Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Umwelt BAFU

Bundesamt für Verkehr BAV

cargorail.ch

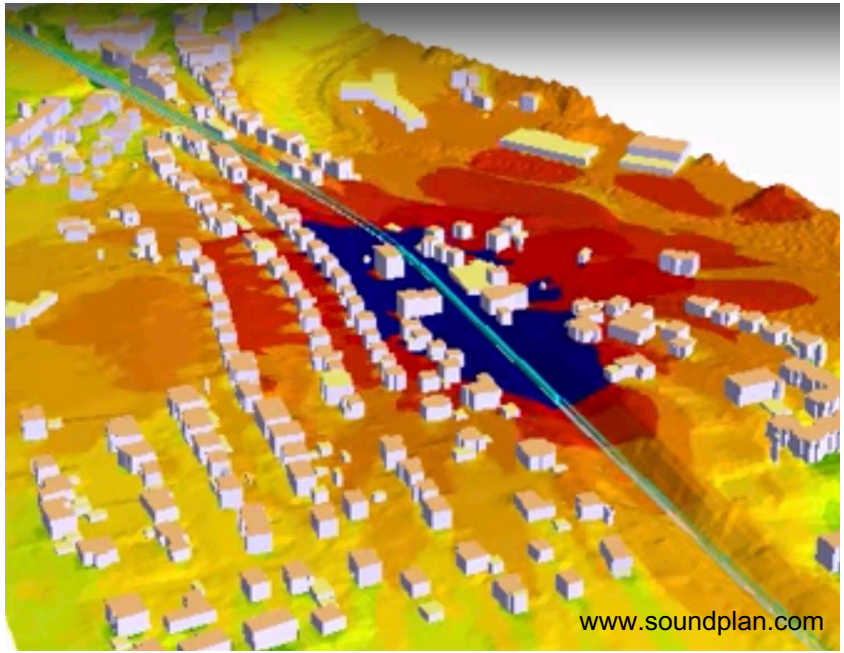
Novel Rail Pads for Improved Noise Reduction and Reduced Track Maintenance

Prof. Holger Frauenrath, EPFL

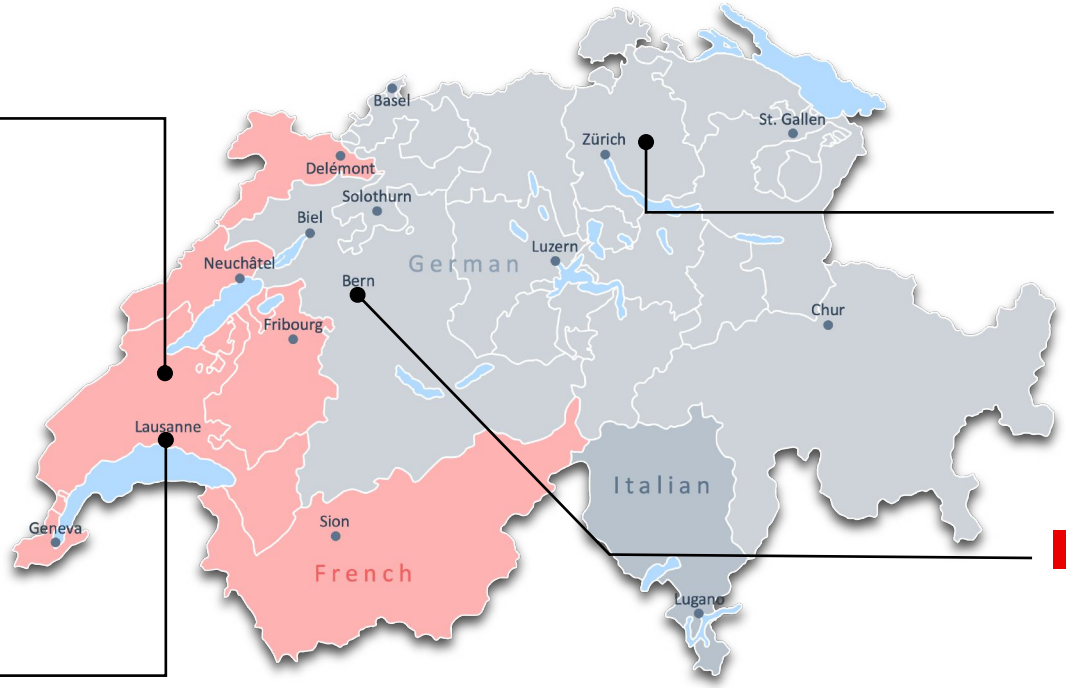
LÄRM FORSCHUNG EISEN BAHN FORUM '21

Novel Rail Pads:
Background and Motivation

- population and urban rail network densities are increasing rapidly
- trains passing by can reach noise levels of up to 100 dB
- rail pads have reciprocal effect on superstructure protection and
- noise emissions
- **solutions needed to reduce noise emissions and improve superstructure protection**



