



SIEMENS



Bangkok, Mai 2016

APMP TCAUV Workshop

Applied Measuring Technology on Metro Systems

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Applied Measuring Technology on Metro Systems

Introduction of trainer

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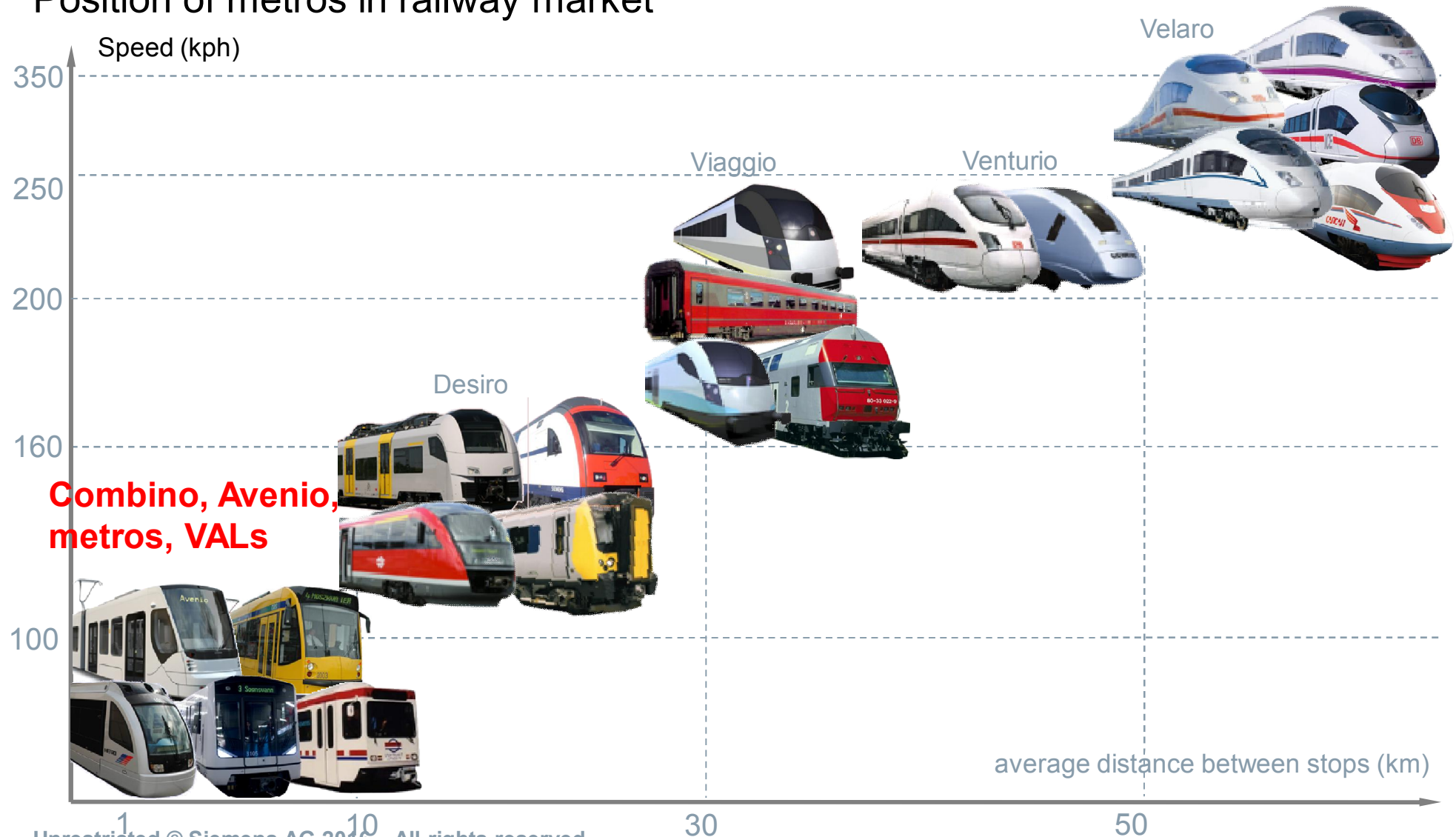
Agenda

- Type of tram and metro
- Examples of best practice/products/platforms

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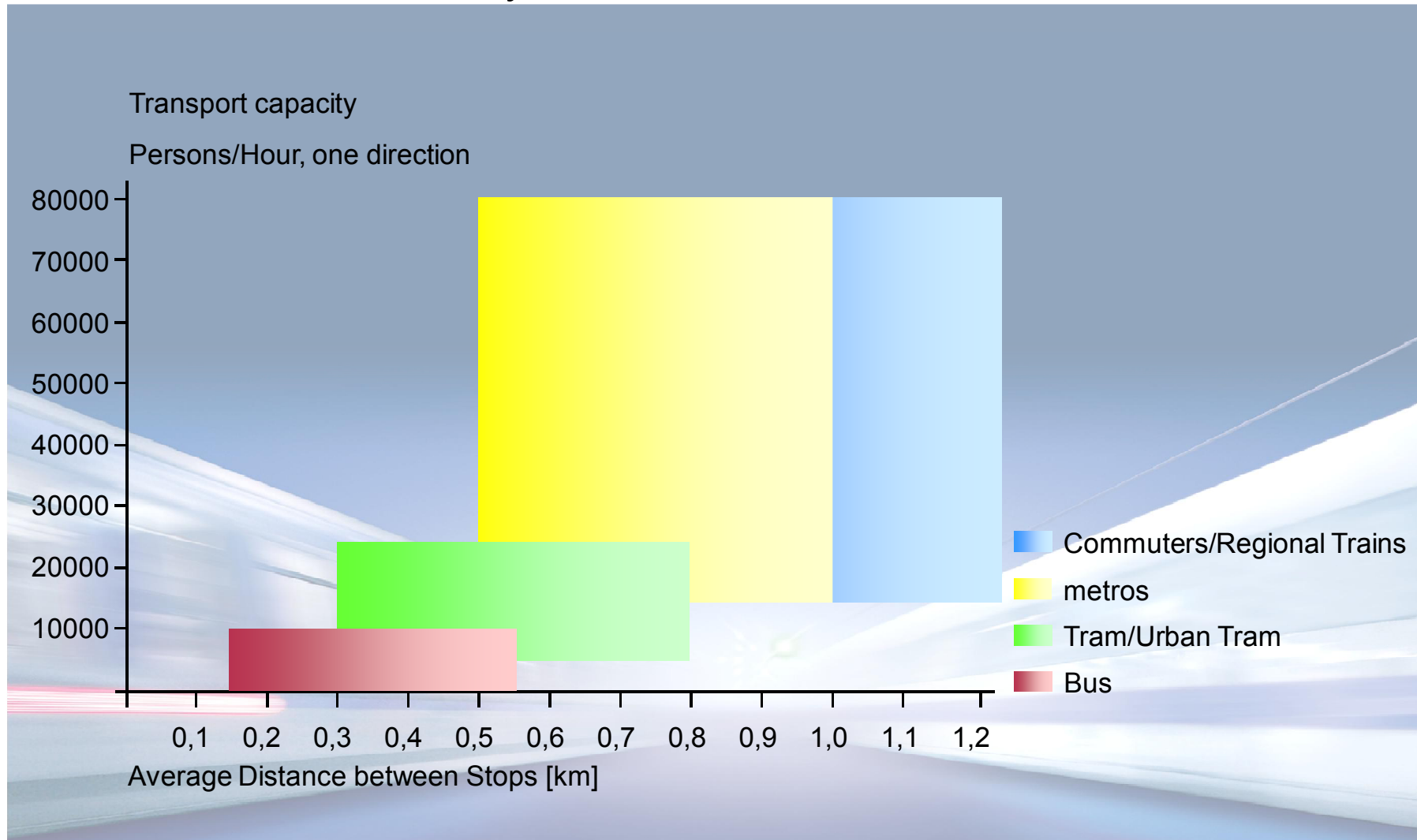
Position of metros in railway market



