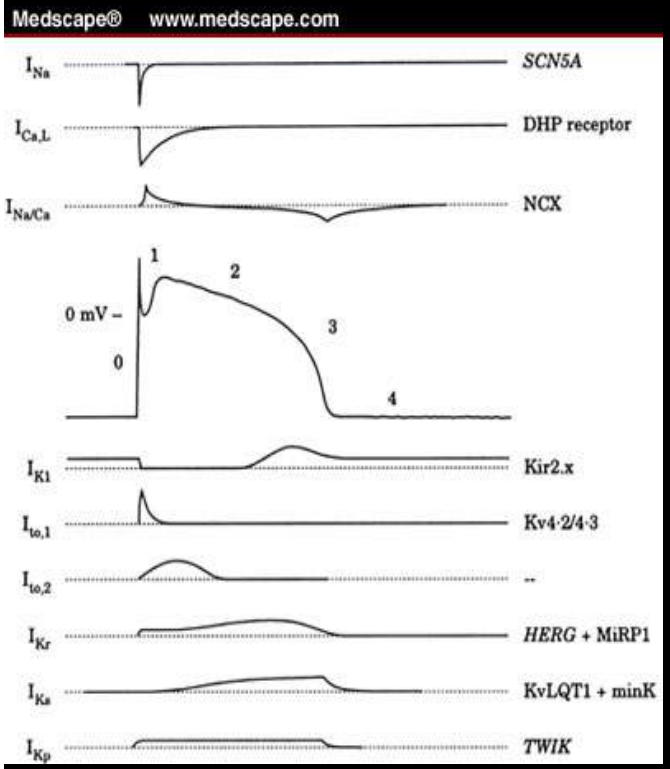
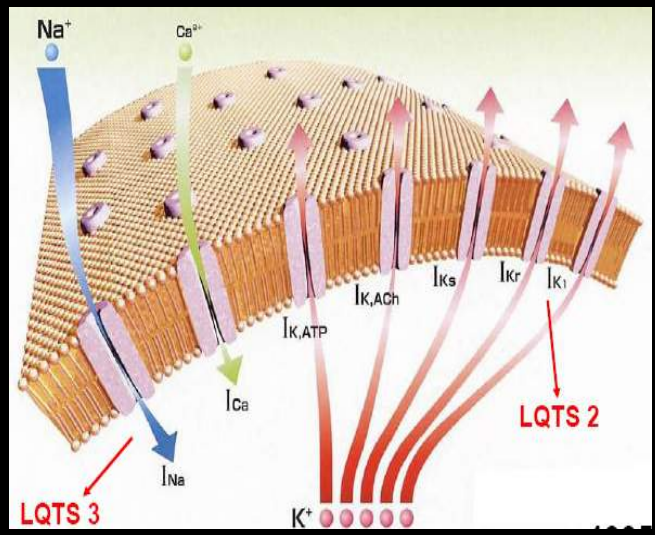
Images et signaux cardiaques: état de l'art et futur

Pierre Jaïs, Bordeaux, IHU LIRYC **ANR-10-IAHU-04**

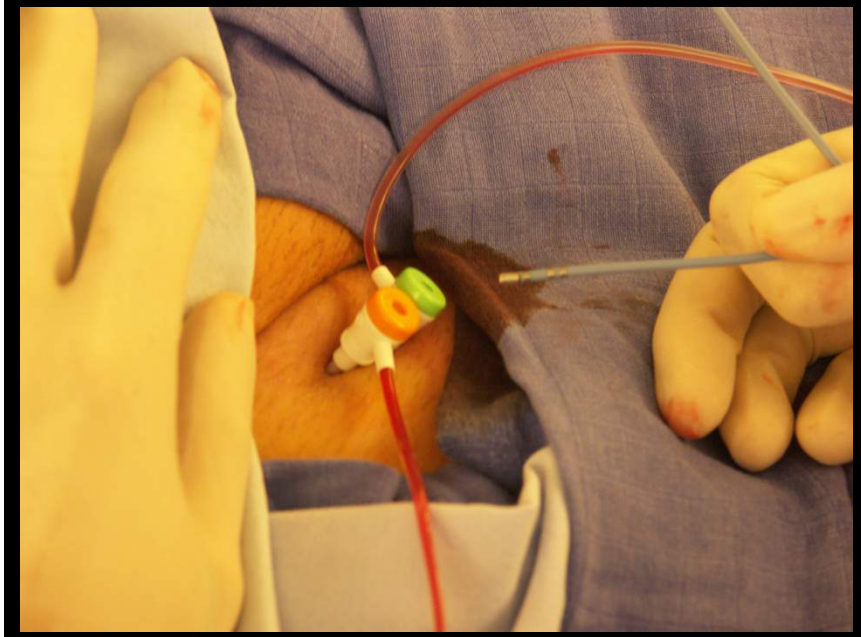
Equipex MUSIC ANR-11-EQPX-0030

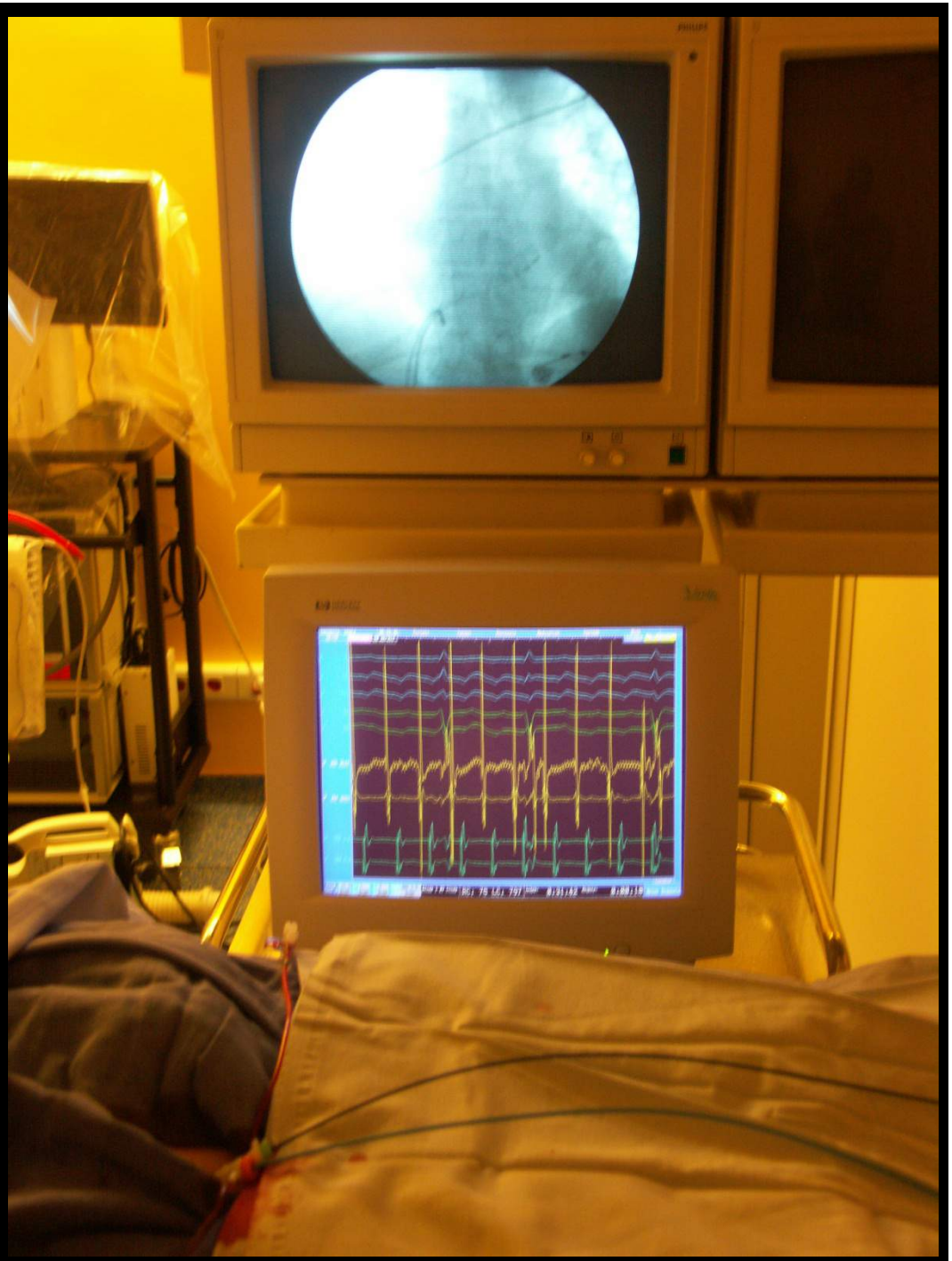
Le cœur, organe électrique





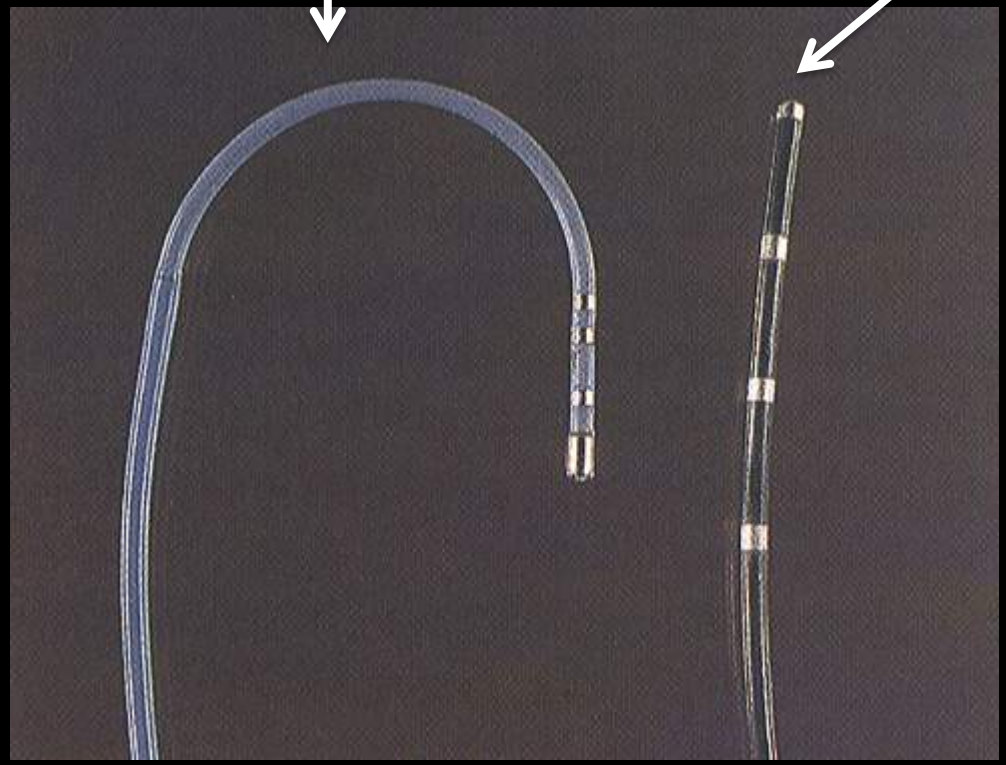
Les explorations en rythmologie

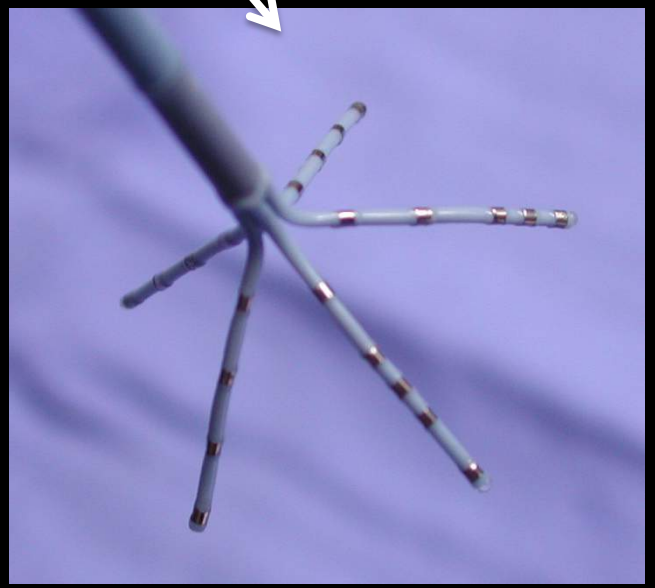


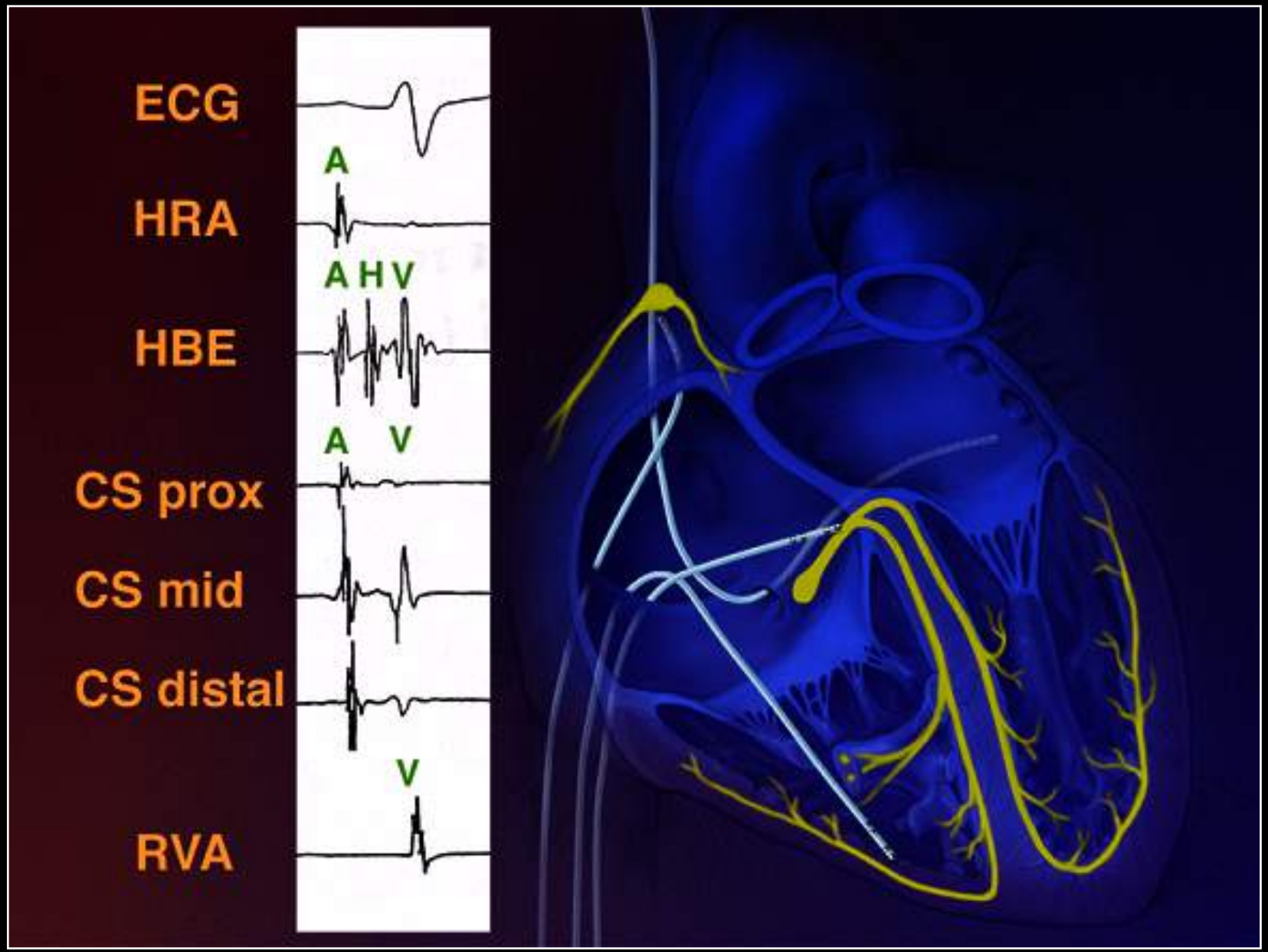


<u>Cathéter d'ablation:</u>
extrémité distale orientable et électrode distale

<u>Cathéters d'électrophysiologie:</u>
Orientable ou non

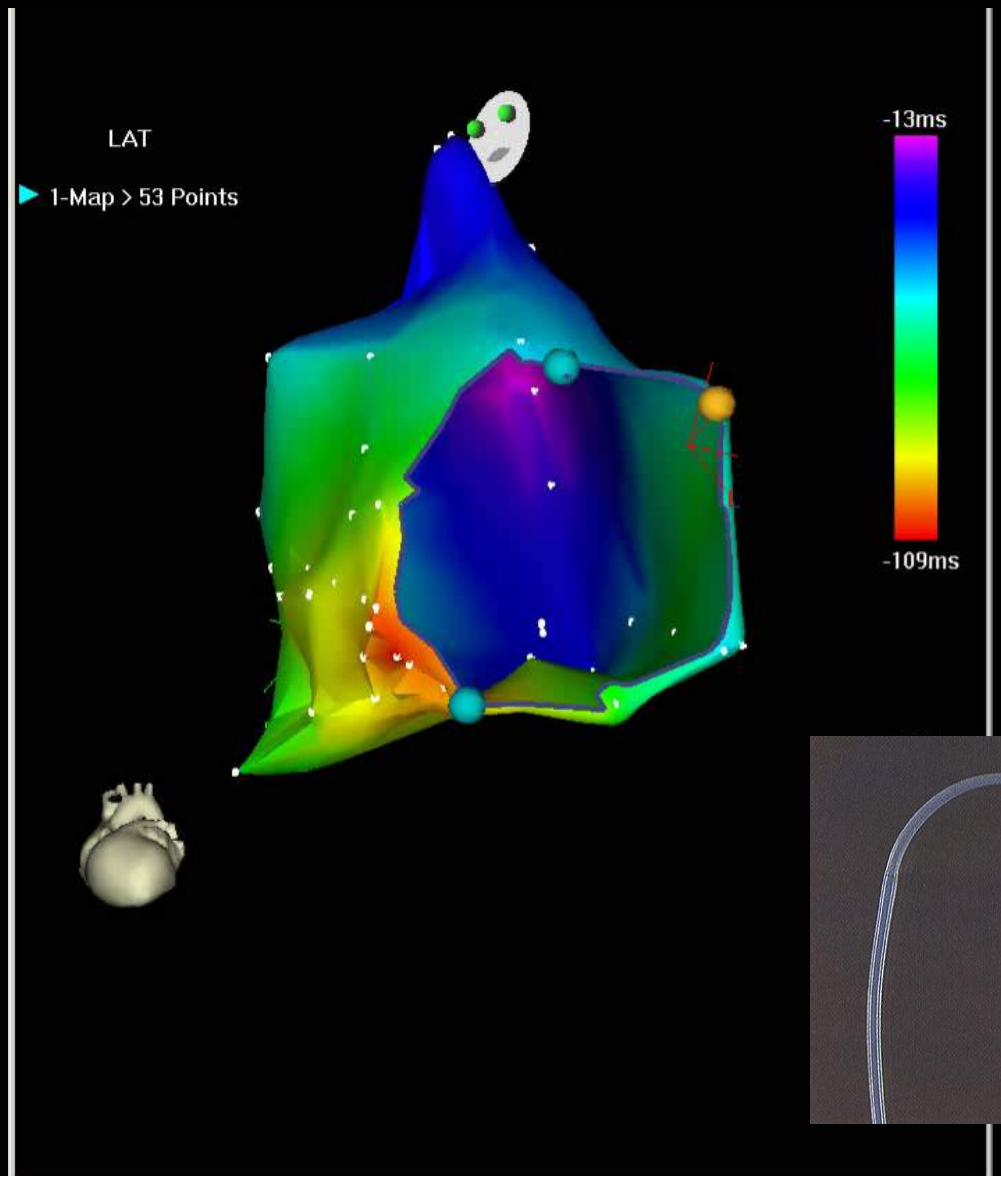


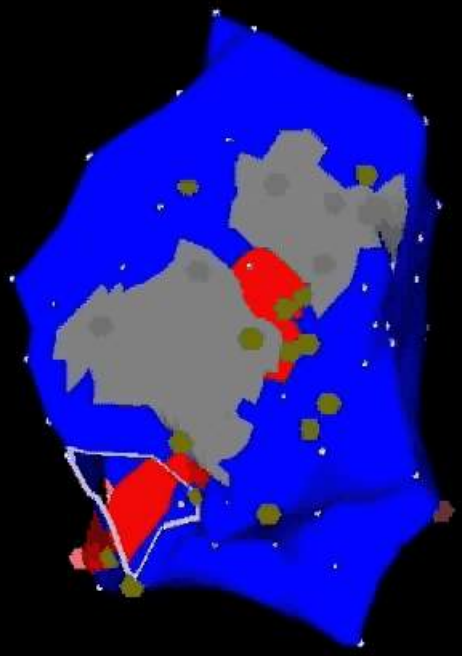


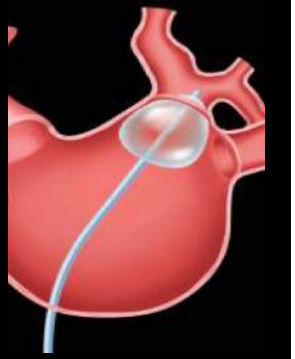


Placement des cathéters : Face

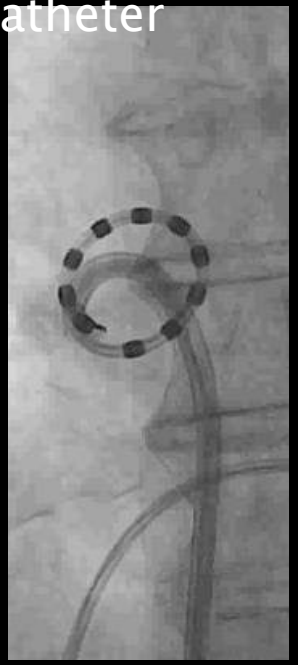
Les arythmies cardiaques

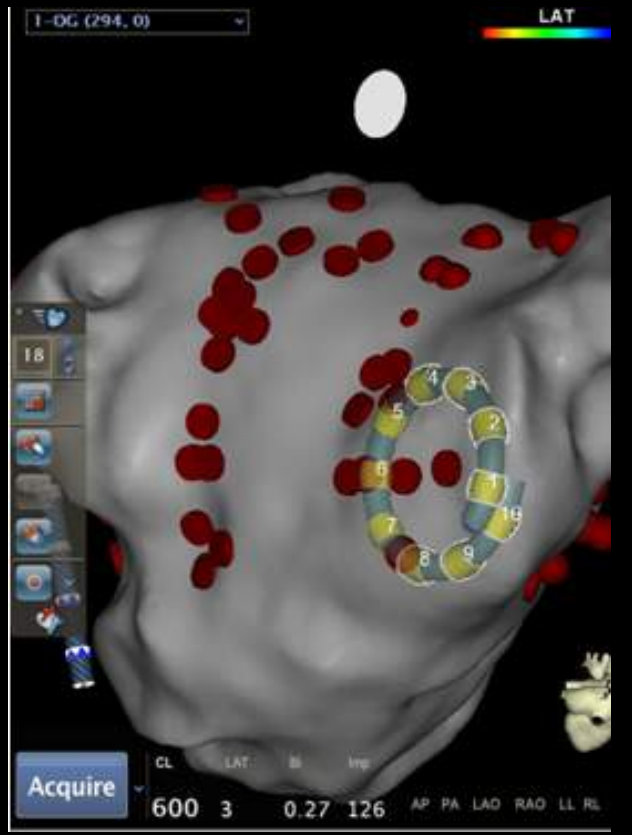




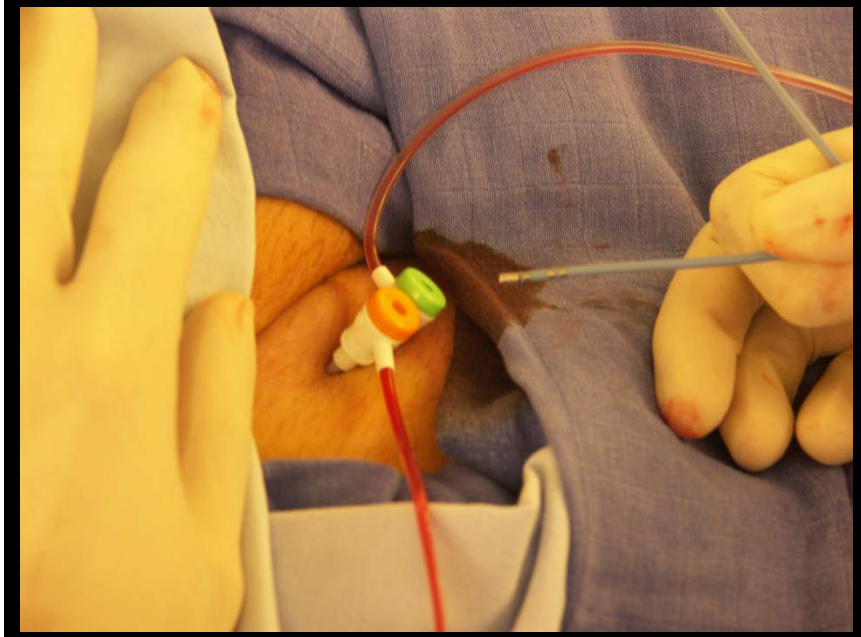


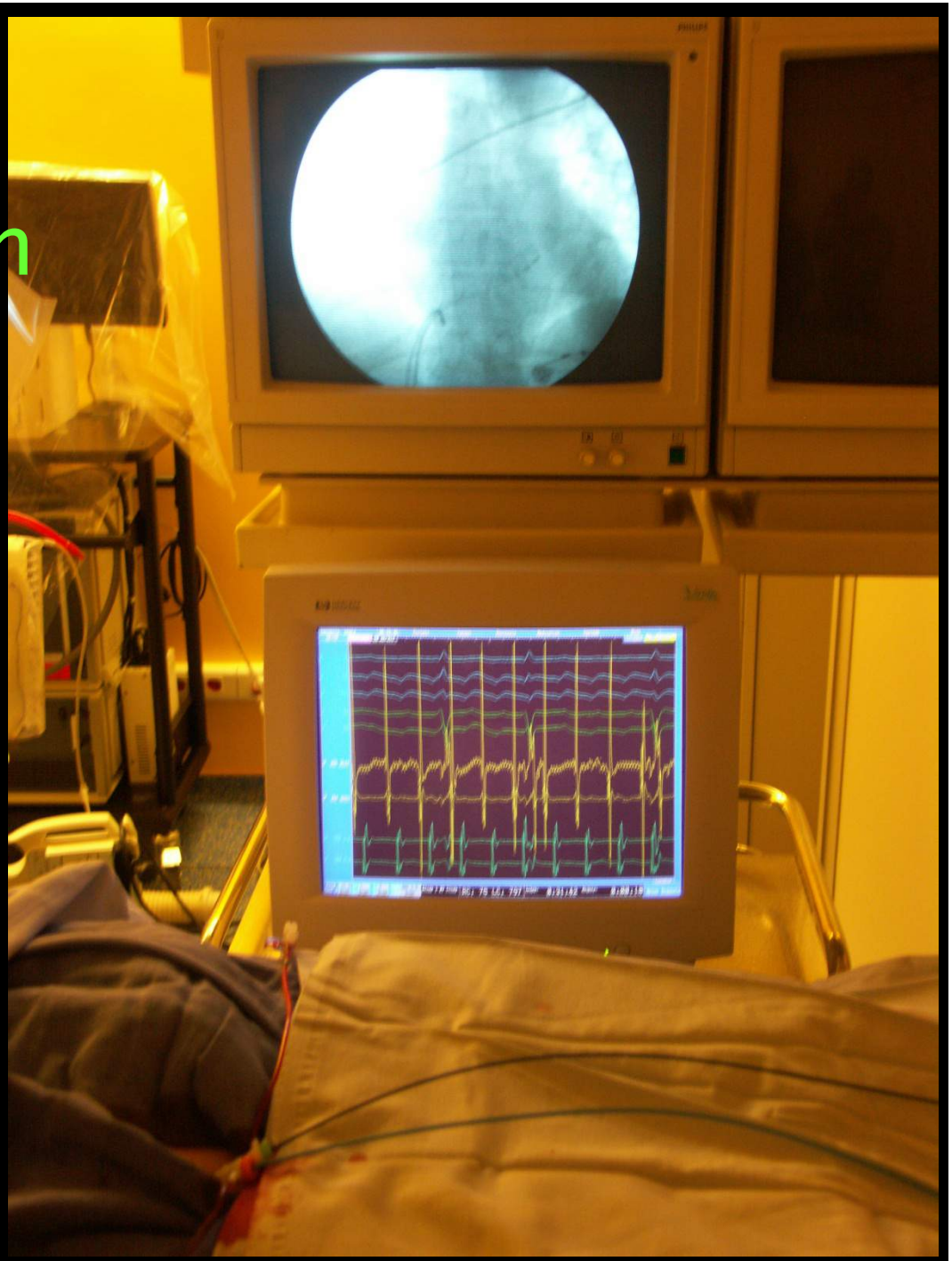
CIRCULAR Catheter, 10 irrigated electrodes, Adjustable size: 25-35 mm Steerable catheter





Les relations structure fonction



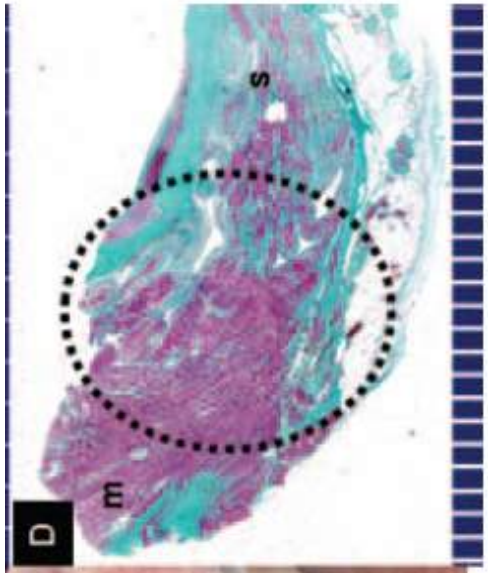


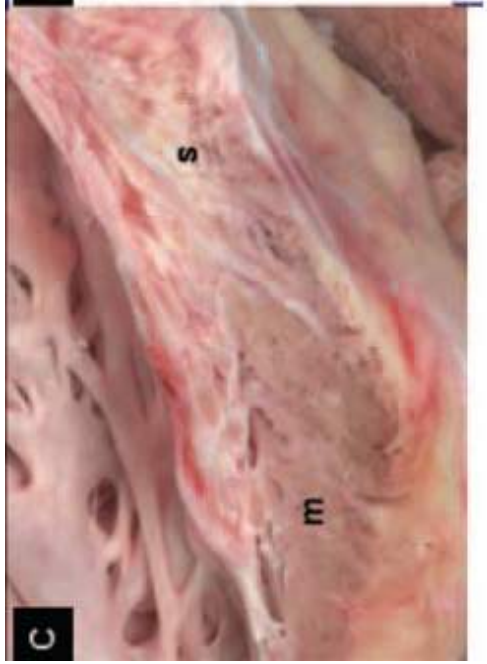
Deneke,
JCE 2005, 16
1246-1251

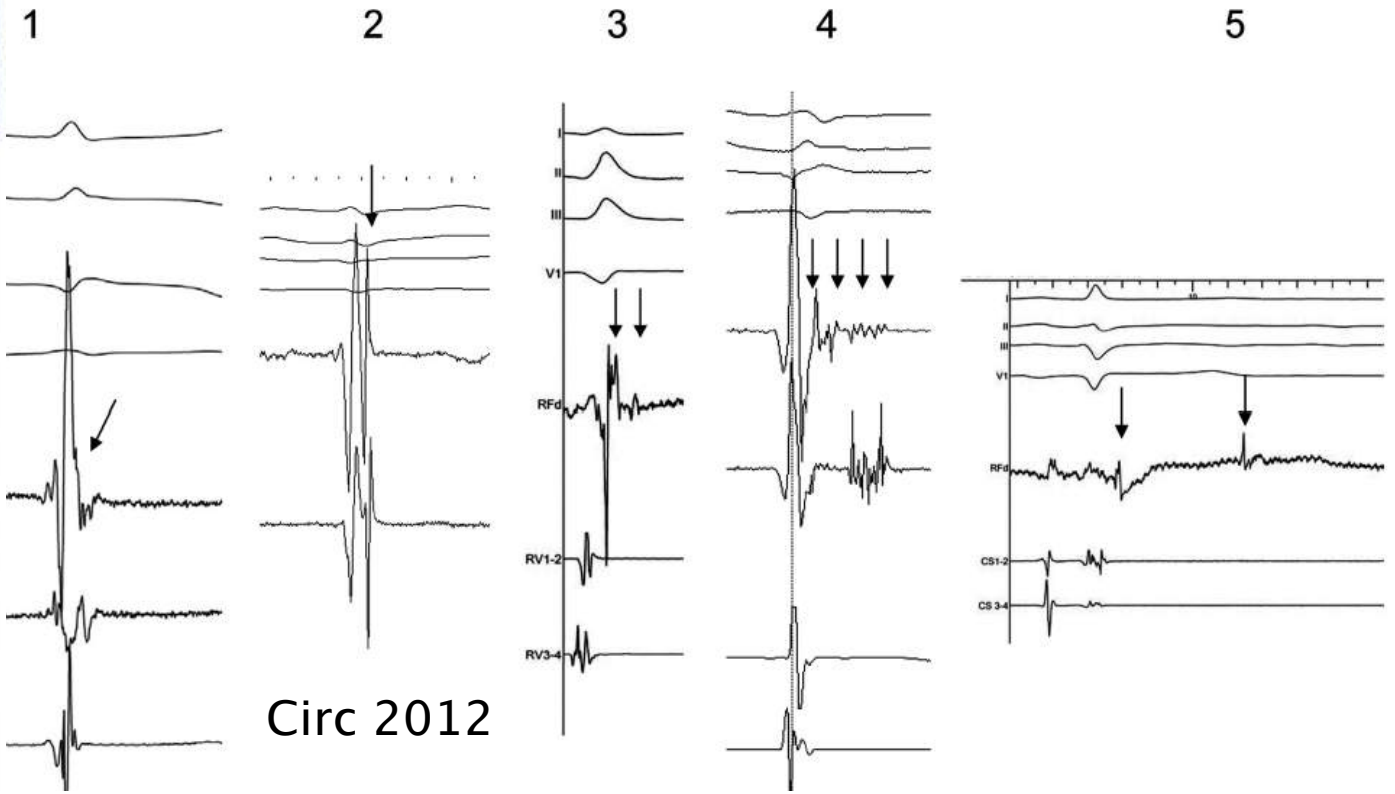
Elimination of Local Abnormal Ventricular Activities

A New End Point for Substrate Modification in Patients With Scar-Related Ventricular Tachycardia

Pierre Jaïs, MD; Philippe Maury, MD; Paul Khairy, MD, PhD; Frédéric Sacher, MD; Isabelle Nault, MD, FRCPC; Yuki Komatsu, MD; Mélèze Hocini, MD; Andrei Forclaz, MD; Amir S. Jadidi, MD; Rukshen Weerasooryia, MBBS; Ashok Shah, MD; Nicolas Derval, MD; ubert Cochet, MD; Sebastien Knecht, MD; Shinsuke Miyazaki, MD; Nick Linton, MEng, MRCP; Lena Rivard, MD; Matthew Wright, MBBS, PhD; Stephen B. Wilton, MD; Daniel Scherr, MD; Patrizio Pascale, MD; Laurent Roten, MD; Michala Pederson, MD; Pierre Bordachar, MD; François Laurent, MD; Steven J. Kim, MEng; Philippe Ritter, MD; Jacques Clementy, MD; Michel Haïssaguerre, MD



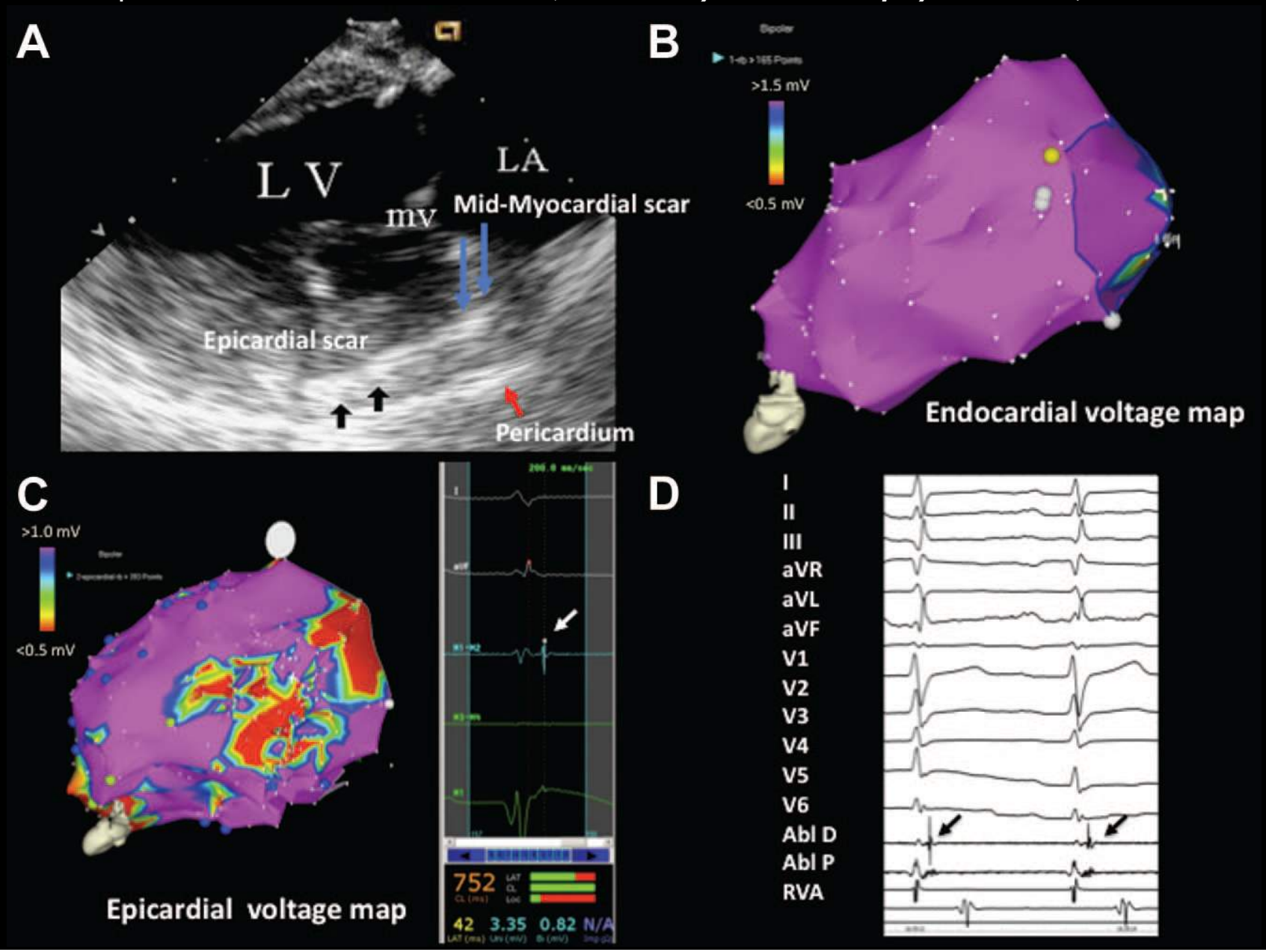




Circ 2012

Assessing Epicardial Substrate Using Intracardiac Echocardiography During VT Ablation

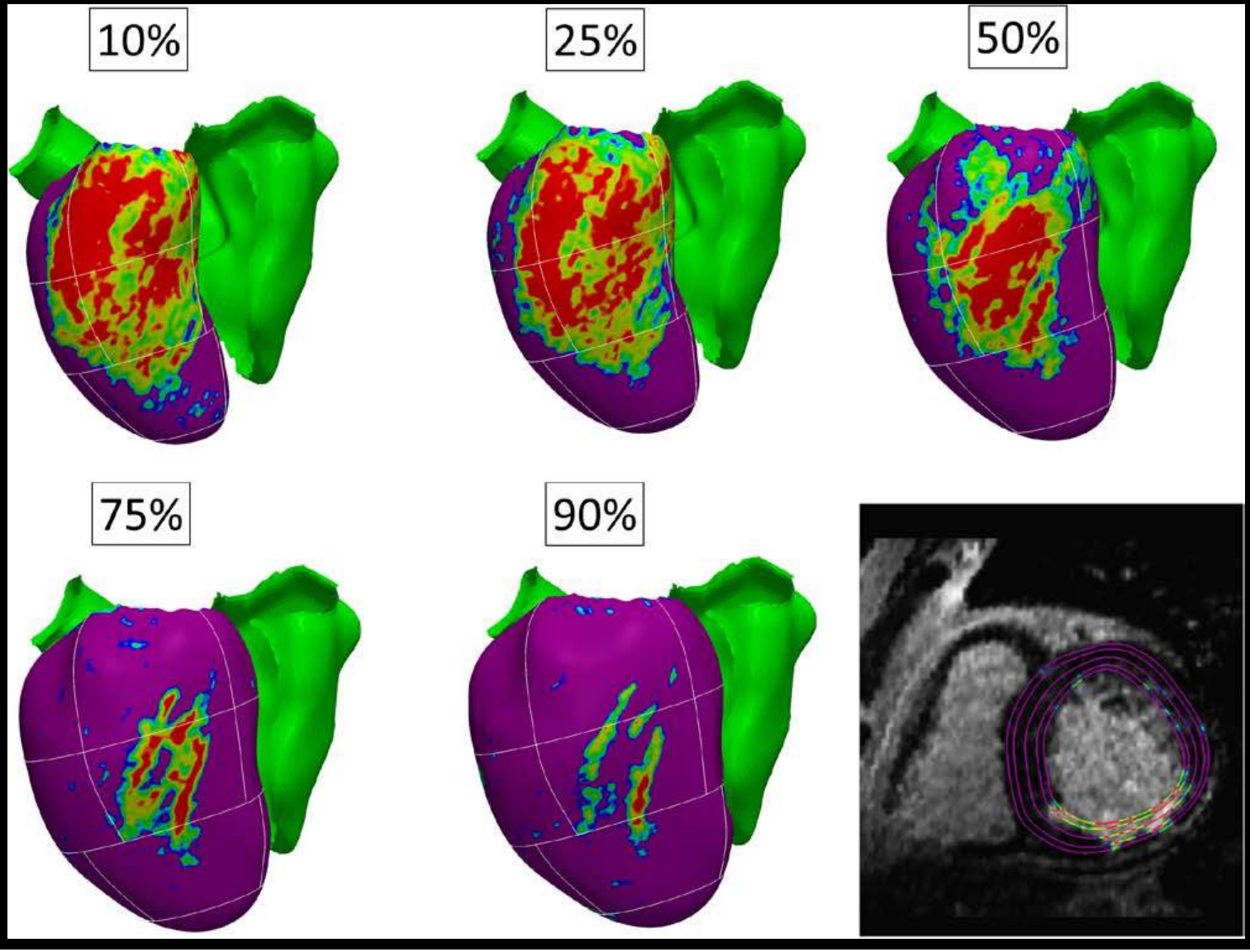
Rupa Bala…. Francis E. Marchlinski; ***Circ Arrhythm Electrophysiol.*** **2011;4:667-673**

