B Griefahn, PE Gautier, K Degen, J Hellbrück, C Lavandier, A Samel, P Tassi

RAPS

Railway noise (and other modes)
Annoyance Performance Sleep

Munich, 27.10.10

deufrako

Temporal structure of traffic noise

Workpackages 1/4: Acoustics, simulation/modelling

- Pierre-Etienne Gautier (SNCF)
- Karl G. Degen (DB AG)

Workpackage 2: Annoyance and Performance

- Cathérine Lavandier (Université de Cergy Pontoise)
- Jürgen Hellbrück (Catholic University Eichstätt-Ingolstadt)

Workpackage 3: Sleep disturbances

- Alexander Samel (DLR)
- Barbara Griefahn (*IfADo*)
- Patricia Tassi (CNRS – CEPA)

Workpackage 2: Cognitive performance

Macro- and micro-structures of railway noise and cognitive performance during work

Workpackage 3: Sleep disturbances

<u>Task 3.0:</u> Agreement on design and methods

<u>Task 3.1:</u> Railway noise, sleep, performance, age (CNRS)

<u>Task 3.2:</u> Effect-oriented weighing of traffic noise

- Meta-analysis (aircraft, rail, road, DLR)

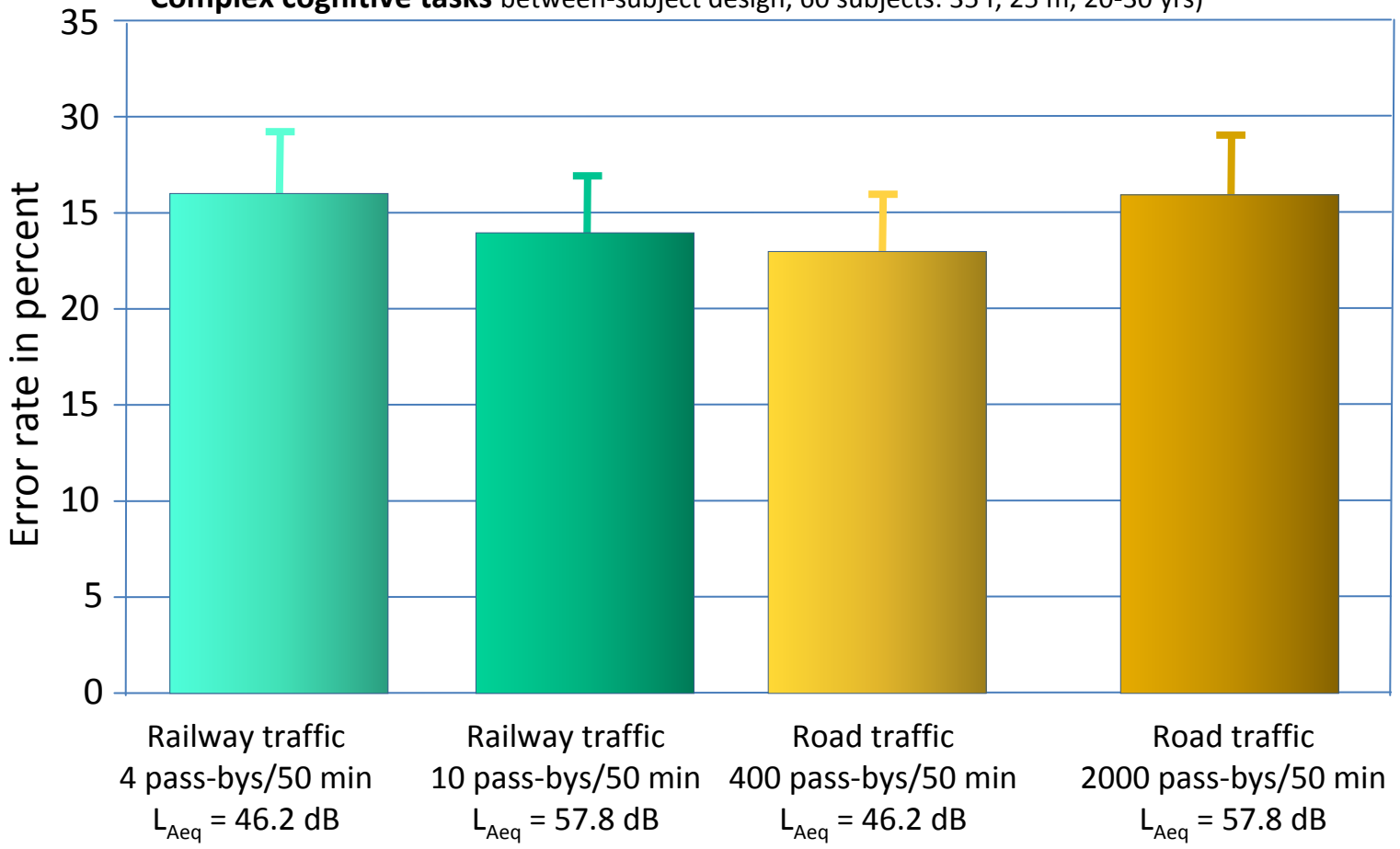
- Lab: Rail & road scenarios (*IfADo*)

- Field: Rail & road noise (DLR)

Comparison between traffic modes

Task 2.2: Cognitive performance

Traffic volume (within-subject design, 40 subjects: 26 f, 14 m, 21-40 yrs), 4 h
Complex cognitive tasks between-subject design, 60 subjects: 35 f, 25 m, 20-30 yrs)

