HANNOVER MESSE

POWER FOR INDUSTRY

CONDENSATOR DOMINIT

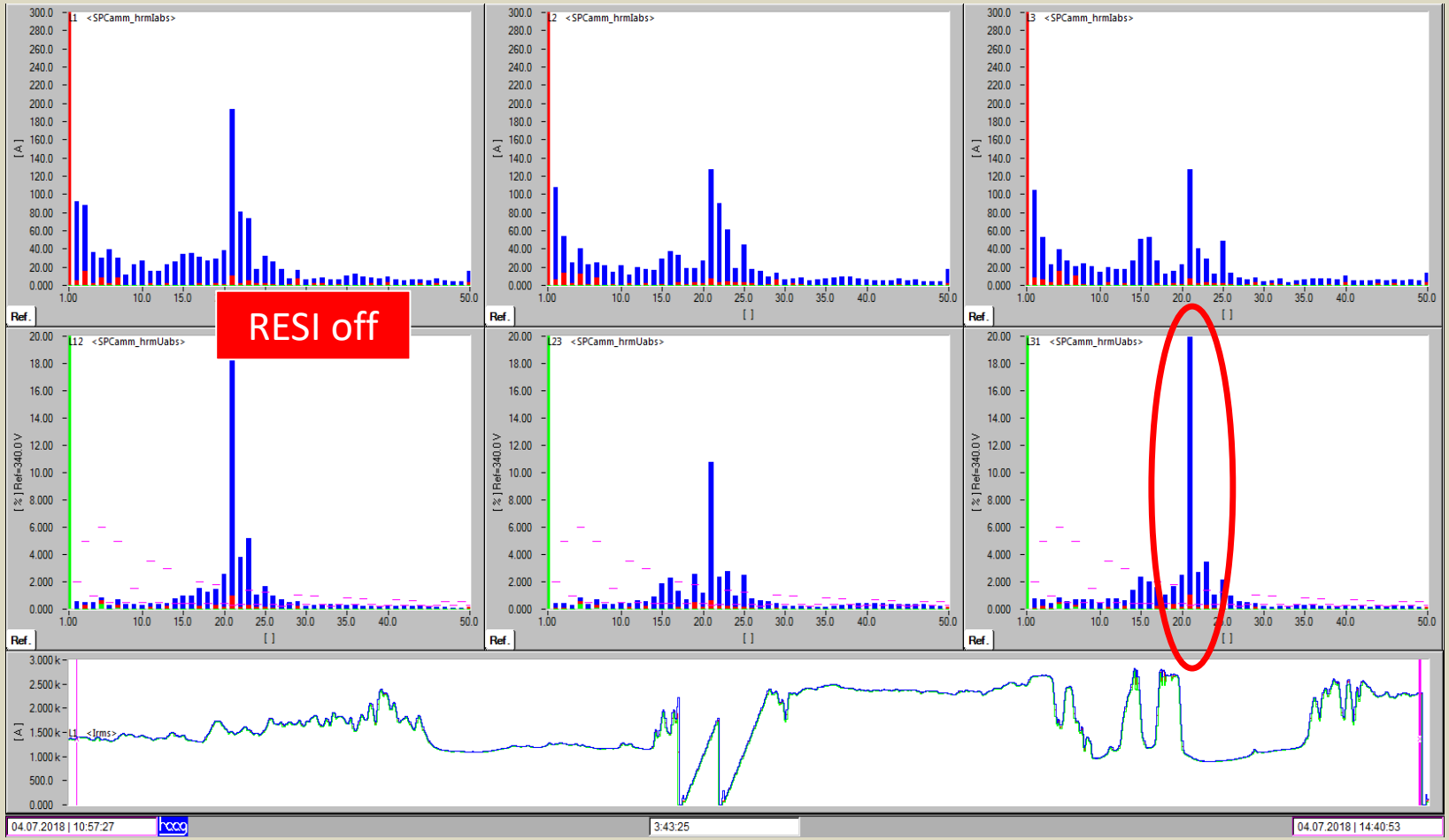
Dr. Christian Dresel,
managing director

Condensator
Dominit GmbH

How to eliminate resonances?

First contact with resonances – No filter installed!

- Solar park (~ 30 MWp)
- 11 solar converters (~1,8 MW) feeding by one 2000 kVA transformer

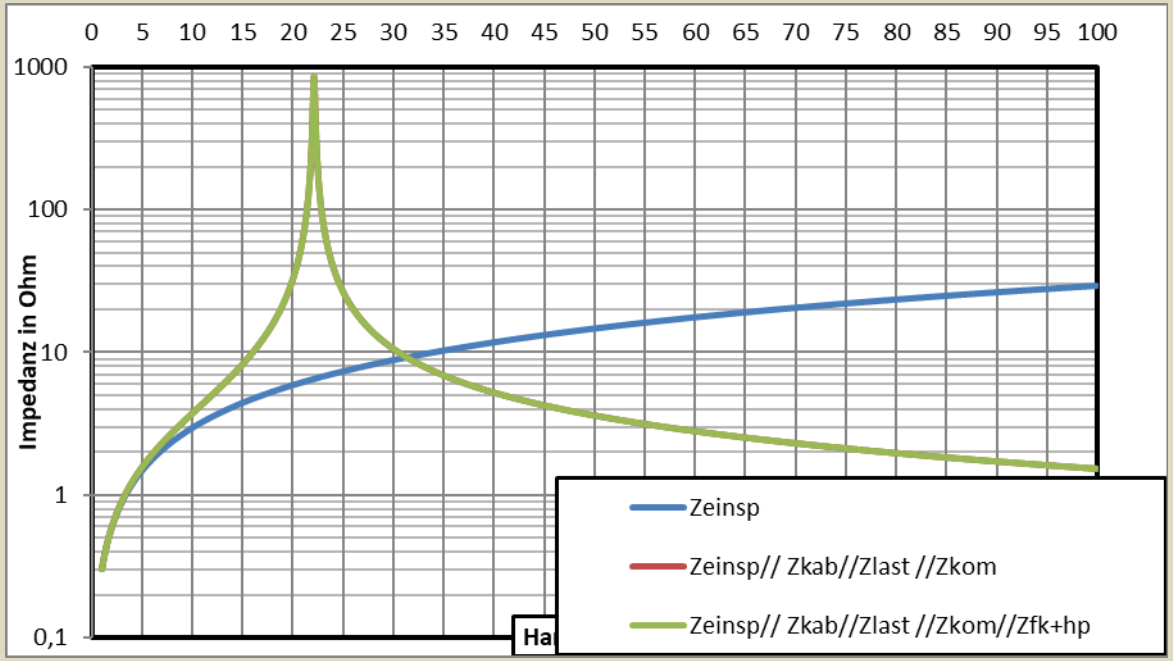


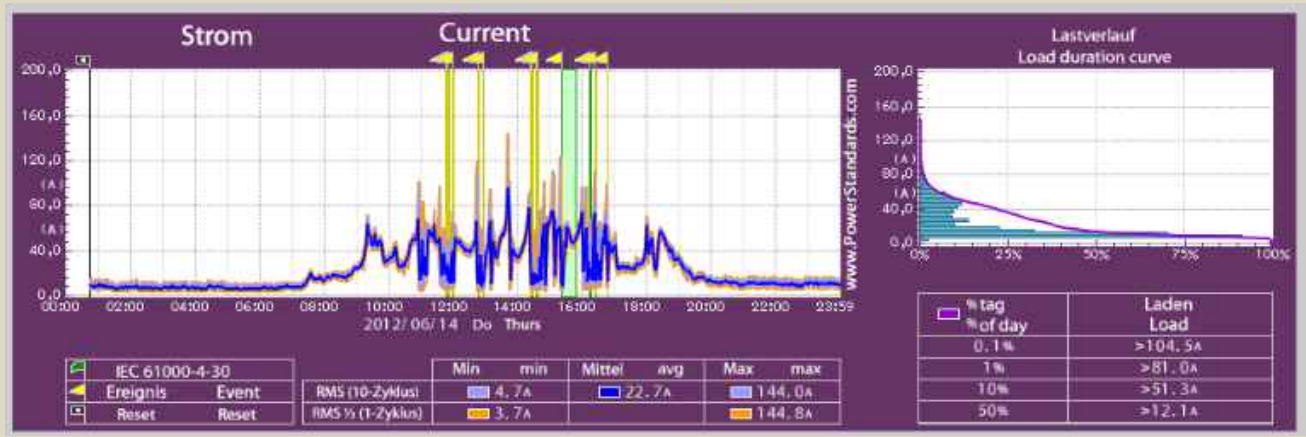
Without RESI-filter

- Resonance at around 1.050 Hz
- Voltage levels up to 20 %

First contact with resonances – No filter installed!

- With given cable capacity and 10 km cables and given transformer the MV impedance shows the following picture

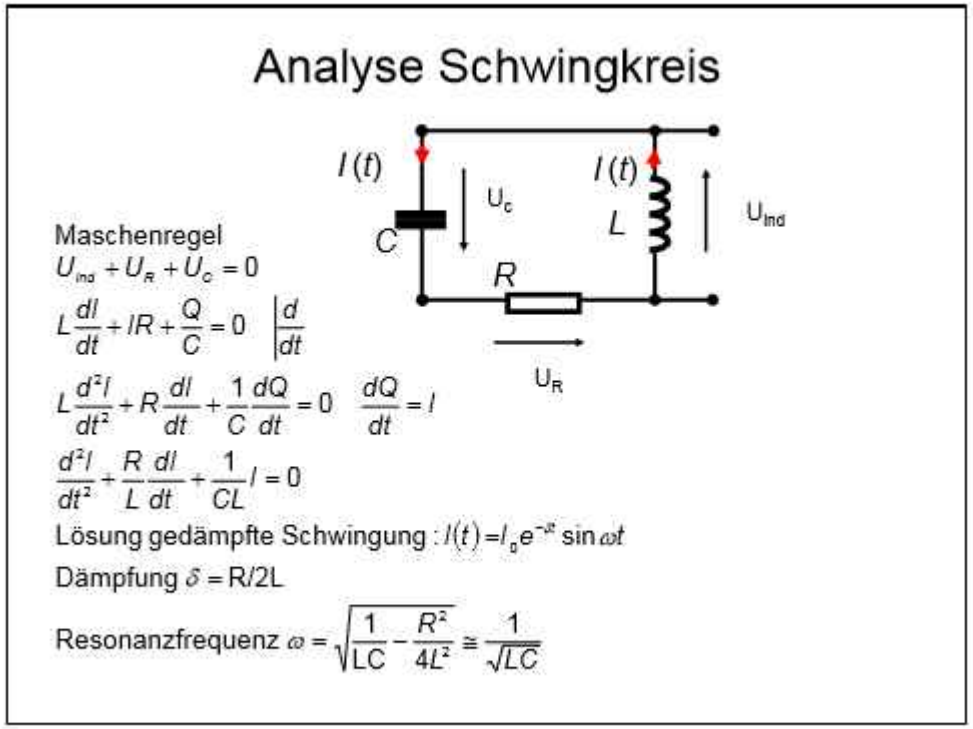




- Harmonic voltages and grid impedance are in line

No filter installed! – What is happening here?

