

VENICE ARRHYTHMIAS, 16-18 OCTOBER, 2015

# Mechanisms of atrial fibrillation terminations in humans: insights from non-invasive cardiac mapping

E. Fetisova, A. Tsyganov, M. Chaykovskaya, V. Kalinin, M. Yakovleva  
Petrovsky Research Surgery Centre, Moscow, Russia

# DISCLOSURE

I have nothing to declare

# Epidemiology and clinical significance of atrial fibrillation

- Atrial fibrillation is the most common sustained cardiac arrhythmia (approximately 8 millions adults over 55 years had AFib in 2010)
- AFib is associated with an increased risk of mortality and morbidity due to thromboembolism and heart failure (AFib is the most common factor in the stroke in the elderly)



# What is Noninvasive ECG Imaging?

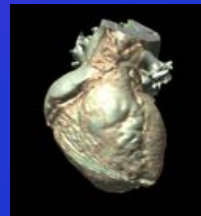
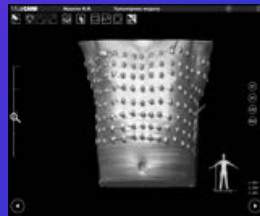
Noninvasive ECGI is the technology of numerical reconstruction and visualization of the electrical heart activity based on the ECG data measured on the body surface



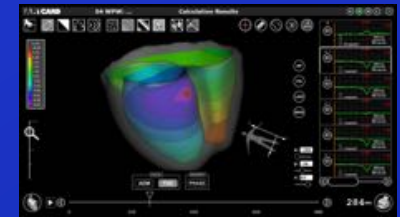
MRI or CT scan



ECG registration



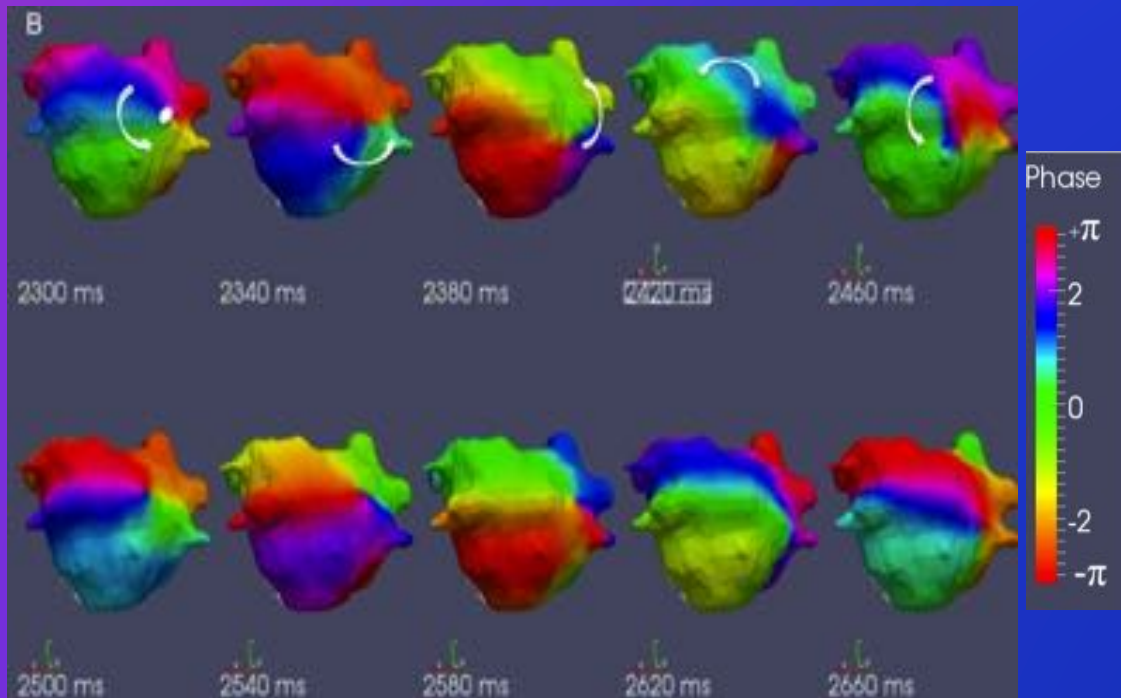
TORSO AND HEART VOLUME  
RECONSTRUCTION



VOLTAGE, ISOCHRONE  
AND PHASE MAPS OF  
EPICARD AND ENDOCARD



# Noninvasive Phase Mapping



Rotors visualization using phase mapping.

Haissaguerre M, Hocini M, Shah AJ, Derval N, Sacher F, Jais P, Dubois R. Noninvasive Panoramic Mapping of Human Atrial Fibrillation mechanisms: **A Feasibility report**. J. Cardiovasc. Electrophysiol. 2013. 24(6): 711-7.

# Objective



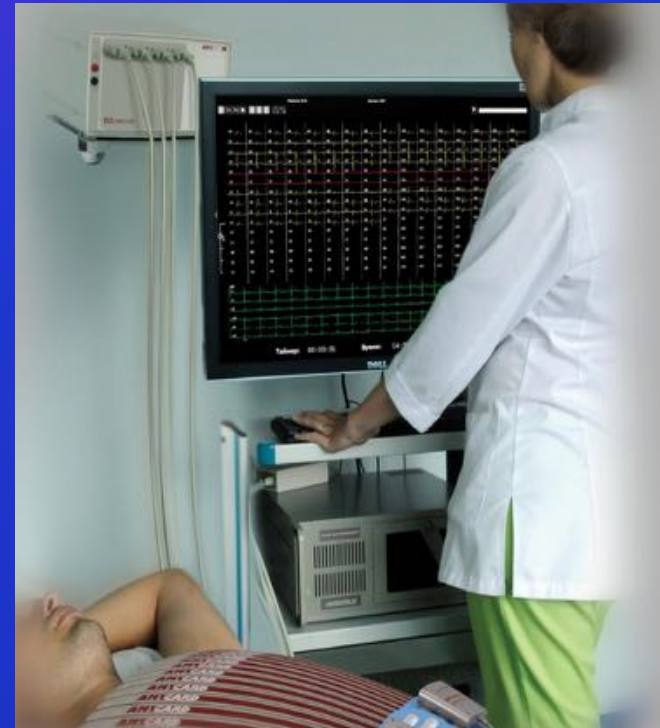
To investigate the process of atrial fibrillation  
induction and termination  
in humans



