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Projected medium energy beam for the East Area M6

Introduction

The construction of a new medium energy beam for the CERN 2 metre H.B.C. has been proposed by the T.C.C. This beam, M6 would have the following characteristics.

$\pi^{\pm}$ $\bar{p}$ $K^{\pm}$ in the momentum range 2 - 4 GeV/c.

The M6 will start from an external target about 50 metres from the end of the East Area and will use only one bunch, 3.5×10^{10} protons, from the P.S. fast extracted beam.

The beam is designed in three parts in the usual manner, the first part providing momentum resolution in the horizontal plane and redefining the target in the vertical removing any halo effect at the target. Two 6 metre electrostatic separators provide a single stage of mass separation. A last stage redefines the momentum removing most of the muon contamination.

Optimum flux of the unstable particles e.g. $K^{\pm}$ at either end of the momentum range is obtained by variation of the vertical acceptance by a triplet at the start of the mass separation stage.

Characteristics

1. 4 GeV/c acceptance Vertical 1.92 mR
   Horizontal 12.0 mR * $\Omega = 0.93 \times 10^{-4}$ ster.

   2 GeV/c acceptance Vertical 5.2 mR
   Horizontal 11.5 mR* $\Omega = 2.4 \times 10^{-4}$ ster.

   * this assumes a working diameter in the quadrupoles of 165 mm.

2. Momentum bite $\pm \frac{1}{2}$ %.

3. Total length of the beam to the centre of the chamber 65.7 metres.

Elements

The layout of the beam is shown in Figure 1. The envelope at a momentum of 4 GeV/c is shown in Figure 2 and at 2 GeV/c in Figure 3. Intermediate momentum are easily interpolated between these extremes.

The main elements required are :

2 standard 1 metre quadrupoles

6 standard 0.5 metre quadrupoles

2 standard 1 metre bending magnets

3 standard 2 metre bending magnets (one of these is common with the U1 and 08 beams)

2 special "Open C" type bending magnets

2 6 metre electrostatic separators (100 KV/cm plates)

5 collimators

Two of the 2 metre standard bending magnets are used to deflect the extracted proton beam, E2, away from the side of the East Area to a position suitable for the start of the M6 beam. Targeting arrangement is shown in Figure 4, it has been designed so that other users requiring lower momentum products may have access to the target simultaneously. Magnets M1 and M2 are of a special open C type and will be kept at constant field. The M6 beam will be tuned for different momenta by moving magnet M2 parallel to the line of the extracted proton beam.

Performance

Momentum resolution at momentum slit

Horizontal magnification 0.75

Half image size (including chromatic aberrations) = 1.6 mm.

Dispersion at momentum slit 7 mm/% $\frac{\Delta p}{p}$

Mass resolution at mass slit

4 GeV/c.

Separation between π and K mesons 3.6 mm.

Magnification 1.35

Chromatic aberration of $^1/_2$ % $\frac{\Delta p}{p}$ 1.8 mm.

Half image size 2.6 mm.

Separation ratio = 1.35

2 GeV/c.

Separation between π and K mesons 28.1 mm.

Magnification 3.6

Chromatic aberration of $^1/_2$ % $\frac{\Delta p}{p}$ 5.5 mm.

Half image size 7.3 mm.

Separation ratio = 3.8

The separation ratio is defined in such a way that complete resolution corresponds to a ratio of greater than or equal to 2.

These figures on the image sizes pre-suppose a target cross-section of 2 x 1 mm. The beam is free of dispersion after magnet M4.

Expected Flux

The expected flux for different momenta is shown in Table 1. An efficiency of 50 % has been assumed for the transmission of the wanted particles through collimators, etc.

In conclusion it is worth mentioning the reasons for the choice of a single stage of mass separation rather than two stages each of one separator as has been commonly used in previous medium energy beams of this type. Studies were made simultaneously of possible variations on a two stage separation design. The first, with a momentum definition stage prior to two independent mass separation stages was discarded before completion as it was clear that the beam length consistent with good mass separation, about 50 metres, was too great to allow the transmission of a useful flux of K mesons at 2 GeV/c. By superimposing the momentum definition and the first mass separation stages in a manner similar to the M2 beam(2) built in the South Hall, the length of the beam was reduced by 15 metres. The decrease in muon contamination inherent in a beam with two stages of mass separation is largely offset in this case, by the halo at the target and the increase in total chromatic aberrations.

