Journées Techniques
Acoustique et Vibrations
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Projet LIFE E-VIA : Influence du revêtement de chaussée sur l'émission sonore des véhicules électriques

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LIFE18 ENV/IT/000201

LIFE E-VIA overview

- LIFE **E-VIA : E**lectric **V**ehicle no**I**se control by **A**ssessment and optimisation of tyre/road interaction
- European LIFE 2018 program – Environment and Resource efficiency
- Project reference: LIFE18 ENV/IT/000201
- Duration: 01/07/2019 to 31/01/2023
- Total budget: 1 797 030 €
- EU contribution (55%): 933 295 €
- Project location: Italy, France, Germany
- Website: https://life-evia.eu

LIFE18 ENV/IT/000201

LIFE E-VIA consortium

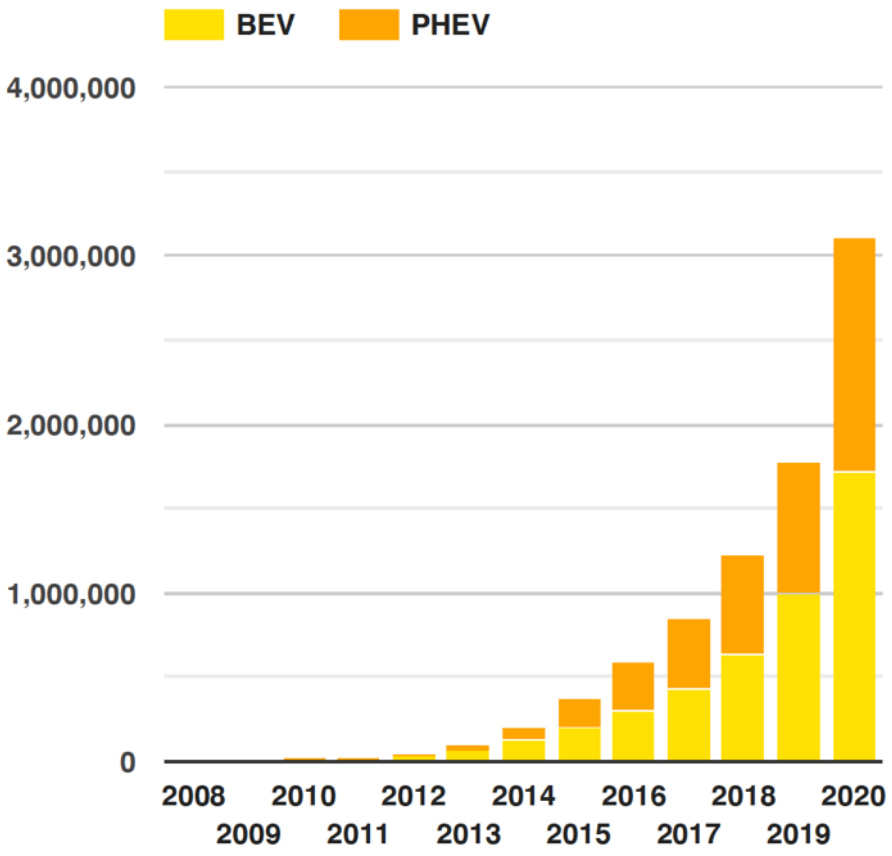
- Italy:
  - Municipality of Florence (FI, Coordinator – Contact person: Arnaldo Melloni)
  - Mediterranea University of Reggio Calabria (UNIRC)
  - iPOOL S.r.l (IPOOL, spin-off company of Pisa CNR)
  - Vie en.ro.se Ingegneria S.r.l (VIENROSE, consultancy firm – Florence)
- France:
  - Université Gustave Eiffel (Nantes, Lyon)
- Germany:
  - Continental Reifen Deutschland GmbH (CRD, tyre manufacturer – Hannover)

LIFE E-VIA actions and planning

Action		2019				2020				2021				2022				2023				2024			
Action numbe	Name of the action	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
A. Preparatory actions (if needed)																									
A.1	Electric vehicles and their noise emission			■	■	■																			
A.2	Quiet pavement technologies and their performance over time			■	■	■																			
A.3	Tyre role in the new context of EV and ICEV			■	■	■																			
B. Implementation actions (obligatory)																									
B.1	Tracks design				■	■	■	■	■	■															
B.2	Tyre-pavement coupling study and prototype implementation			■	■	■	■	■	■	■	■	■													
B.3	Pilot area: Implementation. Replication and tranferability						■	■	■	■	■	■	■	■	■	■	■	■							
B.4	Track efficiency tests in the pilot area							■	■	■	■	■	■	■	■	■									
B.5	Soundscape analysis			■	■	■	■	■	■	■	■	■	■	■											
B.6	Evaluation of EV noise emissions							■	■	■	■	■	■	■	■	■									
B.7	Holistic performances of tyres			■	■	■	■	■	■	■	■	■	■	■	■	■	■								
C. Monitoring of the impact of the project actions (obligatory)																									
C.1	Monitoring of the impact of the project actions			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
C.2	Life cycle analysis (LCA) and life cycle costing (LCC)			■	■	■	■	■	■	■	■	■	■	■	■	■	■								
D. Public awareness and dissemination of results (obligatory)																									
D.1	Information and awareness raising activities			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
D.2	Technical dissemination activities to stakeholders			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
E. Project management (obligatory)																									
E.1	Coordination, Monitoring and Project management			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■							
E.2	After LIFE Plan																■	■							

