Structured Noise Detection: Application on Well Test Pressure Derivative Data
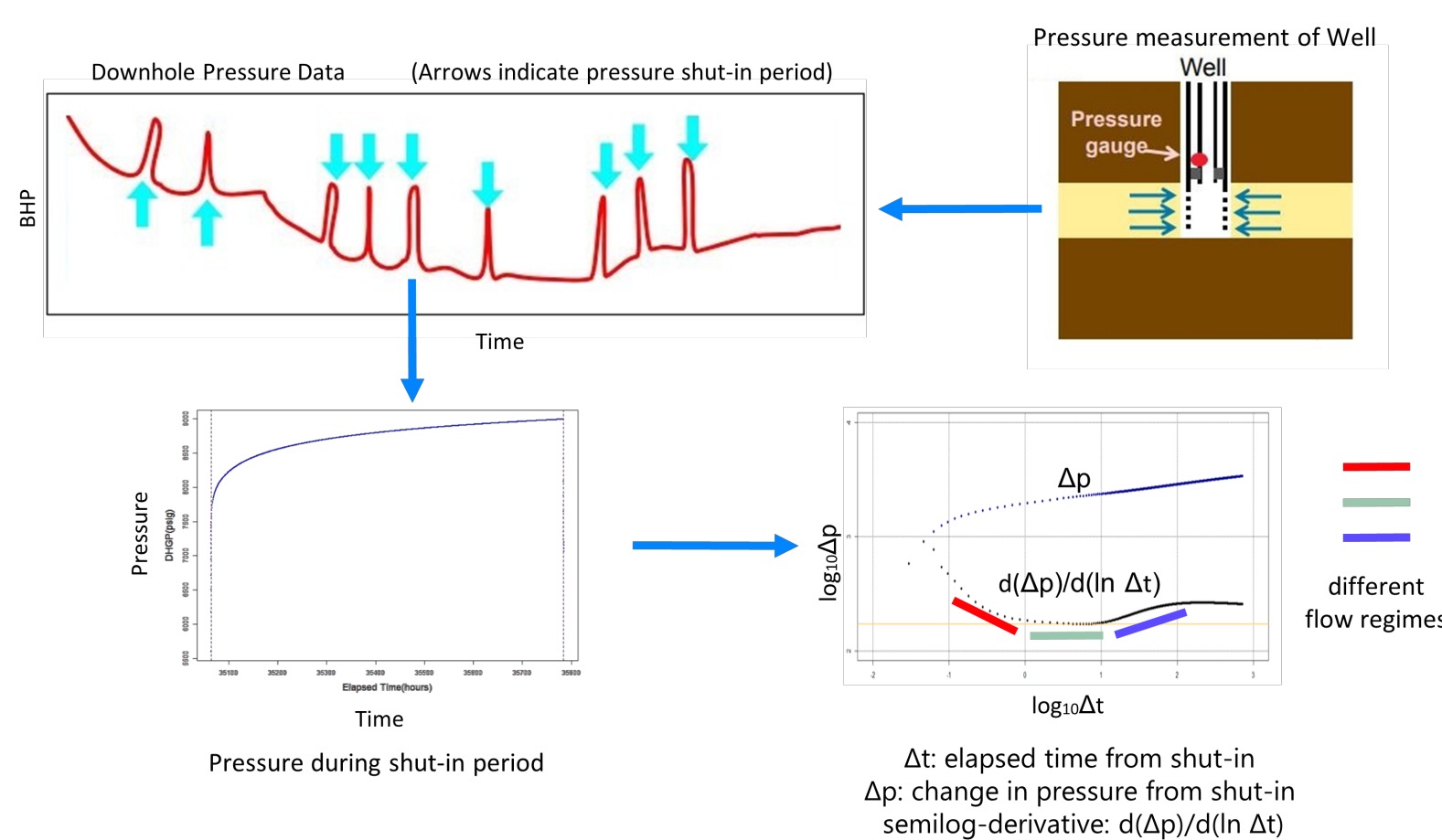
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Motivation

- Permanent downhole pressure gauges are installed in oil/gas well for monitoring.
- The pressure data during shut-in period is converted into pressure derivative data to identify different flow regimes.