What is happening here?

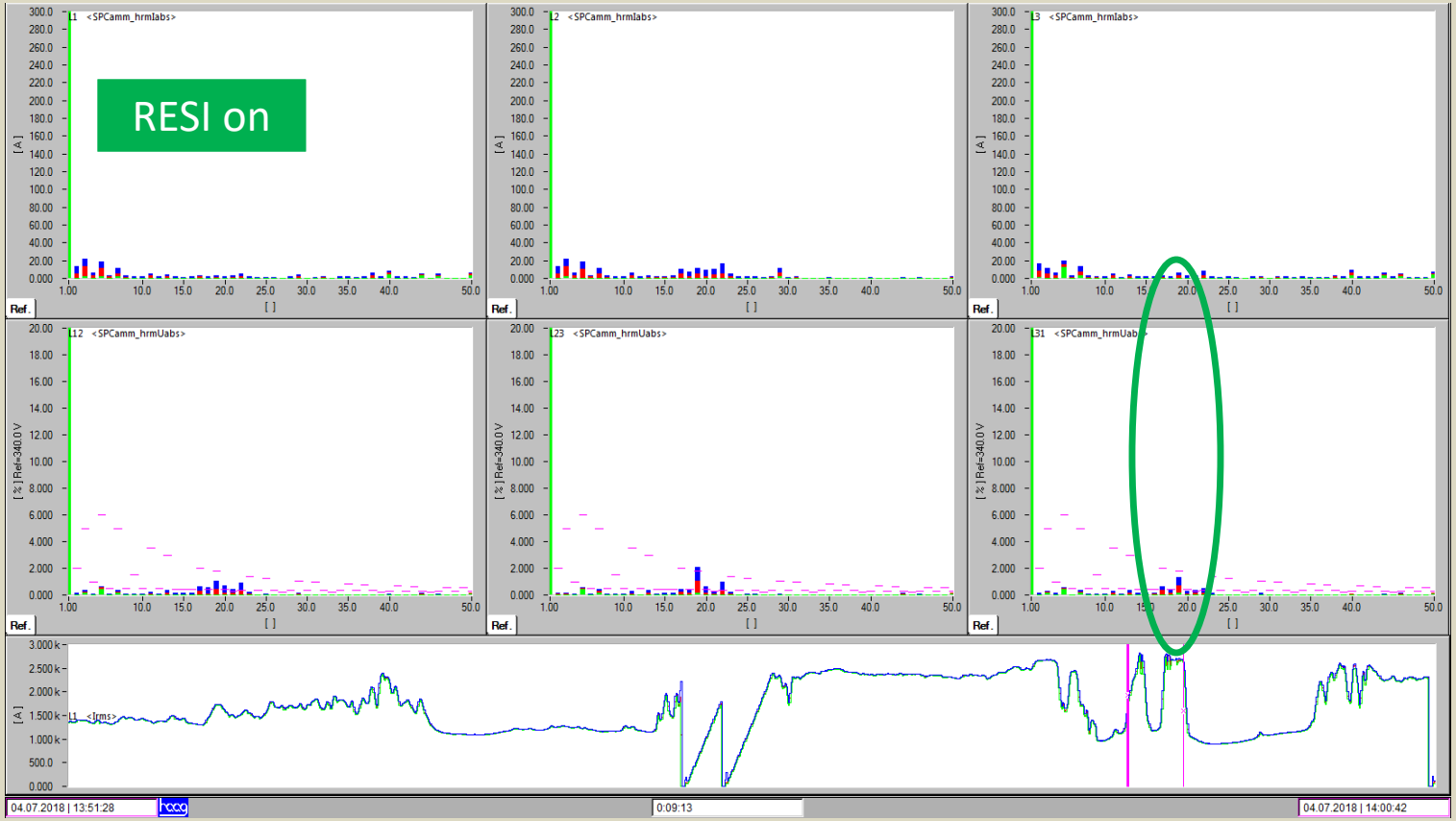


- 10 km MV cable
- 10 microF
- 40 MVA transformer
- 1 mH

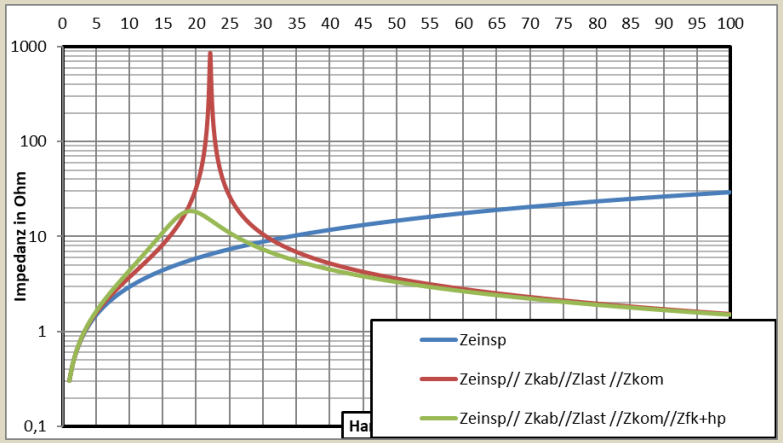
- f = 1500 Hz + -

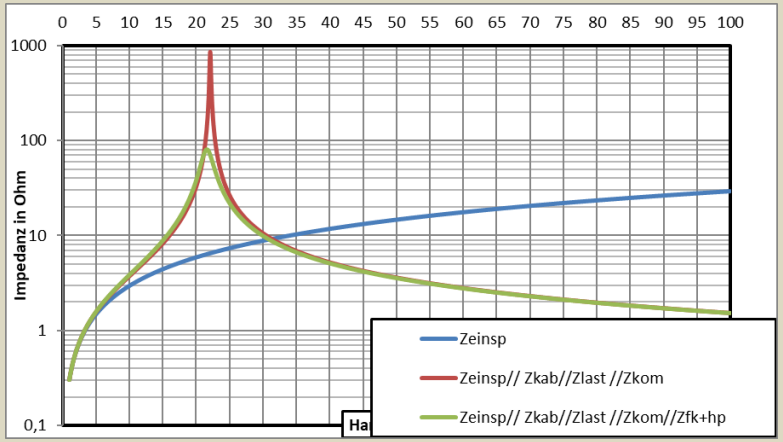
Application 1 – RESI-filter installed

- Solar park
- 11 solar converters (~1,8 MW) feeding by one 2000 kVA transformer

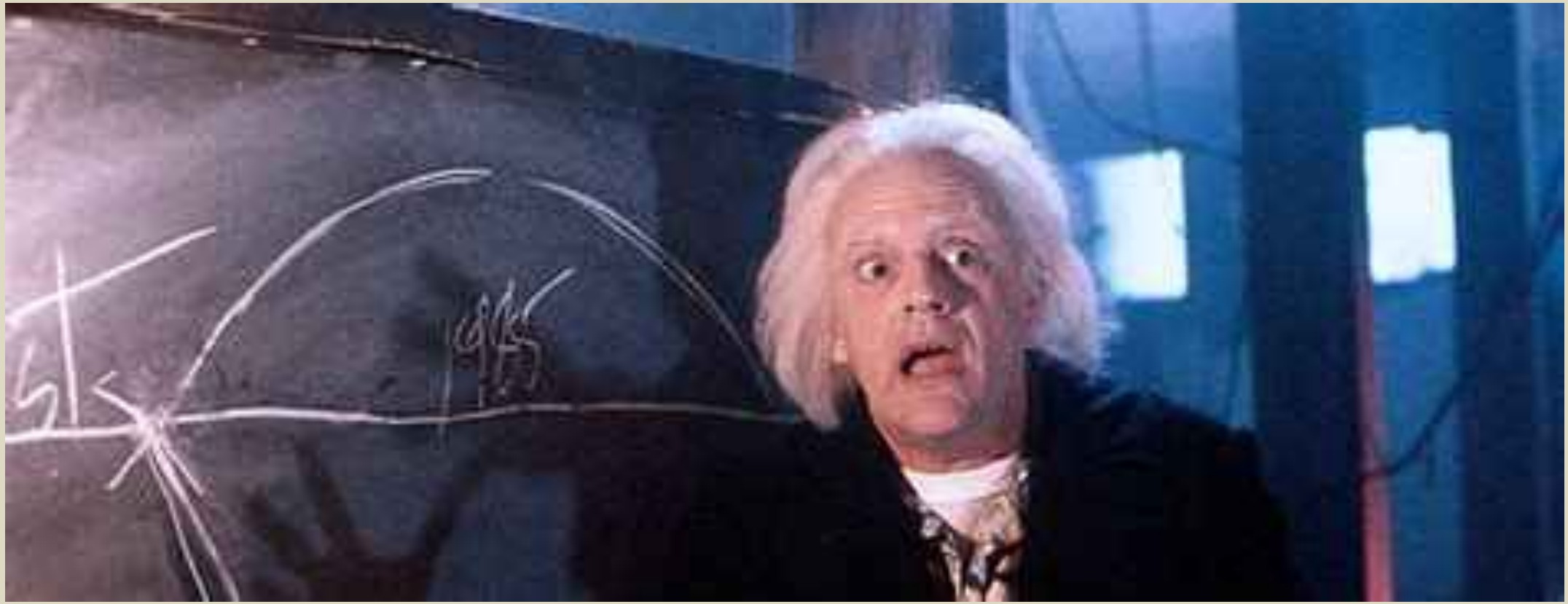


- With RESI-filter
- Resonance eliminated





What can we learn from science?



