ISR-ES/FB/11

15th April 1971

ISR RUNNING-IN

Run n° 44, 5th April 1971, third part (from 14.30 to 18.30 hr.)
p = 15.343 GeV/c, 4 bunches

Luminosity Measurements

1. General

During run 27, a first absolute measurement of the effective beam height by vertical displacement of one beam with respect to the other was made in I4 at 22.5 GeV/c. A similar measurement at I5 was made at 15.3 GeV/c during run 40, while at the same time some incomplete data were taken at I2, I4 and I6.

In order to complement these measurements, and to make new ones, specially for I2 and I6 where better data were required, a programme of luminosity measurements was run in the following order: I6, I2+I4 (simultaneously), I5.

The reference proton momenta were 15.343 GeV/c in both rings, the working points chosen were "FATA FS15" (FS 15, R1 and FS 15, R2 respectively in the two rings).

The currents in the horizontal field magnets had been set initially to the values required to reduce as much as possible the vertical closed orbit distortion around ring 1 (see values recorded in the operations file). No such corrections were present in ring 2.

Protons were stacked in the rings using the standard injection procedure (nominal injection orbit, shutter operating, dump blocks offset by 6 mm.); the currents stacked were limited by saturation (in

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the case of ring 1, the RF voltage was on the lower setting used for stacking studies with narrow PS bunches - in the case of ring 2, a number of missing PS pulses occurred during the latter part of the stacking process). Some instability of the main power supply of ring 2 (about 1 part in 10^4) was present.

The currents stacked were 0.699 A in ring 1 and 0.935 A in ring 2. After withdrawing the inflectors with their shutters centered (i.e. gap closed), the beams were scraped vertically with the dump blocks to currents of 0.685 A and 0.862 A respectively. The corresponding max. dump block excursions were about 9.5 mm. in both cases; after scraping, the dump blocks were again set to their central positions.

The max. vertical displacement given to the dump blocks leaves a free vertical aperture of 13 mm total at that position: this corresponds to 22.4 mm at the maxima of β_V.

2. I6 luminosity measurements

In total 13 points were measured (see fig. 1), with 5 min. counting time per point. The beams were steered simultaneously apart in vertical steps of 0.5 mm each beam, starting from the central position.

The points have been corrected for the slight current drop in the beams during the measurements (about 1.5% and 2% respectively in rings 1 and 2 during 98 min.); accidental counts have been subtracted.

The monitor consisted of two counter telescopes in coincidence respectively below and above the downstream arms of rings 1 and 2, each composed of one counter (9 cm height x 10 cm effective width) at 3 m and one counter (26 cm height x 36 cm width) at 8 m from the crossing point.

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What appears to be a spurious point was obtained at $Z_1 - Z_2 = 7$ mm; no cause for this could be found, and there was no time to repeat this measurement.

There is evidence that the beam in ring 2 started to touch the vacuum chamber wall at the point $Z_1 - Z_2 = 8$ mm since a current loss in ring 2 about 3 to 6 times above normal was observed, the rate of accidental coincidences in I6 went up by a factor 3 in comparison with the point $Z_1 - Z_2 = 6$ mm and the background in I4 due to ring 2 increased more than one order of magnitude.

Once again, it appears that the best beam overlap does not correspond to the corrected closed orbit as derived from the pick-up observations. The optimum setting at I6 was at about $Z_1 = + 1.25$, $Z_2 = - 1.25$ mm; this adjustment was left for the rest of run n° 44, and for runs n° 45, 45' and 45".

An effective beam height of 5.4 mm is derived from the curve, in reasonable agreement with previous values.

A plot of the inverse effective beam height (proportional to counting rate divided by the product of the beam currents) was made (see fig. 2) during the 12 hours period of runs 45' and 45": it shows a beam blow-up in the first half, followed by a levelling off.

3. I2 luminosity measurements

The monitor consisted of two counter telescopes in coincidence, one at large angle (about 45°) below the downstream arm of ring 1, and one at small angle along the downstream arm of ring 2.

In total 9 points were measured, with 10 min. counting time per point (see fig. 3). Accidental counts have been subtracted. The beams were displaced vertically apart in simultaneous steps of 0.5 mm each beam. The best beam overlap was found at a position $Z_1 - Z_2 = -3$ mm : this setting was left for the subsequent runs. The effective beam height derived from the curve is about 6.5 mm, but the statistics are relatively poor.

In order to save time, vertical beam displacements of the same magnitude were made in I4 simultaneously with I2: these are reported below.

During the counting time intervals of the luminosity run in I2, some vertical beam steering in I5 was also made, in order to optimize the luminosity versus background there: 5 adjustments were made in this way, as reported below.

4. I4 luminosity measurements

The vertical beam displacements in I4 were equal to and simultaneous with the ones in I2.

