ISR-OP/FL/ah

17 June 1980

Madame

PERFORMANCE REPORT

MD 1128 - 29.5.80.

AIM To calibrate the 4 scintillator monitors placed upstream and downstream of I8 for both beams versus the proton beam losses in this intersection.

CONCLUSIONS The counting rates measured in the telescopes are rather proportional to multiturn current losses up to 10^9 particles. Monitor calibration coefficients are deduced and can be used to evaluate losses during machine operation (see page 4).

1. INTRODUCTION Several attemps (T. Risselada, A. Verdier and myself) have been made to measure the losses in I8 to ascertain the order of magnitude of beam loss during convential operation. The ion chambers are used to detect beam losses during set-up, stacking and uncontrolled beam losses. These have shown that I8 is a relatively clean area (compared to other intersects) with the present low β, Elsa machine. However Perrot and Bouriot (Ref. Cern - ISR-BOM/80-05, Fev. 1980) have shown that in 1979 the induced radiation in I8 has increased by one order of magnitude and this during a time when the collimator system was fully operational. We decided to investigate beam losses with the scintillator telescopes in a range below the threshold of the existing ion chambers and in particular, to quantify the beam losses in multiturn mode especially during scraping, shaving and acceleration process. The results can be used on line as a measure of collimation efficiency and as an investigation way of possible causes of the increased induced radiations in I8. Finally it is of interest for the stable operation of the super-conducting magnets in this area.

2. LOSSES IN I8 Horizontal bumps of + 20 mm were applied across I8 with HBUM (position 827 and 819) for Ring 1 and with HBUM (position 742 and 750) and RSET for Ring 2. Pulses were injected, kept bunched and accelerated slowly until a few mA were lost. The remaining circulating currents were dumped. Figures 1 and 2 give the beam loss distribution measured with the ionisation chambers.

3. MONITOR SET-UP (Figure 3) Each monitor is made of two scintillators (20 x 20 cm 2) in coincidence placed in the horizontal plane of the beams close to the pipe and separated by about 20 cm. For each beam we have 2 monitors, an upstream and a downstream placed respectively at about 4.5 and 7 meters from the intersection.

4. MEASUREMENTS Figures 4,5,6 and 7 give the counts of the UPI, DOI, UP2 and DP2 obtained during the current losses around I8. Measurements for each beam were done independently. For each beam lost we measured the coincidences (points) coincidences minus accidentals (crosses) and counts for a single scintillator of the coincidence (s).

5. RESULTS

5.1 - Losses in the ISR during experiment

In order to do calibration of the solid detectors installed around I8 during the experiment (see A. Perrot - Performance Report 17.6.1980) we noted with the PIDC the total beam injected, lost in I8 and dumped for each ring.

	Ring 2	Ring 2
Injected current Total	2000 mA	1500 mA
Losses around I8 Total	650	300
Dumped current Total	1350	1200

5.2 - Telescope Calibrations

Linear fits of coincidence (telescope) counts give the following slopes :

UPI	$.75 \times 10^6$	Counts/mA lost in the bumps.
DOI	2.2	"
UP2	1.7	"
DO2	2.6	"

This is valid for total losses in the intersection up to 5 mA above which counts are no longer proportional to losses. It can be assumed to be due to monitor saturation. With a 50 MHz electronic more than about 1.5×10^2

particles per 3.3μs (an ISR turn) cannot be counted. With the multiturn loss process of this experiment the measured limit of saturation is about 10^7 C/S in the telescopes.

From Figure 1 and 2 it can be seen that losses are not uniform in the intersection area due to α, β_H and β_V modulations. From ratio of ionisation chamber voltage at the position of each monitor over the total voltage induced by 1 mA lost in the bump we can deduce the approximate losses in each monitor vicinity.

Then with 2×10^{10} particles (1 mA) lost in I8 we estimate to have

1×10^8	particles lost in	UP1	vicinity	(0.5%)
2.6×10^8	"	DO1	"	(1.3%)
1.3×10^8	"	UP2	"	(0.7%)
4×10^8	"	DO2	"	(2.%)

Using these estimated real losses at the monitor position levels with telescope counting rates measured we get the calibration coefficients K :

UPI	1.3×10^2
DOI	1.2×10^2
UP2	0.8×10^2
DO2	1.5×10^2

The total number of particles N_T flying in the vicinity of each monitor is

$$N_T = K \times C$$

where C is the measured counting rate. Measurements are valid for <u>maximum rates</u> of about 10^7 C/S in the monitors corresponding to backgrounds of about 10^9 particles.

