



Non invasive ECG mapping system: Moving from atrial to ventricular fibrillation

Mélèze Hocini, MD

LIRYC Institute

Hopital Haut Lévèque, Université de Bordeaux



MY CONFLICTS OF INTEREST ARE

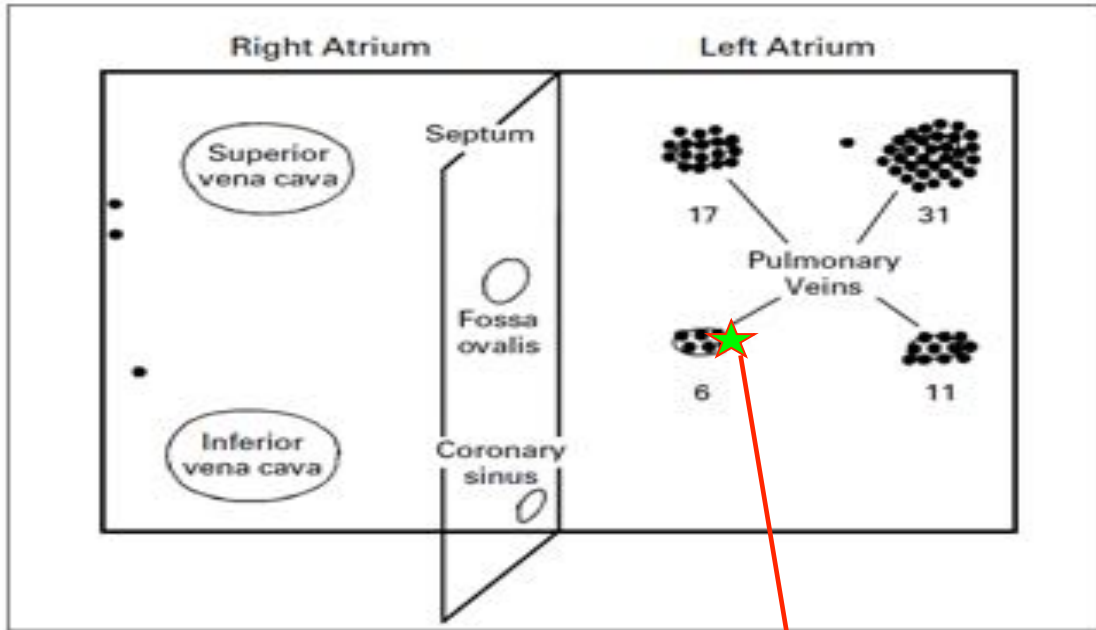


St. Jude Medical,
Biosense-Webster
Boston Scientific
Medtronic,
St. Jude Medical,
CardioInsight

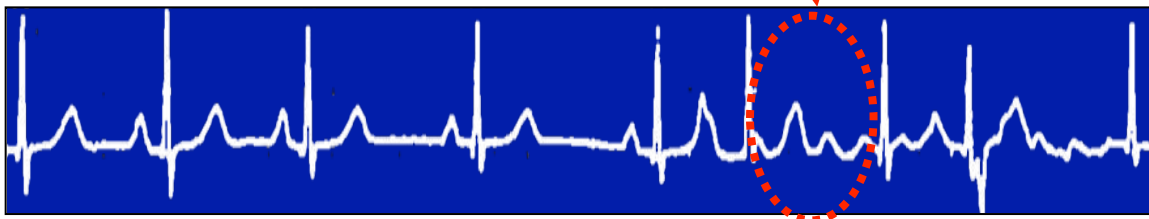


THERAPEUTIC TARGETS FOR AF

Pulmonary Veins



Haissaguerre *et al* **NEJM** (1998)

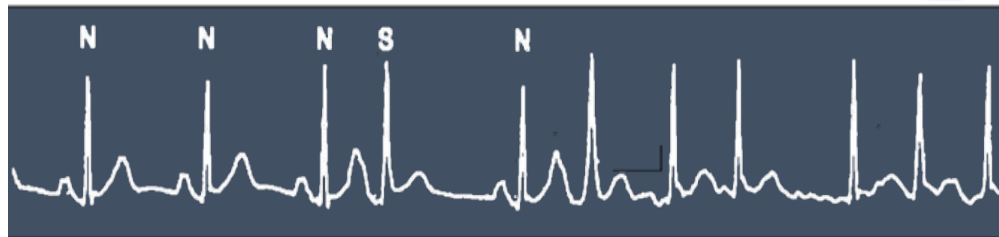




SUBSTRATE OF PAF- PsAF:

2 DIFFERENT 'WORLDS

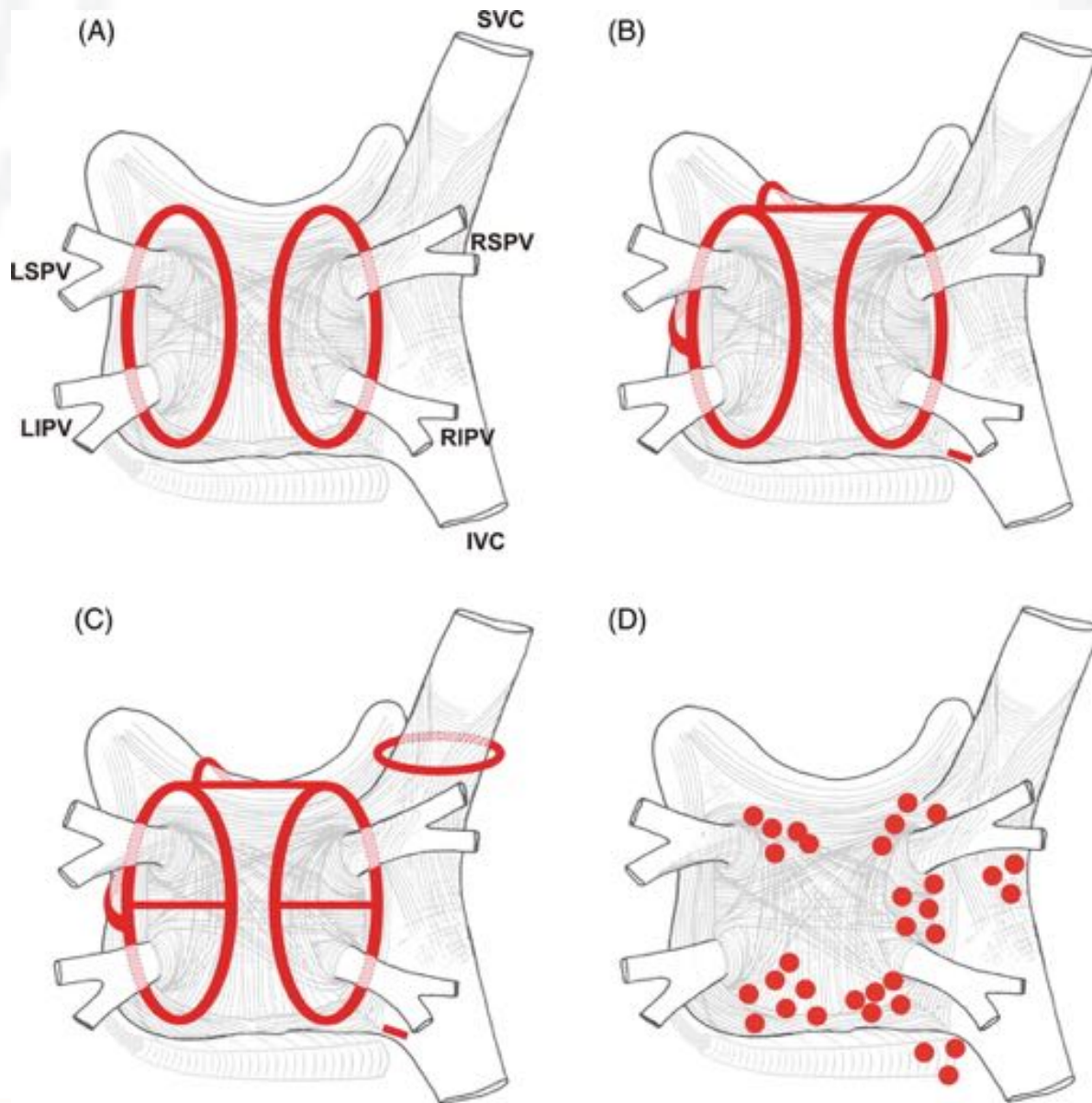
- Paroxysmal AF: PVs are main triggers and drivers:



- Persistent/permanent AF: much complex substrate where PVs are one element:

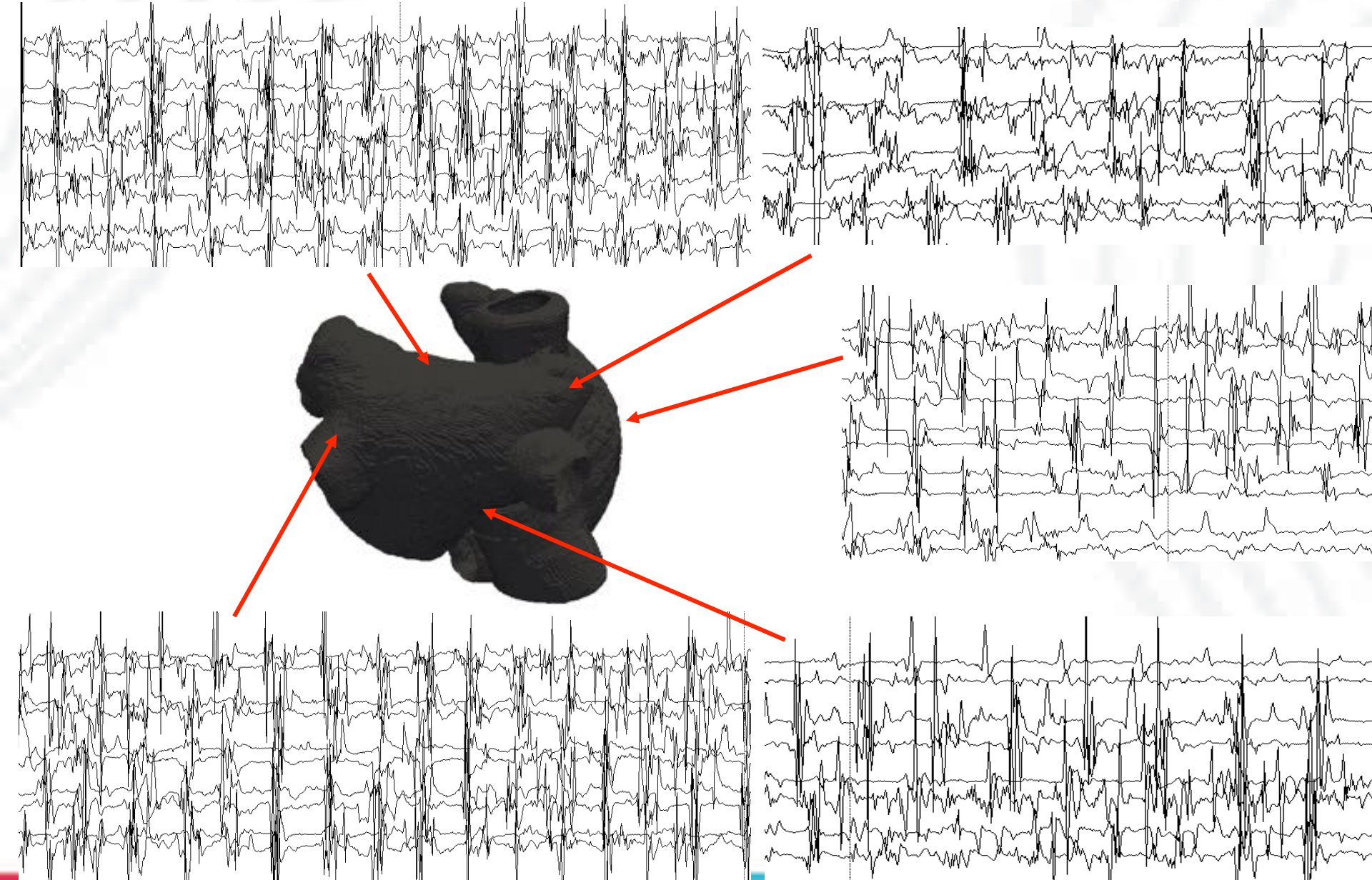


WHERE TO ABLATE?





