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ISR PERFORMANCE REPORT

STANDARD MONITOR STUDIES - PART I

Run 614, Both rings, 26.6 GeV/c, ELSA, SFM OFF

1. AIM

To measure the dependence of the standard monitor constant calibrations on the radial beam position. Results are also given for the I5 reference monitor.

2. EXPERIMENT

The ELSA W.L. was used to have the possibility of stacking at r = <+ 40 mm>.

2.1 Injection Optimisation

IOPY was running and we achieved :

	H	V
R1	2.0	0.4 mm
R2	0.7	1.0 mm

2.2 Closed orbit optimisation

EI26 was applied and corrected to decrease the orbit distortions. We finally obtained :

	Radial Position (mm)	H mm p to p	V mm p to p
R1	+40.2	13.6	5.
	+ 8.4	9.1	8.3
	-18.1	7.9	9.9
R2	+37.1	9.9	6.3
	+ 9.2	4.9	6.2
	-14.5	5.5	4.4

From these measurements, using HAMP for orbit analysis and INPO for orbit interpolation at each intersection, we obtained the theoretical optimum vertical positions, see fig. 1a.

2.3 Luminosity measurements

The first luminosity measurement was done with average beam positions <r> = 35 mm and the second measurement with <r> = -15 mm. The following table summarises beam positions:

		Intensity (A)	Radial positions <mm>
1st Stacks	R1	3.075	+ 35.5 ± 12.5
<+35> mm	R2	2.858	+ 34.8 ± 8.2
2nd Stacks	R1	2.686	- 14.0 ± 12.7
<-15> mm	R2	2.944	- 15.5 ± 10.0

The luminosity measurements were performed with vertical beam displacements of 0.5 mm using ELSA file for bumps. The integration time was 120 sec. Beam-beam, Accidental and backgrounds were recorded for all standard monitors, expect I3, and for the I5 reference monitor.

Optimum vertical positions, h_{eff} and monitor constants σ are obtained from Gaussian fits through BB-Acc counting rates versus the vertical beam positions $Z_1 - Z_2$ using the LUMA program.

The following table gives the results :

Intersection	Average Stack Positions <+35 mm>			Average Stack Position <-15 mm>		
	H_{eff} (mm)	Optimum Pos. $(Z_1 - Z_2)$ (mm)	Monitor Constant (μb)	H_{eff} (mm)	Optimum Pos. $(Z_1 - Z_2)$ (mm)	Monitor Constant (μb)
1	4.88	.38	104.6	3.11	.79	186.4
2	5.0	.26	31.8	3.28	.93	60.5
4	4.40	-.35	39.9	3.24	-.08	89.6
5	4.92	-.22	79.4	3.35	-1.05	147.4
6	4.90	-.24	21.5	3.26	-.80	46.1
7	5.30	.40	28.6	3.32	1.47	29.0
8	5.05	1.94	86.0	3.22	1.69	169.8
I5 Ref.	4.95	.17	632.	3.34	-1.03	611.1

2.4 Errors

a) Statistical errors

The integration times of 120 sec. gave beam-beam rate errors of ± 0.85% for the I5 reference monitor and from ± 2.1% for I1 to ± 4.2% for I7, depending on the monitor acceptances. Taking into account the fact that gaussian fits are done through several points, the error in determination of the beam-beam counts is less.

b) Vertical bump errors

A maximum error of 3% for vertical bumps of ± 3 mm at the central orbit with ELSA can be taken into account (P.R., ISR-ES-KP, Vertical bumps on W.L. ELSA, 10.1.75). The radial dependence of bumps is only known with FP line (ISR-ES-KP, 27.11.74), which shows bumps as 1.5% too small at <35 mm> and 1% too large at <-15 mm>. We can estimate that there is an error of about 5% on the vertical bumps.

c) H_{eff} and σ calculation errors

From the Gaussian fit of luminosity curves, we estimate that there is about 5% error in h_{eff} and σ calculations, the major part coming from the vertical bumps calibration. The total error in vertical optimum position determination is less than 0.05 mm.

