Use of 3D Mapping in CIED Implantation

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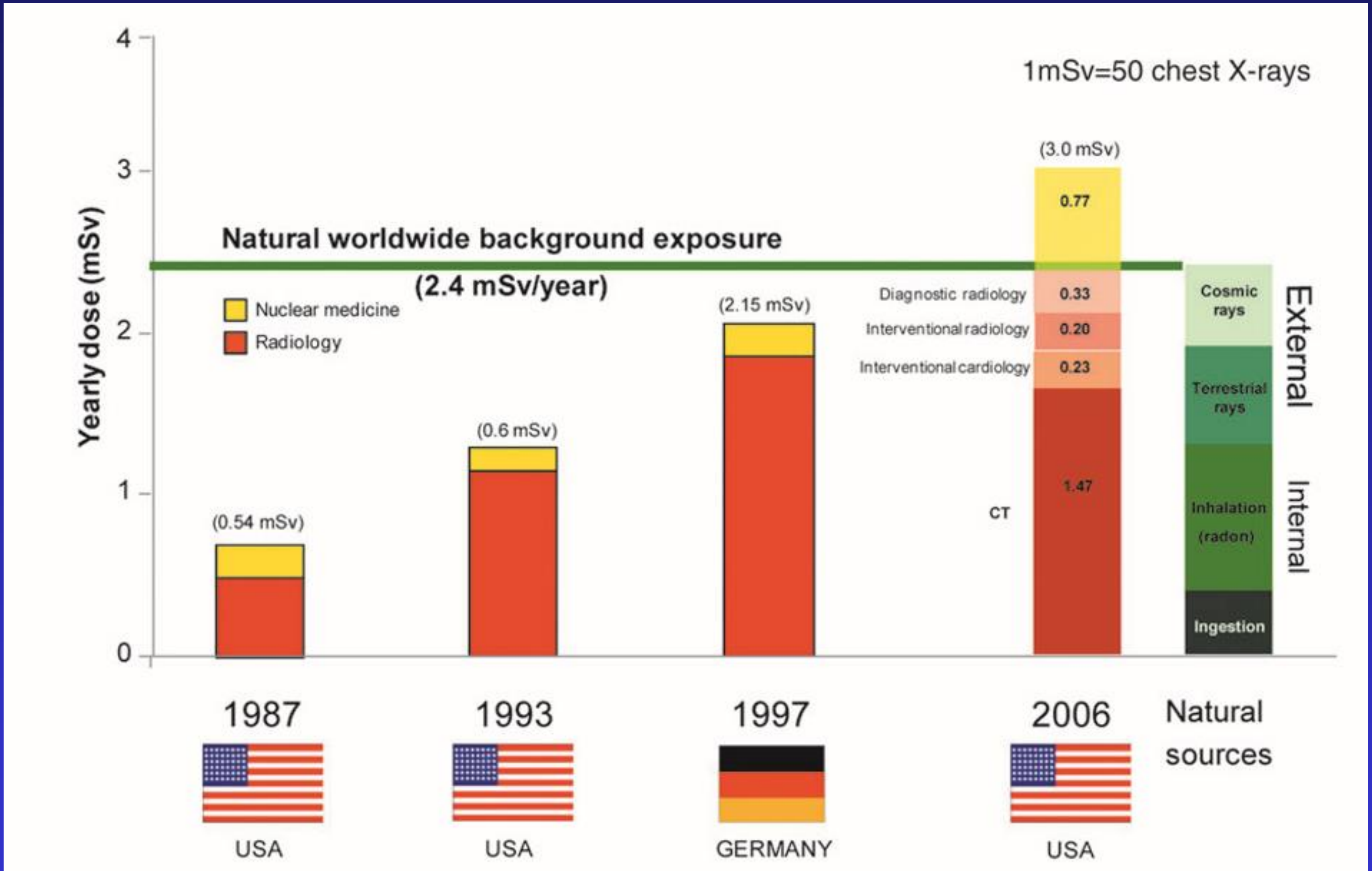
Medical Radiation



Picano E et al. The appropriate and justified use of medical radiation in cardiovascular imaging : a position document of the ESC Associations of Cardiovascular Imaging, Percutaneous Cardiovascular Interventions and Electrophysiology. Eur Heart J 2014;35:665-72

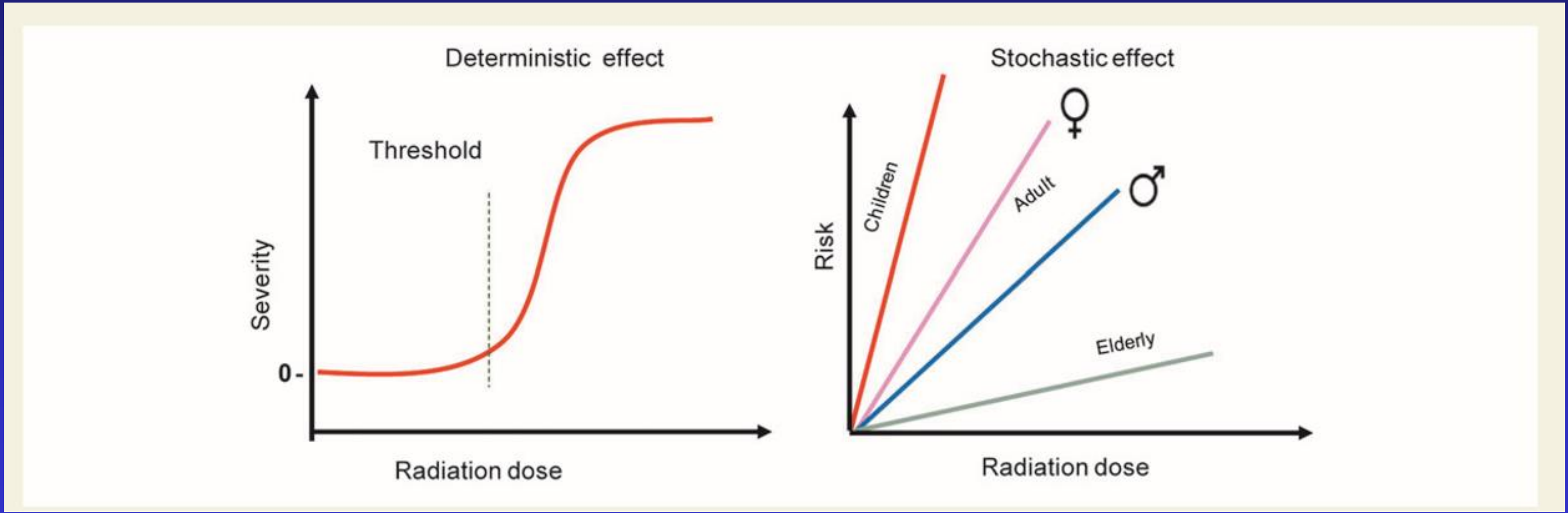
Radiation Dose Parameters

Modality	Parameter	Definition	Units
General	Absorbed dose.	Amount of energy deposited in a material per unit mass.	Gray (Gy) 1 Gy=1 joules per kilogram.
	Equivalent dose.	Absorbed dose multiplied by weighting factor based on the type of radiation (weighting factor of 1 for X-rays and gamma rays).	Sievert (Sv).
	Effective dose.	Whole body quantity based on absorbed organ doses weighted based on their radiation sensitivity and type of radiation; weighted sum of the organ equivalent dose.	Sieverts (Sv).
Fluoroscopy	Kerma (kinetic energy released per unit mass).	Energy transferred per unit mass of irradiated material.	Gray (Gy).
	Air kerma.	Energy transferred per unit mass of air measured with an ionisation chamber.	Gray (Gy).
	Dose area product.	Product of the air kerma and X-ray beam area.	Gy cm^2.
	Peak skin dose	Accumulated absorbed dose to the most irradiated area of skin.	Gray (Gy).
	Fluoroscopy exposure time	Cumulative time fluoroscopy is used.	Seconds/minutes.
CT	CT dose index (CTDI).	Average absorbed dose from one axial CT scan measured with an ionisation chamber	Gray (Gy).
	Weighted CTDI ($CTDI_w$).	CTDI weighted across the field of view with 1/3 for the centre and 2/3 for the edge.	Gray (Gy).
	Volume CTDI ($CTDI_{VOL}$).	$CTDI_w$ divided by pitch.*	Gray (Gy).
	Dose length product.	$CTDI_{VOL}$ multiplied by total scan length.	mGy cm.
Radioisotopes	Radioactivity.	Rate of nuclear decay events (decays per second).	Becquerel (Bq).

*Pitch=table movement per rotation/slice thickness.

Williams MC et al. Using radiation safely in cardiology: what imagers need to know. Heart 2019;105:798-806

Health Hazard of Ionizing Radiation



Picano E et al. The appropriate and justified use of medical radiation in cardiovascular imaging : a position document of the ESC Associations of Cardiovascular Imaging, Percutaneous Cardiovascular Interventions and Electrophysiology. Eur Heart J 2014;35:665-72

Deterministic Effect-Absorbed Dose Threshold

Deterministic effect	Absorbed dose threshold (Gy)*
Skin erythema	3–6
Skin burns	5–10
Temporary hair loss	4
Sterility	3–6
Cataracts	0.5

Williams MC et al. Using radiation safely in cardiology: what imagers need to know. Heart 2019;105:798-806

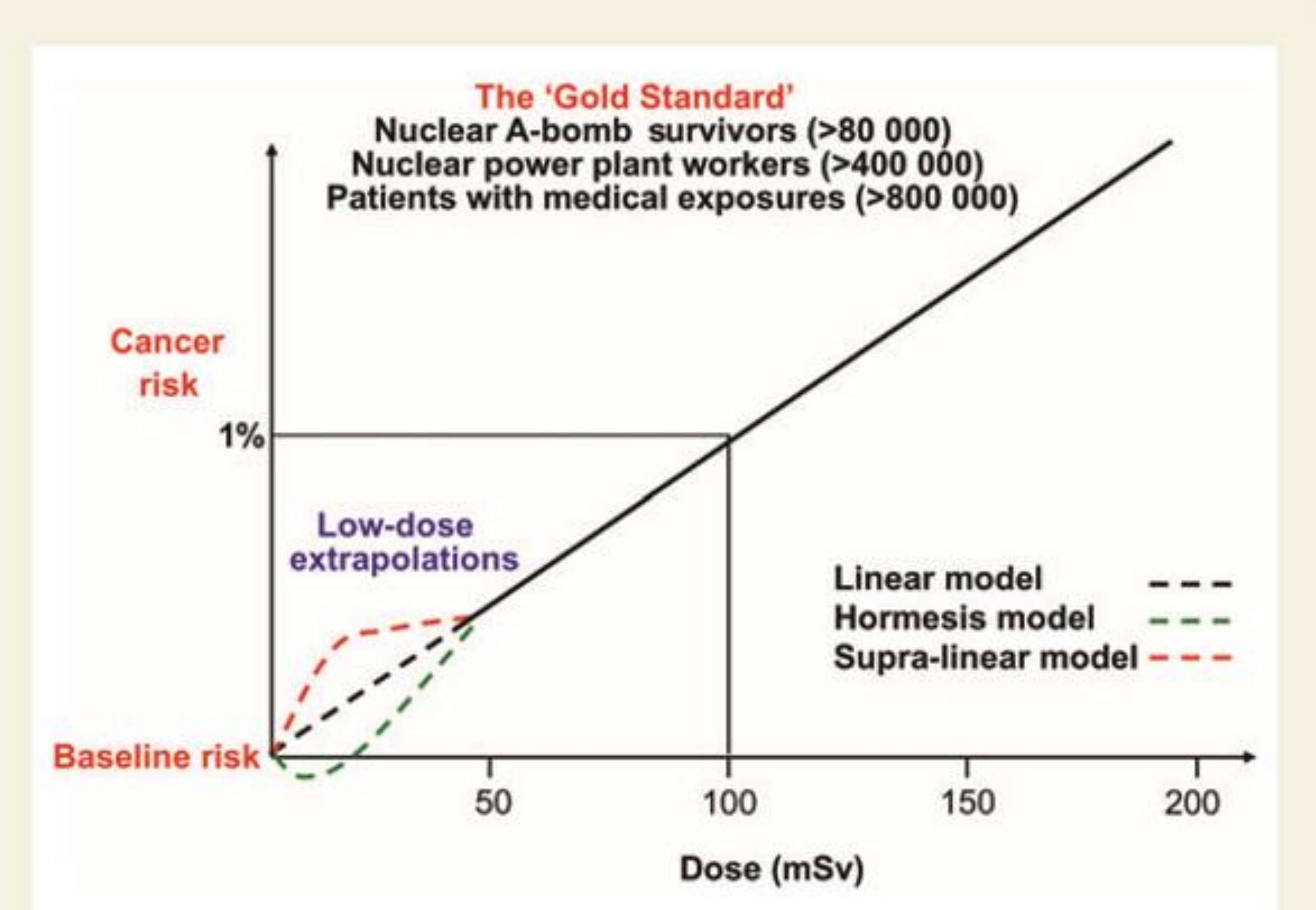
Radiation Dose in Terms of DAP and Fluoroscopy Time

	DAP per exam (Gy cm^2)	Fluoroscopy time per exam (min)
Coronary angiography	31	4.3
Coronary graft angiography	47	13
Percutaneous transluminal coronary angioplasty (single stent)	40	11.3
Pacemaker (permanent)	7	6

DAP, dose area product.

Williams MC et al. Using radiation safely in cardiology: what imagers need to know. Heart 2019;105:798-806

Linear No-Threshold Model for Stochastic Effect



Picano E et al. The appropriate and justified use of medical radiation in cardiovascular imaging : a position document of the ESC Associations of Cardiovascular Imaging, Percutaneous Cardiovascular Interventions and Electrophysiology. Eur Heart J 2014;35:665-72

Standard Average Radiation Doses of Common Cardiac Procedures

	Diagnostic procedures	Effective dose (mSv)	Equivalent CXRs	Background radiation (years)	Reference
Adult	**Conventional radiography**				
	CXR (PA)	0.02	1	2–3 days	Mettler *et al.*[25]
	Invasive fluoroscopy				
	Diagnostic coronary angiography	7 (2–16)	350	2.9	Mettler *et al.*[25]
	PCI	15 (7–57)	750	6.3	Mettler *et al.*[25]
Adult	**Cardiac electrophysiology**				
	Diagnostic EP studies	3.2 (1.3–23.9)	160	1.2	Heidbuchel *et al.*[39]
	Ablation procedure:	15.2 (1.6–59.6)	760	5.7	Heidbuchel *et al.*[39]
	AF	16.6 (6.6–59.2)	830	6.9	Heidbuchel *et al.*[39]
	AT-AVNRT-AVRT	4.4 (1.6–25)	220	1.8	Heidbuchel *et al.*[39]
	VT	12.5 (3 to ≥45)	625	5.2	Heidbuchel *et al.*[39]
	Regular PM or ICD implant	4 (1.4–17)	200	1.6	Heidbuchel *et al.*[39]
	CRT implant	22 (2.2–95)	1100	9.1	Heidbuchel *et al.*[39]
	CT				
	64-slice coronary CTA	15 (3–32)	750 (150–1600)	6.25	Mettler *et al.*[25]
	Calcium score	3 (1–12)	150	1.25	Mettler *et al.*[25]

Picano E et al. The appropriate and justified use of medical radiation in cardiovascular imaging : a position document of the ESC Associations of Cardiovascular Imaging, Percutaneous Cardiovascular Interventions and Electrophysiology. Eur Heart J 2014;35:665-72

Principles of Radiation Protection and Regulations

- ALARA: As low as reasonably achievable
- ALARP: As low as reasonably practicable

Protection From Radiation

- Radiation dose reduction techniques including patient tailored imaging, good operator technique, hardware and software improvements
- Personal protective equipment

