INTERNATIONAL UNION
OF RAILWAYS

UIC Railway Noise Days – Day2

2025

SUSTAINABILITY
Action Week

EU QuieterRail - Whole System Optimisation

QuieterRail

AGENDA

09:00 – 09:20	**Welcome and introduction** • Welcome by UIC representatives • Overview of the workshop objectives and agenda
09:20 – 09:40	**UIC TTI activities** • AeroNoise project: outcomes and noise measurement protocol
09:45 – 10:00	**EU QuieterRail Project Overview** • Brief presentation on QuieterRail project goals and current status • Overview of WP4 objectives and importance
10:00 – 10:40	**Use Case Identification & Criteria for Optimisation** • Introduction to use cases identification • Introduction to optimisation criteria
10:40 – 11:00	**Break at UIC Mezzanine**
11:00 – 12:00	**Discussion with participants** • Discussion with participants on use cases • Discussion on the criteria for optimisation
12:00 – 12:10	**Summary and closing session**
12:10 – 13:00	**Networking Lunch | EU-QuieterRail**

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101176865.

SUSTAINABILITY Action Week

Speakers

Rosa CASQUERO

Head of the Infrastructure

UIC / ADIF

Gennaro Sica

Senior Acoustics Engineer

HS2 Ltd

David Thompson

Professor of Railway Noise and Vibration

ERJU QuieterRail Consortium Member (WP4 Leader)

The Institute of Sound and Vibration Research

Simon Blainey

Professor of Sustainable Transport

ERJU QuieterRail Consortium Member

The University of Birmingham

Jakob Oertli

Engineer / Infrastructure Department

Chair of the UIC Noise Vibration Sector

Swiss Federal Railways (SBB)

INTERNATIONAL UNION
OF RAILWAYS

INTERFACES AND INTERACTION BETWEEN INFRASTRUCTURE SUBSYSTEM AND ROLLING STOCK

Rosa CASQUERO

UIC Head of Infrastructure, AM and TTI

Noise Days, 12 March 2025

RAIL SYSTEM FORUM - 8 SECTORS

Operations

CCS & Telecom

Railway Digital Modelling

Asset Management

Infrastructure subsystem

Train-Track Interaction (TTI)

Rolling Stock

Energy

TRAIN-TRACK INTERACTION SECTOR

Interfaces and Interaction between Infrastructure Subsystem and Rolling Stock

- SWG Aerodynamic and Acoustics
- SWG Railway Dynamics & Gauges
- SWG Pantograph-Catenary
- Innovative Transport

Ongoing Projects

TTI ONGOING PROJECTS

2011	• Effects of instabilities on track resistance and fatigue	(**Y/Q**)	
2016	• Harmonisation of track quality description and assessment	**(HARMOTRACK)**	2024
2020	• Crossing Effects Between Trains Assessment for INF and RS	**(CROSS-T)**	2024
2020	• Aerodynamic noise production	(**AERONOISE**)	2025
2021	• Railway dynamic measuring systems	(**DYNMEASURE**)	2025
2021	• Clearance gauge common codification	**(G-CODE)**	2025
2024	• Validation of measurements of wheel-rail contact forces	**(CONFORCES)**	2026

Project Summary 1

« RSF » / « Train-Track Interaction »/ « Corrugation »

Scope

- Simulation of the mechanism behind rail corrugation growth to replicate real-world cases. Understanding of the mechanism, open tools to model it and also guidelines on preventive and corrective measures to minimize its appearance and growth.

Duration & Cost

- From 01 / 01 / 2026 to 31 / 12 / 2028 - 3 years
- Per year: 90 k€ - Total 270 k€

In collaboration with INFRASTRUCTURE AND SUSTAINABILITY

Project Summary 2

« RSF » / « Train-Track Interaction » / « Panto-simulations »

Scope

- Establishing appropriate testing methods for pantographs to develop accurate numerical models for simulation. The result will be guidelines for simulations performance, that will support acceptance of simulations to replace costly (time and money) tests.

Duration & Cost

- From 01 / 01 / 2026 to 31 / 12 / 2028 - 3 years
- Per year: 90 k€ - Total 270 k€

In collaboration with ENERGY

Project Summary 3

« RSF » / « Train-Track Interaction » / « BridgeStiff »

Scope

- Developing a cost-efficient and reliable stiffness measuring device and simulation tool to link the stiffness outputs with different track configurations. An IRS providing design and maintenance guidelines on stiffness management at bridges will be produced as well.

Duration & Cost

- From 01 / 01 / 2026 to 31 / 12 / 2028 - 3 years
- Per year: 100 k€ - Total 300 k€

In collaboration with INFRASTRUCTURE

INTERNATIONAL UNION OF RAILWAYS

UIC Aeronoise

Project Update

HS2

Gennaro Sica

Aeronoise Technical Lead, Senior Acoustics Engineer HS2

UIC Noise Days, 11-12 March 2025

Aeronoise Project

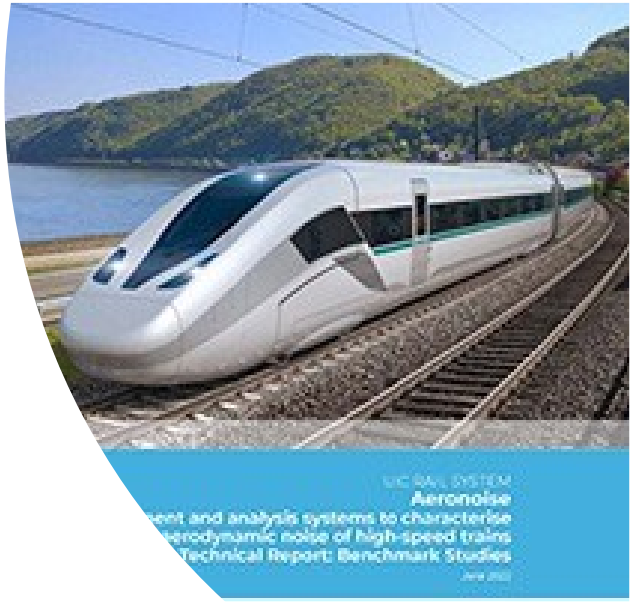
- Participants
  - HS2, SNCF, ADIF, TRAFIKVERKET, BANENOR, SZ
- Objective
  - Creation of New IRS: Measurement and analysis systems to characterise the aerodynamic noise of High Speed trains
- Project is organised in 3 work packages

