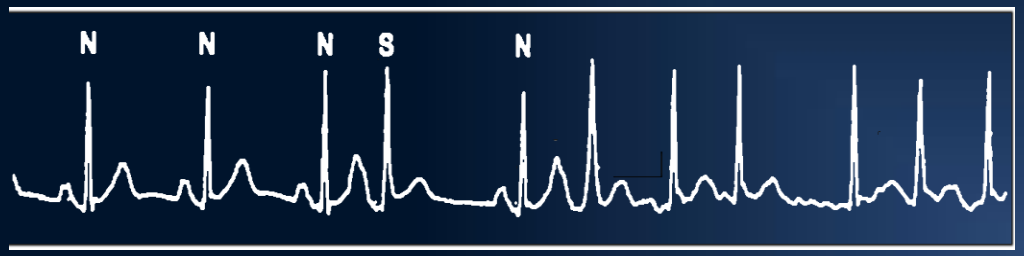
Panoramic non contact mapping of AF substrate

Arnaud DENIS, MD
Hôpital Cardiologique Haut Lévèque
CHU Bordeaux
Lyric Institute

Disclosure: none

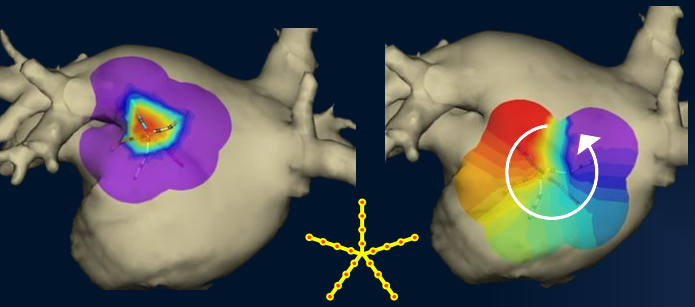
Substrate of Paroxysmal AF- Persistent AF: 2 different ‘worlds’

- Paroxysmal AF: PVs are main triggers and drivers



- Persistent/permanent AF: much complex substrate
  - multiple atrial wavelets,
  - macrorentries and
  - localized sources (focal or reentrant activities)

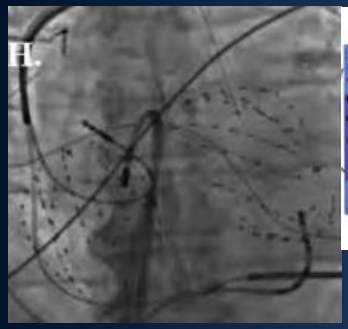
The hunt of AF drivers having ubiquitous locations and intermittent firing



REGIONAL MAPPING

Sahadevan J..Waldo A Epicardial maps..Circ2004

Haissaguerre M..Sanders P, Berenfeld O Localized sources.. Circ 2006 – 2007



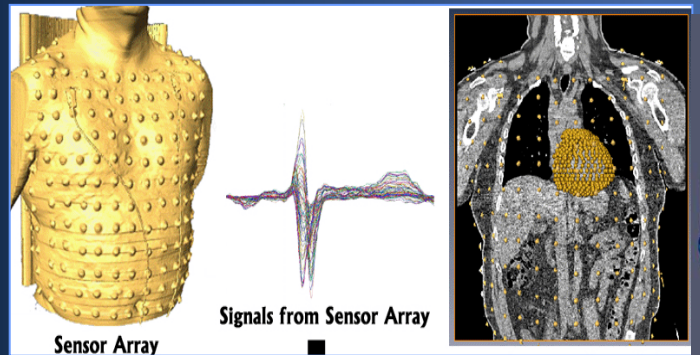
CHAMBER MAPPING

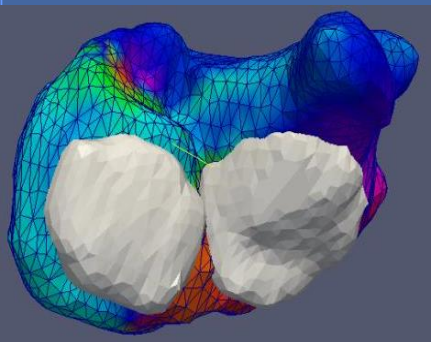
Lin YJ..SAChen EnsiteRA maps..Circ 2005

S Narayan et al Biatrial basket JCE 2012

PANORAMIC MAPPING

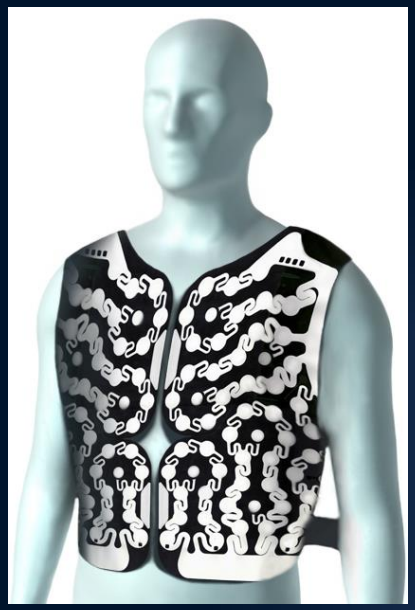
Cuculich W..Lindsay B..Rudy Y Noninvasive…Circ 2010



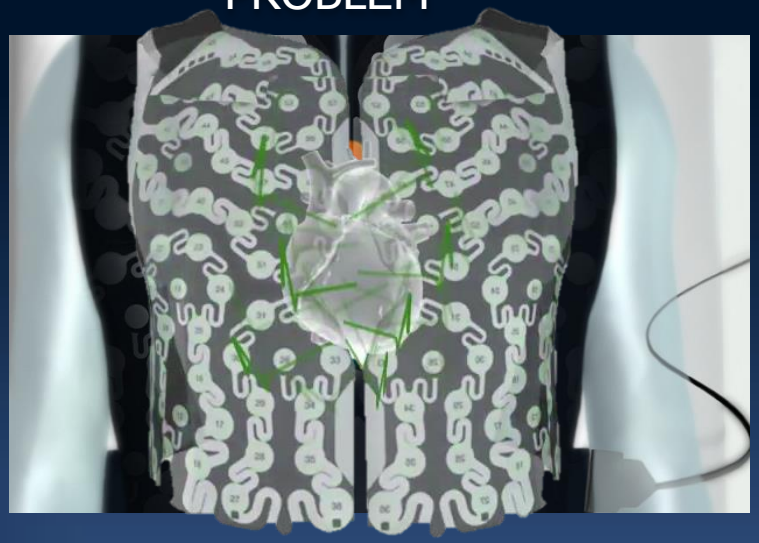


Panoramic cardiac non invasive mapping

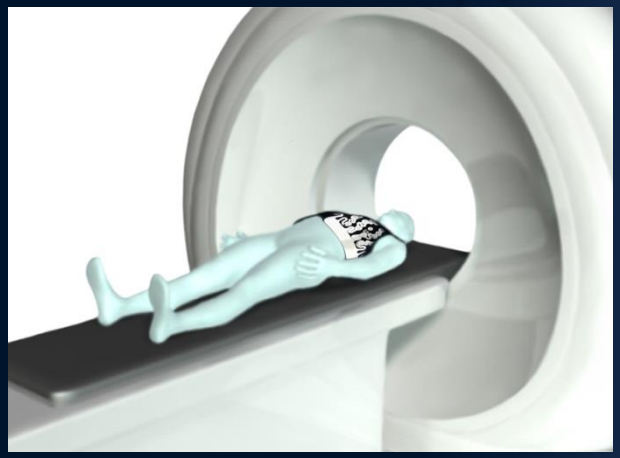
252 ELECTRODE VEST



ECM* ALGORITHMS SOLVES “INVERSE PROBLEM”



HEART CHAMBERS-TORSO Distances/Geometry (CT –MRI)



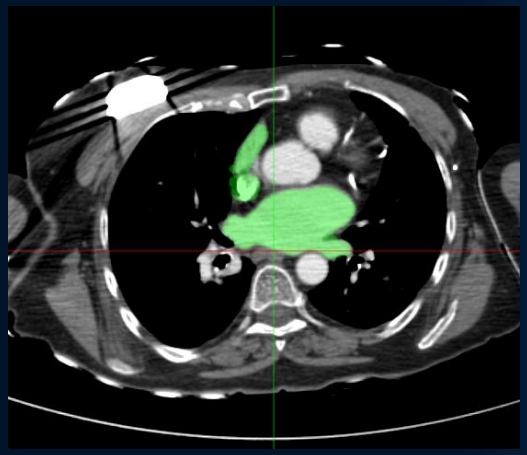
PRE or PER-Procedural instantaneous maps

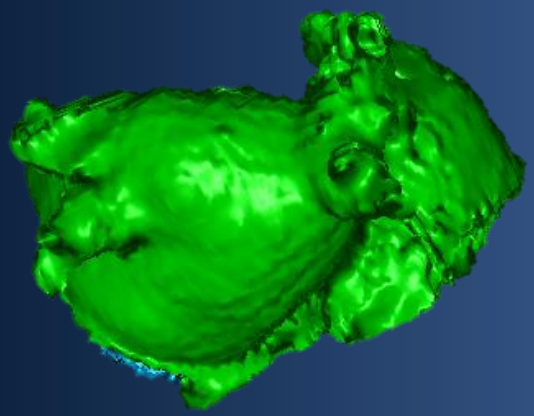
AF mapping-Workflow 1

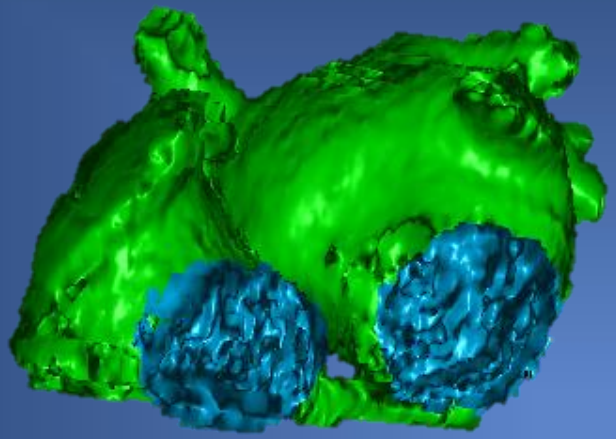
Persistent AF : Preprocedural Bedside Mapping

Paroxysmal AF or Persistent AF in SR : Mapping in the lab

CT segmentation

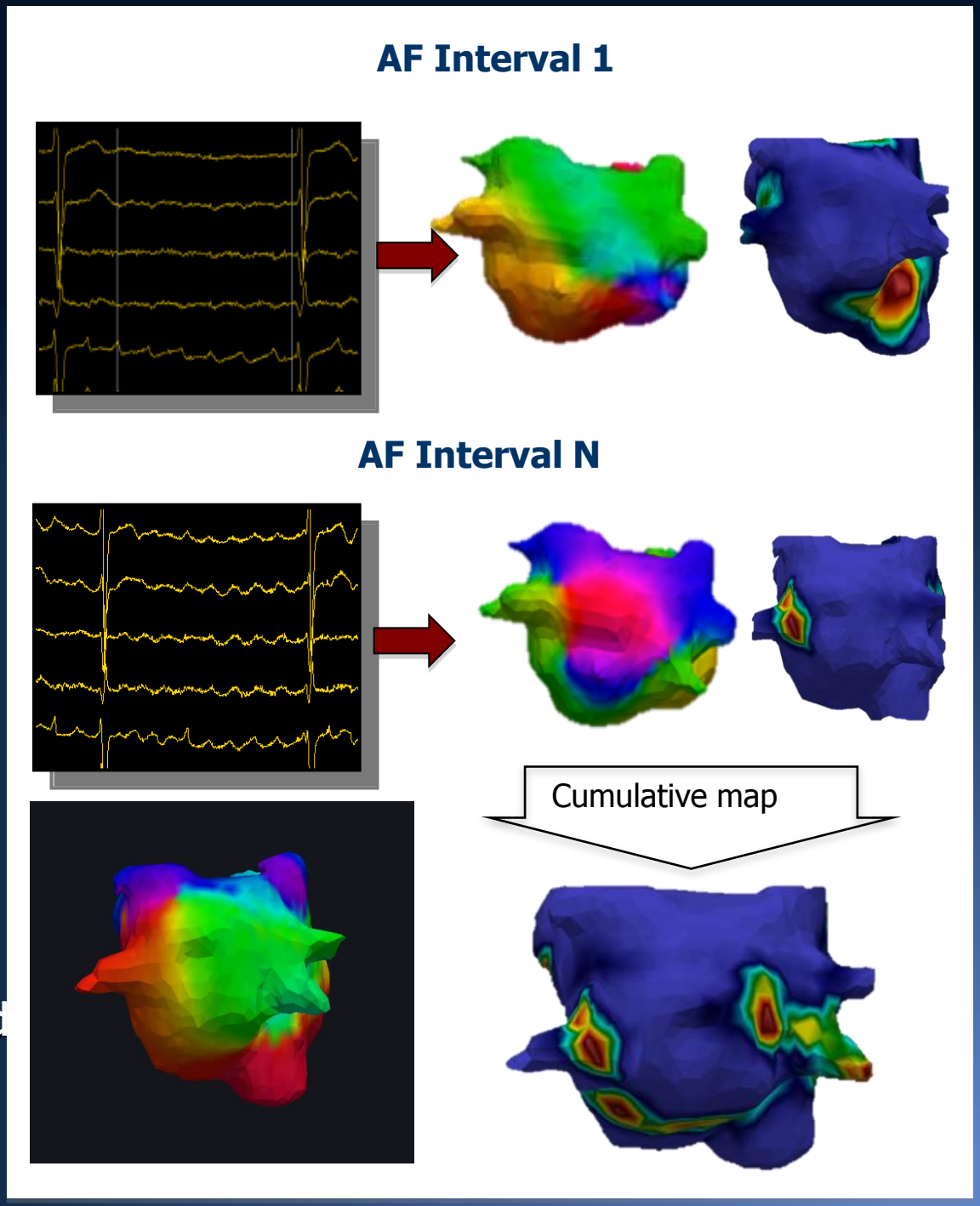




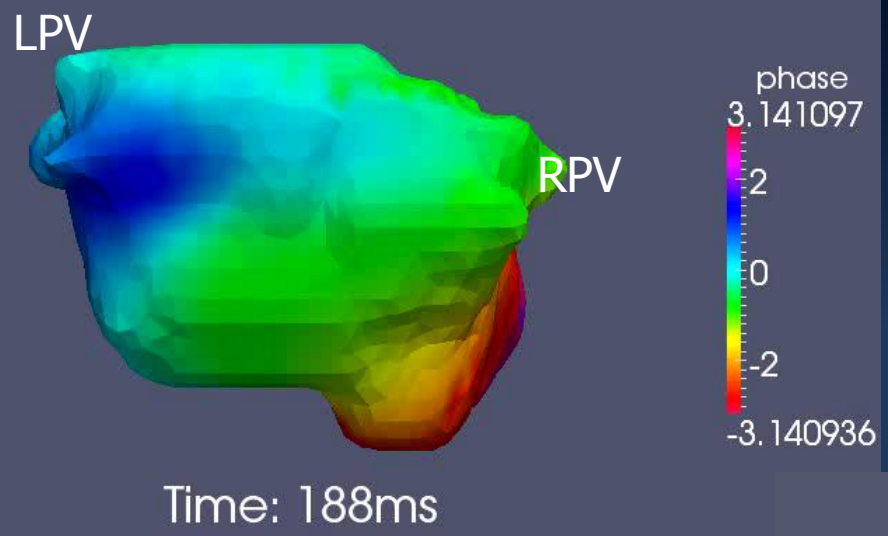


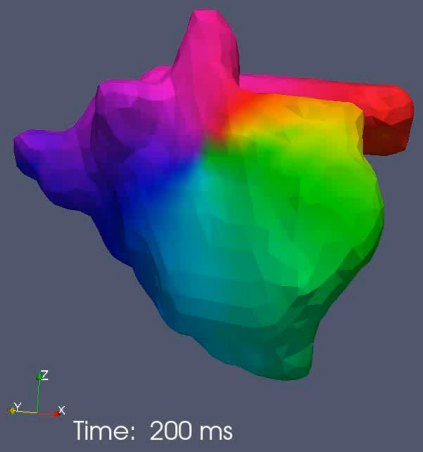
Workflow 2

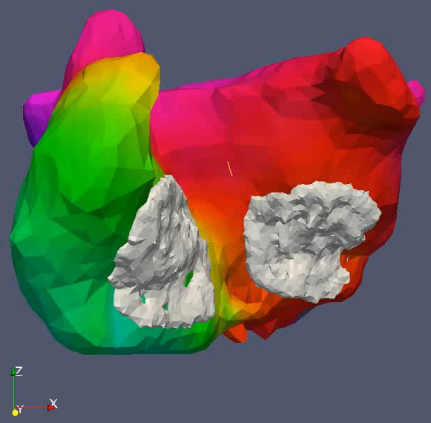
- Windows with long ventricular pauses
- Maps of AF generated using phase mapping algorithm
- Re-entries and focal maps from all windows aggregated into a "Cumulative map"
- Driver regions are ranked , based on statistical prevalence