WHAT TO ABLATE?





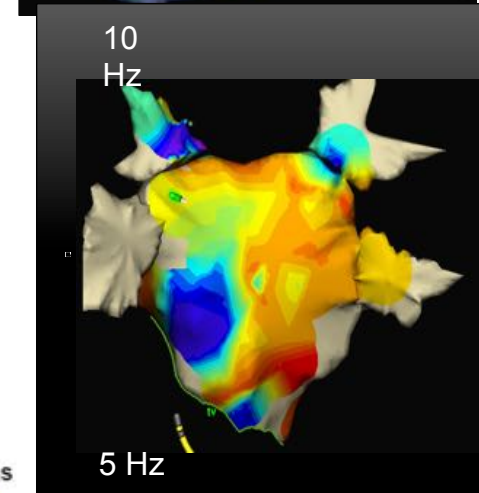
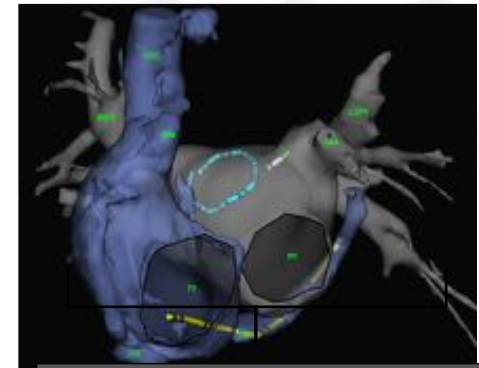
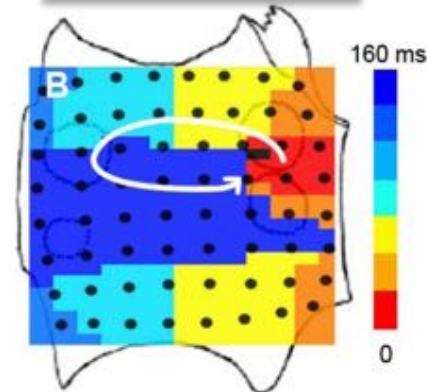
L'INSTITUT DE RYTHMOLOGIE
ET MODÉLISATION CARDIAQUE
BORDEAUX

SIGNAL PROCESSING TO EVIDENCE AF DRIVERS



REGIONAL/CHAMBER MAPPING

- SEQUENTIAL MAPPING
- NavX, Carto, Ensite, Rhythmia, Topera
 - Activation time,
 - Dominant Frequencies,
 - CFAE
 - Phase mapping
- Hypothesis: stability of sources



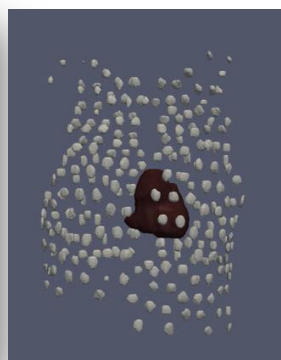
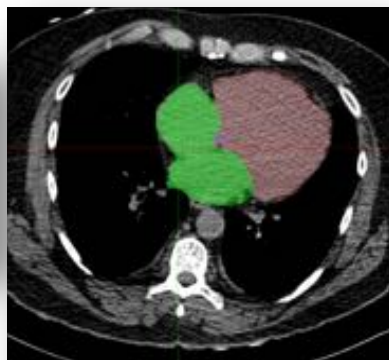
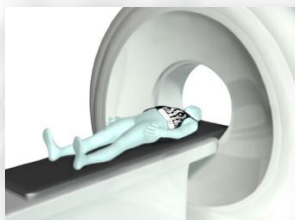


GLOBAL/PANORAMIC MAPPING

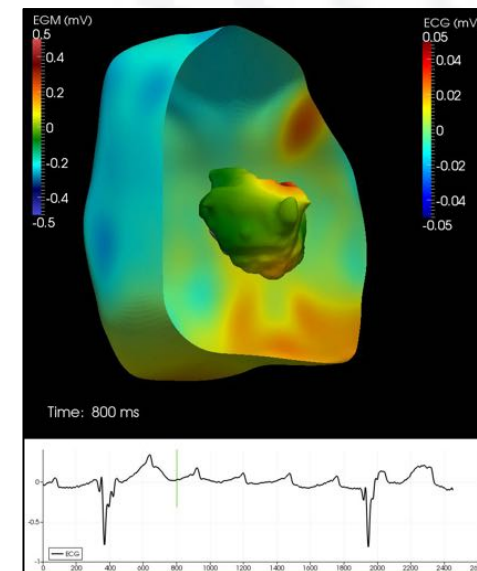
- Non invasive mapping « Electrocardiographic Imaging » (ECGI)
 - 1990 Feasibility (Rudy Y, Gulrajani RM)
 - 2000 First in Human validation
 - 2011 CE mark for Human use



- 252 electrode vest
⇒ Torso Potentials
- CT-Scan
 - Geometry of the heart
 - Relative position of the electrodes



- Optimisation: EGM reconstruction (inverse problem)
⇒ Unipolar Epicardial potentials
- Signal processing

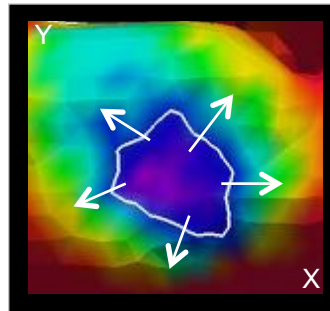




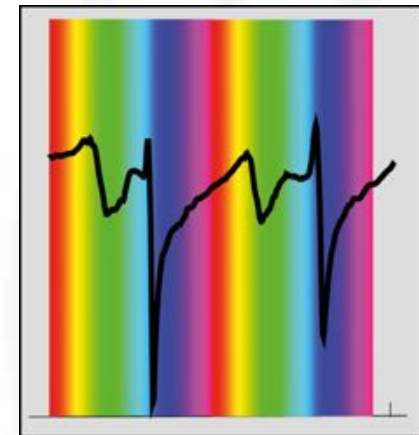
PHASE MAPPING - PRINCIPLE

■ Focus activity

- Phase divergence = Foci



1 Image

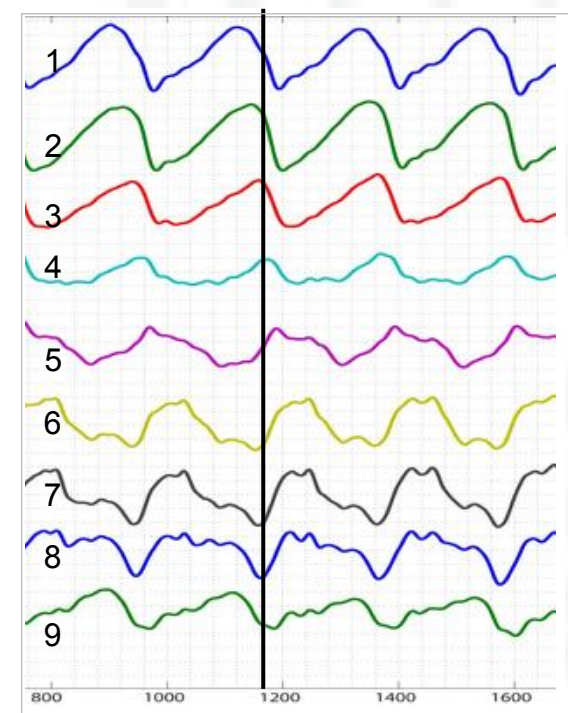


■ Reentry pattern

- Phase singularity = Wavebreaks
- Sequential activation of unipolar raw egms around rotor core



