

Transportation noise annoyance, cognitive performance and sleep disturbances related to temporal structures and traffic modes  
*Deufrako Project “RAPS”*

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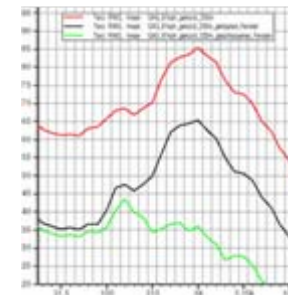
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# Content of the presentation

- RAPS Project
- Noise scenarios
- Perception of sound events in urban context
- Evaluation of the effects of the temporal structure of railway noise on sleep and cognitive performances
- Conclusions

# Main objectives of the RAPS project

- To quantify the differences of sleep disturbances as related to noises emitted from railway, road and air traffic
  - To quantify the effect of the, up to now rather neglected, temporal structure of railway noise, for short-term annoyance, performance and sleep
- ➔ The project focuses on noises emitted from currently operating trains, while respecting as far as possible future technical advances.



# RAPS Project

- Partners
  - Co-opération DEUFRAKO (Noise Group)
  - Partners : SNCF, LINC, LMRTE, DB, CUEI, IfADo, DLR
  - French funding by ADEME (PREDIT)

- Organisation

Workpackage 1 : Simulation, developments of noise scenarios

- SNCF
- DB

Workpackage 2 : Annoyance and performance

- LMRTE, laboratoire mobilités, réseaux, territoires et environnements
- CUEI, catholic University Eichstätt-Ingolstadt

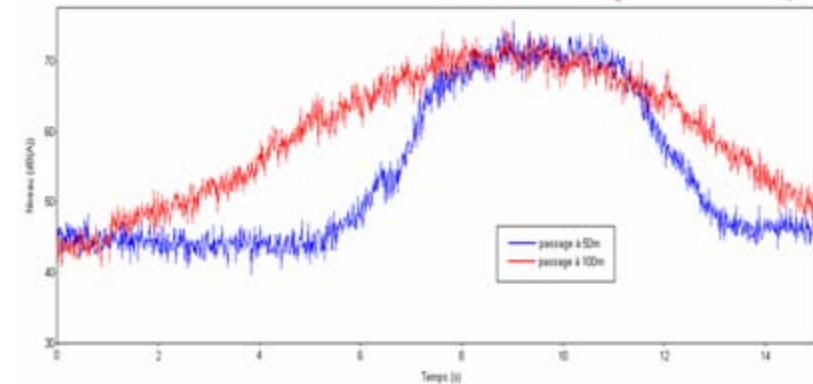
Workpackage 3 : Sleep disturbances

- LINC, Laboratoire d'imagerie et de neurosciences cognitives, Strasbourg
- IfADo, Institut für Arbeitsphysiologie - Universität Dortmund
- DLR, Deutsches Zentrum für Luft und Raumfahrt

