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**eVADER**

**Electric Vehicle Alert for Detection and Emergency Response**

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## Executive summary

One of the objectives of EVADER is to propose technologies that will allow the best compromise between the potential risk of quiet vehicles for pedestrians and the quietness of residents. WP1 aims to characterize noise environment in cities and comfort of residents. Several studies have already dealt with this topic [1] and [2].

The 1<sup>st</sup> site was chosen by partners for its low traffic volume with a moderate noise level (around 40-50 dB(A)): low wind speeds, flat, clean asphalt pavement. The ambient level in the area should be representative of a quiet suburban area, which may be encountered by pedestrians.

The 2<sup>nd</sup> site was chosen by partners for its moderate traffic volume with a noise level more representative of a city center (60-70 dB(A)). It will be necessary to have recordings during which no car is passing in front of the artificial head during clear sequences.

This document shows the noise measurements carried out in three countries, by four different partners near their location, to have European representative data: Paris (France), Barcelona (Spain) and Darmstadt (Germany). A common protocol was defined, using a dummy head to be closer to the human ear (see appendix). Complementary data will be added to the database by AIT in February. The sound files are compared with US recordings from Nissan with microphones. The goal was to create a database of several background noises, representative of different urban environments (city centre, suburbs, countryside), in order to quantify the level of background noise during working days and the noise range covered.

The results show that the expected variability between different locations is about 20 dB. The reference locations have been chosen that correspond with zones of low traffic volume (40-50 dB(A)) and zones of moderate traffic volume (60-70 dB(A)). The noise spectra of the various measurements show the same trends with a relatively higher value at frequencies below 60 Hz.

The noise recordings at all points were carried out with a binaural system as time histories of the perceived sounds. These recordings will be used in future work packages to defined jury tests under laboratory conditions.

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## 1 Introduction

This document shows the noise measurements carried out in typical streets of Barcelona, Paris and Darmstadt in order to quantify the level of background noise during working days and the noise range covered. The locations selected for this activity are:

### **Zone of Low traffic volume**

<b>Country</b>	<b>Partner</b>	<b>City</b>	<b>Street</b>	<b>Coordinates</b>	<b>Level dB(A)</b>
France	PSA	Jouy en Josas	Parc de Diane	N 48°45'19"; E 2°11'22"	46.6
		Bièvres	Chemin de la pâture aux eaux	N 48°45'10"; E 2°12'39"	53.2
France	Renault	Fontenay-le-Fleury	22 rue de la Deménerie	N 48°8'12.69 E 2°04'10.947	49
		Guyancourt	13 Boulevard Paul Cézanne	N 48°7'8.241; E 2°05'4.72	54
Germany	TUD	Darmstadt	Löffelstrasse	N. 49°8'8.042 E. 8°6'56.115	From 45 to 59

Table I: List of locations, concerning zones of low traffic volume.

**Zone of Moderate traffic volume**

<b>Country</b>	<b>Partner</b>	<b>City</b>	<b>Street</b>	<b>Coordinates</b>	<b>Level dB(A)</b>
Spain	IDIADA	Barcelona	Calle Mayor de Sarrià, 9	N 41°39'639; E 2°12'456	66.4
			Calle Villarroel, 139	N 41°38'667; E 2°15'4836	78.5
			Calle Aragón 179- Calle Muntaner 77	N 41°38'726; E 2°15'8285	81.1
France	PSA	Bièvres	4 rue Leon Mignotte	N 48°45'17"; E 2°12'52"	70.2
France	Renault	Paris	53 rue Raymond Losserand	N 48°34'749 E 2°31'9718	65
		Versailles	14 Avenue de Saint Cloud	N 48°30'4529 E 2°12'295	74
Germany	TUD	Darmstadt	Schloss – Cityring	N 49°8'7286, E 8°6'56867	From 74 to 83

Table II: List of locations, concerning zones of moderate traffic volume.

## **2 Methods and results**

All recordings were taken according to the protocol defined in eVADER. It means that all background noises are recorded using a binaural head on the pavement at 1m from the road and 1,5m height. The linear filter was chose to record ambient noises.

Test equipments, photos and meteorological conditions are listed at the end of the document, for every partner.

### 3 Comparison of noise spectra

We can observe on the figures 1 and 2 the comparisons of noise spectra (sound pressure levels in dB SPL) and global A-weighted levels for measurement points in Barcelona (IDIADA) and around Paris (PSA). The figure 3 presents noise spectra (dB SPL) for measurements in Darmstadt (TUD), with two different global levels. The figure 4 presents noise spectra (A-weighted level) for measurements around Paris (Renault).

The results show the important conclusion that the spectrum of the various sounds follows the same trend with differences in level that define the overall SPL. The noise range between quiet and noisy streets is about 20 dB(A).

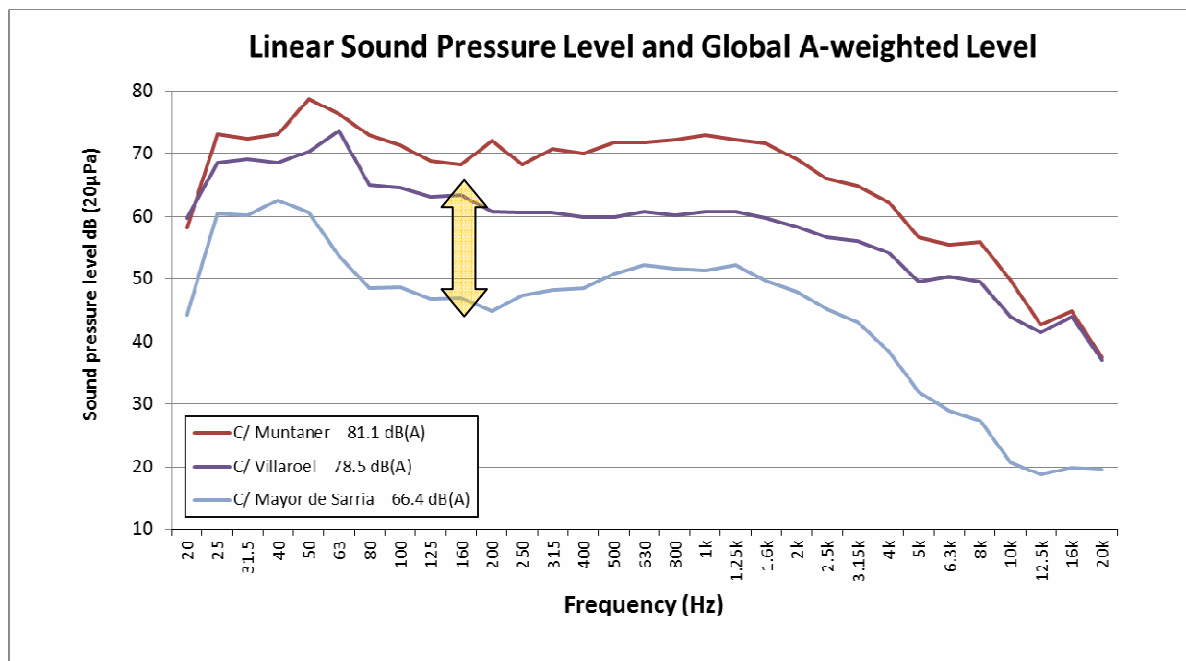


Figure 1: Comparison of noise spectra for ambient urban noise for the three measurement points in Barcelona, Spain (IDIADA).

