



# CORTEX

Core monitoring techniques and  
experimental validation and demonstration

# Reconstruction of ex- and in-core neutron signals

## CORTEX Workshop

Advanced signal processing methods and learning methodologies applied  
to the monitoring of NPP reactor conditions

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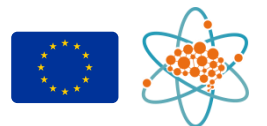


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## Why we need signal reconstruction?

- In case of correctly functioning measuring chains – allows to determine measuring errors
- Helps to recognise incorrect measurements and
  - define the problem (type)
  - replace incorrect measurements with the valid ones



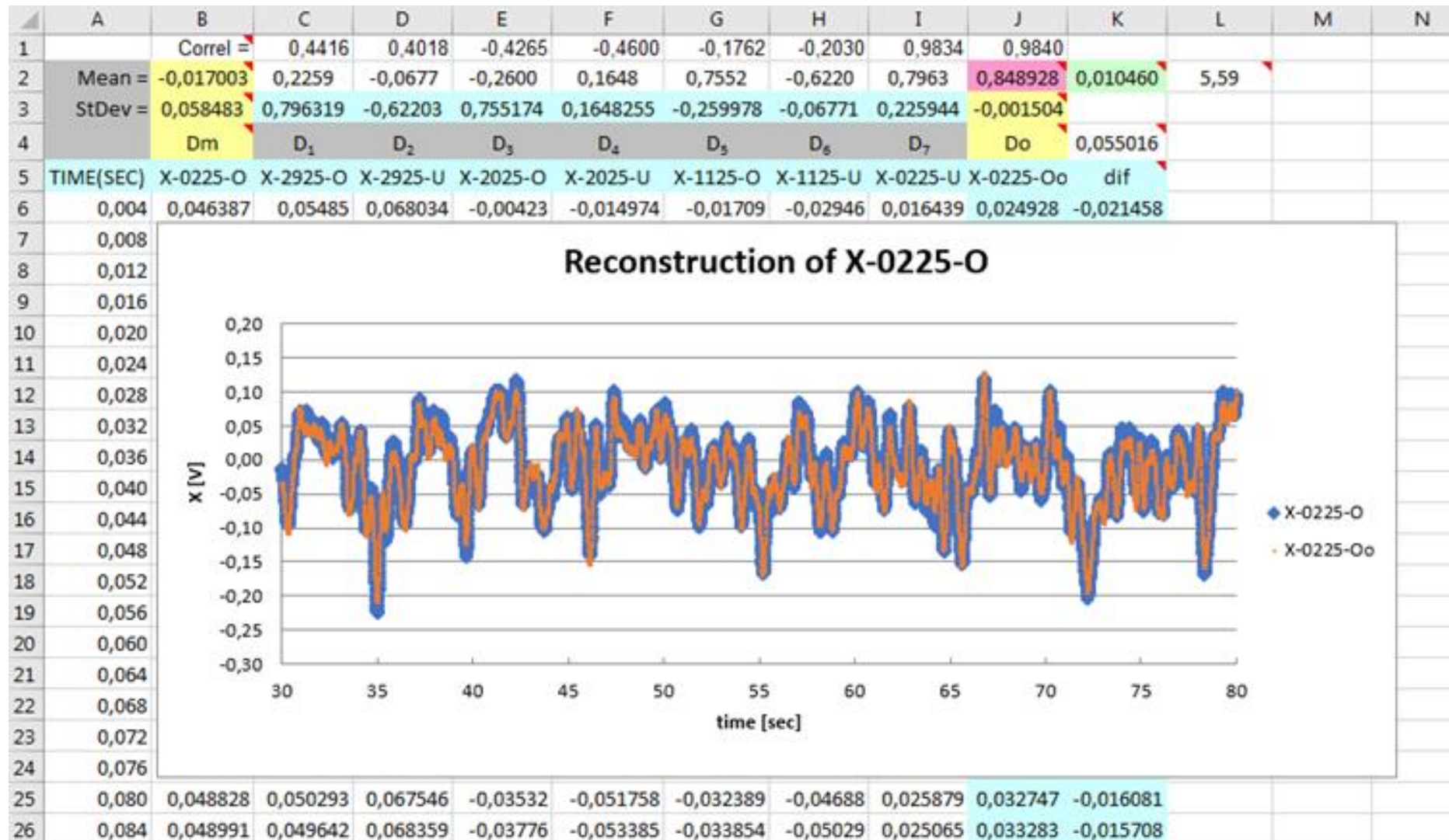
# Reconstruction of ex- and in-core neutron signals

