# Atrial Fibrillation Instantaneous Frequency Through Signal Decomposition Correlates with Recurrence After Electrical Cardioversion

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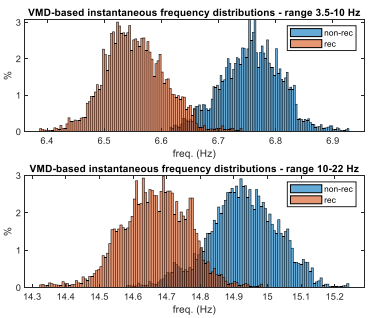
**Aims**: In persistent atrial fibrillation (AF), the faster the atrial activity is propagating, the more stable its propagation paths are on the short-term, suggesting a locally more homogeneous cardiac tissue. In this study, we further investigate this hypothesis by analyzing the instantaneous frequencies of atrial propagation patterns.

**Methods**: High-density body surface potential maps (120 anterior, 64 posterior electrodes) were recorded in 75 patients in persistent AF (31 non-recurrent after electrical cardioversion, 32 recurrent, 12 unknown). For each patient, the body-surface atrial signals were decomposed by means of two data-driven signal decomposition methods: Singular-Spectrum Decomposition (SSD) and Variational Mode Decomposition (VMD). Only the signal components in the frequency ranges 3.5-10Hz (AF activation band) and 10-22Hz (harmonics or fractionation-related content) were kept, and instantaneous frequencies were estimated from those (i.e., a time series of instantaneous frequencies for each subject, each electrode, and each frequency range). We then analyzed the distributions of the instantaneous frequencies.




**Results**: In both ranges 3.5-10Hz and 10-22Hz, the instantaneous frequency distributions of AF patients that did not have AF recurrence after electrical cardioversion showed higher values than those of patients with recurring AF (overall mean+/-STD, SSD 3.5-10Hz: 6.82+/-0.05 vs. 6.70+/-0.05Hz; SSD 10-22Hz: 15.25+/-0.11Hz vs. 14.99+/-0.11Hz; VMD 3.5-10Hz: 6.76+/-0.06Hz vs. 6.55+/-0.05Hz; VMD 10-22Hz: 14.93+/-0.10Hz vs. 14.67+/-0.10Hz; t-test: all p-values $< 0.001$). Additionally, the spatial distributions of instantaneous frequencies over the body surface showed that the range 3.5-10Hz is mainly prevalent at the front, while the range 10-22Hz is mainly prevalent at the back,

**Conclusion**: The noninvasive analysis of instantaneous frequencies during persistent AF through signal decomposition suggests that faster AF propagation patterns may be linked to a more organized AF substrate. This subtle behavior is lost when signal decomposition is not applied.