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ACTIVATION RECOVERY INTERVAL FOR PERSONALIZED CARDIAC ASSESSMENT

Automatic Analysis of Activation Recovery Interval in Heterogeneous Fibrotic Tissue from Chronically Infarcted Swine

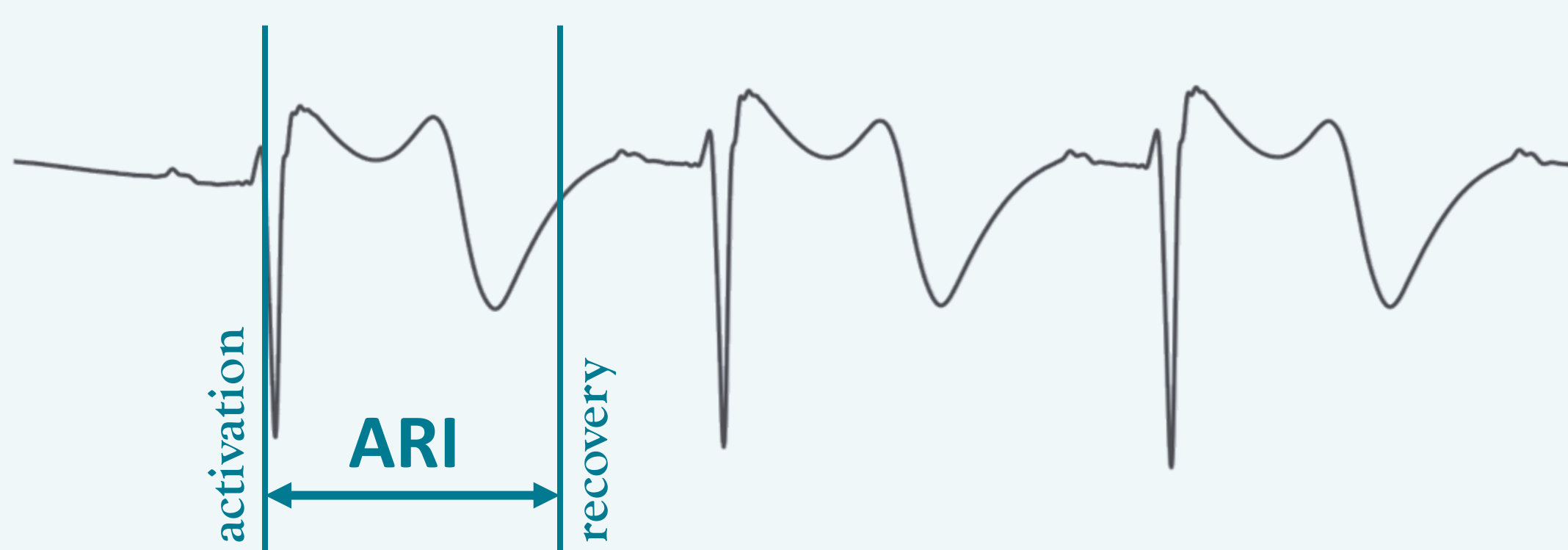
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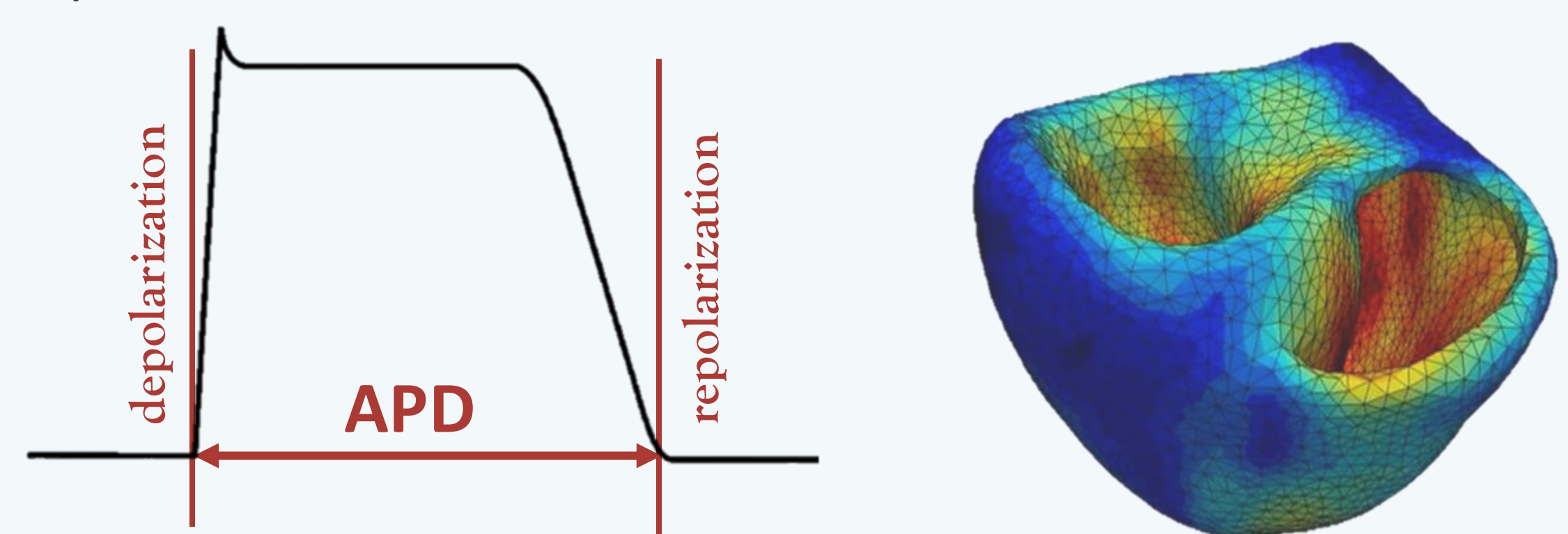
1. WHAT IS THE ACTIVATION RECOVERY INTERVAL?

