6 - 01 - 1984

ACOL magnets summary

L. Rinolfi

Dipoles (BH)

A proposal has been made, in order to solve the problem of special dipole BHS 24. (see corresponding paper). This solution, which needs 2 types of dipoles (BHN and BHW) (see fig. 2 and 3), keeps the field symmetry in the machine, avoids the building of special magnet, simplifies the injection process, facilitates the ejection process and reduces the total cost. Table 1 gives the characteristics.

Decisions

1) R. Sherwood will check that aperture is enough for ejected beam in the dipole.
2) S. Maury will check that this solution works properly for injected beam. He will look the possibility to remove a dipole in the injection line and tell the maximum width of a BHN acceptable in this case.
3) L. Rinolfi will study the possibility to build 8 or 16 BHN according to the previous results
4) No prototypes (BHN or BHW) will be built.

Narrow quadrupoles (QN)

In order to get enough aperture for injected and ejected beam, a proposal has been made to increase the inscribed radius to 100 mm instead of 98.4 mm. (see fig 4). The consequences on the magnets have been accepted. Table 2 gives the characteristics

Decisions

1) No sextupoles for chromaticity corrections
2) No sextupoles in profile for stop-bands corrections except perhaps at the ends.
3) Do not build any prototype.
4) 3D calculations as soon as possible for pole profile corrections (dodecapole)
5) H. Jones will modify 3 drawings in the specification and M. Harold will check that the magnetic field remains good in the required region.

Wide quadrupoles (QW)

M Harold proposed a reduction of K(max) to avoid saturation problems.

The new value is $K = -0,539\ m^{-2}$ instead of $-0,55\ m^{-2}$. (see fig 5 and table 2)

Decisions

1) W Hardt is looking the matching of the optic with this new requirement
2) Build a prototype to optimize the multipoles for chromaticity corrections (prototype where K is maximum).
3) No P.U's in QFW8 plus 7 similar quads symmetrically if sextupoles are included in the profile
4) Keep as "reserve solution" the possibility to put QW at the places where we have semi-quadrupoles (QS).

Semi-quadrupoles (QS)

Some 3D calculations have been made at RAL; results seem good if we use "clamp plates" at both ends.

However M. Harold proposes to reduce the inscribed radius from 132 mm to 120 mm. If same coils are used as in the QW, we can accept a $K = -0,659 \; m^{-2}$ instead of $K = -0,545 \; m^{-2}$. Thus overall length might stay as initially proposed for simplest semi-quad. (see fig. 6 and table 2)

Decisions

1) No P.U.'s will be used in these magnets
2) No sextupoles in profile for chromaticity correction
3) R. Sherwood will check that the aperture is large enough in QDS 53 for ejected beam.
4) Build one prototype.
5) All shimmings will be made in the laboratory; nothing in the machine.
6) W. Hardt will look at effect of increased strength.

Super semi - quadrupole (QSS 54) [for injection]

Figure 7 shows the profile according to the circulating and injected beams

Decisions

1) L Rinolfi will check with A Poncet the maximum of thickness for such vacuum chamber.

2) W. Hardt will study the consequences on the optics if only this one has a strength $K_{(max)} = -0{,}42\ m^{-2}$ with a effective length of 0,91 m ie

$$\int_{QSS54} G\,dl \equiv \int_{QS} G\,dl$$

3) When results will be avalaible, implications of extra length on septa will be studied

Sextupoles

Table 3 shows in line 202 the present sextupole components in order to get chromaticity equal to zero.

However line 205 shows a situation where all sextupole components are remove from all magnets and instead special sextupole magnets are used in the missing magnet straight sections. A rough evalution gives a $B \times \ell \sim 0{,}16$ T.m for the K(max) which is not a large value for iron core sextupole magnets.

Decisions

1) Keep this solution as reserve

2) B. Autin will ask Z. Guo to do some investigations for resonances aspects.

3) Z. Guo will calculate the strenght of special sextupole magnets with sextupoles in dipoles only (case 206)

4) Z. Guo will study stability in case 202, 205 and 206.

