Acoutrain Summary:

Main Achievements and Outstanding Issues

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From Acoutrain DoW

“The goal of the proposed project is to speed up the product authorisation by introducing some elements of virtual testing while retaining the same degree of reliability and accuracy”.

Scientific and Technical objectives

1. Introduce virtual certification with a reliable simulation approach
2. Establish a method for separation of infrastructure and rolling stock noise contributions
3. Establish measurement procedures for new running conditions, specifically braking and curving
4. Develop procedures to obtain inputs for the European Noise Directive

Target 1: Introduce virtual certification with a reliable simulation approach: Achievements (I)

Development of procedures :

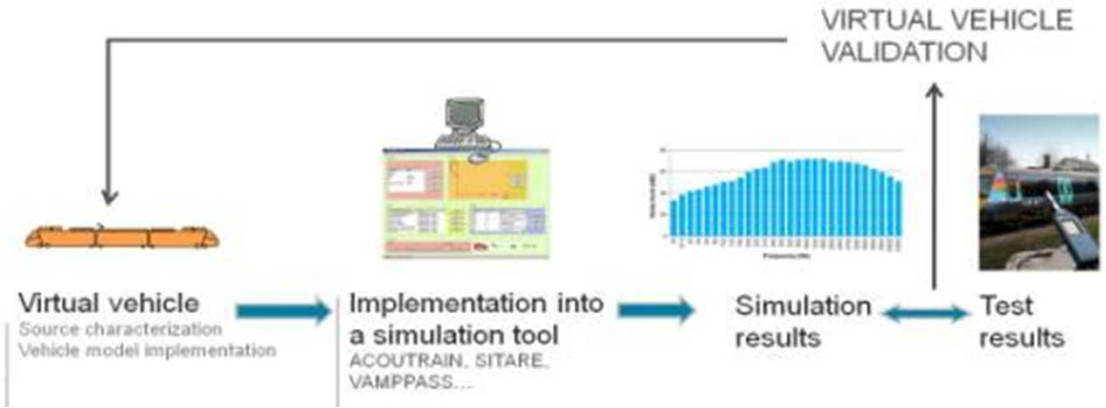
•A virtual testing certification procedure have been developed including guidelines for defining and validating a virtual reference vehicle.

•A method for virtual vehicle validation is proposed and tested (in part).

•Tool certification and validation procedures are proposed.

•Reference cases for tool validation are defined and validation reference data calculated.

•The simplified approach for TSI testing has been clarified with flow-charts for specific application cases to harmonize its use.



Target 1: Introduce virtual certification with a reliable simulation approach: Achievements (II)

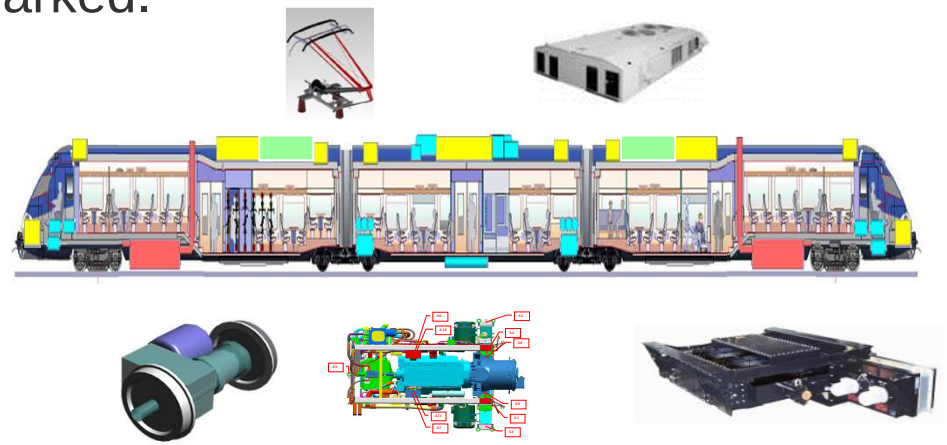
Source modelling and installation effects:

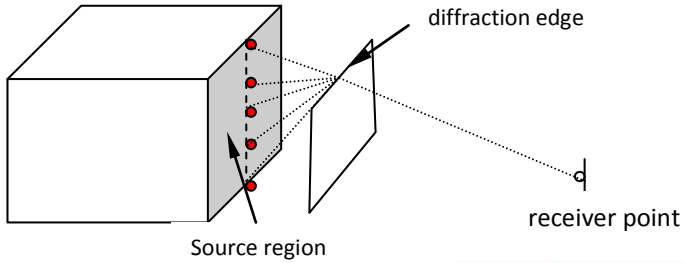
•An experimental procedure for determining equivalent multipole models of real vehicle sources is established and validated for real sources.

