Bergvesenet
Postboks 3021, N-7441 Trondheim

Rapportarkivet

Bergvesenet rapport nr	Intern Journal nr	Internt arkiv nr	Rapport lokalisering	Gradering
5504*				

Kommer fra ..arkiv	Ekstern rapport nr	Oversendt fra	Fortrolig pga	Fortrolig fra dato:
Ni&Ol	R 054/03	Ni&Ol		

Tittel

OMS-logg Test at Nikkel & Olivin A/S, 10.11.1993

Forfatter	Dato	År	Bedrift (Oppdragsgiver og/eller oppdragstaker)
Toivanen, Risto-Matti	18.05	1993	Outokumpu Metals & Resources for Ni & Ol

Kommune	Fylke	Bergdistrikt	1: 50 000 kartblad	1: 250 000 kartblad
Ballangen	Nordland		13311	Narvik

Fagområde	Dokument type	Forekomster (forekomst, gruvefelt, undersøkelsesfelt)
Geofysikk		Bruvannsfeltet Råna Østmalmen

Råstoffgruppe	Råstofftype
Malm/metall	Ni, Cu

Sammendrag, innholdsfortegnelse eller innholdsbeskrivelse

OMS er et geofysisk borhulls-loggesystem som måler gamma-gamma, sp.v., magn. susept. og el. ledningsevne. Hensikten med testen var å finne malmgrenser og estimering av gehalt.
Resultatet viser at kompakt malm blir godt registret på alle måletyper. For lavgehalter synes suseptibilitet og gamma-gamma være nyttige ved at Ni 0,4-0,5 % kan skilles ut. det er en klar korrelasjon mellom malm og impregnasjon på susept.
Problem oppstår der det er lange analyseintervall og som gir unøyaktig korrelasjon.
Det anbefales brukt gamma-gamma og susept. sammen; muligens vil bare susept. være nok. Mindre borhullsdiameter gir bedre resultater.

outokumpu mining services

Risto-Matti Toivanen

18.05.1993

OMS-LOGG TEST AT NIKKEL & OLIVIN A/S 10-11.03.1993

OMS-logg

OMS-logg system has been designed for fast determination of ore contacts and grades in mine planning.

- *minimize dilution and ore loss*
- *reduce expensive core drilling*
- *reduce sampling and assay costs*
- *get analyzing results at once*

OMS-LOGG TEST AT NIKKEL & OLIVIN A/S 10-11.03.93

OMS-logg geophysical borehole logging system was tested at Nikkel & Olivin AS nikkel mine 10-11.03.1993. Gamma-gamma density, magnetic susceptibility and electric conductivity probes were used. The main purpose for measuring was to try to find a method to help determining the ore boundaries as well as ore grade estimation. It looks like susceptibility logging is the best way to ore boundary/quality detection.

Results

For compact ore all methods mentioned above give clearly ore contacts (eg. BH 171, 15.4-24.8m, appendix 1).

For low grade ore conductivity is not enough sensitive but susceptibility and gamma-gamma will be useful methods so that critical Ni content 0.4-0.5 % can be separated (appendix 2 and 3). Gamma-gamma density can show in some cases rock types as well (appendix 4).

Background susceptibilities are very low in both waste and host rocks showing that even accessory amount of magnetite is very low. On the other hand ore minerals are magnetic and therefore there is a clear correlation between ore and susceptibility in weak ore, too.

Area where larger amount of pyrrhotite exists susceptibility alone is not enough. Unfortunately, gamma-gamma logging was not done in that area (probe damage).

Susceptibility logging in production holes shows that ore boundaries can be determinated in Ø 64 mm holes, too (appendix 5).

Long assay intervals (average 2m) cause inaccuracy in correlation with susceptibility and gamma-gamma results. (Correlations between gamma-gamma and susceptibility compared to density/Ni-content are exponential and corresponding mean values of analyses are calculated by linear method). This influence can be avoid by more accurate analyzing and calibration.

The correlation of Ni-content to density and to susceptibility should be calculated using enough representative samples with small assay intervals (eg. make analyses every 0.25 - 0.5 m from core drill samples). However, in this stage laboratory tests would be sufficient enough and more field tests with OMS-logg are not needed.

Statistical analyses of data have not been done because of variation with in assay increments (core sample intervals are too long for calibration and statistical calculation), so material is handled only visually.

Recommended combination for borehole logging system is gamma-gamma and susceptibility together, but by further laboratory tests and customers needs will show if only one method is required. Possibly just susceptibility logging will in practice be sufficient (excluding rich pyrrhotite areas). Susceptibility probe will be more sensitive by using ø 36 mm cover tube instead of ø 52 cover (used in tests).

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Nikkel & Olivin A/S

OMS-logg testmeasurements 10-11.93

level	profile	corehole no.	size mm	susceptibility	conductivity	gamma-gamma
	246	2600	178	46 x		
			180	46 x		
		2625	187	46 x		
			186	46 x		
		2675	171	46 x	x	
		2700	134	46 x	x	
			122	46 x	x	
	340		207	46 x	x	
			142	46 x	x	x
			143	46 x	x	x
			144	46 x	x	x
			148	46 x	x	x
			149	46 x	x	
	340	8/10 / 6 production holes			64 x	x

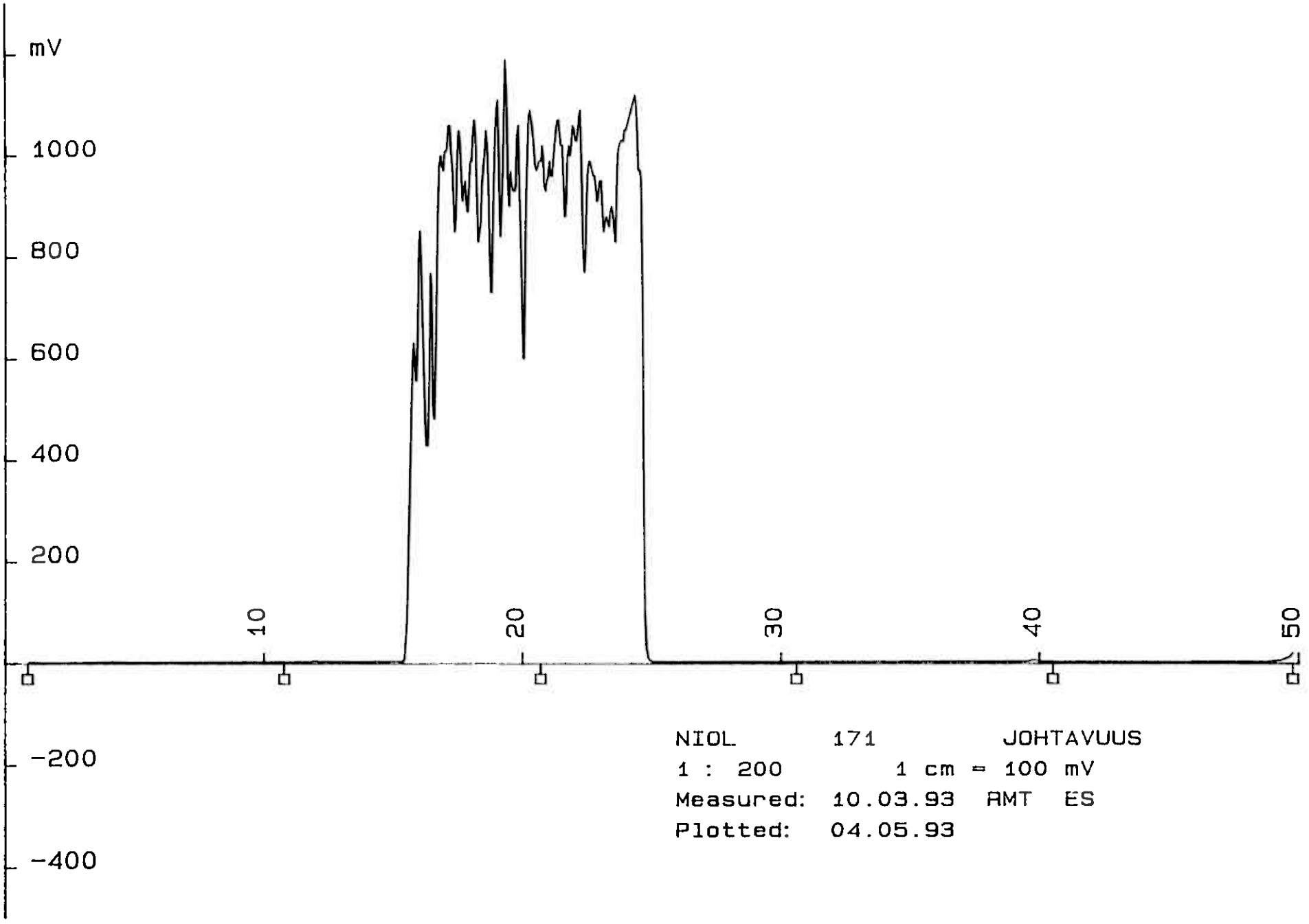
Outokumpu Oy, Geoanalyyttinen laboratorio
Korjalankatu 2
83500 OUTOKUMPU

AAS-TULOKSIA 19.02.93 13:45

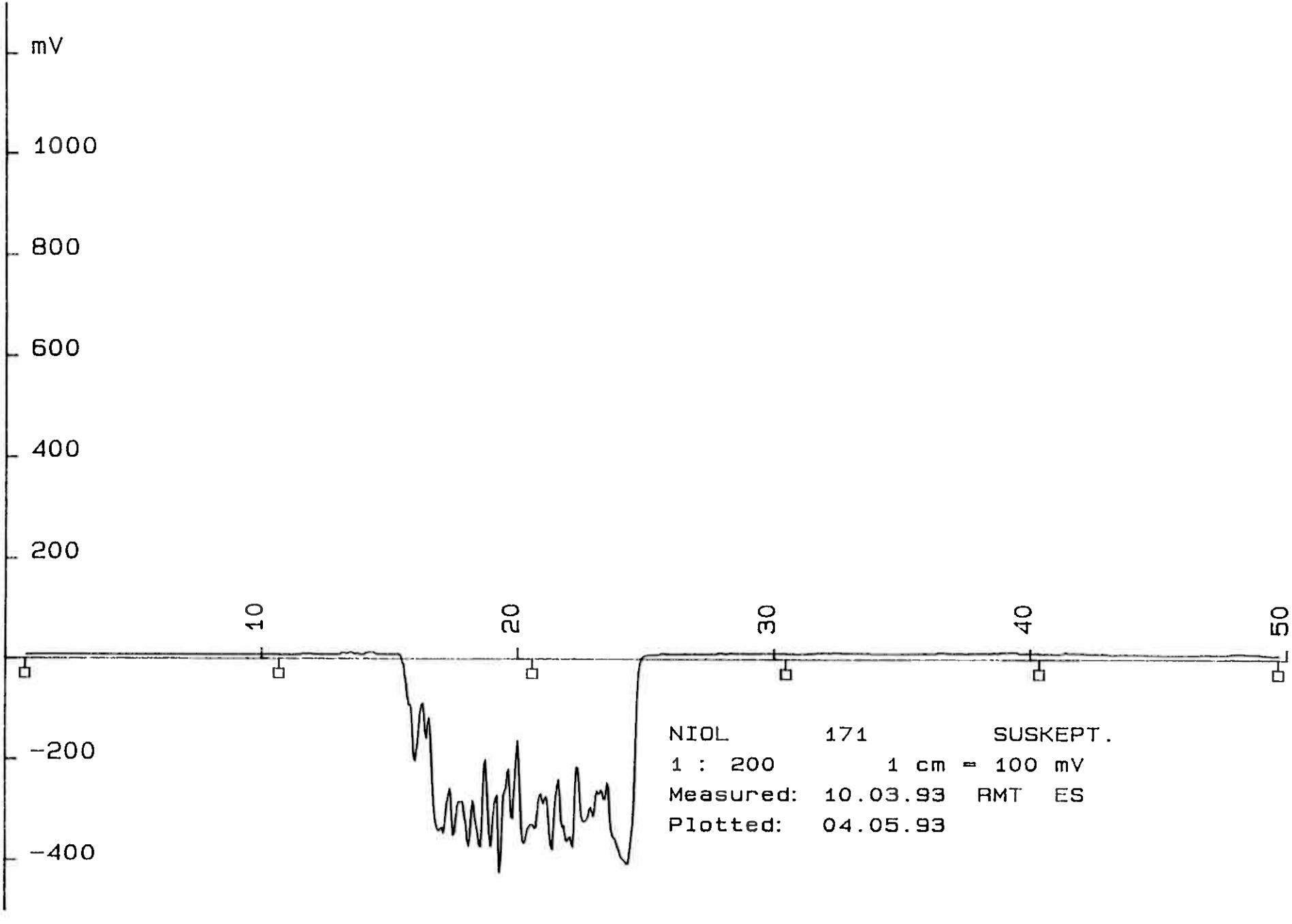
TILAAJA : Markus Ekberg
ALUE : RANA
KARTTALEHTI :
NÄYTETYYPPI : KAIRAUS
KUSTANNUSPAIKKA : NIKKEL OG OLIVIN

näyte	Ni AAS ppm		bh	fra - til
93-05041	0,1554.	%	170-92	- 9 m
93-05042	0,4155.		"	-11,10m
93-05043	1,0647.		"	-12,70m
93-05044	0,4748.		"	- 14,6m
93-05045	32247.	%	"	- 15,45m
93-05046	0,0467.		"	- 18,60m
93-05047	0,1478.		"	-20,3 m
93-05048	0,1112.		"	- 22,2 m
93-05049	0,1035.		"	25,8 - 26,8 m
93-05050	2,7225.		171-92	16 - 18 m
93-05051	3,4658.		"	- 20m
93-05052	3,3088.		"	- 22 m
93-05053	3,2988.		"	- 24,8 m
93-05054	0,1567.		"	39 - 41,70m
93-05055	0,1472.		172-93	0 - 2 m
93-05056	0,1462.		"	- 4 m
93-05057	0,1793.		"	- 5,4 m
93-05058	0,2723.		"	5,6 - 8 m
93-05059	0,3703.		"	- 10 m
93-05060	0,4032.		"	- 12 m
93-05061	0,2191.		"	- 14 m
93-05062	0,1914.		"	- 16 m
93-05063	0,1440.		"	- 18 m
93-05064	0,3761.		"	- 20 m
93-05065	0,2744.		"	- 22 m
93-05066	0,2339.		"	- 23,5 m
93-05067	0,1641.		"	- 24,6 m
93-05068	0,2010.		173-93	0 - 2 m
93-05069	0,1779.		"	- 4 m
93-05070	0,2169.		"	- 6 m
93-05071	0,2030.		"	- 8,1 m
93-05072	0,2220.		"	- 10,2 m
93-05073	0,8682.		"	- 12,2 m
93-05074	0,4579.		"	- 14,3 m
93-05075	0,0460.		"	- 17,3 m
93-05076	0,4272.		"	19,3 - 21,3 m
93-05077	0,3454.		"	21,5 - 22,5 m
93-05078	0,2980.		"	22,75 - 24,15 m
93-05079	0,0401.		"	- 26 m
93-05080	0,0442.		"	- 27,5 m

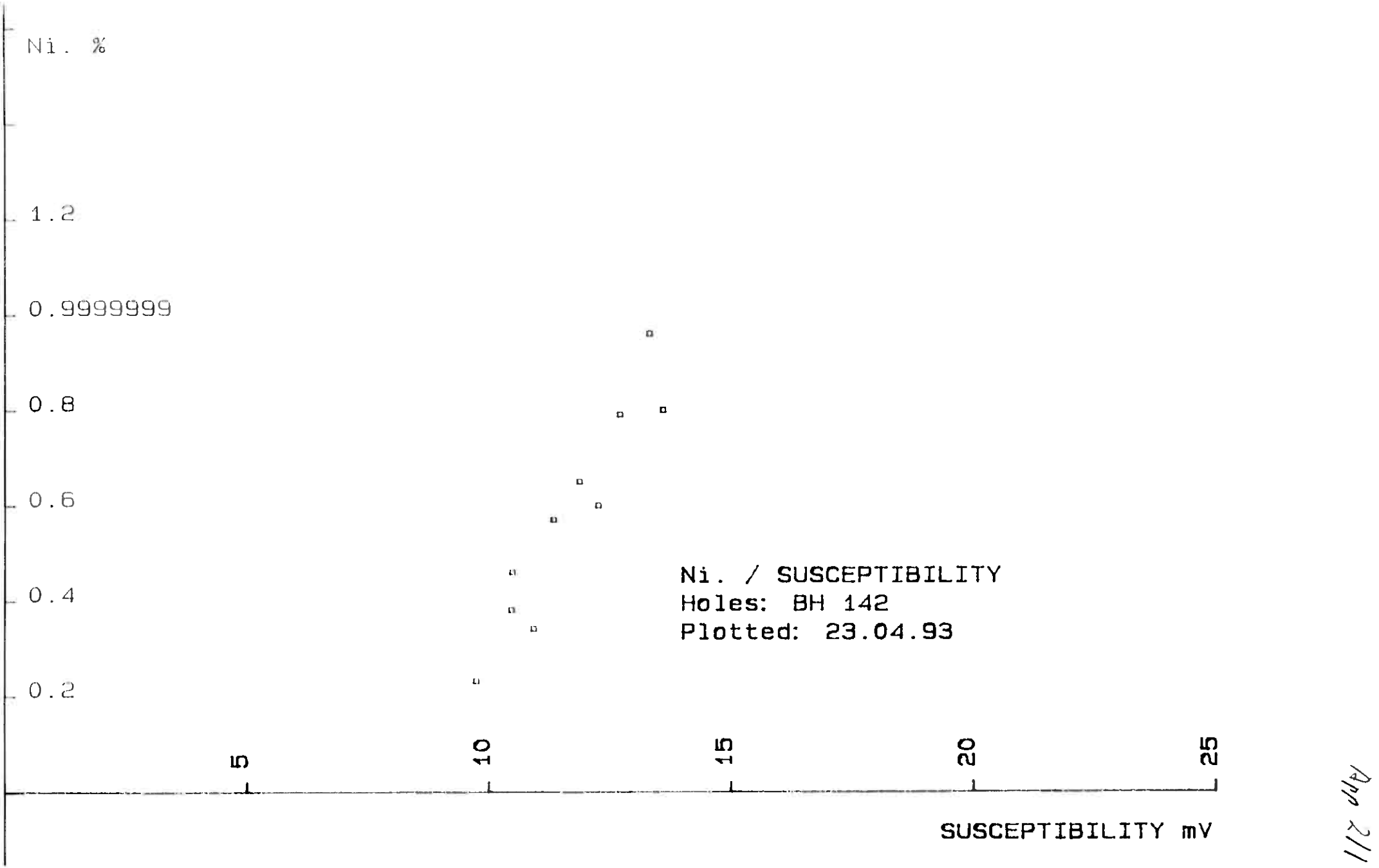
fortsetter


mV
1000
800
600
400
200
-200
-400
10
20
30
40
50
NIOL 171 JOHTAVUUS
1 : 200 1 cm = 100 mV
Measured: 10.03.93 AMT ES
Plotted: 04.05.93

Apr. 1/2


mV
1000
800
600
400
200
-200
-400
10
20
30
40
50
NIOL 171 SUSKEPT.
1 : 200 1 cm = 100 mV
Measured: 10.03.93 RMT ES
Plotted: 04.05.93

App. 1/2


Ni. %
1.2
0.9999999
0.8
0.6
0.4
0.2
5
10
15
20
25
SUSCEPTIBILITY mV
Ni. / SUSCEPTIBILITY
Holes: BH 142
Plotted: 23.04.93

Apr 21/1

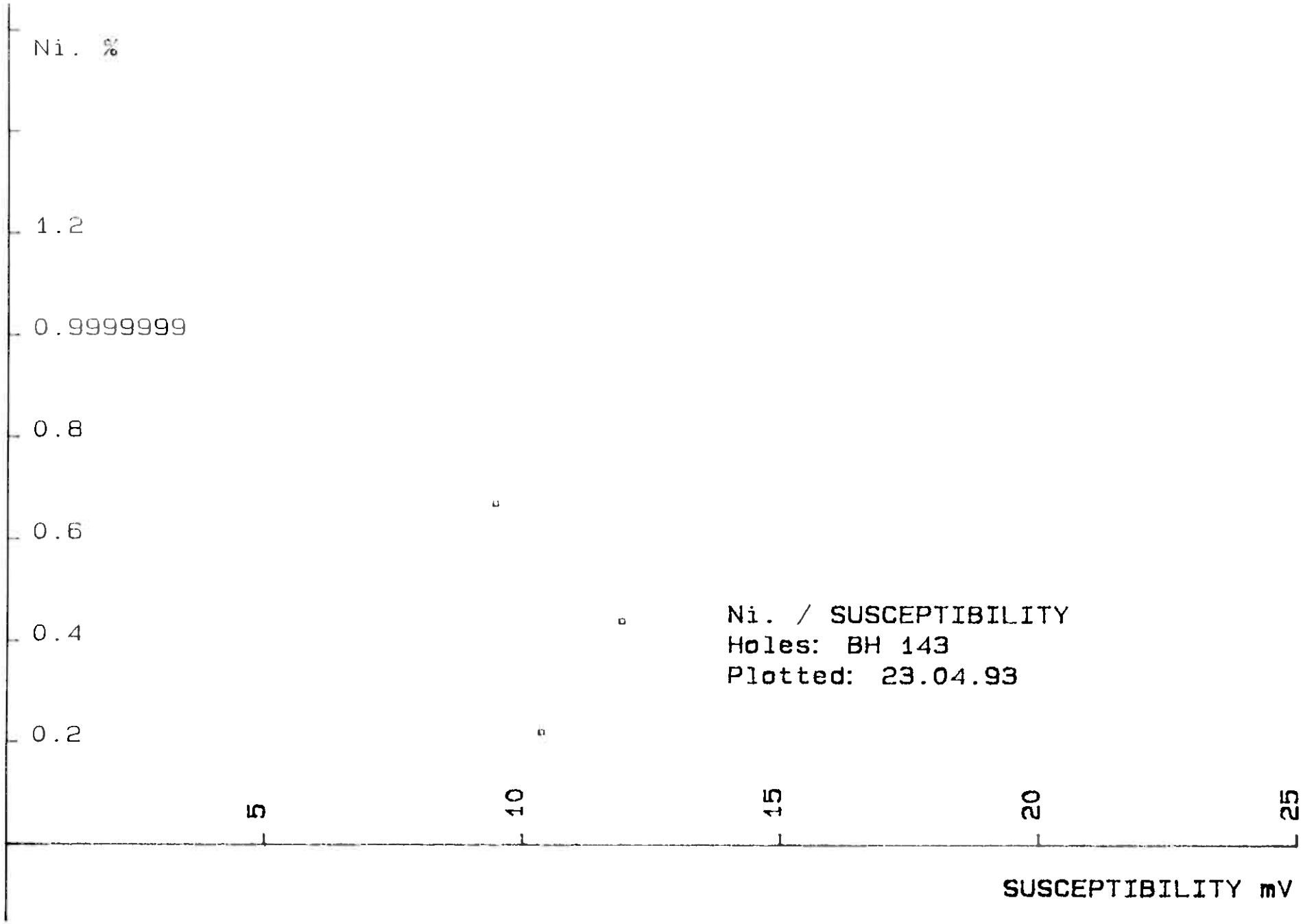

Ni. %
1.2
0.9999999
0.8
0.6
0.4
0.2
5
10
15
20
25
SUSCEPTIBILITY mV
Ni. / SUSCEPTIBILITY
Holes: BH 143
Plotted: 23.04.93

Fig. 2/2

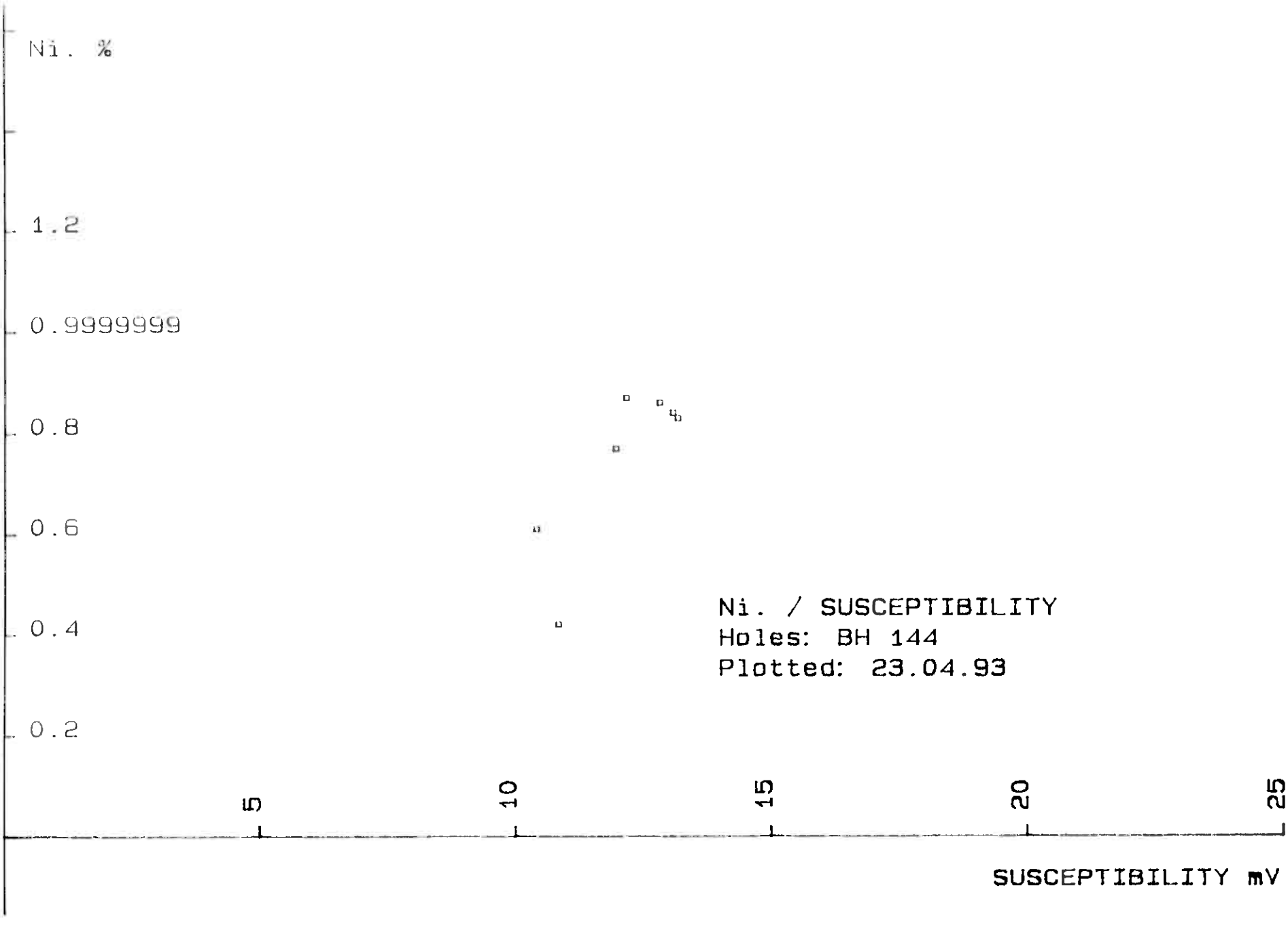

Ni. %
1.2
0.9999999
0.8
0.6
0.4
0.2
5
10
15
20
25
SUSCEPTIBILITY mV
Ni. / SUSCEPTIBILITY
Holes: BH 144
Plotted: 23.04.93