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Position of metros in railway market

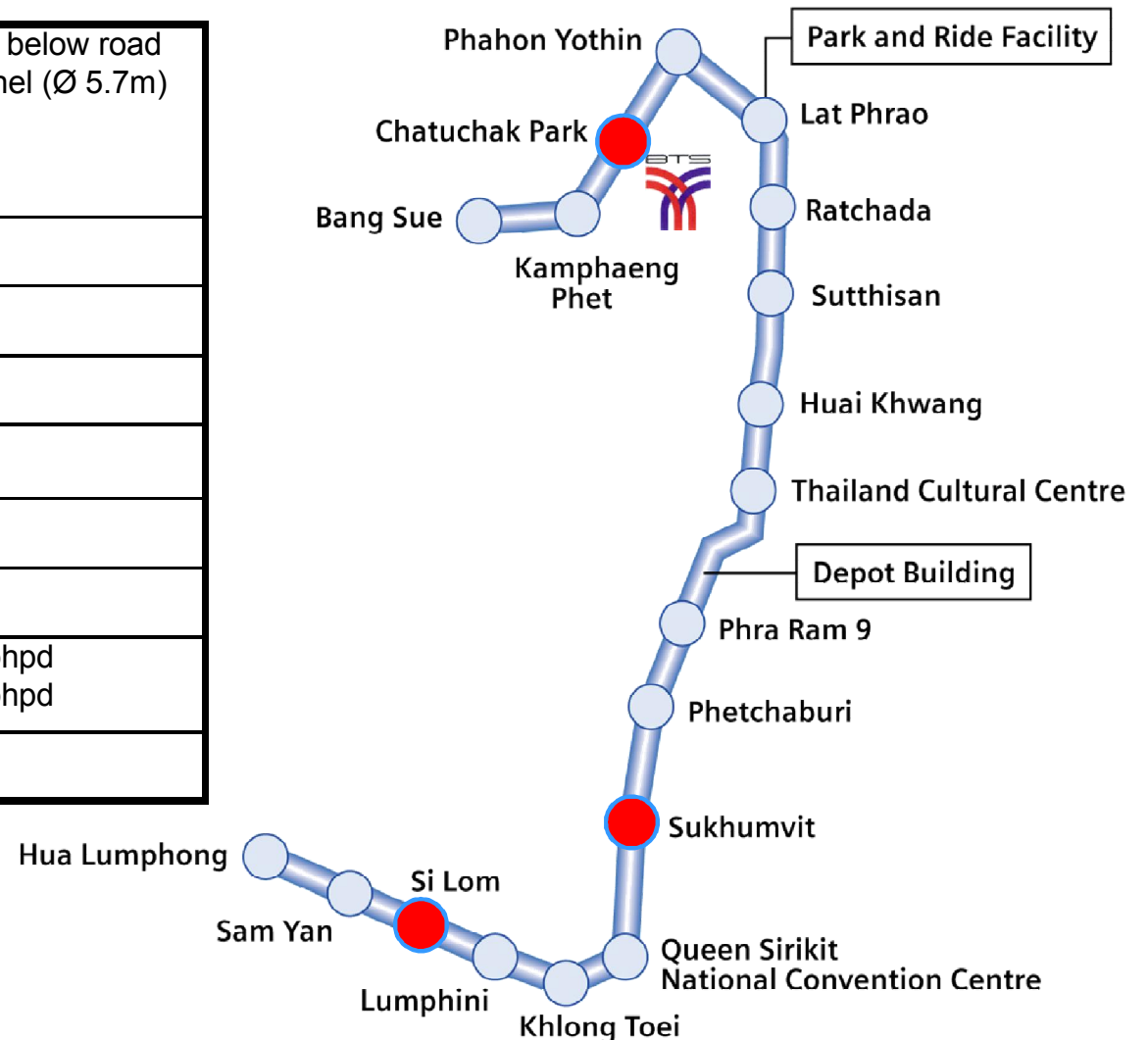


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MRTA underground

Vertical alignment:	Underground – 14-30 m below road surface – twin bored tunnel (Ø 5.7m)
Number of Lines:	1
Length of Lines:	20 km
Number of Stations	18
Number of Trains:	19 3-car (Mc-T-Mc)
Traction Power System:	750 V DC, 3rd rail
Minimum Headway:	2 min (actual 3.3 min)
System Capacity:	Initial: 12,000 pphpd Future: 57,000 pphpd
Ridership actual:	170,000 p/day