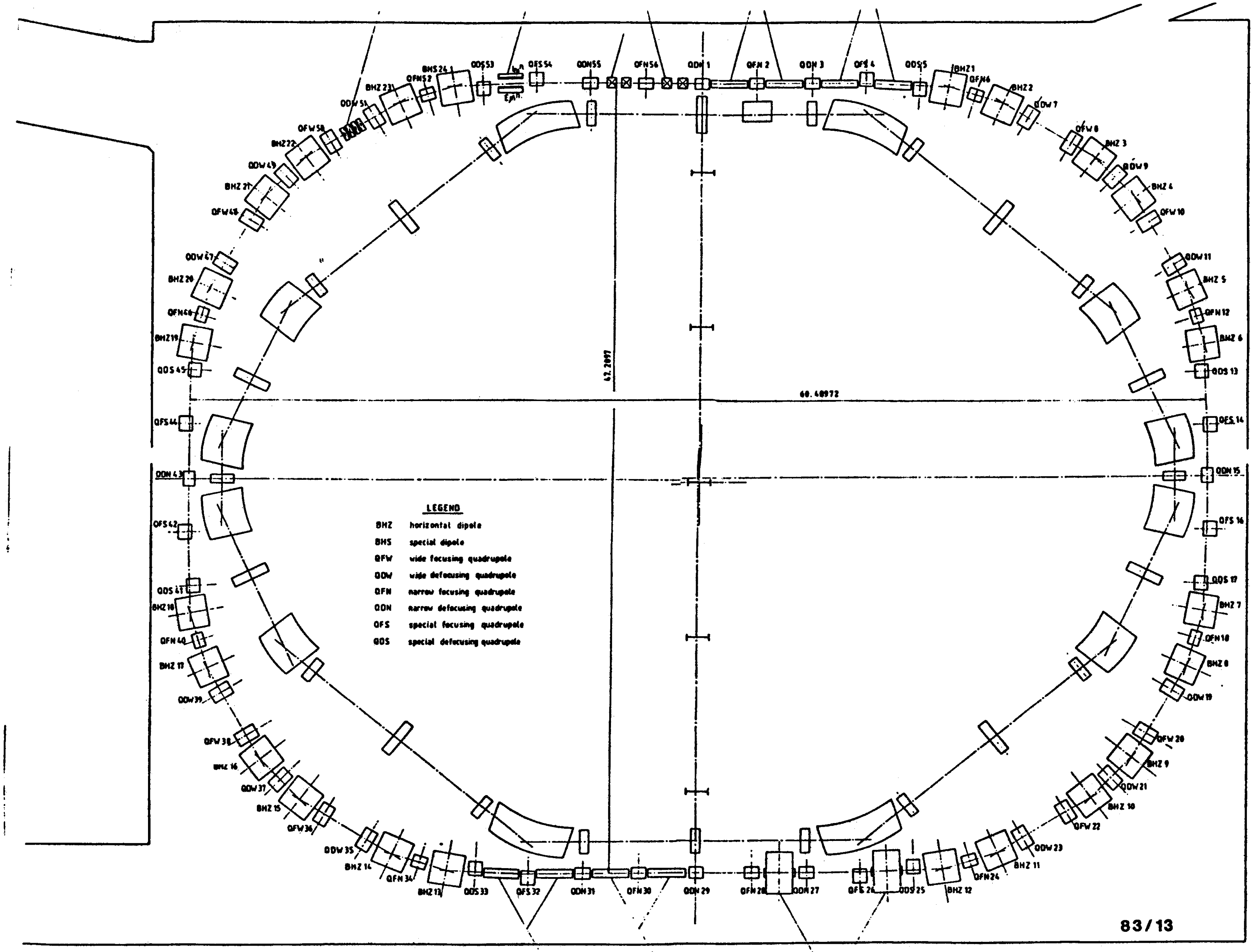