Project Started in 2020	WP1 – benchmark completed in 2022	WP2 – Protocol development completed In 2023	WP3 – Demonstrator started in 2024

- Delivery Partner for the project
  - SENER and ISVR Consulting

- **<u>This presentation concern WP2</u>**

WP1 Deliverable



Download WP1 deliverable for free at: https://www.shop-etf.com/en/aeronoise-measurement-and-analysis-systems-to-characterise-the-aerodynamic-noise-of-high-speed-trains-technical-report-benchmark-studies

Goals of the Project

UIC organized the *Aeronoise* project initiative, aimed at developing a new pass-by noise measuring methodology with the following goals:

- Quantitative assessment of the different contributions of aerodynamic noise, particularly those originating in the highest parts of the train (since they are more difficult to attenuate in practice using conventional barriers).
- Simple processing of the measured information, compared to the usual processing in measurements using microphone arrays.
- Necessary instrumentation composed of standard off-the-shelf measurement microphones, available at a moderate cost.
- Add on to ISO 3095

Aeronoise Methodology Concept

The Aeronoise Method is made of three main parts:

- Measurement Set Up
- Post Processing / Inversion
- Assessment Grades
  - General Acoustics Assessment
  - Detailed Acoustics Assessment

The difference between General and Detailed Assessment is in the level of accuracy involved in separation among the sources.

Aeronoise Methodology
Test set up

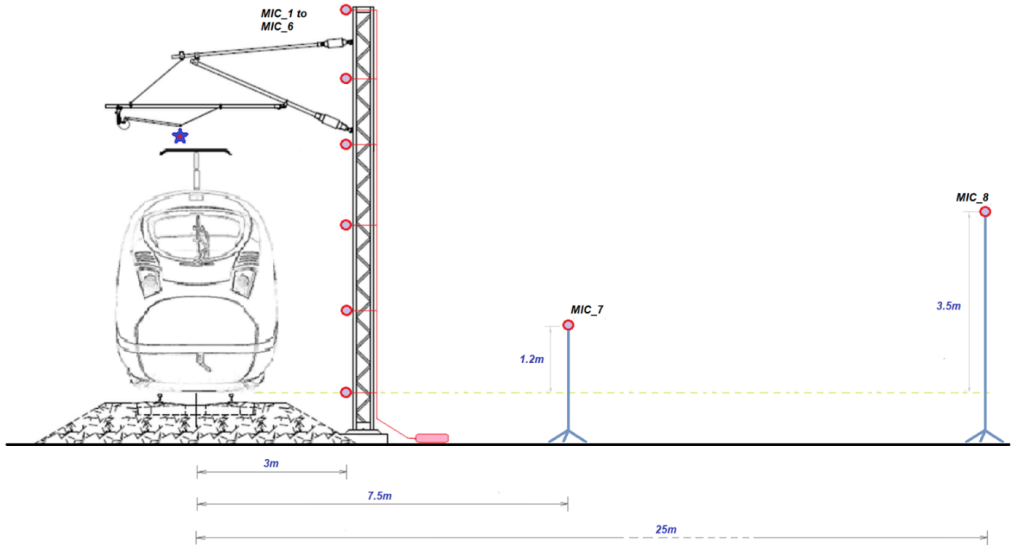
Simplification of HS2/Sener Approach

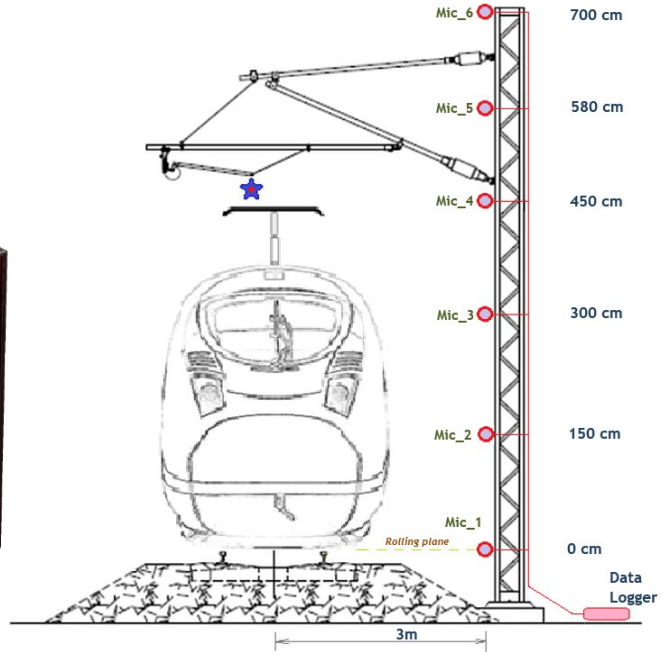
In addition to ISO-3095
Microphone positions, for both Assessment types

- 6 Microphones on the Catenary Pole
- Train body helping in source separation
- Sensor for identify speed of the train