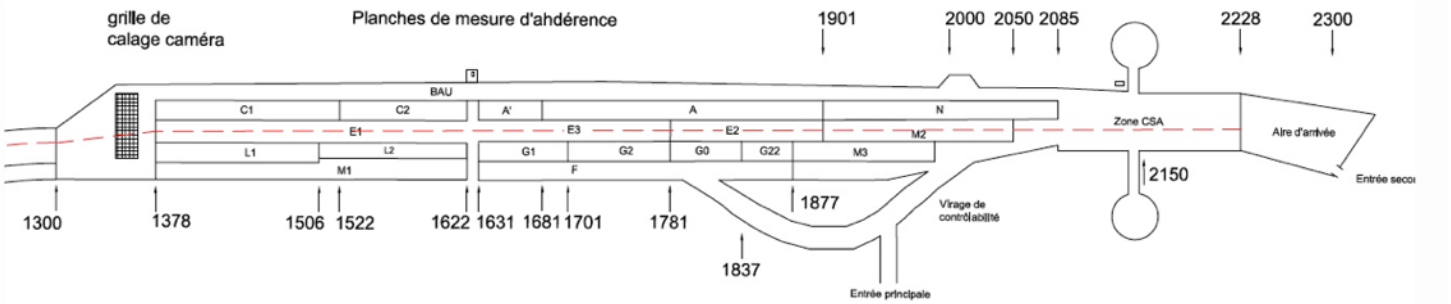
Context of the study

- Exponential increase of EV fleet in the European area (3.1M of EVs in 2020, 10.7% of new registrations) – Source: EAFO
- Projection scenario: 15% to 30% of the global market share by 2030 – Source: IEA
- Quietness of electric motors: tyre/road interaction becomes the prominent source of noise emission from EVs at urban speed
- LIFE E-VIA main objective: reduction of tyre/road noise by proper optimization of the tyre/road interaction
- Present study: assessment of road surface influence on EV noise emission



