

Measuring Under High-Voltage in Railways

A PANTOGRAPH MONITORING SOLUTION

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EPIC Meeting on Fiber Sensors at
HBK FiberSensing

19-20 April 2023, Porto, Portugal



Agenda

1. Overhead line maintenance – the beginning
2. Development phase – the prototype
3. Test results – the potential
4. Pantograph monitoring solution - the future

The beginning

OVERHEAD LINE MAINTENANCE

For safe and reliable operation of rail infrastructure, the correct contact between the pantograph and the catenary lines must be ensured.

Irregularities need to be detected on time to prevent severe damage.



The beginning

- Force measurement – EN50317
- Zigzag movement

CONTACT FORCE CALCULATION

$$F_c = \sum_{i=1}^{k_f} F_{Sensor,i} + \frac{m_{above}}{k_a} \sum_{i=1}^{k_a} a_{Sensor,i} + F_{corr,aero}$$

POSITION OF CONTACT LINE

$$x = \frac{F_2}{F_1 + F_2} L - L/2$$

F_c = contact force

$F_{Sensor,i}$ = measured force at sensor i

$a_{Sensor,i}$ = measured acceleration at sensor i

k_f = number of force sensors

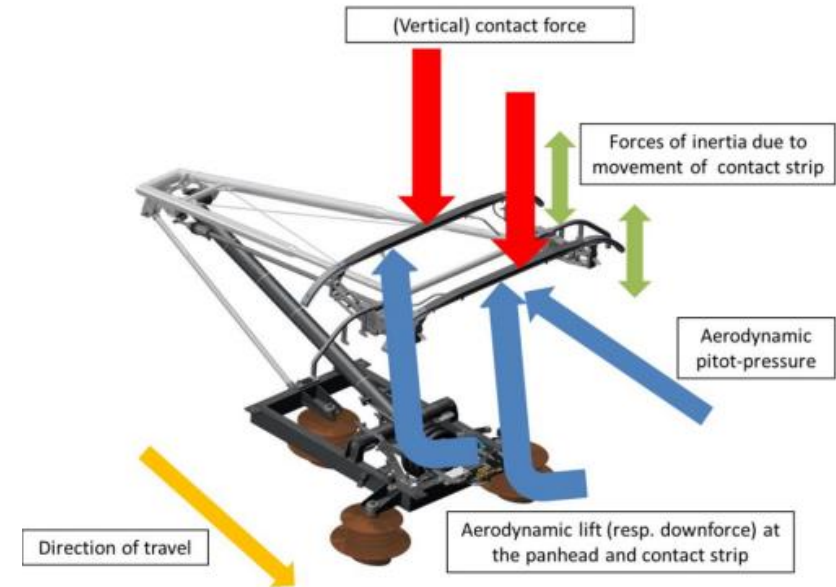
k_a = number of acceleration sensors

m_{above} = mass of the panhead located above the force sensors

$F_{corr,aero}$ = aerodynamic correction force

$x = 0 \rightarrow$ middle position

L = distance between force sensors



The beginning



Austria, 2015



HBM/ÖBB/SIEMENS



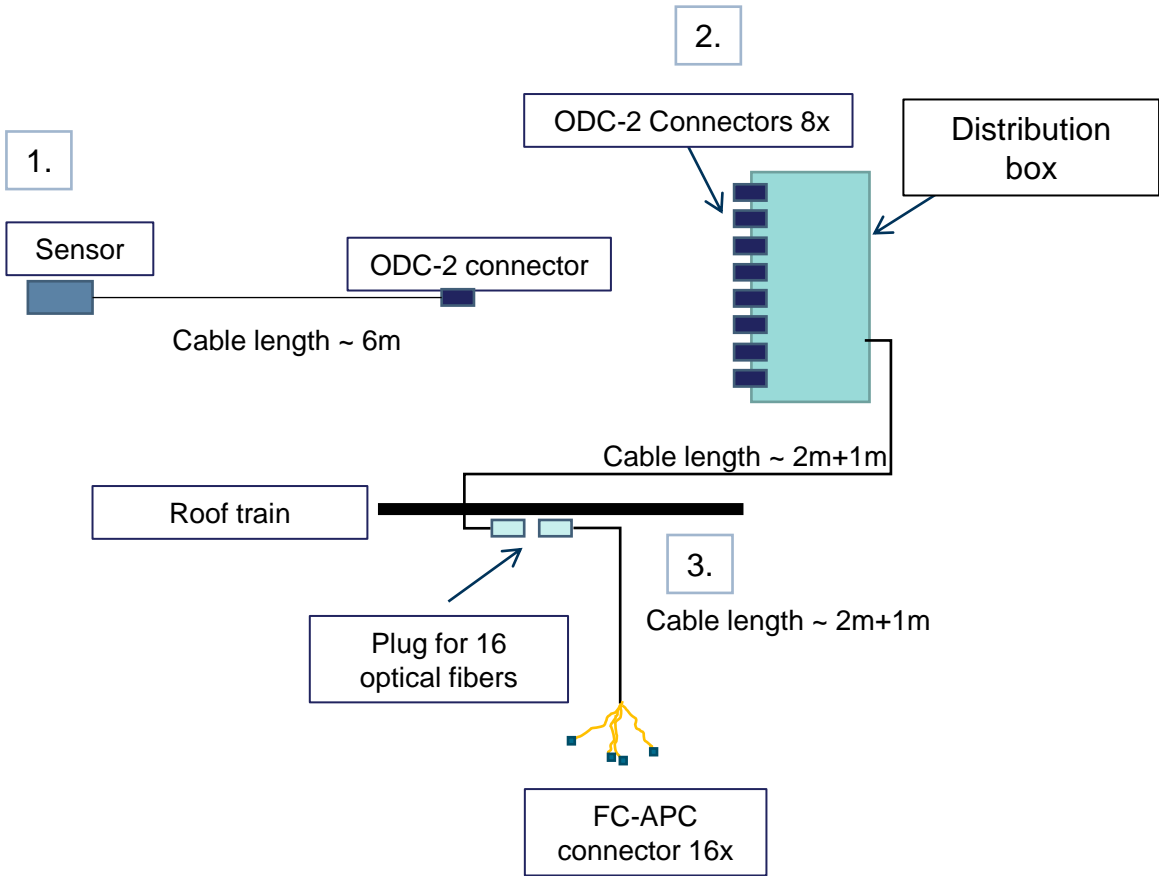
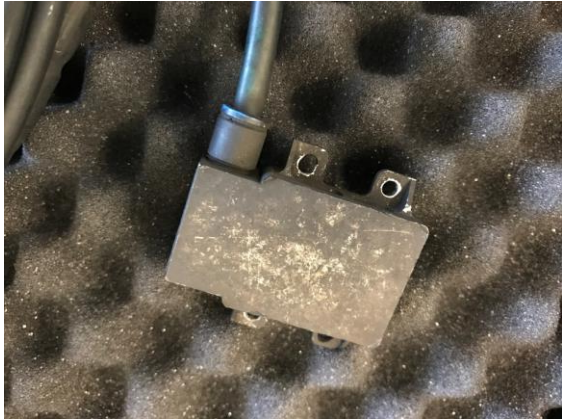
Joint development of a fiber optic-based pantograph monitoring solution