3. OPTIMUM POSITIONS ANALYSIS

3.1 Tilt of horizontal planes

Fig. 1b shows the measured optimum positions for <+35> and <-15> mm stacks. The following table gives the respective tilts of horizontal planes for each intersection, measured by pick-ups and by monitors. It also gives the optimum positions obtained with both measurement systems.

	Intersection	I5 Ref.	I1	I2	I4	I5	I6	I7	I8
TILTS (mR)	Pick-ups	+22.0	-14.0	- 8.4	-11.6	+22.0	+12.0	-15.6	+4.0
	Monitors	+17.2	- 8.0	-13.2	- 5.2	+16.0	+10.8	-21.6	+4.6
Optimum Positions (mm)	Pick-ups	- 1.10	+ 0.8	+ .74	- 0.02	- 1.10	- 0.5	+ 1.03	+0.48
	Monitors	- 1.04	+ 0.8	+ .92	- 0.08	- 1.02	- 0.8	+ 1.48	+1.7

The slopes and optimum positions are more or less in agreement for both measurements except in I8 where there is a good agreement for the slope but a very big difference in the optimum position (1.2 mm). This could be due to bad vertical pick-up positions near this intersection.

3.2 Evaluation of decrease in luminosity due to Tilts

Taking into account the tilts of the horizontal planes and using G. Guignard's calculations, we get a maximum decrease of 1.7% and 4.2% in luminosity for h_{eff} = 5 mm and 3.2 mm respectively, and for a tilt of 20 mR.

3.3 Standard and Reference Monitors in I5

The very good agreement between the two monitors in I5 (for the slope as well as for the optimum position) lends confidence to the measurements.

4. H_{EFF} ANALYSIS

4.1 Figure 2a shows h_{eff} measurements for each intersection for <+35> and <-15> mm radial positions.

We can see that for the same injection intensity and shaving, h_{eff} is much smaller at <-15> mm. This result corresponds to the blow-up observed at the top of the stack with ELSA line.

4.2 Figure 2b shows the variations of h_{eff} in per cent for each intersection, compared with the value given by the I5 reference monitor. It is difficult to explain the high discrepancies (up to 11%); the influence of the horizontal plane tilts does not appear to be the major contributing factor.

5. MONITOR CALIBRATION CONSTANT σ

Figure 3 shows the values for σ for the two radial positions and the following table shows the variations for σ from <-15> to <+35> mm.

Intersection	I5 Ref.	I1	I2	I4	I5	I6	I7	I8
$\frac{\sigma\ <+35>}{\sigma\ <-15>}$	-0.034	0.44	0.47	0.55	0.46	0.53	0.014	0.49

We can see that σ for I5 Ref and I7 are more or less independent of the radial position and are, in fact, inside the experimental error. This lends confidence to the luminosity measurement performed with the reference monitor in I5 and with the standard monitor in I7, where the low-β section is installed. Both monitors are placed either above or below the pipe and their acceptance is constant for particles coming from any part of the interaction diamond. For the other standard monitors placed radially to the pipe, the strong dependence of σ on the radial position (a factor of about 2) could mainly be explained by the radial inhomogeneity of their acceptances when the origin of the interactions is displaced along the radial axis.

Due to the geometry of the machine, the monitors placed in the uneven intersections are nearer the diamond and their acceptance is greater. Furthermore, the counting rates are strongly dependent on the material which the particles have to cross to go out of the pipe. This explains why the σ of I8 is very high, the vacuum chamber being very transparent to particles in this intersection. More details and calculations for each specific intersection are being prepared but the general behaviour of σs is relatively well understood.

6. CONCLUSIONS

The strong dependence of the tilts of horizontal planes on the radial positions for ELSA line explains the optimum position change from one run to another, conditions and positions of the stacks never being exactly the same.

From the intrinsic characteristics of the actual monitors (mainly their positions) the strong dependence of their calibration constants on the radial position does not permit systematic deduction of h_{eff} and luminosity at each intersection. However, from a fast steering after filling, with 2 or 3 points on each side of the curves, we can deduce not only the optimum positions but also the real h_{eff} for each intersection with an accuracy of about 5 per cent.

