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SM/afm

# INJECTION AND EJECTION FOR THE AC MACHINE

## 1. Injection

This injection scheme is consistent with the 60° phase advance per cell and is designed to leave (at least) two straight sections free for cooling systems (Fig. 1).

Figure 2 shows the central orbit and the envelope of the injected beam for an emittance of $200\pi$ mm.mrad and a 6% momentum spread.

The kicker strength (16 mrad over 2 × 2 metres) is such that the separation between the circulating beam and the injected beam is 20 mm.

The angle of the septum with respect to the axis of the straight section is 0.4°. The deflection of the beam inside the septum is 206 mrad so that the beam clears the quadrupole QF51.

## 2. Ejection

The ejection is calculated with the same emittance in both planes: $8\pi$ mm.mrad and with a momentum spread of 5 o/oo.

The ejection kickers have exactly the same values as those of the injection kickers.

### 2.1. Horizontal ejection with septum (Fig. 5)

The limitation comes from the bending magnet B1 and not from the quadrupole QF5. For a 2 m long septum, the field must be increased to 1.4 T if the ejection uses the injection kicker.

If the ejection is made in the opposite straight section, an extra kicker is needed but its deflection can be reduced to 10 mrad.

### 2.2. Vertical ejection with Lambertson magnet (Fig. 5)

After horizontal deflection in the kicker, the beam is ejected vertically in a radial field magnet of the Lambertson type.

In this plane, the limitation is not due to the bending magnet but to the focusing quadrupole QF5. The field is then 1.5 T in the Lambertson magnet.

The cross-sections of the circulating and ejected beams at the entrance to the Lambertson magnet are drawn in Fig. 7.

## 3. Summary

3.1. Horizontal injection and vertical ejection on the same side of the machine is possible but the field in the ejection septum is high (Fig. 8).

3.2. Vertical injection and ejection with the kicker-septum method on the same side of the machine can be done (Fig. 9). The trajectories are exactly the same as shown in Figs 2 and 5; the only difference is in changing the names of the quadrupoles.

3.3. Horizontal injection and ejection with the kicker-septum method on the opposite side for injection and ejection (Fig. 10).

## 4. Preliminary conclusion

A number of injection-ejection schemes have been studied and they can be adapted to the various possible sites of the machine. However, in order to limit the number of configurations to be studied and in view of the advantages presented by the hall 181 located at the I1 intersection of the ISR, priority will be given to the scheme where injection and ejection take place in opposite straight sections (Fig. 10).

The last study (Fig. 11) shows the injection in the vertical plane for various reasons, but essentially geographical ones. On the other hand, the ejection will certainly take place in the horizontal plane.

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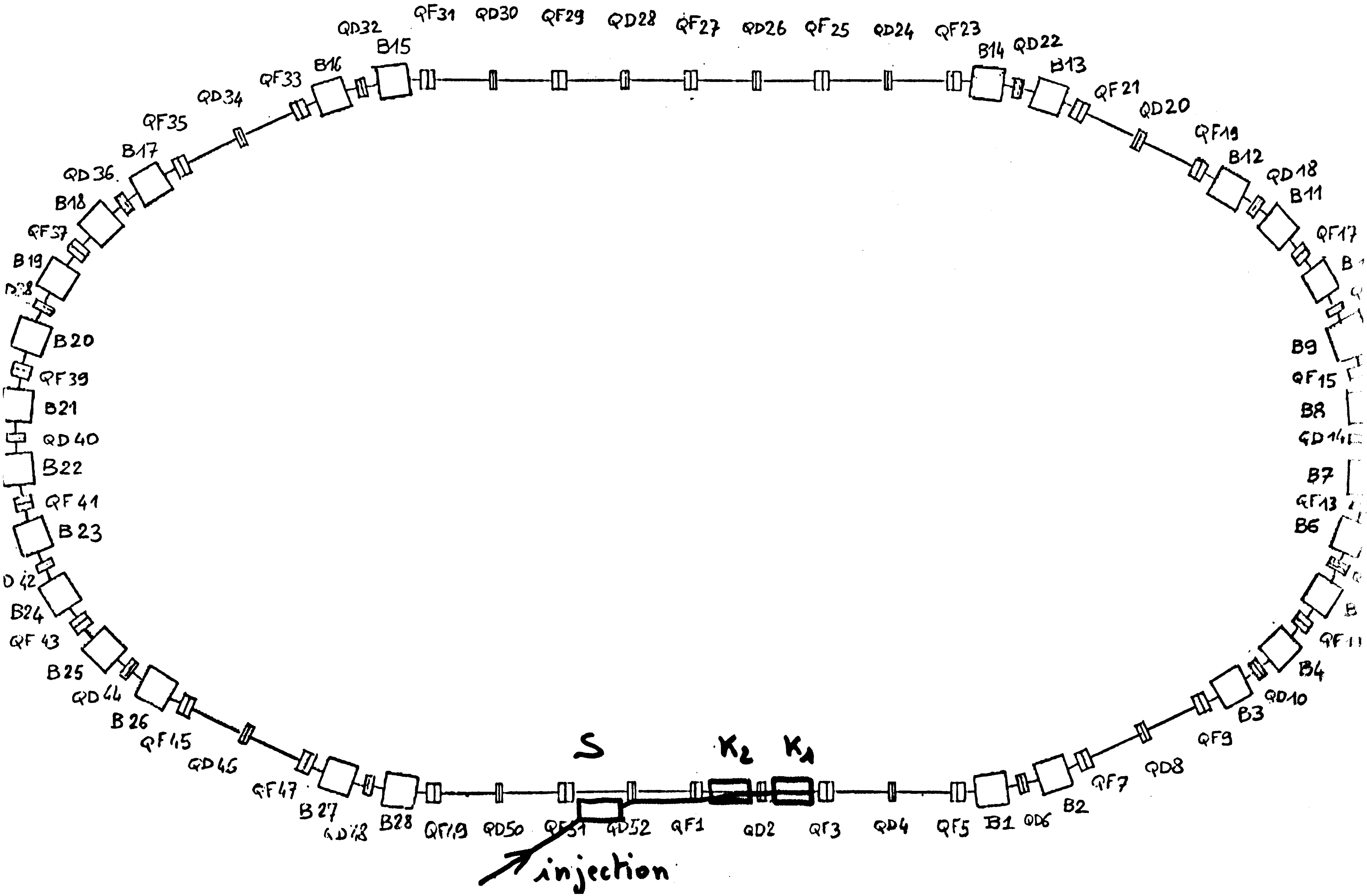
FIGURE 1