For Detailed Assessment

- Accelerometers on the track



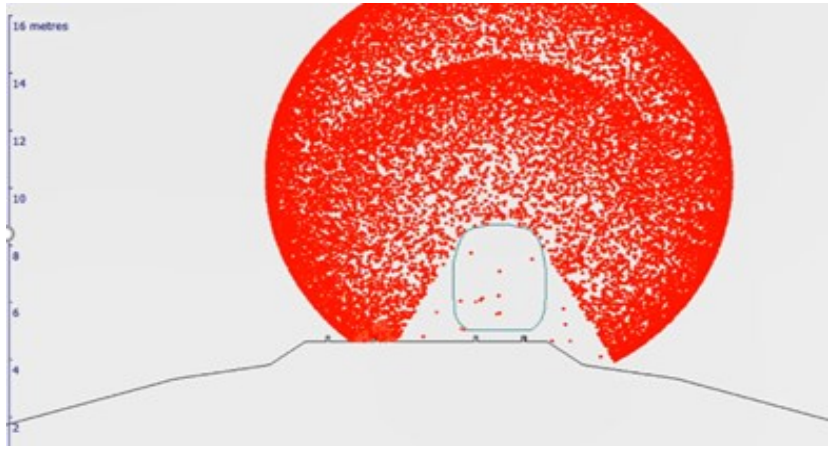


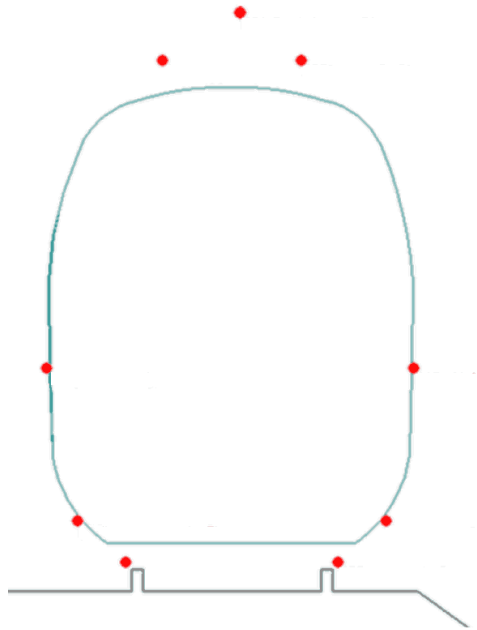
Aeronoise Methodology Processing - Model

Processing of the data is required to obtain source separation for the aeroacoustics assessment.

Processing based on the following modelling assumptions:

- **5 Source Noise Model** to represent emission from HS train
- **Height and distribution of the sources is known** and based on experimental observation of source mechanism and train geometry
- pantograph noise source is considered as a unique equivalent source, while the other sources are considered as dual, being located symmetrically with respect to the main vertical axis of the train.





Aeronoise Methodology Processing - Inversion

- Acoustical Transfer Functions (“Visibility Factors”, VF) are pre-calculated and tabulated for a number of typical train cross section shapes.
- Expert users can derive VF for their train.
- From the pass-by noise levels recorded in the microphones and the pre-calculated visibility factors, a non-linear system of equations (if working in dBs) is set-up and inverted.
- Hints, parameters and constraints for using the readily available non-linear solver in Excel are proposed to the users.

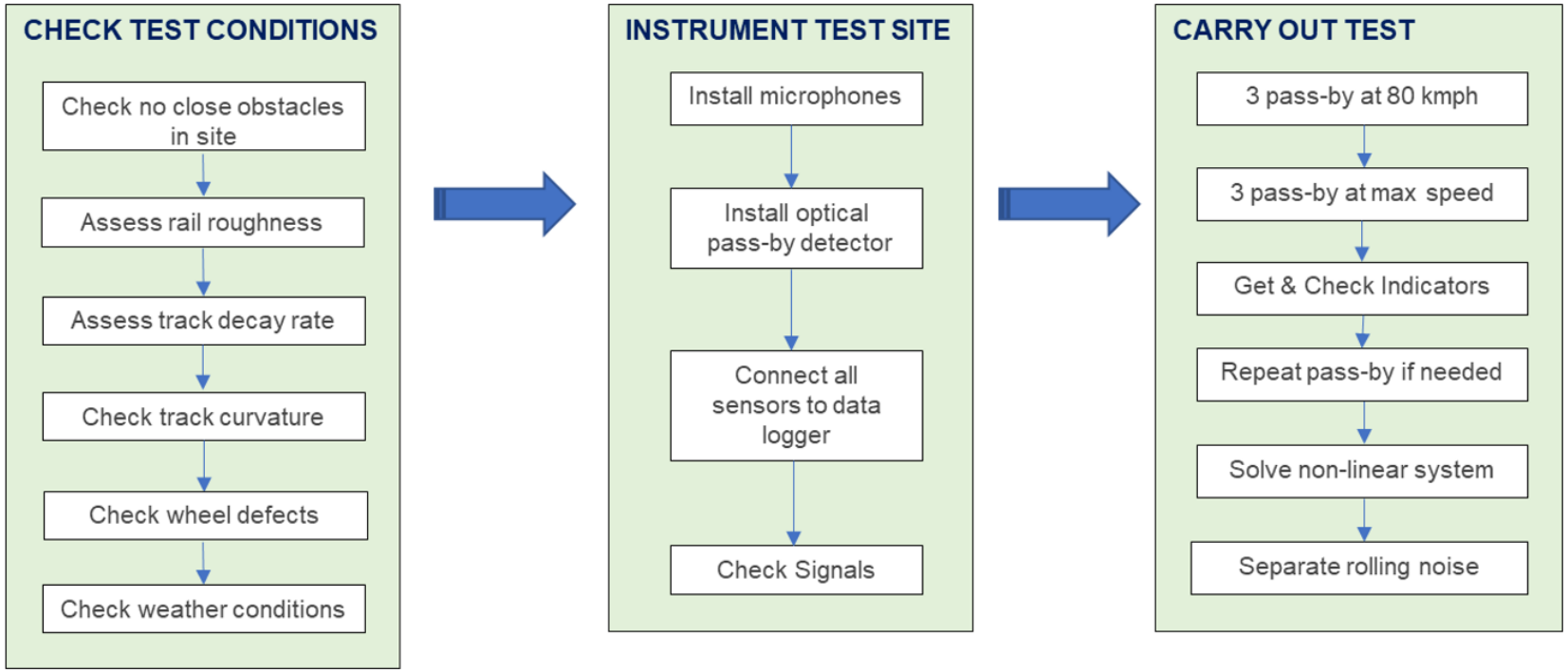
$$Lp\_Mic\_1 = (Lw\_roll + VF\_roll,1) \oplus (Lw\_low\_aero + VF\_low\_aero,1) \oplus (Lw\_mid + VF\_mid,1) \oplus (Lw\_high\_aero + VF\_high\_aero,1) \oplus (Lw\_panto + VF\_panto,1)$$

$$Lp\_Mic\_2 = (Lw\_roll + VF\_roll,2) \oplus (Lw\_low\_aero + VF\_low\_aero,2) \oplus (Lw\_mid + VF\_mid,2) \oplus (Lw\_high\_aero + VF\_high\_aero,2) \oplus (Lw\_panto + VF\_panto,2)$$

$$\vdots$$

$$Lp\_Mic\_n = (Lw\_roll + VF\_roll,n) \oplus (Lw\_low\_aero + VF\_low\_aero,n) \oplus (Lw\_mid + VF\_mid,n) \oplus (Lw\_high\_aero + VF\_high\_aero,n) \oplus (Lw\_panto + VF\_panto,n)$$

