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MEASUREMENTS OF PROTON FLUX AND BEAM PROFILE IN THE e_2 BEAM

(Slow Ejection)

Measurements of intensity and of the density distribution of the e_2 beam were performed during a run in June and a test run in July 1966. The results are compared with measurements performed earlier.

August 1965	is referred to as	A
October 1965	"	B
January 1966	"	C
June 1966	"	D
July 1966	"	E

I. Calibration of the Secondary Emission Chamber [1] (SEC) and Ejection Efficiency

The calibration of the SEC is based on

1) The cross-section in p-p scattering measured by the Cocconi Group;

2) Measurements of the induced activity in foils. The cross-sections used for the calculation of the proton flux are summarized in Table 1.

Table 1

	Method	$C^{12} \rightarrow C^{11}$	$Al^{27} \rightarrow F^{18}$	$Al^{27} \rightarrow Na^{24}$	Ref.
σ (mb)	Adopted values	26.0	6.3	8.6	
	p GeV/c 28	25.9 ± 1.2	6.03 ± 0.113	8.34 ± 0.23 8.5 ± 0.6*)	[2] [3]
	17 28	26.9 ± 5 % 26.8	6.3 ± 6.5 % 6.2	8.6 ± 6.5 % 8.6	[4, 5]

*) given as upper limit

The activity of Na^{24} was measured by counting the β activity as well as the intensity of the 2.75 MeV γ line over an area of $6 \times 6\ cm^2$.

The results of run A to E are reviewed in Table 2 (see on next page). The position of the SEC was, during run A, inside the Ring Area (at the position of the external targets of the μ_1 beam). For the runs B to E the position of SEC was in the East Area, about 9 metres in front of the H_2 target of the Cocconi Group.

Comparing the results of Table 2, two inconsistencies may be remarked :

1) The efficiency of SEC is in agreement for the four runs A B D and E with a mean value of 8 % . During the run C, however, the efficiency of the SEC increased to 10.3 %, based on four independent measurements. One of several explanations could be the increased width of the beam during the run C and, in consequence, a less clean p-beam.

2) The proton flux measured by the β counts of Na^{24} is for the runs C D and E consistently higher compared with the other measurements during the same run. In Table 3 the SEC efficiency is given, taking the mean of all measurements of $Na^{24}(\beta)$, $Na^{24}(\gamma)$ and F^{18}. The apparent higher proton flux from $Na^{24}(\beta)$ (resulting in a lower SEC efficiency) suggests a lower efficiency of ejection as given with 75 and 60 % in run A and B respectively, where the proton flux was based on $Na^{24}(\beta)$ measurements only. However, the consistency would require for the run A a proportional increase of the SEC efficiency as in run B .

Table 3 : SEC efficiency (mean of all activity measurements)

$Na^{24}(\beta)$	$Na^{24}(\gamma)$	F^{18}
7.25 %	8.4 %	8.3 %

T a b l e 2

Run	Circulating protons/burst 10^{11} (1)	Mean of Bursts	Mom. GeV/c	(1) 10^{11} protons ejected/burst using the method of induced activity: pp-elast.	C^{11} (β)	F^{18} (β)	Na^{24} (γ)	Na^{24} (β) (1)	Efficiency of Ejection %	(1) (10^{10}) Sec. charged particles/burst collected by SEC (%)	Efficiency of SEC (2) (%)	Mean Efficiency of SEC (%)
A	5.45	17	19.2					(4.07)	(75)	3.36	(8.2)	(8.2)
B	5.75	>100	19.2					(3.45)	(60)	2.92	(8.5)	(8.5)
C	8.32	1240	19.2	3.52					42	4.34	12.3	11.5
					3.66				44		11.8	(10.3)
						4.14			49.8		10.5	
								(6.69)	(80)		(6.5)	
D	9.844	300	16.7			5.75			58.5	3.96	6.9	7.8
	9.098	1500					4.56		50.1	3.69	8.1	(7.4)
	8.84	300					4.34		49	3.60	8.3	
	9.844	300						(6.35)	(65)		(6.2)	
E	9.128	200	16.7			1.10			12.0 (3)	0.85	7.7	8.2
							0.97		10.6		8.7	(7.8)
								(1.21)	(13.2)		(7.0)	

(1) The Na^{24}(β) measurements and values based on those are given in brackets, since they are in disagrement with the other measurements
(2) The efficiency of SEC is defined at the ratio of the secondary charged particles measured by the SEC to the protons ejected measured by the activation method or by elastic pp-scattering
(3) Not optimized for efficiency

Fig. 1 shows the fluctuation of the ejection efficiency during 56 hours of the run D, based on the SEC measurements. Fig. 2 shows the fluctuation during 5 hours in steps of 160 sec. The large fluctuation suggests that the ejection is strongly dependent from the injection and the position of the closed orbit.