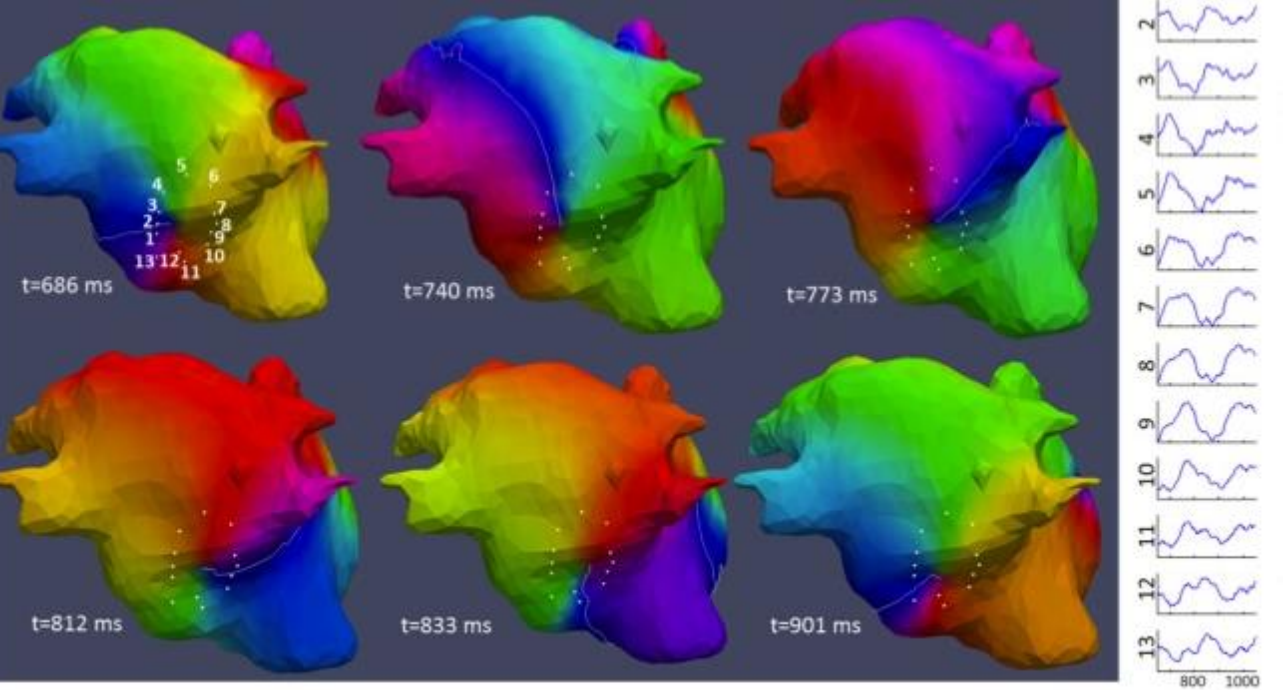
AF Drivers – Focal and Reentrant



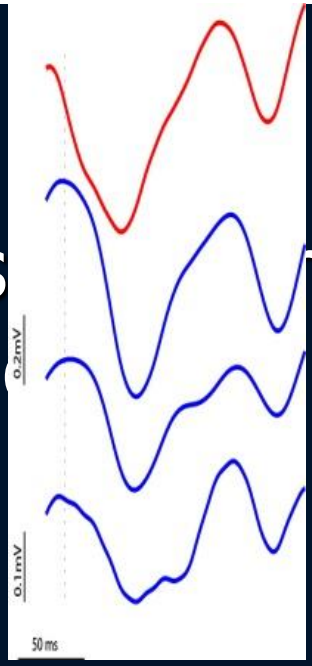


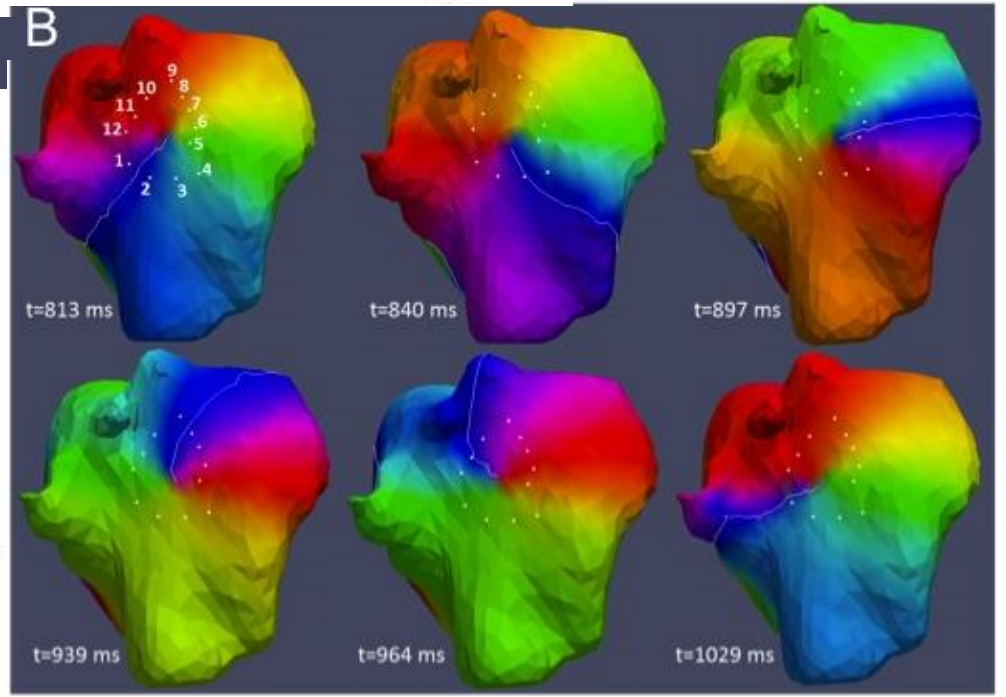


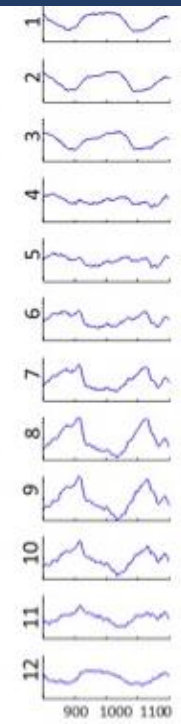
Sequential activation of unipolar raw EGMs around cores



