RHYTHM 2015

Arrhythmias & Heart Failure: New Insights & Technological Advances

Palais du Pharo, Marseille, France — May 28-30, 2015

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EBAC

How to Ablate Atrial Tachycardia

Nadir SAOUDI, Monaco (whose very modest disclosures are depicted below)

| Company Name	Relationship
Biosense Webster, Sorin Medtronic, St. Jude	Sponsored Humanitarian missions
Sanofi	Lecture fee (almost nothing, a misery, believe me...)
Biosense Webster, Sorin, Medtronic, St. Jude , Stereotaxis, Daïchi Sankyo, Spectrum Dynamics, Boston Scientific, Biotronik, Medico Boehringer Ingelheim, General Electric	MUAC 15 Sponsorship One of the nicest Course in the French Riviera You should come…

Classification of AT
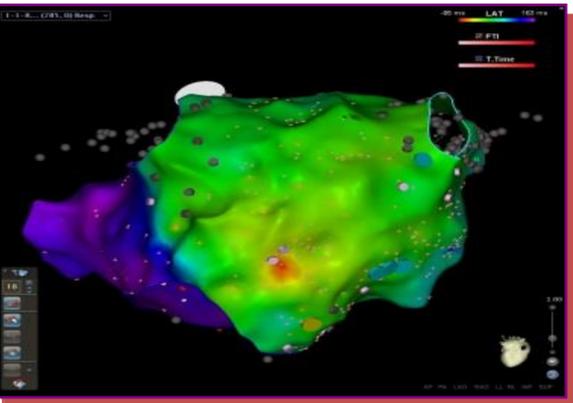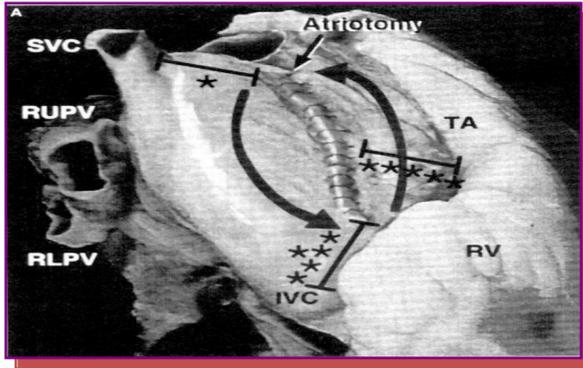
Macroreentrant Atrial Tachycardia (MRAT)

1. Reentry around a 'large' central obstacle
2. Endocardial activation covers ATCL: no early activation
3. Transient entrainment is always possible
4. Lines of block reflected by DS Eg
5. Isthmus participation proven by AT interruption with pressure/ablation
6. Very complex/multiple reentry circuits after baffle atrial surgery (Mustard, Senning), Fontan procedure, Maze, line ablation for AF
6. PPI-TCL at pacing site < 20 ms = inside the circuit.
7. MRAT if PPI=TCL from ≥ 2 A sites, separated by > 2 cm

Focal AT

1. Activation starts rhythmically at a small area and spreads centrifugally wo covering TCL
2. May also be reentrant (microreentry = very small circuits)

Atrial Pace Mapping is of Little Help

11: Between LIPV and CS:

12: Lateral to LIPV

Site 12
Site 11
Site 10
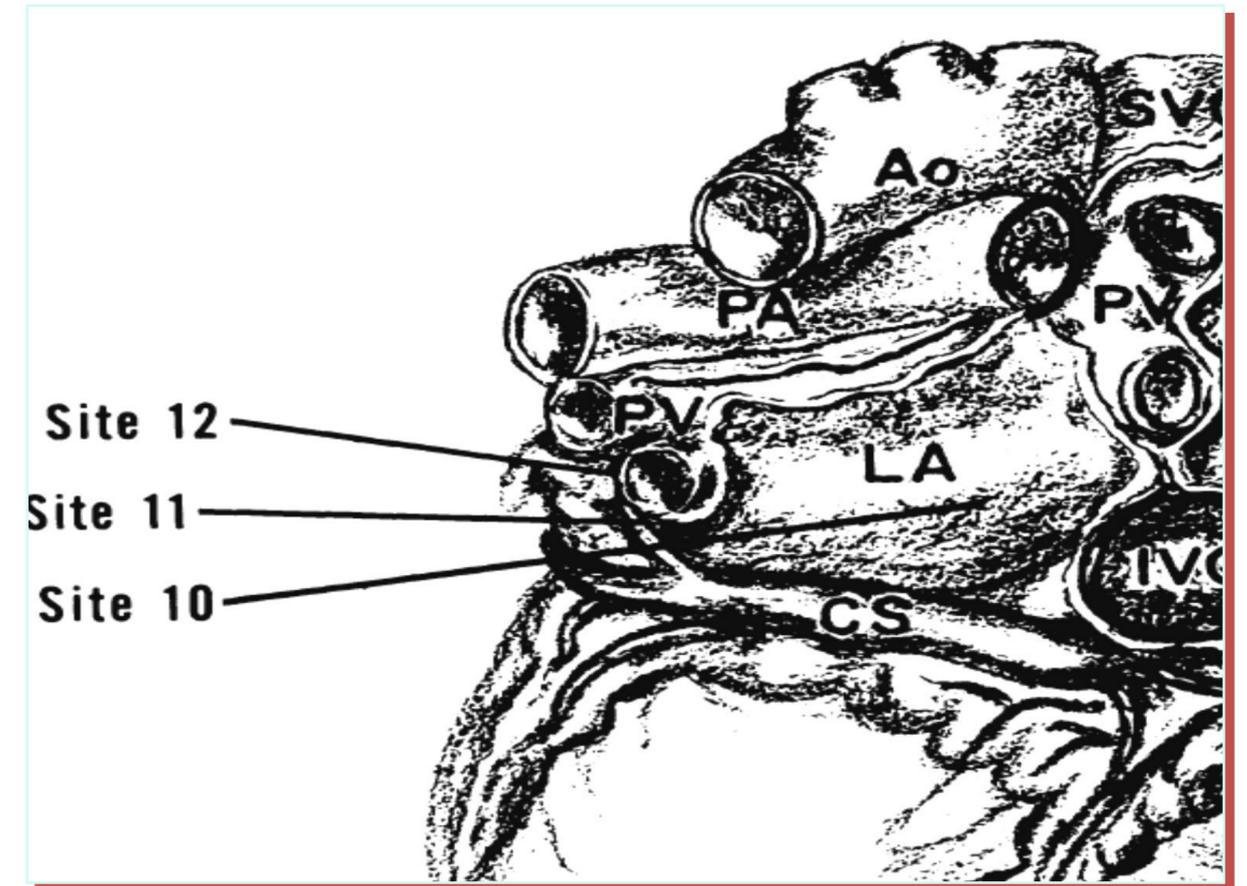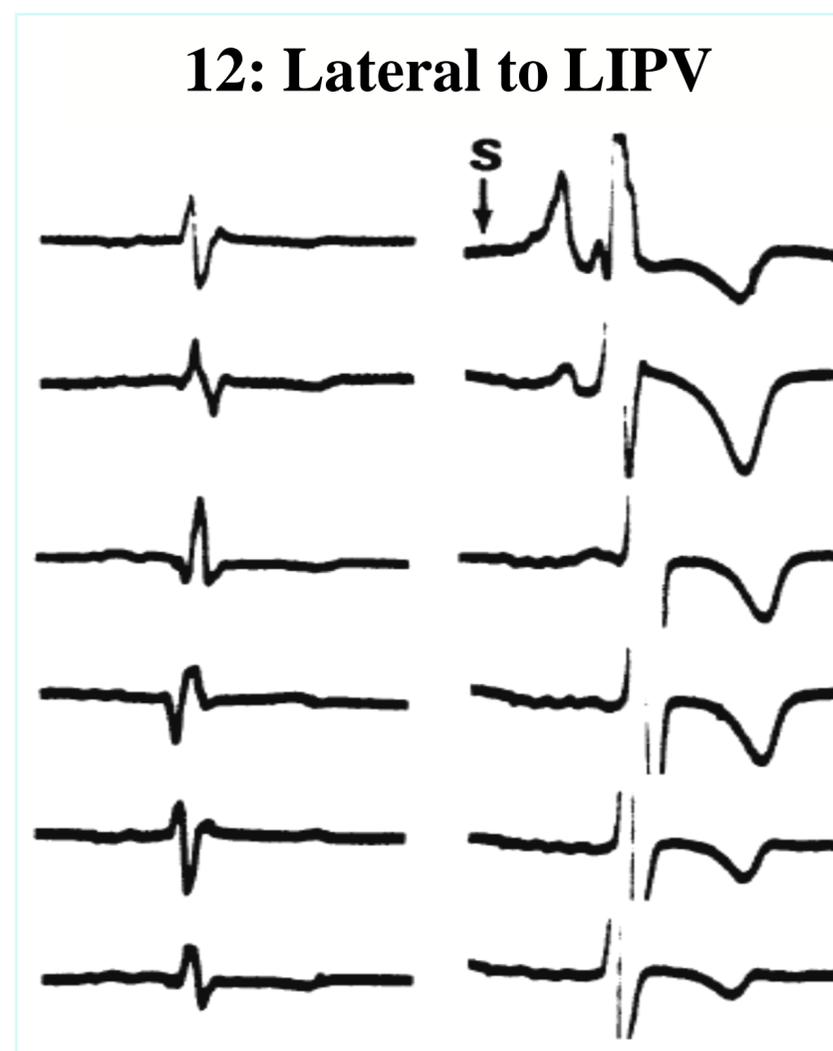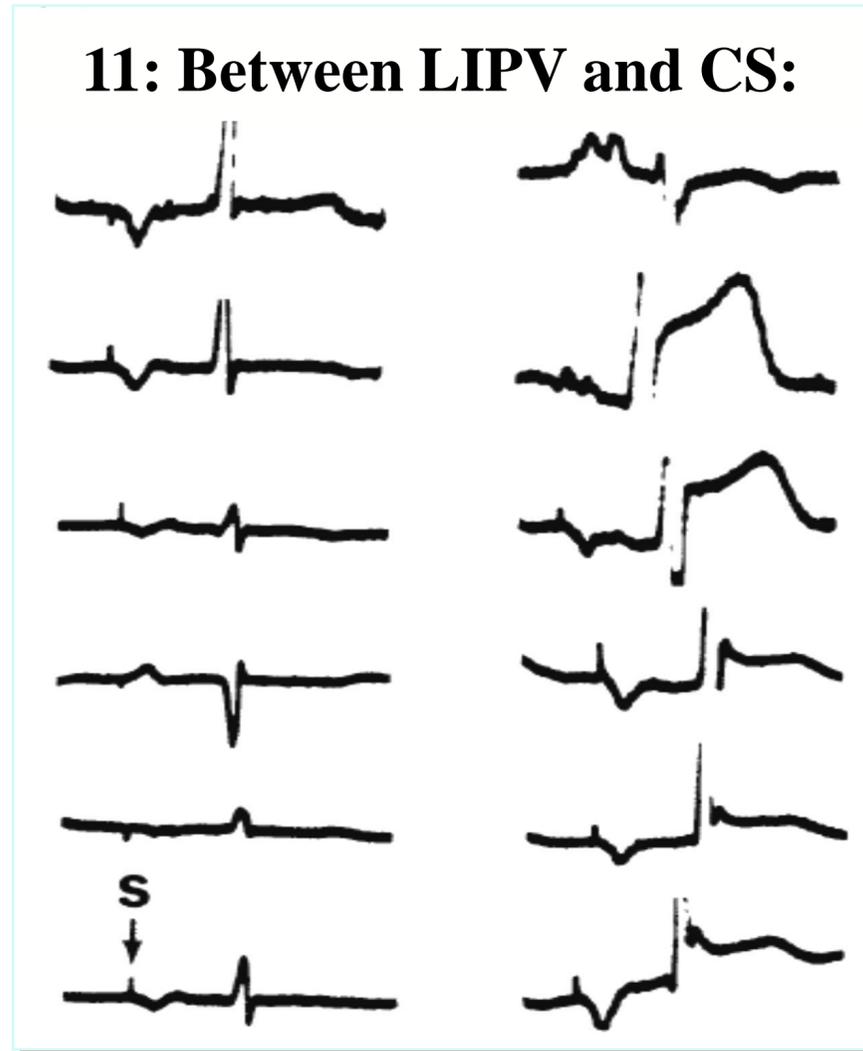
- **P>O in I = RA and LA**
- **P<O in I = LA near LPV**

Mac Lean et Waldo et Al ; Circulation 1975: 52, 426-433

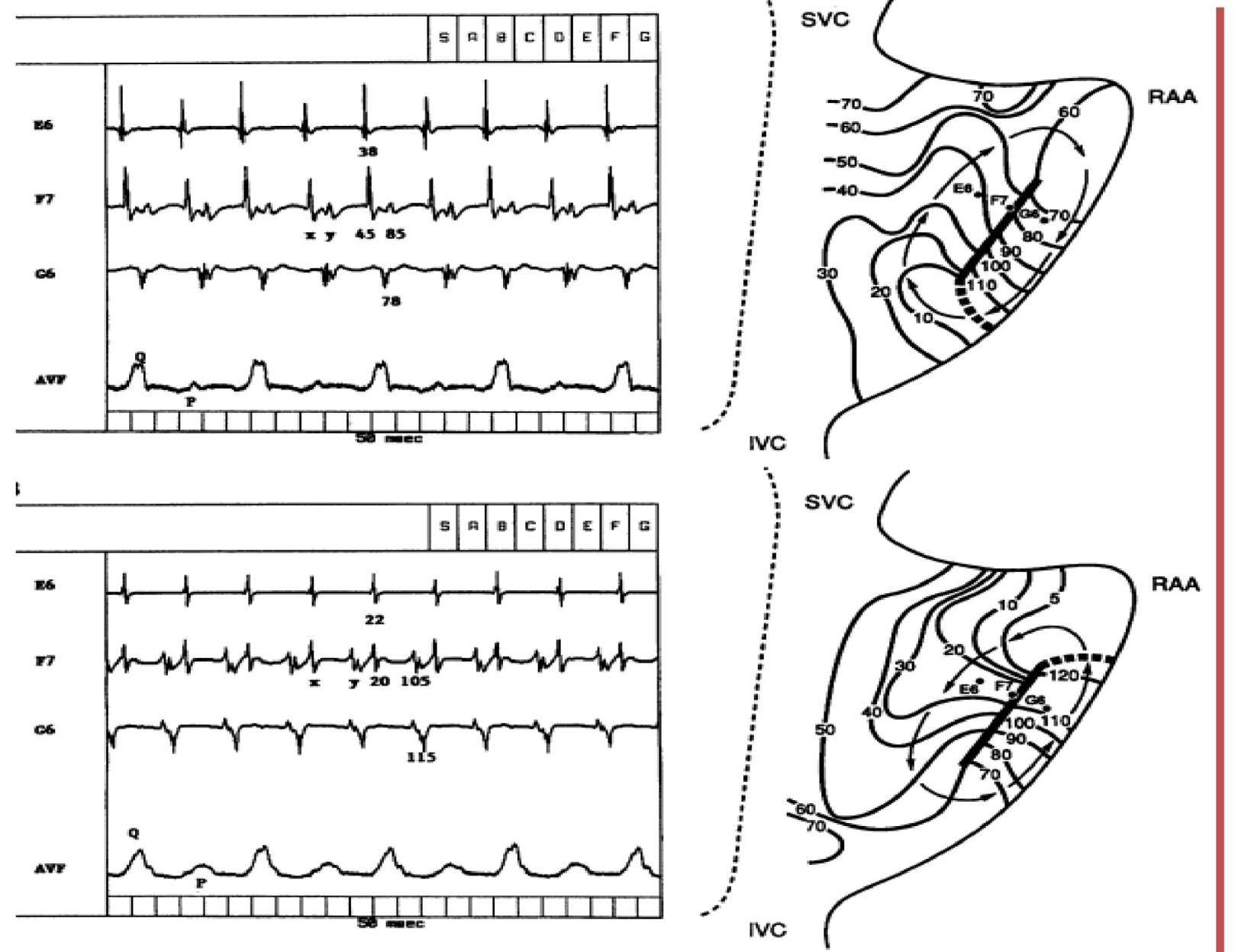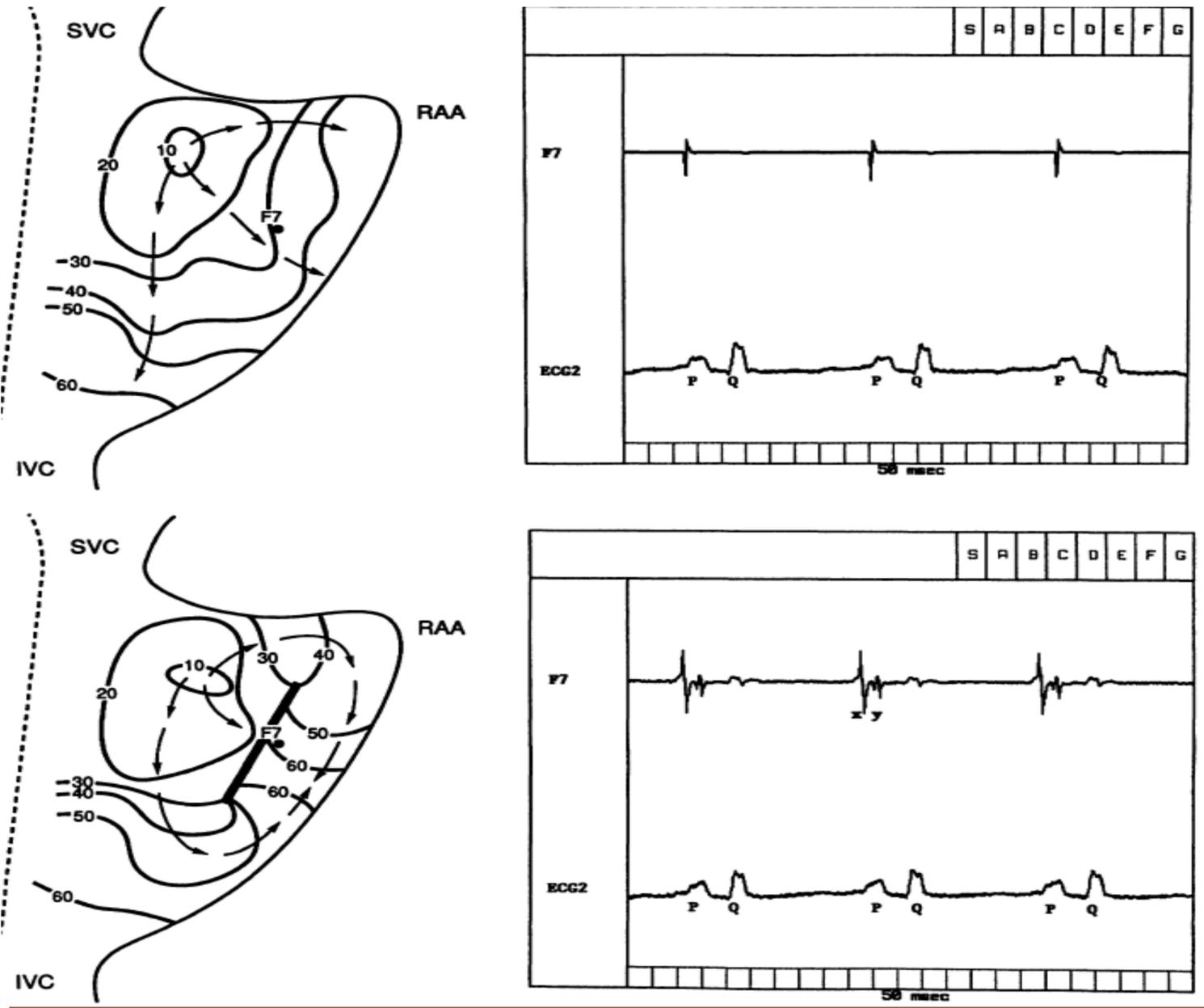- **Spatial Resolution is 32 mm in the CS (configurational changes)**

Man et Al, Circulation 1996; 94: 1357-1363
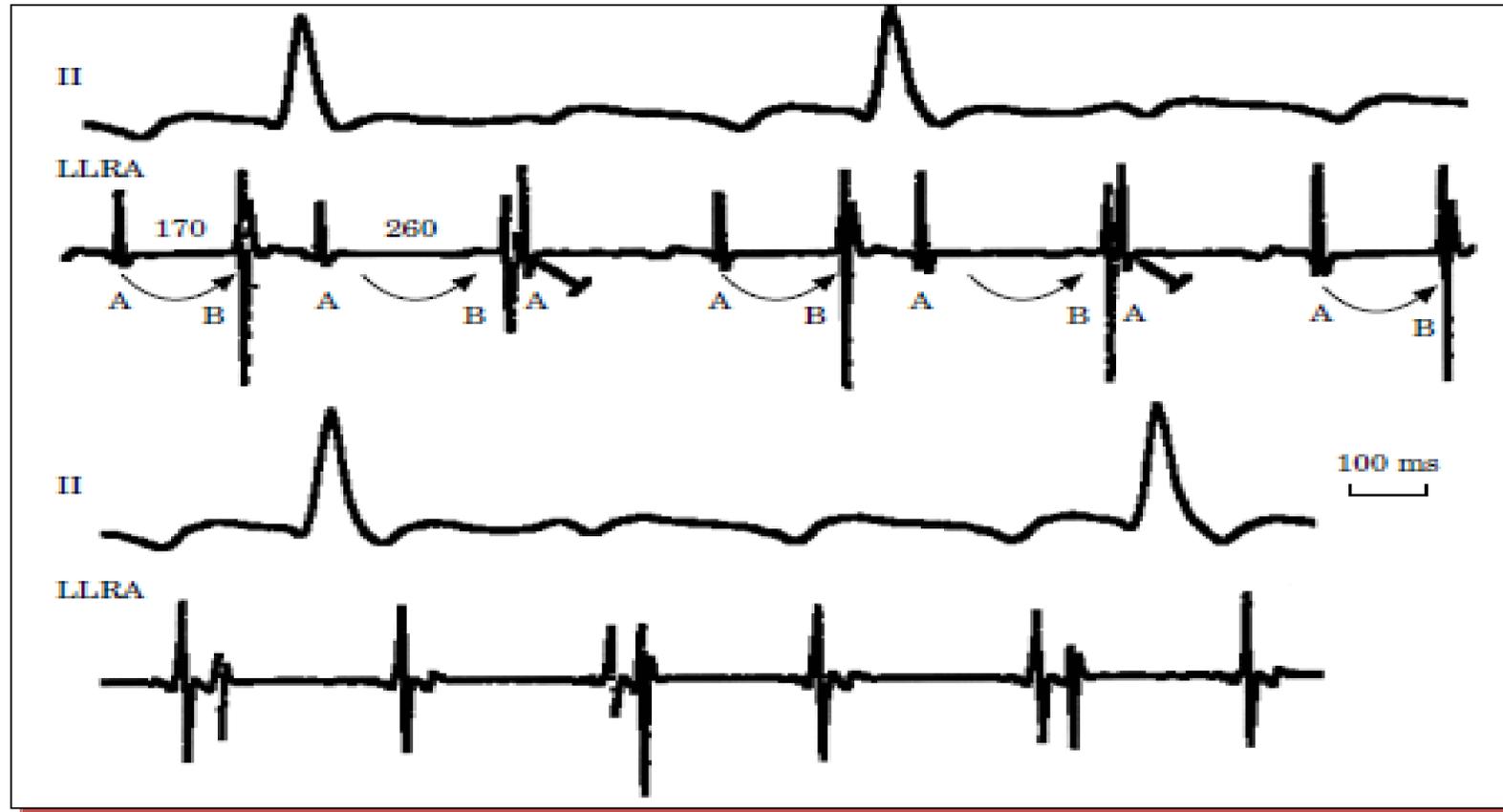
Double Potentials During Post Lesion AT

