# Identification of bad wheels:
# The use of monitoring stations for targeted maintenance

# Content

- Wheel defects
- Motivation to reduce wheel defects
- Vehicle Design
- Excitation of vibration with polygonal wheels
- Monitoring stations of SBB
- Evaluation of the optimal measuring position
- Conclusions

# Wheel defects

UIC classes of out of roundness

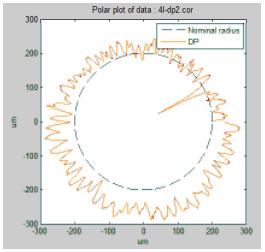
I) Localised circularity defects
- a) Flats (wheel slide)
- b) Spalling (break out of metal pieces, thermal damage, high impact stresses)
- c) Localised spreading (material hardness deviation along the circumference)

II) Periodic circularity defects
- d) Eccentricity
- e) Ovality
- f) Periodic out of roundness deviation (n order, corrugation < 80mm, polygonisation > 80mm)

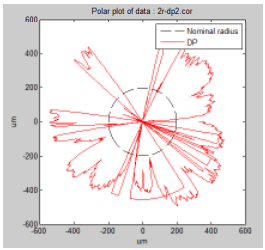
III) Stochastic circularity defects
- g) Combination of I) und II)
- h) others

# Wheel defects

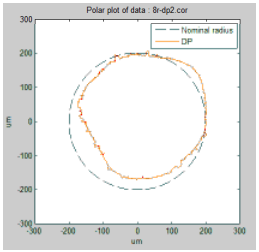
Wheel flat,
corrugation (< 80mm)