Data were collected by several of the groups working in I4. The curve shown (see fig. 4) was obtained with the monitors described previously (see Run n° 27). Nine points were measured, 7 of which are affected by a high (> 25%) accidental rate. The two best points were obtained with an asymmetrical setting of the two beams, corresponding to a positive displacement in both rings; the plots of the rates in single telescopes (see fig. 5 and 6) show very strikingly this background effect, with "quiet" settings of about + 1.5 mm and + 2.5 mm respectively in rings 1 and 2. These settings were left for the subsequent runs. The effective beam height as measured is 5.2 mm, but this value should be considered as nominal only, due to the presence of such high accidental rates.

During runs 45' + 45", a plot was made of the relationship between counting rate and beam current product (see fig. 7): this also shows a blow up in the effective beam height (amounting to

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about 10% during the last 8.5 hr. of running).

5. I5 luminosity measurements

Time did not permit to measure a full luminosity curve at I5 (see fig. 8). However, seven points were measured and the vertical positions of both beams were optimized for maximum luminosity. It was observed that these vertical beam positions coincided more or less with the positions for minimum background. It was also found, however, that a vertical beam displacement of 1 mm for either ring away from this position increased the background rate by a factor 5 to 10.

6. Conclusion

It has been shown so far that it is possible to measure in the intersection regions I2, I4, I5 and I6 the effective beam height with the method of vertical beam displacement. It has been found that a vertical shift of 1 mm to either beam causes a significant change in luminosity and that it may cause in some regions under certain beam conditions a significant change in background rate. There have been so far two runs at 15.3 GeV/c and one run at 22.5 GeV/c for luminosity measurements; the working points have been different for each run. The vertical beam positions at the crossing points giving optimum luminosity appear to be different. This requires individual adjustments before the runs, in order to get the most out of the ISR running time.

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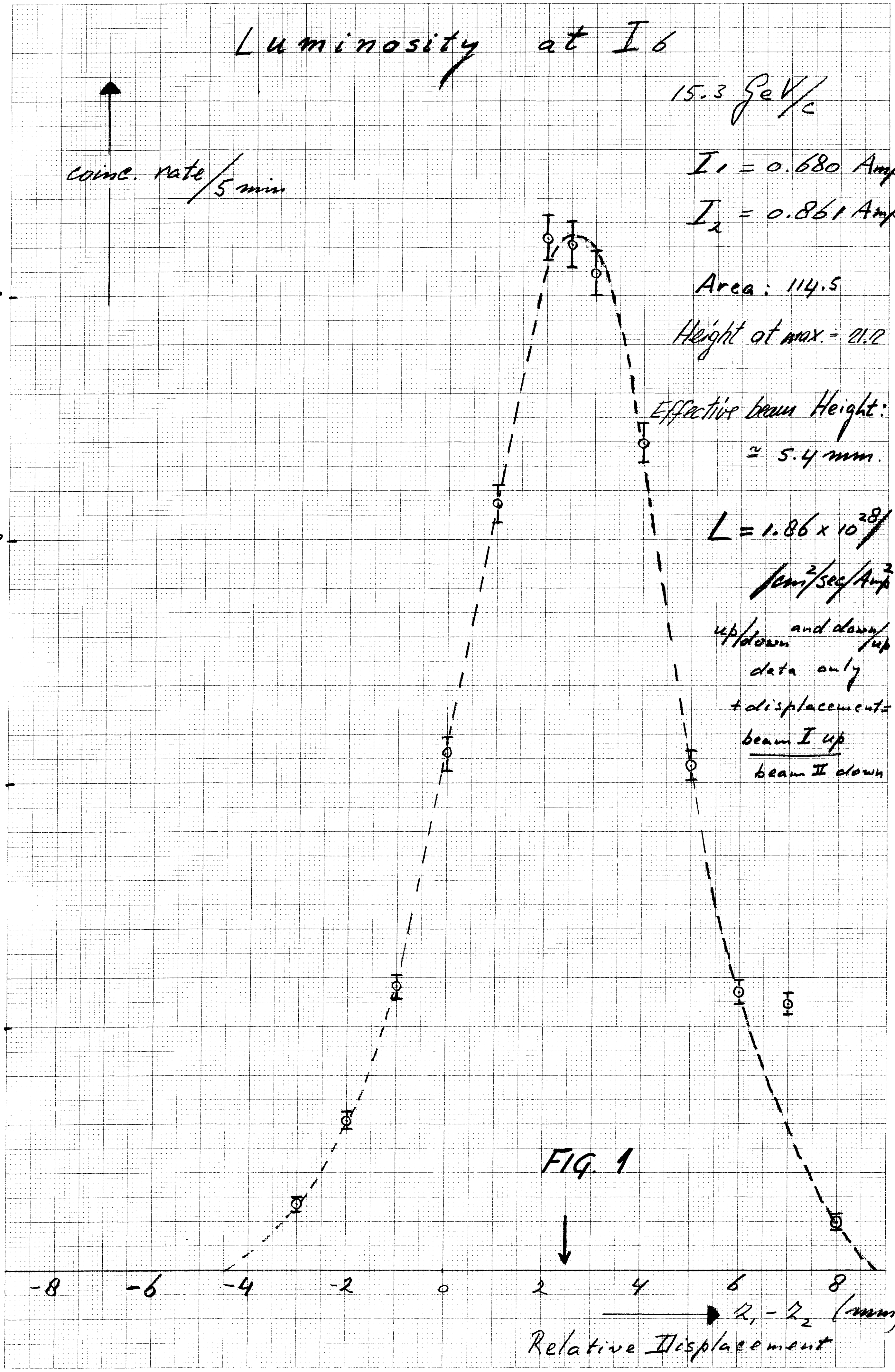

