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Brakeblock detection @ INFRABEL

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- Brake block effect on Rolling Noise
- WIM introduction at Infrabel
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Builds, **renovates** and **maintains** the rail network

→ *Infrabel invests around €1 billion annually to manage, renovate and develop the Belgian railway infrastructure*

One of the largest **employers** in Belgium

→*12,464 employees (2014)*

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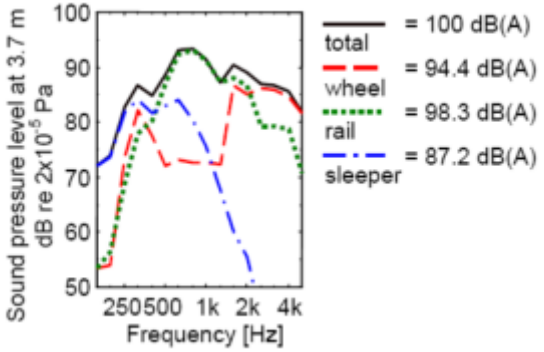
A major player in high-speed transport: Belgium is the first European country to have completed its high-speed network from border to border

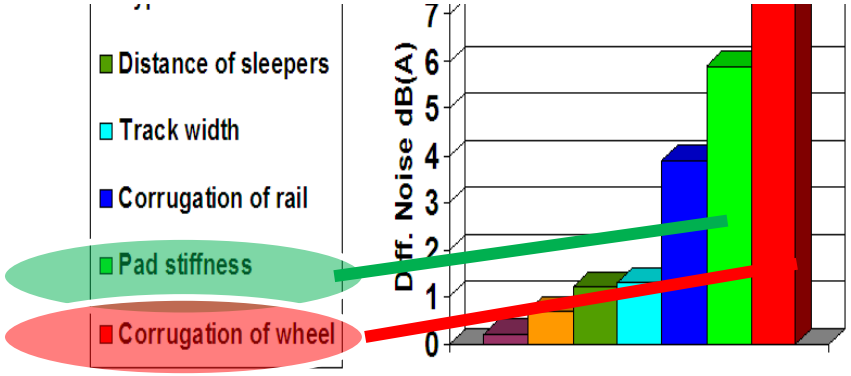
→ *It takes less than 2 hours to travel from Brussels to Amsterdam, Cologne, Paris or London*

A major player in **sustainable, efficient mobility**

→*The number of passengers using the Belgian network grew by approx. 50% between 2000 and 2014*