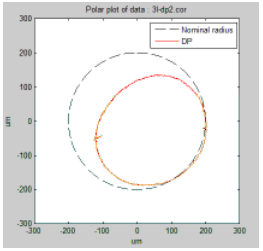

Spalling



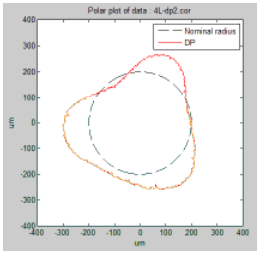

Localised spreading



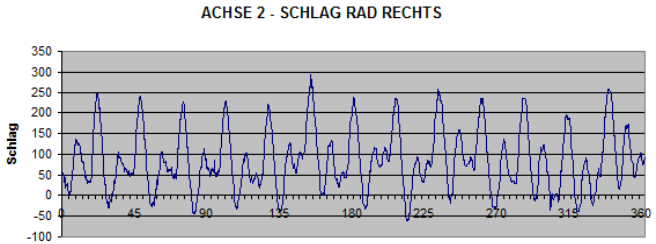

Excentricity, ovality



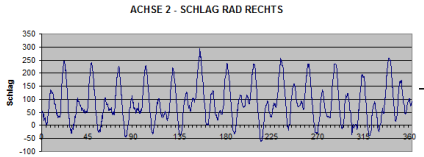

3rd order polygon

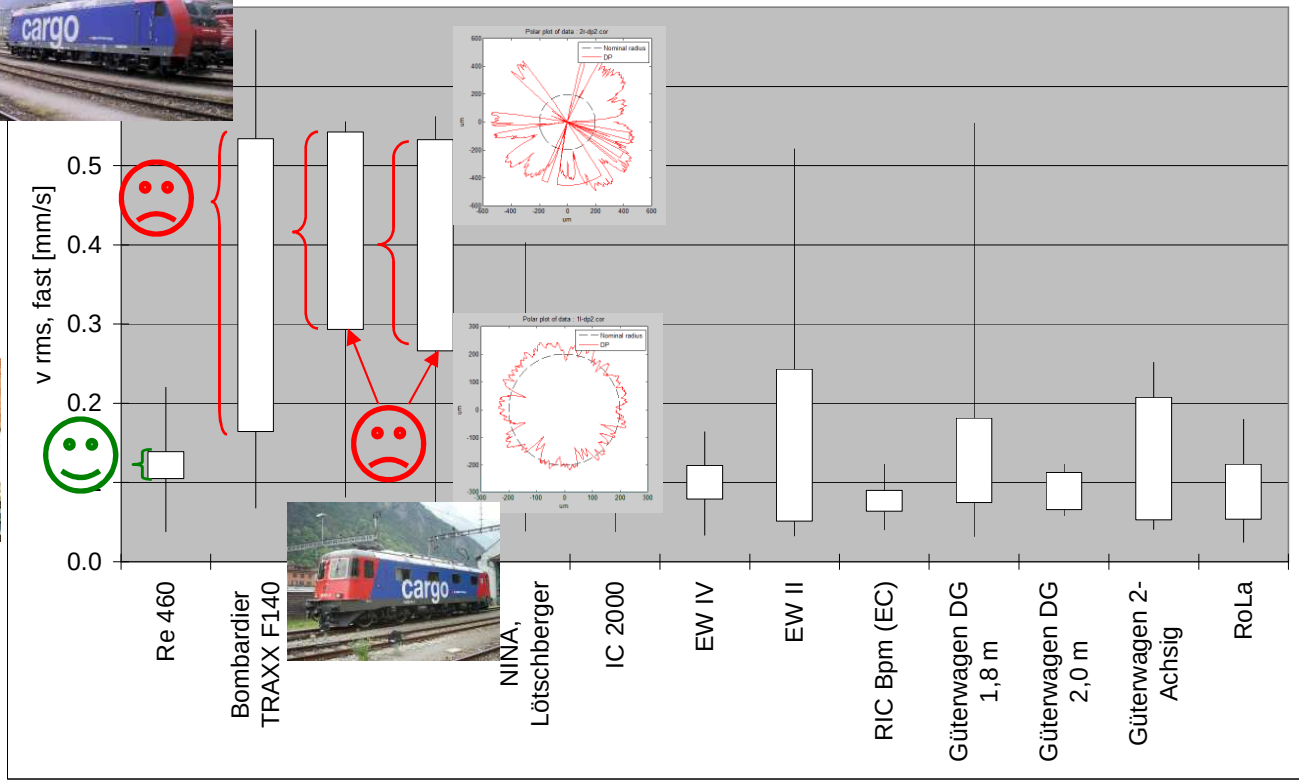



14th/28th order polygon



# Motivation to reduce wheel defects





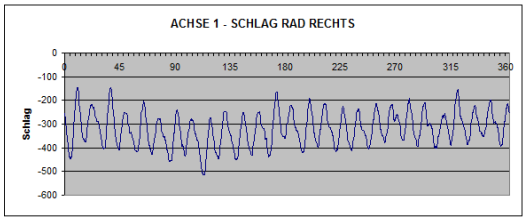
# Vehicle Design

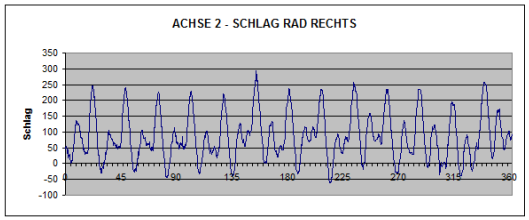
| | Unsprung Mass | Radial Steering | Brake |
|---|---|---|---|
| Loco SBB Re 460<br>Passenger Traffic<br>$v_{max}$ 200 km/h | 1900 kg ☺ | Passiv ☺ | Sinter Brake Block ☺ |
| Loco SBB Re 482 / 484 (TRAXX F140)<br>Freight Traffic<br>$v_{max}$ 140 km/h | 4500 kg (nose-suspended motor) ☹ | Nein ☹ | Wheel Disc Brake ☺ |

