


6th WG QRTV Meeting 17th-19th May San Diego State University

1. Comparison between coming, stopping and starting of EVs and combustion engines driven cars for sound issues.
2. What kind of sound the road users associate with a car, enhancing his attention as reaction ?
3. Working out of significant and definable frequencies
4. Creation of a target sound definition

AUE mobility *Is a project of*  **D'Angelico
Acoustic Consult**

Supported by  **Federal Ministry
of Transport, Building
and Urban Development**

Coordinated by  **NOW**
National Organisation Hydrogen and
Fuel Cell Technology

Member of the  **Model Regions
Electromobility**

The Project is part of the Model Regions Electric Mobility Programme of the Federal Ministry for Transport, Building and Urban Development (BMVBS). The programme's funding budget, which runs from 2009 to 2011, is about 130 million Euro. It is financed from the German government's second economic stimulus package.

AUE mobility

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In a survey of the AUE- mobility project, 30% of the asked EV drivers described dangerous Situations that they directly attribute to the less noise of EVs.

This percentage does not match to expected enhanced risk reviews of EVs , done with the standardised sound level measurements method.

The goal was to get details how the changing EVs soundscape influence the detection of the EVs as a car, or ,if changing sound is equivalent or even more significant than a volume assessment.

Online survey AUE – Mobility
Participant > 600 driven EV Kilometer > 800.000 km

Weblink <http://aue-mobility.de/research> please join it!



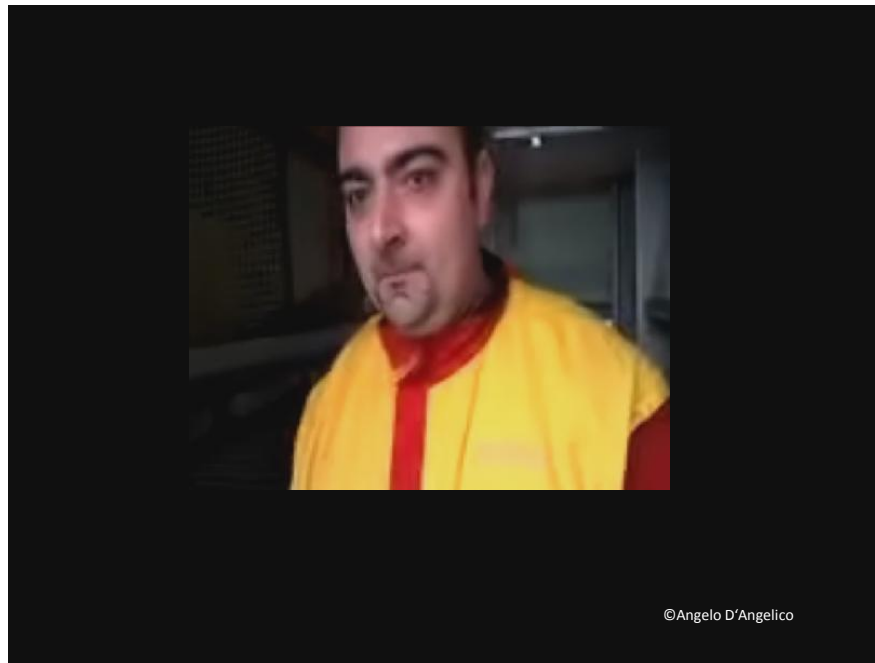
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Typical response from a EV driver of a courier company, when asked whether he has increased critical situations because of the noise decrease of his EV





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Vehicle coming from the rear ,is not detected as a car
by the bicycle driver.

