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SECONDARY BEAMS FOR TESTS IN THE PS EAST EXPERIMENTAL AREA

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1. Introduction

This report gives a description of the four secondary beams used in the PS East Experimental Area for testing experimental apparatus.

Section 2 gives some information on the layout of the beams, whose main parameters are given in Section 3.

Part 4 is a short handbook, where the future users will find some practical information on the equipment available (beam monitoring, targets, etc.) and (hopefully !) will find some help to operate the beams.

2. General layout in the East Area

A general view of the beams is shown on Fig. 1.

The primary proton beams, the four secondary beams themselves and the associated shielding, huts, etc. cover about 2000 m^2 (half the East Hall area), the downstream part being used since 1983 for the construction of a LEP experiment.

2.1 Primary beams

The test beams are derived from the slow-extracted proton beam e17, ejected in the PS straight section 62.

This extracted beam, called primary beam, is split in two branches, e17 and e17-South, which feed two production targets, sources of the four secondary beams.

The splitting is obtained by means of a special iron septum D.C. magnet (SMH01) with a vertical field, located on the extracted beam at a horizontal waist where the beam is vertically expanded. The gap and the vertical position of the splitting magnet may be adjusted by remote control.

By playing with the intensity, with the optics of the extracted primary beam, and also with the splitter parameters, it is possible to adjust the number of protons hitting the two production targets.

The main parameters of the primary beams are given in the following table.

TABLE 1

Characteristics of the primary beam
(slow extraction SE62)

Type of particles :	protons
Momentum :	24 GeV/c
Typical beam spill length:	400 msec
Typical repetition rate :	1 to 3/14.4 sec (PS "supercycle")
Minimum repetition time :	2.4 sec ("B cycle")
Maximum proton intensity on each target :	$2x10^{11}$ particles/pulse*

* Limited by the radiation level in the downstream part of the East Hall

2.2 Secondary beams

Figure 2 gives a schematic layout of the secondary beam lines.

The North target (primary beam branch e17) is the source of the three secondary beams t9, t10 and t11 produced at different horizontal and vertical angles.

The South target (primary branch e17-South) is the source of the t7 beam (production angle 0°).

The usual height of the beams in the East Hall is 1.26 m above the floor level. But in order to give the possibility of testing large pieces of equipment, we have increased the level of 3 lines, namely t9, t10 and t11, as explained on Fig. 2: a vertical magnet BVT01 placed upstream of the North target bends the primary line e17 by 30 mrad. Then, by using different vertical production angles, it is possible to get beam levels as high as 2.28 m (t9) and 2.50 m (t10 and t11). The t7 beam, previously used for physics, is at 1.28 m above the floor level.

3. Beam properties

3.1 Optics

The four beams* are designed in order to provide the users with momentum analysed, non-separated secondary particles (momentum resolution of the order of 1%), positive or negative polarity. They are intended to be used as test facilities for experimental apparatus.

The polarity, momentum, intensity and momentum bite may be adjusted inside a large range up to the nominal values. The experimental areas are large enough to house more than one user's apparatus at a time.

The beams consist of two focusing stages:

- the first one (2 quadrupoles and a bending magnet) performs the momentum analysis at a variable-aperture horizontal collimator (MCH01, "momentum slit"). A vertical collimator MCV01 may be used to adjust the beam intensity;

- the second one performs the momentum recombination (use of a "field lens") and refocuses the beam into the experimental area.

The final focus may be moved along the area by changing the currents in the last pair of quadrupoles; steering dipoles are available in order to adjust the beam position (horizontal and vertical).

The beams are equipped with detectors (scintillators, multiwire-proportional chambers MWPC, Cerenkov counters).

The necessary signals and equipment for beam tuning are available in the Control huts (EP27 for t7 and t9, EP18 for t10 and t11). More details are given in Section 4.

3.2 Intensities

The following section gives the intensity estimations in the beams for p^+, π^+, π^-. In general, the numbers given are based on computations; some measurements have been made and are reported. Checks with previous beams show that these numbers are realistic.

As far as electrons (or positrons) are concerned, we have a good knowledge at zero degree production angle (t7 and t9 beams). Some measurements in the t11 beam are also reported.

*) The t7 beam was built for the experiment PS188 (channelling)

The secondary fluxes are calculated from:

$$N_S = N_p \, \eta \, \Omega \, \Delta p \, Y_i \, e^{-L/\lambda_i}$$

where

N_p = Number of protons impinging on the production target

η = Target efficiency

Ω = Solid angle of the beam (Steradian)

Δp = Secondary momentum bite (GeV/c)

Y_i = Yield for the particle i

L = Beam length (metres)

λ_i = Decay length for the particle i (metres)

The product $N_p.\eta$ represents the number of protons interacting in the target.

The target efficiency η depends on many factors, such as target length and material, particle type and momentum ... As far as our beam lines are concerned, we use the η values measured for pions produced by external targets (Ref. 1). The mean values used for the computations ($0.1 \leq \eta \leq 0.35$) are shown on the plot of Fig. 3. These η values, together with the yields Yi given by Sanford and Wang (Refs. 2 and 3), give computed pions fluxes which are in good agreement with the measured values (for example: beam c13, Ref. 4, similar to the beams t7 and t9).

The computed intensities at the end of each beam (p^+, π^+, π^-) are given on the figures in the last part of this report. As an example, we have also computed the fluxes of K^+, K^- and $\bar{p}$ which may be found at the end of the t9 beam (these results may be used as an order of magnitude for the other beams).

The fluxes of electrons (or positrons) are estimated from the computations of R. Beckmann (Ref. 5). The yields are calculated by Monte-Carlo simulations of the different processes involved, the predominant one being pair production of gammas from the π_0 decay close to the target.

Two important results are shown on Figs. 4 and 5.

- Figure 4 shows the electron component of a beam produced at zero degree versus the particle momentum. Some experimental data are shown together with the computed curve; both confirm a drastic reduction of the electron percentage when the beam momentum increases.

- Figure 5 shows the computed effect of the prodution angle on the electron yield: at 55 mrad (about the production angle of the beam t10) the electron yield is four times smaller than at zero degree at 1 GeV/c, and drops when the momentum increases.

These effects are confirmed by the measurements which have been performed by the UA2 team in the beam t11 (angle of production # 150 mrad). The results shown on Fig. 27 compared to those at a zero degree production angle (see for example Fig. 4), confirm the very important diminution of the electron component in a beam when the angle of production increases.

3.3 Beam parameters (t7, t9, t10, t11)

The main characteristics of the beams are given in the following way. For EACH beam, we give at the end of this note the following tables or figures:

- a table of parameters
- a table which gives the nominal value of the currents in the transport elements as a function of the beam momentum
- the optics
- two figures which show how to move the beam focus along the beam line in the users' area, together with the relative increase of the spot-size (results of computations)
- the calculated intensities versus beam momentum
- the intensity measurements (if any).

Note that there are 2 different lines for the beam t7: the South one, with a full compensation of the chromatic dispersion at the end of the beam, and the North one, not compensated and which gives always a large beam size in the horizontal plane (spatial dispersion).

Beam t7 : see page 23 - 29
Beam t9 : see page 30 - 35
Beam t10: see page 36 - 40
Beam t11: see page 41 - 46

3.4 Special test areas

The maximum intensity available in the test beams is of the order of 10^6 particles per second (see preceding chapter).

3.4.1 Higher intensities

In some cases, higher intensities are requested by the users; for this purpose, a special area has been prepared. This small area is visible on Fig. 1, at the upstream part of the beam t7 (ZT7), between the bending magnet BHZ01 and the dump of the primary proton beam.

A special TV screen, named MTV10, has been installed a few meters downstream of the target (MTV09) in order to tune the primary beam in this area.

Irradiation of material is possible in this area under different conditions:

- as "only user" (no target for t7), proton intensity in the range $10^9/10^{11}$ per second are possible at 24 GeV/c.
- as parasitic user of the beam t7 (target in the primary beam), intensity below 10^{11} is still possible (degraded primary protons and secondary particles).

The access to this area is possible only when primary beams are stopped. For small pieces of equipment, the access is possible via the normal access door 137; for big or heavy pieces, an access by the top of the shielding has been prepared. The time necessary to open the shielding is at least half a day (all beams stopped).

3.4.2 Very low intensities

Some users ask for very low intensities: the areas called $t9^1$ and $t9^2$ receive very low fluxes of muons coming from the target of t_7. The access to these areas are possible via stair cases (no doors), see Fig. 1.

4. Short user's guide

4.1 Targets available

As explained before, the primary beam is split in 2 branches. The target used by the beam t7 is visible on Fig. 1 at the position MTV09; the common target for the beams t9, t10 and t11 is at the place MTV07. The users of these 3 beams have to agree on the use of a common target.

The targets are mounted on a remotely controlled mechanism (12 possible positions). Ask the PS Main Control Room (MCR) in order to change the target.

Tables 10 and 11 give the list of the targets available on request.

TABLE 10

List of the targets available for the beam t7

1 ZnS-Screen

2 Al ♦3x50 + W ♦20x3**

3 Al ♦3x150

4 ZnS-Screen

5 Al ♦4x190

6 Al ♦4x190

7 ZnS-Screen

8 Al ♦3x125 + W ♦20x3**

9 Al ♦5x250*

10 Al_2O_3-Screen

11 BeO ♦4.3x240*

12 Passage (for primary beam irradiations)

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* Normally used for maximum yield

** Special targets: aluminium bar followed by a tungsten converter (more electrons)

N.B.: a) Dimensions: in mm

♦3x150 = diameter 3 mm
length 150 mm

b) Control of the targets: PS Main Control Room (MCR)

TABLE 11

List of the targets available for the beams t9, t10, t11
(common target)

1 ZnS-Screen
2 Cu ♦4x25
3 Cu ♦4x50
4 Be ♦5x200 + W ♦20x3**
5 Al ♦5x150
6 Al ♦3x5x200 + W ♦10x3**
7 ZnS-Screen
8 Cu ♦4x100
9 Al_2O_3-Screen
10 Al ♦5x250*
11 Al ♦5x200
12 Al Sheet ♦80x1mm thick

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* Normally used for maximum yield
** Special targets: aluminium bar followed by a tungsten converter (more electrons)

N.B.: a) Dimensions: in mm

♦5x150 = diameter 5 mm
length 150 mm

3x5x200 = vertical 3 mm, horizontal 5 mm, length 200 mm

b) Control of the target: PS Main Control Room (MCR)

4.2 Standard detectors

Each test beam of the East Hall (ZT07, ZT09, ZT10, ZT11 in computer names) is equipped with some detectors in order to facilitate its setting-up or to provide beam diagnostic during operation.

These detectors, called "Standard Detectors (SDs)" are:

- Multi-wire proportional chambers (MWPCs);
- Cerenkov counters (CHERs);
- Scintillation counters (SCINTs).

Their positions in the beams are shown on drawing 60.787.0 (Fig. 1, available from Mrs. G. Granger (PS), phone 2009).

The output signals produced by the Standard Detectors are collected in the two Beam Control Rooms of the test Hall located in:

- barrack EP27A/door A for the beams ZT07 and ZT09
- barrack EP18 /door C for the beams ZT10 and ZT11.

The Standard Detectors are essential for operation. Therefore the users should never remove them from the beam line.

4.2.1 Multi-Wire Proportional Chambers (MWPCs)

There are two MWPCs in each secondary beam: - MWPC01 is located next to the last magnet in the beam; - MWPC02 is located at the reference focus of the beam (see Fig. 1). Each MWPC provides the horizontal and vertical profile of the beam and the signals' outputs of the MWPC are sent to the Beam Control Rooms where they are shaped by some electronics (integrators + CAVIAR microcomputer) and then displayed on TV monitors. In addition to the beam profiles other information like size and beam position are given. However, no information can be obtained from the MWPCs about the physical properties of the beam. If desired, the profiles displayed on the TV monitors of the Beam Control Rooms can be sent to the beam users. The HT voltage and the gas flow necessary to supply the MWPCs are set by the operator at the beginning of a run and should need no further adjustment. In order to see the beam profile after the beam has been set up it is essential that the Monitor Program runs in the CAVIAR microcomputer and that MENU 3 has been selected. Section 4.2.4 will explain the use of the Monitor Program in detail. If no beam is detected after a correct set-up, please check the position of the beam stopper at the beam door. If the beam stopper position (UP) is correct and still no beam is detected then call the operator (BEEP 13*7017).

4.2.2 Cerenkov Counters

Each secondary beam is equipped with a Cerenkov Counter (CHER) of the total reflection type. Its length and position in the beam is shown on Fig. 1. Its mechanical characteristics are shown on drawing EP 82.550. The upstream and downstream windows are made of Mylard sheet, thickness 0.6 mm each. The maximum working pressure is limited to 4 abs. bar. The CHER can be filled with one of the following gases:

CO2, He, Ar, N2 and SF6 (the last one is not available from CERN store). The quantity of gas necessary during a run must be supplied by the beam user. The filling of a CHER is made via a Gas Distribution Rack (GSD) which is located next to the Beam Control Room of a specific beam. The beam user calculates the working pressure of his CHER and takes care of all steps necessary to fill his CHER. He must proceed according to the rules fixed by the CERN GENERAL SAFETY CODE. The synoptic scheme engraved on the front pannel of the Gas Distribution Rack indicates the order of the different operations. For a working pressure below the atmospheric pressure (< 1 abs. bar) it is first necessary to empty the CHER by means of a vacuum pump. Never connect the vacuum pump directly to the CHER when the working pressure is bigger than 1 abs. bar. All CHERs installed in the East Hall have been equipped with AVP56 photomultipliers. The nominal HT voltage of these tubes is - 1.840 kV and it is set by the operator at the beginning of a run. One output signal is brought to the Beam Control Room, read by a scaler and displayed on a TV monitor. A second output signal, decoupled from the previous one, is available for the user at the photomultiplier base. The HT power supply of the photomultiplier is also installed in the Beam Control Room.

4.2.3 Scintillation Counters (SCICO)

There are two Scintillation Counters installed in each secondary beam (ZT07, ZT09, ZT10, ZT11). They are mainly used for beam definition. SCICO01 is located downstream of the last magnet in the beam (it is mounted on the same support as MWPC02). Its dimensions are: 100x100x5 mm. SCICO02 is located at the reference focus of the beam (it is mounted on the same support as MWPC02). Its dimensions are: 30x30x5 mm. All SCICOs of the secondary beam are equipped with AVP56 photomultipliers. The nominal HT voltage of these photomultipliers is - 1.840 kV and this value is set by the East Hall operator at the beginning of a run. For each SCICO two output signals are available at its photomultiplier base:

- one signal is sent to the Beam Control Room of the corresponding beam;
- the second, electrically decoupled from the first one, is for user disposal.

4.2.4 Beam Monitoring Programs

For the beams ZT07 and ZT09 the program of monitoring is:
- WN.CTN.TBEAMLIB#T07T09;

For the beams ZT10 and ZT11 the program of monitoring is:
- WN.CTN.TBEAMLIB#T10T11.

The two programs reside in the central IBM machine and they are down-loaded at the beginning of the run into the EUROCAV-micro-computers, which are installed in the Beam Control Rooms.

If a program is lost during a run, the user can reload it by running on the central IBM the following file:
- EXEC FROM D2.PUB.CAVLK CLEAR;

alternatively he can contact the Beam Operator (BEEP 13*7017).

The EUROCAV-microcomputer supports the standard CAVIAR commands, i.e. RUN, LIST, TMODE, ESCAPE, SCRATCH etc. etc.

The programs of monitoring are menu-driven:

- Menus 3 and 4 deal with MWPC detectors and they are essential in order to visualize the beam profile;

- Menus 1 and 2 deal with beam controls (see Chapter 5) and menus 5, 6 and 7 deal with general beam facilities.

4.3 Beam controls

The Beam Controls available to the user are:

- setting of the currents in the beam transport elements from the secondary target downwards;

- selection of the particle polarity;

- adjustment of the vertical and horizontal acceptance of the beam by means of collimators.

The equipment for the setting-up and the adjustment of the beams is installed in two barracks (called Beam Control Rooms):

- barrack EP27A/door A for beams ZT07 and ZT09;
- barrack EP18 /door C for beams ZT10 and ZT11.

A Beam Control Room is equipped with three racks of electronics, a video terminal and a printer.

Two racks are labelled Beam Control and the third is labelled Beam Monitoring.

In a Beam Control Rack are gathered all the commands for the setting-up and the adjustment of the beam;

In the Beam Monitoring Rack are gathered all the monitoring signals of the two beams (see Section 4.2)

All the other adjustments of the beams (i.e. intensity, timing etc.) are under control of the PS Main Control Room (MCR).

4.4 Current setting

The currents in the transport elements of a beam can be set:

- manually, using the "SELECTOR" installed in each Beam Control Rack;
- automatically, using the menu No. 1 of the monitor program of that specific beam.

The manual setting mode overrides the automatic setting one.

For manual setting proceed as follow:

1. Contact the East Generator Building (EGB), via INTERCOM or BEEP 13*3005, in order to obtain the remote commands of the power supplies.

