The use of vibration health response information in the framework of environmental health impact assessment.

Peter Lercher[1],
Rainer Flesch[2], Michael Cik[2],
Benedikt Tappauf[3]

[1] Medizinische Universität Innsbruck
[2] Graz University of Technology
[3] Tappauf.consultants GmbH

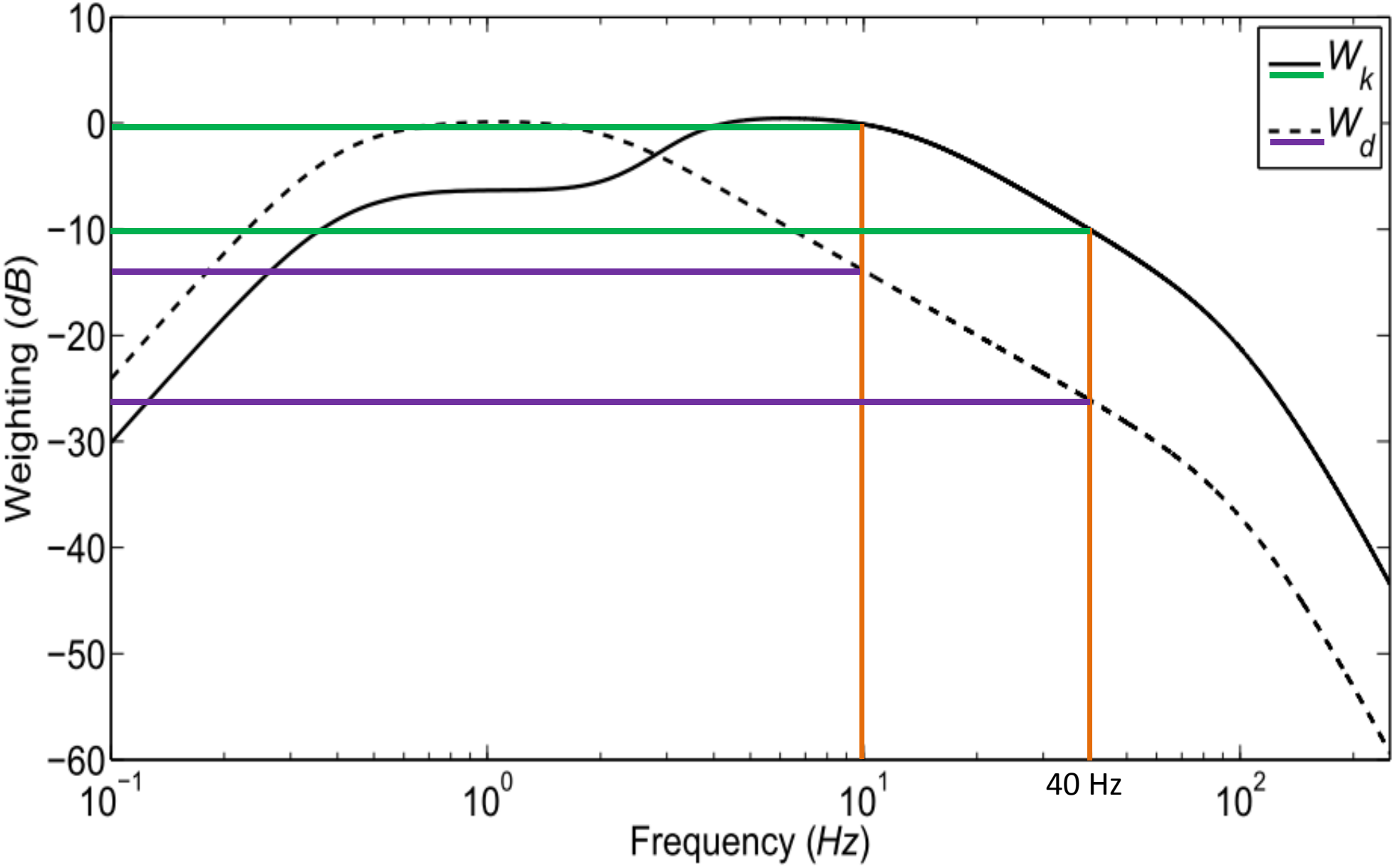
Introduction

- ISO 2631–2:2003 lets choice open to the national guideline committees
  - ➲ A broad variety of guideline approaches were established in different countries
- Question raised by a Public health viewpoint
  - ➲ Does this variety provide an equal protection of various populations across Europe against potential adverse health effects
- Based on the case study in Graz we report about our experience in using available exposure health relationships and derive future options

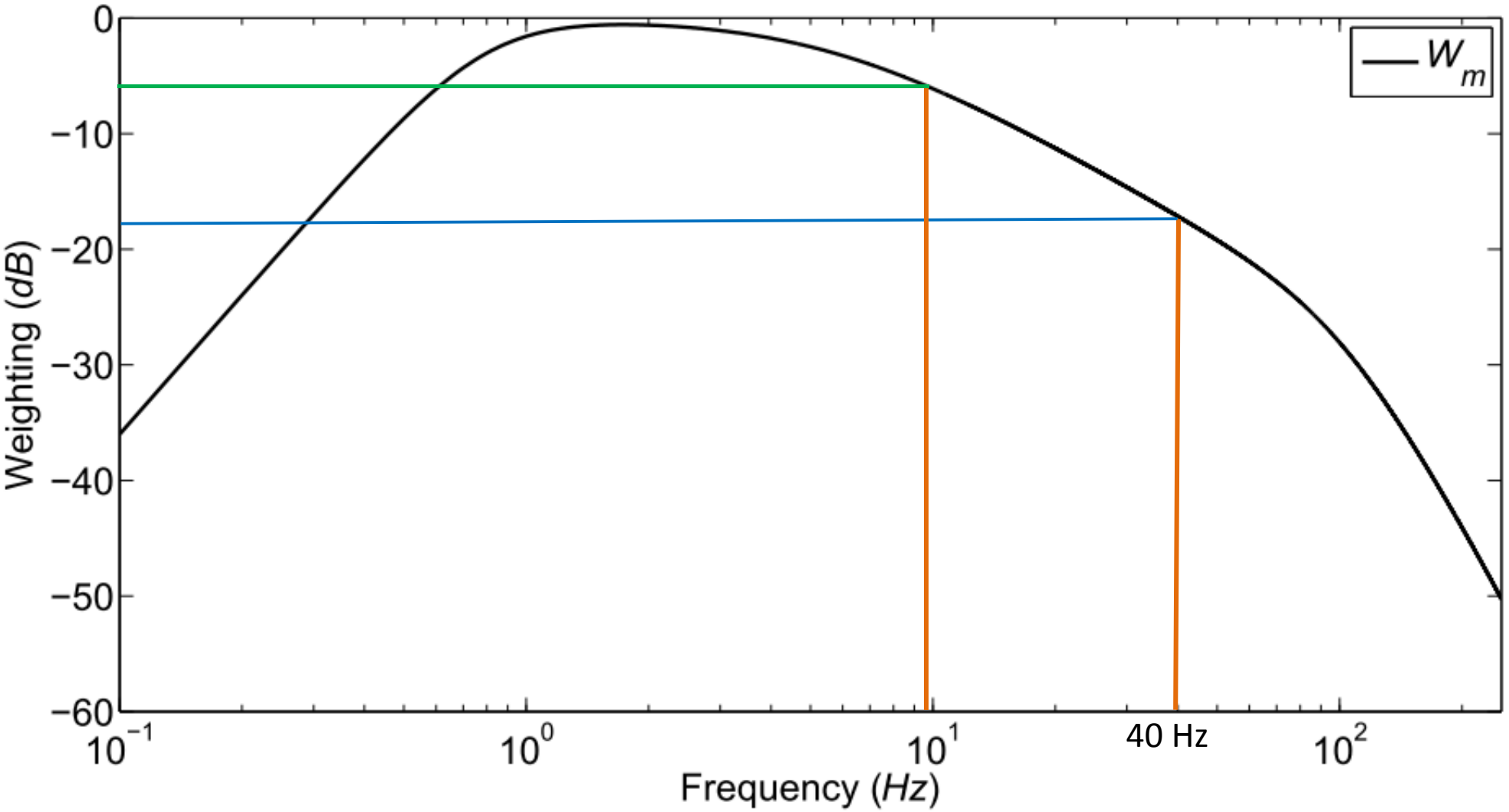
The measurement: are we measuring the right thing?