A Multidisciplinary Team



HEIG VD

EPFL

Empa
Materials Science and Technology

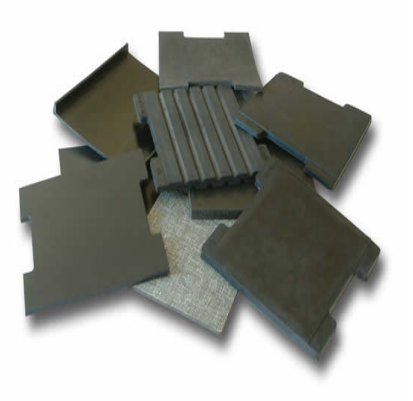
SBB CFF FFS

Project Premises and Goals

EPFL

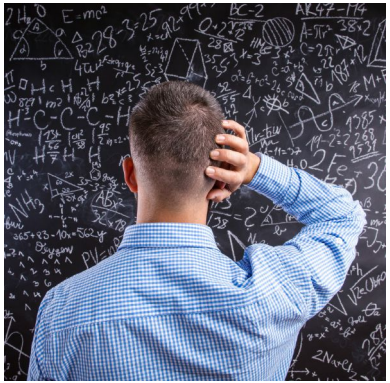
1

combined noise reduction & superstructure protection cannot be obtained from optimal single-material pads



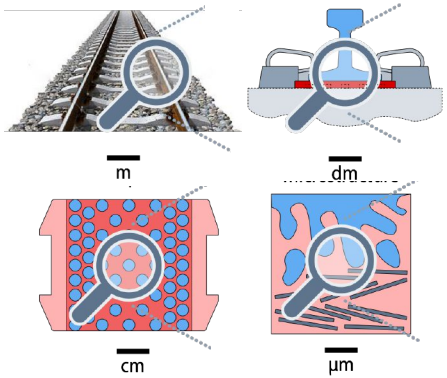
2

understand relationships of materials properties, rail pad mechanics, and railway track acoustics



3

consider structure & function of rail/pad/sleeper system across multiple length scales and structural levels



high-damping multi-material rail pads for combined noise reductions and superstructure protection

Testing and Modeling at Different Length-Scales and Structure Levels

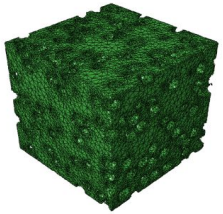
experiment

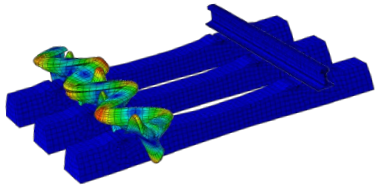
materials properties

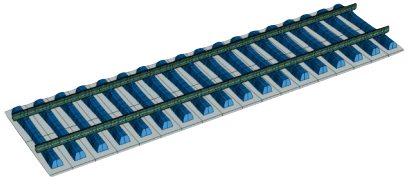
component properties

system performance

modeling



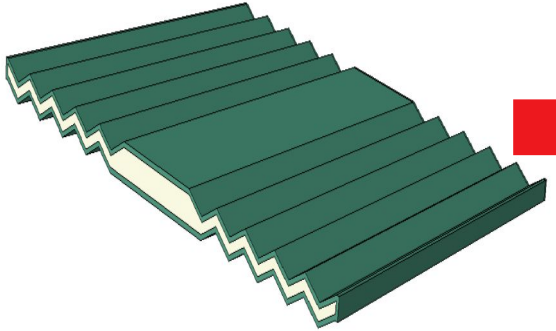




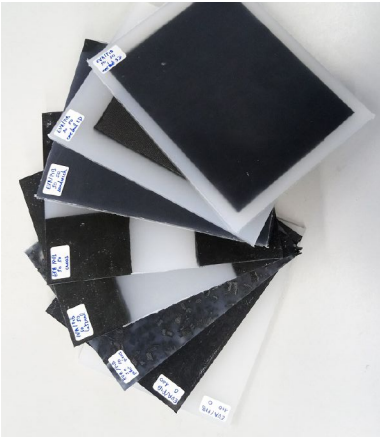
toolchain of **modeling** and **experimental testing** covering materials properties (polymers), component properties (rail, pad, sleeper, fastening system) and the entire system (acoustic/mechanic field testing)

Rail Pad Design, Prototype Production and Testing

design and modelling



mold design and prototyping



mechanical testing

experimentally validated materials **rheology models**, used for development of new rail pad designs
experimental testing of selected geometries, with damping materials to reduce vibrations that cause noise

