Visual Signal
Enhanced Module 1.3 Feature

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Enhanced Module

- Fast Gaussian Filter/Trend Removal
- Fast Short Term Fourier Transform
- Rolling MSE
- Fast MSE
- Bump Removal
- Peak Detection
- Teager Operator
- ICA/PCA

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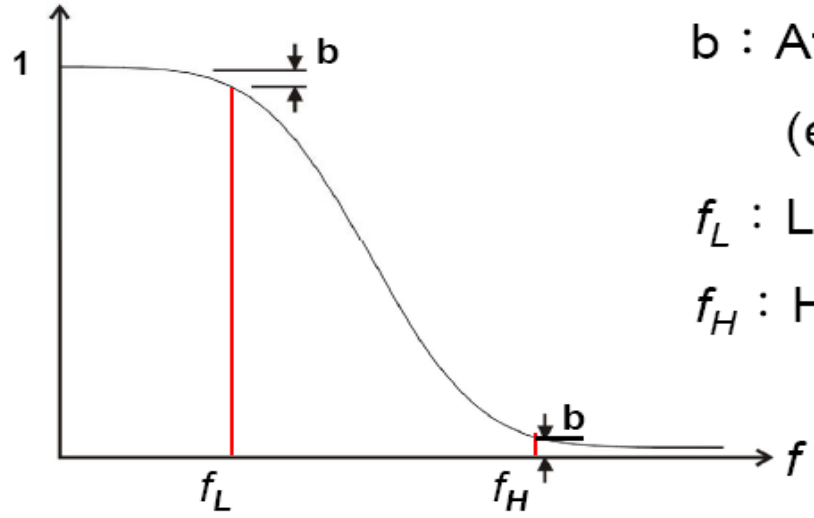
Gaussian Filter

- Trend estimator: Removing Trend Before Applying TFA
- No Phase Shift



b : Attenuation factor

(e.g. b=0.01)

f_L : Low frequency

f_H : High frequency

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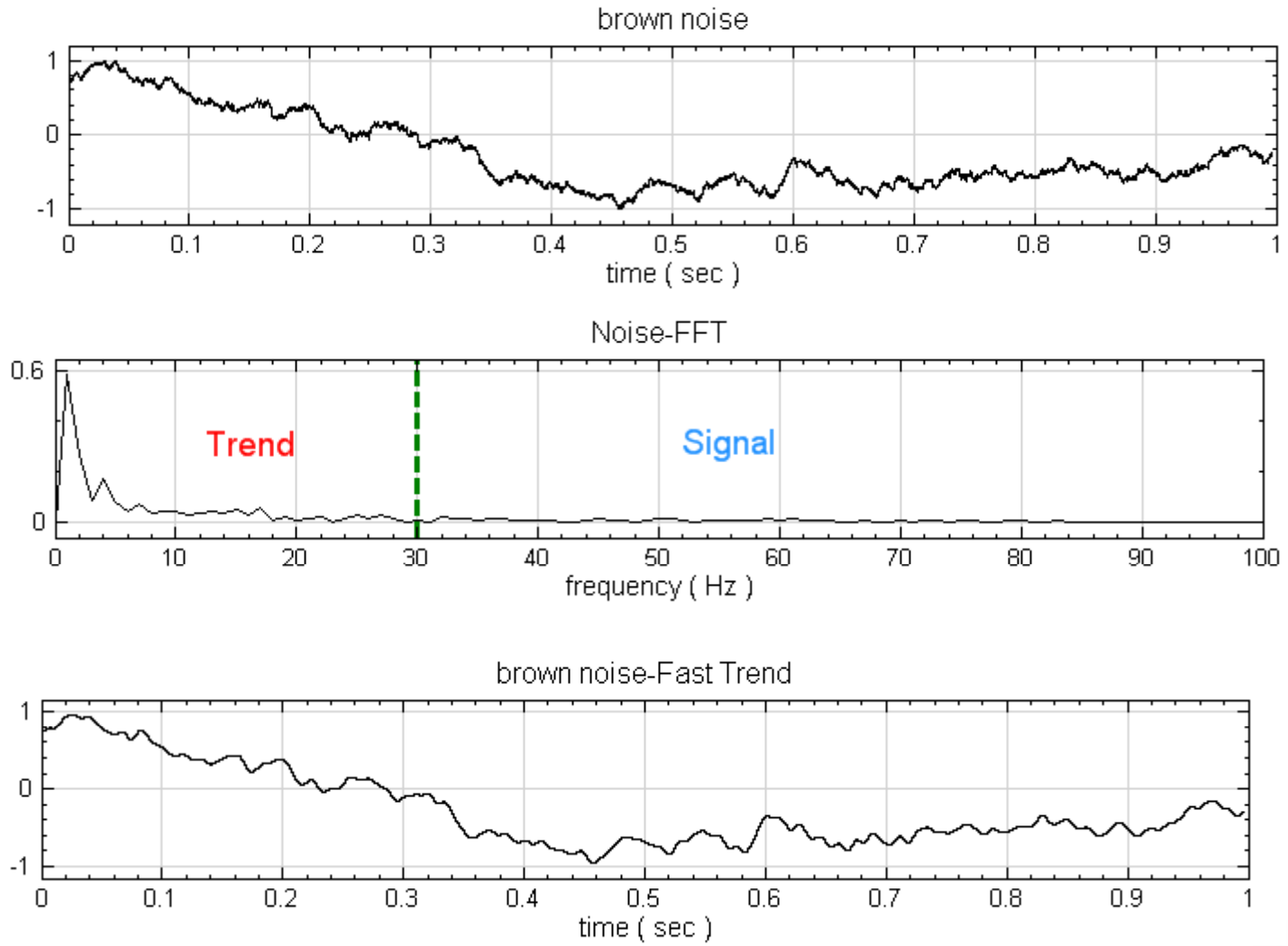
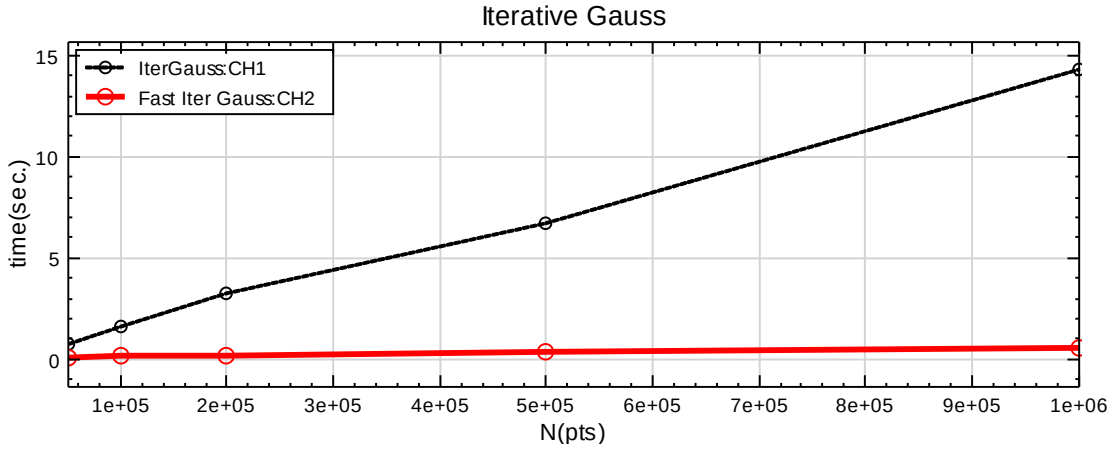
- Brown noise : two – million points, remove frequency greater than 30 Hz



Fast Gaussian Filter

(1) Handle Large Scale Data(16 Million data points on 32 bit machine)

(2) 100 x Faster than previous version



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Time Freq Analysis: STFT

- When does that freq Happen?