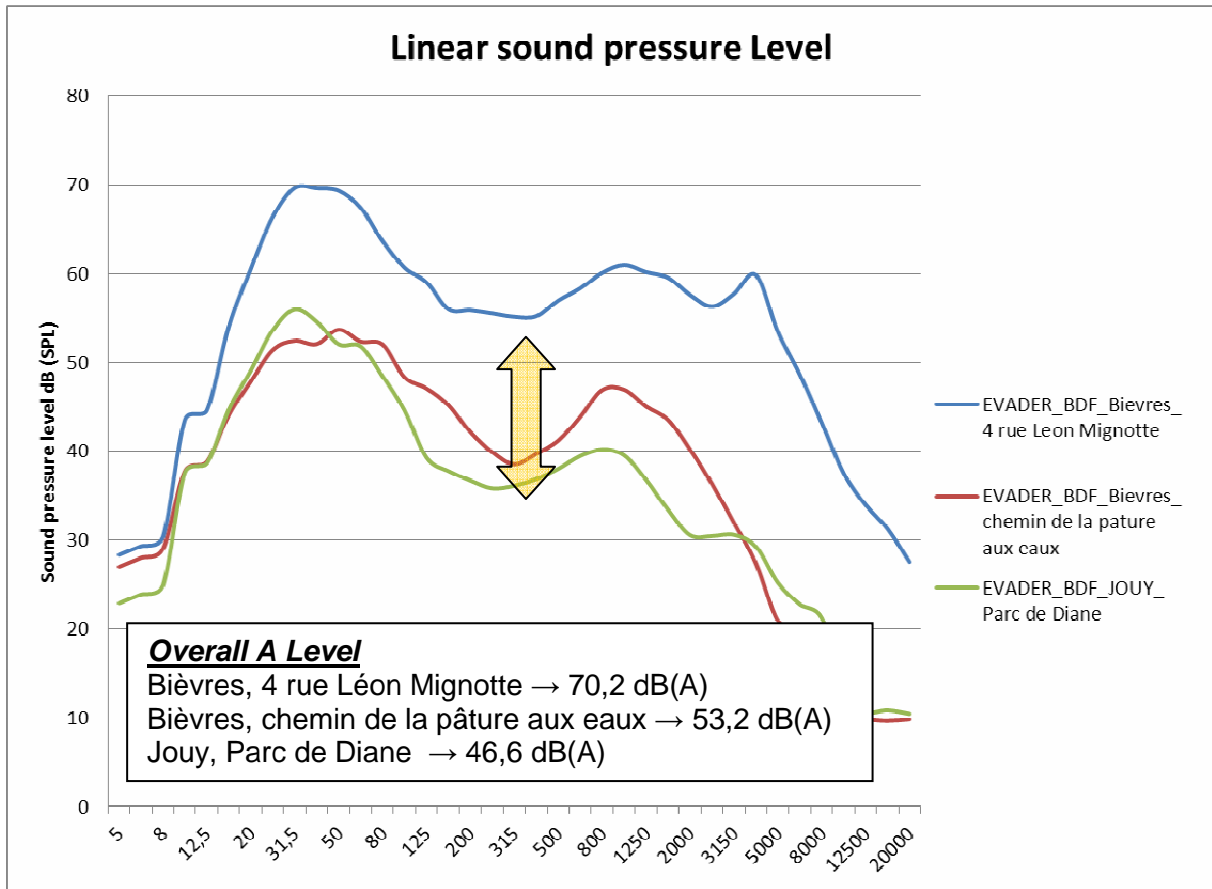
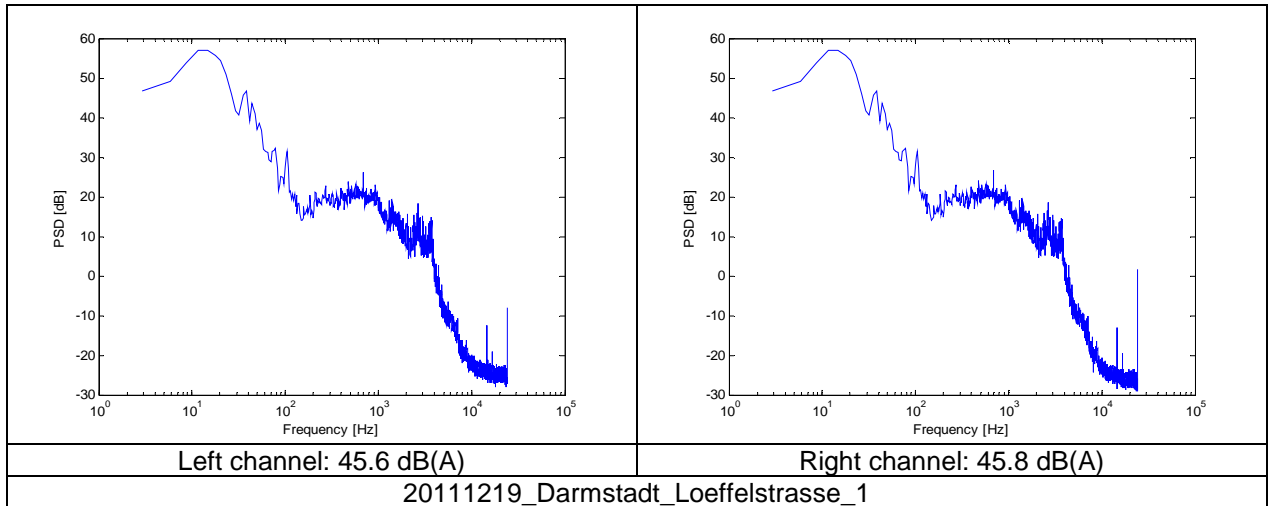


Figure 2: Comparison of noise spectra for ambient urban noise for the three measurement points around Paris, France (PSA).





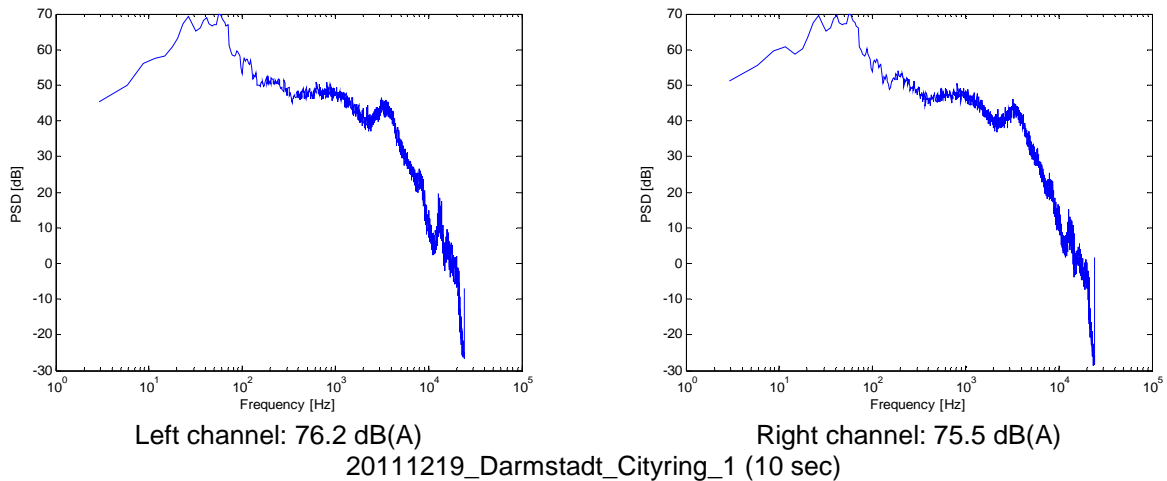


Figure 3: Comparison of noise spectra for ambient urban noise for the two measurement points in Darmstadt, Germany (TUD)

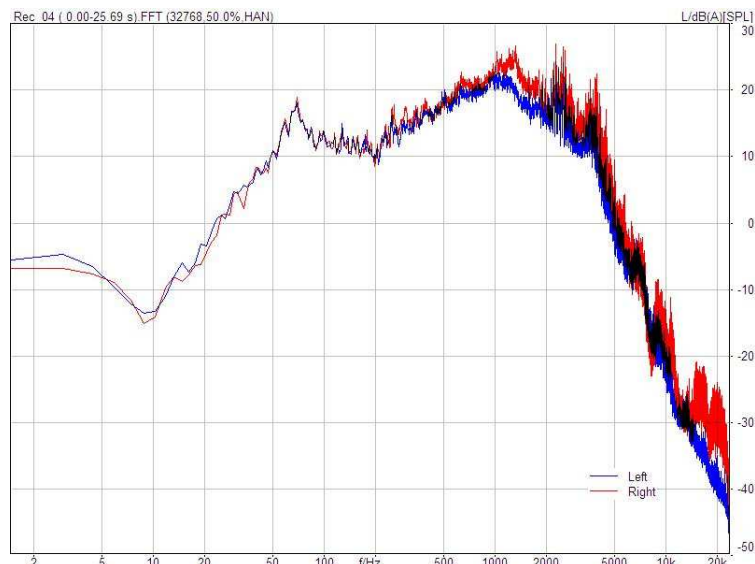


Figure 4: Noise spectra (A-weighted noise levels) for ambient urban noise for the one of the measurement points in Paris, France (Renault)

The creation of a database of several background noises allows us to yield information on typical background noise, shielding effects and to qualify the comfort perception for residents, in order to take advantage of the low noise emission of electric vehicles. The task was done by IDIADA (in Barcelona), TUD (in Darmstadt), Renault and PSA (around Paris) to have European representative data. We have also compared our measurements to Nissan Americas database of noise environments.

Vehicle traffic noise is influenced by the surrounding environment, along with traffic volume, road surface, building locations, as well as building mechanicals. Several locations through the Metro Detroit area (United States) were selected to be measured. Each of these locations provided a unique traffic environment for the pedestrian. Several of the locations measured were from the market research testing for Vehicle Sound for Pedestrian:

- NTCNA Parking Lot
- Residential Side Street
- Traffic Round-about

- City Streets
- Major Suburban Intersections-High volume
- U of M Hospital Access Road
- Downtown Ann Arbor Michigan