What can we learn from science?

Significant low number of scientific publications!

Most publications focus on

specific aspects of resonances.

No general awerness of the problem.

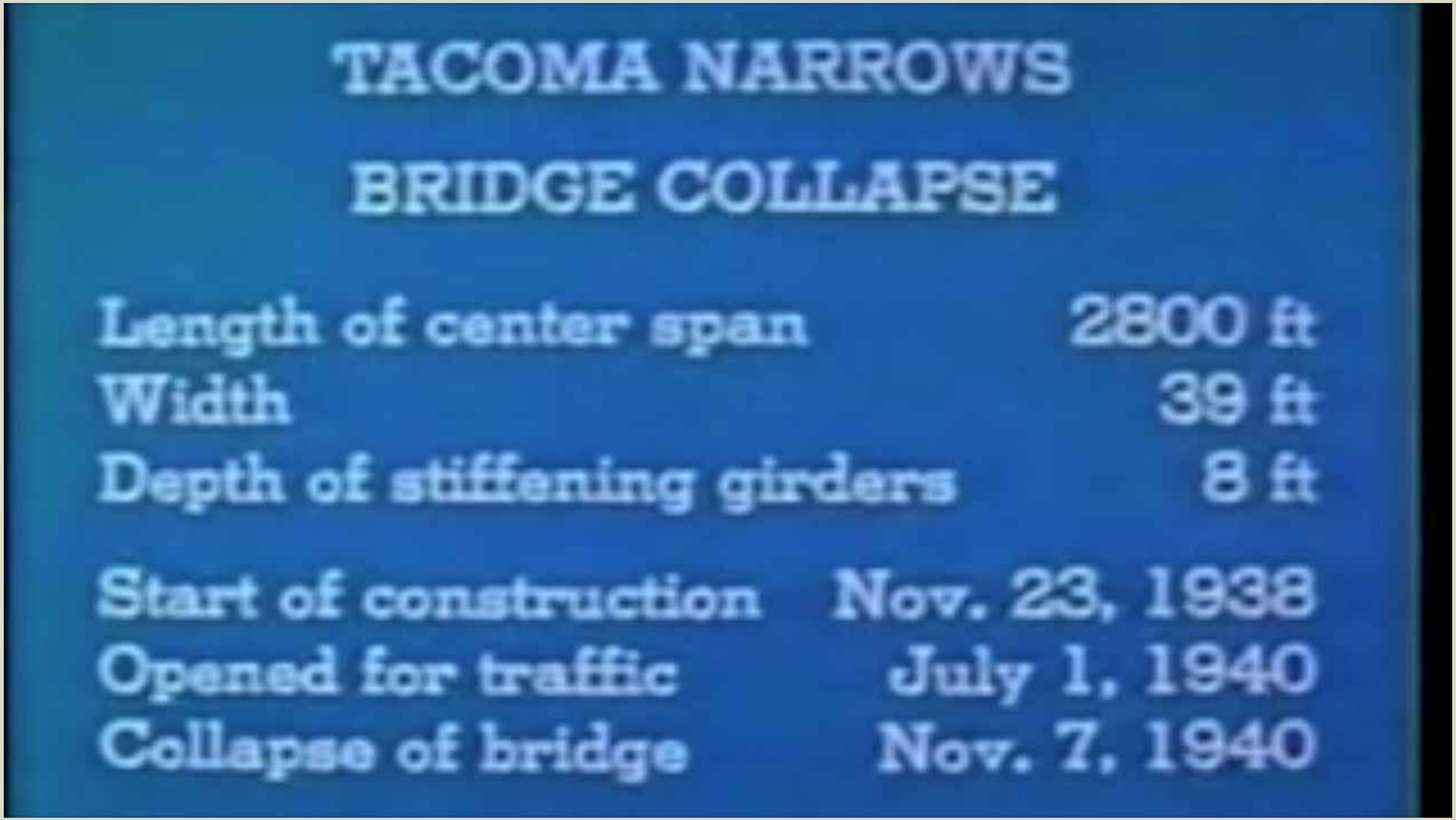
What can we learn from science?

V. SUMMARY: A theory is presented for harmonics created by resonances in converter-grid systems. This type of harmonics is becoming …
…as eliminating the generation of harmonics from nonlinearsources,e.g.,by using PWM rectifier store place diode rectifiers. **These solutions will not work for harmonics created by resonance. Instead, since impedance is the root cause, development of solutions to this new type of harmonic problems must focus on modifying system impedance such that all resonances are properly damped.** This can be achieved by using passive components or active control, so the implementation of damping may appear to be similar to harmonic filtering, but the design criteria and models to be used are very different, as has been demonstrated in a number of recent publications, see, e.g., [20].

Prof. Jian Sun, New York

Is this the future of our grid?

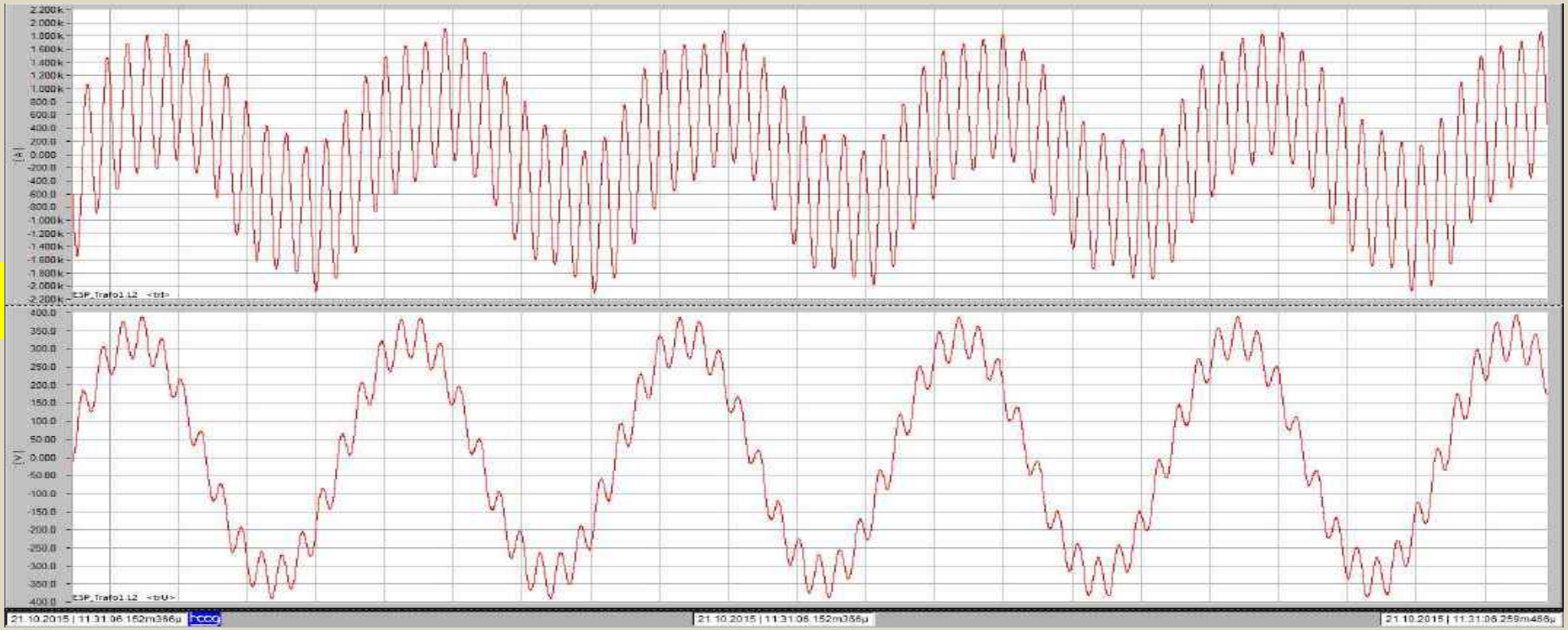
® https://www.youtube.com/watch?v=3mclp9QmCGs