2. Check that all the red LEDs under the square push buttons of the SELECTOR are lighted up; if not, contact the East Generator Building.

3. Check on the DATAPLEX that the polarity of the power supplies is identical to that of the beam, i.e. negative particles = negative polarity of the power supplies and vice versa (exception for the element MC208 of the beam ZT07 when the branch "NORD" of the beam is used).

   If the polarity of a power supply is not correct, change it first by pushing upwards the interlock switch of the DATAPLEX and then actuating the +/- push button of the SELECTOR; reestablish the polarity interlock (switch down) on the DATAPLEX at the end of the invertion.

4. Push upwards the switch SELECTION and actuate the square push button 1 of the SELECTOR; the power supply 1 is accessed and the button 1 lights up.

5. Actuate the FAST/SLOW/INCREASE/DECREASE push button of the SELECTOR for current setting.

6. Read the value of the current on the DVM of the SELECTOR; the sign of the reading indicates the polarity of the beam i.e. negative reading = negative particles and vice versa.

7. Repeat points 5/6 until the nominal value of current of the element 1, for a given energy of the particles, is reached.

8. Repeat points 4 to 7 for the "n" transport elements of the beam.

9. The nominal value of currents at various beam energies for all the beams of the East Hall are given in the tables Nos. 3, 5, 7 and 9.

10. Go to the Beam Door, check that all the 5 keys of the door are locked and then lift up the beam stopper; the pannels DANGER RADIATION and ENTRANCE FORBIDDEN then light up; at the beginning of each run the Main Control Room (MCR) must authorize the first operation of the beam stopper. For access to the beams: see § 5.2.

    If the user does not succeed in setting the current of one or more transport elements, he has to contact the East Generator Building (EBG) via INTERCOM or BEEP 13*3005.

    If no beam is detected after point 10 of the previous procedure the user should contact the Main Control Room (MCR) via INTERCOM or PHONE 6671.

5. Appendix

5.1 Use of deuterons as primary particles

Usually, the primary particles extracted from the PS are protons at a momentum of 24 GeV/c.

Sometimes, the PS accelerator is adjusted for ions; a slow-extracted beam is still possible in the East Hall, but in that case, the secondary intensities in the test beams may be completely different.

Deuterons at 12 GeV/c nucleon have been used a few times in the past years. In the following, we report some flux measurements performed in the beam t9 with deuterons as primary particles instead of protons.

The flux measurements have been done at 2 energies, namely 4 and 7 GeV/c with a telescope scintillator and a Cerenkov Counter in order to see the electrons (negative polarity). The target was: Al-8 mm diameter - 250 mm long.

With exactly the same settings, these flux measurements were also done with 24 GeV/c primary protons.

In the following table a résumé of the results is presented, as a comparison between the yields measured for the two different kinds of primary particles.

a) π^- measurements:

Flux ratio	p = 4 GeV/c	p = 7 GeV/c
$r = \frac{\pi^- \text{ (deuterons: 12 GeV/c/n)}}{\pi^- \text{ (protons: 24 GeV/c)}}$	0.32	0.045

b) Electron content:

We define: $R = e^-/\pi^-$.

Ratio R	p = 4 GeV/c	p = 7 GeV/c
R (protons: 24 GeV/c)	0.21	0.07
R (deuterons: 12 GeV/c/n)	0.06	-.--

We conclude that the use of deuterons of 12 GeV/c/n in place of protons of 24 GeV/c reduces the π^- yields by a large factor.

At 4 GeV/c, the reduction factor is about 3 for the pions and as high as 10 for the electrons.

If we look at the production cross-sections, we see that deuterons of 12 GeV/c/n behave very closely to protons of 12 GeV/c.

RADIATION SAFETY IN
THE PS EXPERIMENTAL AREAS
(version française au verso)

RADIATION SAFETY 87/1
JF/fp - 12.05.987

- Prepared by T.S.O.: K. Bätzner
- Approved by R.S.O.: L. Danloy

ACCESS CONTROL FOR THE EAST HALL SECONDARY BEAM ENCLOSURES

ENTRY

1. Keep button (1) pressed whilst removing a key from the store. Each person entering must take a key.
   THIS KEY IS YOUR GUARANTEE OF SAFETY and should remain in your possession during your stay in the closed area.
2. When "Accès possible" lights up (indicating beam stopper closed), keep button (2) pressed whilst opening door.

EXIT

1. Open door whilst pressing button (3).
2. Replace key in store.
3. When all keys are in the store, the beam stopper may be opened (*).
   It is the responsibility of the person replacing the last key to ensure that no one is left inside the enclosure.

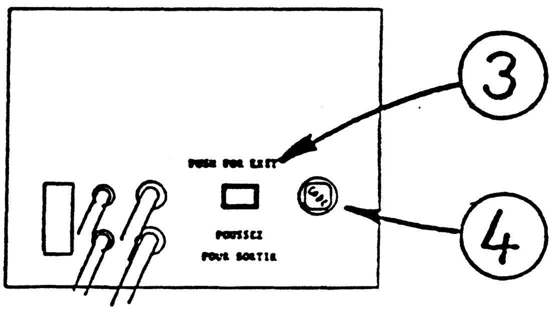
FREE ACCESS (during installation)

If one of the keys from the store is placed in position (4) inside the door, the lock will be released (and the beam stopper cannot be opened).

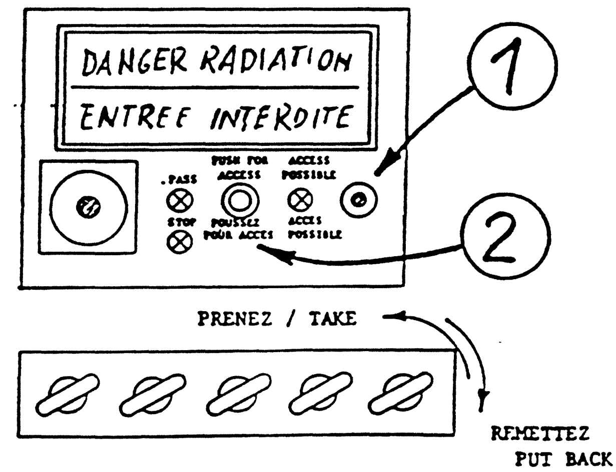
RESPONSIBILITY

- It is the responsibility of the experimental team(s) using the beam to follow ONLY the procedure described above for access to the enclosure.
- Film badges should be worn at all times in the East Hall.

(*) After modifications to the beam or enclosure, or a machine stop, the Main Control Room will lift the veto on beam stopper opening when requested, providing security conditions and the enclosure walls are in order.



interior



exterior

SECURITE RADIATIONS DANS
LES ZONES EXPERIMENTALES DU PS
(english version overleaf)

SECURITE RADIATIONS 87/1
LD/fp - 12.05.1987

- Préparé par T.S.O.: K. Bätzner
- Approuvé par R.S.O.: L. Danloy

PROCEDURE D'ACCES AUX FAISCEAUX SECONDAIRES DU HALL EST (bât. 157)

ENTREE

1. Appuyer sur le bouton (1) et simultanément prendre une clé et la garder. Toute personne qui entre doit prendre une clé. CETTE CLE EST VOTRE GARANTIE DE SECURITE.
2. Quand la lampe "Accès possible" est allumée, (le beam stopper est fermé), appuyer sur le bouton (2) et ouvrir la porte.

SORTIE

1. Appuyer sur le bouton (3) et simultanément pousser la porte.
2. Remettre la clé dans le distributeur.
3. Si toutes les clés sont en place dans le distributeur, le beam stopper peut être ouvert (*). La personne qui remet la dernière clé doit vérifier que personne ne reste dans la zone.

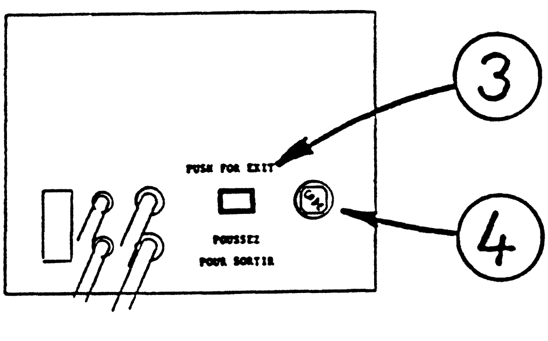
ACCES LIBRE (en périodes d'installation)

Une des clés placée en position (4), à l'intérieur de la porte, permet un accès libre (impossibilité d'ouvrir le beam stopper).

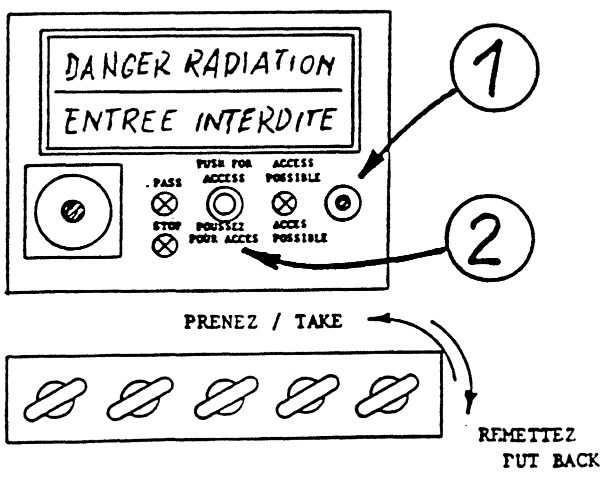
RESPONSABILITE

- L'application de CETTE PROCEDURE, à L'EXCLUSION DE TOUTE AUTRE, est sous l'entière responsabilité des utilisateurs.
- Tout utilisateur doit porter son film badge dans le hall.

(*) Après un arrêt ou des modifications, la Salle de Contrôle principale (MCR) enlèvera le "veto" du beam stopper sur demande des utilisateurs si les conditions de sécurité et les murs d'enceinte sont en ordre.



interieur



exterieur

CPS OPERATION Period 1 WEEK 29 - 30 1987 July 13-27 PSO 982

This schedule is definitive at time of publication for later changes see MAIN CONTROL ROOM ☎ 6677

ACCESS	
LPI	X X X X
BOOSTER	X X X X X X
EXP. AREAS	E E E
PS RING	X X X X X X
TRANSF. TUNNELS	TT2, TT10, TT70

06oo 12oo 18oo 24oo

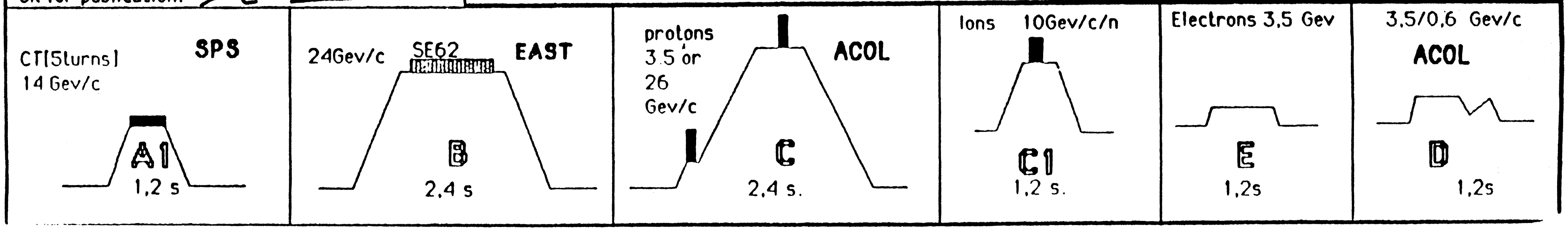
DATE JULY	mon 13	tue 14	wed 15	thu 16	fri 17	sat 18	sun 19	mo 20	tue 21	wed 22	thu 23	fri 24	sat 25	sun 26	mon 27
SUPERCYCLE	MD PS	2A1 B 2D or D B or C 2D or D 2E	C1 or C C1 or C							2A1 B 2D or C B or C 2D or C 2E					
SPS Halton		MD SPS e+		SU + HEP											
LPI Frammery	SU+MD	e+ to PS & SPS							SU + MD	e+ to PS & SPS					
ACOL Maury-Pedersen		3,5 Gev/c, 26 Gev/c Running-in													
EAST AREA t7: Klanner, Voltolini, Sauli. t9: Bosio, Ekelhof, F.Luzzi, Piccinini. t10: Bellazzini,Plotow-B,Del Papa. t11Buran,Massam,Agoritsas,Spinelli		SU } e17(SE62)													

MAGNET CYCLES:

A1[105]= 14Gev/c-1.2s.
C1[103]=10Gev/c/n -1,2s.
B[162]=24Gev/c-600ms -2,4s
C[210]=3,5/26,3Gev/c -2,4s
D[65]=3,5/0.6Gev/c -1.2s
E[21]=3,5 Gev/c - 1,2s.

__Intensities e17:__
Each target not more than 2. 10^{11} ppp

OK for publication: [signature]



5.3 Example of "CPS operation" sheet

RADIATION SECURITY SYMBOLS AND ABBREVIATIONS

RING, ANNEAU EXPERIMENTAL ZONES ZONES EXPERIMENTALES TRANSFER TUNNELS	no access/pas d'accès	TT	Tunnels	S	South	E	East	X	Ring
	restricted access/ accès limité	$\overline{\underline{TT}}$	Tunnels	$\overline{\underline{S}}$	South	$\overline{\underline{E}}$	East	$\overline{\underline{X}}$	Ring

N.B. Exact conditions in a given Experimental Area depend upon beams in use, etc.; further details can be obtained from the MCR. - Les conditions exactes pour une zone d'expérience donnée dépendent des faisceaux utilisés, etc.; de plus amples détails peuvent être obtenus à la MCR.

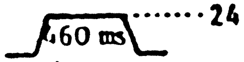
PS OPERATION

Ejection Example
- FE16 3b : one-turn fast extraction from straight section 16; 3 bunches extracted.
- SE62 : slow resonant extraction from straight section 62.
- CT : continuous transfer process to the SPS.
- FE16 20b: all the beam (20 bunches) is extracted in position 16.


Stacking


Stacking and short transfers.

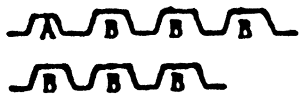
PS MAGNETIC CYCLE



GeV/c } B: Notation: 24 GeV/c, 460 ms - 2,4 s.

} A: Notation: 10 GeV/c - 1,2 s.

Supercycle : Groups of cycles



ABBB, ABBB etc.

BBB, BBB etc.

BEAM LINES

$\boxed{e_{15}}$: Beam transport for beam line e_{15} is energized.  : No beam transport available.

MD-PS : During this period, mode of PS operation and beam utilization are specified in a Machine Development programmé available in the MCR.

Distribution

Notice Boards : PS, EP, EF, SB, TIS, DD, LEP, SPS and as requested to : Mrs. E. Durieu : Tel. 3704

Editor : G. Rosset

REFERENCES

1. MPS/Int. MU/EP 68-5, 05.07.68, Efficiency of external targets, L. Hoffmann and H. Schönbacher.

2. JRS/CLW1 and JRS/CLW2, 1967, (Brookhaven National Laboratory), Empirical formulae for particle production in p-Be collision between 10 and 35 GeV/c. J.R. Sanford and C.L. Wang

3. BNL-22452, 25.01.1977, Low energy kaon and antiproton production in p-Be collision between 10 and 30 GeV/c, C.L. Wang.

4. PS/MU/BL/NOTE 81-7, 23.10.1981, The c13 beam, K. Bätzner, M. Chassard, D. Dumollard, D.J. Simon.

5. PS/MU/EP/NOTE 82-13, 14.10.1982, Electron yield from p-N collisions, R. Beckmann.

6. Nuclear Physics B 254-491/527, 1985, Channeling radiation from 2 to 55 GeV/c electrons and positrons, J. Bak, E. Uggerhoj et al.

7. Thesis (Aarhus Universitet), May 1984, An experimental investigation of channeling radiation produced by 2 to 55 GeV/c electrons and positrons, J.F. Bak.