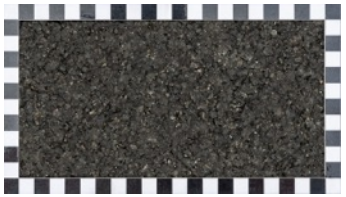
Measurement campaign

- 6 test sections of UNI EIFFEL reference test track in Nantes, France



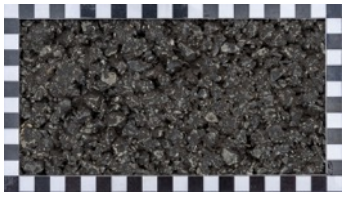
3 impervious road surfaces

N – ISO 10844



E1 – DAC 0/10

E3 – SMA 0/10

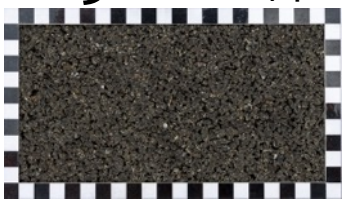


3 absorbing road surfaces

A – PA 0/6

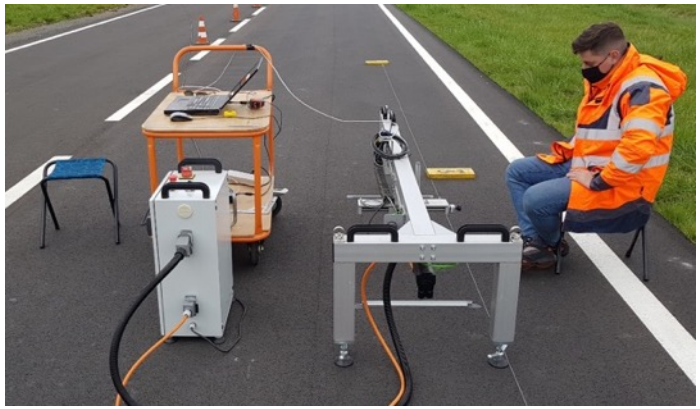
M2 - VTAC 0/6

M3 - VTAC 0/4

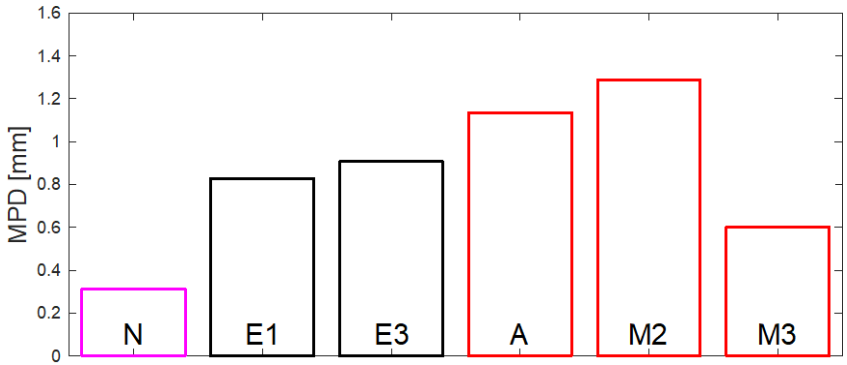


Measurement campaign

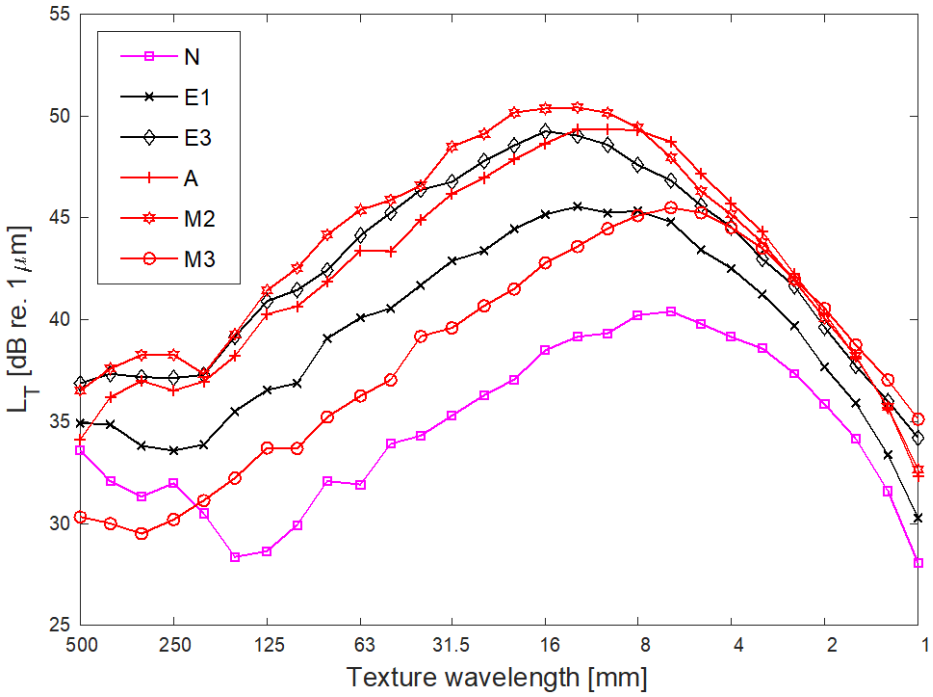
- Characterization of road surface texture