- Where to measure ?
  - Middle of the room
  - Based on residents advice
  - Based on pilot measurements
- Which measure ?
  - Integration of all axes
  - Vertical axis only
  - Horizontal axis only (e.g. in sleeping rooms)

Frequency weighting schemes: Wk versus Wd



Frequency weighting schemes: Wm*



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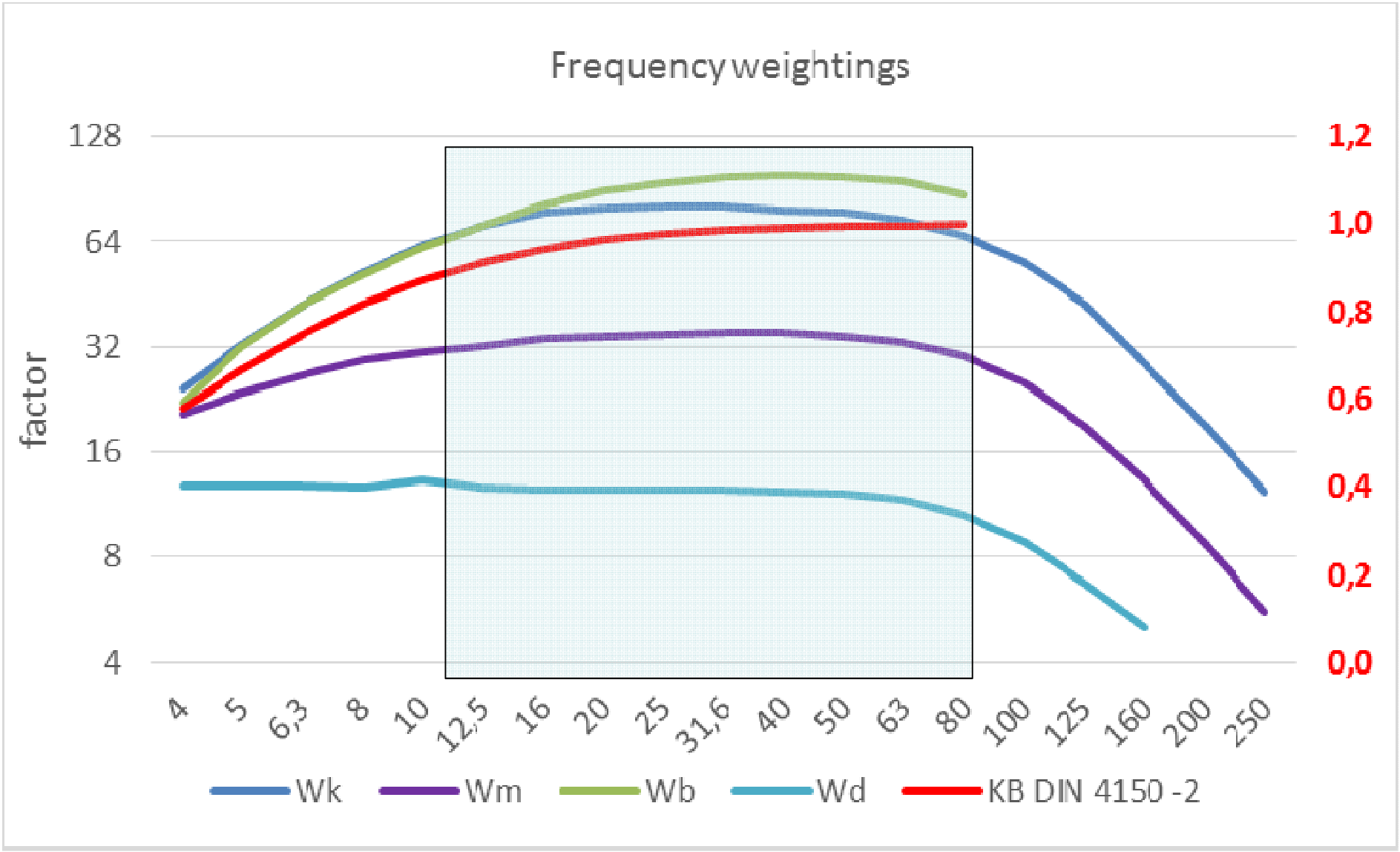
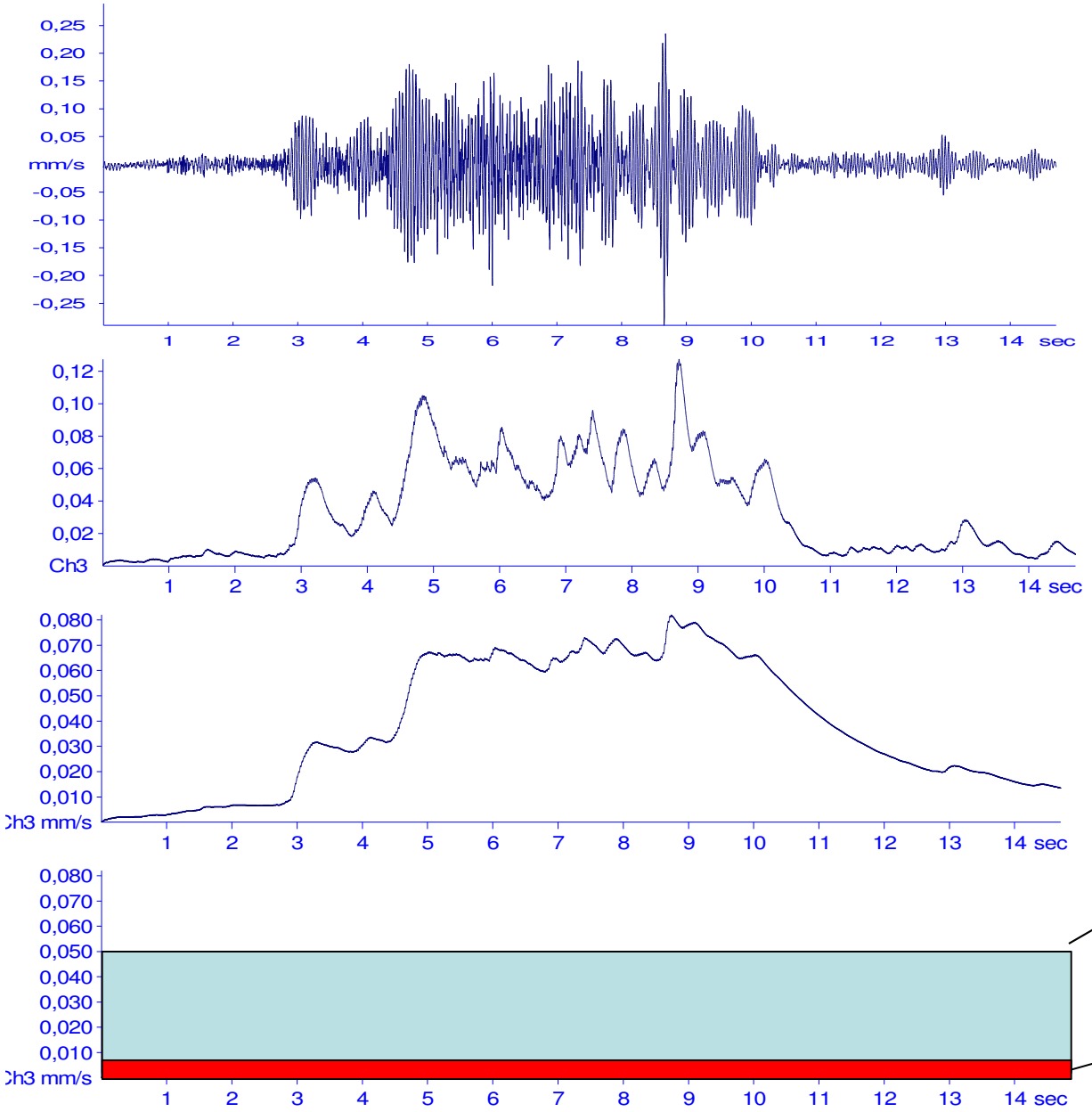
* Austrian guideline: ONORM S 9012

