Wavelet analysis II

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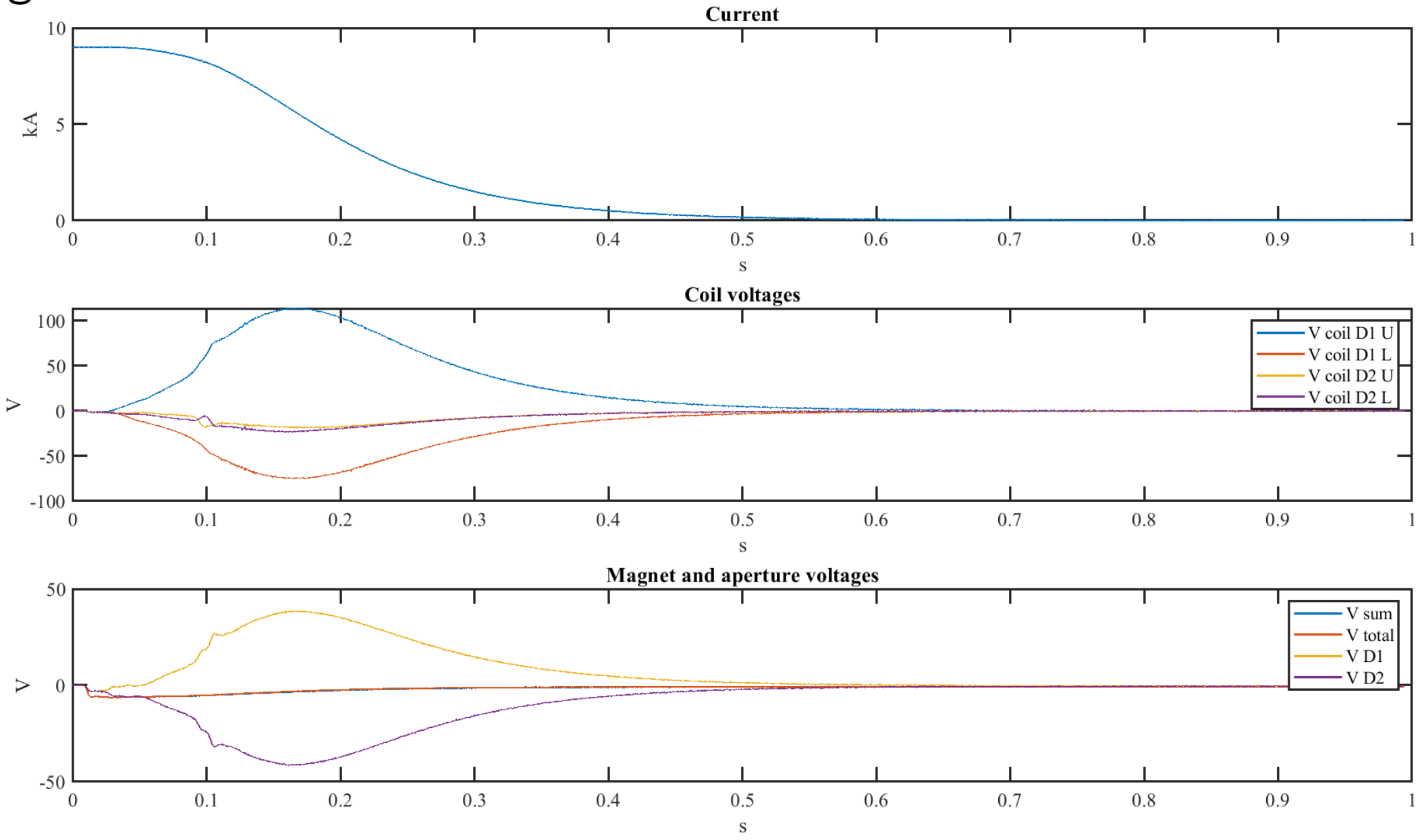
Post processing by using wavelet transform

- We start from the raw signals in time domain (current, coil voltages, aperture voltages)
- We apply the WT (‘Morlet’: complex exponential x gaussian window)
  - Scalogram (frequencies as function of time)
- We select a band of interest (natural behavior < f > noise)
  - Search for **maximum** as function of **frequency** and as function of **time**
- We reconstruct the signal in the time domain (it contains only the spikes)
  - Search for **maximum** as function of **time**
- We check if there are **correlations** with current level, voltage level, ramp rate

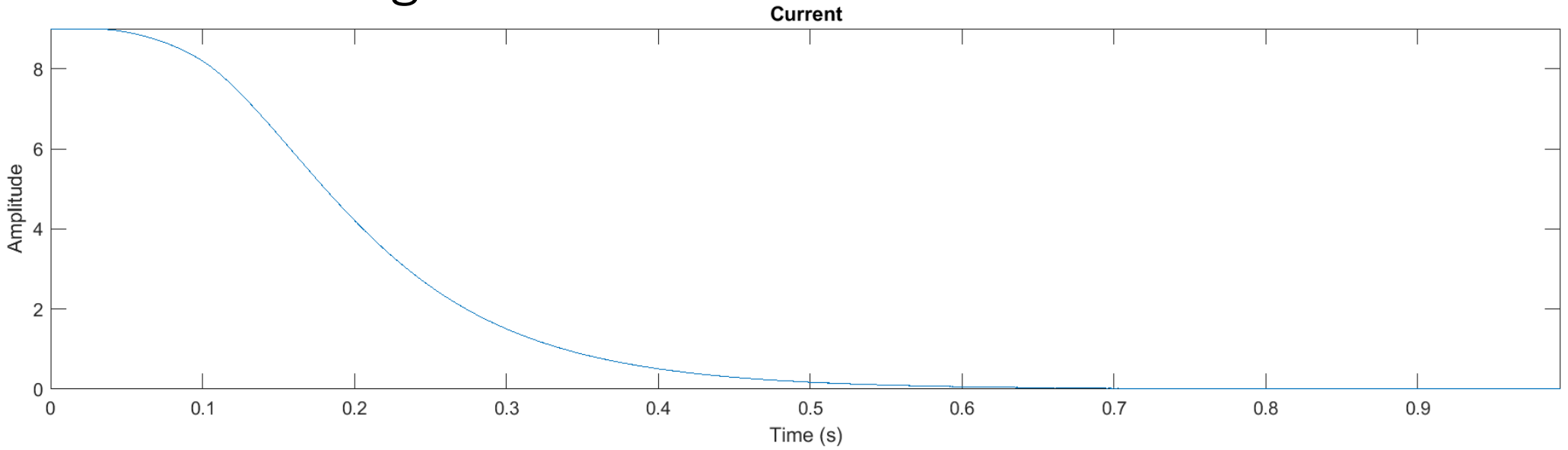
Example:

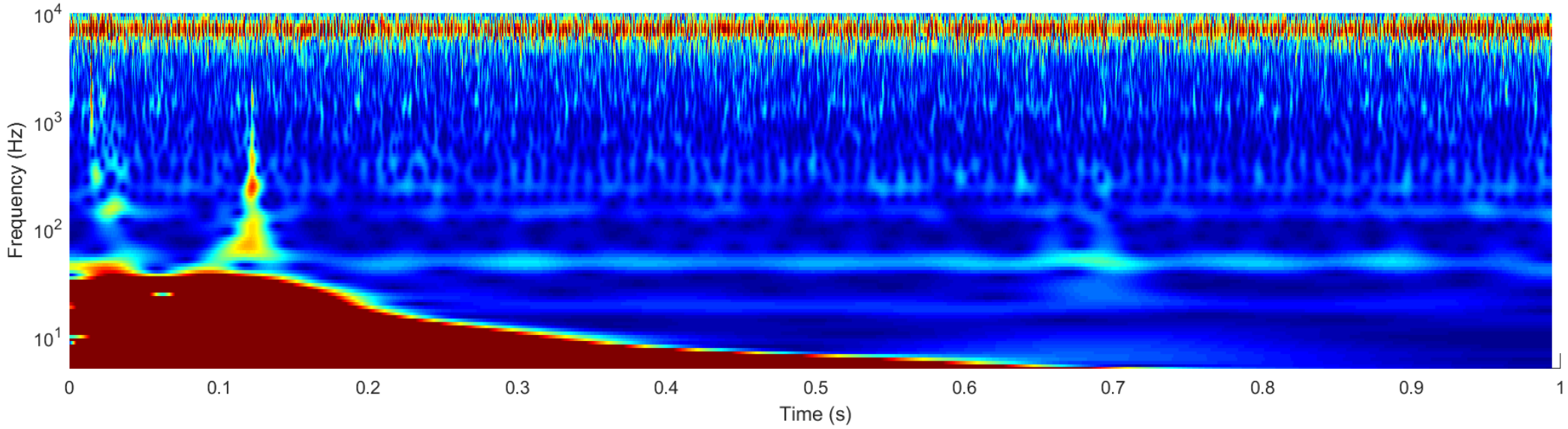
HCLMBHA001-CR000001_2__K2003101803_a027(0)_HF.csv

Raw signals

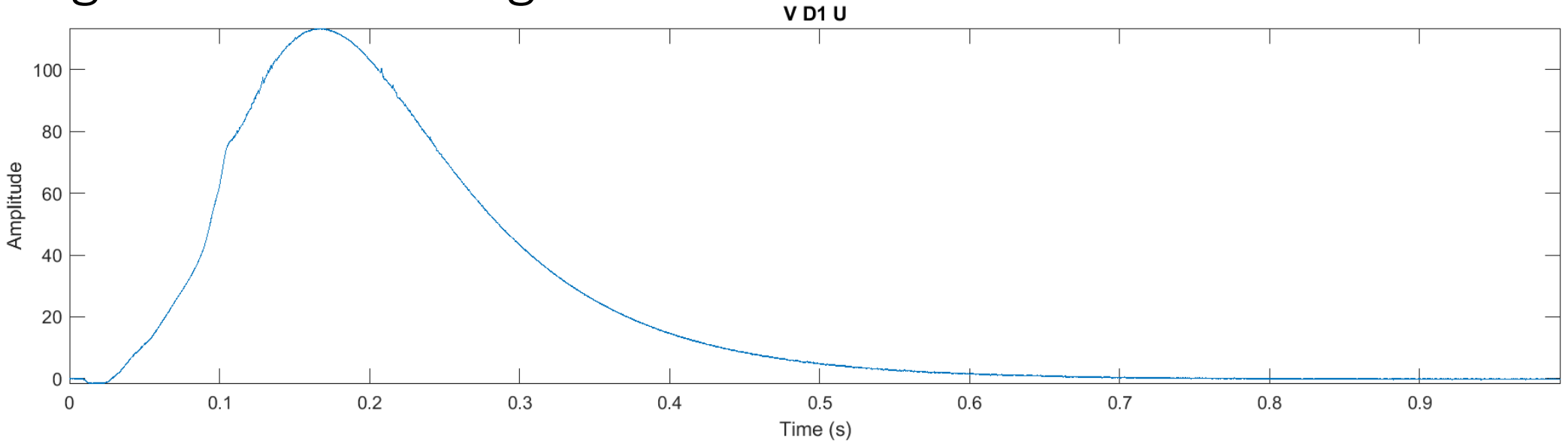

Current
kA
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
s
Coil voltages
V
100
50
0
-50
-100
V coil D1 U
V coil D1 L
V coil D2 U
V coil D2 L
s
Magnet and aperture voltages
V
50
0
-50
V sum
V total
V D1
V D2
s