## How to reconstruct ex- and in-core signals?

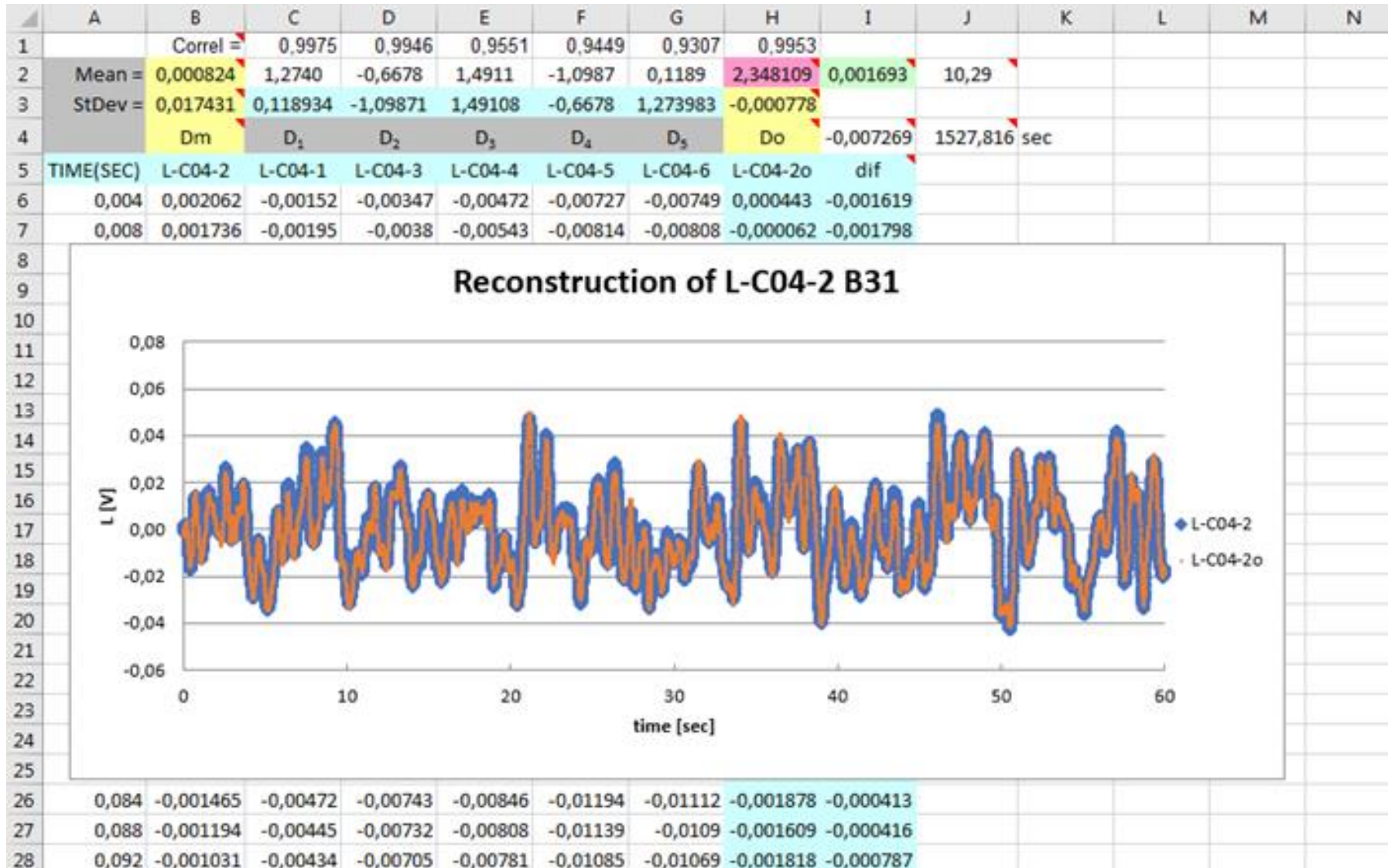
- Ex-core signals
  - For the reconstruction of the selected ex-core signal use linear combination of remaining ex-core signals (7 signals)
- In-core signals
  - VVER-1000 – for the reconstruction use 10 SPNDs in the vicinity
  - Konvoi and Goesgen – use remaining SPNDs signals of the of the string (5 signals)



