EUROPEAN TYRE & RUBBER manufacturers' association

European tyre and Rim Technical Organization

TYRES & ROAD TRAFFIC NOISE: WHERE IS THE POTENTIAL?

September 13th and 14th 2021

AGENDA

WHERE WE SHOULD LOOK FOR TYRE and ROAD TRAFFIC NOISE IMPROVEMENTS

- *Noise regulations evolutions vehicles, tyres, roads*
- *Tyre vs Vehicle: approach about UN R117 & R51*
- *Current EU market status*

HISTORY & CURRENT STATUS

MARGIN FOR IMPROVING

- *Trade-offs*
- *The central role of measurements accuracy*

- *Noise generation: from Road to Tyre & Vehicle*
- *Meaning of decibel*

NOISE BASICS

POTENTIAL in the road mobility compartment

- *Seeking for harvesting noise reductions:*
  Where is the problem
  What can be effective

Tyre industry:

- *aware of the issue*
- *aware of regulatory framework*
- *committed to contribute*

CONTEXT

WAY FORWARD AND KEY TAKE-AWAY

- *Vision and proposal for real-world time effective noise improvements, while safeguarding other ambitious sustainability and safety priorities.*

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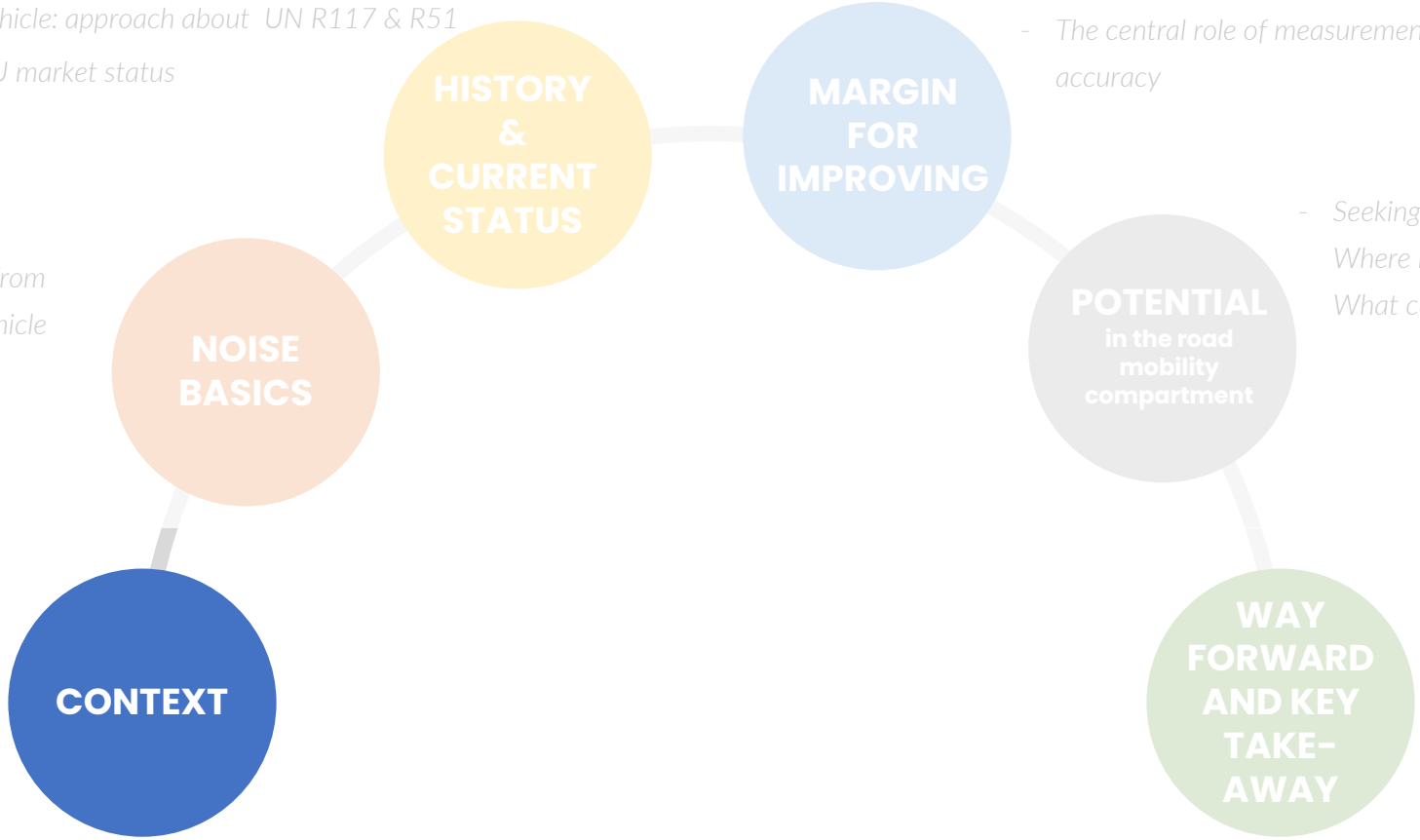

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- *Vision and proposal for real-world time effective noise improvements, while safeguarding other ambitious sustainability and safety priorities.*

CONTEXT

Tyre Industry

- ***recognizes the need to contribute to the reduction of noise pollution***
  - *environmental noise is an important problem for the society to be addressed through effective and efficient **actions** also **including transport noise** measures;*
  - *there is a need to **focus on time-efficient and cost efficient measures addressing the real-world** road transport noise*

- ***is aware of the legal obligations of the EU***
  - *there is legal obligation of the **EU Commission** for a detailed study on sound level limits by 1 July 2021 and **to** then **submit, as appropriate, a legislative proposal*** as well as of the noise ambition included within the **EC Zero Pollution Action Plan communication****

- ***is aware of the recent and ongoing studies***
  - *investigating the current sound emission levels of M and N category vehicles to propose possible improved sound level limits for the next phases of the Regulation (EU) No 540/2014 in the coming years. **EC preliminary direction towards most efficient measures**** for noise negative health effects mitigation:*
    - ❑ *limit tightening after phase 3 [R51]*
    - ❑ *more severe ASEP [R51]*
    - ❑ *additional 2 stages tyre limits (2x2dB) [R117]*

    } is the potential here?

**Regulation (EU) No 540/2014 as amended by Regulation (EU) 2017/1576 of 26 June 2017 and Regulation (EU) 2019/839*

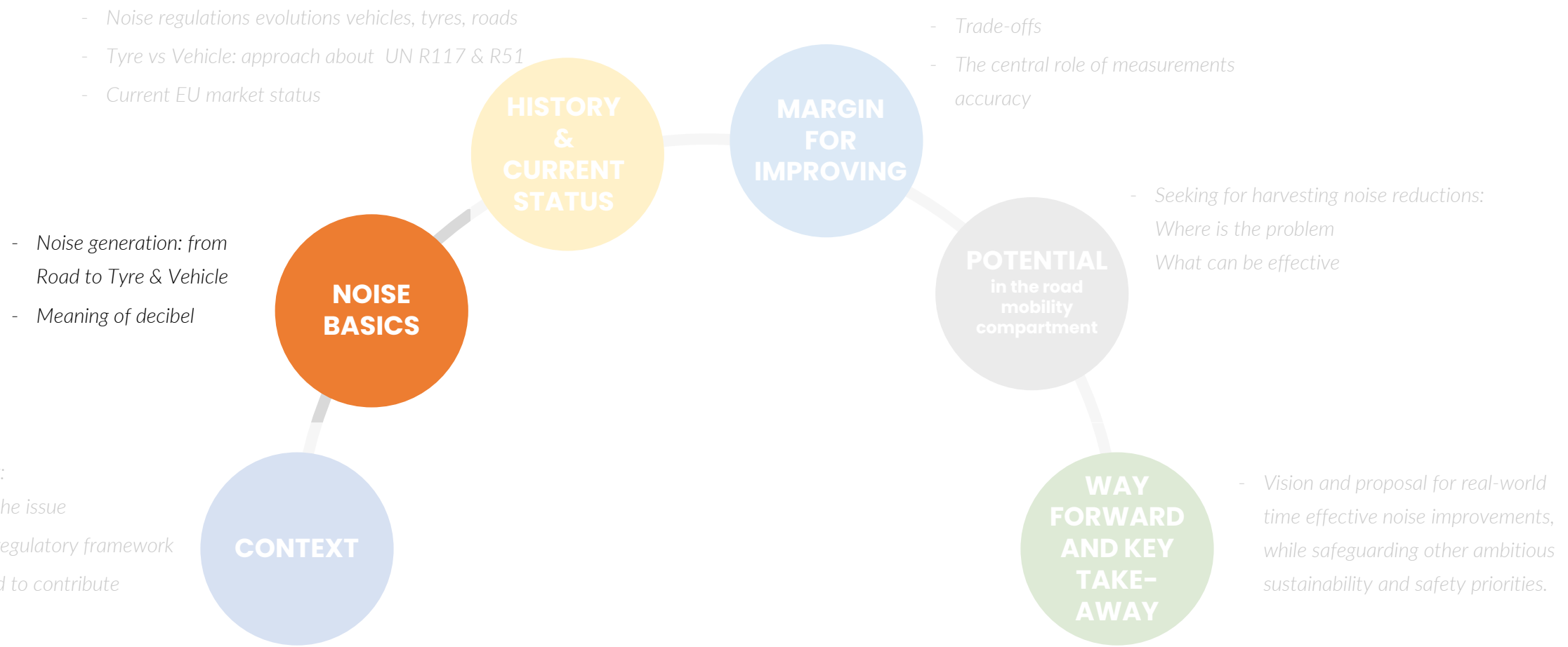
***COM(2021) 400 final of 12.5.2021*

****Informal document GRBP-73-23 (73rd GRBP, 26-29 January 2021, agenda item 7)*

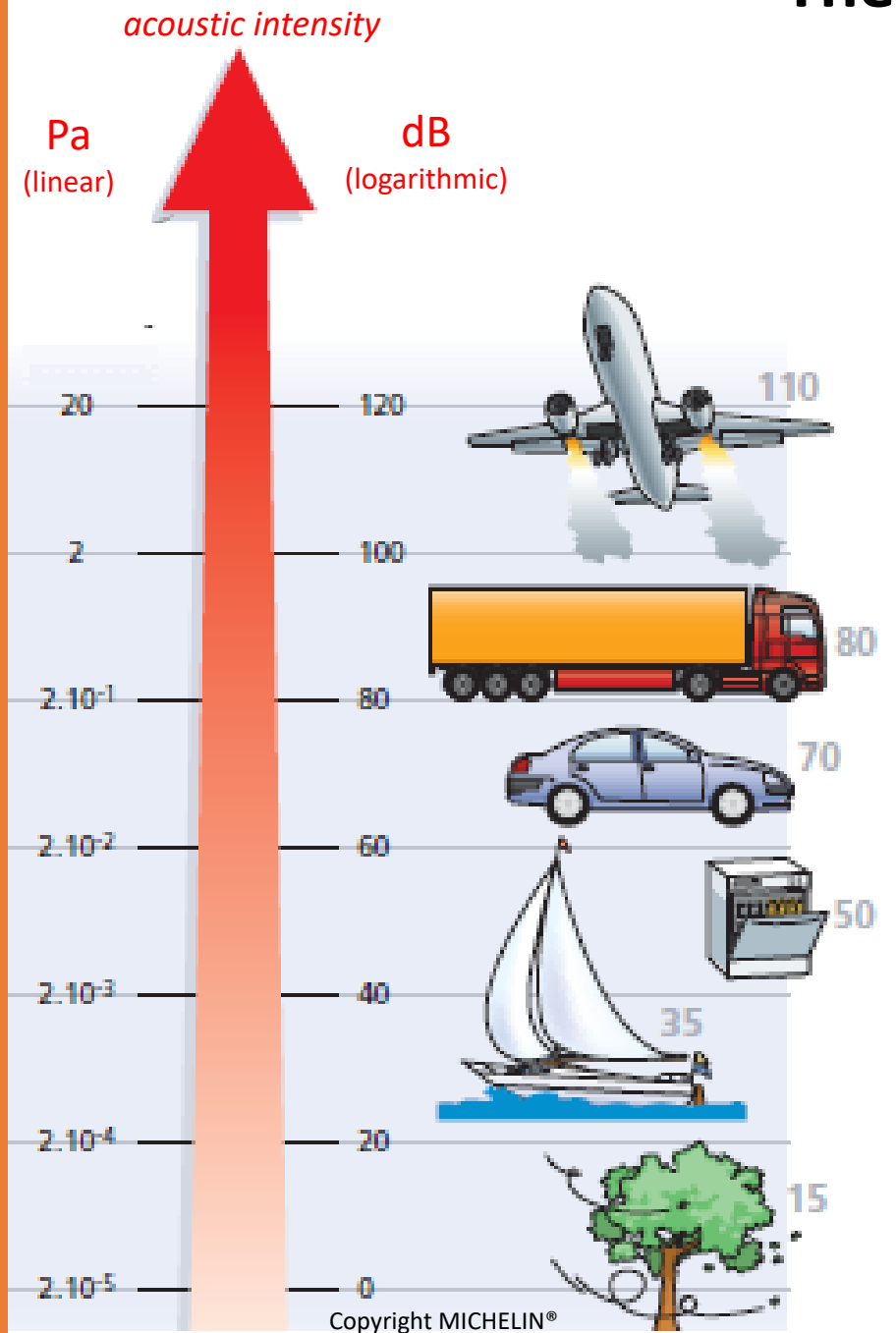
This document is aiming at analysing technical facts, providing industry views on the EC preliminary direction as well as seeking for feasible proposals.