Frequency weighting schemes: Another view



Time weighting



No time weighting t=1/400 sec

Vmax=0.25 mm/s

$$v_{eff}(t) = \sqrt{\frac{1}{\tau}\int_{\xi=0}^{t} e^{-\frac{t-\xi}{\tau}} v^2(\xi)d\xi}$$

fast t= 1/8 sec

Veff(0.125 s) = 0.12 mm/s

slow t = 1 sec

Veff(1 s) = 0.08 mm/s

RMS passby t = 15 sec

Veff(15 s) = 0.05 mm/s

RMS (16h) (100 trains)

Veff(16 h) = 0.008 mm/s

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Conversion: empirical relationship* between different weighting parameters

From	To	Factor
Frequency Weighting		
Velocity without weighting	W_m velocity	1
W_m acceleration	W_m velocity	1/35.7
W_m weighting	W_k weighting	2.2*
Time Weighting		
RMS pass by	Slow linear filter	1.7
RMS pass by	Fast linear filter	2.2
RMS pass by	Maximum	5

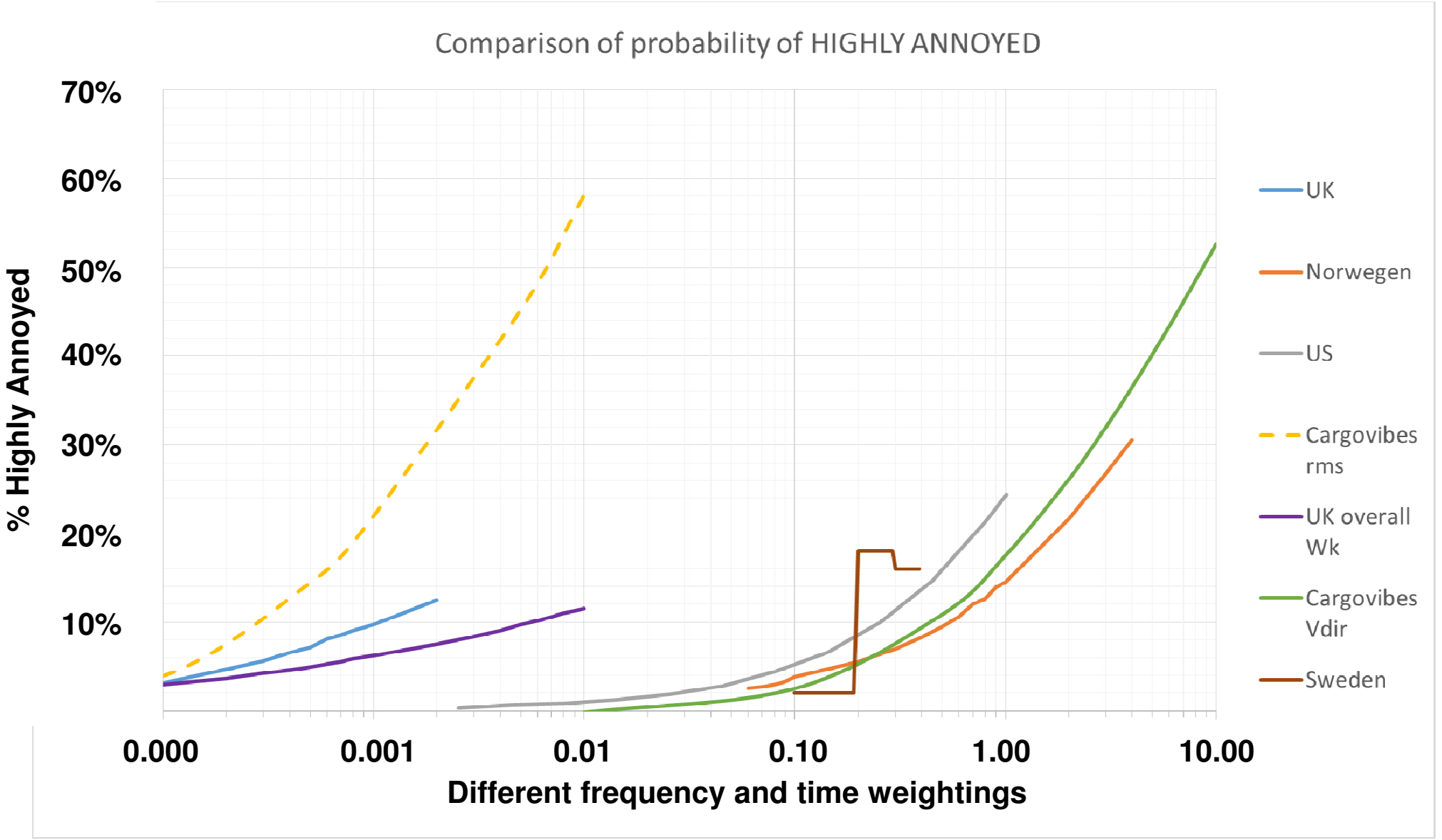
* if frequencies lower than 12 Hz are dominant then 1.2