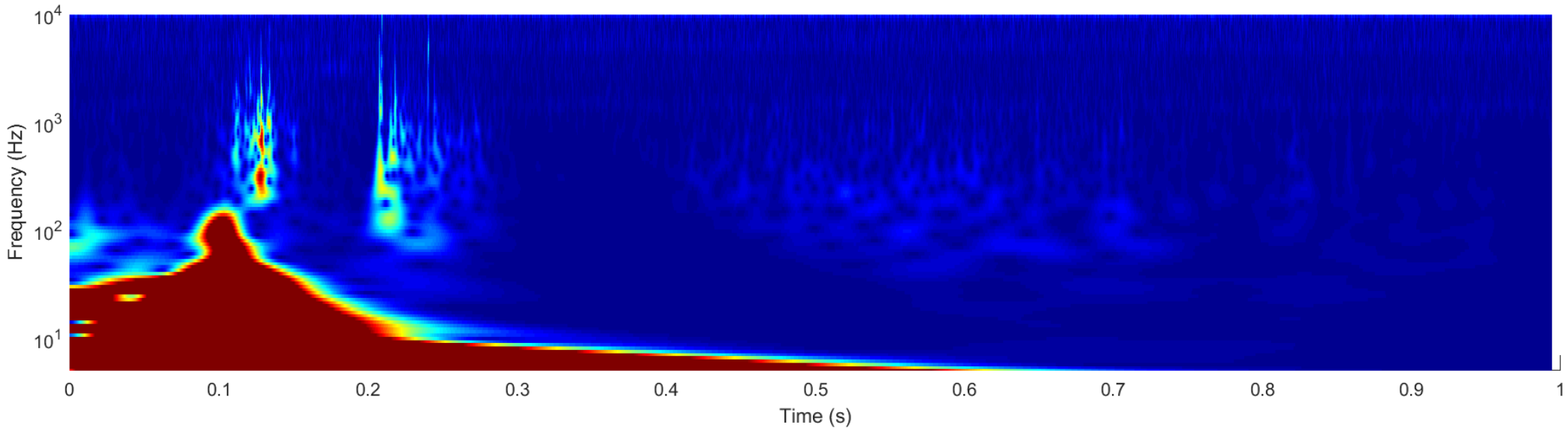
Current: WT and scalogram





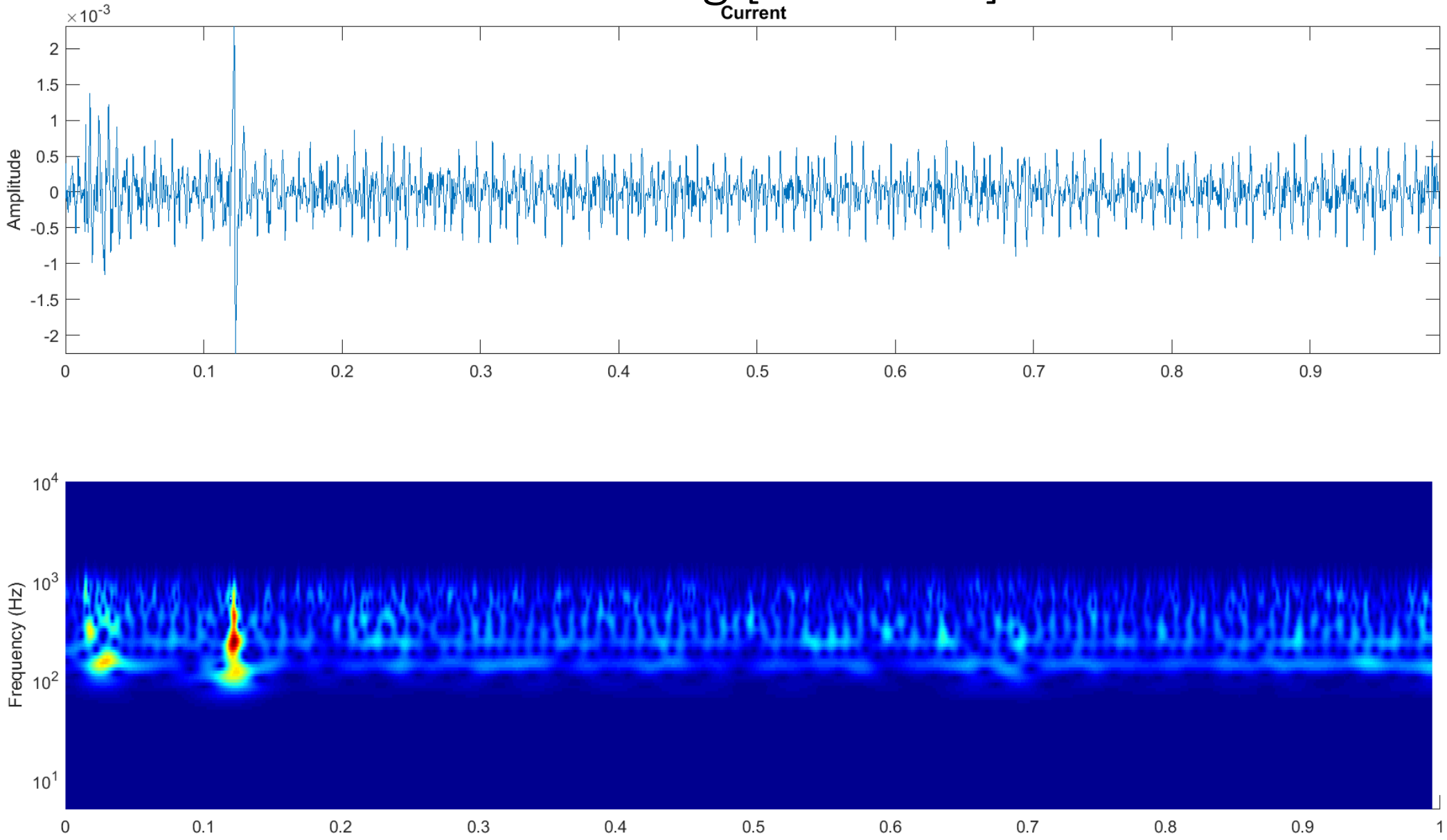
Coil voltage: WT and scalogram



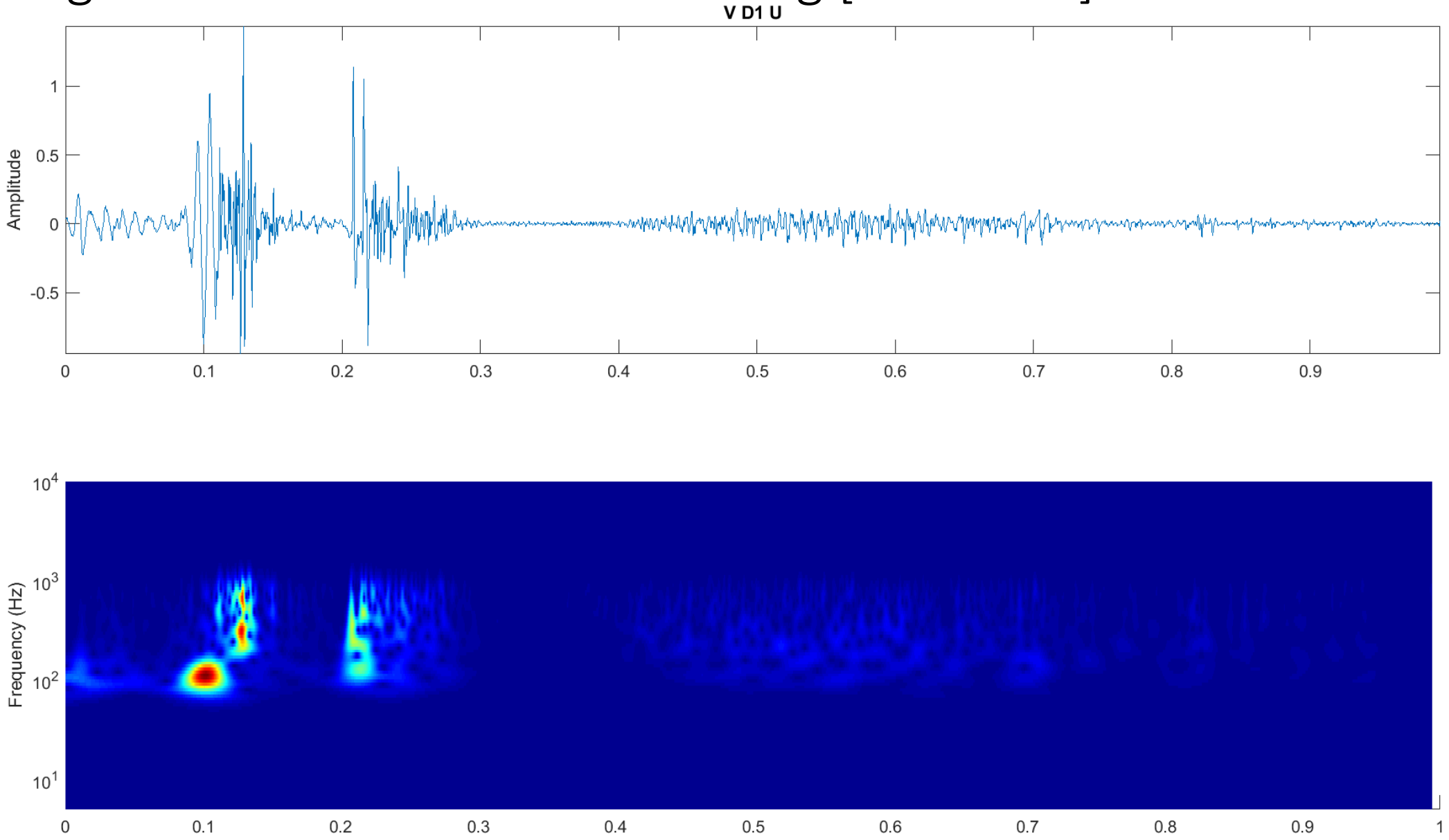


Filtering and reconstruction

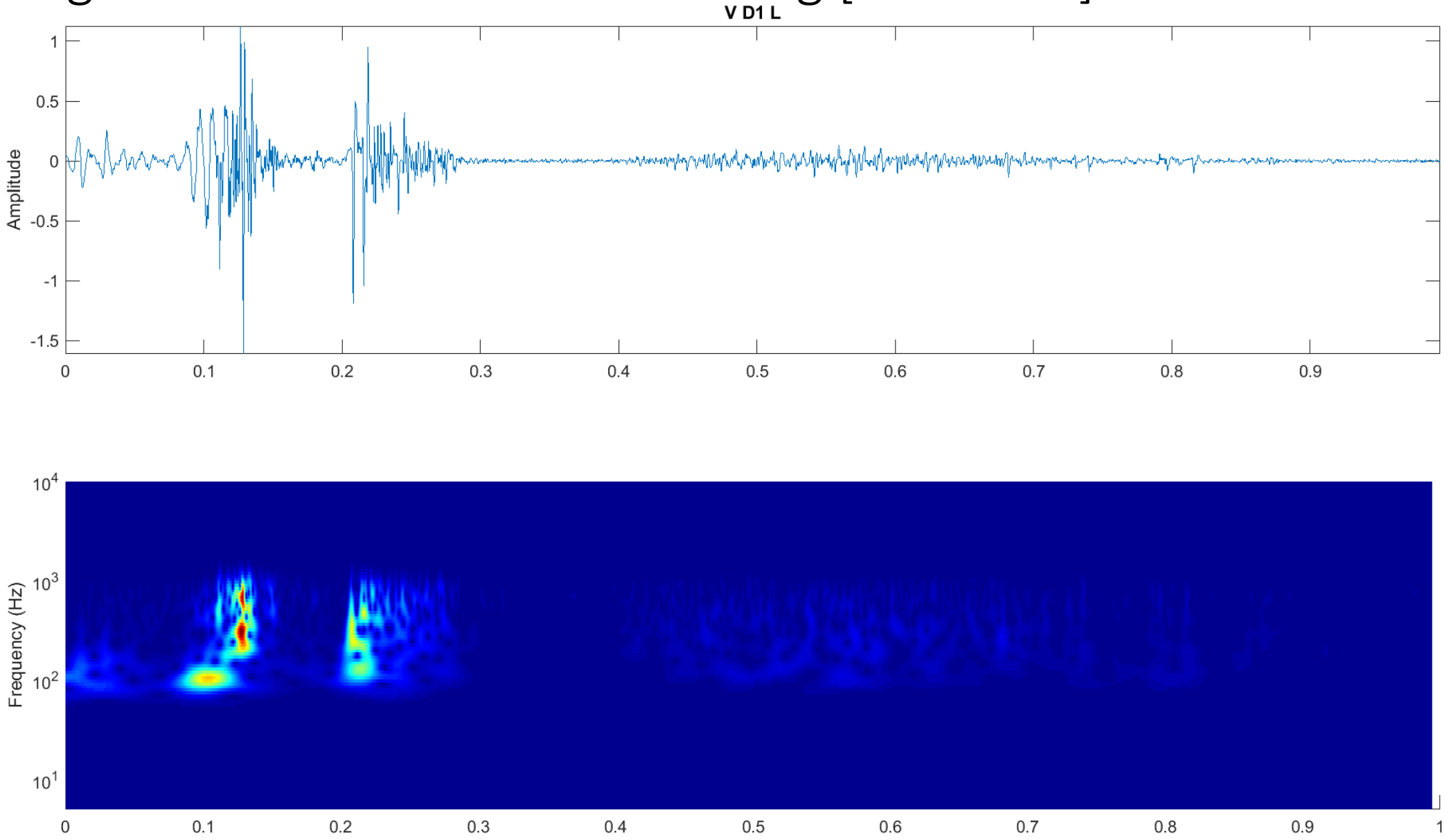
Current: reconstruction after filtering [100 1000] Hz



