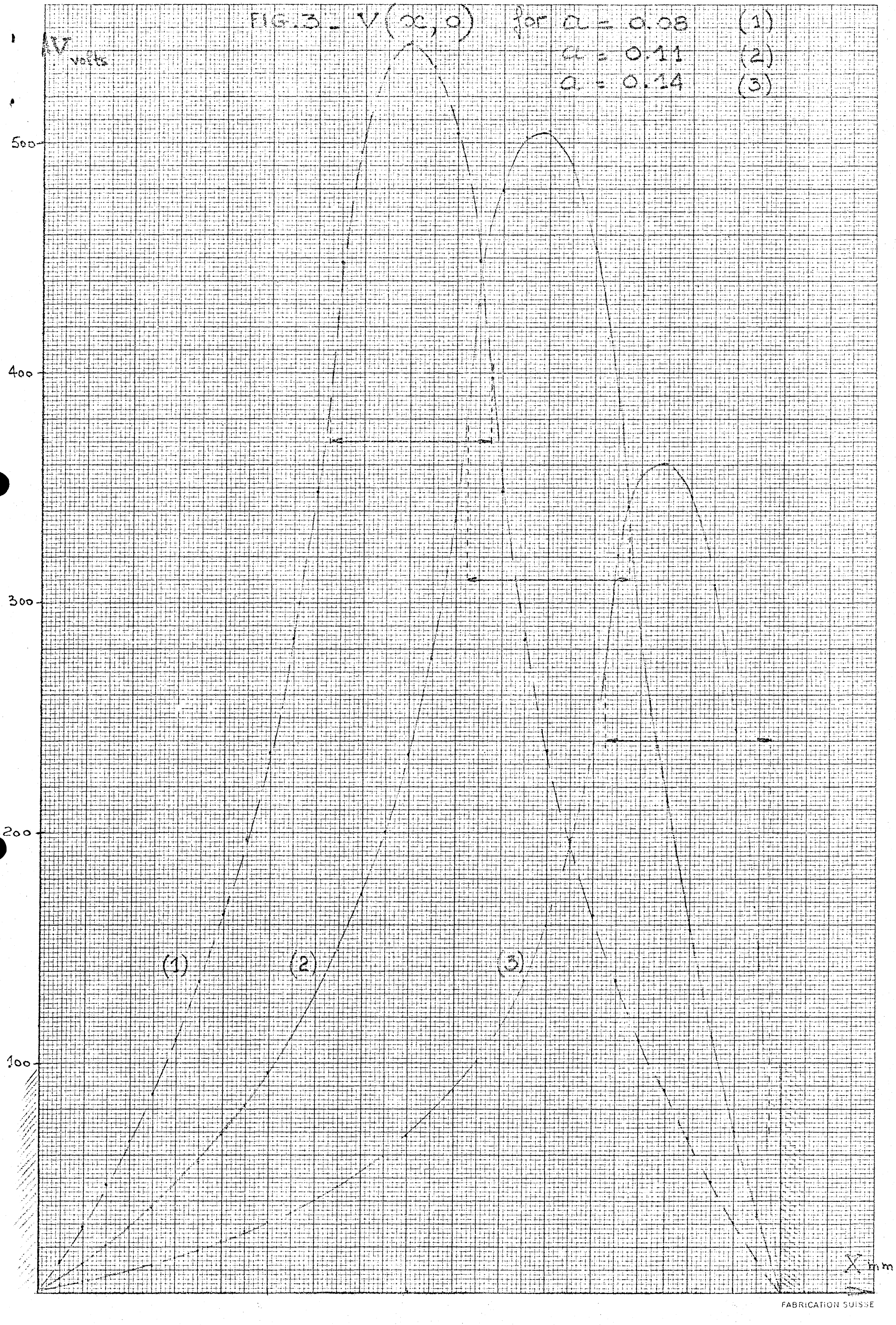