As nt

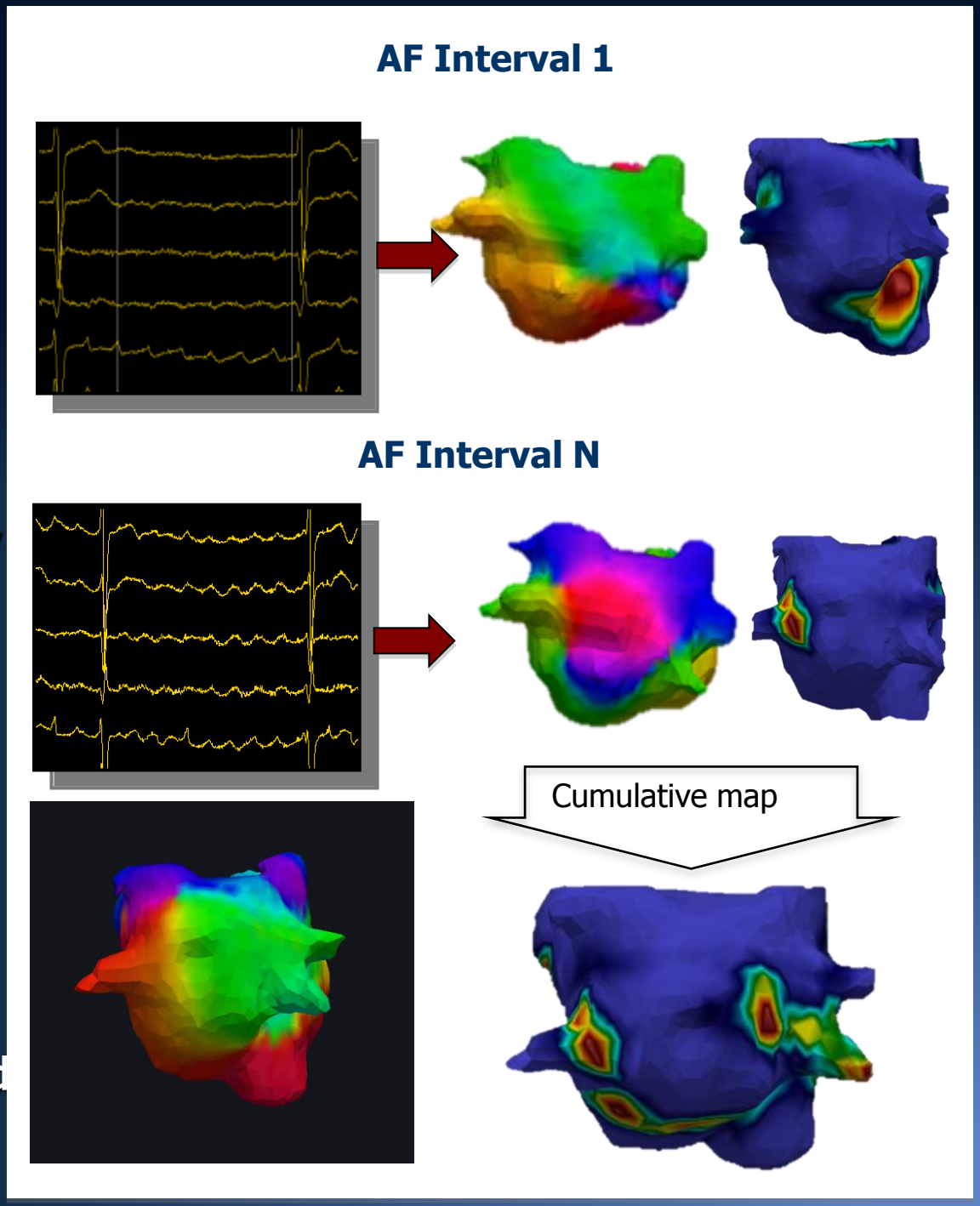




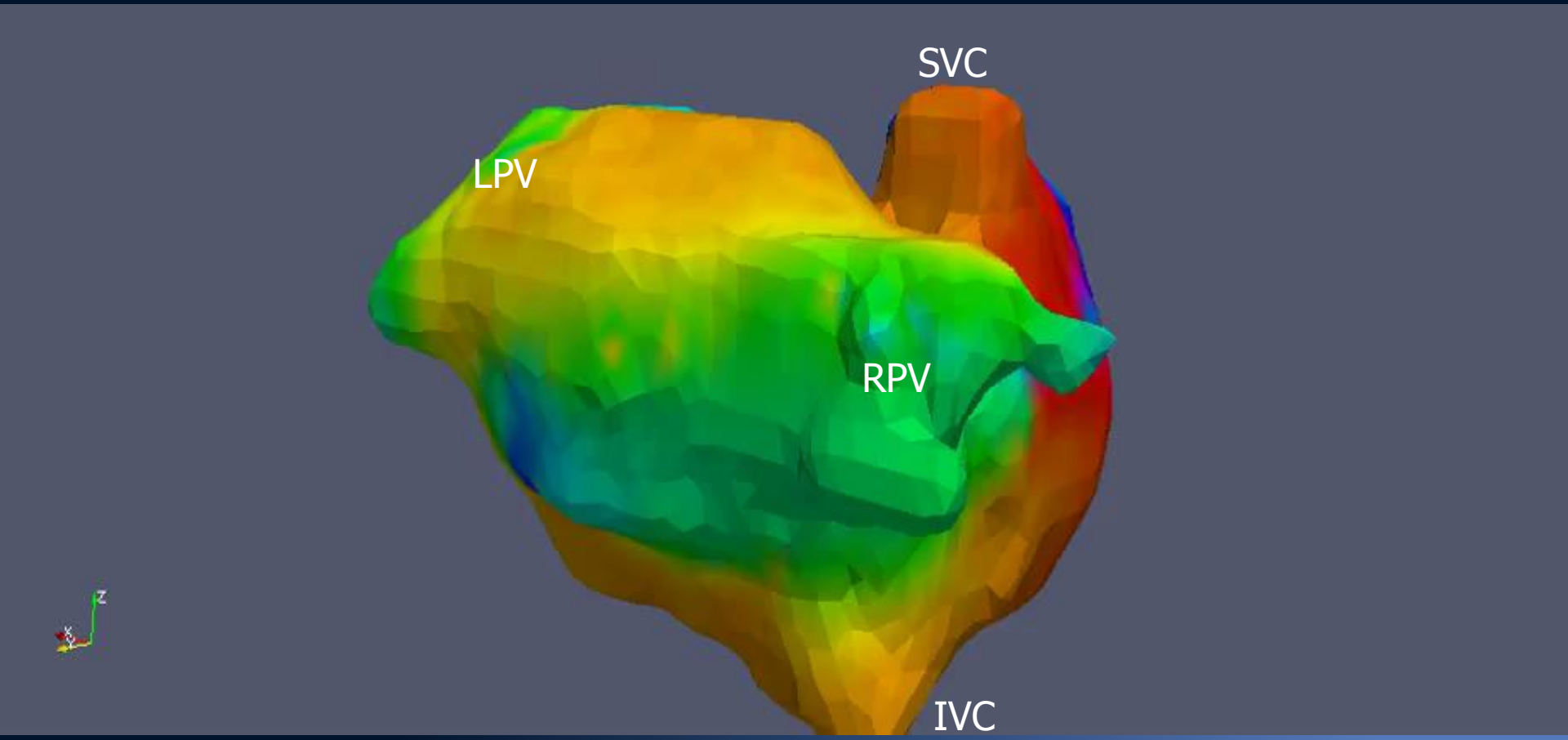


Workflow 2

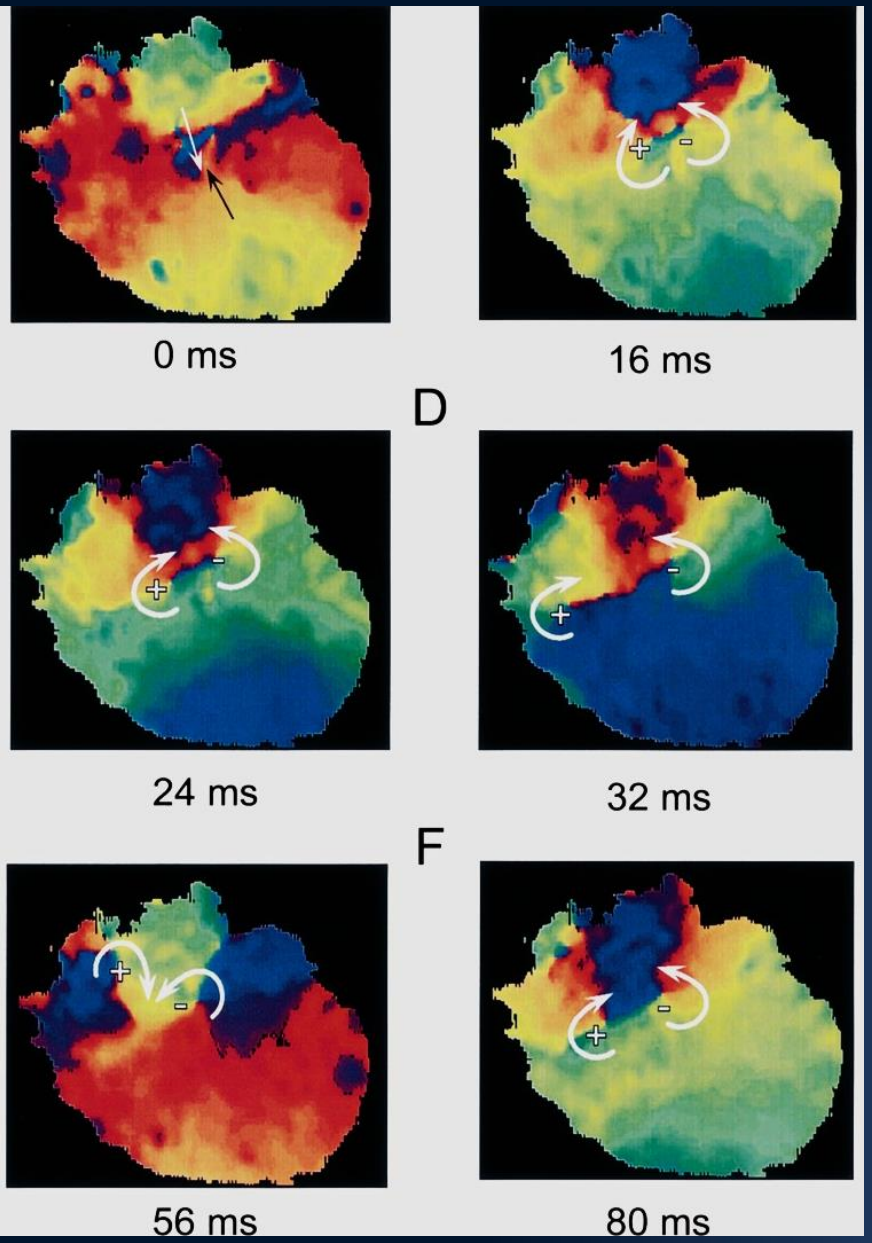
- AF window selected with calipers
- Map (movie) computed to provide automatically detected re-entries and foci.
- Re-entries and focal maps from all windows aggregated into a "Cumulative map"
- Driver regions are ranked , based on statistical prevalence



Mapping in paroxysmal AF



"Figure of 8 reentry"

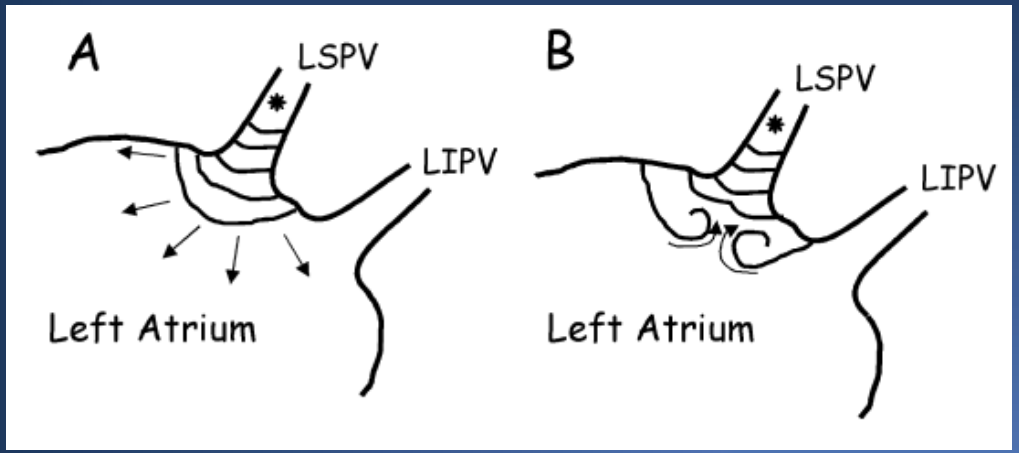


Chen J et al Cardiovascular Res 2000;48:220

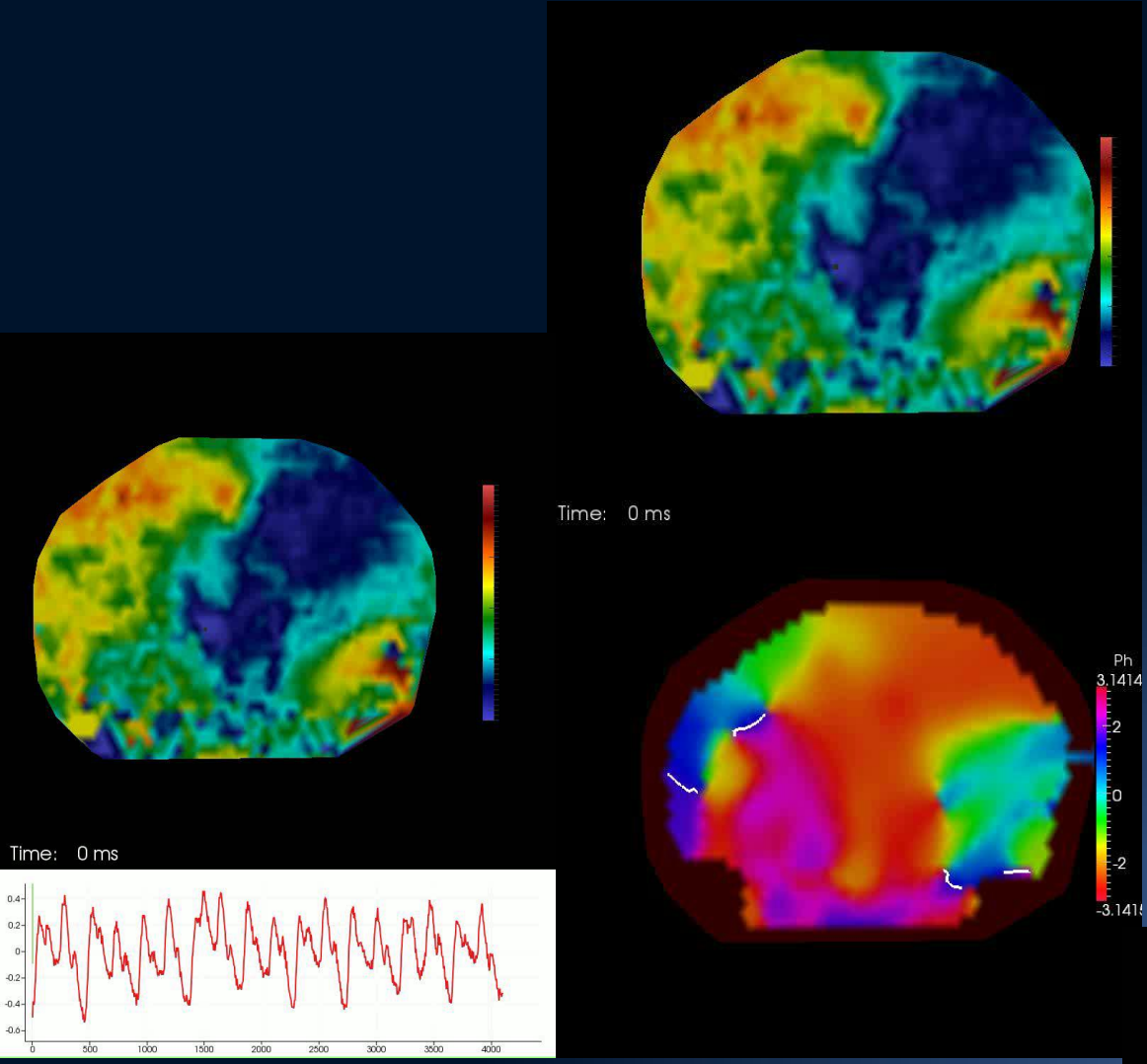
Optical mapping sheep heart

Figure of 8 reentry:

How close can two rotors get before annihilated? 4mm!



Jalife et al Cardiovasc Research 2002; 52 : 204

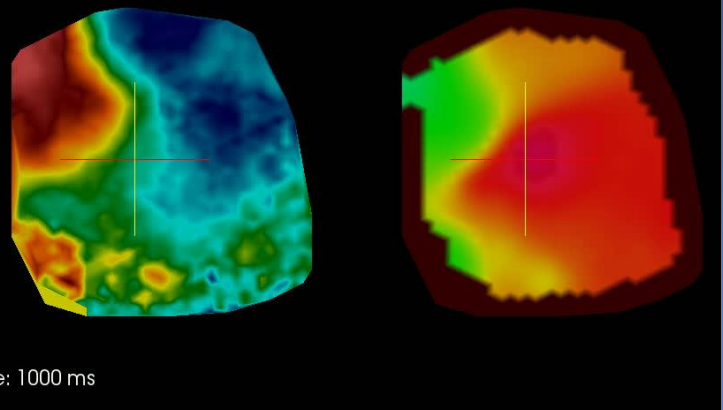


Optical mapping
5 experiments in sheep AF model

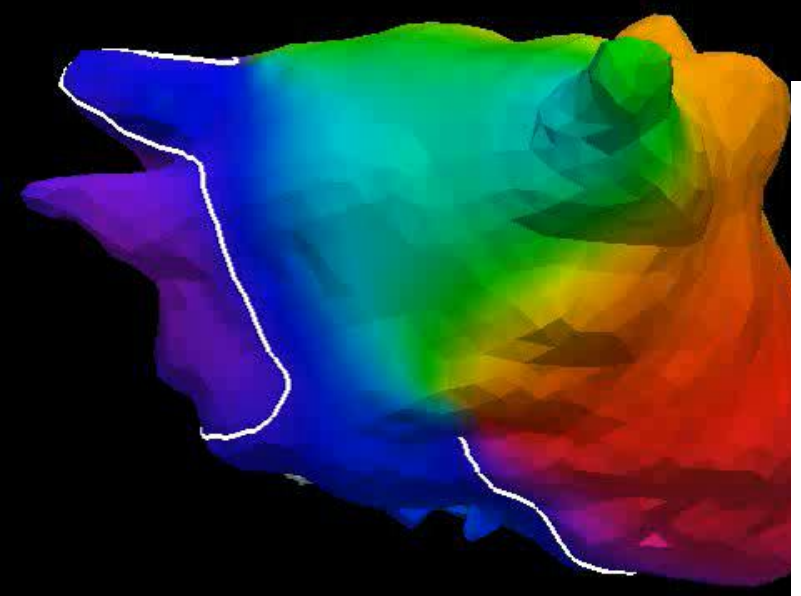
Validation of phase algorithms vs. Fluorescent signals

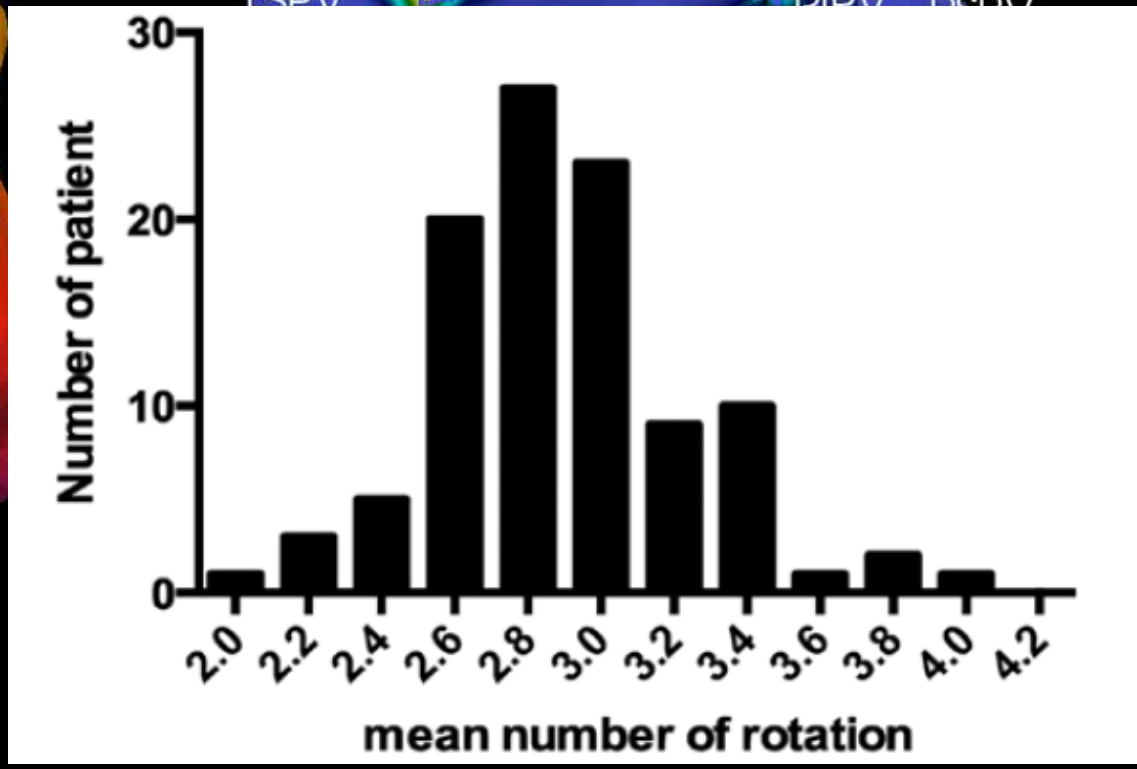
S. Gutrob,
O. Bernus,
R. Dubois,
I. Efimov