# Ex-core data reconstruction



# In-core data reconstruction

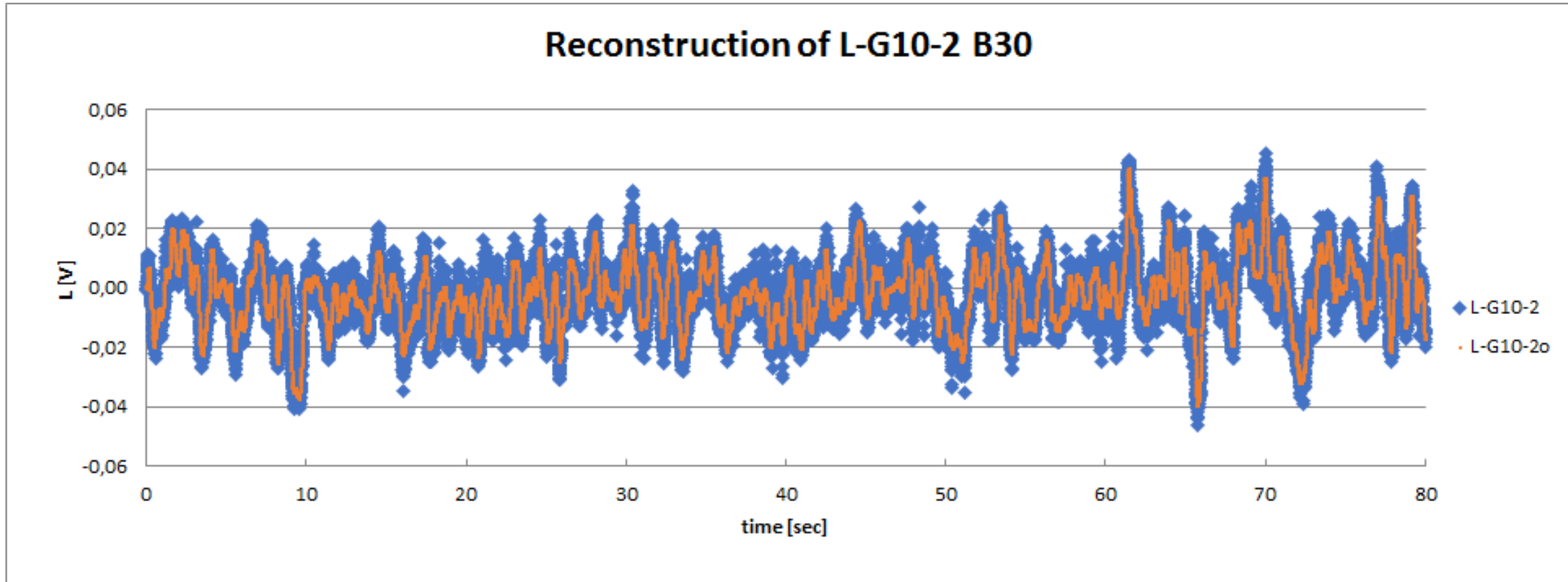


## Reconstruction features

- Reconstruction inhibits high frequencies of the measured signals
- Reconstruction allows to **separate** signal and the added noise:  
Signal reconstruction = measured signal + difference
- Signal **reconstruction** estimates **real (physical) signal**
- **Difference** approximates the **noise** added by to real signal by measuring equipment (e.g. due to A/D conversion)

