Cardiac Position Sensitivity Using Stochastic Collocation

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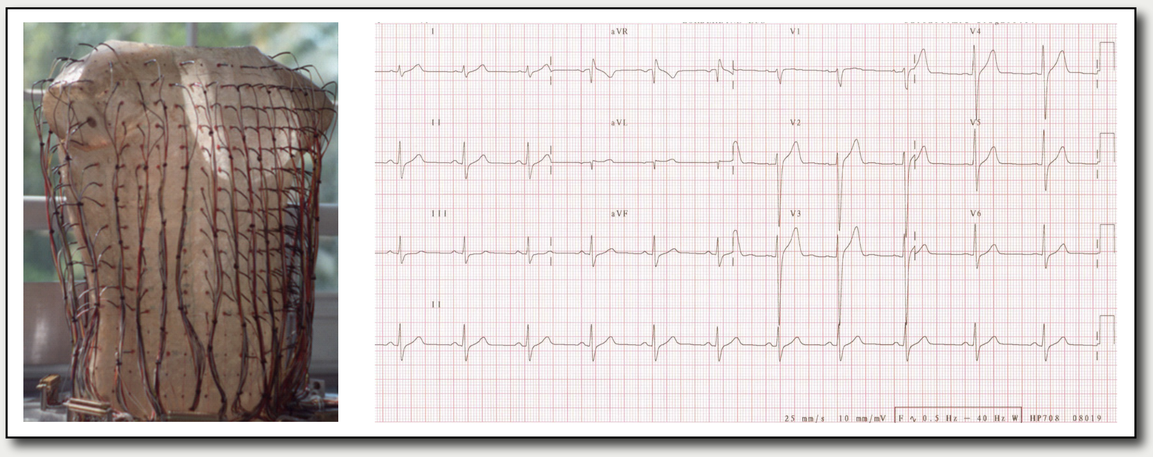
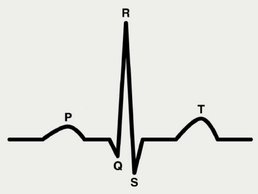
Electrocardiogram

Electrocardiogram (ECG) is a diagnostic tool that measures and records the electrical activity of the heart. Interpretation of these details allows the monitoring and diagnostic of a wide range of heart conditions, such as Rhythm disturbances, ischemia, infarctions.



Ischemia is the reduction of the amount of blood which the arteries provide for the heart to function at normal parameters.

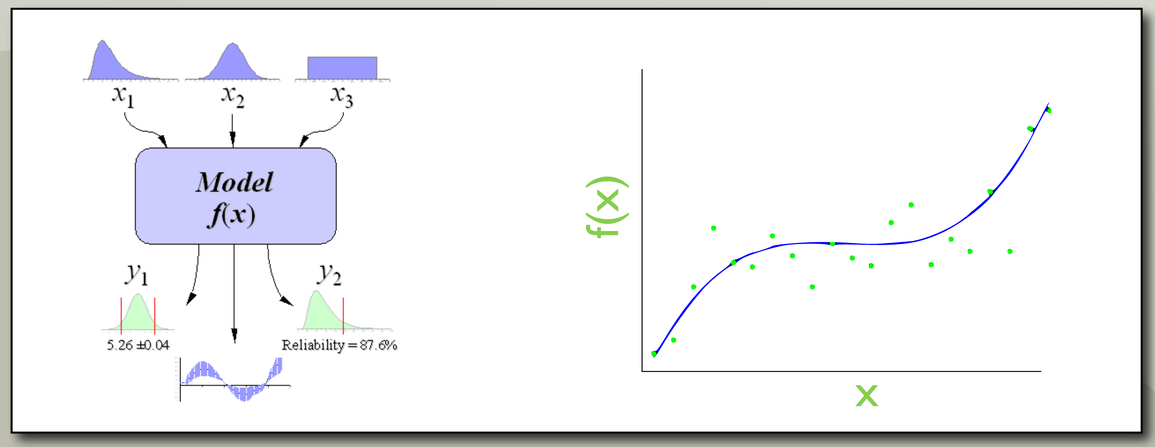


Morphological changes can be detected as ST elevations or depressions.