Brake block /rolling noise

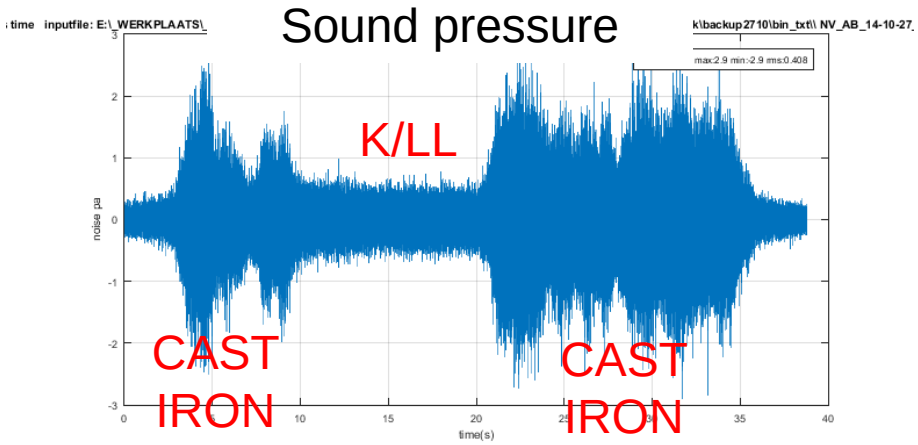


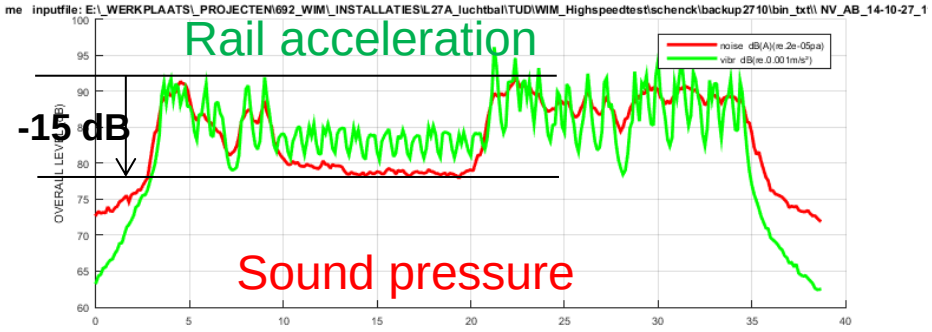


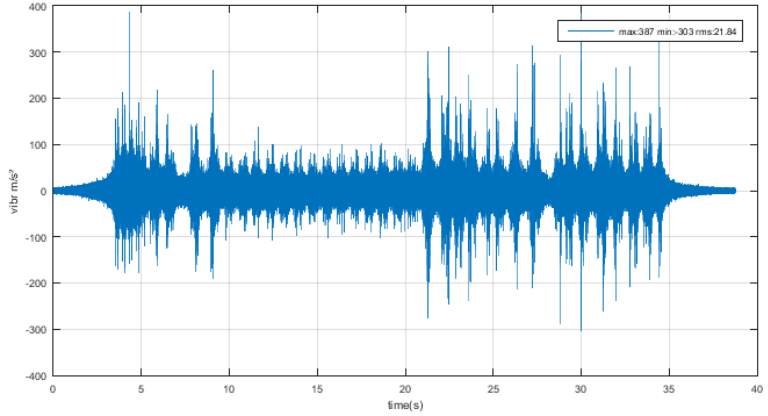
Cast iron blocks

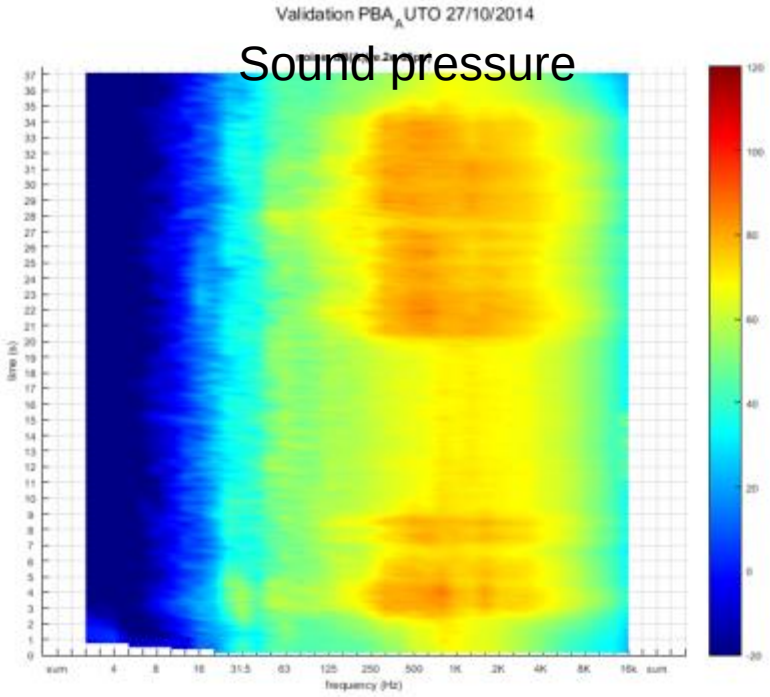
LL/K blocks

Brake block effect on PERMANENT N&V emission >10 dB->15 dB









Monitoring N&V @ Infrabel

Infrastructure

EM130 measurement train + N&V sensors, fully automatic acquisition, post processing, data transfer (since 2012)

Rolling stock

WIM systems + Noise & vibration emission monitoring:

- Tender 2011
- 2 suppliers tested in 2014
- 15 double track systems to be installed 2015-2
- By end 2017 ,7 systems operational, including

  Automatic detection of type of brake block

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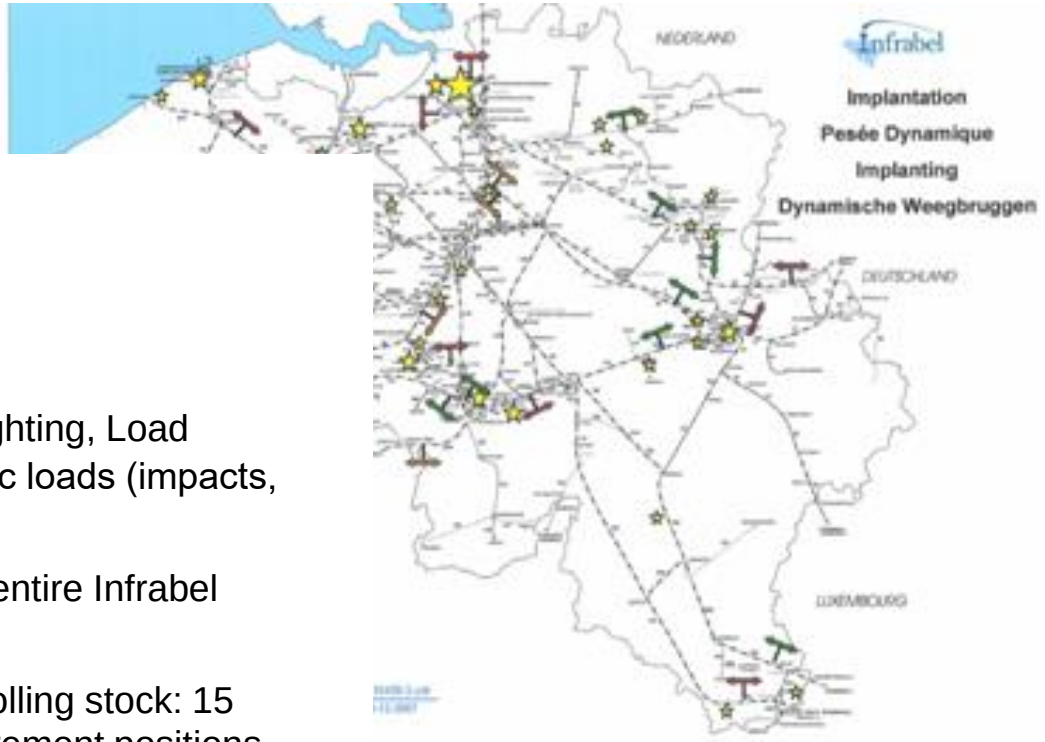