syntax

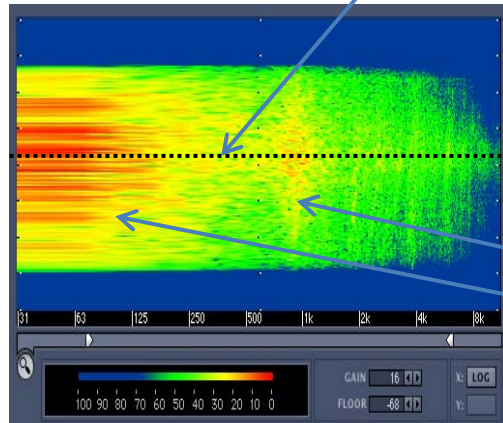


indicates the passing or zero point

Frequency



Total Drive duration in seconds

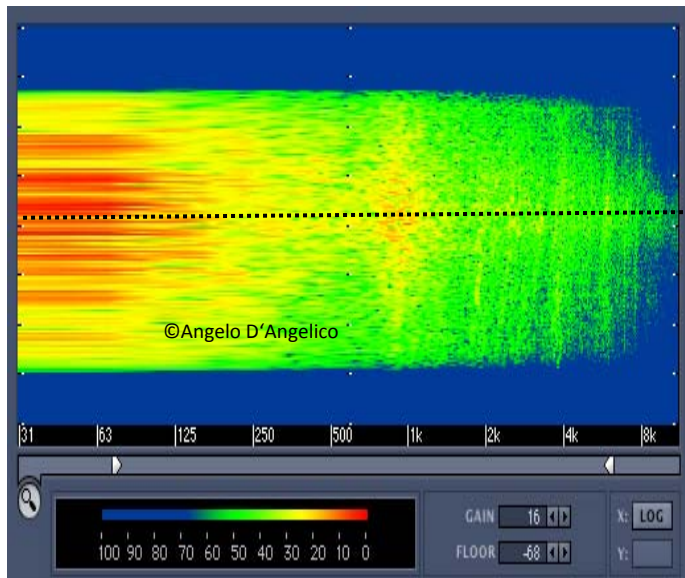


Color indicates the frequency volume amplitude in relation to the driving time moment.
Blue indicates low volume
Changing to green to yellow to red indicates rising up of volume

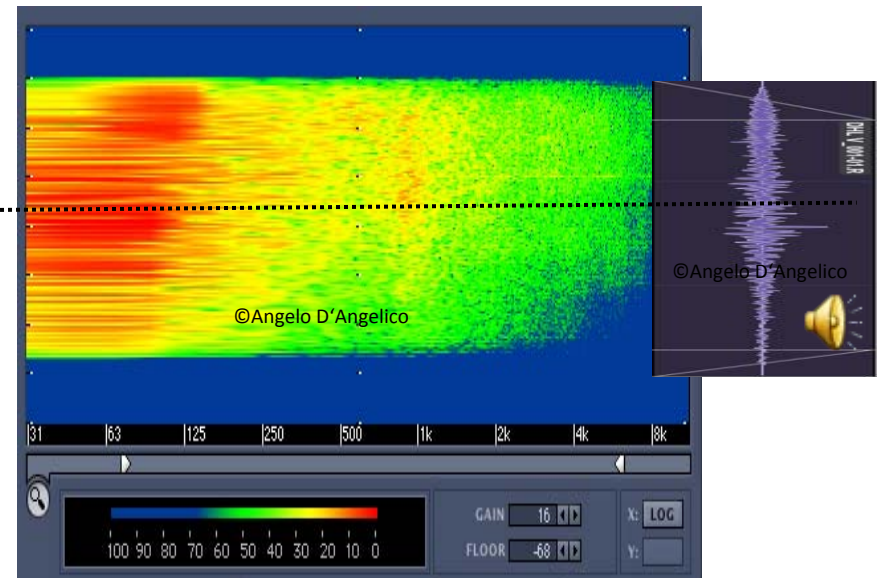
This graph allows a consideration of the frequency volume in dependence of the vehicle position. We will do a detailed look at the moment before passing the zero point.