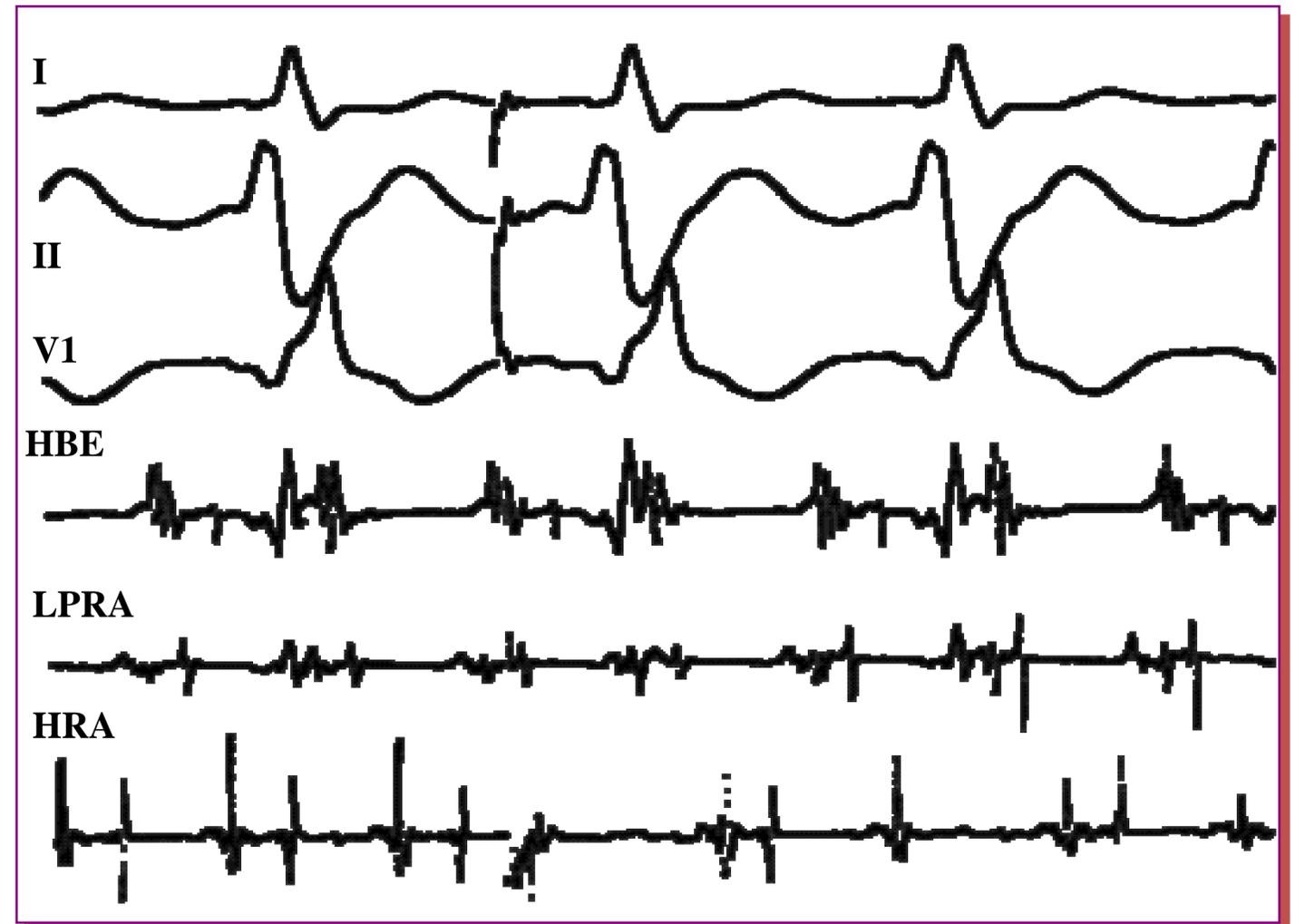- ## Canine RA Crush-Injury Model

- ## SR and A Pacing
- ## Sustained A Flutter

Second degree block within a Double Spike electrogram may identify local dead end Pathway
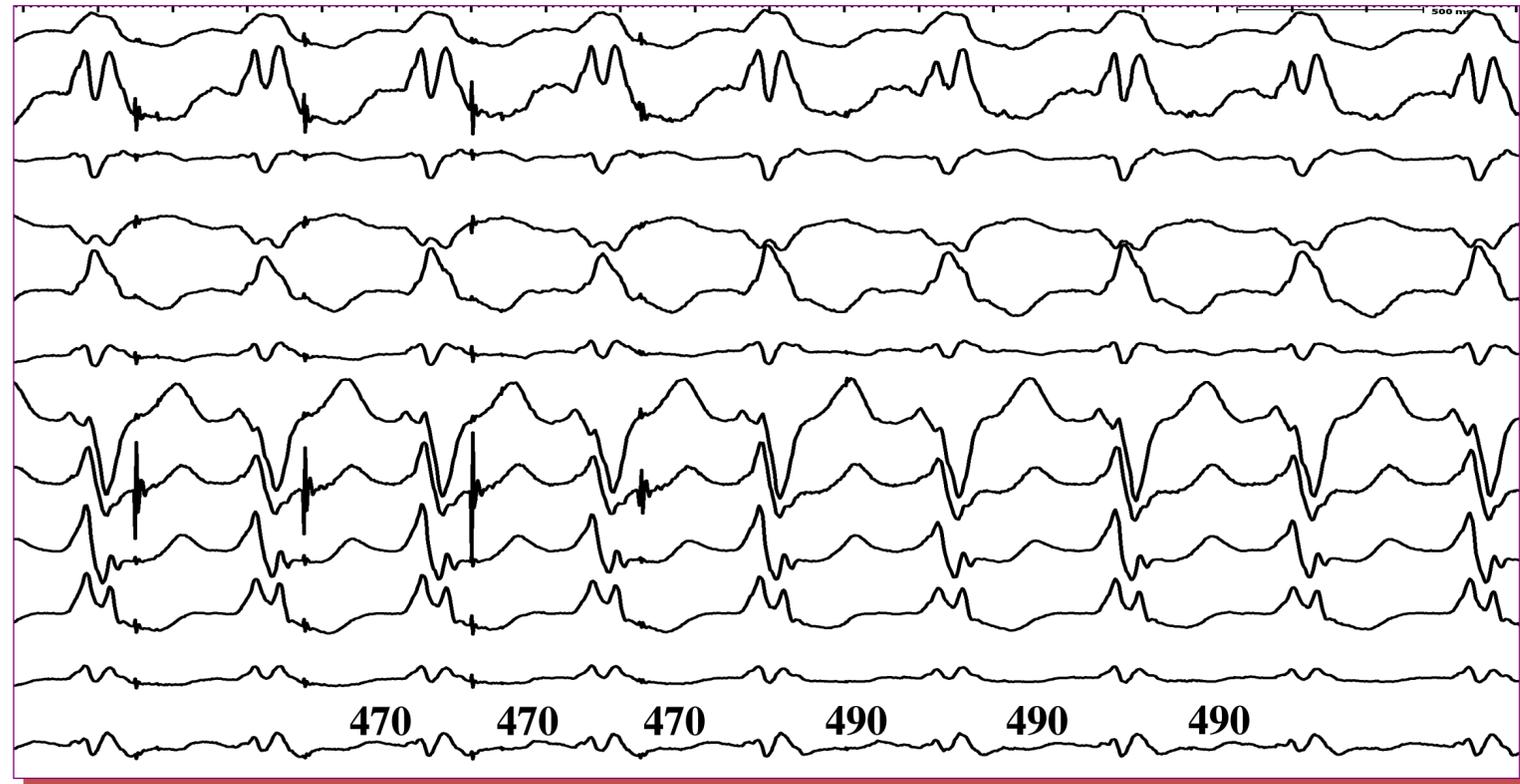

- **Spontaneous 3:2 and 2:1 within DS electrogram**

- **PAC induced 2:1 within DS electrogram**

Saoudi N et Al. European Heart Journal (2001) 22, 1162–1182
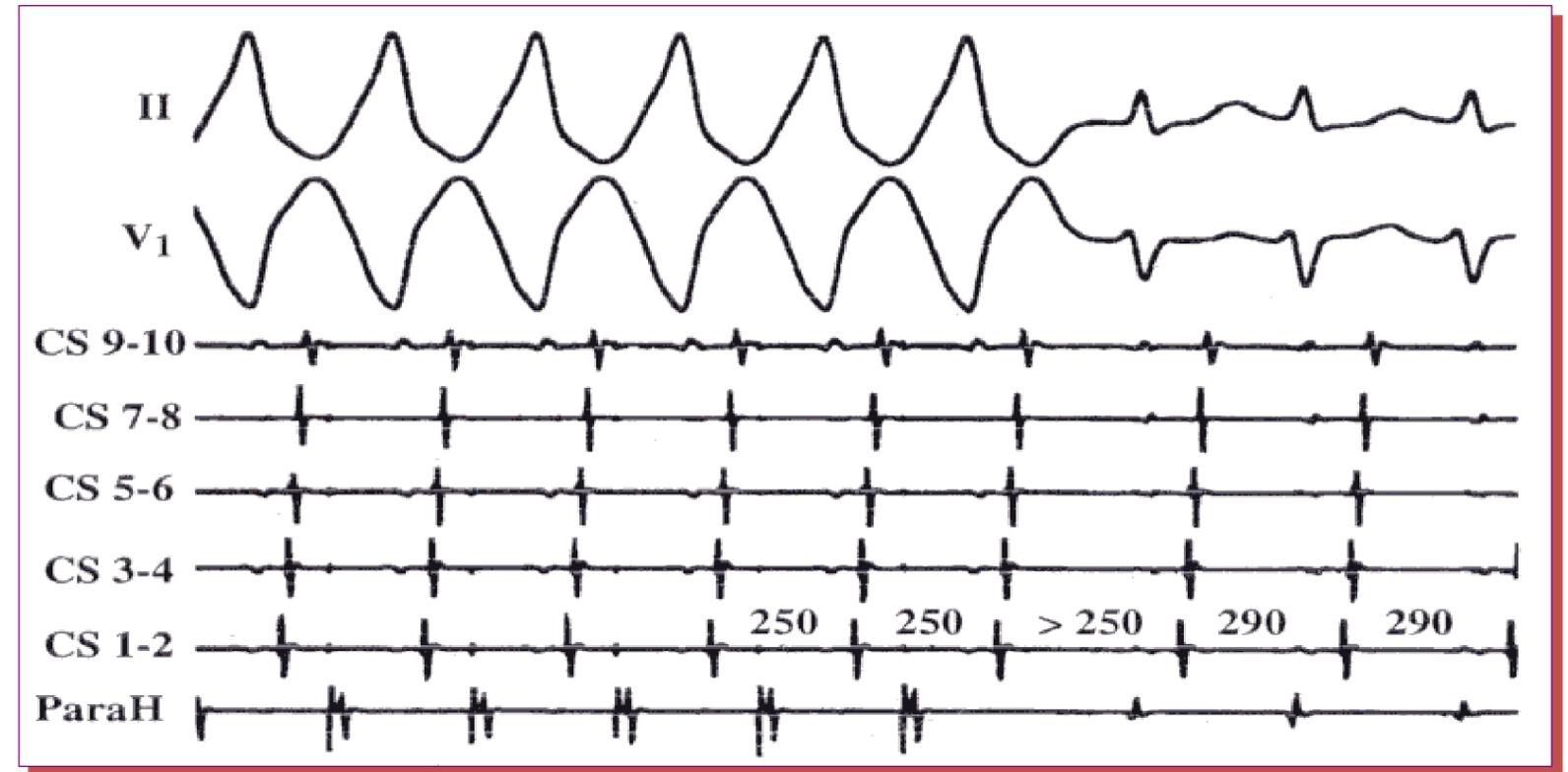
Concealed Entrainment

- **Tachycardia may be transiently entrained and even interrupted without being able to demonstrate any of the entrainment criteria**
- **2 types of concealed entrainment**

1. **Pacing within a protected isthmus**

2. **Pacing from a site orthodromically distal to an area of slow conduction**

Waldo A et Al. Circulation 1983; 67: 73-83
Saoudi N, Castellanos A et al. PACE 1998 (21): 2105-2125
Saoudi et al J Cardiovasc Electrophysiol. 2001.12 ; 5 : 852-866

Limits of the use of Entrainment in the EP Lab

Misleading Long PPI After Entrainment

- **76 pts with confirmed typical AFL**
- **Ent at 4 CTI sites (10-40 ms <TCL)**
- **Long PPI in 18% as a function of ≠ PCL/TCL/P site**
- **Conduction delay caused by local pacing latency (MAP) at different sites within CTI**

*Vollmann D et Al. J Am Coll Cardiol 2012;59:819–24*
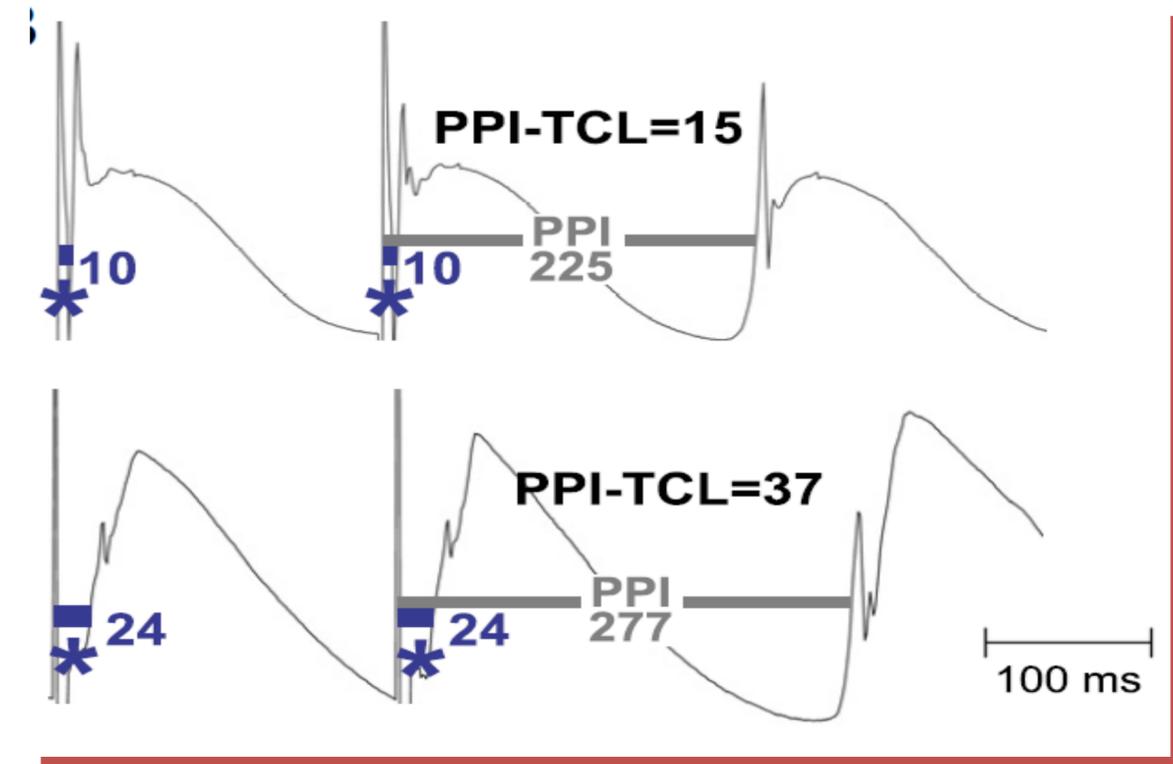
Alteration/Termination during Attempted Entrainment dg/after AF Abl

- **386 pacing attempts 5–40 ms < TCL**
- **AT altered if CL or activation pattern altered ≥ 10 s (5/386)**
- **If TCL - PCL ≤ 20ms, 2/353 (0.5%) altered/terminated AT**
- **If TCL - PCL > 20ms, 3/33 (9%) altered/terminated AT**
- **Greater CL instability in ATs altered/terminated vs unchanged *(11% vs 4.5%; P < .007)***

Barbhaiya CR et Al. Heart Rhythm 2015;12:32–35

Tools

Number Needed to Entrain: A New Criterion for Entrainment Mapping in Pts With IART

A Activation Map

B PPI-TCL Map

C NNE Map
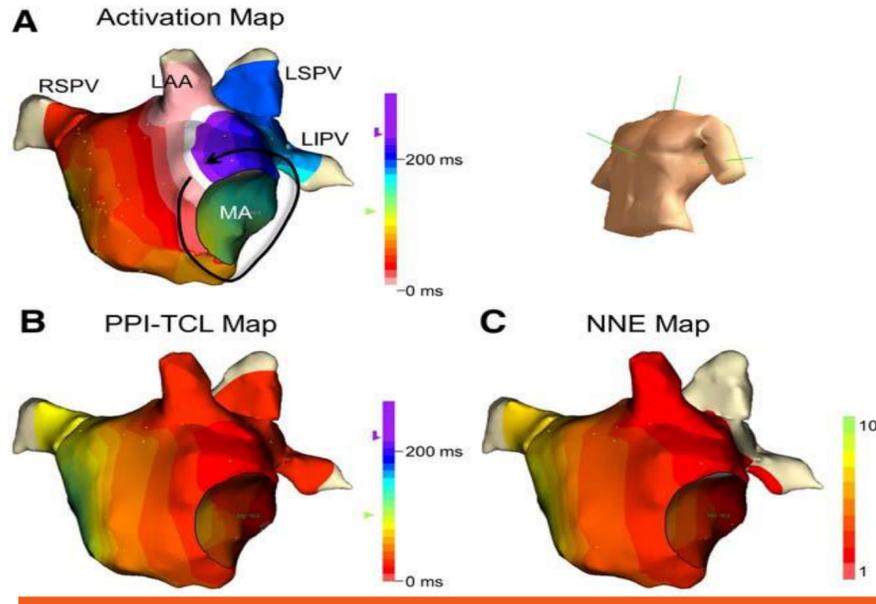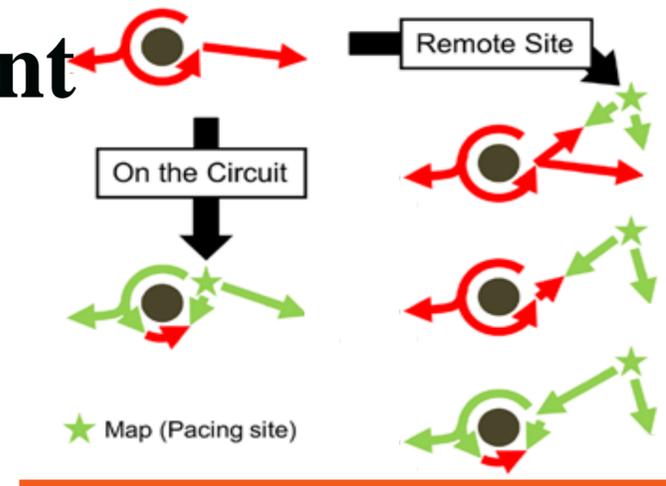
- **317 attempts in 76 IART**
- **Median = 2 NNE within the reentrant circuit**
- **Correlated to PPI -TCL ($r = 0.906$; $P<0.001$).**
- **Interesting if difficulties in PPI measurements or AT alteration/termination**

Maruyama M et Al. Circ Arrhythm Electrophysiol. 2014;7:490-496

Ent From Downstream Sites on Multielectrode Catheters to Diagnose MRAT
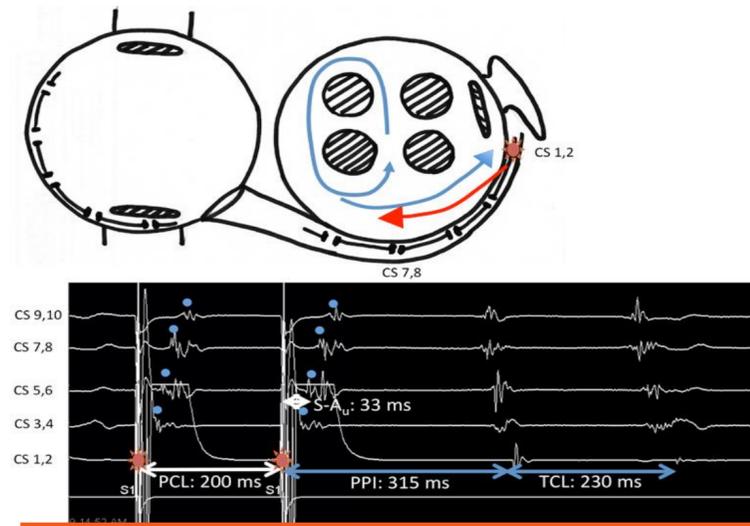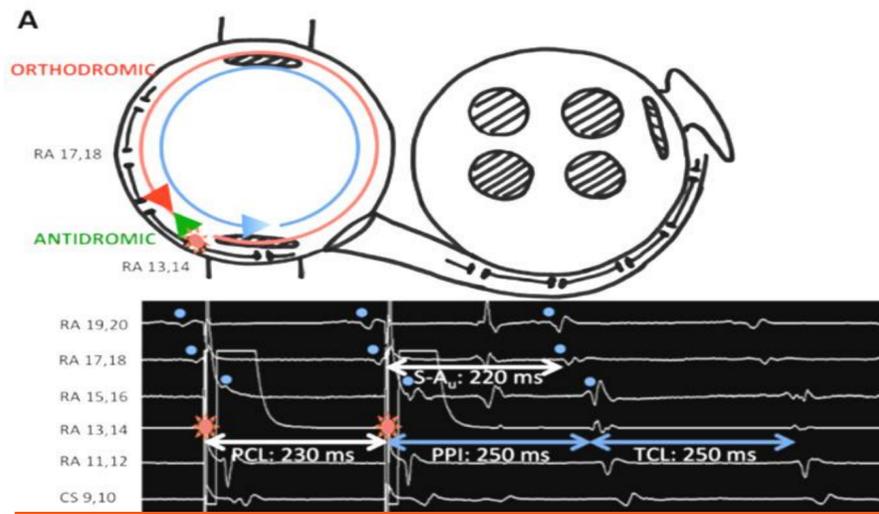
- **66 ATs in 62 pts**
- **P within CS from electrodes showing later A than adjacent ones**
- **A at neighboring upstream Egs: time S to last upstream accelerated A Eg (S-Au)**
- **Long S-Au despite short distance = orth. activation of upstream site (Constant fusion)**

- **S-A upstream/ TCL >75% Sites close to a MRAT**
- **Sites remote from MRATs or focal ATs S-A upstream/TCL <25%**

Barbahiya CR et Al. Circulation. 2014;129:2503-2510

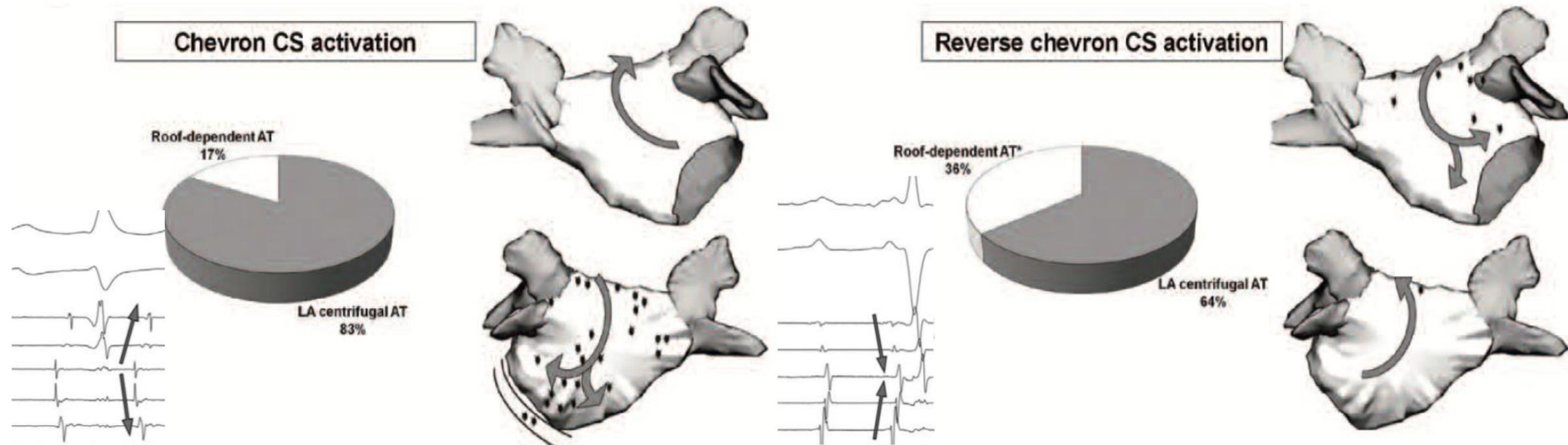# Mapping Strategy for AT Following AF Ablation