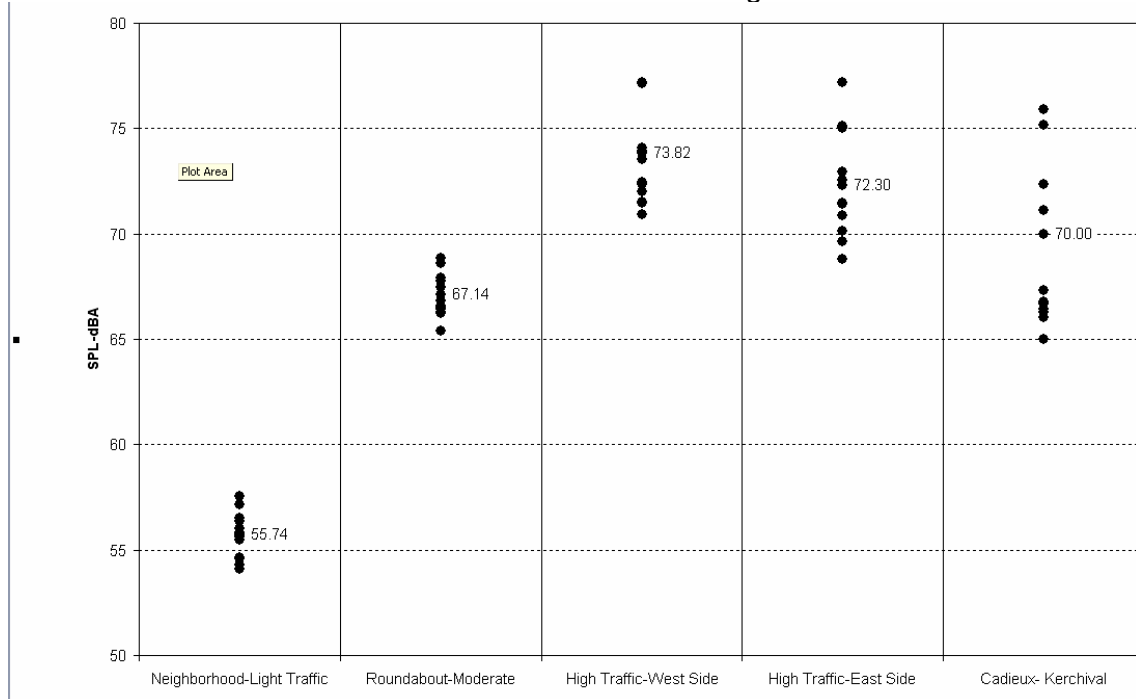


Figure 5: Distribution of traffic noise levels – Metro Detroit (Nissan United States)

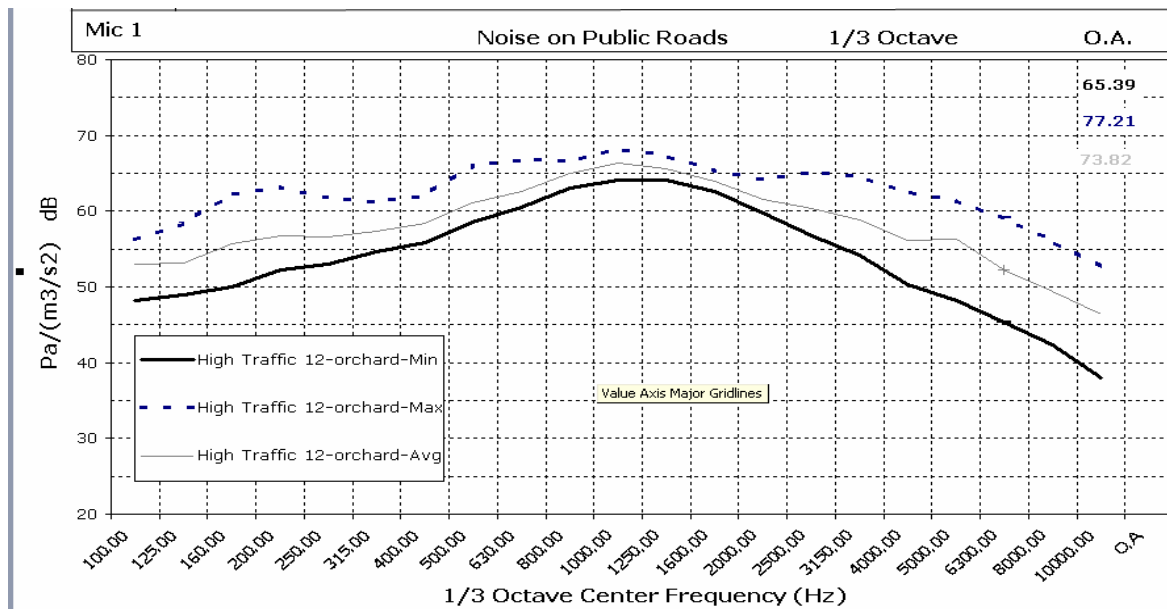


Figure 6: Noise spectra – Metro Detroit (Nissan United States)

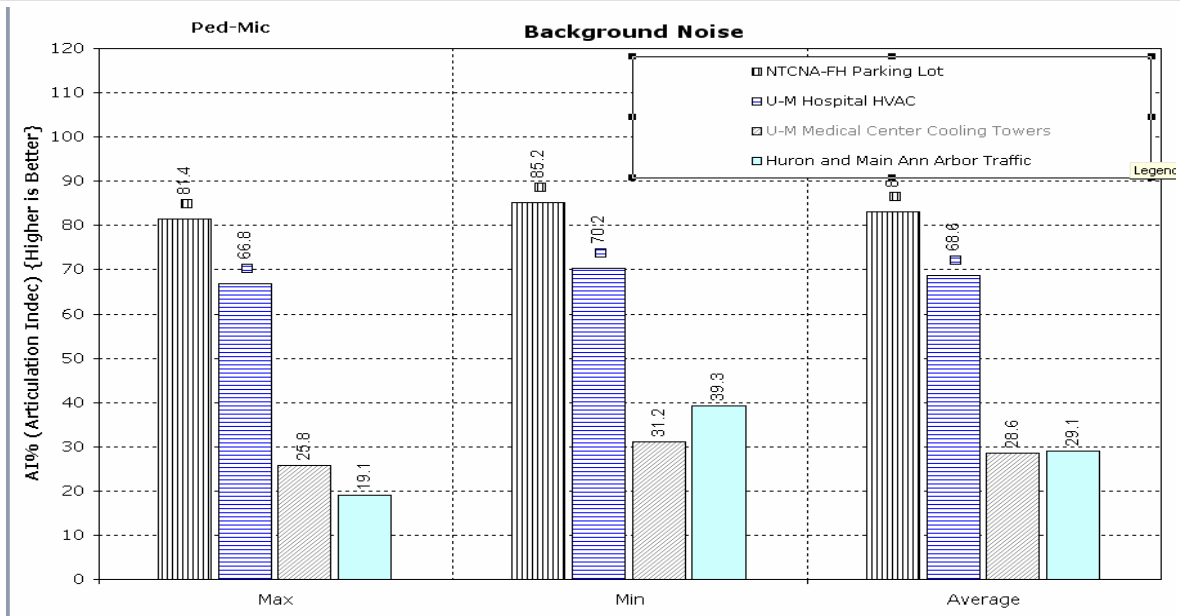


Figure 7: Articulation Index values – Metro Detroit (Nissan United States)

The figure 5 presents overall A-weighted levels (dB(A)) for ambient noises. We observe that the levels are ranged from low of 55 dBA on neighborhood streets to a high of 78dBA on high traffic suburban intersection. The figure 6 presents noise spectra and the figure 7 Articulation Index values, ranged from 19 on city street to 81 in NTCNA parking lot.

The comparison between our noise levels in European cities, measured with a dummy head and the Nissan data, from United States, recorded by microphones show us that the locations that we have chose are representative of different urban environments (city centers, suburbs), during working days.

## 4 Considerations on the variability of urban noise due to road surface characteristics

The measurements of urban noise are influenced by many parameters, which are traffic related and how this traffic integrates into the measured street.

The acoustic characteristics of the road surface are very important to define the overall noise level in a given street. In actual fact, for the same street geometry, traffic flow and structure one can get important variations in the average overall noise and spectrum just due to the type of road surface laid in the street. The aim of this section is to provide an order of magnitude of the variability that one can expect due to this parameter.

During December 2011, several streets in Barcelona were re-surfaced for maintenance purpose as apart of an decision taken by the to reduce the noise in certain important roads, the City Council of Barcelona had decided to apply sound reduction surfaces in streets than previously had conventional layers. The urban noise of some of these streets before and after the implementation of the road surface was assessed by IDIADA in order to get information about the effect on urban noise in the street. The streets studied by IDIADA during this period were:

- Calle Balmes (street). See figures 5 and 6 below.
- Paseo Bonanova

### 4.1 Influence on exterior noise

The principal advantage offered by the measurements carried out with the acoustic head is that they can be post-processed. As the objective of this exercise in eVADER is to quantify the effect produced by the application of a low-noise asphalt and to compare the values of the measurements before and after the application of the low-noise rolling layer, time history sections with the same type and number of vehicles were selected in order to synthesize time histories with a duration of 60 seconds containing the same number and type of noise contributions from passing vehicles. This normalisation of the measurement was carried out in order to have time histories that could be compared. This normalisation allows us explore comparatively the psycho-acoustic aspects that cannot be analysed with the measurements made with the sound level meter. Table I presents the global values of *Leq* and *Loudness* calculated from the synthesized time histories. As an example, Figure 7 shows the spectrum of the exterior noise (environmental noise) in Paseo Bonanova obtained before and after the application of the low-noise asphalt.





Figure 7. Preparation of the set-up for the measurements with the artificial head (Paseo Bonanova - Barcelona)

<b>Balmes street</b>		
<b>Exterior noise with AH</b>	<b>Leq (dB(A))</b>	<b>Loudness(aver.)[sone]</b>
Existent asphalt	76,1	40,45
Low-noise asphalt	72,3	33,25
	<b>Reduction= 3,8dBA</b>	<b>7,2soneGF</b>

<b>P. Bonanova</b>		
<b>Exterior noise with AH</b>	<b>Leq (dB(A))</b>	<b>Loudness(aver.)[sone]</b>
Existent asphalt	77,4	36,1
Low-noise asphalt	71,4	27,8
	<b>Reduction= 6dBA</b>	<b>8,3soneGF</b>

Table III. Global results of Leq and Loudness of the normalised measurement of exterior noise with the binaural acoustic head (AH).

