Mlle P. SHINNIE E-6

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ISR PERFORMANCE REPORT

Run 656 - 26.6 GeV/c - both rings - 8S (SFM on) 11/11/75

1. AIM

To measure the radial dependence of the calibration constants of luminosity monitors used by the physics groups, of the reference monitor installed in I5 and of the standard monitors.

2. CONCLUSIONS

- The physics monitors installed in I2, I6 and I8 and the I5 Reference monitor show a radial dependence which could be explained by momentum spread across the aperture (~ 8% of σ variation).
- The I4 and I7 physics monitors are strongly dependent on the radial position.
- For the standard monitors, the results of run 614 (P.R. of 11/11/75) have been confirmed. The strong radial dependence (a factor of 2) is mainly due to the scintillators set on the side of the vacuum pipe. Two other geometrical configurations tried in I1 did not improve the results.

  On the other hand, the I7 standard monitor, placed vertically above the beam pipe, behaves similarly to the accurate physics monitor.

3. EXPERIMENT

3.1 Stack parameters

In order to obtain accurate vertical bumps and to be able to stack from <+40> to <-20> mm, we used 8S working line (SFM on) displaced below the diagonal. The CO 26 Closed orbit file was used.

We obtained three stacks successively with the following characteristics :

		Currents (A)	Positions (mm)	Average Position (mm)	Momenta (GeV/c)	Average Momenta (GeV/c)
Stack 1	Beam 1	3.541	39.7/28.0	33.9 ±5.9	27.128/26.969	27.049
<+34> mm	Beam 2	3.692	40.6/27.8	34.2 ±6.4	27.141/26.967	27.054
Stack 3	Beam 1	3.473	5.7/-8.0	-1.2 ±6.9	26.665/26.479	26.572
<0> mm	Beam 2	3.197	7.3/-3.7	+1.8 ±5.5	26.668/26.537	26.603
Stack 2	Beam 1	3.986	-8.2/-20.6	-14.4±6.2	26.476/26.306	26.391
<-14> mm	Beam 2	2.996	-8.8/-20.3	-14.6±5.8	26.468/26.311	26.390

3.2 Measurements

Luminosity measurements were performed using FPSM bump file. Beam-beam integration time was 100 sec.

All the physics groups were present to take data. Their results will be compared with those of the standard monitors.

In I1 three different sets of standard monitors placed at different positions were tested in order to compare the radial dependences.

$I\text{-}1_{St.}$ normal one, taking inelastic events

$I1_{in+el.}$ taking elastic and inelastic events

$I1_{in.}$ taking inelastic events with dissymmetric angles.

For the I5 reference monitor we tested two different electronic settings, the normal one using 12 scintillators, and the other one using only 8 of the 12. We did not obtain a significant difference as shown in Table I.

For the three different radial stacks, Table I gives the optimum positions, h_{eff} and σ, fitted from Gaussians (LUMA program) or obtained from physics groups.

4. RESULTS

4.1 Optimum positions

Taking into account the real stack positions at the intersections ($r_{int} = \langle r \rangle \times \frac{\alpha_{pint}}{\bar{\alpha}_p} = \langle r \rangle \times 1.18$) we can deduce the respective tilt of the beams in the horizontal plane. Table II gives the results.

The tilt of the beams in the horizontal plane gives a luminosity decrease for final stacks. An evaluation has been made by G. Guignard, ISR-OP/73-56 :

$$1 - \frac{L}{L_1} \simeq a\, \theta^2$$

with $1 - \frac{L}{L_1}$ expressed in %.

$$a = 1.2 \times 10^{-2} \times \left(\frac{3.5}{h_{eff}}\right)^2$$

θ = angle of tilt in mrad.

For a stack filling all the aperture of the ISR, and for $h_{eff} = 3.5$ mm, the decrease of luminosity is 1.2% for a 10 mR tilt.

We can deduce from these results (Table II) that the loss of luminosity for high intensity stacks (8S working lines) is less than 1%.

4.2 Effective heights

Fig. 2 shows for each stack the discrepancies in h_{eff} (in %), measured at each intersection, and compared to the I-5 reference monitor. The results agree to within 4% for the physics monitors (and the I-5 reference monitor) and to 6% for the Standard monitor.

4.3 Monitor constant calibration

Figure 3 and 4 show the variation of monitor constants for the 3 radial measurements performed.

a) Physics and I-5 reference monitors (fig. 3a)

The I2, I5, I6 ("elastics") and I8 variations agree for the most part, with the exception of some discrepancies for I8 centered stacks.