out-of-roundness

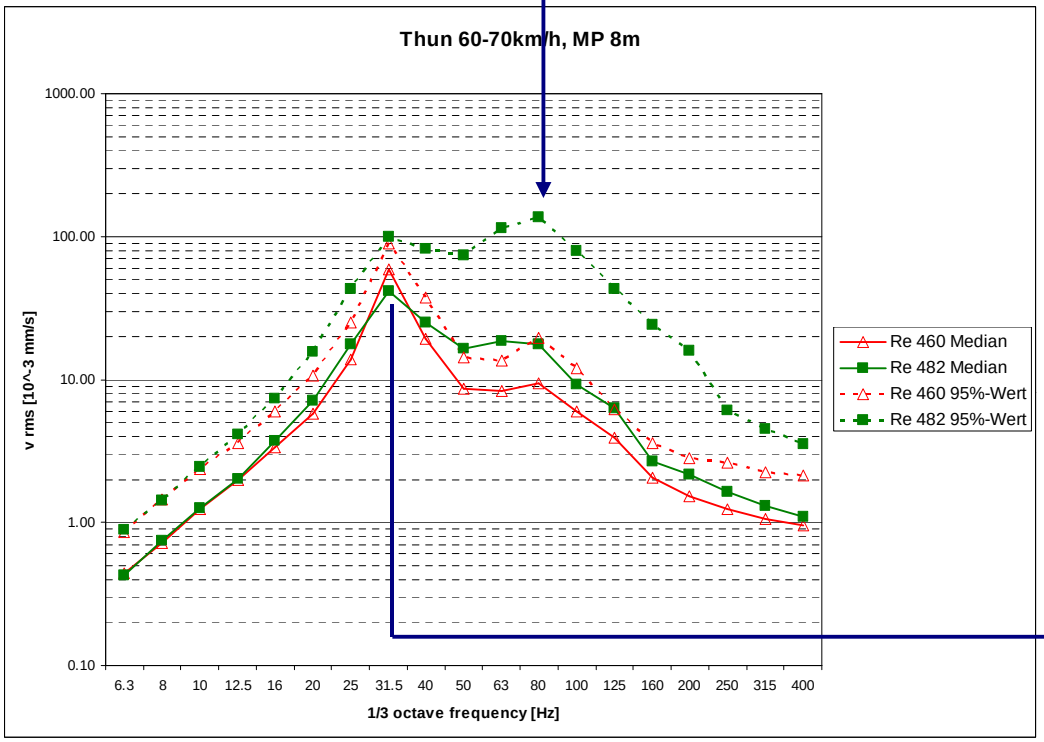
high unsprung mass x high out-of-roundness = high vibration excitation

# Excitation of vibration




out-of-roundness: polygonal wheels (wavelength = 28/14 cm)

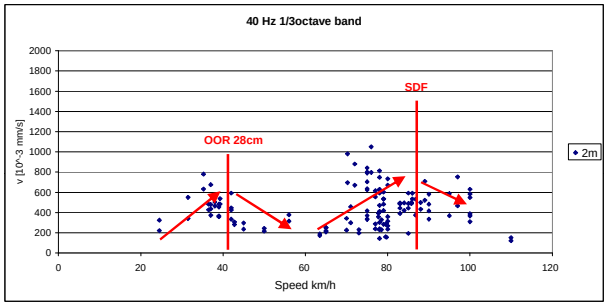



groundborne vibration

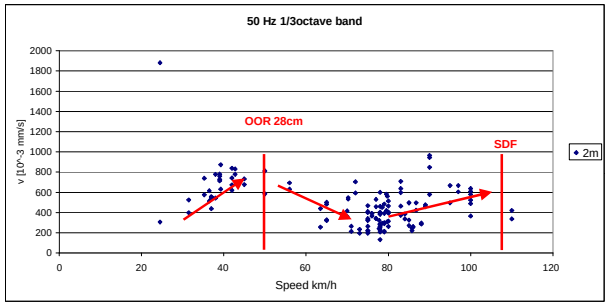
sleeper passing frequency (wavelength = 60 cm)

