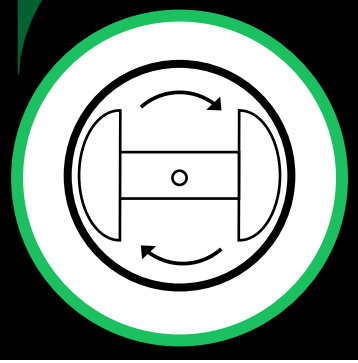
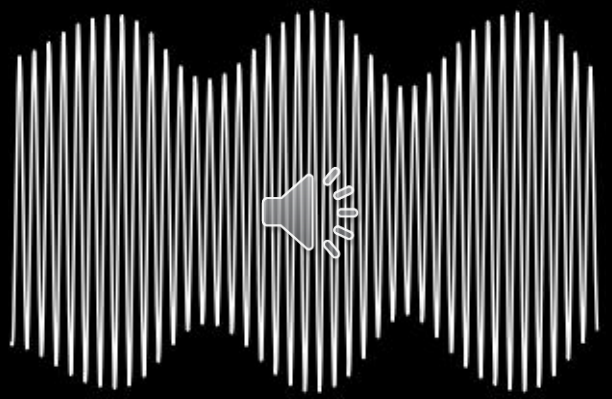
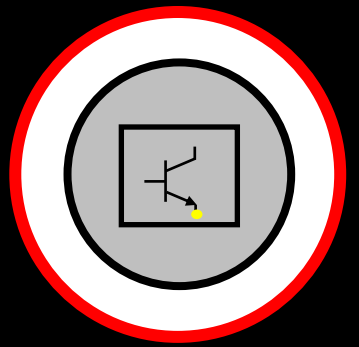
Investigating Power Quality Trends Using Targeted Measurements in Liander's Grid







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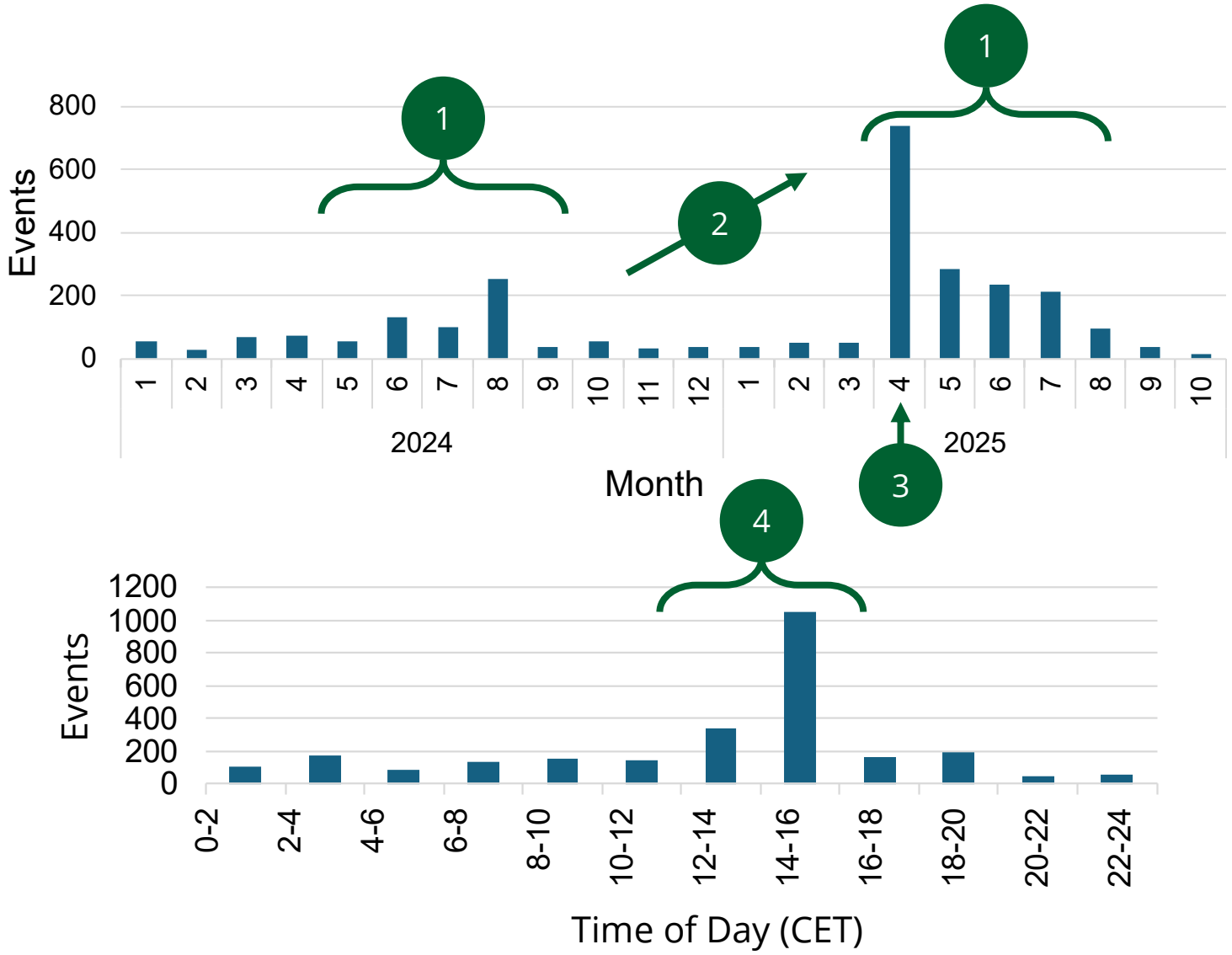
Thanks to

Leo Brummelkamp, Peter van Oirsouw, Jeroen van Tongeren, Rob Kopmeiners, Huug Brinkers, René Wassink, Frank Wensink, Jan Bozelie, Jesper Jansen

... and everyone who contributed across Alliander and beyond

Power Quality trend in Liander's grid

Events with P_{LT}>1 (during 2 hour time window)



Observations

1. Majority of events during the spring/summer period.
2. Significant increase in 2025 compared to 2024
3. Peak in April 2025.
4. Majority during mid-day.

