

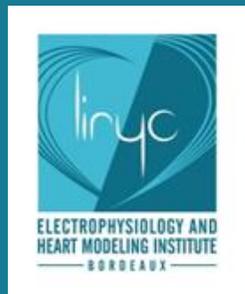
ARYTHMIES VENTRICULAIRES

INDICATION ESC 2022 ET APPORT DE L'IMAGERIE EN RYTHMO



Frédéric Sacher, MD, PhD

University of Bordeaux
Bordeaux University Hospital
LIRYC Institute
FRANCE



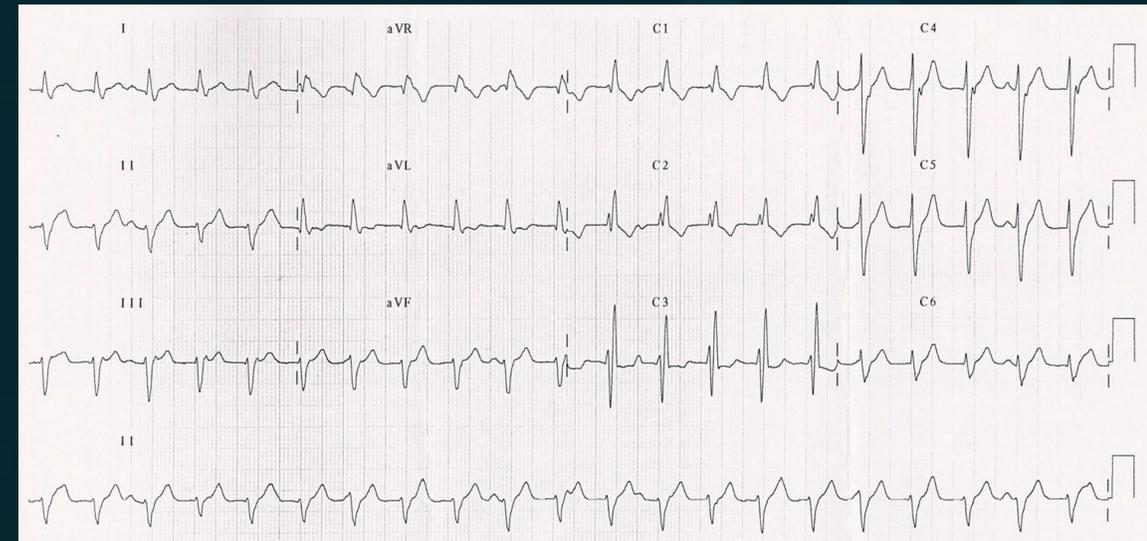
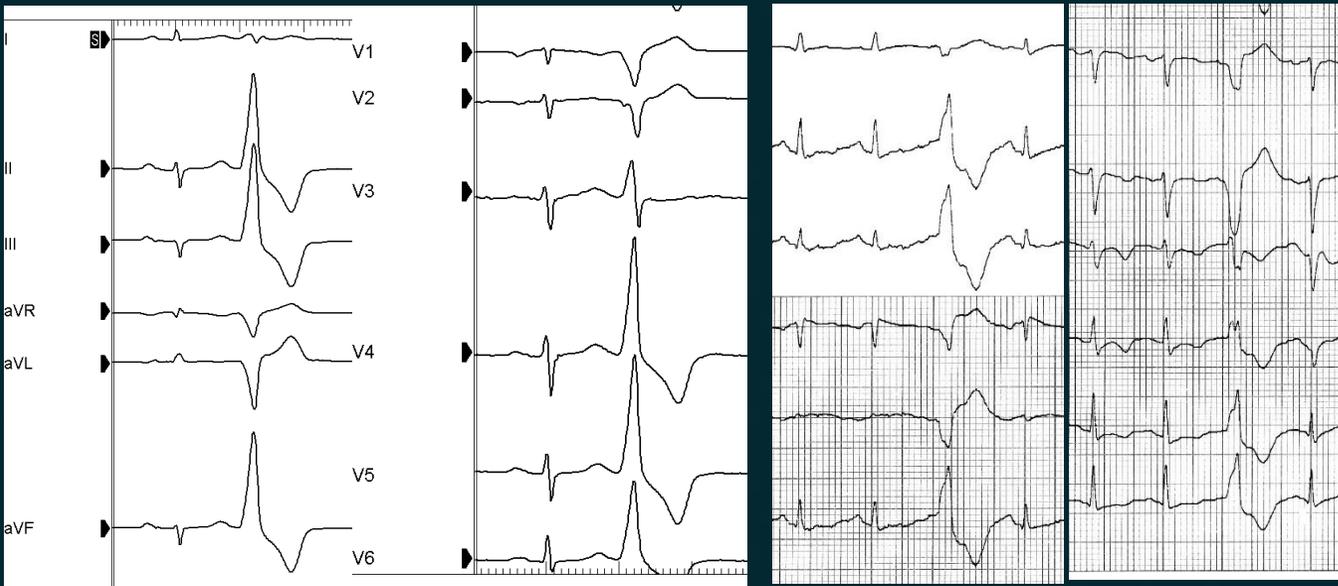
RELATIONSHIP WITH INDUSTRY

- **Speaking honorarium:** Biosense Webster, Boston Scientific, Medtronic, Abbott, Microport, Bayer Healthcare
- **Consulting fees:** Boston scientific, Bayer Healthcare, Inheart

IMAGING IN VENTRICULAR ARRHYTHMIAS

In patients with PVCs/VT and a presentation not typical for an idiopathic origin,^c CMR should be considered, despite a normal echocardiogram.

Ila



IMAGING IN VENTRICULAR ARRHYTHMIAS

In patients with PVCs/VT and a presentation not typical for an idiopathic origin,^c CMR should be considered, despite a normal echocardiogram.

IIa

In patients with an unexplained reduced EF and a PVC burden of at least 10%, PVC-induced cardiomyopathy should be considered.

IIa

In patients with suspected PVC-induced cardiomyopathy, CMR should be considered.

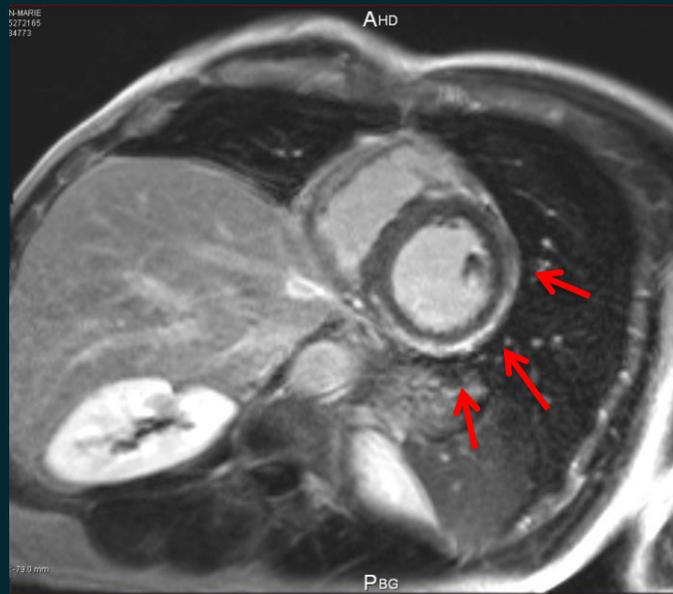
IIa

CMR with LGE should be considered in DCM/HNDCM patients for assessing the aetiology and the risk of VA/SCD.

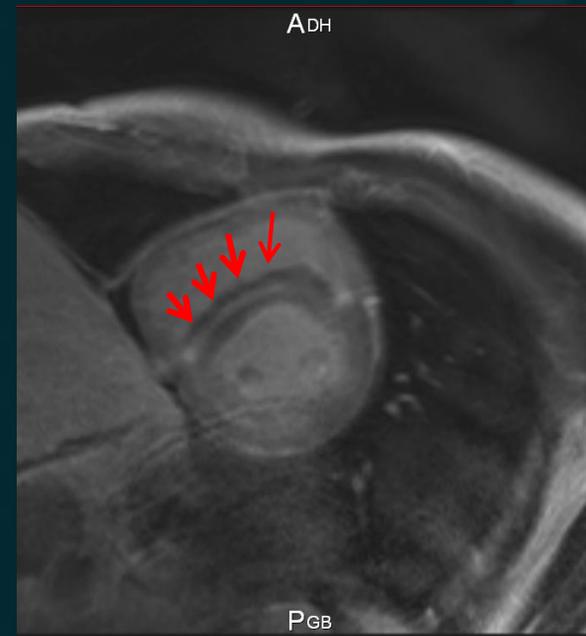
IIa

SCAR IDENTIFICATION

➤ Epicardial substrate

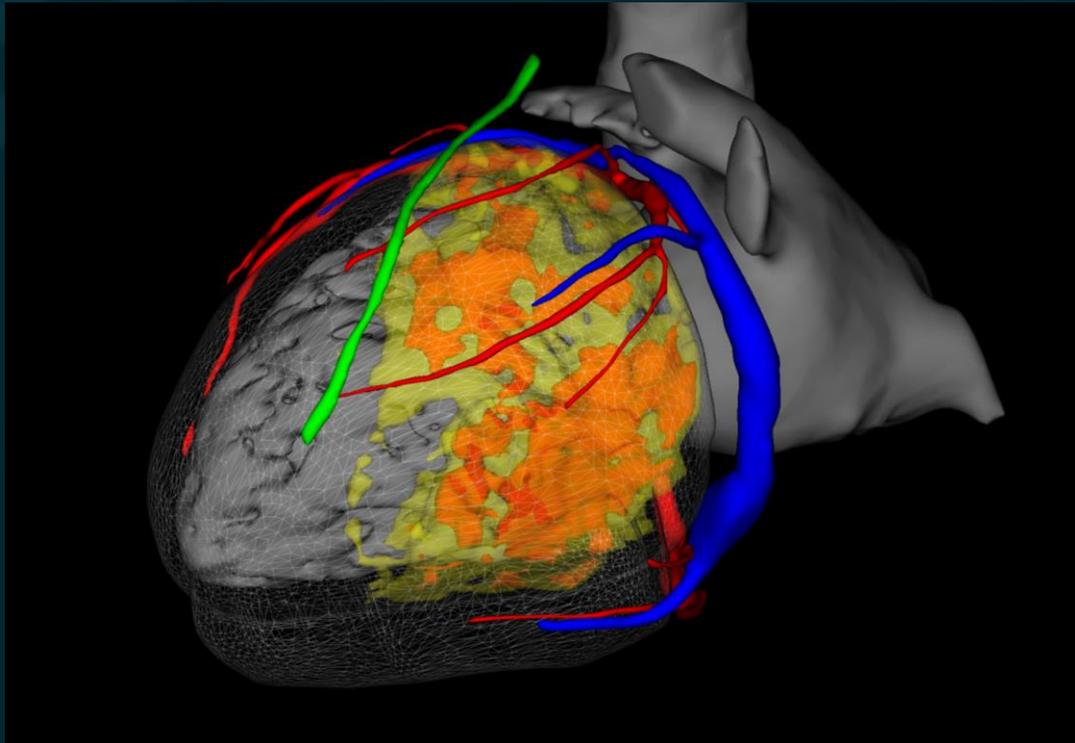


➤ Intraseptal substrate

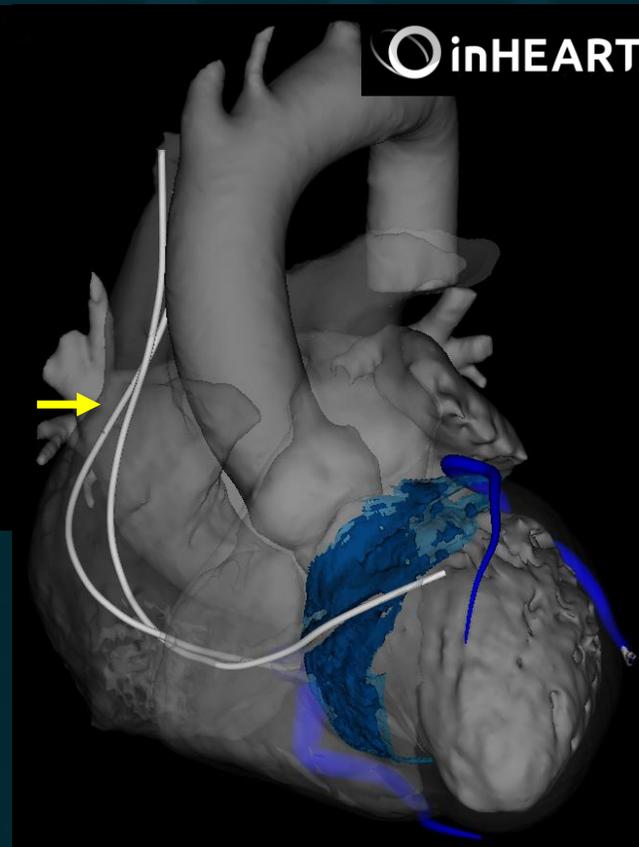
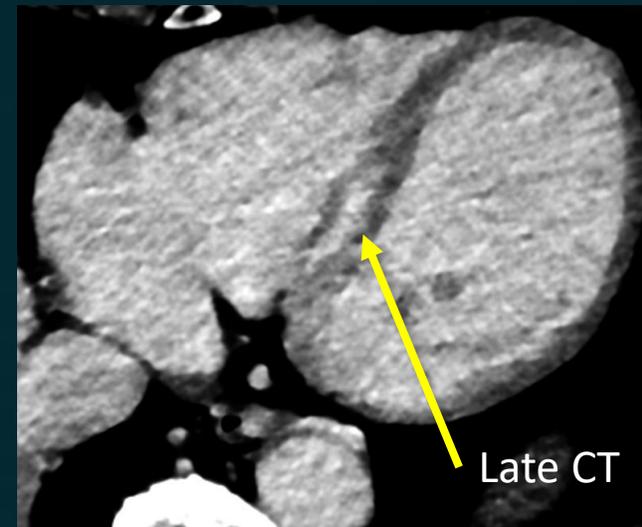


SCAR IDENTIFICATION

➤ Epicardial substrate



➤ Intraseptal substrate



INDICATION OF ABLATION IN IDIOPATHIC/NICMP

Idiopathic PVC/VT and PVC-induced cardiomyopathy

Catheter ablation as first-line treatment is recommended for symptomatic idiopathic VT/PVCs from the RVOT or the left fascicles.