ROLLING STOCK MONITORING

Initial project requirements (2009)

- W.I.M. installations for: axle load weighting, Load distribution over wheels/axles,…, dynamic loads (impacts, wheelflats,..)
- Installation over a 3 year period on the entire Infrabel network
- cover more than 90% of the complete rolling stock: 15 installations on double track = 30 measurement positions

Additional demand

- N&V measurement will be included to build up a database with train TEL level - ISO 3095 + raw N&V data
- Post processing with TNO-PBA software will lead to dBase with acoustic quality of rolling stock

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2011: WIM: Technical specification published

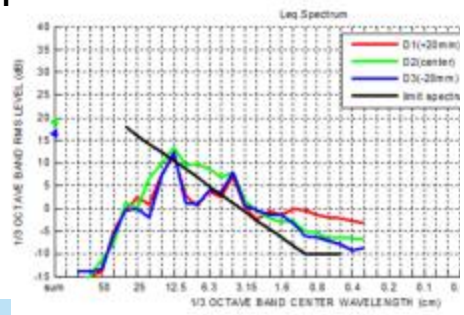
- <30 ton /axle
- Available after 30s
- 2400 axle/hour
- +/- 5% trainweight
- 10% axle loads (30-120km/h)
- Timestamp train identification
- Total trainweight + individual detection of vehicle, axle, wheel parameters
- Min. 7 meter measurement area
- TEL (transit exposure level) volgens ISO 3095:2005(E)+ raw railacceleration+microphone data
- One year evaluation, 4 calibration tests planned

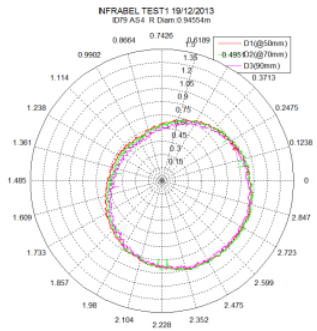
2012: Initial 5 companies

2013: November installation 2 selected system

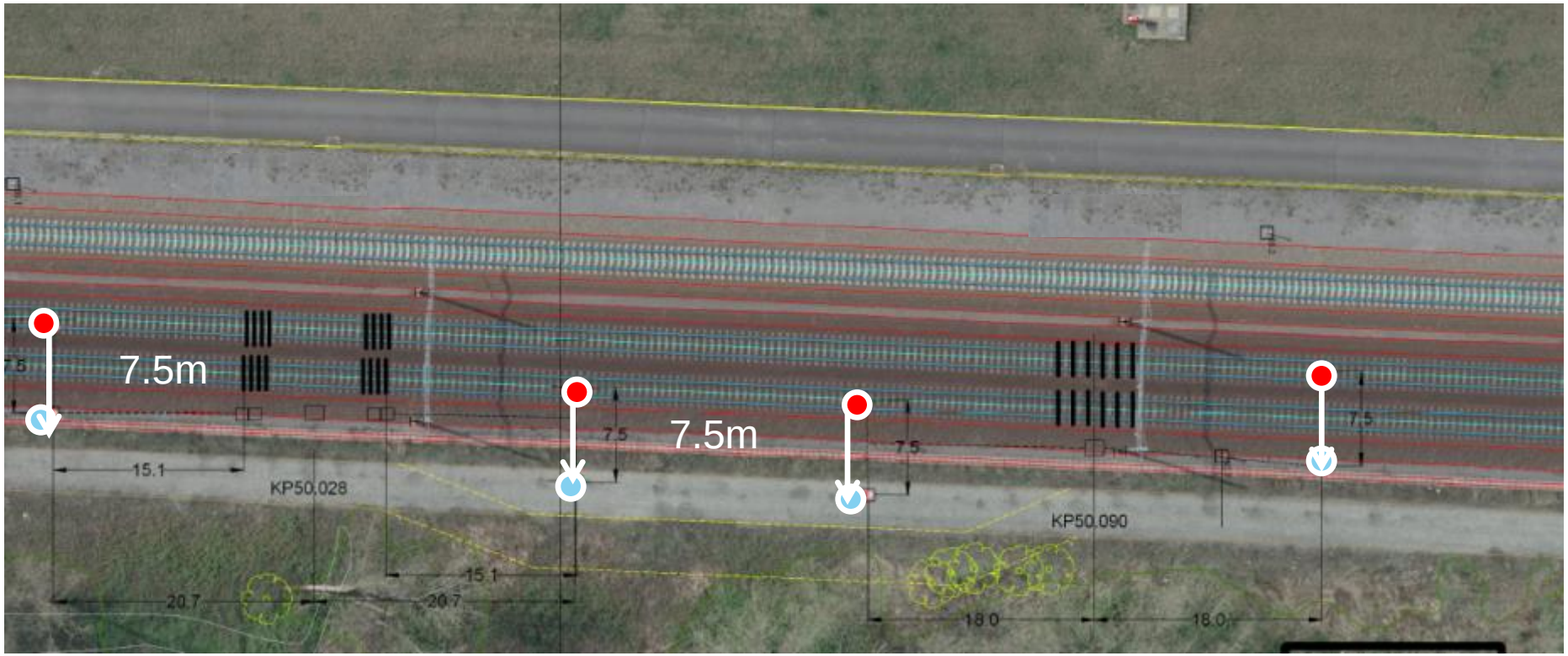
2014: 4 tests with “calibration train” with