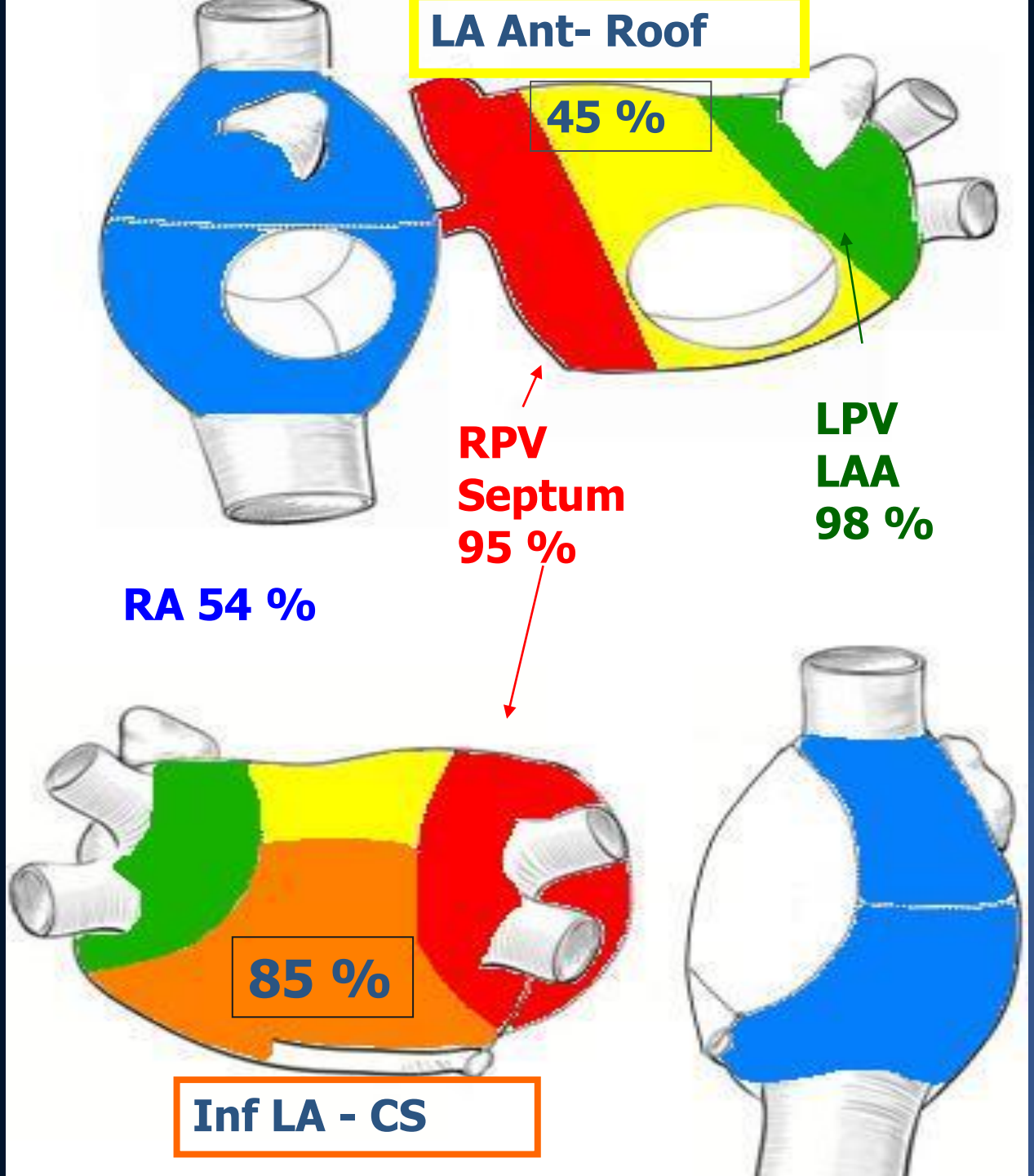
Bordeaux-Wash U



Mapping in persistent AF

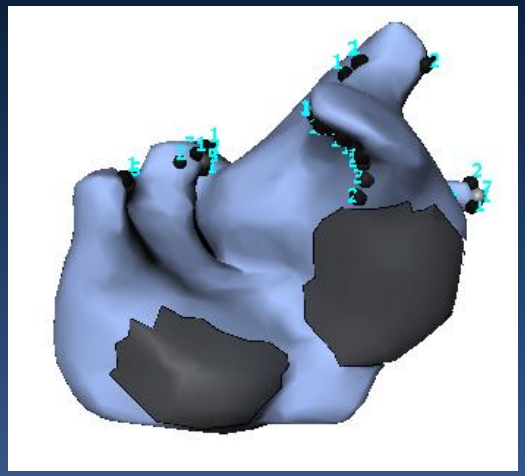






DISTRIBUTION OF DRIVERS

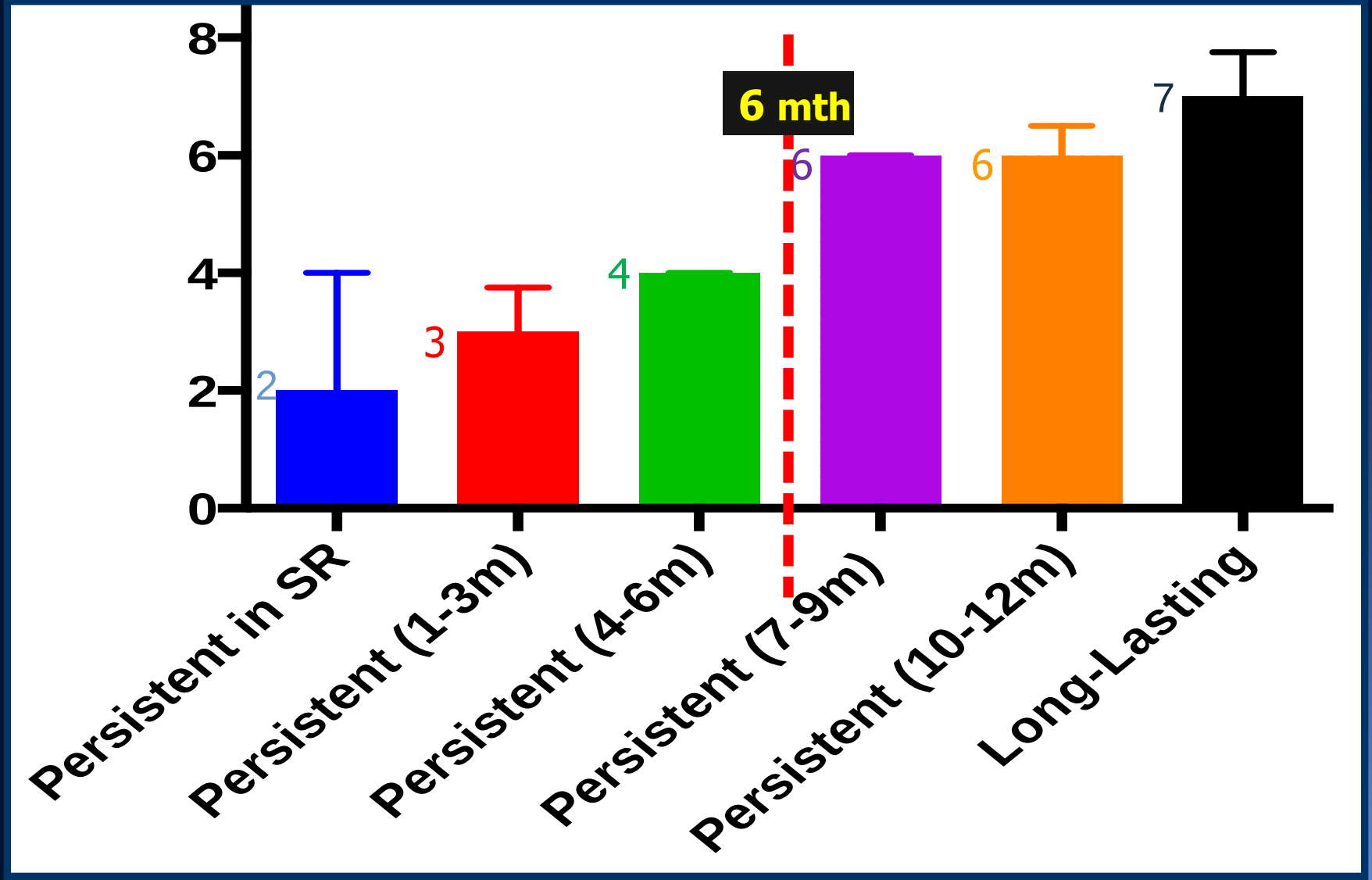
4 driver regions per patients



FOCAL DISCHARGES
Mainly observed from

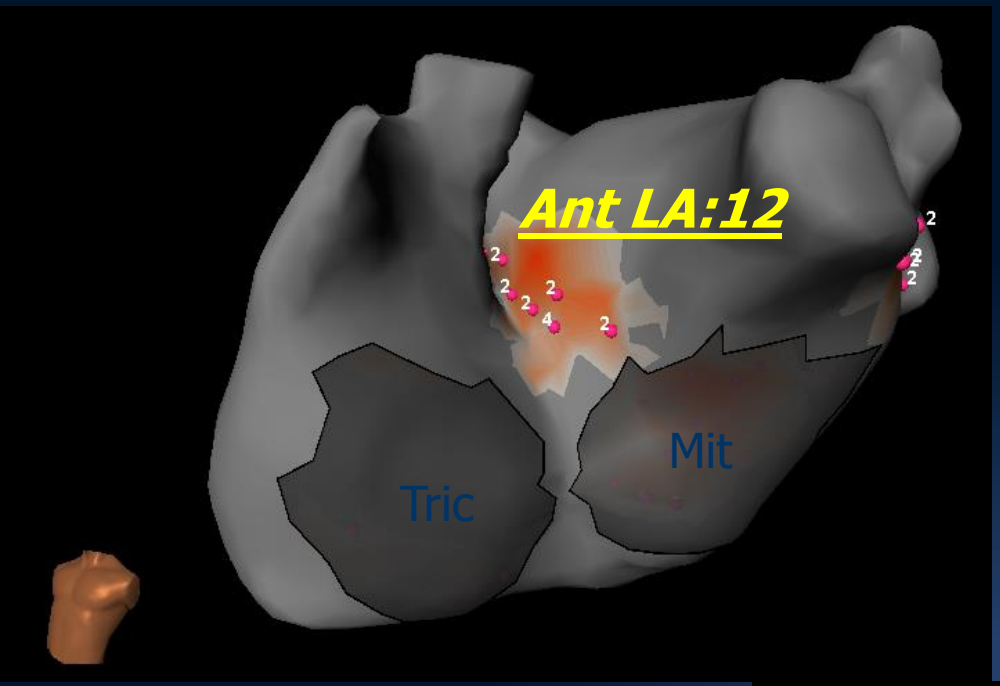
PVs (60 % of pts)
LAA or RAA

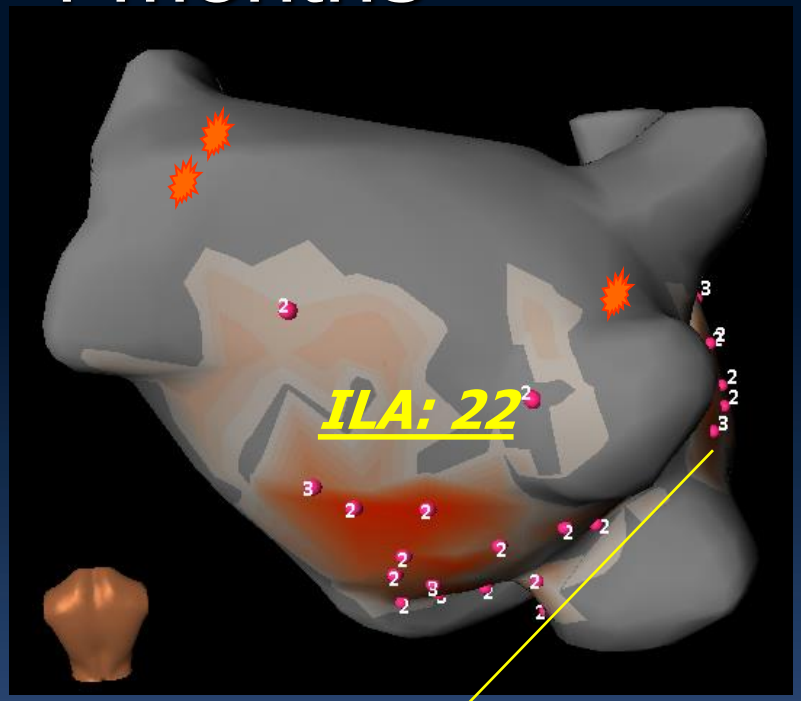
No. of targeted driver regions increases with PsAF duration