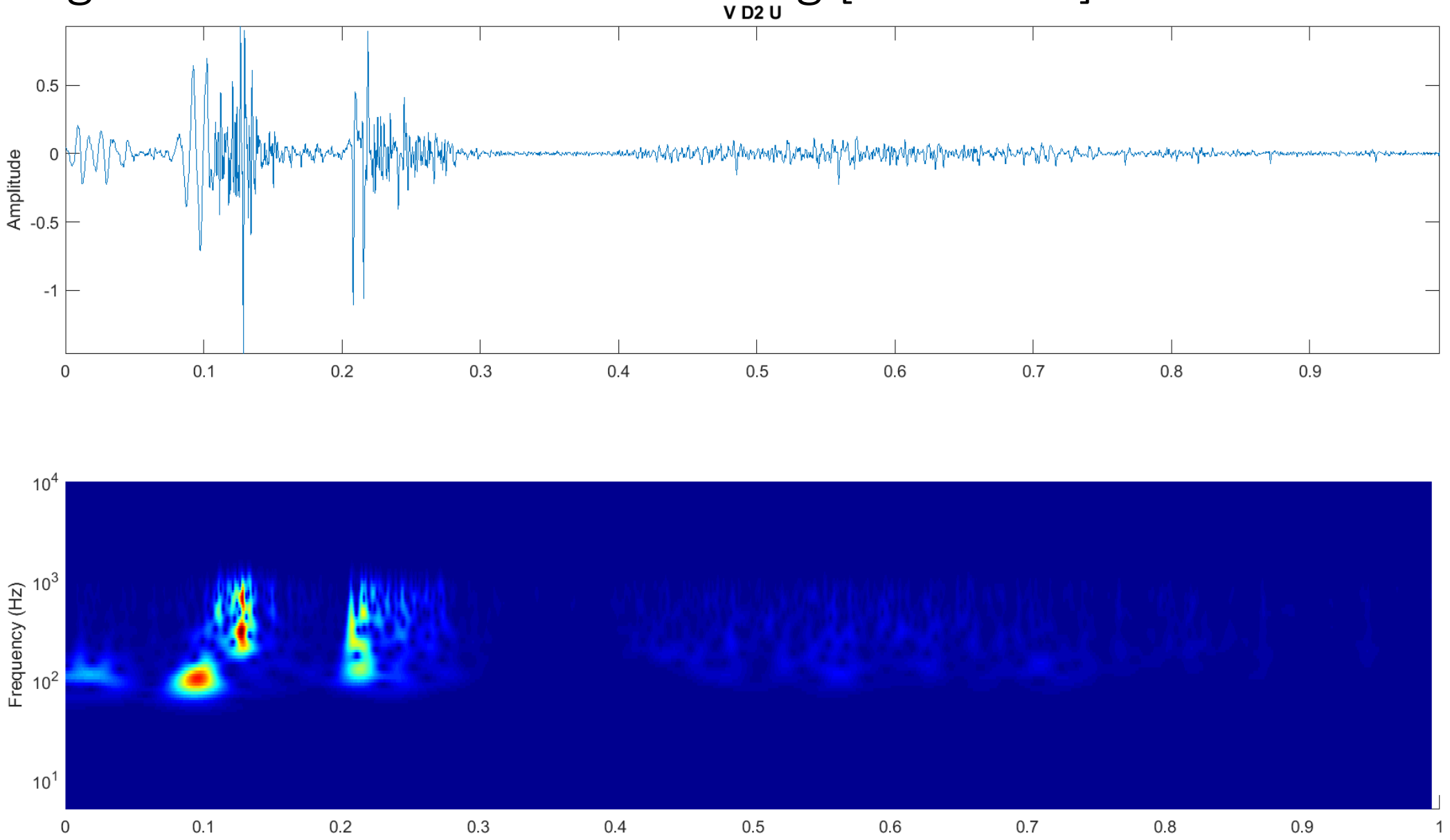
Coil voltage: reconstruction after filtering [100 1000] Hz



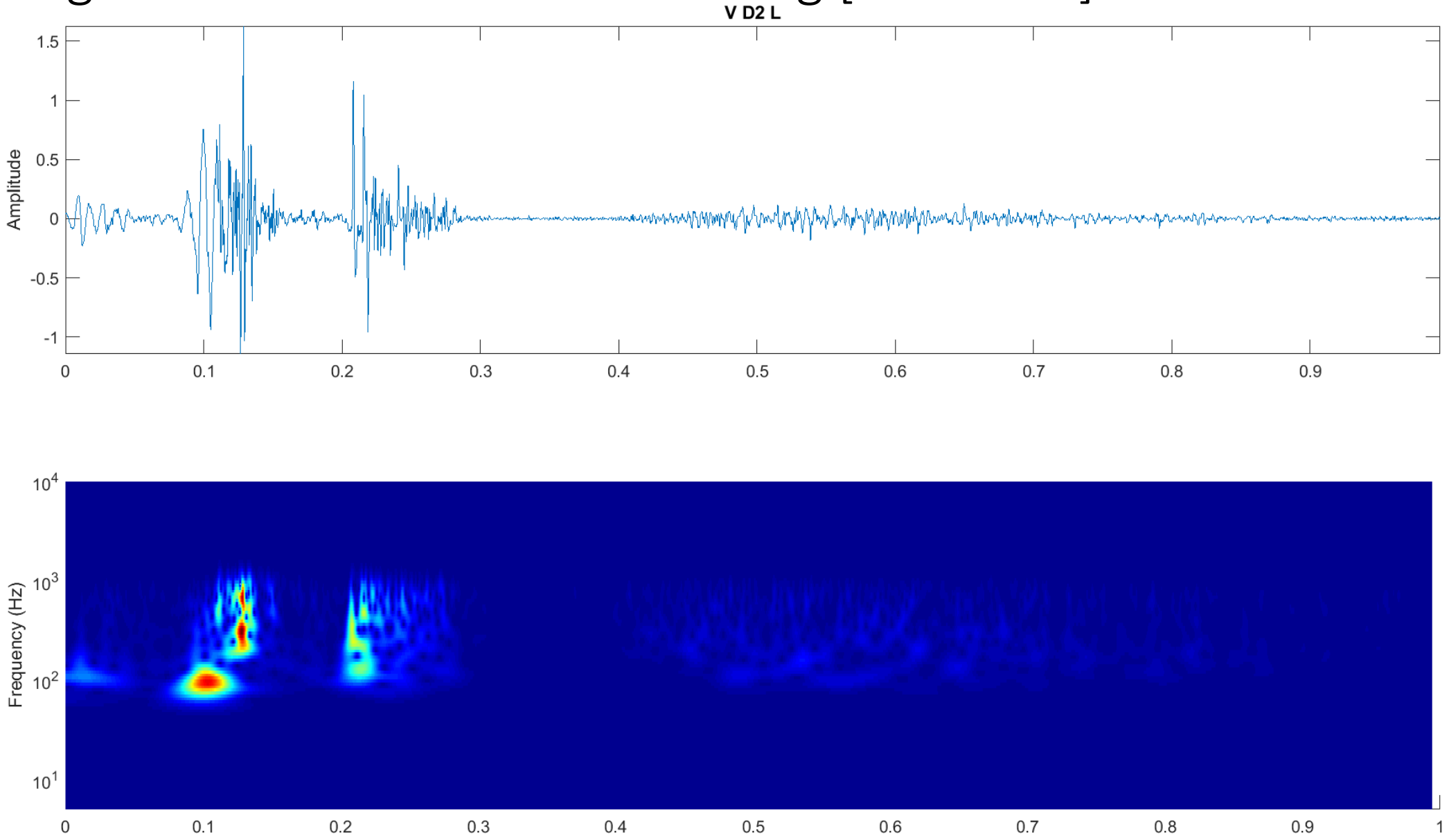
Coil voltage: reconstruction after filtering [100 1000] Hz



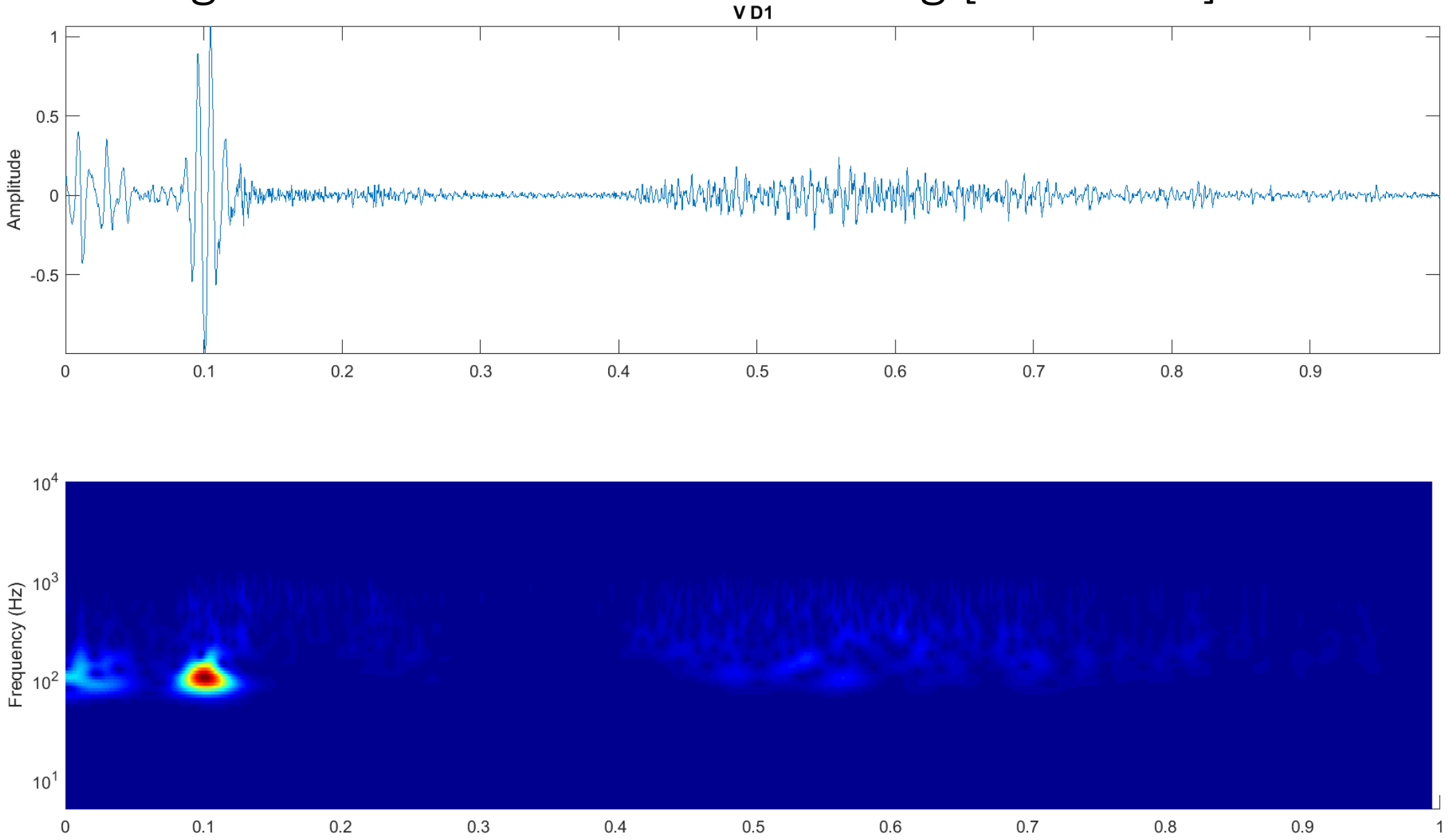
Coil voltage: reconstruction after filtering [100 1000] Hz



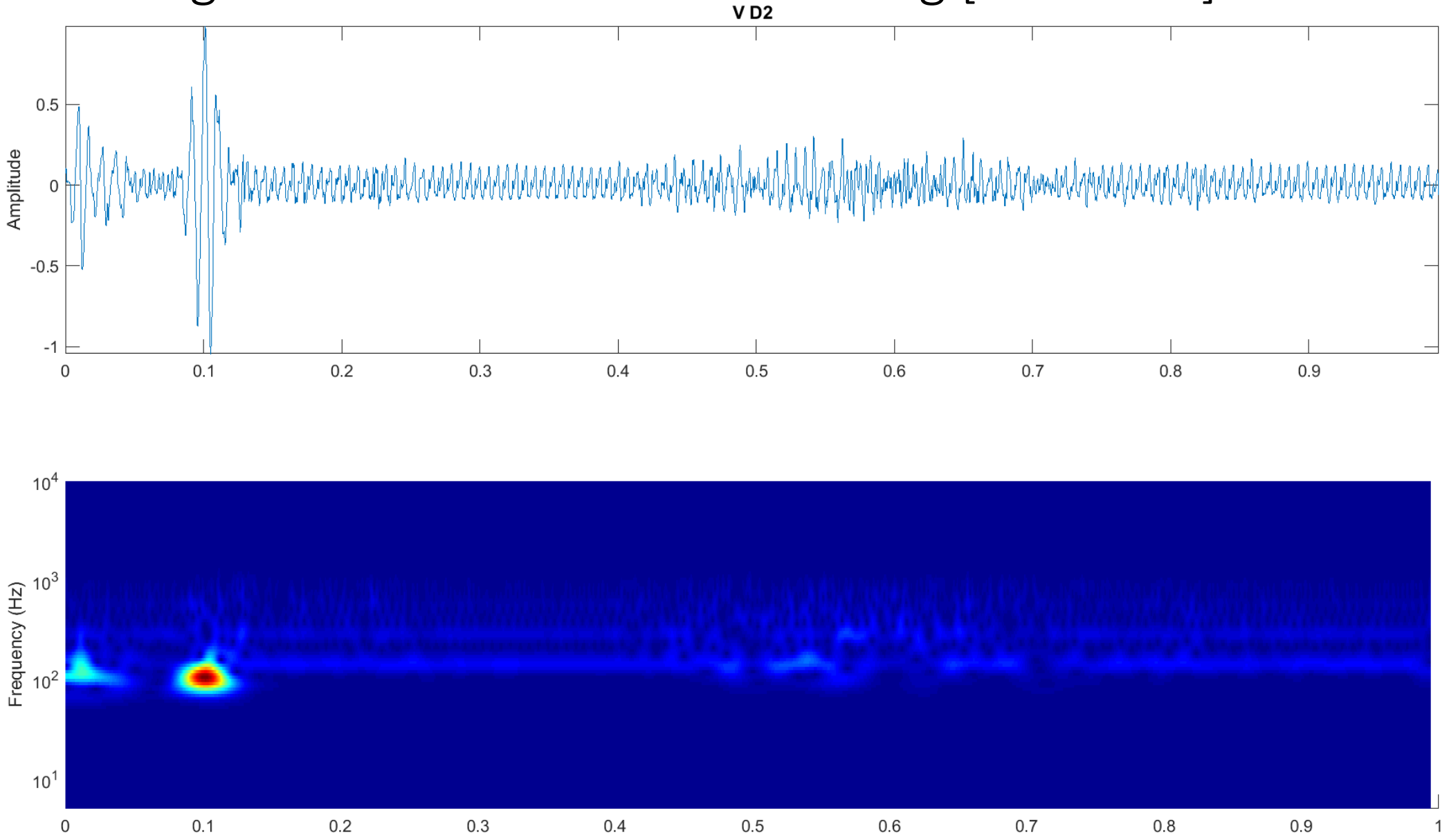
Coil voltage: reconstruction after filtering [100 1000] Hz



