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Acoustics II

Acoustic Virtual Reality

Reto Pieren

2024

Acoustic Virtual Reality

- Definition?
  - About the creation of immersive digital environments allowing for simulated audible experiences
- Gained topicality in recent years
  - → availability of commercial VR tools (hardware and software)

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Acoustic Virtual Reality

- Immersion = Perception of being physically present in a non-physical world

- High plausibility → high immersion
- High immersion → high plausibility
  - Realistic sounds, no audible artefacts, stable source localization,…
  - Add visual cues → combination with visualisation
  - User interaction → at least head rotation

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Game engines

Game engines

- Cross-platform software development environments to build video games
- Rapid evolutions (current products: Unity, Unreal Engine)
- More and more used for other purposes like simulators and demonstrators (sports training, architectural design, learning, communication,…)

Game engines

- Focus on real-time image rendering

- Contain audio engine for real-time audio processing:
  - Handling of audio files
  - Audio modification/effects
  - Reproduction rendering
  - Playback of multichannel audio

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Game engines: Audio engine

- Processing of +100 audio signals simultaneously, but not very reliable
- User activity-based triggering of audio events

- Source modelling
  - «audio objects» with selectable and programmable functionalities
  - Basis of audio content: Source and ambience recordings
  - Typically no source directivity

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Game engines: Audio engine

- Propagation simulation:
  - Some propagation effects available, e.g. divergence, air absorption or generic reverbs
  - Different options for unphysical and sometimes physical models
  - Usually no propagation delay, no Doppler effect, no ground reflection,…

Game engines: Audio engine

- Mainly unphysical models being used in practice
- Why is 1/r divergence not preferred in video games?
  - Leading to low speech intelligibility at large distances to a virtual speaker
  - Amplitude never drops to zero → all sources always active
  - Large dynamic range: large level variations for slight back-and-forth movements at short distance to a source

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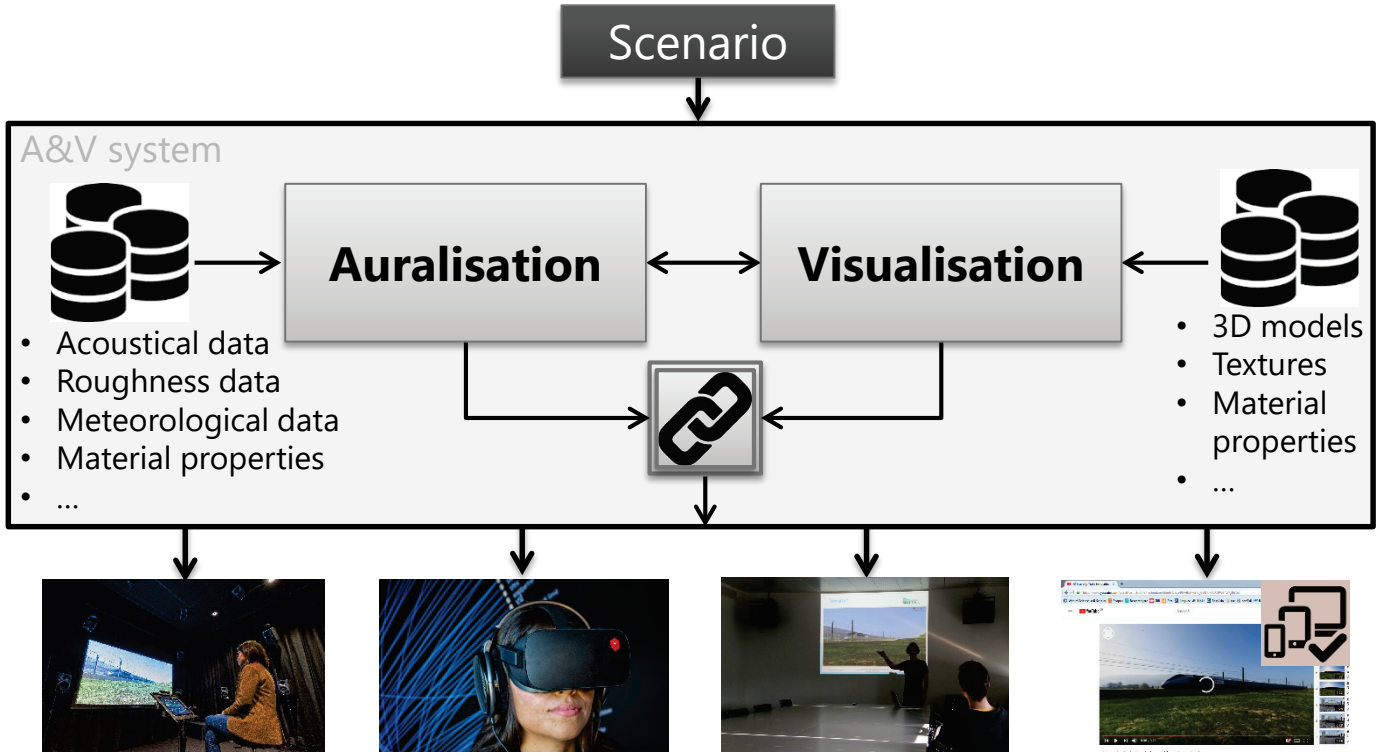
Game engines: Audio engine