Bismuth-containing Radiation-absorbing Drape

Bismuth-containing Radiation-absorbing Drape

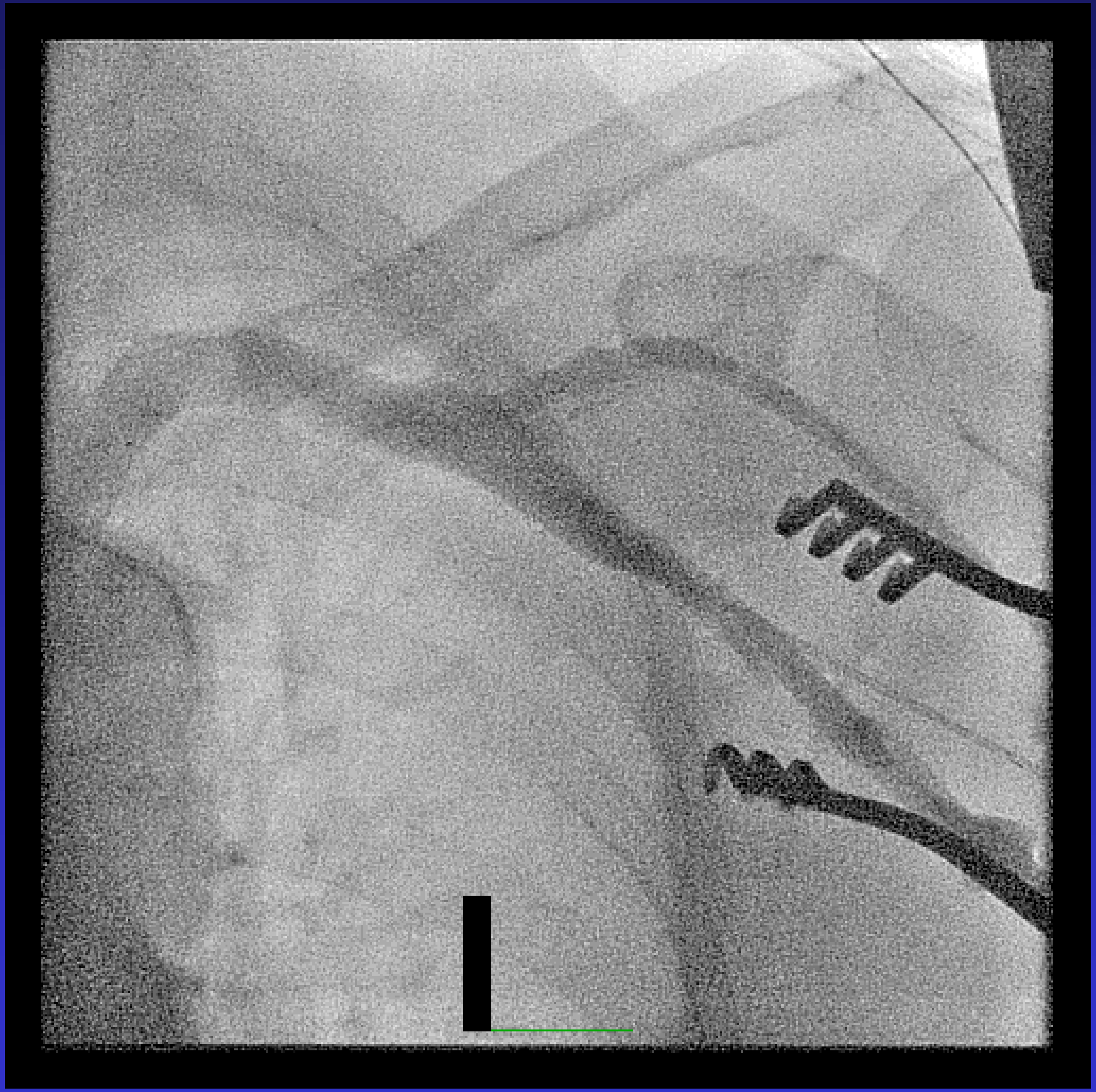
Radiation Doses as Measured at Six Body Locations by TLD

	Mean Dose/DAP Average (SD) (μgy/μGym^2)			
Location	**Radiation-Absorbing Drape**	**Control**	**Difference (%)**	**P Value**
Left hand	0.0362 (0.0461)	0.1027 (0.0655)	65	0.0008
Right hand	0.0374 (0.0461)	0.0991 (0.1212)	62	0.0003
Left eye	0.0006 (0.0036)	0.0008 (0.0085)	27	0.42
Right eye	0.0107 (0.0126)	0.0175 (0.0190)	39	0.002
Body	0.0267 (0.0241)	0.0761 (0.0561)	65	0.0004
Right foot	0.0512 (0.0314)	0.0539 (0.0259)	5	0.49

SD = standard deviation; TLD = thermoluminescent dosimeter.

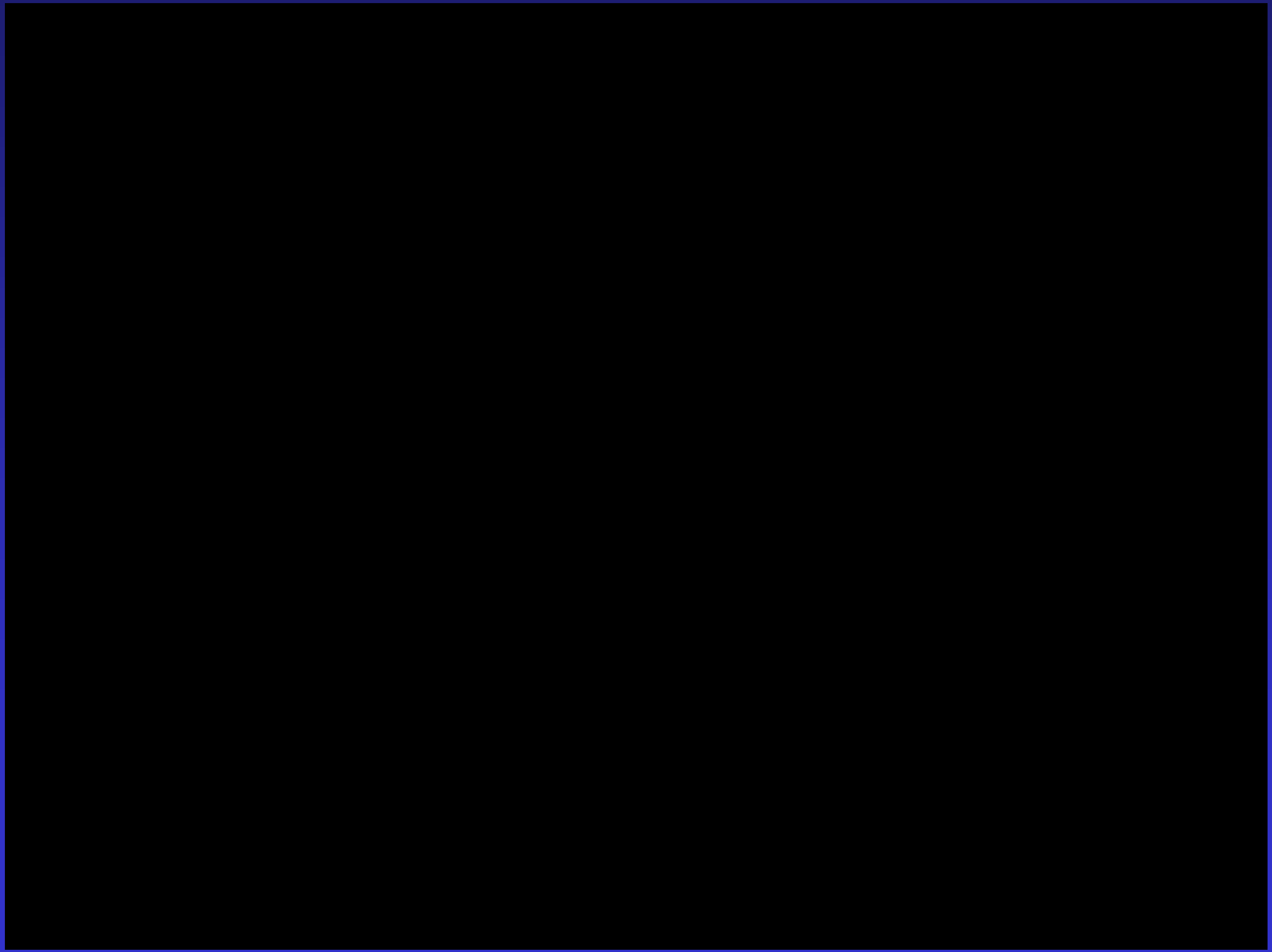
Jones MA et al. The benefits of using a bismuth-containing, radiation-absorbing drape in cardiac resynchronization implant procedures. PACE 2014;37(7):828-33

Contrast Venography-guided Axillary Vein Puncture



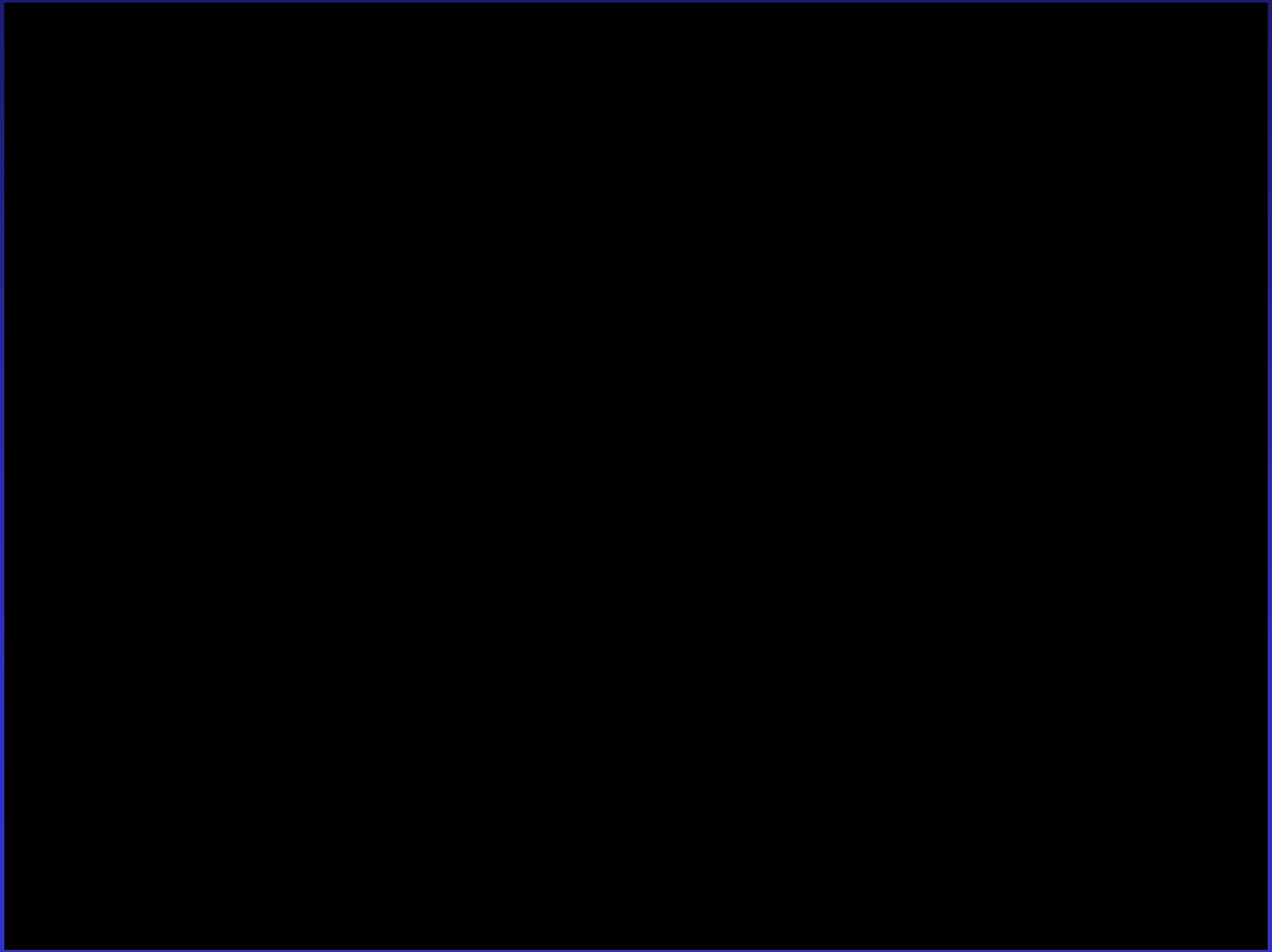
Chan NY et al. Venous access and long-term pacemaker lead failure: comparing contrast-guided axillary vein puncture with subclavian puncture and cephalic cutdown. Europace 2017;19(7):1193-7

USG-guided Axillary Vein Puncture



USG-guided Axillary Vein Puncture

USG-guided Axillary Vein Puncture



USG-guided vs Fluoroscopic-guided Axillary Vein Puncture

Success rates: 92 vs 91% (USG vs fluoroscopy groups)
No acute or long-term complication in both groups

	USAA (n = 49)	AVA using fluoroscopic landmarks (n = 46)	*P* value
Total procedure time, minute	48 (40-70)	49 (40-60)	.55
Air-Kerma,(mGy)	11 (8-20)	37 (24-81)	<.00001
DAP, Gy-cm^2	3 (2-5)	10 (6-16)	<.00001
Fluoroscopy time, second	97 (62-163)	271 (185-365)	<.00001
X-rays emission time, second	7 (4-10)	21 (13-39)	<.00001

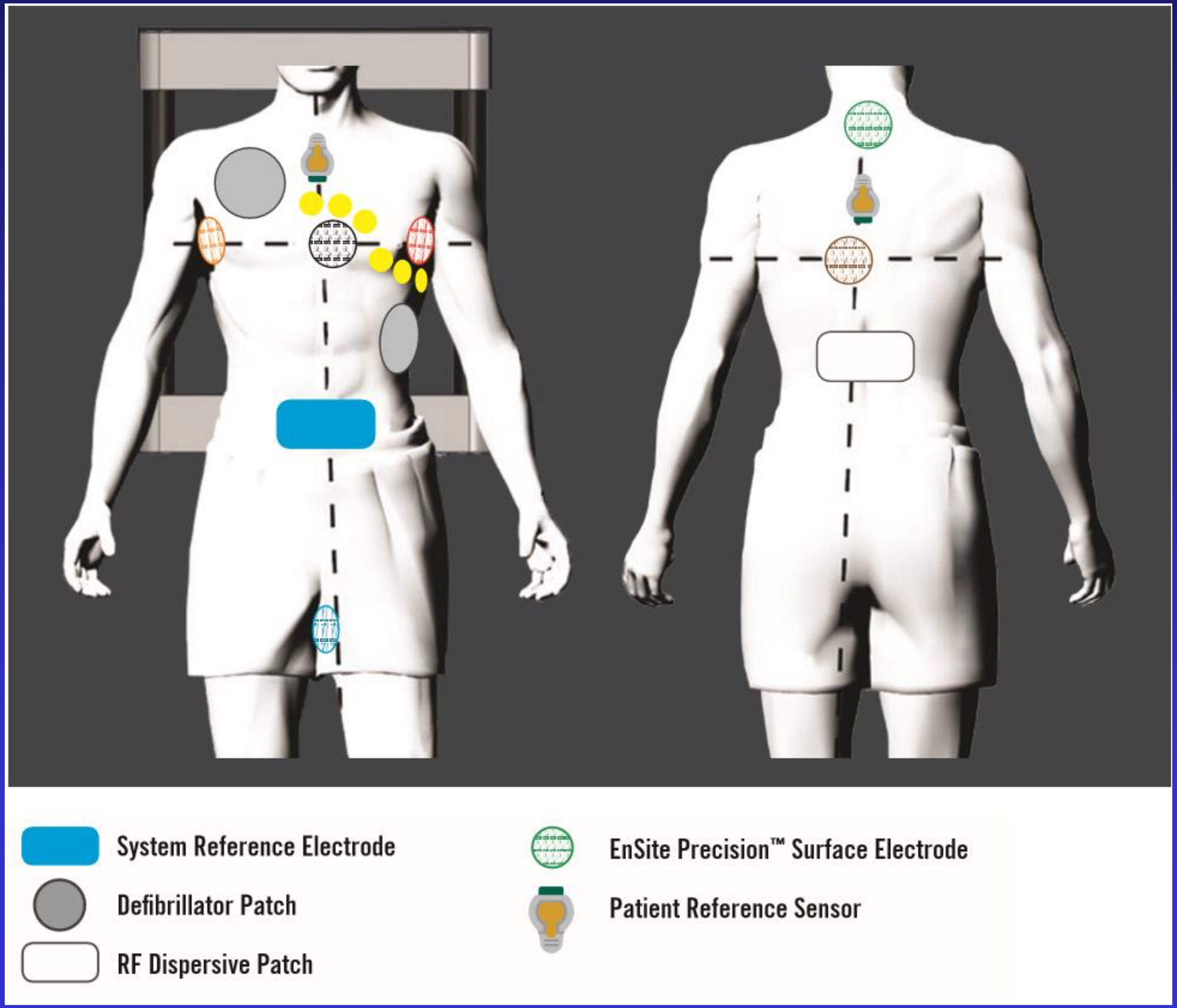
Abbreviation: DAP, dose-area product.