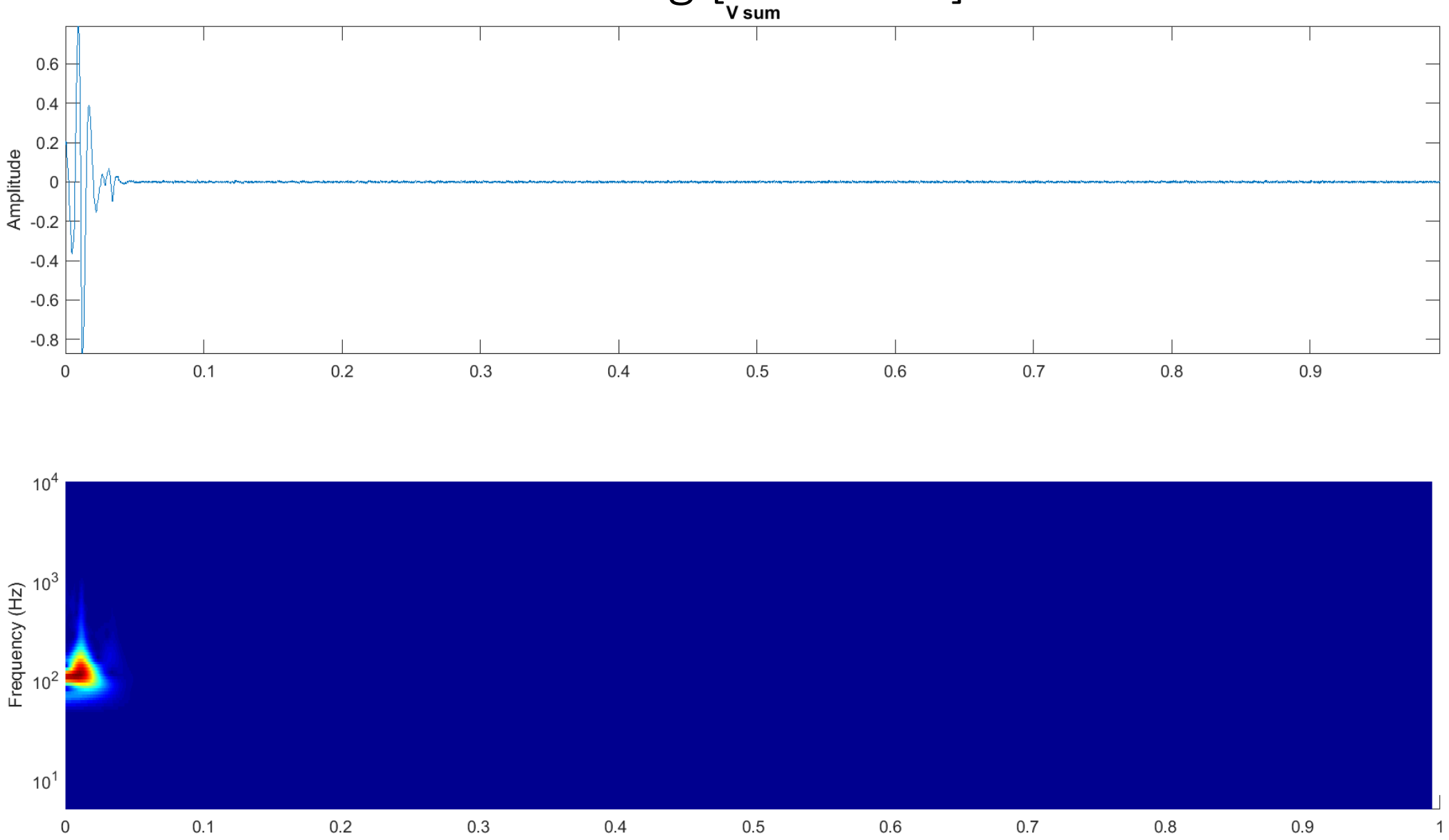
Aperture voltage: reconstruction after filtering [100 1000] Hz



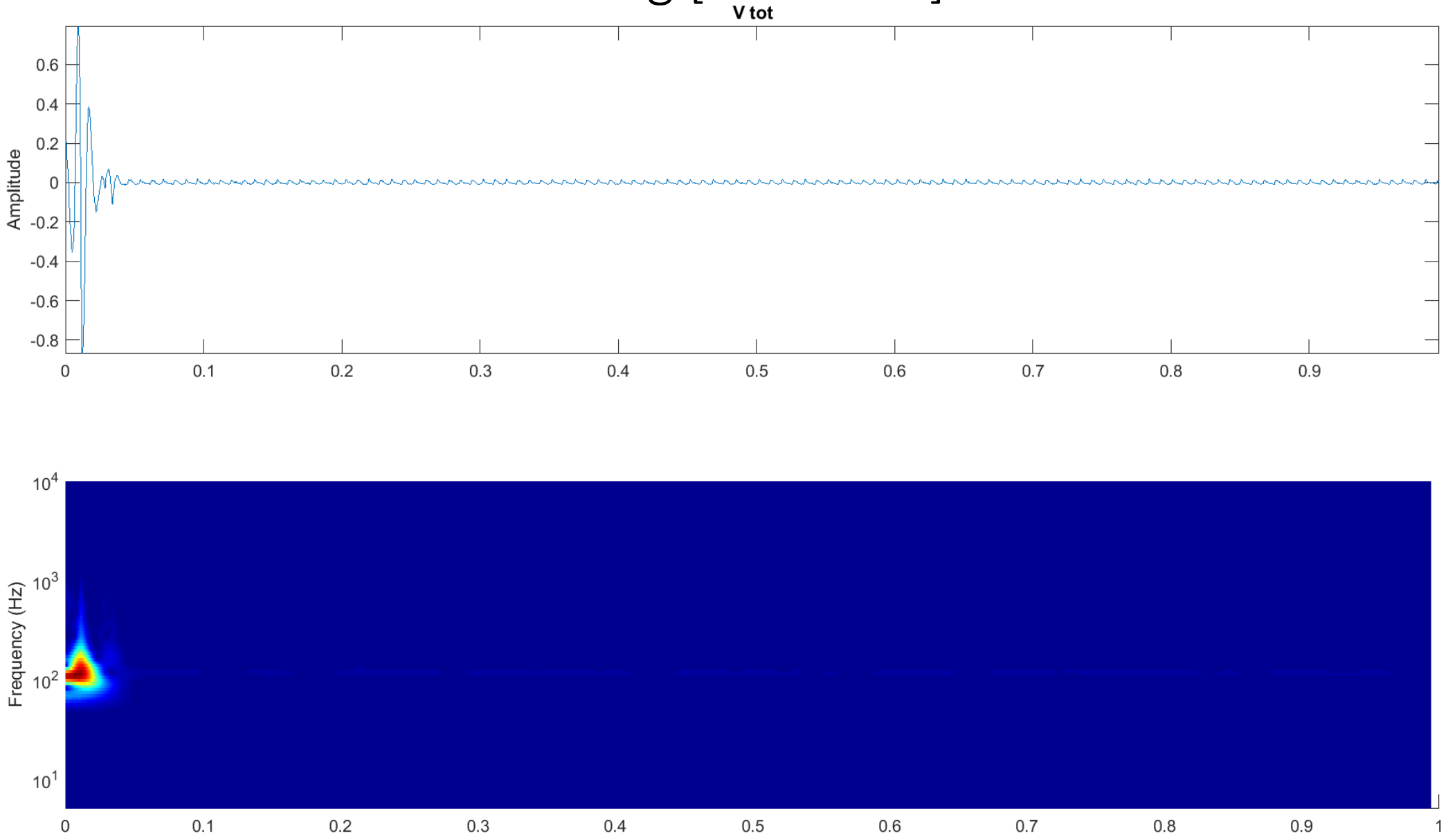
Aperture voltage: reconstruction after filtering [100 1000] Hz



V sum: reconstruction after filtering [100 1000] Hz



V tot: Reconstruction after filtering [100 1000] Hz



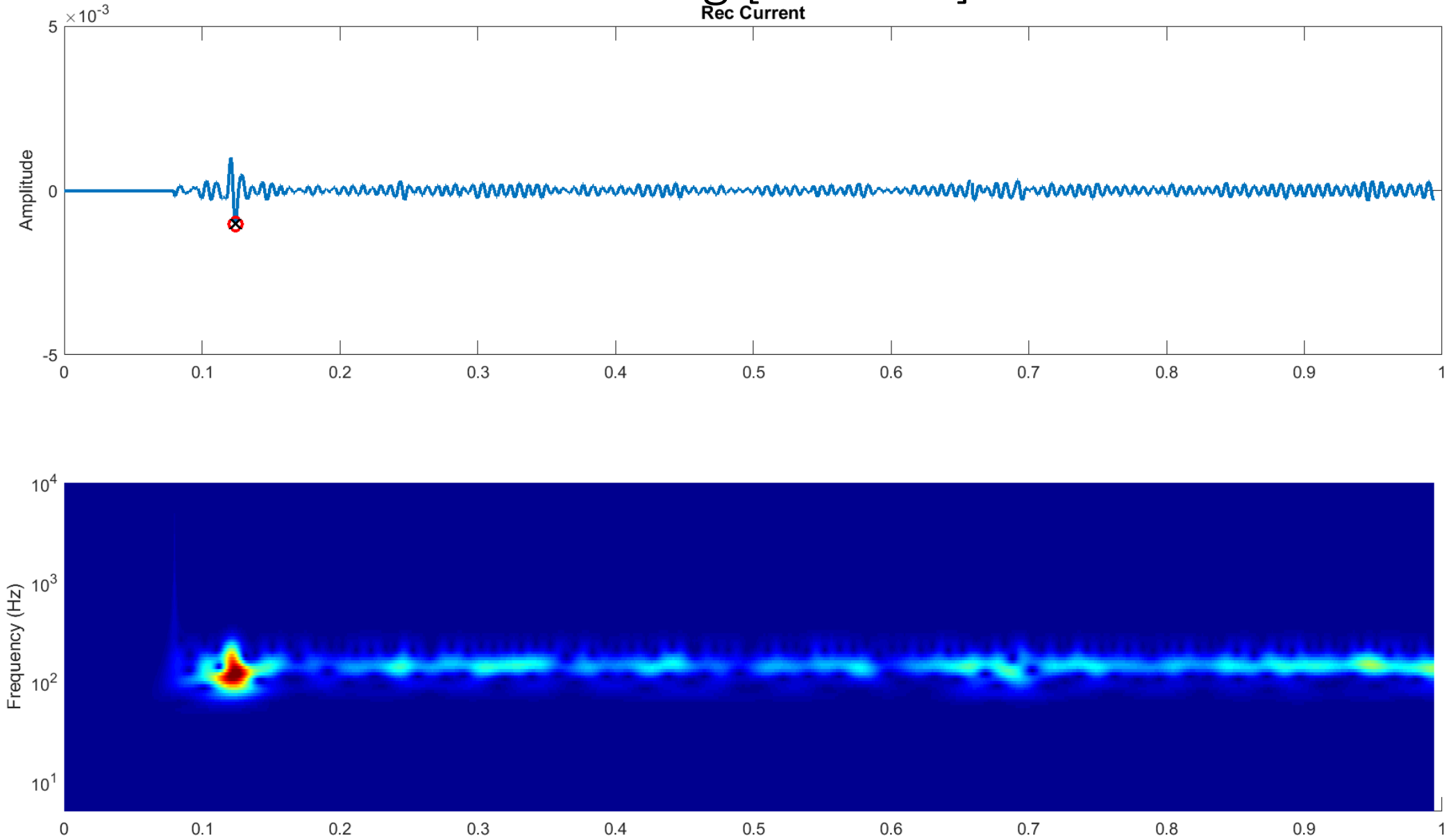
Further splitting of spectra in two bands:

i) [100 200] Hz

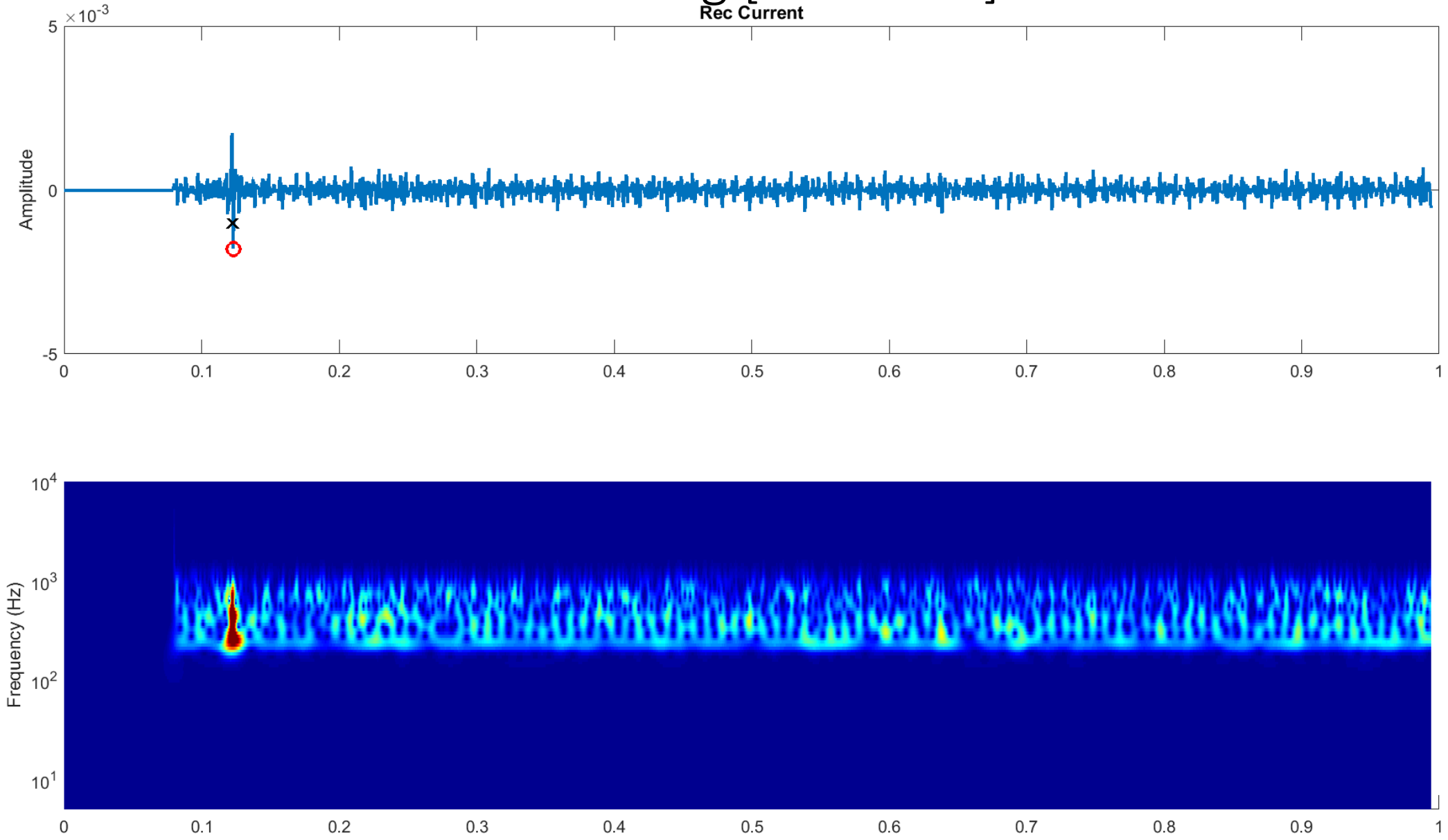
ii) [250 1000] Hz

Search for maximum i.e. the biggest spike

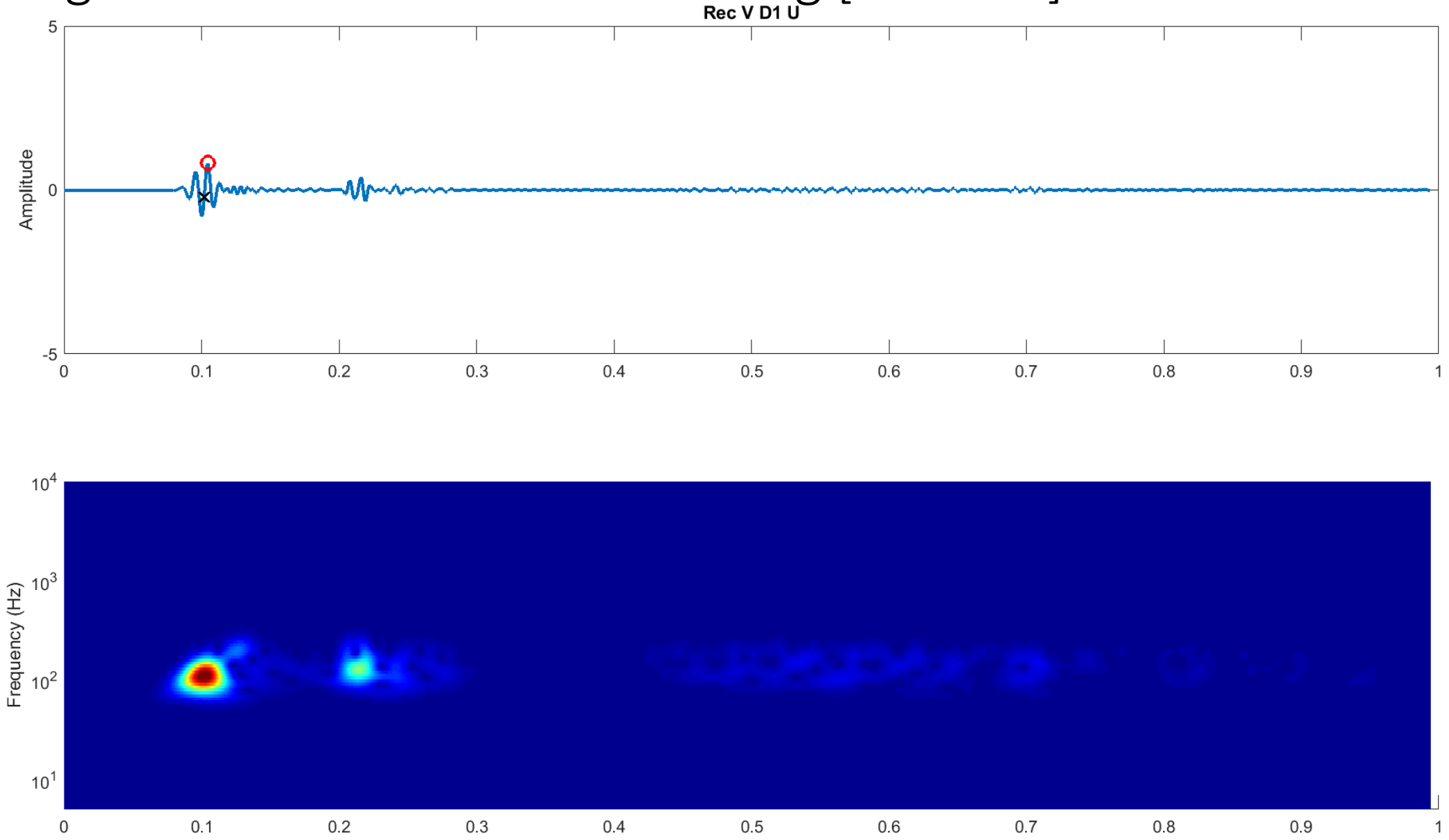
Current: reconstruction after filtering [100 200] Hz



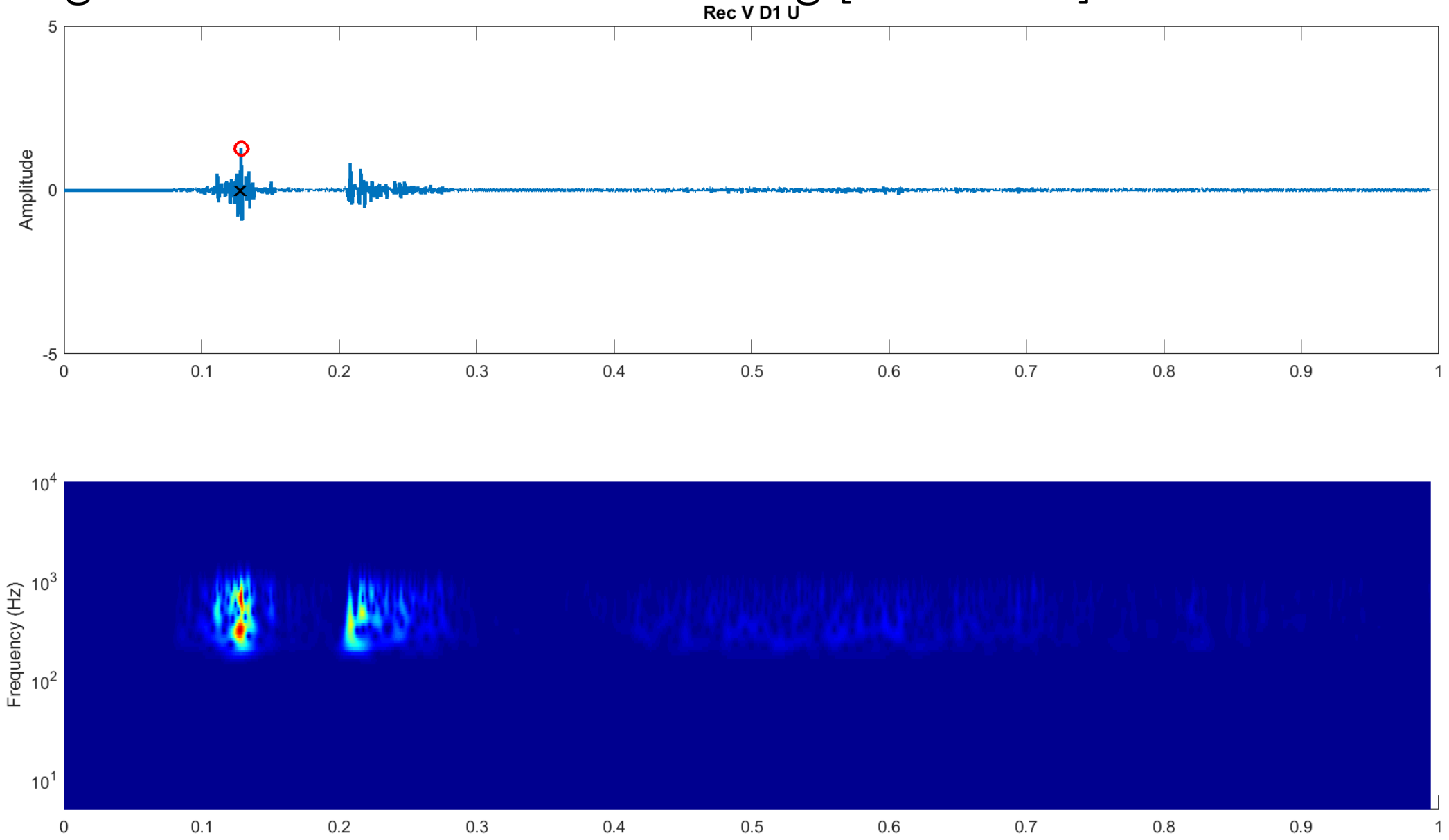
Current: reconstruction after filtering [250 1000] Hz