I

Beta-blockers or non-dihydropyridine CCBs are indicated in symptomatic patients with idiopathic VT/PVCs from an origin other than the RVOT or the left fascicles.

I

Beta-blockers, non-dihydropyridine CCBs or flecainide should be considered when catheter ablation is not available, not desired, or is particularly risky in symptomatic patients with idiopathic VT/PVCs from the RVOT or the left fascicles.

IIa

Catheter ablation or flecainide should be considered in symptomatic patients with idiopathic VT/PVCs from an origin other than the RVOT or the left fascicles.

IIa

In non-responders to CRT with frequent, predominately monomorphic PVCs limiting optimal biventricular pacing despite pharmacological therapy, catheter ablation or AADs should be considered.

IIa

Catheter ablation may be considered for idiopathic VT/PVCs in asymptomatic patients with repeatedly more than 20% of PVCs per day at follow-up.

IIb

Amiodarone as a first-line treatment is not recommended in patients with idiopathic VTs/PVCs.

III

IMAGING CAN PLAY A ROLE FOR SCAR RELATED VA ABLATION

■ **Before ablation**

- Elimination of thrombus (LV but also left appendage in case of transeptal access)
- diagnosis of VT substrate and need for epicardial access
- feasibility and risk of epicardial access

■ **To guide ablation**

- accurate definition of the substrate to target
- identifying structures at risk (coronaries, phrenic)
- And improve outcome?

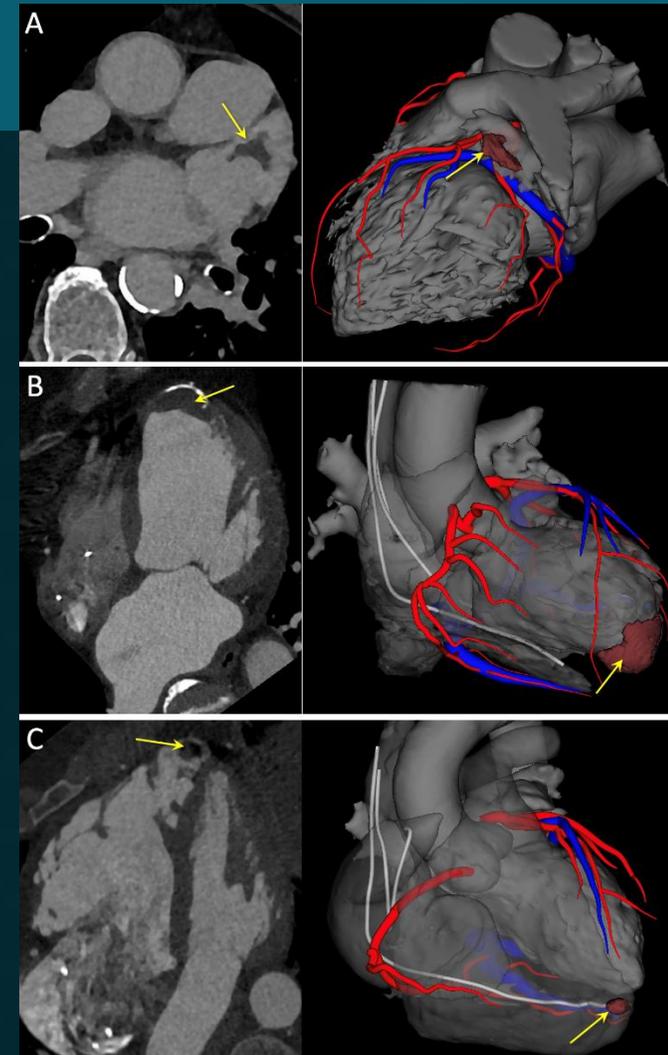
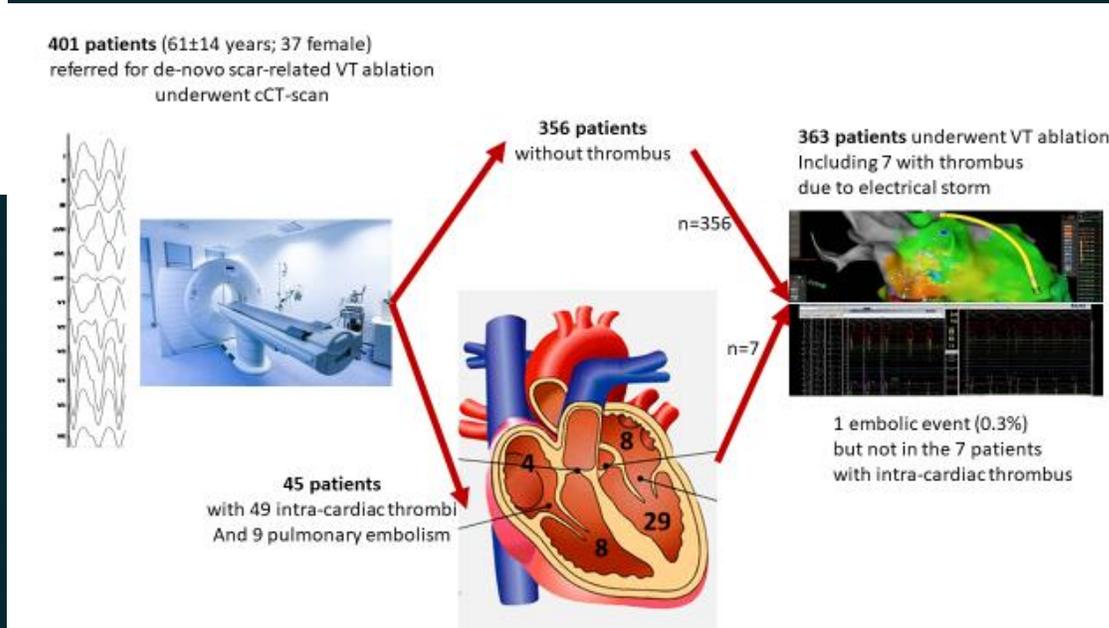
■ **After ablation**

- characterization of lesion formation (transmurality)
- detection of complications (steam pop)

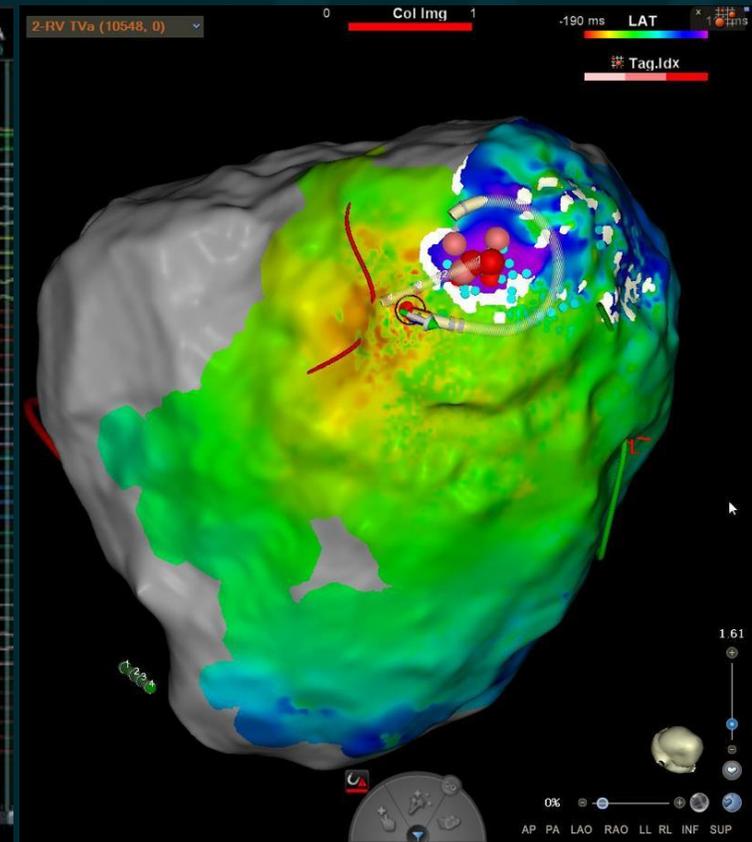
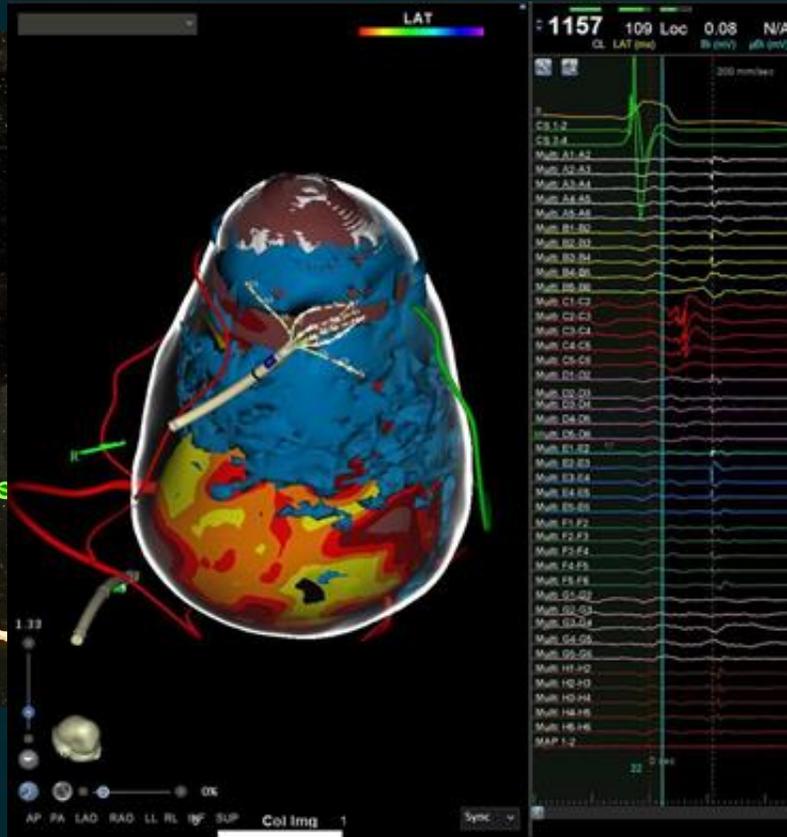
IMAGING CAN PLAY A ROLE BEFORE ABLATION

Elimination of intra-cardiac thrombus

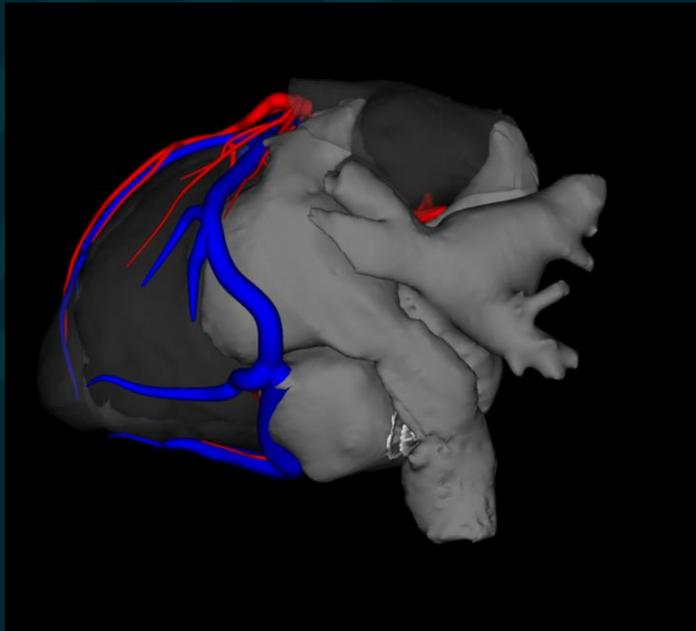
COR	LOE	Recommendations
I	B-NR	1. In patients with LV dysfunction undergoing catheter ablation of VA, preprocedural or intraprocedural imaging is recommended to rule out cardiac thrombi.



