Patient-tailored Approach for Atrial Fibrillation:

Electrogram-Based Ablation Targeting Low-Voltage, Fractionation, Dispersion

Amir Jadidi, MD

University Heart Center Freiburg-Bad Krozingen Germany

RHYTHM Nice

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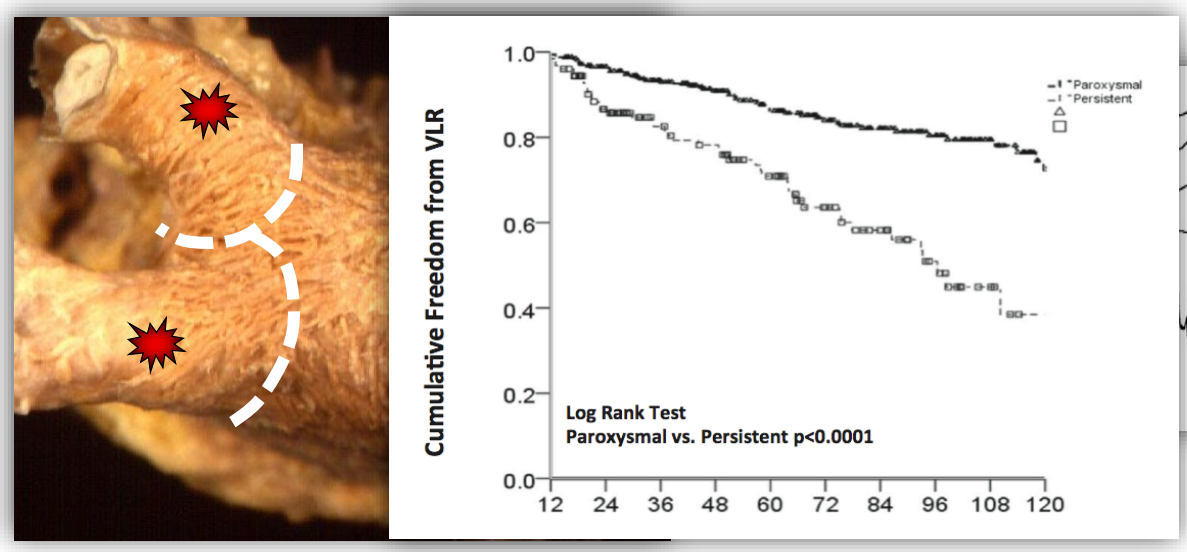
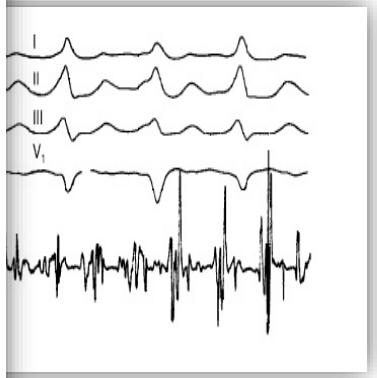
Paroxysmal Atrial Fibrillation Initiated by Ectopic Beats from the Pulmonary Veins





Engl J Med 1998

Steinberg et al.: Heart Rhythm 2014

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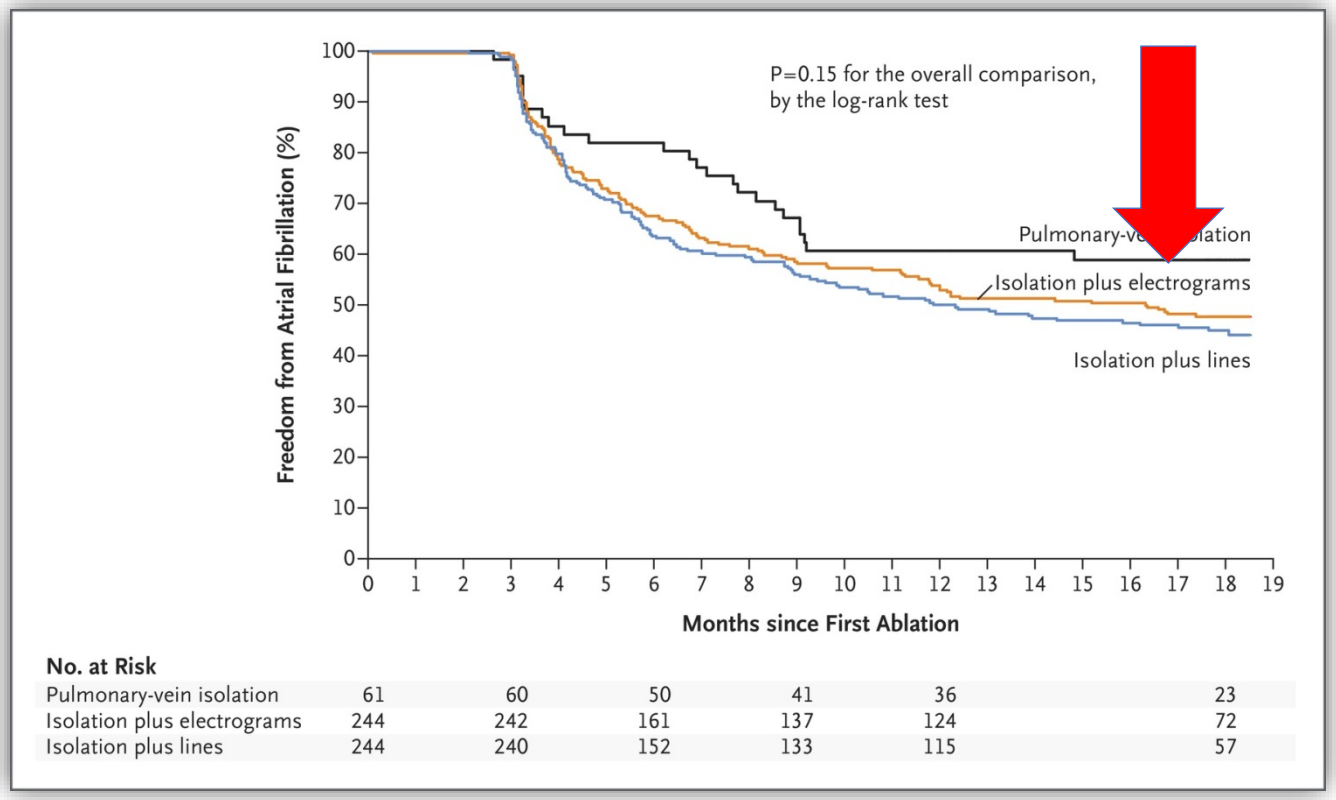
Success of Ablation in Persistent AF Results of Conventional Approaches



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

Verma A.: STAR AF II, NEJM 2015

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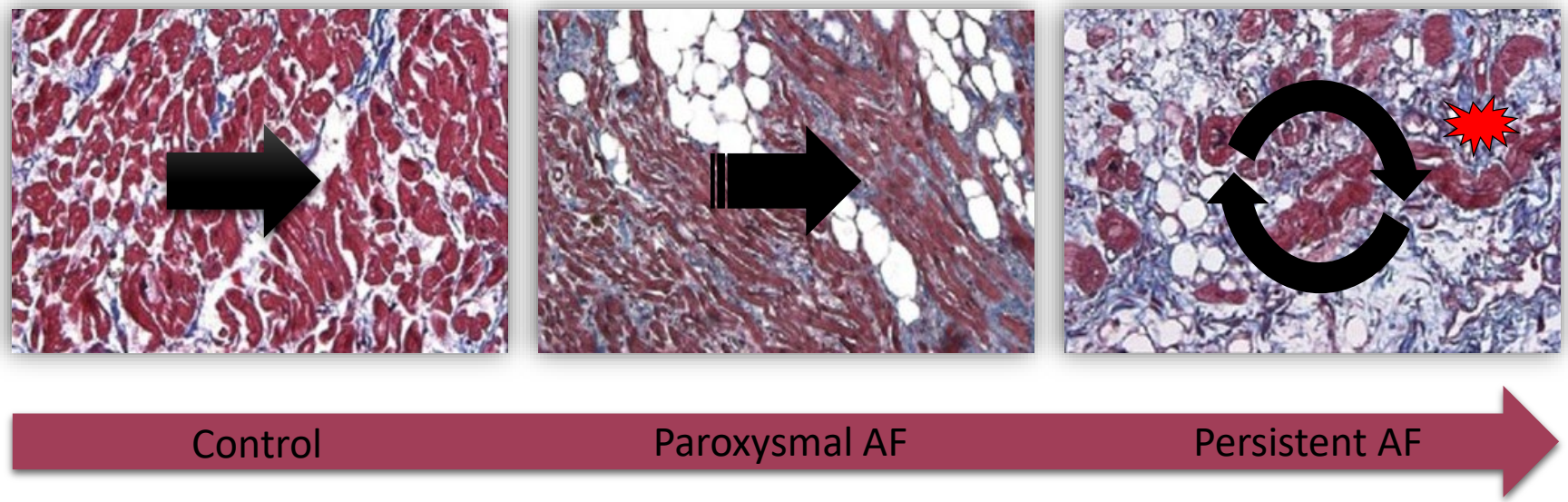
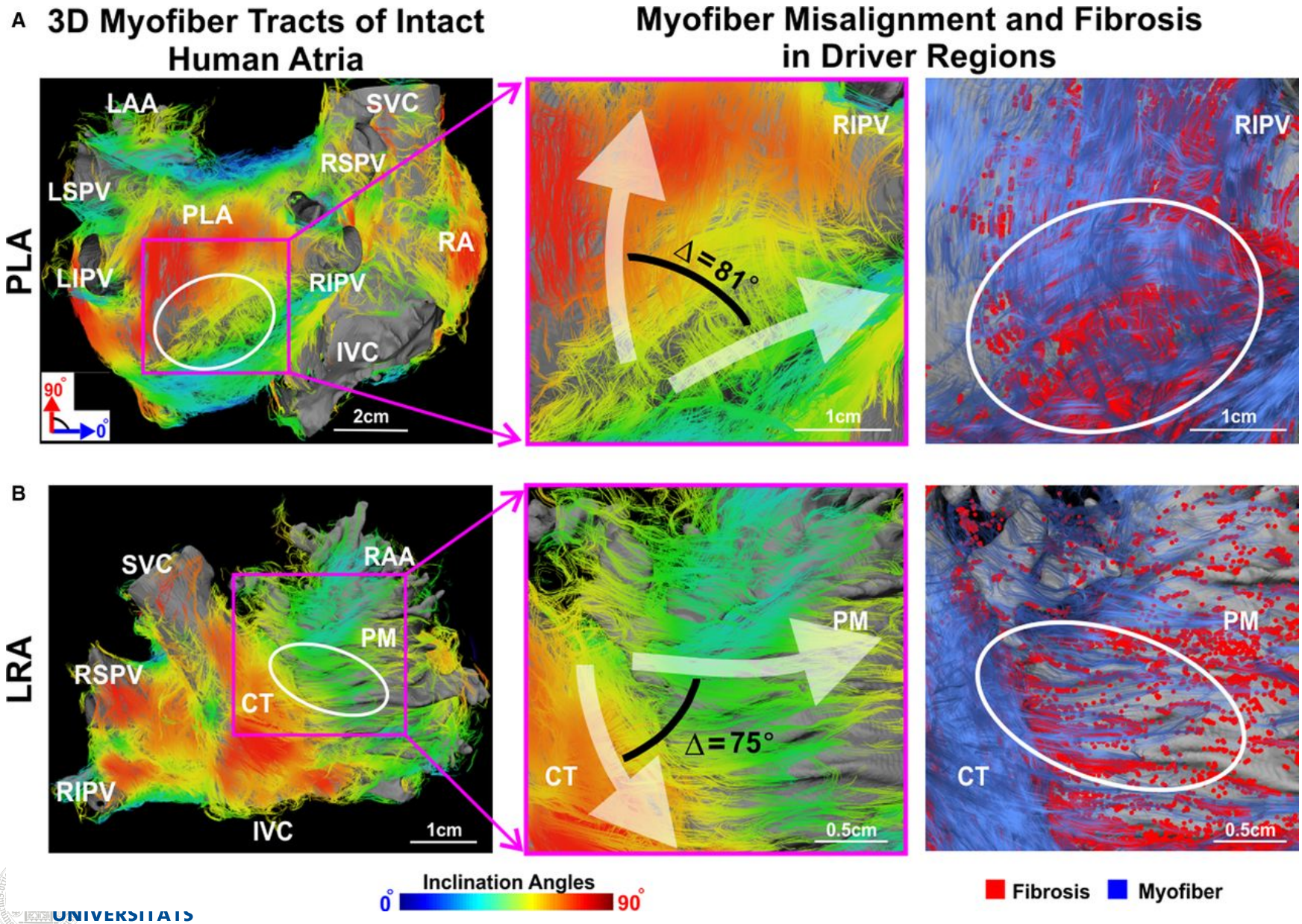
The Pathophysiological Substrate of Persistent AF: Fibrosis