In intracardiac electrograms (iEGMs), the **Activation Recovery Interval (ARI)** corresponds to the interval between the activation (ATs) and recovery times (RTs). However, there is not always consensus on their exact locations, so the data is usually manually annotated by experts.



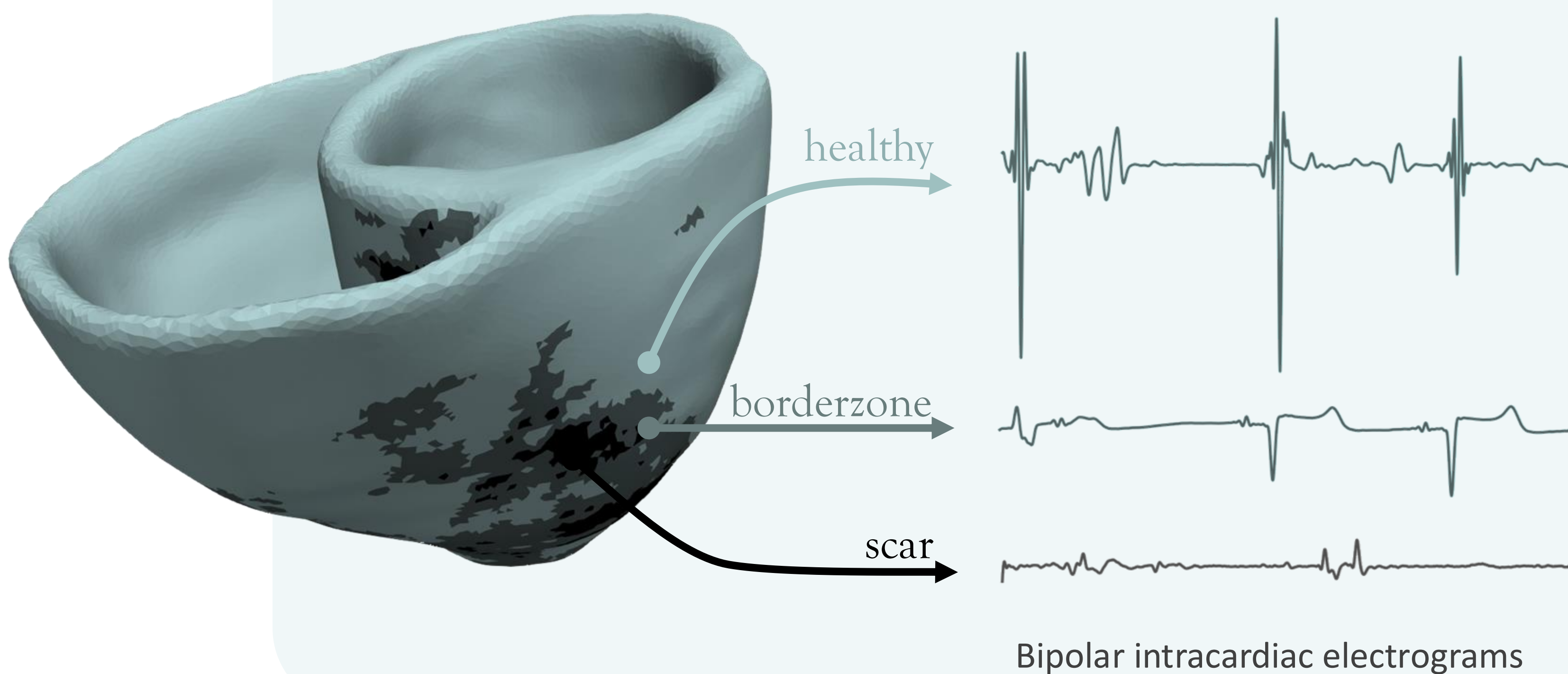
2. ARI HELPS TO UNDERSTAND THE RISK OF ARRHYTHMIA