Flow regime identification ➡ Reservoir condition, production forecast

Objective

Detection and removal of "structured noise" to automate flow regime identification.

Pressure Derivative data free from Structured Noise

Structured Noise Corrupted Pressure Derivative data
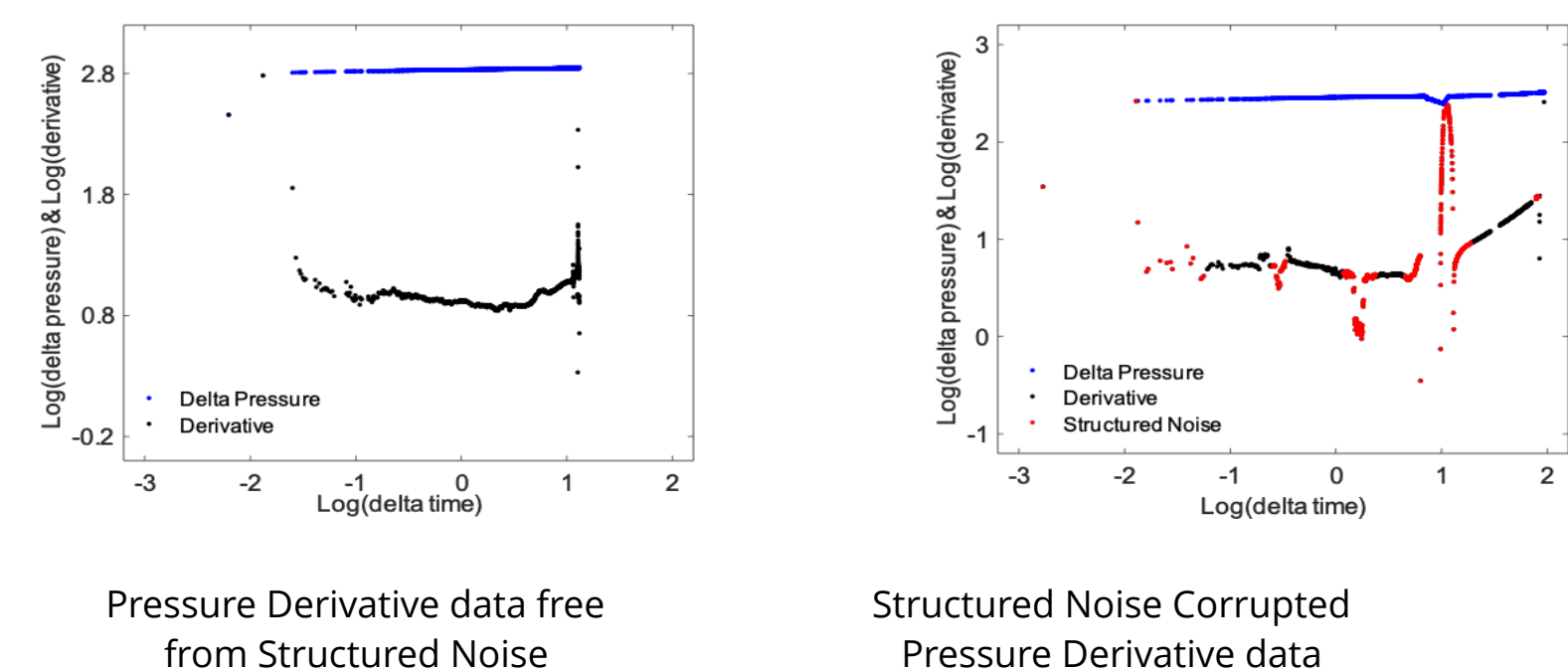
Structured Noise: Pressure response to non-reservoir origin phenomena that maintain similar structure in different observation.
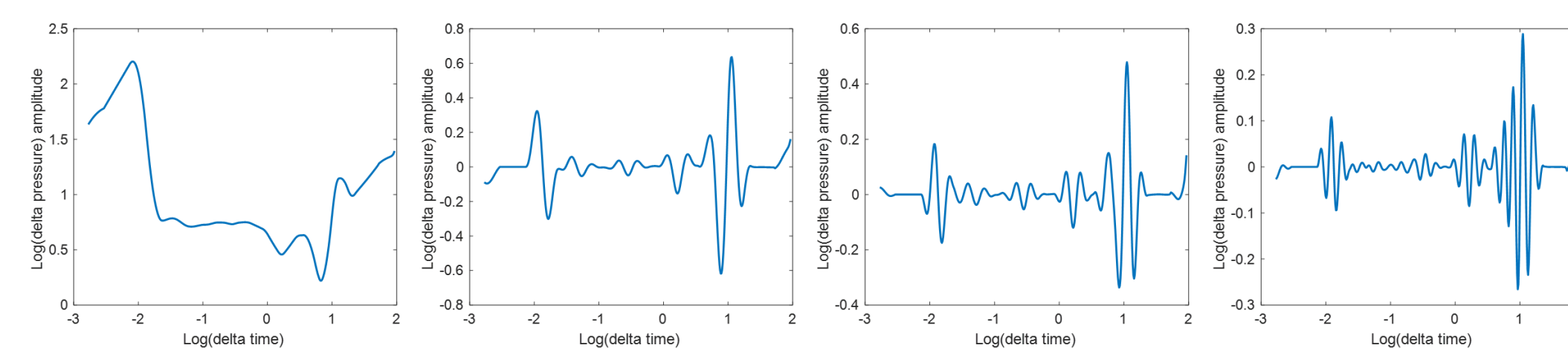
Our Approach