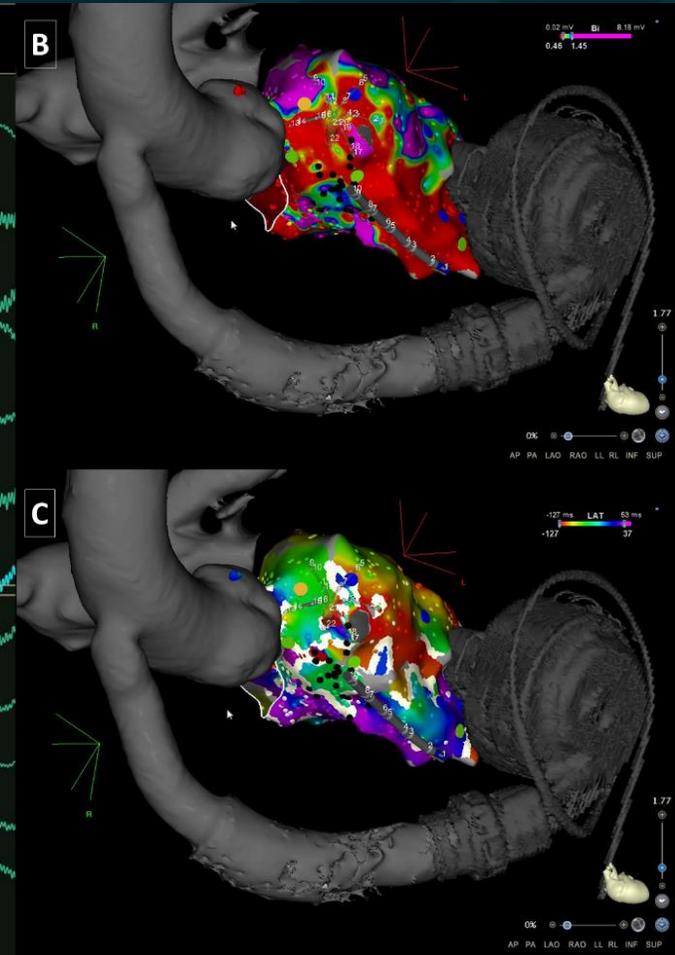
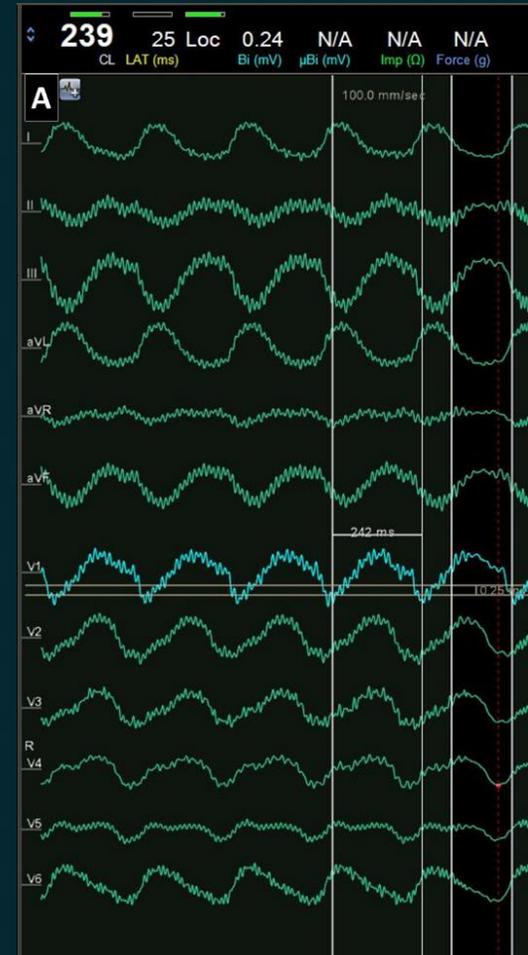
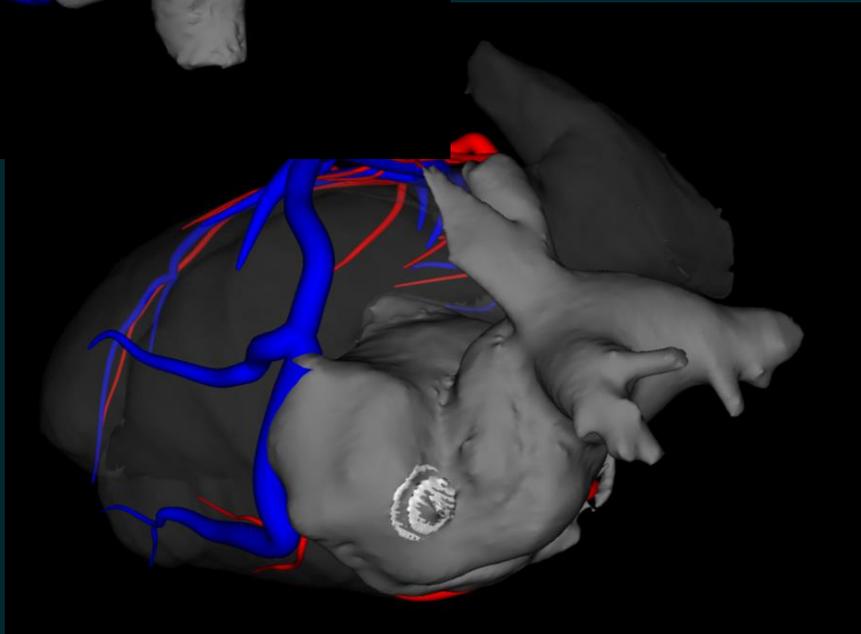
EXAMPLE FROM DR MARCHAND



BETTER UNDERSTANDING OF THE ANATOMY/SUBSTRATE IN COMPLEX SITUATION



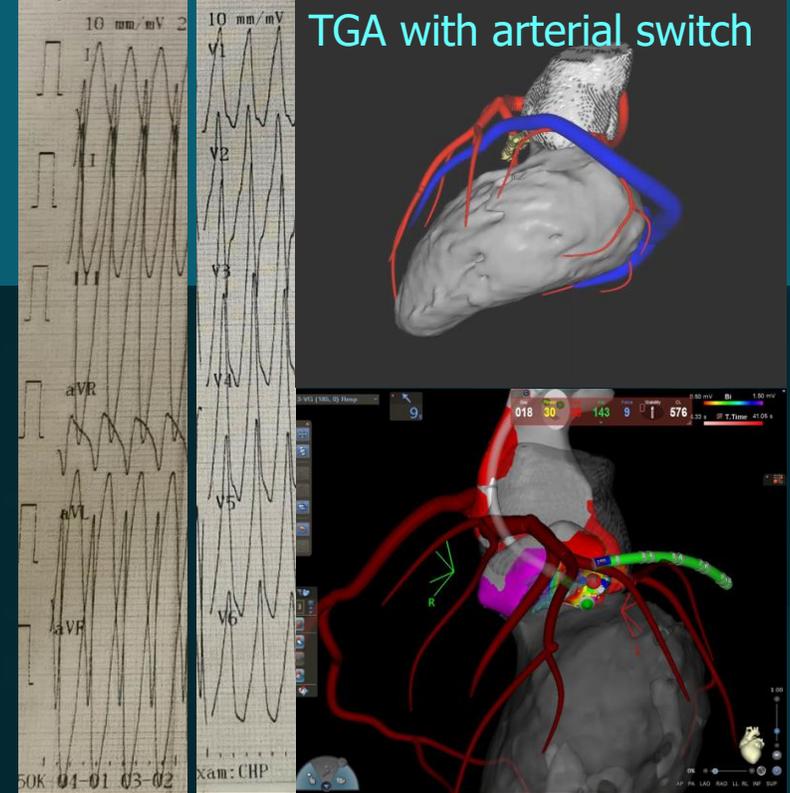
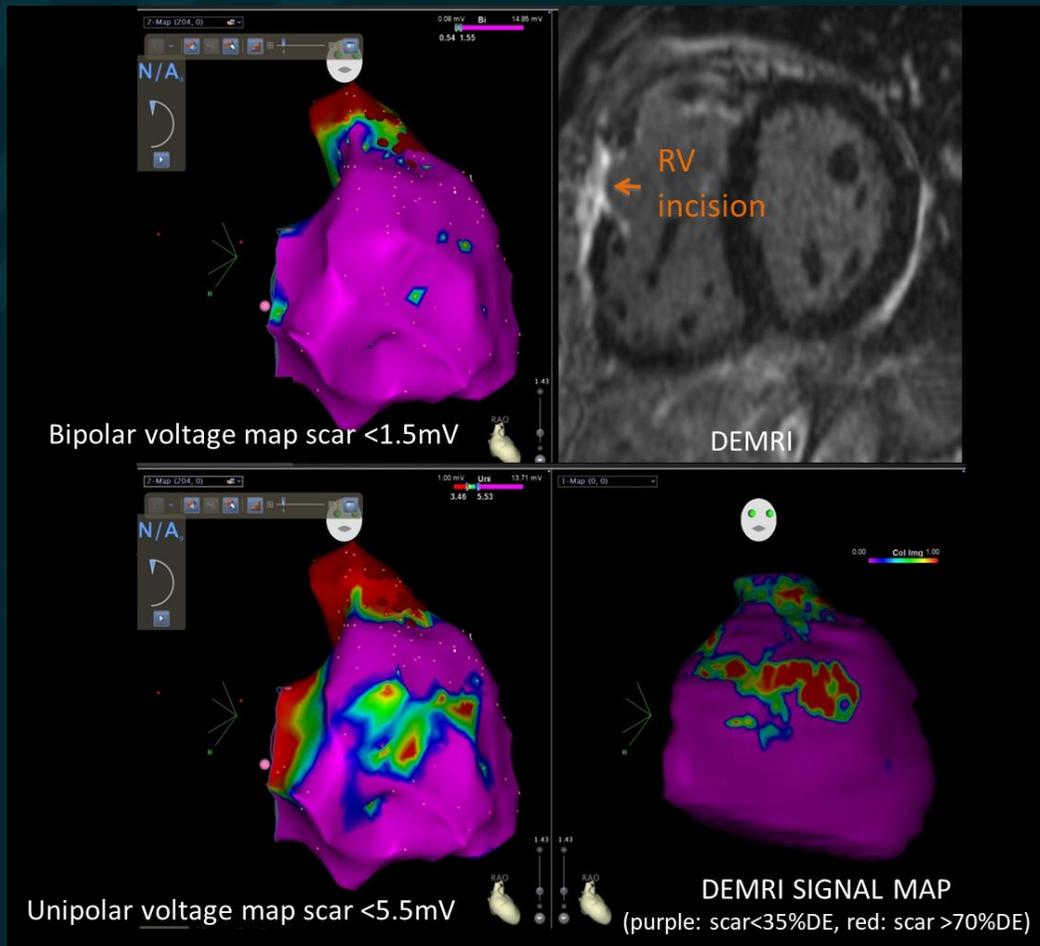
Mustard



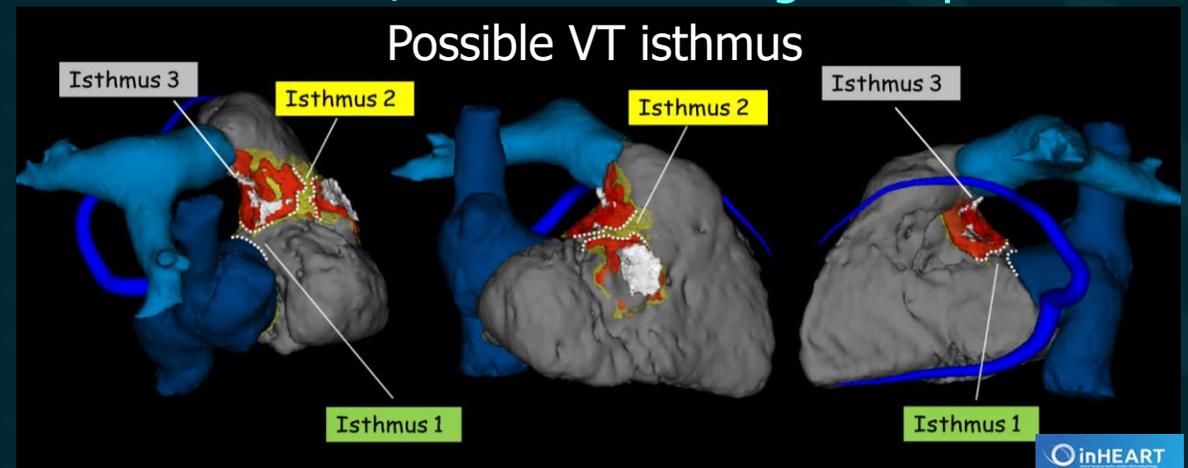
Heart Mate 3

SCAR IDENTIFICATION

Isthmus identification with HR cMRI in Fallot patients



d-TGA / DORV with surgical repair



CORONARY ARTERY DISEASE

In patients with CAD and recurrent, symptomatic SMVT, or ICD shocks for SMVT despite chronic amiodarone therapy, catheter ablation is recommended in preference to escalating AAD therapy.

