

# Termination of Atrial Fibrillation by Catheter Ablation can be Successfully Predicted from Baseline ECG

A. Buttu<sup>1</sup>, J Van Zaen<sup>1</sup>, A. Viso<sup>1</sup>, A. Forclaz<sup>2</sup>, P. Pascale<sup>2</sup>, SM. Narayan<sup>3</sup>, JM. Vesin<sup>1</sup>, E. Pruvot<sup>2</sup>

<sup>1</sup>Applied Signal Processing Group, Swiss Federal Institute of Technology EPFL, Lausanne, Switzerland

<sup>2</sup>Department of Cardiology, University Hospital Center Vaudois CHUV, Lausanne, Switzerland

<sup>3</sup>University of California, San Diego, USA

## Introduction

- Stepwise radiofrequency catheter ablation (step-CA) has become the treatment of choice for the restoration of sinus rhythm (SR) in patients (pts) with long standing persistent atrial fibrillation (LS-pAF).
- Its success rate appears limited as the amount of ablation to achieve long term SR is unknown.
- Multiple organization indices have been used to predict the outcome of step-CA, however with limited success.
- ➔ Our study is aimed at developing innovative indices computed from the baseline ECG (BL, before ablation) in order to predict the outcome of step-CA.

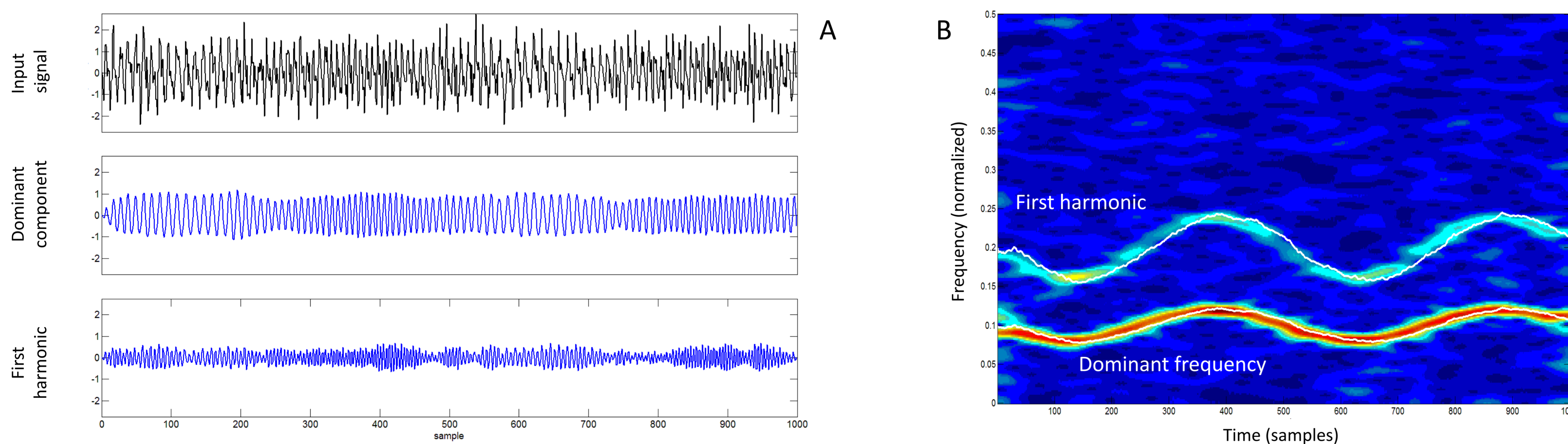
## Methods

### Clinical Characteristics

- 17 consecutive male pts (60±5 y, continuous AF duration 21±9 months) underwent step-CA consisting in pulmonary veins isolation, left atrial (LA) defragmentation and linear ablations, and right atrial (RA) ablations if non terminated (Figure 1).
- Chest lead V<sub>6</sub> was placed in the back (V<sub>6b</sub>) to improve antero-posterior AF recordings.