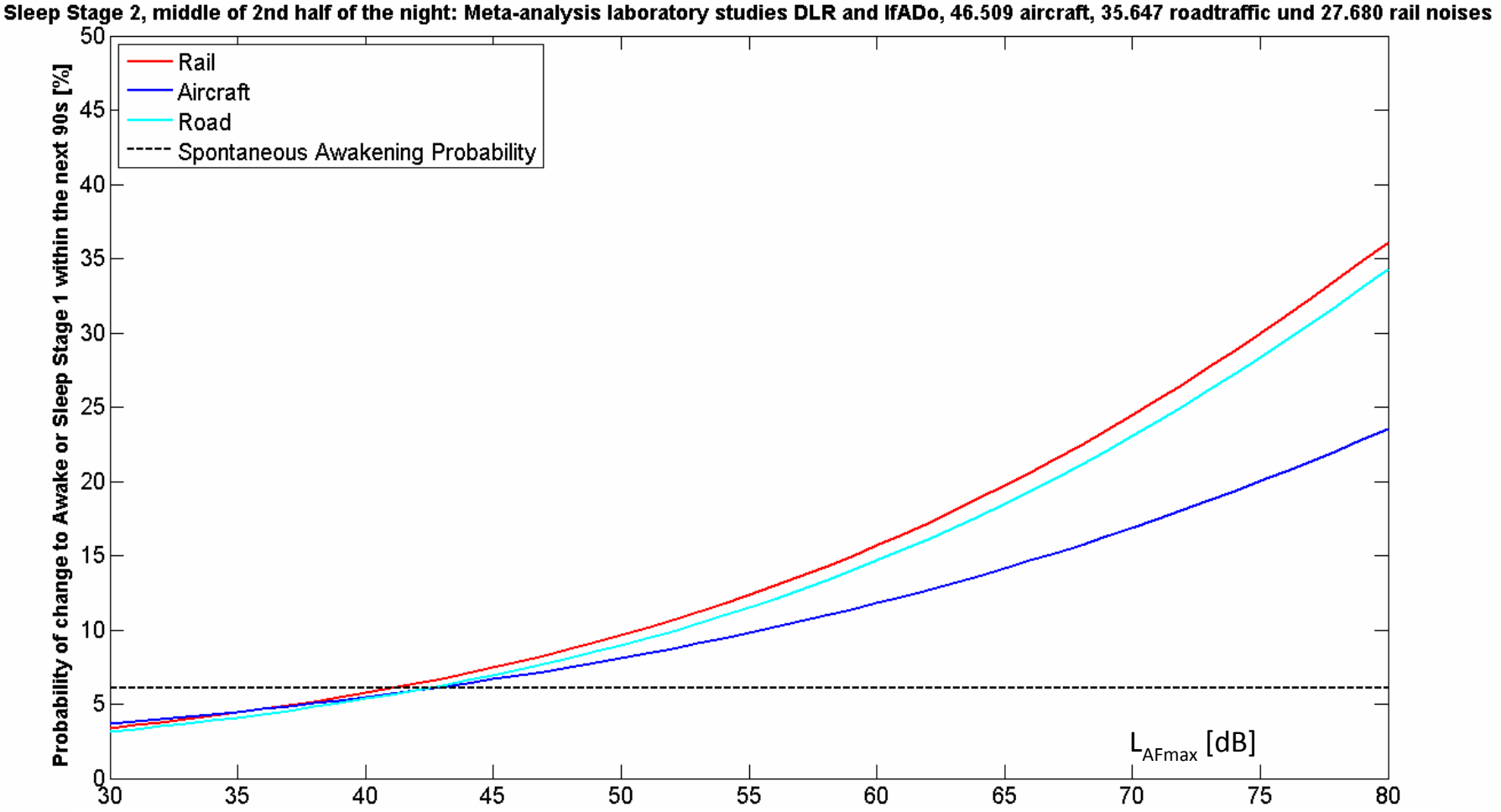


Annoyance: road > rail
Ability to concentrate under road traffic noise subjectively worse

KATHOLISCHE UNIVERSITÄT EICHSTÄTT INGOLSTADT

Comparison between traffic modes

Task 3.2: Effect-oriented weighing of traffic noise
Meta-analysis (aircraft, rail, road, DLR)



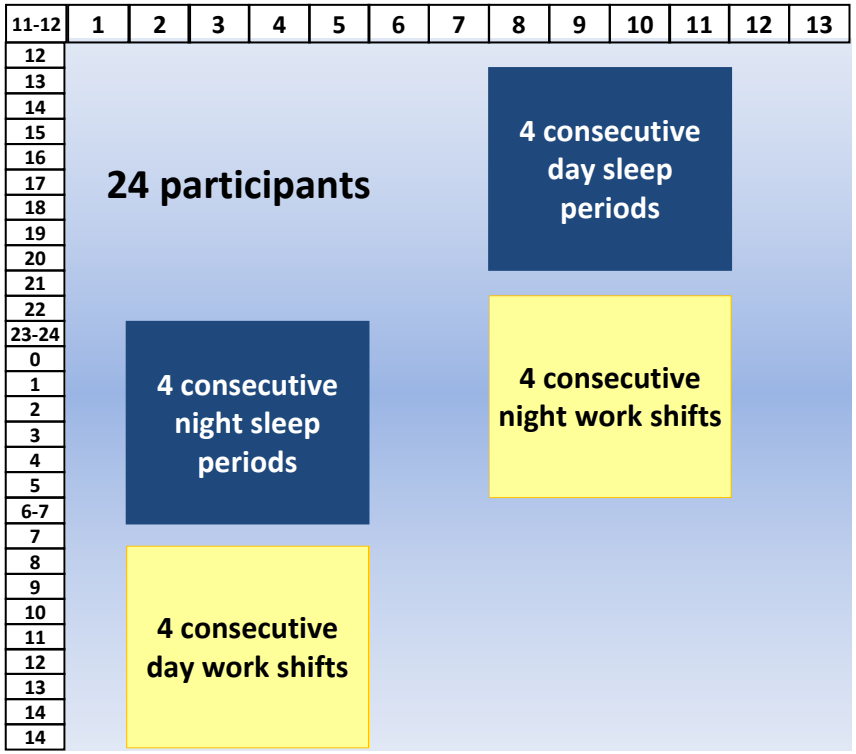
Meta-analysis on the basis of studies performed at DLR and ***IfADo*** with a total of 336 participants and 3808 nights (192 rail-, 192 road-, 1656 air traffic, 1256 quiet)