The ARI can be used as a surrogate for the **Action Potential Duration (APD)**, reflecting the time it takes for cardiac cells to depolarize and repolarize. The dispersion of the APD values across the myocardium can give valuable insights into how arrhythmias initiate and be used to assess their risk.



3. IMPORTANCE IN SCARRED MYOCARDIAL TISSUE

Scarred myocardial tissue has different mechanical and electrophysiological properties such as lower conduction velocities and reduced signal amplitudes, meaning the **ARI can vary across the tissues, rhythms, and patients**.

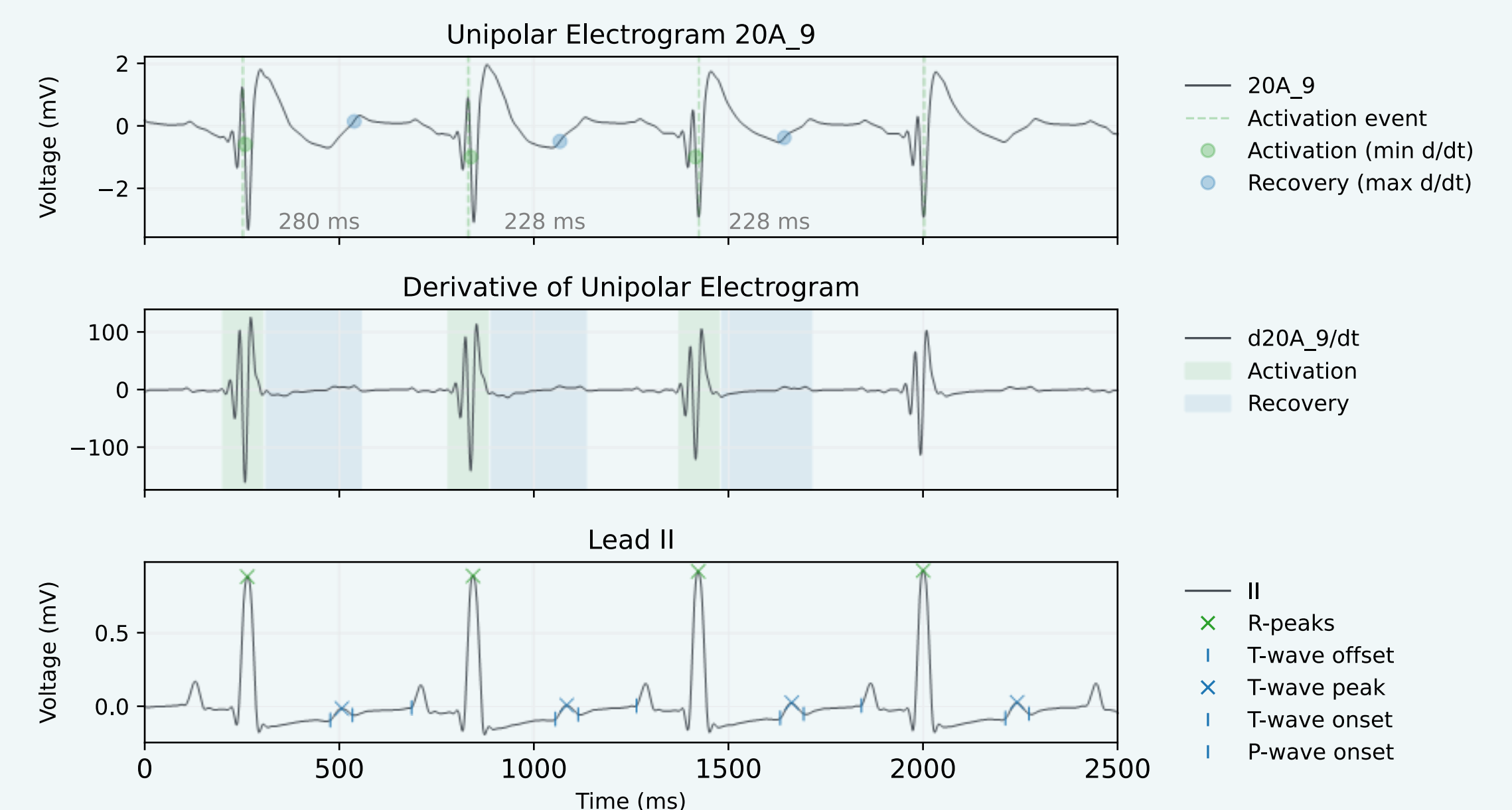