Perfect match for optical
Complete solution
HBK know-how
HBK Austria expertise and experience



The prototype



The prototype

- ▲ Fire safety certification → EN 45545
- ▲ System components protection degree
- ▲ Optical connectors for railways
- ▲ FS65HDA performance
- ▲ Calibration procedure → EN 50317

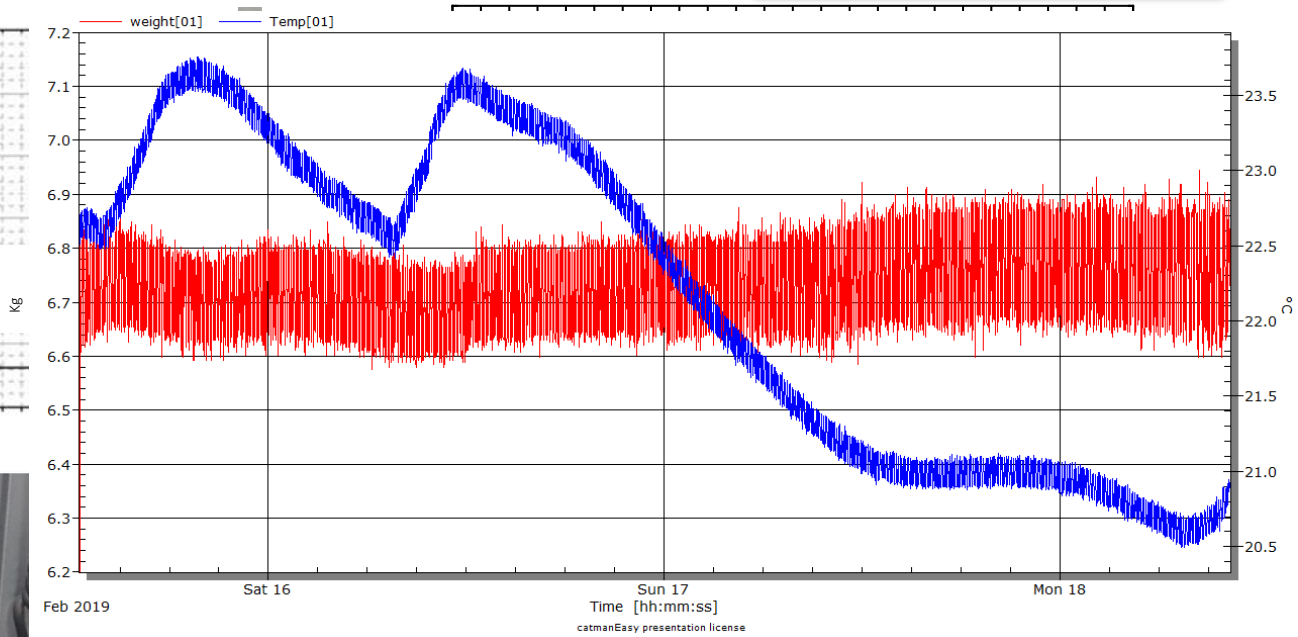


The potential

FS66HDL – Heavy Duty Force Sensor