I

In patients with CAD and haemodynamically well-tolerated SMVT and LVEF $\geq 40\%$, catheter ablation in experienced centres should be considered as an alternative to ICD therapy, provided that established endpoints have been reached.^b

IIa

Catheter ablation should be considered in patients with CAD and recurrent, symptomatic SMVT, or ICD shocks for SMVT despite beta-blocker or sotalol treatment.

IIa

IMAGING CAN PLAY A ROLE

■ **Before ablation**

- Elimination of thrombus (LV but also left appendage in case of transeptal access)
- diagnosis of VT substrate and need for epicardial access
- feasibility and risk of epicardial access

■ **To guide ablation**

- **accurate definition of the substrate to target**
- **identifying structures at risk (coronaries, phrenic)**
- **And improve outcome?**

■ **After ablation**

- characterization of lesion formation (transmurality)
- detection of complications (steam pop)

VT vs SUBSTRATE MAPPING

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<http://dx.doi.org/10.1016/j.jacc.2015.10.026>

Ablation of Stable VTs Versus Substrate Ablation in Ischemic Cardiomyopathy

The VISTA Randomized Multicenter Trial



	n=58	n=60		
	Substrate-Based Ablation (%)	Clinical Ablation (%)	p Value	HR (95% CI)
VT recurrence rate	15.5 (8.4-27.7)	48.3 (36.6-61.2)	<0.001	0.26 (0.11-0.61)
All-cause mortality rate	8.6 (1.4-14.2)	15.0 (5.9-24.2)	0.21	0.54 (0.17-1.82)
Arrhythmia-related rehospitalization	12.1 (3.8-19.7)	31.7 (22.1-41.6)	0.014	0.31 (0.13-0.78)
Composite: rehospitalization and mortality	20.7 (10.3-30.1)	46.7 (34.0-59.3)	0.003	0.32 (0.17-0.61)
Composite: VT recurrence and mortality	24.1 (13.2-35.1)	63.3 (51.1-75.5)	<0.001	0.20 (0.09-0.43)
Radiofrequency duration (min)	68 ±21	35 ±27		

■ F-Up: 12 months

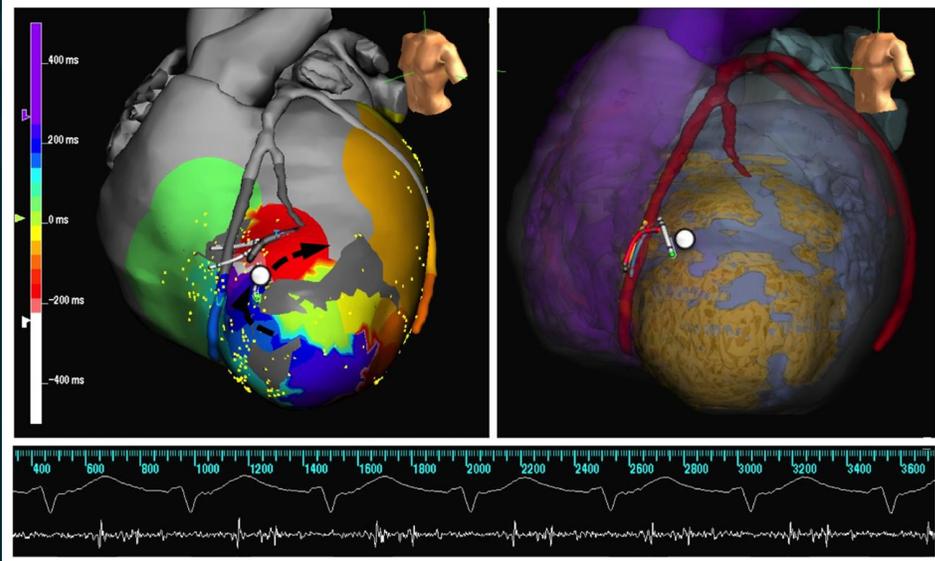
CONVENTIONAL SUBSTRATE MAPPING

	Endpoint	Patients	Map density	Type of mapping catheter	RF duration	Endpoint achievement
Jais et al. Circulation 2012	LAVA elimination	56 ICM, 14 NICM	>600	Pentaray, BW	23 min	67%
Vergara et al. JCE 2012	LP elimination	36 ICM, 14 NICM	300-600	Livewire (20 poles) or Inquiry AFocus II, SJM	≈30 min?	84%
Di Biase et al. JACC 2012	Elimination of all abnormal potentials	43 ICM	Endo:370 Epi: 410	? Ablation catheter	74 min	100%
Tung et al. Circ AE 2013	Ablation of interconnected channels	15 ICM, 2 NICM, 5 others	>300 Mediane614	Livewire DecaNav Constellation	?	?
Tilz et al. Europace 2014	Electrical isolation of the substrate	12 isch CMP	550	3.5 mm irrigated-tip catheter	53 ± 15min	50%
Berruezo et al. Circ AE 2015	Ablation of interconnected channels	75 ICM, 26 NICM	Endo:481 Epi: 486	?	28 min	84%
Tzou et al. Circ AE 2015	Core isolation	32 ICM, 12 NICM	Endo:522 Epi: 456	? Ablation catheter	111 RF applic.	84%

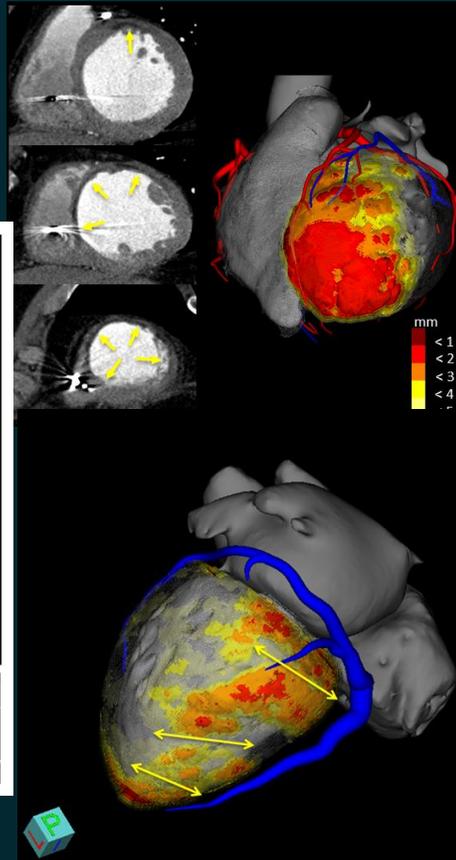
IMAGING FOR VT ABLATION TO GUIDE ABLATION

CT scan

Wall thickness

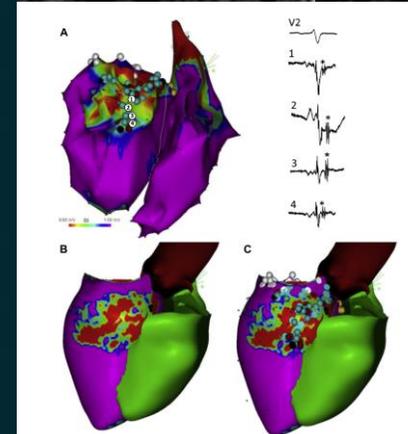
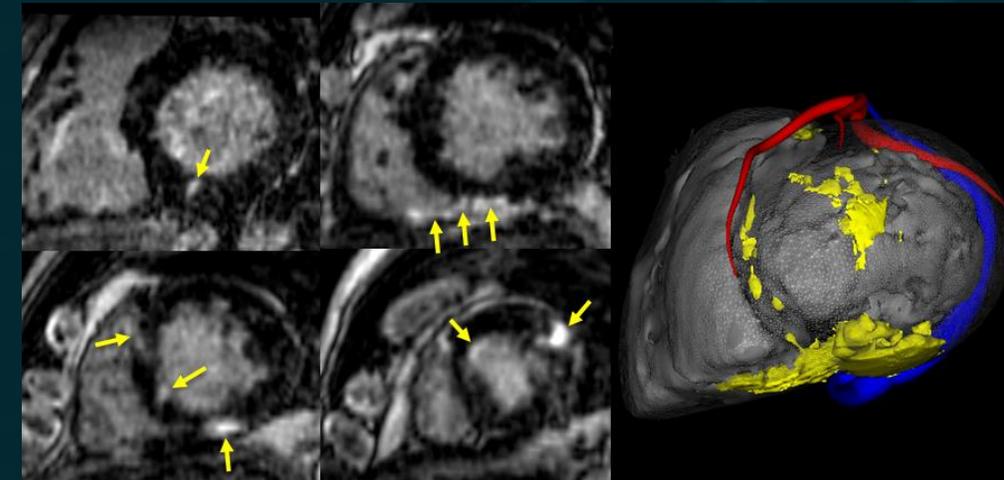


Komatsu Y et al. Circ A & E 2013



MRI

Signal Intensity



Andreu D. et al. HR 2017

- ICE, MIBG, PET Scan...

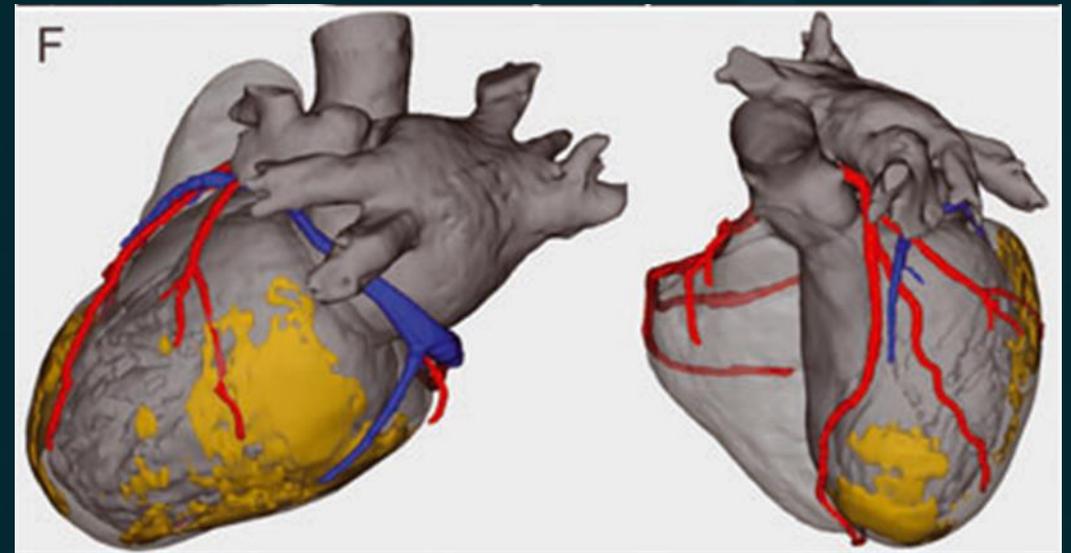
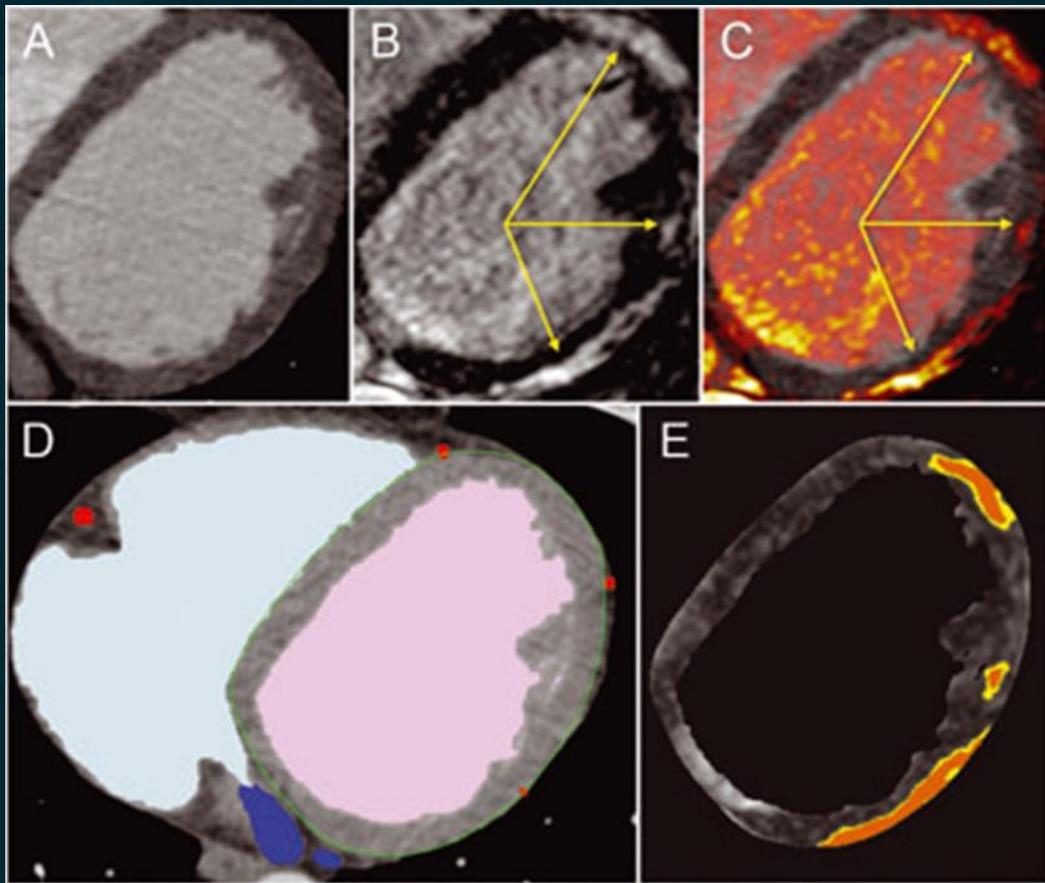
IMAGING FOR VT ABLATION TO GUIDE ABLATION

