ISR-OP/CF/svw 1st February 1977

ISR PERFORMANCE REPORT

Influence of the Booster on the ISR Circulating Beams

Test of 22nd December, 1976

SUMMARY AND CONCLUSION

An influence of the booster pulsing on background conditions in the intersections was very often observed last year during high intensity runs at 26 GeV/c.

During the tests which took place on 22nd December, equipment liable to be affected, and, therefore, to affect the circulating beams was checked and beam behaviour studied.

Apart from observations made on several power supplies, explained in (1), nothing has been discovered susceptible to explain this effect.

The influence of the Booster on the beams could be seen and appeared to be in the radial plane and stronger at the top.

The 1 sec. repetition rate which will be used this year at the Booster is not worse than the 1.2 sec. repetition rate used so far, the only important parameter being the disturbance on the 18 kV, which can be controlled within certain limits at the Booster.

The effect of the experimental magnets on the closed orbit could be observed with the magnetic beam position monitor in I-5, and, therefore, their influence on the effect of the Booster is understood.

1. Experiment

The tests took place after a 26 GeV/c physics run with currents of 19.7 A in ring 1 and 22.7 A in ring 2.

The booster supercycle used during these tests was made of 3 cycles followed by 2 missing cycles.

Starting with normal cycle and 18 kV disturbance, i.e. a repetition rate of 1.2 sec. (supercycle = 6 sec.) and $\Delta V/v = 0.3\%$, this disturbance was then increased to about 1% by suppressing progressively the compensation system at the Booster.

This was then repeated with a 1 sec. cycle (supercycle = 5 sec.).

Near the end of the test the 18 kV disturbance was increased to about 1.4%, the Booster then using 4 groups instead of the usual 3.

During this time, some ISR components and parameters were checked :

- earth currents in the auxiliary buildings (Cassard)

- clearing electrodes (Strubin)
- Transverse feedback (Thorndahl)
- PIDC (Halvarsson)
- Beam Profile Monitor (Huguenin)

nothing unusual could be observed on this equipment.

The power supplies used during the previous physics run were all checked (1).

The background conditions in some intersections, the 18 kV and the flux in the reference units were recorded.

2. Results

2.1 18 kV

The difference between the phases T and S and R and S of the 18 kV network can be measured for one of the two lines (NIII6) supplying the PC building (3). We recorded these two signals during the tests :

i) On a SEFRAM recorder, where we could follow the amplitude of the disturbance generated by the Booster on the 18 kV network (fig. 1) during the tests. The calibration figure of 140 Volts/cm, which was usually used to quantify the disturbance does not seem to fit exactly and has to be reconsidered.

ii) With a higher measurement frequency on magnetic tape, it was then possible to see from these recordings that the amplitude of the 18 kV was modulated by the Booster supercycle as defined previously (fig. 2), each cycle generating a dip which, of course, became more pronounced when the disturbance was increased from 0.3% to 1% and 1.4%.

iii) the effect of the Booster was also visible on the 380 Volt network in the auxiliary buildings. Fig. 3 shows BT recordings made by Mr. Cassard in A7, where a structure can be seen corresponding to the Booster super-cycle.

2.2 Magnetic flux

The signal $d\phi/dt$ given by the 4 reference units (F and D for each ring) was recorded on magnetic tape. No influence could be observed (fig. 4). Considering the perturbation of $\Delta I/I = 10^{-5}$ induced by the Booster on the PFW's (1), we definitely remained in the noise level for these signals (2).

2.3 Background in the Intersections

In order to make the beams more sensitive the aperture in the vacuum chamber was restricted by successively putting one of the halo scrapers in the position given by a "find beam" single shot.

For ring 1, fig. 5 shows the background structure given by the standard monitors in I-5, and also a recording of the Booster pulsing. As can be seen, the correlation between the two signals is obvious.

The major effect was observed when the "outer" scraper was "in", but each cycle of the Booster also induced a spike when the "inner" scraper was the limitation. When the "underside" scraper was against the beam only a small spike was observed for each supercycle. This indicates, therefore, that the beams were mainly affected in the radial plane.

The 1 second cycle, which is planned to be used this year by the Booster, did not affect the beam conditions more than the usual 1.2 sec mode (fig. 6), the important parameter being, however, the amplitude of the disturbance induced by the Booster on the 18 kV network: the background fluctuations were more pronounced when this amplitude was increased (fig. 7).

In ring 2, which generally seemed more sensitive than the other ring to this effect, the background was recorded in intersections 2 and 4 and from these observations one can draw the same conclusions. Fig. 8 shows the influence of the different scrapers in ring 2.

2.4 Experimental magnets

The influence of the experimental magnets on the effect of the Booster pulsing was observed several times during the physics runs. It was also possible to see this during these last tests.

Fig. 9 shows the behaviour of the I2 background in ring 2 for different settings of the I2 experimental magnet and of the I6 Lamp Shade Magnet. One can see that the background fluctuations were less pronounced when the I6 LSM was at −100% and worse when this magnet was set at +100%. Equally, the background conditions were better when the R209 Magnet was put at +100%.

This influence can be explained if we consider the distortion created by these magnets on the closed orbit, in one side or the other for the I6 LSM depending on its polarity; distortion which was measured in I5 during the tests with the magnetic beam position monitor (see Section 3).

C. Fischer

References :

1) Effect of Booster Pulsing on Power Supplies - Performance Report, S. Oliver 17.01.76.

2) Performance Report, R. Jung, 20.01.76.

3) Mesure des variations de tension du réseau 18 kV, Performance Report, E. Sbrissa, 10.4.74.

3. Measurements with the magnetic beam detector during the test of the Booster influence on the ISR

Owing to the special requirements of the measurements to be performed, the magnetic beam detector was not used in the normal way, i.e. with a measuring time constant of ~10 secs and with automatic tracking of the centre of gravity of the beam, but instead the positioning feedback loop was opened and the error signal was recorded, thus giving a measure of the beam position with respect to the detector frame. In this way, the measuring time constant could be reduced to 0.5 s, making observation of influences due to the Booster cycle possible.

The beam was modulated with a vertical amplitude of 0.2 mm p-to-p in I5. For the 22 A stack in R2 this gave a resolution of ca. 0.05 mm for the horizontal position and 0.01 mm for the vertical position.

Fig. 10 shows the horizontal and vertical beam positions along with timing marks corresponding to the Booster cycle. No correlation can be seen between the beam position and the Booster cycle within the precision of measurement, i.e. 0.01 mm vertically and 0.05 mm horizontally.

As mentioned by S. Oliver a current variation of about 15 mA synchronous with the Booster cycle was found in the CP power supply for R2. In order to know whether this variation would give rise to a beam displacement detectable by the magnetic beam detector, the orbit distortion was calculated for a current of 15 mA in the CP's. As shown in fig. 11, the maximum distortion is about 0.007 mm and occurs in the inner arcs. In the intersections the distortion is reduced by a factor of 15 with respect to the maximum value, giving only 5.10^{-4} mm of horizontal beam displacement, i.e. a hundred times smaller than the resolution of the beam detector.

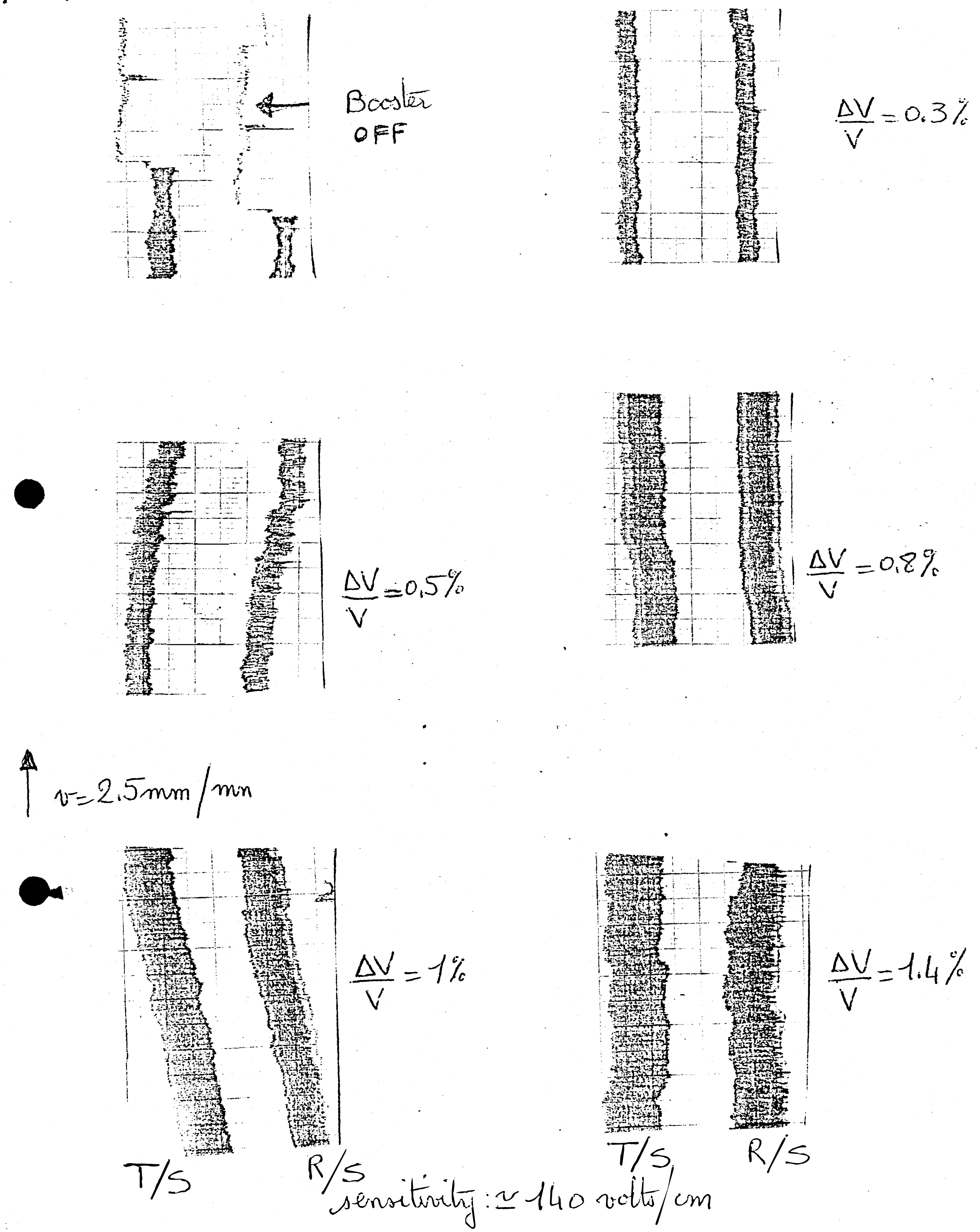
Figs. 12 through 14 show the influence of different experimental magnets on the beam position. A strange and unexplained behaviour was seen, when the experimental magnet in I6 (Lampshade magnet) was powered.