DLR

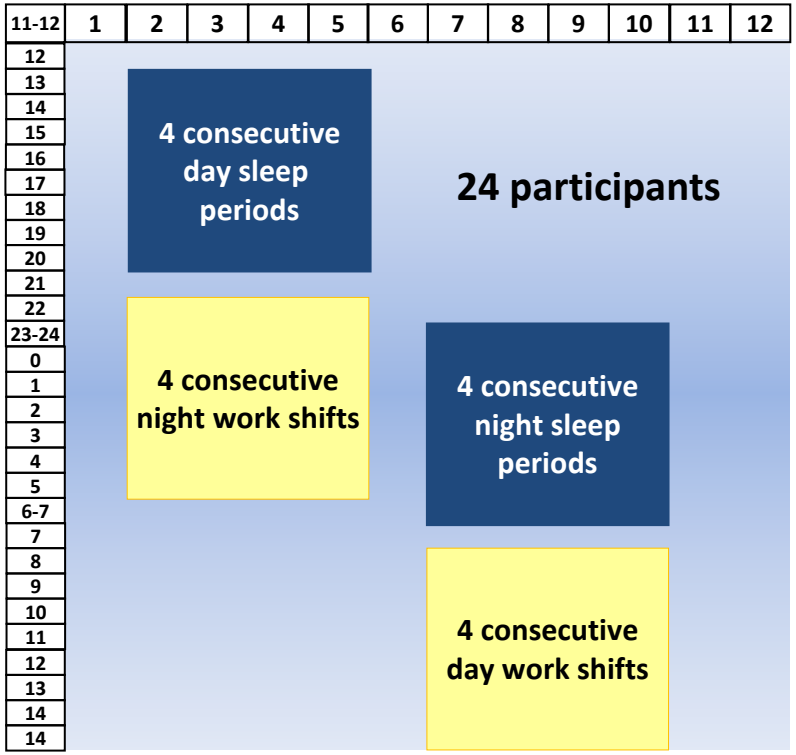
Comparison between traffic modes

Task 3.2: Laboratory – Experimental design (*IfADo*)

4 night sleep – day sleep periods
then 4 day sleep – night sleep periods



4 day sleep – night sleep periods
then 4 night sleep – day sleep periods



Traffic noise scenarios (8h)

Railway traffic

20 pass-bys: L_{Aeq} – 42-45 dB
40 pass-bys: L_{Aeq} – 46-54 dB
58 pass-bys: L_{Aeq} – 51-54 dB

Road traffic noise

1 300 pass-bys: L_{Aeq} – 42-43 dB
4 300 pass-bys: L_{Aeq} – 41-49 dB
8 600 pass-bys: L_{Aeq} – 49-56 dB

