national accelerator laboratory	Author T. Gordon Walker	Section	Page 1 of 8
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Subject

A 120 GEV/C UNSEPARATED BEAM USING SMALL APERTURE COMPONENTS

The object of this work was to investigate the properties of a high momentum unseparated beam suitable for counter and spark chamber experiments using the four feet long, one inch diameter quadrupoles suggested by Maschke[1] for use in a general purpose EPB target station.

The beam is of a simple two-stage design with a momentum slit at the intermediate focus and momentum recombination at the final focus. The beam is shown schematically in Fig. 1. Matching and tracking were performed using the computer program TRAMP.[2] The parameters of the magnetic elements are given in Table I. One-inch quadrupoles are used to define the acceptance at the target. Downstream two-inch diameter quadrupoles are required to contain the off-momentum rays of ± 1% $\Delta p/p$. If a momentum bite greater than 2% is required the apertures will correspondingly have to be increased. The quadrupoles are about four feet long. The bending magnets have 2" × 6" apertures and are about 16 feet long.

Phase space distributions and solid angle acceptances were computed using IPSO FACTO.[3] A slit of about one inch is used at the intermediate focus to define the momentum to ±1%. The beam distributions at the intermediate and final foci are shown on Figs. 2 and 3. The effective solid angle subtended at the target by the beam is on Fig. 4. The integrated effective solid angle is 7.3 microsteradian per cent with a 2% momentum bite. The flux of pions at the final focus depends on the production angle at the target but as long as this is with $500/p_0 = 4$ mrad, then fluxes of several 10^6 pions per 10^{12} protons on the target can be expected using the CKP[4] estimates.

The main properties of the beam are listed in Table II. An adequate beam can clearly be designed using small aperture components. The savings in manufacturing cost and power consumption are considerable.

REFERENCES

[1] A. Maschke, NAL Memo (1967).

[2] TRAMP, J. W. Gardner and D. Whiteside, Rutherford Laboratory report NIRL/M/21 (1961).

[3] IPSO FACTO, N. M. King and P. W. Simpson, Rutherford Laboratory report, RHEL/R103 (1965).

[4] Cocconi, Koester, and Perkins, Lawrence Radiation Laboratory report UCRL-10022 (1961).

FIGURE CAPTIONS

Fig. 1. Beam layout and ray diagram for 120 GeV/c beam. Note the different scales.

Fig. 2. Phase space at the intermediate focus.

Fig. 3. Phase space at the final focus.

Fig. 4. Momentum acceptance of the beam. Effective solid angle as a function of momentum.

Table 1. Beam Elements

Element		Magnetic Field	Aperture
Q_1	DH	7510 g/cm	125 cm x 2.5 cm diam
Q_2	FH	6100 g/cm	125 cm x 2.5 cm diam
M1-10		4600 g	500 cm x 15 cm x 5 cm
Q_3	FH	5780 g/cm	125 cm x 5 cm diam
Q_4	DH	6950 g/cm	125 cm x 5 cm diam
Q_5	DH	6950 g/cm	125 cm x 5 cm diam
Q_6	FH	5780 g/cm	125 cm x 5 cm diam
M1-20		4600 g	500 cm x 15 cm x 5 cm
Q_7	FH	6100 g/cm	125 cm x 5 cm diam
Q_8	DH	7510 g/cm	125 cm x 5 cm diam

Table 2. Main Properties of the Beam

Design momentum	= 120 GeV/c
Length	= 203 m.
1" quadrupoles	= 2
2" quadrupoles	= 6
16' magnets 2" x 6"	= 20
Magnifications at M'M	= 1.1
Intermediate focus M'V	= 1.2
Dispersion at int. focus	= 1.25 cm per 1% $\Delta p/p$
Momentum slit	= $\pm$ 1.4 cm
Momentum acceptance	= $\pm$ 1%
Magnifications at M_H	= 1.0
final focus M_V	= 1.0
Assumed EPB size	= 0.25 h x 0.25 v cm^2
Spot size at final focus for $\pm$ 1% $\Delta p/p$	= 0.4 h x 0.6 v cm^2
Effective solid angle	= 7.3 μster per cent $\Delta p/p$
Estimated pion flux at 0^o using CKP and target efficiency of 0.3	$\sim 3\ 10^6$ per 10^{12} protons

