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EJECTION EFFICIENCIES MEASURED IN MAY 1968

The last machine development in May was used to compare simultaneously intensity measurements of

1) internal beam current (measured with the current transformators [1] Unser and Hereward)and circulating protons measured with the PU station.

2) external beam intensity (measured with the current transformer Battisti [2]) for ejection from ss 58.

3) induced activity in Al for the fast ejection from ss 1 and ss 58 and for slow ejection from ss 62.

Losses indicated by the AIC [3] of the beam loss system were observed during the time of the fast ejection in the different channels.

The results of the measurements obtained from the different monitors are summarized in Table 1.

The signal of both internal transformers was given in mA . The value of the Unser-transformer was corrected and the reading of both transformers converted into the number of protons.

The following behaviour of the internal beam current transformer was observed later (end of May 1968) :

a) the reading is not influenced by the average radial position, nor by

b) the length of the bunch,

c) the reading seems to be indpendent of the energy of the circulating protons.

On the contrary, the intensity reading of the PU station depends on the bunch length.

The flux measurement with the external current transformer for ejection 58 was (during the measurements in May) not consistent with the internal beam current transformer, nor with the activity measurements. The ejection efficiency would have been 103 or 109 %, respectively. This behaviour of the current transformer (due to a voltage overshoot at high intensities) has been improved during the Summer 1968.

Foils for activity measurements were exposed for

a) fast ejection from ss 1 : in ss 2 and behind M 007;

b) fast ejection from ss 58: behind the external transformer;

c) slow ejection from ss 62: near to TV station 3.

All the screens in front of the foils were removed. The following measurements were made for the different foils :

a) beam distributions in the horizontal and vertical plane down to flux densities of 10^{-4};

b) flux densities outside the beam line to ensure that the background of stray radiation is negligible;

d) intensity of the 1.38 and 2.75 MeV γ line of Na^{24};

c) the yield ratio of F^{18} to Na^{24} from the β activity.

The statistical accuracy of γ intensity measurements is about ± 1 % . Each value given in Table 1 is the mean value of several foils, measured twice for each ejection. Short (between 30 and 90 min.) and long duration measurements (between 300 and 600 m.) agree within their statistical accuracy, as well as the results of the measurement of the 1.38 and 2.75 γ lines.

The evaluation of the paper tapes of the measurement in the multi-channel analyzer was handled by the Program GAPLOTA [3]. Program PRODURA [4] was employed to evaluate the β measurements for the yield ratio F^{18}/Na^{24}, needed to exclude Na^{24} production by low momentum particles. The rms error for the yield ratio is in the range of 1 to 1.5 % for the measurements of each ejection. Corrections due to the result of those yield ratios were neglected, if the correction was $\lesssim$ 1 % . This was the case for the fast ejection from ss 1 . A 2 % and a 4 % correction was applied for ejection 58 and 62, respectively (Table 1). A second exposure using the slow ejection 62 is omitted in Table 1, since a correction of nearly 30 % would have been required due to the measured yield ratio F^{18}/Na^{24}. This suggests either a drift of the ejection settings or in the beam parameters between the two exposures.

TABLE 1

*)	FE 1 (1exp.)	FE 1 (2exp.)	FE 1 reduced intensity	FE 58	SE 62
1 Ip circulating protons (before shaving)	2.019	2.005	1.229	2.037	1.685
2 TR Unser (before ejection)	1.727	1.716	1.055	1.561	1.447
3 TR Hereward	1.63	1.61	0.98	1.58	-
4 TR 58 Battisti	-	-	-	1.61	-
5 Activity meas. (Na^{24}-γ)	1.62	1.57	0.98	1.48	1.17
6 Ratio (5)/(2) (%)	93.5	91.5	93.0	94.5	81
7 Ratio (6) corrected by the ratio F^{18}/Na^{24}	(93.5)	(91.5)	(93.0)	92.5	78
8 AIC relative loss measurement	160 mV			170 mV	
mainly in ss	1 to 8			61	

*) 1 to 5 in units of 10^{14} protons

The accuracy of the absolute value [3] of the activity measurements is limited essentially due to the error in the cross-section and (but far less) to the calibration of the counting efficiency. A cross-section of 8.6 mb was adopted for the reaction $Al^{27} \rightarrow Na^{24}$ at 10 and 19.2 GeV/c.

Fast ejection

The efficiency of the fast ejection based on the Na^{24} activity and the Unser transformer is about 92 to 93 % for fast ejection from ss 1 and ss 58.

Fig. 1 shows the beam distribution in ss 2 in the horizontal and vertical plane. The assymetry in the horizontal plane suggests a not exact placing of the internal beam in the kicker and, as a consequence, a loss of protons may be expected. This assymetry was far less pronouced for ejection from ss 58. However, the "placing" is more critical for the ejection from ss 1 (10.5 GeV/c) compared to ejection from ss 58 (19.2 GeV/c), since the lateral beam dimension is larger in the first case.

Loss observations

Table 2 summarizes the loss observations during fast ejection from ss 1 and ss 58. Measurements of Benincasa and Johnson [5] indicate about 2000 mV correspond to a loss of 10^{12} proton/pulse. However the beam loss system cannot be used to determine the number of proton lost. Nevertheless the loss measurements suggest a fast ejection efficiency inferior to 100 % .