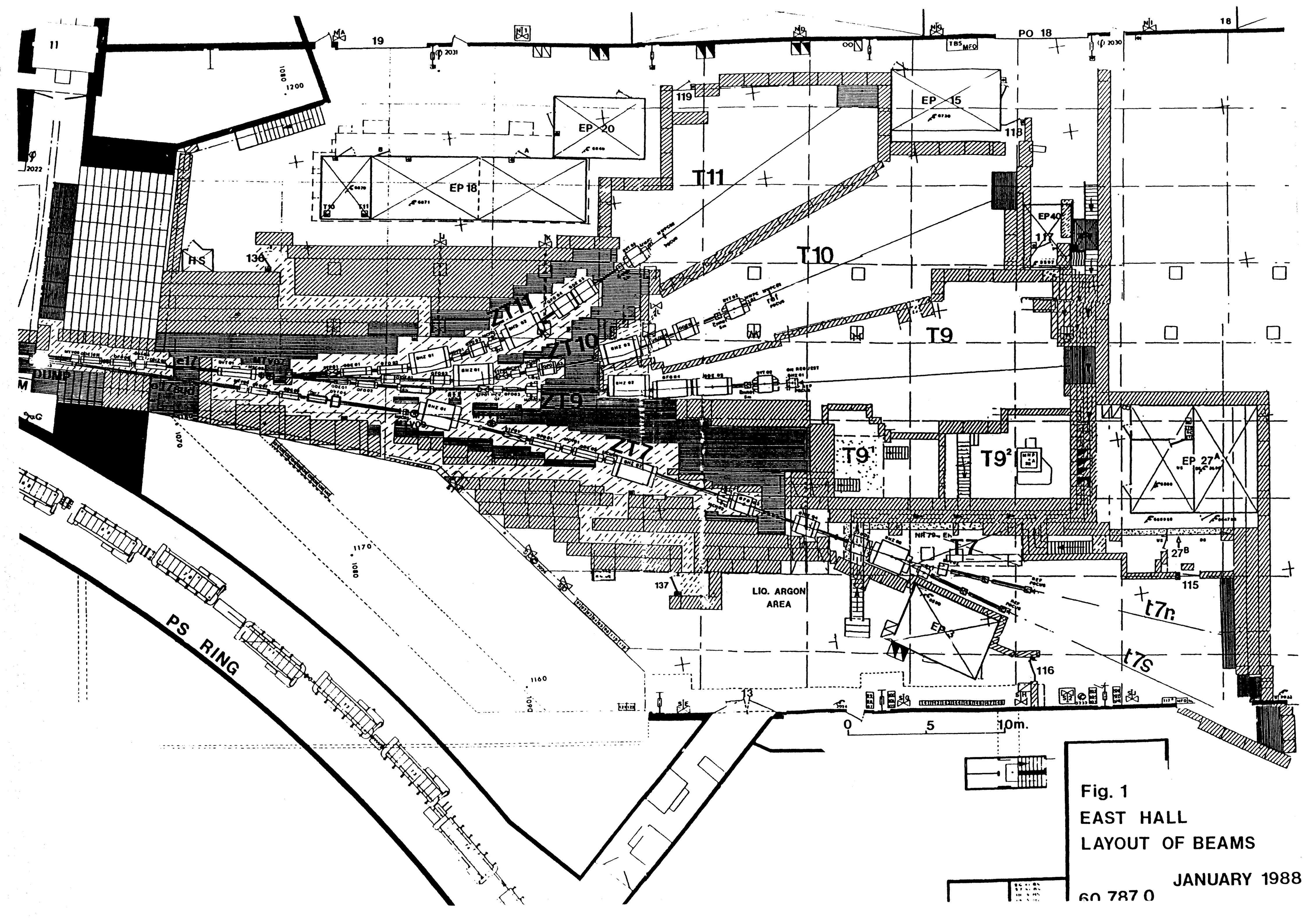


Fig. 1
EAST HALL
LAYOUT OF BEAMS

JANUARY 1988

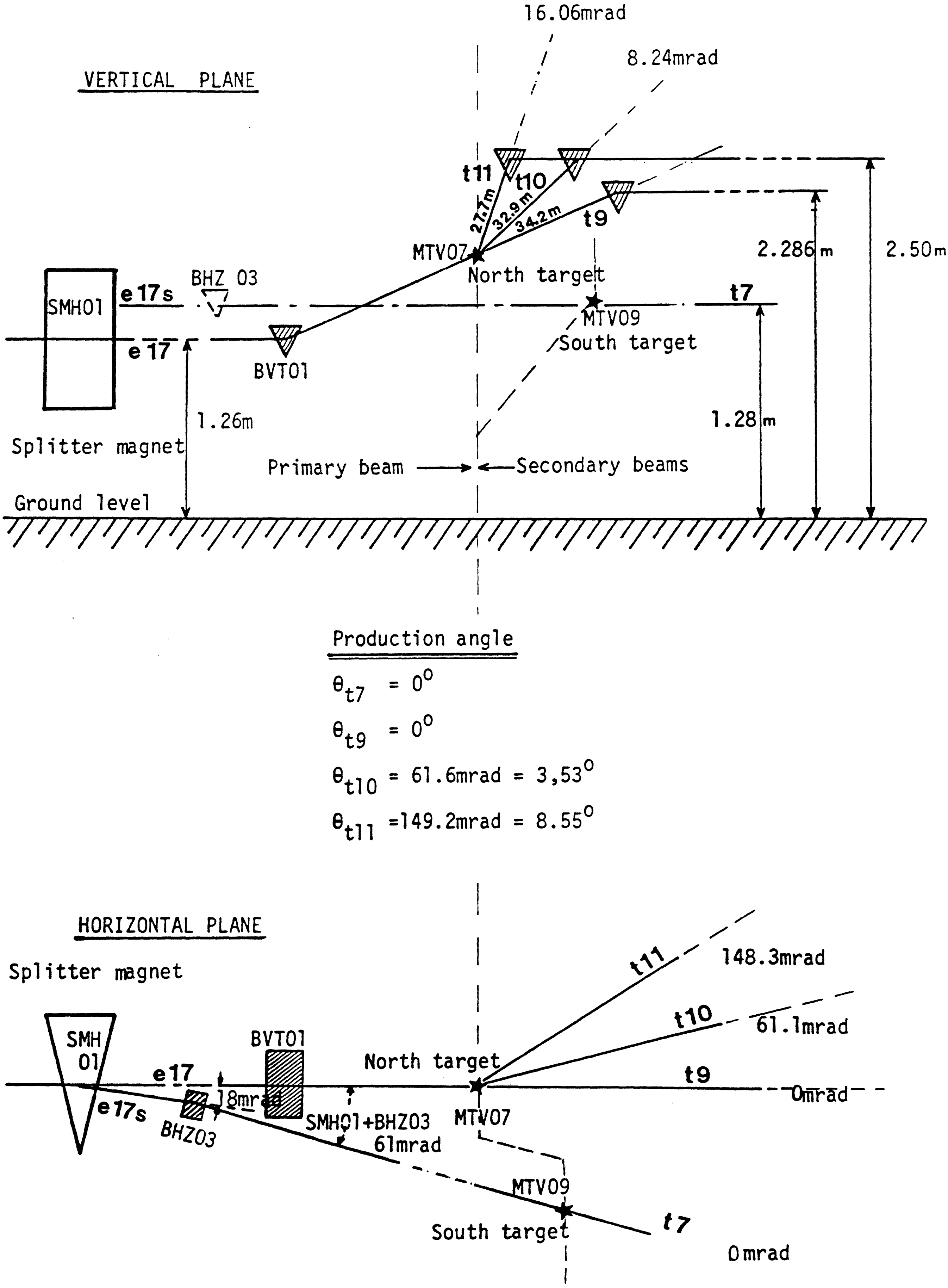


Fig : 2 Schematic layout of the secondary beams

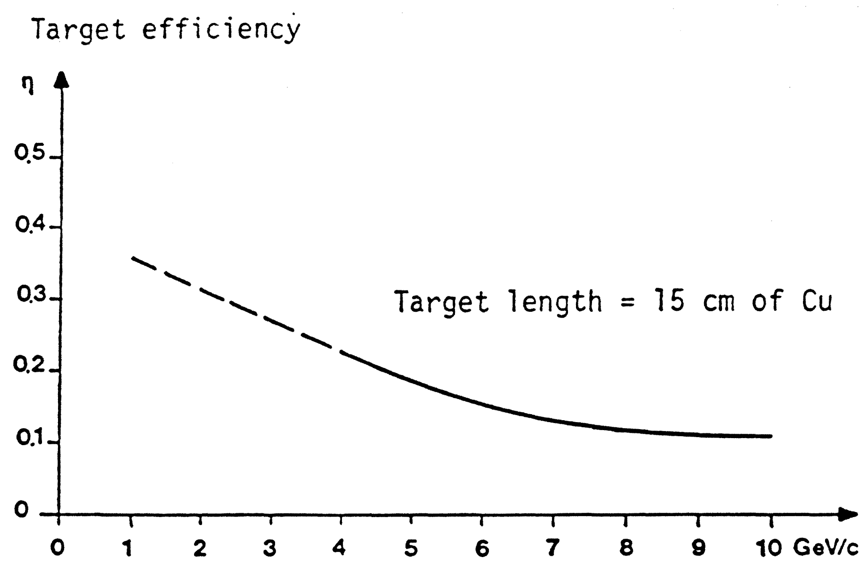


Fig 3.
Estimated target efficiency versus beam momentum
(from Refs. 1 and 4)

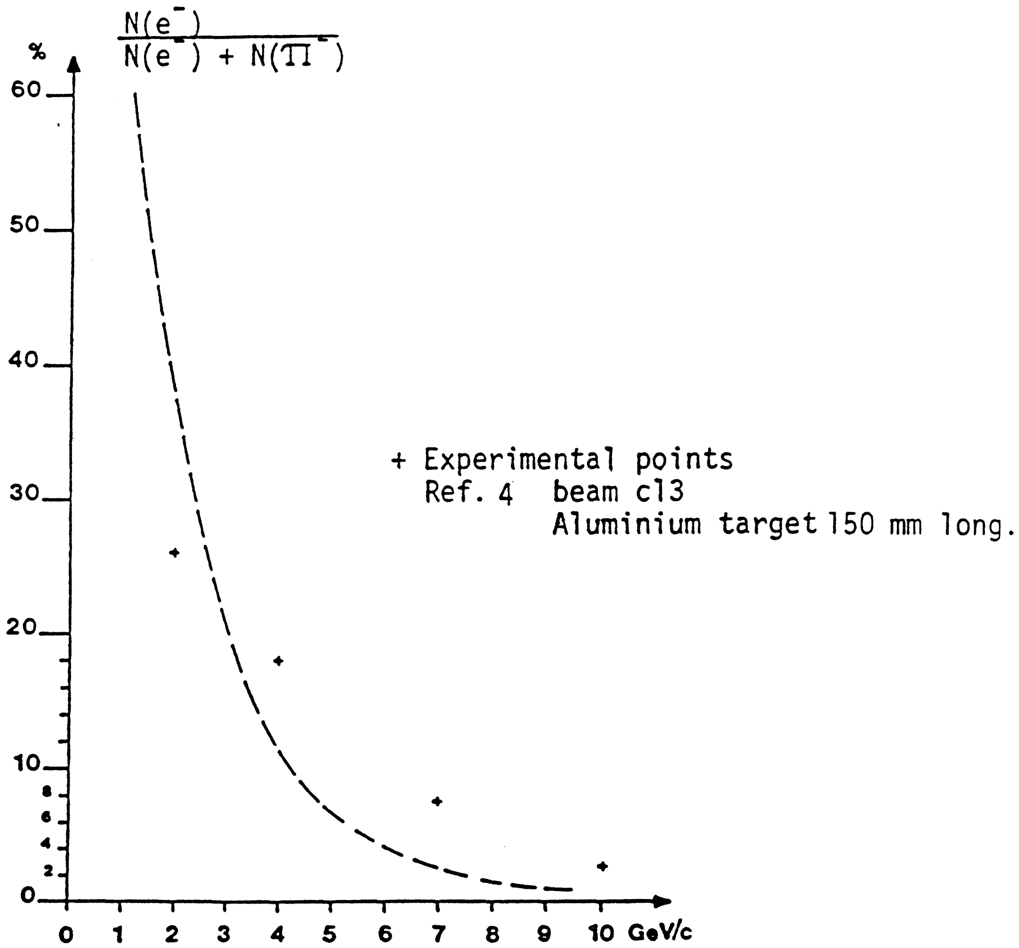


Fig 4.
Percentage of e^- in a negative beam calculated in Ref. 5
(zero degree production angle).

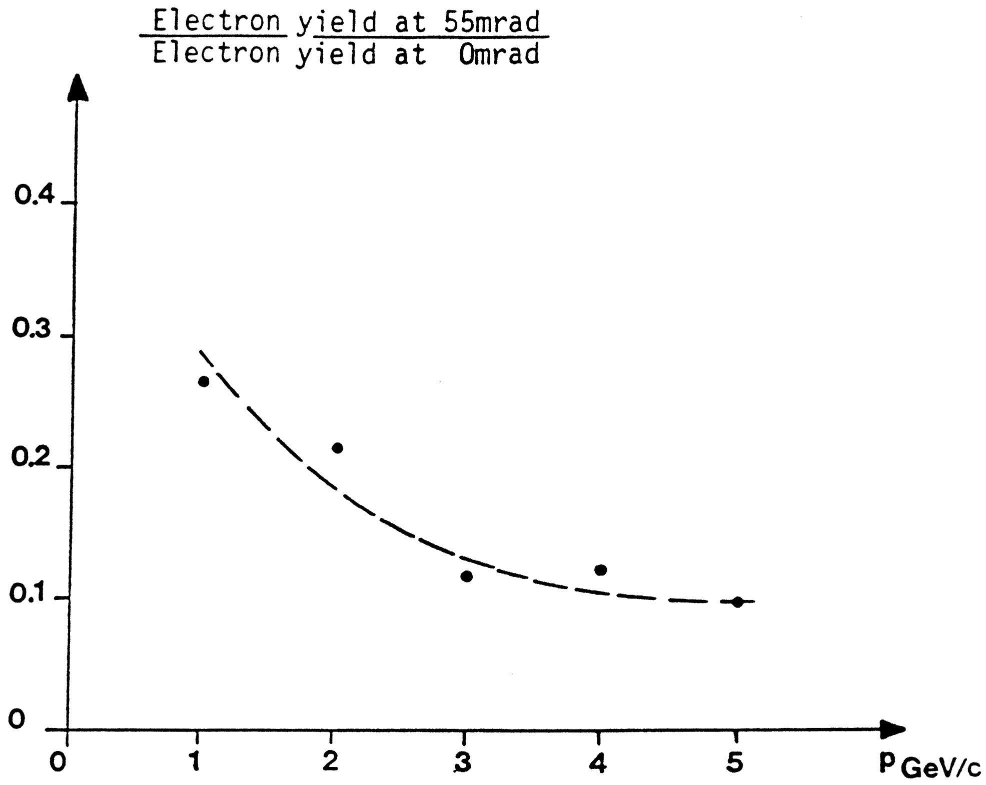


Fig 5.
Effect of the production angle on electron (positron) yield (from computations in Ref. 5)

TABLE 2

CHARACTERISTICS OF THE BEAM t7

Maximum design momentum (GeV/c)		10	
Length at reference focus[1] (m)		45	
Beam height (m)		1.28	
Production angle (mrad)	(H	---	
	(V	---	
	(total	0	
Angular acceptance (mrad)	(αH	± 12.8	
	(αV	± 4	
Solid angle Ω = παH χ αV (μsterad)		160	
Horizontal magnification at momentum slit		2.3	
Dispersion at momentum slit (mm/% Δp/p)		9.3	
Theoretical momentum resolution[2] (%)		± 0.7	
Optical characteristics at reference focus[1]		South	North[3]
dispersion (mm/% Δp/p)	(H	---	28
	(V		
magnification	(H	3.2	3.5
	(V	3.4	3.6
Calculated beam cross-section for full beam angular acceptance and Δp/p = ± 1 % (mm)		30Hx25V	70Hx30V

---

1 10 m downstream of the last vertical dipole

2 For a 3x3 mm^2 apparent production target

3 In the North branch, the chromatic dispersion is not compensated

TABLE 3

ZT07 - NOMINAL VALUE OF THE CURRENTS OF THE TRANSPORT ELEMENTS

	1	2	3	4	5	6	7	8*
IDENTIF	M219	Q606	Q607	MC208	Q123	Q141	Q125	M213
SUPPLY	R2a23	R312	R311	R318	R210	R309	R2a21	R316
ELEMENT	BHZ01	QF001	QDE02	BHZ03	QF003	QDE04	QF005	BHZ03
MOMENTUM								
1.0	45	64	54	57	30	31	34	54
2.0	91	128	108	114	61	62	68	108
3.0	135	192	162	171	91	93	102	162
4.0	182	256	216	228	122	124	136	226
5.0	227	321	269	286	152	157	173	270
6.0	270	384	324	342	182	186	206	324
7.0	315	448	377	399	213	217	240	378
8.0	364	512	432	456	244	248	275	432
9.0	409	576	485	513	274	279	309	495
10.0	454	642	538	572	304	314	346	570