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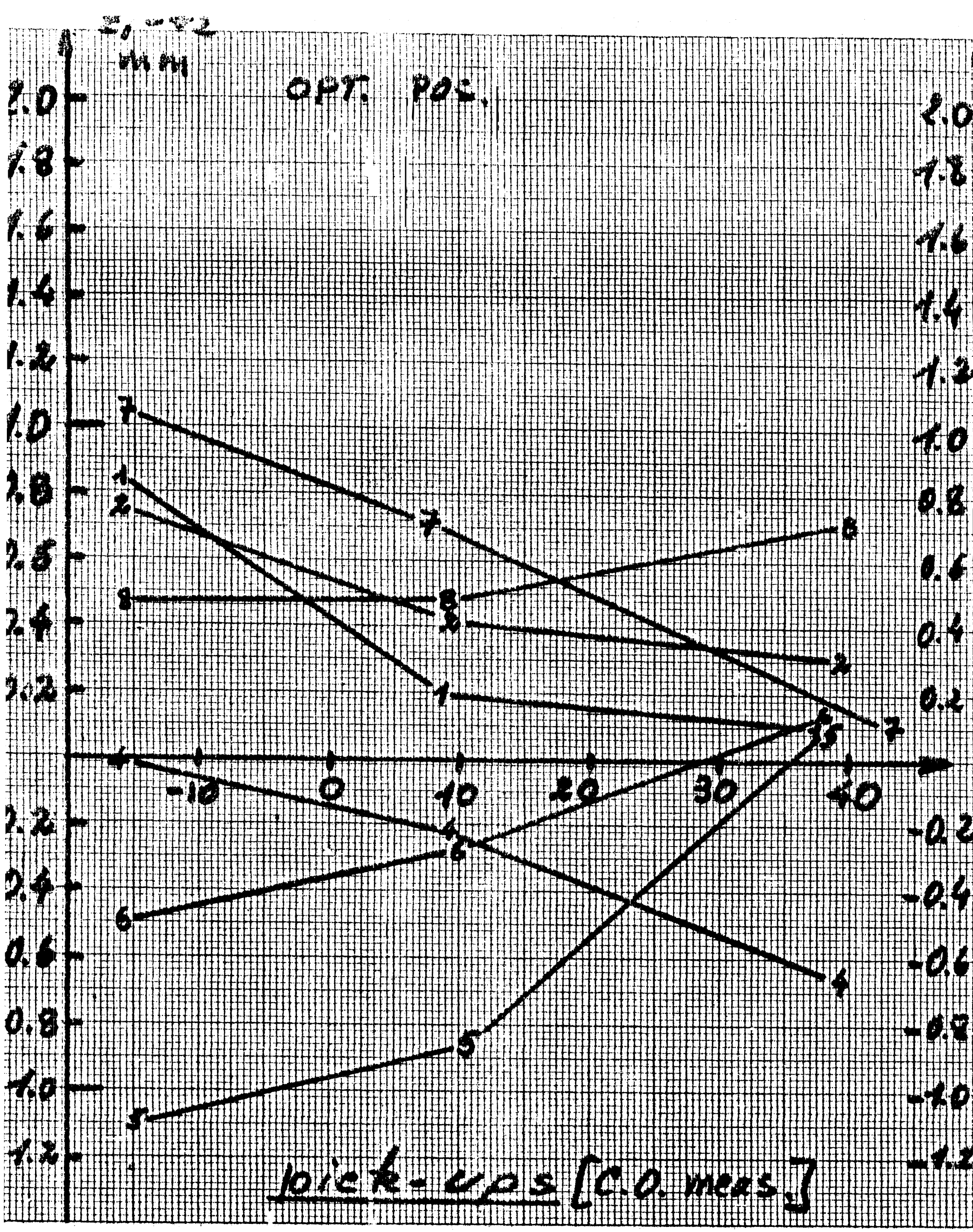
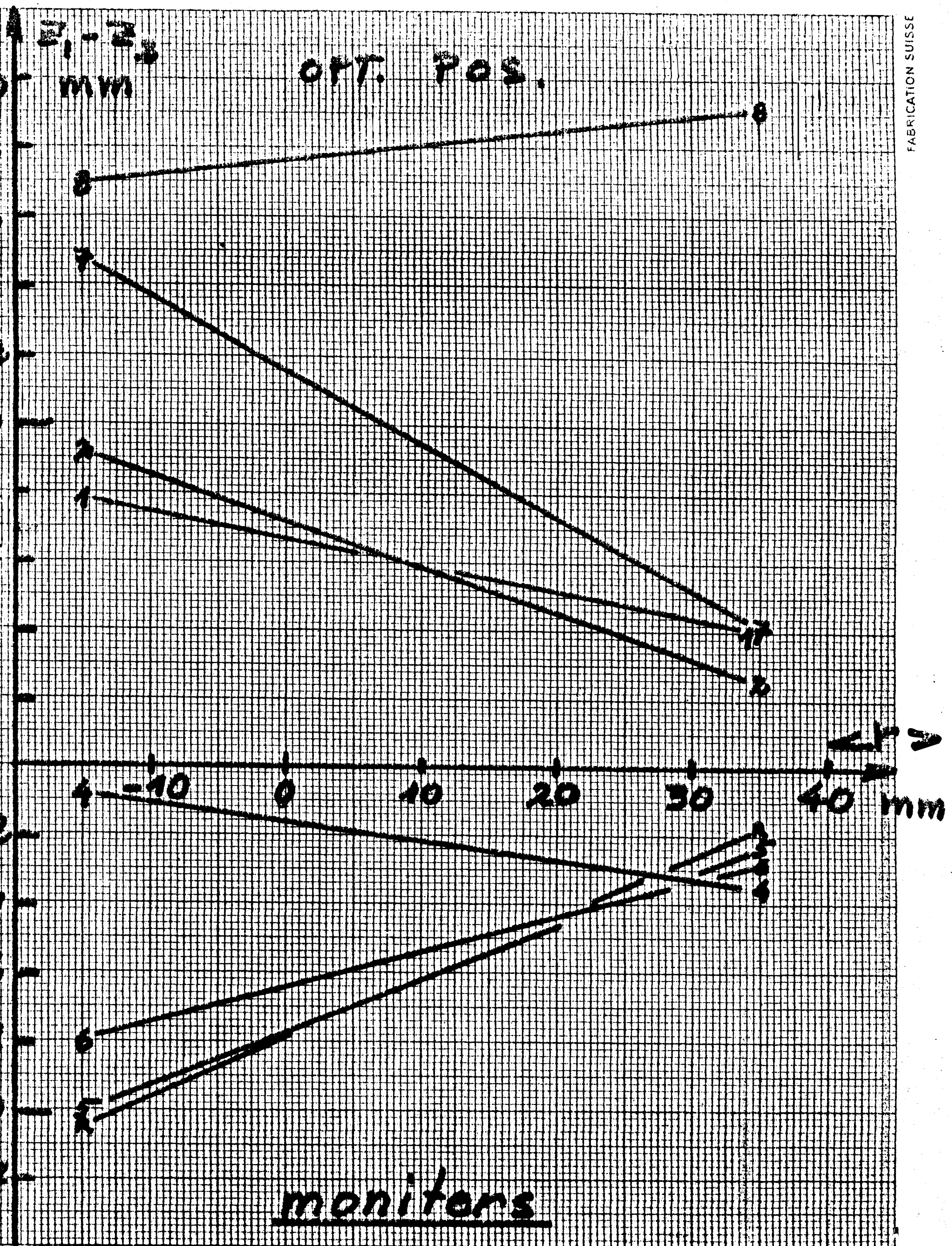