This design was in fact discarded because even with four quadrupoles between the target and the first vertical separator it was impossible to obtain a vertical acceptance greater than 3.5 mR, compared with 5.2 mR in the proposed beam.

It is worth stressing that the question of having the maximum possible accepted solid angle is a great importance as, due to the nature of the fast extracted proton beam, the M6 must give a useful flux of K mesons at the CERN 2 metre chamber on 5 % of the P.S.

A.L. Grant.

REFERENCES

1) D. Dekkers et al. NP - Internal 65-5

2) J. Goldberg, J.M. Perreau, CERN 63-12

Table 1. Expected Flux

	Cross-section[1] $\frac{d^2\sigma}{d\Omega dp}$ mb/Nuc Sr^{-1} GeV/c^{-1}	Flux at entry of beam	Flux at chamber
2 GeV/c K^+	50.0	9500	57
K^-	30.0	5690	33
$\bar{P}$	3.2	607	304
3 GeV/c K^+	42.0	9960	252
K^-	26.0	5980	156
$\bar{P}$	2.7	620	310
4 GeV/c K^+	32.9	5440	299
K^-	20.5	3400	192
$\bar{P}$	2.1	348	174

Note: Assumes a target 15 cm. in length

PS Intensity 3.5×10^{10} protons (one bunch) at 23.1 GeV/c

Efficiency 50 %

Momentum bite $\pm \frac{1}{2}$ %

M6 BEAM

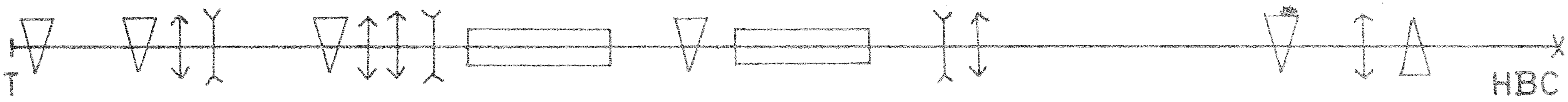

fig.1

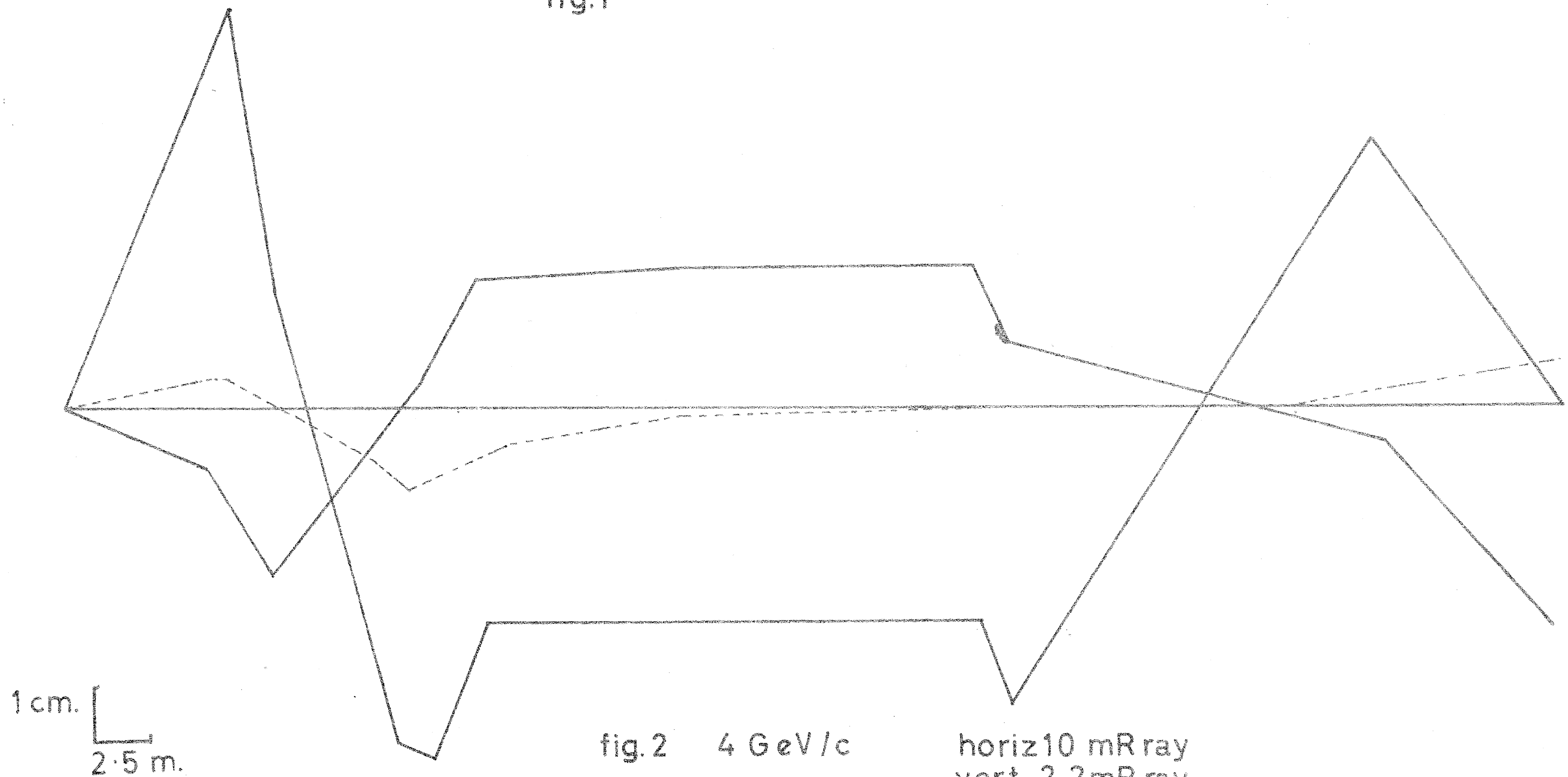

fig.2 4 GeV/c horiz 10 mR ray

vert. 2.2 mR ray.