The variations of monitor constants with radial positions can be easily explained by momentum dependence. For the I-5 reference monitor, taking monitor constants from previous runs at 22.5, 26.6 and 31.4 GeV/c, we found a variation of about 65 μb/GeV/c at 26.6 GeV/c (fig. 5a). If we apply this momentum dependence of σ to the stacks of this experiment, we obtain the fig. 5b, which fits the $I\text{-}5_{Ref.}$ experimental curve to better than 2%. For I4 ("F1F2") and for I7 ("M") the strong monitor constant dependence cannot be explained by momentum spread only.

b) Standard monitors

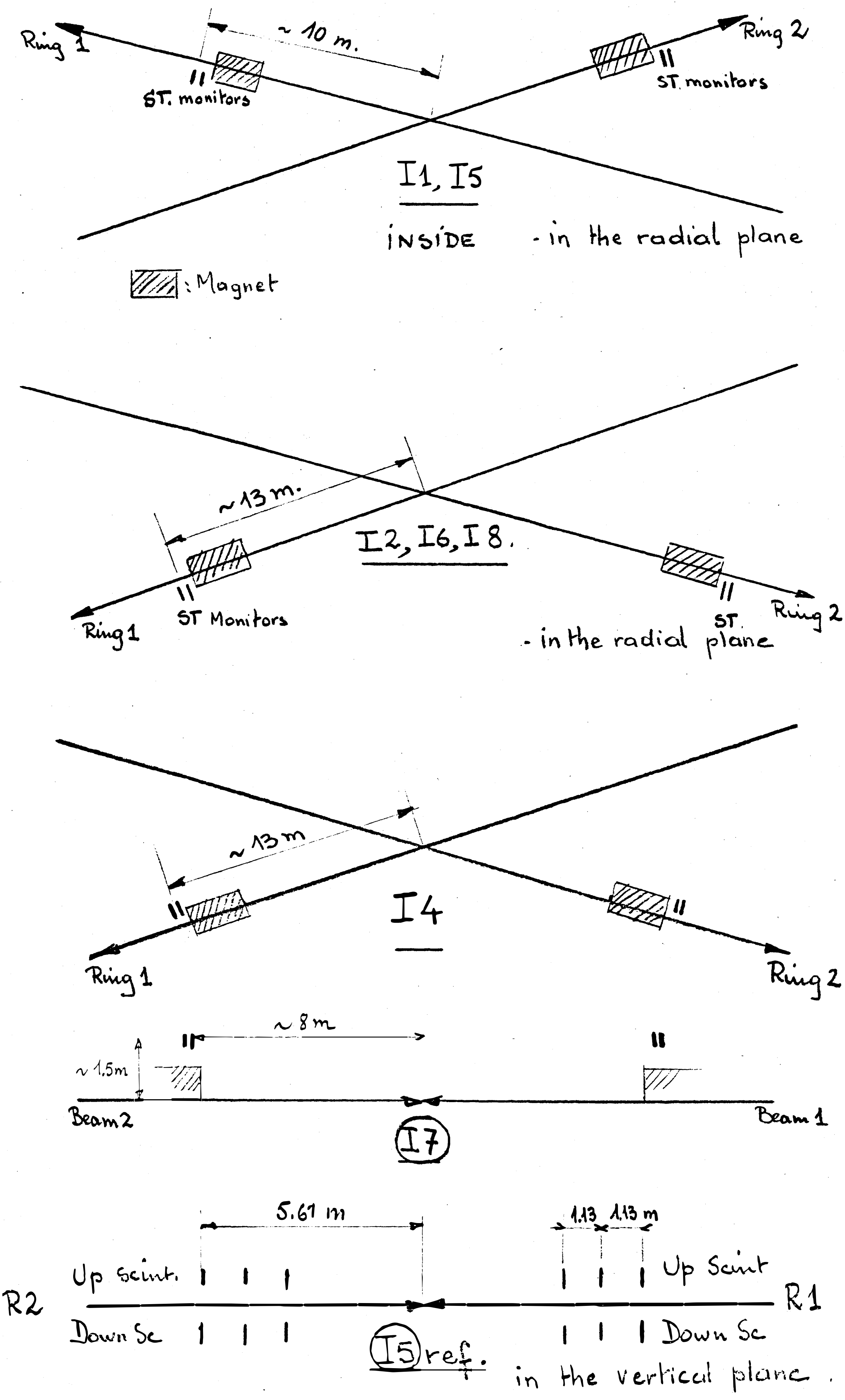
Figure 3b shows the radial dependence of standard monitors (except for I2 and I3) which take inelastic events. The monitors installed in I1, I5, I6 and I8 are strongly radial dependent. This could be explained by the radial positions of scintillators in the forward downstream direction at a place where the slope of the differential cross section $\frac{d\sigma_{pp}}{d\theta}$ is very high.

This is confirmed by fig. 4b where two different sets of scintillators, positioned at opposite angles in I4 are compared; one set is placed radially inside the arc of the machine and the other one outside. The curves are very symmetric.