### Signal Processing

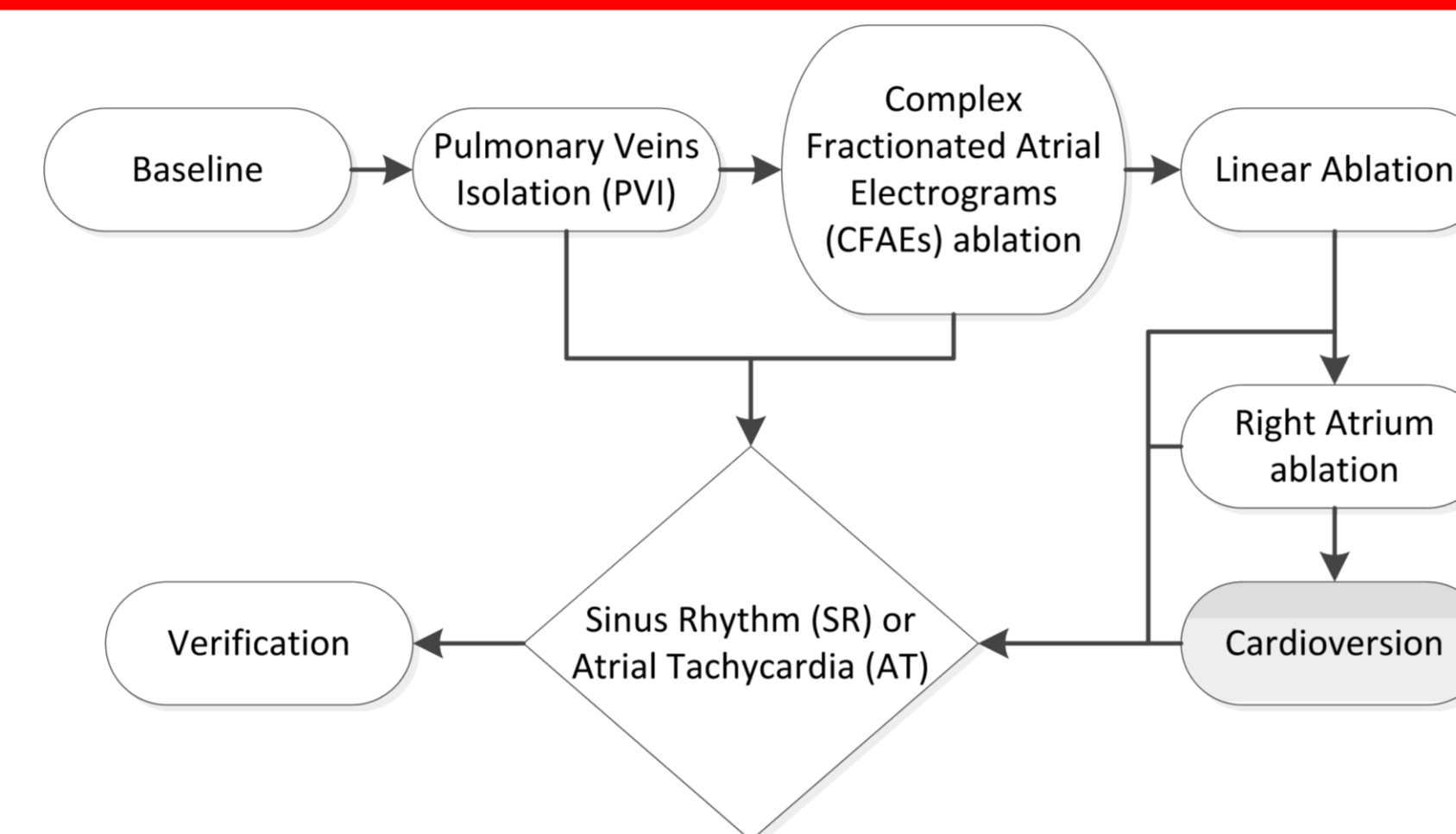
- Cancellation of QRST waves<sup>1</sup> was performed on all ECG precordial leads, on which a frequency analysis based on an adaptive tracking was applied.
- Figure 2 illustrates the principle of the adaptive algorithm applied on a synthetic signal for the extraction of the dominant frequency and its first harmonic component over time.



**Figure 2: Adaptive tracking algorithm.** Panel A: synthetic signal (top) and its extracted dominant (middle) and first harmonic (bottom) components. Panel B: illustrates the ability of the adaptive algorithm to track the fluctuations of the dominant frequency and its first harmonic.

