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ISR-TH/EK/ss

6th December 1971

ISR RUNNING-IN

Run 127 (29.11.71), 10.5 GeV/c, 4 Bunches, Ring 1 and Ring 2.
Working lines : 10 FA
Injection at – 34 mm.
Acceleration to 49.5 mm. in Ring 1, 48 mm. in Ring 2.

Survey of Beam Behaviour at 10.5 GeV/c

The purpose of this session was a survey of beam behaviour at 10.5 GeV/c. Emittances were measured in the transfer tunnels, on the first turn, and of a circulating beam. The emittances of the circulating beam were found to be rather large, as in Run 103. The emittance measurements with SEM grids are not yet analysed. The bunch size was measured directly via the bunch length, by spill out and by debunching. All experiments agree in that 1.6 KV bunches are rather full. A second debunching experiment gave a larger momentum spread which might be indicative of blow-up after switching off the RF. This needs further study. A new type of instability with coherent signals on the (Q-8) filter was observed which sets in when RF acceleration starts. It was later on also observed at 15 GeV/c.

1. Emittance measurements in the transfer tunnels and on the first turn

Data have been taken for the emittances at the beginning of the transfer tunnel and at either end, and on the first turn in both rings. No analysis is given because of P. Brummer's absence.

2. Measurement of circulating beam size

Data were taken in both rings, at injection orbit and after acceleration, and with the inner and outer ST. The results for the m amplitudes at the ST and for the beam radius at maximum horizontal β are shown in Table I. Typical scans are shown in Fig. 2.1.

