

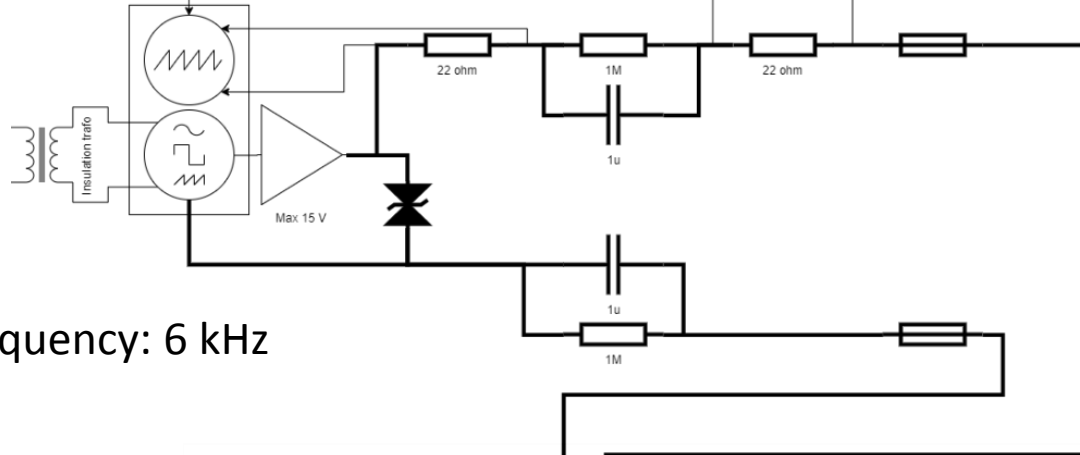


TFM measurement results

Mateusz Bednarek, Jaromir Ludwin

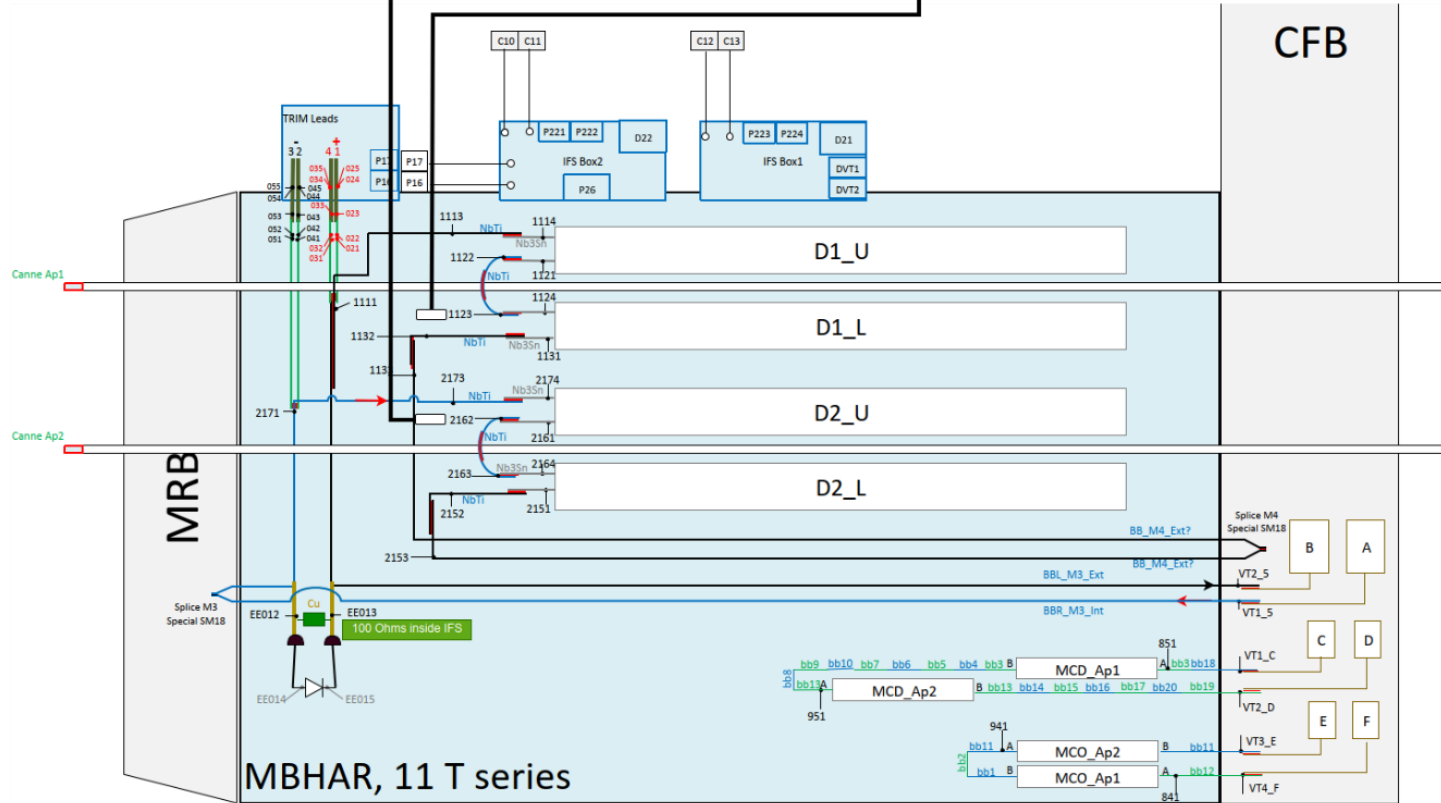
TE-MPE-EE ELQA Team

With important inputs form Emmanuele Ravaioli

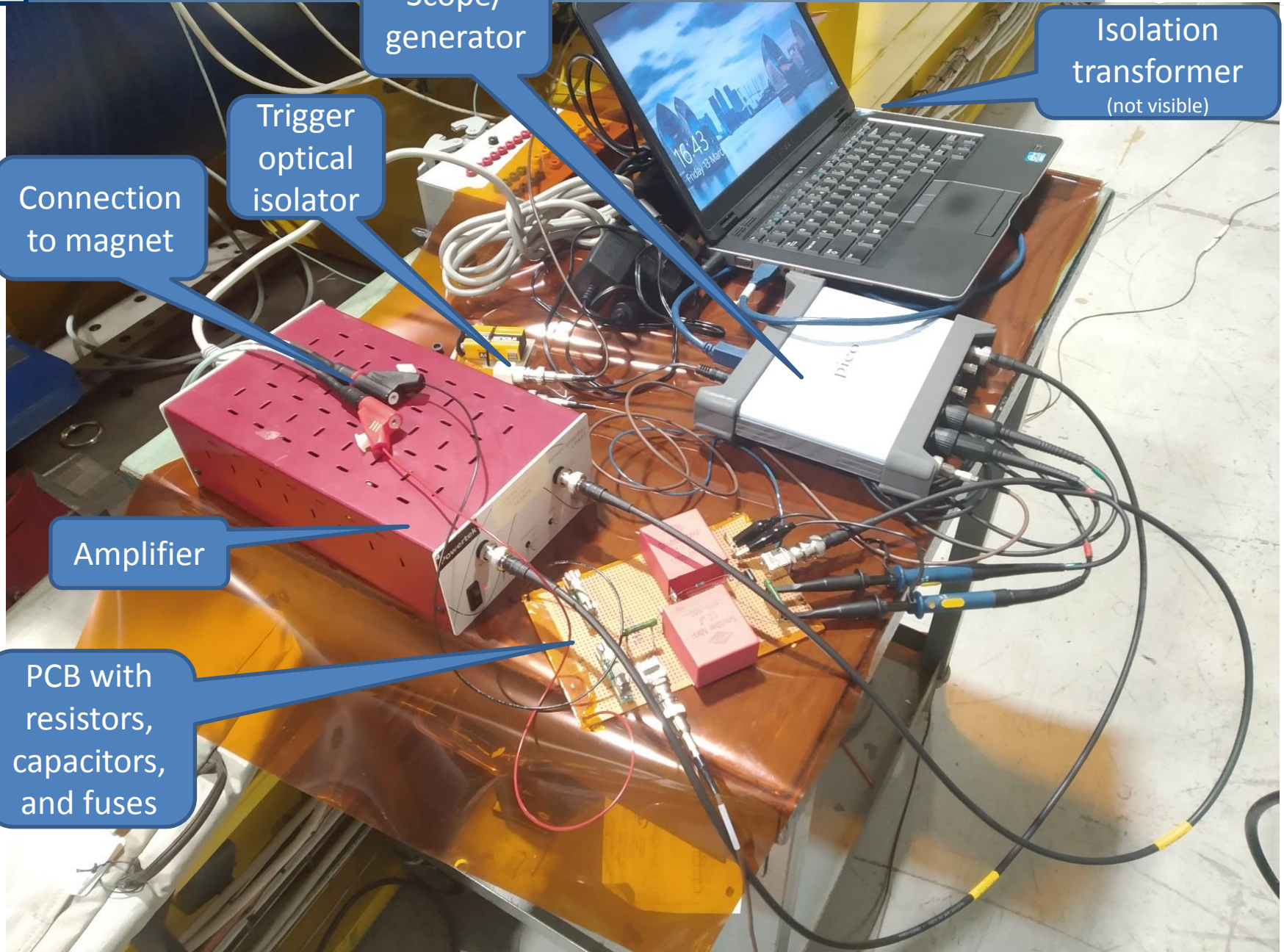


single frequency: 6 kHz

10 Fuses/Fusibles/Sicherungen
MI6FA50V0,1
 500V AC FA 0,1A
 IR=200kA
 500V FA 0,1 A 6.32
L080464P
 Made in France N°LOT: 5984480/A/M /17/13



Setup



Scope/
generator

Isolation
transformer
(not visible)