$$F(\omega,\tau)=\int_{-\infty}^{\infty} y(t)\cdot w(t-\tau)\cdot e^{-i\omega t}dt$$

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Fast STFT

- Features:
  - Large Scale: handle 20 M points 32 bit machine
  - 100x speed up
  - Marginal Time/Freq Accuracy Verification
  - Higher order STFT

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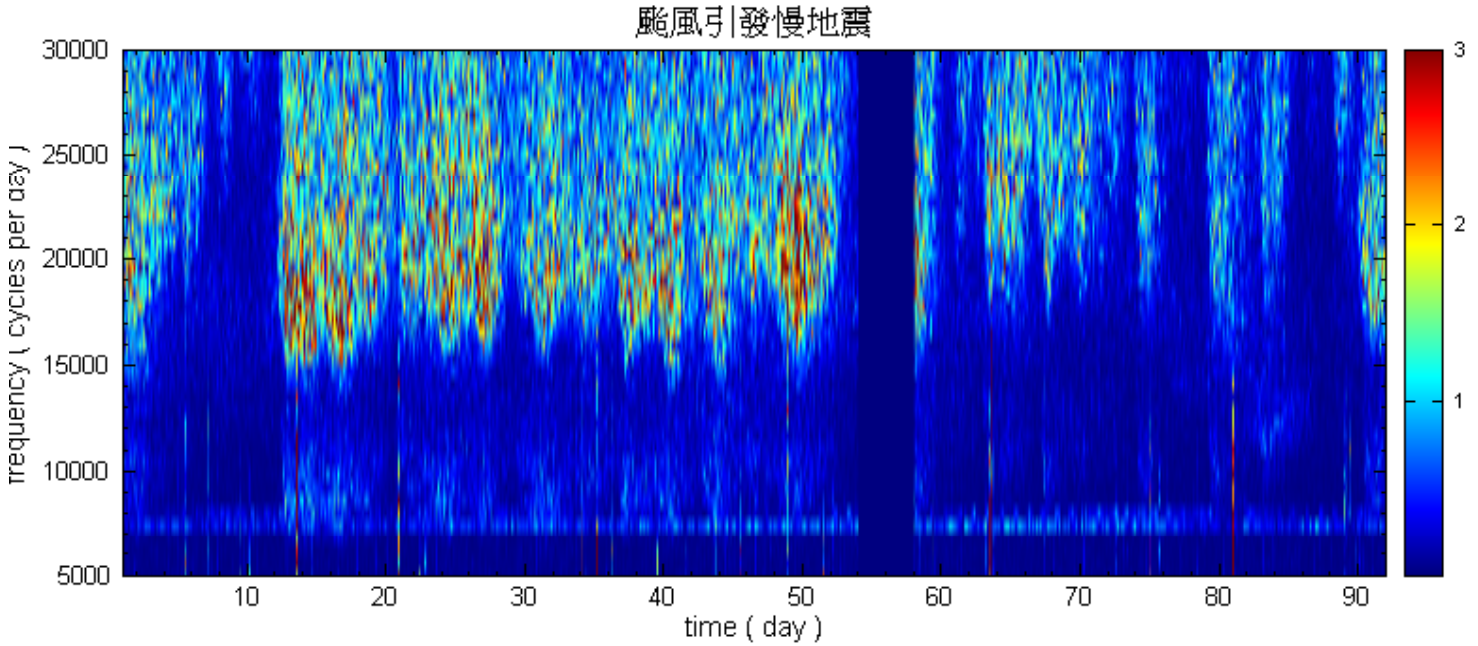
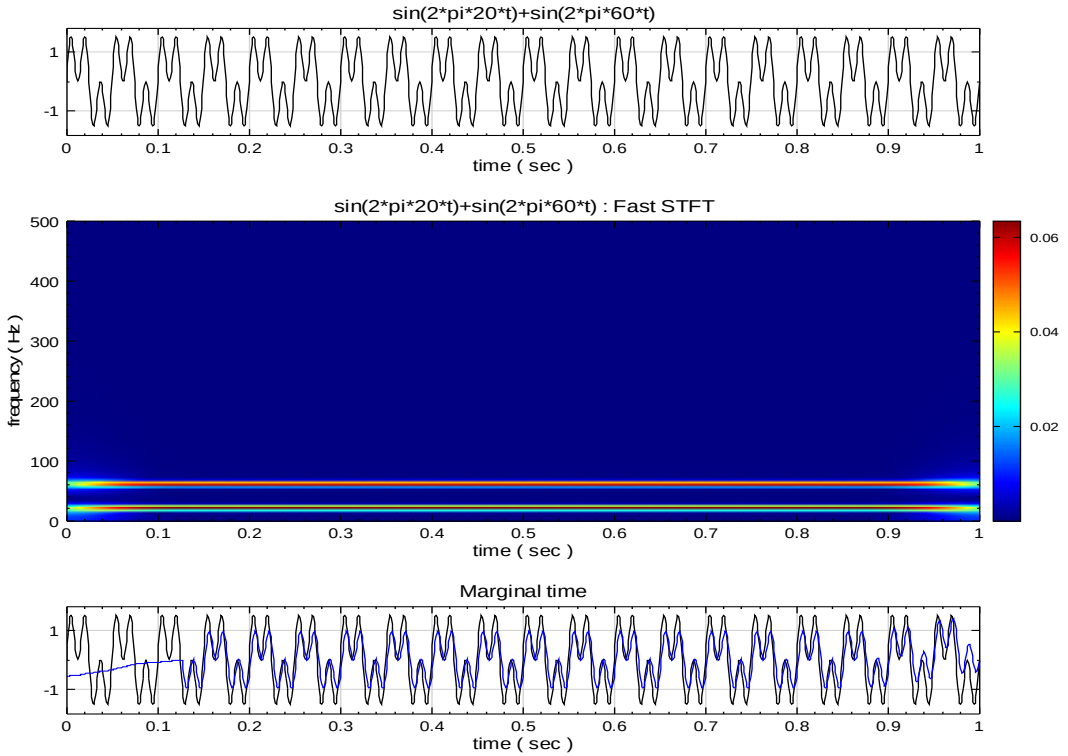
Fast STFT

Example: Seismograph data (地震儀資料): 8 M points,1st order points ~ 11 sec



Fast STFT: verify the results by Marginal Time

Marginal Time: $$y(\tau) = \mathrm{Re}[\int_{-\infty}^{\infty} F(\omega,\tau)\cdot d\omega]$$



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MSE

- Multiscale entropy(MSE) is a measurement of a system's complexity

Rolling MSE

- Rolling MSE: Partition Data into segment of windows, compute multiscale entropy for each window

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Rolling MSE

- Applications:
  - (a) measure signal's complexity as function of time and scale.
  - (b) Online Diagnosis (monitoring)
  - (c) Earthquake prediction
- Features:
  - (1) 3-*D* (time, scale, entropy) display of results