Railway bonus

Railway traffic

40 pass-bys: L_{Aeq} = 49.4 dB

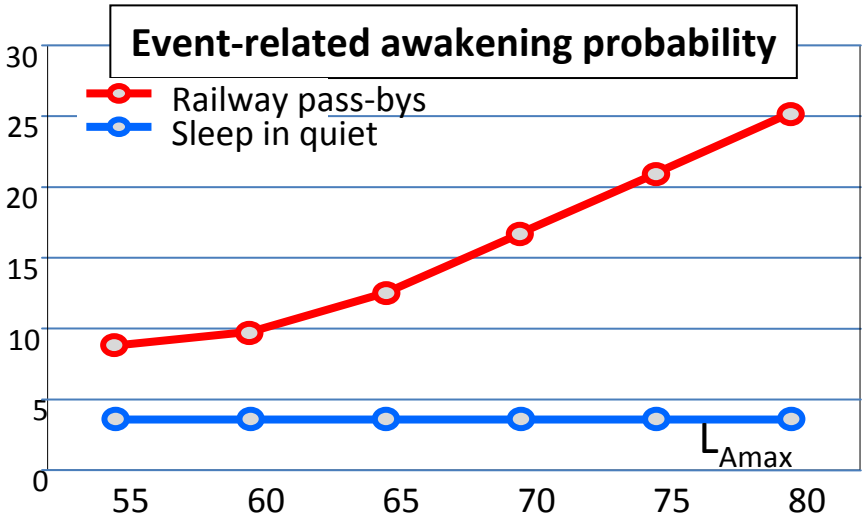
Road traffic noise

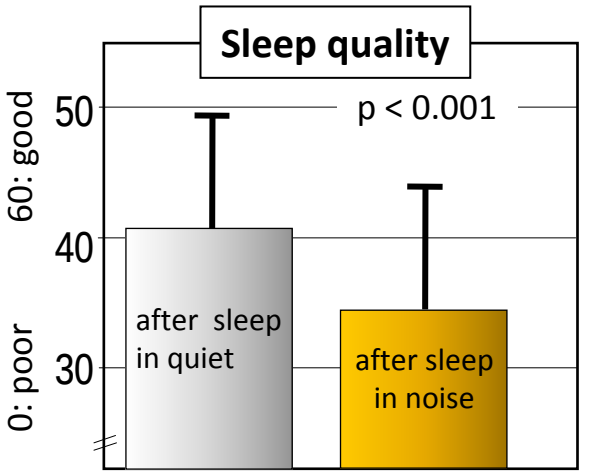
4 300 pass-bys: L_{Aeq} = 44.6 dB

IfADo

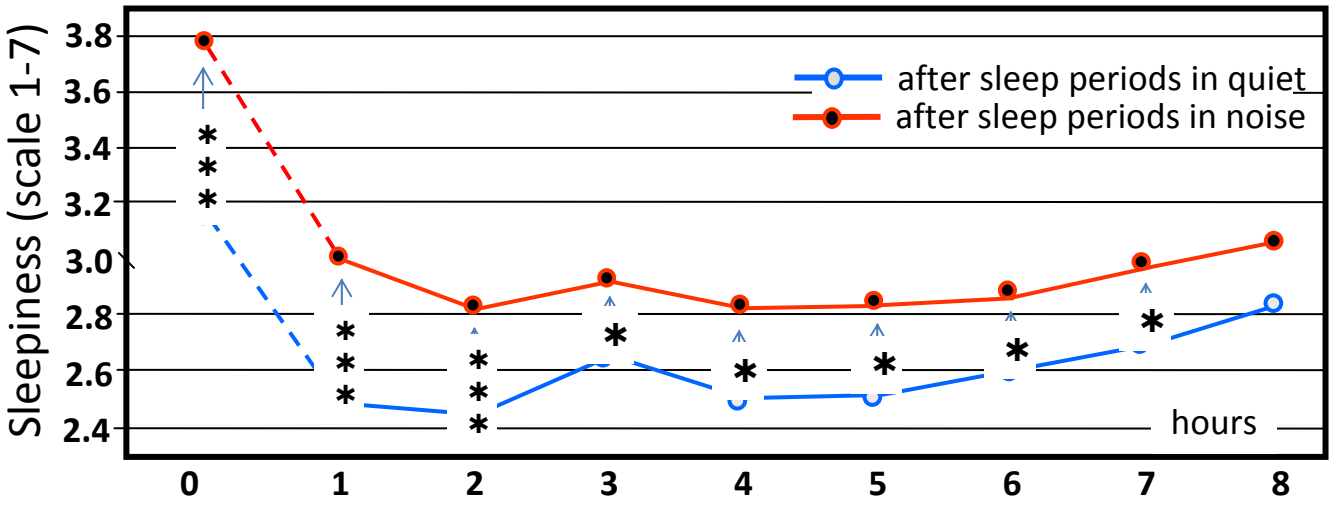
Comparison between traffic modes

Task 3.2: Laboratory – Subjective evaluation (*IfADo*)





Sleepiness during work shifts after sleep in quiet and in noise



IfADo

Comparison between traffic modes

Task 3.2: Laboratory – Effects of noise on sleep structure and evaluation (*IfADo*)

Total sleep period, physiologic measures

Sleep period time (SPT)
449.2 min
445.4 min

Total sleep time (TST)
417.0 min
409.7 min

Intermittent wakefulness (WASO)
32.2 min
35.7 min

Total number of wake periods
20.2
19.0

Slow-wave-sleep (SWS)
60.9 min
61.7 min

REM-sleep (SPT)
109.3 min
107.4 min

Sleep efficiency-Index (SEI)
0.93
0.93

Sleep disturbance-Index (SDI)
0.01
0.02

1st sleep cycle

Sleep latency (SOL)
13.4 min
12.8 min

Latency to slow-wave-sleep (SWSL)
22.8 min
17.9 min

Slow-wave-sleep (SWS)
24.6 min
29.1 min

REM-sleep
20.8 min
19.4 min

Subjective evaluation

Sleep quality (SSQ)
32.9
35.9

Sleepiness (KSS)
4.0
3.5

Rail traffic noise, L_{Aeq} = 49.4 dBA
Road traffic noise, L_{Aeq} = 44.6 dBA

IfADo

Comparison between traffic modes

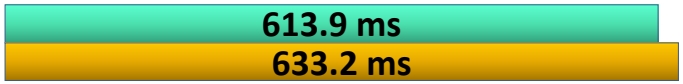
Task 3.2: Laboratory – Sleepiness and performance during work shifts (*IfADo*)

Sleepiness during work shifts

Performance during work shifts

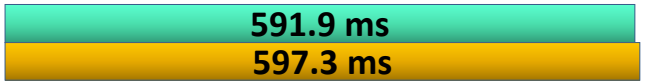
Reaction times

Selective attention (Go-/Nogo)

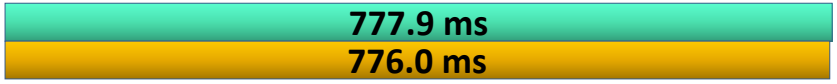


Divided attention auditive (GETAa)