- The pressure data is decomposed using Singular Spectrum Analysis (SSA) to separate out trend and structured noise.
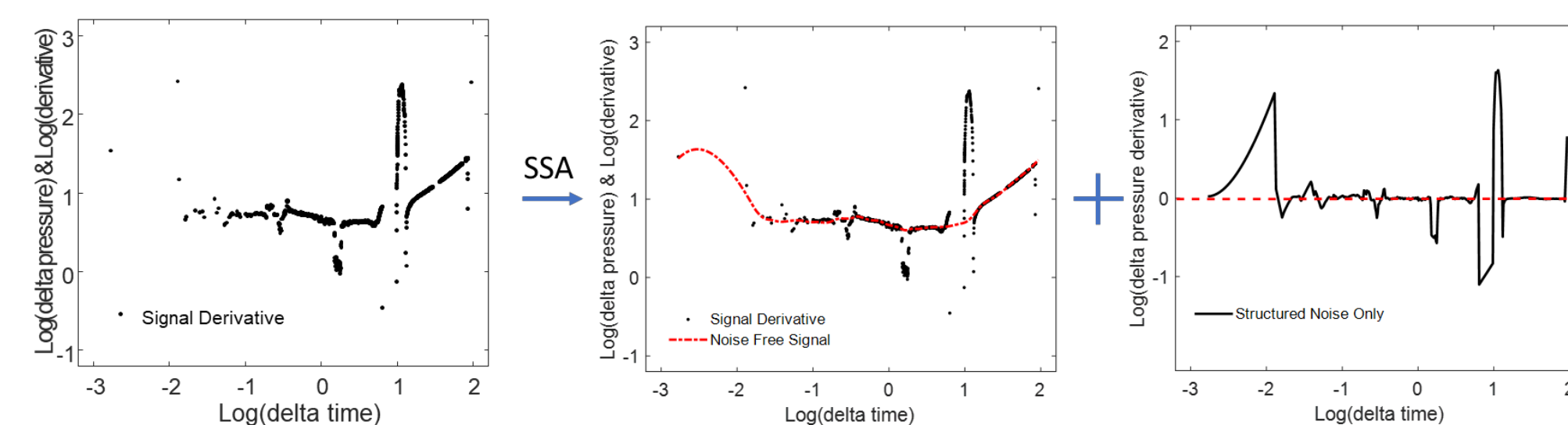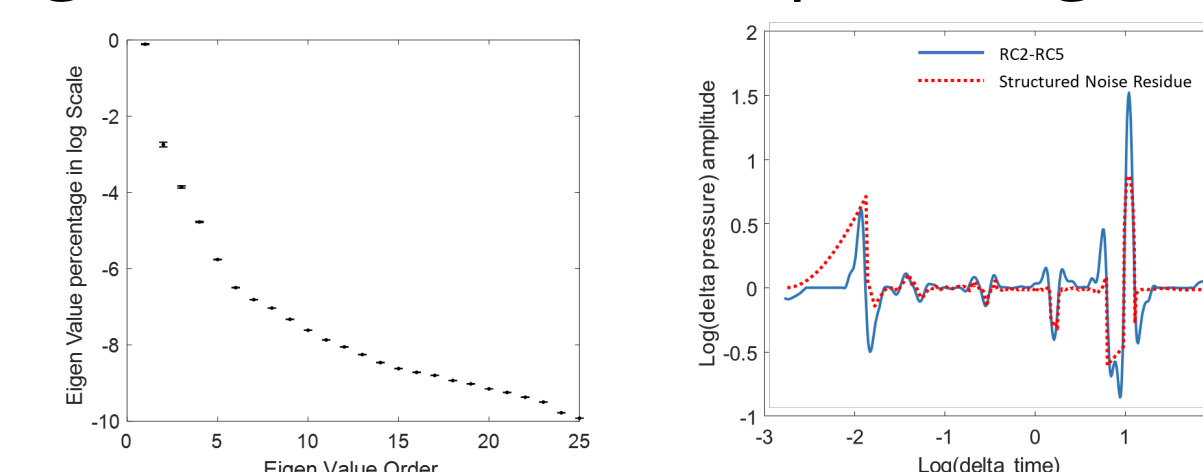