Positional changes of the heart with posture and respiration can alter ECG signal amplitude and morphology in ways that influence clinical decision making

Statistical Analysis

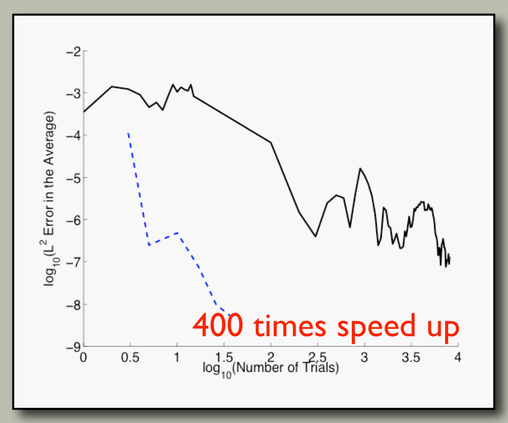
The goal of our study is to evaluate the impact positional changes of the heart on the ECG in the specific clinical setting of myocardial ischemia. To carry out the necessary comprehensive sensitivity analysis, we apply a novel and highly efficient statistical approach, the generalized polynomial chaos-stochastic collocation method (gPC- SC), to a boundary element formulation of the electrocardiographic forward problem, and we drove these simulations with measured epicardial potentials from whole-heart experiments.



Our Method: gPC-SC
Generalized Polynomial Chaos
- Represents stochastic process via polynomials of random variables
- Significantly reduces polynomial degree

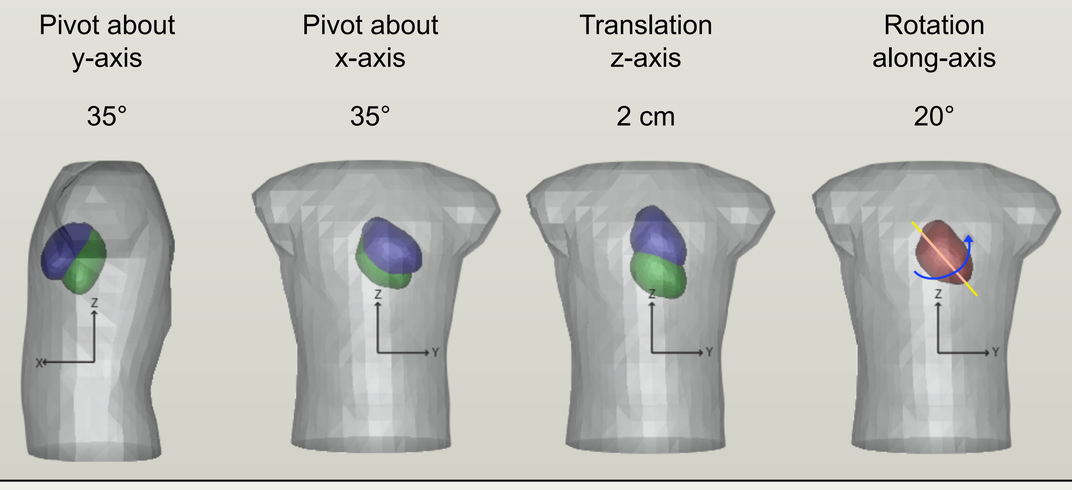
Stochastic Collocation
- Takes advantage of quadrature rules to calculate means, variances, and moments

This method is a fast and efficient way to calculate the statistics (400 faster that the reference method: Monte Carlo)