Trigger
optical
isolator

Connection
to magnet

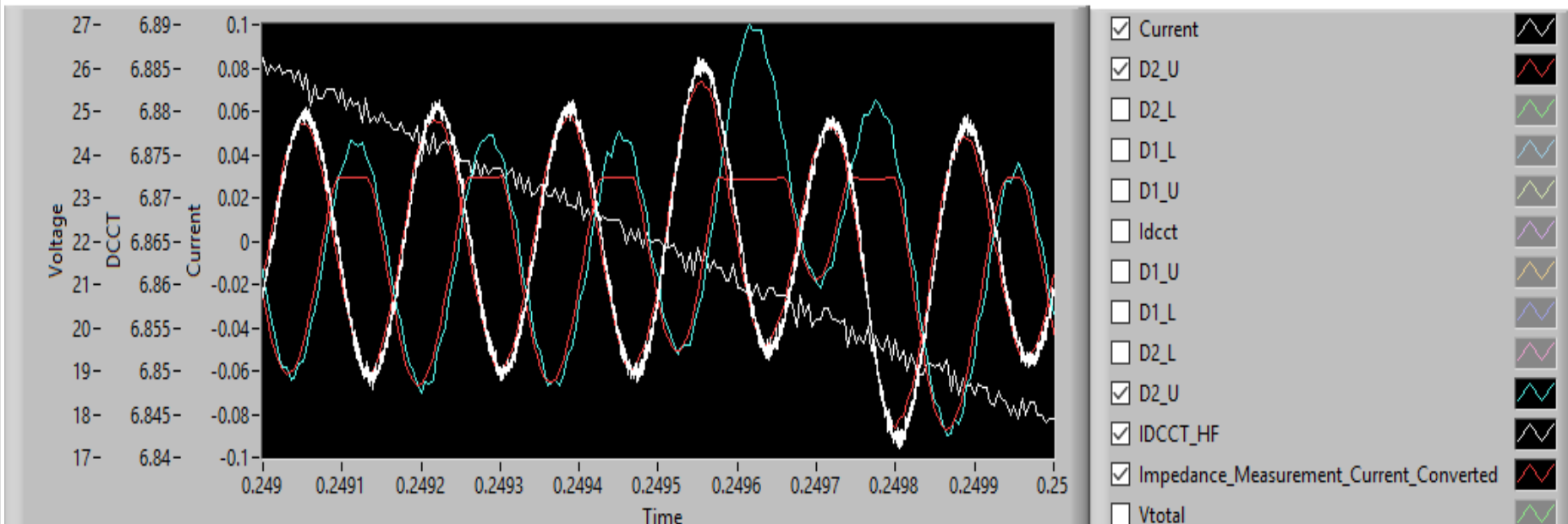
Amplifier

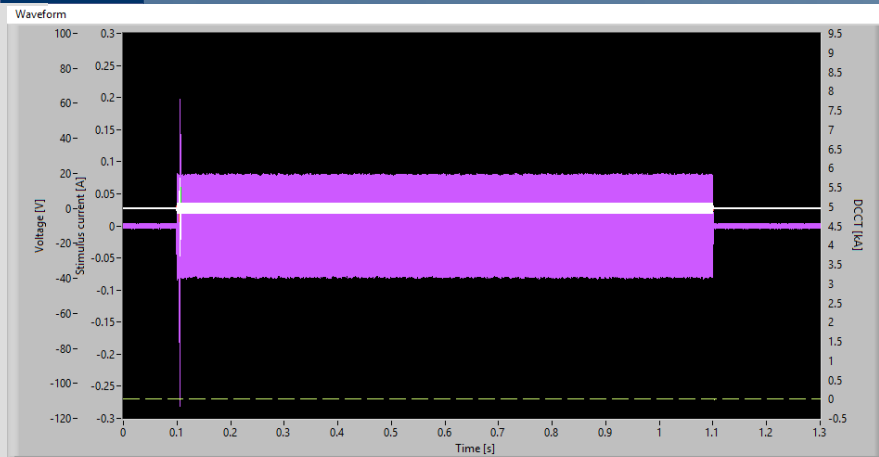
PCB with
resistors,
capacitors,
and fuses

3 data acquisition systems

- Oscilloscope ~ 3 MS/s – stimulus only
- SM18 DAQ 200 kS/s – all signals
- uQDS 205 kS/s – magnet voltages only (clipping)