- **128 pts (246 AT) after stepwise approach in LS pers AF**

- **238/246 (97%) AT successfully mapped**

- **FAT = 14%**

- **Localized R = 40%**

- **MRAT = 109 46%**
  - **61 (25%) PM**
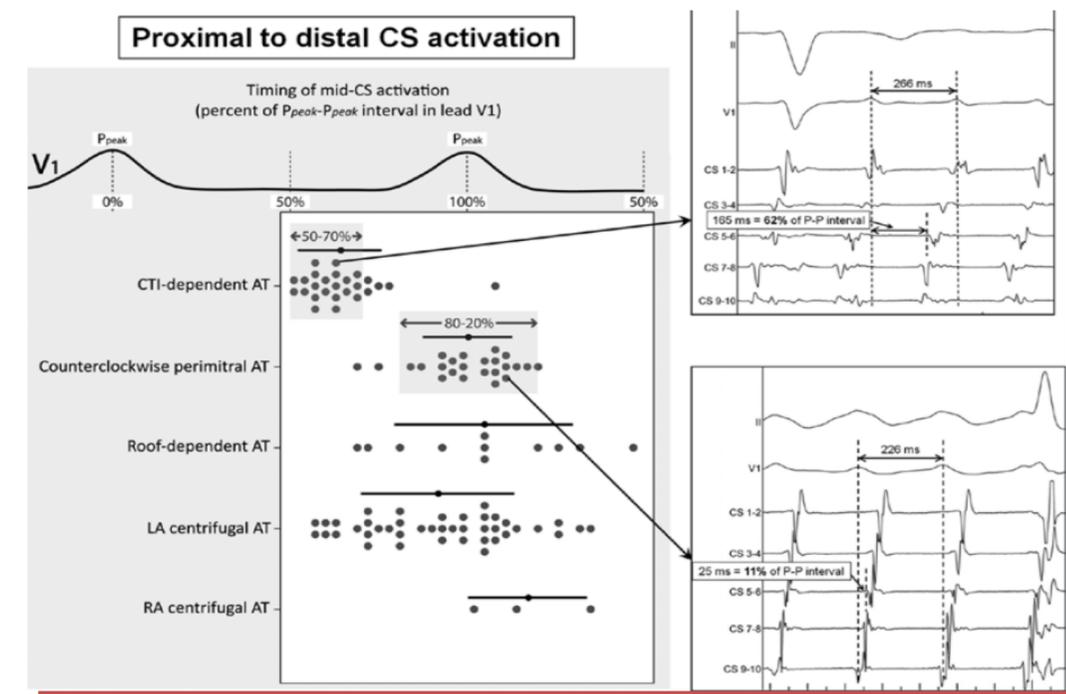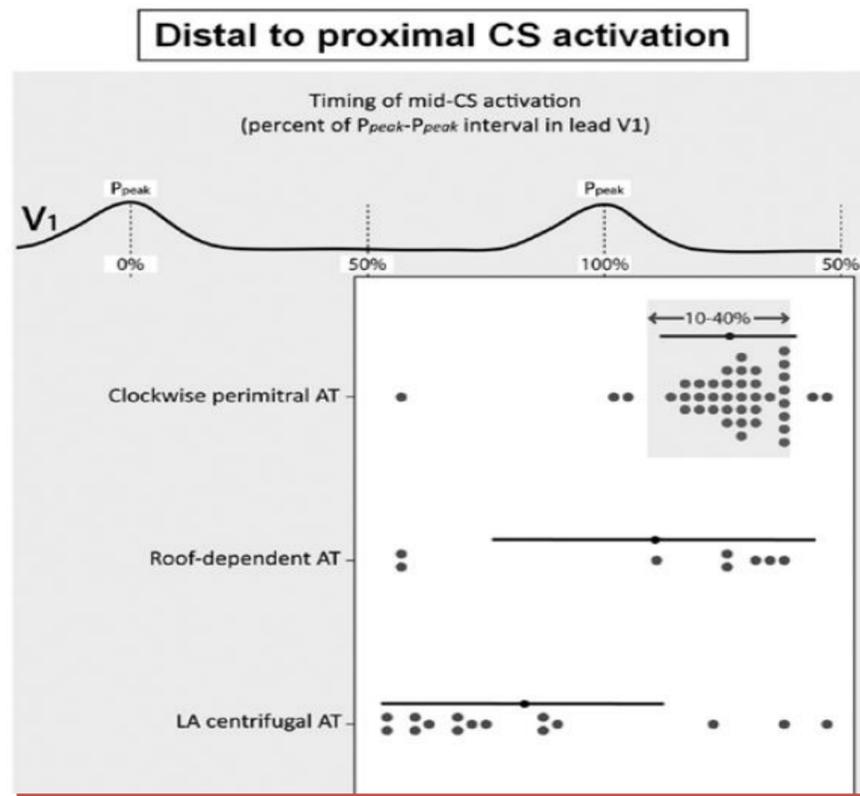 - **31 (13%) Roof dependant**
  - **17 (7%) CTI dep**

Jais P. et Al. J Cardiovasc Electrophysiol 2009;20:480-491
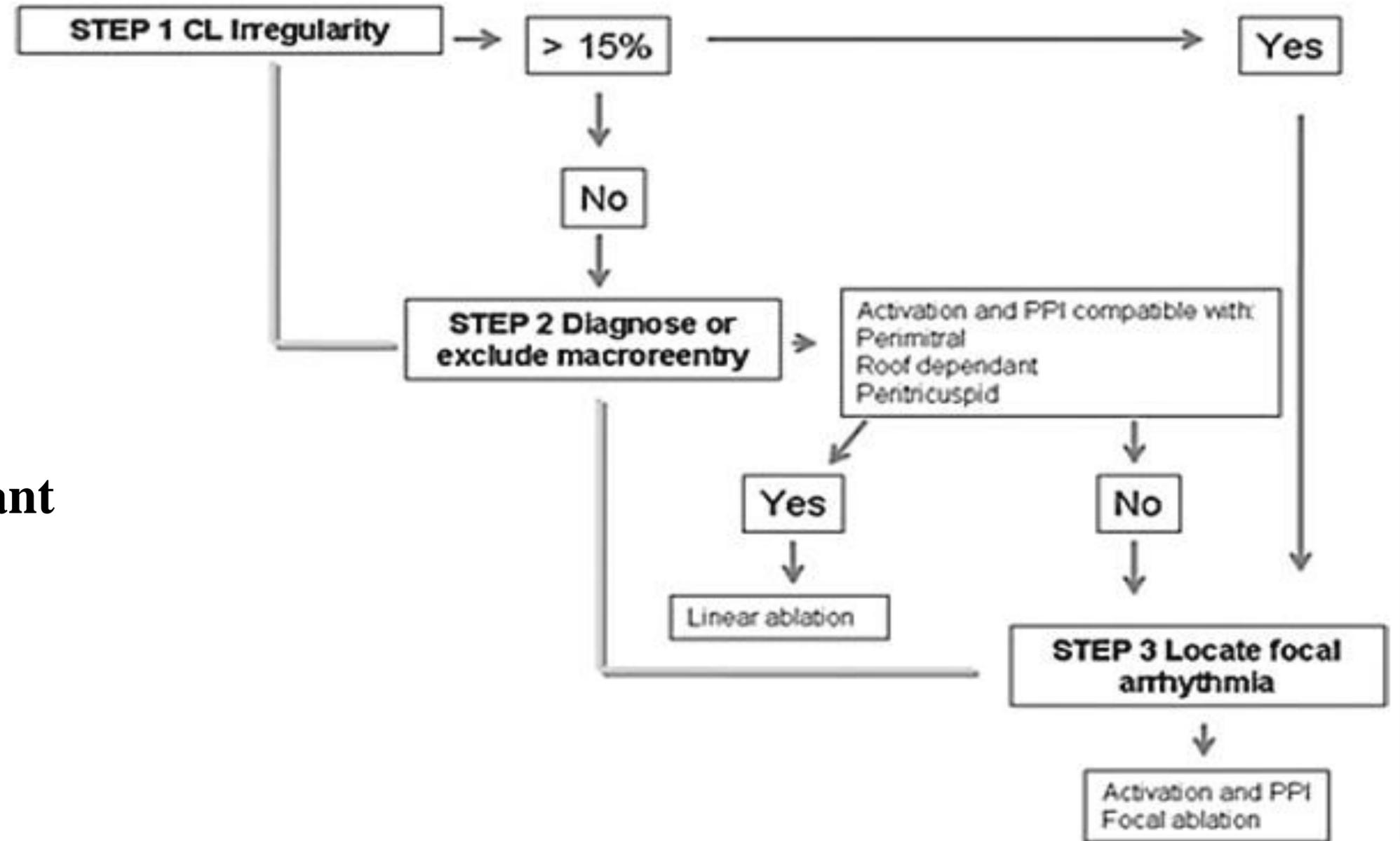
CS Activation Pattern

- **140 AT during or after Pers AF ablation**
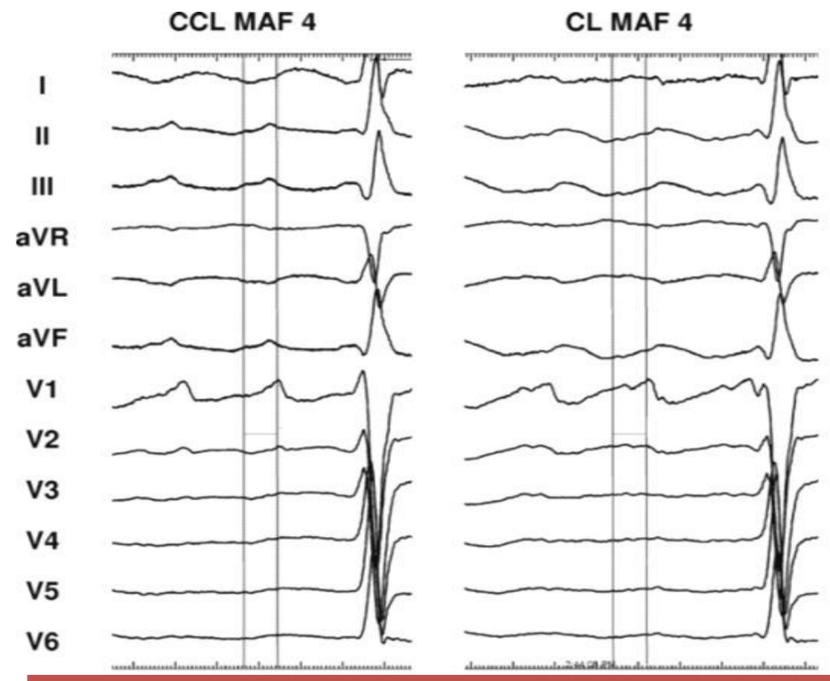- **223 diagnosed AT: 124 MRAT (56%) and 99 centrifugal (44%)**

Chevron CS activation

Roof-dependent AT 17%

LA centrifugal AT 83%

Reverse chevron CS activation

Roof-dependent AT* 36%

LA centrifugal AT 64%

Mid CS Timing

Distal to proximal CS activation

Timing of mid-CS activation (percent of P_{peak}-P_{peak} interval in lead V1)

Clockwise perimitral AT

Roof-dependent AT

LA centrifugal AT

- **10-40% of PP = CW PM *MRAT* (*PPV=82%, NPV=75%*)**

- **50-70% of PP= CTI dep MRAT (*PPV=70%, NPV = 93%*)**
- **80-20% of PP = CCW PM MRAT (*PPV=41%, NPV=91%*)**

Proximal to distal CS activation

Timing of mid-CS activation (percent of P_{peak}-P_{peak} interval in lead V1)

CTI-dependent AT

Counterclockwise perimitral AT

Roof-dependent AT

LA centrifugal AT

RA centrifugal AT

Pascale P et Al. Circ Arrhythm Electrophysiol 2013;6;481-490

Peri Mitral MRAT

- **Always flutter aspect** *Gerstenfeld EP et Al. Heart*
- **F 0> in V1** *Rhythm 2007;4:1136 –43*

- **40 recurrent PM MRAT at 1 y**
  - **Previous MI linear block in 13 (32.5%)**
  - **MI ablation (delay wo block) in 13 (32.5%)**
- **Termination in 26/40**
- **73.5% free from TA/AF at 13 mths**

Miyazaki S et Al. Heart Rhythm 2015;12:104–110
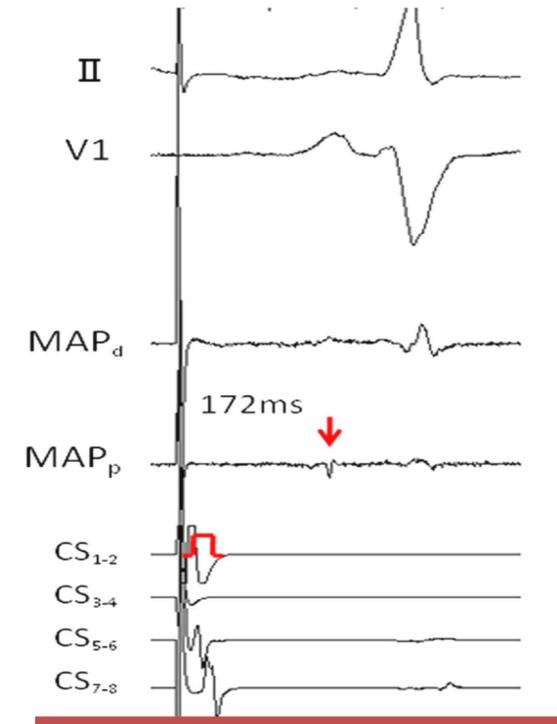
Conduction delay >149 ms predicted spontaneous PMAT

Roof Dependant MRAT
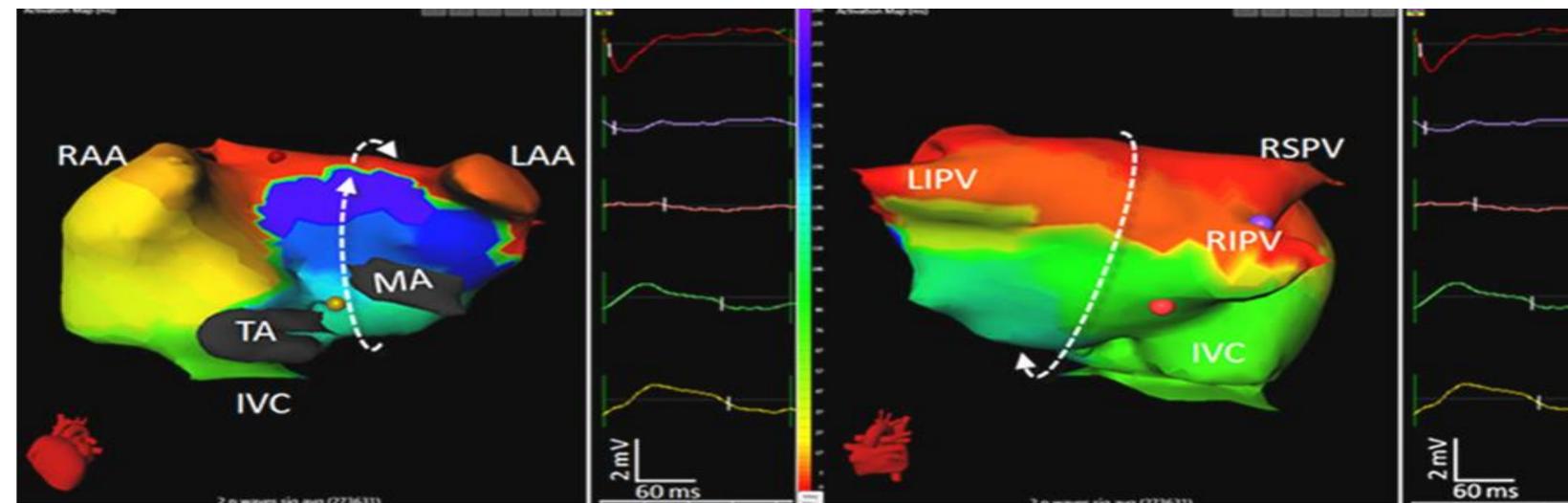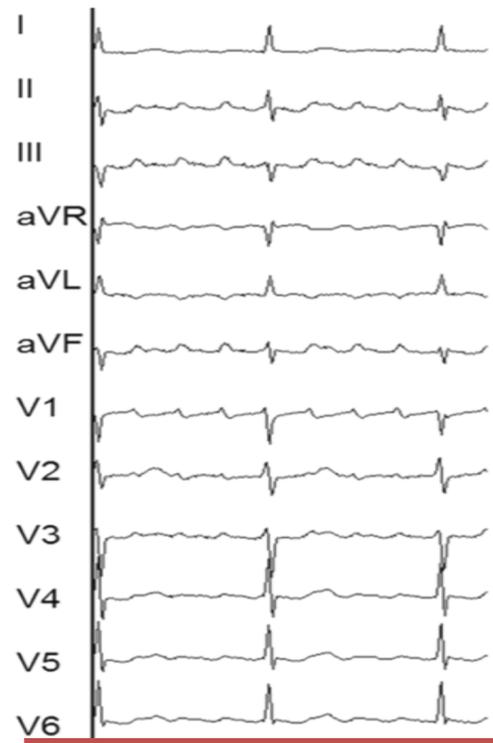
Shah AJ et Al. J Am Coll Cardiol 2013;62:889–97

MRAT After Surgical Repair of CHD
Isolated Channels Between Scars Allow "Focal" Ablation

- **16 pts post ASD repair (6), ToF (4), and Fontan procedure (6)**
- **65/69 AT from the RA**
- **Carto RA maps (15 MRATs , 2 focal AT , and 2 A pacing (no stable AT)**
- <u>**Circuit within a large low V area**</u> **(bip ≤0.5 mV)**

- **Many sites within circuit, but outside isolated channel exhibited diastolic potential, ent with concealed fusion and PPI =TCL**
- **Ablation at one such site (RF1) failed to terminate tachycardia.**

- **Single RF2 application within channel identified from the map terminated AT** <u>**despite local pacing failure to capture**</u>

Nakagawa H et Al. Circulation 2001;103;699-709
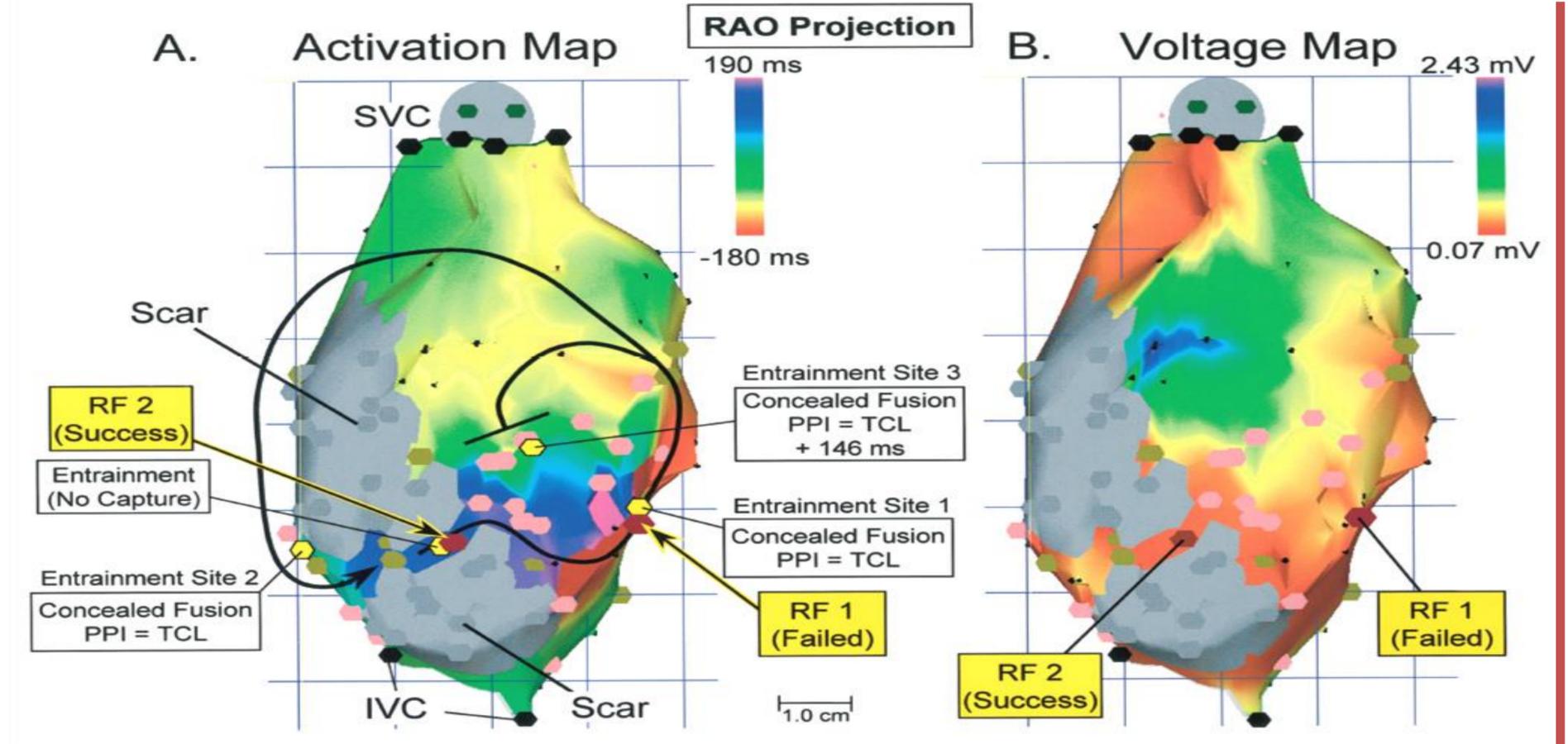
MRAT After Surgical Repair of CHD
Isolated Channels Between Scars Allow "Focal" Ablation

- **Extremely small A potential in mimicking dense scar in 7/15 cases terminating MRAT (<0.1 mV)**
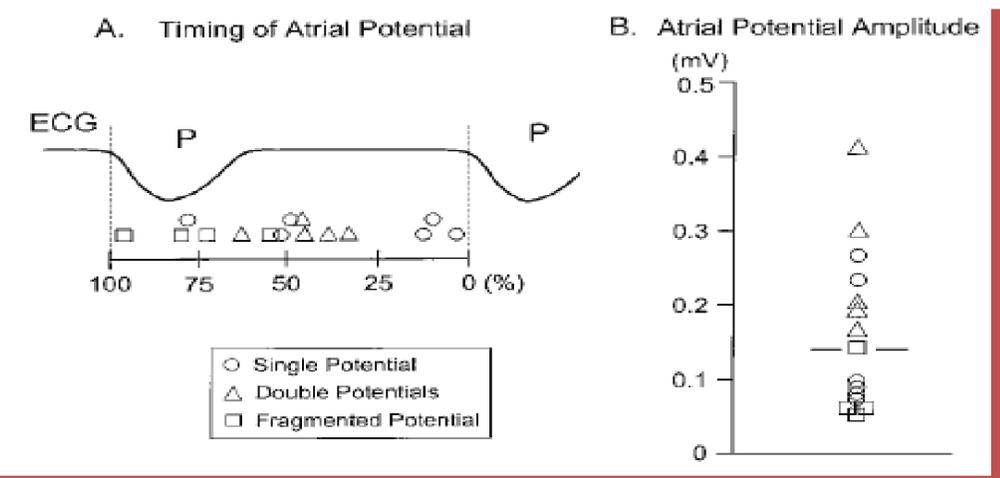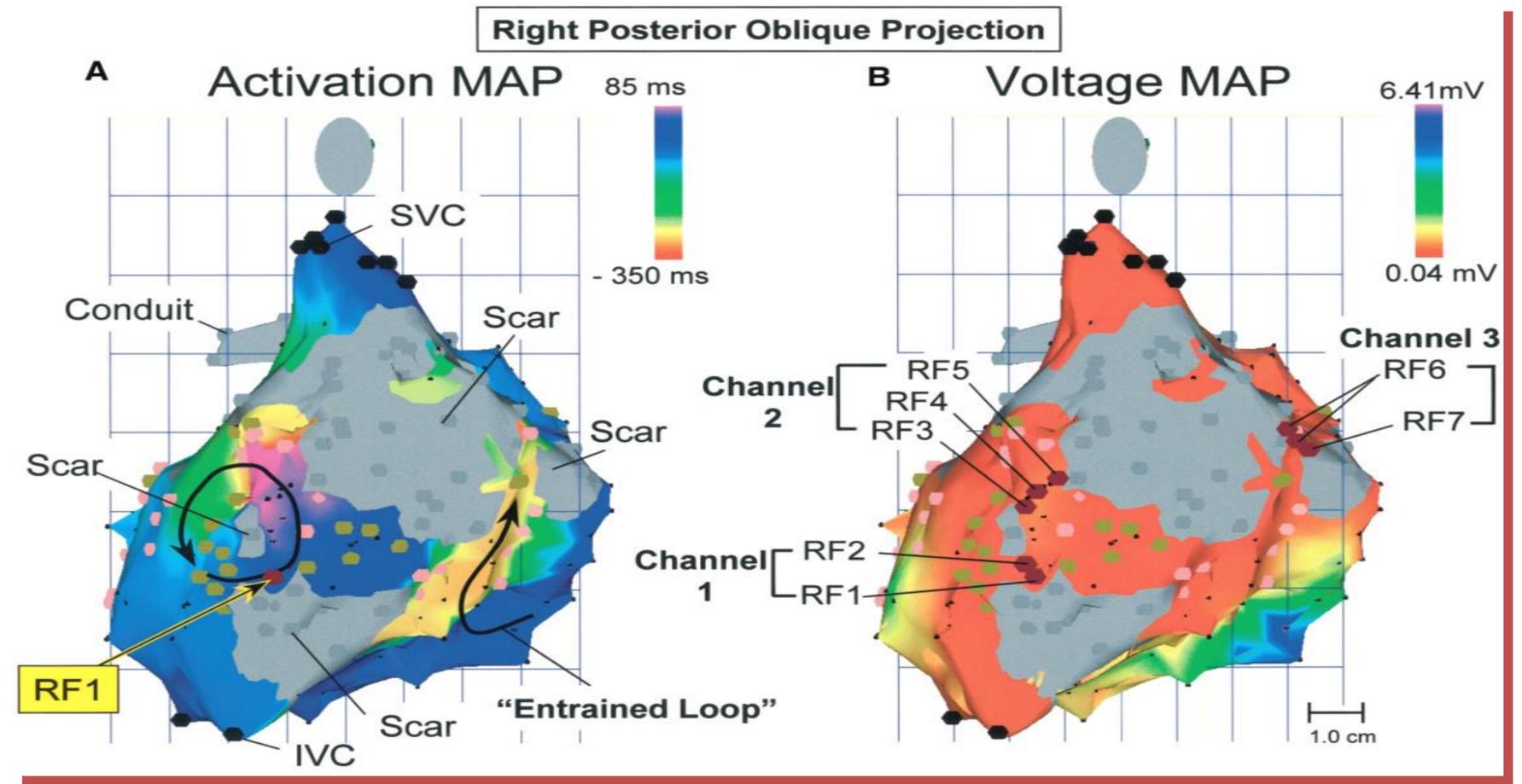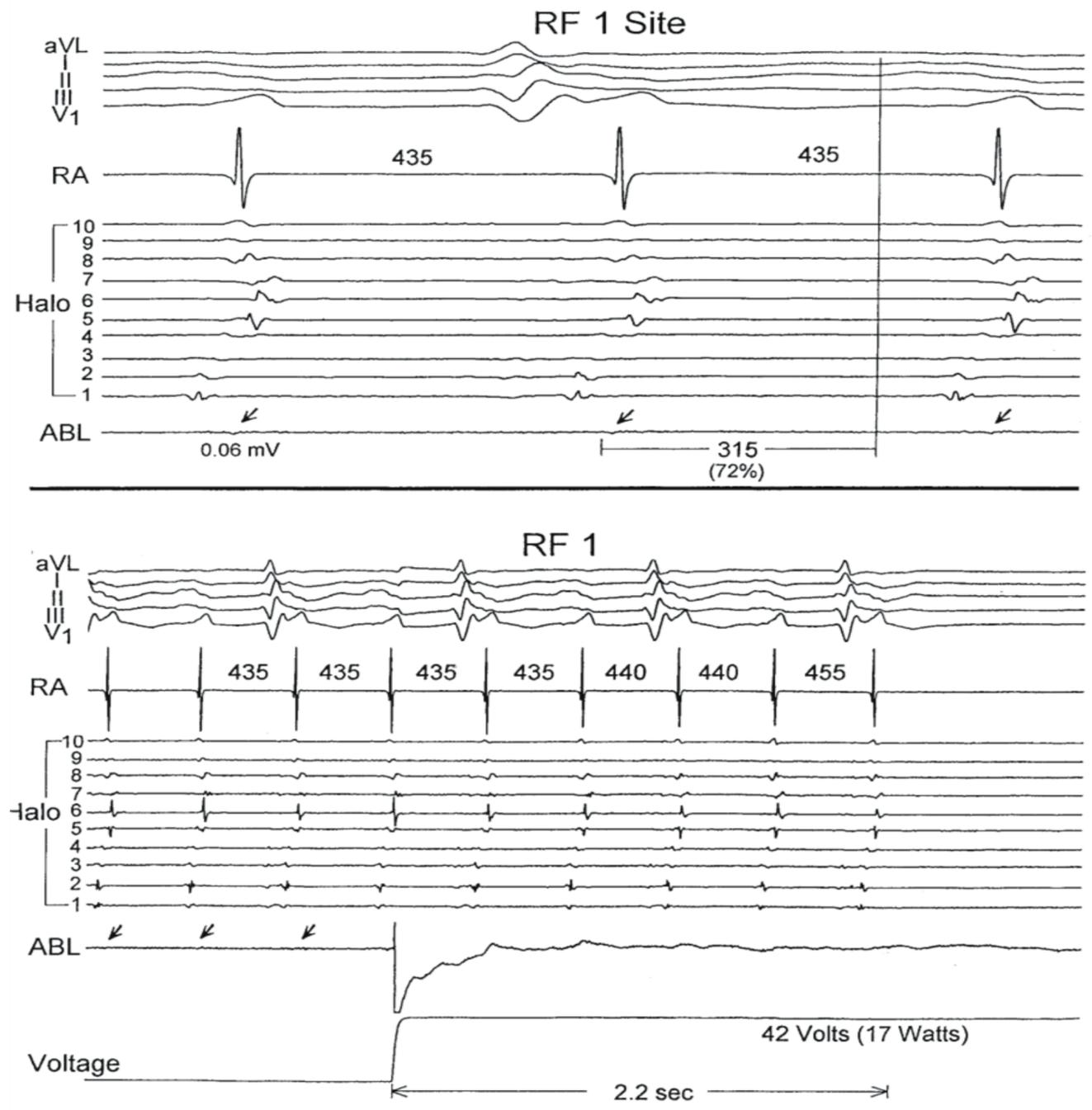
FAT and High Density Mapping