Modified from: Platonov P et al.: JACC 2011



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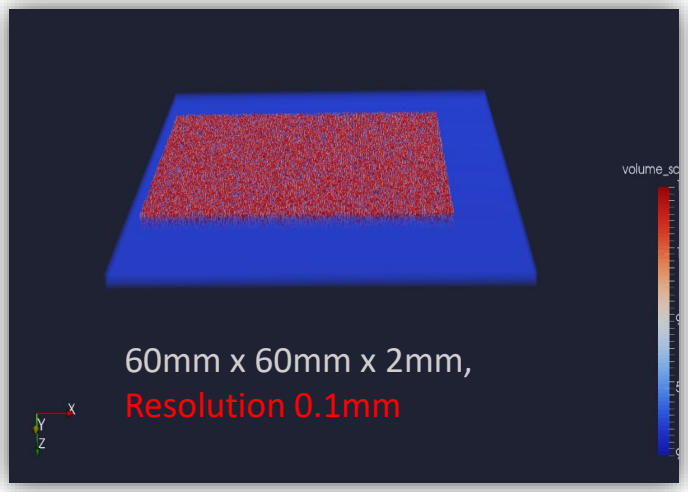
Zhao J. et al. J Am Heart Assoc 2017

AF Simulation Model (Courtemanche-Ramirez-Nattel) Incorporating 3D Atrial Fibrotic Patch



Conditions of induction of rotational activity:

- Minimum size of atrial fibrosis area **≥10mm x 10mm x 2mm**
- Degree of atrial fibrosis of **30…50%**

Rottmann M, Arentz T, Dössel O, Jadidi A: Computing in Cardiology 2016

Rotational Activity in 3D Patch of Fibrosis

Rottmann M, Arentz T, Dössel O, Jadidi A.: Impact of Three Dimensional Atrial Fibrosis on Develpment and Stability of Rotational and Focal Sources in Atrial Fibrillation. Computing in Cardiology 2016; 43.

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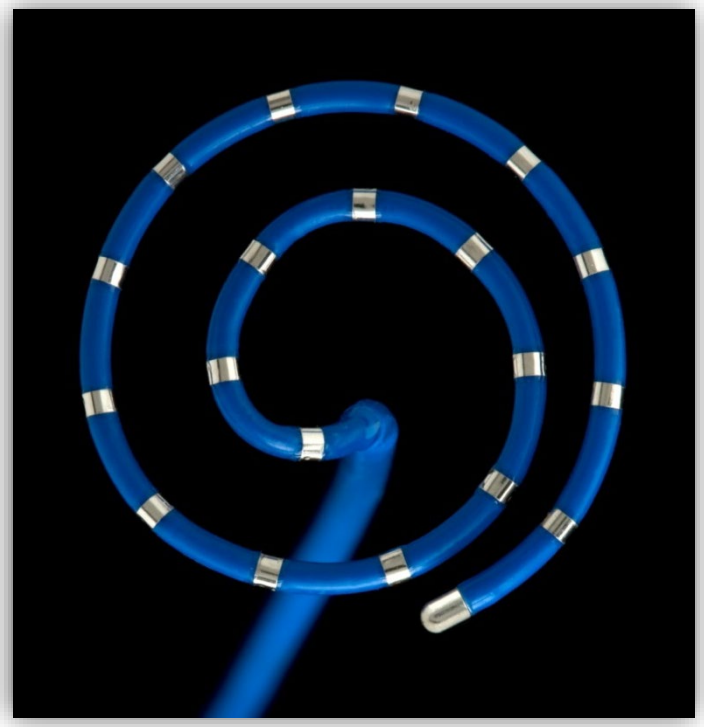
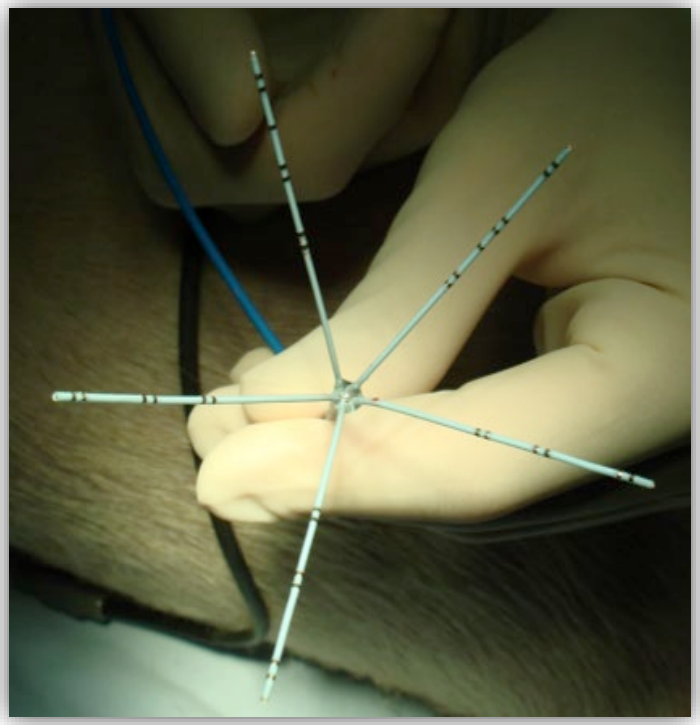
Karlsruher Institut für Technologie

High density Mapping

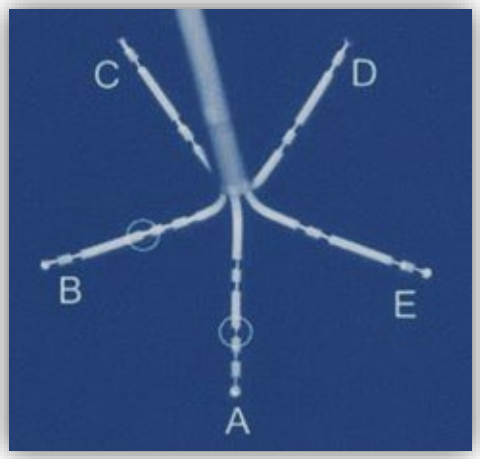


Jadidi A. et al.: Circulation EP 2016



Anter E. et al.: Circulation EP 2015

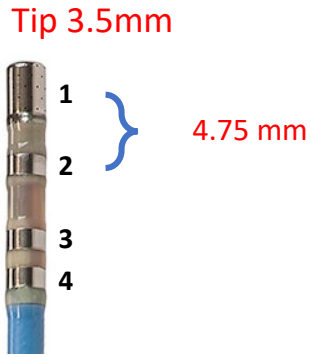
High-Resolution Mapping of Scar-Related Atrial Arrhythmias Using Smaller Electrodes With Closer Interelectrode Spacing



Anter E. et al.: Circulation EP 2015

3D-Mapping RA/LA using both catheters

- in 10 pts with normal atria to define normal voltage cuttoffs
- in 20 pts with scar-related ATs



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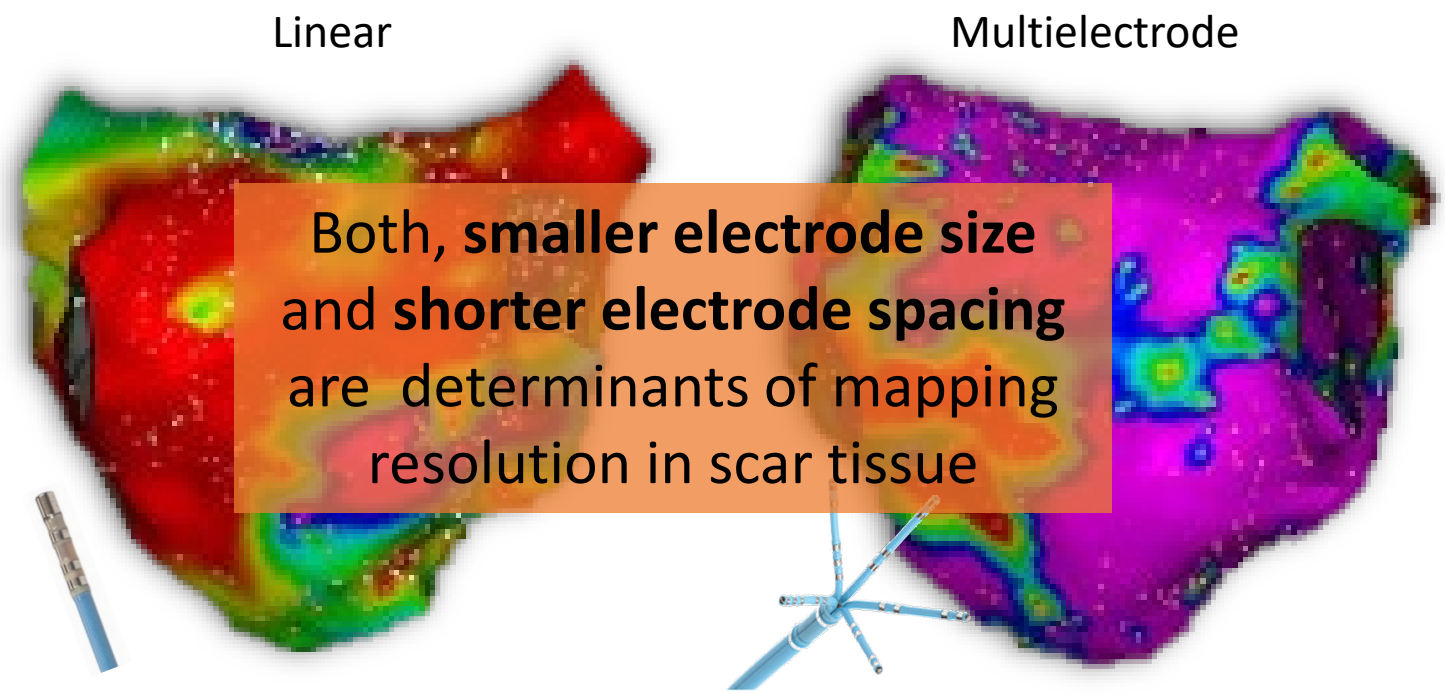
Low Versus High Resolution Mapping of Atrial Low Voltage Substrate



Both, **smaller electrode size** and **shorter electrode spacing** are determinants of mapping resolution in scar tissue