Luminosity at I 6
15.3 GeV/c
coinc. rate/5 min
I_1 = 0.680 Amp
I_2 = 0.861 Amp
Area: 114.5
Height at max. = 21.2
Effective beam Height: ≃ 5.4 mm.
L = 1.86 x 10^28 / cm^2/sec/Amp^2
up/down and down/up data only
+displacement= beam I up / beam II down
2000
1500
1000
500
-8
-6
-4
-2
0
2
4
6
8
$z_1 - z_2$ (mm)
Relative Displacement
FIG. 1

Inverse Effective beam height in I6

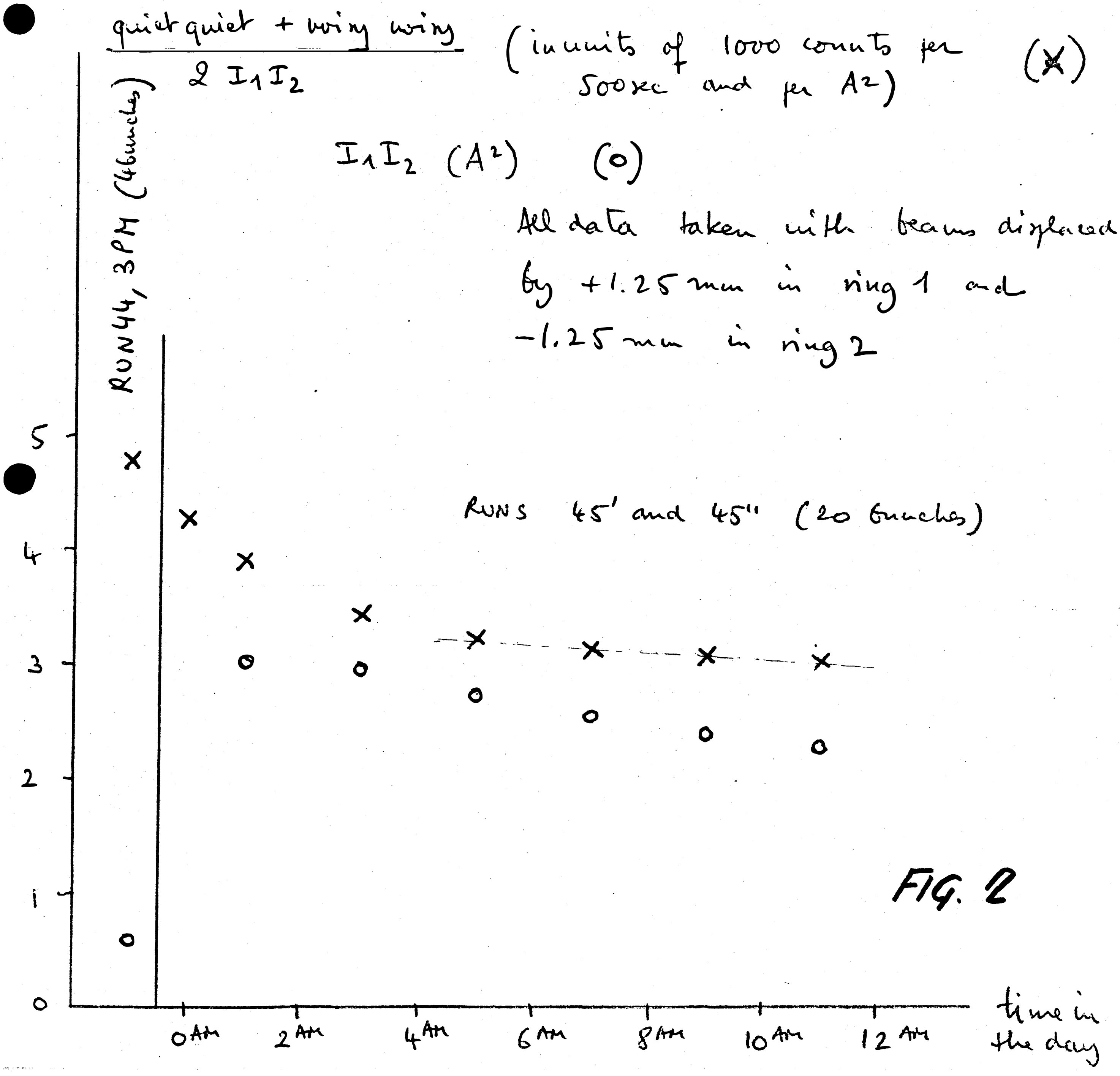
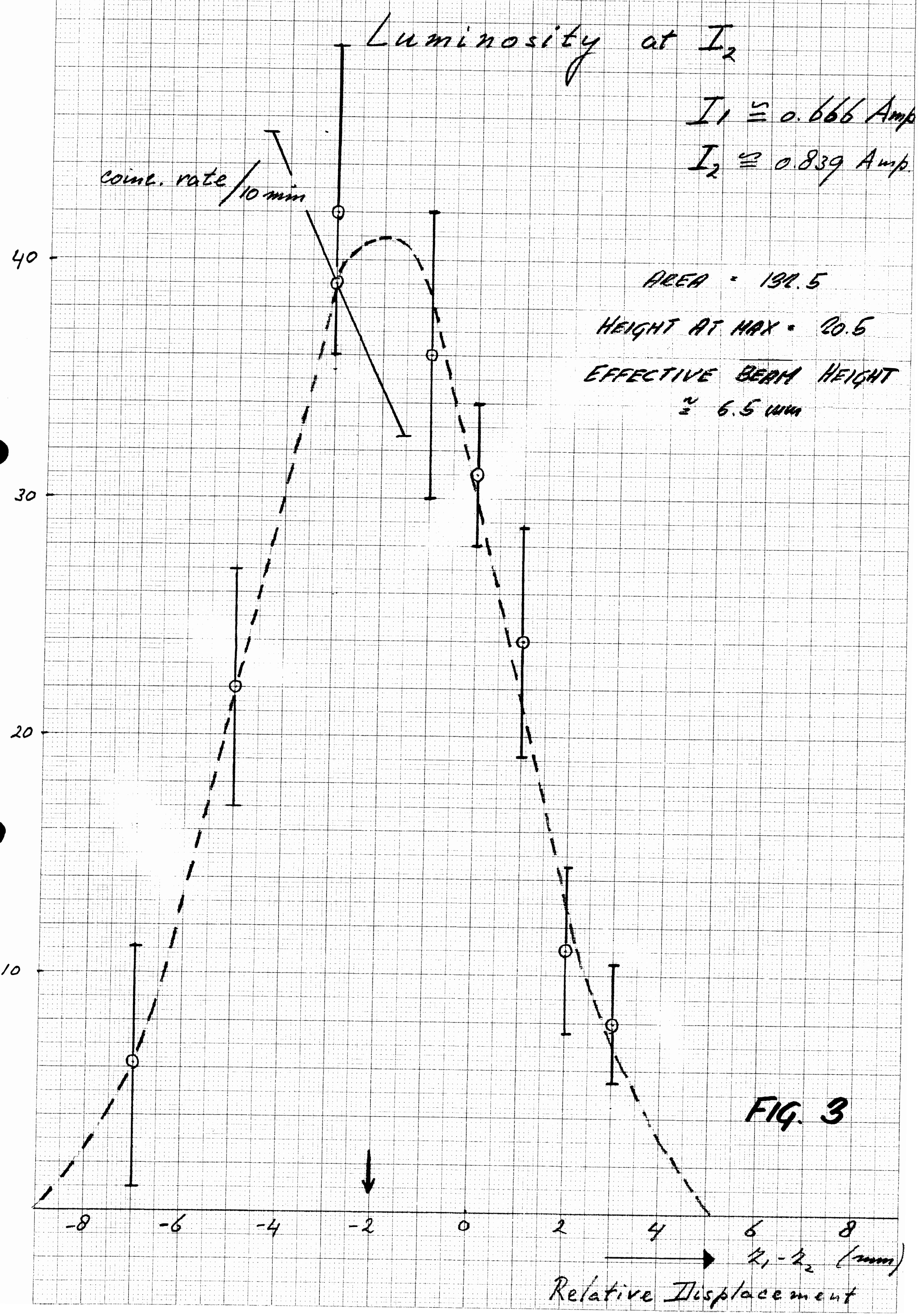