5.3 Applications

Several measurements were performed during ISR operation and we give here the results of beam losses evaluations in I8 using the monitor calibration coefficients K:

Operation	Monitor	C	N_T
Stacking R1 (31 Amps) with shaving from 170 to 140 mA	DO1 DO2	5.5×10^5 1.2×10^5	6.6×10^7 1.8×10^7
End of stacking (Beam 1 only)	DO1 DO2	3.5×10^2 0.15×10^2	4.2×10^4 2.2×10^3
* During acceleration to 31 GeV/c	DO1 DO1	3.2×10^5 (7 mA lost) 1.3×10^6 (21 mA lost)	3.8×10^7 1.6×10^8
Stable beams 30 x 31 Amps $L \sim 20 \times 10^{30}$	DO1 DO2 UP2	4.5×10^4 4.6×10^4 1×10^2	5.4×10^6 6.9×10^6 $.8 \times 10^4$
Beam 1 only stable 30 Amps	DO1 DO2 UP2	10^3 10^2 1	1.2×10^5 1.5×10^4 0.8×10^2

* Figure 8 shows the losses measured in DO1 during acceleration and for different current losses.

Further measurements could be done mainly during operation in beam 2.

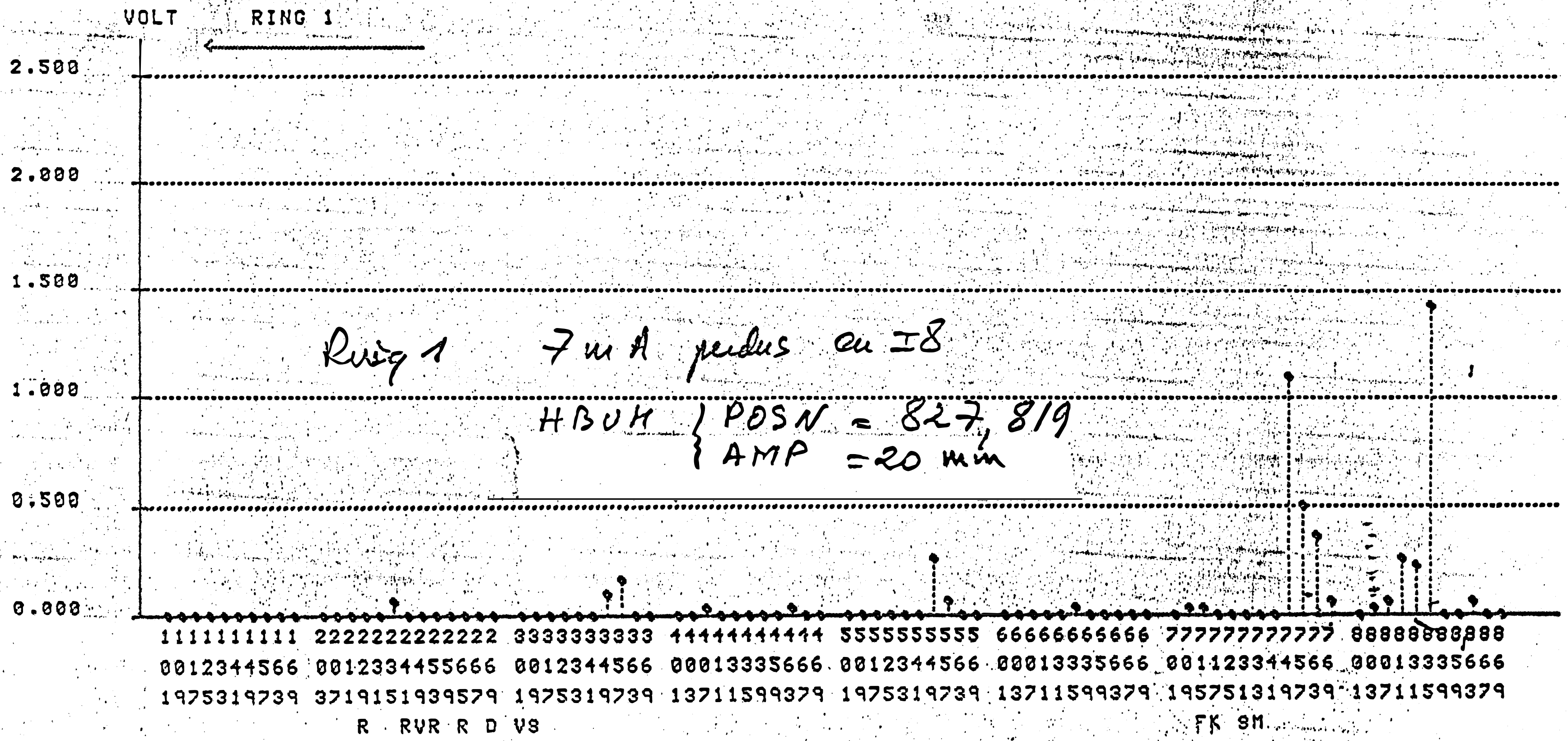
F. Lemeilleur.