- Know axle loads
- Know wheel faults
- Direct measured roughness





- Railacceleration
- Noise emission - ISO3095



L75: De Pinte

TNO – PBA software

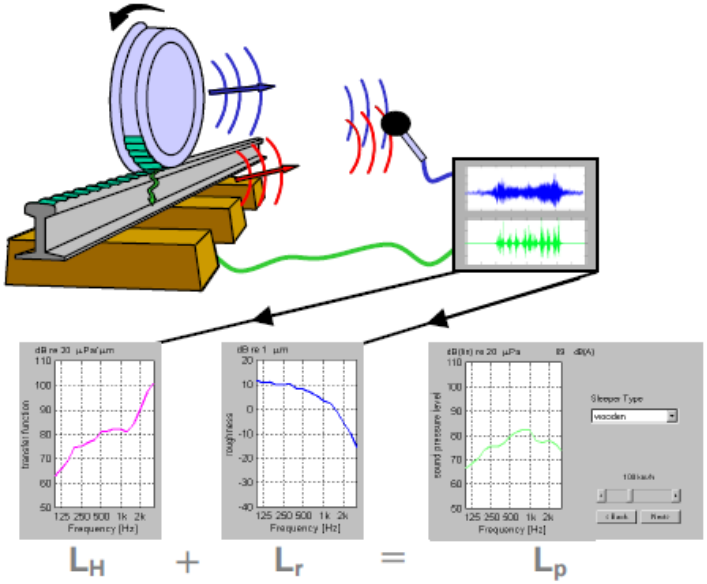


Figure 1.2: Schematic overview of the analysis procedure with a typical r roughness and total transfer function can be used to calculate the total sound a given train speed.

Knowing position of wheel in timeframe is important for quality of results

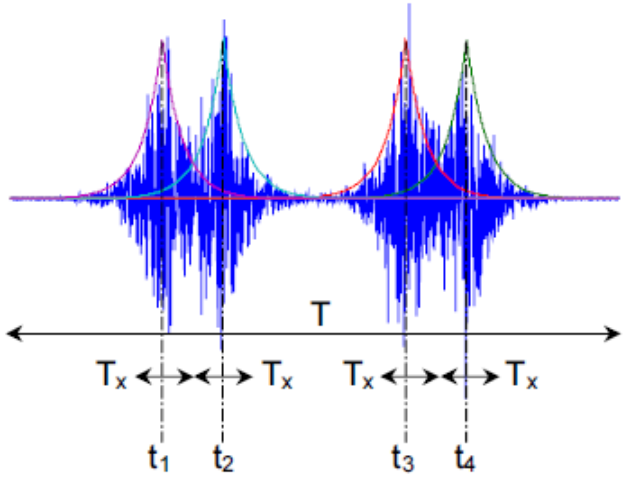


Figure 3.1 Vertical acceleration measurement during four wheel passages.

Single value indicator for roughness

$L_{\lambda CA}$ (Harmonoise project (2003)

$$L_{\lambda CA} = 10 \log \sum_{\lambda=20\,cm}^{0,4\,cm} 10^{\frac{1}{10}\{R(\lambda)+\Lambda(\lambda)+C(\lambda)+A(f(\lambda,v))\}}$$

0 – 4 dB “smooth rail”
5 – 7 dB “ground rail” (approx. 1 month after grinding)
7 – 9 dB average rail roughness (average of 30 Dutch sites [6])
10 –11 dB “smooth wheels” (unbraked, disc-braked, or sinter blocks ([6]);
12 dB average rail roughness of the Dutch network in calculation scheme [15];
14 –17 dB corrugated rail;
18 –20 dB “rough wheels” (cast-iron blocks, disc+additional cast iron blocks)
25 –28 dB severely corrugated track

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Advantage of combining WIM with PBA

- PBA needs exact axle passage time on accelerometer
- WIM systems can provide this info with high precision
- PBA analysis can be automized
- Hardware, software, power, ICT,… and can be combined
- Presence of composite brake block can be linked to trainnumber, operator,…..