Cardiac MRI or CT scan

	Advantages	Disadvantages
MRI	<ul style="list-style-type: none">- Scar identification- No X-ray	<ul style="list-style-type: none">- Spatial resolution- Acquisition sequences dependant on the company- Access- Quality of the images in patients with ICD- Claustrophobia
CT scan	<ul style="list-style-type: none">- Spatial resolution- Acquisition sequences identical whatever is the company- Easier to get in patients with ICD- Scar identification possible (wall thinning and late acquisition)	<ul style="list-style-type: none">X-ray

IMAGING FOR VT ABLATION TO GUIDE ABLATION

Cardiac MRI AND CT scan



A: MDCT

B: MRI

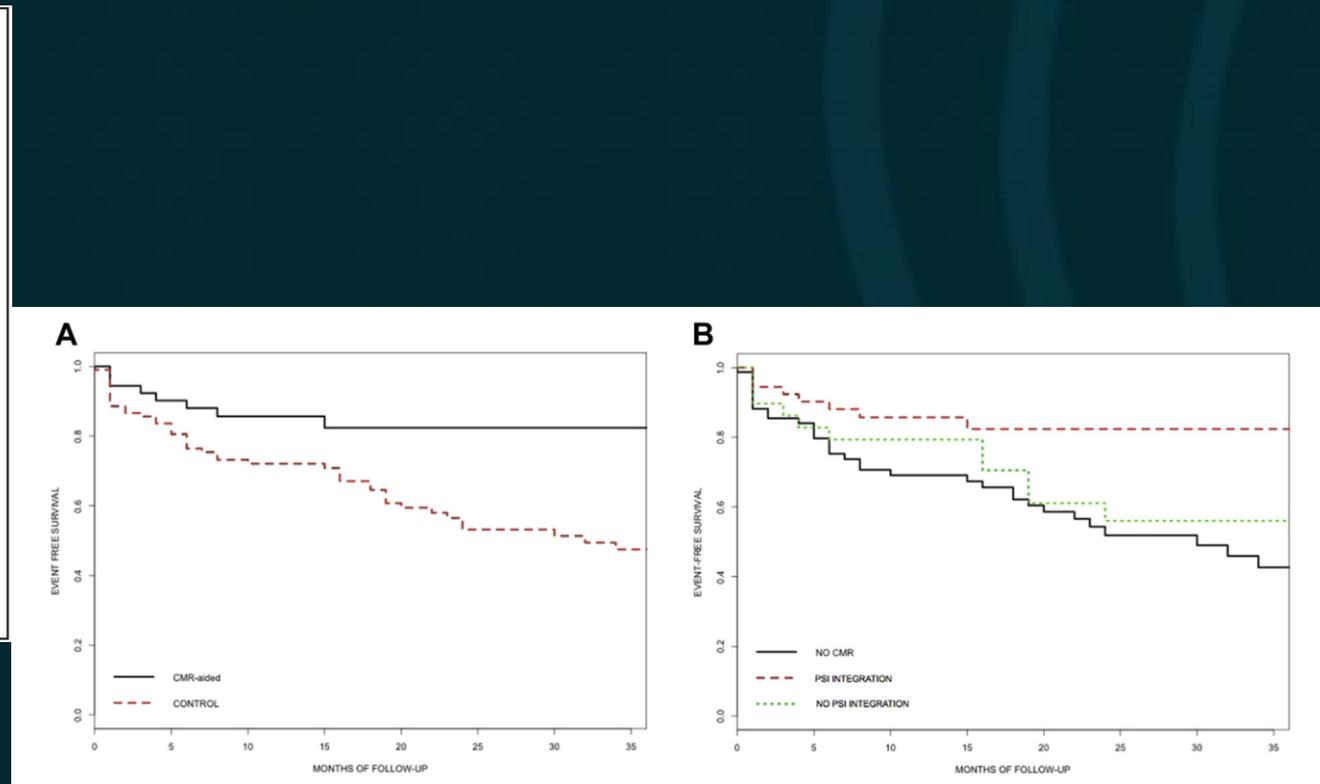
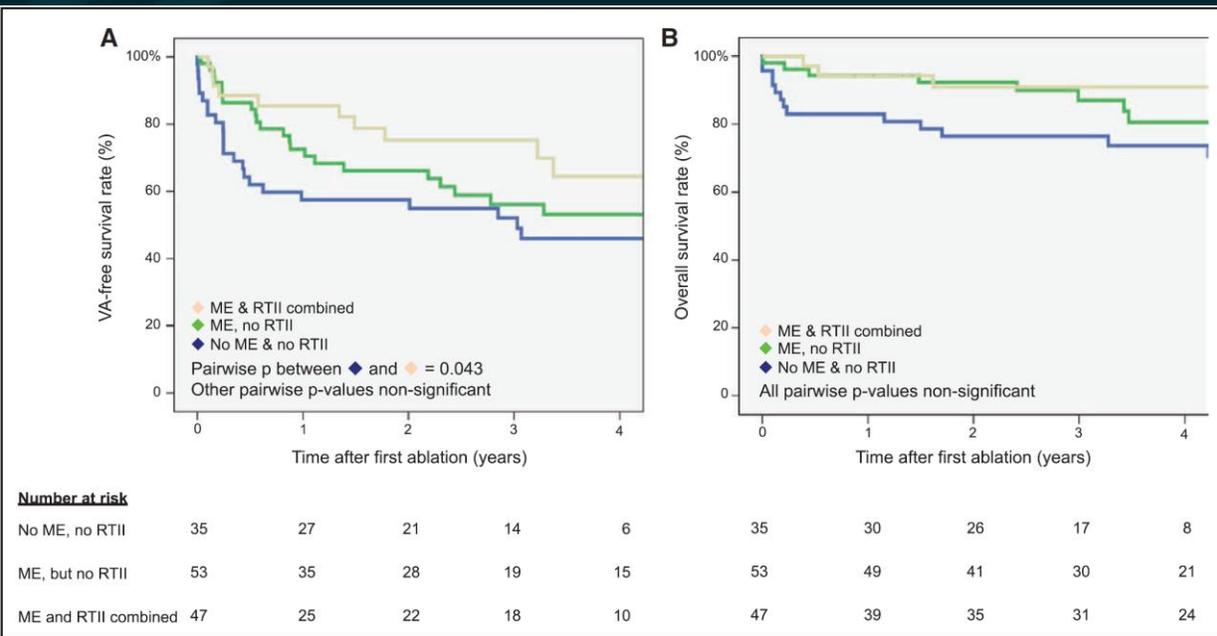
C: fused image

D: Cardiac chambers and epicardial vessels are segmented from MDCT data

E: Myocardial scar & gray zone are segmented from MRI

IMAGING FOR VT ABLATION TO GUIDE ABLATION

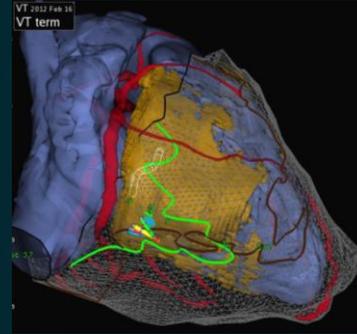
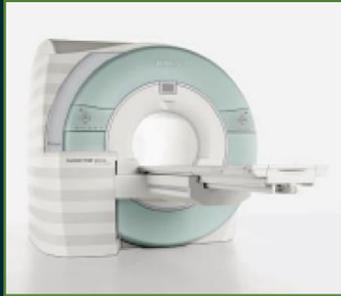
Image integration (and use of multipolar mapping Catheters) associated with fewer VT recurrences



Wolf M, Sacher F et al. Circ AE 2018

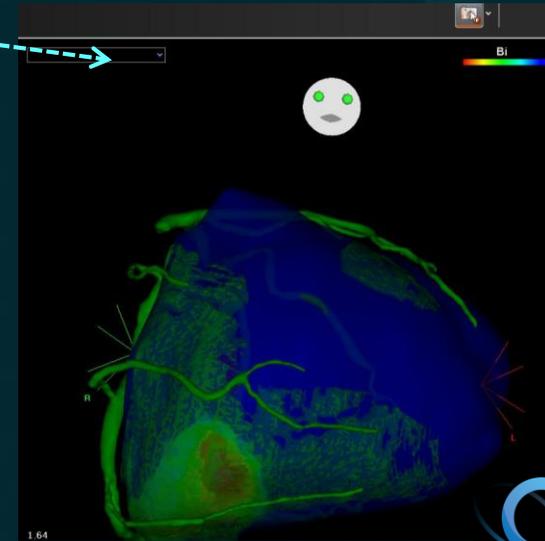
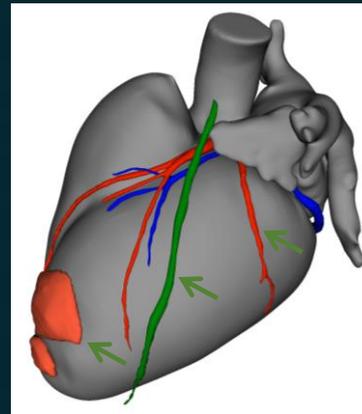
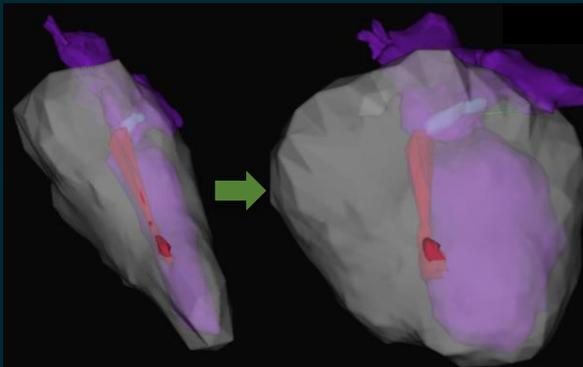
Andreu D et al. Heart Rhythm 2017