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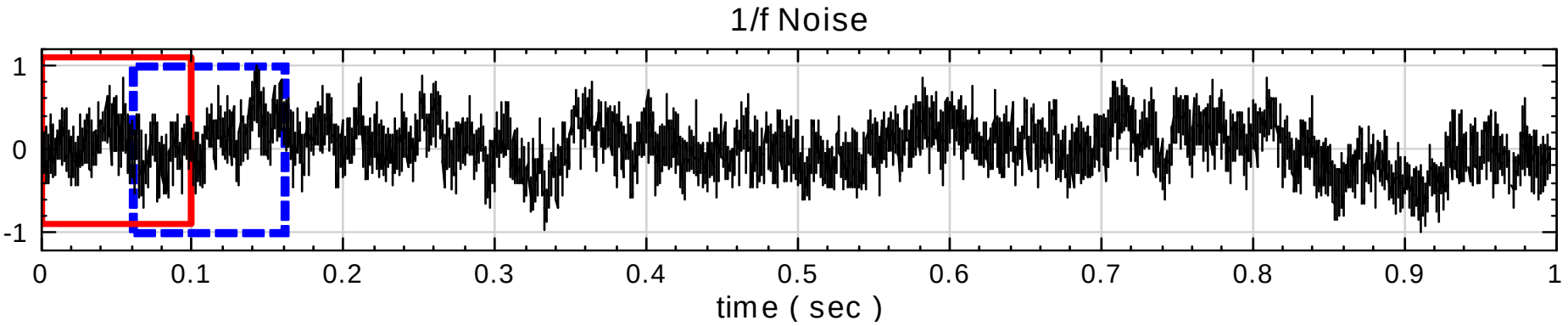
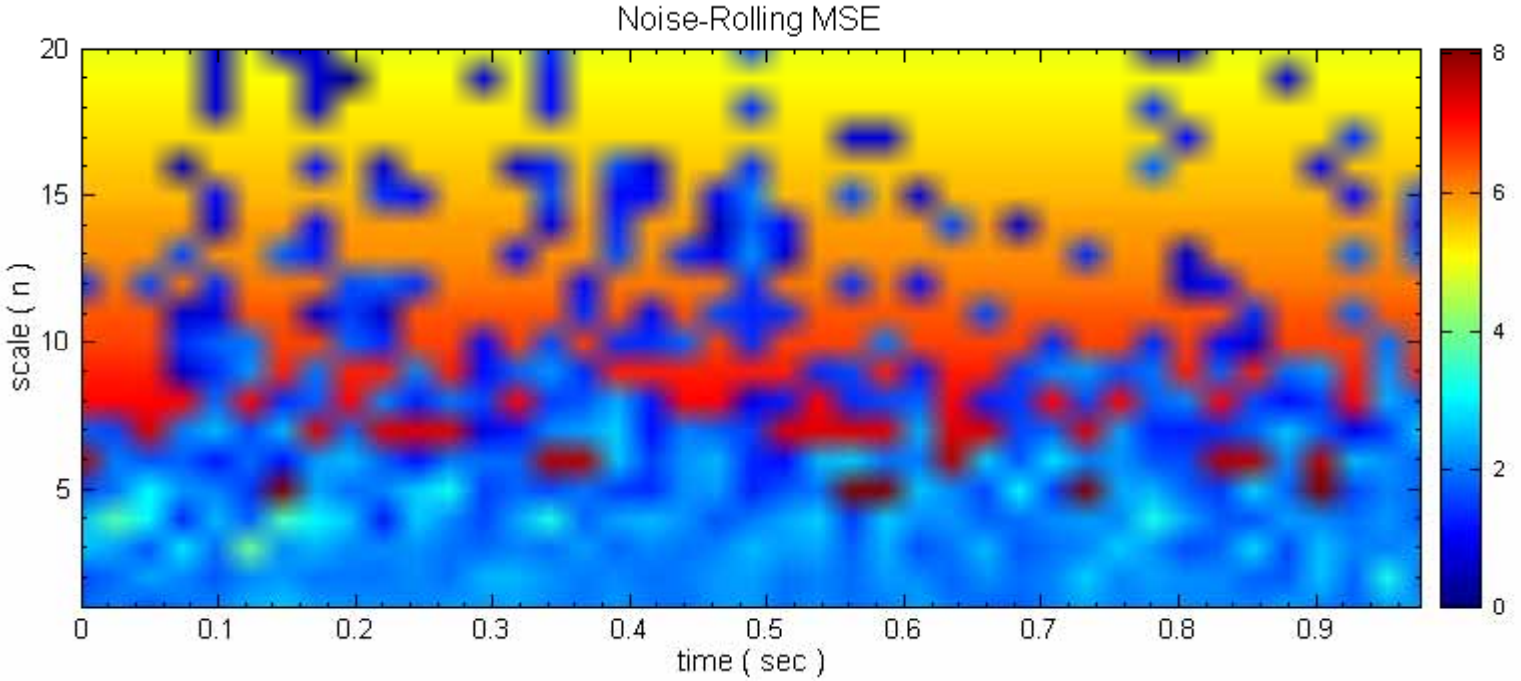
Rolling MSE: example





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Fast MSE

- Fetures: high speed computations: 100x speed up for *N* >= 80,000.