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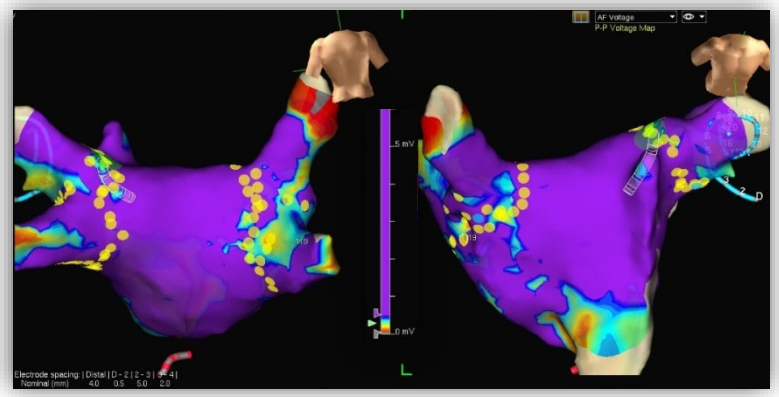
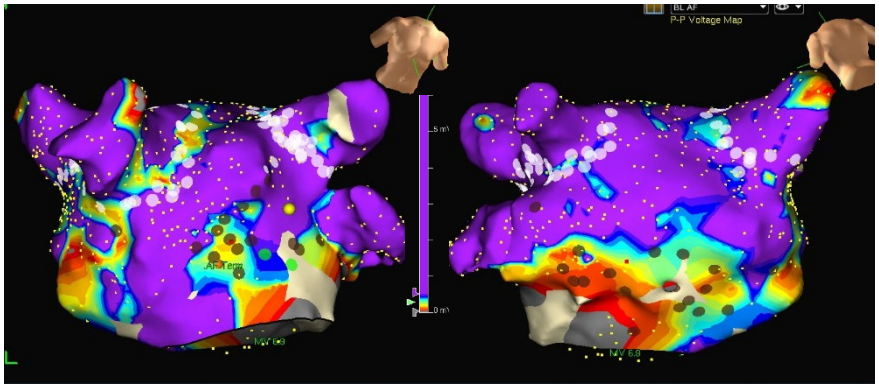
Anter E et al.: Circulation EP 2015

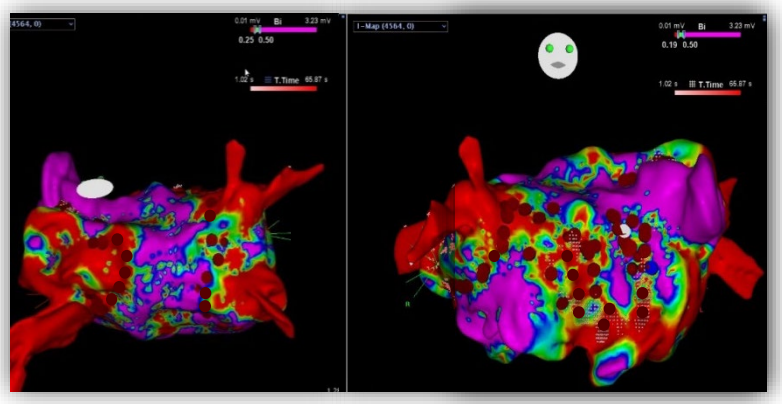
Low Voltage-Guided Ablation of Atrial Fibrillation



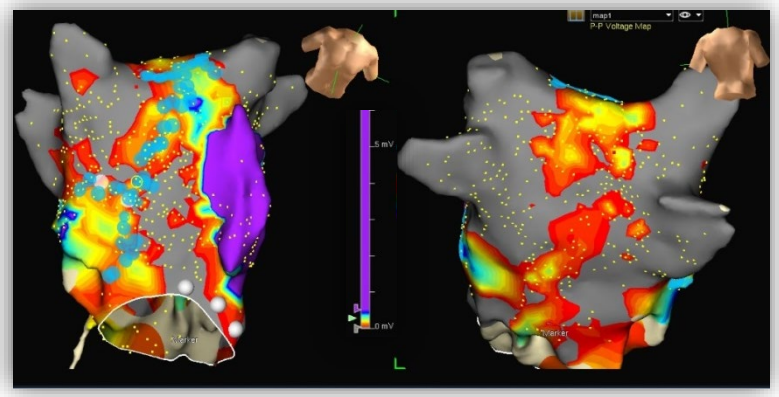
90% in paroxysmal- 45% in persistent AF



30% of persistent AF



20% of persistent AF



5% of persistent AF

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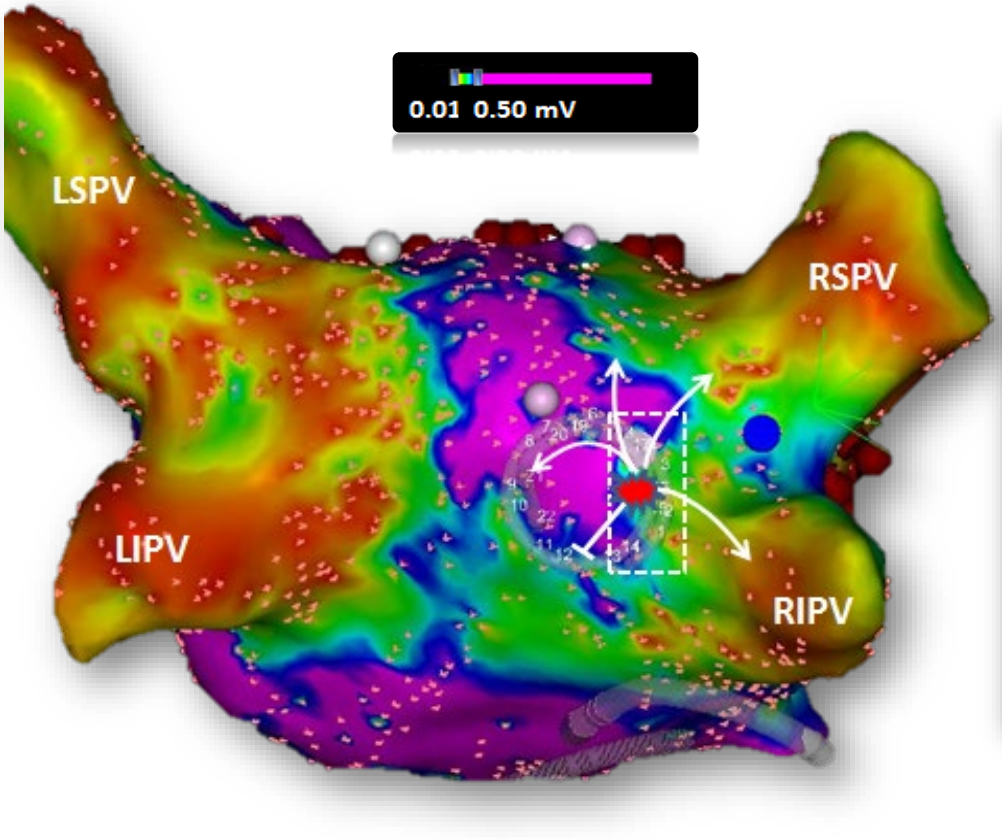
Jadidi A et al.: Circulation EP 2016

High-Density Mapping in Atrial Fibrillation:

Identifying the Arrhythmogenic Substrate: Low-Voltage, Fractionated, Rapid Activity



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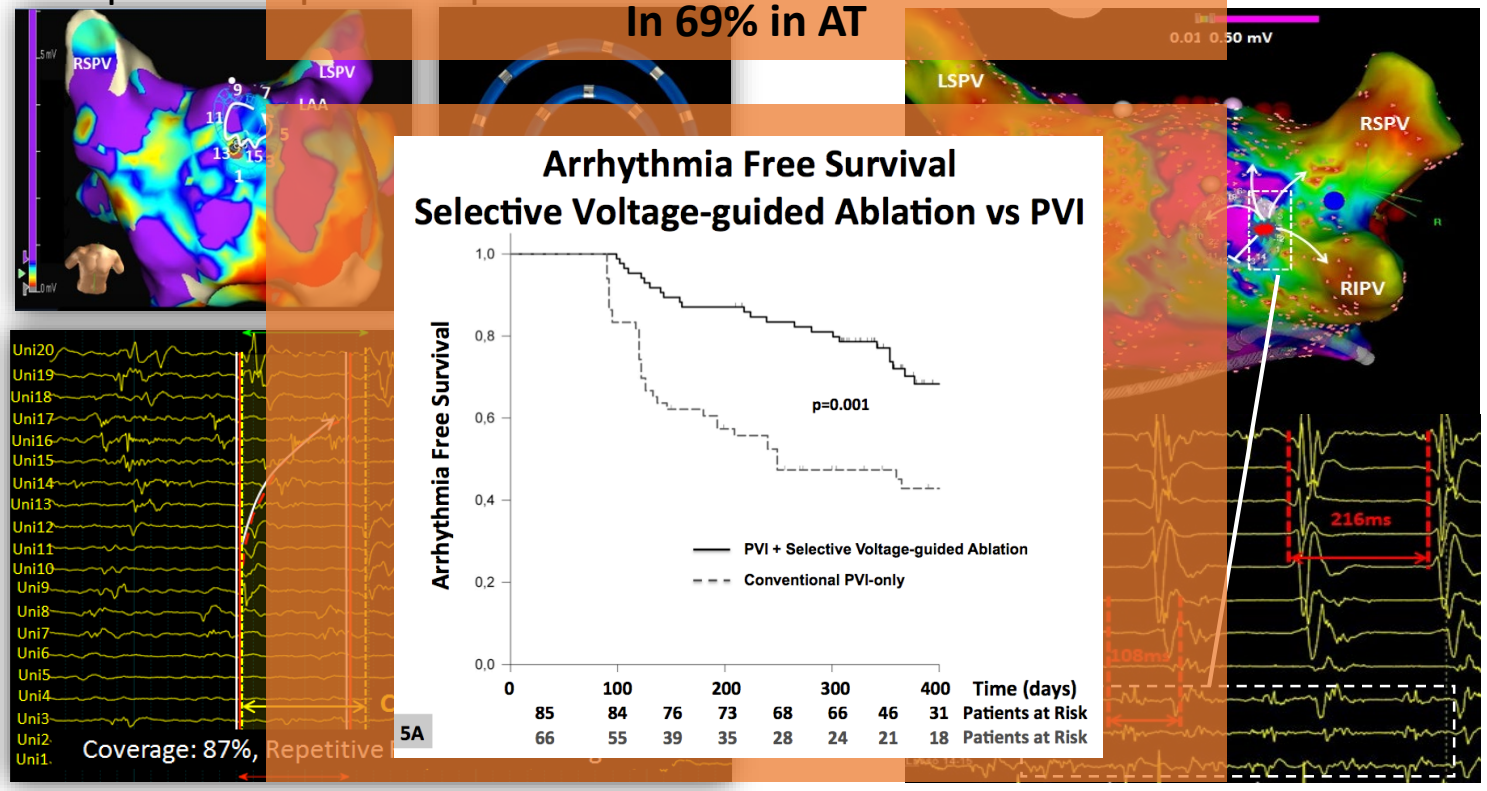
Jadidi A, et al 2019

AF Sources Locate to Low Voltage Substrate <0.5mV

Rotational Source with Spatio-temporal Dispersion

Termination in 72% after 11 min of RF,
In 69% in AT

Focal Source



Low Voltage in AF <0.5mV (1mm Lasso)

Low Voltage in SR <0.5mV with 0.5-1.0mV transitional zone.