- **Multispline catheter mapping**
- **27 FAT: Local focus in 19 (70%) and local reentry in 8 (30%)**
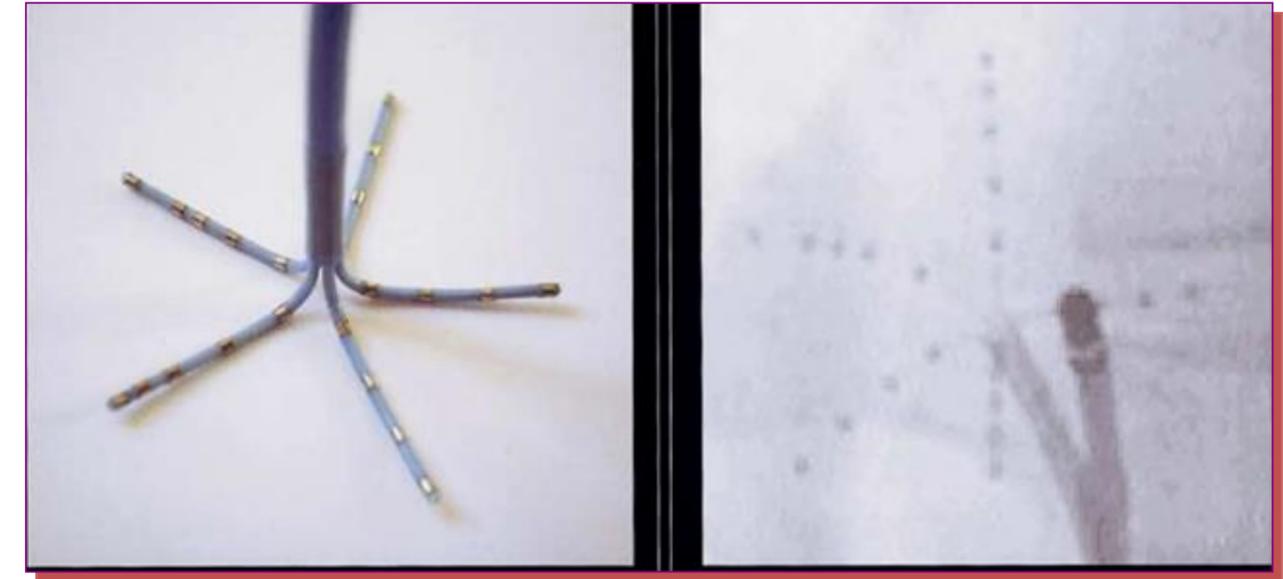
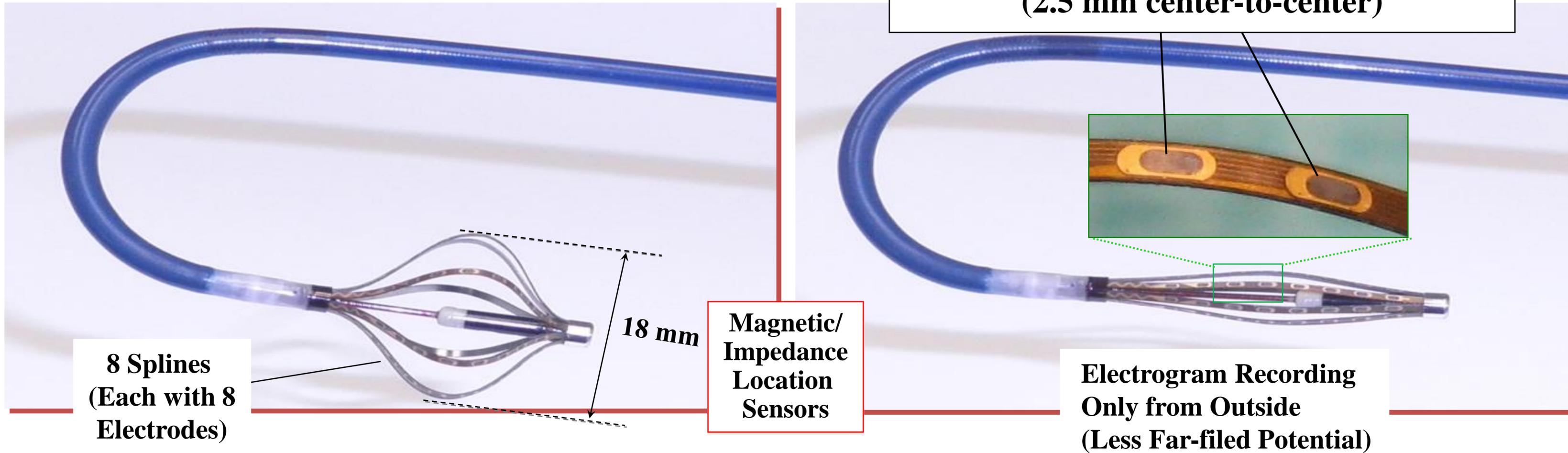*Sanders P et Al. J Am Coll Cardiol 2005;46:2088 –99*
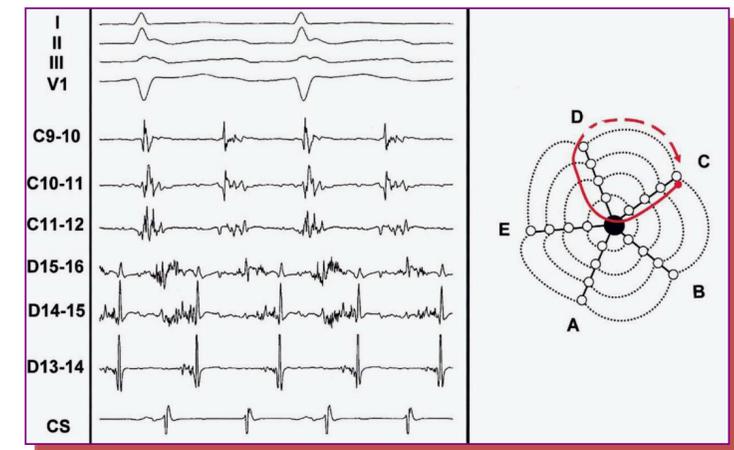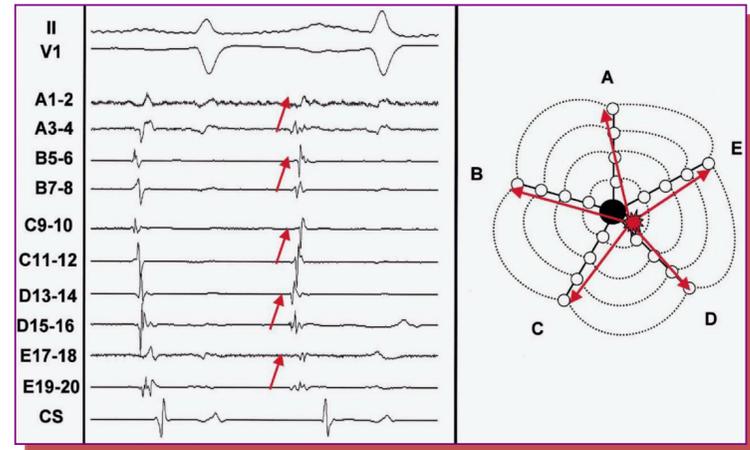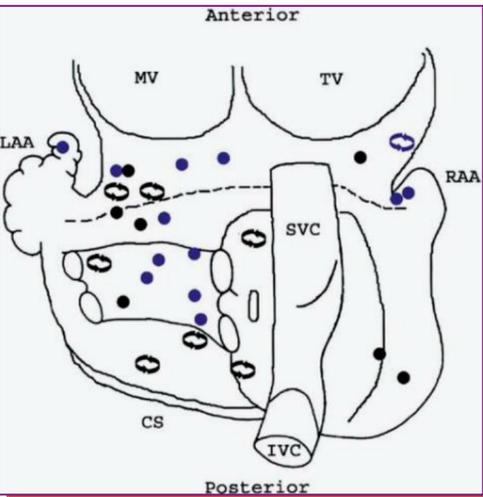
A. Annie. 66 ans

- **IM dystrophique**
- **2004: Plastie mitrale avec annuloplastie et fermeture de FOP**
- **2013: Flutter atypique rebelle aux drogues**

Courtesy of DG Latcu and SS Bun
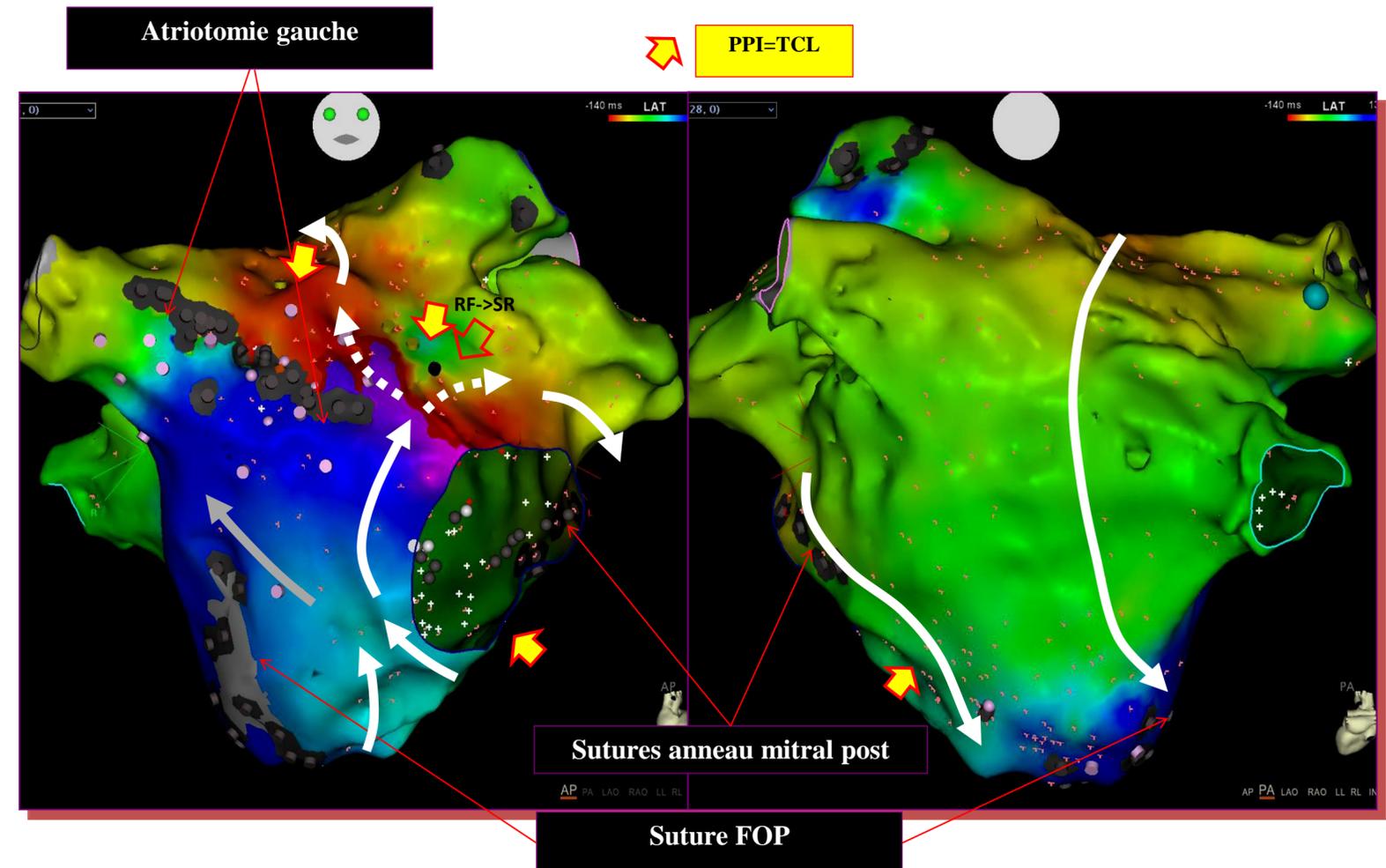
RHYTHMIA Mapping System and Orion™ High-Resolution Mapping Catheter

- **Station processes high quality signals Very low Noise level (bip <0.01 mV): 192 channels + ECG**

64 Low Noise Electrodes (0.4 mm²)
(2.5 mm center-to-center)

8 Splines
(Each with 8 Electrodes)

18 mm

Magnetic/ Impedance Location Sensors

Electrogram Recording Only from Outside (Less Far-filed Potential)

- **Automated Beat Selection based on: Eg time stability + Location stability + Respiratory phase**
- **Geometry / Anatomy Creation updated continuously**
- **Reference Eg from 2 separate sites (other catheters) to exclude PB's**
- **Multiple Potentials: System uses Eg timing in surrounding area to decide which one to use for timing annotation**

LA Activation Map During AT

61 M, Prior Surgical & Catheter Ablation of AF/AT

- Mapping EGMs: 9,645
- Mapping Time: 15.7 min
- Manual Verification of 59 EGMs (12.1 min)

AT CL 181 ms

Peri Mitral MRAT

LSPV

LIPV

RIPV

99 ms
82 ms
99 ms
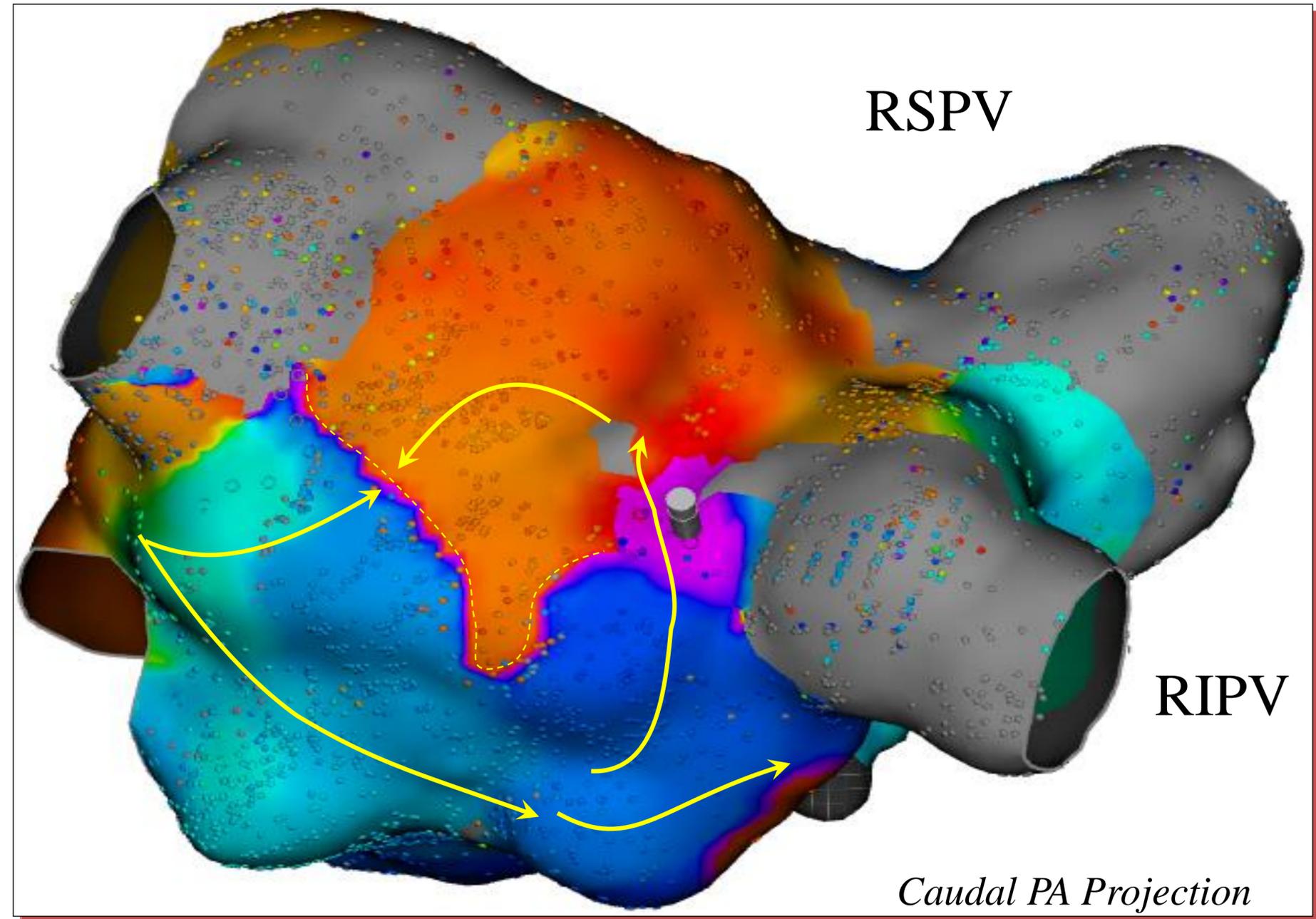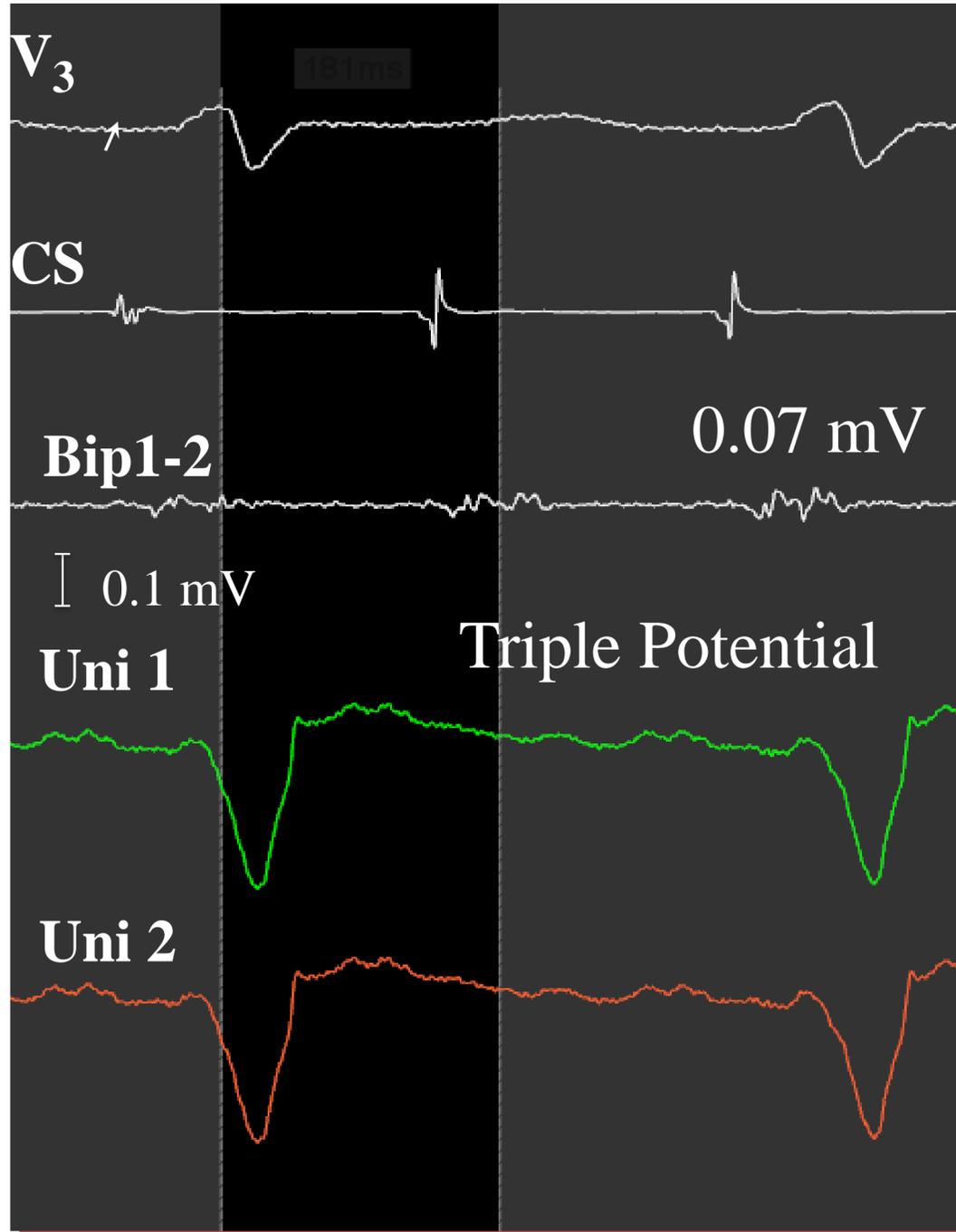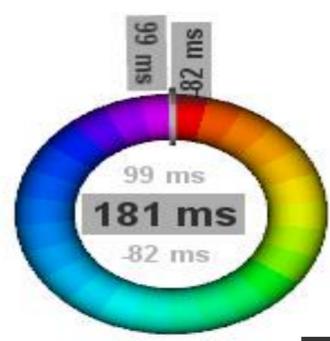**181 ms**
-82 ms