- Singular Spectrum Analysis (SSA): A data adaptive, non-parametric time series analysis method.
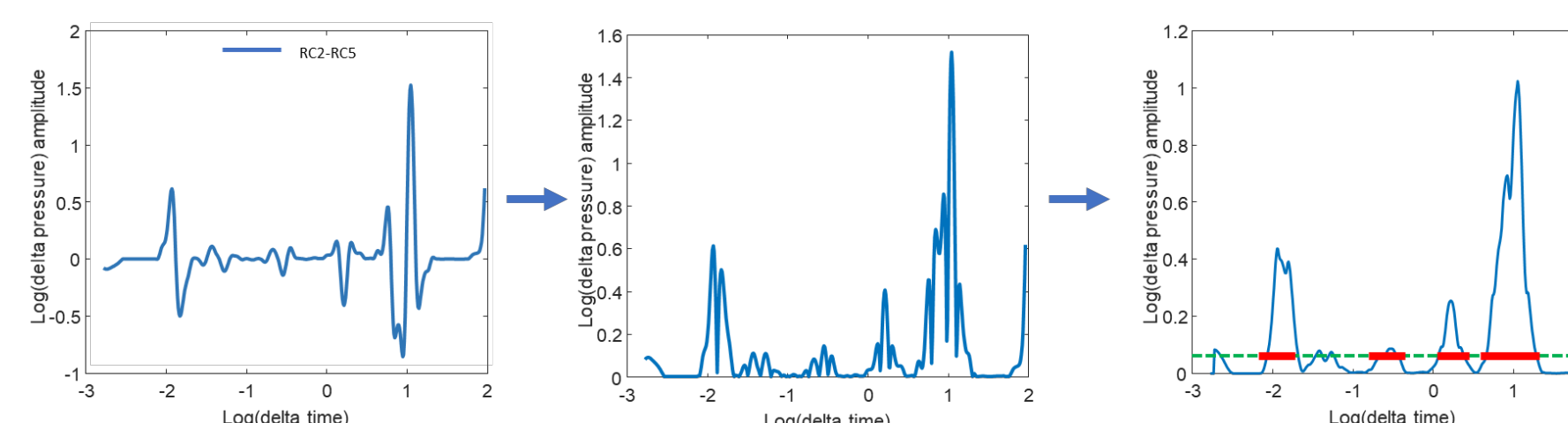
Method