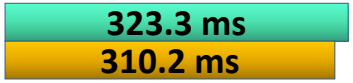
Divided attention visual (GETAv)



Working memory(ARGE)



Psychomotor vigilance Test (PVT)



Error rates

Go-/Nogo

GETAa

GETAv

ARGE

IfADo

Rail traffic noise, L_{Aeq} = 49.4 dBA
Road traffic noise, L_{Aeq} = 44.6 dBA

Comparison between traffic modes

Task 3.2: Field study – Acoustic conditions (DLR)

Location ‘Rheinschiene‘ Köln - Koblenz
Participants 22 female, 11 male, 22-68 yrs (1 >50 yrs), min bedtime 00:00 - 6:00 h
Design 9 consecutive nights each, measures over all the year (season)
Recordings PSG, FPA, ECG, annoyance, SQ, SRT, RR

Number of traffic noise events

- Freight trains: 9.476 „undisturbed“ + 2.360 „disturbed“
- Passenger trains: 3.294 „undisturbed“ + 899 „disturbed“
- Road traffic: 7.365 „undisturbed“ + 1.822 „disturbed“

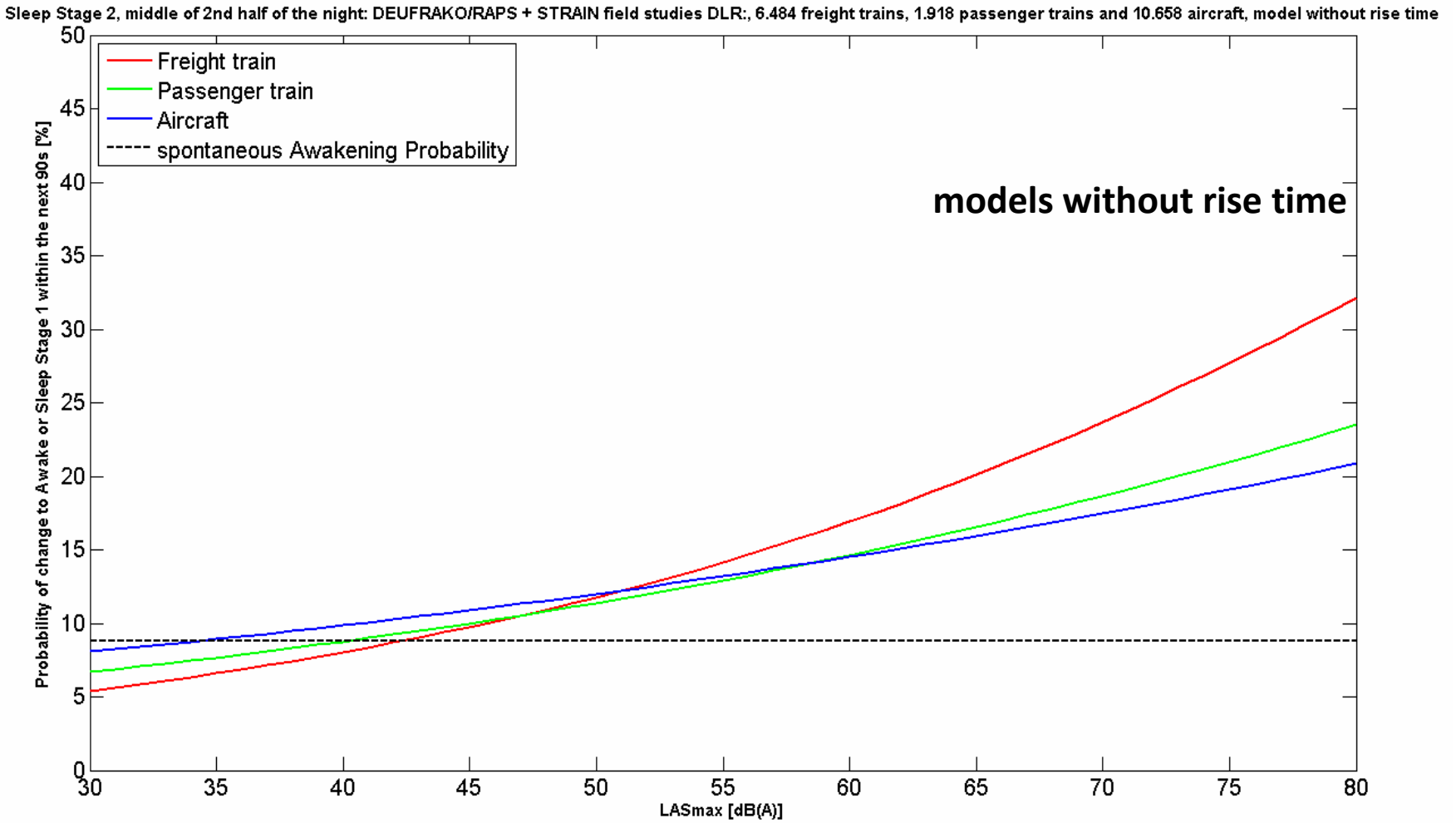
Time length of noise events: Median (25. | 75. percentile)

- Freight trains: 65.2 s (49.6 s | 85.1 s)
- Passenger trains: 29.4 s (23.6 s | 38.3 s)