Spectrogram courier delivery van Passing Speed 30 km/h Whole Time diagram

EV



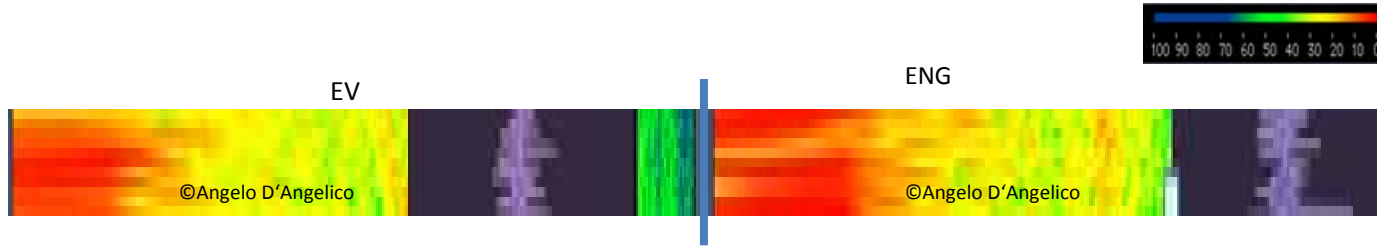
ENG



High pass filtered at 40HZ

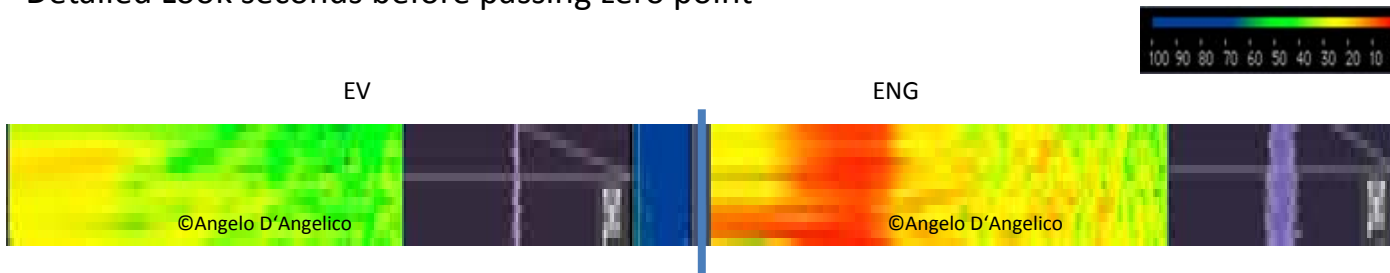
Spectrogram courier delivery van continuous Speed 30 km/h

Detailed Look at passing Zero point



Very similar Sound and level Amplitude at zero point passing

Detailed Look seconds before passing zero point

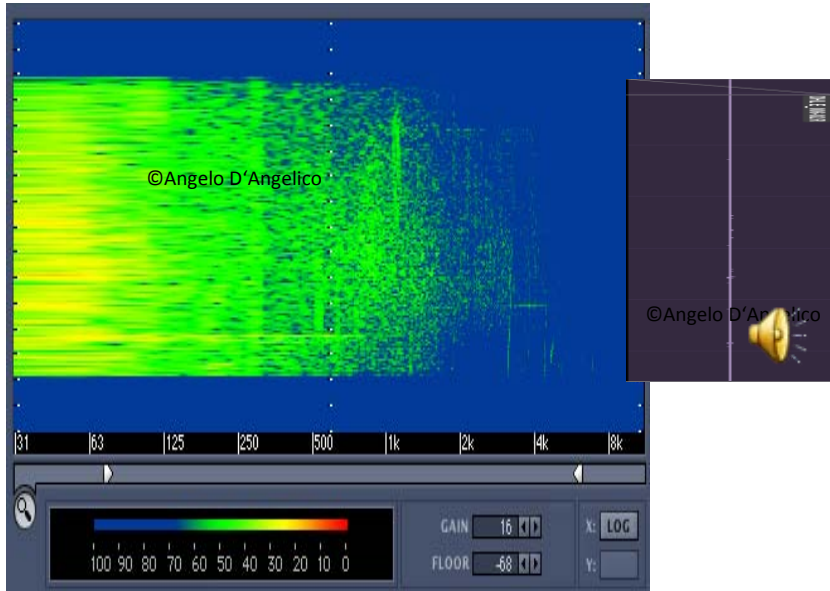


Very different soundscape and volume amplitude before zero point passing

High pass filtered at 40HZ

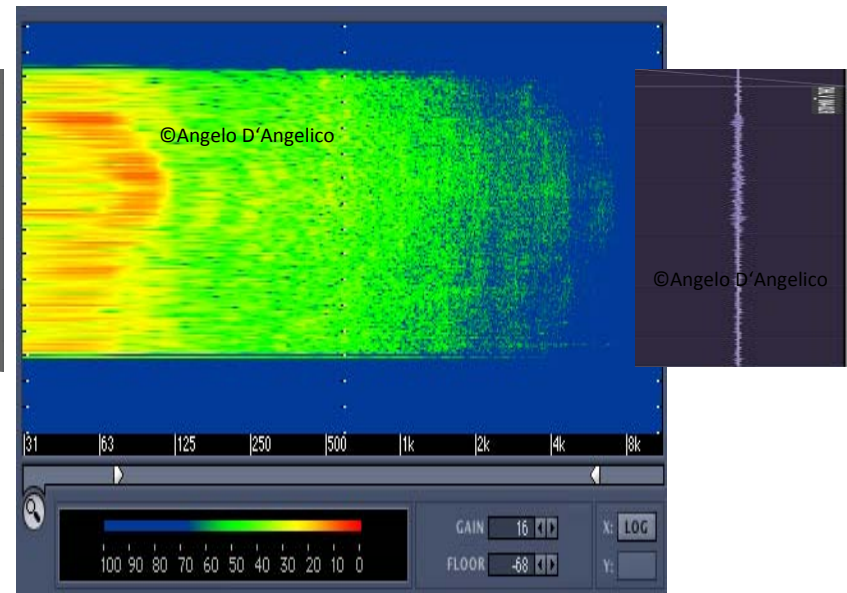
Spectrogram delivery van
Stopping 10 m before zero point
Whole Time diagram