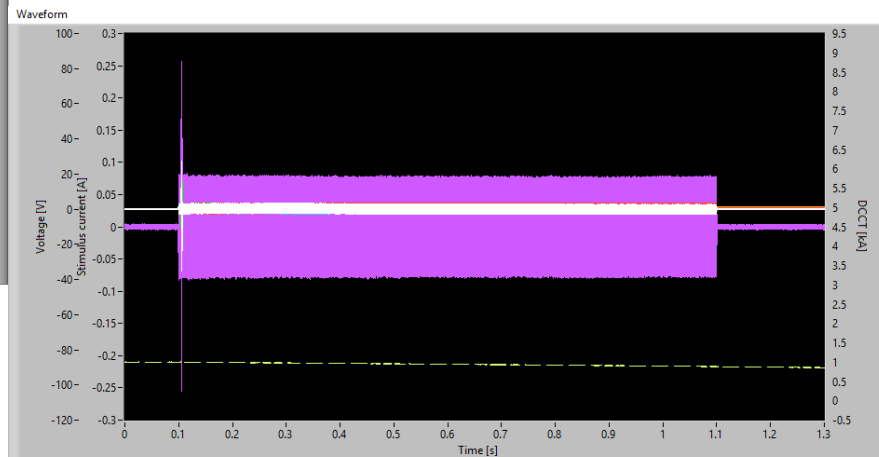
Fully consistent readings





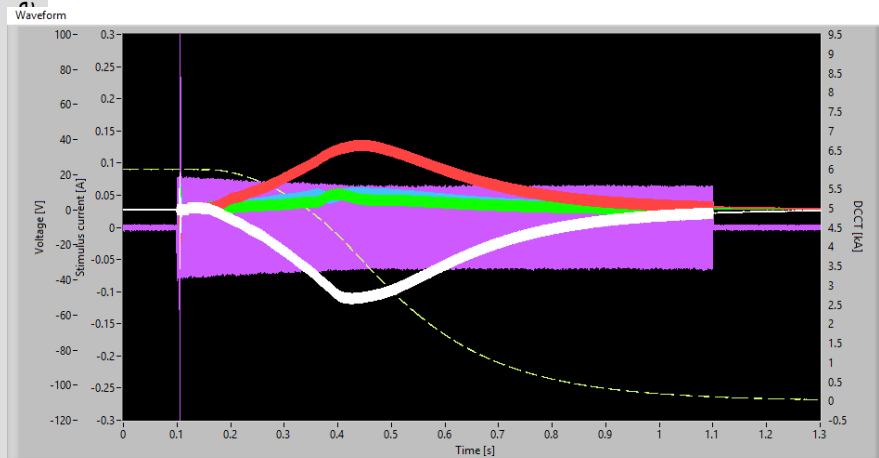
0 A

- D1_U
- D1_L
- D2_L
- D2_U
- IDCCT_HF
- Stimulus current
- Vtotal



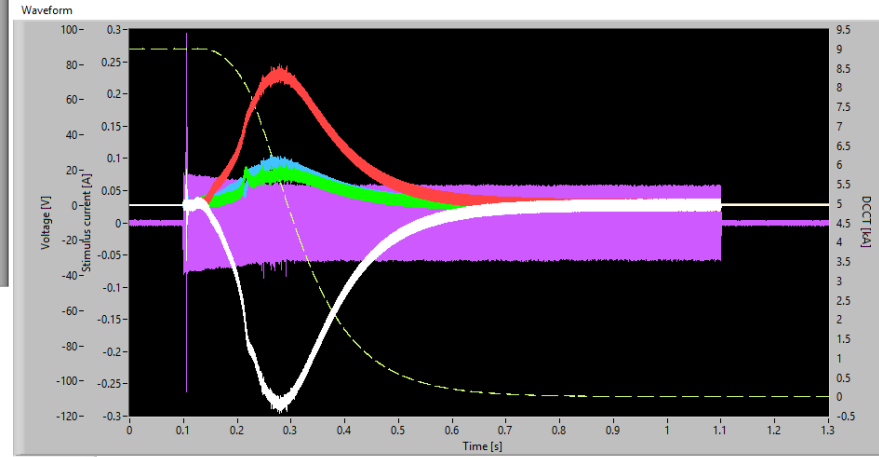
1 kA

- D1_U
- D1_L
- D2_L
- D2_U
- IDCCT_HF
- Stimulus current
- Vtotal



6 kA

- D1_U
- D1_L
- D2_L
- D2_U
- IDCCT_HF
- Stimulus current
- Vtotal

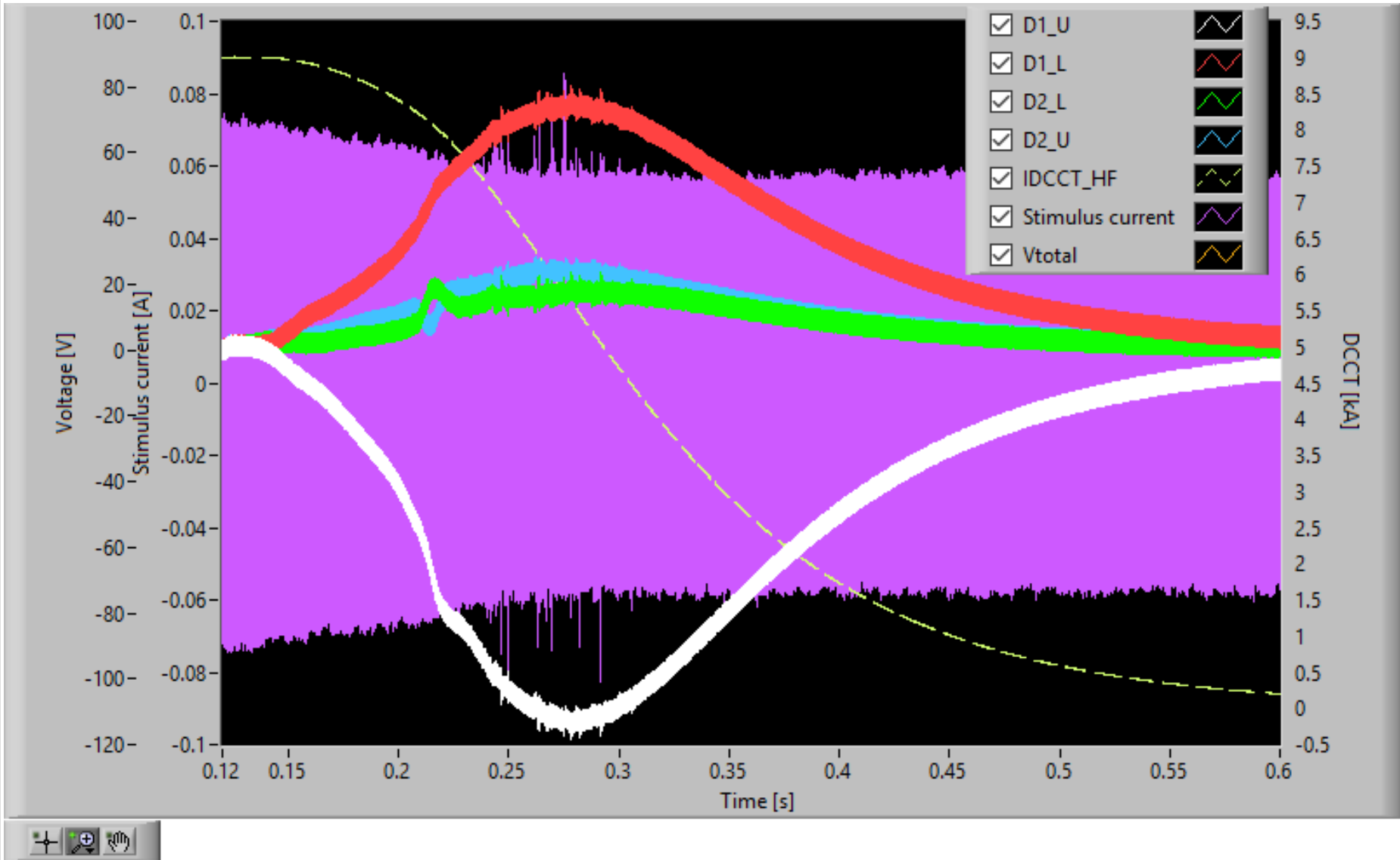