ION CHAMBER READING

DATA READ: 80-05-30 AT 02H19M14S

RUN: 1128M ENERGY R1: 26.590 R2: 26.588 INITIAL CURRENT R1: 0.148 R2: 0.000

TRIGGER: IMMEDIATE INTEGRATION TIME: 10.000 SECS FINAL CURRENT R1: 0.041 R2: 0.000



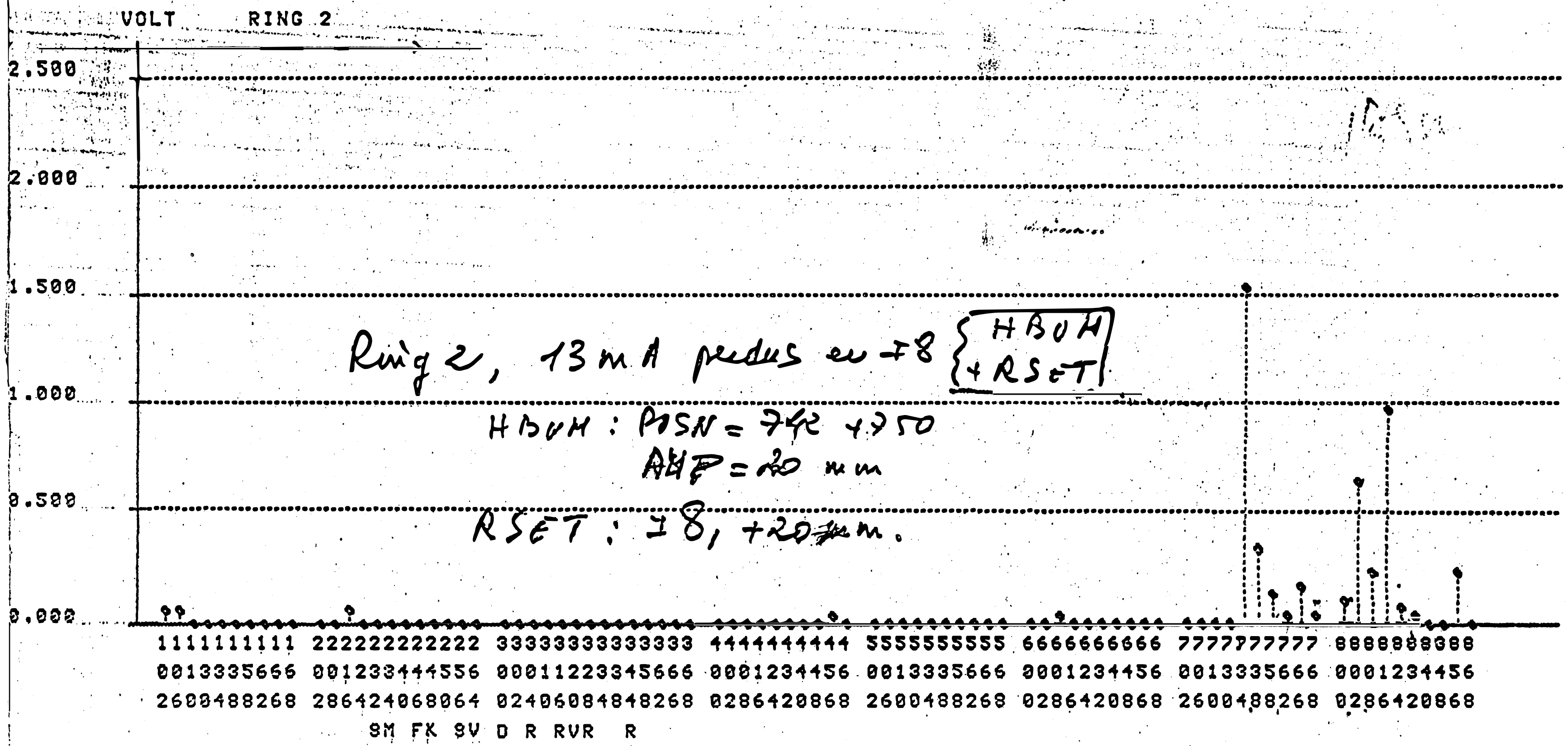