EV



Only few changes EV

ENG

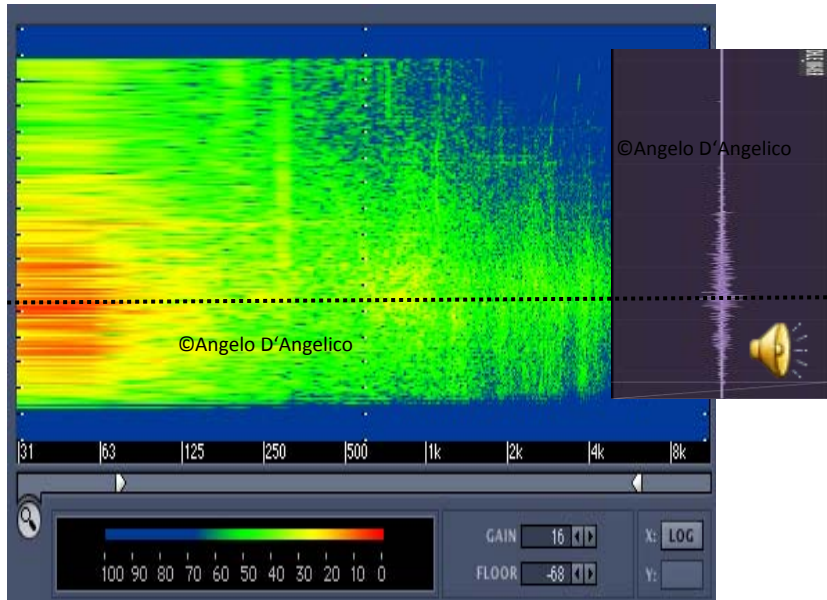


Explicit low frequency Modulation changes.
Combustion engine communicates
„ I'm stopping „

High pass filtered at 40HZ

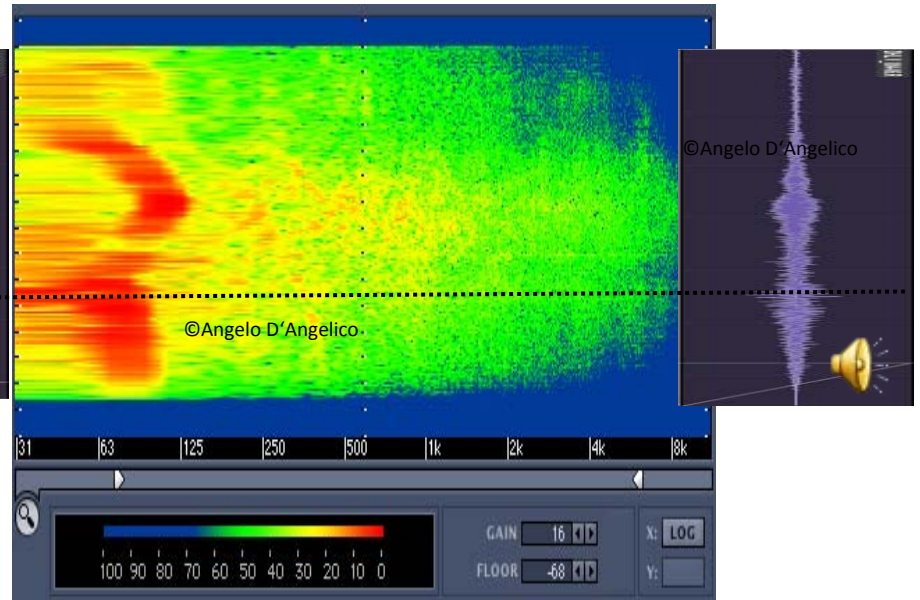
Spectrogram delivery van Starting 10m before zero point