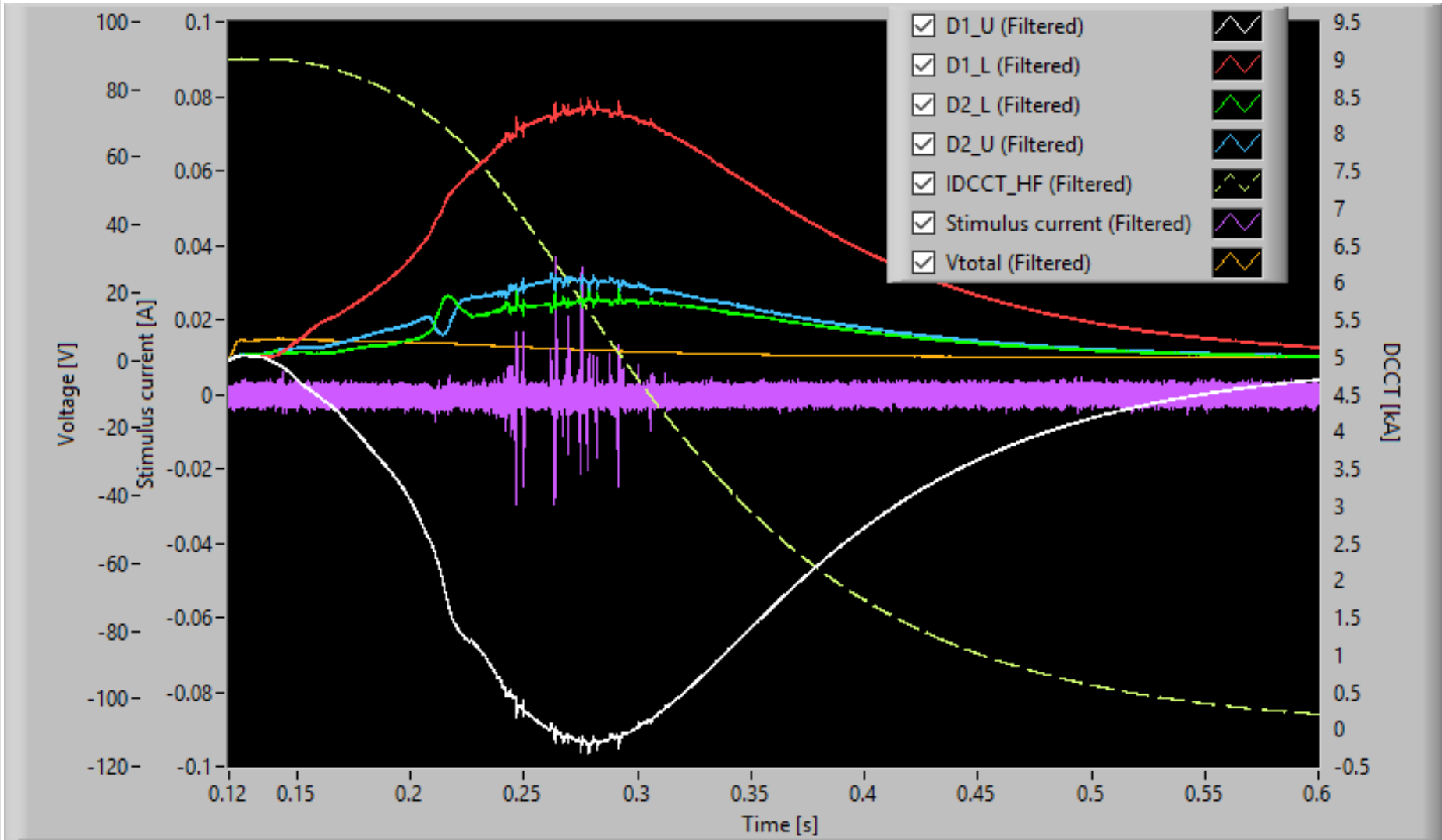
9 kA

- D1_U
- D1_L
- D2_L
- D2_U
- IDCCT_HF
- Stimulus current
- Vtotal

ak, Jaromir Lud

MBHA-001

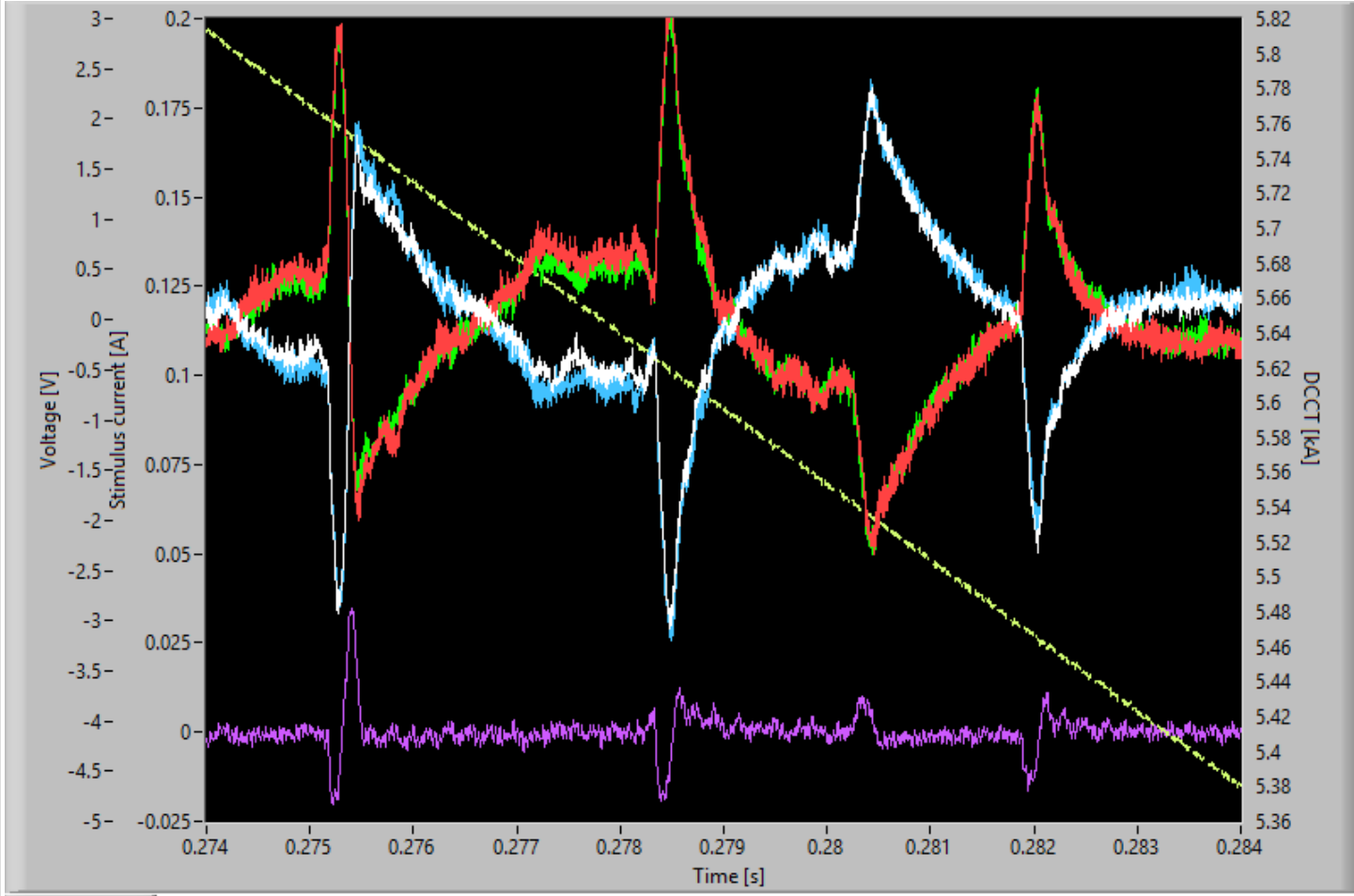






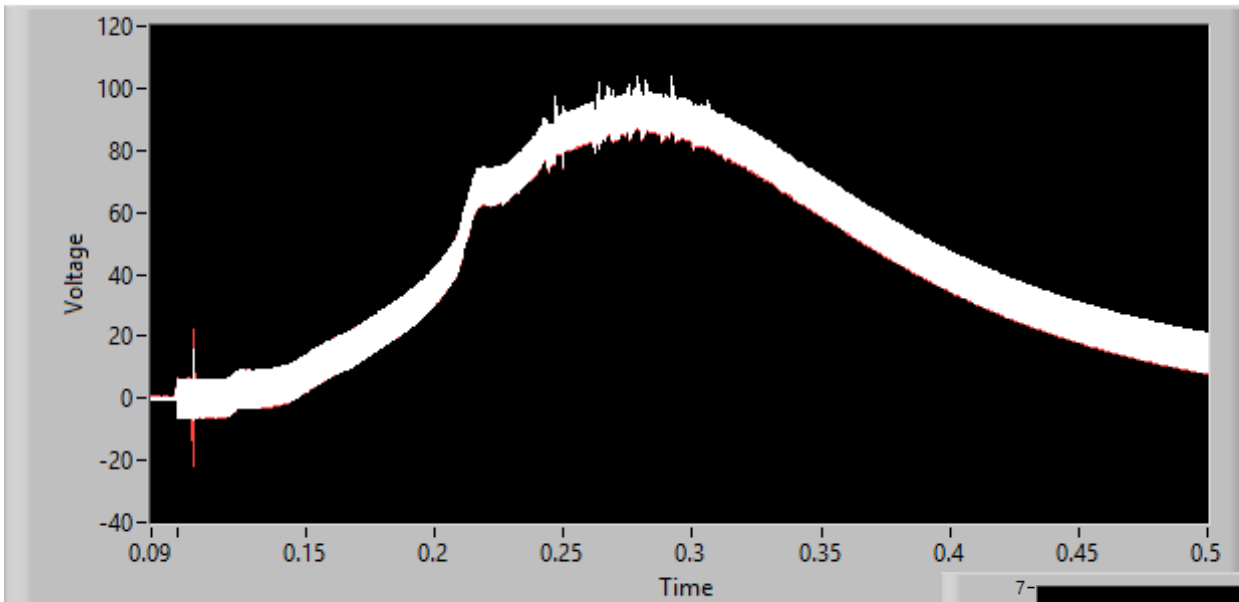
9 kA test with 6 kHz bandstop and 50 Hz highpass* filters

Zoom on spikes



* DCCT signal does not have a 50 Hz highpass filter applied

