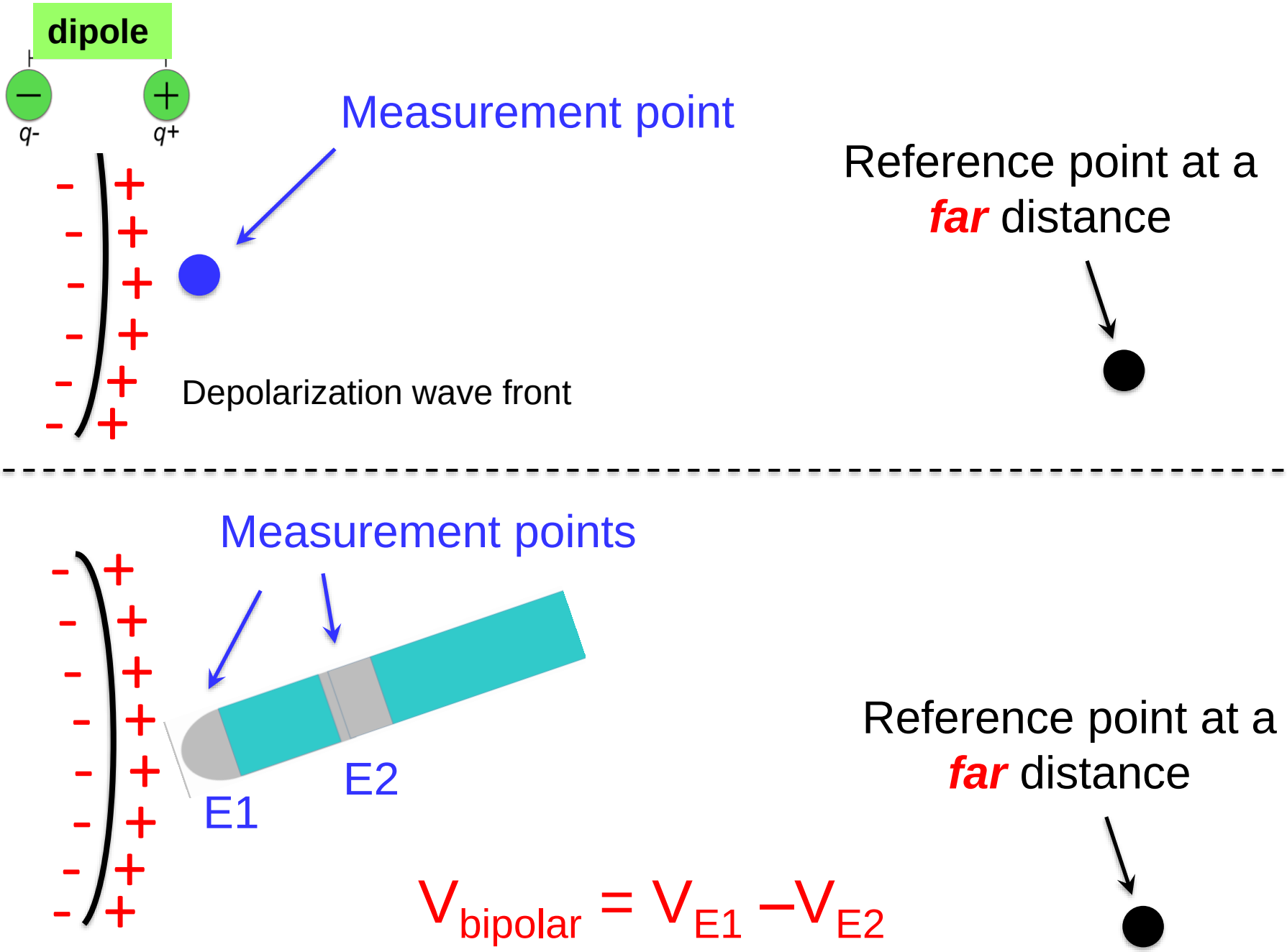
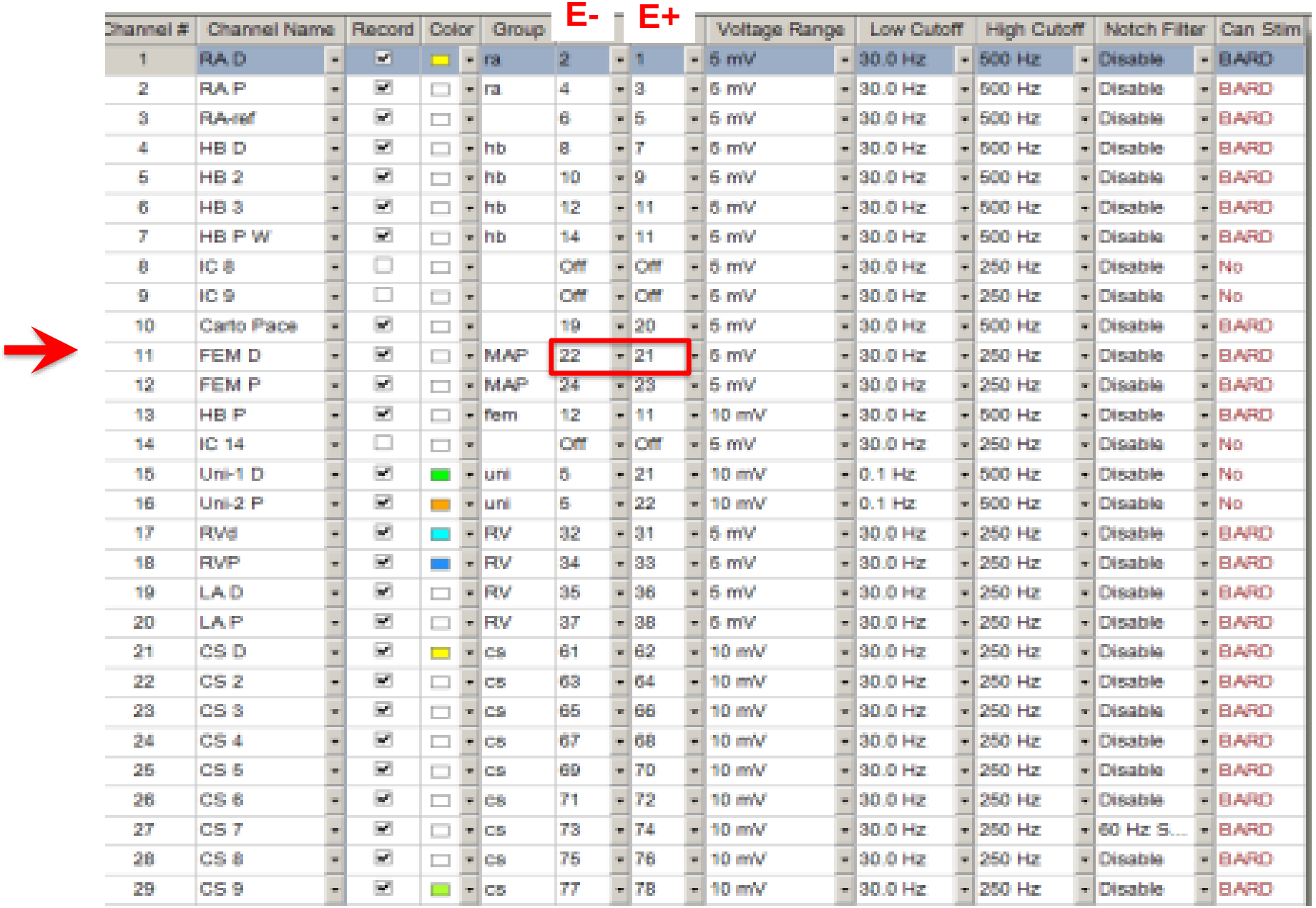

dipole
q-
q+
Measurement point
Reference point at a
far distance
Depolarization wave front
Measurement points
E1
E2
Reference point at a
far distance
$V_{bipolar} = V_{E1} - V_{E2}$

Figure 2.1A.



Channel #	Channel Name	Record	Color	Group	E-	E+	Voltage Range	Low Cutoff	High Cutoff	Notch Filter	Can Stim
1	RA D	☑		ra	2	1	5 mV	30.0 Hz	500 Hz	Disable	BARD
2	RA P	☑		ra	4	3	5 mV	30.0 Hz	500 Hz	Disable	BARD
3	RA-ref	☑			6	5	5 mV	30.0 Hz	500 Hz	Disable	BARD
4	HB D	☑		hb	8	7	5 mV	30.0 Hz	500 Hz	Disable	BARD
5	HB 2	☑		hb	10	9	5 mV	30.0 Hz	500 Hz	Disable	BARD
6	HB 3	☑		hb	12	11	5 mV	30.0 Hz	500 Hz	Disable	BARD
7	HB P W	☑		hb	14	11	5 mV	30.0 Hz	500 Hz	Disable	BARD
8	IC 8	☐			Off	Off	5 mV	30.0 Hz	250 Hz	Disable	No
9	IC 9	☐			Off	Off	5 mV	30.0 Hz	250 Hz	Disable	No
10	Carto Pace	☑			19	20	5 mV	30.0 Hz	500 Hz	Disable	BARD
11	FEM D	☑		MAP	22	21	5 mV	30.0 Hz	250 Hz	Disable	BARD
12	FEM P	☑		MAP	24	23	5 mV	30.0 Hz	250 Hz	Disable	BARD
13	HB P	☑		fem	12	11	10 mV	30.0 Hz	500 Hz	Disable	BARD
14	IC 14	☐			Off	Off	5 mV	30.0 Hz	250 Hz	Disable	No
15	Uni-1 D	☑		uni	5	21	10 mV	0.1 Hz	500 Hz	Disable	No
16	Uni-2 P	☑		uni	5	22	10 mV	0.1 Hz	500 Hz	Disable	No
17	RVd	☑		RV	32	31	5 mV	30.0 Hz	250 Hz	Disable	BARD
18	RVP	☑		RV	34	33	5 mV	30.0 Hz	250 Hz	Disable	BARD
19	LA D	☑		RV	35	36	5 mV	30.0 Hz	250 Hz	Disable	BARD
20	LA P	☑		RV	37	38	5 mV	30.0 Hz	250 Hz	Disable	BARD
21	CS D	☑		cs	61	62	10 mV	30.0 Hz	250 Hz	Disable	BARD
22	CS 2	☑		cs	63	64	10 mV	30.0 Hz	250 Hz	Disable	BARD
23	CS 3	☑		cs	65	66	10 mV	30.0 Hz	250 Hz	Disable	BARD
24	CS 4	☑		cs	67	68	10 mV	30.0 Hz	250 Hz	Disable	BARD
25	CS 5	☑		cs	69	70	10 mV	30.0 Hz	250 Hz	Disable	BARD
26	CS 6	☑		cs	71	72	10 mV	30.0 Hz	250 Hz	Disable	BARD
27	CS 7	☑		cs	73	74	10 mV	30.0 Hz	250 Hz	60 Hz S...	BARD
28	CS 8	☑		cs	75	76	10 mV	30.0 Hz	250 Hz	Disable	BARD
29	CS 9	☑		cs	77	78	10 mV	30.0 Hz	250 Hz	Disable	BARD

Figure 2.1B.

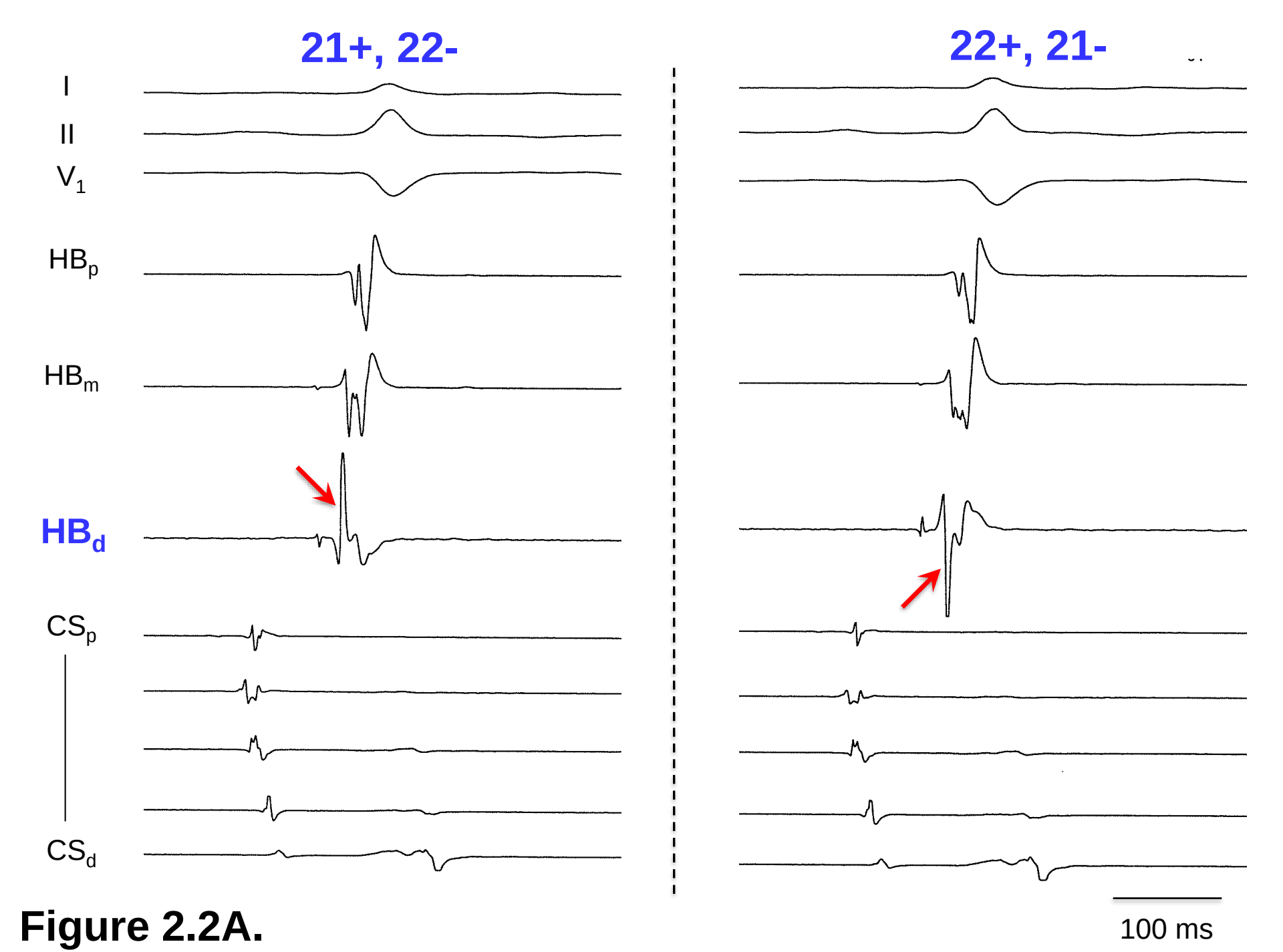


Figure 2.2A.

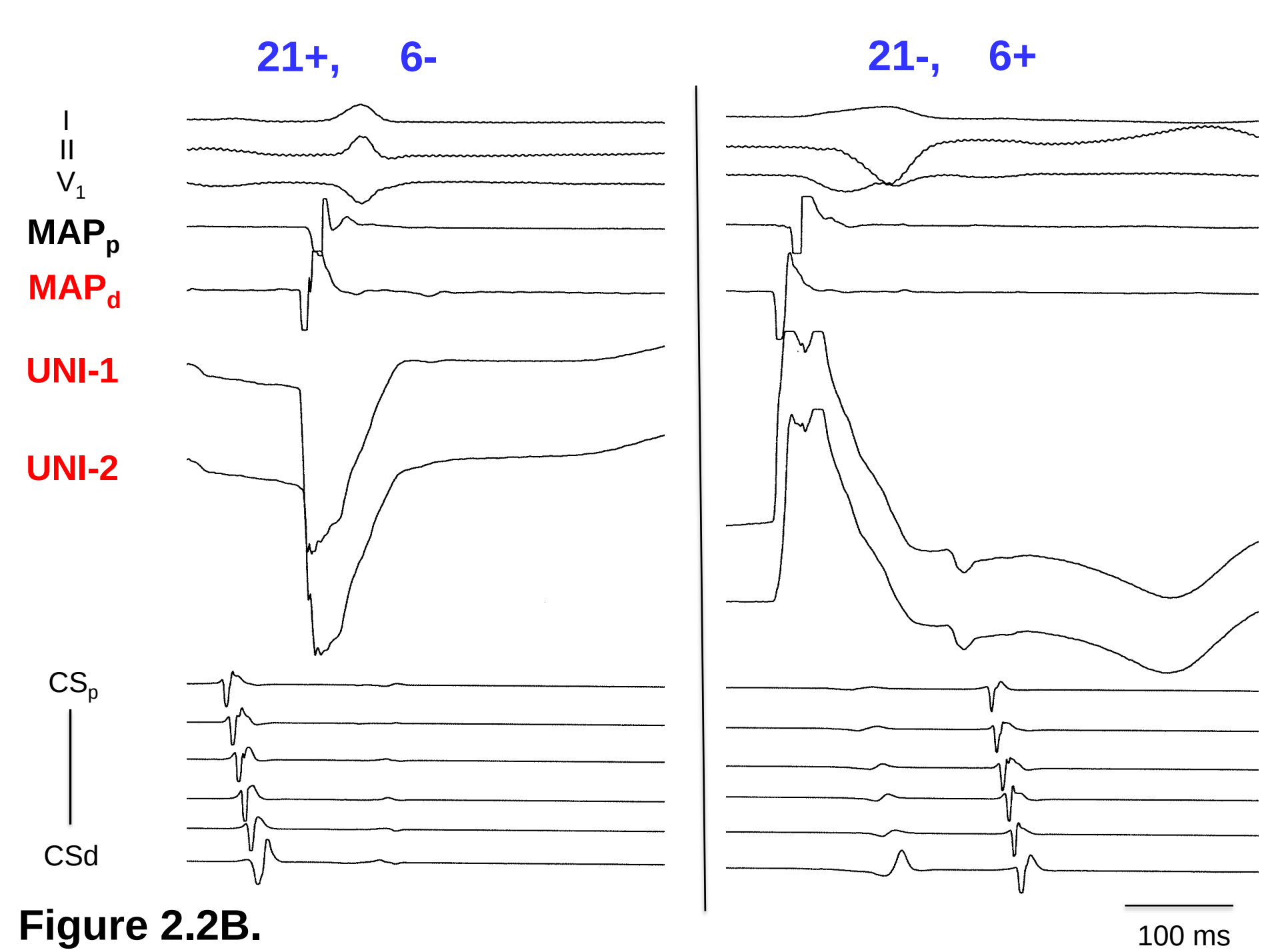
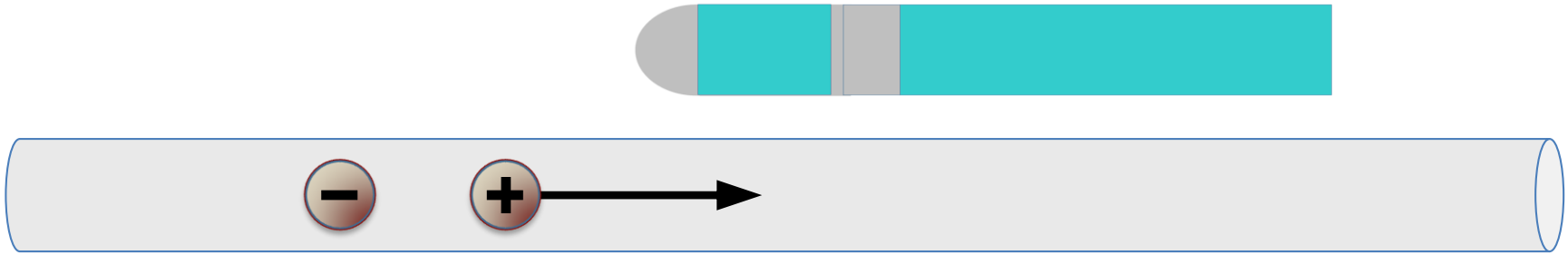


Figure 2.2B.



Tip

Ring

Bipolar

Figure 2.3A.

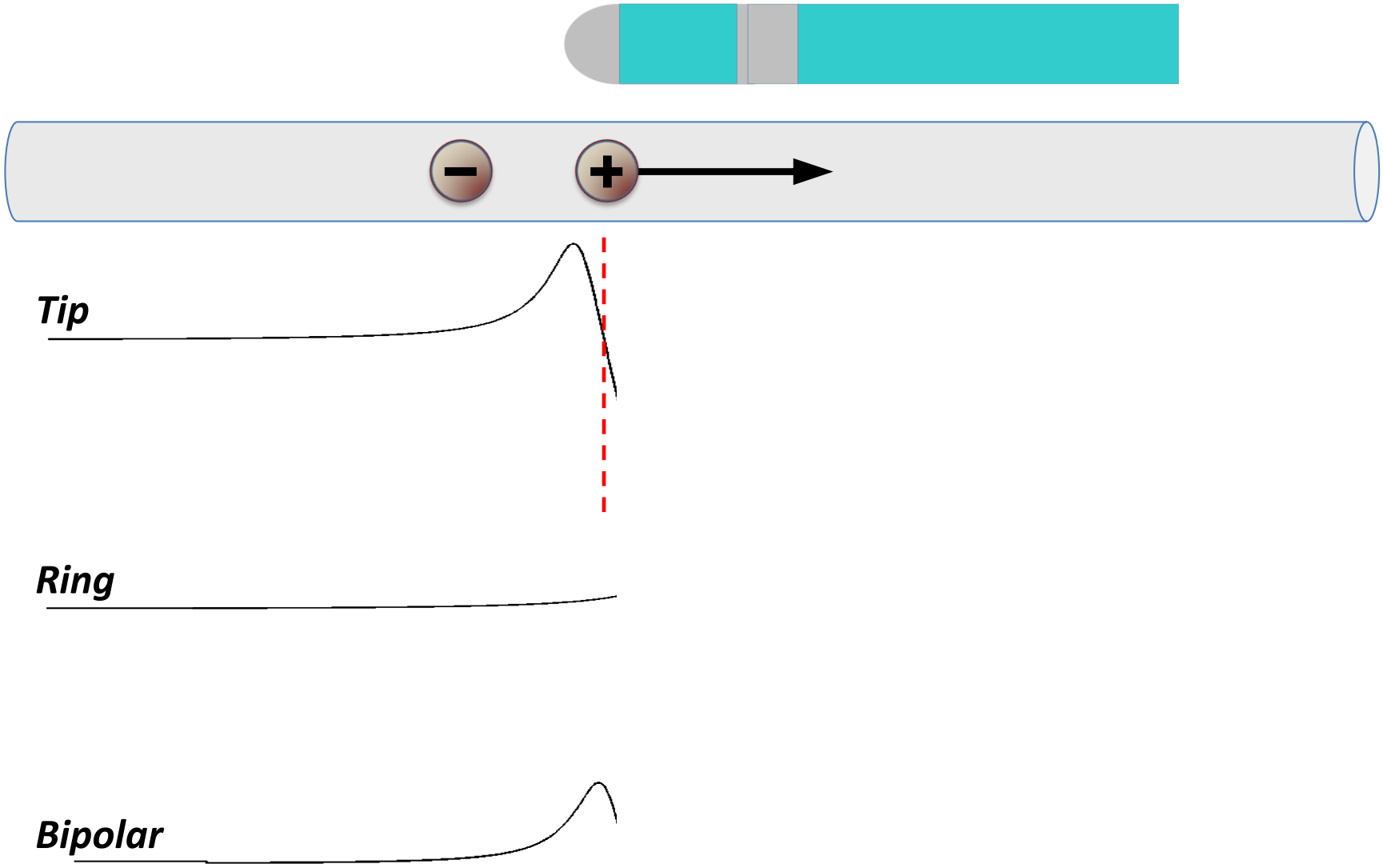


Figure 2.3B.

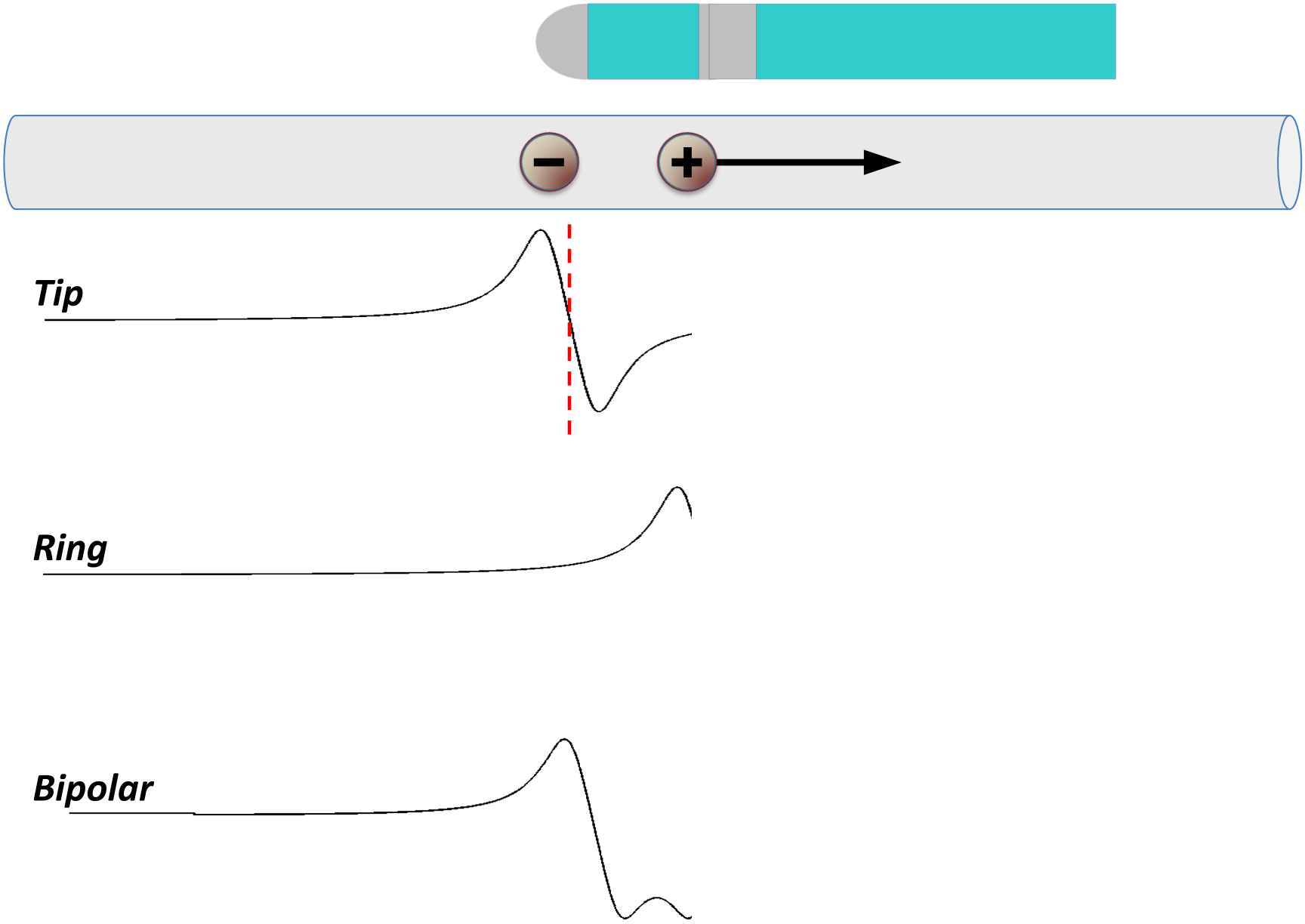


Figure 2.3C.

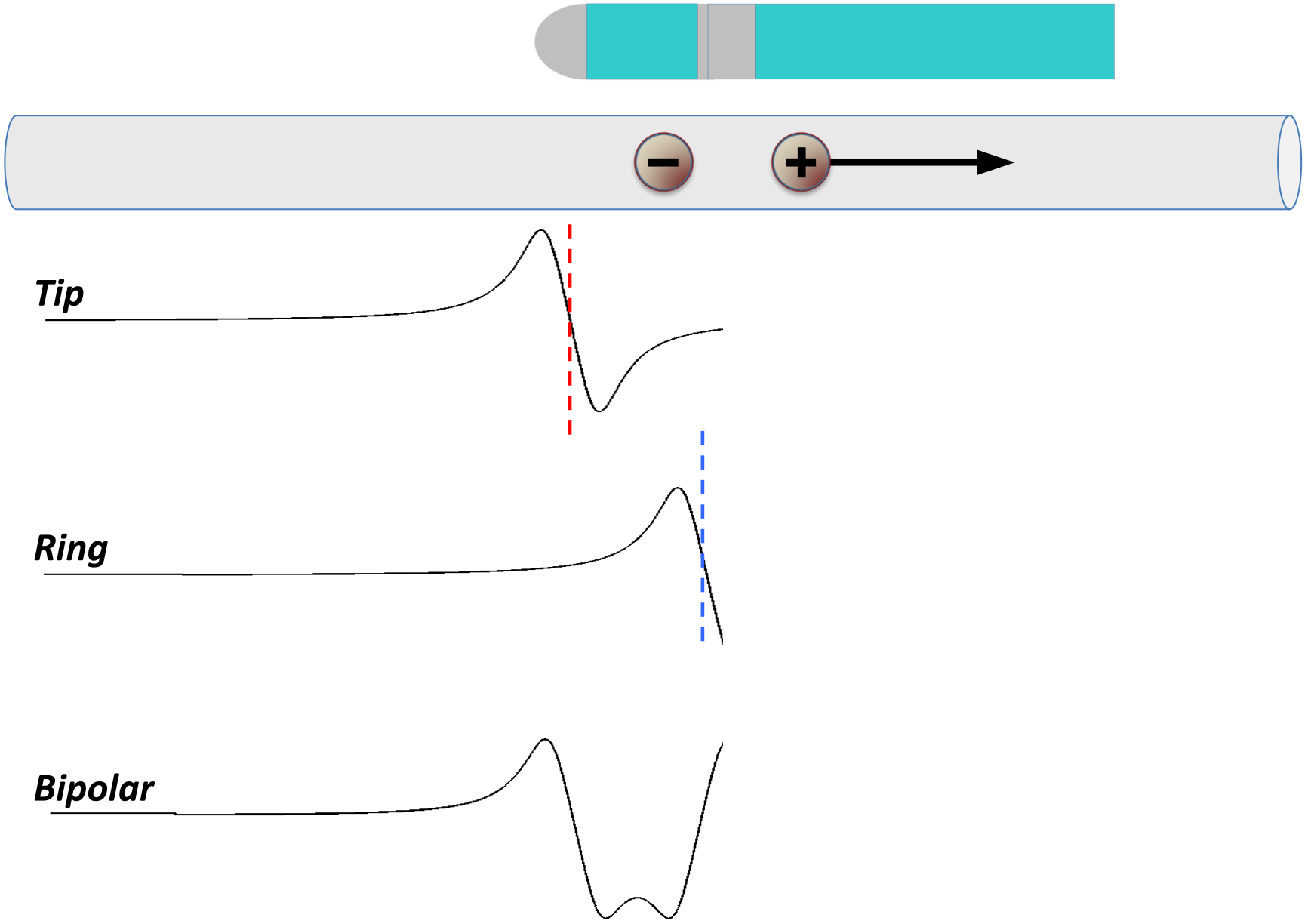


Figure 2.3D.

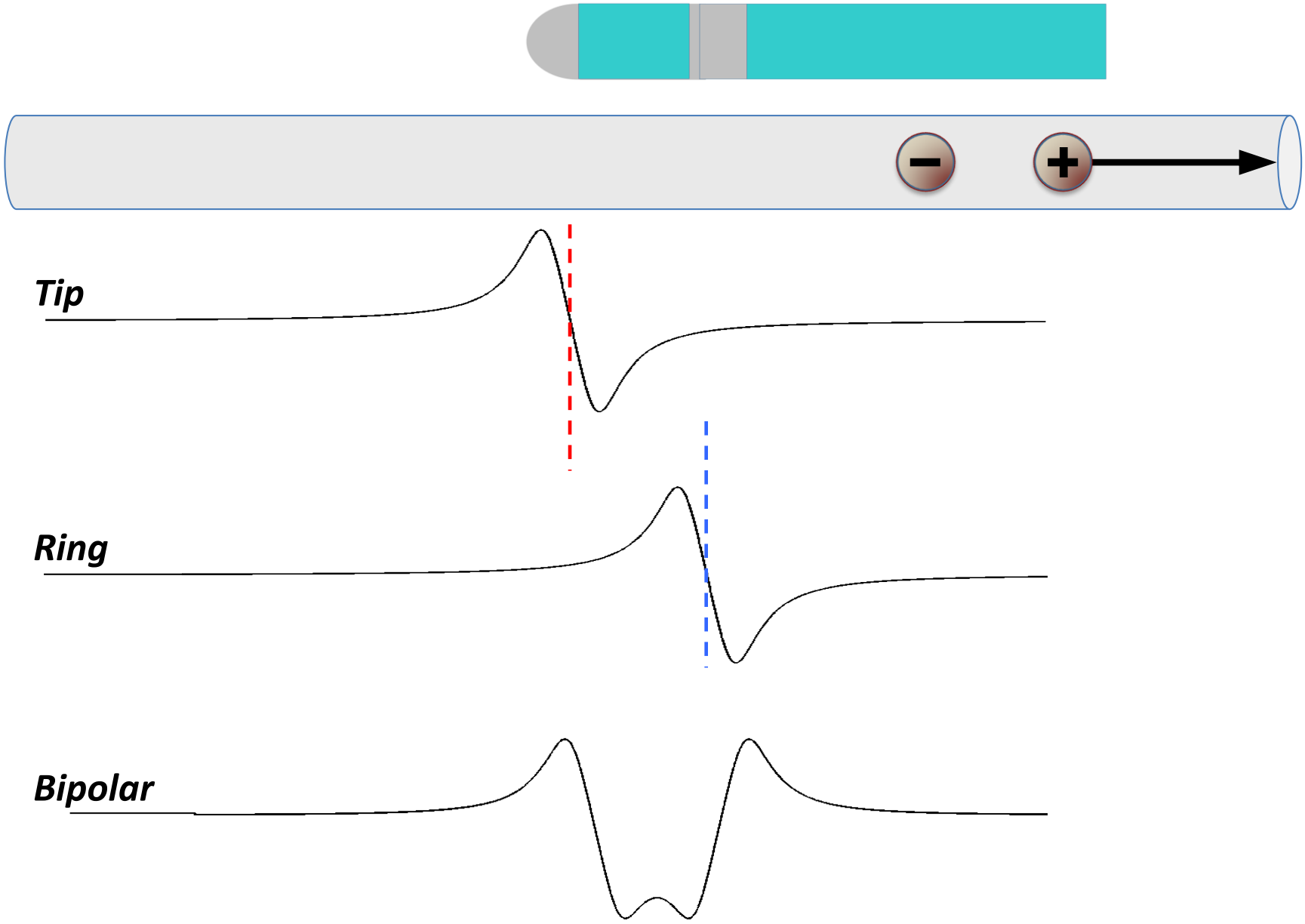


Figure 2.3E.

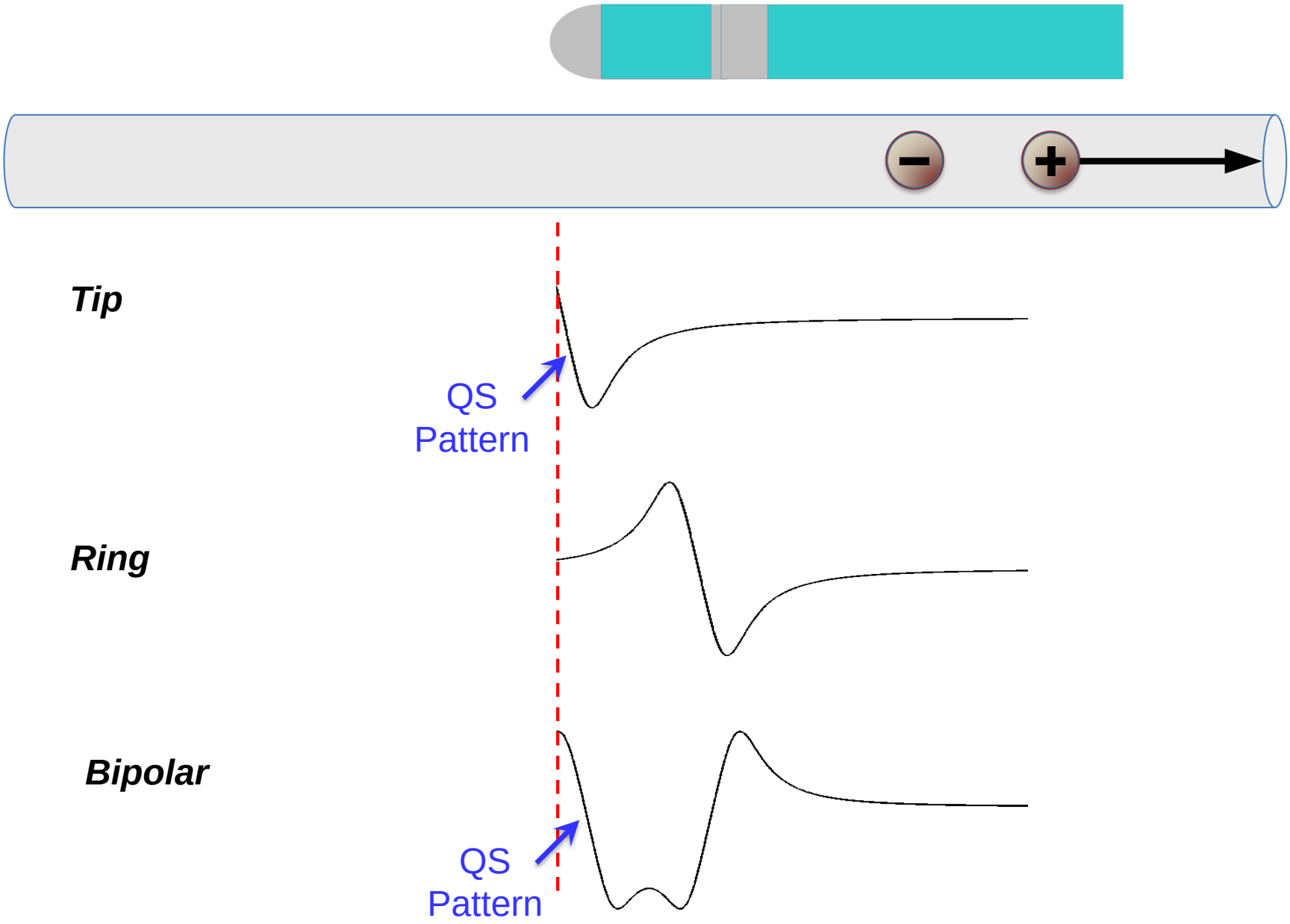


Figure 2.3F.

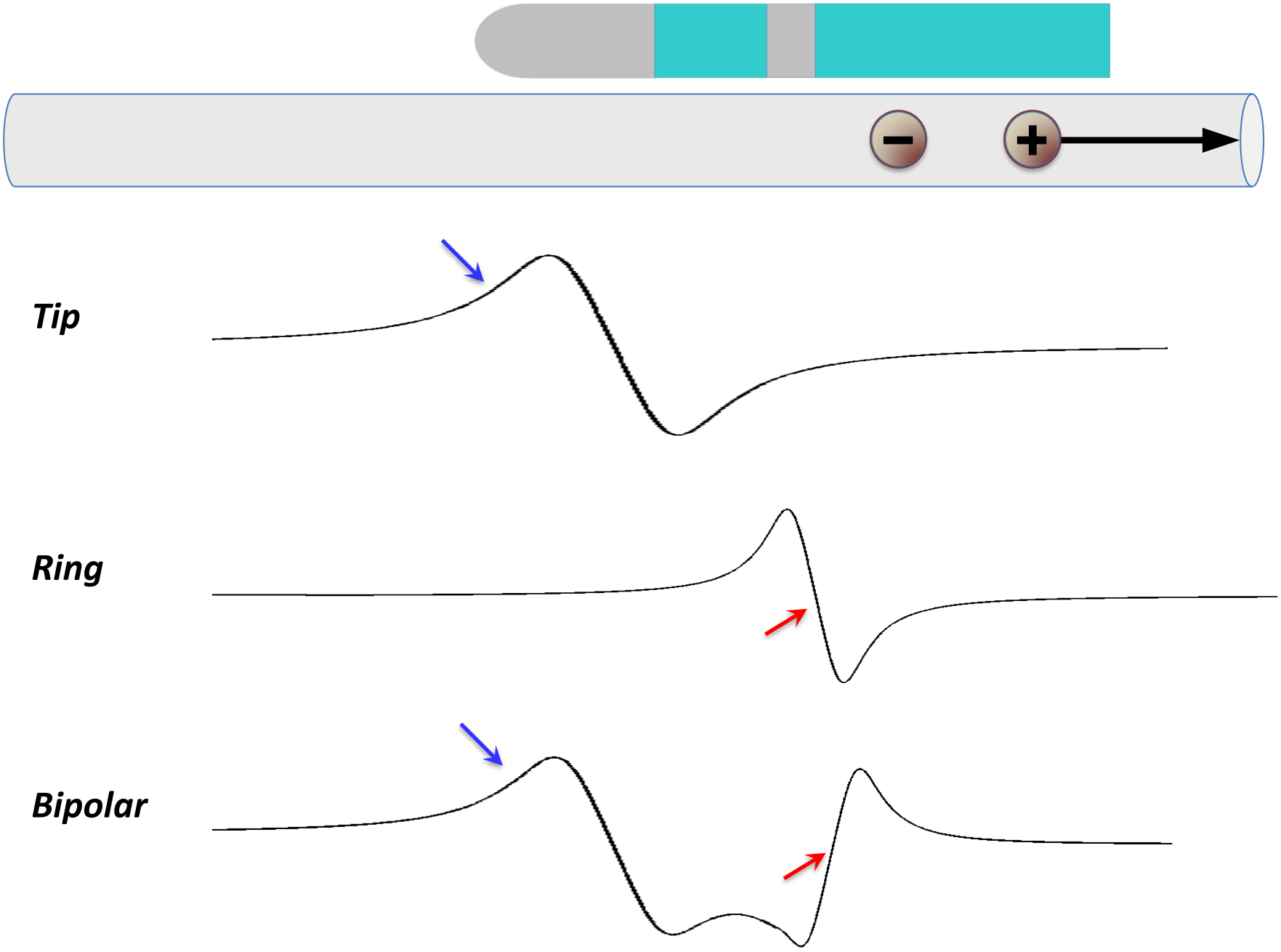


Figure 2.4A.