AGENDA

WHERE WE SHOULD LOOK FOR ROAD TRAFFIC NOISE IMPROVEMENTS



The meaning of Decibel



The acoustic intensity is a ratio between the sound emitted by a source and the reference human audibility.

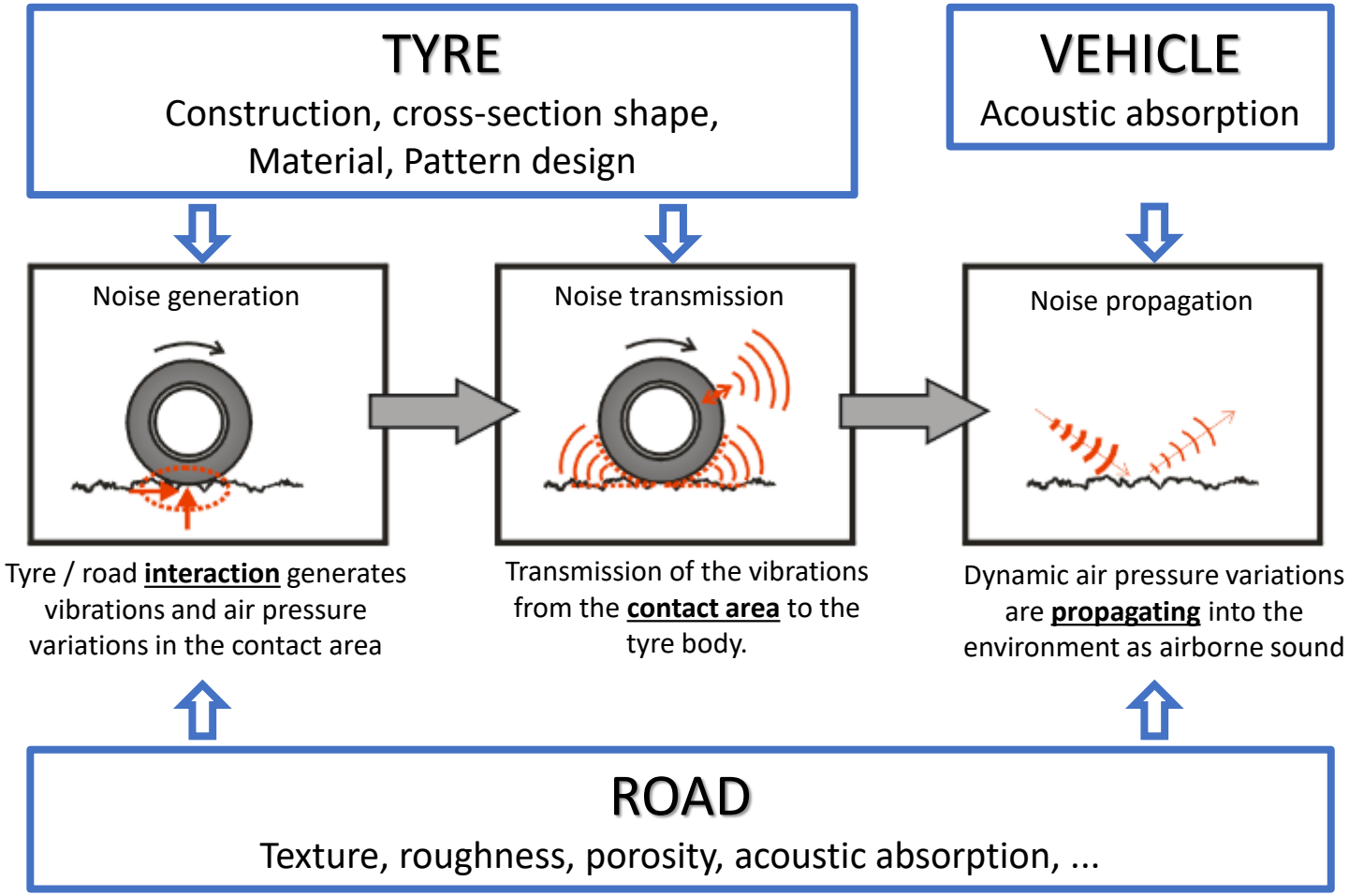
*This acoustic intensity is usually written in decibel (dB) - a **logarithmic,** not linear, scale.*

Examples

- **Reducing noise by 3dB is the same as halving (!) the noise intensity.**
- **If one car emits 70dB, for instance, the sum of the sound emitted by the two cars is not 140dB but 73dB.**

=> Thus, noise reductions expressed in dB, may appear limited, they have a major impact on sound intensity and the product design.

Generation mechanism of tyre-road noise (C1 tyres)



1. **Tyre-Road contact**
   - Premium tyre profiles are constantly being further optimized to reduce excitation, with the constraints of the performances trade offs.
   - On the road side, the texture design of the road surface influences the vibration excitation of the tyre tread.
2. **Vibration transmission**
   - This can be improved by introducing materials with higher damping, which would have a negative effect on rolling resistance and thus CO2 emissions
3. **Noise propagation**
   - After the airborne noise has been emitted, it can only be counteracted with sound-absorbing materials.
   - In modern vehicles, the wheel arches and the underbody are already optimized in this regard.
   - Porous and sound-absorbing road surfaces and other passive measures in the immediate vicinity of the road and on buildings are a key option.
4. **Human sensitivity**
   - To be addressed according to the key critical impacts: e.g. noise peaks

Noise is the result of vehicle, tyre and road interaction.

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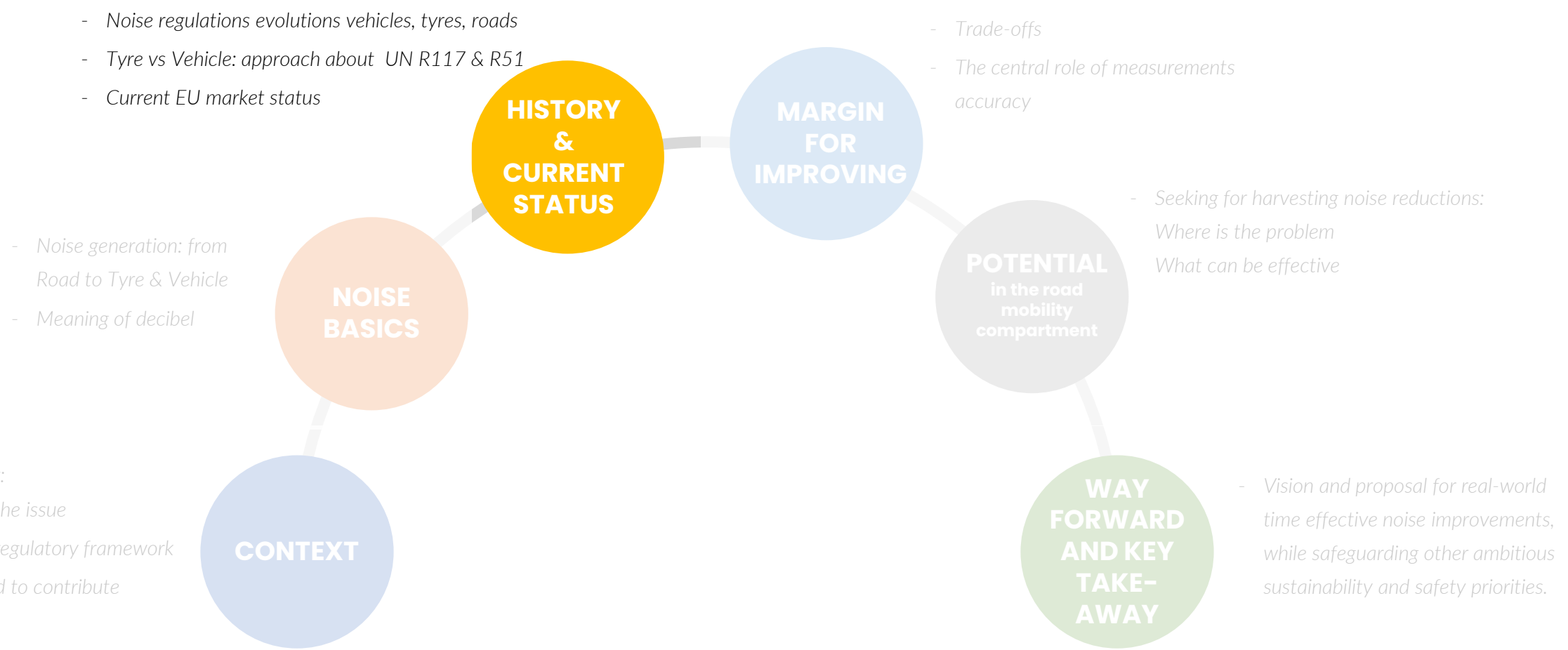
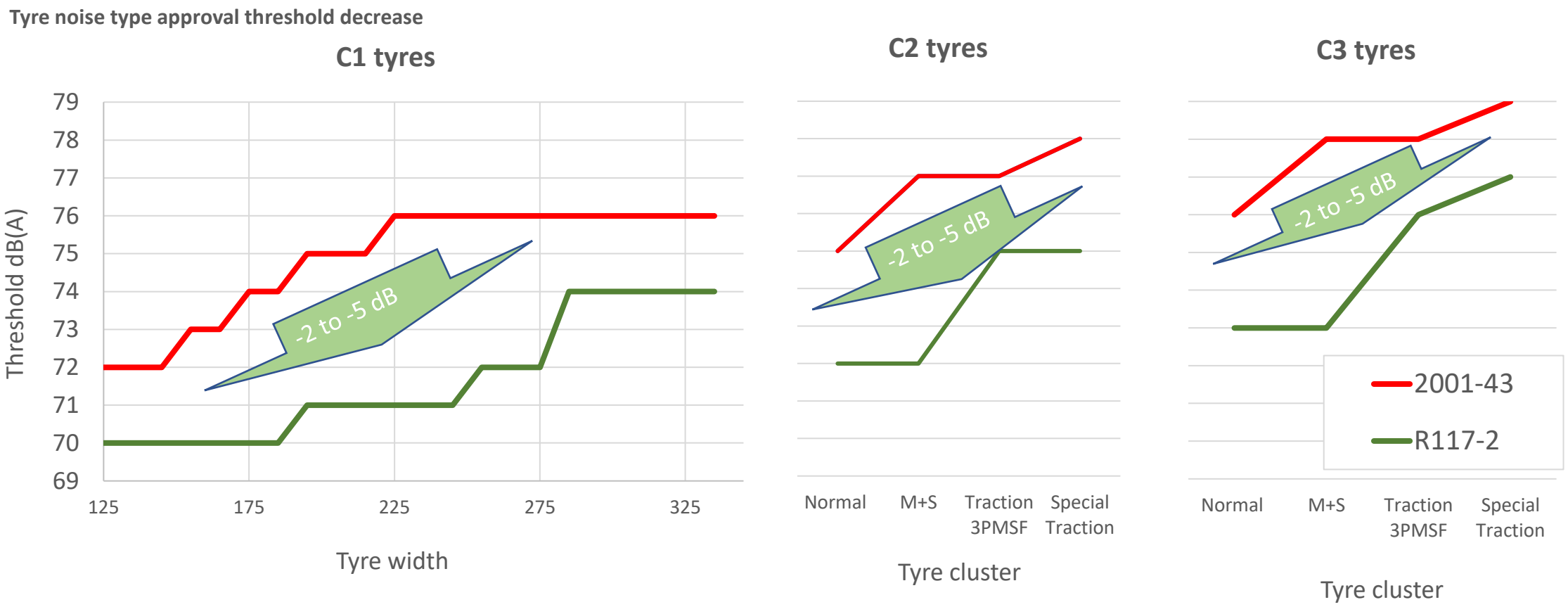


History of Noise improvements by Tyre Industry

HISTORY & STATUS



- 3 dB reduction corresponds to reduce acoustic intensity by a factor 2
- 5 dB reduction corresponds to reduce the acoustic intensity by 3

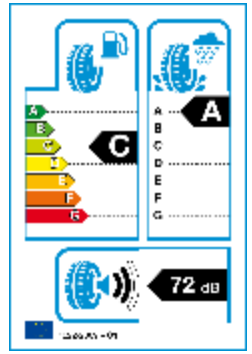
In addition to R117, tyres are also indirectly regulated by R51

The tyre industry has made important progress and reduced noise by up to 5 dB, more than halving sound emissions.

