



ENG52 – WP1 status and plans TU Eindhoven

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Where innovation starts

Content

- **Goals of TU Eindhoven within WP1**
- **Status of the work:**
 - **Work on the Alliander Live Lab data**
 - **Work on the Delta network data**
- **Publications**
- **Next steps**

Goals of TU/e within WP1

- **Main goal: Characterize Power Quality (PQ) propagation in distribution networks, together with VSL**

Steps:

- **Create simulation inputs:**
 - Use measurement data of the Alliander LiveLab (NL)
 - Use measurement data of the Delta network (NL)
 - If necessary, use additional own meters
- **Model the network (Digsilent Power Factory) to draw additional conclusions about propagation**

Status of the work M6 – M18

- **Description of the Live Lab test network and measurement plan – deliverable D2 REG(TU-E), part of JRP D1.1.3 – completed**
- **Data gathering – continued (both networks), not yet complete**
- **Modeling – LiveLab model completed, MSc thesis posted on the share point**
- **Modeling of the Delta network – to be done**
- **Regular meetings with VSL and Alliander**

Measurements for LiveLab (NL)

- **MV/LV network (10/0.4 kV), connected to a 150 kV network**
- **150/10 kV substation monitored and many (12 of ~20 on two feeders) 10/0.4 kV substations (MV, some also LV side)**
- **7 types of PQ analyzers/RTUs, different current sensors**
- **Measurement simultaneous but not synchronized, logged according the a “ Δx ” threshold, not at fixed time intervals**

Map of the Alliander Live Lab

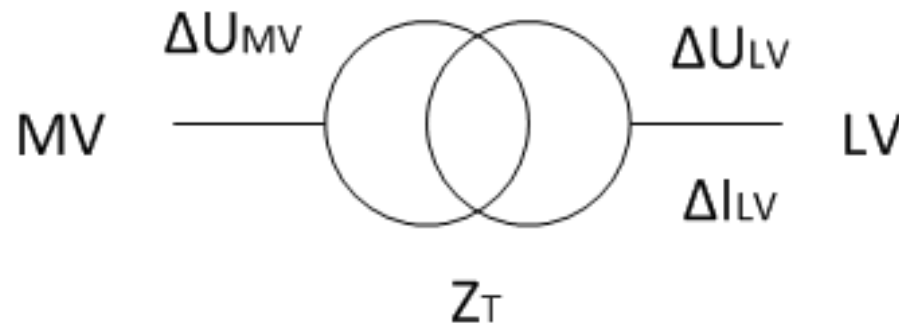


Status of LiveLab data

- **Data for rapid voltage variations available – short term RMS values of voltage and current**
- **Data for harmonics partly available – current harmonics not yet available**
- **Data for harmonic current summation obtained by own measurements – waveform recording ~one week**

LiveLab data – voltage flicker (1/2)

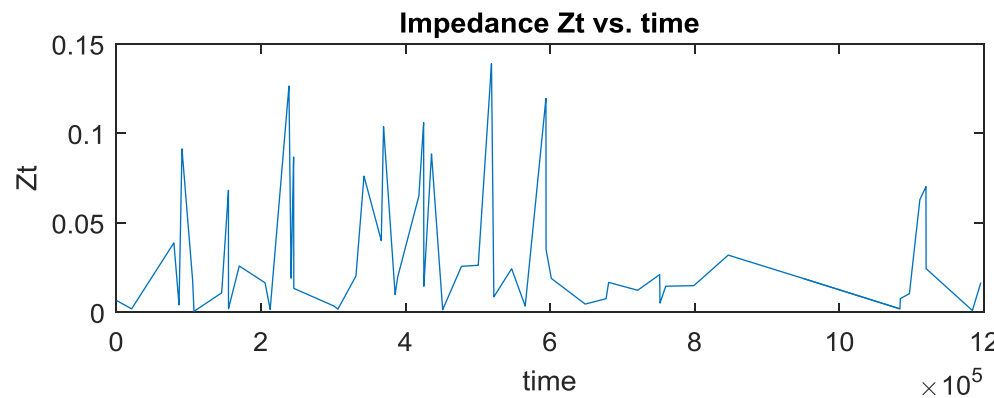
- Exploration of contributions of LV and MV side by using simultaneous variations of voltages on both sides and LV side current