4. OUR METHOD TO COMPUTE THE ARI

We propose a fully automatic algorithm to detect ATs and RTs in unipolar electrograms (UEs) that takes advantage of the surface-lead ECG fiducials, for which techniques are well more developed.

Activation Times: using a Multilevel Discrete Wavelet Transform (DWT), frequencies 15,6-125 Hz are used to find activation peaks and the corresponding local derivative minima (as per Wyatt's method). ATs can be filtered based on Lead II's R-peaks.

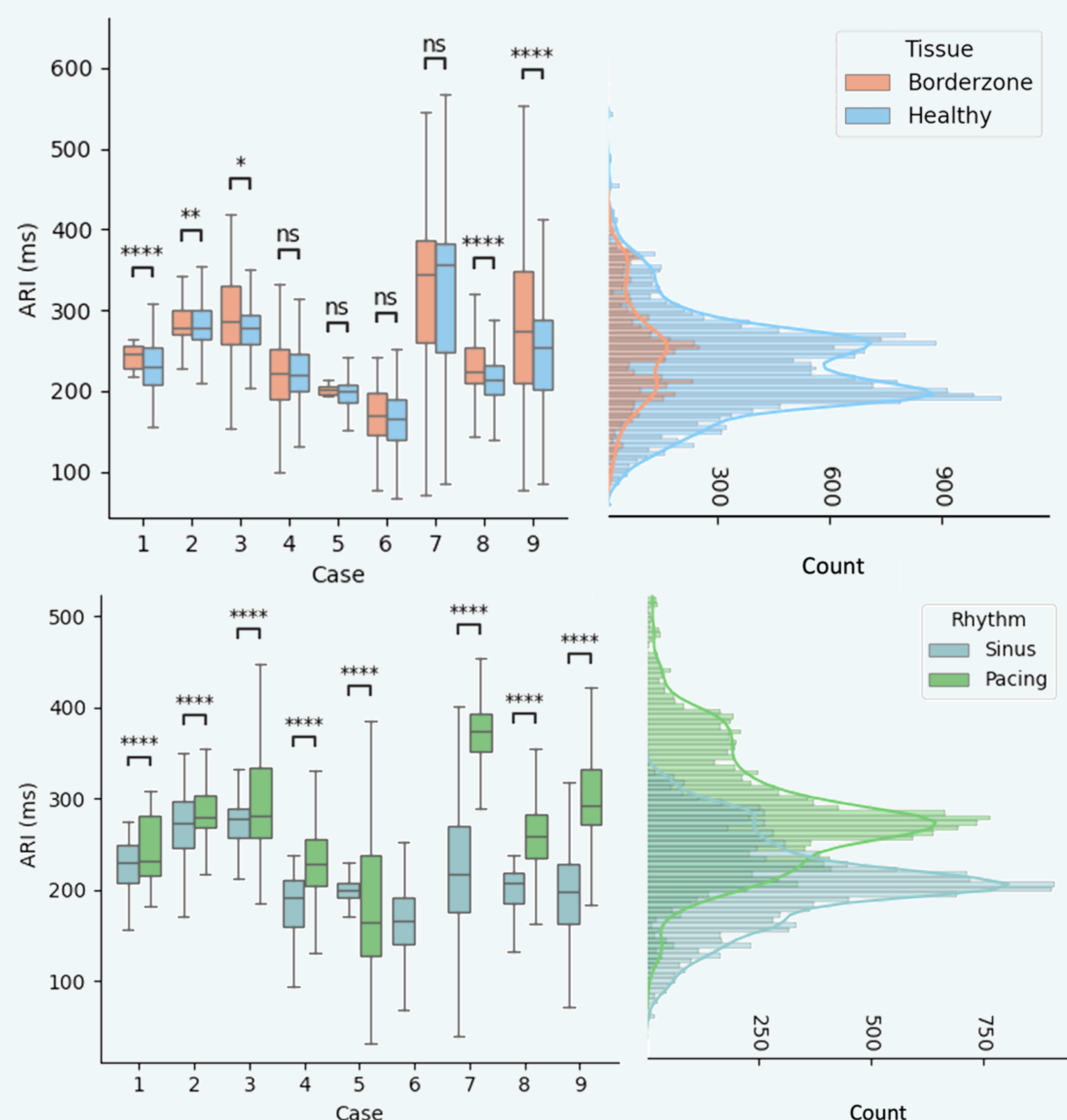
Recovery Times: recovery detection windows are defined between 60 ms after ATs up until 20 ms after Lead II's T-wave offsets.