Fig. 2/3

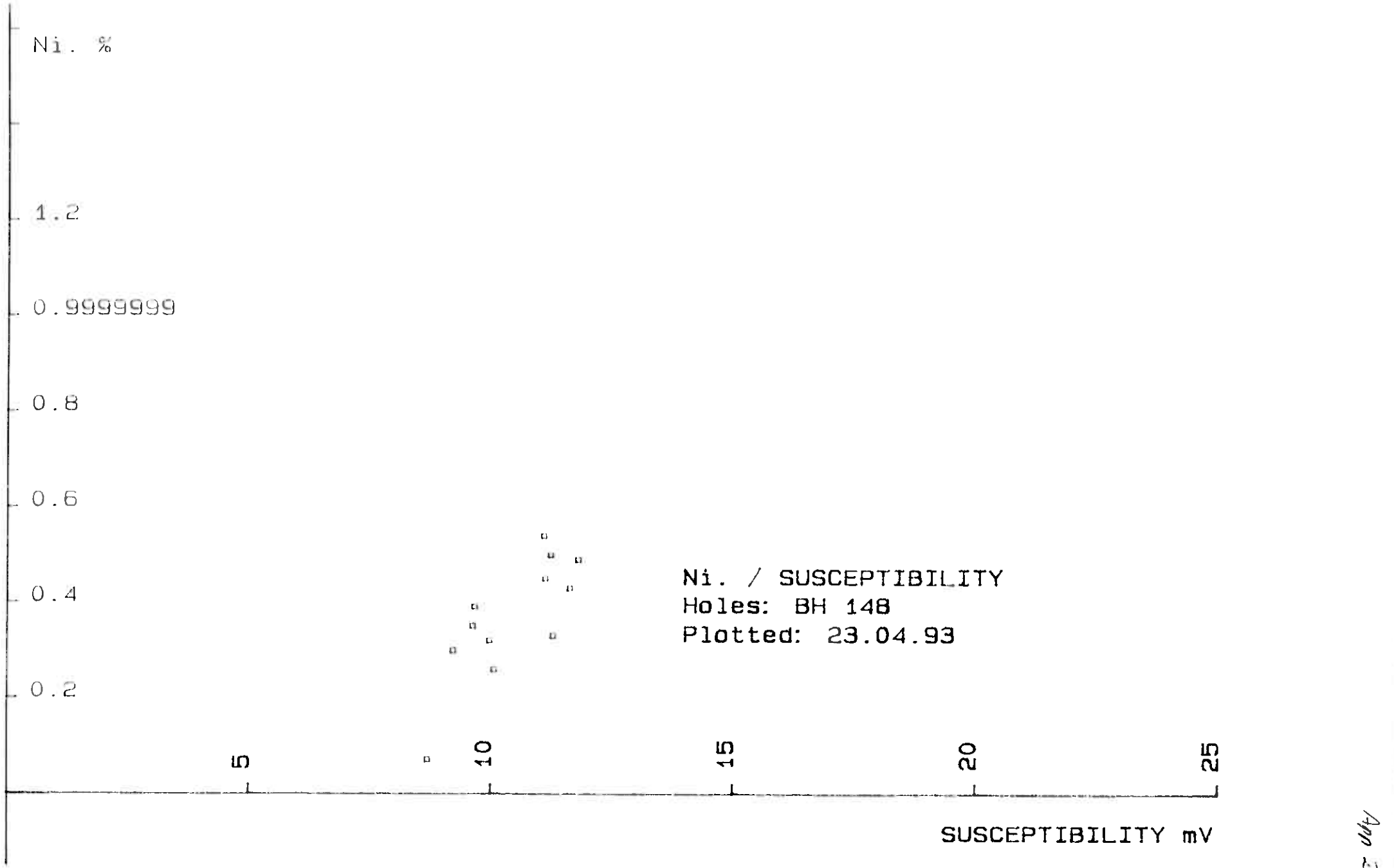
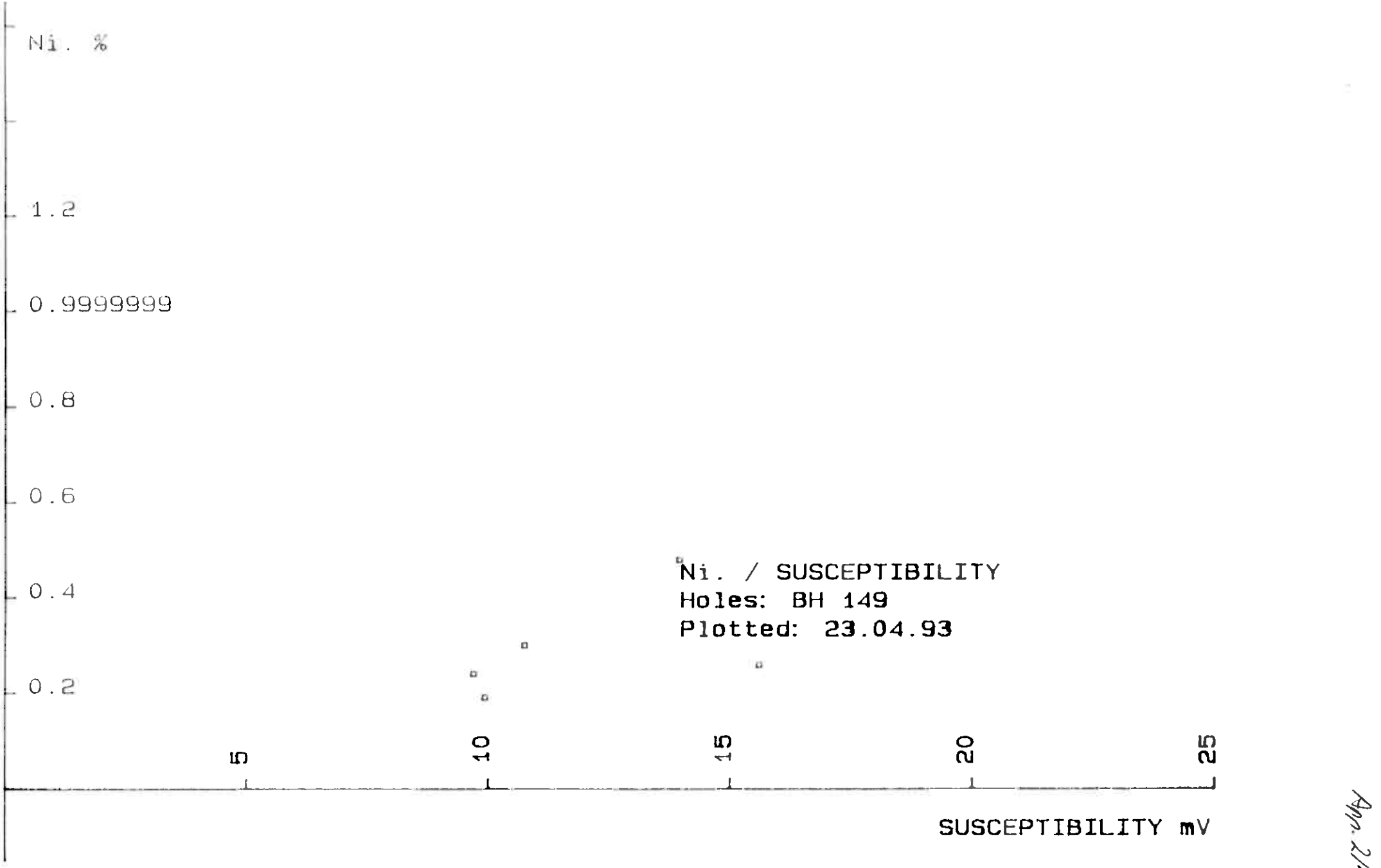
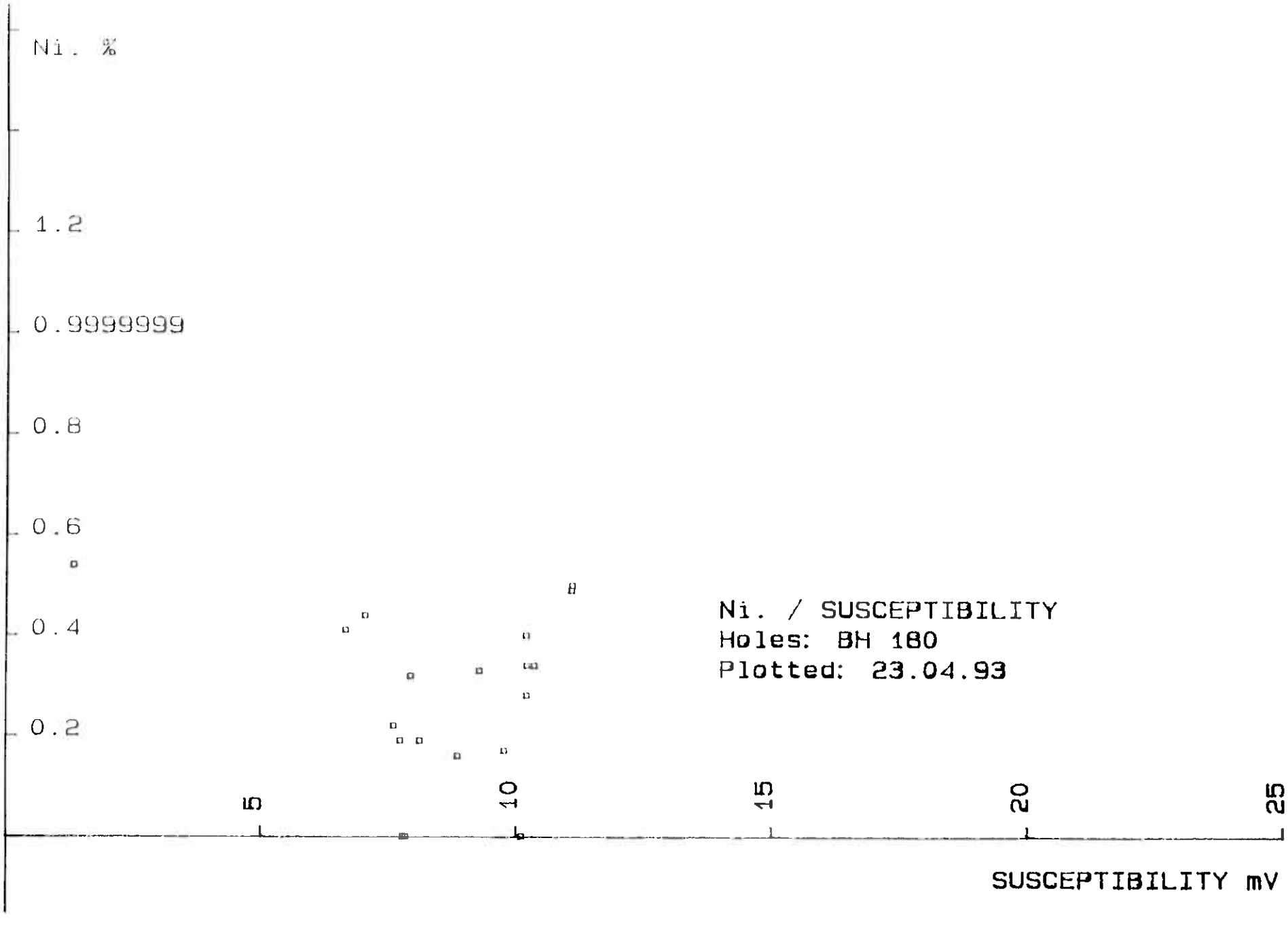

Ni. %
1.2
0.9999999
0.8
0.6
0.4
0.2
5
10
15
20
25
SUSCEPTIBILITY mV
Ni. / SUSCEPTIBILITY
Holes: BH 148
Plotted: 23.04.93

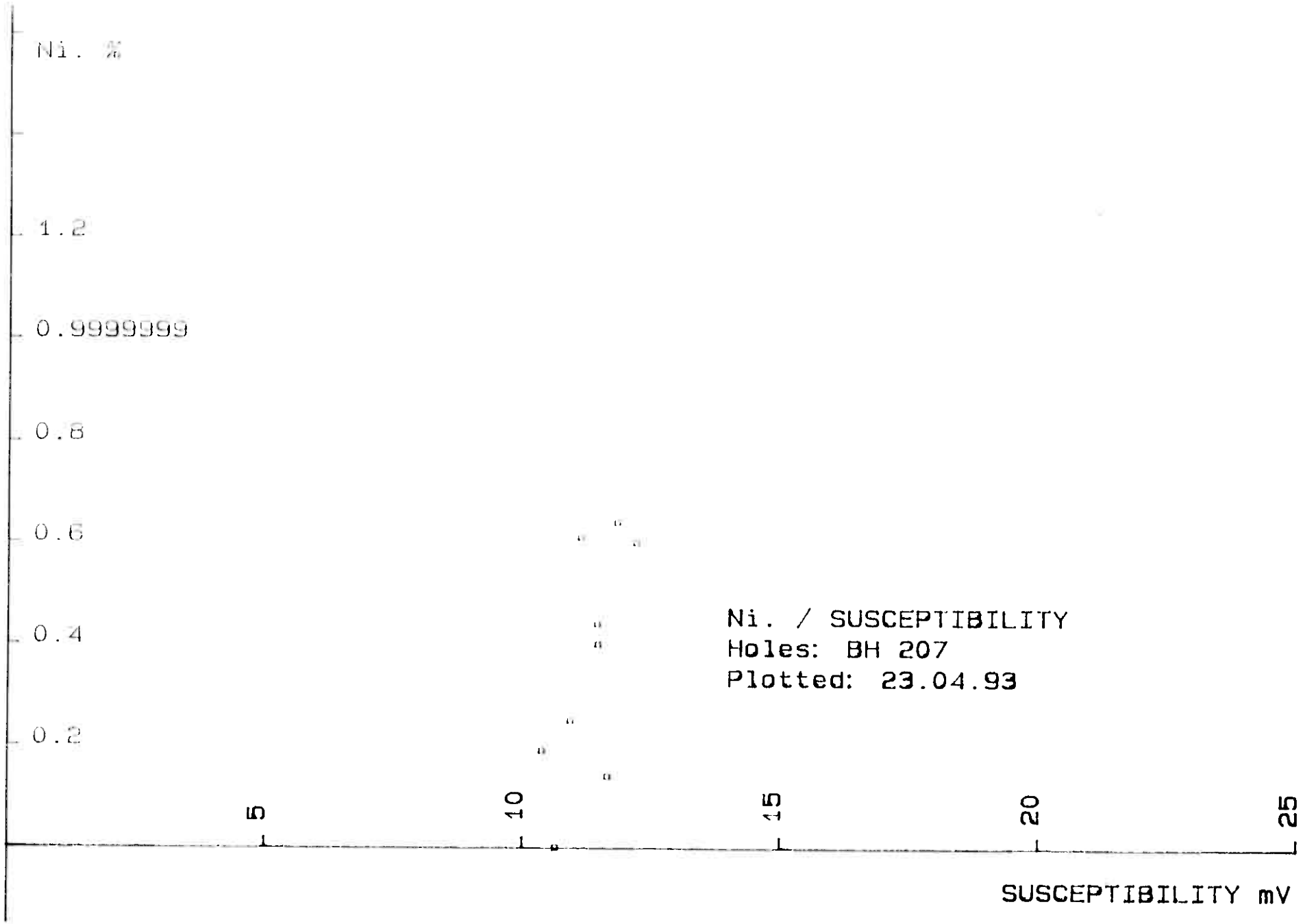
Fig 2/4


Ni. %
1.2
0.9999999
0.8
0.6
0.4
0.2
Ni. / SUSCEPTIBILITY
Holes: BH 149
Plotted: 23.04.93
5
10
15
20
25
SUSCEPTIBILITY mV

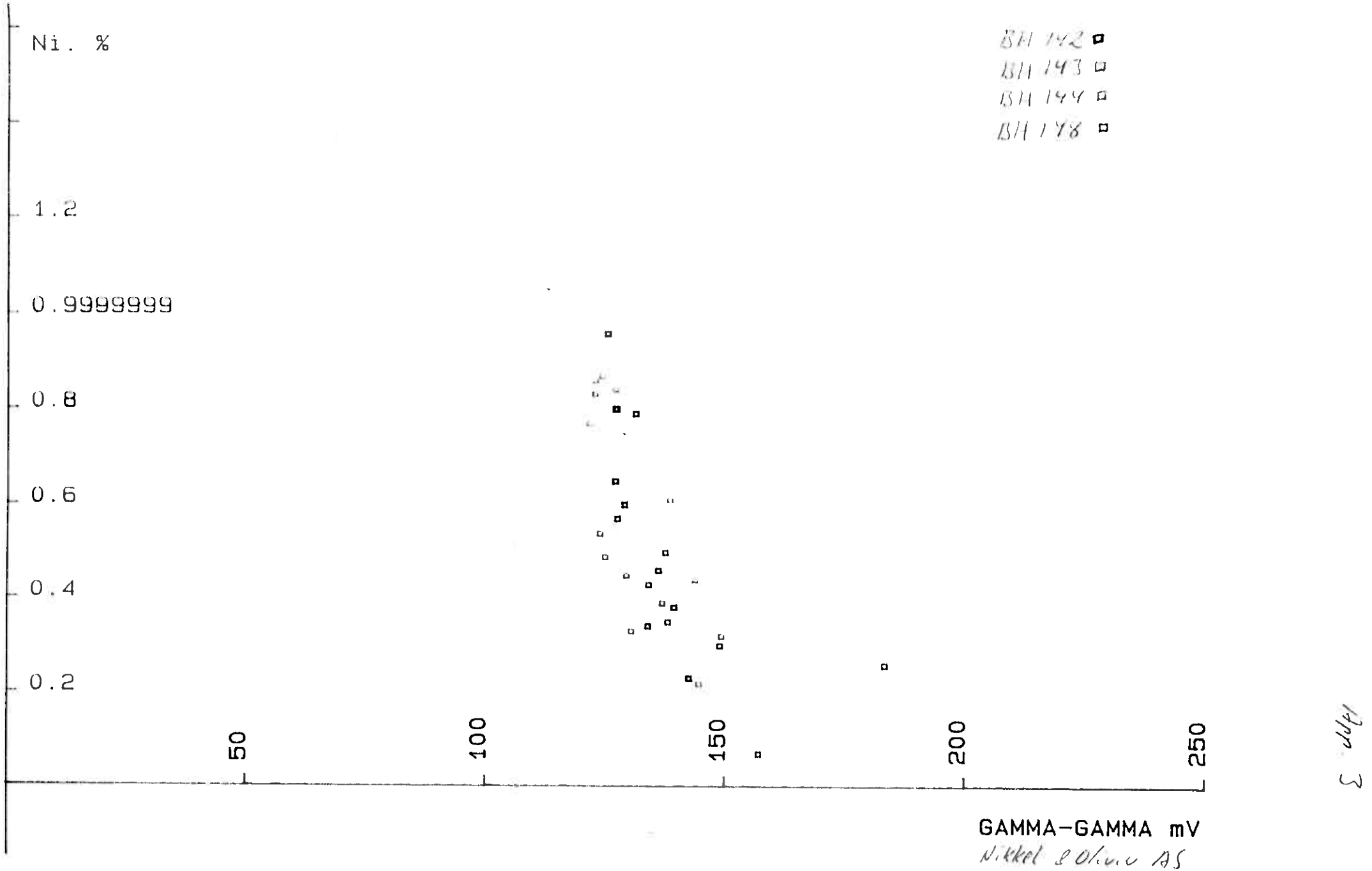
Ann. 2/5


Ni. %
1.2
0.9999999
0.8
0.6
0.4
0.2
5
10
15
20
25
Ni. / SUSCEPTIBILITY
Holes: BH 180
Plotted: 23.04.93
SUSCEPTIBILITY mV

App. 2/2


Ni. %
1.2
0.9999999
0.8
0.6
0.4
0.2
5
10
15
20
25
SUSCEPTIBILITY mV
Ni. / SUSCEPTIBILITY
Holes: BH 207
Plotted: 23.04.93

App. 21


Ni. %
BH 142
BH 143
BH 144
BH 178
1.2
0.9999999
0.8
0.6
0.4
0.2
50
100
150
200
250
GAMMA–GAMMA mV
Nikkel & Olivin AS

Nikkel og Olivin A.S Grana (320) 19 92 Apr 4/1

DIAMANTBORING

Borhull nr. 144-92 Profil 27125

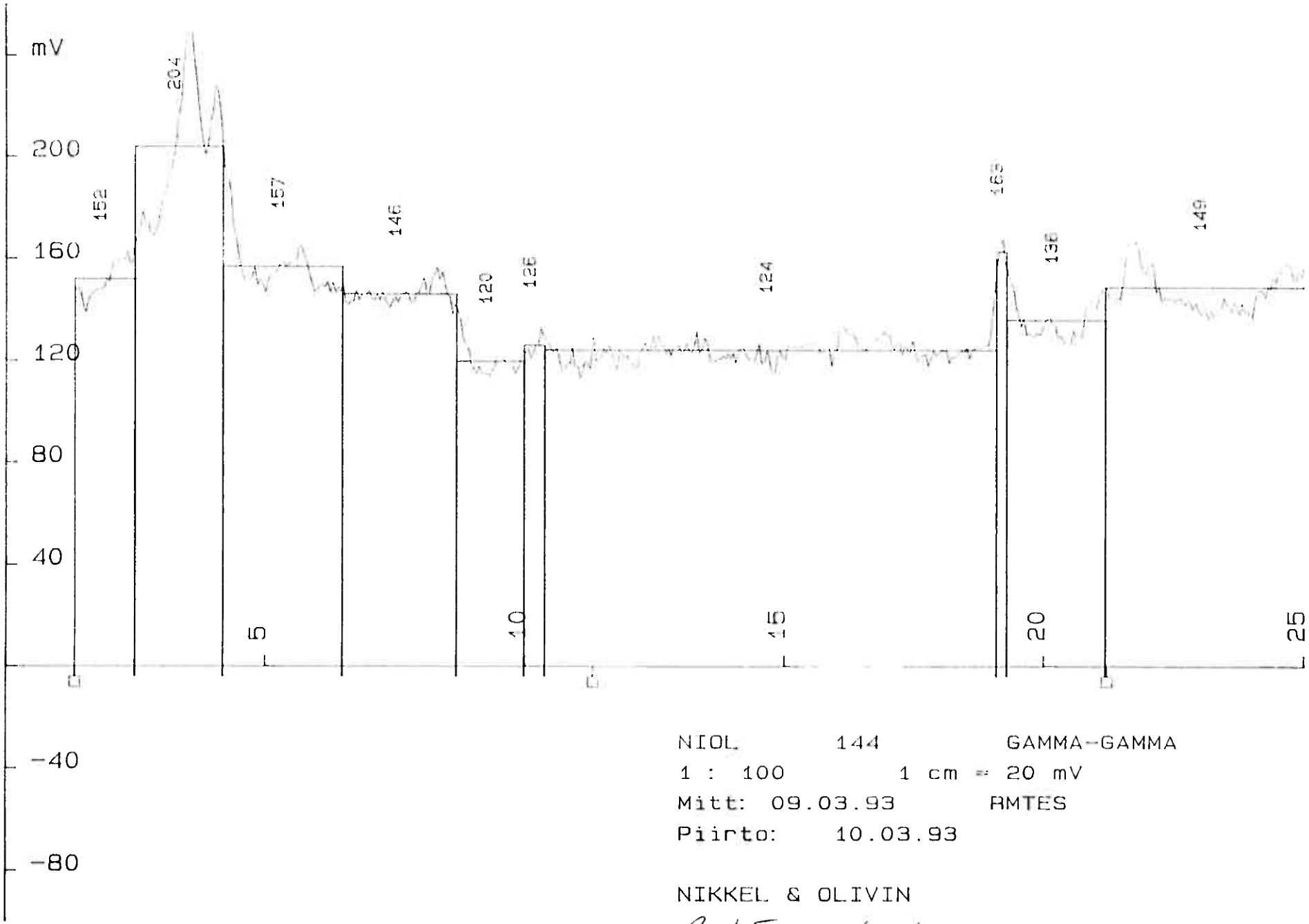
Koordinator: Y 27125 X 1294

Plassert i høyde _____ m.

- i retning 0° (N) Logget av: MS
- med helning -30° Dato: 13.11.92

Borhullets lengde 29,00 m

Boret meter	Logget lengde	Bergart	Analyse-seksjon	% Ni
- 1,20	1,20	Pr. m/ svak - spor mm.		
- 2,50	1,30	Per m/ spor mm.		
- 4,20	1,70	Pegmat. til sone ba		
- 6,50	2,30	Ol - Pr. m/ overgang til		
- 8,70	2,20	Pyr		
- 10,00	1,30	Pr. m/ mid - god imp.		
- 10,40	0,40	Pr.; delv omvandlet; spor mm.		
- 19,10	8,70	Pr. m/ mid god imp.		
- 19,30	0,20	Anl m/ grunnal Ø2-3 mm		
- 21,20	1,90	Pr. m/ svak mm.		
- 25,45	4,25	Pr.		
- 27,25	1,80	Anl m/ grunnal Ø 1-2 mm		
- 29,00	1,75	Pr.		
SLUTT				



NIOL 144 GAMMA-GAMMA
1 : 100 1 cm = 20 mV
Mitt: 09.03.93 RMTES
Piirto: 10.03.93

NIKKEL & OLIVIN
Rock Type - limit

Nikkel og Olivin A.S _____ 19____ App. 4/3

DIAMANTBORING

Borhull nr. 148-92

Koordinator: Y _____

Plasst i høyde _____ m.

- i retning _____
- med helning _____

Borhullets lengde 30,00

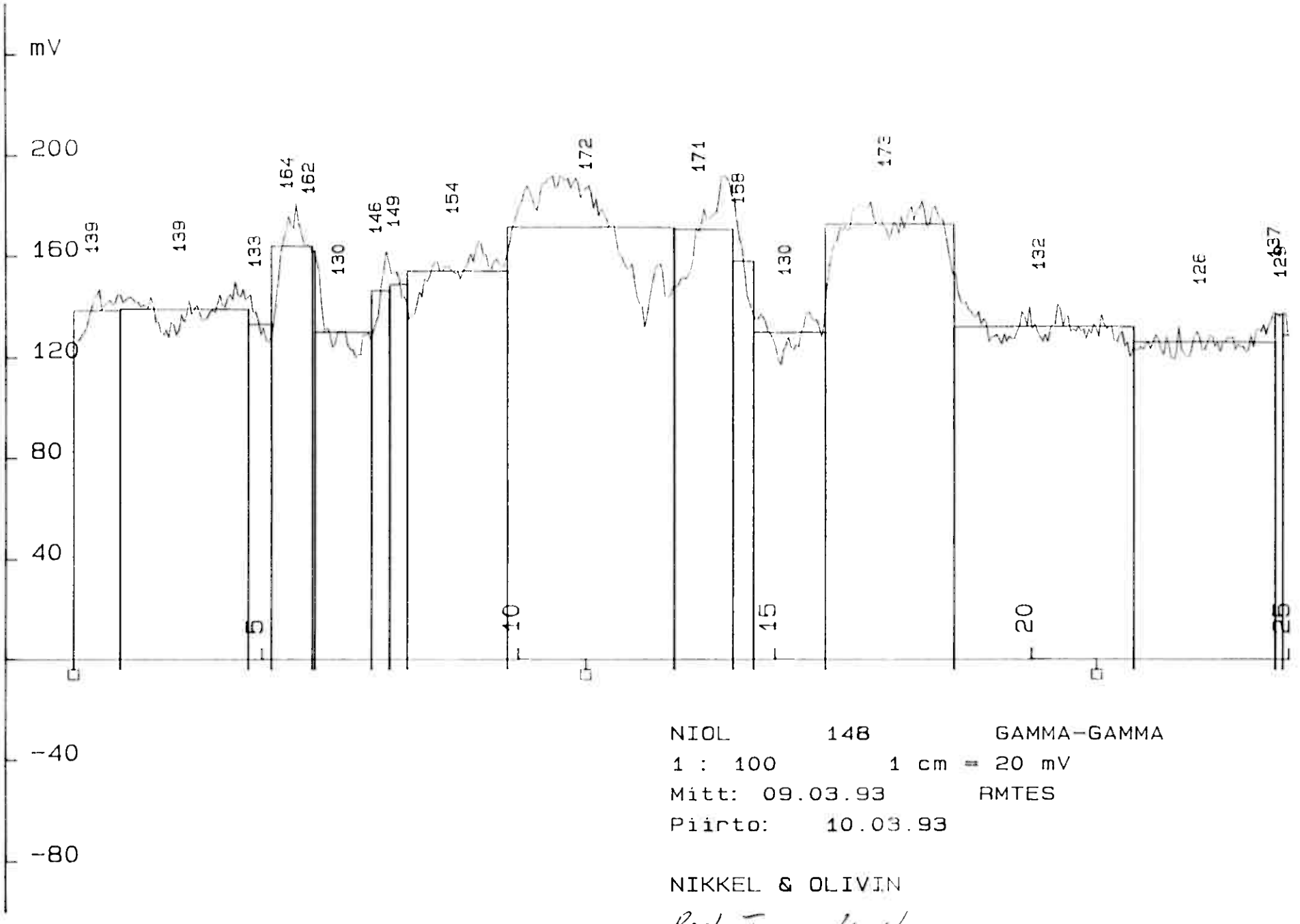
Profil _____

X _____

Logget av:

Dato:

Boret meter	Logget lengde	Bergart	Analyse-seksjon	% Ni
- 1,00		Pyr ~/ god (mid) impr.		
- 2,25		Pyr ~/ su - sp mine		
- 4,75		Pyr ~/ (sv) - mid impr.		
- 5,20		Pyr ~/ god impr.		
- 6,05		Gneis		
- 7,15		Pyr ~/ god impr.		
- 7,50		Pyr		
- 7,85		Pyr i avblanding ~/ Pyr; god impr.		
- 9,80		Pyr ~/ svak impr.		
- 13,05		Gneis ~/ sl. pr. og kl/ser. av min.		
- 14,20		Pyr		
- 14,60		Gneis		
- 16,00		Granatglimmergneis		
- 18,50		Overgangsb.		
- 22,00		Ol - Pyr ~/ god min.		
- 24,75		Pyr ~/ mid impr.		
		(avtagende impr. mot slutt.)		
- 24,90		Gneis		
- 28,80		Pyr ~/ svak		
- 30,00		Pyr		
SLUTT				

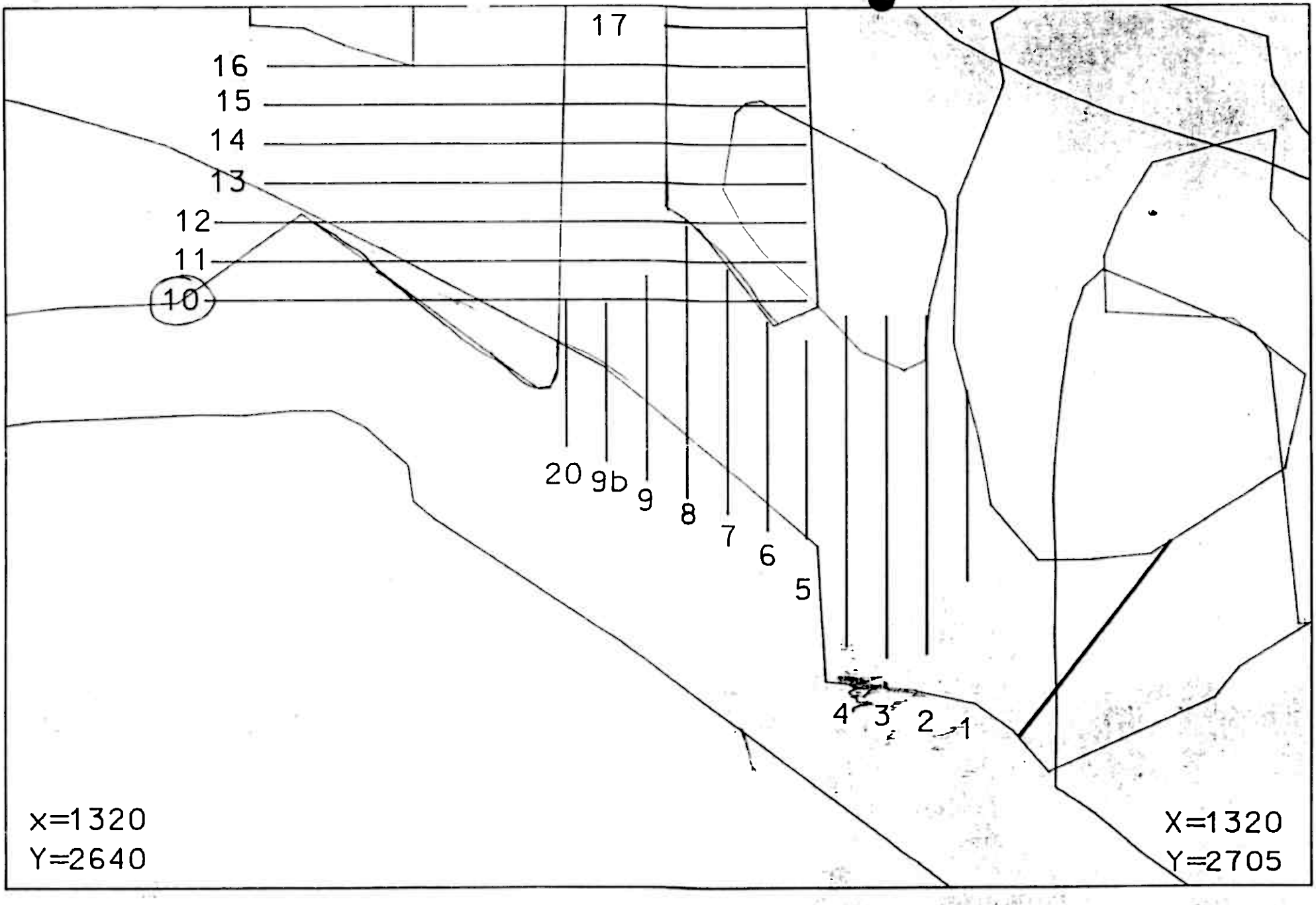


NIOL 148 GAMMA-GAMMA
1 : 100 1 cm = 20 mV
Mitt: 09.03.93 RMTES
Piirto: 10.03.93

NIKKEL & OLIVIN
Rock Type - limits

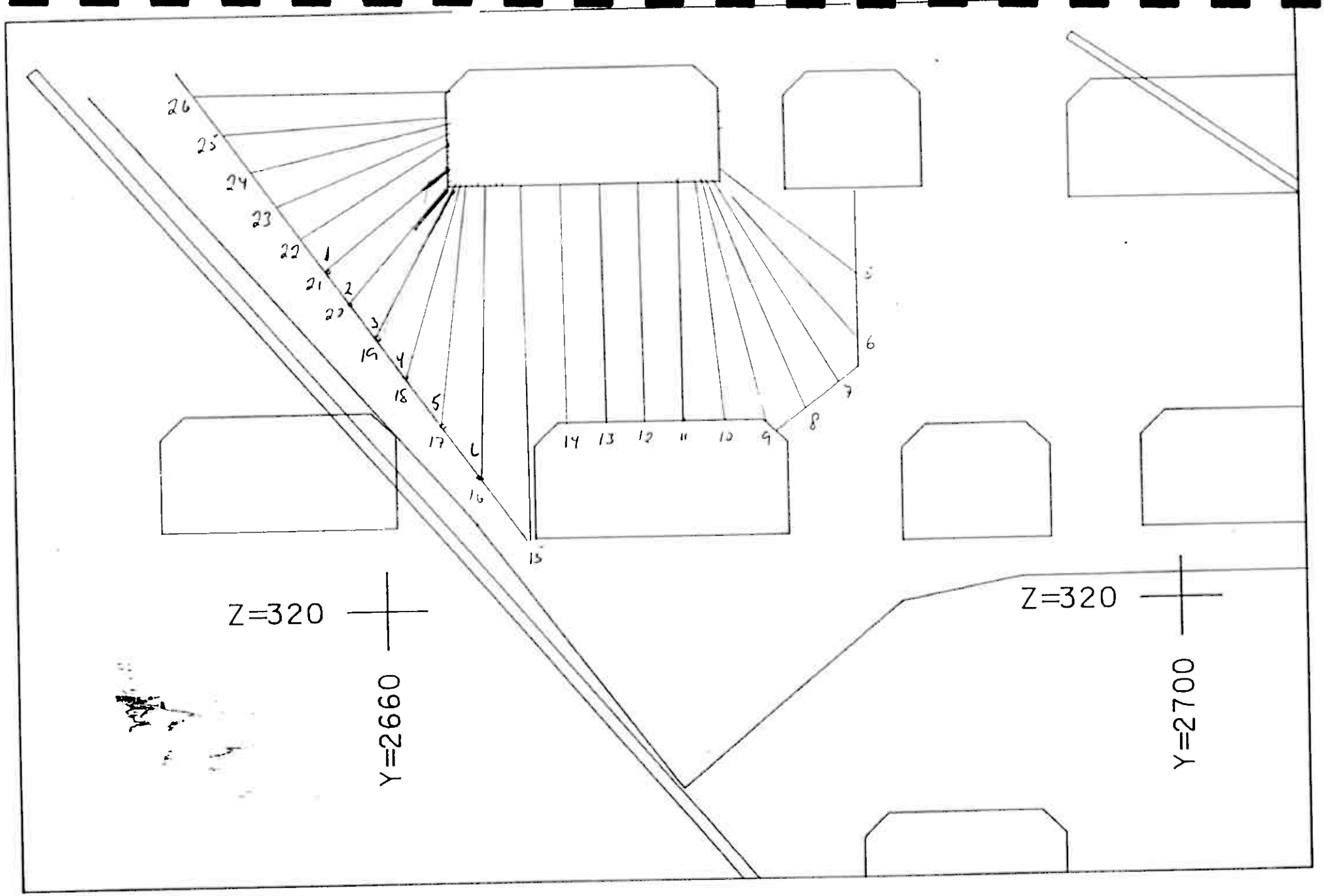
Measurement of production drill fan, level 340, section 10, holes 16 to 21

The hole no. 21 is waste
The beginning of hole no. 20 is ore and rest waste.
Rest of holes no. 19-16 are in ore.