Coil voltage: reconstruction after filtering [100 200] Hz



Coil voltage: reconstruction after filtering [250 1000] Hz

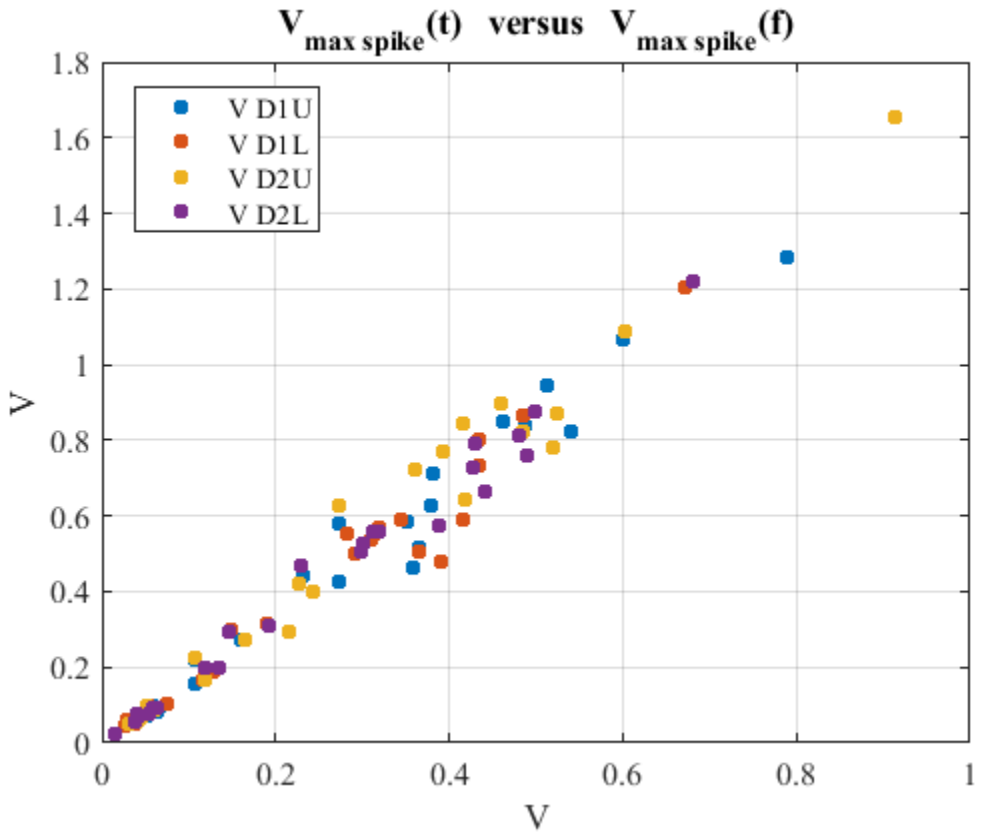


Correlations

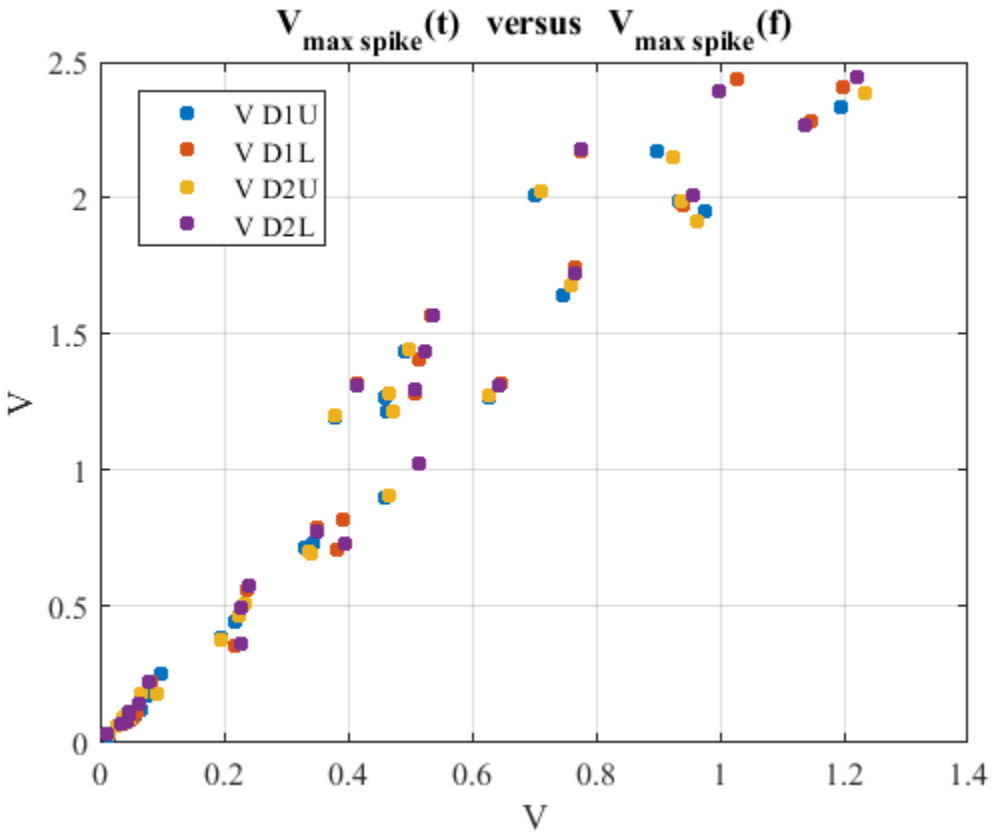
- $t_{max\ spike}$ $f_{max\ spike}$
- $V_{max\ spike}(t)$ $V_{max\ spike}(f)$
- $I_{max\ spike}(t)$ $I_{max\ spike}(f)$