Fig. 2.1

Ring 1 Ring 2

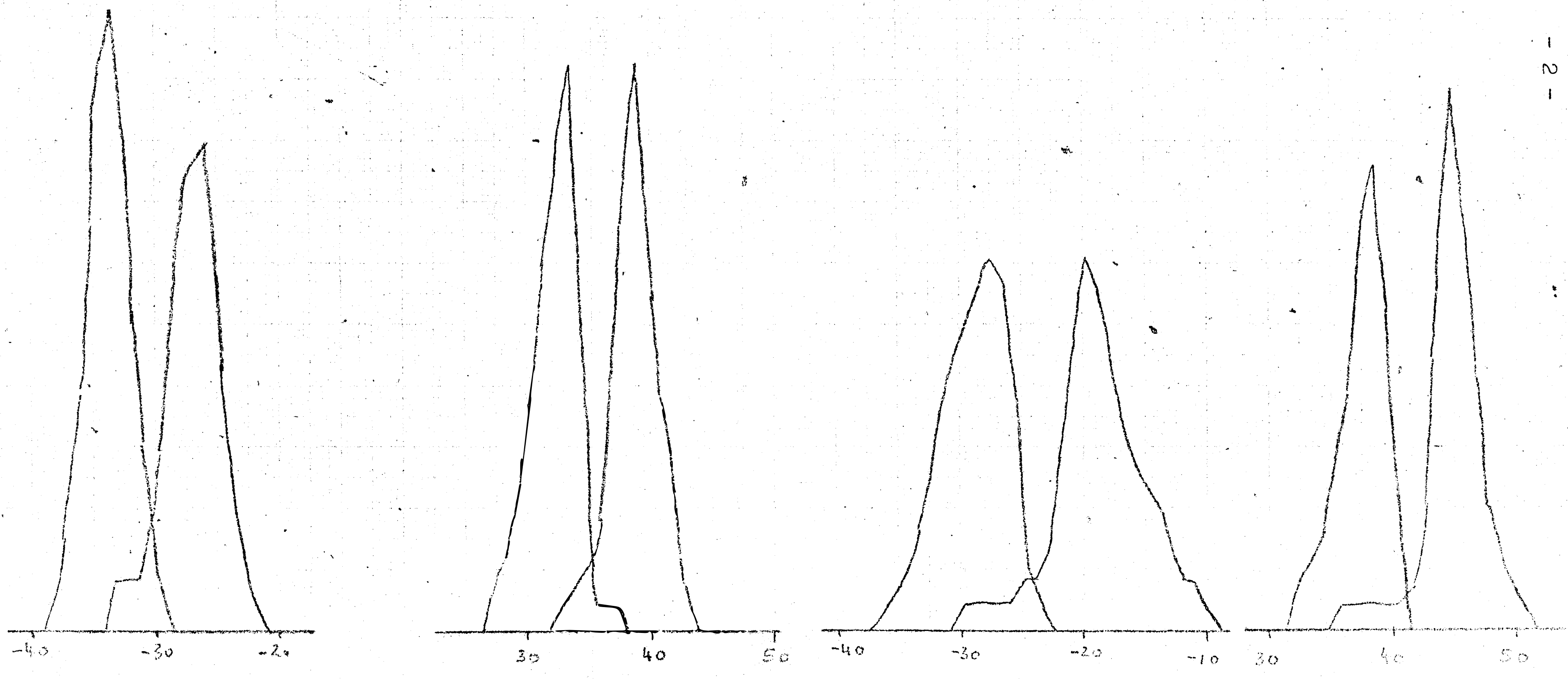


Table I

Horizontal Beam Radius

Ring	Rad. pos.	Runs radius at ST (mm)	Max. beam radius (mm)
1	inj.	5	15
	after acc.	4.2	13
2	inj.	5.6	17
	after acc.	4.2	13

These results are in agreement with those of Run 103.

3. Spill out measurement (M. de Jonge)

Spill out was measured in both rings. Results of the measurement is given in Fig. 3.1. Values indicated are averaged over 10 measurements.

Spill out is less in Ring 2, than in Ring 1. This difference is probably due to the difference in injection conditions. In Ring 1 around 15 mA was injected, in Ring 2 only 12.5 - 13 mA. Taking this difference into account the same values are found for both rings for the spill out.

The current pattern observed in Ring 1 and Ring 2 are different (see Fig. 3.2). A sudden loss in current is observed in Ring 2 when acceleration starts. This coincides with coherent signals from the high horizontal filter.

4. Coherent signals in Ring 2

Coherent signals were observed on the high horizontal filters which show (Q-8) f. They only occur when the RF is on, and do not occur above the high 50 Hz. noise level on any other filter in Ring 2 and Ring 1. The signal is much smaller in Ring 1 on the HH filter. See Figs. 4.1 to 4.4.