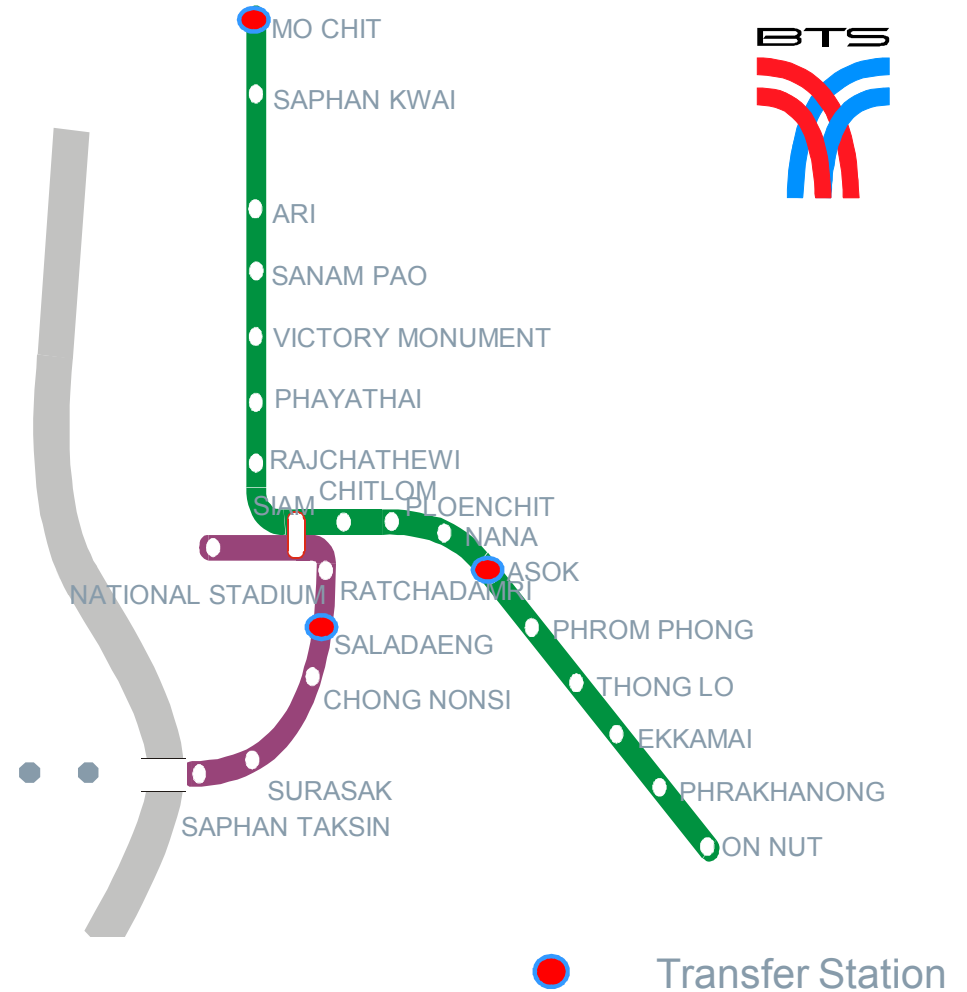


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BTSC skytrain

- Number of Lines 2 Lines (SKV+SLM)
- Length of both Lines 25.84 km (16.8+9.0)
- Number of Stations 25 (17 + 8)
- No. of trains actual 35 3-car (Mc-T-Mc)
- Traction Power System 750 V DC, 3rd rail
- Minimum Headway 2 min (actual 2.2 min)
- System Capacity 648,000 p/day
- Ridership actual average 390,000 p/day



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Measuring technologies are applied mainly

to ensure safety

to ensure performance and reliability

Safety concerns mainly

Track work

Train axles

performance and reliability concerns mainly

Condition of equipment

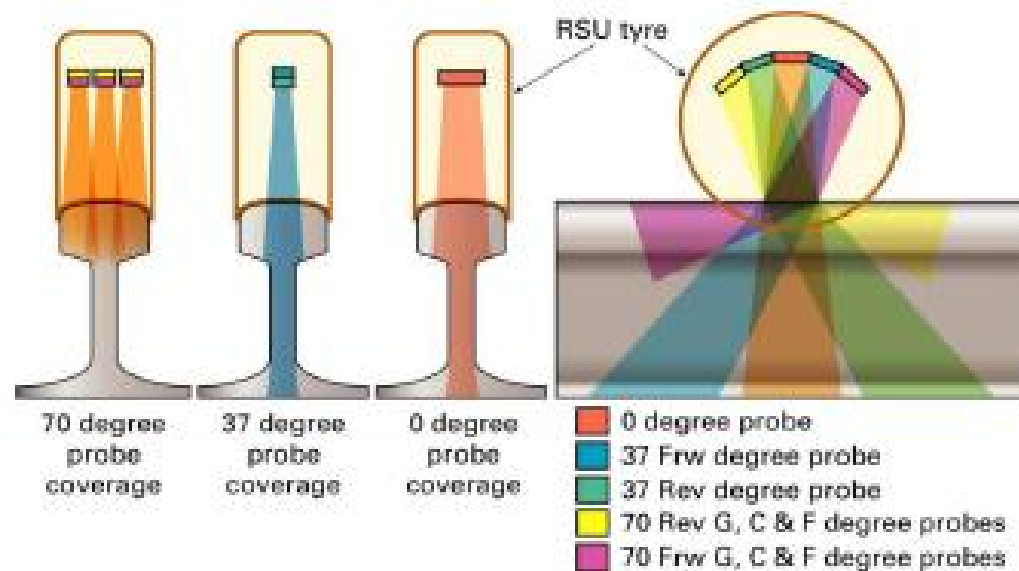
Live time extension studies

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Track work welding joint

BTSC and MRTA track network has together over 10.000 welding joint. The welding joint are inspected frequently with special ultrasonic equipment.