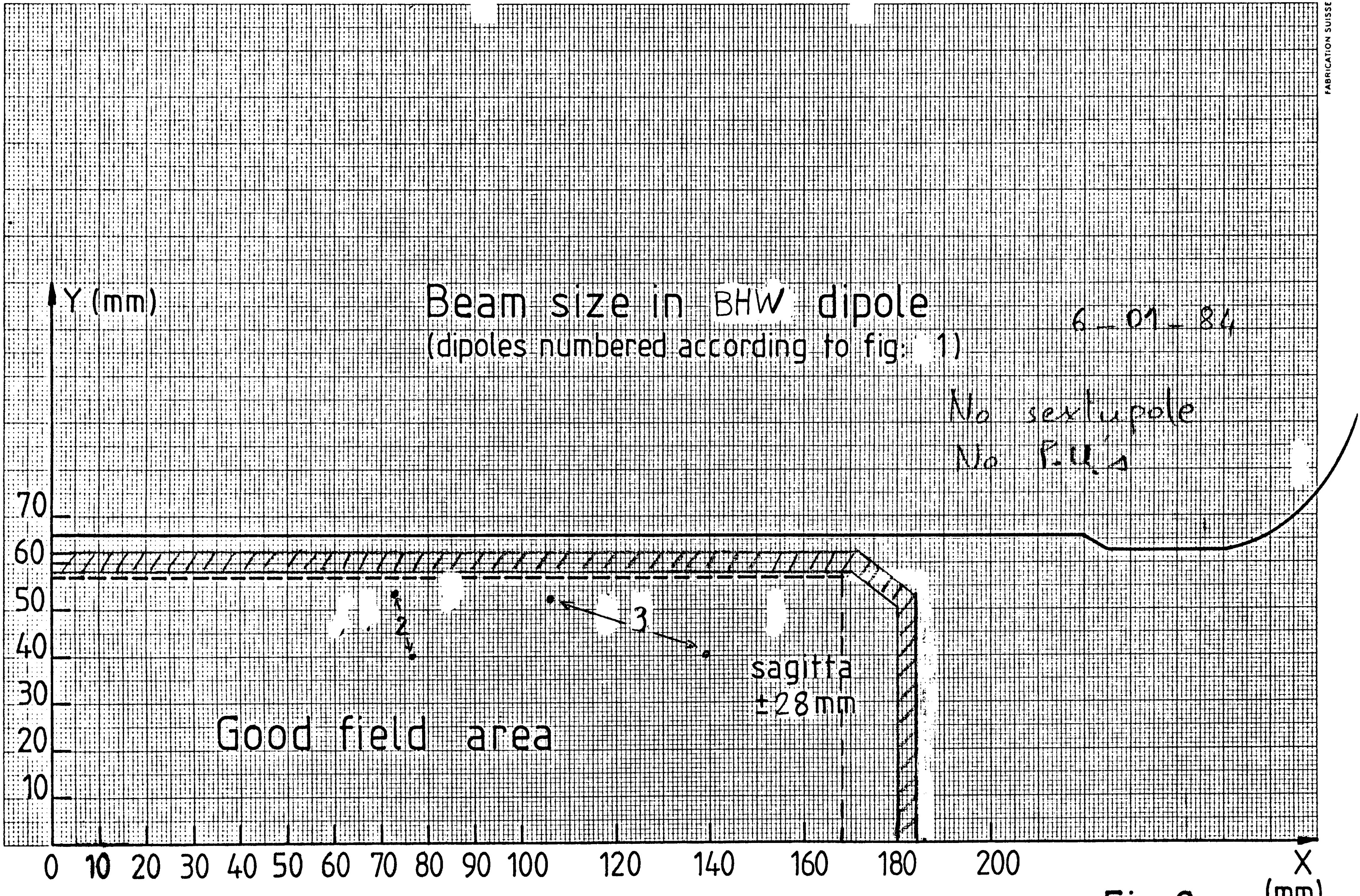