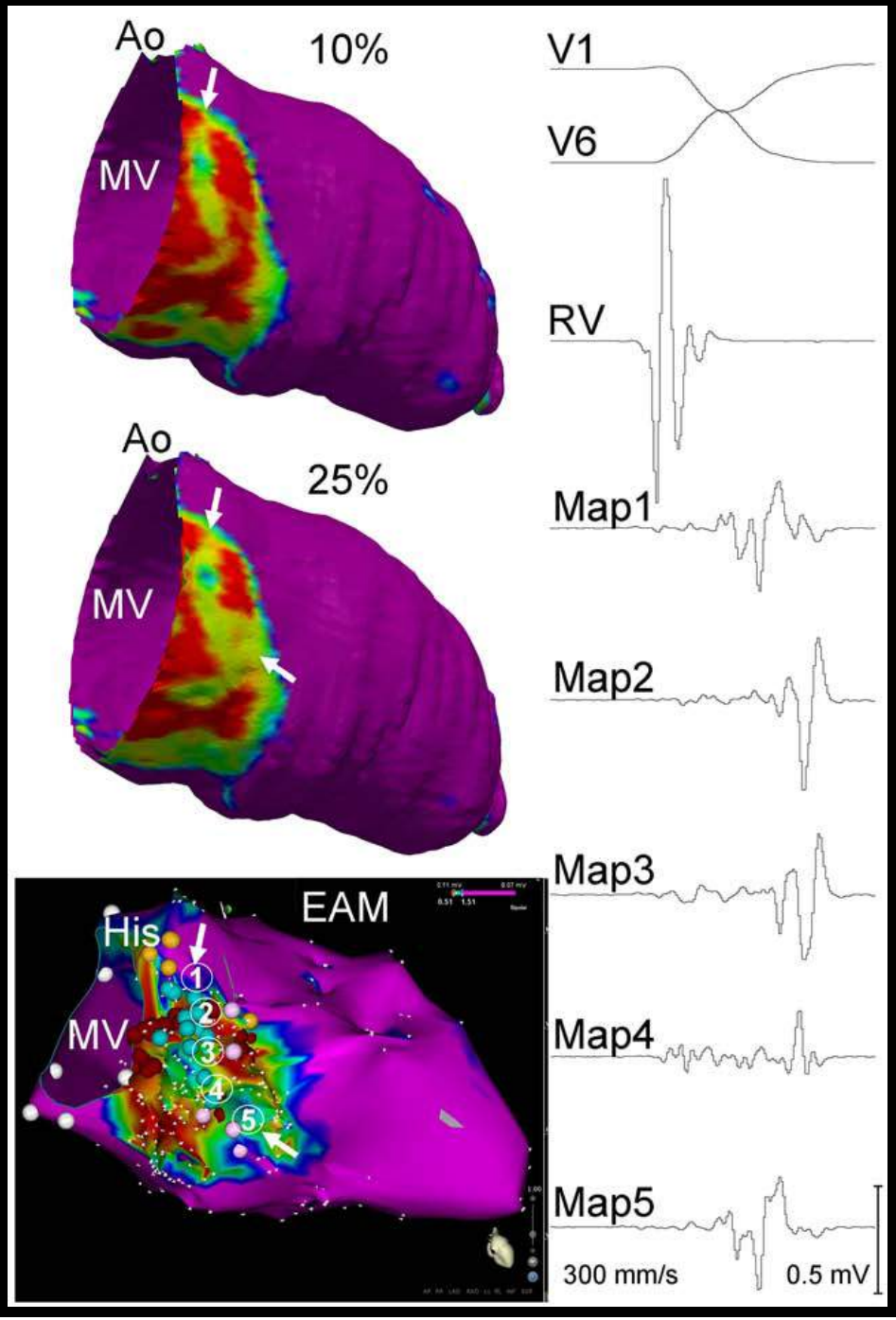


Three-Dimensional Architecture of Scar and Conducting Channels Based on High Resolution ce-CMR Insights for Ventricular Tachycardia Ablation

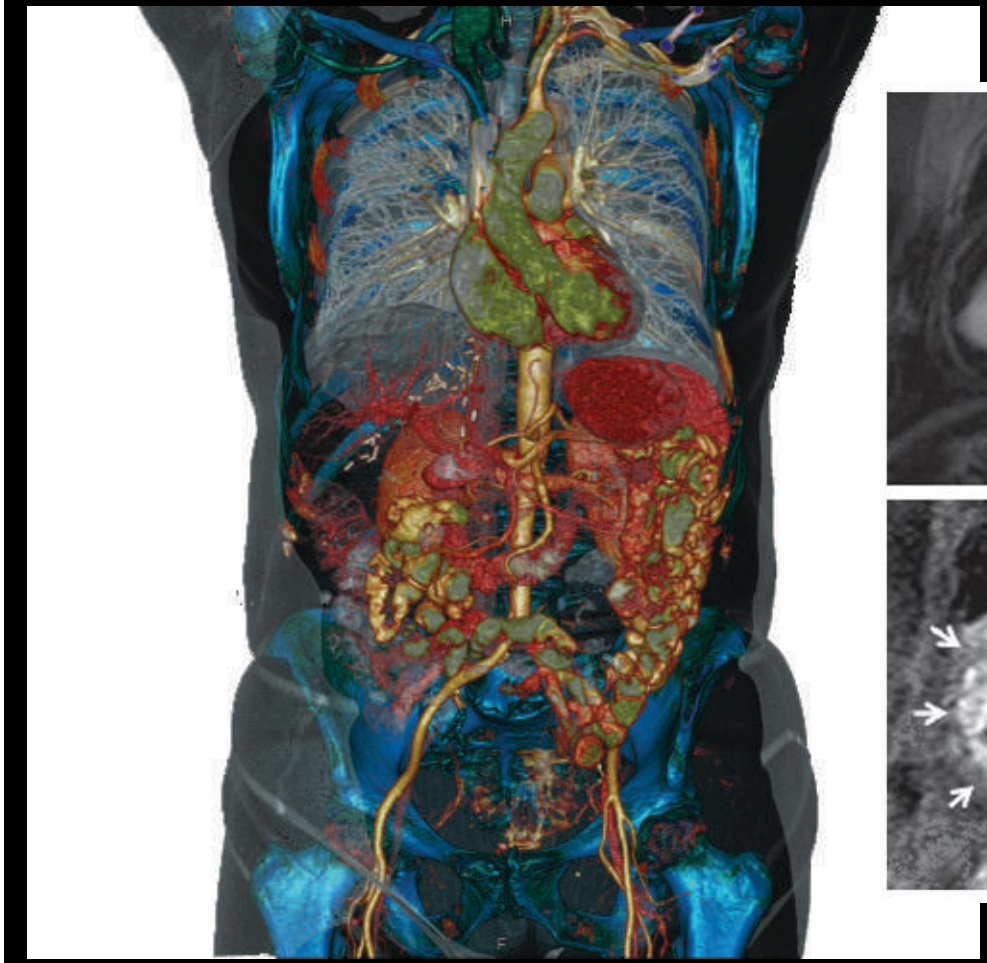
Juan Fernández-Armenta, Antonio Berruezo…Josep Brugada

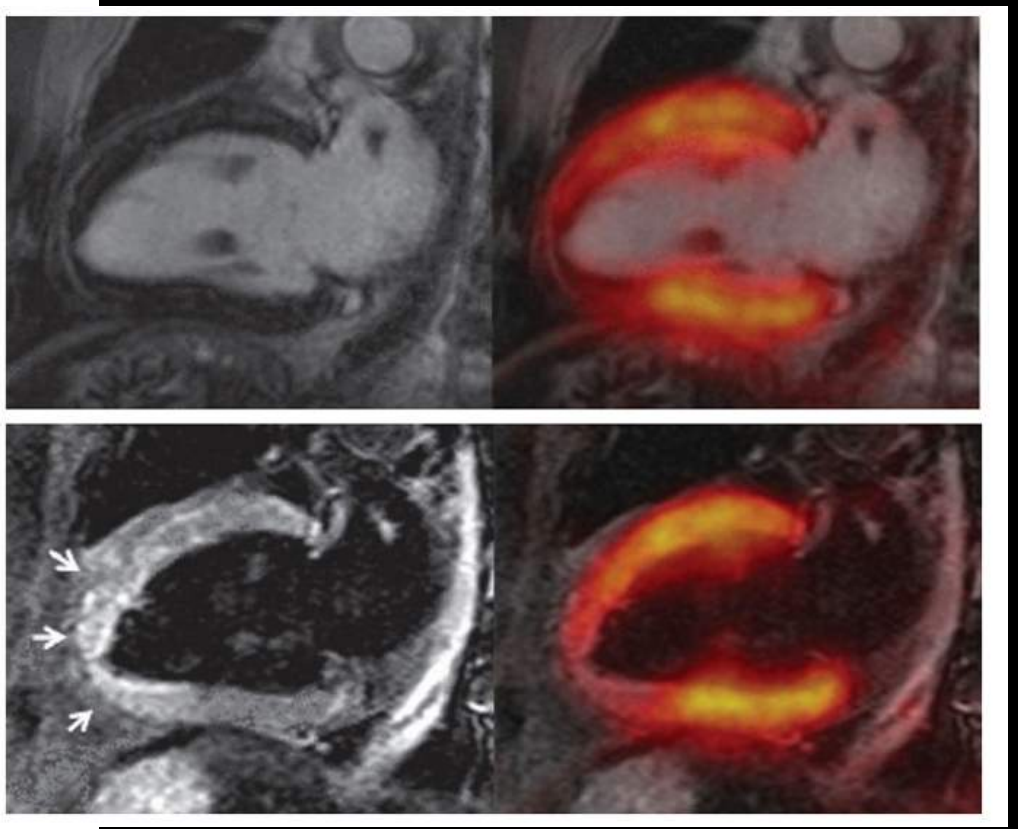
(*Circ Arrhythm Electrophysiol*. 2013;6:528-537.)




Ao
10%
MV
Ao
25%
MV
EAM
His
MV
1
2
3
4
5
V1
V6
RV
Map1
Map2
Map3
Map4
Map5
300 mm/s
0.5 mV

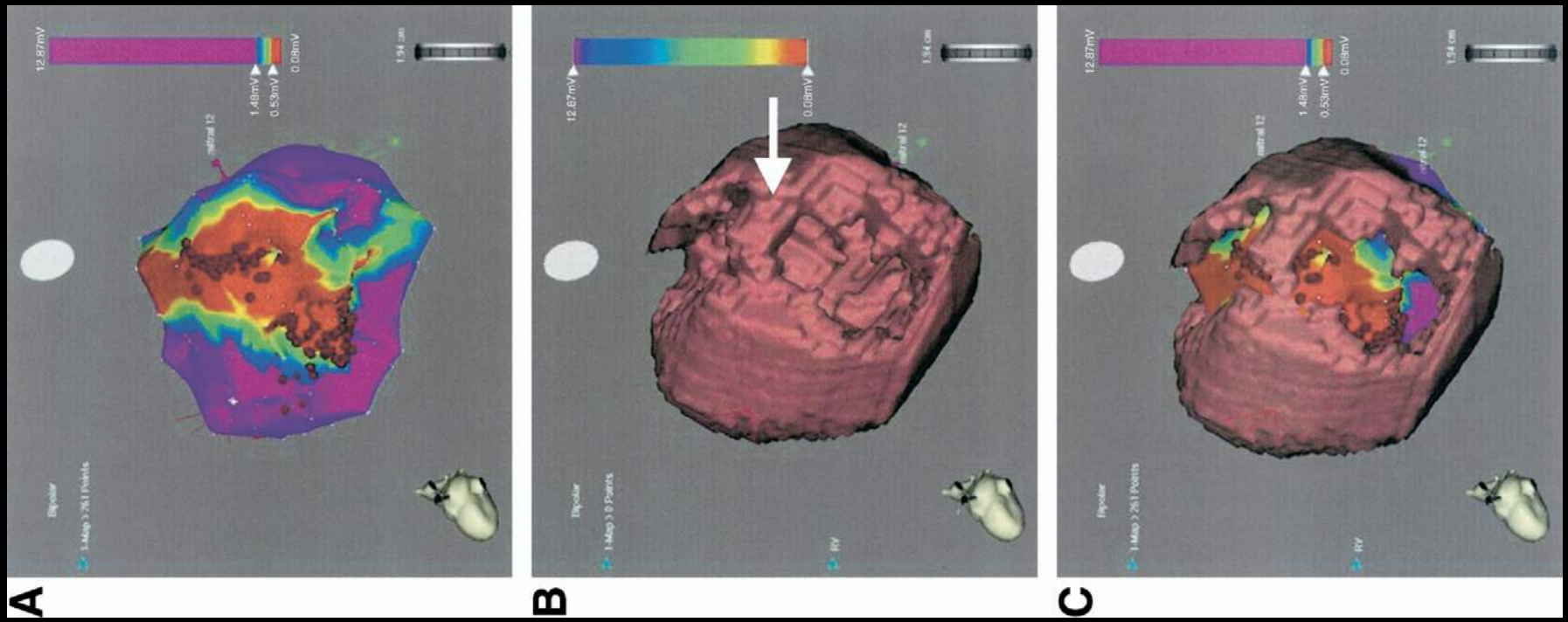
PET scan/IRM





Tim Dickfeld et al:

Integration of Three-Dimensional Scar Maps for Ventricular Tachycardia Ablation With Positron Emission Tomography-Computed Tomography



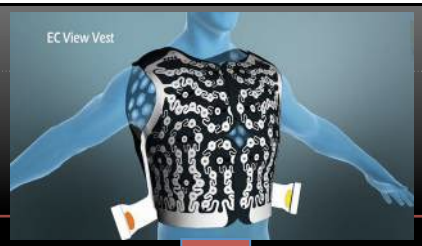
J Am Coll Cardiol Img 2008;1:73- 82)

LIRYC - IMAGING
MUSIC: **Mu**lti-modality Platform for **S**pecific **I**maging in **C**ardiology

MUSIC: Utiliser tout type d'image contenant une information pertinente pour guider l'ablation d'arythmie cardiaque

Exporter des modèles personnalisés ainsi construits vers les systèmes de navigation 3d

MUSIC



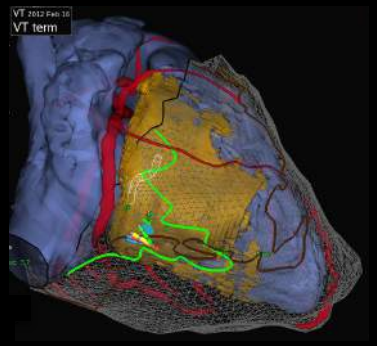
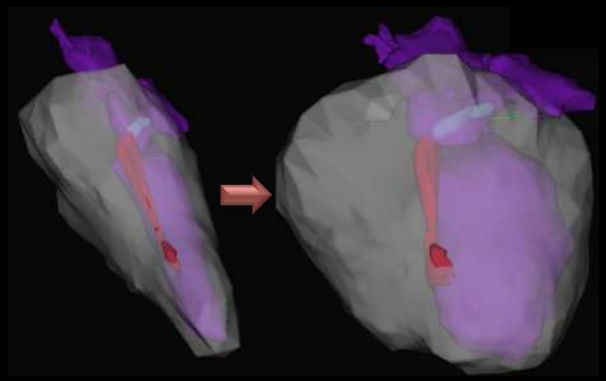
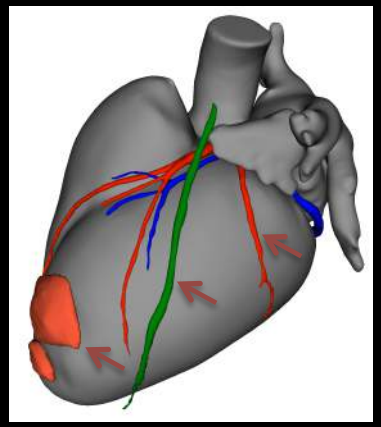
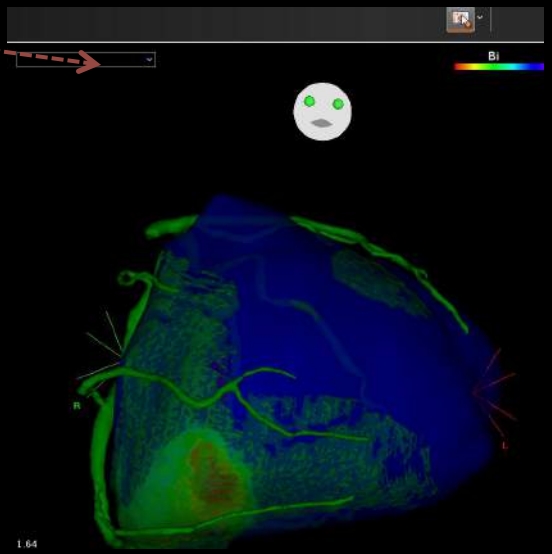


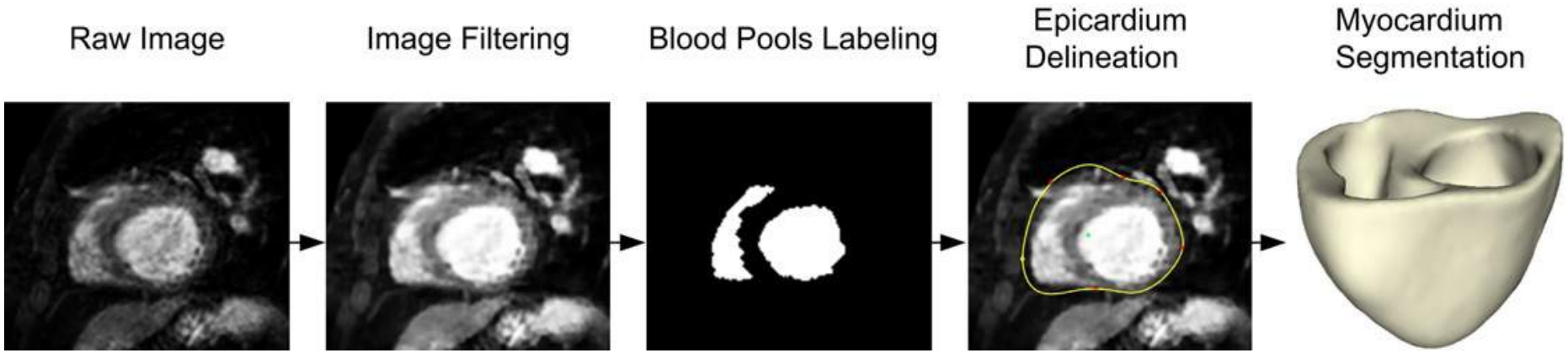
IMAGE INTEGRATION

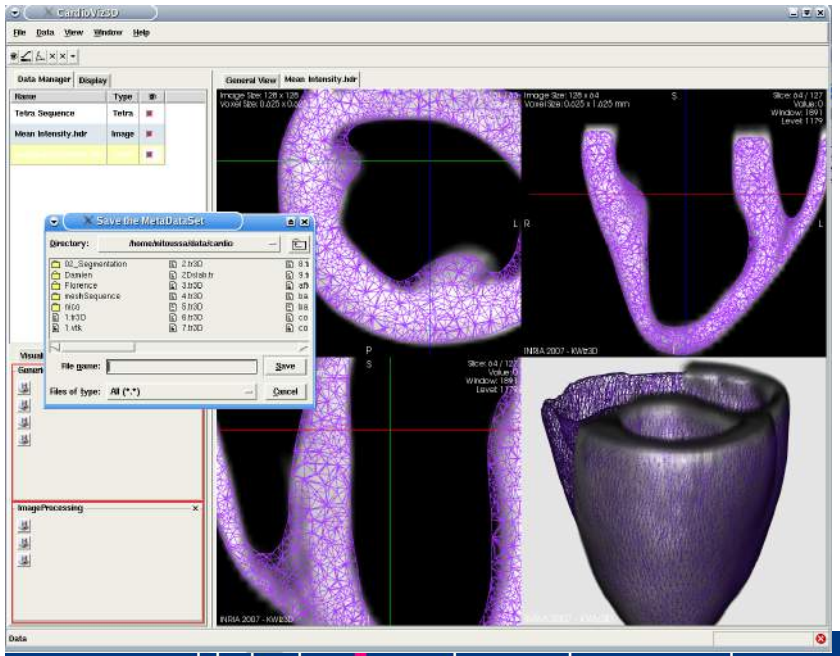


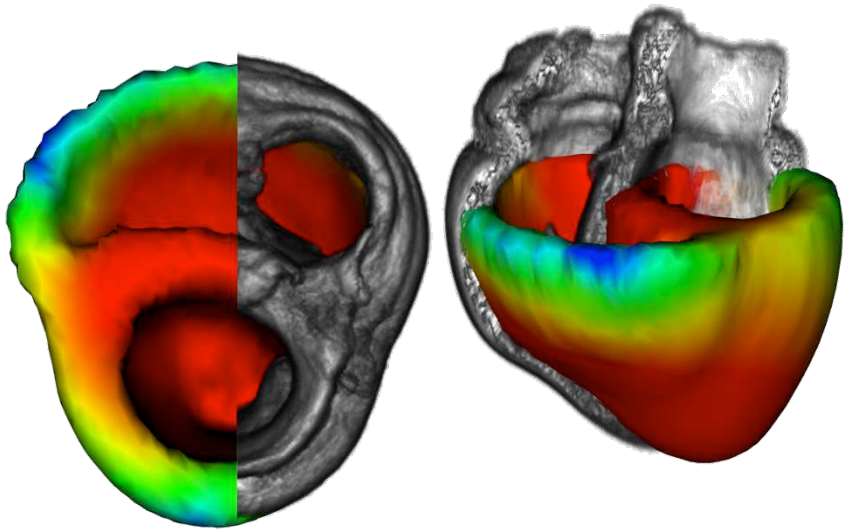




CardioViz3D puis MedInria

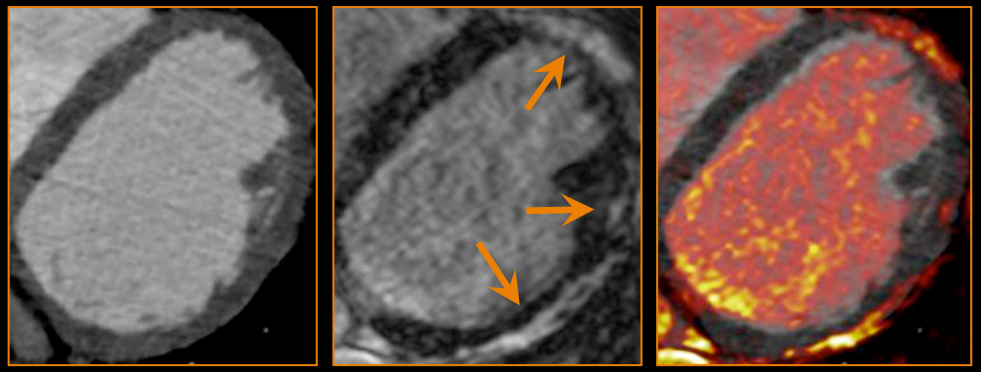




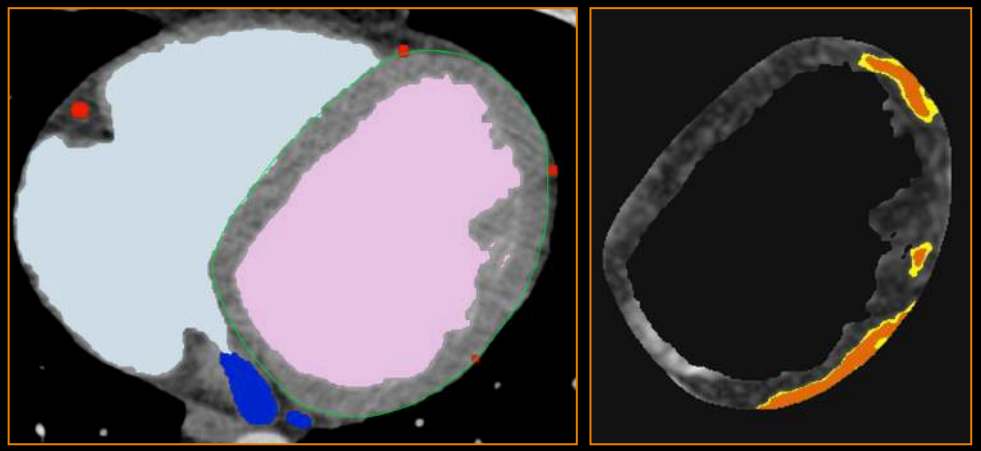


MUSIC fusion scanner IRM

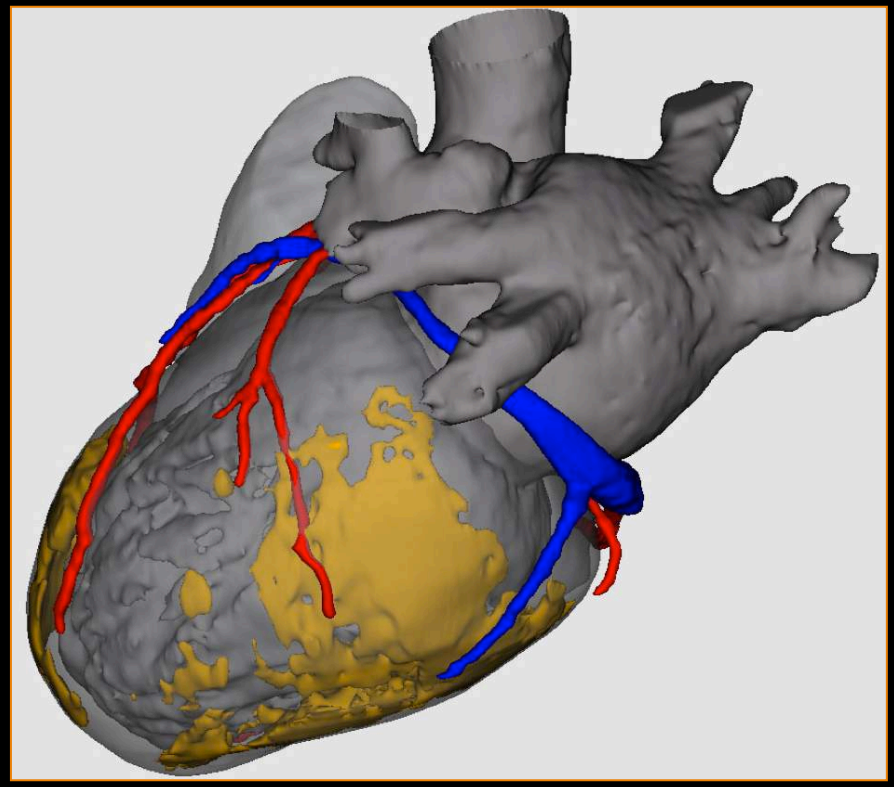
MDCT/MRI FUSION



SEGMENTATION



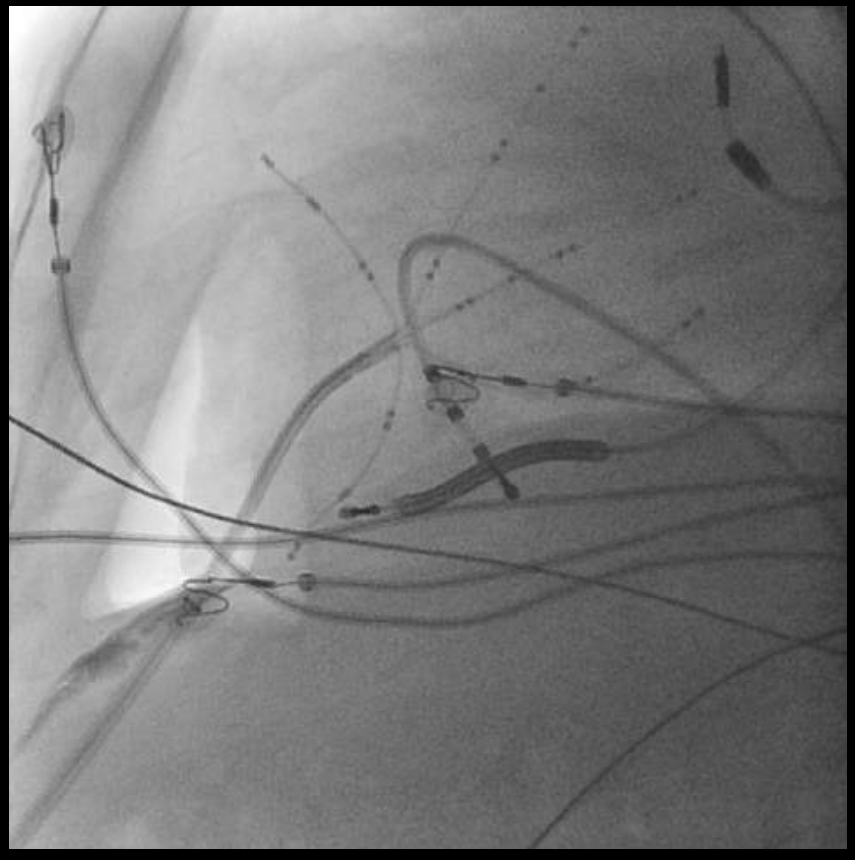
MODELING



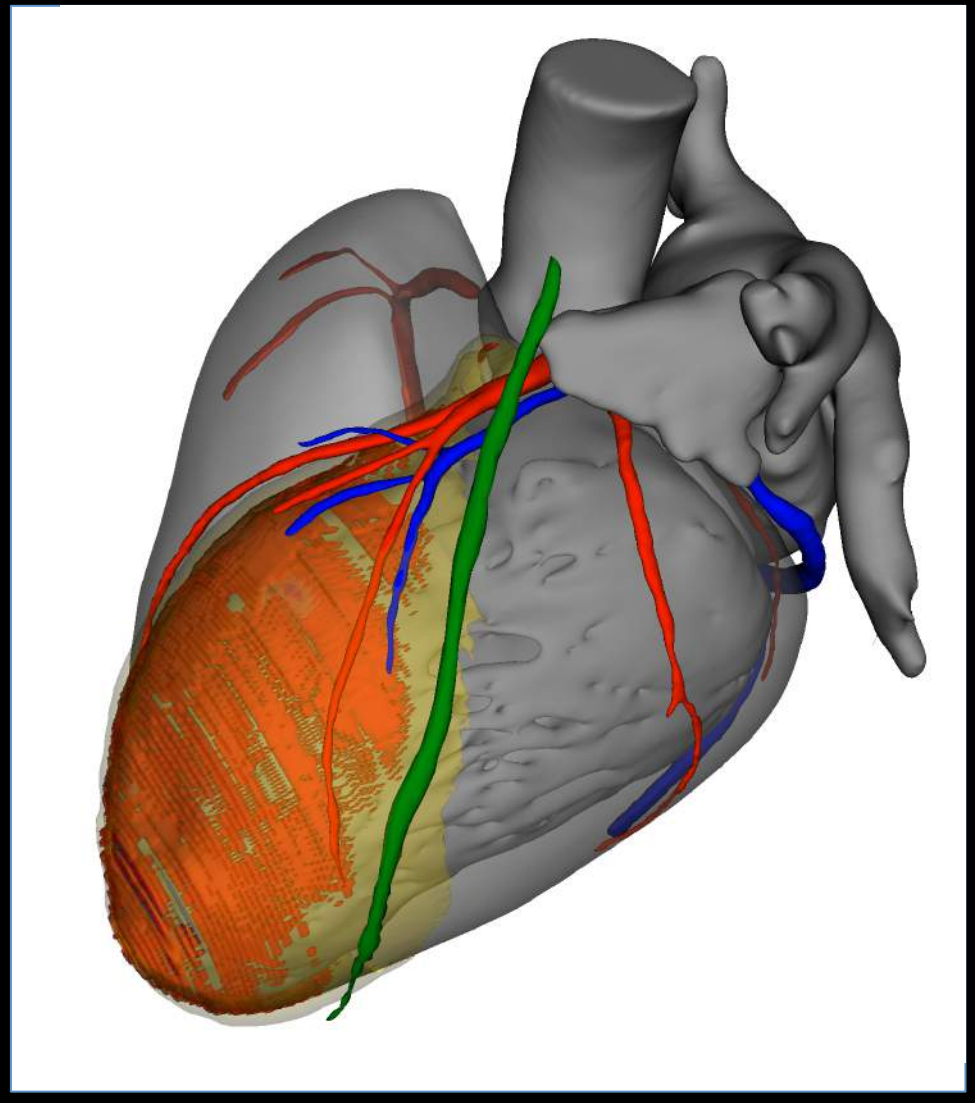
Intégration image et cartographie haute densité

STRUCTURAL SUBSTRATE

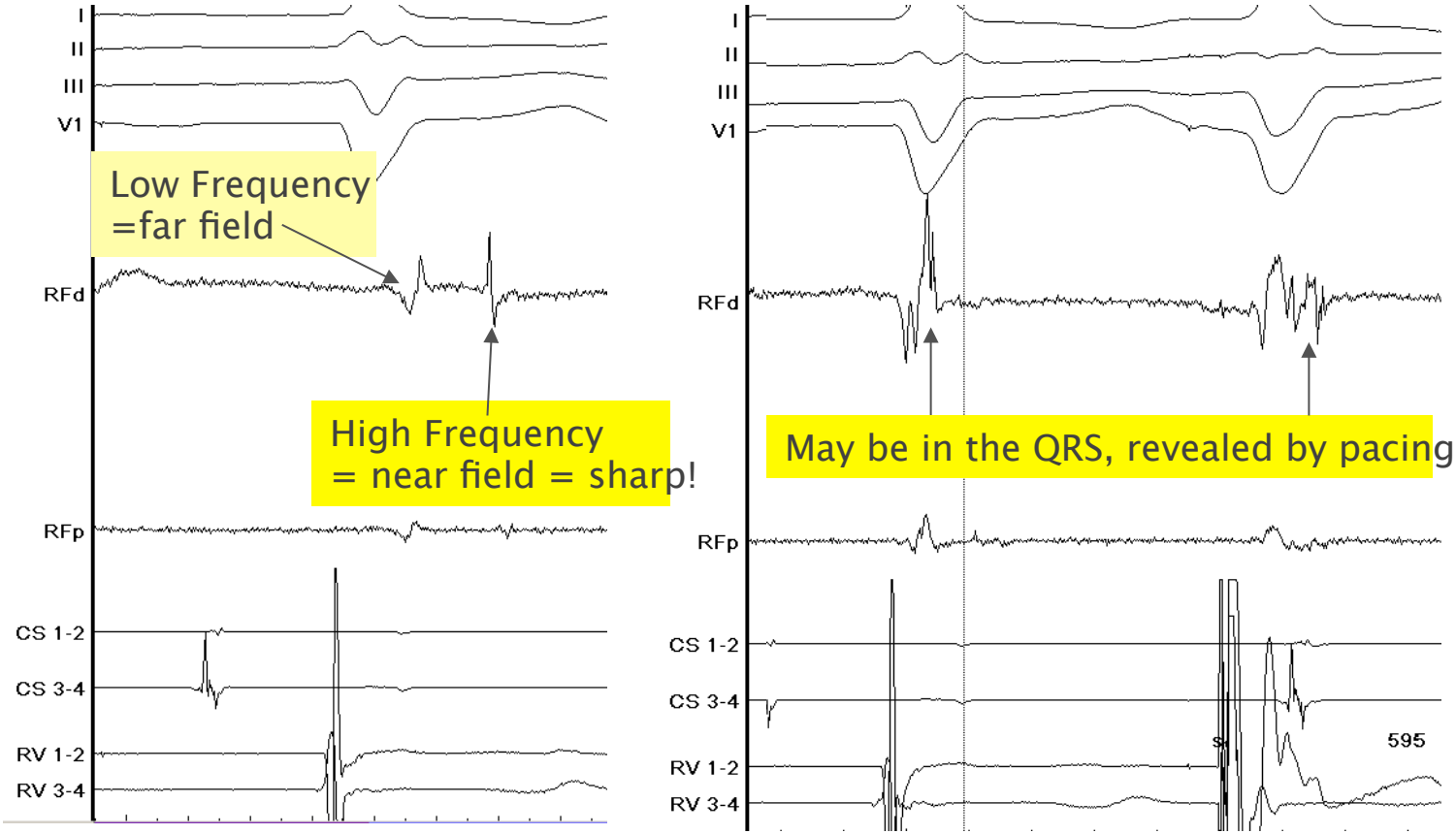
- ISCHEMIC CARDIOMYOPATHY
- DILATED CARDIOMYOPATHY
- MYOCARDITIS
- ARVC
- CONGENITAL …