QD32
QF31
QD30
QF29
QD28
QF27
QD26
QF25
QD24
QF23
B15
B14
QD22
B13
QF21
QD20
QF19
B12
QD18
B11
QF17
B16
QF33
QD34
QF35
B17
QD36
B18
QF37
B19
B20
QF39
B21
QD40
B22
QF41
B23
B24
QF 43
B25
QD44
B26
QF45
QD46
QF47
B27
B28
QF49
QD50
QD52
QF1
QD2
QF3
QD4
QF5
B1
QD6
B2
QF7
QD8
QF9
B3
QD10
B4
B9
QF15
B8
B7
QF13
B6
S
K2
K1
injection

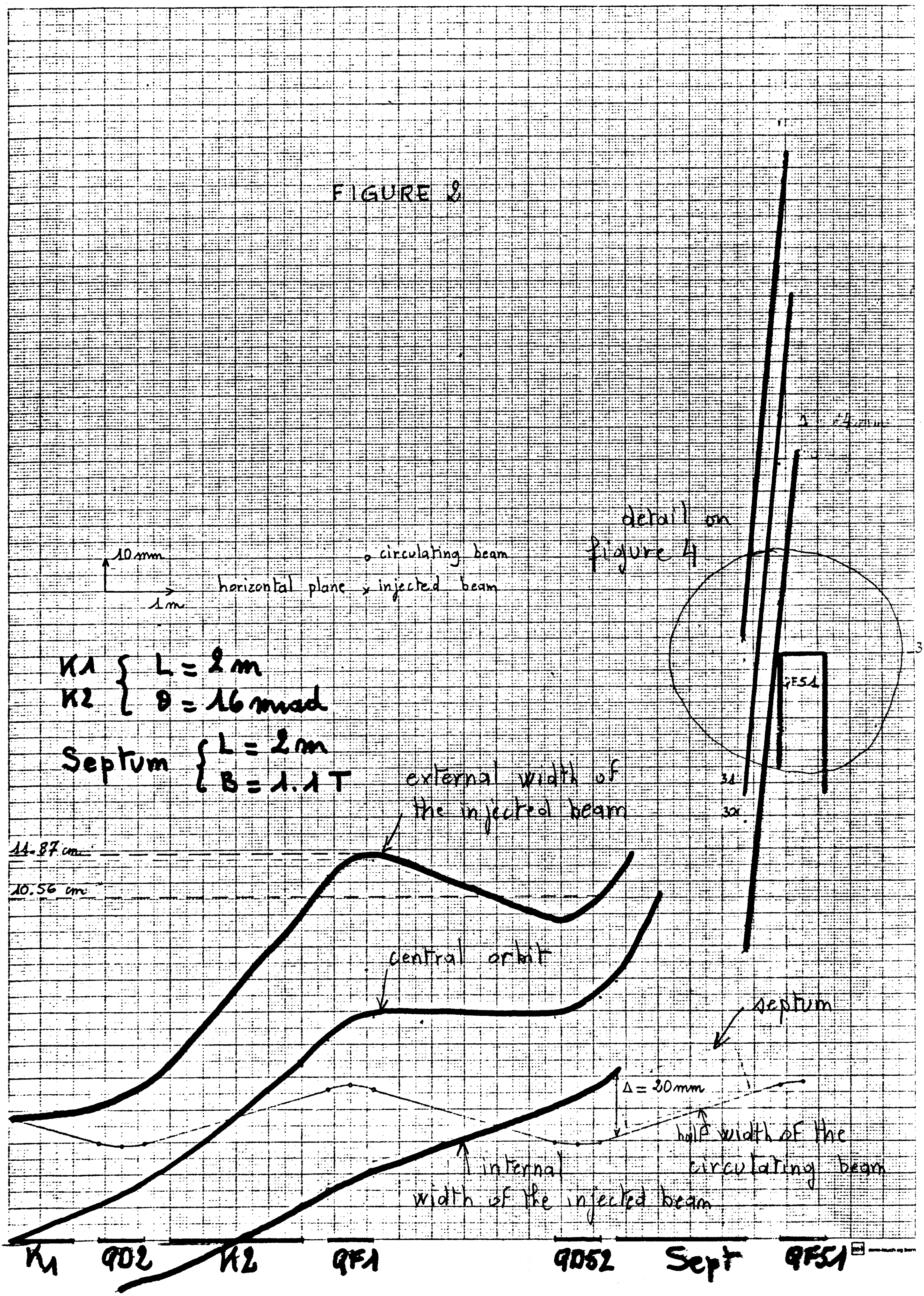

10 mm
1 m
horizontal plane
o circulating beam
x injected beam
detail on figure 4
K1 { L = 2 m
K2 { θ = 16 mrad
Septum { L = 2 m
B = 1.1 T
external width of the injected beam
11.87 cm
10.56 cm
central orbit
septum
Δ = 20 mm
half width of the circulating beam
internal width of the injected beam
QFS1
K1
QD2
K2
QF1
QDS2
Sept
QFS1