We observe that the effect of the porous asphalt on the noise in Paseo Bonanova is mainly an important uniform reduction of the overall level of the frequency spectra above 500 Hz. Note that the overall noise reduction with sound absorbent surface is about 6 dB(A).

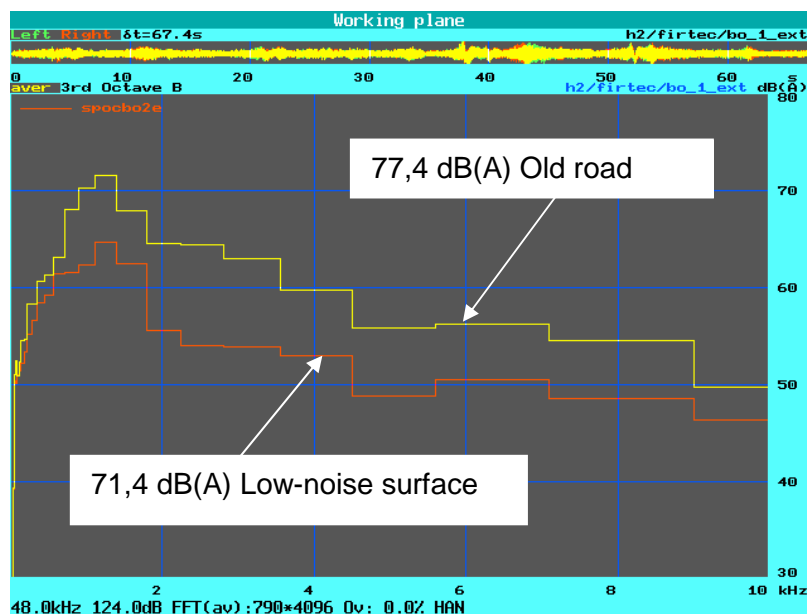


Figure 8. The spectrum of the exterior vehicle noise (environmental noise) in Paseo Bonanova (Barcelona). The plots show the difference in noise level before and after the implementation of the low noise road surface.

## 4.2. Influence on interior vehicle noise

The measurement of the interior noise of the reference vehicle (Ford Focus Wagon 2.0i) was carried out under controlled driving conditions (3<sup>rd</sup> gear, 50 km/h) using the artificial head (see Figure 9). In this driving condition, the engine noise inside the vehicle was relatively low. In this case the measured data was processed in a way that the presented results correspond to time histories in which the vehicle was completely stabilised and the recordings were free from any exterior noise source. The results of the psycho-acoustical parameters of *Sharpness*, *Loudness* and *Articulation Index* are presented because they are relevant parameters in relation with the sound quality inside the vehicle. Figure 9 shows the change in the noise spectrum of the interior noise of the car when it was driven along Paseo Bonanova before and after the resurfacing of the road.

Table IV shows the values of *de Leq*, *Loudness*, *Sharpness* and *Articulation Index* associated with the interior noise of the reference vehicle for the two streets studied before and after the implementation of the porous asphalt. This result proves that porous asphalt has a very important impact on the level and quality of the noise inside the vehicle. The attenuation of the high frequency components reduces the value of the loudness and the sharpness of the interior noise, making it more comfortable. This also improves the value of the Articulation Index which is closely related to comfort perception.



Figure 9. Position of the binaural acoustic head in the reference vehicle for the measurement of interior noise (passenger position).

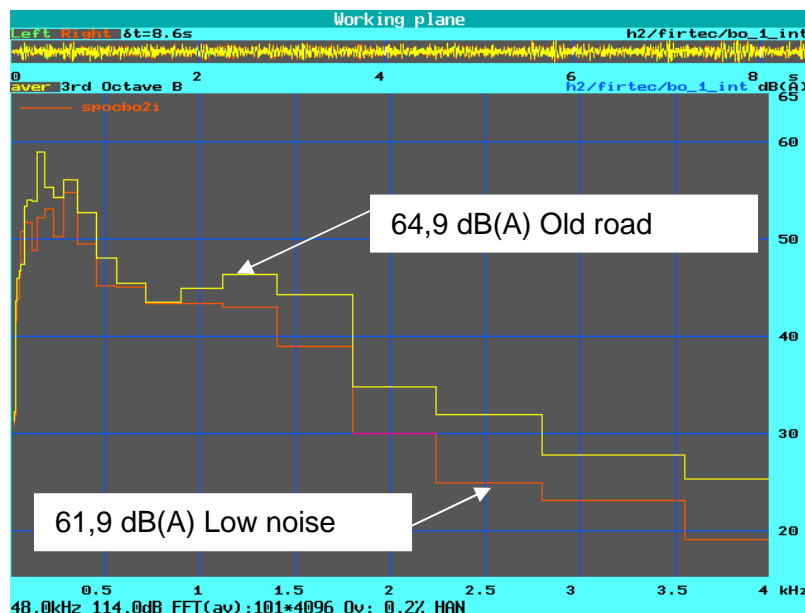


Figure 10. Interior noise spectrum of the reference car driven (3<sup>rd</sup> gear, 50 km/h) on Paseo Bonanova in Barcelona.

This variability in the interior sound due to the effect of road surface characteristics can vary from about 1 dB(A) to 3 dB(A), as shown in table II. We can then conclude that the expected effect of the road surface in exterior noise can reach about 6 dB(A) and around 3 dB(A) in the interior noise. This effect can be considered as equivalent to a dispersion that one can add to the measurements of urban noise and interior noise in vehicles.

Balmes street				
Interior noise with AH	Leq (dB(A))	Loudness(aver.)(sone)	Sharpness(aver.)(acum)	A.I.(aver.)(%)
Existent asphalt	64,1	15,9	0,813	90,2
Low-noise asphalt	63,3	14,7	0,809	91,3
Reduction= 0,8dBA      1,2soneGF      0,004acum      1,10%				

P. Bonanova				
Interior noise with AH	Leq (dB(A))	Loudness(aver.)(sone)	Sharpness(aver.)(acum)	A.I.(aver.)(%)
Existent asphalt	64,9	16,3	0,89	90,1
Low-noise asphalt	61,9	13,5	0,717	93,2
Reduction= 3dBA      2,8soneGF      0,173acum      3,10%				

Table IV. Result of the measurements of interior noise in the reference vehicle (Ford Focus Wagon 2.0i) with a binaural acoustic head.

It is important to say that the utility of the psychoacoustics parameters presented here will be to determine in Work Package 2 when defining the target sounds of electric vehicles for eVADER.

### 4.3 Some notes on the absorption coefficient of road surfaces

The equipment used to measure the absorption coefficient of the road surfaces in this exercise is an impedance tube based on the two-microphone technique and adapted by Applus+ IDIADA to characterise acoustically the rolling surfaces. The two-microphone



method uses the measurement of the acoustic pressure at two points on the duct to distinguish the incident and the reflected component of the sound field produced by a sample of material. This allows the measurement of the absorption coefficient on the surface located at the end of the duct. Figure 11 depicts the results of the measurement of the absorption coefficient carried out with the acoustic impedance tube in Paseo Bonanova before and after the implementation of the porous surface. We observe that the new porous asphalt exhibits a dramatic change in the absorption coefficient which explains the big influence that this type of road surface has on both the interior and the exterior vehicle noise.

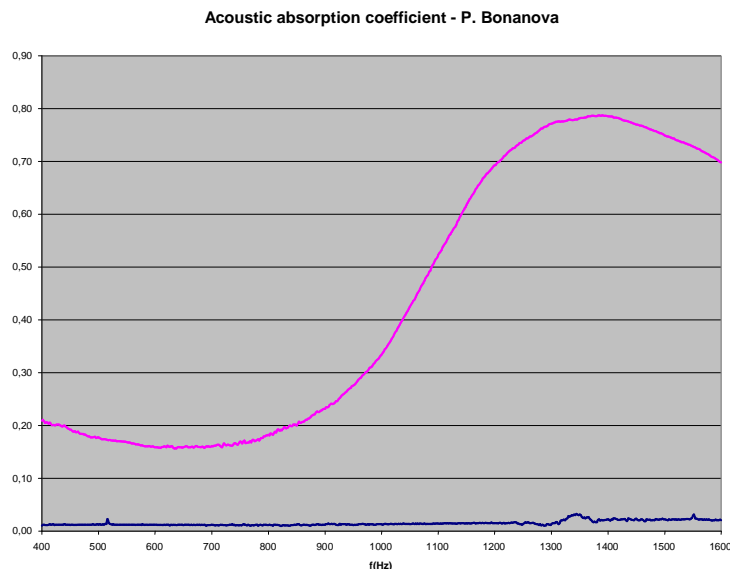


Figure 11. The measured absorption coefficient of the road surface in Paseo Bonanova before (blue line) and after (red line) the implementation of a low-noise road surface. The data has been obtained using and impedance tube.

These findings suggest that, as expected, it is possible to tune the acoustic properties of road surfaces to satisfy certain requirements. This means that road surface can modify the spectrum of the urban noise and the interior noise of vehicles.

The main characteristics determining noisiness of road surfaces are geometrical features, acoustical and mechanical properties of the pavement. Previous research has shown that two independent tyre noise generation processes can be identified; one in the low frequency range below 1kHz which is roughness induced; the other in the high frequency range is identified as air-pumping. It has been shown that the noise level increases with increasing texture depth. However, at a certain point this increase ceases due to the tyre being unable to form a seal down to the base of the aggregate, hence reducing air-pumping.