1. Efficient decomposition to separate out trend and structured noise.
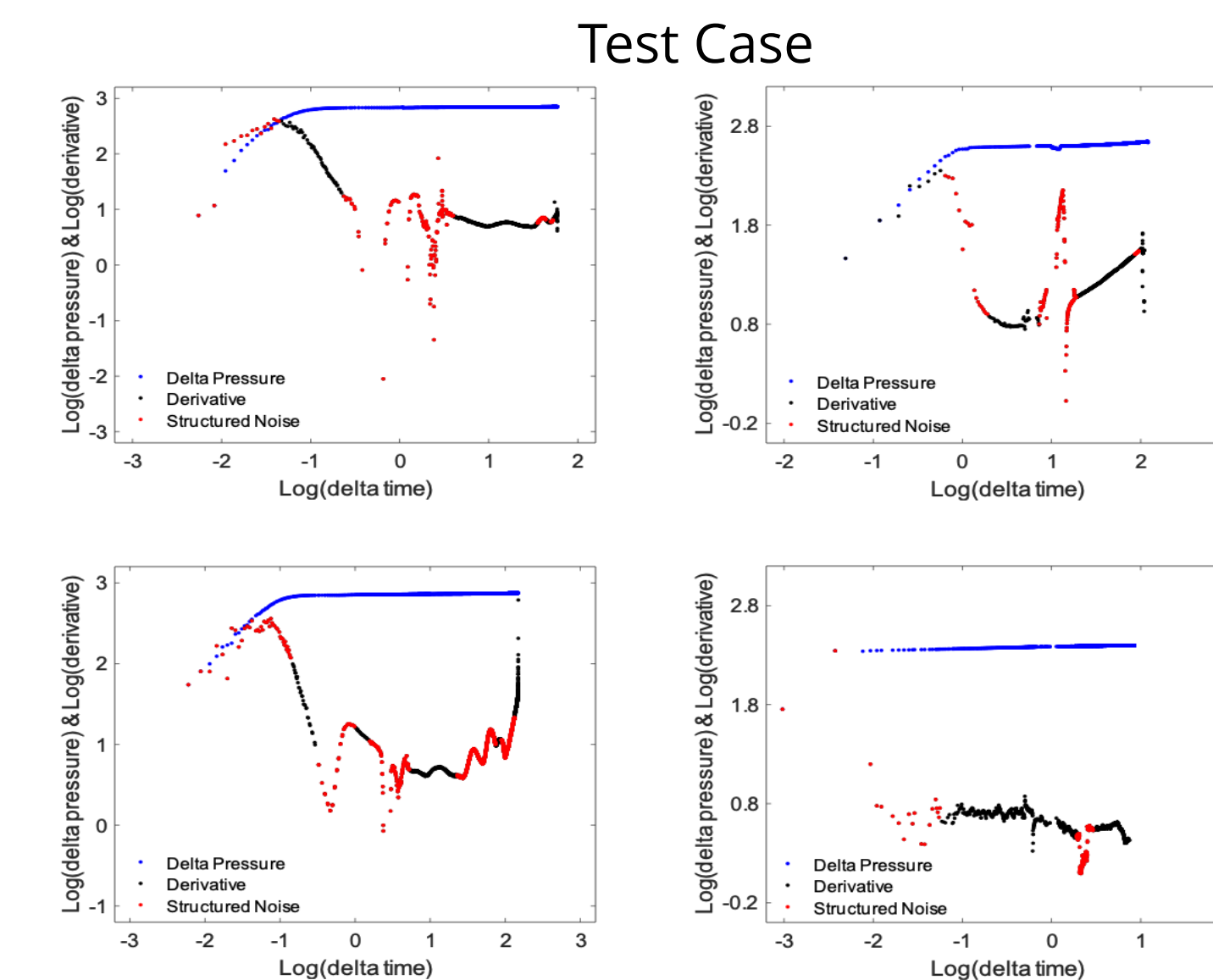   - Embedding dimension selection based on noise bandwidth.