Voltage between points of interest



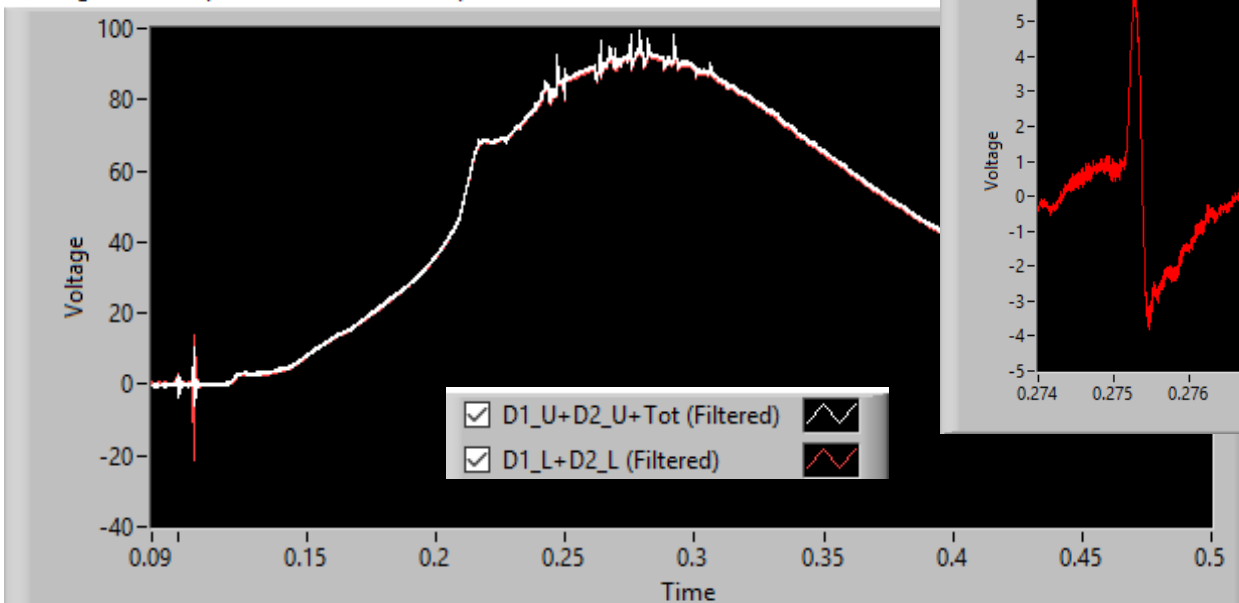
- D1_U+D2_U+Tot
- D1_L+D2_L

Two parallel branches measured independently:

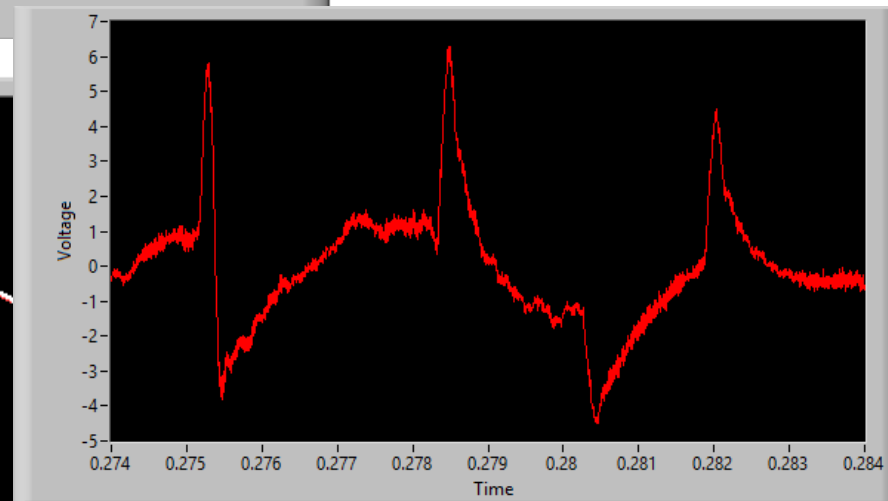
- D1_U + D2_U + magnet terminals
- D1_L + D2_L

Everything adds up properly

Voltage between points of interest bandstop filtered



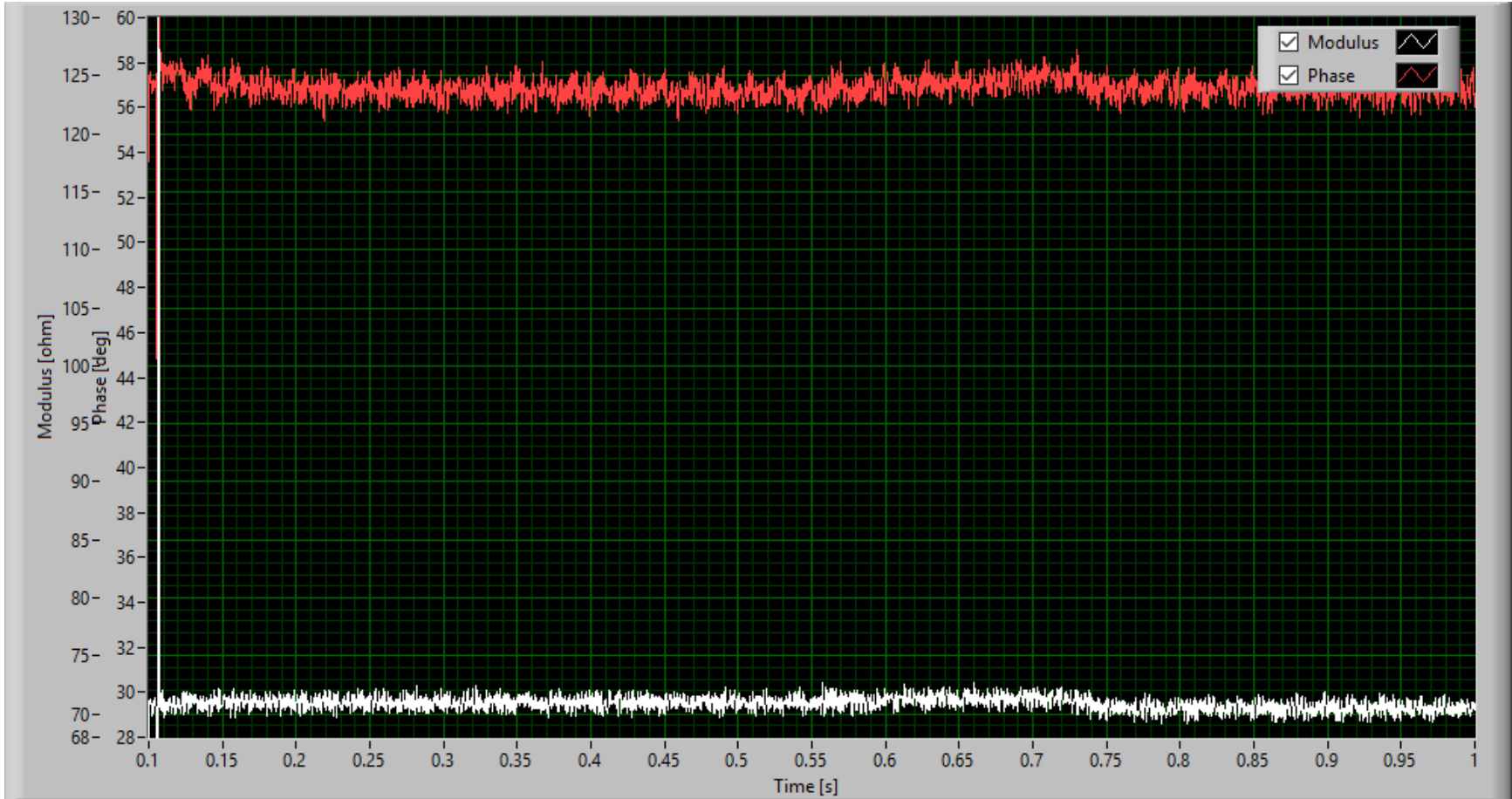
- D1_U+D2_U+Tot (Filtered)
- D1_L+D2_L (Filtered)

