Evaluating turnouts using post-positioned measuring car data inclusive the rail surface signal

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Motivation

Frequent

1,4 turnouts per track kilometre in Austria

Necessary

A network is only possible due to turnouts

Underexplored

Condition monitoring compared to open track

Complicated

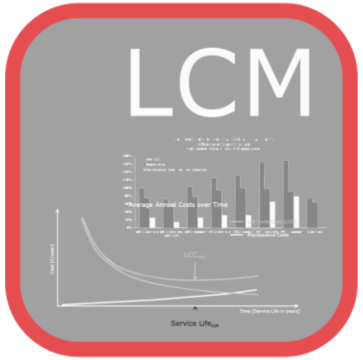
Many (moveable) and highly loaded parts

Cost intensive

Factor 10 compared to the open track

Focus of IMs

According to questionnaires



What is the aim of LCM?

3 main questions of LCM

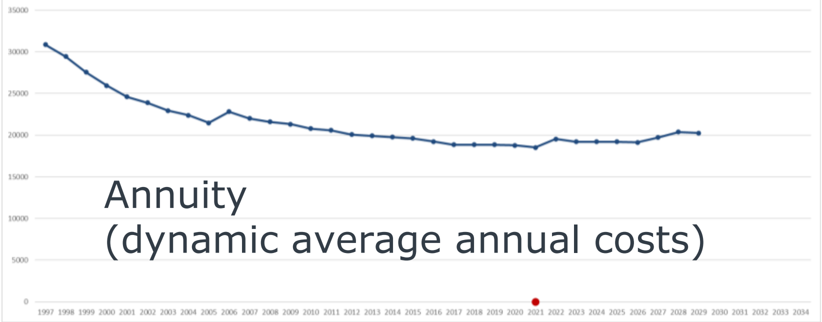
1. Which turnout-components should be chosen? → Regulation / out of scope
2. When to carry out which maintenance task?
3. When should the maintenance be stopped and the turnout renewed?

} Combined evaluation! (questions 2 and 3)

*Assumption: Asset is necessary for the desired operation

LCM of turnouts

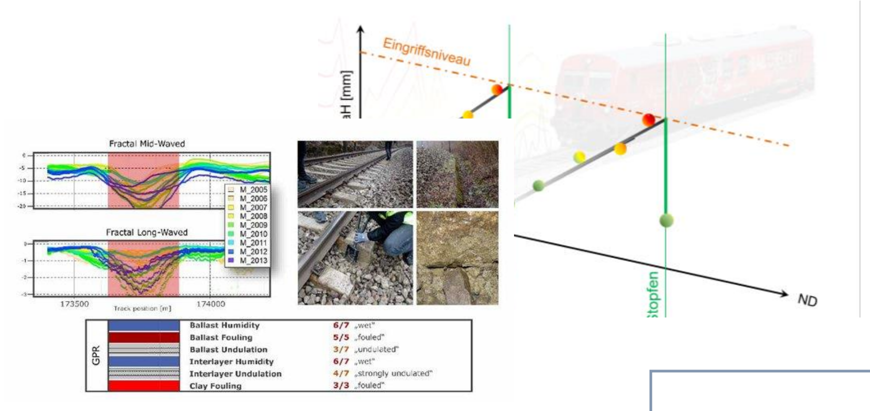
LCM - Turnouts



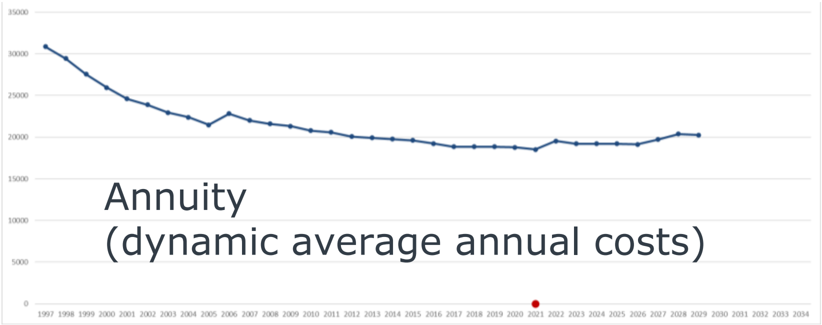
Economic assessment

- Final basis for decision
- Standard procedure
- Requires reliable input data from the technical evaluation

LCM of turnouts



LCM - Turnouts



Technical evaluation

Input →

Economic assessment

- System knowledge required
- No standard solution available
- Based on **measurement data**

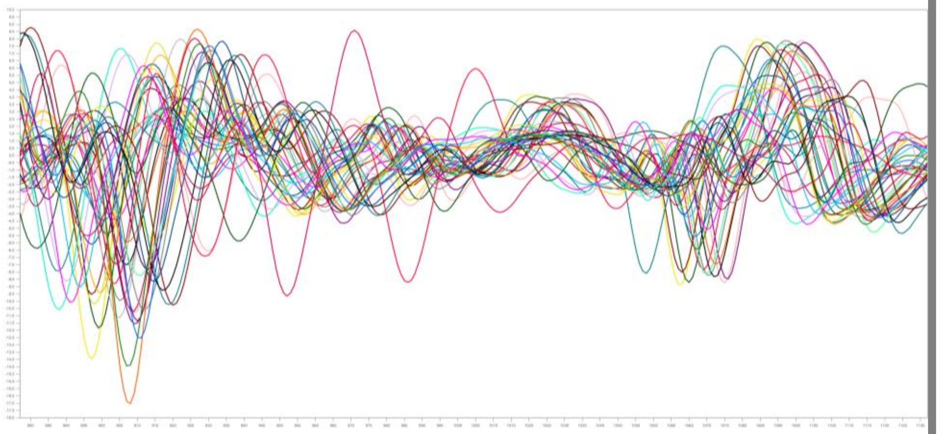
- Final basis for decision
- Standard procedure
- Requires reliable input data from the technical evaluation

Data basis for the technical evaluation of turnouts

Rail measurement car for the open track (OeBB)