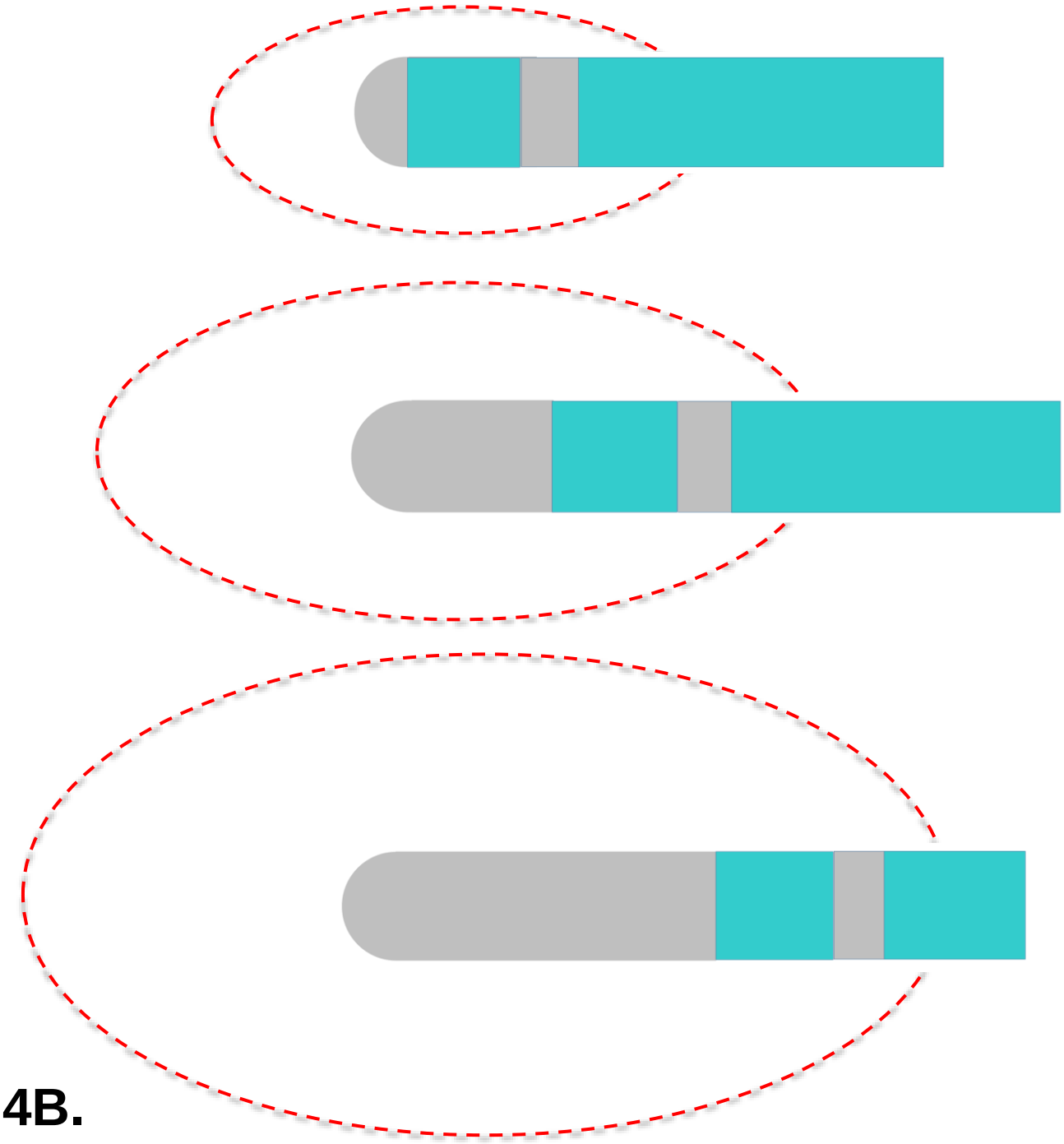


Figure 2.4B.

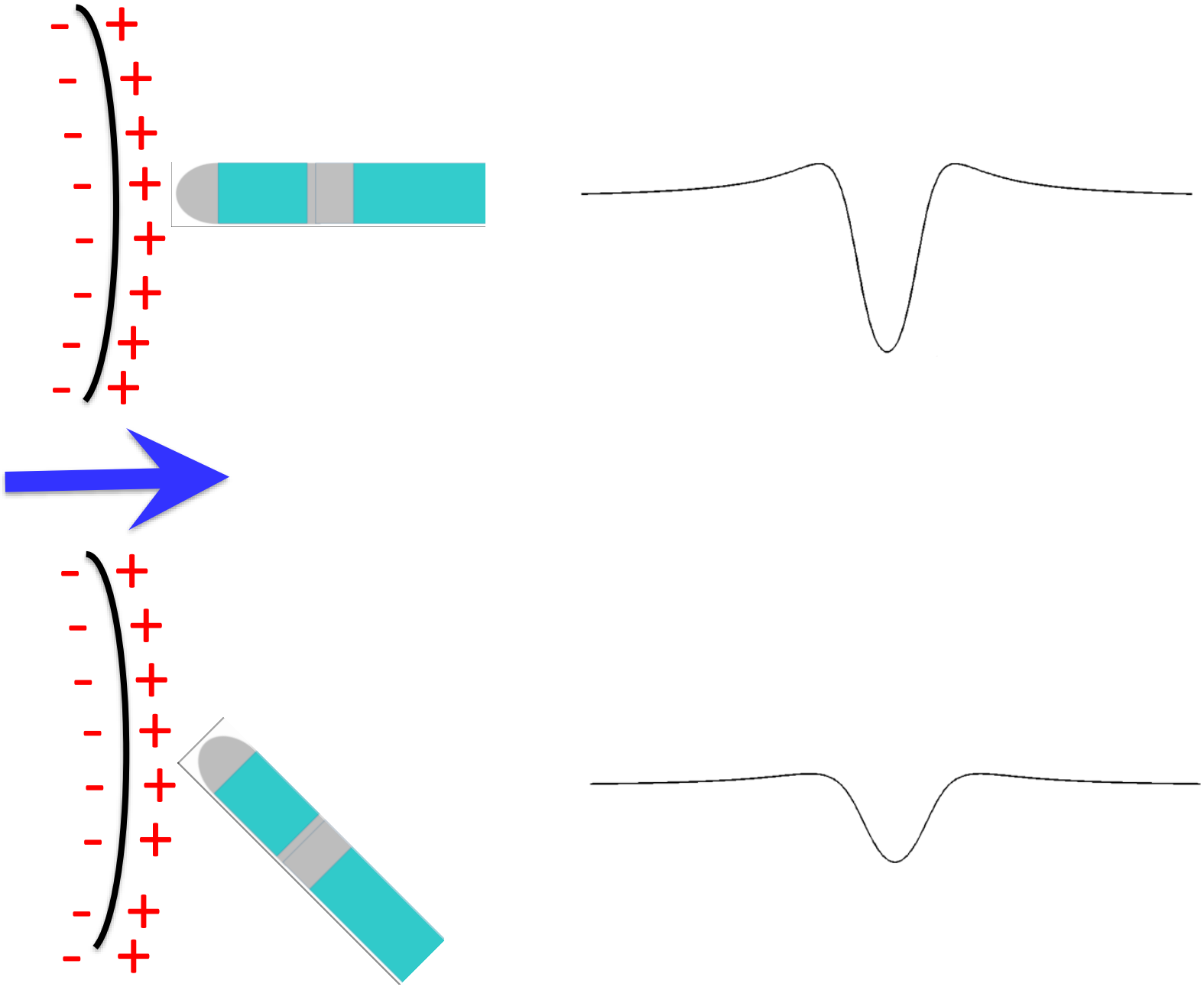


Figure 2.5A.

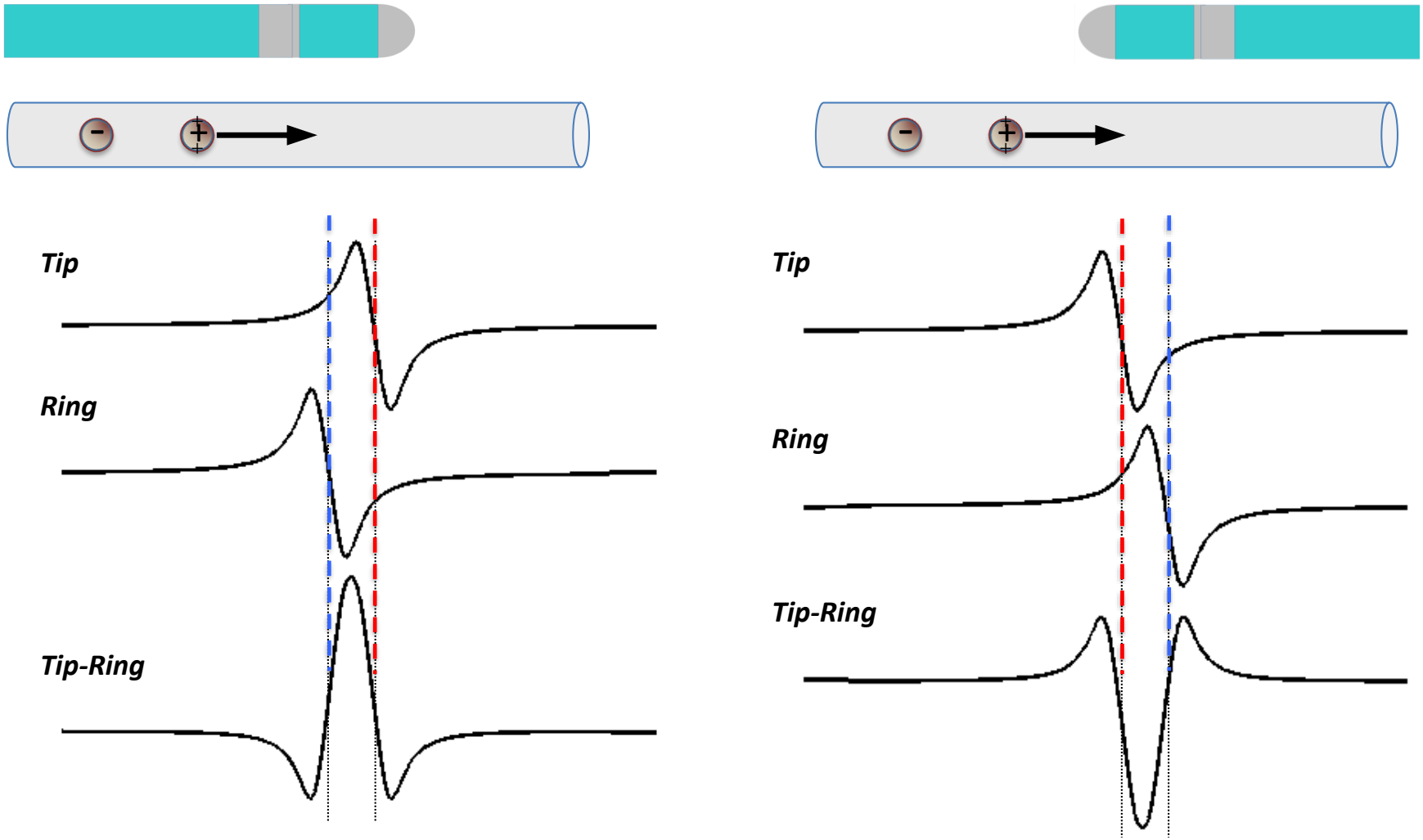


Figure 2.5B.

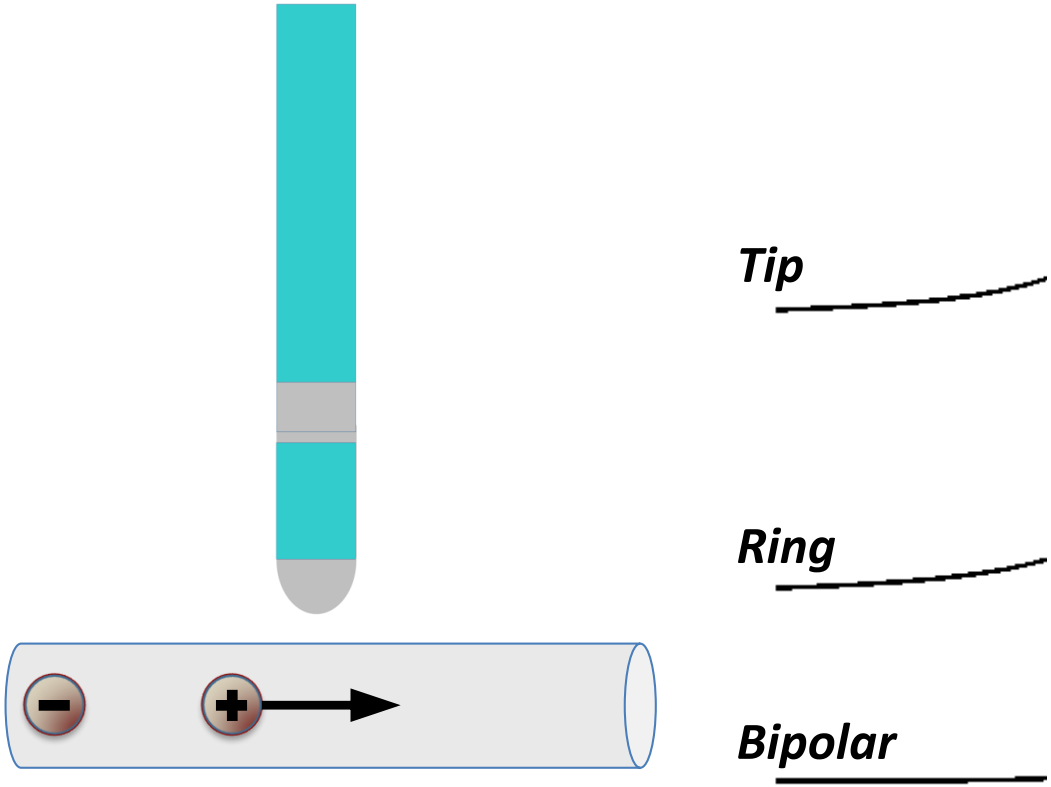


Figure 2.6A.

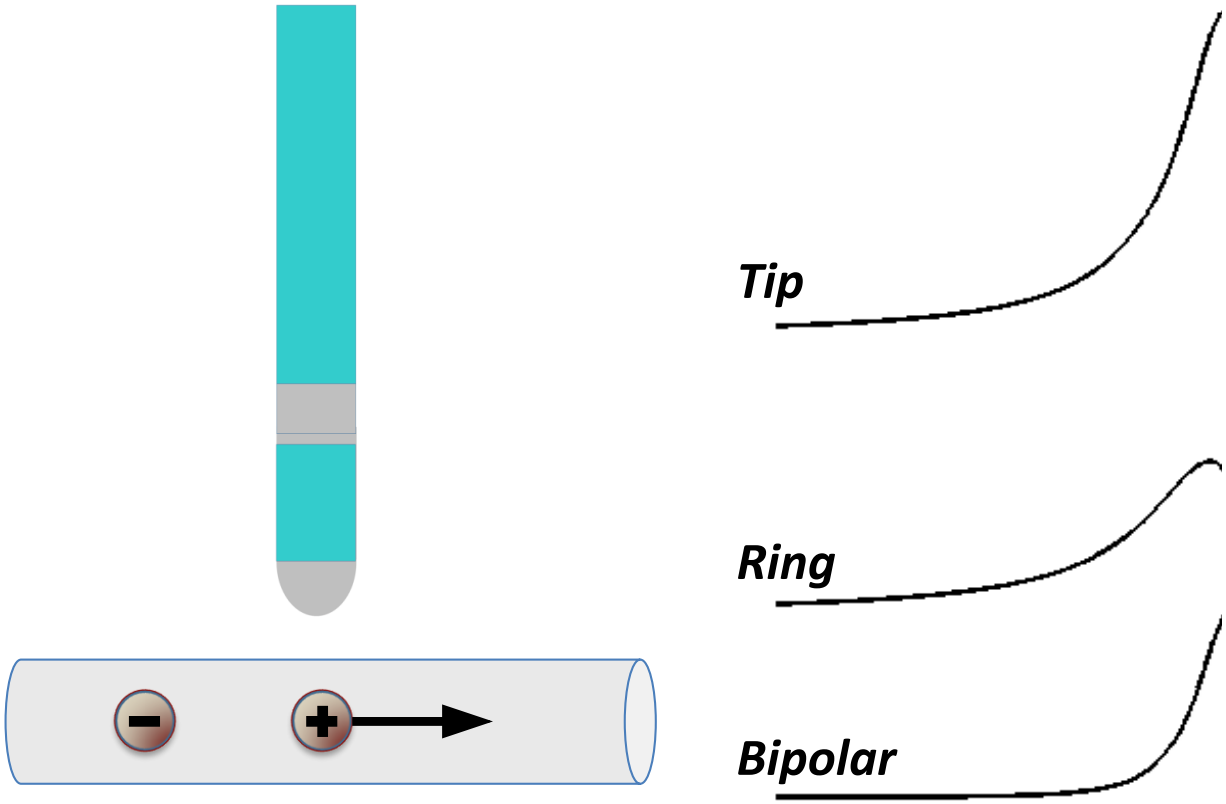


Figure 2.6B.

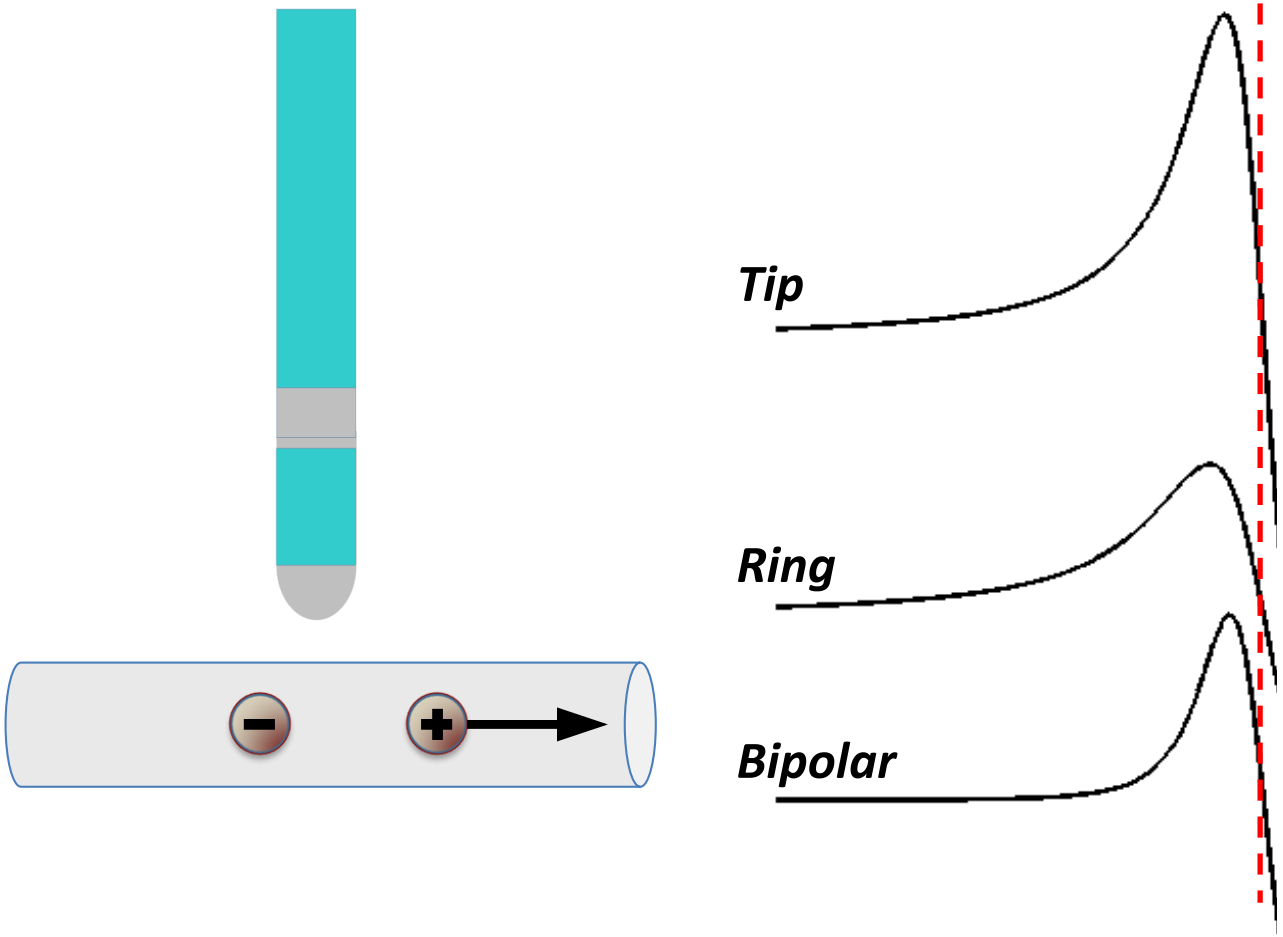


Figure 2.6C.

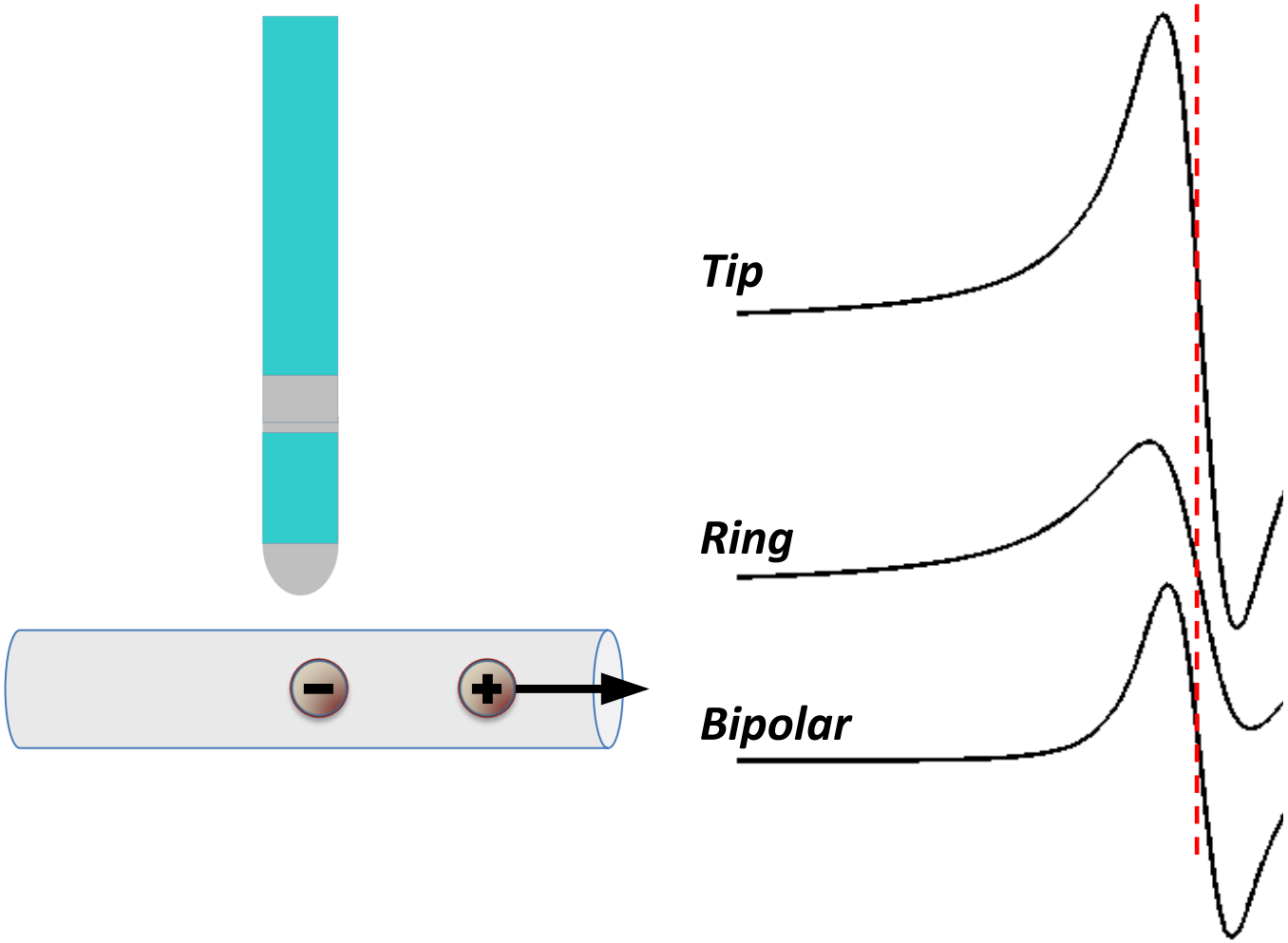


Figure 2.6D.

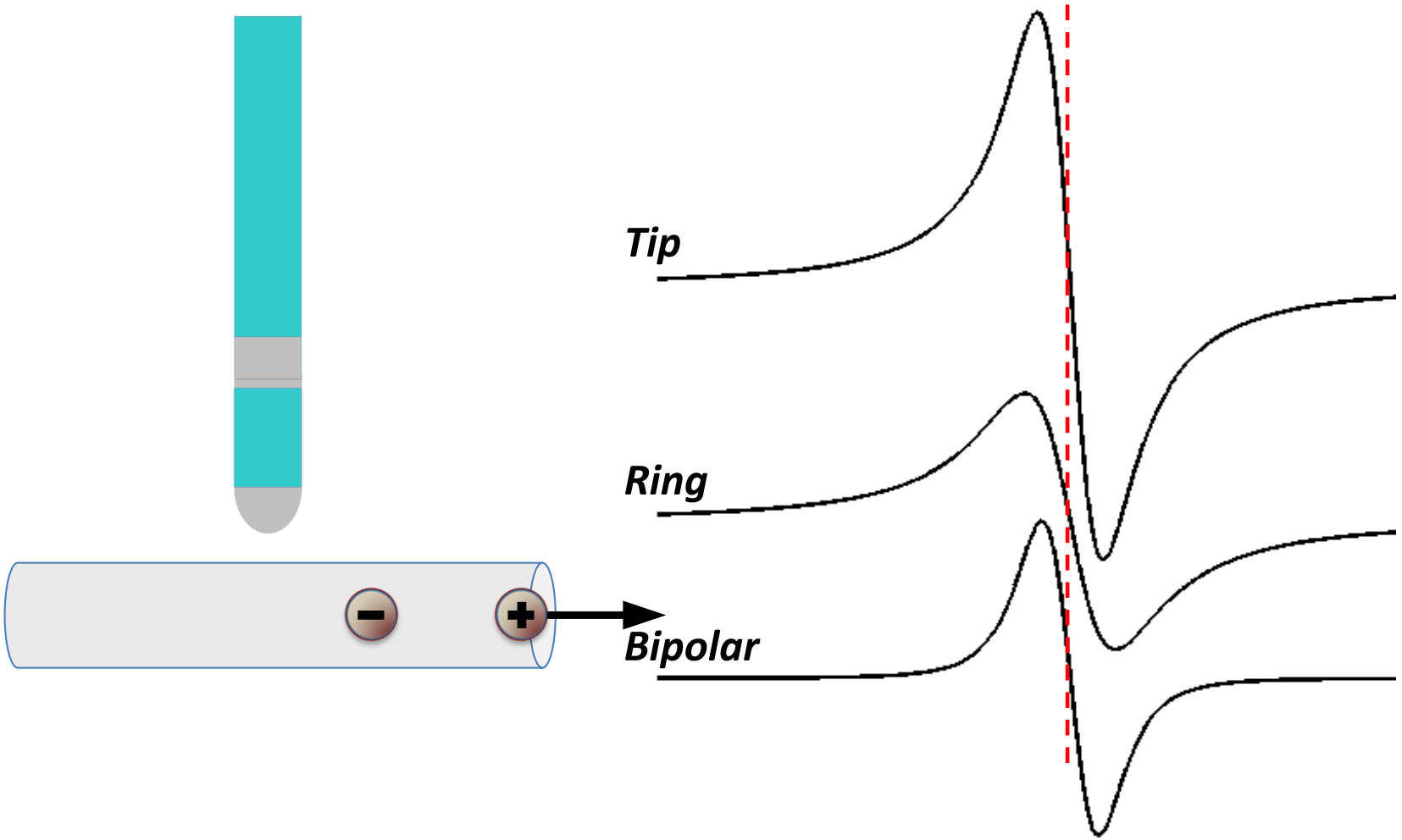


Figure 2.6E.

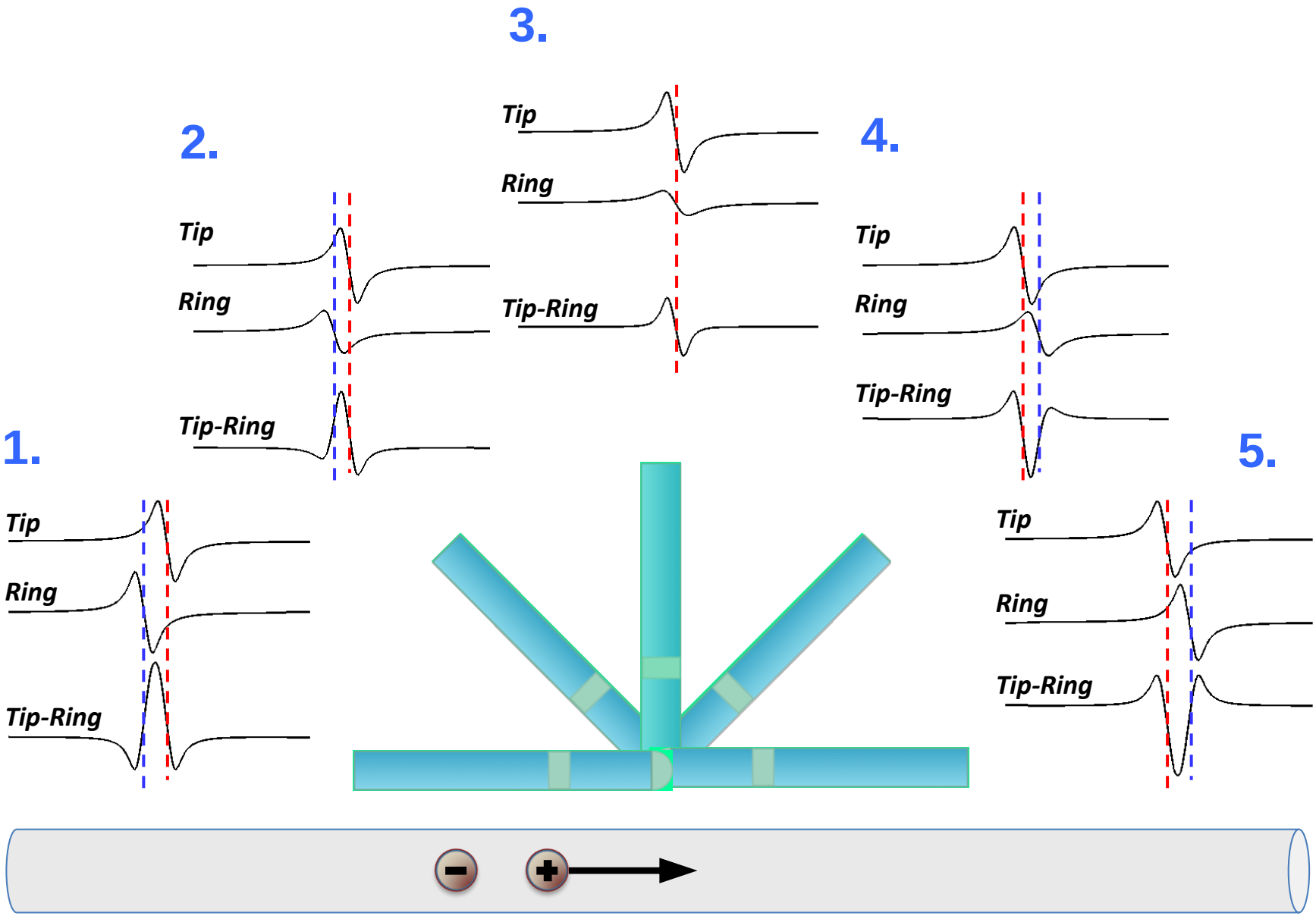
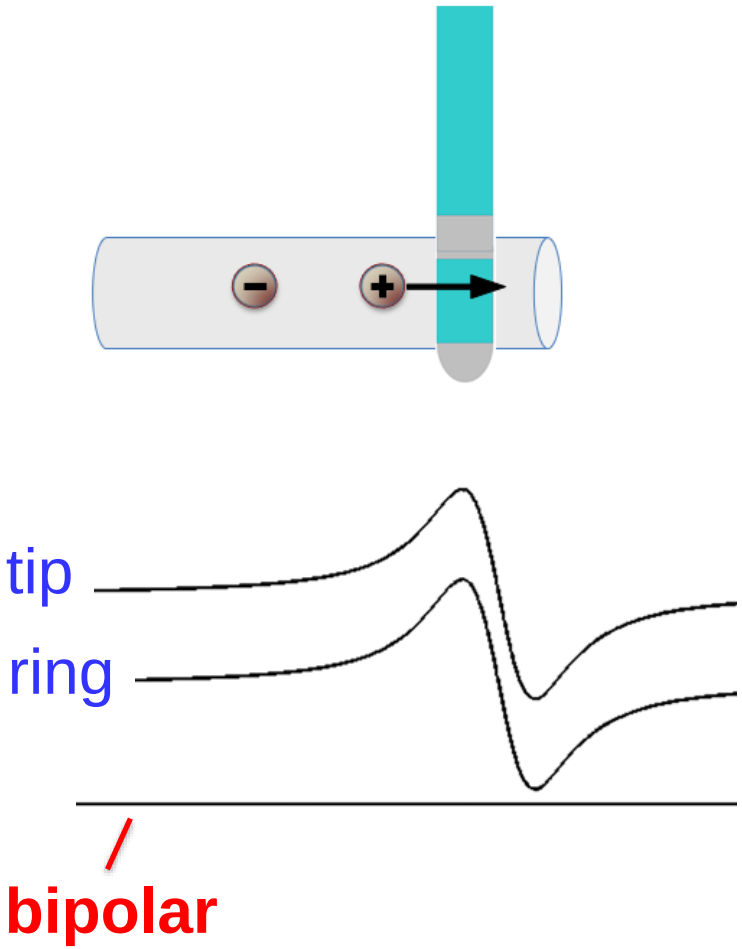

1.
Tip
Ring
Tip-Ring
2.
Tip
Ring
Tip-Ring
3.
Tip
Ring
Tip-Ring
4.
Tip
Ring
Tip-Ring
5.
Tip
Ring
Tip-Ring

Figure 2.6F.


tip
ring
bipolar

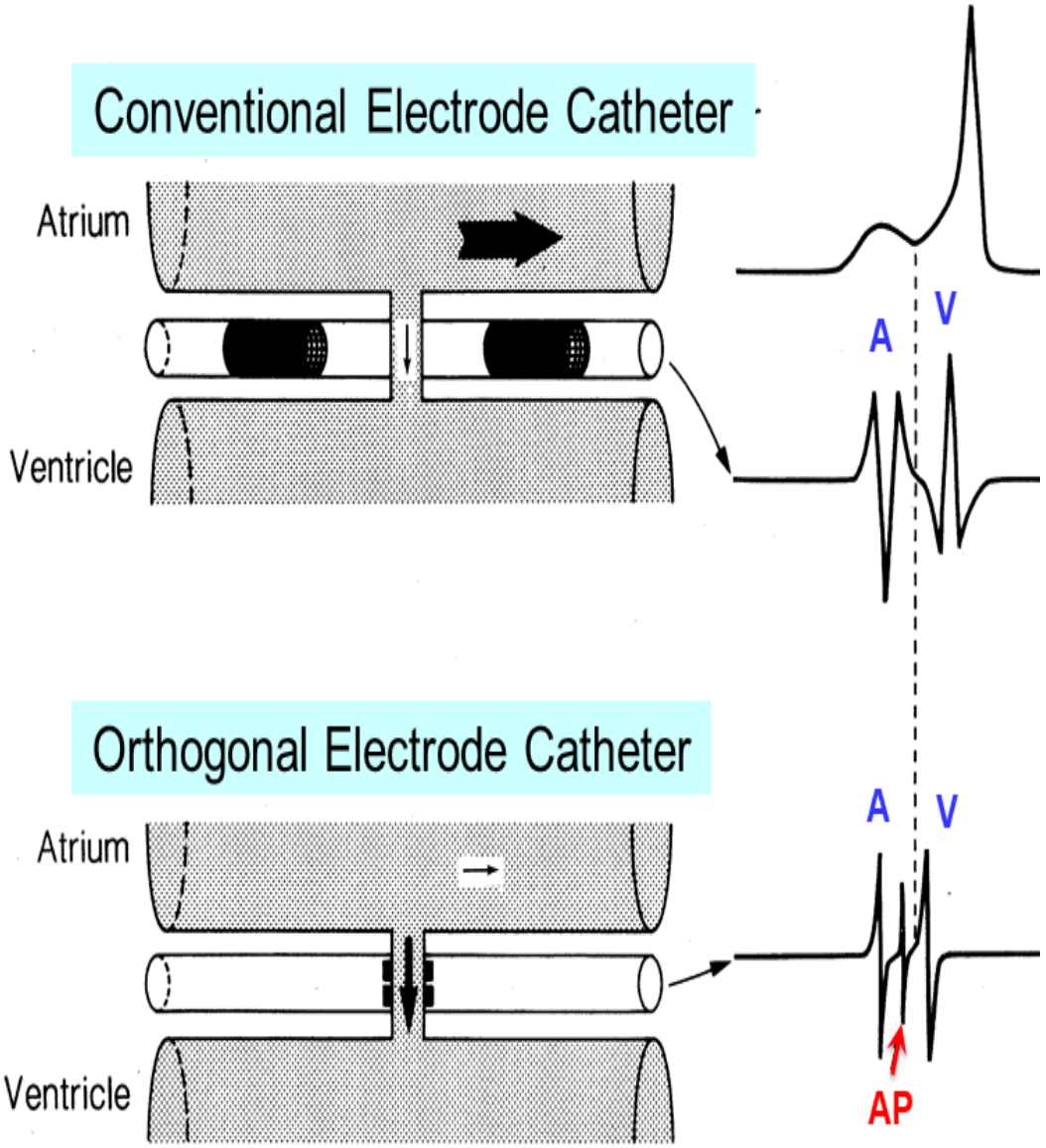

Conventional Electrode Catheter
Atrium
Ventricle
A
V
Orthogonal Electrode Catheter
Atrium
Ventricle
A
V
AP

Figure 2.7A.

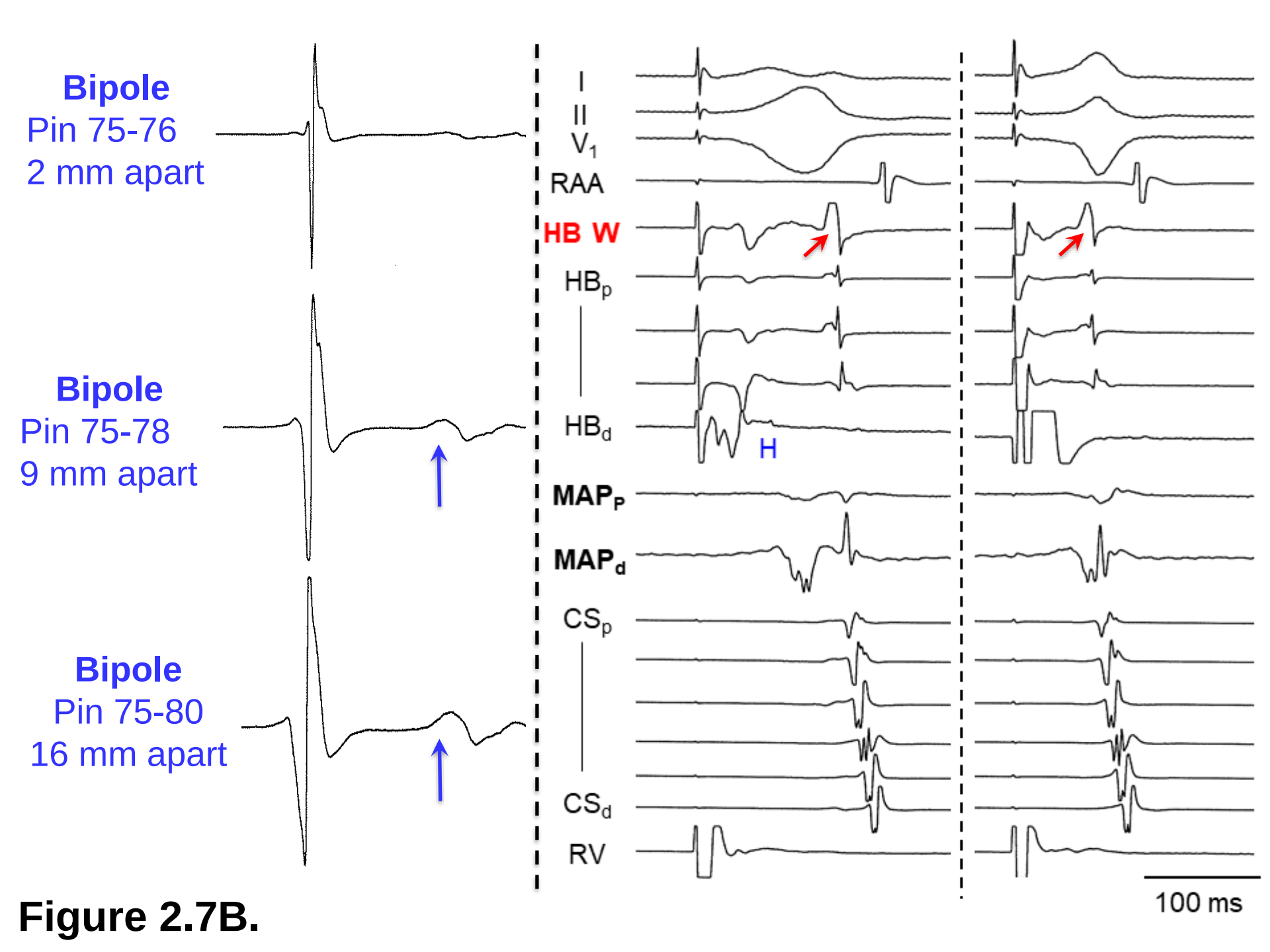

Bipole
Pin 75-76
2 mm apart
Bipole
Pin 75-78
9 mm apart
Bipole
Pin 75-80
16 mm apart
I
II
V1
RAA
HB W
HBp
HBd
H
MAPP
MAPd
CSp
CSd
RV
100 ms

Figure 2.7B.

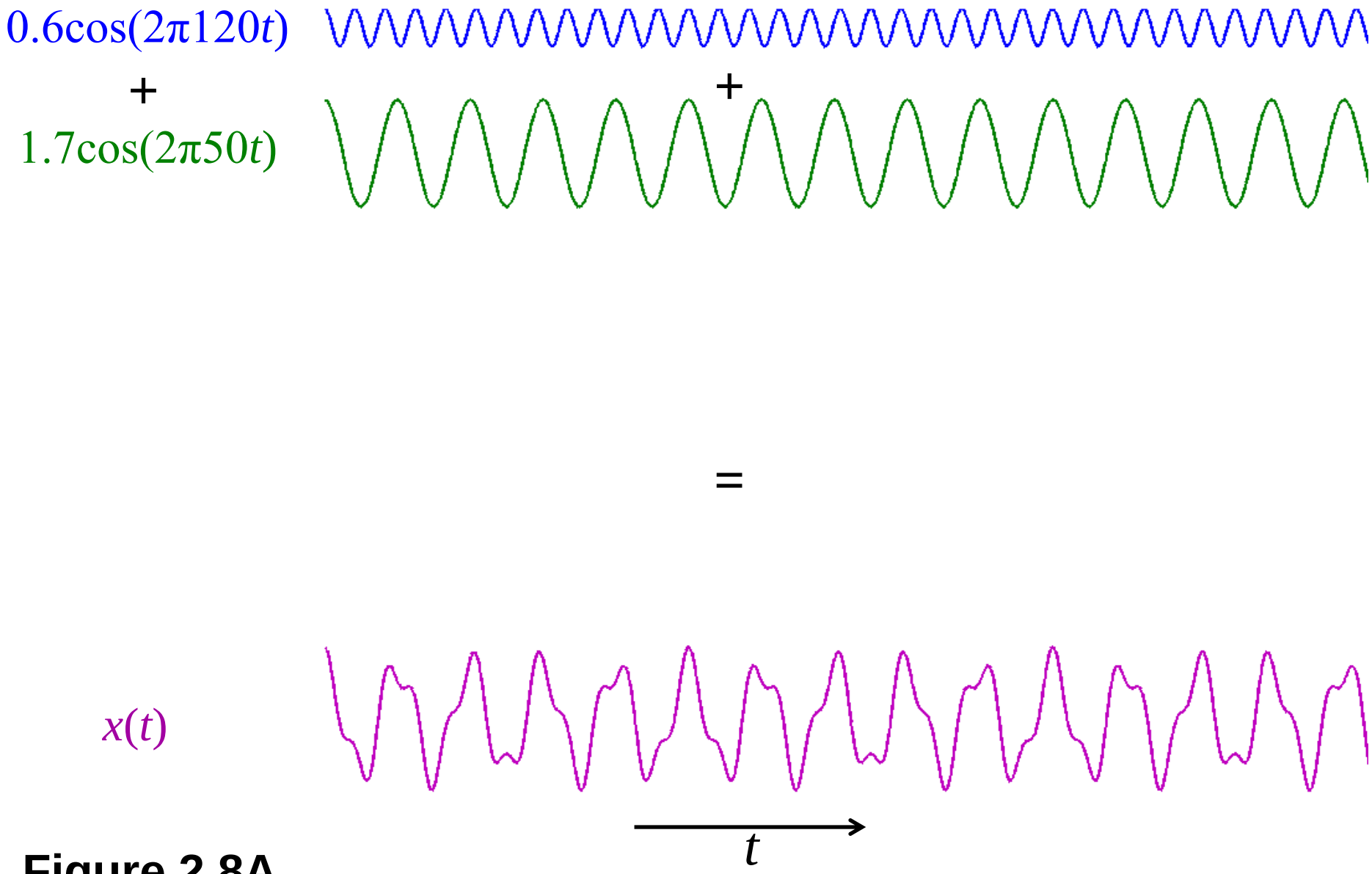


Figure 2.8A.