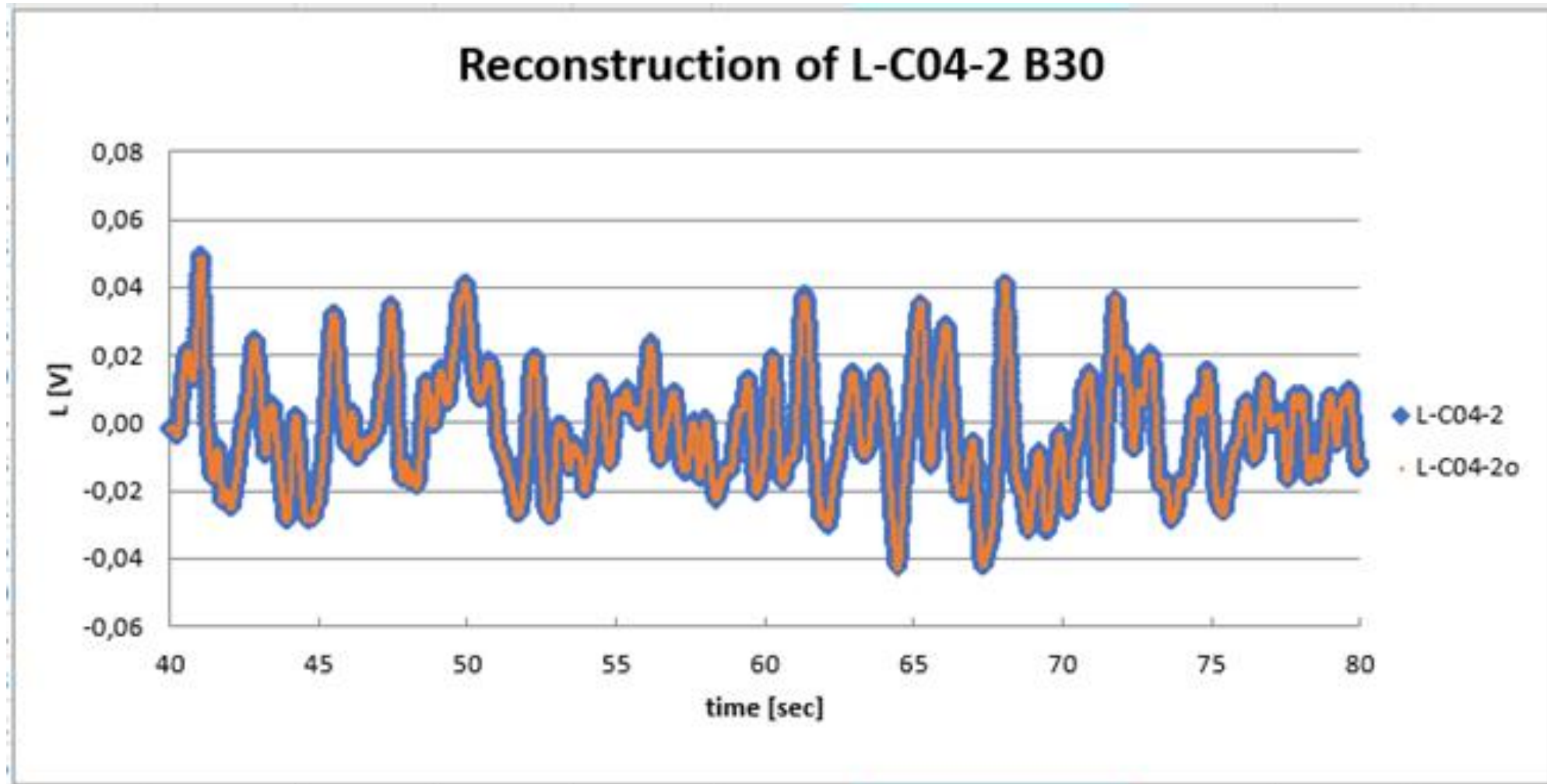


# Reconstruction: example of high noise signal



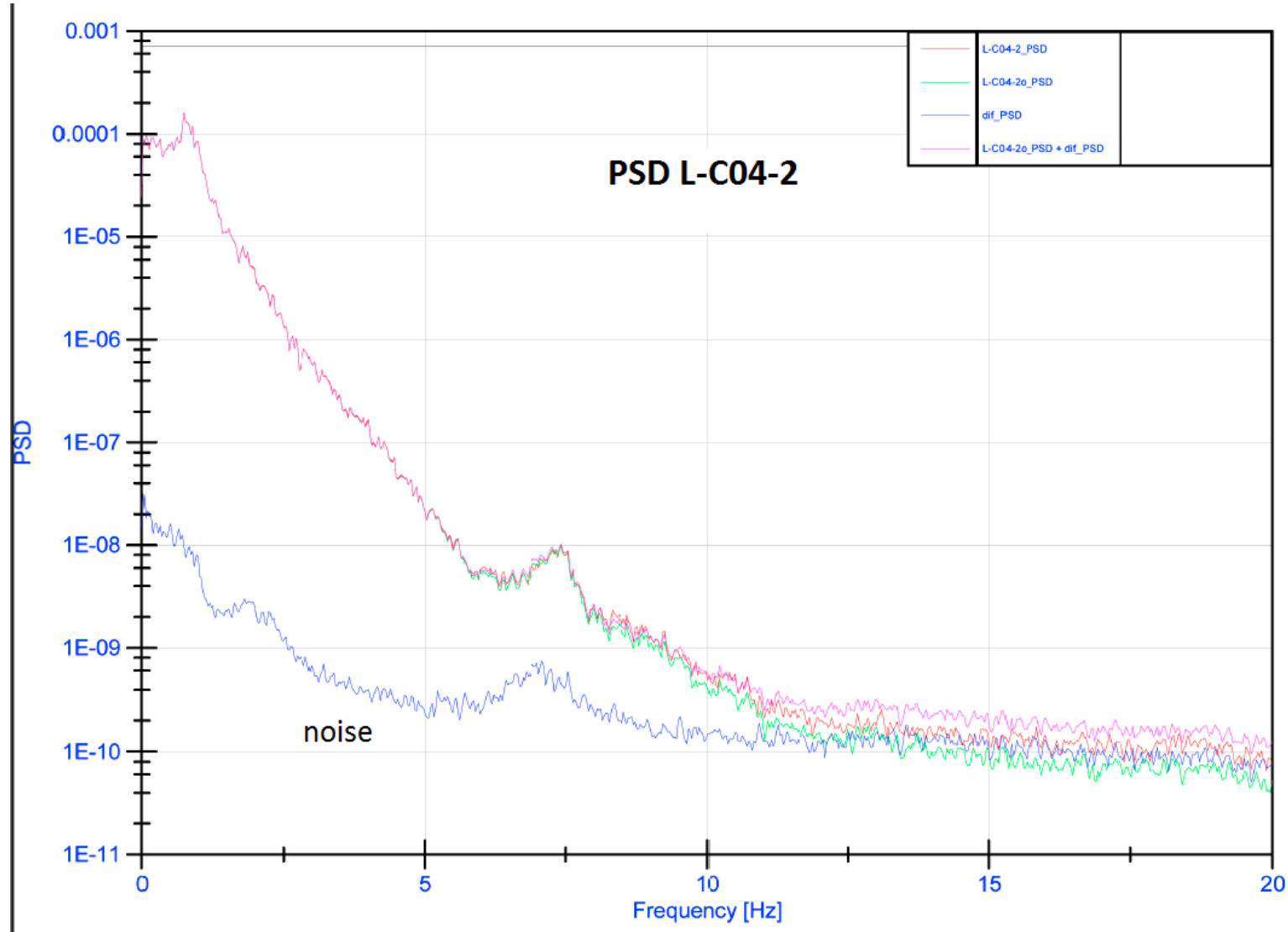
**Signal reconstruction passes through the center of a cloud caused by the added noise**