Applications: used to analyze biological, DNA, mechanical, earthquake, …signals

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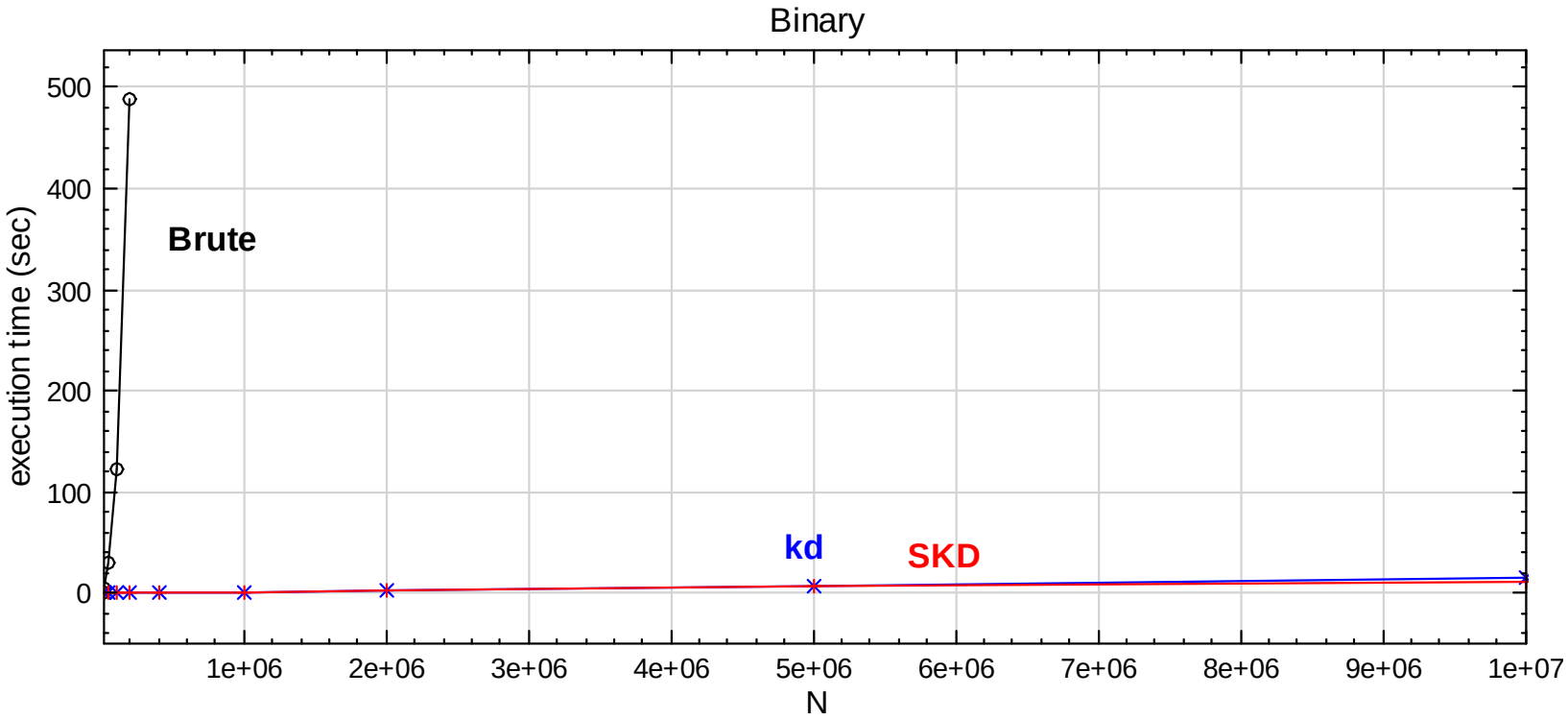
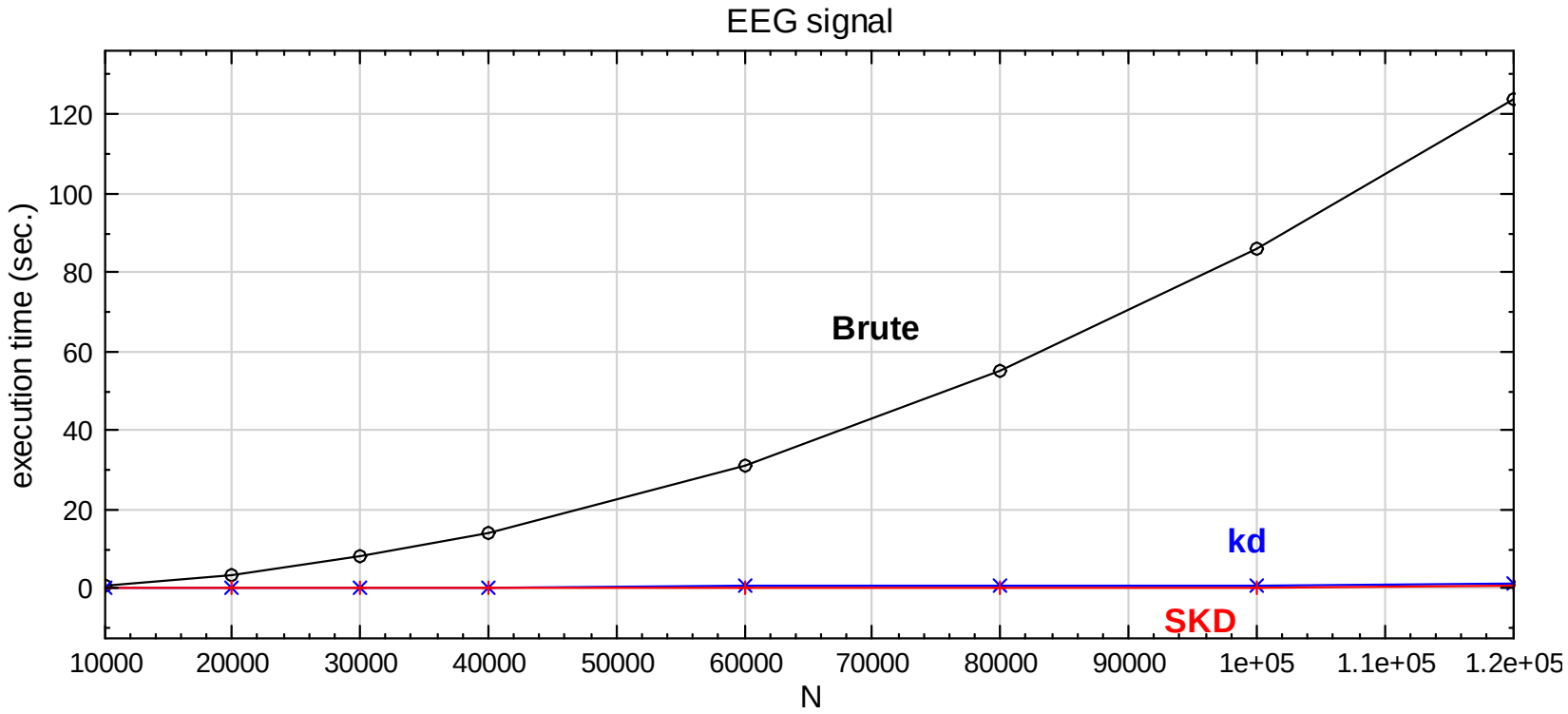
- Example (i) DNA sequence one million points within 2 sec



- Example (ii) EEG Signal: one hundred-thousand points within one sec

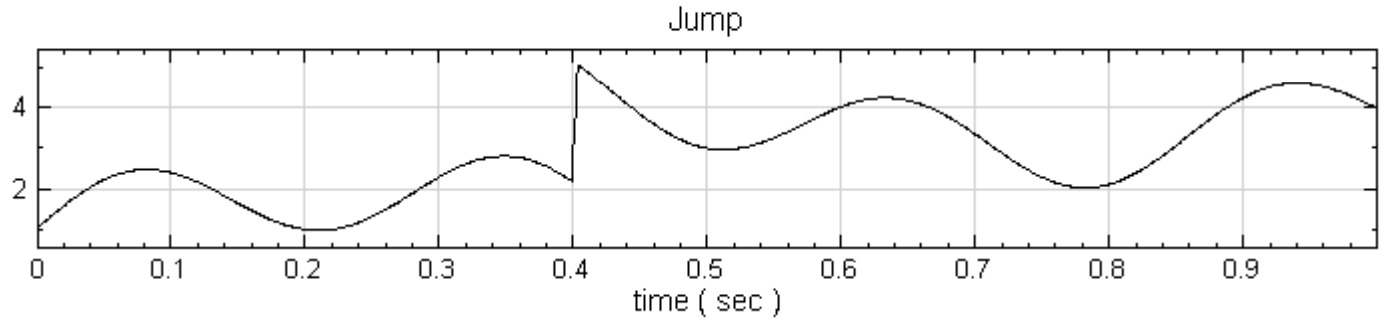


Bump Removal

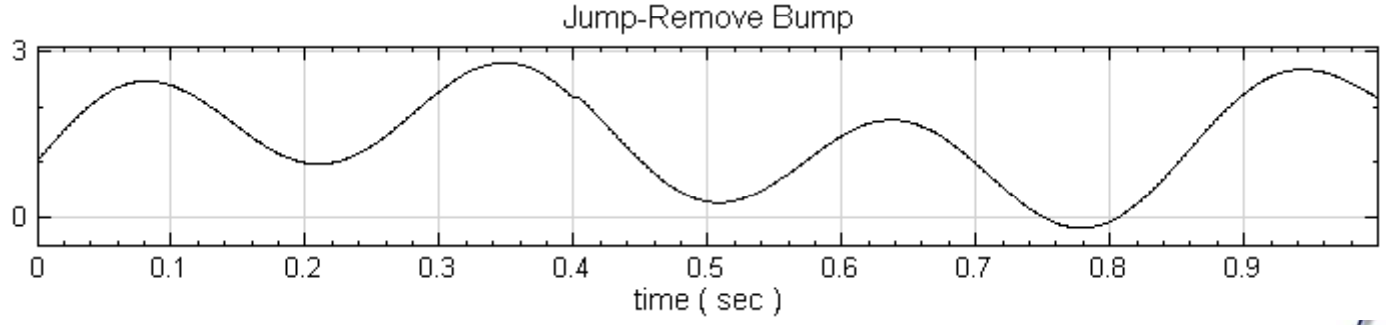
- Automatically Remove speckle/jump noise from hardware
- Features:
  - User’ definition of Bump