Left Lateral Projection

Courtesy of H Nakagawa MD and WM Jackman, MD
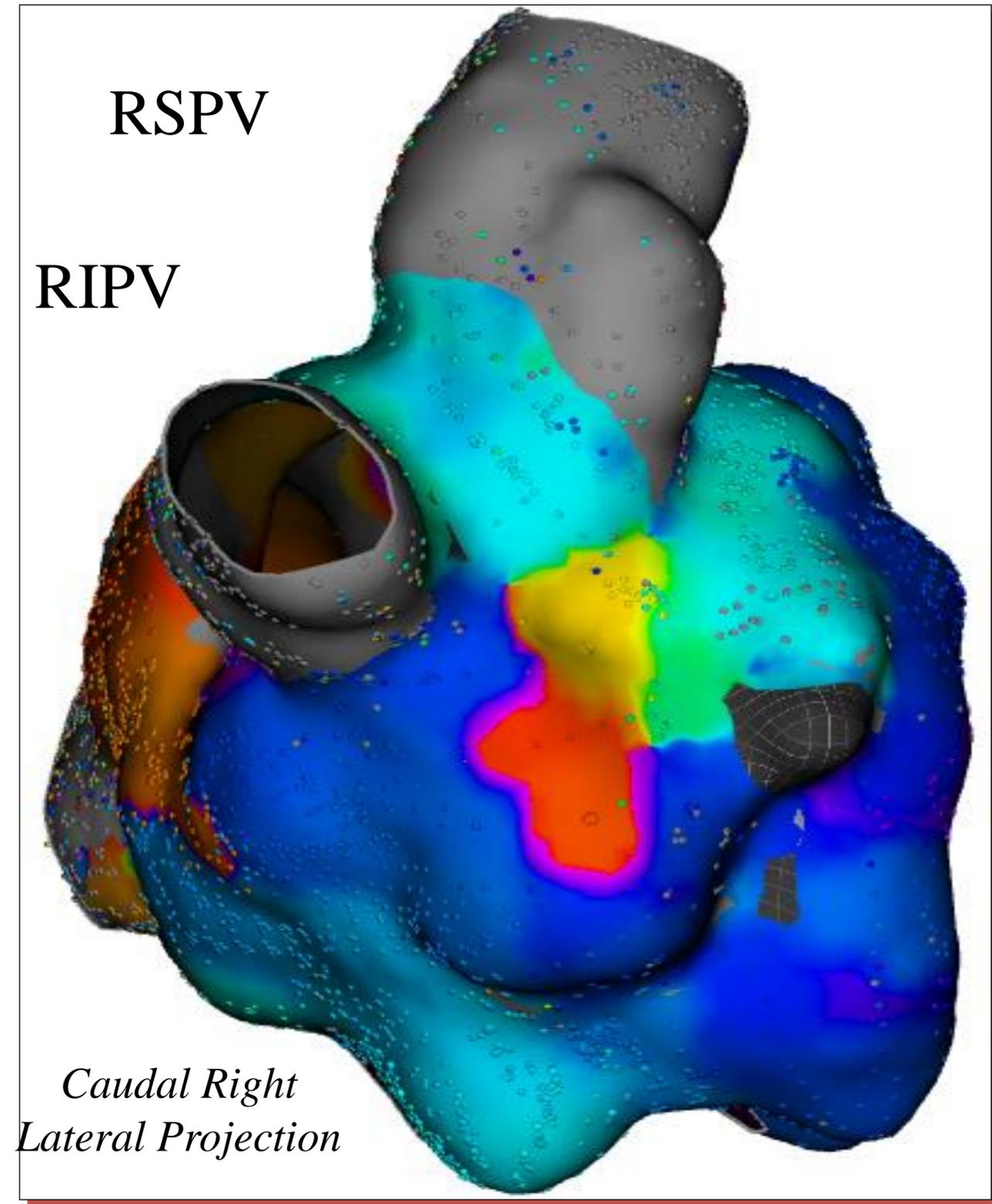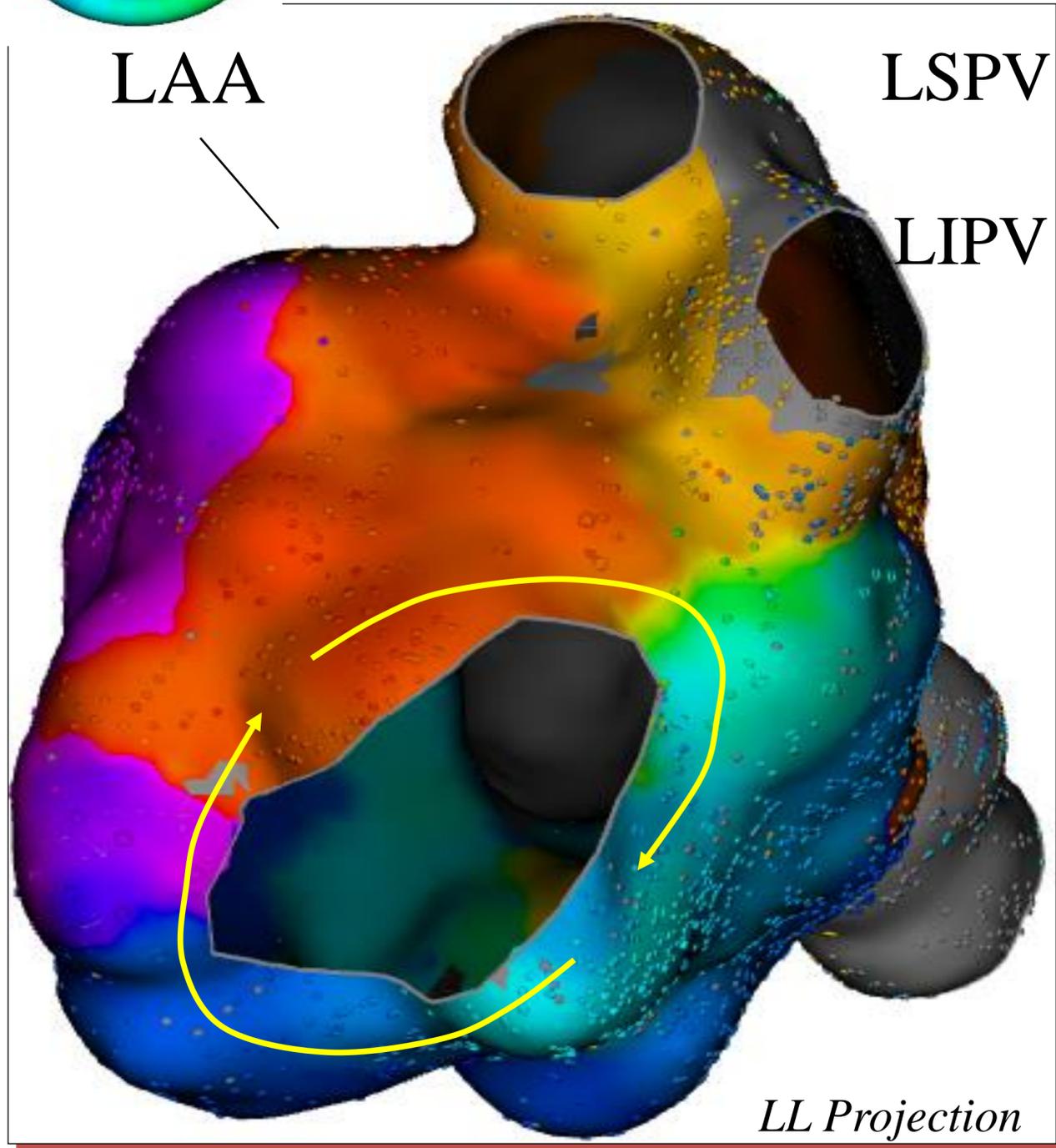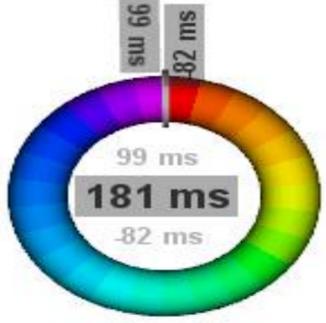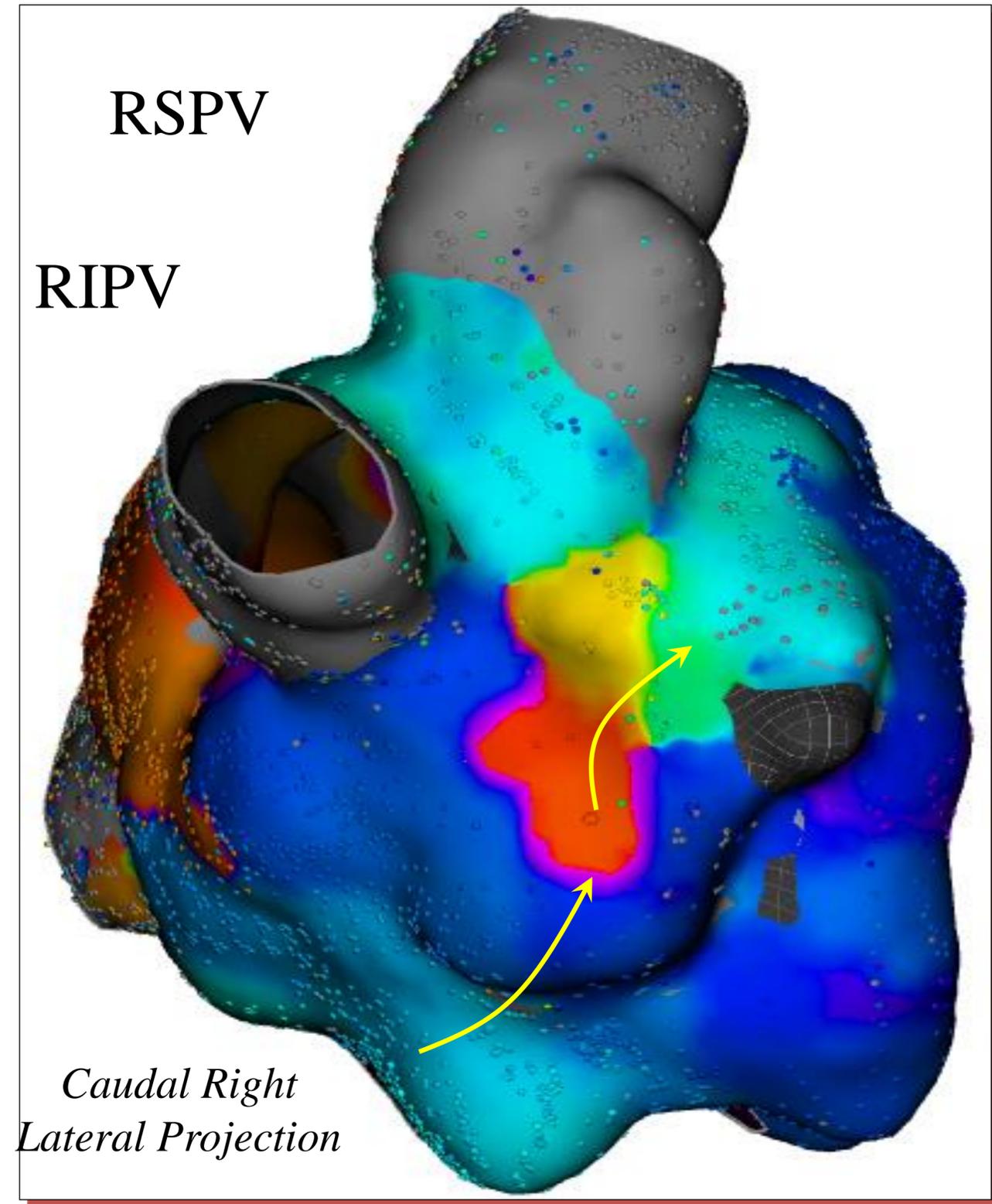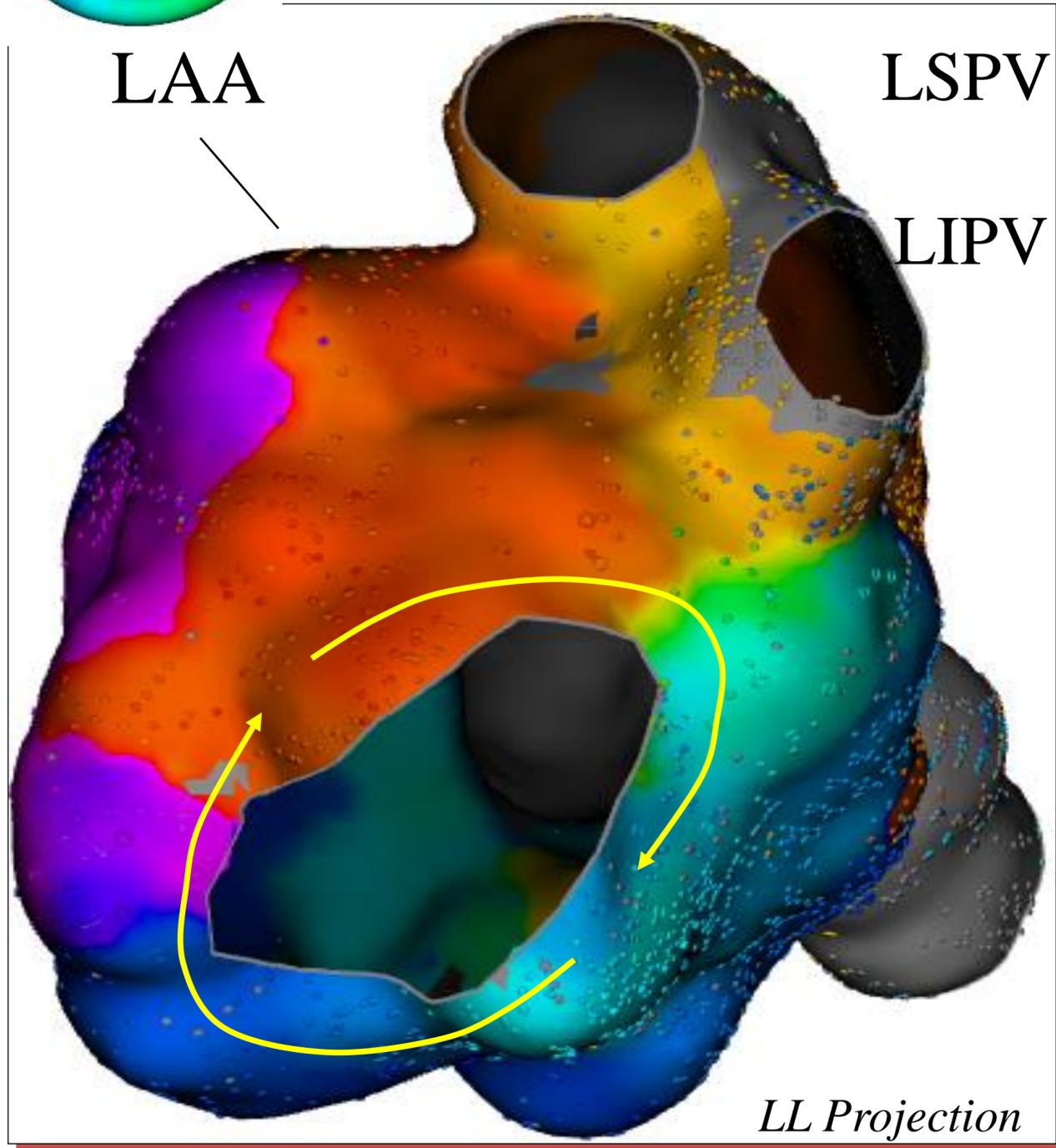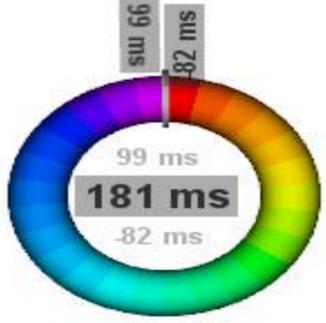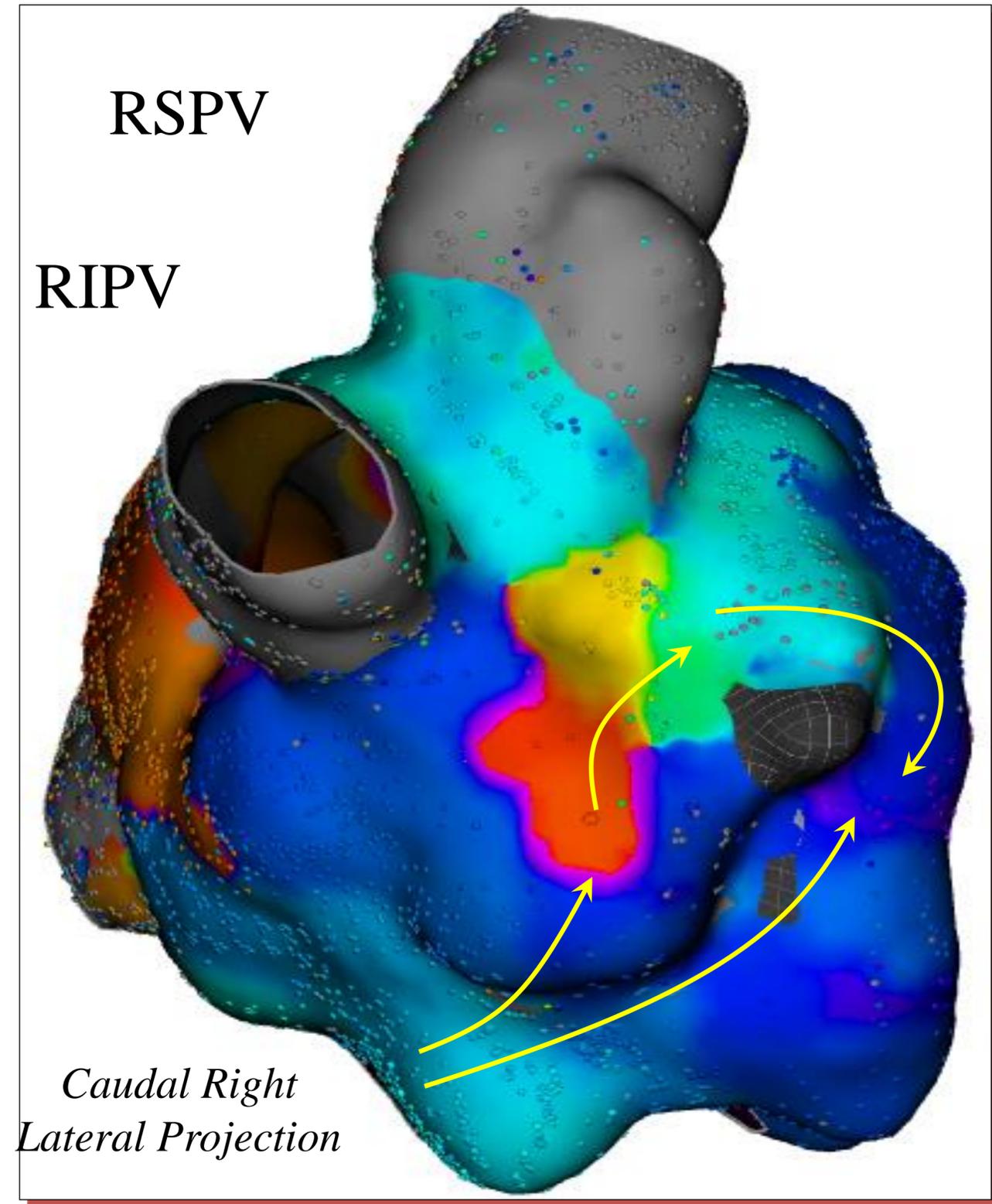
LA Activation Map During AT