Fig. 4a shows the results of different set-ups in I1, each placed radially in different configurations. These trials which were intended to be less radial dependent, were unsuccessful.

Finally, the monitor placed in I7 at a large angle above the beam pipe, shows a radial dependence very similar to that which we obtain with accurate physics monitors. We are able, for this reason, to give good luminosity values in this interestion.

F. Lemeilleur, R. Olsen, T. Verbeeck


Ring 1
~ 10 m.
Ring 2
ST. monitors
ST. monitors
I1, I5
INSIDE
- in the radial plane
: Magnet
~ 13 m.
I2, I6, I8.
ST Monitors
Ring 1
ST.
Ring 2
- in the radial plane
~ 13 m
I4
Ring 1
Ring 2
~ 8 m
~ 1,5 m
Beam 2
Beam 1
I7
5.61 m
1.13
1.13 m
Up Scint.
Up Scint
R2
R1
Down Sc
Down Sc
I5 ref.
in the vertical plane.

— Fig. 1 —

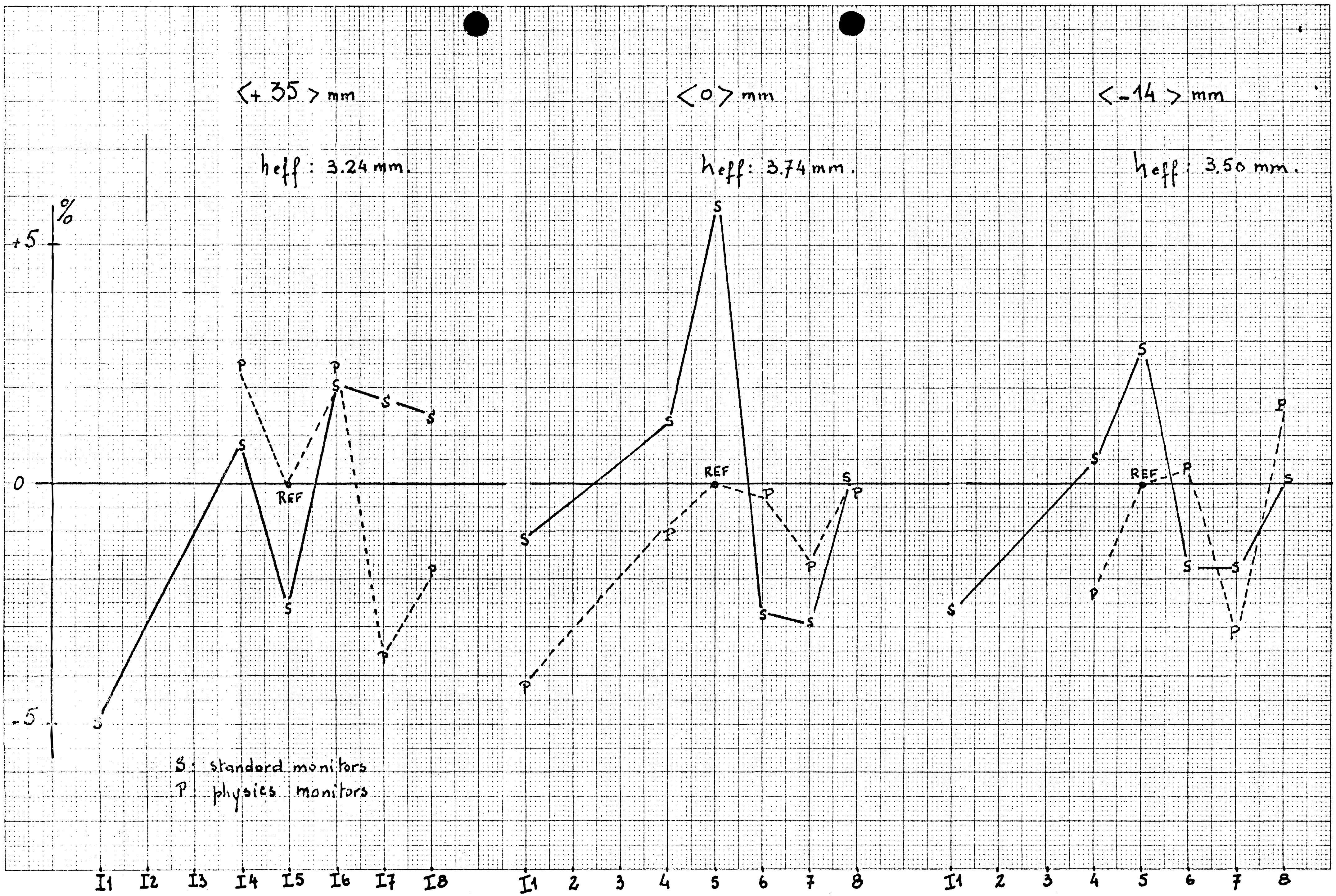
Monitor set	Optimum Position (mm)			heff (mm)			σ (μb)			σ variations ($\frac{\sigma}{\sigma_{max}}$)		
	<+35>	<0>	<-14>	<+35>	<0>	<-14>	<+35>	<0>	<-14>	<+35>	<0>	<-14
ST	-.02	-0.01	0.01	3.08	3.7	3.41	79.94	94.85	118.83	.67	.80	1
D1D2	-.32	.03	.02	2.93	3.79	3.44	62.08	113.86	113.80	.55	1	1
U_1U_2	-.13	0.0	0.0	3.17	3.68	3.47	33.61	52.44	53.56	.63	.98	1
4 ST	0.0	-.14	-.21	3.27	3.79	3.52	30.28	21.27	14.66	1	.70	.48
5 ST	0.0	.1	.2	3.16	3.96	3.60	83.55	141.42	146.71	.57	.96	1
6 ST	-.13	.04	.02	3.31	3.64	3.44	27.43	58.77	48.46	.47	1	.82
7 ST	-.13	.08	.10	3.30	3.63	3.44	25.87	25.53	23.71	1	.985	.915
8 -	.15	.31	.32	3.29	3.75	3.50	71.27	144.36	157.46	.45	.92	1
1 PH						3.35			610.0			
2 PH							256.5	237.7	232.1	1	.927	.905
4 PH	.06	-.12	-.22	3.32	3.71	3.42	130.3	111.7	106.95	1	.857	.821
6 PH	-.10	.02	.03	3.31	3.73	3.51	10978.	10248.	10055.	1	.933	.916
7 PH	-.03	.14	.07	3.13	3.68	3.39	3222.	3886.	3965.	.813	.980	1
8 PH	.12	.275	.310	3.18	3.75	3.56	471.6	457.6	430.1	1	.97	.912
5 REF Scint.	0.0	.17	.20	3.24	3.74	3.50	647.6	604.11	599.12	1	.933	.925
5 REF Scint.	0.0	.18	.20	3.23	3.73	3.50	833.65	779.04	771.63	1	.935	.920