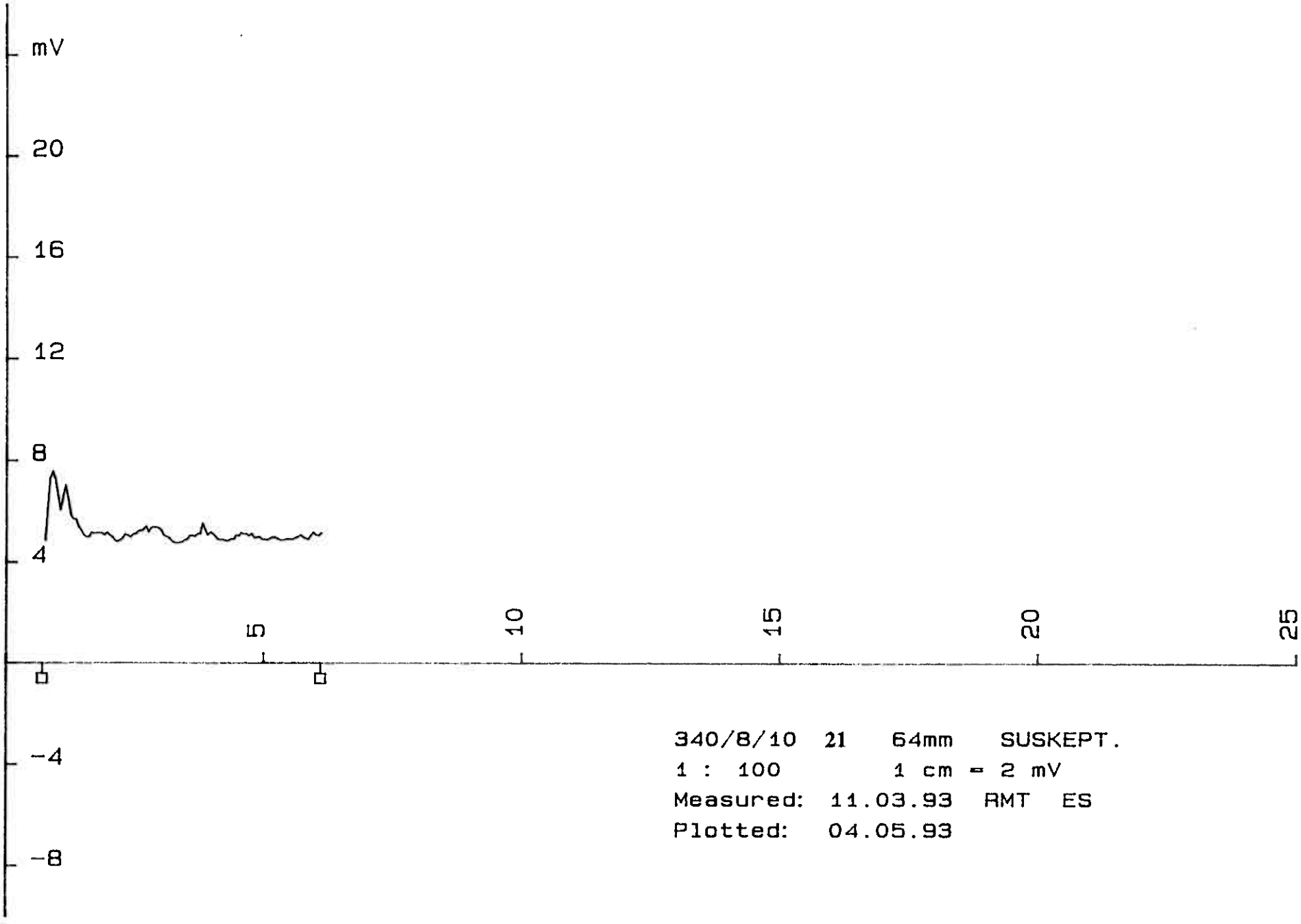
c:\dgn\340-3.dgn Mar. 5, 1993 18:36:56 PALLING OG VIFTEBORING 340/3 M = 1 : 250

App 5/2



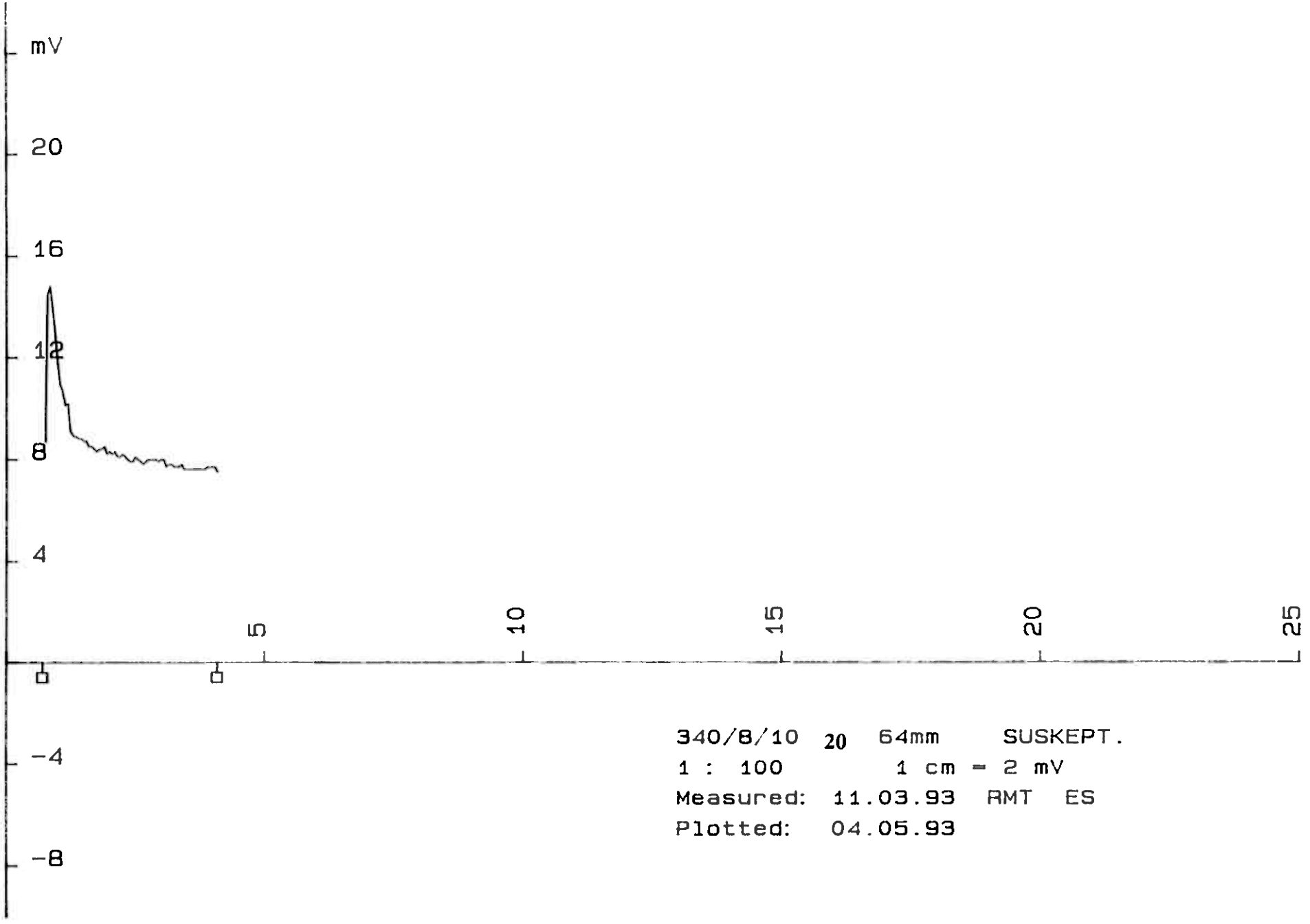
c:\dgn\340-3.dgn Mar. 4, 1993 16:49:39 VIFTE 10 (1350N)

Ark 5/3

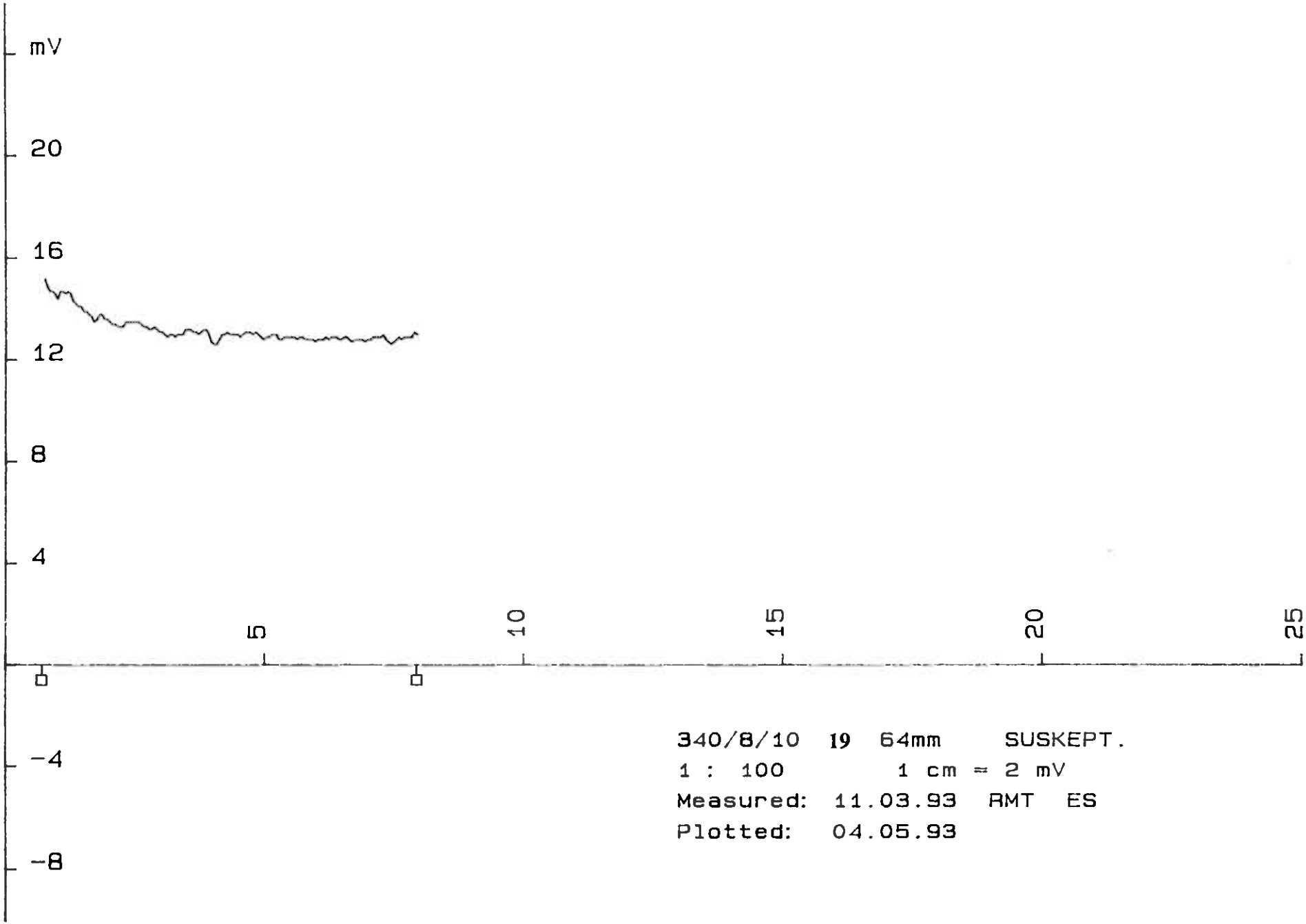


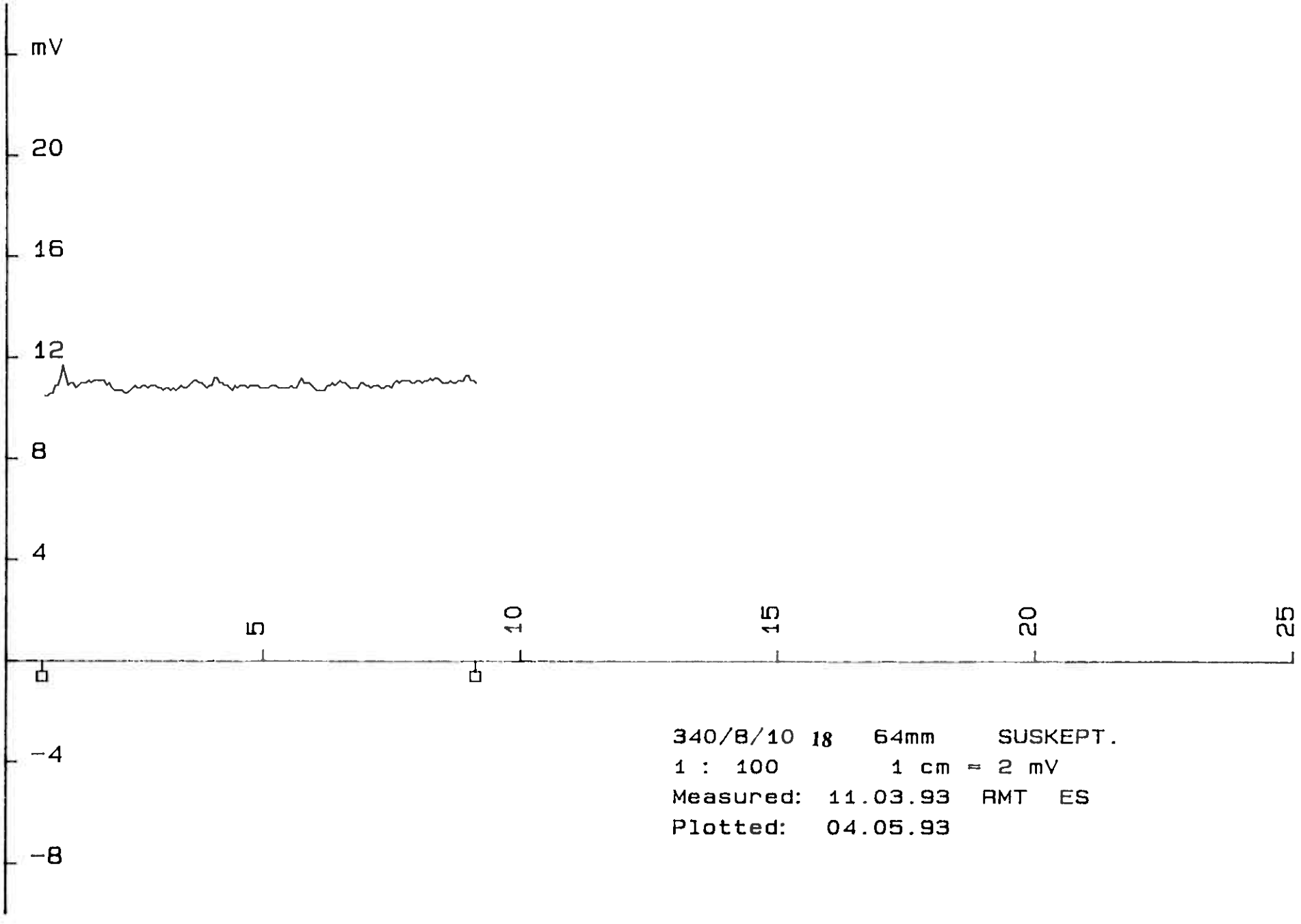
340/8/10 21 64mm SUSKEPT.
1 : 100 1 cm = 2 mV
Measured: 11.03.93 RMT ES
Plotted: 04.05.93

Apr 5/4

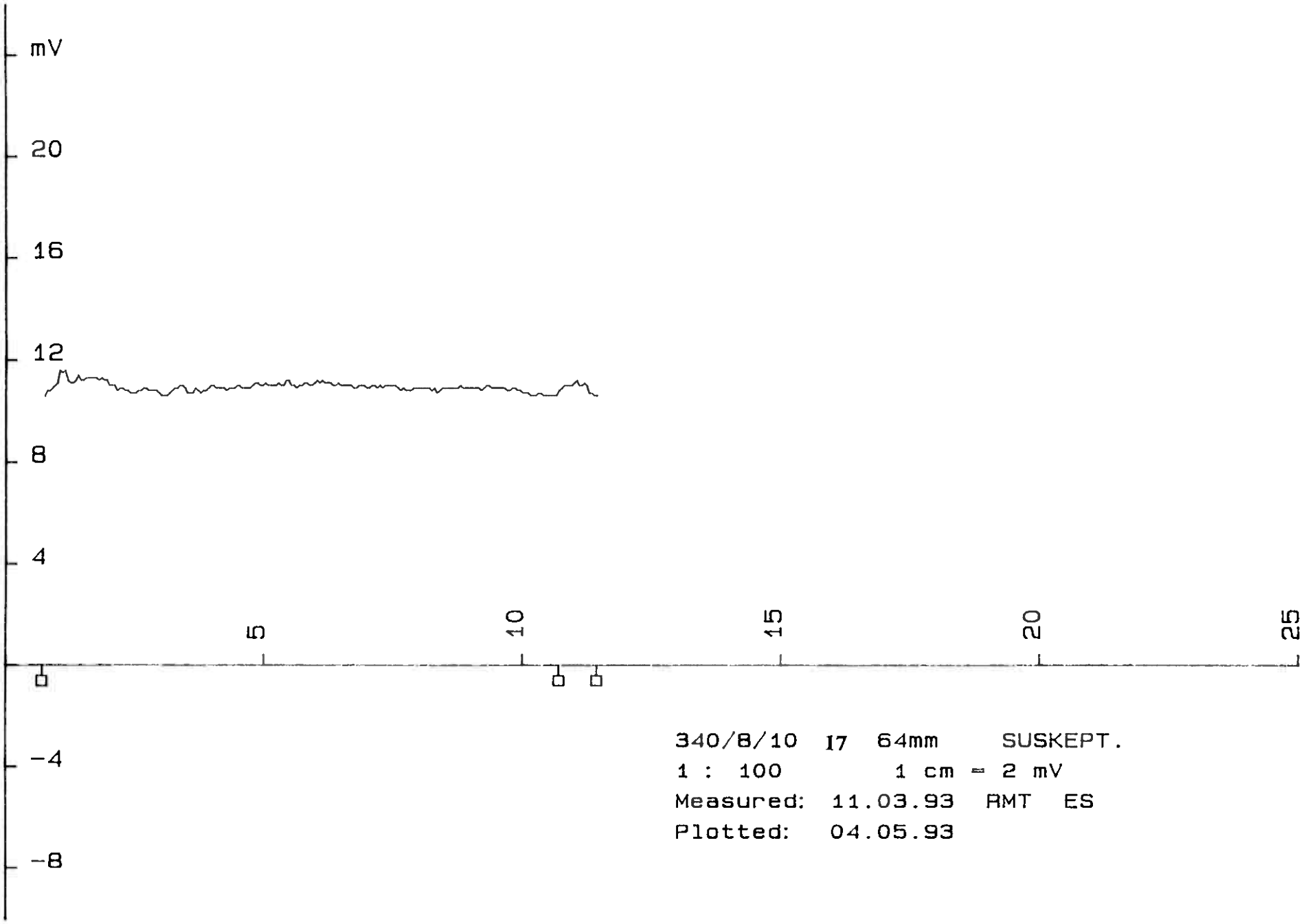

mV
20
16
12
8
4
5
10
15
20
25
-4
-8
340/8/10 20 64mm SUSKEPT.
1 : 100 1 cm = 2 mV
Measured: 11.03.93 RMT ES
Plotted: 04.05.93

Apn 5/3

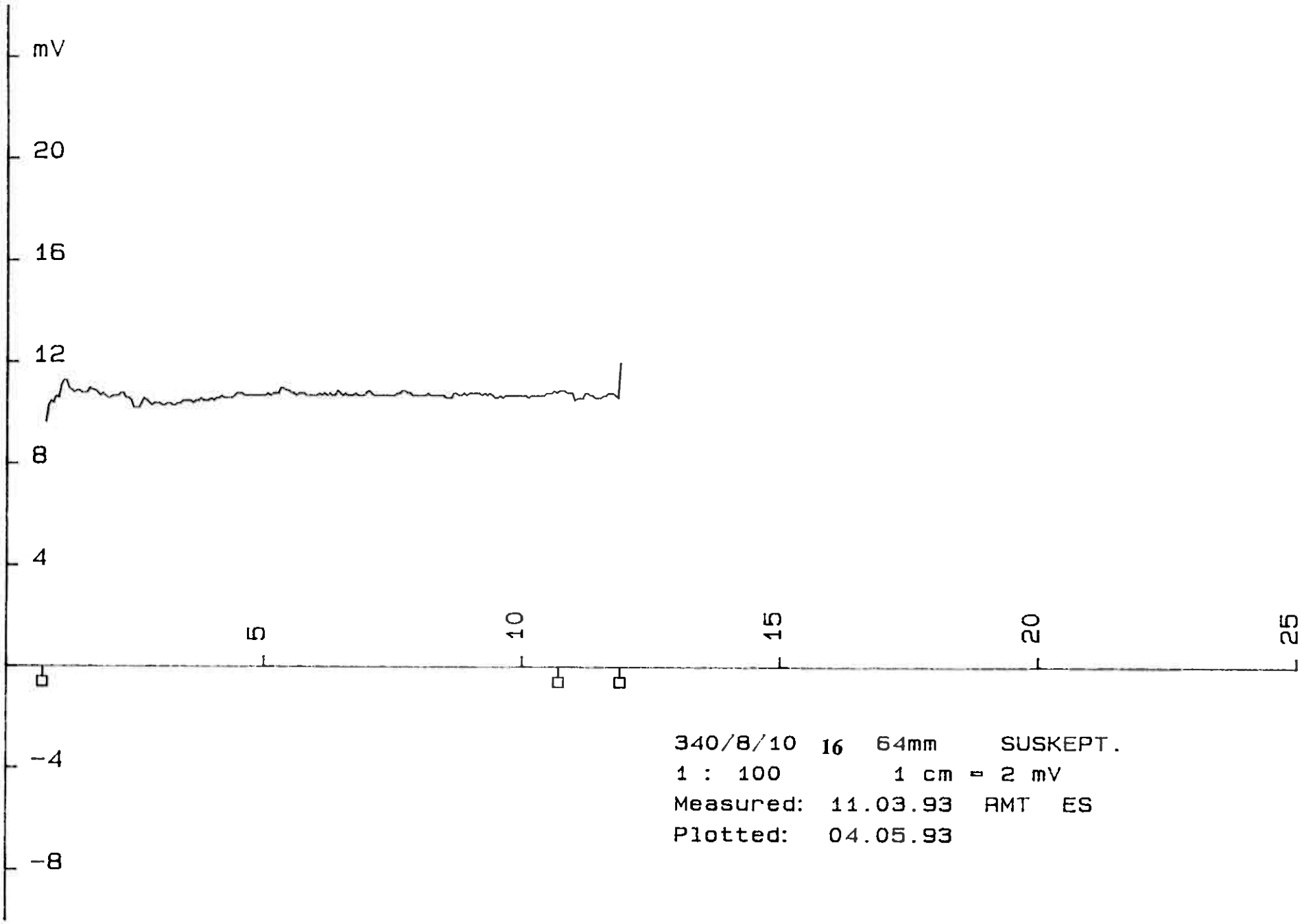

mV
20
16
12
8
4
-4
-8
5
10
15
20
25
340/8/10 19 64mm SUSKEPT.
1 : 100 1 cm = 2 mV
Measured: 11.03.93 RMT ES
Plotted: 04.05.93


mV
20
16
12
8
4
-4
-8
5
10
15
20
25
340/8/10 18 64mm SUSKEPT.
1 : 100 1 cm = 2 mV
Measured: 11.03.93 RMT ES
Plotted: 04.05.93

4/5 ms

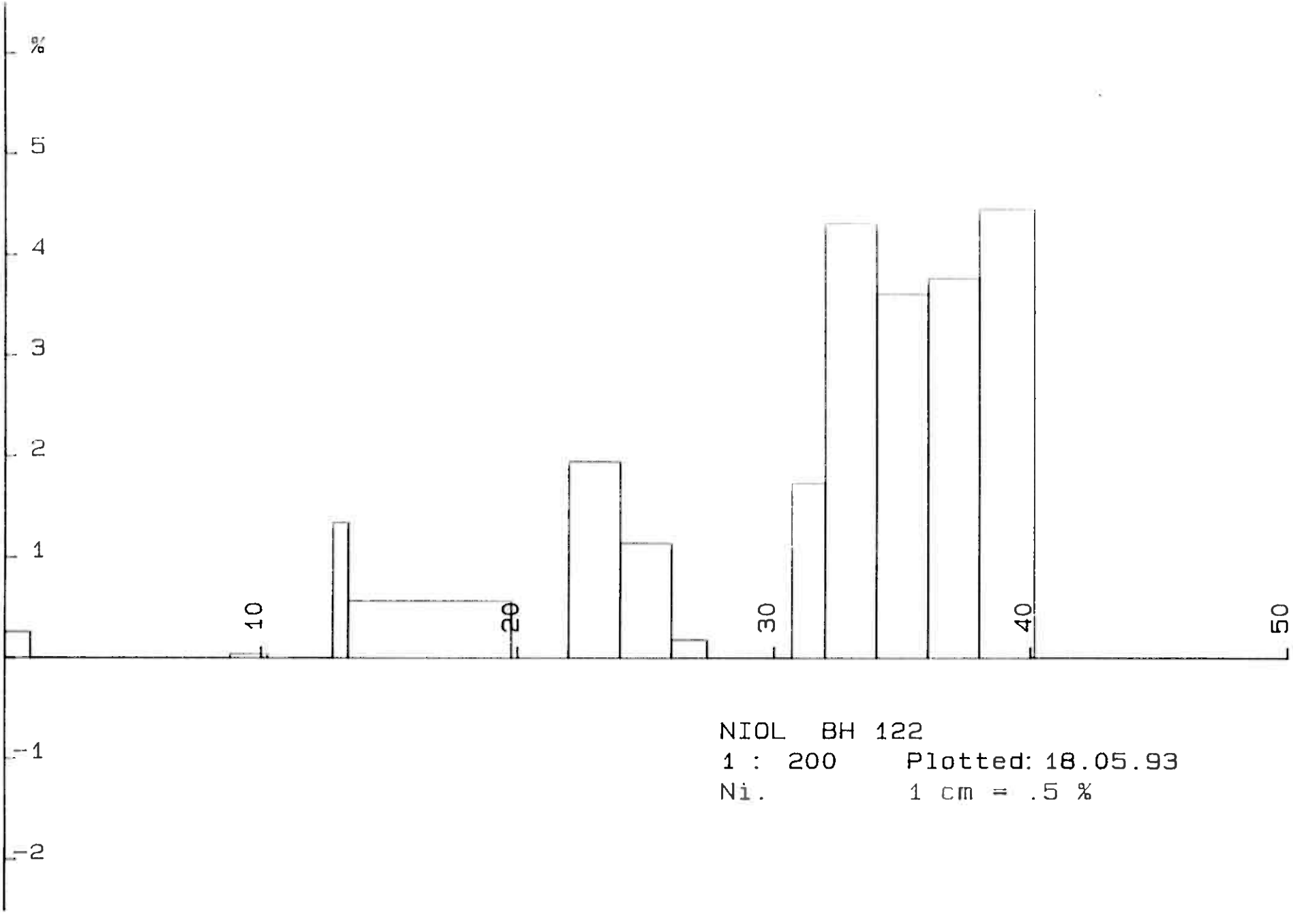

mV
20
16
12
8
4
5
10
15
20
25
-4
-8
340/8/10 17 64mm SUSKEPT.
1 : 100 1 cm = 2 mV
Measured: 11.03.93 RMT ES
Plotted: 04.05.93