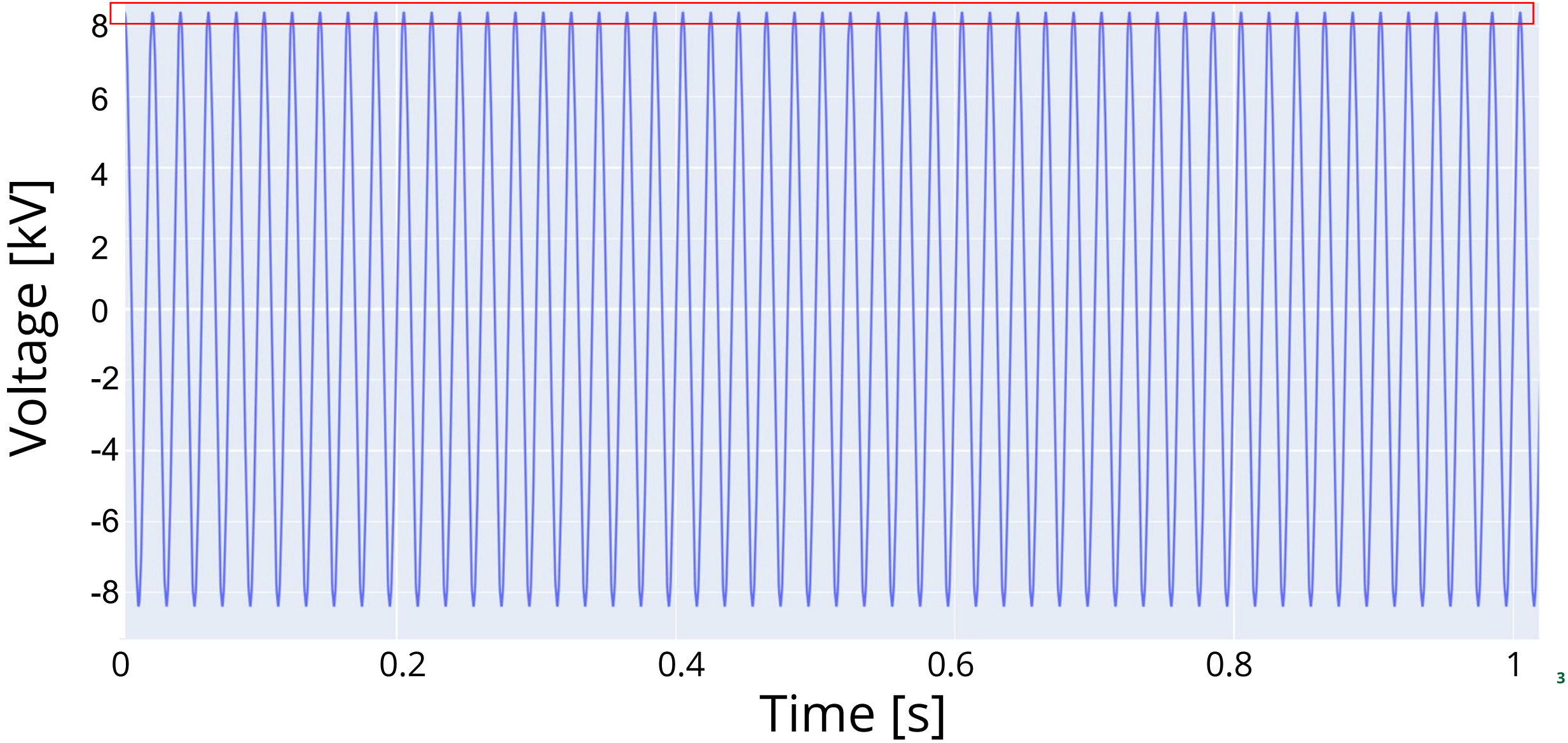
Conclusion

This trend is reason for concern, more detailed measurements are required to understand it.

*P_{LT}: Long term flicker perceptibility

Expected measurement result

Phase voltage in “ideal” stable 10kV-grid – 1 s



Expected measurement result

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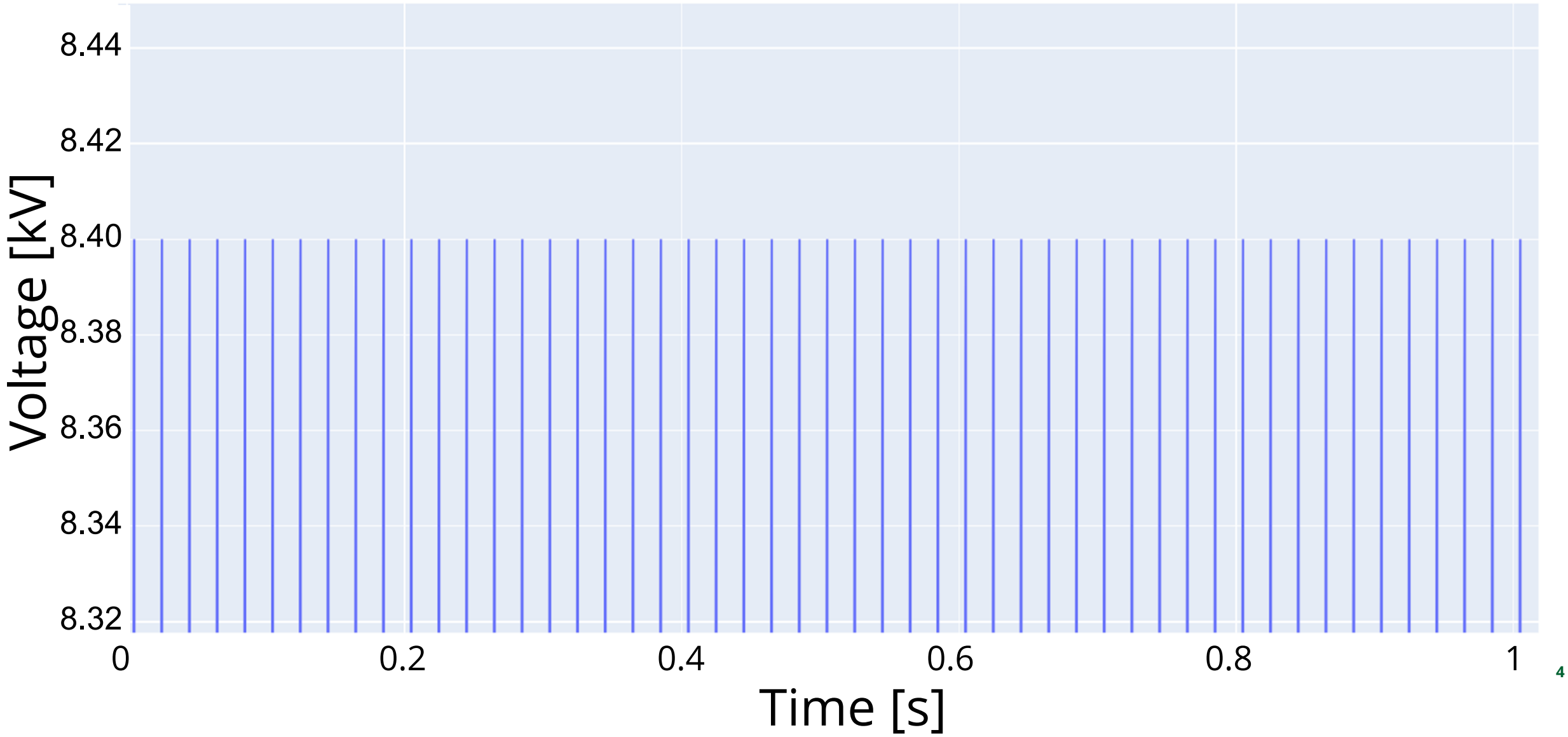
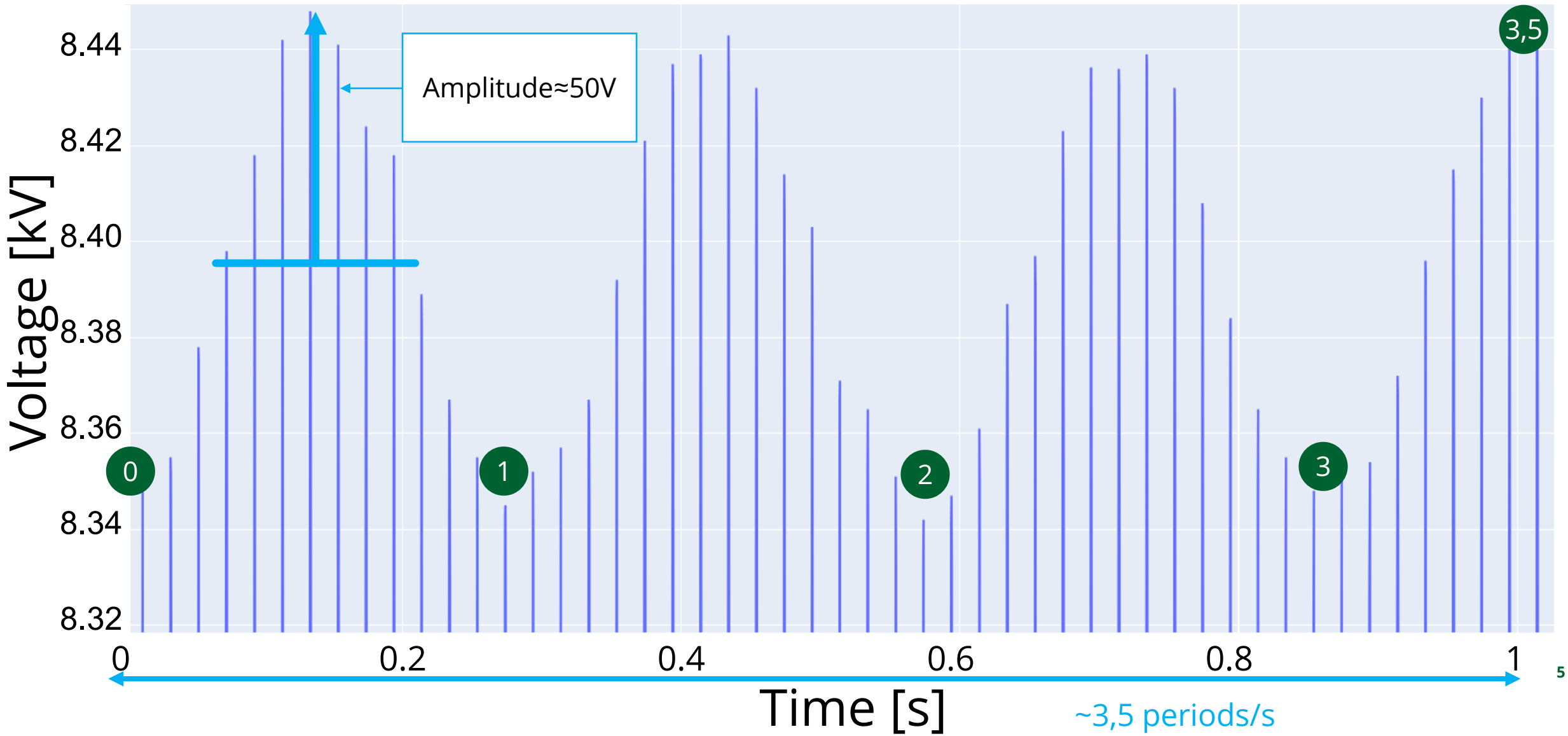