In addition to the reduced levels of noise being produced by road surfaces with optimised textures some surfaces, notably porous asphalts actually attenuate noise levels by an absorptive mechanism. In order to achieve the greatest possible noise reduction, the sound absorption of the road must be optimal which means that the sound absorption of the road must be as high as possible in the frequency range which is most significant for road noise.

In actual fact, it is the selection of the road construction parameters what defines the final acoustic absorption of the surface.

The absorption coefficient of road surfaces can be expressed as a function of physical parameters that interact to define the capability of the material to dissipate acoustic energy

[9] [10]. These parameters are the porosity,  $\Omega$ , the air flow resistivity,  $R_s$ , the tortuosity,  $\sqrt{K}$ , and the thickness of the road layers,  $d$ . In general, the absorption coefficient of a porous material can be expressed as

$$\alpha = 1 - \left| \frac{Z - \rho_o c_o}{Z + \rho_o c_o} \right| \quad (1)$$

where  $Z$  is the surface impedance and  $\rho_o c_o$  is the specific impedance of air ( $\rho_o$  is the air density and  $c_o$  is the speed of sound). The value of  $Z$  can be calculated by

$$Z = W \cdot \coth(jkd) \quad (2)$$

where  $k$  is the wave-number of the medium,  $d$  is the thickness and  $j = \sqrt{-1}$ . The value of  $k$  and  $W$  in equation (2) can be expressed respectively as

$$k = \frac{2\pi f}{c_o} \sqrt{K\gamma} \sqrt{1 - j \frac{f_u}{f}} \sqrt{1 - \left(1 - \frac{1}{\gamma}\right) \left(1 - j \frac{f_\theta}{f}\right)} \quad (3)$$

$$W = \frac{\rho_o c_o}{\Omega} \sqrt{\frac{K}{\gamma}} \frac{\sqrt{1 - j f_u / f}}{\sqrt{1 - \left(1 - \frac{1}{\gamma}\right) \left(1 - j f_\theta / f\right)}} \quad (4)$$

In equations (3) and (4),  $\gamma$  is the ratio of the specific heats of air and the terms  $f_u$  and  $f_\theta$  represent the characteristic frequencies associated to viscous and thermal effects. These are given by

$$f_u = \frac{1}{2\pi} \frac{R_s}{\rho_o} \frac{\Omega}{K} \quad (5)$$

$$f_\theta = \frac{1}{2\pi} \frac{R_s}{\rho_o} \frac{\Omega}{N_{pr}} \quad (6)$$

where  $N_{pr}$  is the Prandtl number of air.

The model described above allows the prediction of the acoustic absorption of a road surface from the knowledge of the porosity, the resistivity, the tortuosity and the thickness of the layer.

Woodside *et al* [11] have investigated the relationship between these parameters and the size and shape of the type of aggregates used to build road surfaces. If these relationships are used to express the acoustic parameters  $\Omega$ ,  $R_s$  and  $K$  as a function of the aggregate size [12],  $s$ , and shape (flake versus cubic geometry), equations (1) to (6) can be used to explore the combination of aggregate size and shape that will exhibit a higher absorption coefficient at a desired frequency. Figure 12 shows the calculated effect that the aggregate size and geometry can have on the absorption coefficient at 1 kHz and 2 kHz respectively. To help the interpretation of the curves, the two surfaces depict the same information but from different view points.

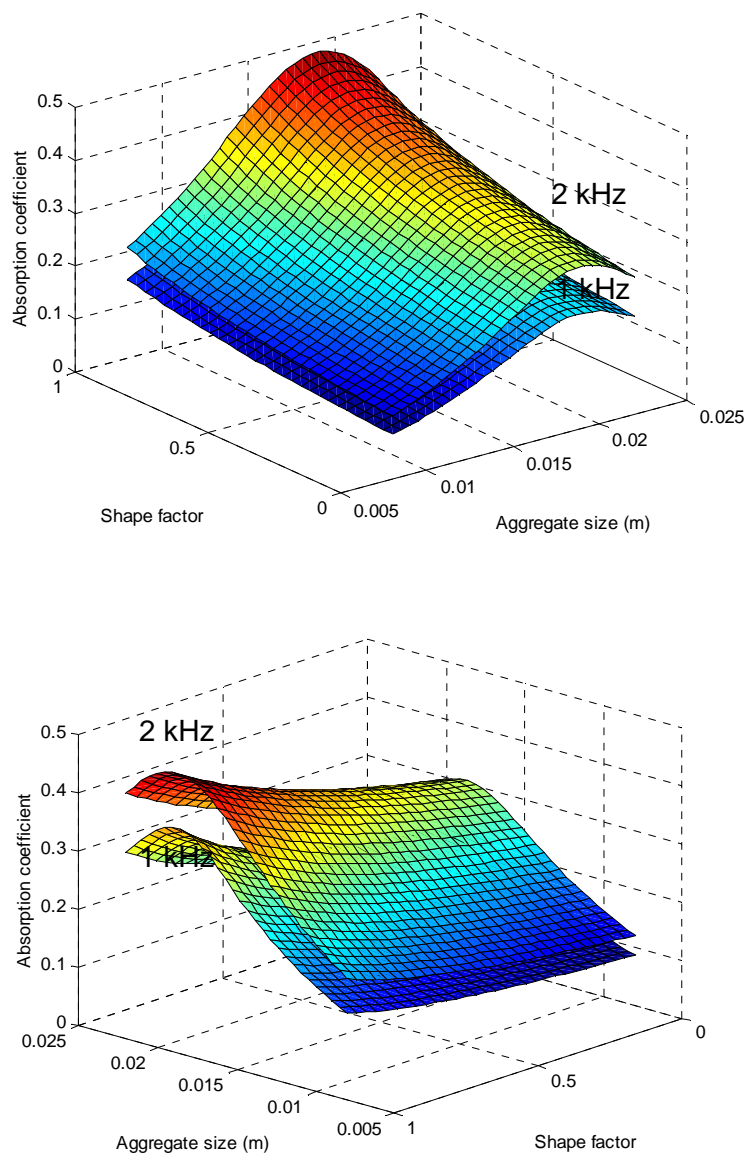


Figure 12: The calculated absorption coefficient of a porous road surface with a thickness of 0.04m. The two surfaces in each figure represent the absorption coefficient for 1 kHz and 2 kHz respectively. The two figures depict the same surfaces but from different view points.

Shape factor: Flake = 0; Cubic = 1.

The result shown in Figure 12 suggests that for a given frequency it is possible to select the geometric characteristics of the aggregate (size and shape) so that a maximum absorption coefficient can be achieved. This suggests that tuning the absorption characteristics of road surfaces can be a feasible strategy to reduce traffic noise depending on the speed and the characteristics of the traffic flow. This aspect must be taken into account in Work Package 2 of eVADER.

Figure 13 shows the contour plots of the two surfaces depicted in Figure 12. From the result shown in this figure it is clear that for certain combinations of aggregate size and shape factor the absorption coefficient of the road surface can reach very high values.

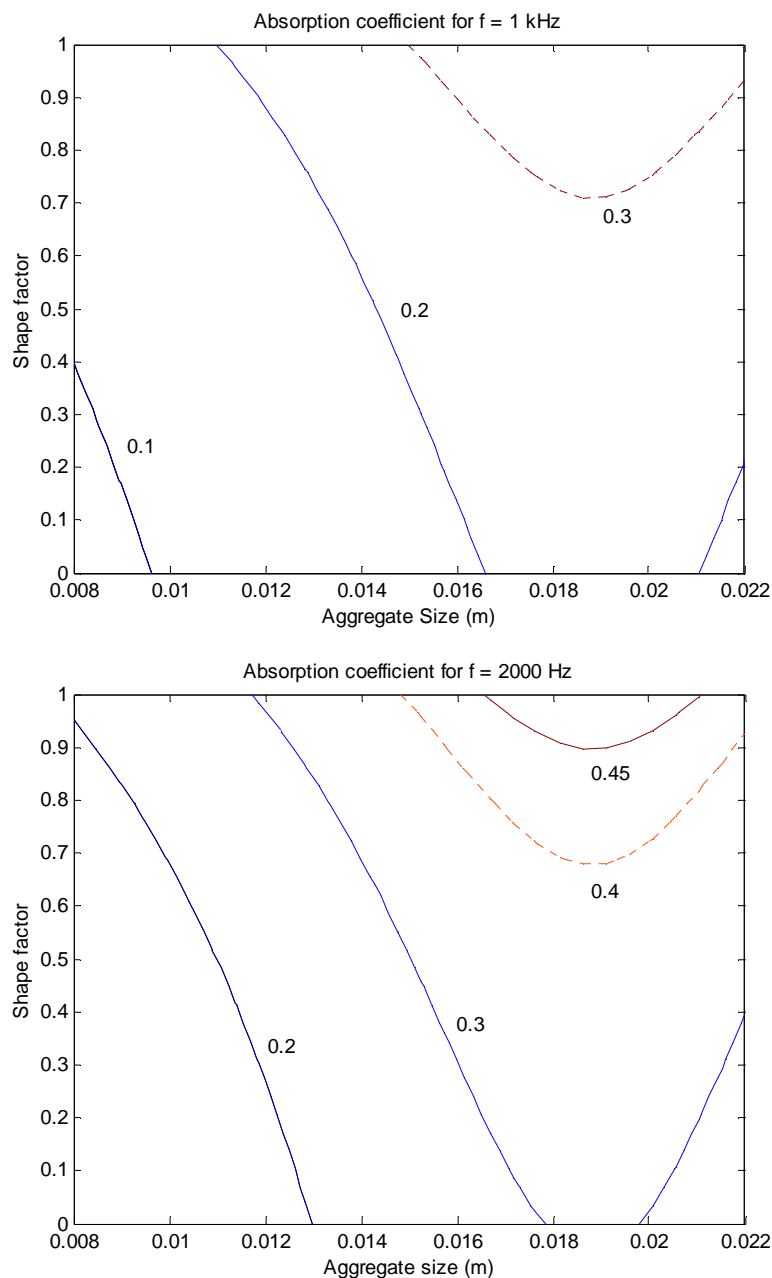


Figure 13: The contour plots corresponding to the surfaces depicted in figure 7



## 5 Conclusion

This document shows the noise measurements carried out in typical streets of Barcelona, Darmstadt and around Paris, in order to quantify the level of background noise during working days and the noise range covered.