* Based on 500 measurements

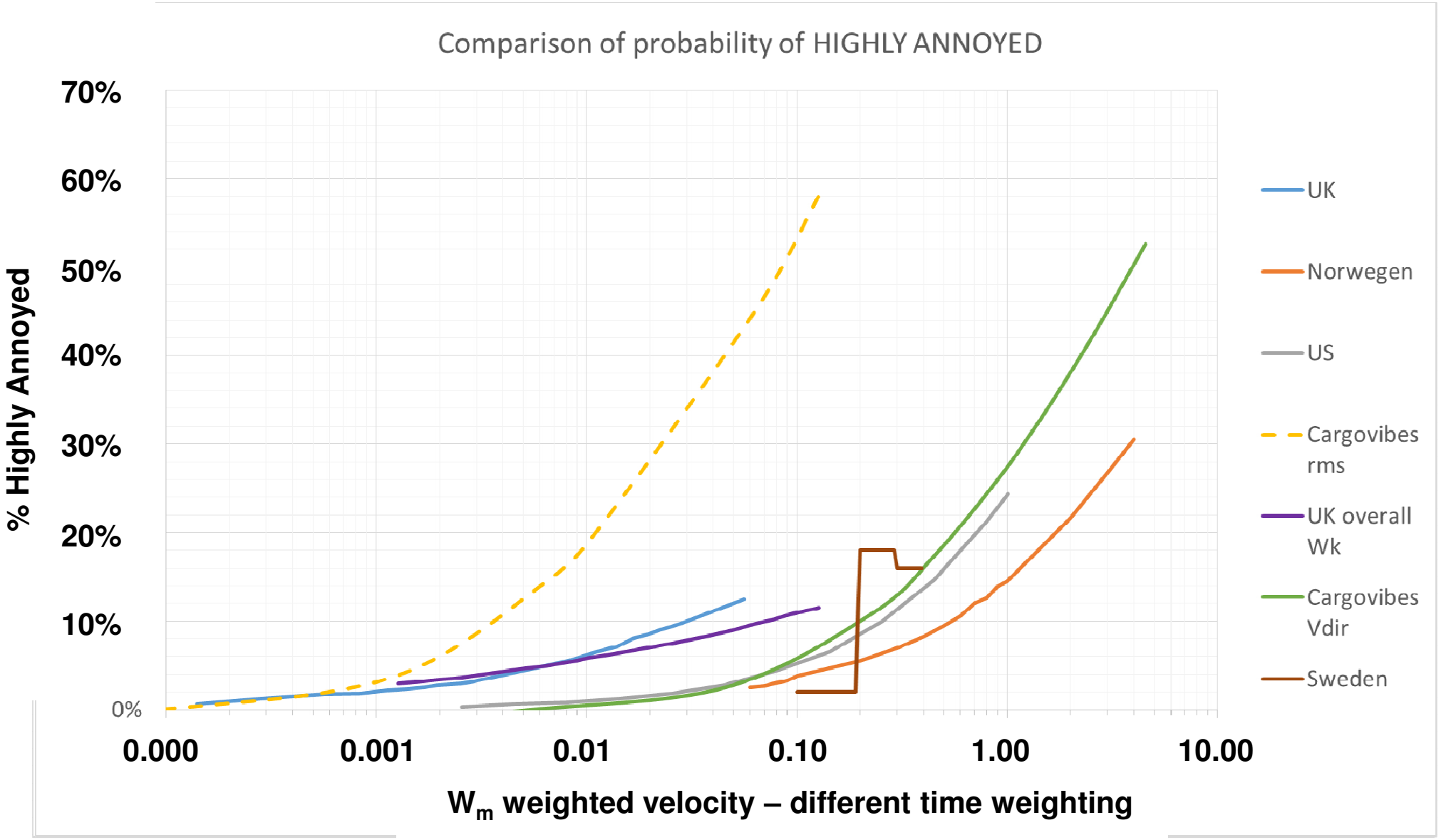
Time and frequency weighting in available exposure response studies

Study	Descriptor Unit Direction	Time weighting	Frequency weighting
Norway	$v_{w,95}$ [mm/s] vertical	1 s	NS 8176/W_m
USA & Canada	Pass by maximum velocity [dB] vertical	1 s	-
UK	RMS 24_{hour} [m/s²]	24h	W_m / W_k
Sweden	Maximum velocity mm/s	1 s	SS 460 48 61/W_m
Cargo-vibes	$v_{w,95}$ [mm/s] RMS 24_{hour} [m/s²] VDV [$m/s^{1,75}$]	0.125 s 24h 24h	W_k