POSITIF PARTICLES = POSITIF SIGN
NEGATIF PARTICLES = NEGATIF SIGN

* BHZ03 POLARITY DEFINES NORD/SUD BRANCH

Momentum in GeV/c

Currents in Amperes

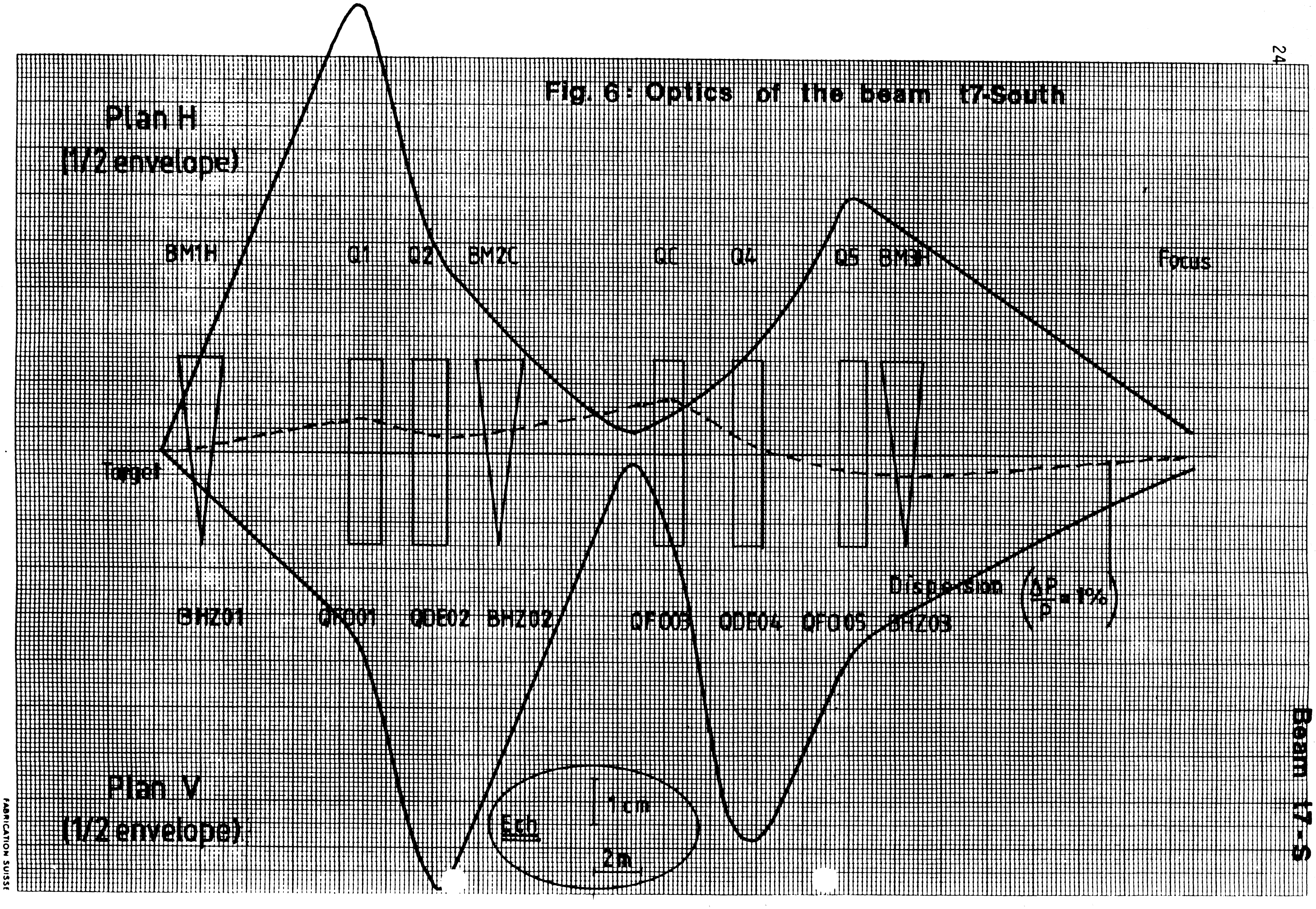


Fig. 6: Optics of the beam t7-South

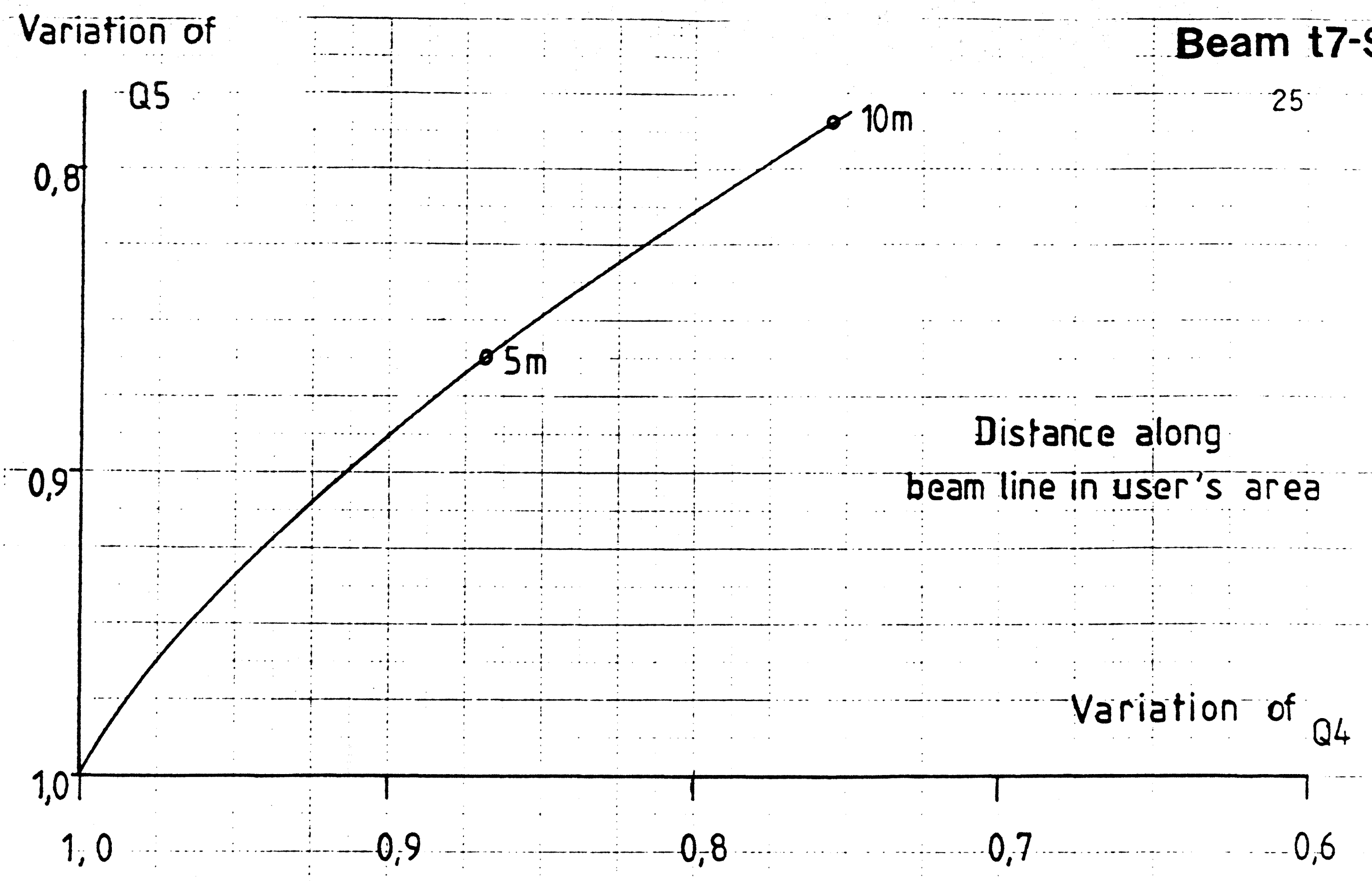


Fig.7 _DISPLACEMENT OF BEAM WAIST IN USER'S AREA; FACTORS FOR VARIATION OF Q4 AND Q5.

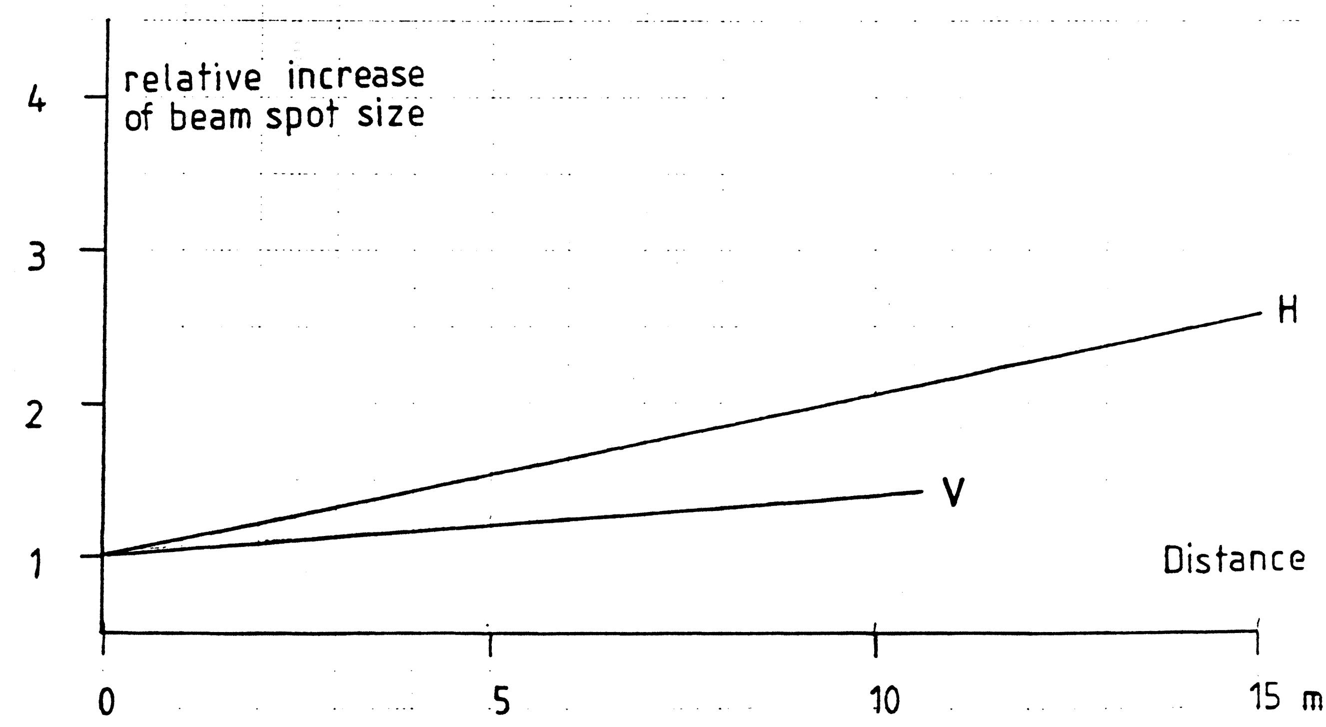
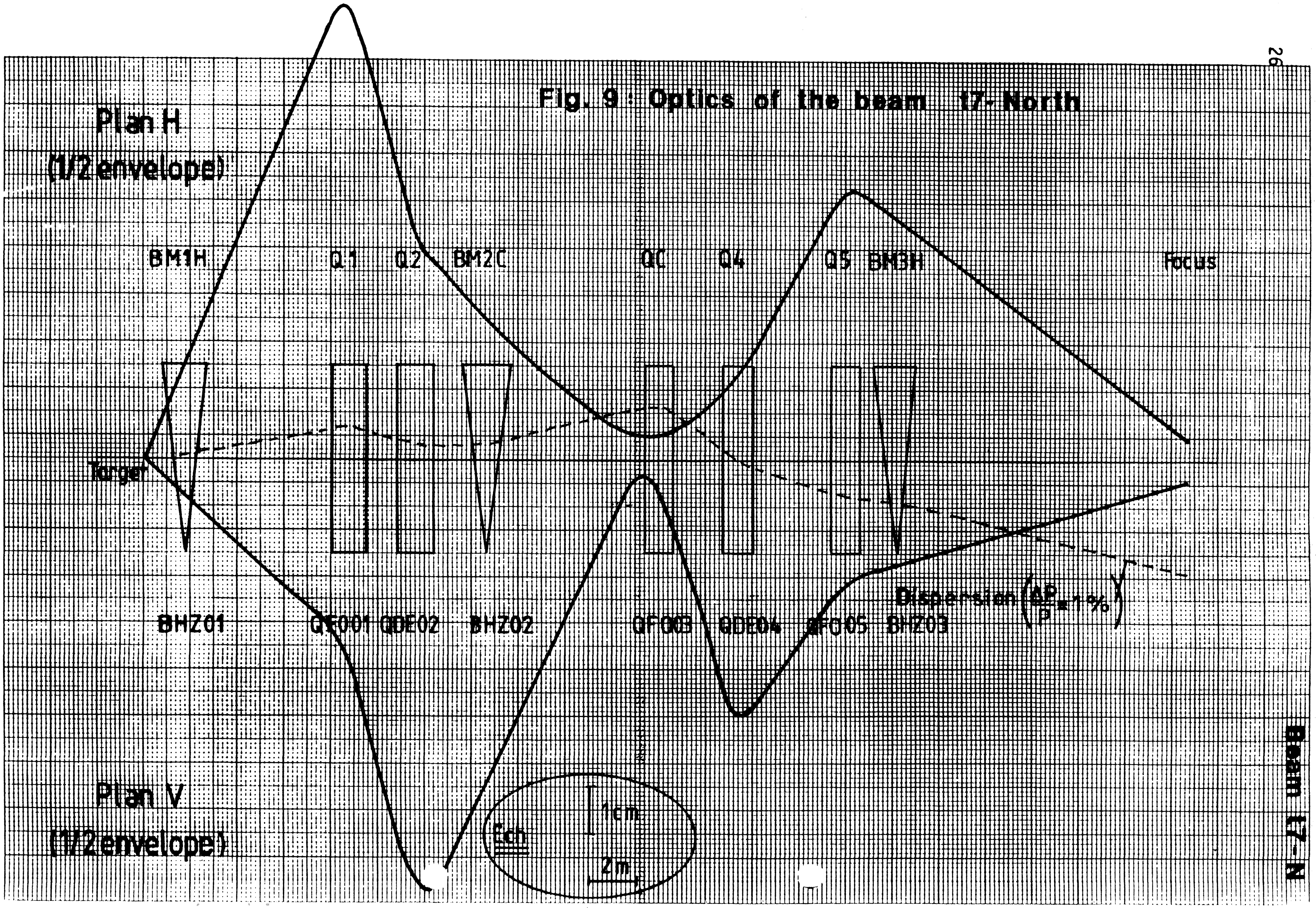


Fig.8 _RELATIVE INCREASE OF BEAM SPOT SIZE IN USER'S AREA. (without scattering).

Fig. 9 : Optics of the beam t7-North



FABRICATION S...

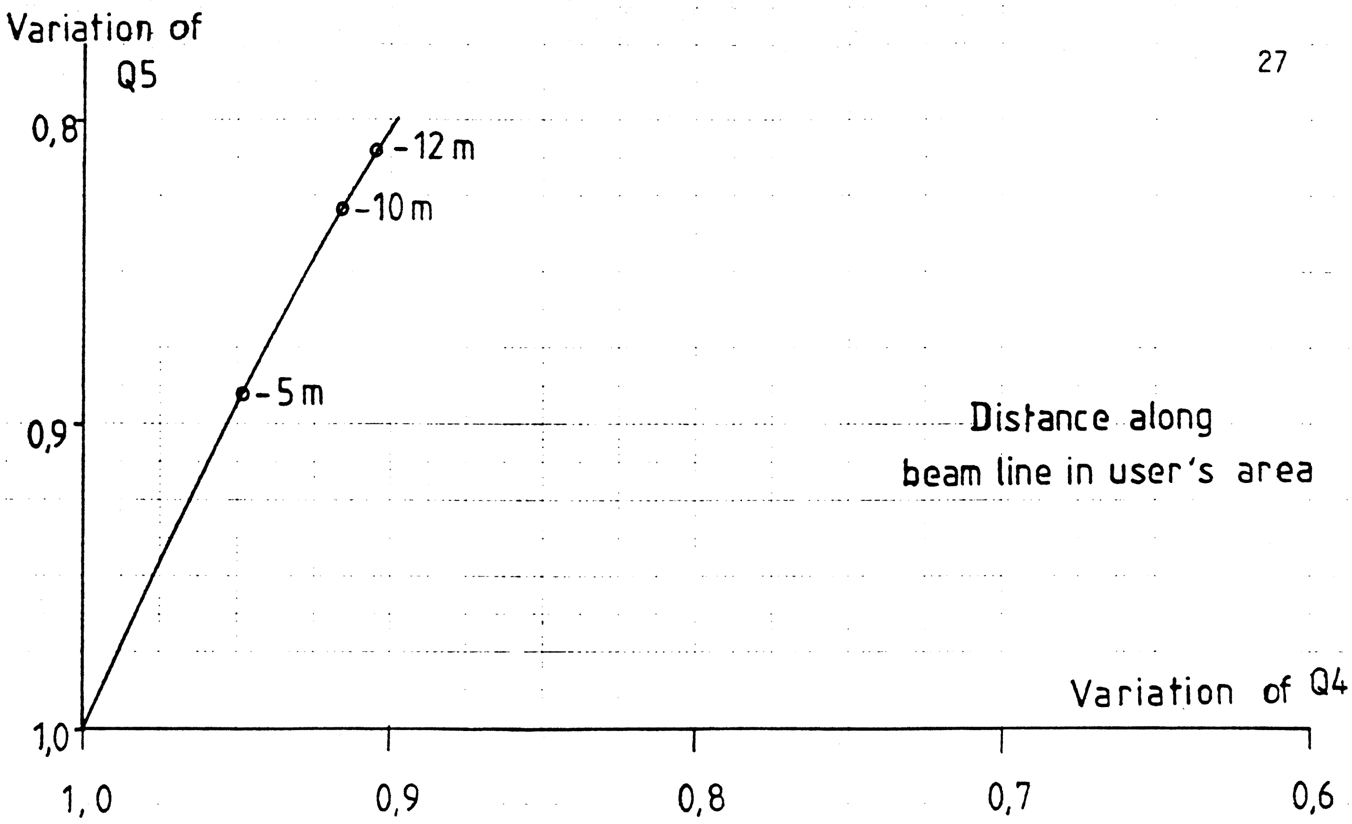


Fig.10 _DISPLACEMENT OF BEAM WAIST IN USER'S AREA; FACTORS FOR VARIATION OF Q4 AND Q5.