# Patient characteristics

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Age	52	50	47	46	70
Gender	female	male	male	male	female
Type of AFib	paroxysmal	paroxysmal	paroxysmal	paroxysmal	paroxysmal
LA diameter (mm)	42	44	40	38	41
EF LV (%)	>55	>55	>55	>55	>55
Spontaneous initiation of AFib	Yes	No	No	Yes	No
Termination of AFib	Propafenone (1mg/kg)	spontaneous	spontaneous	spontaneous	Propafenone (1mg/kg)

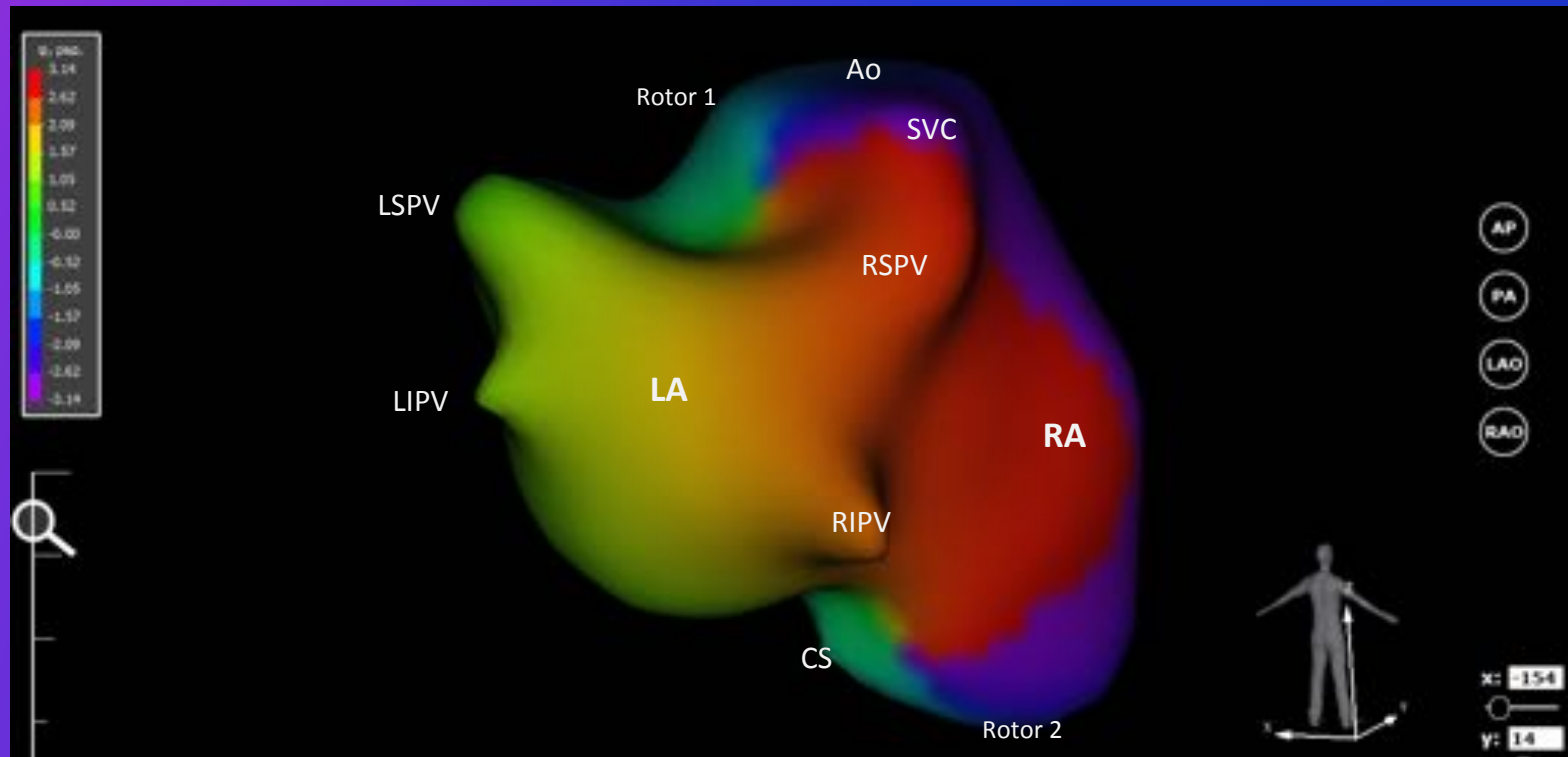
# Mapping system



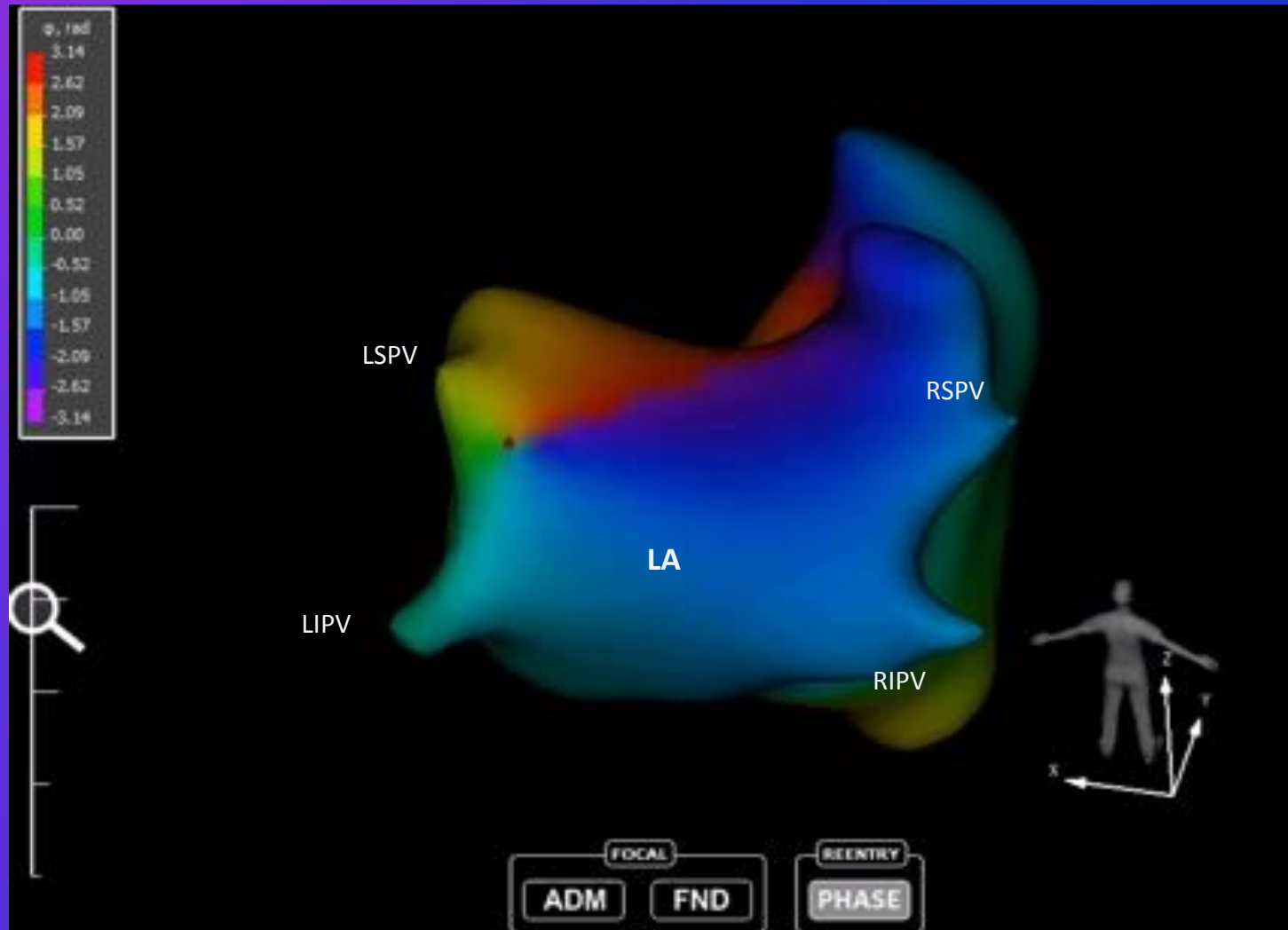
Noninvasive endocardial end epicardial mapping system «AMYCARD 01C» by EP SOLUTIONS SA, Switzerland



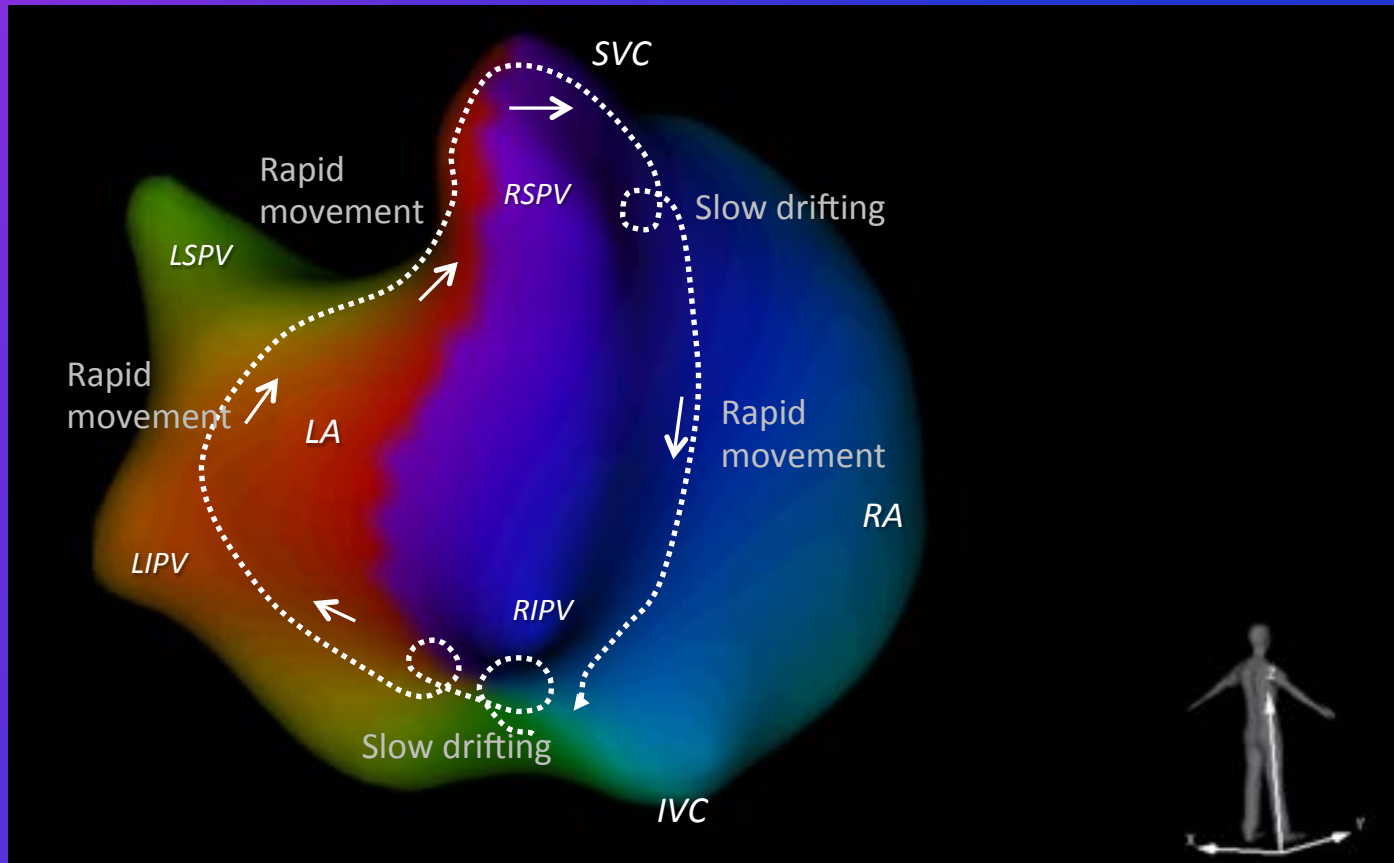
# Typical phase maps during atrial fibrillation