Mean Profile Depth (MPD) - ISO 13473-1

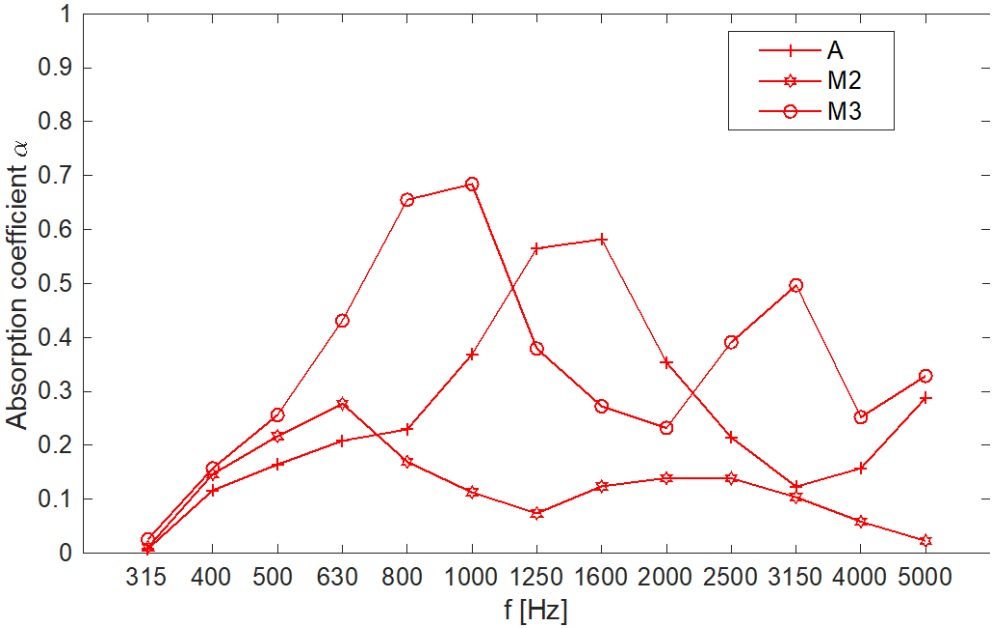


Texture spectra calculated from longitudinal profiles - ISO 13473-4



Measurement campaign

- Sound absorption measurement on test sections A, M2 and M3 - ISO 13472-1



Measurement campaign

- 5 recent electric vehicle models tested in July 2020

Peugeot e-208 - 2020

BMW i3 - 2018

Tesla Model 3 - 2019

Large family car segment

Renault ZOE - 2016

Supermini segment

Nissan LEAF - 2019

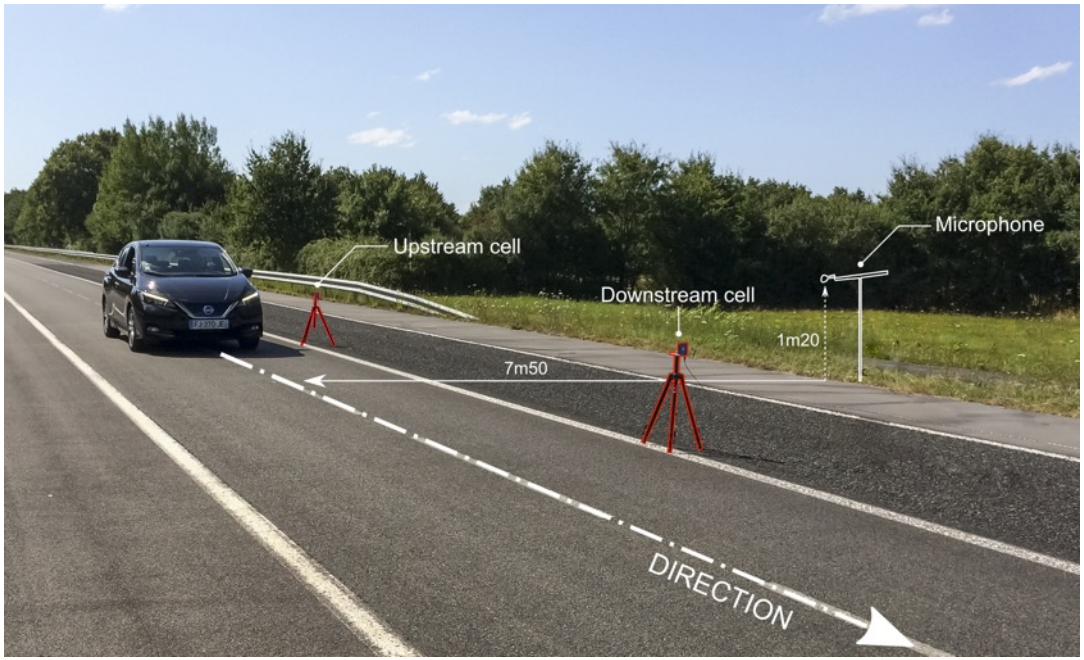
Small family car segment

Evs fitted with OE tyres

ID	Tyre model	Dimensions
e208	Michelin Primacy 4	195/55 R16 87H
zoe	Michelin Energy E-V	185/65 R15 88Q
i3 (front)	Bridgestone Ecopia EP500	175/55 R20 89T
i3 (rear)	Bridgestone Ecopia EP500	195/50 R20 93T
leaf	Michelin Energy Saver	205/55 R16 91V
model3	Michelin Pilot Sport 4 S	235/35 ZR20 92Y

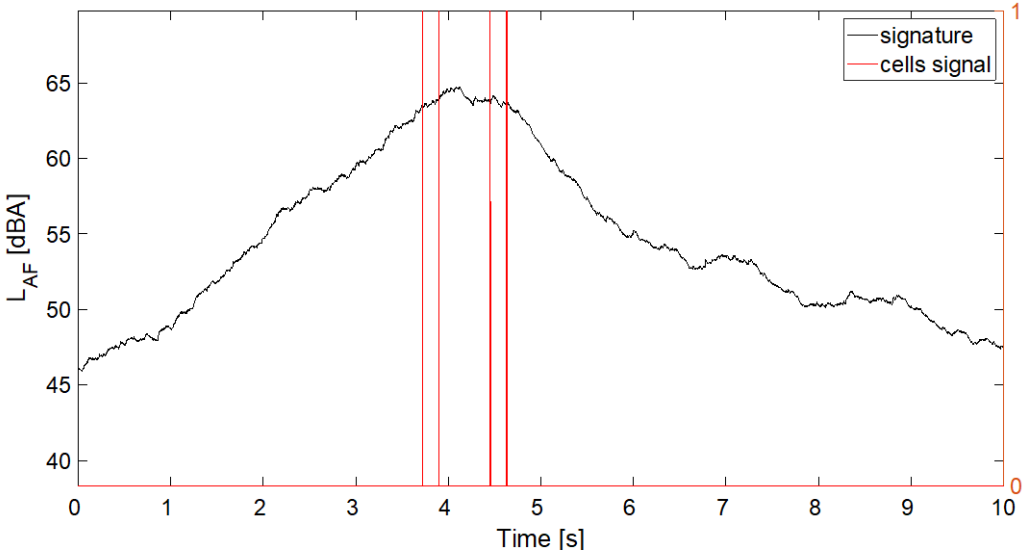
Measurement campaign

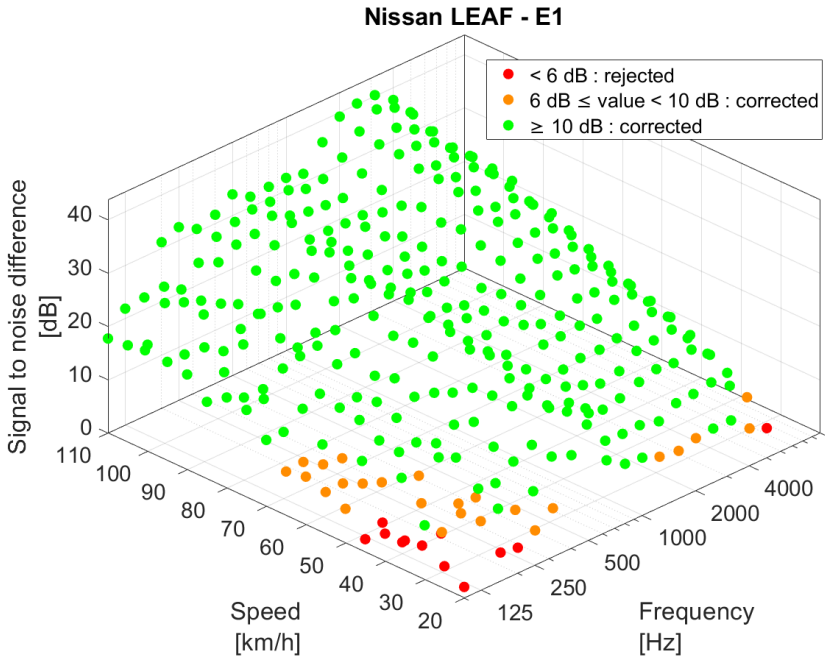
- Controlled Pass-By (CPB) tests
- Microphone position: 7.5 m from the middle of the lane centre and 1.20 m above the road surface (ISO 11819-1)
- AVAS deactivated (except for the Peugeot e-208)
- Several runs at constant speed from 20 to 110 km/h with a 5 km/h step (30 to 110 km/h for the Peugeot e-208)