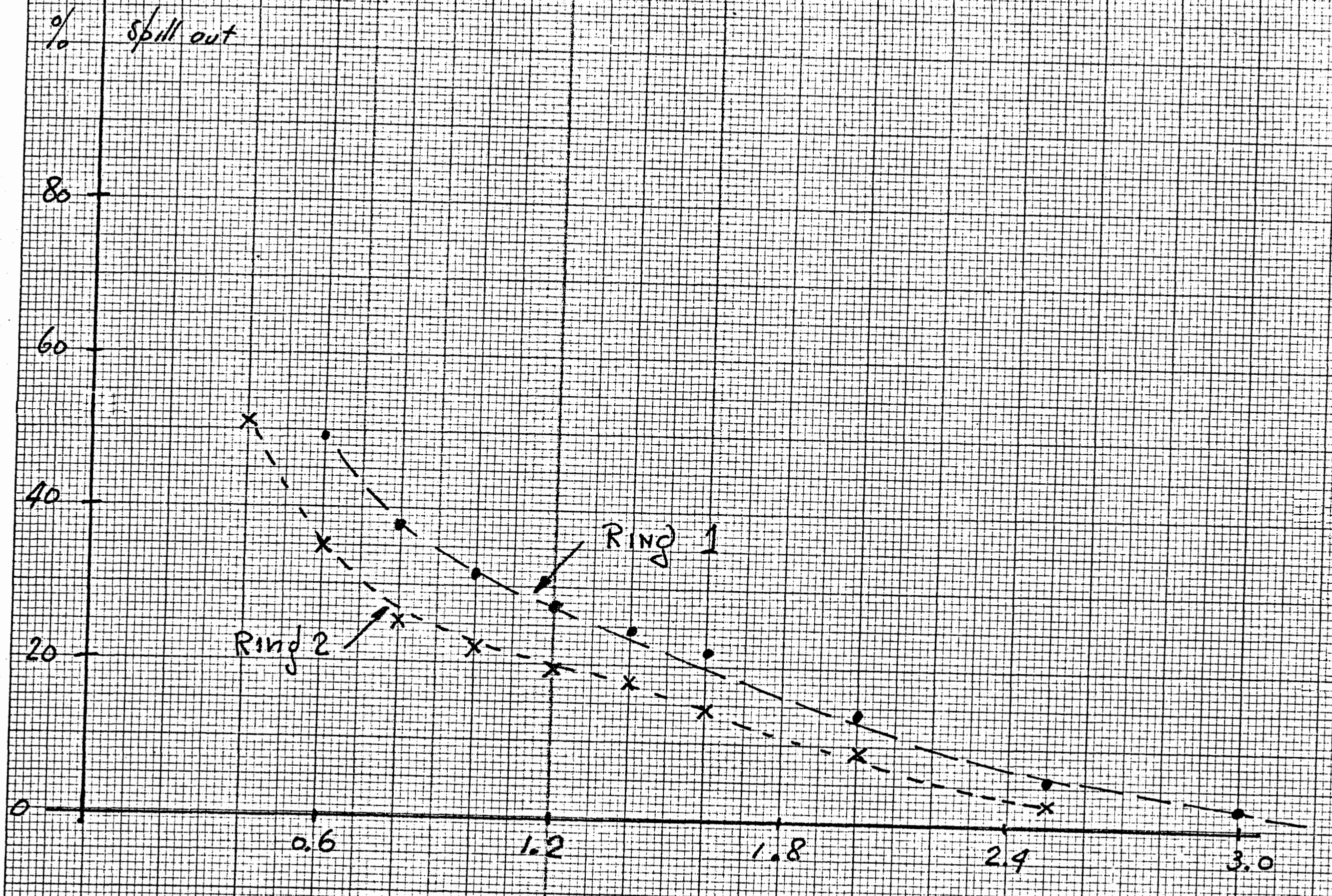
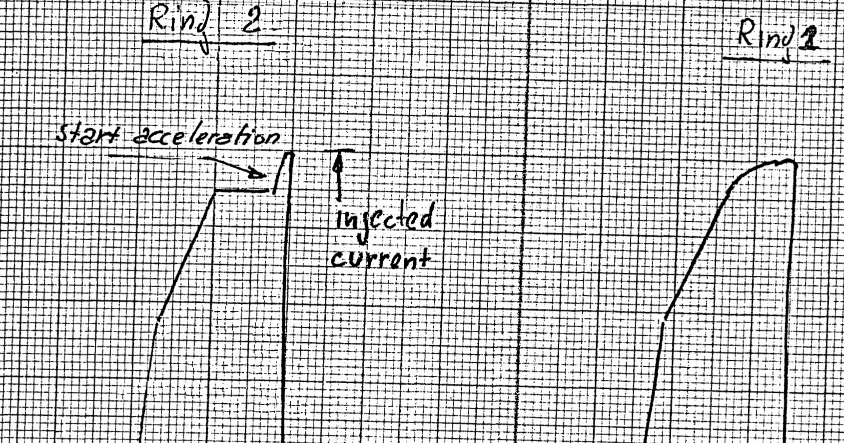