— figure 1 —

ION CHAMBER READING

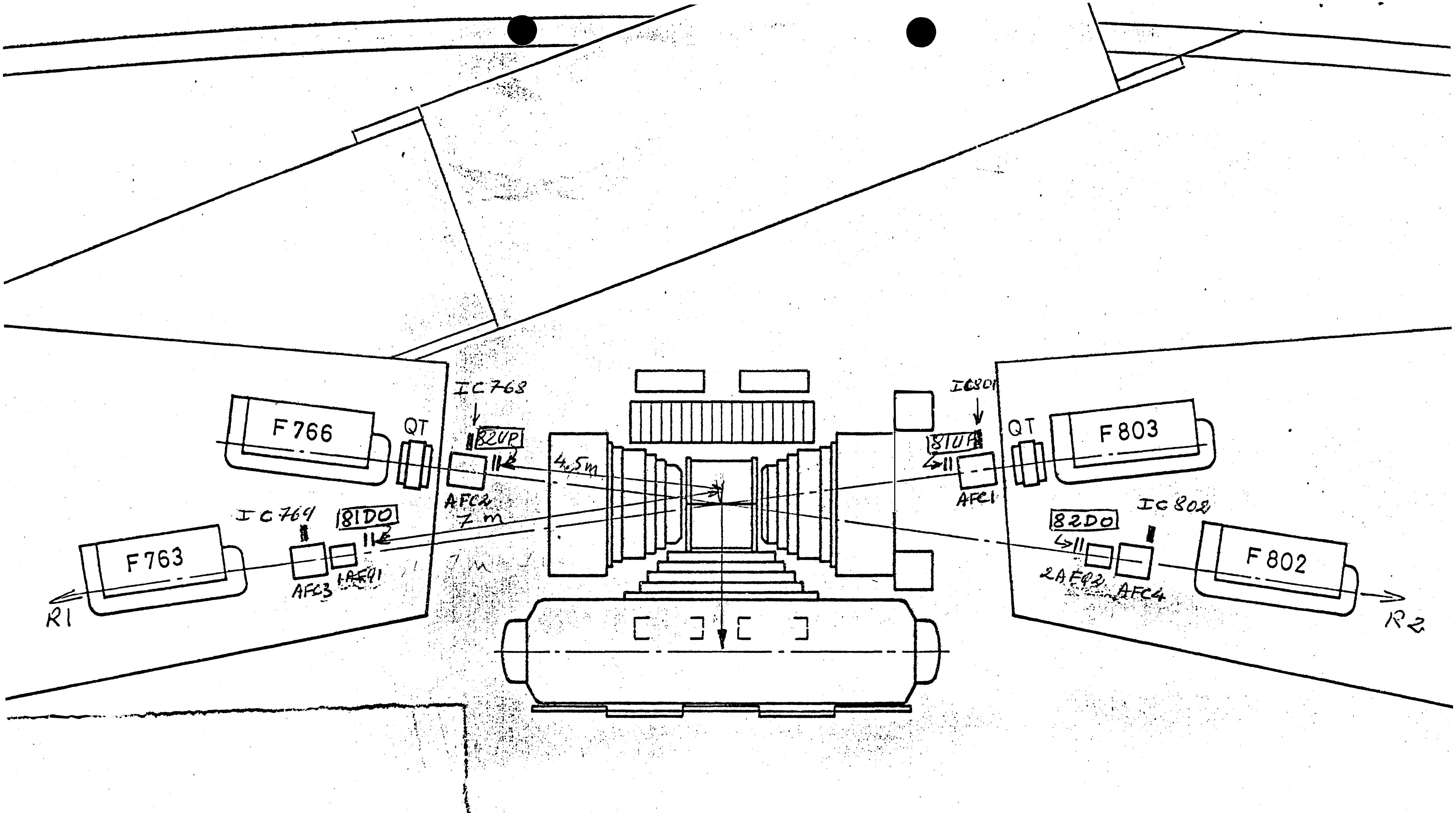
DATA READ: 80-05-30 AT 01H24M59S

RUN: 1128M ENERGY R1: 26.590 R2: 26.587 INITIAL CURRENT R1: 0.000 R2: 0.147

TRIGGER: IMMEDIATE INTEGRATION TIME: 10.000 SECS FINAL CURRENT R1: 0.000 R2: 0.134