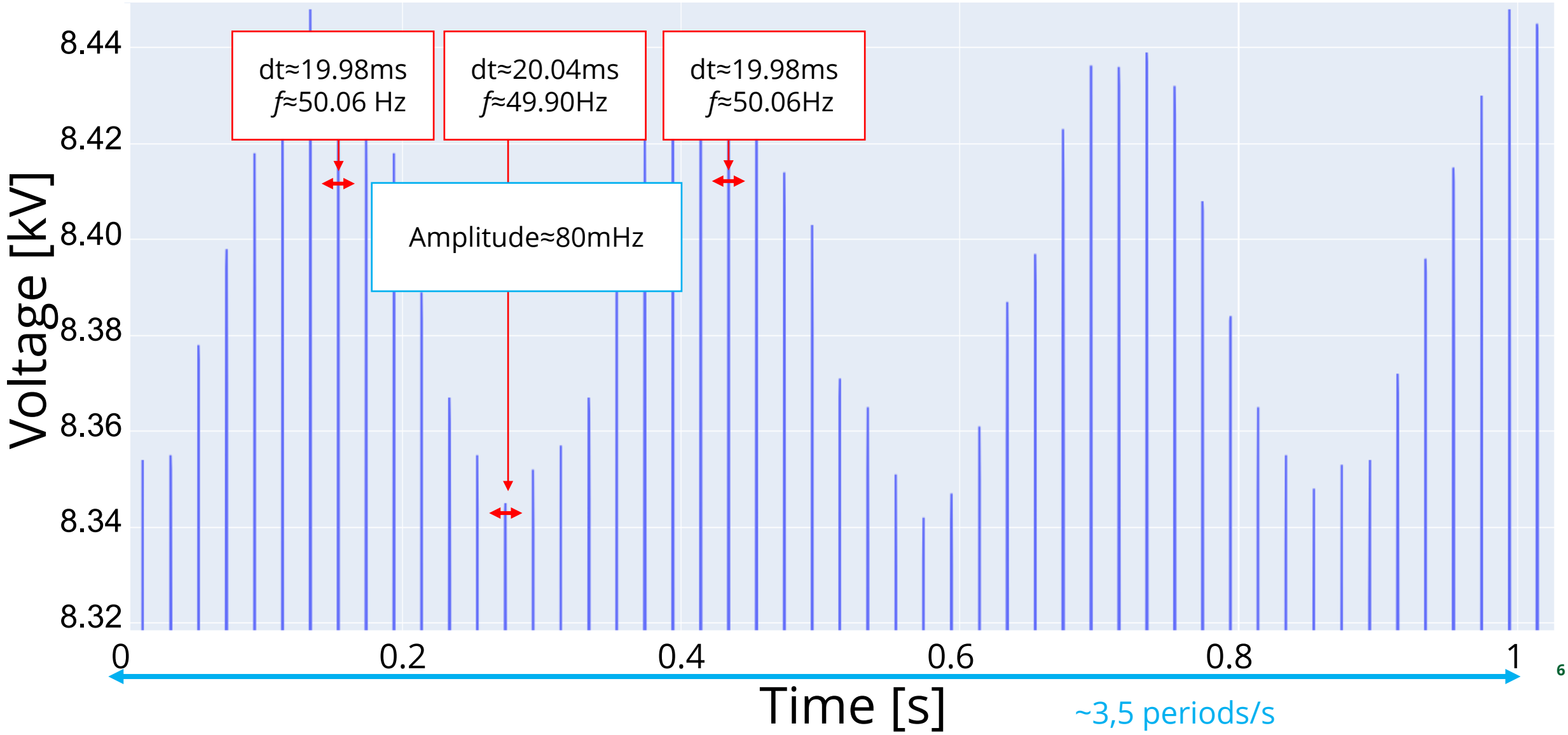
Measurement result

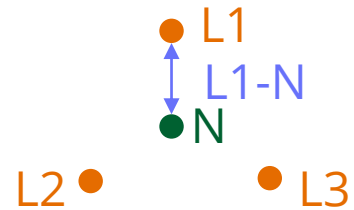
Measured phase voltage in 10kV-grid – 27 april 2025, 12:00 CET