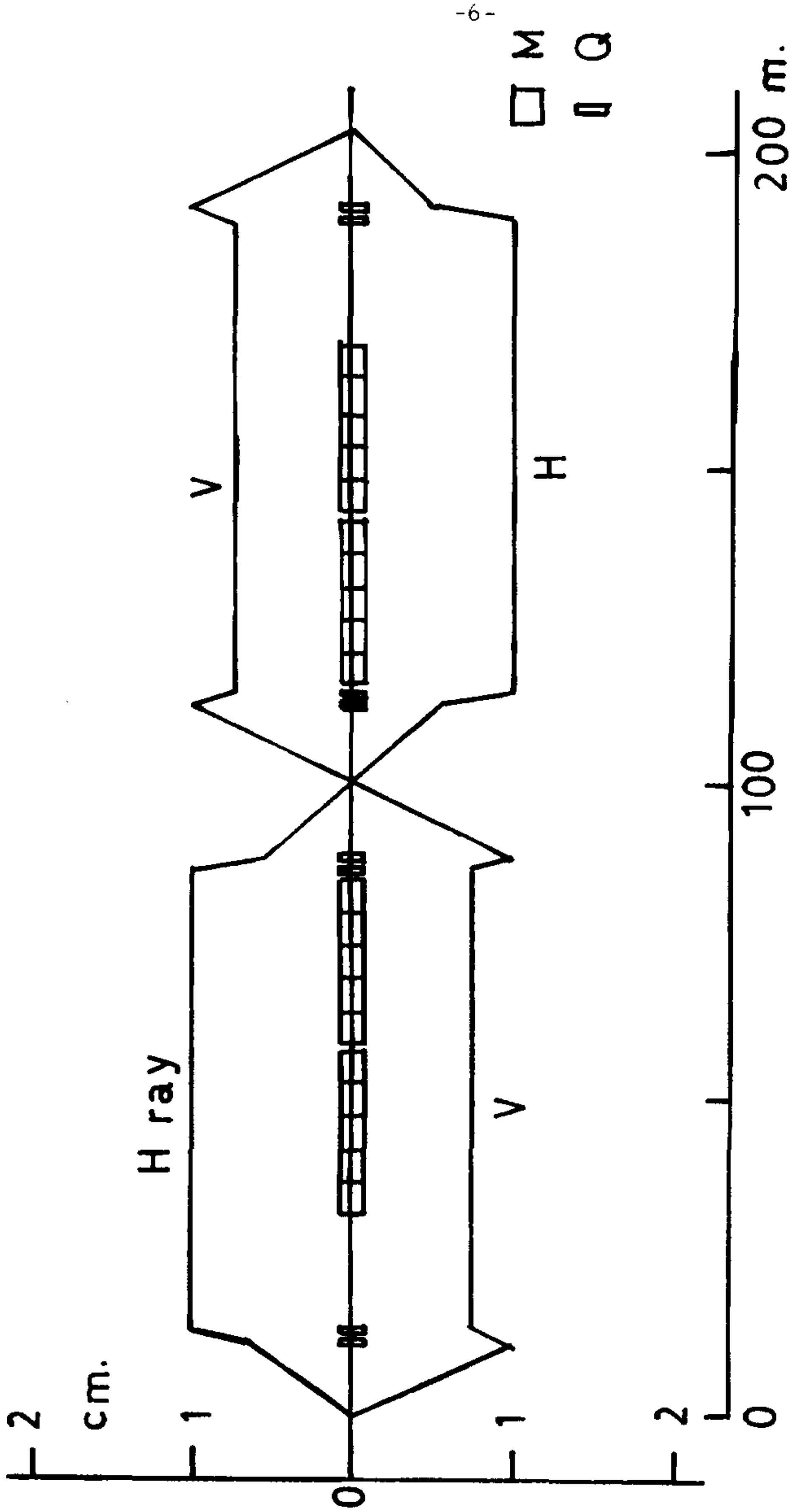

FIG. 1 Beam layout.