(Most important) Requirements for WIM / PBA site

- Same track design (rail, railpads, fixation) for all monitoring sites

- Smooth and monitored rails (below ISO3095 limits) due to extraction of the combined Wheel/rail roughness

- High and stable TDR (track decay rate), requires knowledge about railpads, railfixation, influence temperature..
- High damping, stiff, temperature independent railpads

Intermediate results

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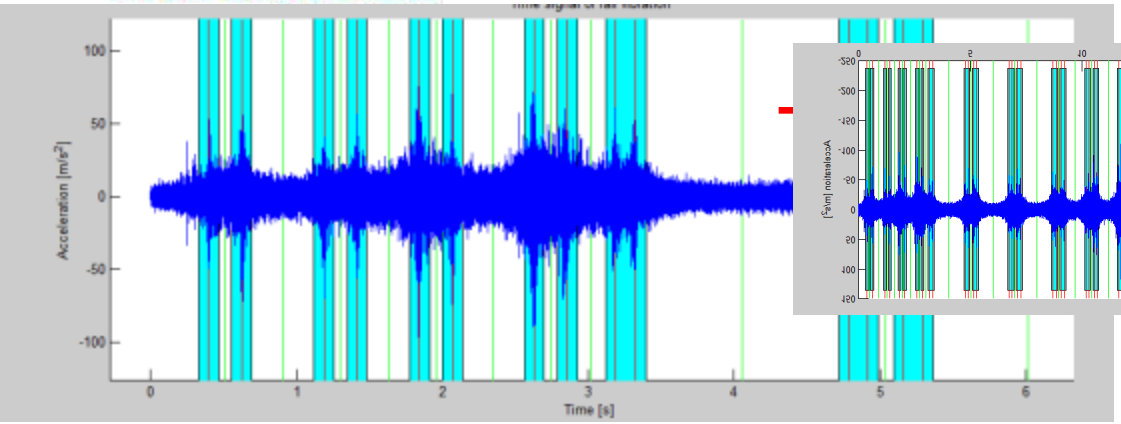
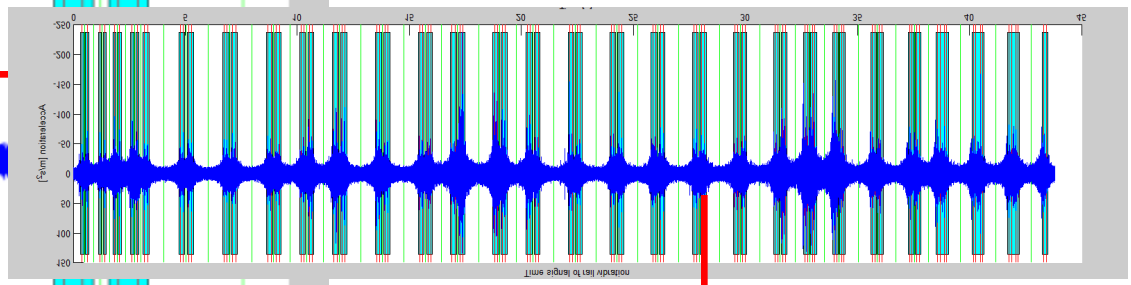
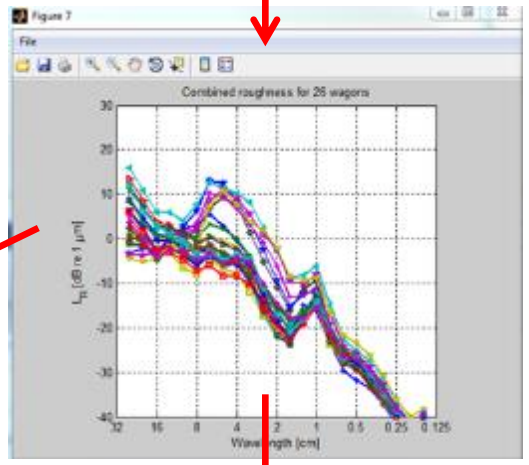




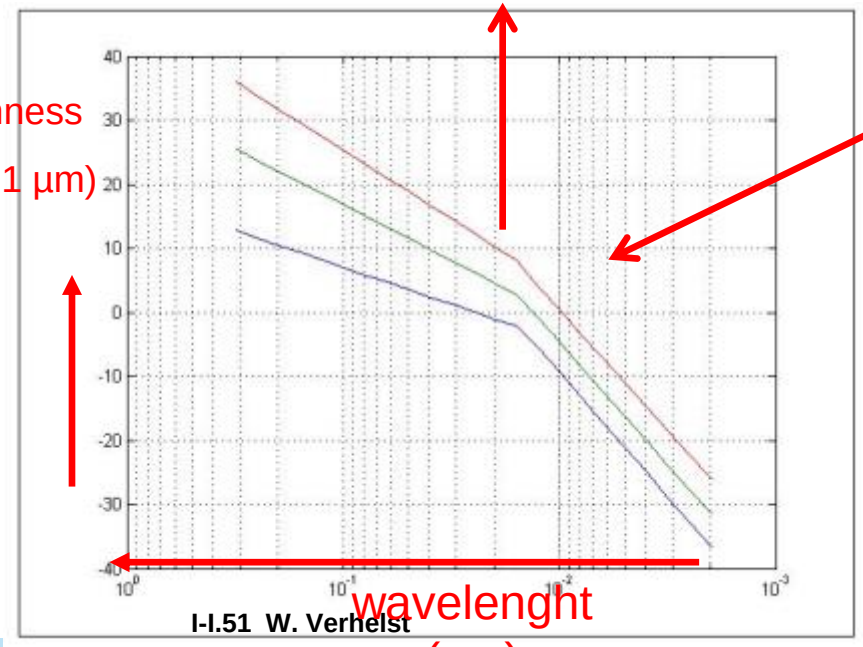


Percentage wheels per level class: 14 78 9

Number of wheels per spectrum class: 8 52 20 0

Roughness

(dB re. 1 µm)



wavelenght

(cm)