- $I(t_{max\ spike})$
- $RR(t_{max\ spike})$
- $V(t_{max\ spike})$

Max in time versus max in frequency

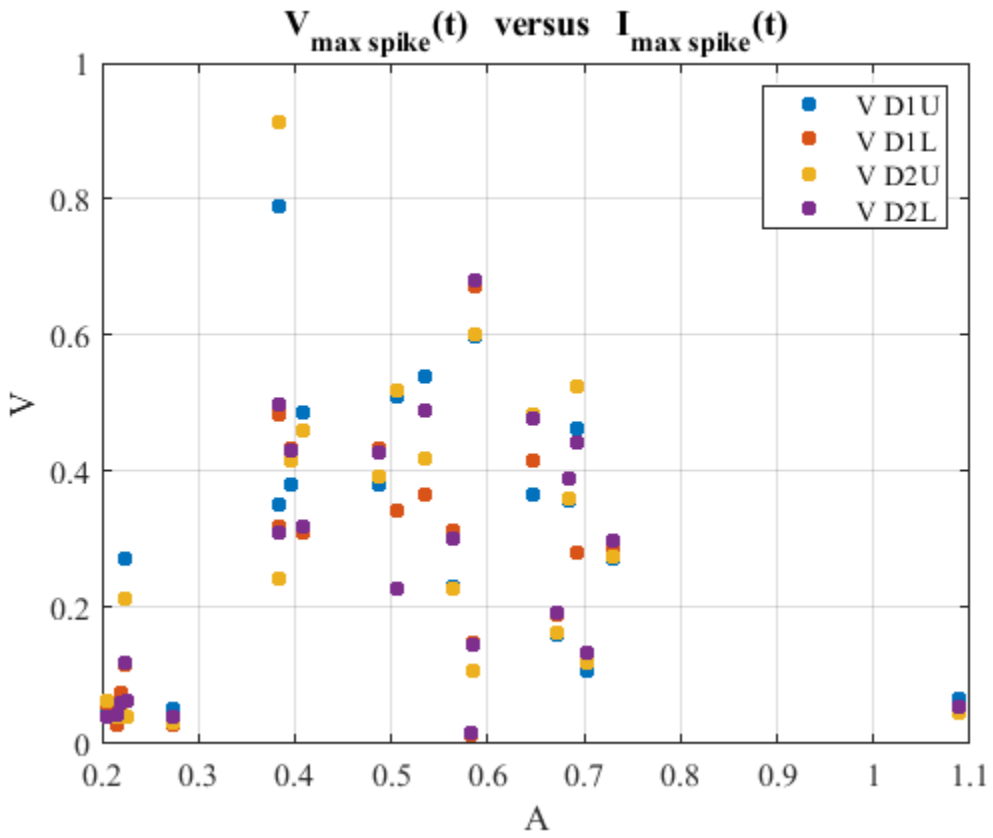


[100 200] Hz

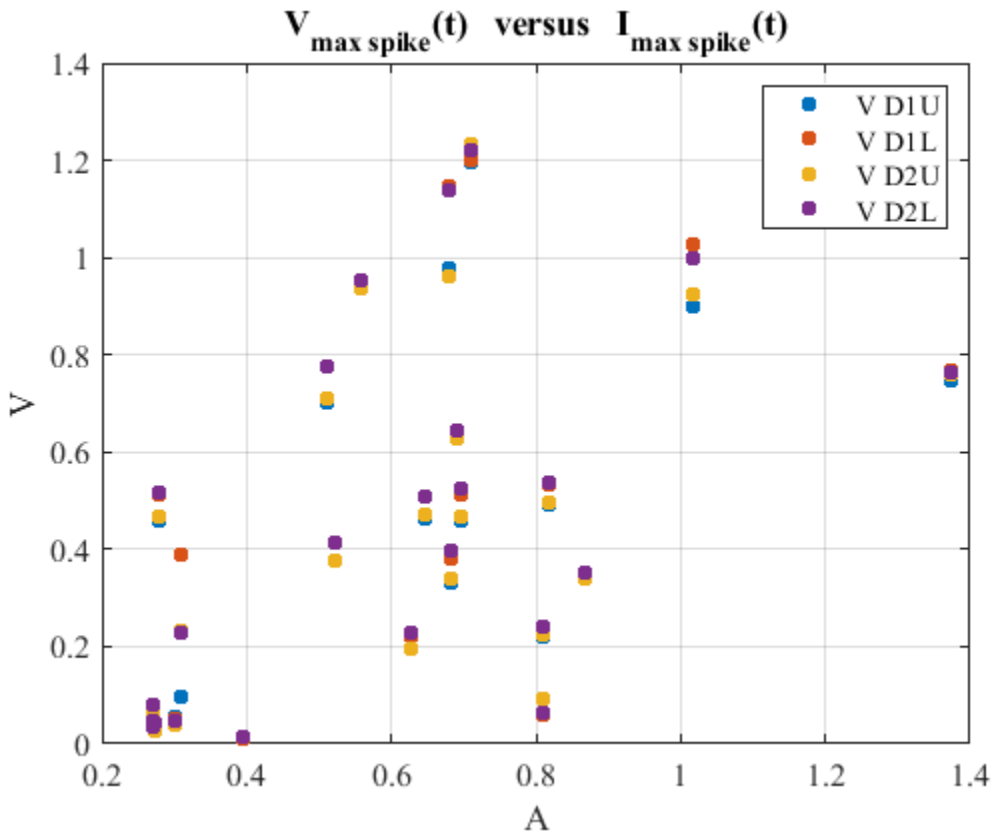


[250 1000] Hz

Spike on voltages versus spike on current

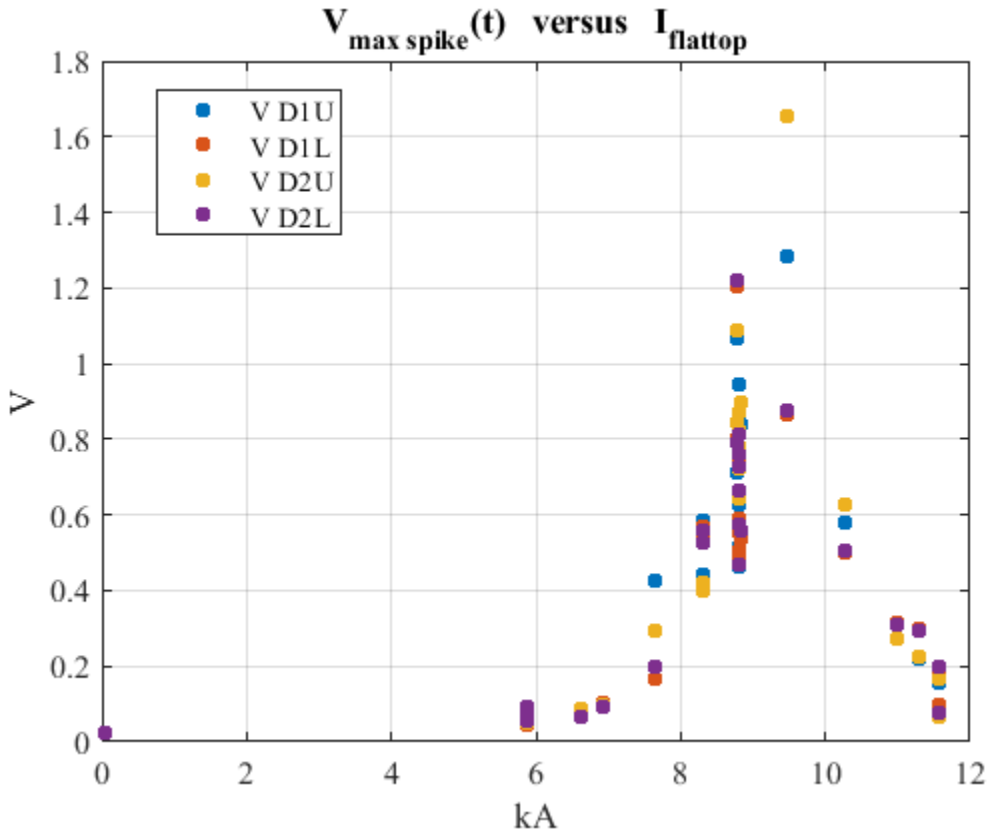


[100 200] Hz

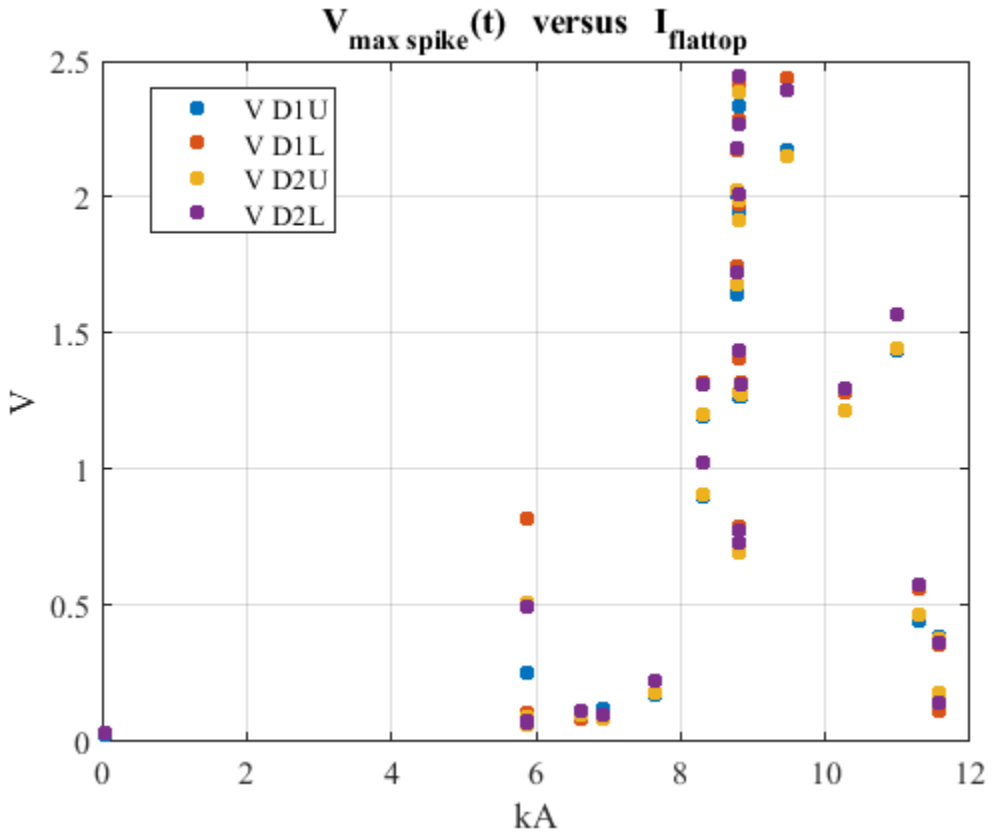


[250 1000] Hz

Spike on voltages versus flattop current

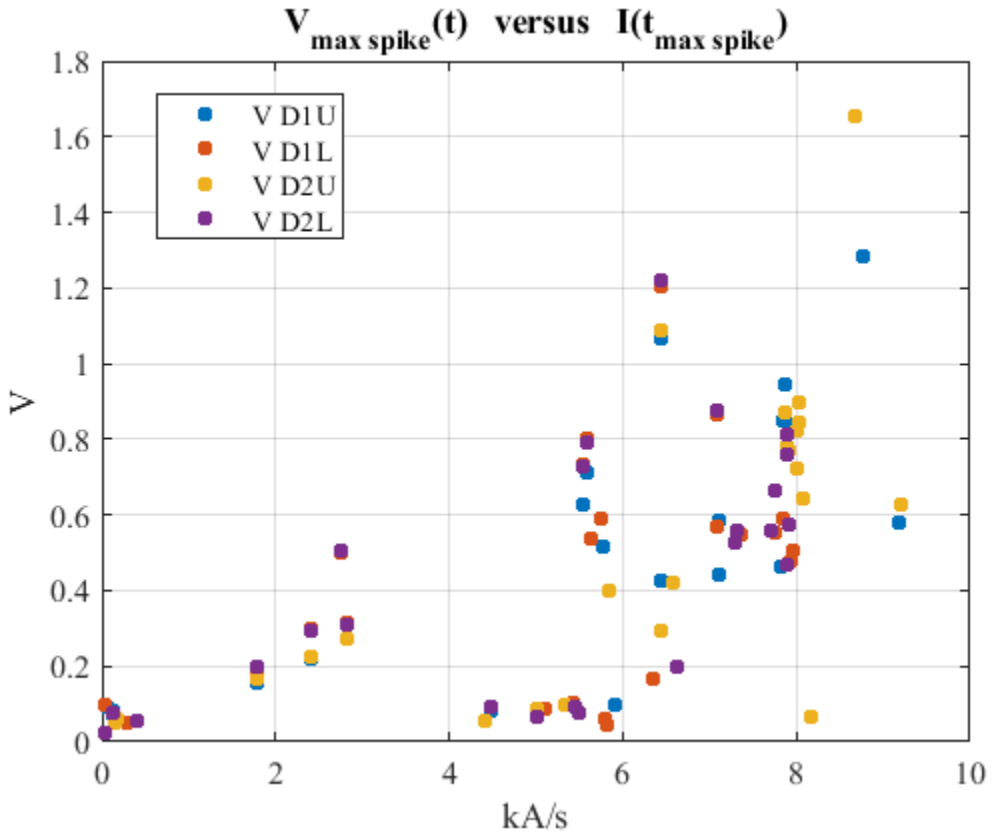


[100 200] Hz

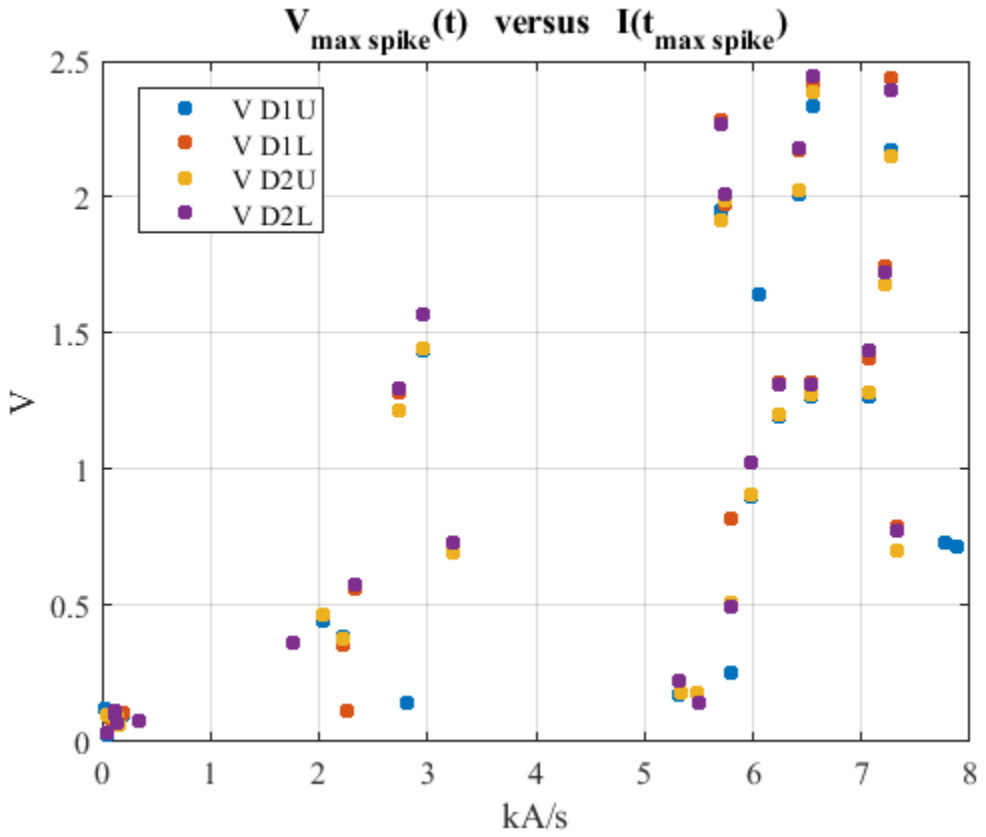


[250 1000] Hz

Spike on voltages versus local current

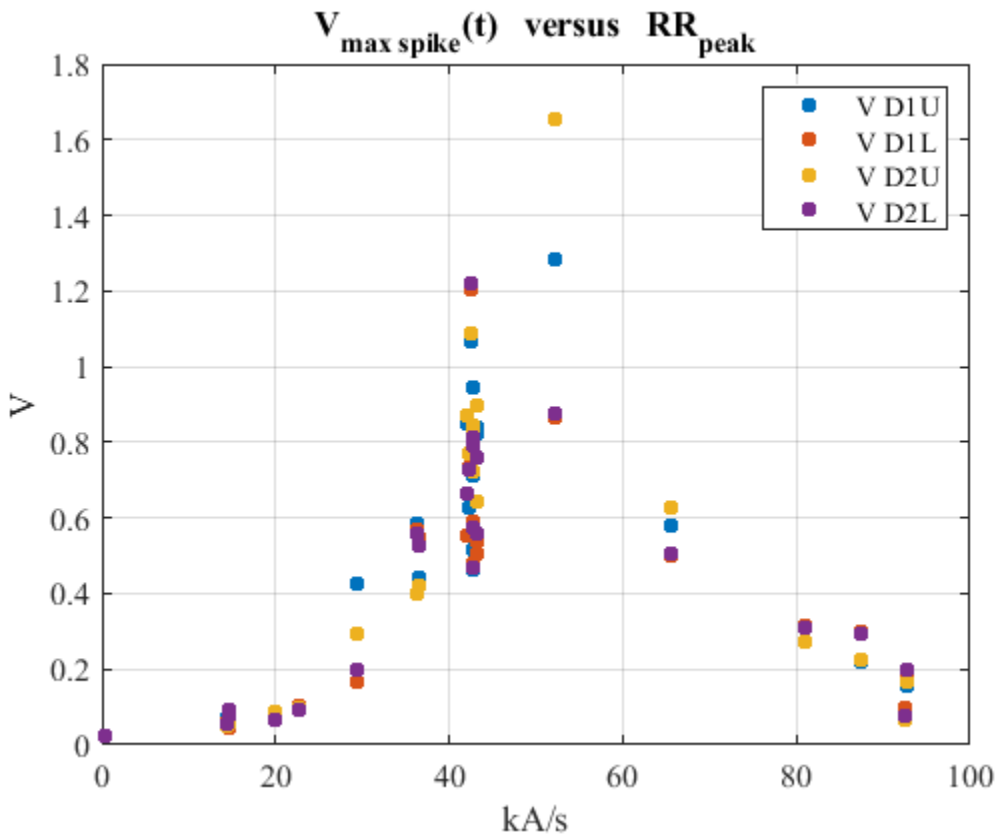


[100 200] Hz

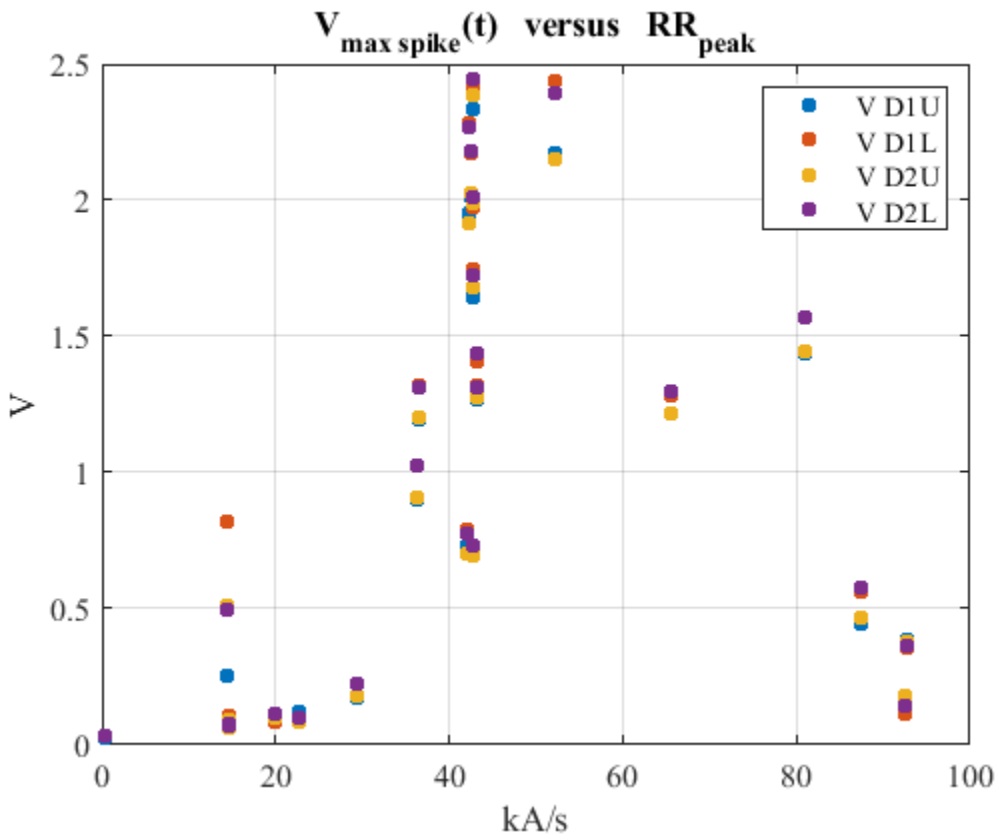