Table I

Tilts (mrad)

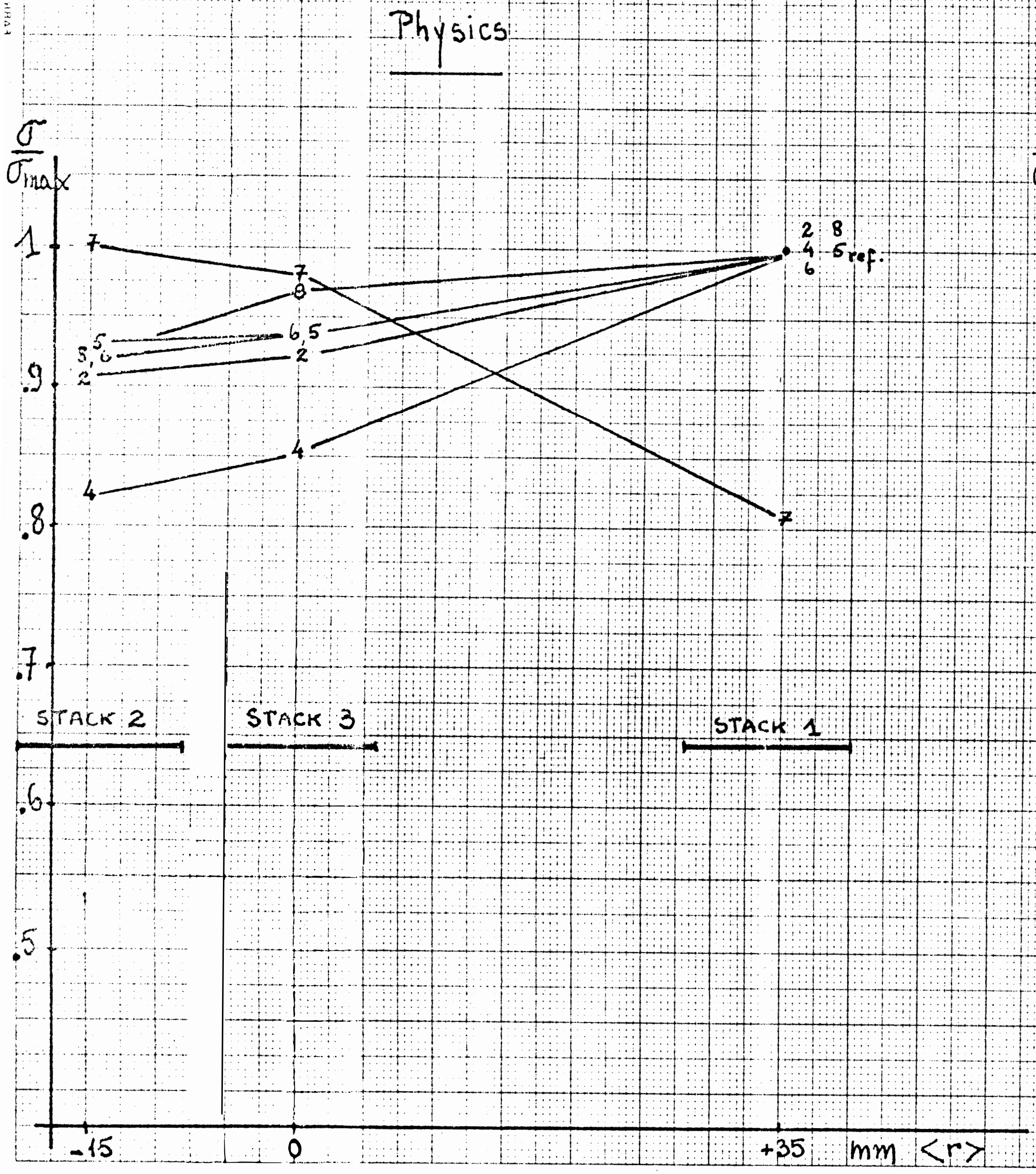
	From <+35> to <0> mm	From <0> to <-14> mm
I1 ST	-.24	1.21
I1 PH	—	—
I2 ST	—	—
I2 PH	—	—
I4 ST	3.42	-4.24
I4 PH	1.45	-6.06
I5 ST	-2.42	6.06
I5 REF.	-4.12	1.82
I6 ST	-4.12	-1.21
I6 PH	-1.93	.61
I7 ST	-5.08	1.21
I7 PH	-4.12	-4.24
I8 ST	-3.87	.61
I8 PH.	-3.75	2.15