Measurement result

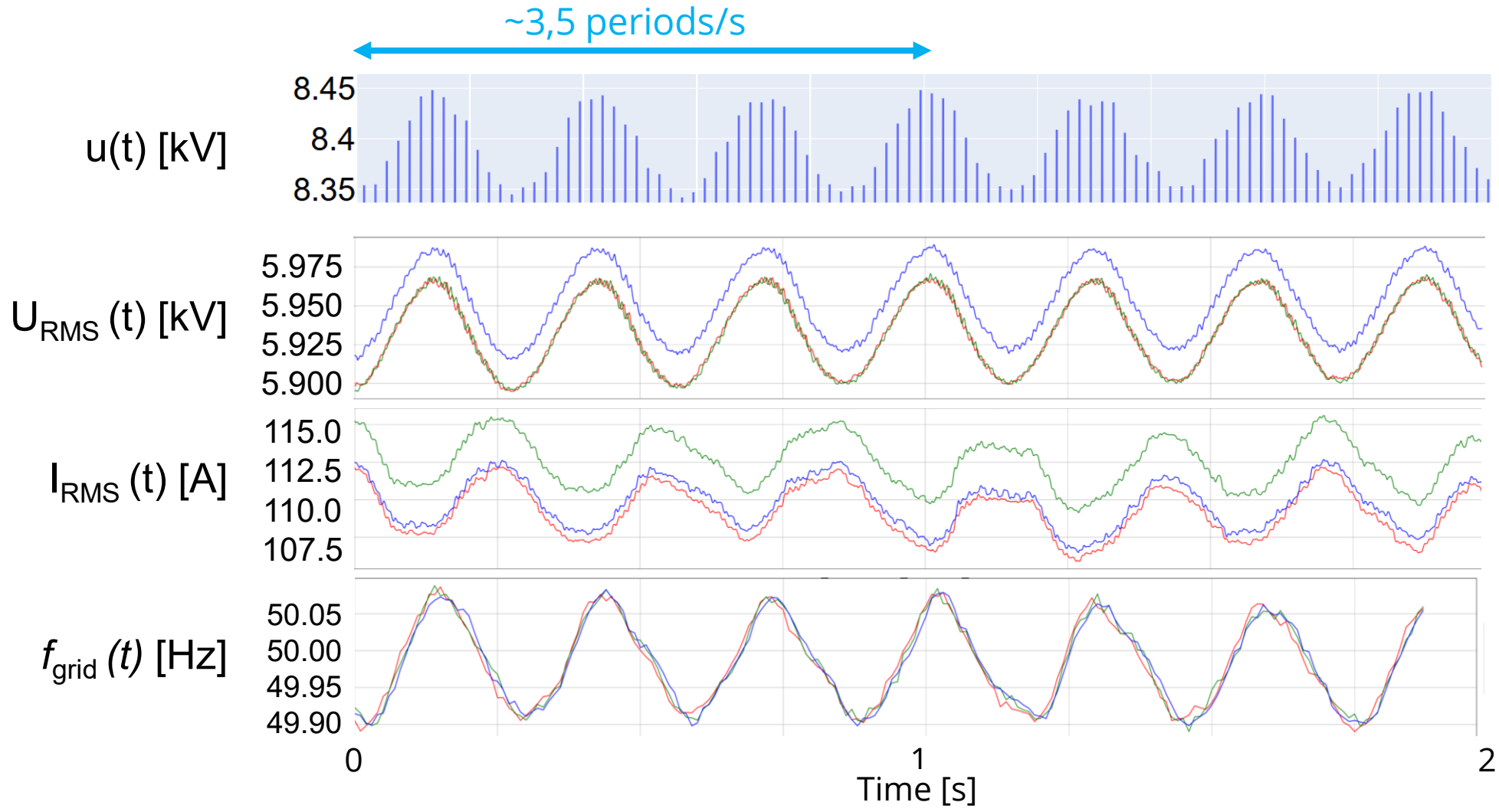
Measured phase voltage in 10kV-grid – 27 april 2025, 12:00 CET