Main issue: Data positioning accuracy

Longitudinal level (3-25m) in the turnout area



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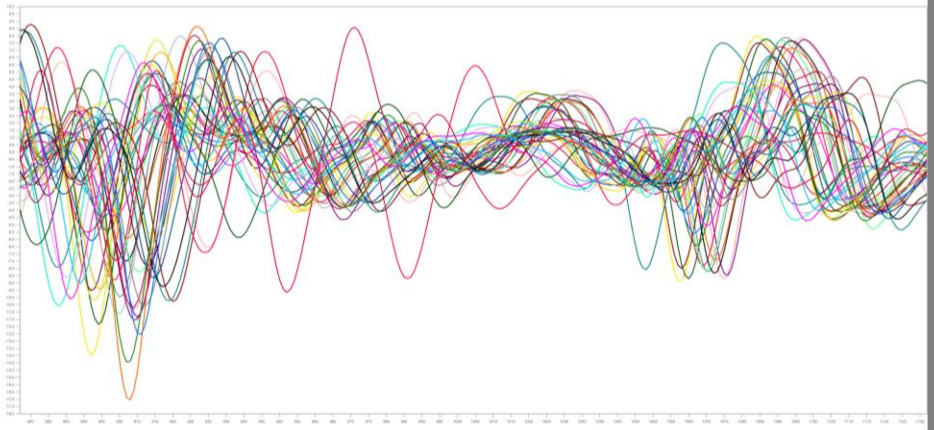
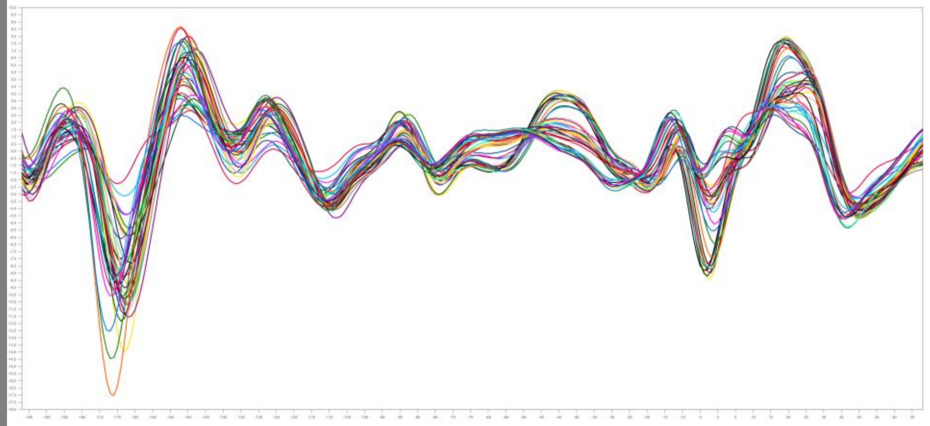


CoMPAcT

Condition Monitoring and Prediction Analytics for Turnouts

@ Fellinger

Positioned Longitudinal level (3-25m)



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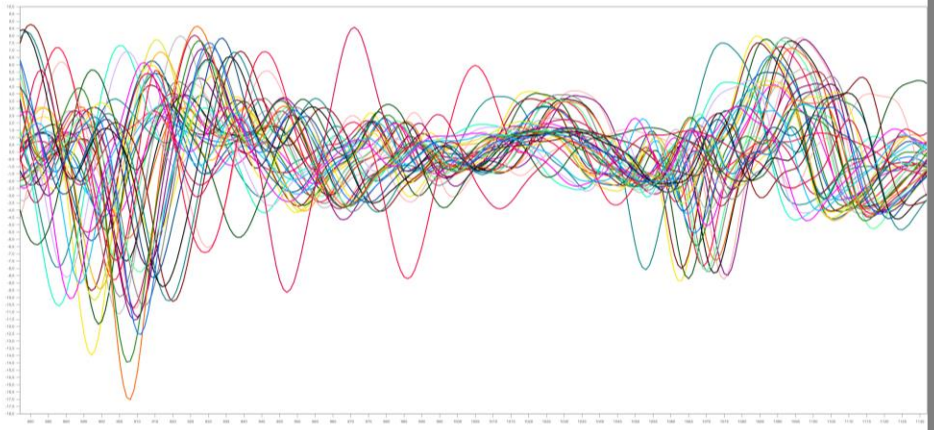

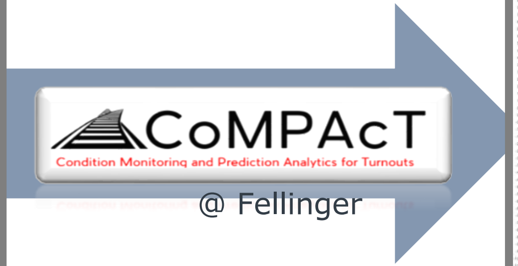

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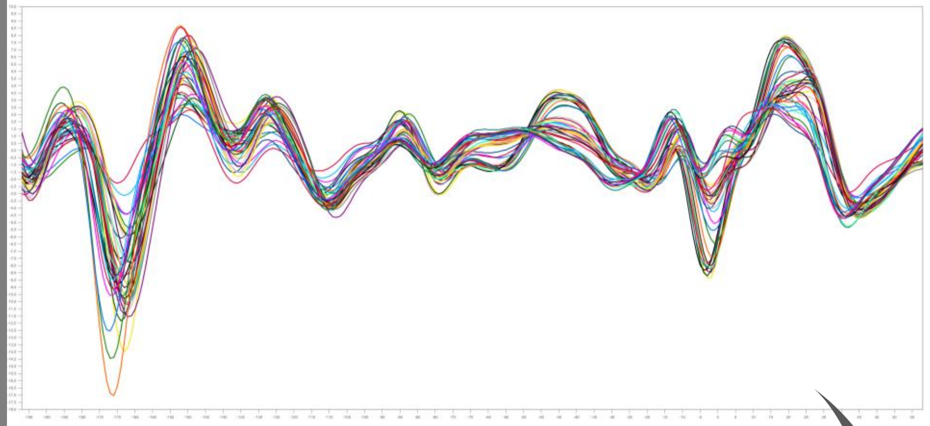
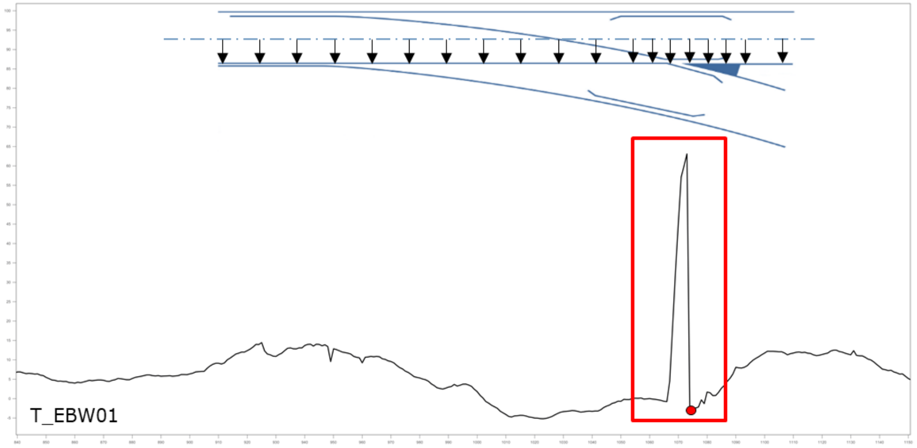


Frog position in half gauge signal



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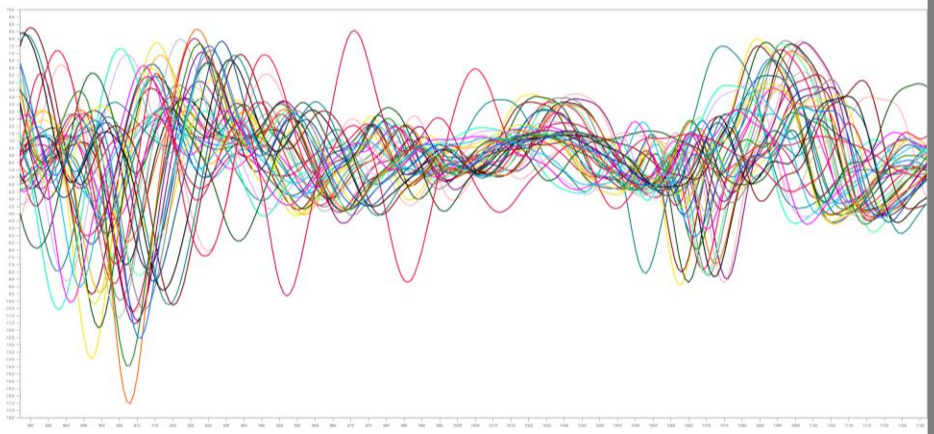