Bump Removal: Example 1

- Jump in data



- Removing Jump



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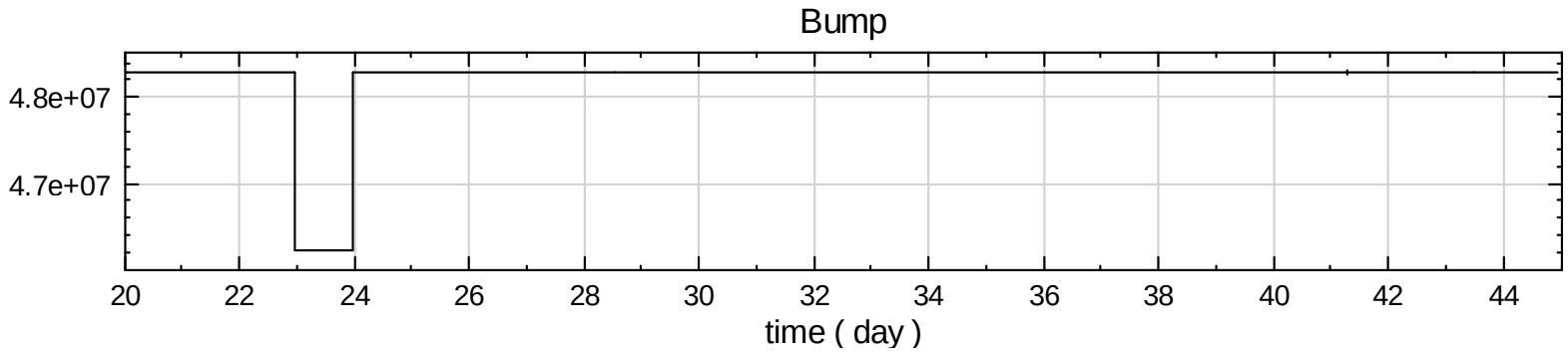
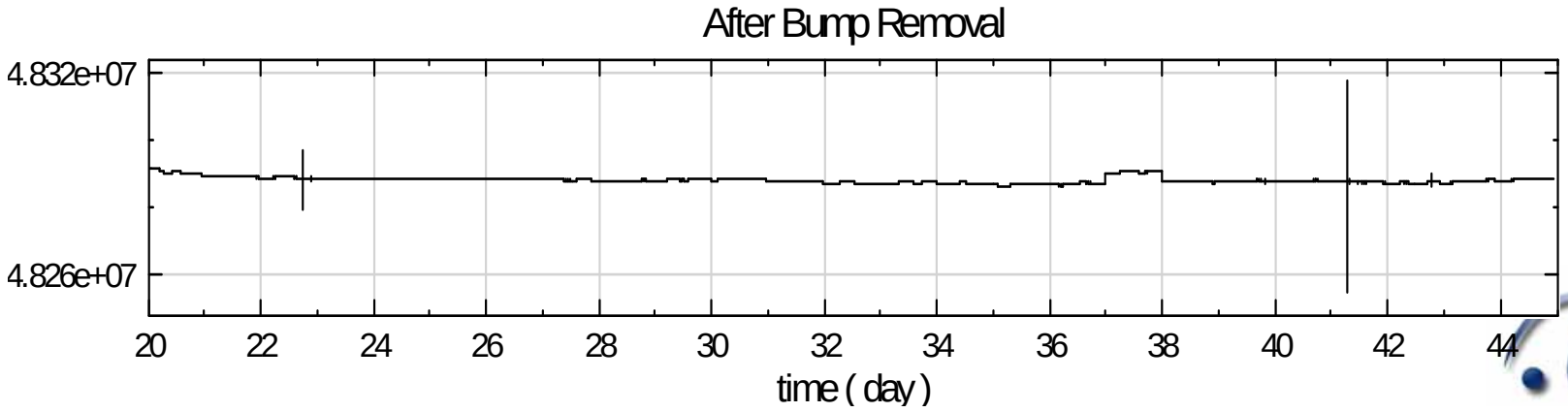
Bump Removal: Example 2

- data



- After bump removal



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Peak Detection

- Detect Peaks of a train of waveforms:
- Applications: RR, EEG spike, ...
- Features:
  - User' definition of Peak
  - Noise Removal

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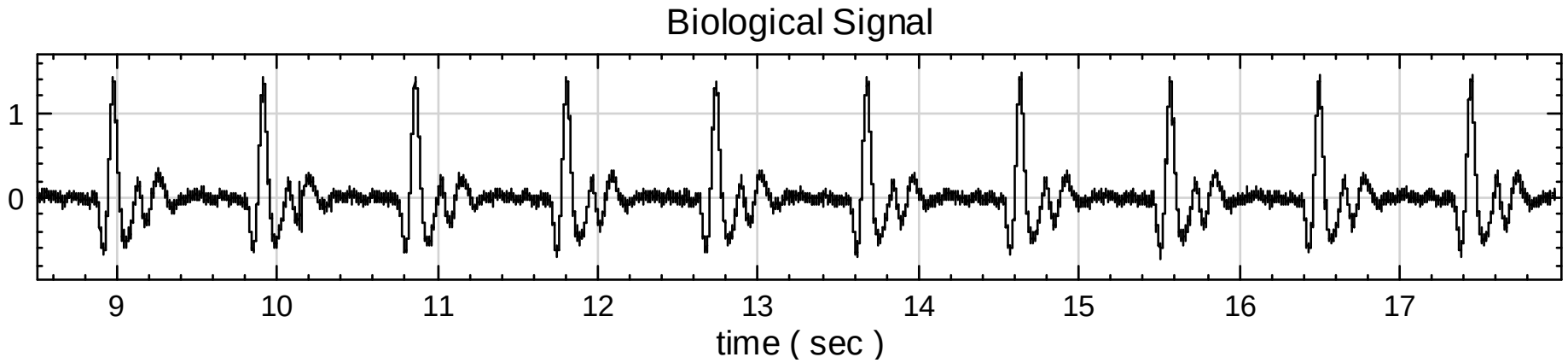
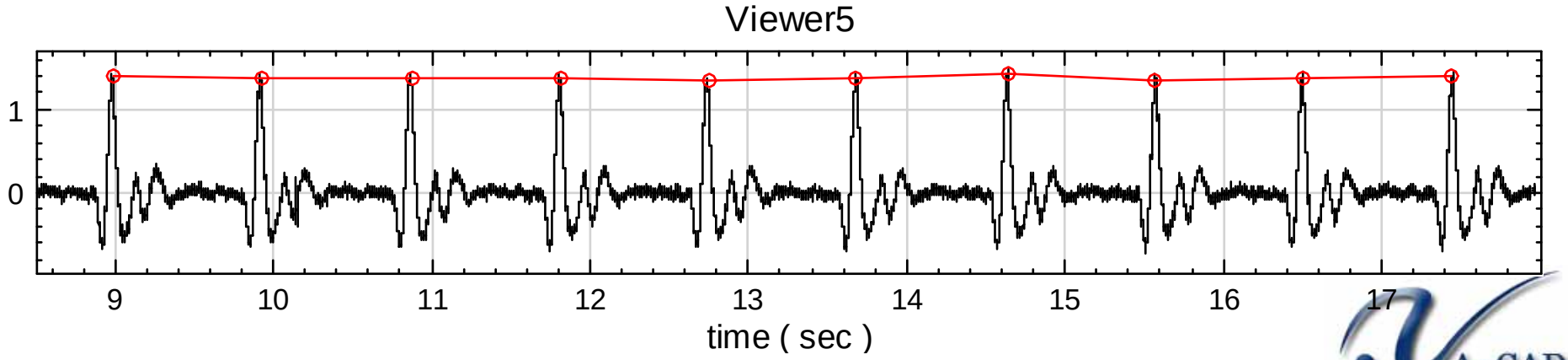
Peak Detection
Example 1