### Measurements of AF Organization (Figure 3)

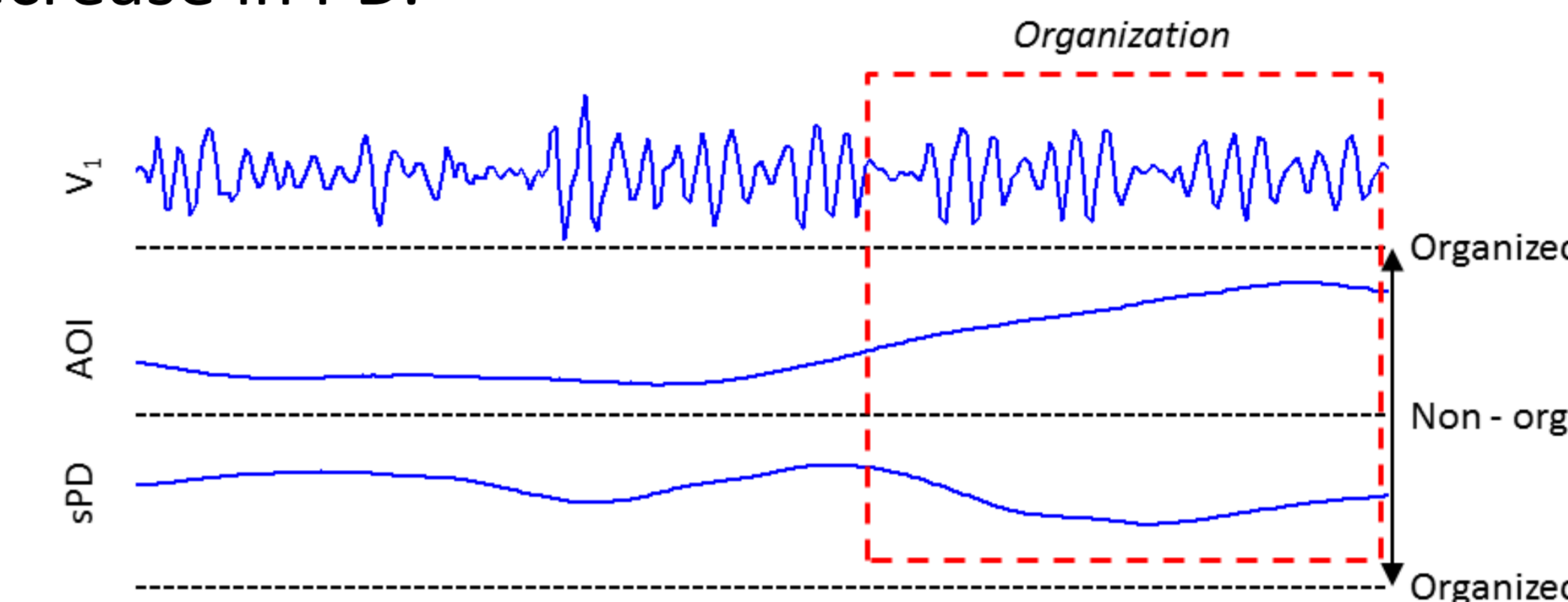
- Adaptive organization index (AOI): ratio between the power of the extracted components and the total power of the signal. AOI estimates the temporal evolution of AF oscillations.
- Variance of the phase difference (PD): variance of the slope of the phase difference (sPD). PD quantifies AF regularity between the dominant and harmonic components.



**Figure 1: Step-CA ablation protocol.**

## Methods

- Figure 3 shows an example of the atrial activity from lead V<sub>1</sub> after QRST cancellation (top) and the resulting AOI (middle) and sPD (bottom) parameters. Note the progressive organization of the ECG signal reflected as a gradual increase in AOI and decrease in PD.