FIGURE 2

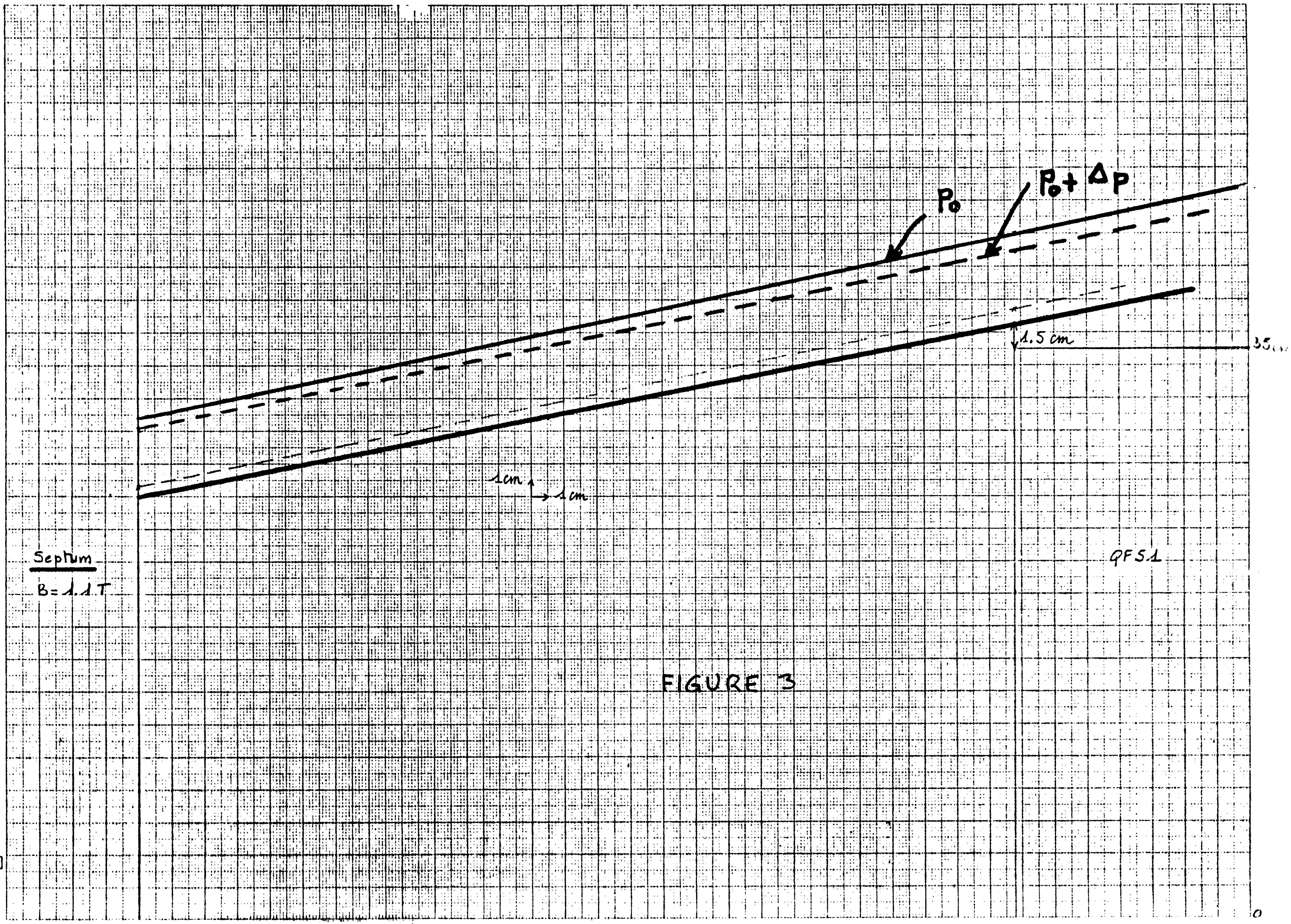
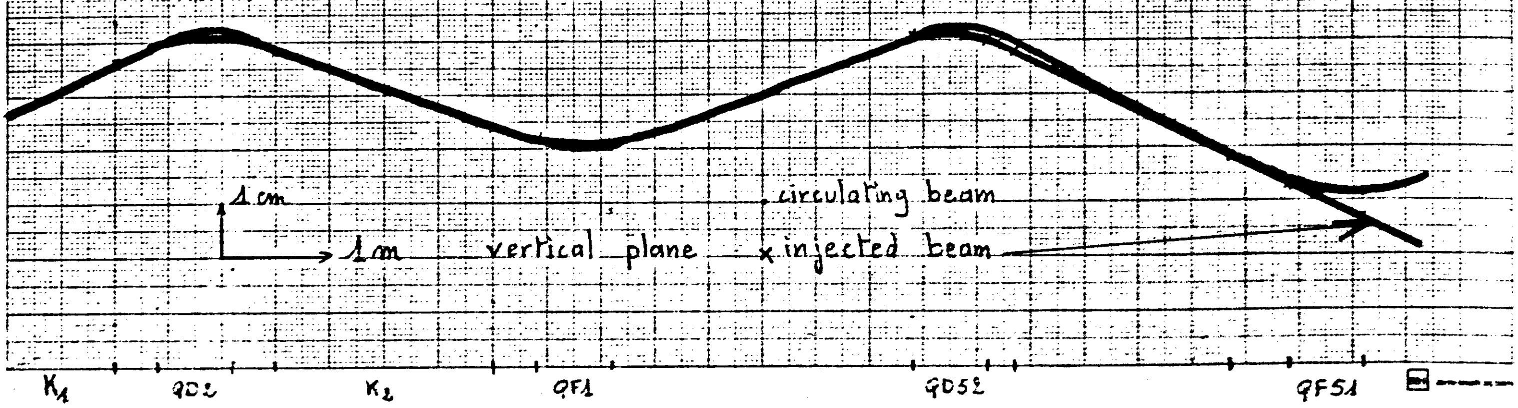