Table II

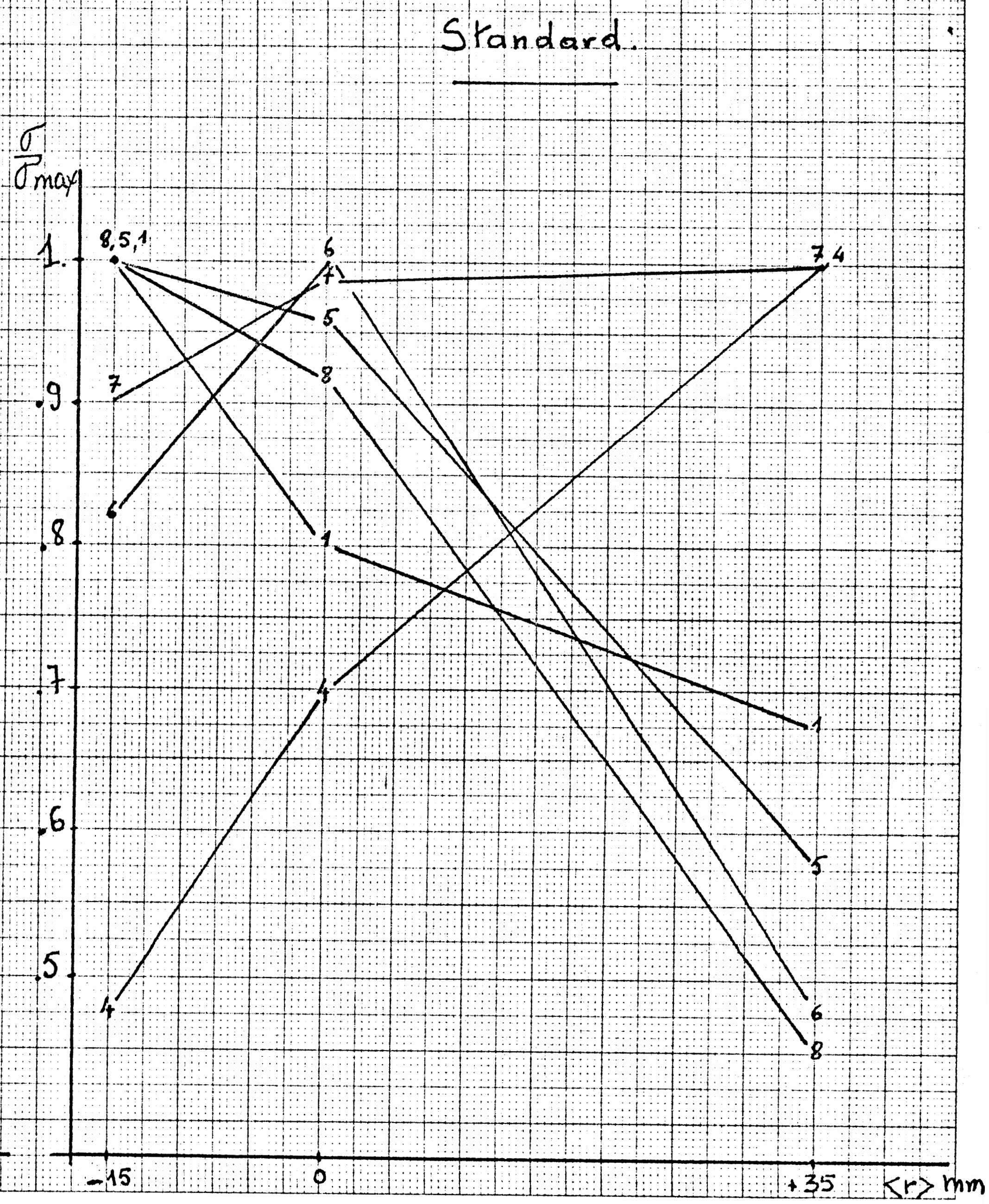


<+35> mm
heff : 3.24 mm.
<0> mm
heff : 3.74 mm.
<-14> mm
heff : 3.50 mm.
%
+5
0
-5
REF
S : standard monitors
P : physics monitors
I1 I2 I3 I4 I5 I6 I7 I8