Where we are: current status of Tyre industry for PBN and other performances

some studies (e.g. Phenomena) are claiming that there is margin for noise limits improvements with no trade-offs

EU market analysis according to EU Label 1222/2009 applied until May 2021.



DATA BY lizeo group

Example for C1 tyres (aggregated data for 2019-2020)

8.7% of the C1 summer market

1 noise wave		Rolling Resistance					
		A	B	C	E	F	G
Wet Grip	A	0.6	2.8	7.7	3.7	0.8	0.0
	B	1.4	3.0	14.4	12.3	3.2	0.2
	C	0.1	1.2	8.7	17.1	6.5	0.2
	E	0.0	0.6	2.2	8.1	2.4	0.2
	F	0.0	0.2	0.9	0.9	0.7	0.1

78.8% of the C1 summer market

2 noise waves		Rolling Resistance					
		A	B	C	E	F	G
Wet Grip	A	0.3	1.4	5.0	3.3	0.4	0.0
	B	0.5	1.6	13.3	13.0	1.7	0.1
	C	0.1	0.6	11.7	26.9	6.6	0.5
	E	0.0	0.3	1.9	5.8	2.0	0.3
	F	0.0	0.2	0.7	1.4	0.7	0.0

Only by label comparison there are no apparent trade-offs, but in reality:

- **target conflicts do exist, especially amongst performances not visible on the label: see next slides**
- **the above data are highly affected by noise measurement uncertainties**

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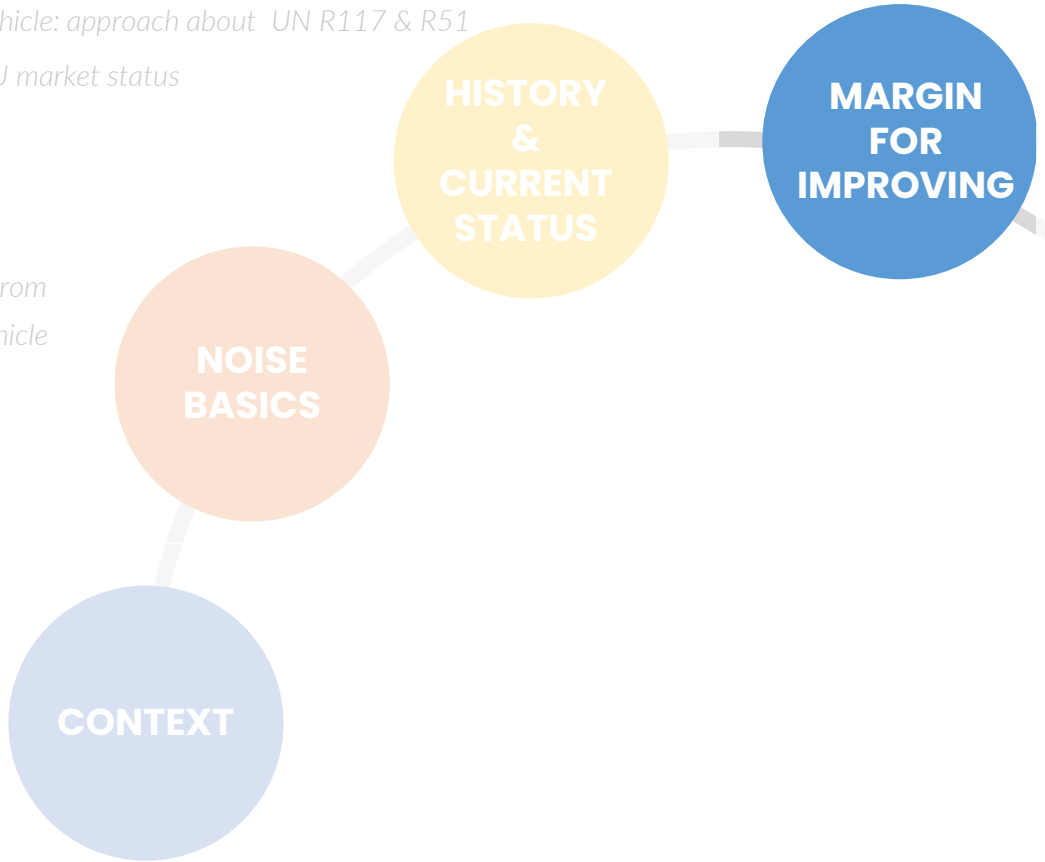

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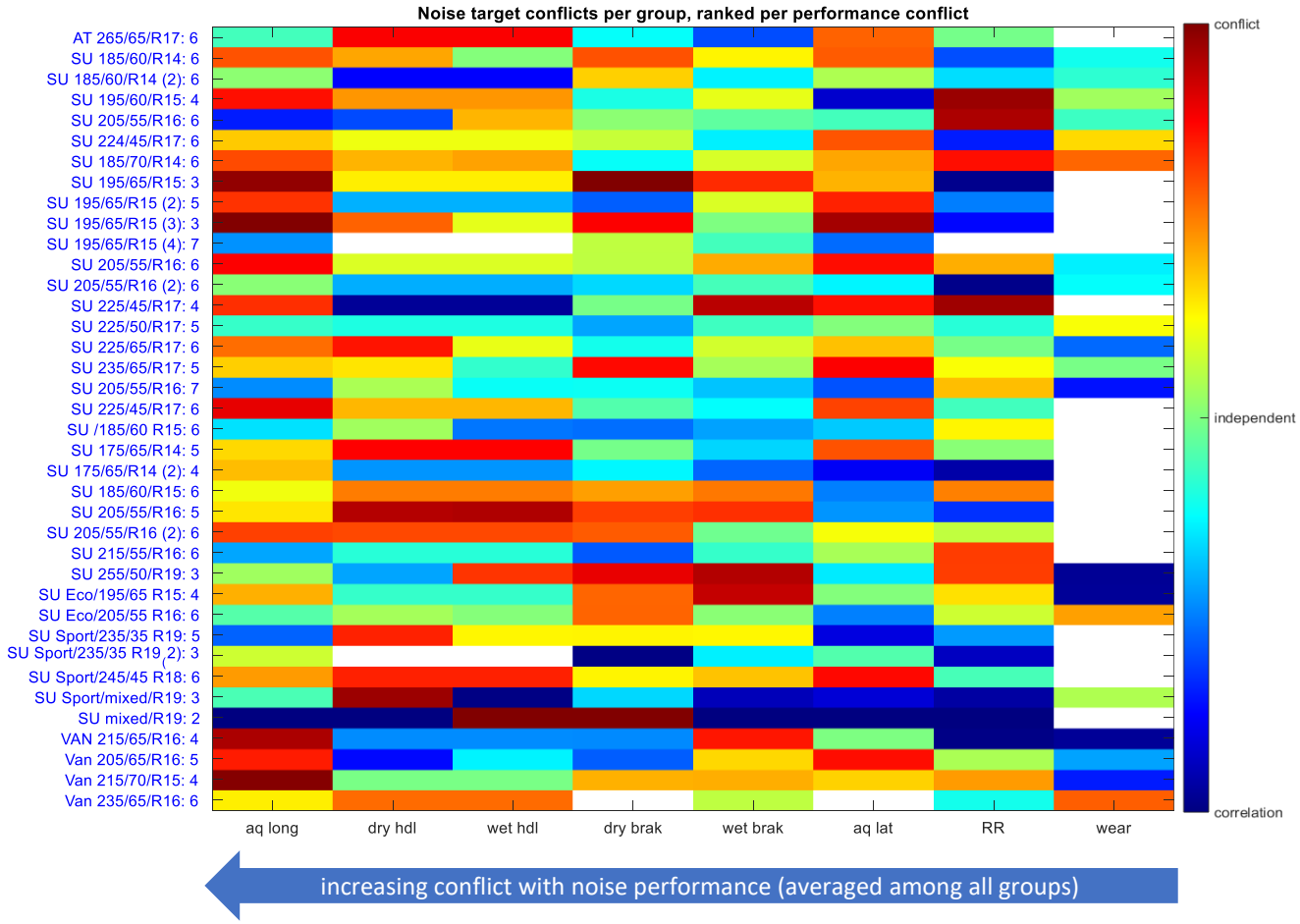
MARGIN FOR IMPROVEMENTS

Pearson coefficient between noise and other performances for individual benchmark groups

- Analysis of 38 benchmark results
- Noise conflicting performances vary significantly even for groups of similar size & segment.
- Some overall trends may be identified, for example conflict between noise & aquaplaning for van tires.
- <u>Studies performed by ACEA and ETRTO revealed significant target conflicts between noise & other (especially safety) performances.</u>



There are market groups with significant noise conflicts, but these conflicts differ per tire size, segment, niche market position & individual tire design strategy.

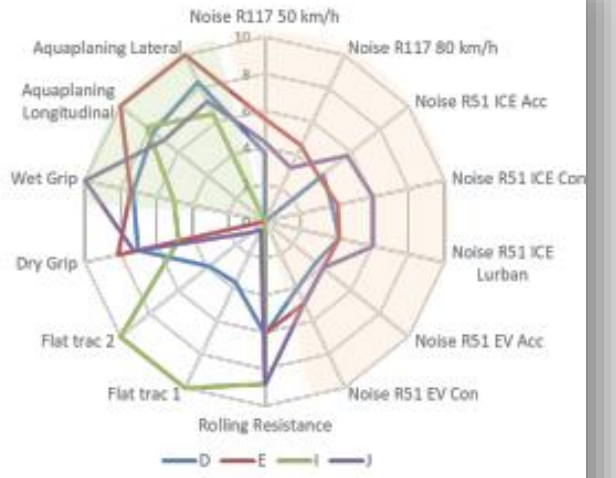
Overall 80 % of analysed groups show strong target conflicts of noise vs. other performances

MARGIN FOR IMPROVEMENTS

Trade offs: are largely linked to currently non-regulated performances, even if some of these are going to be regulated

The 4 **best tyres for Wet Safety**

Rating:
- **0** is defined by:
  the **worst** tyre of the sample
- **10** is defined by:
  the **best** tyre of the sample

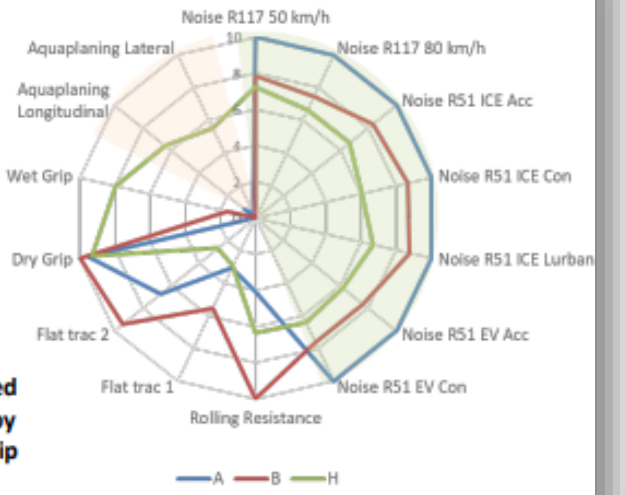


Best for Wet Safety ➔ Worse for Rolling Sound Emission

The 3 **best tyres for Rolling Sound Emission**

Rating:
- **0** is defined by:
  the **worst** tyre of the sample
- **10** is defined by:
  the **best** tyre of the sample

The lowest tyre rolling sound emission was achieved by plain tread tyres (not available on the market) by worsening the performances safety related (wet grip and hydroplaning resistance) at very poor level.