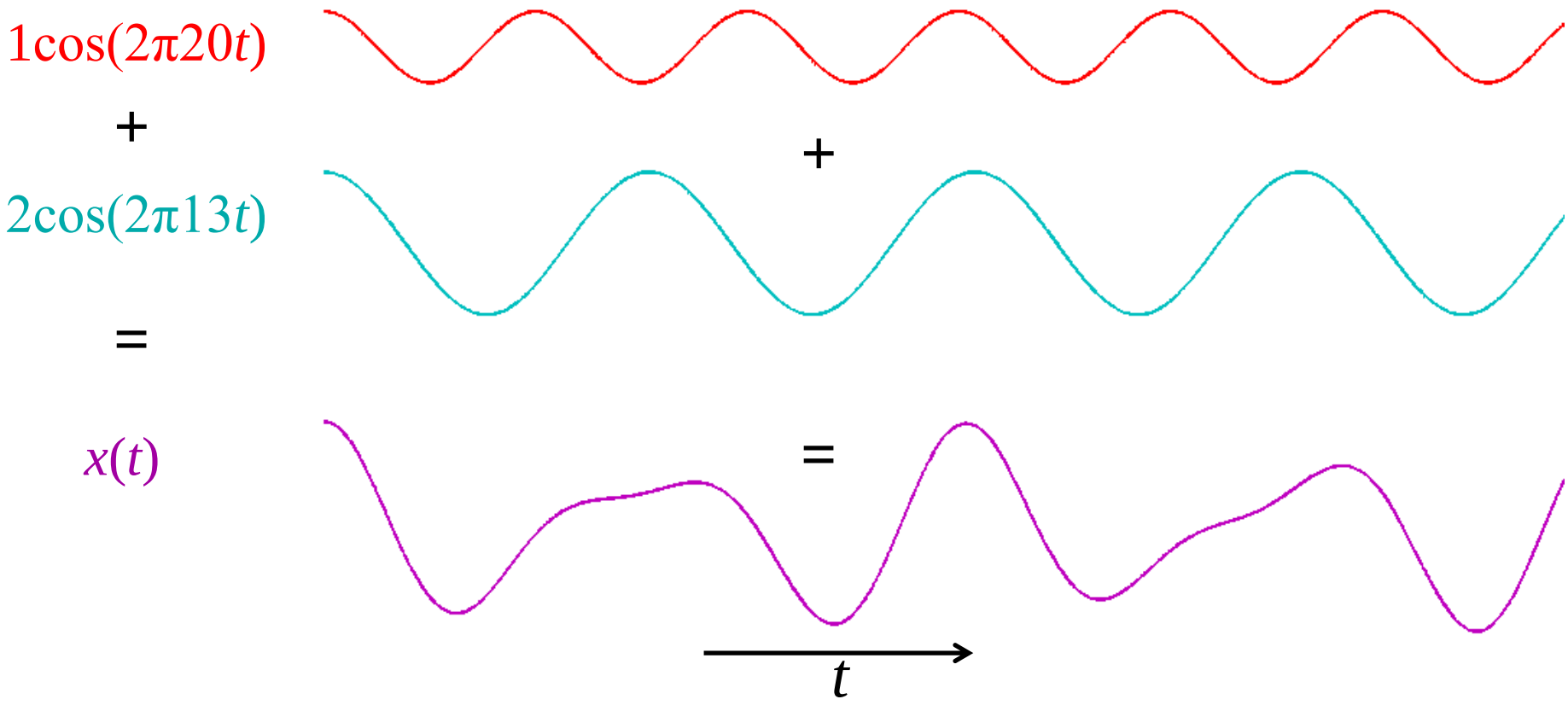


Figure 2.8B.

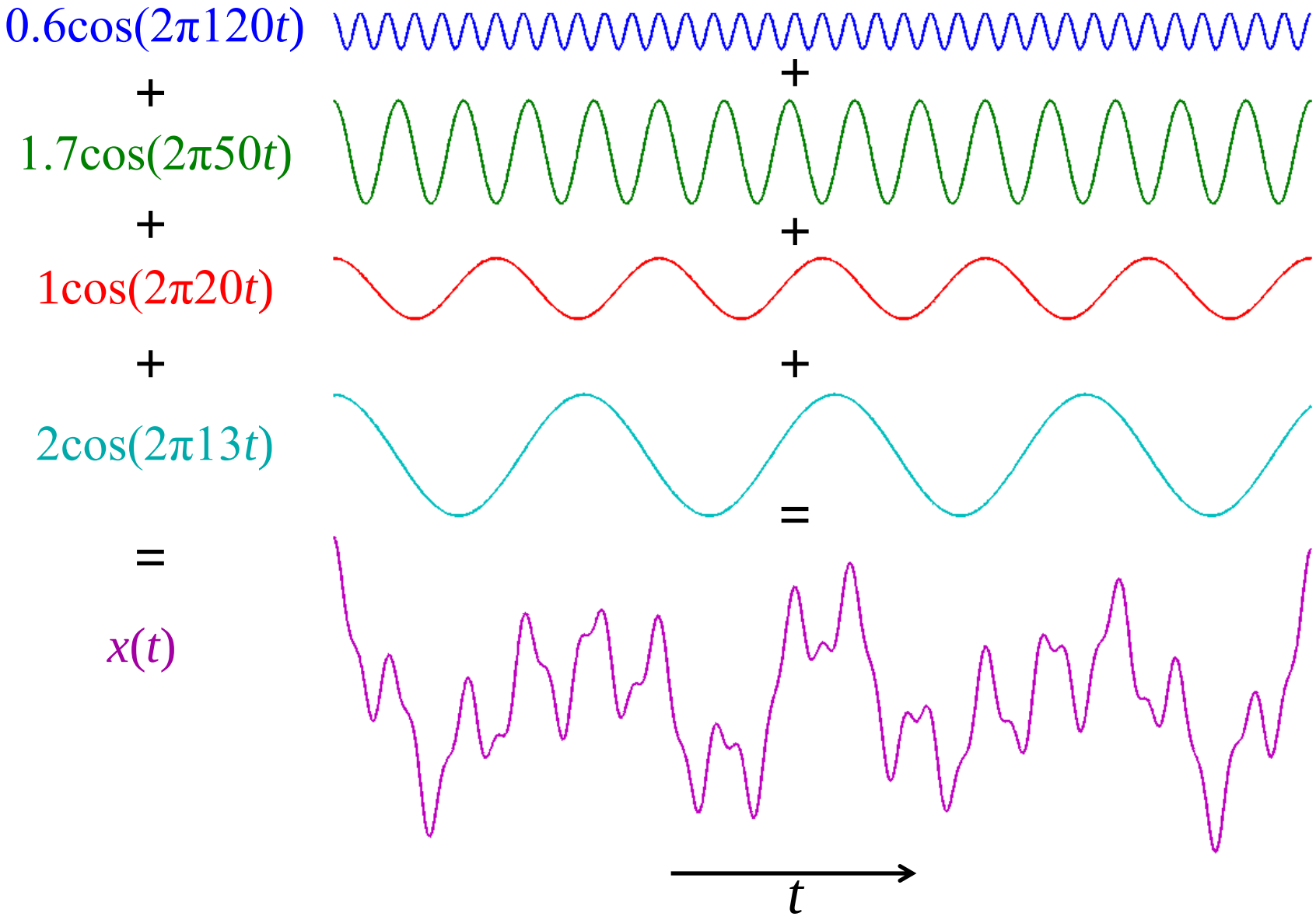


Figure 2.8C.

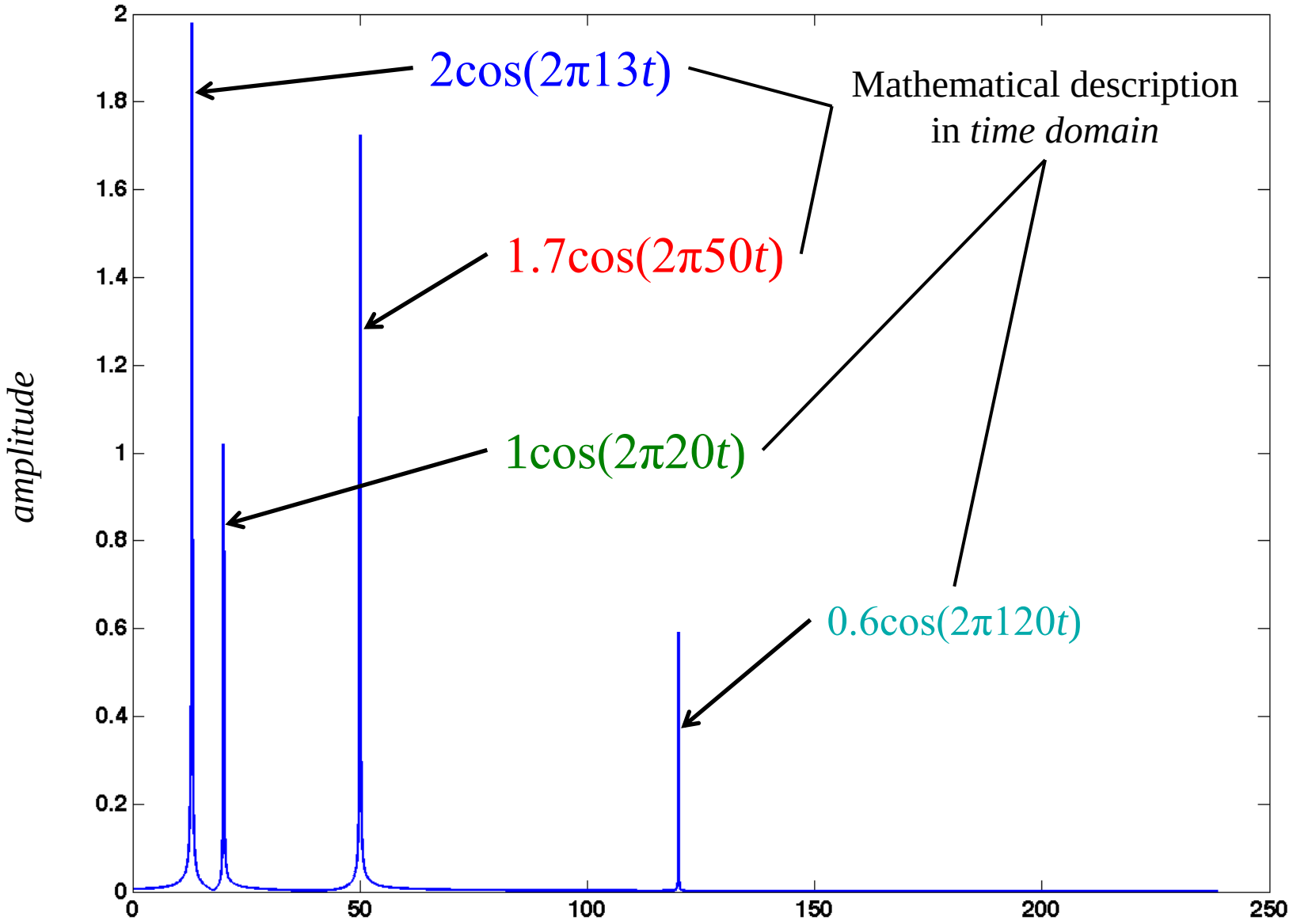
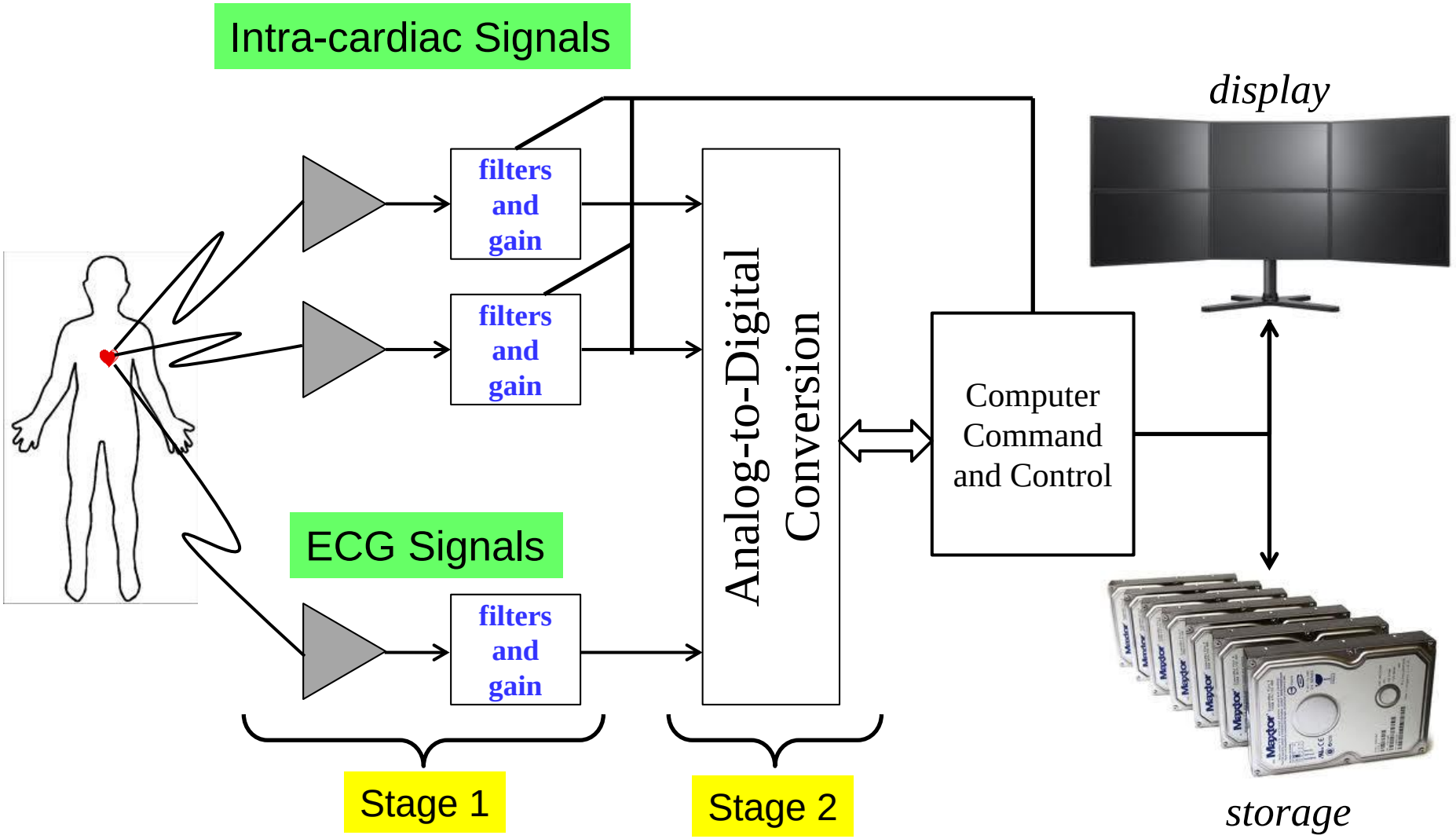

2cos(2π13t)
1.7cos(2π50t)
1cos(2π20t)
0.6cos(2π120t)
Mathematical description
in time domain
amplitude
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
50
100
150
200
250

Figure 2.8D.



- *Analog pre-amplifier*
- *Highpass and Lowpass filters*
- *Gain*

Digitization

Figure 2.9A.

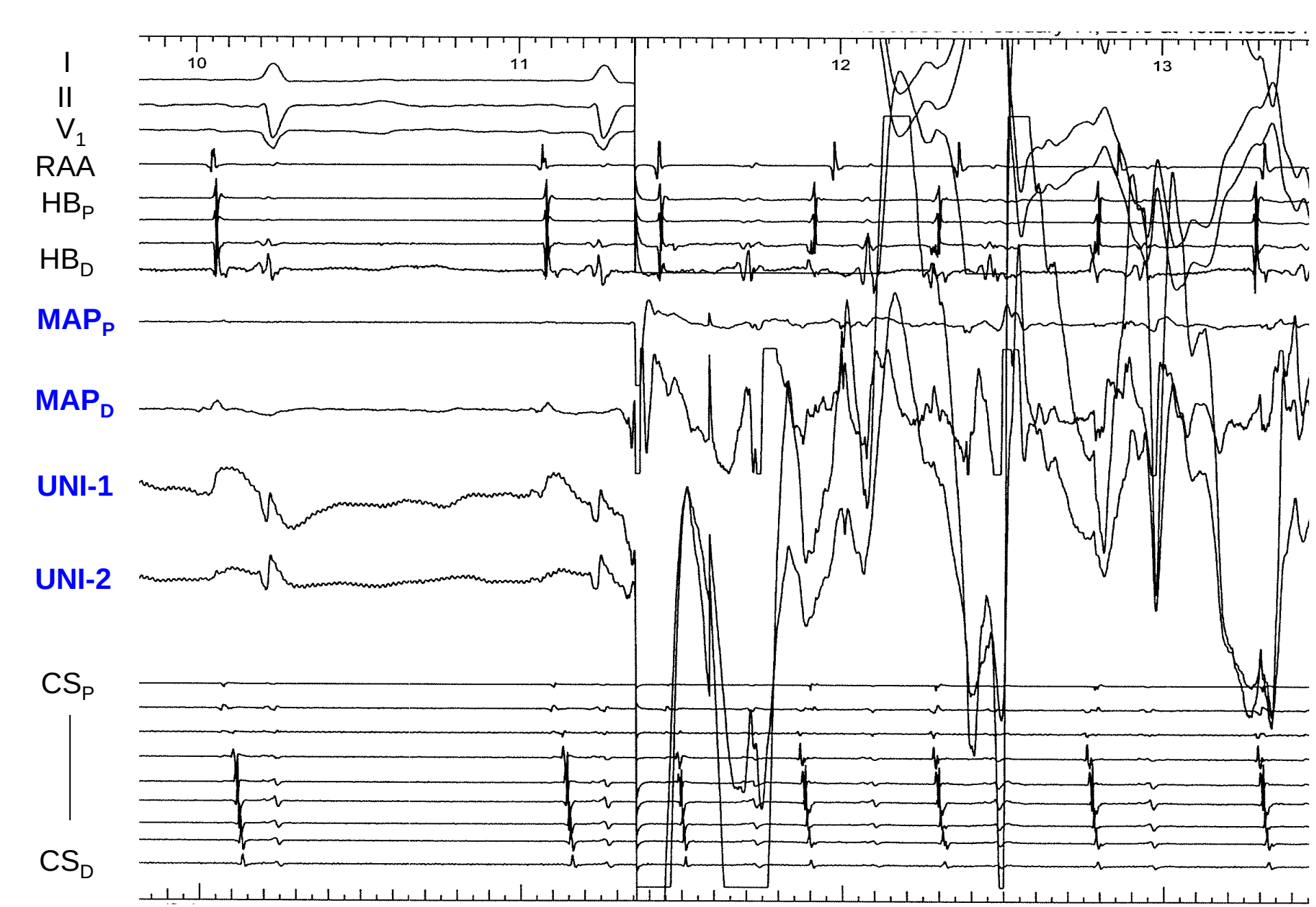


Figure 2.9B.

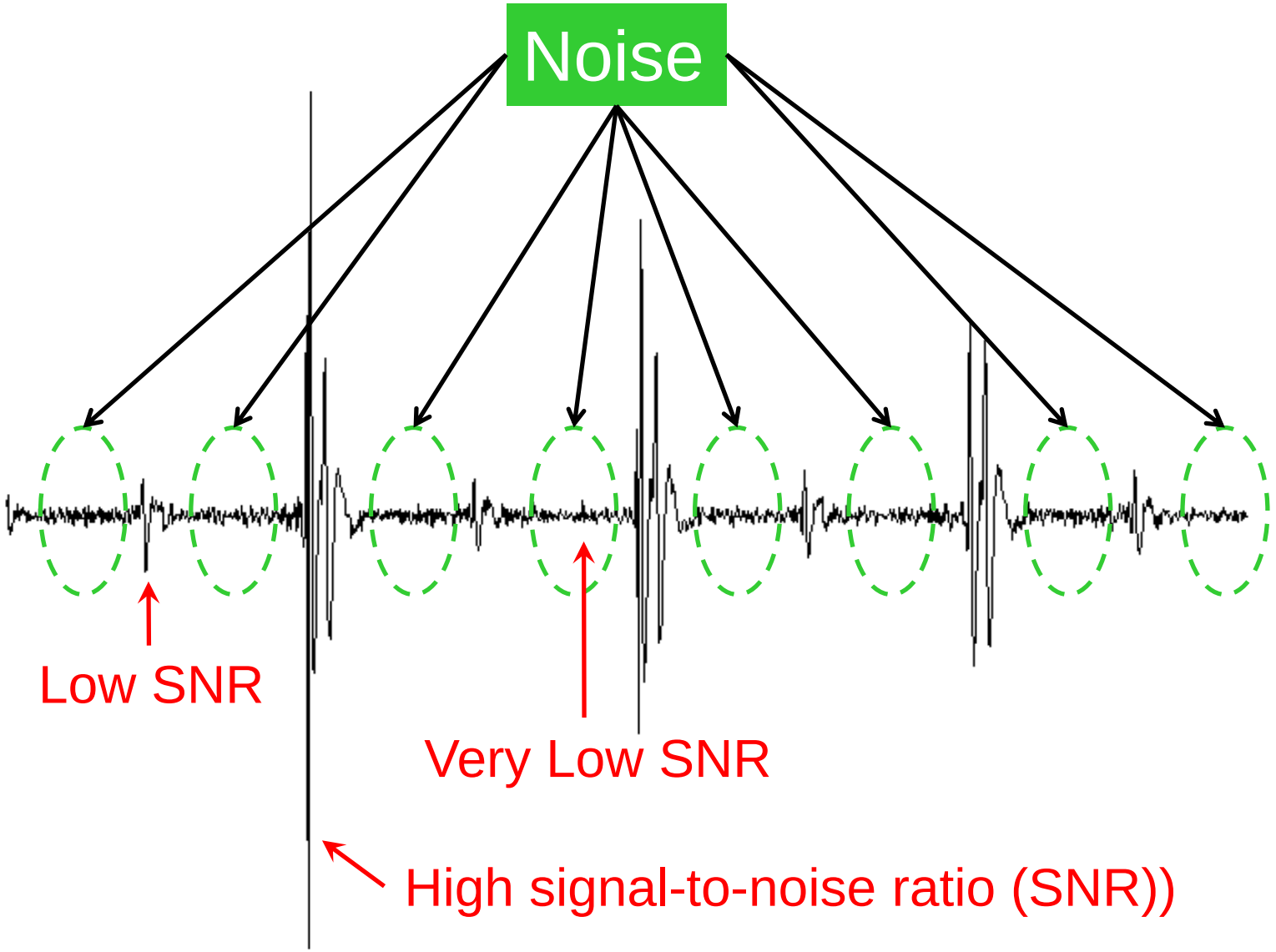


Figure 2.10A.

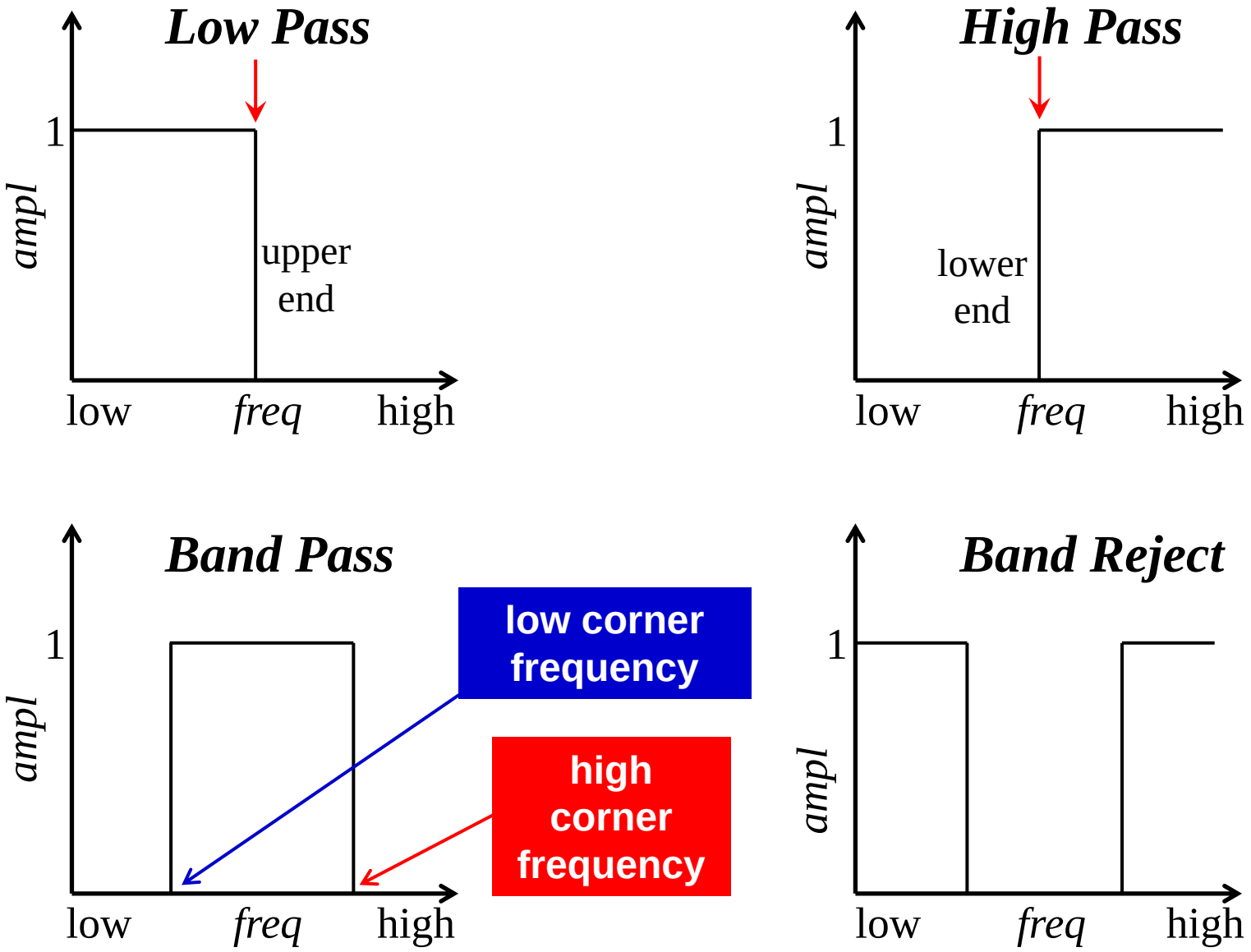

Low Pass
1
ampl
upper
end
low
freq
high
High Pass
1
ampl
lower
end
low
freq
high
Band Pass
1
ampl
low corner
frequency
high
corner
frequency
low
freq
high
Band Reject
1
ampl
low
freq
high

Figure 2.10B.

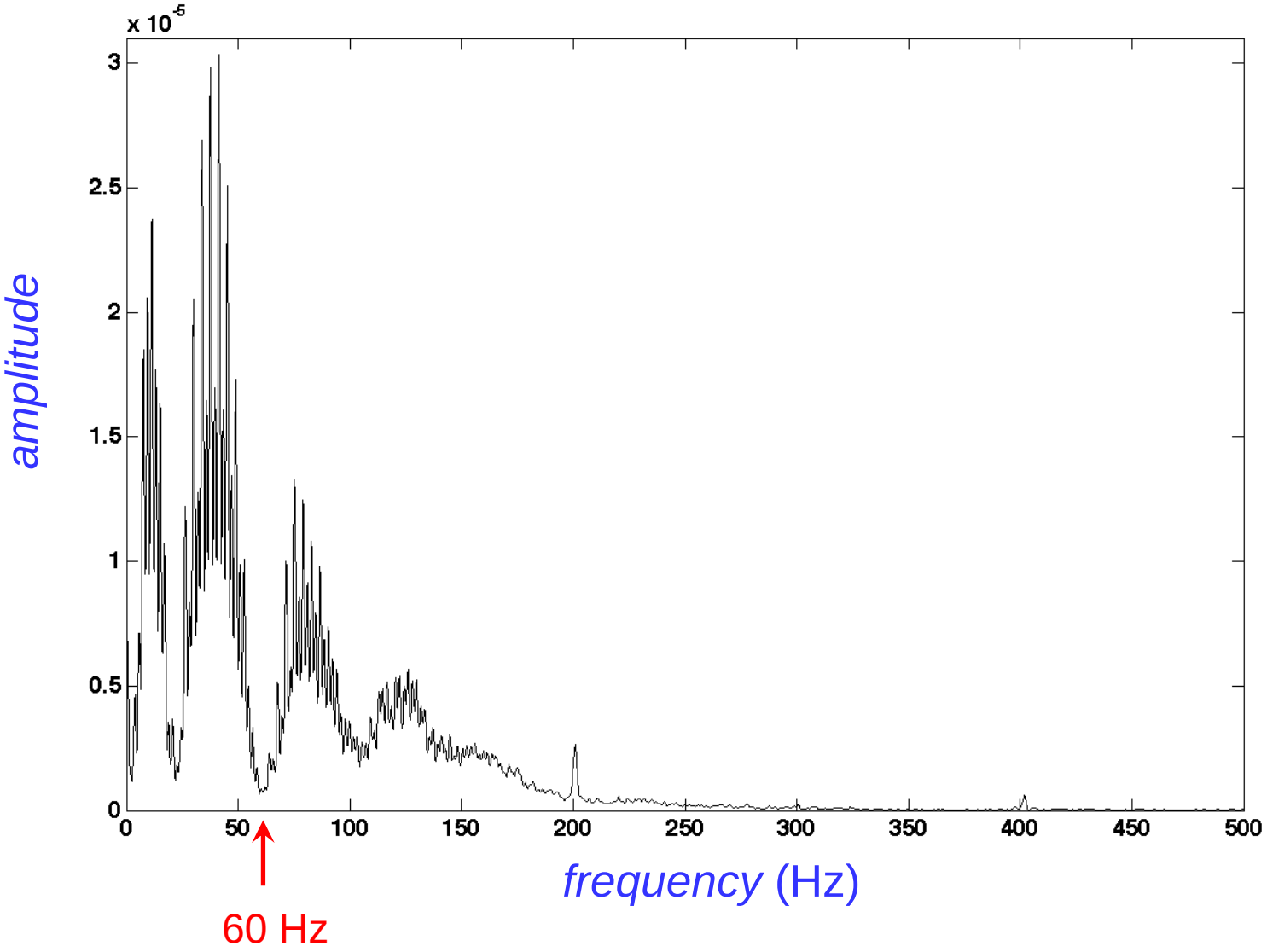
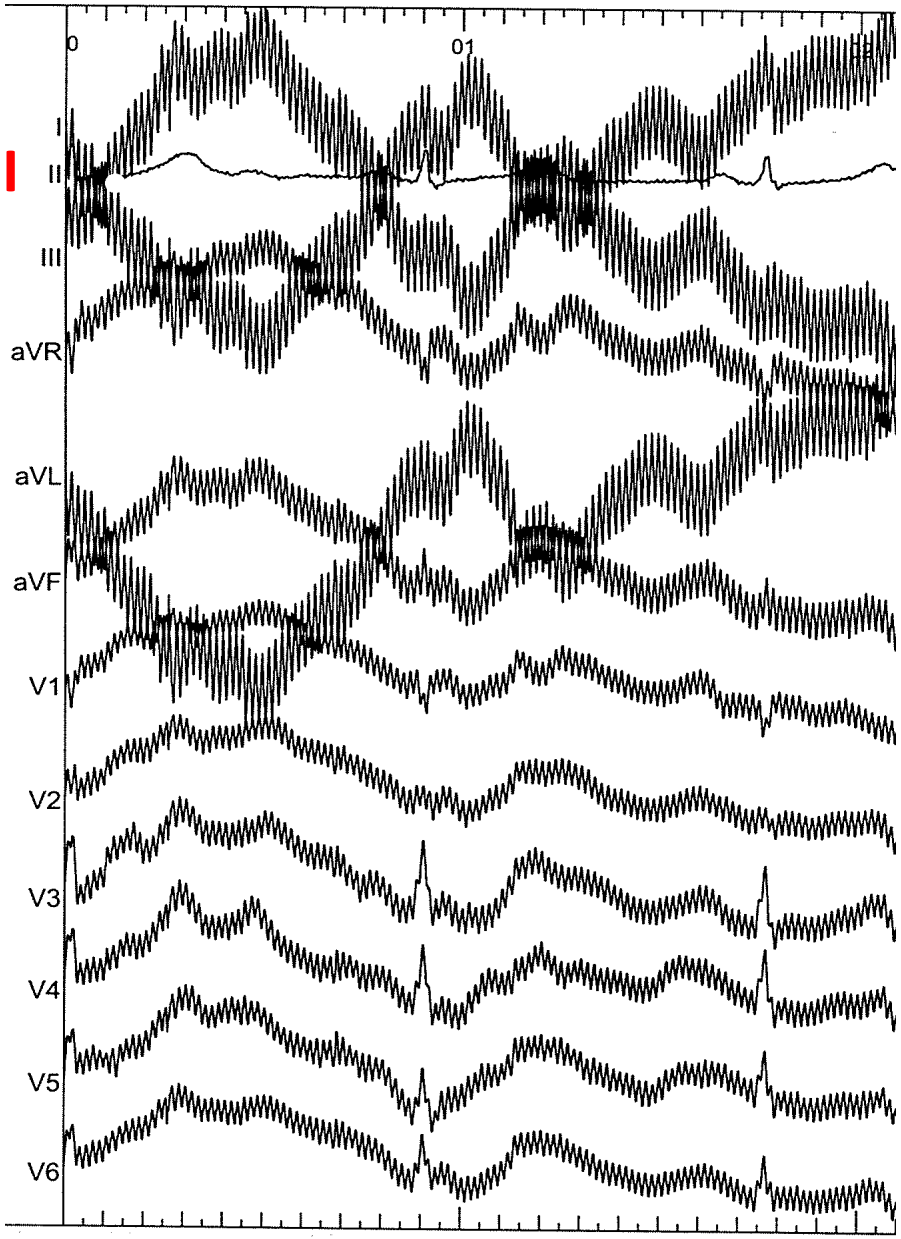

x 10^-5
3
2.5
2
1.5
1
0.5
0
amplitude
0
50
100
150
200
250
300
350
400
450
500
frequency (Hz)
60 Hz

Figure 2.10C.

60 Hz notch filter off

60 Hz notch filter on



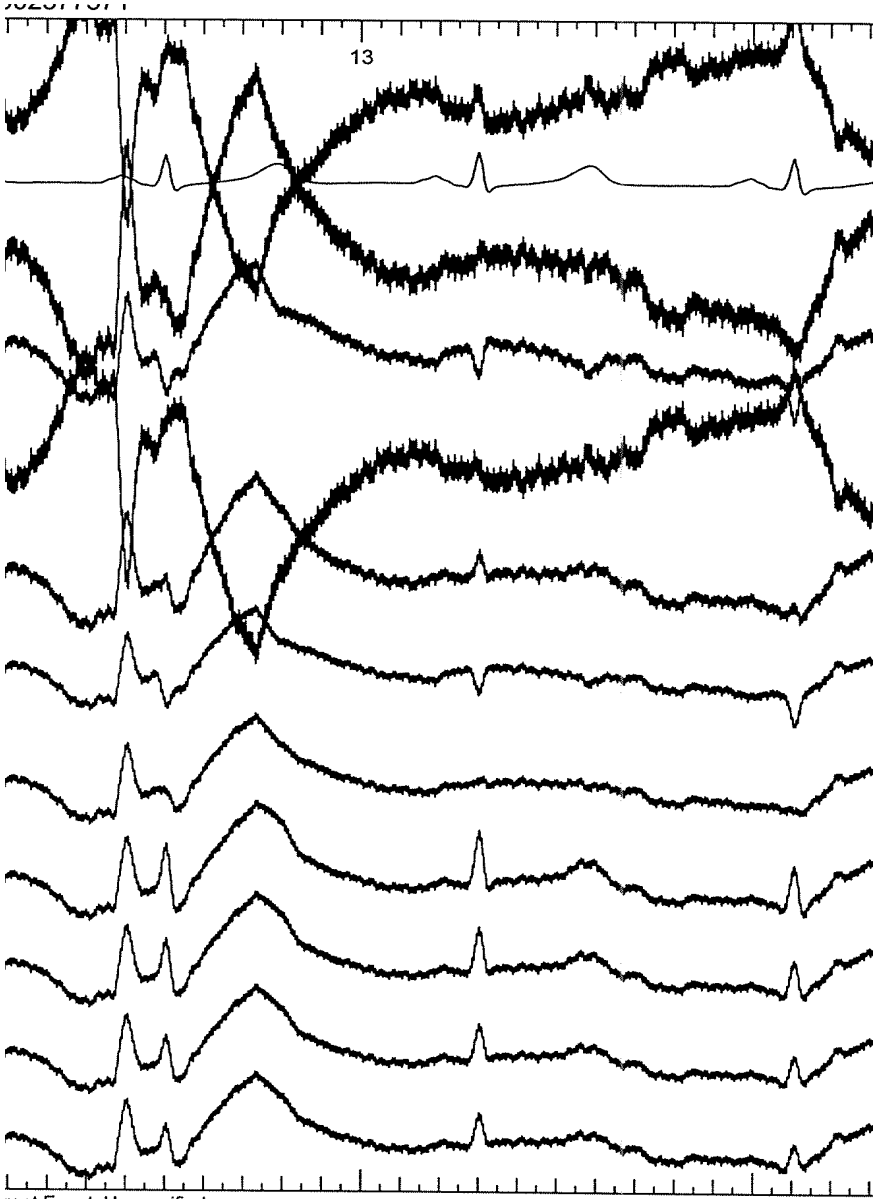


Figure 2.10D.

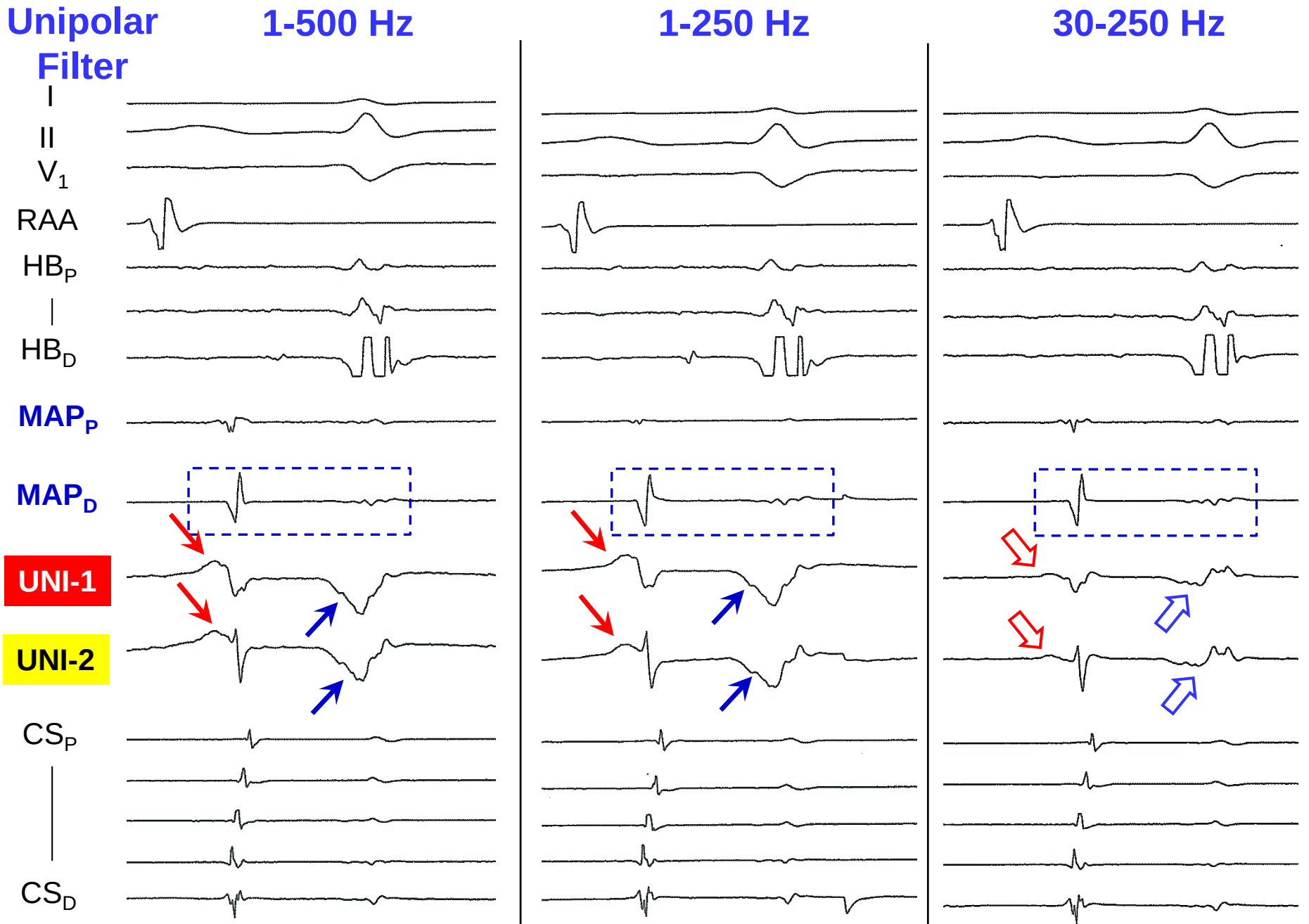

Unipolar
Filter
1-500 Hz
1-250 Hz
30-250 Hz
I
II
V1
RAA
HBP
HBD
MAPP
MAPD
UNI-1
UNI-2
CSP
CSD

Figure 2.11A.