II. Beam Profile

Measurements of the density distribution were performed during the run D and E about 6 m upstream of the H_2 target. (For the beam profiles in an earlier run see Note MPS/MU/EP 65-11). Fig. 3 shows the density distribution of the ejected beam measured by the activiation method (high intensity region) and emulsions (tail of the beam) during the run D . The particle density of beam tail decreases by a factor 10 only, in the range 5 cm to 40 cm from the beam axis. The measurements of the beam profile with and without T.V. screen indicate the increase of the tail with additional material in the beam (Fig. 3 horizontal beam distribution).

III. Conclusions

1. For the run D and E we obtain (8.0 ± 0.5) % for the SEC efficiency. However, the independence of this efficiency from the beam size has to be checked. A SEC with a larger aperture than 6 cm would be useful. A check of the SEC calibration using the fast ejection and the beam monitor (S. Battisti) is foreseen.

2. The method of foil activation to measure proton beam intensities is a technique which is supposed to give results with an accuracy of about 5 %. However, the $Na^{24}(\beta)$ measurements result in a systematically higher beam intensity. Therefore one should not rely on the measurements of $Na^{24}(\beta)$ only and some doubts exist for the efficiency during the A and B runs since only $Na^{24}(\beta)$ measurements were made.

3. From the profile measurements we conclude to reduce the number of windows in order to reduce the tail.

4. Measurements behind the first window inside the Ring and in the position near the H_2 target indicate no beam loss between these two points.

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R e f e r e n c e s

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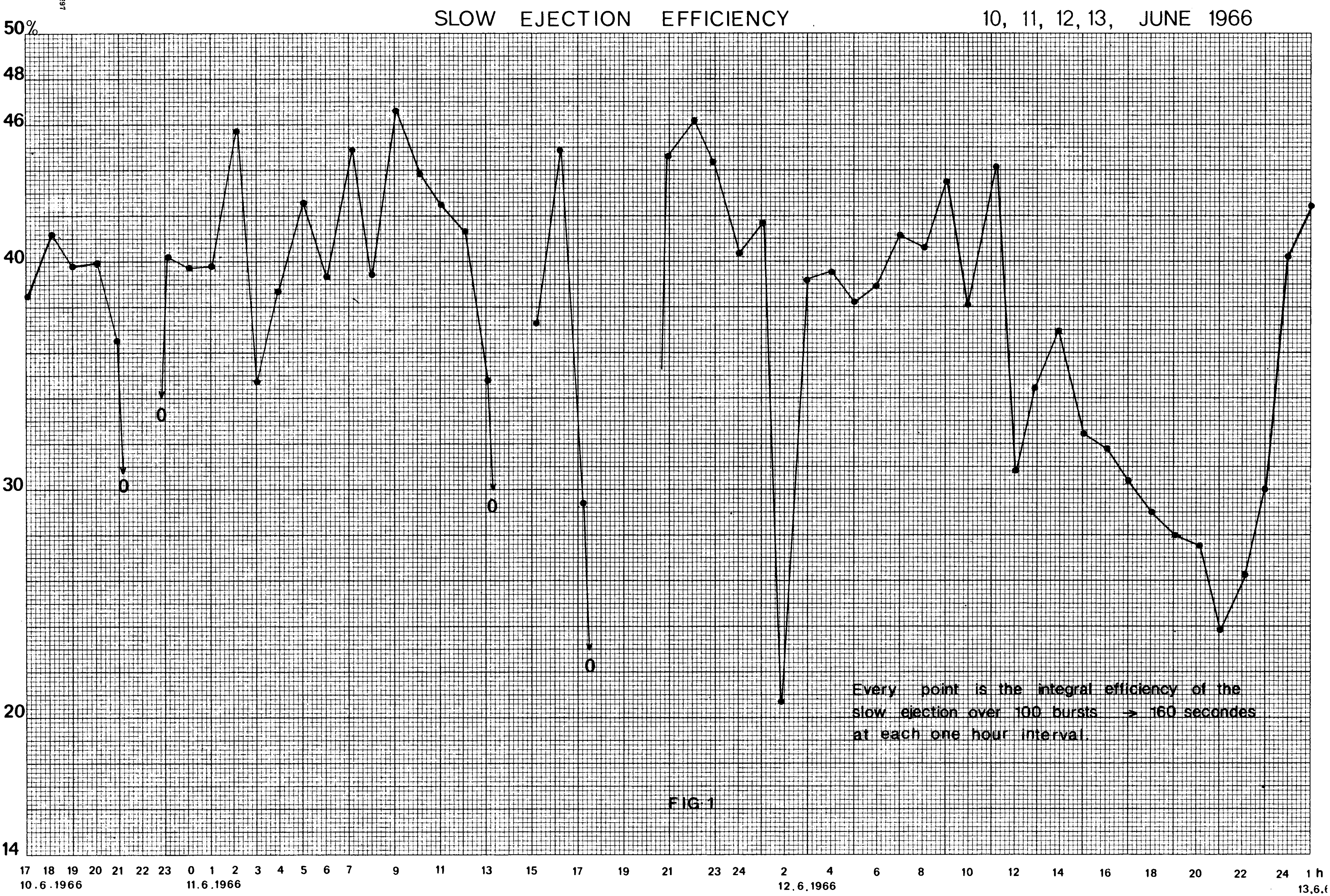


