ISR-BT/WCM/EEK 5th April, 1971.

ISR RUNNING-IN

Run 40, last part from 21.h. to 24 h. 15 GeV/c (4 bunches)

Luminosity Measurements

During run 27, a first absolute measurement of the effective beam height by vertical displacement of one beam with respect to the other, as proposed by van der Meer, was made in I4 at 22.5 GeV/c. A similar measurement attempted in I5 could not be completed due to lack of time; only four points were measured.

This time, a new attempt was made in the crossing regions I2, I4, I5 and I6, at 15.3 GeV/c. The working point for both rings was initially chosen as DORA 2,1 and stacks were made with the moving shutter of the inflector. A stack of 0.69A was made in ring 1 which gave a background rate in I4 of twice the rate due to beam-gas events four minutes after stopping the stacking. This stack was kept until 6 o'clock the following morning. Two stacks subsequently made in ring 2 could not be used due to too high losses (100 times beam-gas events in I4) and were dumped.

The working point of ring 2 was then changed to ANDY 0.8,0, and a useful stack of 0.55 A was made at 21.45h. with which the measurements were started in I5. This stack was lost due to a failure of the power supply of ring 2 at about 22.15h. Ring 2 became again operational at 22.27h., but the next stack was dumped when 25% of the stack was lost for unknown reasons before the end of the stacking. A final stack of 0.52 A made in ring 2 at 22.37 h., with which the measurements in I5 were continued. This stack was also kept circulating until the next morning.

Two further mishaps occurred during this part of the run. Around 22.40h., it was noted that the power supply of the Terwilliger quadrupole TD2 on ring 2 had drifted away from its correct setting, which caused an estimated Q-shift of fortunately only about 0.01. This was corrected at 23.10 h., when the measurements in I5 had been stopped. The last difficulty, which caused loss of time, was in setting the required currents of the radial field magnets with which the beams are vertically displaced. This was due to an error in the typing of the computer instructions for the setting of the currents when the typing of a comma instead of a point was not noticed since both characters look about the same on the print-out.

The scintillation counter arrangements in I4 and I5 were discussed in previous reports. The group in I2 used two independent counter telescopes directed towards the crossing point, but <u>not</u> in coincidence, which were mounted in the pit of I2, i.e. under a large angle with respect to the circulating beams. One of these telescopes looked in the beam direction of ring 1 and the other in the beam direction of ring 2. The group in I6 used two independent counter telescopes in coincidence. Each telescope consisted of two counters of 10 cm x 10 cm in coincidence, adjacent to the vacuum chambers on either side of the crossing point, with one anti-coincidence counter of 0.5 m x 1 m which surrounded the aperture of each telescope.

Both beams were initially positioned at z = 0 in each of the four crossing points I2, I4, I5 and I6, using corrections to the vertical beam positions, as calculated by Autin from the results of closed orbit measurements. Thereafter, both beams were simultaneously displaced in equal vertical steps, but in opposite directions.

The results of the measurements in I5 are plotted in Fig.1 as the coincidence rate per 10 seconds, corrected for random coincidences, versus $z_1 - z_2$. The points marked - 0 - were measured with the first useful stack in ring 2, and the points marked - + - with the stack which was made after the failure of the power supply. These latter points have been normalized to the beam current of the first stack in ring 2. A point measured at $z_1 - z_2 = -7$ mm could not be used due to a too high background which was caused by beam 1 touching the vacuum chamber wall. To cure this we decided to move both beams in I5 upwards with + 2 mm and to continue the measurements. Unfortunately the mishap with the current settings resulted in measurements at $z_1 - z_2 = -3.2$ mm and - 4.4 mm instead of respectively the intended positions of $z_1 - z_2 = -7$ mm and - 8 mm. This difficulty as well as lack of time prevented us from completing the measurements in I5.

In spite of the limitations imposed by the circumstances, about three quarters of the curve could be measured and the the results of the second stack in ring 2 matched well with those of the first stack. The curve in fig. 1 looks reasonably symmetrical. The last figure of the report about run 27 that describes the first attempt of a luminosity measurement in I5 has only four measuring points and these suggest a rather asymmetrical shape. We believe that the present measurement in I5 has been done much more thoroughly and that the apparent asymmetry in I5 measured during run 27, which could easily be caused by an error in a single measuring point, is not true. From Fig. 1 we calculate an effective beam height of 6.2 mm which gives $L = 1.60 \times 10^{28}/\mathrm{cm}^2/\mathrm{sec}/\mathrm{Amp}^2$ for the luminosity. However, these results are only meaningful if we assume that the effective height was the same for the two stacks in ring 2. The colliding beam event rate in I4 and I6 was found to be independent of the vertical beam displacement in I5.