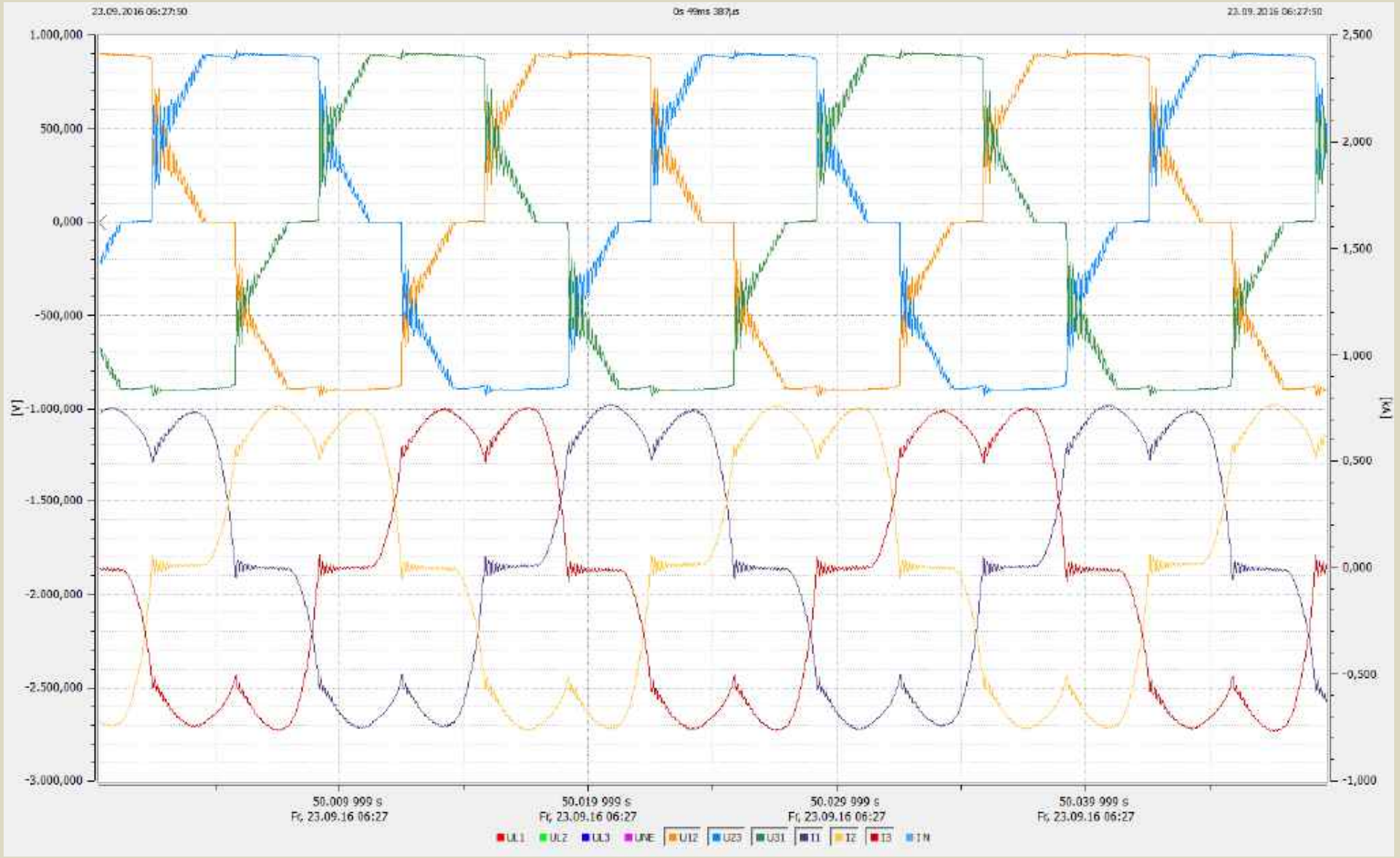
Resonance due to multiple EMC filters

- Multiple high quality EMC filters interact

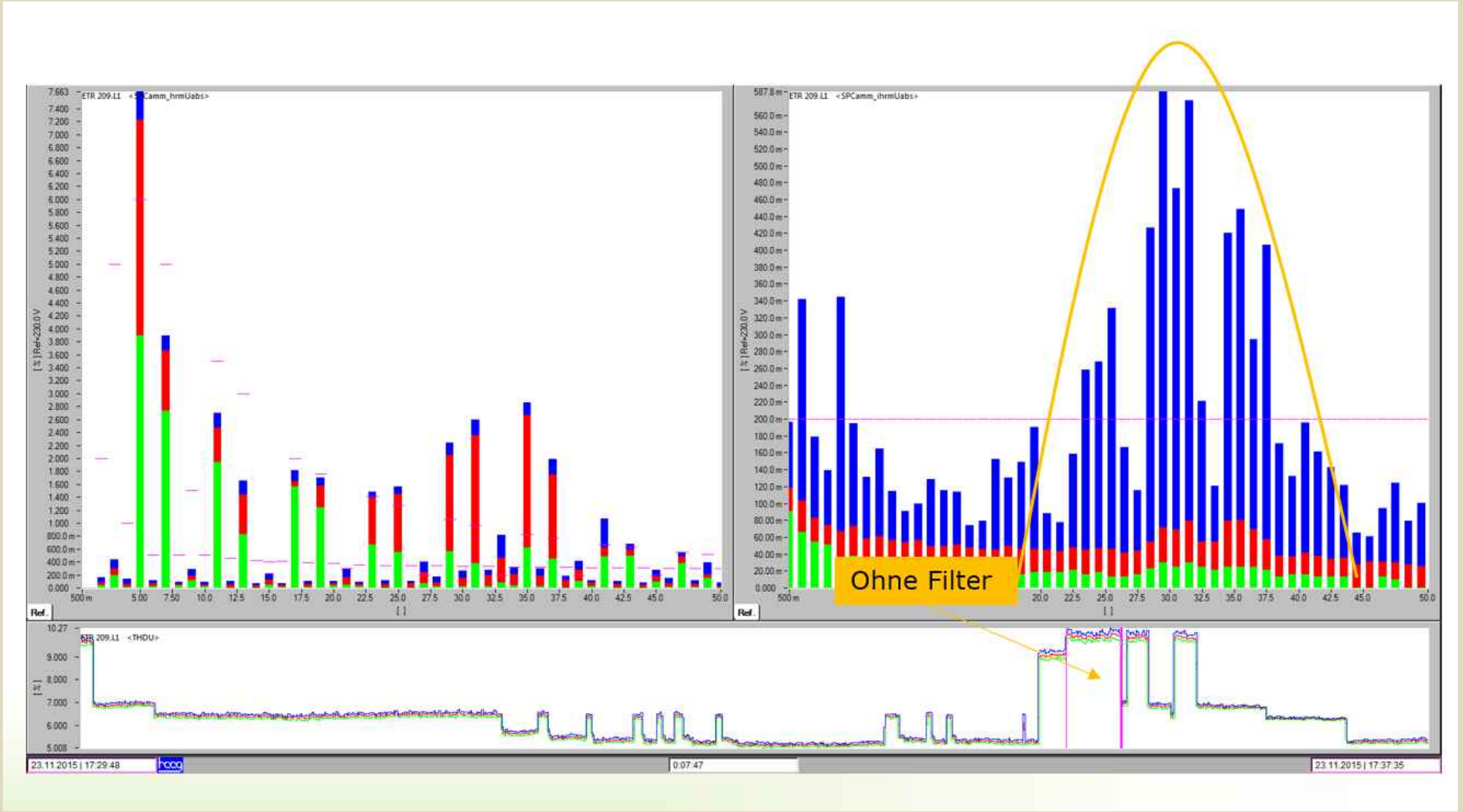
Voltage correspondingly distorted (double zero crossings)



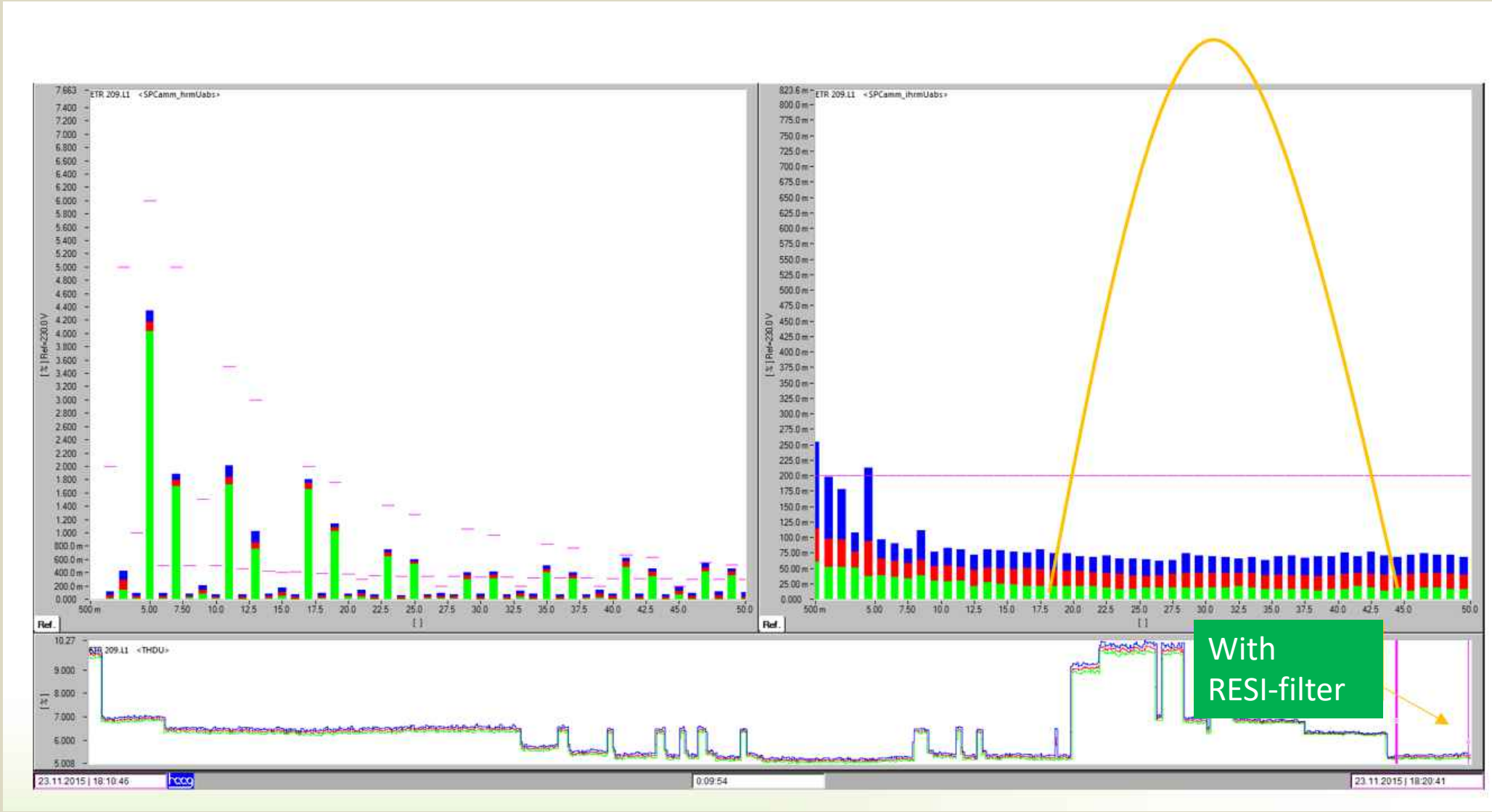
High frequency resonances due to EMC filter on VSD input



High frequency resonances due to EMC filter on VSD input „Interharmonics“ are a clear indicator of resonances