Migliore F et al. Axillary vein access for permanent pacemaker and implantable cardioverter defibrillator implantation: fluoroscopy compared to ultrasound. PACE 2020;43:566-572

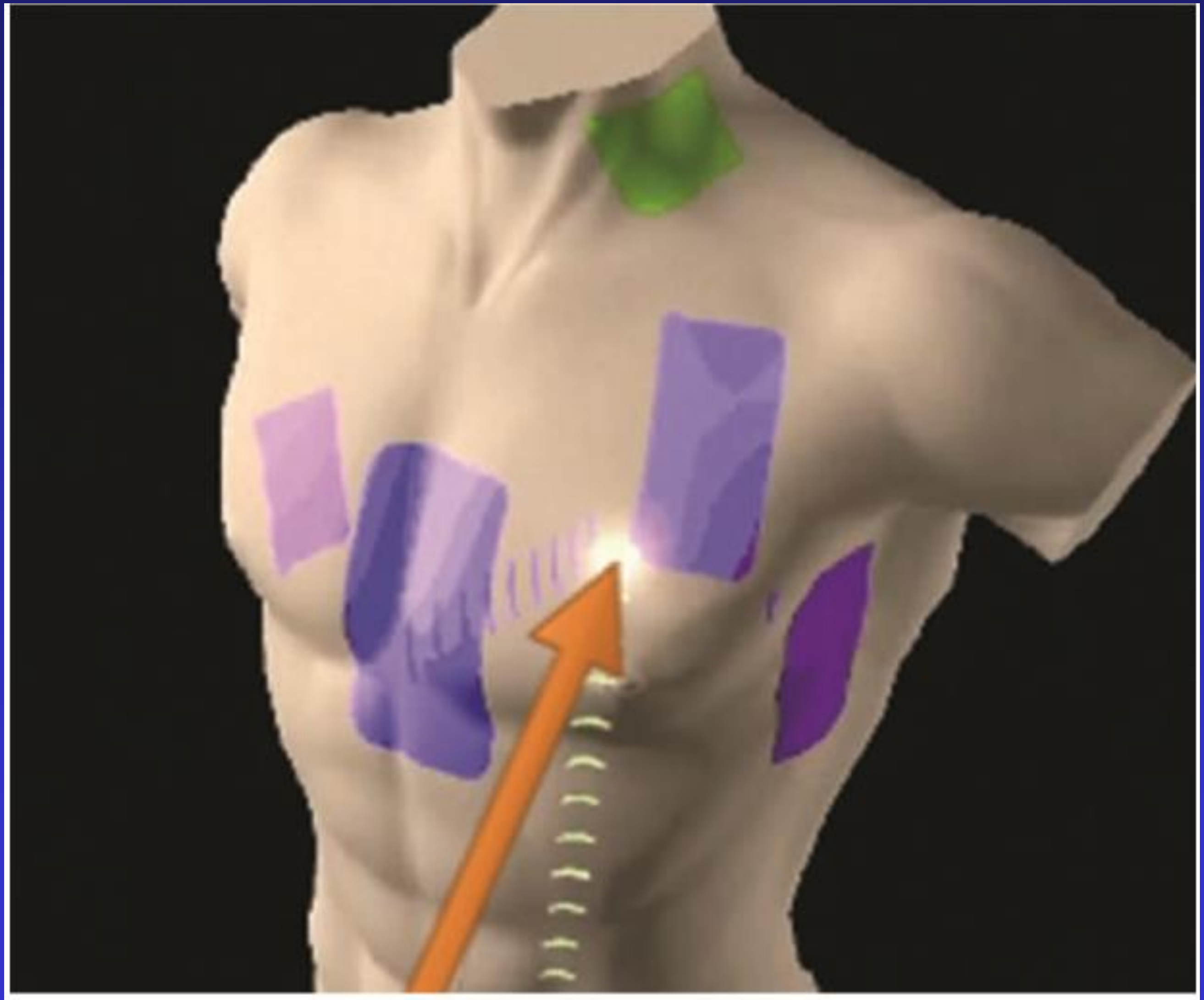
Ensite-guided EP Catheter Placement

Ensite-guided Catheter Ablation

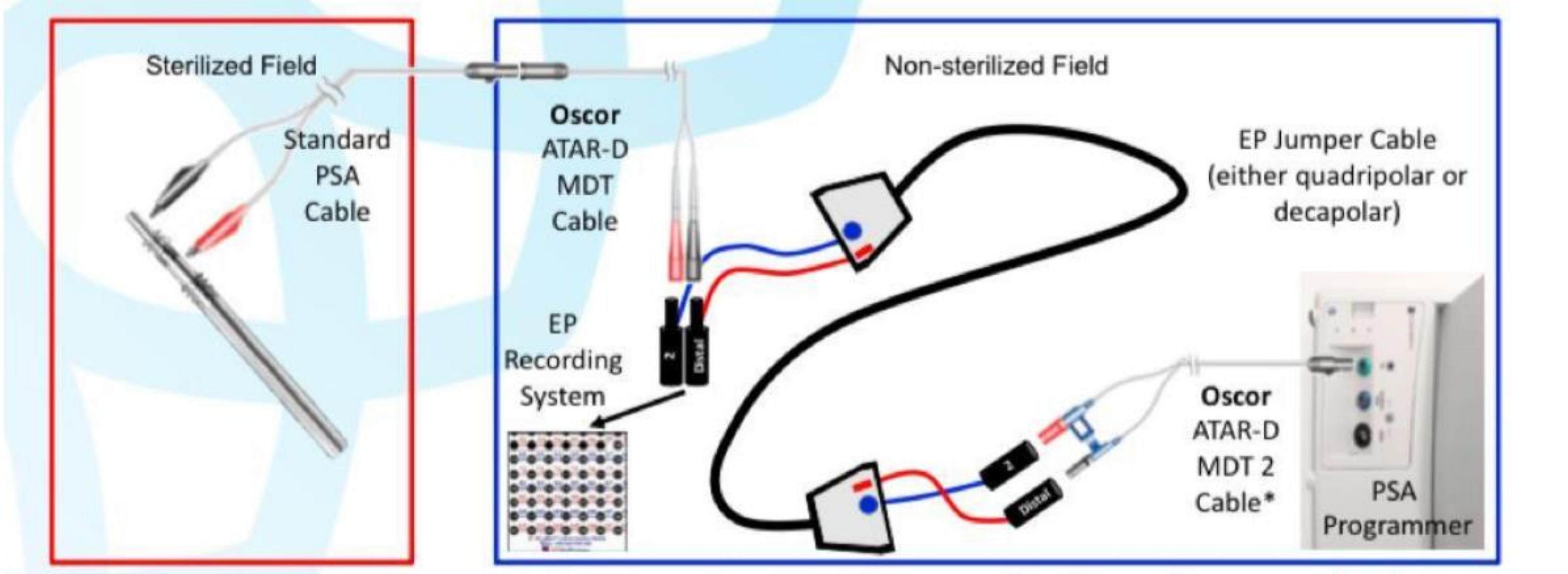
Catheter Localization by Ensite NavX Technology



Catheter Localization by Ensite NavX Technology



Cable Connection for 3D Mapping-guided CIED Implantation



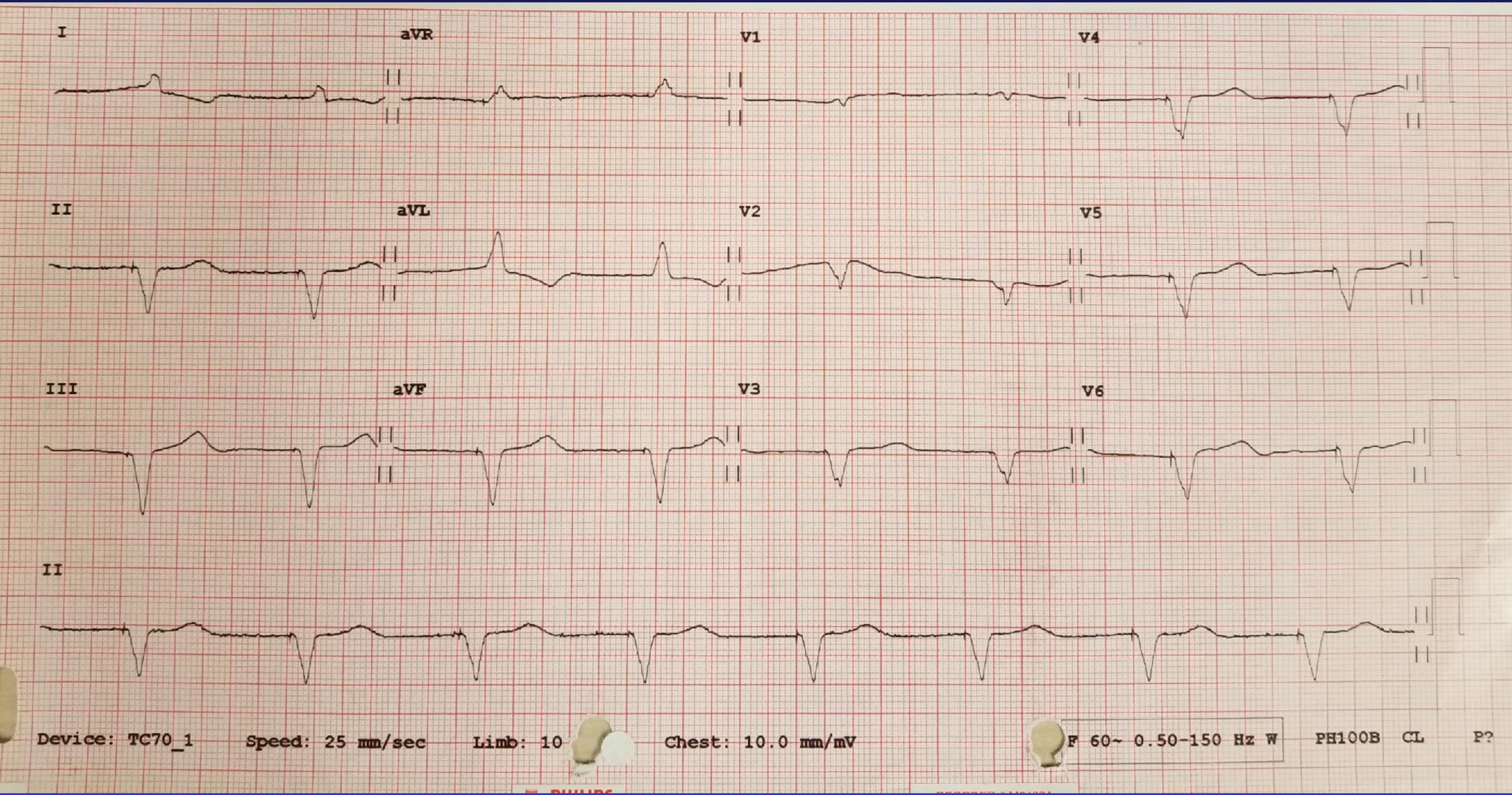
1st Patient

- F/53
- SSS s/p DDDR pacing in 2000

  Developed AF and right MCA infarct in 2011

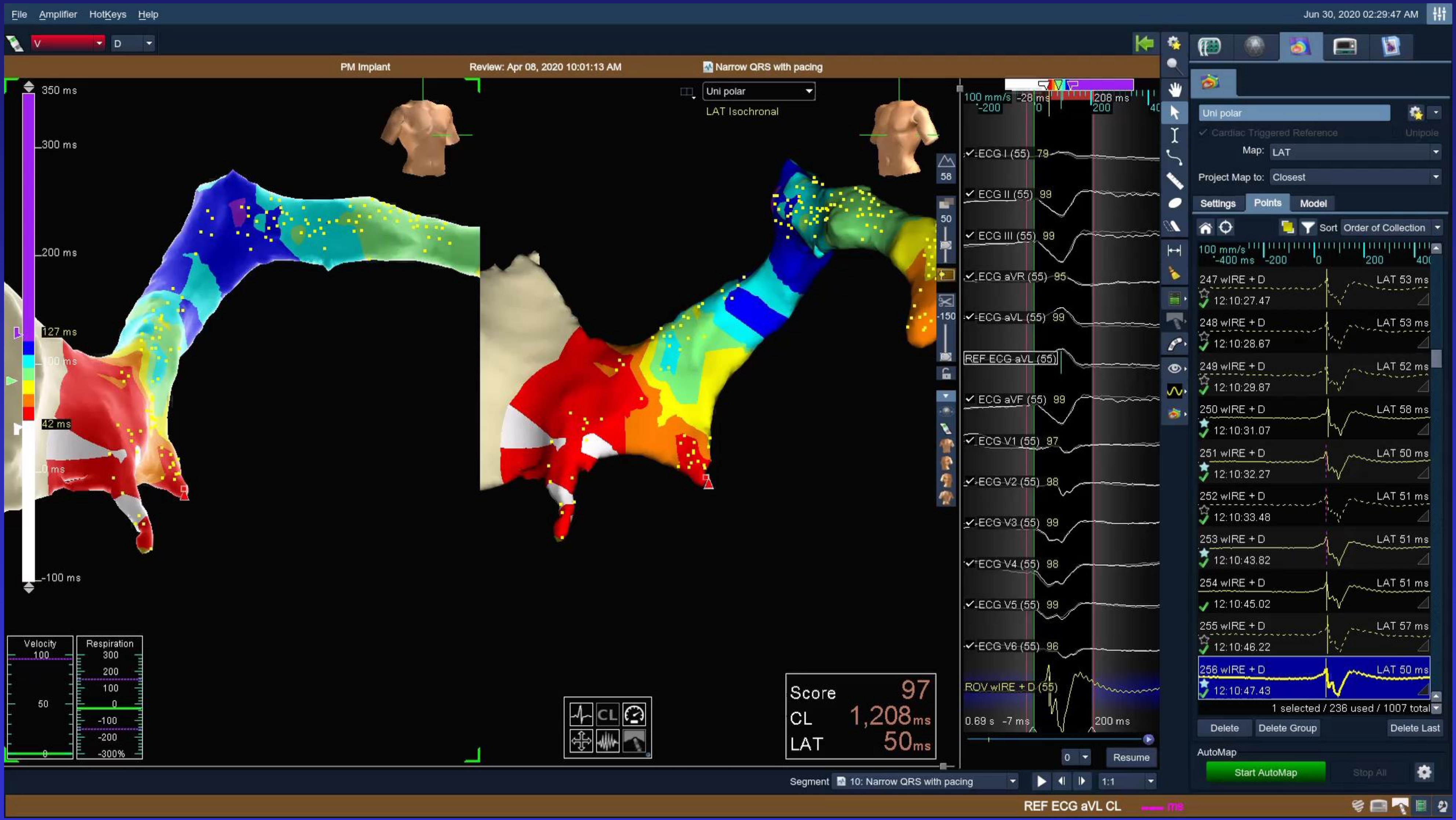
  Menorrhagia and diverticulosis with Fe def anaemia

  Pancytopenia pending workup
- Recurrent heart failure hospitalization since January this year
- Echo: Dilated RA, RV, severe TR; severe impairment in LV systolic function

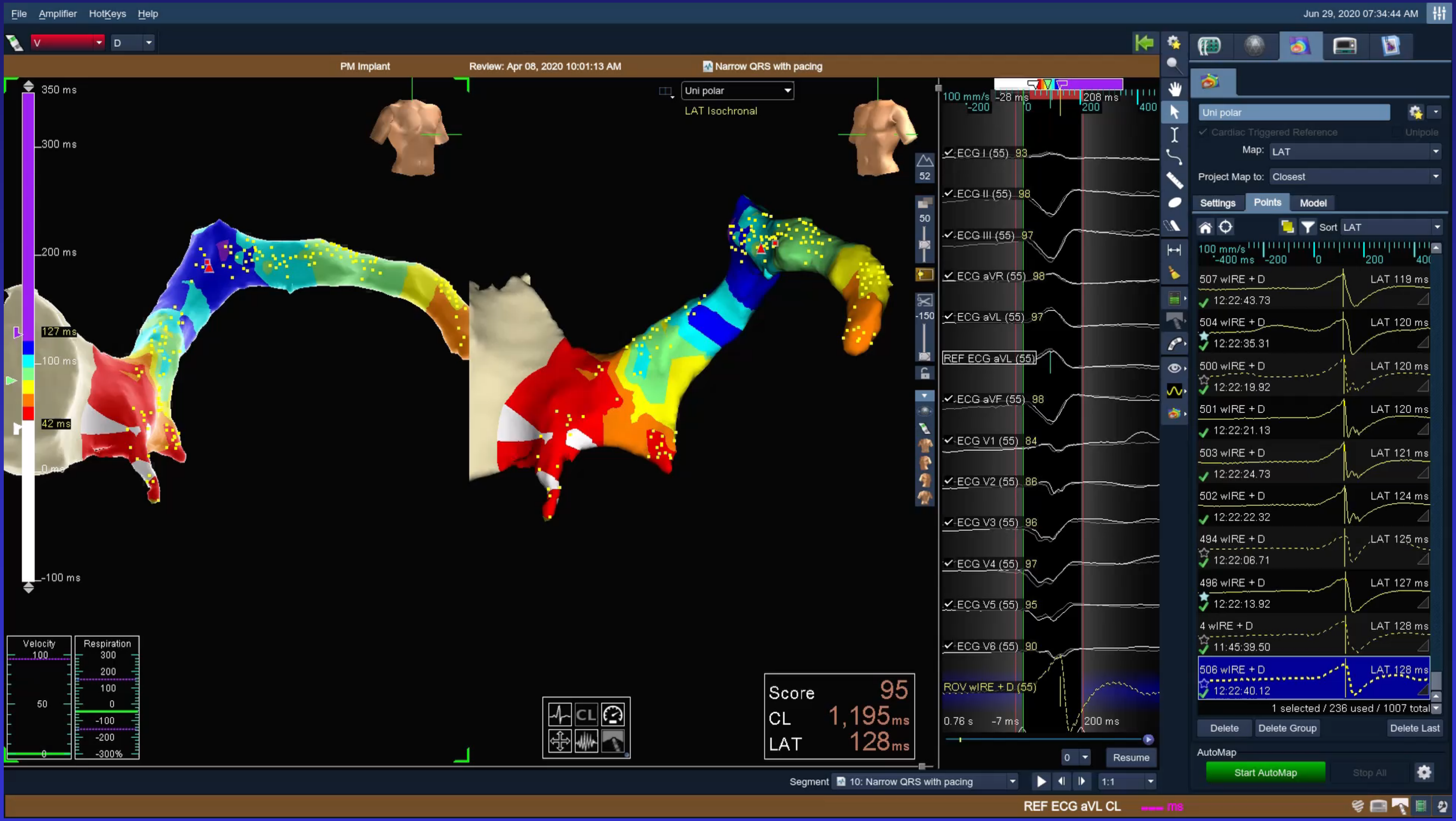

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
Device: TC70_1
Speed: 25 mm/sec
Limb: 10
Chest: 10.0 mm/mV
F 60~ 0.50-150 Hz W
PH100B
CL
P?