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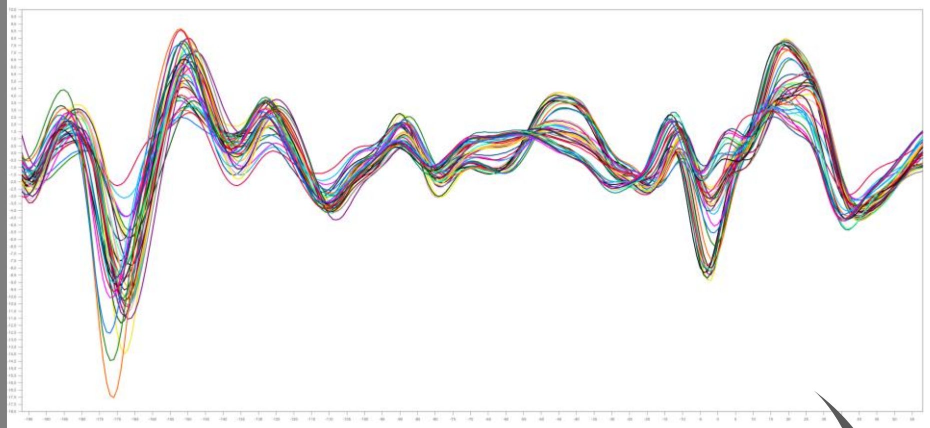

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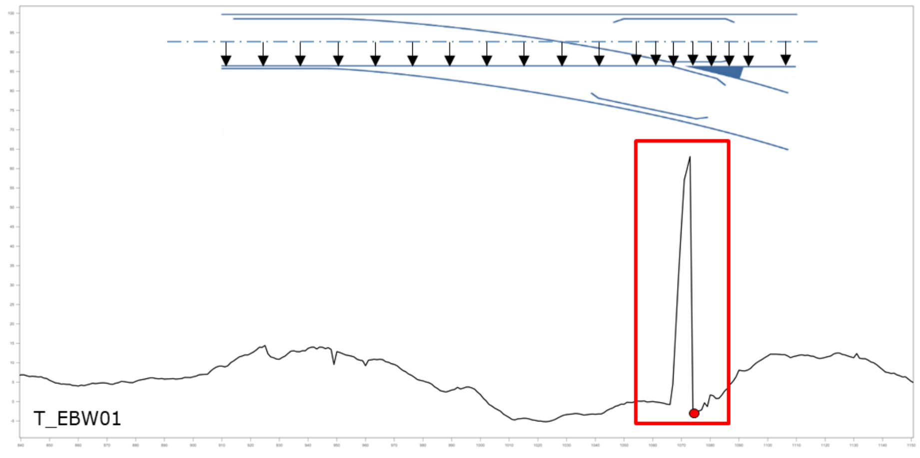
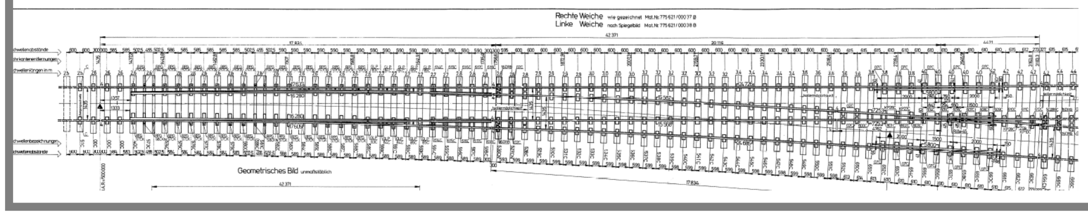


Technical drawing of the turnout



- Relative positioning (+-25cm)
- Absolute positioning (+-25cm)
- Position of turnout components (frog, joints, start, end,…)

} For all relevant signals of the track geometry

Now the measurement data of the measuring car can be used for the condition assessment of turnouts.