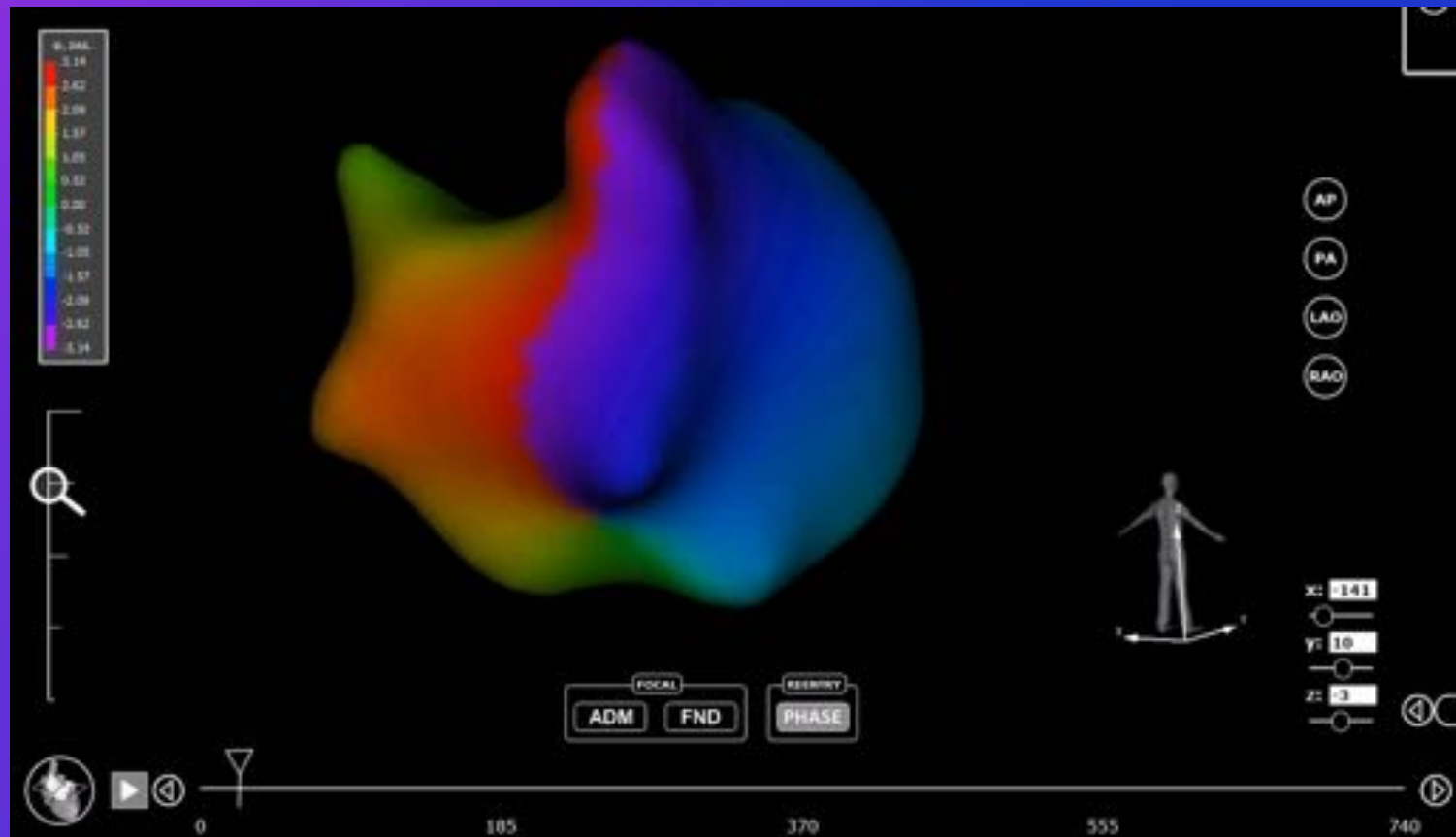
# Typical phase maps during atrial fibrillation



# CW rotor movement: Dominant trajectory



# CW rotor movement: Dominant trajectory



# ATRIAL FIBRILLATION INDUCTION

# Baseline Patient Characteristics: AFib induction and termination Study

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Spontaneous initiation of AFib	Yes	No	No	Yes	No
Spontaneous termination of AFib	No	Yes	Yes	Yes	No
<b>The mechanism of induction</b>	<b>LIPV</b>	_____	_____	<b>RSPV</b>	_____