- Spatial audio meanwhile very good and used:
  - Surround sound reproduction rendering for e.g. 5.1
  - Ambisonic decoding
  - Dynamic binaural for headphones with generic HRTFs

Example: Railway Noise Demonstrator

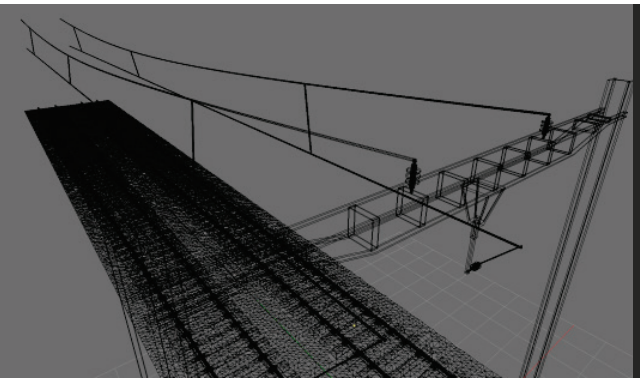
Example Railway noise demonstrator



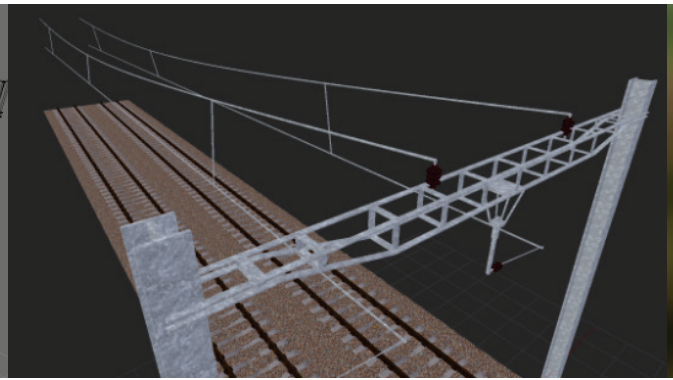
[Pieren, R. et al. (2018): Demonstrator for rail vehicle pass-by events. *Proceedings of Euronoise 2018*.]

Example Railway noise demonstrator: Visualisation process

- Creation of computer generated imagery (CGI) animations
- Use of 3D computer graphics software and a game engine