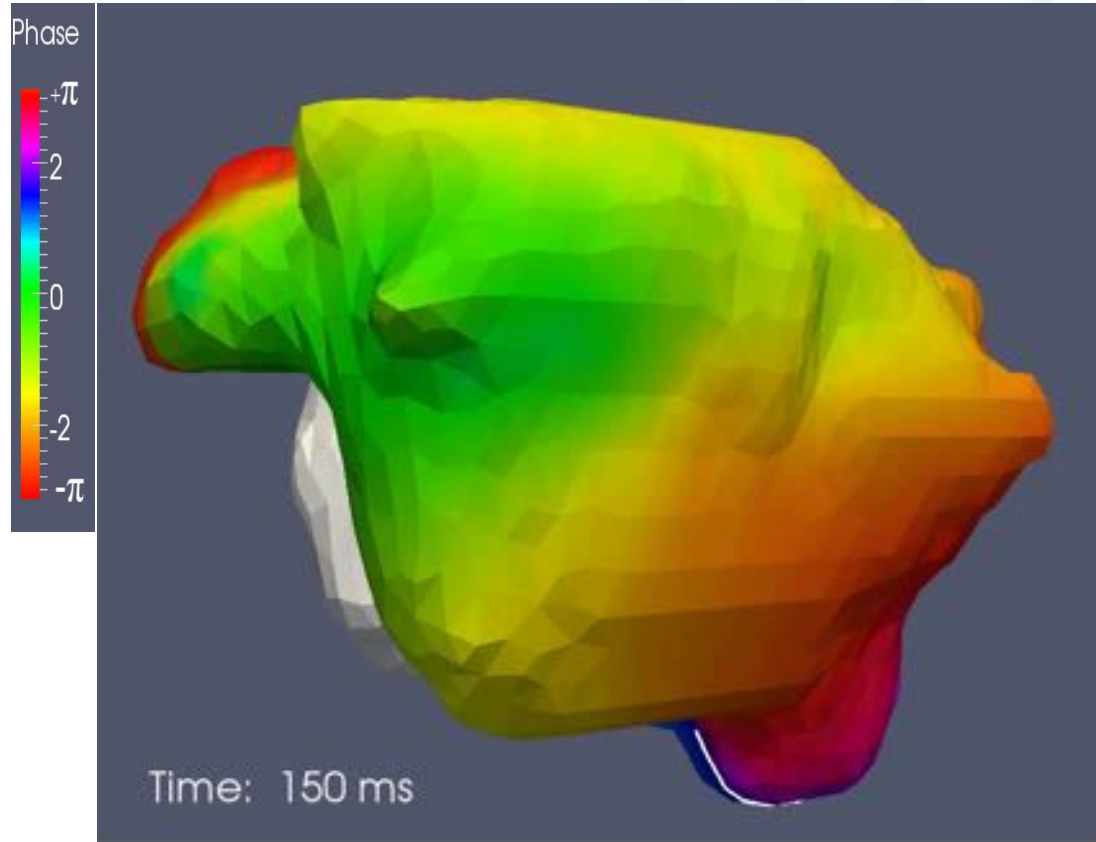
1 Image





PHASE MAPPING - EXAMPLE

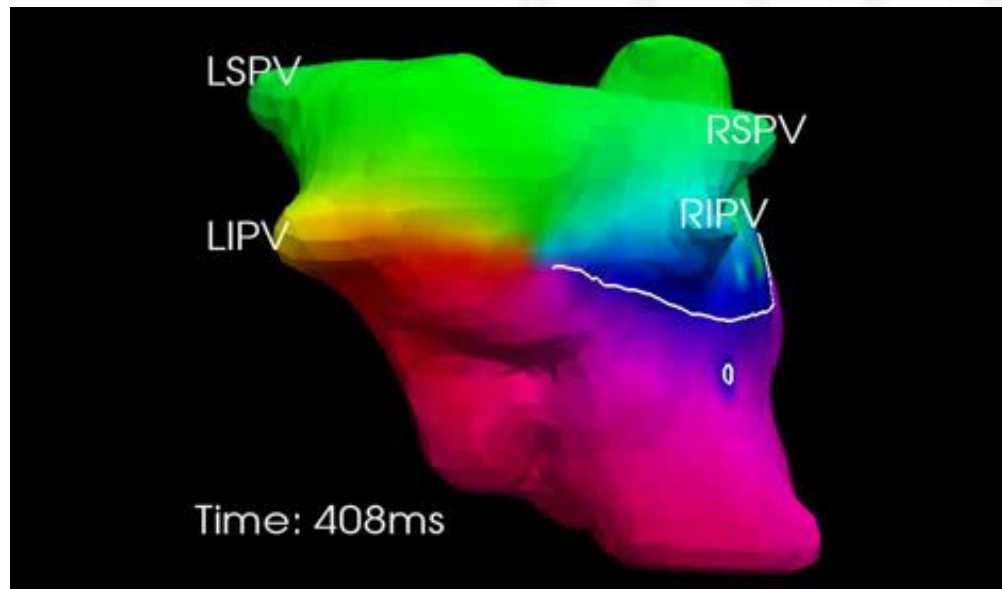
- AF mechanisms
 - Focal discharge





PHASE MAPPING - EXAMPLE

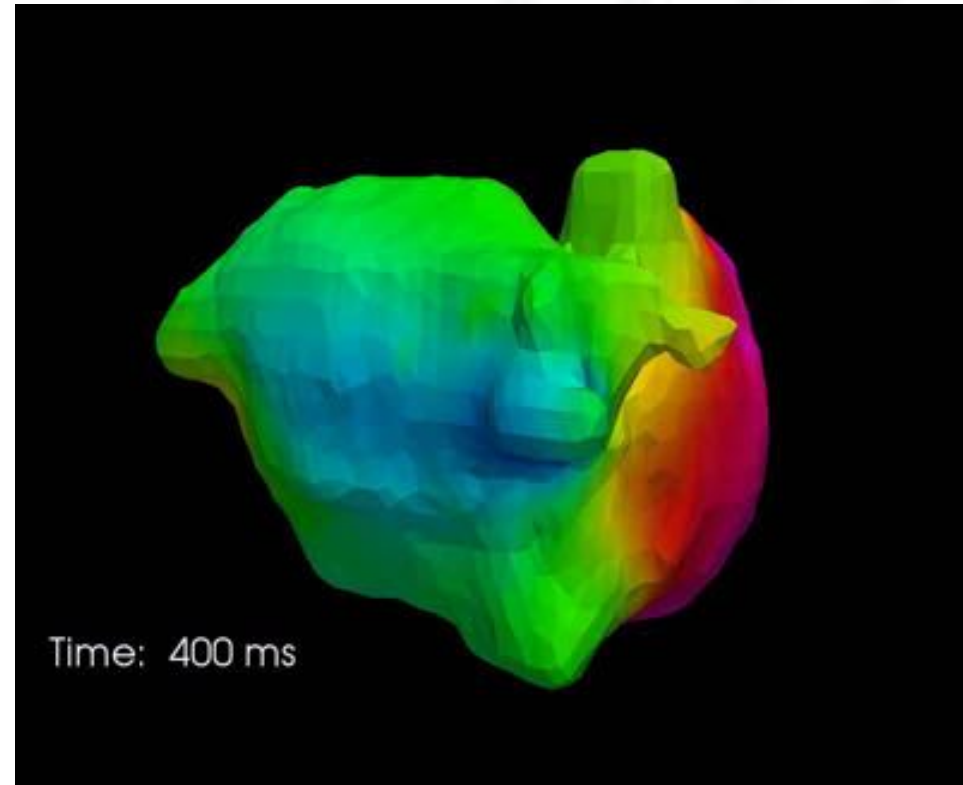
- AF mechanisms
 - Focal discharge
 - Functional/Structural reentry

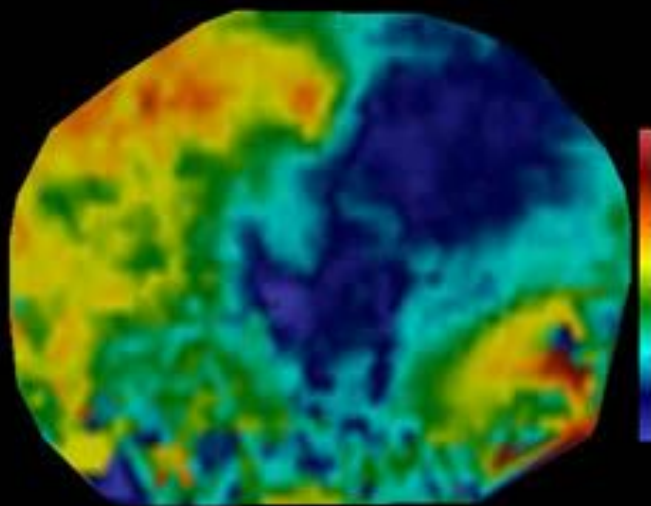




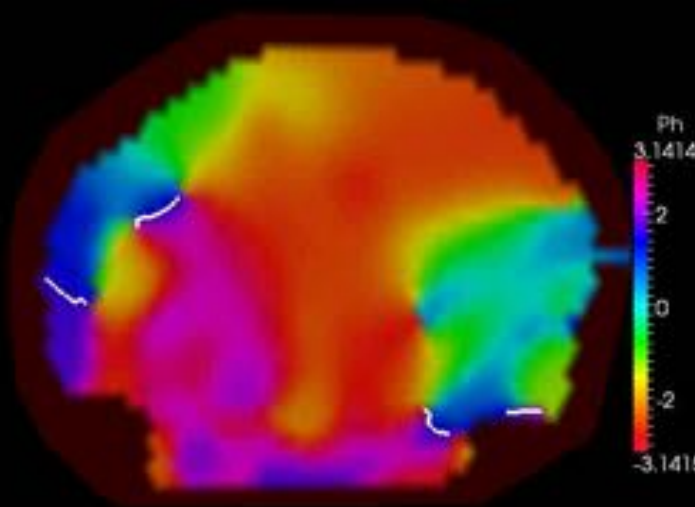
PHASE MAPPING - EXAMPLE

- AF mechanisms
 - Focal discharge that initiate/perpetuate the rotor





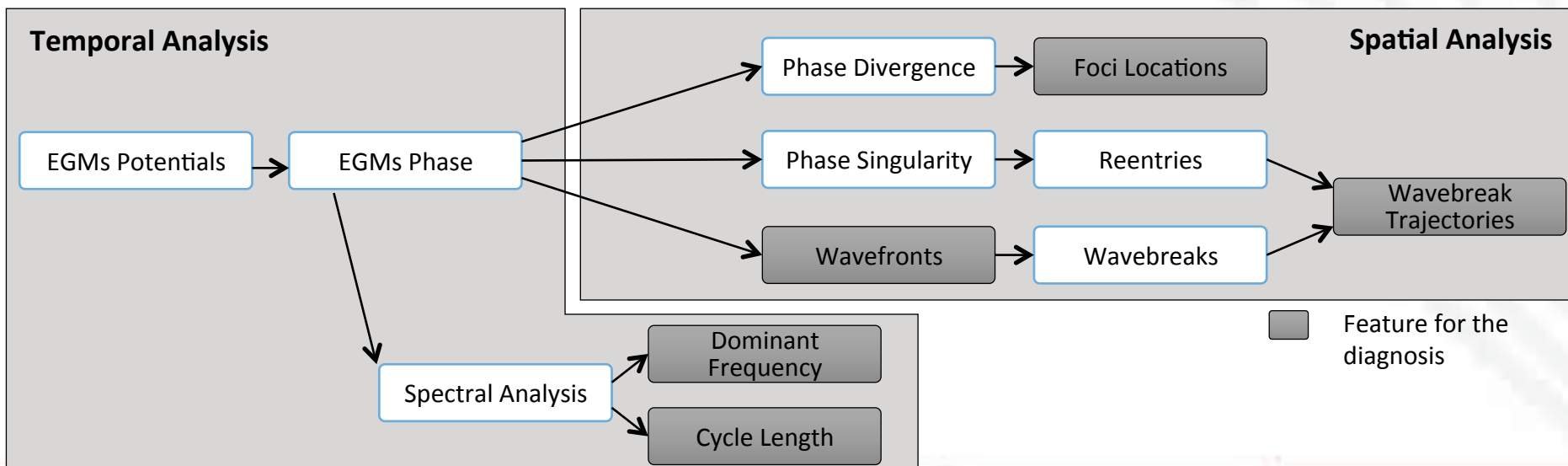
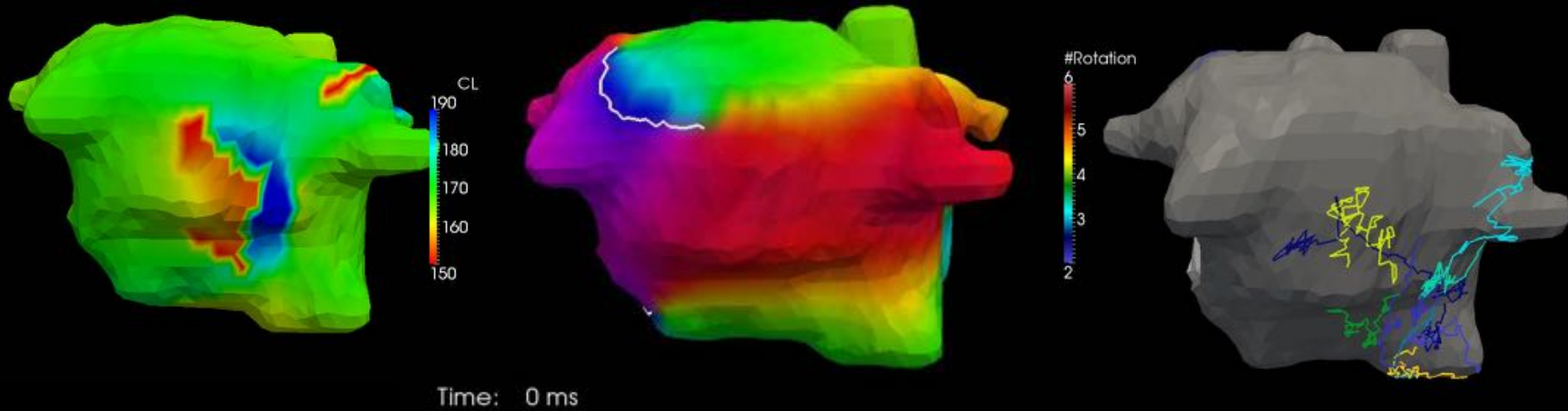
Time: 0 ms



ROTORS IN EXPERIMENTAL AF



PHASE MAPPING DURING AF



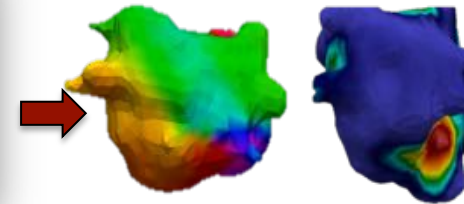
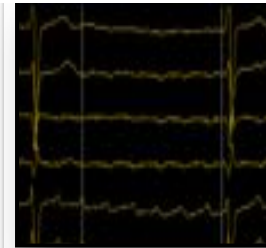


PHASE MAPPING TO GUIDE AF ABLATION

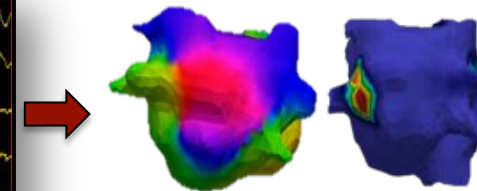
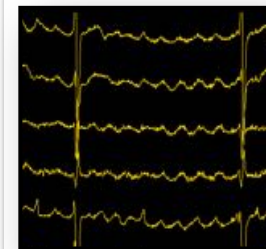
WORKFLOW

- Selection of AF intervals $\sim 1,5$ sec (longest RR intervals)
- Automatic movies/maps localizing foci and rotors
- Rotor and focal maps from all windows aggregated (15 to 30 sec)into a "Cumulative map"
- Statistical map/Road map with hierarchical order (drivers are ranked)