Guidewire Mapping of Cardiac Veins

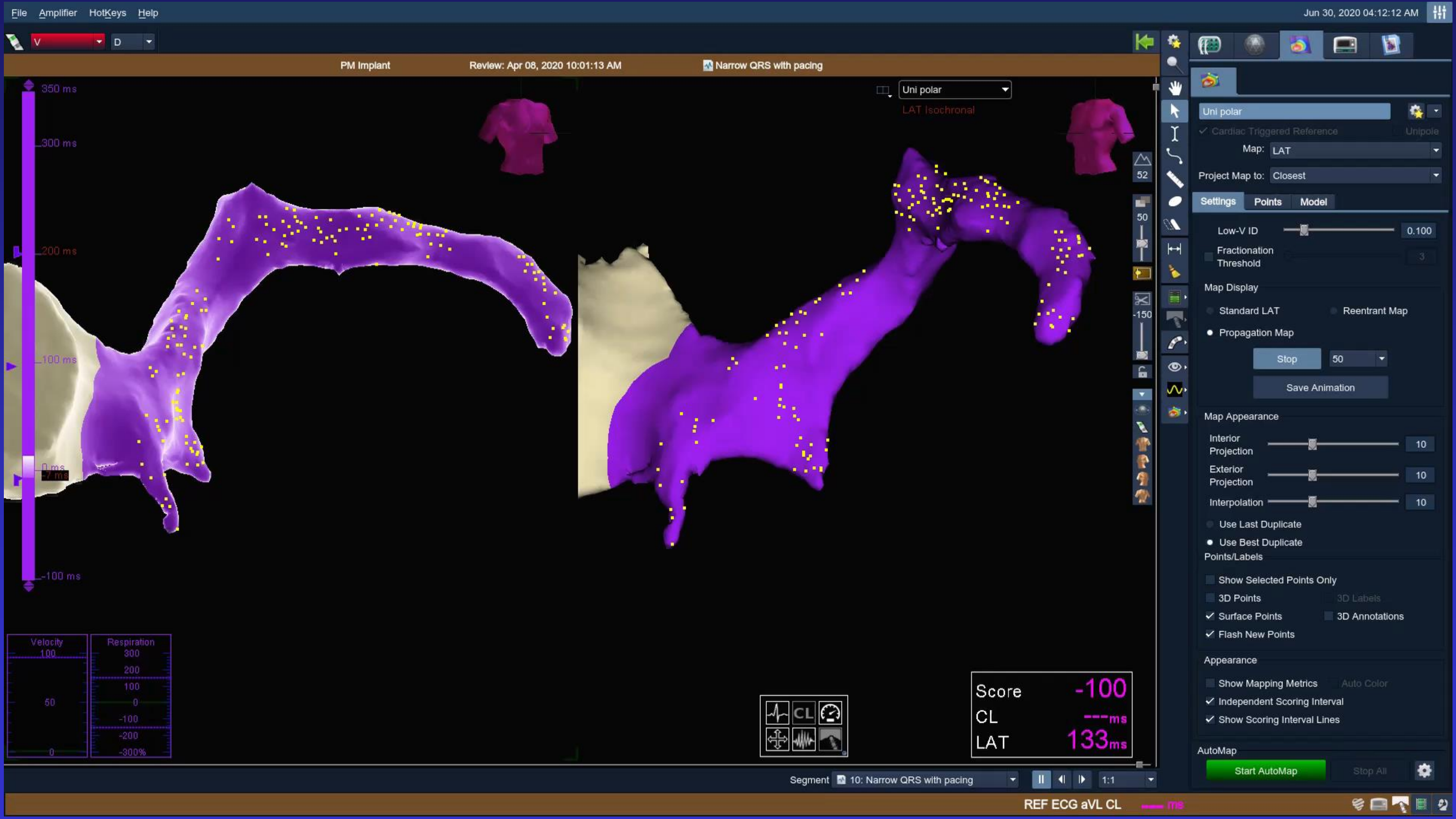
Activation Time of Posterolateral Cardiac Vein

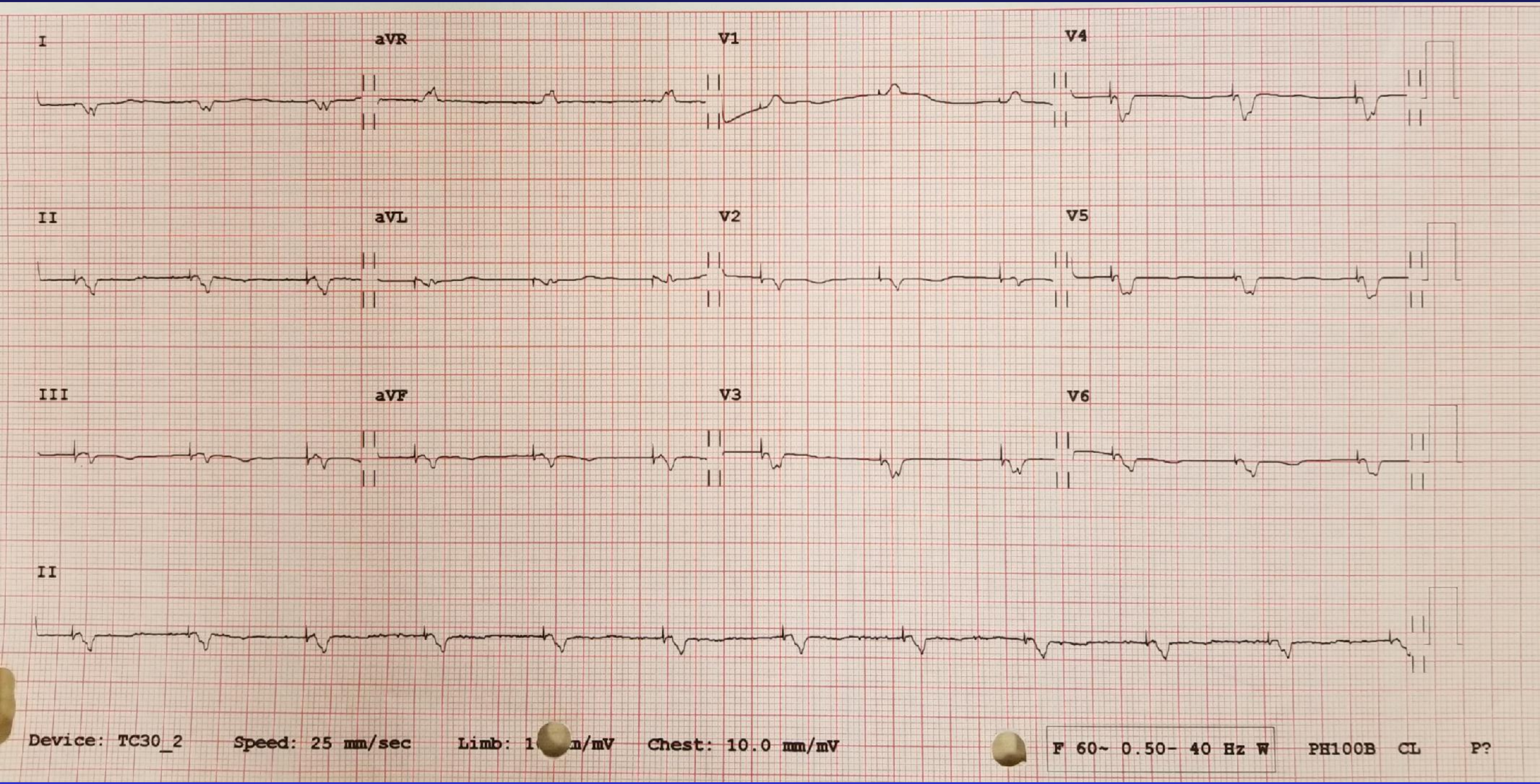


Activation Time of Anterior Cardiac Vein



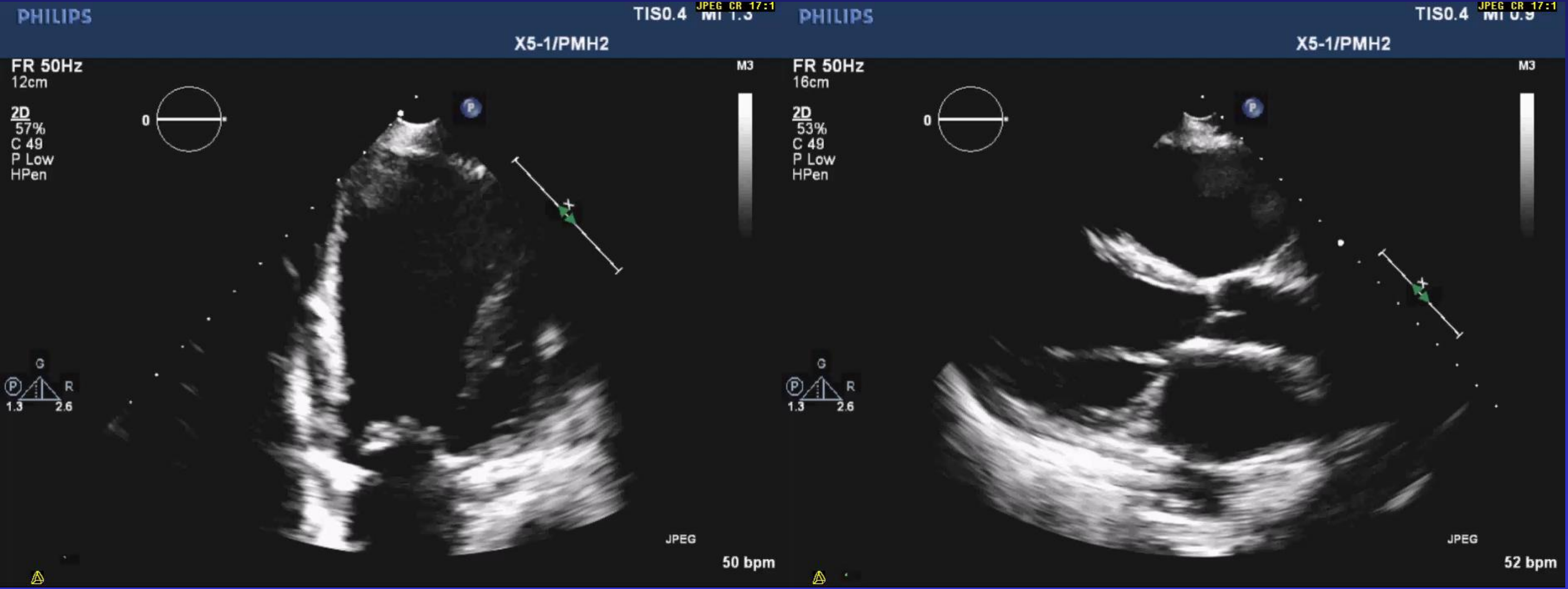
Propagation Map



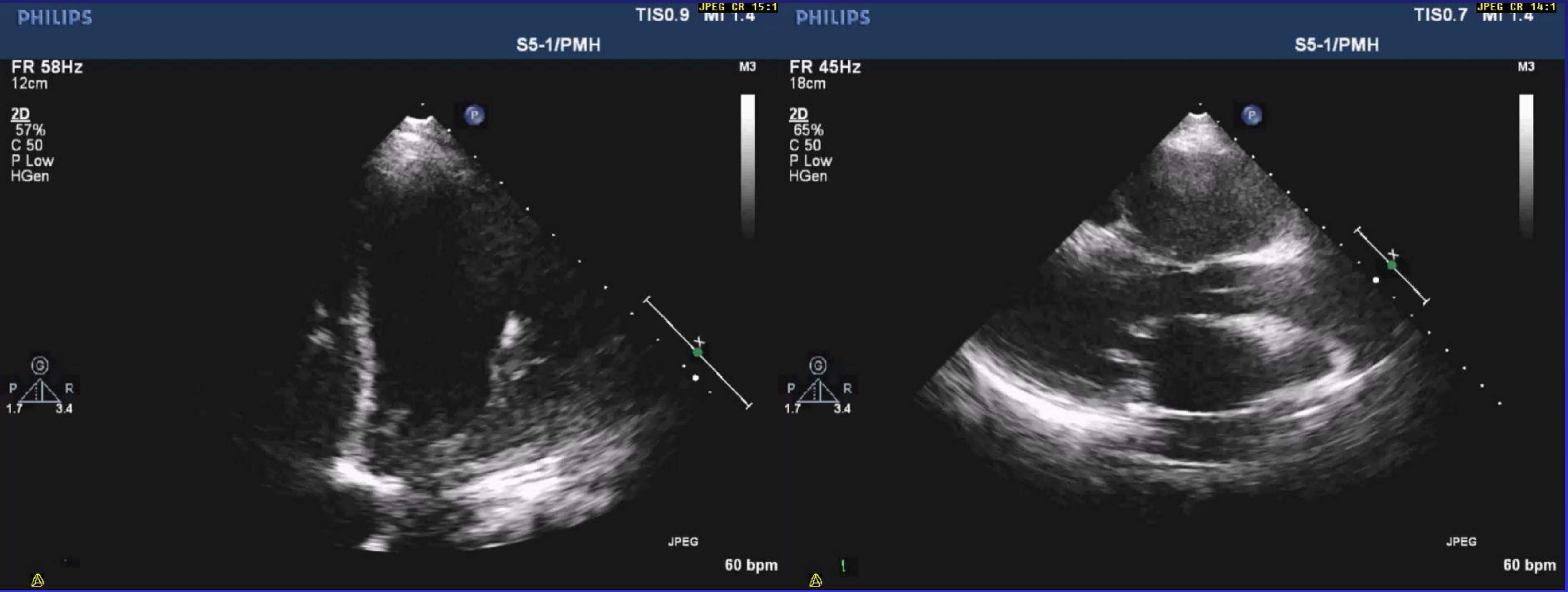


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
Device: TC30_2
Speed: 25 mm/sec
Limb: 1 m/mV
Chest: 10.0 mm/mV
F 60~ 0.50- 40 Hz W
PH100B
CL
P?