I1 2 3 4 5 6 7 8
I1 2 3 4 5 6 7 8

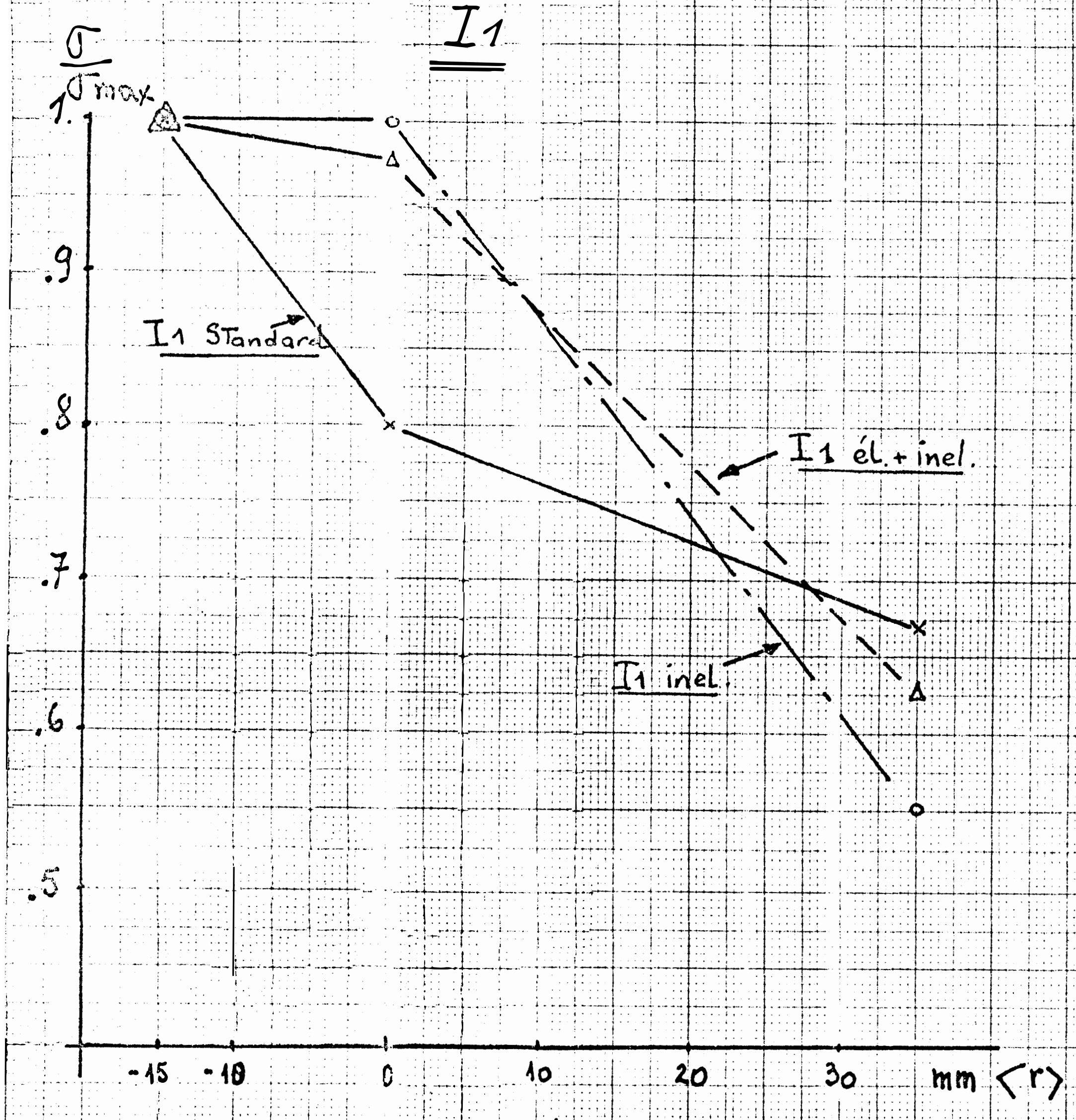
- Fig. 2. -


Physics
σ / σ_{max}
1
.9
.8
.7
.6
.5
-15
0
+35
mm <r>
$\sigma_{ref.}$
STACK 2
STACK 3
STACK 1