EV



only few changes EV

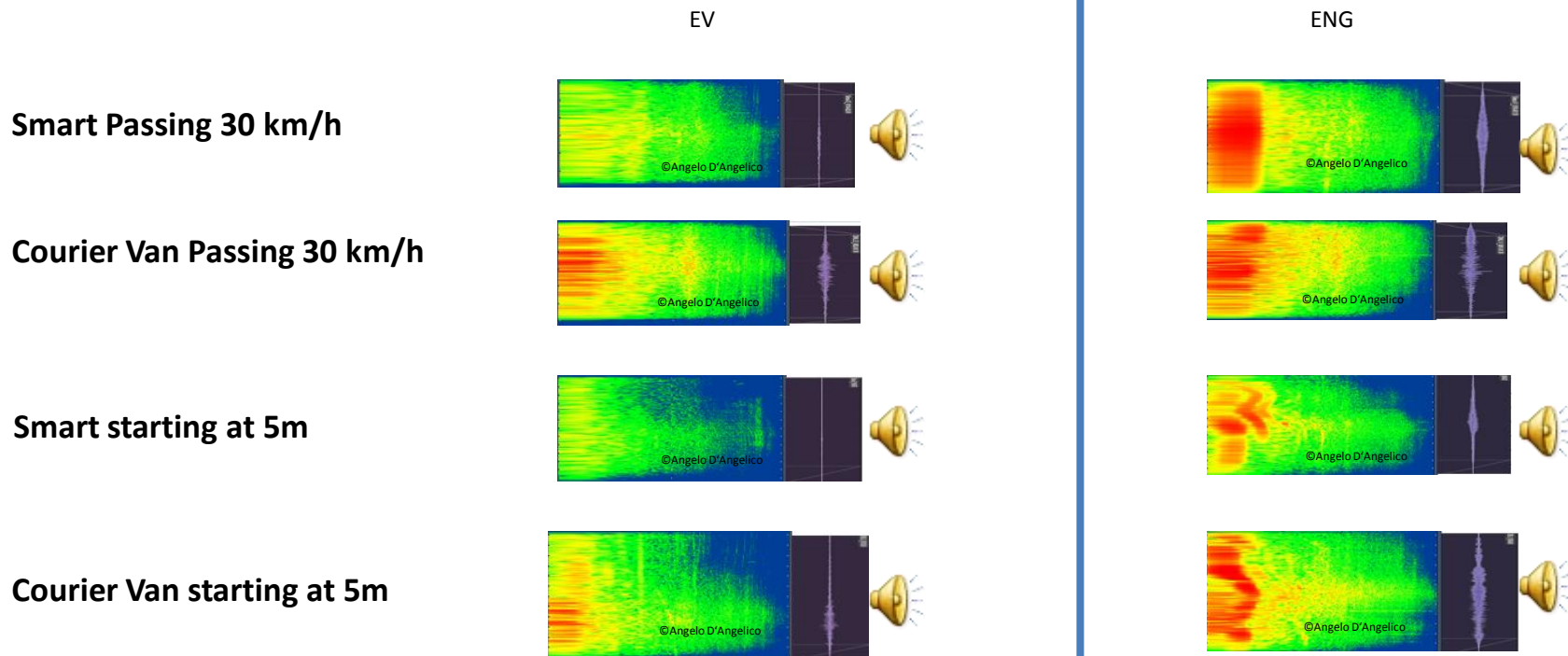
ENG



Very different soundscape and volume amplitude from starting point before passing zero point. Low frequency Modulation of the combustion engine communicates „ I'm starting”

High pass filtered at 40HZ

What is the typical sound of a combustion driven car, which tempt us to increased attention?