The horizontal beam displacement is not continuous, but shows a step at some current levels of the I6 magnet. This step was observed for increasing and for decreasing current for both polarities (fig. 14). The following beam displacements in I5 were measured :

	I2 magnet	I6 magnet	I7 magnet
Horizontal	100% : -0.60 mm	100% : 1.20 mm -100% : 1.40 mm	100% : -0.1 mm -100% : 0.1 mm
Vertical	100% : -0.025 mm	100% : 0.01 mm -100% : -0.02 mm	< 0.01 mm

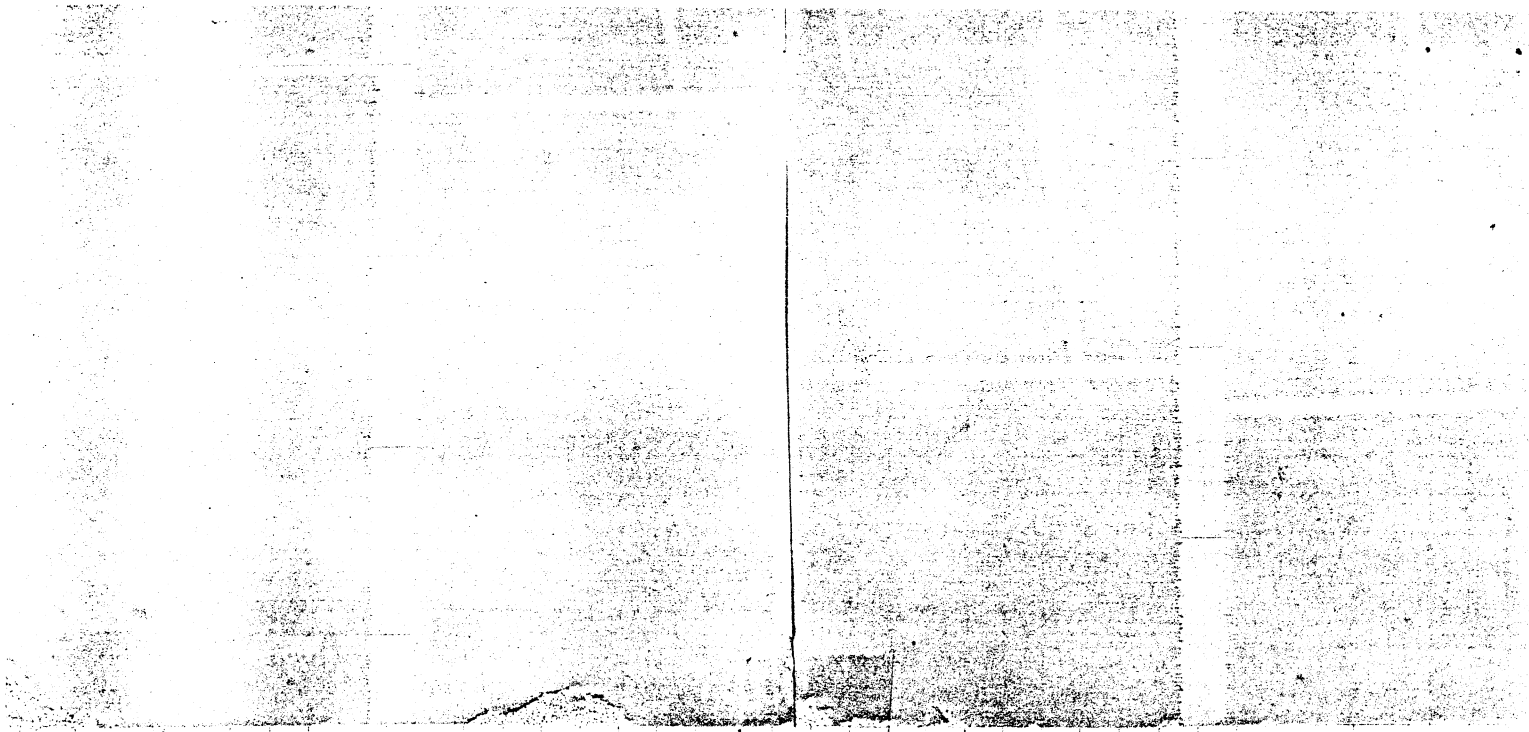
Whilst measuring the beam position in R2, the parasitic current through the vacuum chamber near the intersection point in I5 was monitored in R1. Besides the 50 Hz component a current of about the same size at 1400 Hz was seen (Fig. 15).

K. Brand J-P. Gourber



18 kV recording on SEFRAM Recorder

figure 1



T/S R/S T/S R/S

Booster OFF $\frac{\Delta V}{V} = 0.5\%$

18 kV recording on magnetic tape

$v = 2.5$ mm/sec

sensitivity: 1 mm ≃ 300 volts

$\frac{\Delta V}{V} = 1\%$ $\frac{\Delta V}{V} = 1.4\%$

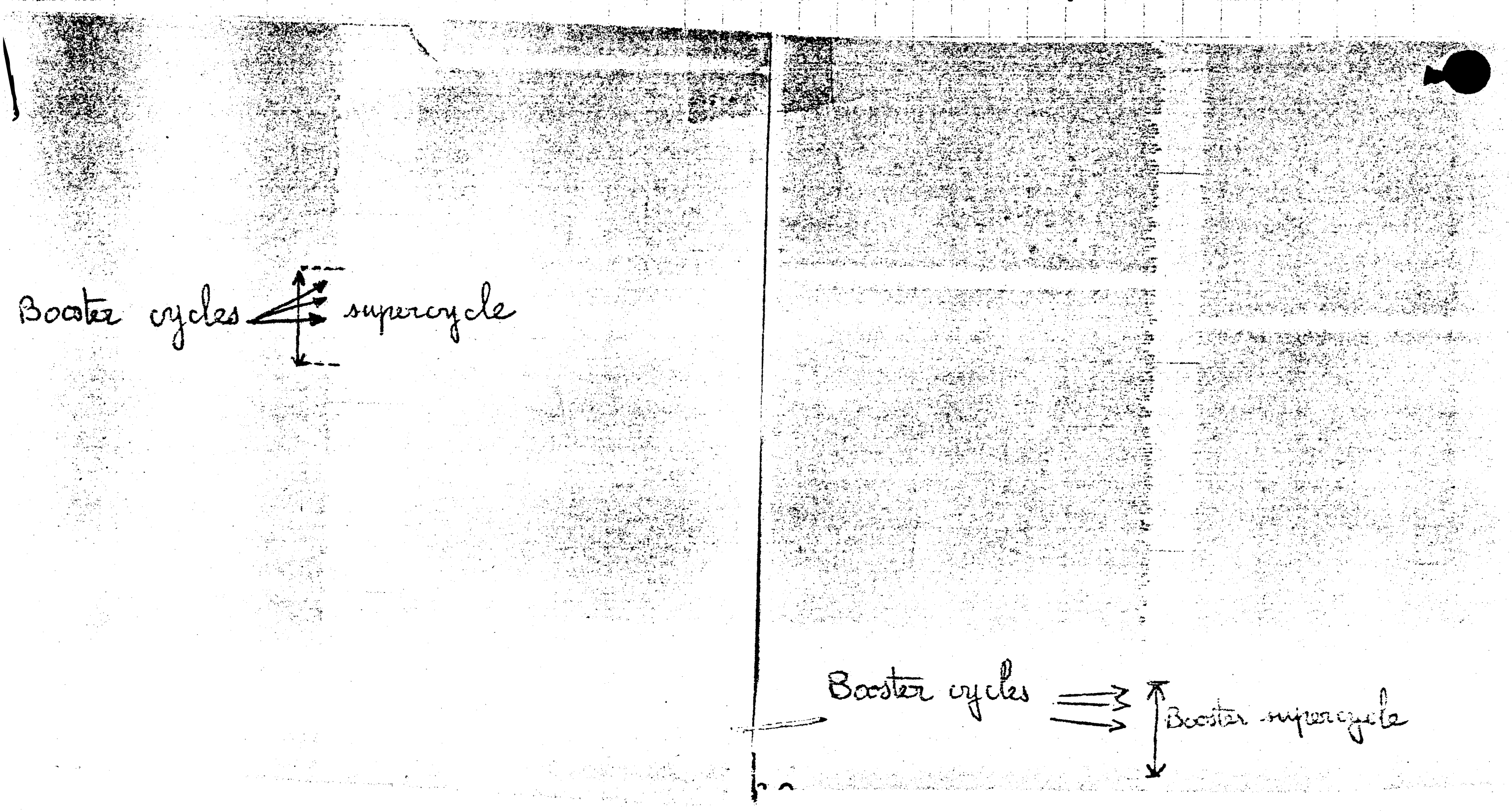
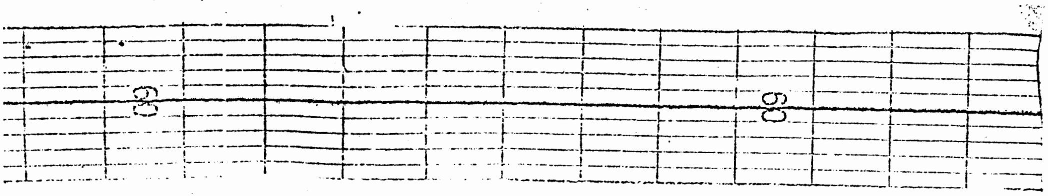