LSPV

LIPV

LL Projection

RSPV

RIPV

Caudal PA Projection

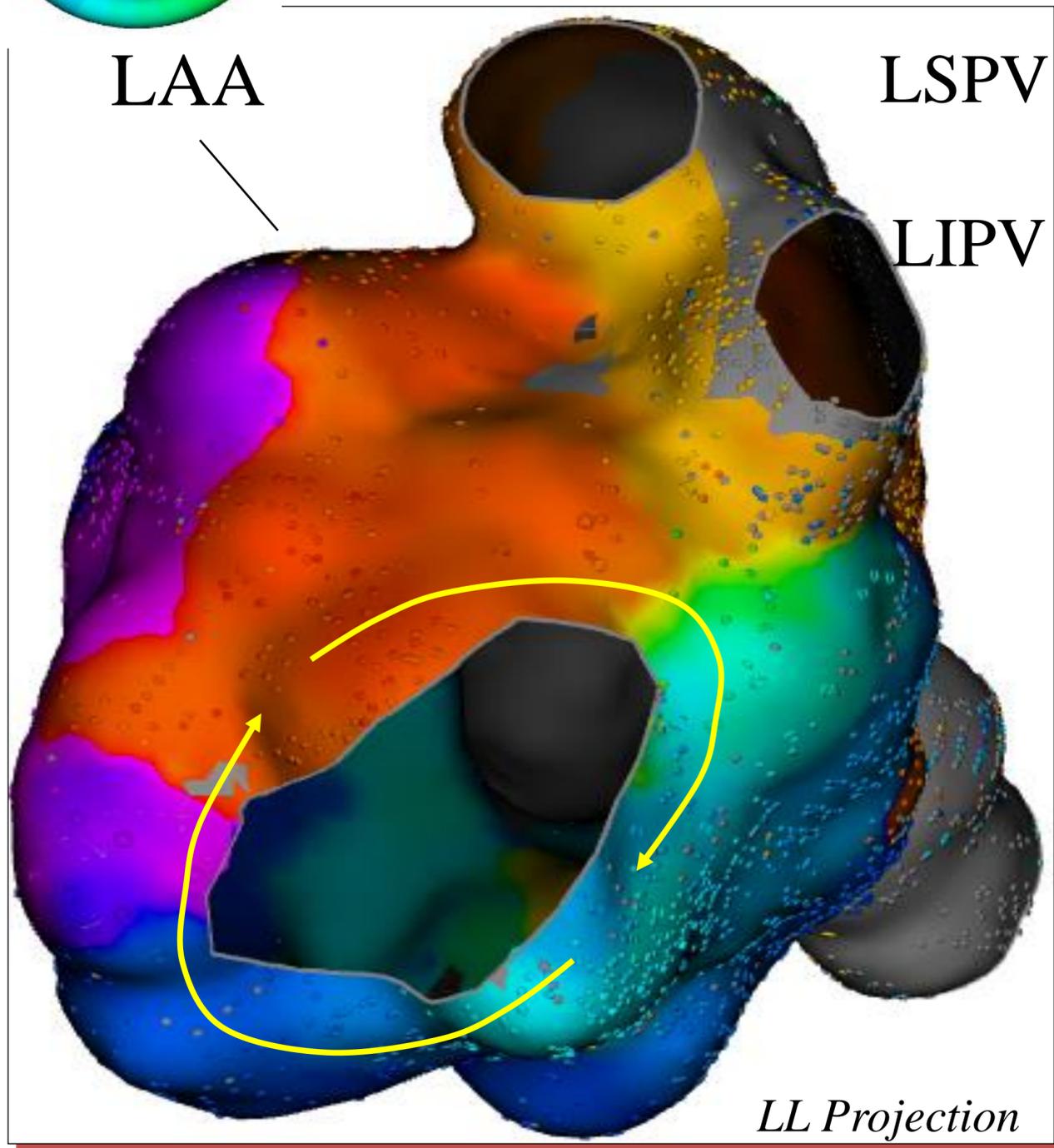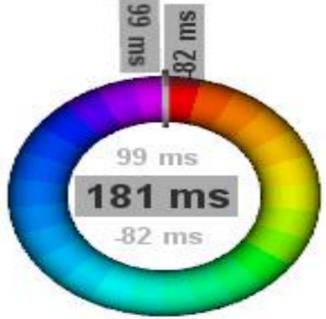*Courtesy of H Nakagawa MD and WM Jackman, MD*
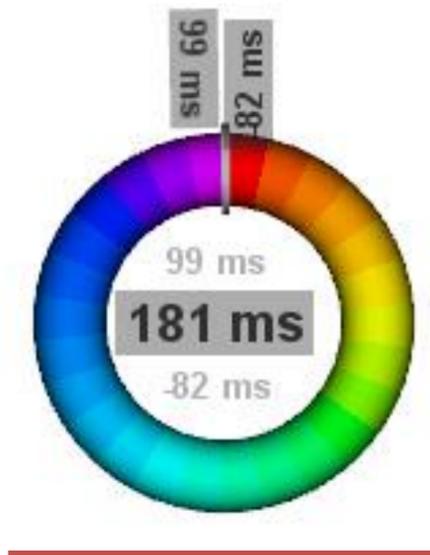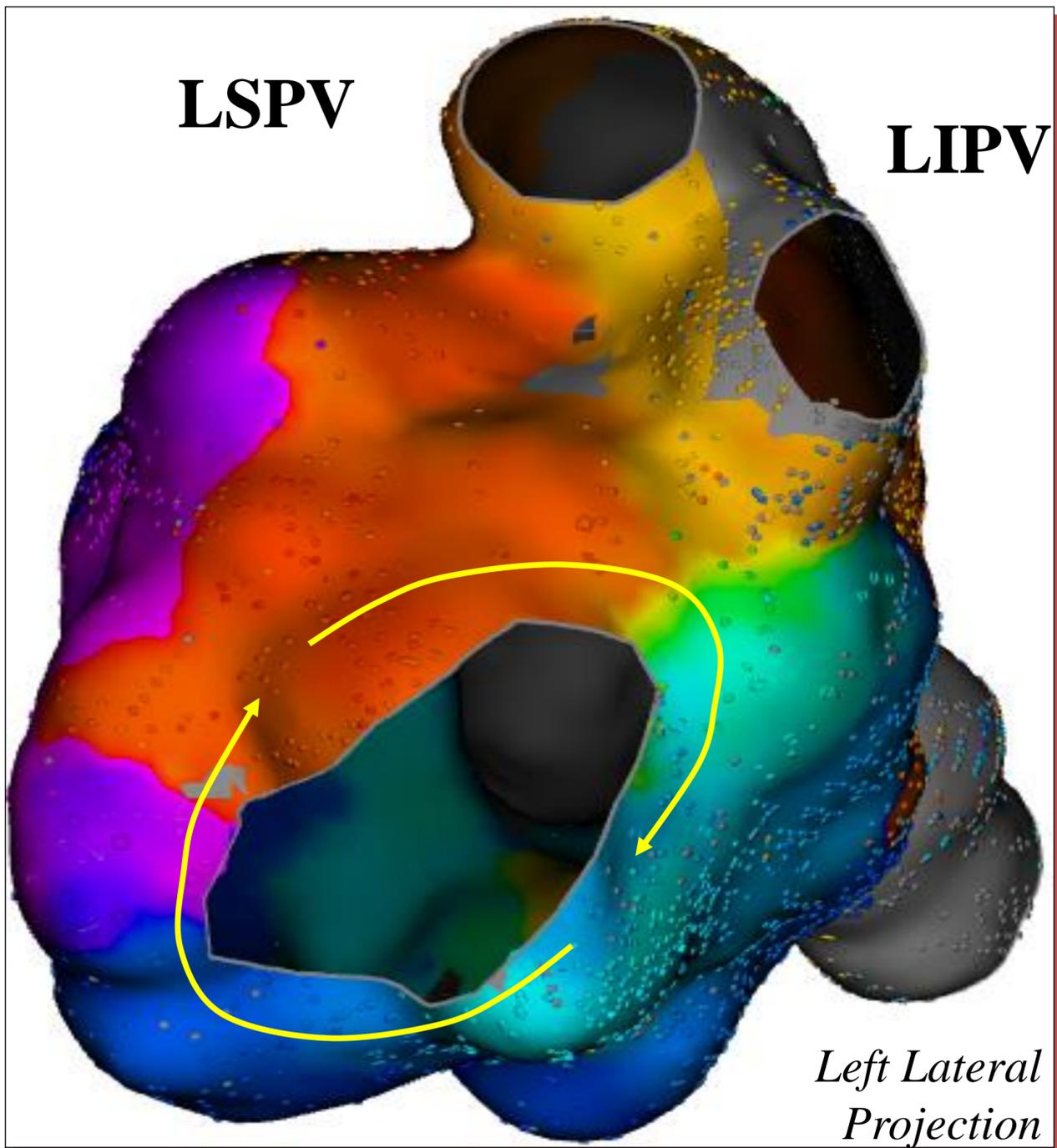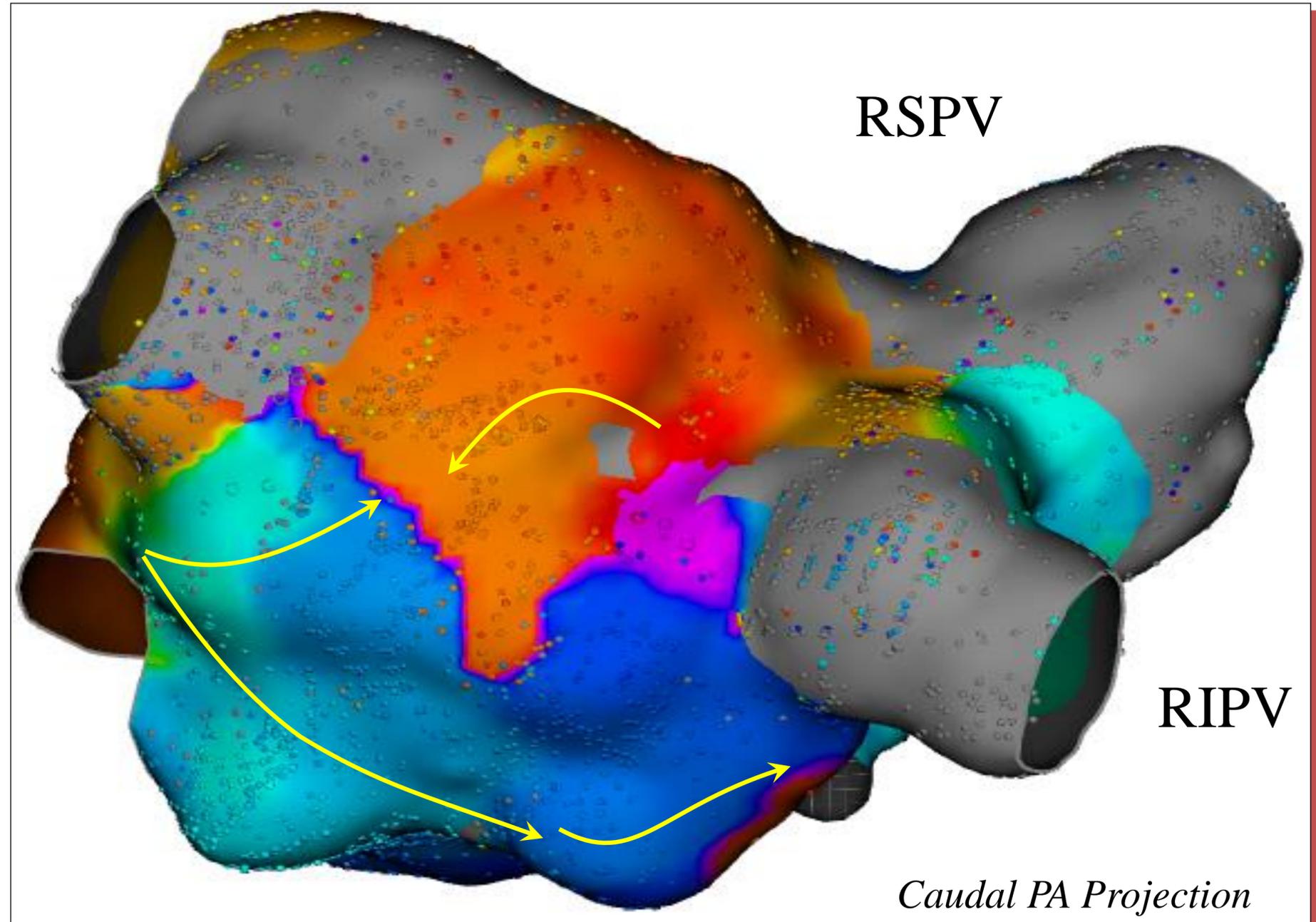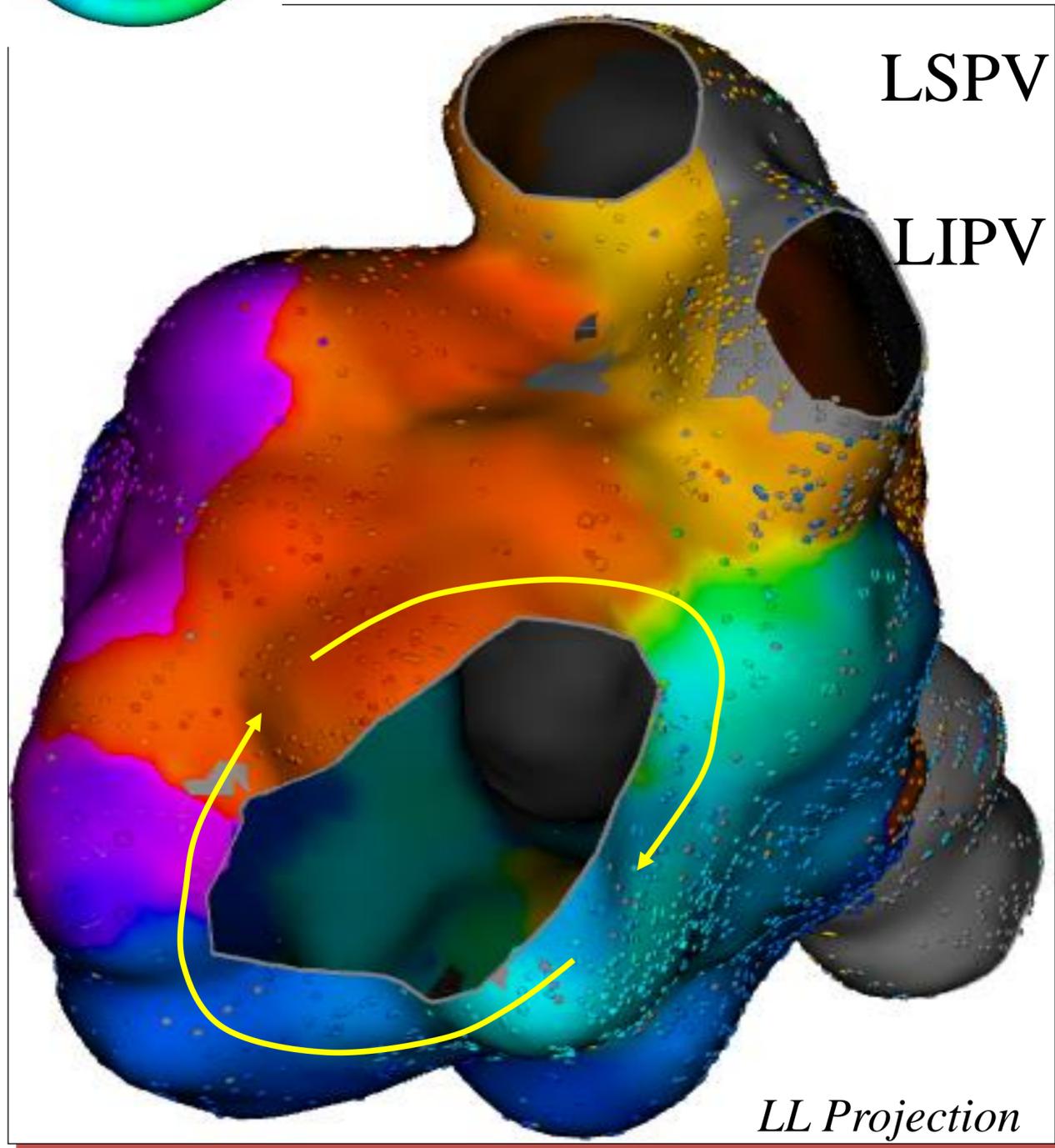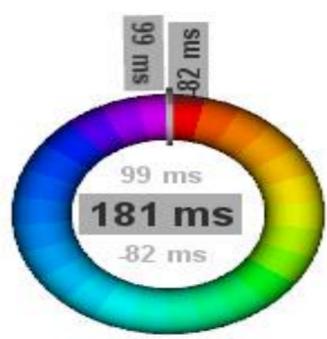
LA Activation Map During AT

LA Activation Map During AT

Courtesy of H Nakagawa MD and
WM Jackman, MD

LA Activation Map During AT

LAA

LSPV

LIPV

LL Projection
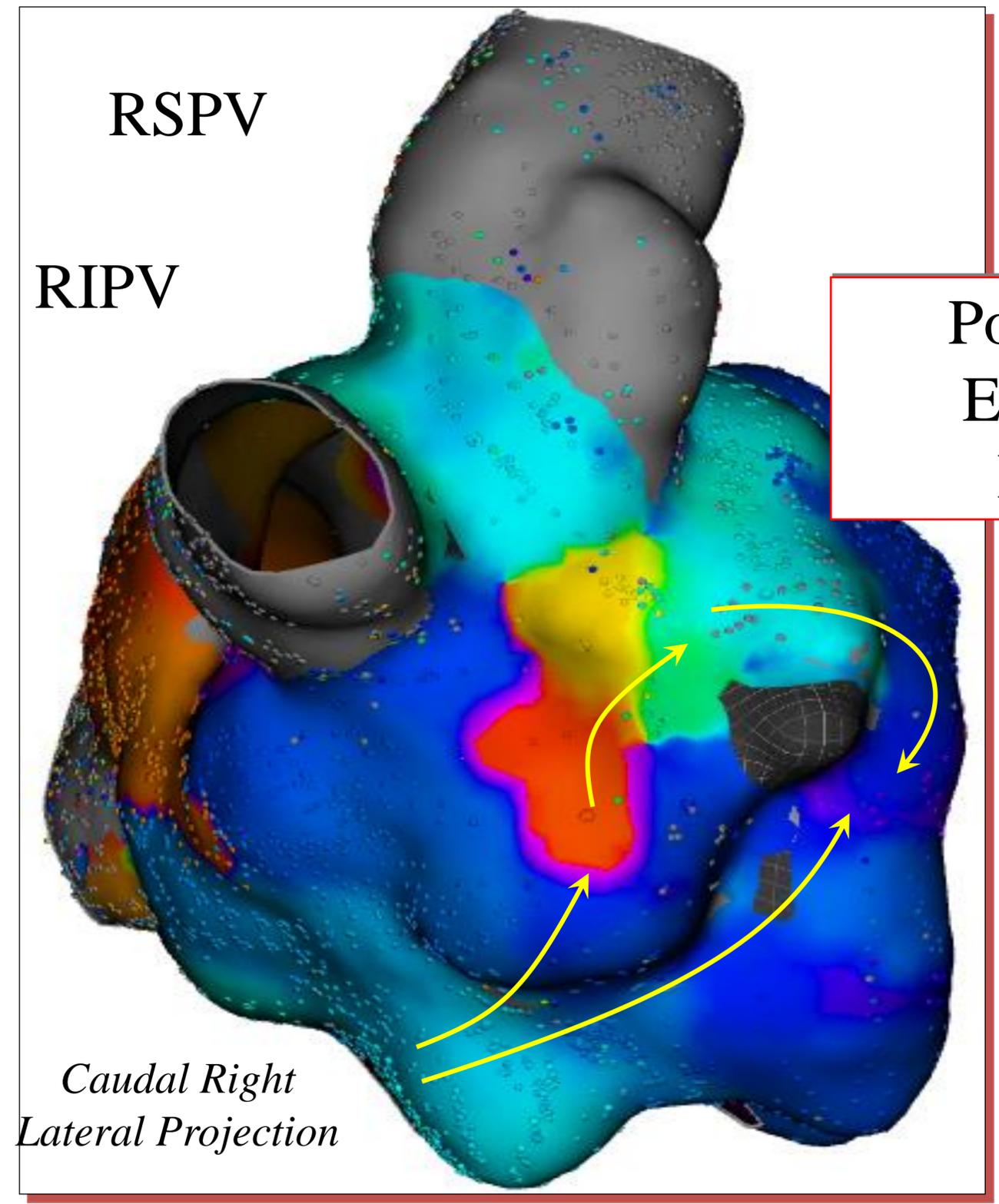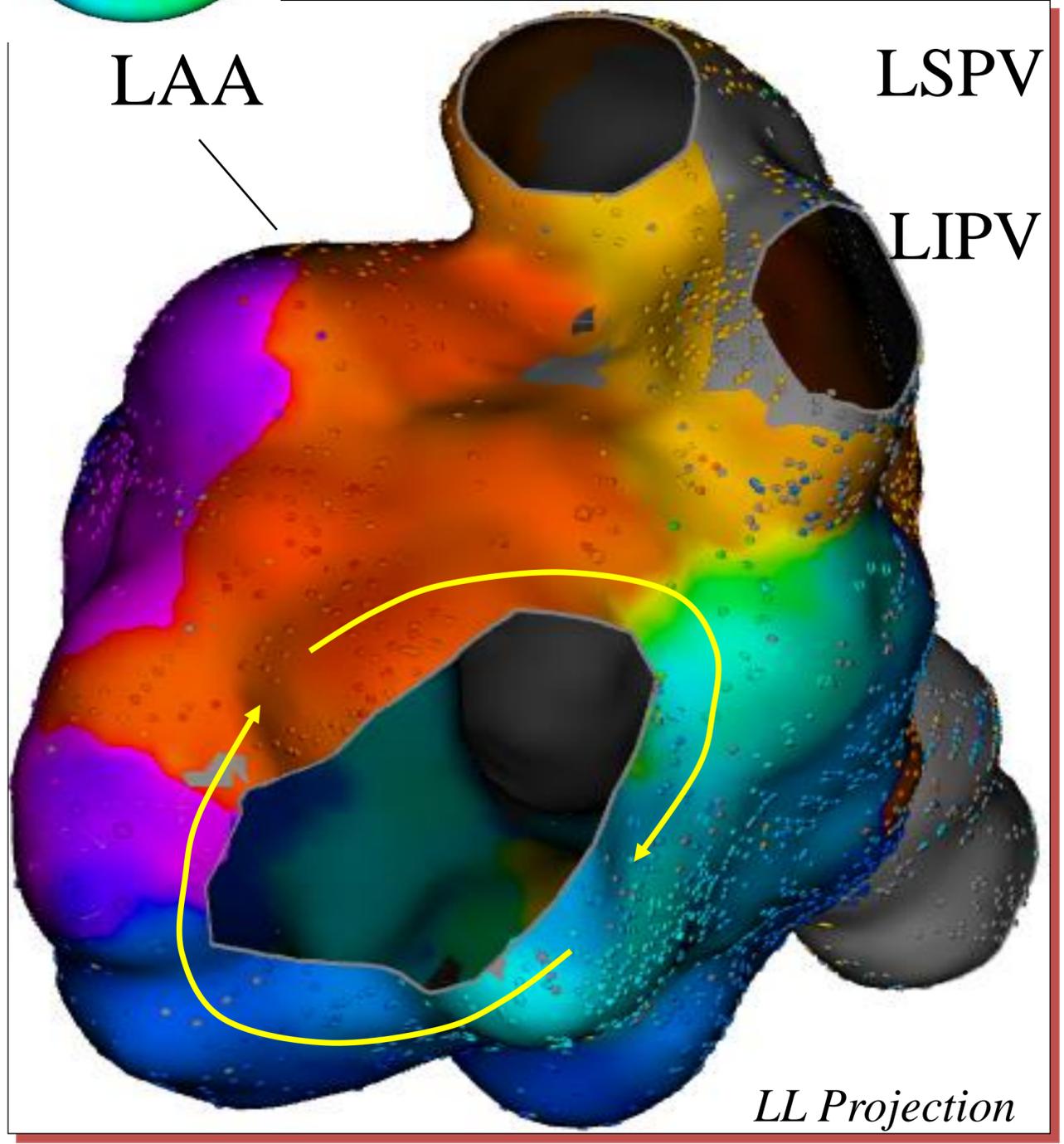
RSPV

RIPV

Caudal Right
Lateral Projection

Courtesy of H Nakagawa MD and WM Jackman, MD

LA Activation Map During AT

LAA
LSPV
LIPV
99 ms
181 ms
-82 ms
LL Projection

RSPV
RIPV
Caudal Right
Lateral Projection

LA Activation Map During AT

99 ms
-82 ms
99 ms
181 ms
-82 ms

LAA

LSPV

LIPV

RSPV

RIPV

LL Projection

Caudal Right Lateral Projection

LA Activation Map During AT

LAA

LSPV

LIPV

LL Projection

RSPV

RIPV

Potentially Entrained Loop ?

Caudal Right Lateral Projection

99 ms

-82 ms

99 ms

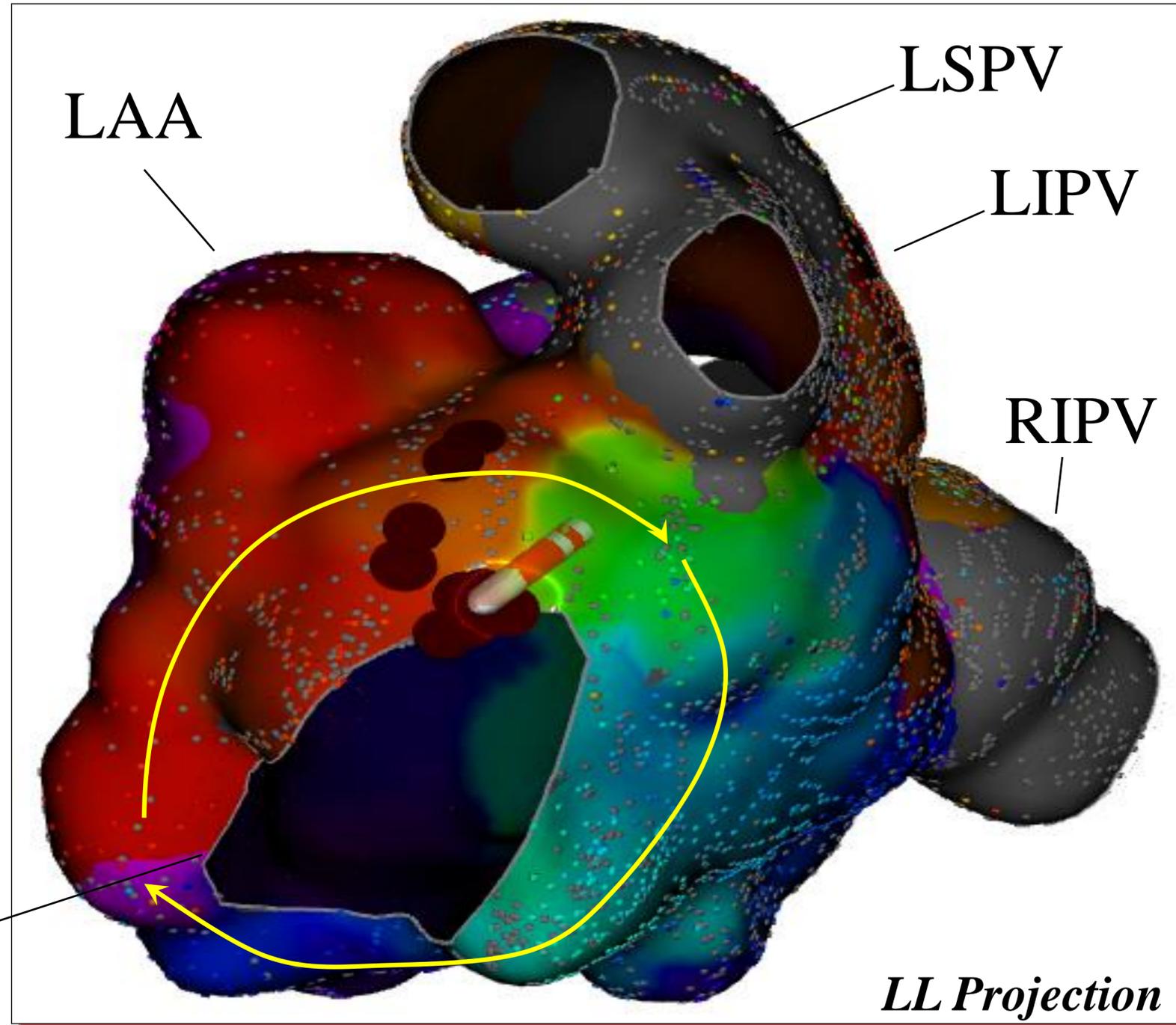**181 ms**

-82 ms

Courtesy of H Nakagawa MD and WM Jackman, MD

Ablation at the Mitral Isthmus

- **AT#1 (CL 181 ms)**

Linear Lesion Along the Mitral Isthmus Terminated AT

LAA

LSPV

LIPV

RIPV

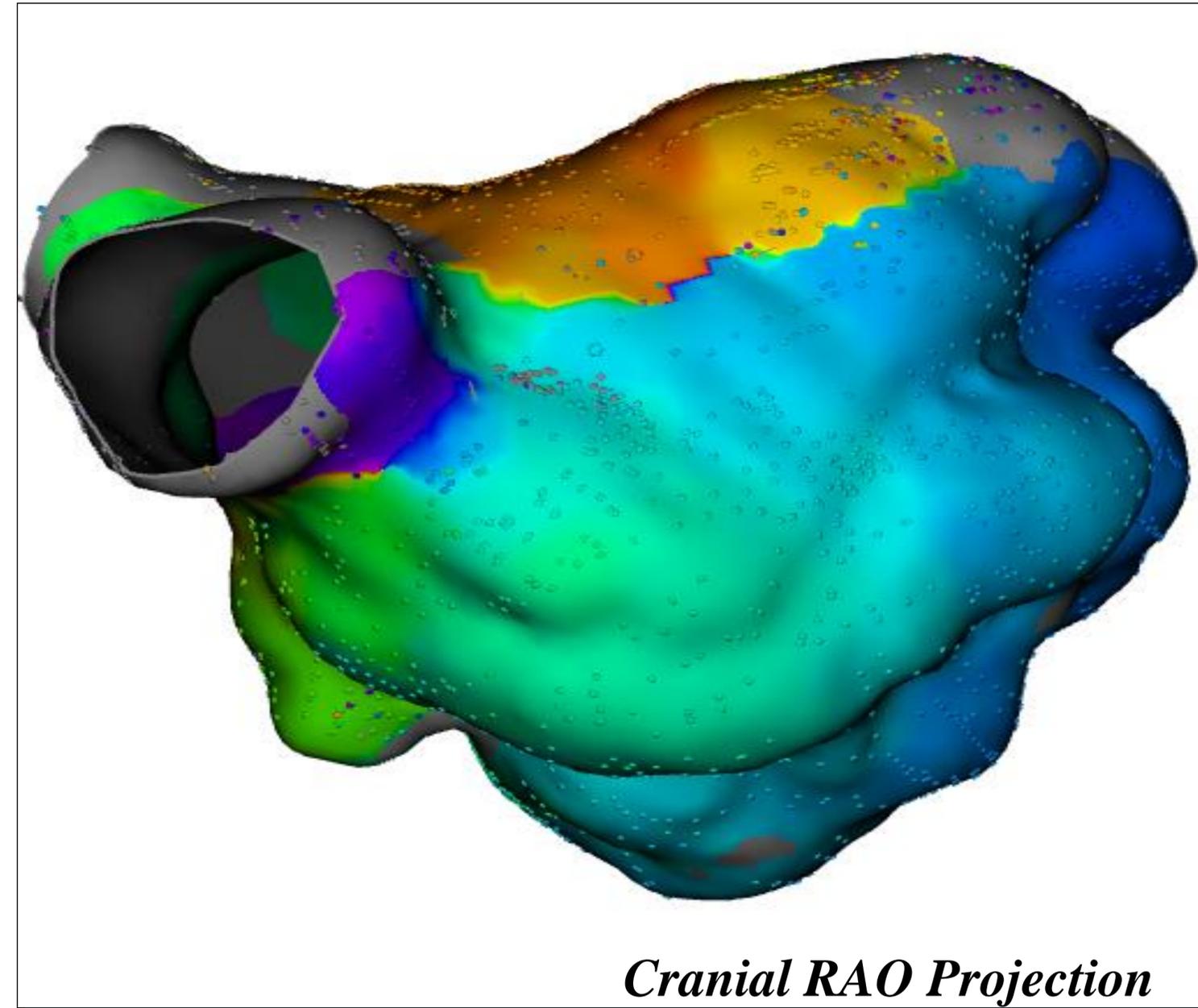Mitral Annulus

LL Projection

Courtesy of H Nakagawa MD and WM Jackman, MD

LA Activation Map During induced AT #2 (CL 266 ms)