The most economically relevant maintenance tasks

2. When to carry out which maintenance task?
3. When should the maintenance be stopped and the turnout renewed?

Ballast

Ballast Cleaning

Tamping

Sleepers + Fasteners

Sleeper Exchange

Screw hole restoration

Metal parts

Exchange

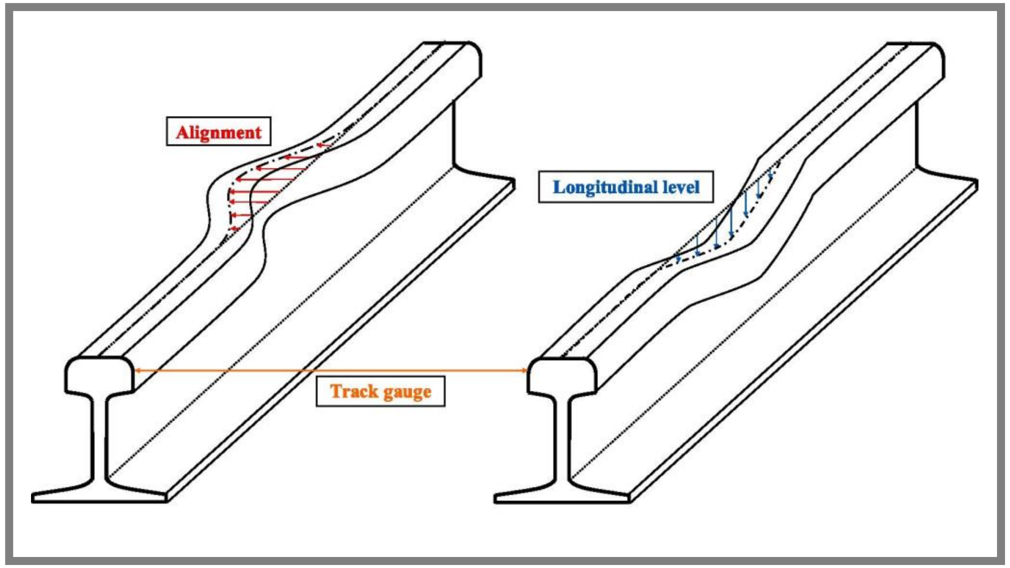
Grinding

Welding

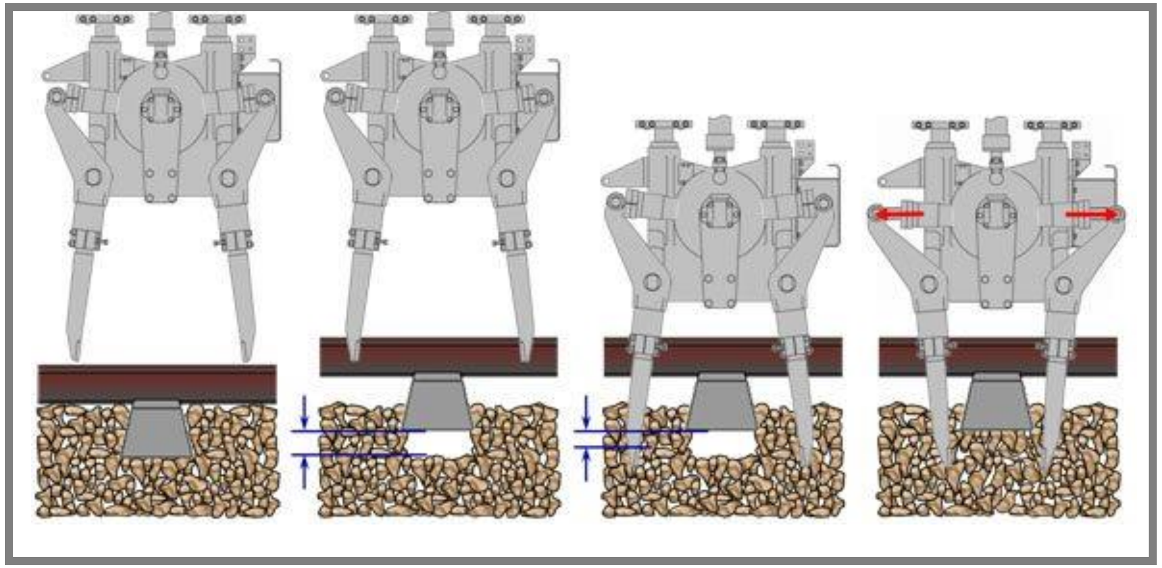
Repairing

Restoration of the track geometry - tamping

At the latest when the track geometry falls below a certain quality level, it must be restored by means of a maintenance process. The levelling, lining and tamping process improves the track geometry and stabilises the track by compacting the ballast.



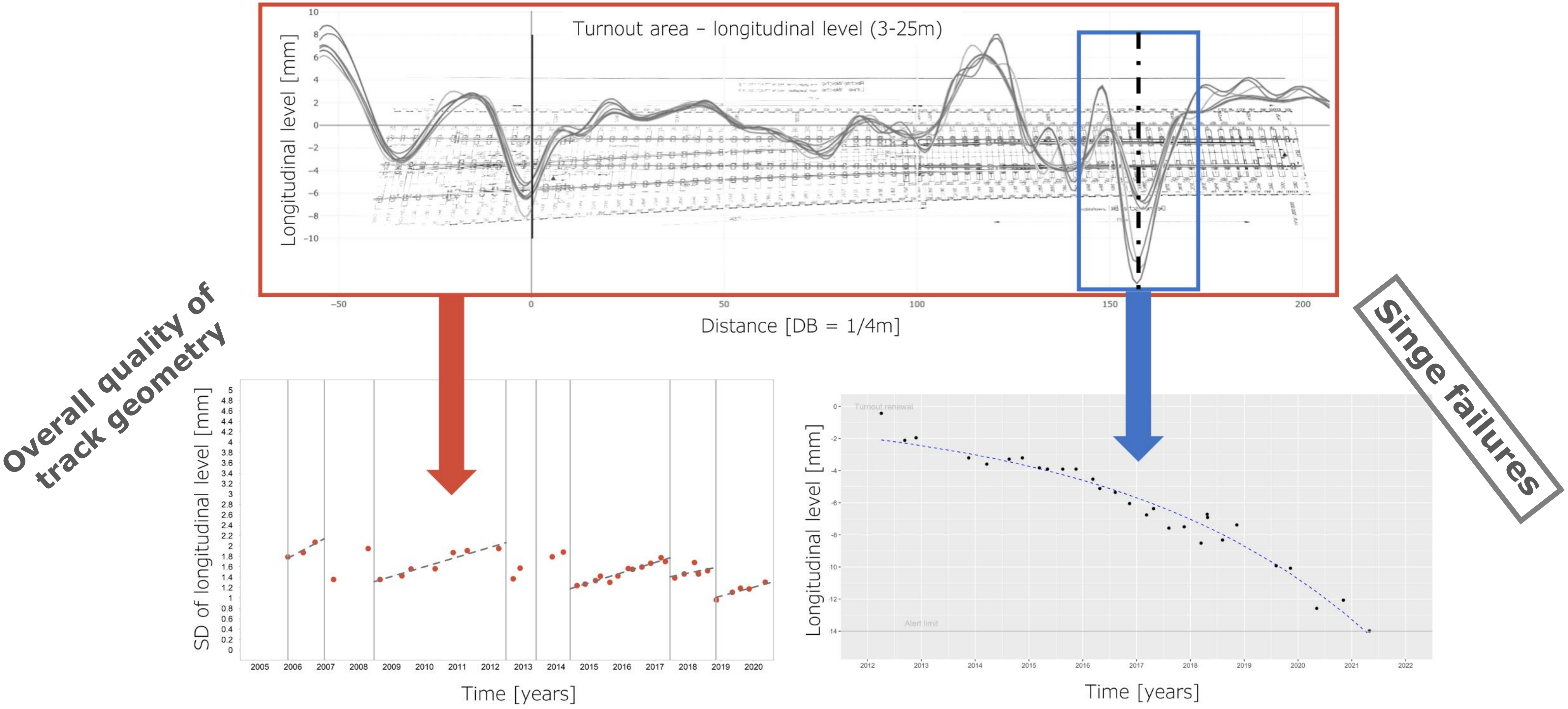
https://www.sciencedirect.com/science/article/pii/S0263224120310794



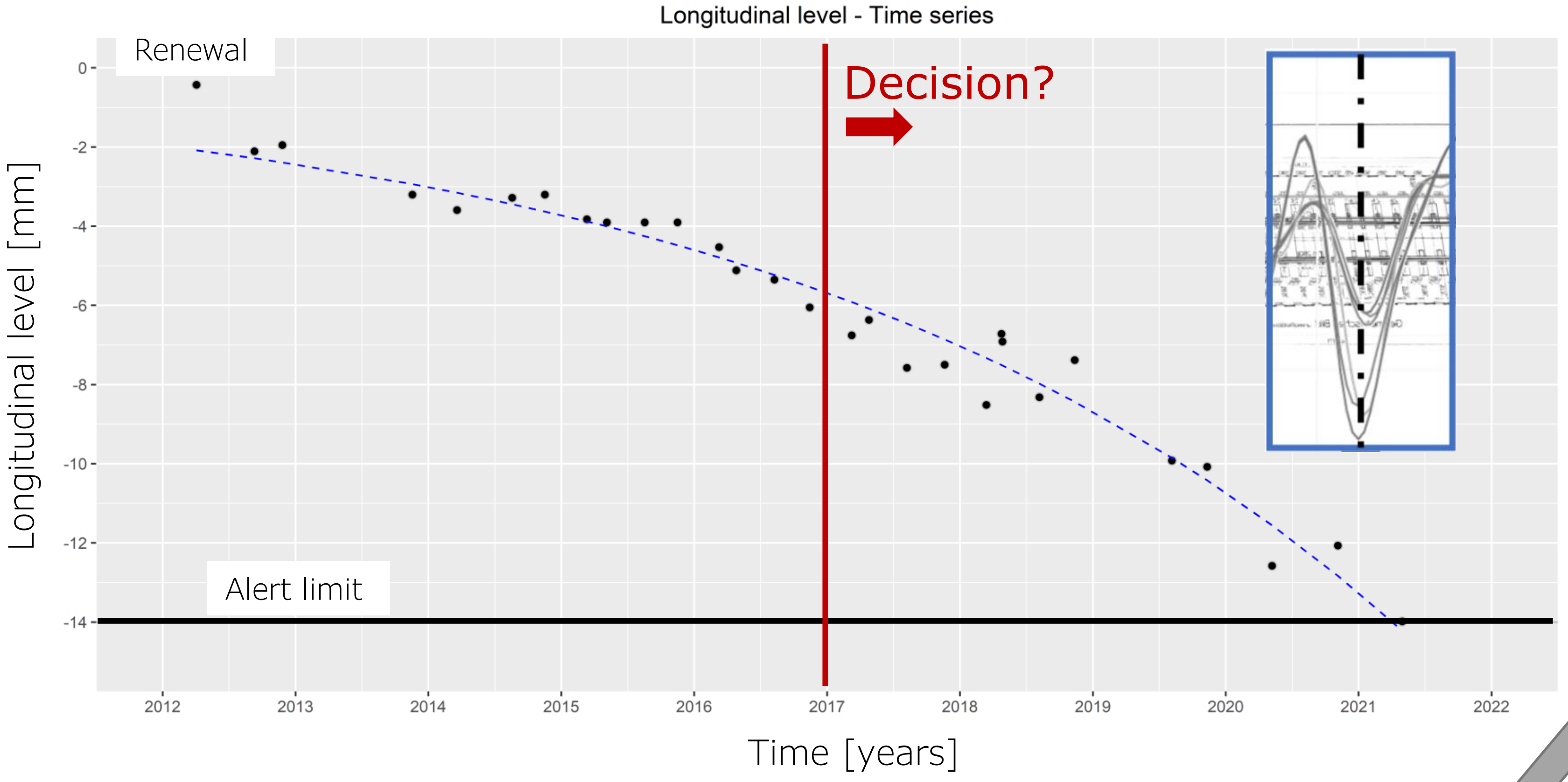
L. Zaayman, "Chapter 6 - Track Lifting, Levelling,Aligning and Tamping," in *Mechanisation Of Track Work In Developing Countries*, 1st ed., 2003, pp. 136–165, ISBN 978-0-620-56289-8.