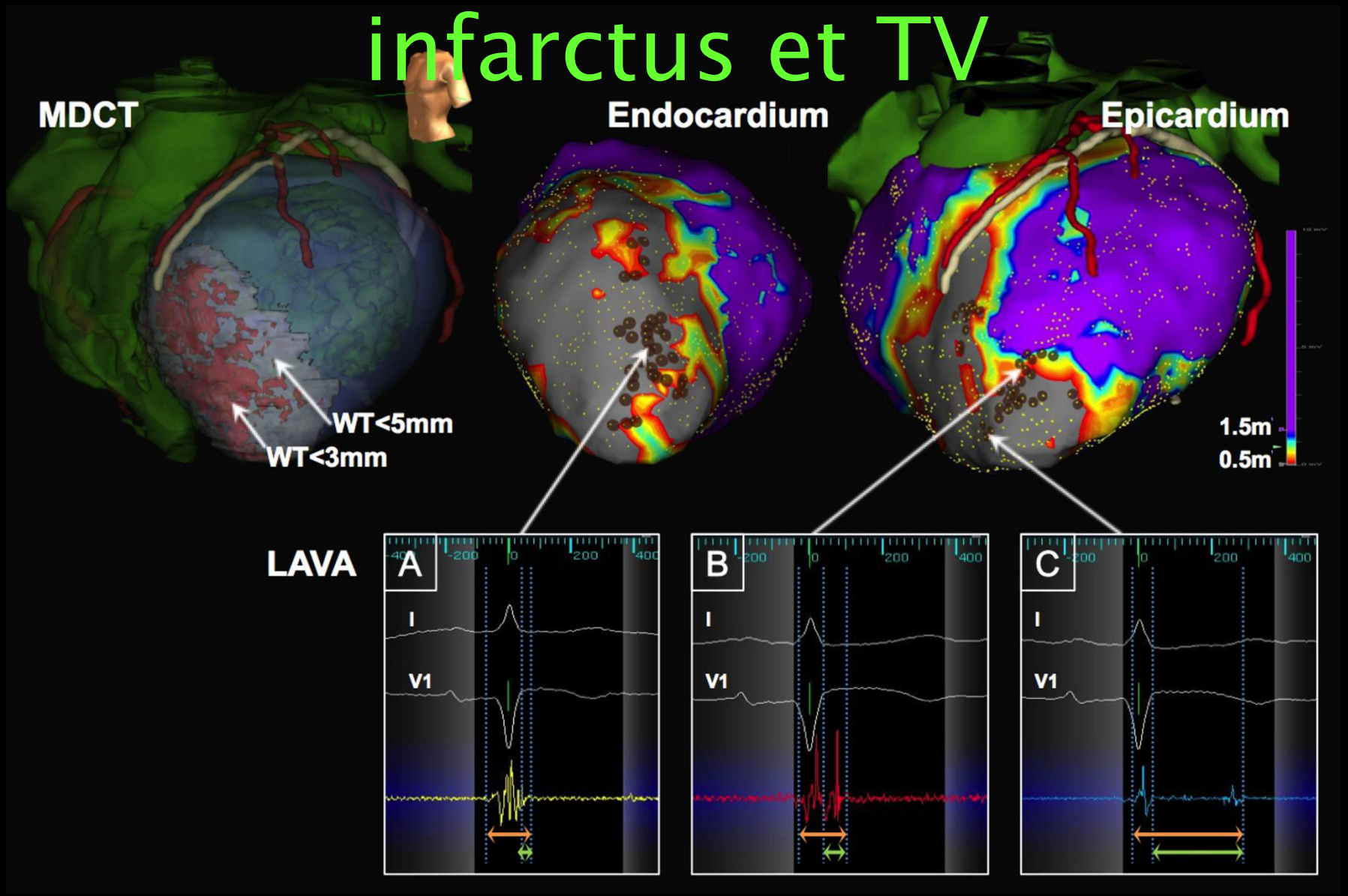
ENABLES MAPPING / ABLATION GUIDANCE

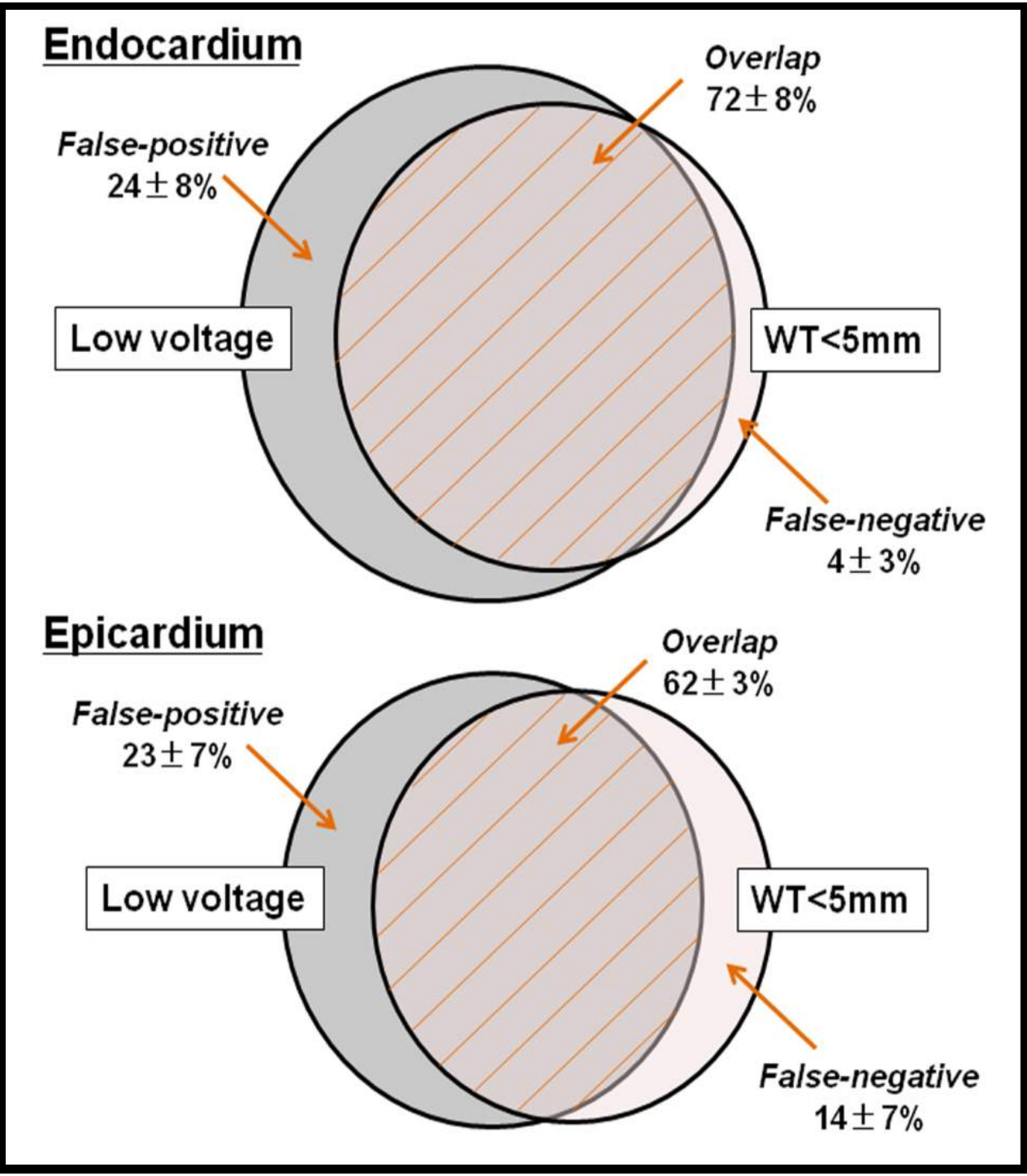


LAVA:
Potentiels anormaux

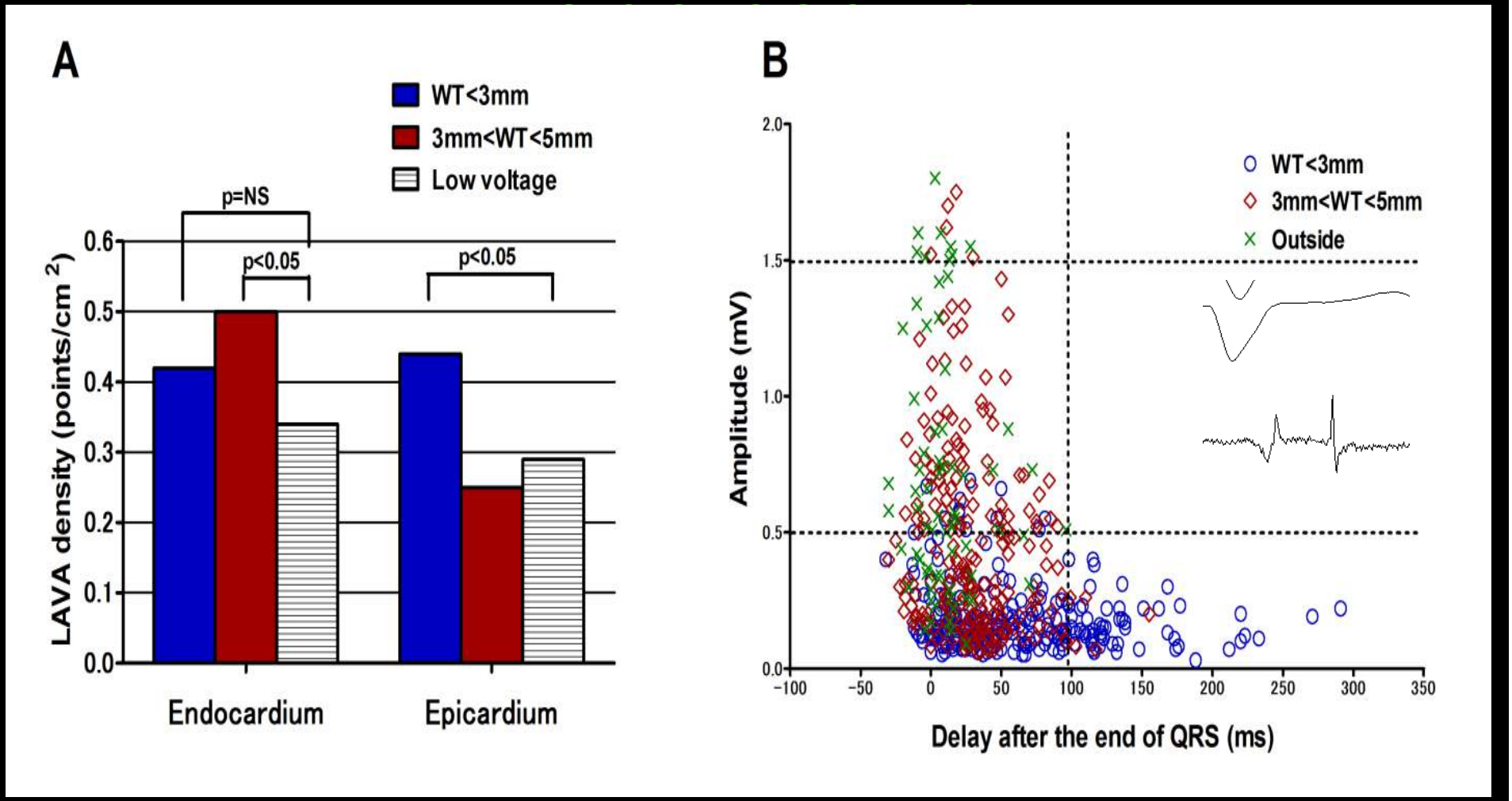


Scanner cardiaque chez 13 patients consecutifs apres infarctus et TV



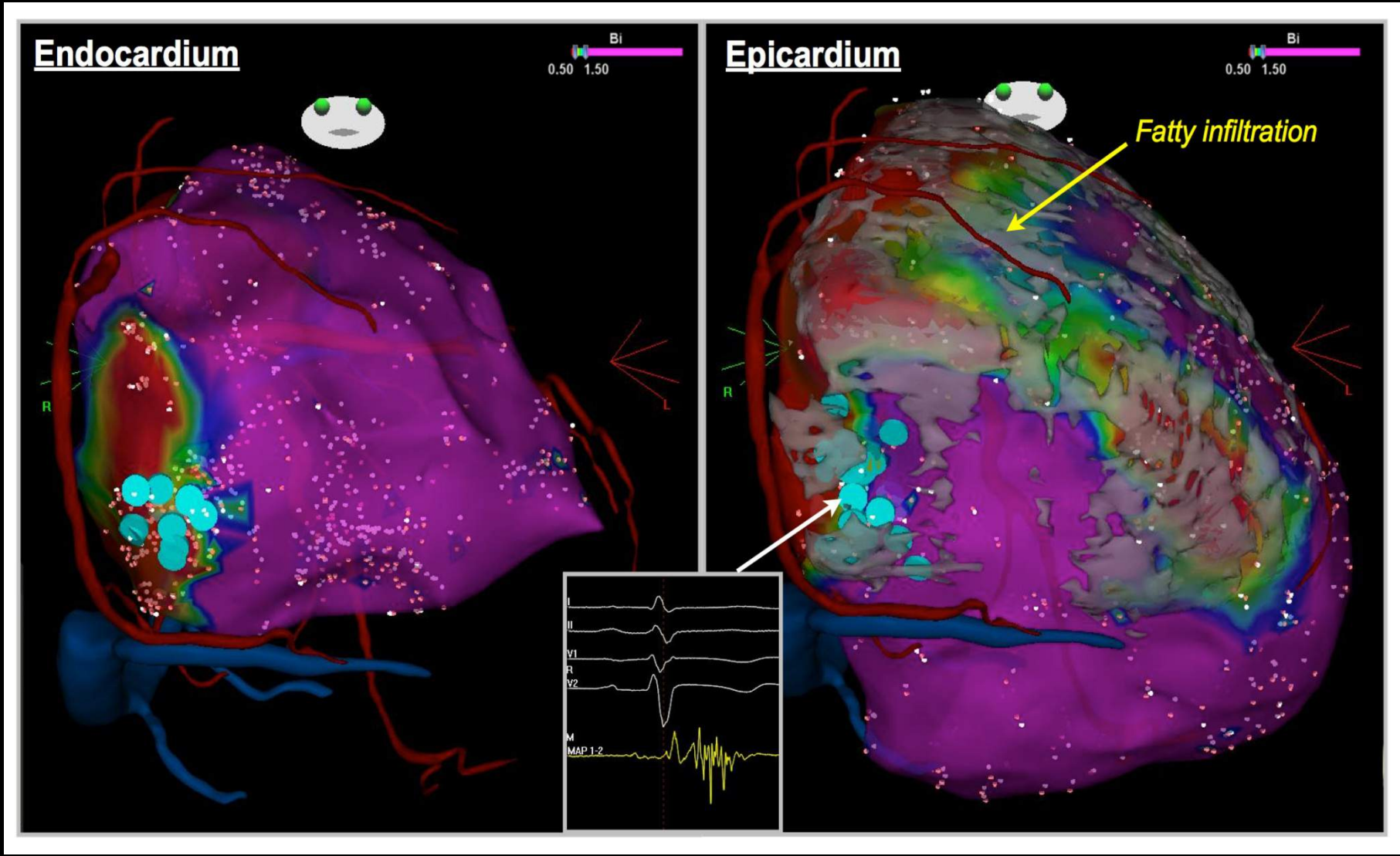

Endocardium
Overlap
72±8%
False-positive
24±8%
Low voltage
WT<5mm
False-negative
4±3%
Epicardium
Overlap
62±3%
False-positive
23±7%
Low voltage
WT<5mm
False-negative
14±7%

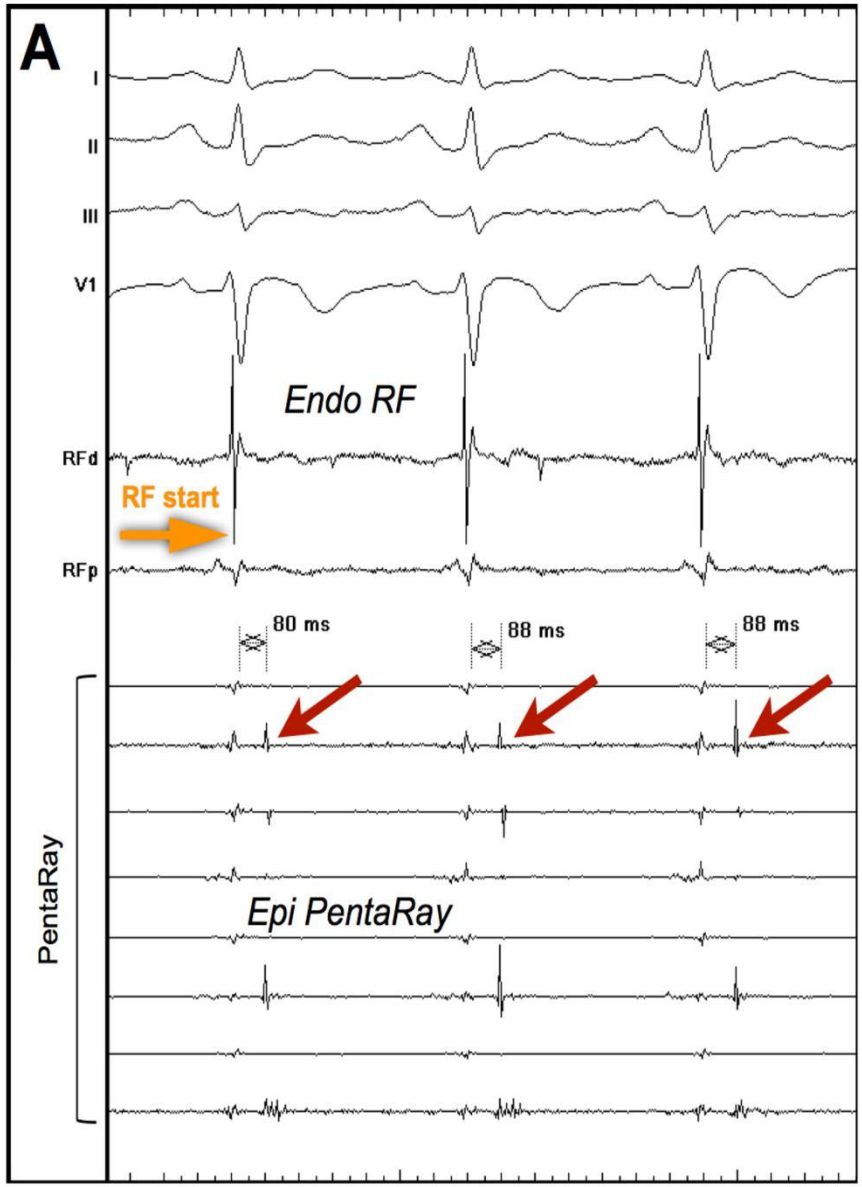
15,000 électrogrammes analysés,
538 LAVA; 87% LAVA <5mm

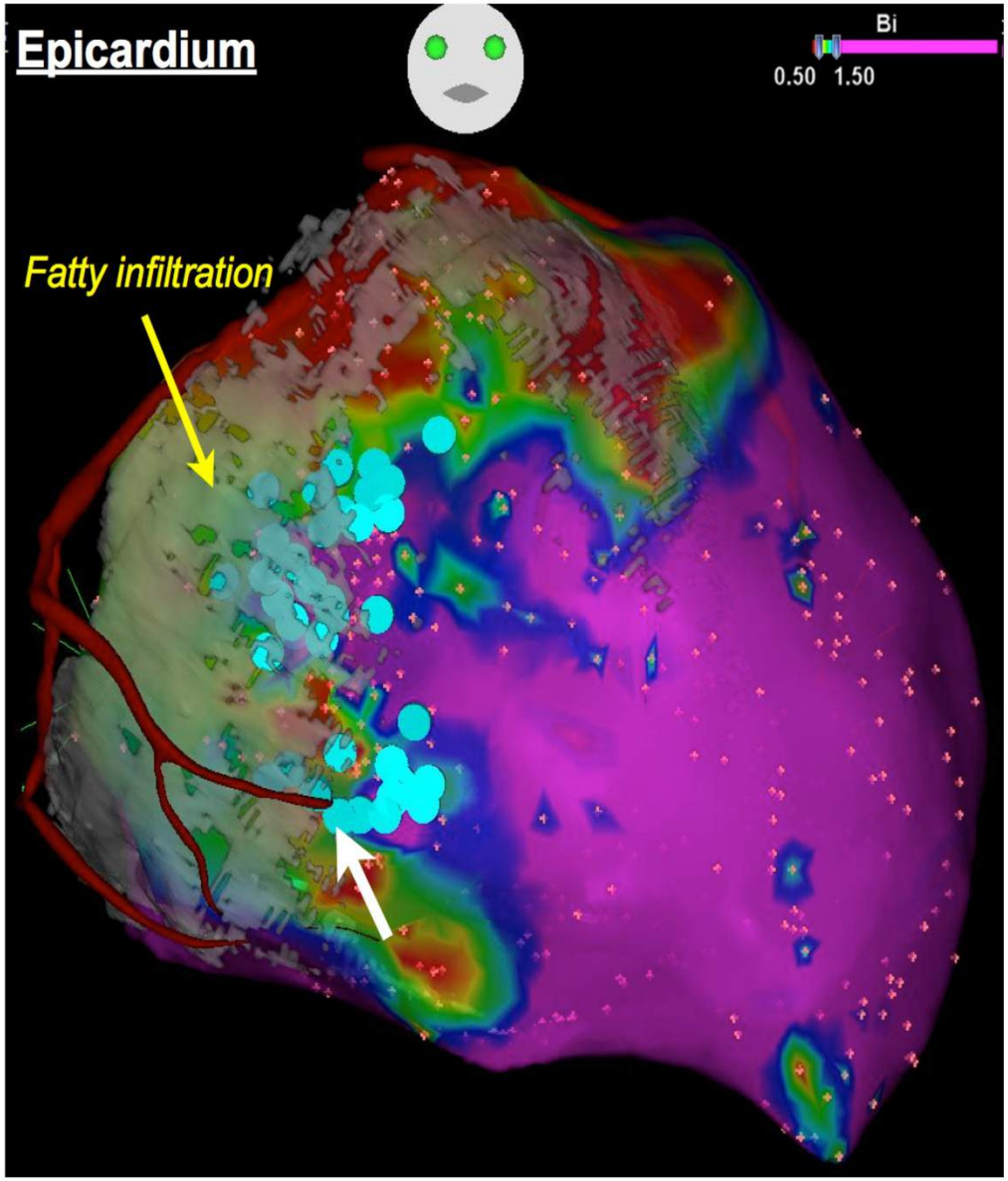


Ablation TV guidée par imagerie (DAVD)

Relation structure fonction

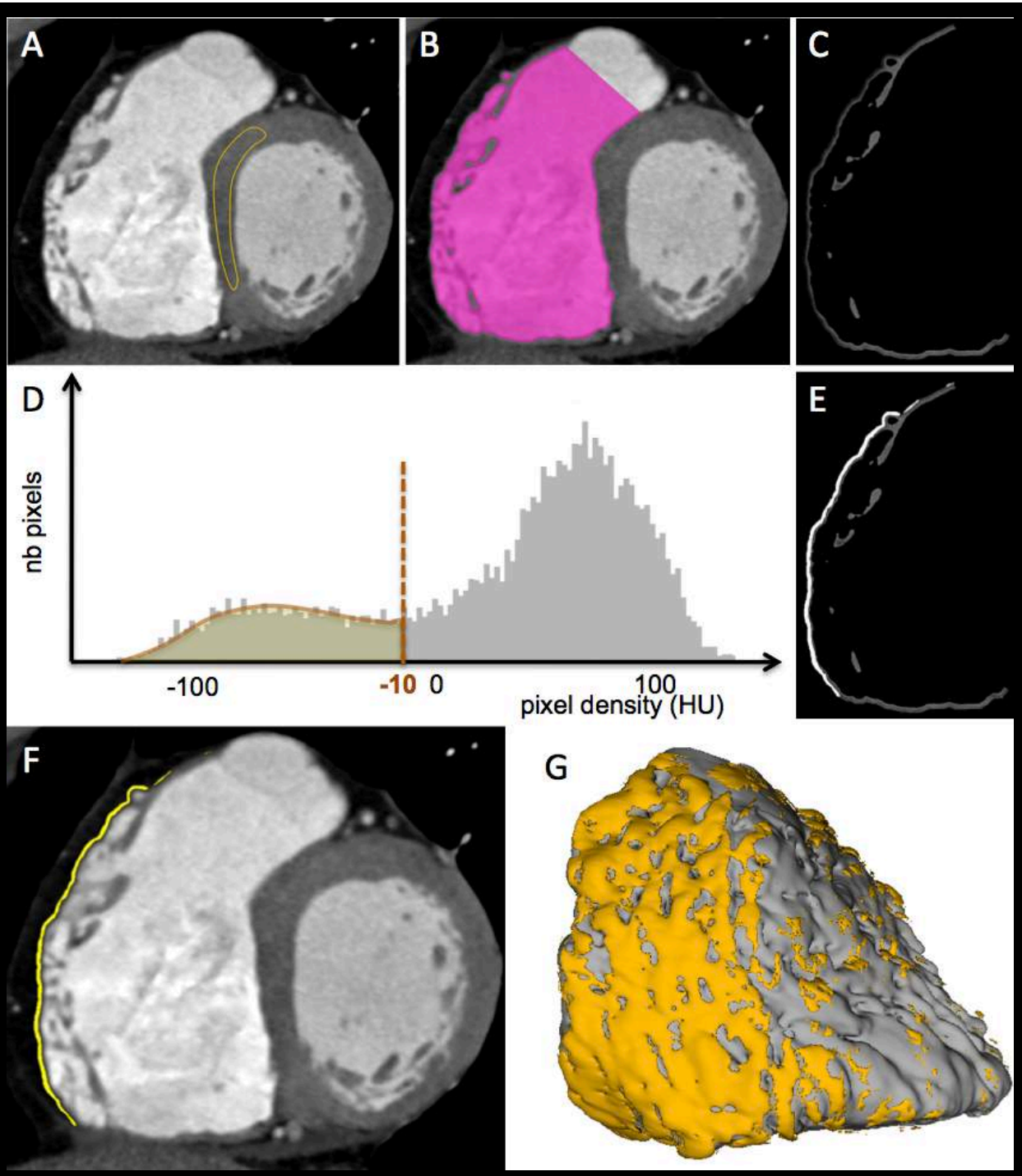


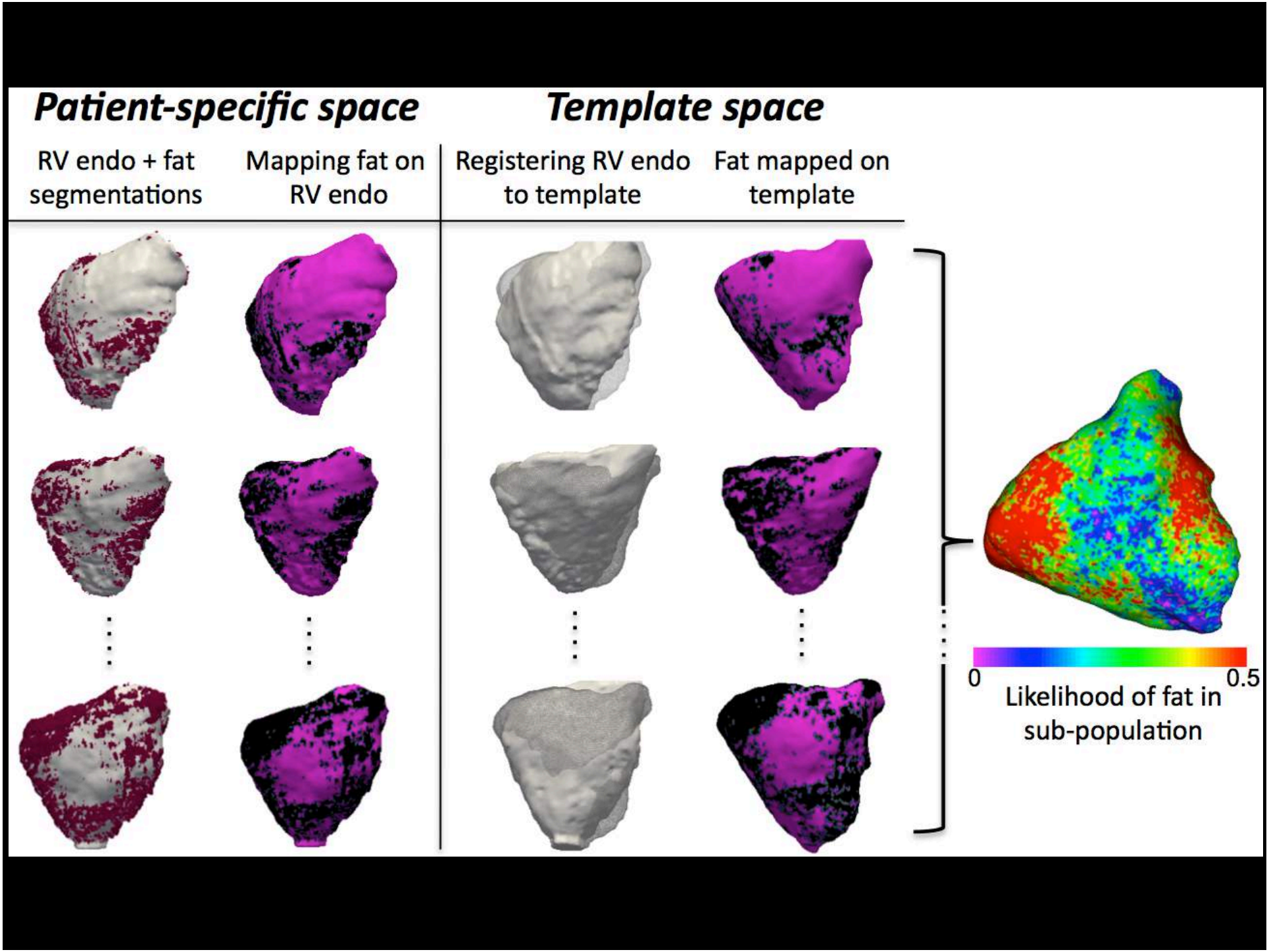

A
I
II
III
V1
Endo RF
RFd
RF start
RFp
80 ms
88 ms
88 ms
PentaRay
Epi PentaRay

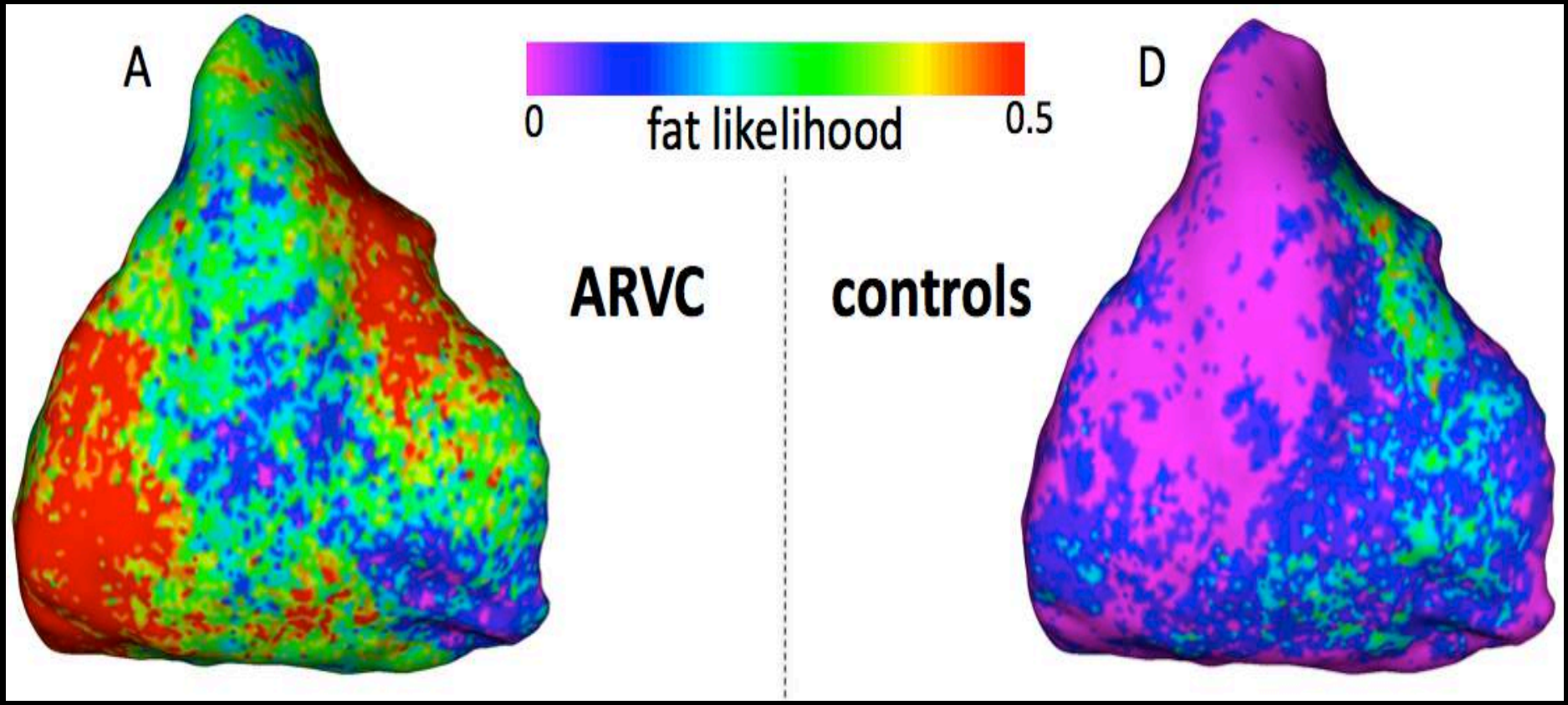

Epicardium
Bi
0.50 1.50
Fatty infiltration

Ablation Endocardique, monitoring epicardique

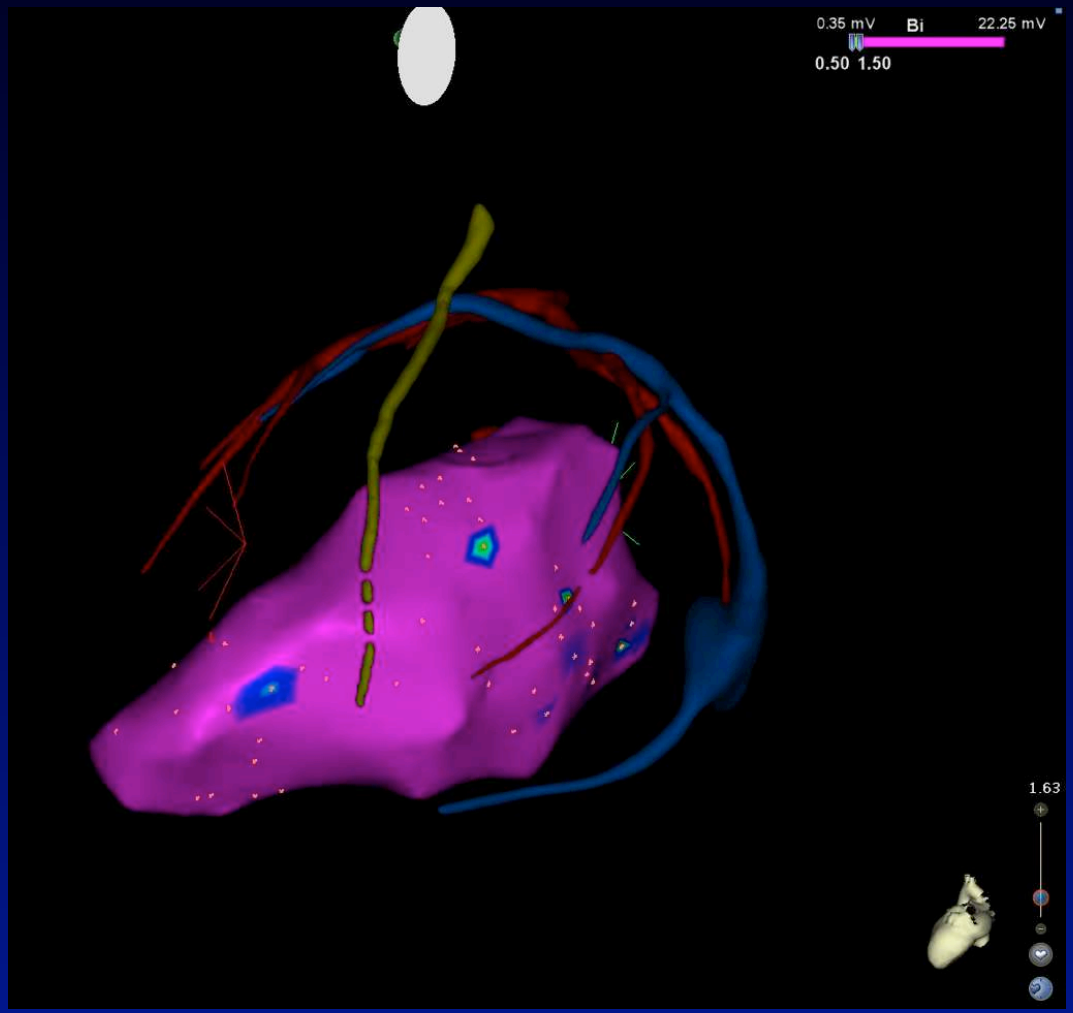
H Cochet…..P Jaïs
soumis
36 DAVD pts
scanner
(IMR chez 20)
Comparés a 36
Pts controles
& 36 ischémiques



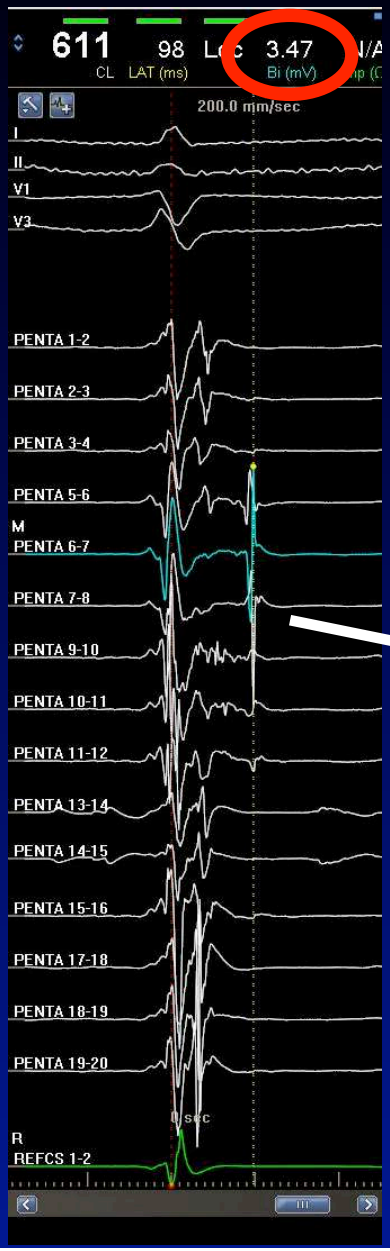

Patient-specific space
Template space
RV endo + fat segmentations
Mapping fat on RV endo
Registering RV endo to template
Fat mapped on template
0
0.5
Likelihood of fat in sub-population

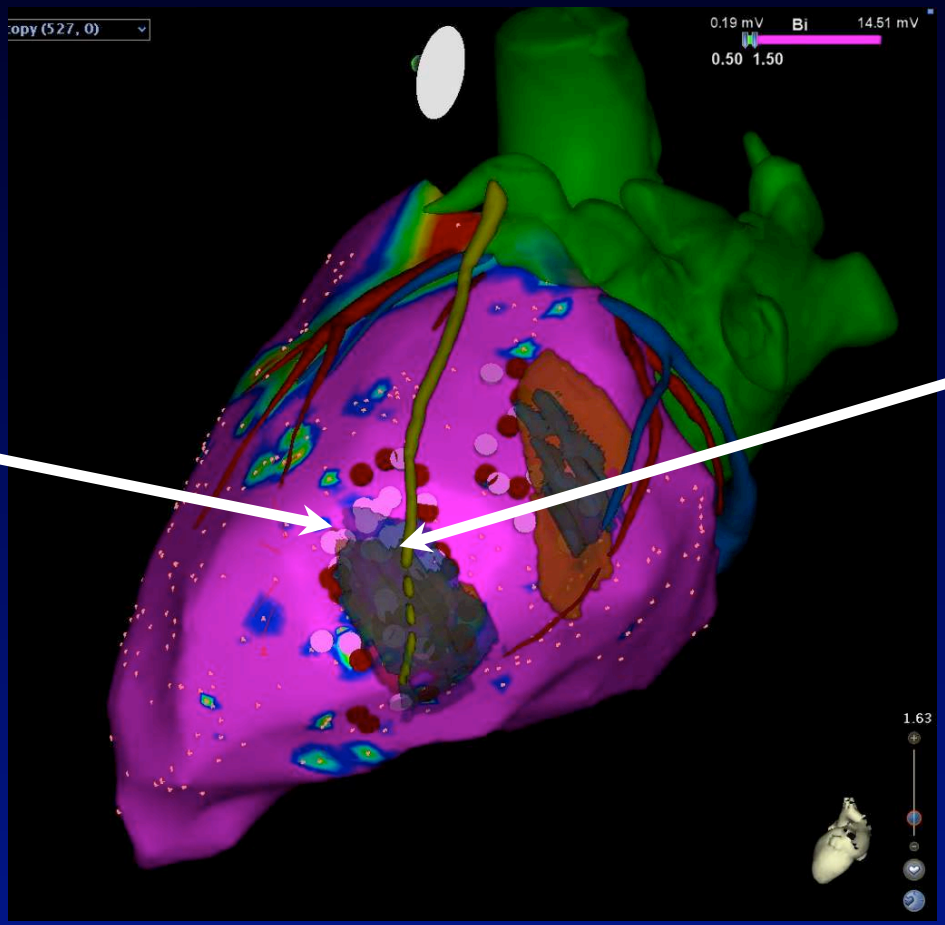

A
0
fat likelihood
0.5
D
ARVC
controls

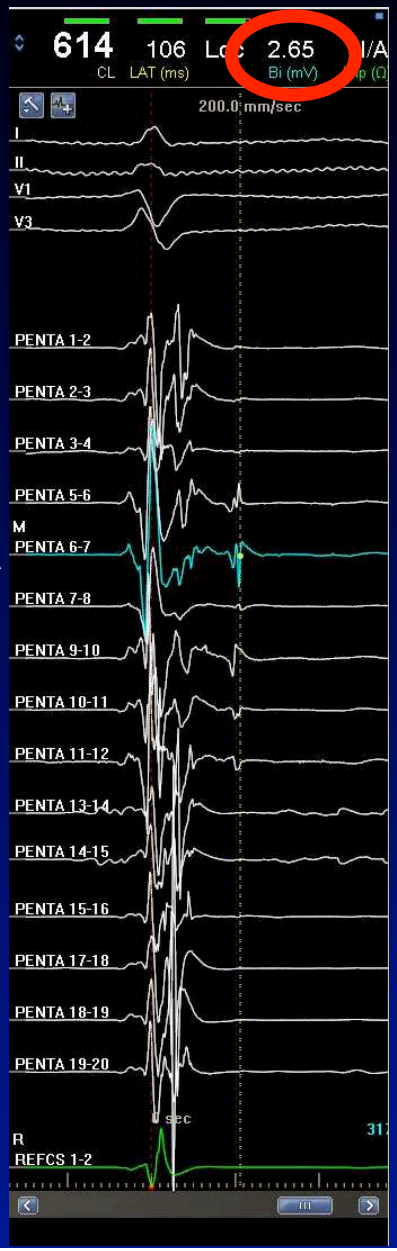
Cartographie endocardique normale…



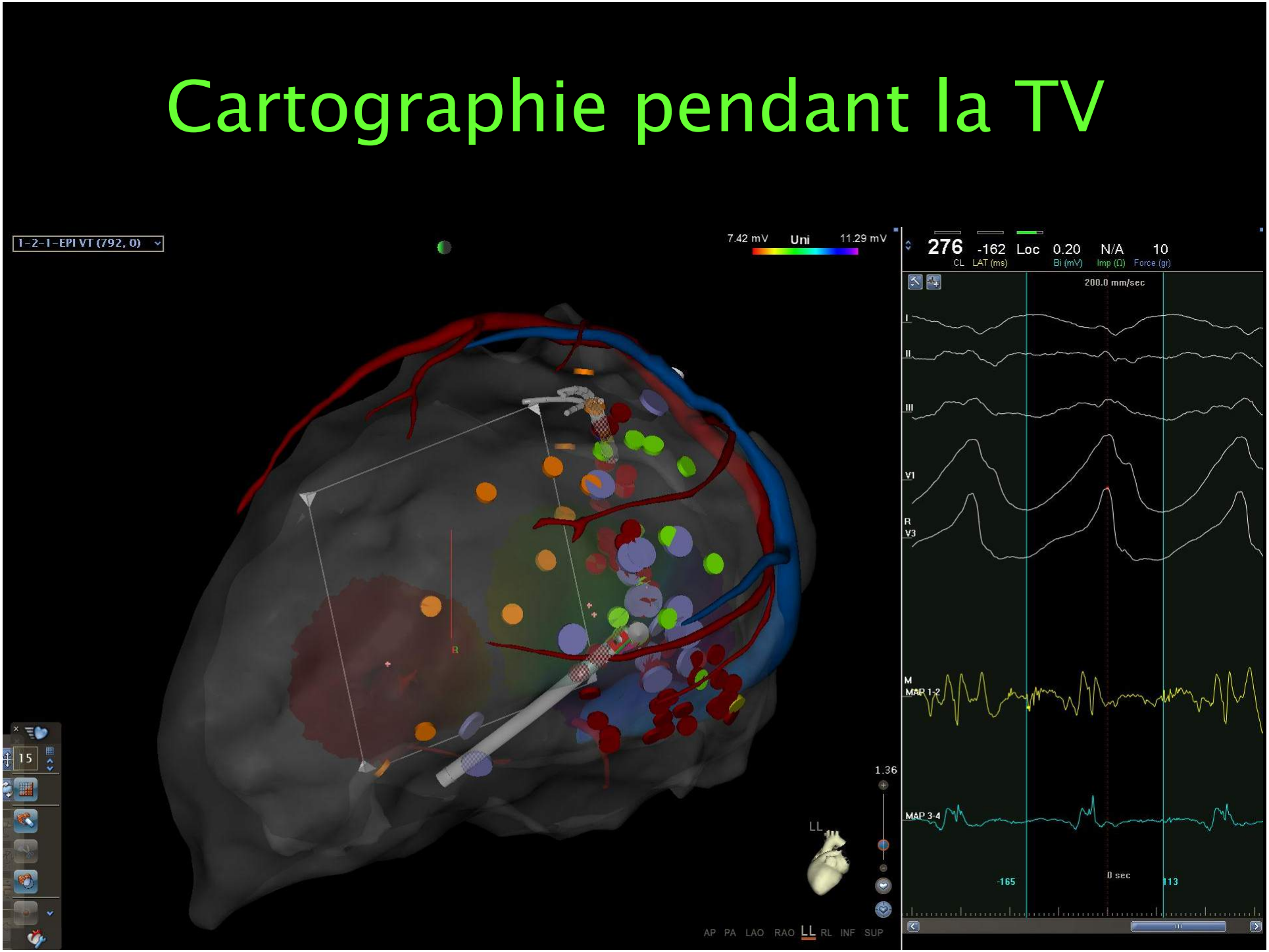
Mais la face epicardique est très anormale, comme prédit par l'imagerie

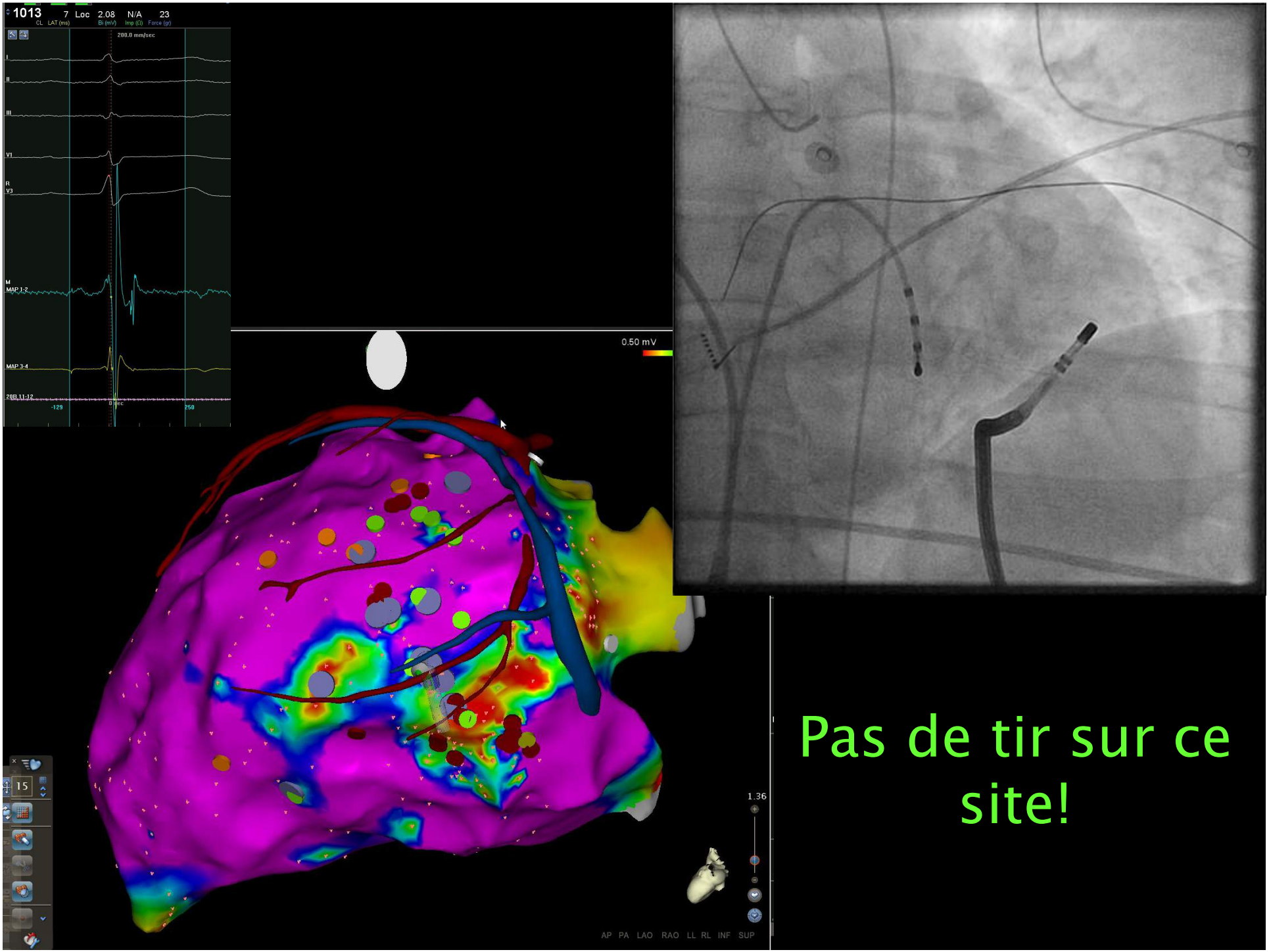






Cartographie pendant la TV



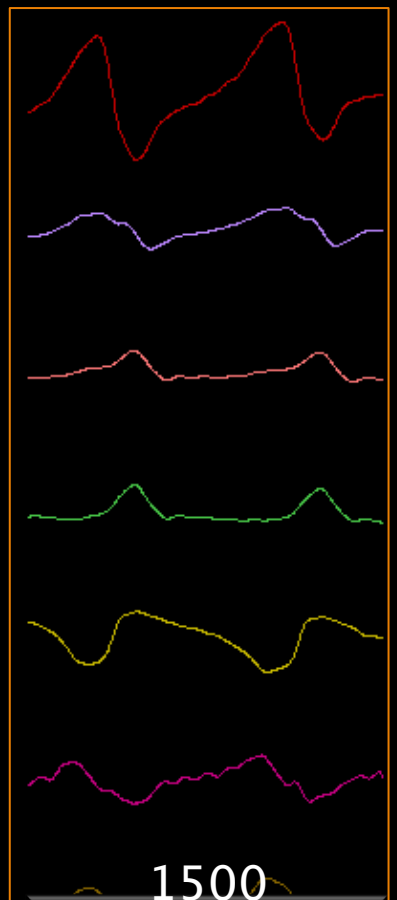

1013 7 Loc 2.08 N/A 23
CL LAT (ms) Bi (mV) Imp (Ω) Force (gr)
200.0 mm/sec
I
II
III
V1
R
V3
M
MAP 1-2
MAP 3-4
20B 11-12
-129
0 sec
250
0.50 mV
15
1.36
AP PA LAO RAO LL RL INF SUP
Pas de tir sur ce site!