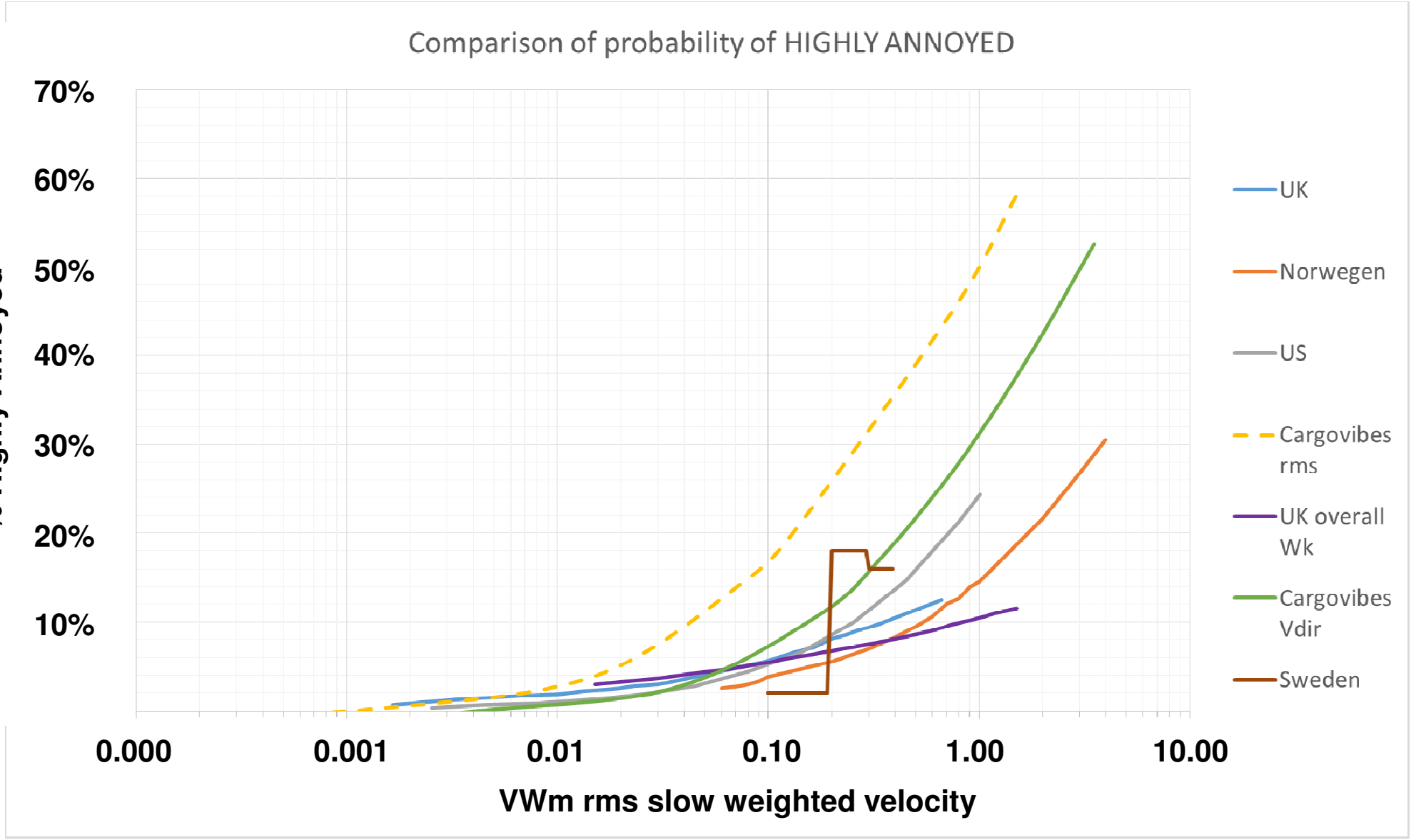
Exposure Response studies: the raw mess



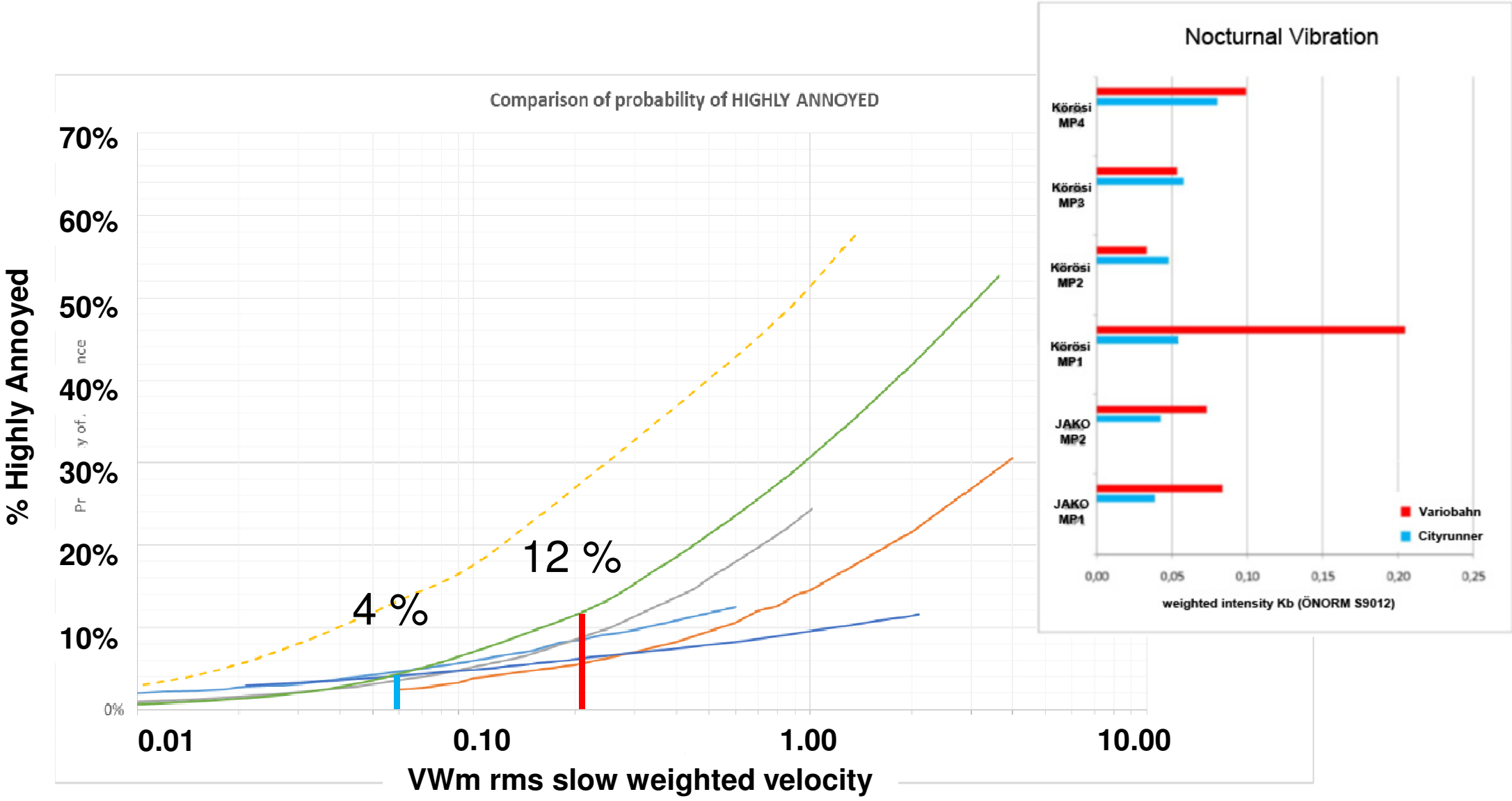
Exposure Response studies: first step
Conversion to Wm weighted velocity