Laboratory-Scale Development Using a Three-Sleeper Unit Cell

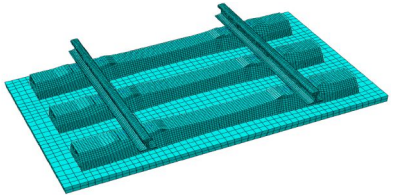
experiment

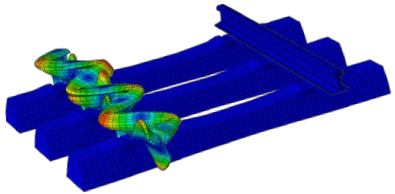
three-sleeper cell

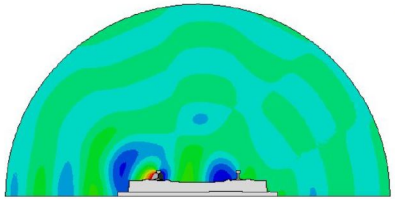
dynamic response

acoustic response

modeling

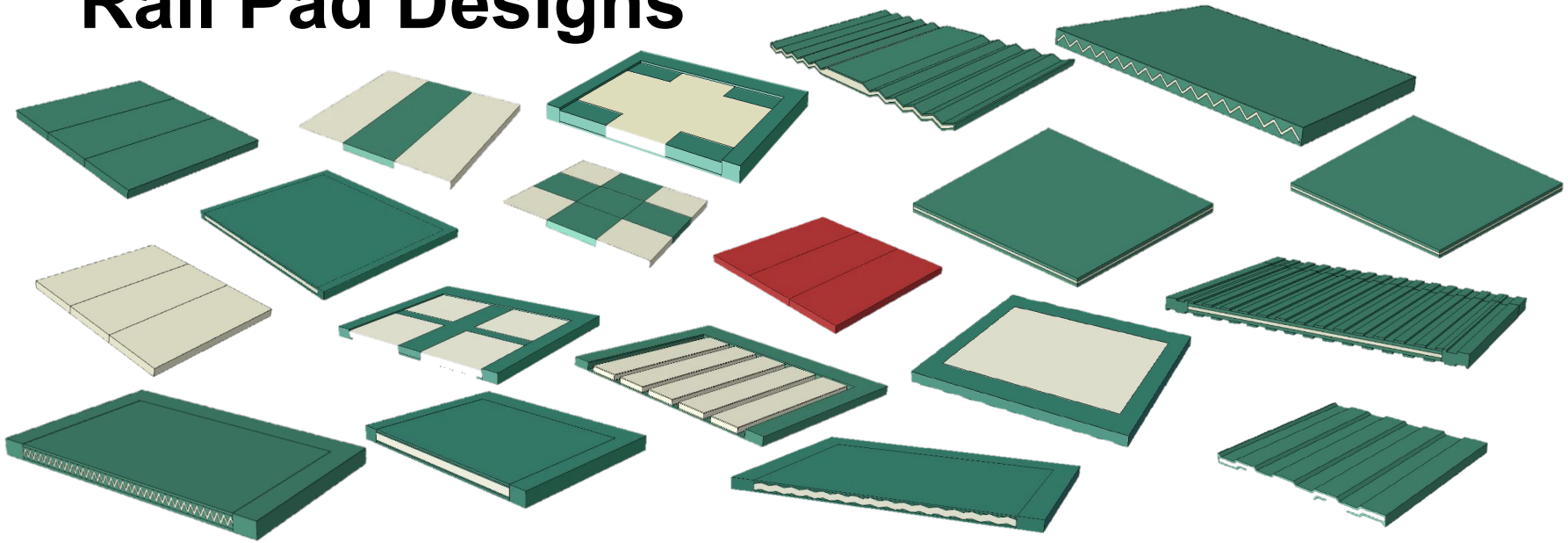






rigourous modeling of vibrational and acoustic properties of tracks equipped with the new rail pads
experimentally tested and validated at the laboratory scale using a three-sleeper sub-cell