LEGEND
BHZ horizontal dipole
BHS special dipole
QFW wide focusing quadrupole
QDW wide defocusing quadrupole
QFN narrow focusing quadrupole
QDN narrow defocusing quadrupole
QFS special focusing quadrupole
QDS special defocusing quadrupole
60.40972
42.2897
83/13

Fig 1



Beam size in BHW dipole
(dipoles numbered according to fig: 1)
6-01-84
No sextupole
No P.U.'s
Y (mm)
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
X (mm)
2
3
sagitta
±28mm
Good field area
FABRICATION SUISSE

Fig. 2

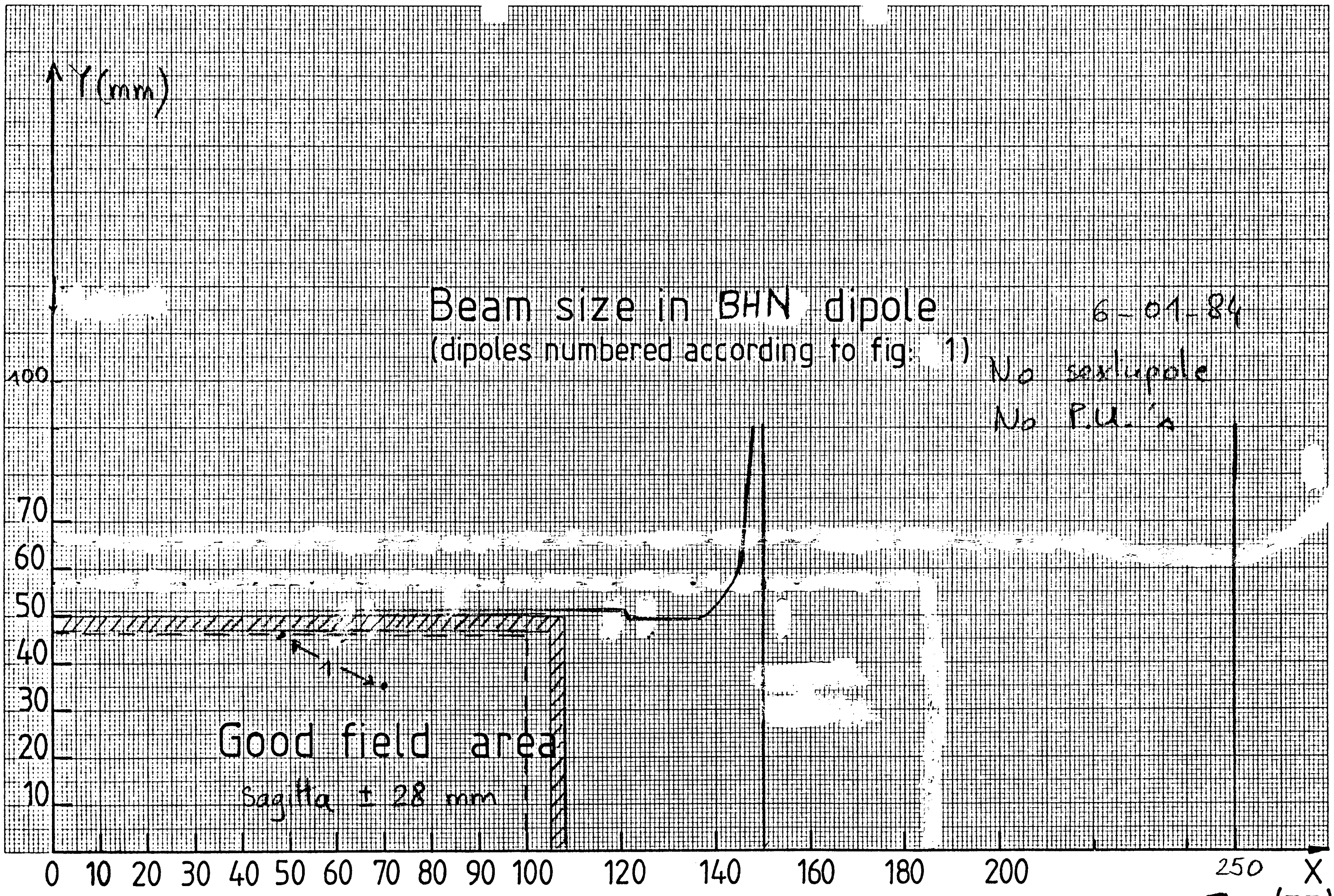
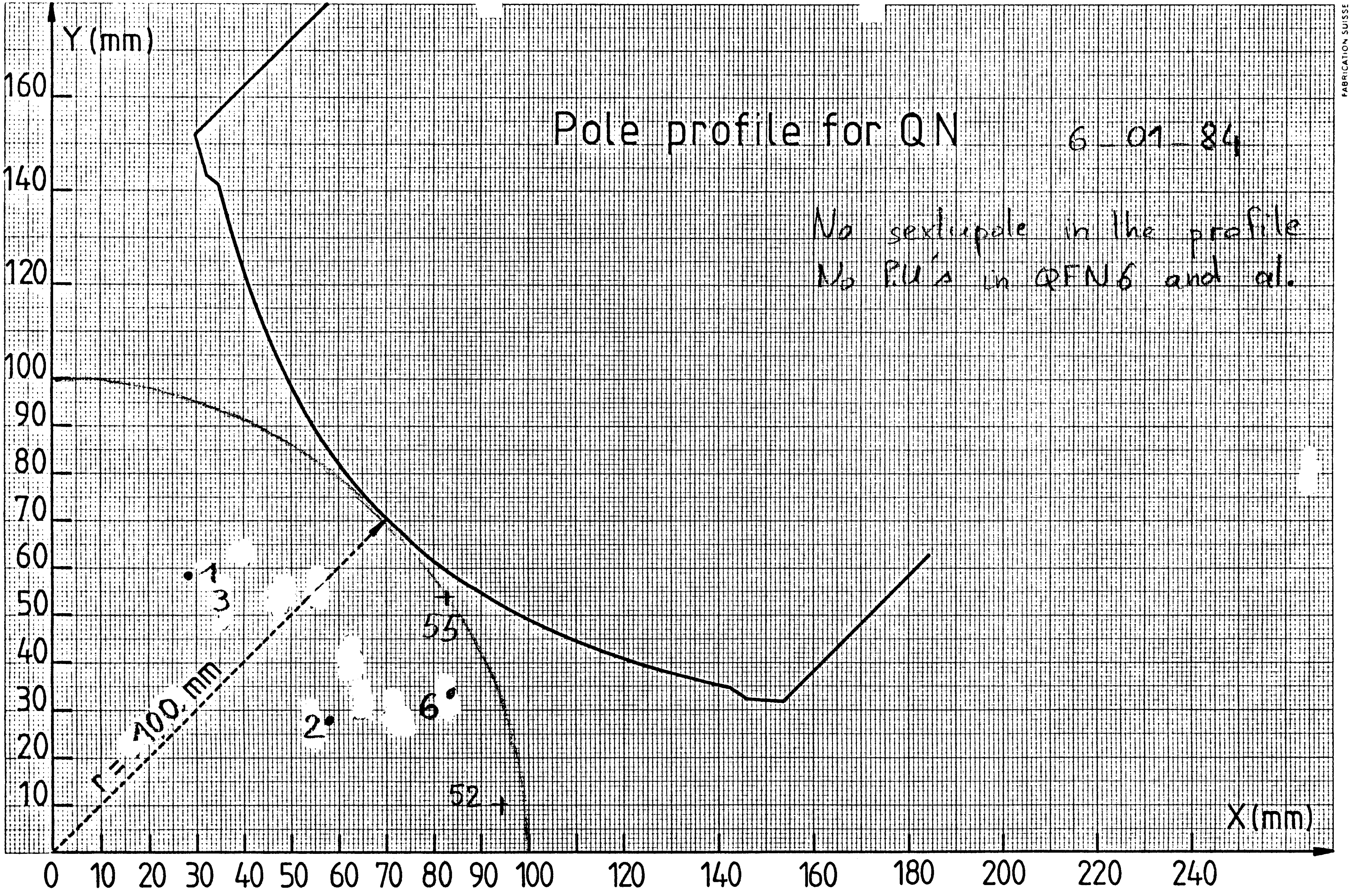