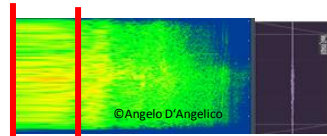


High pass filtered at 40HZ

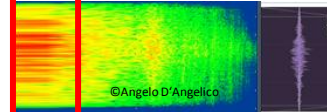
Most significant frequency area

EV

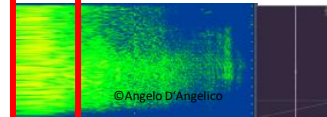
Smart Passing 30 km/h



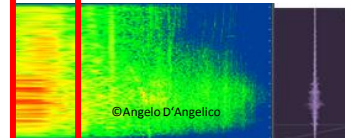
Courier Van Passing 30 km/h



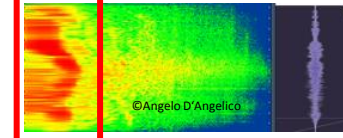
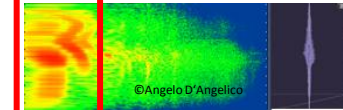
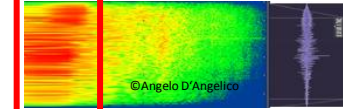
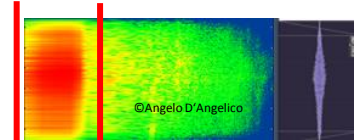
Smart starting at 5m



Courier Van starting at 5m

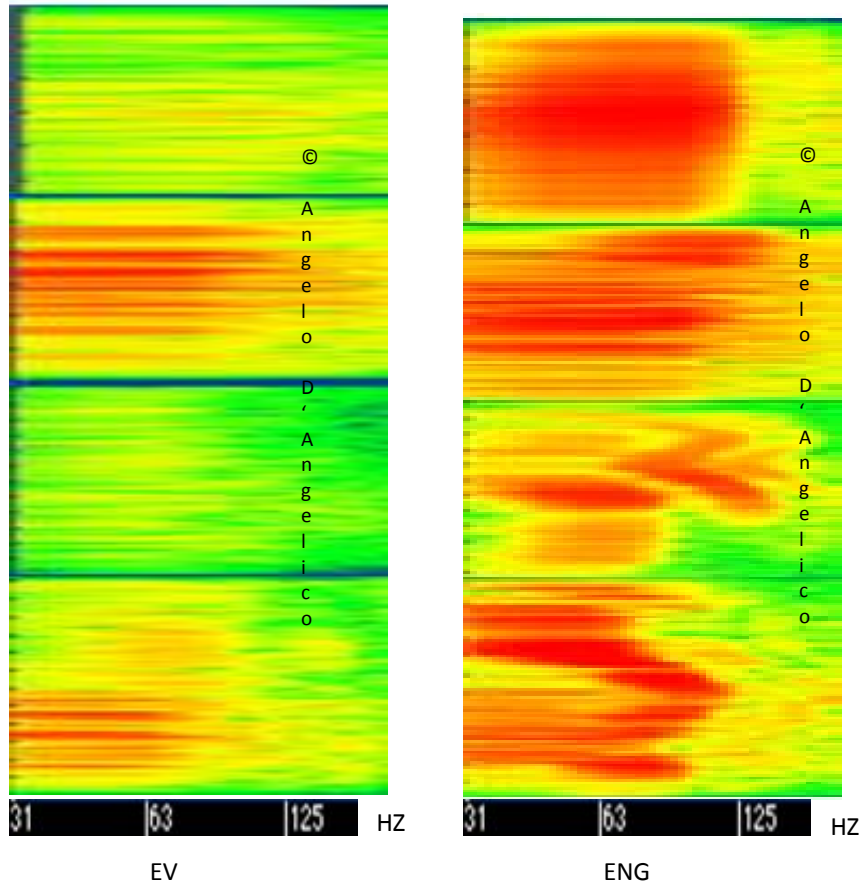


Eng



36 db High pass filtered at 40HZ

Detailed Look at most significant frequency area



Amplified frequency
between 40 – 130 Hz

Pitching Modulation of this
frequency communicates

Coming
Stopping
Starting (fast or slow)

We're trained by experience to
associate the sound of pitching
low frequency with " car "

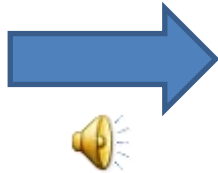
High pass filtered at 40HZ

Reduced to the max

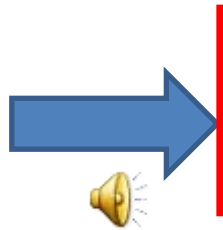
Significant frequency of combustion driven Car Sound
Car model, size and manufacturer independent