DLR

Comparison between traffic modes

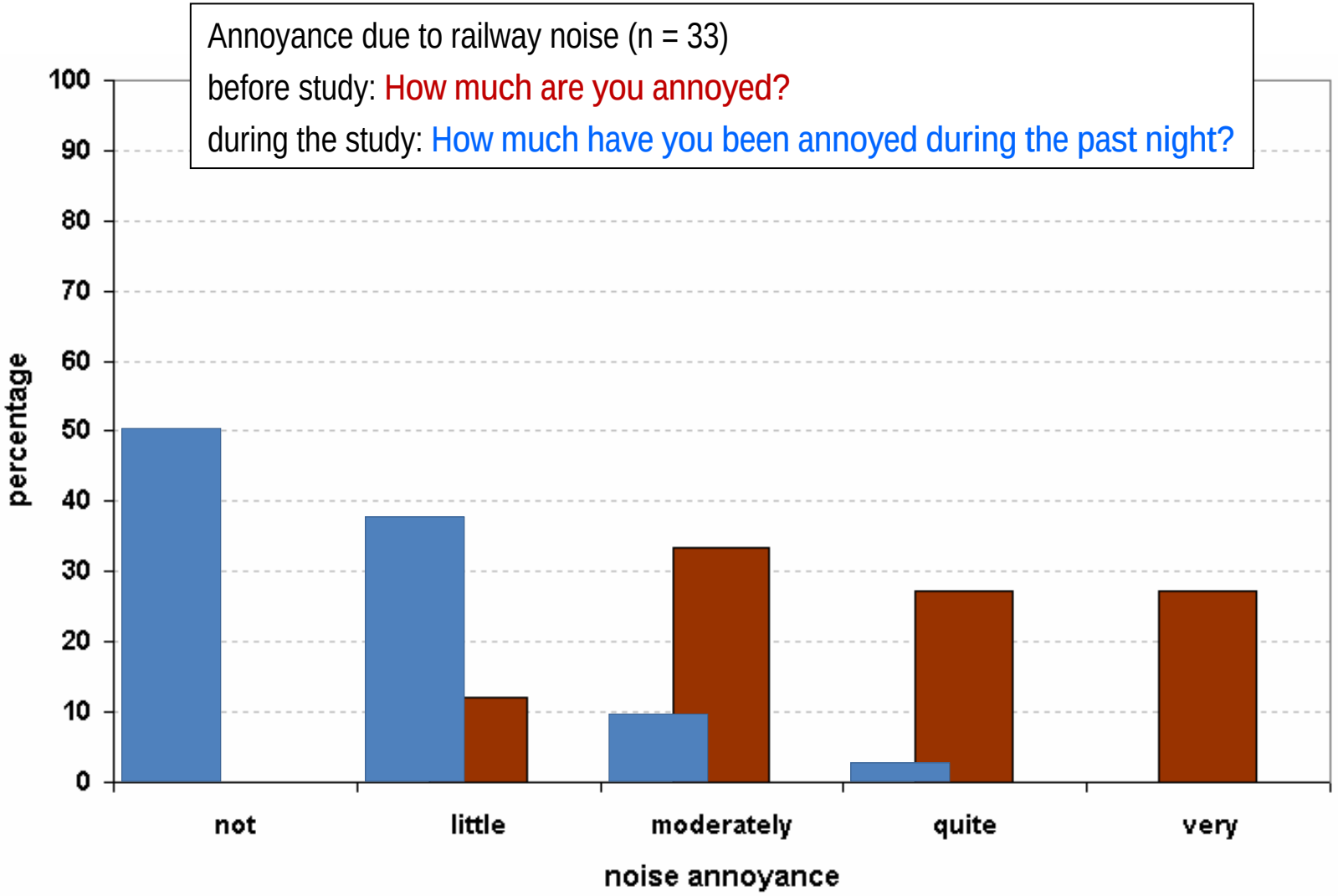
Task 3.2: Field study – Event-related awakenings (DLR)