Fig 3.1



$$\text{spill out} = \frac{\text{left over current}}{\text{injected current}}$$

Fig 3.2

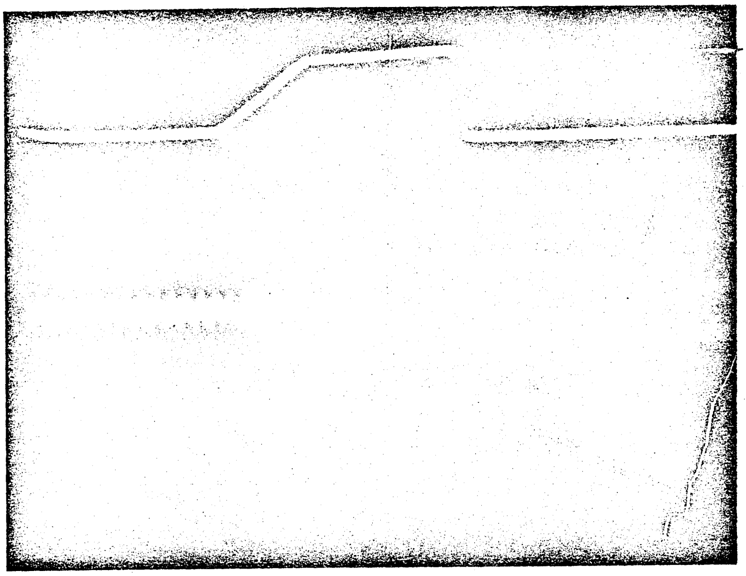


Fig. 4.1

RF analog voltage

HH output 0.2V/div.

0.1s/div. R2

(20 x gain?) ?

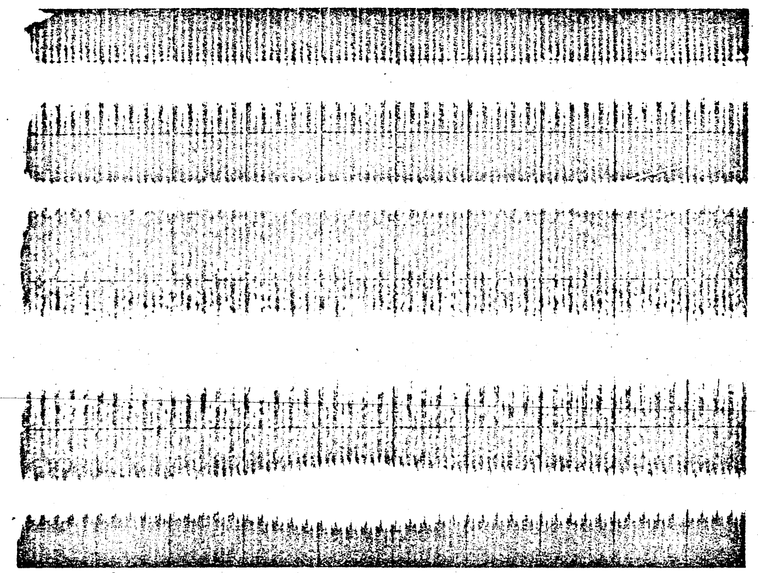


Fig. 4.2 R1, 0.1s/div.

VL 0.2V/div.

VH 0.2V/div.

HL 0.2V/div.

HH 0.2V/div.

(20 x gain?)