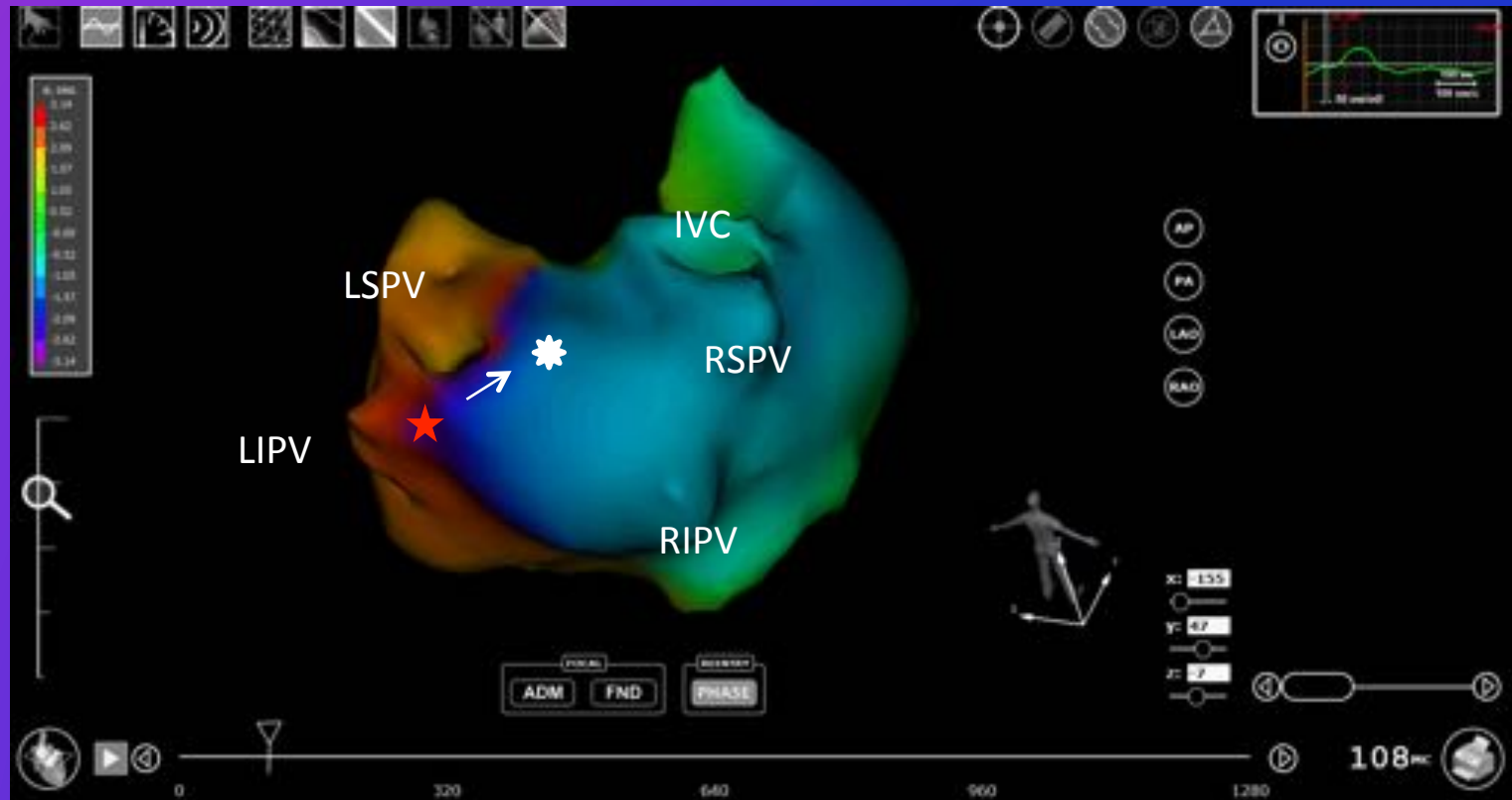


## Ectopical activity in LIPV triggered AFib



Red arrow  
indicates the  
PAC

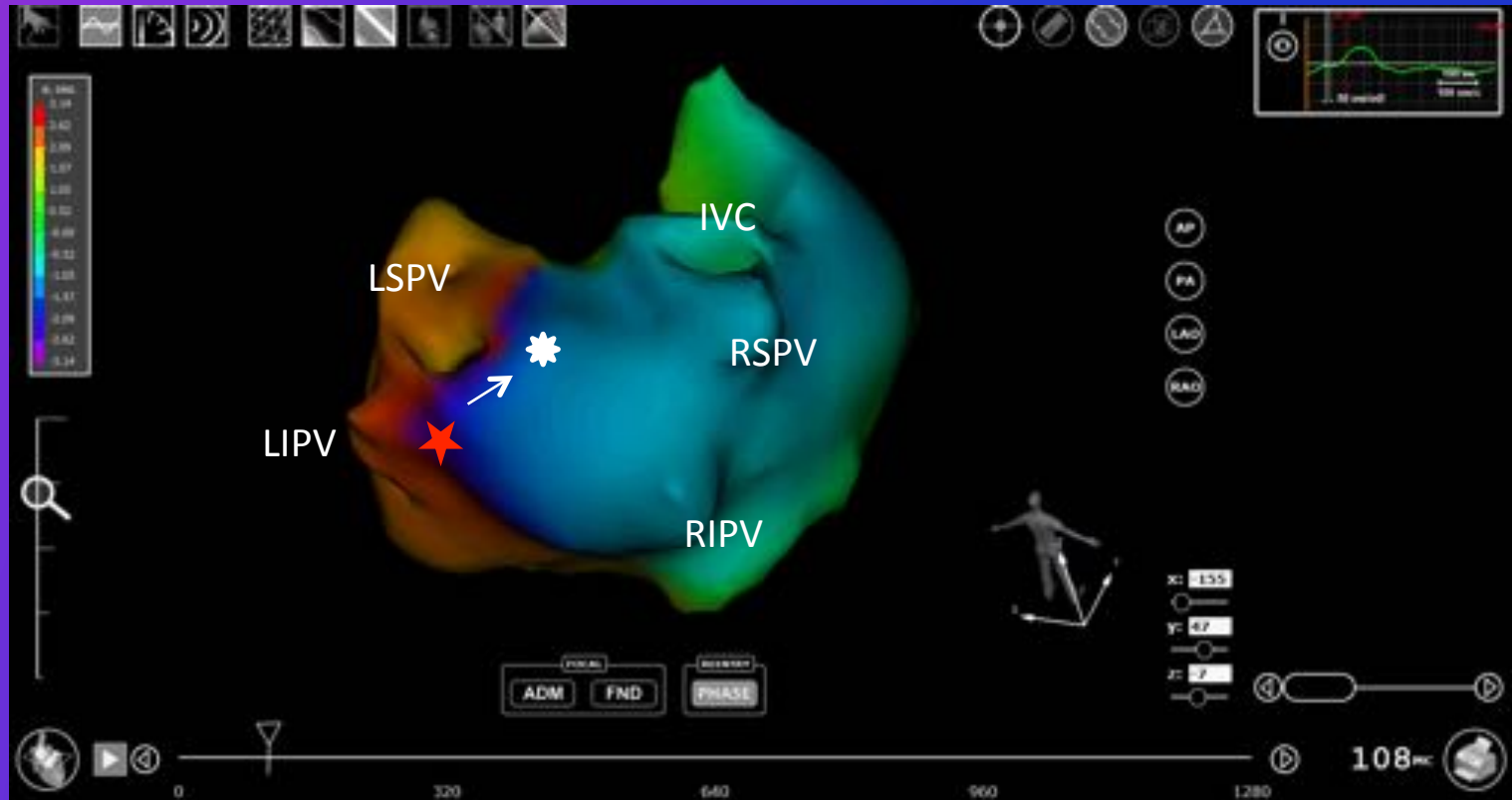
# Ectopical activity in LIPV triggered AFib



the red star- ectopic focus

the white star- the emergence of the rotor

# Ectopical activity in LIPV triggered AFib



[video]