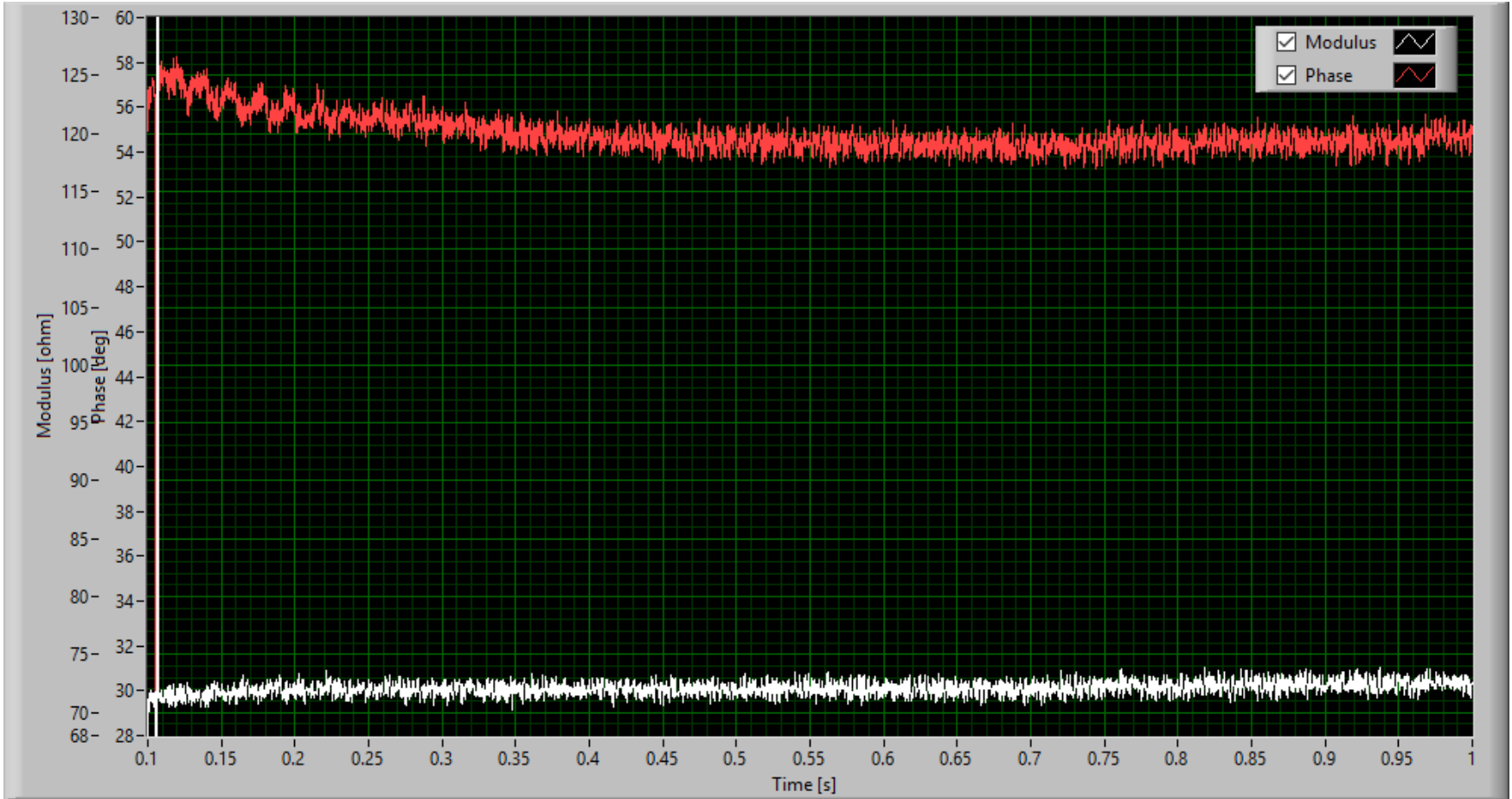


Second sum should have less uncertainty so we will use it for further analysis

Impedance calculation

- Calculation of magnitude and phase of current and voltage using Discrete Fourier Transform
- Each sample is made of 3 cycles of 6 kHz signal, moving forward every single cycle.
- Calculated phase shift of voltage signal is taken relative to calculated current phase.
- Having complex voltage and current signals we can calculate complex impedance.



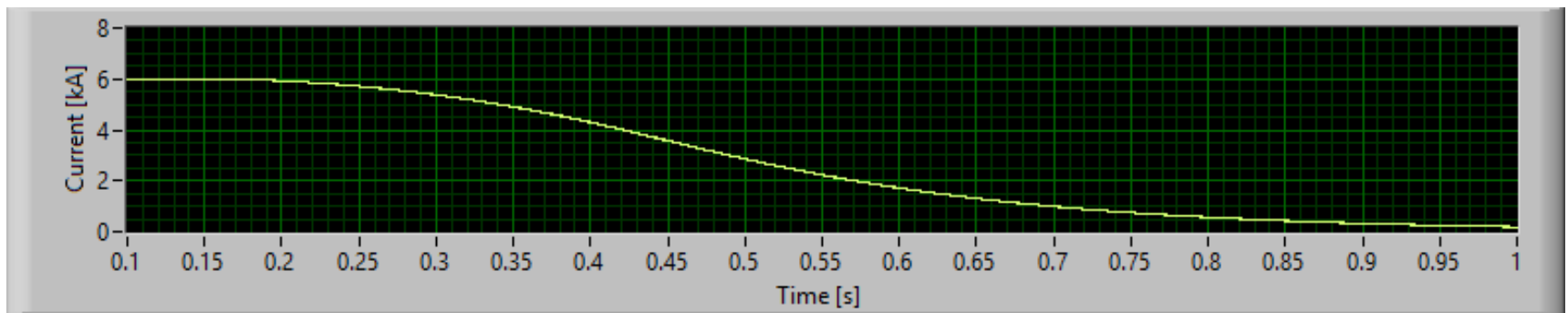
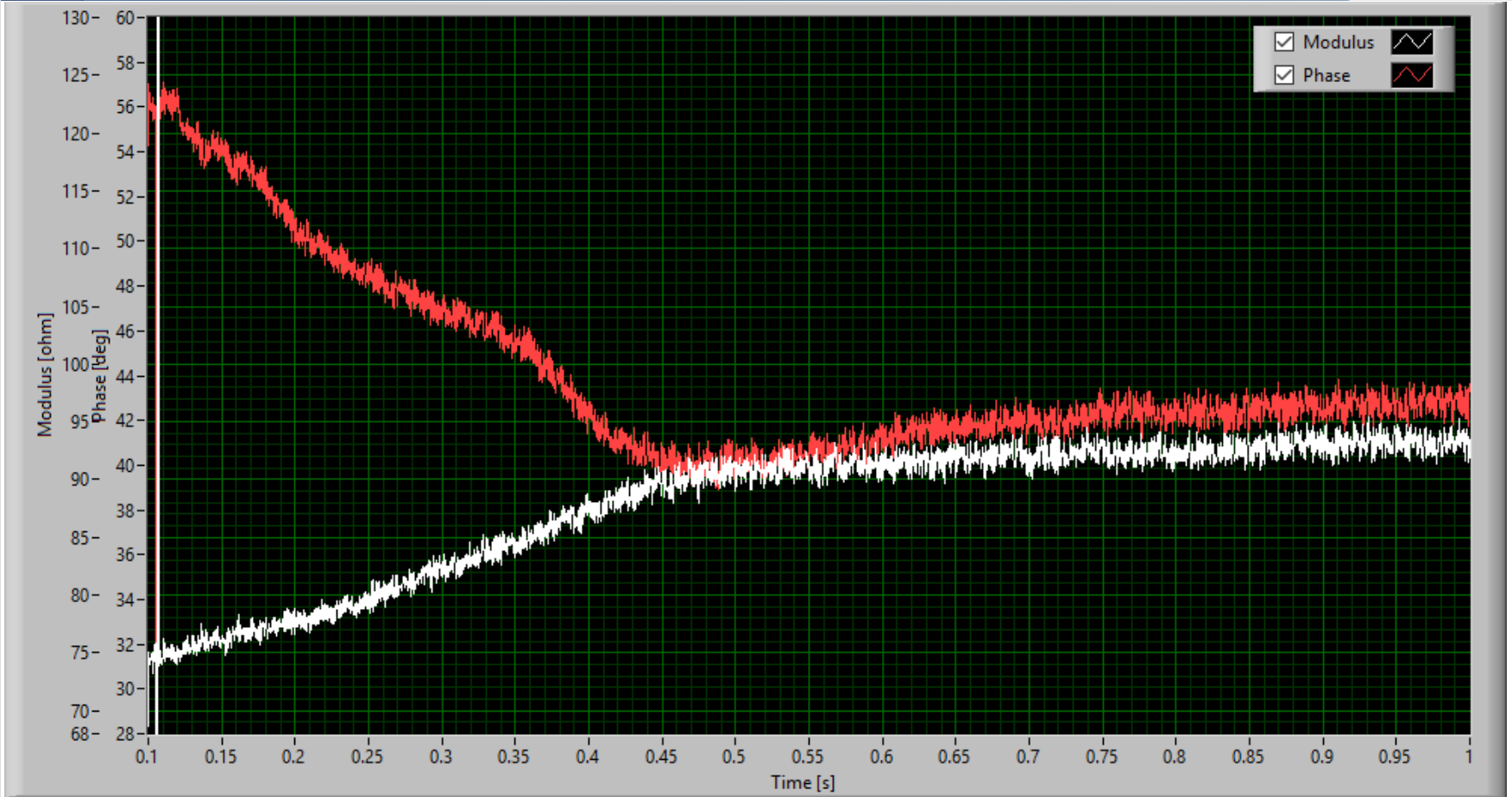