MYOCARDITE

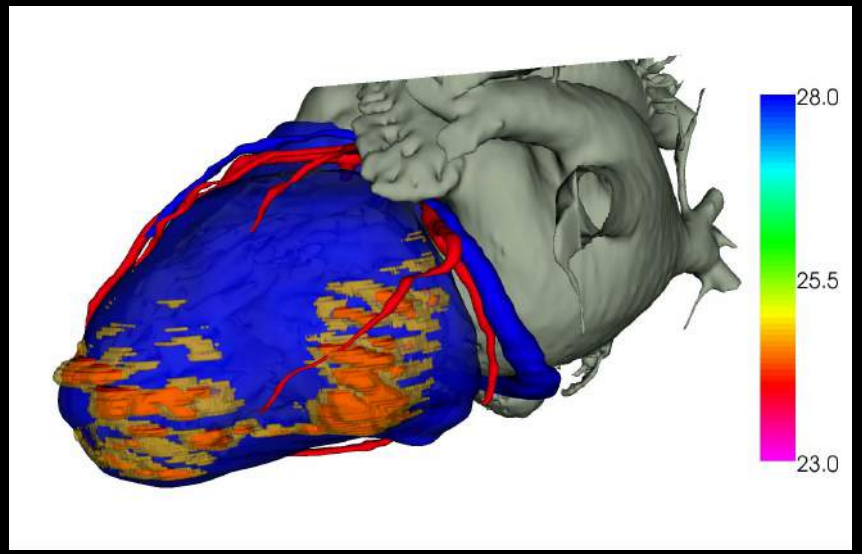
CARTO ECG: VT activation map

252 electrode vest

Heart-torso geometry (CT)