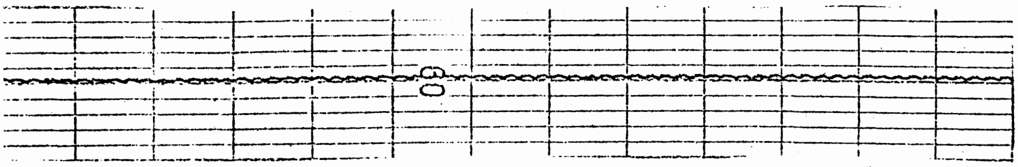
Figure 9



Booster "OFF"

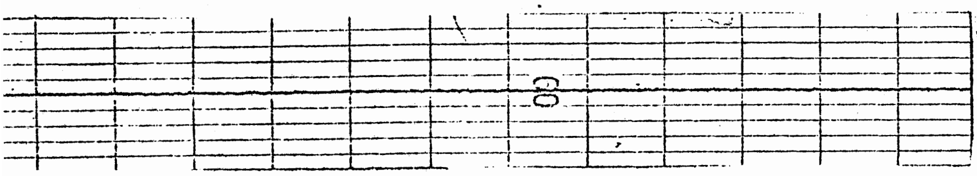
$\vec{v} = 20\ mm/mn$

sensitivity: 0.6 mm = 1%



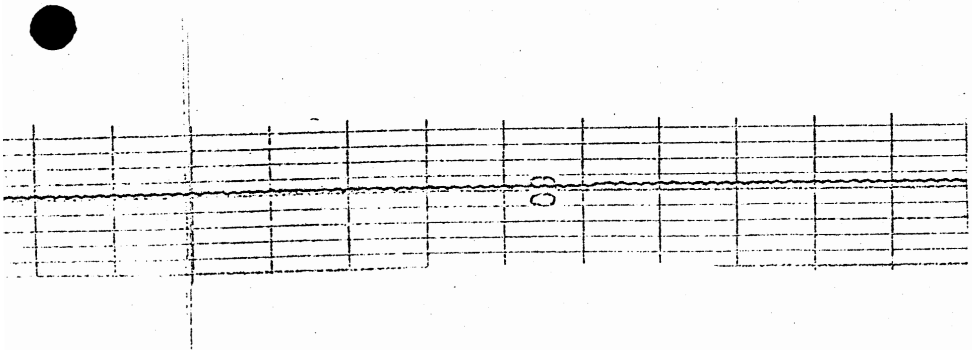
supercycle = 6 sec

$\frac{\Delta V}{V} = 1\%$



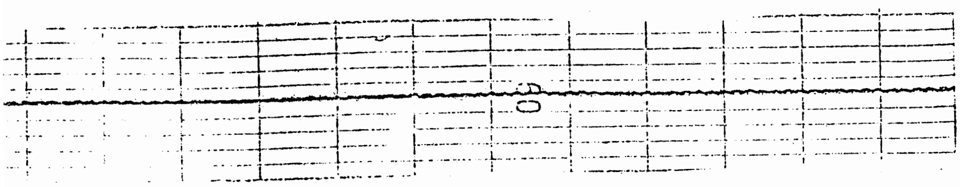
supercycle = 6 sec

$\frac{\Delta V}{V} = 0.5\%$



supercycle = 5 sec

$\frac{\Delta V}{V} = 0.8\%$



supercycle = 5 sec

$\frac{\Delta V}{V} = 1.4\%$