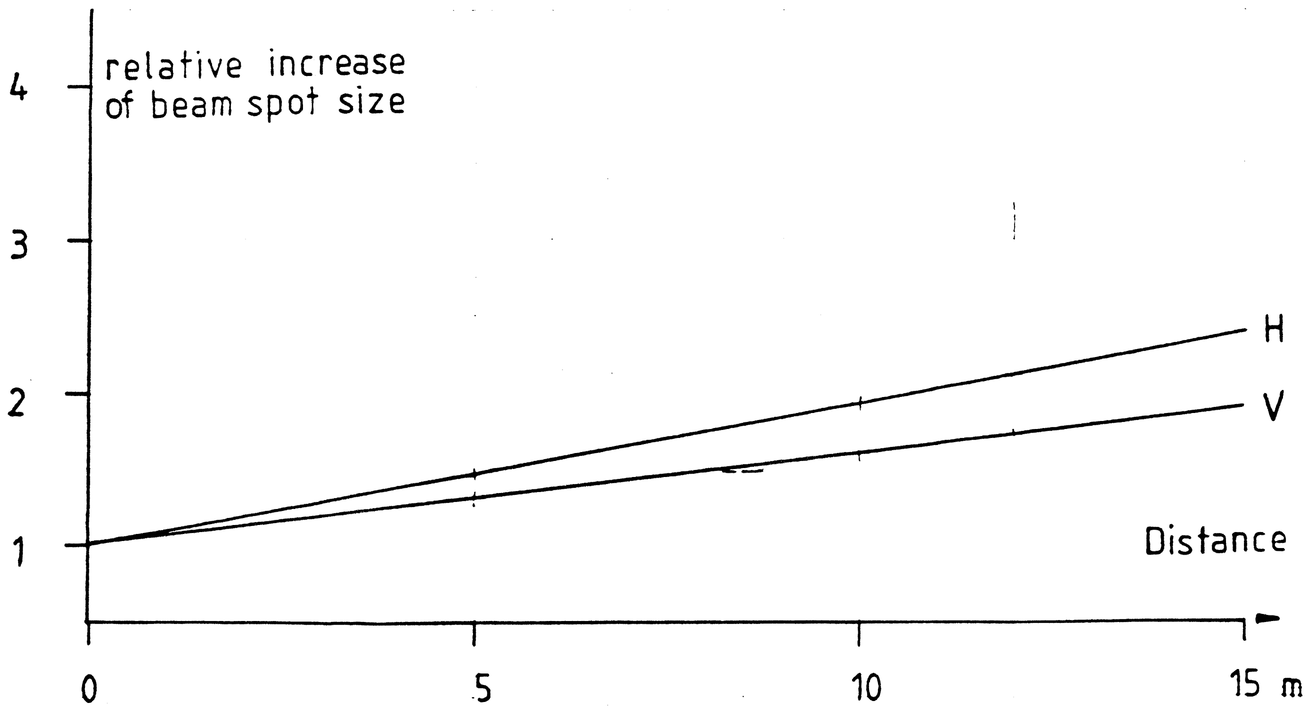


Fig.11 _RELATIVE INCREASE OF BEAM SPOT SIZE IN USER'S AREA. (without scattering).

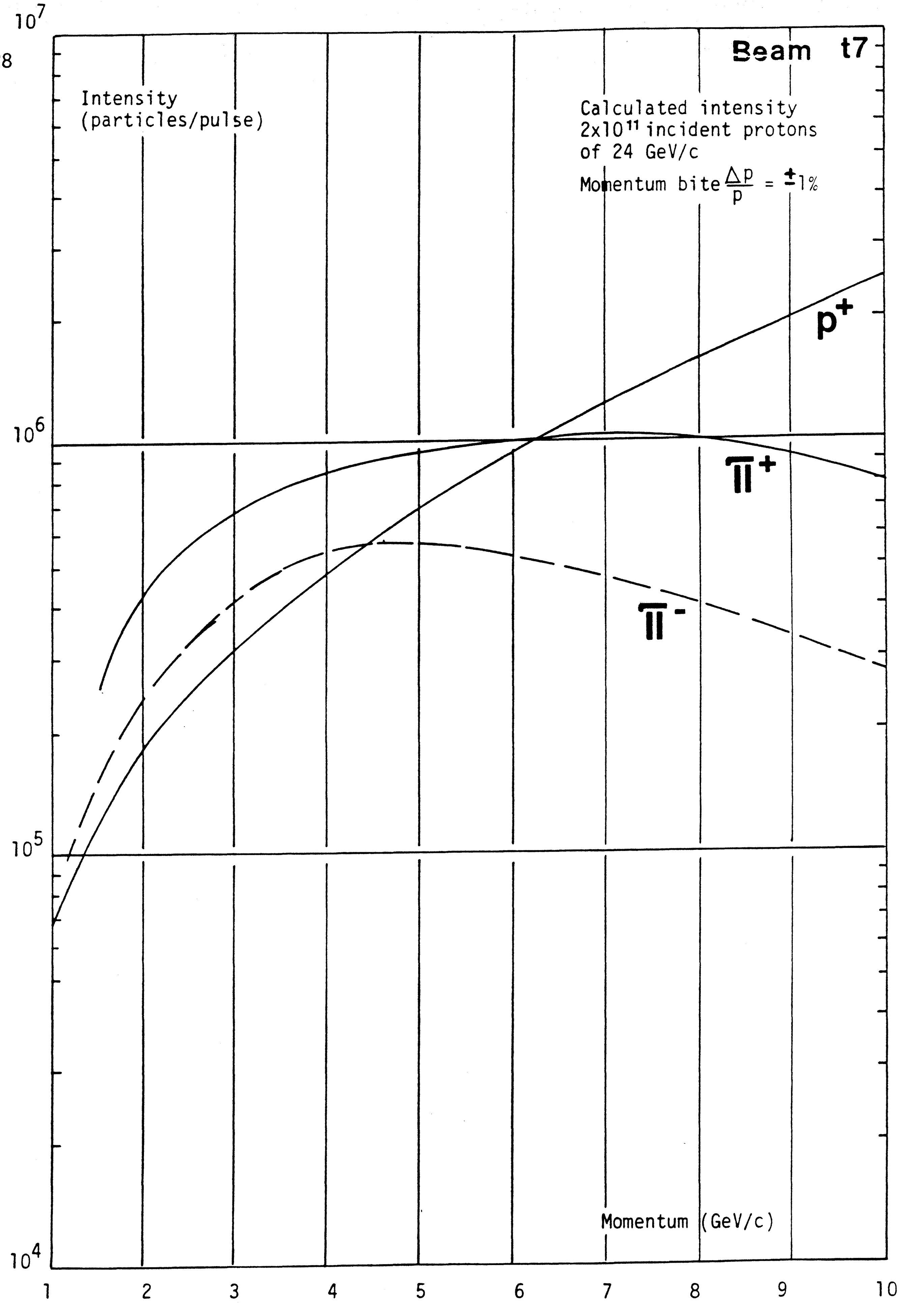


Fig. 12 Calculated intensity at the reference focus of t7.

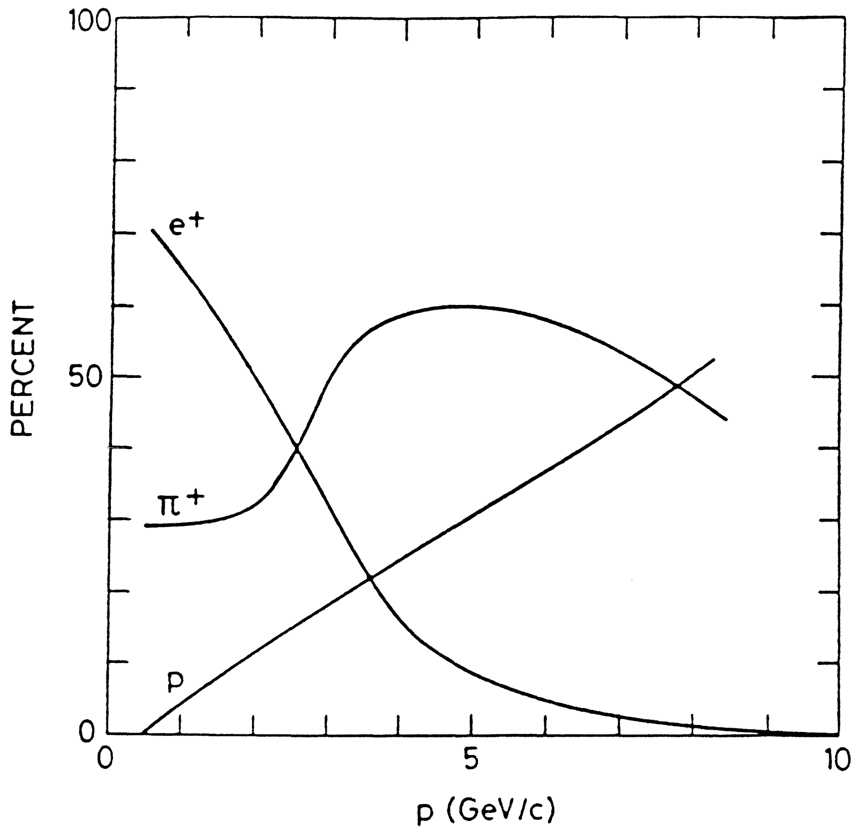


Fig.13 Relative distribution of protons, pions and positrons in the t7-beam, as measured by PS188 (Ref. 6,7)

TABLE 4

CHARACTERISTICS OF THE BEAM t9

Maximum design momentum (GeV/c)		10
Length at reference focus[1] (m)		34.5
Beam height (m)		2.28
Production angle (mrad)	(H	---
	(V	---
	(total	0
Angular acceptance (mrad)	(αH	± 3.6
	(αV	± 5.1
Solid angle $\Omega = \pi\alpha H \times \alpha V$ (μsterad)		58
Horizontal magnification at momentum slit		1.15
Dispersion at momentum slit (mm/% $\Delta p/p$)		4.2
Theoretical momentum resolution[2] (%)		± 1.1
Optical characteristics at reference focus[1]		
dispersion (mm/% $\Delta p/p$)	(H	---
	(V	0.7
magnification	(H	1.4
	(V	0.3
Calculated beam cross-section for full beam angular acceptance and $\Delta p/p = \pm 1$ % (mm)		9Hx4V

[1] 2.5 m downstream of the last vertical dipole

[2] For a 4x4 mm^2 apparent production target

TABLE 5

ZT09 - NOMINAL VALUE OF THE CURRENTS OF THE TRANSPORT ELEMENTS

	1	2	3	4	5	6	7	8	9
IDENTIF	Q7504	Q1202	MNP19a	Q7501	MC205	Q221	Q222	M106	Mdx30
SUPPLY	R2a27	R217	R2a28	R317	R314	R315	R2a25	R313	R310
ELEMENT	QDE01	QF002	BHZ01	QF003	BHZ02	QF004	QDE05	BVT02	DHZ01
MOMENTUM									
1.0	39	35	55	21	48	33	30	27	
2.0	79	70	110	41	96	65	60	54	
3.0	118	105	165	62	144	98	90	81	
4.0	158	140	220	83	191	130	120	108	
5.0	197	176	275	104	239	163	150	135	
6.0	236	211	330	124	287	195	180	162	
7.0	276	246	384	145	335	227	210	189	
8.0	315	281	439	166	383	260	240	216	
9.0	355	315	503	186	431	293	270	243	
10.0	394	351	580	207	479	325	300	270	