Platform



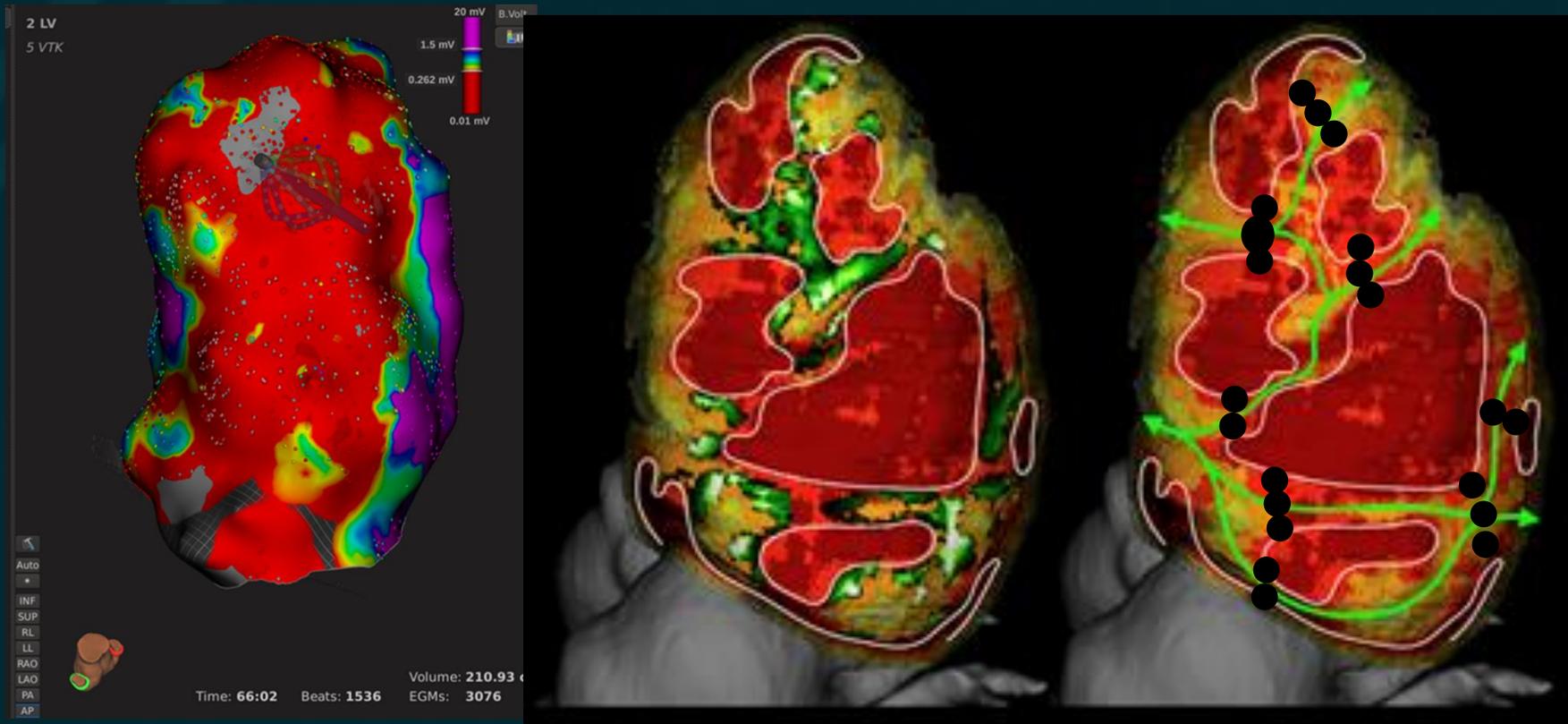
Soon:
photon-counting CT

IMAGE INTEGRATION



SUBSTRATE MAPPING AND ABLATION BASED ON CT SCAN IN ISCHEMIC CMP

HYPOTHESIS: CHANNELS DELIMITED
BY WALL THICKNESS HETEROGENEITY

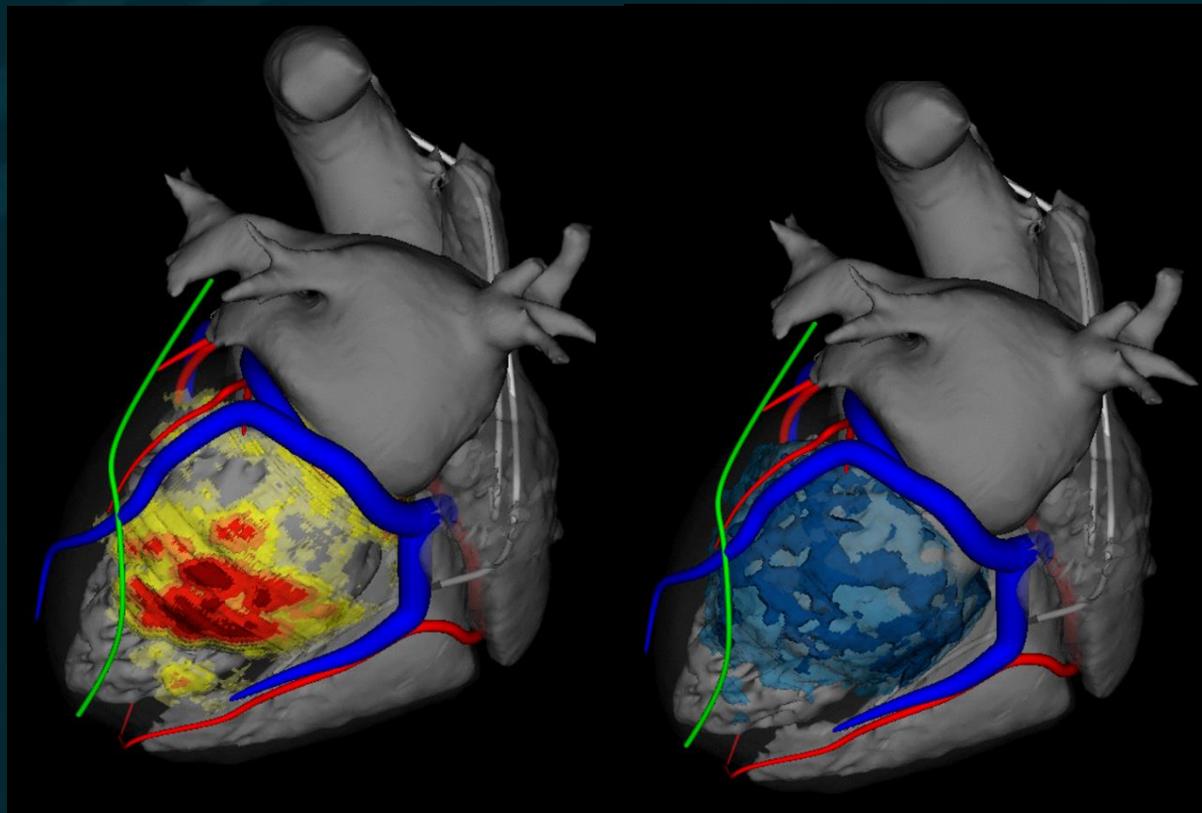


■ Strategy evaluated:

- 1) Merge CT scan in 3D mapping
- 2) CT isthmus ablation
- 3) Induction
 - Non inducible: Stop
 - Inducible: VT mapping & ablation

Potential isthmii based on wall thickness heterogeneity identified on CT scan with the MUSIC software in a patient with inferior MI.

- 62 YO MALE WITH INFERIOR MI 20 YEARS AGO
- CABG, LVEF 35%
- RECURRENT VT



Substrate modelling:

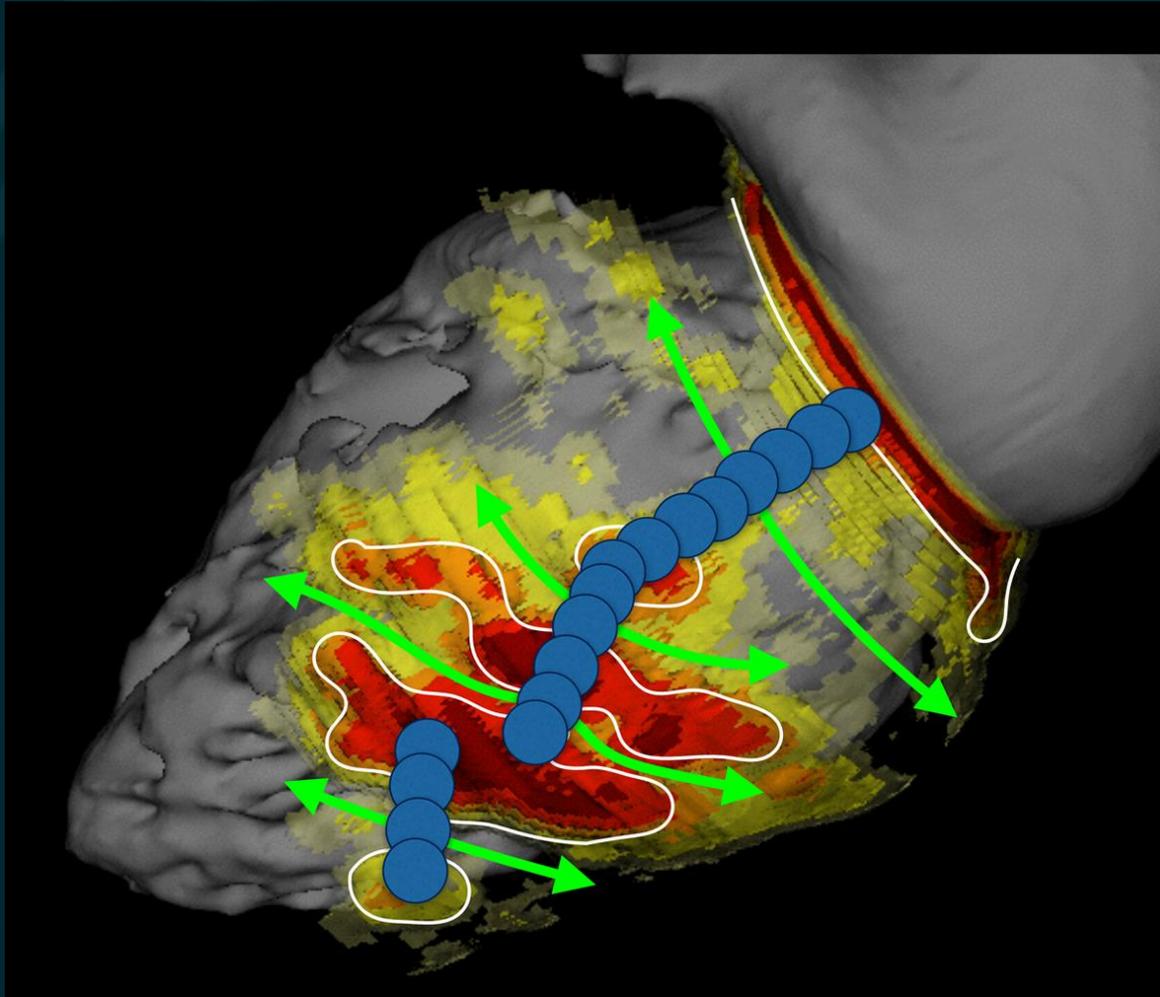
- Wall thinning from arterial time CT
- Late contrast: acquisition 8 min post contrast injection

Aim

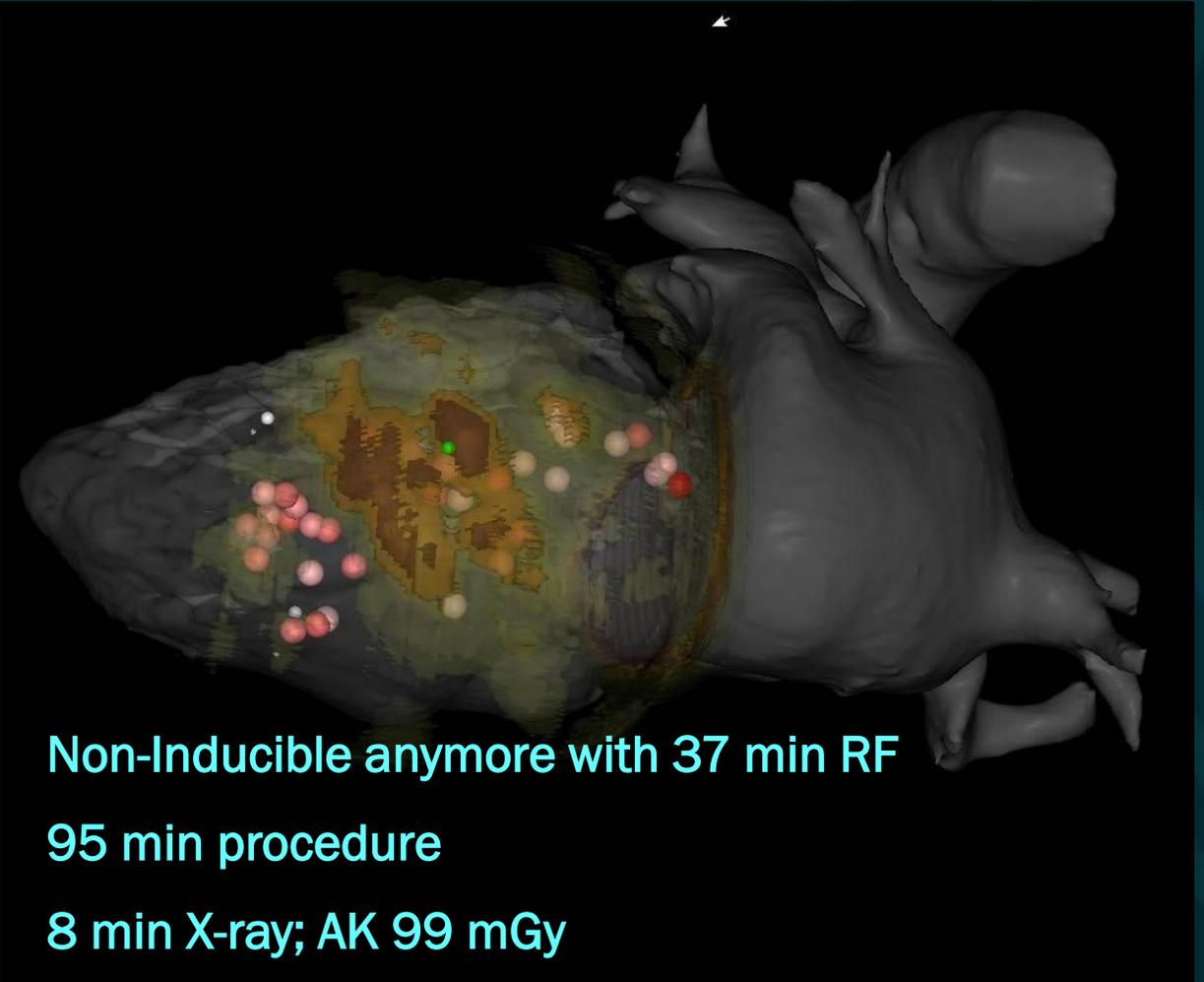
- Comprehensive substrate localization
- Pre-procedure strategy
- More efficient/faster procedure