- Detecting Peak of 脈診儀 data



- Peak-Peak Interval



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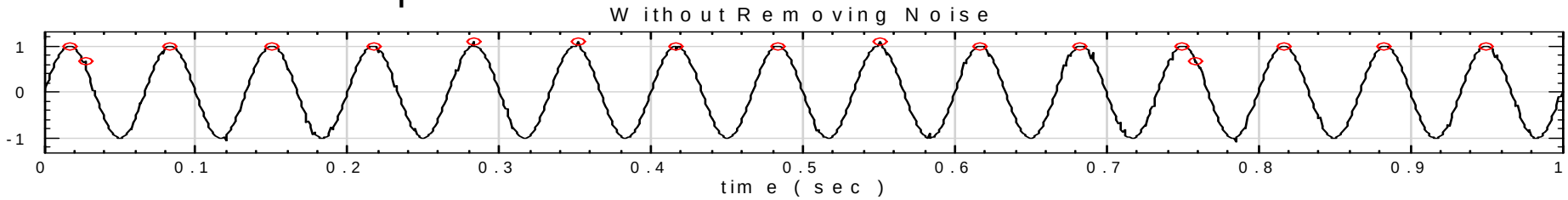
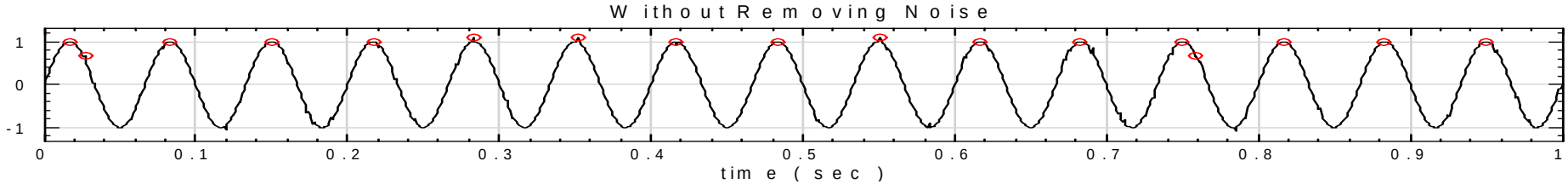
Peak Detection
Example 2

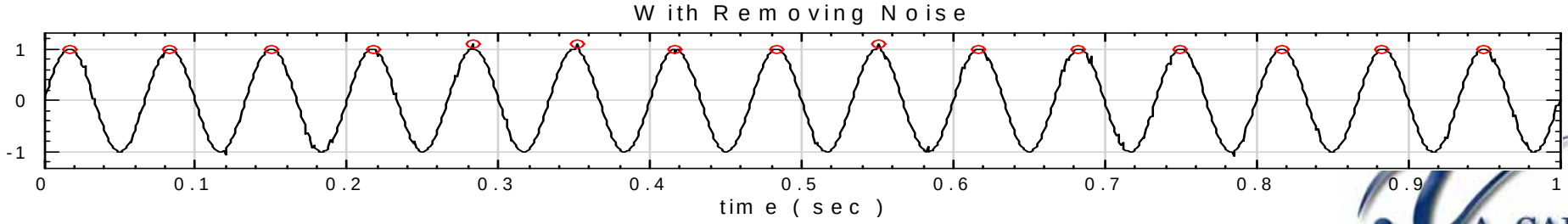
- Sine Wave + Speckle Noise



- Detecting Peak without Noise Removal: False peak!



- Detecting Peak With Noise Removal



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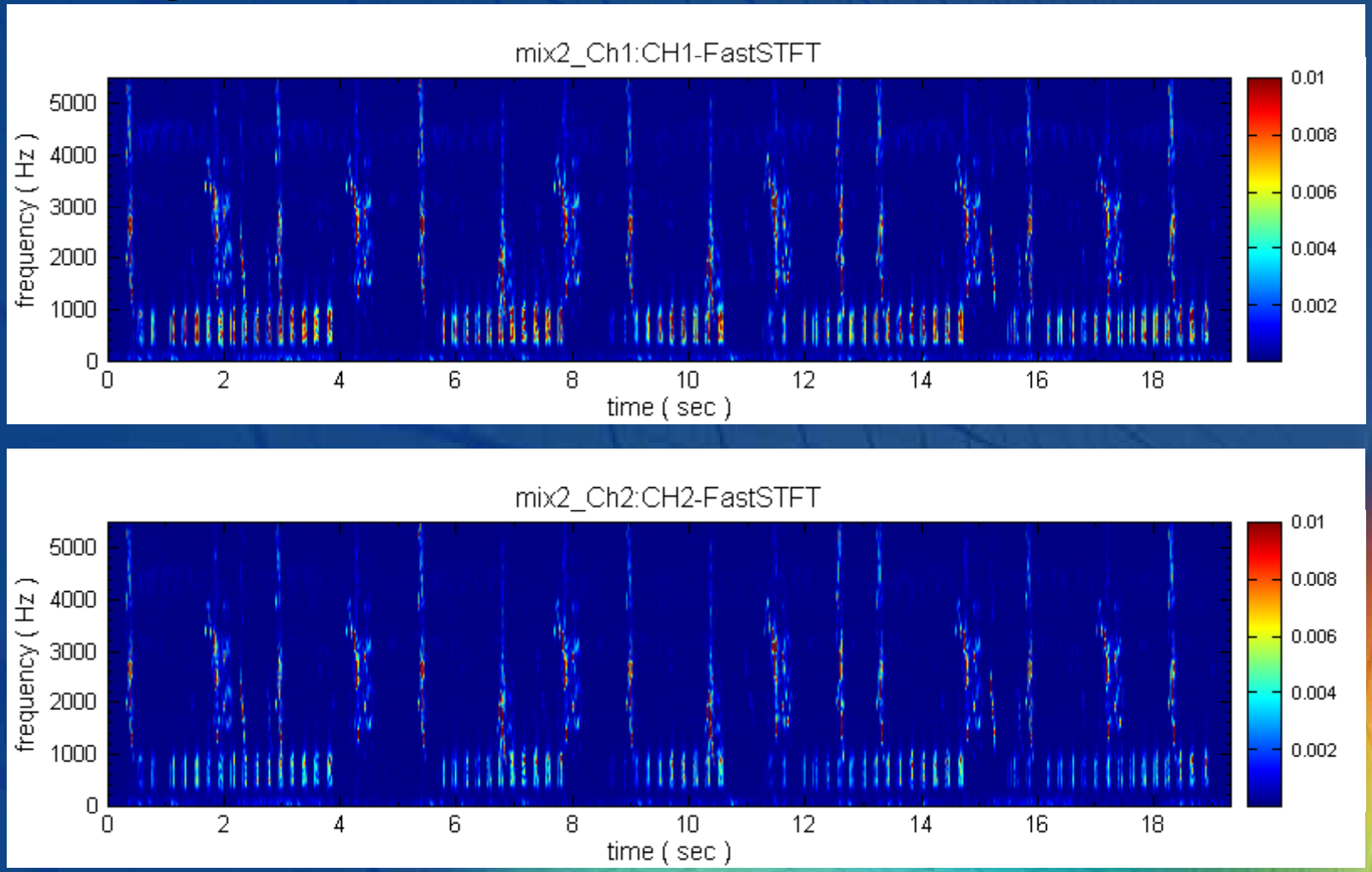
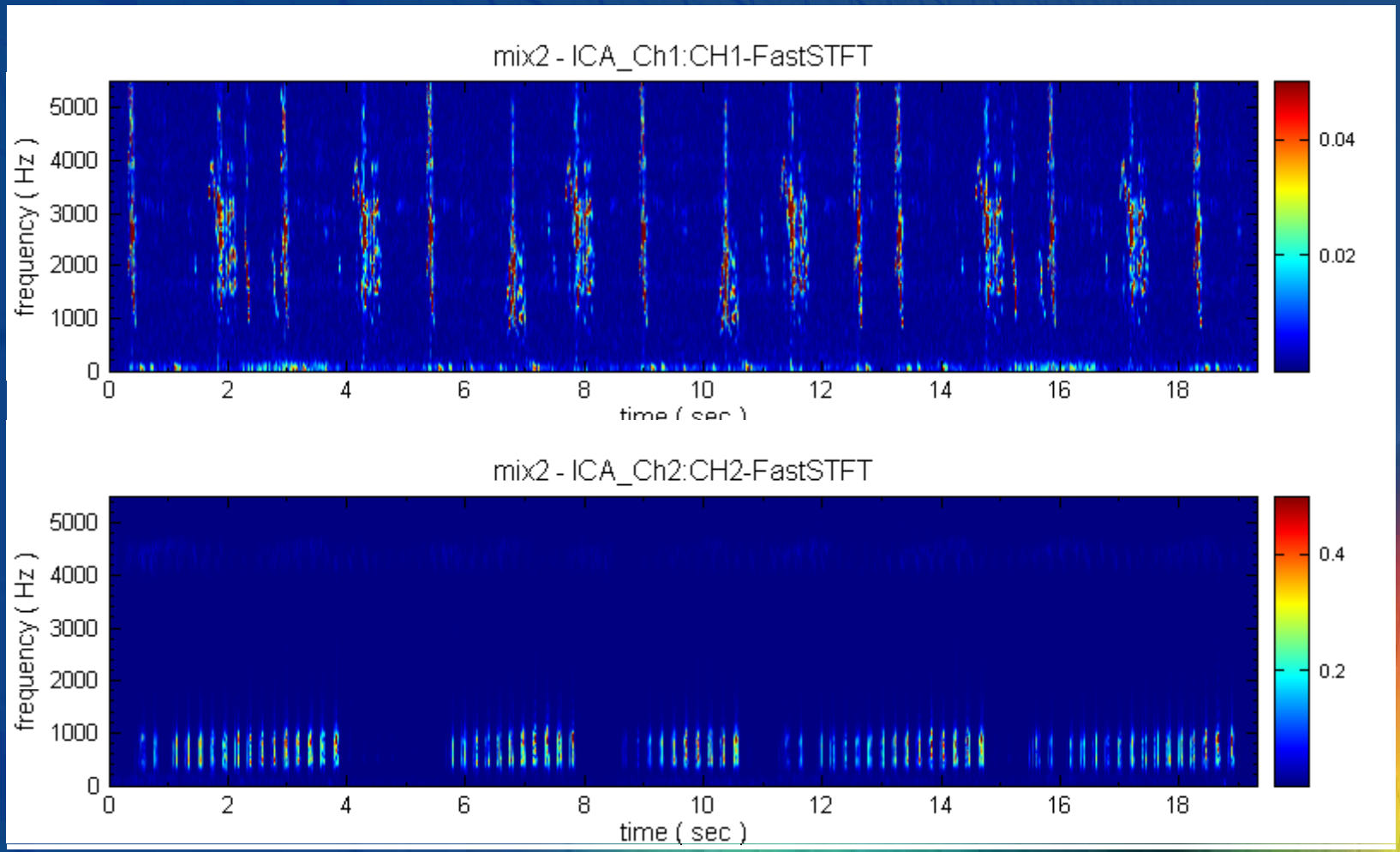
ICA/PCA