Measurement result

Measured phase voltage in 10kV-grid – 27 april 2025, 12:00 CET



Expect

3.5 Hz oscillations in

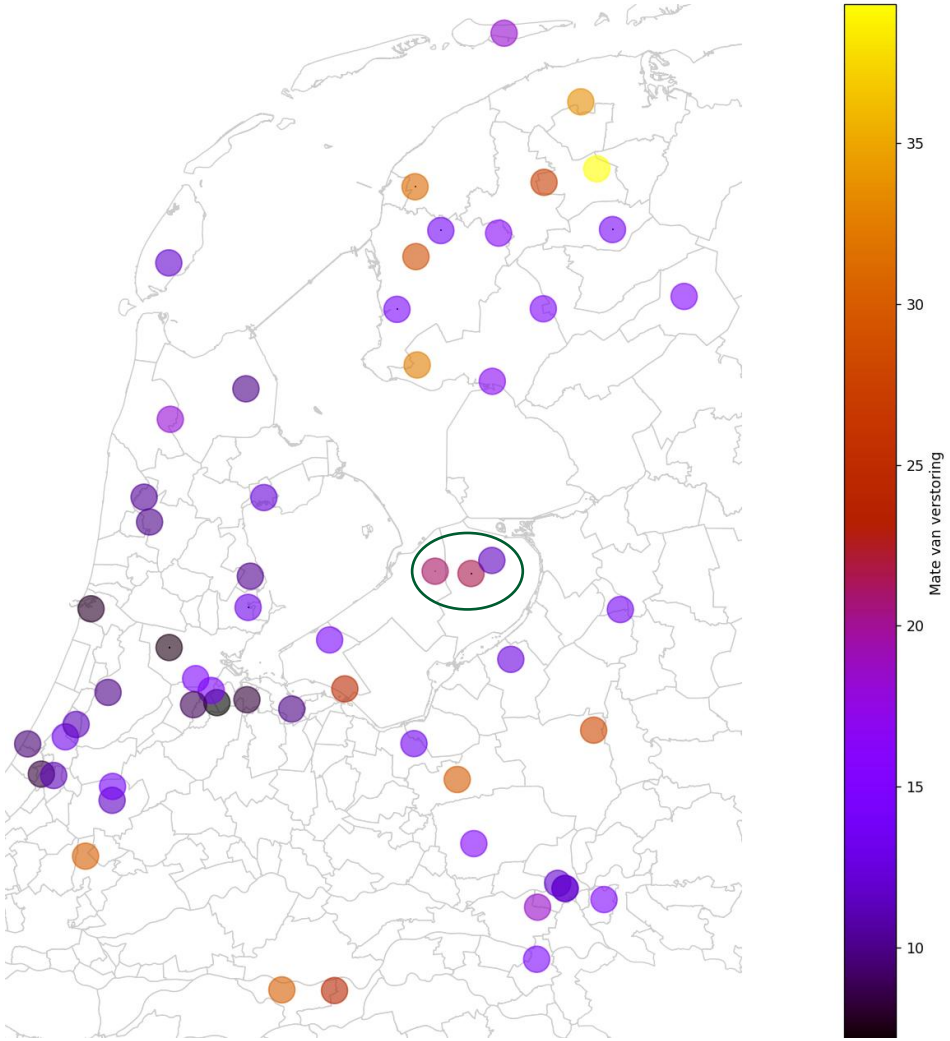
Voltage

Current

Grid frequency

Measurement result

3.5 Hz “intensity” map 3 May 2025, 14:00 CET
Credit: René Wassink



Expect

3.5 Hz oscillations in

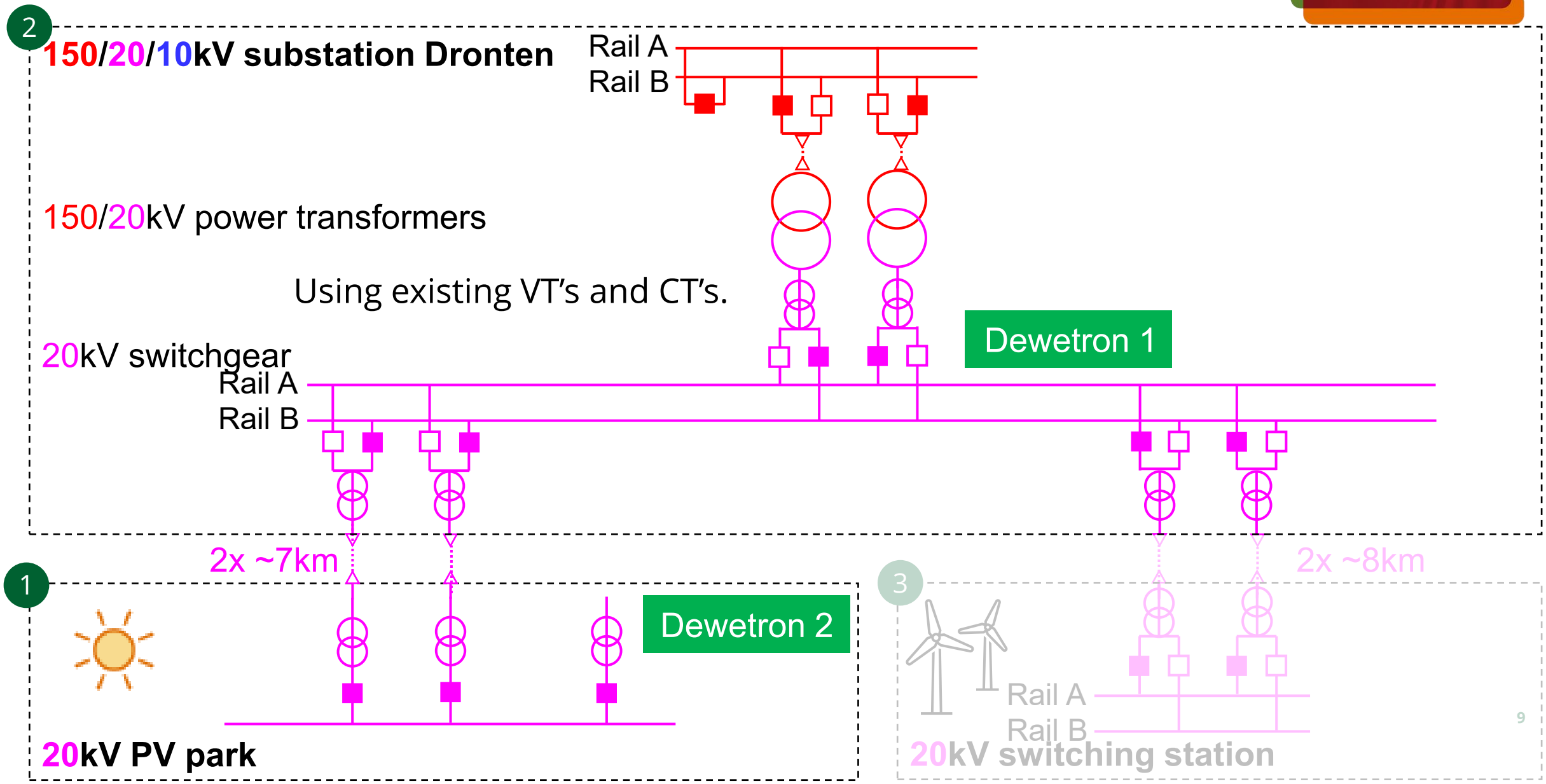
Voltage

Current

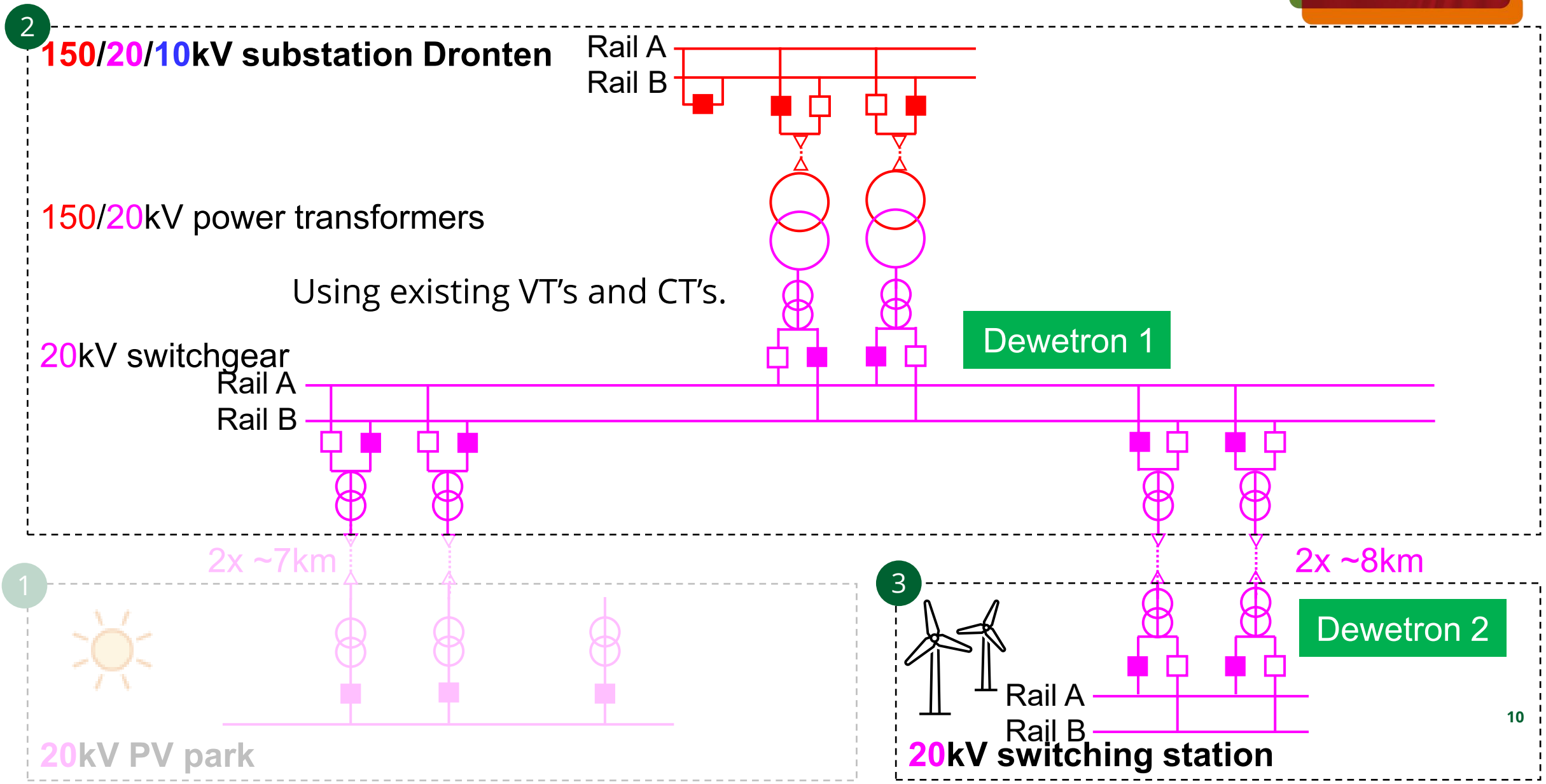
Grid frequency

in **Liander’s grid** [8]