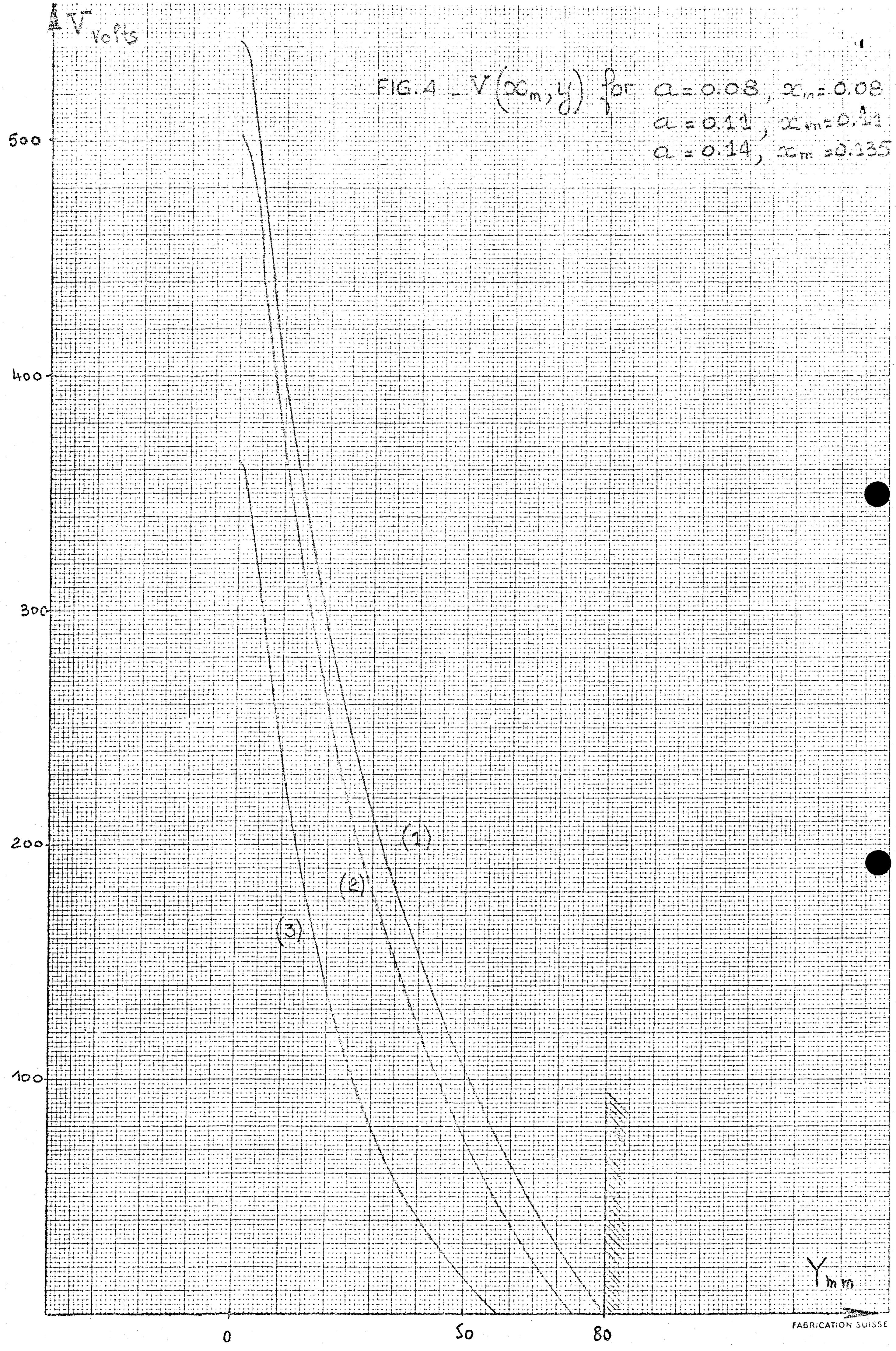