Aeronoise assessment grades: general acoustic assessment



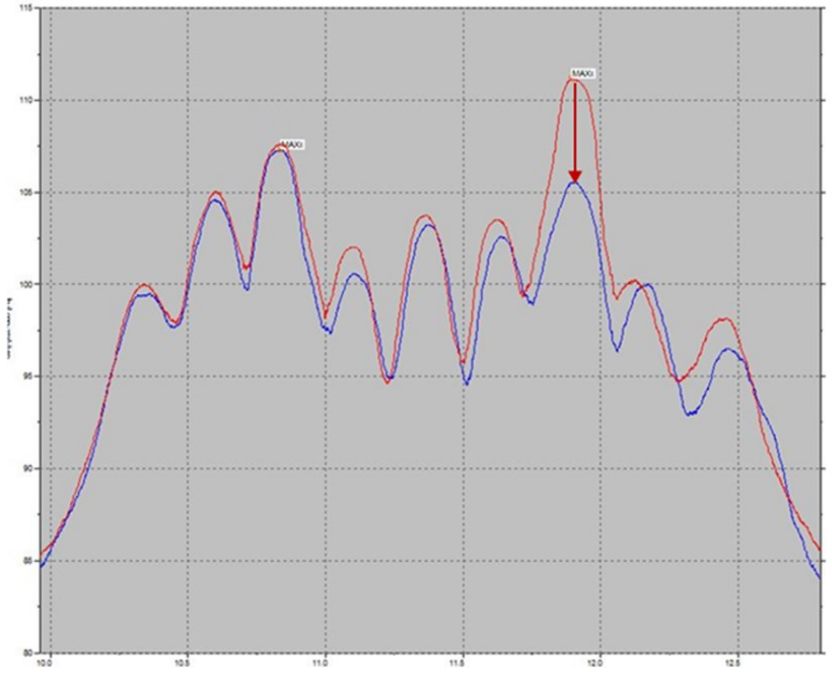
Simplified separation approach between low level aerodynamic noise and rolling noise

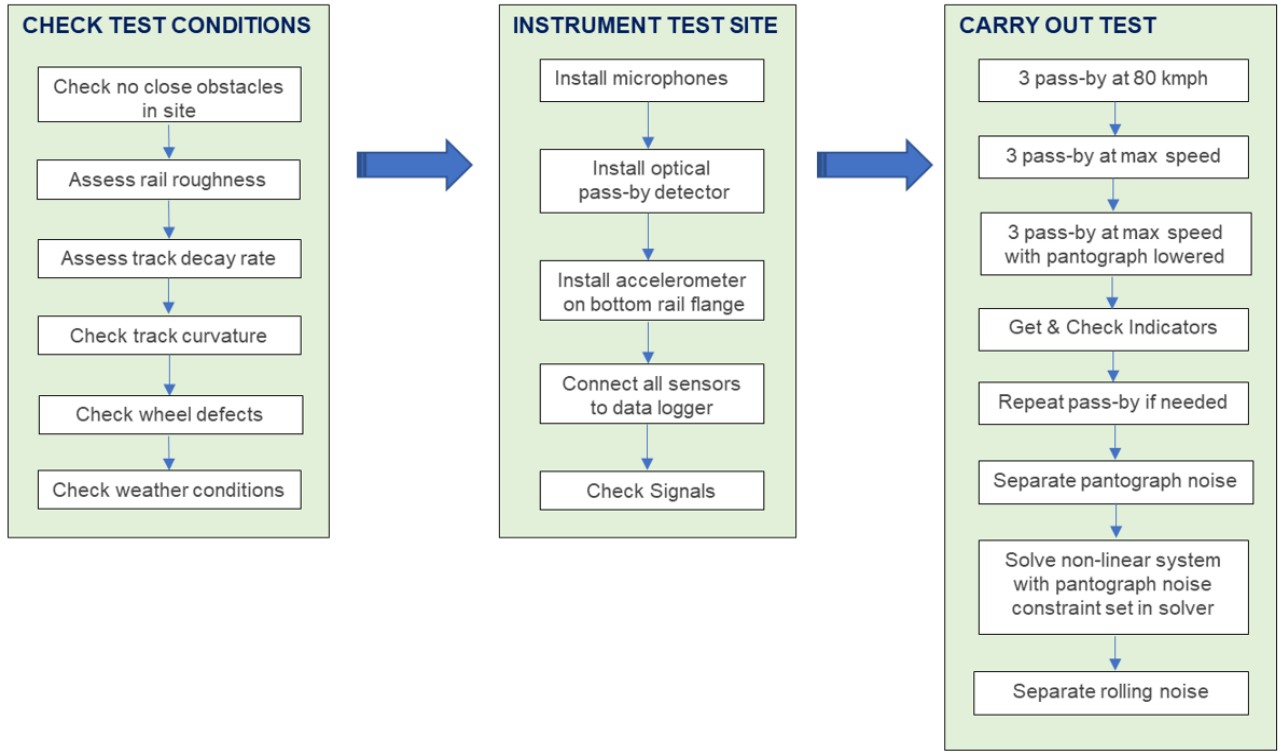
- A pass-by is measured at a speed V_{ref} where rolling noise dominates above aerodynamic
- Rolling noise is assumed to evolve according to $30 \cdot \log(V_{meas}/V_{ref})$;
- Any measured excess in low level noise with respect to rolling noise estimation is assumed to be aerodynamic noise.

Aeronoise assessment grades: detailed acoustic assessment

Improve the source separation respect to the General Acoustic Assessment:

- Separation of low-level noise into rolling noise and low-level aerodynamic noise carried out using specialized software tools such as TWINS or PBA, instead of using simple evolution laws.
- Assessment of pantograph noise is complemented with comparisons of results obtained with raised and lowered pantograph.