- Independent Component Analysis/Principle Component Analysis
- Applications
  - Mechanical Vibration
  - Separation of Sound,
  - Stock Price Analysis
  - EEG Analysis
- Features :
  - Solvers: Symmetric/Deflation approaches
  - Objective Function(Nonlinearity): tanh(), Kurtosis(), Gaussian(),..
  - Correlation(independence) Threshold Setting
  - Physical Sign corrected automatically
  - eigen-values, SVD for PCA

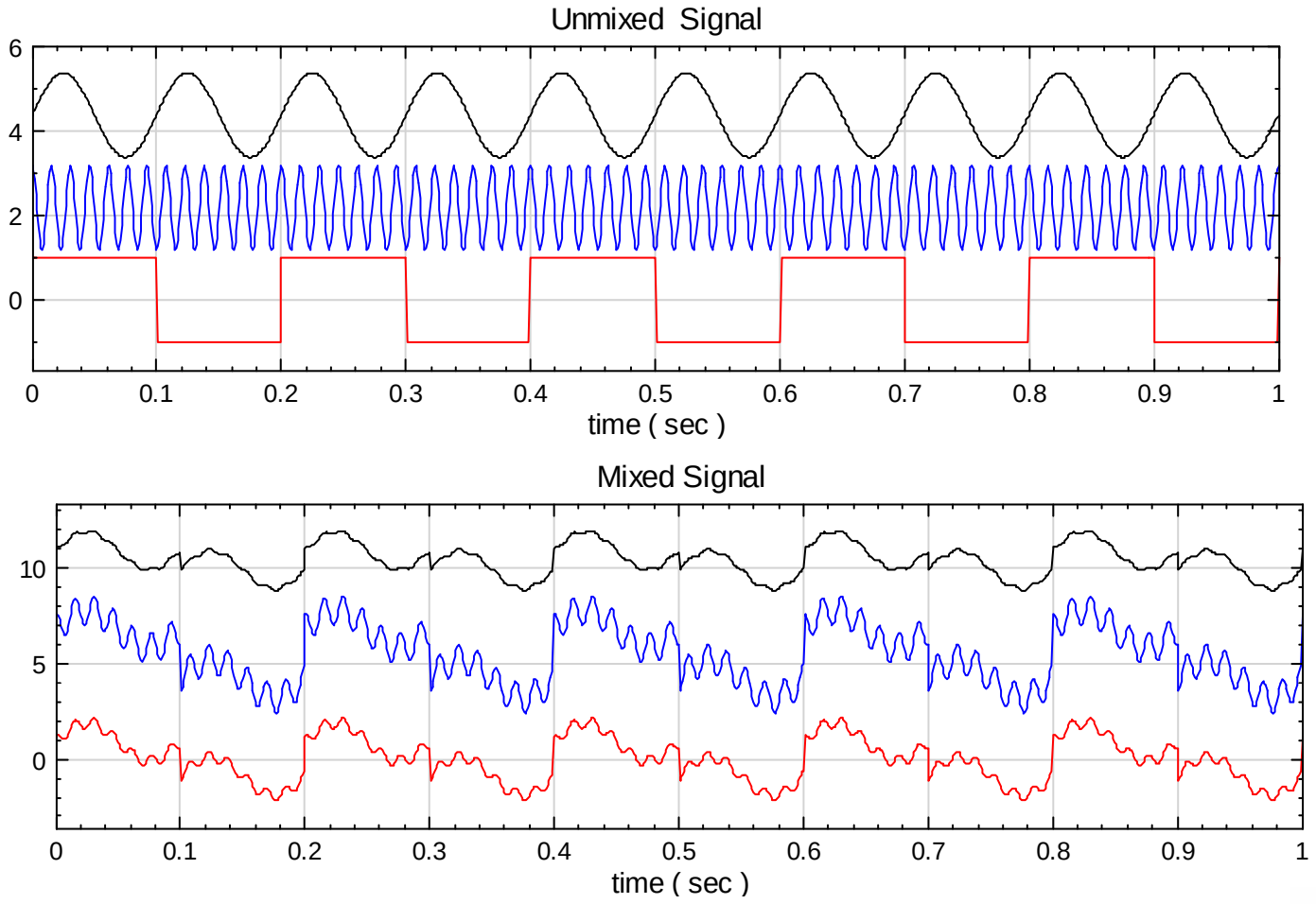
- Example: Separation of Two Frog Sound
- Mixing Sounds