all at 10.5 GeV/c

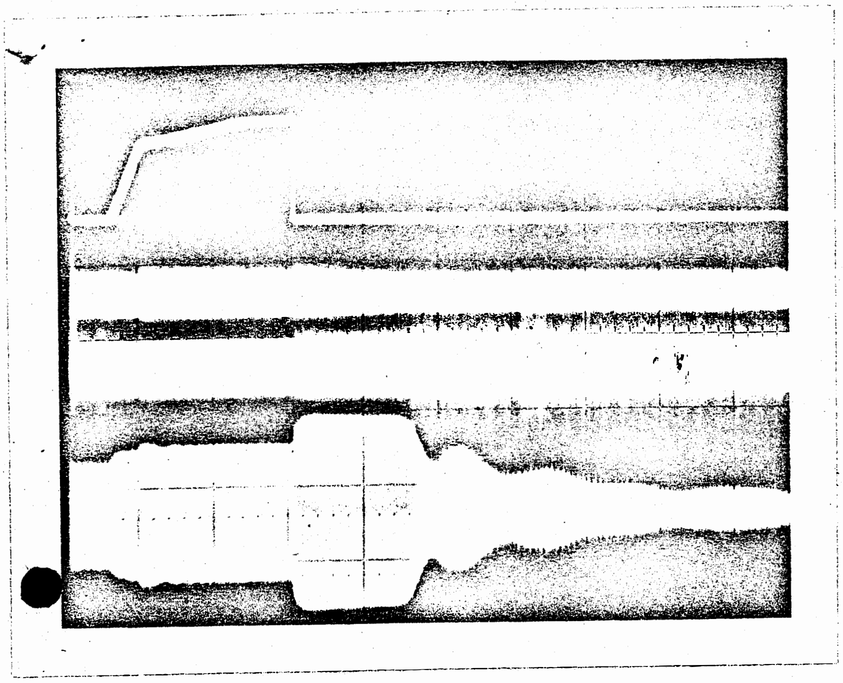


Fig. 4.3 R2 0.5s/div.

RF analog voltage

VH 0.2V/div.

HL 0.2V/div.

HH 0.5V/div.

20 x gain

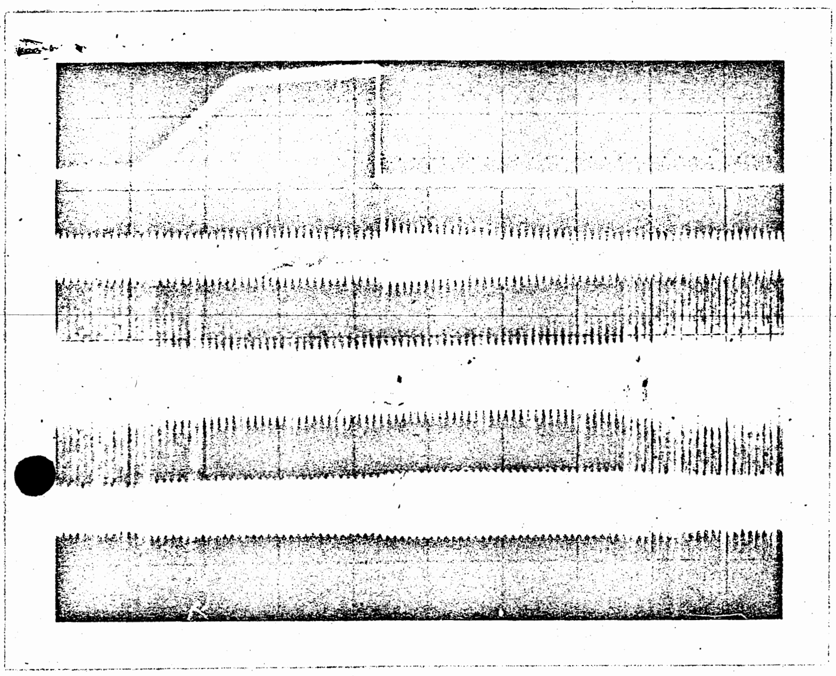


Fig. 4.4 R1 0.5s/div.

RF analog voltage

VH 0.2V/div.

HL 0.2V/div.

HH 0.5V/div.

20 x gain

all at 15 GeV/c

The same observation was also done during Run 129, at 15 GeV/c. The same signals occurred. Therefore this new phenomenon is not characteristic for 10.5 GeV.

5. <u>Momentum Spread Measurements by Debunching</u> (K. Hübner, B. Zotter)

5.1 Debunching time measurements with spectum analyser tuned to 9.50 MHz (Band width 10-300 KHz) and 320 KHz (BW 10KHz), zero dispersion, linear scale.