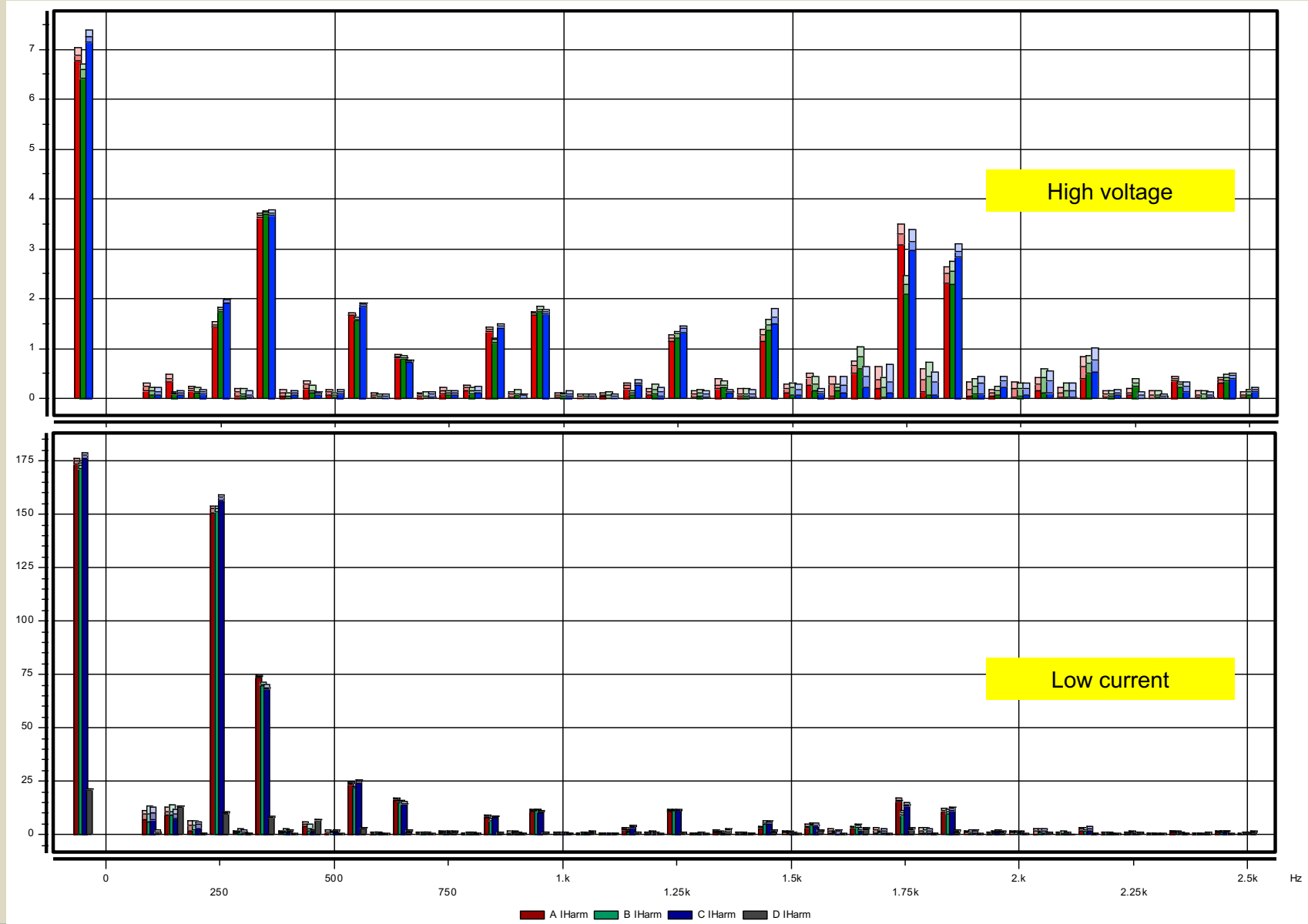
High frequency resonances due to EMC filter on VSD input „Interharmonics“ are a clear indicator of resonances



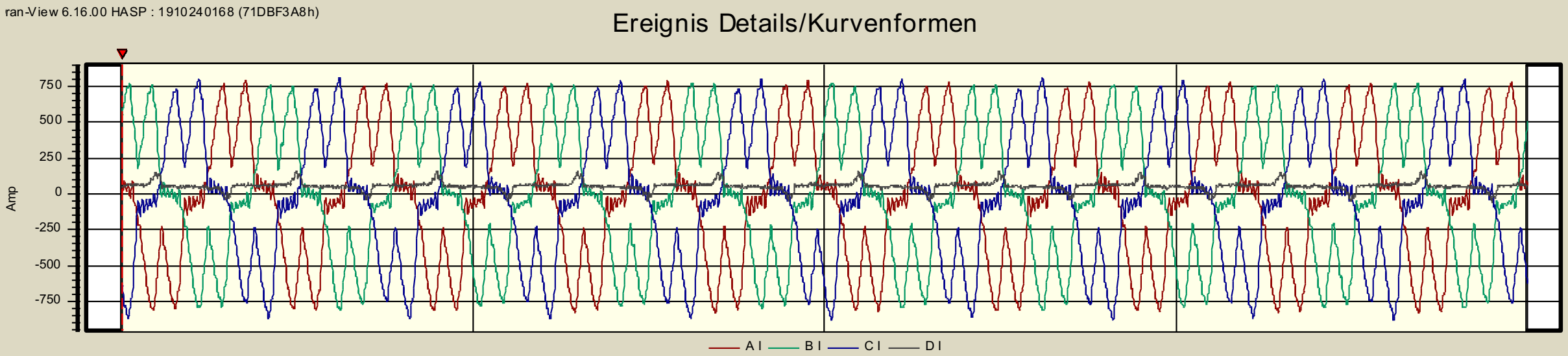
High impedance is indicating resonance!

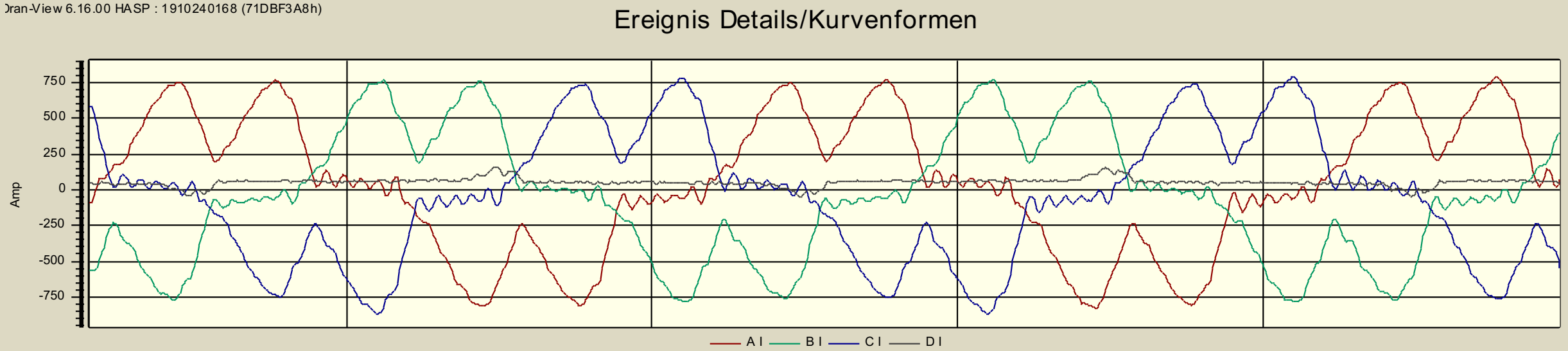
Clear Indication of a resonance point

High voltage at low current

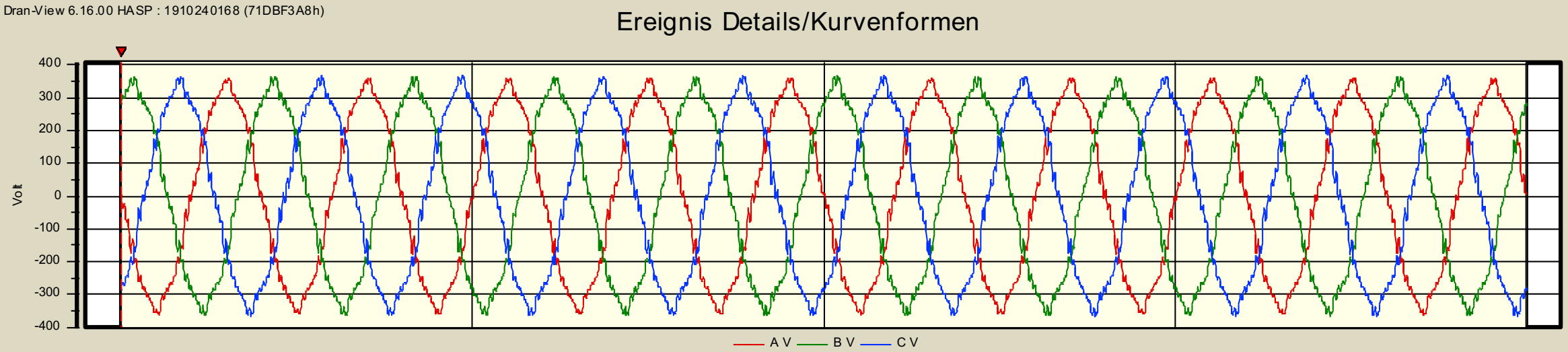


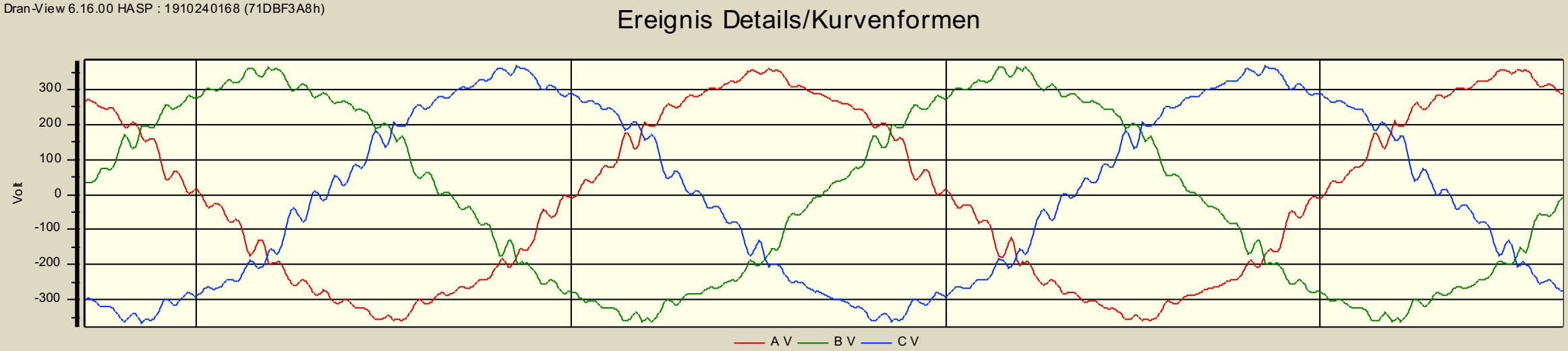
Current wave form in a resonant grid





Voltage waveform!