AM 5/8



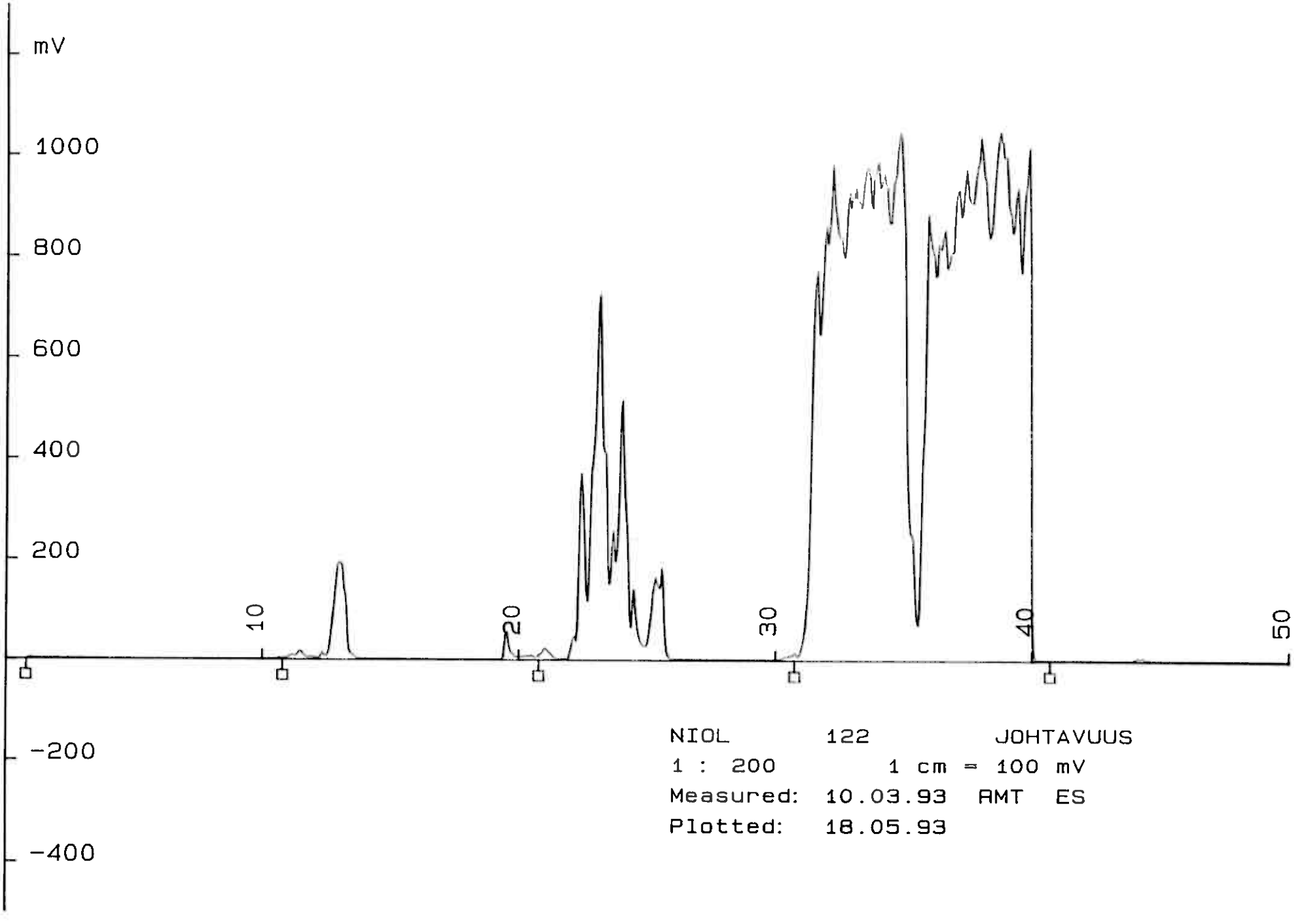
340/8/10 **16** 64mm SUSKEPT.
1 : 100 1 cm = 2 mV
Measured: 11.03.93 AMT ES
Plotted: 04.05.93

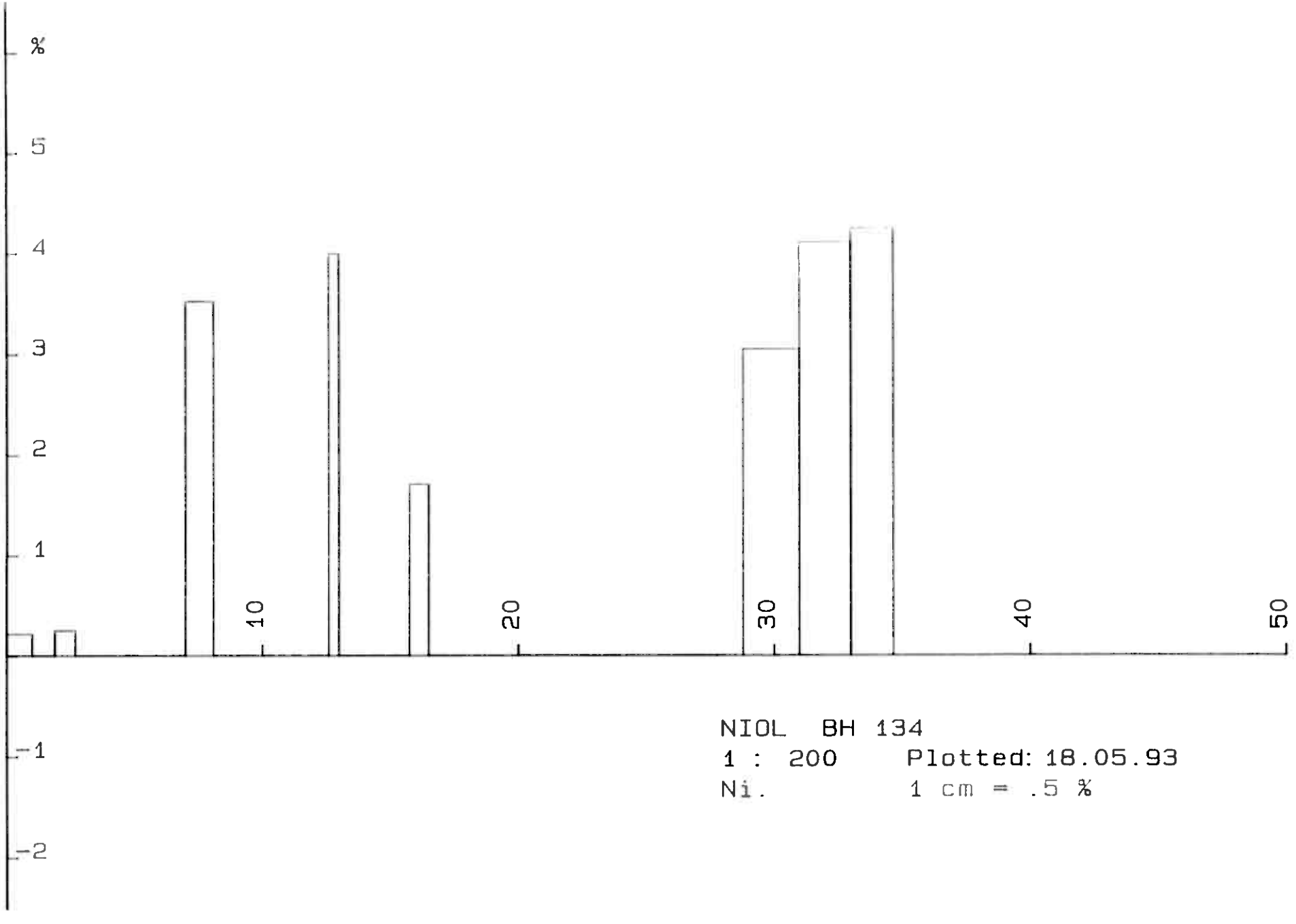
AM 5/5



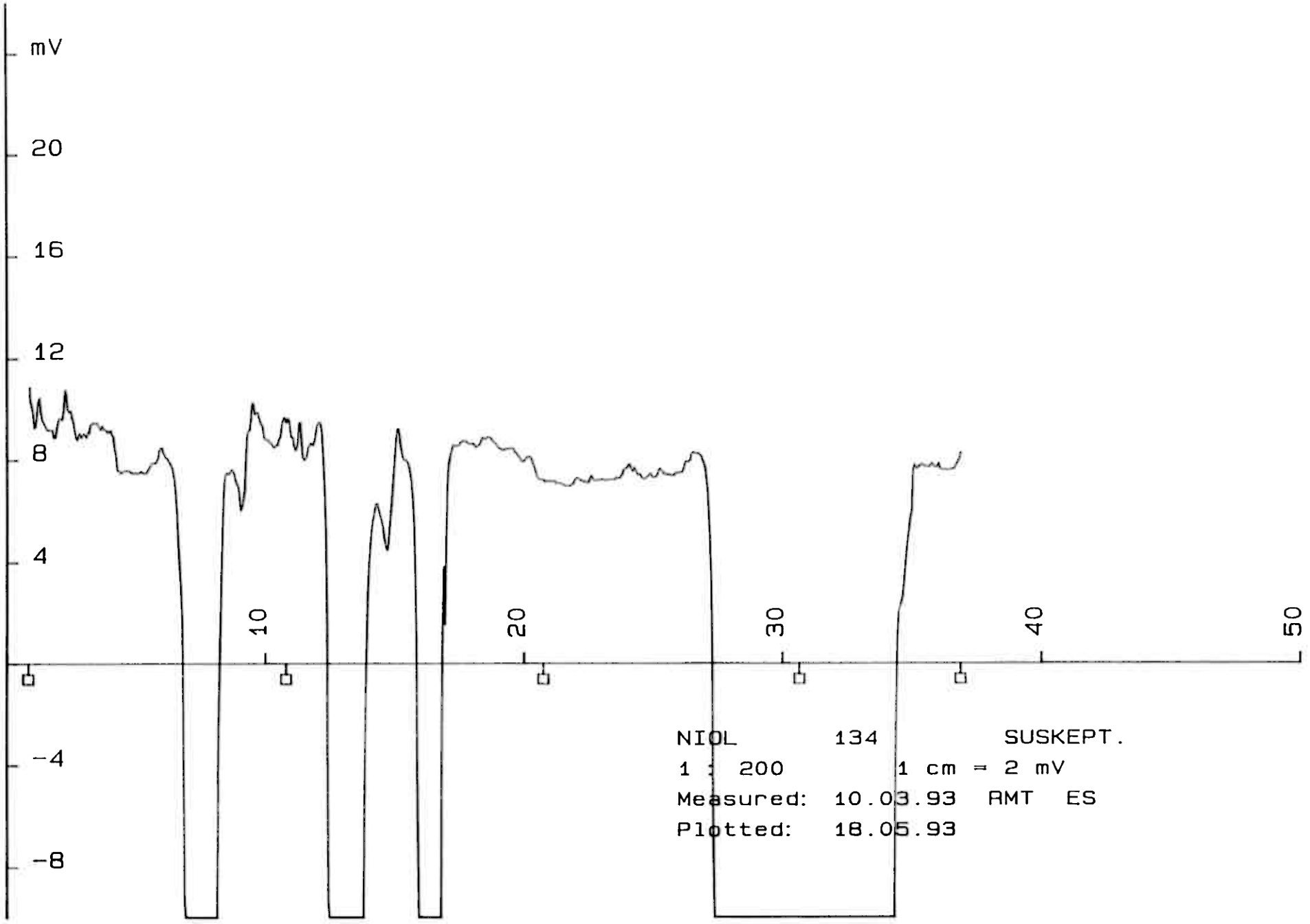
NIOL BH 122
1 : 200 Plotted: 18.05.93
Ni. 1 cm = .5 %

App. 6/1

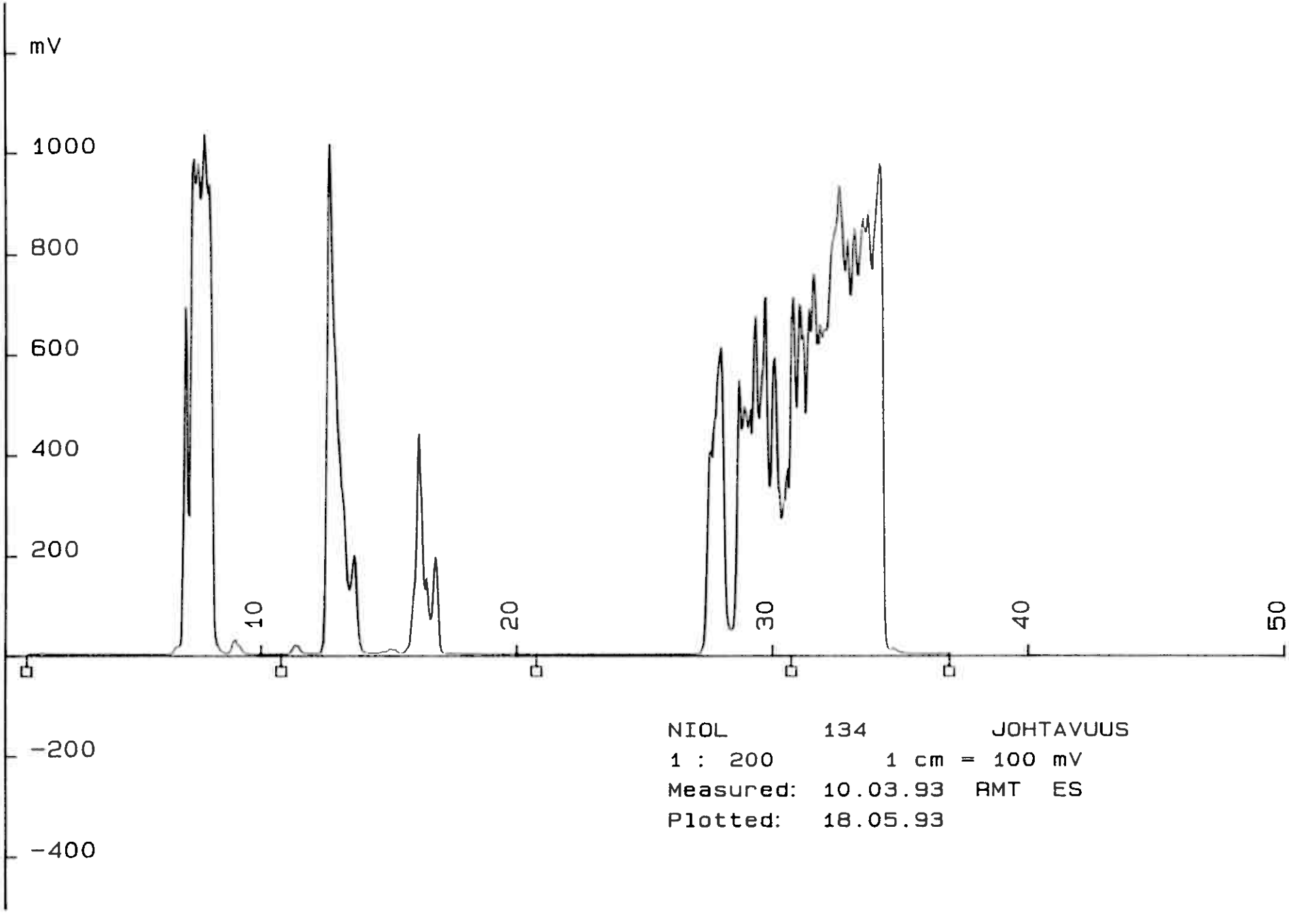

mV
1000
800
600
400
200
-200
-400
10
20
30
40
50
NIOL 122 JOHTAVUUS
1 : 200 1 cm = 100 mV
Measured: 10.03.93 AMT ES
Plotted: 18.05.93

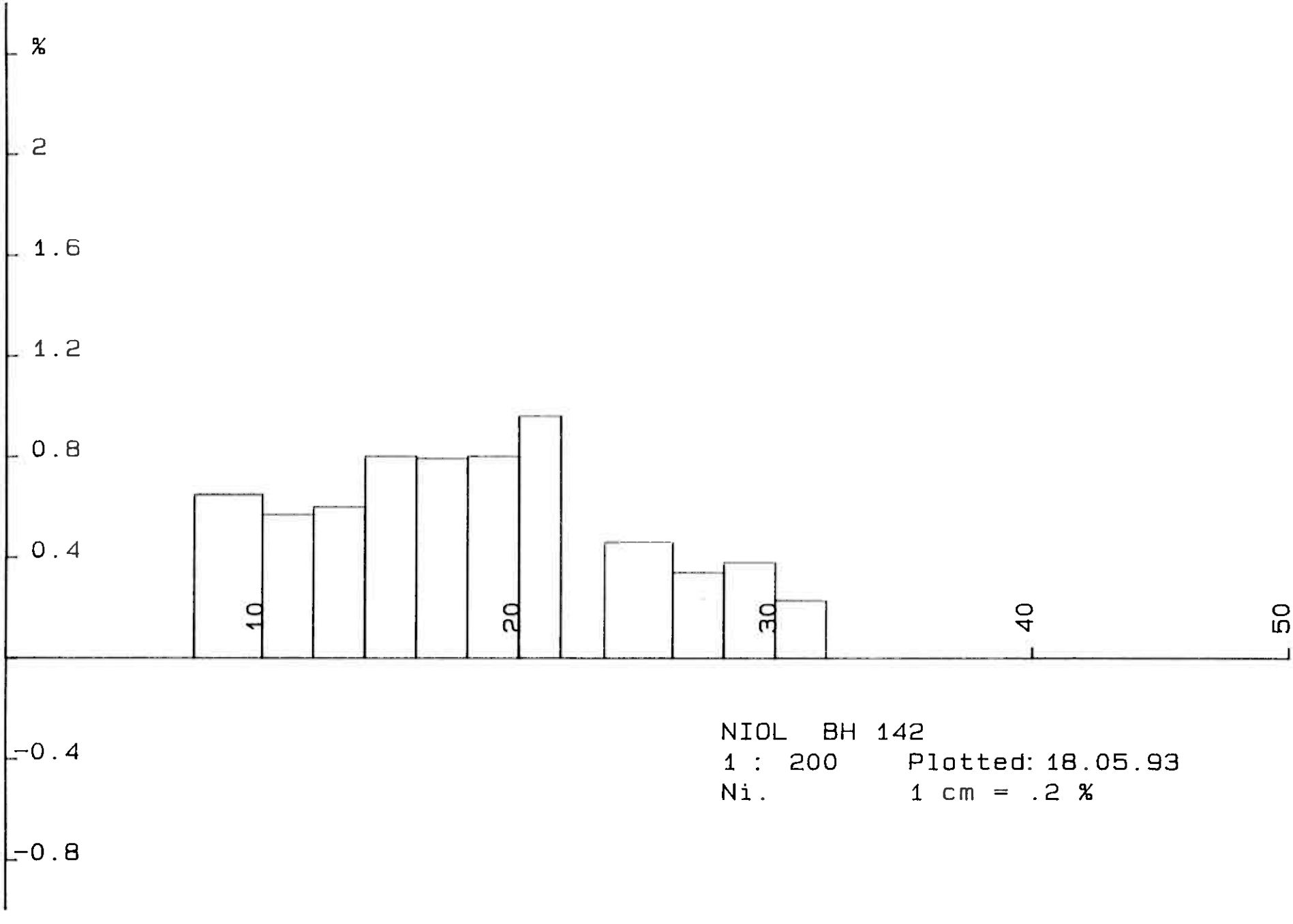


NIOL BH 134
1 : 200 Plotted: 18.05.93
Ni. 1 cm = .5 %

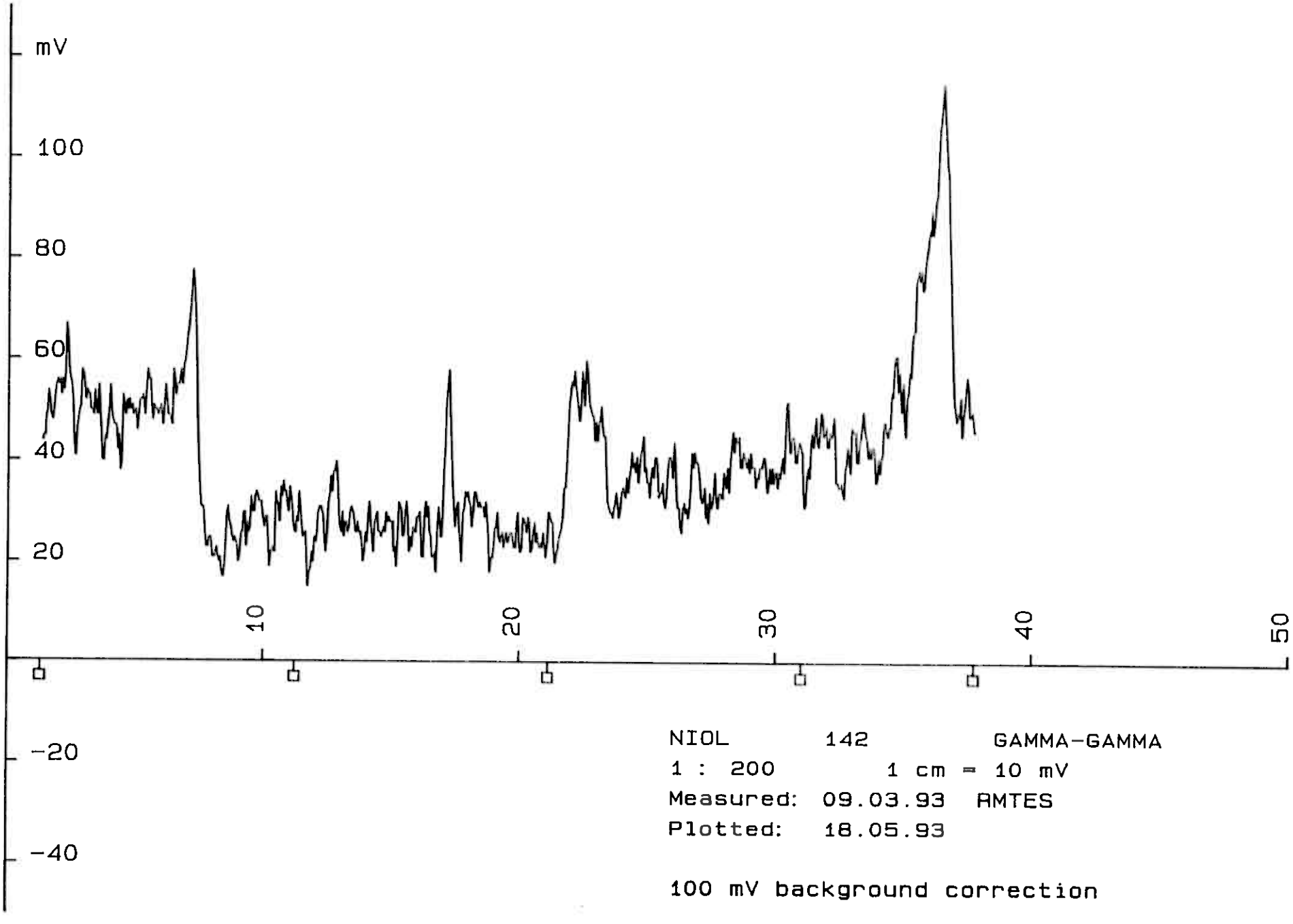

mV
20
16
12
8
4
-4
-8
10
20
30
40
50
NIOL 134 SUSKEPT.
1 : 200 1 cm = 2 mV
Measured: 10.03.93 AMT ES
Plotted: 18.05.93

App. 6/4


mV
1000
800
600
400
200
-200
-400
10
20
30
40
50
NIOL 134 JOHTAVUUS
1 : 200 1 cm = 100 mV
Measured: 10.03.93 RMT ES
Plotted: 18.05.93

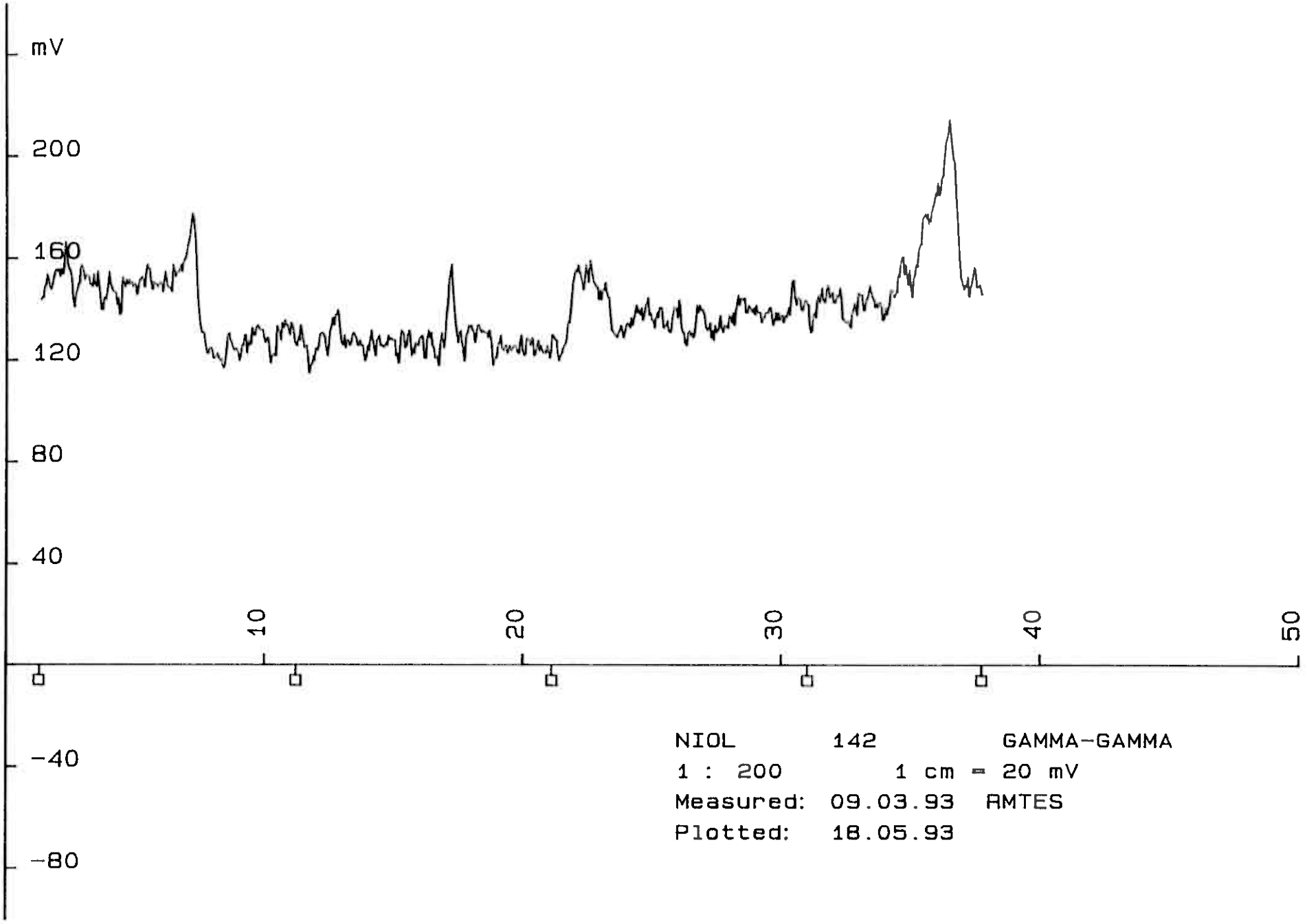


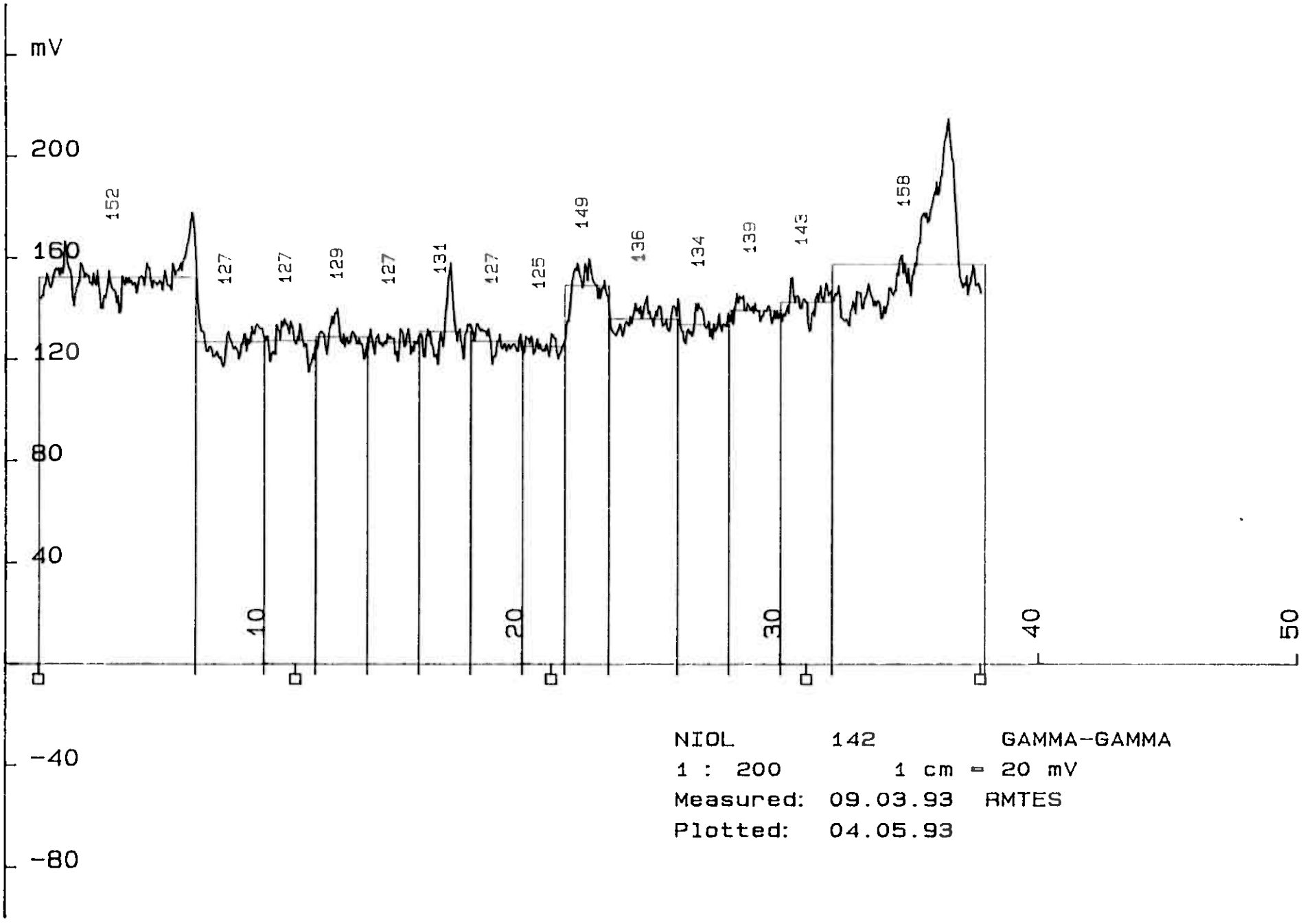
NIOL BH 142
1 : 200 Plotted: 18.05.93
Ni. 1 cm = .2 %