TABLE 2

Fast ejection 1	ss 1	2	3	4	5	6	7	others
Losses in mV/pulse	50	35	10	15	10	30	10	about 0
Fast ejection 58		ss 58		ss 61	others			
Losses in mV/pulse		~ 0		170	about 0			

Slow ejection

The efficiency of the slow ejection based on the Na^{24} activity and the Unser transformer, is 81 % . A correction by the measured ratio $F^{18}(\beta)/Na^{24}(\beta)$ of 4 % reduces the efficiency to 78 % .

Assuming (against the evidence of the loss measurements) the absolute value of the fast ejection efficiency as 100 % and using the activity measurement only as relative number, then an efficiency of (85 ± 1.6 %) may be obtained as an upper limit. It should be stressed in this case that neither the absolute cross-section of the monitor reaction nor the counting efficiency have to be taken into account.

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REFERENCES

[1] K. UNSER
MPS/CO 68-1

[2] S. BATTISTI
MPS/CO 66-1 (Internal)

[3] L. HOFFMANN
MPS/MU/EP 68-6 (Internal)

[4] L. HOFFMANN and H. SCHOENBACHER
MPS/MU/EP 68-7 (Internal)

[5] G. BENINCASA and C. JOHNSON
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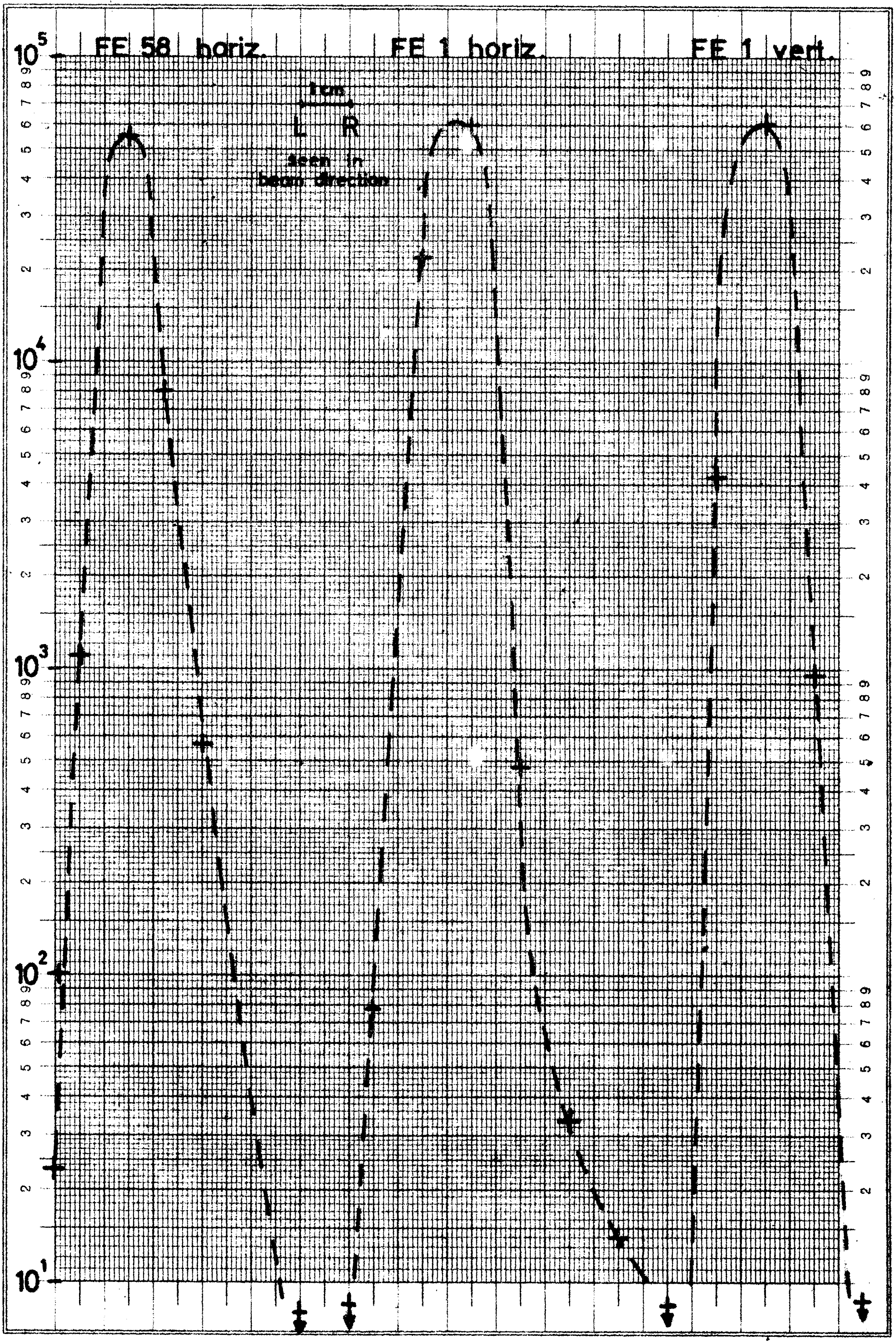

Fig. 1