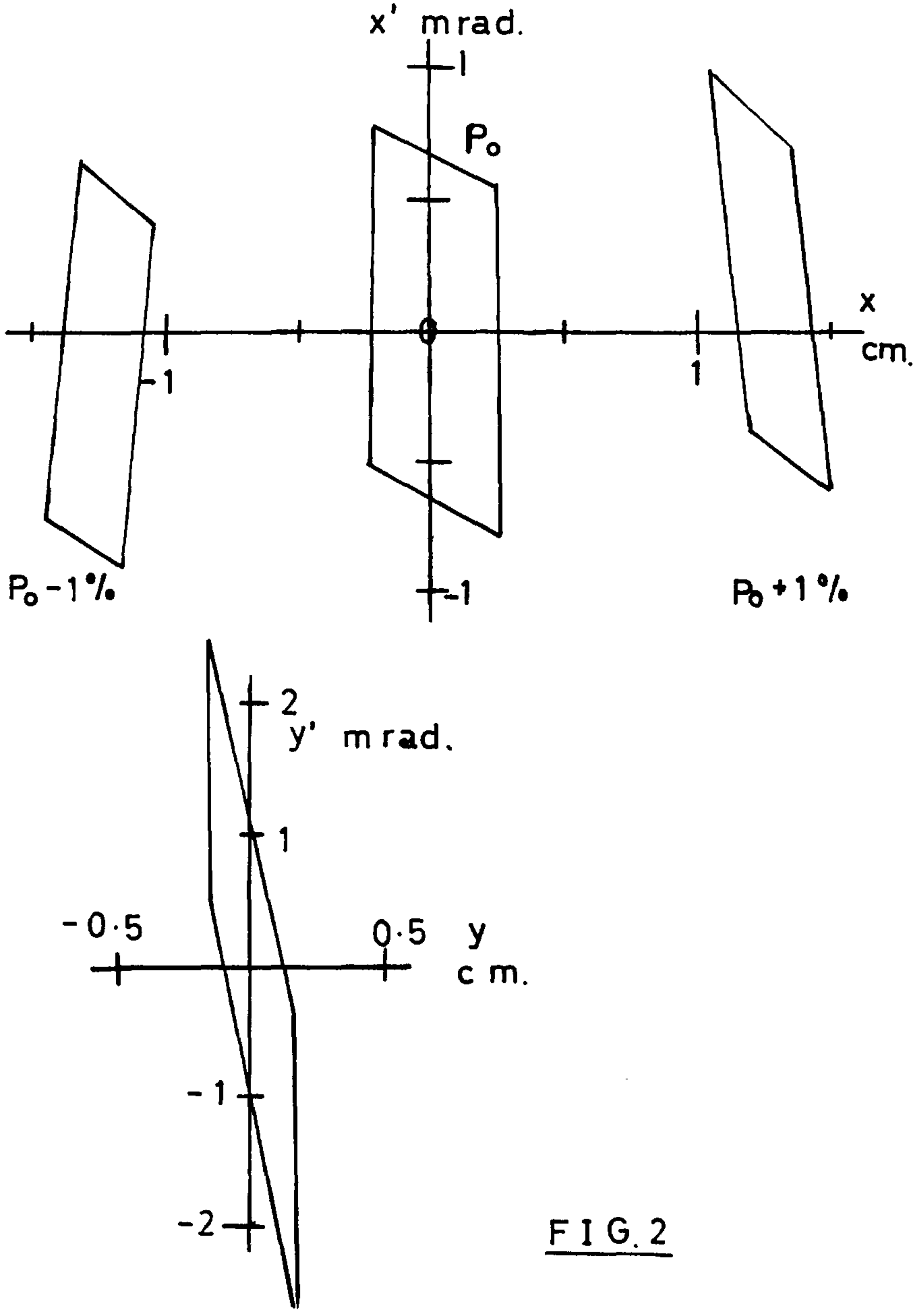

FIG. 2

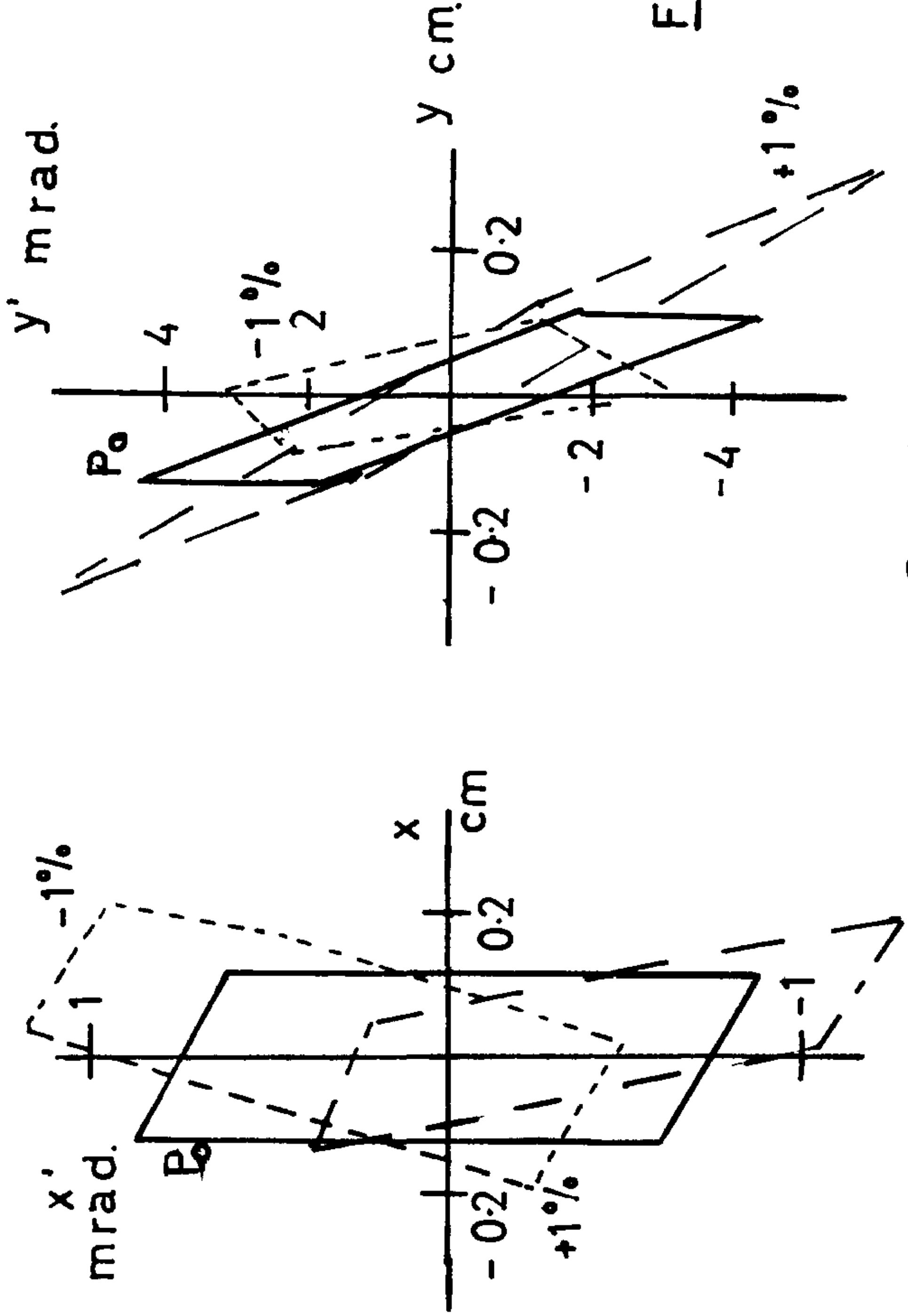
y' mrad.
y cm.
4
2
-2
-4
0.2
- 0.2
-1%