The results show that the expected variability between different locations is about 20 dB. The reference locations have been chosen so that they correspond with a zone of low traffic volume and a zone of moderate traffic volume. The noise spectra of the various measurements show the same trends with a relatively higher value at frequencies below 60 Hz

The noise recordings at all points were carried out with a binaural system as time histories of the perceived sounds. These recordings will be used in future work packages to define jury tests under laboratory conditions.

In this report we have also presented an advanced way of assessing the effect of porous asphalts on the exterior and the interior vehicle noise. This approach is based not only on the measurement of the time average sound pressure level but also on binaural measurements with an artificial head and an impedance tube that allows the *in situ* non-destructive assessment of the absorption coefficient presented by a road surface. This integral assessment methodology provides all the information needed to quantify the impact of low-noise road surfaces on the acoustic comfort of pedestrians and vehicle passengers. Furthermore, the information obtained from the combined use of these measurement tools allows a more precise definition of the type of acoustic characteristics expected from a road surface to maximise the acoustic comfort.

This investigation of the effect of porous asphalts on the acoustic comfort can also be used in combination with a mathematical model of the acoustic absorption of road surfaces. The availability of a model to predict the acoustic absorption allows the definition of the geometric characteristics of the road surface components to achieve the desired absorption coefficient in the frequency band of interest. These considerations and results can be useful in the synthesitation of sounds foreseen in Work Package 2.

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## EVADER protocol

### Objectives

We could record environmental noise with an artificial head located in two different urban environments in addition to sound level meters. The two different urban environments must be choice to be European representative.

The 1<sup>st</sup> site will be chosen for its low traffic volume with a moderate noise level (around 40-50 dB(A)): low wind speeds, flat, clean asphalt pavement. The ambient level in the area should be representative of a quiet suburban area, which may be encountered by pedestrians.

The 2<sup>nd</sup> site will be chosen for its moderate traffic volume with a noise level more representative of a city center (60-70 dB(A)). It will be necessary to have recordings during which no car is passing in front of the artificial head during clear sequences.

### Instrumentation set-up

Dummy Head: Head Acoustics? Cortex? Other?

Acquisition system

Equalization filter: linear LIN or L0

Synchronization & Sampling frequency: 48 kHz

Recording Range: 104 dB

Recording: 24 bits

### Description of measurement site

Address, City, Country, GPS coordinates (Latitude, Longitude)

The data will be recorded using a binaural head, on the pavement, in front of the road which the pedestrian is close to cross.

Distance to the road, on the pavement: 1m

Height: 1.50 m

### Measurement Conditions

- Photos and schematic representation of the measurement site (visual obstacles, intersections),
- Meteorological conditions (precipitations, wind, temperature and fluctuations during the measurement period),
- Traffic conditions
- Different sound sources present
- Connectors (preferably XLR)
- Microphones: frequency response (preferably)

### Results presentation

- A-weighted levels during all the measurement period
- Noise spectrum during the selected period
- File format: Wave

An alternative format (.dat) will be also provided to have some redundancy for safety.

- Name file: YearMonthDate\_City\_Site\_Partner

In order to have the calibration information with wav format, we have to record a calibrated sound source in a wav file too (pistonphone at 1 kHz at X dB for example).



## Test instrumentation

### 1. IDIADA (Barcelona)

#### ***Test measurement:***

The measurements have been done with the following equipment:

- Head Acoustic Dummy
- Pulse Acquisition System
- Software PULSE 14.1.1
- Connection cables BNC-BNC



Figure 1 : Head Acoustic Dummy



Figure 2: Acquisition System

#### ***Set-up:***

Equalization filter: Linear  
Synchronization & Sampling Frequency (Head Acoustics): 48 kHz  
Frequency span of acquisition system 25.6 kHz  
Recording Range: 114 dB  
Recording: 24 bits

#### ***Meteorological conditions:***

Sky: clear  
Wind: negligible

Temp.: 11 °C

## **2. TUD (Darmstadt, Germany)**

Dummy Head: HEAD Acoustic HMS IV

Meteorological conditions: ca. 2°C, no precipitations, moderate wind

Almost no traffic

Sound sources present:

- Some cars passing in the front of the head and right hand side
- Some cyclists and pedestrians

## **3. PSA (Vélizy, France)**

### **Test instrumentation**

The measurements have been done with the following equipment:

- Head Acoustic Dummy (Numerical)
- Software Head recorder 2.0.510 (HEAD acoustics)
- Connection cables USB



Figure 3 : Head Acoustic Dummy with windscreen

### ***Set-up:***

Equalization filter: Linear

Synchronization & Sampling Frequency (Head Acoustics): 48 kHz

Recording Range: 114 dB

Recording: 24 bits

### ***Meteorological conditions:***

Sky: clear  
Wind: negligible  
Temp.: 3 °C

#### **4. Renault (Guyancourt, France)**

##### ***Test instrumentation:***

The measurements have been done with the following equipment:

- Head Acoustic Dummy (Numerical)
- Software Head recorder 2.0.510 (HEAD acoustics)
- Connection cables USB

##### ***Set-up:***

Equalization filter: Linear  
Synchronization & Sampling Frequency (Head Acoustics): 48 kHz  
Recording Range: 114 dB  
Recording: 24 bits

##### ***Meteorological conditions:***

Sky: clear  
Wind: negligible  
Temp.: 3 °C

#### **5. Nissan (USA)**

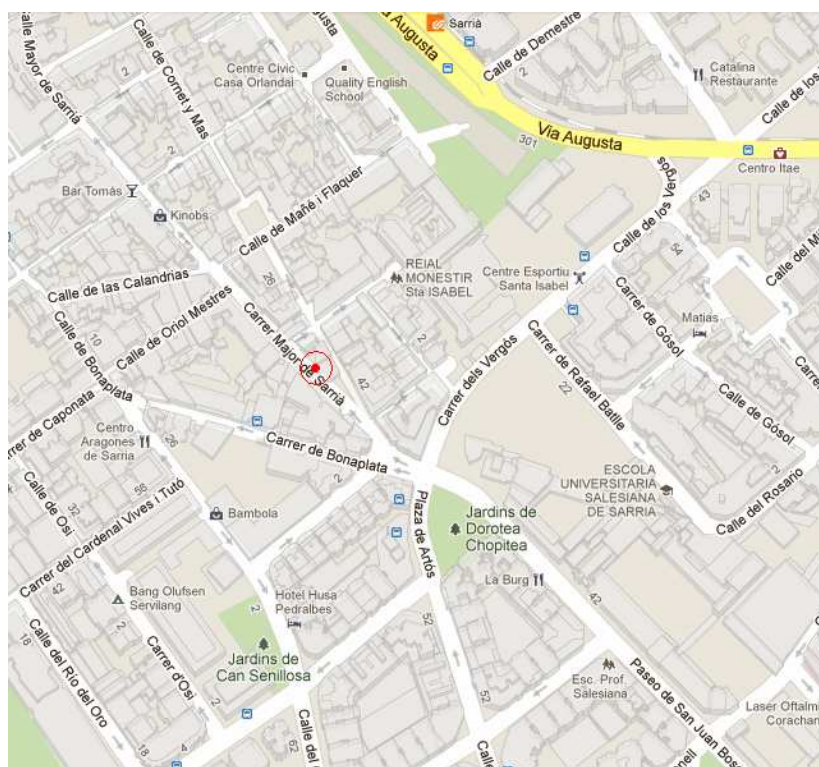
##### ***Test equipment:***

Microphone: B&K ½ inch Microphone Model 4942  
Sensitivity: 50 mV/Pa  
Frequency: 6.3 - 16000 Hz  
Dynamic Range: 14.6 - 146 dB  
Temperature: - 40 to 150° C (- 40 to 302° F)  
Polarization: 0 V  
Front-End- LMS Scaddas III Mobile Front-end  
Computer- Dell M70  
Software-Test Lab-Spectral Testing (11A)  
Pedestal Microphone Stand

## Measurement conditions

### 1. Barcelona, Spain: IDIADA

- **Location 1: Calle Mayor de Sarria**





The structure of the traffic was mainly defined passenger cars, vans and bicycles.