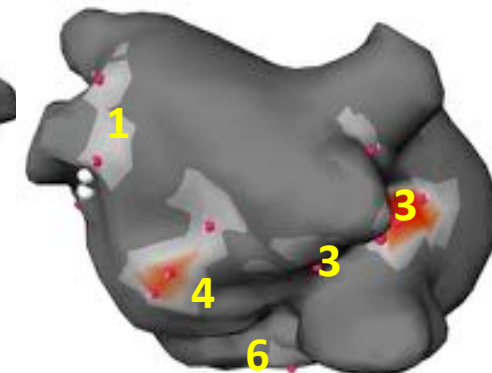
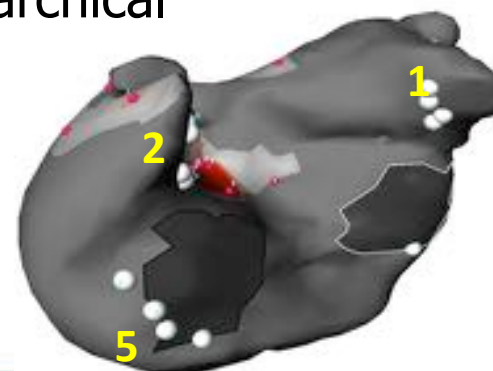
AF Interval 1



AF Interval N



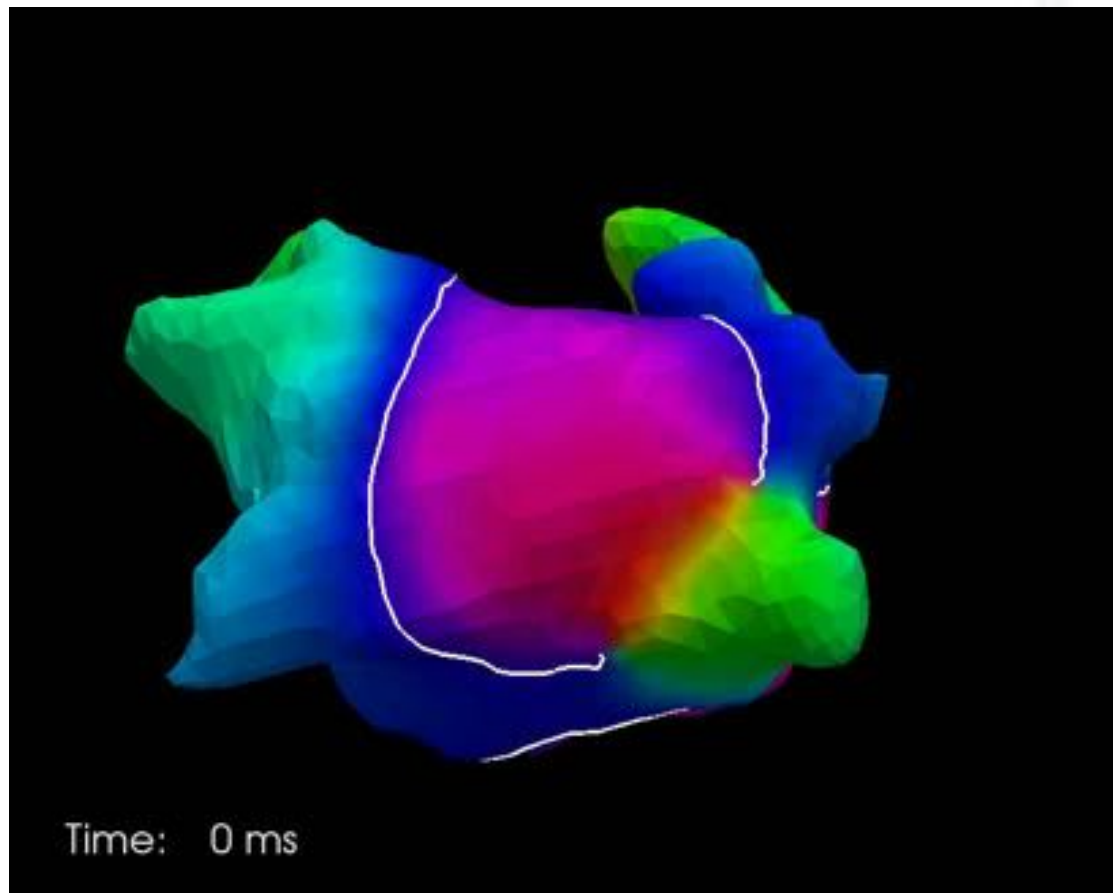
Cumulative map





RESULTS IN PAROXYSMAL AF :41 PTS

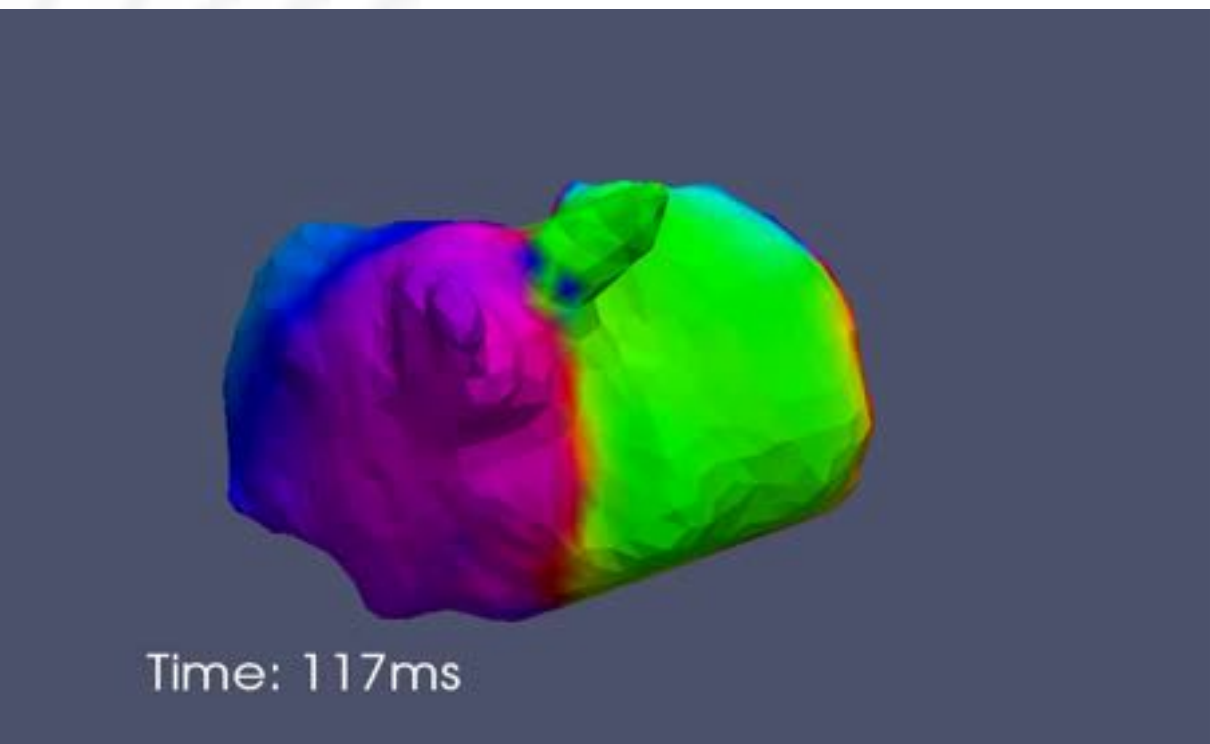
AF drivers originate from PV/post LA region : PV discharges interacting with short lived ostial rotors



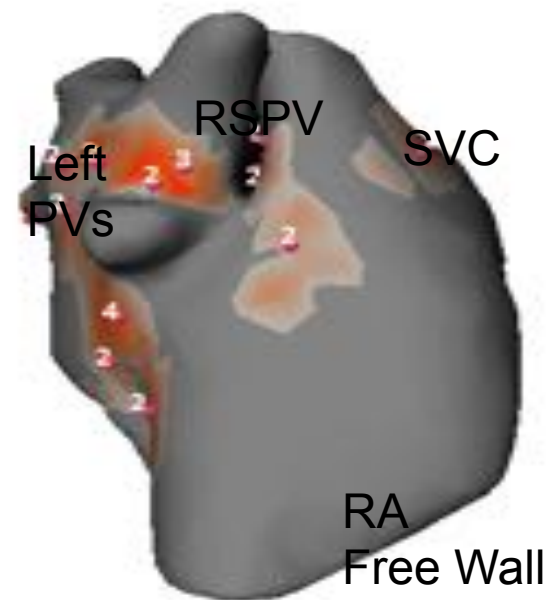


RESULTS : PsAF MULTIPLE INTERPLAYING AF DRIVERS

260 consecutifs PsAF pt, 54% SHD

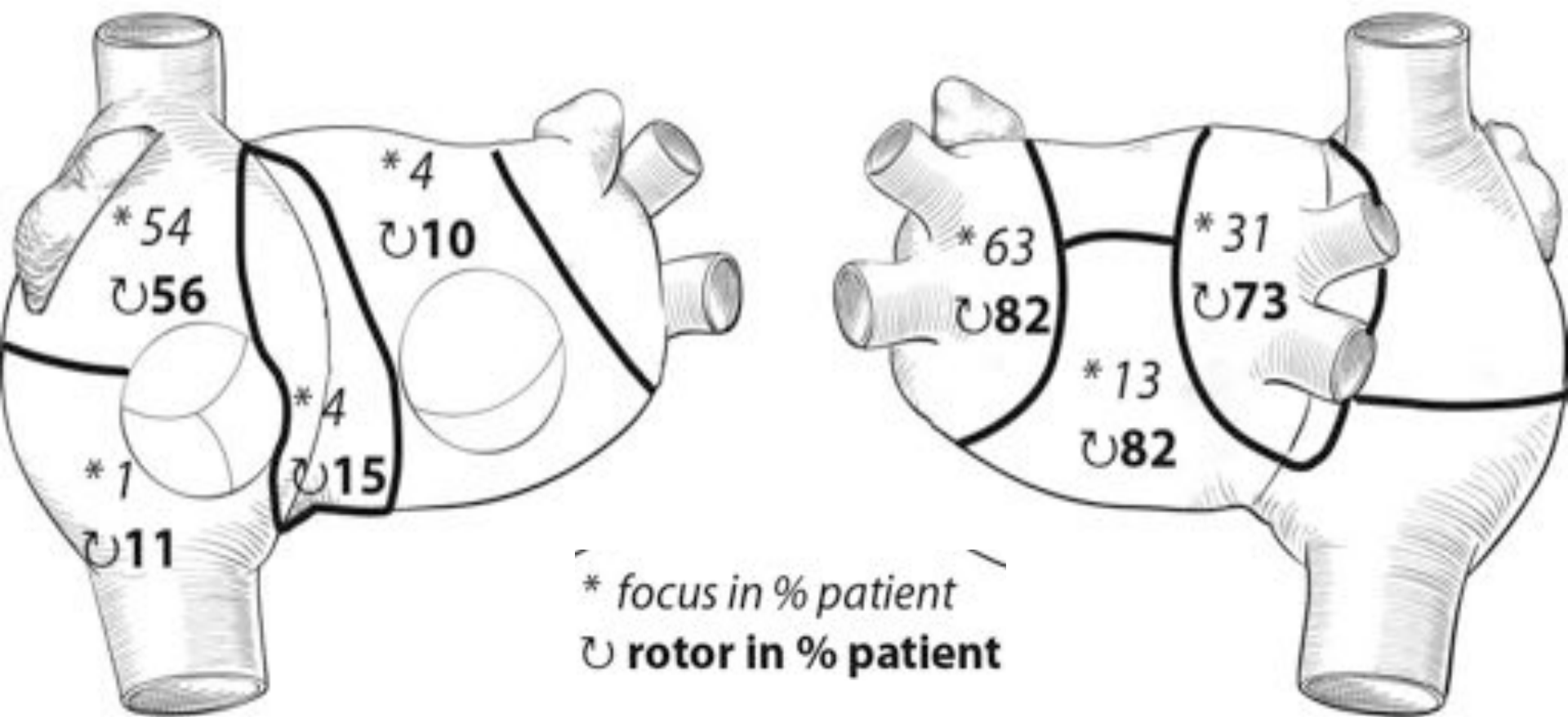


4.3 regions (1 to 7 LA/RA regions)