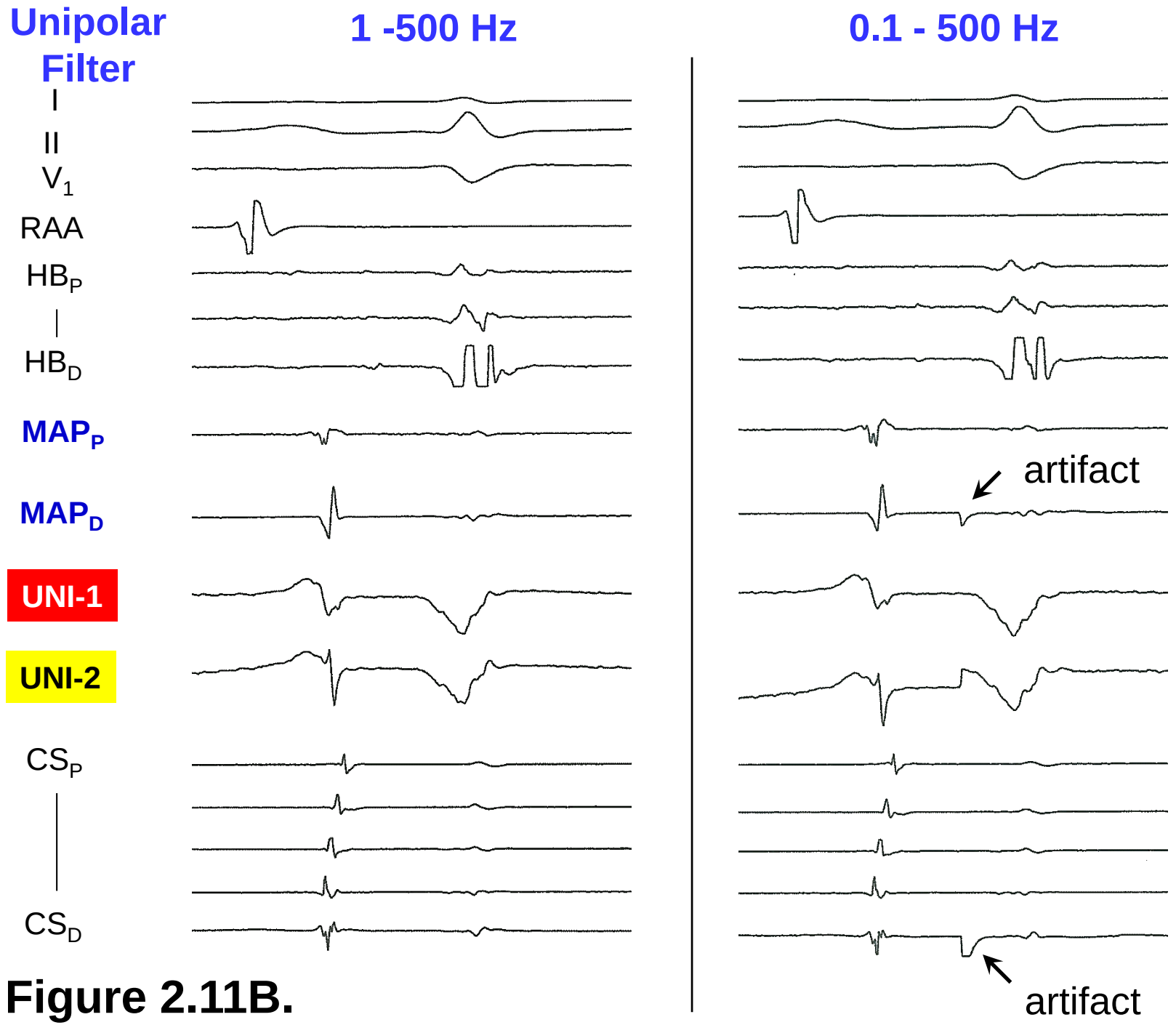

Unipolar Filter
1 -500 Hz
0.1 - 500 Hz
I
II
V1
RAA
HBP
HBD
MAPP
MAPD
UNI-1
UNI-2
CSP
CSD
artifact
artifact

Figure 2.11B.

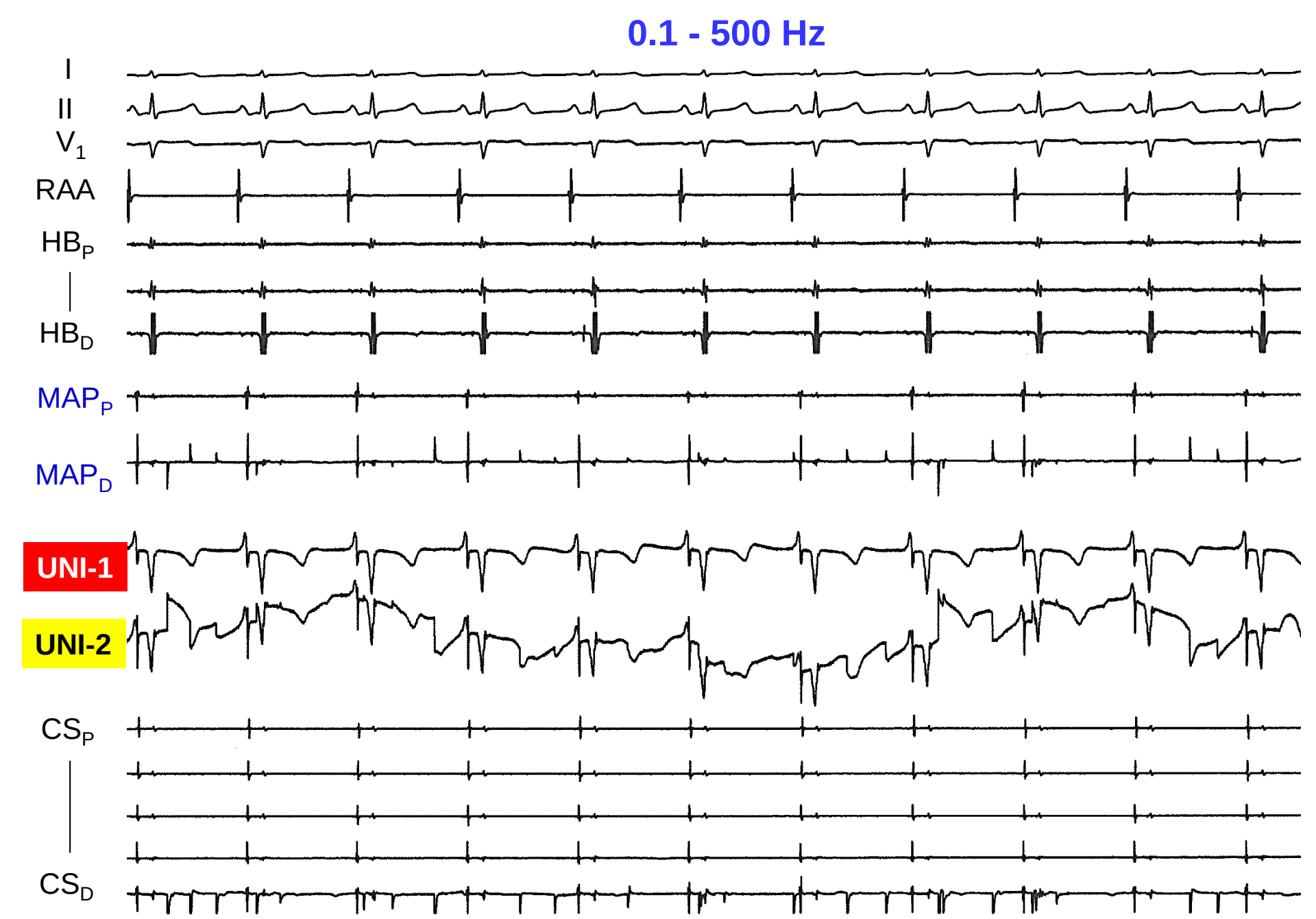


Figure 2.11C.

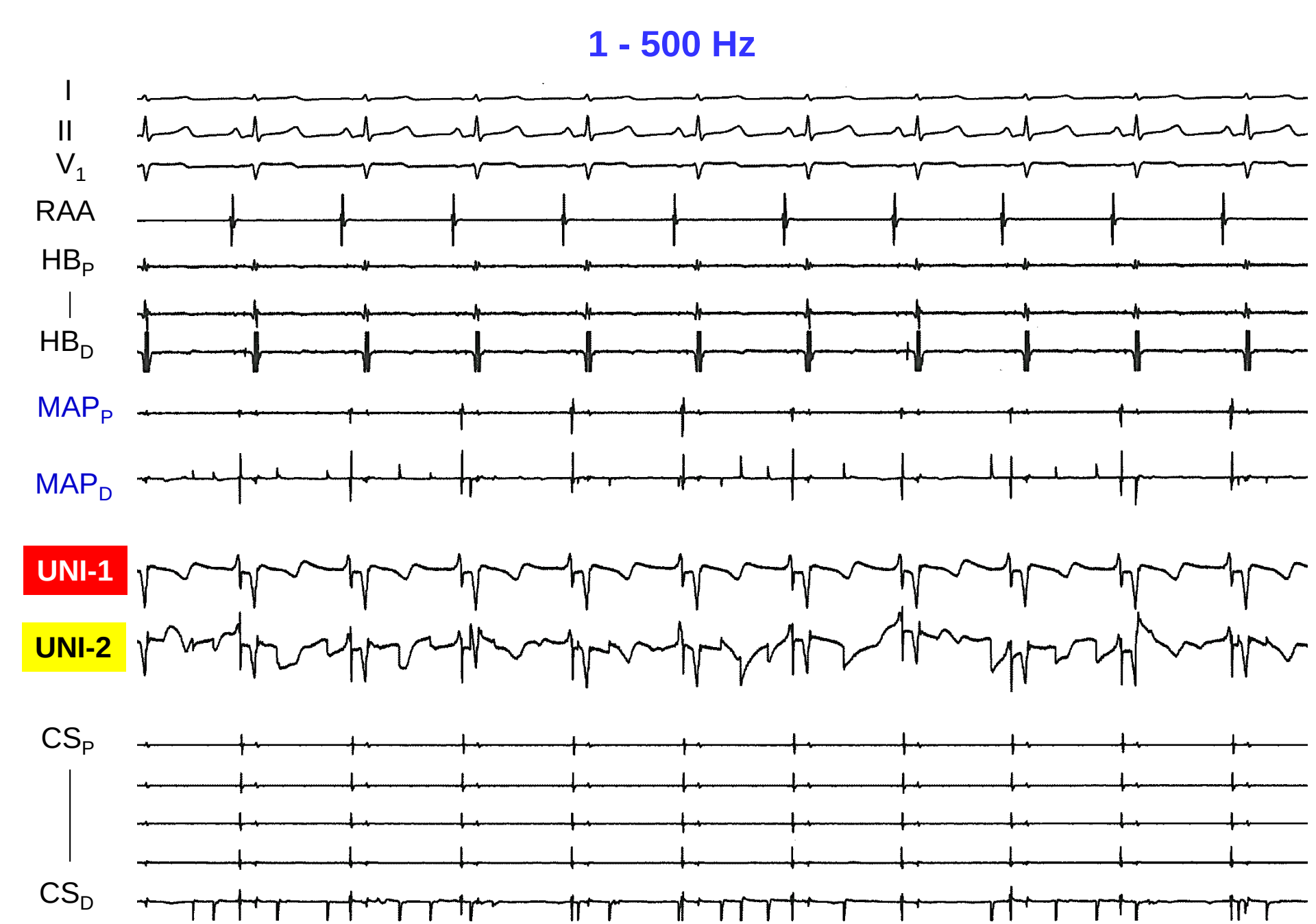


Figure 2.11D.

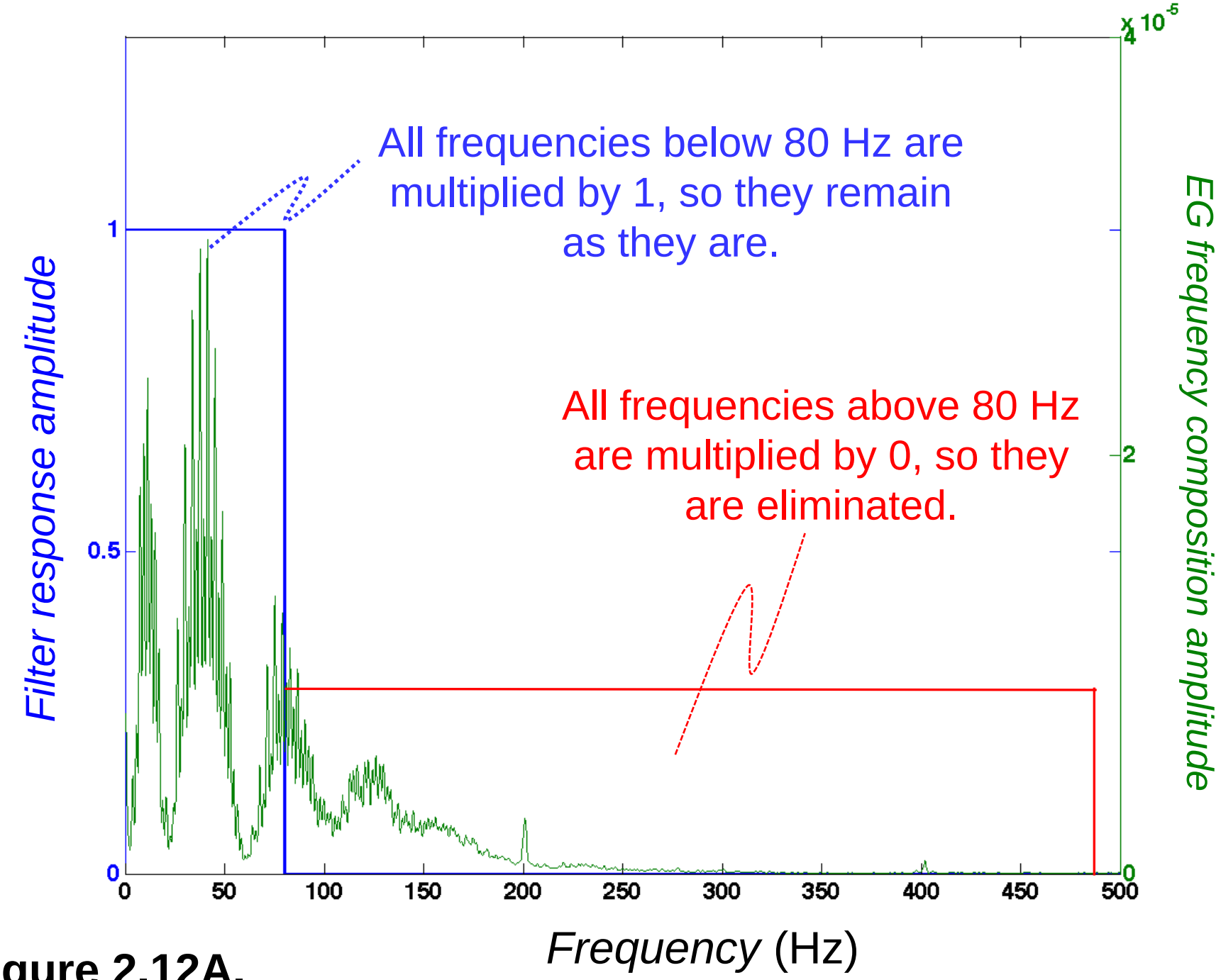

All frequencies below 80 Hz are multiplied by 1, so they remain as they are.
All frequencies above 80 Hz are multiplied by 0, so they are eliminated.
Filter response amplitude
EG frequency composition amplitude
Frequency (Hz)
x 10^-5
0
0.5
1
0
2
4
0
50
100
150
200
250
300
350
400
450
500

Figure 2.12A.

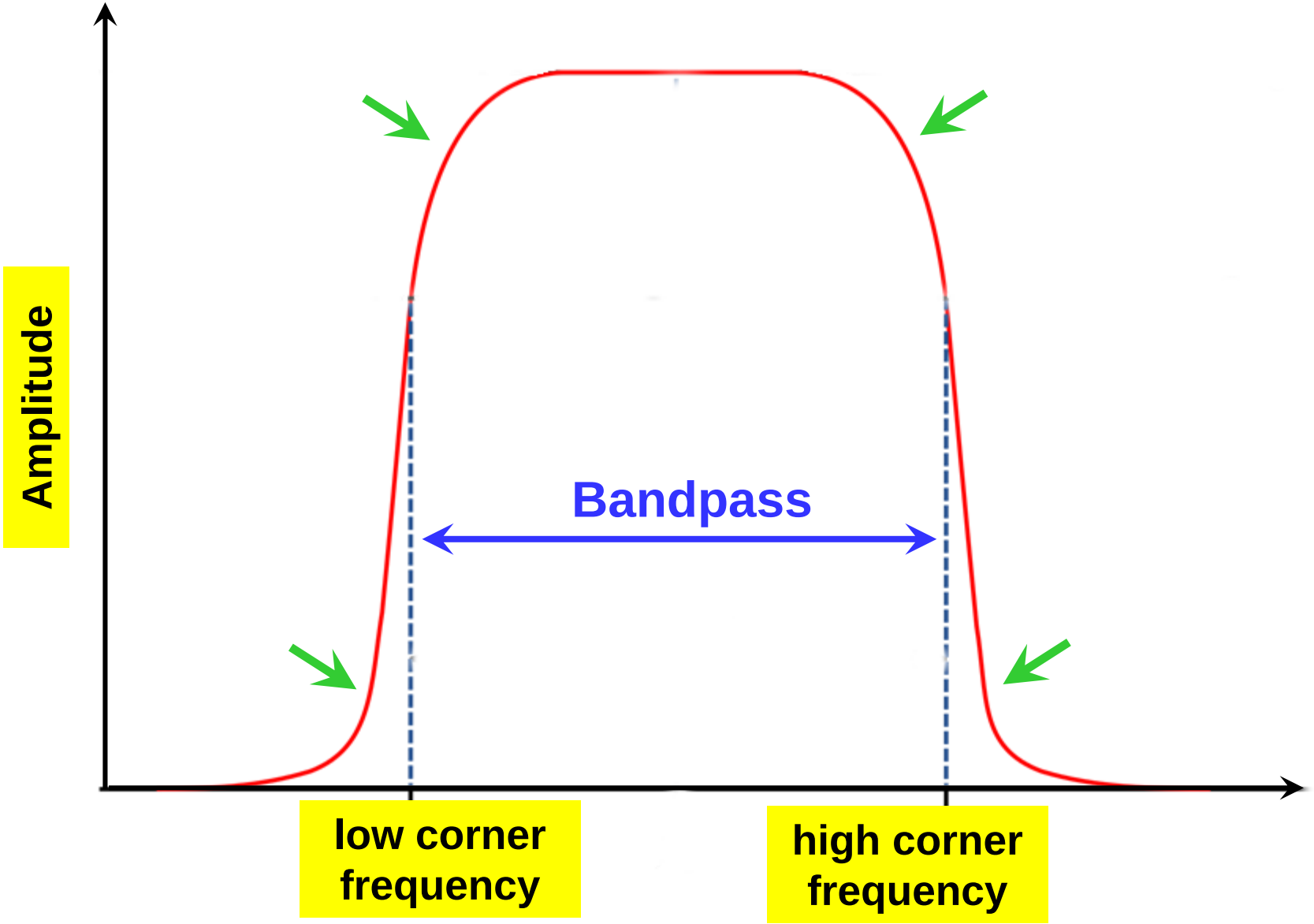

Amplitude
Bandpass
low corner frequency
high corner frequency

Figure 2.12B.

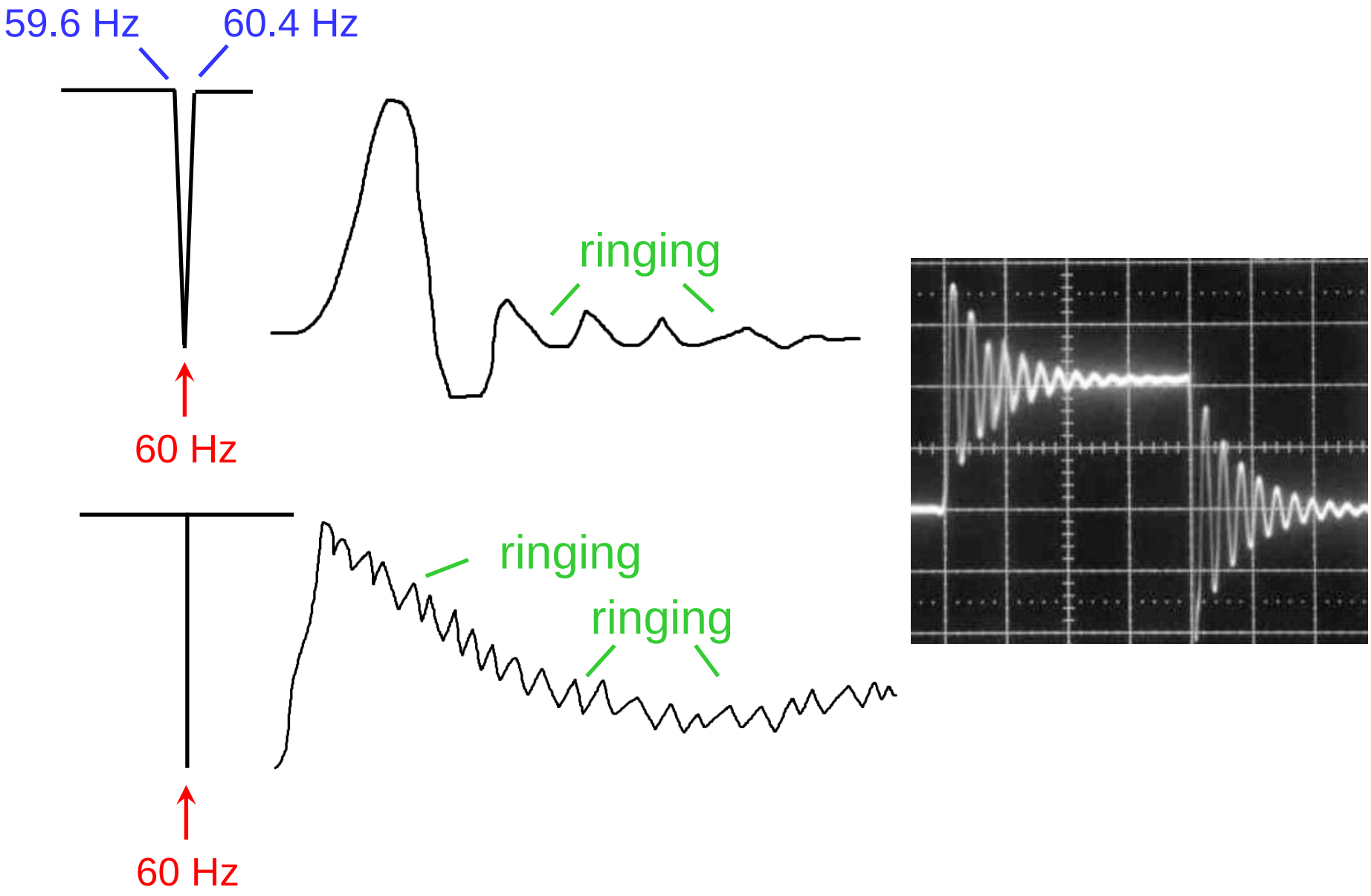


Figure 2.12C.

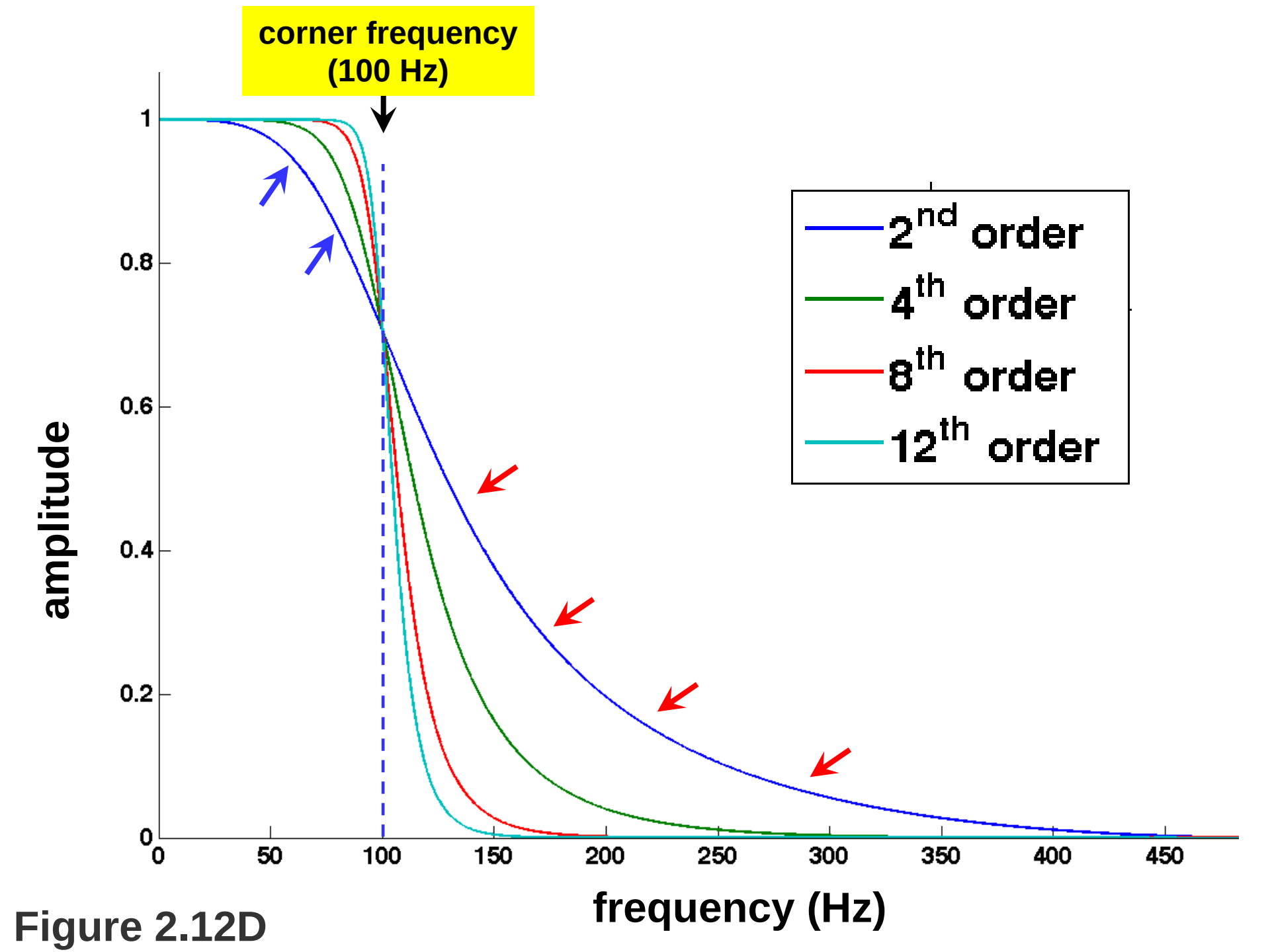

corner frequency
(100 Hz)
amplitude
frequency (Hz)
2nd order
4th order
8th order
12th order
0
0.2
0.4
0.6
0.8
1
0
50
100
150
200
250
300
350
400
450

Figure 2.12D

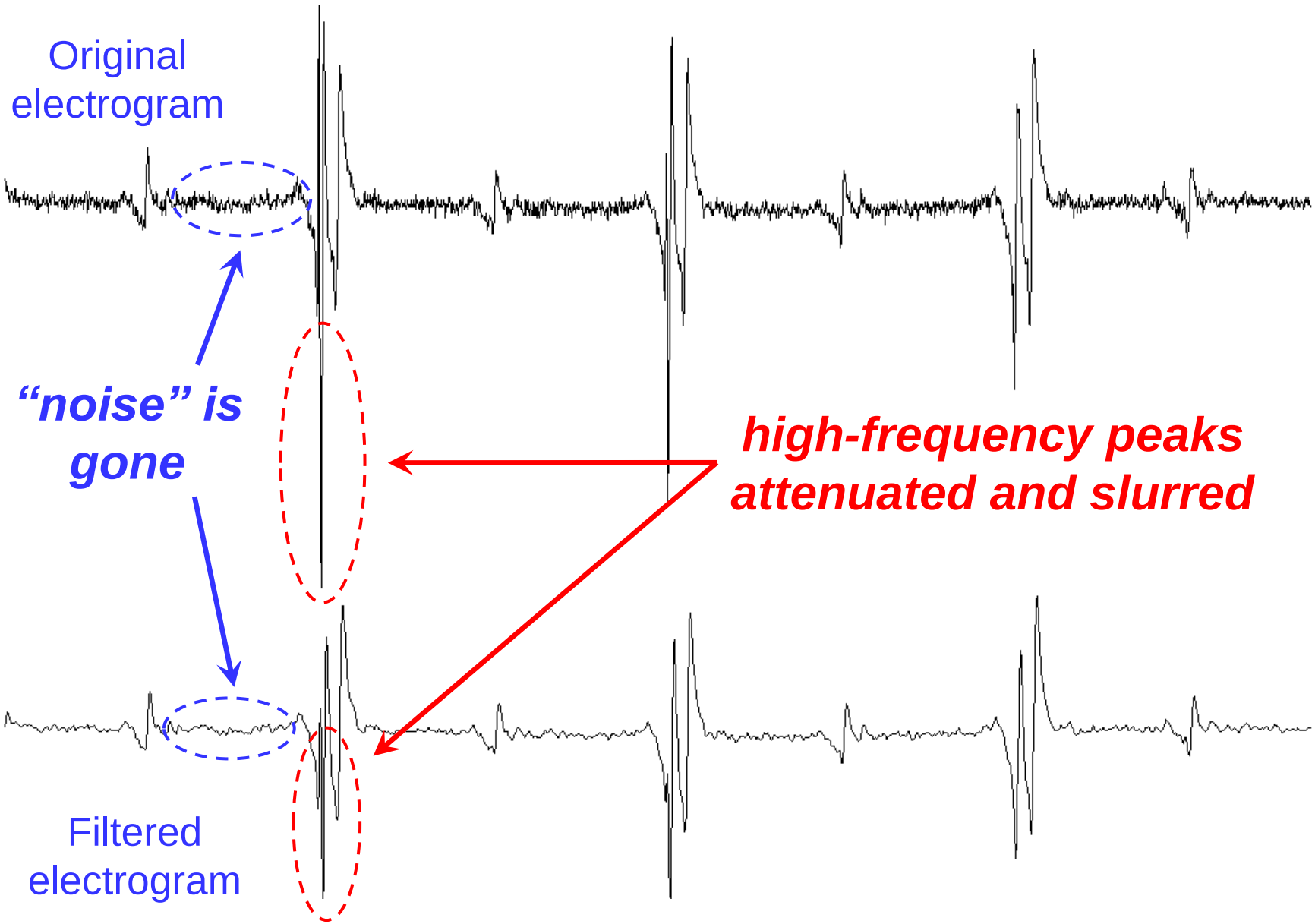

Original electrogram
"noise" is gone
high-frequency peaks attenuated and slurred
Filtered electrogram
Time →

Figure 2.13A

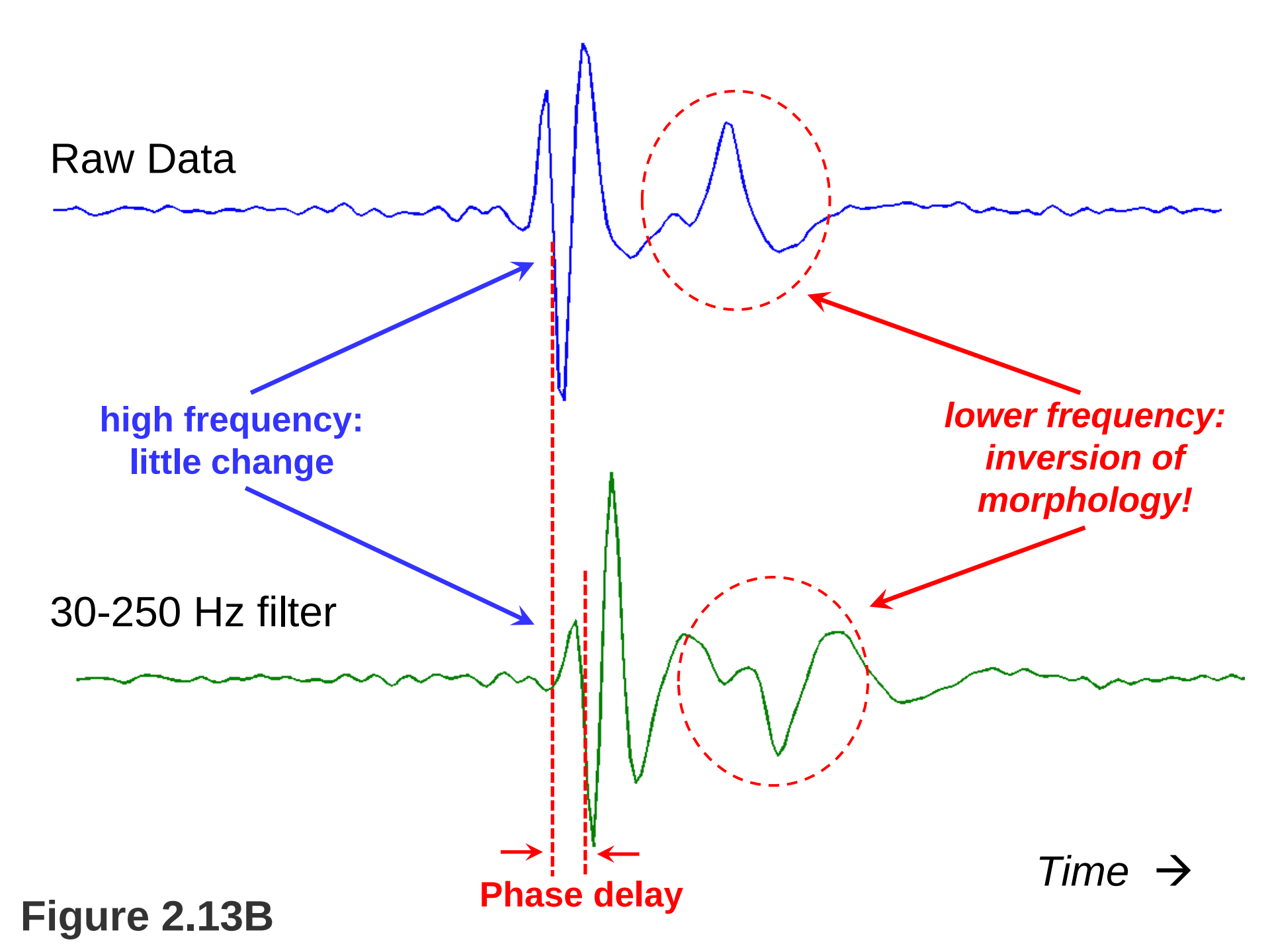

Raw Data
high frequency:
little change
lower frequency:
inversion of
morphology!
30-250 Hz filter
Phase delay
Time →

Figure 2.13B

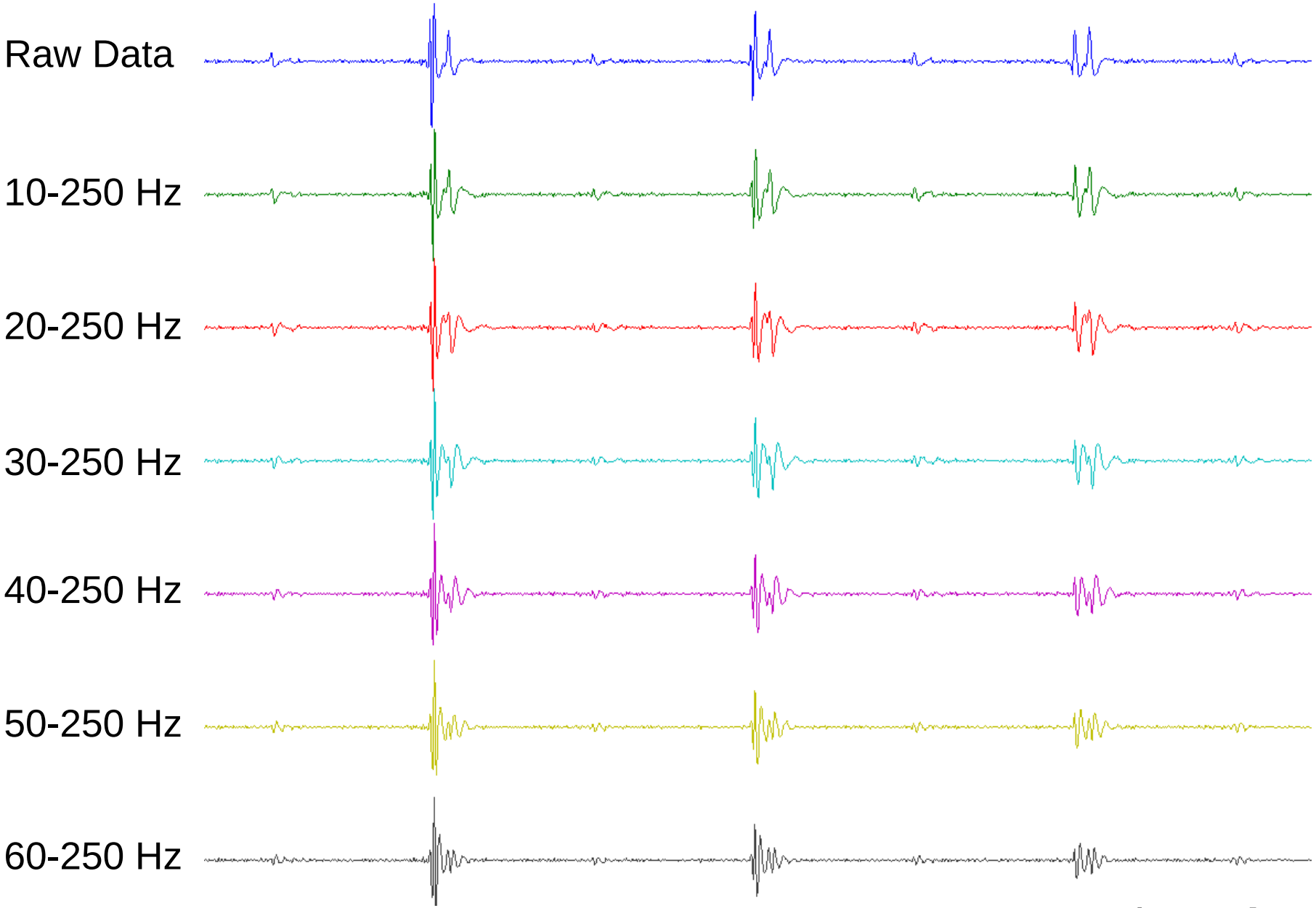

Raw Data
10-250 Hz
20-250 Hz
30-250 Hz
40-250 Hz
50-250 Hz
60-250 Hz
Time →

Figure 2.13C

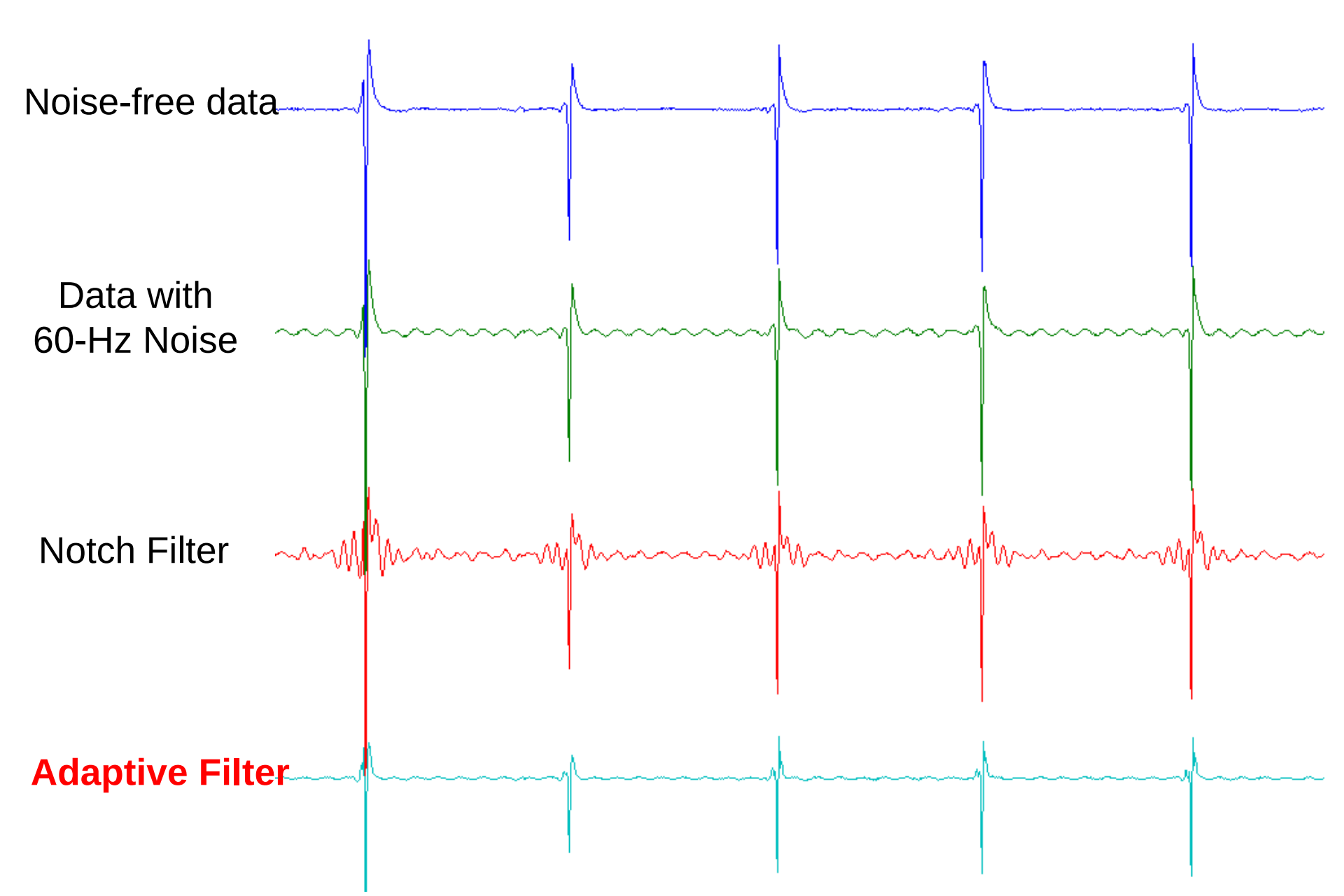
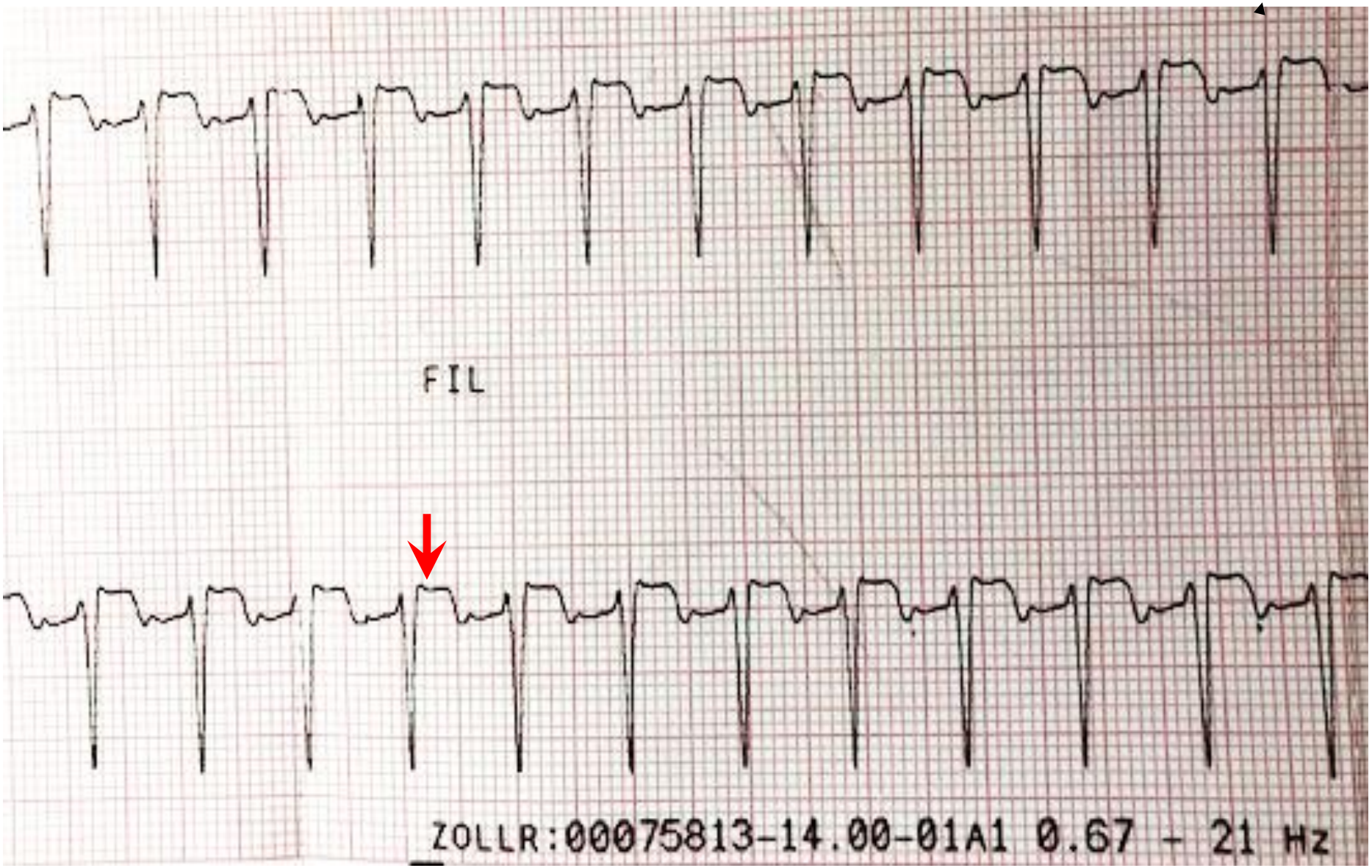