3D mesh



Textures

Bump maps & shading

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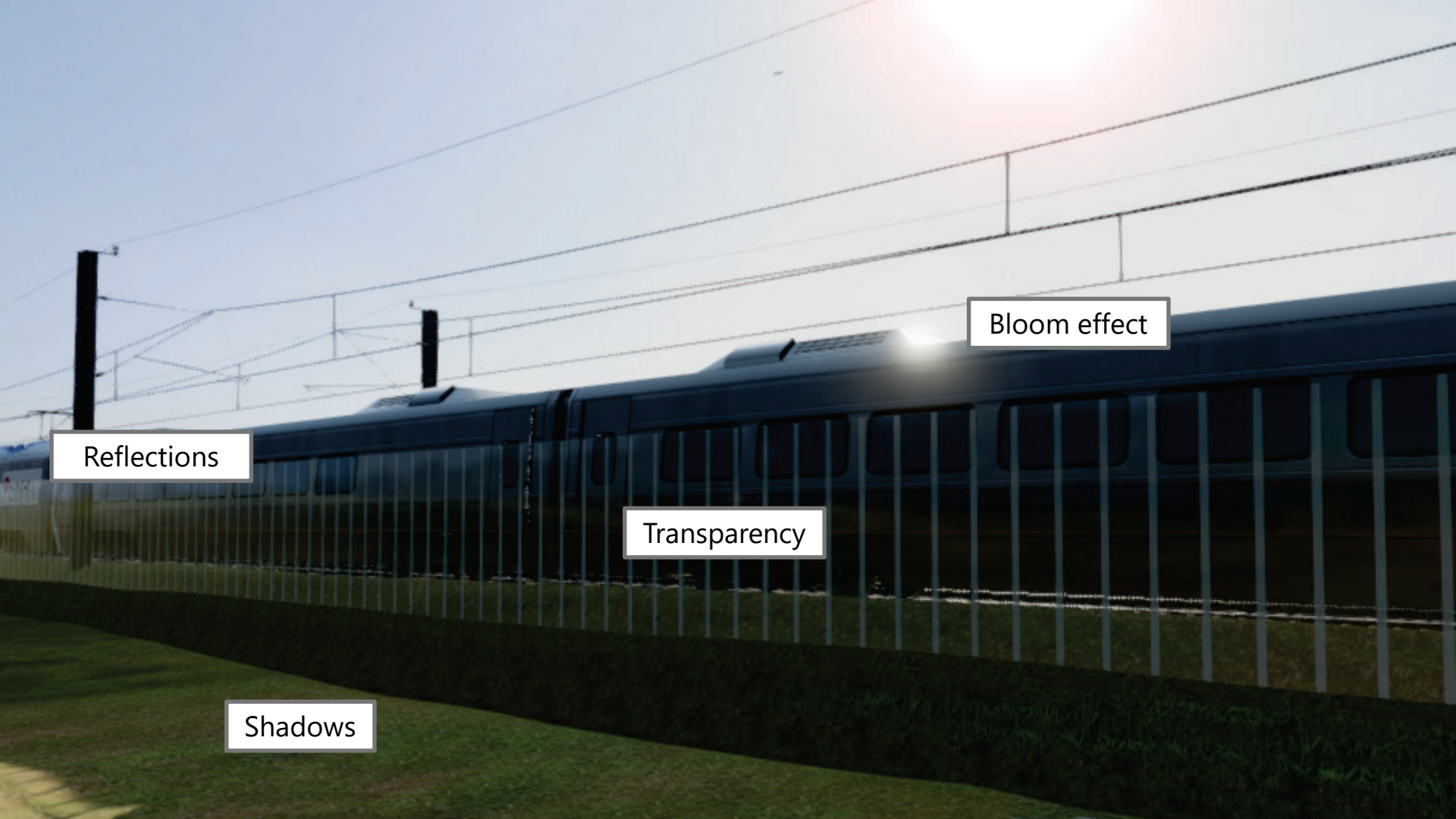
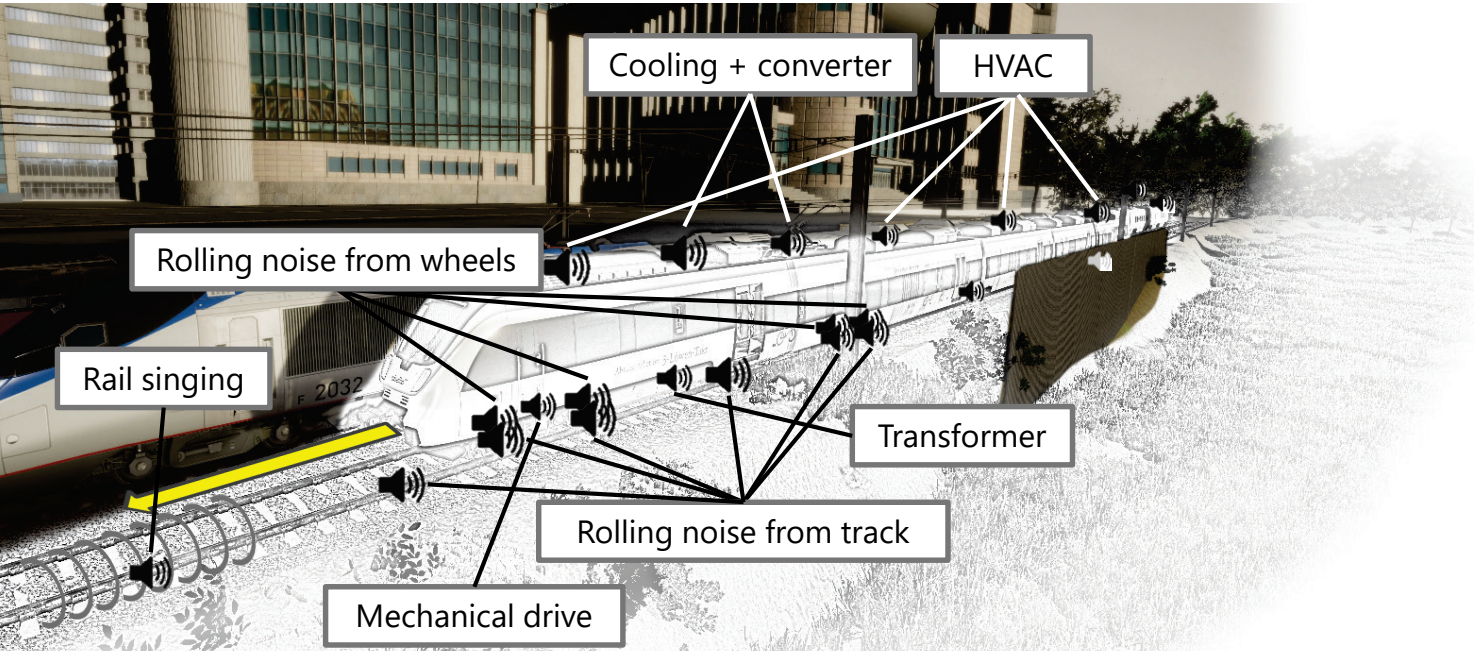