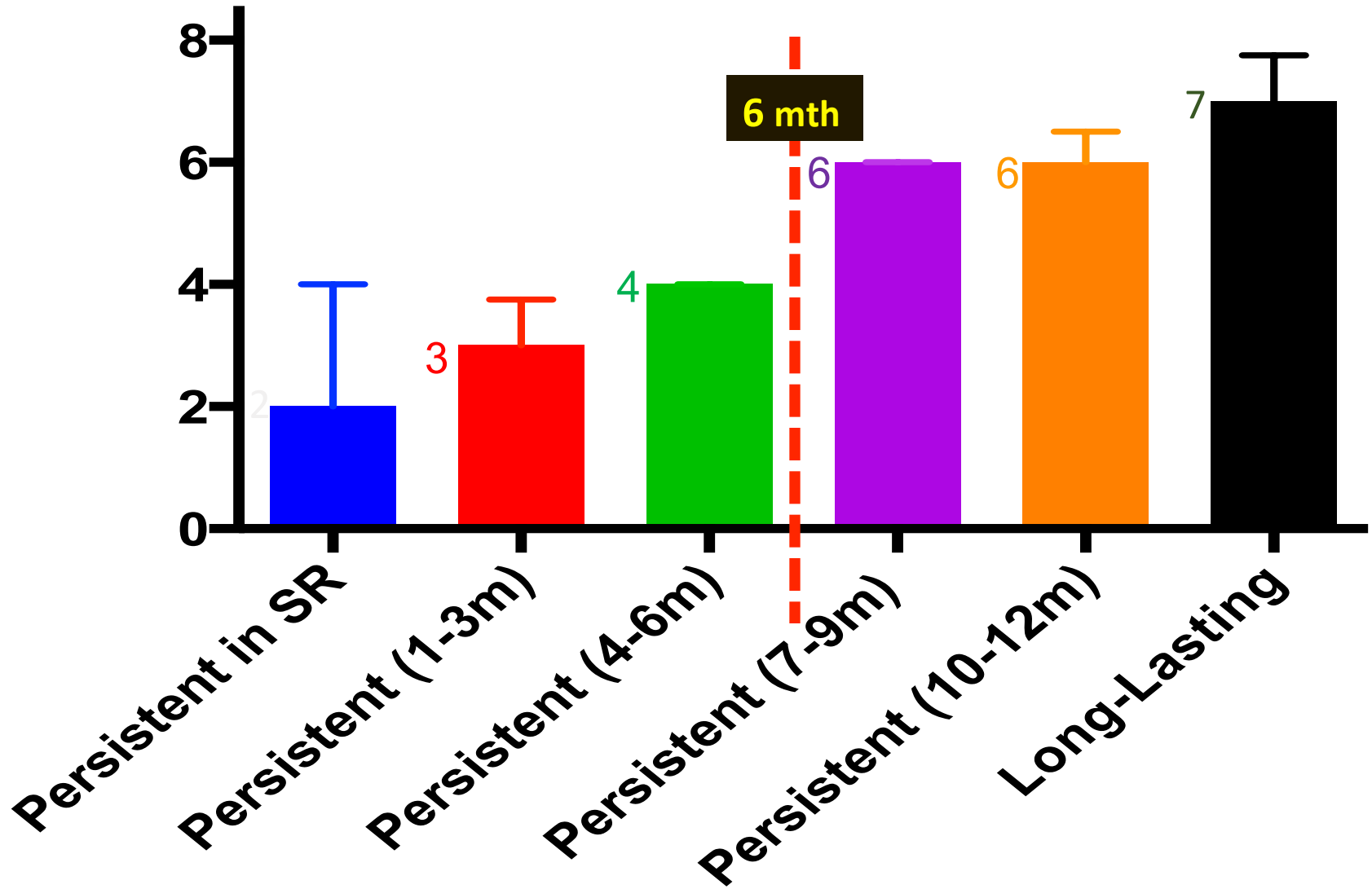
Short living (3-4 reentries/firings)
but periodically recurring in same areas

Totally, 4720 drivers mapped in 103 initial pts



Distribution in % of pts within 7 predefined regions

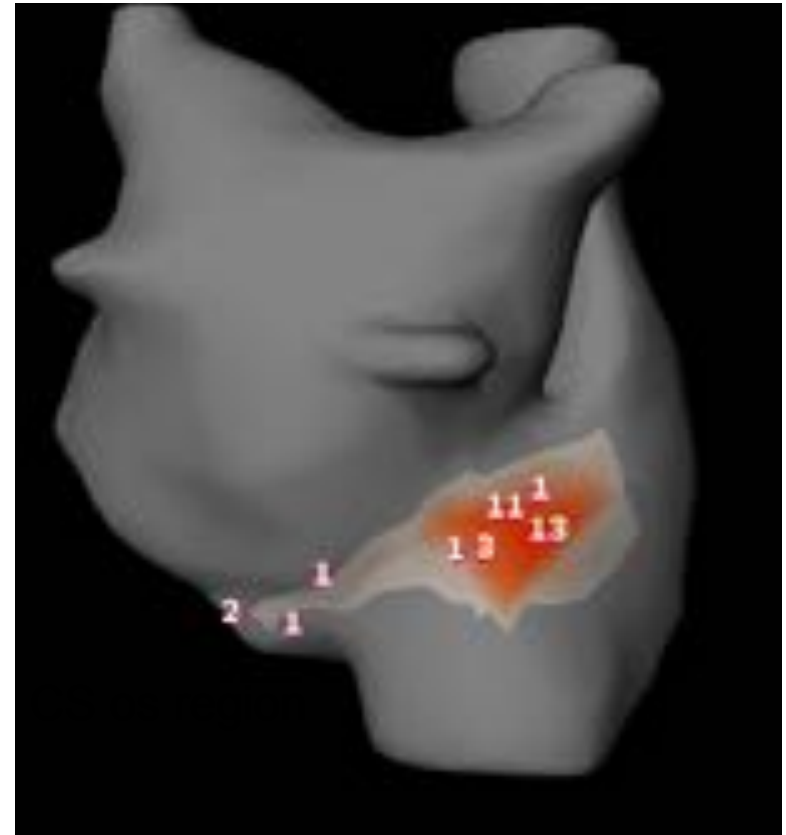
Results 1- Number of driver regions increase with AF duration



SINGLE TARGETED REGION is rare (9% of patients)