Trigger IF pulse (for RF off) or VO pulse (with RF). RF - off pulse after stacking. The momentum spread is calculated from :

$$\frac{\Delta p}{p} = \frac{2\pi R}{30\ c\eta\Delta t}$$

where η inj. = 4.48×10^{-3}, η co + 20 = 4.92×10^{-3}

Ring	Orbit	RF Status	Debunching time Δt(ms) for 9.5 MHz	$\left(\frac{\Delta p}{p}\right)_{meas} 10^{-3}$	$\frac{\Delta p}{p}\ 10^{-3}$ theoret. full width at base	Fig.
1	injection	off	19^*	1.2	Bunch 1.7	A
	injection	trap+match	22^*	1.1	Bunch 1.5	
	injection	V_f = 1.6 KV	34^*	0.69	Bucket 0.96	B
	acc. to C.L. + 20mm	no turndown	20^*	1.1	Bunch 1.5	
	"	V_f = 1.6 KV	32^*	0.67	Bucket 0.96	
2	injection	off	19^{*+}	1.2	Bunch 1.7	
	injection	trap+match	17^+	1.4	Bunch 1.5	
	injection	V_f = 1.6 KV	26^+	0.96	Bucket 0.96	
	acc. to C.L. + 20mm	V_f = 2.5 KV	26^+	0.9	Bucket 1.2	
	"	V_f = 1.6 KV	30^+	0.7	Bucket 0.96	C