Resonances at higher frequencies

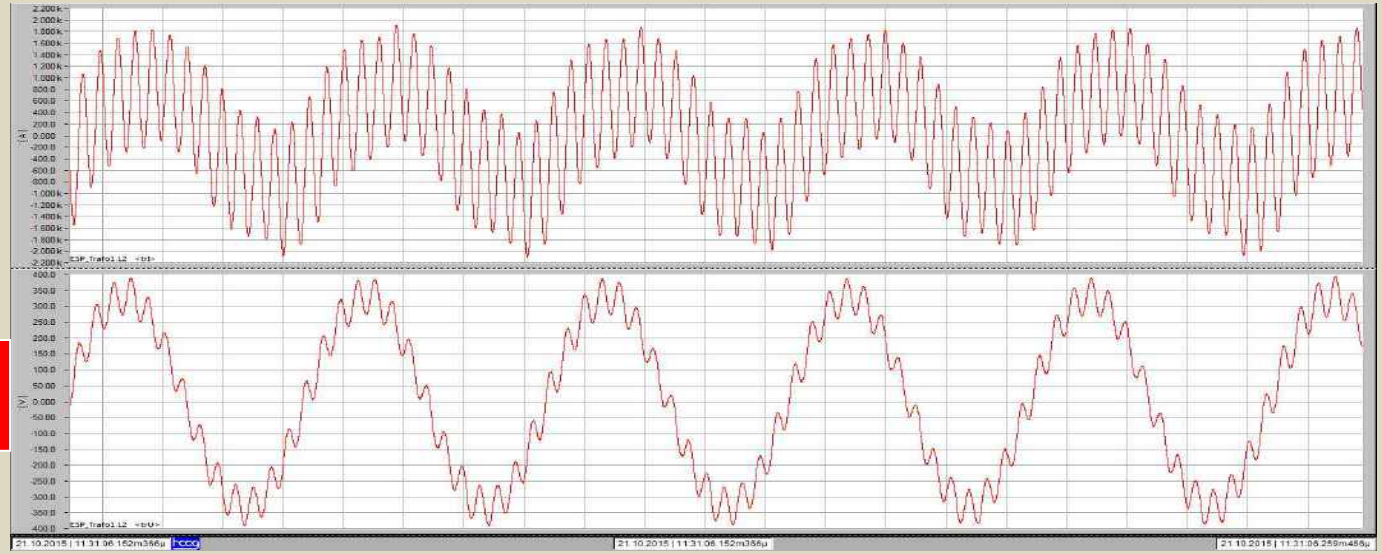
bis 9 kHz	Zulässige Ströme nach VDE-AR-N 4105 für NS Einspeiser	Ströme lt. Messung L1 - Max	L2 - Max	L3 - Max
4,5 kHz	0,06 A	0,007	0,019	0,017
4,7 kHz	0,06 A	0,008	0,018	0,016
4,9 kHz	0,06 A	0,01	0,028	0,017
5,1 kHz	0,06 A	0,013	0,034	0,027
5,3 kHz	0,05 A	0,018	0,057	0,03
5,5 kHz	0,05 A	0,035	0,083	0,062
5,7 kHz	0,05 A	0,047	0,151	0,11
5,9 kHz	0,05 A	**1,181**	**0,743**	**0,794**
6,1 kHz	0,05 A	**0,896**	**0,667**	**0,784**
6,3 kHz	0,05 A	0,049	0,093	0,084
6,5 kHz	0,04 A	0,025	0,071	0,054
6,7 kHz	0,04 A	0,017	0,037	0,025
6,9 kHz	0,04 A	0,015	0,027	0,025
7,1 kHz	0,04 A	0,012	0,023	0,017

Too much love can kill you!

Resonance current clearly visible

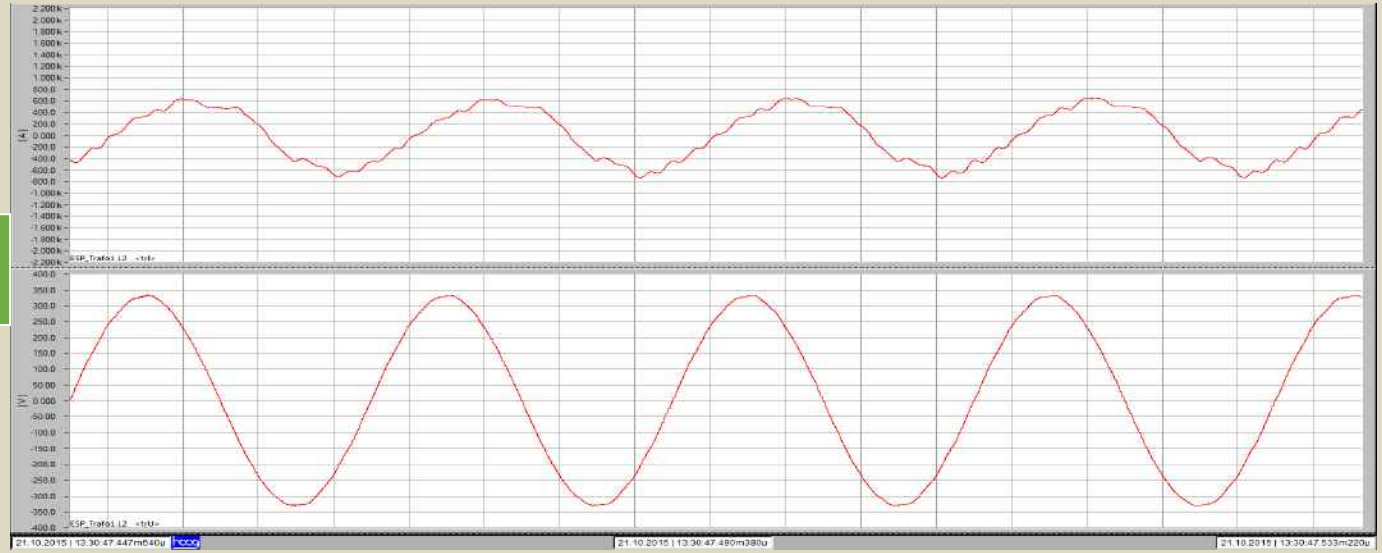
Filter „OFF“

Voltage correspondingly distorted (double zero crossings)