+1%
Po
x' mrad.
x cm
1
-1
0.2
- 0.2
-1%
+1%
Po

FIG. 3

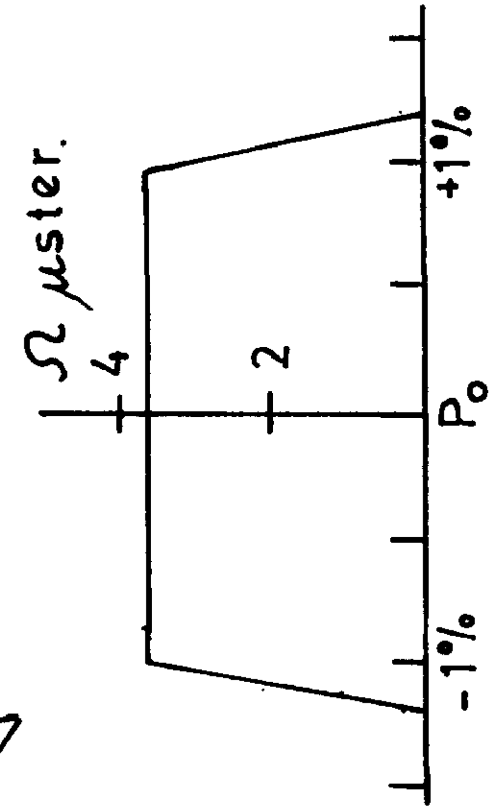
Ω μster.
4
2
Po
+1%
-1%

FIG 4