frequency 9.5 MHz*
0.32 MHz$^+$

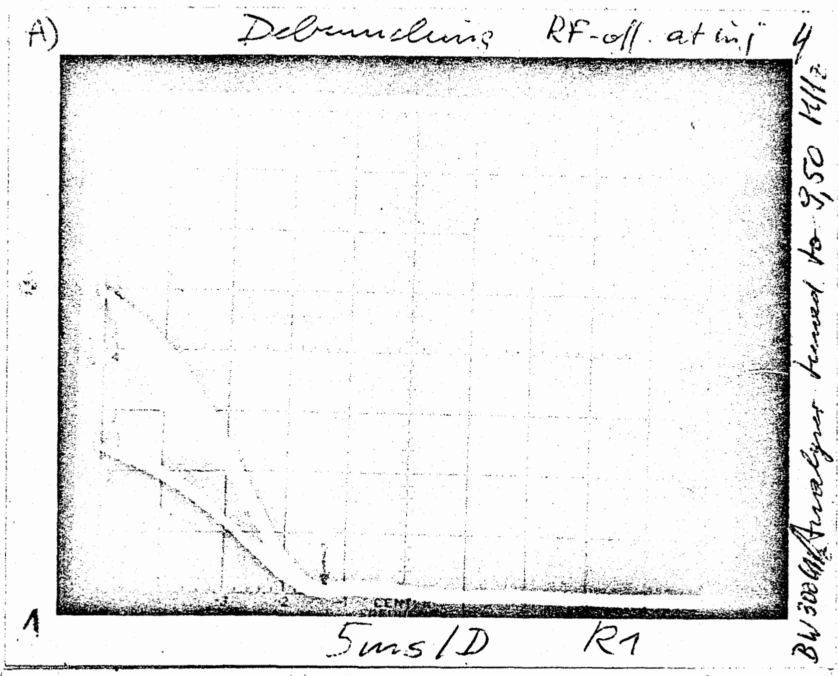


Fig. A

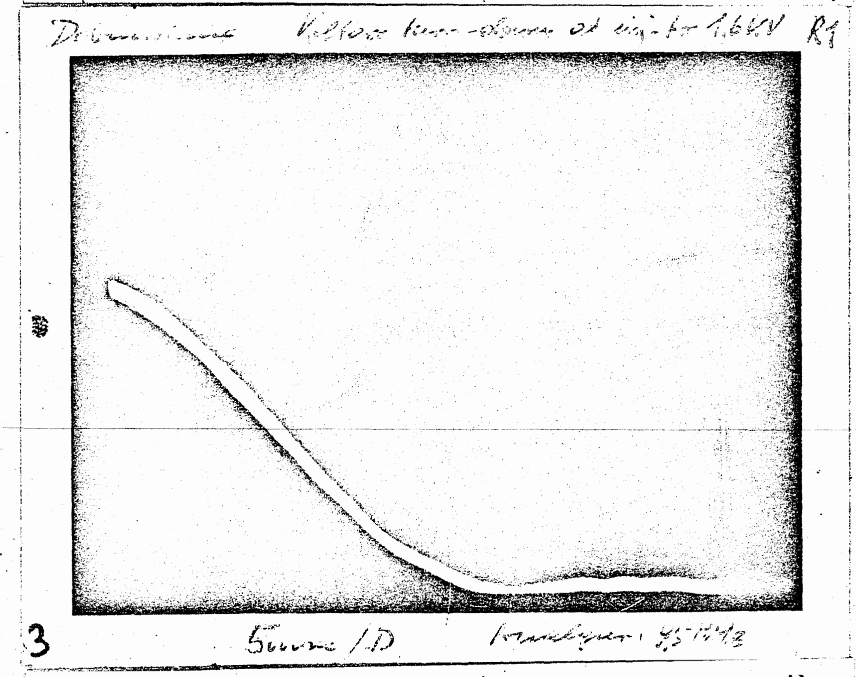


Fig. B

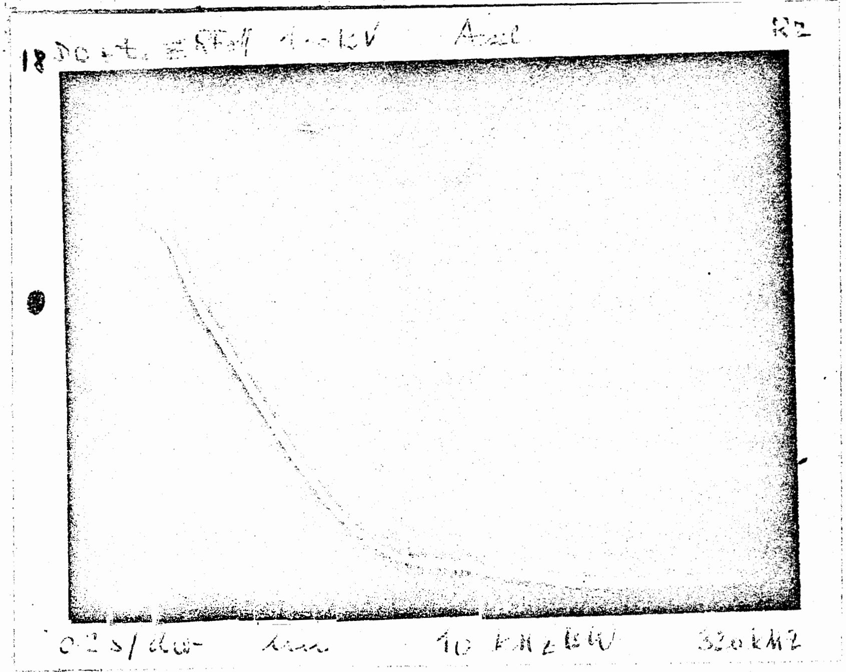


Fig. C

5.2 Second debunching (part of the circulating beam is removed with the inflection kicker triggered from the Q-kicker). Spectum analyser as above (BW 10 KHz). Peaks appear periodically, but their spacing varies from case to case for the same RF conditions over a wide range. The peaks sometimes even increase before decreasing into the noise noise level (usually 5-8 peaks could be seen). Not much specific information can be drawn from this experiment.