FIG. 2



Luminosity at I_2
$I_1 \cong 0.666$ Amp
$I_2 \cong 0.839$ Amp.
coinc. rate / 10 min
AREA = 132.5
HEIGHT AT MAX = 20.5
EFFECTIVE BEAM HEIGHT
≅ 6.5 mm
40
30
20
10
-8
-6
-4
-2
0
2
4
6
8
$z_1 - z_2$ (mm)
Relative Displacement

FIG. 3

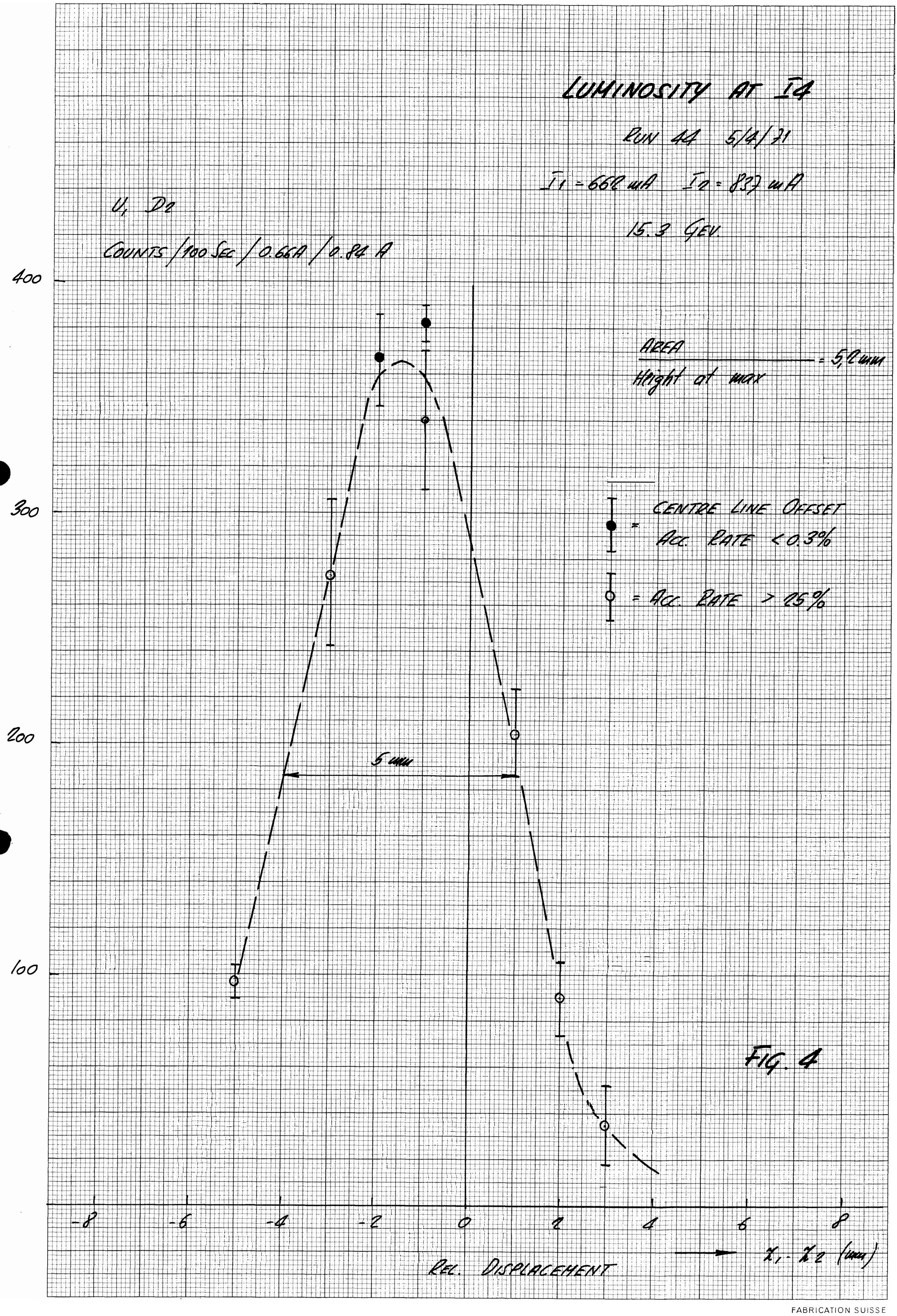
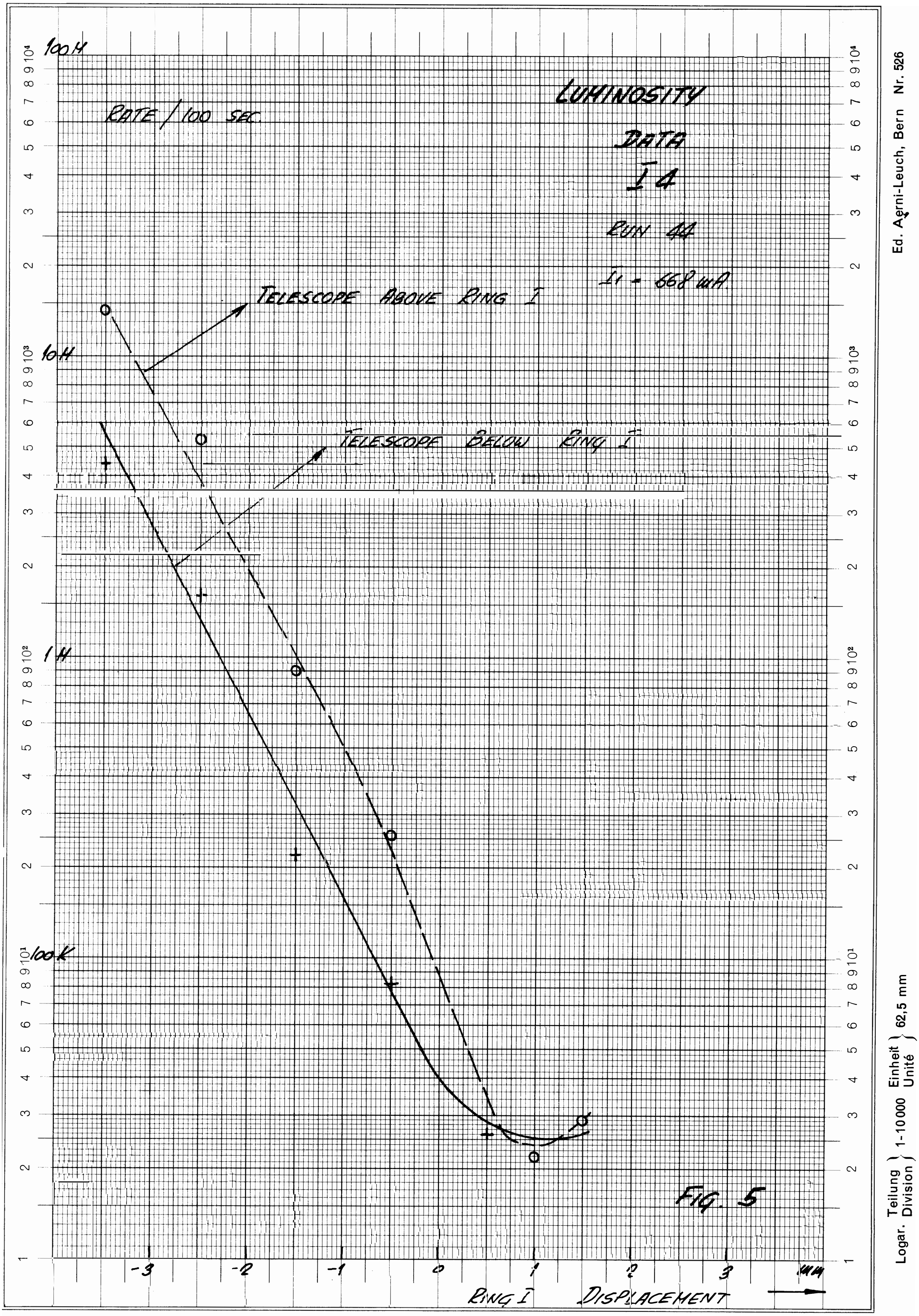
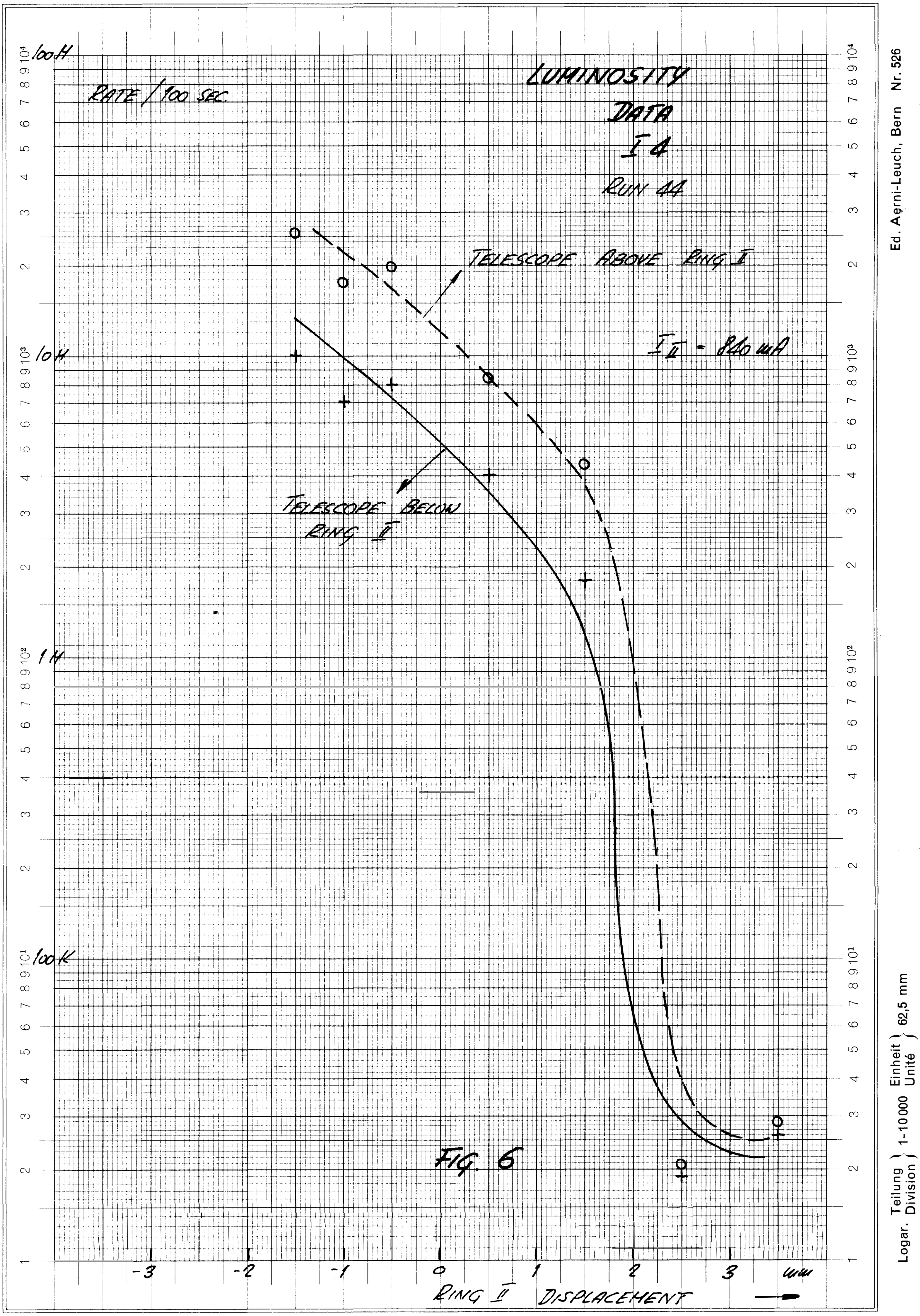