Use of frequency modulation sound to communicate

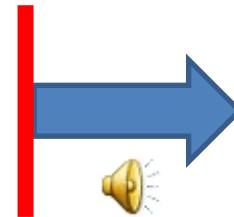
Driving



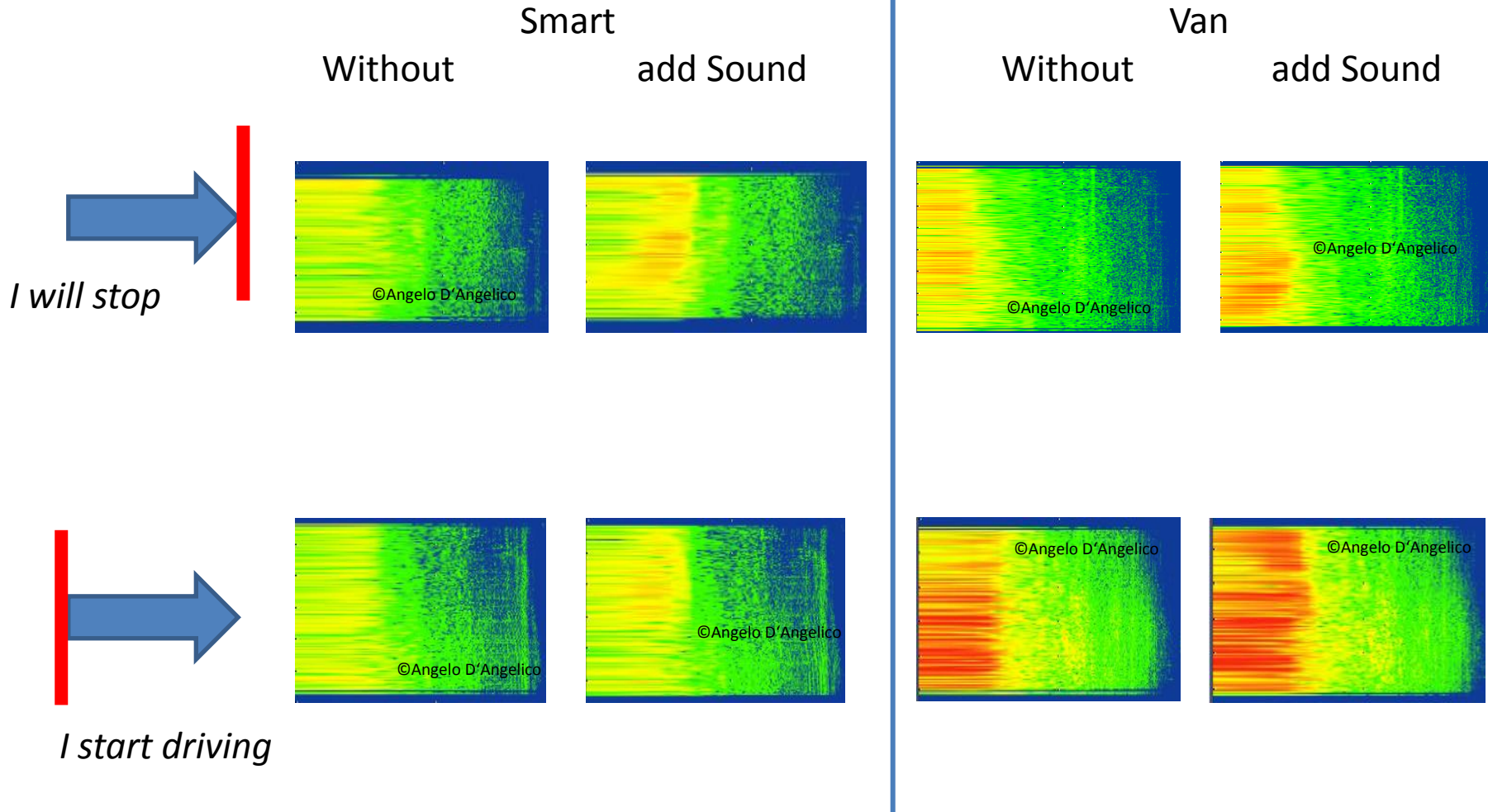
I will stop



I start driving



Sound examples integrated into EVs soundscape



How loud should it be ?