SENSITIVITY DEPENDENCE ON TEMPERATURE

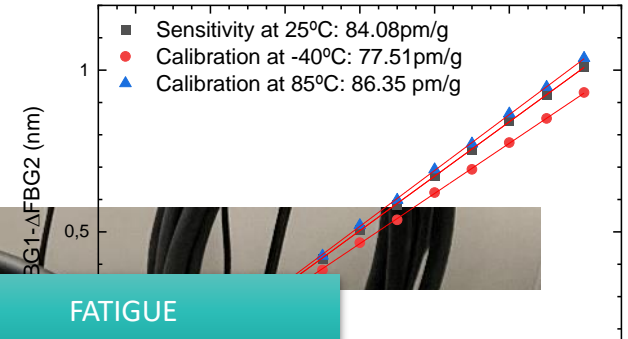
DRIFT



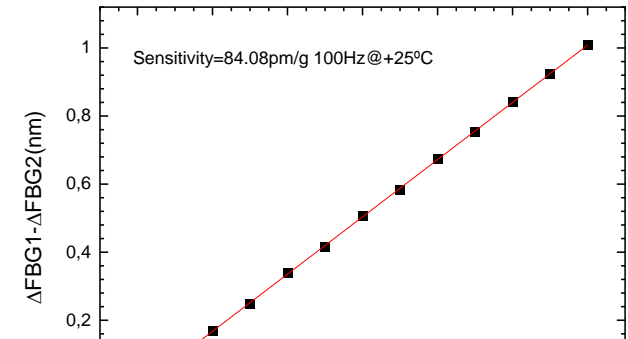
The potential

FS65HDA – Heavy Duty Accelerometer

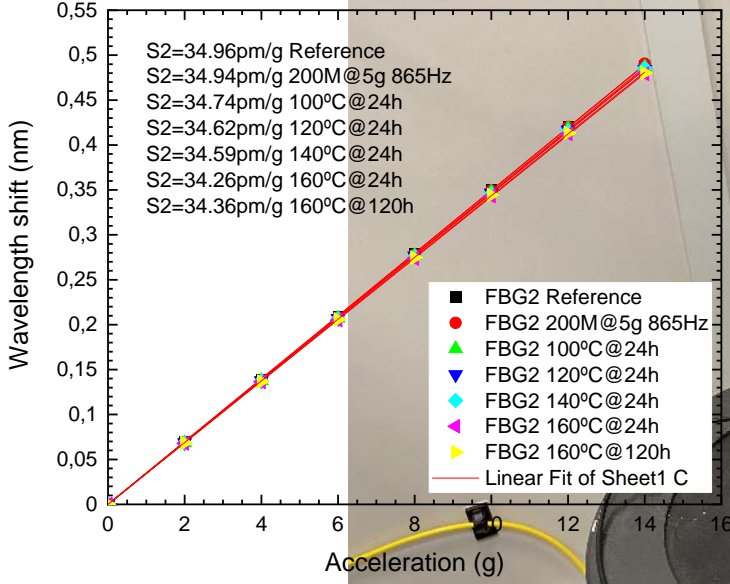
THERMAL RESPONSE



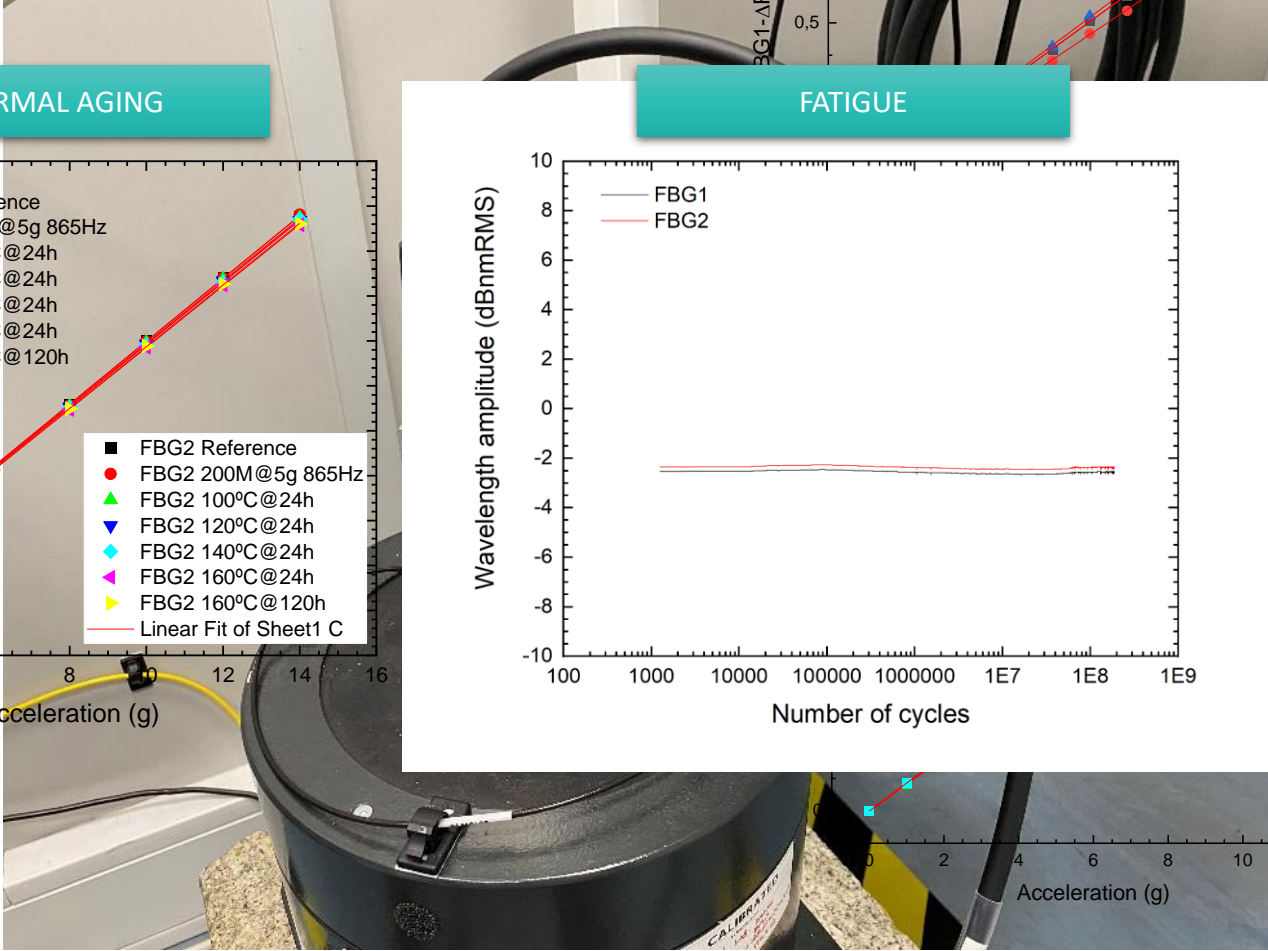
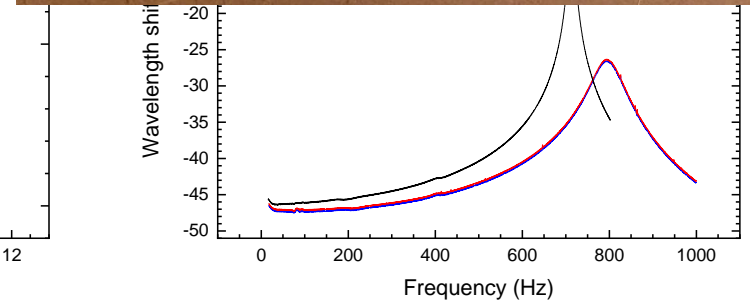
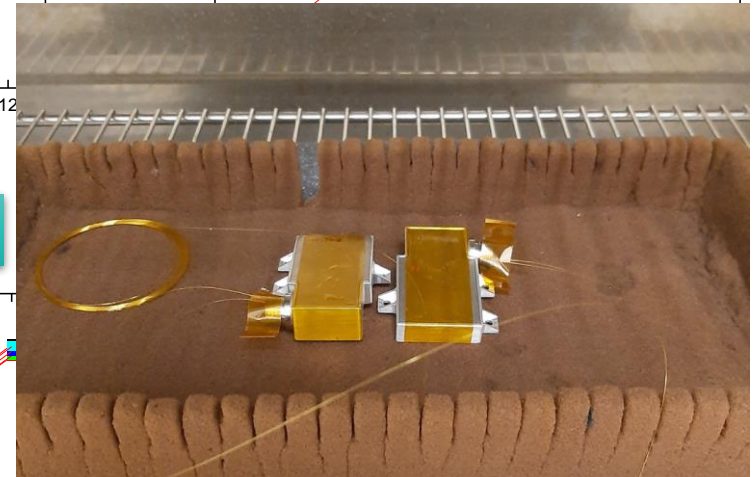
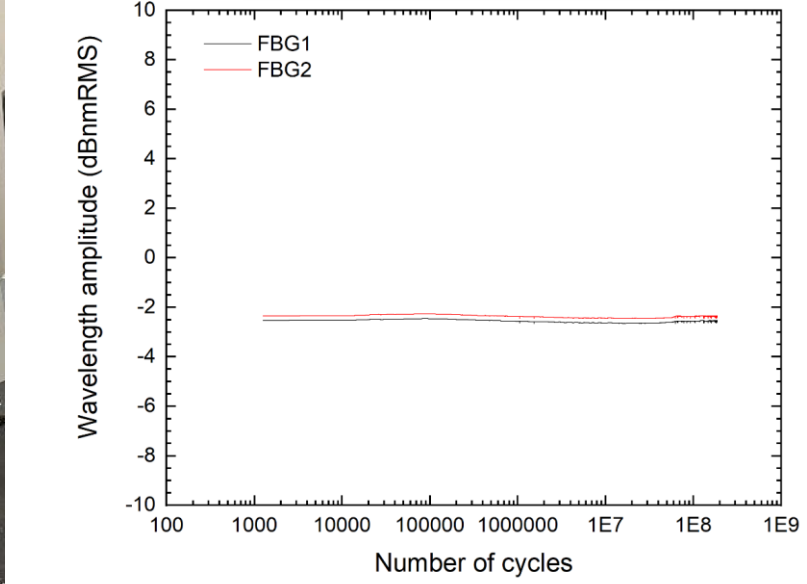
LINEARITY