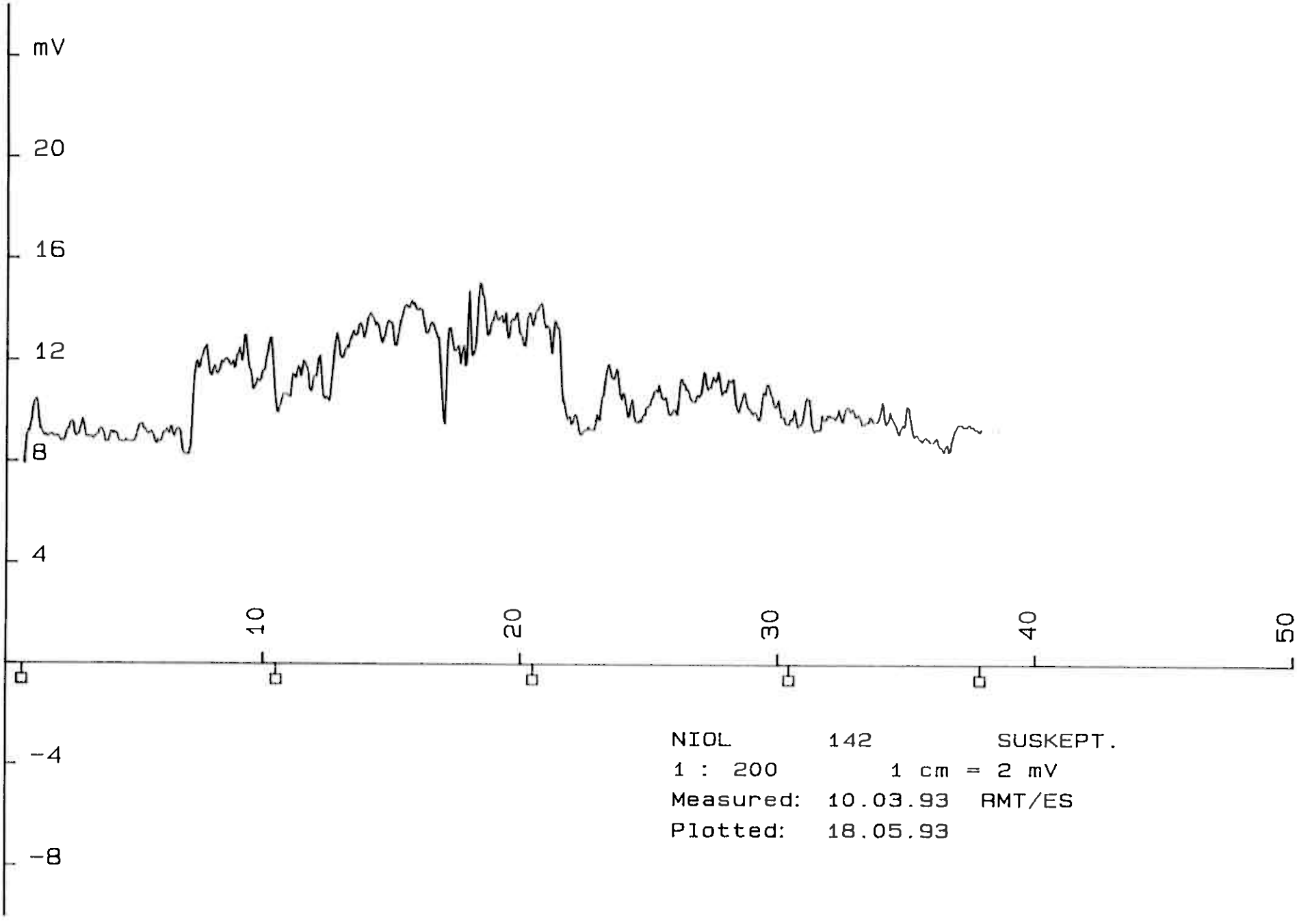
NIOL 142 GAMMA-GAMMA
1 : 200 1 cm = 10 mV
Measured: 09.03.93 AMTES
Plotted: 18.05.93

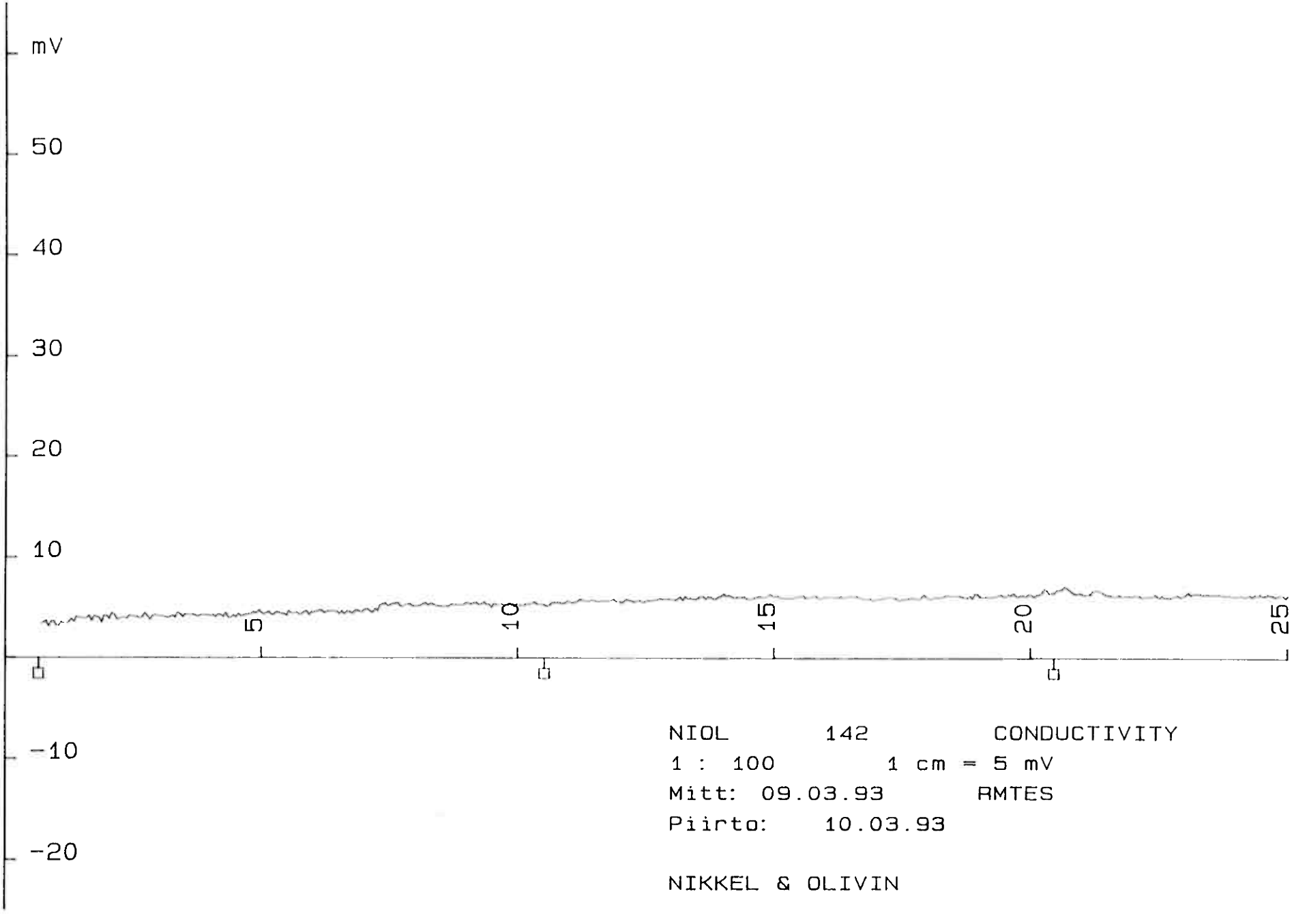
100 mV background correction


mV
200
160
120
80
40
10
20
30
40
50
-40
-80
NIOL 142 GAMMA-GAMMA
1 : 200 1 cm = 20 mV
Measured: 09.03.93 RMTES
Plotted: 18.05.93



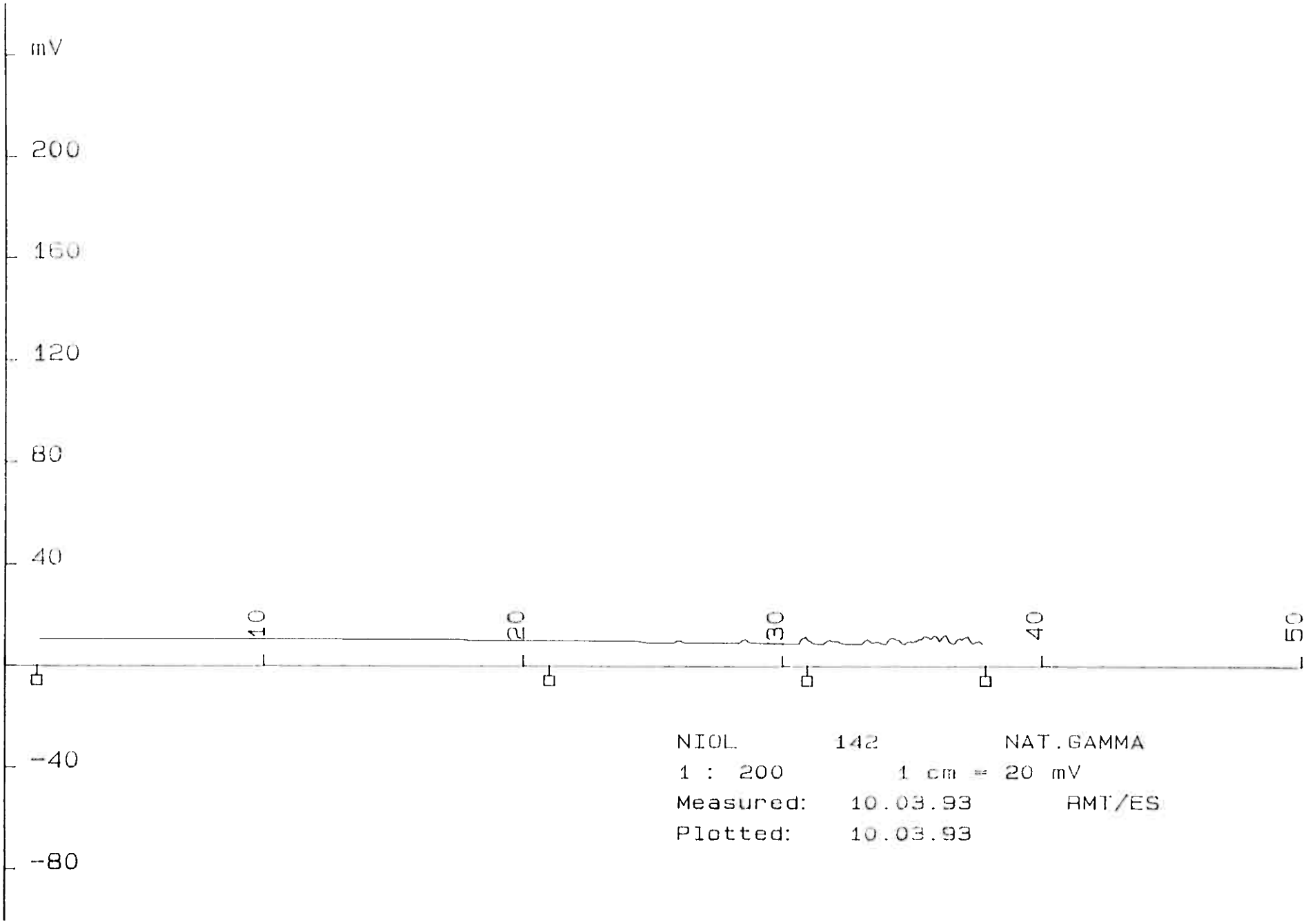
NIOL 142 GAMMA-GAMMA
1 : 200 1 cm = 20 mV
Measured: 09.03.93 RMTES
Plotted: 04.05.93


mV
20
16
12
8
4
-4
-8
10
20
30
40
50
NIOL 142 SUSKEPT.
1 : 200 1 cm = 2 mV
Measured: 10.03.93 RMT/ES
Plotted: 18.05.93

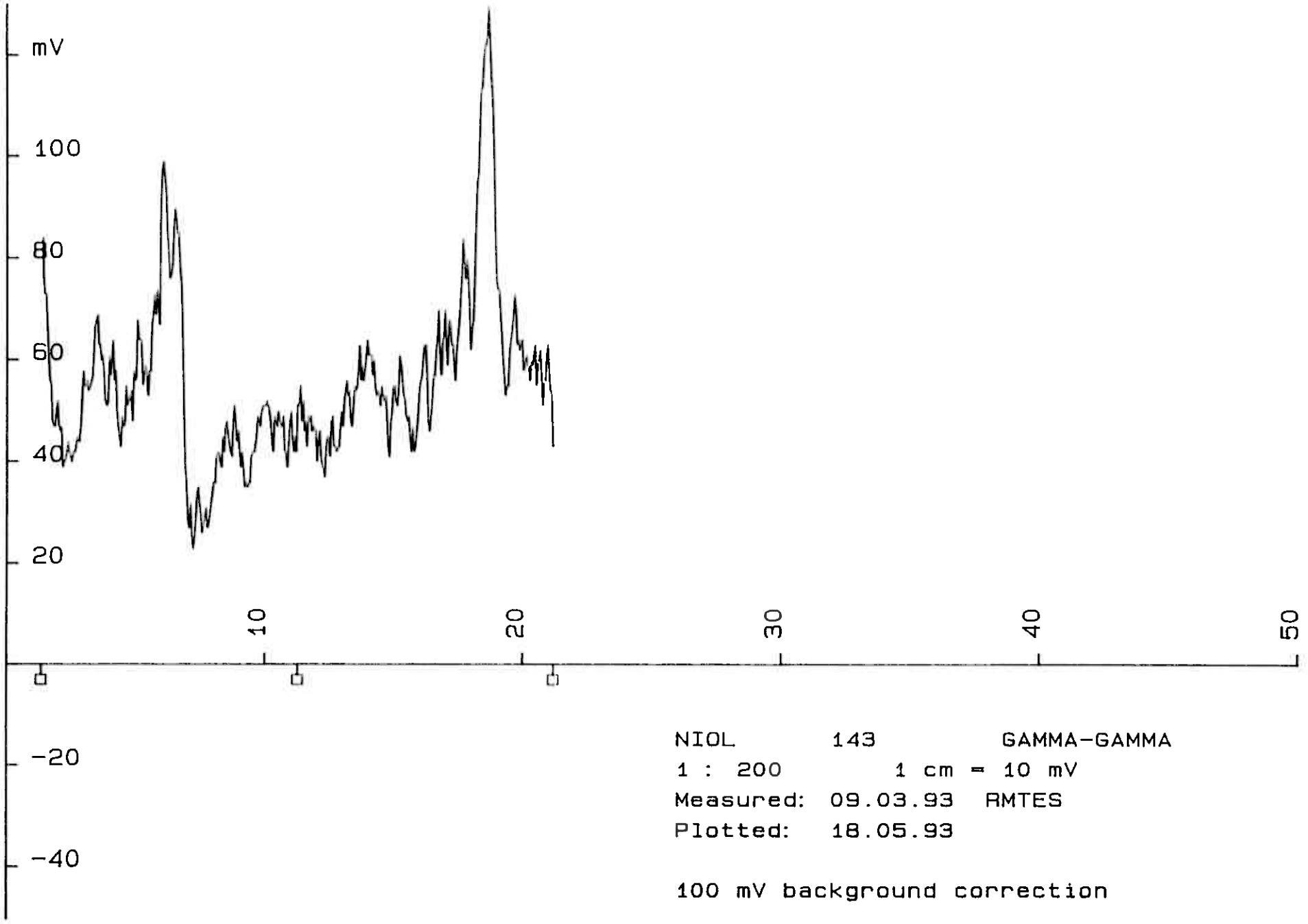


NIOL 142 CONDUCTIVITY
1 : 100 1 cm = 5 mV
Mitt: 09.03.93 RMTES
Piirto: 10.03.93

NIKKEL & OLIVIN

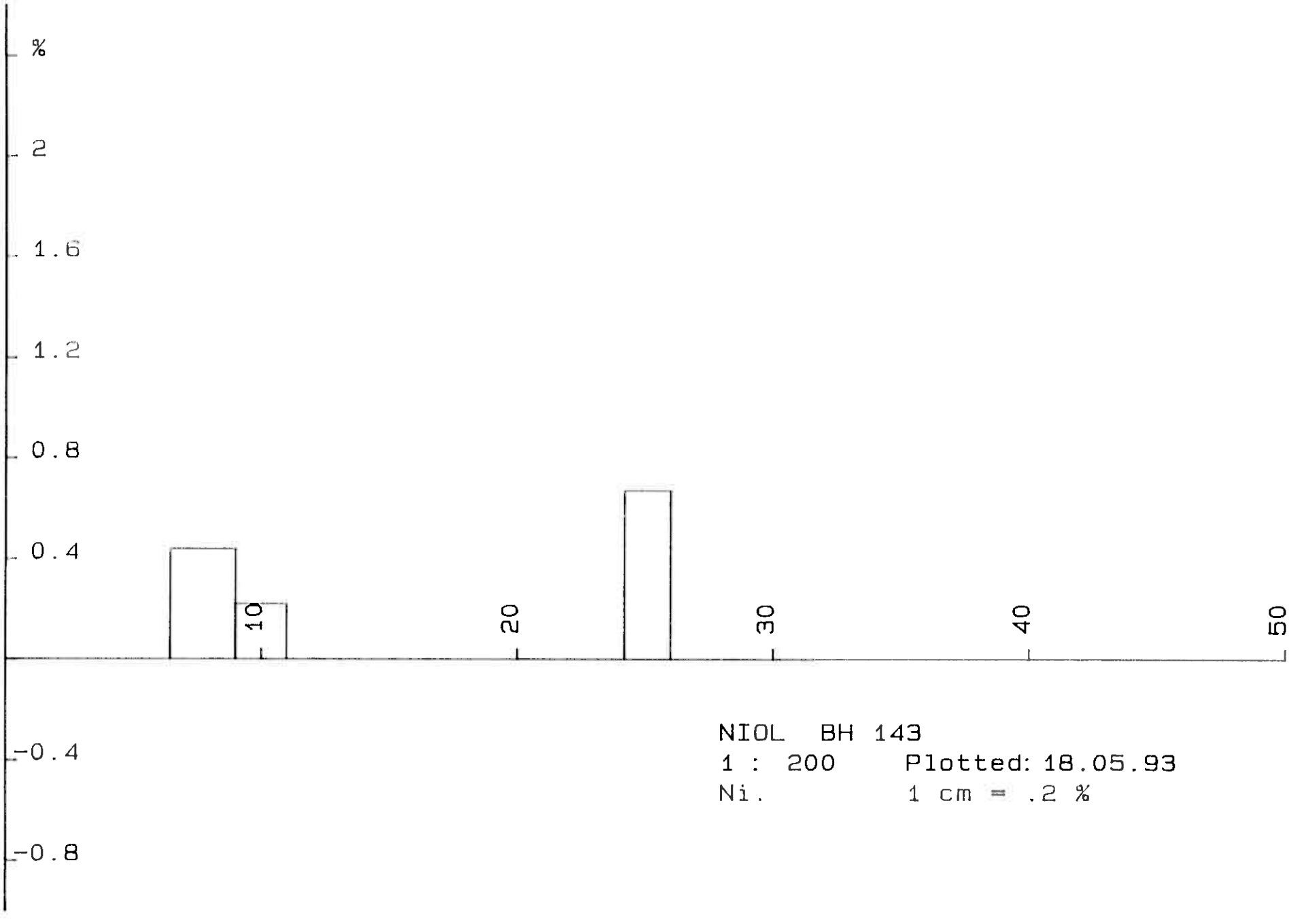

mV
200
160
120
80
40
10
20
30
40
50
-40
-80
NIOL 142 NAT.GAMMA
1 : 200 1 cm = 20 mV
Measured: 10.03.93 RMT/ES
Plotted: 10.03.93

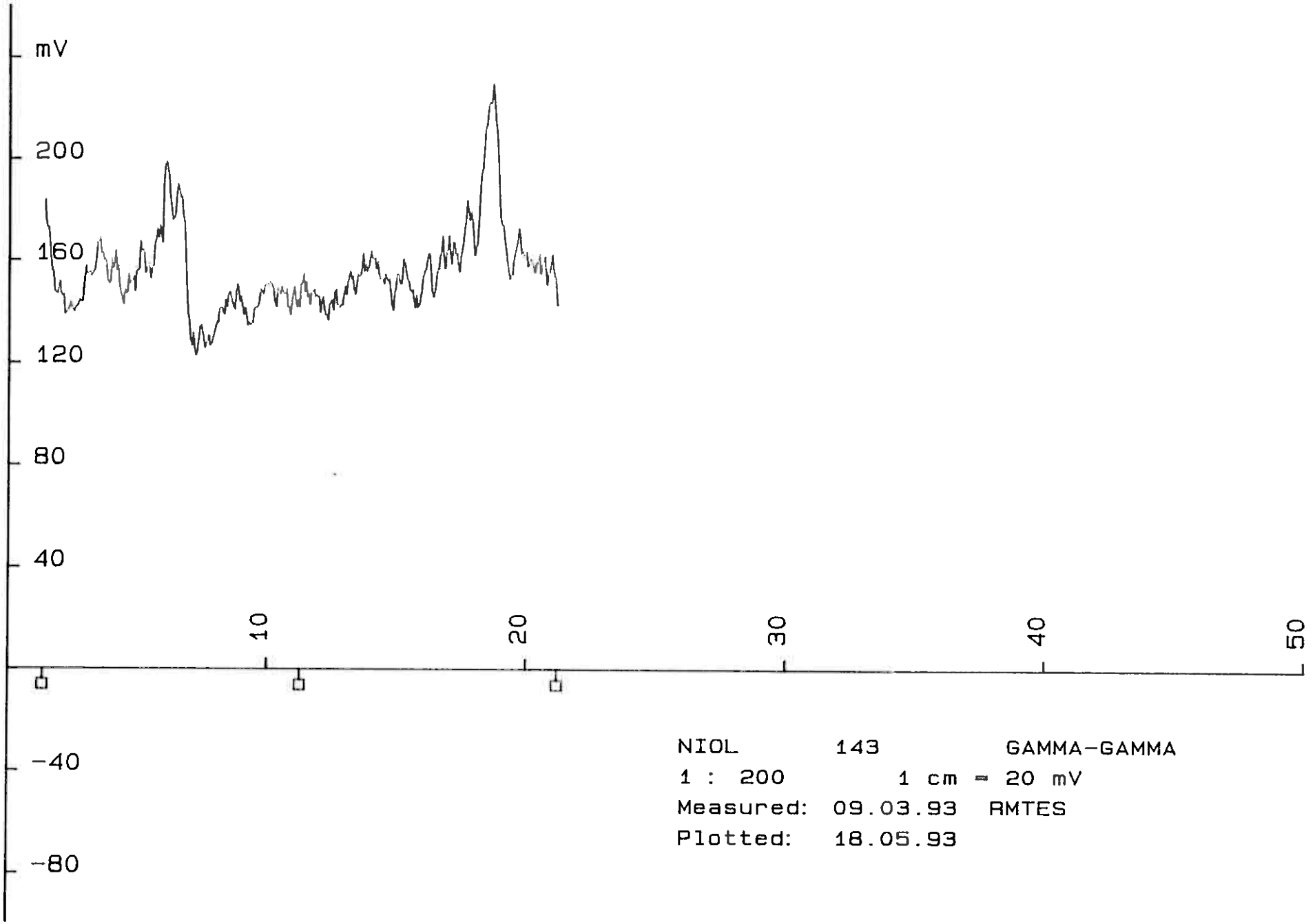
App. 6/12

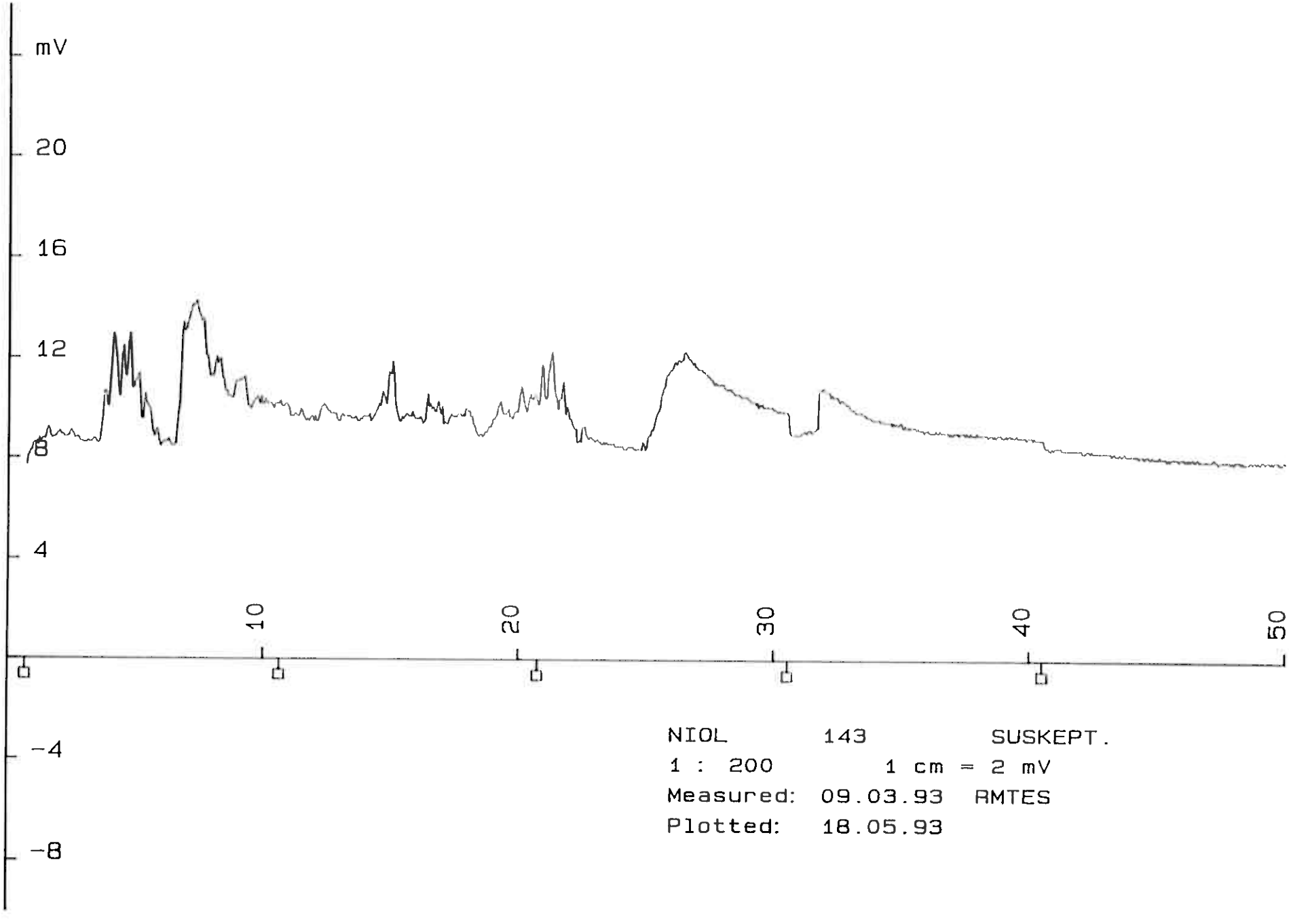


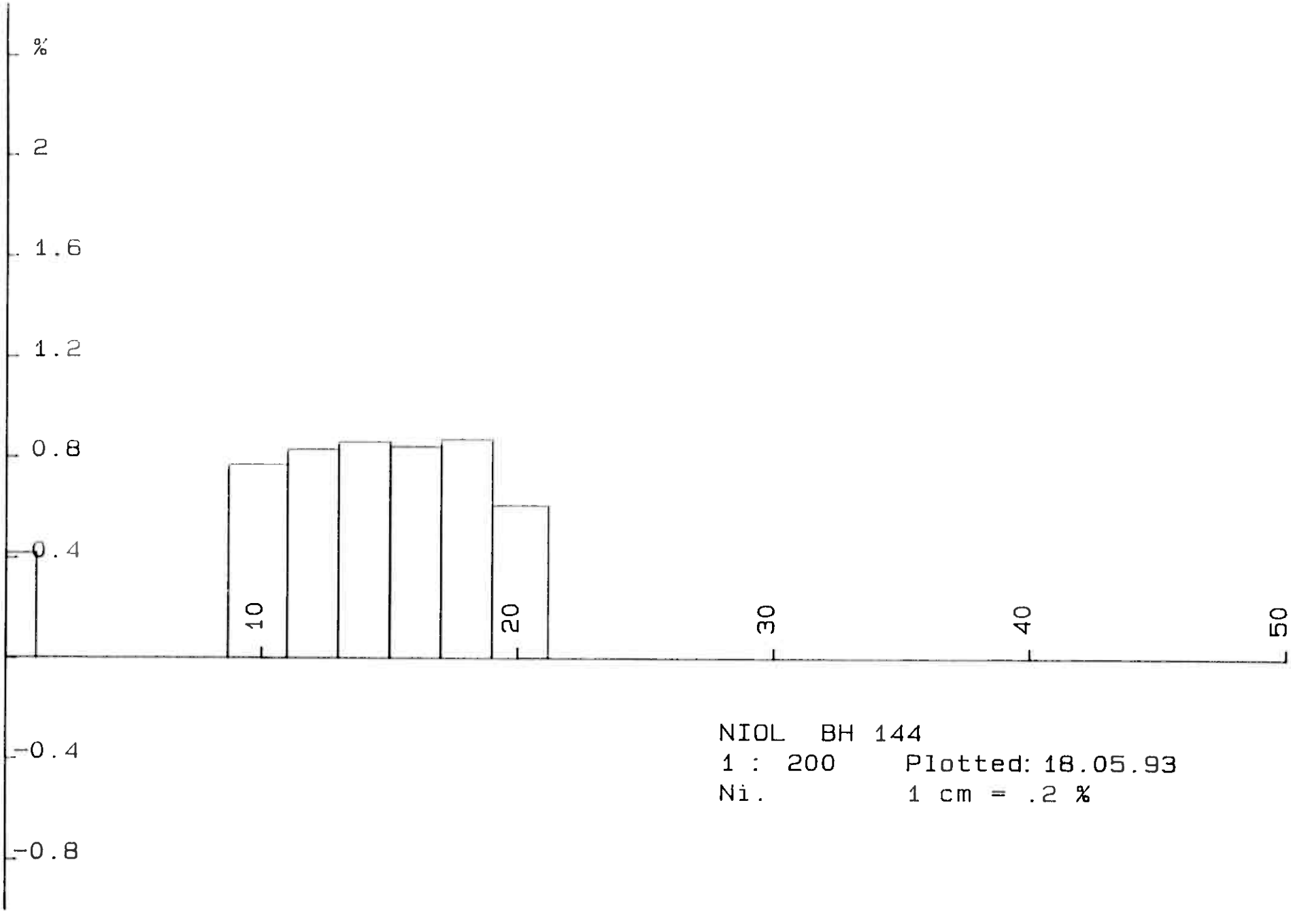
NIOL 143 GAMMA-GAMMA
1 : 200 1 cm = 10 mV
Measured: 09.03.93 RMTES
Plotted: 18.05.93