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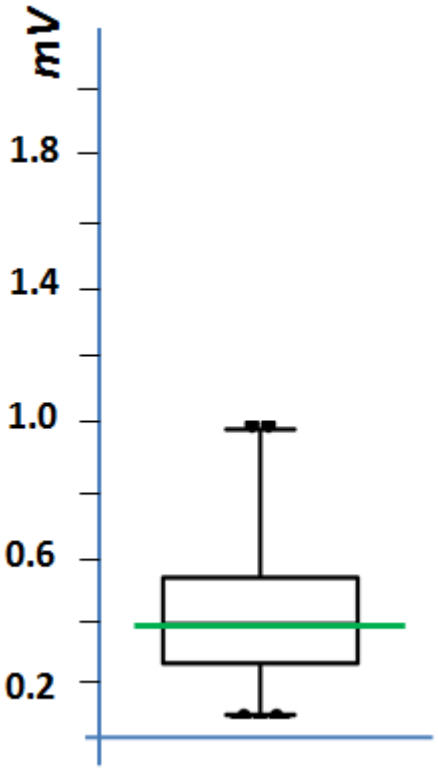
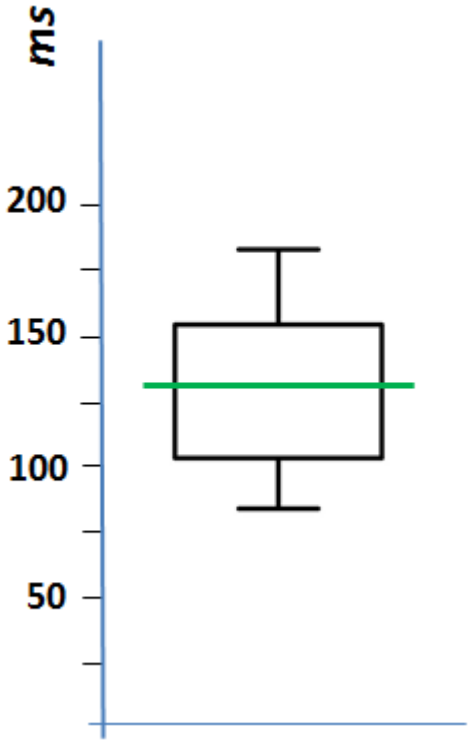
Jadidi A, ..., Haissaguerre, Arentz: Circulation Arrhythmia 2016

Electrogram-Charakteristics at AF Termination Sites: Low Voltage and Prolonged Activity



Reduced Voltage



Prolonged Activity

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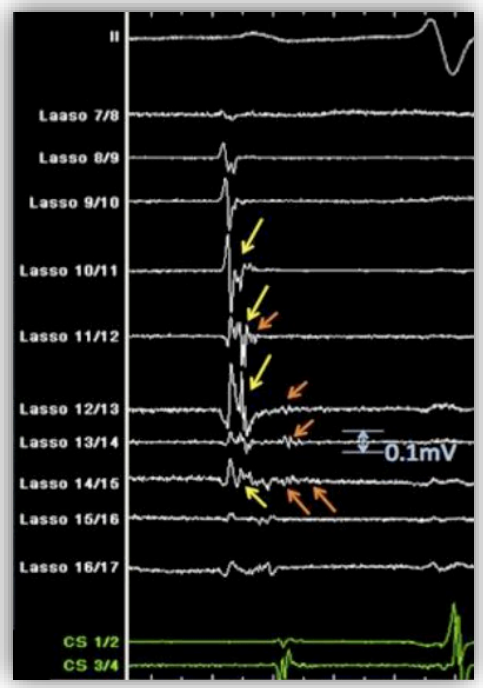
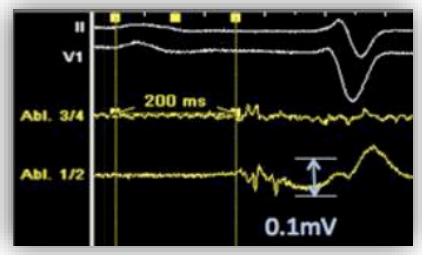
Jadidi A et al.: 2019

Local Electrogram Characteristics at AF Termination Sites after Sinus Rhythm Restoration

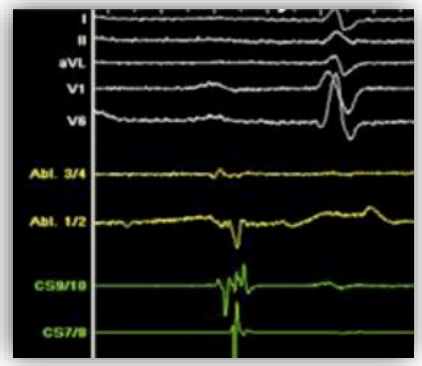
Sinus Rhythm



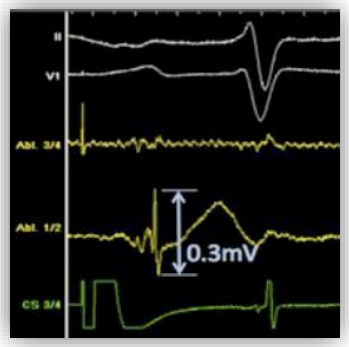
Sinus Rhythm



Sinus Rhythm



Mid-CS Pacing



Sinus Rhythm

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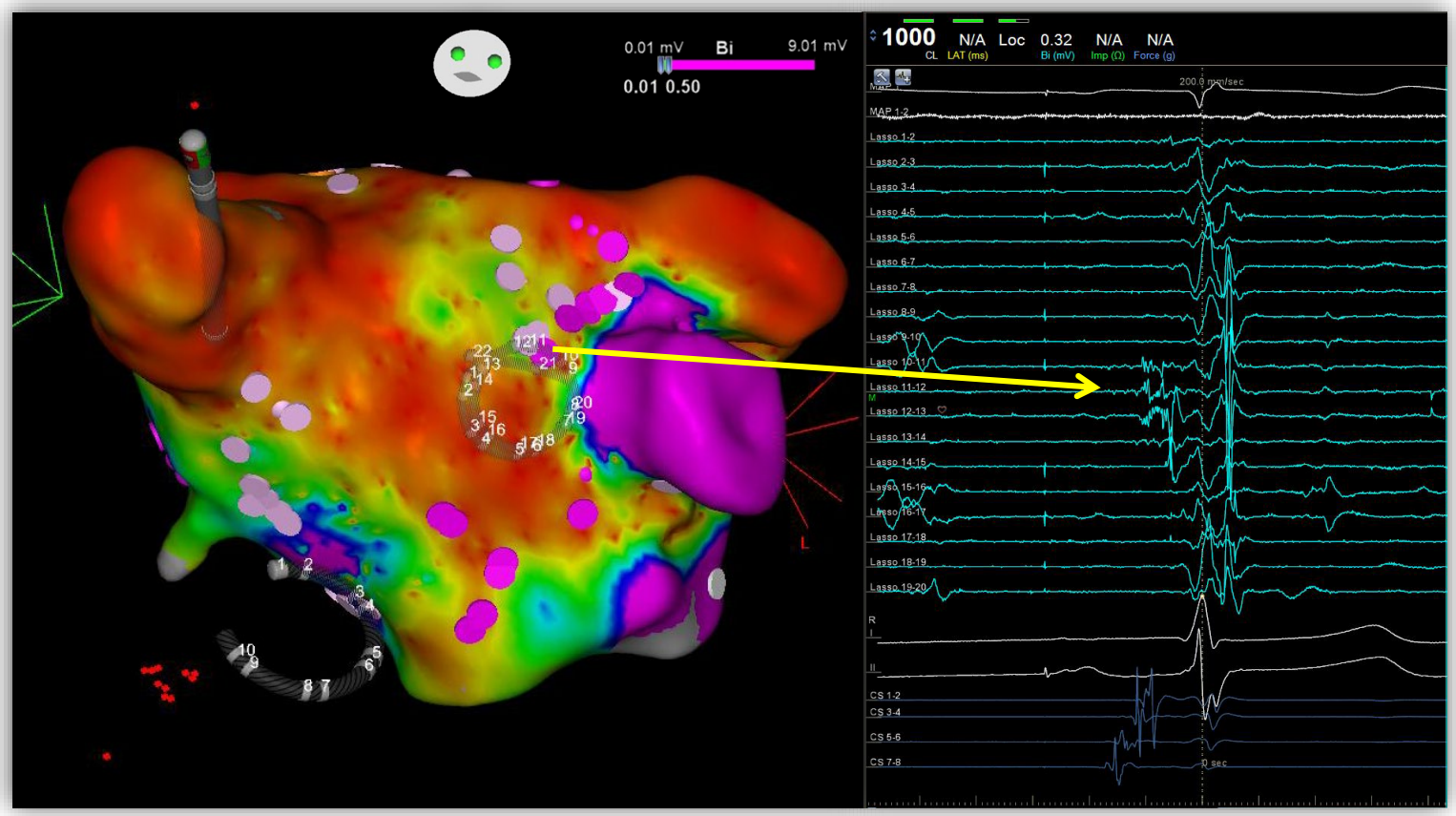
Jadidi A et al.: 2019

Atrial Fibrillation Maintained by Low Voltage Substrate

Case Example:

- 60 year old, male with persistent AF
- PVI in 12/2016
- 11/2017: Re-do procedure for recurrence of persistent AF and multiple atrial tachycardias

The Electrogram Signature of AF Substrate in Sinus Rhythm: Fractionated Delayed Activity