# Reconstruction: example of low noise signal

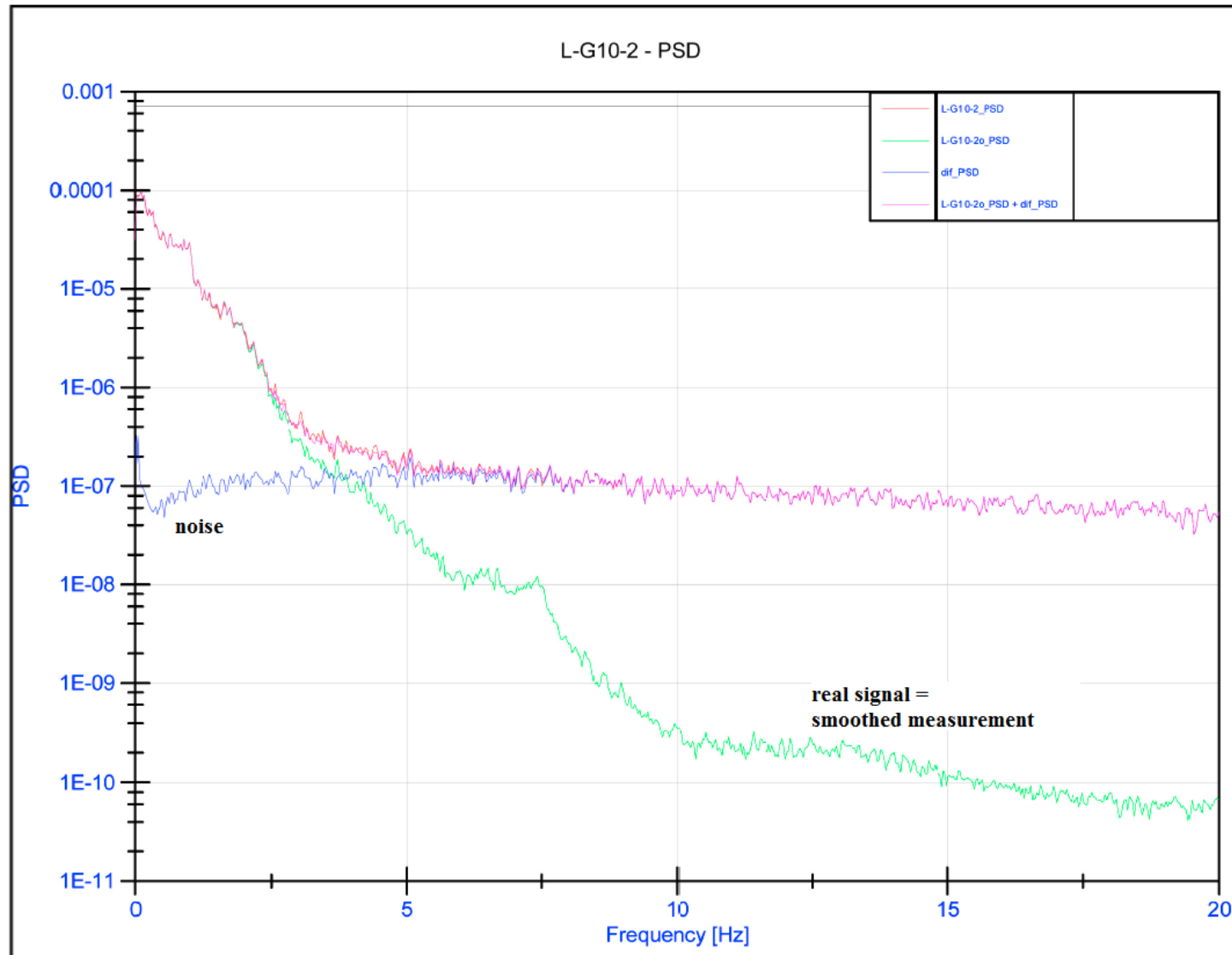




# PSD of low noise signal L-C04-2

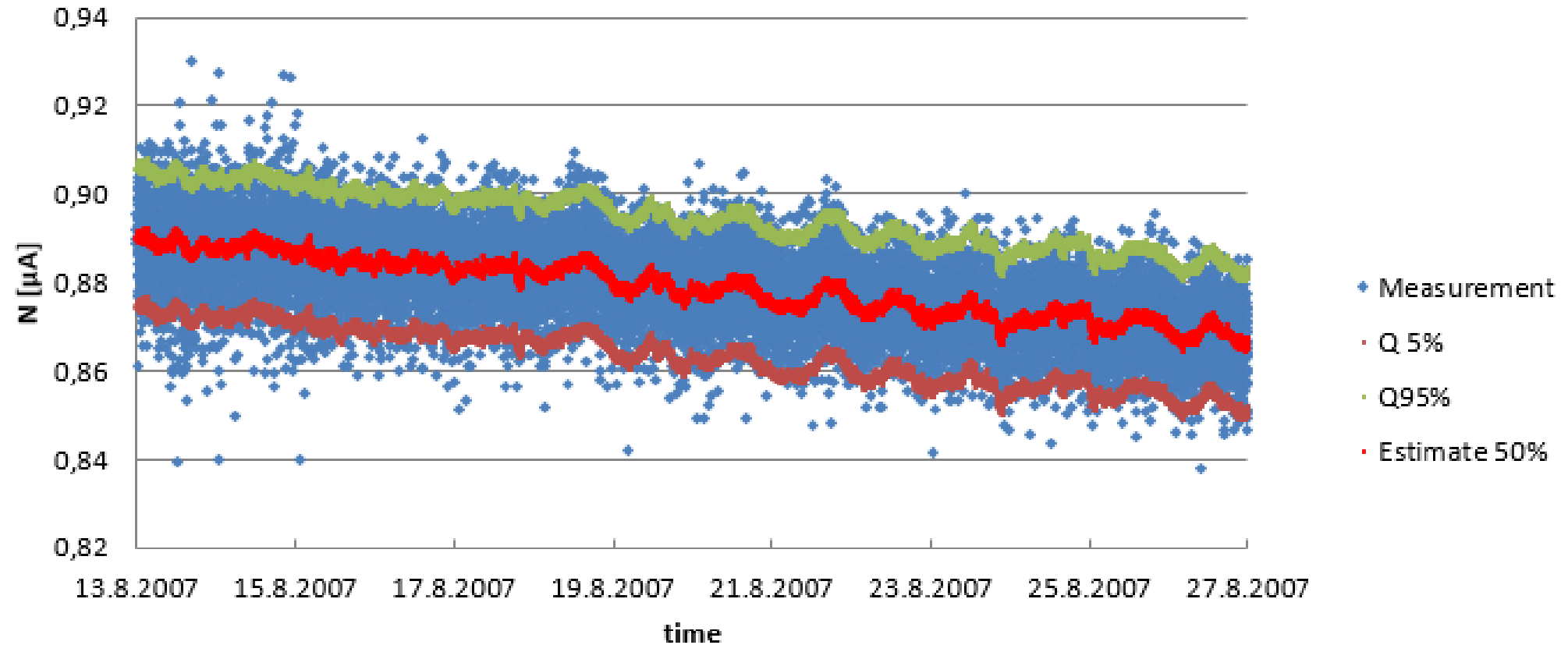