FIGURE 3

FIGURE 4



1 cm
1 m
vertical plane
circulating beam
injected beam
K1
QD2
K2
QF1
QDS2
QFS1

FIGURE 5

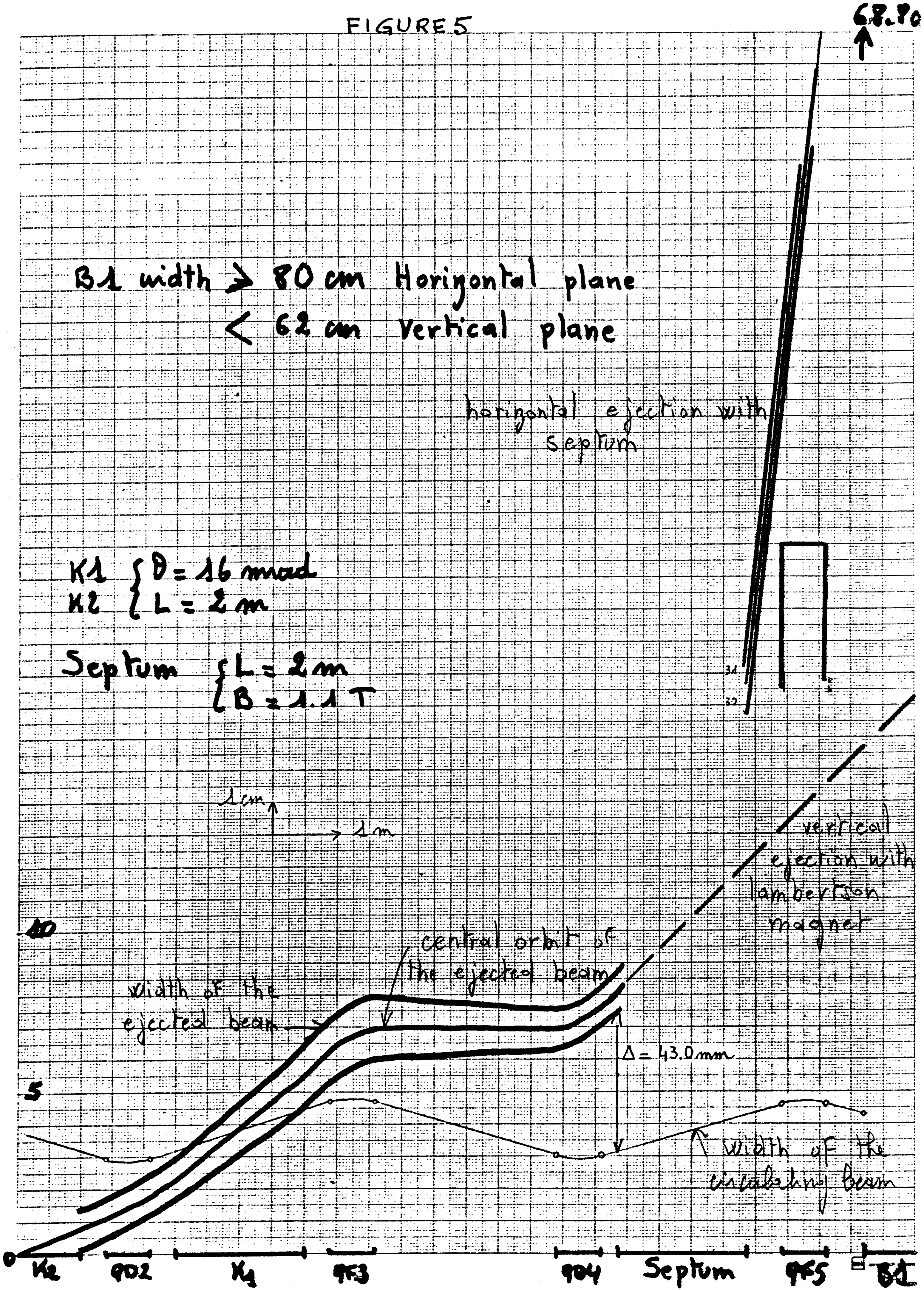
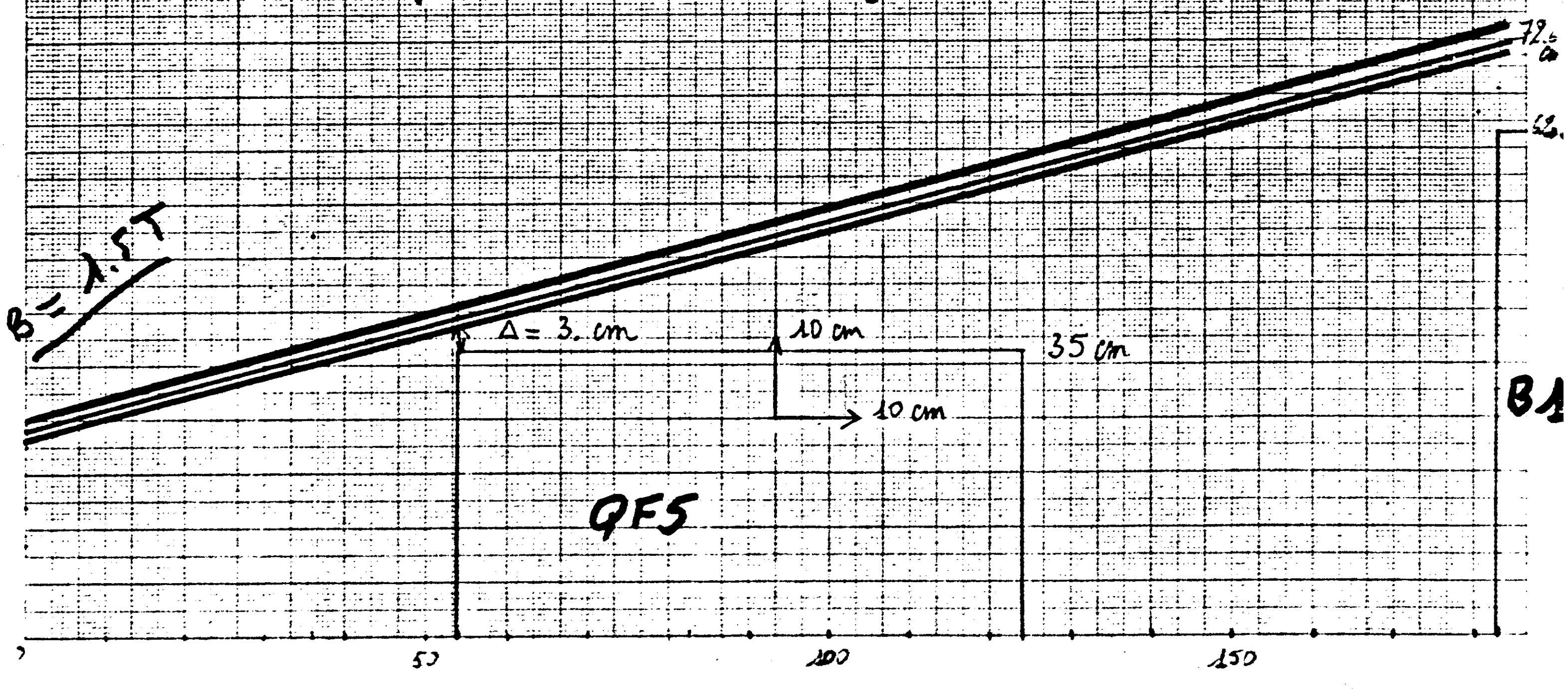