At 23.14 h., we decided to measure simultaneously the effective beam height in I2, I4 and I6. Again we had trouble with the current settings at some of the measuring points and, due to lack of time, the measurements could not be finished. Nevertheless, we deduce from Fig. 2 for the results in I6 and Fig. 3 for the results in I4 that the Van der Meer method for measuring the effective beam height also works for these crossing points.

The measurements in I2 are plotted in Fig. 4. The results show that the rates in the telescopes looking to respectively ring 1 and ring 2 are within statistics independent of the vertical beam displacements. This probably means that they are counting background rather than particles which originate in colliding beam events. The colliding beam event rate in I5 was found to be independent of the simultaneous beam displacements in I2, I4 and I6.

We conclude from the measurements in I4 and I6 that the method of centering each of the stacks by vertical closed orbit corrections which are determined from the positions measured with pick-up electrodes is not sufficiently precise. Fig. 3 shows that the colliding beam event rate in I4 is a factor of two higher when the beam in ring 1 is displaced by -0.5 mm and in ring 2 by + 0.5 mm, although it is not even sure that this is the optimum position. Similarly, we found for I5 that the optimum vertical beam position is - 1.5 mm for ring 1 and + 1.5 mm for ring 2. We suggest, therefore, to check the vertical beam positions from time to time in each crossing point in use for colliding beam experiments by the measurement of the colliding beam event rate for a few vertical beam displacements in steps of ± 0.5 mm.

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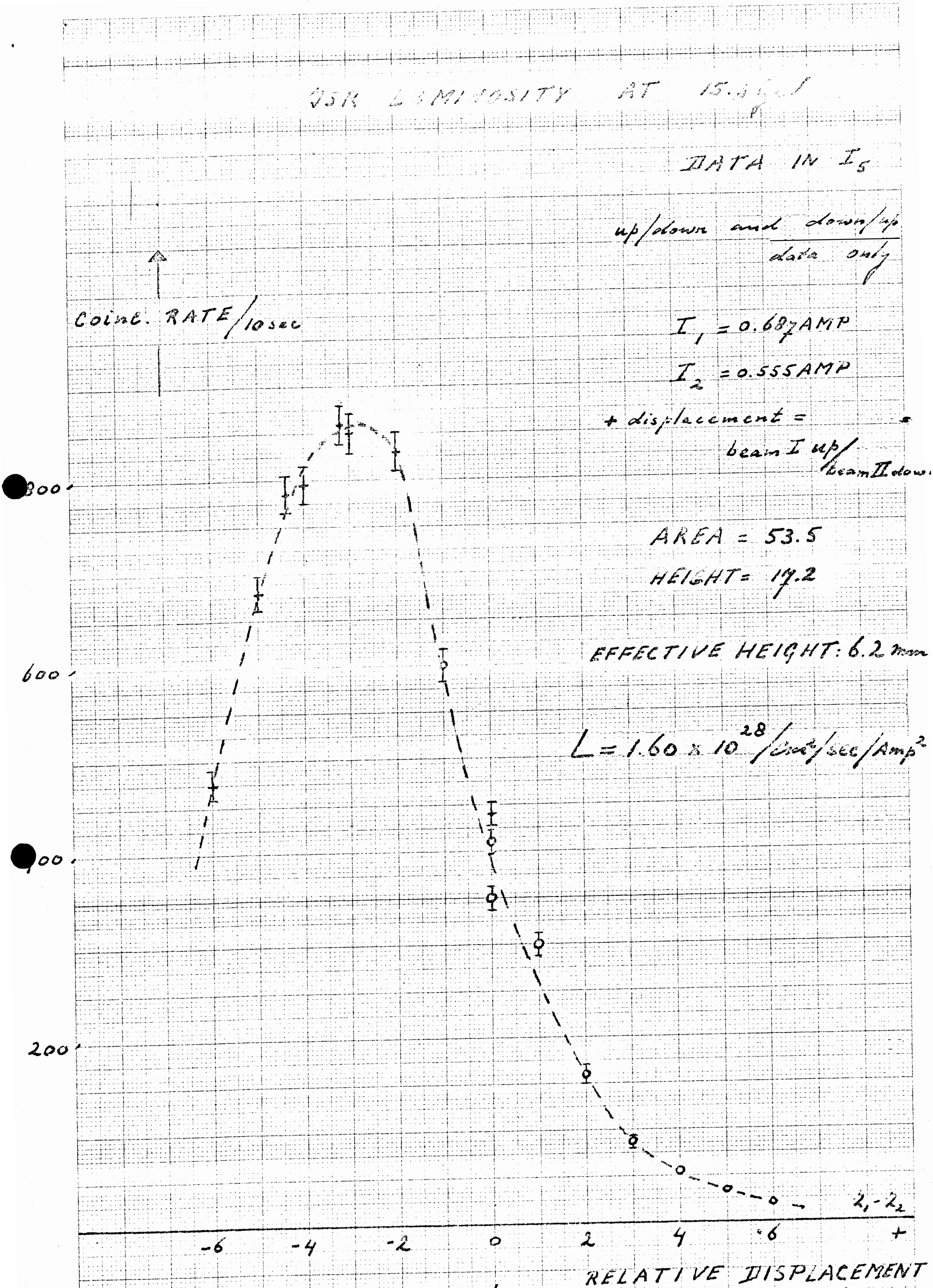