Exposure Response studies: second step Conversion to VWm rms and slow weighting

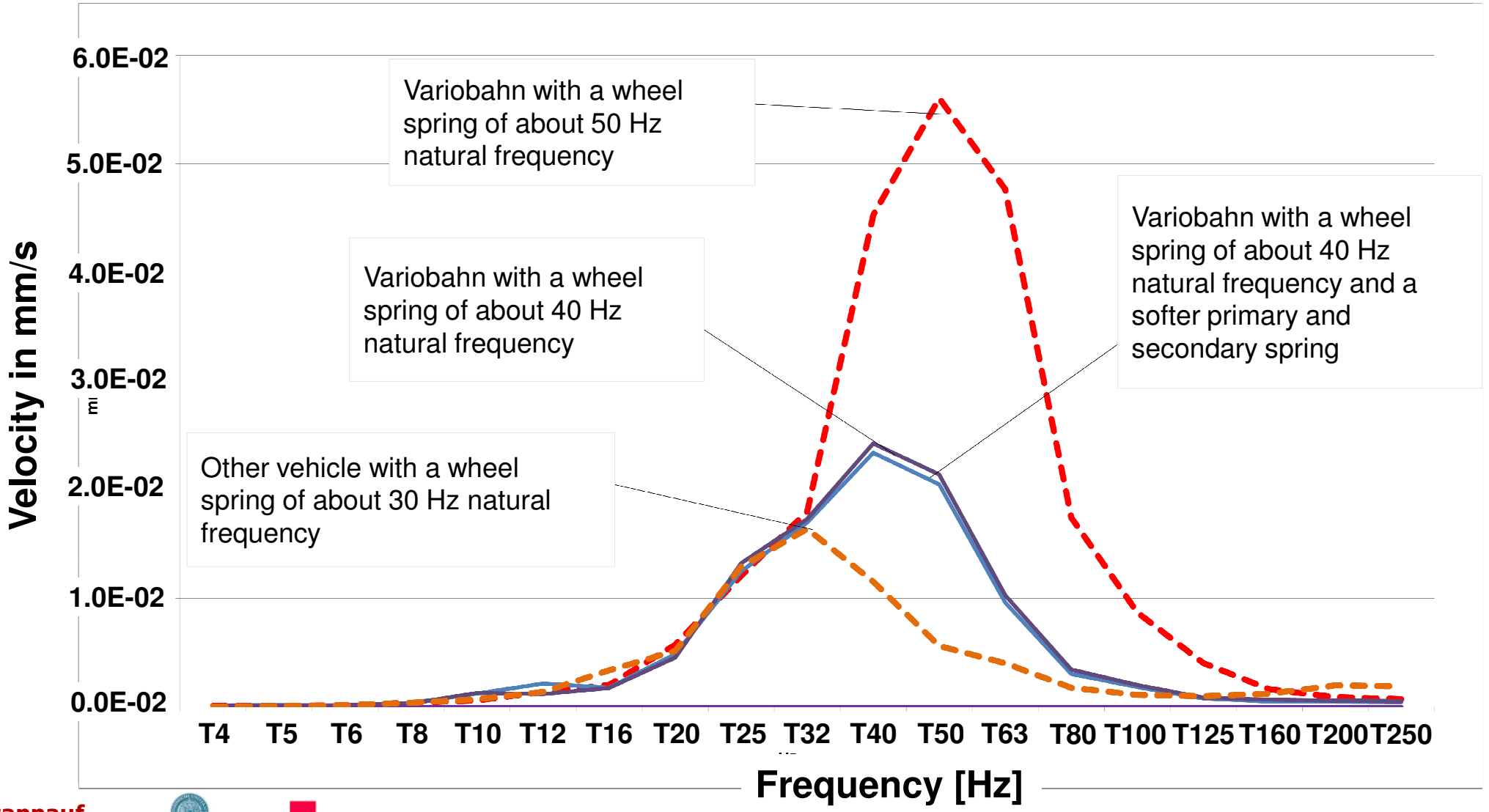


Predicted annoyance response by the new tram in one home with low vibration impact: in 2011