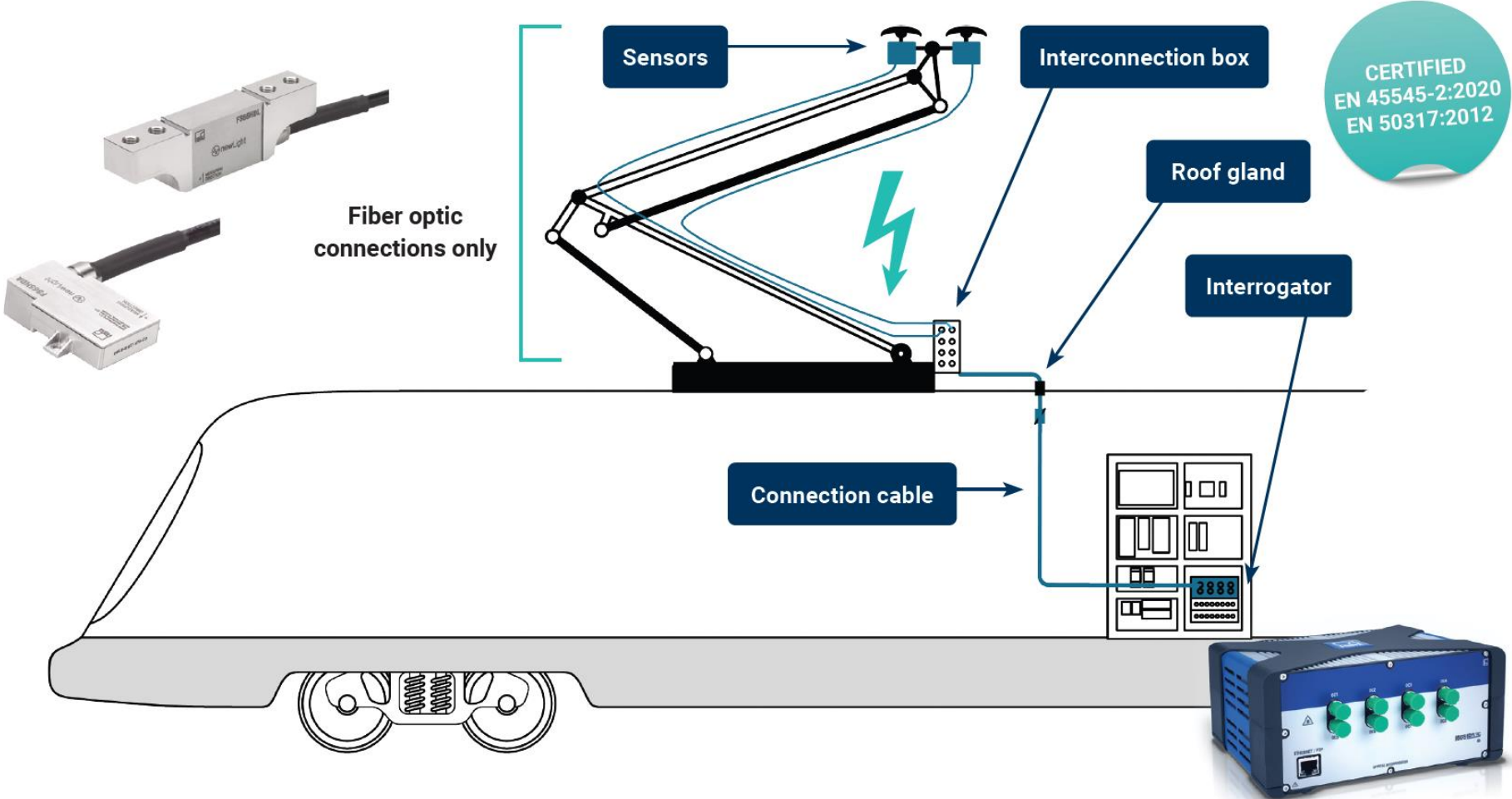
THERMAL AGING



FATIGUE



The future – a pantograph monitoring solution

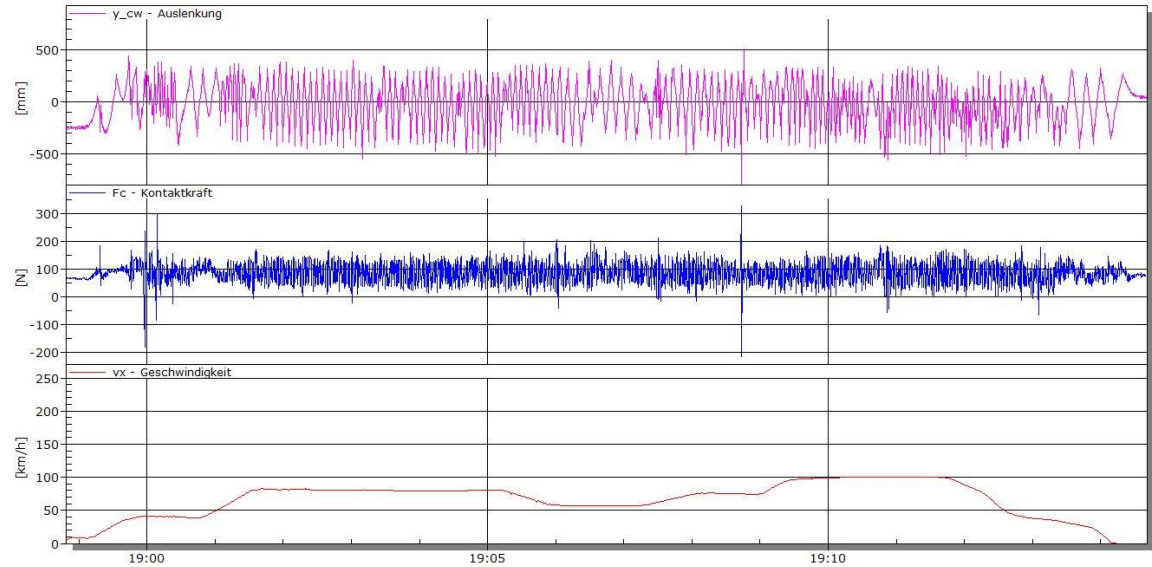
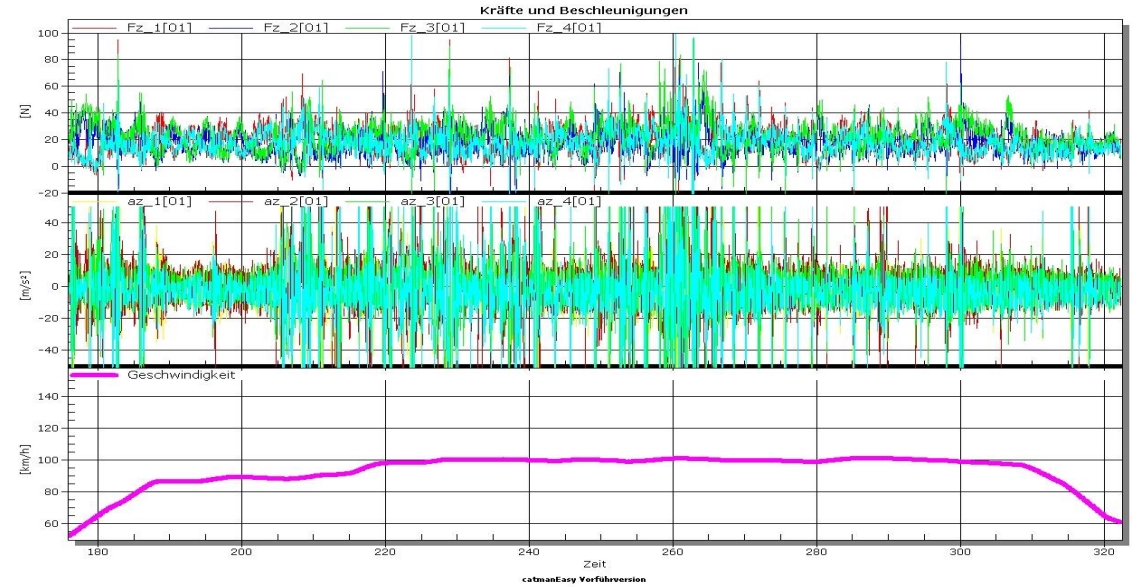
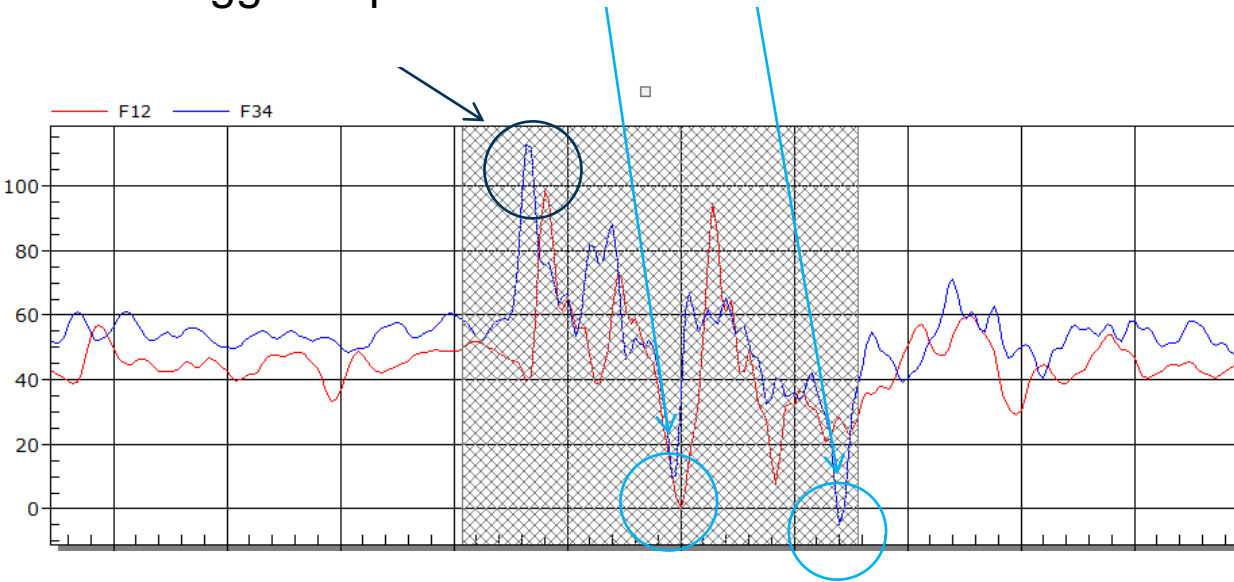


The future

- ▲ Detected problem in overhead line
- ▲ Sum force per contact strip in red and blue