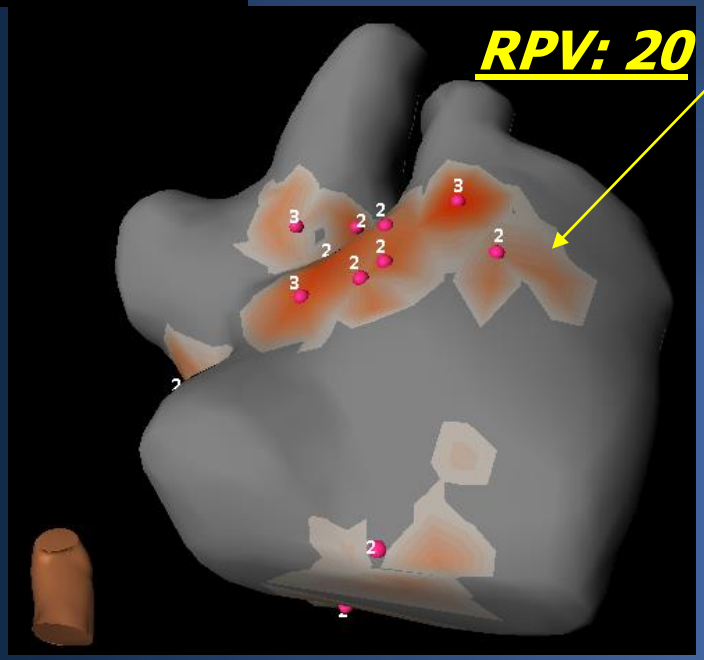


Circulation 2014;130:530

Case: Pers AF 4 months



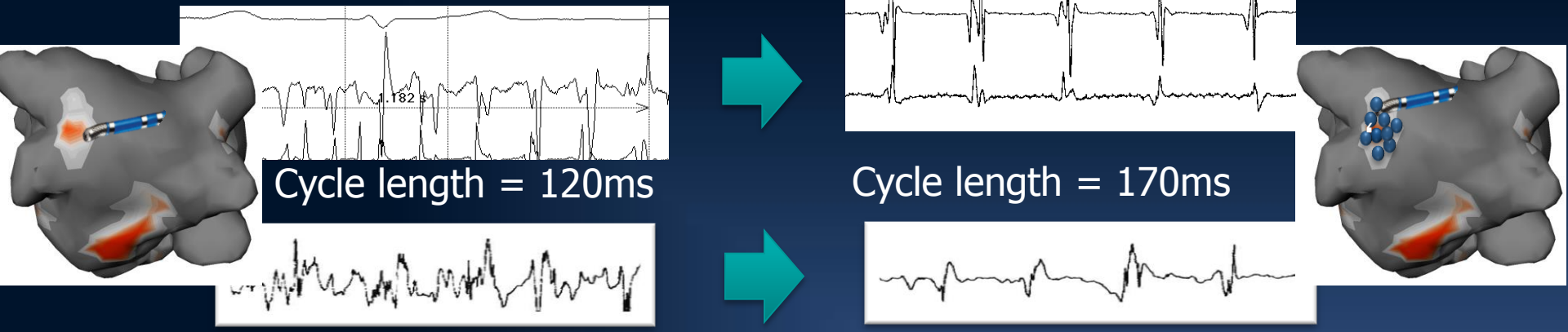




LAA CL: 145 ms
RAA CL: 146 ms

Ablation local endpoint

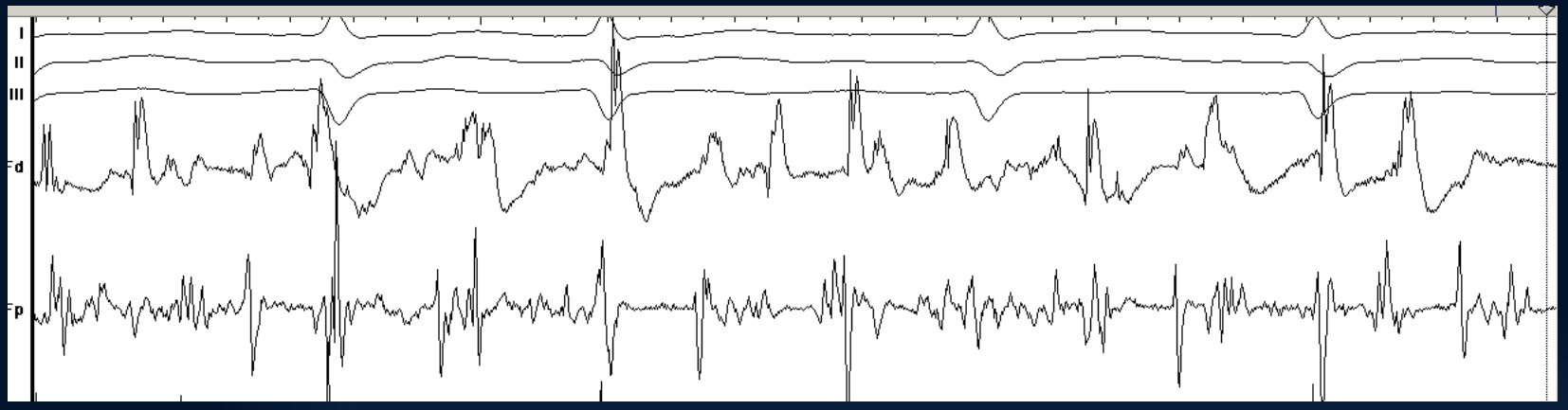
Increase local cycle length



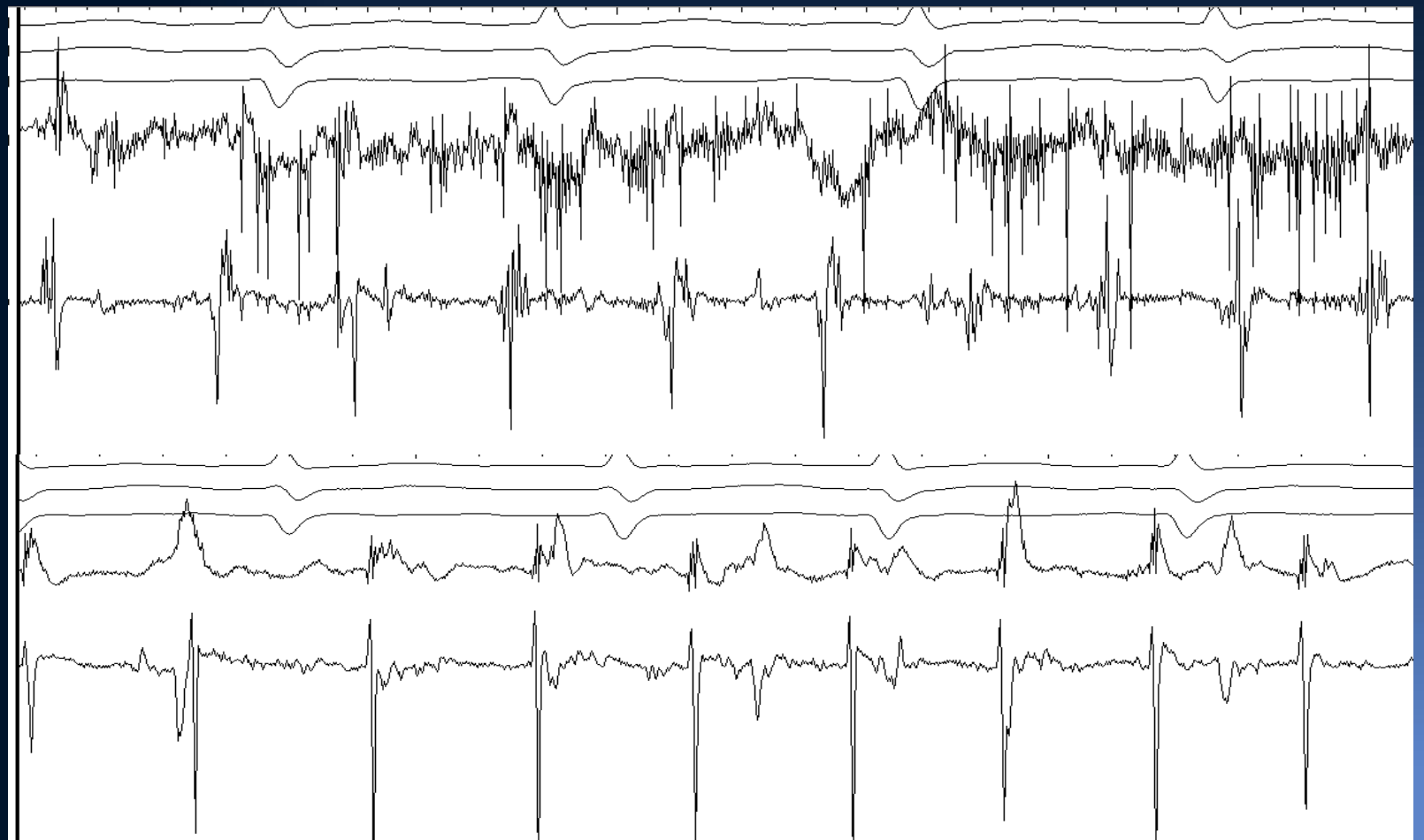
Transform rapid complex signals into slower organized signals

Achieve electrogram abolition is undue/excessive

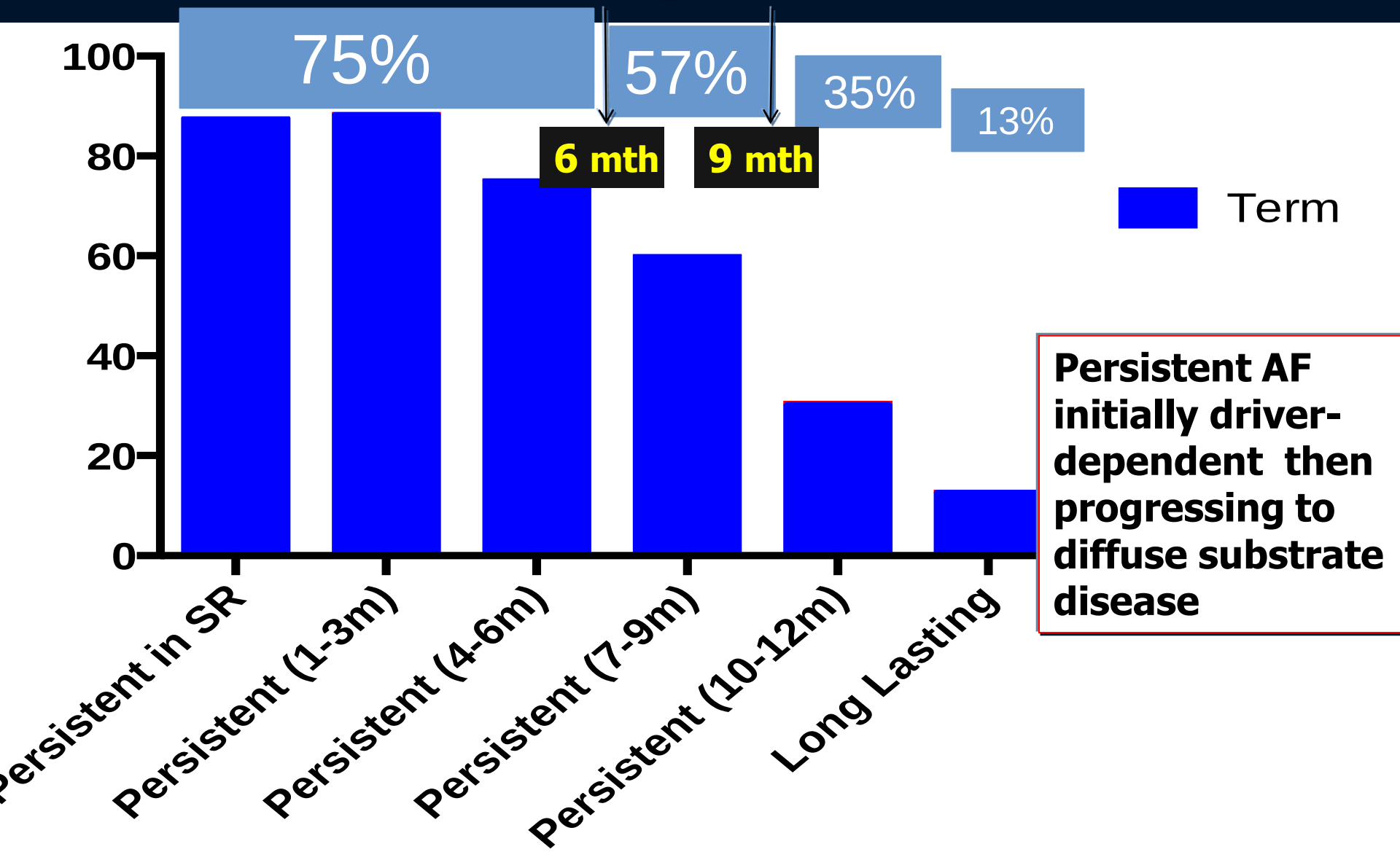
Pre Ablation



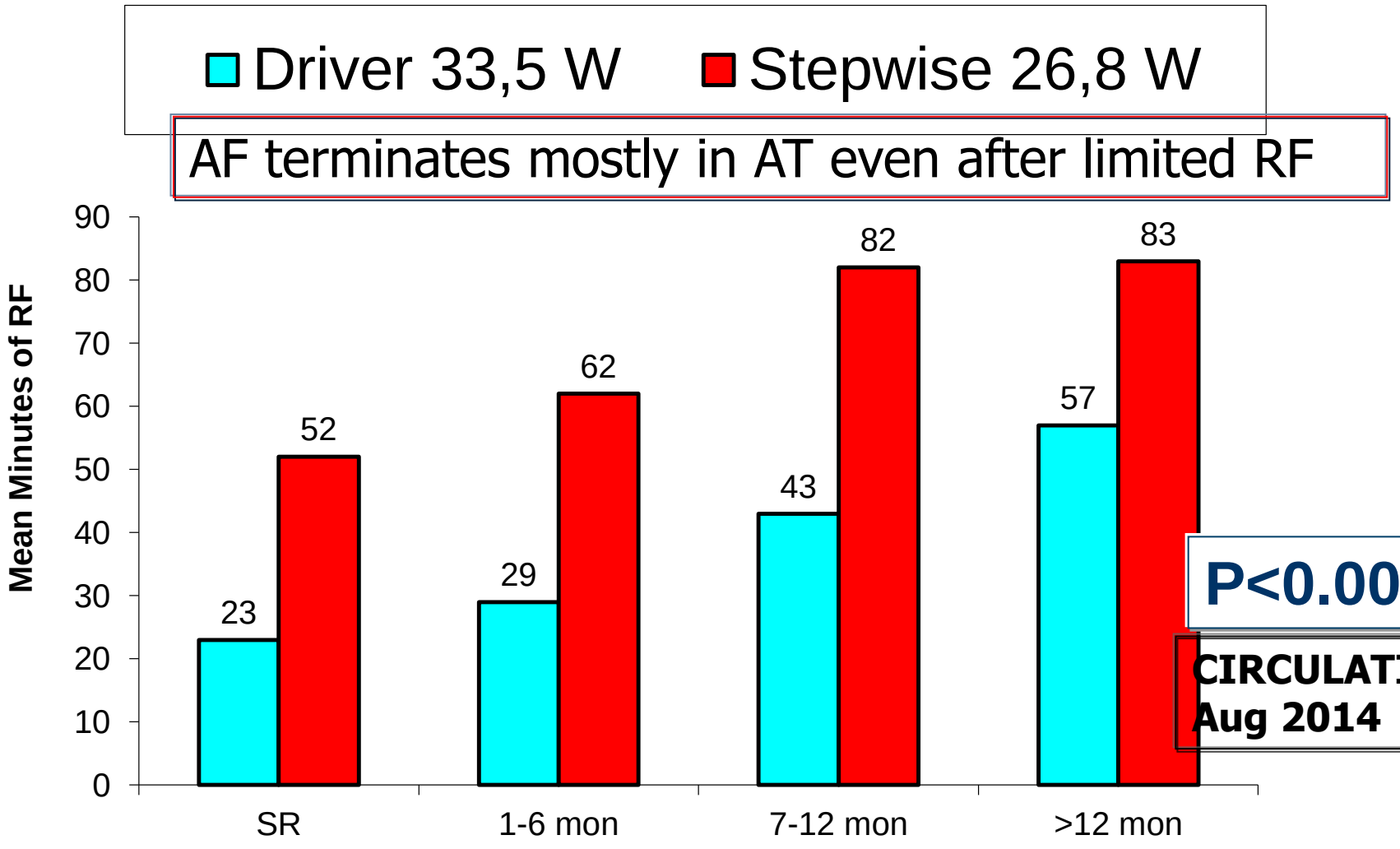
After 10 sec of RF



Results 2- AF termination targeting driver regions (n=172 pts)