Noise-free data
Data with
60-Hz Noise
Notch Filter
Adaptive Filter
Time →

Figure 2.13D



0.67 – 21 Hz

Figure 2.14A

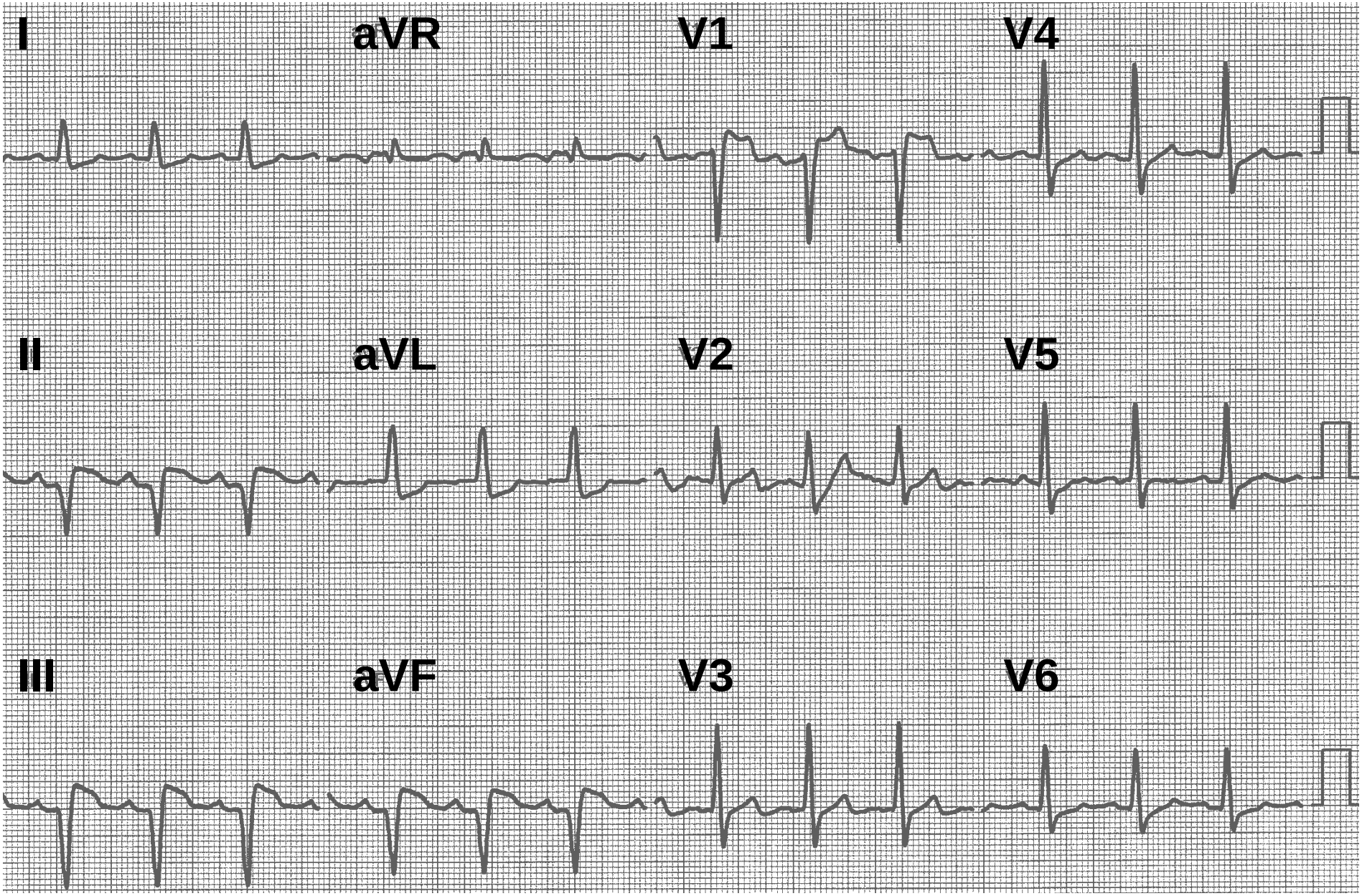


Figure 2.14B.

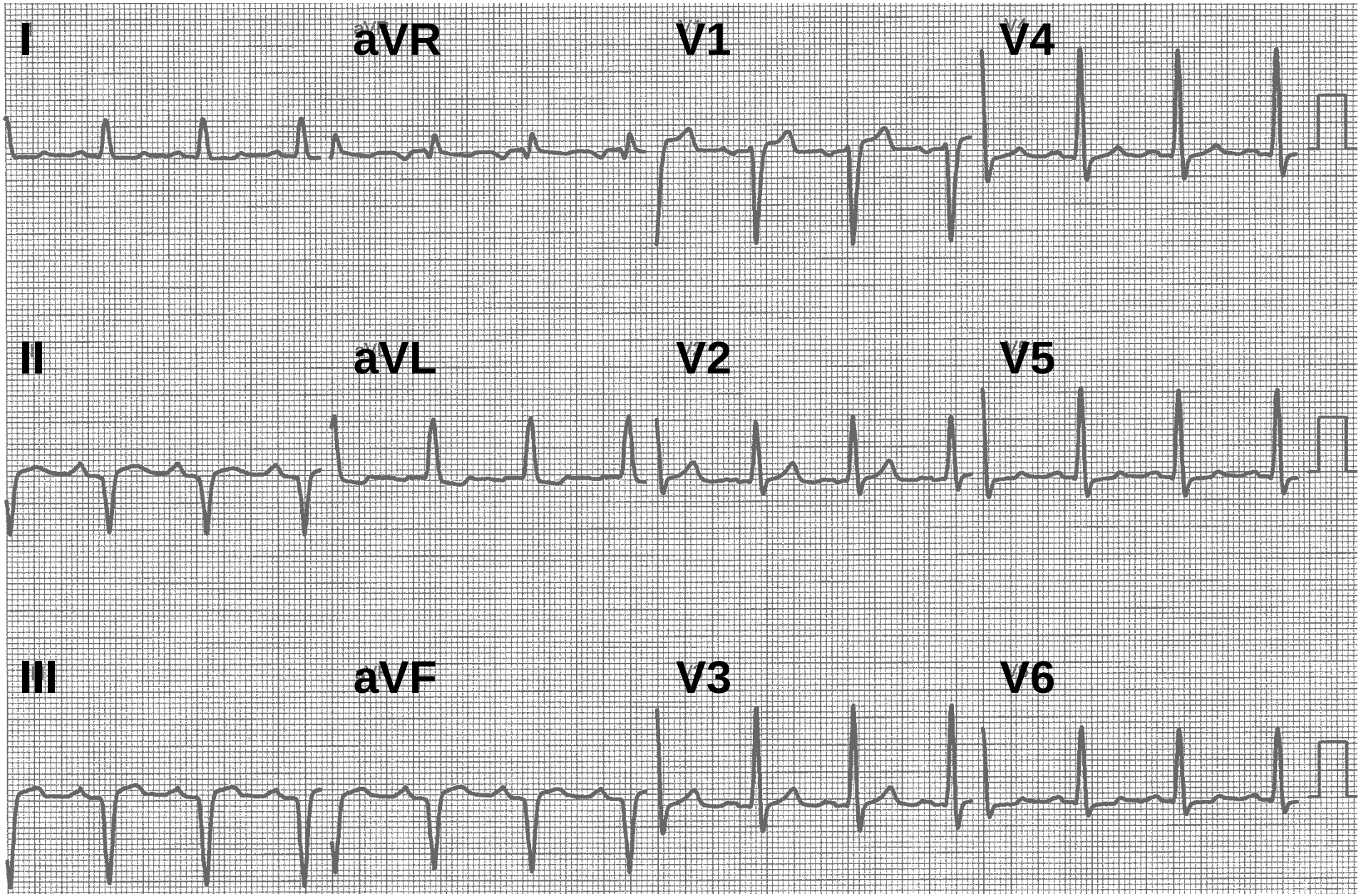


Figure 2.14C

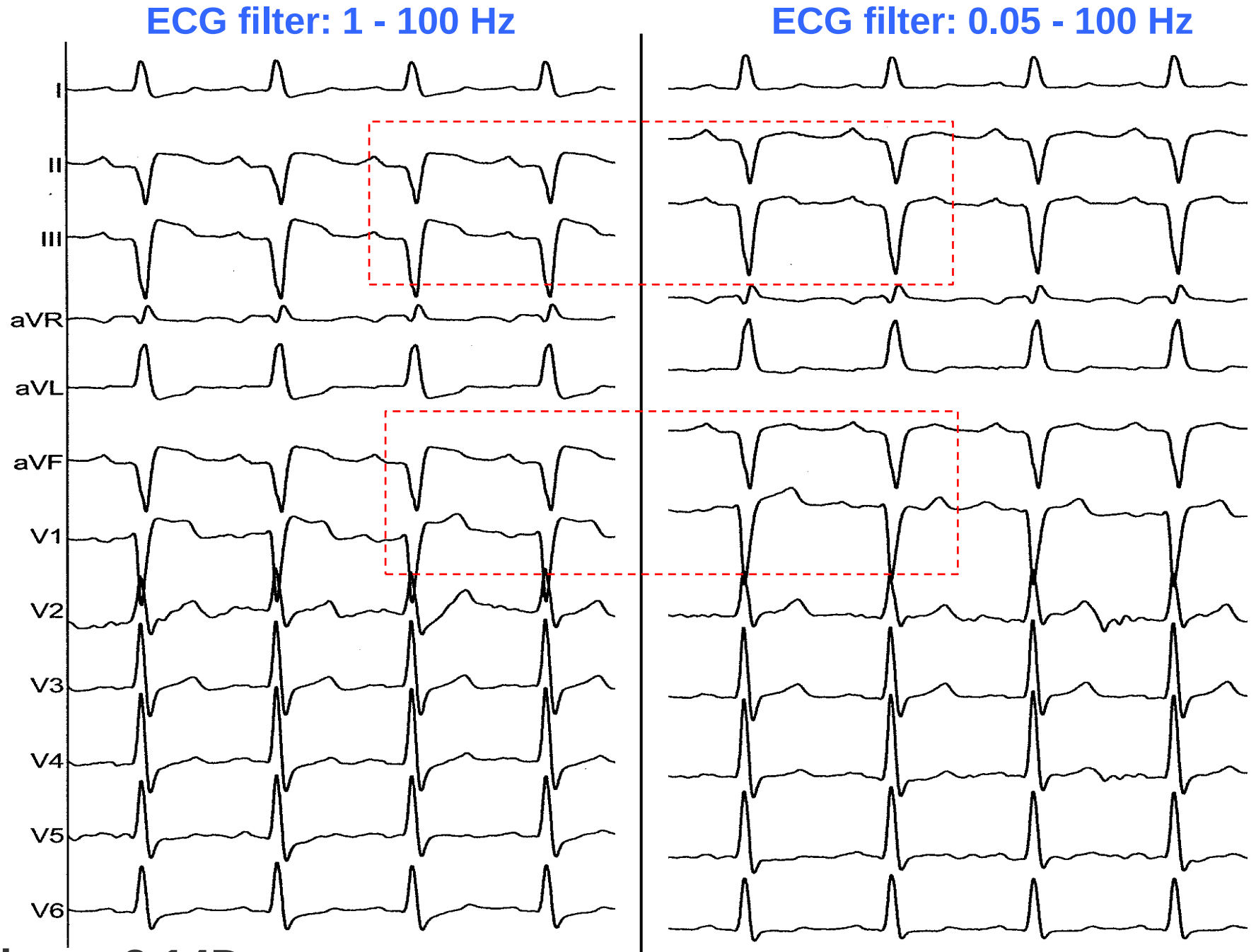

ECG filter: 1 - 100 Hz
ECG filter: 0.05 - 100 Hz
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

Figure 2.14D

Filter: 1-100 Hz

Figure 2.15A

Filter: 0.05-100 Hz

Figure 2.15B

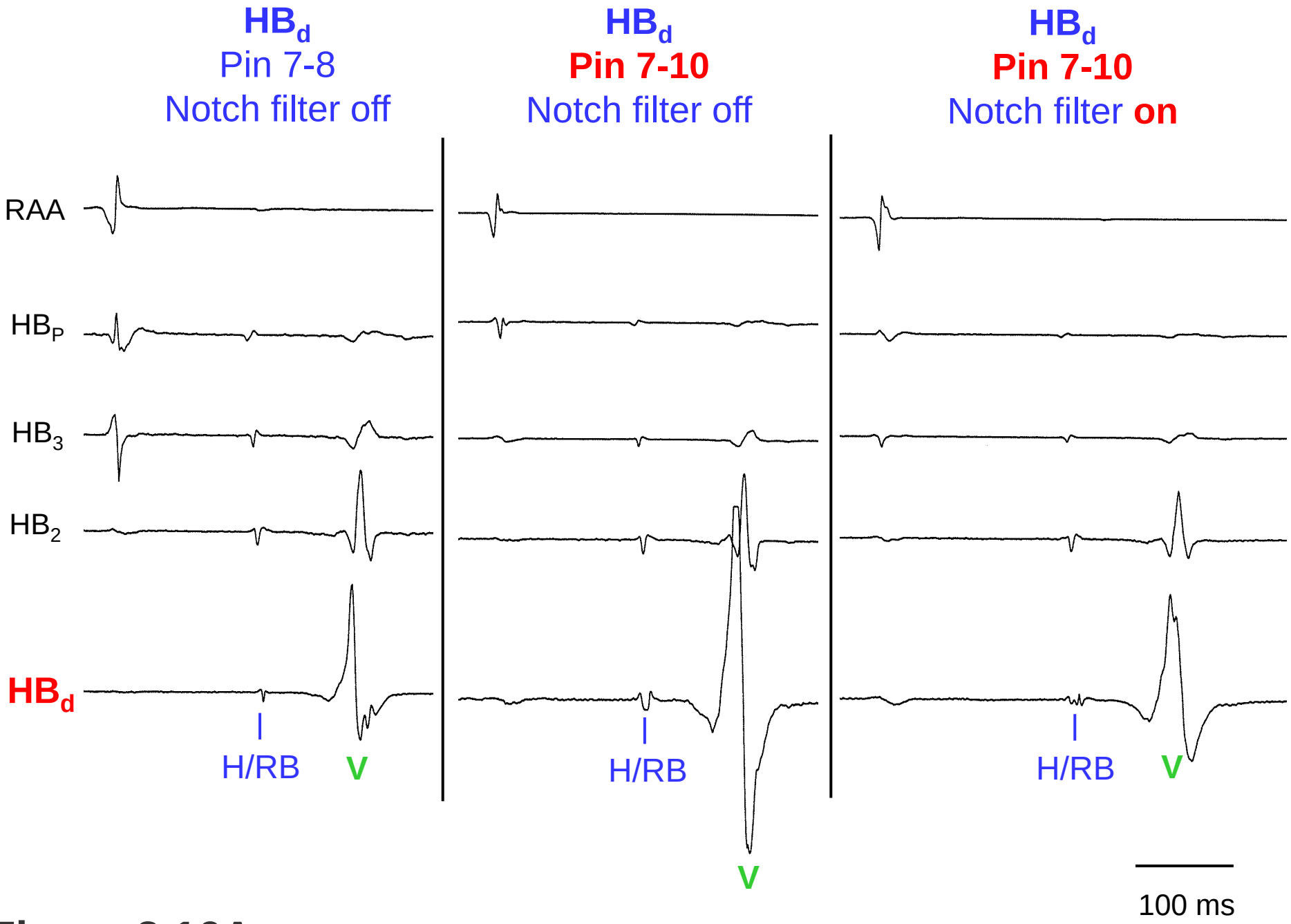
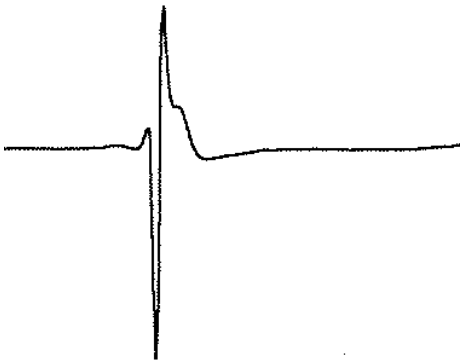

HBd
Pin 7-8
Notch filter off
HBd
Pin 7-10
Notch filter off
HBd
Pin 7-10
Notch filter on
RAA
HBP
HB3
HB2
HBd
H/RB
V
H/RB
V
H/RB
V
V
100 ms

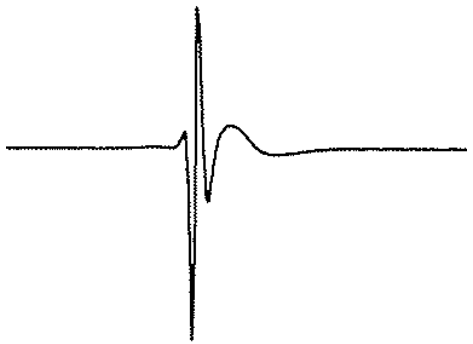
Figure 2.16A

Electrodes:
2 mm apart
Notch filter off

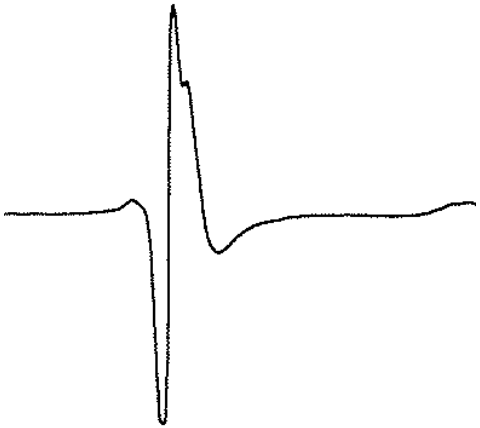


Electrodes:
2 mm apart
Adaptive filter **on**

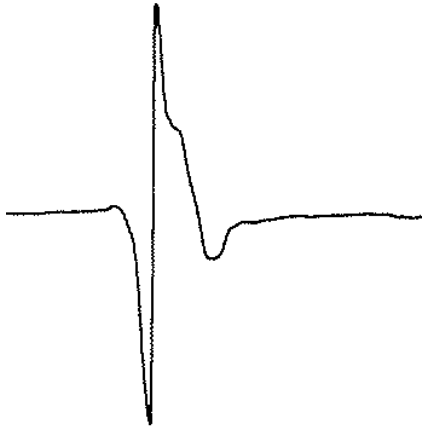
Electrodes:
2 mm apart
Notch filter **on**



Electrodes:
12 mm apart
Notch filter off



Electrodes:
12 mm apart
Adaptive filter **on**



Electrodes:
12 mm apart
Notch filter **on**

100 ms

Figure 2.16B

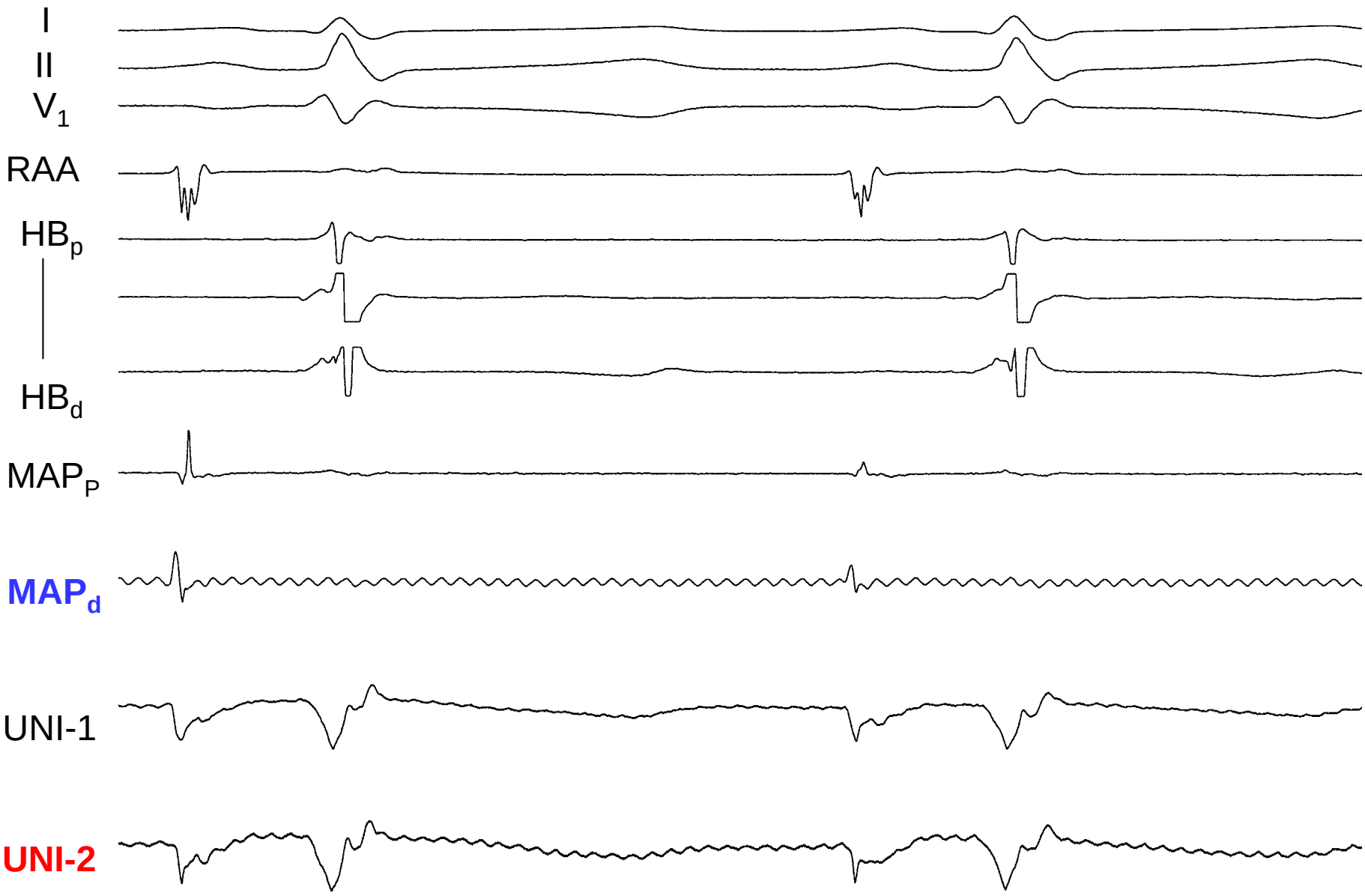


Figure 2.17A.

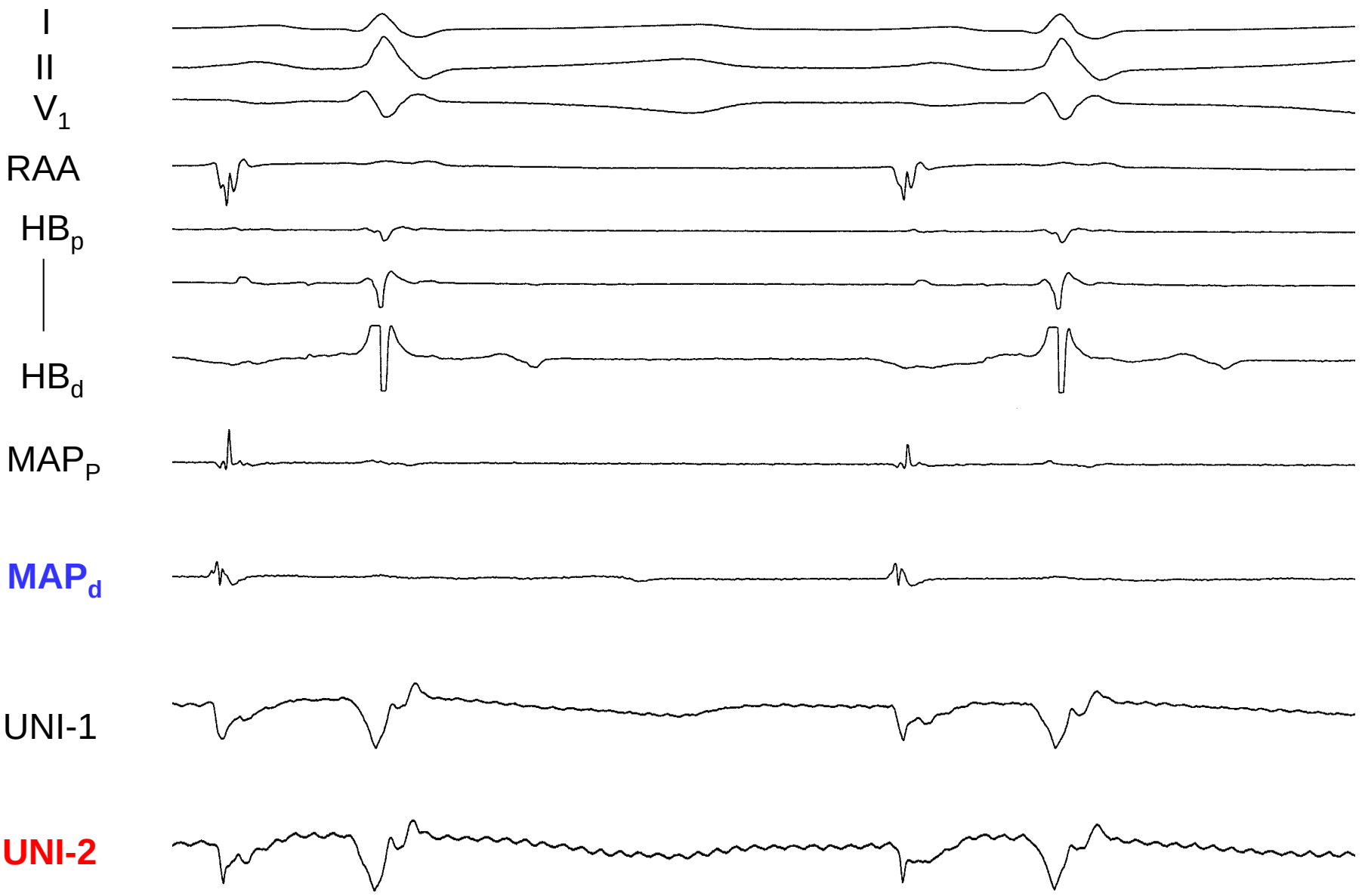


Figure 2.17B.

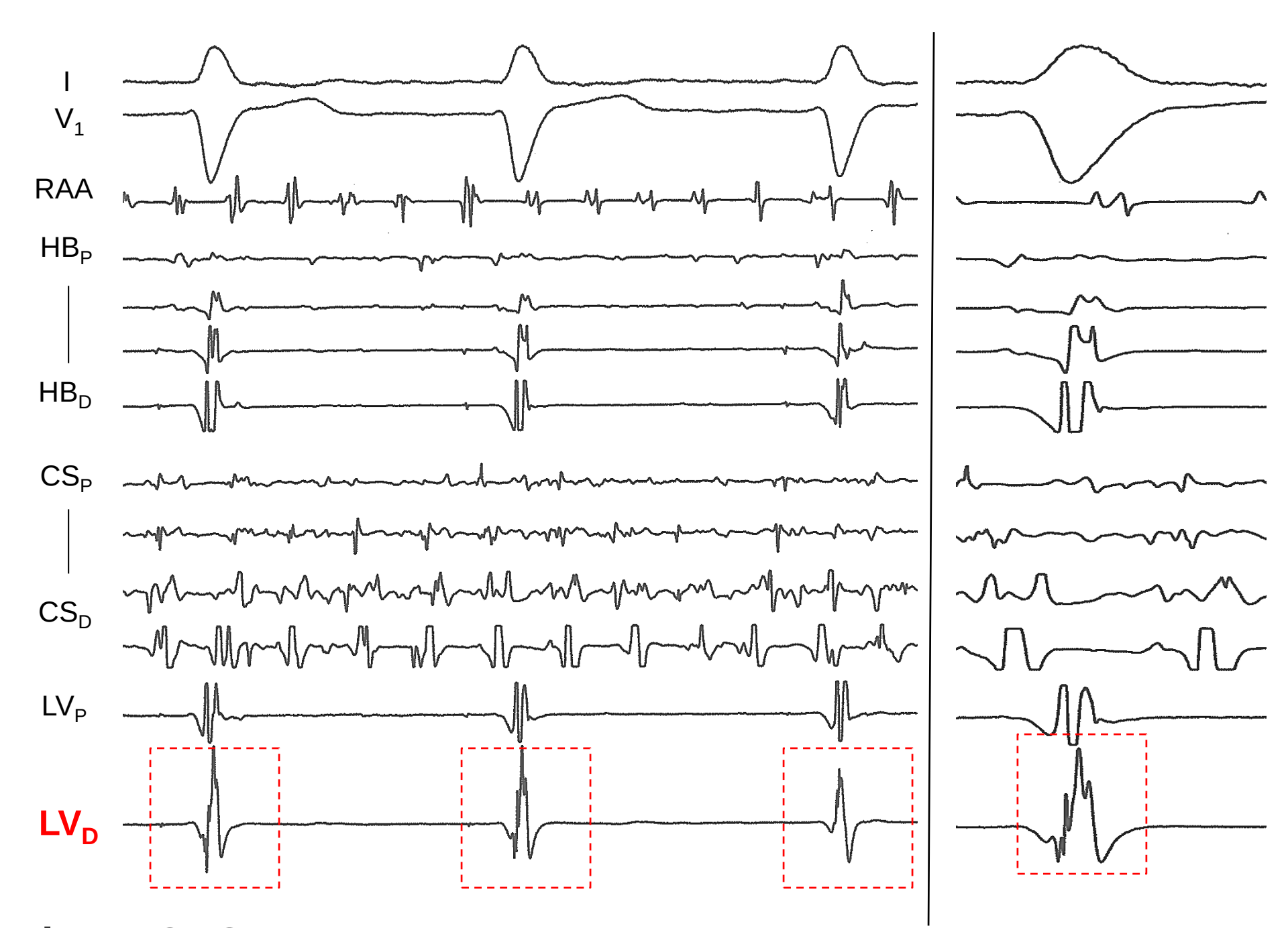


Figure 2.18A

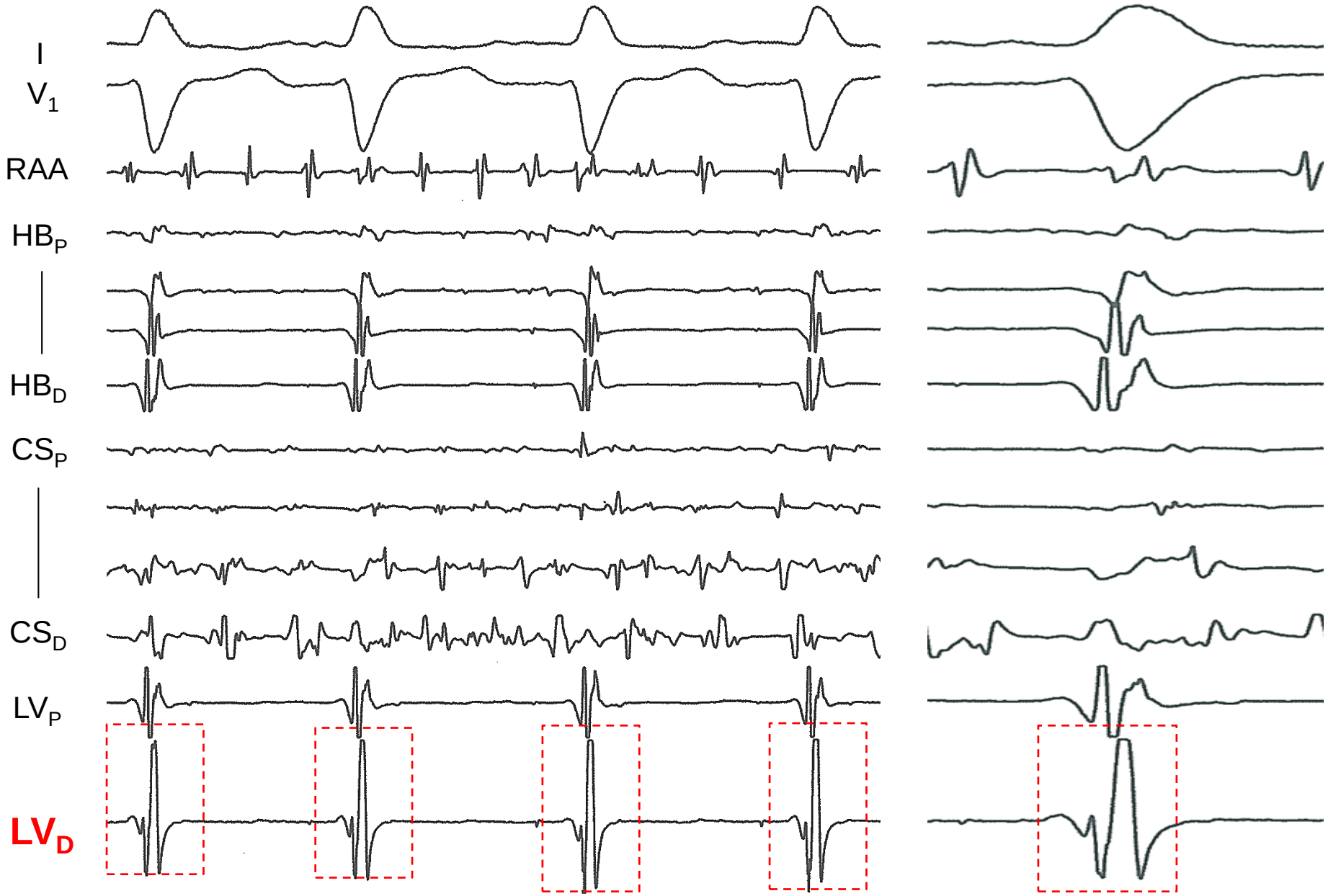


Figure 2.18B

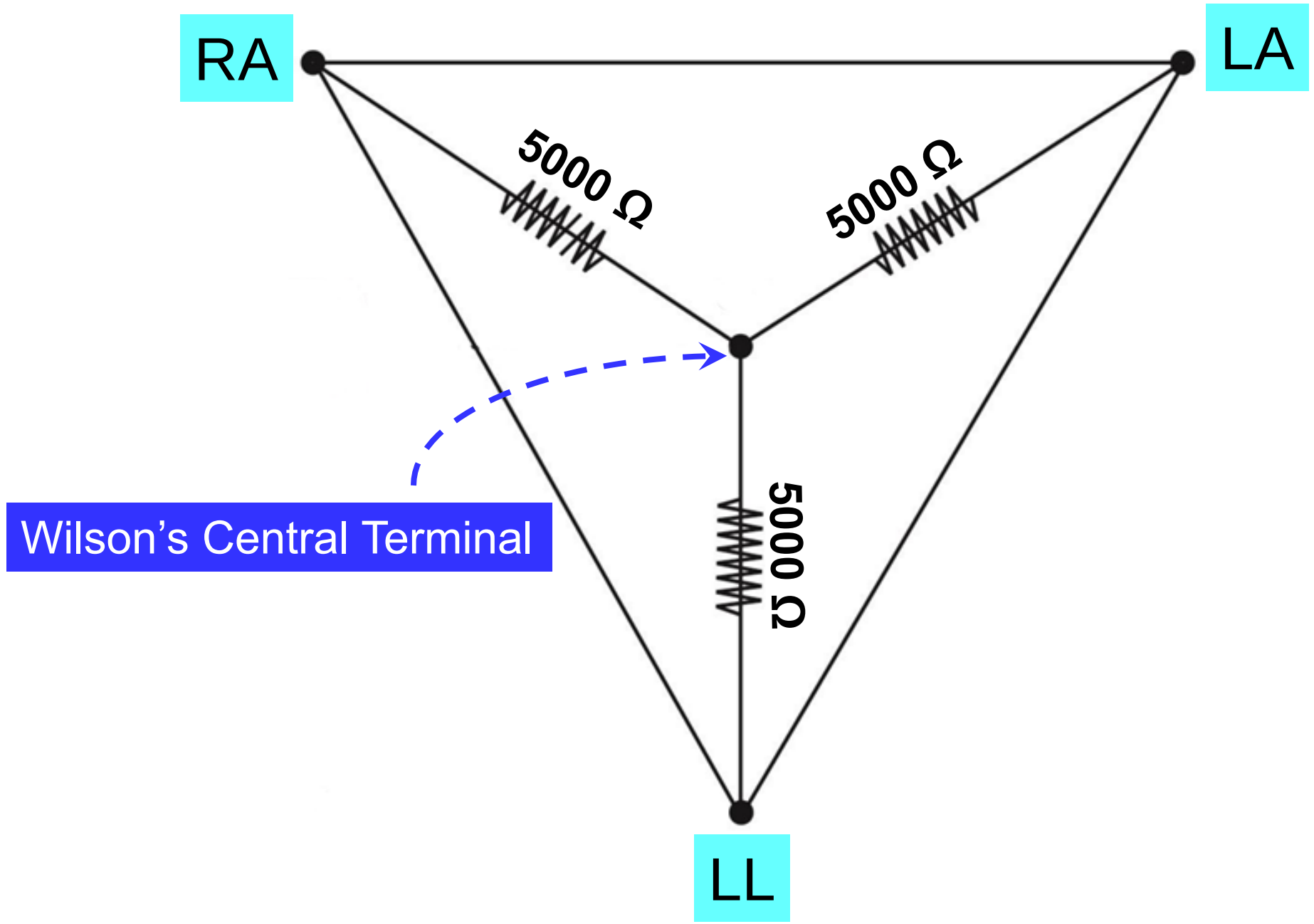


Figure 2.19A.