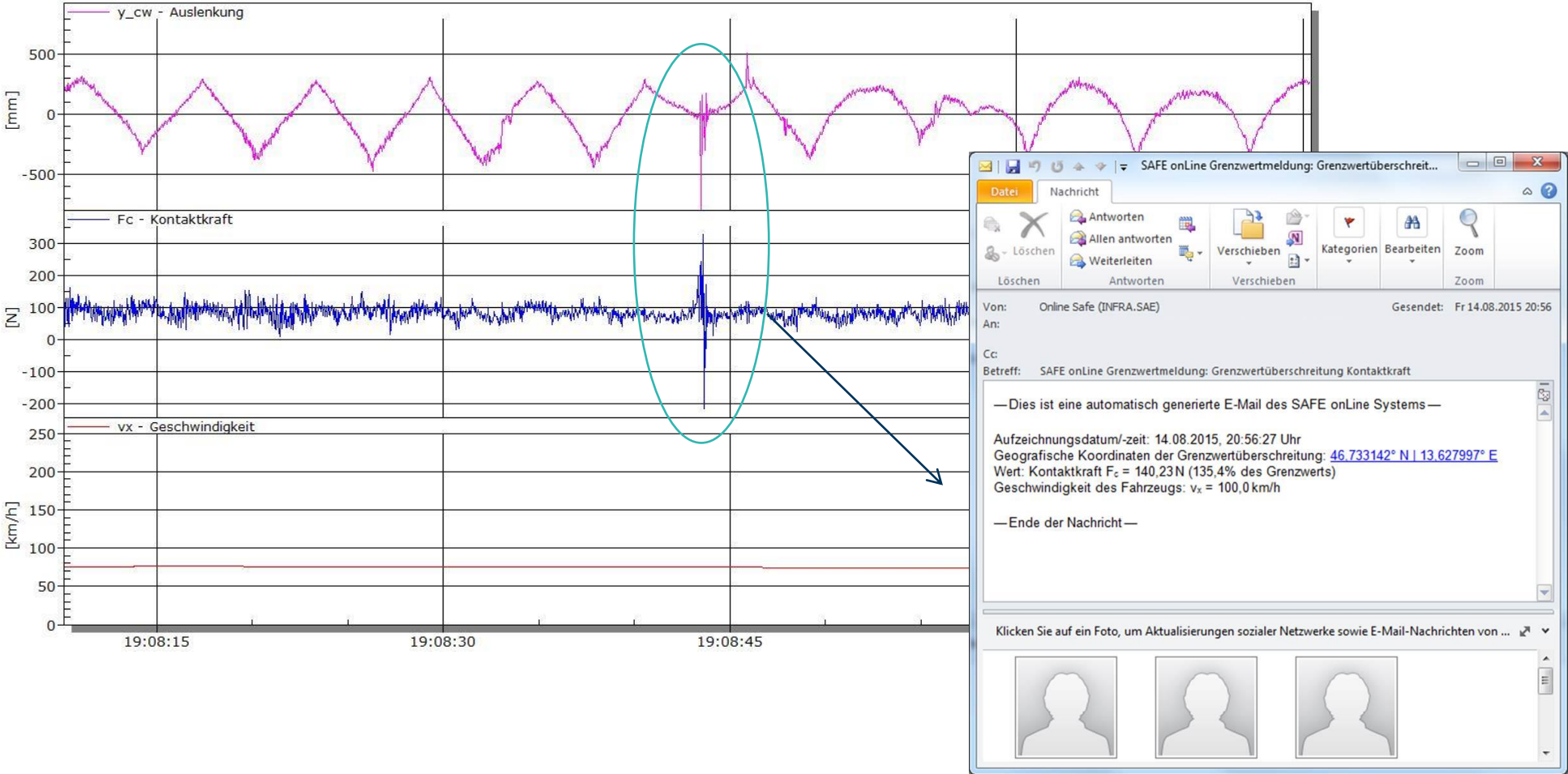
followed by lose of contact (force ≤ 0)