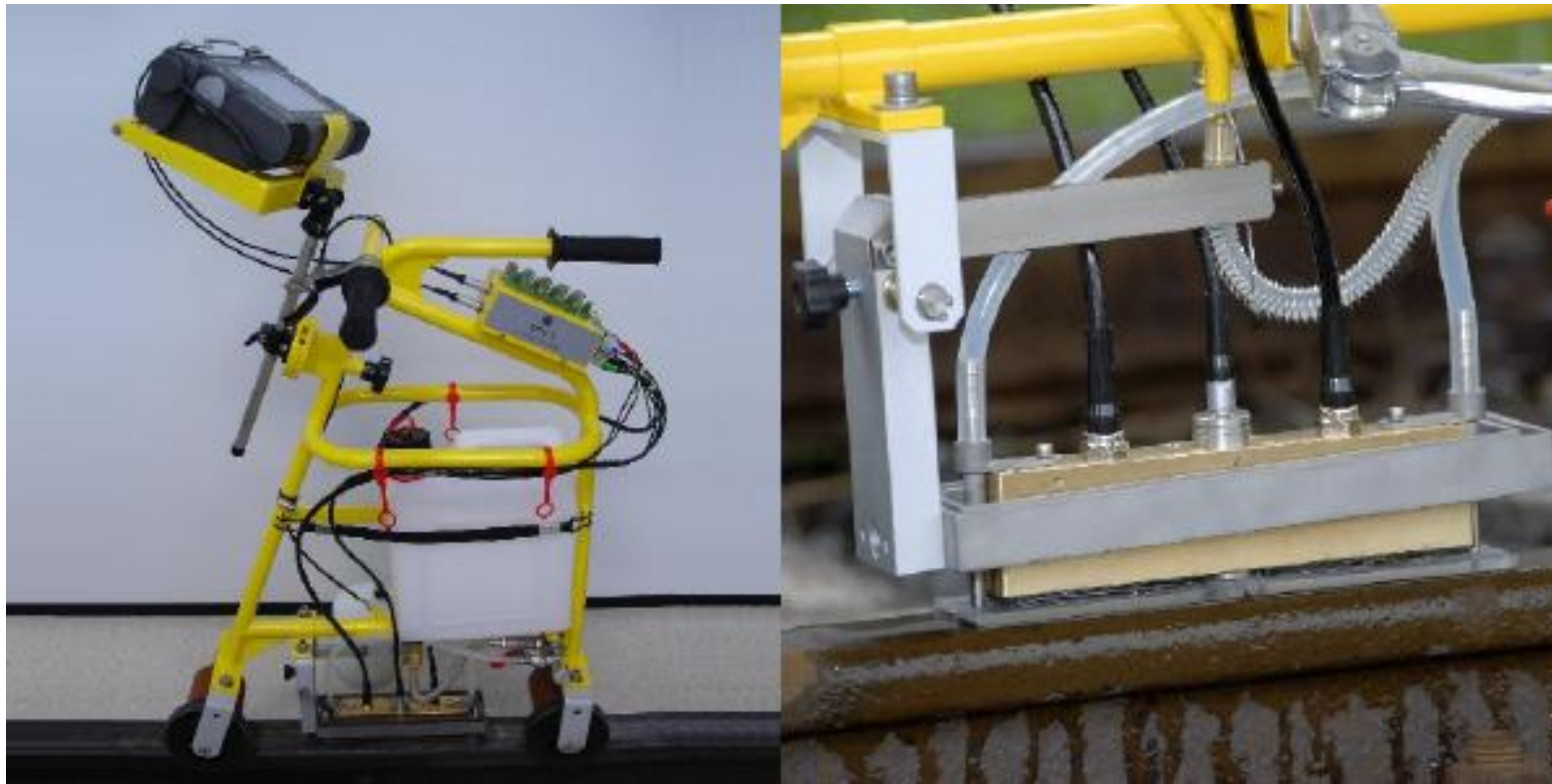
For this UT testing a special developed UT test equipment is used inspecting the track at different angles

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Track work welding joint

The ultrasonic equipment is installed on a trolley to allow fast and exact UT inspection of the welding joint



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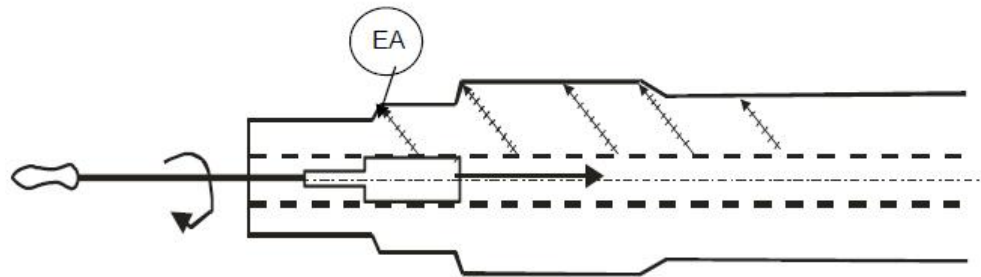
Train axle inspections

Train axles are a critical part. As they are reused for many years so fatigue cracks can occur. Train axles must be inspected for cracks by ultrasonic frequently.

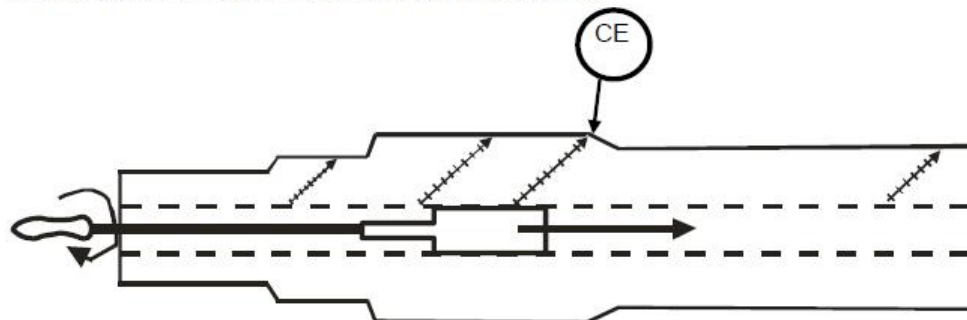
Train axle are hollow to enable the UT testing from inside.

The axles are UT tested with a special probe under different angles .

Incidence direction to the outside (main bearing)



Incidence direction to the middle of the axle (shaft journal)



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Train axle inspections



Train axle inspections

Train axles are tested a special qualified personal trained by European experts.

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Performance and reliability

Condition of equipment and live time extension studies.



The bogie contains the parts with the most impact on performance and reliability.

Main focus is

Wheelsets

Traction motor

Primary springs

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Performance and reliability

Condition Monitoring of track and wheel

Vibration measuring and data analyzing to provide a basis to determine

- optimal re-profiling intervals of train wheel
- track condition and required corrective actions