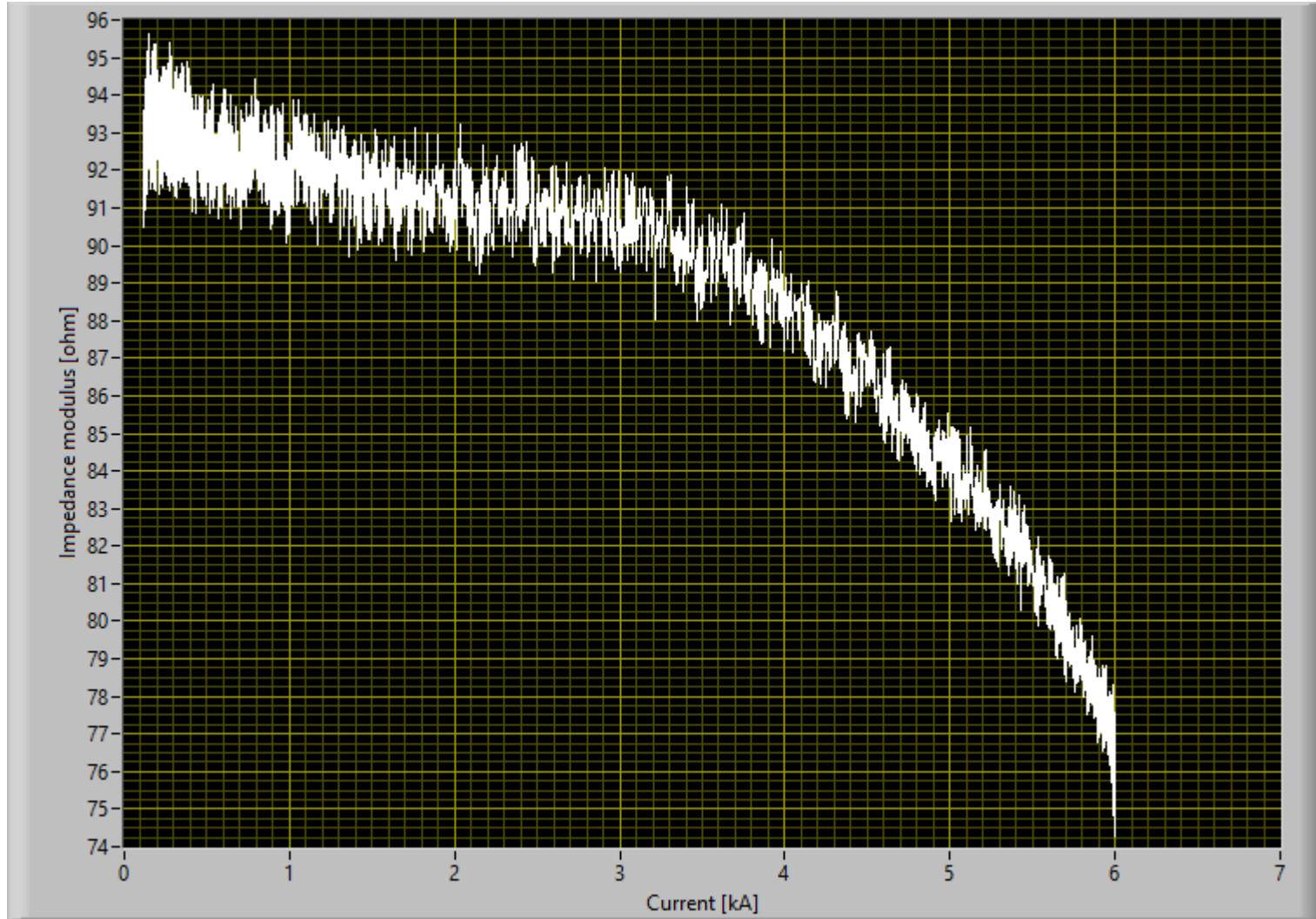
Impedance at 6 kA

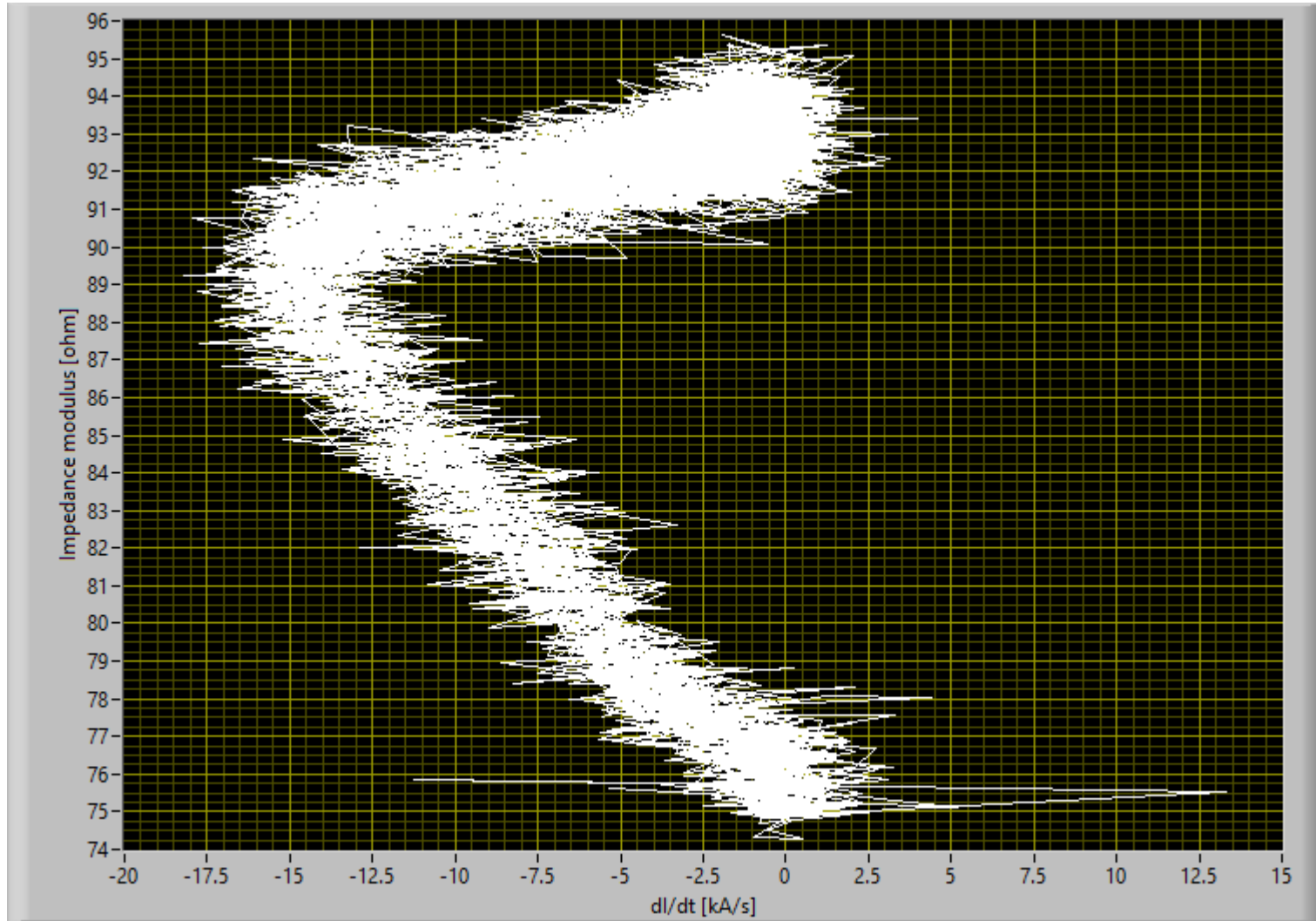


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Impedance vs Current



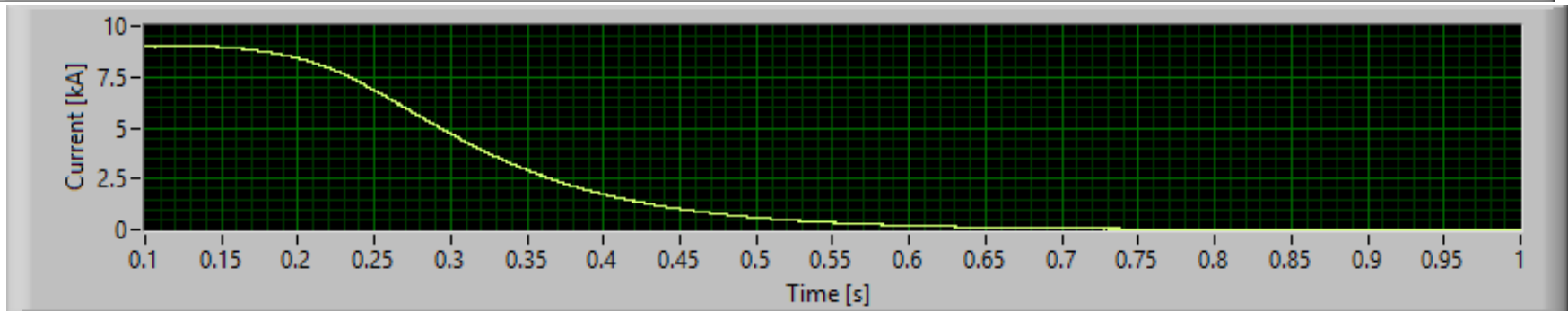
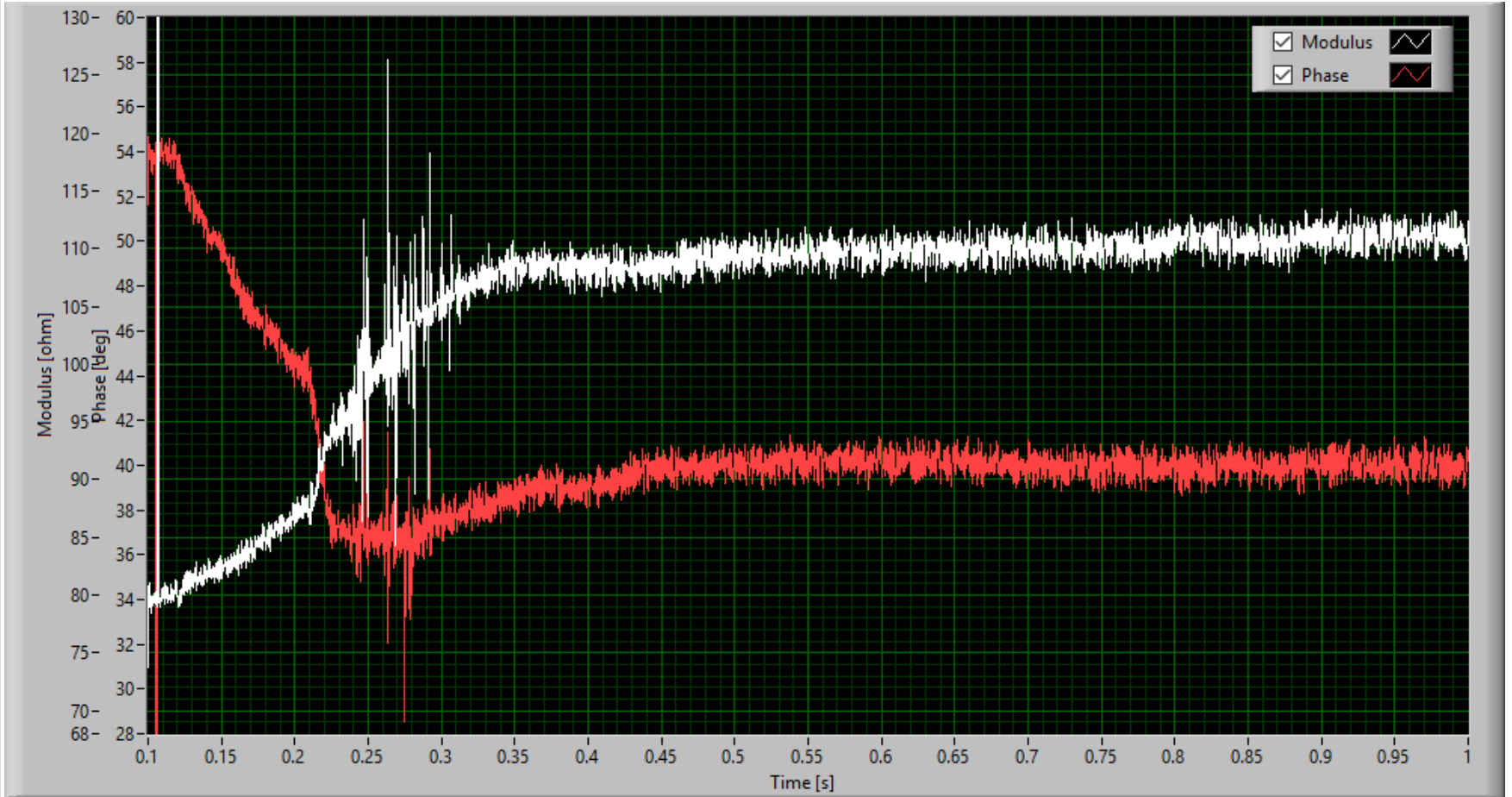