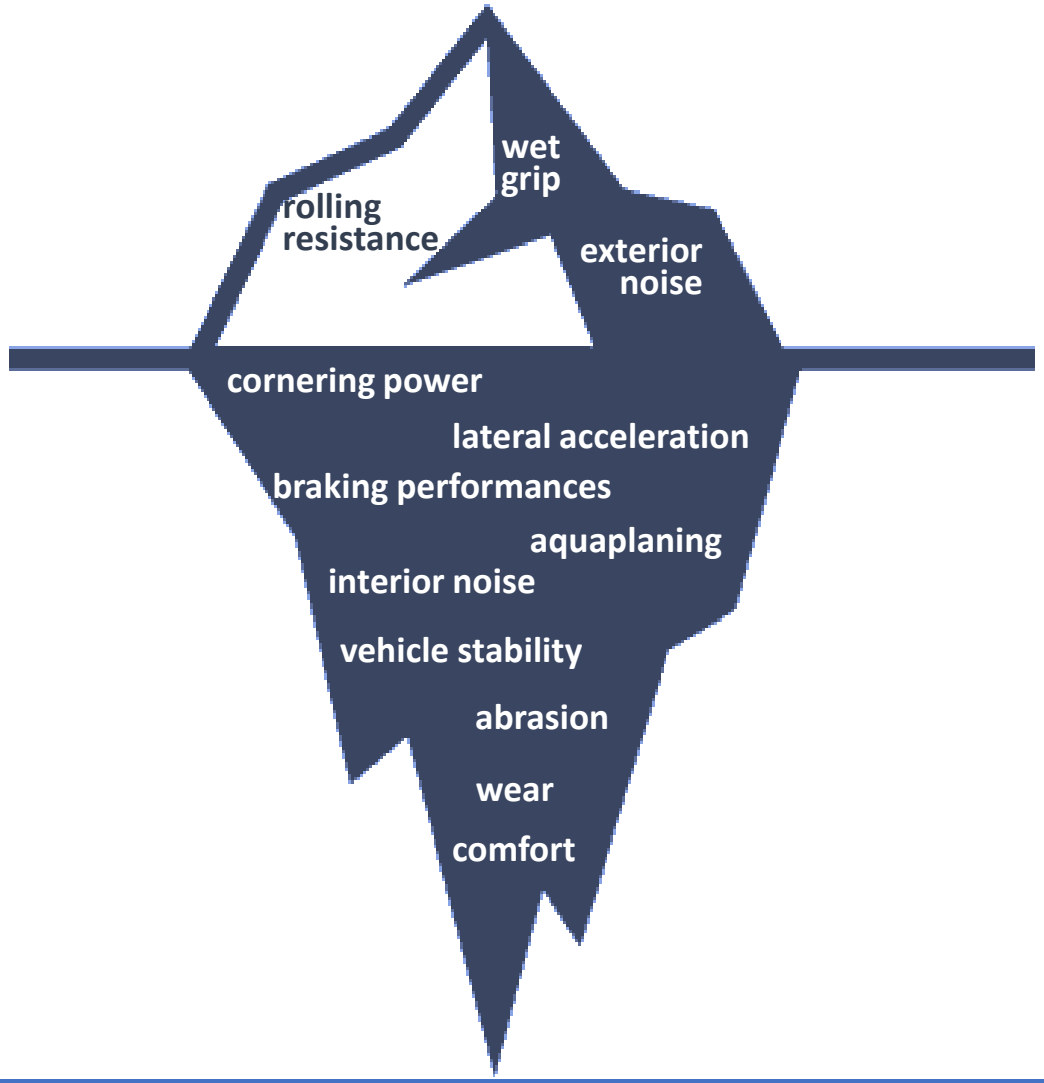


Best for Rolling Sound Emmission ➔ Worst for Aquaplaning

ETRTO-UTAC study presented at UN GRBP:
We are close to slick tyres noise potential

MARGIN FOR IMPROVEMENTS

Conclusion on trade offs



The European Tyre Label is a good indicator of basic tyre performance. However, both tyre safety and comfort also depend on other performances in all conditions and for their entire lifespan. Many parameters are not covered by the label: wet-weather handling, dry braking performance, high-speed stability, aquaplaning , wear resistance, comfort and interior noise…

Trade offs linked to non-regulated performances are being overlooked by the majority of studies

- Assessments of potential noise improvements by the tyre are based just on evaluations of label databases, which **refer only to regulated performances**.
- Referring to available data-sets and **not collecting new measurement data vs non-regulated performances.**
- Often referring to outdated data stets.
- **Effect of quiet roads is mentioned, but often underrated** due to assumed high cost (not quantified in detail). A quiet road will benefit immediately on all the vehicles without the need for waiting for the market renovation.

Example: Phenomena study

Based on currently available data in tyre databases (Dutch VACO database and Swiss Database), reductions of 2dB from 2022 and 2dB in 2026 seem to be feasible. From the viewpoint of impact, the most numerous tyre groups and those with the largest mileage would be most beneficial for tighter limits.

2-4 dB in the tyre noise depending on road surface, vehicle type and speed and tyre size. The potential is highest for smooth, absorptive and well maintained road surfaces. Noise reduction can be calculated for different road surfaces, such as in the

According to a Dutch tyre database[263], around 20% of car tyres on the market in 2018 were 4 dB below the highest level of 72 dB(A). This would need to increase significantly in the coming years to around 80% to take effect in overall traffic noise levels. The potential is strongest if EU tyre noise limits are tightened, as previously proposed in the GRB (UNECE)[264].

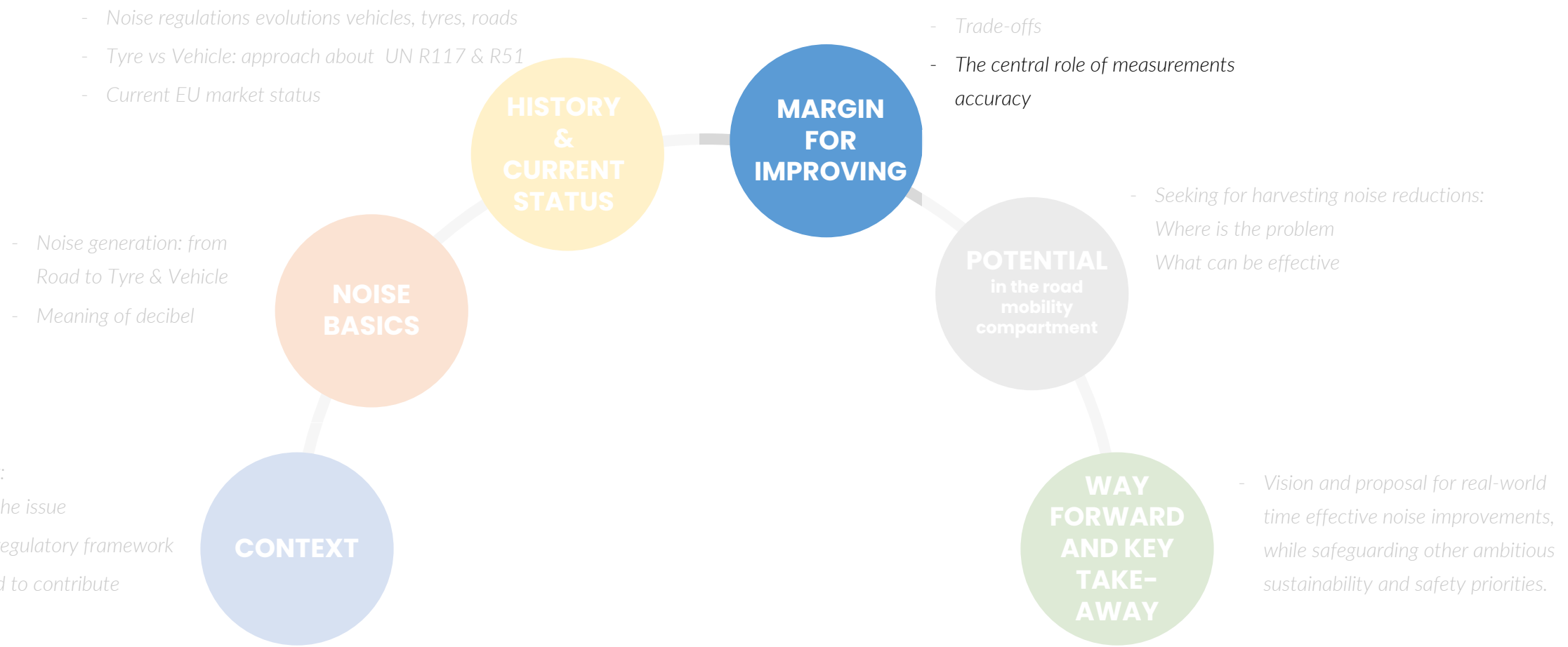
Table 7.1 Scenarios with a single noise solution for road traffic noise. In all cases a final situation in 2035 (or 2024 for scenario B) is specified; for intermediate years, linear interpolation is applied

Scenario	Description
A - quiet roads	The fractions of roads with a quiet surface are increased, for road types 5 8. The length percentages are 22.5% in 2035, which is a factor of 4.5 higher than the baseline value of 5%.
B - quiet tyres	The tyre labels for the three vehicle types are gradually decreased from 70/72/75 (baseline) to 66/69/70 in the period 2020-2024, and remain constant after 2024.

Trade offs are not visible in assessments when based only on label performances

AGENDA

WHERE WE SHOULD LOOK FOR ROAD TRAFFIC NOISE IMPROVEMENTS



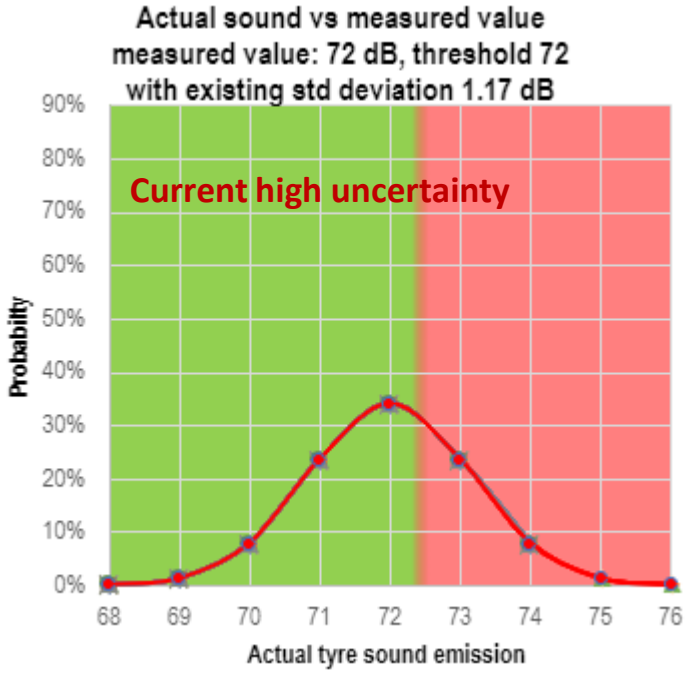
MARGIN FOR IMPROVEMENTS

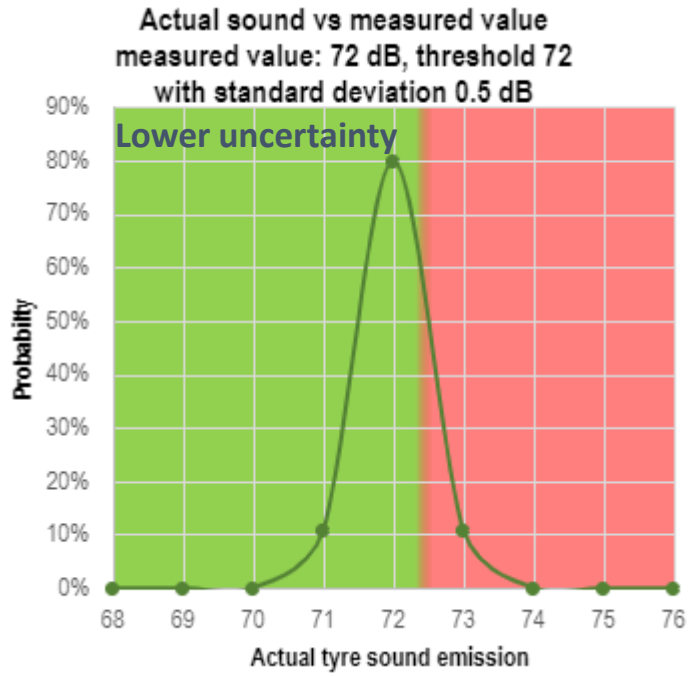
Anyhow **significant margins** for improving do exist when analysing Noise Measurement Uncertainty

Concept

With the **current test method** the variability could allow to homologate a noisier tyre (e.g. 73 dB for a threshold of 72)→ Right part of the curve

Once **new method** will be available, with lower uncertainty, this will not be possible anymore.
→ tyres "in the range of more than 2 dB above the current limits", which today can benefit from the variability, cannot be homologated anymore.