Prediction of a necessary tamping task

From a technical point of view, tamping tasks of turnouts can be triggered according to one of 2 parameters



Evaluation of a single track geometry failure



- Failure grows in a superlinear way
- Waiting for the alert limit?
  - The failure will return
- Shifting the limit upwards?
- Is this preventive maintenance?
- Dealing with symptoms!

The correct questions must be:

- **Technical:** Why is the single failure at this position?
- **Economical:** Could it be useful (cheaper) to treat the cause rather than the symptoms?

More data necessary

The rail surface signal

Laser Sensor

The sensors used to measure the rail corrugation are Optimess triangulation sensors, type OMS-18006. Refer to the "OPTIMESS OMS 18006 Operation Manual" for details.

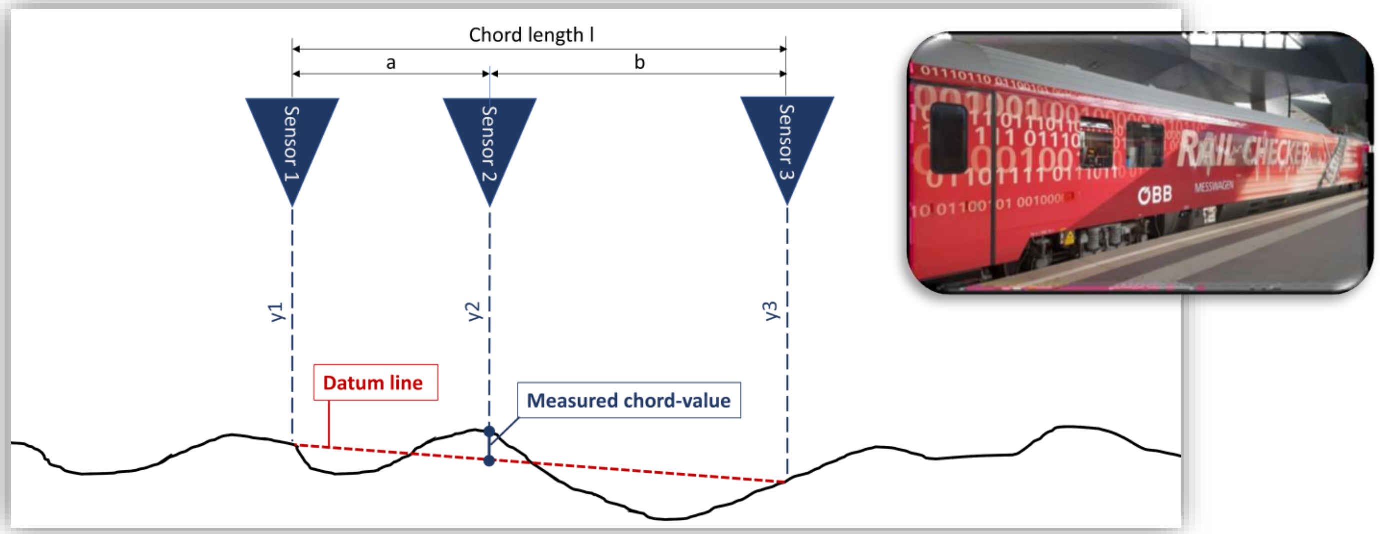
A typical sensor has following specifications:

- Laser :	3b / 650 – 660nm / 10mW
- Spot Size:	0.2mm
- Measuring Range:	32mm
- Standoff:	120mm
- Receiver:	CCD line
- Bandwidth:	16kHz
- Filter Type	No Filter
- Resolution:	6µm
- Reproducibility:	30µm
- Output Range:	±10V, linear, isolated analog output
- Operating Power:	±15V, 150mA
- Housing Protection Class:	IP65
- Temperature:	-20°C… +50°C
- Weight:	ca. 900g

The exact specifications per sensor may vary, to see the specific specifications per sensor, refer to the manufacturer issued certificate delivered with each sensor.

Laser Sensor Speed and Orientation

The sensors have a bandwidth of 16 kHz and allow, when sampling in 5mm distance increments, measuring speeds of up to 250km/h.



Sampling Rate: 5 mm
Measuring speed: 250 km/h
Wavelength range: 20-1000 mm

Main issue: Data positioning accuracy … again

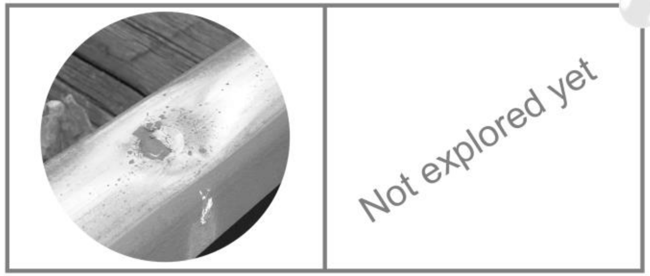
Data plausibility check

Data filtering

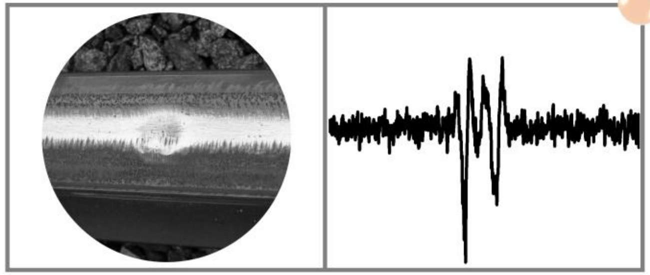
Enhancement of the positioning methodology