Bigger impact

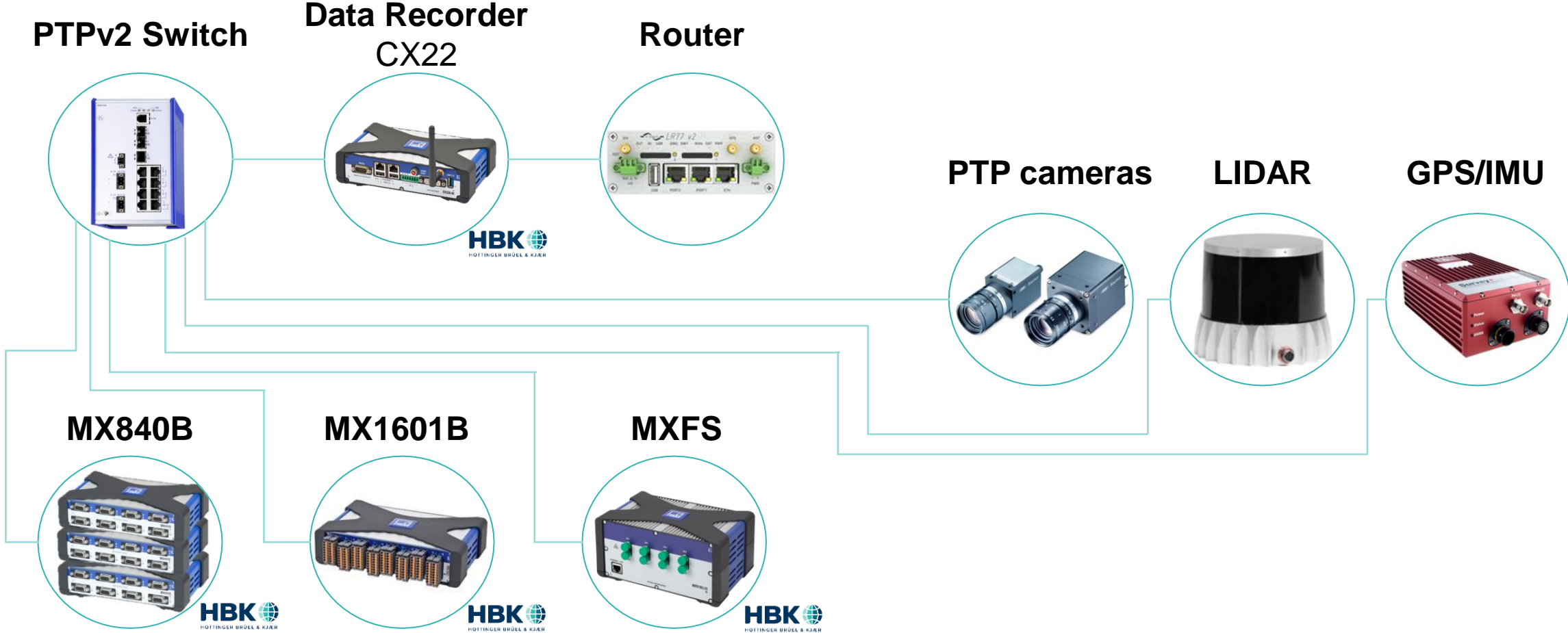


The future

Automatic alarm



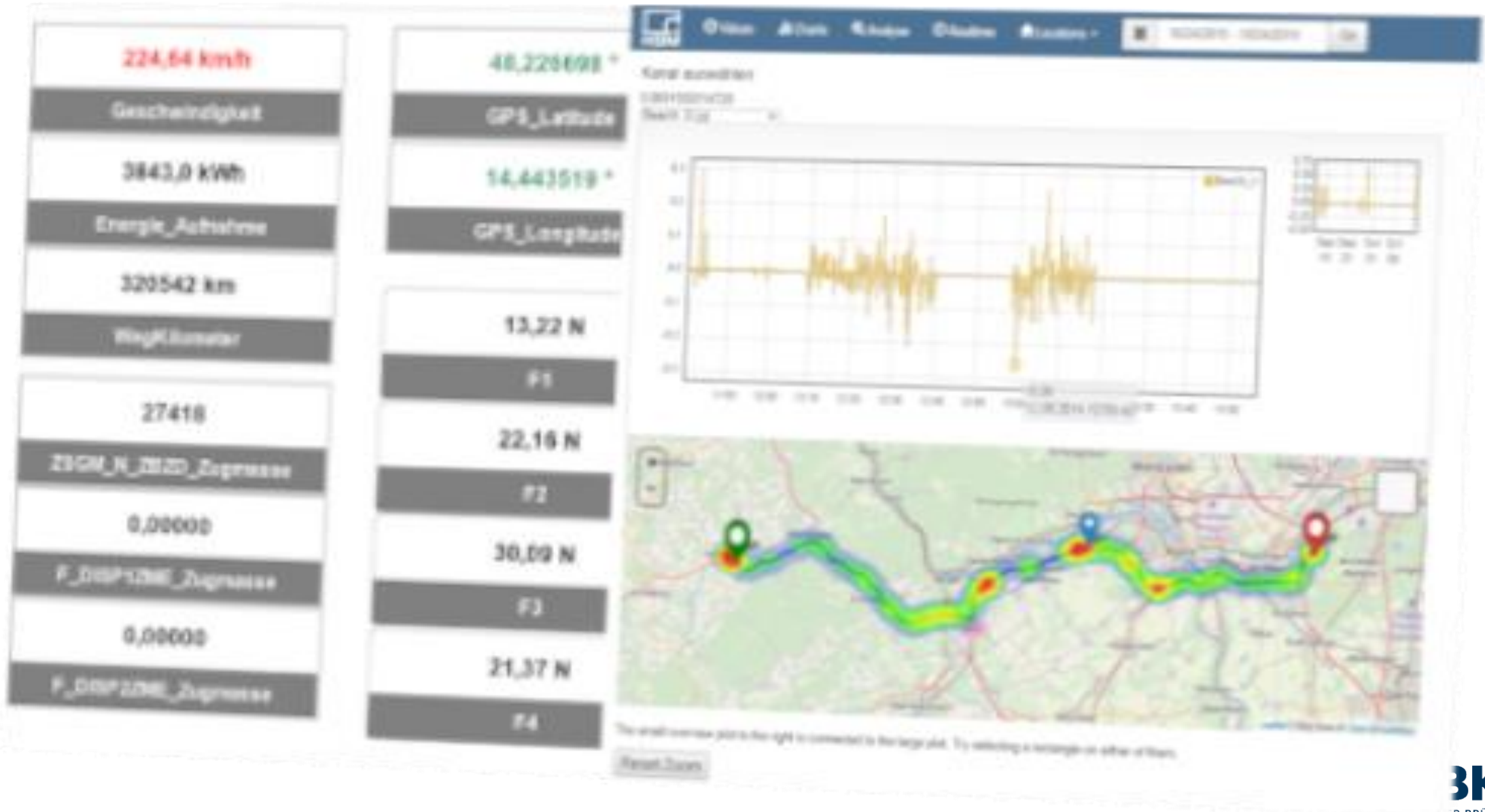