Measurement setup PV (10 Sept - 8 Oct)



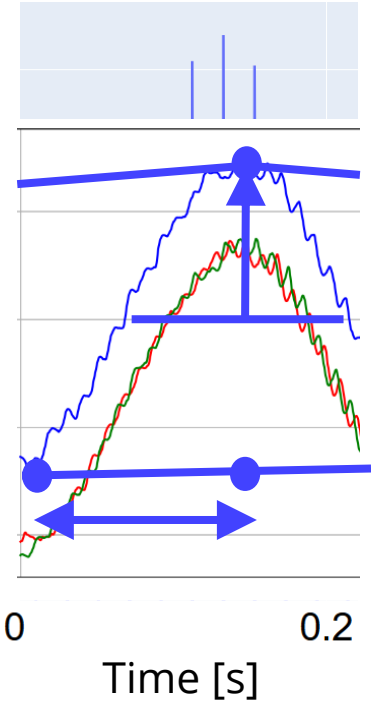
Measurement setup Wind (8 Oct – 20 Oct)



Analysis

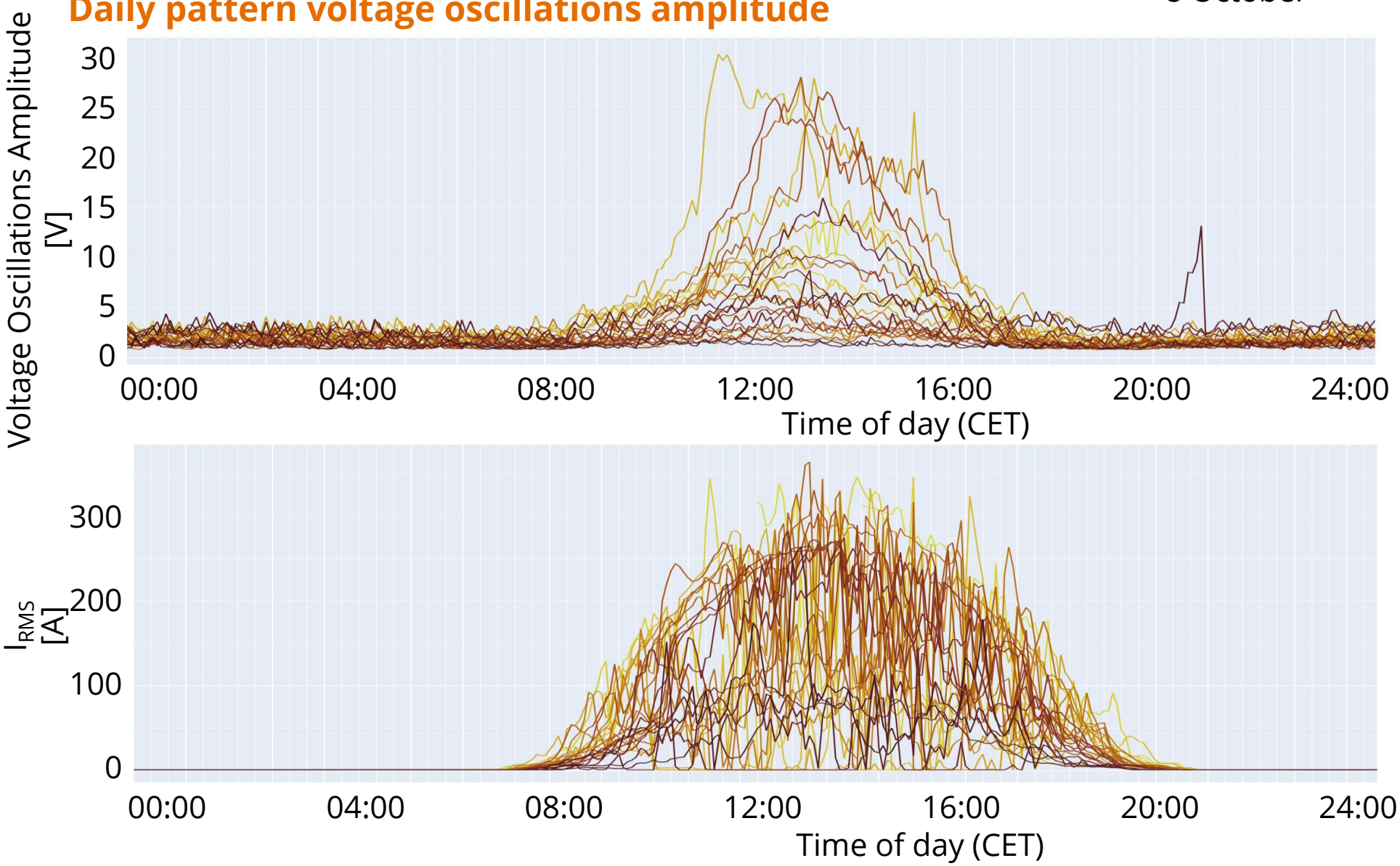
Steps in analysis script

Step	Voltage	Current	Frequency
1	Determine zero-crossings		Use voltage zero-crossings
2	Determine RMS value over 1 period		Calculate frequency over 1 period
3	Plot RMS values		Plot frequency values
4	Find peaks and valleys		
5	**Calculate Oscillations Amplitudes (VOA, COA & FOA)**		
6	**Calculate Oscillations Frequency (VOF, COF & FOF)**		
7	Average results in a dataframe		
8	Plot results		