# TERMINATION OF ATRIAL FIBRILLATION

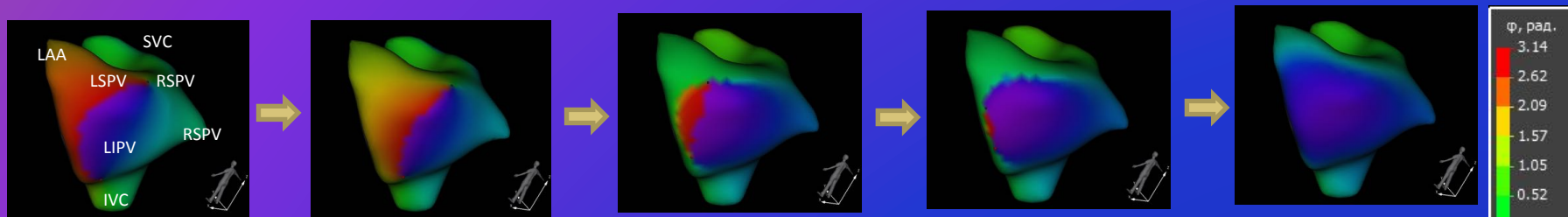
# Spontaneous atrial fibrillation termination

# Termination of atrial fibrillation

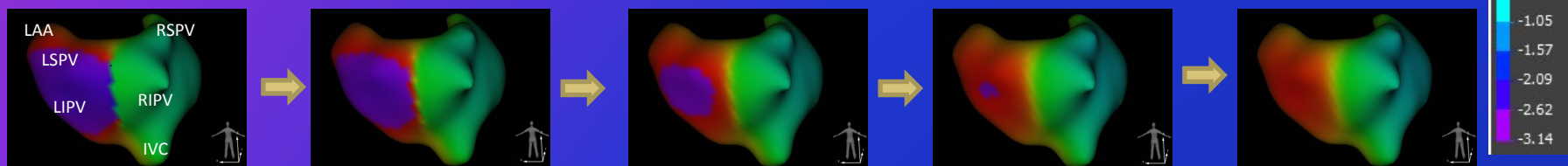




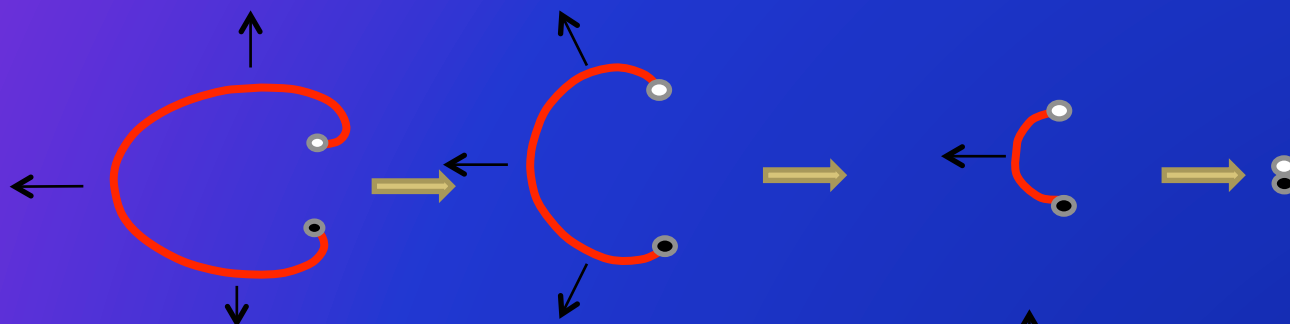
A



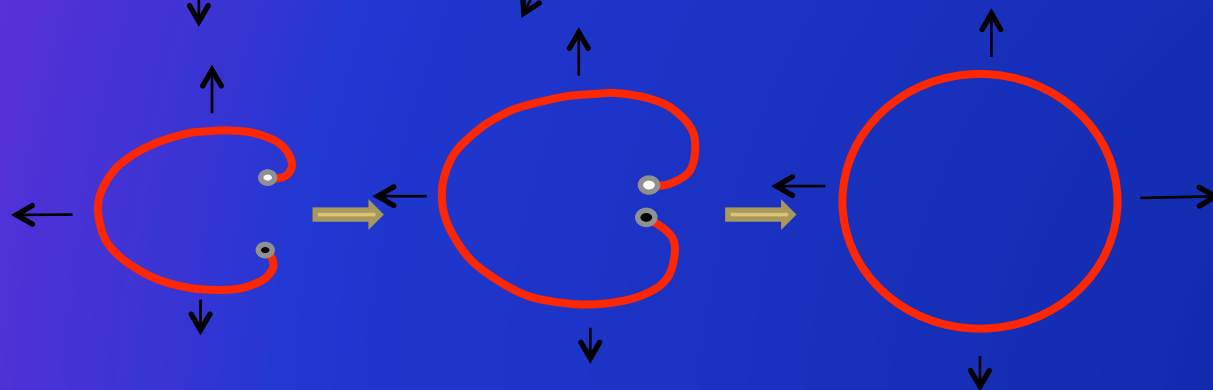
B



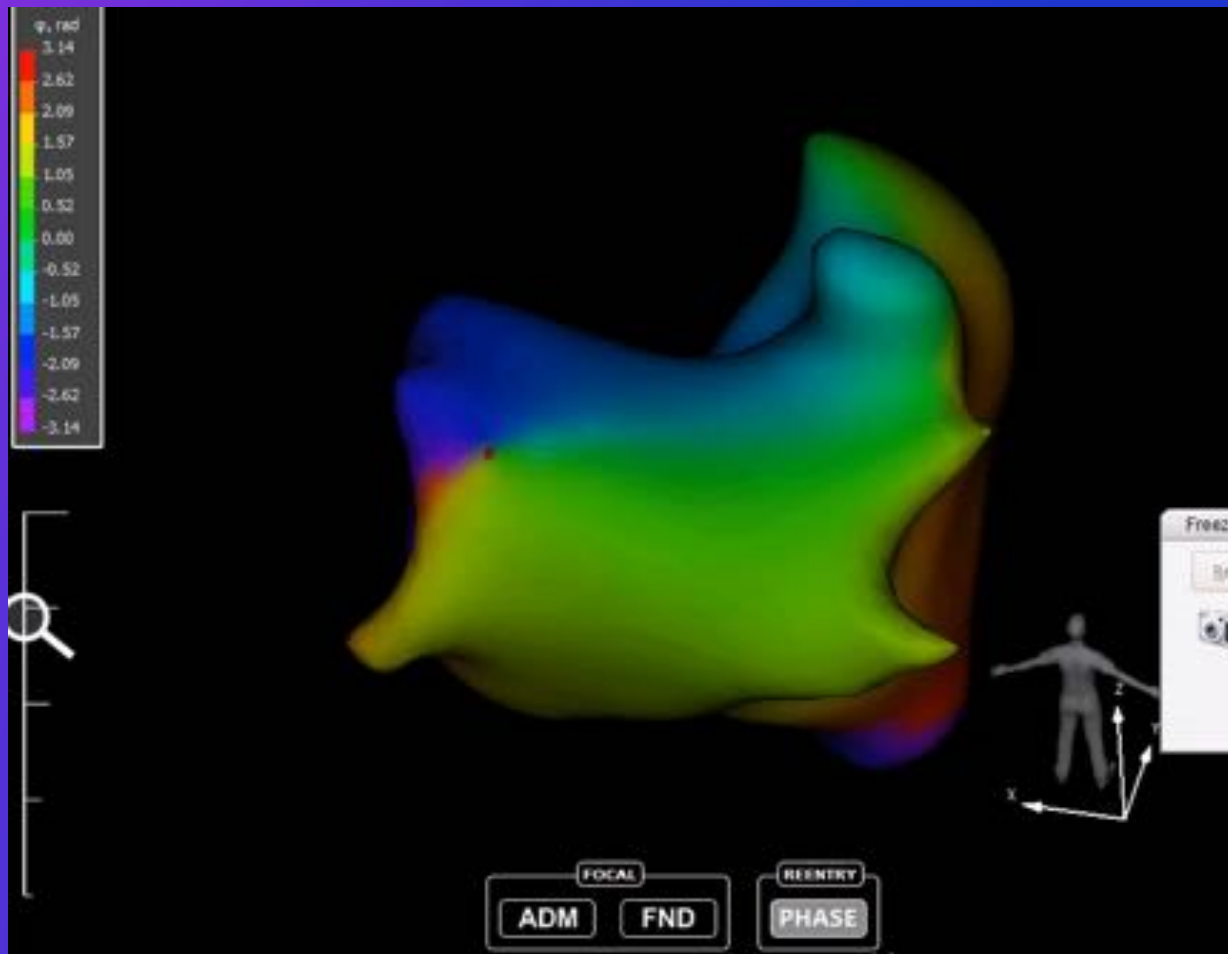
A



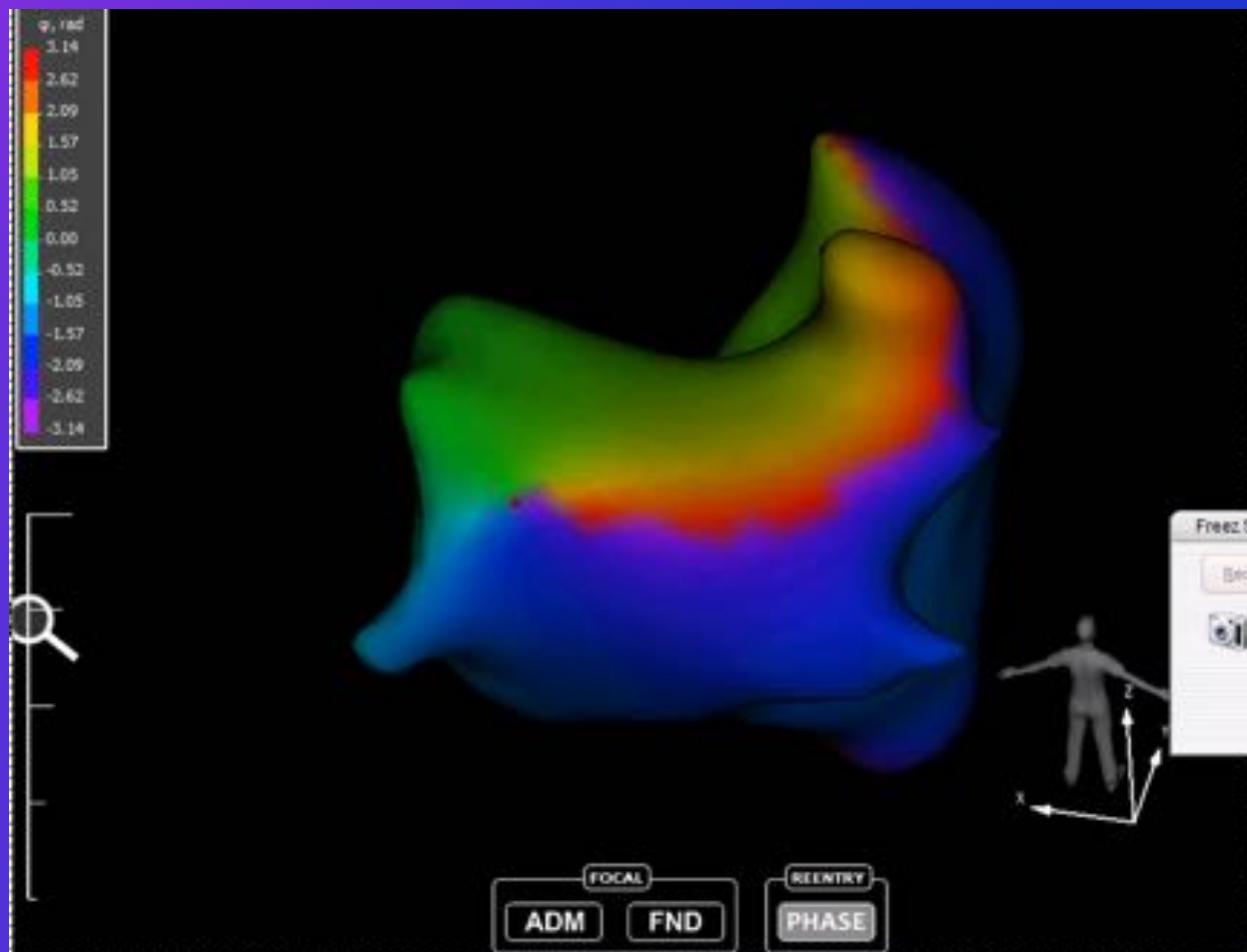
B



# Event A



# Event B

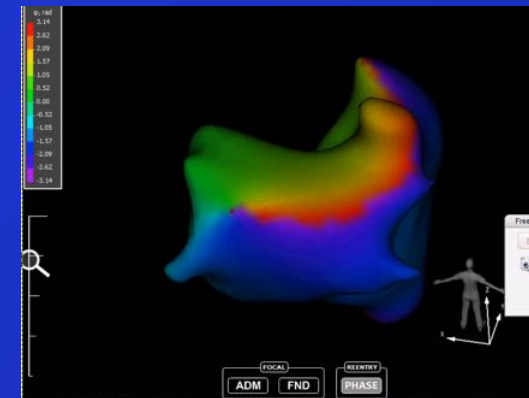
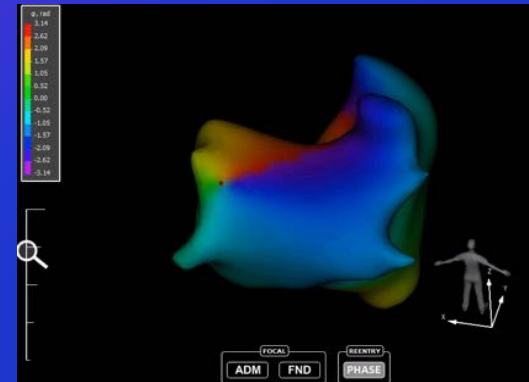
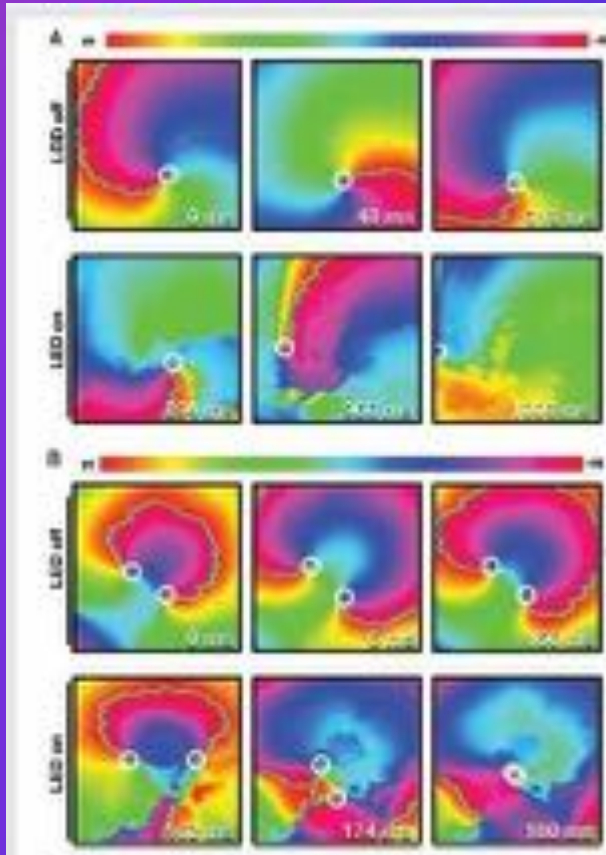


# Pharmacological cardioversion

## Estimated parameters (on baseline condition and under propafenone administration)

- Rotors stability (score of rotation)