Link to the technical drawing

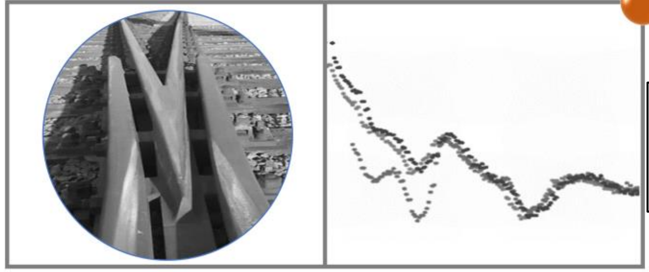
Research field – Rail surface signal



Skip marks

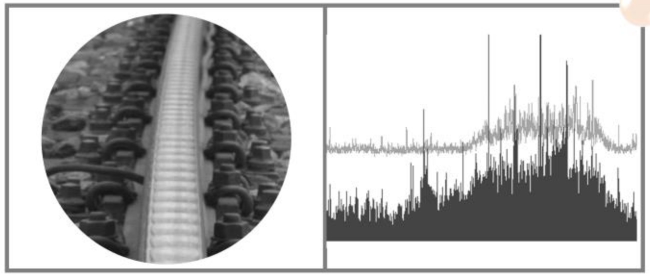


Squat detection

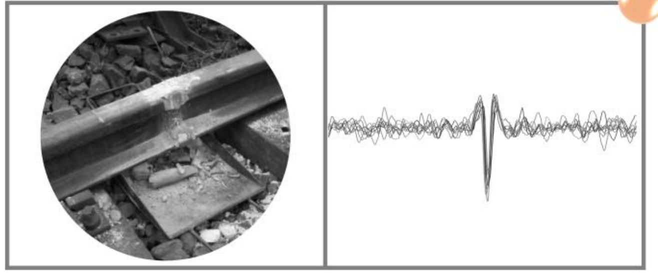


Turnout components

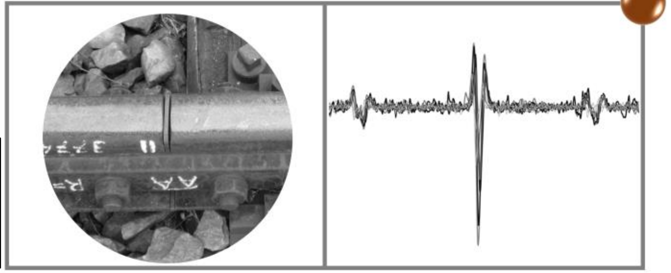
FFG Rail4Future
Resilient Digital Railway Systems to enhance performance



Rail Corrugations



Welding joints



Insulated rail joints

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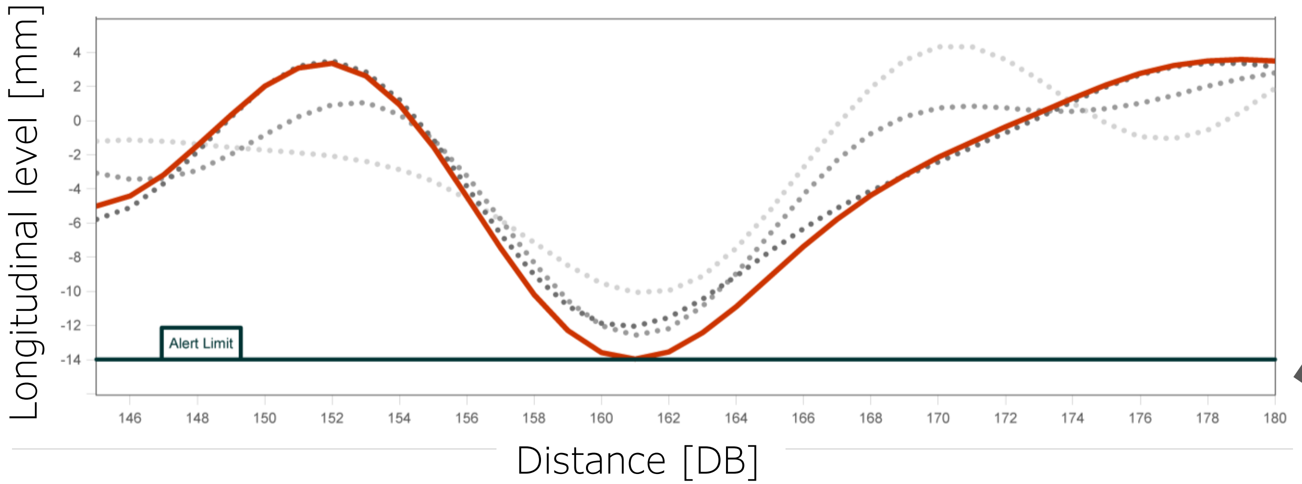
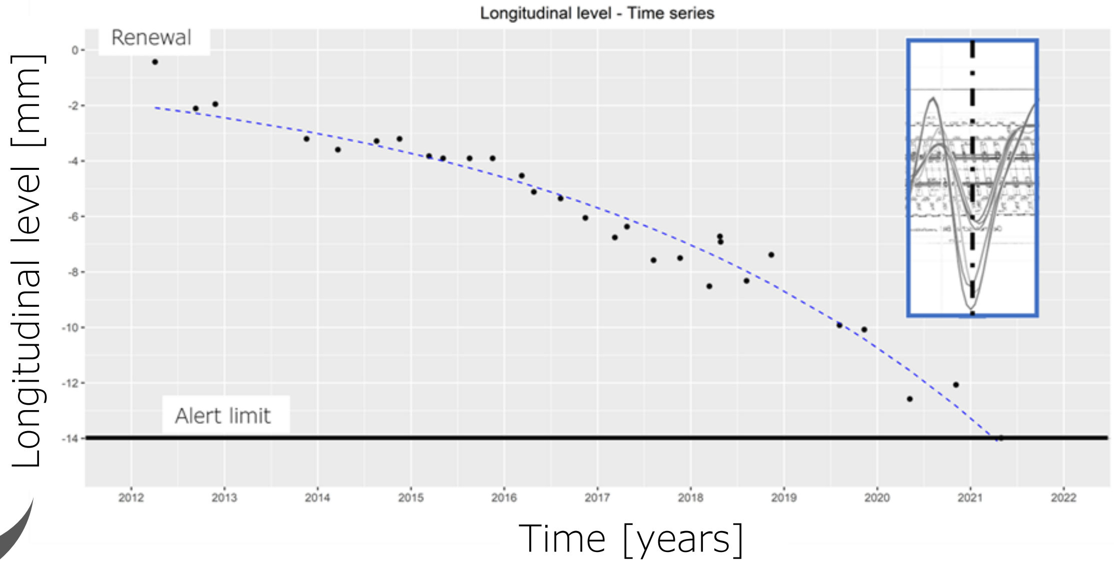
Resilient Digital Railway Systems to enhance performance