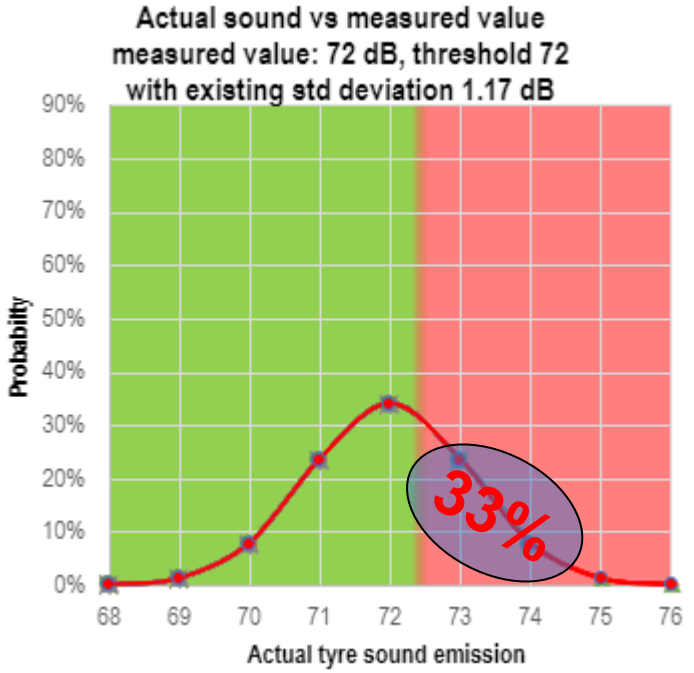


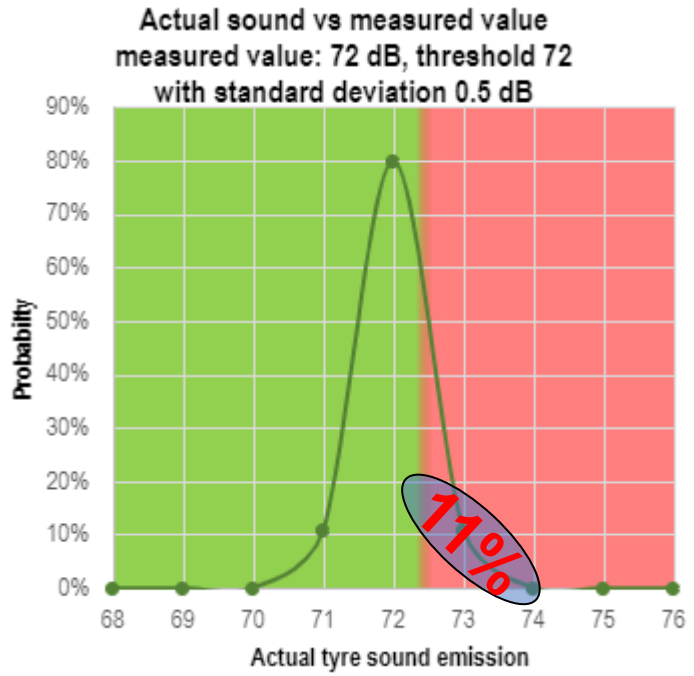
MARGIN FOR IMPROVEMENTS

Measurement Uncertainty
Quantifying the potential

With current measurements uncertainty statistically there is a probability **1 out of 3 tyres is approved as compliant with the limit although its noise emissions are actually above the limits.**

Assuming a strong improvement of measurement uncertainties (standard deviation from current 1.17 dB(A) to 0.7-0.5 dB(A)), the proportion of tyres in this category will be reduced to potentially up to 10%, so that tyres **2dB(A) above the threshold will be eliminated**.





Global assumption : gaussian uncertainties distribution, random tyre test on different tracks

C1 summer tyres: granularity analysis to further quantify the measurements uncertainty potential

Lizeo Database: 2019-2020 C1 Normal tyres, excluding A/T tyres (i.e. “Summer” tyres). The dataset can be affected by non-recent data.

MARGIN FOR IMPROVEMENTS

Tyre size (width) / dB — Limit by size — Allowances (only for XL)

	65	66	67	68	69	70	71	72	73	74	75	76	77	78
135	0.0	0.0	1.9	27.6	**19.0**	**42.9**	4.8	0.0	1.9	0.0	1.9	0.0	0.0	0.0
145	0.0	0.0	1.5	18.7	**16.7**	**47.4**	12.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0
155	0.0	0.2	1.7	16.6	**13.7**	**51.3**	9.0	6.5	0.7	0.2	0.0	0.0	0.0	0.0
165	0.0	0.1	2.0	13.9	**15.1**	**48.4**	13.3	5.9	0.6	0.4	0.4	0.0	0.0	0.0
175	0.0	0.1	2.2	11.3	**15.4**	**50.1**	12.0	7.4	1.0	0.3	0.1	0.0	0.1	0.0
185	0.0	0.2	3.0	11.5	14.2	**50.2**	**12.9**	5.7	1.5	0.7	0.0	0.0	0.0	0.0
195	0.0	0.3	1.9	5.8	12.6	**20.0**	**43.8**	11.3	1.7	1.9	0.7	0.1	0.0	0.0
205	0.1	0.6	2.4	3.8	11.2	**17.3**	**39.0**	20.1	2.6	1.8	0.7	0.2	0.0	0.1
215	0.1	0.3	1.6	3.8	9.9	**14.2**	**36.5**	26.3	3.9	2.2	0.7	0.3	0.0	0.0
225	0.0	0.3	2.3	3.1	9.2	**13.7**	**38.7**	26.6	2.8	1.7	1.1	0.2	0.1	0.0
235	0.0	0.0	0.9	3.1	7.8	**12.1**	**37.1**	30.9	3.4	2.5	1.2	0.7	0.2	0.1
245	0.0	0.2	1.1	3.1	6.6	12.1	**34.6**	**33.8**	4.3	2.2	1.6	0.4	0.1	0.0
255	0.1	0.0	0.8	1.8	5.6	8.4	**20.7**	**30.2**	27.2	2.9	1.3	0.8	0.0	0.0
265	0.0	0.0	0.3	1.3	3.8	6.6	**19.3**	**32.9**	27.3	4.3	2.9	1.0	0.2	0.1
275	0.0	0.2	0.6	1.3	4.0	8.1	**18.3**	**31.0**	31.4	2.3	1.7	0.8	0.1	0.1
285	0.0	0.1	0.4	1.7	2.3	5.5	10.9	15.1	**26.7**	**19.5**	15.6	1.9	0.3	0.0
295	0.0	0.0	0.4	1.0	0.9	6.8	8.6	15.6	**22.1**	**22.0**	21.8	0.7	0.0	0.0
305	0.0	0.0	0.0	0.0	1.7	2.2	7.6	16.2	**24.2**	**21.4**	23.8	2.4	0.4	0.0
315	0.0	0.0	0.5	0.5	3.7	4.5	13.1	11.8	**20.9**	**24.9**	17.4	2.1	0.5	0.0
325	0.0	0.0	0.0	0.0	2.3	8.0	9.7	10.9	**32.6**	**14.3**	20.0	1.1	0.0	1.1
335	0.0	0.0	0.0	0.0	0.0	3.2	3.2	4.8	**11.3**	**54.8**	16.1	6.5	0.0	0.0
345	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	**24.4**	**43.9**	14.6	0.0	0.0	0.0
355	0.0	0.0	0.0	0.0	0.0	0.0	42.9	14.3	**0.0**	**28.6**	14.3	0.0	0.0	0.0

8.7% 1 wave* | 78.8% of tyres 2 waves* | 12.5% 3 waves*

Each line is 100%: the distribution of dB across that size

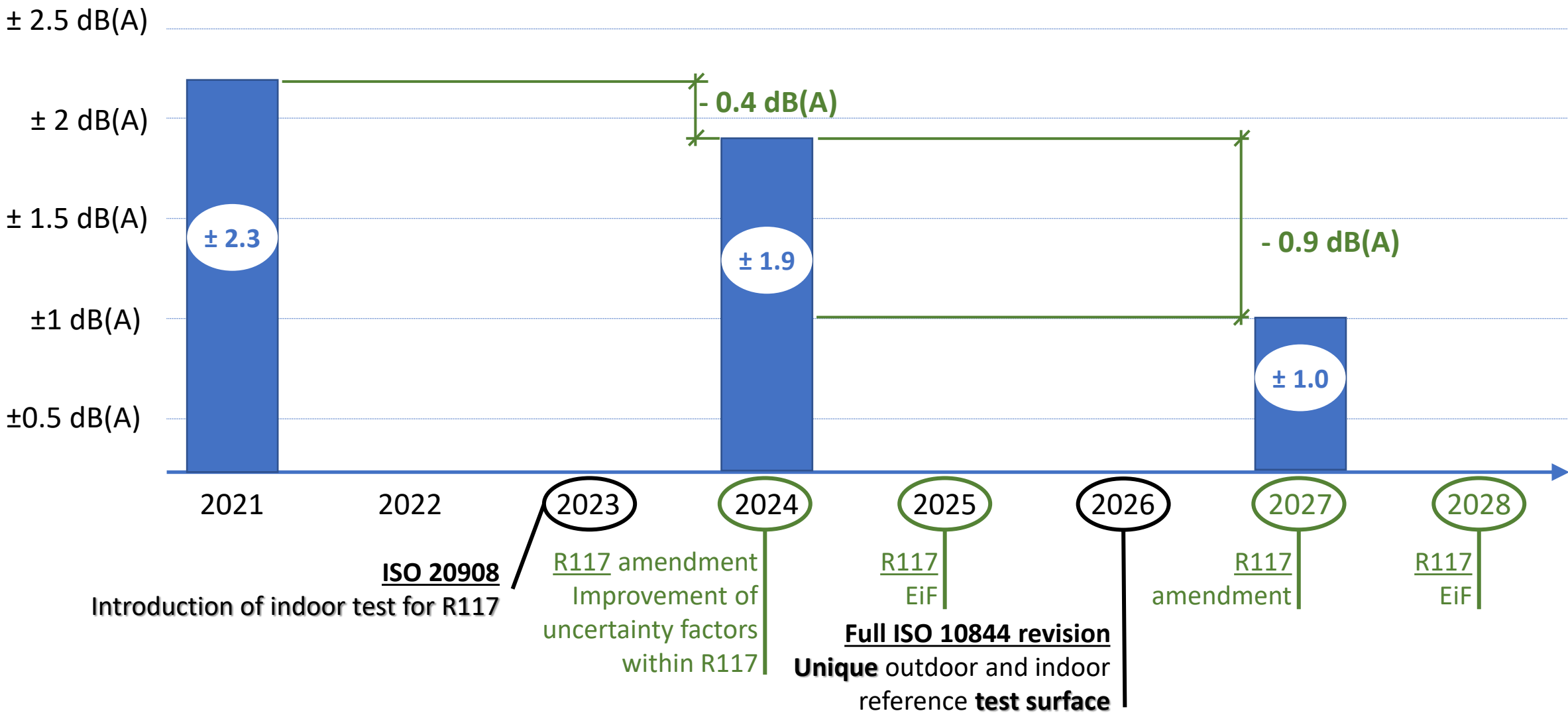
Further market surveillance based on current method can anyhow produce noise improvements, and even more once new more accurate methods will be in place.