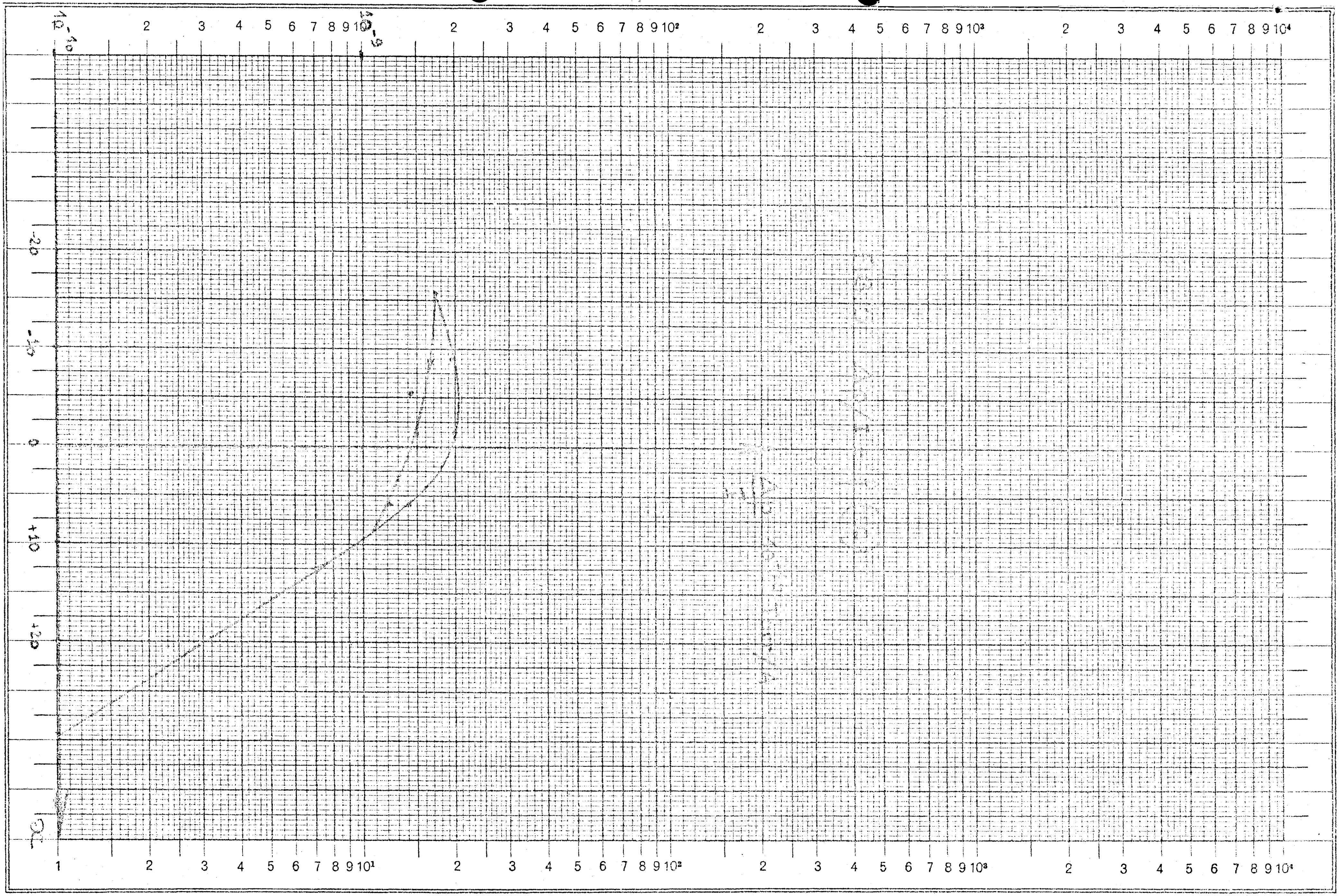

FIG. 2 MODEL FOR THE CALCULATION OF THE BEAM POTENTIAL



FABRICATION SUISSE



V volts
FIG. 4 _ V(xm, y) for a = 0.08, xm = 0.08
a = 0.11, xm = 0.11
a = 0.14, xm = 0.135
500
400
300
200
100
(1)
(2)
(3)
Y mm
0
50
80



1 2 3 4 5 6 7 8 9 10¹ 2 3 4 5 6 7 8 9 10² 2 3 4 5 6 7 8 9 10³ 2 3 4 5 6 7 8 9 10⁴
-20
-10
0
+10
+20