100 mV background correction


%
2
1.6
1.2
0.8
0.4
-0.4
-0.8
10
20
30
40
50
NIOL BH 143
1 : 200 Plotted: 18.05.93
Ni. 1 cm = .2 %

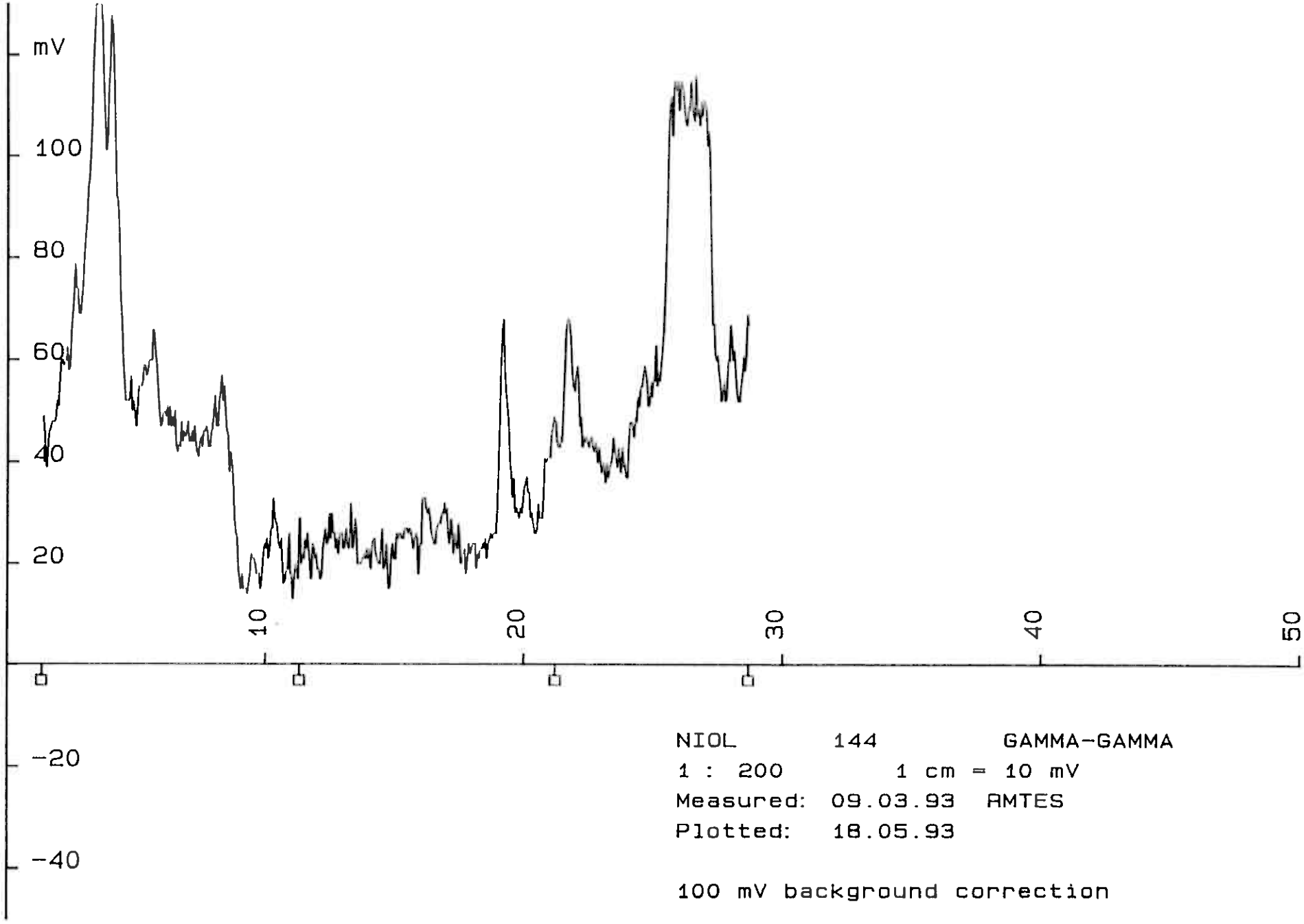

mV
200
160
120
80
40
10
20
30
40
50
-40
-80
NIOL 143 GAMMA-GAMMA
1 : 200 1 cm = 20 mV
Measured: 09.03.93 RMTES
Plotted: 18.05.93


mV
20
16
12
8
4
-4
-8
10
20
30
40
50
NIOL 143 SUSKEPT.
1 : 200 1 cm = 2 mV
Measured: 09.03.93 RMTES
Plotted: 18.05.93



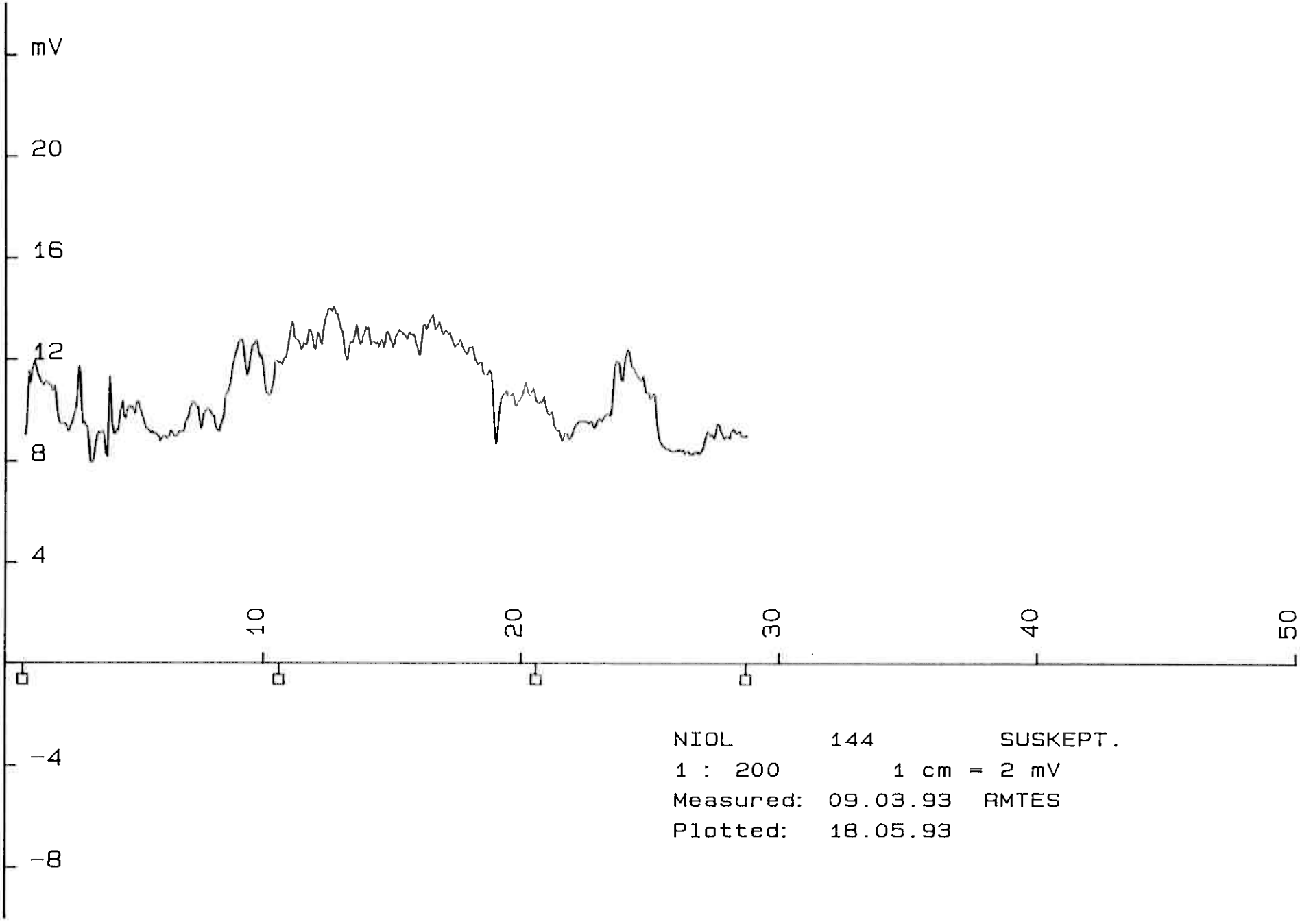
NIOL BH 144
1 : 200 Plotted: 18.05.93
Ni. 1 cm = .2 %

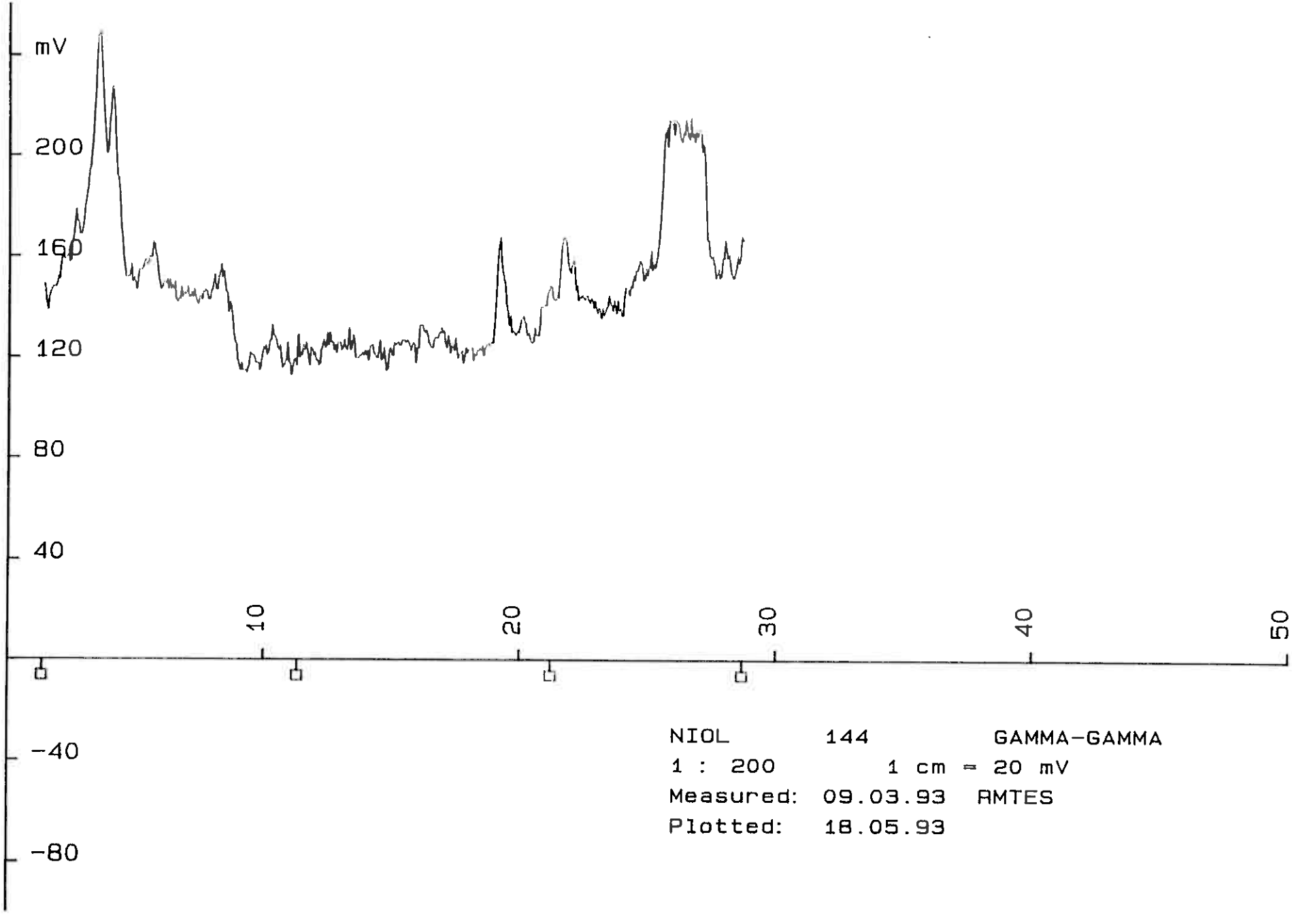
App. 6/17



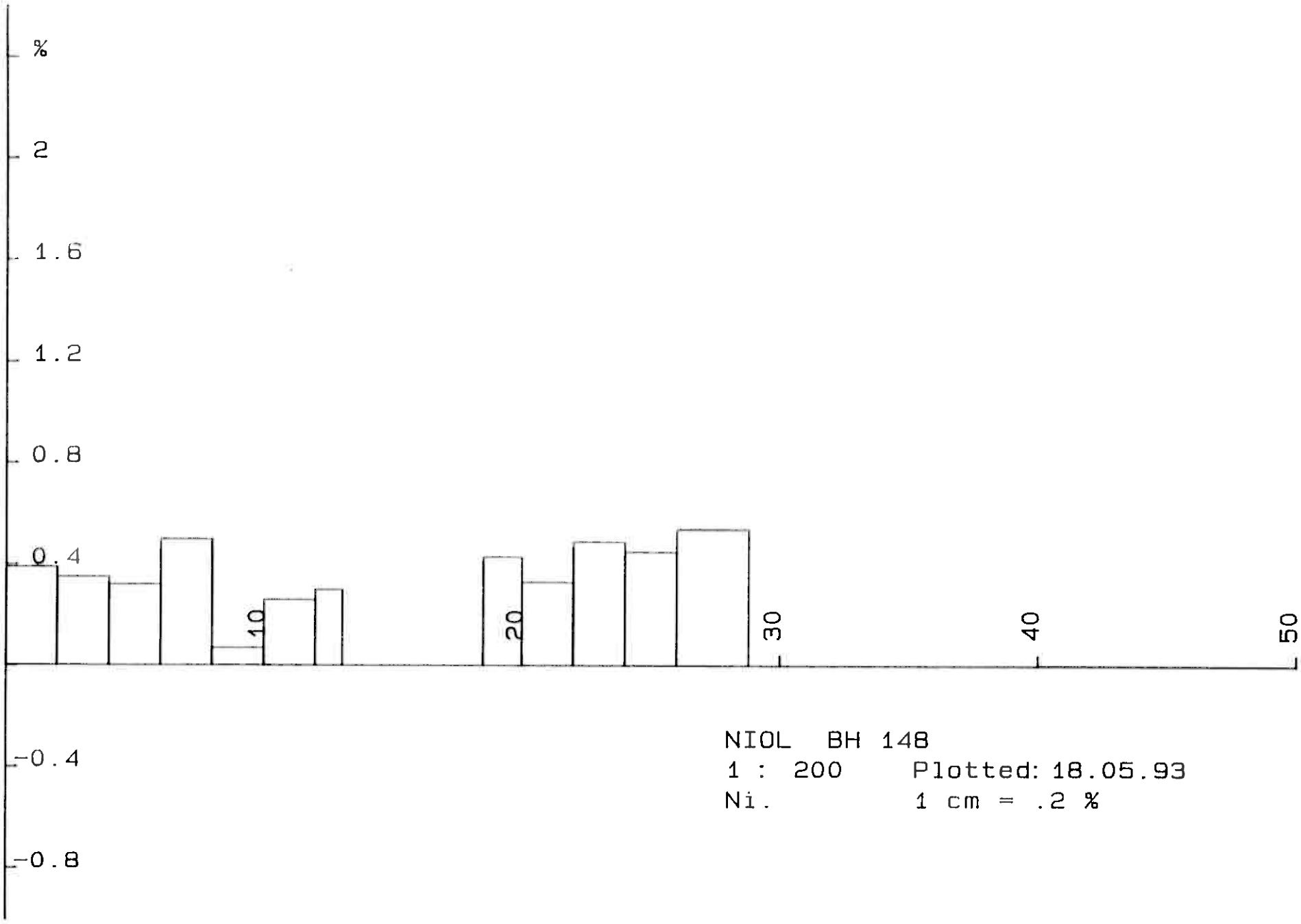
NIOL 144 GAMMA-GAMMA
1 : 200 1 cm = 10 mV
Measured: 09.03.93 AMTES
Plotted: 18.05.93

100 mV background correction

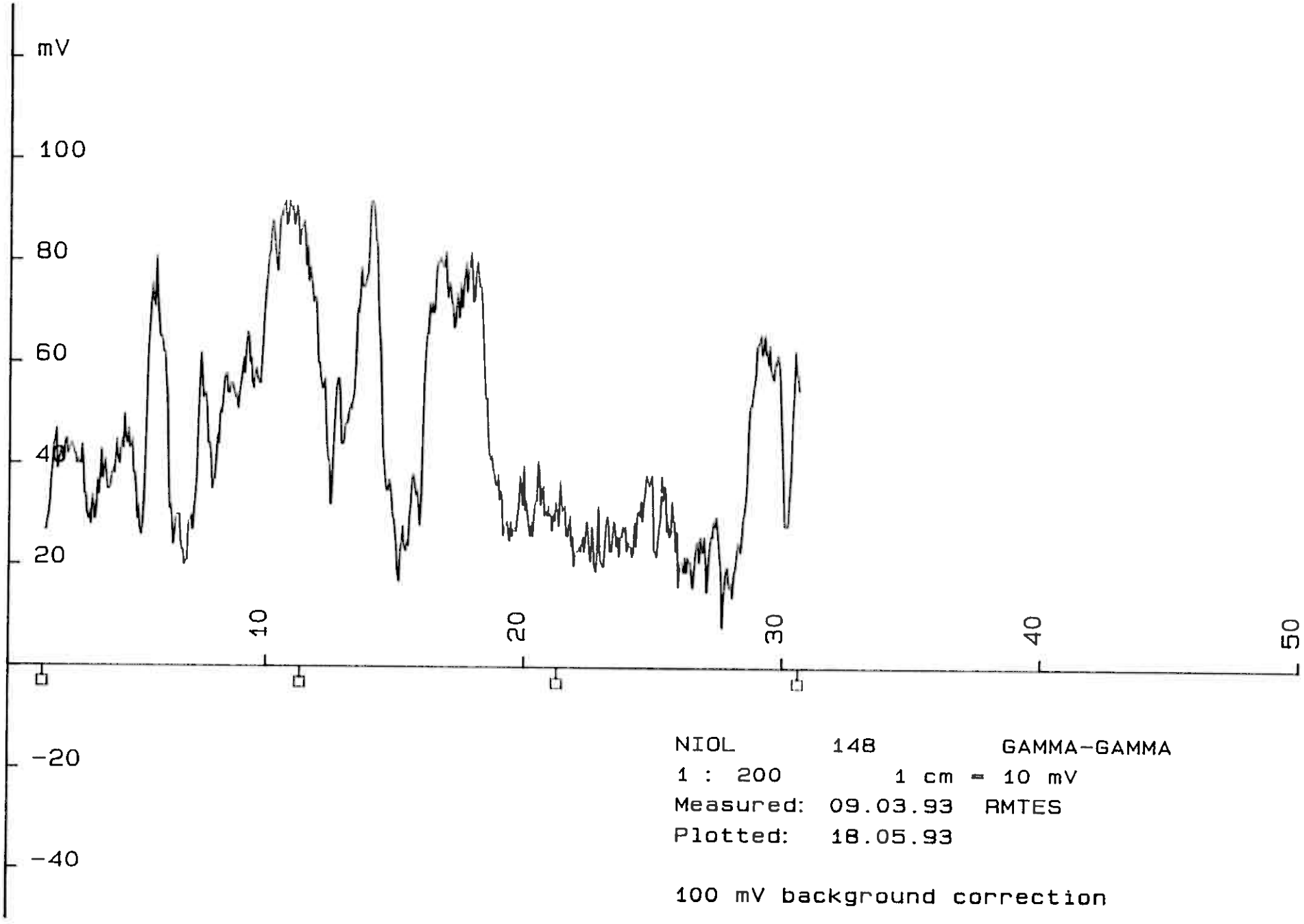

mV
20
16
12
8
4
10
20
30
40
50
-4
-8
NIOL 144 SUSKEPT.
1 : 200 1 cm = 2 mV
Measured: 09.03.93 RMTES
Plotted: 18.05.93


mV
200
160
120
80
40
10
20
30
40
50
-40
-80
NIOL 144 GAMMA-GAMMA
1 : 200 1 cm = 20 mV
Measured: 09.03.93 AMTES
Plotted: 18.05.93

App. 6/20



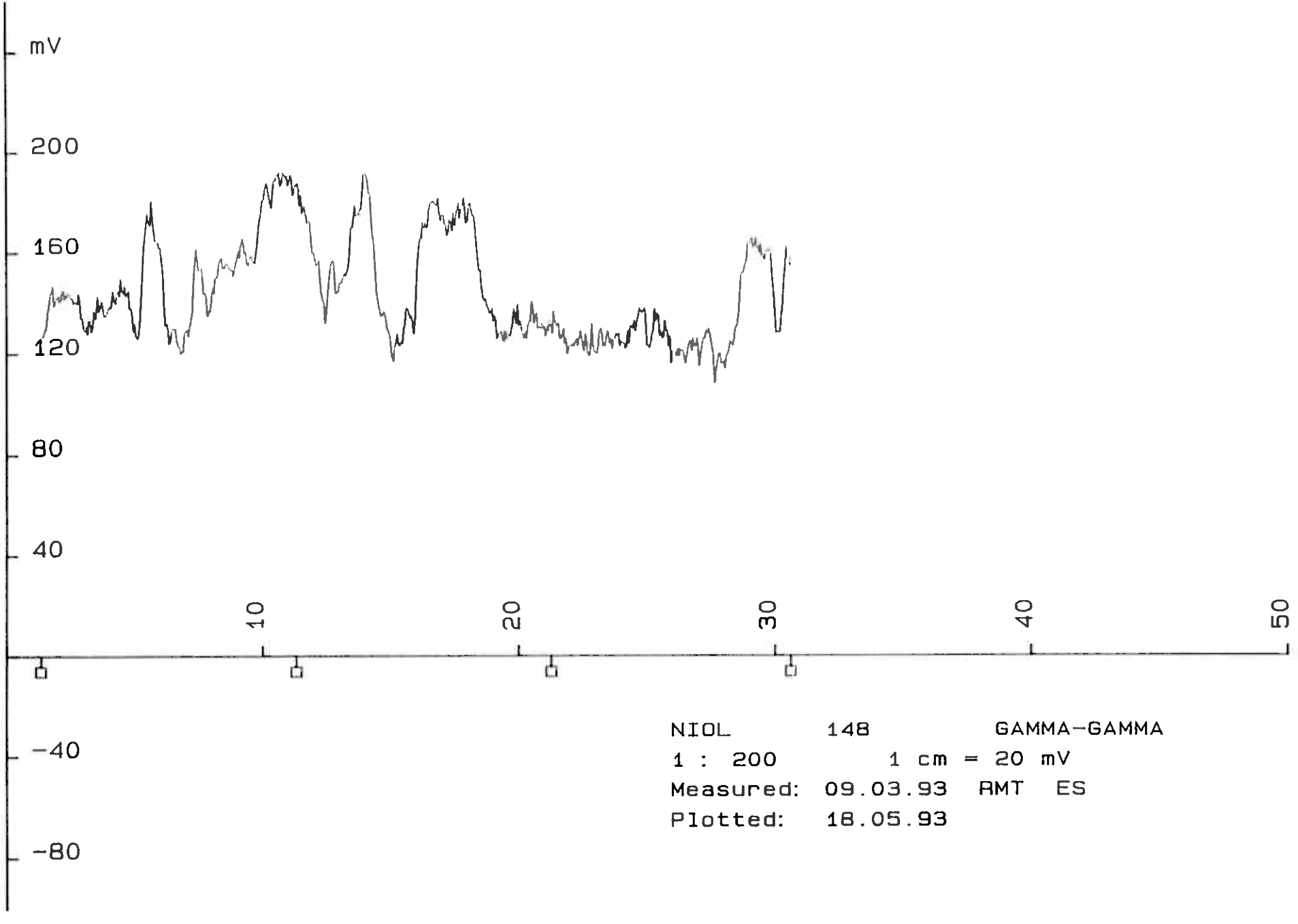
NIOL BH 148
1 : 200 Plotted: 18.05.93
Ni. 1 cm = .2 %

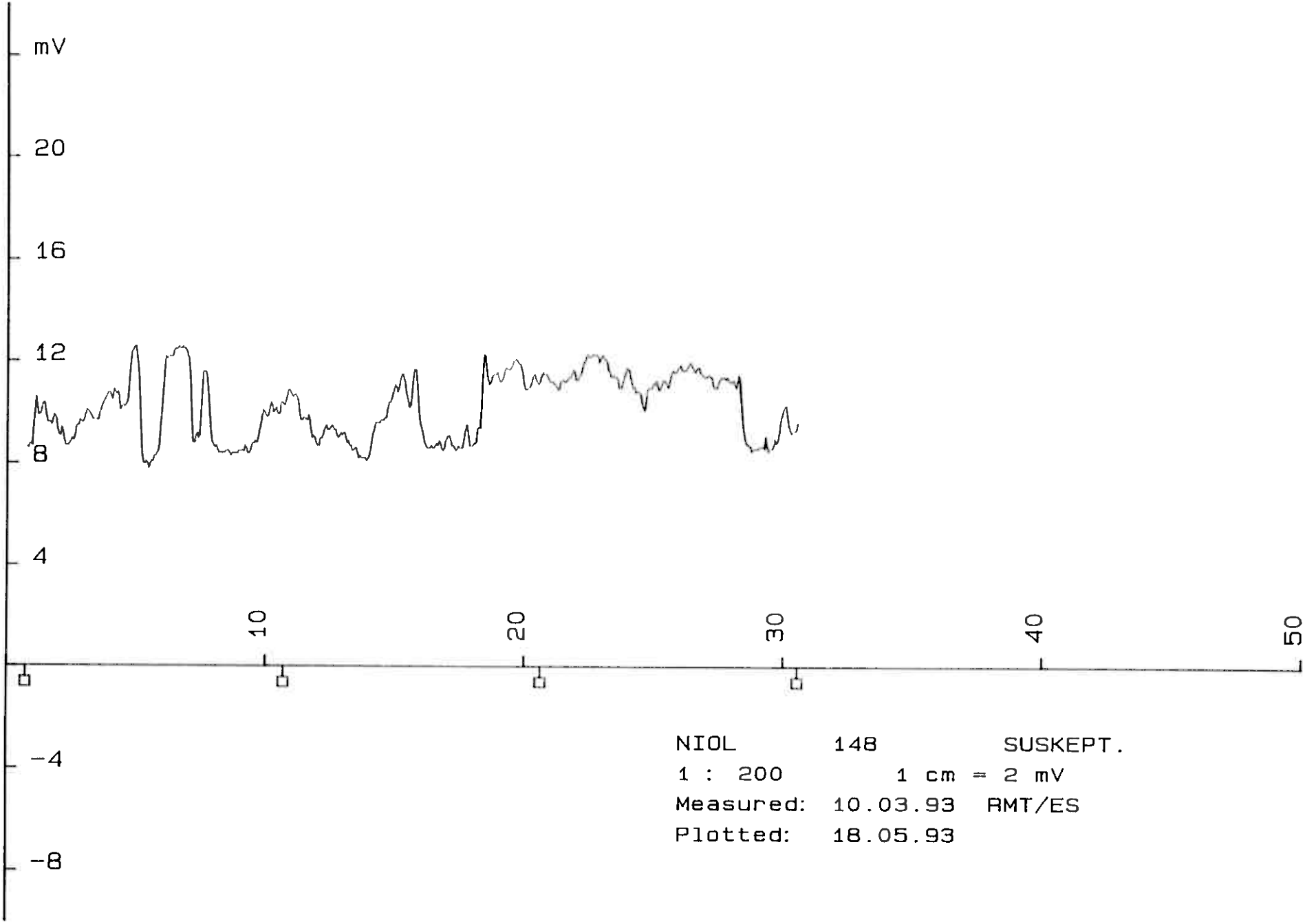


NIOL 148 GAMMA-GAMMA
1 : 200 1 cm = 10 mV
Measured: 09.03.93 RMTES
Plotted: 18.05.93