Bloom effect
Reflections
Transparency
Shadows

Example Railway noise demonstrator: Auralisation model



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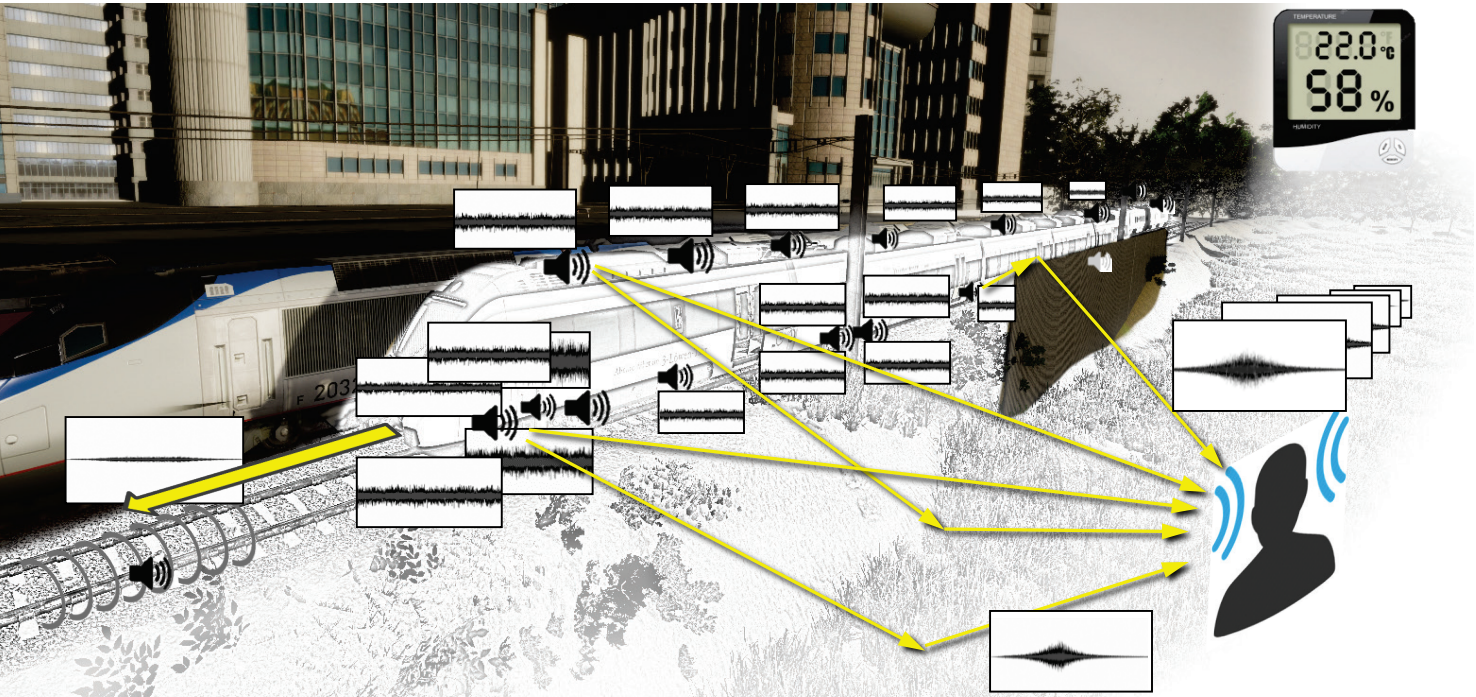
Example Railway noise demonstrator: Auralisation model