68.80
B1 width > 80 cm Horizontal plane
< 62 cm vertical plane
horizontal ejection with septum
K1 {θ = 16 mrad
K2 {L = 2 m
Septum {L = 2 m
{B = 1.1 T
1cm
1m
vertical ejection with lambertson magnet
10
central orbit of the ejected beam
width of the ejected beam
Δ = 43.0 mm
5
width of the circulating beam
0
K2
QD2
K1
QF3
QD4
Septum
QF5
B1

FIGURE 6

ejection with lambertson magnet



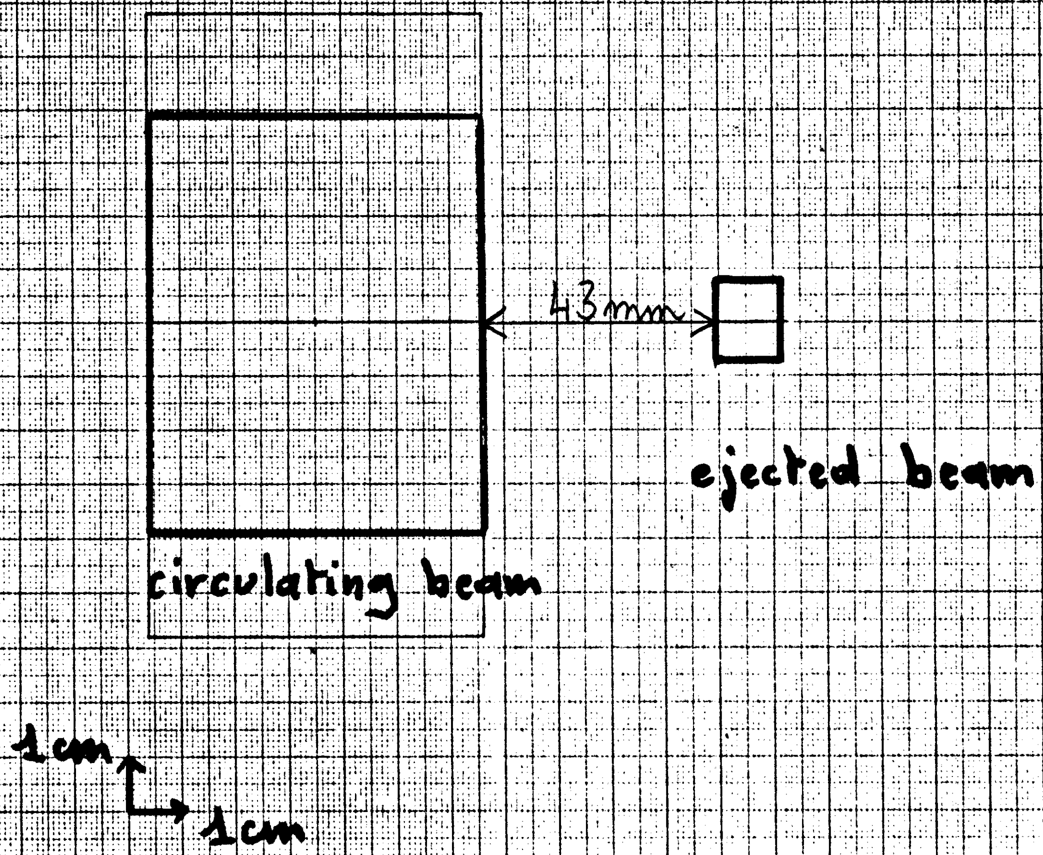
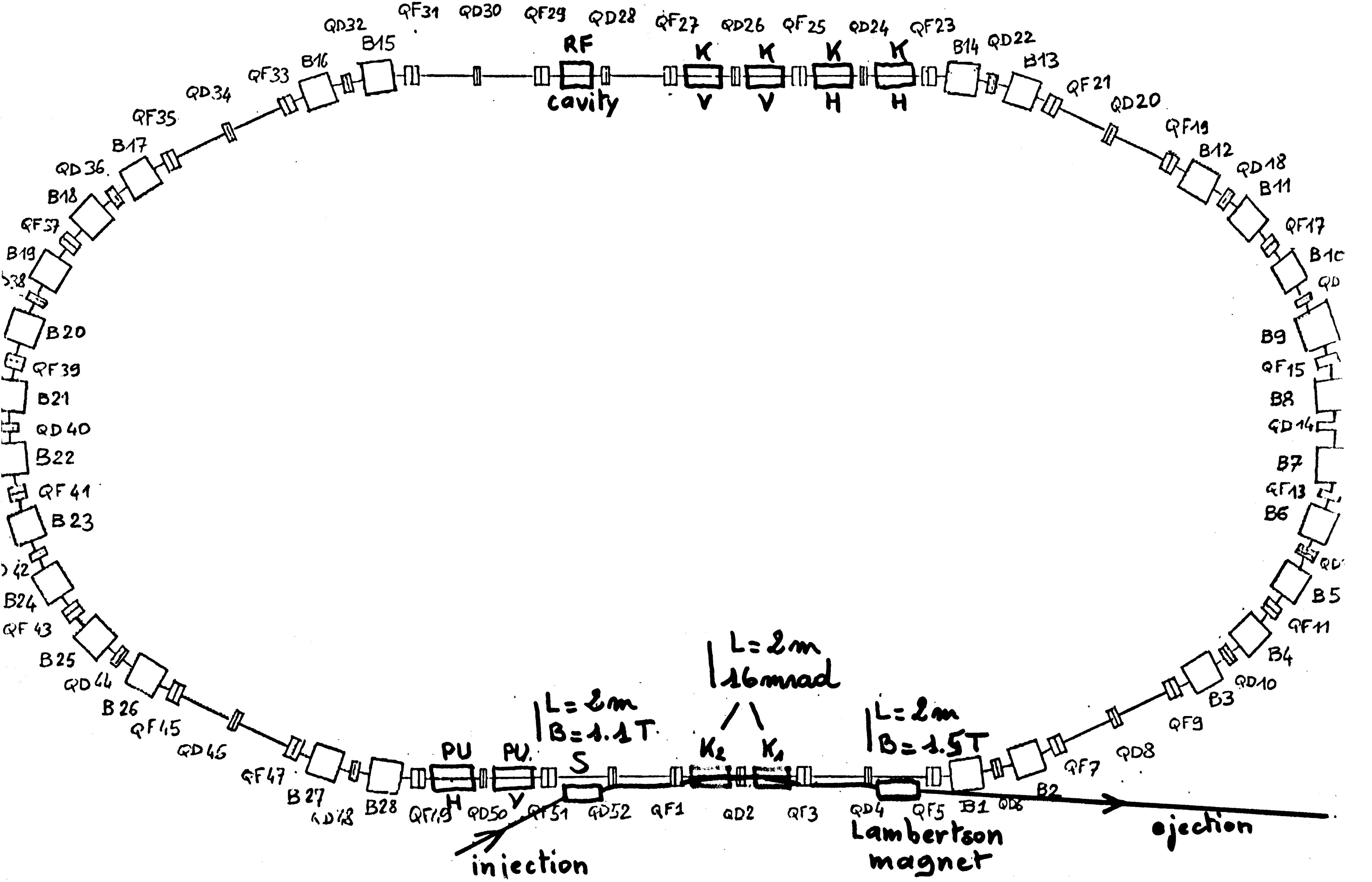