POSITIF PARTICLES = POSITIF SIGN
NEGATIF PARTICLES = NEGATIF SIGN

Momentum in GeV/c

Currents in Amperes

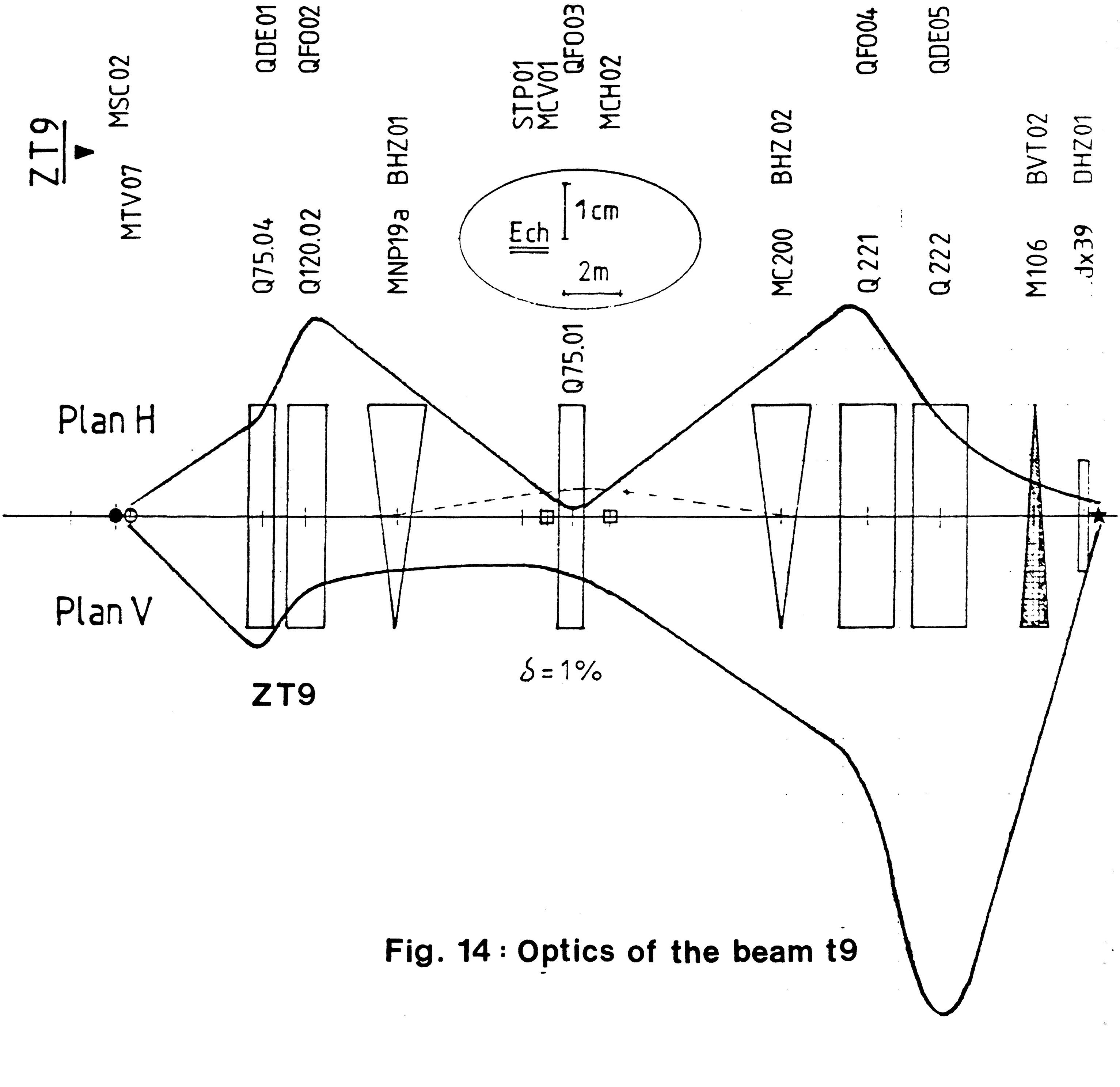


Fig. 14 : Optics of the beam t9

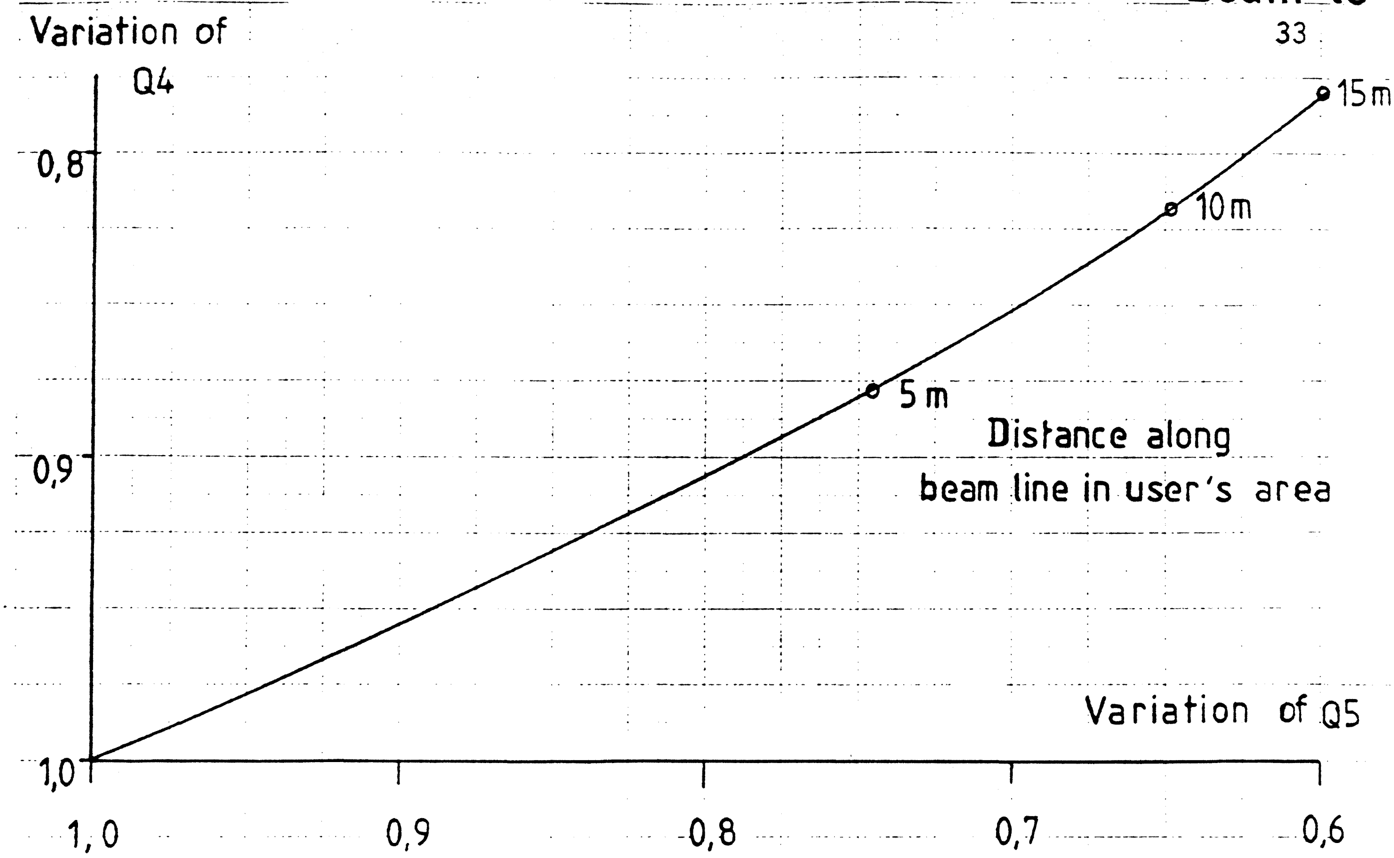


Fig.15 _DISPLACEMENT OF BEAM WAIST IN USER'S AREA; FACTORS FOR VARIATION OF Q4 AND Q5.

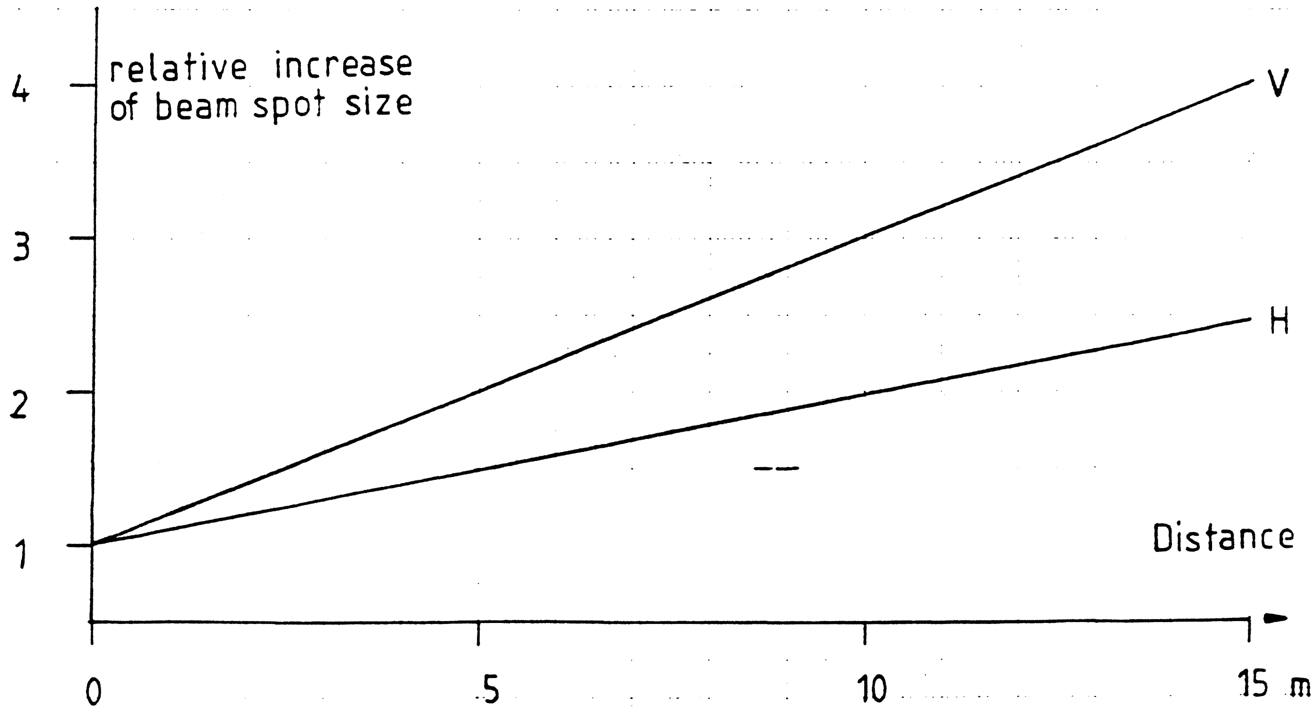


Fig.16 _RELATIVE INCREASE OF BEAM SPOT SIZE IN USER'S AREA. (without scattering).

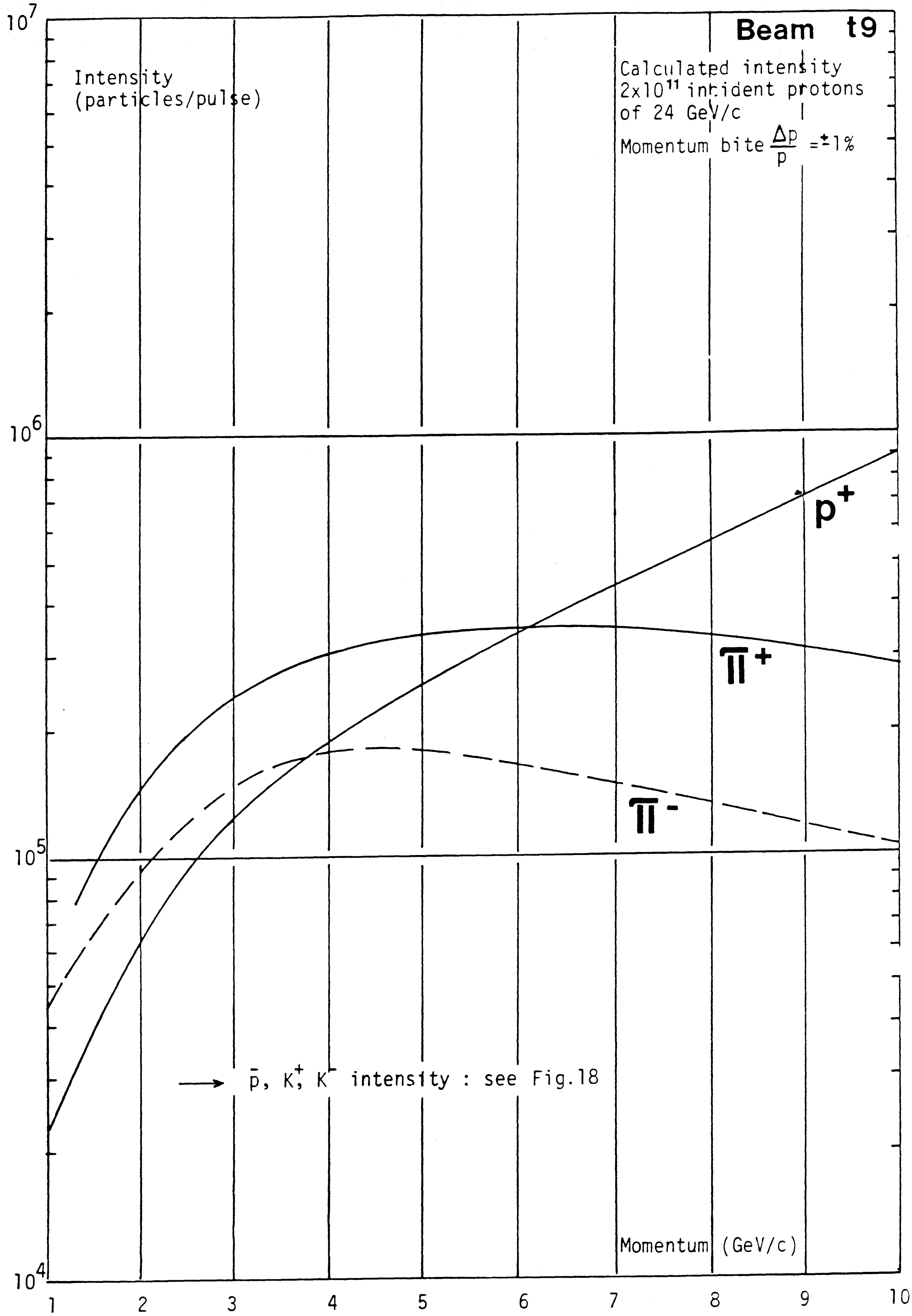


Fig.17 : Calculated intensity at the reference focus of t9.

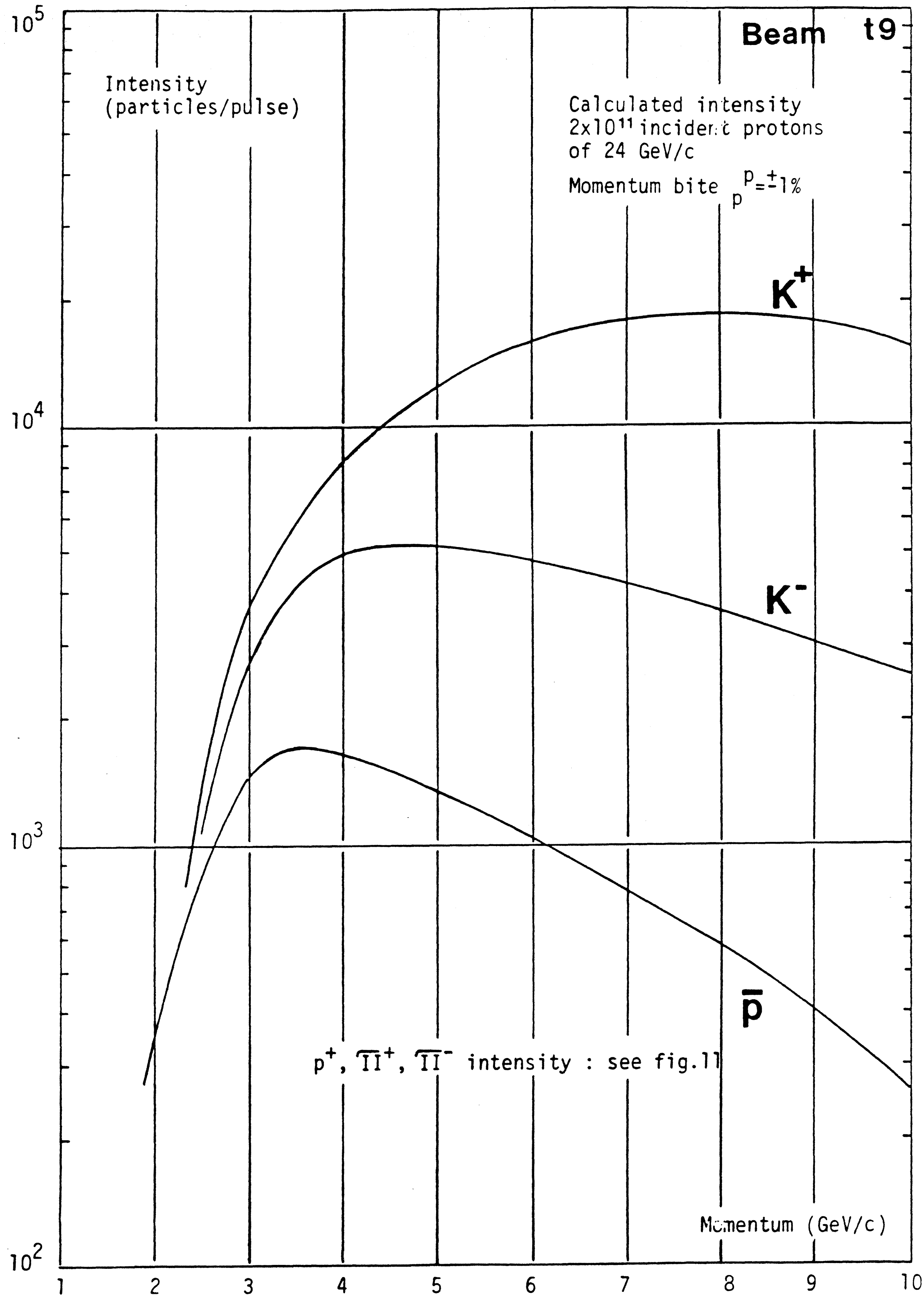


Fig. 18 : Calculated intensity at the reference focus of t9

TABLE 6

CHARACTERISTICS OF THE BEAM t10

Maximum design momentum (GeV/c)		5
Length at reference focus[1] (m)		33
Beam height (m)		2.50
Production angle (mrad)	(H	61.06
	(V	8.24
	(total	61.6
Angular acceptance (mrad)	(αH	± 5
	(αV	± 12.7
Solid angle Ω = παH χ αV (μsterad)		200
Horizontal magnification at momentum slit		3.
Dispersion at momentum slit (mm/% Δp/p)		9.
Theoretical momentum resolution[2] (%)		± 1.3
Optical characteristics at reference focus[1]		
dispersion (mm/% Δp/p)	(H	0
	(V	1
magnification	(H	0.7
	(V	0.85
Calculated beam cross-section for full beam angular acceptance and Δp/p = ± 1 % (mm)		16Hx7.4V

---

1 2.5 m downstream of the last vertical dipole

2 For a 4x4 mm^2 apparent production target

TABLE 7

ZT10 - NOMINAL VALUE OF THE CURRENTS OF THE TRANSPORT ELEMENTS

	1	2	3	4	5	6	7	8
IDENTIF	Q801	Q802	MC207	QFS03	MC201	Q108	Q109	M117
SUPPLY	R201	R211	R304	R117	R303	R213	R205	R216
ELEMENT	QDE01	QF002	BHZ01	QF003	BHZ02	QF004	QDE05	BVT02
MOMENTUM								
1.0	85	92	160	42	156	58	52	34
1.5	129	138	240	63	234	87	81	51
2.0	170	184	320	84	312	116	104	68
2.5	215	230	400	106	390	145	133	85
3.0	258	276	480	127	468	174	156	102
3.5	301	322	560	149	546	203	185	119
4.0	344	368	640	170	614	232	208	136
4.5	390	414	720	191	792	261	237	153
5.0	433	460	810	213	801	295	260	174