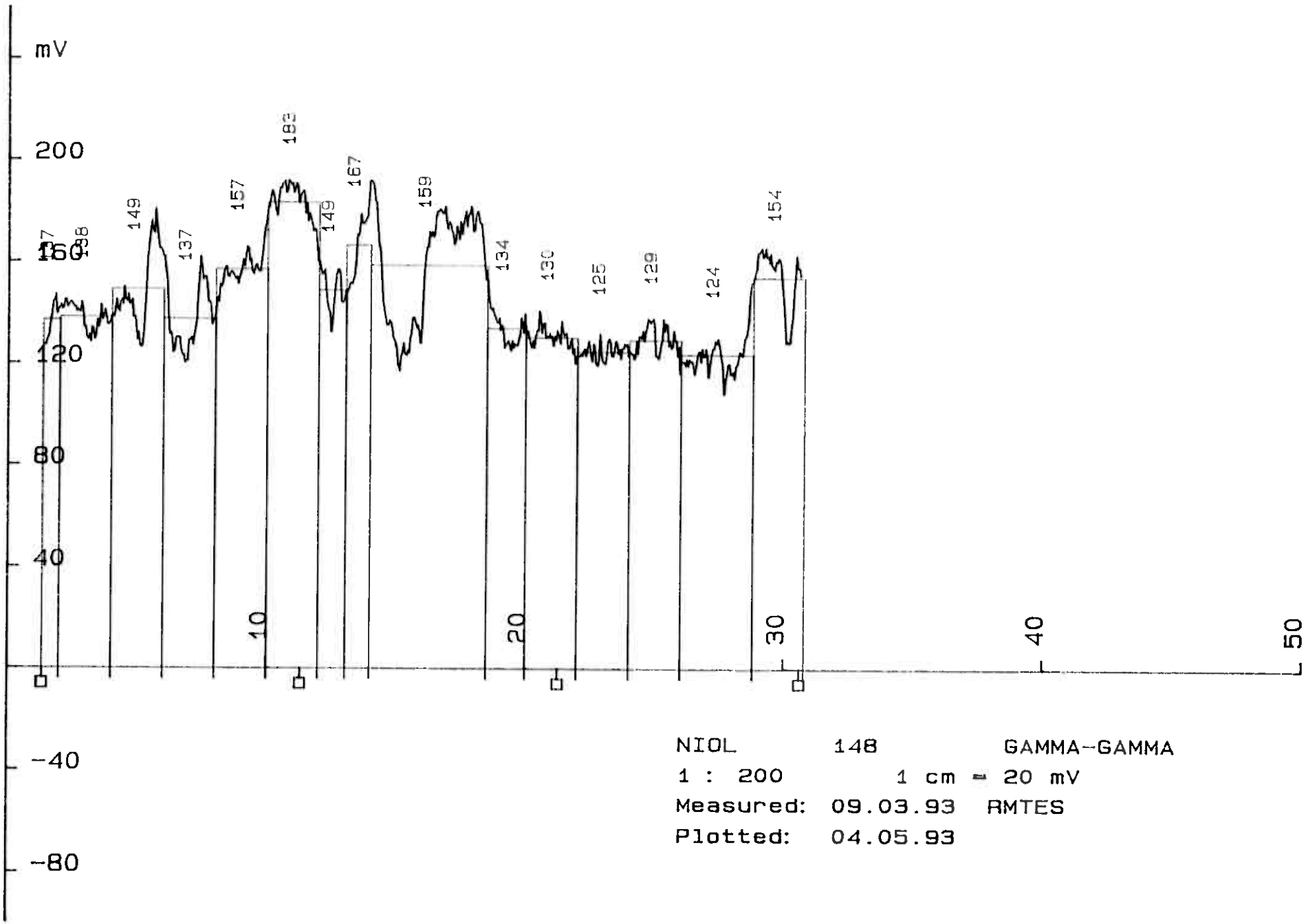
100 mV background correction

App. 6/22

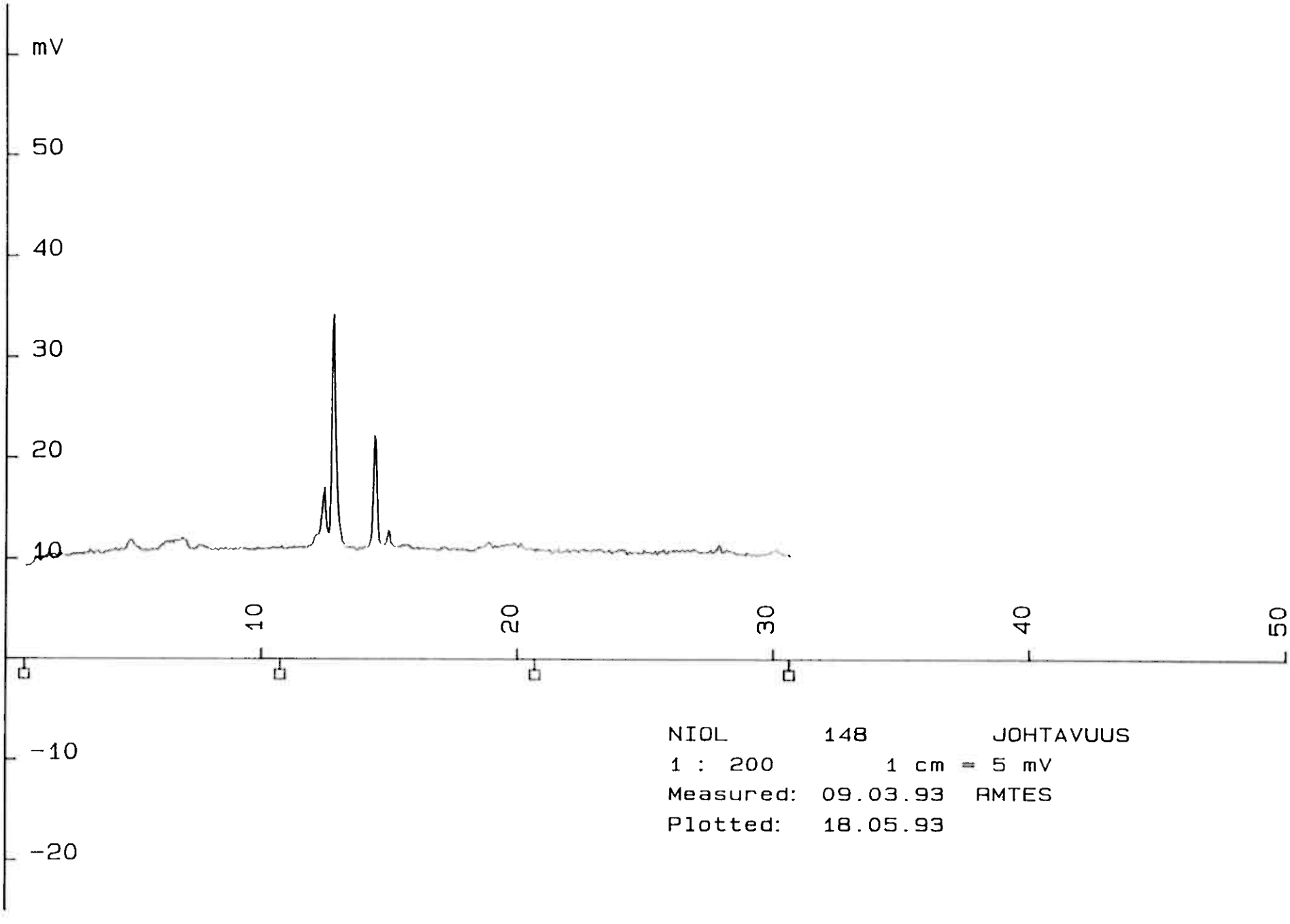

mV
200
160
120
80
40
10
20
30
40
50
-40
-80
NIOL 148 GAMMA-GAMMA
1 : 200 1 cm = 20 mV
Measured: 09.03.93 RMT ES
Plotted: 18.05.93

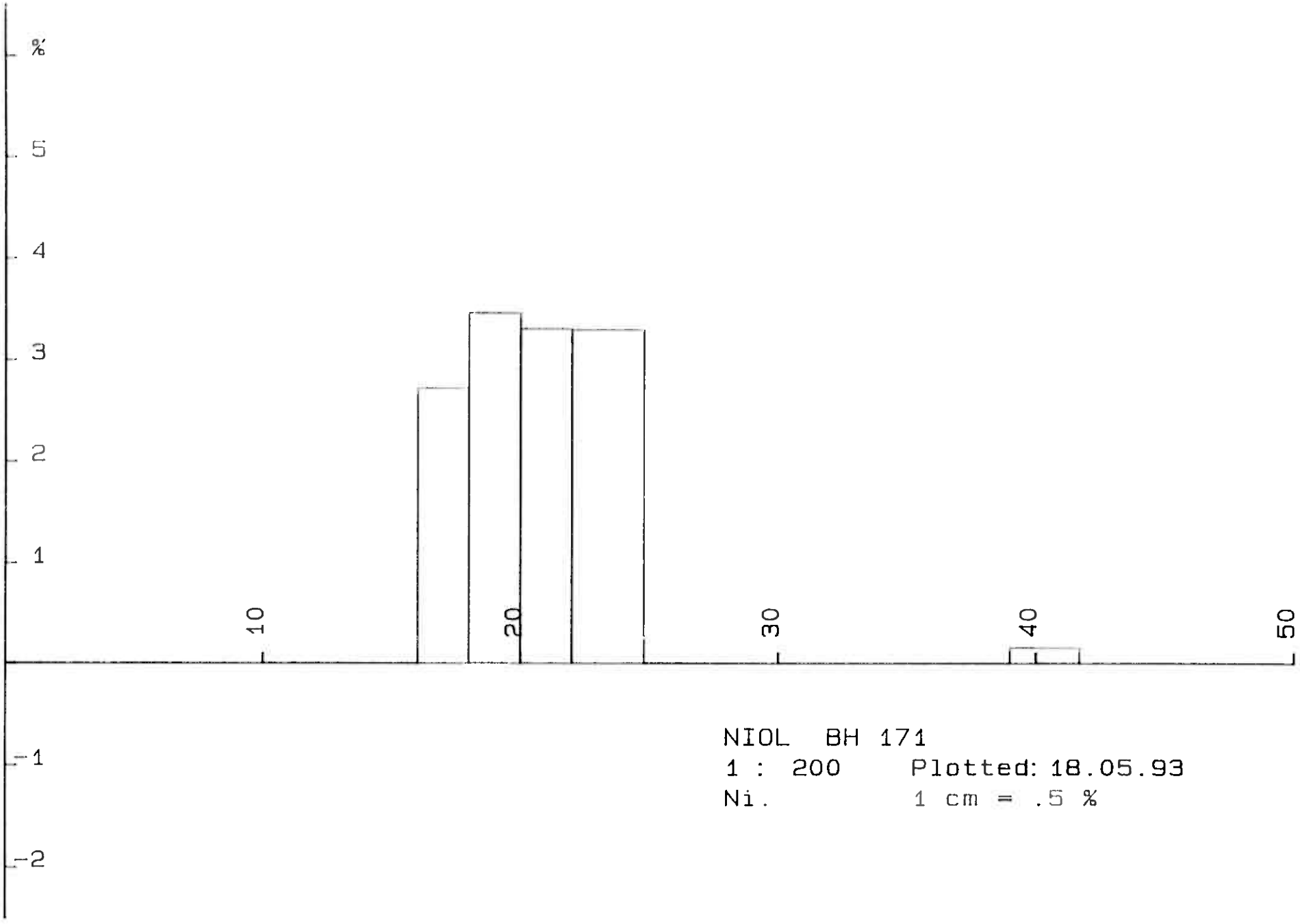


NIOL 148 SUSKEPT.
1 : 200 1 cm = 2 mV
Measured: 10.03.93 RMT/ES
Plotted: 18.05.93

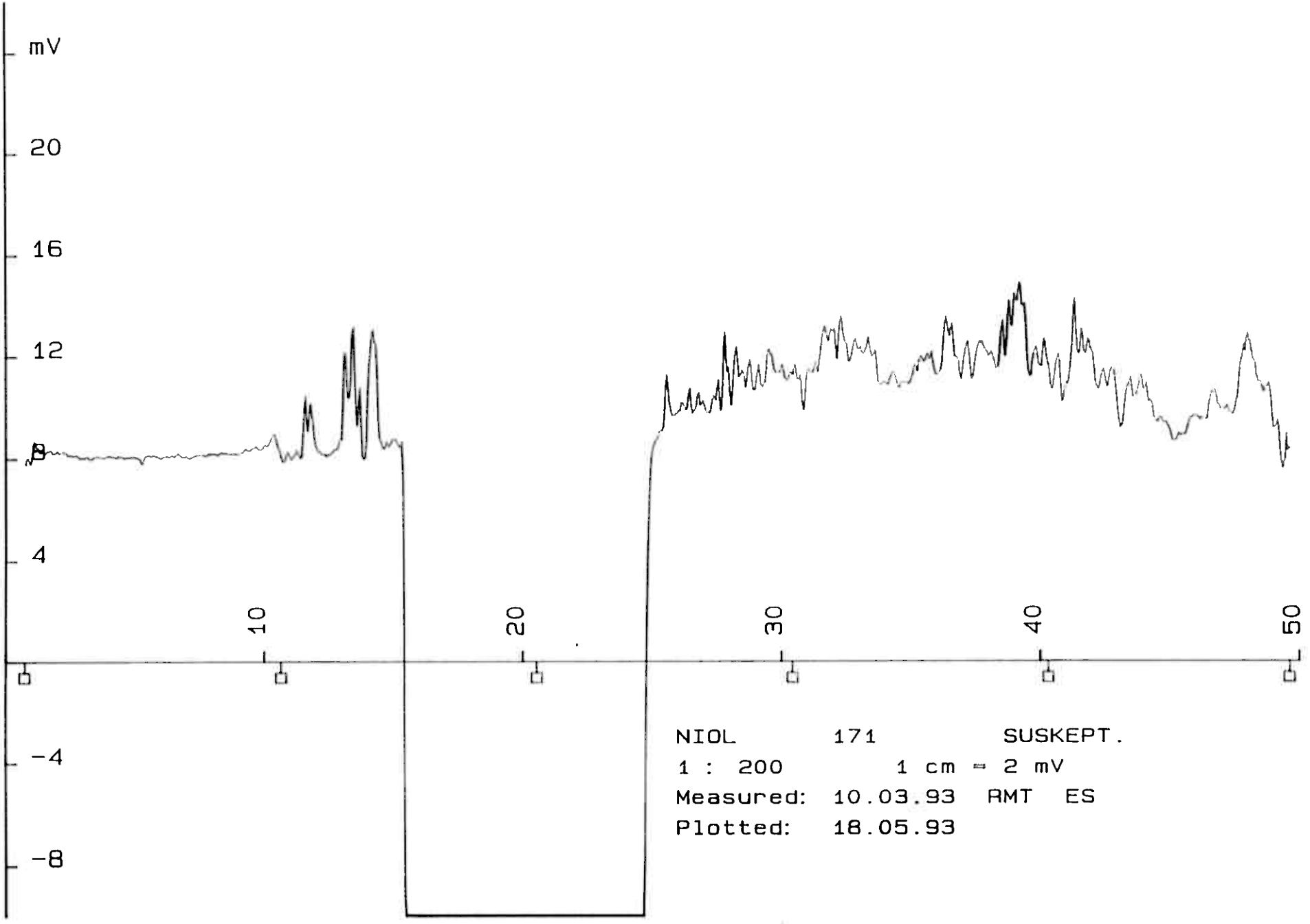


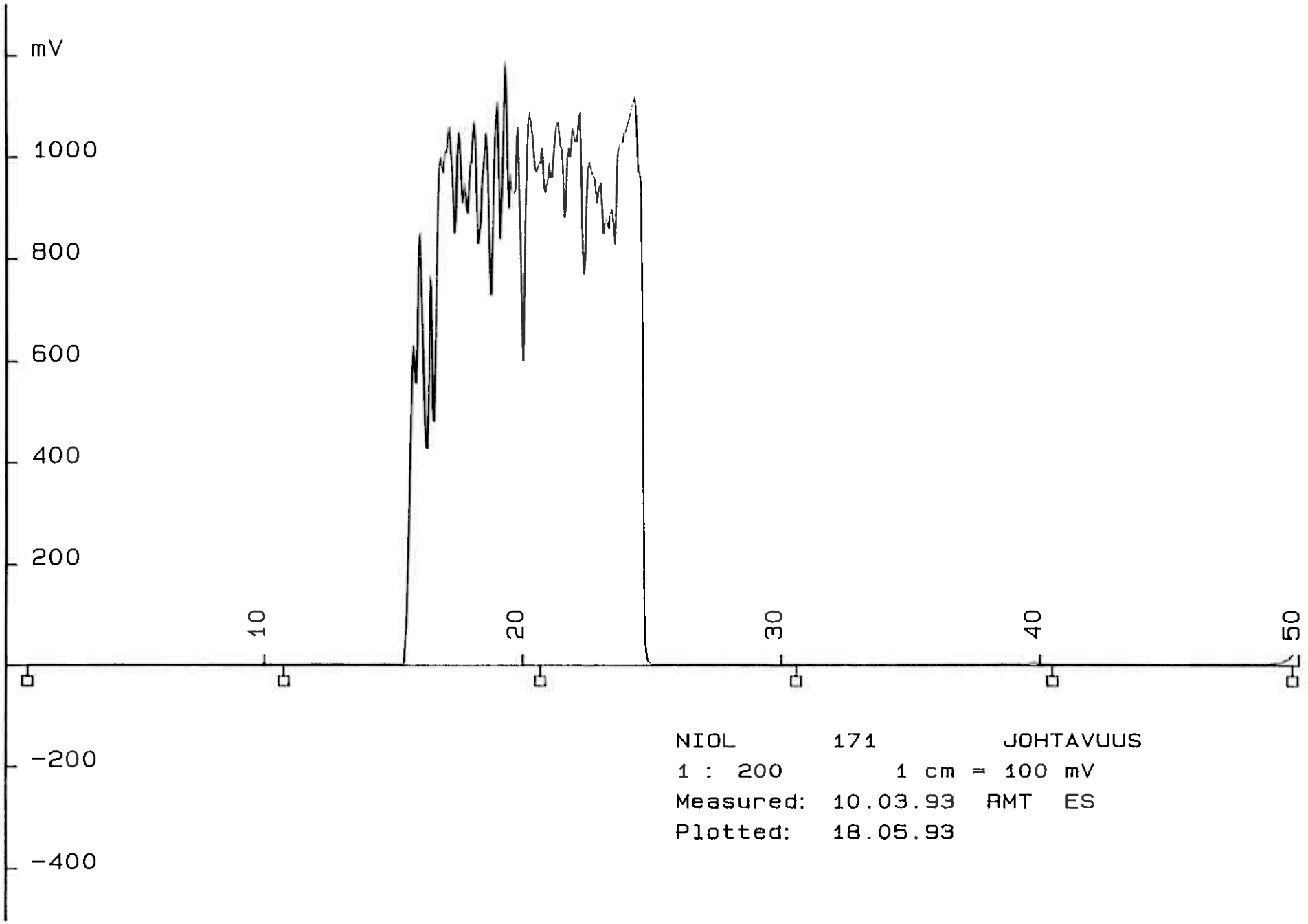
NIOL 148 GAMMA-GAMMA
1 : 200 1 cm = 20 mV
Measured: 09.03.93 RMTES
Plotted: 04.05.93


mV
50
40
30
20
10
10
20
30
40
50
-10
-20
NIOL 148 JOHTAVUUS
1 : 200 1 cm = 5 mV
Measured: 09.03.93 RMTES
Plotted: 18.05.93

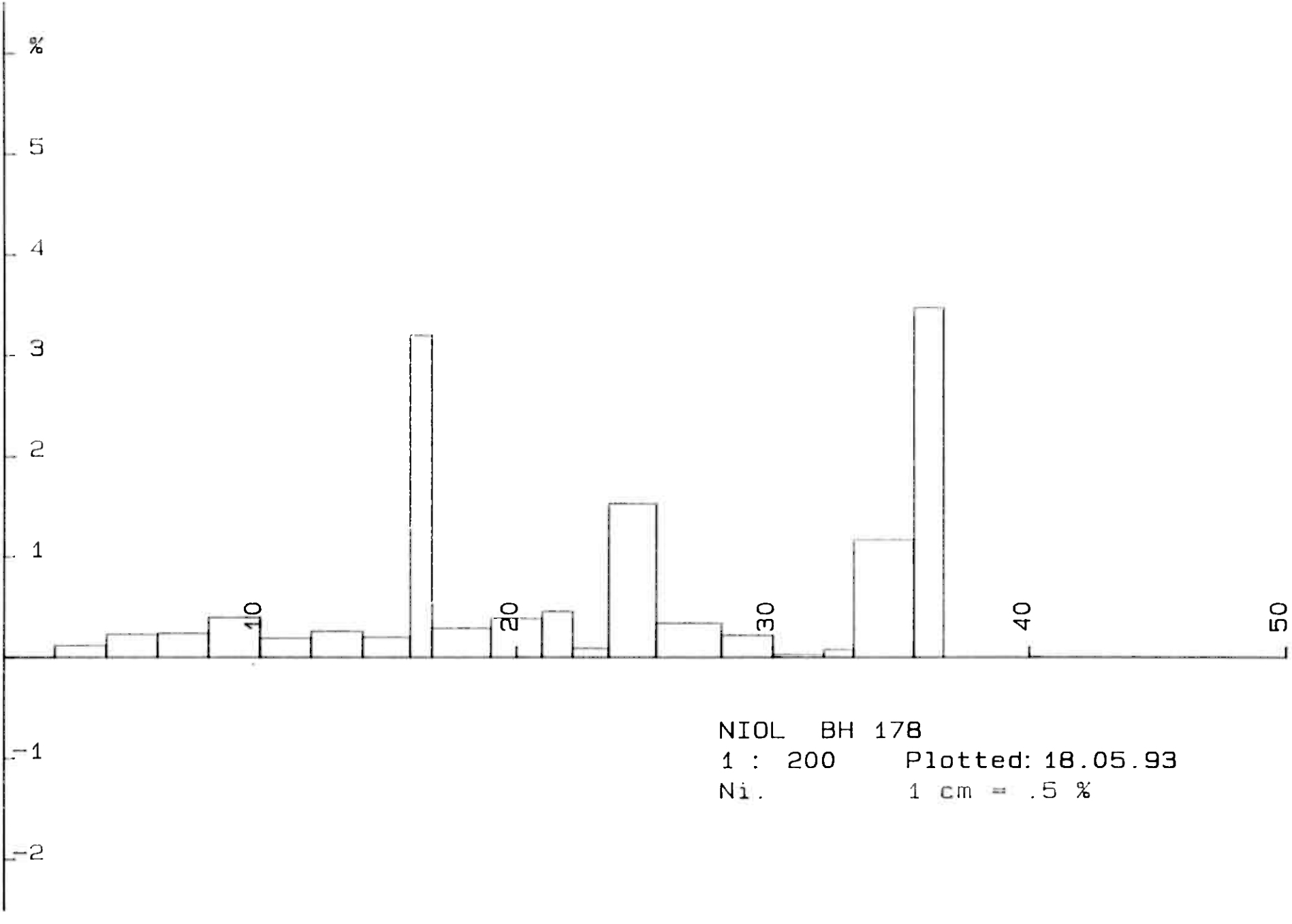


NIOL BH 171
1 : 200 Plotted: 18.05.93
Ni. 1 cm = .5 %

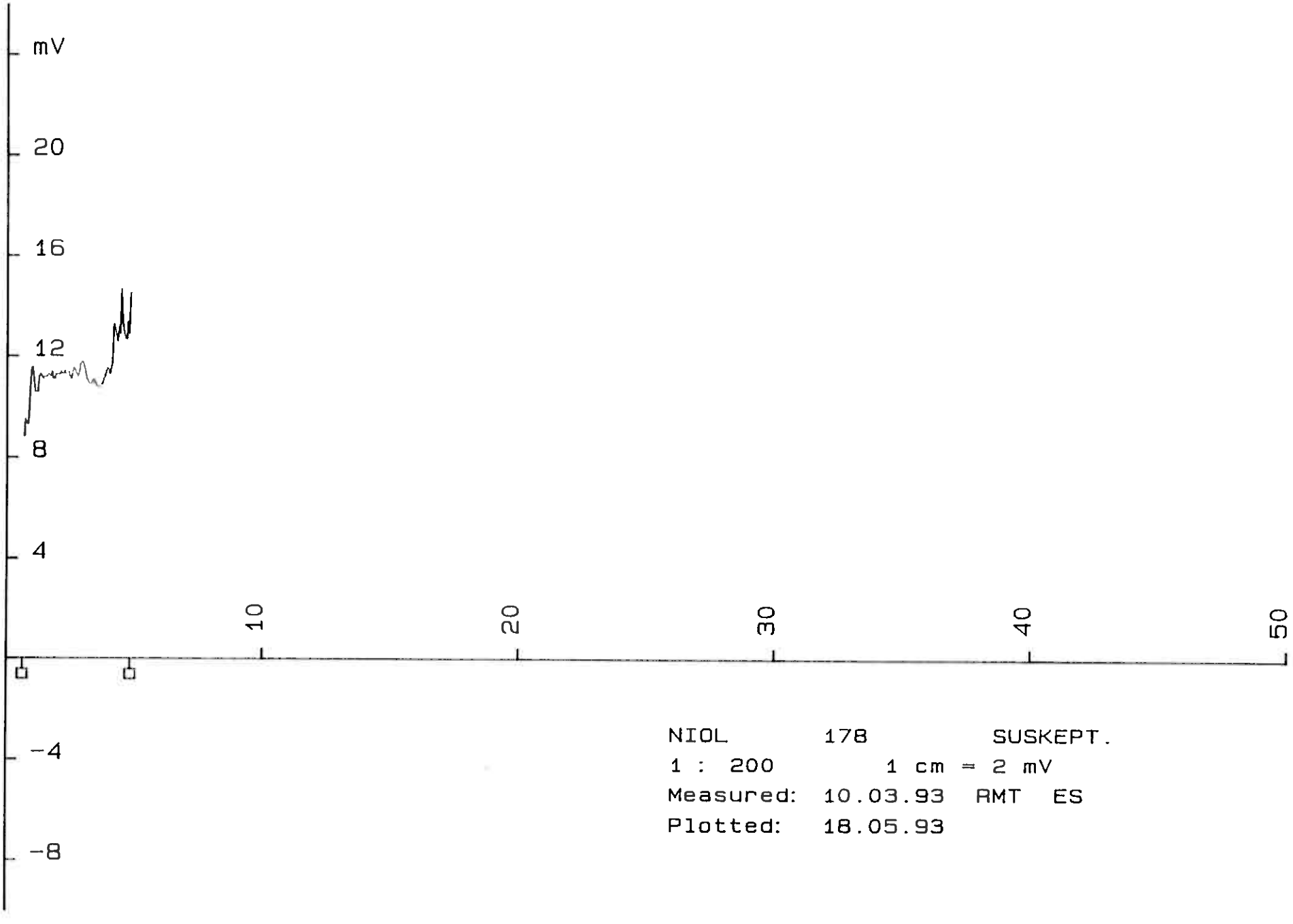

mV
20
16
12
8
4
-4
-8
10
20
30
40
50
NIOL 171 SUSKEPT.
1 : 200 1 cm = 2 mV
Measured: 10.03.93 AMT ES
Plotted: 18.05.93

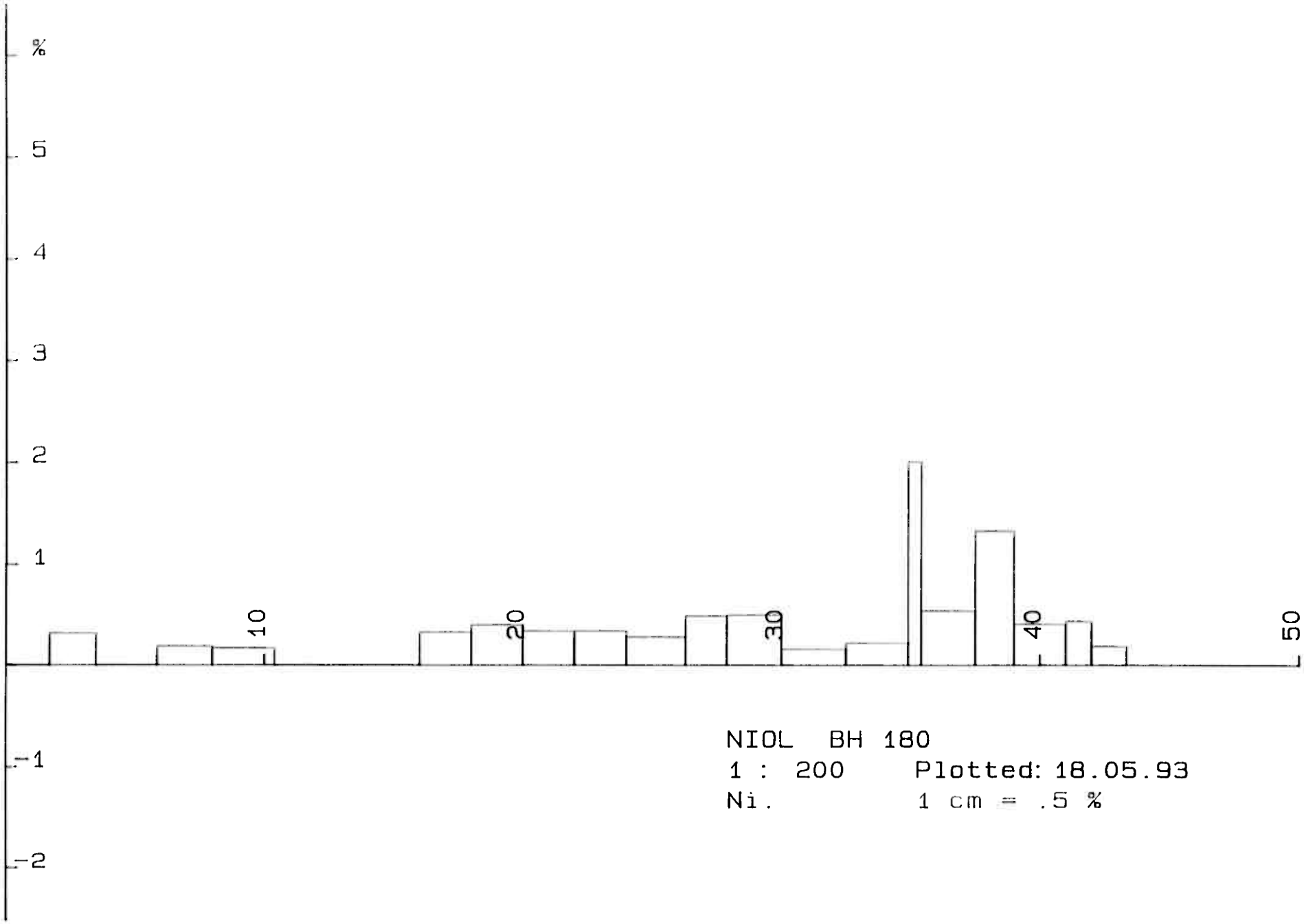


NIOL 171 JOHTAVUUS
1 : 200 1 cm = 100 mV
Measured: 10.03.93 RMT ES
Plotted: 18.05.93