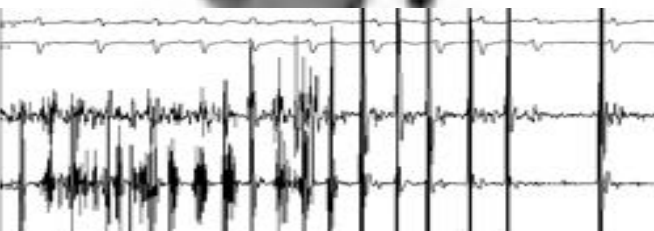
F 76 yr -Pers AF in SR

F 59yo , Pers AF 3m

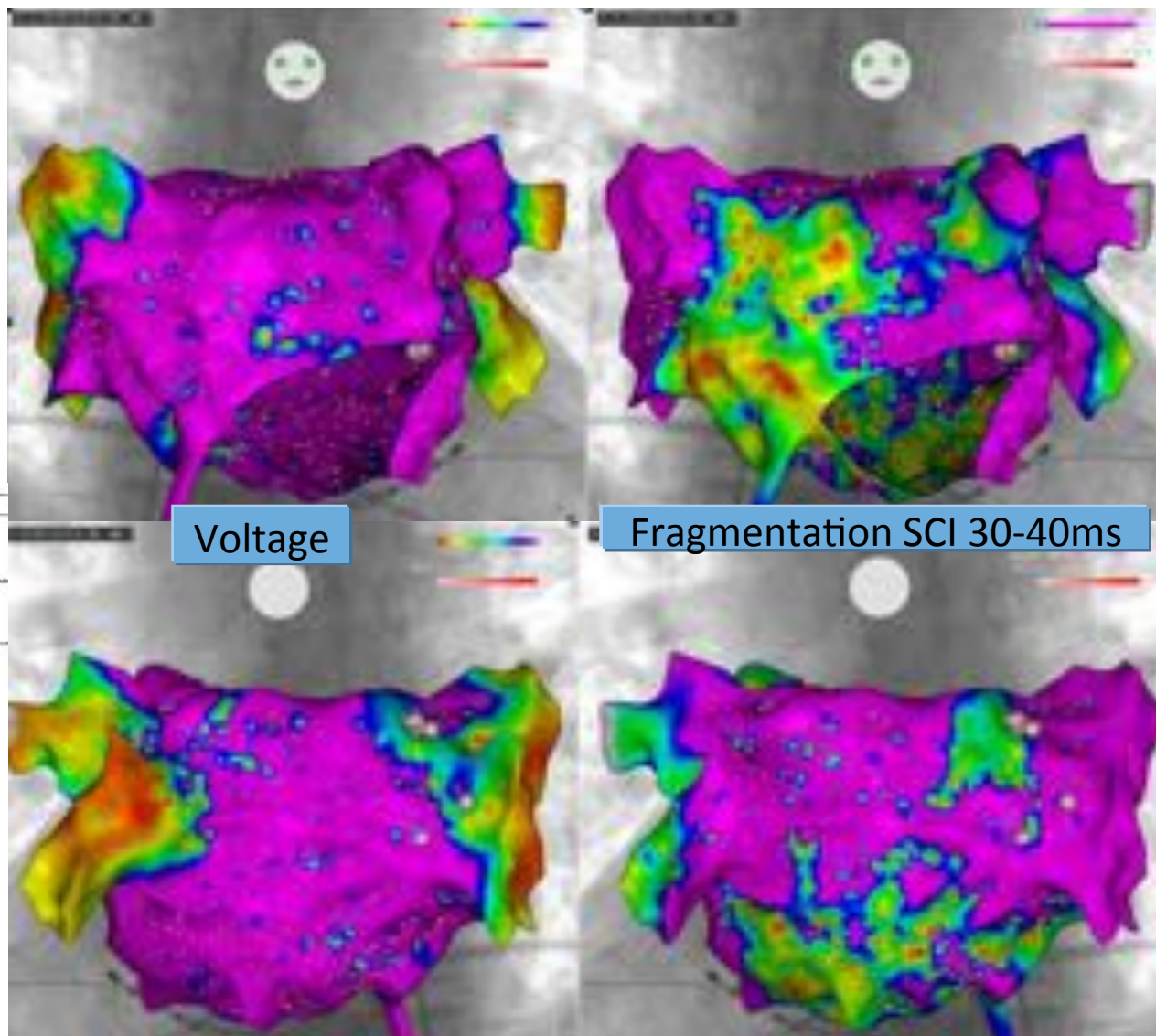


SINGLE Ablated region M 52yrs AF 1mth LA 18cm²

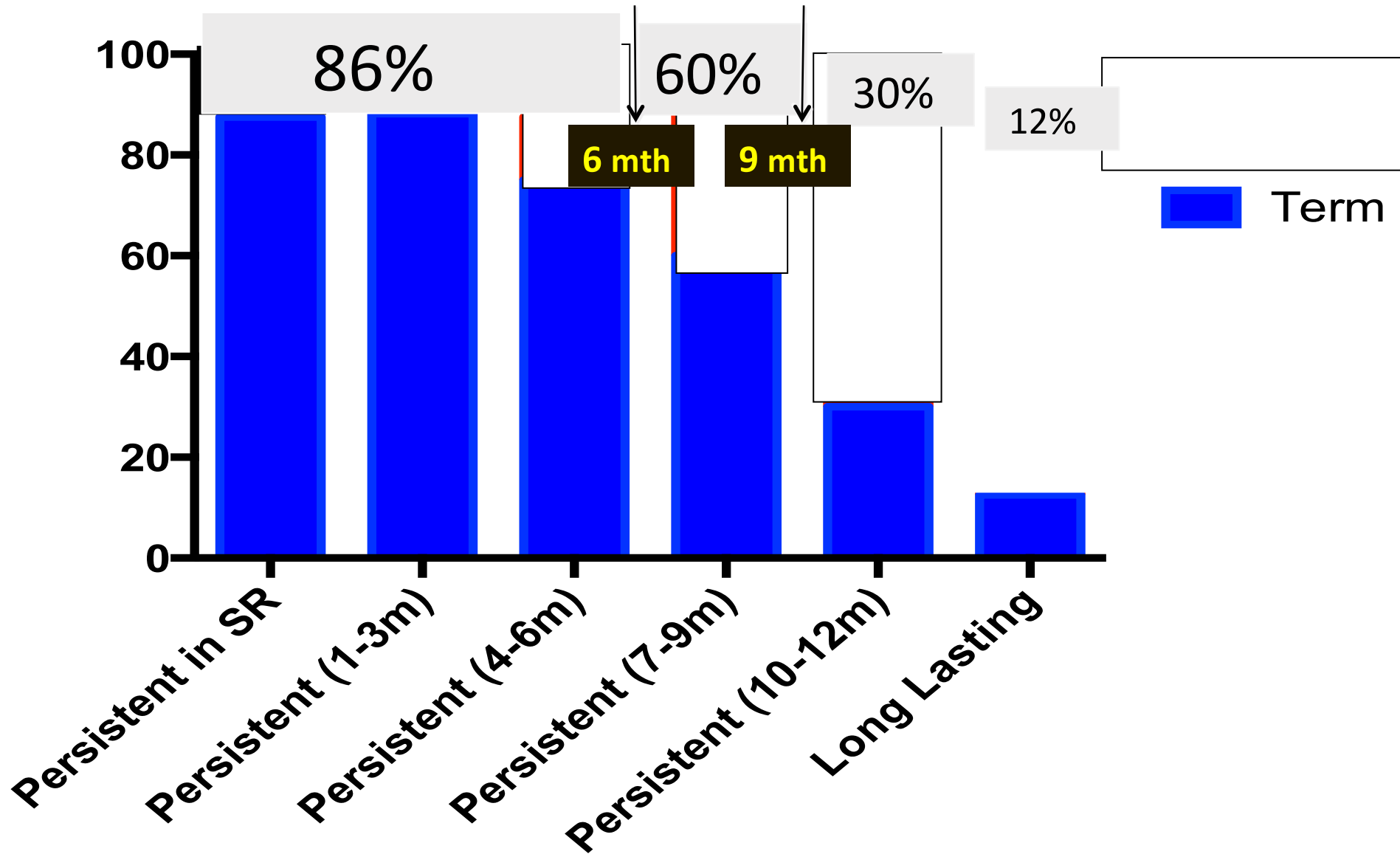
LAA Posterior ridge



AF Termination with 4
min RF
at first region
(& noninducible
afterwards)

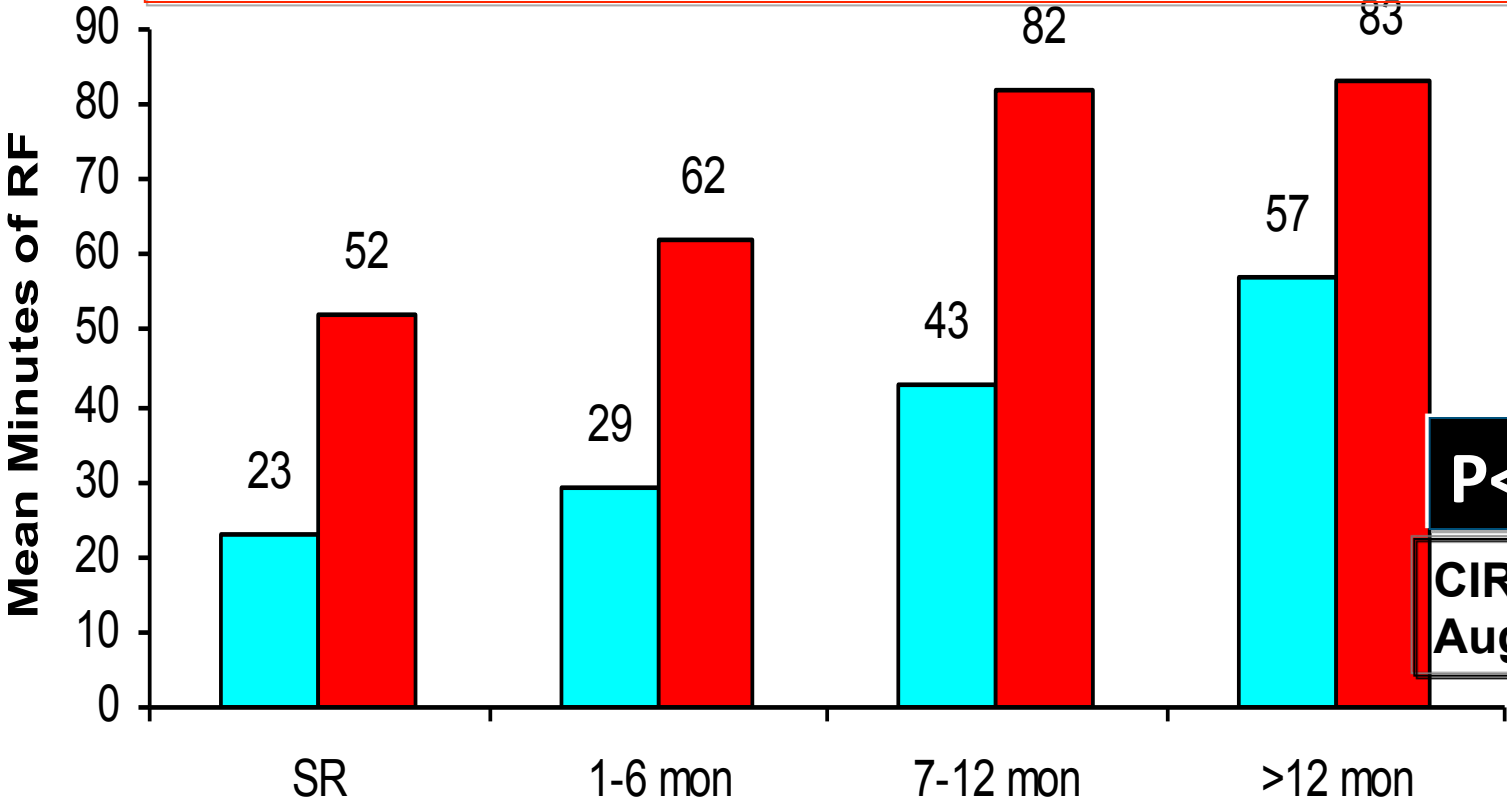


Results 2- AF termination targeting driver regions (n=172 pts)



DRASTIC REDUCTION OF RF Duration for AF termination: Driver vs Stepwise ablation

AF terminates mostly in AT even after limited RF



Approximately **-50%** - 38% - 27%

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	66%	19% 40% parox	15% 54%parox
Pts without AF termination N=15	58%	15% All Persist	37% All Persist

* <0.001

CONCLUSIONS

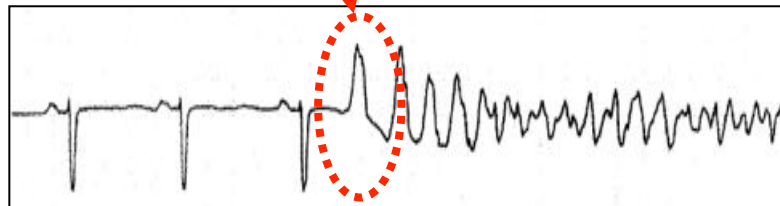
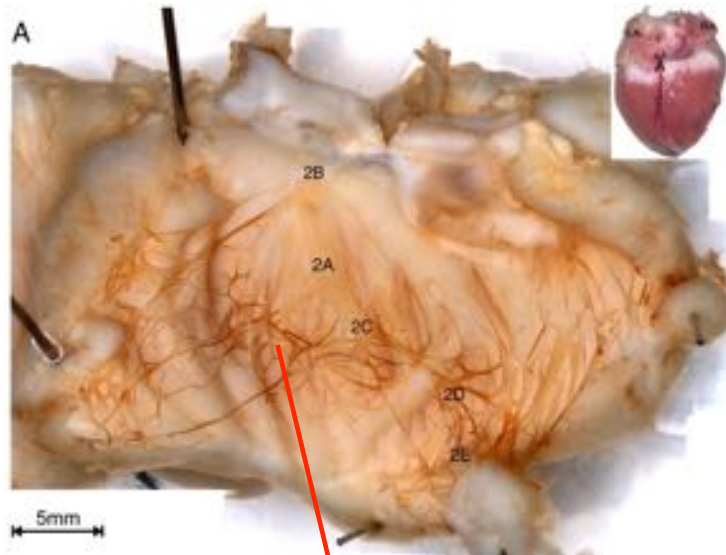
1. Noninvasive mapping visualises AF drivers which are Multiple , Meandering, ShortLasting and
2. Targeted ablation allows high rate of AF termination with minimal RF delivery.
3. Reproducibility in 8 centers (AFACART) with 78-85% AF freedom at one year when AF was terminated but 38% of AT.
4. Needs randomized studies
5. Needs signal processing improvement for small signals