Results PV Park

Daily pattern voltage oscillations amplitude



Remark

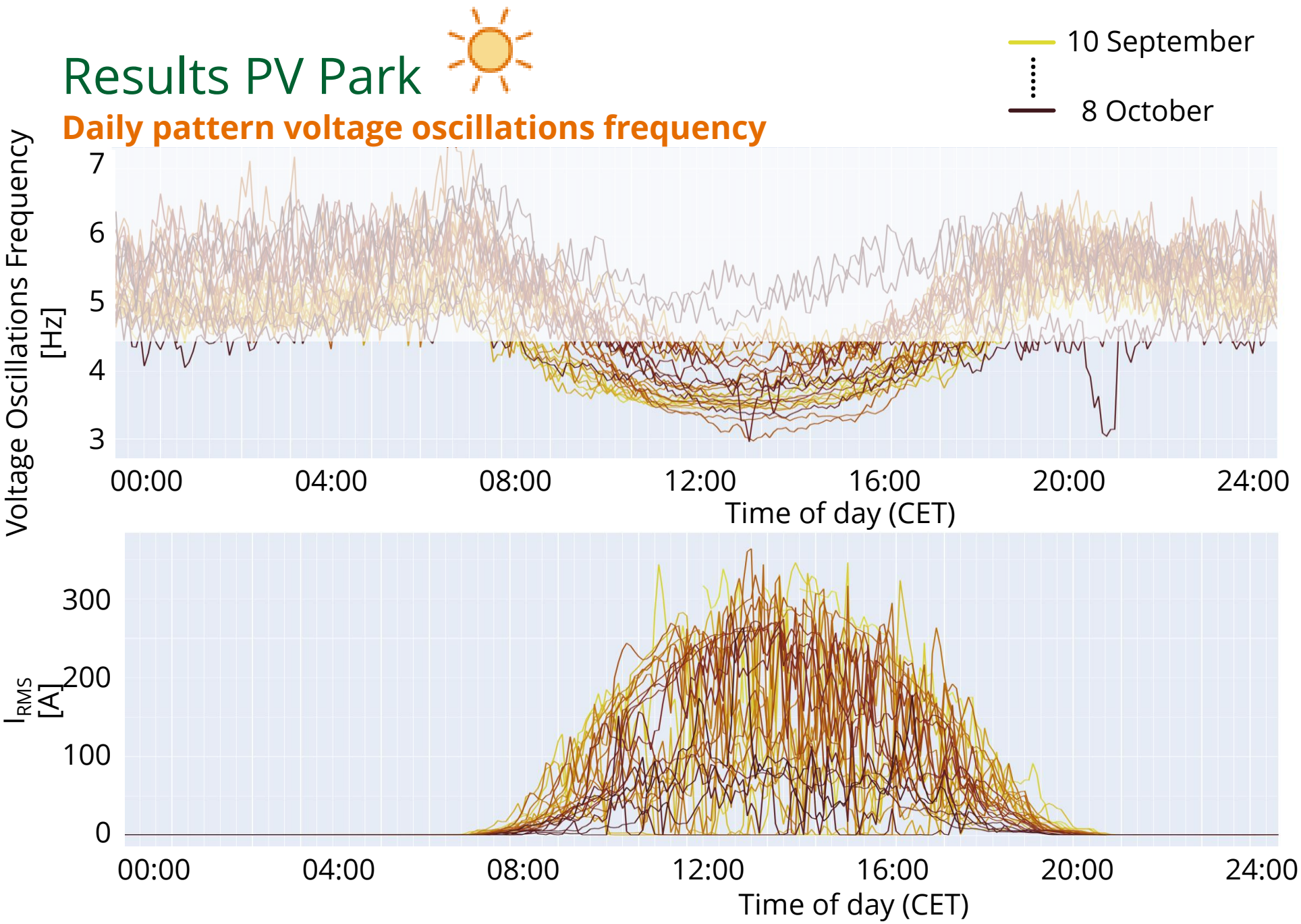
The peak around 20:00 PM had a known unrelated origin

Conclusions

1. The oscillations are present in Liander's grid.
2. The oscillations occur mainly between 10:00 AM and 17:00 PM during solar infeed.

Results PV Park

Daily pattern voltage oscillations frequency



Remark

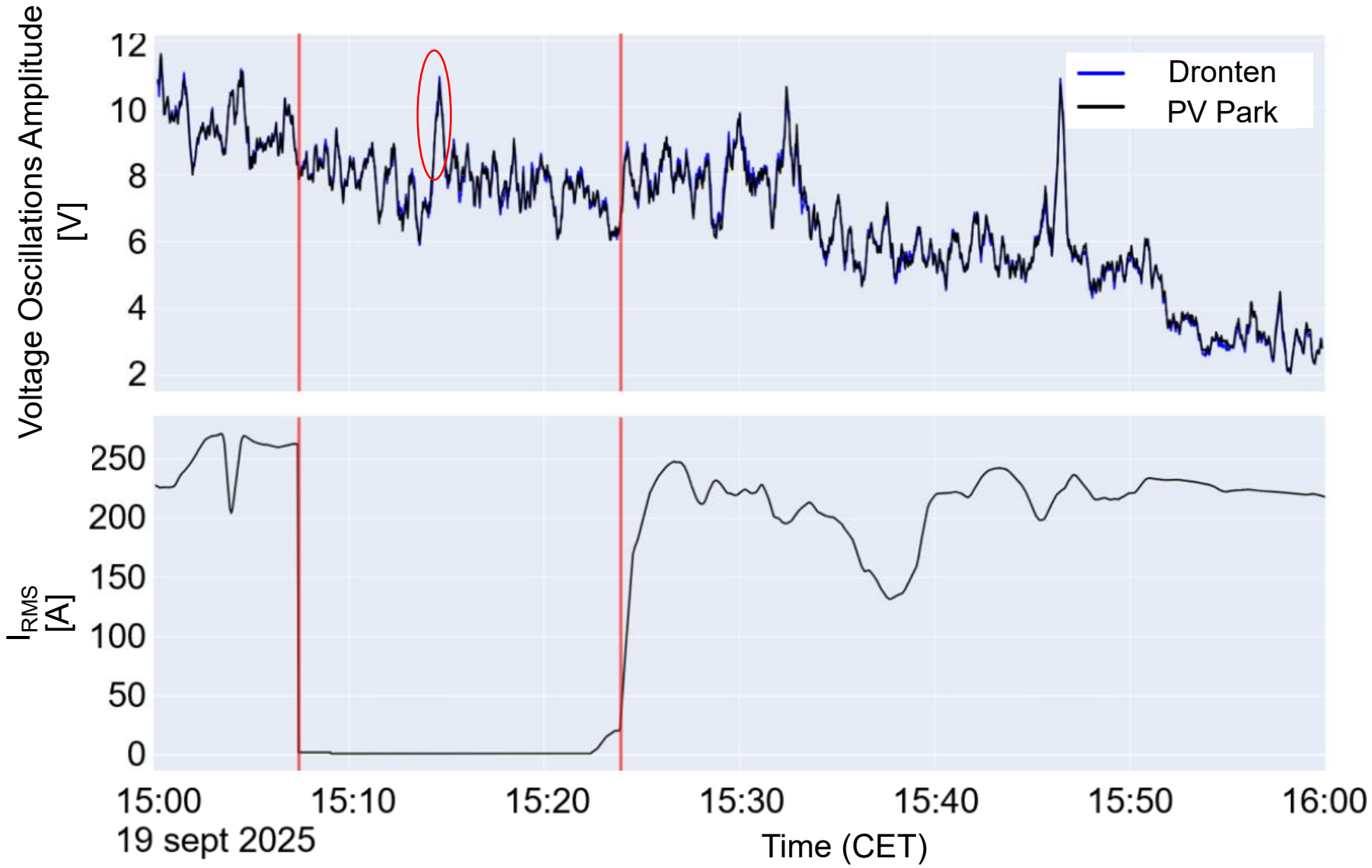
Oscillation frequencies above 4.5 Hz unreliable and therefore shaded.

Conclusion

1. The 3.5 Hz oscillations **frequency is not fixed**. Both a frequency of 3.0 Hz is recorded and frequencies above 3.5 Hz are recorded.