➔ **Presentation is focused onto the work carried out in France**

# WP1 - Noise scenarios

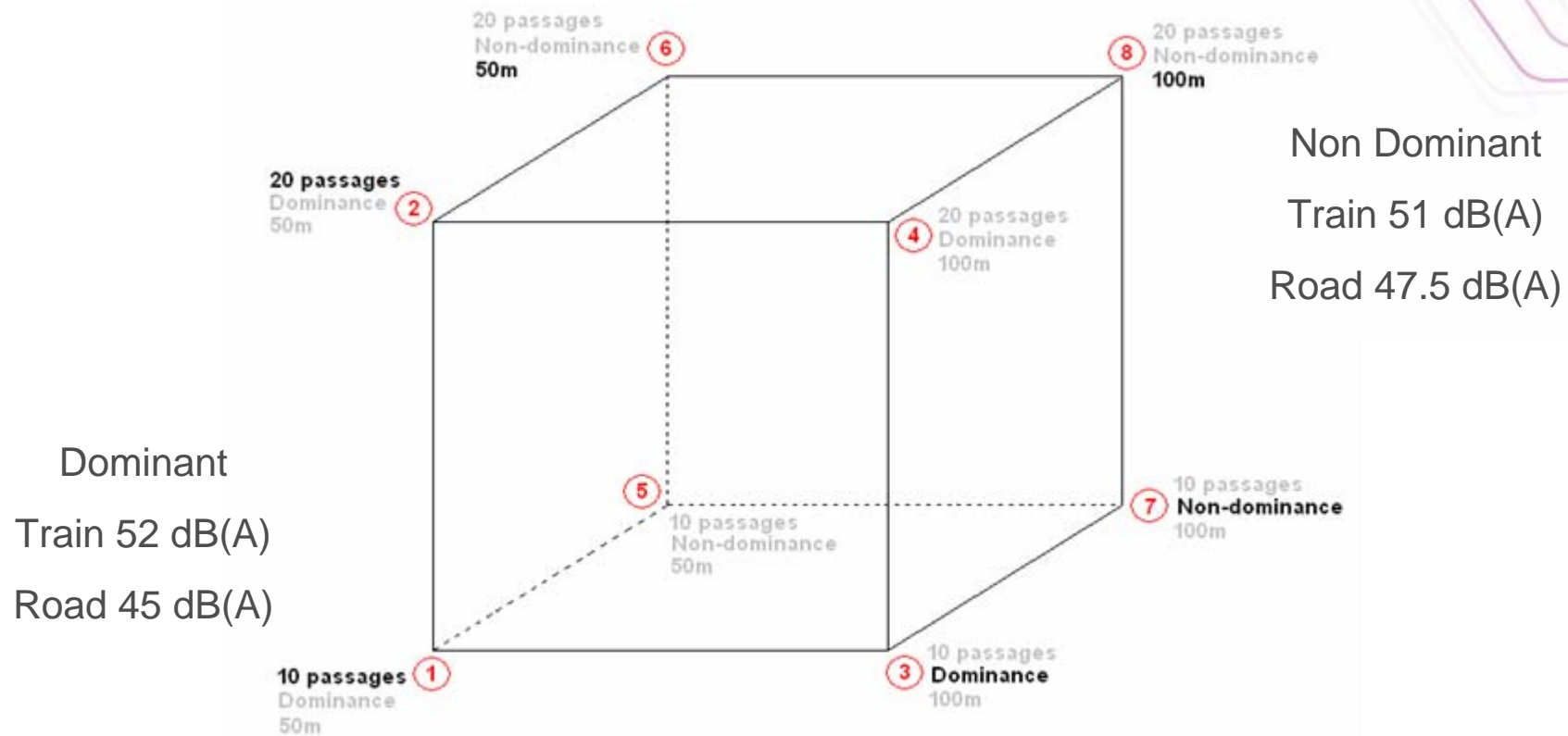
- Objectives
  - To provide sound samples to expose people in the laboratory to the railway noise
  - To show several temporal structure properties of train pass-by
- Methodology
  - State of the art of existing situations
    - Distances to the track : urban areas (50m / 100m)
    - Train speed : commercial speed (~100 km/h)
    - Train type : Corail, fret, regional train, high speed train
    - Composition : axle/bogie, cast iron brake blocks, K blocks, EMU, DMU, ...
  - Definition of scenarios
    - Number of trains : mean value of the main lines near acoustic « hot spots » (and « 2 x »)
    - Composition : representative of existing traffic (database)
  - Recording of sound samples
  - Definition of the filter corresponding to the windows (French and German windows)