380 v. recording in A7

figure 3

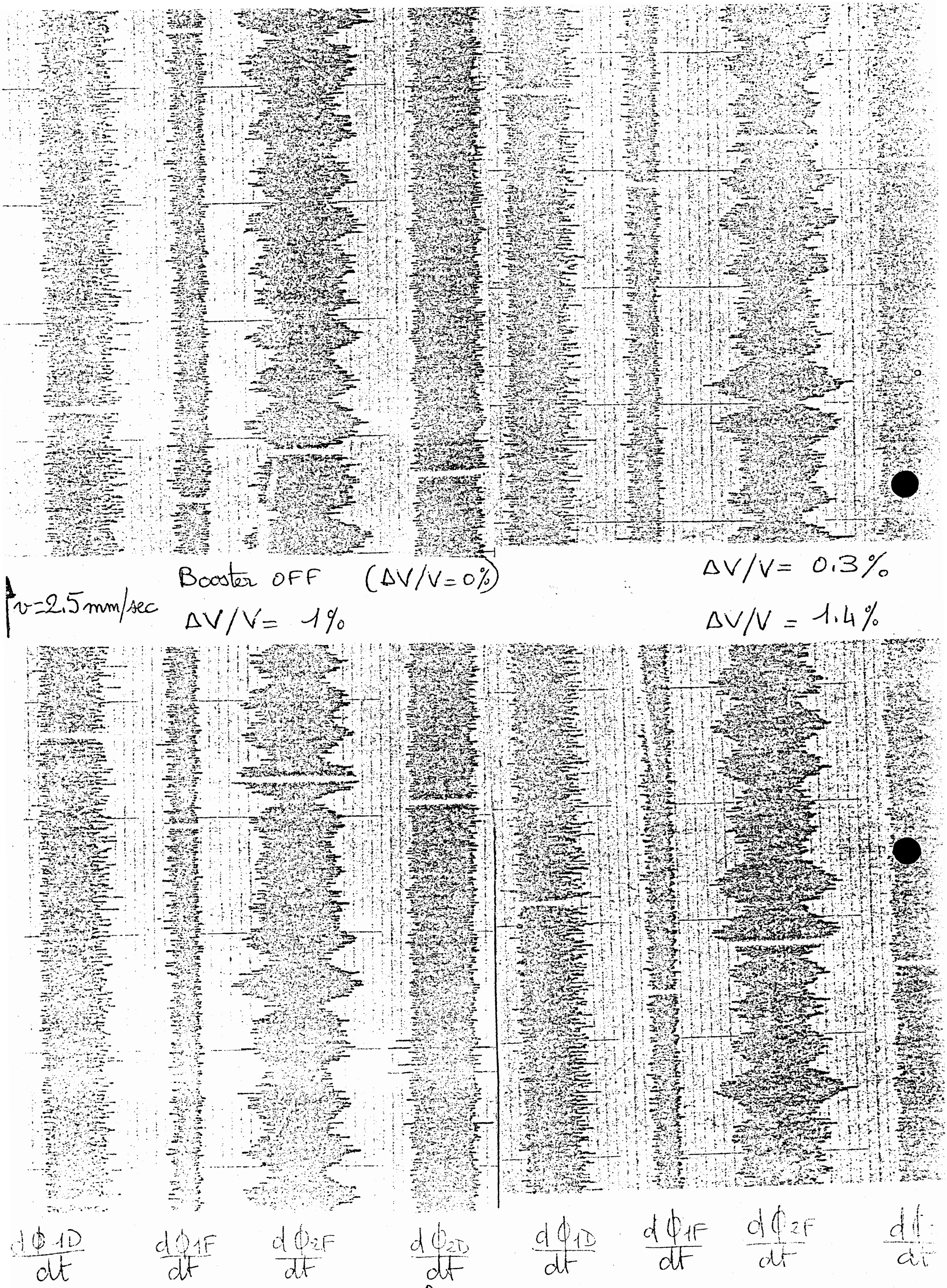
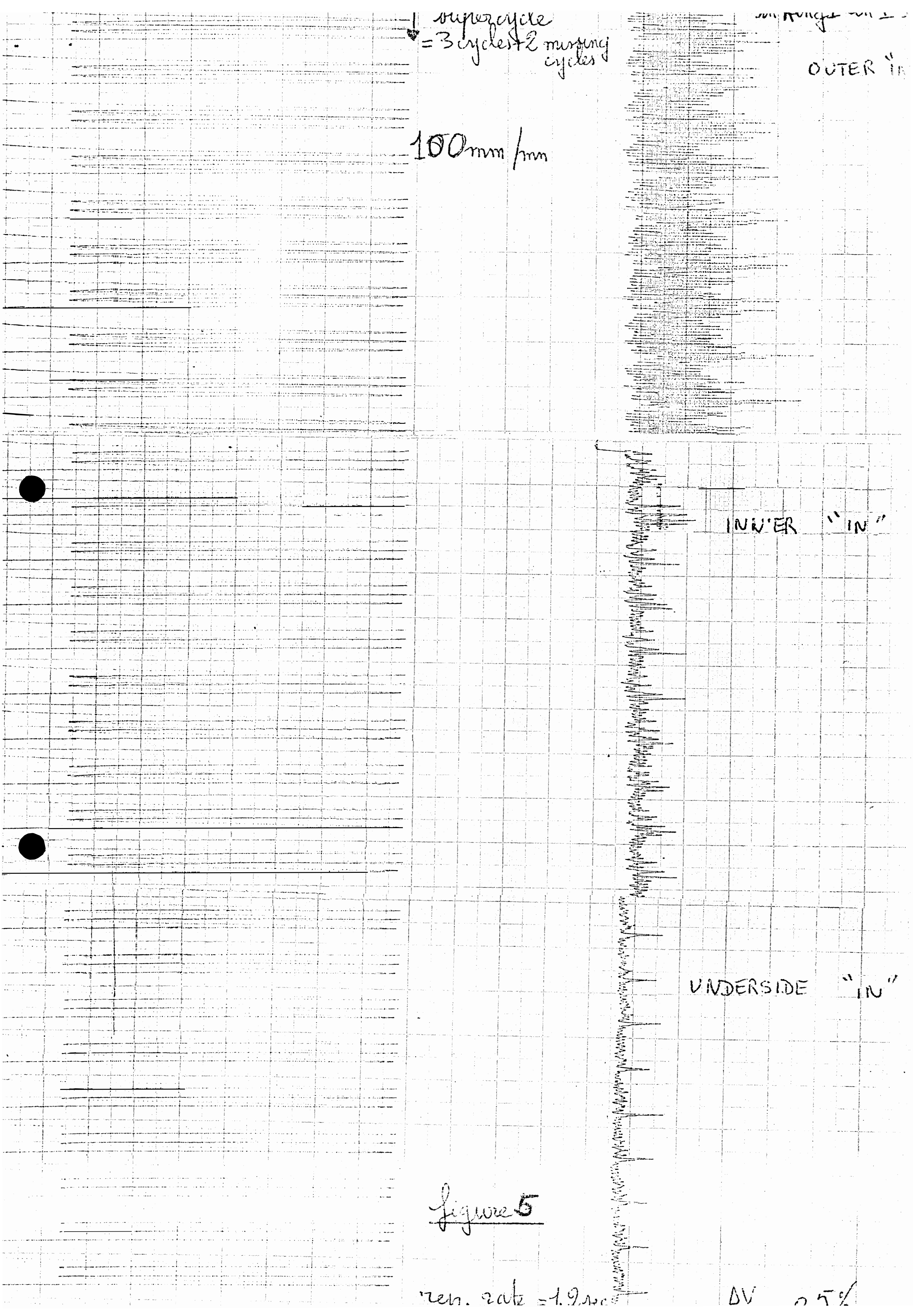
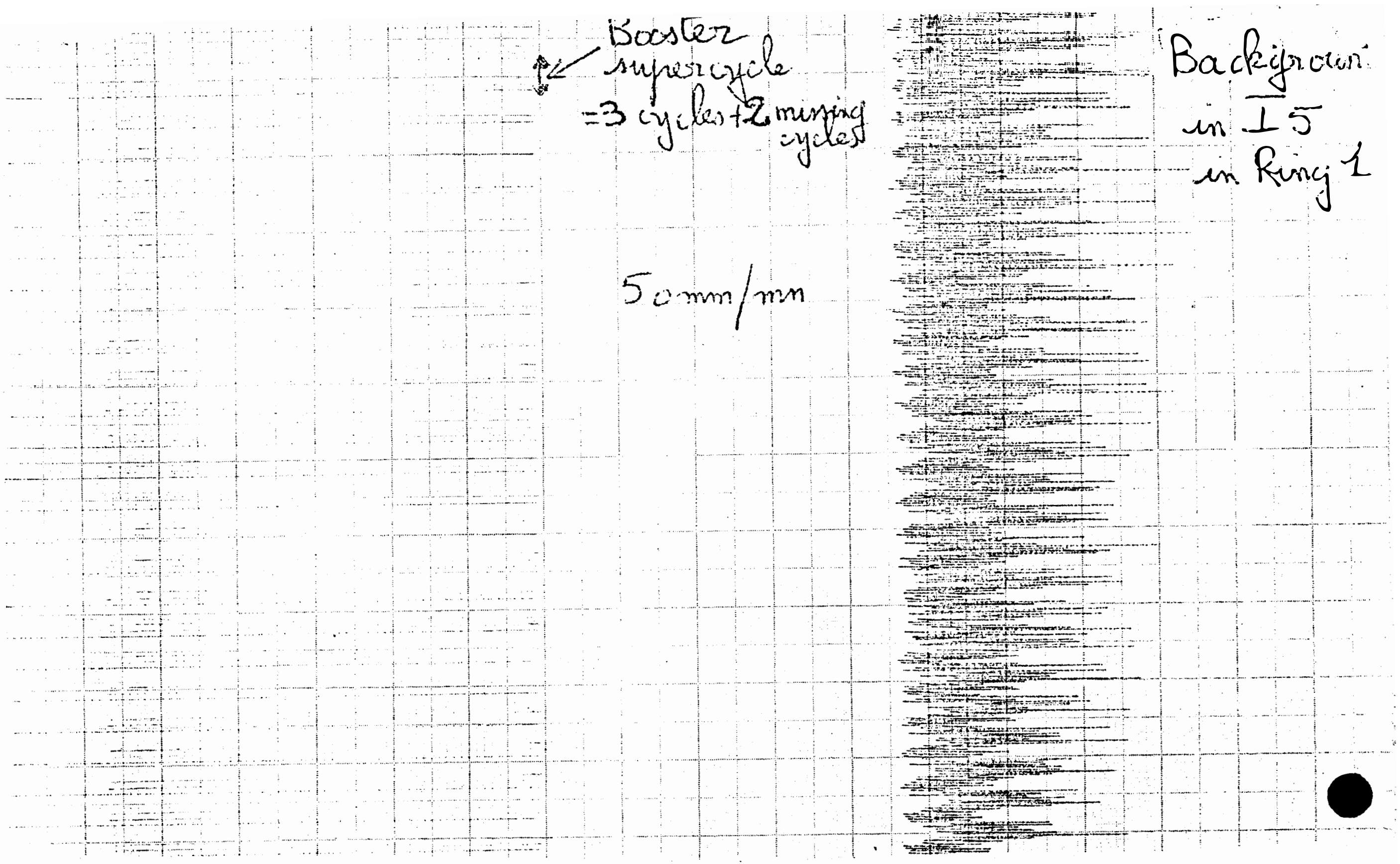

Booster OFF (ΔV/V=0%)
ΔV/V= 0.3%
v=2.5 mm/sec
ΔV/V= 1%
ΔV/V = 1.4%
dΦ1D/dt
dΦ1F/dt
dΦ2F/dt
dΦ2D/dt
dΦ1D/dt
dΦ1F/dt
dΦ2F/dt

figure 4

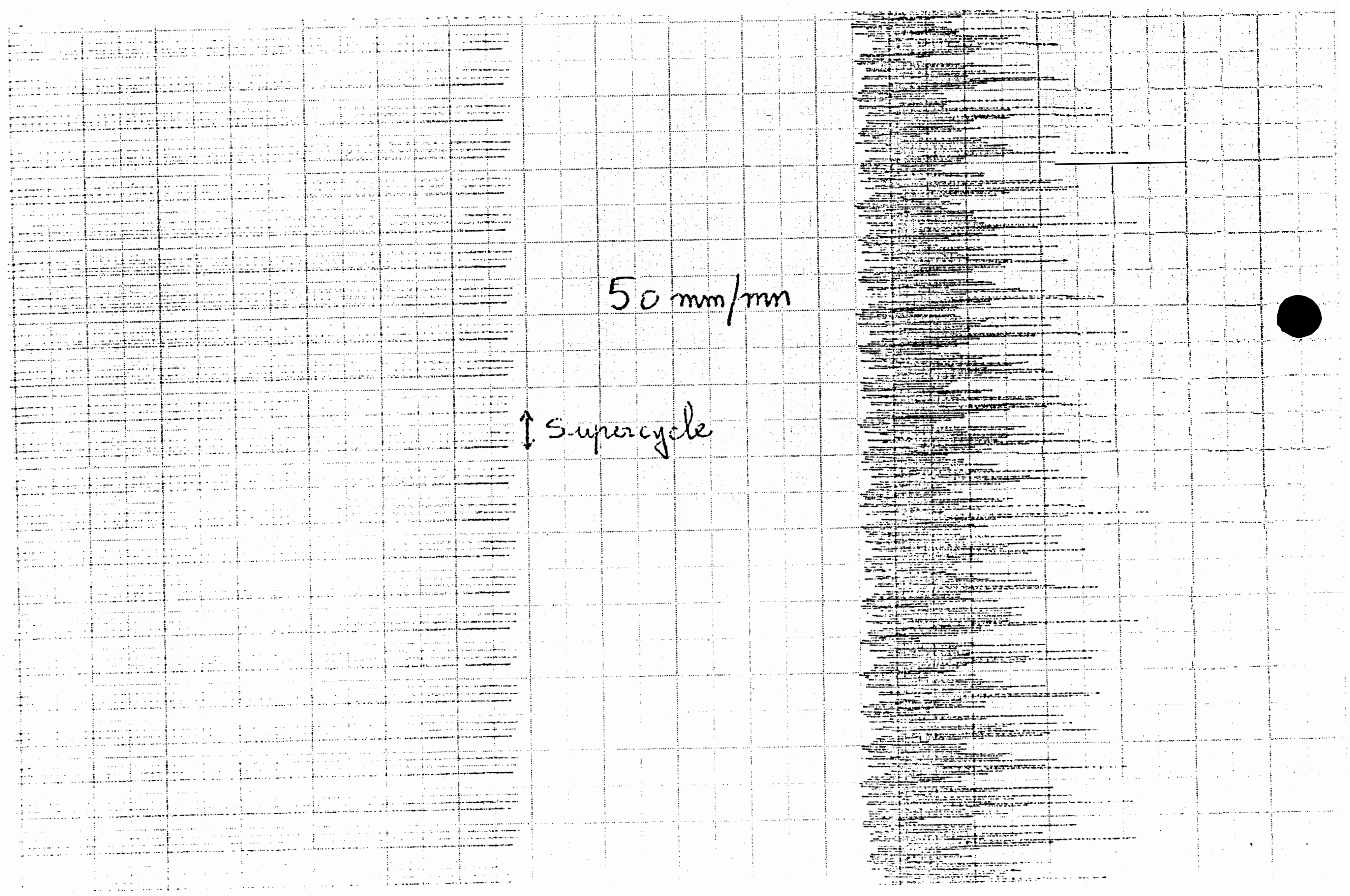


supercycle
= 3 cycles + 2 missing cycles
100mm/mn
OUTER "IN
INNER "IN"
UNDERSIDE "IN"
ΔV