Beam size in BHN dipole
(dipoles numbered according to fig. 1)
6-01-84
No sextupole
No P.U.'s
Y (mm)
X (mm)
Good field area
Sagitta ± 28 mm
0 10 20 30 40 50 60 70 80 90 100 120 140 160 180 200 250
10 20 30 40 50 60 70 100
FABRICATION SUISSE

Fig. 3



Pole profile for QN
6_01_84
No sextupole in the profile
No P.U's in QFN6 and al.
Y (mm)
X(mm)
r = 100 mm
1
2
3
6
55
52
0
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
220
240
FABRICATION SUISSE

Fig. 4

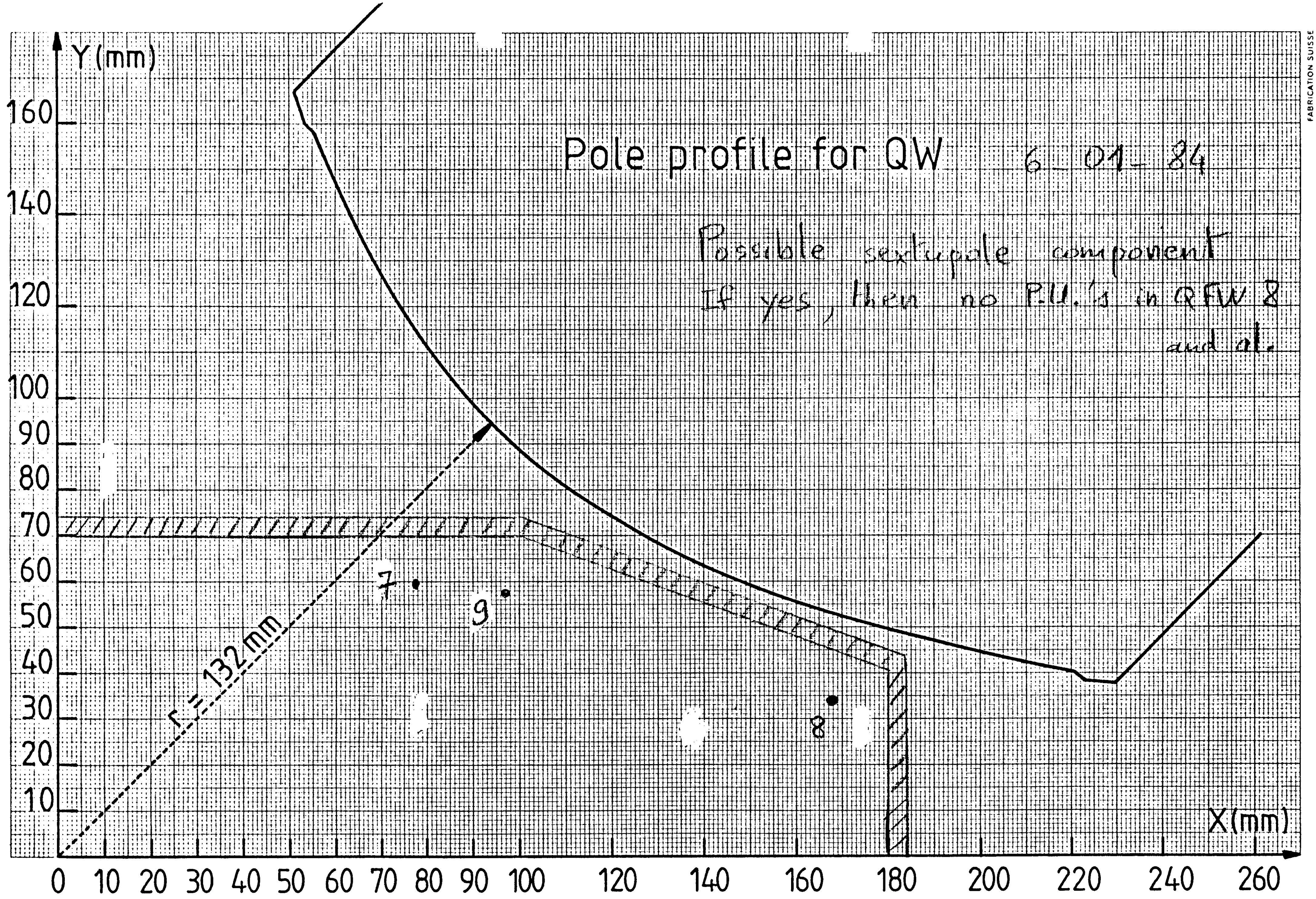
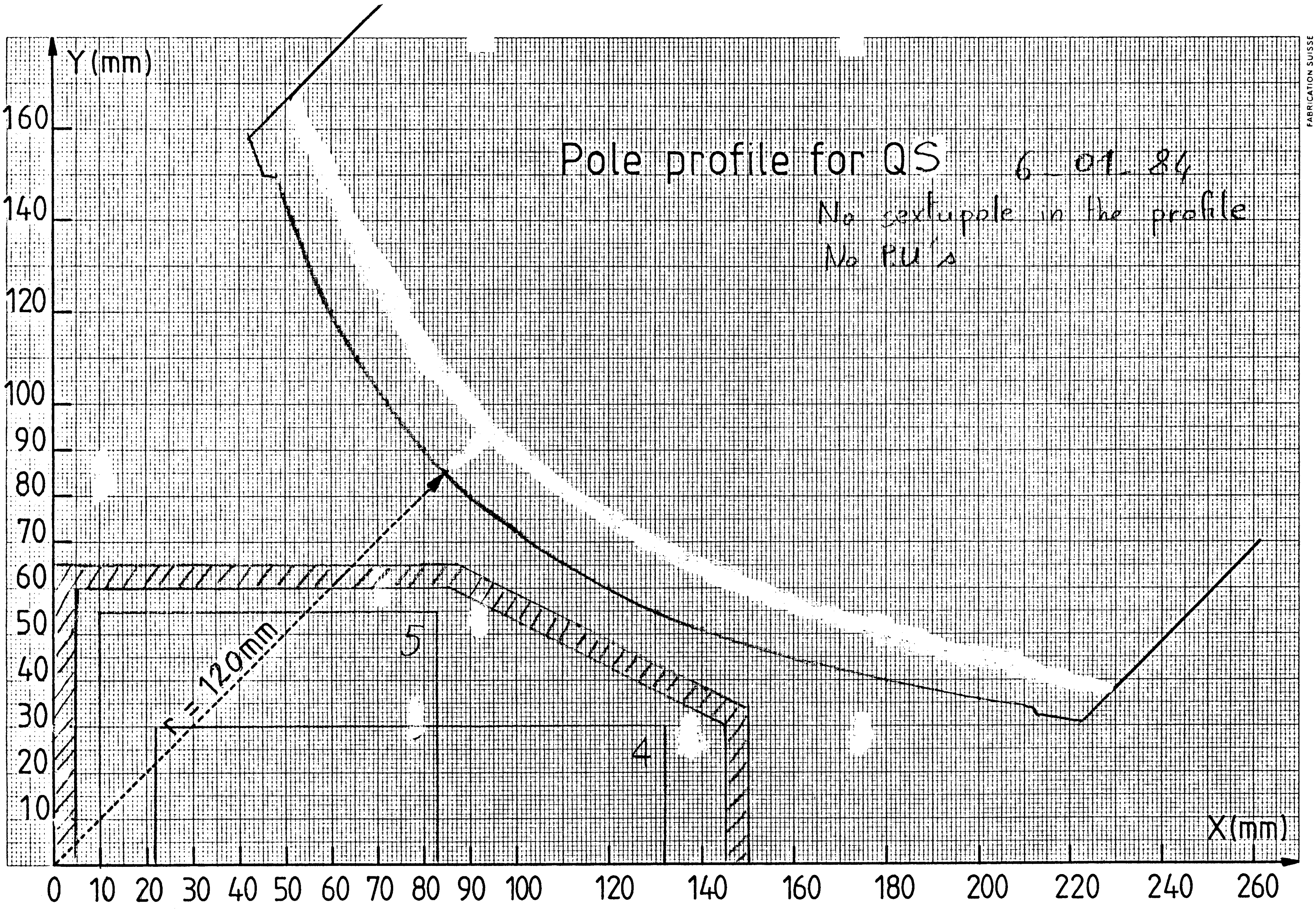
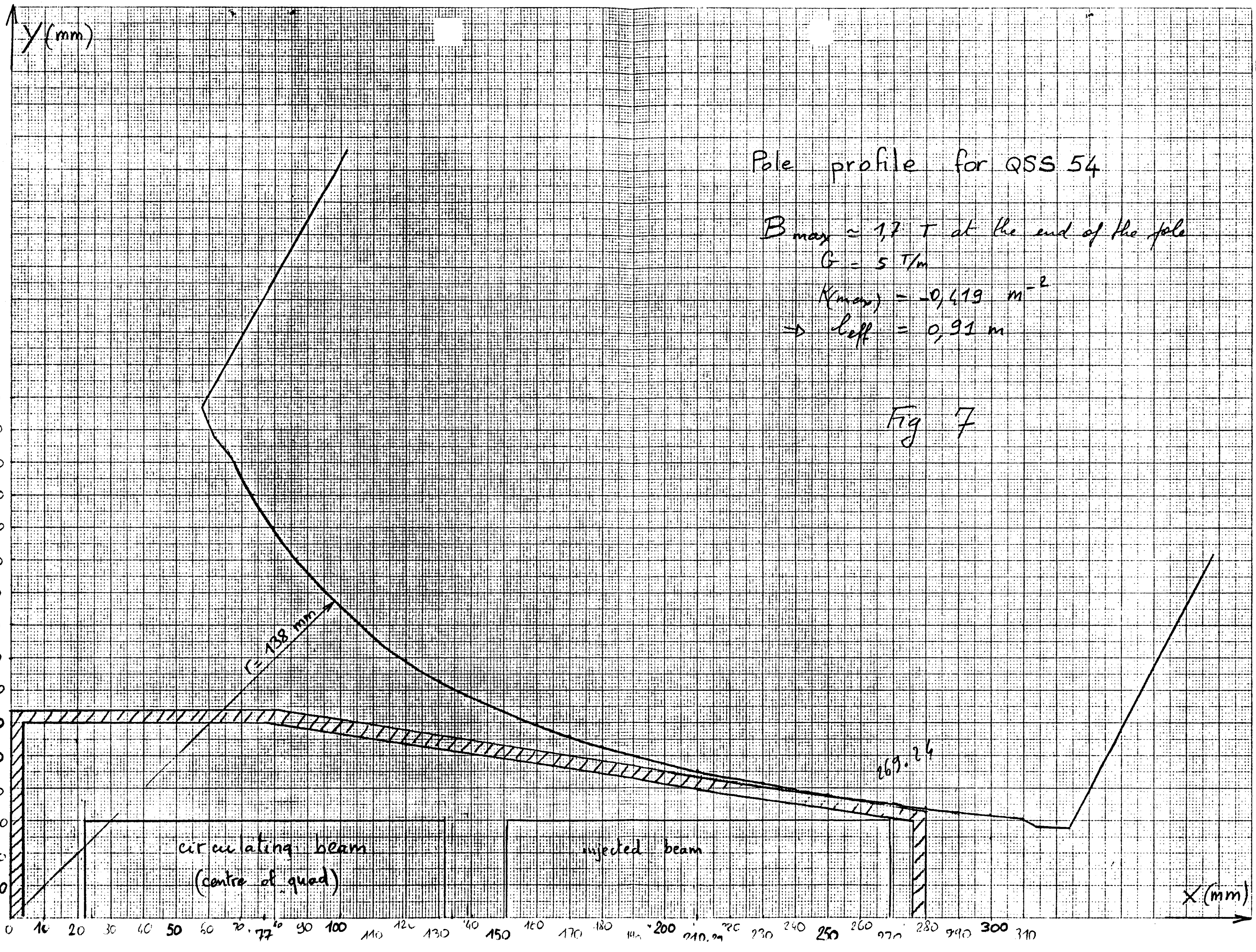