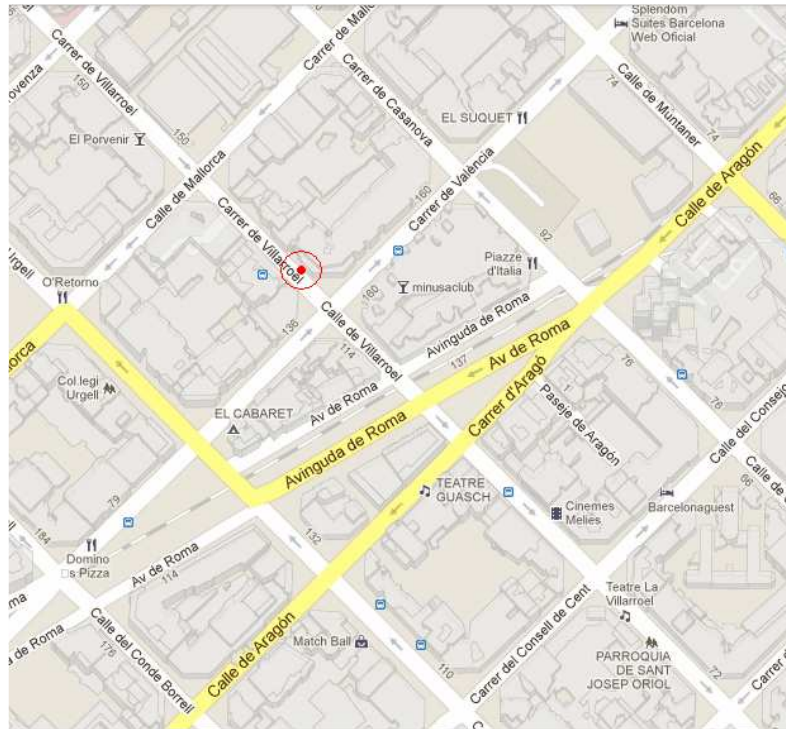
- **Location 2: Calle Aragón-Muntader**





Different sound sources present: Cars, motorcycles and vans.

- **Location 3: Calle Villarroel**



Different sound sources present: passenger cars, motorcycles, vans, trucks and buses.

## 2. Darmstadt, Germany: TUD

- *Location 1 (low traffic volume): Löffelstrasse*



Meteorological conditions: ca. 2°C, no precipitations, moderate wind

Almost no traffic

Sound sources present:

- Some cars passing in the front of the head and right hand side
- Some cyclists and pedestrians

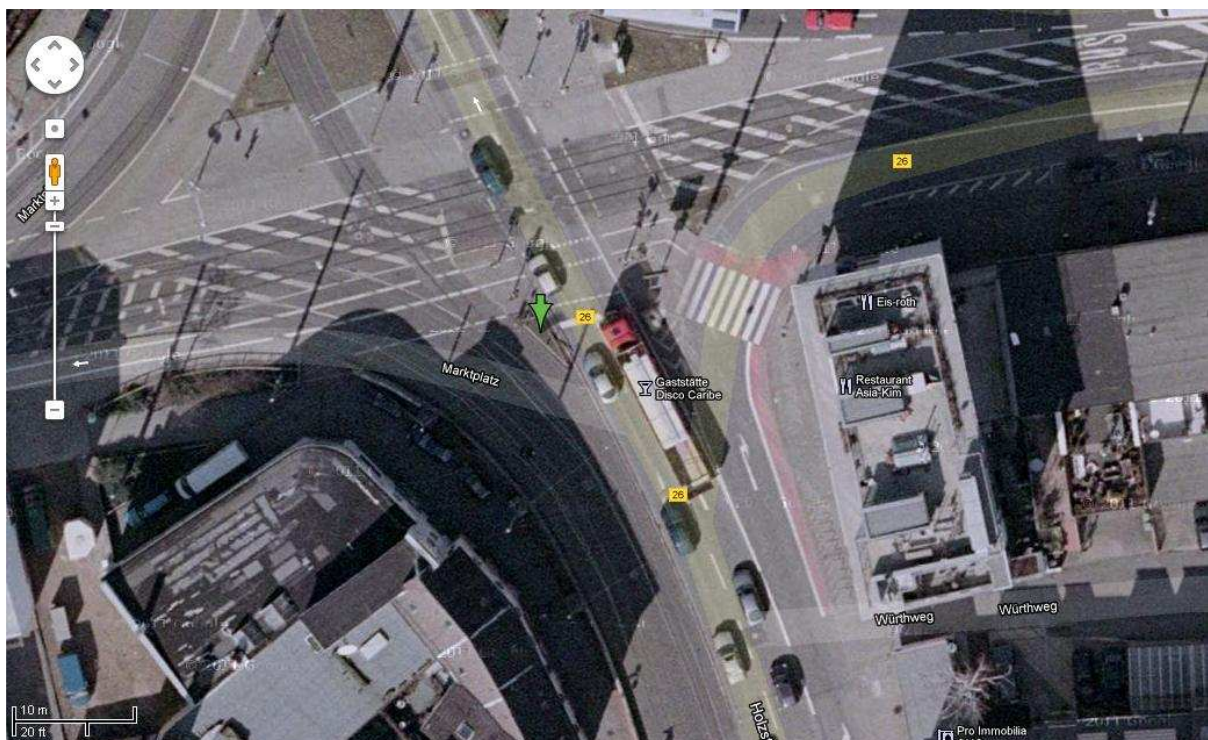








- **Location 2 (high traffic volume): Schloss – Cityring**



Meteorological conditions: ca. 0°C, no precipitations, moderate wind

Traffic conditions: much traffic

Sound sources present:

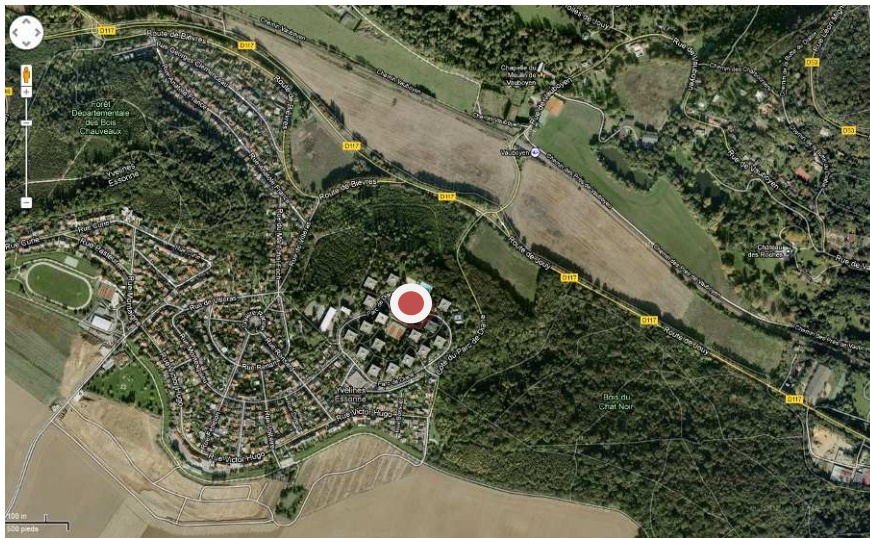
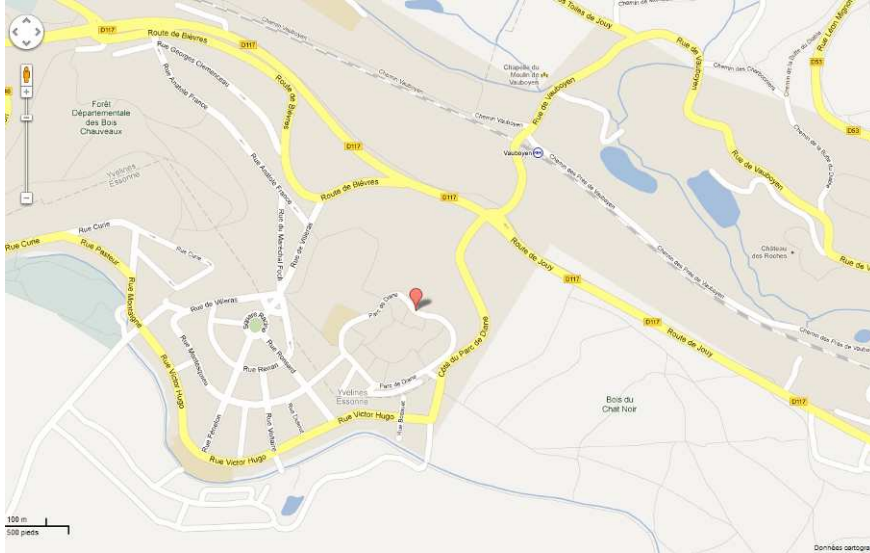
- The carillon of Darmstadt's castle on the left hand side
- Sound signals for visually impaired people from the traffic signals
- Passing cars in the front of the dummy head
- Busses on the left hand side
- Tramway in the back of the head, right side
- Pedestrians and some cyclists passing on the sides of the dummy head