figure 5

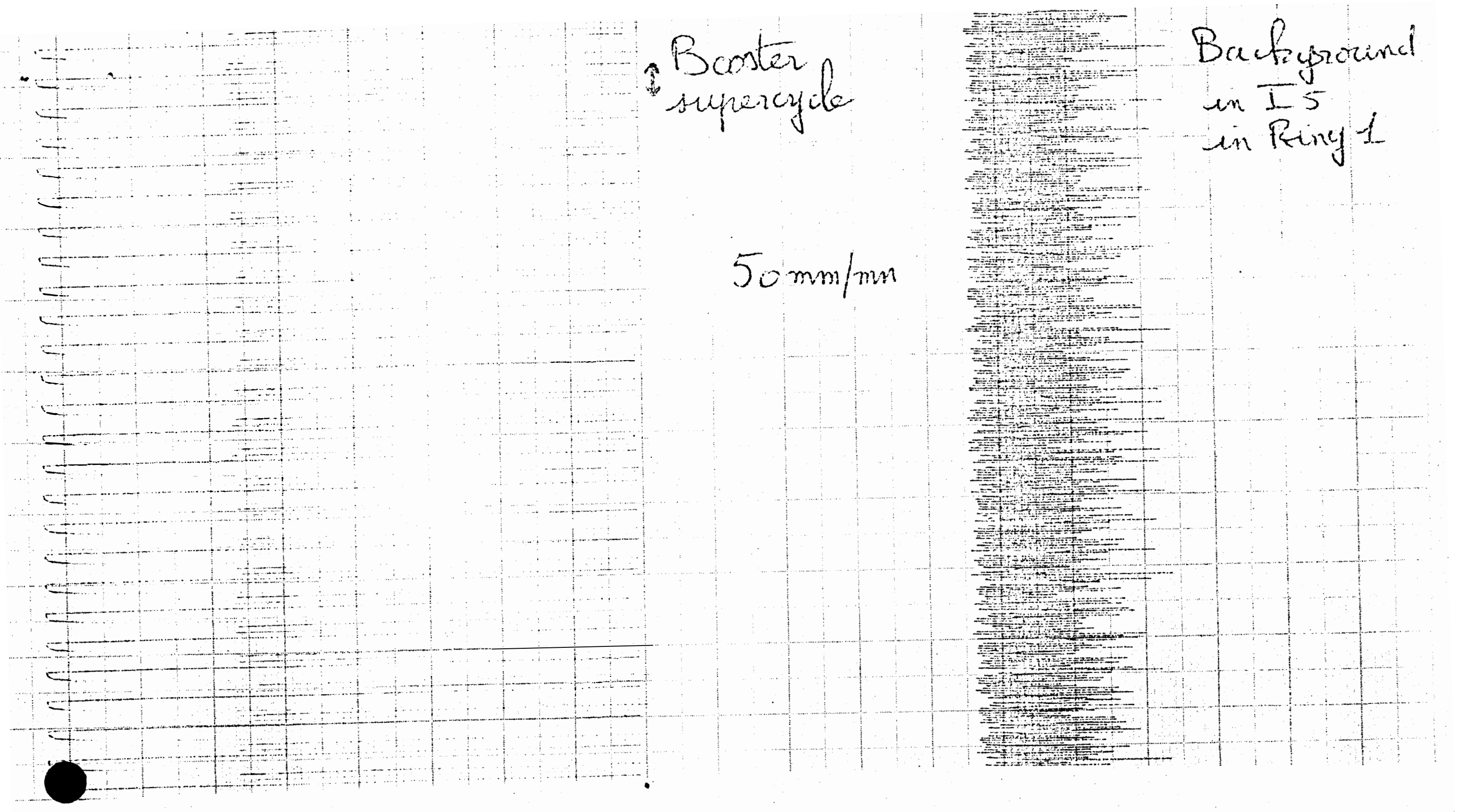


rep. rate: 1sec ; $\frac{\Delta V}{V} \simeq 0.8\%$

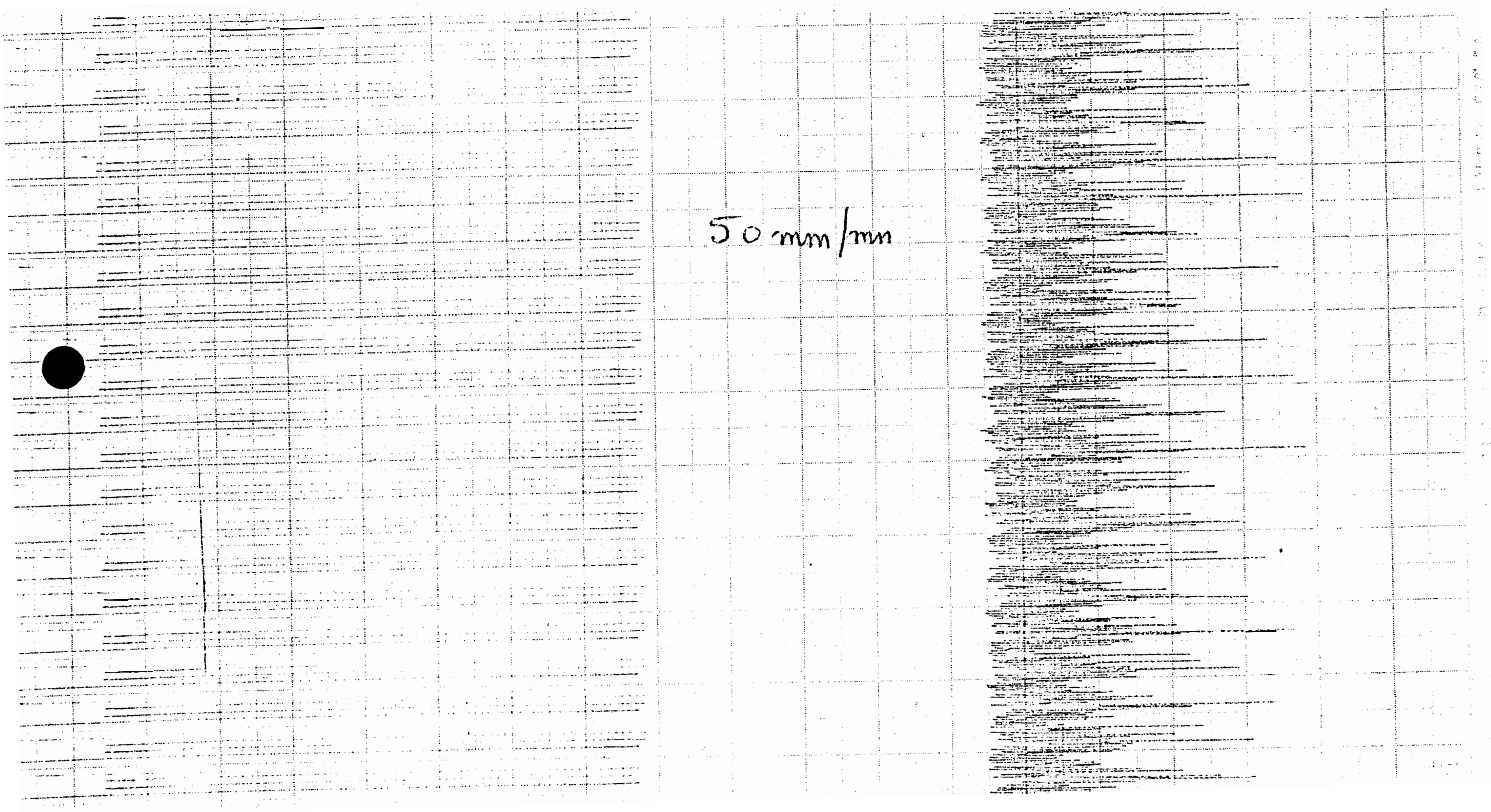


rep. rate: 1.2 sec ; $\frac{\Delta V}{V} \simeq 1\%$

figure 6