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Setup

Three accelerometers

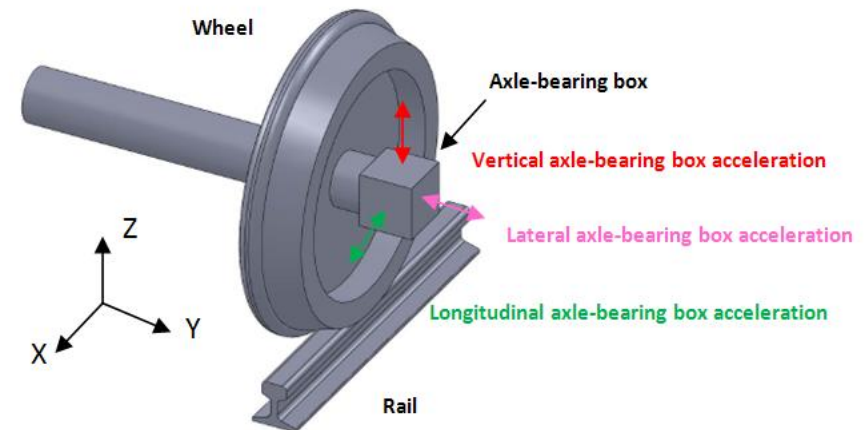
Installed on the leading axle

Data recorded via a real time analyzer

Data analysis

Used sampling rate is 25 KHz with different filter

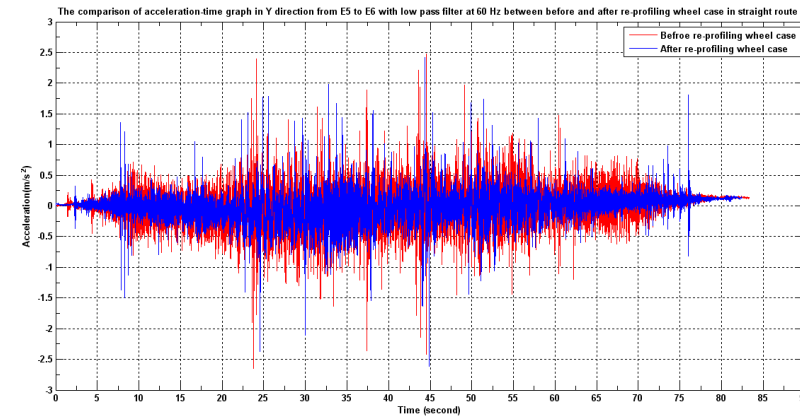
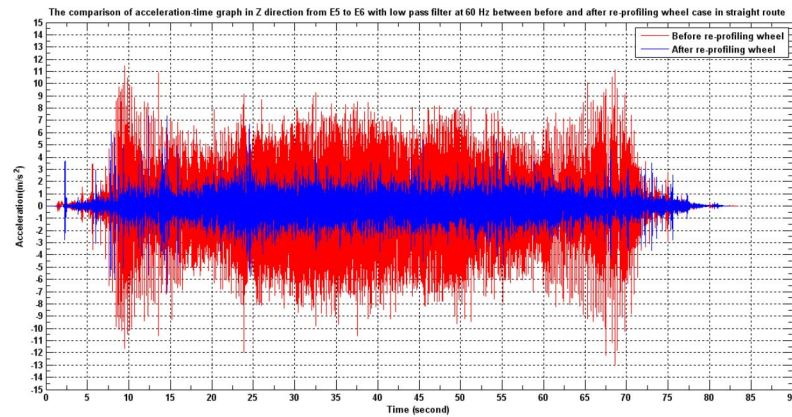
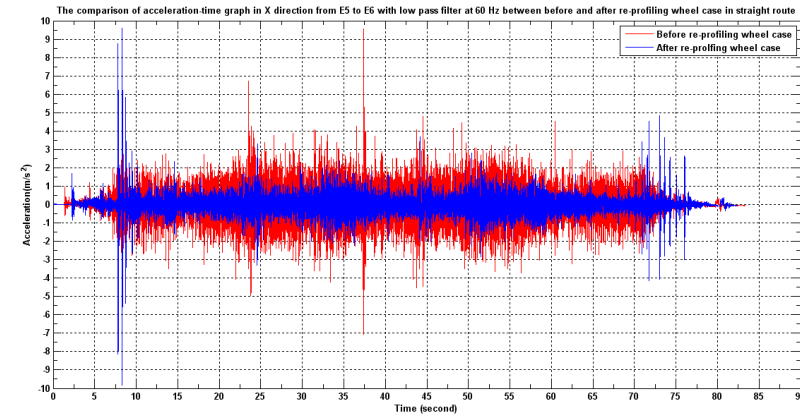
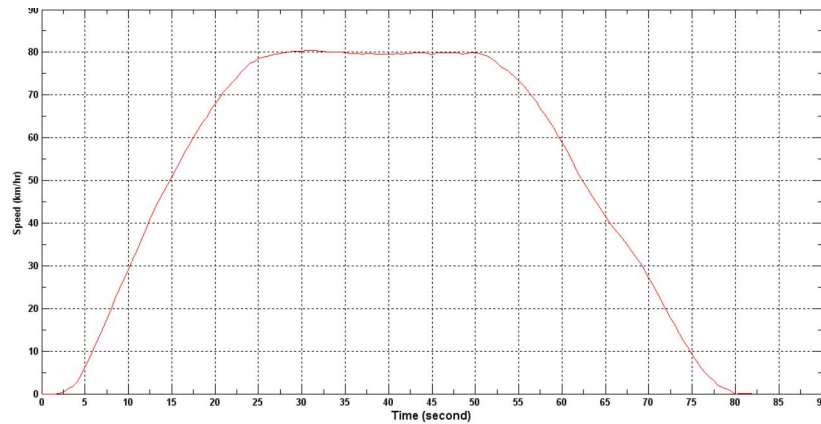
Time and frequency domain software



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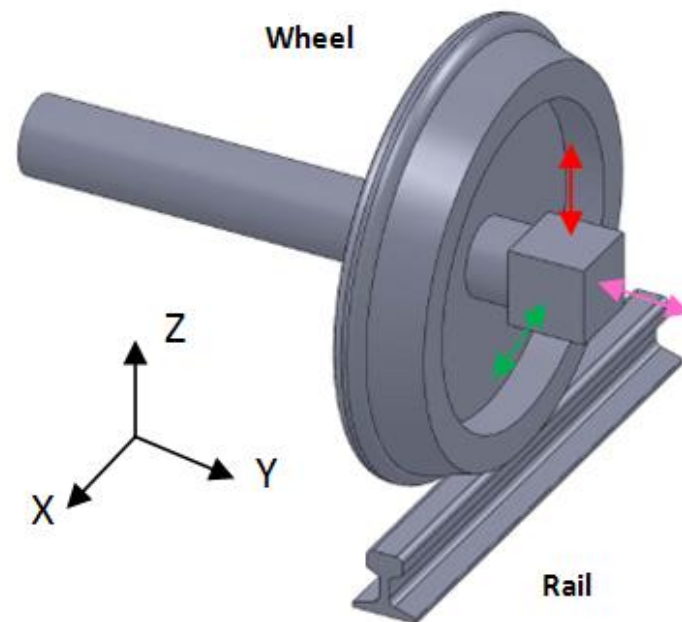
Optimal re-profiling intervals of train wheel



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Optimal re-profiling intervals of train wheel



Z axis → a new reprofiled wheel creates at 80 km/h vibration at an range of 1,5 m/ss. after 70.000 km the level increased to an range of 4 m/ss. This is a typical effect as the wheel become out of shape

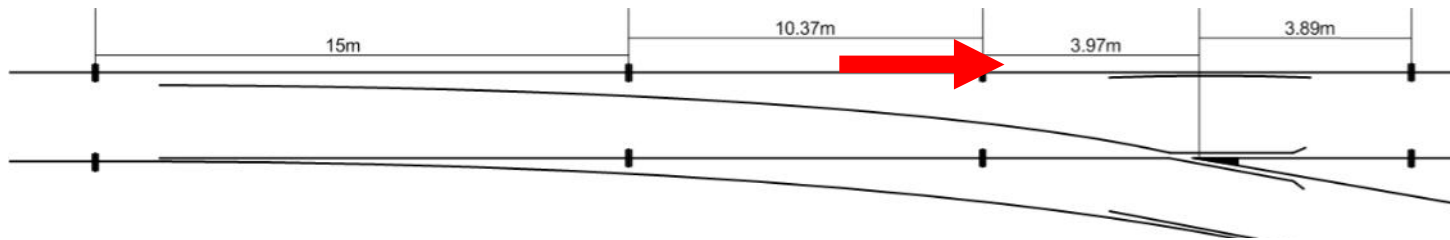
X and Y axis → the vibration range between a new reprofiled wheel and after 80.000 km are similar. Hunting is not observed after 80.000 km.