Holistic evaluation: Track geometry – Rail surface

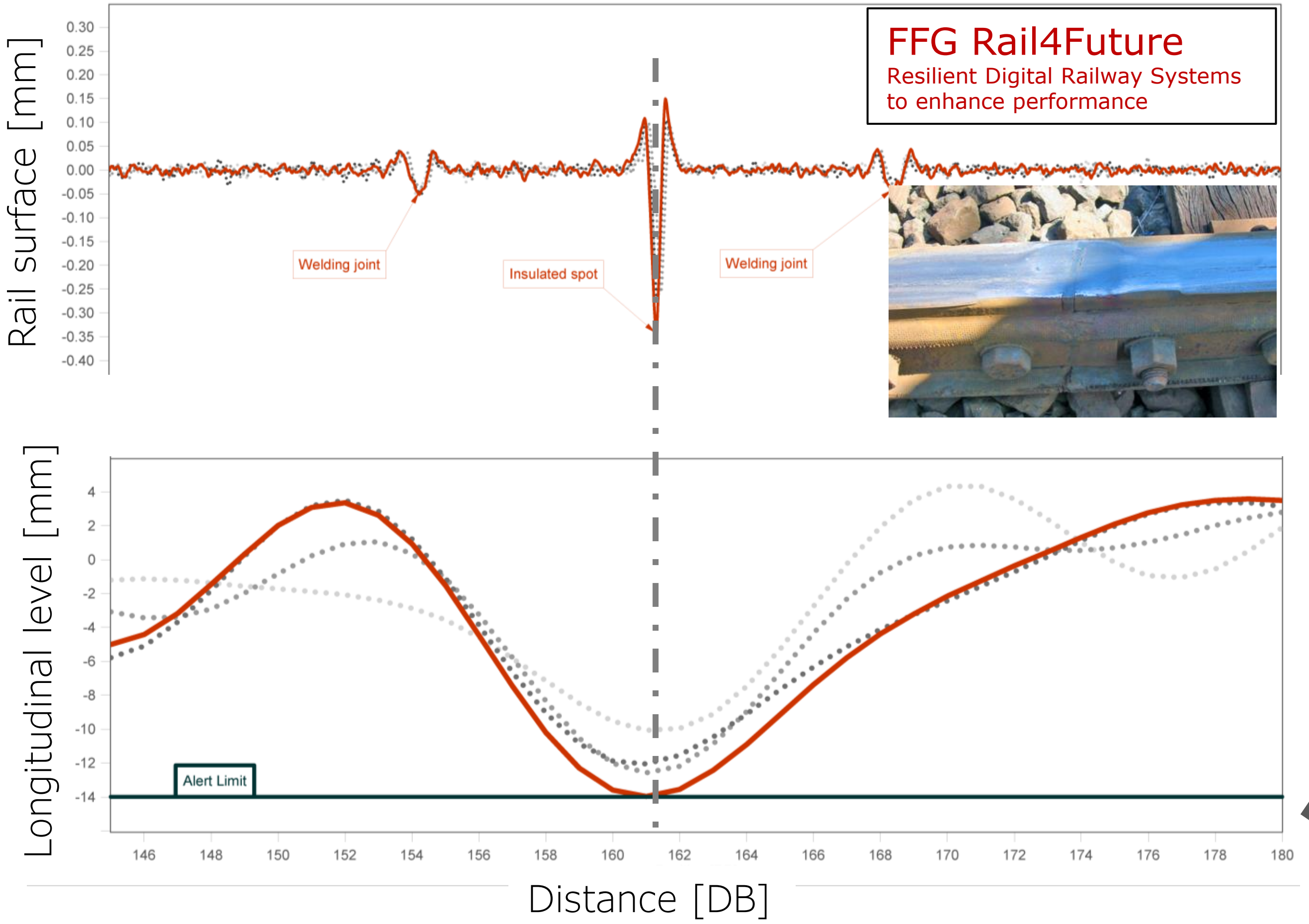
1. Detection of the single failure in the track geometry

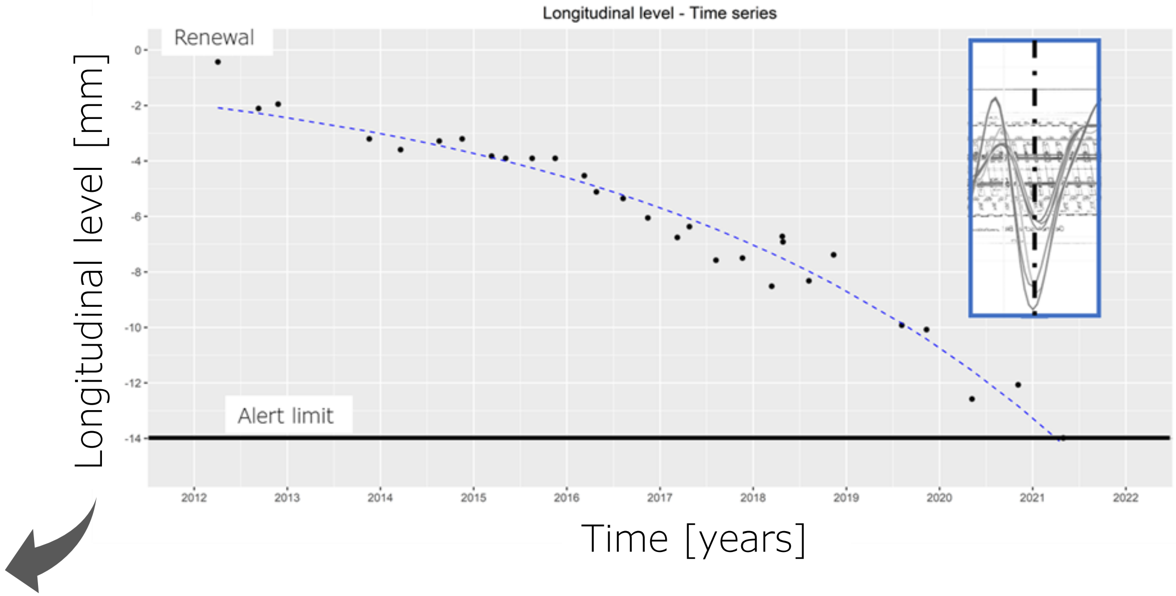




Holistic evaluation: Track geometry – Rail surface

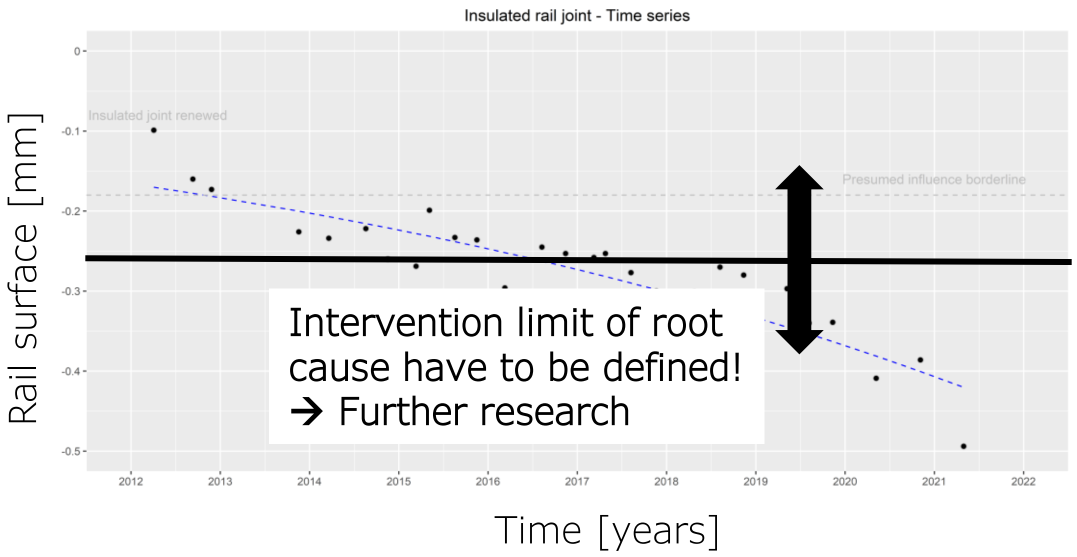
1. Detection of the single failure in the track geometry
2. Detection of the cause of the fault (in this case the increased load input due to a worn insulated rail joint)