rep. rate : 1 sec ; $\frac{\Delta V}{V} = 0.3\%$



rep rate = 1 sec ; $\frac{\Delta V}{V} \simeq 0.8\%$

figure 7

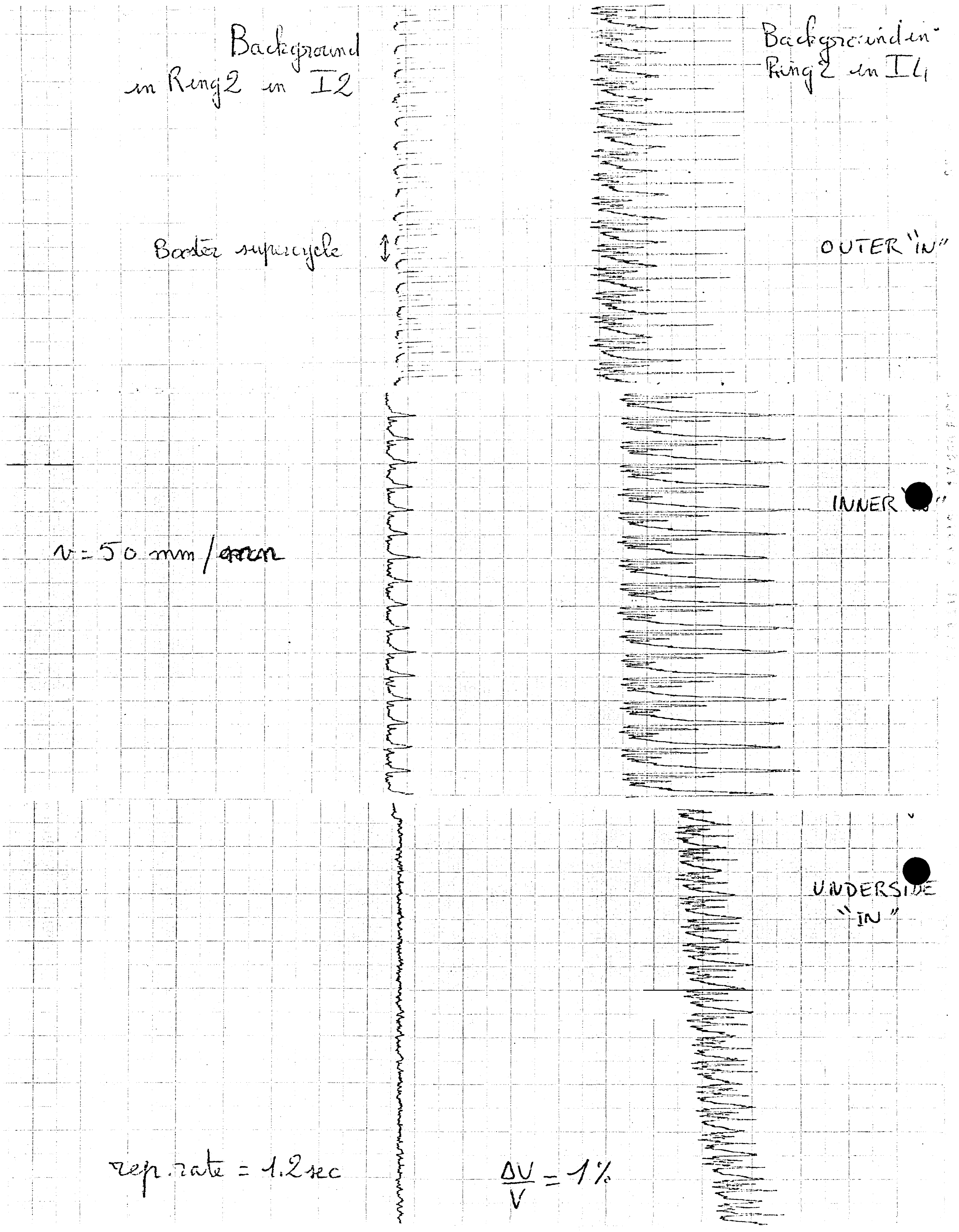
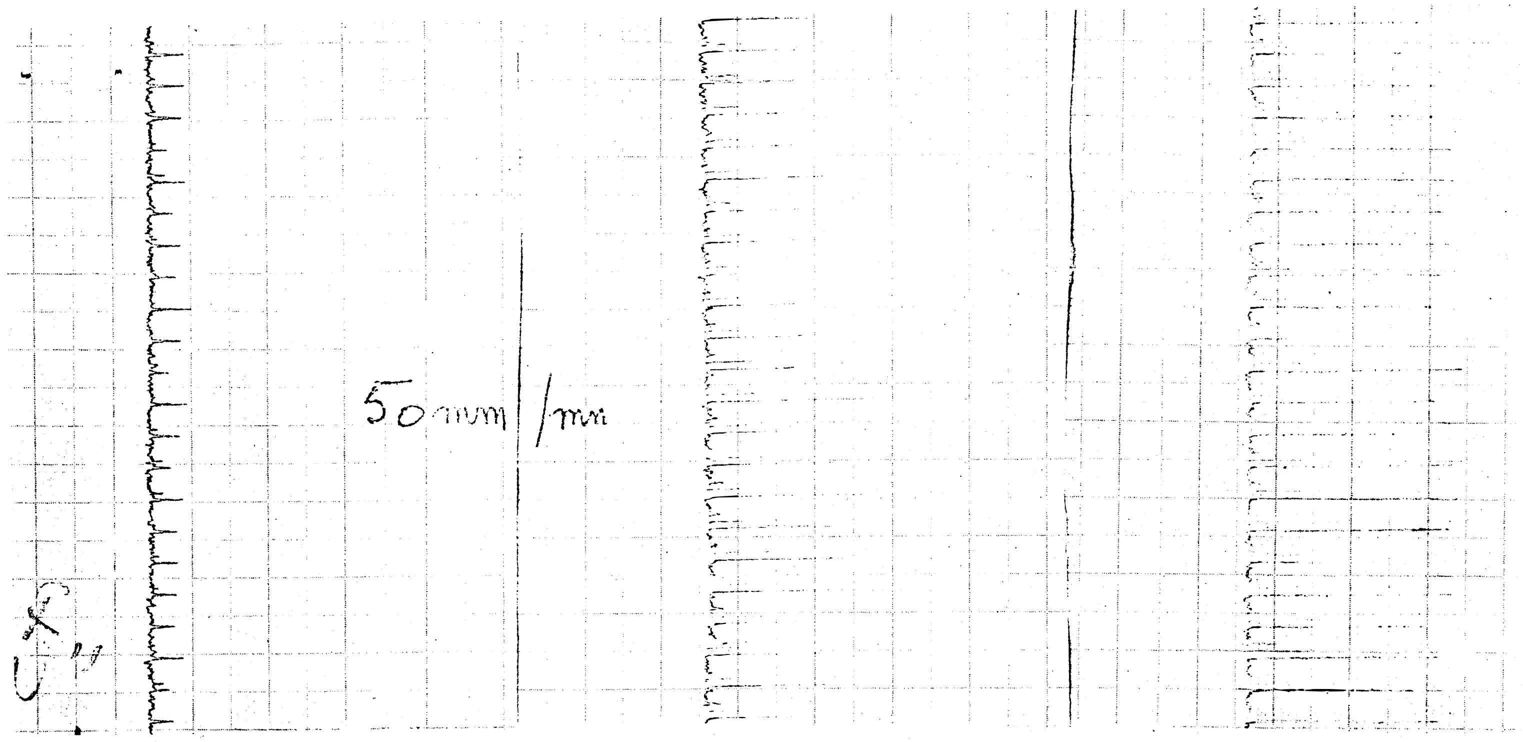
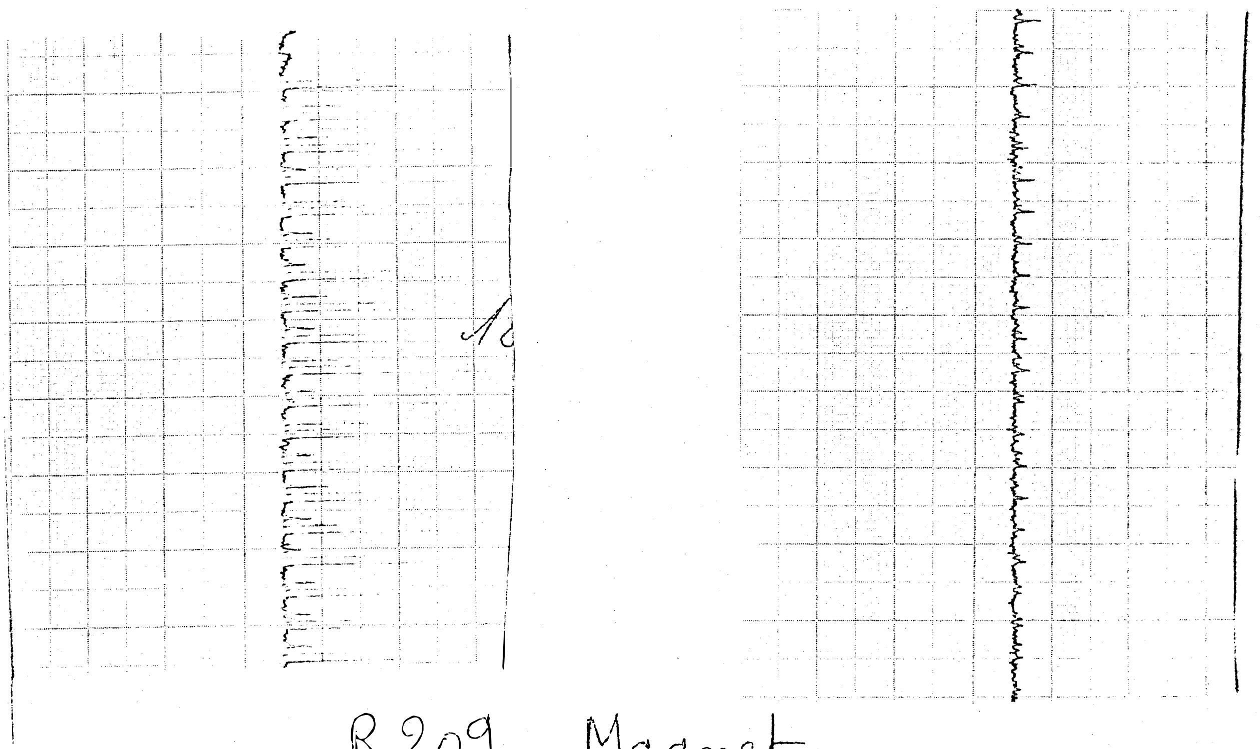