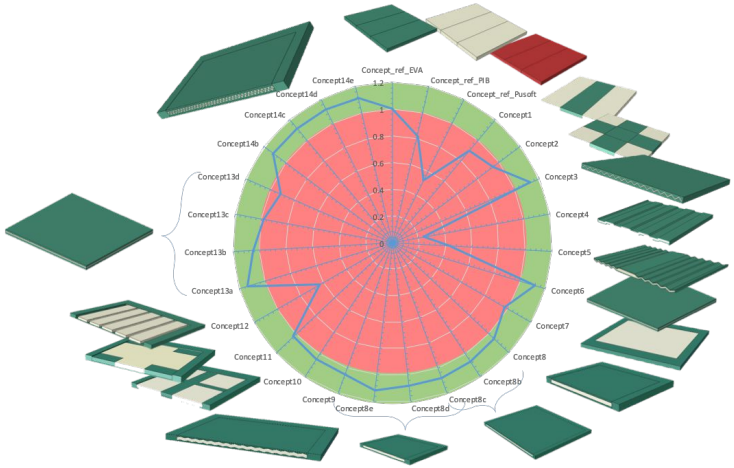
A Library of Multi-Material Rail Pad Designs



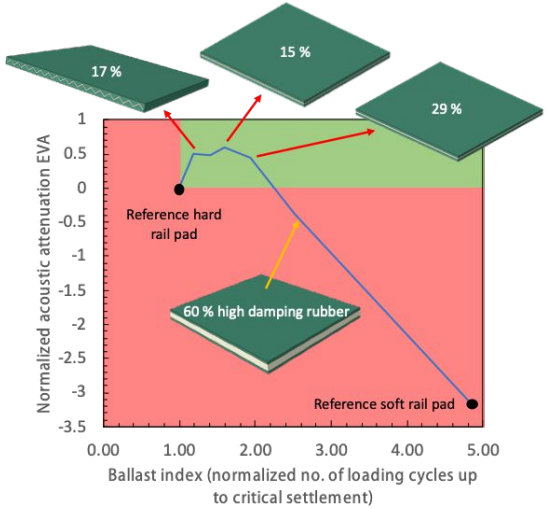
iterative **modeling** and **testing** of many new designs of multi-material rail pads

Rail Pad Performance Optimization

figure of merit
for noise radiation



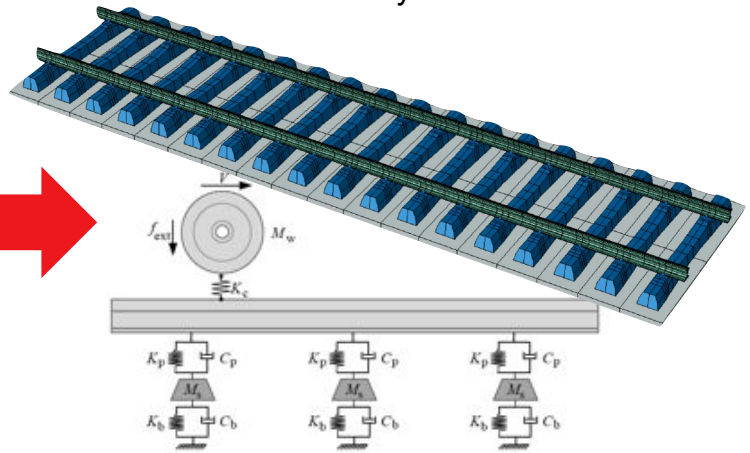
Pareto diagram: noise & track
protection performance



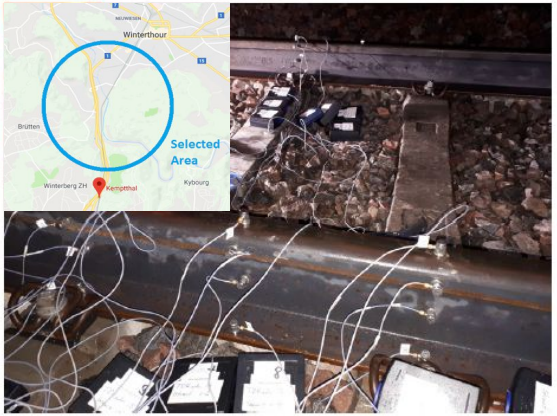
iterative performance optimization at three-sleeper scale with respect to both noise and track protection

Full-Scale Track Simulation and Field-Testing

numerical full-track models
fast semi-analytical models



field measurements
track dynamics, train pass-by noise



performance of most promising designs assessed using **numerical / semi-analytical full track models**
validation from field tests with reference rail pads, to be followed by **scale-up for final field testing**

Conclusions and Outlook

- comprehensive characterization (physical-chemical, rheological, mechanical) of existing and prospective rail pad materials
- experimental set-ups implemented for laboratory analysis of mechanical and acoustic response at different length-scales up to three-sleeper cell
- corresponding simulation methods (finite element and analytical models) implemented and extended to full system after verification at laboratory scale
- platform established for parametric studies of effect of materials properties and geometry on track response at different levels
- **optimized prototype designs combine optimum noise performance with reduced stiffness for improved ballast protection**
- **scale-up of prototype production and field testing planned for 2022**