- $\Delta U_{MV} \sim \Delta U_{LV}$ means MV side contribution, ΔI_{LV} and transformer impedance as a logical check

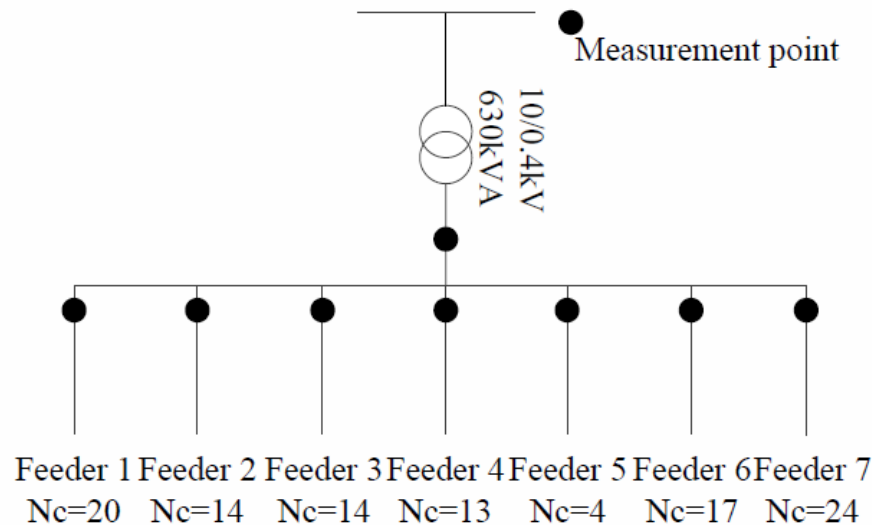
LiveLab data – voltage flicker (2/2)

- **Results of filtered simultaneous variation data:**
 - Limited number of points with exactly equal time-steps
 - Tolerance of “simultaneity” adds to uncertainty
 - Points with logical Z_T values occur only every few hours – not frequent enough for flicker
- **Conclusion: LiveLab data not appropriate for the analysis due to the lack of synchronization**



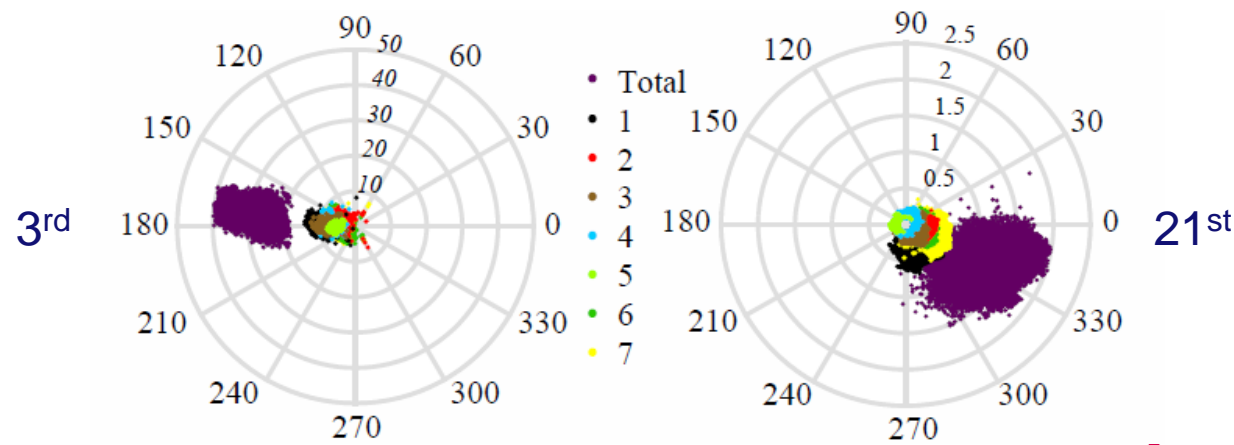
Summation of harmonic currents (1/2)