*Values depending on database update status

about 70% of the C1 market is compliant within the test limit tolerance (2dB): there is a huge improvement potential from addressing the measurement accuracy

MARGIN FOR IMPROVEMENTS

Proposed roadmap to reduce uncertainty in R117



Tyre industry is investigating further methodologies to accelerate this roadmap

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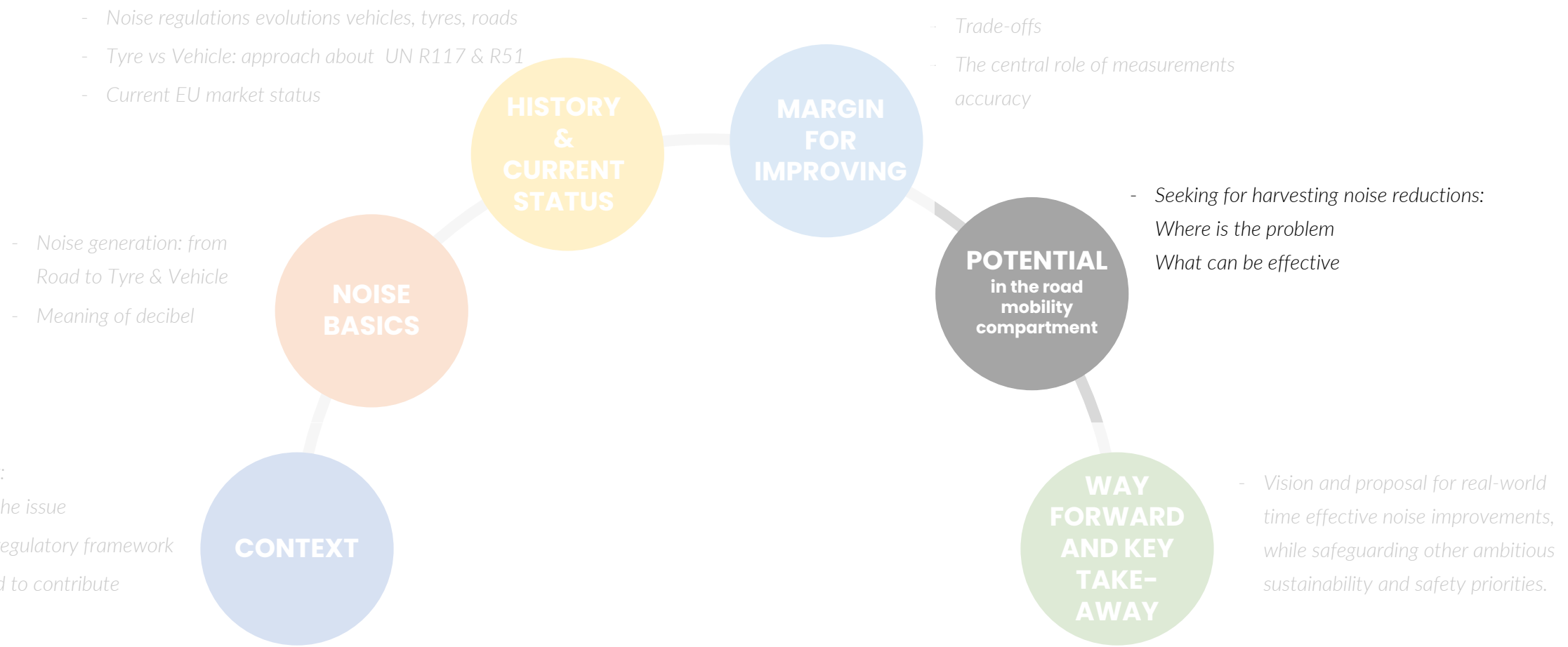


Exploring the potential for transport noise reduction

where to act

from an H2020 prj

Current regulatory approach

Vehicle	Tire	Road
		
separately optimized for - noise - safety - environmental impact - ….	**separately** optimized for - noise - safety - environmental impact - ….	**separately** optimized for - noise - safety - environmental impact - ….
Regulatory reference: **UN R51 / Reg.(EU) 540/2014 & Reg.(EU) 2019/839**	**UN R117 / Reg.(EU) 2019/2144 Reg.(EU) 740/2020**	**NONE**
Noise reduction with lowest trade-off on other **vehicle** performances	Noise reduction with lowest trade-off on other **tire** performances	

Holistic approach

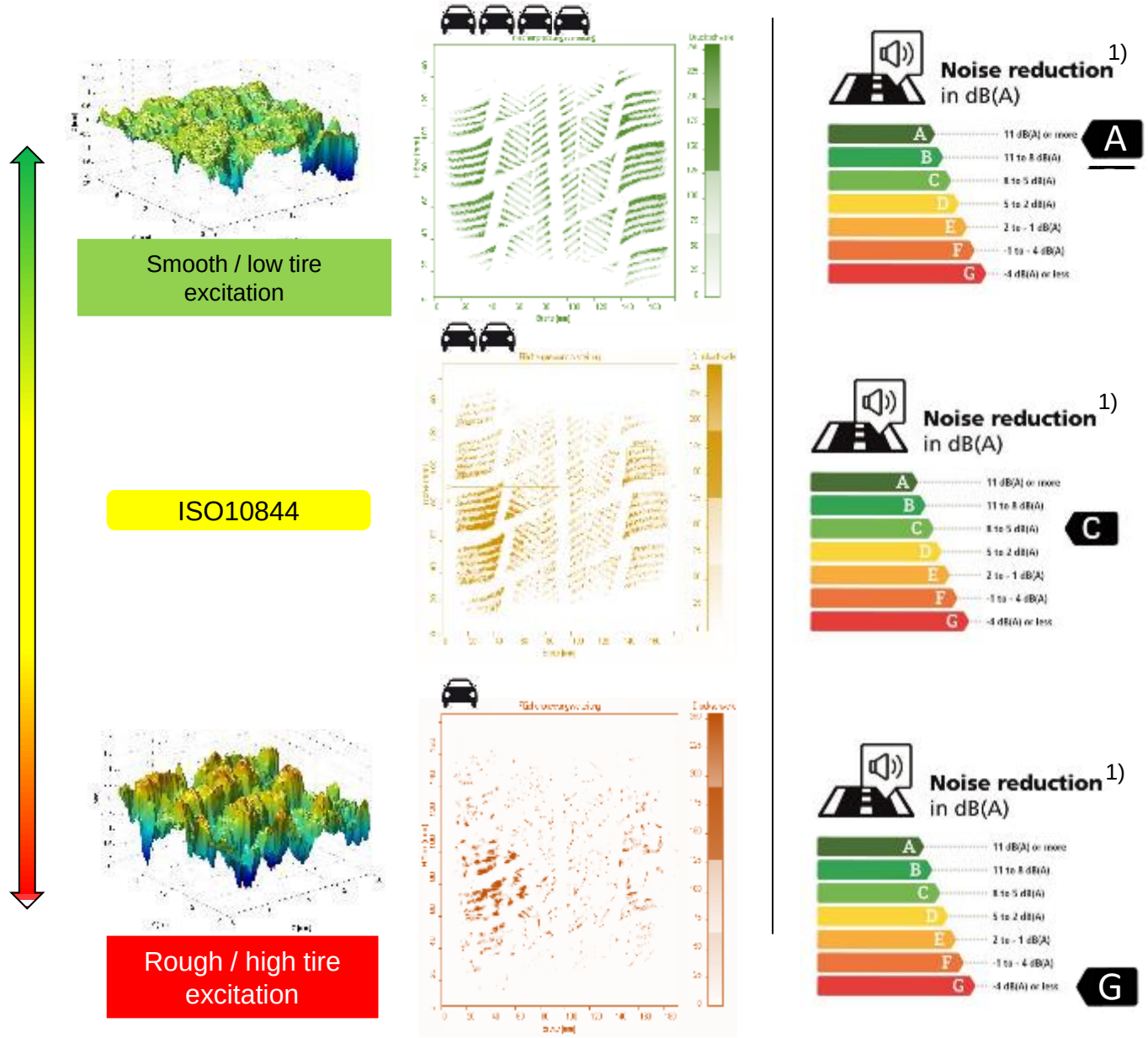
Vehicle / Tire / Road

overall optimized for - safety - environmental impact - ….
Can balanced requirements deliver even higher noise reduction with lowest trade-off on overall system performances?

Tyre-Road Contact

Influence of the road & potential

- The properties of the road surface have a **major influence** on the generation of the rolling noise
- The interaction of the tyre pattern with the road and thus the **vibration excitation of the tyre varies due to the design of the road** surface roughness, porosity and many other parameters of the road surface
- **For the same tyre there are noise differences evaluated in different studies between 5 and 12 dB on public roads**
- **Research into noise-optimized road surfaces,** not impacting roads safety and durability, **shall be one of the key objectives** with regard to a further reduction in traffic noise.

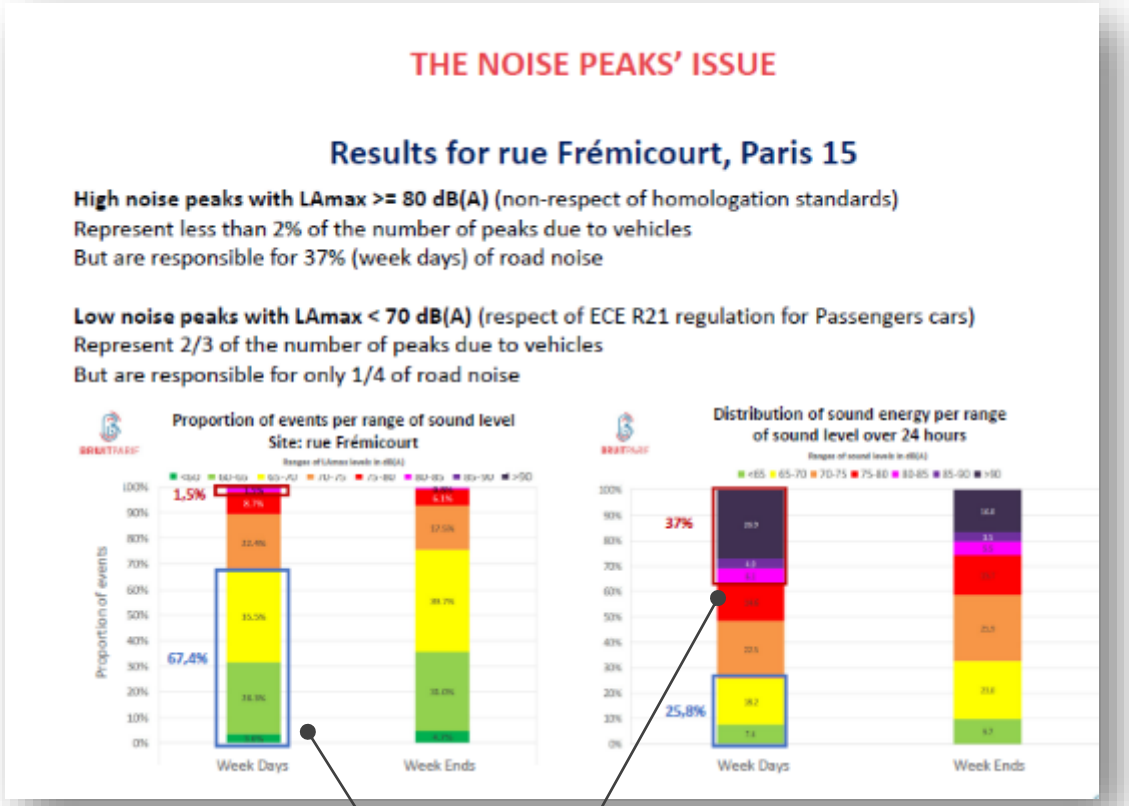


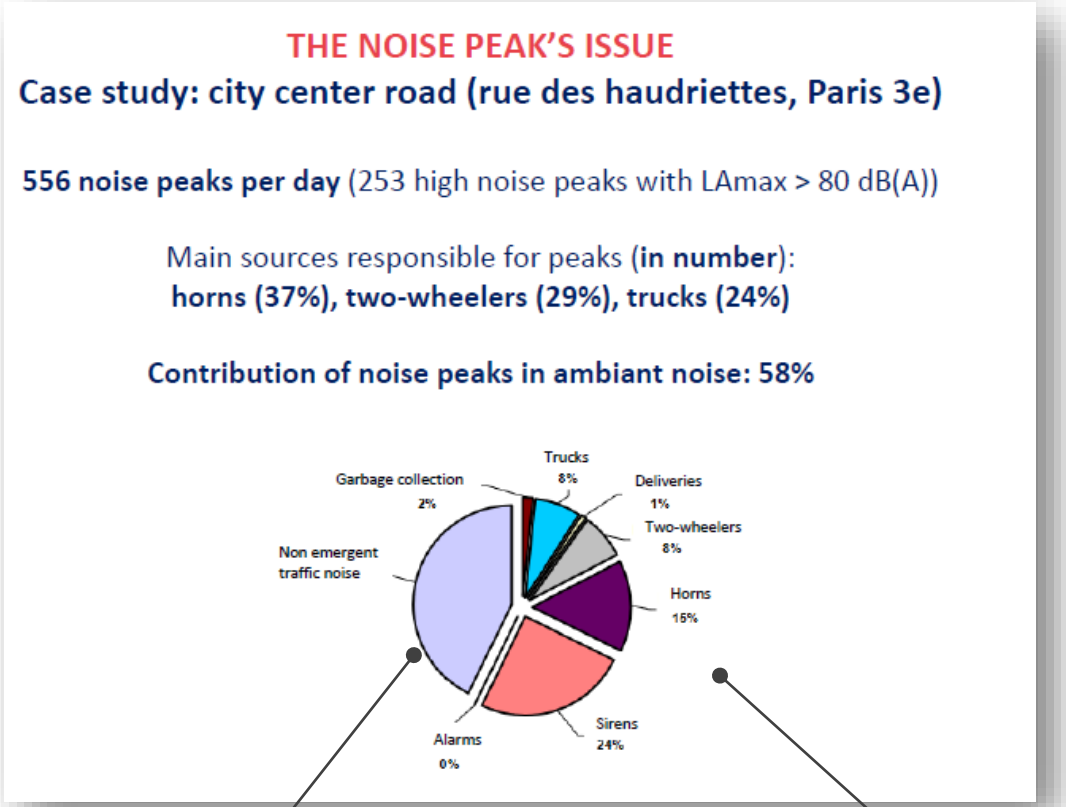
1) Informal document GRB-65-22-Add.1: https://unece.org/DAM/trans/doc/2017/wp29grb/GRB-65-22e-Add.1.pdf