FIGURE 7

FIGURE 8



QF31
QD30
QF29
QD28
QF27
QD26
QF25
QD24
QF23
QD32
B15
RF
cavity
K
V
K
V
K
H
K
H
B14
QD22
B13
QF21
QD20
QF19
B12
QD18
B11
QF17
QF33
B16
QD34
QF35
B17
QD36
B18
QF37
B19
B20
QF39
B21
QD40
B22
QF41
B23
B24
QF43
B25
QD44
B26
QF45
QD46
QF47
B27
B28
PU
H
PU.
V
L=2m
B=1.1T
S
L=2m
16mrad
K2
K1
L=2m
B=1.5T
QD50
QD52
QF1
QD2
QF3
QD4
QF5
B1
B2
QF7
QD8
QF9
B3
QD10
B4
QF11
B5
B6
QF13
B7
QD14
B8
QF15
B9
injection
Lambertson
magnet
ejection

FIGURE 9

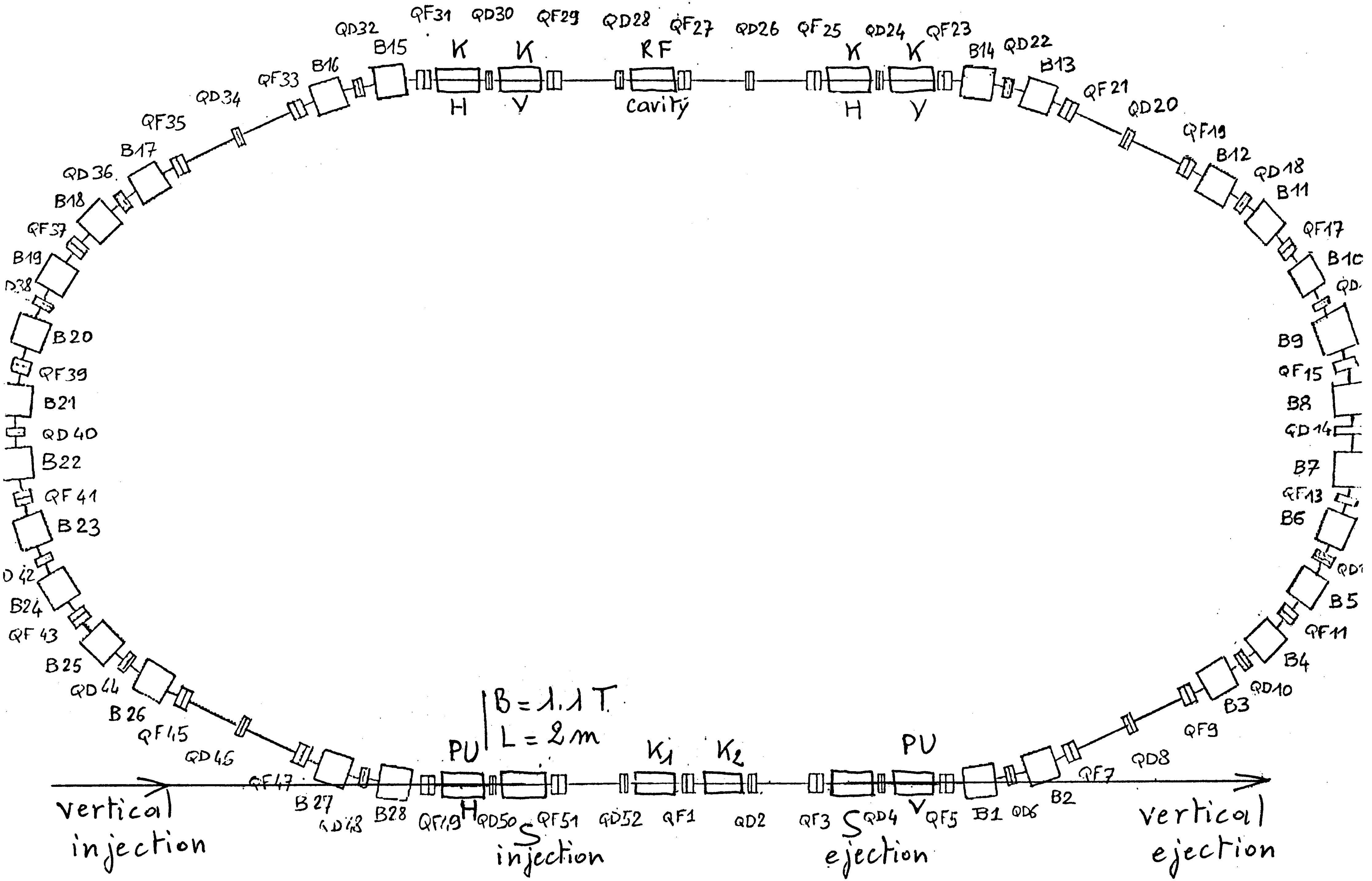

QD32
QF31
QD30
QF29
QD28
QF27
QD26
QF25
QD24
QF23
B15
K
K
RF
K
K
B14
QD22
B13
H
V
cavity
H
V
QF21
QD20
QF19
B12
QD18
B11
QF17
B9
QF15
B8
QD14
B7
QF13
B6
B5
QF11
B4
QD10
B3
QF9
QD8
QF7
B2
QD34
QF33
B16
QF35
B17
QD36
B18
QF37
B19
B20
QF39
B21
QD40
B22
QF41
B23
B24
QF43
B25
QD44
B26
QF45
QD46
QF47
B27
B28
B = 1.1 T.
L = 2 m
PU
H
QD50
QF51
QD52
K1
QF1
K2
QD2
QF3
QD4
PU
V
QF5
B1
QD6
vertical injection
injection
ejection
vertical ejection