RA
LA
(+)
HIGH LEVEL
V1
V6
ECG
Simulator
V2
V5
V3
V4
C
RL
(-)
LL
POWER
ON
LEAD
E 30
C 60
G 120
240
10
50
100 Hz
125
2.0
OFF
QRS
LOWBAT
DALE TECHNOLOGY CORPORATION
EHS12

Figure 2.19B

Noise on ECG

ECG generated by Stimulator

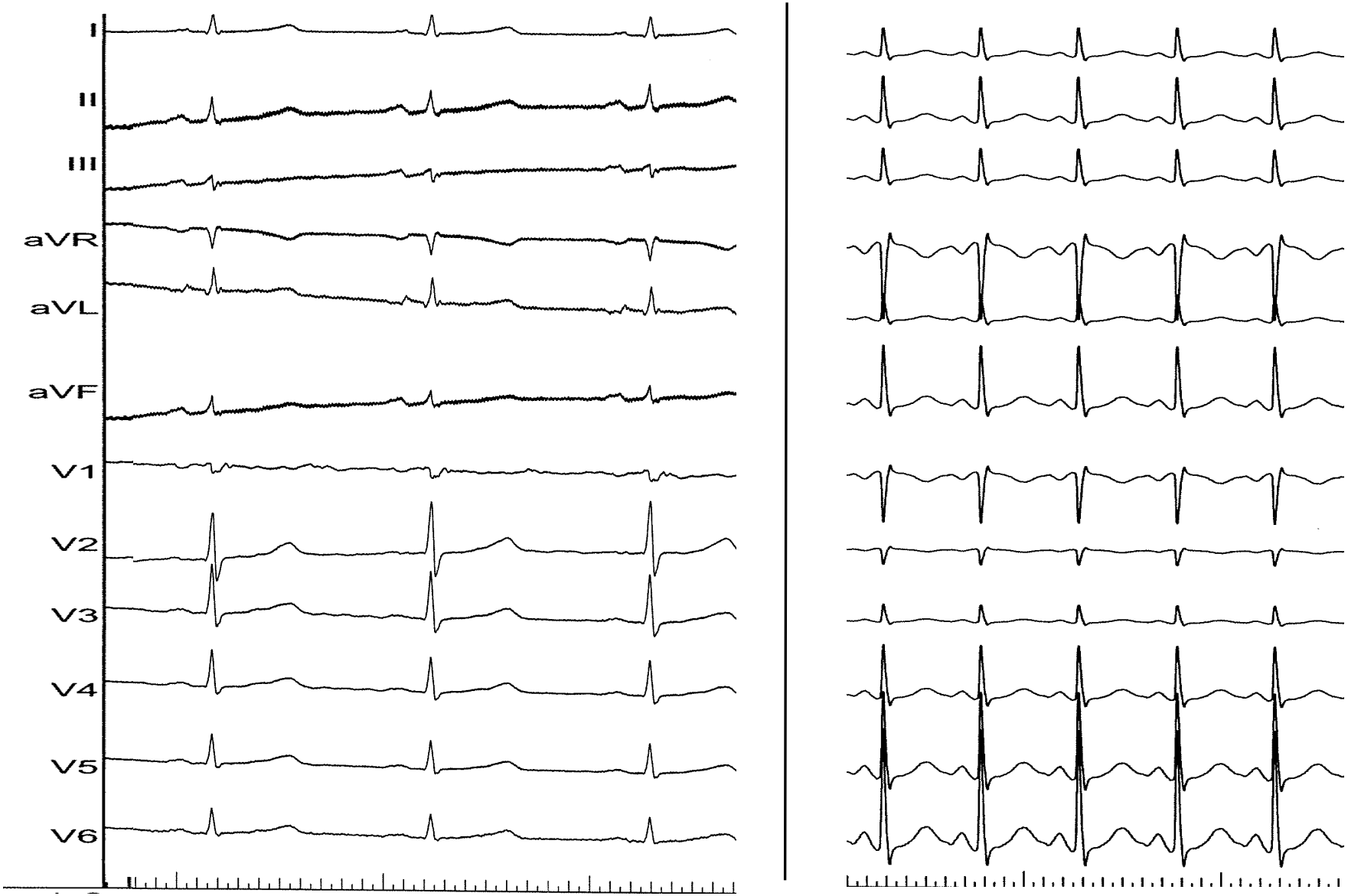


Figure 2.19C

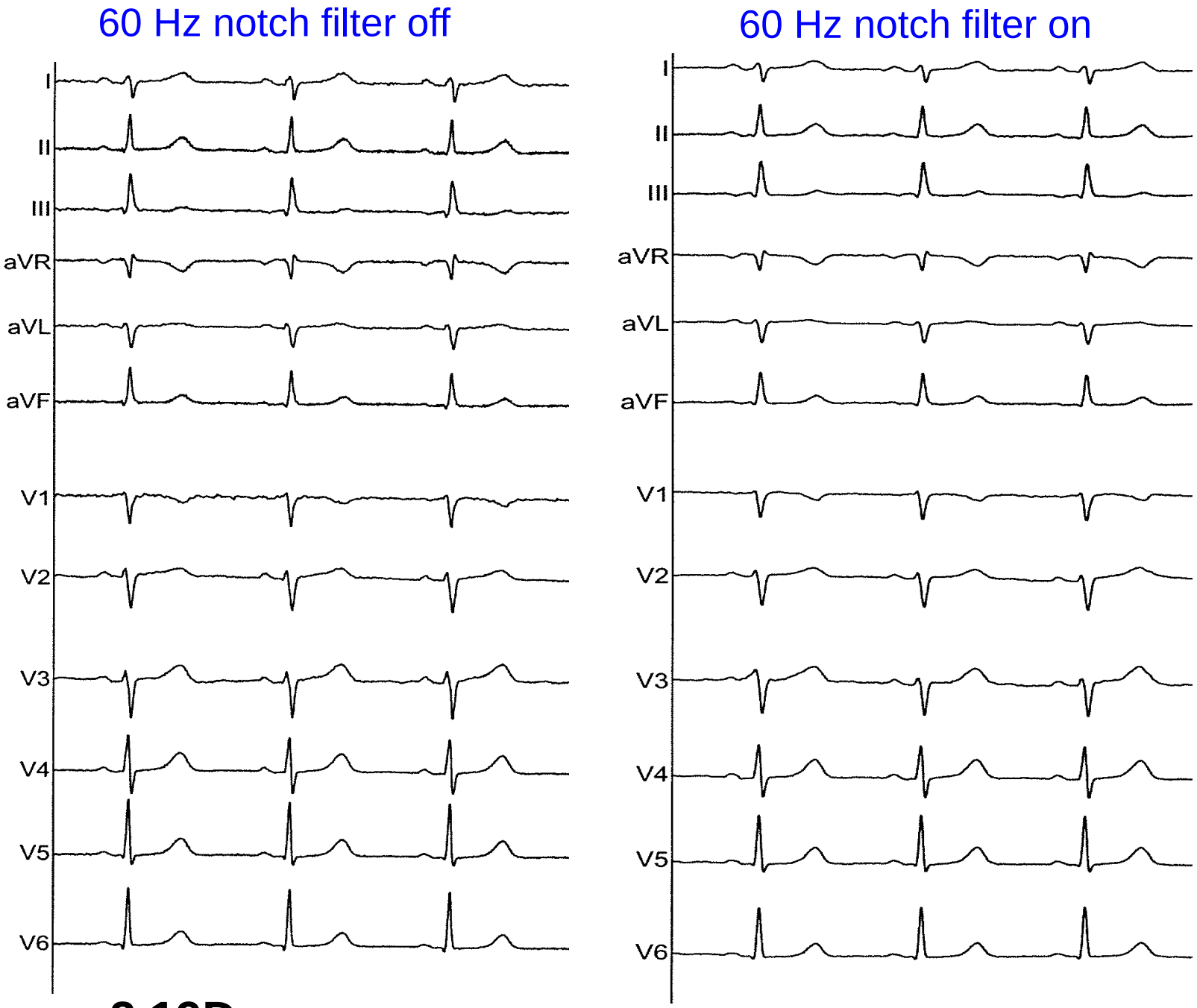
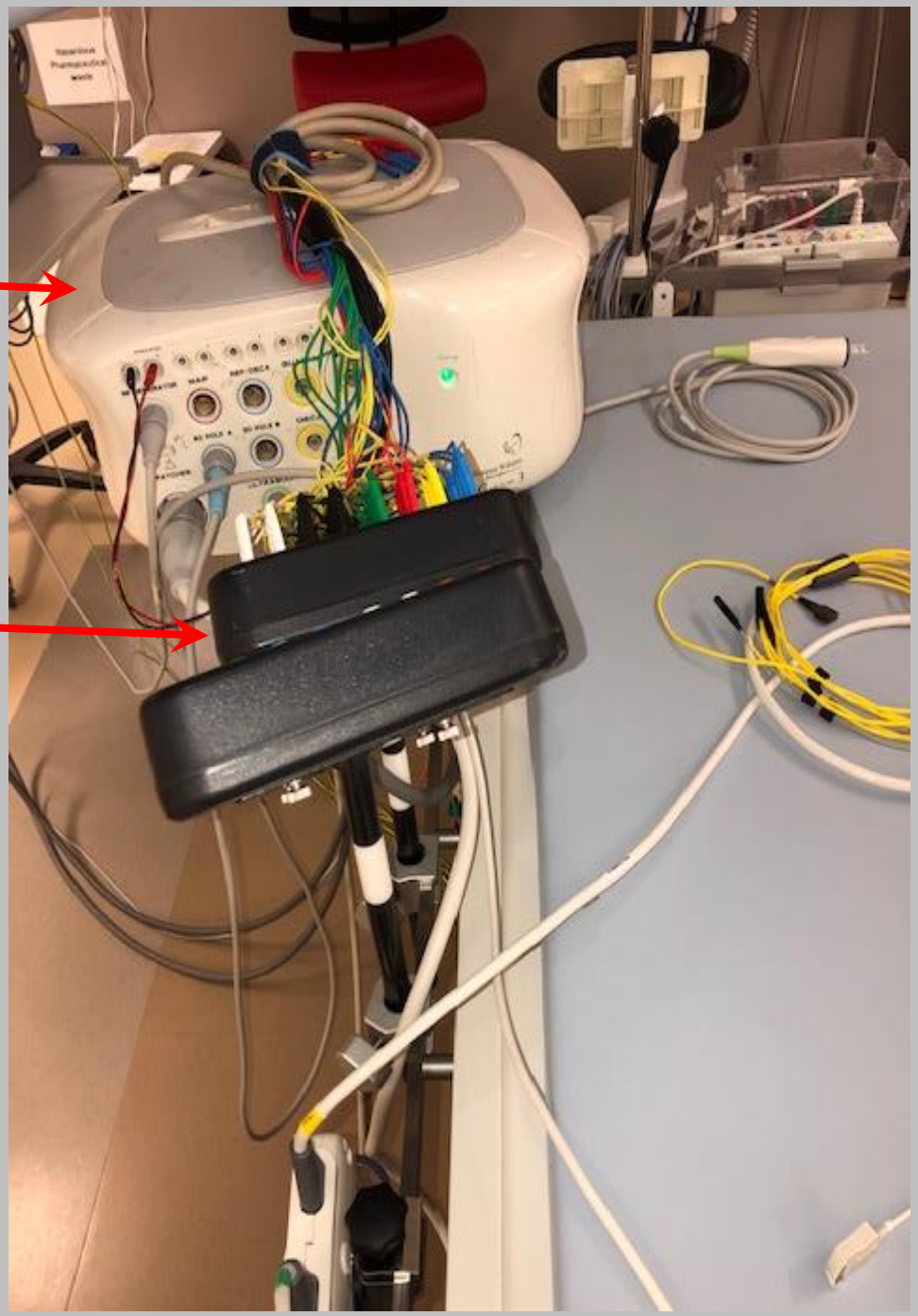

60 Hz notch filter off
60 Hz notch filter on
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

Figure 2.19D

CARTO Patient-Interface Unit (PIU)

Bard Pin Box



Foot end of x-ray table

Head end of x-ray table

Figure 2.20A

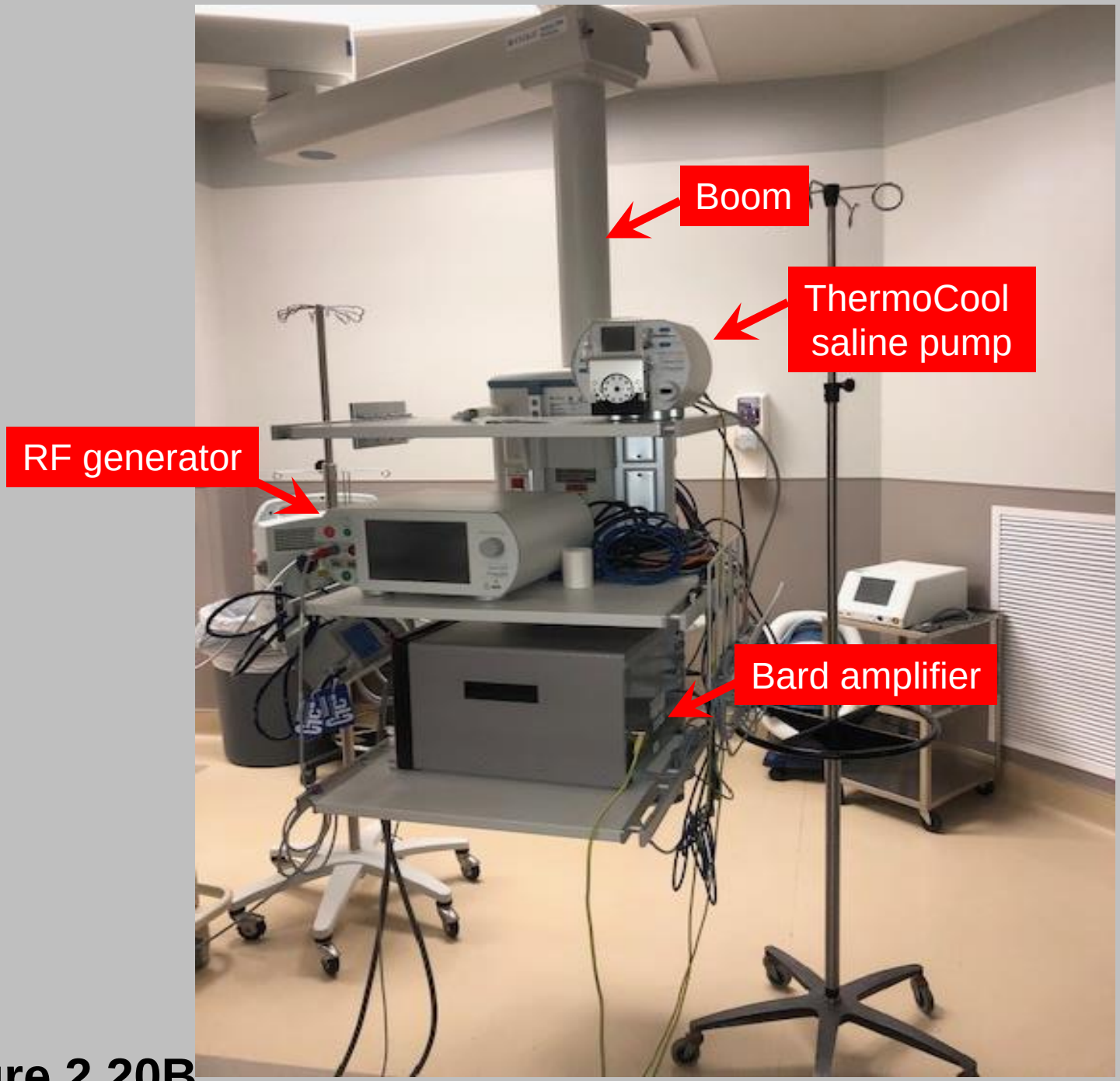


Figure 2.20B.

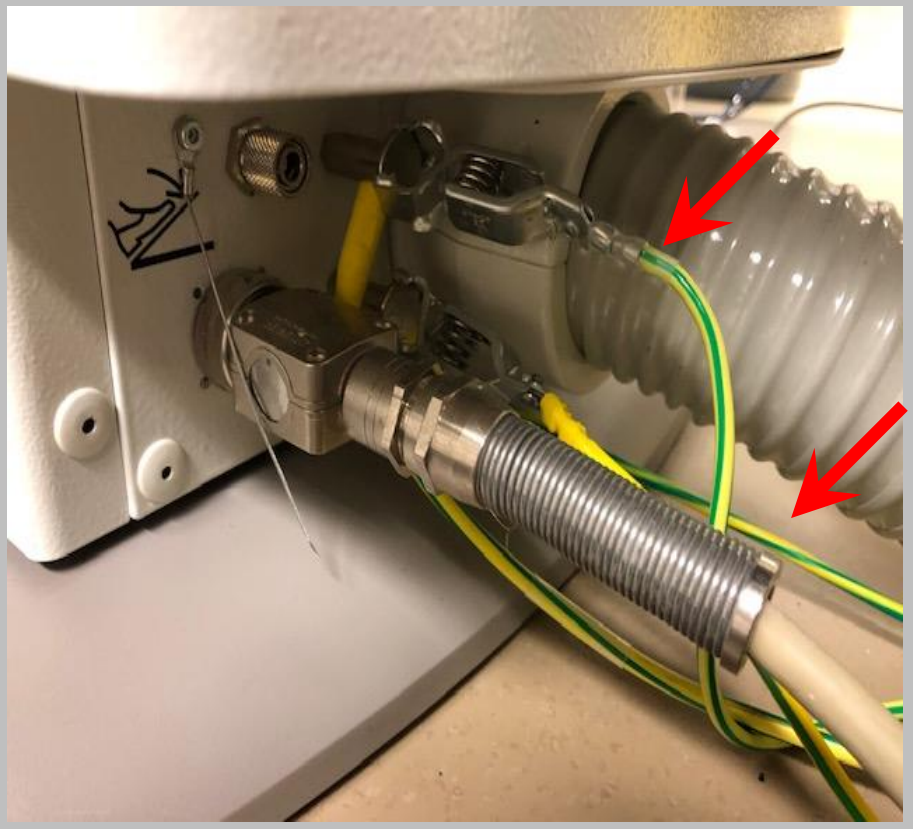


Figure 2.20C

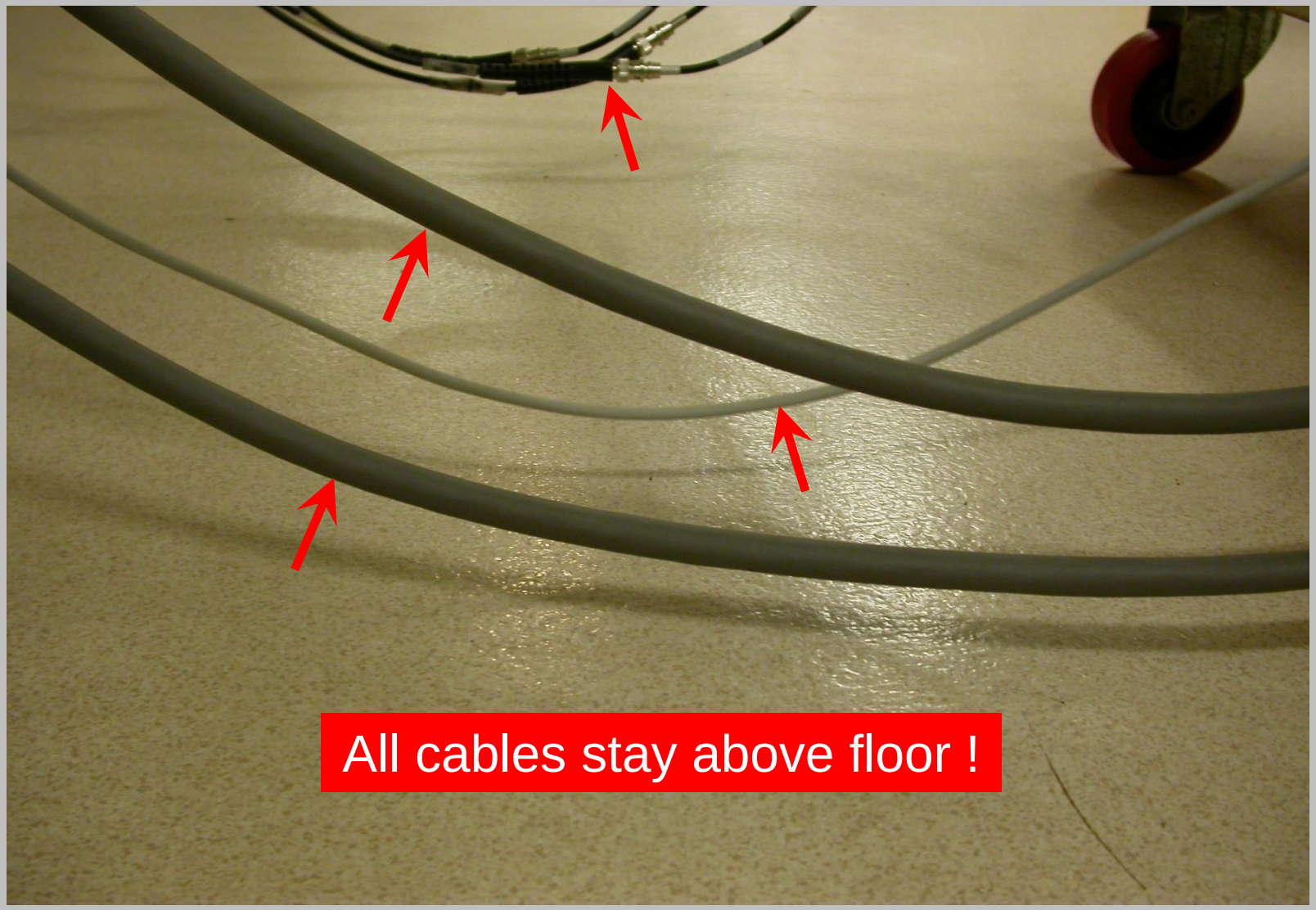


Figure 2.20D.

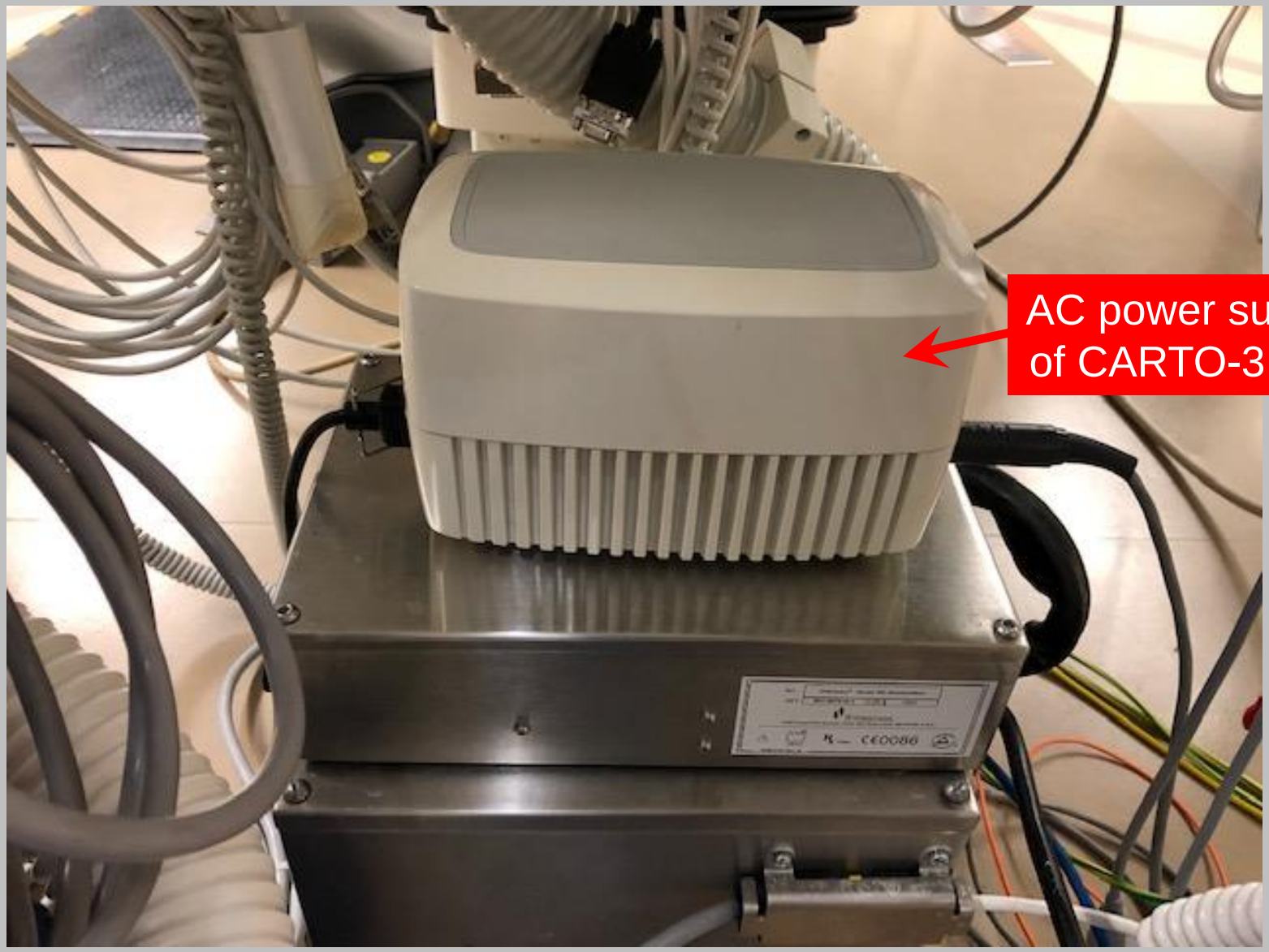


Figure 2.21A

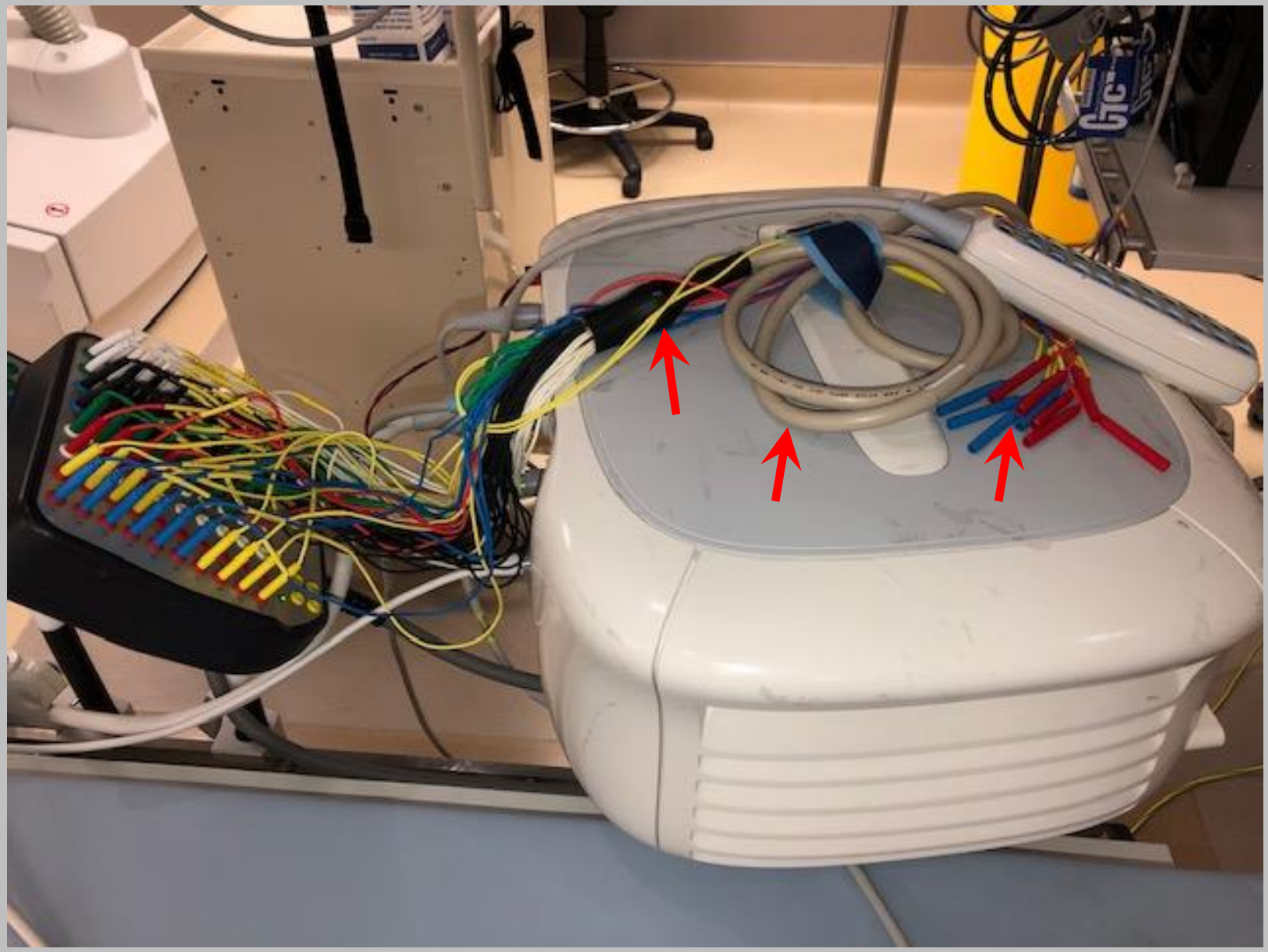
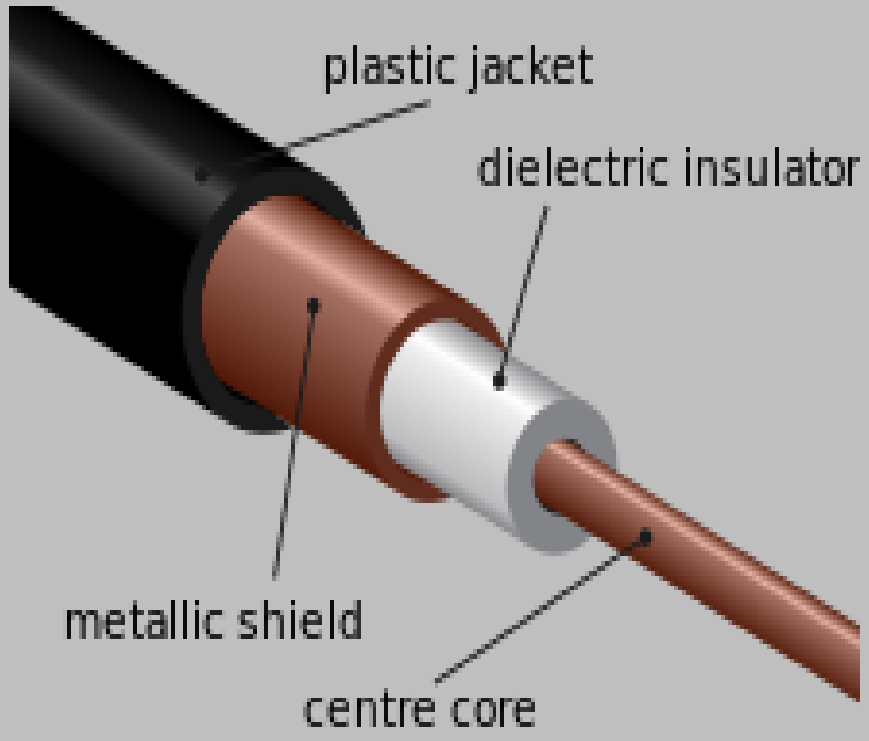


Figure 2.21B

Figure 2.22A



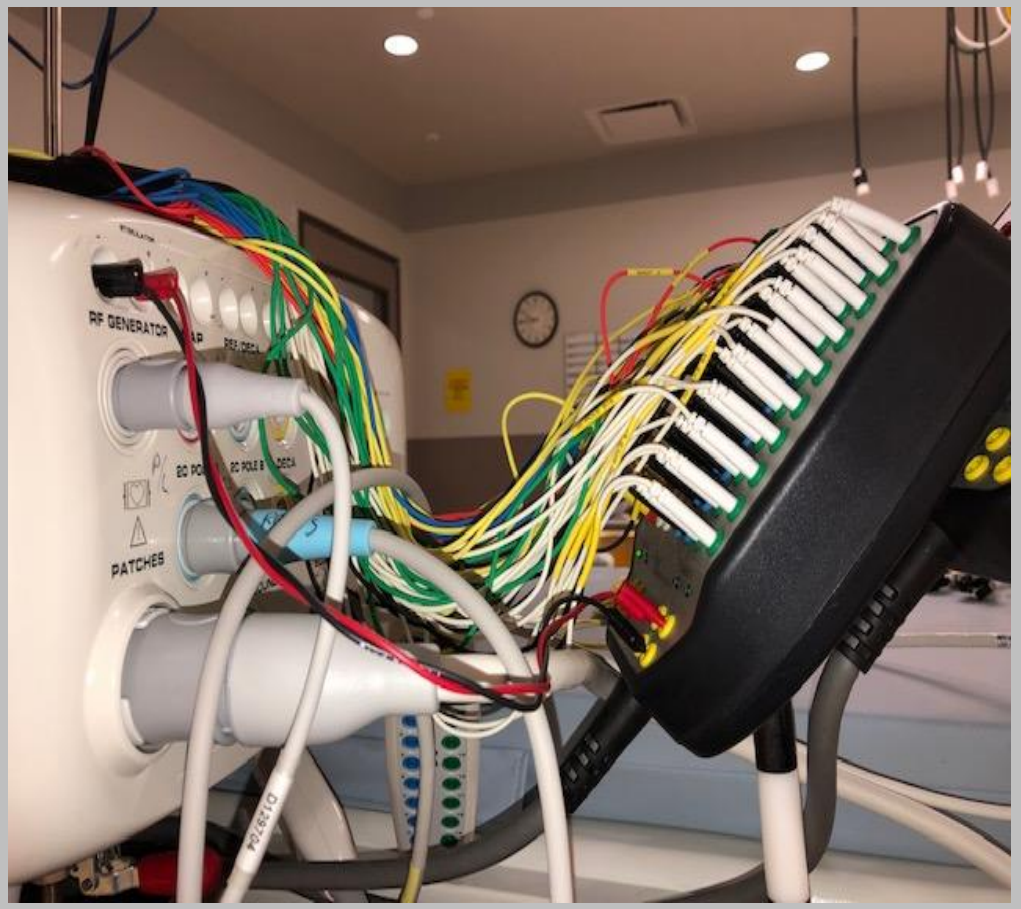
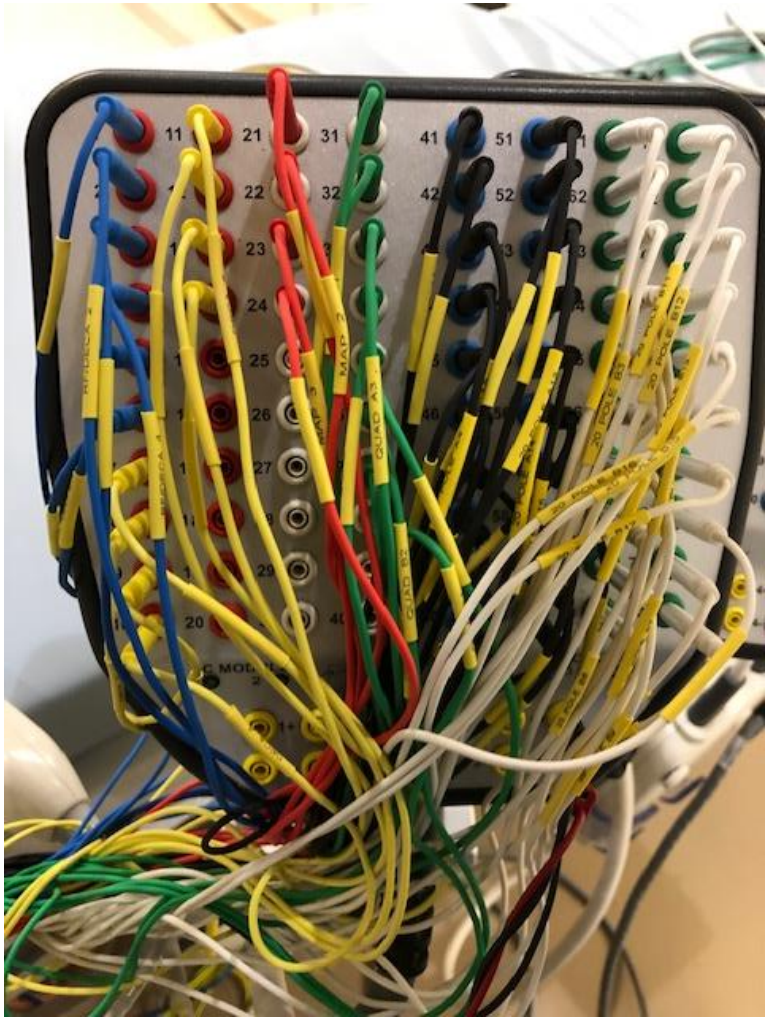


Figure source: Wikipedia

Figure 2.22B



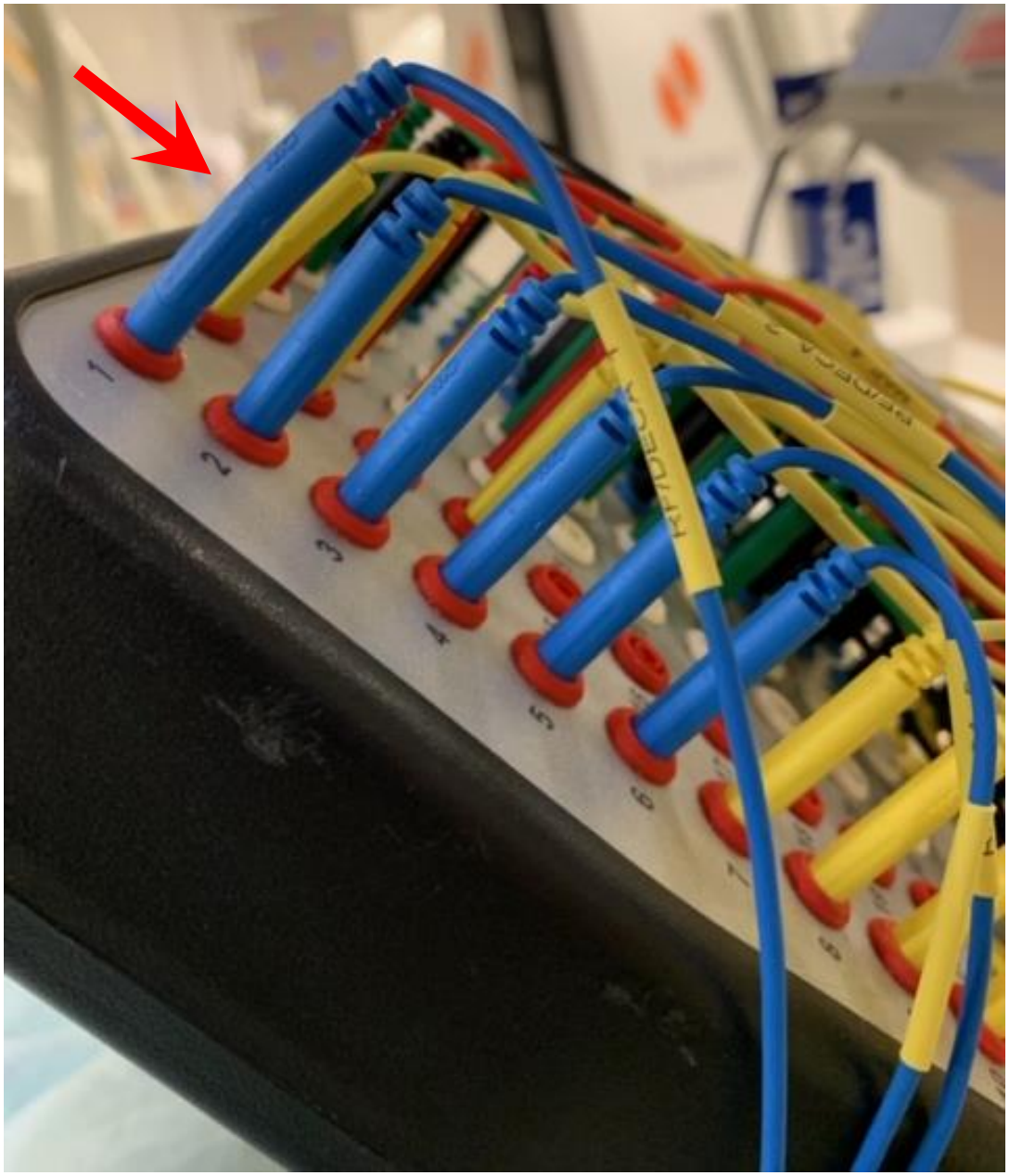
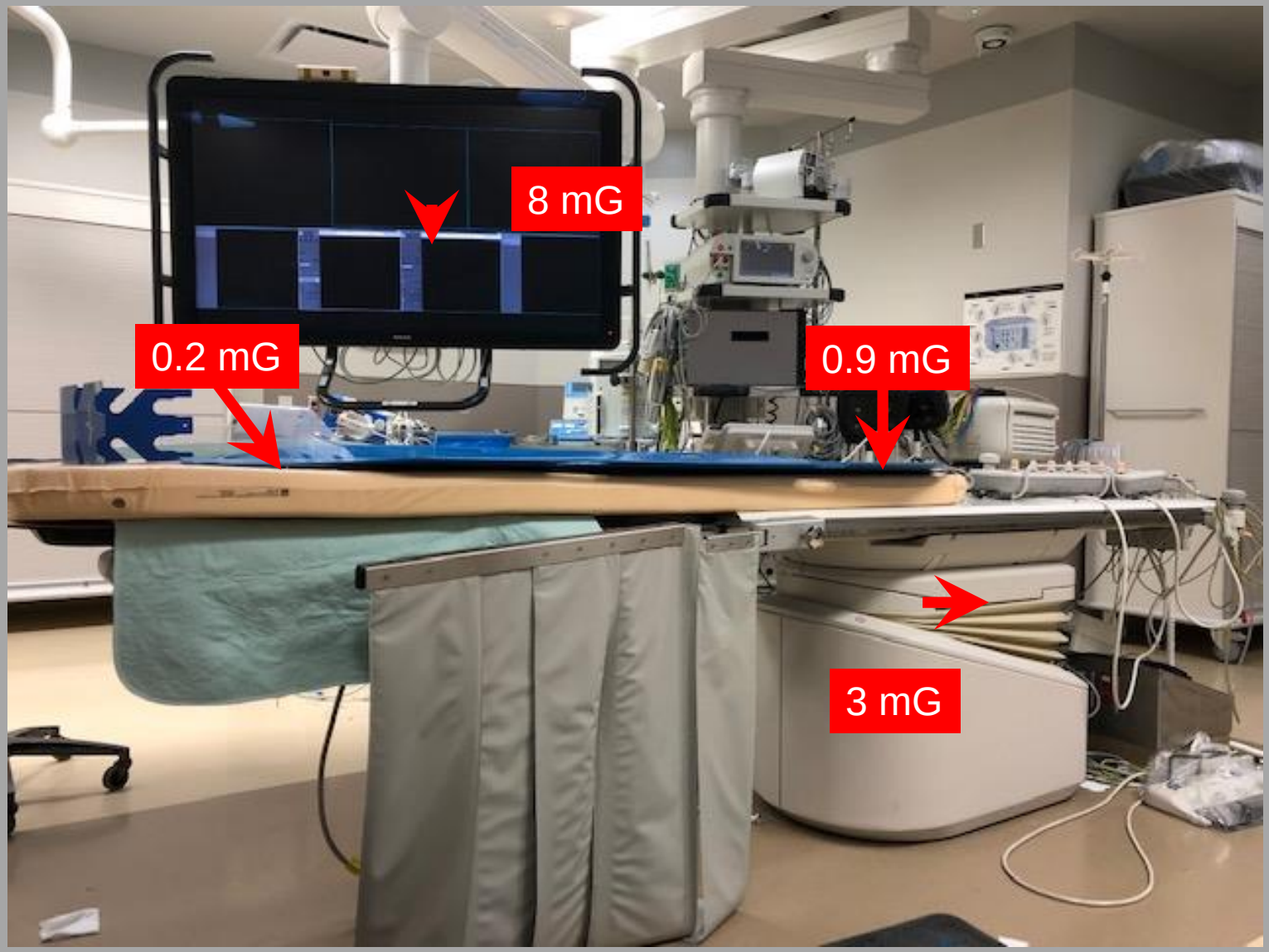


Figure 2.22C

Figure 2.22D

X-ray system NOT turned on



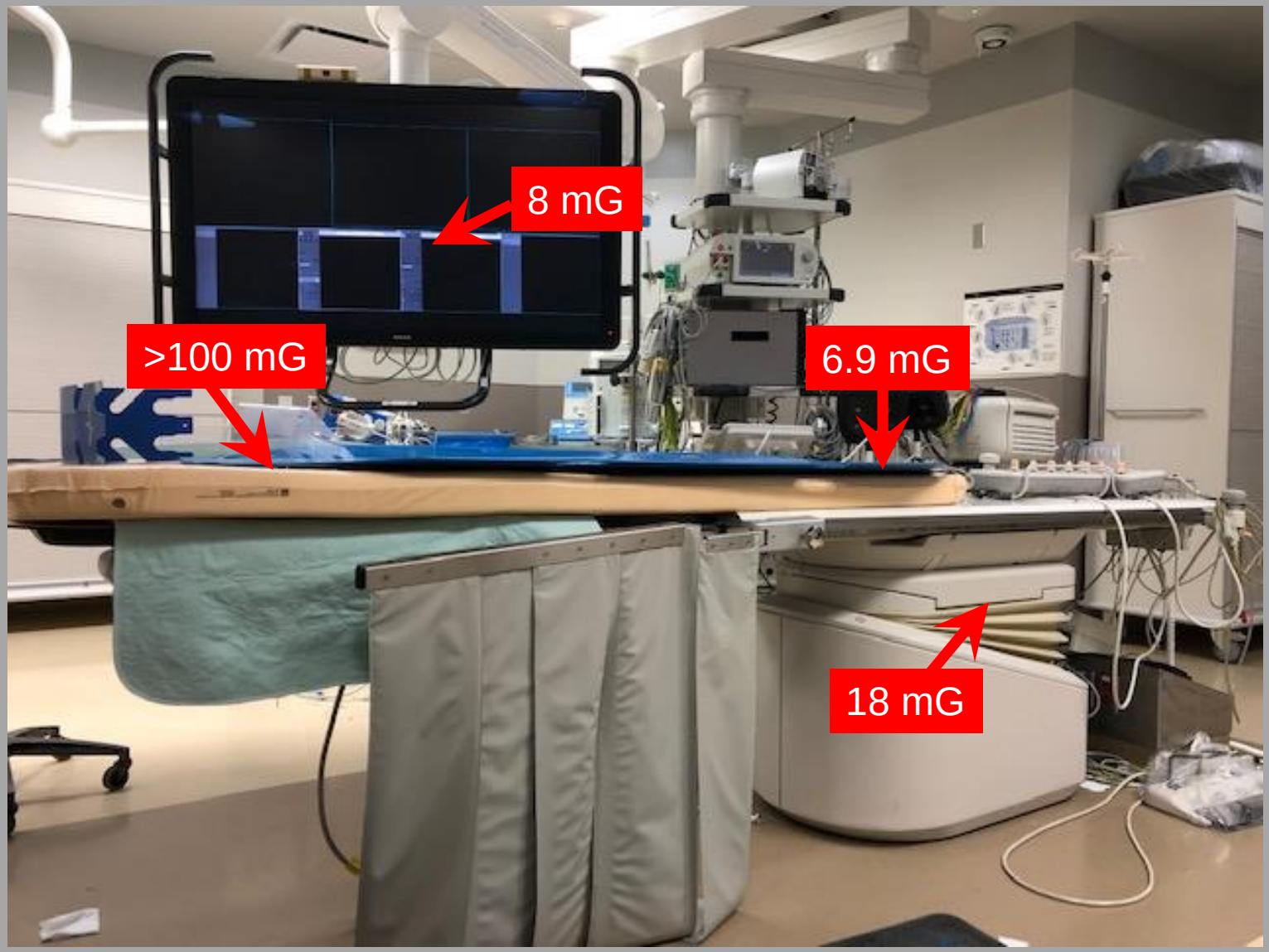
HEAD

FOOT

mG = milli Gauss

Figure 2.23A.