RV Pacing-induced Cardiomyopathy



Reverse Remodelling of LV After Ensite-guided CRT



ESC Guidelines on CRT Optimization

Recommendations	Class [a]	Level [b]	Ref. [c]
1) The goal of CRT should be to achieve BiV pacing as close to 100% as possible since the survival benefit and reduction in hospitalization are strongly associated with an increasing percentage of BiV pacing.	IIa	B	67–69
2) Apical position of the LV lead should be avoided when possible.	IIa	B	70–72
3) LV lead placement may be targeted at the latest activated LV segment.	IIb	B	73

Brignole M et al. 2013 ESC guidelines on cardiac pacing and cardiac resynchronization therapy. European Heart Journal 2013;34:2281-2329

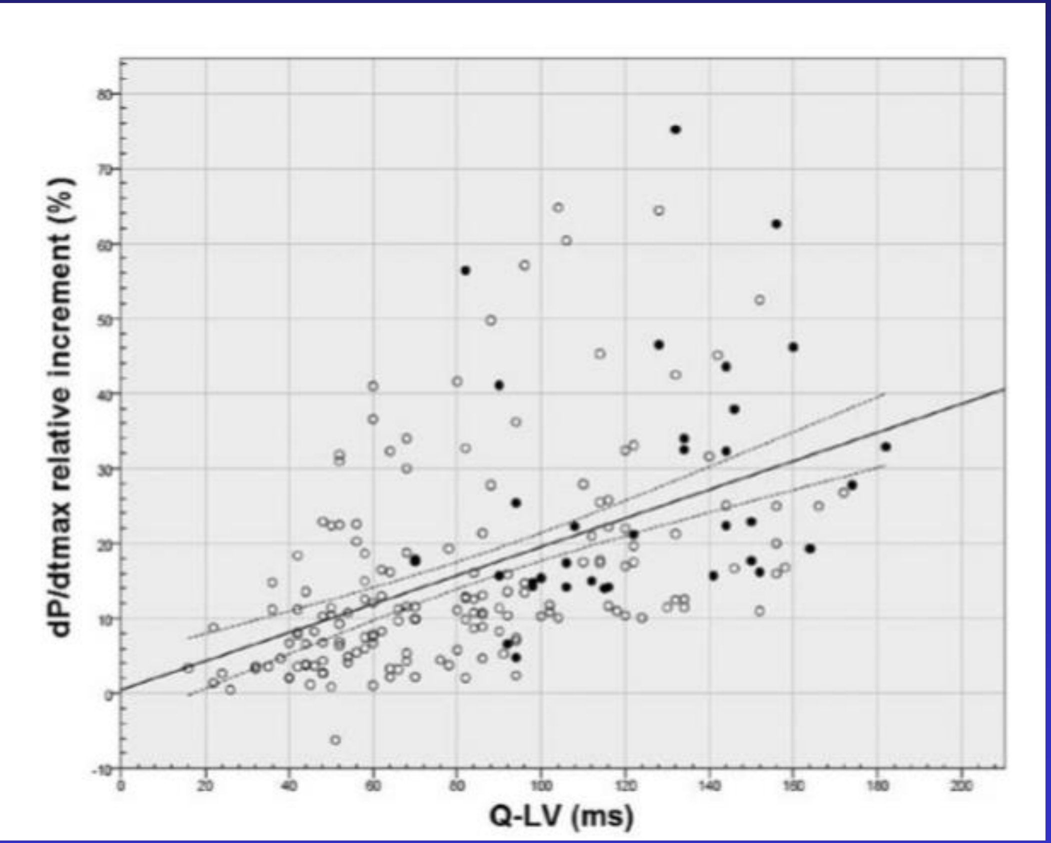
Q-LV Interval and Acute Haemodynamics in CRT

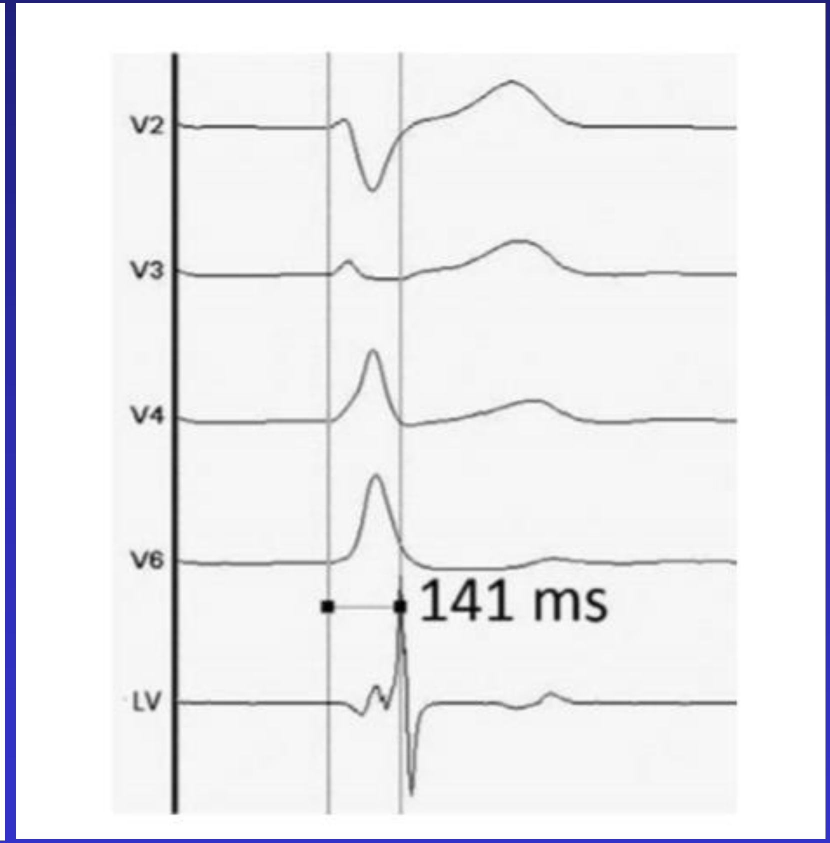
N=32 patients underwent CRT

All available cardiac veins tested, Q-LV interval measured at each pacing site, LV dP/dt_{max} measured at baseline and during pacing

In 31 out of 32 patients, highest LV dP/dt_{max} correlated with maximum Q-LV interval

Q-LV interval >95ms corresponded to >10% ↑ in LV dP/dt_{max}





Zanon F et al. Determination of the longest intrapatient left ventricular electrical delay may predict acute hemodynamic improvement in patients after cardiac resynchronization therapy. Circ Arrhythm Electrophysiol 2014;7:377-83)

LV Lead Location and CRT Response

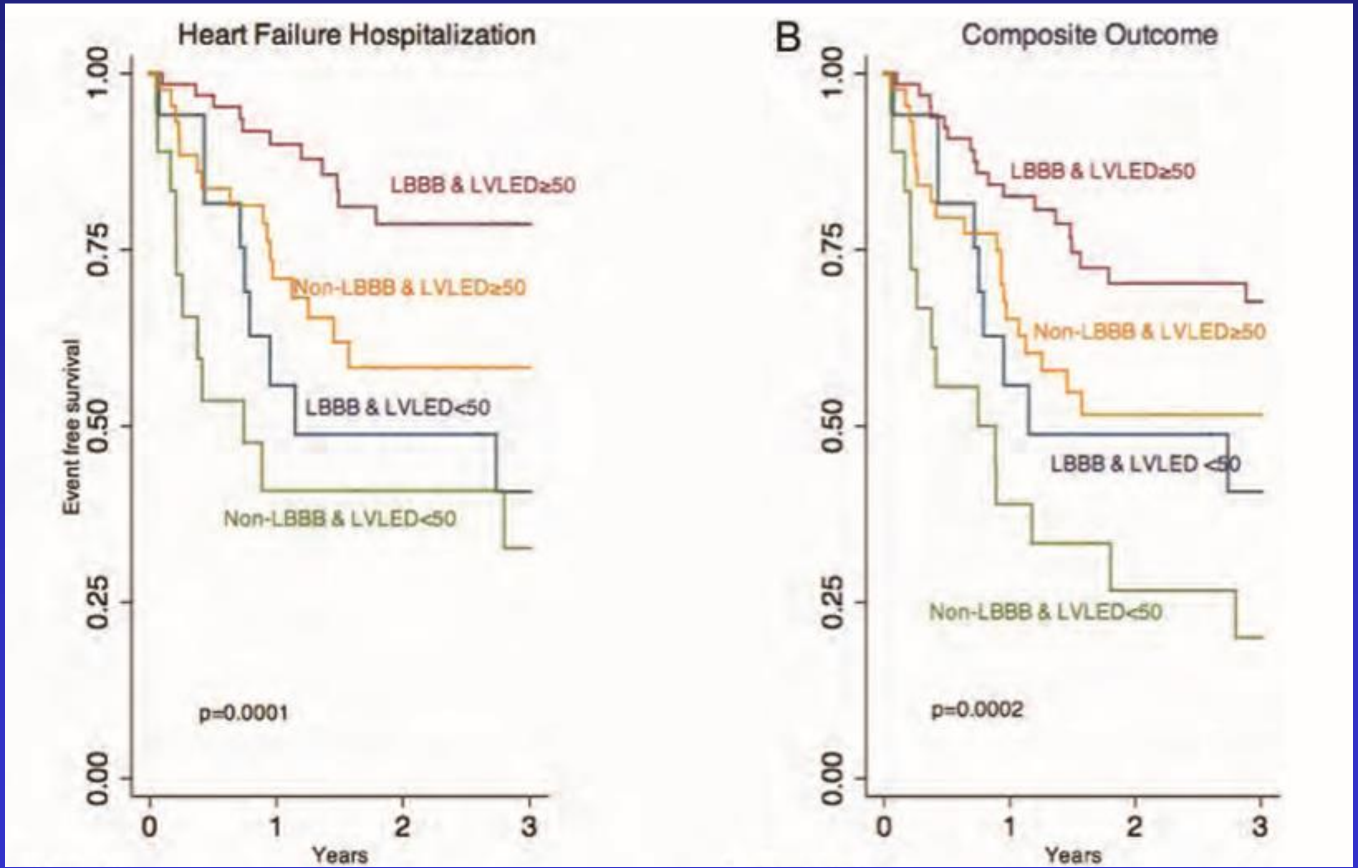
N=144 patients underwent CRT

Left ventricular lead electrical delay (LVLED)=interval between QRS onset on ECG to the peak of sensed LV electrogram and corrected for QRS width

Time to 1st heart failure hospitalization

Composite outcome of all-cause mortality, HFH, LVAD implantation and cardiac transplantation at 3 years

Cox regression model, long LVLED predicts improved outcome



Kandala J et al. QRS morphology, left ventricular lead location, and clinical outcome in patients receiving cardiac resynchronization therapy. Eur Heart J 2013;34:2252-62

Ensite NavX-guided CRT Implantation

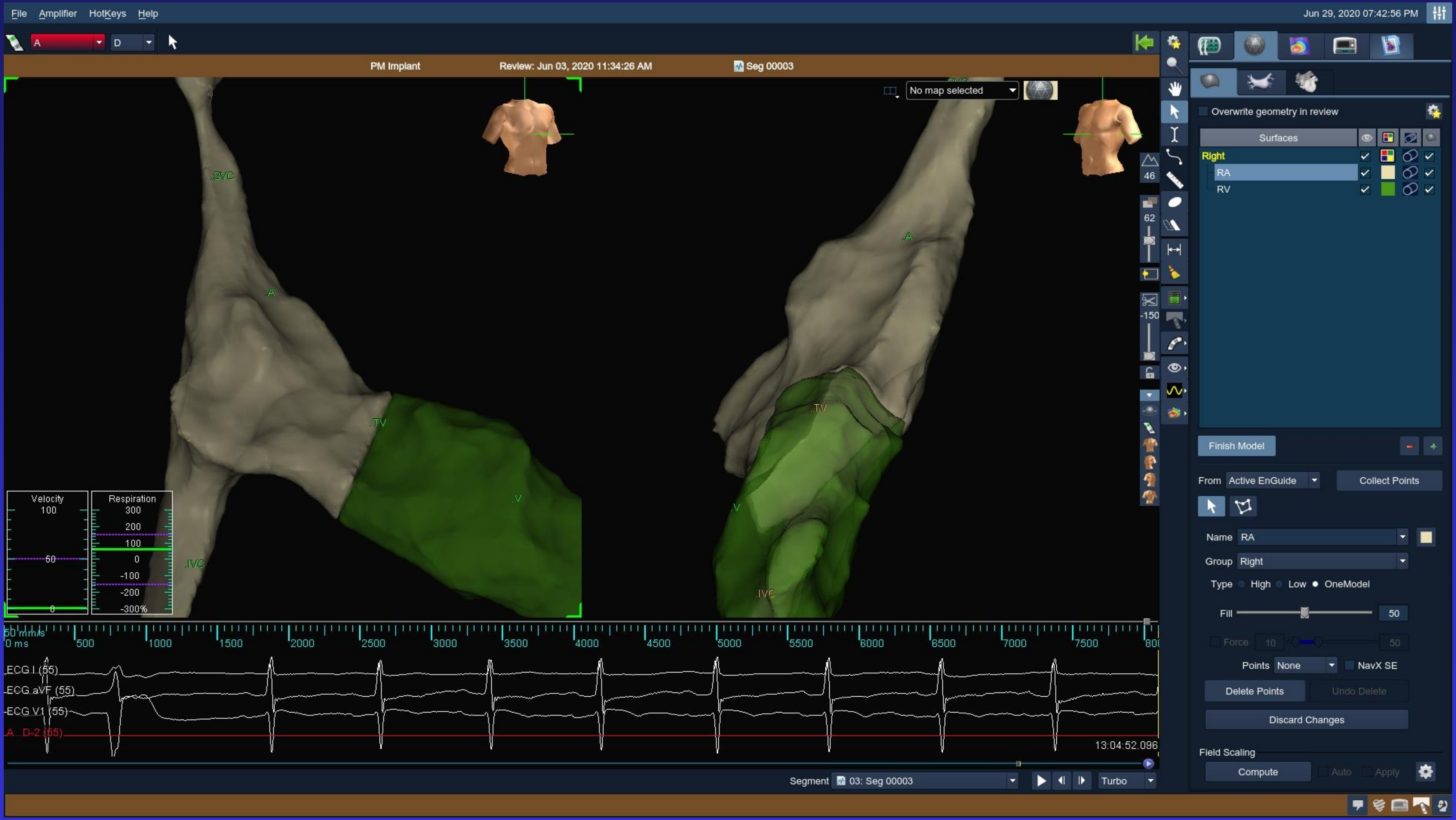
	Ensite-guided group (n=125)	Conventional group (n=250)	P-value
LV lead placement success rate	122 (98%)	242 (97%)	0.76
Median fluoroscopic time (minutes)	4.1 (0.3-10.4)	16 (11-26)	<0.001
CS angiography	33 (26%)	208 (83%)	<0.001
Complication rate	5 (4%)	17 (7%)	0.28

Greco MD et al. Three-dimensional electroanatomic mapping system-enhanced cardiac resynchronization therapy device implantation: results from a multicenter registry. J Cardiovasc Electrophysiol 2017;28:85-93

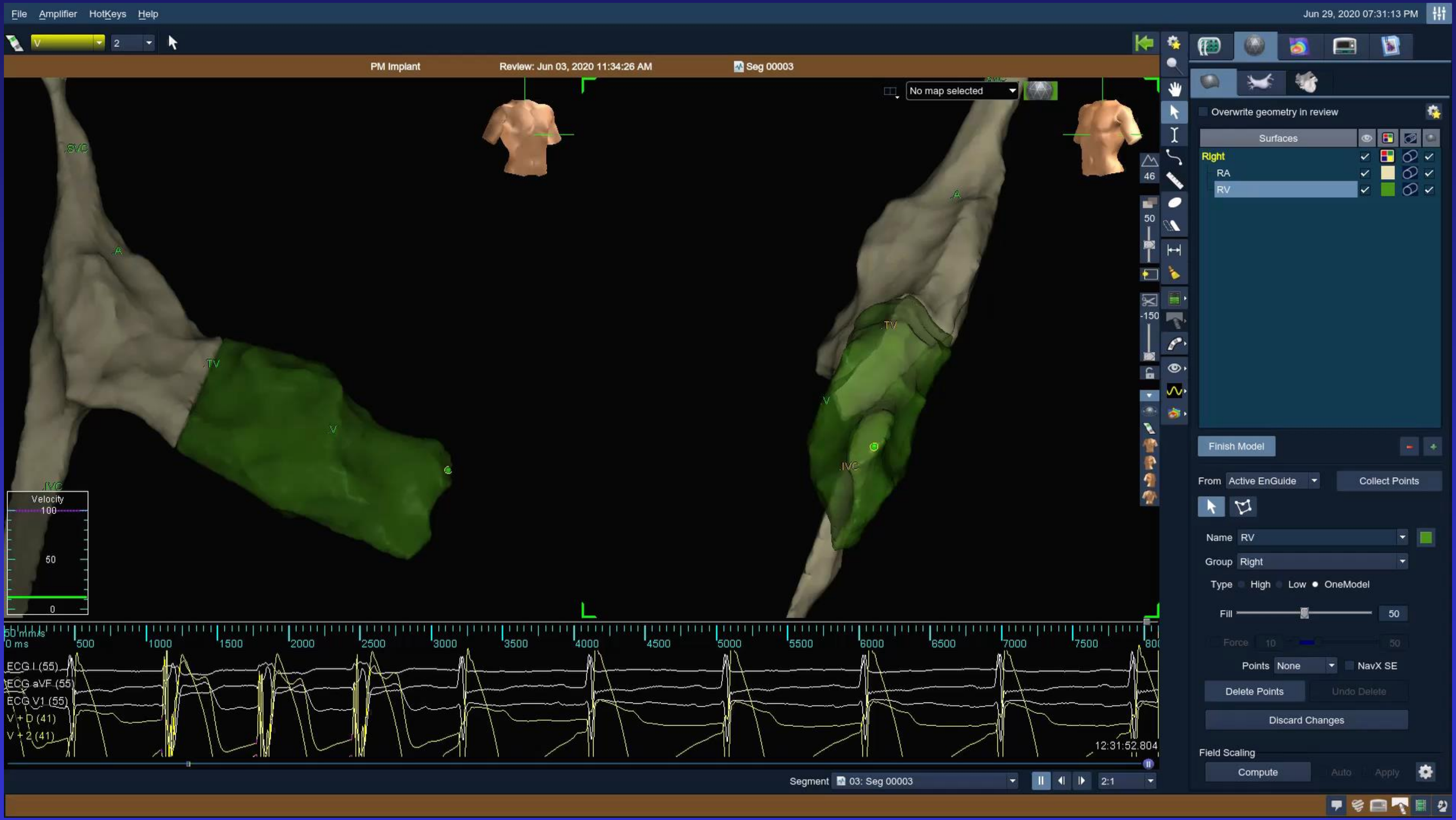
2^{nd} Patient

- F/83
- History of HT, DM, hyperlipidaemia, right basal ganglia infarct and bilateral DMR
- Presented with syncope
- ECG showed 2 to 1 AVB