I-I.51 W. Verheist

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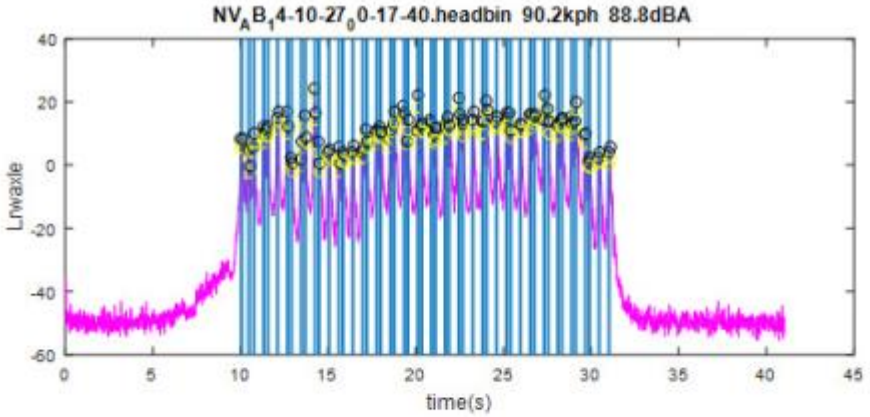

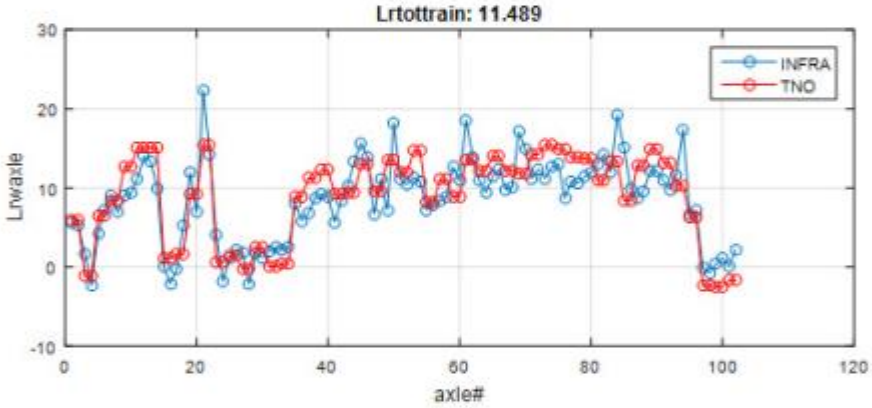

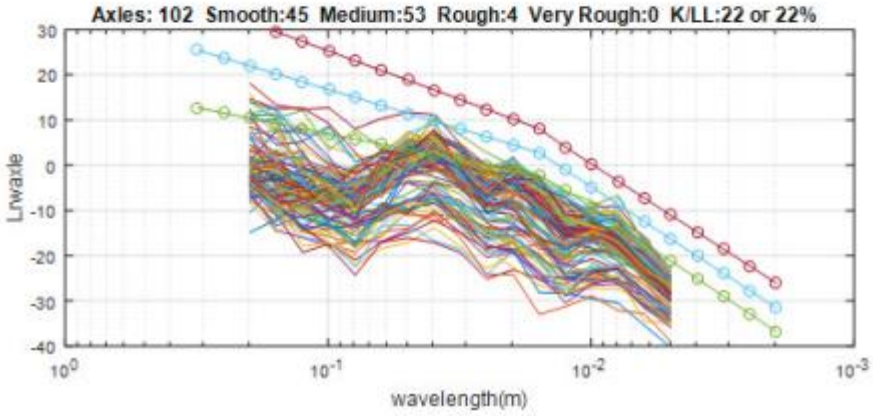

Validation of the system

- **Visual**
  - by **high speed camera** brake block recognition
  - First test in october 2014

- By combining knowledge of direct and indirect measured wheel roughness (early 2015)