POSITIF PARTICLES = POSITIF SIGN
NEGATIF PARTICLES = NEGATIF SIGN

Momentum in GeV/c

Currents in Amperes

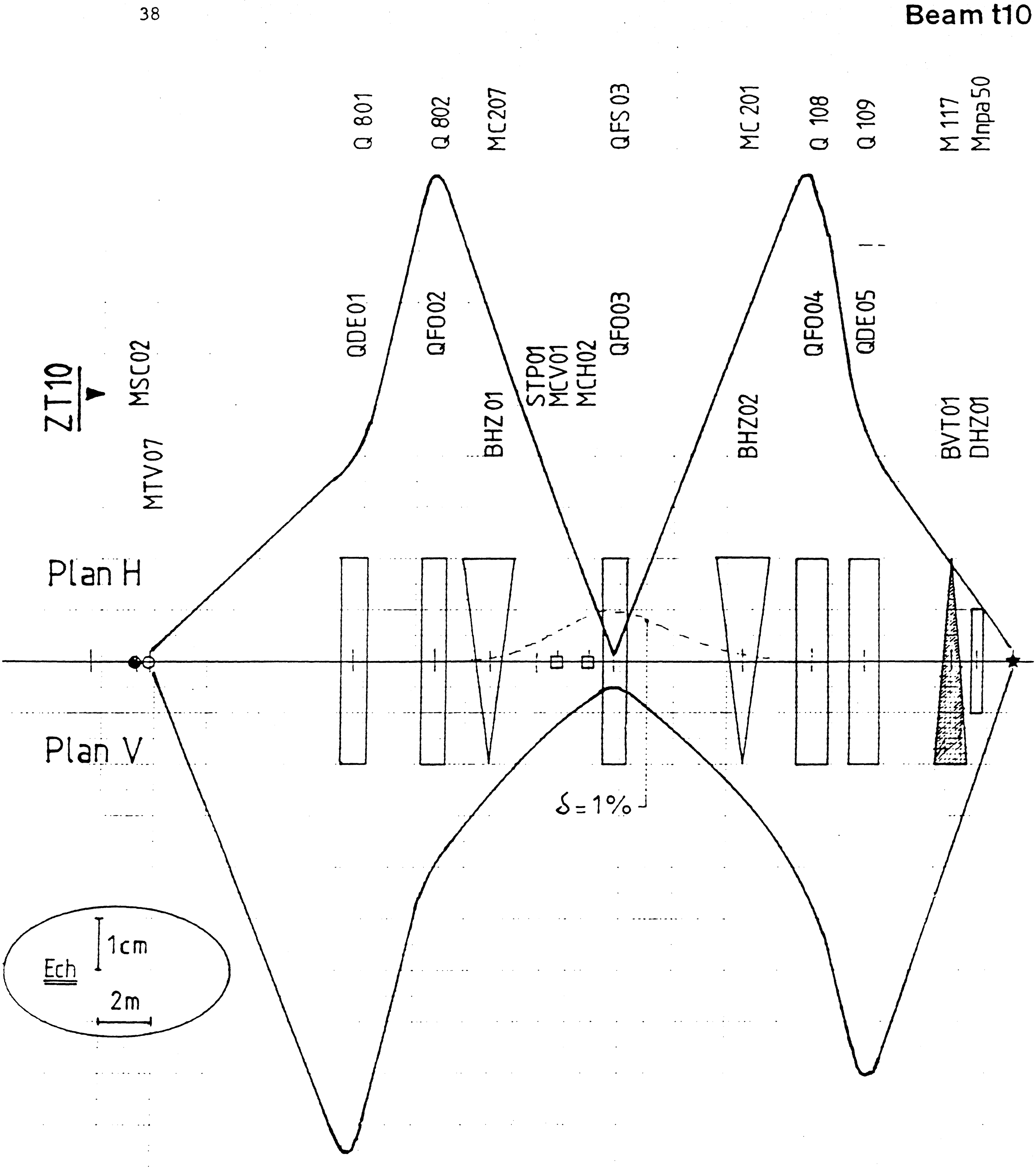


Fig. 19 : Optics of the beam t10

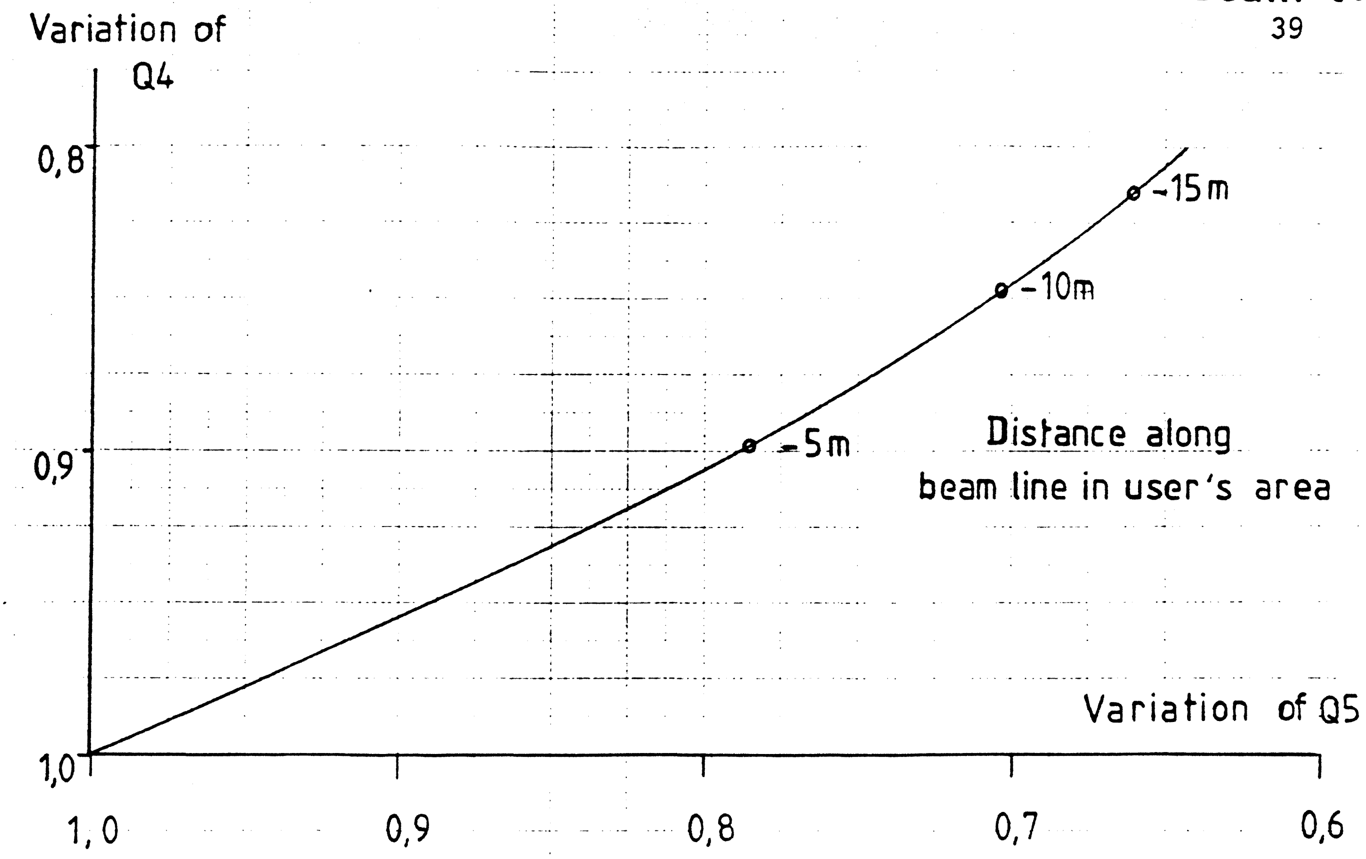


Fig.20 _ DISPLACEMENT OF BEAM WAIST IN USER'S AREA; FACTORS FOR VARIATION OF Q4 AND Q5.

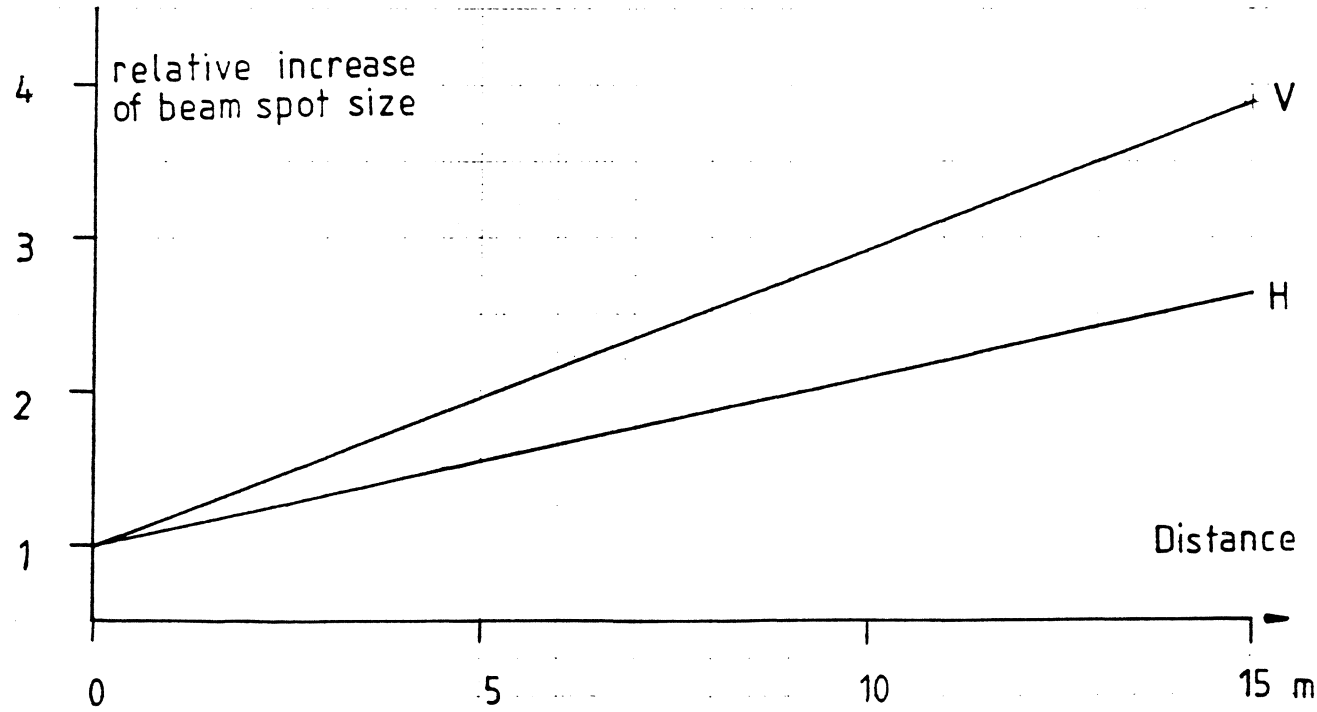


Fig.21 _ RELATIVE INCREASE OF BEAM SPOT SIZE IN USER'S AREA. (without scattering).

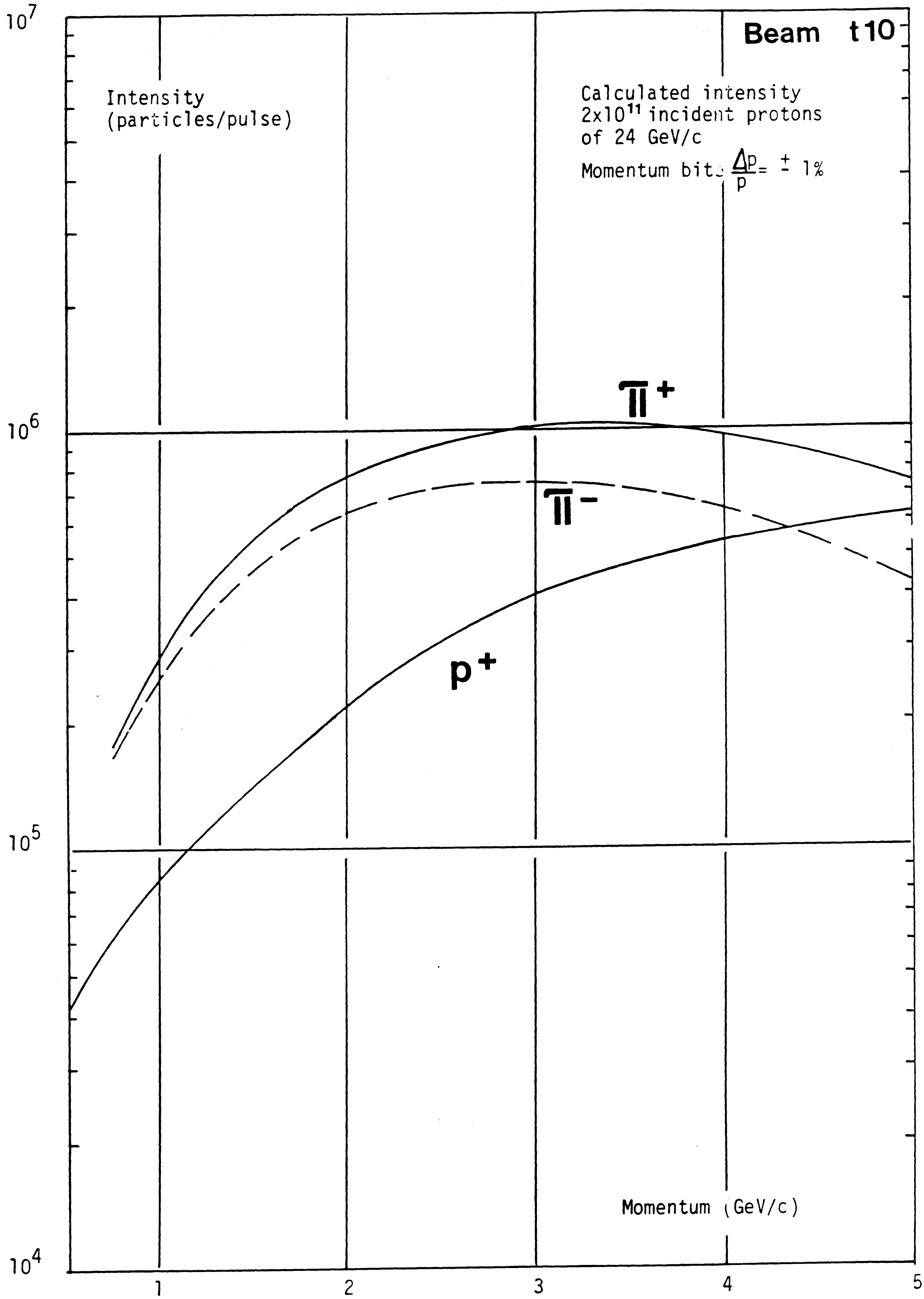


Fig.22 : Calculated intensity at the reference focus of t10.

TABLE 8

CHARACTERISTICS OF THE BEAM t11

Maximum design momentum (GeV/c)		3.5
Length at reference focus[1] (m)		28.
Beam height (m)		2.5
Production angle (mrad)	(H	148.36
	(V	16.06
	(total	149.2
Angular acceptance (mrad)	(αH	± 6.2
	(αV	± 19.7
Solid angle Ω = παH χ αV (μsterad)		384
Horizontal magnification at momentum slit		3.6
Dispersion at momentum slit (mm/% Δp/p)		7.5
Theoretical momentum resolution[2] (%)		± 1.9
Optical characteristics at reference focus[1]		
dispersion (mm/% Δp/p)	(H	0
	(V	1.1
magnification	(H	0.7
	(V	1.3
Calculated beam cross-section for full beam angular acceptance and Δp/p = ± 1 % (mm)		18Hx10V

1 2.5 m downstream of the last vertical dipole

2 For a 4x4 mm^2 apparent production target

TABLE 9

ZT11 - NOMINAL VALUE OF THE CURRENTS OF THE TRANSPORT ELEMENTS

	1	2	3	4	5	6	7	8
IDENTIF	Q604	Q602	MC206	QFS01	M221	Q119	Q120	M112
SUPPLY	R305	R301	R302	R118	R204	R212	R207	R209
ELEMENT	QDE01	QF002	BHZ01	QF003	BHZ02	QF004	QDE05	BVT02
MOMENTUM								
0.5	51	51	105	33	80	41	40	19
1.0	102	102	210	66	160	82	80	38
1.5	153	153	315	99	240	123	121	57
2.0	204	204	420	132	320	164	161	76
2.5	256	255	525	165	400	205	201	95
3.0	308	306	630	198	480	246	243	115
3.5	361	357	750	231	575	287	285	135