# WP2 - Perception of sound events in urban context

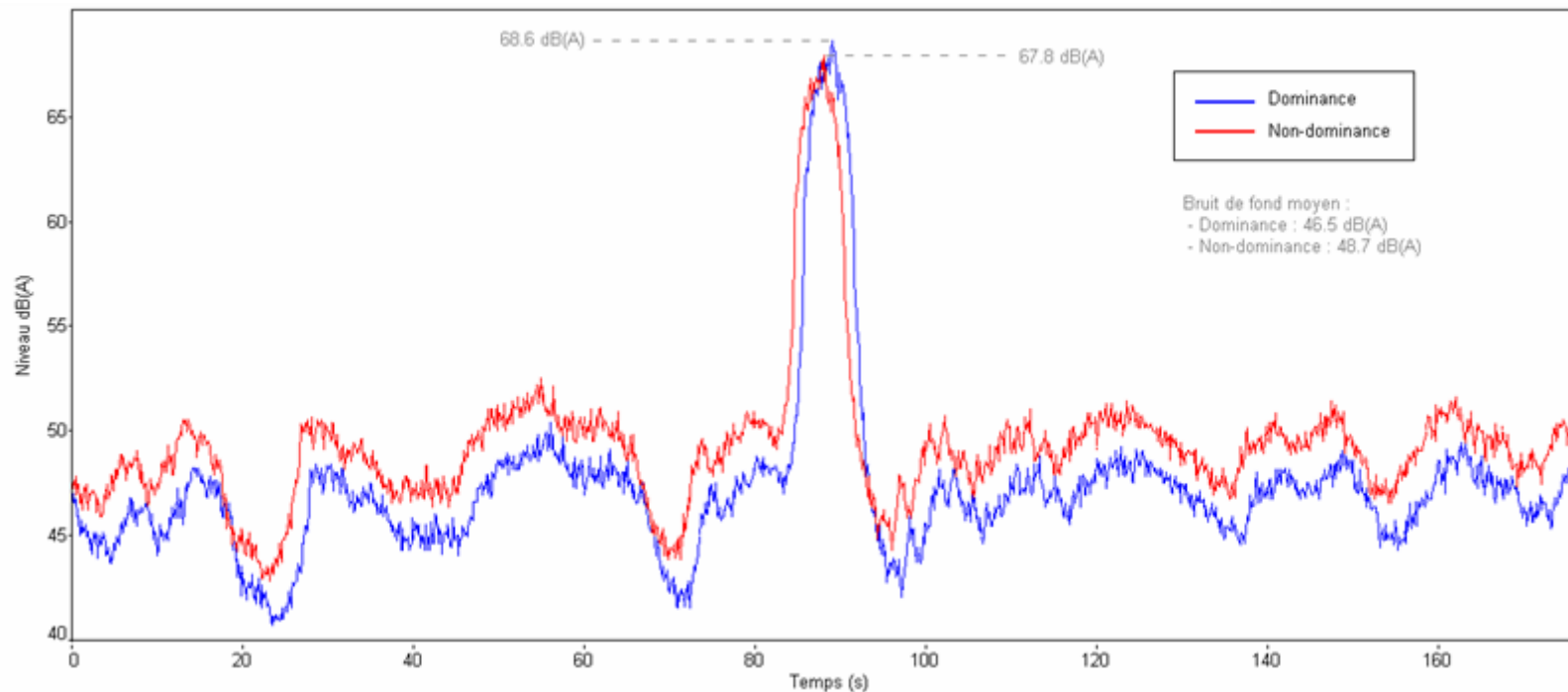
- Objectives
  - To evaluate the influence of scenario parameters on annoyance and performance in a multi exposure context
- Methodology
  - People are sitting in a laboratory in front of a picture of an open window during 1 hour
  - 6 scenarios are presented
    - Dominance / Non dominance of the railway noise into the continuous road noise (continuous flow of cars)
    - 10 or 20 train pass-bys
      - N1 = 10 pass bys = 6x Corails + 2x Fret + 1x TER + 1x TGV
      - or
      - N2 = 20 pass bys = 12x Corails + 4x Fret + 2x TER + 2x TGV
    - at 50m or 100m far from the track (very close !)