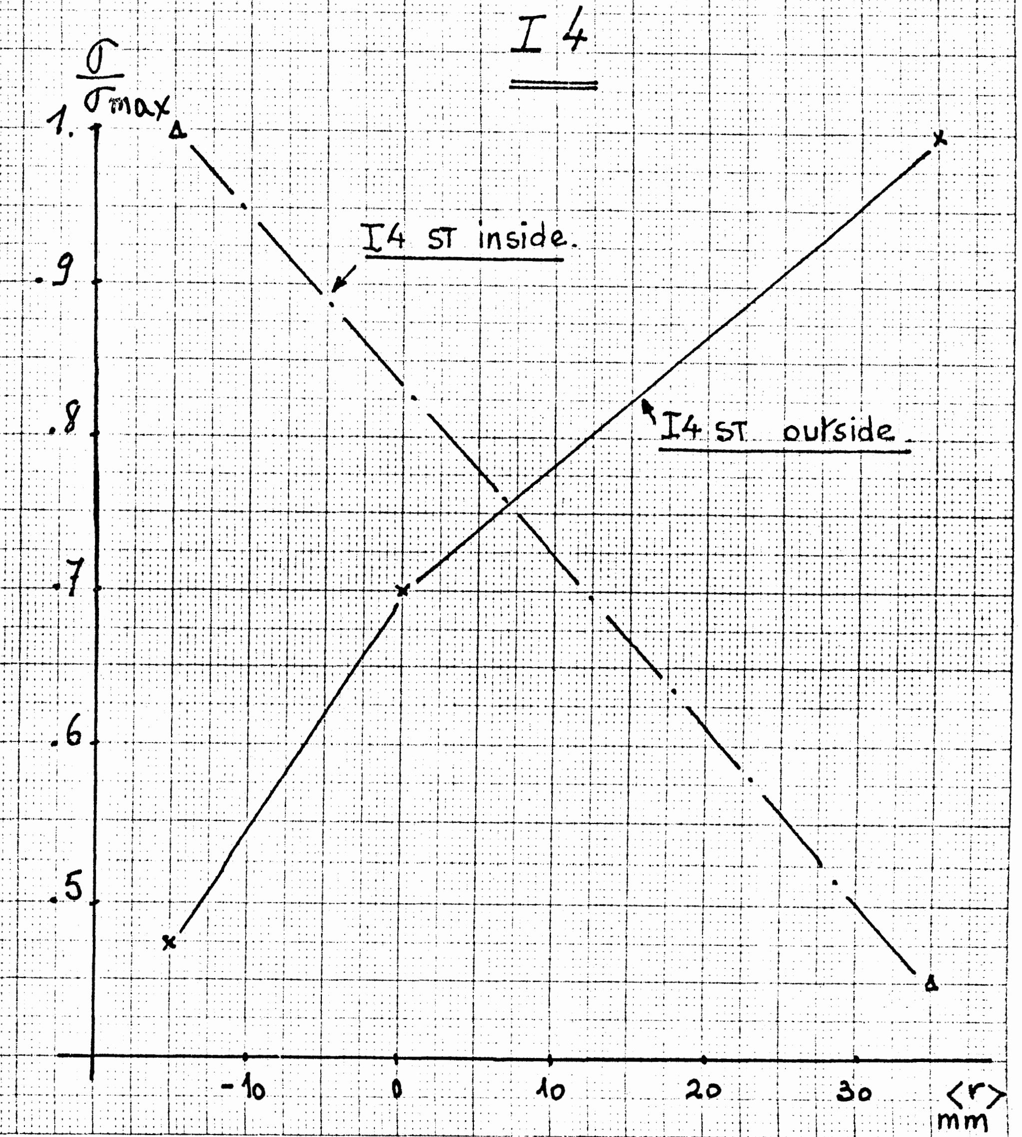
- Fig. 3a. -


Standard.
σ / σ_{max}
1.
.9
.8
.7
.6
.5
-15
0
+35
<r> mm

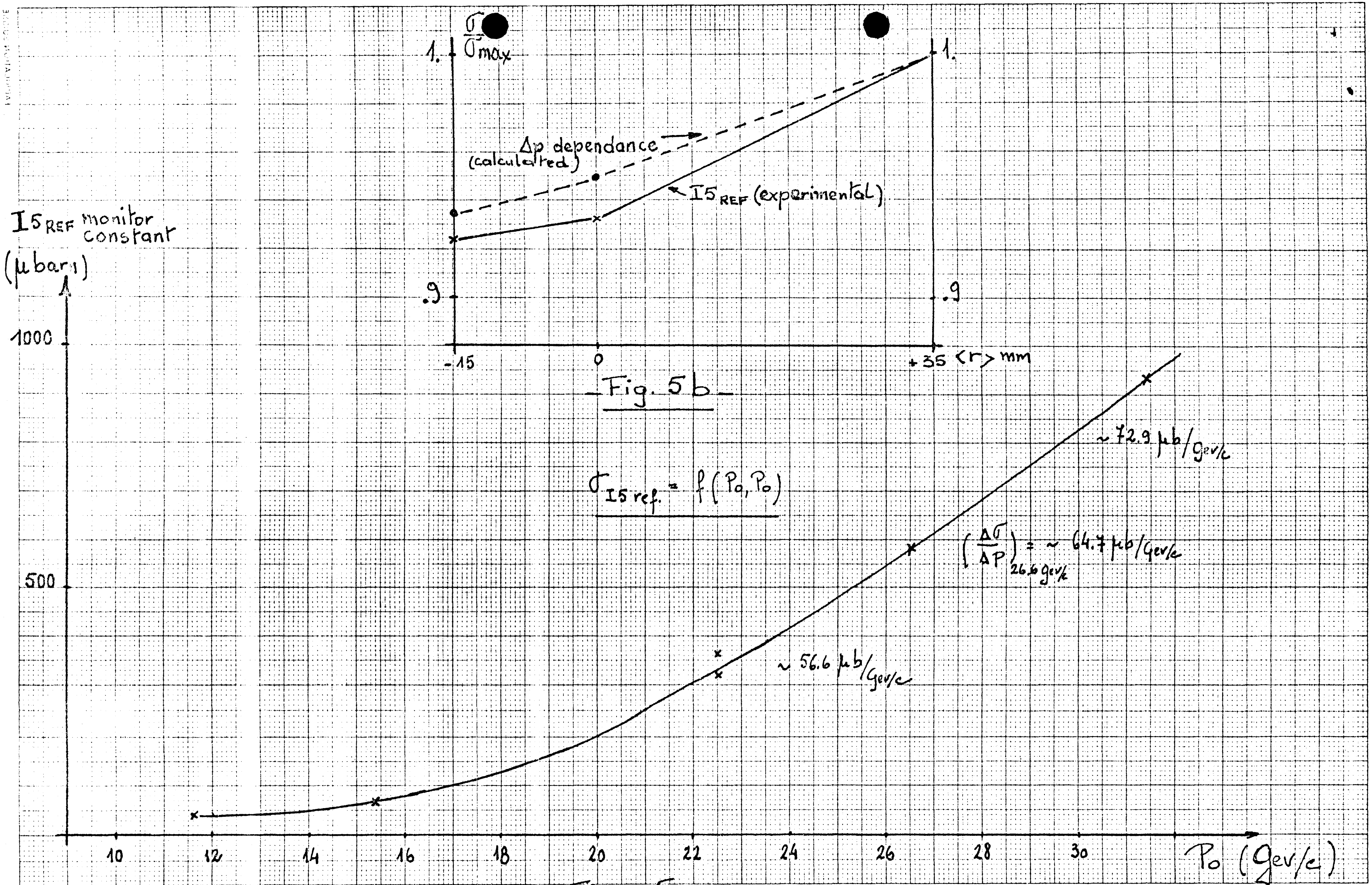
- Fig. 3b. -


σ / σmax
I1
1.
.9
.8
.7
.6
.5
I1 Standard
I1 él. + inel.
I1 inel.
-15
-10
0
10
20
30
mm ⟨r⟩

- Fig. 4a.-


σ / σmax
I4
1.
.9
.8
.7
.6
.5
I4 ST inside.
I4 ST outside.
-10
0
10
20
30
⟨r⟩
mm

- Fig. 4b.-



σ / σ_{max}
1.
.9
Δp dependance (calculated)
I5 REF (experimental)
-15
0
+35 <r> mm
I5 REF monitor constant (μbarn)
1000
500
$\sigma_{I5\,ref.} = f(P_a, P_o)$
~ 72.9 μb/Gev/c
$\left(\frac{\Delta\sigma}{\Delta P}\right)_{26.6\,Gev/c} = \sim 64.7$ μb/Gev/c
~ 56.6 μb/Gev/c
10
12
14
16
18
20
22
24
26
28
30
Po (Gev/c)

- Fig. 5b -

- Fig. 5a -