VF mapping

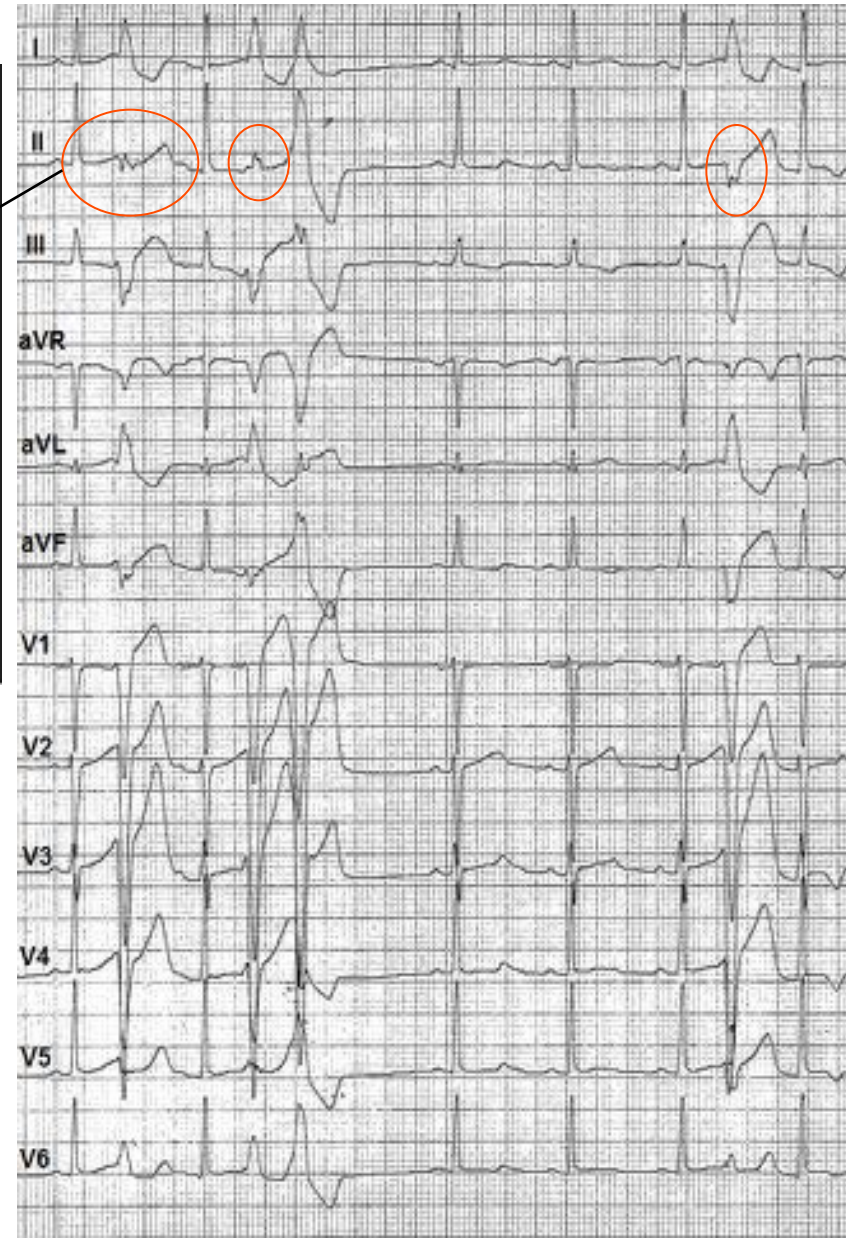
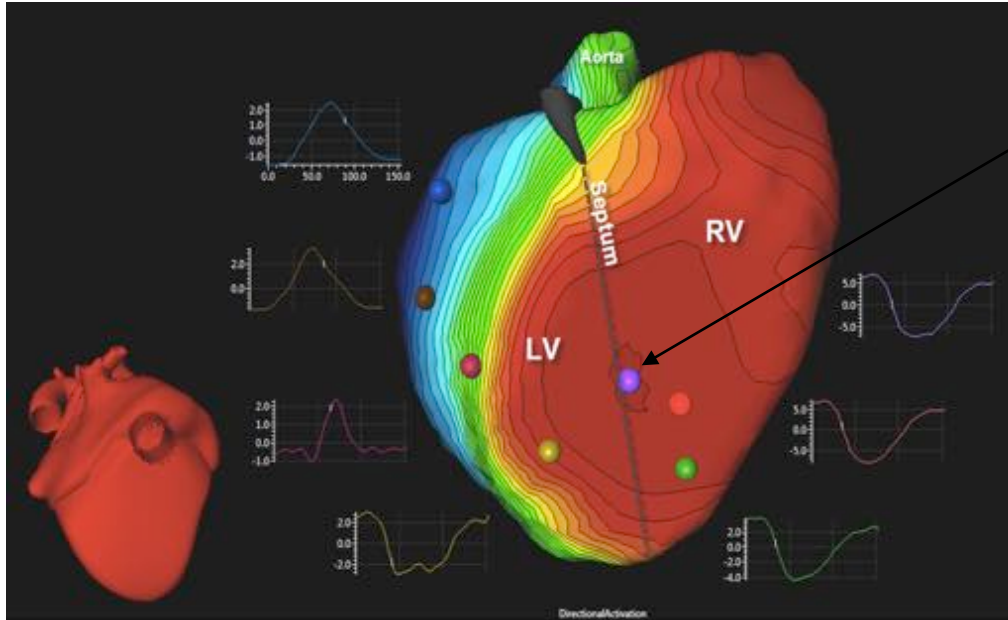


THERAPEUTIC TARGETS

Purkinje Fibers



Ablation of VF triggers



M 37 years -15 VF in 12 months
Few pleiomorphic VPBs

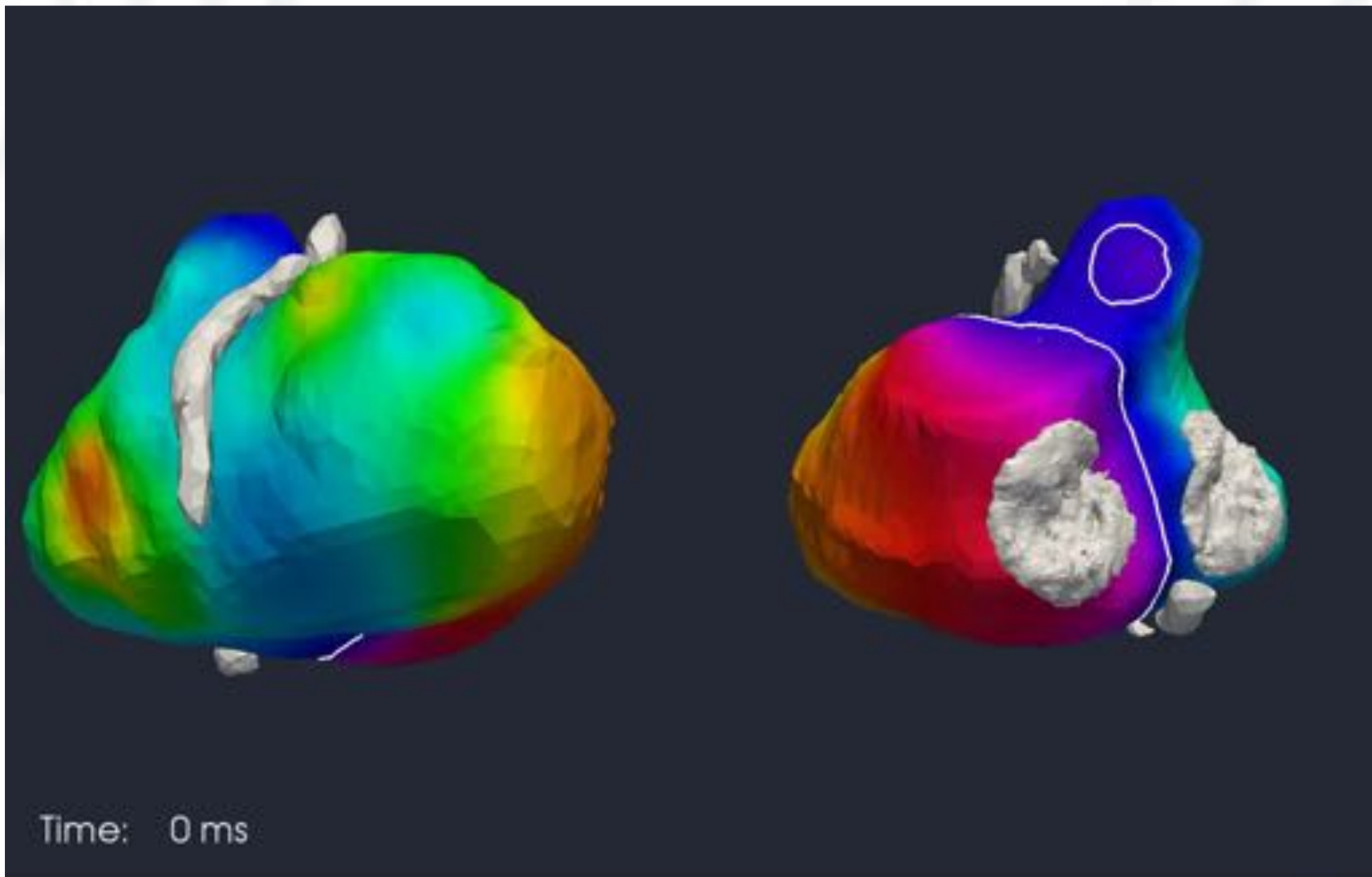
Successful ablation of VF based on
real time perprocedural mapping