Conclusions & Next Steps

A simple method has been developed in WP2 to achieve experimental separation of the different pass-by noise contributions has been developed in line with Aeronoise Objectives. Method rely on three elements:

- Test set up
- Processing / Inversion
- 2 Assessment grades

UIC Aeronoise complete methodological proposal is expected to be completed after the WP3 experimental validation of the methodology through 2 campaigns:

- France – SNCF network by SNCF – July 2024
- Spain – ADIF network by Aeronoise – April 2025

Initial results will be presented at:

- UIC World Congress High Speed Rail – 8 to 11 July – Beijing, China
- IWRN 15 – 15 to 19 September – Isla de la Toja, Spain

IRS to be completed by Q1 2026

UIC TTI White Paper on OCS/Pantograph Interaction (Noise Section)

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Thank you
for your attention

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EU QuieterRail Project

Track optimisation for noise, vibration and LCC

QuieterRail

Track optimisation for noise, vibration and LCC

- David Thompson, ISVR, University of Southampton
- Jakob Oertli, SBB/UIC
- Simon Blainey, University of Birmingham
- Marcus Young, University of Southampton

UIC Noise Days, Paris, 12 March 2025

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101101973.

Agenda

1.	QuieterRail project overview and WP4 objectives	David Thompson
2.	Selection of Use Cases	Jakob Oertli
3.	Scope of Optimisation Tool	David Thompson
4.	Optimisation Criteria and Online Tool	Simon Blainey & Marcus Young

QuieterRail project overview and WP4 objectives

David Thompson, ISVR

UIC, Paris, 12 March 2025

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101101973.

QuieterRail

A step change in prediction, mapping, acceptance testing and cost-effective mitigation for railway noise and vibration

- Total EU Funding: 3.28M€
- Partners: 16
- Duration: 36 Months
- Start Date: 1st October 2024
- End Date: 30th September 2027

Project Coordinator: UNIFE

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QuieterRail

Coordinator: unife THE EUROPEAN RAIL INDUSTRY

Technical leader: VIBRATEC

KU LEUVEN

TNO innovation for life

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Wölfel Developing people. Engineering the future.

uic INTERNATIONAL UNION OF RAILWAYS

CSTB le futur en construction

ICR Ingeniería para el Control del Ruido

RINA

SYTRAL MOBILITÉS

Empa Materials Science and Technology

Hes·so

University of Southampton

UNIVERSITY OF CAMBRIDGE

Four work streams

Noise analysis and evaluation methods

WP1 Noise in curves

WP2 Transposition, uncertainties and acceptance testing

Cost-effective noise mitigation

WP3 On-board roughness monitoring and rail grinding

WP4 Track optimisation for noise, vibration and LCC

Ground-borne vibration prediction

WP5 Ground vibration prediction and experiments.

WP6 Hybrid vibration prediction tool

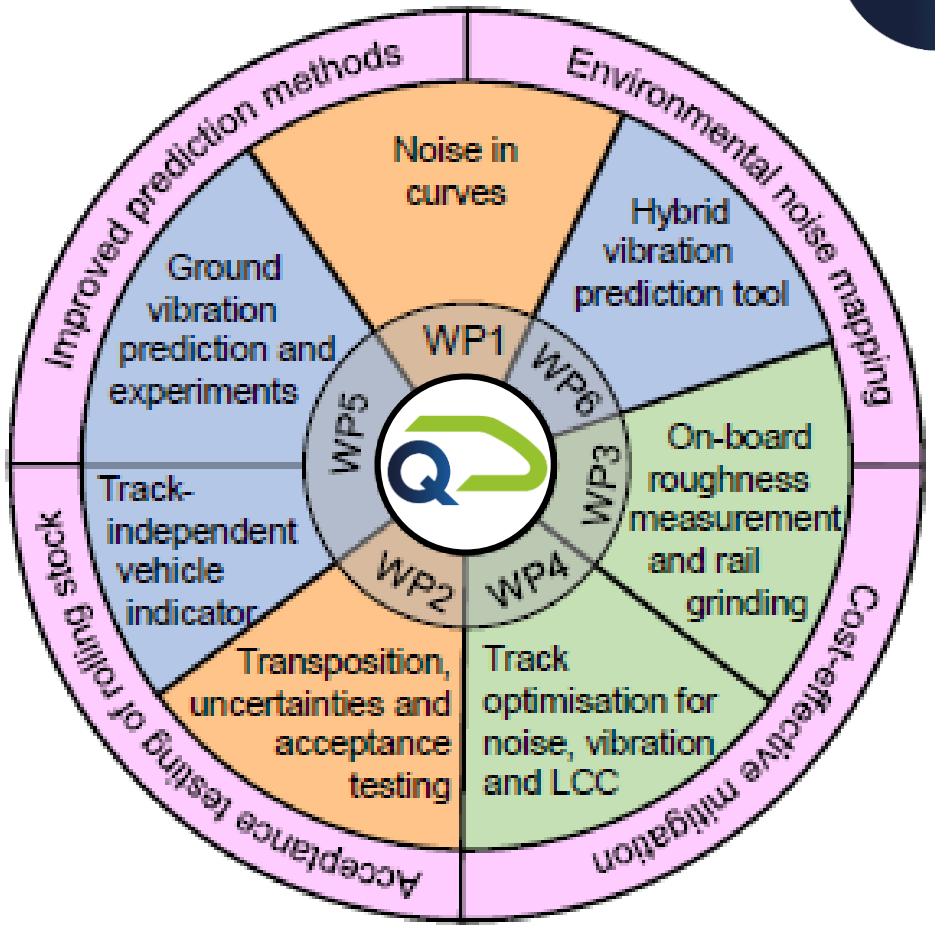
In situ testing to support validation

Noise and vibration measurements to support the WP1, WP2 and WP5 on urban and mainline railway networks

Impact

QuieterRail's impact is focused in four main areas:

- Cost-effective mitigation of N&V
- Improved prediction methods for railway N&V
- Developments of acceptance testing of rolling stock
- Improved environmental noise mapping, extended to include vibration



Track optimisation for noise, vibration and life cycle costs

Background to WP4

- Noise and vibration abatement methods often introduce additional costs to the railway
- It is therefore essential to demonstrate whether their benefits outweigh these additional costs.
- The effects of changes to the system on **noise** and **vibration** are often contradictory.