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oculus

Railway noise demonstration: Web-based sharing platform

YouTube CH

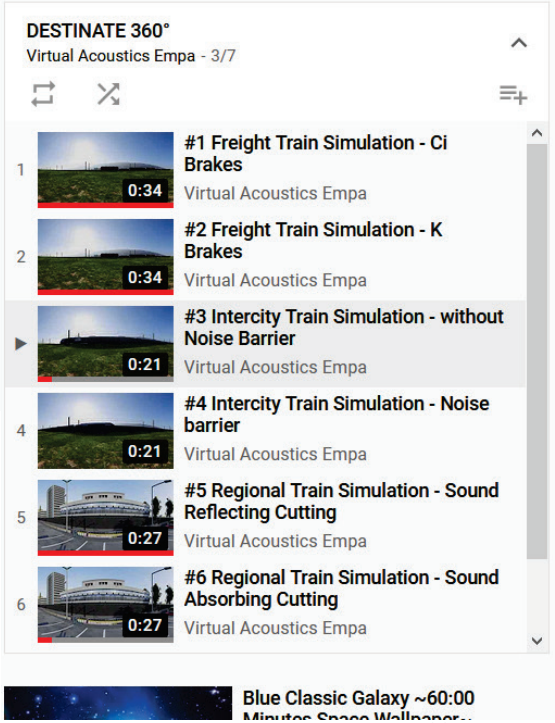
Empa Virtual acoustics

YouTube

YouTube channel:

Virtual Acoustics Empa

goo.gl/AK5Y7T



Examples from S²R project DESTINATE (2016-18)

- 360-degree spherical videos
- Dynamic binaural via 1st order Ambisonics
- Playback on smartphone, tablet, PC +headphones

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Simulation of Rail Vehicle Noise
using Sound and Image Synthesis

#2 Composite Brake Blocks (K)

Shift2Rail

DESTINATE

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Simulation of Rail Vehicle Noise
using Sound and Image Synthesis

#3 Intercity Train without Noise Barrier

Shift2Rail

DESTINATE

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Simulation of Rail Vehicle Noise
using Sound and Image Synthesis

#4 Intercity Train with Noise Barrier

Shift2Rail

DESTINATE

Railway line cutting: Multiple sound reflections and diffraction

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Simulation of Rail Vehicle Noise
using Sound and Image Synthesis