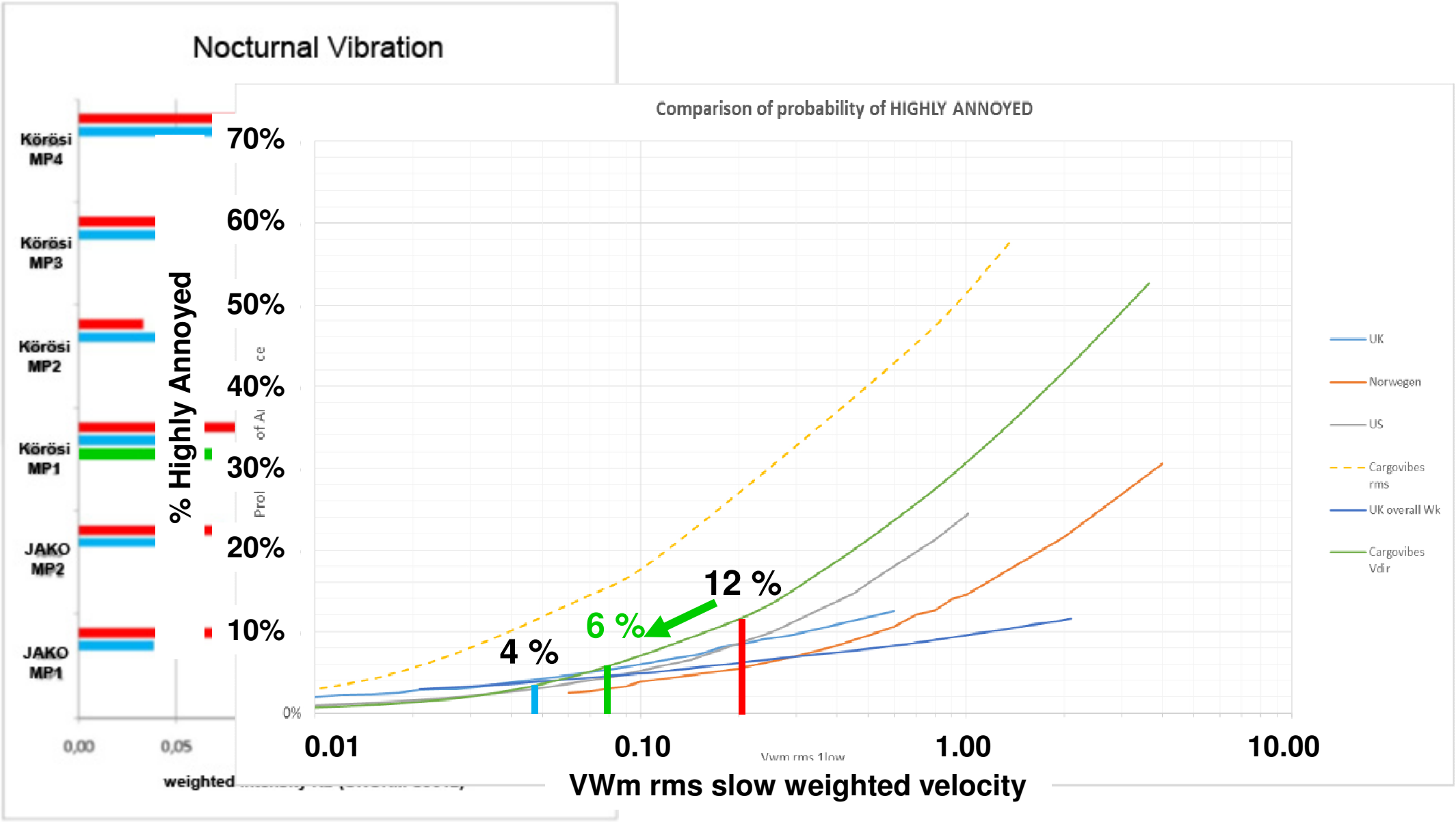


Interventions done on the vehicle: free field measurements

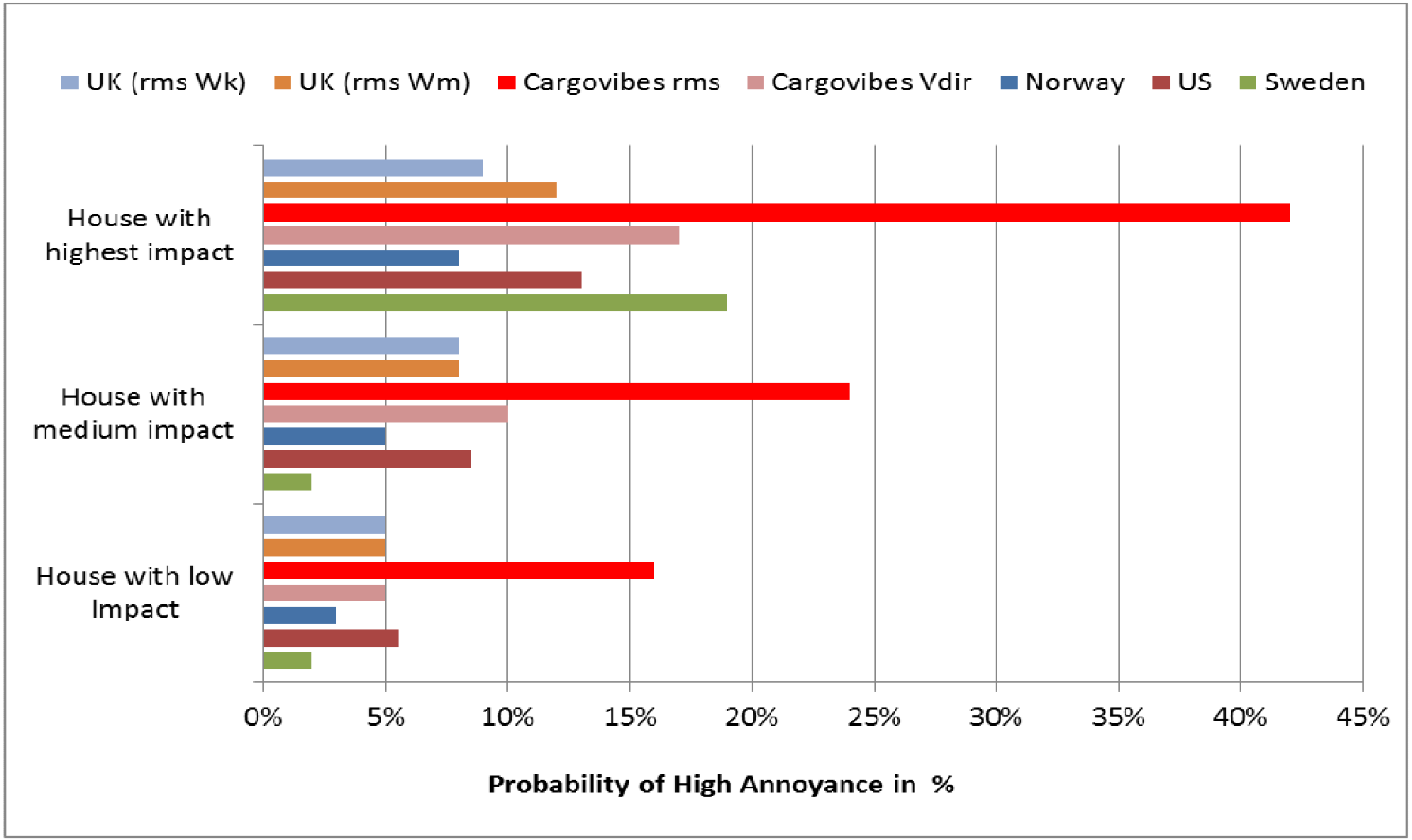
The results show that a change in the vibration emissions was achieved by **reducing the stiffness of the wheel spring** only.



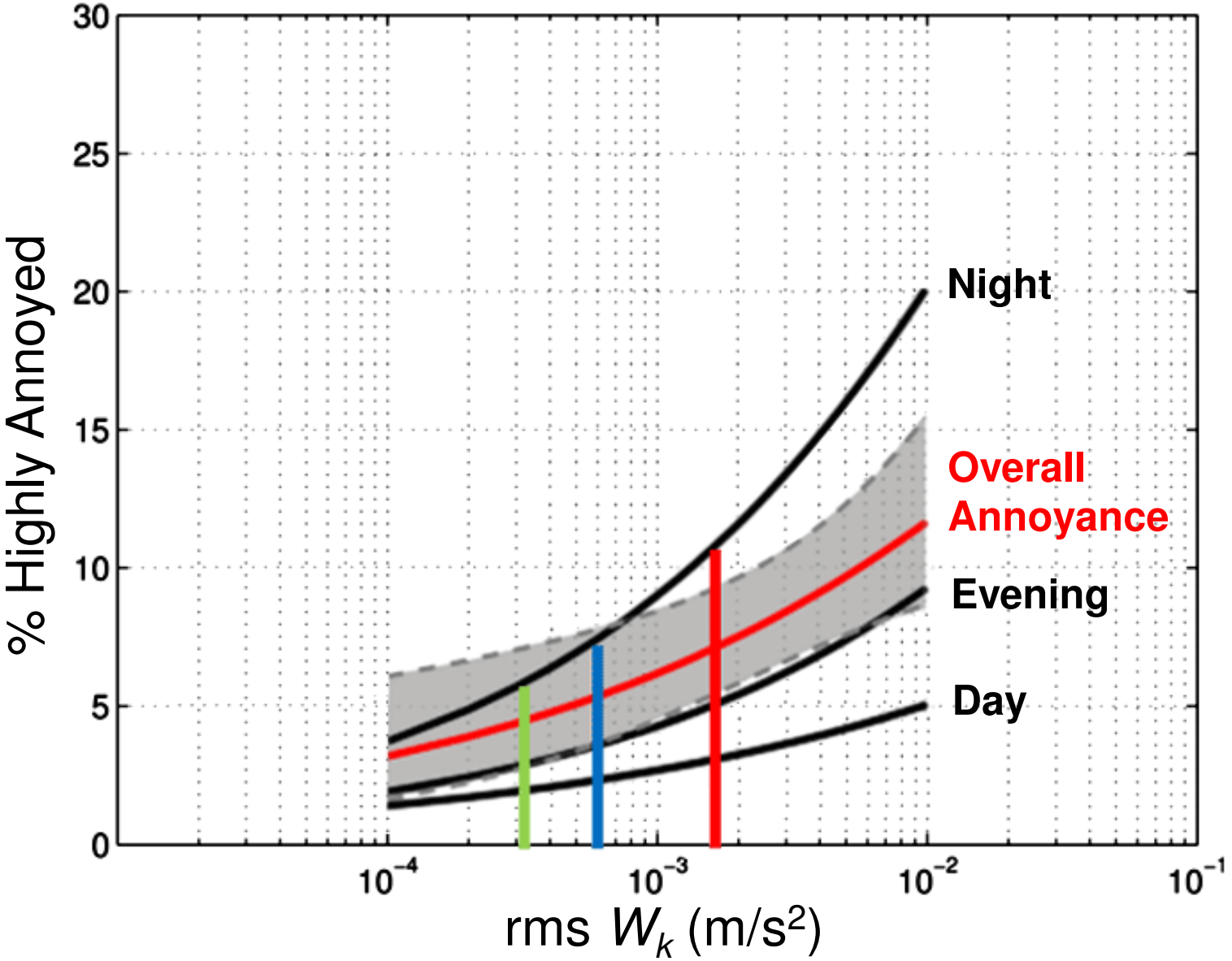
Predicted annoyance response by the new tram after intervention in home with low vibration impact: 2014