Noise analysis

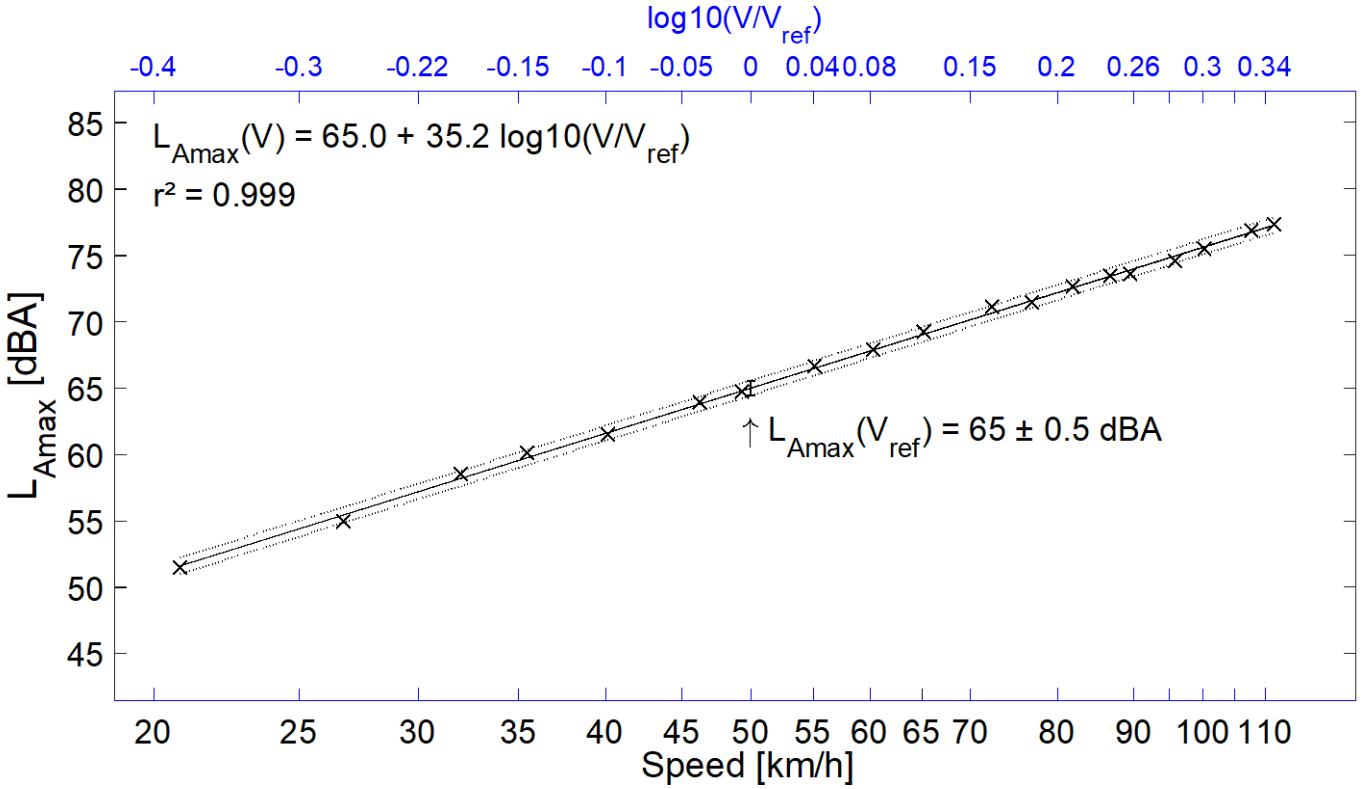
- L_{Amax} identification from the time signature for each run
- Spectra in 1/3 octave frequency band between 100Hz and 5000Hz
- Correction of background noise level (SNR<6dBA rejected)