POSITIF PARTICLES = POSITIF SIGN
NEGATIF PARTICLES = NEGATIF SIGN

Momentum in GeV/c

Currents in Amperes

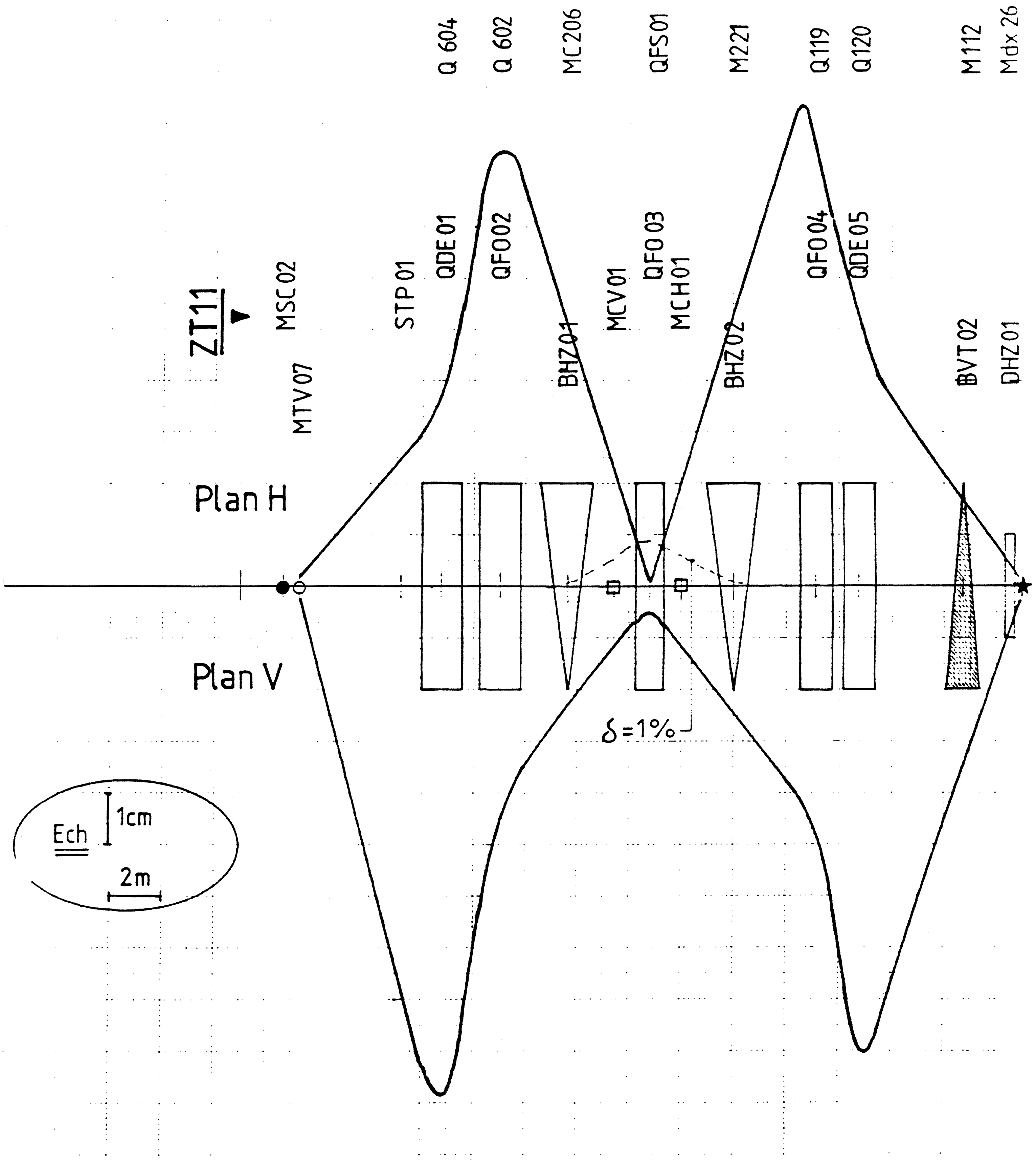


Fig. 23 : Optics of the beam t11

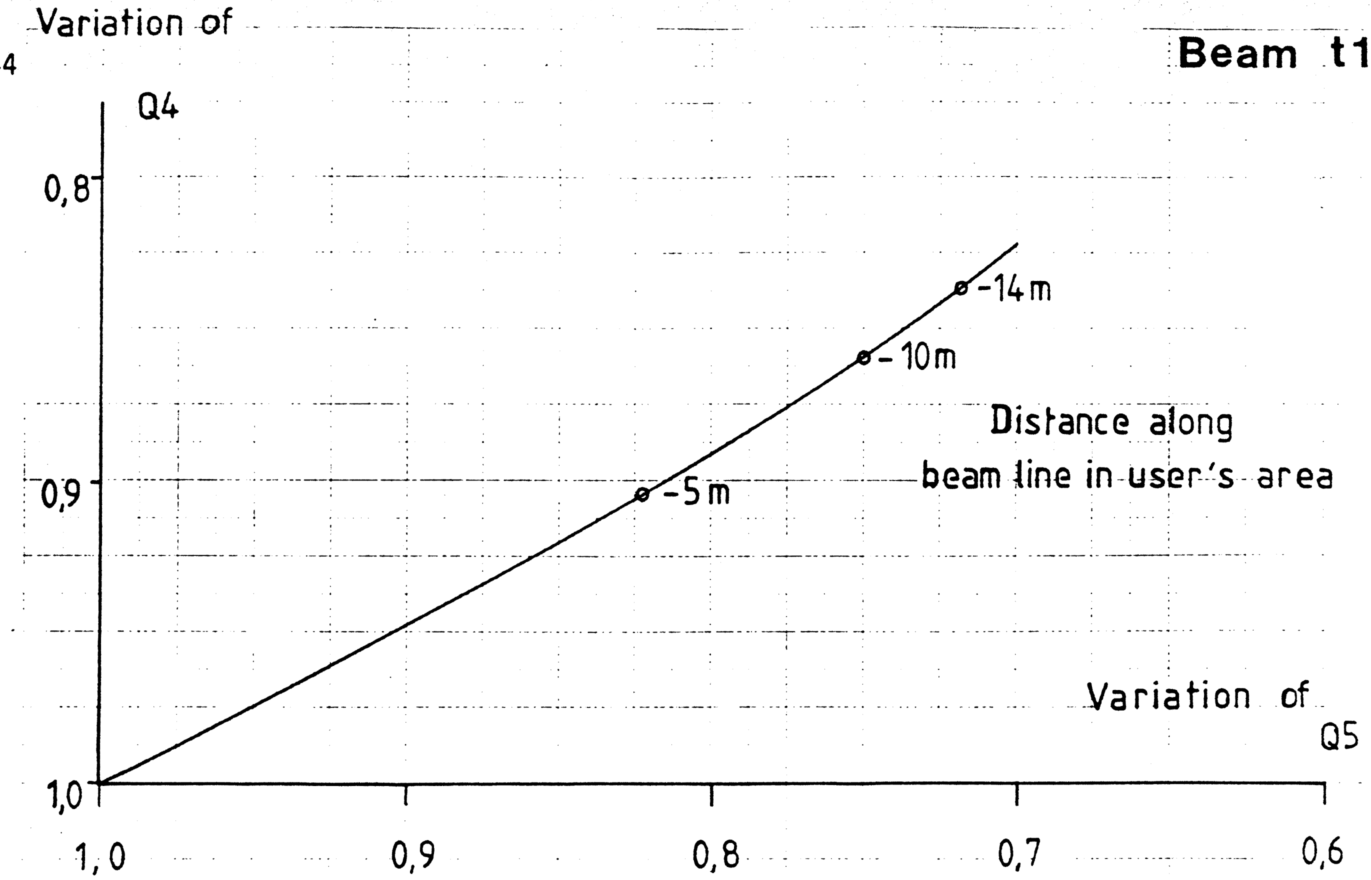


Fig. 24 _ DISPLACEMENT OF BEAM WAIST IN USER'S AREA; FACTORS FOR VARIATION OF Q4 AND Q5.

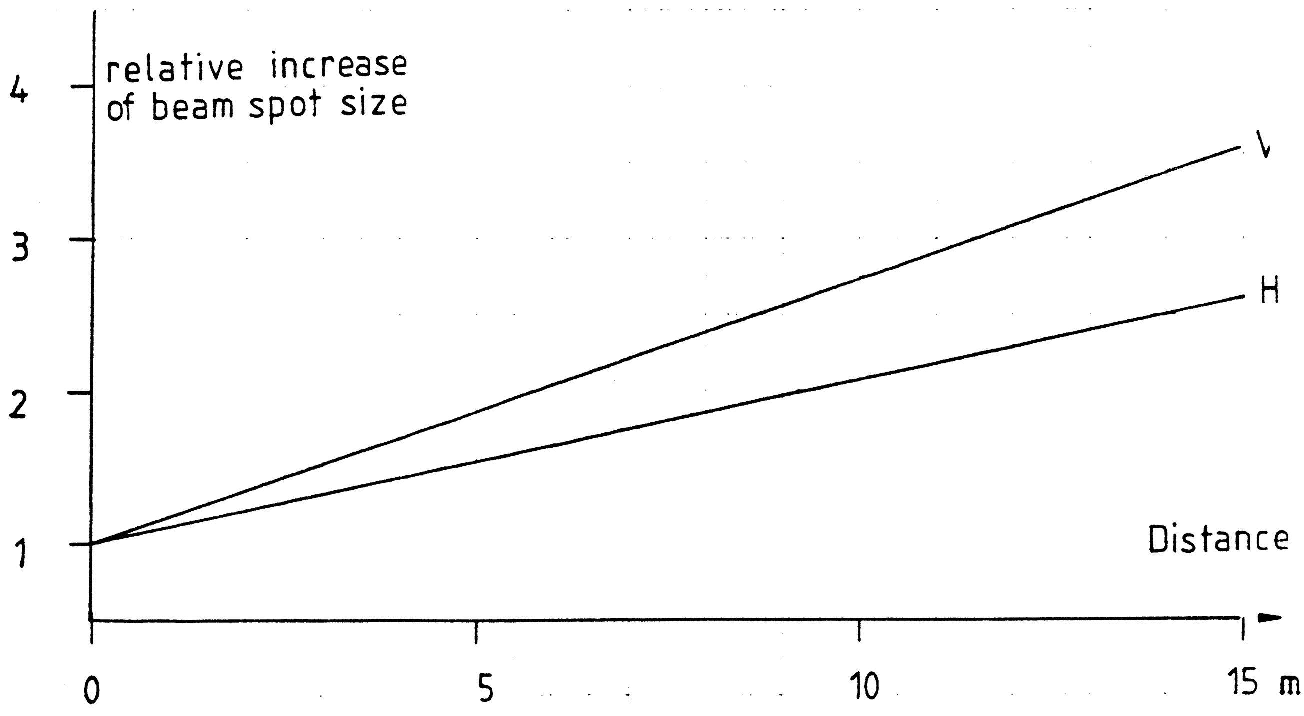


Fig. 25 _ RELATIVE INCREASE OF BEAM SPOT SIZE IN USER'S AREA. (without scattering).

Beam t11

Calculated intensity
2×10^{11} incident protons
of 24 GeV/c
Momentum bite $\frac{\Delta p}{p} = \pm 1\%$

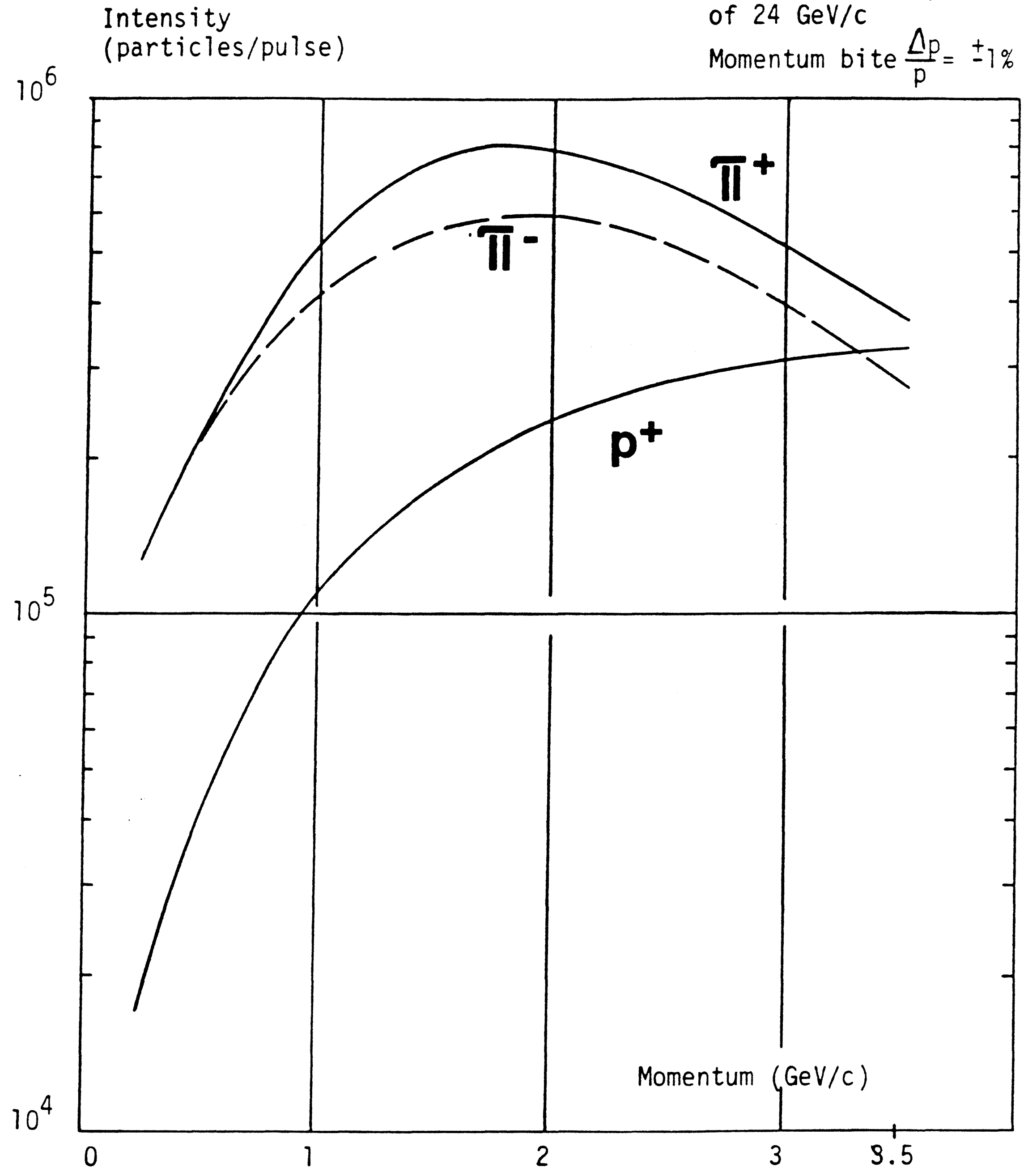


Fig.26 : Calculated intensity at the reference focus of t11.

Beam t11

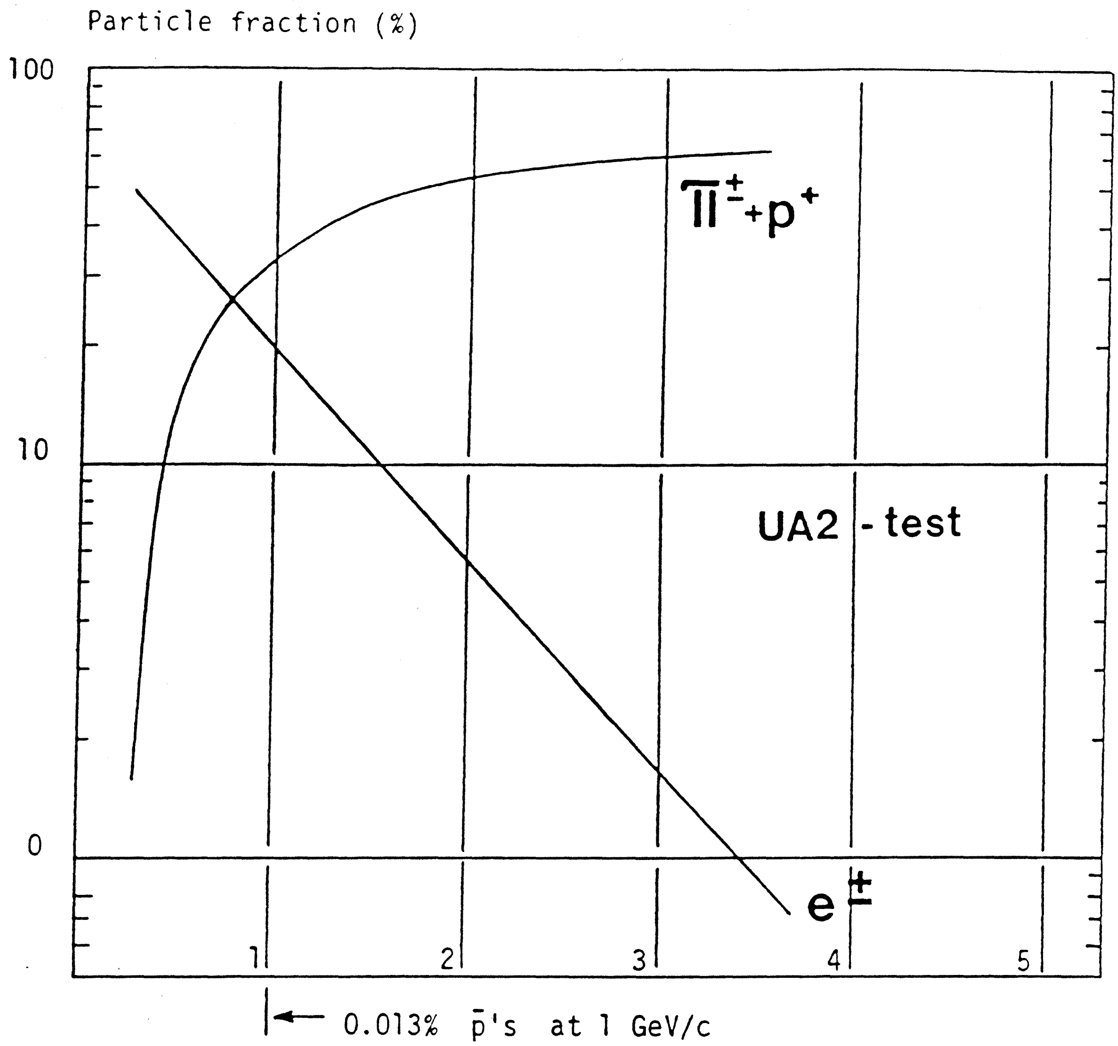


Fig.27 Observed particle fractions in the t11 beam (particle identification by 2 Čerenkov counters + 1 pre-shower detector) UA2-test (1987)