- Own measurement in one of the MV/LV substations of LiveLab
- Synchronized waveform recording of feeder currents and the total transformer current
- Compensation of connected feeders analyzed



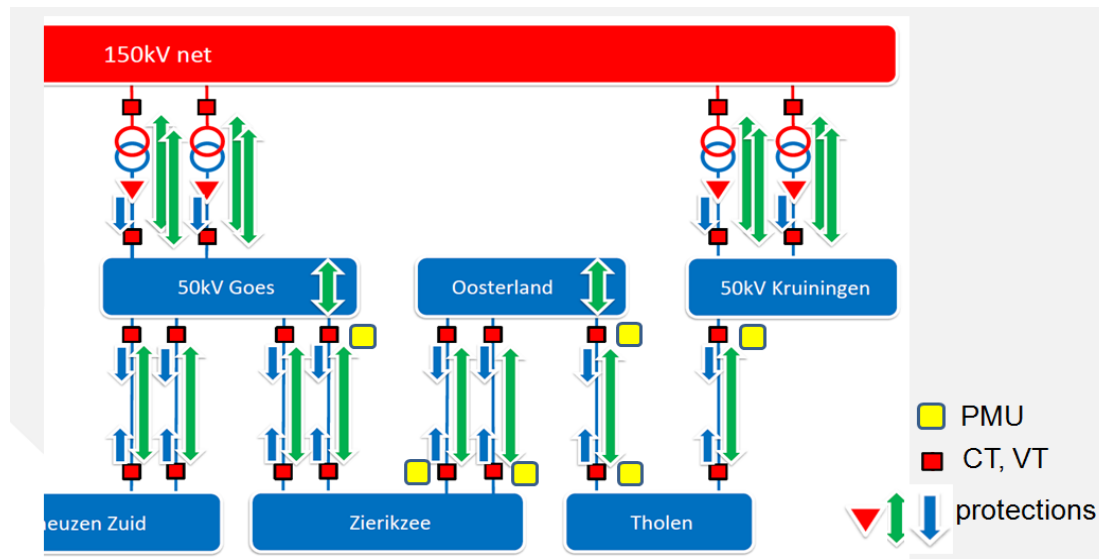
Summation of harmonic currents (2/2)

- Distribution of phase angles of harmonic currents analyzed
- Summation coefficients calculated (IEC 61000-3-6)
- Results compared to other, industrial locations
- Obtained results mostly more pessimistic than by IEC



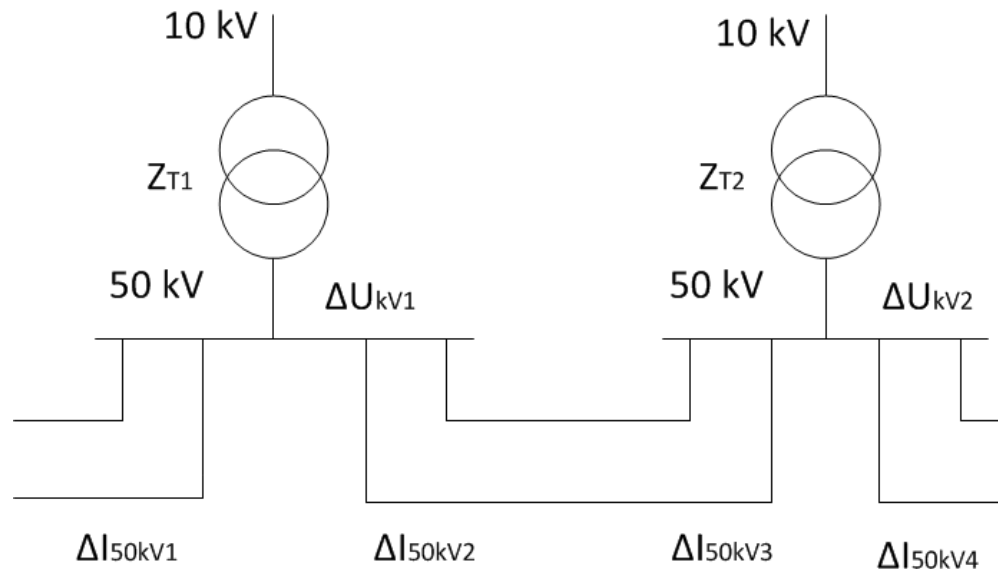
Measurements for the Delta network (NL)