2. Accurate identification of structured noise components.
   - Based on Eigen values of corresponding components.

3. Precise temporal localization of structured noise segments.
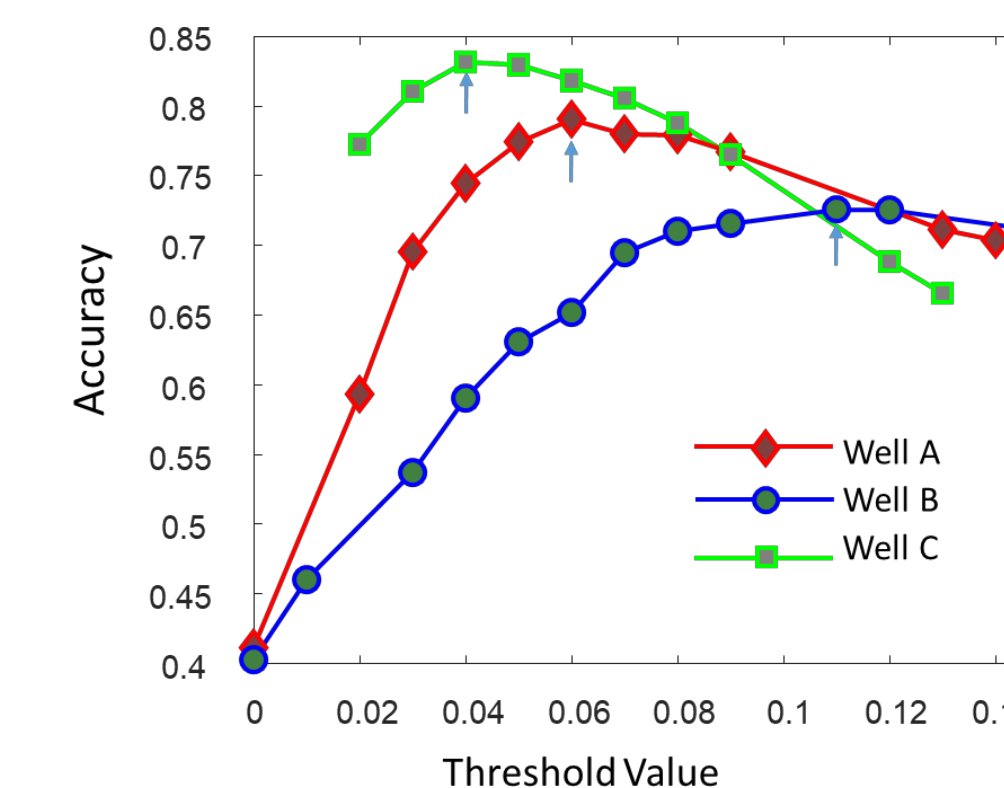   - Single-sample threshold selection.

Experimental Results

Test Case

Accuracy (F1-Score)

Well	No Lower Bound	Minimum Threshold > 0	Minimum Threshold > 0.02
A	69.73%	74.07%	75.02%
B	63.22%	66.22%	67.14%
C	80.36%	80.36%	80.59%
Average	71.1%	73.55%	74.25%

Accuracy vs Threshold

The proposed method is:

1. Fast, scalable and interpretable.
2. Parameters are readily fine-tunable.
3. No extensive manual labeling.