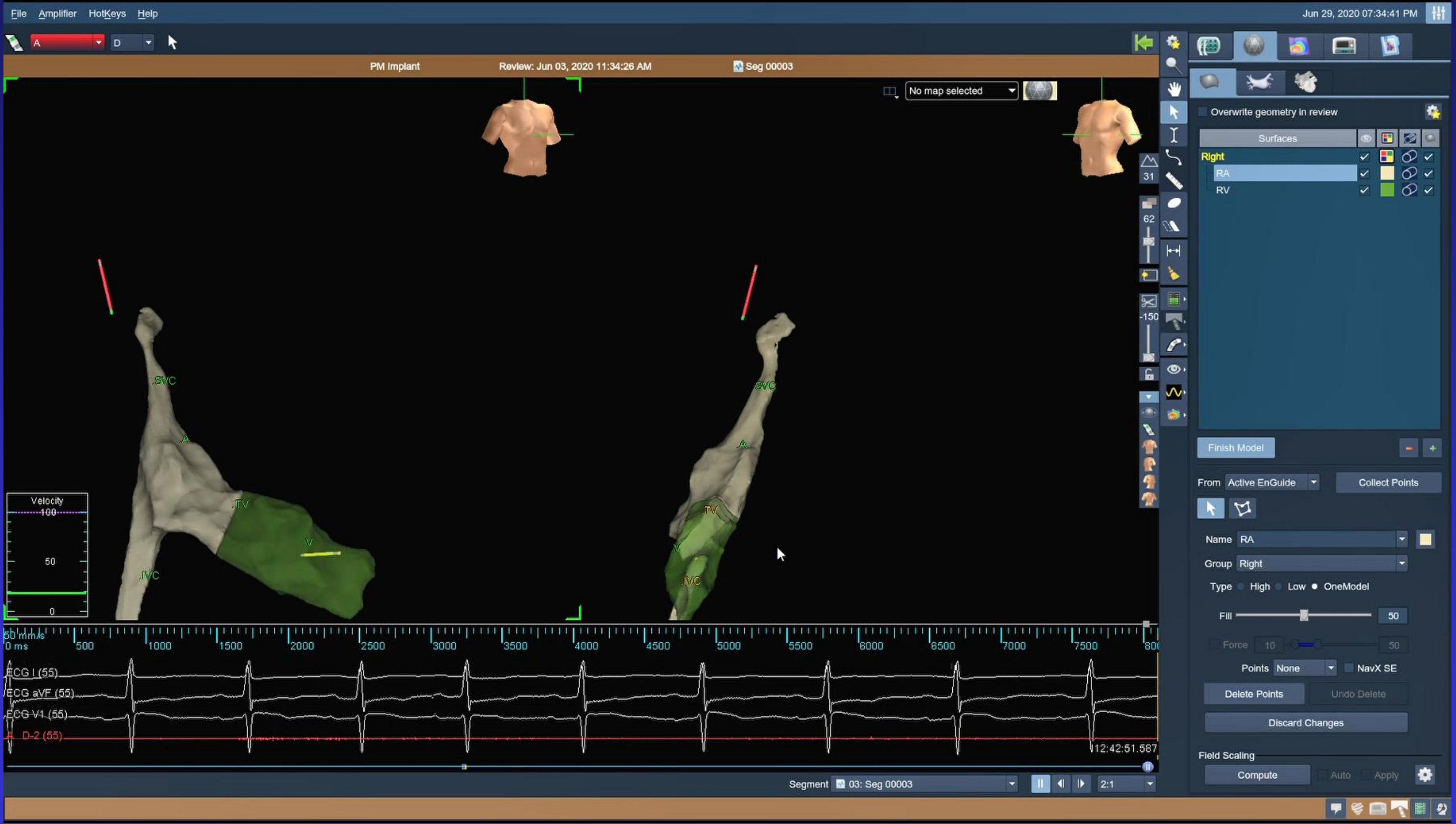
RA and RV Geometry



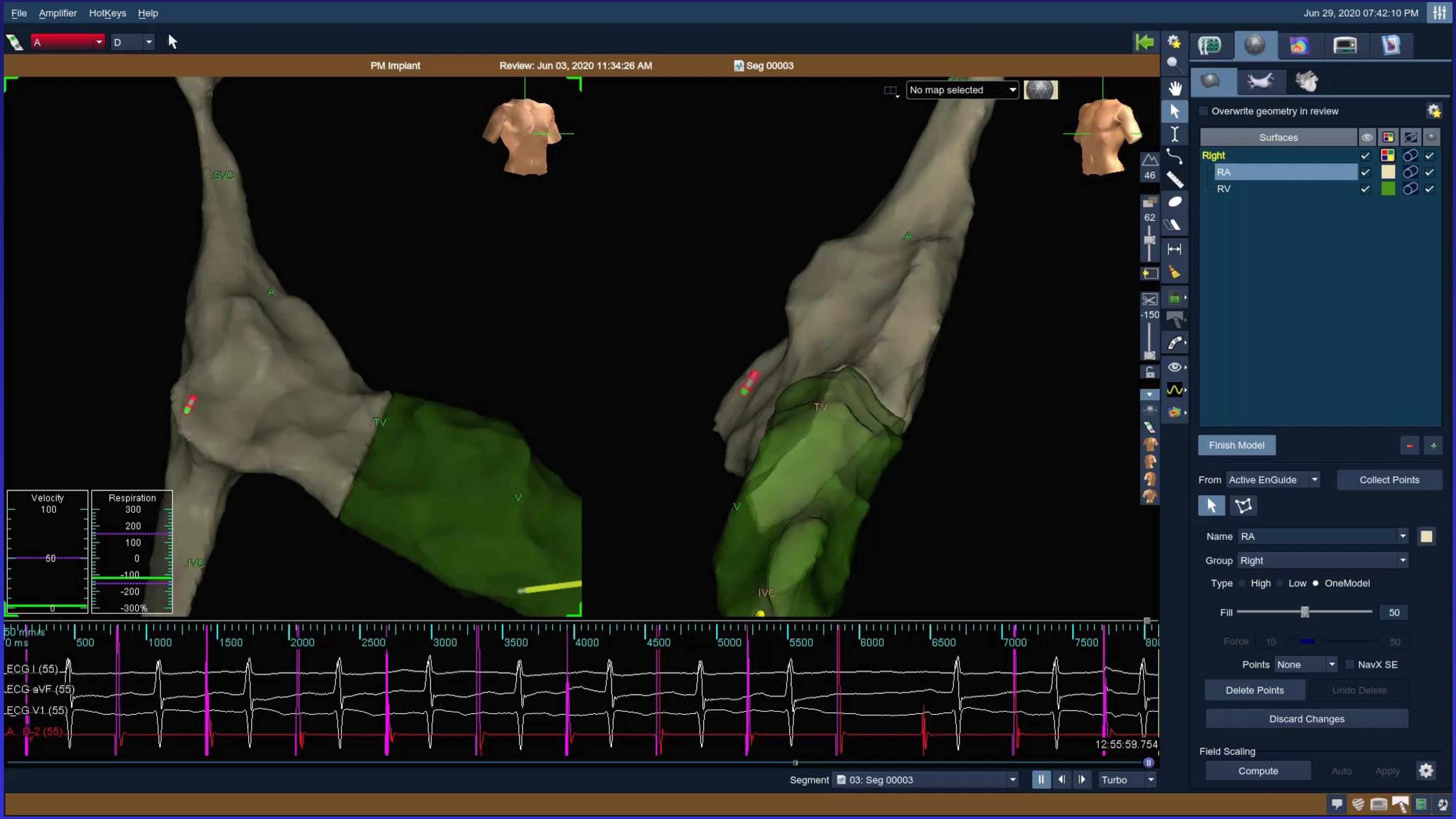
Ensite-guided RV Lead Placement

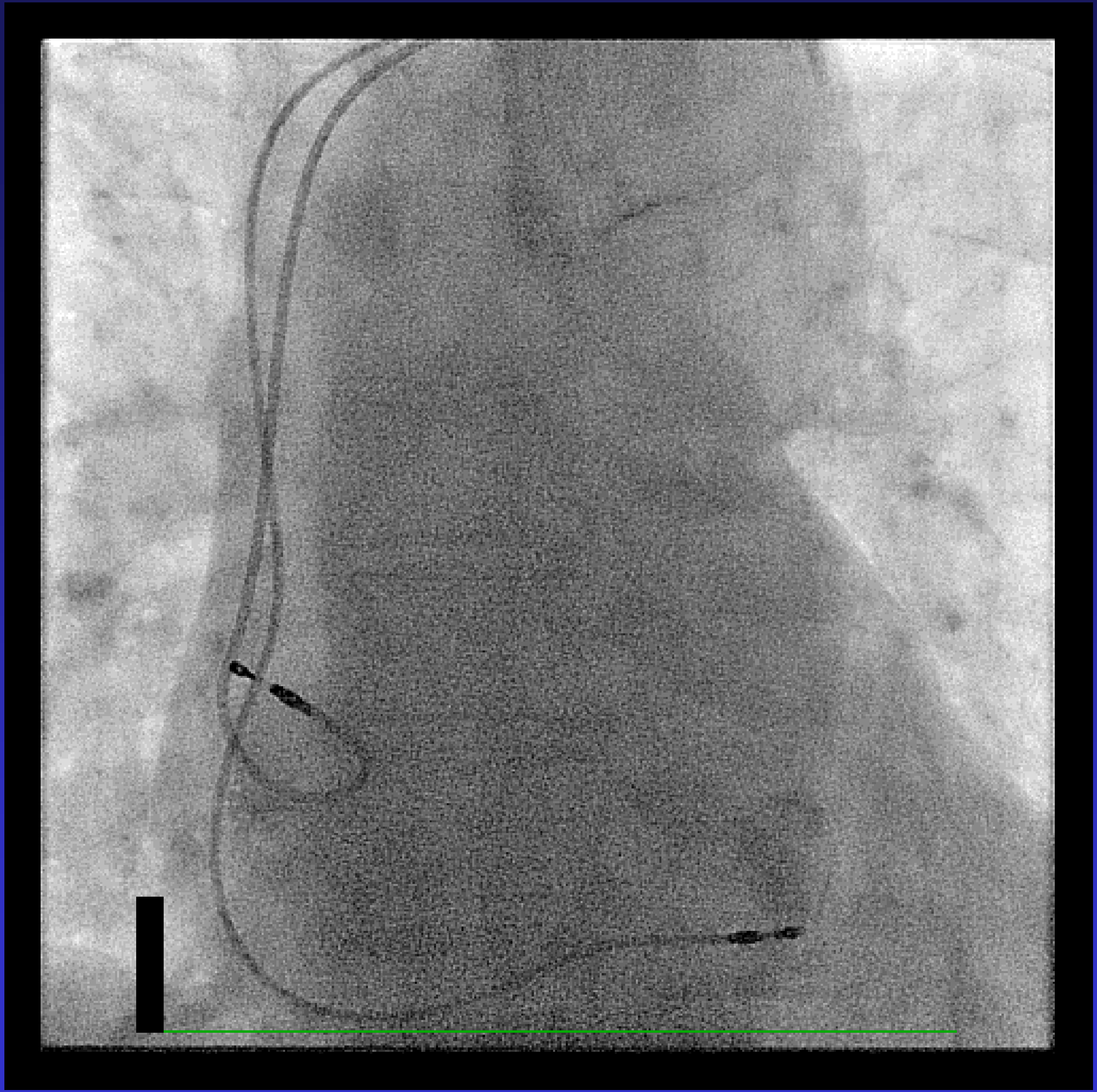


RA Lead Advancement



RA Lead Placement in RAA





Ensite-guided Pacemaker Implantation

Study (Author, year)	Design	Sample size (zero-fluoroscopy group)	Female (no. of patients)	Mean age (years)	Indications				Method	Follow-up time	Complication				Pacemaker type	Fluoroscopy time	Radiation exposure
					advanced AVB	SSS	VT	Other			Lead dislodgment	Infection	Malfunction	Other			
Jesus, 1992	Pros	20	6 (30%)	71.9 (±2.1)	17	2	0	1	TTE	n/a	1	0	0	0	TP	n/a	n/a
Ruiz-Granell, 2008	Retro	15	9 (60%)	72 (±13)	15	0	0	0	EnSite NavX	3 months	1	0	0	0	Single-chamber PM	n/a	n/a
Pinneri, 2013	Retro	53	23 (43%)	77 (±12)	41	9	0	3	TTE	24 h	0	0	4	2	TP	n/a	n/a
Castrejón-Castrejón, 2013	Retro	35	6 (17%)	63 (±16)	0	0	35	0	EnSite NavX	7-27 months	0	1	0	2	Single- and dual-chamber ICD		
	n/a	n/a															
Silver, 2015	Retro	19	5 (26%)	15(±4)	7	1	10	1	Ensite Velocity	n/a	1	0	0	0	PM, ICD	3.2 min (range 0.1-10.5)	6 mGy (range 1-244)
Ferri, 2016	Pros	113	51 (45%)	80	93	5	4	11	TTE	n/a	0	3	10	4	TP	n/a	n/a
Colella, 2016	Retro	26	8 (31%)	72 (±11)	0	0	0	26	EnSite Velocity	6 months	1	0	0	1	CRT-D and CRT-P	0 min (range 0-1.5)	n/a
Del Greco, 2017	Retro	125	25 (20%)	74	0	0	0	125	EnSite NavX	n/a	4	0	0	1	CRT-D and CRT-P	4.1 min (range 0.3-10.4)	n/a
Silvetti, 2018	Pros	11	8 (73%)	11.1 (±4.5)	11	0	0	0	EnSite Velocity	17 months	1	0	0	0	Single and dual chamber PM	n/a	0.3 mGy (range 0.0-1.0)
Guo, 2018	Retro	6	4 (67%)	50	4	1	0	1	EnSite NavX	6 months	0	0	0	0	Single and dual chamber PM	0	0
Patel, 2019	Retro	18	4 (22%)	n/a	0	0	16	2	EnSite Precision	4-6 weeks	0	0	0	0	Single chamber ICD, dual chamber PM	4.5 s	0.03 $\mu Gy \cdot m^2$

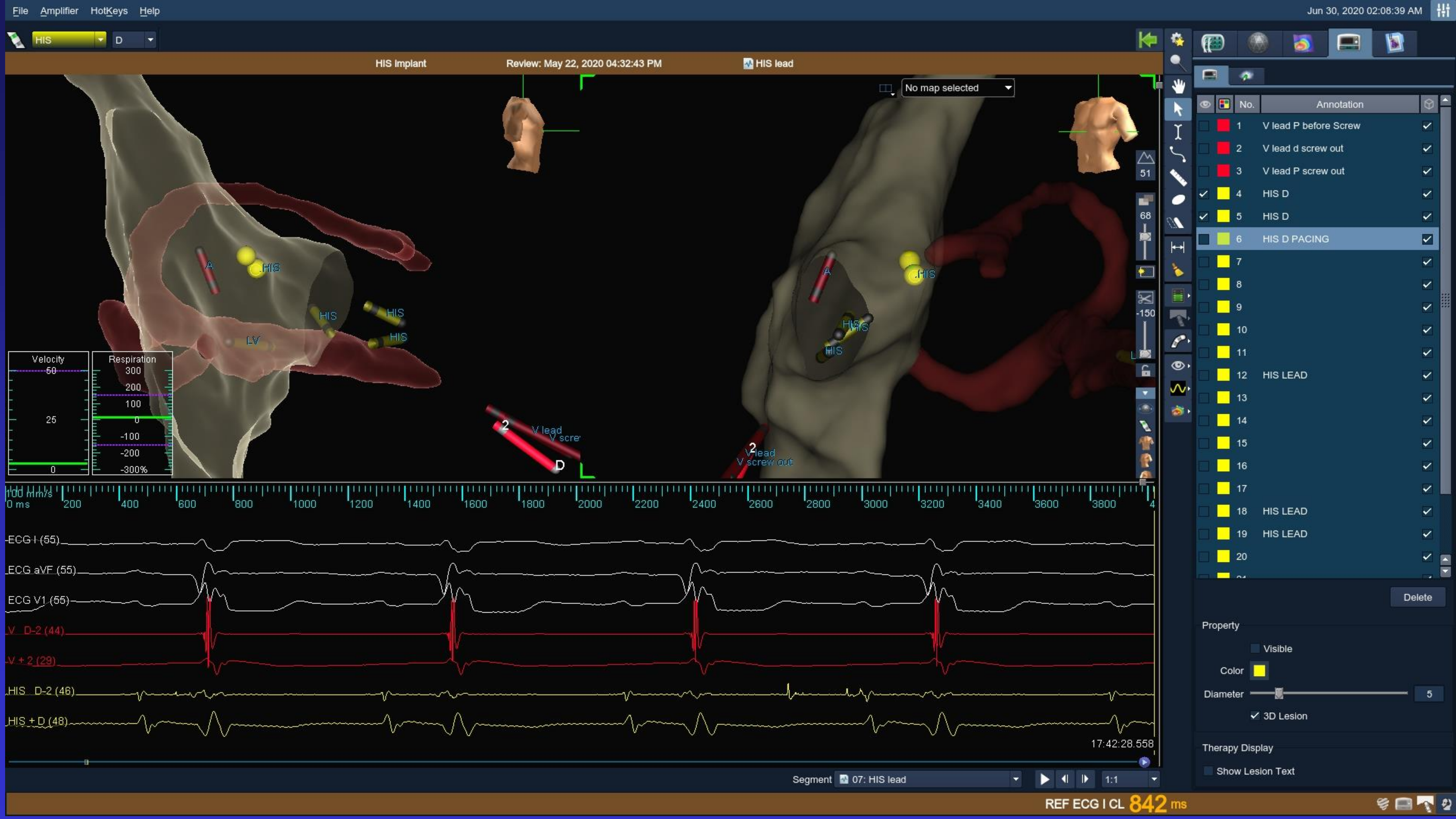
Qiu J et al. Progress in zero-fluoroscopy implantation of cardiac electronic device. PACE 2020;3:609-17