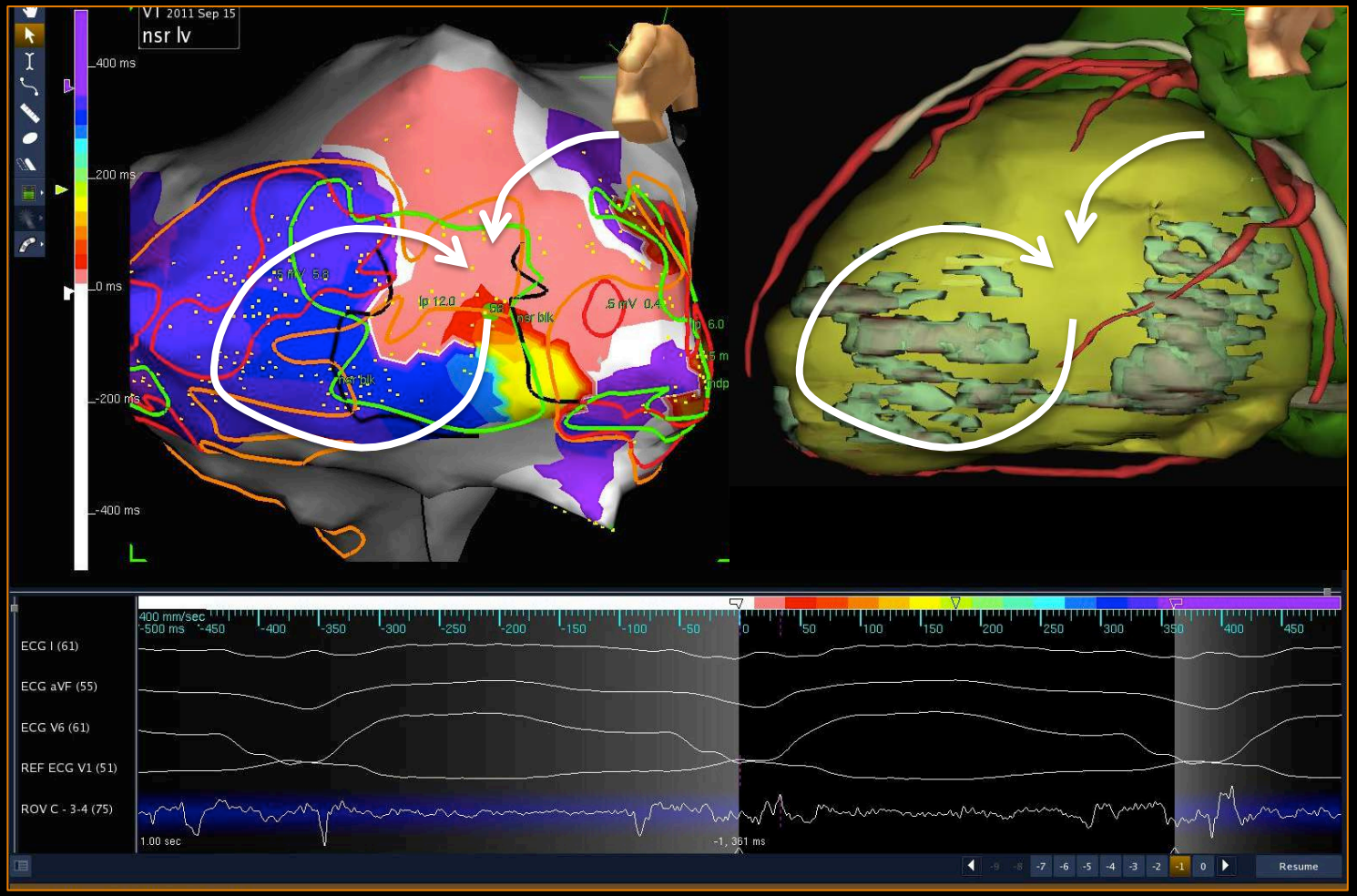


1500 Epicardial Unipolar EGMs



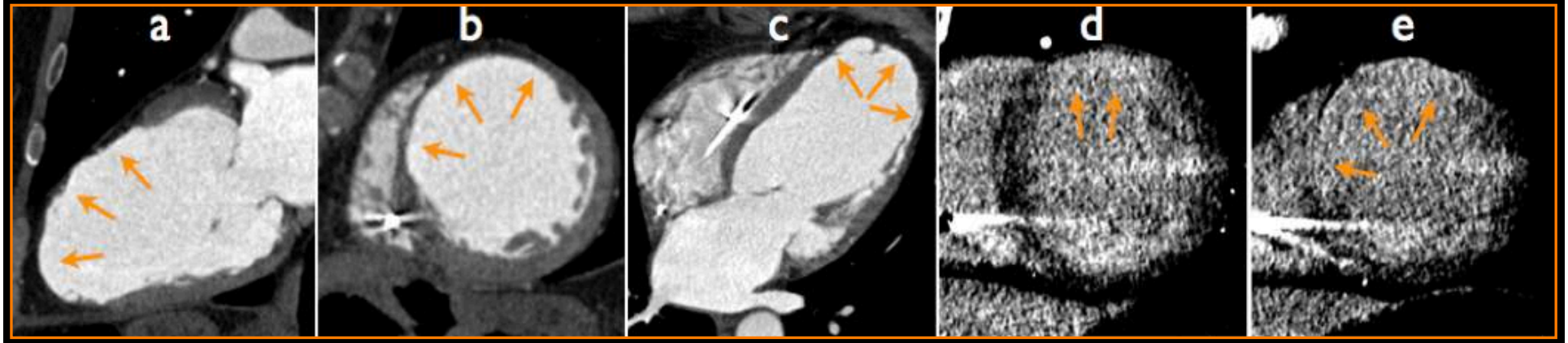
MYOCARDITE

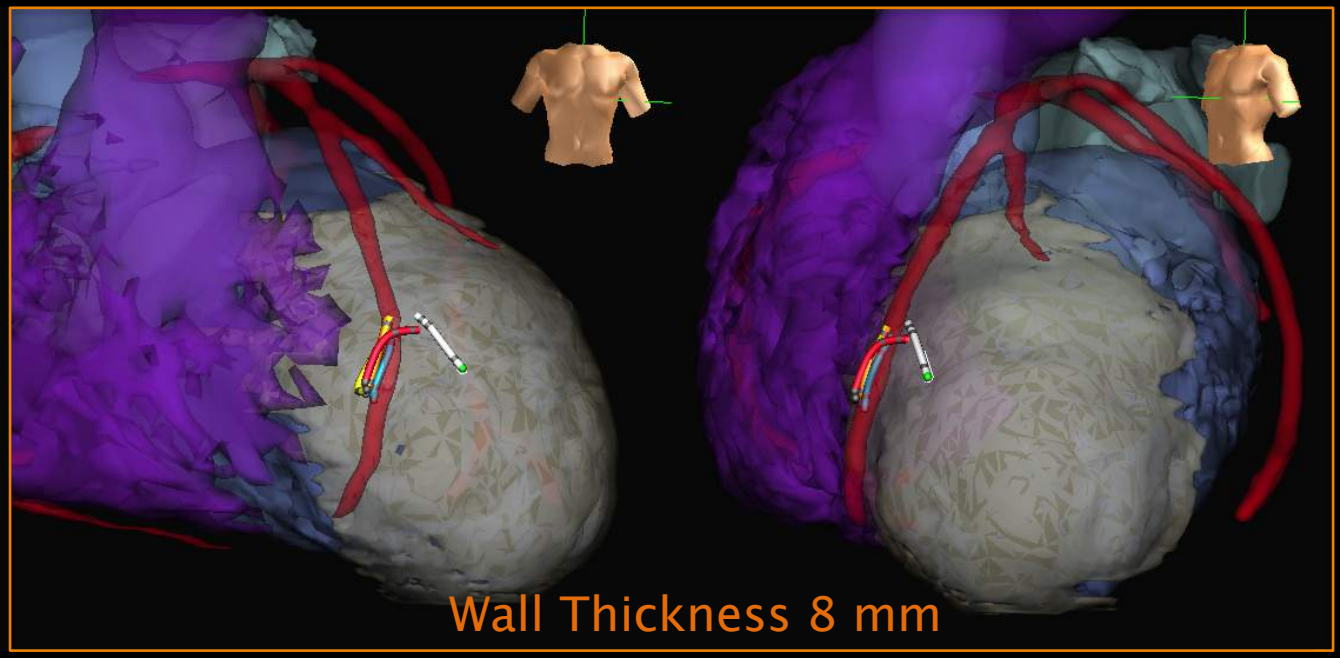
INVASIVE MAPPING CONFIRMED THE SITE



Cardiopathie ischémique

History: 58 yo man with ischemic cardiomyopathy. Recurrent ICD shocks

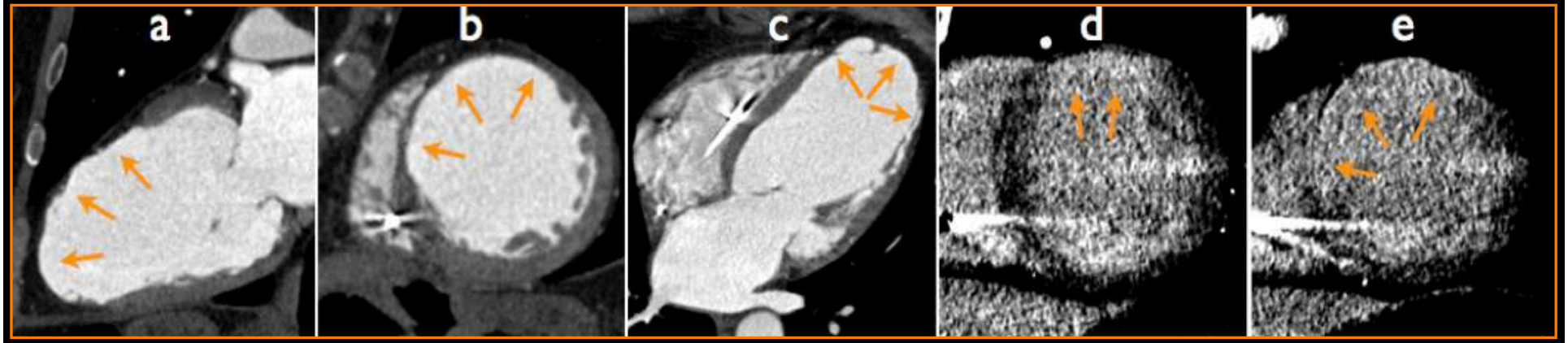


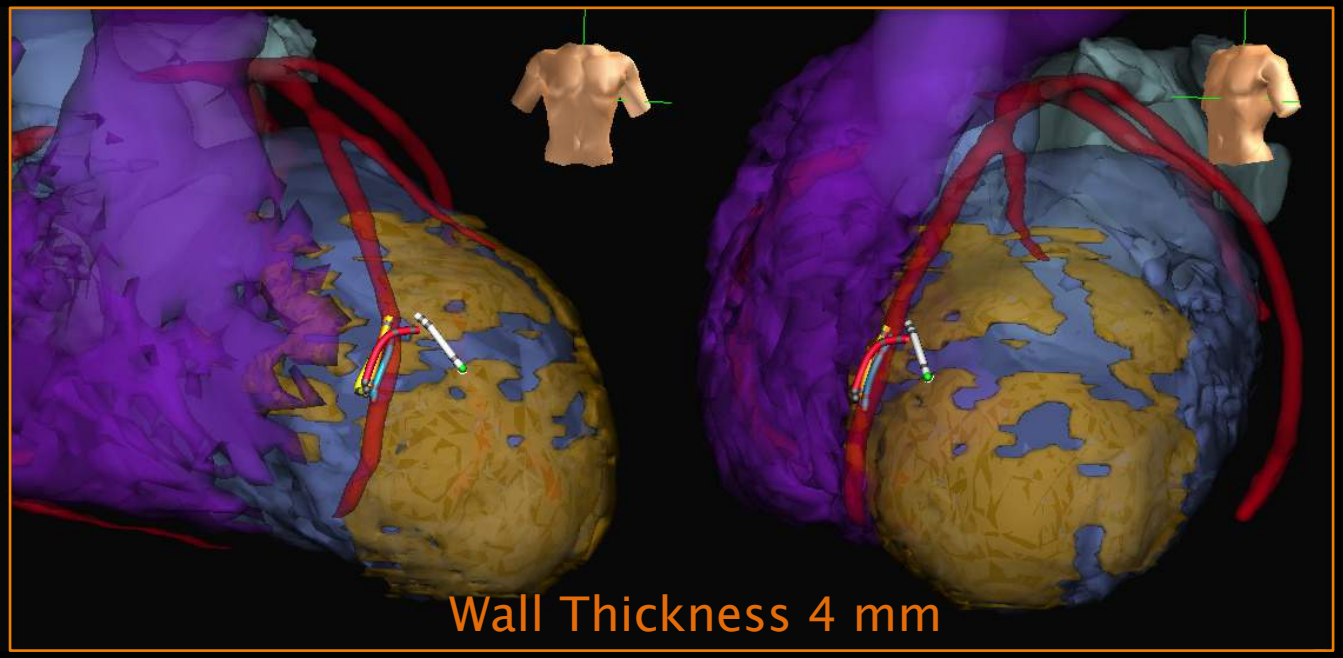


Wall Thickness 8 mm

Cardiopathie ischémique

History: 58 yo man with ischemic cardiomyopathy. Recurrent ICD shocks

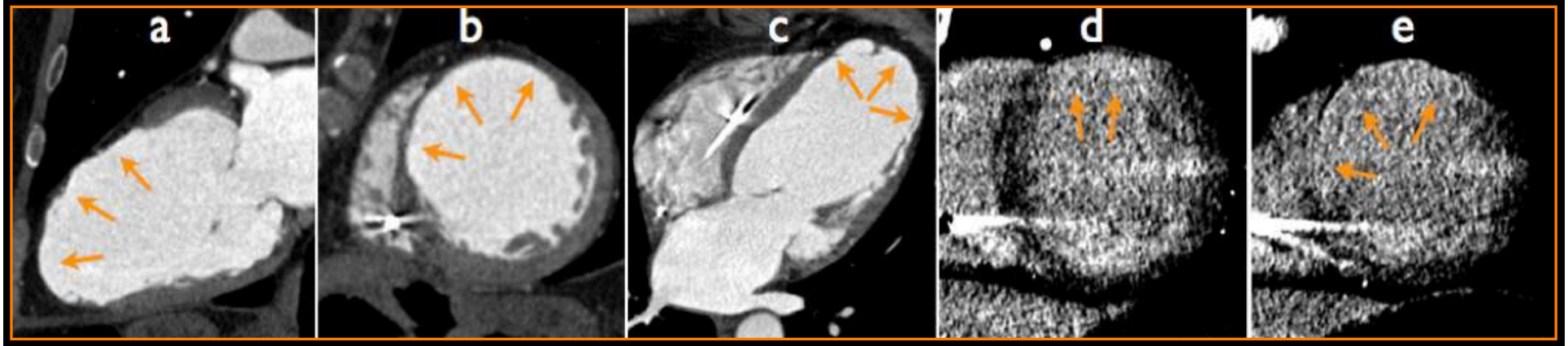


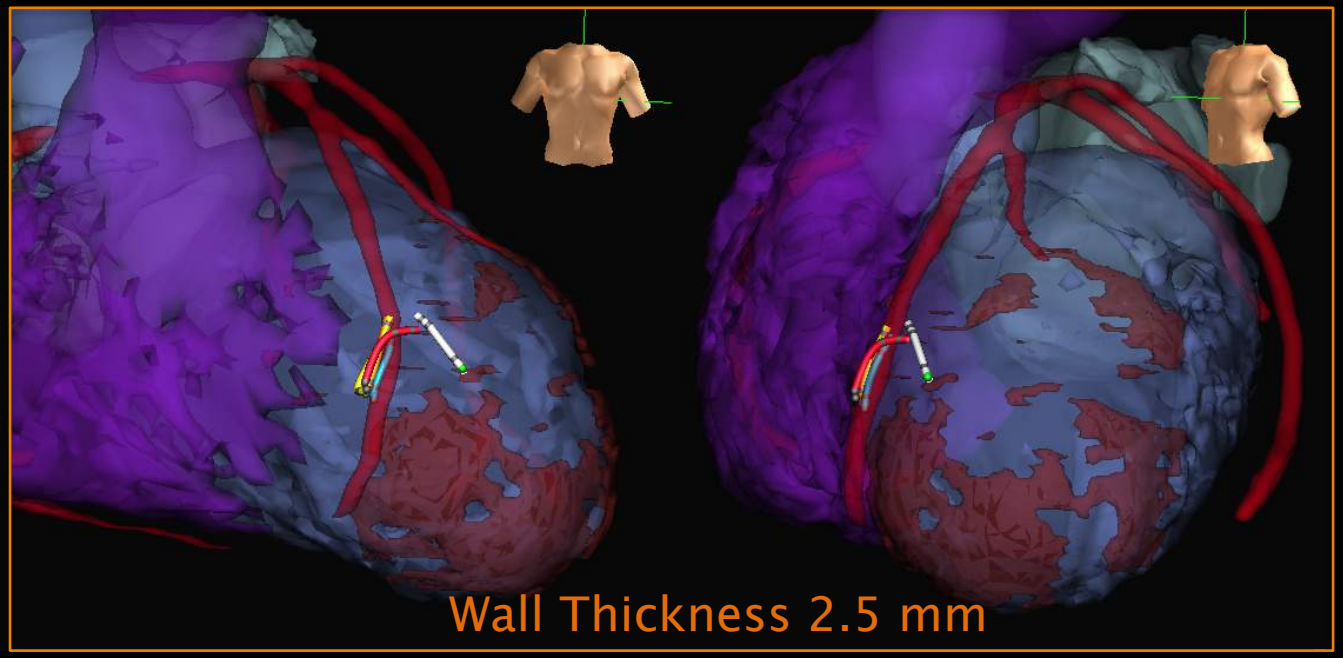


Wall Thickness 4 mm

Cardiopathie ischémique

History: 58 yo man with ischemic cardiomyopathy. Recurrent ICD shocks

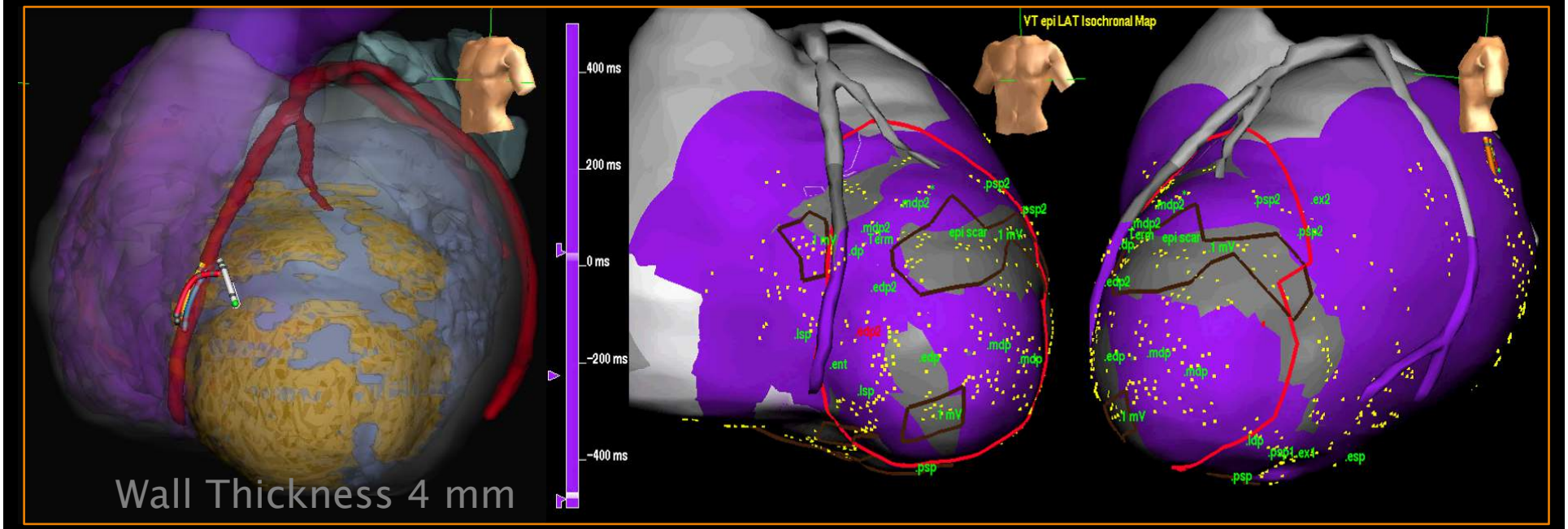




Wall Thickness 2.5 mm

Cardiopathie ischémique

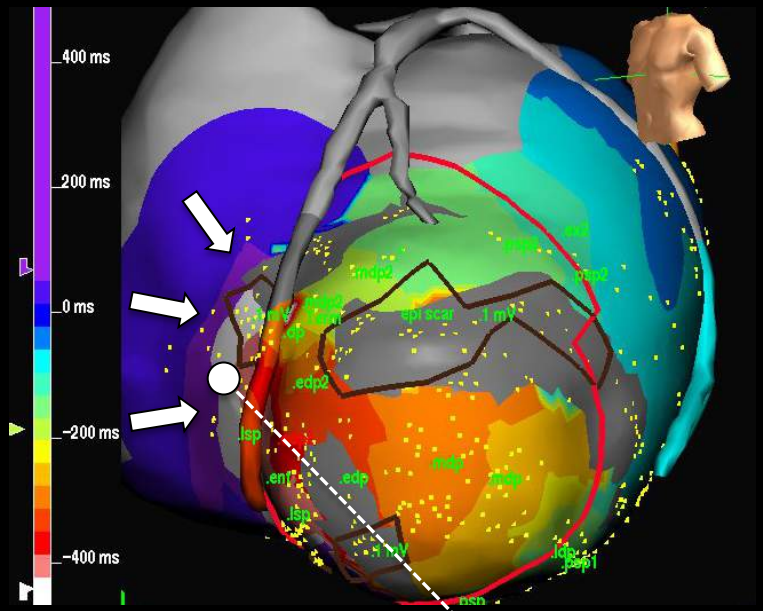
WALL THINNING vs VT ACTIVATION

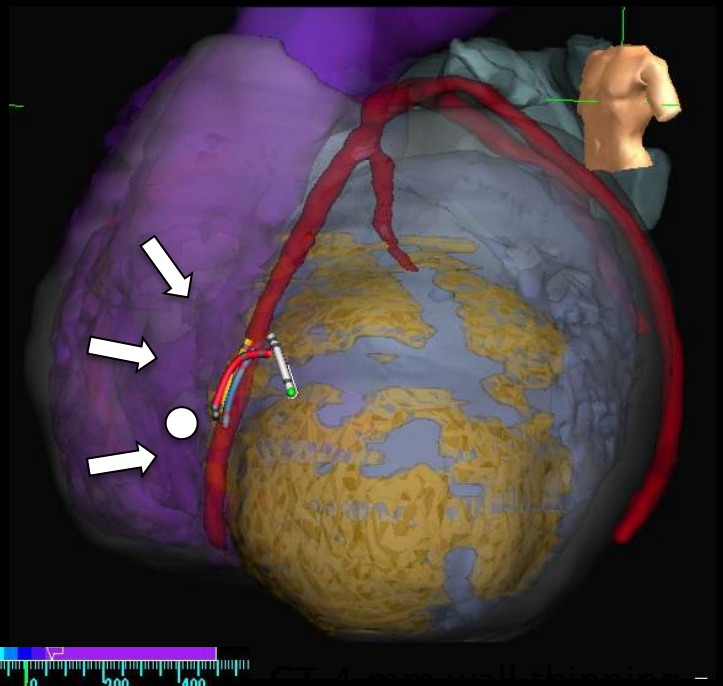


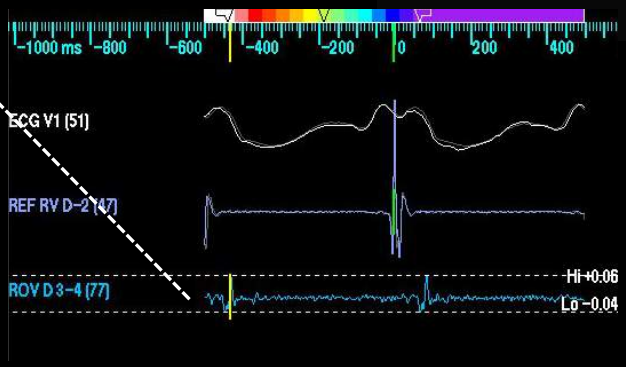
Cardiopathie ischémique

ISTHMUS ENTRY

LATE SYSTOLIC



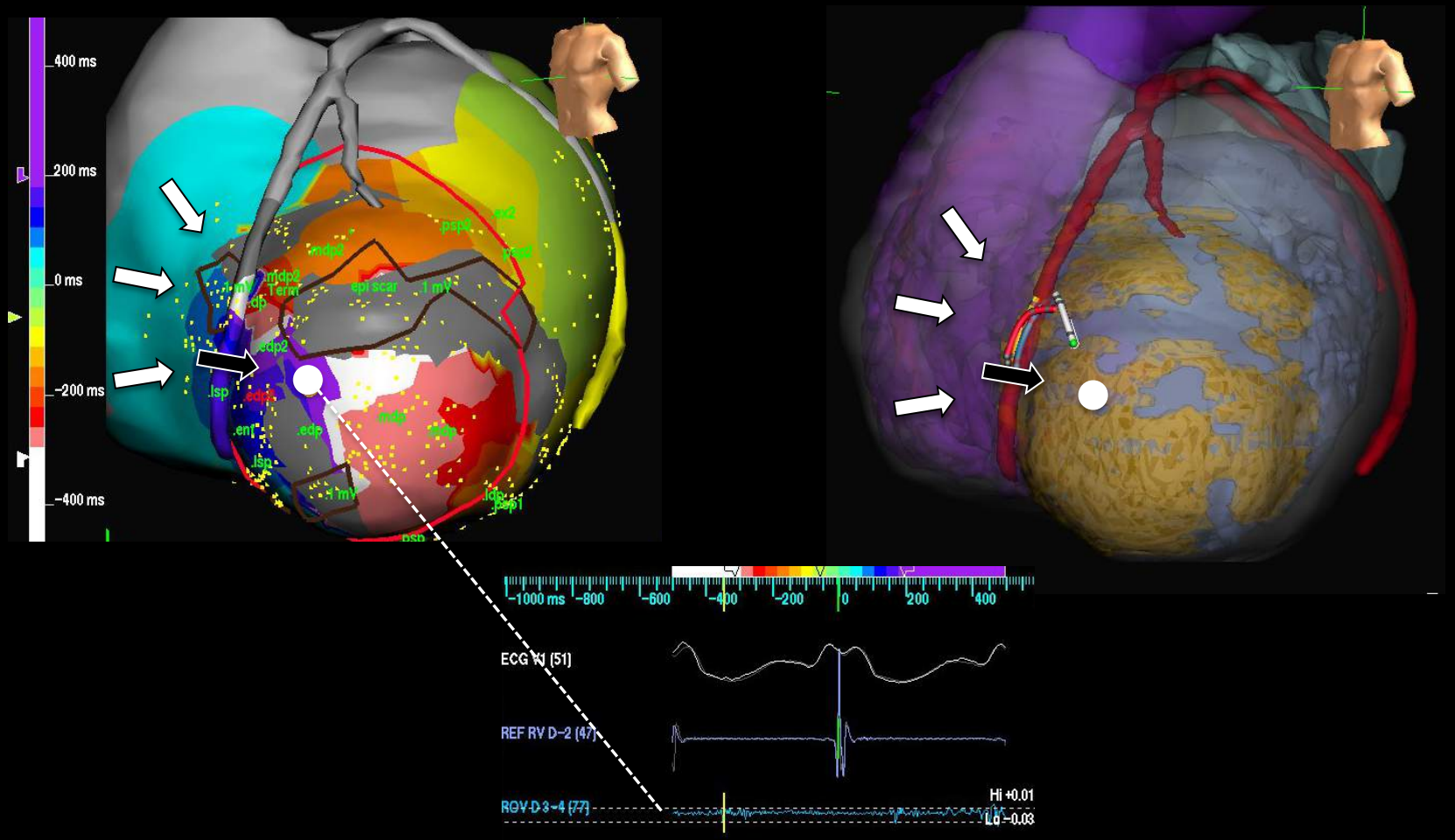




Cardiopathie ischémique

CHANNEL 1

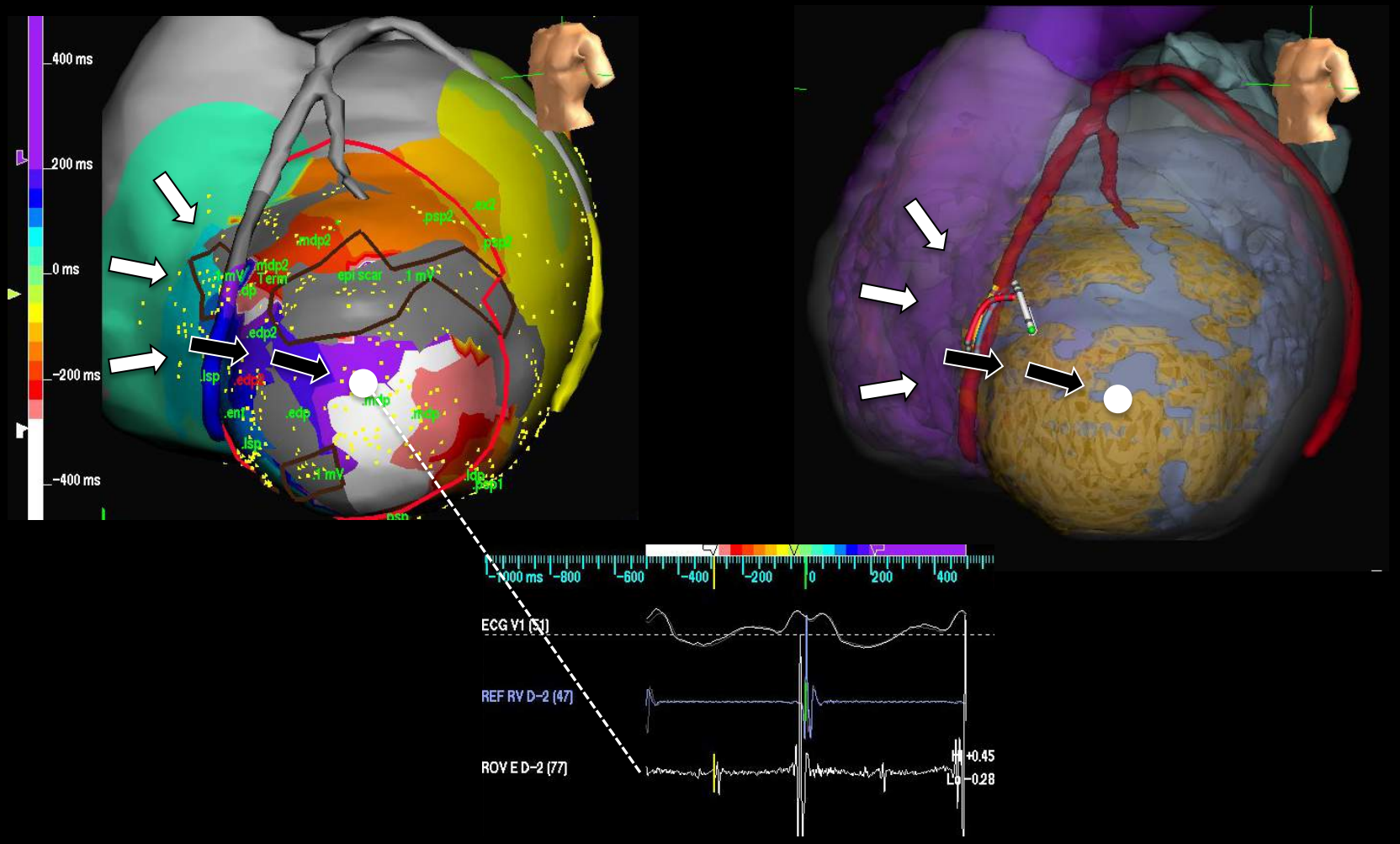
EARLY DIASTOLIC



Cardiopathie ischémique

CHANNEL 1

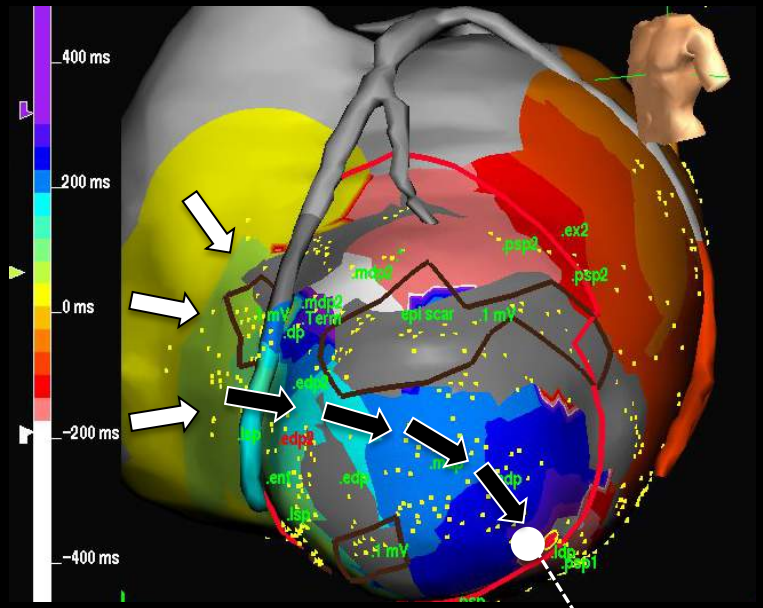
MID DIASTOLIC

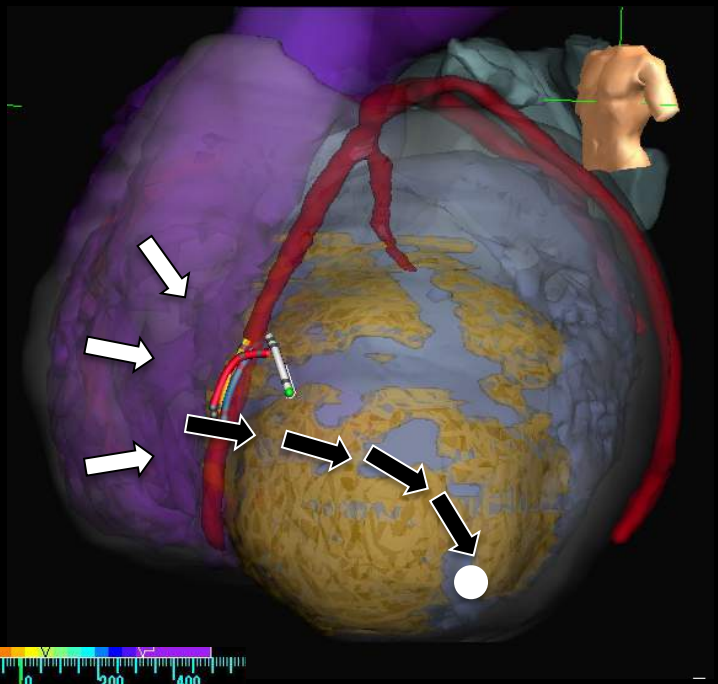


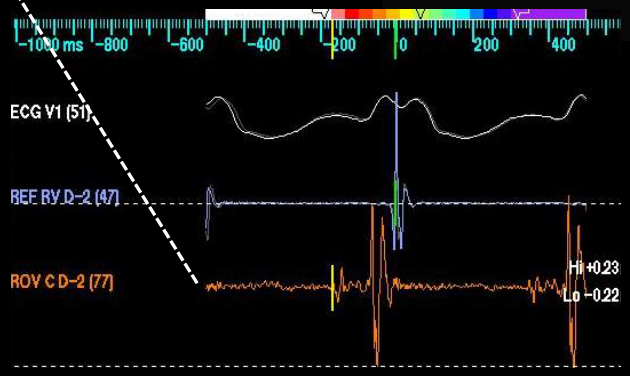
Cardiopathie ischémique

CHANNEL 1

LATE DIASTOLIC



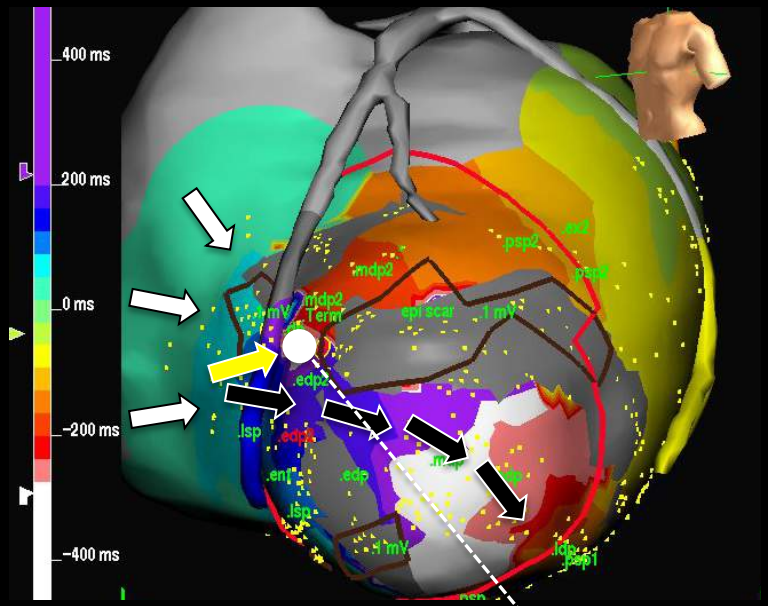


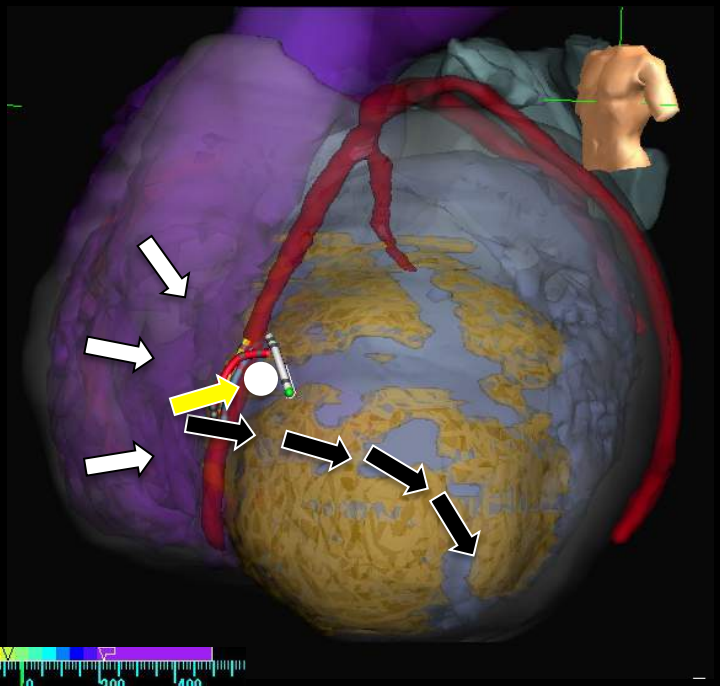


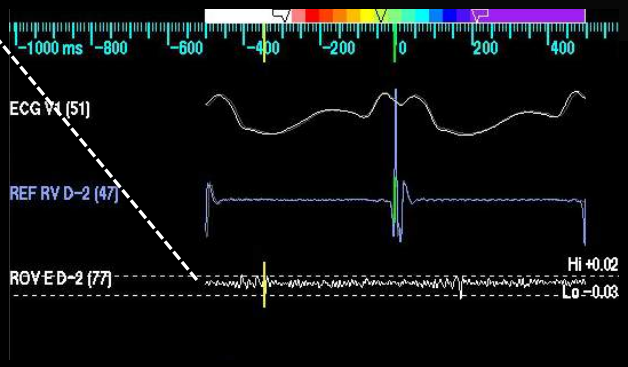
Cardiopathie ischémique

CHANNEL 2

EARLY DIASTOLIC



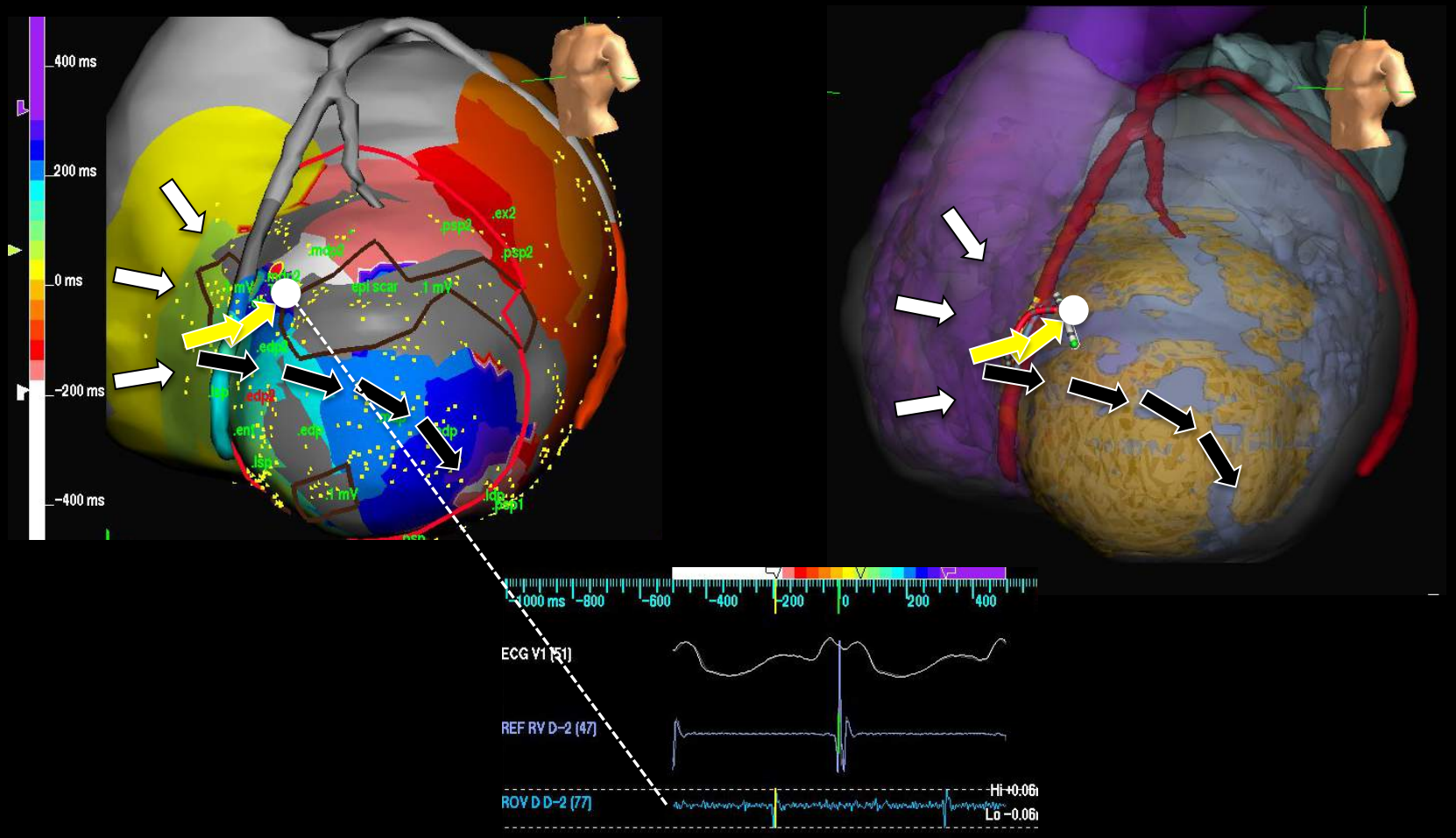




Cardiopathie ischémique

CHANNEL 2

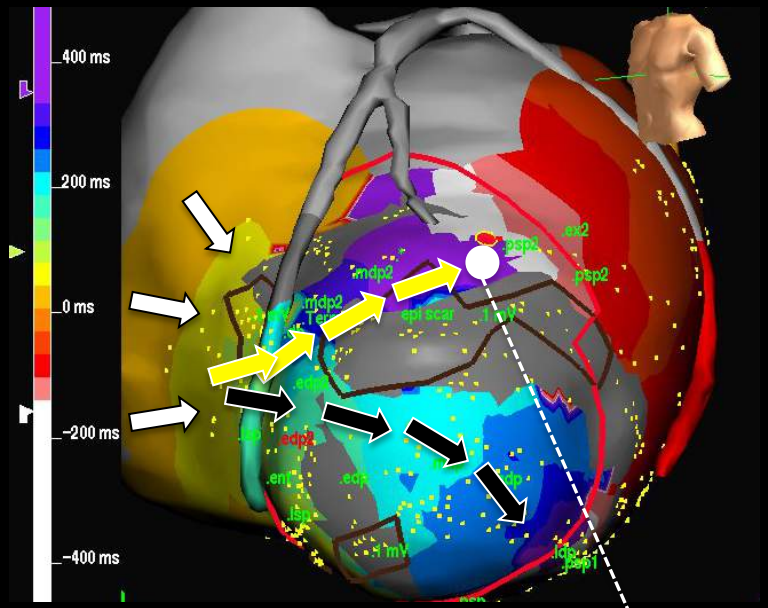
MID DIASTOLIC

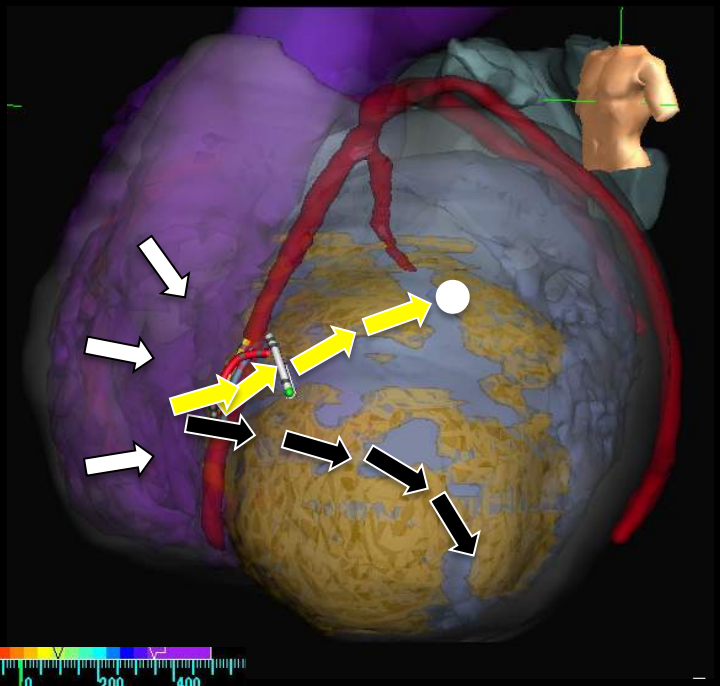


Cardiopathie ischémique

CHANNEL 2

LATE DIASTOLIC

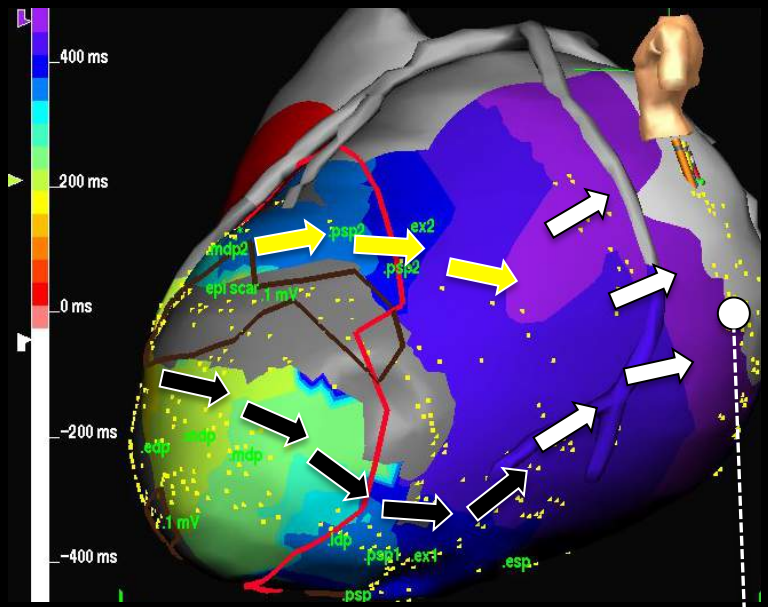


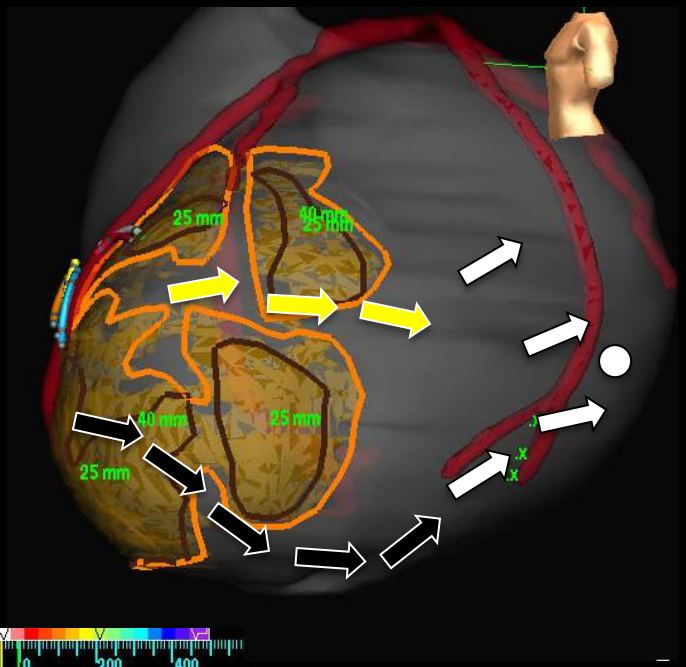


Cardiopathie ischémique

ISTHMUS EXIT

EARLY SYSTOLIC

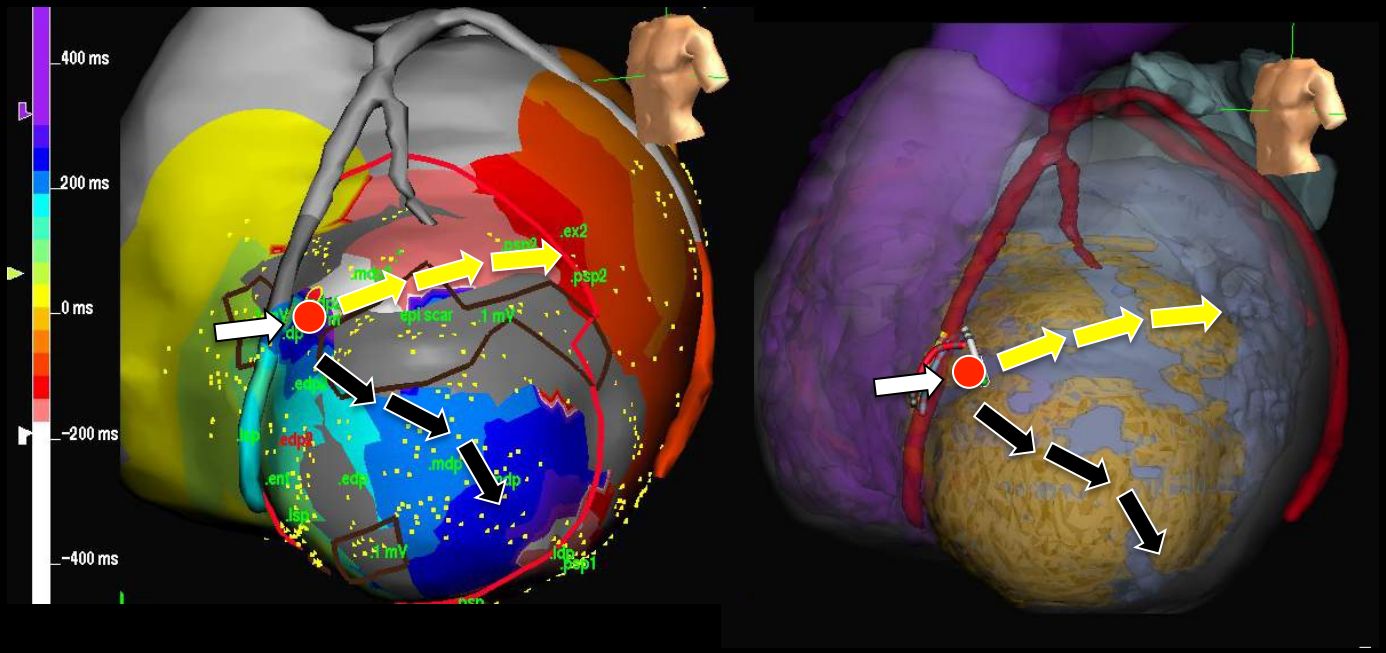


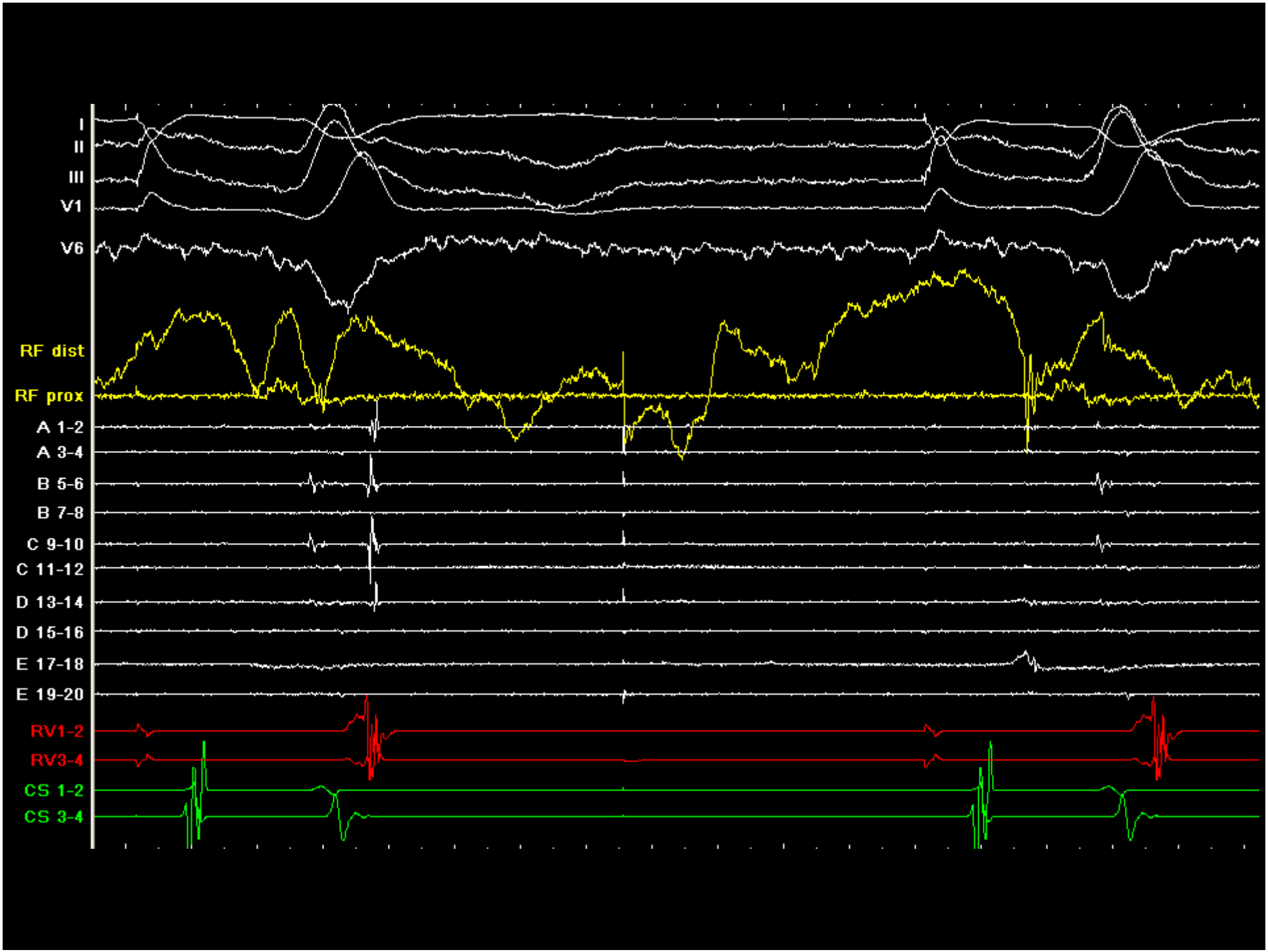


Cardiopathie ischémique

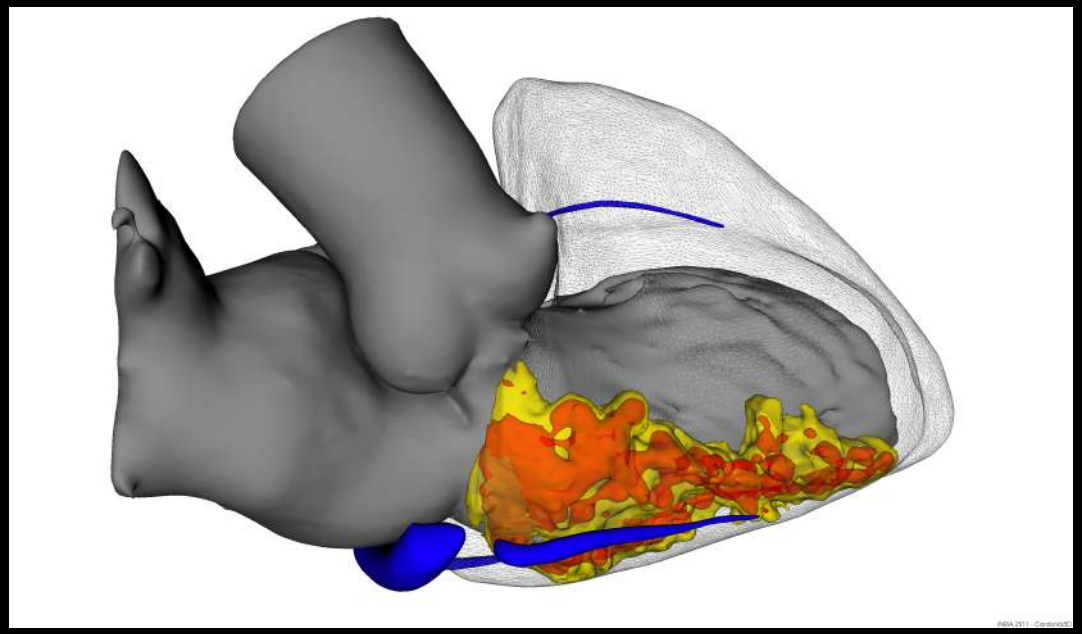
SITE OF VT TERMINATION

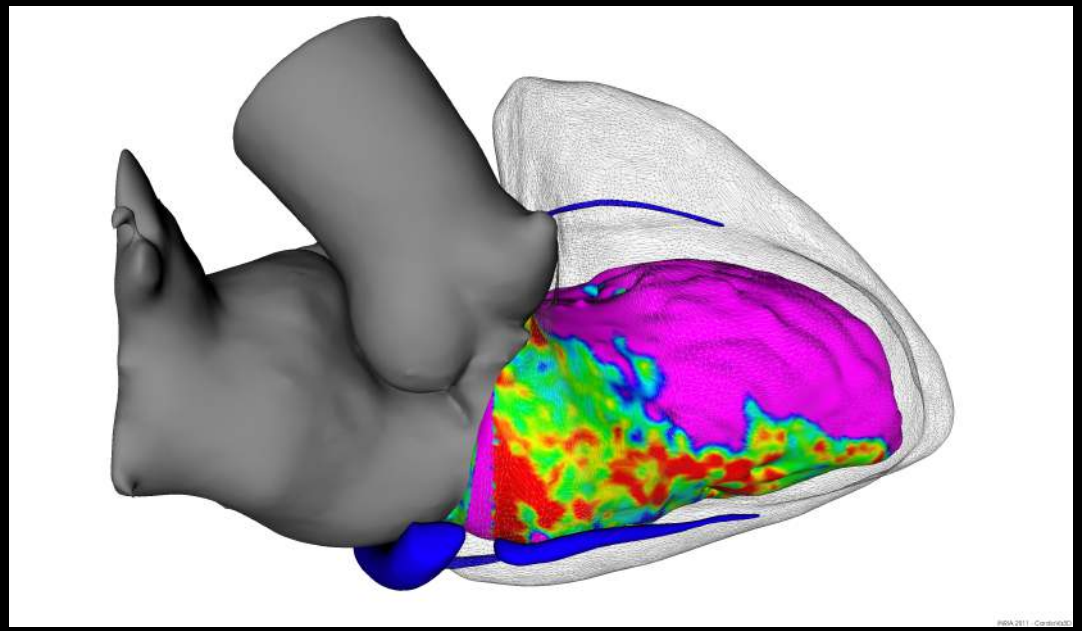
ENTRANCE TO CHANNELS 1 & 2



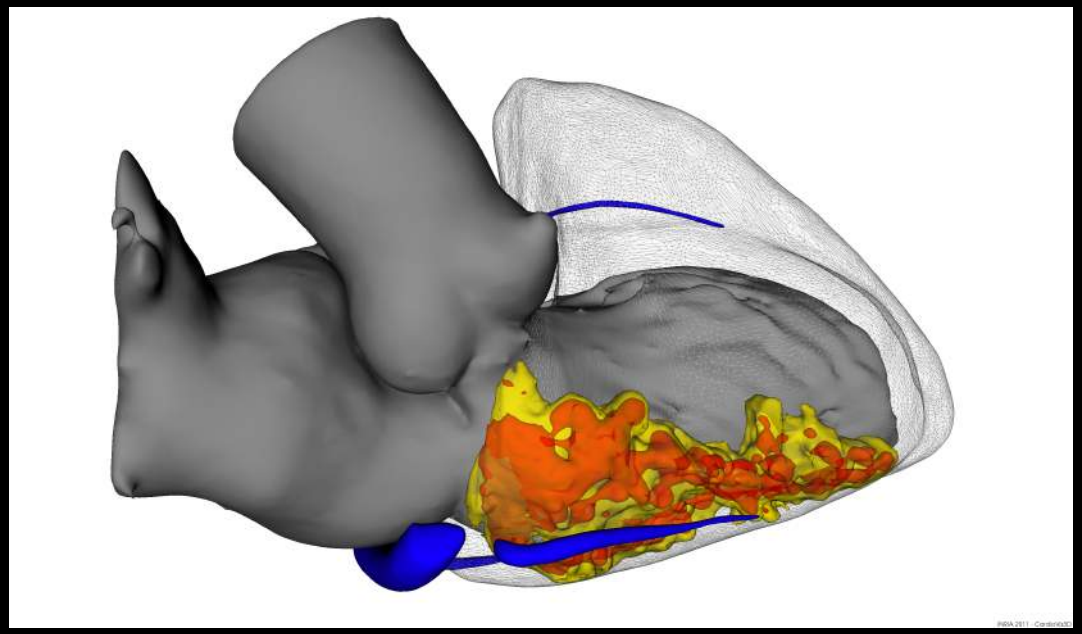

I
II
III
V1
V6
RF dist
RF prox
A 1-2
A 3-4
B 5-6
B 7-8
C 9-10
C 11-12
D 13-14
D 15-16
E 17-18
E 19-20
RV1-2
RV3-4
CS 1-2
CS 3-4

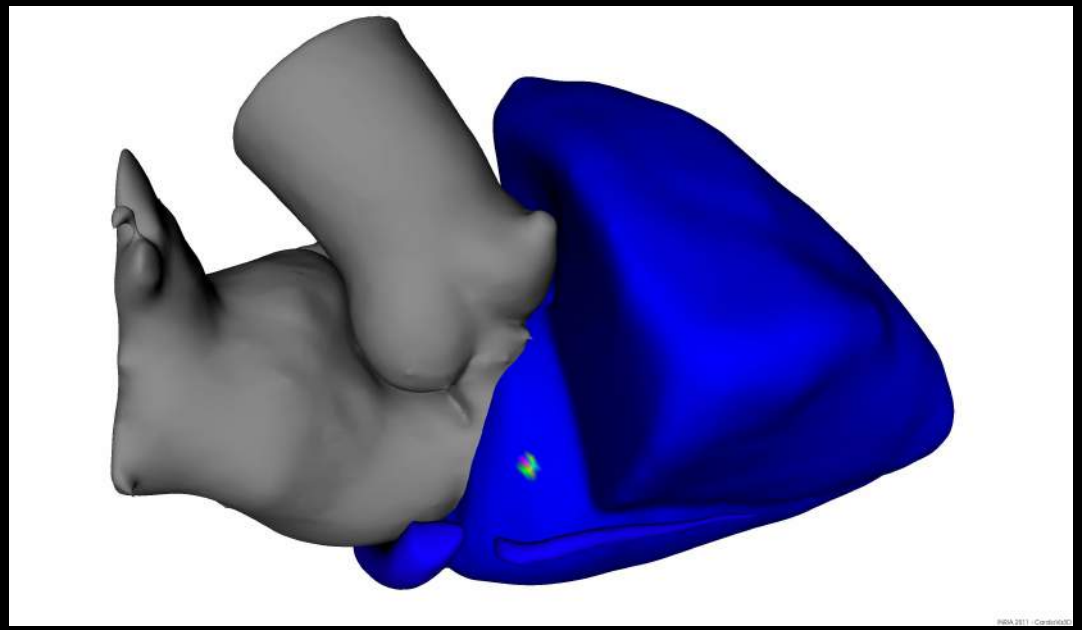
Avant l'intervention





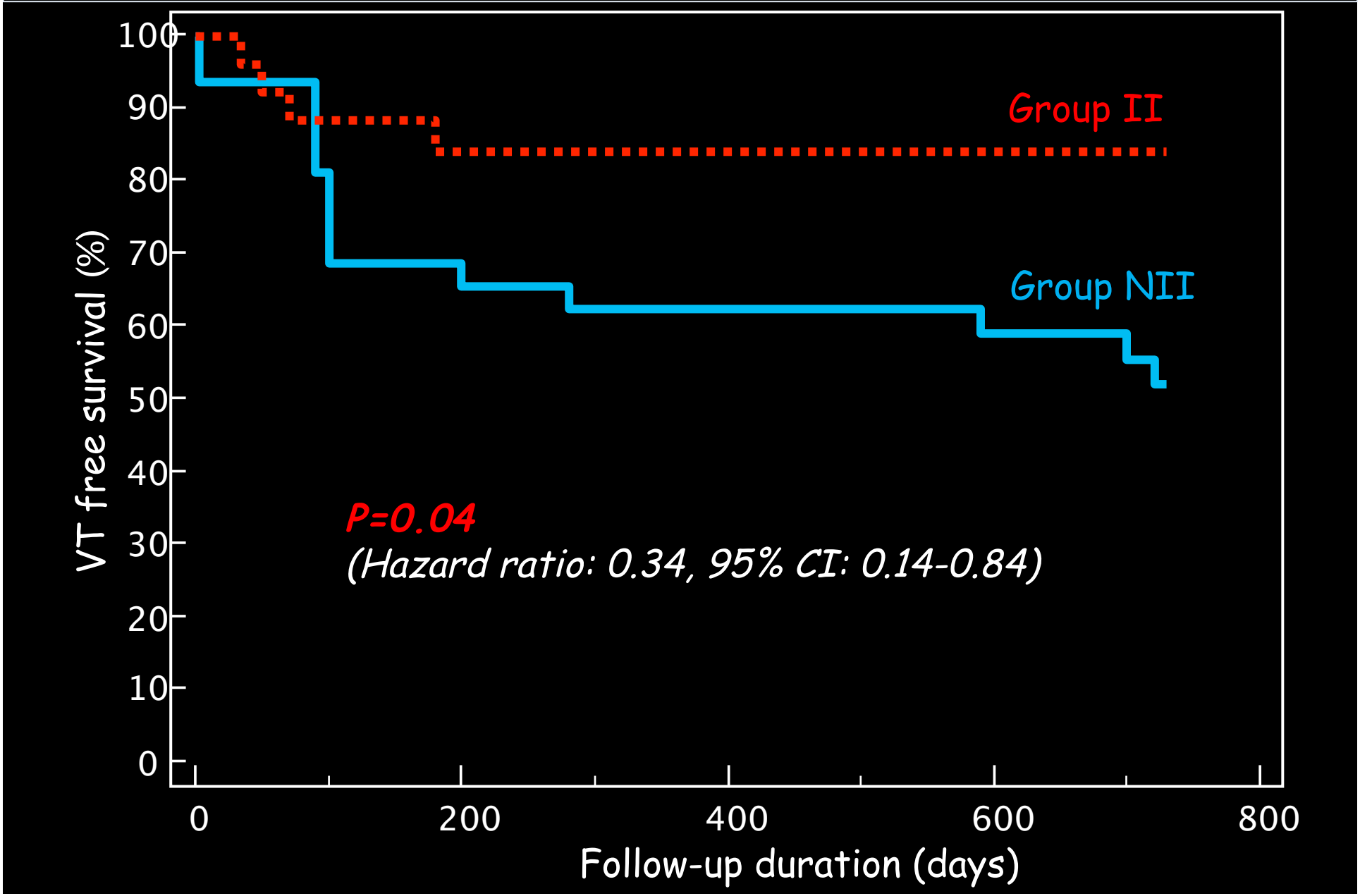
Avant l'intervention

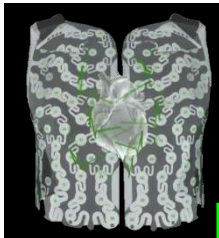




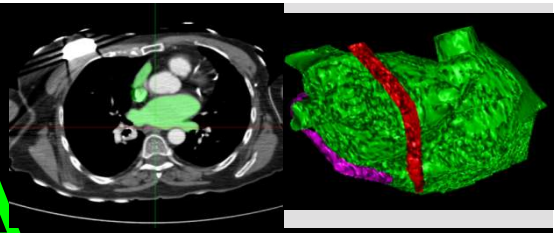
ECGI
70 ms of epi actiavtion during VT
-> exit of VT isthmus

Kaplan-Meier analysis of VT recurrence after the initial VT ablation w/wo image integration in patients with ischemic cardiomyopathy

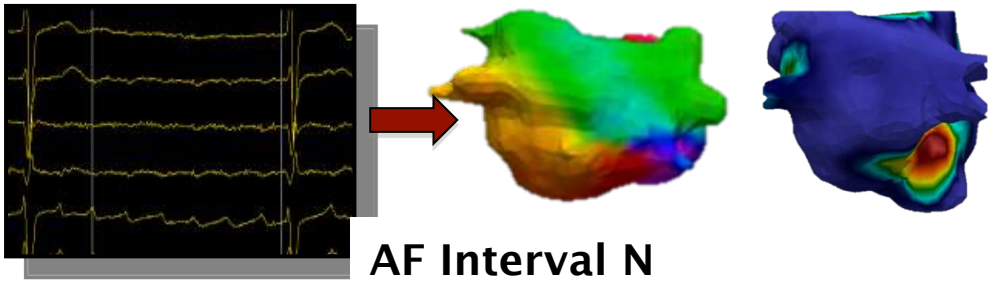




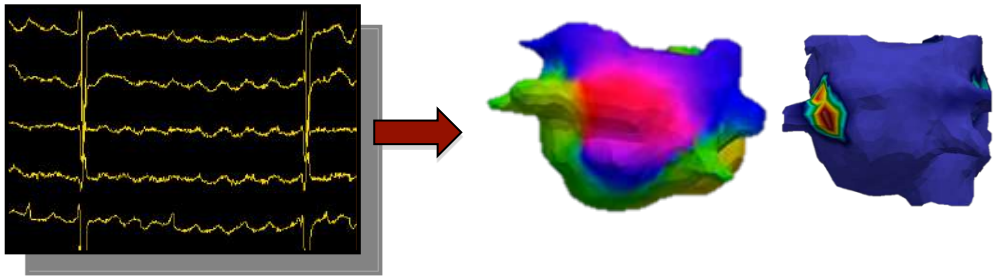
Cartographie non invasive de la FA

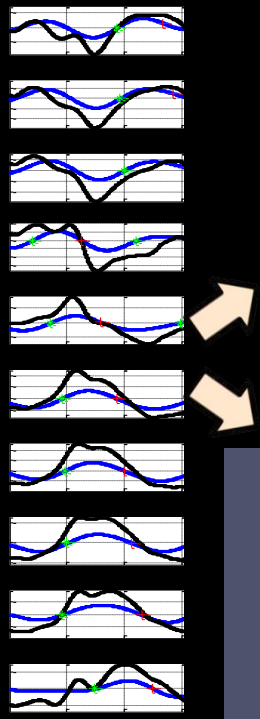


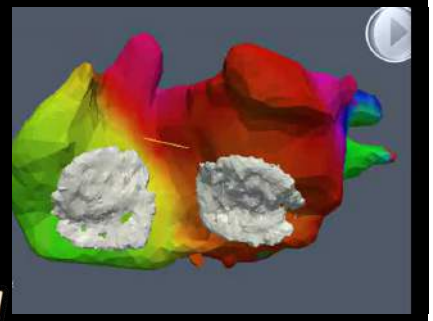
AF Interval 1

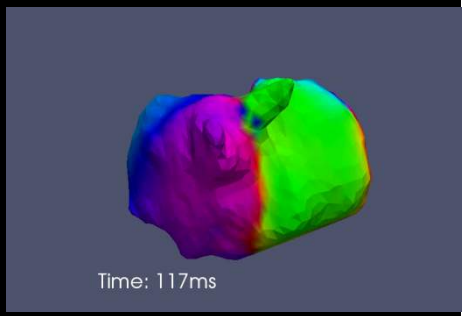


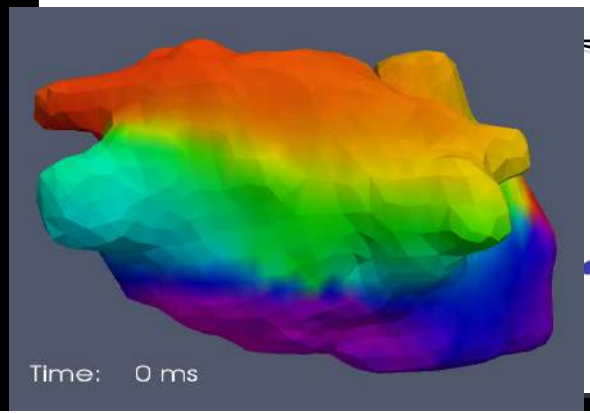
AF Interval N



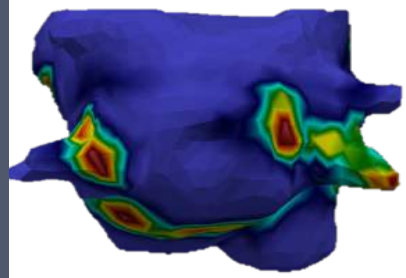








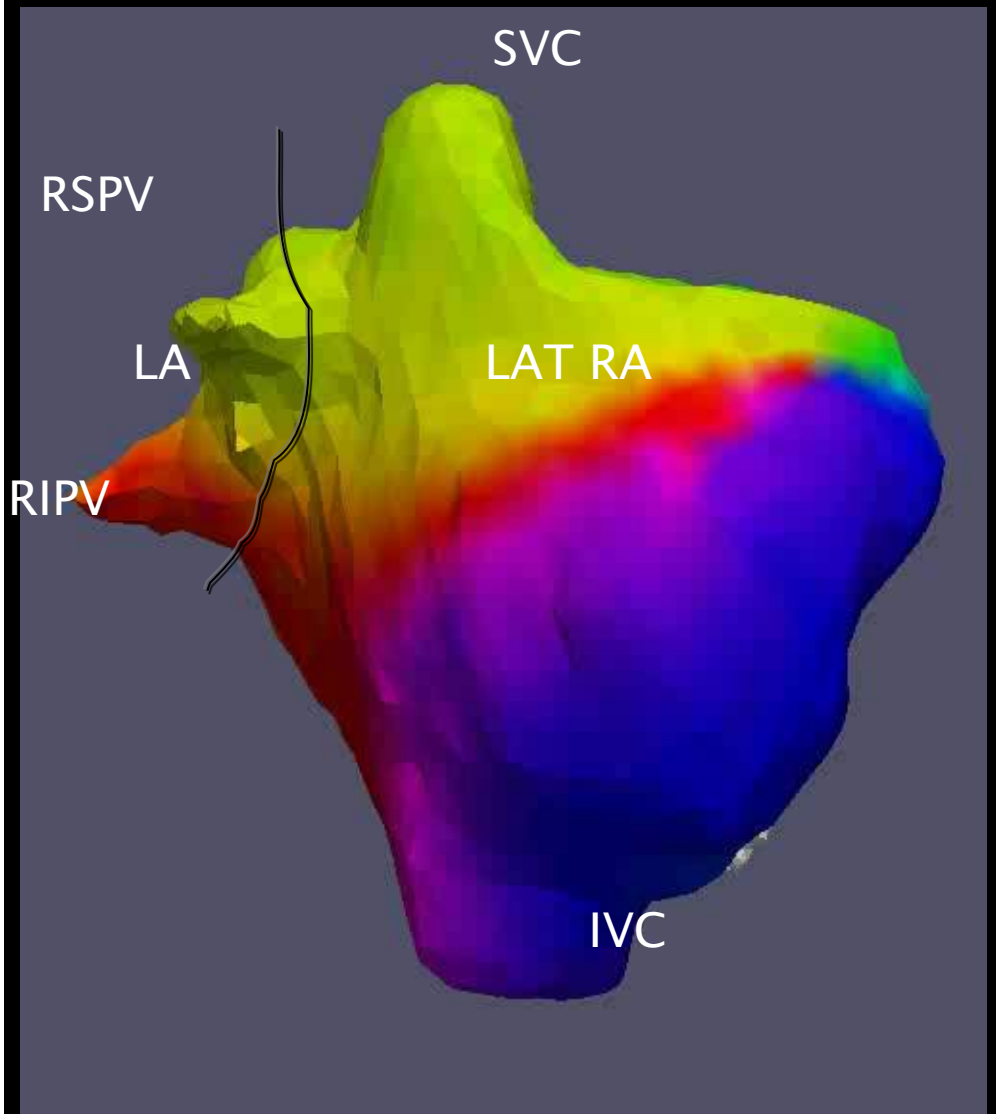
Cumulative map



CardioInsight®

Case 1: SINGLE TARGETED REGION (9% of patients)