[250 1000] Hz

Spike on voltages versus peak ramp rate

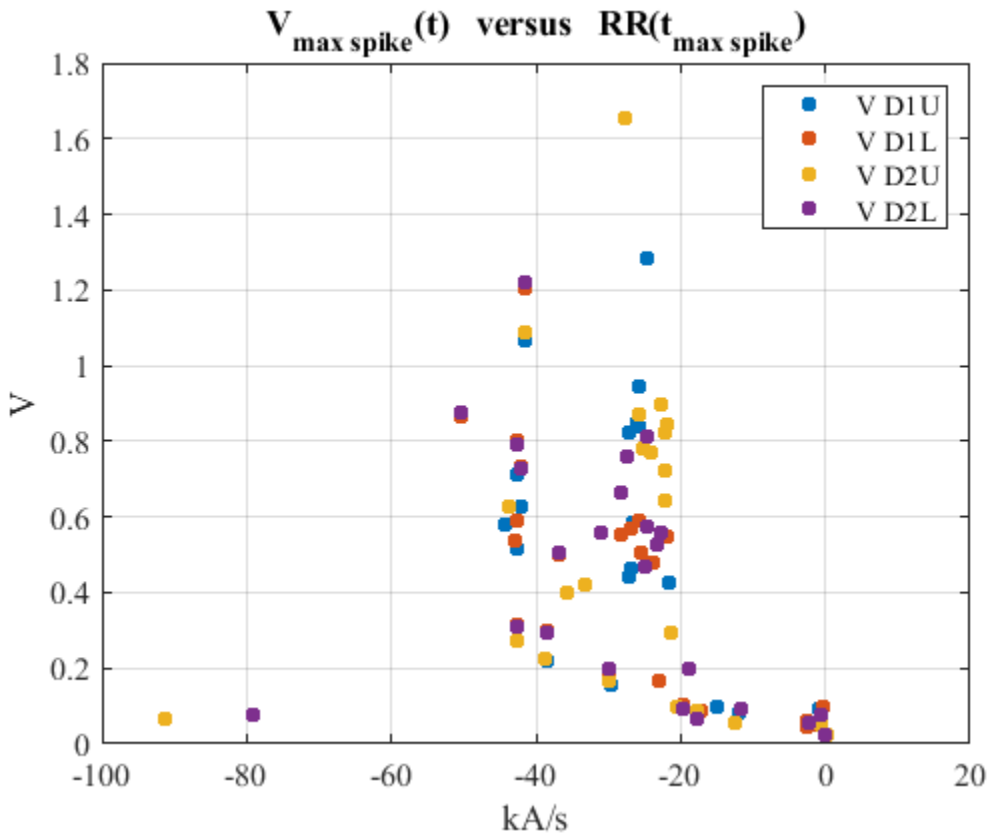


[100 200] Hz

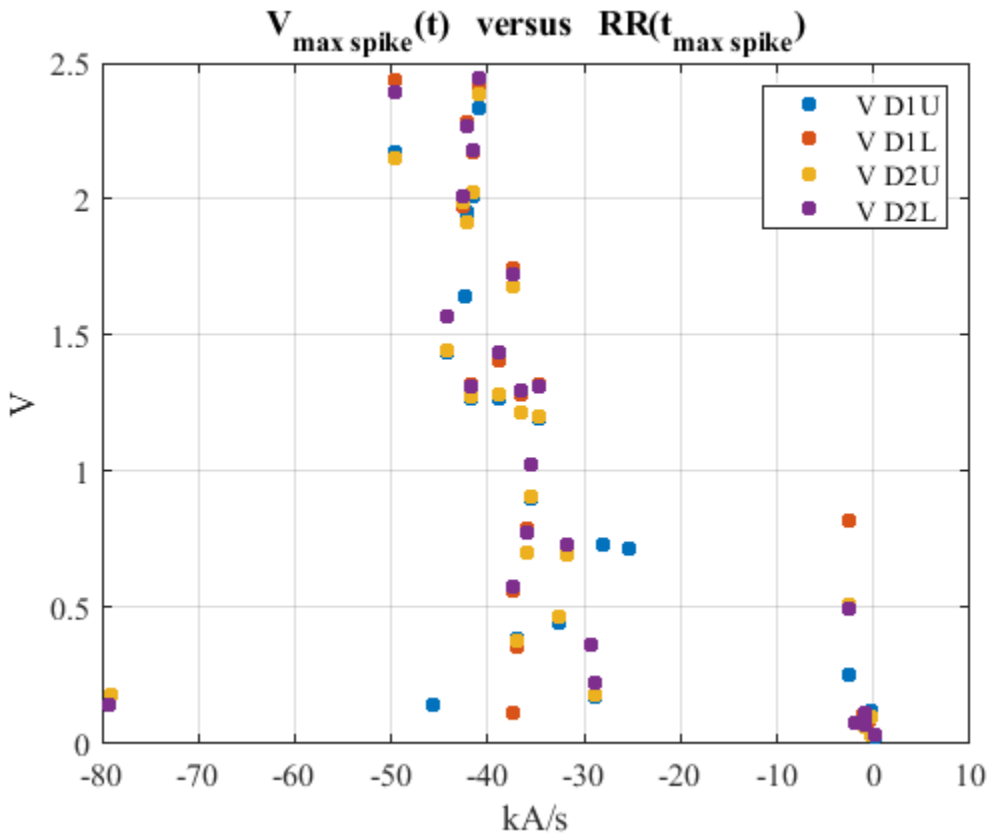


[250 1000] Hz

Spike on voltages versus local ramp rate

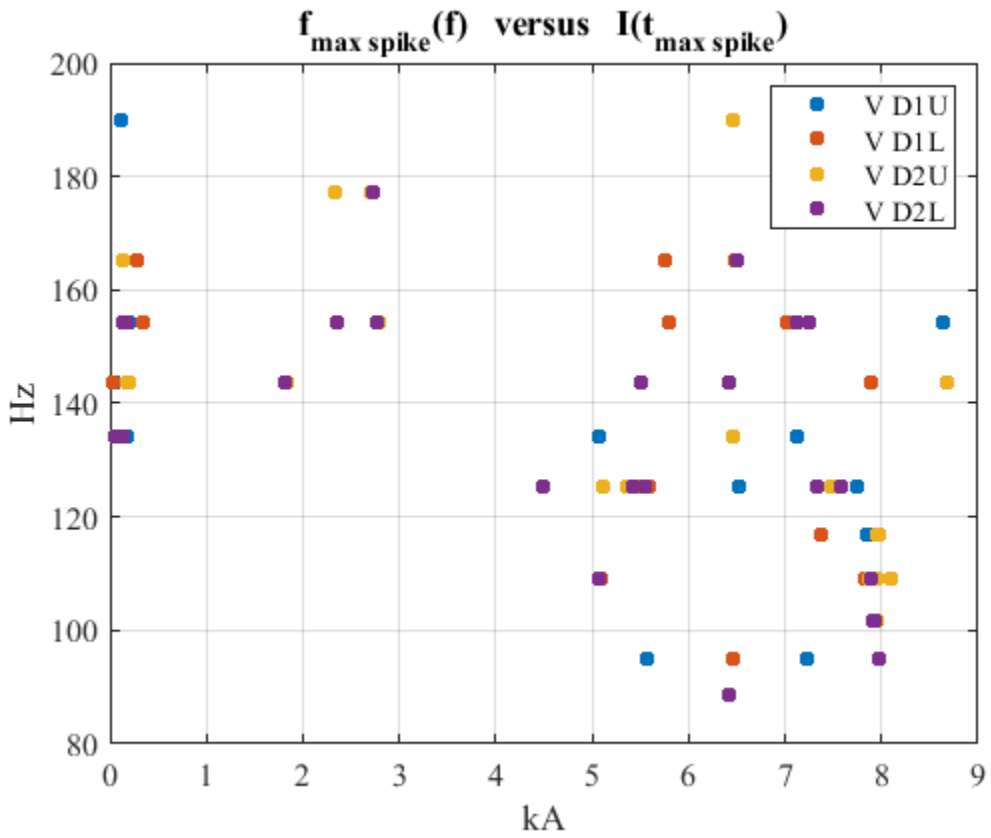


[100 200] Hz

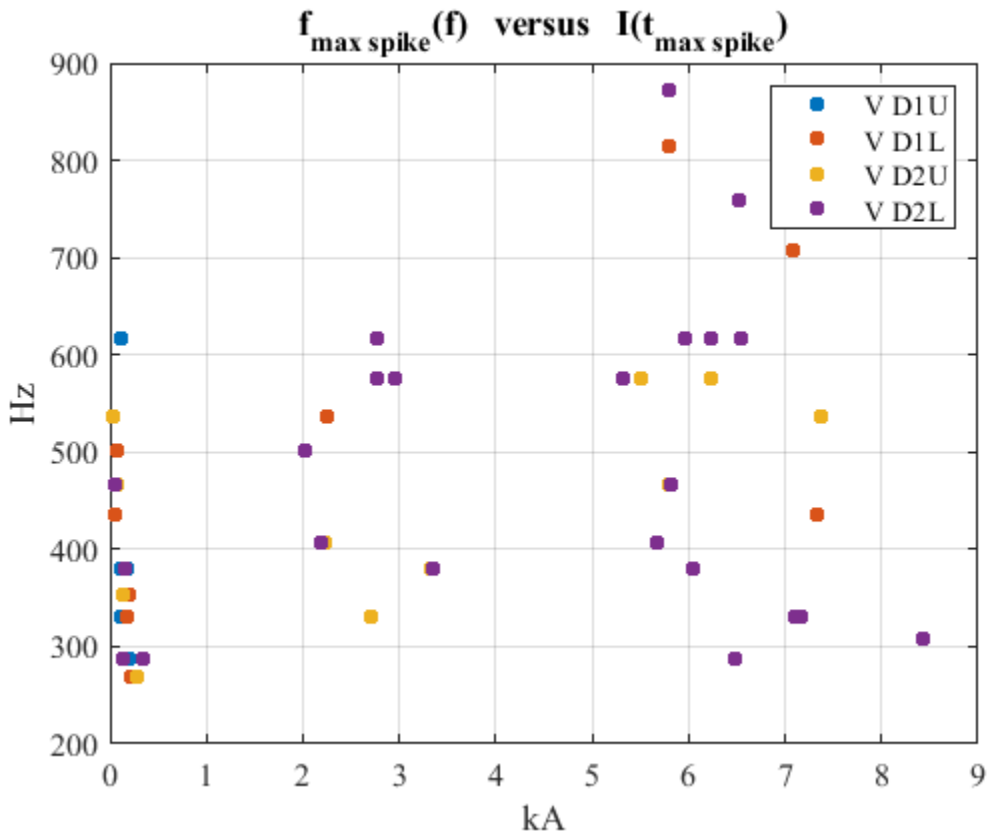


[250 1000] Hz

Frequency of spike versus local current

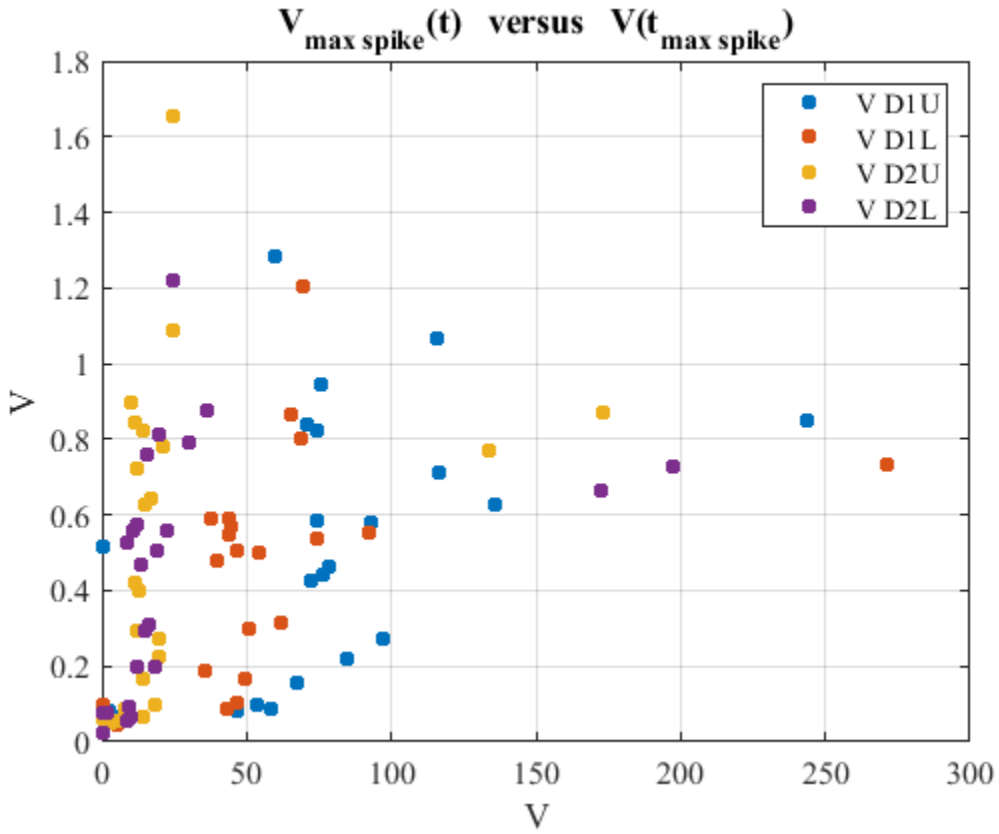


[100 200] Hz

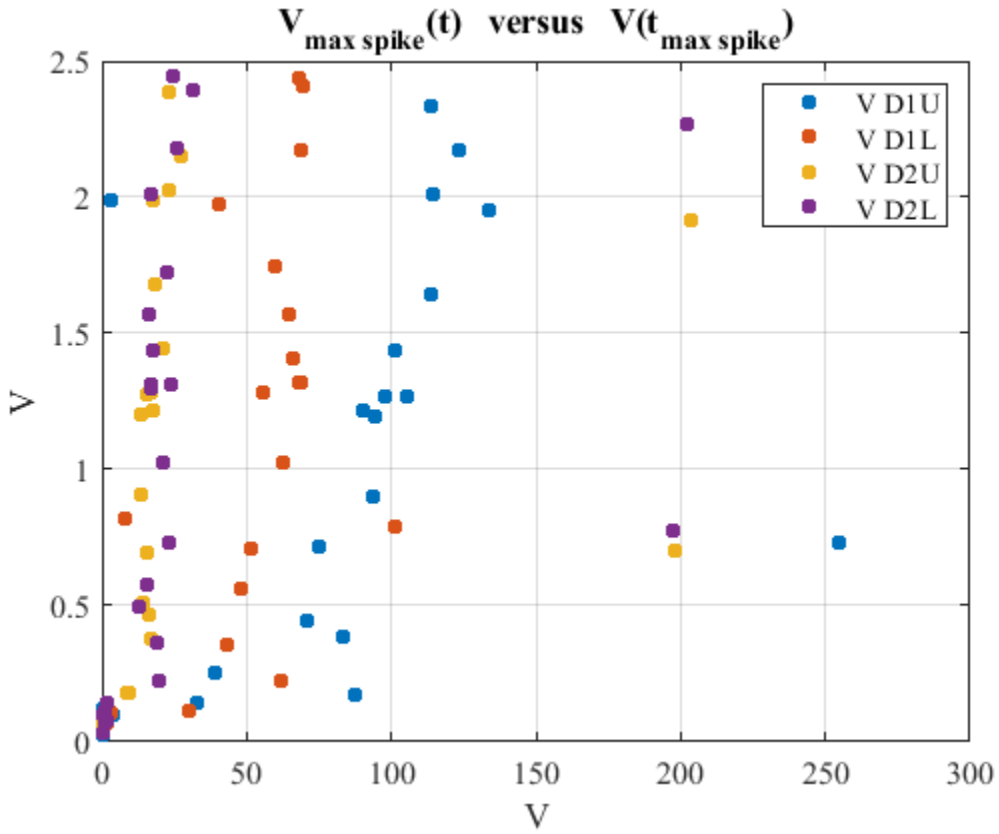


[250 1000] Hz

Spike on voltages versus local voltage



[100 200] Hz



[250 1000] Hz

Conclusions

- No conclusions yet

- Next
  - Same analysis on the quench antennas