Conclusion: the interval of reprofiling at 80.000 km has been confirmed. An extension is not recommended as the wheel out of shape effect shows already significant impact.

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Analysis of track work, turnouts



Turn out layout

Vibration before build up welding on frog

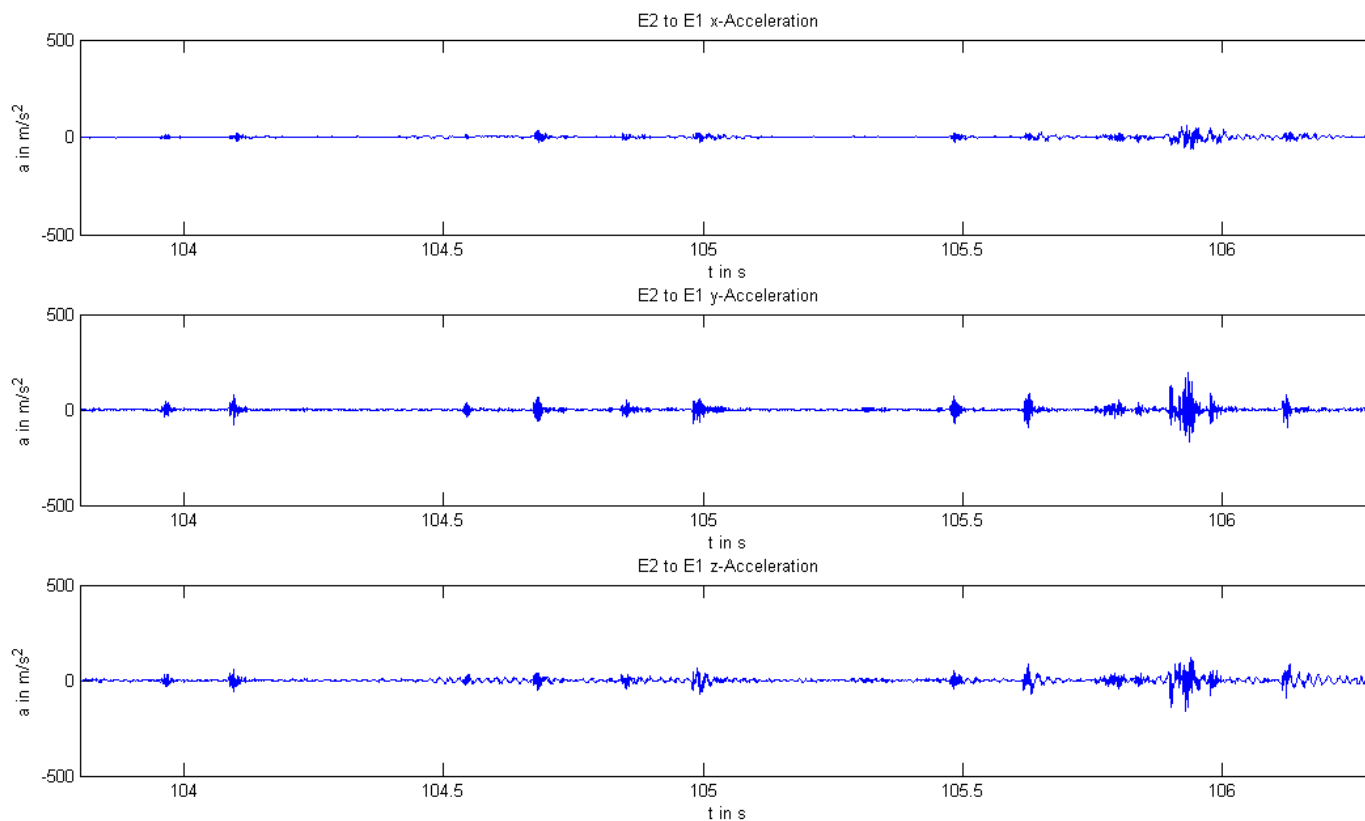
X axis

Y axis

Impact at guide rail → adjustment successful

Z axis

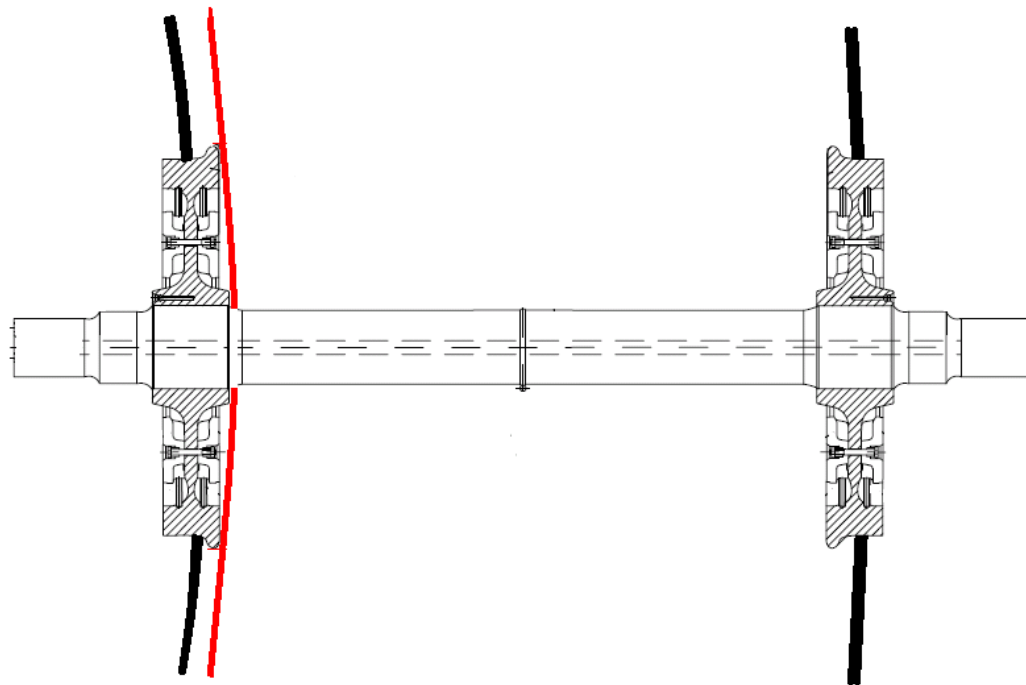
Impact at frog → welding successful



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Analysis of track work, guide rails



Guide rails are used in narrow curves to guide the wheel set.