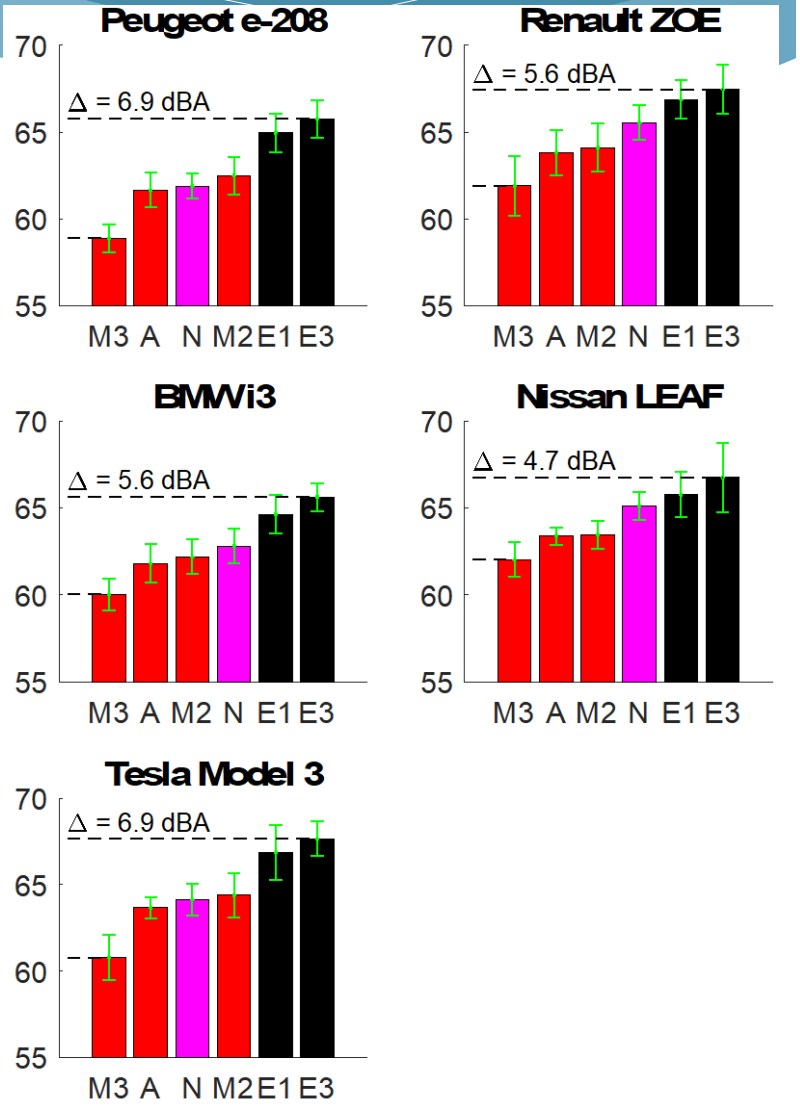
Noise analysis

- Analysis trough a logarithmic regression of overall and spectral noise levels versus vehicle speed *V*
- Temperature correction of noise levels at 20°C



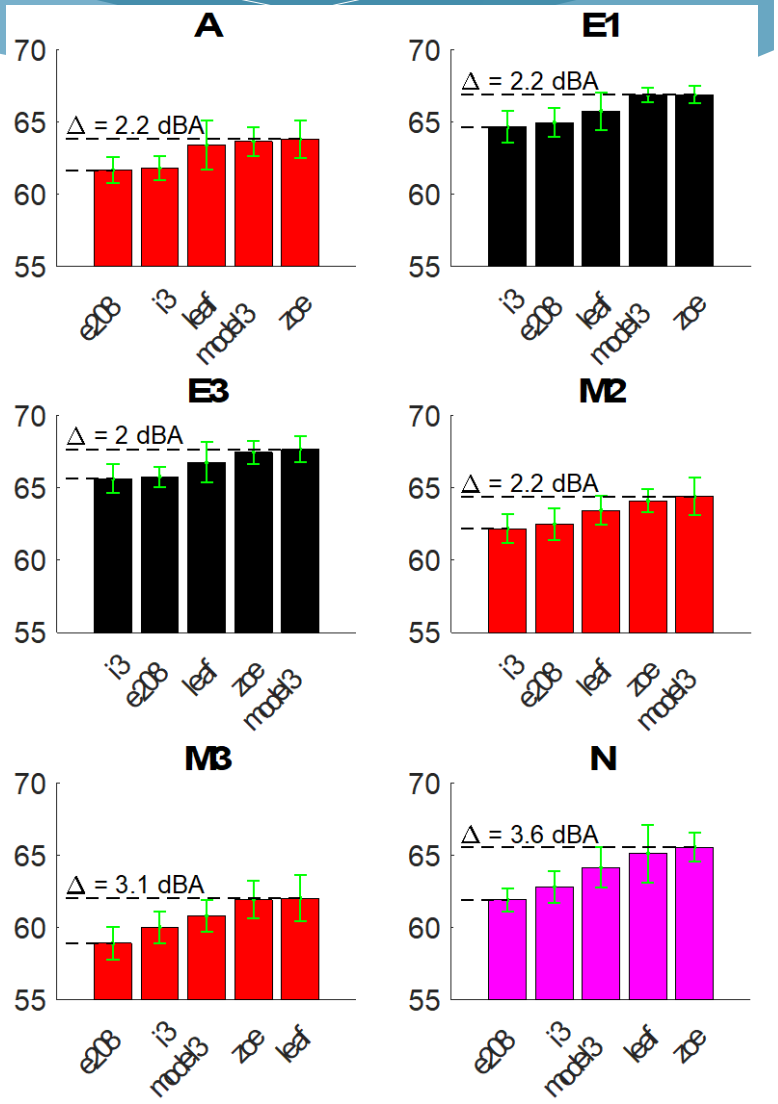
Results

- Histogram of CPB noise levels at 50 km/h comparing test sections for each EV model
- Similar ranking of road surfaces for the different EV models
- Road surfaces with low texture levels (N, M3) and/or absorption properties (A, M2 and M3) among the quietest test sections
- Difference between the quietest and the loudest test sections (resp. M3 and E3) quite influenced by the EV model
- Considering the 30 road/vehicule configurations, difference of 8.8 dBA observed between the quietest and the loudest combinations (i.e. e208/M3 vs. model3/E3)