# PSD of high noise signal L-G10-2

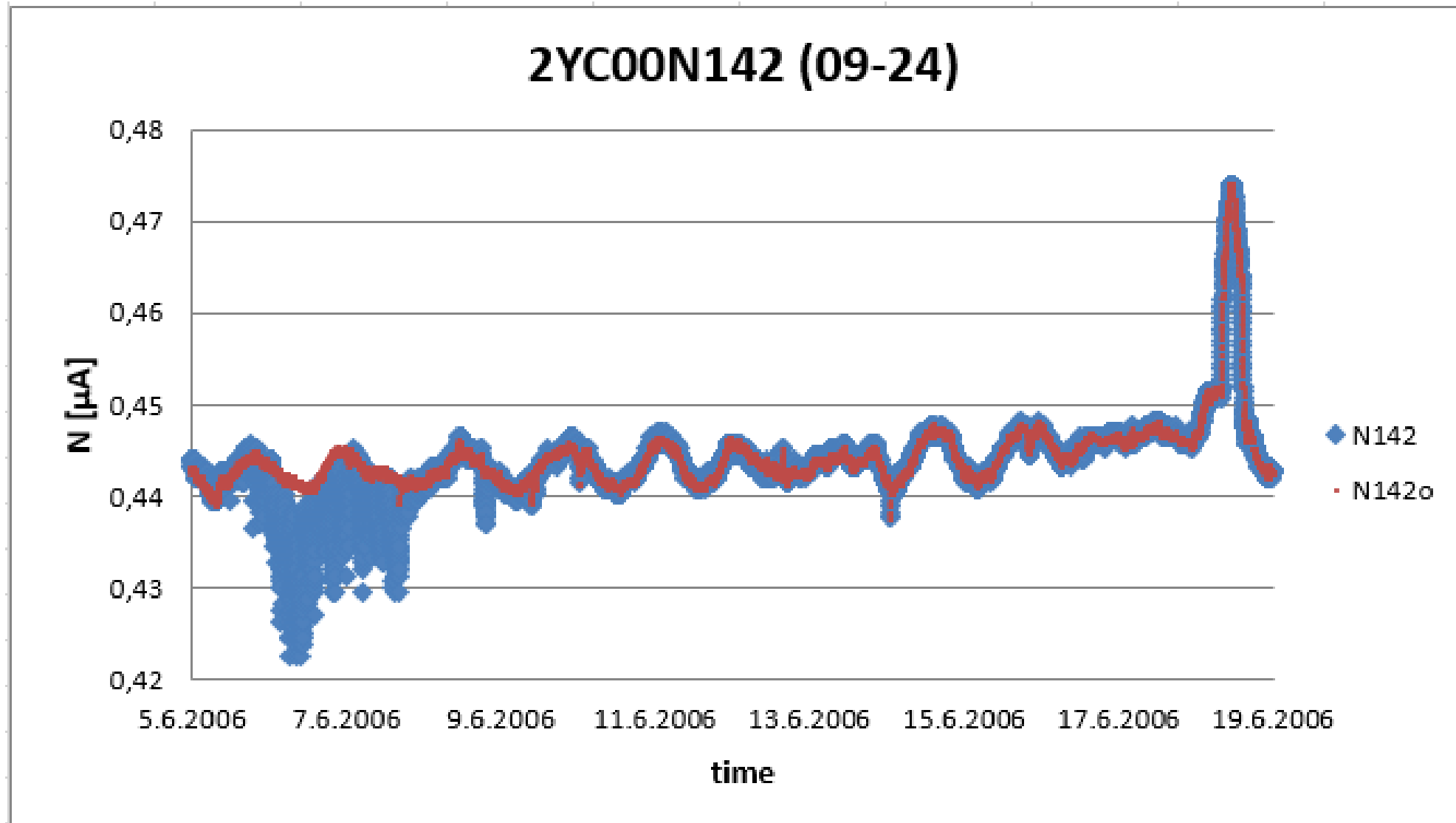


# Reconstruction: stable symmetrical noise identification