DLR

Comparison between traffic modes

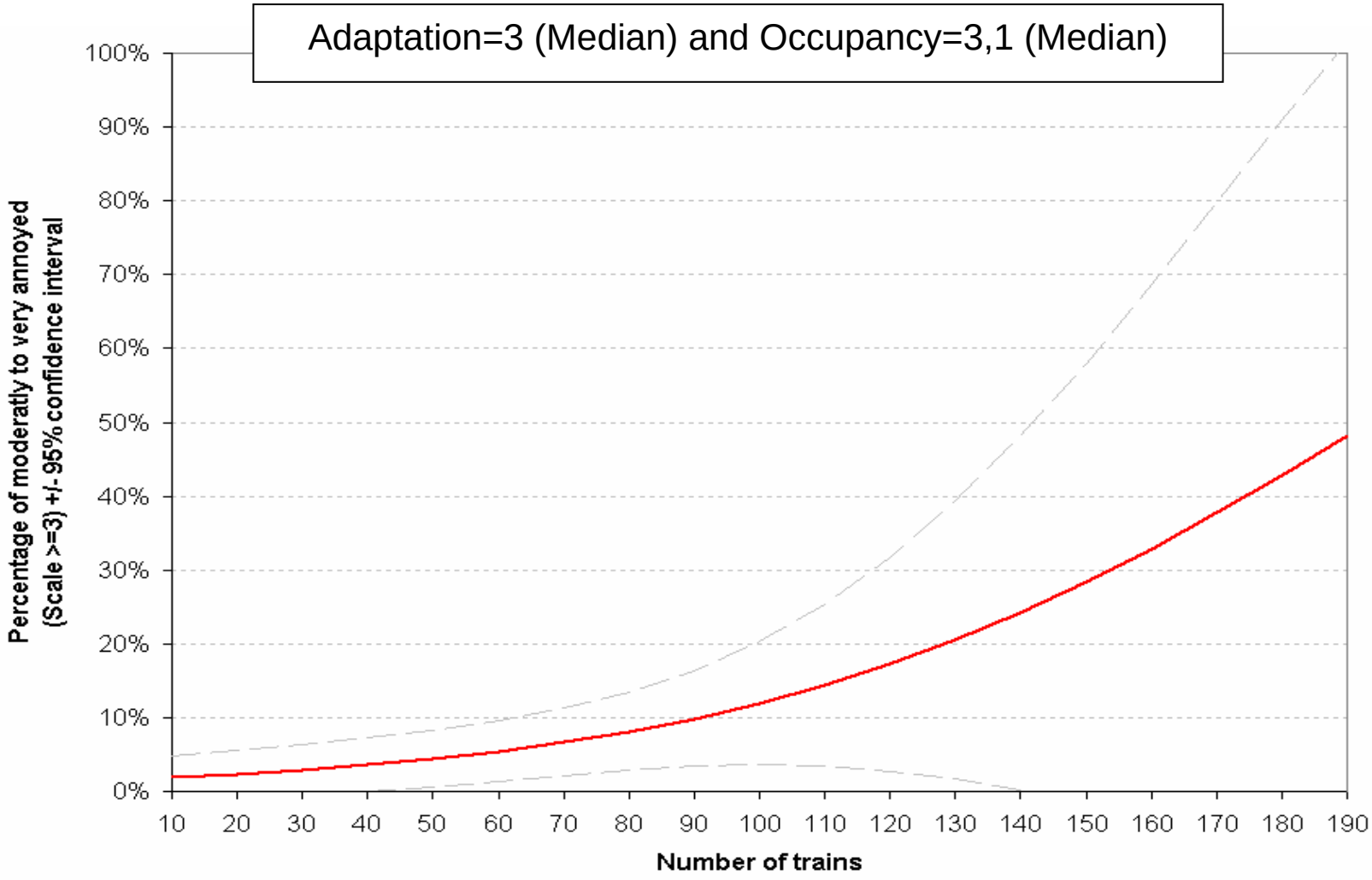
Task 3.2: Field study – Noise annoyance (DLR)



DLR

Comparison between traffic modes

Task 3.2: Field study – Noise annoyance (DLR)



DLR

Railway noise: carbon composite brakes

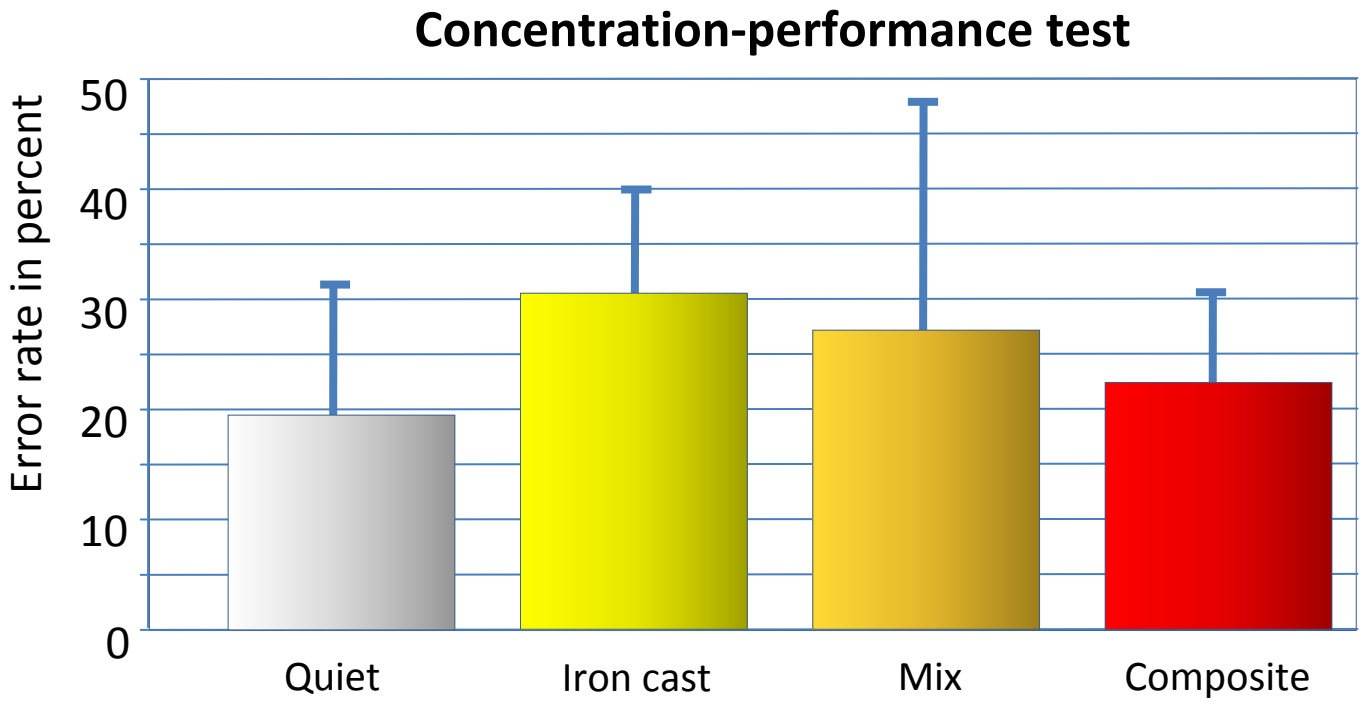
Task 2.2: Composite brakes – Cognitive performance (KUEI)