ISR LUMINOSITY AT 15.3 GeV
DATA IN I_5
up/down and down/up data only
COINC. RATE/10 sec
I_1 = 0.687 AMP
I_2 = 0.555 AMP
+ displacement = beam I up/beam II down
AREA = 53.5
HEIGHT = 17.2
EFFECTIVE HEIGHT: 6.2 mm
$L = 1.60 \times 10^{28}$/cm²/sec/Amp²
800
600
400
200
$z_1 - z_2$
-6
-4
-2
0
2
4
6
+
RELATIVE DISPLACEMENT (mm)

Fig. 1.

Luminosity Measurement I…

up/down and down/up data only

$I_1 = 0.686$ Amp

$I_2 = 0.516$ Amp

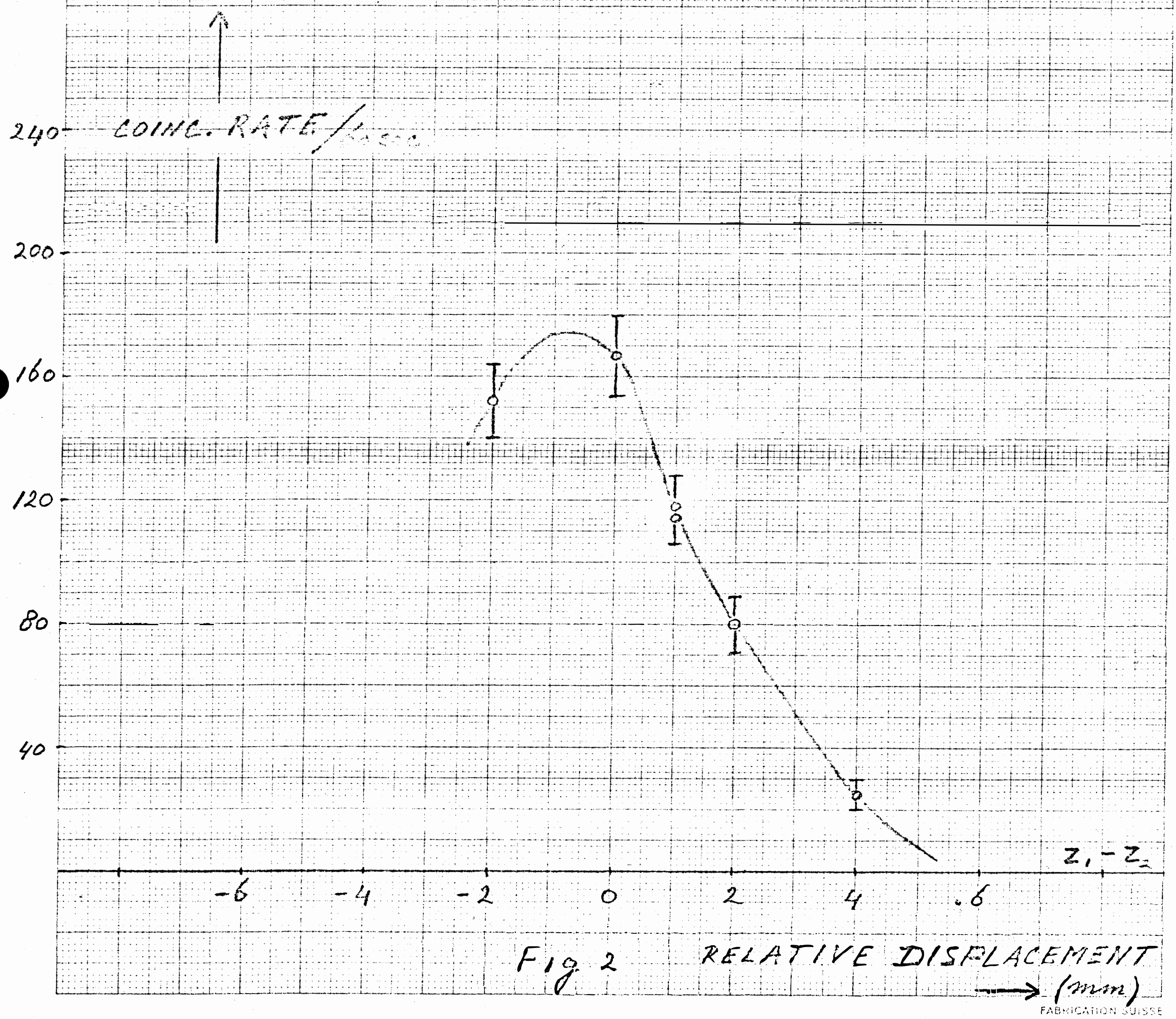