X-ray system turned on



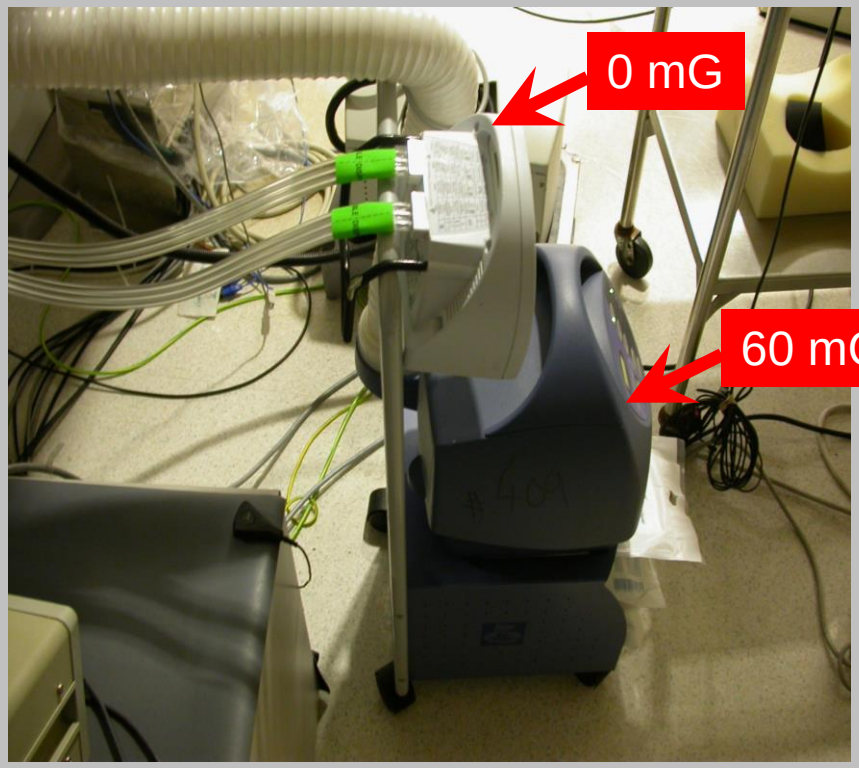
HEAD

FOOT

Figure 2.23B.

mG = milli Gauss

Tri-field meter



iv bump: 5-6 mGauss

Zoll defibrillator 6-8 mGauss

Figure 2.24A.

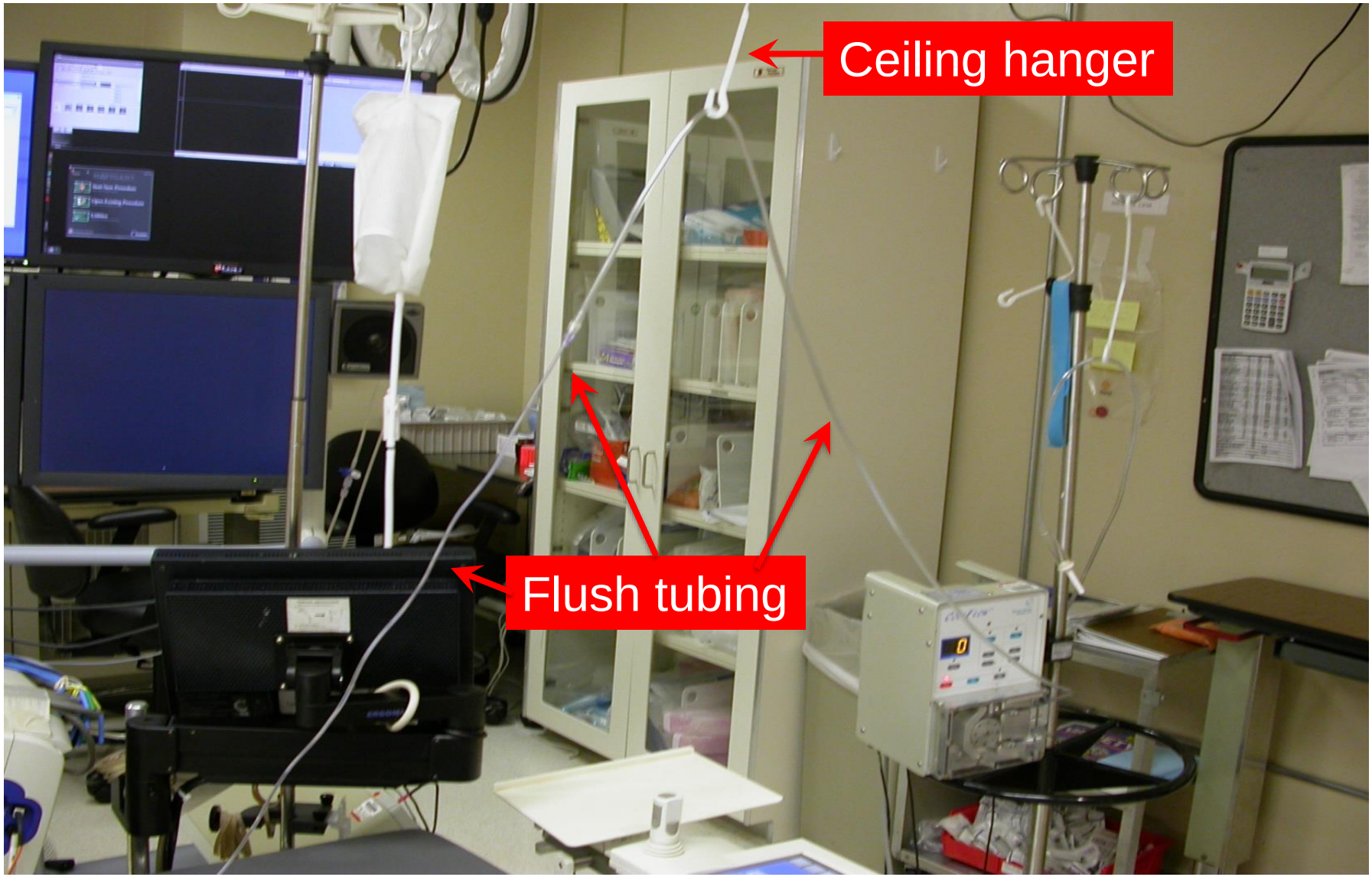


Figure 2.24B.

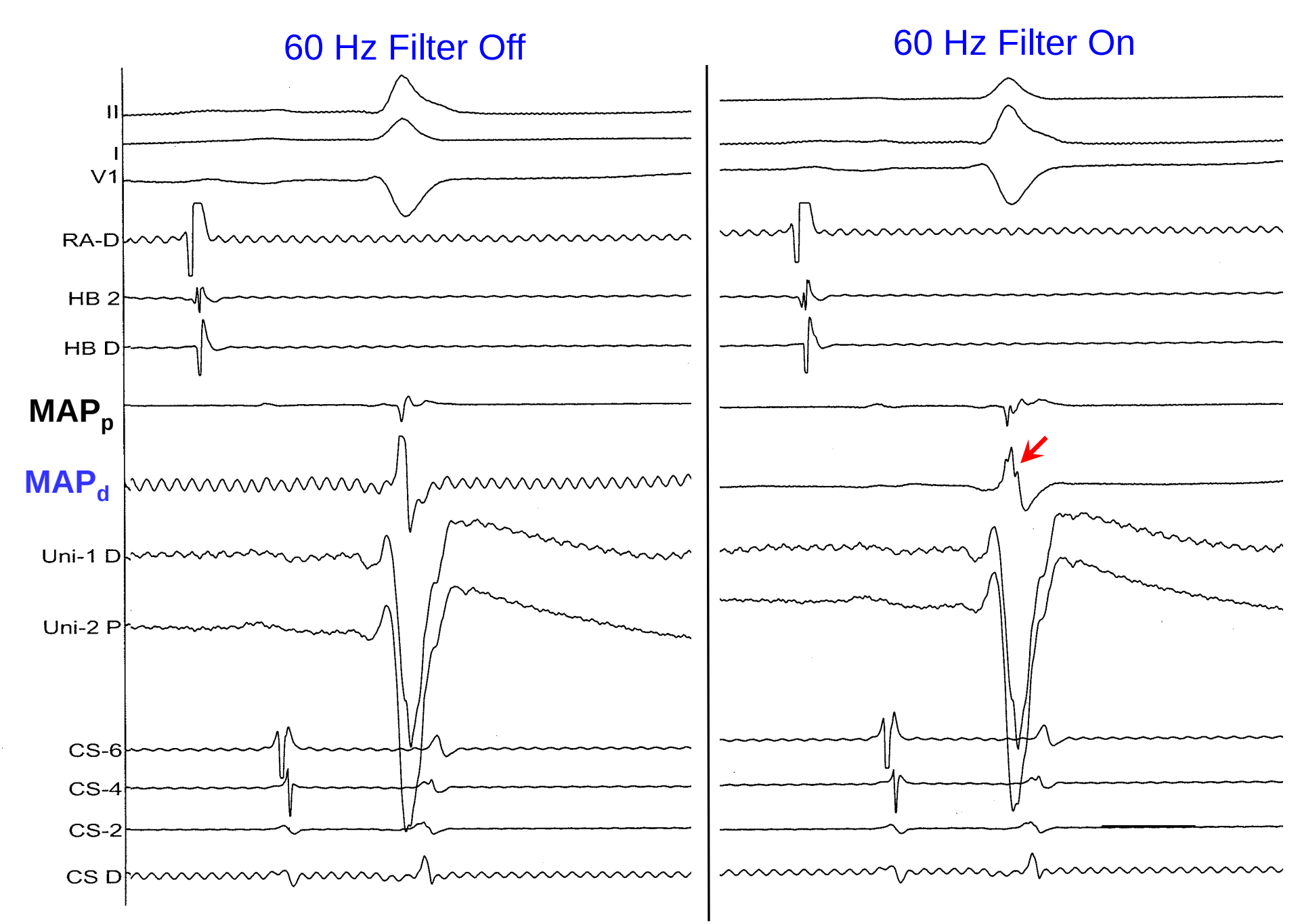

60 Hz Filter Off
60 Hz Filter On
II
I
V1
RA-D
HB 2
HB D
MAPp
MAPd
Uni-1 D
Uni-2 P
CS-6
CS-4
CS-2
CS D

Figure 2.25A

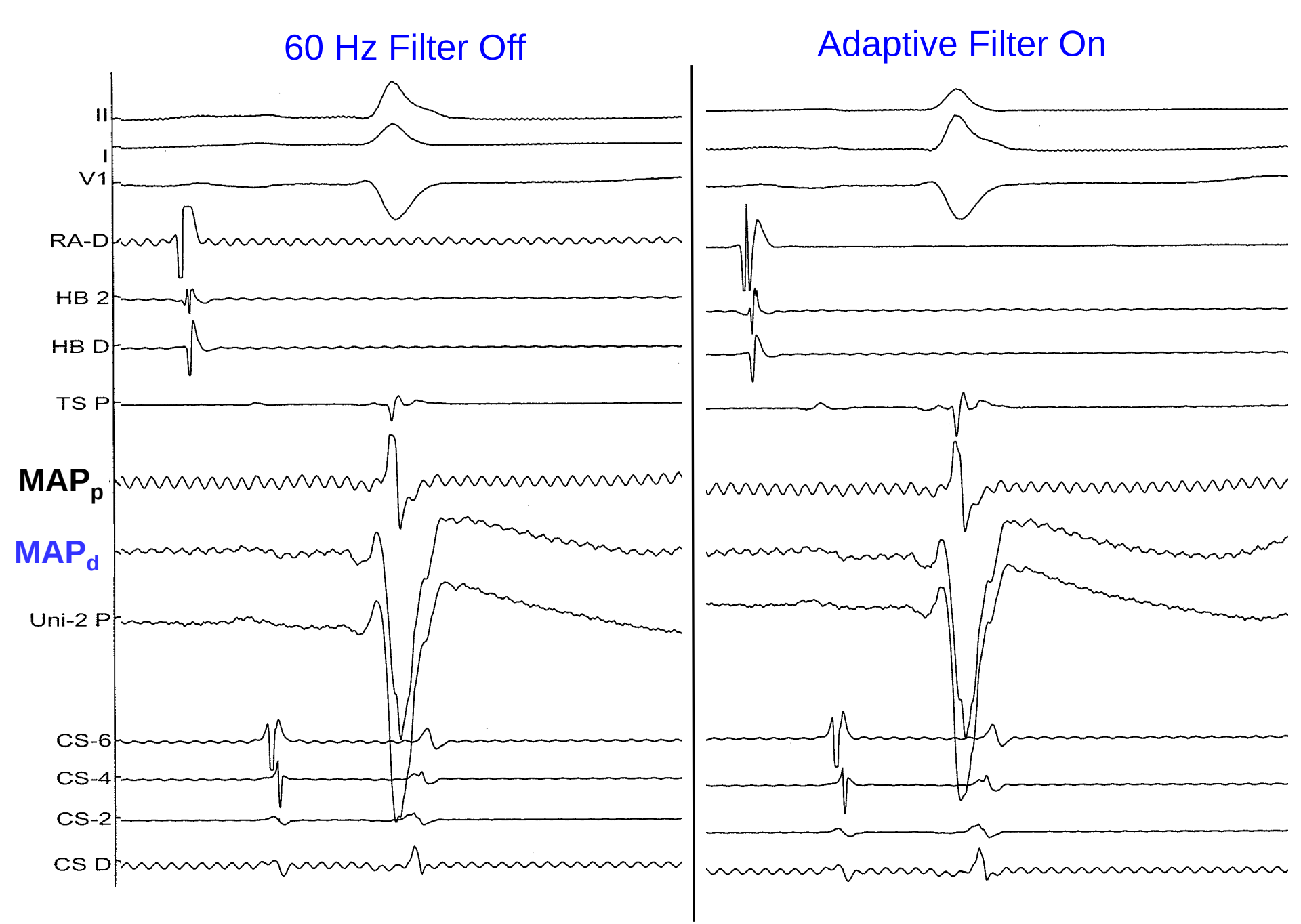

60 Hz Filter Off
Adaptive Filter On
II
I
V1
RA-D
HB 2
HB D
TS P
MAPp
MAPd
Uni-2 P
CS-6
CS-4
CS-2
CS D

Figure 2.25B

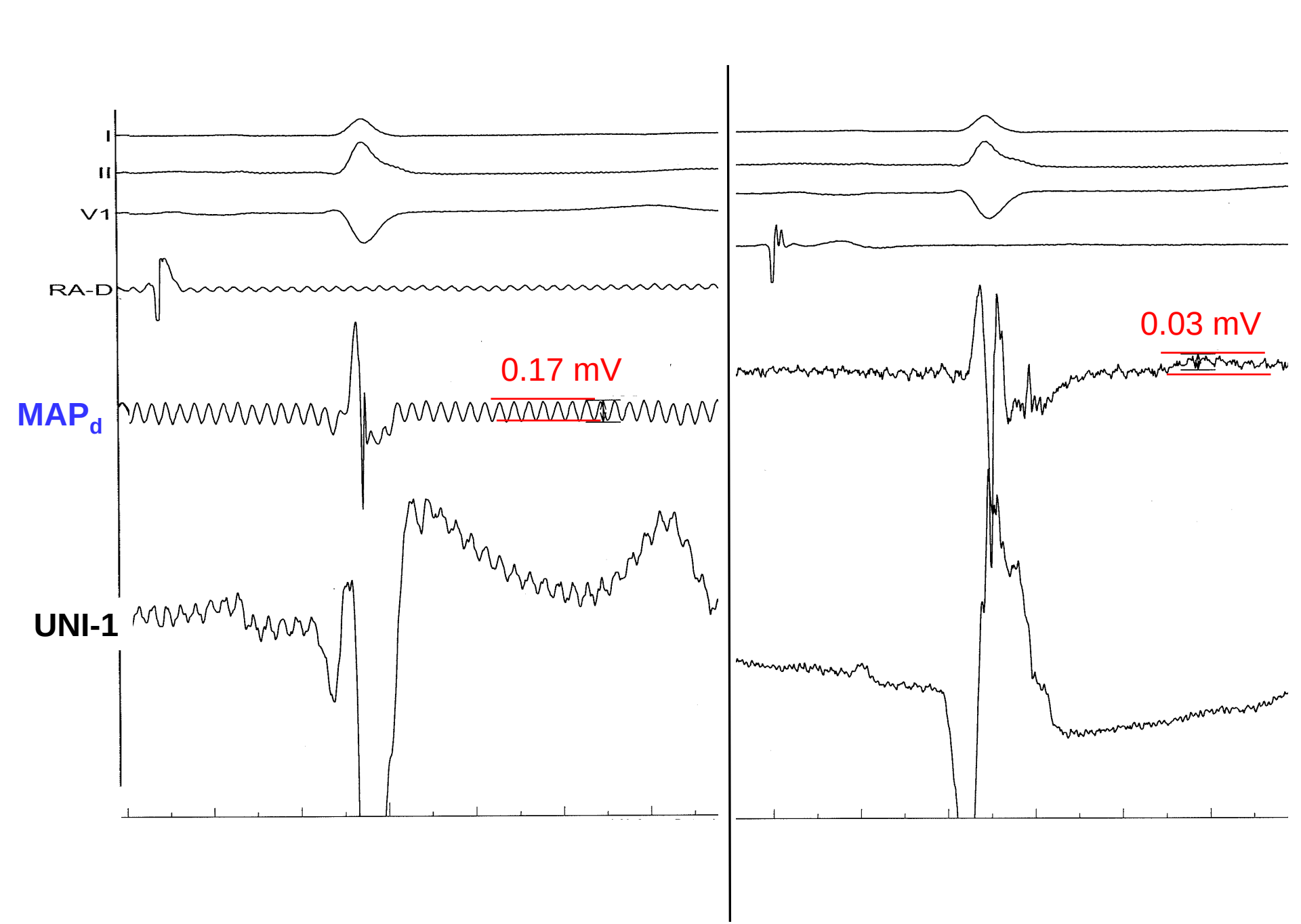


Figure 2.25C

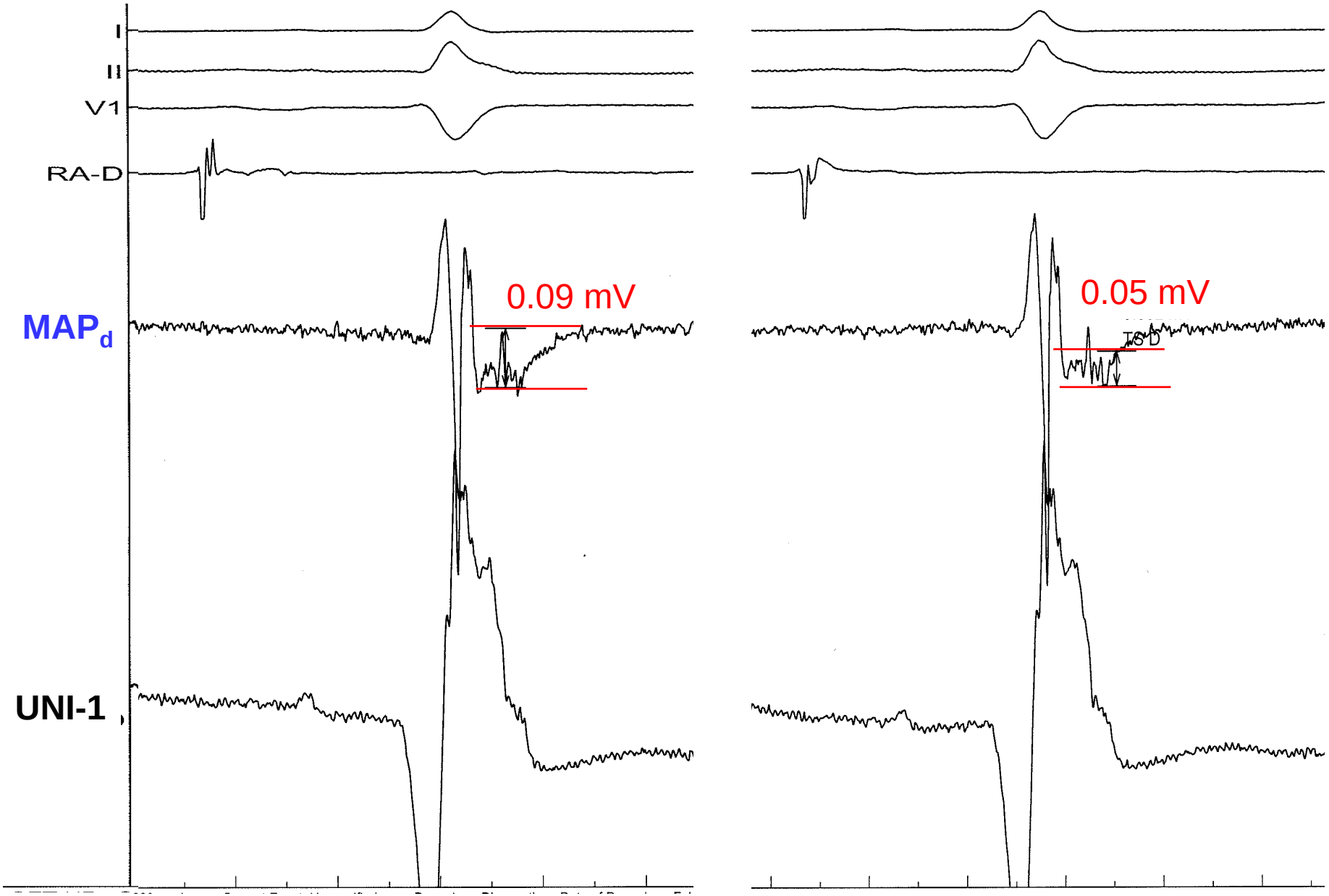


Figure 2.25D

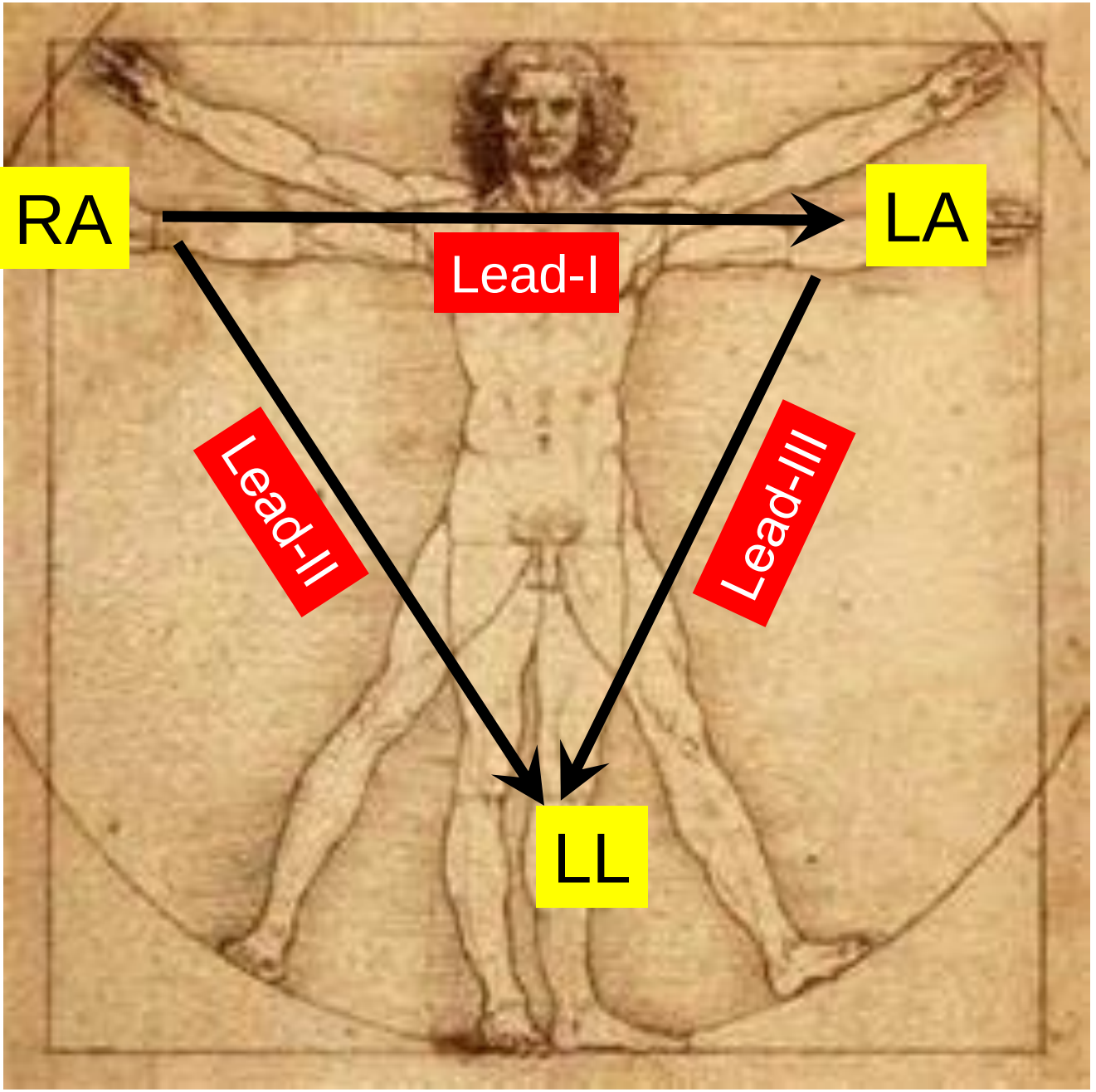


Figure 2.26A.

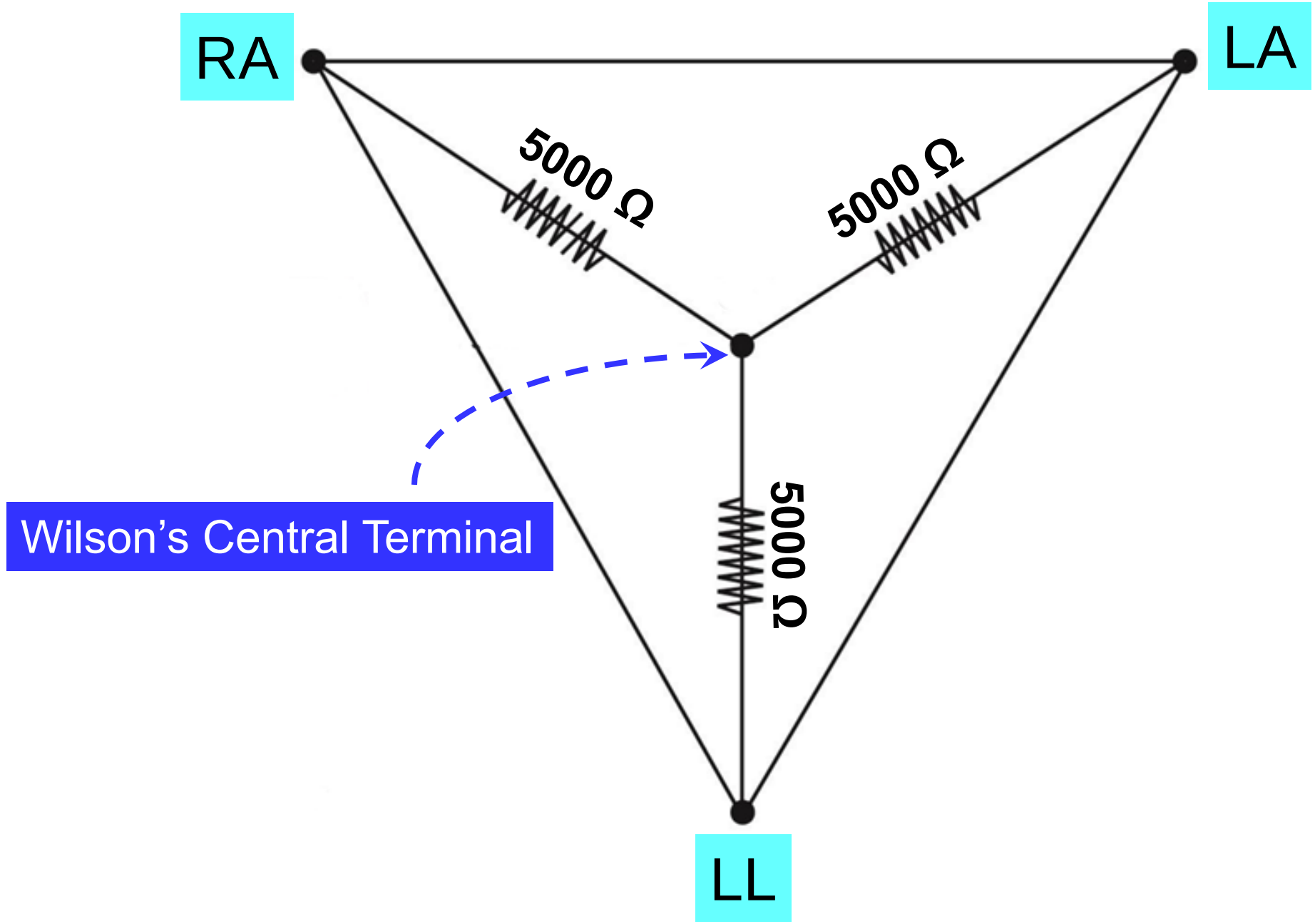


Figure 2.26B.

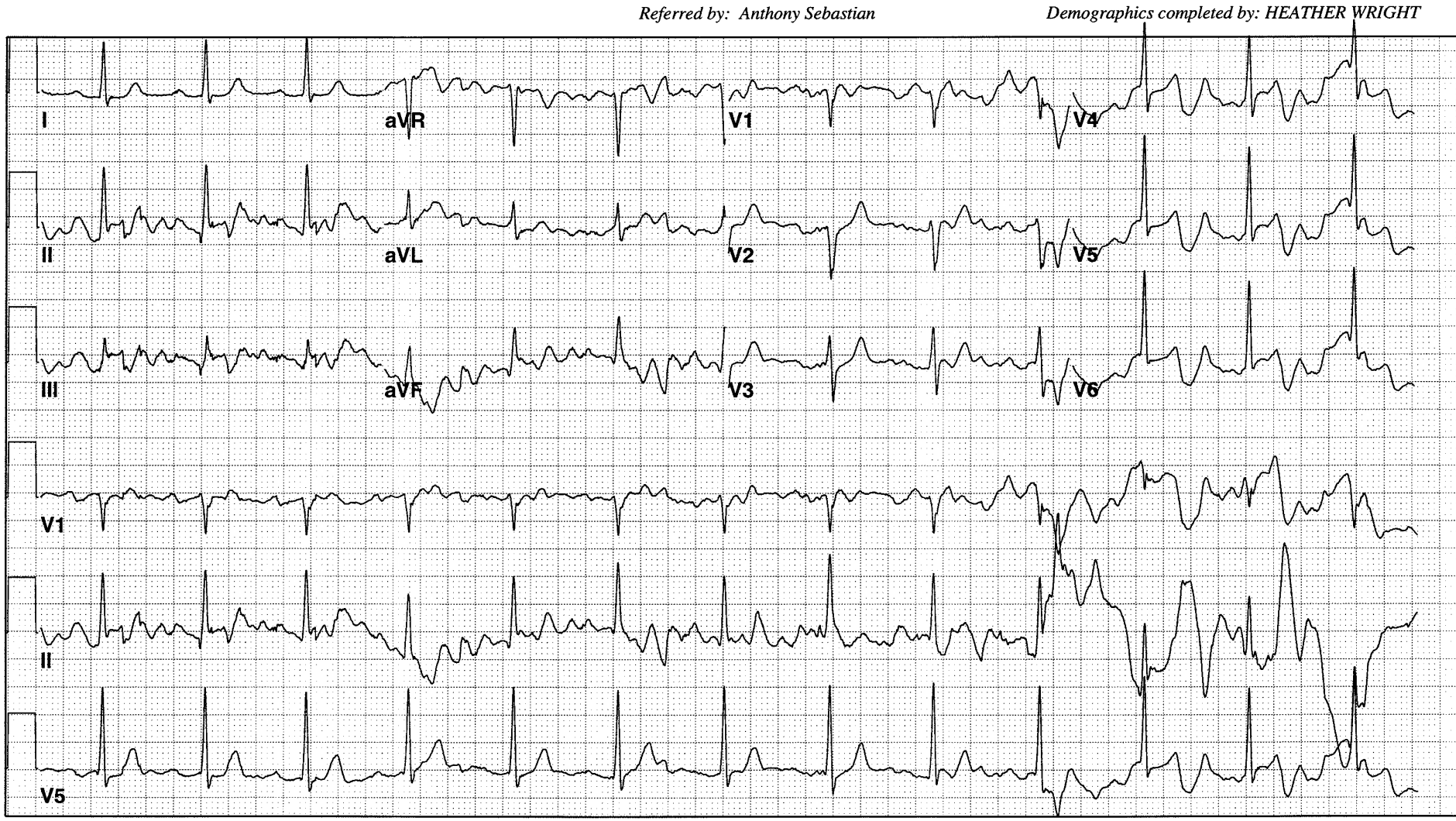

Referred by: Anthony Sebastian
Demographics completed by: HEATHER WRIGHT
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
25mm/s 10mm/mV 150Hz 7.1.1 12SL 241 HD CID: 16
SID: E002458434 EID:1045 EDT: 09:36 09–FEB–2013 ORDER: E02090053 ACCOUNT: E006433946
Page 1 of

Figure 2.26C.

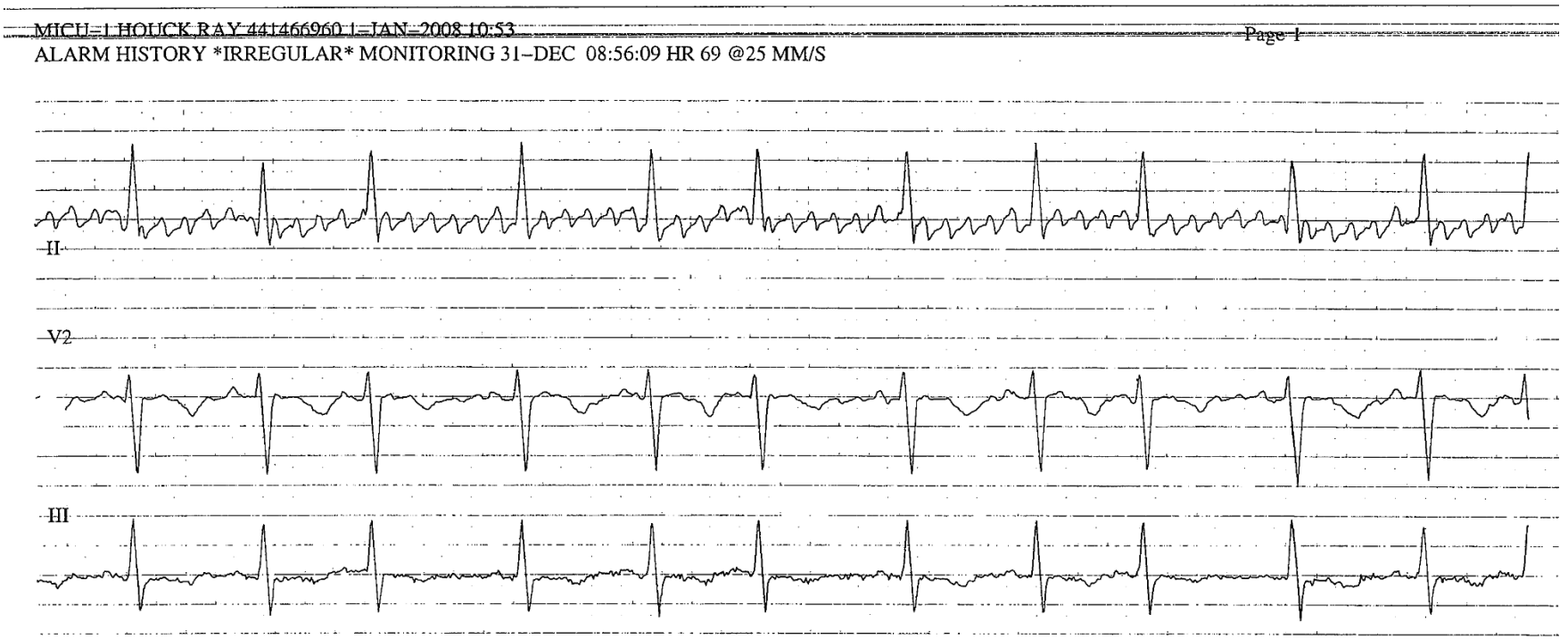

MICU-1 HOUCK,RAY 441466960 1-JAN-2008 10:53
Page 1
ALARM HISTORY *IRREGULAR* MONITORING 31-DEC 08:56:09 HR 69 @25 MM/S
II
V2
III

Figure 2.26D.

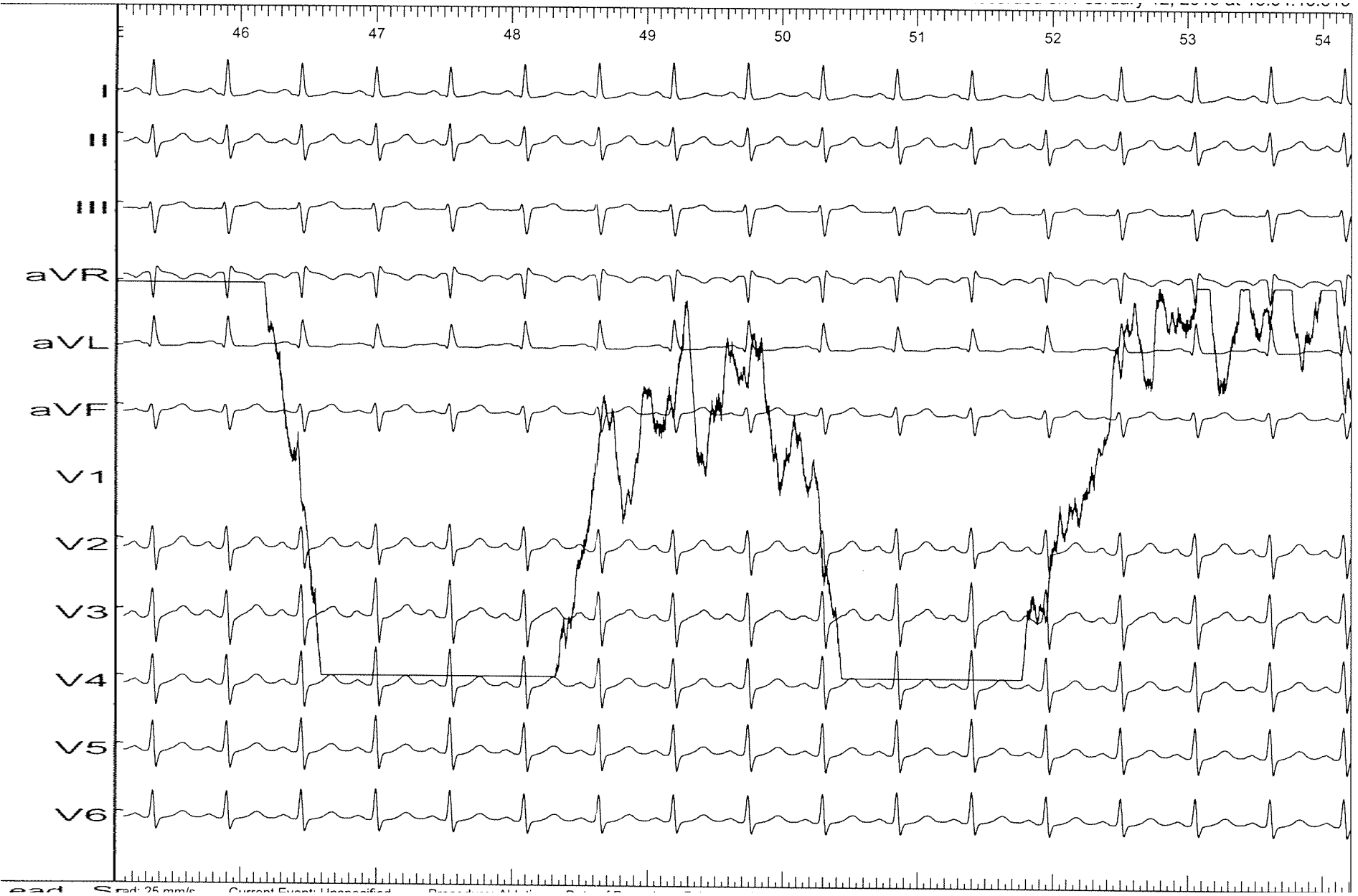


Figure 2.27A.