# WP2 - Perception of sound events in urban context



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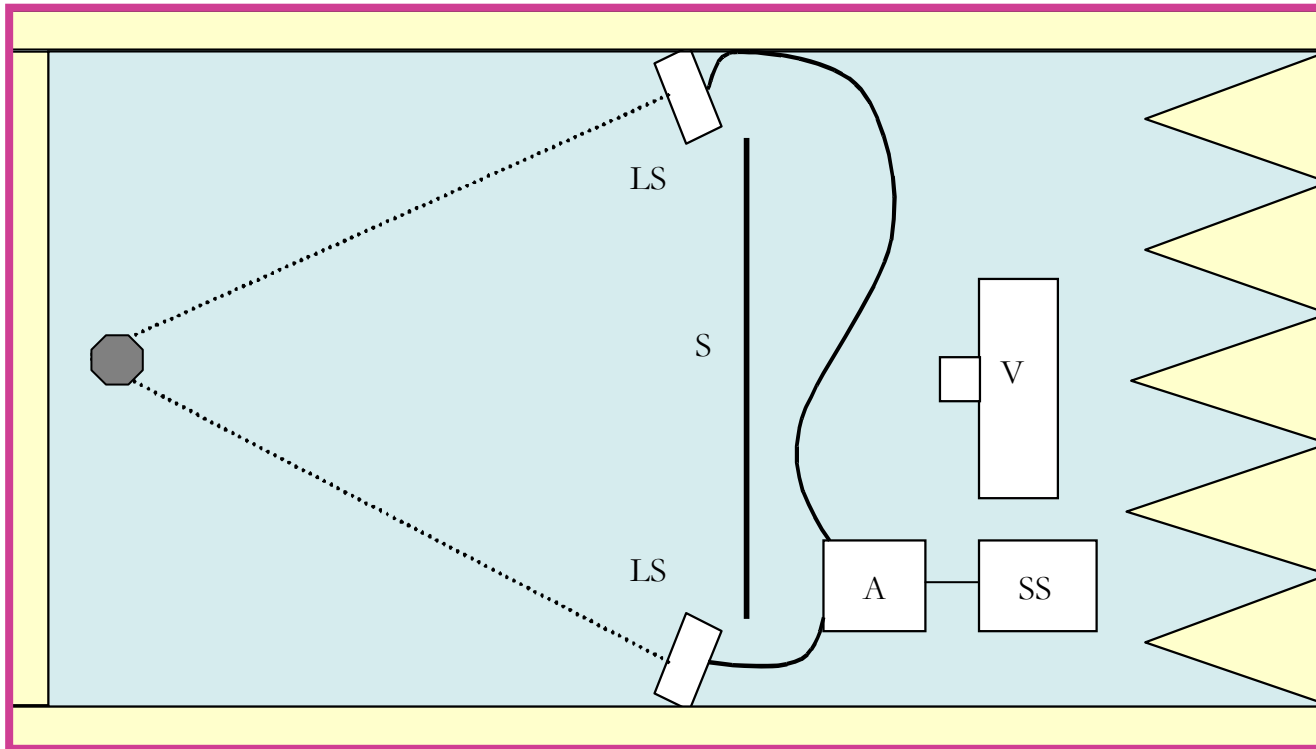
- Sound samples are equalized in regard to LAeq(1 hour)
- LAeq = 53 dB(A) inside the room with tilted window (attenuation of 11 dB(A) compared to outdoor sound environment)
- Time signals of 2 scenarios





# WP2 - Perception of sound events in urban context

- Room equipment



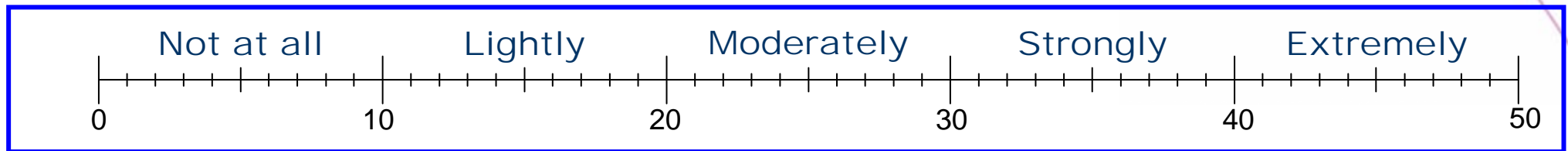
V = Vidéo - projector  
SS = Stereo Signal  
A = Amplificator  
LS = Loudspeakers  
S = Screen

● = Subject



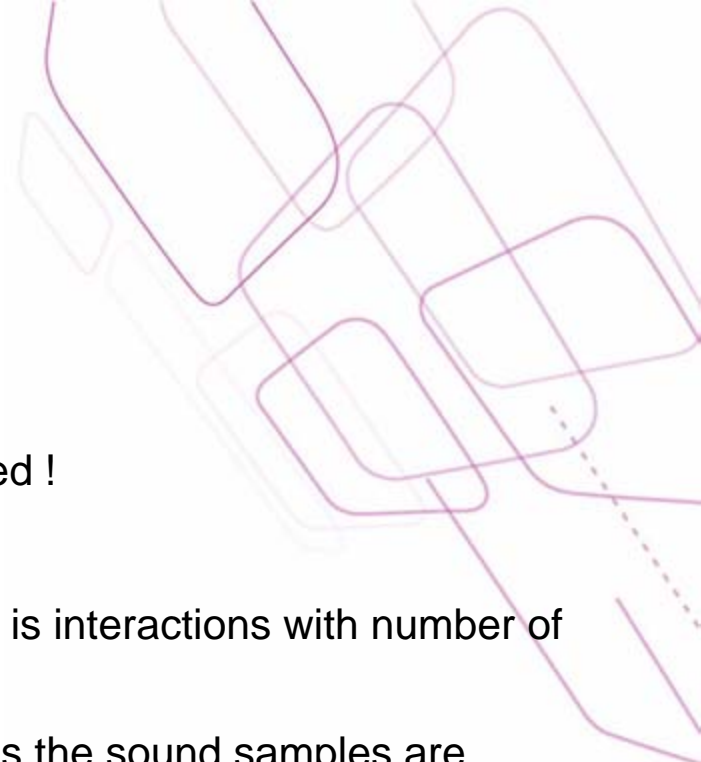
## WP2 - Perception of sound events in urban context