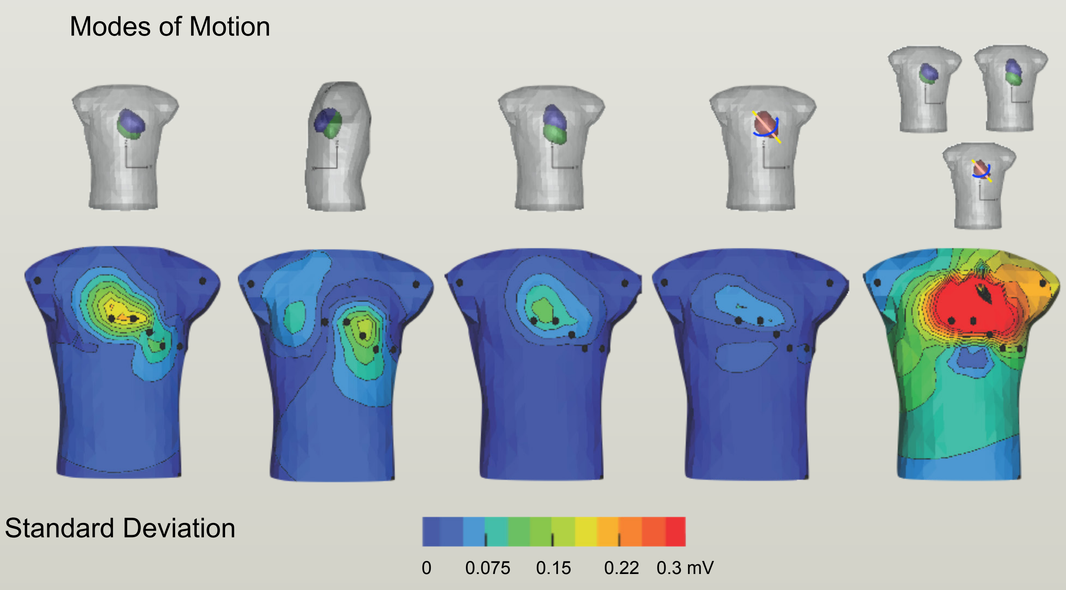


Modeling and Visualization of Uncertainty in Heart Position

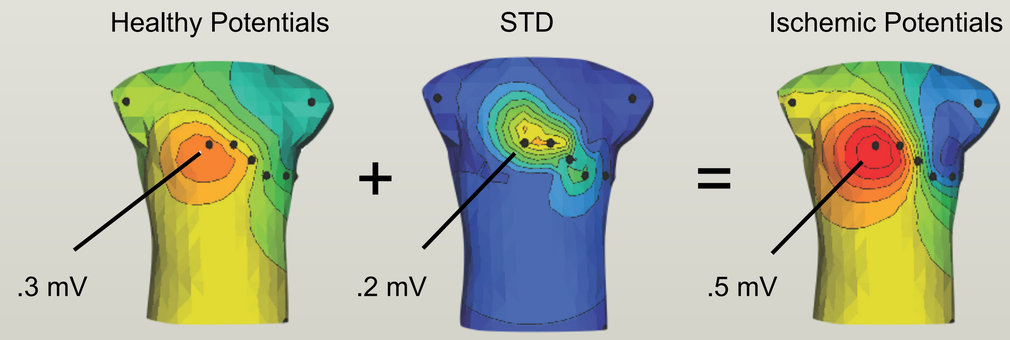
Heart Motion from experiment



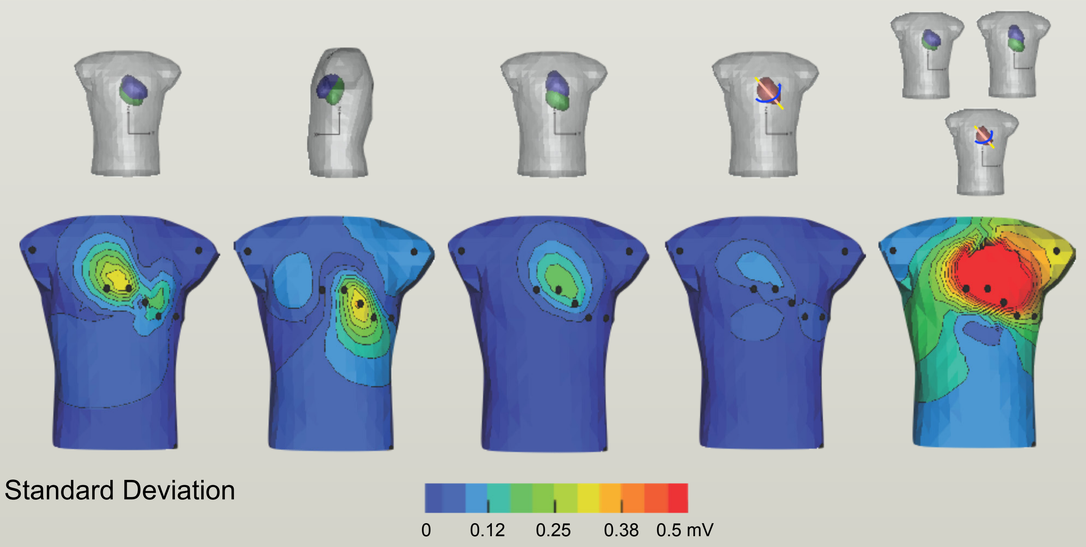
False Positive



Results



False Negative



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