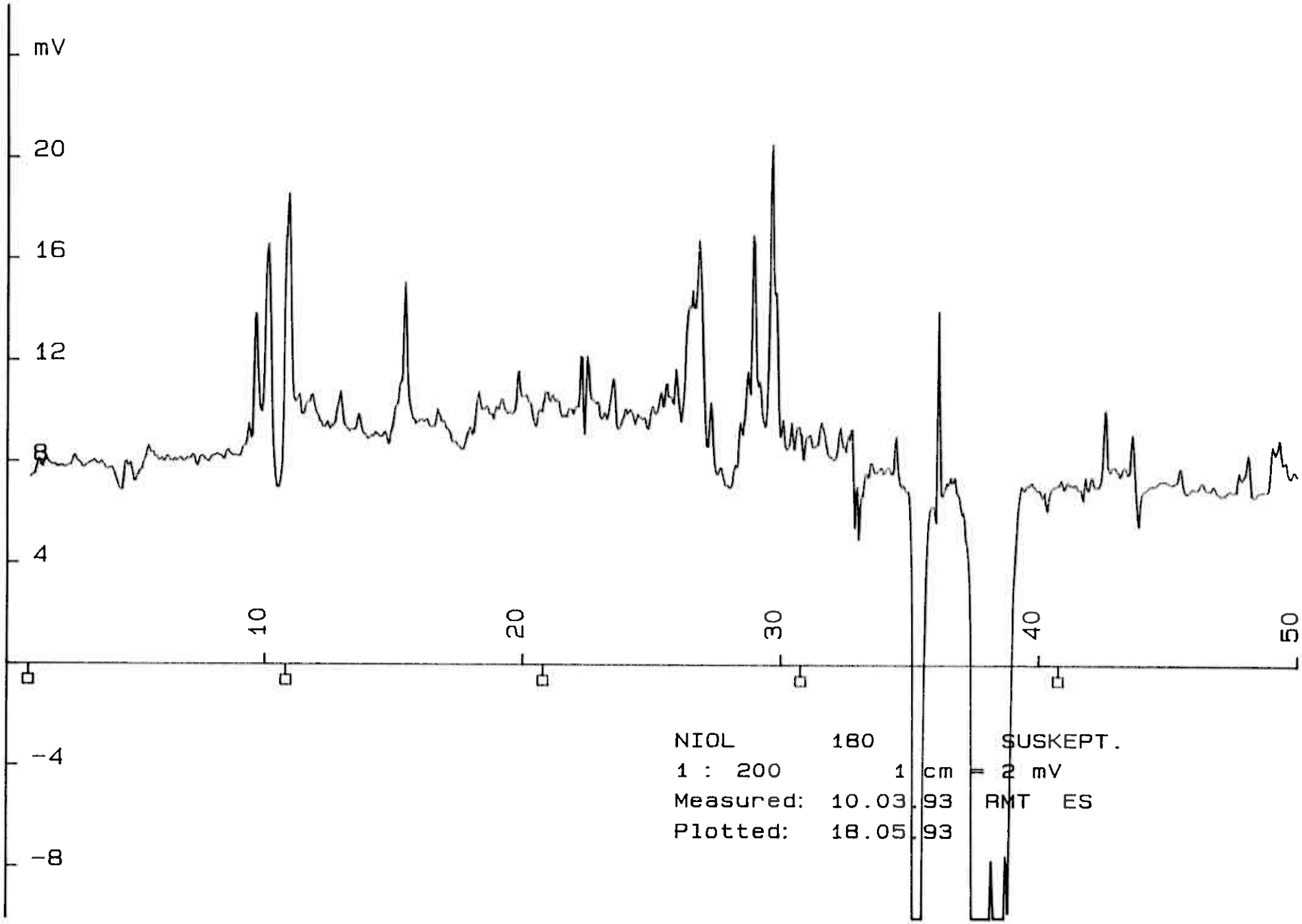


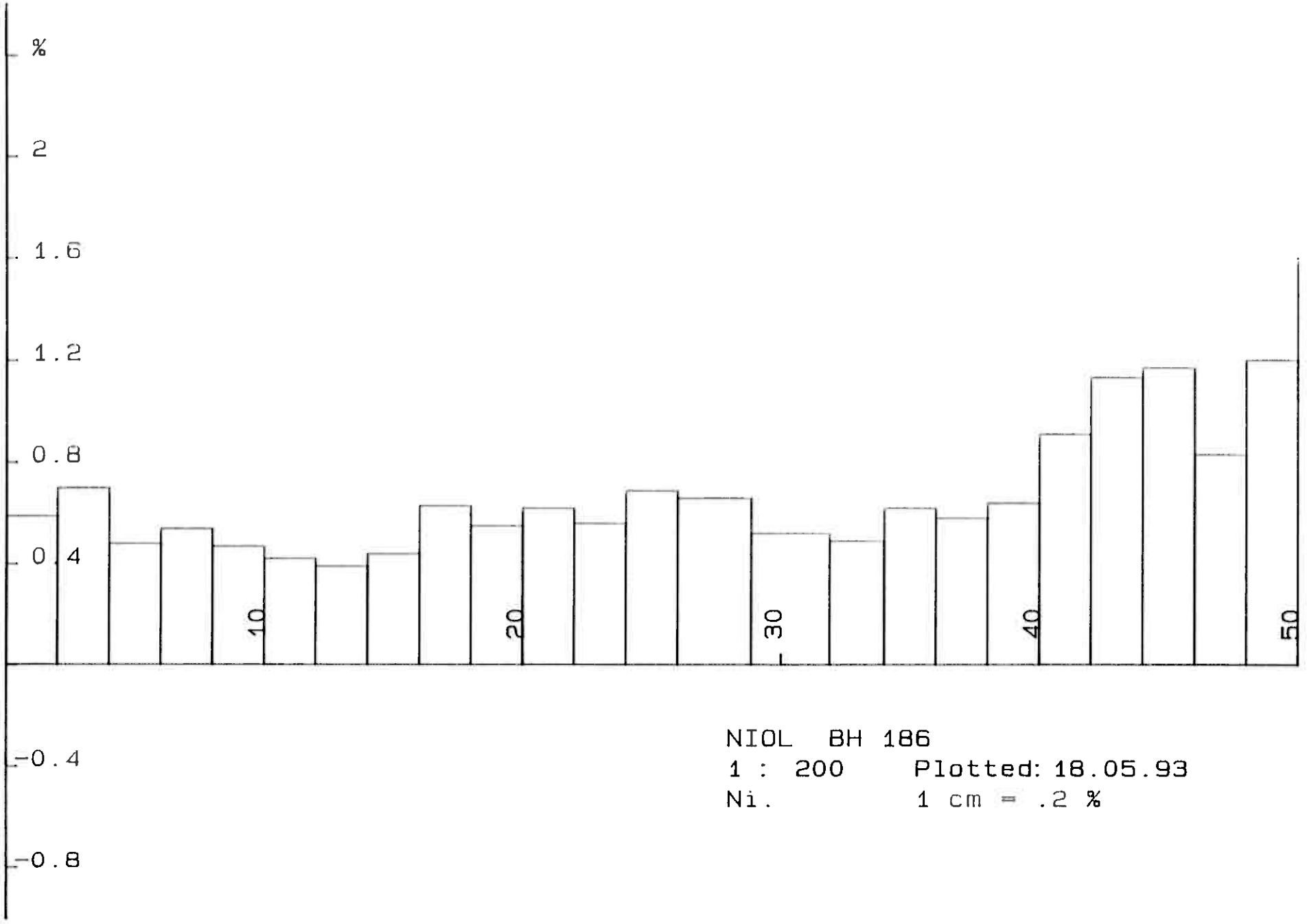
NIOL BH 178
1 : 200 Plotted: 18.05.93
Ni. 1 cm = .5 %


mV
20
16
12
8
4
10
20
30
40
50
-4
-8
NIOL 178 SUSKEPT.
1 : 200 1 cm = 2 mV
Measured: 10.03.93 RMT ES
Plotted: 18.05.93

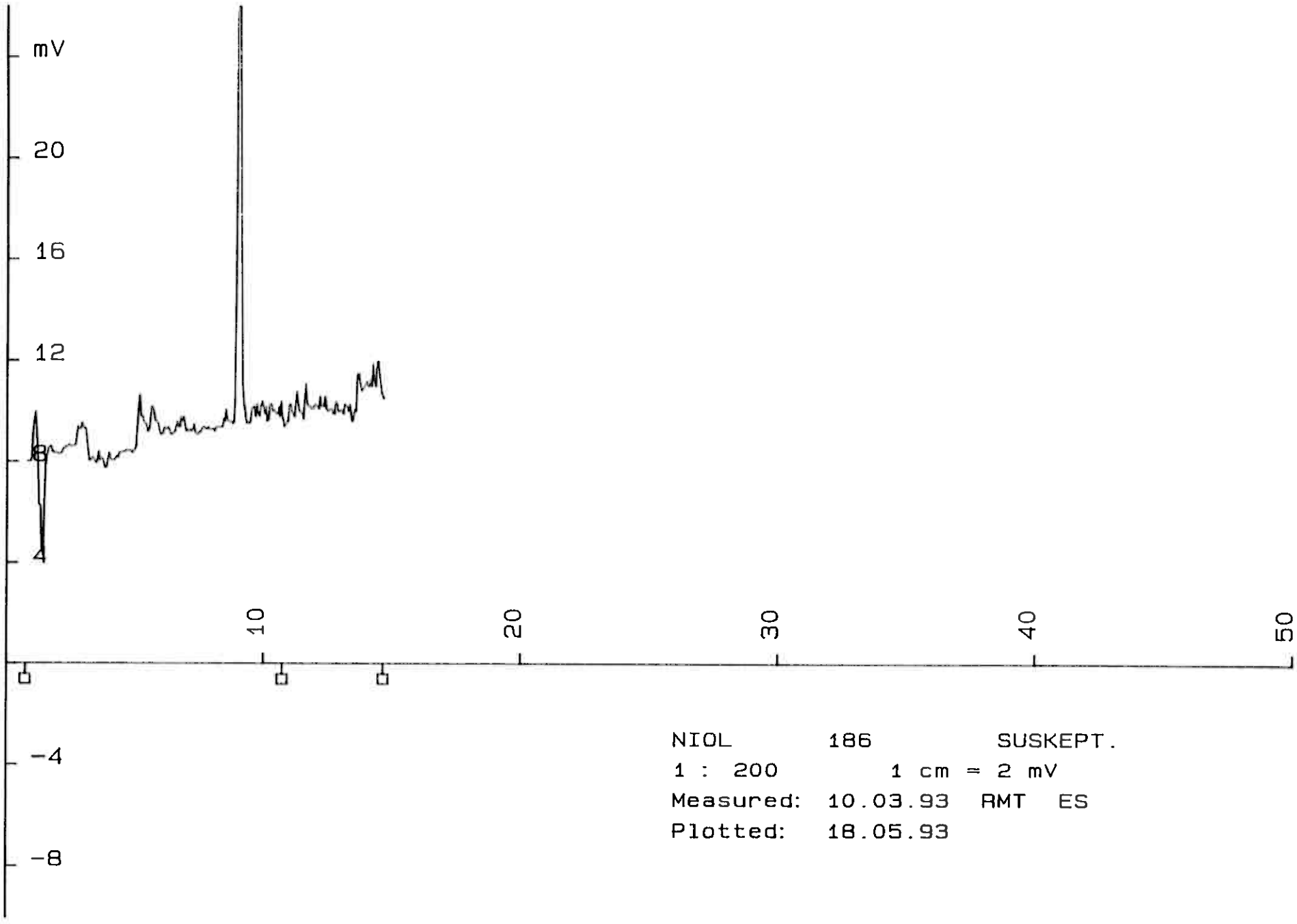


NIOL BH 180
1 : 200 Plotted: 18.05.93
Ni. 1 cm = .5 %

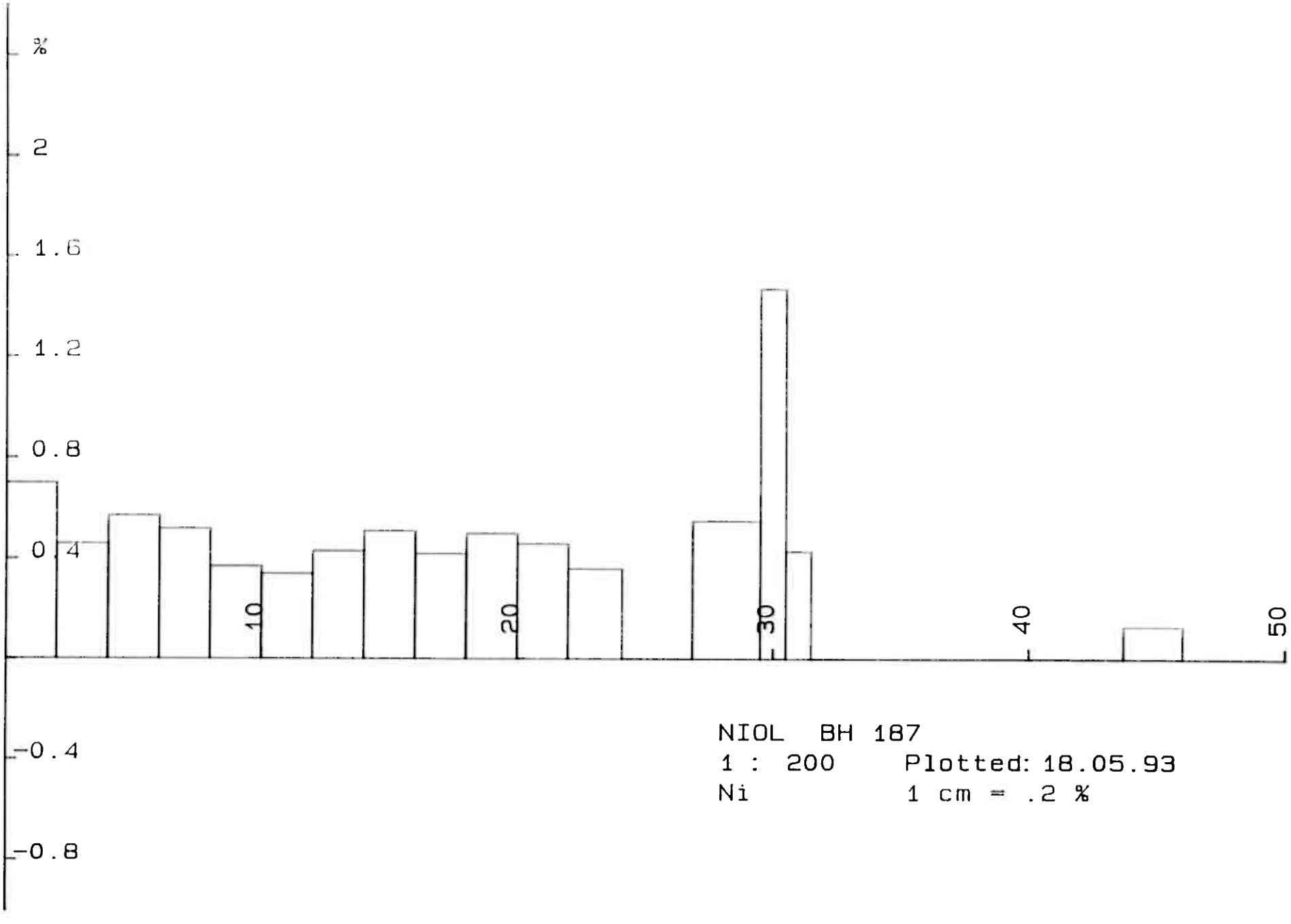

mV
20
16
12
8
4
-4
-8
10
20
30
40
50
NIOL 180 SUSKEPT.
1 : 200 1 cm = 2 mV
Measured: 10.03.93 RMT ES
Plotted: 18.05.93

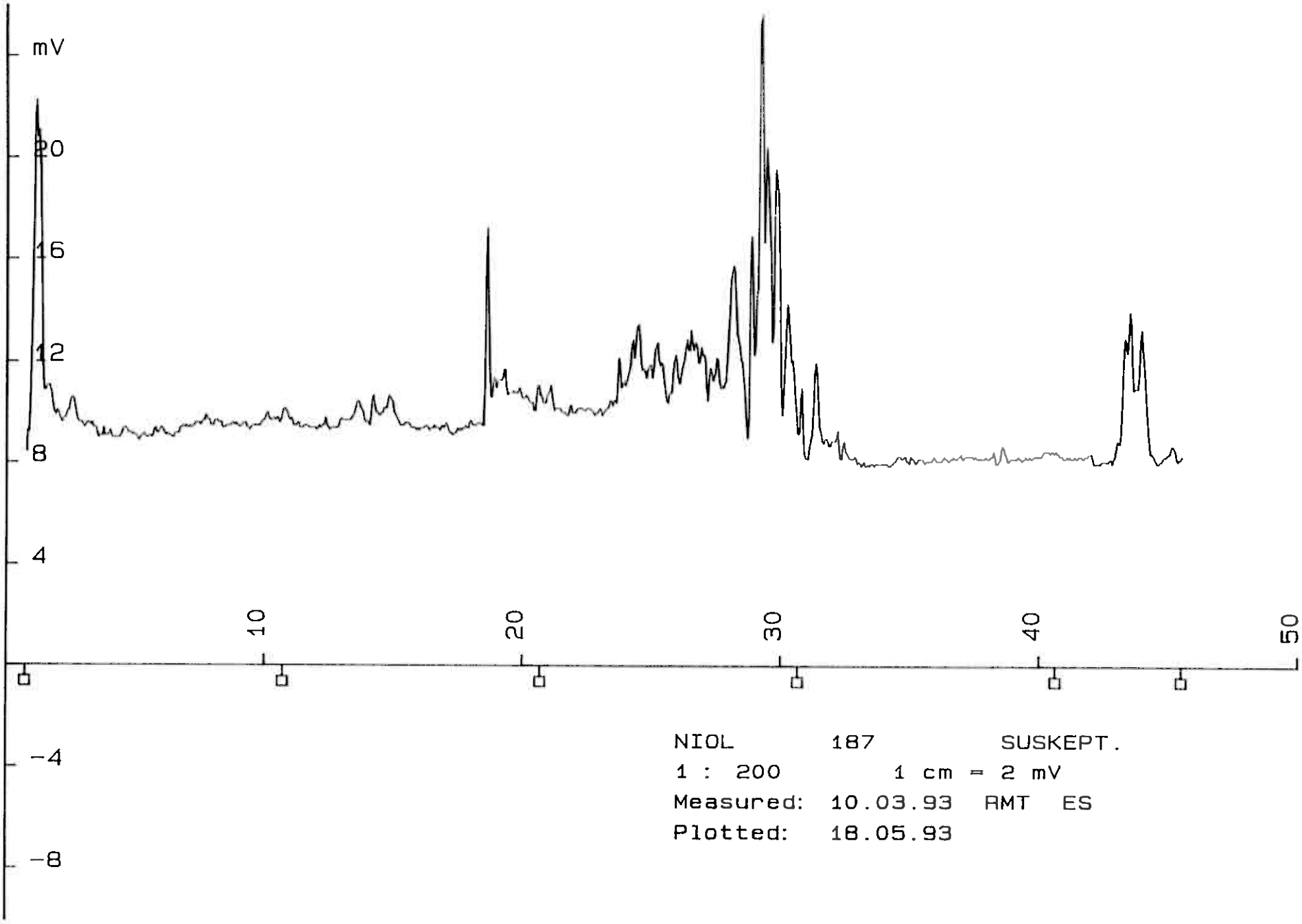


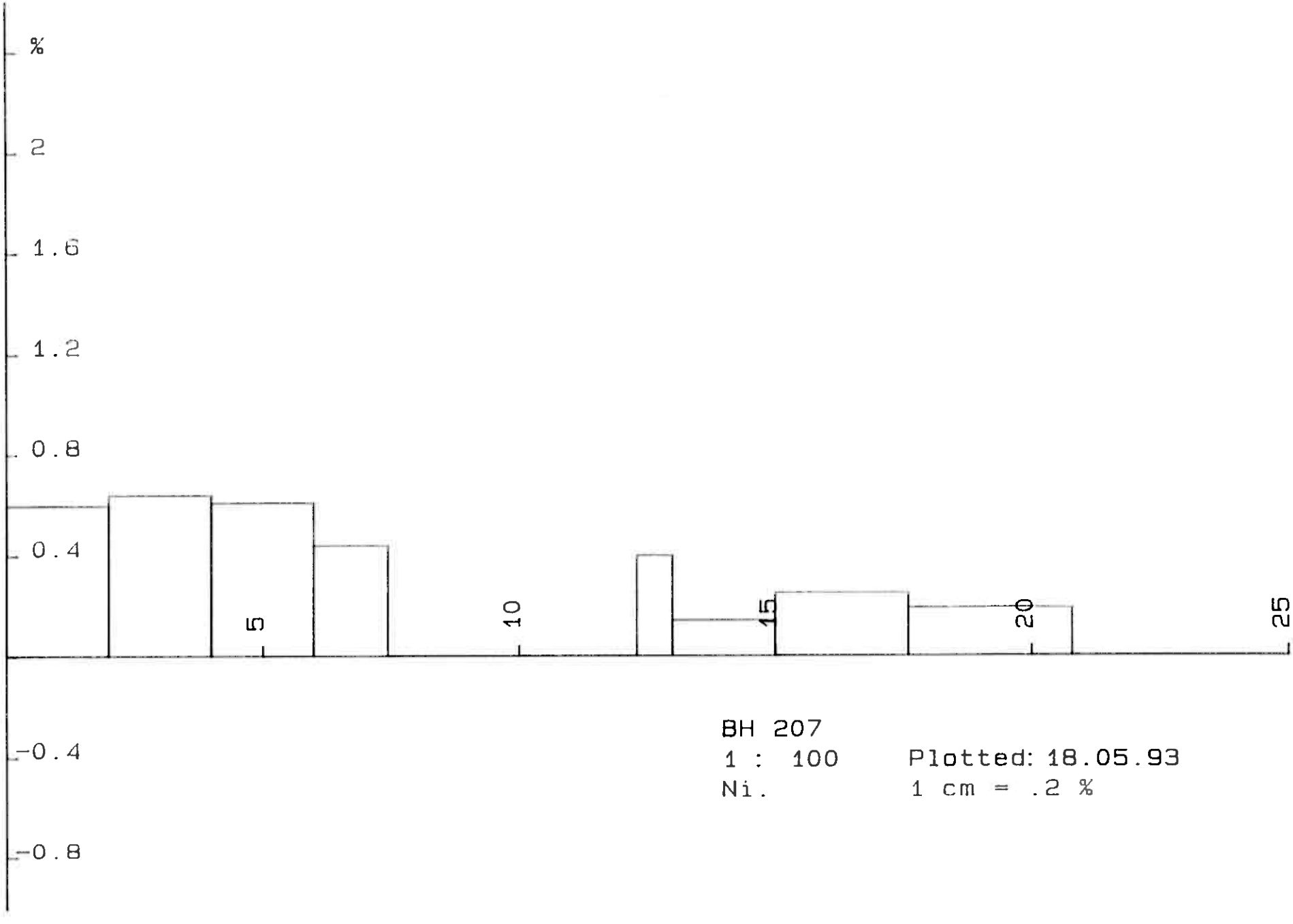
NIOL BH 186
1 : 200 Plotted: 18.05.93
Ni. 1 cm = .2 %



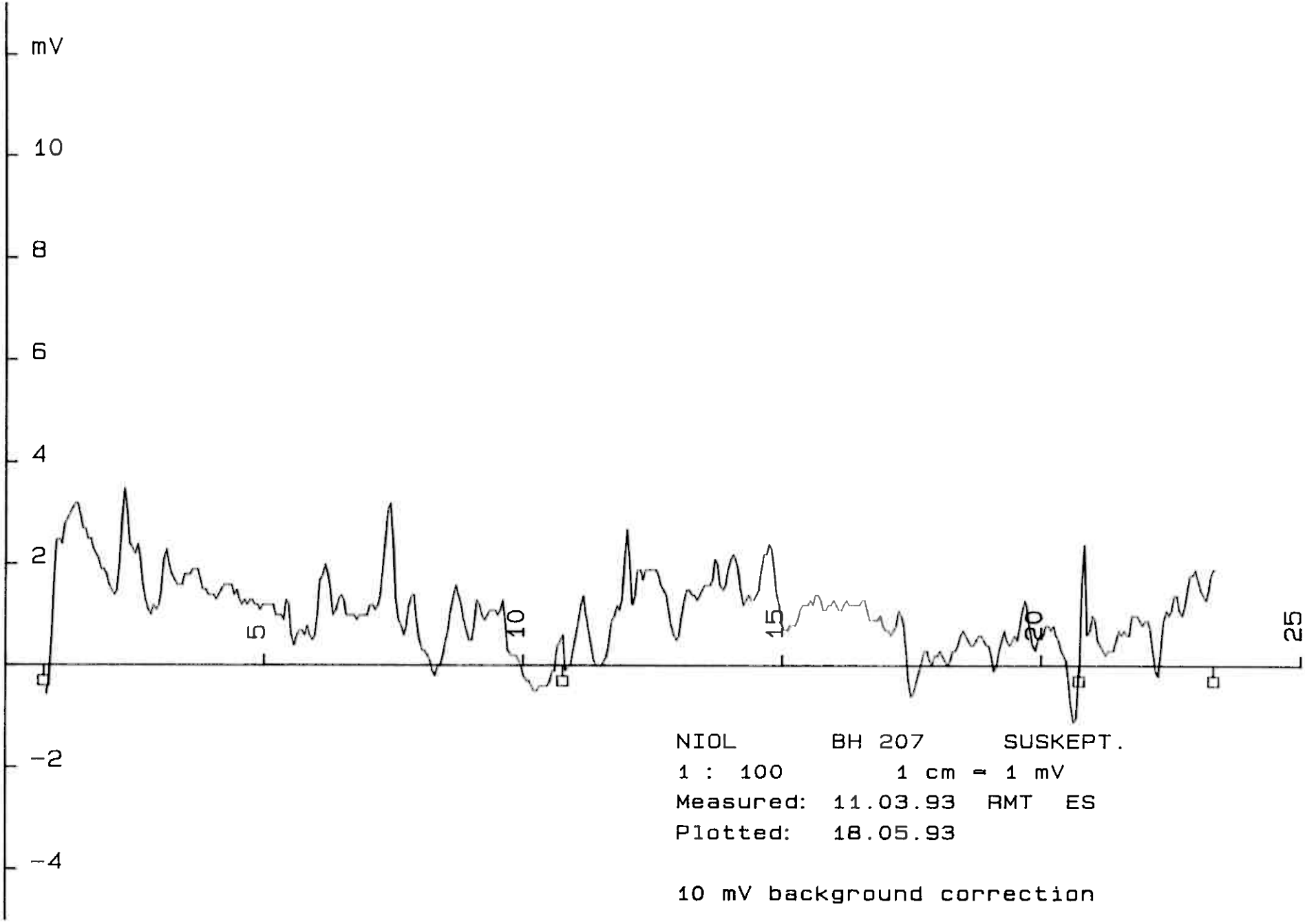
NIOL 186 SUSKEPT.
1 : 200 1 cm = 2 mV
Measured: 10.03.93 RMT ES
Plotted: 18.05.93

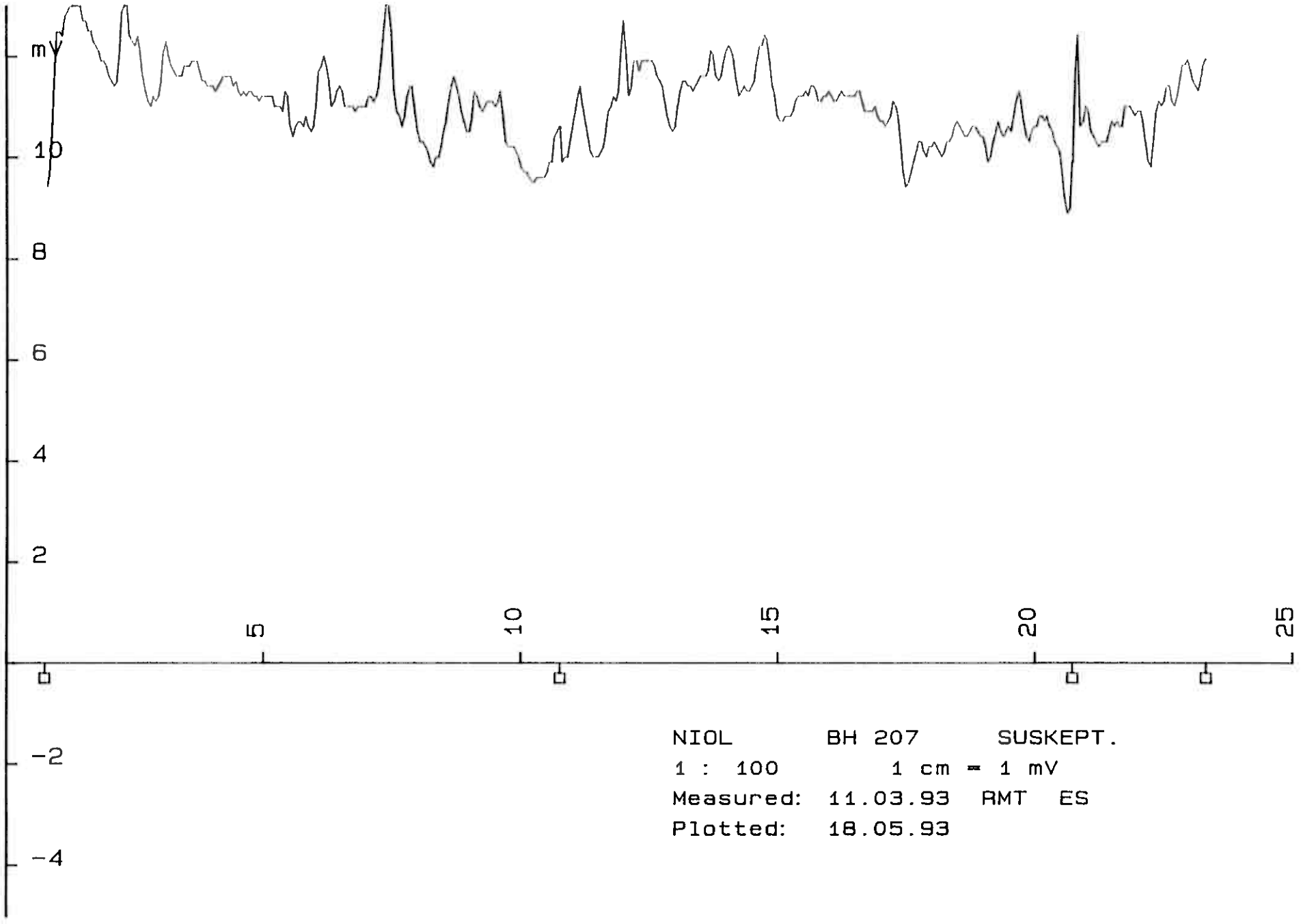

%
2
1.6
1.2
0.8
0.4
-0.4
-0.8
10
20
30
40
50
NIOL BH 187
1 : 200 Plotted: 18.05.93
Ni 1 cm = .2 %


mV
20
16
12
8
4
10
20
30
40
50
-4
-8
NIOL 187 SUSKEPT.
1 : 200 1 cm = 2 mV
Measured: 10.03.93 RMT ES
Plotted: 18.05.93



BH 207
1 : 100 Plotted: 18.05.93
Ni. 1 cm = .2 %


mV
10
8
6
4
2
-2
-4
5
10
15
20
25
NIOL BH 207 SUSKEPT.
1 : 100 1 cm = 1 mV
Measured: 11.03.93 RMT ES
Plotted: 18.05.93
10 mV background correction



NIOL BH 207 SUSKEPT.
1 : 100 1 cm = 1 mV
Measured: 11.03.93 RMT ES
Plotted: 18.05.93