Pole profile for QW
6-01-84
Possible sextupole component
If yes, then no P.U.'s in QFW 8
and al.
Y (mm)
X (mm)
r = 132 mm
7
9
8
0
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
220
240
260
FABRICATION SUISSE

Fig. 5



Pole profile for QS
6_01_84
No sextupole in the profile
No P.U's
Y (mm)
X (mm)
r = 120mm
5
4
0
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
220
240
260
FABRICATION SUISSE

Fig. 6



Pole profile for QSS 54
B max ≃ 1,7 T at the end of the pole
G = 5 T/m
K(max) = -0,419 m^-2
⇒ l_eff = 0,91 m
Y (mm)
X (mm)
r = 138 mm
269.24
circulating beam
(centre of quad)
injected beam

Fig 7

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Dipoles parameters

		BHN	BHW
Number		8	16
Field	(T)	1,6	1,6
Effective length	(m)	1,823	1,823
Field x eff. length	(T. m)	2,93	2,93
Bending radius	(m)	7,453	7,453
Core length	(m)	1,89	1,89
Gap height	(mm)	± 51	± 66
Overall length	(m)	2,2	2,28
Overall width	(m)	0,8	1,86
Overall height	(m)	0,52	1,08
Good field width	(mm)	± 100	± 168
Good field height	(mm)	± 47	± 54
Nominal current	(A)	2272	1838
Nominal power	(kW)	63,1	72
Number of turns		30	42 (+12)
Conductor sections	(mm^2)	20 x 20	24 x 24
Current density	(A/mm^2)	5,7	3,5 (3,7)
Average length / turn	(m)	4,4	6,5 (5,7)
Water flow / coil	(l/mn)	22	22 (6)
Temperature rise	(°C)	20	20
Copper weight	(kg)	952	2610
Steel weight	(kg)	5 000	24 000

Table 1

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Quadrupoles parameters

		QN	QW	QS
Number		20	20	16
Gradient (D)	(T/m)	6,92	5,98	6
Gradient (F)	(T/m)	5,90	6,42	6,5
Effective length	(m)	0,7	0,72	0,638
Inscribed circle radius	(m)	0,10	0,132	0,120
Core length	(m)	0,62	0,60	0,522
Overall length	(m)	0,84	0,83	0,82
Overall width	(m)	0,85	1,28	0,90
Overall height	(m)	0,85	1,2	1,2
Good field width	(mm)	± 94	± 170	+ 132
Good field height	(mm)	± 60	± 60	± 56
Nominal current	(A)	1925	1730	1810
Nominal power	(kW)	29,3	38	18
Turns / pole		15	27	23
Conductor sections	(mm^2)	20 x 15,6	21 x 18,2	21 x 17
Current density	(A/mm^2)	6,6	5,1	5,7
Coolant hole diameter	(mm)	5	7,4	7
Average length / turn	(m)	2	2	2
Temperature / coil	(°C)	29	20	20
Pressure drop / coil	(N/m^2)	10^6	10^6	10^6
Water flow / quad	(l/mn)	14,4	27	13
Resistance / quad	(mΩ)	7,4	13	6,5
Inductance / quad	(mH)	5,4	30	15
Copper weight	(kg)	310	590	300
Steel weight	(kg)	1450	5000	2550

Table 2

Table 3 The different pattern of sextupole for ξ based on AC83 13 (

** = 8 dipoles without shims

units: m^{-2} $\frac{B''\ell}{B\rho}$

Job No	SDB** SFB	SN	SDQ (QDW 7)	SFQ (QFN 6)	SDP (QDW 9)	SFP (QFW 8)	SDS1	SFS1
181	0.08 -0.08	0.05	0.2082	0.00	0.1834	-0.2300	0.3402	-0.2388
182	0.08 -0.08	0.00	0.2082	0.00	0.1834	-0.2300	0.4302	-0.1532
201	0.08 -0.05	0.05	0.2082	0.00	0.1834	-0.2300	0.3417	-0.2781
→ 202	0.08 -0.05	0.00	0.2082	0.00	0.1834	-0.2300	0.4317	-0.1925 (Present solution)
203	0.10 -0.05	0.05	0.2082	0.00	0.1834	-0.2300	0.3010	-0.2738
204	0.10 -0.05	0.00	0.2082	0.00	0.1834	-0.2300	0.3910	-0.1682
205	0	0	0	0	0	0	1.120	-0.7236
206	0.08 -0.05	0	0	0	0	0	?	?