### 3. Around Paris, France: PSA

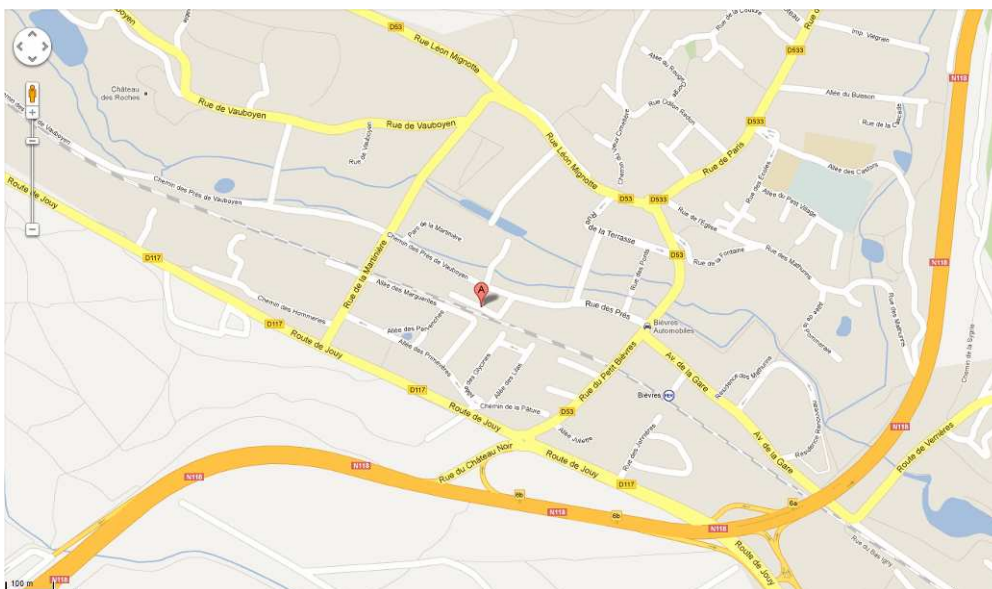
- *Location 1 : Jouy-en-Josas*



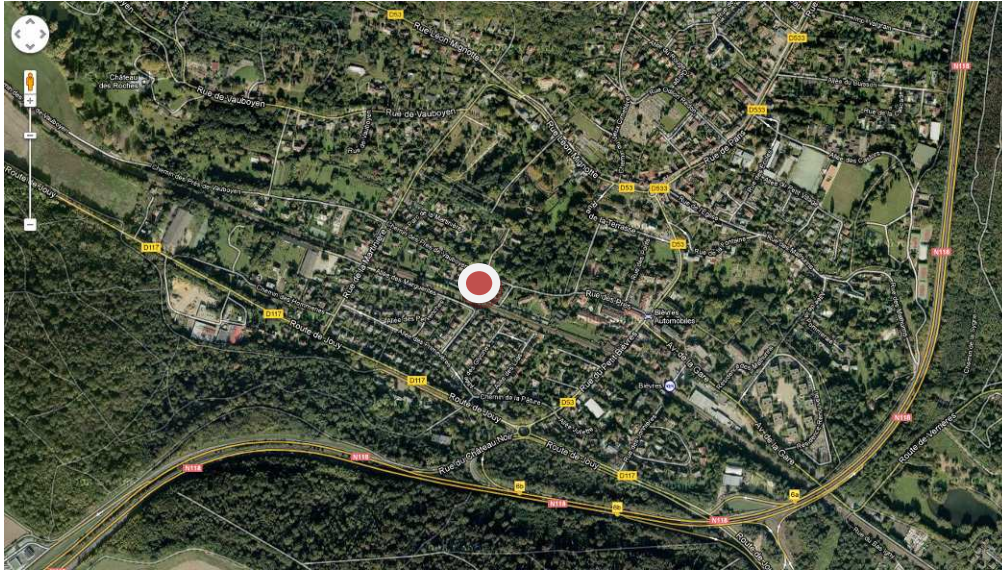


The structure of the traffic was mainly defined passenger cars, vans and bicycles.

- **Location 2: Chemin de la pâture aux eaux - Bièvres**



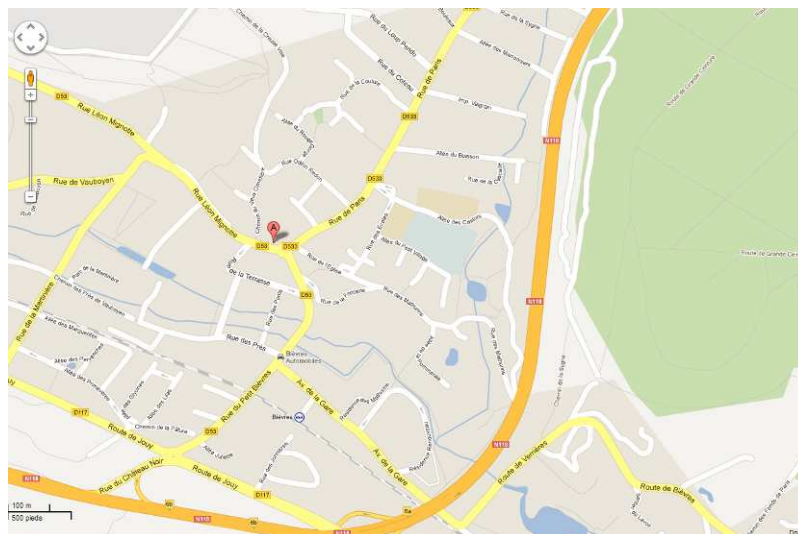
**Title: Notes on the background noise in Europe**  
Public





The structure of the traffic was mainly defined passenger cars, vans and bicycles. We will note that the street is a dead end serving the residence. The residence is located not far from a speedway (N118) a 2\*2 road with a 110km/h speed limit

- **Location 3 : 4 rue Léon Mignotte - Bièvres**





**Title: Notes on the background noise in Europe**  
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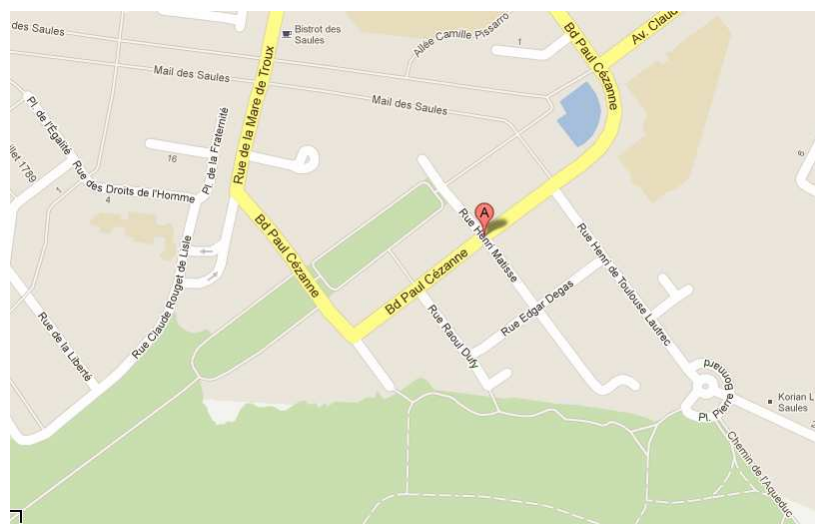




Different sound sources present: passenger cars, motorcycles, vans, trucks and buses. We will note that the head dummy is located on footpath and before a traffic circle. This made it possible to record various situations of rolling: approaches, deceleration, stop and starting.

#### **4. Paris, France: Renault**

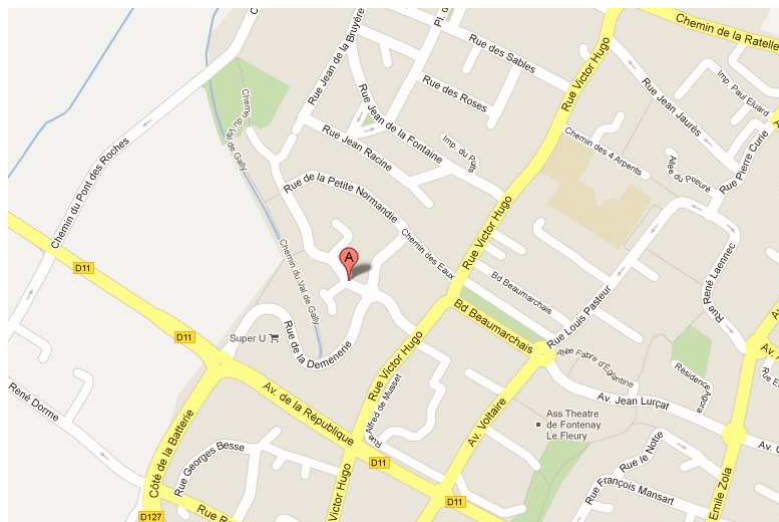
- ***Location 1 : 13 Boulevard Paul Cézanne - Guyancourt***







- **Location 2 : 22 rue de la Deménerie - 78330 Fontenay-le-Fleury**





- **Location 3 : 14 avenue de Saint Cloud - 78000 Versailles**



## **5. Nissan (United States)**

All measurement were conducted during high traffic volume 3:30pm-5:00pm. All measurements were of standard traffic patterns. No Siren, horns, excessively loud Exhaust noise, or air brakes were used in data. All sound files were evaluated for excessive noise contribution before processing to insure no abnormal traffic sound were analyzed.

Pedestrian Microphone location – in US market.

Location Passenger side of vehicle on side walk.

Height 5-ft 8-inches (approx 173 CM) Average Height in US.

Street location Uniqueness to each traffic location. (see photos)

**Title: Notes on the background noise in Europe**  
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