- Rotors cycle length
- Rotors meandering area square
- Number of events PhS collision (A and B type)
- The type of the final event, which led to sinus rhythm recovery

# Termination of atrial fibrillation in vitro



Brian O. Bingen, Marc C. Engels, Martin J. Schalij, Wanchana Jangsangthong, Zeinab Neshati, Iolanda Feola, Dirk L. Ypey, Said F.A. Askar, Alexander V. Panfilov, Daniel A. Pijnappels, and Antoine A. F. de Vries. Light-induced termination of spiral wave arrhythmias by optogenetic engineering of atrial cardiomyocytes. *Cardiovascular Research* 2014; 104: 194 – 205.



# Conclusions

- Mutual annihilation of rotors with opposite direction of rotation is the basic mechanism of spontaneous and propafenone-induced AFib termination
- The most of rotors annihilation events didn't lead to AFib termination, because the second re-entrant wave could be a cause of AFib maintenance
- AFib termination is a stochastic process. The probability of AFib termination depends on rotors collision probability and a random number of co-exited reentrant waves
- It is difficult to explain drug-induced AFib termination using the conception of wave length (i.e. conduction velocity and refractory period duration)
- The influence of drug-induced changes of myocardial cellular EP properties on a complex and stochastic mechanism of AFib termination required further investigations

Thank you very much for attention!