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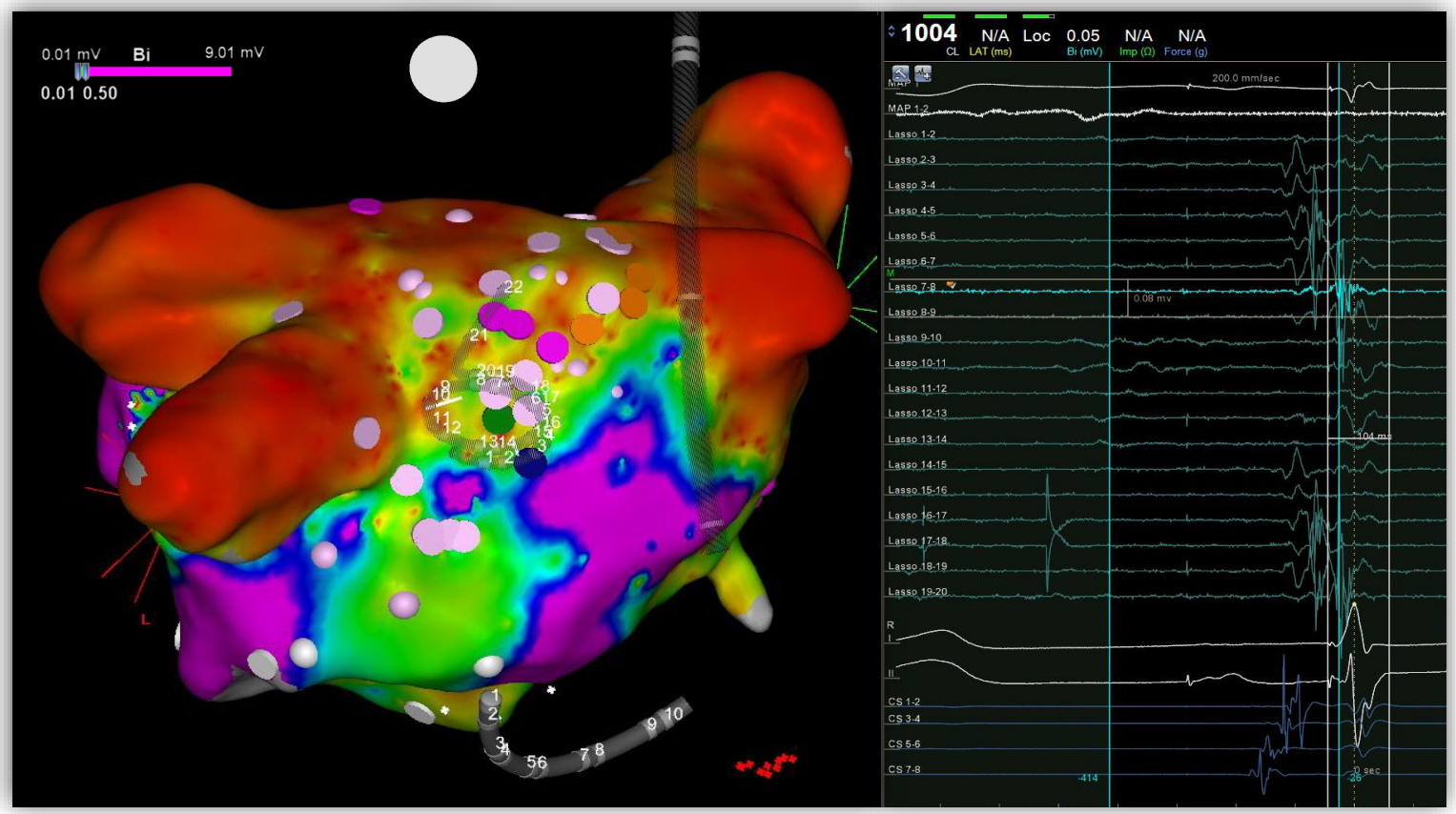
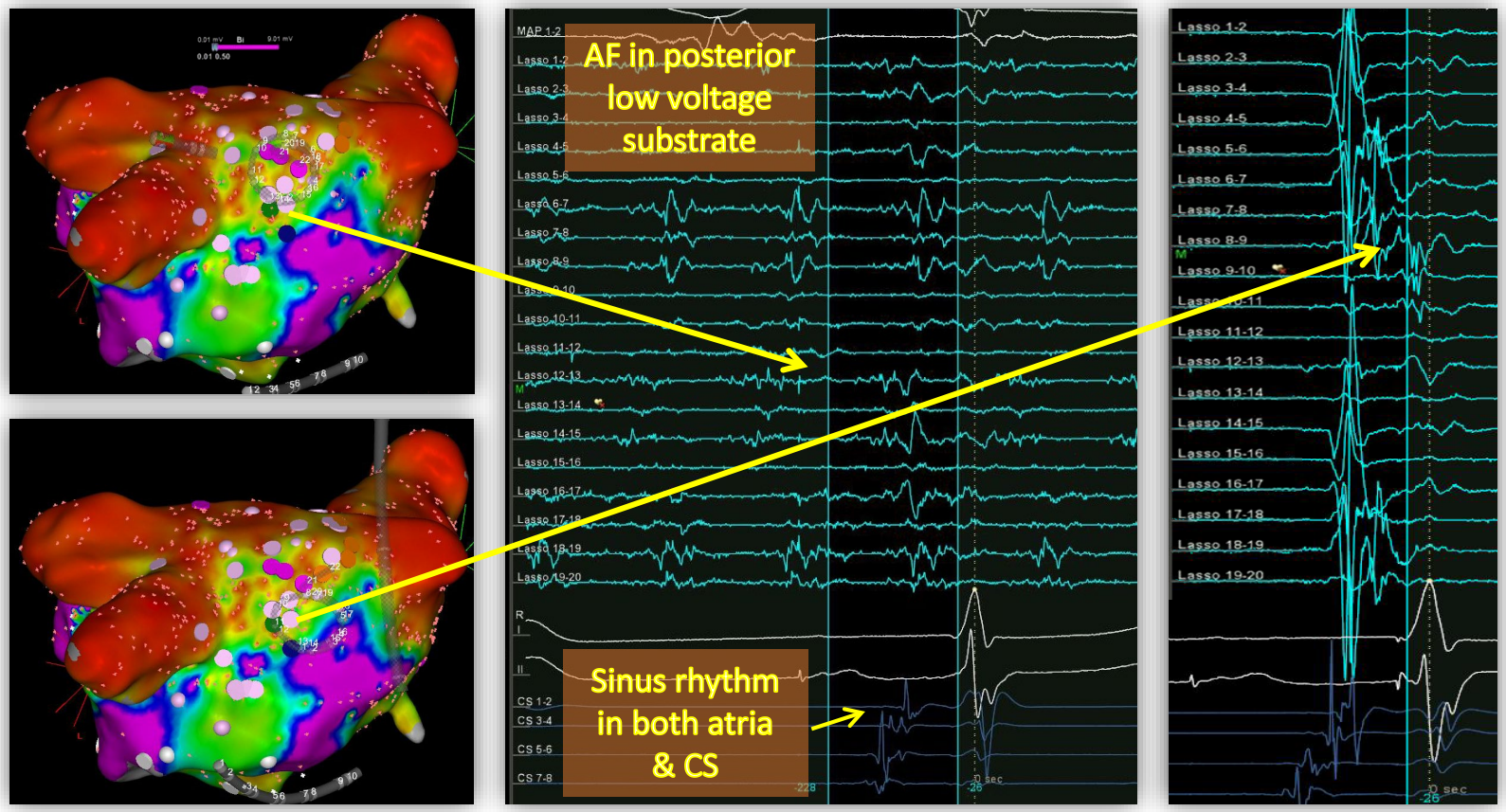
Jadidi A, UHZ Bad Krozingen 2019

The Electrogram Signature of AF Substrate in Sinus Rhythm: Fractionated Delayed Activity



Jadidi A, UHZ Bad Krozingen 2019

The Electrogram Signature of AF Substrate during AF and Sinus Rhythm



AF persists in posterior low voltage substrate

During SR

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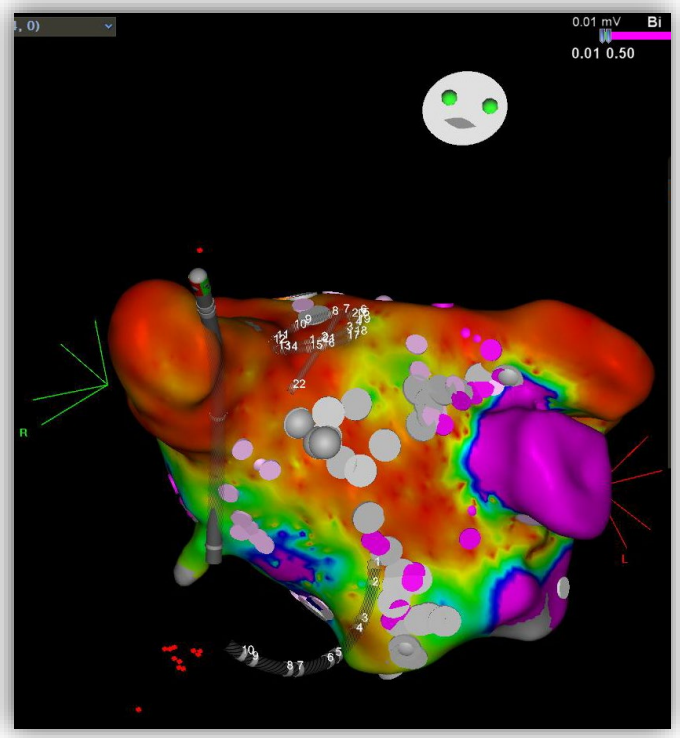
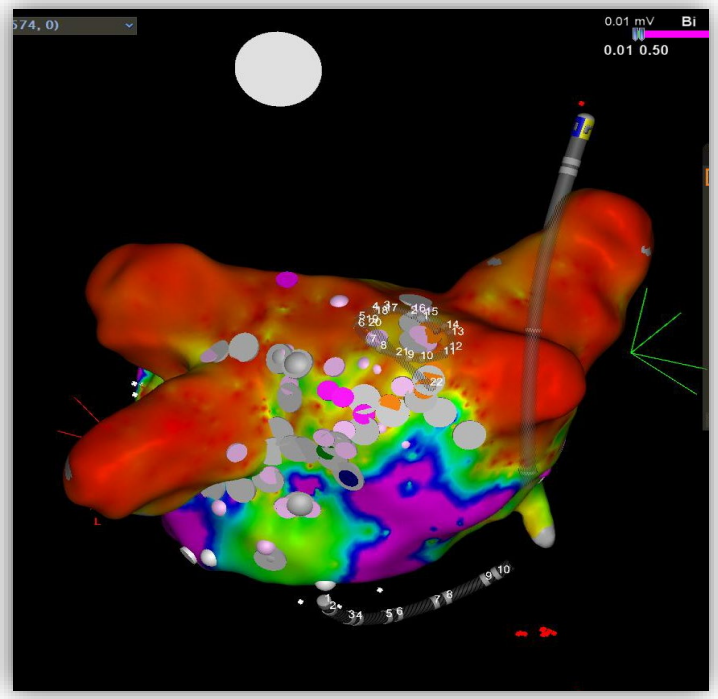
Jadidi A, UHZ Bad Krozingen 2019

Ablation Set to Eliminate AF Substrate: Anterior LA



Anterior LA



Posterior LA

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Correlation of Low Voltage Substrate and Prolonged Activities

in Persistent Atrial Fibrillation versus Sinus Rhythm

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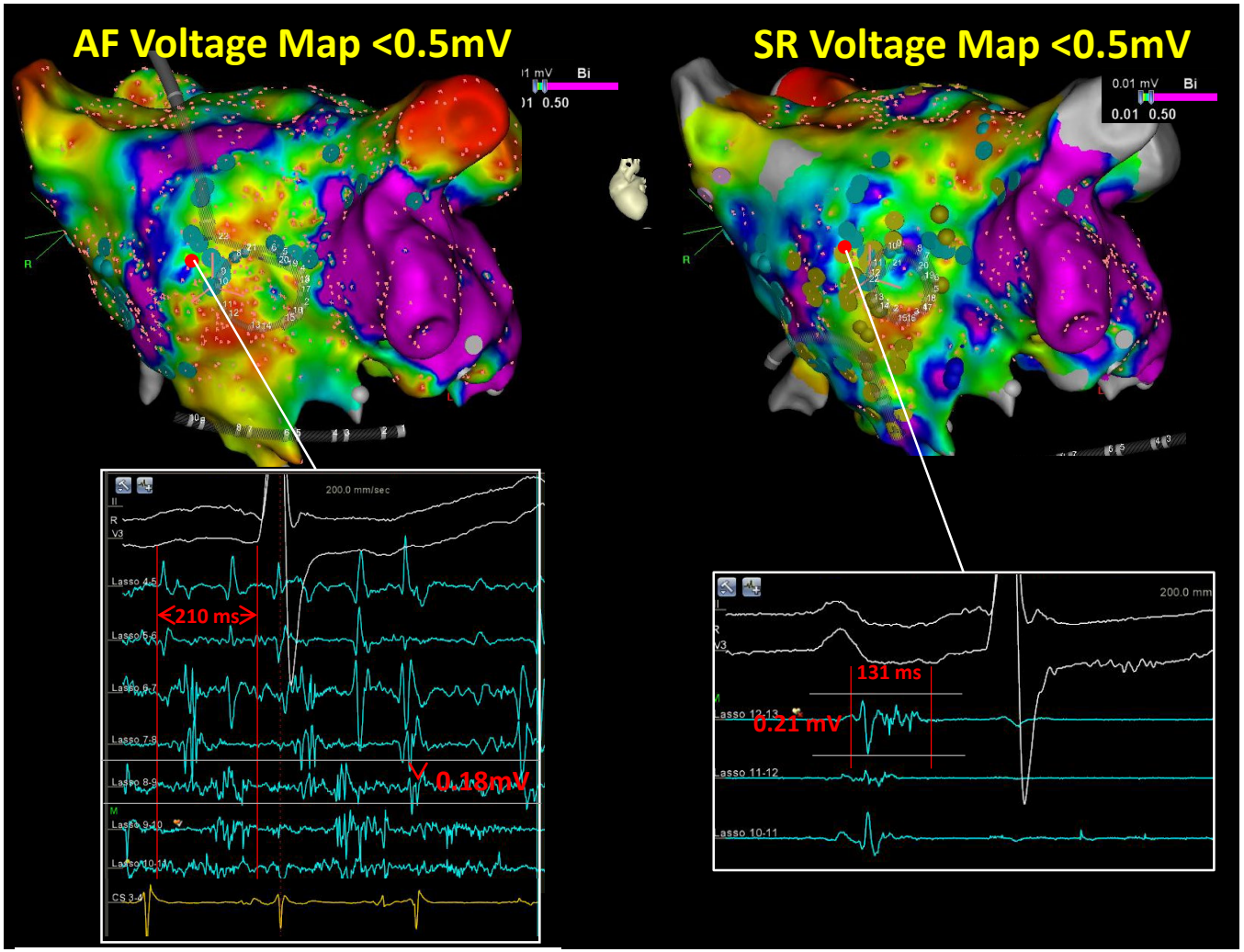
Jadidi A 2019