FIGURE 10

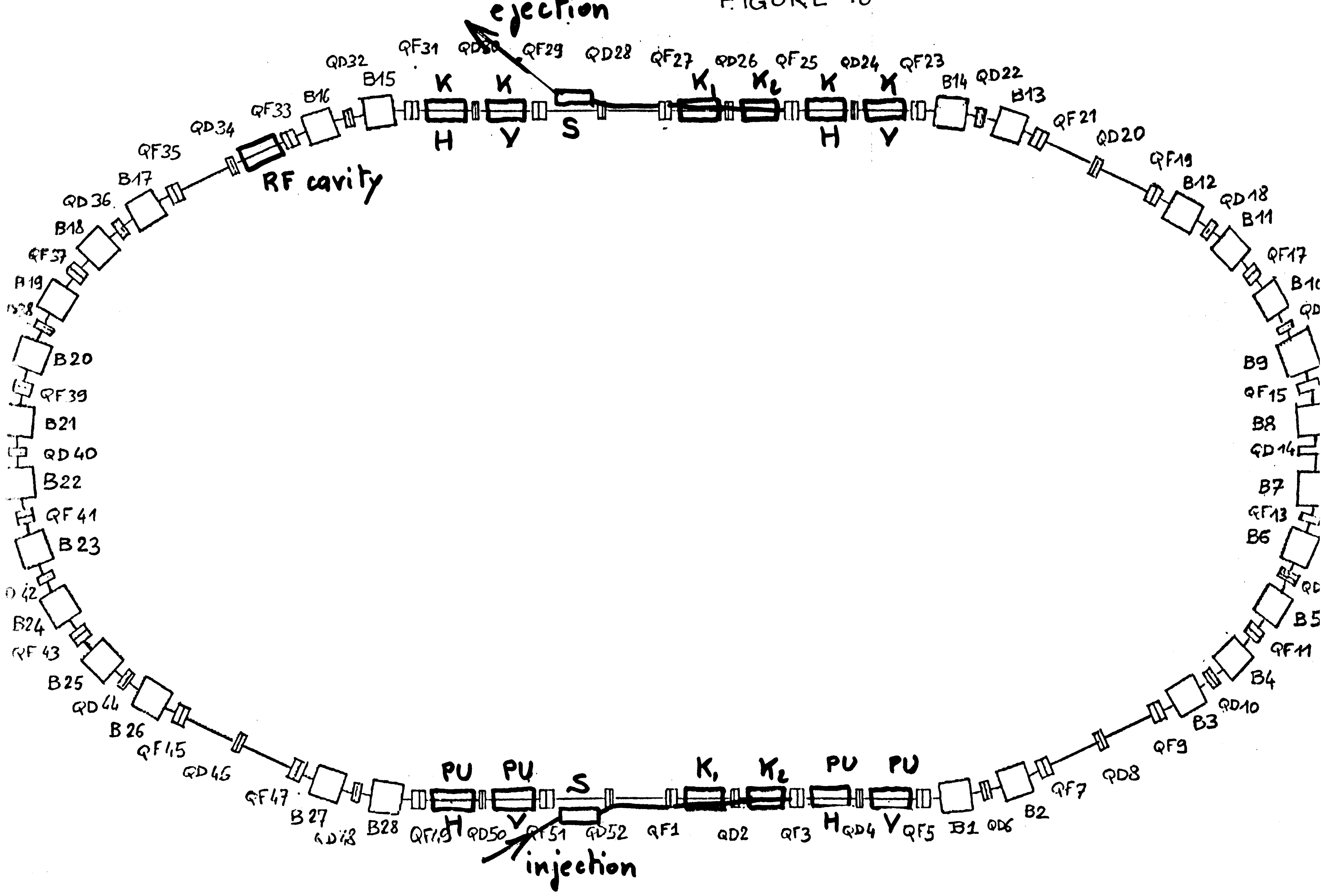

ejection
injection
RF cavity
QF31
QD30
QF29
QD28
QF27
QD26
QF25
QD24
QF23
QD32
B15
B16
QF33
QD34
QF35
B17
QD36
B18
QF37
B19
B20
QF39
B21
QD40
B22
QF41
B23
B24
QF43
B25
QD44
B26
QF45
QD46
QF47
B27
B28
QD50
QF51
QD52
QF1
QD2
QF3
QD4
QF5
B1
QD6
B2
QF7
QD8
QF9
B3
QD10
B4
QF11
B5
B6
QF13
B7
QD14
B8
QF15
B9
QF17
B11
QD18
B12
QF19
QD20
QF21
B13
QD22
B14
K
H
V
S
K1
K2
PU