- **Aim**: To develop a **web-based tool** to support the whole system optimisation for noise, vibration, and LCC on railway tracks.
    - The online tool should be flexible to the needs of the user.
    - It should not require long calculations.
    - It should be based on proven methods and reliable data (including costs).

Track optimisation for noise, vibration and life cycle costs

WP4 tasks

Task 4.1: Define **use cases** and **criteria** for whole system optimisation

- Who will use the tool and what questions will they want to ask?

Task 4.2: **Noise and vibration reductions** of a range of abatement methods and for different combinations of track components.

- Calculations: results to be stored in a database for use by the tool.

Task 4.3: Determination of **impact values**.

- Determine typical range of installation and maintenance costs, maintenance frequencies and lifespans.

Task 4.4: **Web-based tool** for whole system optimisation.

- Life cycle modelling tool using open-source code.

Task 4.5: **Whole system optimisation**.

- Demonstrate application to several case studies to assess the costs/benefits of different combinations of solutions.

QuieterRail

Introduction to Use Cases

Jakob Oertli

UIC Noise Day, Paris, 12 March 2025

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101101973.

‘Use Cases’

Use case:
A usage scenario for which the tool may be useful

Users and possible questions / use cases (examples):

Infrastructure manager:
- Track component combinations with the best overall cost/benefit ratio including noise and vibration:
    - Which track components are of interest?
    - Connection to existing tools? Which ones?

Noise and vibration experts
- Noise and vibration mitigation methods to achieve limit values:
    - Which noise and vibration methods are of interest?
    - Only Leq or also peak values?
    - For which types of rolling stock?
    - Connection to existing tools? Which ones?

Policy makers
- What are the trade-offs between costs for noise and vibration measures versus health benefits or environmental effects

Case studies

Case study:

Testing the tool at the end of the project

Possibilities for case studies (max 5) for demonstration in Task 4.5:

- A track renewal of a section of track (length?) – which track components should be used? What additional noise/vibration mitigation is required?
- A widening from two to four tracks of a section of track (length?) – which track components should be used? What additional noise/vibration mitigation is required?
- A noise complaint site where different mitigation options should be weighed against cost and benefit
- A vibration complaint site where different mitigation options should be weighed against cost and benefit
- A site where train speed is to be raised while respecting noise / vibration requirements

QuieterRail

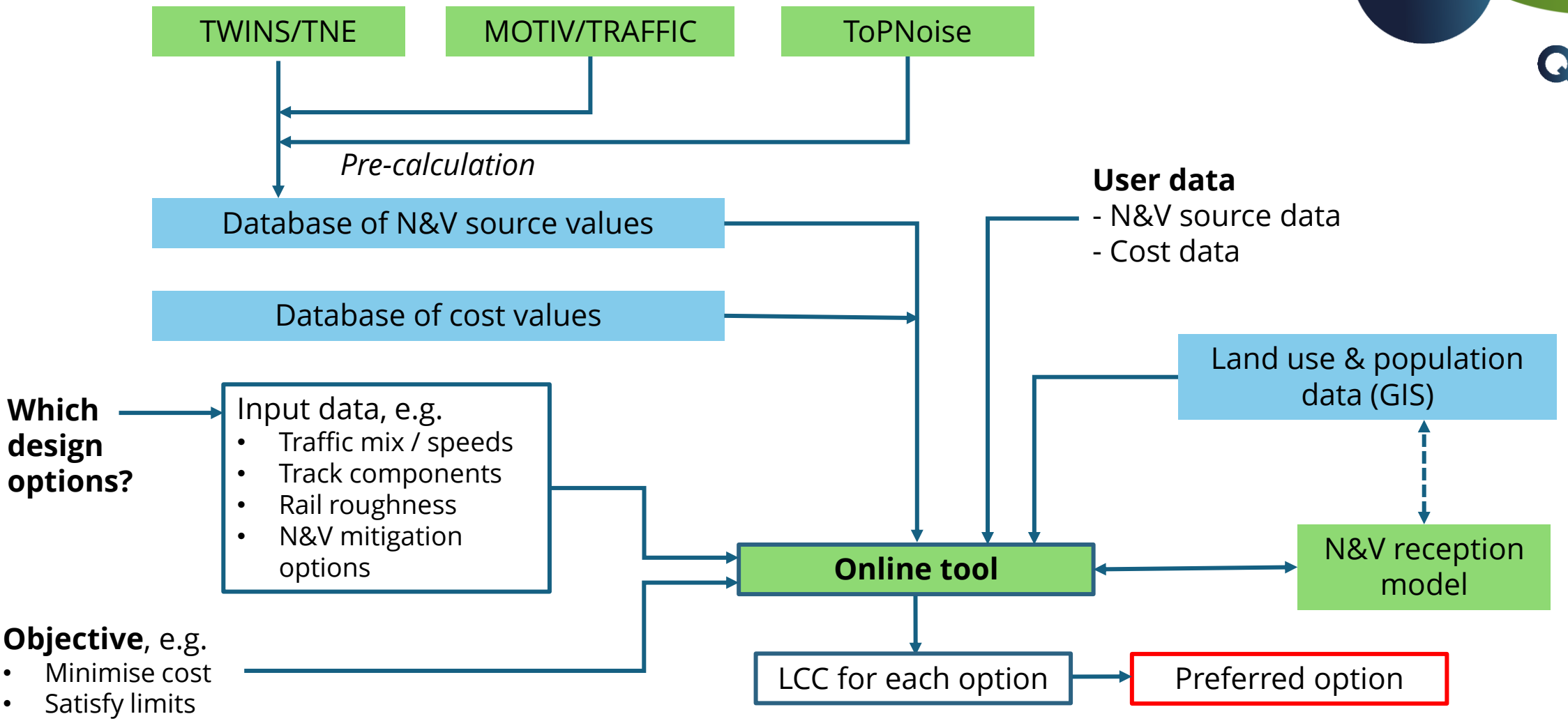
Scope of optimisation tool

David Thompson, ISVR

UIC, Paris, 12 March 2025

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101101973.