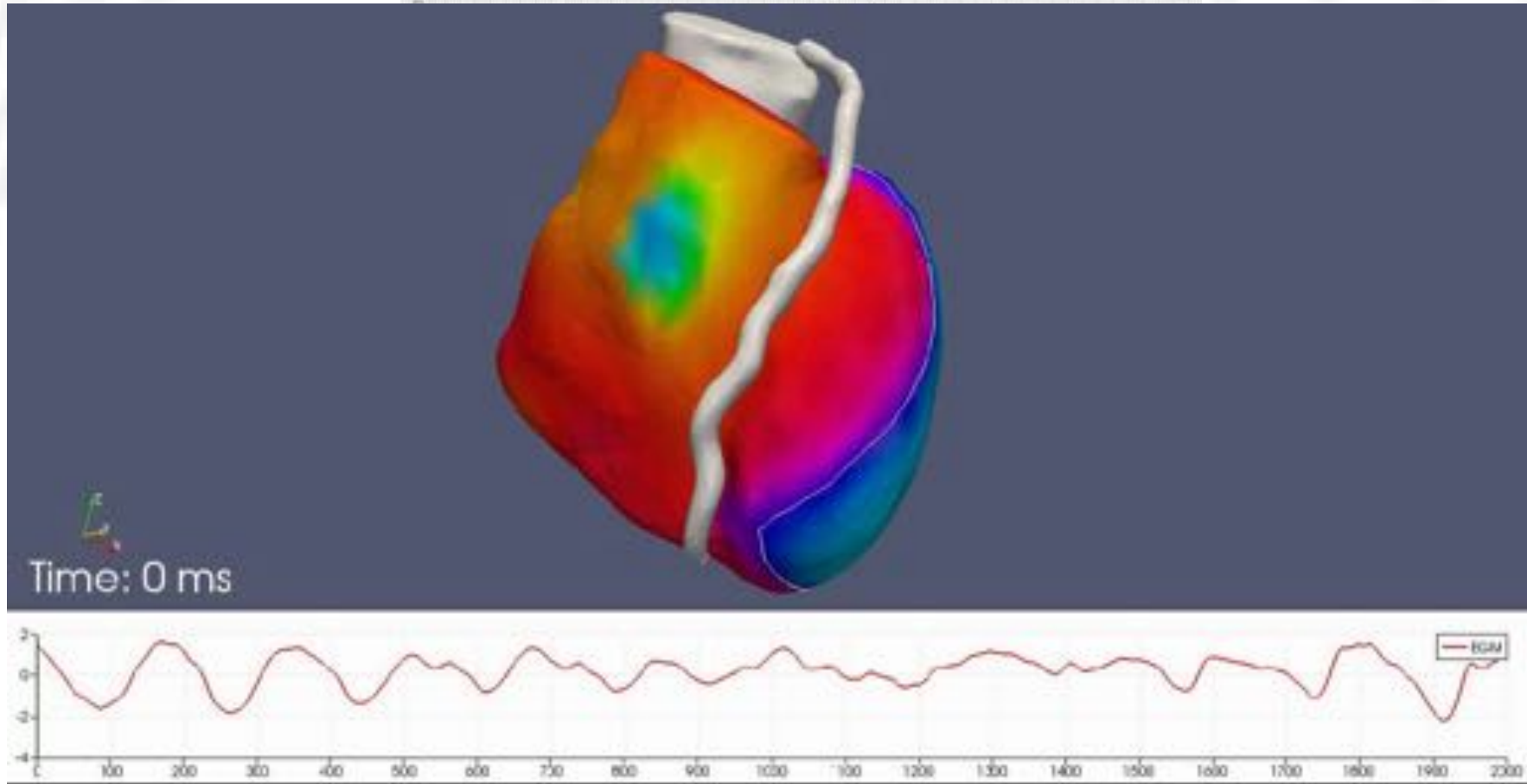
VENTRICULAR FIBRILLATION SUBSTRATE IN HUMAN IN VIVO

- **N=46 pts/ 100 VF episodes**
- **VF differences depending on SHD+++**

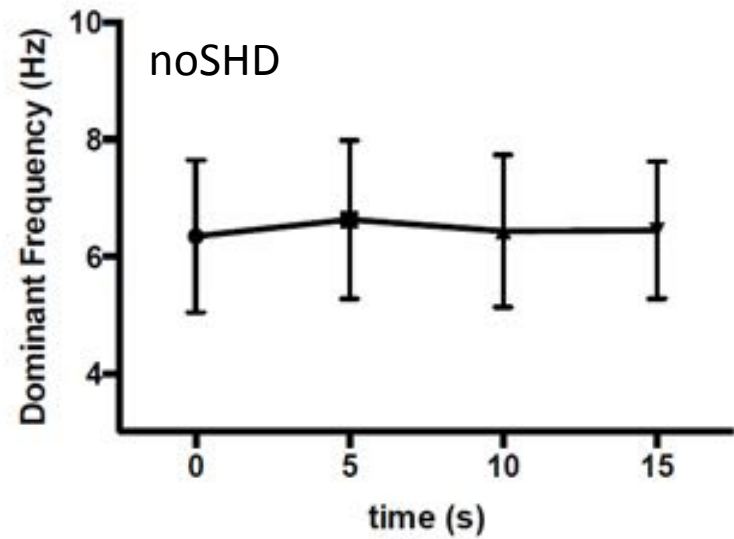
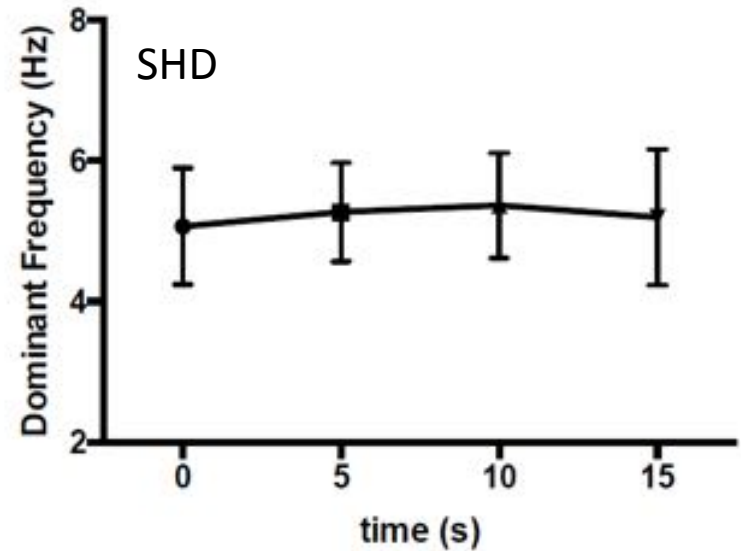
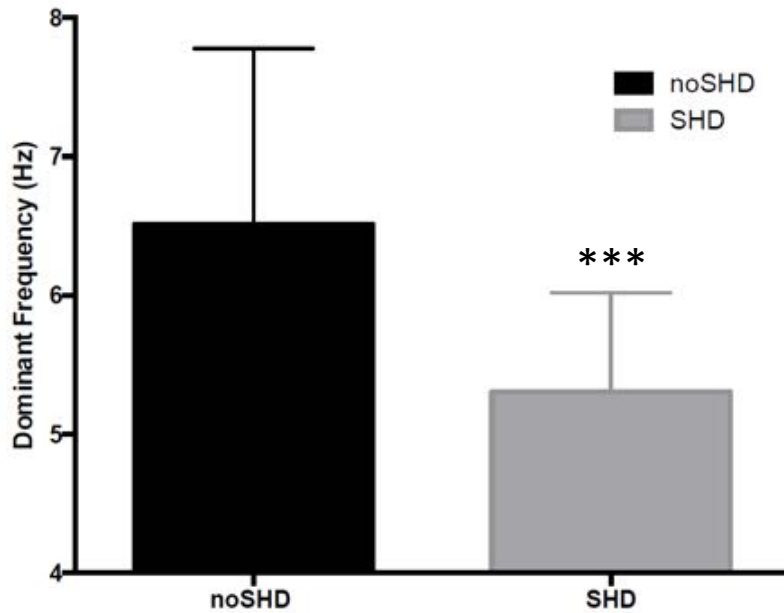
CASE: 60 YEAR OLD MAN WITH ACUTE MI



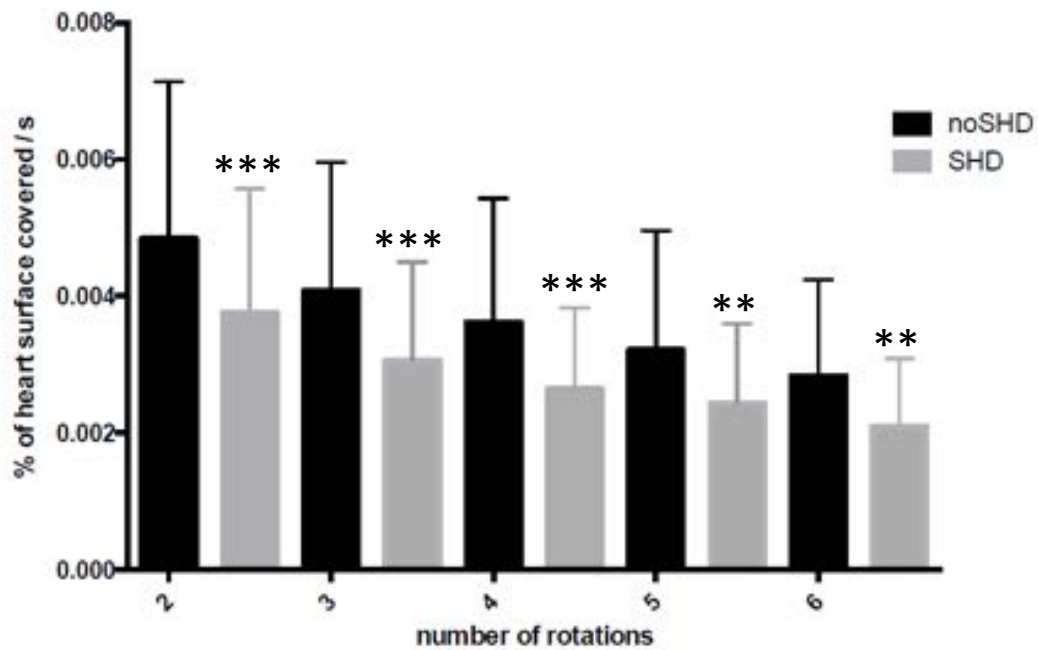
CASE: MALE 52Y OLD, SCD BRUGADA TYPE 1



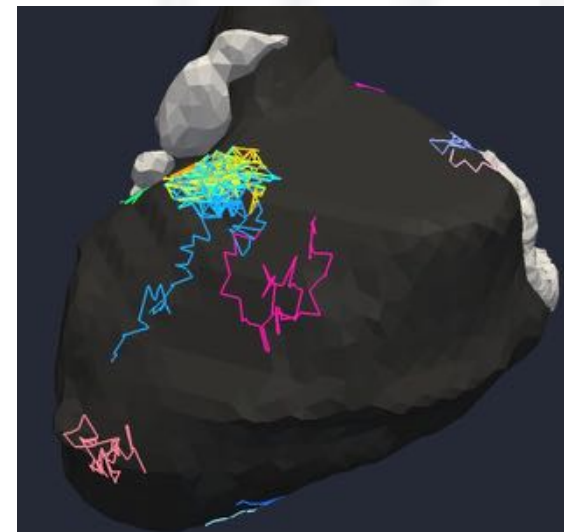
DOMINANT FREQUENCIES



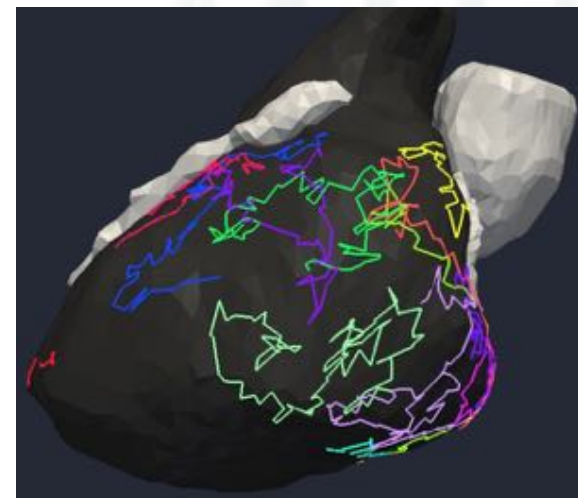
ROTOR TRAJECTORIES AND CLUSTERING



SHD

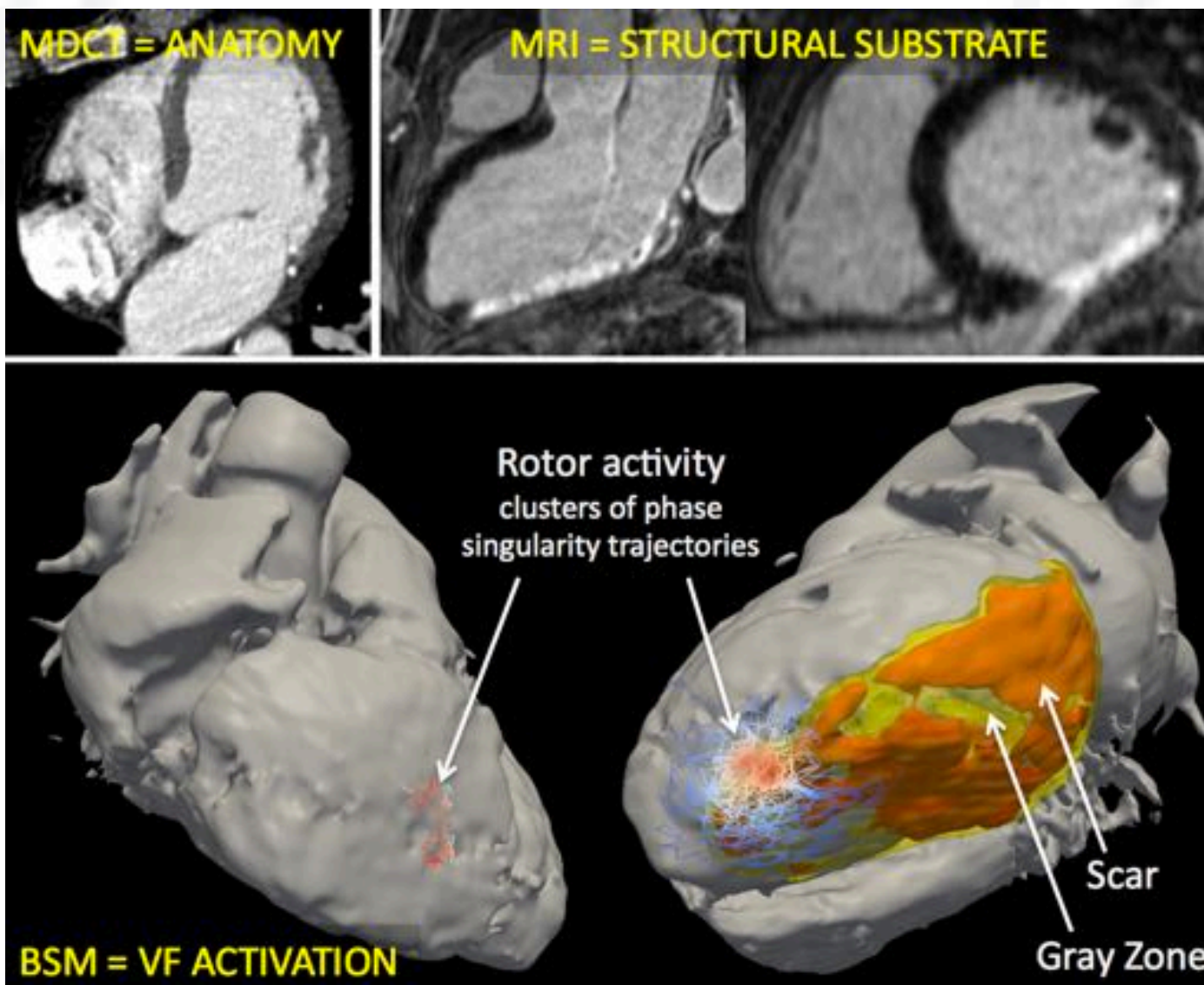


No SHD





Core rotor and scar location



CONCLUSIONS

1. First demonstration of 3D panoramic VF mapping in humans *in vivo* confirming a role for rotors in maintenance of VF.
2. Demonstrate that the VF dynamics differ in patients with SHD from those without SHD.
3. Non invasive mapping may provide new insights on physiopathology of human VF.
4. Potential clinical implications to define individual substrate-based interventions.
5. Triggers most often from Purkinje network.