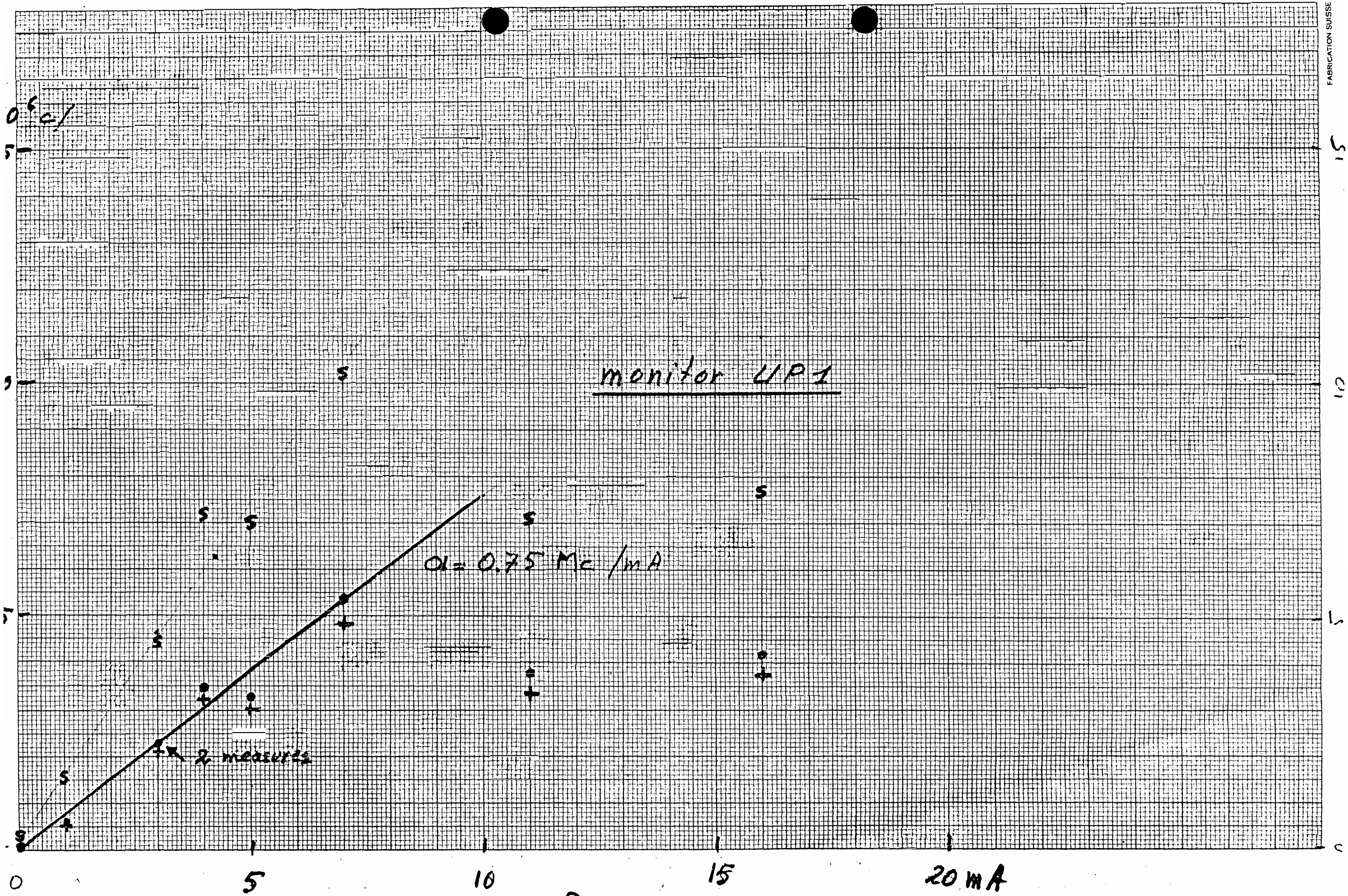


– figure 2 –



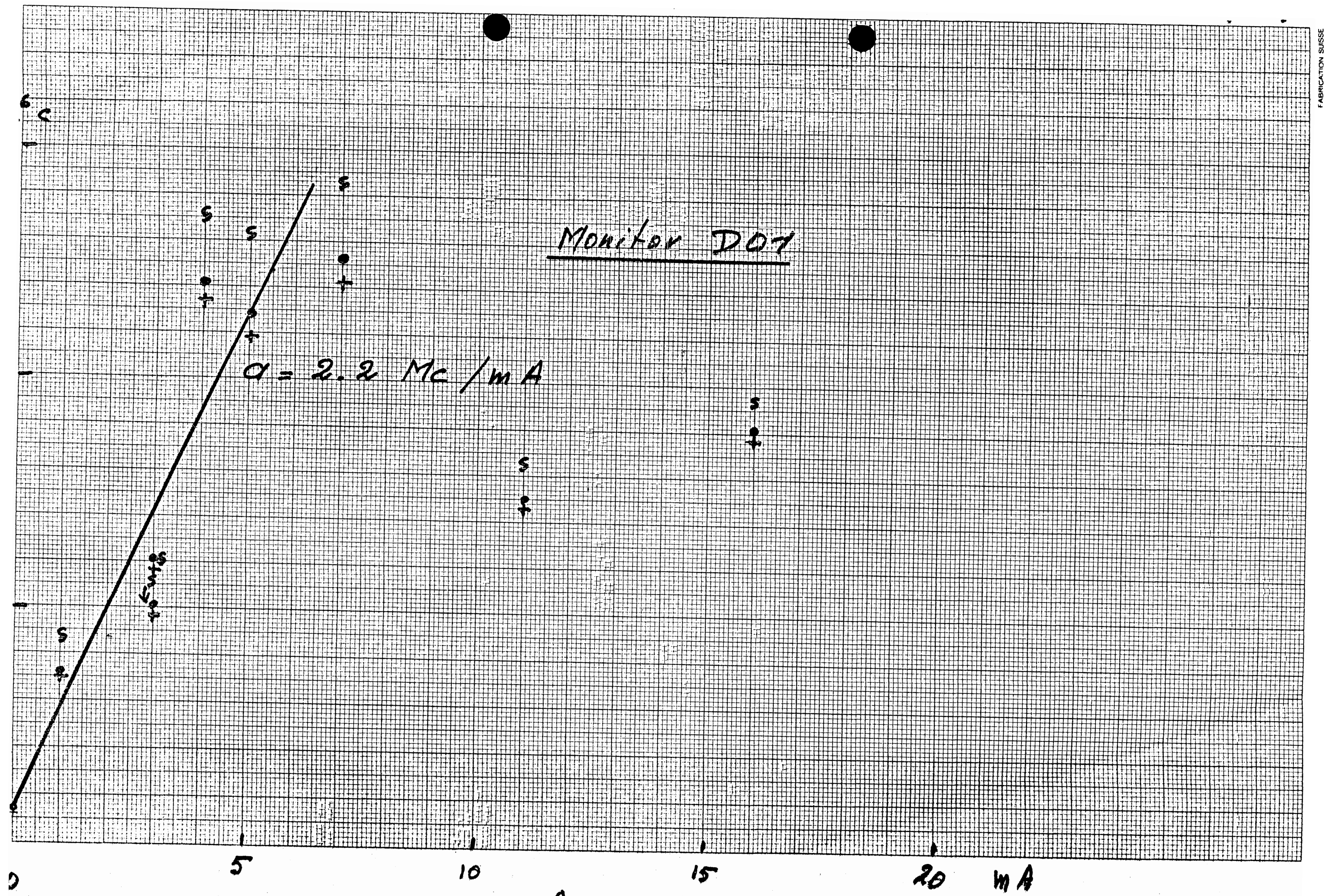
IC 768
82UP
AFC2
4,5 m
7 m
F 766
QT
IC 764
81DO
F 763
AFC3
1AFQ1
R1
IC801
81UP
AFC1
QT
F 803
IC 802
82DO
2AFQ2
AFC4
F 802
R2