3rd Patient

- M/60
- History of COPD, HT and ischaemic cardiomyopathy with heart failure
- Presented syncope, developed pulseless VT in A&E and successfully resuscitated
- Echo: dilated LV, severe impairment in LV systolic function, wall thinning and akinesia over inferior and posterior segments, hypokinesia over lateral wall

His Mapping With SelectSecure (3830) Lead


File
Amplifier
HotKeys
Help
Jun 30, 2020 02:04:24 AM
HIS
D
HIS Implant
Review: May 22, 2020 04:32:43 PM
HIS lead
No map selected
No.
Annotation
1 V lead P before Screw
2 V lead d screw out
3 V lead P screw out
4 HIS D
5 HIS D
6 HIS D PACING
7
8
9
10
11
12 HIS LEAD
13
14
15
16
17
18 HIS LEAD
19 HIS LEAD
20
Delete
Property
Visible
Color
Diameter
5
3D Lesion
Therapy Display
Show Lesion Text
Velocity
Respiration
100 mm/s
0 ms
ECG I (55)
ECG aVF (55)
ECG V1 (55)
V D-2 (66)
V + 2 (29)
HIS D-2 (54)
17:41:14.826
Segment
07: HIS lead
1:1
REF ECG I CL 762 ms



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Amplifier
HotKeys
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D
HIS Implant
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HIS lead
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No.
Annotation
1 V lead P before Screw
2 V lead d screw out
3 V lead P screw out
4 HIS D
5 HIS D
6 HIS D PACING
7
8
9
10
11
12 HIS LEAD
13
14
15
16
17
18 HIS LEAD
19 HIS LEAD
20
Delete
Property
Visible
Color
Diameter
5
3D Lesion
Therapy Display
Show Lesion Text
Velocity
Respiration
HIS
LV
A
V lead
V screw out
ECG I (55)
ECG aVF (55)
ECG V1 (55)
V D-2 (44)
V + 2 (29)
HIS D-2 (46)
HIS + D (48)
17:42:28.558
Segment
07: HIS lead
1:1
REF ECG I CL 842 ms


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Amplifier
HotKeys
Help
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HIS
D
HIS Implant
Review: May 22, 2020 04:32:43 PM
HIS lead
No map selected
No.
Annotation
1 V lead P before Screw
2 V lead d screw out
3 V lead P screw out
4 HIS D
5 HIS D
6 HIS D PACING
7
8
9
10
11
12 HIS LEAD
13
14
15
16
17
18 HIS LEAD
19 HIS LEAD
20
Delete
Property
Visible
Color
Diameter
5
3D Lesion
Therapy Display
Show Lesion Text
Velocity
50
25
0
Respiration
300
200
100
0
-100
-200
-300%
HIS
LV
V lead
V screw out
100 mm/s
0 ms
ECG I (55)
ECG aVF (55)
ECG V1 (55)
V D-2 (44)
V + 2 (29)
HIS D-2 (46)
HIS + D (48)
17:43:10.555
Segment
07: HIS lead
1:1
REF ECG I CL 867 ms

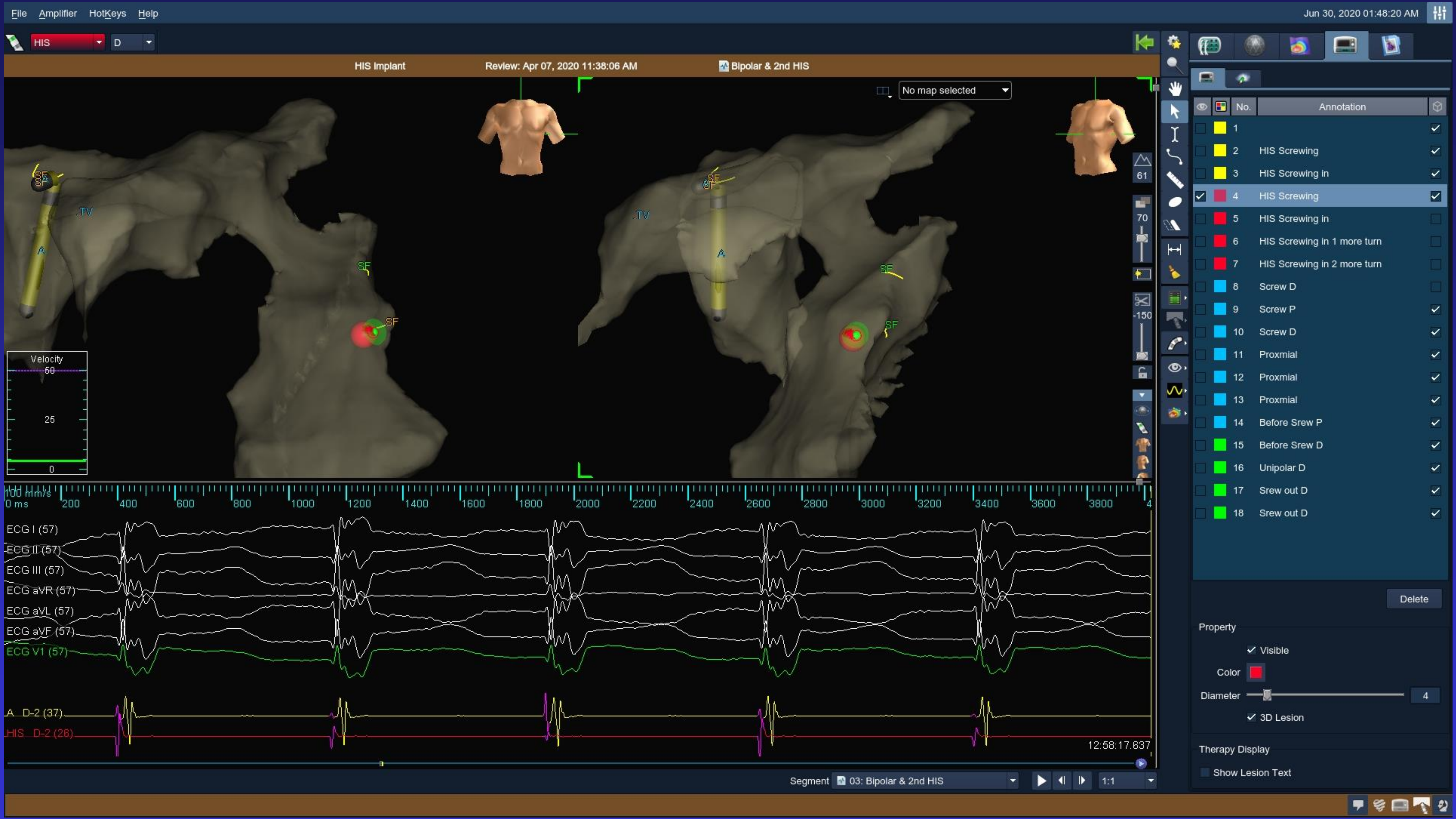

File
Amplifier
HotKeys
Help
Jun 30, 2020 02:10:42 AM
HIS
D
HIS Implant
Review: May 22, 2020 04:32:43 PM
HIS lead
No map selected
No.
Annotation
3 V lead P screw out
4 HIS D
5 HIS D
6 HIS D PACING
7
8
9
10
11
12 HIS LEAD
13
14
15
16
17
18 HIS LEAD
19 HIS LEAD
20
21
22
Delete
Property
Visible
Color
Diameter
5
3D Lesion
Therapy Display
Show Lesion Text
Velocity
Respiration
V lead
V screw out
ECG I (55)
ECG aVF (55)
ECG V1 (55)
V D-2 (44)
V + 2 (29)
HIS D-2 (59)
HIS + D (48)
17:43:17.897
Segment
07: HIS lead
2:1
REF ECG I CL 842 ms

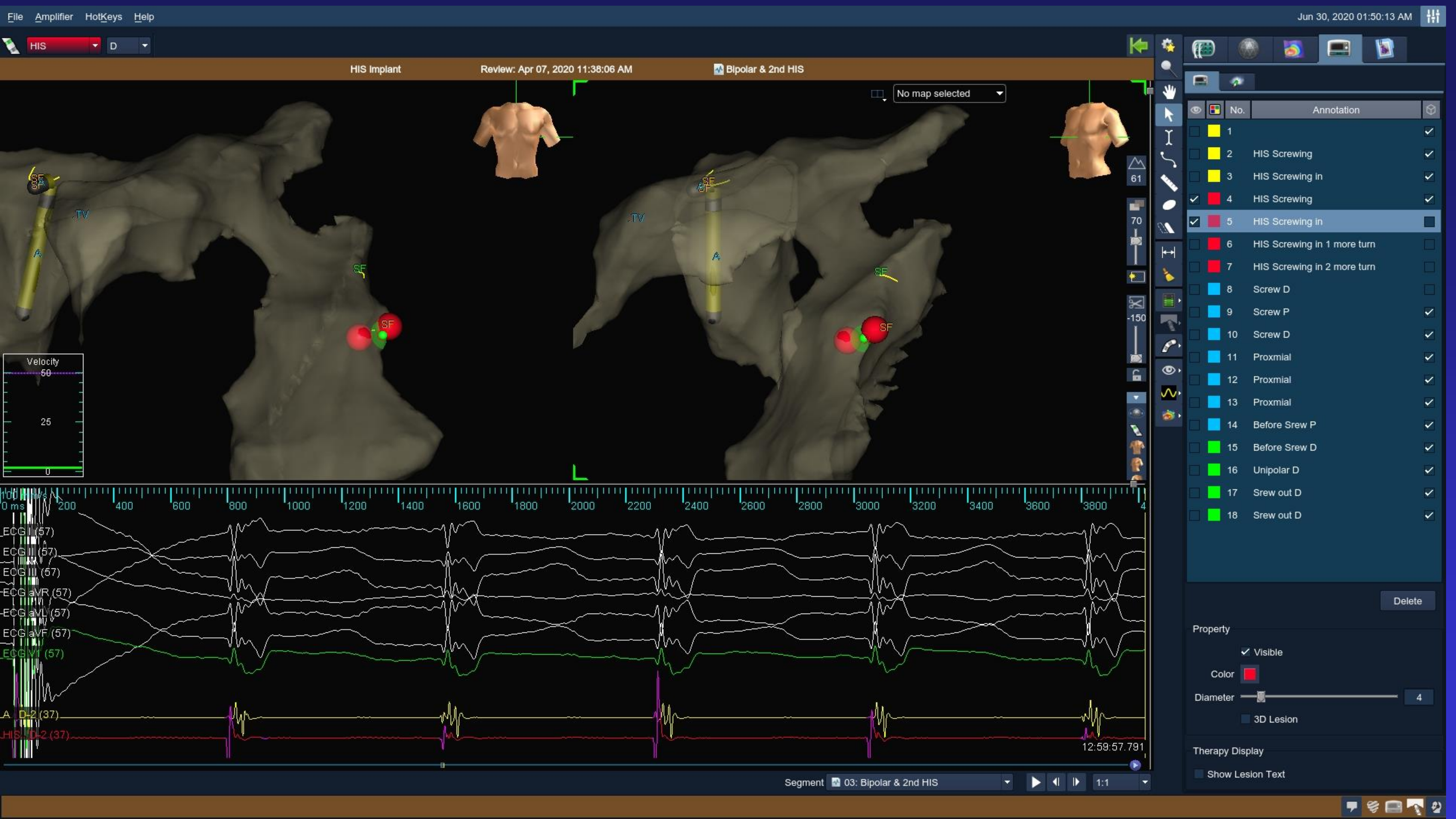
Extensive His Bundle Area Mapping

4^{th} Patient

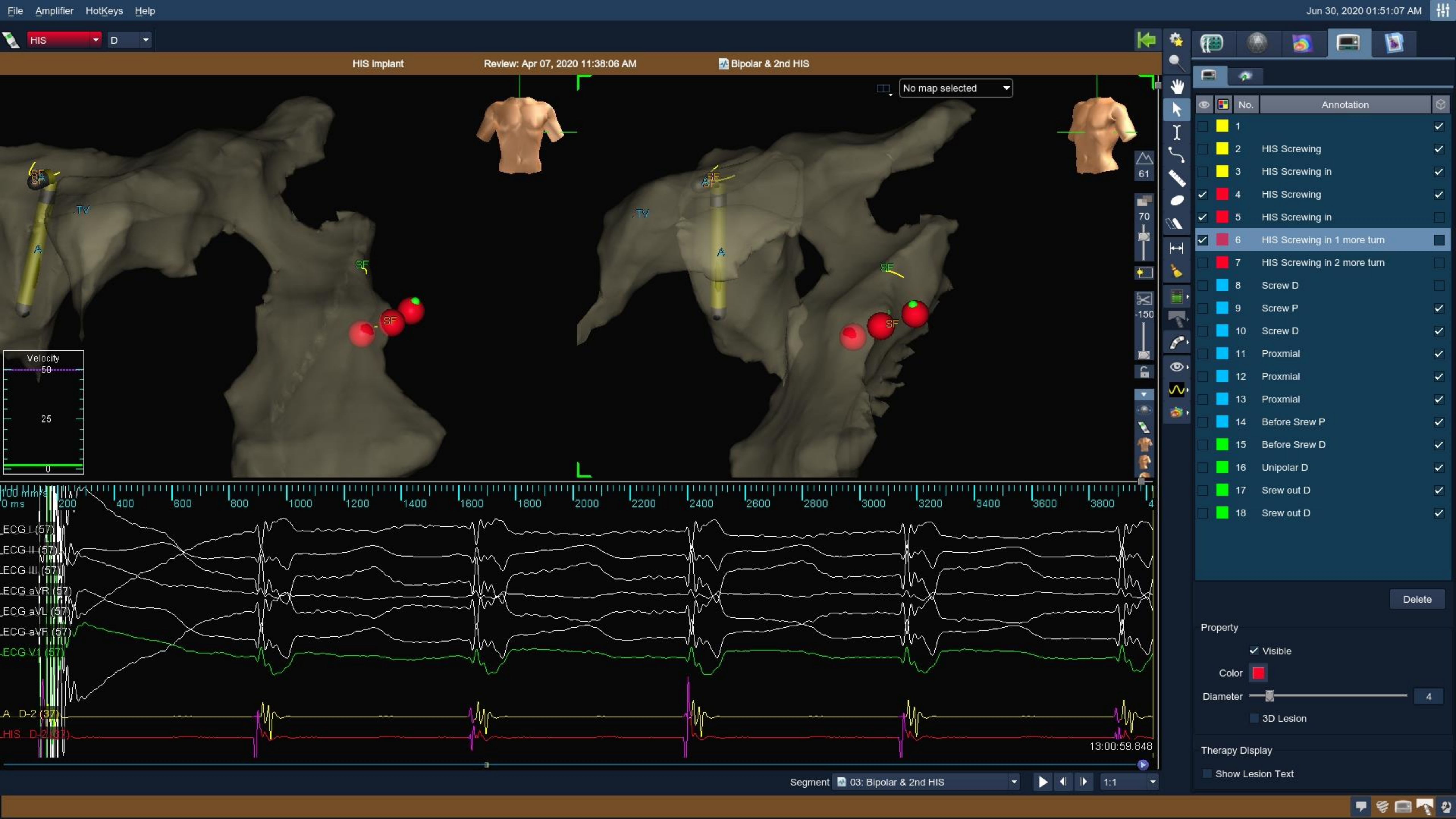
- M/91
- Known DM, HT, hyperlipidaemia, old bilateral BG infarcts and heart failure
- Presented with decrease in general condition
- ECG showed complete AV block