- MV ring (50 kV) connected to a 150 kV network and 10 kV networks
- PMU data available with the help of VSL
- Measurement RMS single cycle, harmonics 1 s



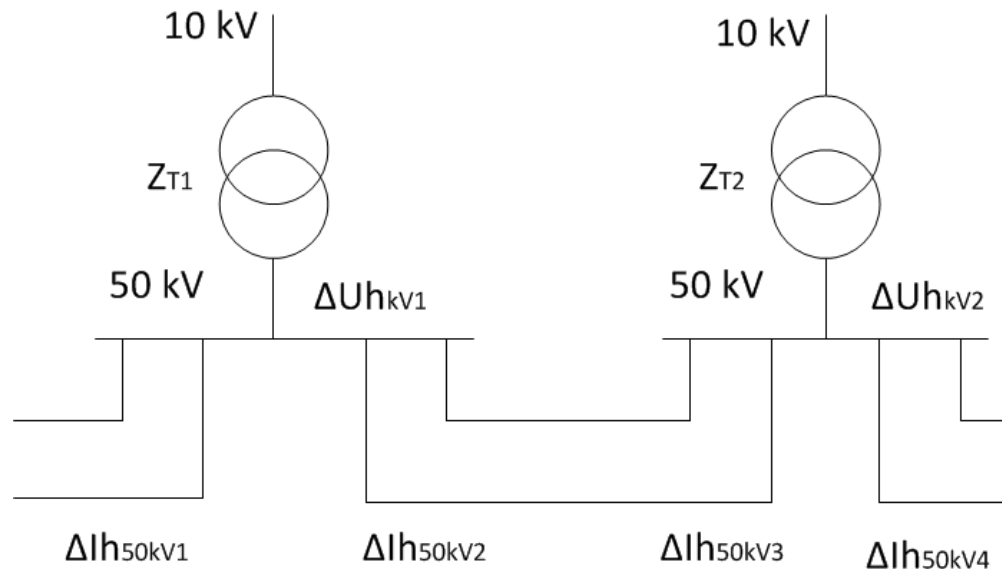
Delta network – propagation of flicker

- Comparison of variations on five 50 kV busbars
- Determination of contribution of 150 kV network and some of the 10 kV network
- Concept analogue to LiveLab, but with modifications
- All data synchronized



Delta network – propagation of harmonics

- Estimation of 10 kV network equivalent harmonic impedance – for harmonic load-flow studies
- Impedance calculated based on harmonic voltage perturbations coming from the 150 kV network
- Concept analogue to rapid voltage variations



Publications

- **Paper presented at CIRED 2015, together with VSL: “Analysis of the Propagation of Power quality Phenomena using Wide-Area Measurements” - describing the research approach**
- **Journal paper submitted to the IEEE Transactions on Power Delivery: “A Study on Harmonic Current Summation Using the Aggregated Phase Angles” – propagation of harmonic currents in distribution networks**
- **Two papers planned for ICHQP 2016**

Next steps – coming 6 months

- **Continue measurement data gathering**
- **Finish modeling of the Delta network**
- **Continue the study on the impedance of aggregated MV loads – propagation of harmonics**
- **Continue the study on the propagation of rapid voltage variations - flicker**