LUMINOSITY AT I4
RUN 44 5/4/71
I_1 = 660 mA I_2 = 837 mA
15.3 GEV
U, D2
COUNTS / 100 SEC / 0.66A / 0.84 A
400
300
200
100
AREA / Height at max = 5,0 mm
= CENTRE LINE OFFSET ACC. RATE < 0.3%
= ACC. RATE > 25%
5 mm
-8
-6
-4
-2
0
2
4
6
8
REL. DISPLACEMENT
$Z_1 - Z_2$ (mm)

FIG. 4



LUMINOSITY
DATA
I 4
RUN 44
I1 = 668 mA
RATE / 100 SEC.
TELESCOPE ABOVE RING I
TELESCOPE BELOW RING I
100 K
10 K
1 K
100 K
-3
-2
-1
0
1
2
3
mm
RING I DISPLACEMENT
Ed. Aerni-Leuch, Bern Nr. 526
Logar. Teilung Division 1-10 000 Einheit Unité 62,5 mm

FIG. 5


RATE / 100 SEC.
LUMINOSITY
DATA
I 4
RUN 44
TELESCOPE ABOVE RING II
I_{II} = 840 mA
TELESCOPE BELOW
RING II
100 H
10 H
1 H
100 K
-3
-2
-1
0
1
2
3
mm
RING II DISPLACEMENT
Ed. Aerni-Leuch, Bern Nr. 526
Logar. Teilung / Division 1-10 000 Einheit / Unité 62,5 mm
FIG. 6