– figure 3 –

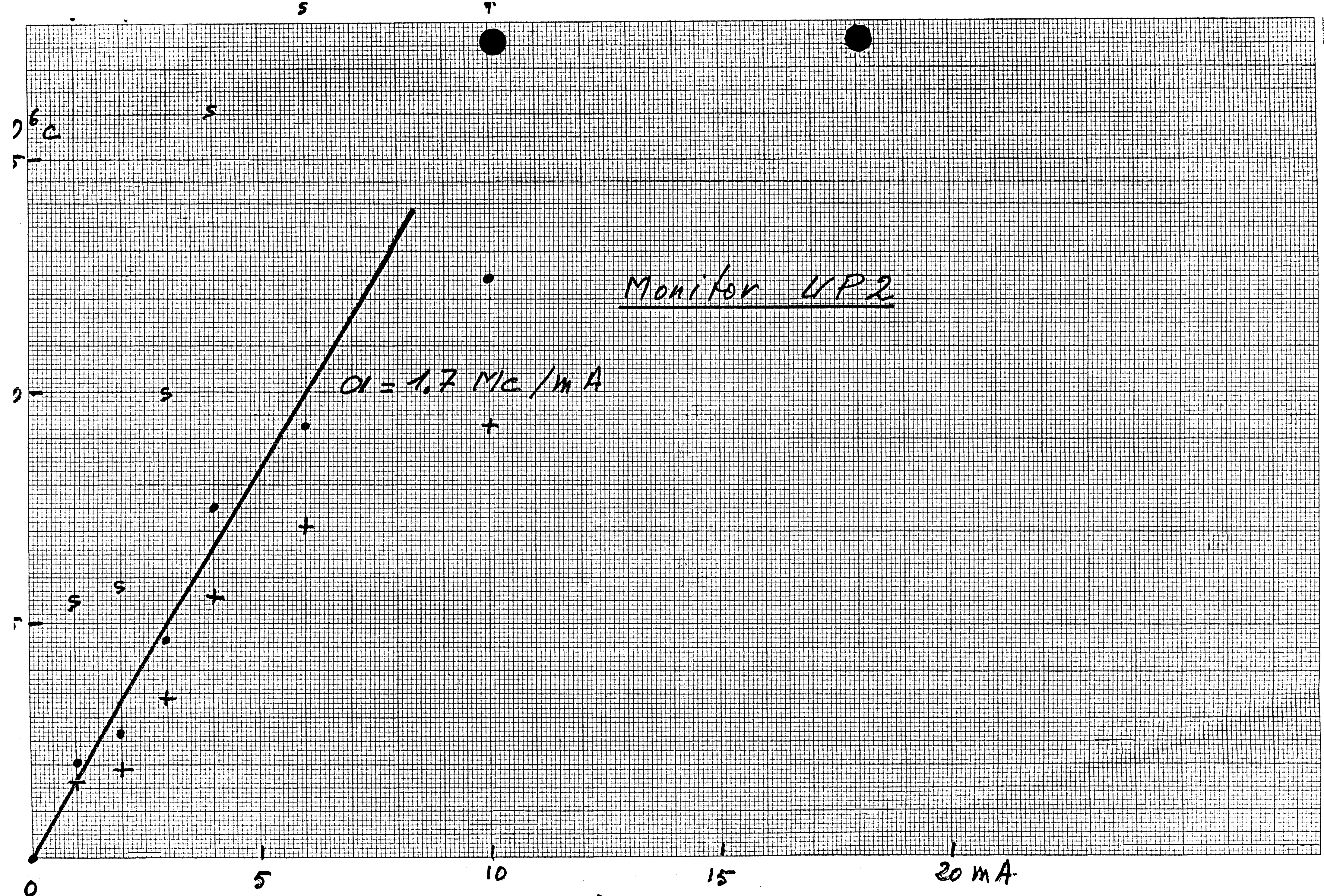


0^6 c/
monitor UP1
α = 0.75 Mc /mA
2 measures
0
5
10
15
20 mA