Ring	Orbit	RF Status	Distance between peaks ms	Fig.	$\left(\frac{\Delta p}{p}\right)$ meas. x 10^{-3}
1	inj.	off	190, 100 (log scale picture)		3.69, 7.01
1	inj.	Vf=1.6kV	220	D	3.19
1	acc. to CO + 20	no turn-down	310 (also 700 & 200 have been seen).		2.05

5.3 Conclusions

The values of $\left(\frac{\Delta p}{p}\right)$ measured by debunching before voltage turn-down are a bit below the values of $\left(\frac{\Delta p}{p}\right)$ max. for a bunch 15.5 n sec. long. The momentum spread after turn-down to 1.6 KV indicates that the final buckets are nearly full, indicating a total blow-up of 1.8 in area between injection and end of RF handling.

The values of $\frac{\Delta p}{p}$ measured by second debunching are varying but consistently larger than the former ones by a factor of over 3. This could be interpreted as a blow-up occurring directly after debunching, the variations might be due to the arbitrary timing of kicking the beam by manually triggering the Q-kicker.

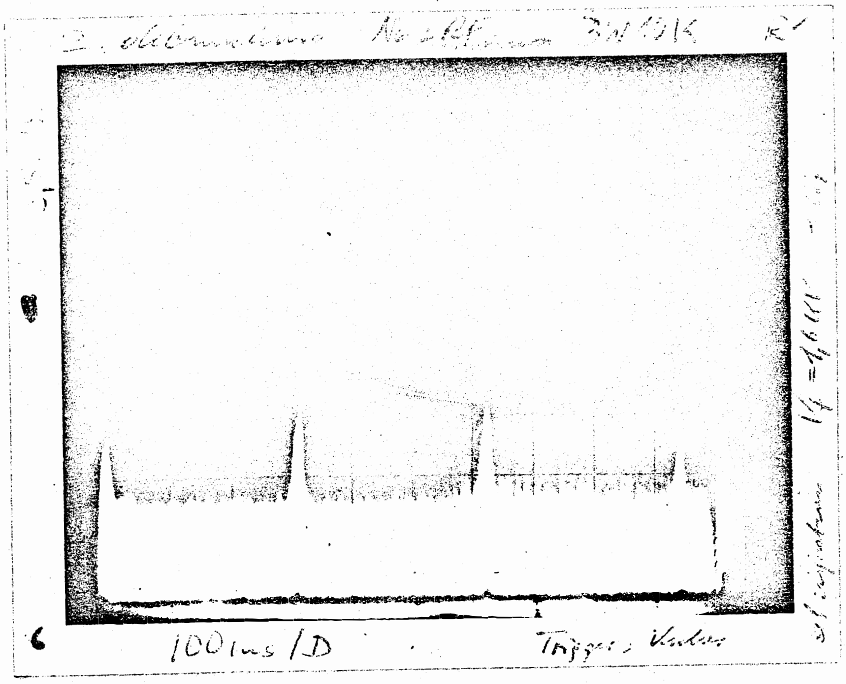


Fig. D

6. Bunch area measurements (K. Hübner)

Bunch area at injection

$$\Delta\tau = 16.10^{-9} \pm 15\% \quad \text{sec.}$$

$$\frac{\Delta p}{moc} = 2.1.10^{-2} \pm 15\%$$

$$A = 1.6.10^{-2} \pm 30\% \quad \varphi_{RF}\ \text{m.c}$$

For I_s = 14 mA

= 4700 protons/eV/c φ RF (Perameter list = 8500 protons/eV/c φ RF)

Bunch area at stacking orbit after voltage turn-down to 1.6 KV

Stationary bucket

$$= 43 \pm 5.10^{-9} \quad \text{sec.}$$

$$A = 2.2.10^{-2} \pm 15\% \ \varphi\ \text{RF m.c}$$

For I_s = 11 mA

= 2700 protons/eV/c φ RF

7. Microwave observations are reported separately by P. Bramham.

Acknowledgement : P. Bramham, S. Hansen, K. Hübner and B. Zotter did most of the work.

E. Keil