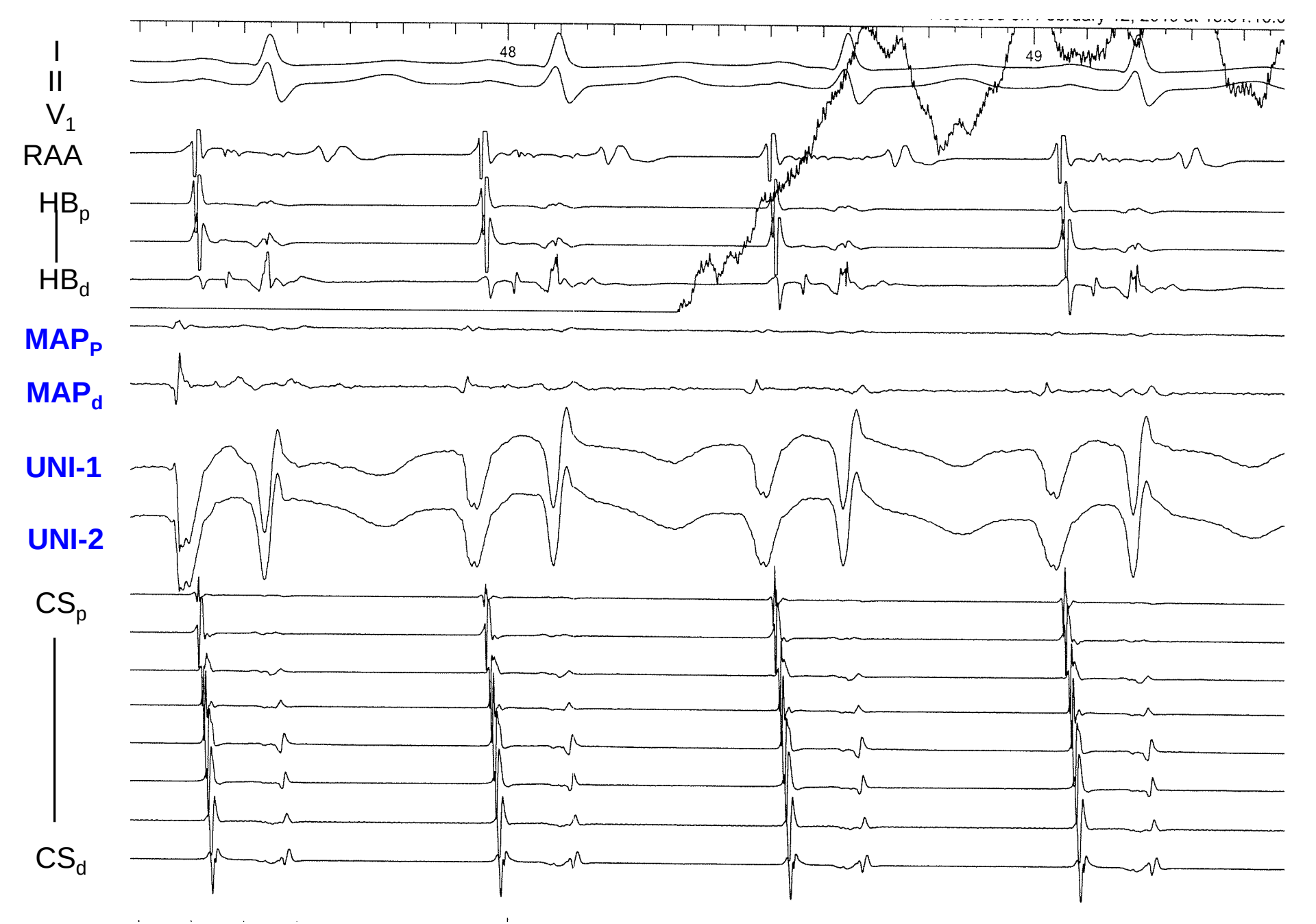


Figure 2.27B.

Figure 2.27C.

Figure 2.27D.

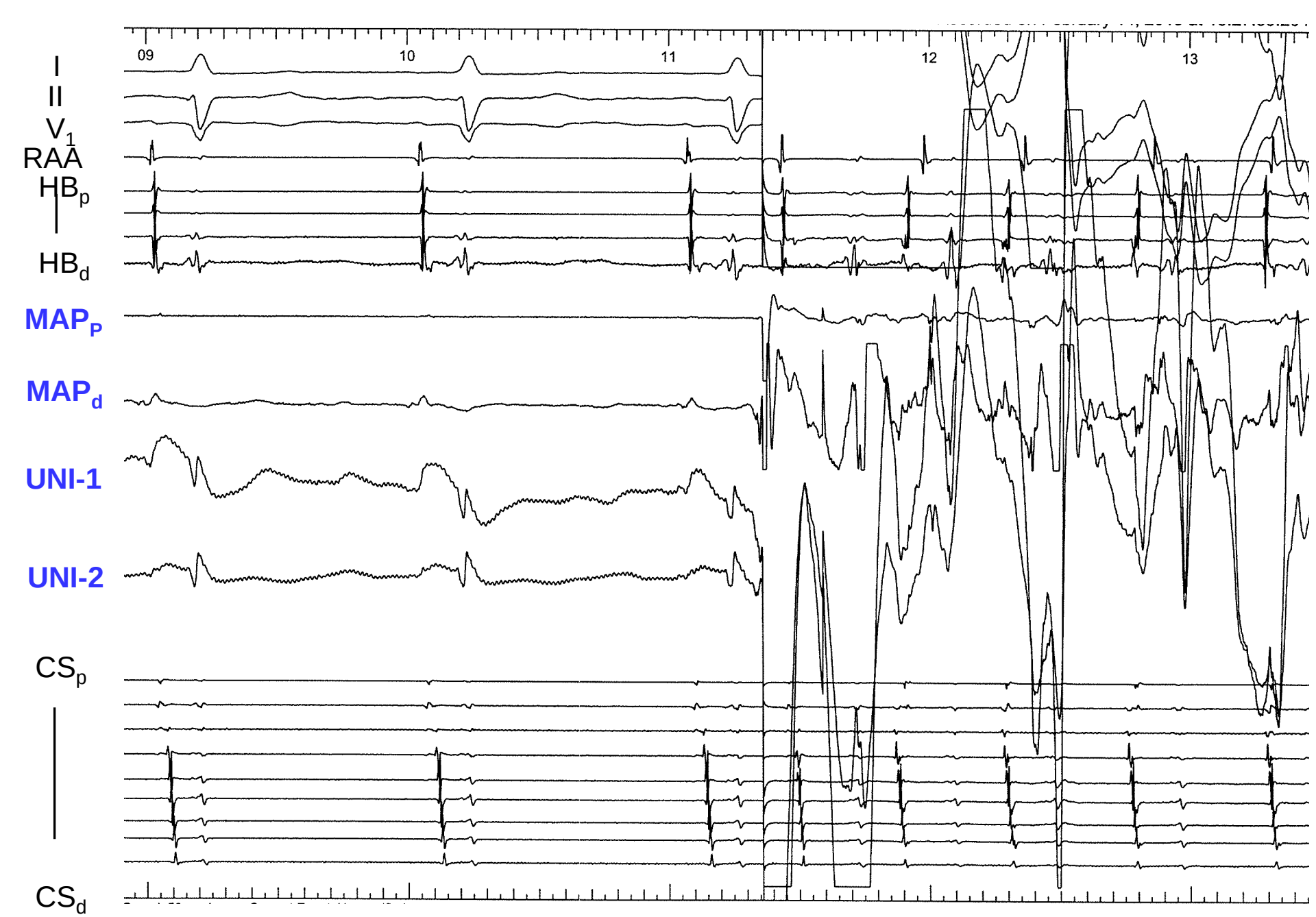


Figure 2.28A.

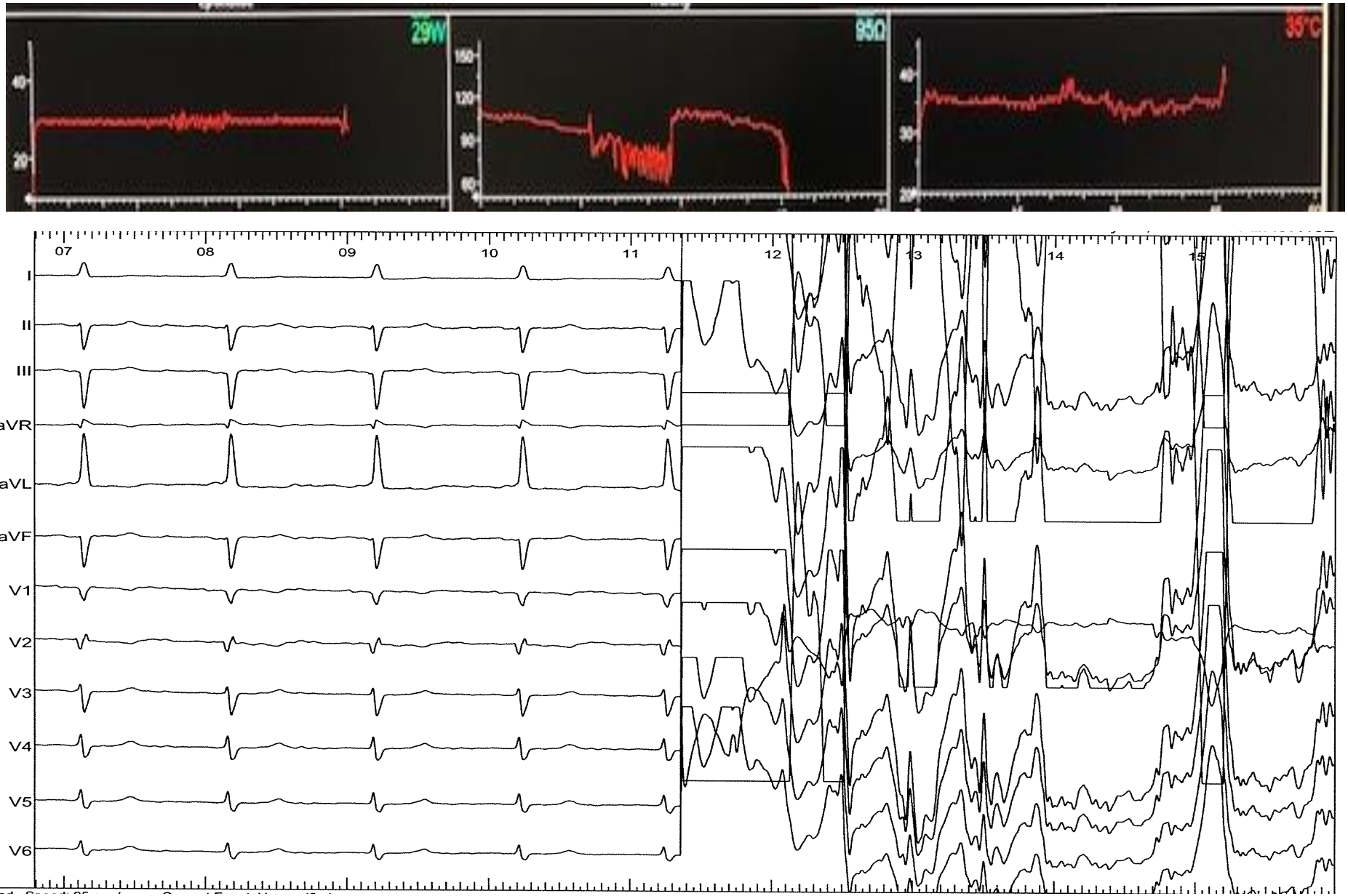

Power
Impedance
Temperature
29W
95Ω
35°C
07
08
09
10
11
12
13
14
15
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

Figure 2.28B.

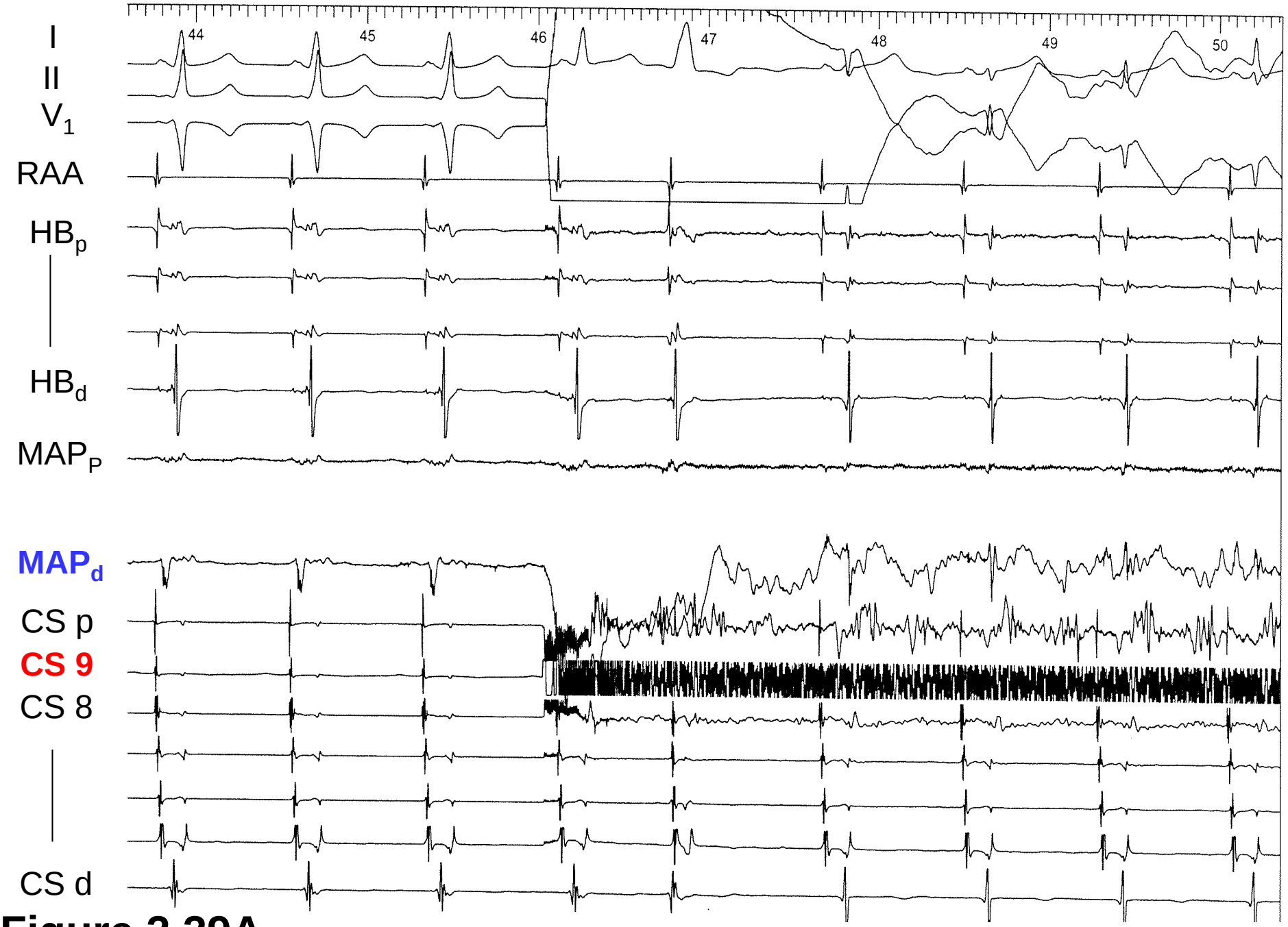


Figure 2.29A.

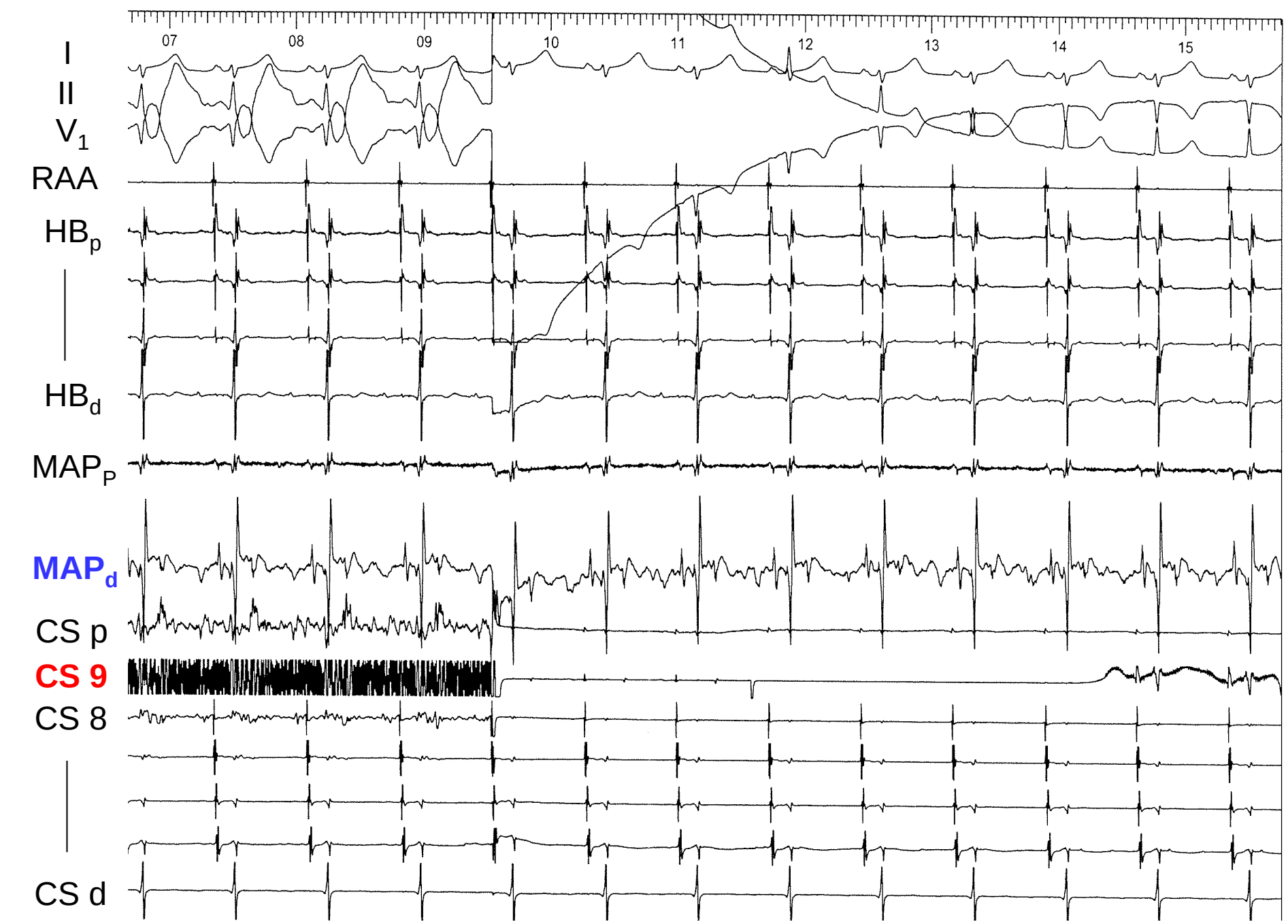

07
08
09
10
11
12
13
14
15
I
II
V1
RAA
HBp
HBd
MAPP
MAPd
CS p
CS 9
CS 8
CS d

Figure 2.29B.

BARD

CARTO® 3

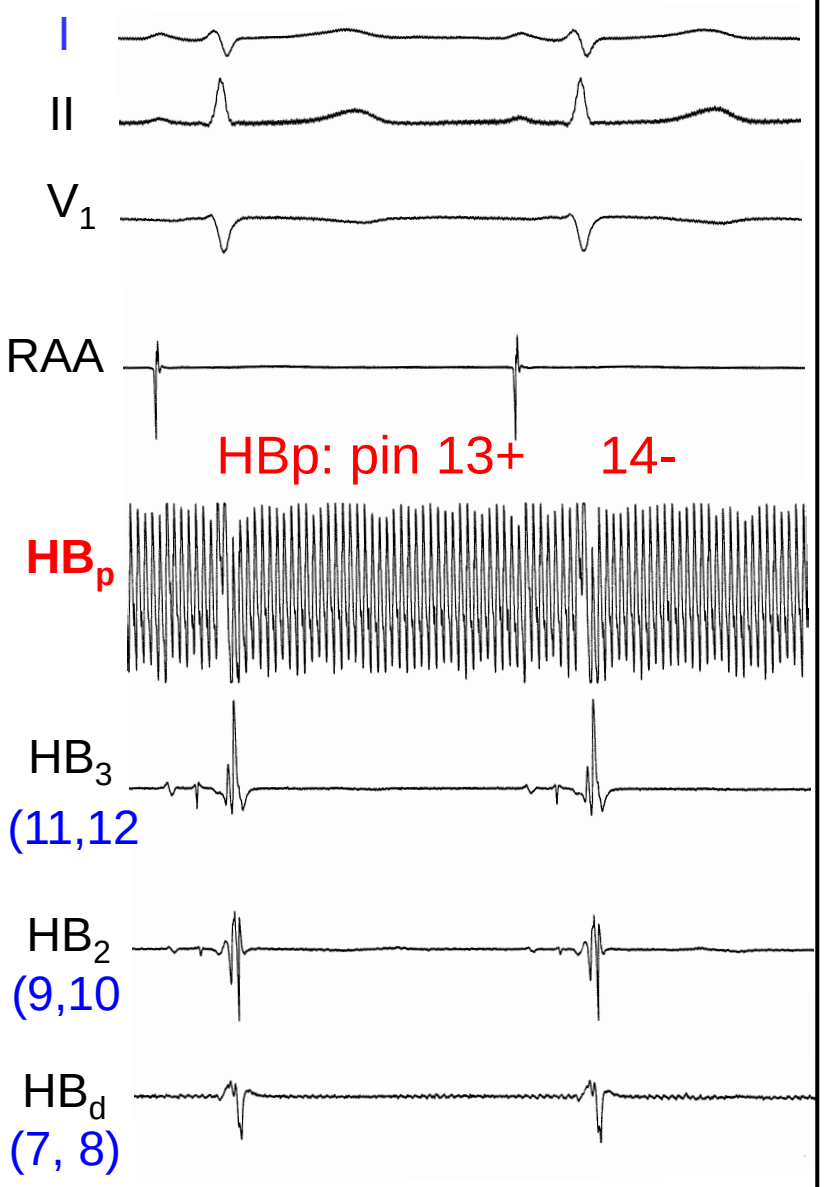


Figure 2.30A.

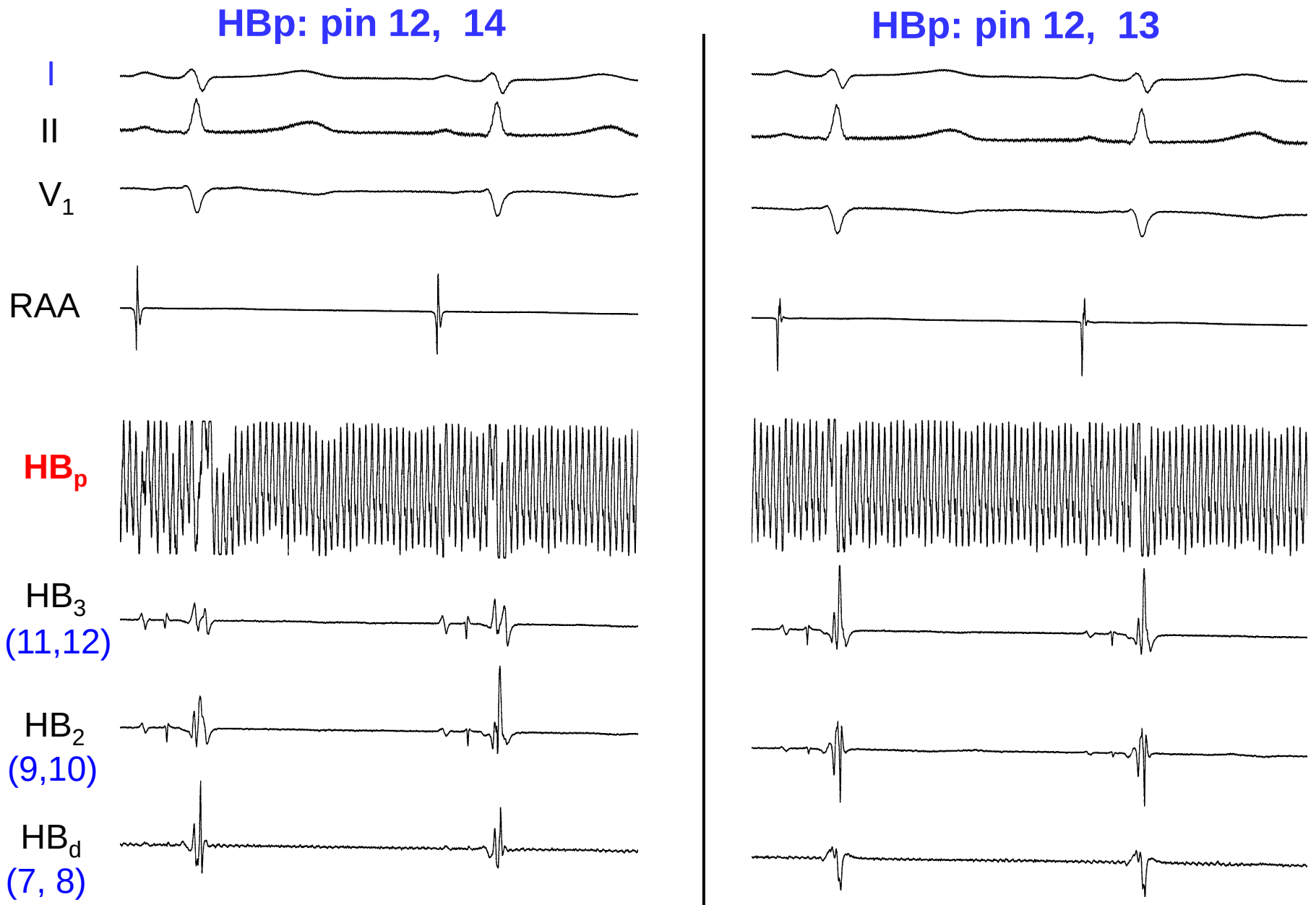


Figure 2.30B.

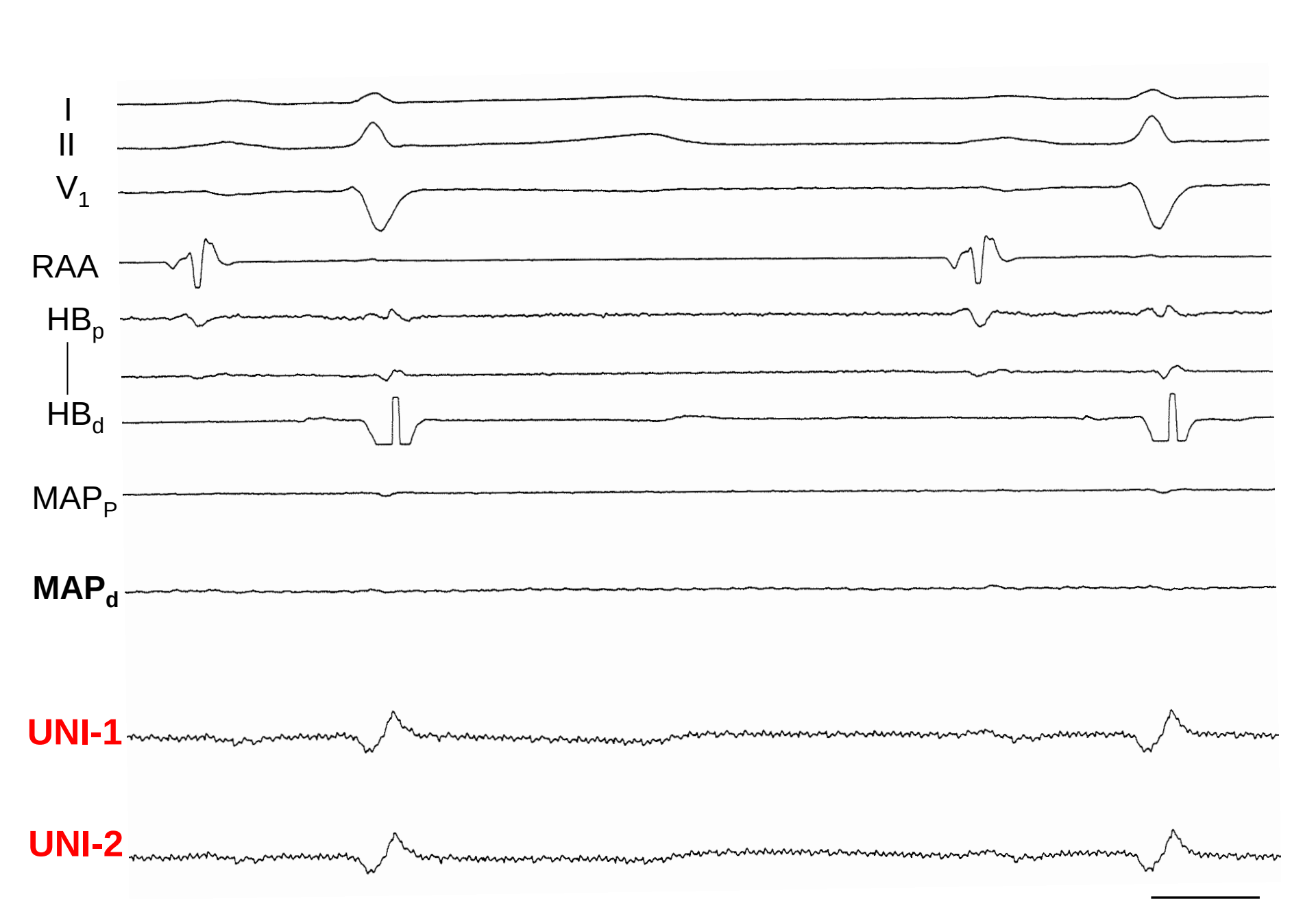


Figure 2.31A.

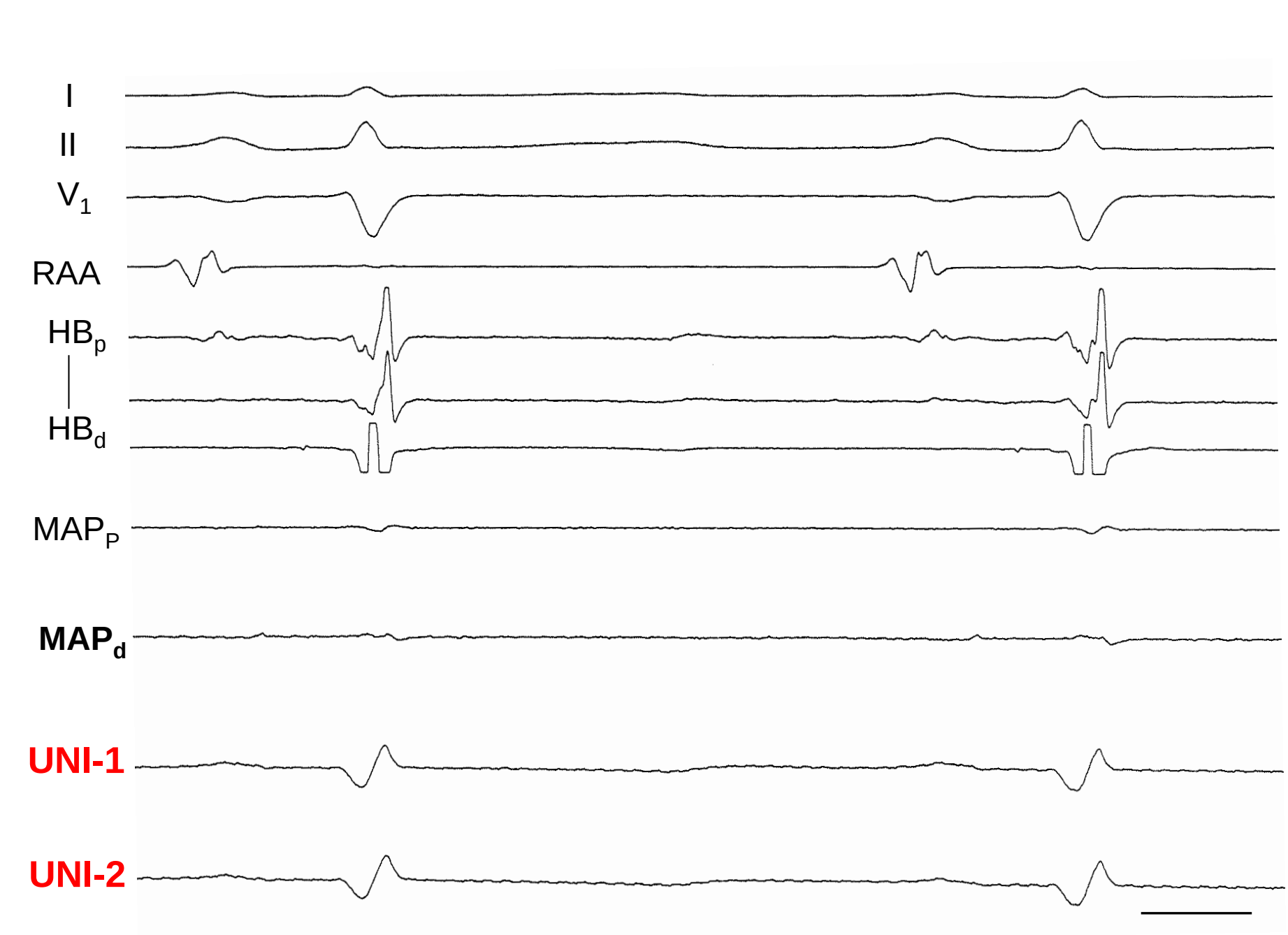


Figure 2.31B.

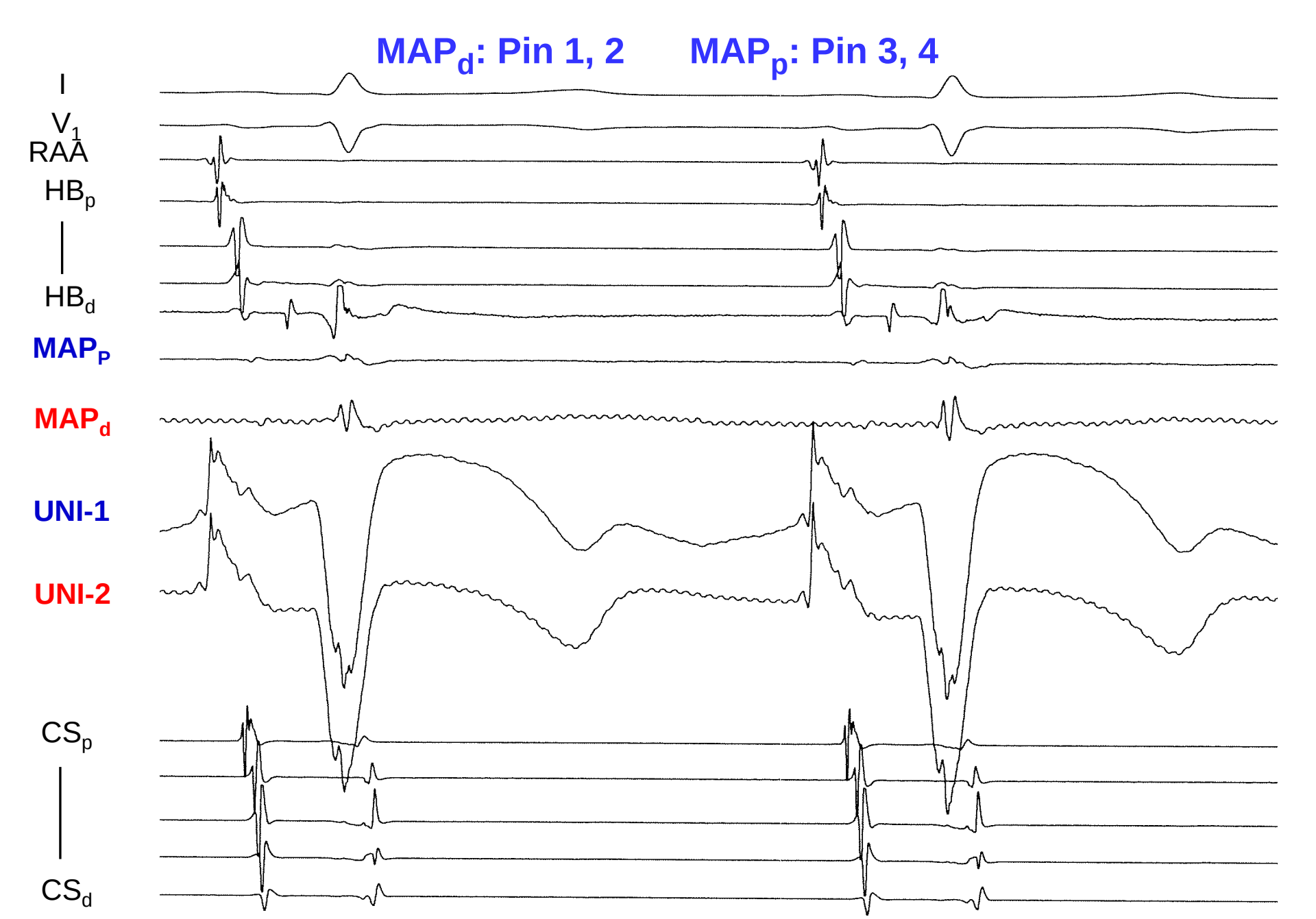

MAPd: Pin 1, 2
MAPp: Pin 3, 4
I
V1
RAA
HBp
HBd
MAPP
MAPd
UNI-1
UNI-2
CSp
CSd
100 ms

Figure 2.32A.

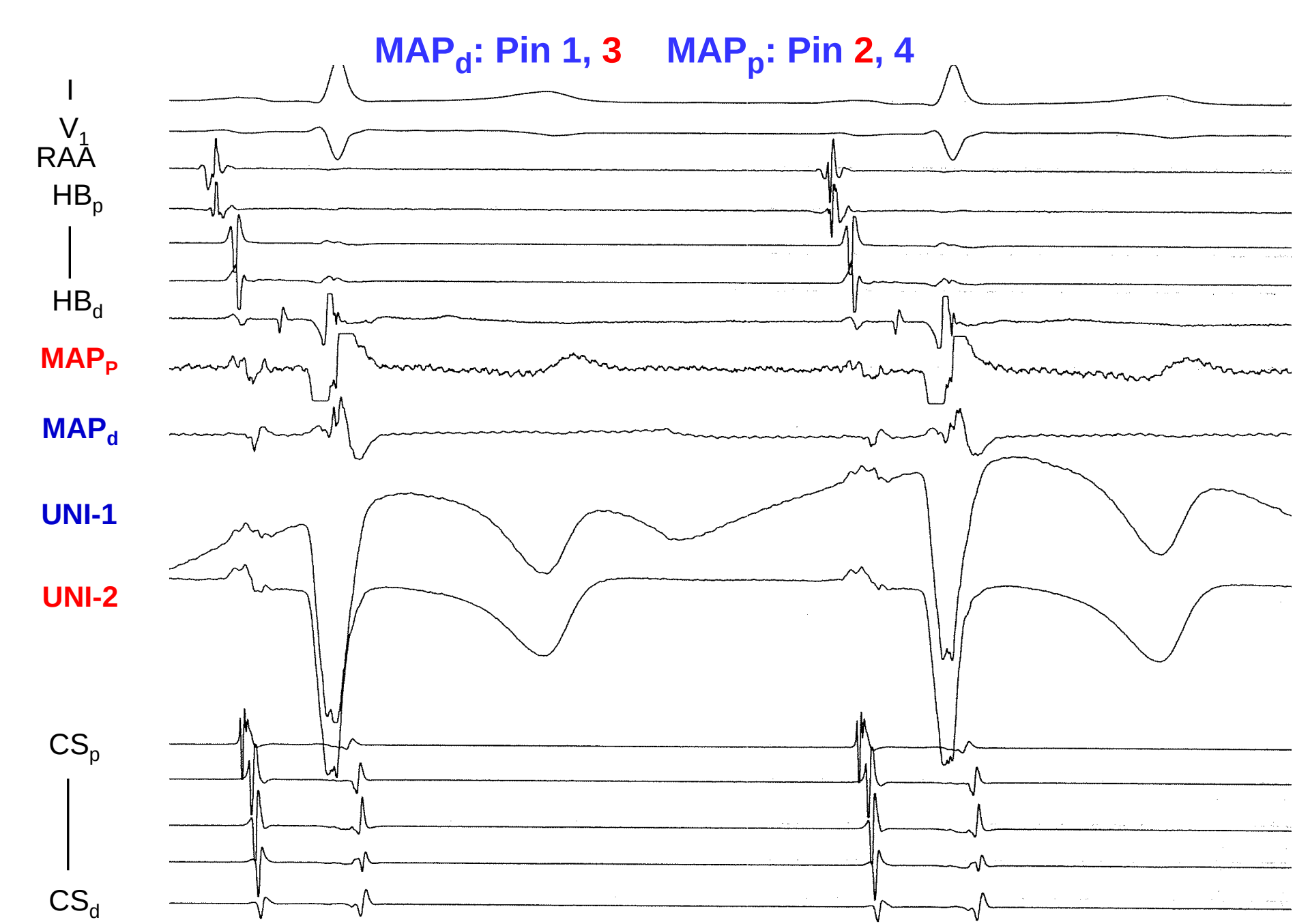

MAPd: Pin 1, 3
MAPp: Pin 2, 4
I
V1
RAA
HBp
HBd
MAPP
MAPd
UNI-1
UNI-2
CSp
CSd
100 ms

Figure 2.32B.

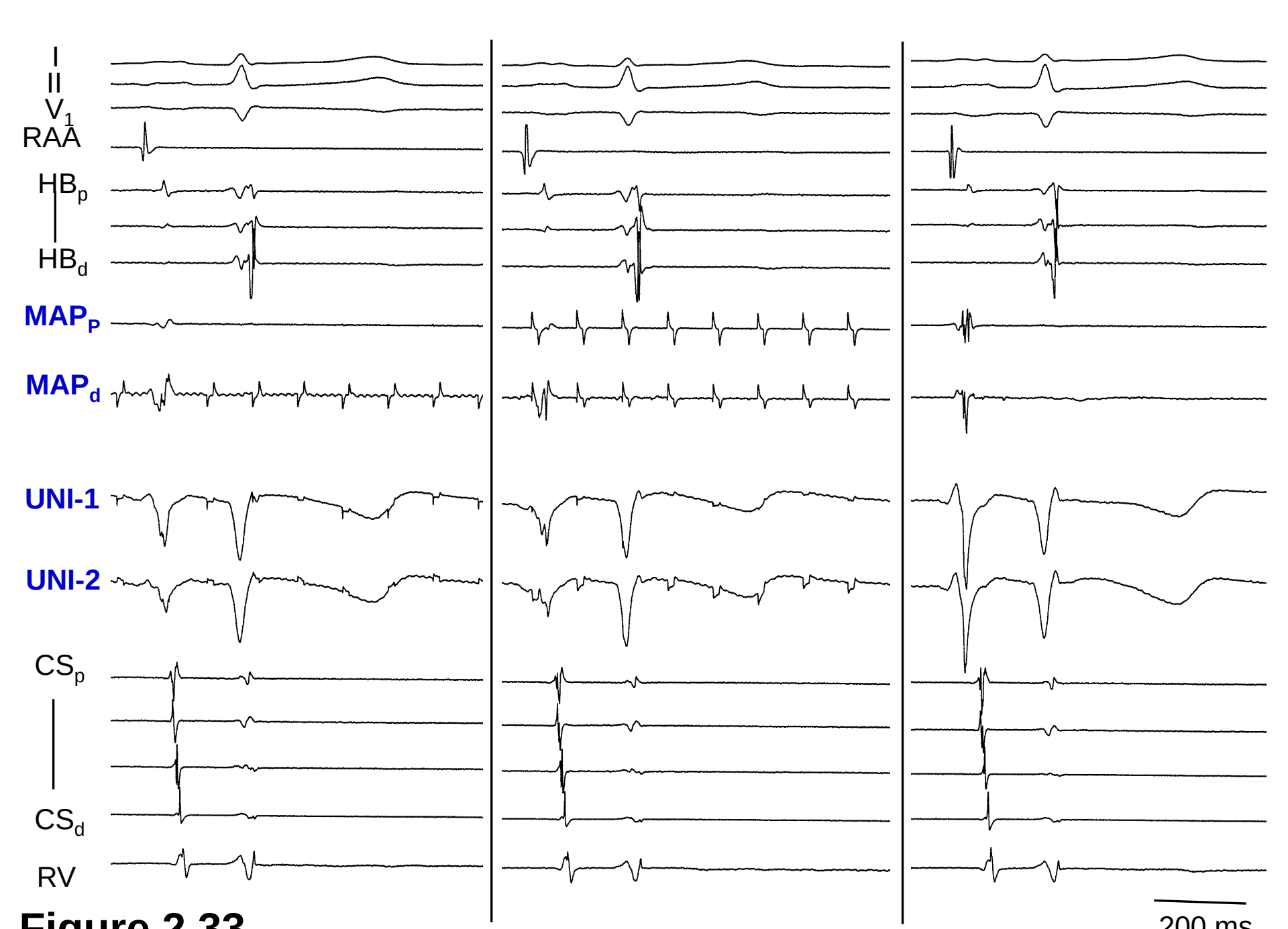


Figure 2.33