# Excitation of vibration

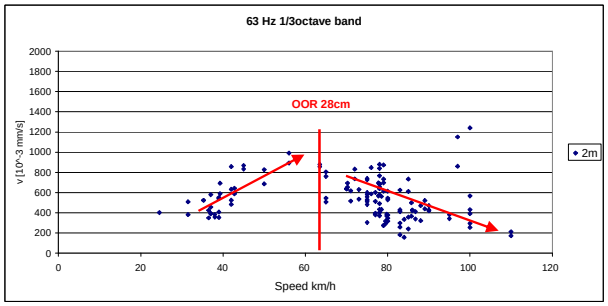
40 Hz



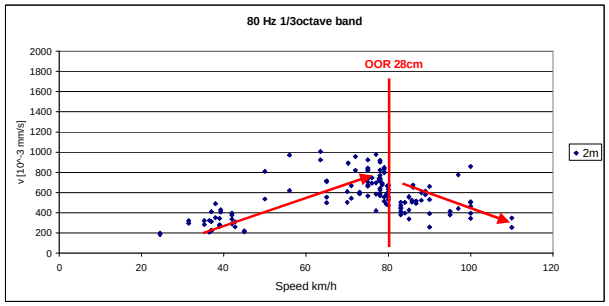

50 Hz



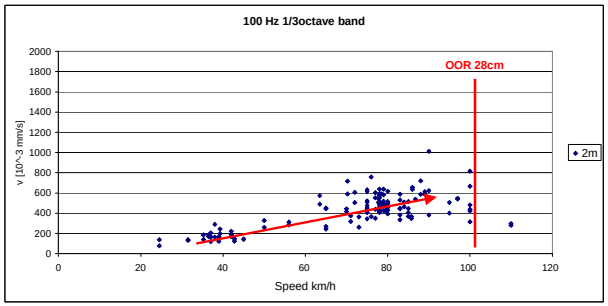

63 Hz



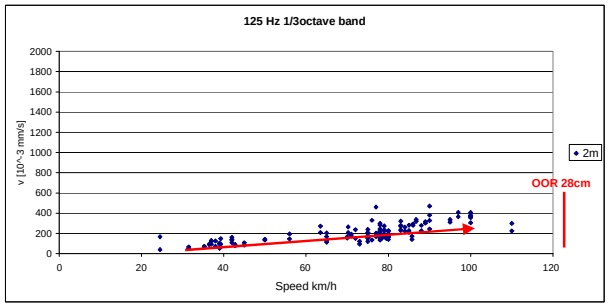

80 Hz



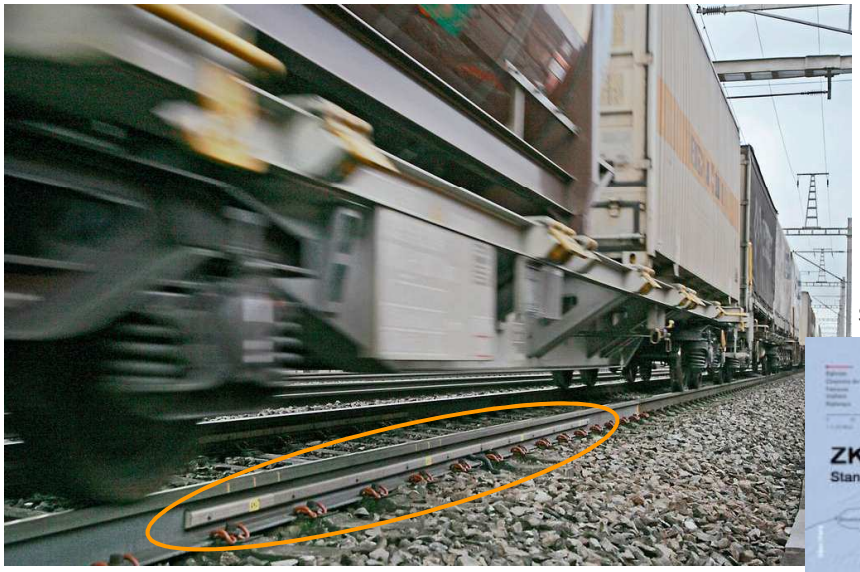

100 Hz




125 Hz



# Monitoring stations of SBB



Source figures: SBB AG

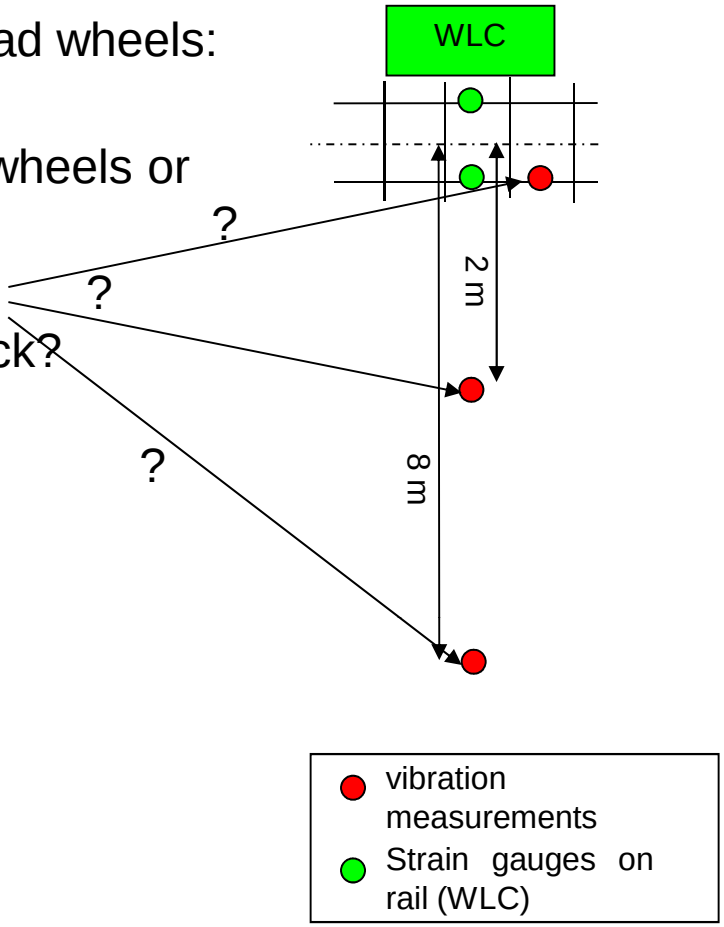
RLC = wheel load checkpoint:

Limits:
Wheel load ratio 1:1,7
Static axle load 25.5 t
Dynamic wheel load 40 t

# Evaluation of the optimal measuring position

Additional measuring point to WLC to detect bad wheels:

- Can the existing WLC detect bad wheels?
  Wheel flats yes, but what about polygonal wheels or other wheel tread defects?
- If no, where to install additional sensors?
  Rail foot, in the ground 2m or 8m to the track?