FABRICATION SUISSE

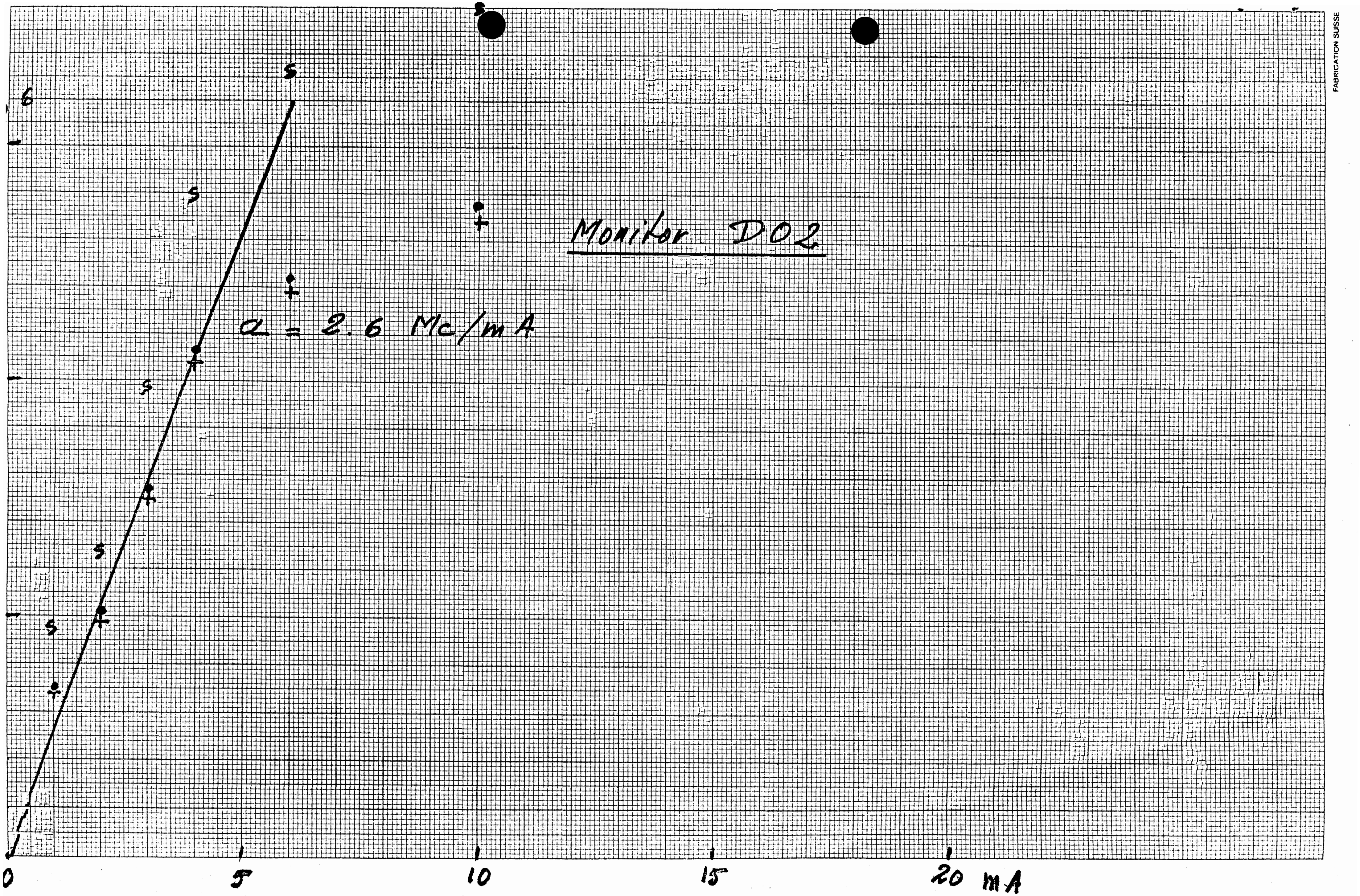
- Figure 4 -



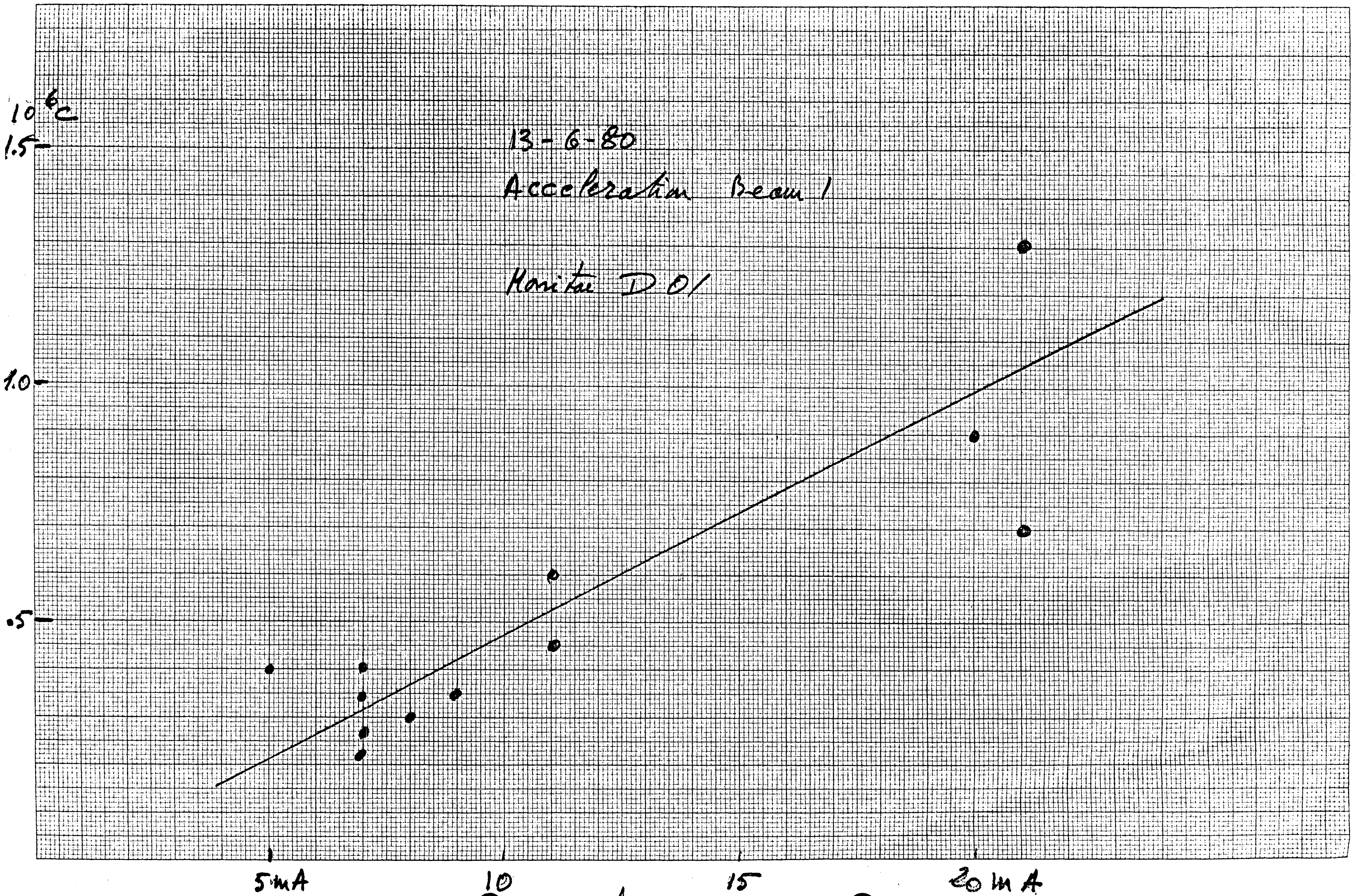
- figure 5 -



- figure 6 -



- figure 7 -



10⁶C
1.5
1.0
.5
13-6-80
Acceleration Beam 1
Monitor D01
5mA
10
15
20 mA

- fig 8 -