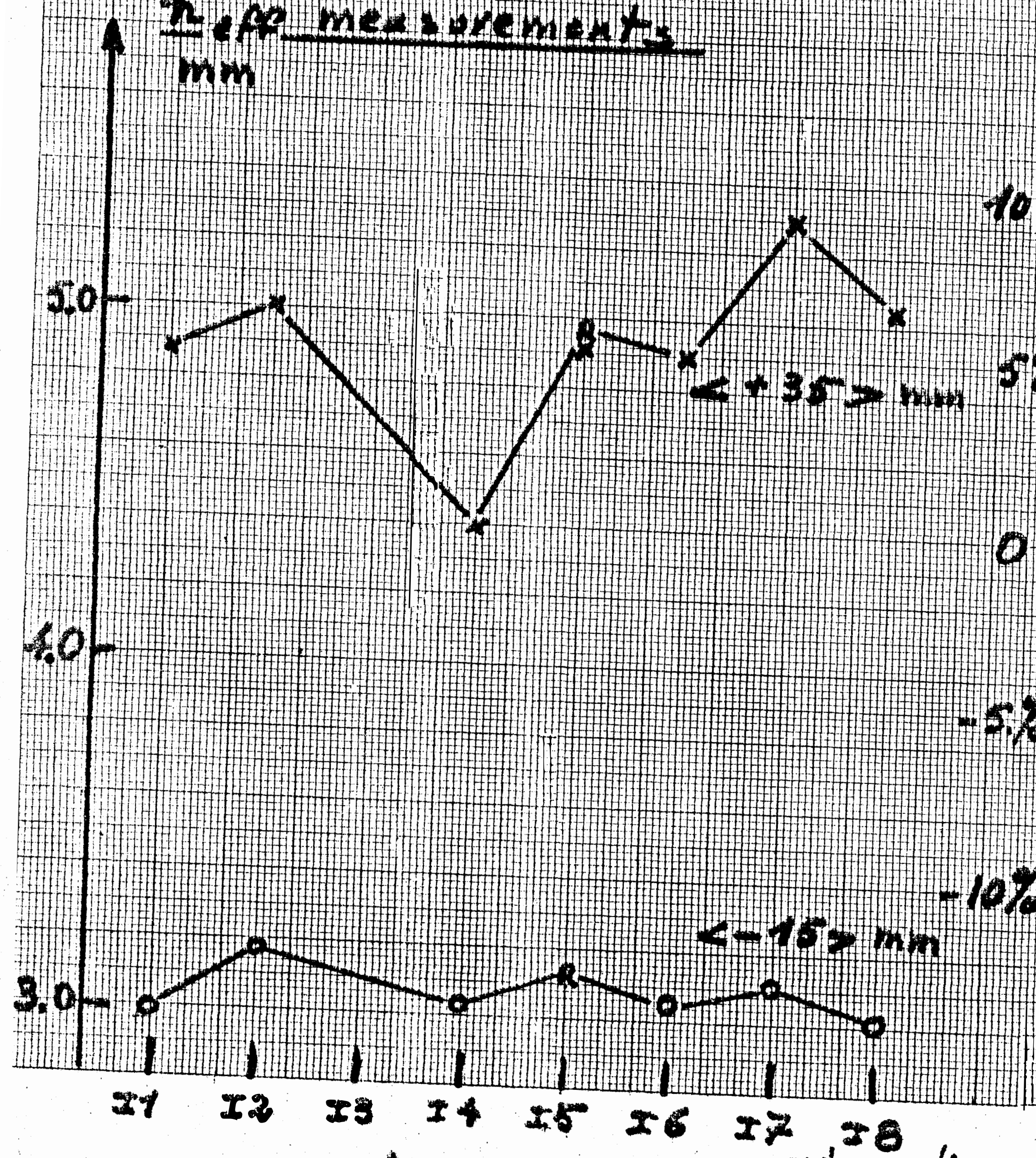