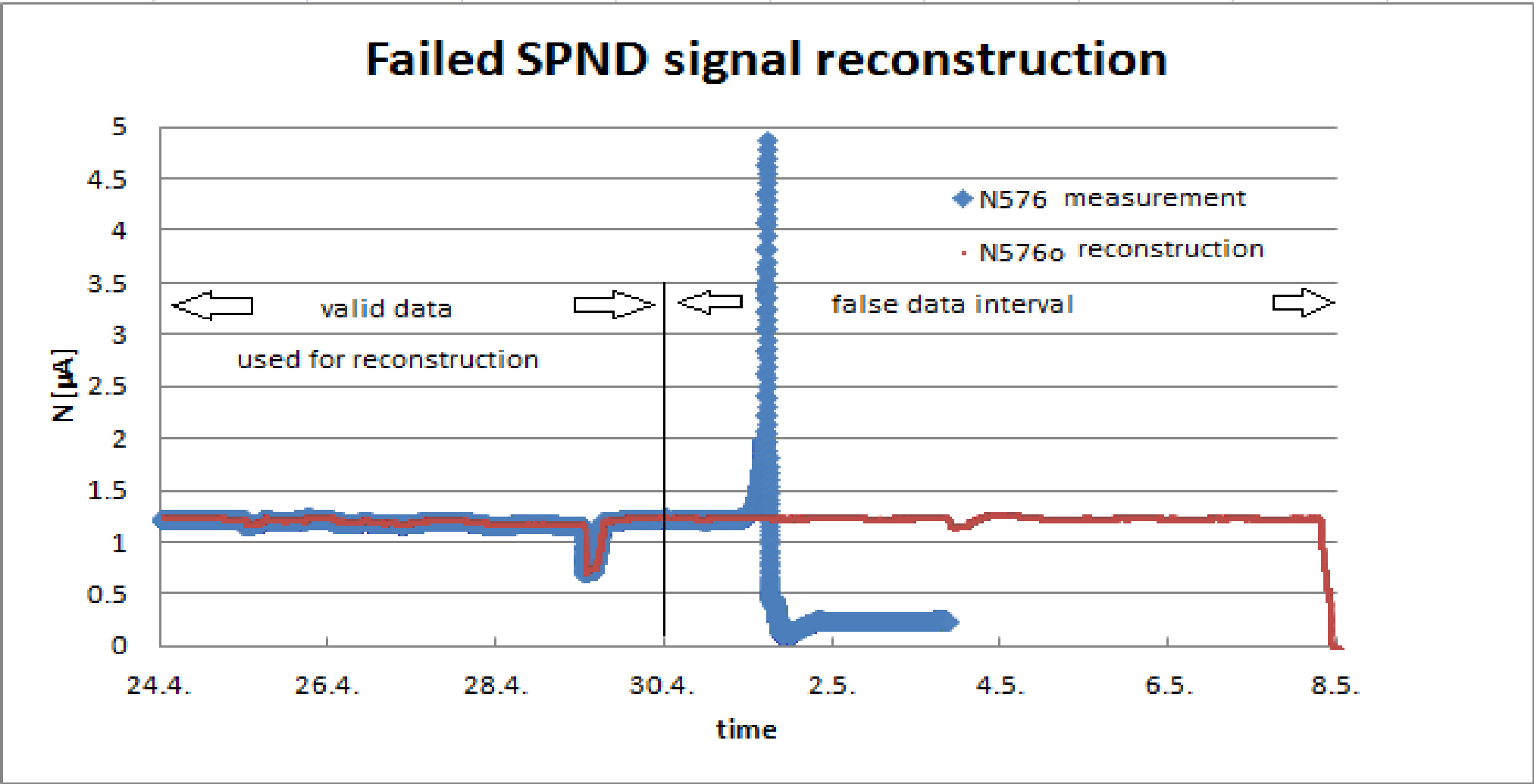
## High noise SPND



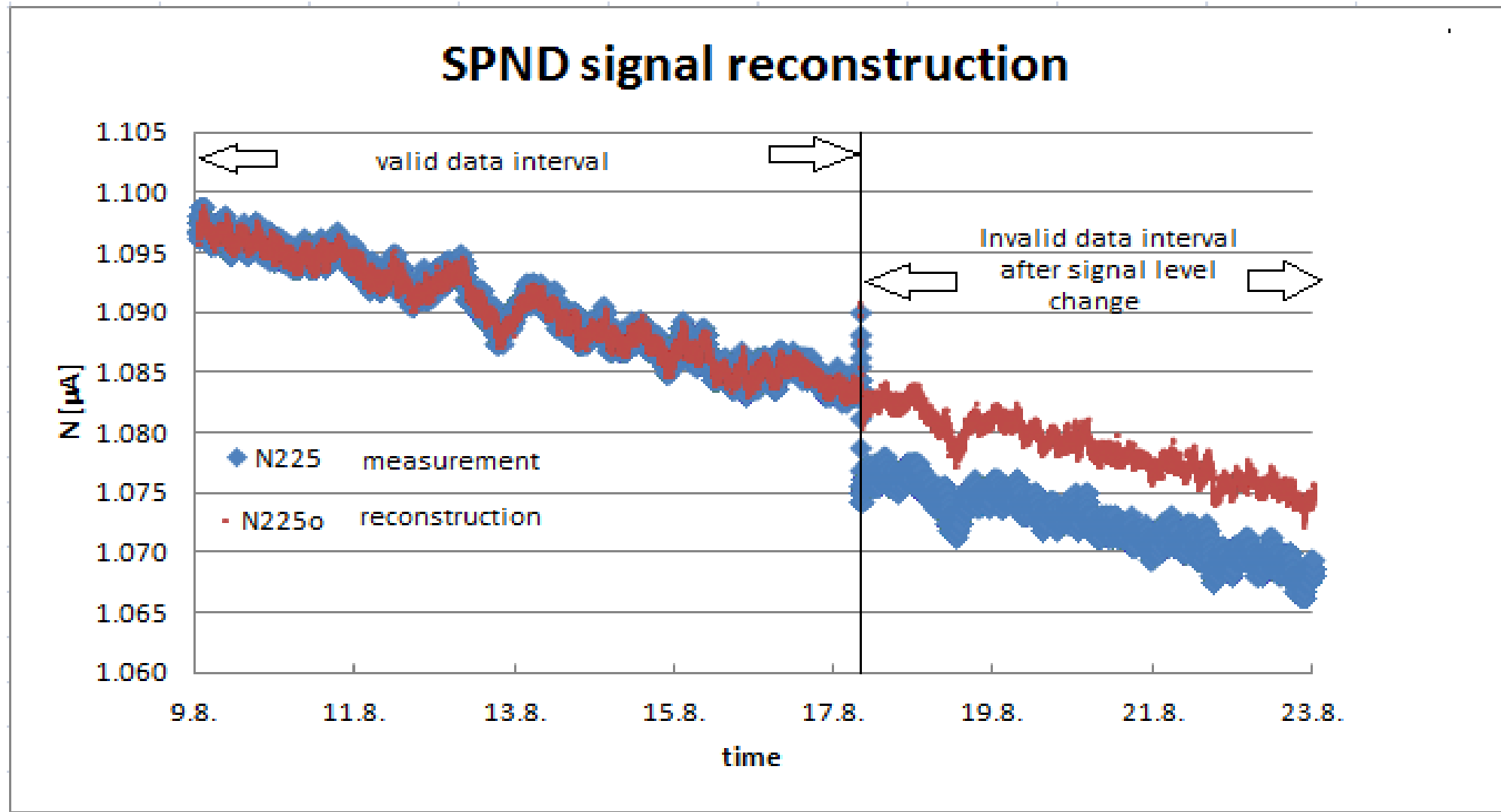
# Reconstruction: temporary asymmetrical noise identification