  - Testtrain with known roughness
  - Direct measurement of a whole freight train

Visual validation: standstill

Cast iron brake block

Composite brake block

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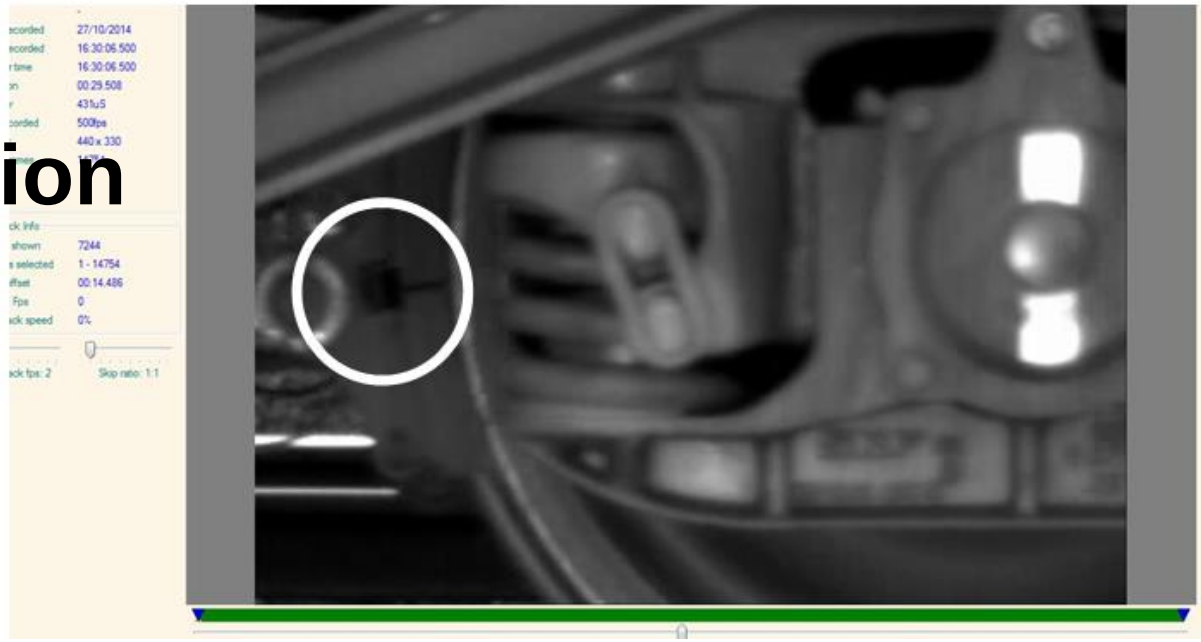
Visual validation running train: High speed camera