Top: UE signal showing activation (green) and recovery (blue) times, and the corresponding ARIs. The dashed vertical lines correspond to an "activation event". Middle: first derivative of the UE signal, along with the detection windows for activation (green) and recovery (blue) times, used to find the minimum and maximum derivatives. Bottom: lead II and the detected fiducials, namely the R-peaks and T-wave limits.

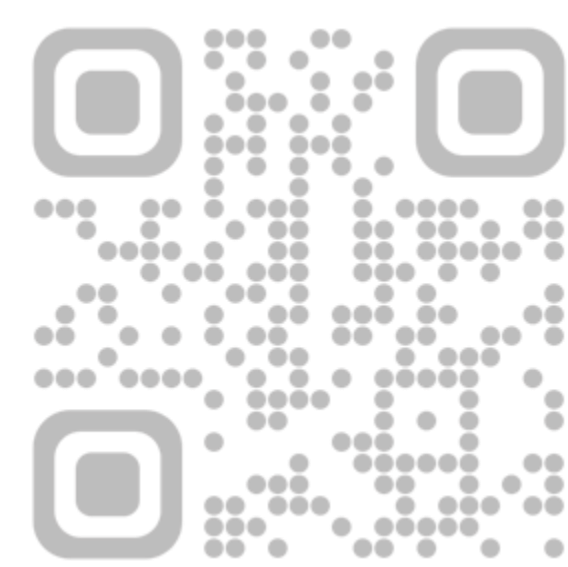
5. ARI ACROSS TISSUES AND RHYTHMS

A cohort of 2900 iEGMs from the left ventricular endocardium of 9 infarcted swine (CARTO3 mapping system) was used to study the ARI distributions in sinus rhythm and pacing conditions [1].



Distributions of tissue- (top) and rhythm- (bottom) stratified ARI values per case and combined distributions. **** indicates p-value < 1e-4 from the Mann-Whitney U test. Boxplots show quartiles and median values.

Check our work!



6. MAIN TAKEAWAYS

- Automated processing of iEGM recordings is a valuable tool for analyzing large volumes of data needed for electrophysiological studies. By using a surface lead ECG signal as a reference, **our methodology ensures correct estimation of the ARI**.
- ARI values can differ significantly among tissue types and rhythm conditions at the case level, suggesting that **repolarization patterns are highly diversified**.
- Instead of assuming electrophysiological properties at the population level, these findings support the need for **personalized approaches** in clinical assessment and cardiac arrhythmia interventions.

7. REFERENCES

- [1] T. Escartin et al., "The extent of LGE-defined fibrosis predicts ventricular arrhythmia severity: insights from a preclinical model of chronic infarction," Lecture Notes in Computer Science, vol. 13958, pp. 698-707, 2023.