Background in Ring2 in I2
Booster supercycle
v = 50 mm/min
rep. rate = 1.2 sec
Background in Ring2 in I4
OUTER "IN"
INNER "IN"
UNDERSIDE "IN"
ΔV/V = 1%

figure 8



I 6 Lamp Shade Magnet

at -100%   0 %   +100%



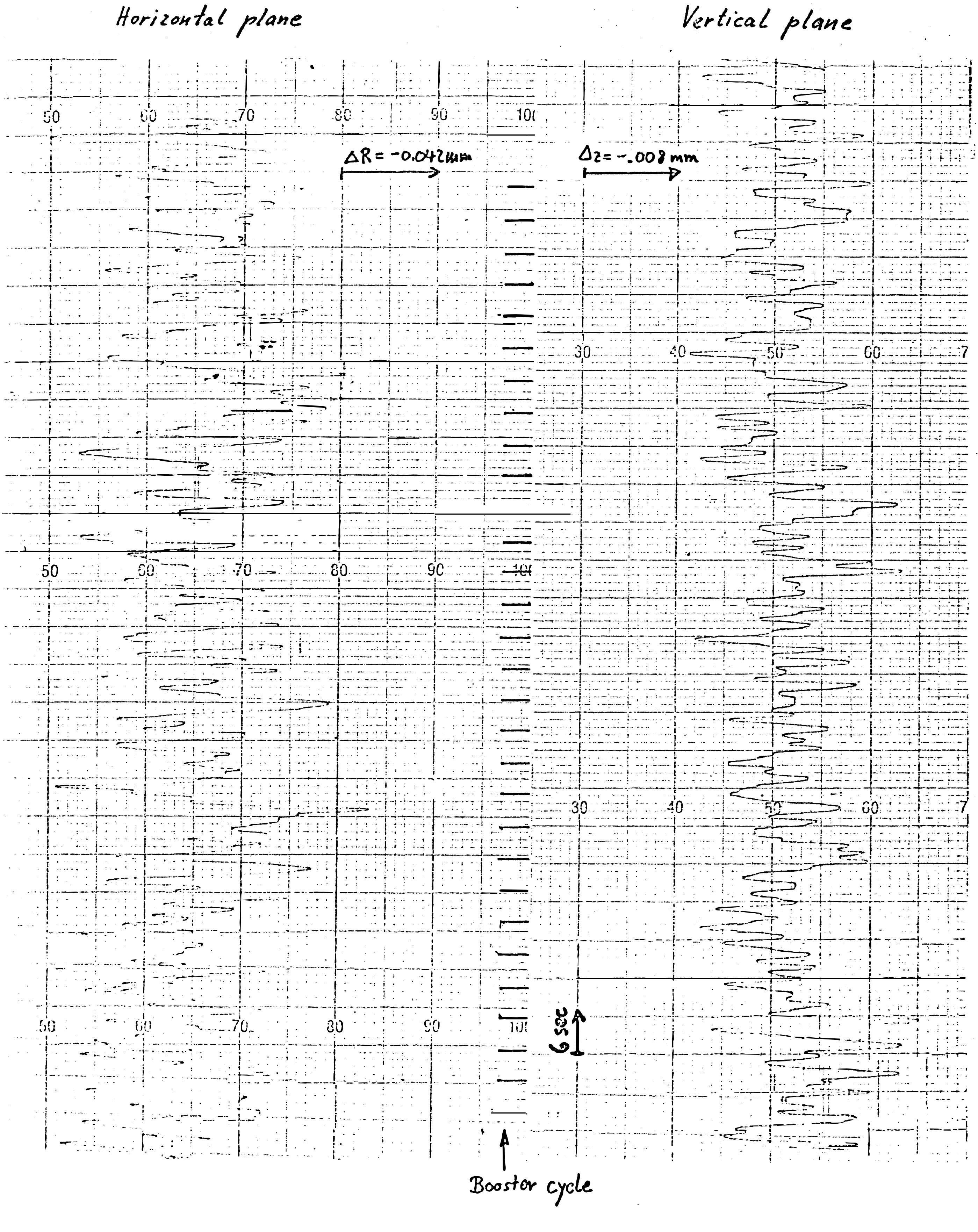
R209 Magnet

OFF   100%

Background in Ring 2 in I 2

Booster repetition rate : 1sec (supercycle = 5 sec)

figure 9



Horizontal plane
Vertical plane
ΔR = -0.042 mm
Δz = -.008 mm
50
60
70
80
90
100
30
40
50
60
6 sec
Booster cycle