VARIATION OF EFFECTIVE HEIGHT WITH TIME

RUN 45' + 45" 6/4/71
π 15 GEV/c

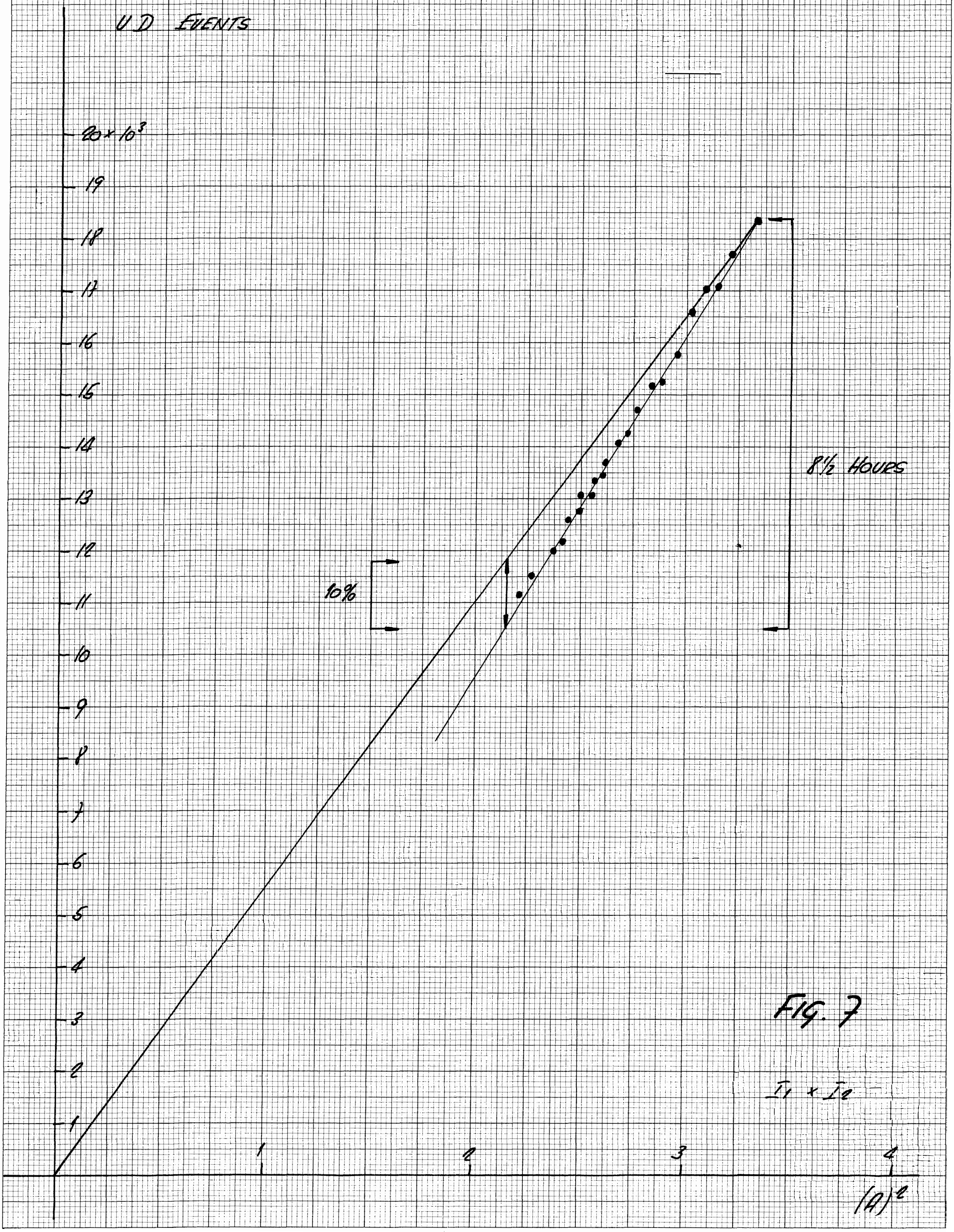


FIG. 7

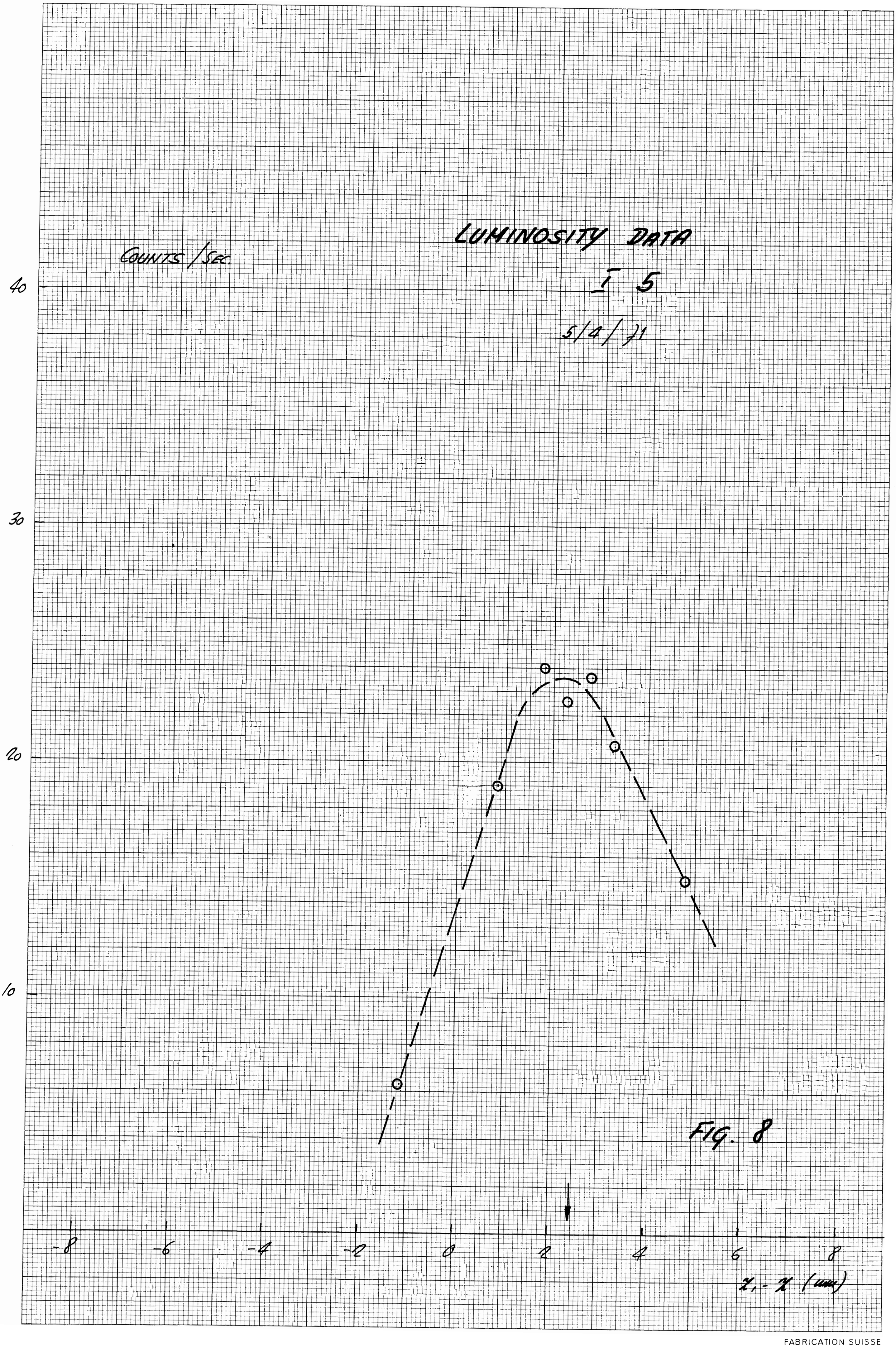


FIG. 8