- - - - - $\Delta p/p = +1/2\%$

M 6 BEAM

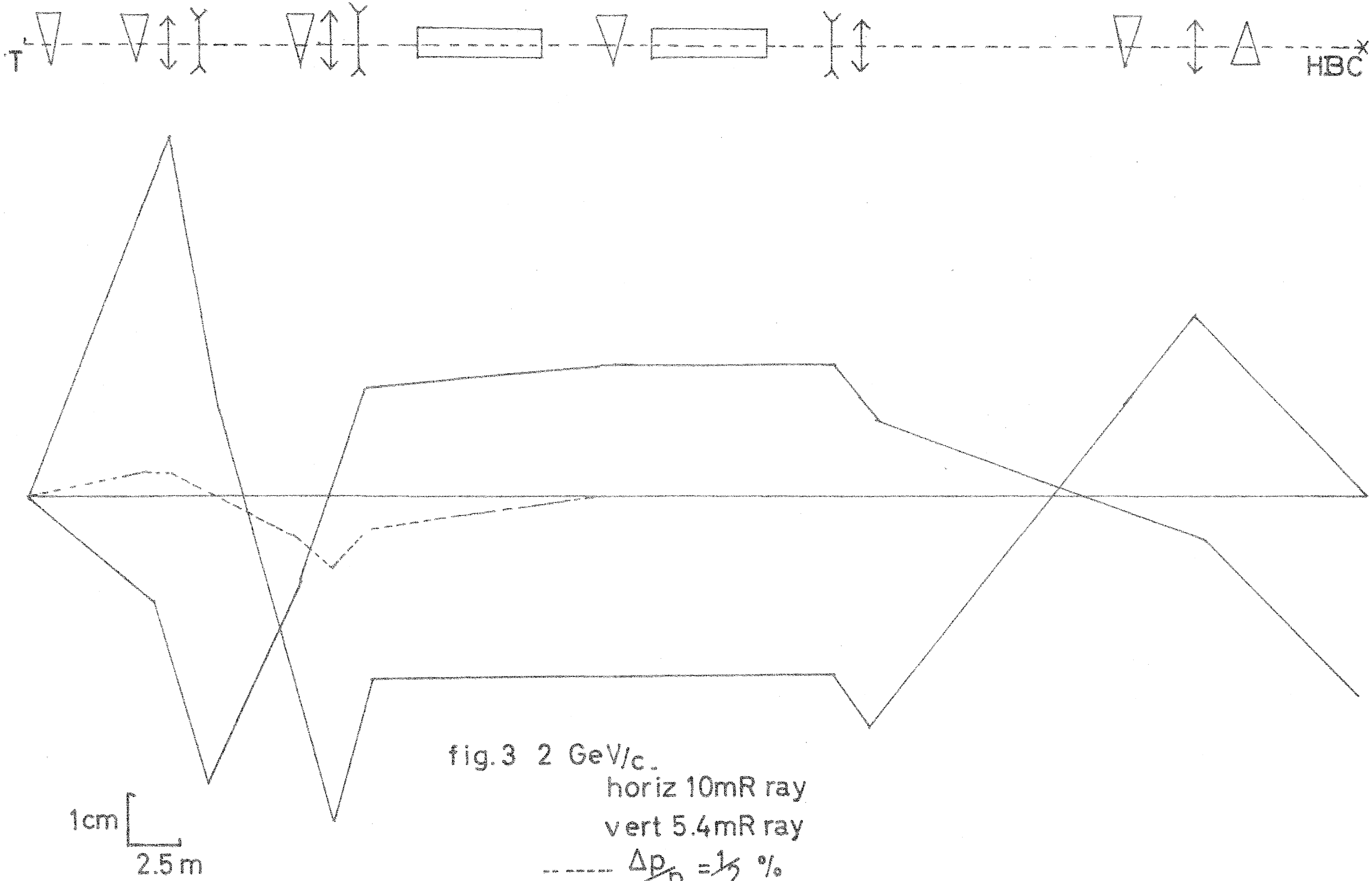

fig. 3 2 GeV/c.