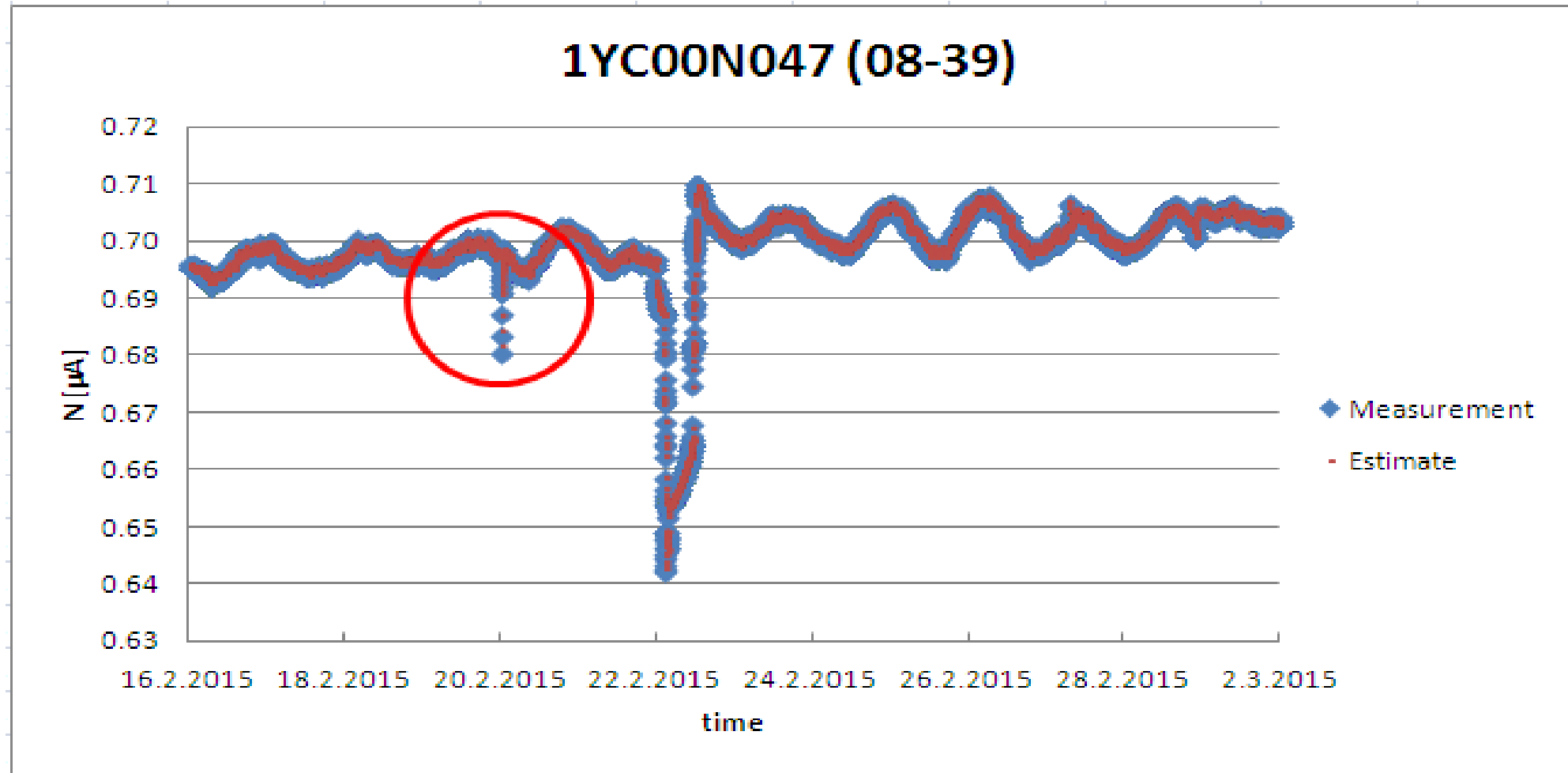
# Reconstruction: SPND failure



# Reconstruction: Signal level change



# Reconstruction: Identification of anomalies



**Control rod test causes increase of reconstruction deviations**

**Thank you for your attention!**