Results PV Park

Test – PV park off during positive electricity prices



Finding

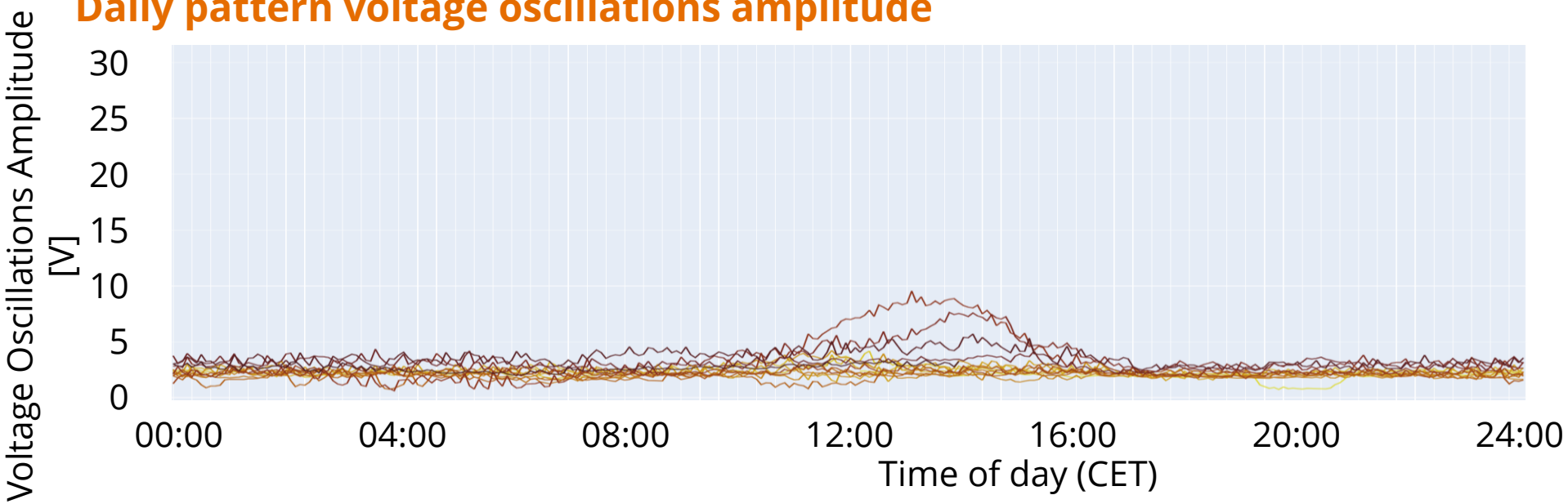
Right after 15:23 PM, the Voltage Oscillations Amplitude (VOA) rises, but a higher peak in VOA is visible around 15:14 PM.

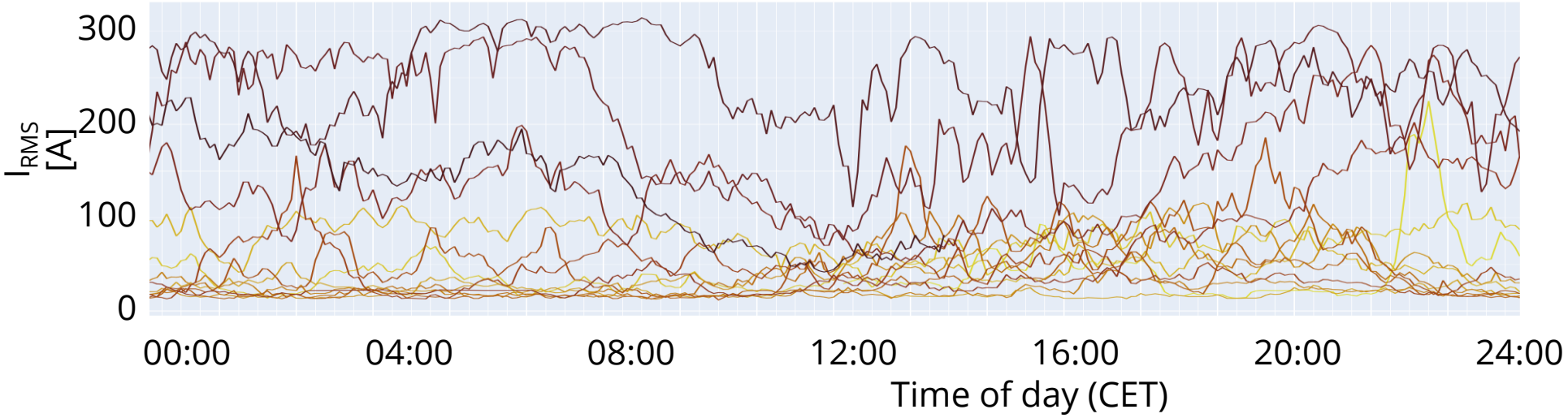
Conclusion

1. If this PV park acts as a source, it is **not the only source** of 3.5 Hz oscillations.

Results Wind

Daily pattern voltage oscillations amplitude





Conclusions

1. Only small amplitude oscillations observed during this period.
2. During high level of wind infeed, no oscillations with significant amplitude were observed during this period.

Conclusions and next steps

Conclusions measurement campaign Alliander fall 2025

1) The 3.5 Hz oscillations are:
   1) present in **Liander's** grid.
   2) recorded in **voltage**, **current** and **frequency**.
   3) mainly present between **10:00 AM** and **17:00 PM**.
2) The 3.5 Hz oscillations **frequency is not fixed**. Both a frequency of 3.0 Hz is recorded and frequencies above 3.5 Hz are recorded.
3) If this PV park acts as a source, it is **not the only source** of 3.5 Hz oscillations.
4) The new script allows for **quick analysis** of measurement data over the entire measurement campaign.

Next steps

1) Prepare new measurement campaigns
2) Apply methods to determine connectee's inidividual contribution
3) Strengthen cooperation

We go further as we walk together, but our journey continues.

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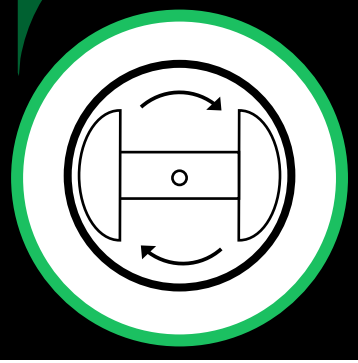

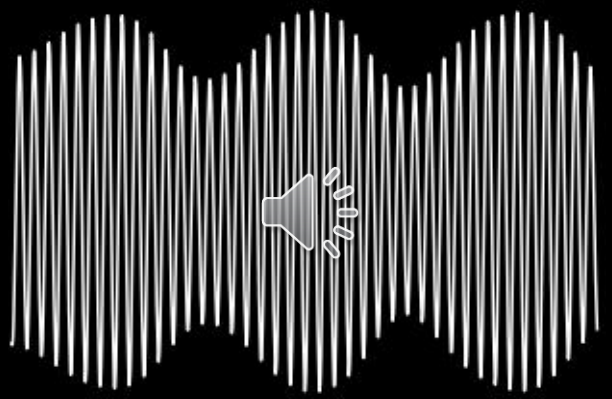

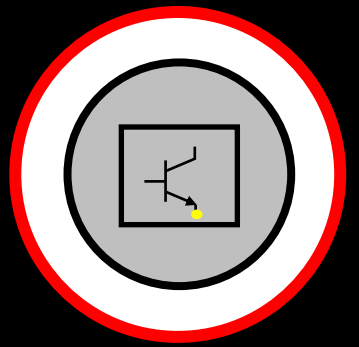

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