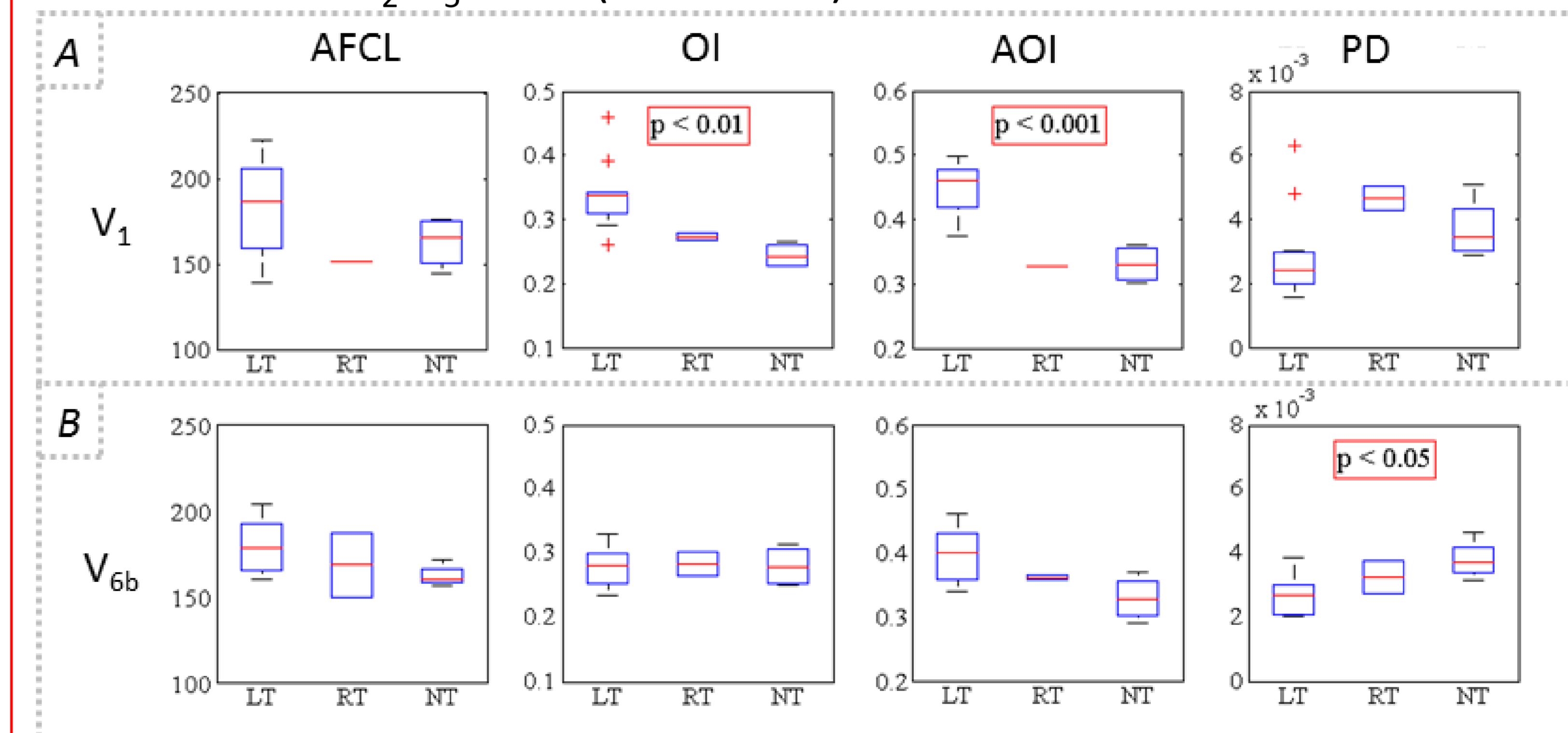
**Figure 3: Example of organization indices.**

Top: V<sub>1</sub> free of the ventricular complexes.  
Middle: AOI.  
Bottom: sPD.

- Both indices were compared to classical ones: a spectrum base organization index<sup>2</sup> (OI), and the mean ECG AF cycle length (AFCL) averaged from all chest leads.

## Results

- LS-pAF was terminated in 13/17 (76%) during step-CA: 11 during LA ablation (LT), 2 during RA ablation (RT), and 4 were non terminated (NT).
- Figure 4 shows that LT was best separated from RT/NT before ablation by AOI on lead V<sub>1</sub> (panel A) and PD from lead V<sub>6b</sub> (panel B) as compared to OI and AFCL respectively. Results from V<sub>2</sub>-V<sub>5</sub> leads (not shown) were less discriminative.



**Figure 4: Comparison of the performance of organization indices before ablation.** LT was best separated from RT/NT by AOI computed on lead V<sub>1</sub> (panel A) and PD computed on lead V<sub>6b</sub> (panel B) as compared to OI and AFCL respectively.

## Conclusion

- Our preliminary results indicate that adaptive organization indices computed before ablation perform better than classical indices for separating LT from RT/NT pts.
- These findings are suggestive of a higher baseline organization in patients who can be left terminated compared to patients requiring bi-atrial ablation.