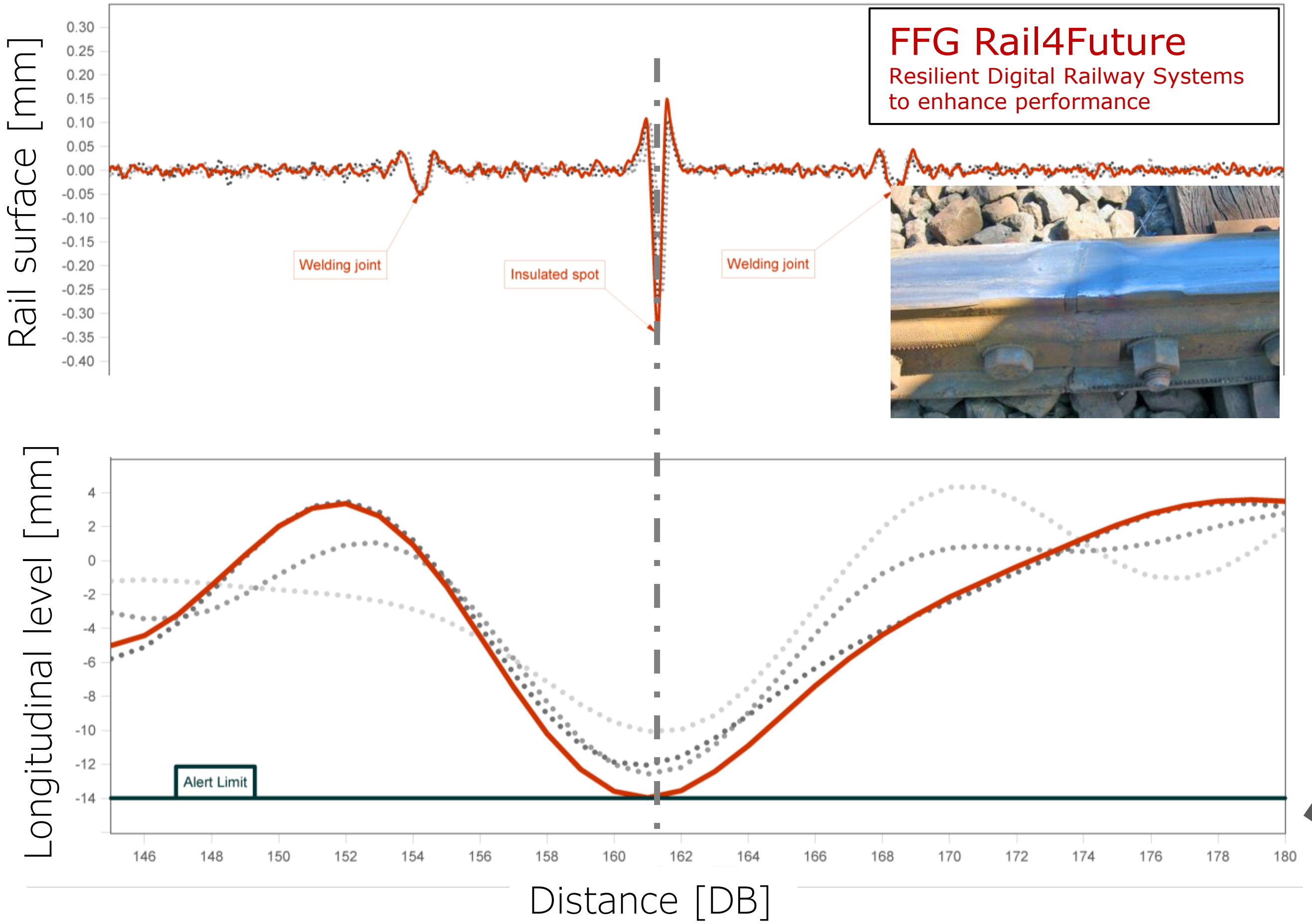


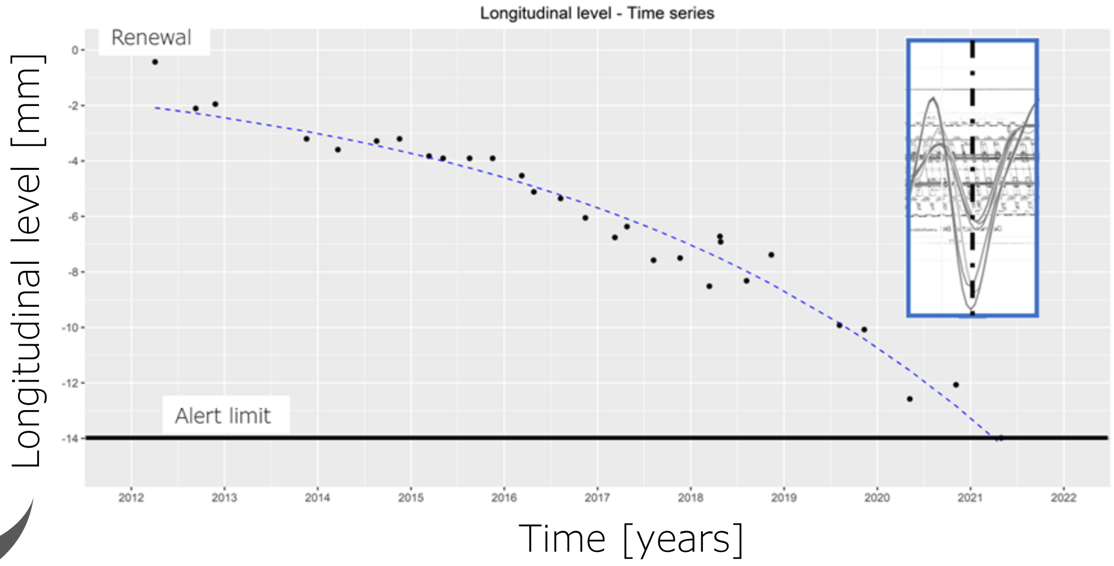


Holistic evaluation: Track geometry – Rail surface

1. Detection of the single failure in the track geometry
2. Detection of the cause of the fault (in this case the increased load input due to a worn insulated rail joint)
3. Technical/economic evaluation of the failure treatment (symptoms vs. eliminating the cause)







Summary

1. Turnouts are complex and costly, but they are also necessary for a network. Proper LCM can lead to significant cost reductions for the railway system.

2. By using appropriate post-positioning methods, measurement car data of the track can also be used for the LCM of turnouts.

3. LCM (which includes maintenance planning) should also include the root cause auf single failures → preventive maintenance.

4. The rail surface signal can provide information about possible failure roots originating from the rail.

5. Other failure origins have already been dealt with in the past (ballast, subsoil). However, differences in system stiffness are not yet directly assessable.

6. Future research is going to find an financial optimum between correcting symptoms and improving the origin of the problem.

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