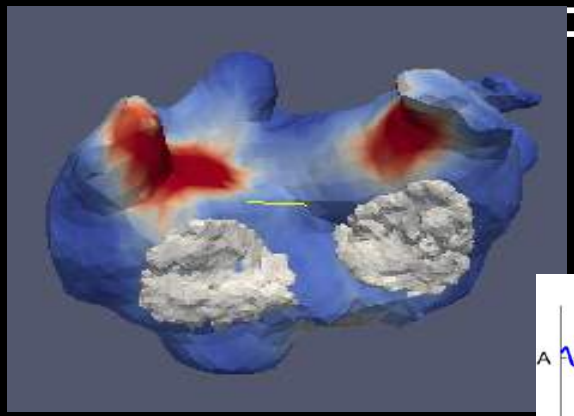
F 76 y – Pers AF presenting in SR

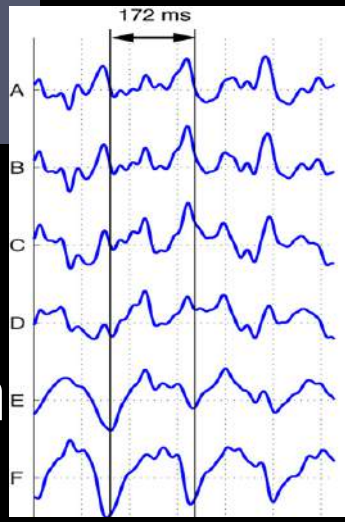


AF induced by pacing

2 regions harbor sources,

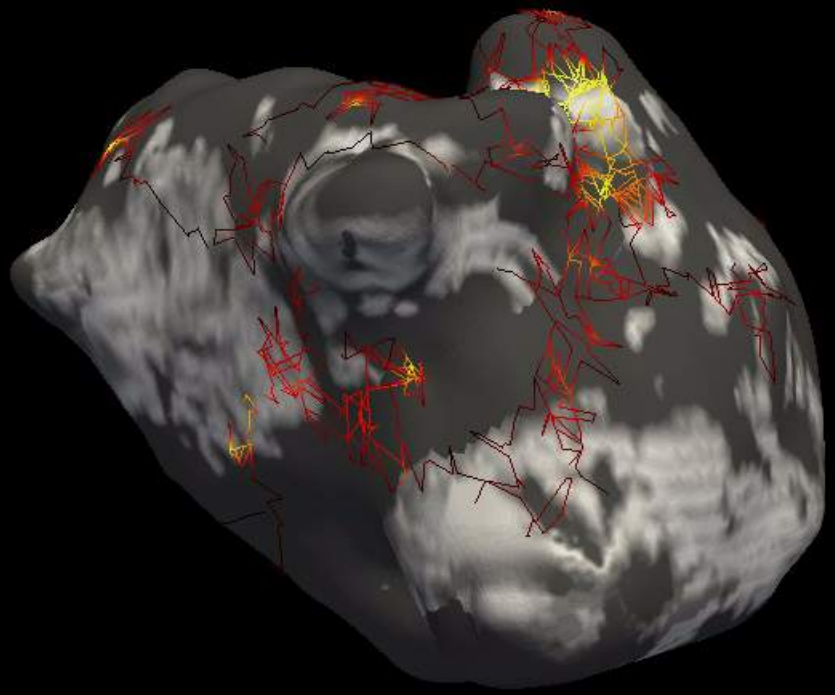
Foci





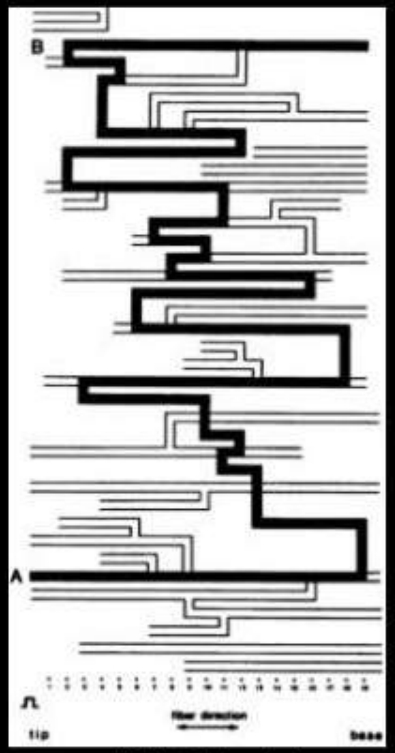
AF term in 1st RA Region

Trajectoires des rotors et fibrose atriale à l'IRM

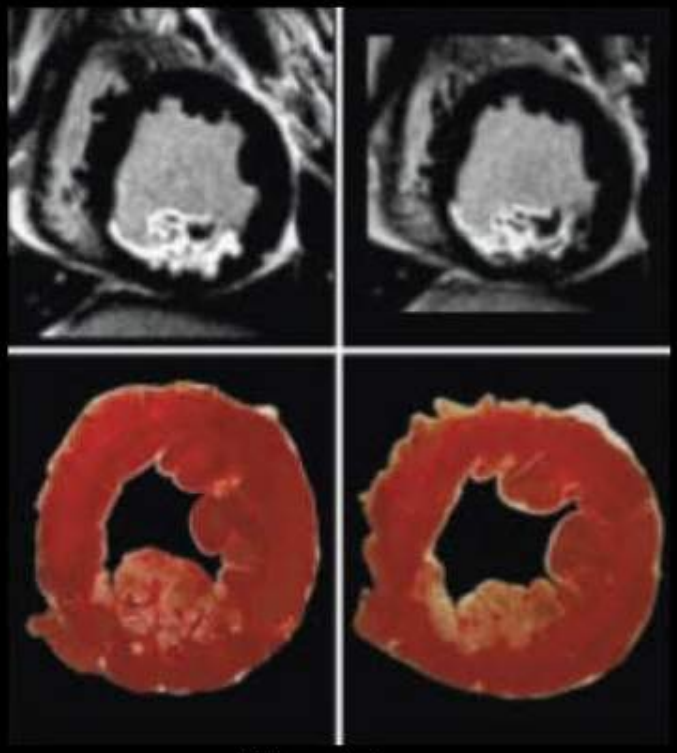


VENTRICULAR ARRHYTHMIAS

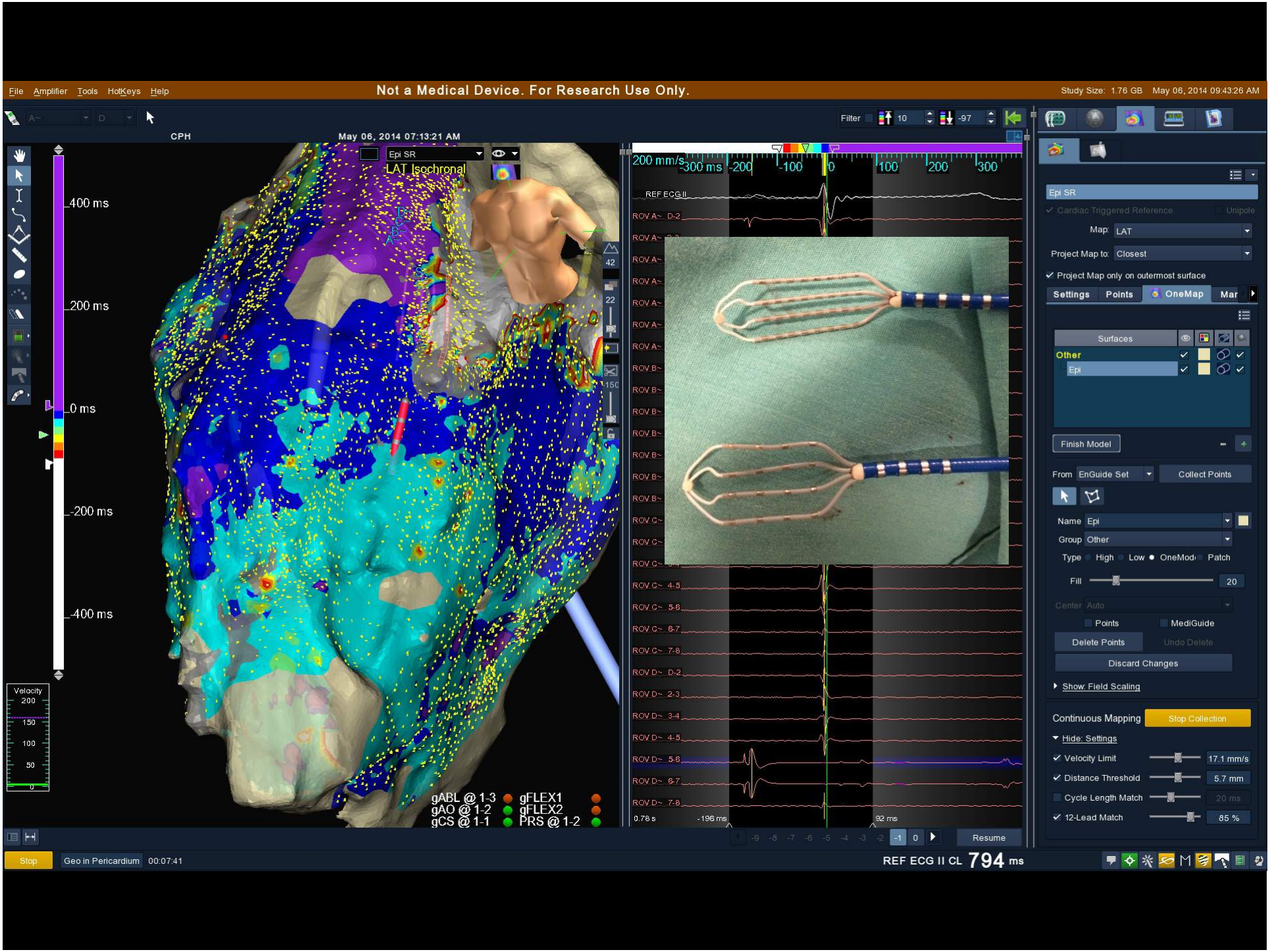
PC Ursell et al.
Structural and electrophysiological changes in the epicardial border zone of canine myocardial infarcts during infarct healing.
Circ. Res. 1985;56;436-451

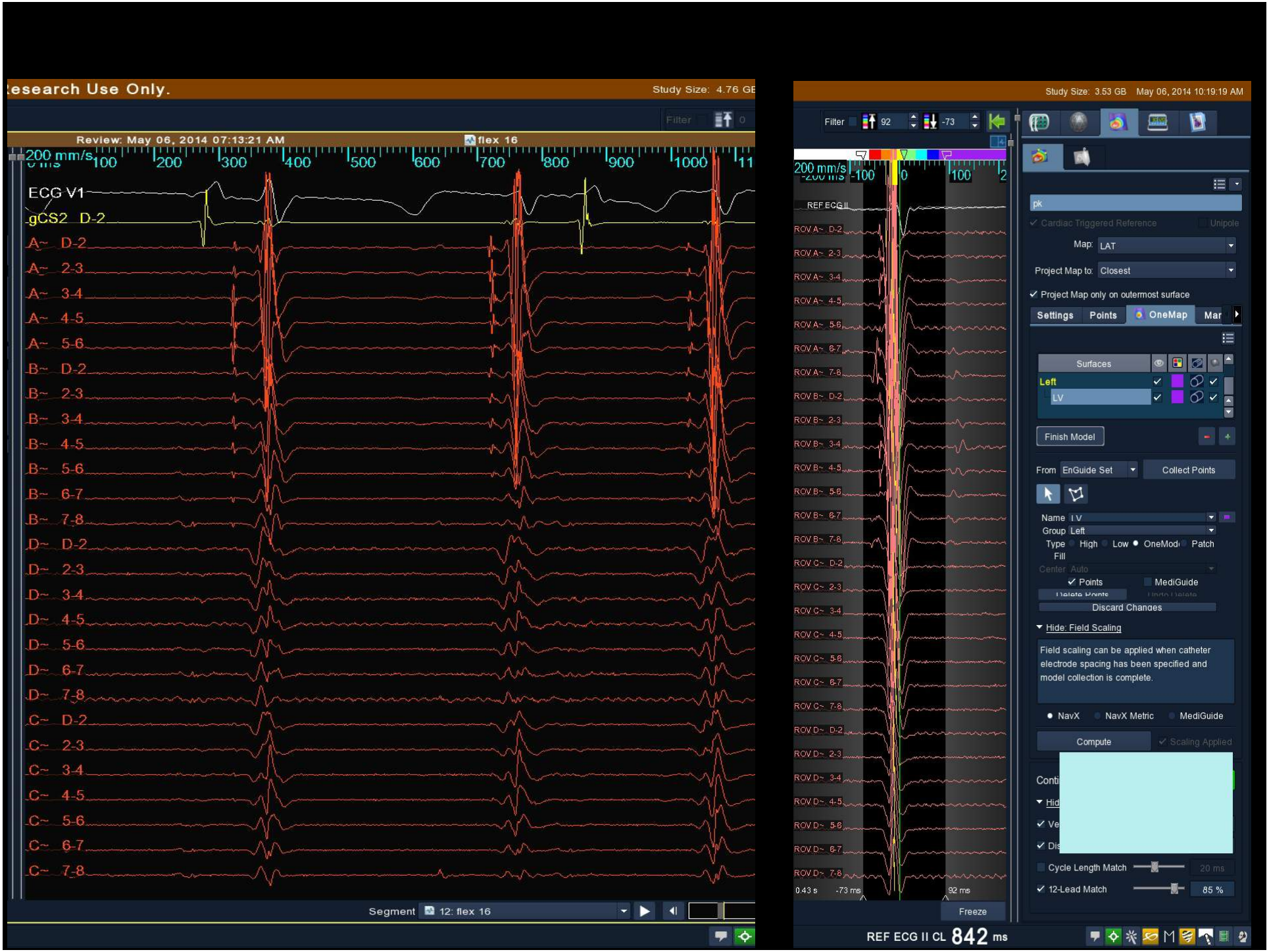


JM de Bakker et al.
Slow conduction in the infarcted human heart. 'Zigzag' course of activation.
Circulation 1993;88;915-926



A Wagner et al.
Contrast-enhanced MRI for detection of subendocardial myocardial infarcts: an imaging study.
Lancet. 2003;361:374-379.


File Amplifier Tools HotKeys Help
Not a Medical Device. For Research Use Only.
Study Size: 1.76 GB May 06, 2014 09:43:26 AM
CPH
May 06, 2014 07:13:21 AM
Epi SR
LAT Isochronal
400 ms
200 ms
0 ms
-200 ms
-400 ms
Velocity
gABL @ 1-3
gAO @ 1-2
gCS @ 1-1
gFLEX1
gFLEX2
PRS @ 1-2
200 mm/s
REF ECG II
Epi SR
Cardiac Triggered Reference
Unipole
Map: LAT
Project Map to: Closest
Project Map only on outermost surface
Settings
Points
OneMap
Surfaces
Other
Epi
Finish Model
From EnGuide Set
Collect Points
Name Epi
Group Other
Type High Low OneMod Patch
Fill 20
Center Auto
Points
MediGuide
Delete Points
Undo Delete
Discard Changes
Show: Field Scaling
Continuous Mapping
Stop Collection
Hide: Settings
Velocity Limit 17.1 mm/s
Distance Threshold 5.7 mm
Cycle Length Match 20 ms
12-Lead Match 85 %
Resume
Stop
Geo in Pericardium 00:07:41
REF ECG II CL 794 ms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gCS2 D-2
Segment 12: flex 16
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Filter 92 -73
REF ECG II
Cardiac Triggered Reference
Unipole
Map: LAT
Project Map to: Closest
Project Map only on outermost surface
Settings Points OneMap
Surfaces
Left
LV
Finish Model
From EnGuide Set
Collect Points
Name LV
Group Left
Type High Low OneMod Patch
Fill
Center Auto
Points
MediGuide
Discard Changes
Hide: Field Scaling
Field scaling can be applied when catheter electrode spacing has been specified and model collection is complete.
NavX NavX Metric MediGuide
Compute
Scaling Applied
Cycle Length Match 20 ms
12-Lead Match 85 %
Freeze
REF ECG II CL 842 ms

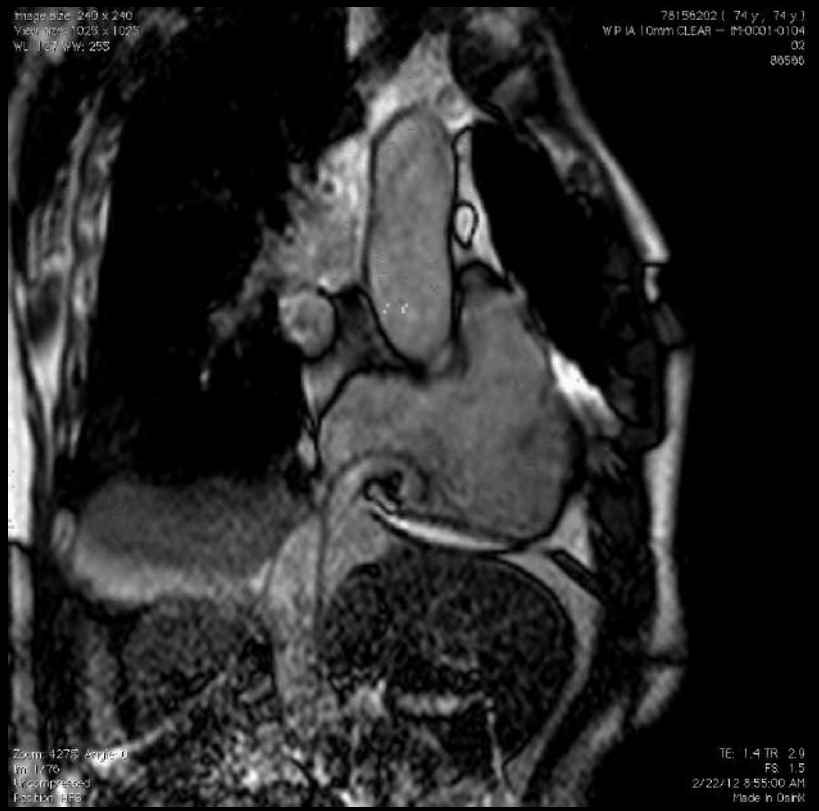
IRM interventionnelle

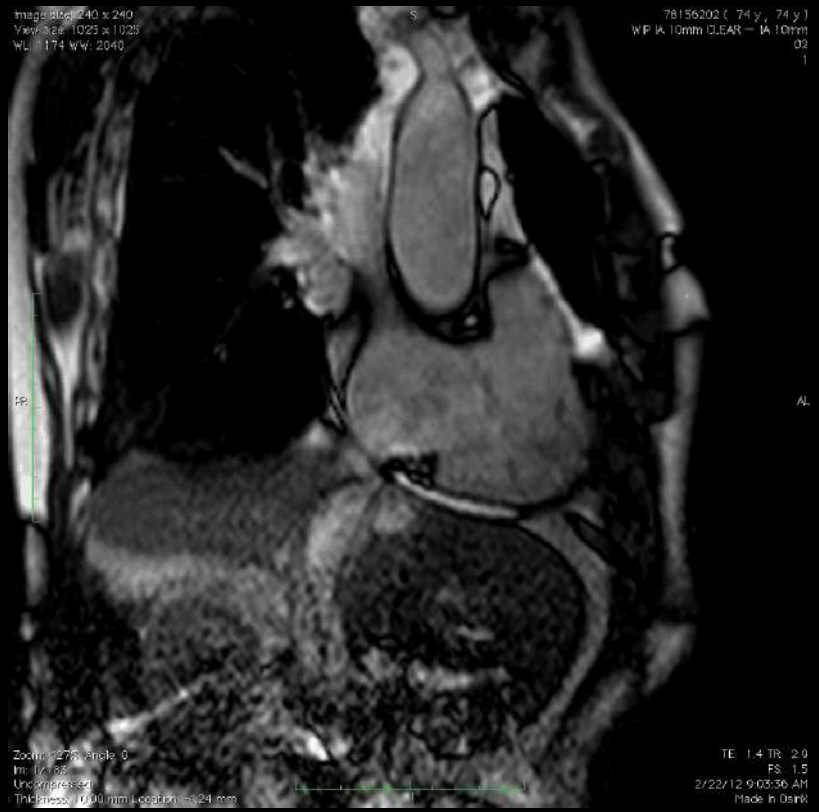
Problems solved:

- sterile patient access, patient monitoring, communication,
- MR compatible catheter technology / EP recording system

Eitel et al, EHJ 2012

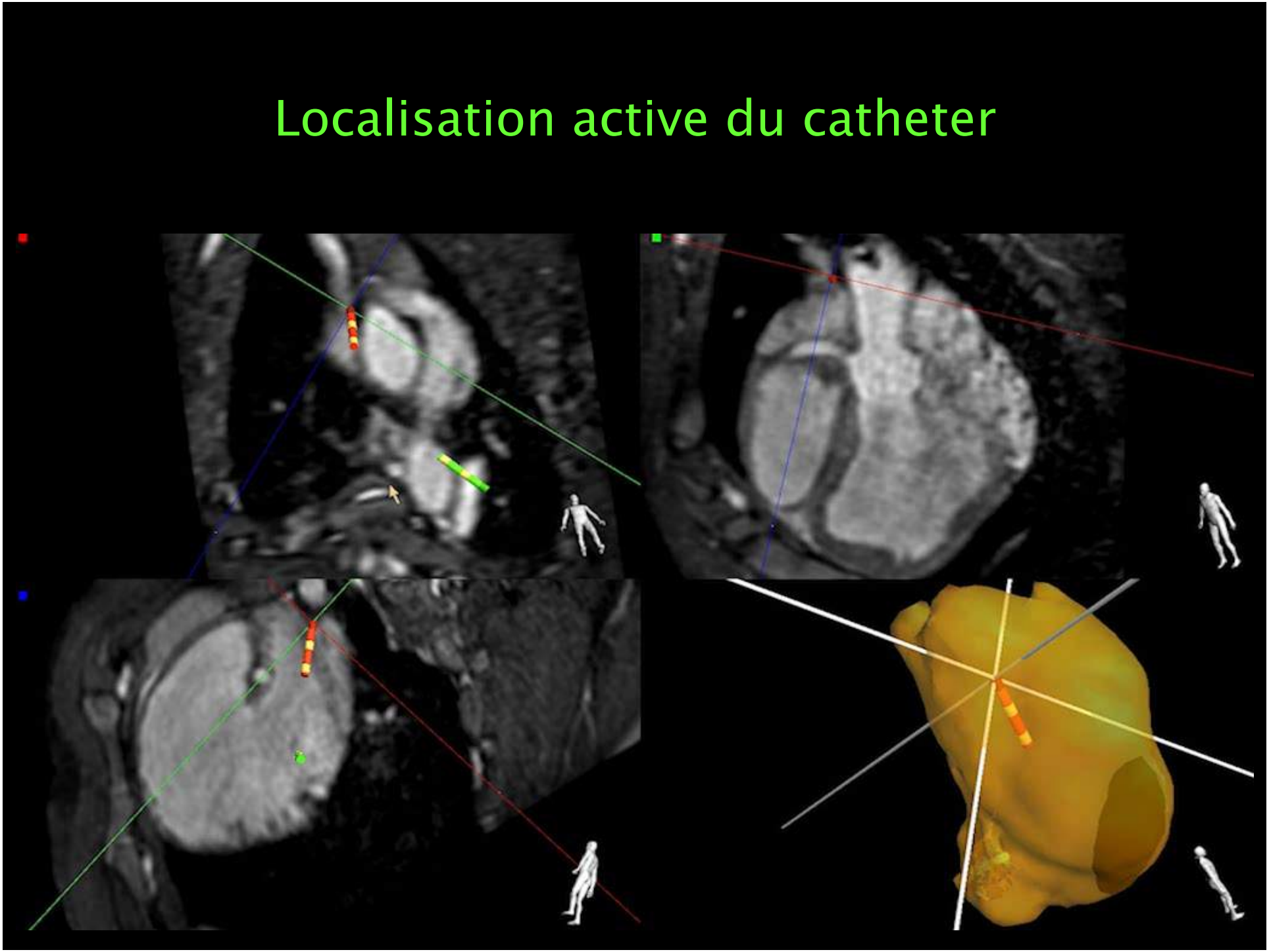
Localisation passive du catheter





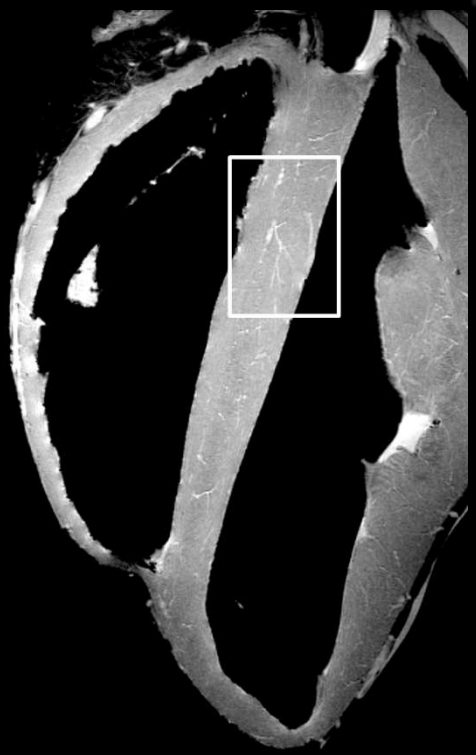
Piorkowski et al., CircAE 2013

Localisation active du catheter



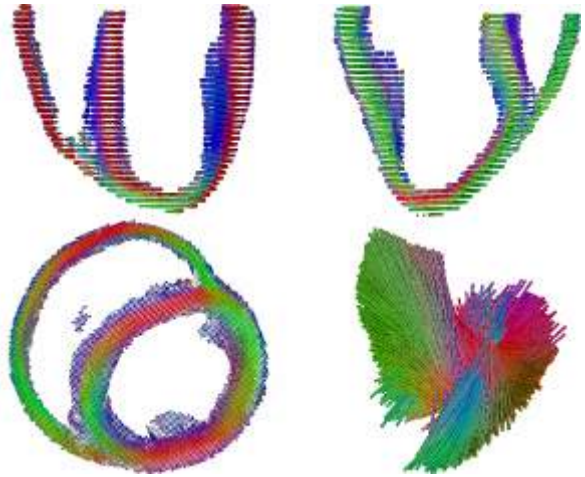
Bruker
9.4 T/30 cm

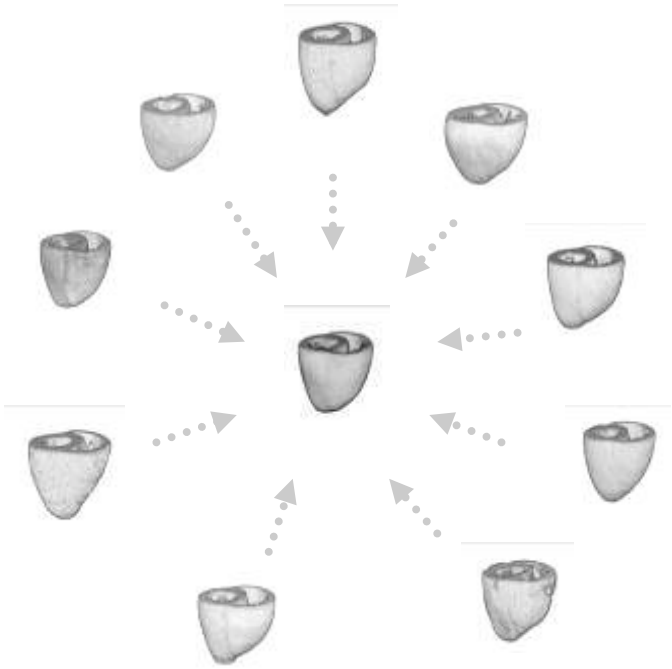
sheep heart fixed in 4% of formaldehyde

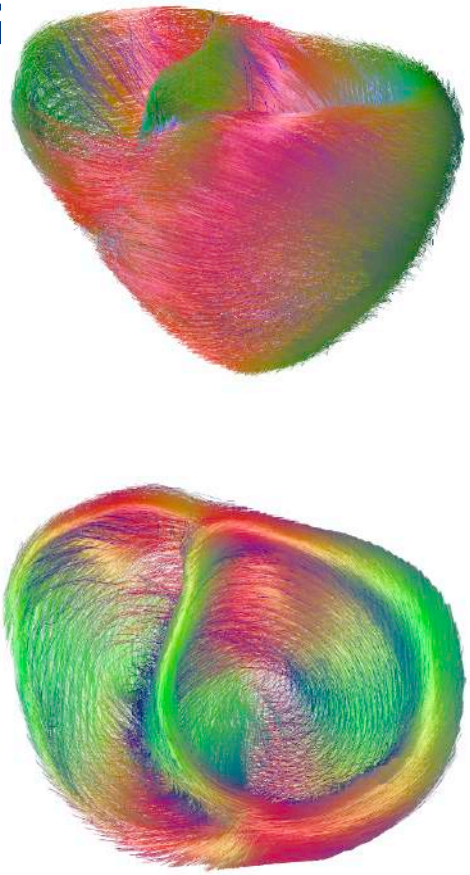


3D T1w images (FLASH sequence)
TR/TE/matrix size/TA= 35ms/4.26ms/512×410×408/98min
isotropic resolution= 200 µm3

Orientation des fibres myocardiques







DT-MRI of Canine Heart (courtesy of JHU)

Statistical Analysis From 9 Canine Hearts

Patient Specific Fiber Structure

J.M. Peyrat, M. Sermesant, X. Pennec, H. Delingette, C. Xu, E. McVeigh, N. A. **A Computational Framework for the Statistical Analysis of Cardiac Diffusion Tensors: Application to a Small Database of Canine Hearts**. *IEEE Transactions on Medical Imaging*, 26(11):1500-1514, November 2007

Simulation de la performance myocardique

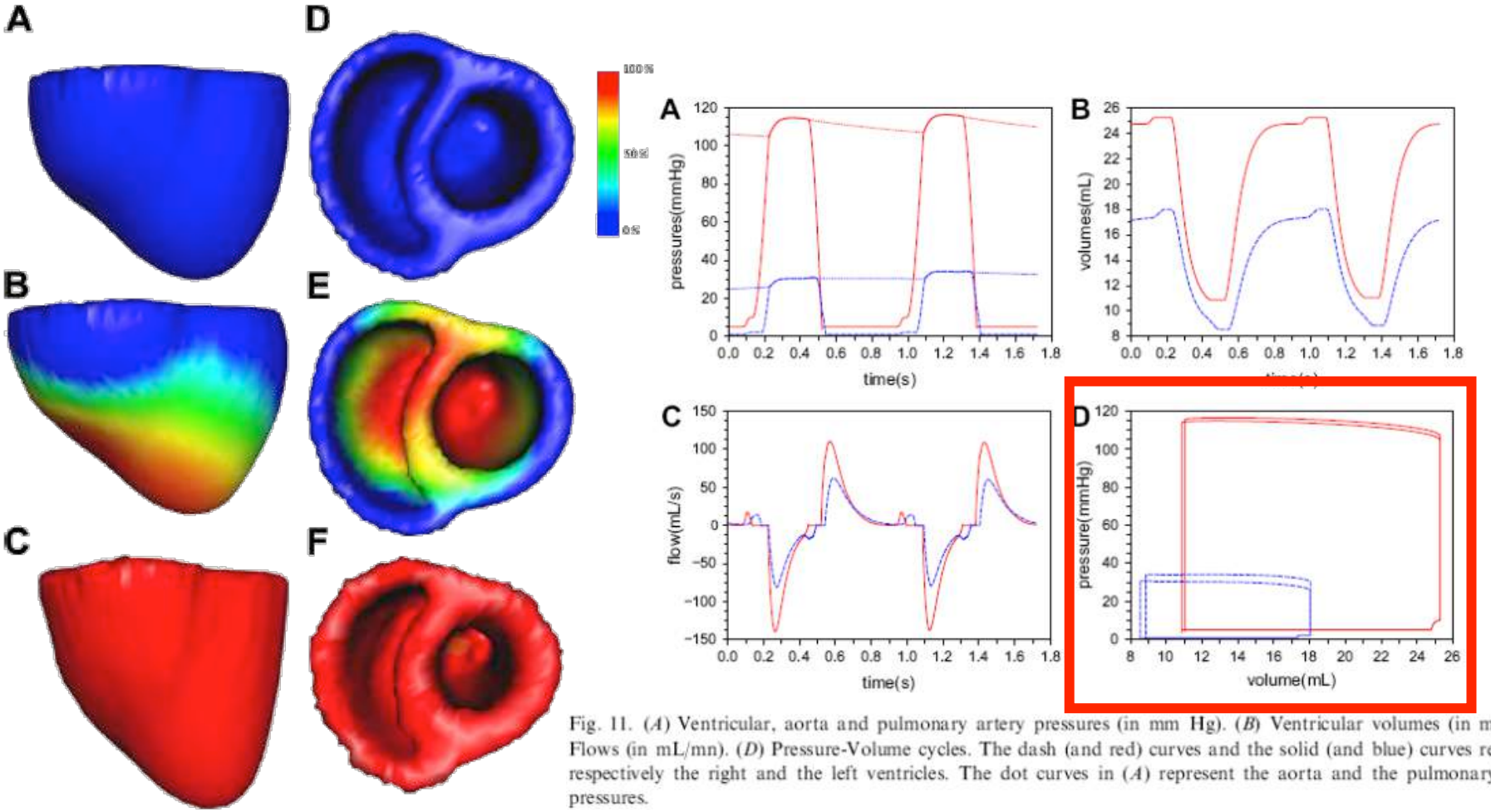


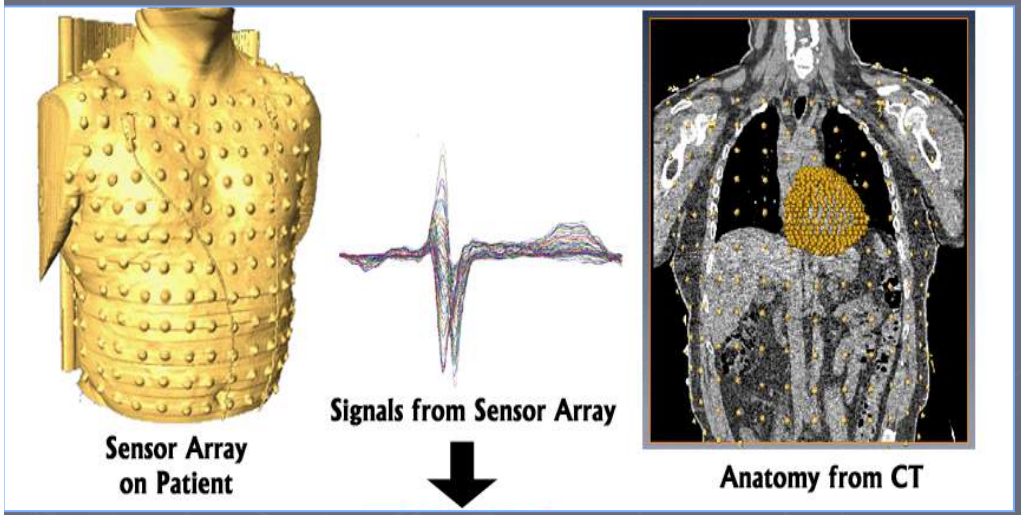
Fig. 11. (*A*) Ventricular, aorta and pulmonary artery pressures (in mm Hg). (*B*) Ventricular volumes (in mL). (*C*) Flows (in mL/mn). (*D*) Pressure-Volume cycles. The dash (and red) curves and the solid (and blue) curves represent respectively the right and the left ventricles. The dot curves in (*A*) represent the aorta and the pulmonary artery pressures.

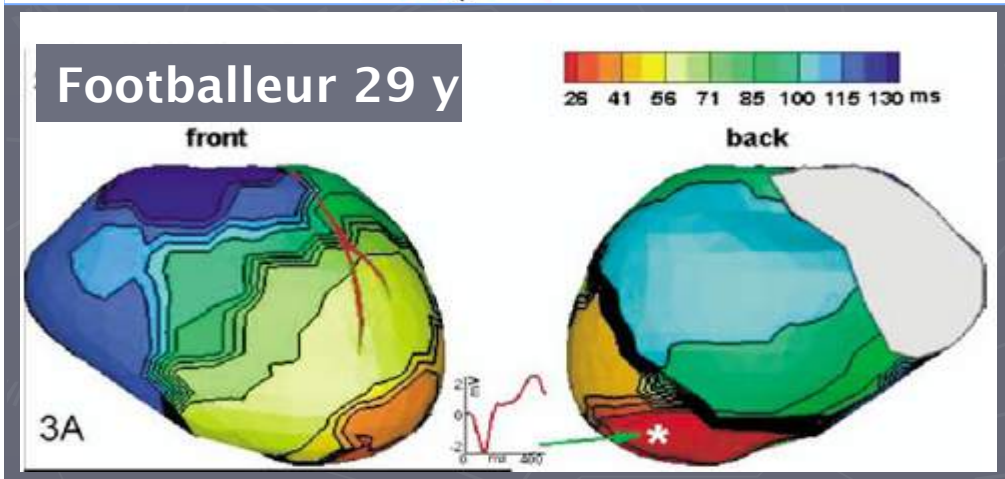
Sermesant, Peyrat, Chinchapatnam, Billet, Mansi, Rhode, Delingette, Razavi, Ayache., *Toward Patient-Specific Myocardial Models of the Heart*, Heart Failure Clinics, 2008.