The curve inner wheel is kept in position in normal operation.

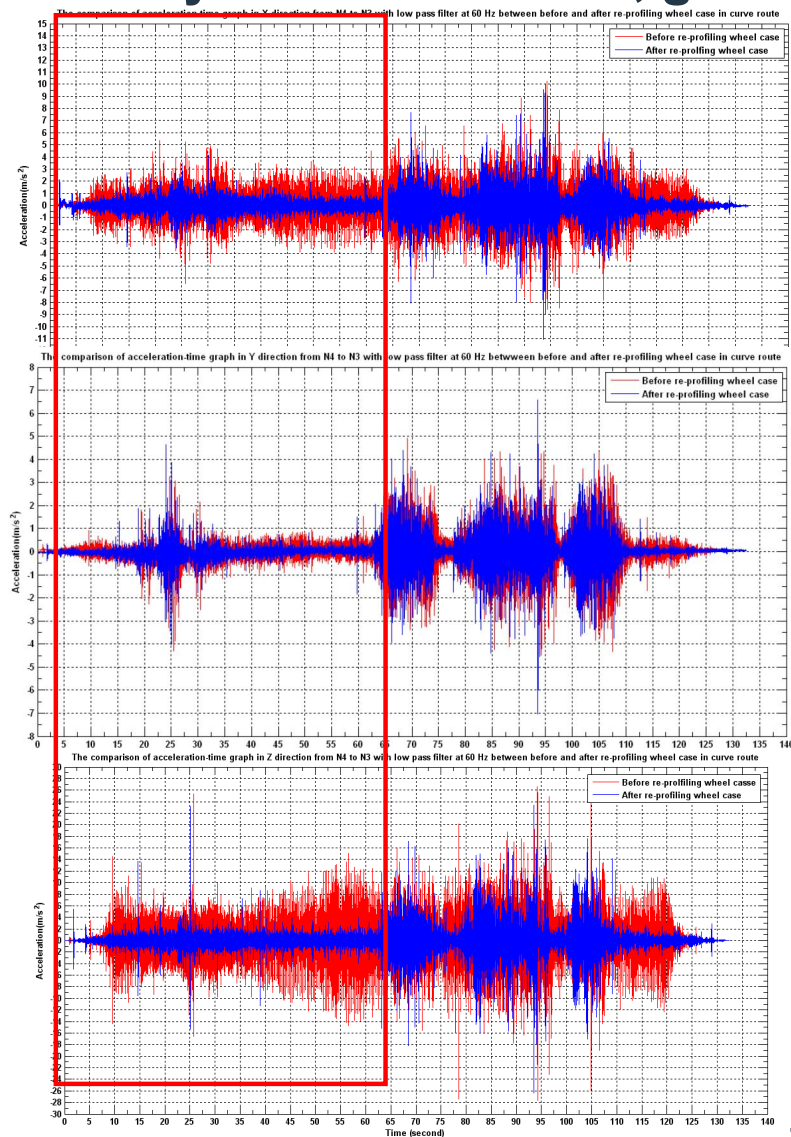
A natural sinus movement is not possible and wheel flange lubrication is not effective.

Guide rails are an out-of-date practice from the UK at a time when track work and wheel suffer from wear at narrow curves.

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Analysis of track work, guide rails



X Axis

The shattered movement is limited and in curves normal

Y Axis

The movement of the wheel set is without guide rails almost equal but are now a natural wheel flange contact.

Z Axis

The climbing of the wheel onto the guide rail is eliminated. With guide rails the acceleration was far above acceptable limits and can cause safety problems

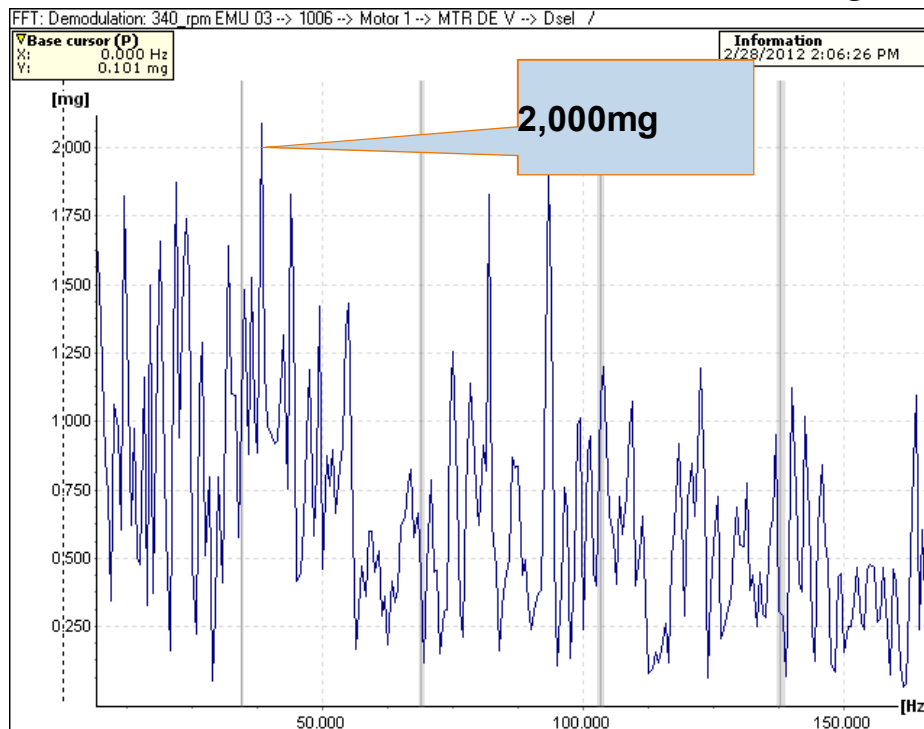
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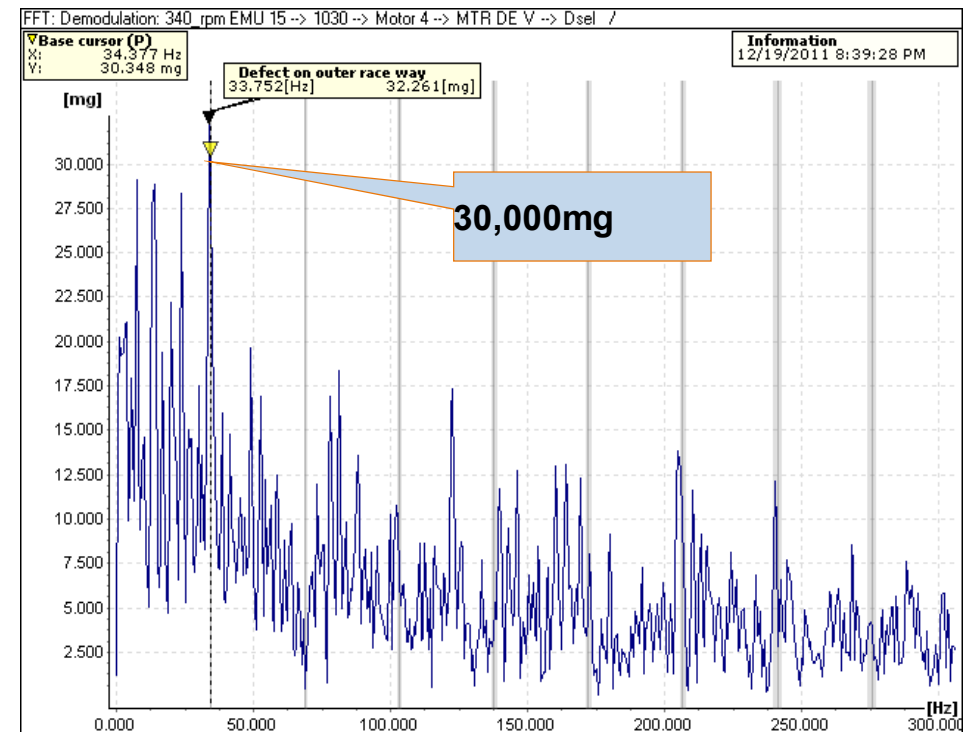
Performance and reliability