Electrogram Characteristics in AF versus in SR in 40 patients



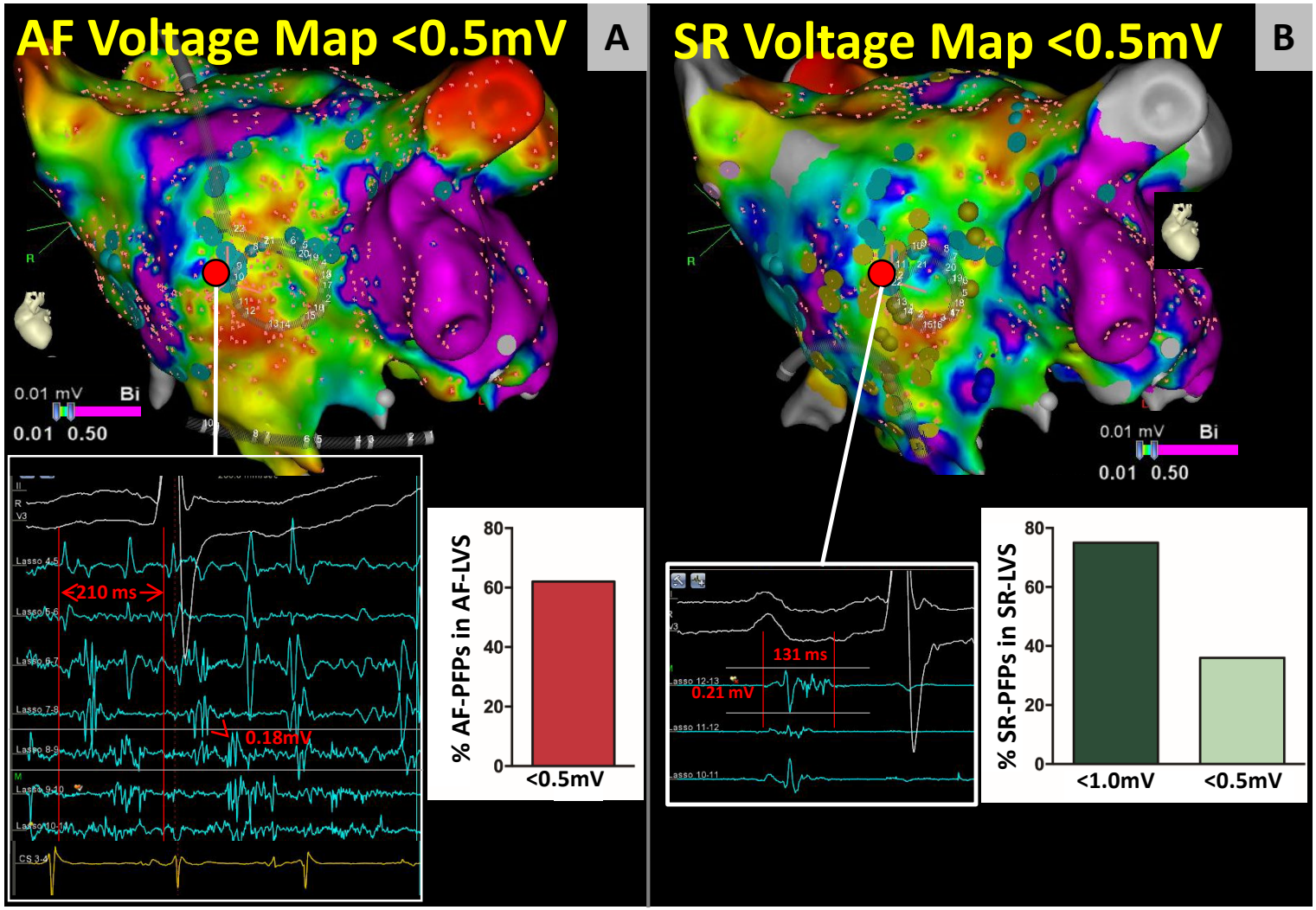
- Best match of low voltage areas, when using <0.5mV in AF and <1.0 mV in SR
- 70% of sites with fractionated potentials in SR (≥5 defl., >50ms) showed prolonged activity during AF (>70% CL coverage)

Spatio-temporal dispersion in AF (CL coverage >70% AFCL)

Slow conduction in sinus rhythm

Chen J, ..., Arentz T, Jadidi A et al. 2019

Electrogram Characteristics in AF versus in SR in 40 patients



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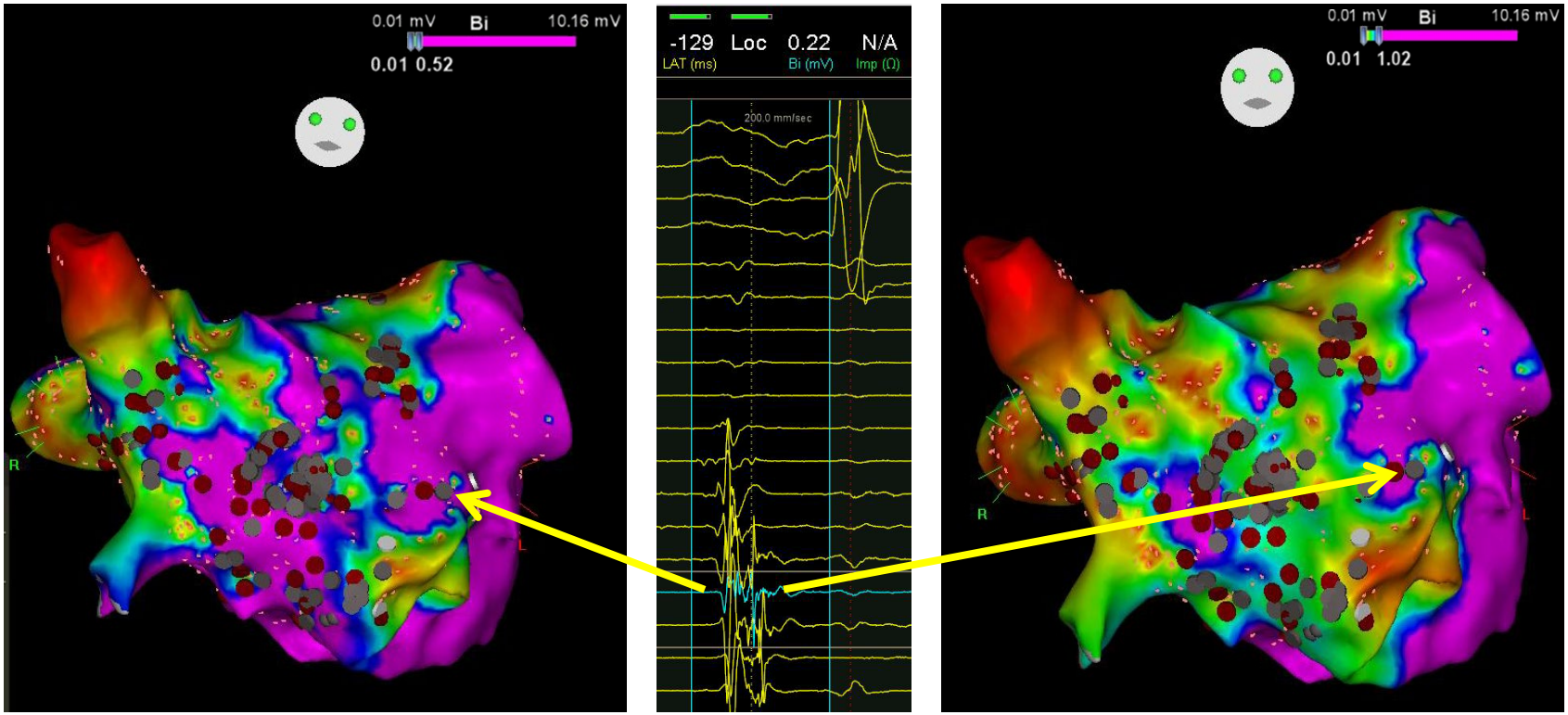
Chen J, ..., Jadidi A et al.: in preparation 2019

During SR Combination of Low Voltage (<0.5-1.0mV) and Electrophysiological Criteria to Determine the Ablation Target



Voltage <0.5mV

Voltage <1.0mV

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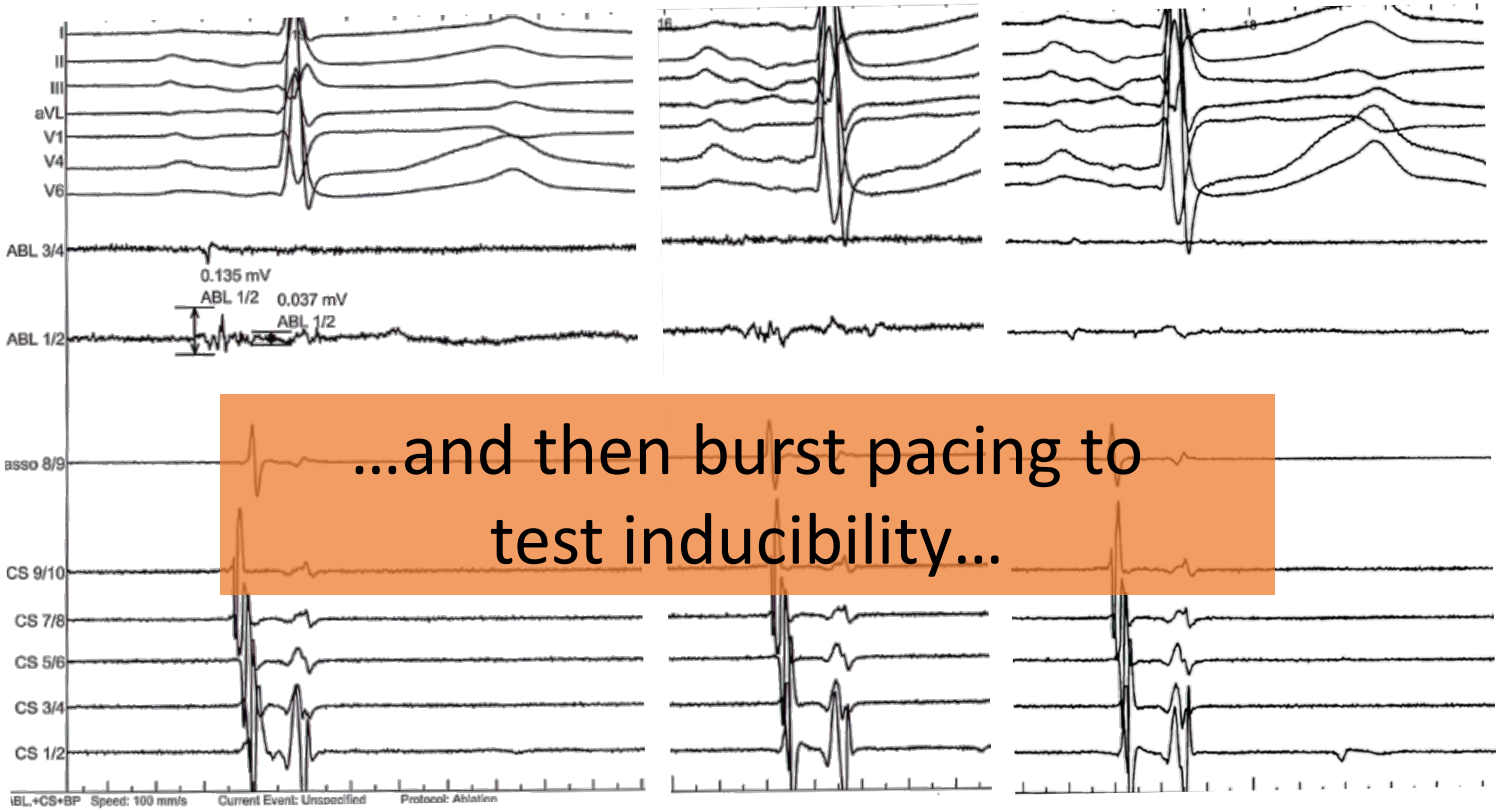
Jadidi A, …, Arentz T et al.: under review

Ablation of Fractionatd Potentials in SR in Low Voltage Areas (<1.0 mV)



…and then burst pacing to test inducibility…

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Jadidi A, …, Arentz T et al.: SOLVE Pilot Study

Results: 12 Months Follow Up Patients

- AF recurrence: 18%
- AT recurrence: 9%
- **Arrhythmia freedom at 12 months: 73%**
- **Freedom from AF at 12 months: 82%**