Cartographie et Thérapie Extracorporelle

1- CIBLAGE de l'AFFECTION

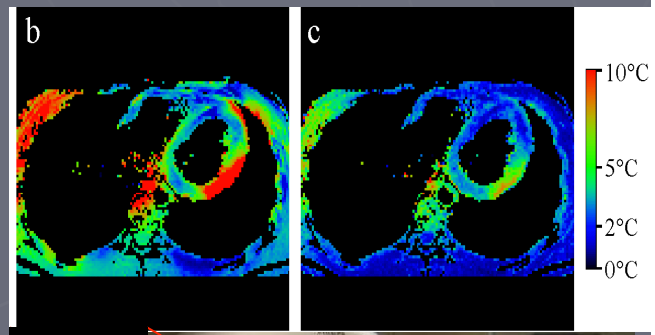
Repérage par Cartographie ECG / IMAGERIE

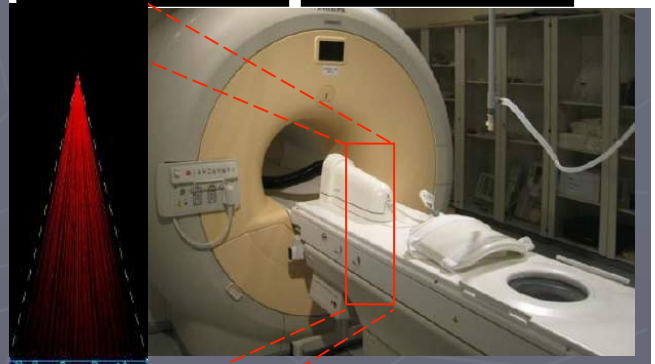


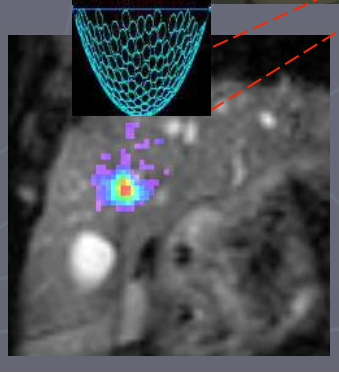


Site d'Origine Tachycardies

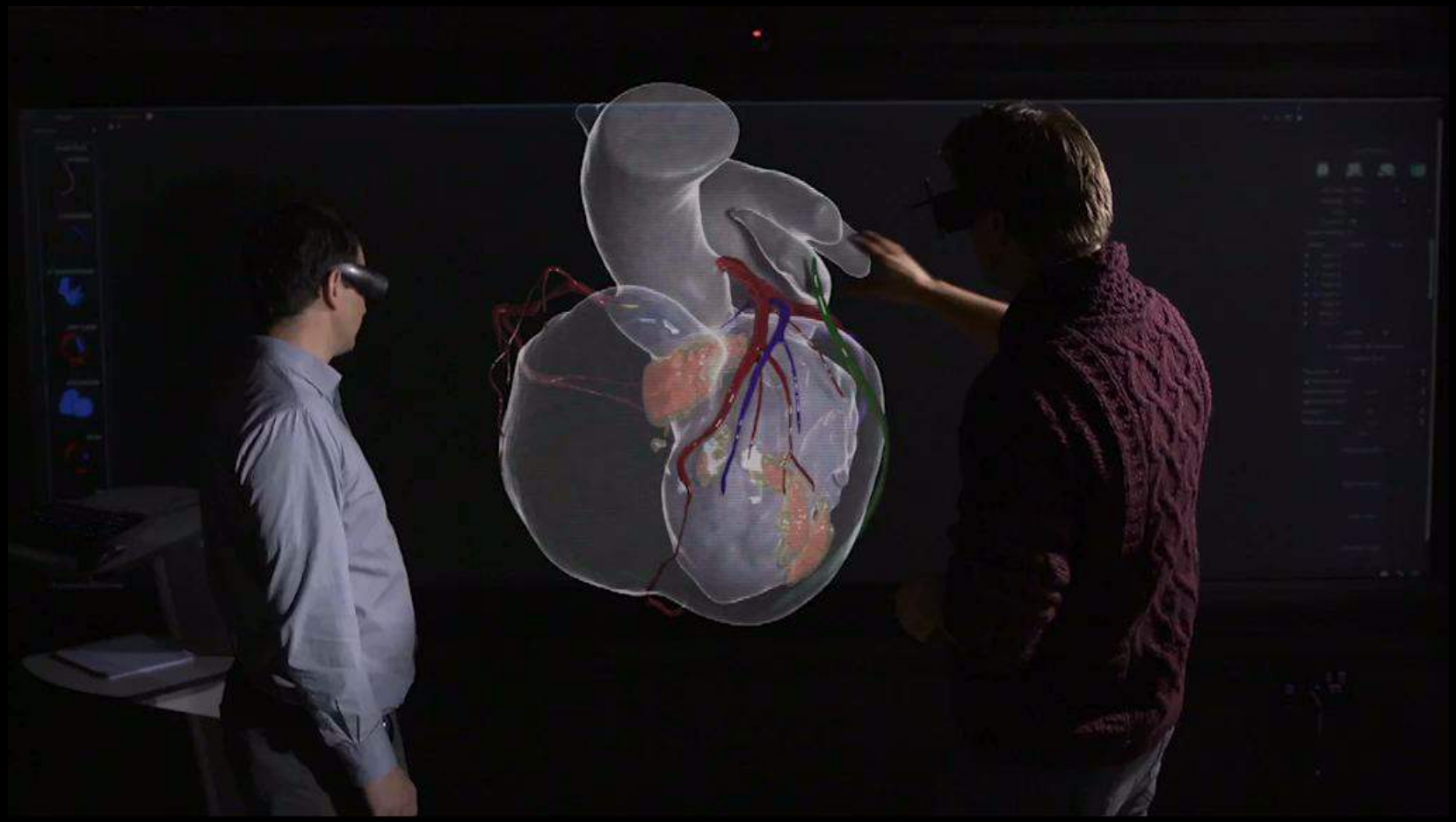
2 - THERAPIE EXTERNE

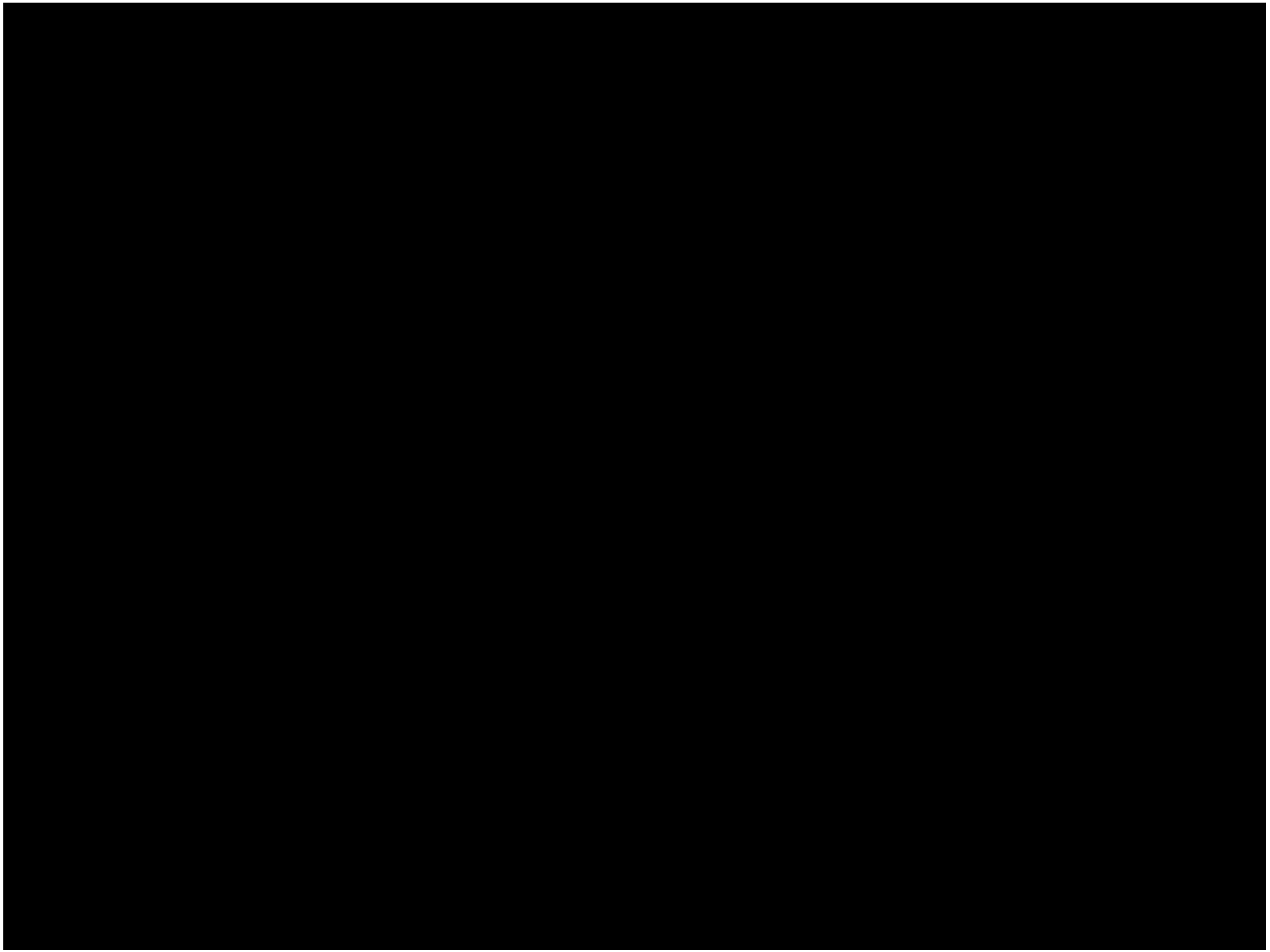


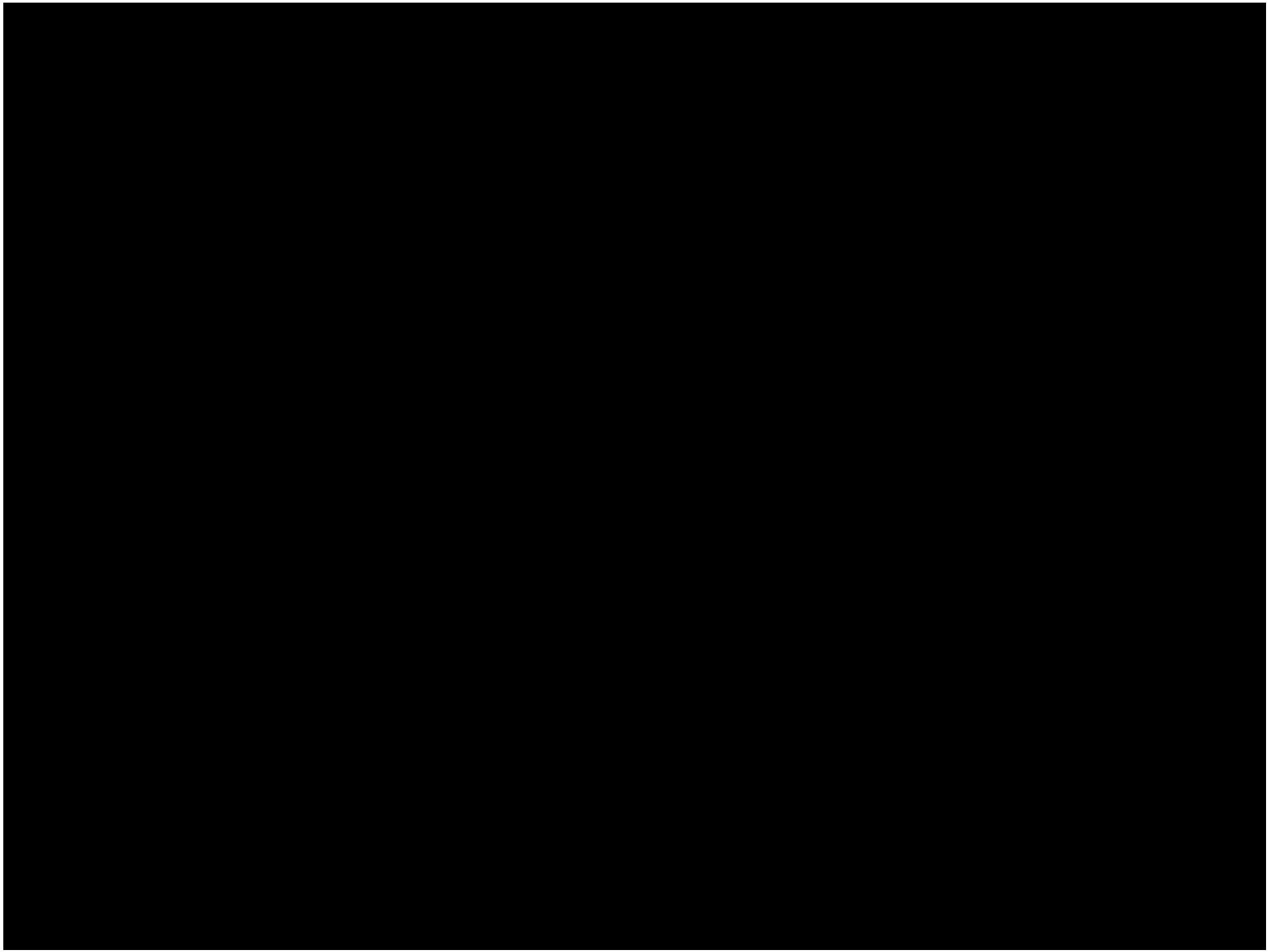


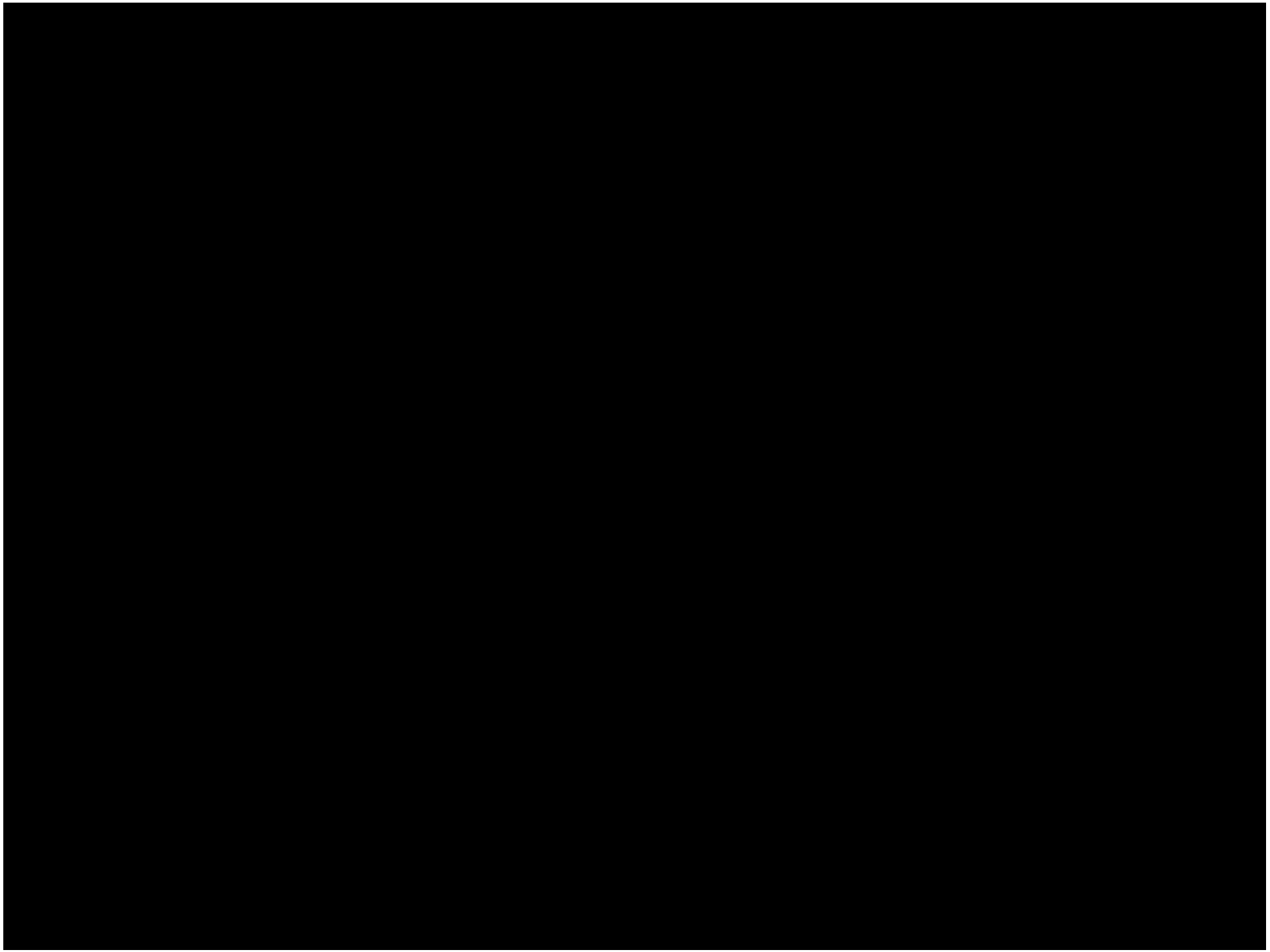


Tirs d' Ultrasons focalisés









Results:

- LAVA were observed in 188 pts (96%) , endocardially in 84% and epicardial in 73%
- Endocardial LAVA were more frequent in ICM than in NICM (87% vs 58% $p=4.10^{-4}$) respectively while there was no difference for epi LAVA (79 vs 86% p=ns)
- LAVA eliminated in 62% of patients; NI in 68%
- When an epicardial approach was taken, RF was delivered epicardially in ICM and NICM in 49 vs 68%.

Results

- Total RF duration 28±15 min
- Procedure time 219±87 min
- Failure to totally eliminate LAVA not correlated with duration of ablation, type of CMP or amplitude of late potential
- 1pt died of intraprocedural electromechanical dissociation.
- 5 tamponade, including 1 RV perforation requiring surgical repair.
- 2 TIA
- 1 AV block.

- FU of 26± 21 month,
- 69% VT free 82% no shock
- Multivariate analysis: complete LAVA elimination had a significantly superior outcome

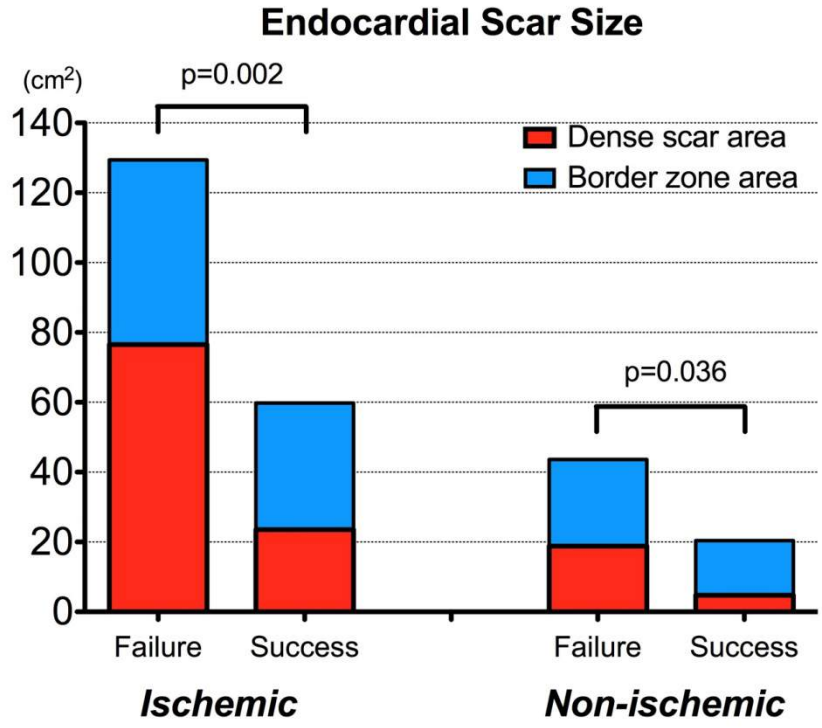
Multivariate analysis for VT recurrence

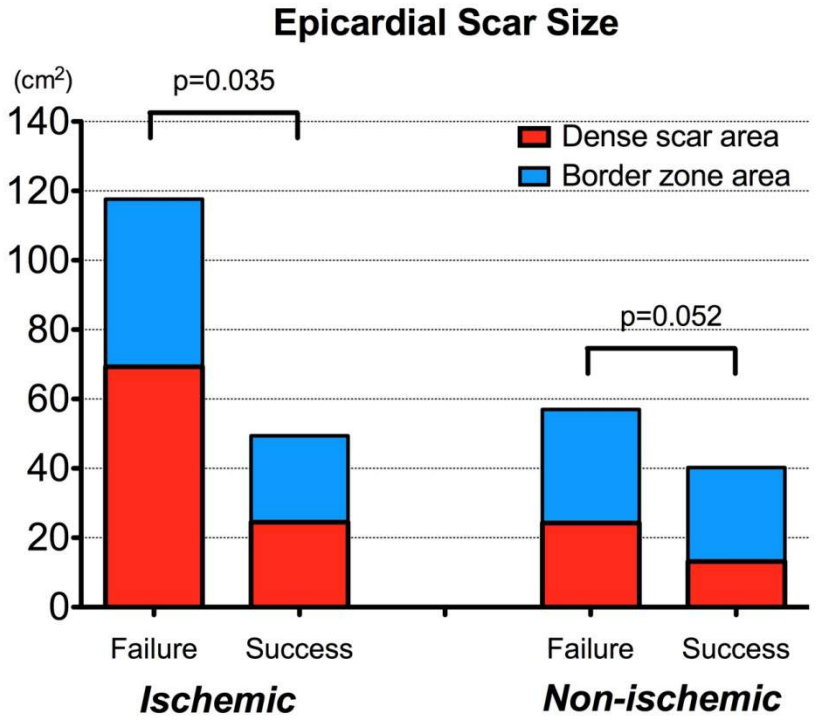
	OR	95% CI	P-value
LVEF (%)	0.89	0.79 – 1.01	0.06
No image integrated ablation	31.6	2.86 – 349.7	0.005
Incomplete LAVA elimination	12.9	1.86 - 89.2	0.01
RF duration (min)	1.06	1.01 – 1.11	0.02

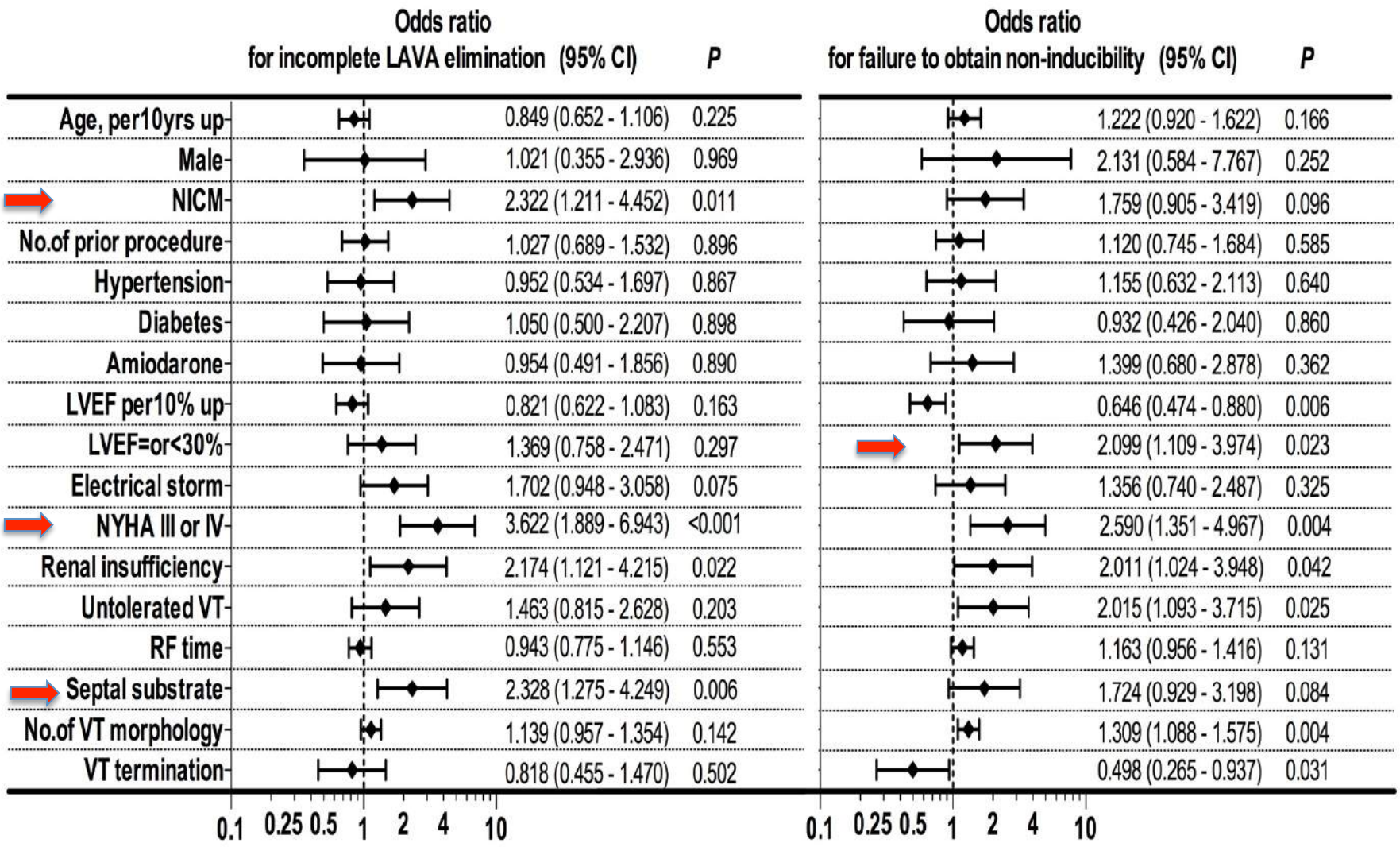
Results

- The 1-month mortality in the 194 procedural survivors was 5% (10 patients),
- uncontrollable ventricular arrhythmias in 5,
- Refractory heart failure in 3,
- Acute myocardial infarction leading to cardiac arrest in 1,
- Sepsis in 1 patient.

Failure vs success to eliminate LAVA






Odds ratio
for incomplete LAVA elimination (95% CI)
P
Odds ratio
for failure to obtain non-inducibility (95% CI)
P
Age, per10yrs up
0.849 (0.652 - 1.106)
0.225
1.222 (0.920 - 1.622)
0.166
Male
1.021 (0.355 - 2.936)
0.969
2.131 (0.584 - 7.767)
0.252
NICM
2.322 (1.211 - 4.452)
0.011
1.759 (0.905 - 3.419)
0.096
No.of prior procedure
1.027 (0.689 - 1.532)
0.896
1.120 (0.745 - 1.684)
0.585
Hypertension
0.952 (0.534 - 1.697)
0.867
1.155 (0.632 - 2.113)
0.640
Diabetes
1.050 (0.500 - 2.207)
0.898
0.932 (0.426 - 2.040)
0.860
Amiodarone
0.954 (0.491 - 1.856)
0.890
1.399 (0.680 - 2.878)
0.362
LVEF per10% up
0.821 (0.622 - 1.083)
0.163
0.646 (0.474 - 0.880)
0.006
LVEF=or<30%
1.369 (0.758 - 2.471)
0.297
2.099 (1.109 - 3.974)
0.023
Electrical storm
1.702 (0.948 - 3.058)
0.075
1.356 (0.740 - 2.487)
0.325
NYHA III or IV
3.622 (1.889 - 6.943)
<0.001
2.590 (1.351 - 4.967)
0.004
Renal insufficiency
2.174 (1.121 - 4.215)
0.022
2.011 (1.024 - 3.948)
0.042
Untolerated VT
1.463 (0.815 - 2.628)
0.203
2.015 (1.093 - 3.715)
0.025
RF time
0.943 (0.775 - 1.146)
0.553
1.163 (0.956 - 1.416)
0.131
Septal substrate
2.328 (1.275 - 4.249)
0.006
1.724 (0.929 - 3.198)
0.084
No.of VT morphology
1.139 (0.957 - 1.354)
0.142
1.309 (1.088 - 1.575)
0.004
VT termination
0.818 (0.455 - 1.470)
0.502
0.498 (0.265 - 0.937)
0.031
0.1
0.25
0.5
1
2
4
10
0.1
0.25
0.5
1
2
4
10

Ischemic and Non Ischemic scar related VT

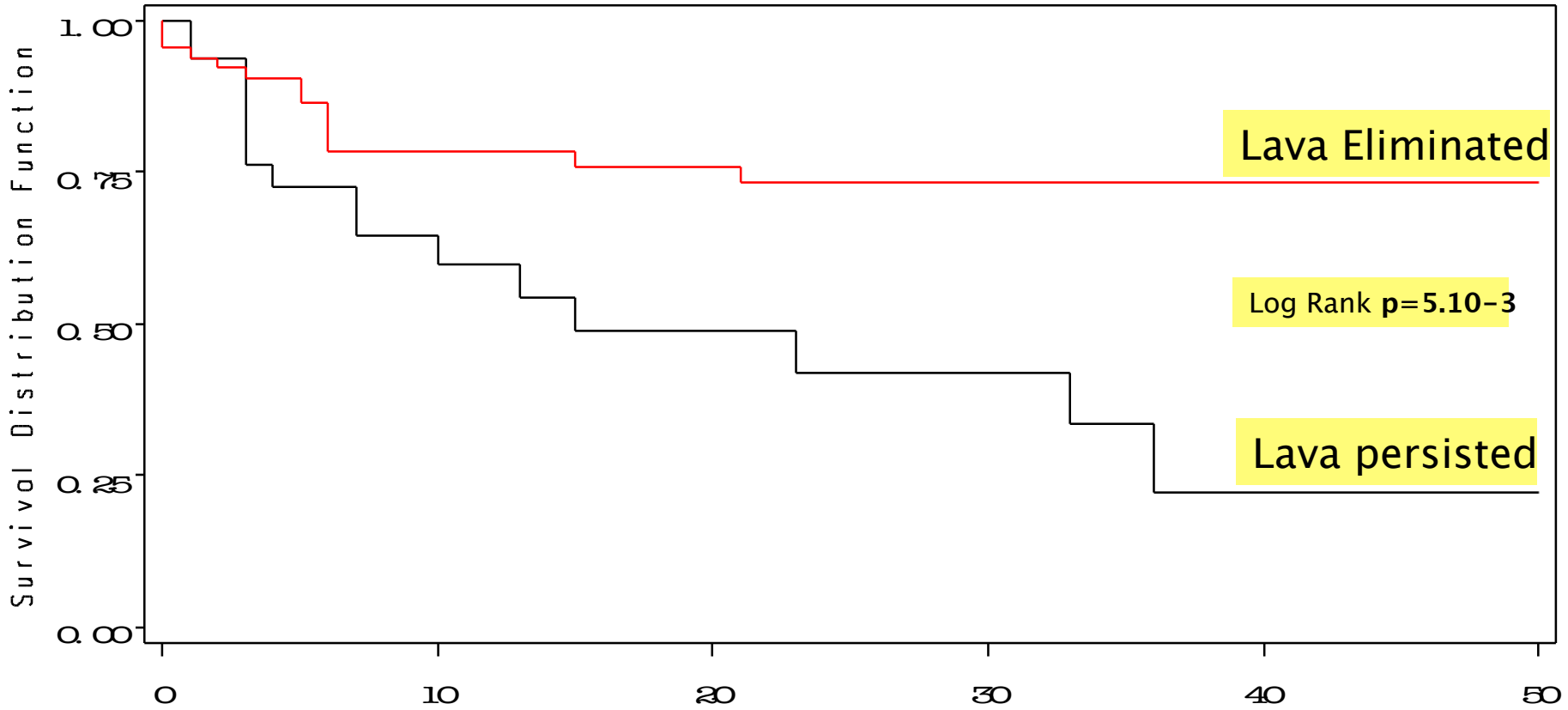
Table 3. Clinical and Procedural Characteristics of Patients with and without VT recurrence

	Patients with VT recurrence (n=36)	Patients without VT recurrence (n=77)	p Value
Age	62 [56, 69]	63 [53, 72]	0.58
Male	35 (97%)	70 (91%)	0.22
LVEF, %	30 [25, 35]	31 [25, 40]	0.40
Ischemic cardiomyopathy	23 (64%)	56 (73%)	0.34
Non-ischemic cardiomyopathy	13 (36%)	21 (27%)	
Electrical storm before ablation	19 (53%)	35 (46%)	0.47
Transseptal approach	31 (86%)	62 (81%)	0.47
Both endo- and epicardial approach	19 (53%)	41 (53%)	0.96
Scar involving septum	16 (44%)	24 (31%)	0.17
No. of VT observed during procedure	1.5 [0.25, 3.0]	2.0 [0.5, 3.0]	0.88
Maximum EGM-duration, ms	156 [134, 217]	188 [142, 245]	0.26
Maximum delay of LAVA, ms	188 [151, 242]	221 [158, 265]	0.37
Procedural duration, min	240 [190, 300]	265 [200, 309]	0.41
RF duration, min	31 [18, 44]	30 [21, 46]	0.82
Incomplete elimination of LAVA	21 (58%)	23 (30%)	**0.004**

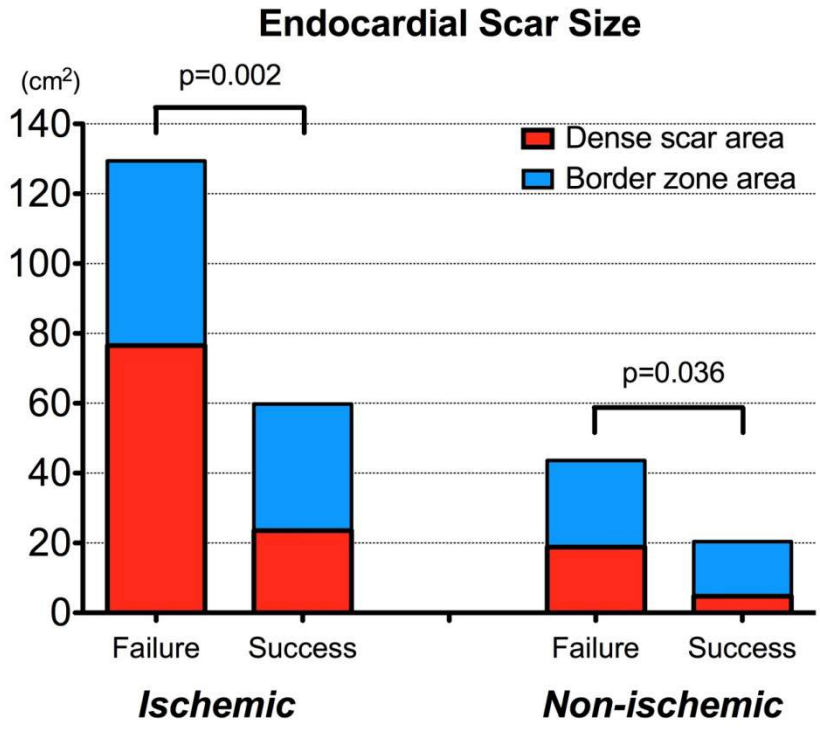
Data are presented as median [25th, 75th percentiles] or n (%).

LAVA elimination:

Clear end point
Achievable independently of VT inducibility or tolerar
Associated with a better prognosis



Failure vs success to eliminate LAVA



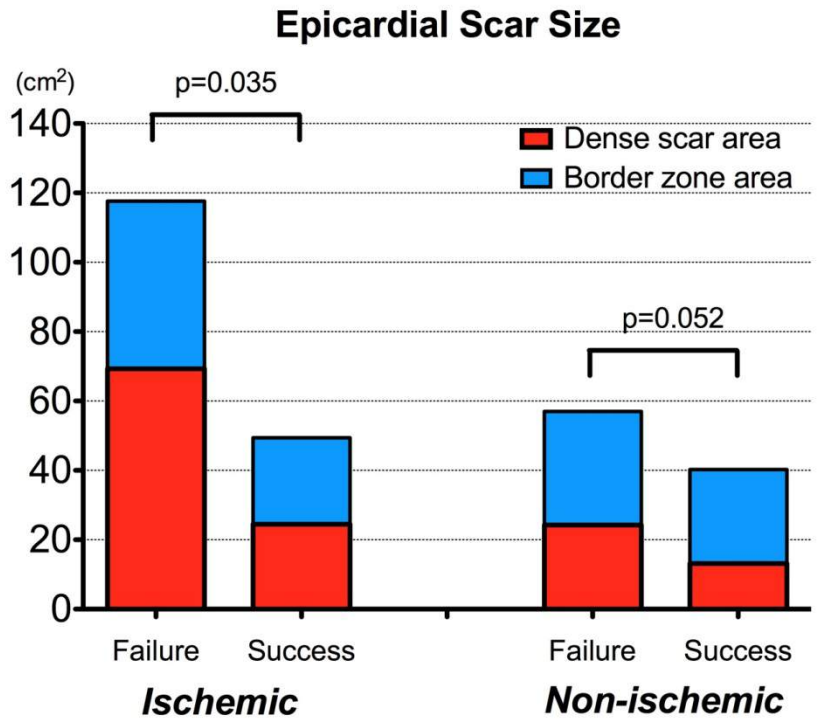


Table 2. Clinical and Procedural Characteristics of Patients with and without Difficult-to-Eliminate LAVA

	Patients with difficult-to-eliminate LAVA (n=36)	Patients with complete LAVA elimination (n=69)	p Value
Age	61 [55, 68]	63 [55, 73]	0.34
Male	33 (92%)	64 (93%)	0.84
LVEF, %	30 [25, 40]	30 [25, 40]	0.88
Ischemic cardiomyopathy	25 (69%)	52 (75%)	0.52
Non-ischemic cardiomyopathy	11 (31%)	17 (25%)	
Electrical storm before ablation	20 (56%)	32 (46%)	0.37
Transseptal approach	27 (75%)	60 (87%)	0.12
Both endo- and epicardial approach	20 (56%)	33 (48%)	0.45
Mapping during paced rhythm	8 (22%)	11 (16%)	0.43
Scar involving septum	20 (56%)	19 (28%)	**0.005**
No. of VT observed during procedure	2.0 [1.0, 3.0]	1.0 [0, 3.0]	0.23
Maximum EGM-duration, ms	202 [145, 255]	183 [140, 239]	0.37
Maximum delay of LAVA, ms	225 [151, 296]	207 [155, 258]	0.55
Low-voltage area, cm2			
Endo	81.3 [40.6, 142.1]	50.9 [28.0, 76.6]	**0.046**
Epi	99.6 [54.3, 127.6]	45.5 [39.1, 91.7]	**0.019**
Dense scar area, cm2			
Endo	36.6 [21.9]	20.0 [6.5, 34.1]	**0.013**
Epi	43.1 [26.1, 70.9]	19.0 [11.1, 54.8]	**0.019**

Data are presented as median [25th, 75th percentiles] or n (%). LAVA=local abnormal ventricular activities; LVEF=left ventricular ejection fraction.