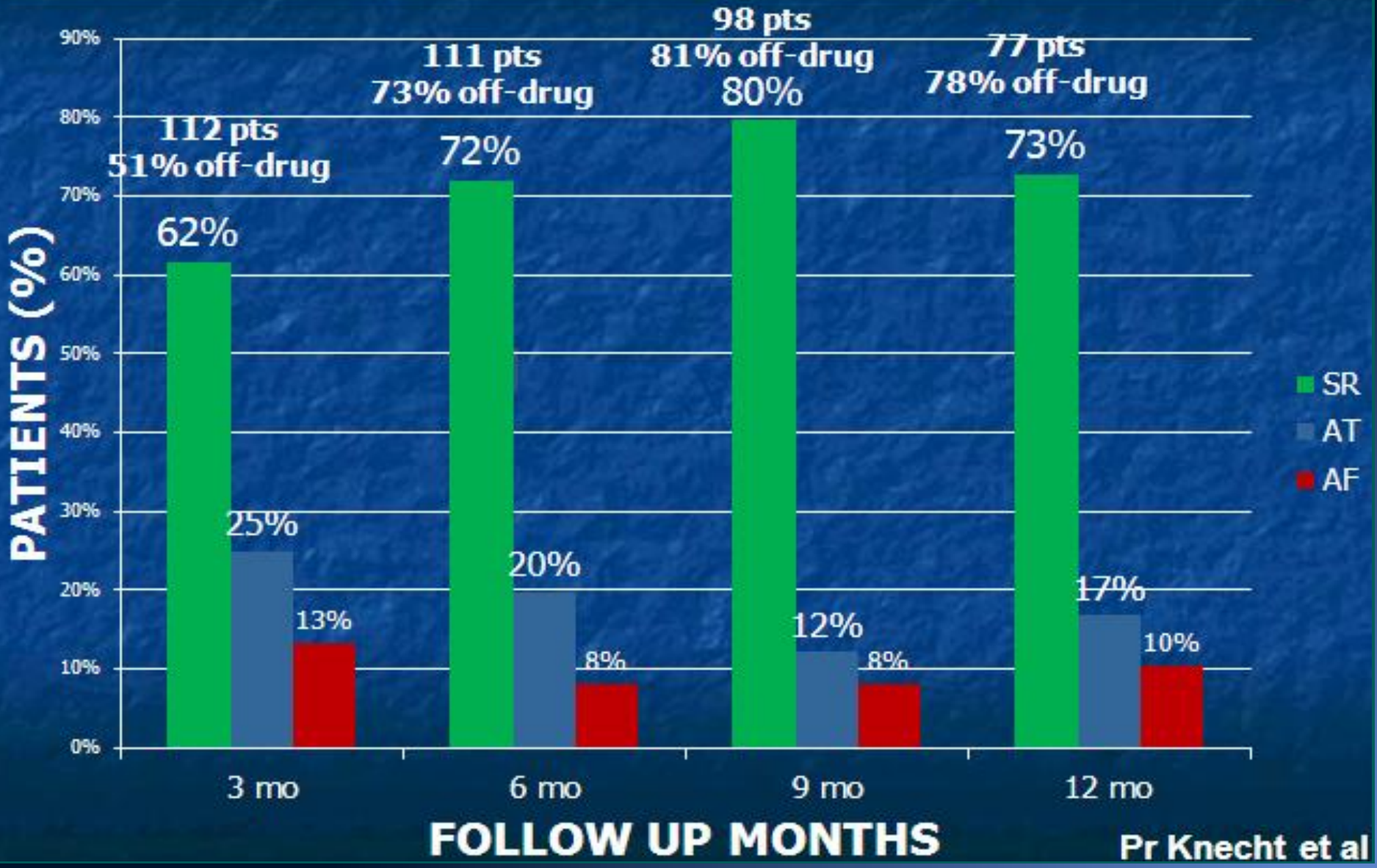


Drastic decrease of RF Duration



Approximately - 50% - 38% - 27%

AFACART study from 8 European centers
FOLLOW-UP (First results)



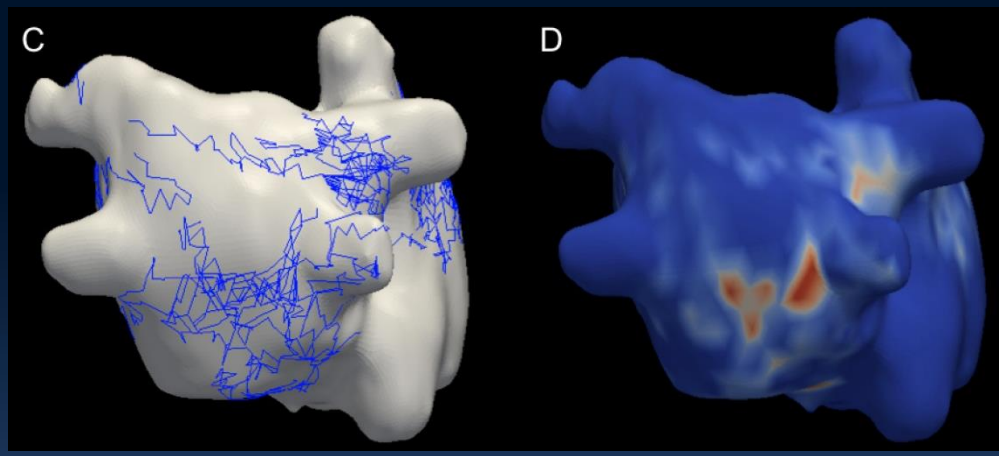
Pr Knecht et al

Conclusions

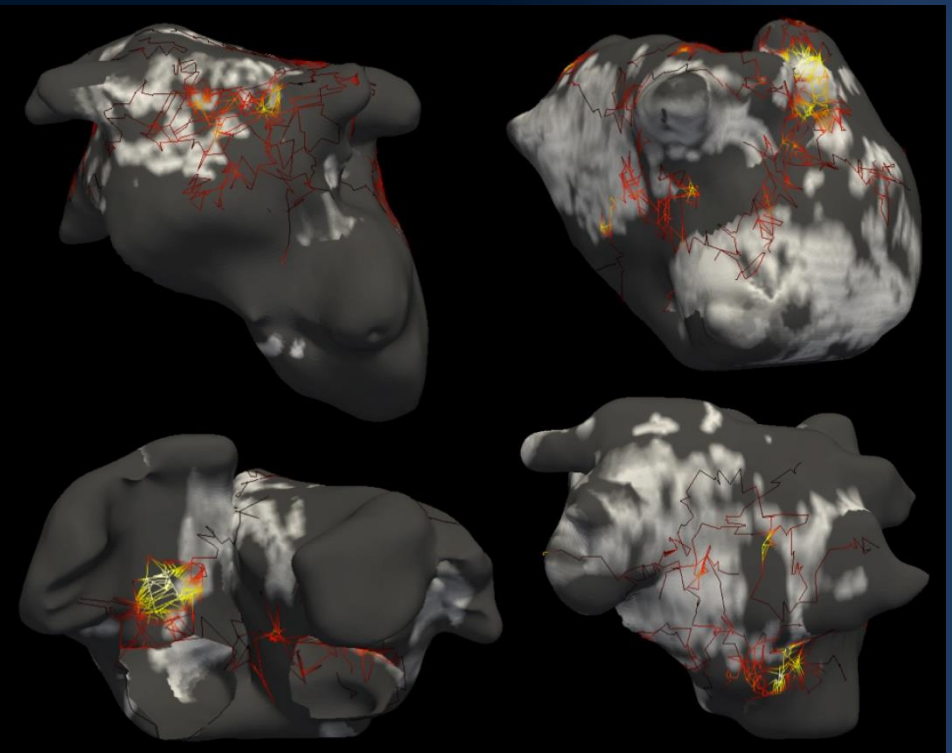
- AF can be mapped noninvasively with 3D visualization of drivers
  - Focal activities
  - Re-entrant activities (temporally and spatially unstable)
- In paroxysmal AF: PV discharges triggering short lived ostial reentries
- In PsAF: wider and more complex atrial substrate
  - AF termination with less RF delivery, ablation focused on most critical region
  - Inclusion of Early PsAF or preablation SR restoration is recommended
  - Reproducibility of acute and chronic success in 8 centers (AFACART)

Atrial Fibrosis and Reentrant drivers in PsAF

Noninvasive egm mapping



Noninvasive structural imaging



1-Reentries present in 81% at borders of LE-MRI – 8% within fibrotic areas– 11% outside

2- Higher local fibrosis entropy and density

3- Indicate structural based reentry rather than rotor stricto sensu

H Cochet et al (submitted)

Egms recorded in reentrant driver regions harbour CFAEs

Fractionated Egms span a greater part of AF cycle length in driver regions than elsewhere (71% vs 47%)

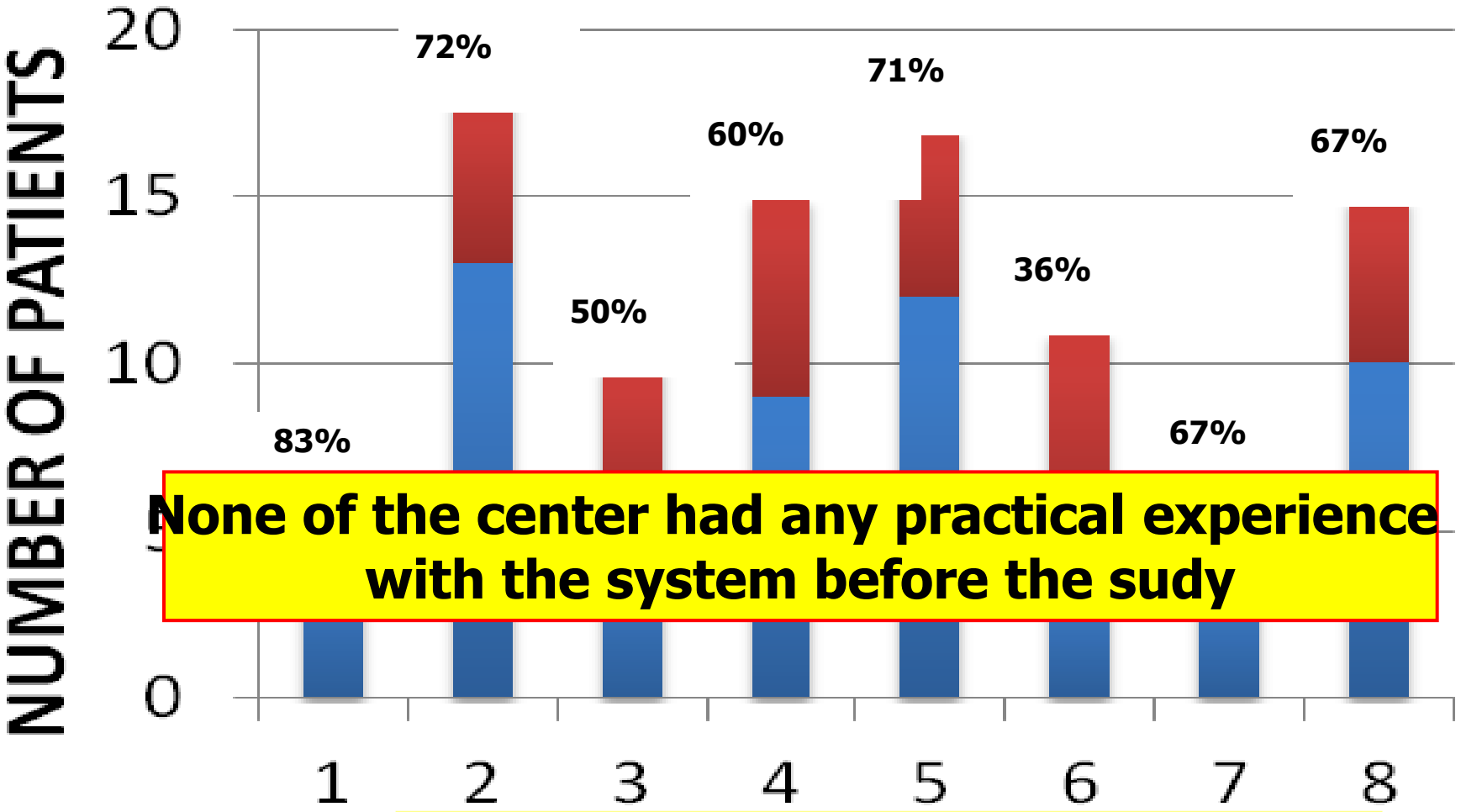
Drivers occupy 19±11 % whereas CFAE occupy 49±16 % of total atrial surface* (AFACART study)

Driver regions

No Driver regions

*Sonia Ammar…Isabel Deisenhofer Munich

Multicenter Reproducibility of AF termination rate targeting drivers



None of the center had any practical experience with the system before the sudy

AFACART European study

Pr Knecht et al

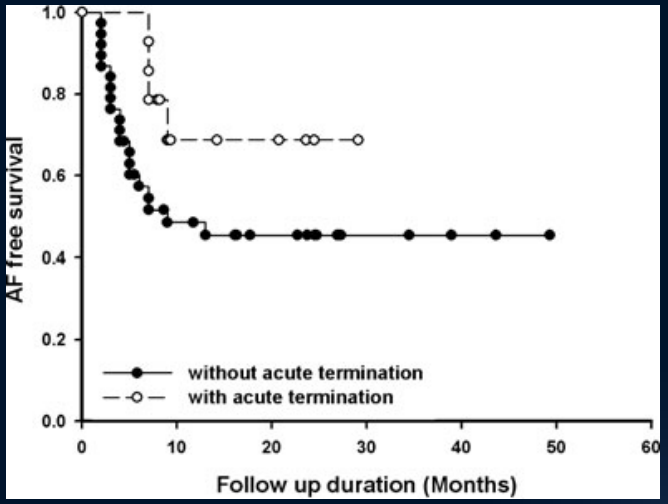
Outcome at 12 months in 90 pts

(redo ablations in 17pts)