figure 10

Horizontal orbit distortion for 15 mA in CP windings

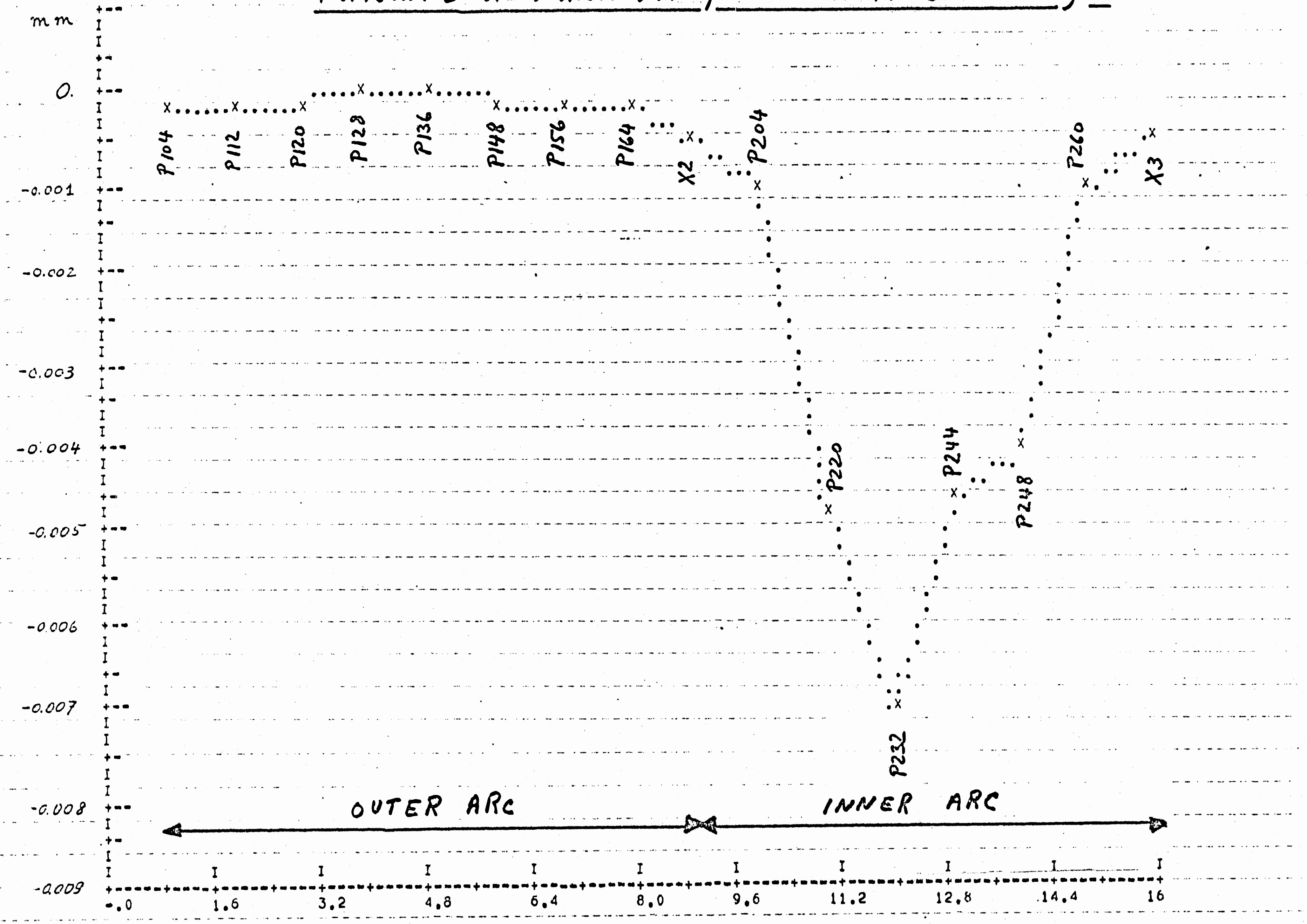


figure 11

Vertical displacement in I5

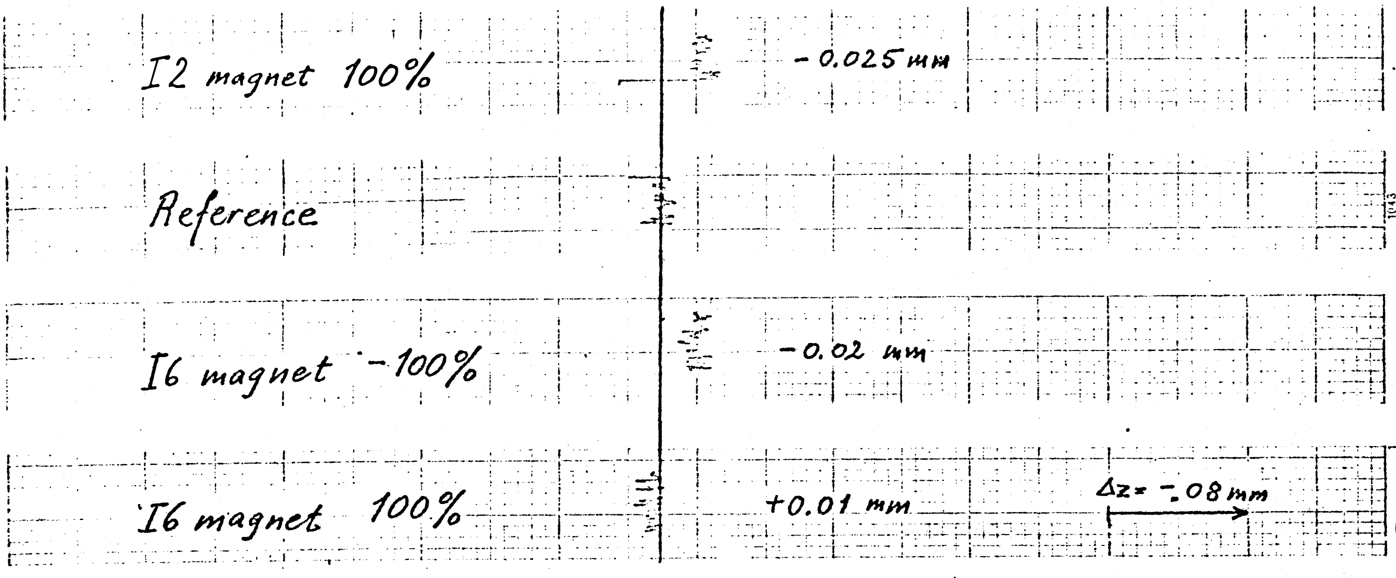


figure 12

Horizontal displacement in I5

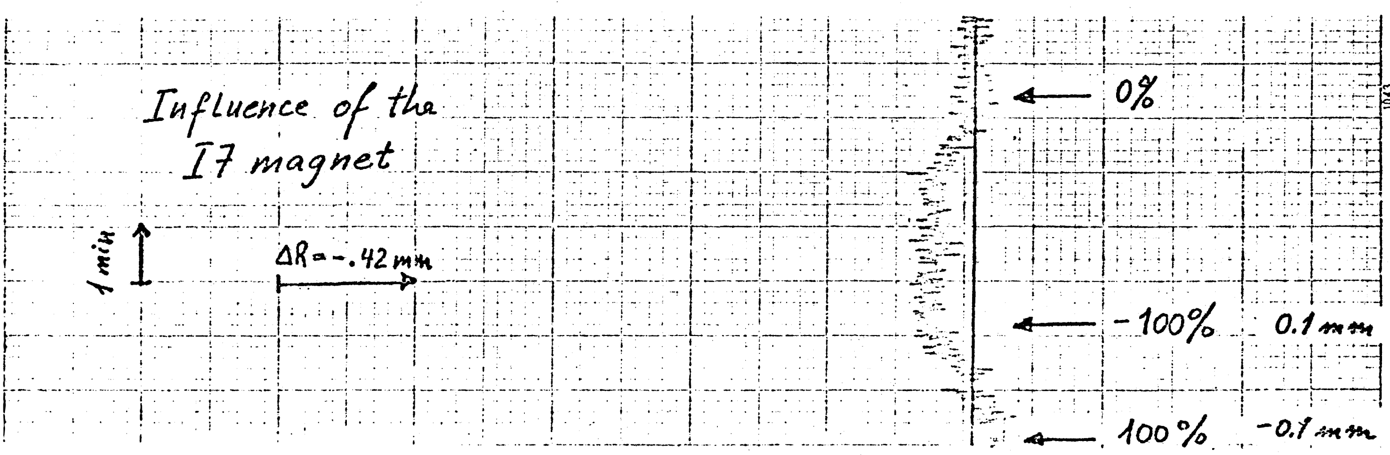
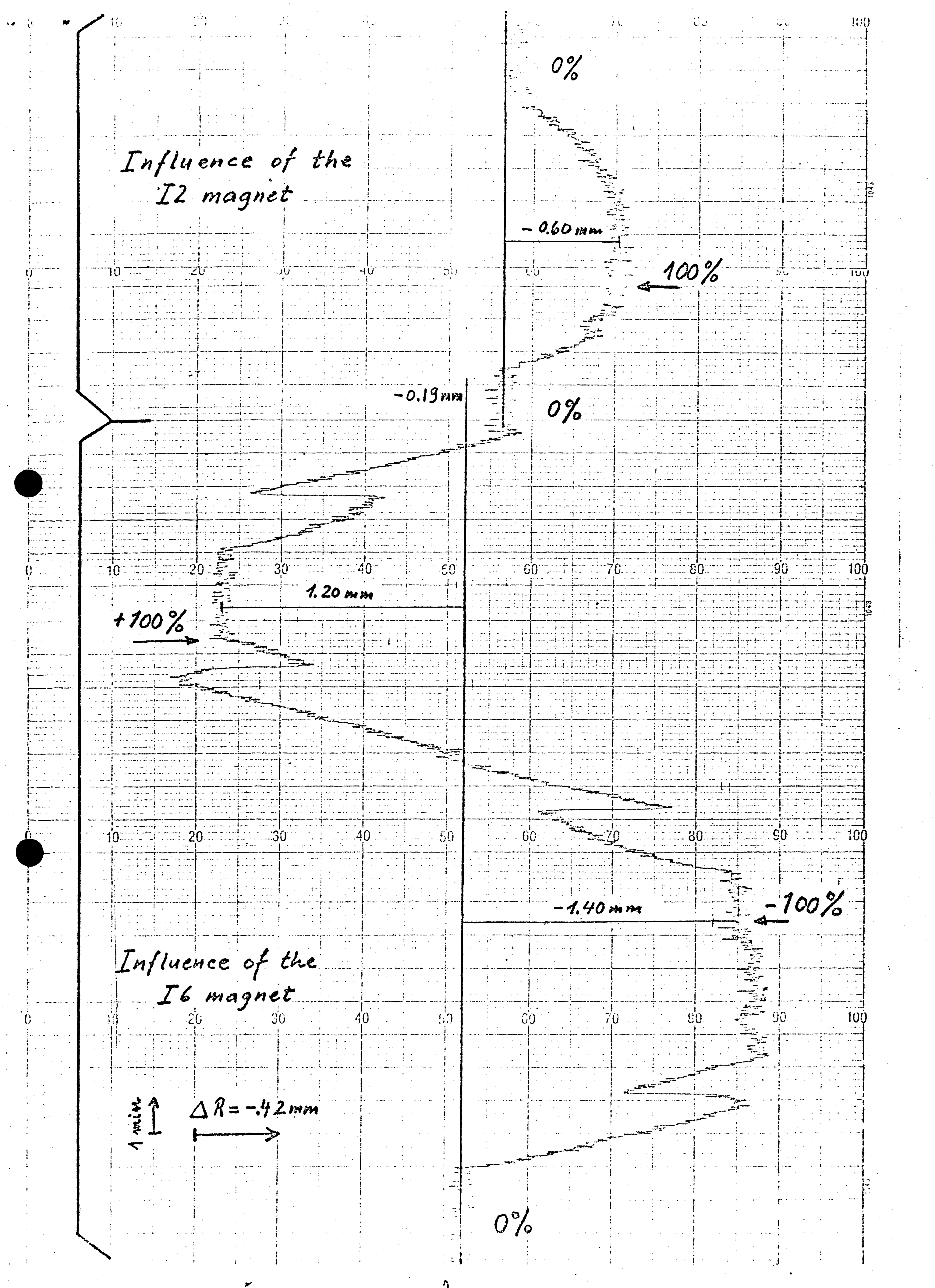


figure 13



0%
Influence of the
I2 magnet
- 0.60 mm
100%
-0.19 mm
0%
1.20 mm
+100%
-1.40 mm
-100%
Influence of the
I6 magnet
1 min
ΔR = -.42 mm
0%

figure 14

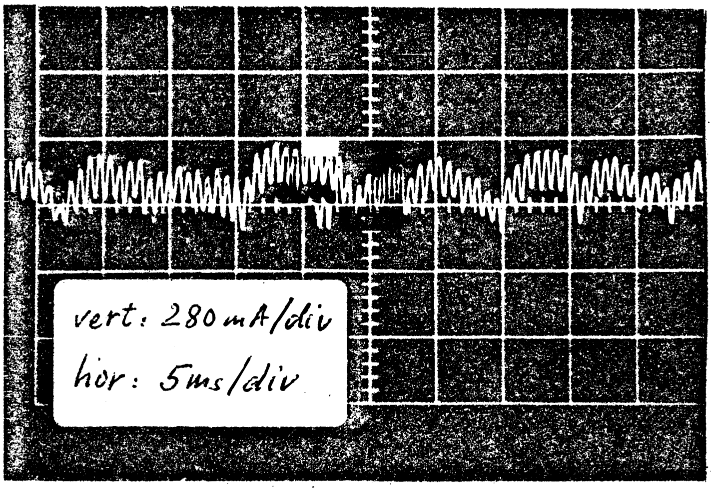


figure 15