Multiple Cox regression analysis

The predictor of heart failure which led to death during follow-up

Table 5 Multivariate Cox regression analysis for heart failure which led to death

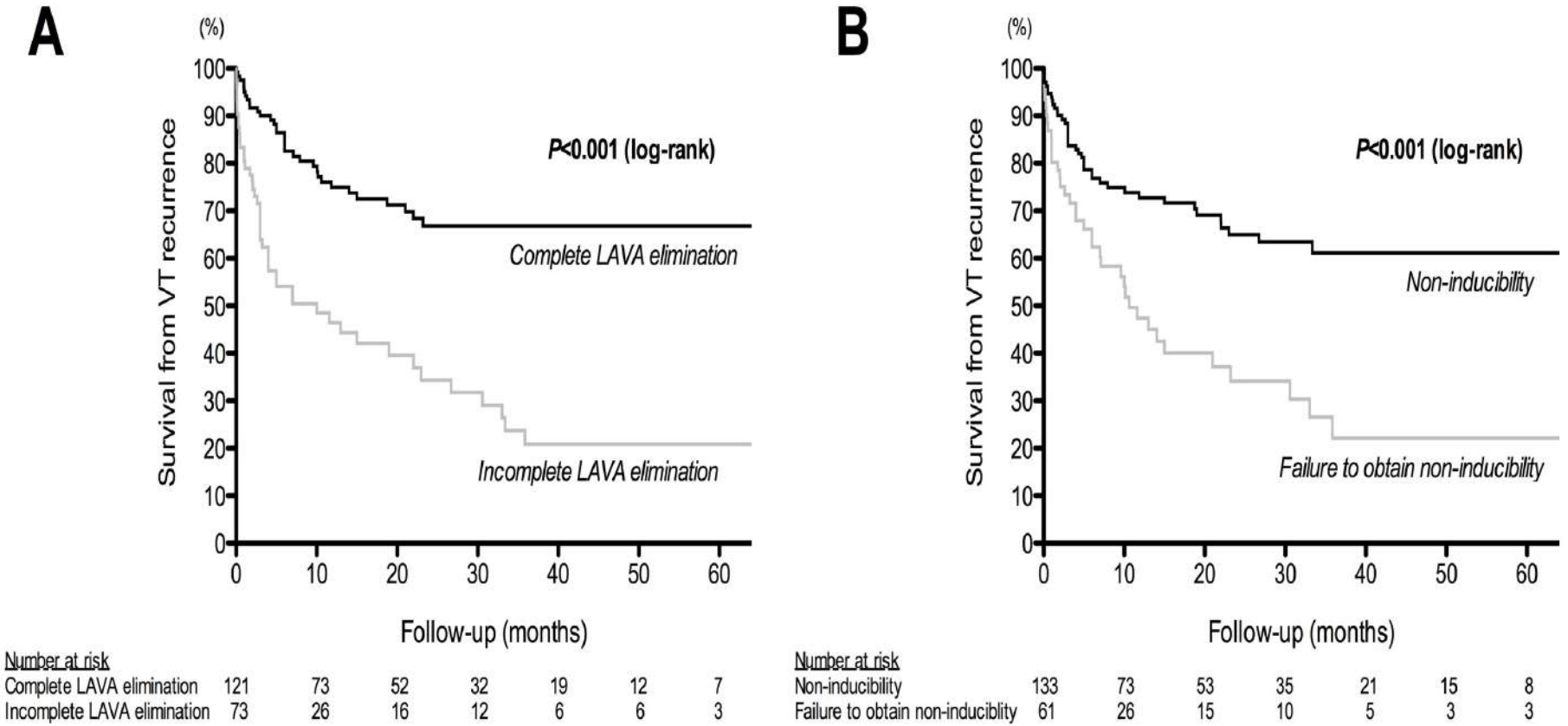
	HR	95% Confidence Interval	p Value
LVEF	0.934	0.868 - 1.005	0.069
Electrical storm before ablation	2.456	0.780 - 7.733	0.125
No. of VT observed during procedure	1.273	0.958 - 1.691	0.096
Incomplete elimination of LAVA	**2.456**	**1.291 - 10.939**	**0.015**

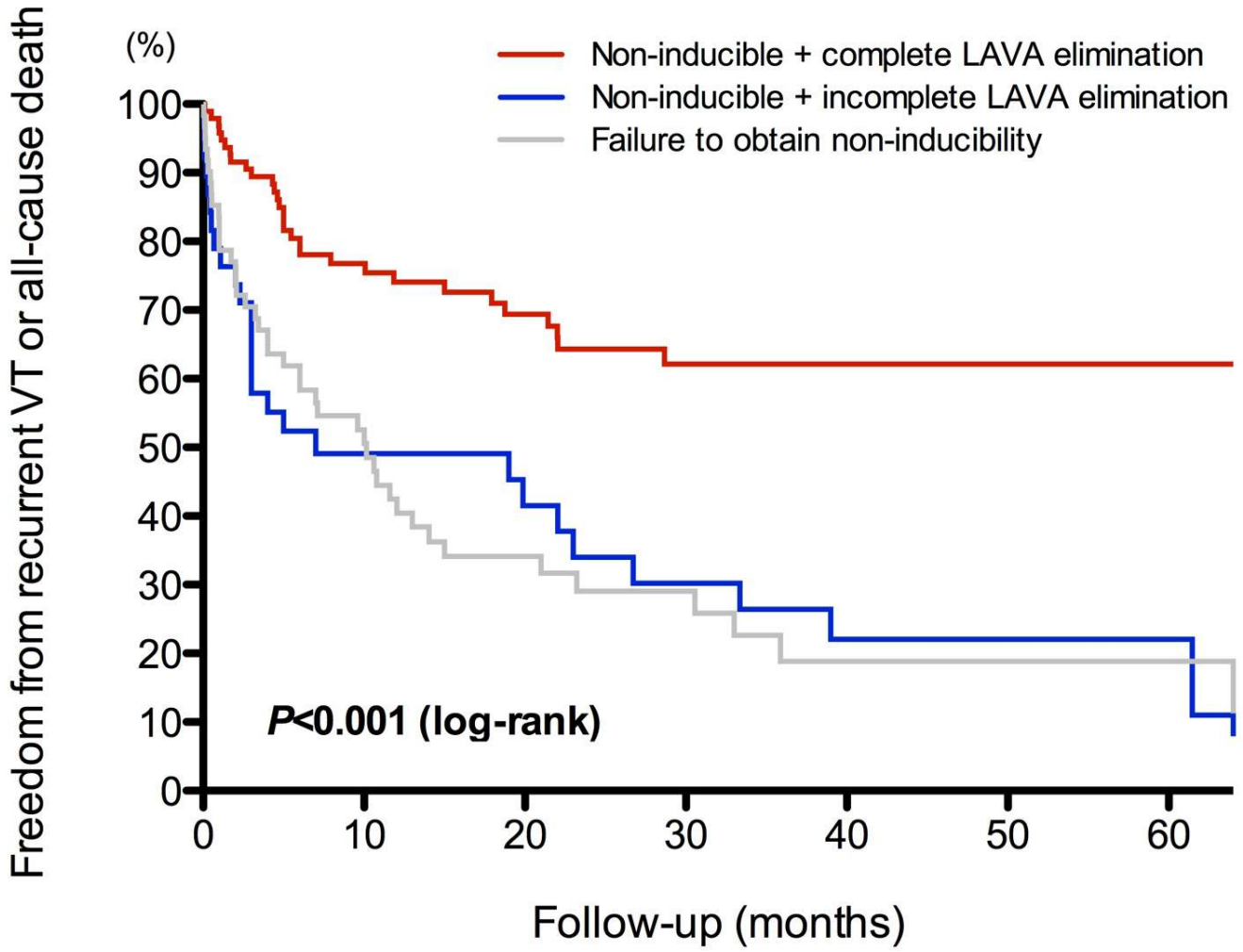
Conclusion

- High resolution imaging (Music platform) exported to the navigation systems may help better understanding and treating ventricular arrhythmias
- LAVA elimination in sinus rhythm is feasible and safe in scar related VT
- The outcome is better when LAVA are entirely eliminated with fewer VT recurrences and death
- This is more difficult in presence of septal or very large (endo and particularly epi) scars

incomplete LAVA elimination =higher risk of recurrent VT HR 3.03 and mortality HR 2.779, p=0.001

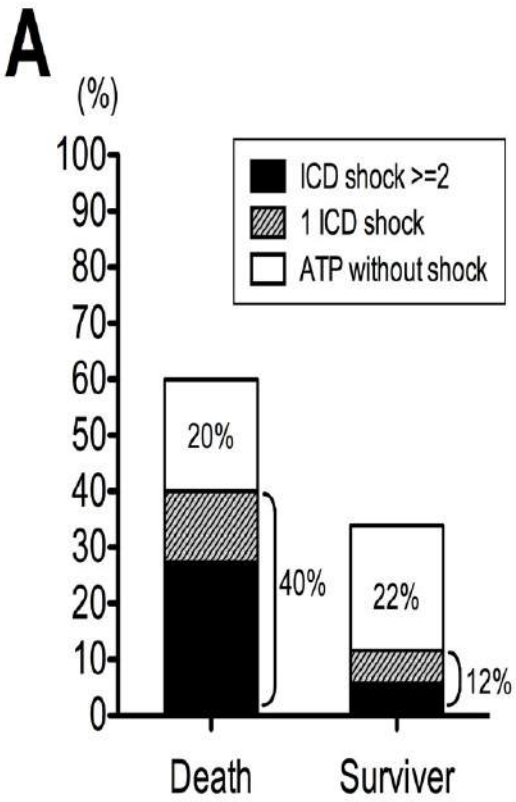
failure to achieve the non-inducibility = higher recurrent VT HR 1.937 p=0.004] but not mortality

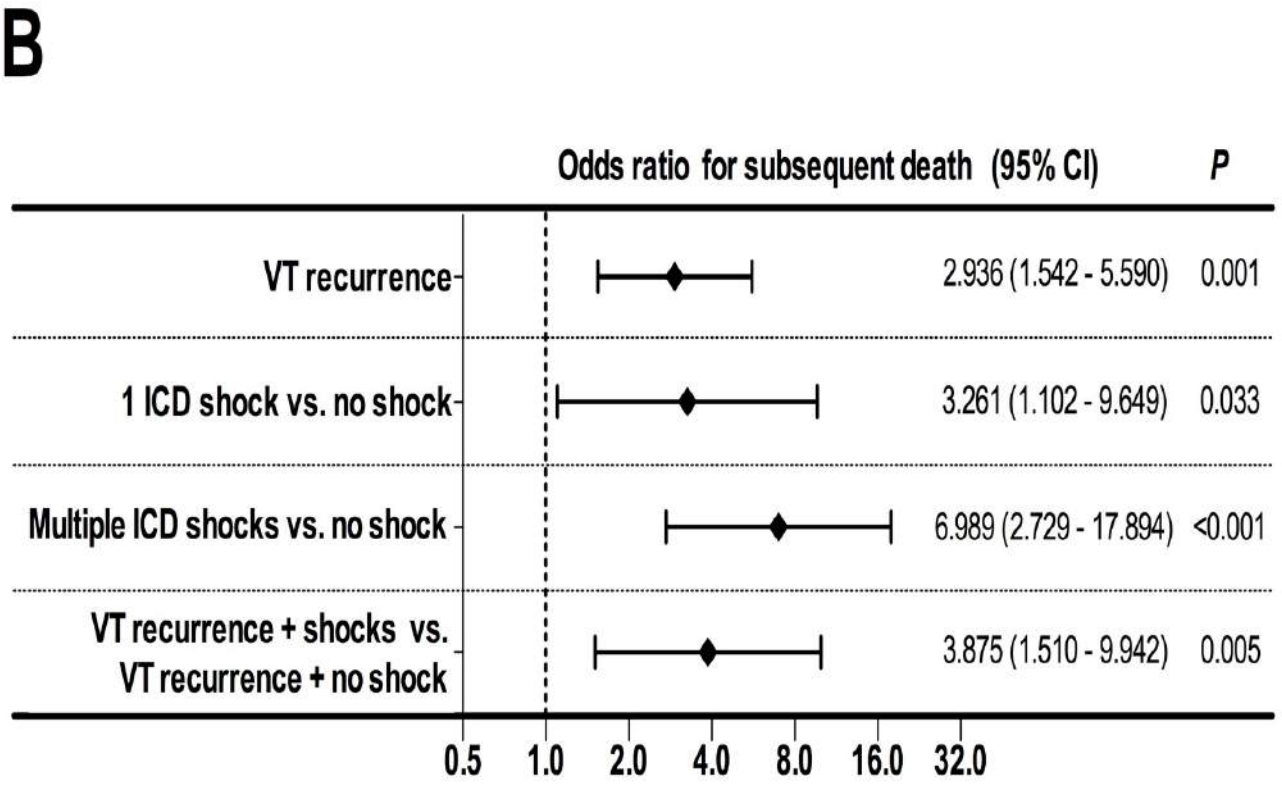




Number at risk							
Non-inducible + complete elimination	95	58	42	27	16	11	7
Non-inducible + incomplete elimination	38	16	12	9	6	5	2
Failure to obtain non-inducibility	61	26	15	10	5	3	3

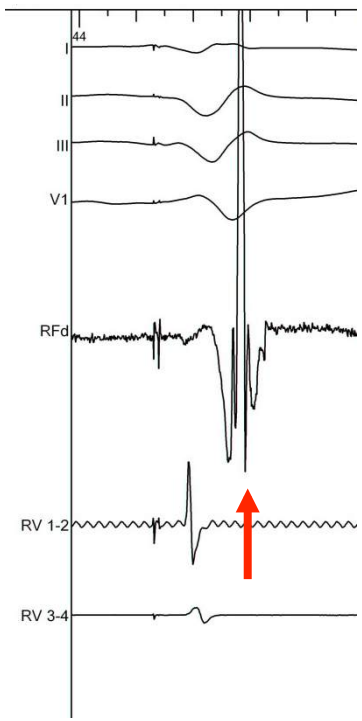
incomplete LAVA = higher rate of ICD shocks **36% vs 10%, p<0.001**
VT recurrences more frequent in patients who subsequently died **60% vs 34%.**
Higher mortality was associated with ICD shocks **40% vs 12%**
but not with anti-tachycardia pacing **20% vs 22%**

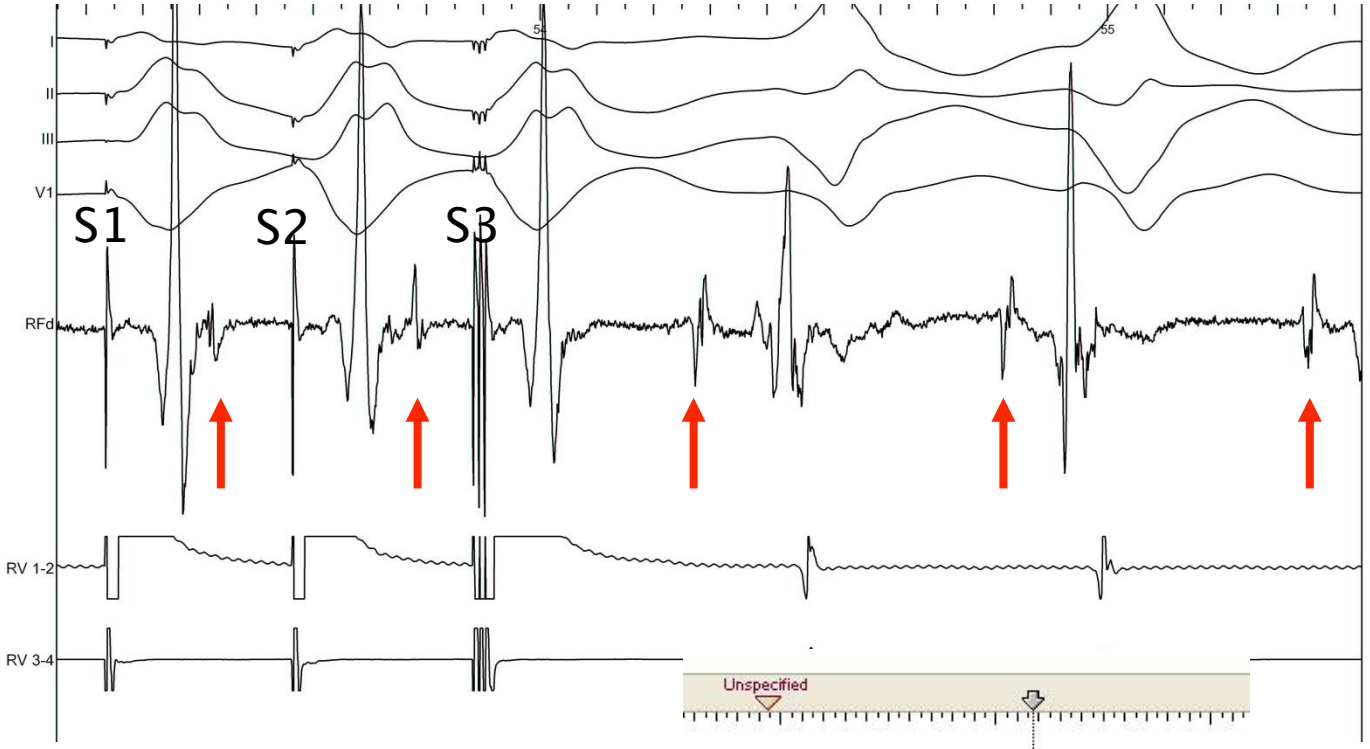




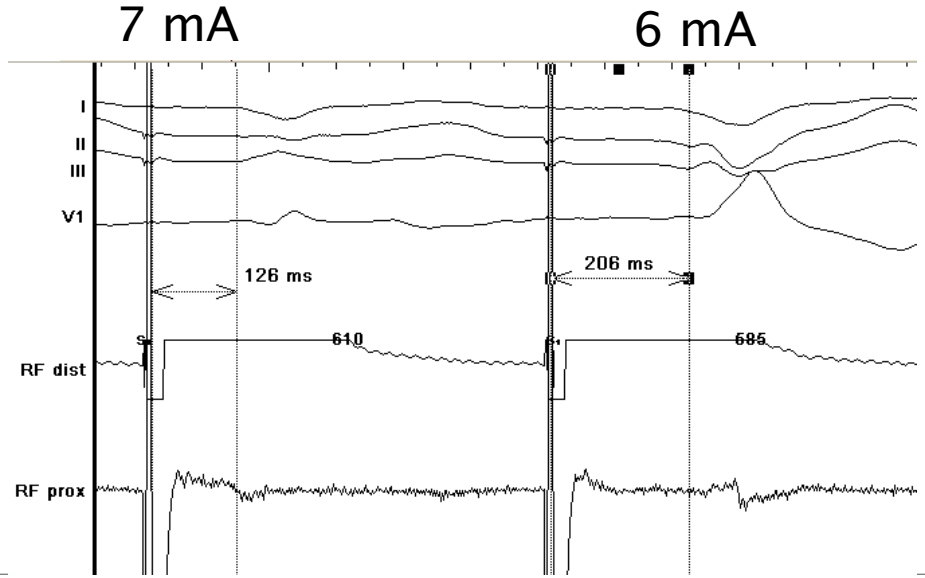
LAVA elimination and non inducibility, Methods:

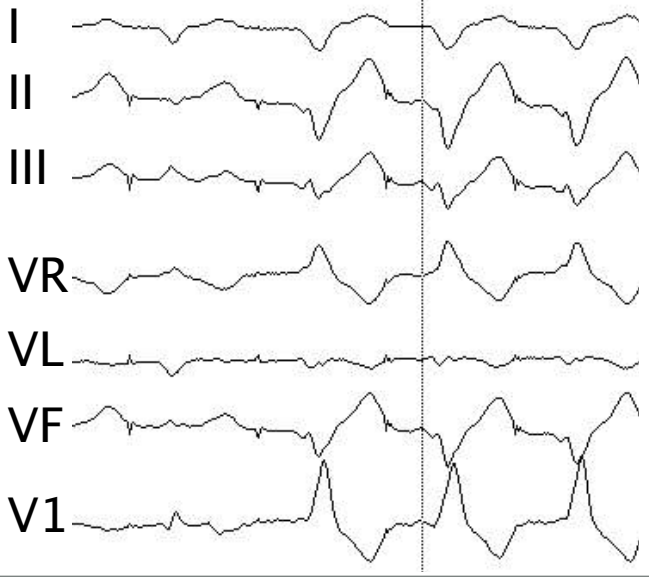
- 195 pts (179 males, age 65±11 years) 1±0.6 VT catheter ablation procedures
- ICD in all
- 144 ICM, 51 NICM
- Mapping endocardially in all but 2, epicardially in 79(failed in 1), Pentaray in most
- LVEF 32±10%
- Referred for electrical storm: 51%


I
II
III
V1
RFd
RV 1-2
RV 3-4

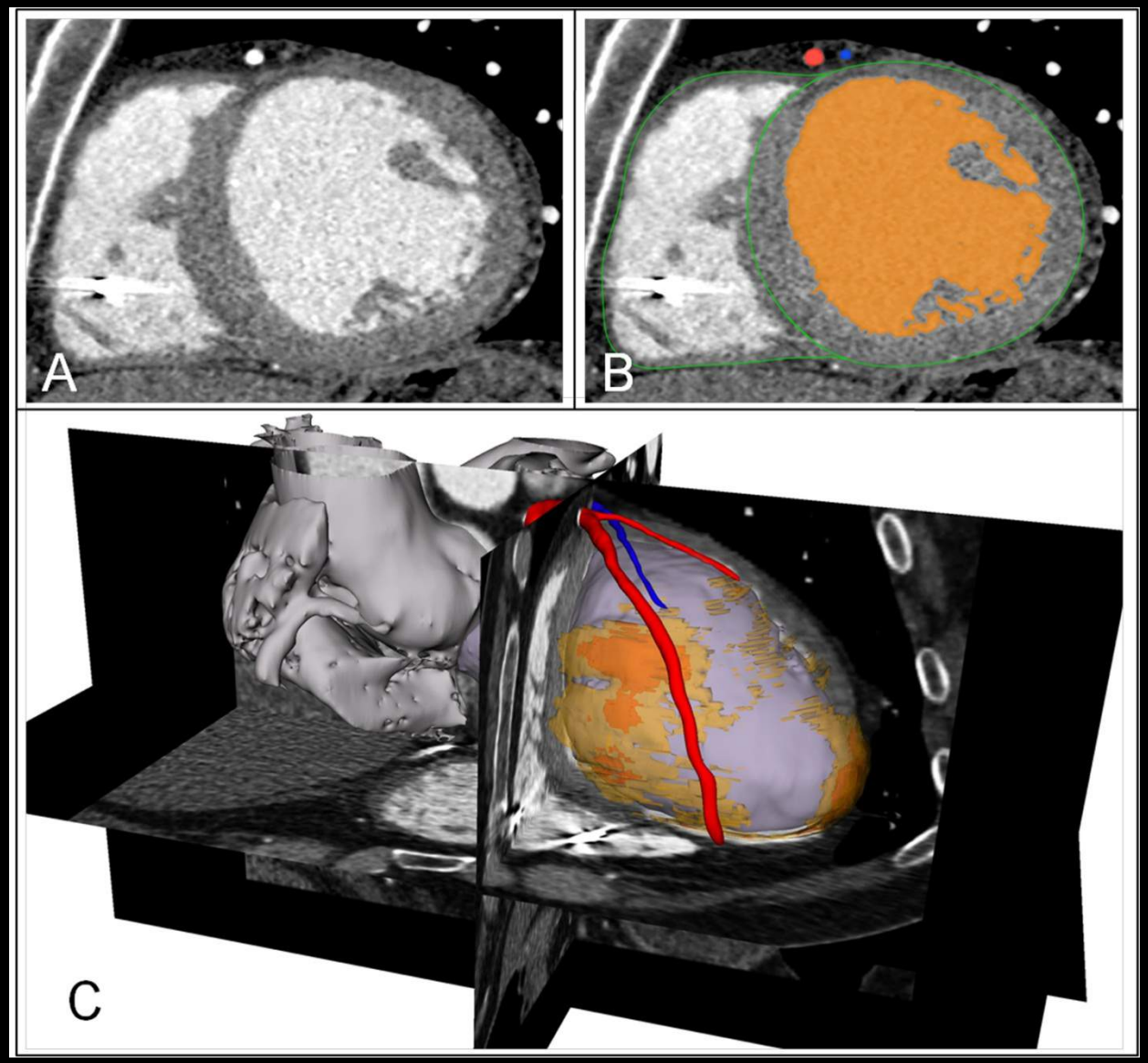

I
II
III
V1
S1
S2
S3
RFd
RV 1-2
RV 3-4

Unspecified

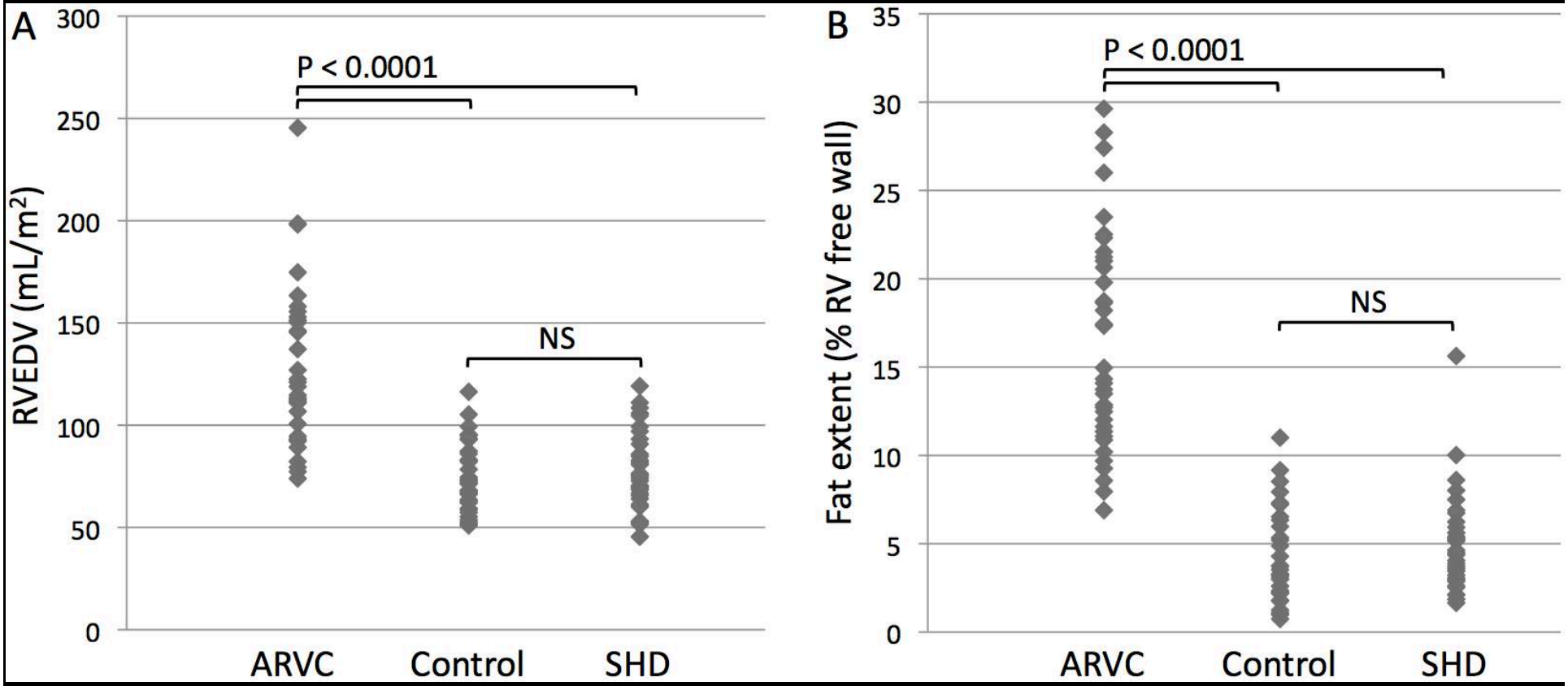

7 mA
6 mA
I
II
III
V1
126 ms
206 ms
610
685
RF dist
RF prox


I
II
III
VR
VL
VF
V1

Scanner cardiaque

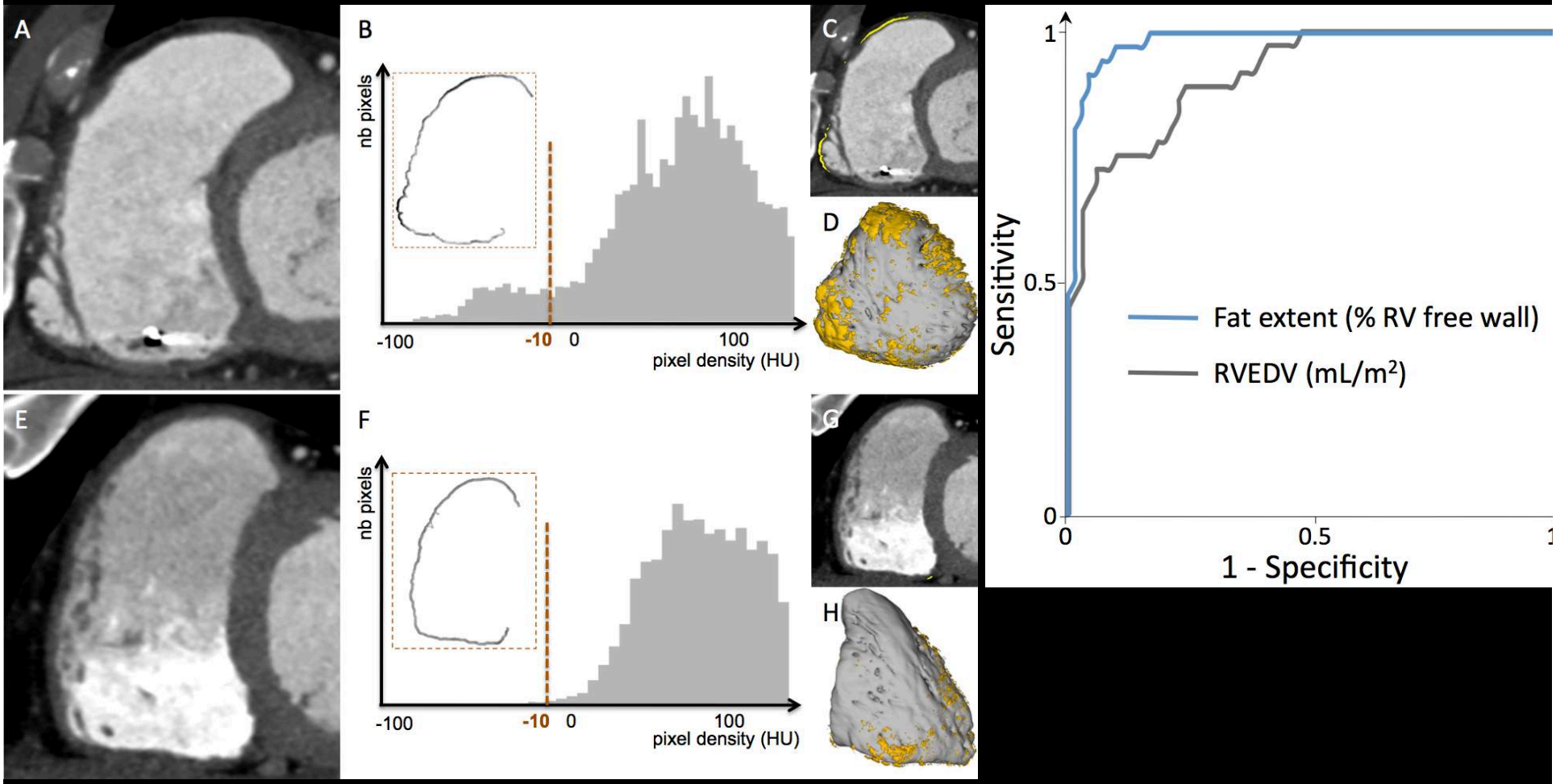


Resultats



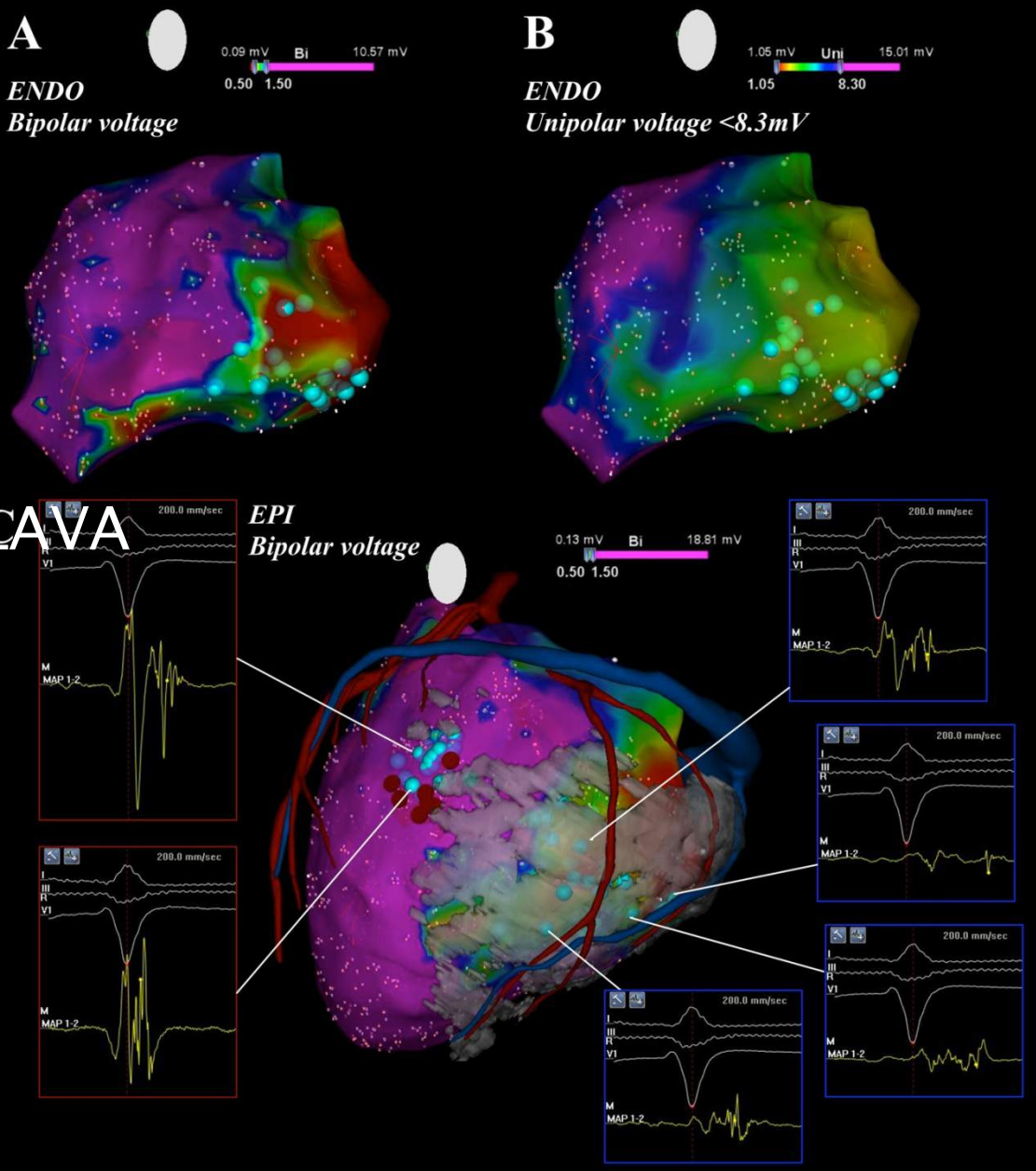
RVEDV was 126±38 in ARVC
77±19 in ischemic
75±17 mL/m² in controls

Fat extent 16.5±6.1 % in ARV
5.0±2.7 % in ischemic
4.2±2.6 % in controls



A fat extent cut-off of 8.5% diagnosed ARVC with 93% specificity and 94% sensitivity.

From a total of 173 endocardial ablations targeting Epi-LAVA at the facing site, 48 (28%) applications (ICM: 20/71 [28%], NICM: 3/39 [8%], ARVC: 25/63 [40%]) successfully eliminated the Epi-LAVA



Is Imaging associated with improved ablations???

	Study population (n=58)
Patient age (yrs)	63 ± 11
Male	54 (93%)
Hypertension	38 (65%)
Diabetes Mellitus	12 (21%)
Hyperlipidemia	43 (74%)
LVEF (%)	33 ± 10
LVDd (mm)	62 ± 7.5
ICD/CRTD	50 (86%)
VT storm (>3 times/day)	31 (53%)
Imaging (CT/MRI)	35 (60%)
Amiodarone	41 (71%)
Beta-blocker	53 (91%)

Dilated CMP
/myocarditis

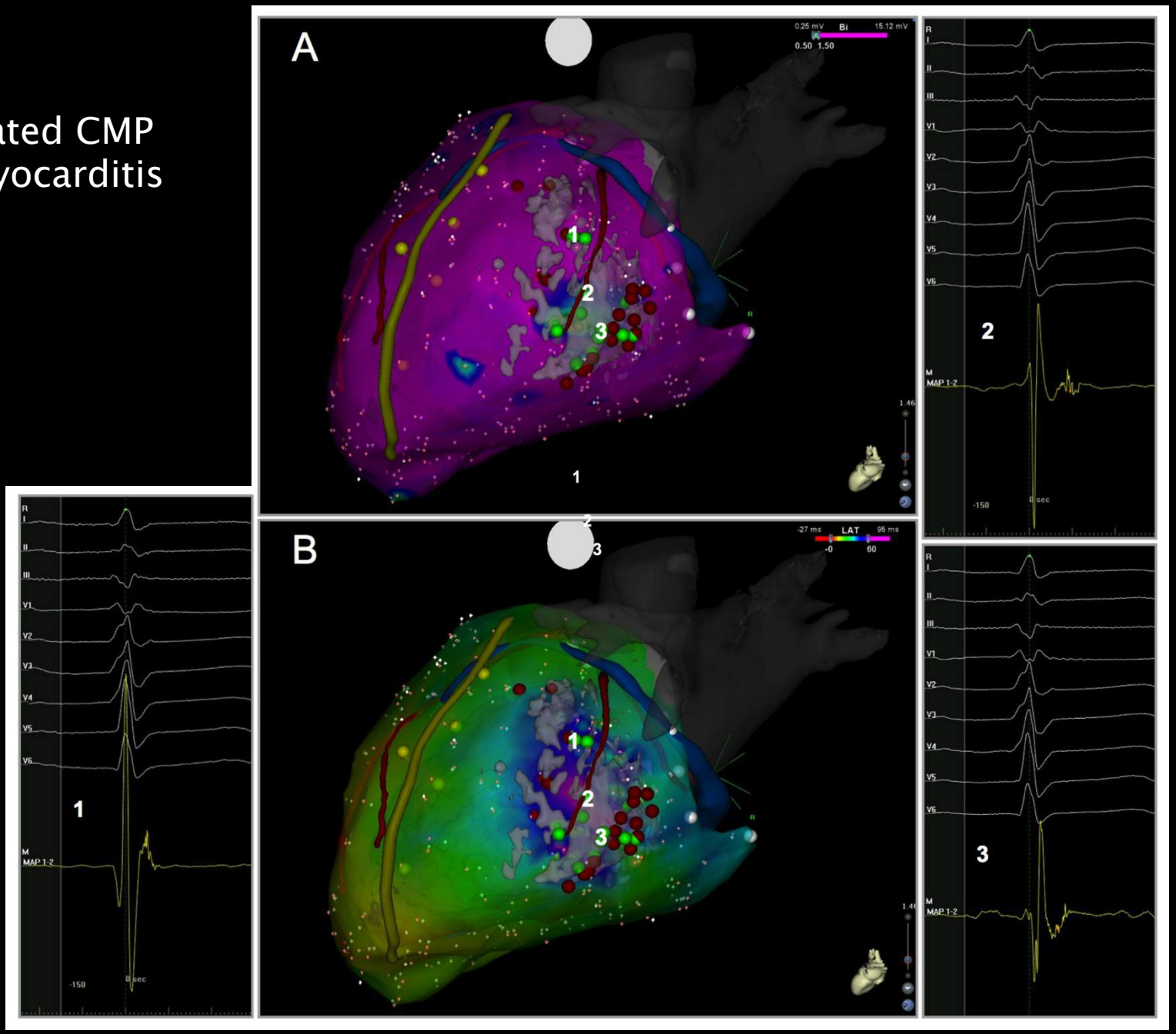
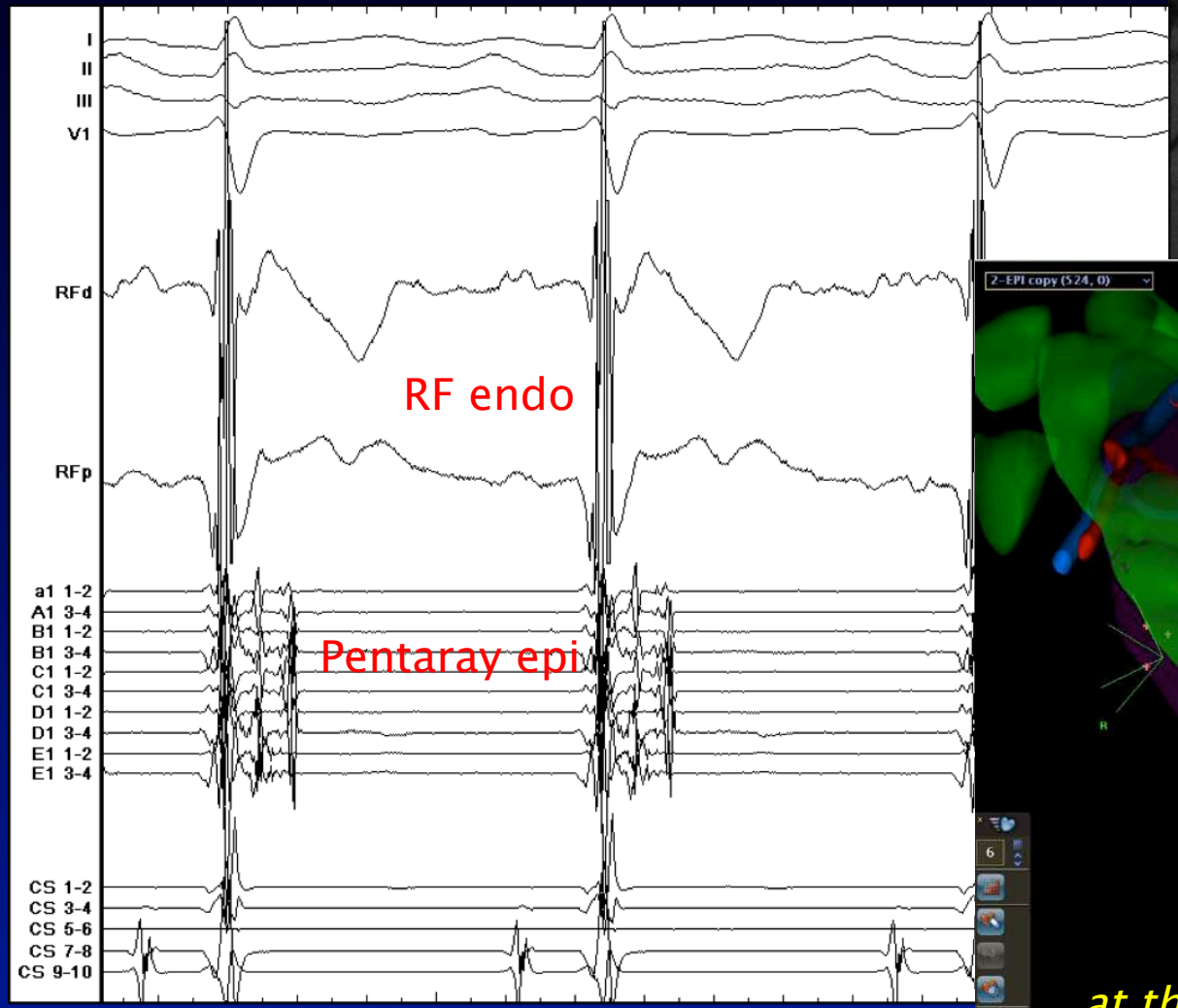
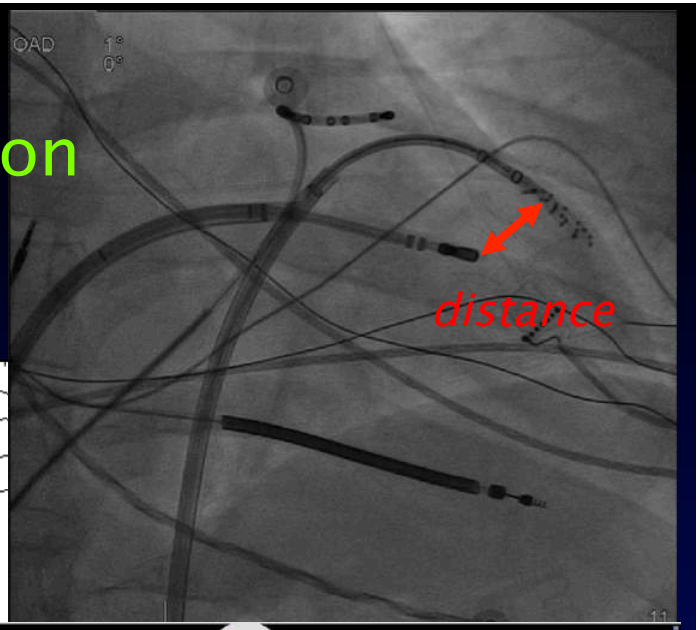
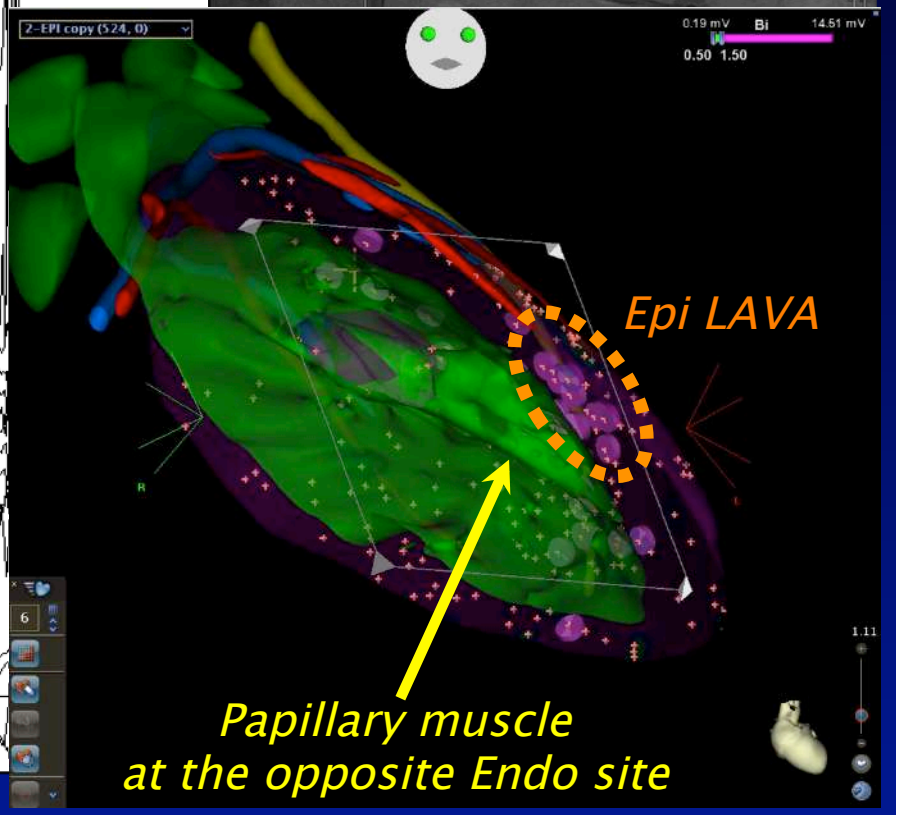


Fig 4

articularité anatomique de la localisation de la cible: muscle papillaire







LAVA conducted intermittently after epicardial ablation

(completely eliminated by further ablation)