The ideal road surface is porous and smooth, but like with tyres, there are also conflicting goals here

Focus on effects: Local peaks disturbance

L_{den} does not consider local peaks, which have a strong impact





- ***Local peaks represent a major part of local (not only traffic) sound emission.***
- ***However Lden calculation does not consider them: regulatory limits on tyres and vehicles do not address the major disturbance as it is measured and felt by citizen.***

Vehicles and tyres non emergent sound only taken in consideration

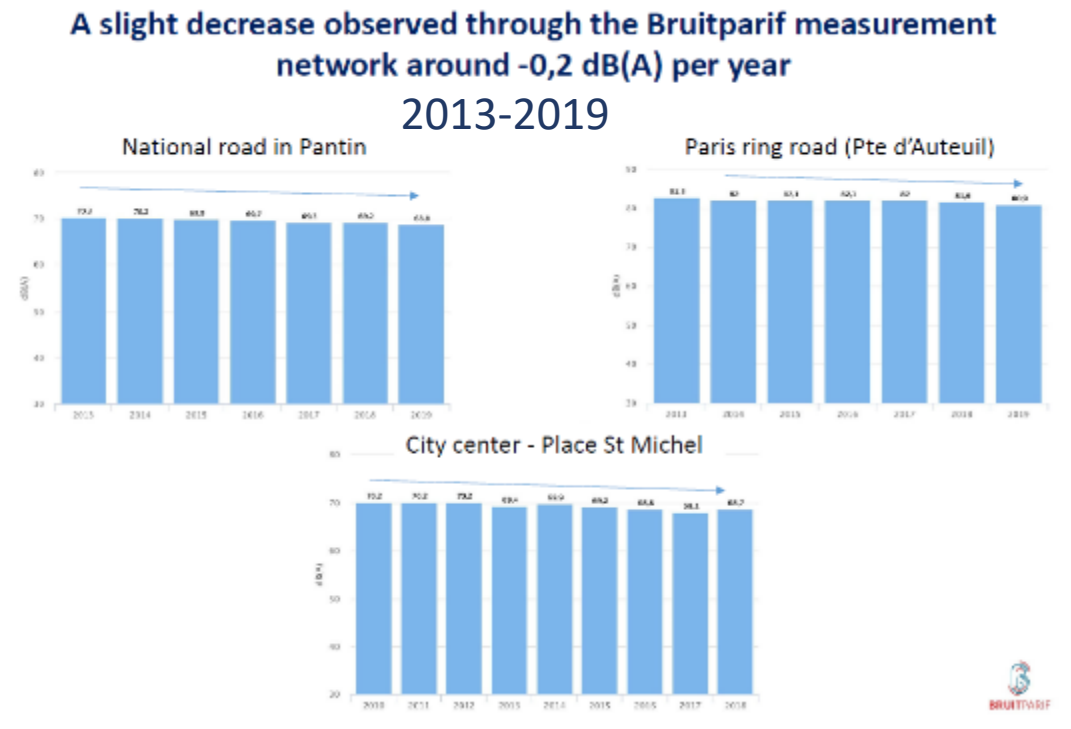
Main local peaks sources are

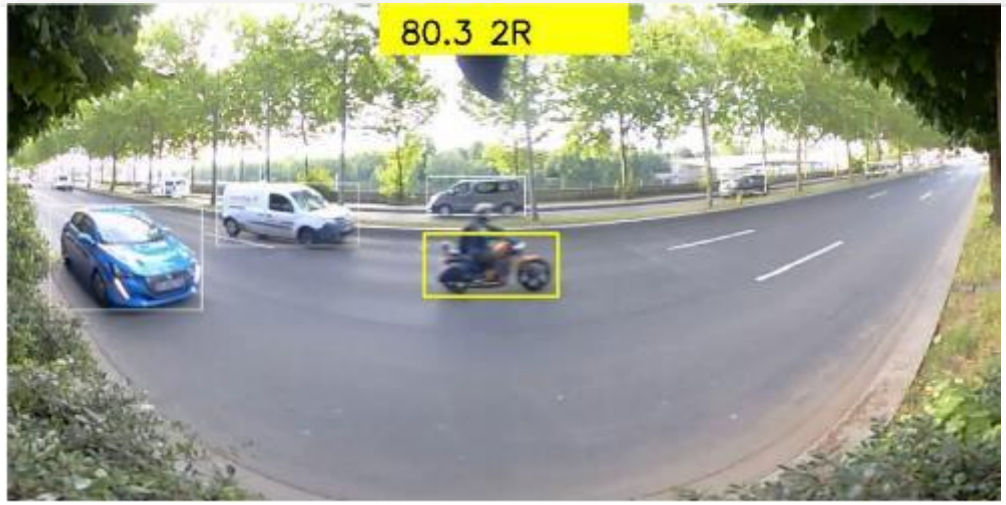
- **Horns and sirens**
- **2 wheels**
- **Trucks**

Tyres are not a part of these peaks

Focus on effects: Local peaks disturbance

Lden does not consider local peaks, which have a strong impact



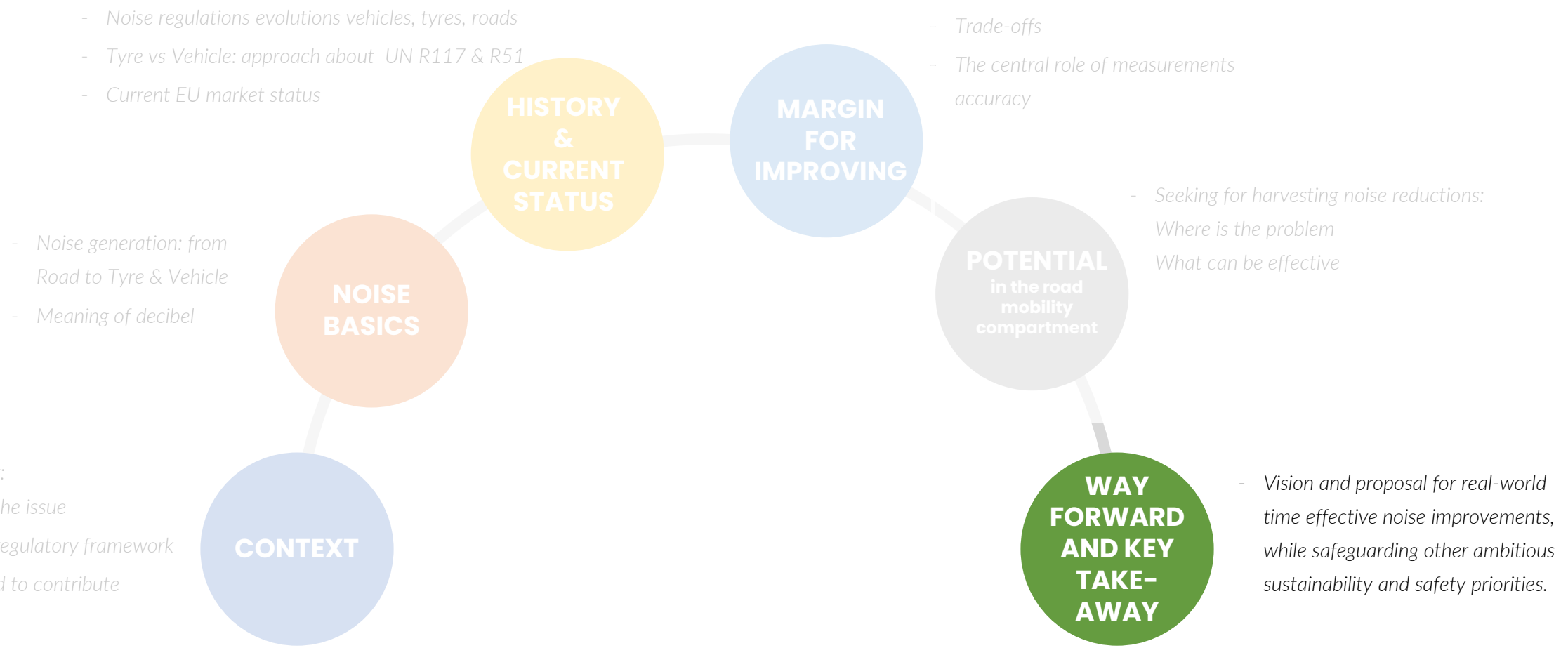


Masking effect : vehicle at 68 dB + motorbike at 80.3 dB equivalent to a total of 80.6 dB : no impact of the vehicle sound emission, nor of vehicle sound emission reduction.

Addressing tyre noise limits will not address the major disturbances that would remain out of scope. Taking into account the masking effect of the peak, the progress made on threshold will not be perceived by citizens.

AGENDA

WHERE WE SHOULD LOOK FOR ROAD TRAFFIC NOISE IMPROVEMENTS



WAY FORWARD

KEY TAKE AWAY

1. **Measurement Uncertainty:** there is a potential to address **a very significant part of the market that** may result in not-compliant tyres if tested with a more accurate method and thus requiring re-design for noise reduction and improvements. **Industry is working on very clear deadlines to achieve these improvements and the relevant results.**

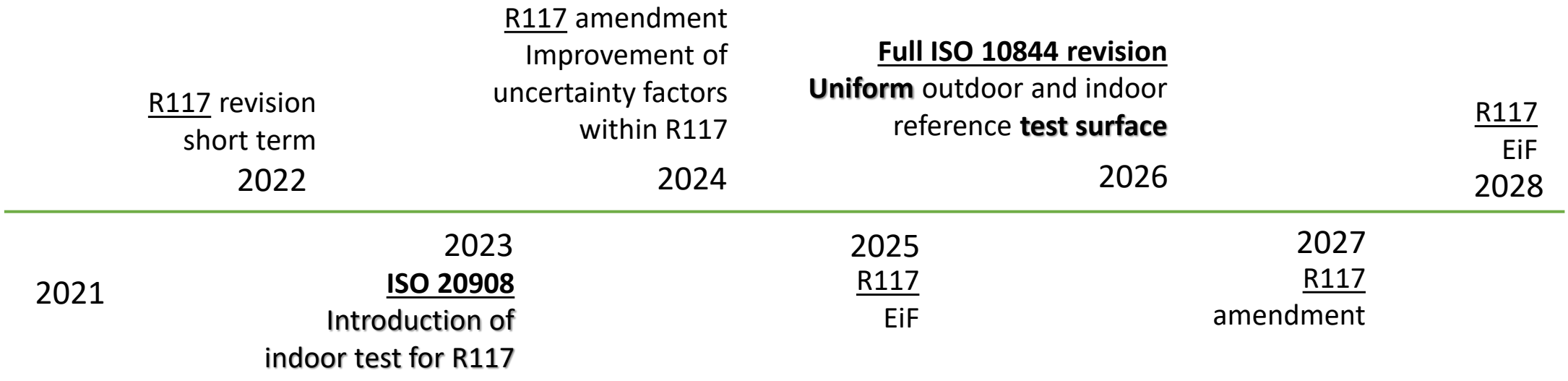
2. **Trade offs: non regulated performances are in clear trade off with noise performance and some of these performances are going to be regulated**