Whole system optimisation tool



Summary of proposed cases for calculations

Rolling on straight track – Included

- Models for rolling noise and ground vibration are well established and validated
- Should cover the majority of situations
- Covers variations in:
  - Train speed
  - Rail roughness
  - Wheel roughness (brake type)
  - Sleeper type
  - Rail pad stiffness
  - Under-sleeper pads
  - Ballast and slab tracks
  - Track decay rate (indirectly)
  - Wheel design
  - Ground stiffness / wavespeed
  - Mitigation measures for both noise and vibration

Summary of proposed cases for calculations

Impacts at S&C or joints – Passive provision

- Locally important giving higher noise/vibration levels
- Some previous research on impact noise and vibration but no validated models
- In WP5 models will be developed for ground vibration due to impacts (due at end of project)

Curving (excl. squeal) – Passive provision

- Very little previous research and no validated models
- **Relative changes** expected to be similar to straight track
- In WP1 models for rolling noise in curves will be developed
- In WP5 models for ground vibration due to curving will be developed

Summary of proposed cases for calculations

Roughness growth – Passive provision

- Track design can influence the growth of rail roughness or corrugation
- **Causal link is not well understood.** Models lack maturity and validation
- User may select different roughness spectra if known

Tunnels – Passive provision?

- Ground-borne noise and vibration are affected by track design
- Models are available (e.g. MOTIV) but it is not included in proposed database or in mapping
- Absolute vibration and noise levels are strongly dependent on soil and building properties

Curve squeal – Excluded

- Highly variable and unpredictable
- Models lack maturity and validation
- Modelling and validation measurements in WP1 (due at end of project)
- **Track design has very little influence**

Summary of proposed cases for calculations

Aerodynamic noise – Excluded

- Not affected by track design (apart from noise barriers)
- Models exist but are extremely costly

Traction noise – Excluded

- Not affected by track design (apart from noise barriers)
- Empirical data

Bridges – Excluded

- Structure-borne noise is affected by track design
- Large variation in bridge designs so impractical to include in the tool

Earthworks / transition zones – Excluded

- Not included in the current noise and vibration models
- Require bespoke modelling

Summary of proposed cases for calculations – noise

	Availability of data	Availability / maturity of models	Influence of track on source	Uncertainty	Include
Rolling	high	high	high	moderate	yes
Impact	limited	limited	high	large	passive
Curving (excl squeal)	limited	none	high	unknown	passive
Tunnels	n/a	n/a	n/a	n/a	n/a
Roughness growth	limited	limited	high	large	passive
Curve squeal	site-specific	limited	none	large	no
Aerodynamic noise	limited	limited	none	moderate	no
Traction noise	some	none	none	large	no
Bridges	site-specific	limited	high	large	no
Earthworks	limited	limited	none	large	no
Transition zones	n/a	n/a	n/a	n/a	n/a

Summary of proposed cases for calculations – vibration

	Availability of data	Availability / maturity of models	Influence of track on source	Uncertainty	Include
Rolling	high	high	high	moderate	yes
Impact	limited	limited	high	large	passive
Curving (excl squeal)	limited	none	high	unknown	passive
Tunnels	site-specific	high	high	large	passive
Roughness growth	limited	limited	high	large	passive
Curve squeal	n/a	n/a	n/a	n/a	n/a
Aerodynamic noise	n/a	n/a	n/a	n/a	n/a
Traction noise	n/a	n/a	n/a	n/a	n/a
Bridges	site-specific	limited	high	large	no
Earthworks	site-specific	limited	limited	large	no
Transition zones	site-specific	limited	high	large	no

Potential mitigation measures

For noise

- Optimised rail pads (material/geometry)*
- Rail dampers
- Rail shields
- Optimised rail grinding*
- Noise barriers (2 m, 3 m)
- Mini-barriers

*: *also effect on vibration*

For vibration

- Very soft rail fasteners*
- Under-sleeper pads*
- Under-ballast mats
- Stiff soil barrier
- Sheet pile wall
- Soft-filled trench
- Heavy masses beside the track

*: *also effect on noise*

QuieterRail

Optimisation Criteria and Online Tool

Simon Blainey & Marcus Young

UIC Noise Day, Paris, 12 March 2025

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101101973.

Background: What do we mean by ‘optimisation’?

Noise/vibration reduction gives benefits but costs money. There are several possible approaches to optimisation:

1. Express the benefits of e.g. reduced noise in financial terms (called monetisation) and balance them against the additional costs.

   A higher initial cost may also be offset by a reduced life cycle cost.

   ‘Optimisation’ then means finding the lowest overall cost.

2. Some environmental benefits may be required irrespective of cost (e.g. to achieve legal limits).

   Now ‘optimisation’ is about finding the lowest overall cost subject to meeting one or more constraints

3. Some costs or benefits may be difficult to monetise

   In this case we need to trade off monetised and non-monetised impacts through multi-criteria analysis.

What optimisation/assessment criteria are we considering?

Changes in noise and vibration levels

Attainment of legal limit values on noise and vibration

Construction/installation costs

Maintenance costs

End of life costs

Whole life carbon emissions

Health impacts of noise and vibration

Impacts on RAMS

Which of these criteria can be monetised?

Changes in noise and vibration levels	**Yes**
Attainment of legal limit values on noise and vibration	**No** (constraint)
Construction/installation costs	**Yes**
Maintenance costs	**Yes**
End of life costs	**Yes**
Whole life carbon emissions	**Yes**
Health impacts of noise and vibration	**Yes**
Impacts on RAMS	**Partially**

Depending on the extent to which RAMS can be monetised it may be necessary to assign weights to different criteria

How will the optimisation be achieved?

Impact values will be determined for the interventions and use cases being considered, based on a) model outputs, b) published evidence and c) information from infrastructure managers

Information on costs associated with interventions will be gathered from infrastructure managers and published evidence

Impacts will be monetised where possible

A review of valuations of railway noise recommended by governments and supranational organisations has been carried out

How will the optimisation be achieved?

Review of valuations of railway noise

EU Handbook on the External Costs of Transport (2020). A new version is being worked on. Distinguishes between annoyance and health costs.