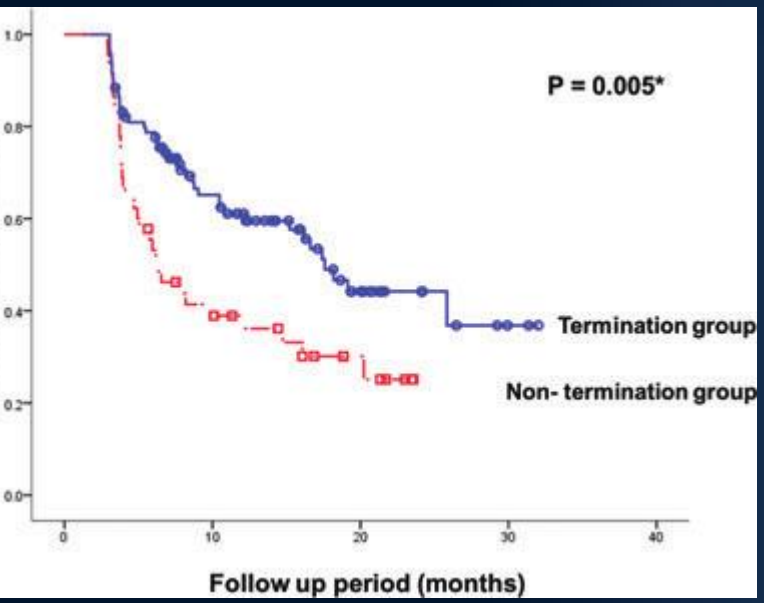
	AF FREE OUTCOME		AF
	Sinus Rhythm	**Atrial tachycardia**	
Pts with AF termination N=75	85% AF freedom		**15%** **54%parox**
Pts without AF termination N=15	63% AF freedom		**37%** **All Persist**

*<0.001

Driver domains in Persistent AF Circulation 2014



The Strongest Procedural Endpoint for Persistent AF is Termination

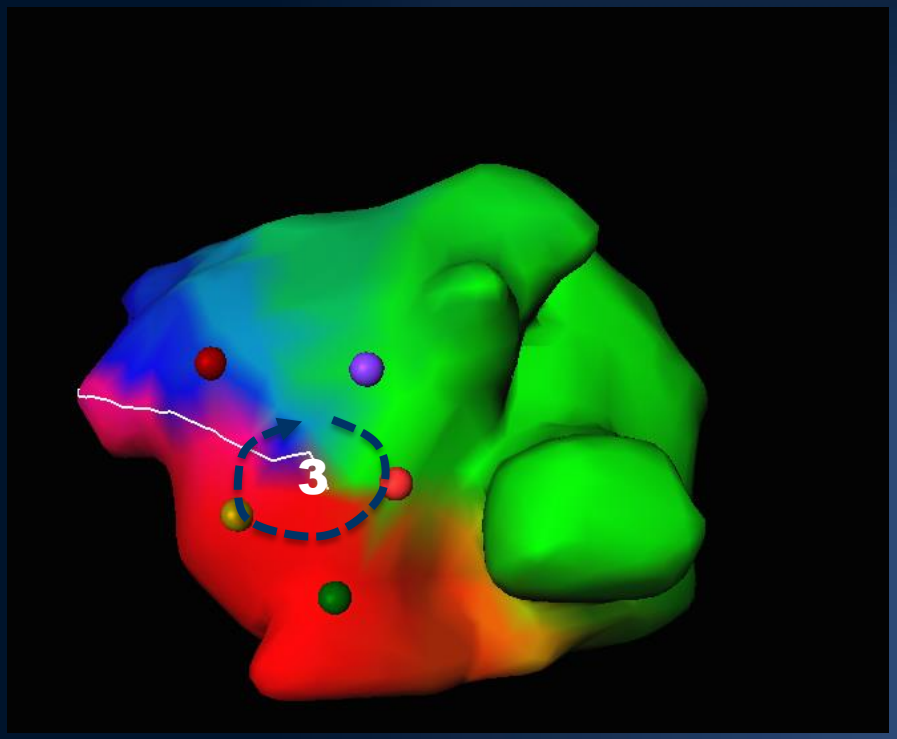


Better outcome in 18 of 21 reports from literature

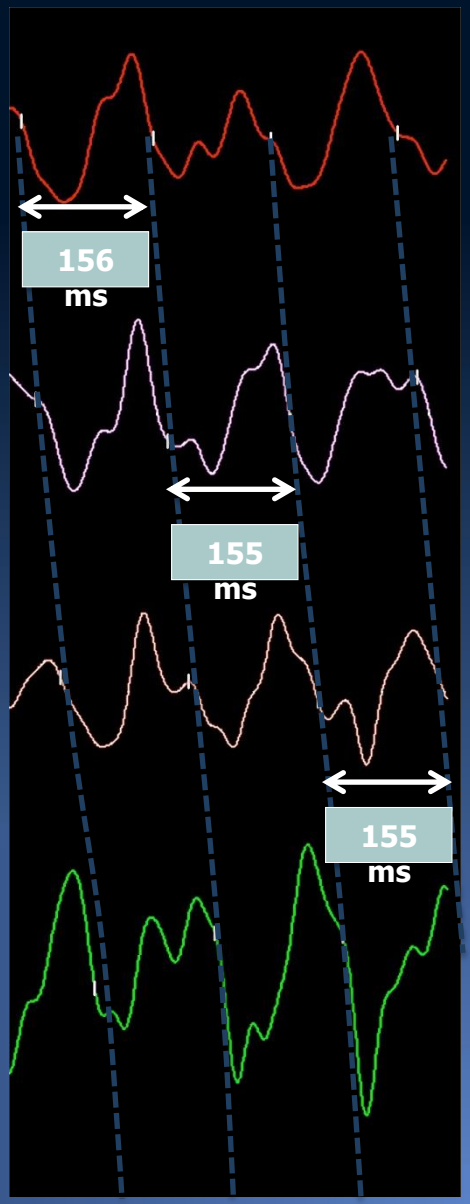
O'Neill et al-EHJ 2009 Lin … Chen SA-JCE 2009 Kang … Kim YH-JCE 2012 Rostock ..Circ 2011 etc…

Confirmation of Egm quality and Reentry

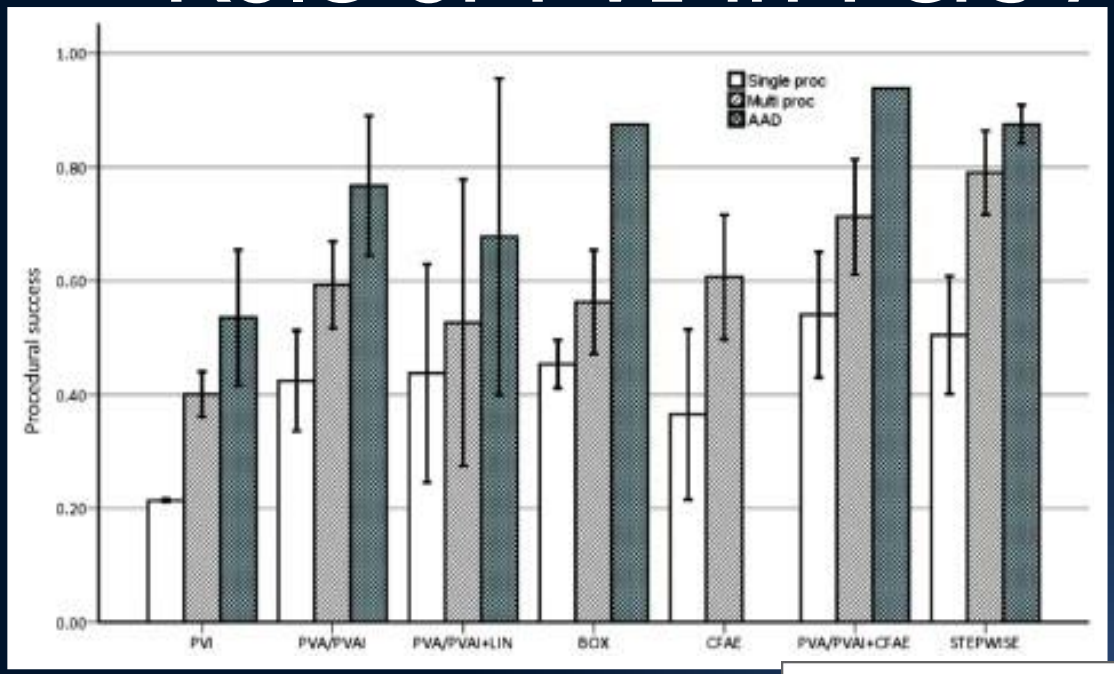
For a driver to be considered reentrant, the sequence of AF electrograms should cover the entire cycle length



Three rotations, Time of Rotation = 153 ms

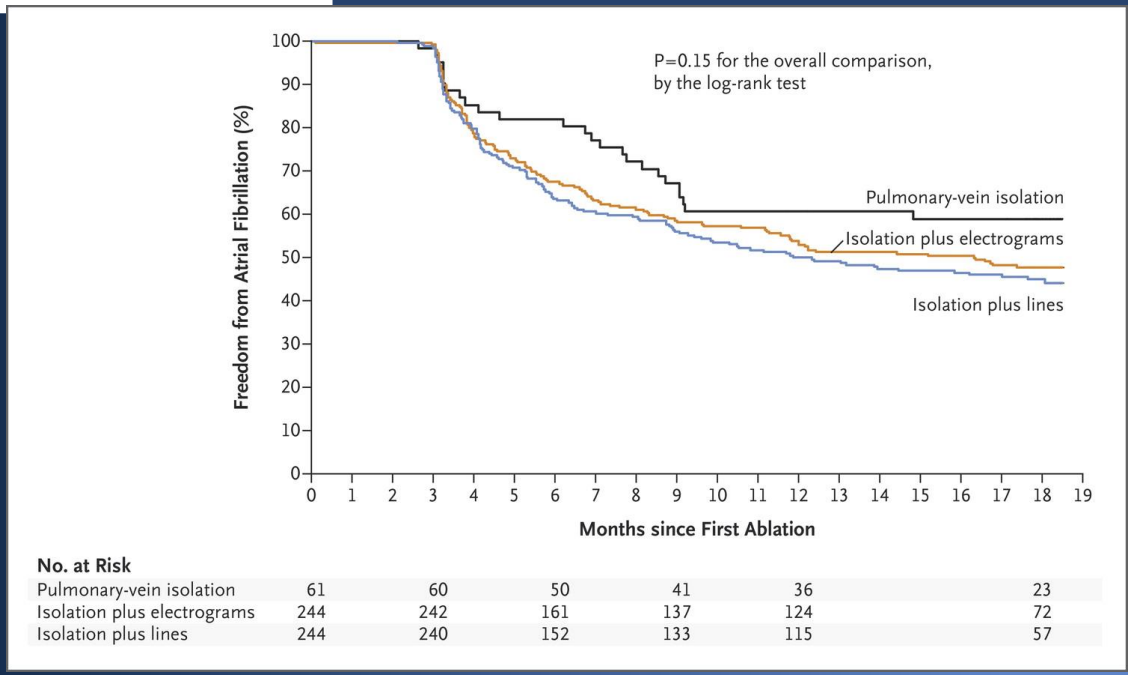


Role of PVI in Pers AF… STAR AF II



Brooks et al - 32 studies of long-standing persistent AF ablation from 1990 – 2009

Verma et al



No. at Risk

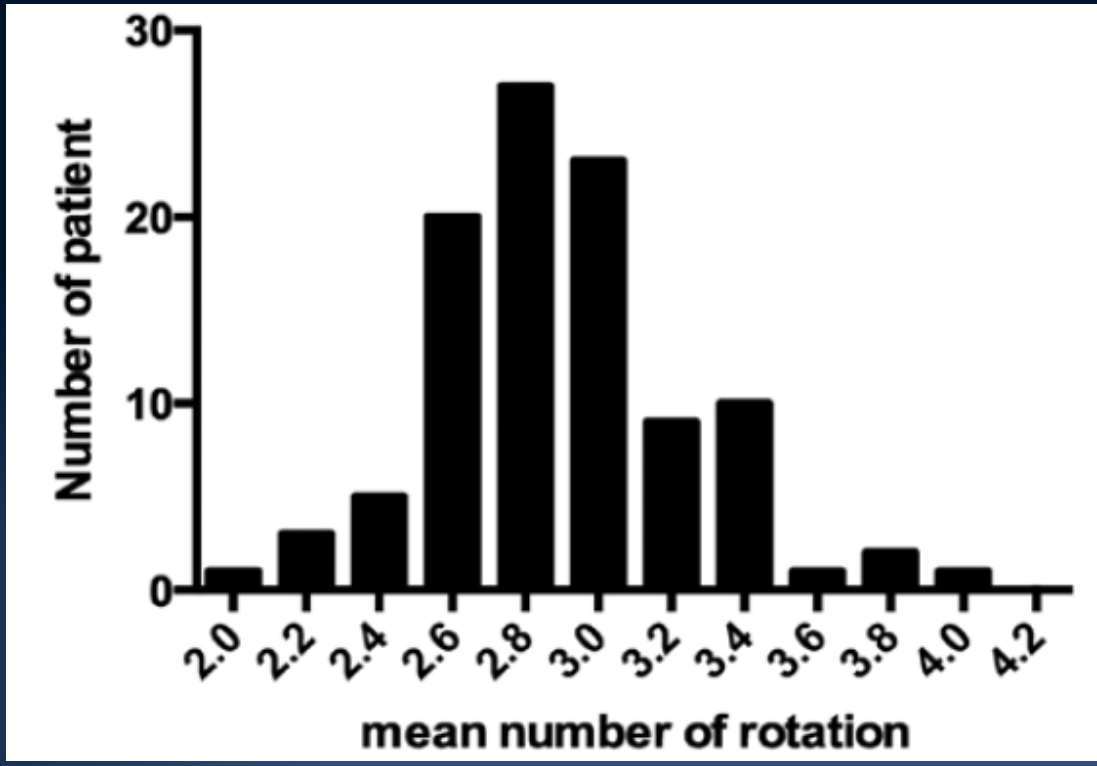
Pulmonary-vein isolation	61	60	50	41	36	23
Isolation plus electrograms	244	242	161	137	124	72
Isolation plus lines	244	240	152	133	115	57