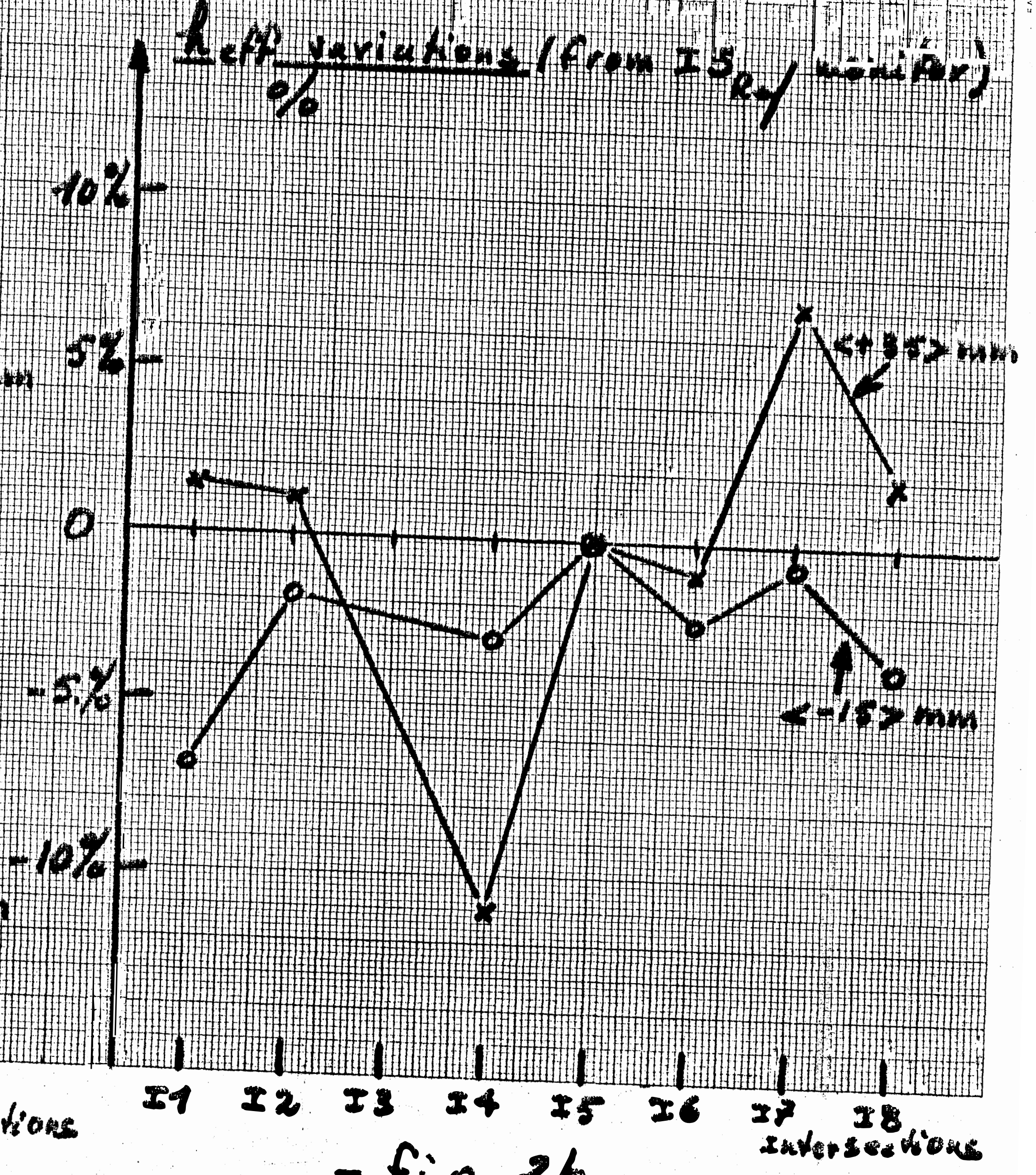
- fig 1a -



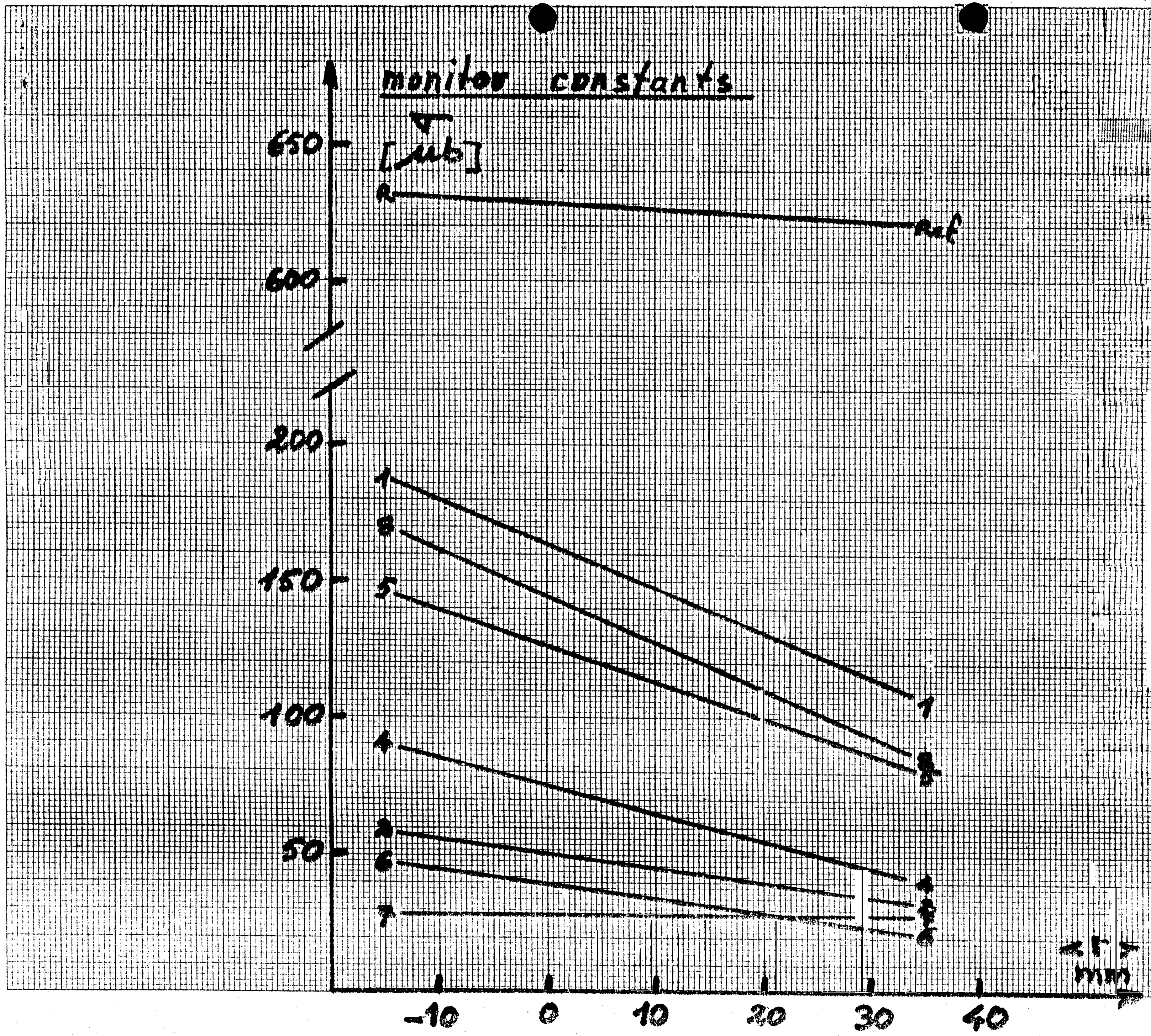
- fig 1b -


h eff measurements
mm
5.0
4.0
3.0
<+35> mm
<-15> mm
I1
I2
I3
I4
I5
I6
I7
I8
Intersections

- fig 2a -


h eff variations (from I5 rel/ monitor)
%
10%
5%
0
-5%
-10%
<+35> mm
<-15> mm
I1
I2
I3
I4
I5
I6
I7
I8
Intersections

- fig 2b -



— Fig. 3 —

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