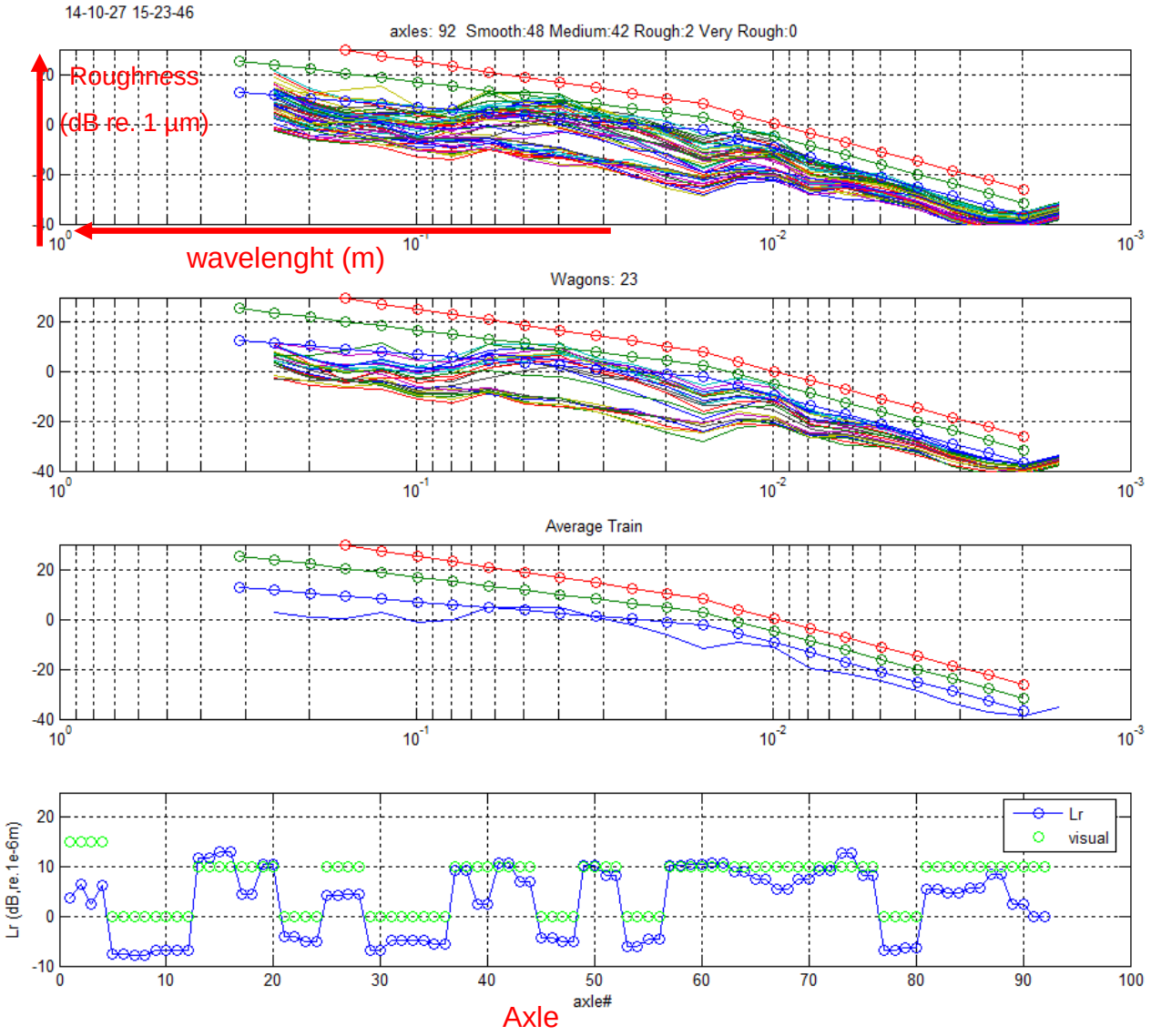
Example of analysis of a freight train

axle

wagon

train

validation



10: cast iron
0 : composite

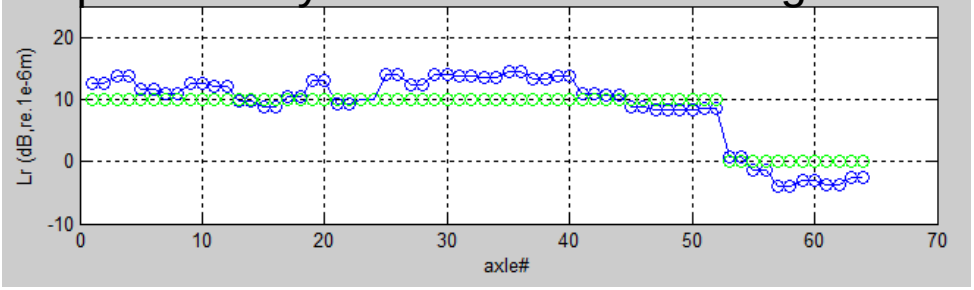
15: not recognised on camera

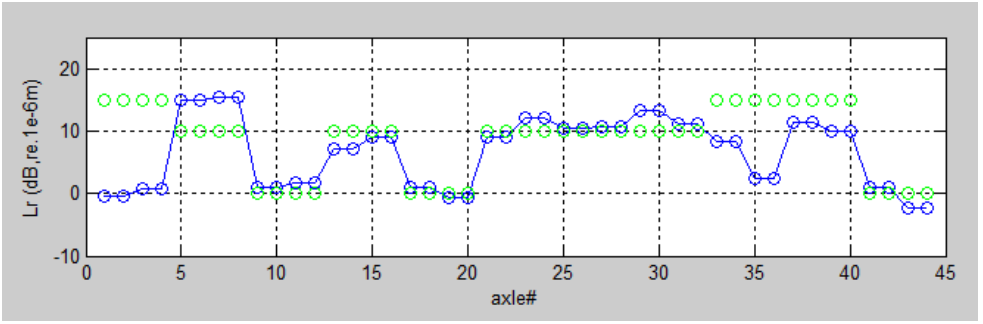
Example of analysis of some other freight trains

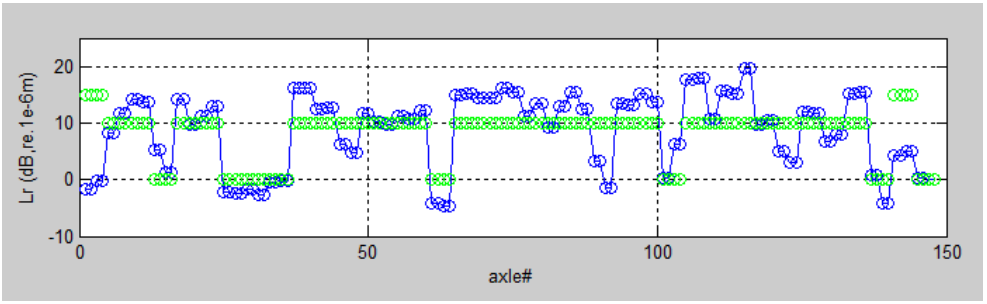
- **CALCULATION**: Single value indicator for roughness

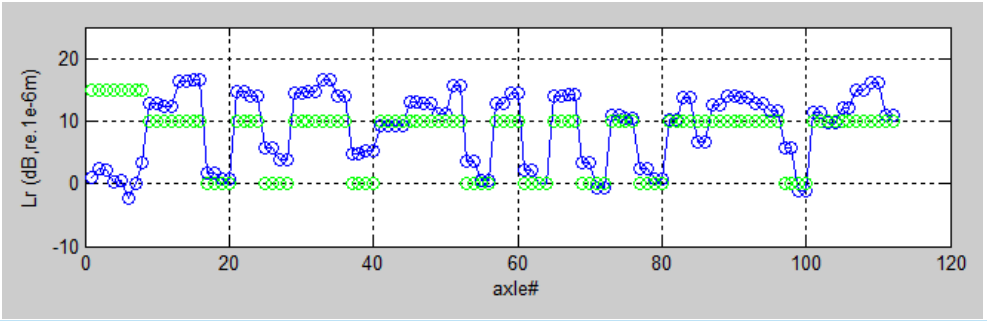
- **Manually extracted by checking high speed camera images**

10: cast iron
0 : composite
15: not recognised on camera









Conclusions

- Detection of type of brake block, axle by axle in real-time is possible
- Implementation an counting of axles on Belgian railway network is ongoing
- Retrofit, stimulated by E.C. (replacement of cast iron brake block by composite break blacks) can be followed closely and evaluated in detail (e.g. Operators, investments, real emission at 7.5m)
- Future NDTAC on real measured data
- Check of new composite blocks entering the market