horiz 10mR ray
vert 5.4mR ray
------ $\Delta p/p = 1/2$ %

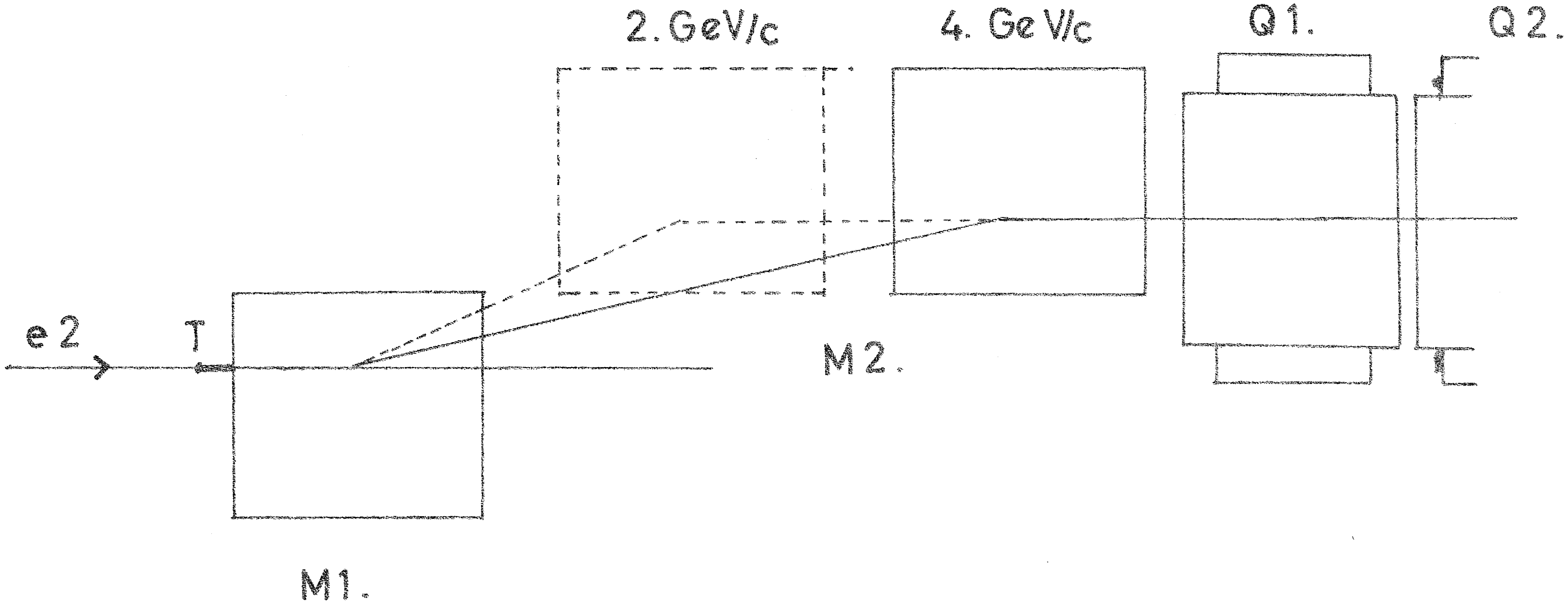

fig. 4