- Separated Signal



ICA: Flip Sign 1



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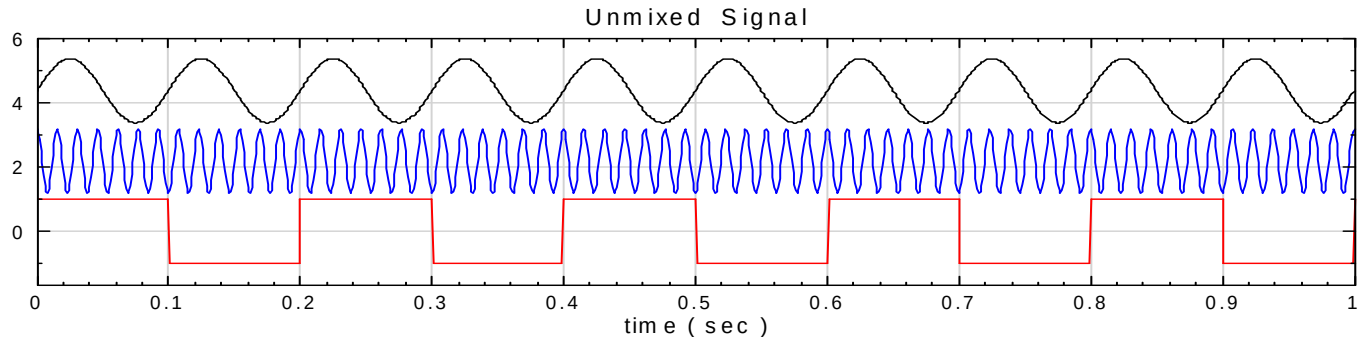
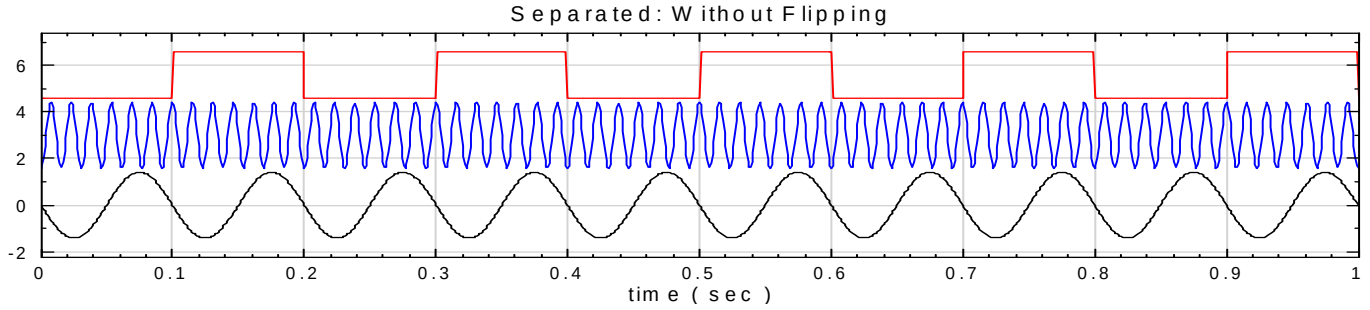
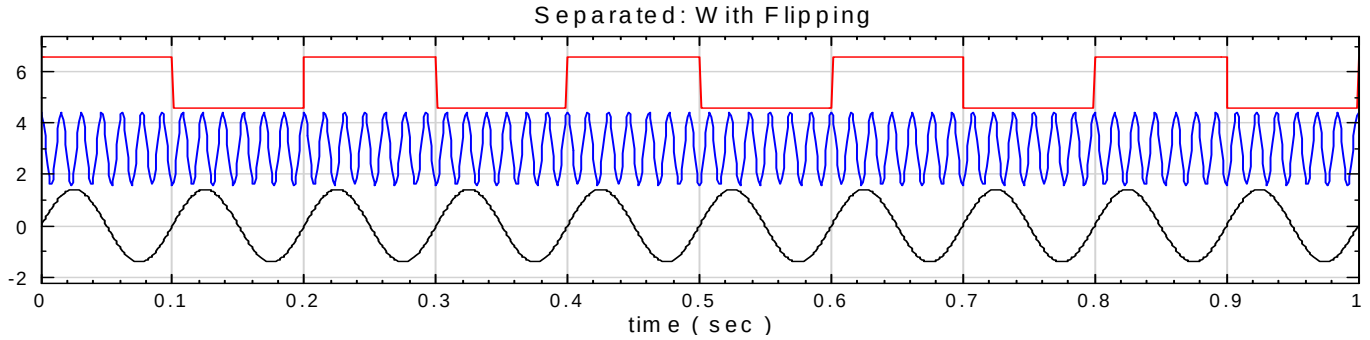
ICA: Flip Sign 2







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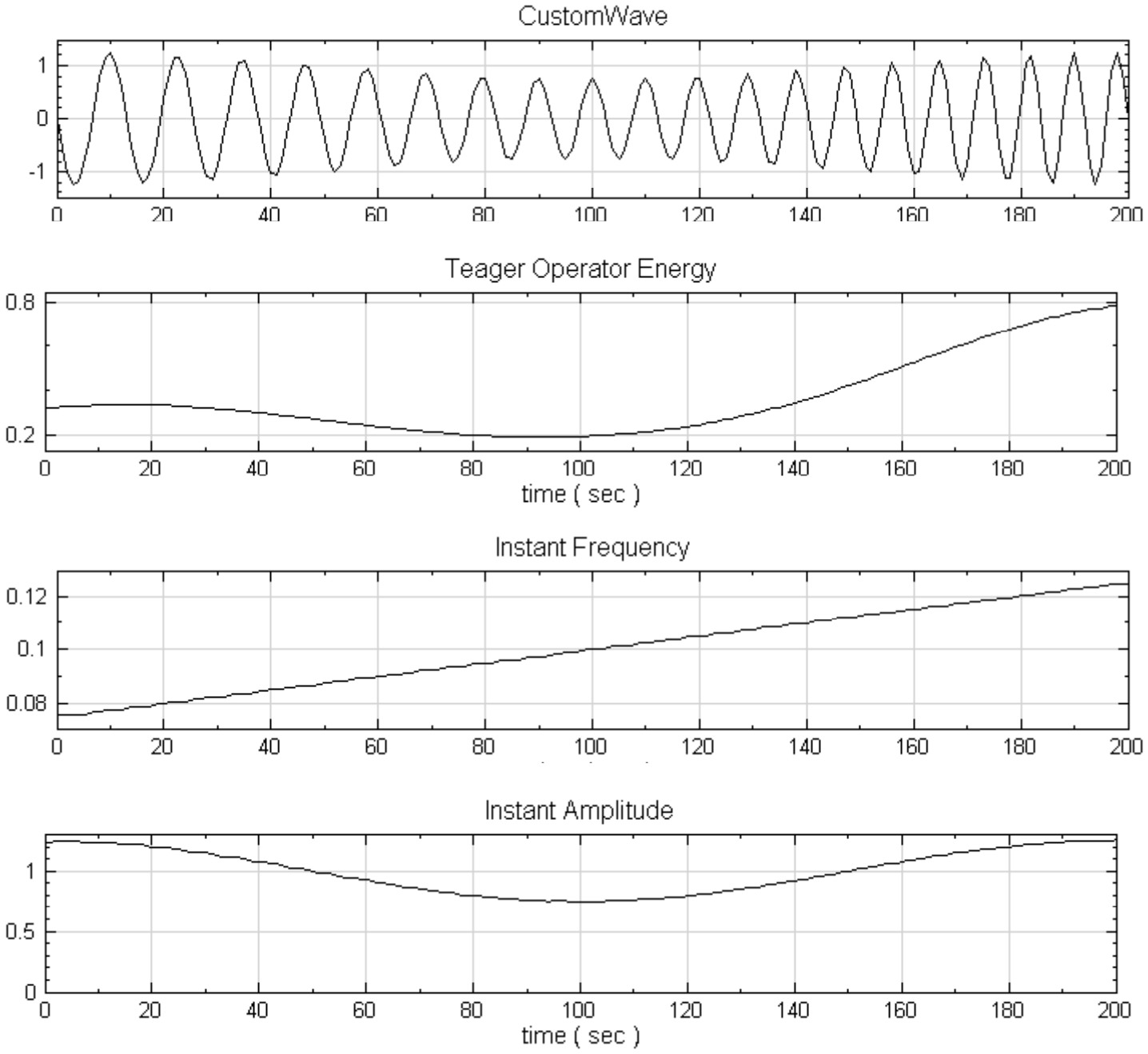
Example : Given a Signal



Teager Operator

- Newly Developed Nonlinear Time Frequency Analysis Tool
- Features
  - AM/FM analysis
  - TEO
  - Instaneous Frequency

Thank you!

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