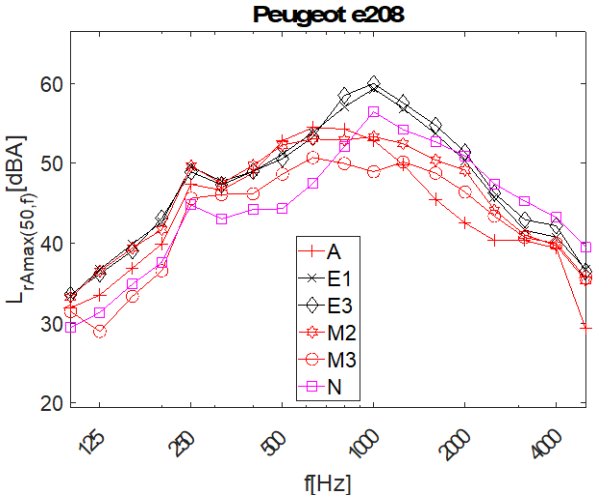
Results

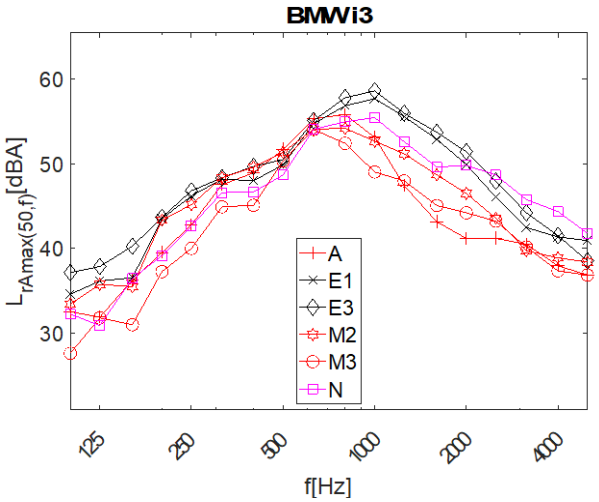
- Histogram of CPB noise levels at 50 km/h comparing EV models for each test section
- Ranking EV models differs from one surface to another
- Quietest vehicles: Peugeot e-208 and BMW i3
- Loudest vehicle (or nearly): Renault ZOE
- No clear relationship between EV segment and overall noise level
- Difference between the quietest and the loudest EV ranges from 2 dBA for test section E3 to 3.6 dBA for test section N.
- Tyre/road noise emission on M3 and N (low MPD and texture levels) more sensitive to tyre tread pattern