Provides marginal cost of railway noise per dB/person/year by 5dB noise bins for each EU country (plus UK, Norway and Switzerland). Adjusted for differences in prices and income.

Some countries have their own suitable valuation tables, including France, Germany, Netherlands, UK and the Nordic countries.

Valuations are all for airborne noise, not for vibration or ground-borne noise. Research relating the degree of annoyance with vibration and noise levels can be used to adjust valuations to account for this.

How will the optimisation be achieved?

Impact values will be used to identify the benefit-cost ratio of each intervention along with its impact on non-monetisable factors at a set of representative sample locations

The optimal set of interventions on a case study route section will be identified based on minimising total social cost, either in absolute terms or subject to budget constraints and/or limiting thresholds of permitted noise

Probability distributions will be constructed around the financial valuations of each impact

A sensitivity analysis will be undertaken of the costs/benefits of the different interventions to determine which have the largest impact on overall life cycle costs

The web-based tool developed during the project will play a key role in this process

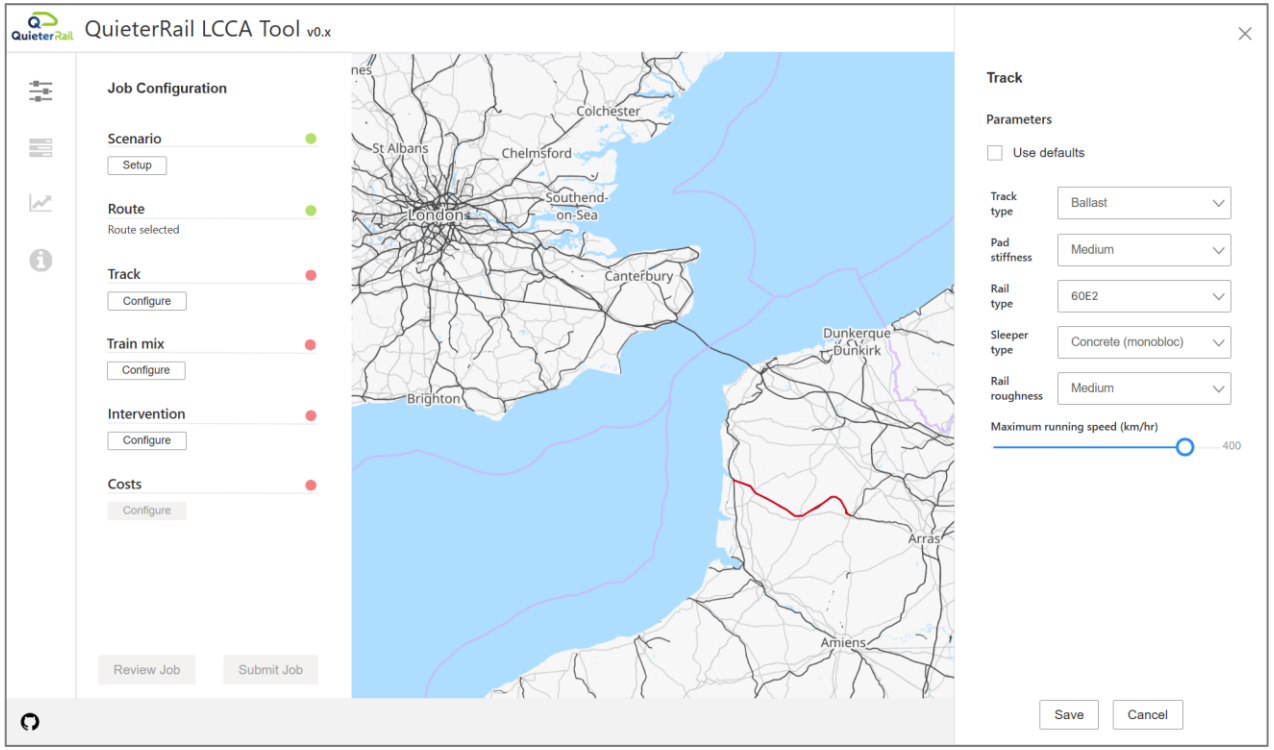
How will the optimisation be achieved?

Overview of web-based tool

Will support whole system optimisation by providing a user-friendly interface to assess the impacts of different intervention scenarios in different national/local contexts

Will be tested and validated for several case studies based on key use cases identified in the first phase of this project work package

An initial prototype of the tool's interface has been developed



Demonstration of web-based tool prototype

Online Demo

Some questions

- How useful will this tool be for your organisation?
- Do you have suggestions to improve usability or applicability?
- What types of Use Cases can you foresee using it for?
- What criteria are used to decide between different noise mitigation options in your organisation/country?
- Are there asset databases of track components installed on each section of line in your organisation/country? Could they be accessed by potential users of the tool?

QuieterRail

Thank you!

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12/03/2025

Break time

EU QuieterRail - Whole System Optimisation

09:00 – 09:20	**Welcome and introduction** • Welcome by UIC representatives • Overview of the workshop objectives and agenda
09:20 – 09:40	**UIC TEG activities** • AeroNoise project: outcomes and noise measurement protocol
09:45 – 10:00	**EU QuieterRail Project Overview** • Brief presentation on QuieterRail project goals and current status • Overview of WP4 objectives and importance
10:00 – 10:40	**Use Case Identification & Criteria for Optimisation** • Introduction to use cases identification • Introduction to optimisation criteria
10:40 – 11:00	**Break at UIC Mezzanine**
11:00 – 12:00	**Discussion with participants** • Discussion with participants on use cases • Discussion on the criteria for optimisation
12:00 – 12:10	**Summary and closing session**
12:10 – 13:00	**Networking Lunch | EU-QuieterRail**

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Discussion with participants

Jakob Oertli

Engineer Infrastructure Department

Chair of the UIC Noise Vibration Sector

Swiss Federal Railways (SBB)

Anup Chalisey

Professional Head of Infrastructure

Chair of the Train Track Interaction Sector

The Rail Safety and Standards Board (RSSB)

Pınar Yılmazer

Head of Sustainability Programme

International Union of Railways (UIC)

INTERNATIONAL UNION
OF RAILWAYS

Thank you
for your attention

Event Feedback & Satisfaction Survey | UIC Railway Noise Days 11-12/03

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