Jadidi A, …, Arentz T et al.: SOLVE Pilot Study

Novel Ablation Strategies for Persistent AF

AF Ablation Guided by Spatiotemporal Electrogram Dispersion Without Pulmonary Vein Isolation

A Wholly Patient-Tailored Approach

Julien Seitz, MD,[a] Clément Bars, MD,[a,b] Guillaume Théodore, MD,[c] Sylvain Beurtheret, MD,[a] Nicolas Lellouche, MD, PhD,[d] Michel Bremondy, MD,[a] Ange Ferracci, MD,[a] Jacques Faure, MD,[a] Guillaume Penaranda,[e] Masatoshi Yamazaki, MD, PhD,[f] Uma Mahesh R. Avula, MD,[f] Laurence Curel, MS,[a] Sabrina Siame,[a] Omer Berenfeld, PhD,[f] André Pisapia, MD,[a] Jérôme Kalifa, MD, PhD[f]

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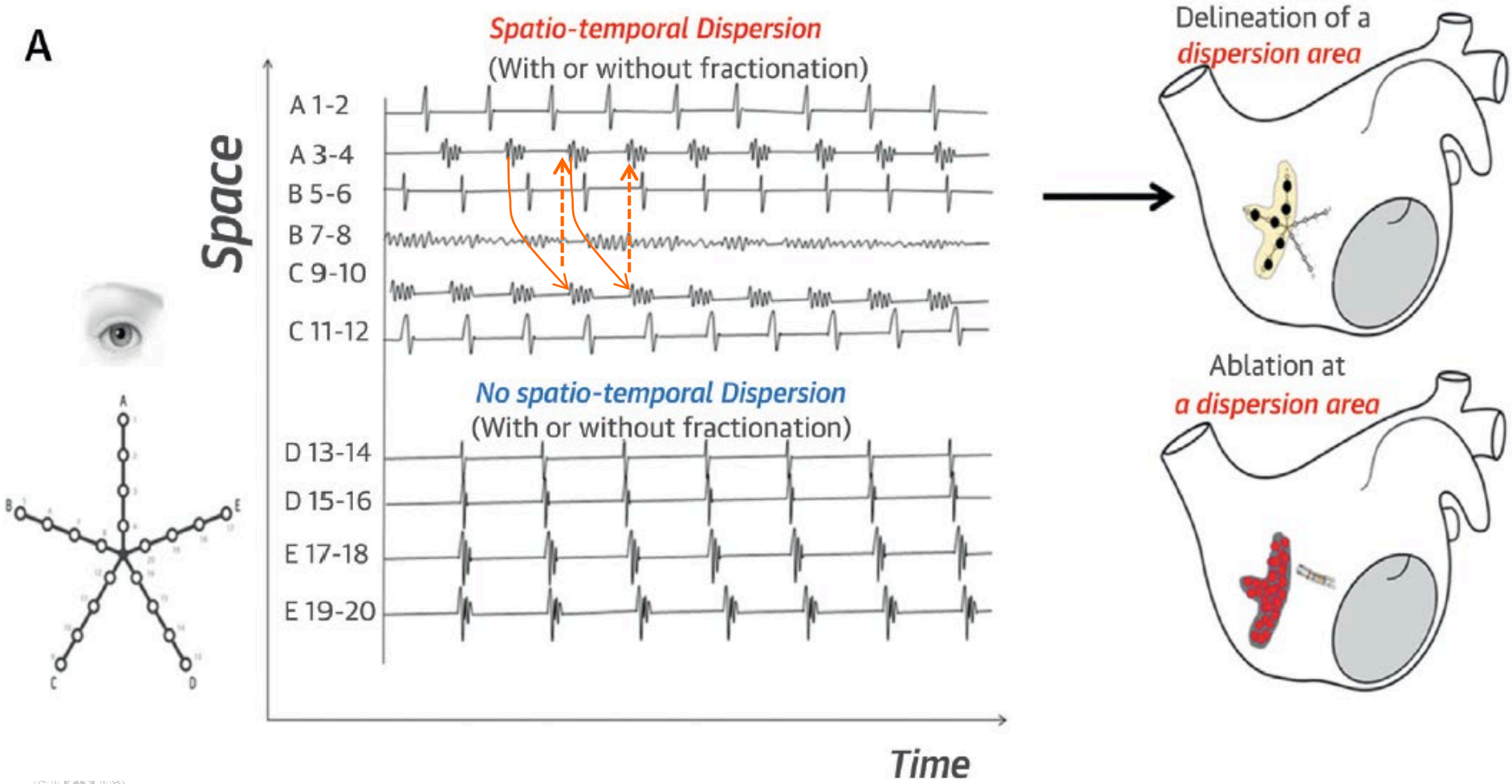
Seitz J..Kalifa J, AF Ablation Guided by Spatio-Temporal Dispersion – JACC 2017

Novel Ablation Strategies for Persistent AF



Seitz J..Kalifa J, AF Ablation Guided by Spatio-Temporal Dispersion – JACC 2017

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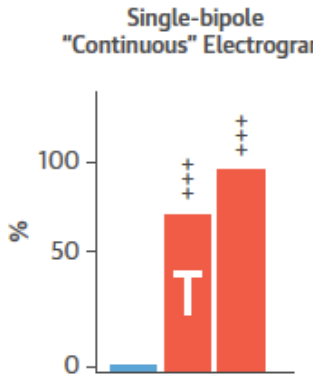
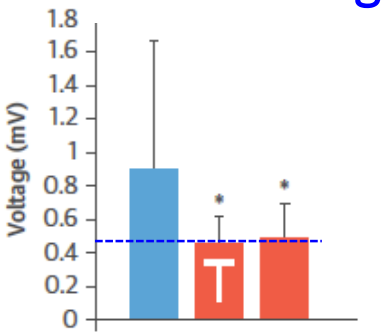
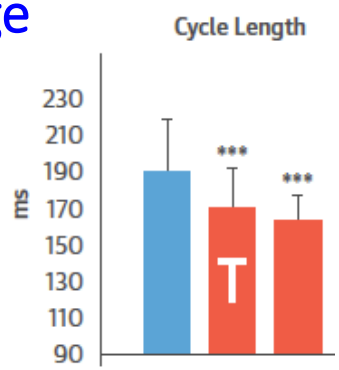
Novel Ablation Strategies for Persistent AF

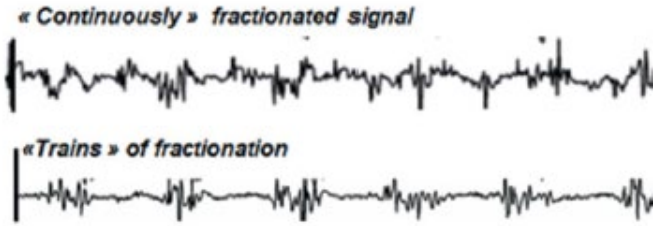


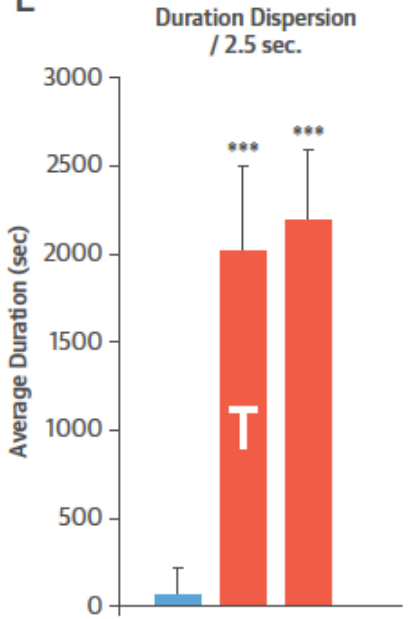
Low Voltage



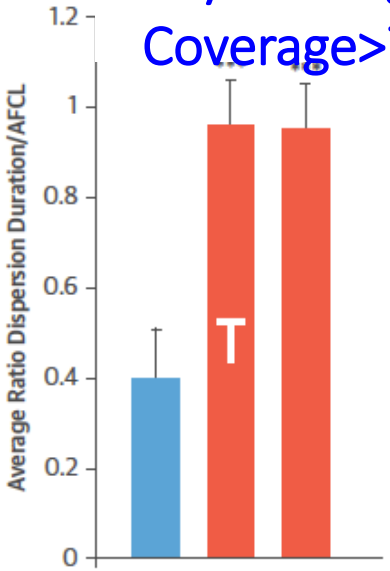


Prolonged Activity

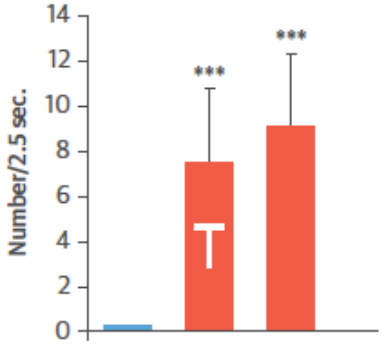




Cycle Length Coverage>70%



Rotations



Seitz J..Kalifa J, AF Ablation Guided by Spatio-Temporal Dispersion – JACC 2017

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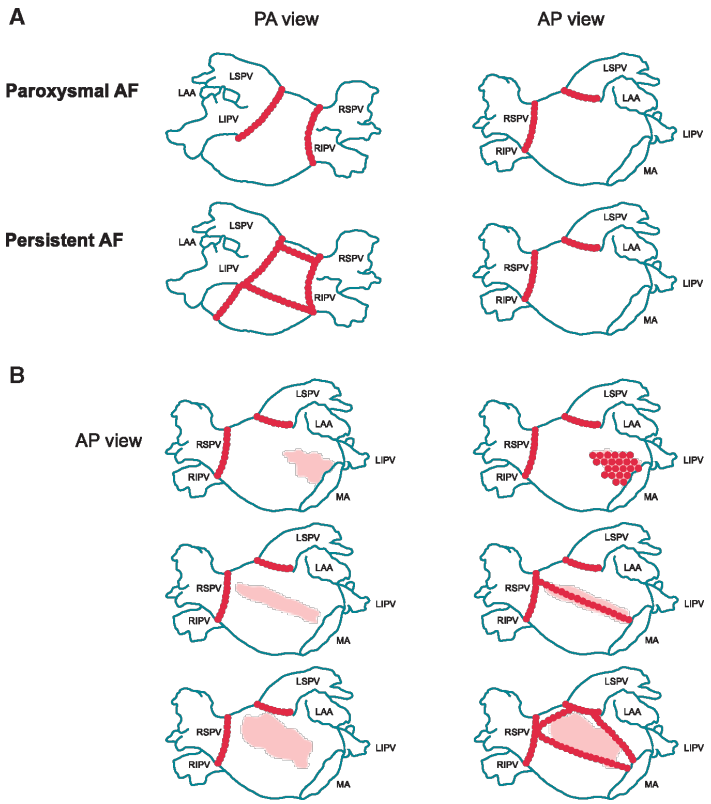
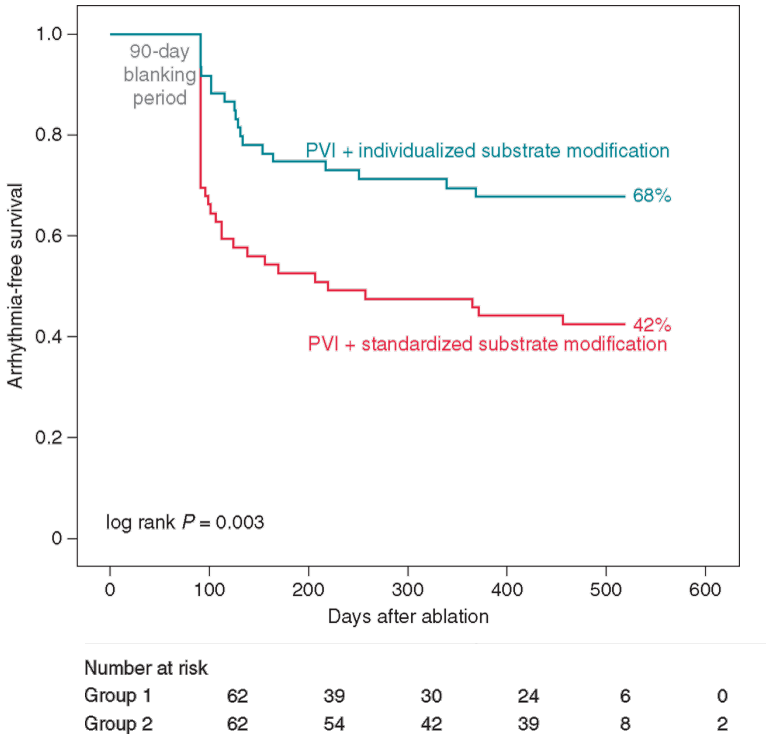
Studies Using PVI plus Substrate Based Approach Targeting Low Voltage Areas