100 ms-166ms
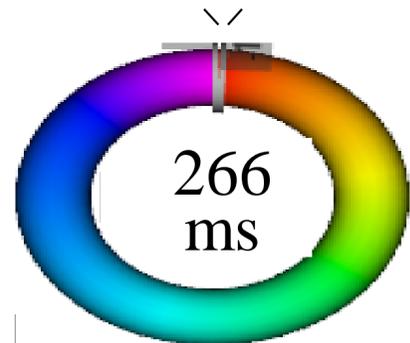
266 ms

- **Mapping EGMs:** 8,365
- **Mapping Time:** 22.7 min

Possible Reentry Around RIPV

PA Projection

Cranial RAO Projection
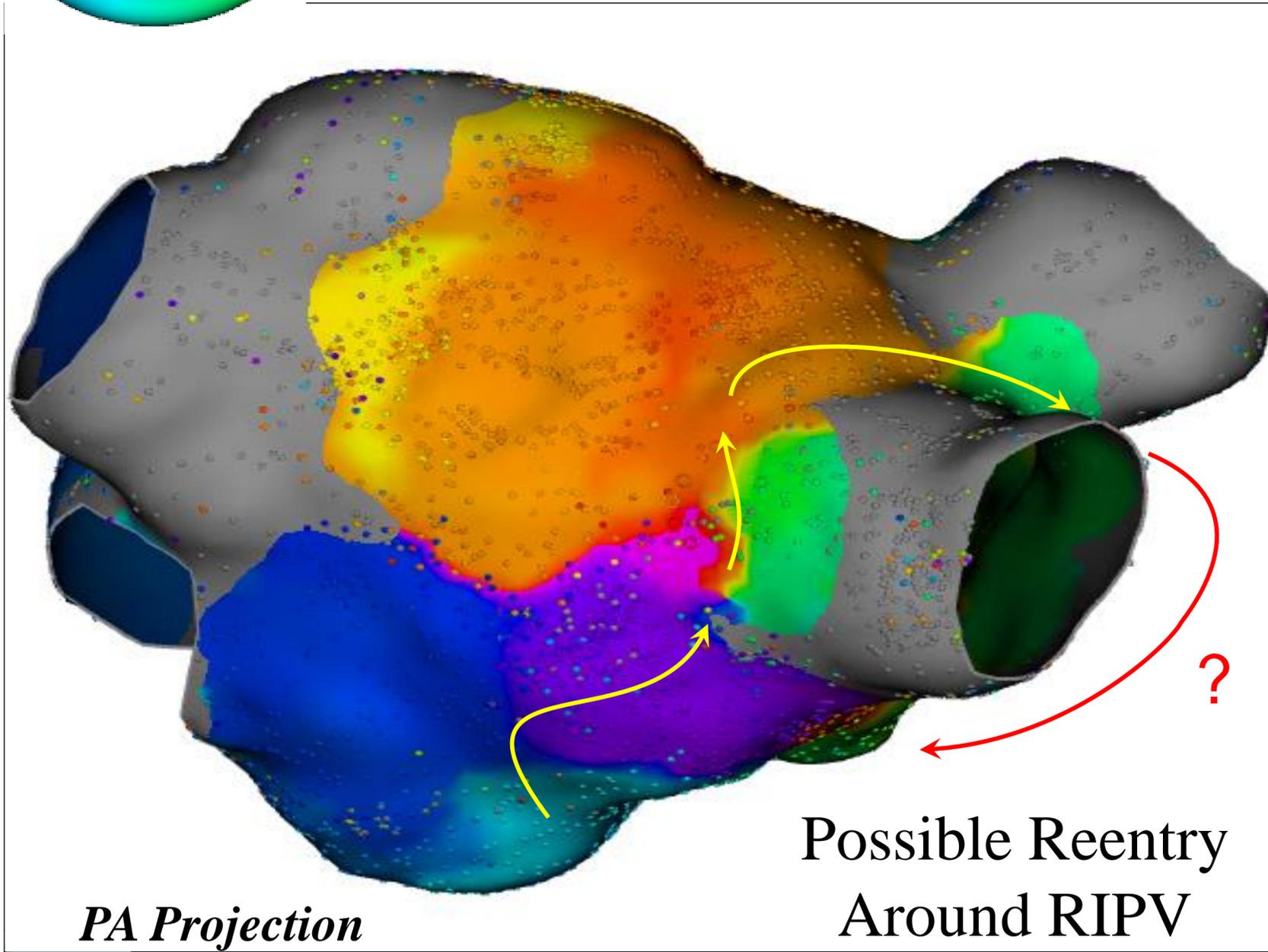
Courtesy of H Nakagawa MD and WM Jackman, MD
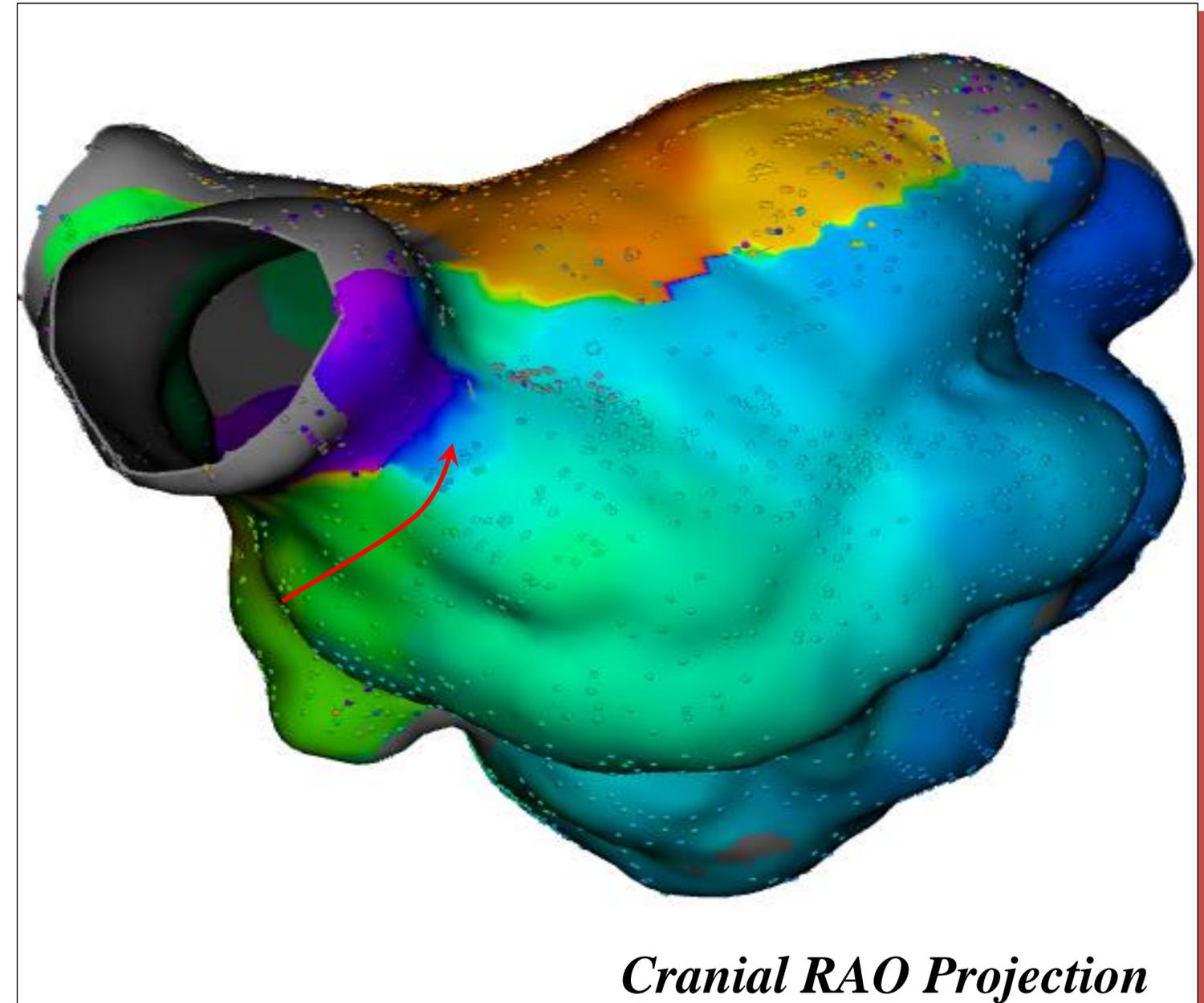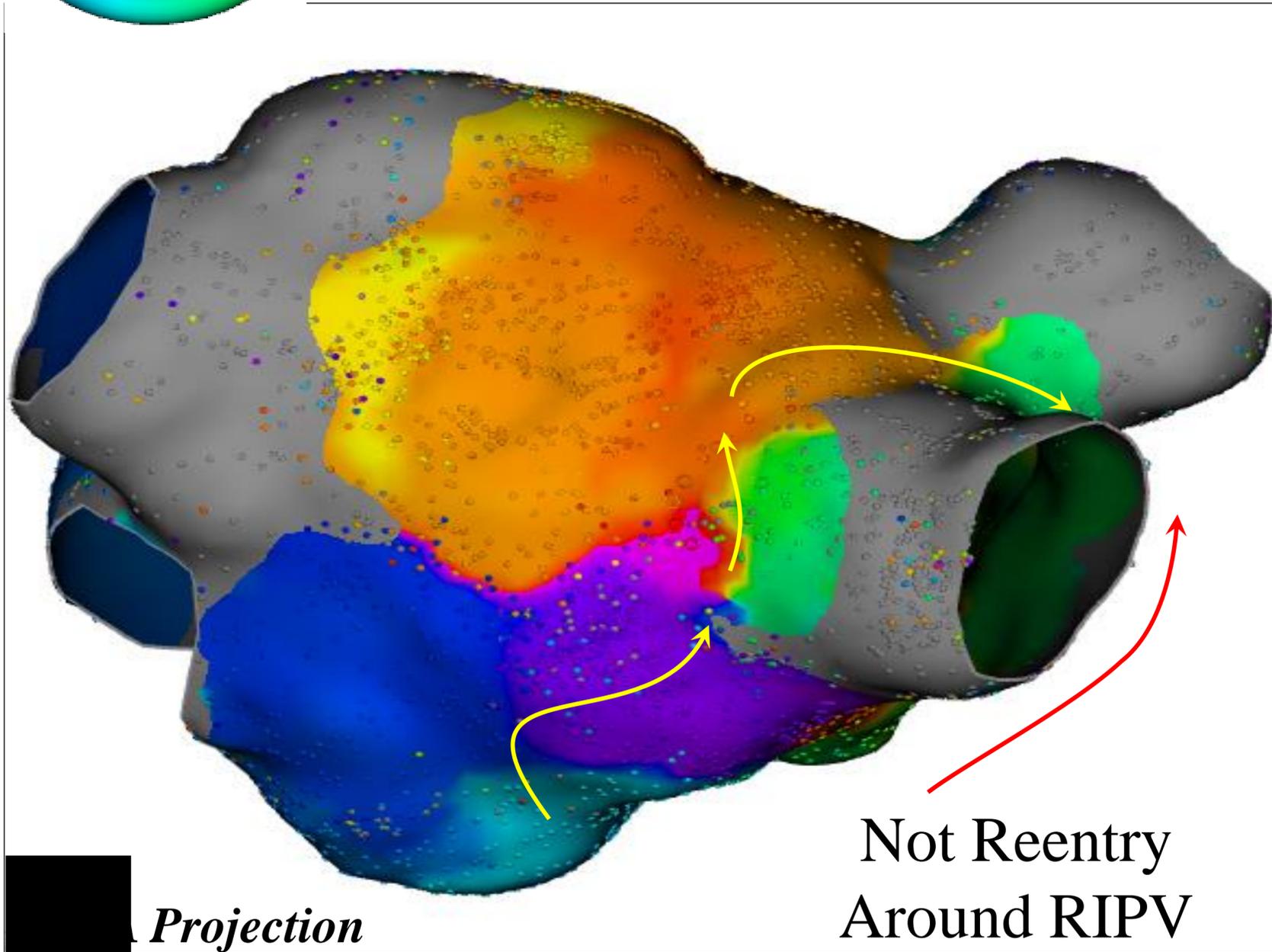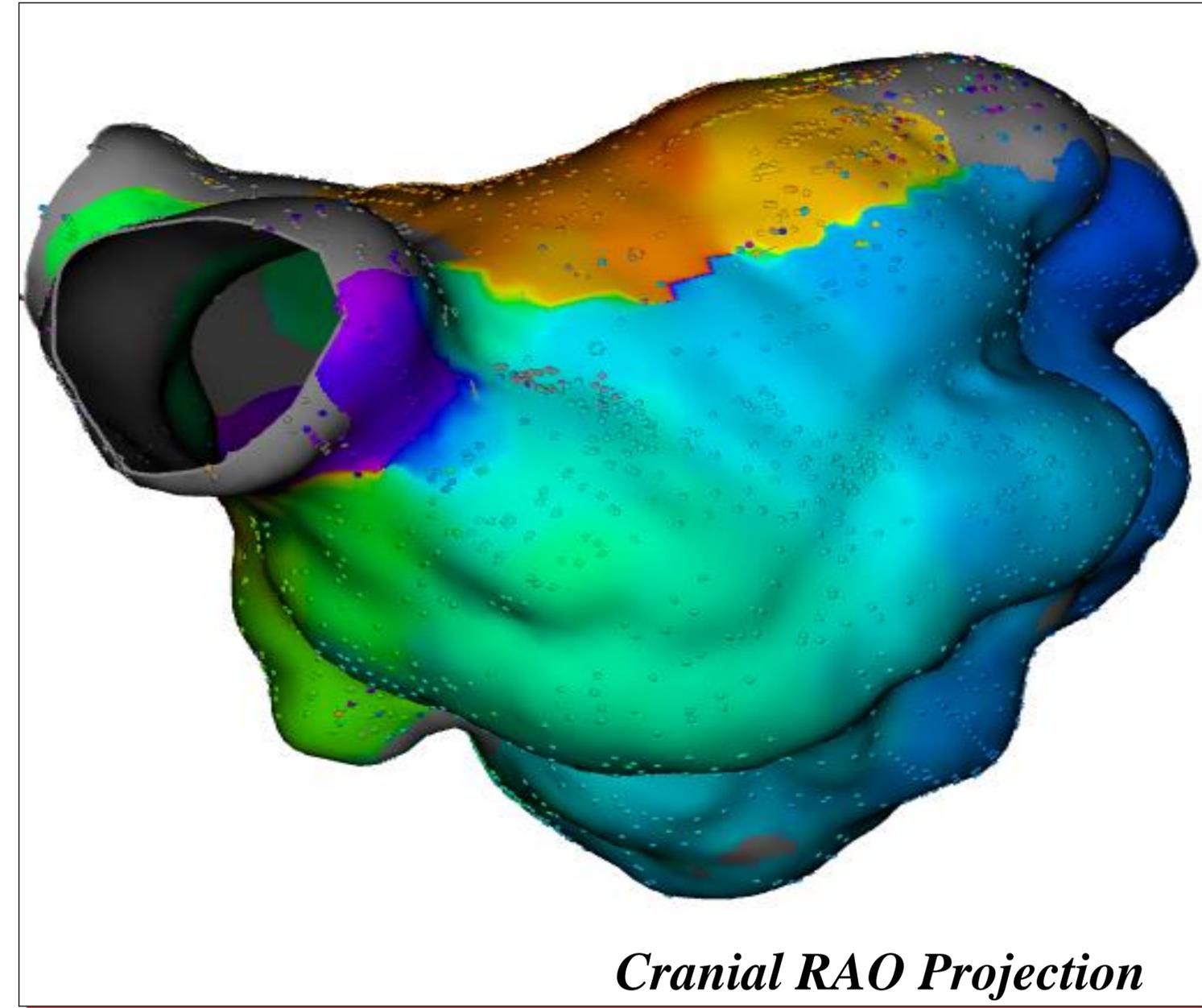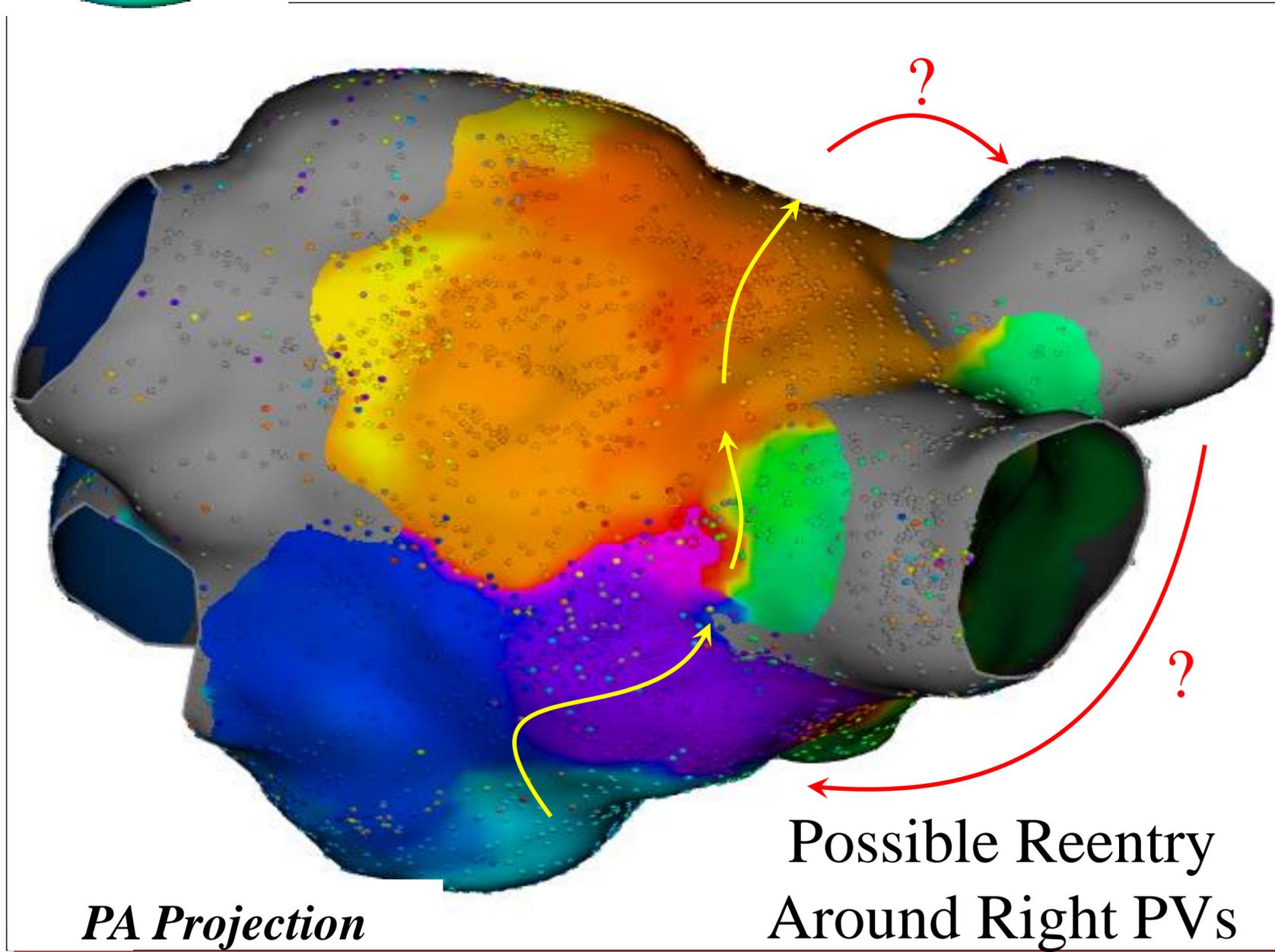
LA Activation Map During induced AT # 2

100 ms-166ms

266 ms

- Mapping EGMs: 8,365
- Mapping Time: 22.7 min

Not Reentry
Around RIPV

A Projection

Cranial RAO Projection

Courtesy of H Nakagawa MD and WM Jackman, MD

LA Activation Map During induced AT # 2

100 ms-166ms

266 ms

- **Mapping EGMs: 8,365**
- **Mapping Time: 22.7 min**

PA Projection

Possible Reentry Around Right PVs

Cranial RAO Projection
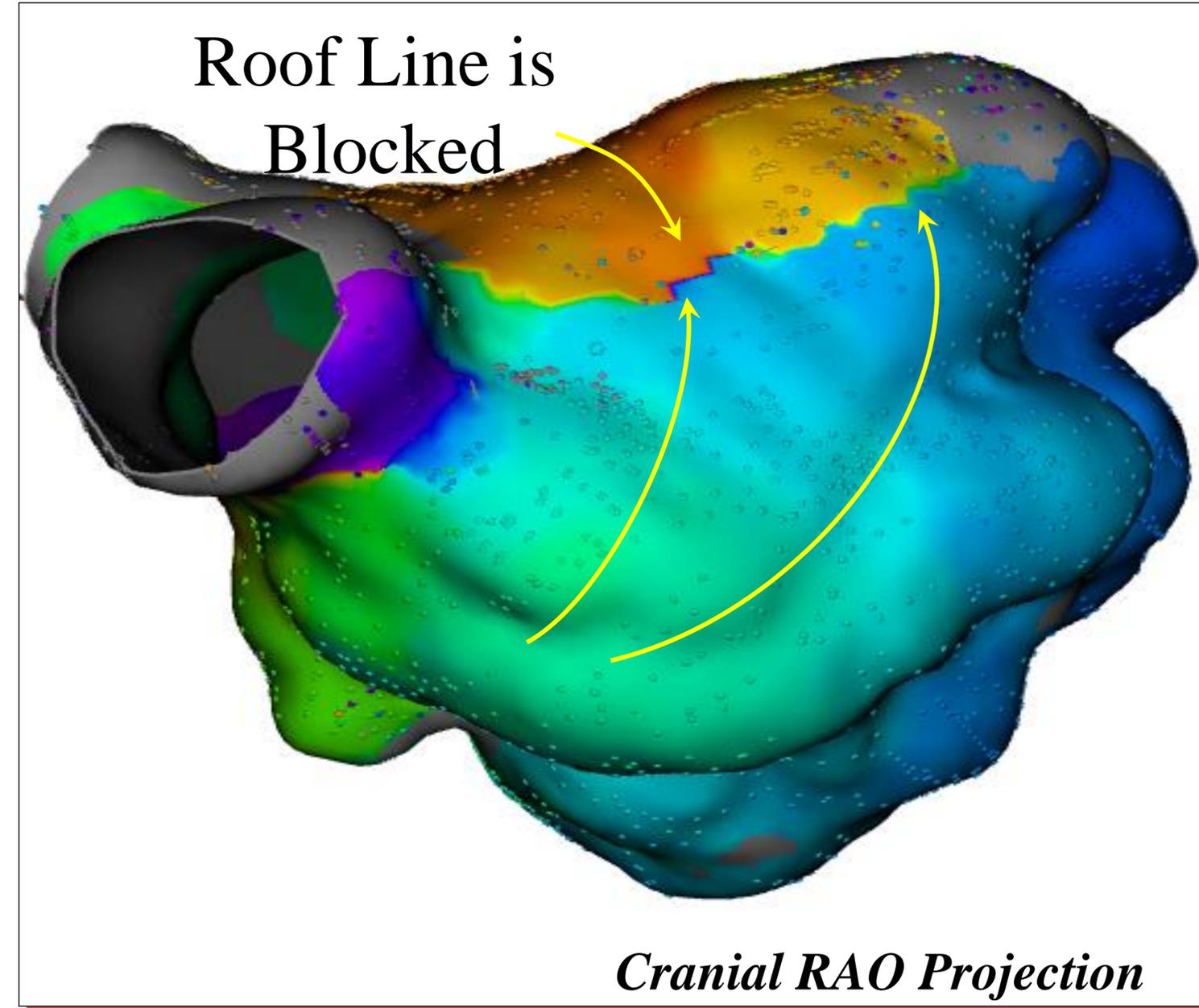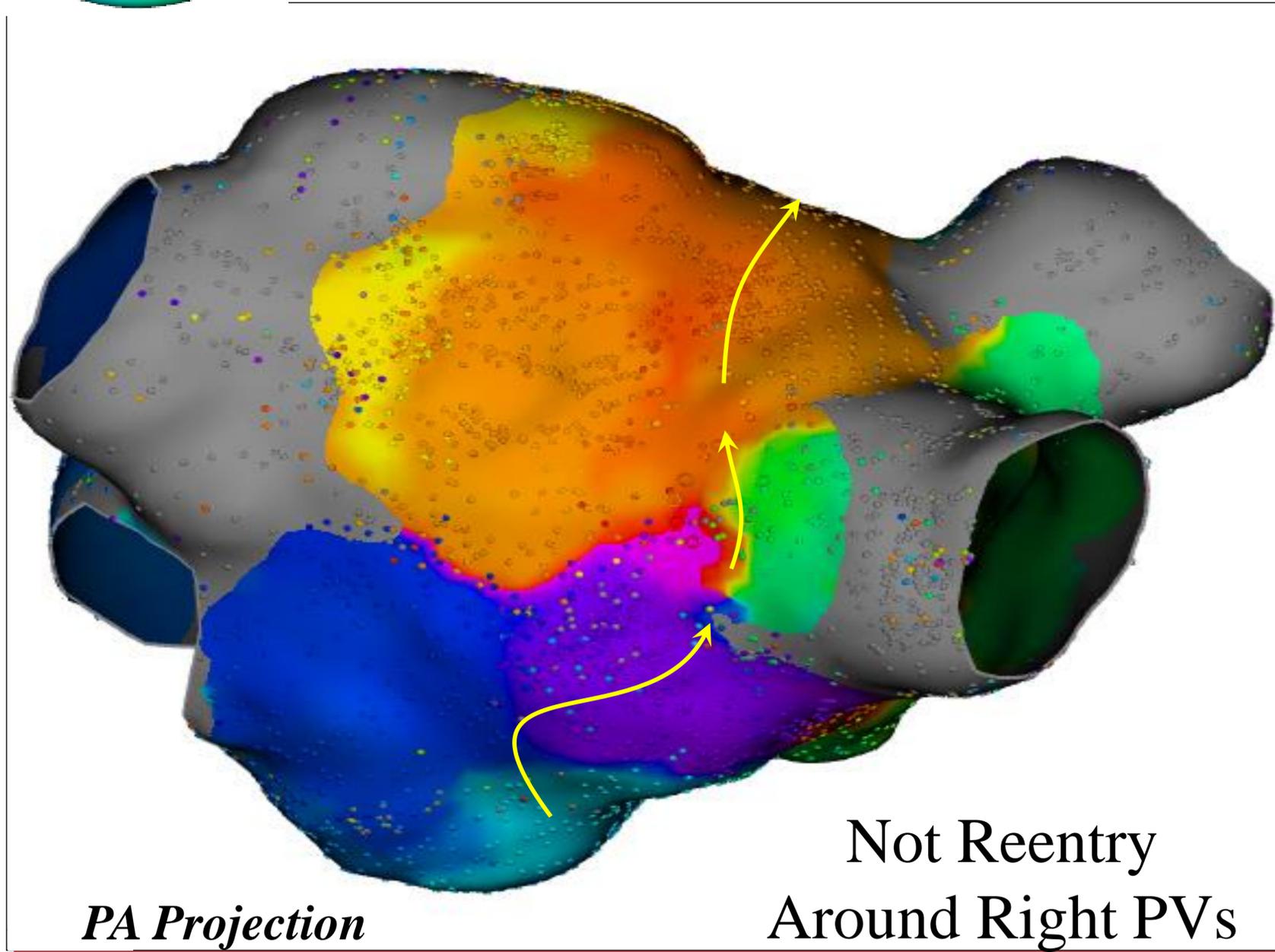
Courtesy of H Nakagawa MD and WM Jackman, MD