- The task to be achieved is reading (comic books)
- Each subject evaluates only one situation and estimates the annoyance to achieve the task



- The subjects estimates the number of events

# WP2 - Perception of sound events in urban context



- Main results

- ➔ When the number of trains is higher (20 / 10), people are less annoyed !

- ➔ When railway noise is dominant, people are more annoyed, but there is interactions with number of trains and distance to the track

When railway noise is dominant, people focus on events (pass-by). As the sound samples are equalized, pass-by levels decreases when number of pass-bys increases which can reduce the annoyance.

- ➔ In non dominant situation of the railway noise, people don't focus on events (they strongly underestimated the number of events). They focus on background noise which is amplified by forgotten trains.

- ➔ The fact that a sound is associated to an event depends on the context

Cars are events in markets or parks / Cars are not events along a road (they are part of the road)

Trains are events in dominant situations / Trains are not events in non dominant situations

# WP3 - Sleep disturbance

- Objectives
  - To evaluate the effects of the temporal structure of railway noise on sleep and cognitive performance
  - To study the effects of nocturnal railway noise on waking EEG and cognitive performance
    - in young and middle-aged adults,
    - living for many years either near a railway track or in a quiet area
- Methodology
  - 40 people living near railway lines or in quiet area stay one week in the laboratory
  - A pilot study with candidates is organized at home (measurement during 3 nights)
  - Laboratory study :
    - 1 habituation night
    - 3 experimental nights
    - the following day
  - Two scenarios
    - Moderate traffic density : 30 trains per day
    - High traffic density : 60 trains per day



## WP3 - Sleep disturbance

- Main results

➔ Several markers are in favor of a greater sensitivity of young people to nocturnal railway noise disturbances :

- Their cardiac and most of all vascular reactivity to noise is very enhanced compared to juniors living in quiet areas (hypersensitivity)
- They show higher “slow wave power density” during the day than seniors
- Subjective complaints about noise are higher in juniors than in seniors.
- Juniors living near a railway show higher % errors in the PVT than any other subjects.

➔ Nocturnal freight is not free of negative effects on health, especially in young people.

➔ However, if we consider railway as more ecological, special equipments to reduce the noise of the global system should be provided especially in living areas. Limitation of nocturnal traffic can be also considered.

## WP3 - Sleep disturbance

- The LMRTE studied the sound quality of the train pass-by and their influence on functional discomfort
  - The LINC analysed the effect of night train noise on sleeping pattern, cognitive performances and repercussions on the cardiovascular sphere
  - The SNCF supplied traffic data to define the most representative scenarios of real current and future situations, and brought its railway expertise in the implementation of methodologies and contributed to discussions on the results analysis
- ➔ **The German laboratories have also been worked on all the transport noise: road, aircraft and railway noise. Their work makes it possible to compare and takes into perspective the relative effects of each mode of transport.**

# Conclusion

- Night train noise have little effect on the sleeping pattern and the cognitive performances the next day, but that permanent exposure to night train noise produces adverse effects
- ➔ **In general, train noises, while being generally considered as harmless or relatively ecological, present nonetheless all the effects that will have to be taken into consideration if we want to develop railway freight further**
- A such study had never been carried out until now on the railway noise, in partnership with laboratories and railway operators



Thank you for your attention..

This project comes within the scope of a DEUFRAKO cooperation (Noise Group) and is subsidised by the ADEME, for the French part.

We would like to thank in particular all the partners involved in the project and the persons who took part in the experiments and made the realisation of these studies possible.