Test 1



Test 2

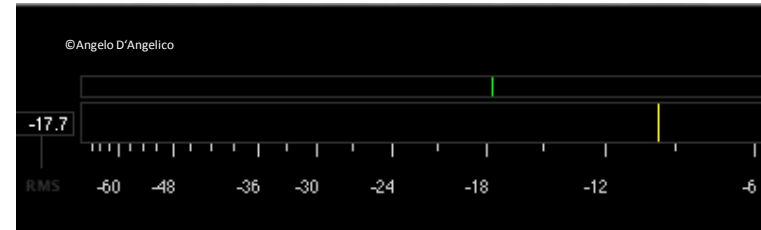


How loud should it be ?

Look at the same volume amplitude !

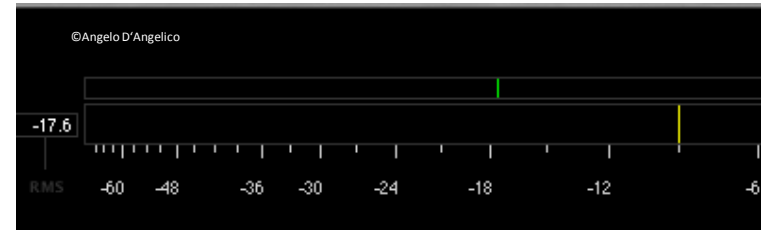
Example with unmodulated Sound

Test 1



Example with frequency modulated Sound

Test 2



Although the examples got the same level,
the frequency modulated sound is better audible

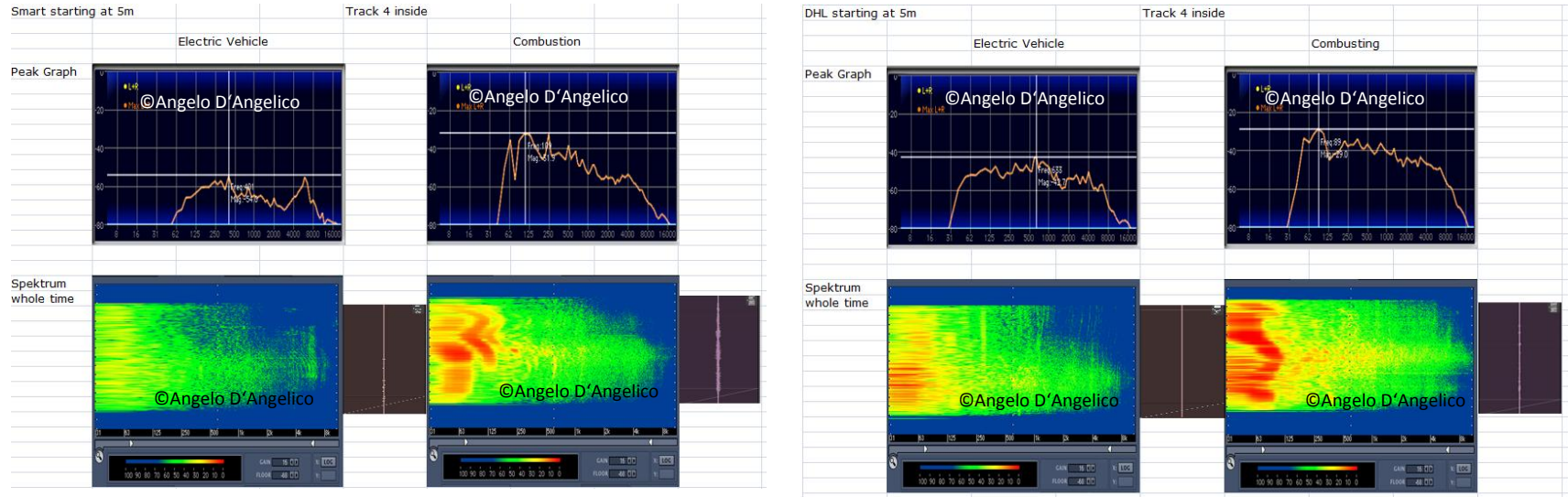
- Frequency modulation of additional sound for safety reasons can be used to reduce the needed sound volume level .
- Only a short period with additional sound could be enough
- Smooth common operation for original and additional sound

Next steps Acoustic Consult

1. detailed look at needed volume in urban spaces
2. Integration of know how for brand sound communications
3. Generating and integration of evaluated sound in EVs,
based on mechanical design construction, with no need of sound speakers.

very interesting

Measuring and visual analysing to differences inside the vehicles
for driver security and fatigue reasons



But not for today

Thank you for your attention



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