Which annoyance prediction is the proper choice for all houses with different vibration impact?



Vibration exposure during night hours: annoyance



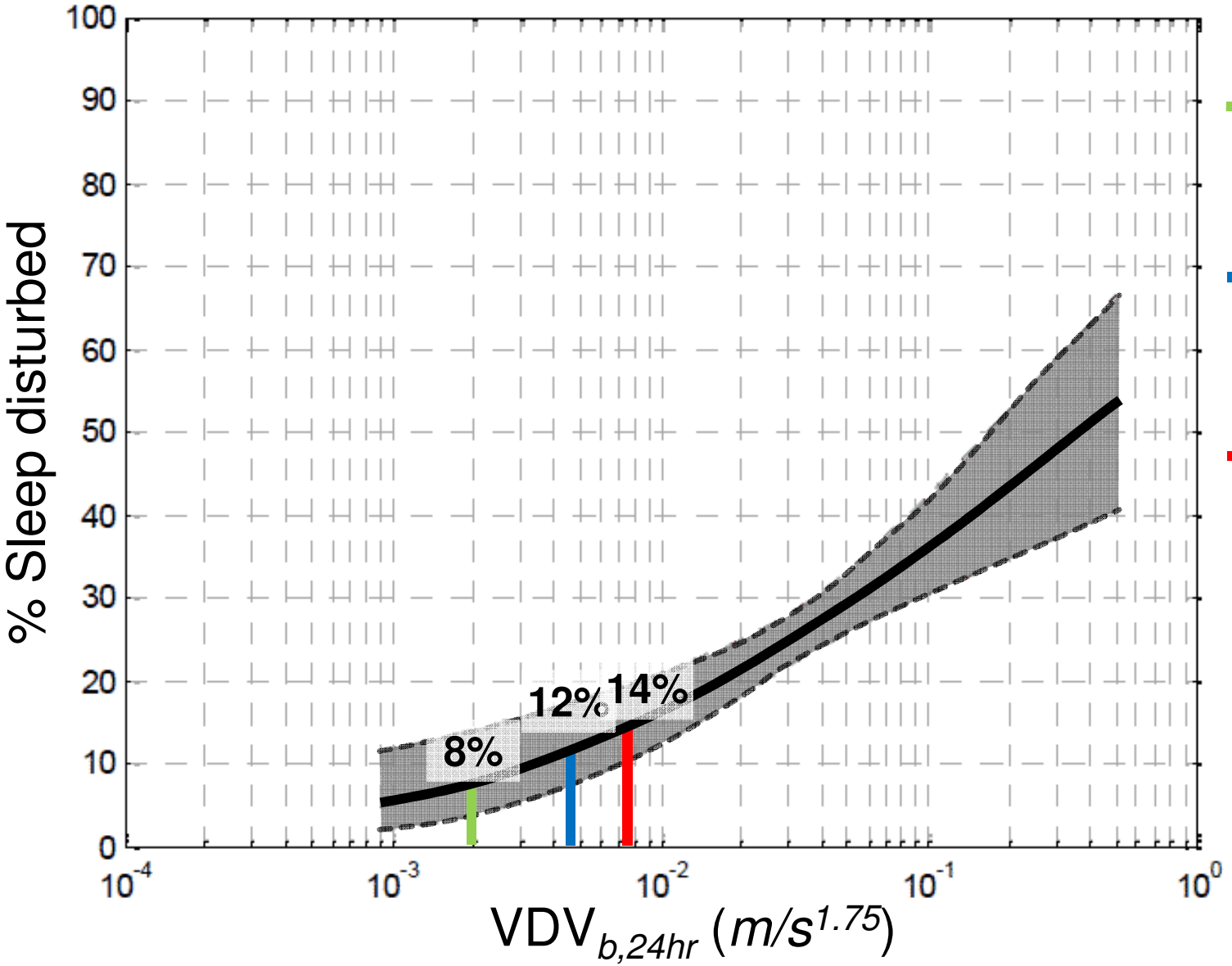
House with low impact

House with medium impact

House with high impact

Source: Peris et al. J Acoust Soc Am. 2014 Jan;135(1):194-204.

Vibration exposure during night hours: Sleep disturbance



House with low impact

House with medium impact

House with high impact

Source: Woodcock et al. Technical Report 6: Determination of exposure-response relationships. Defra, London, 2011

What questions are still left for our case assessment?

- To what extend are vibration-response curves from railway surveys applicable for tramways ?
- What is the proportion of freight trains in the various exposure response surveys?
- How much annoyance due to the acoustic impact of the various train types do the response curves contain?
- What about the amount of accompanying secondary airborne sound in the buildings?
- What about the indoor signal to noise ratios in the various exposure response surveys?
- What about the combined effects due to sensory cross-modality stimulation?

Conclusions and future needs

- Different frequency weightings lead to unwanted uncertainty in the prediction of annoyance
- From a practical point of view, exposure-response relationships based on a maximum Running RMS are more efficient than relationships using RMS values over a certain assessment time.
- Unweighted (but band passed) maximum velocities would be an alternative for better comparison between studies and as input for meta-analyses
- A unified European procedure for the assessment of vibrations in residential environments is necessary
- However, only combined response information from vibration, primary and secondary sounds will provide accurate local assessments
- Most existing surveys rely on a large number of interviews but a small number of measurements. Future studies should be based on unweighted data – usually available from the providers.