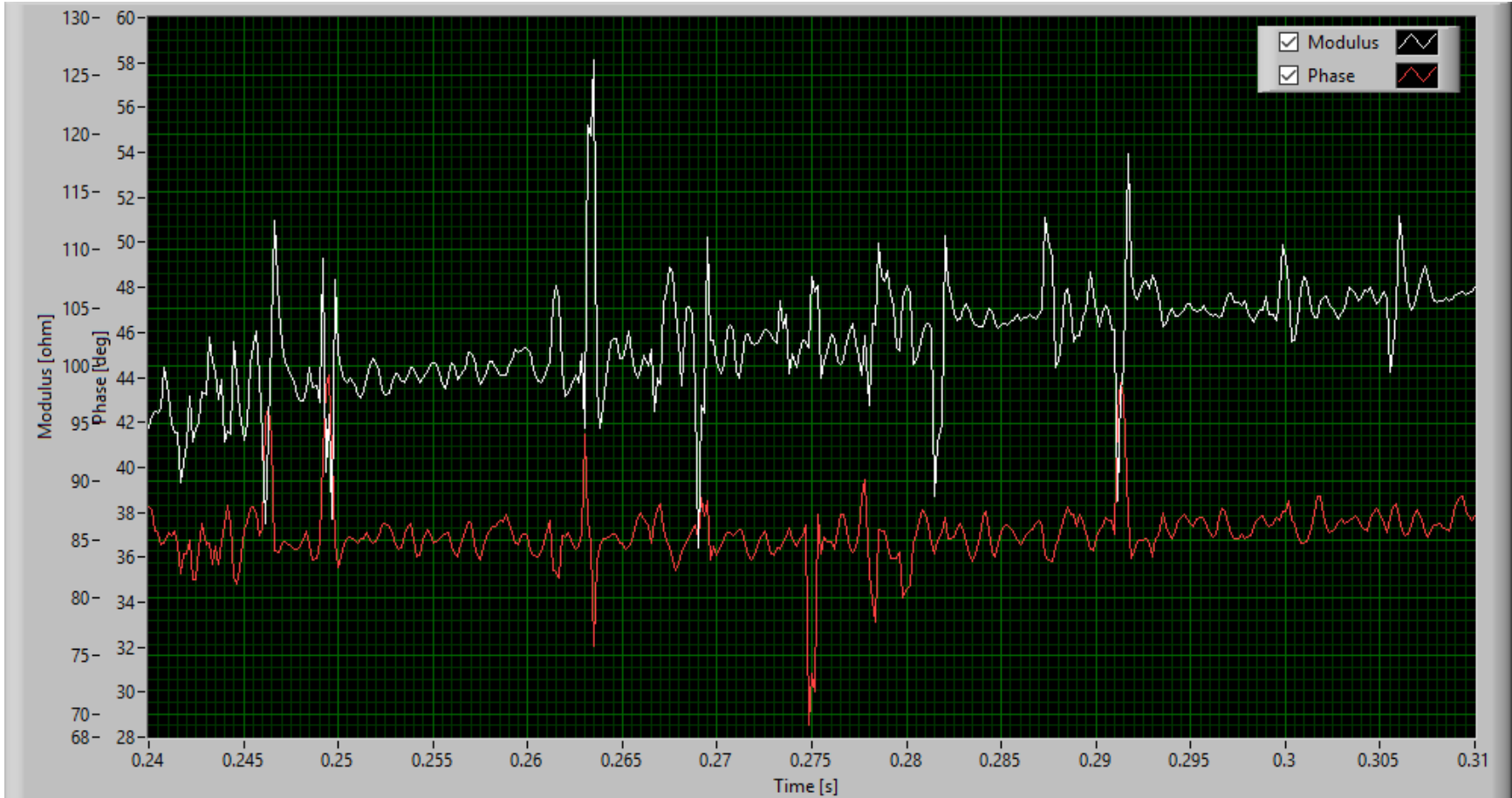


Impedance at 9 kA

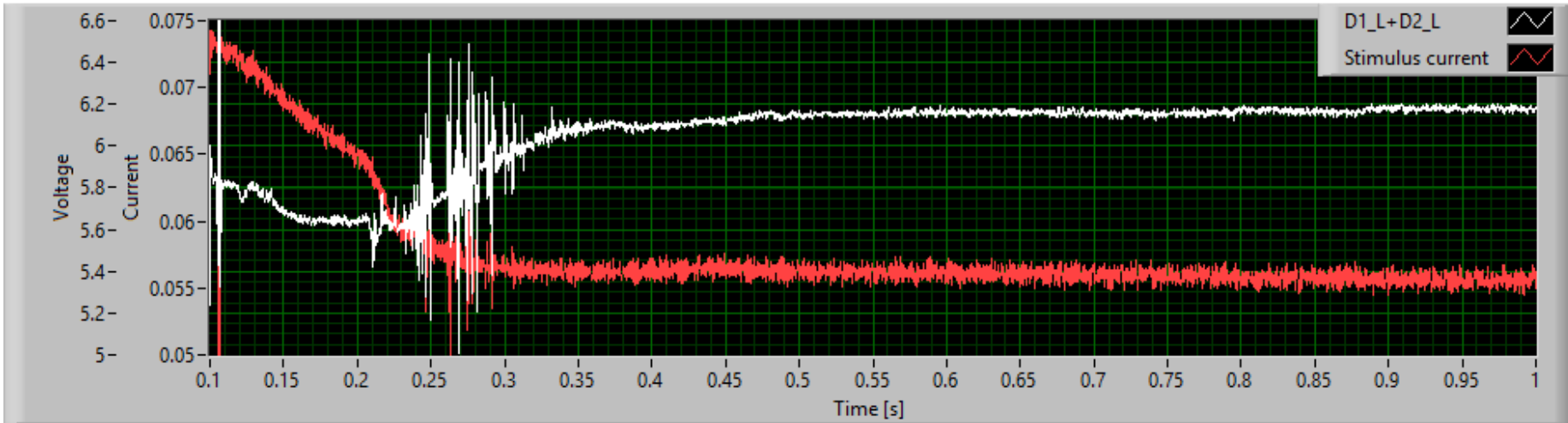


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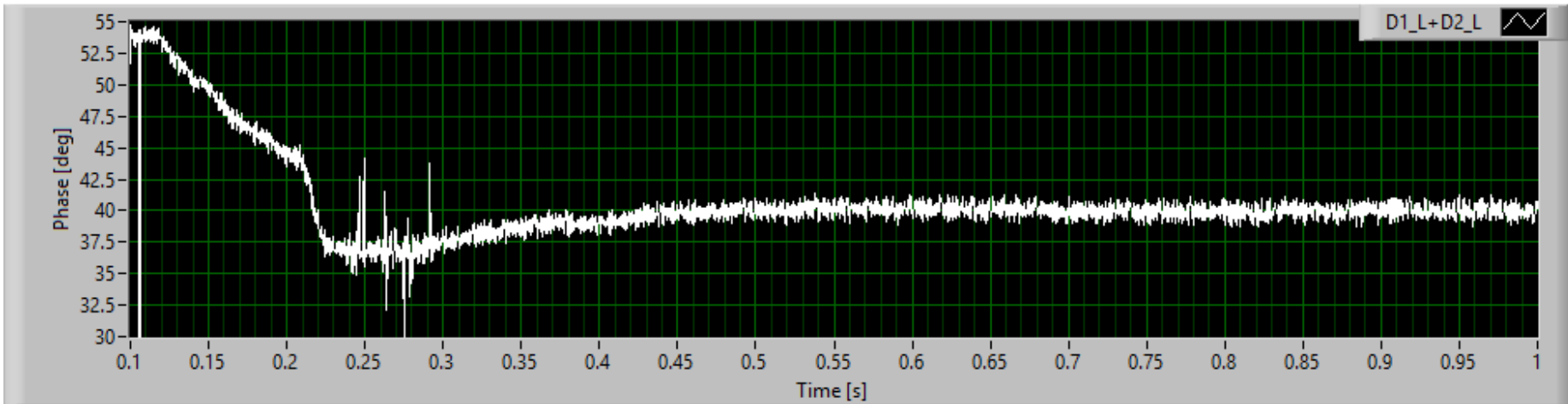




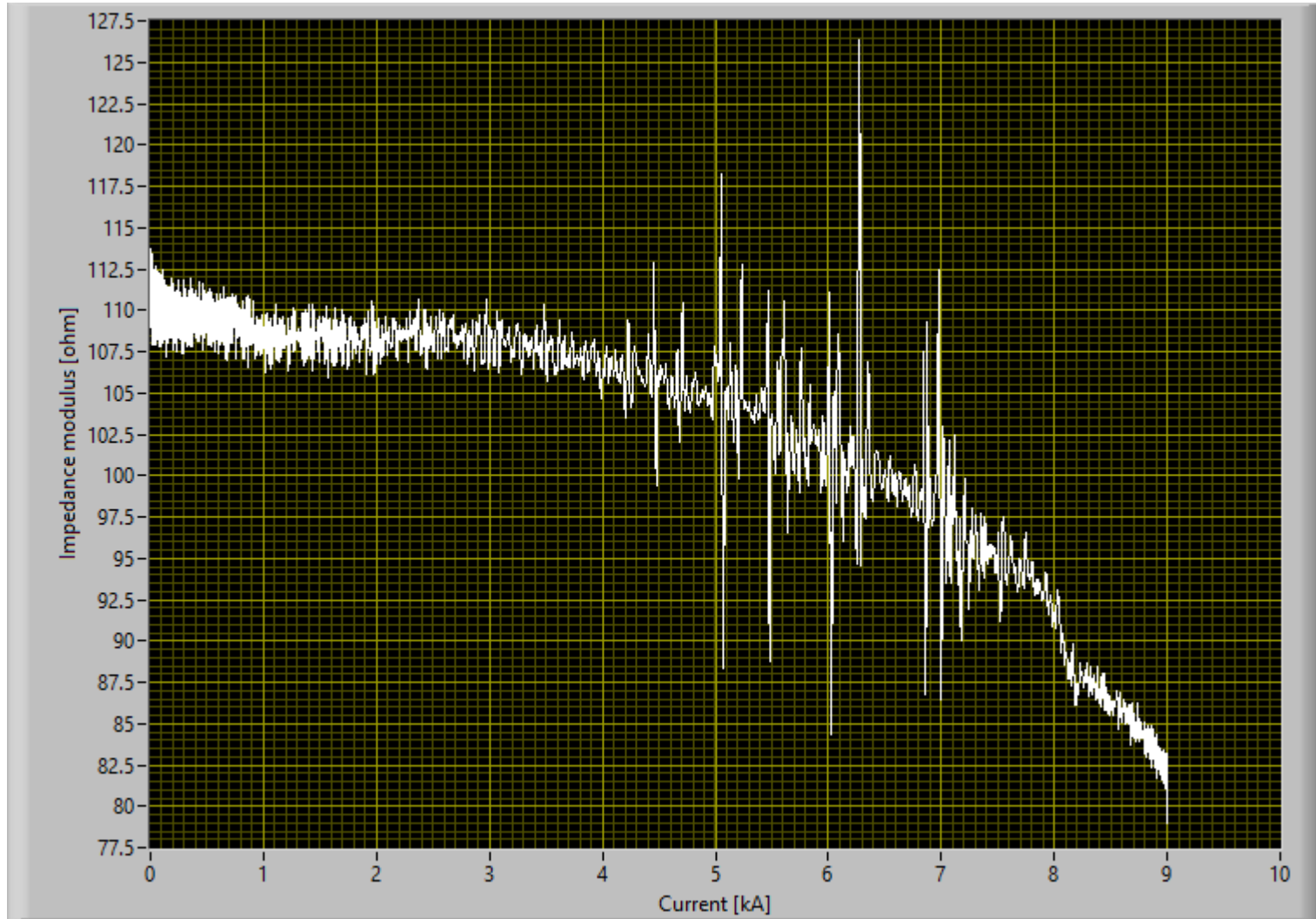
Magnitude

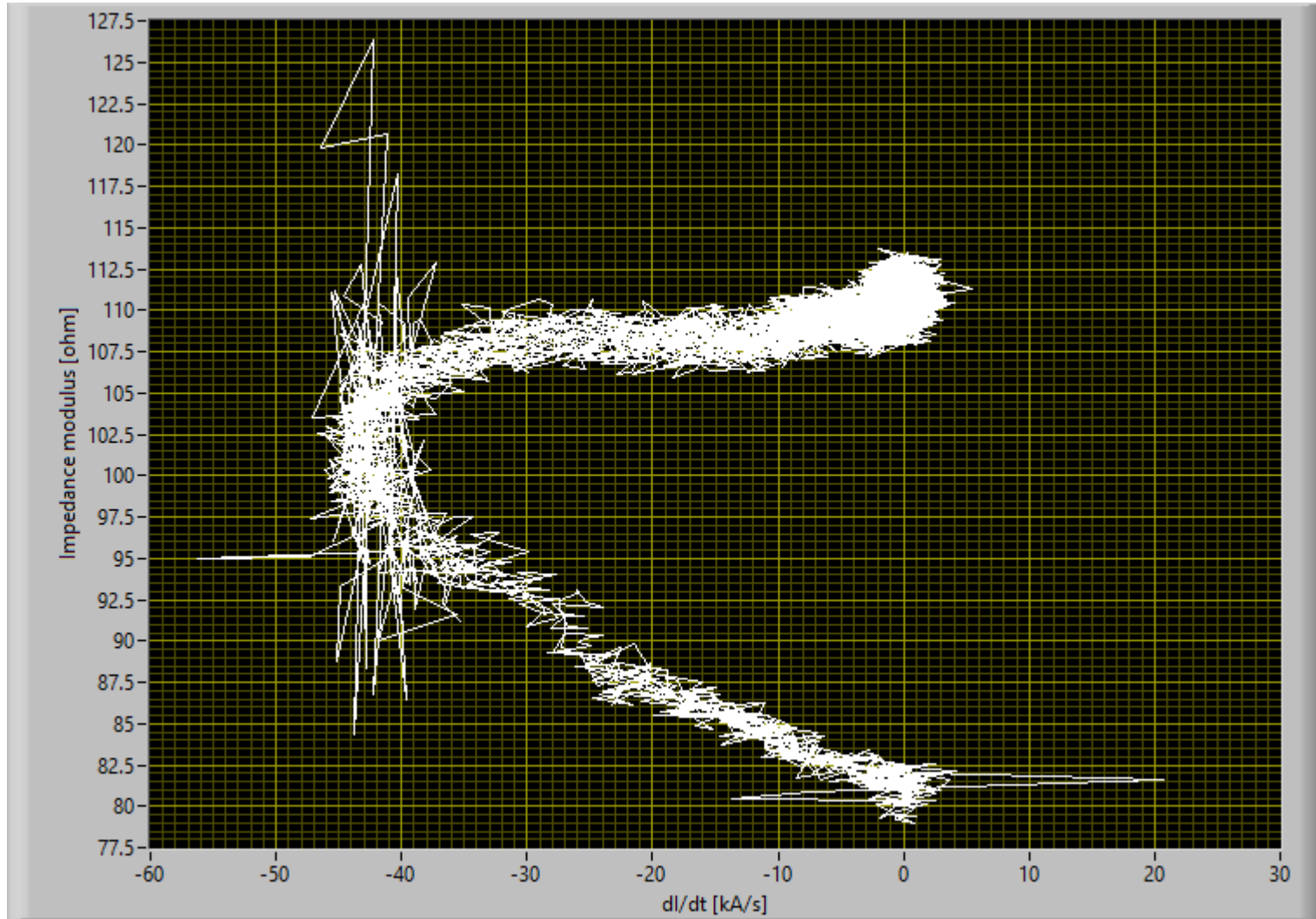


Phase



- The modulation frequency is within the spikes spectrum





- We managed to conduct the measurement safely
- **Within the measurement resolution** we do not see change of the impedance between the spikes
- Some of measured values seem to be hard to explain
- We would like to repeat the measurement at different frequencies and at higher current levels