Task 2.2: Cognitive performance (KUEI)

10 pass-bys / 50 min (within-subject design, subjects: 19 f, 1 m, 20-30 yrs), 2 h

Quiet	Iron cast brakes	Mixed brakes	Carbon composite
L_{Aeq} = 24 dB	L_{Aeq} = 71 dB	L_{Aeq} = 69 dB	L_{Aeq} = 65 dB

Concentration-performance test CarbonC > IronC (Serial recall, grammatical reasoning no effect)



KATHOLISCHE UNIVERSITÄT EICHSTÄTT INGOLSTADT

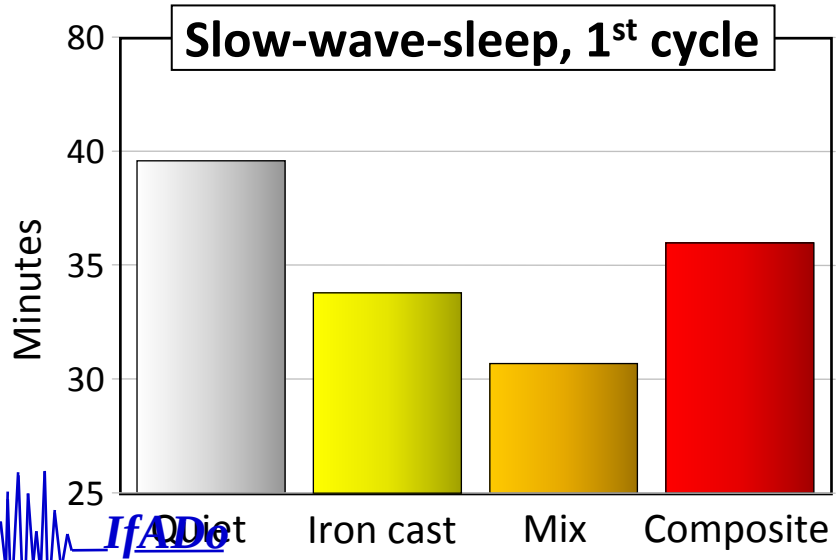
Railway noise: carbon composite brakes

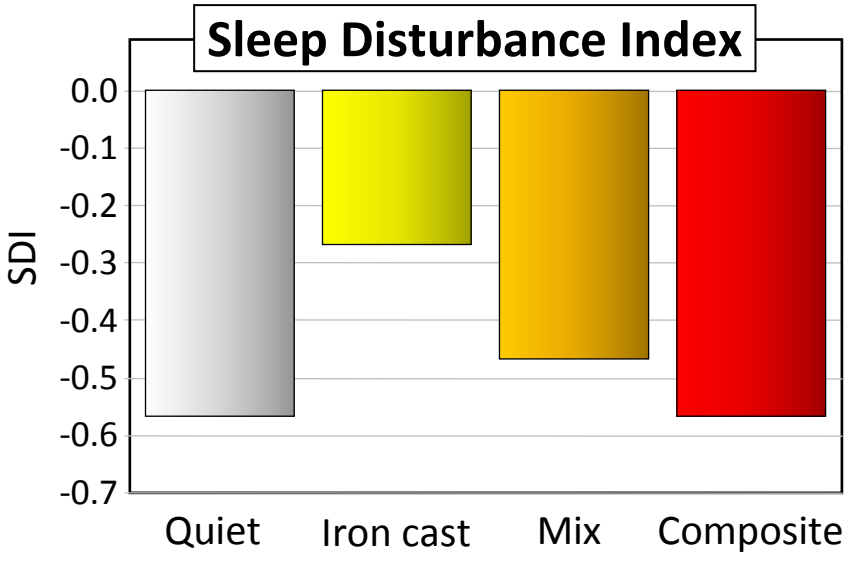
Task 3.3: Composite brakes – Effects on sleep (*IfADo*)

Task 3.3: Sleep (*IfADo*)

quiet, 20, 40, 80 pass-bys / 8h (within-subject design, subjects: 6 f, 6 m, 18-26 yrs)

1st week					2nd week				3rd week			
Sun	Mon	Tue	Wed	Thu	Mon	Tue	Wed	Thu	Mon	Tue	Wed	Thu
Quiet	Iron cast brakes (L_{AFmax}: 73.4 dB)				Mixed brakes (L_{AFmax}: 65.4 dB)				Carbon composite brakes (L_{AFmax}: 73.1 dB)			
	20	40	80	Quiet	20	40	80	Quiet	20	40	80	Quiet



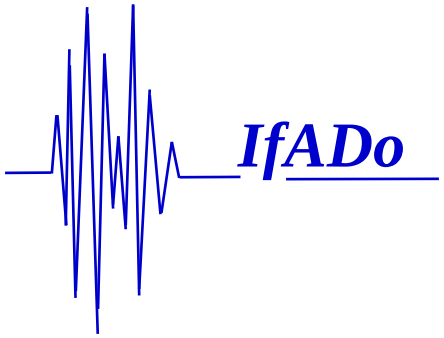


IfADo

Conclusions and recommendations

- Enforce noise abatement
- Enforce installation of carbon composite brakes
- Railway bonus
  - concerning daytime – supported
  - concerning sleep disturbances still questionable

KATHOLISCHE UNIVERSITÄT EICHSTÄTT INGOLSTADT



DLR