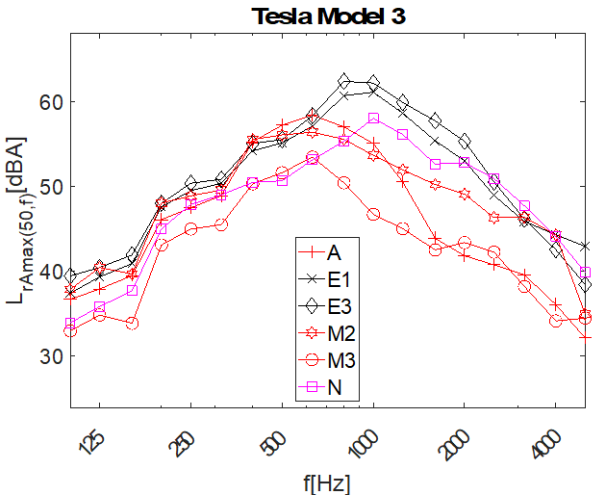


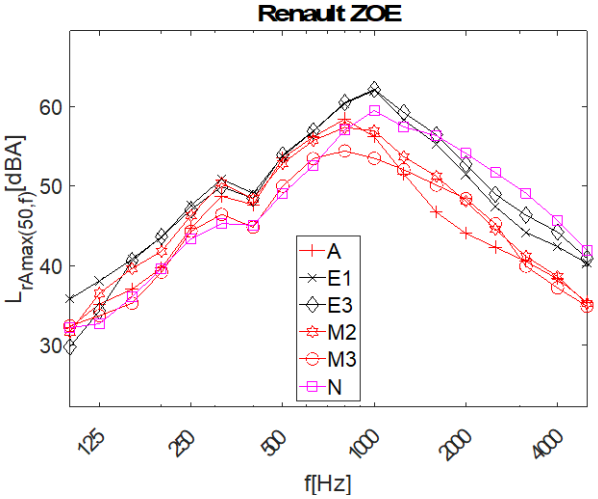
Results

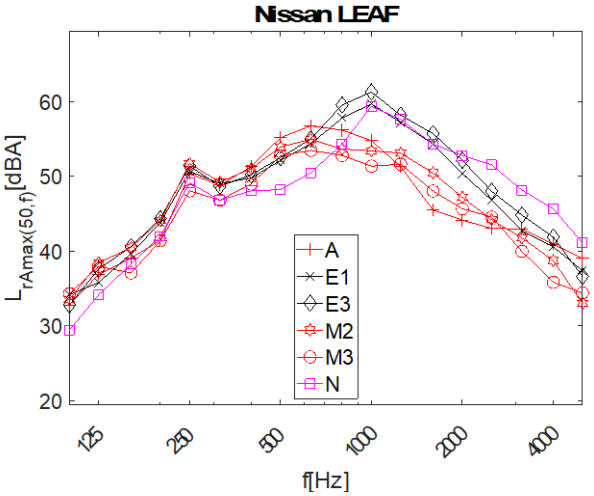
- Spectra at 50 km/h











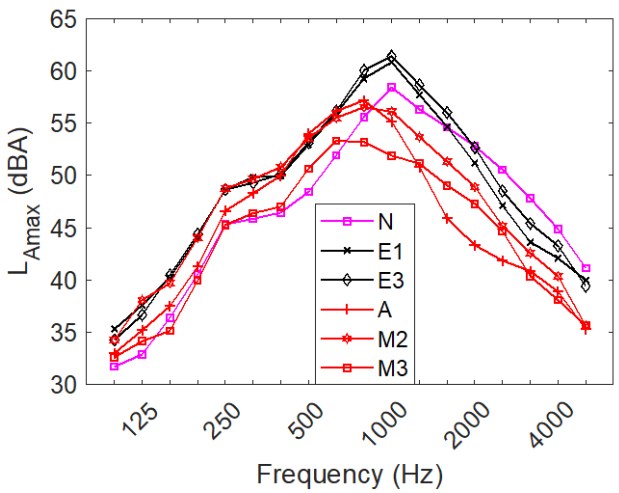
Average EV at 50 km/h

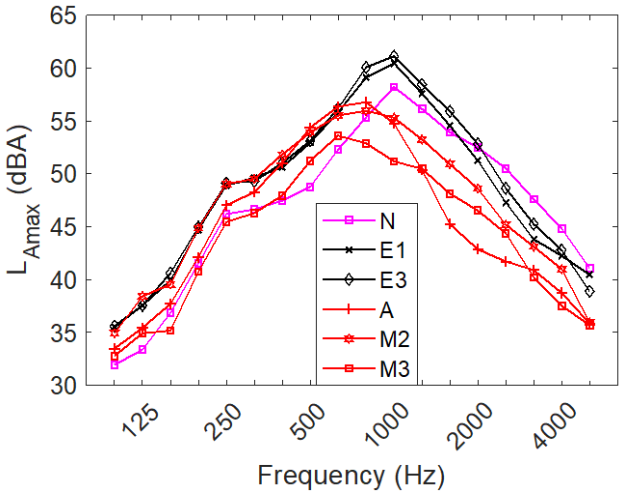
Breakdown of the 10 best-selling EV models in 2020
per vehicle class, based on EAFO statistics and Euro NCAP vehicle classes

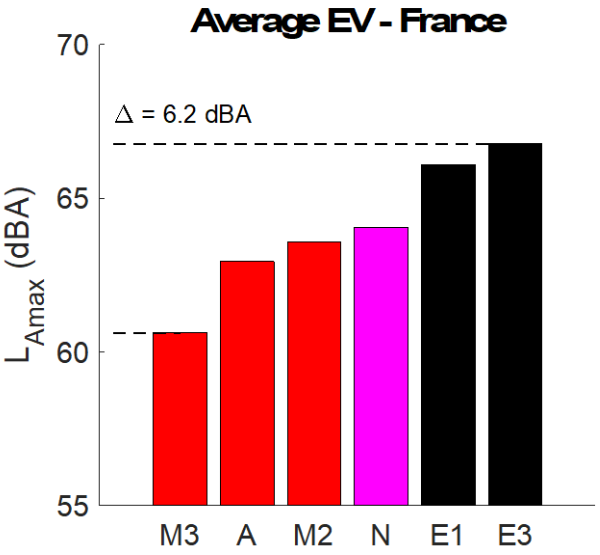
	supermini	small family car + small off-road car	large family car + large off-road car
France	67.4%	21.6%	11.0%
Italy	73.7%	12.2%	14.1%
Germany	42.9%	38.1%	19.0%
Norway	5.6%	64.1%	30.2%
Europe	41.7%	37.7%	20.6%

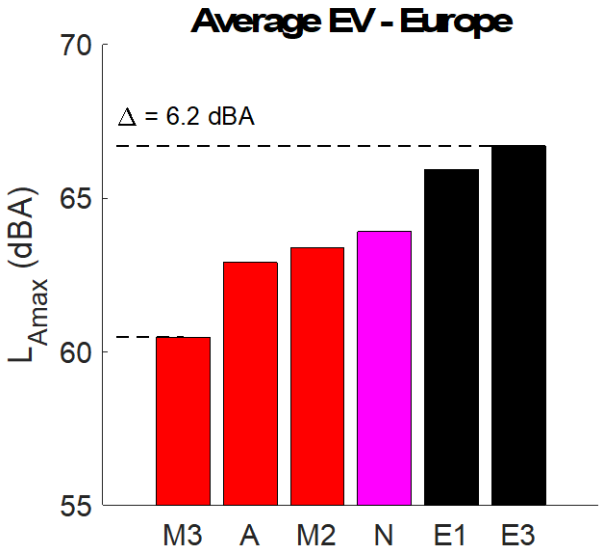
Average EV at 50 km/h

- Average EV spectra calculated from EAFO statistics and measured data
- Overall noise level of average EV quite similar for France and Europe
- Road surface influence: overall stake of 6.2 dBA









Conclusions

- Measurement of CPB noise levels of 5 EV models on 6 road surfaces at constant vehicle speed between 20 km/h and 110 km/h
- At 50 km/h, maximum difference of 8.8 dBA on overall CPB noise levels between the quietest and the loudest combinations
- Noise reduction between E3 and M3 ranged from 4.7 dBA (Nissan LEAF) to 6.9 dBA (Peugeot e-208 or Tesla Model 3)
- For a given test section, noise levels of EVs ranged from 2 dBA (on E3) to 3.6 dBA (on M3)
- Noise spectrum of an average EV calculated from the current EV traffic mixes in France and Europe.
- Road surface (rather than traffic mix) was found to be predominant for noise reduction, with a possible overall stake of 6.2 dBA

Thank you for your attention

J. Cesbron, S. Bianchetti, M-A. Pallas, A. Le Bellec, V. Gary and P. Klein, *Road surface influence on electric vehicle noise emission at urban speed*, Noise Mapping Journal 2021 (accepted for publication)

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