FIGURE II

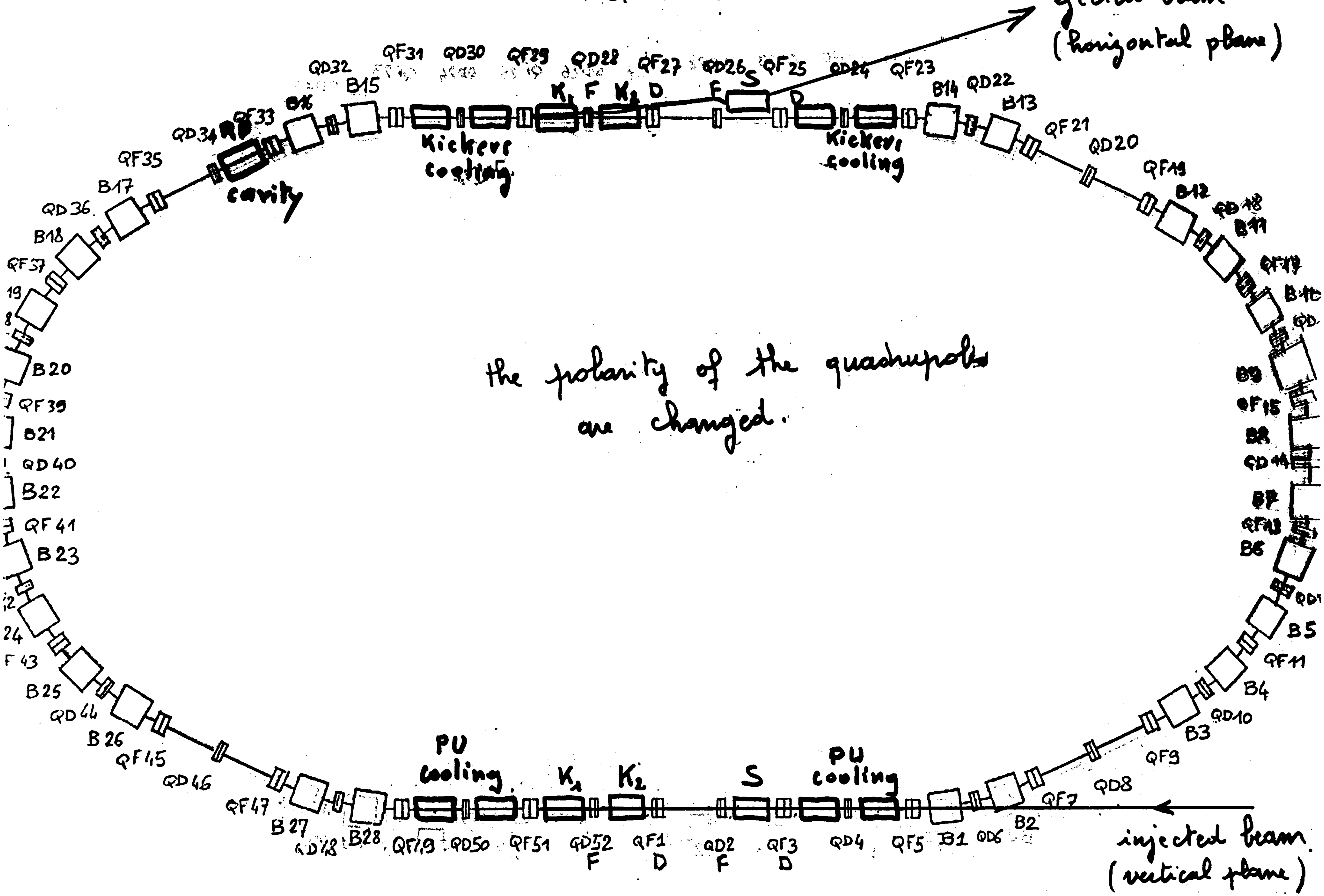

ejected beam
(horizontal plane)
injected beam
(vertical plane)
the polarity of the quadrupoles
are changed.
Kickers cooling
Kickers cooling
PU cooling
PU cooling
cavity
K1 F K2 D
F S
D
K1 K2
S
QF31 QD30 QF29 QD28 QF27 QD26 QF25 QD24 QF23
QD32 B15 QF33 QD34 QF35 B17 QD36 B18 QF37
B20 QF39 B21 QD40 B22 QF41 B23
B25 QD44 B26 QF45 QD46 QF47 B27 B28
QF49 QD50 QF51 QD52 QF1 QD2 QF3 QD4 QF5 B1 QD6 B2 QF7 QD8 QF9 B3 QD10 B4 QF11 B5
F D F D
B14 QD22 B13 QF21 QD20 QF19 B12 QD18 B11 QF17
B9 QF15 B8 B7 B6

TABLE 1

$\varepsilon_H = \varepsilon_V = 200\,\pi$ mm mrad $\quad x = \sqrt{\beta_H \varepsilon_H} \quad \frac{\Delta p}{p} = \pm 3\% \quad y = \sqrt{\beta_V \varepsilon_V}$

| | | x (cm) | $\alpha_p \frac{\Delta p}{p}$ (cm) | ΔR (cm) | y (cm) |
|---|---|---|---|---|---|
| Septum | IN | 4.17 | .639 | 30.79 | 3.83 |
| | OUT | 3.02 | .054 | 8.16 | 5.77 |
| QDS2 | IN | 2.90 | .050 | 7.65 | 6.0[illegible] |
| | OUT | 2.91 | .065 | 6.96 | 6.1[illegible] |
| QF1 | IN | 4.64 | .233 | 7.00 | 4.1[illegible] |
| | OUT | 4.64 | .228 | 6.29 | 4.16 |
| K2 | IN | 4.37 | .20 | 5.50 | 4.41 |
| | OUT | 3.16 | .078 | 2.28 | 5.79 |
| QD2 | IN | 2.96 | .059 | 1.91 | 6.07 |
| | OUT | 2.97 | .033 | 1.12 | 5.97 |
| K1 | IN | 3.17 | .02 | .8 | 5.5[illegible] |
| | OUT | 4.43 | .0 | 0 | 3.65 |

**injected beam direction**

ΔR is the distance between the central orbits of the circulating beam and injected beam.

# TABLE 2

$\varepsilon_H = \varepsilon_V = 8\pi$ mm mrad

$x = \sqrt{\beta_H \varepsilon_H}$ $\quad \frac{\Delta p}{p} = \pm 2.5‰$ $\quad y = \sqrt{\beta_V \varepsilon}$

| | | $x$ (cm) | $\alpha_p \frac{\Delta p}{p}$ (cm) | $\Delta R$ (cm) | $y$ (cm |
|---|---|---|---|---|---|
| K1 | IN | .875 | 0 | 30.79 | .88 |
| | OUT | .63 | 0 | 8.16 | 1.16 |
| QD2 | IN | .59 | .003 | 7.65 | 1.2 |
| | OUT | .59 | .005 | 6.96 | 1.1 |
| K2 | IN | .64 | .006 | 7.00 | 1.1 |
| | OUT | .89 | .017 | 6.29 | .73 |
| QF3 | IN | .94 | .019 | 5.50 | .66 |
| | OUT | .94 | .019 | 2.28 | .6 |
| QD4 | IN | .59 | .005 | 1.81 | .79 |
| | OUT | .59 | .004 | 1.12 | .78 |
| Septum | IN | .61 | .004 | .8 | .75 |
| | OUT | .84 | .053 | 0 | .54 |

ejected beam direction