PLANIFICATION OF ABLATION

Preprocedural strategy



Real ablation lesion set



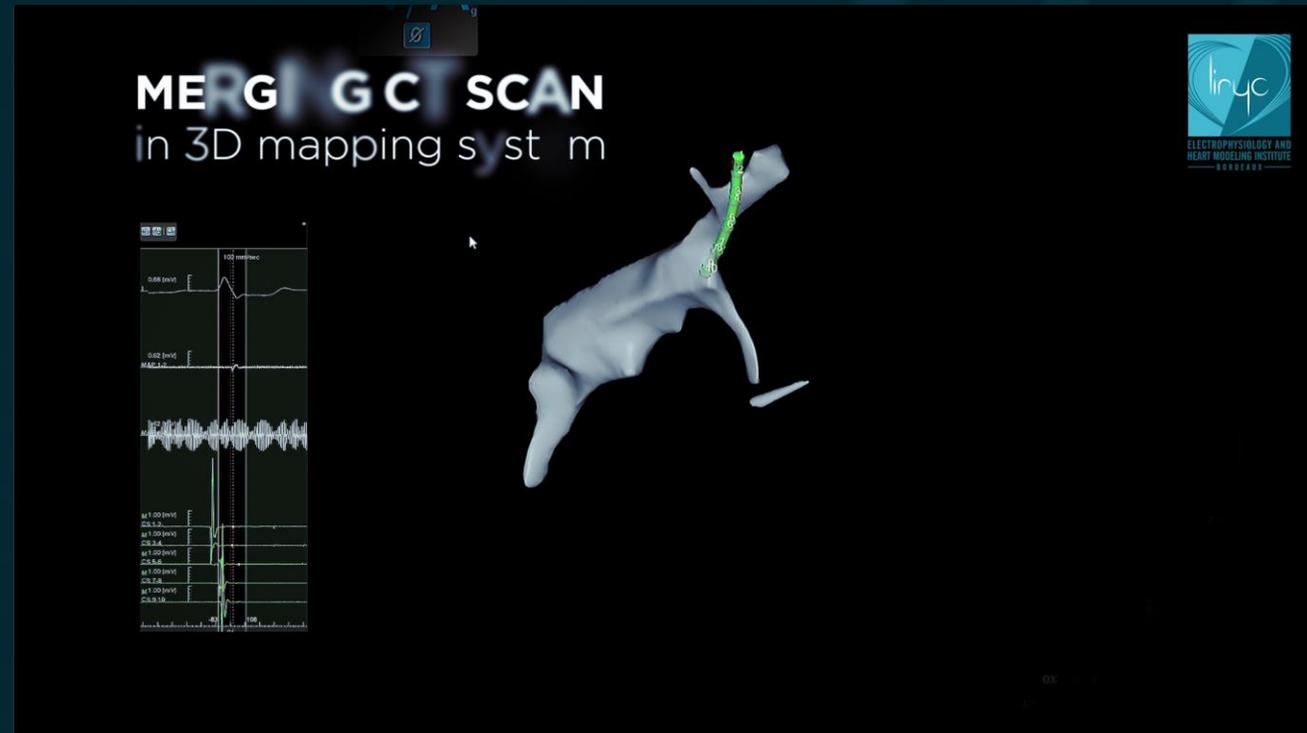
WORKFLOW

Importing images from any imaging modality in 3D system after treatment with dedicated software

- Inheart solution works with all 3D mapping systems (CARTO, Rhythmia, Precision, EnsiteX)

Merging

- Anatomy acquisition in 3D system: CS , Pulmonary artery with the left and right branch or aortic arch depending on the access
- Once merge is OK, Check with ablation catheter at the LV apex to make sure the merge is reliable



WORKFLOW

Ablation of the identified isthmus

- 40-50 Watts for 45-60 sec. sometimes more, depending on impedance drop, signal reduction, catheter position and contact force
- Block the isthmus or at least render them unexcitable (pacing a 10 mA and 2 ms)

Inducibility

- If negative: stop there
- If positive: map and ablate the induced VT

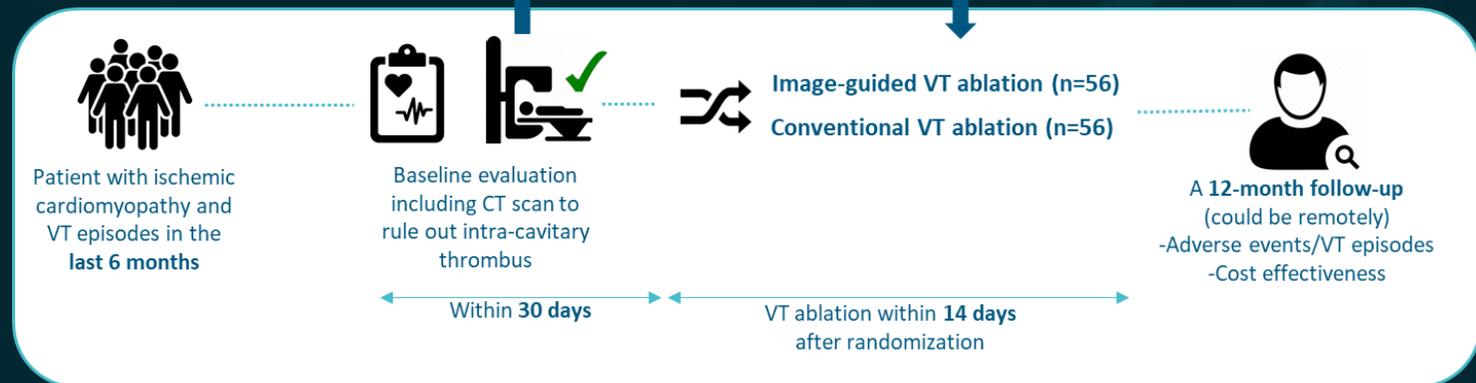


MULTICENTRIC RANDOMISED EUROPEAN STUDY **InEurHeart**



Funded by the European Union

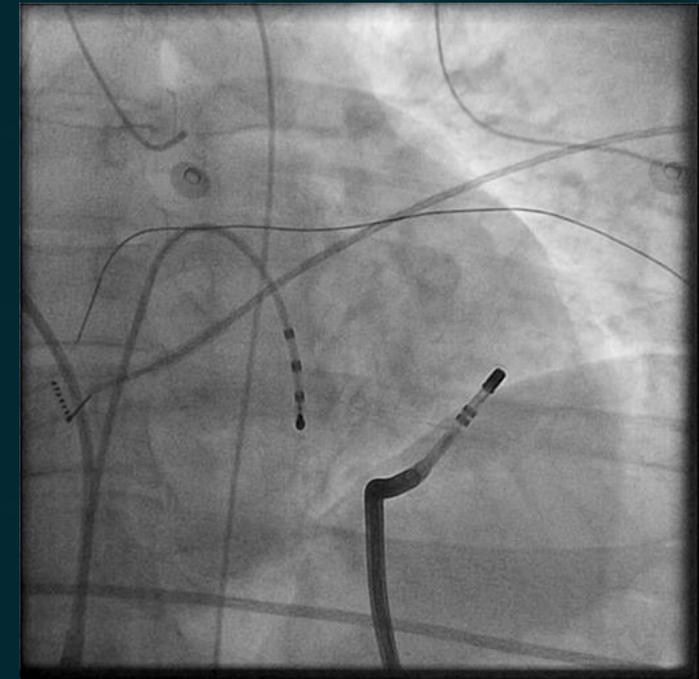
NCT 05225935



1. Bordeaux University Hospital (Pr. Frédéric Sacher)
2. Toulouse University Hospital (Pr. Philippe Maury)
3. Clermont-Ferrand University Hospital (Dr. Grégoire Massoulié)
4. Paris University Hospital (Dr. Xavier Waintraub)
5. Limoges University Hospital (Dr. Benoît Guy-Moyat)



IMAGING TO AVOID COMPLICATIONS



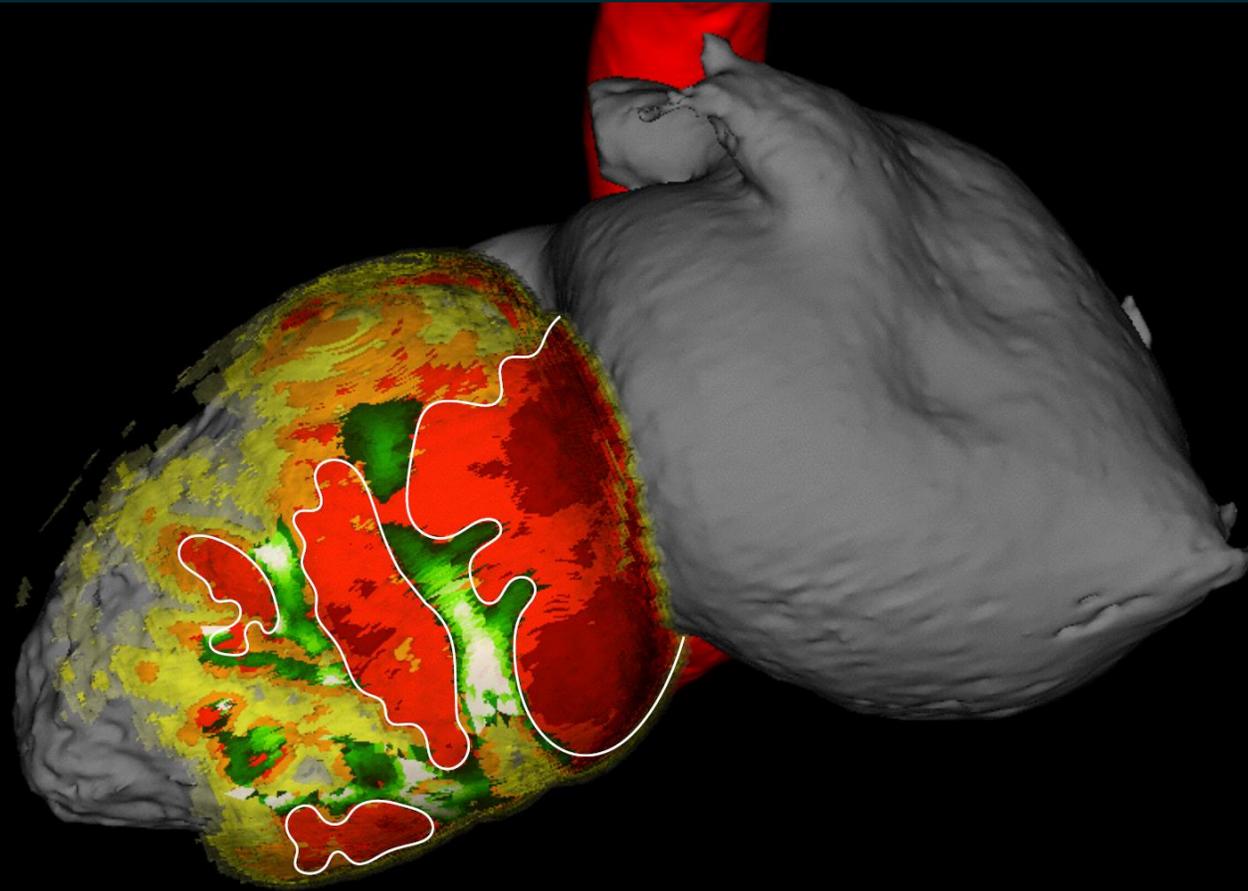
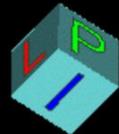
RADIOTHERAPY