   Hydroplaning → Wet grip @ worn
   Wear ← Abrasion

   There is a **clearly scheduled industry commitment on the improvement of other performances addressing climate and safety while continuing working on the improvement of traffic sound emission by drastically reducing the measurement uncertainty**

Detailed plan on noise measurement uncertainty

WAY FORWARD



Starting with an improvement of measurement uncertainties

- Planning and progress of test method development
- Significant improvement in measurement uncertainty is connected to introductions of ISO 20908 and especially a completely revised concept with a worldwide uniform test track surface within ISO 10844

Tyre industry supports the assessment of methodologies necessary to **evaluate the whole ecosystem**, e.g. road surface, peak noise, traffic regulations, etc. and stimulate its improvement regarding noise

- Launch project calls on road/tyre interaction optimization for noise
- Develop road labelling approach

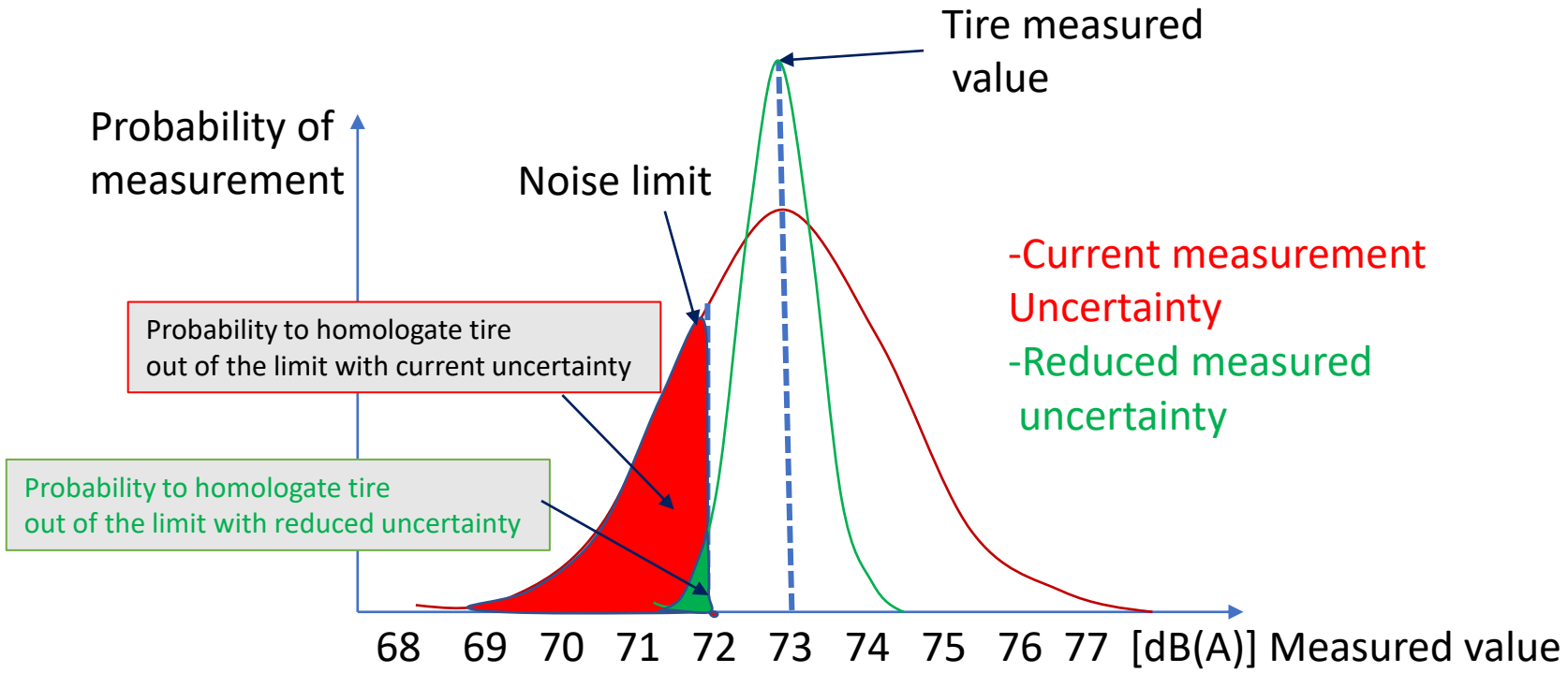
Additional Questions

Thank you

MARGIN FOR IMPROVEMENTS

Measurement Uncertainty starting from the perspective of a known "true" measurement value

Example:
Tire noise limit Reg.117= 72 dB
Tire "true" value =73 dB



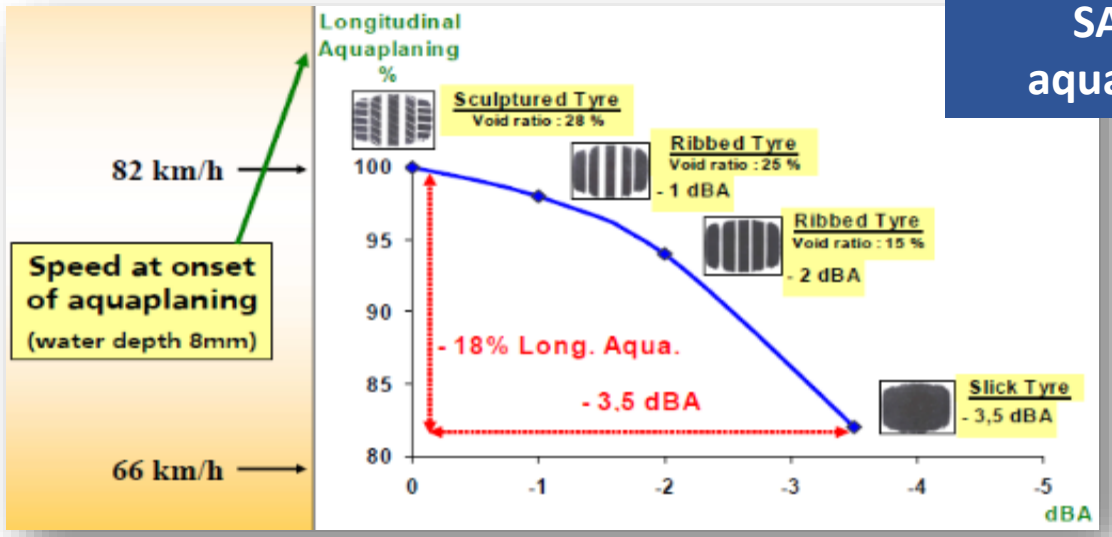
By measurement uncertainty reduction probability to homologate tire out of the limits is strongly reduced

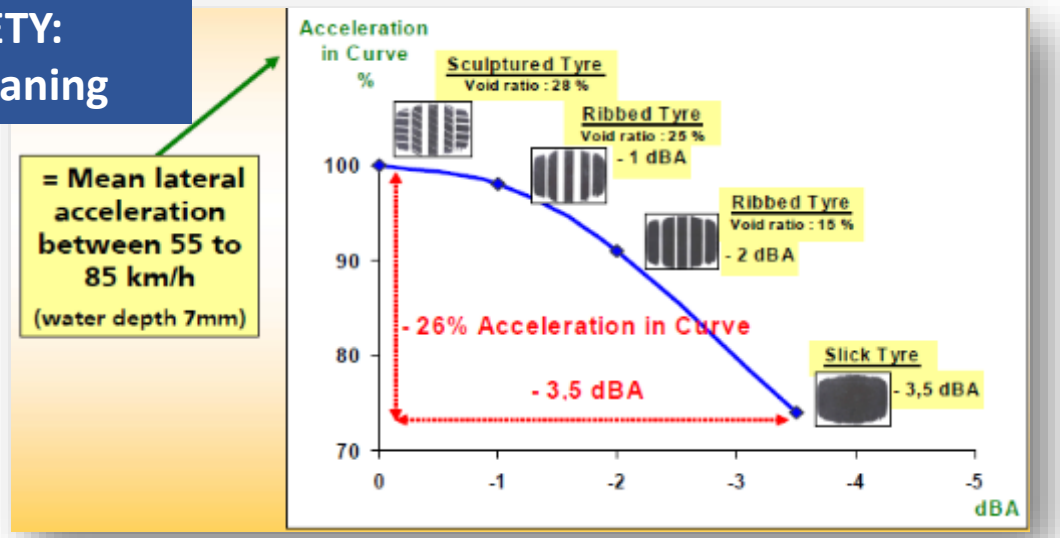
MARGIN FOR IMPROVEMENTS

Example: actual design trade-offs

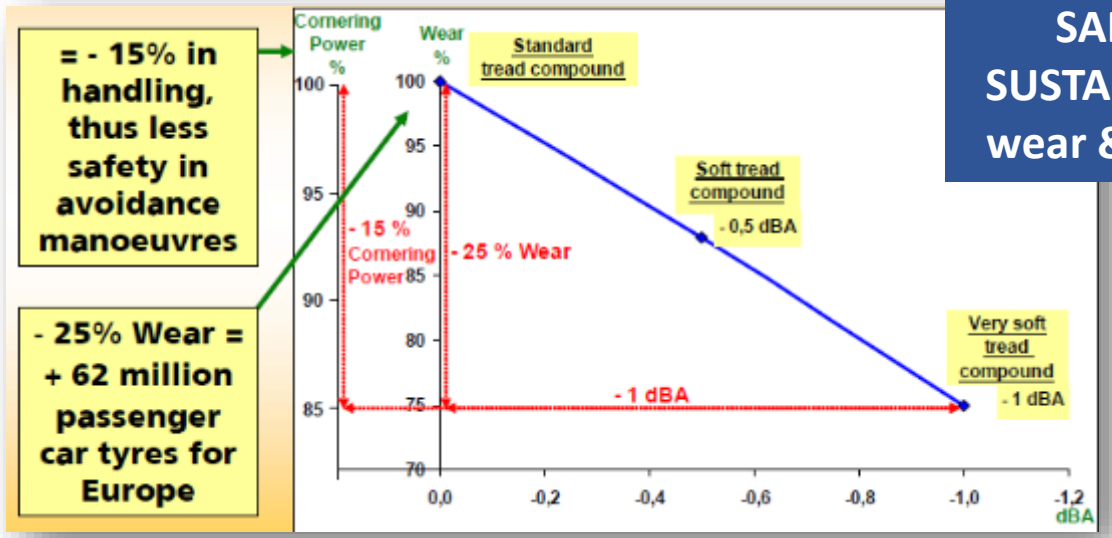
This is an example for one specific tyre size: values are illustrative for this example, but concept is valid as general rule

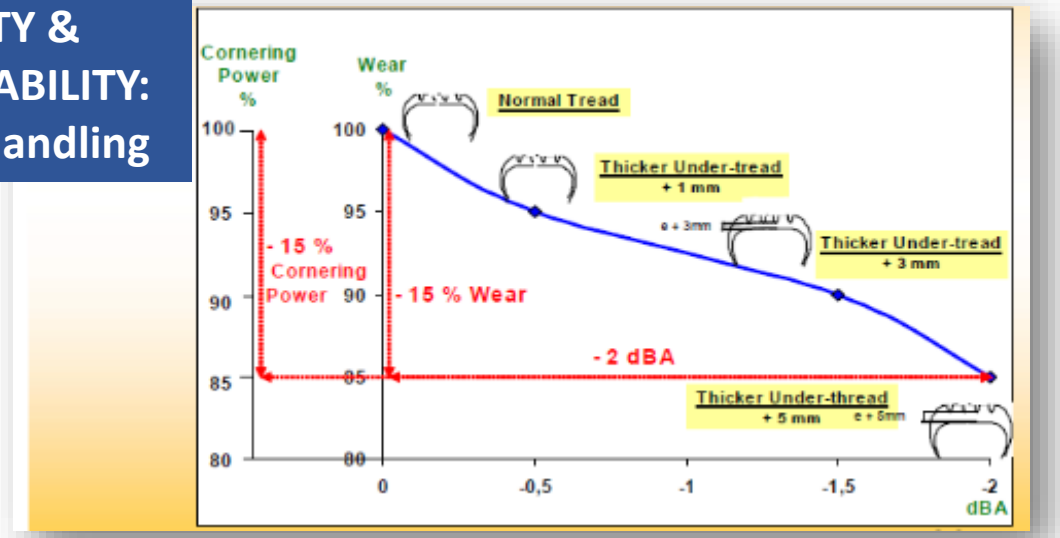
SAFETY: aquaplaning





SAFETY & SUSTAINABILITY: wear & handling





Trade offs are fully visible when analysing non-regulated tyre performances, that by the way, are part of the forthcoming regulatory approach supported by tyre industry