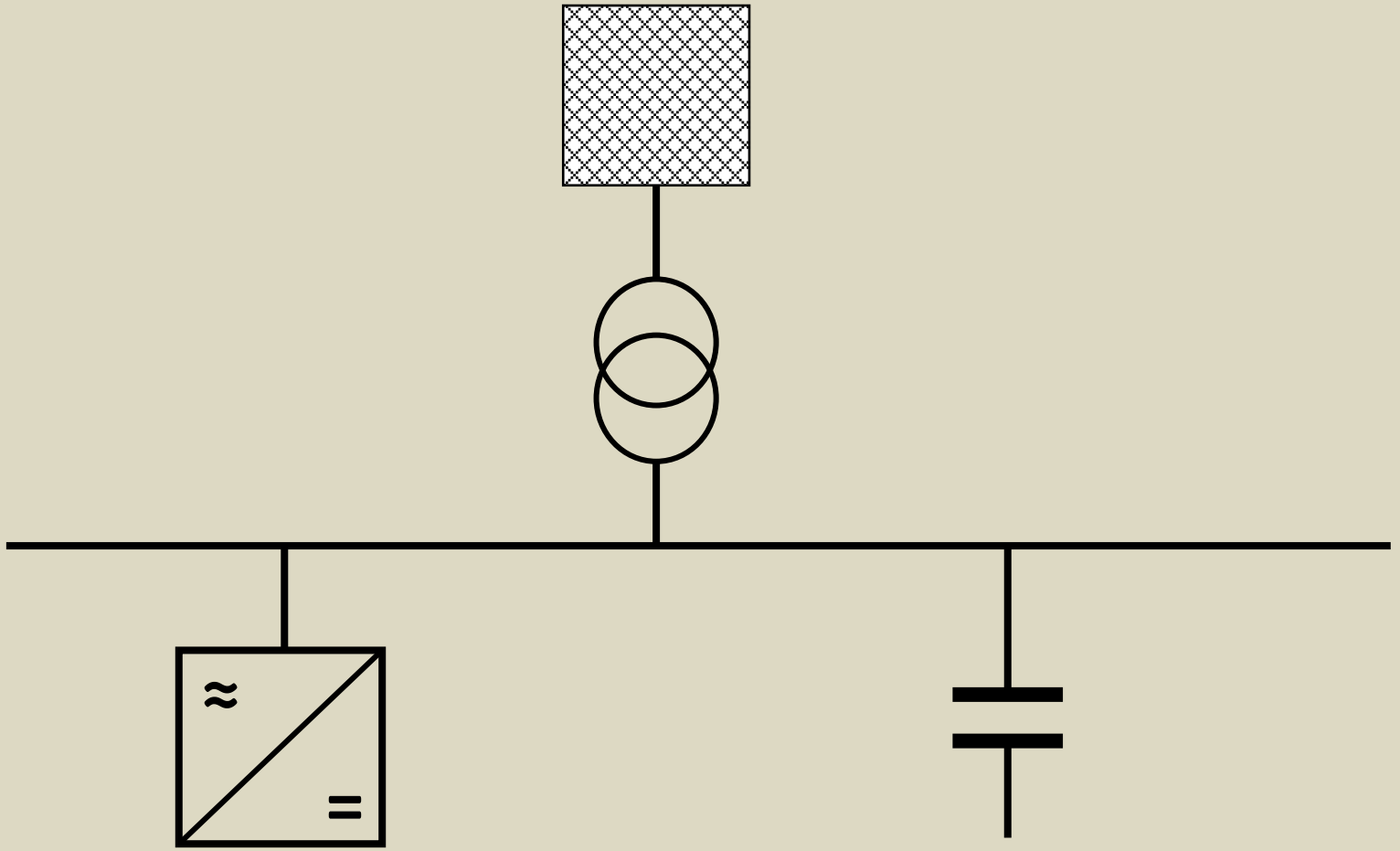


Filter „ON“

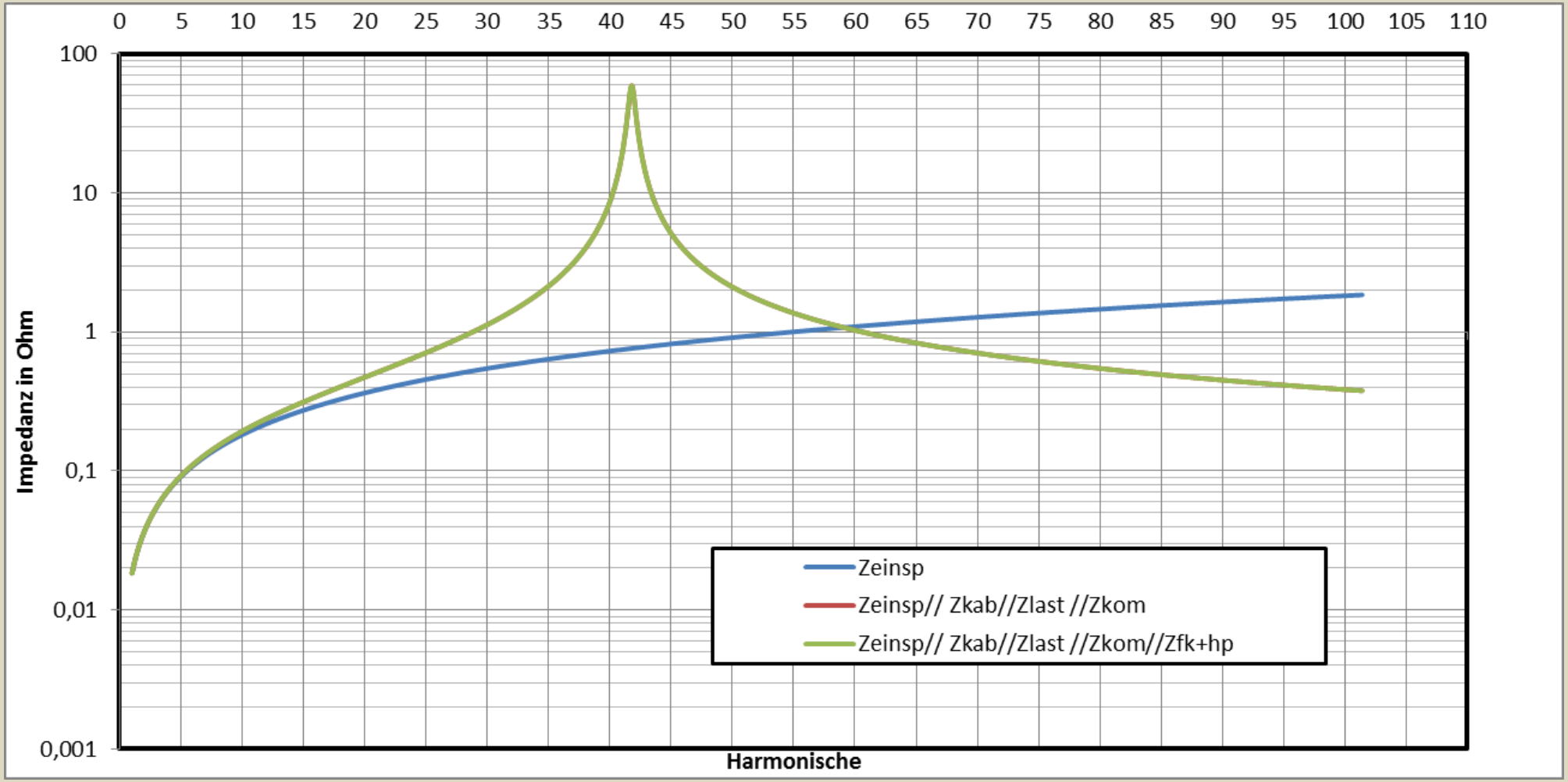
With filter results in a nearly perfect sine



Another option:
Non detuned cap banks!

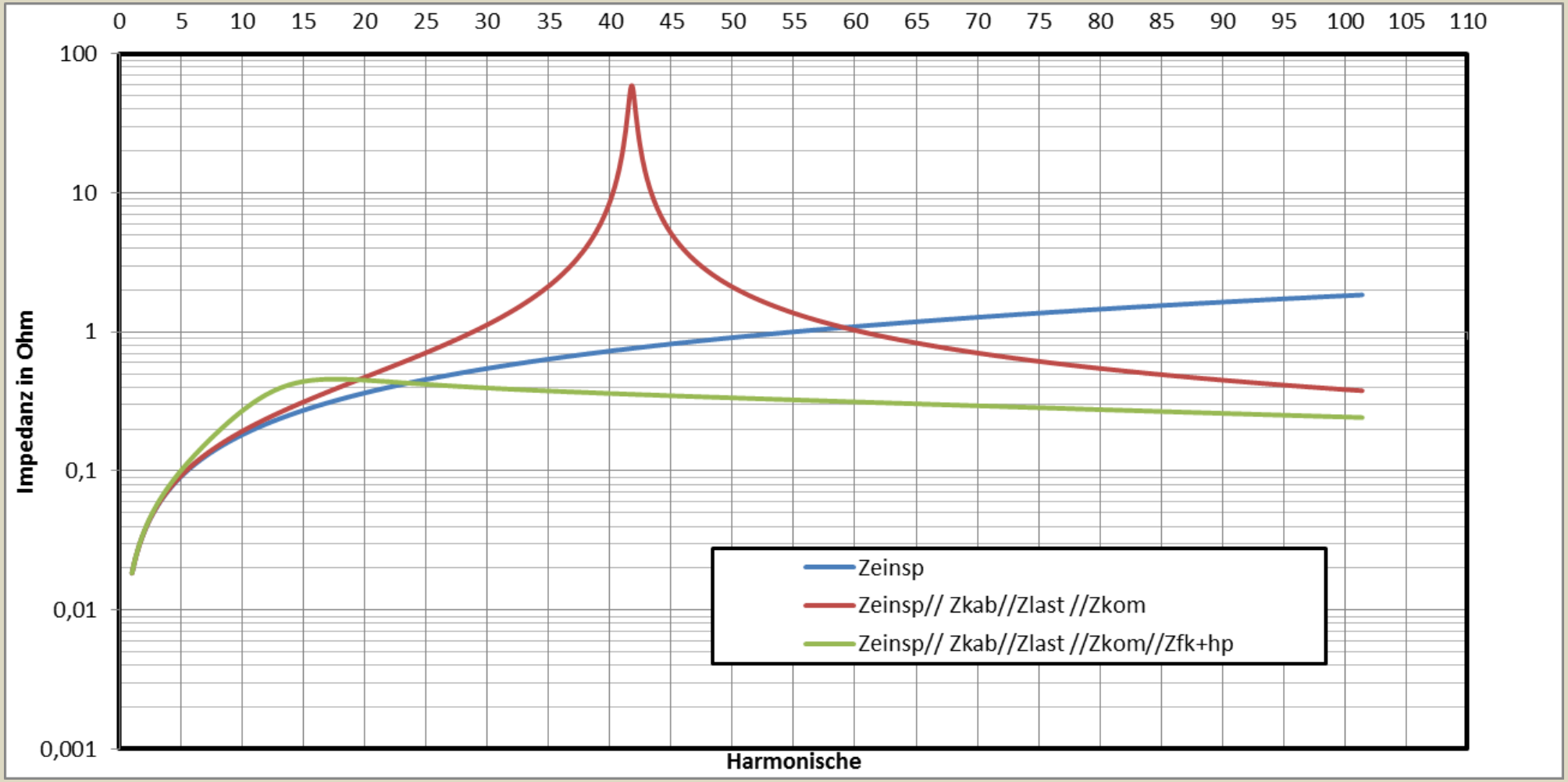


Resonances in MV:
10 km cable and a MV transformer



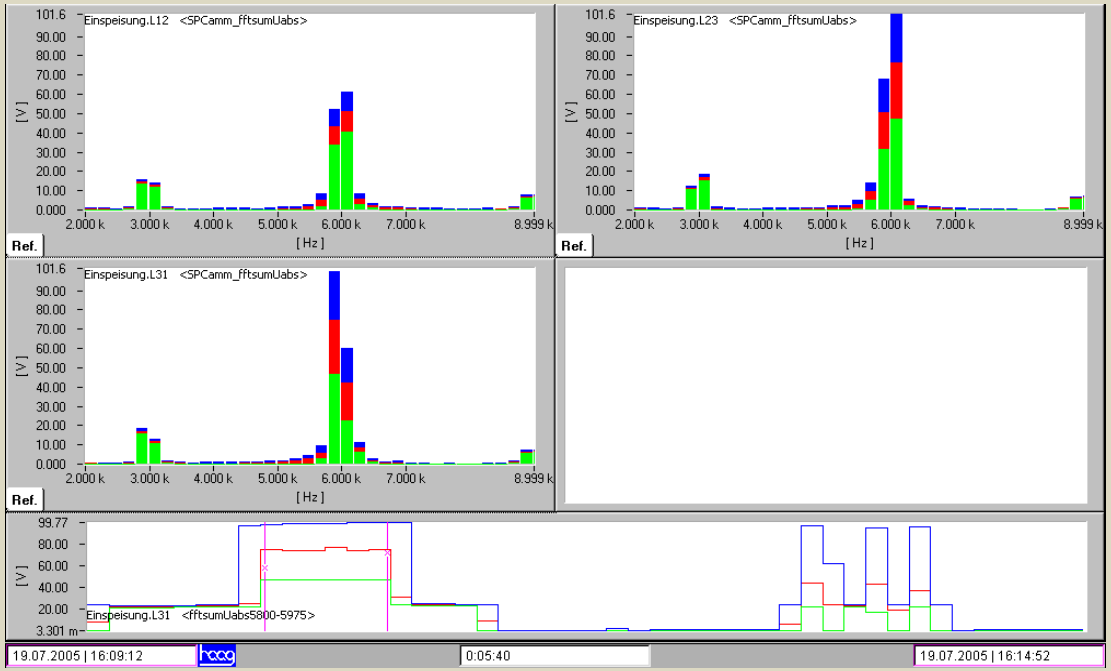
Example: Grid 50 MVA, Transformator 630 kvar, Kabel 100 µF

Resonances –
RESI kills them all!