CT-BASED TARGETS

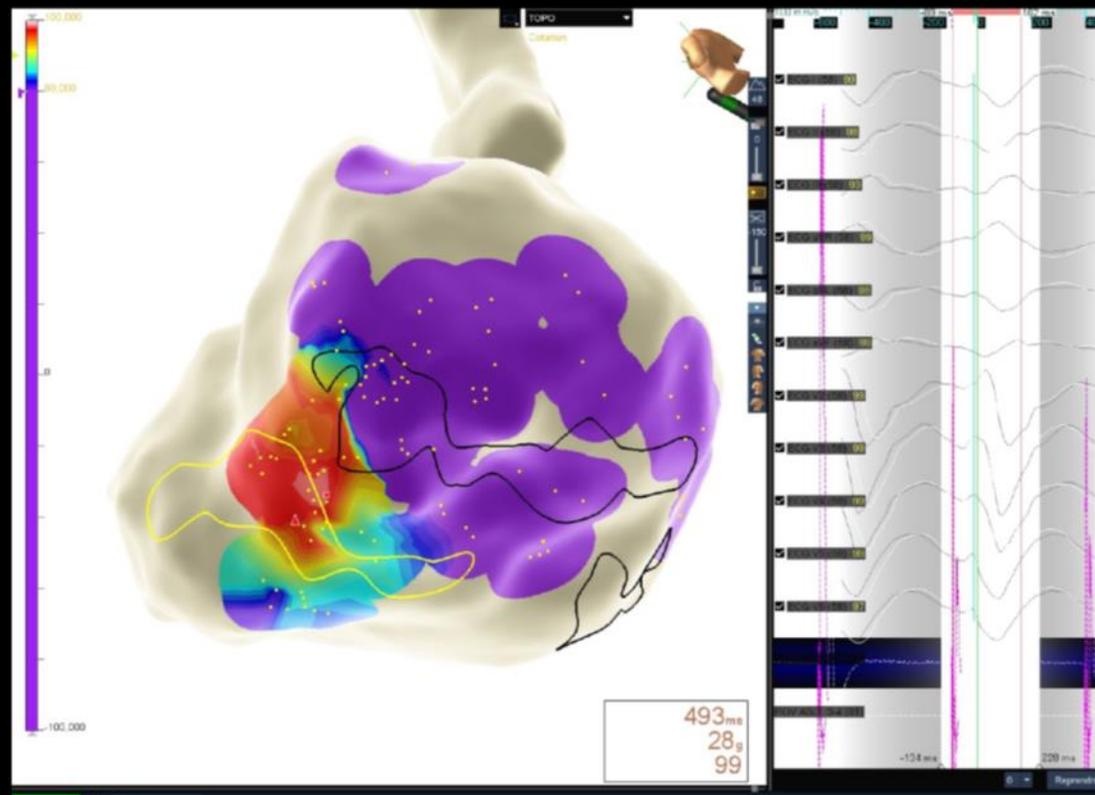
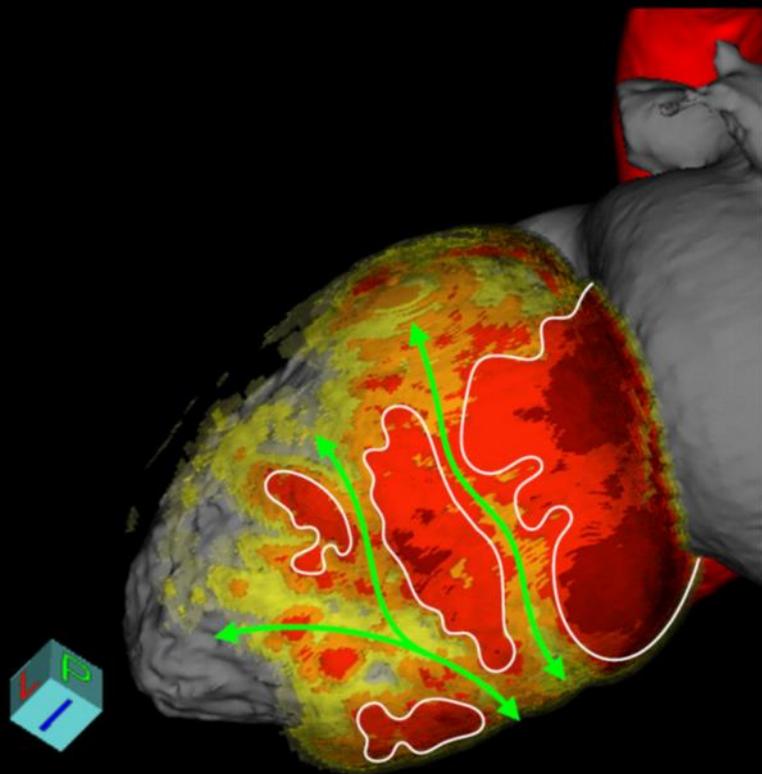
- Wall thickness channels

wall thickness map

→ **channelness filter**

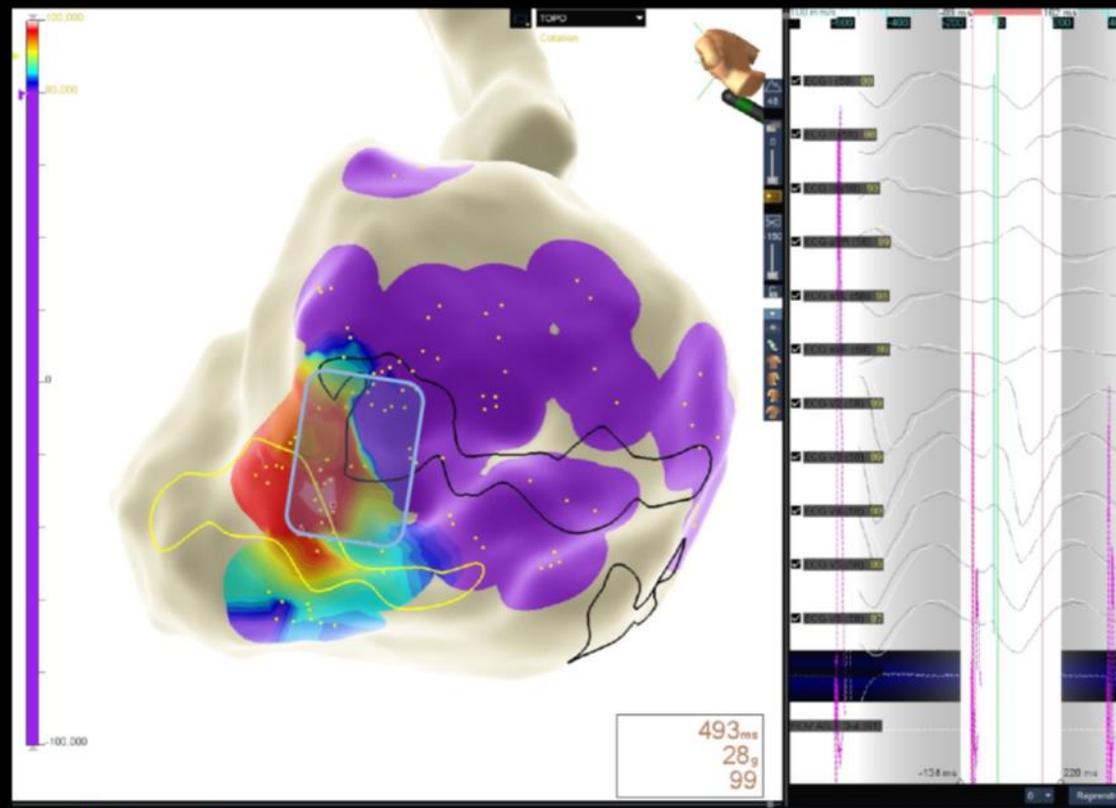
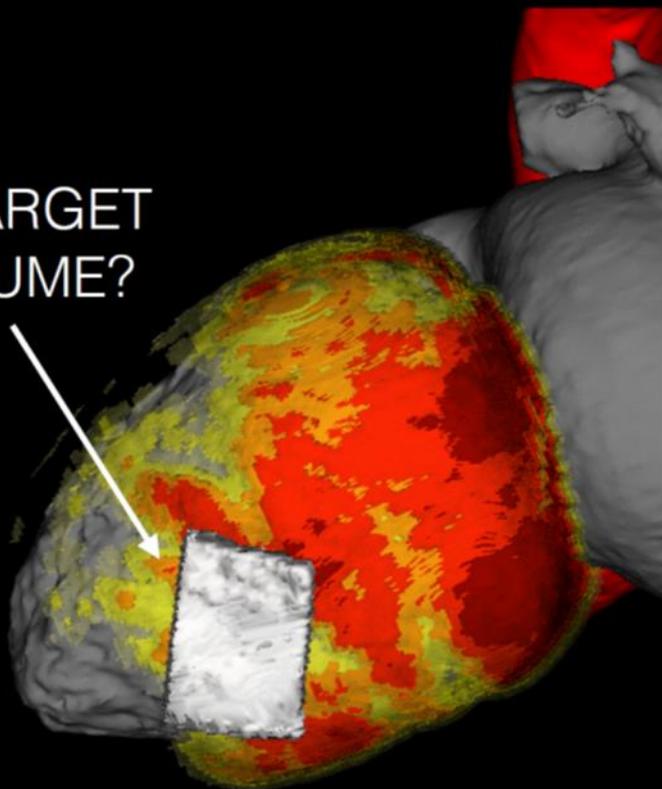
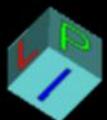


RADIOTHERAPY



RADIOTHERAPY

RT TARGET
VOLUME?

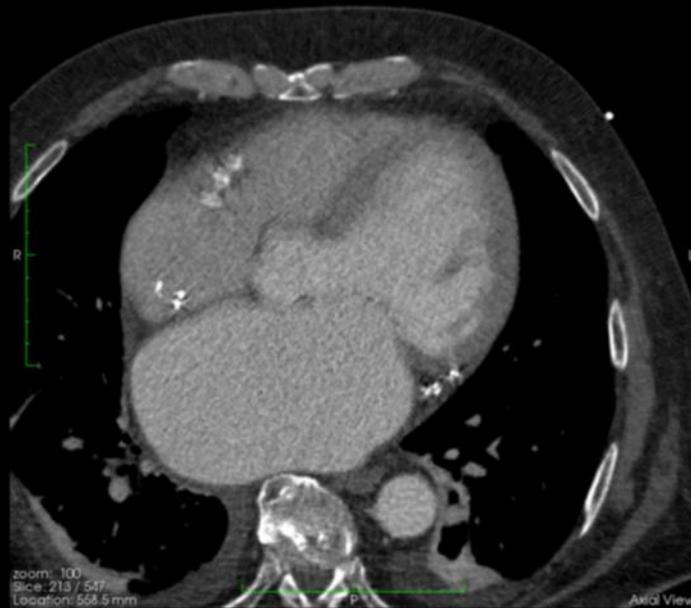


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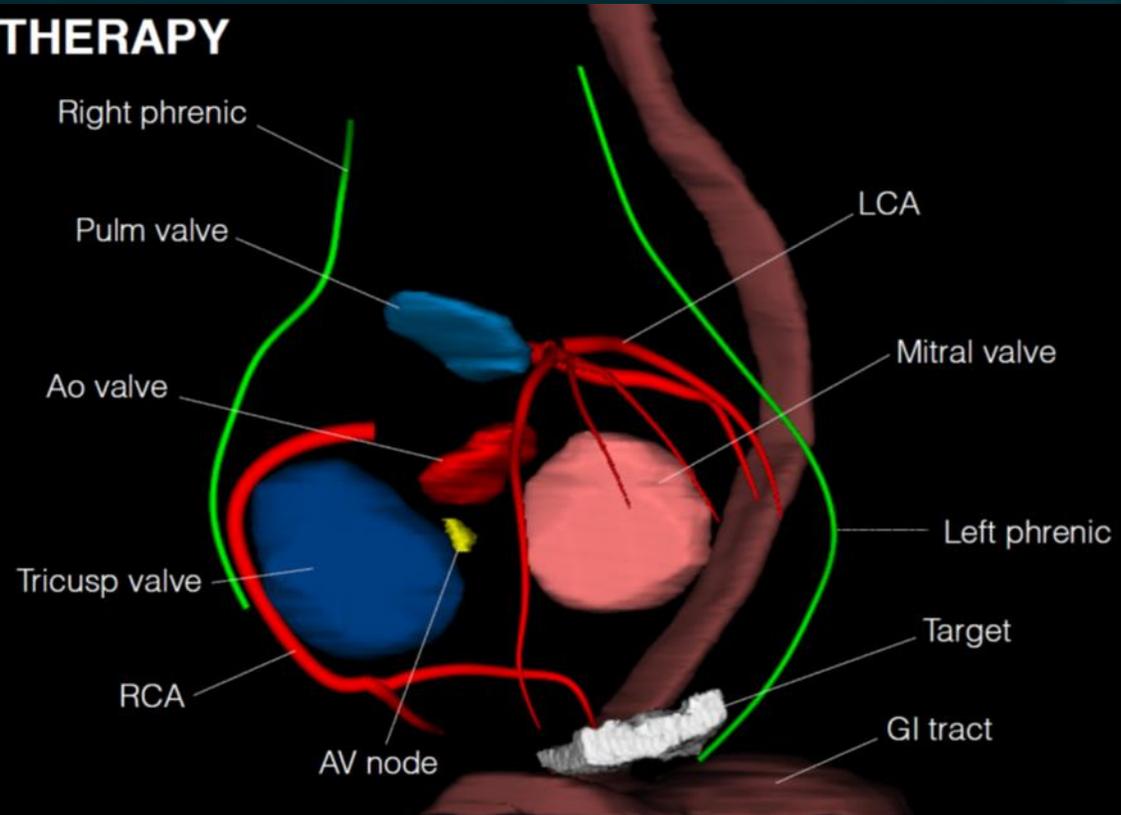
FILES EXPORTED TO RADIATION THERAPY

Image size: 512x512
Voxel size: 0.625x0.625
X: 244 px Y: 221 px volume: 95
X: 17.8571 mm Y: -235.294 mm
WW/WL: 623 / 153

CyberKnife
VT: 20/04/04-20.00.05
00_clData



native CT series



+11 separate segmentations:
1 target volume + 10 vulnerable structures