Motor bearing condition monitoring

Every type of bearing has typical vibration pattern. The intensity of this vibration indicates the condition of the bearing



Good bearing



Defect bearing

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Condition monitoring of primary springs for live time extension

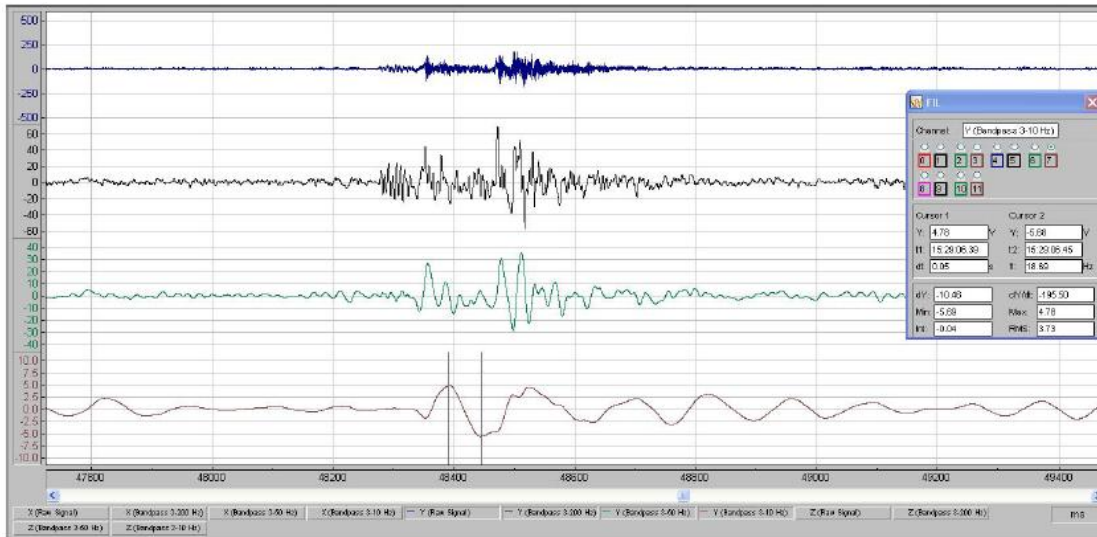


Figure 14 OLD primary springs: Run from N5 to N4, Position S2, Y Sensor

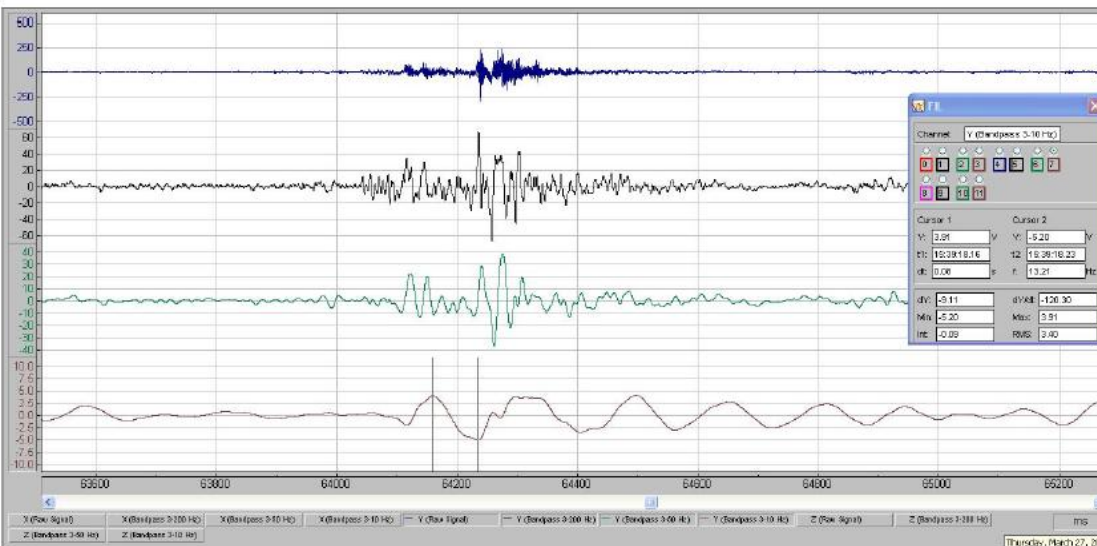


Figure 15 NEW primary springs: Run from N5 to N4, Position S2, Y Sensor

Measuring of vibrations emitted to the bogie frame and comparison of old and new spring the condition of used springs is determined.

Applied analyzing methods show the potential live time extension of up to 14 years instead of renewing every 6 years.

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Thank you for your attention