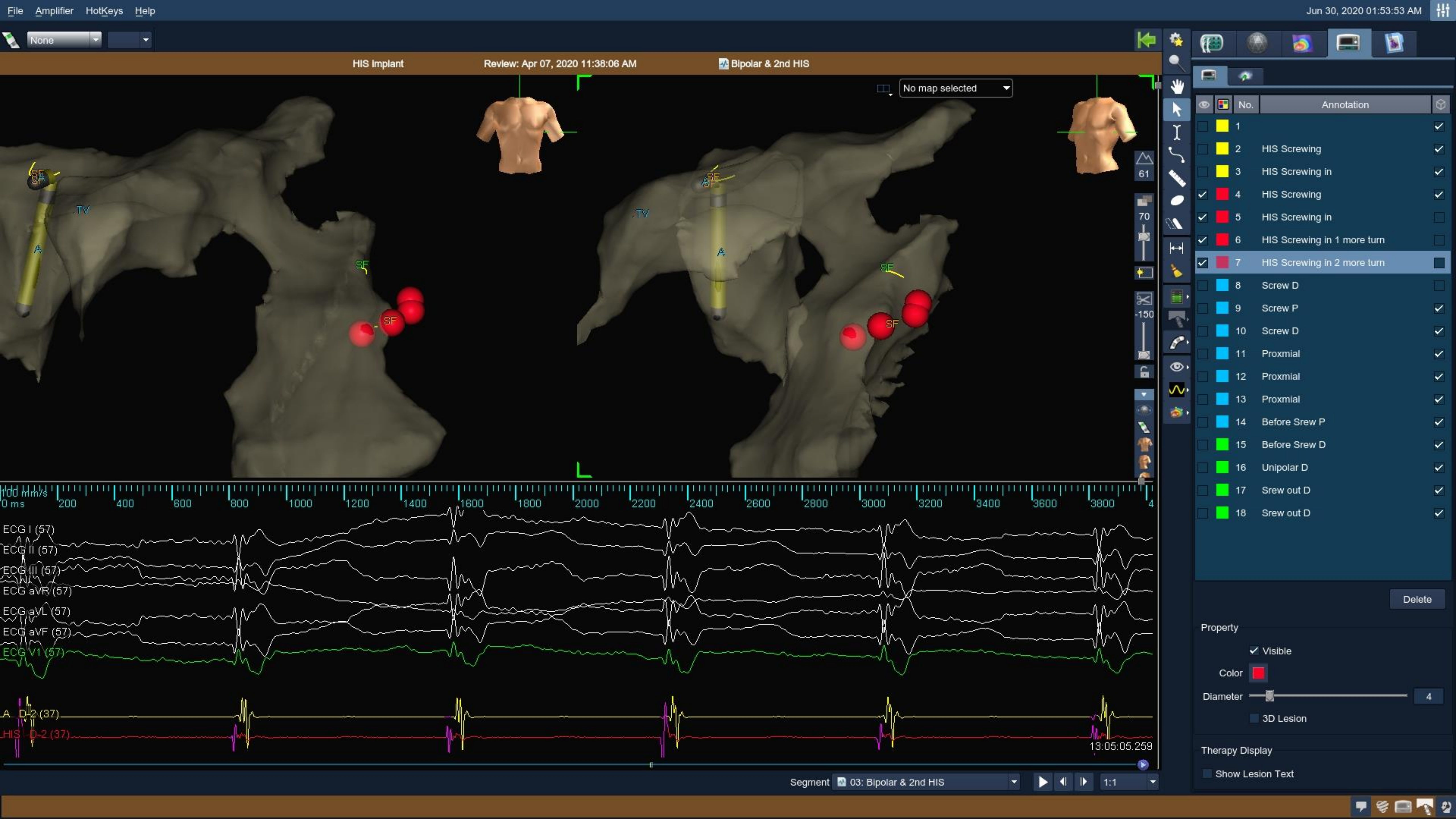
LB Area Mapping With SelectSecure (3830) Lead


File Amplifier HotKeys Help
Jun 30, 2020 01:48:20 AM
HIS
D
HIS Implant
Review: Apr 07, 2020 11:38:06 AM
Bipolar & 2nd HIS
No map selected
TV
A
SF
Velocity
50
25
0
61
70
-150
100 mm/s
0 ms
200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000 3200 3400 3600 3800
ECG I (57)
ECG II (57)
ECG III (57)
ECG aVR (57)
ECG aVL (57)
ECG aVF (57)
ECG V1 (57)
A D-2 (37)
HIS D-2 (26)
12:58:17.637
Segment
03: Bipolar & 2nd HIS
1:1
No.
Annotation
1
2 HIS Screwing
3 HIS Screwing in
4 HIS Screwing
5 HIS Screwing in
6 HIS Screwing in 1 more turn
7 HIS Screwing in 2 more turn
8 Screw D
9 Screw P
10 Screw D
11 Proxmial
12 Proxmial
13 Proxmial
14 Before Srew P
15 Before Srew D
16 Unipolar D
17 Srew out D
18 Srew out D
Delete
Property
Visible
Color
Diameter
4
3D Lesion
Therapy Display
Show Lesion Text

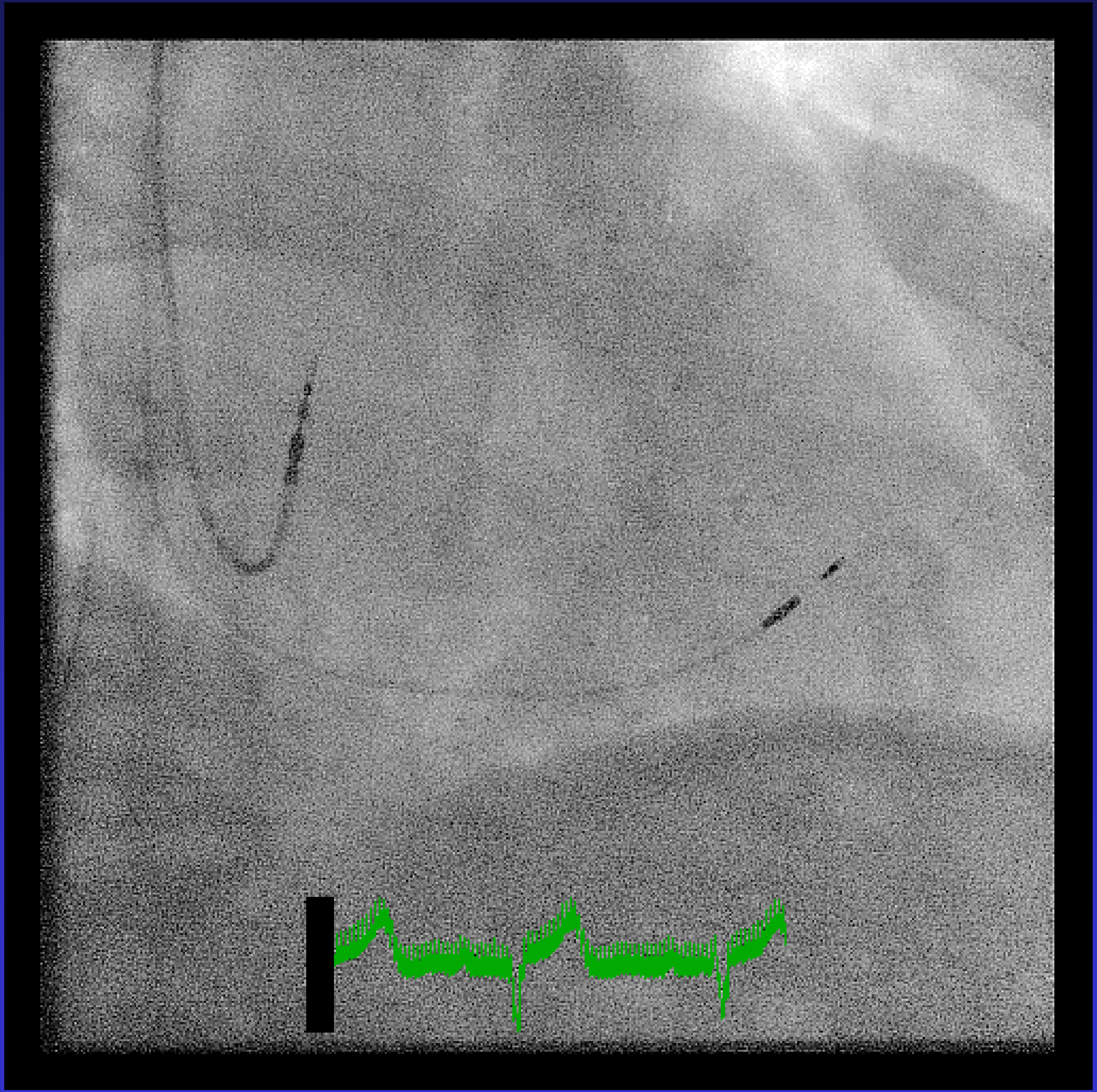


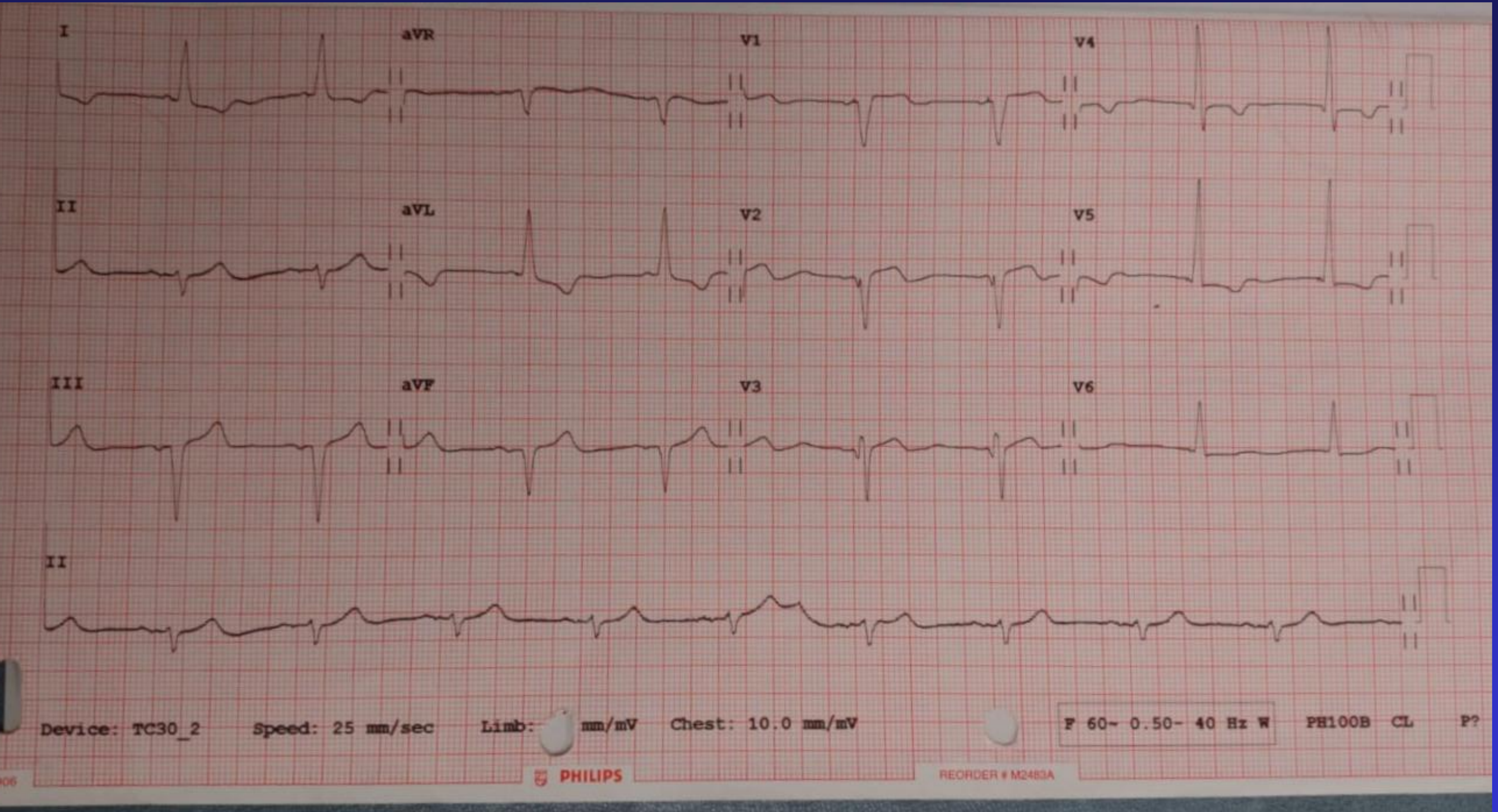
File
Amplifier
HotKeys
Help
Jun 30, 2020 01:50:13 AM
HIS
D
HIS Implant
Review: Apr 07, 2020 11:38:06 AM
Bipolar & 2nd HIS
No map selected
TV
A
SF
Velocity
50
25
0
61
70
-150
No.
Annotation
1
2 HIS Screwing
3 HIS Screwing in
4 HIS Screwing
5 HIS Screwing in
6 HIS Screwing in 1 more turn
7 HIS Screwing in 2 more turn
8 Screw D
9 Screw P
10 Screw D
11 Proxmial
12 Proxmial
13 Proxmial
14 Before Srew P
15 Before Srew D
16 Unipolar D
17 Srew out D
18 Srew out D
Delete
Property
Visible
Color
Diameter
4
3D Lesion
Therapy Display
Show Lesion Text
100 mm/s
0 ms
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
ECG I (57)
ECG II (57)
ECG III (57)
ECG aVR (57)
ECG aVL (57)
ECG aVF (57)
ECG V1 (57)
A D-2 (37)
HIS D-2 (37)
12:59:57.791
Segment
03: Bipolar & 2nd HIS
1:1


File Amplifier HotKeys Help
Jun 30, 2020 01:51:07 AM
HIS
D
HIS Implant
Review: Apr 07, 2020 11:38:06 AM
Bipolar & 2nd HIS
No map selected
TV
A
SF
Velocity
50
25
0
61
70
-150
No.
Annotation
1
2 HIS Screwing
3 HIS Screwing in
4 HIS Screwing
5 HIS Screwing in
6 HIS Screwing in 1 more turn
7 HIS Screwing in 2 more turn
8 Screw D
9 Screw P
10 Screw D
11 Proxmial
12 Proxmial
13 Proxmial
14 Before Srew P
15 Before Srew D
16 Unipolar D
17 Srew out D
18 Srew out D
Delete
Property
Visible
Color
Diameter
4
3D Lesion
Therapy Display
Show Lesion Text
100 mm/s
0 ms
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
ECG I (57)
ECG II (57)
ECG III (57)
ECG aVR (57)
ECG aVL (57)
ECG aVF (57)
ECG V1 (57)
A D-2 (37)
HIS D-2 (37)
13:00:59.848
Segment
03: Bipolar & 2nd HIS
1:1



File
Amplifier
HotKeys
Help
Jun 30, 2020 01:53:53 AM
None
HIS Implant
Review: Apr 07, 2020 11:38:06 AM
Bipolar & 2nd HIS
No map selected
SF
TV
A
SF
SF
TV
A
SF
SF
61
70
-150
No.
Annotation
1
2 HIS Screwing
3 HIS Screwing in
4 HIS Screwing
5 HIS Screwing in
6 HIS Screwing in 1 more turn
7 HIS Screwing in 2 more turn
8 Screw D
9 Screw P
10 Screw D
11 Proxmial
12 Proxmial
13 Proxmial
14 Before Srew P
15 Before Srew D
16 Unipolar D
17 Srew out D
18 Srew out D
Delete
Property
Visible
Color
Diameter
4
3D Lesion
Therapy Display
Show Lesion Text
100 mm/s
0 ms
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
ECG I (57)
ECG II (57)
ECG III (57)
ECG aVR (57)
ECG aVL (57)
ECG aVF (57)
ECG V1 (57)
A D-2 (37)
HIS D-2 (37)
13:05:05.259
Segment
03: Bipolar & 2nd HIS
1:1




I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
Device: TC30_2
Speed: 25 mm/sec
Limb:
mm/mV
Chest: 10.0 mm/mV
F 60~ 0.50- 40 Hz W
PH100B CL
PHILIPS
REORDER # M2483A

Conclusions

- Cardiac procedures contribute over 40% of medical radiation and every effort should be put to limit radiation dose to both patients and operators
- Use of bismuth-containing radiation absorbing drape can significantly reduces the radiation exposure of operators

Conclusions

- USG-guided axillary vein puncture can eliminate the use of contrast and reduce fluoroscopic exposure for venous access
- 3D electroanatomic mapping system can guide various CIED implantation and reduce radiation exposure
- CRT guided by 3D electroanatomic mapping system may improve response rate