Fig 2

Luminosity Measurement L_4

up/down and down/up data only

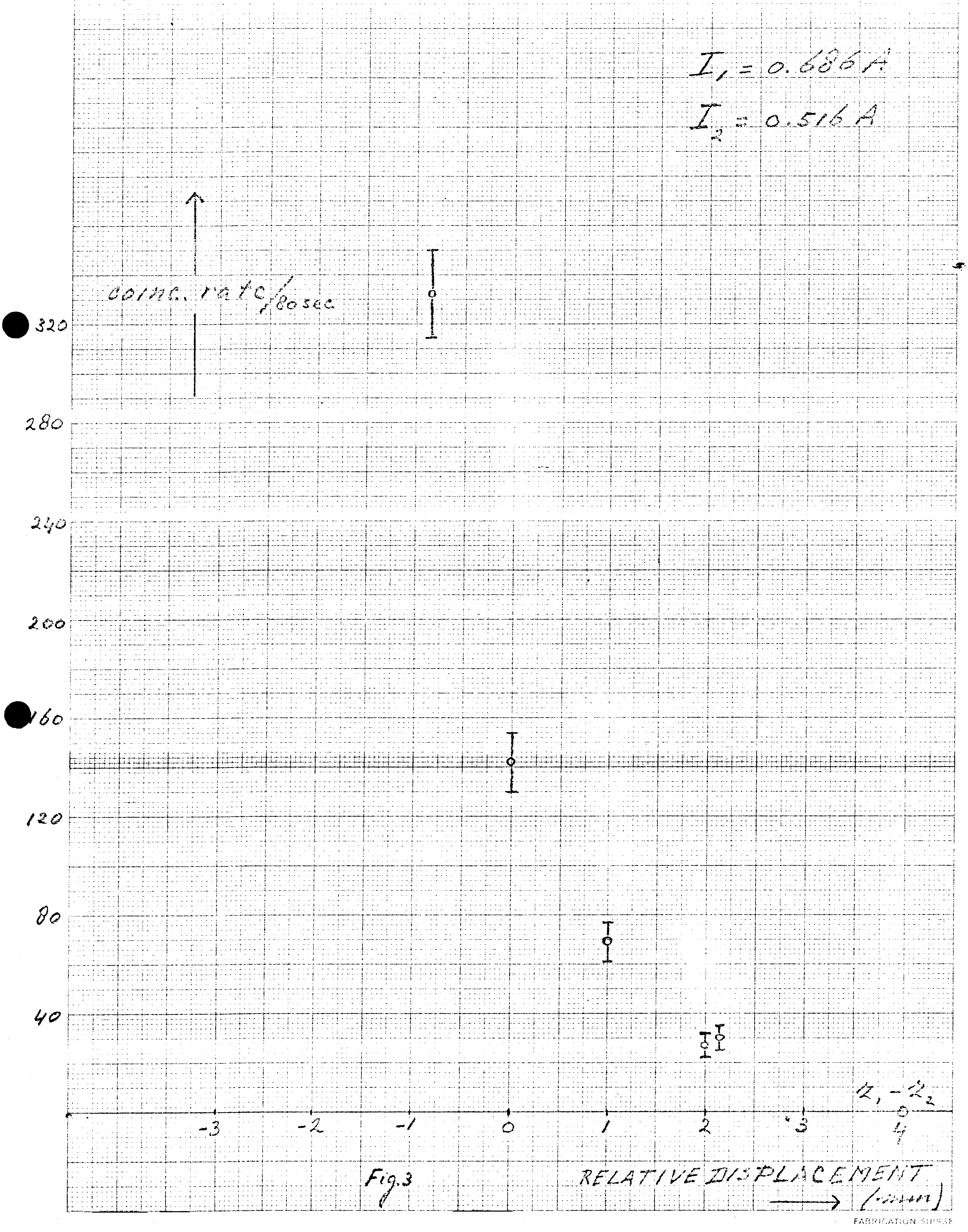

Fig.3

measurements in I_2

up/down and down/up data only

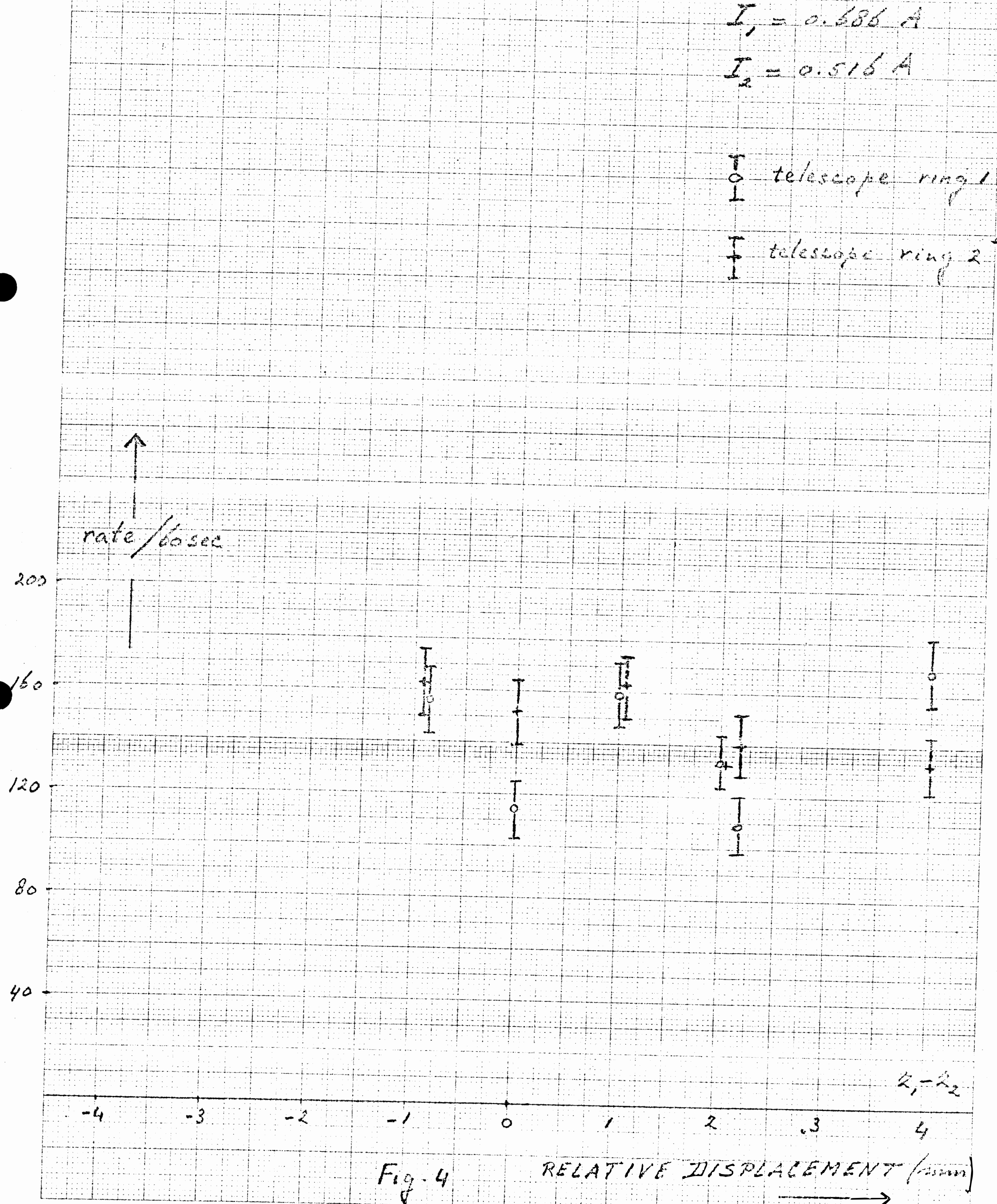

Fig. 4