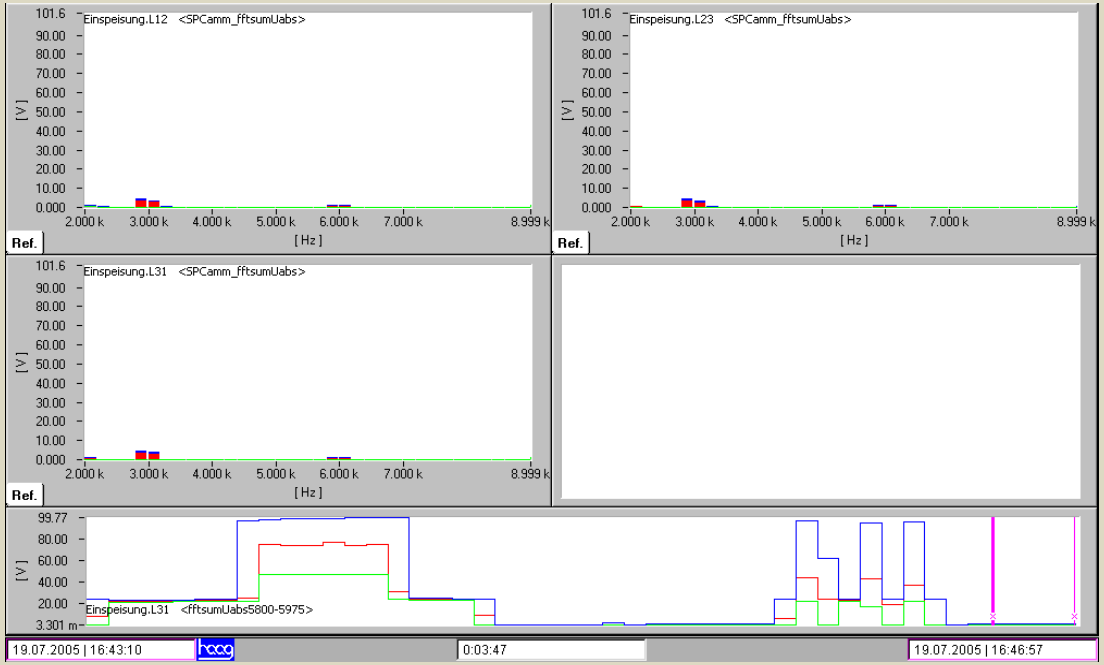
Example: Grid 50 MVA, Transformator 630 kVA, Kabel 100 µF + RESI

Resonances – RESI



Noise level at 6 kHz > 25%

Filter „OFF“



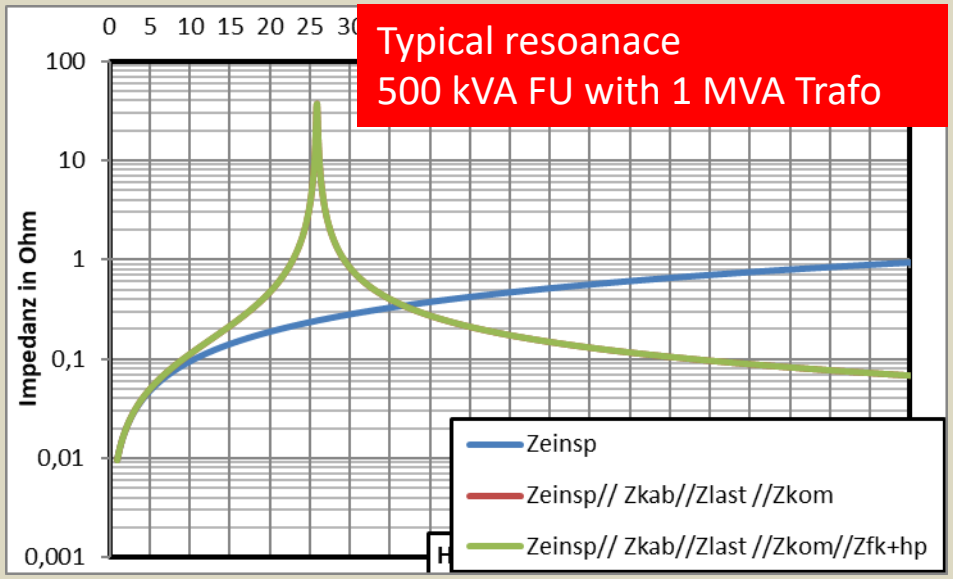
Noise level < 0,2%

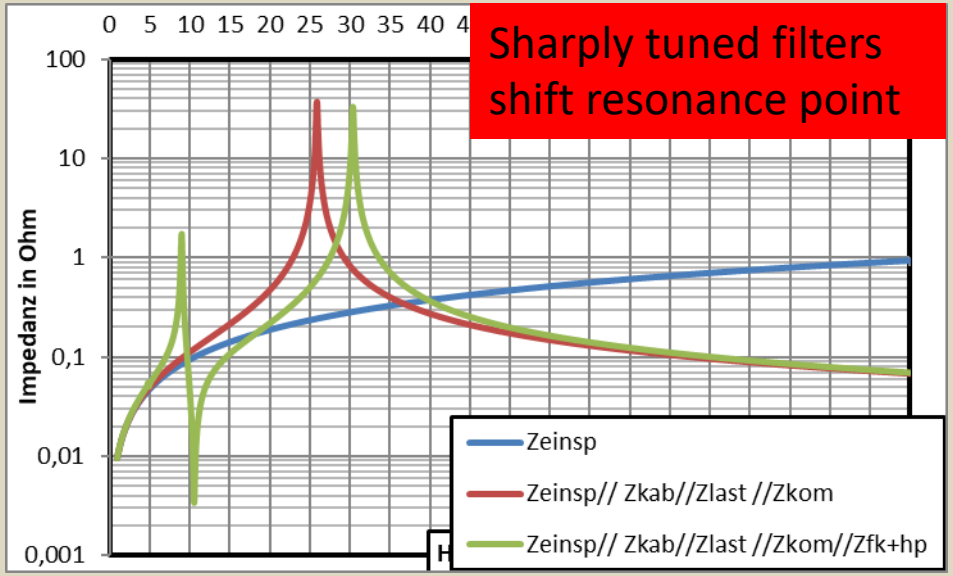
Filter „ON“

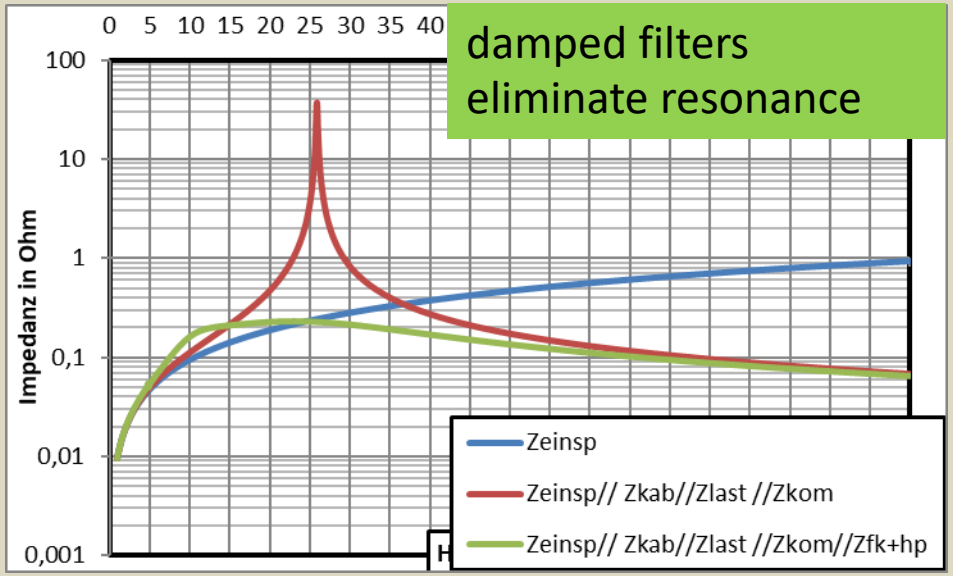
OS-Pegel der Phasenspannungen (Min., Mittel und Max.-Werte)

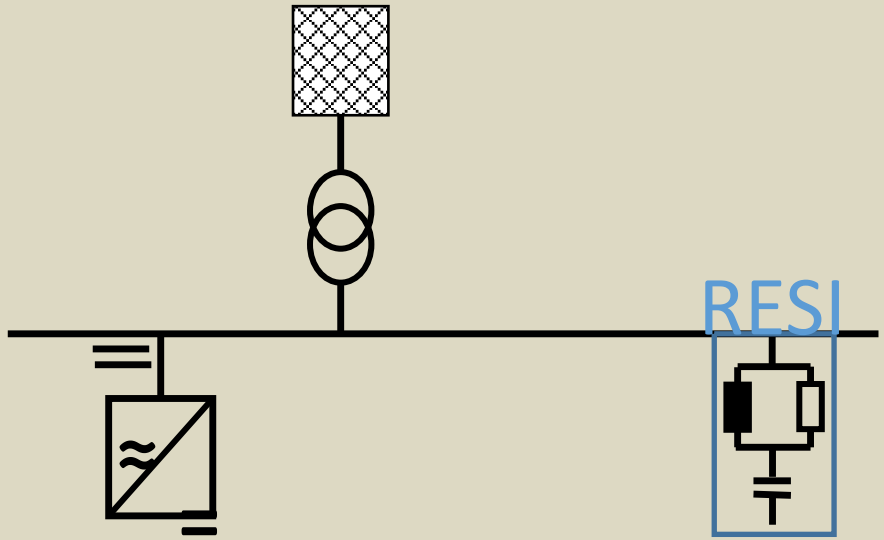
Why are resonances an issue NOW?

Why do we need an RLC Filter (RESI-Filter)?









RESI: Compact

- Size
  B x T x H =

  522 x 424 x 959 mm

RESI-mod:

- Modul in IP 20
- Size
  B x T x H =
  230 x 344 x 1400 mm

GridClass® Technology

RESI in cubicle

- Rittal VX25-cubicle
- Size
  B x T x H =
  812 x 650 x 2100 mm

RESI-HV:
Medium and high voltage

- RESI-HV

How to find us?

- www.dominit.eu
- Hall 13, Booth E 70 (Around the corner)
- 3th and 4th September in Willingen our Power Quality seminar „Always ensure the Power Quality“ (Language: german)

Seminar for e-specialists of all kinds and planning offices on the topic of power quality
(practice-oriented including live measurements, case studies from daily business,
how to ensure compliance with standards)