Implications of STAR AF II

- Need for identification of subgroup benefiting from PVI only

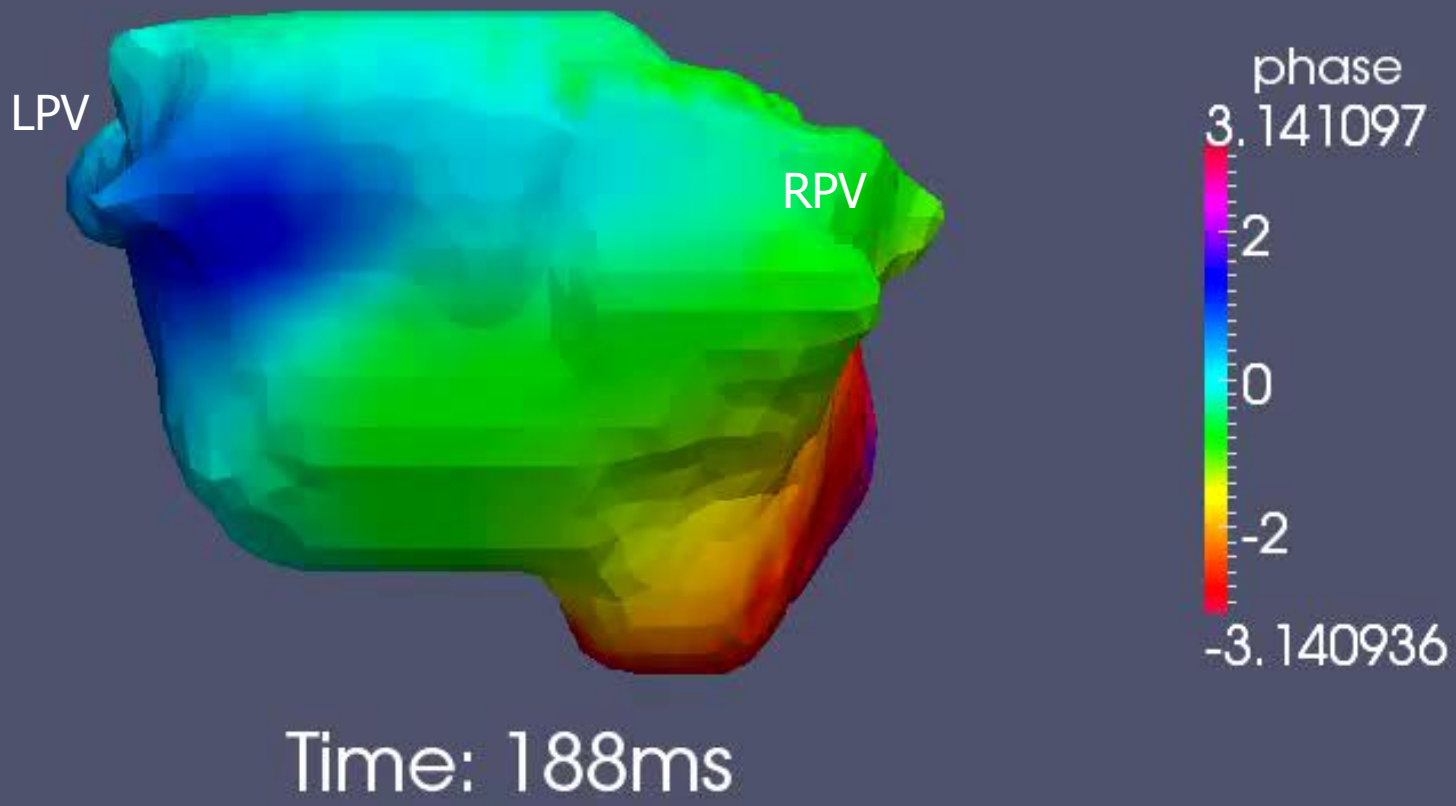
- Nearly ½ of patients remain in AF, indicating inadequate targeting of atrial substrate
- Clearly indicates an individualized atrial substrate mapping approach to improve upon results from PVI

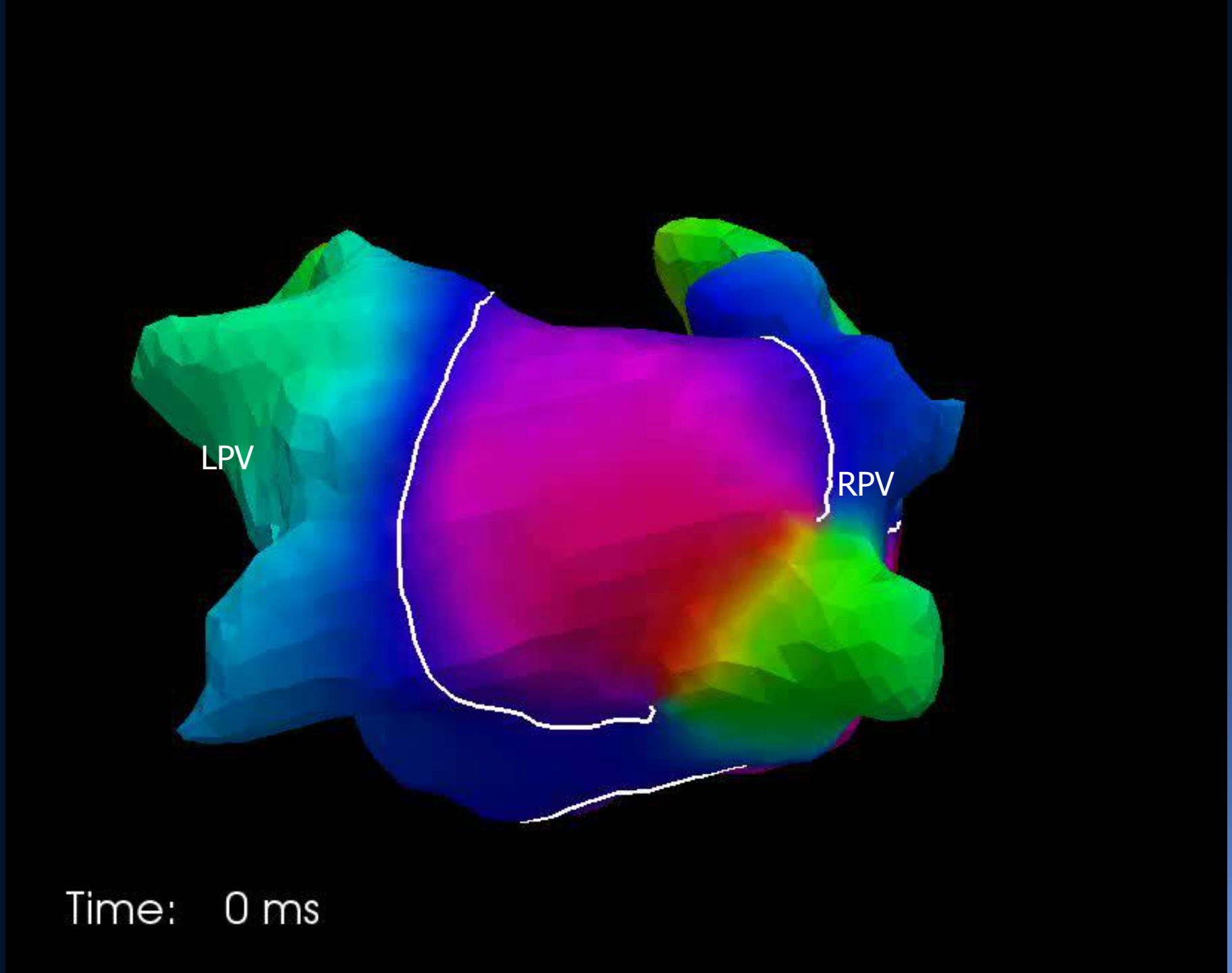
Short living (3 reentries/firings)



Temporal Stability of Rotors and Atrial Activation Patterns in Persistent Human Atrial Fibrillation (Walters et al)

Twelve percent of activations represented transient rotors, seen in 85% of mapped regions with a median duration of 3 rotations. A total of 87% were centered on an area of short CL activity (<100 ms), although such activity had a positive predictive value for rotors of only 0.12.


LPV
RPV
phase
3.141097
2
0
-2
-3.140936
Time: 188ms

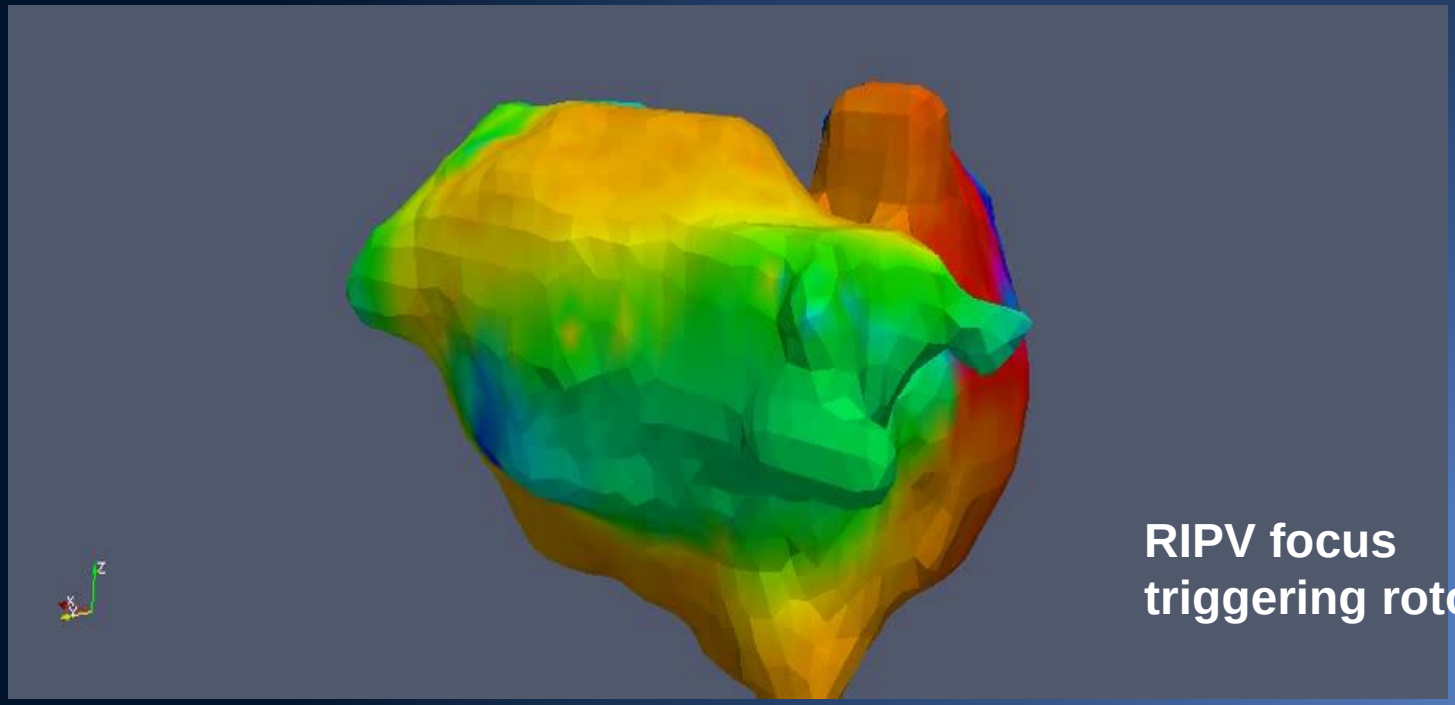

LPV
RPV
Time: 0 ms

Time: 0 ms

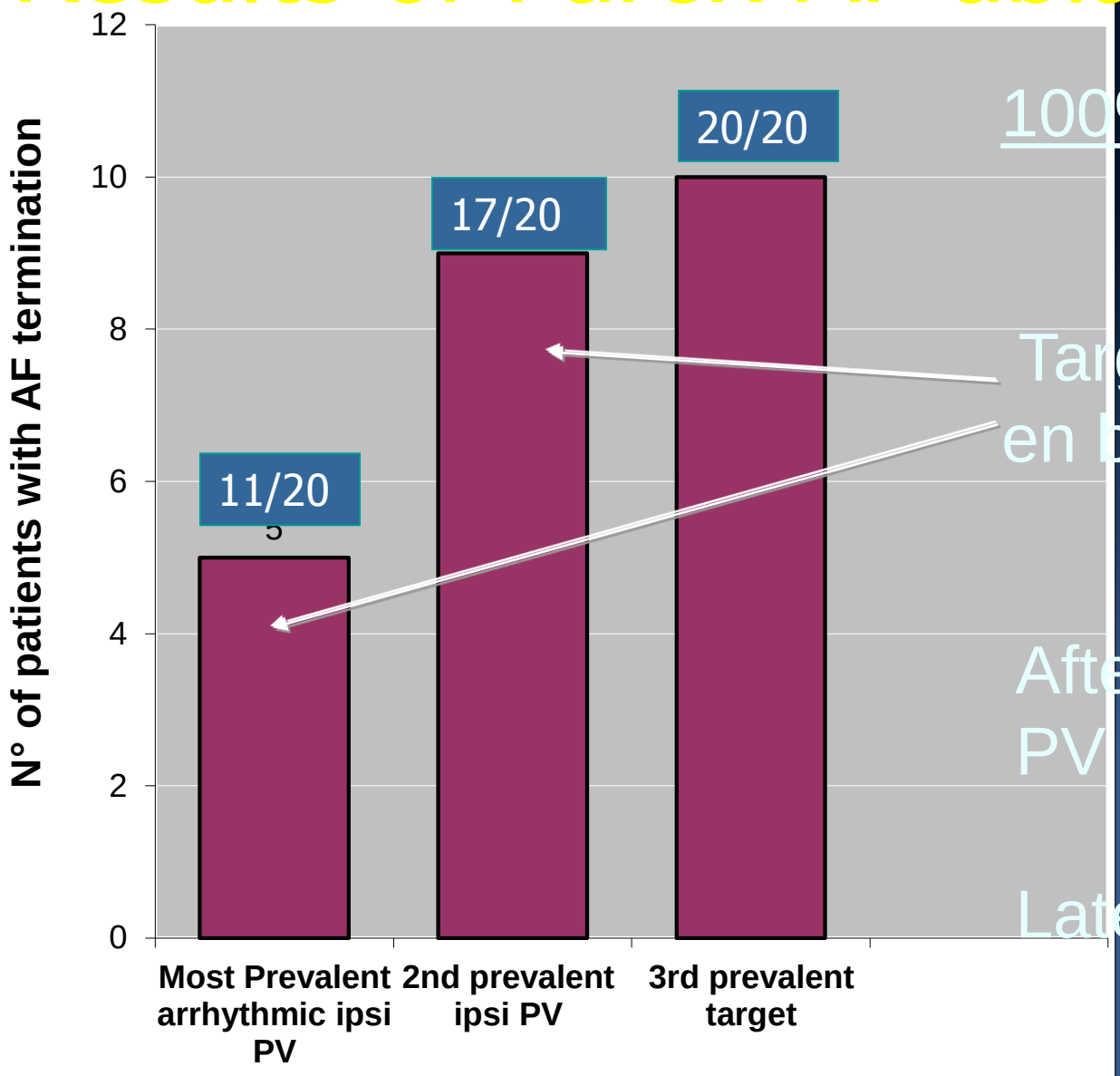
Results in paroxysmal AF

20 pts **, AF spontaneous in 7/ induced in 13**

- ***NonInvasive*** **Perprocedural**: Sources originate from the PV/post LA regions
  PV discharges interacting with short lived ostial rotors



Results of Parox AF ablation n=20



100% AF termination

Targeting ostial PV en bloc (~ 7 min RF)

After AF termination, PV ectopics in 5 pts..

Later full PVI in all