The future



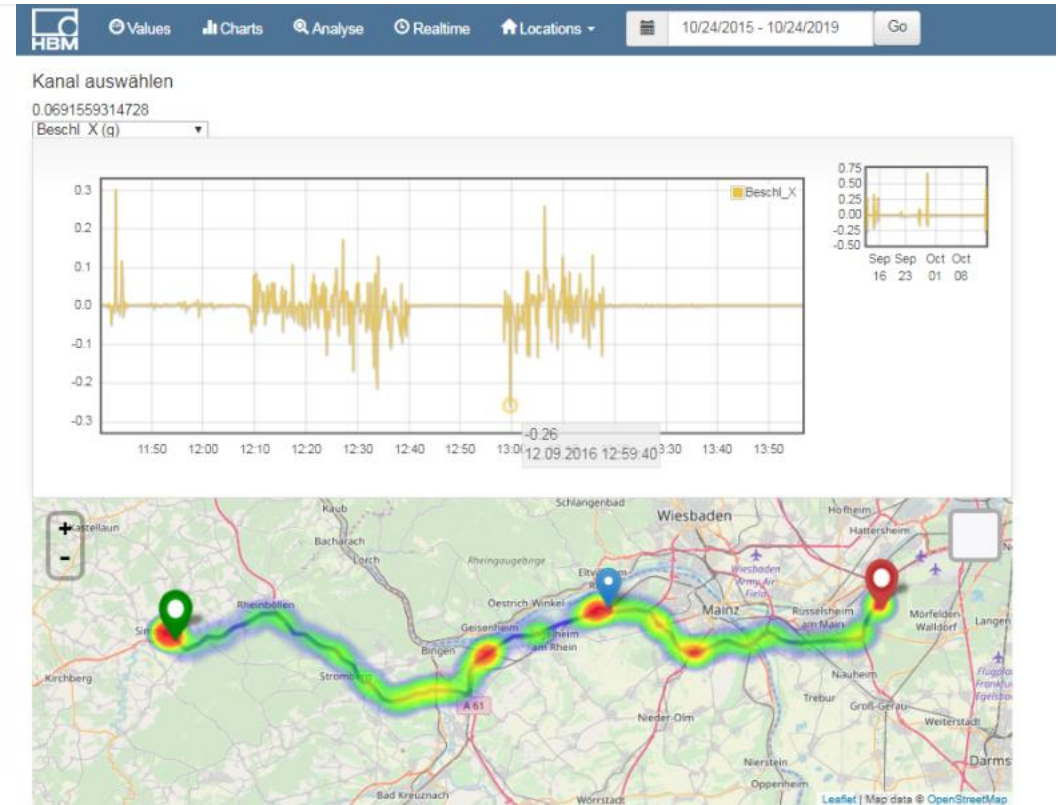
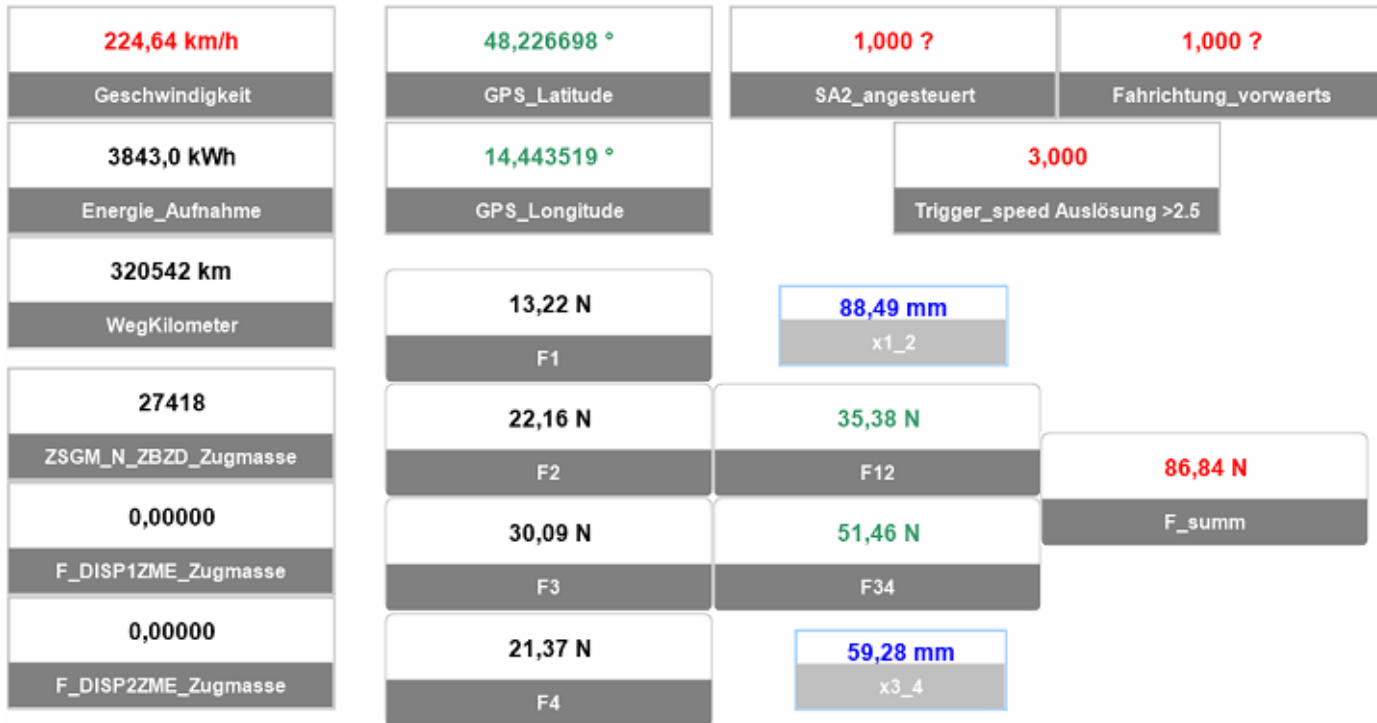
The future