FIG 1

SIS/R/13697

SIS/R/13698

SHORT TERM SLOW EJECTION EFFICIENCY 10,11 JUNE 1966

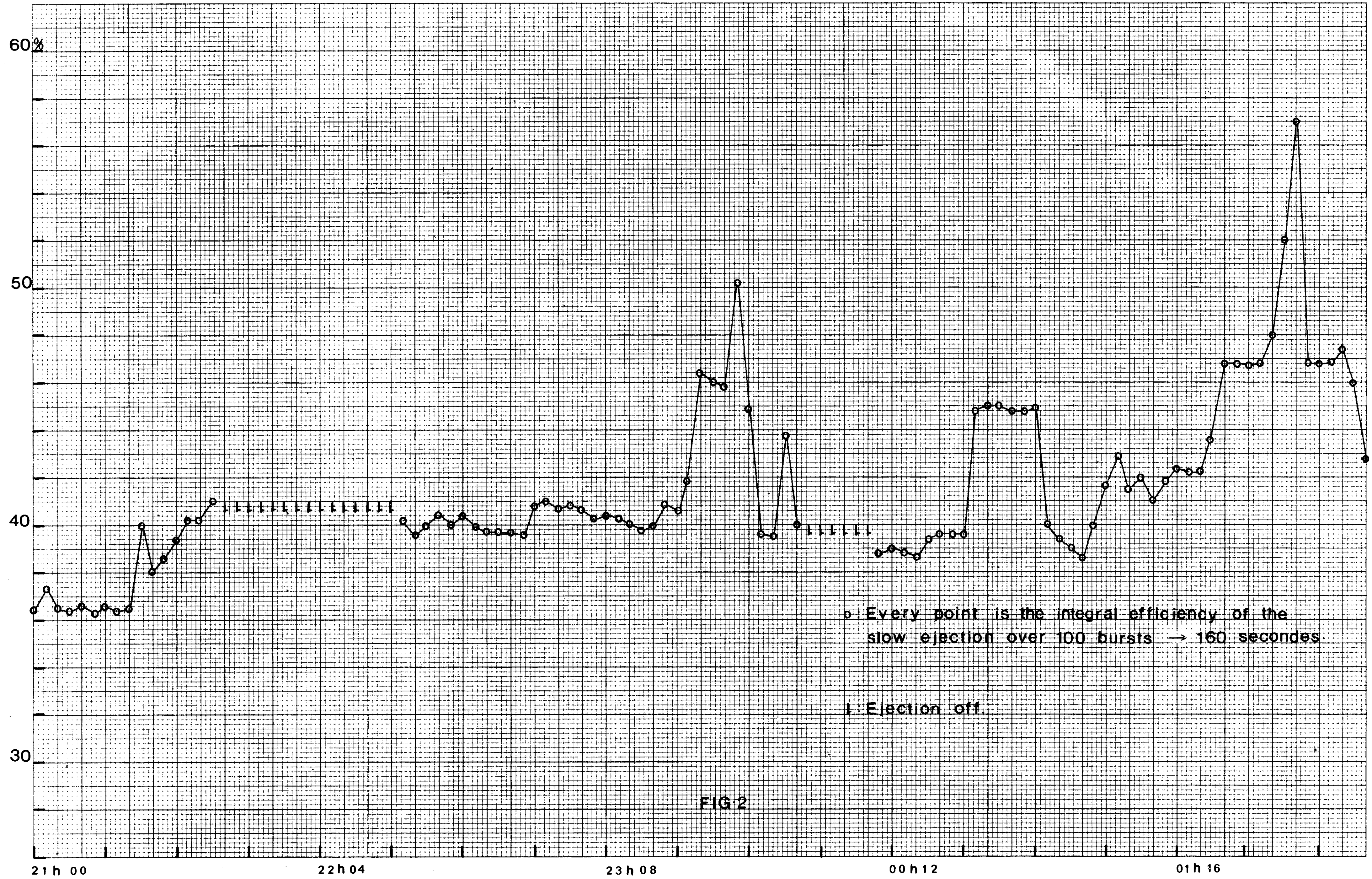
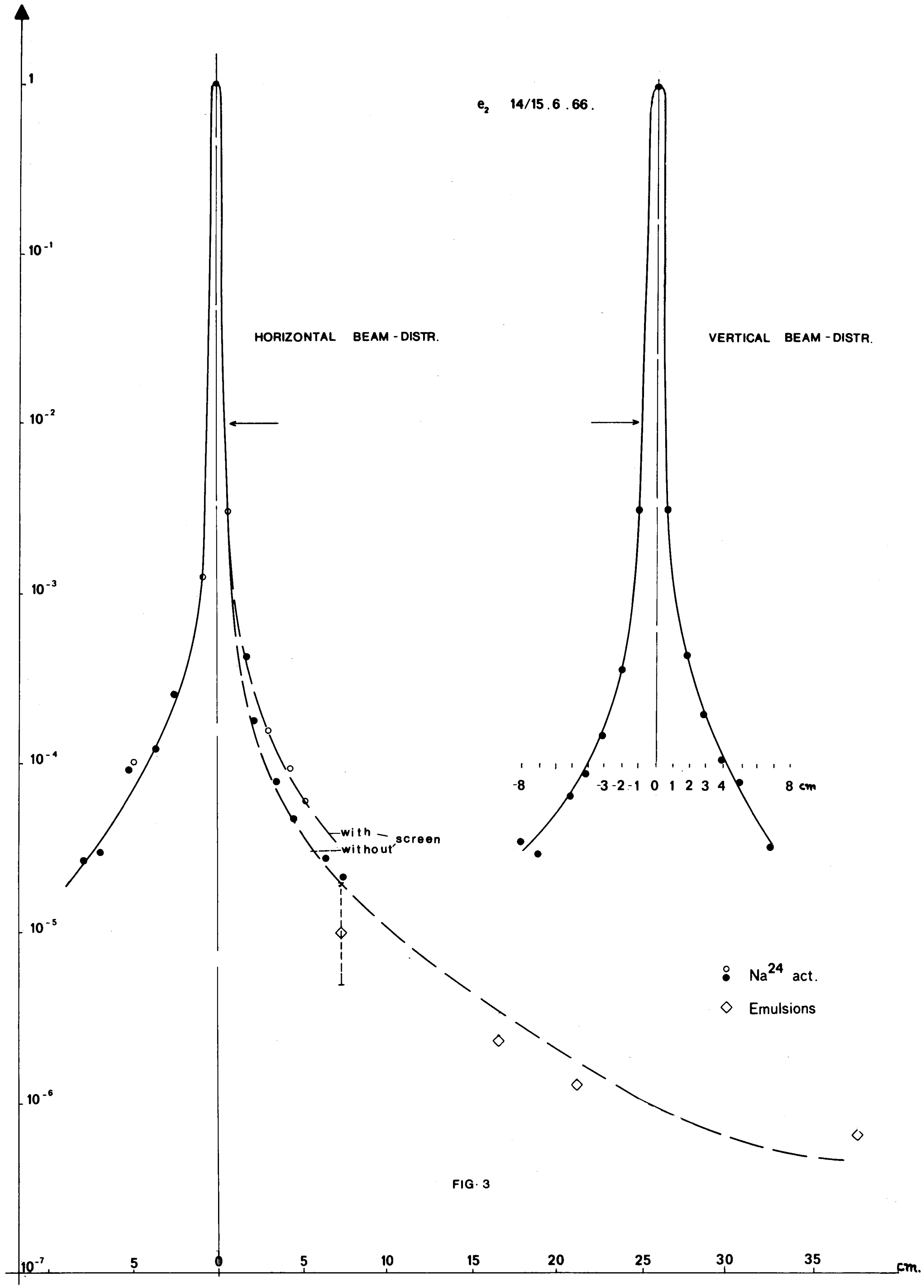


FIG 2



e_2 14/15.6.66.
HORIZONTAL BEAM - DISTR.
VERTICAL BEAM - DISTR.
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
5
0
5
10
15
20
25
30
35
cm.
-8
-3 -2 -1 0 1 2 3 4
8 cm
with
without
screen
Na^{24} act.
Emulsions

FIG. 3