Title	N of Pts	Voltage Criterium	Catheter Used for Mapping	Endpoint of Ablation	Success
Jadidi et al.: Circ EP 2016	85 45	<0,5 in AF <1,0 in SR (w fragm. Pot, CL-coverage>70% or Rapid)	Lasso AF Focus Pentaray	Termination of AF, Ablation of prolonged activity, Non Inducibility for AT	69% at 13 M
Rolf et al.: Circ EP 2014	116	<0,5 in SR	Lasso	Reduction of LP, Non Capture, Lines	70% at 12 M (7d Holter)
Yang et al.: Circ EP 2016	86	0.1-0.4 0.4-1.3 in SR (w fragm. Pot)	Lasso	Reduction of LP, Defragmentation, Short Lines	70% at 24 M (7d Holter)
Kottkamp et al.: JCE 2016	31	<0.5 0.5-1.5 (2.5) (w fragm. Pot)	Contact Force Ablation catheter	Box Isolation of Low voltage substrate	72% at 12 M (7d Holter)
Seitz J. ..., Kalifa J. et al, JACC 2017		Spatio-temp-Dispersion Sites & AF-Term Sites display Low Voltage<0.5mV	PentaRay	AF termination	>70% at 12 M

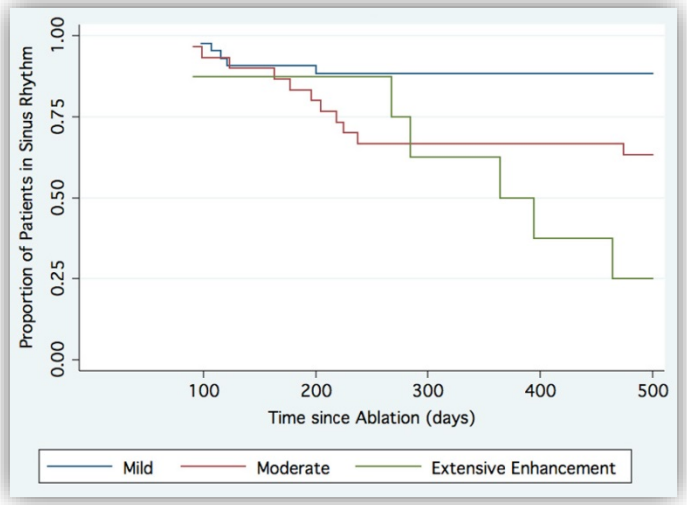
Voltage Guided Ablation for AF: a Randomized Study





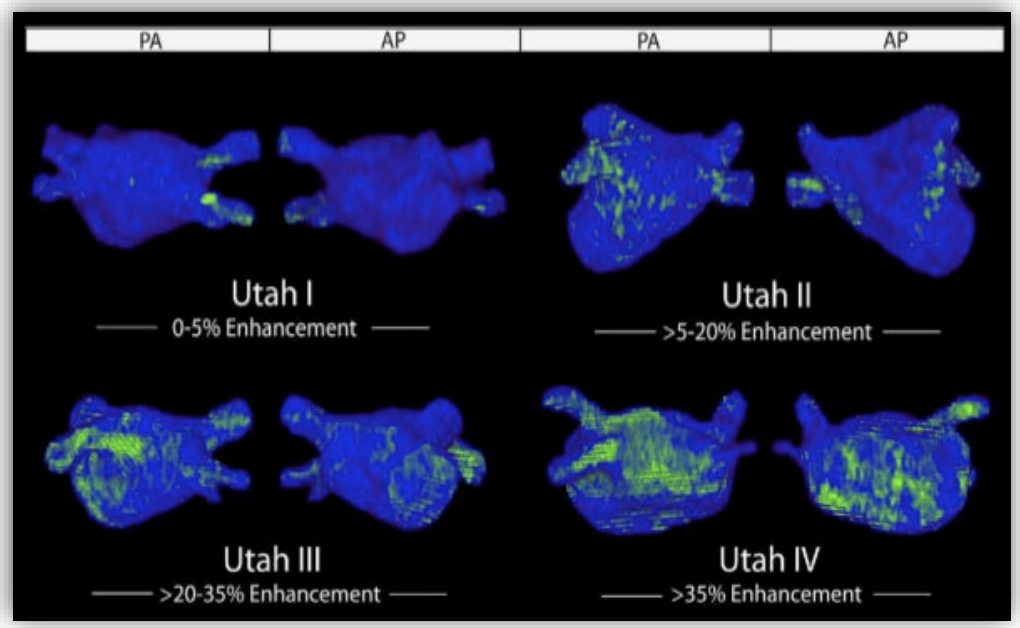
Kircher S et al.: Europace 2017

Success of PVI Depends on Degree of Fibrosis

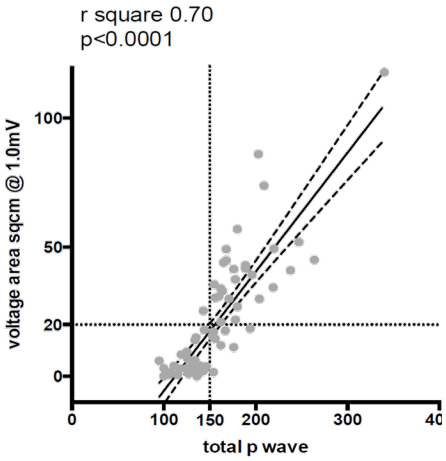


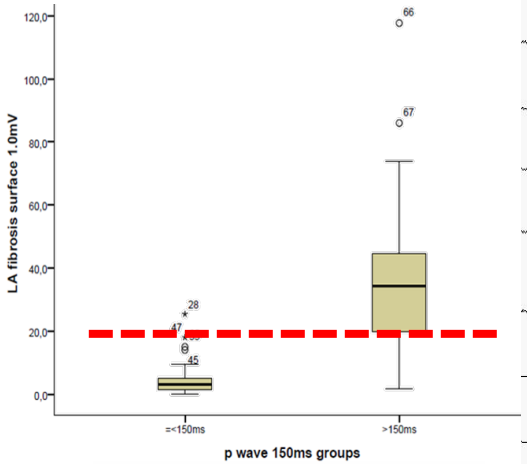
Oakes RS, …, Marrouche NF: Circulation 2009

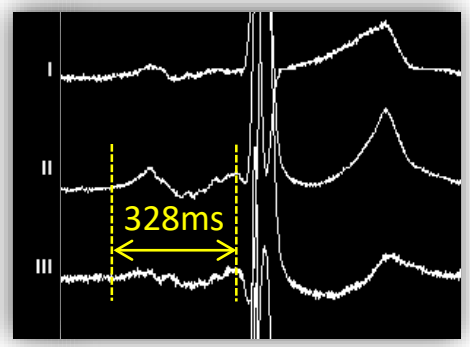
Marrouche et al.: JAMA 2014



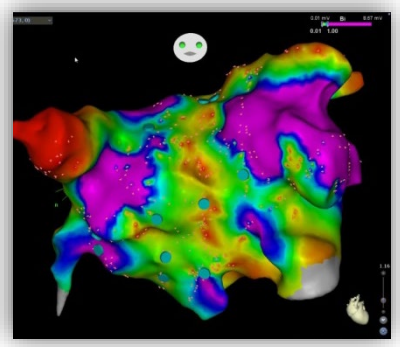
Amplified Digital 12 Lead ECG Identifies Patients with and without Low Voltage Substrate



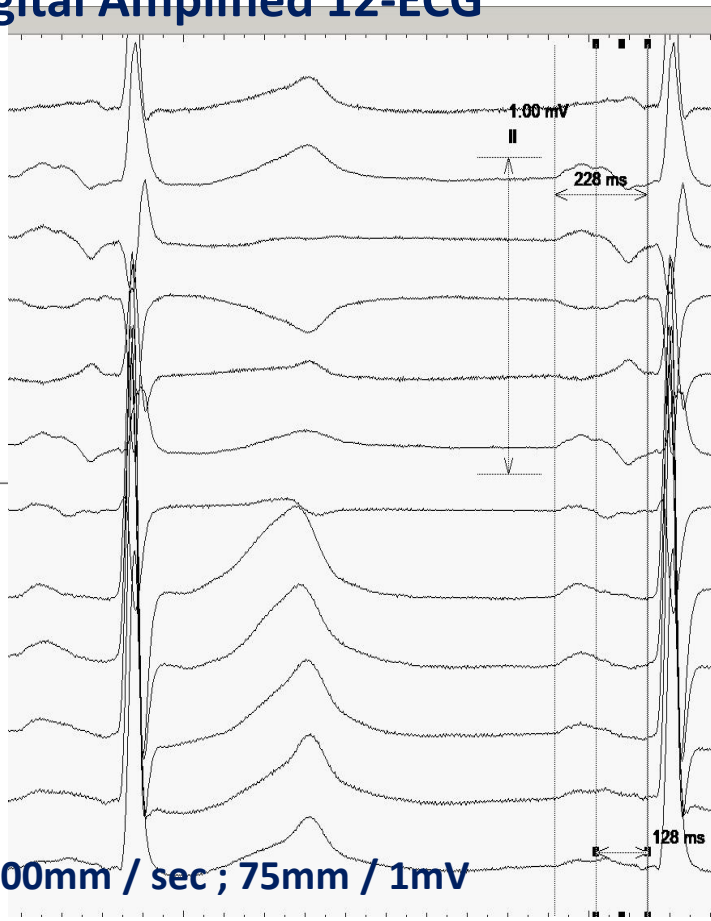




vs.



Digital Amplified 12-ECG



100mm / sec ; 75mm / 1mV

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Jadidi A, Müller-Edenborn B, Arentz T et al.: JACC EP 2018

Conclusions I

- High density multi-electrode mapping allows identification of arrhythmogenic atrial substrate.
- Elimination of fractionated / delayed potentials within low voltage areas during sinus rhythm is associated with non-inducibility of AF in 80% of persistent AF patients.
- PVI plus low voltage-based ablation resulted in arrhythmia freedom in 70% of patients after 1 year.
- Presence of LA low voltage substrate can be accurately identified prior to the EP-study/AF ablation by use of amplified digital P-wave duration in 12-lead-ECG.

Conclusions II

- How to ablate persistent AF ? “PVI-only” is efficient in patients without low voltage substrate (success rates: 80%) independent of AF type (paroxysmal or persistent).
- However, “PVI-only” results in high arrhythmia recurrences in patients with atrial low voltage substrate (>50% recurrence after 1 year !).
- Additional patient-tailored low voltage-based ablation of slow conduction areas (delayed potentials) ameliorates 1-year success rate from 50% to 70%.
- Low voltage and fractionated areas in SR vs. AF correlate in 70% of sites.
- Low Voltage areas are more extensive during AF than SR. Ablation of LVS during AF results in larger ablated tissue than during SR, although the success rates are similar (70% after 1 year FU).
- Identification of arrhythmogenic slow conduction substrate in AF necessitates high expertise of EGM interpretation.
- Identification of the arrhythmogenic substrate is easier and reproducible during sinus rhythm.

Merci …

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Tim Henderson « Chaos »