The future

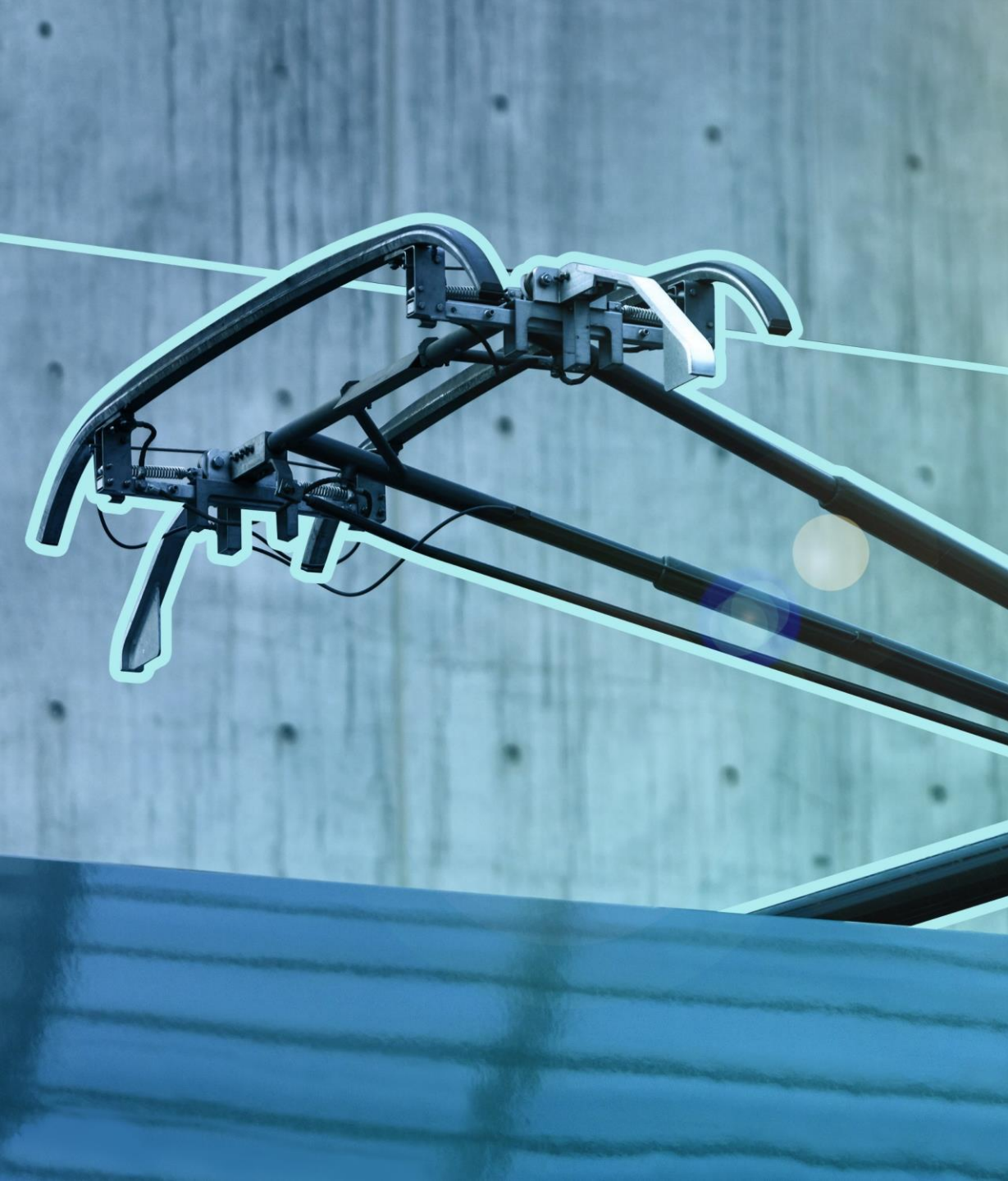


The future



The small overview plot to the right is connected to the large plot. Try selecting a rectangle on either of them.

Reset Zoom



HBK Pantograph Monitoring Solution

- ▲ Typical applications
 - Predictive overhead line maintenance
 - 24/7 overhead line monitoring through regular trains
 - Contact force determination
 - Active pantograph control
 - Homologation and testing of pantograph according to EN50317

Thank You

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