#5 Sound Reflecting Cutting

Shift2Rail

DESTINATE

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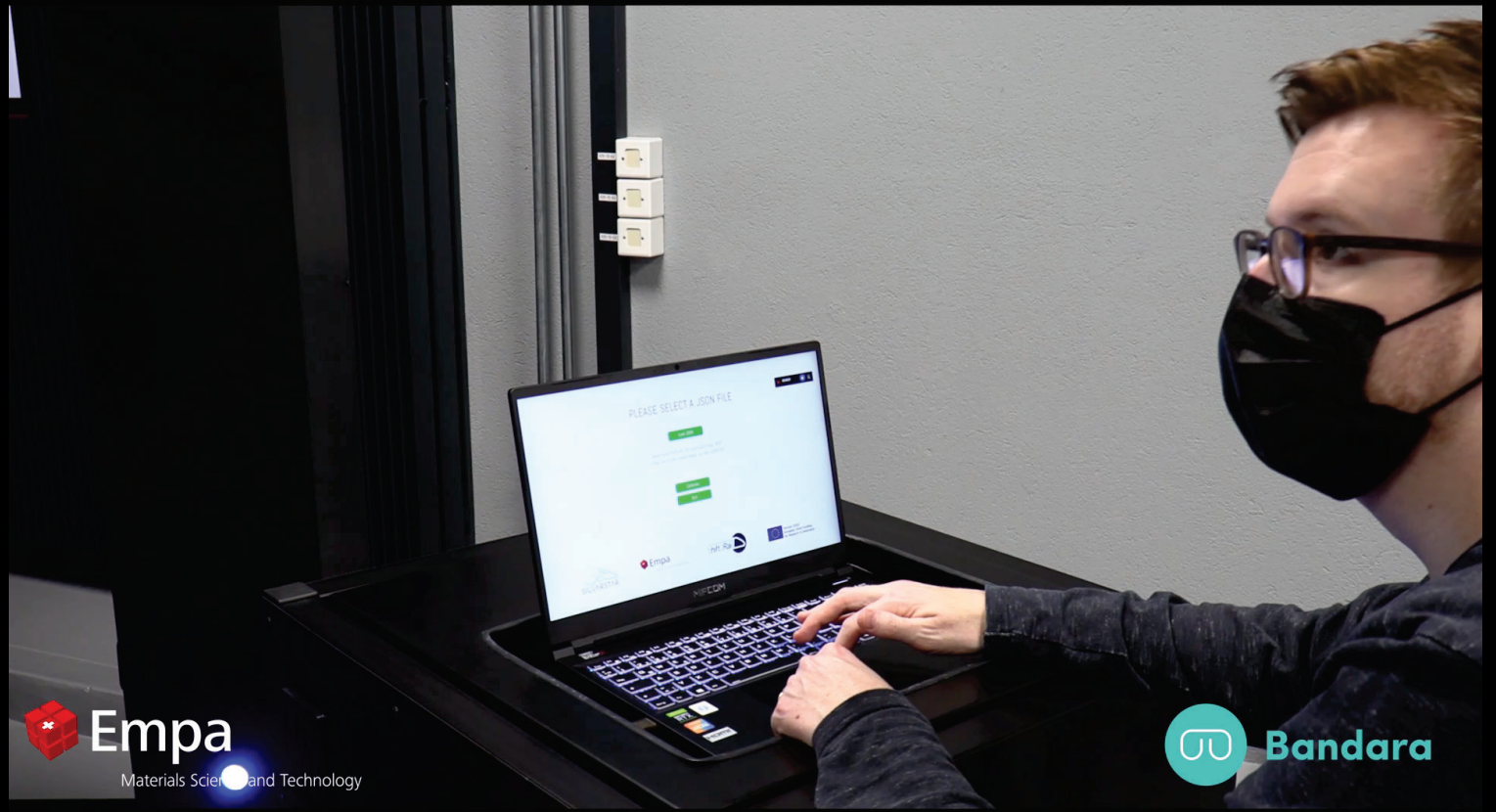
Simulation of Rail Vehicle Noise
using Sound and Image Synthesis

#6 Sound Absorbing Cutting

Shift2Rail

DESTINATE


PLEASE SELECT A JSON FILE
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Take home messages

- Auralization is increasingly important topic.
- Acoustical situations can synthetically be rendered audible using physics-based models.
- High plausibility of complex scenes within reach.

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