# Evaluation of the optimal measuring position

WLC signal

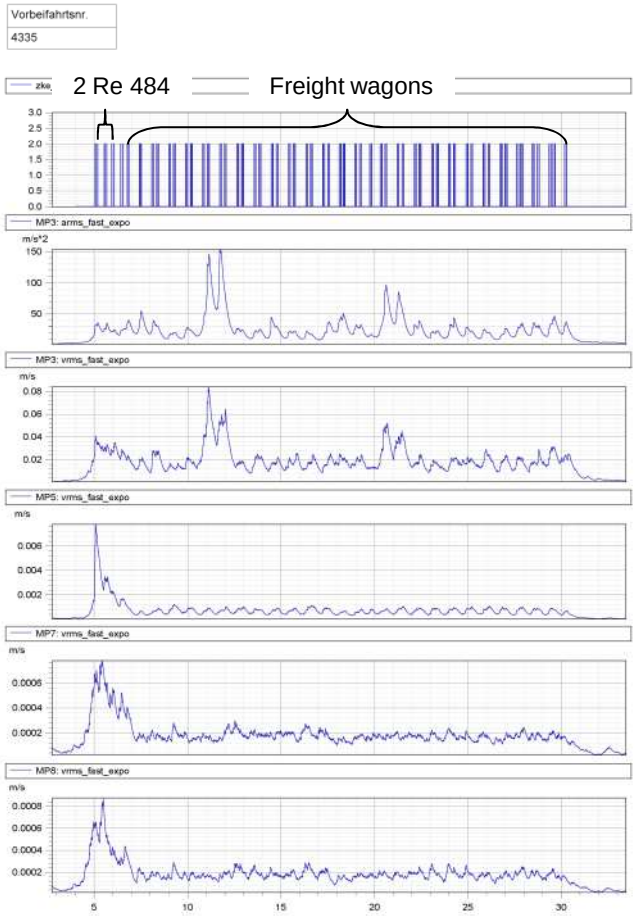
Rail foot $a_{rms}$

Rail foot $v_{rms}$

Ground 2m $v_{rms}$

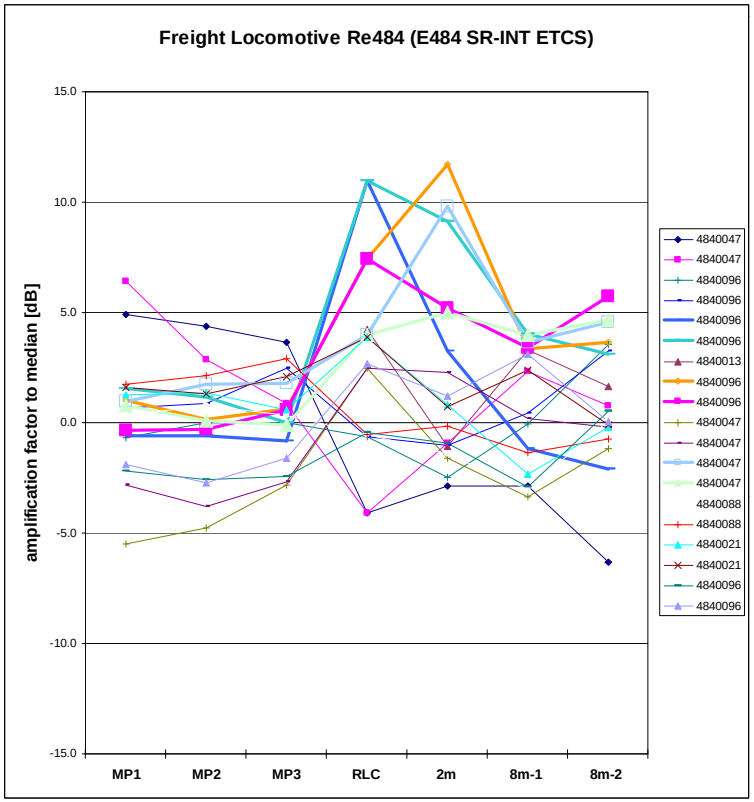
Ground 8m $v_{rms}$

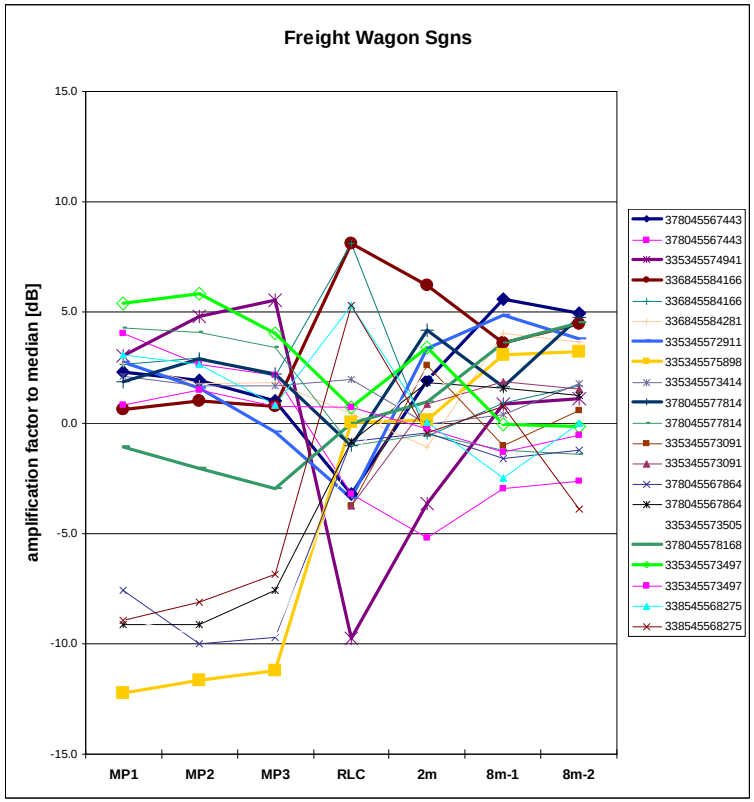
Ground 8m $v_{rms}$



# Evaluation of the optimal measuring position

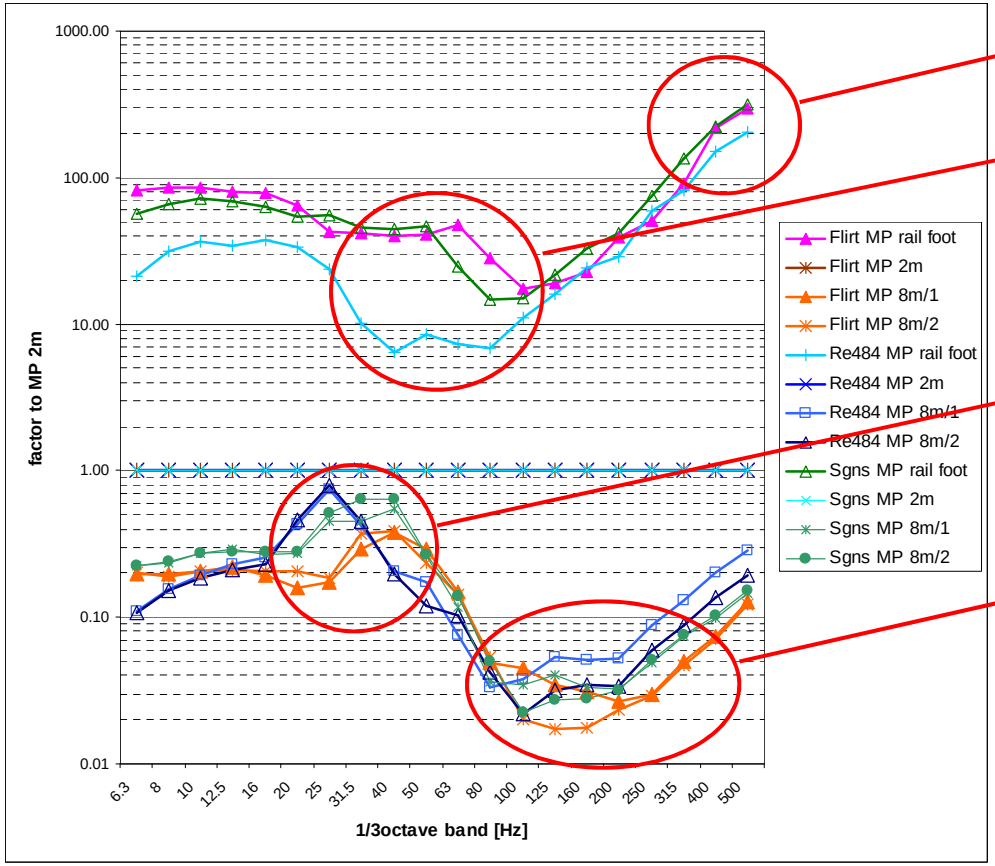
## Correlation between measuring positions



# Evaluation of the optimal measuring position

## Vibration transmission from rail foot to the soil at 2m and 8m




Vibration energy is transmitted longitudinal in the rail (noise radiation, TDR)

Good transmission from the rail to the soil (eigenfrequency depending on unsprung mass and track/soil stiffness)

Good transmission from 2m to 8m in the soil

Transmission loss in the soft soil of Cadenazzo

# Evaluation of the optimal measuring position

| | + | - |
|---|---|---|
| rail foot | detection of wheel roughness (high frequent excitation) or short wheel tread defects | bad correlation to ground vibration |
| RLC | detection of wheel flats, good correlation with ground vibration for Re484, Re 420/620 | bad correlation to ground vibration for freight vehicles |
| 2m | direct detection of relevant vibration and frequencies | influence of quasi static load (freight vehicles) |
| 8m | direct detection of relevant vibration and frequencies<br>no influence of quasi static load (freight vehicles) | frequencies above 50Hz can be strongly reduced in soft soils |

# Conclusions

- The vehicle design has a strong influence on wheel defects (radial steering, wheel slide protection, brake system, wheel material, unsprung mass?)
- Wheel defects have a dominant influence on groundborne vibration
- To control groundborne vibration, a stationary monitoring system to monitor wheel condition is recommended
- In Brunnen (Gotthard line, wheel load checkpoint), SBB installed this year the first permanent monitoring station for wheel condition and groundborne vibration with acceleration sensors at 2m and 8m in the ground