LA Activation Map During induced AT # 2

100 ms-166ms

266 ms

- **Mapping EGMs: 8,365**
- **Mapping Time: 22.7 min**

Not Reentry
Around Right PVs

PA Projection

Roof Line is
Blocked

Cranial RAO Projection

AT #1

AT #2

100 ms-166ms

266 ms

RSPV

RIPV

RIPV

RSPV
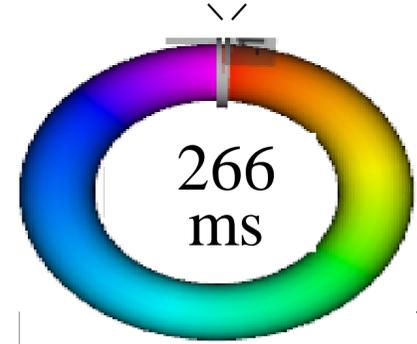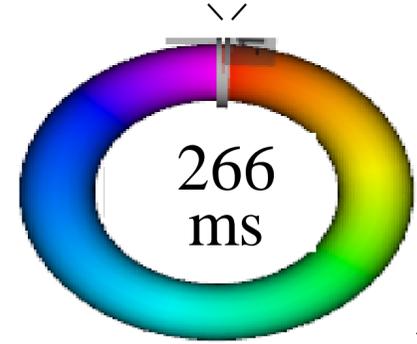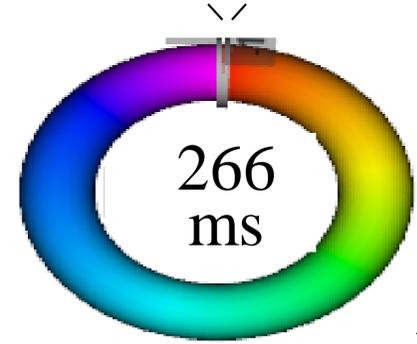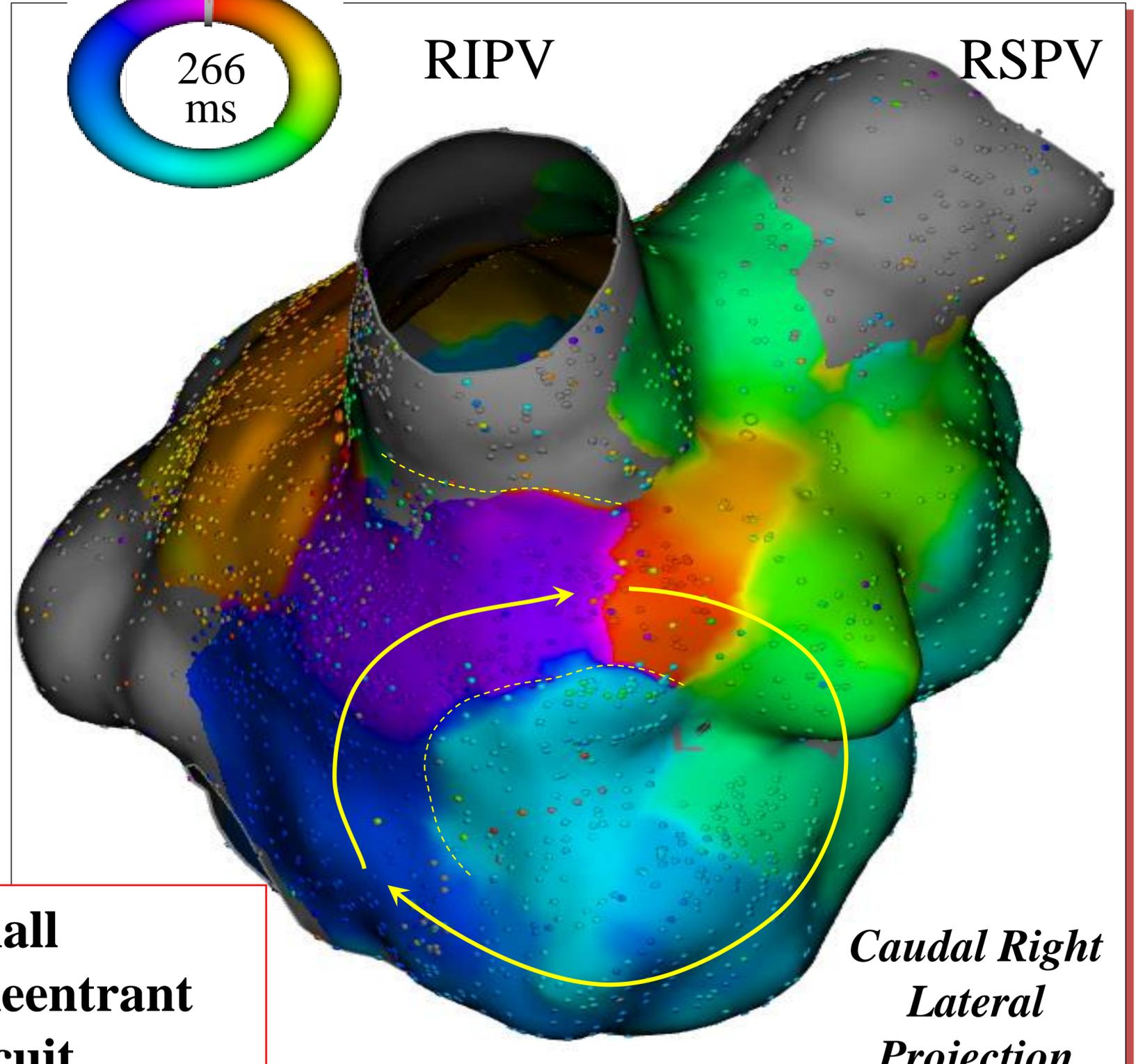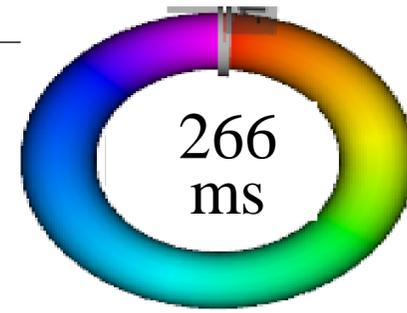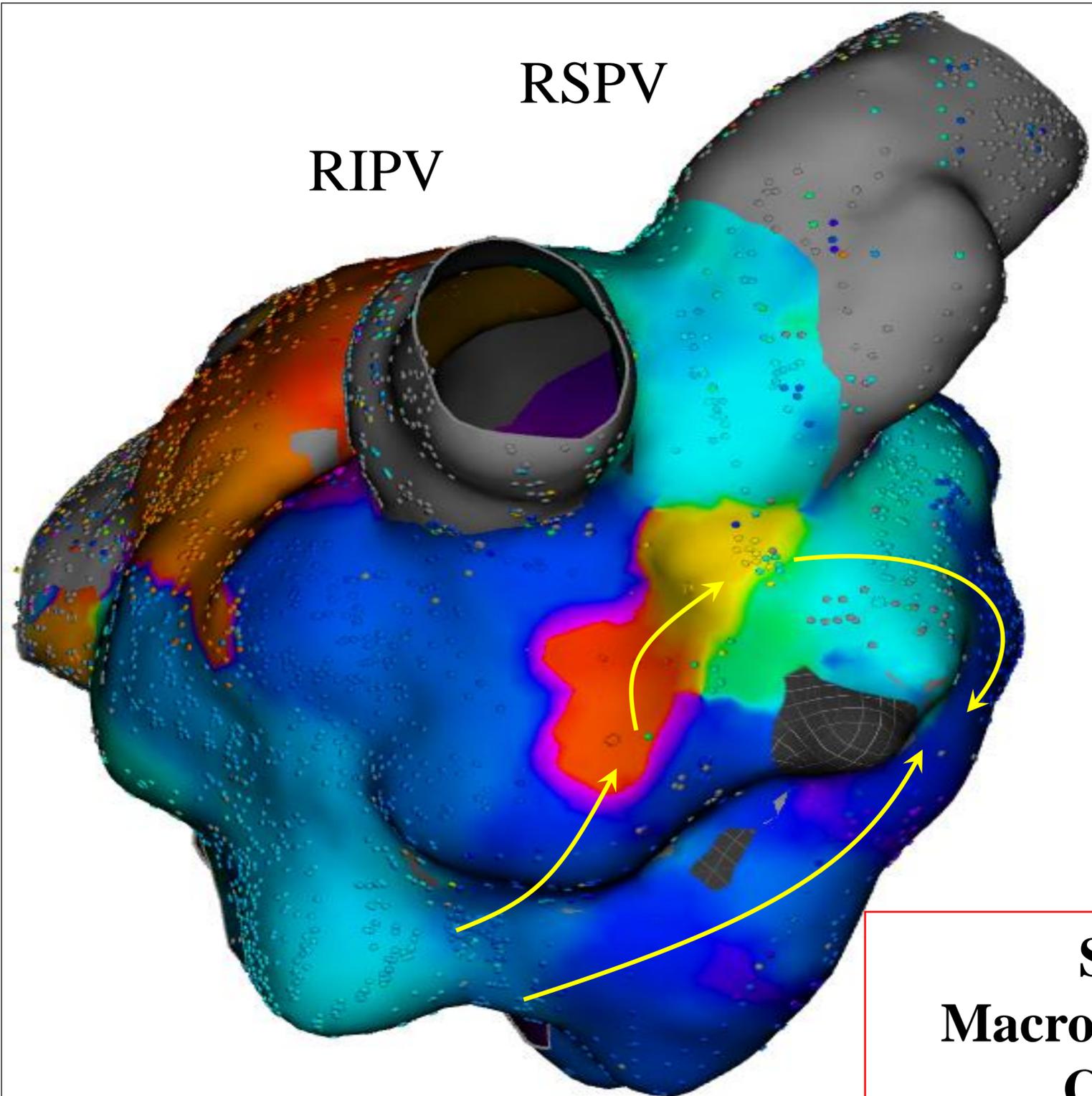
Small
Macro-Reentrant
Circuit

*Caudal Right
Lateral
Projection*

Courtesy of H Nakagawa MD and WM Jackman, MD

Ablation at Channel During induced AT # 2

100 ms-166ms

266 ms

V3

CS

Fractionated Potentials
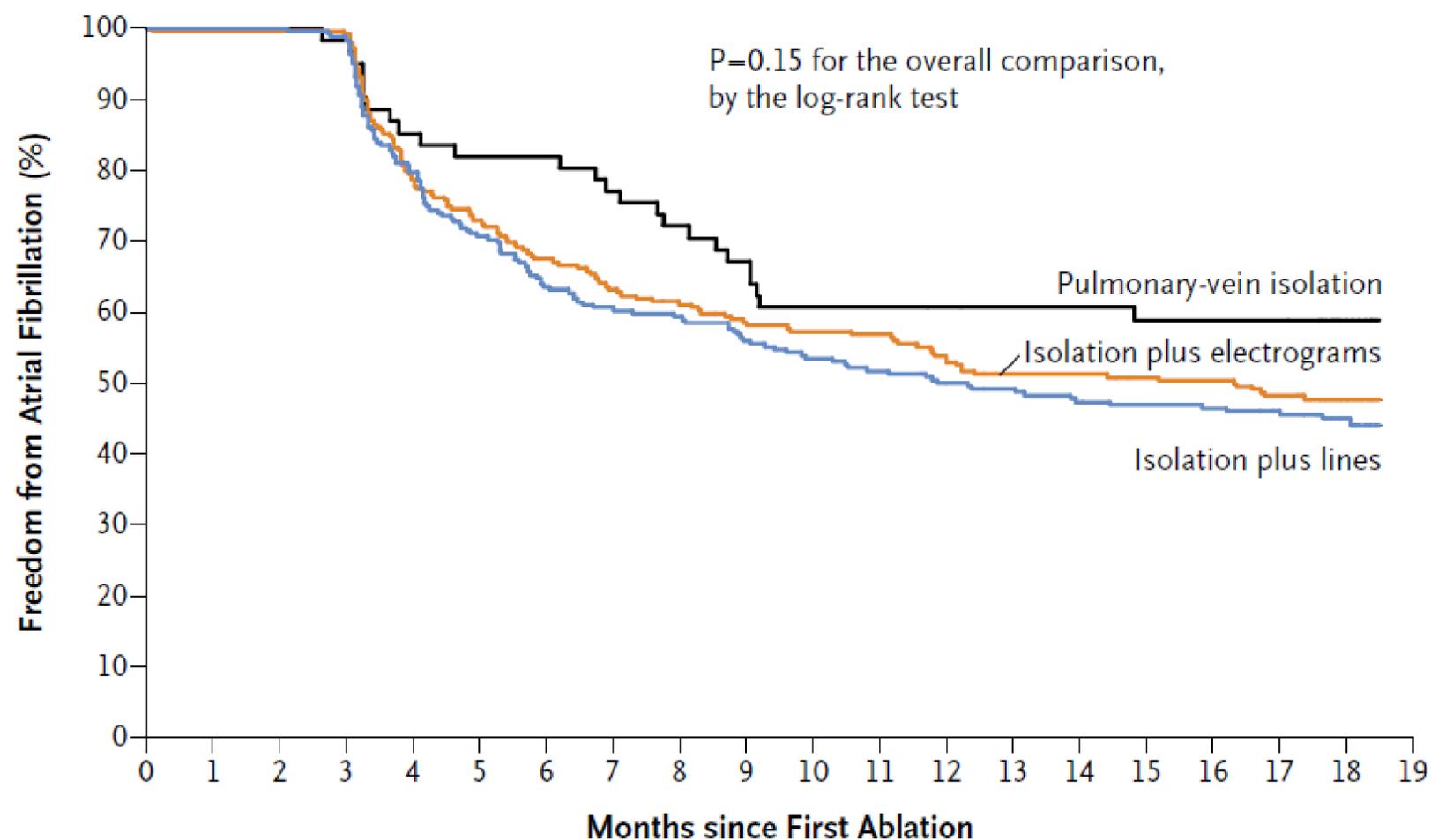
Bip d

Uni1

Uni2

266ms

RIPV

RSPV
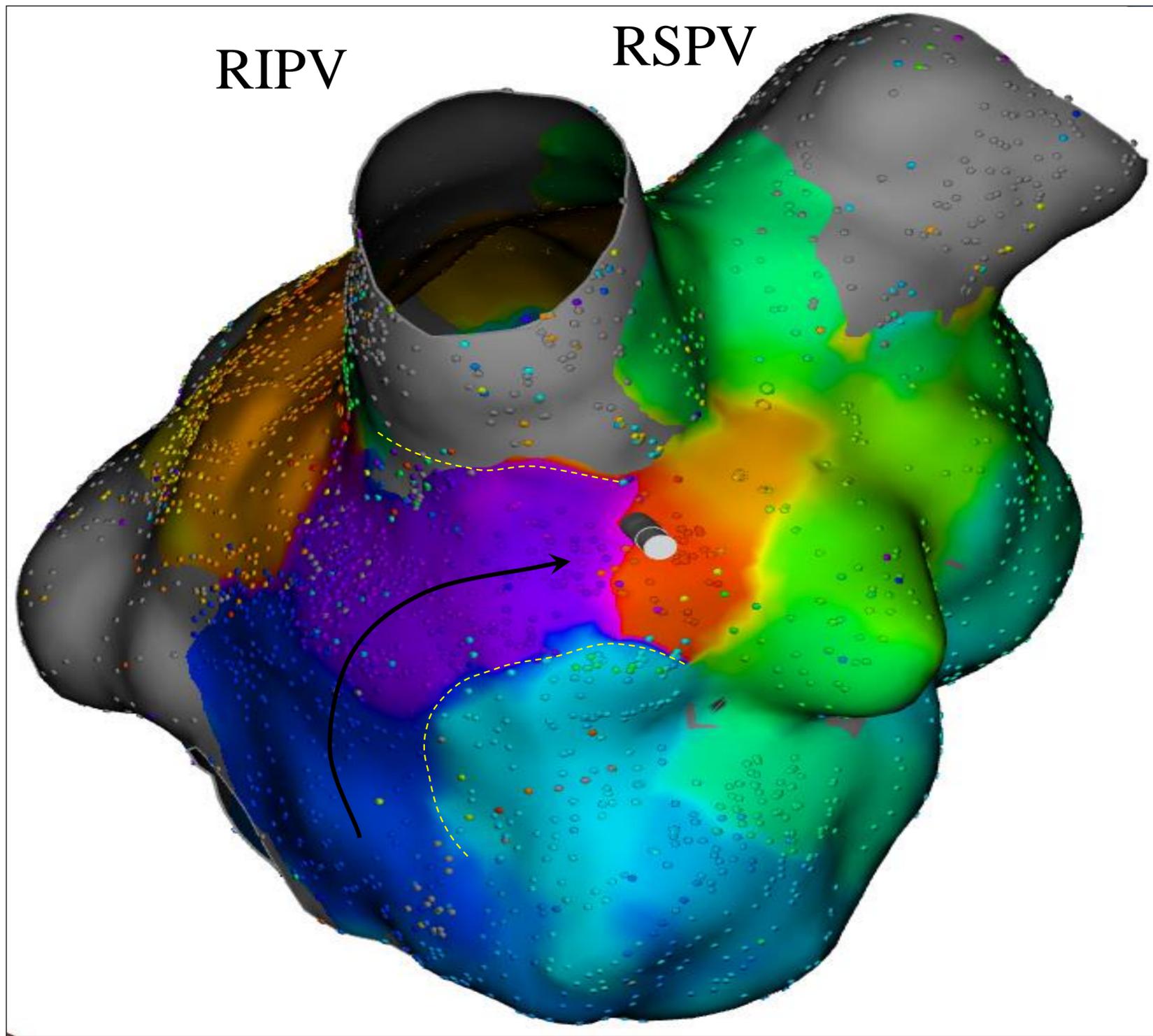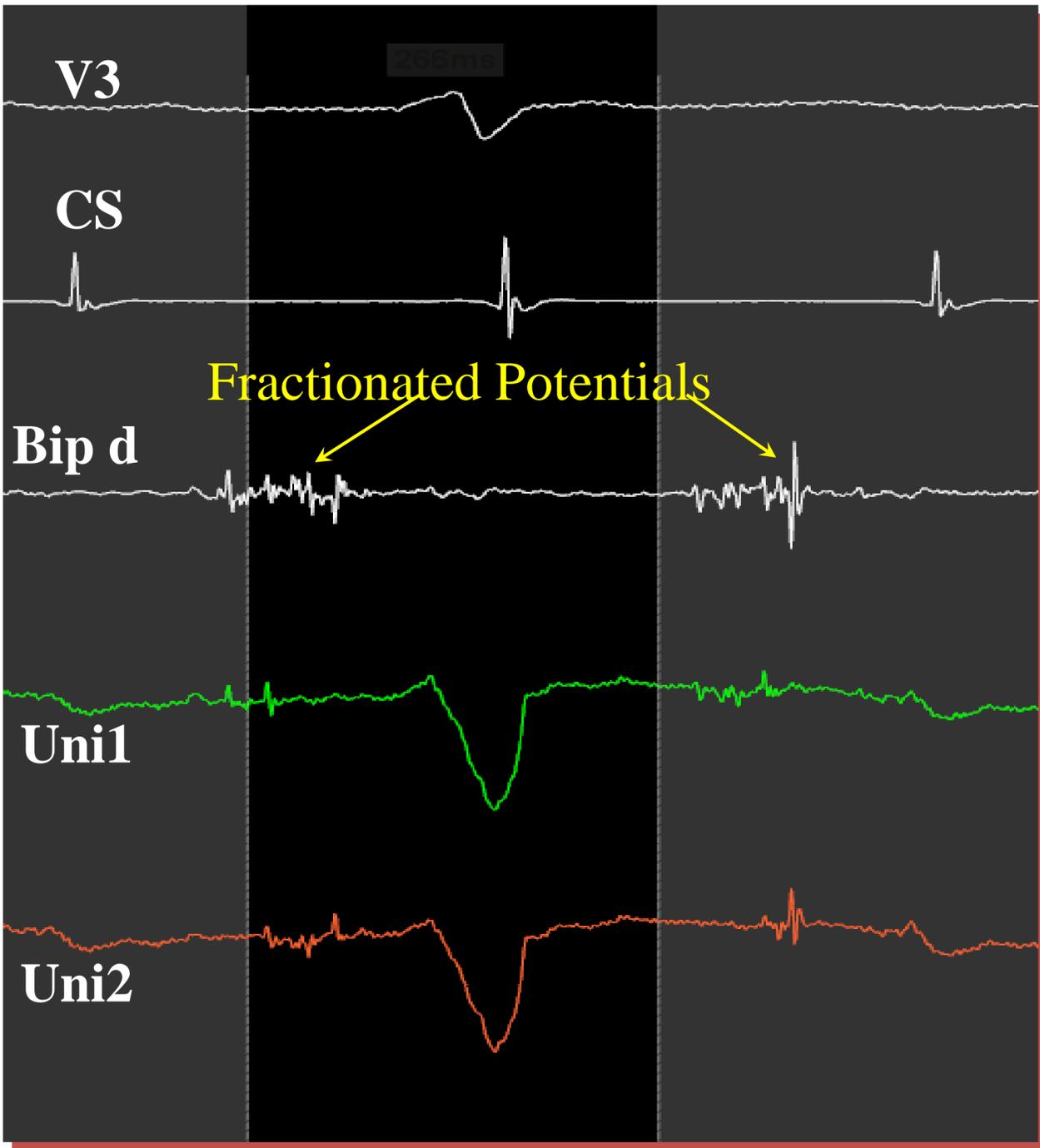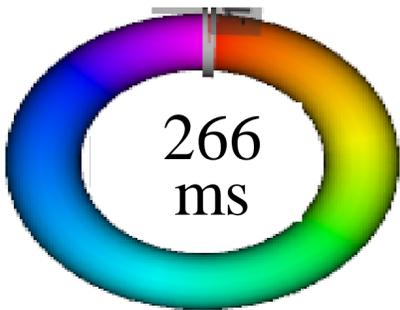
Courtesy of H Nakagawa MD and WM Jackman, MD

Ablation in Persistent AF (STAR AF 2)

- **589 pts (median =2.2 y) randomised to**
  - **PVI alone (67)**
  - **PVI + ablation abnormal Egs (263)**
  - **PVI+ linear LA lesions (259)**
- **Successful PVI in 97% of all pts**

	PVI	PVI+Eg	PVI+Lines	p
Proc Time (mn)	167	229*	223*	*<.001
No AA 18 mths	59%	48%	44%	ns
No AA dg 18 mths	48%	37%	33%	ns
No AF after 2 proc	72%	60%	58%	ns

P=0.15 for the overall comparison, by the log-rank test

Pulmonary-vein isolation
Isolation plus electrograms
Isolation plus lines

Freedom from Atrial Fibrillation (%)
Months since First Ablation

Welcome to the Monaco USA Arrhythmia Course 2015, March 19-21

http://muacmonaco.wix.com/monacousaarrhythmiacourse