•Computationally efficient aero-acoustic source models are developed and validated using data from wind tunnel tests.

•Guidance has been produced on how to reliably predict rolling noise and procedures proposed to model different types of wheels.

•A measurement protocol for wheel roughness has been developed and successfully tested. Equipment/analysis procedures has been bench marked.

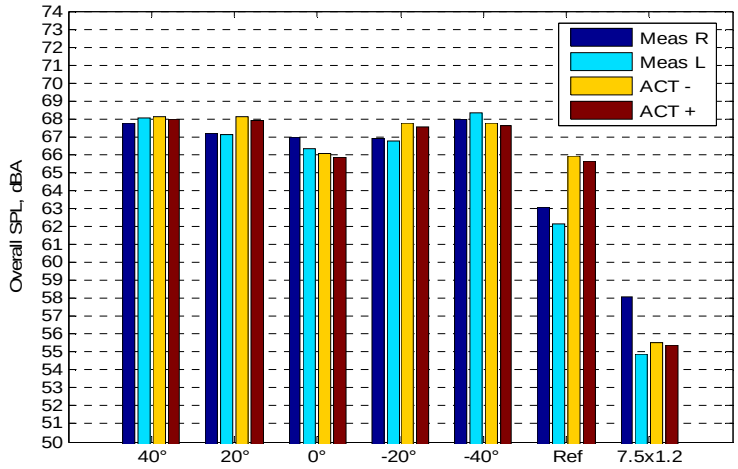


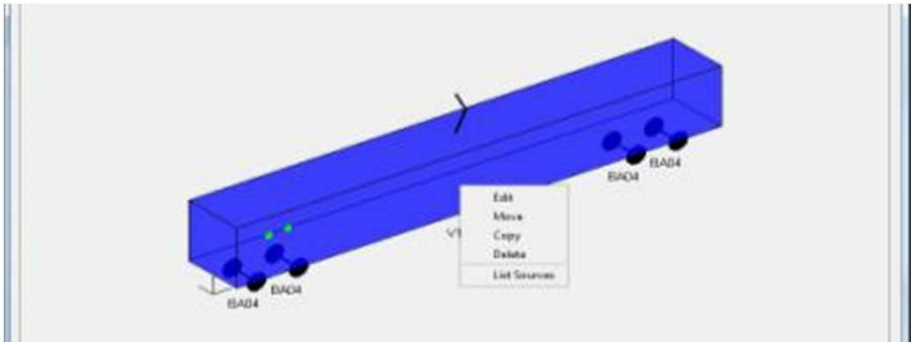


Target 1: Introduce virtual certification with a reliable simulation approach: Achievements (III)

Simulation tool development and assessment:

- A specification of capabilities for simulation tools for virtual certification has been established
- An ACOUTRAIN simulation tool has been developed
- A series of reference cases has been defined for validation of prediction tools





Target 1: Introduce virtual certification with a reliable simulation approach: Achievements (IV)

Procedure and tool validation

- Two measurement campaigns for validation of the virtual testing procedure are completed.
- In-situ directivity measurements and ground impedance measurements could contribute to a new state of the art.
- Detailed knowledge about rail vehicle sources and the importance of their associated installation effect and directivity is derived.
- The testing and modelling work have clarified the effort required to set up and validate virtual vehicle model => Recommendations for organising VT-certification to be suggested in the final deliverables.

Target 1: Introduce virtual certification with a reliable simulation approach: Needs for future work

Methodology development:

•Source models and experimental characterization of installation effects to be validated *in-situ*.

•Calculation procedures for source integration to be validated together with the source models established.

•Calibration of virtual vehicle models using measurement data: *Process is needed, including criteria for how and when.*

•The concept of reference vehicle has been introduced with a dedicated validation process, but *application experience is needed!*

Method/Process validation:

•Data is lacking for full validation of the procedures proposed and for a quantification of uncertainty of VT results.

•The correlation between measurement and simulation results is *presently not good enough for virtual certification purposes. More work needed.*

Process and guidelines :

•Guidelines for NoBo's (or similar) for model and tool assessments needed.

•Guidelines and an agreed procedure for model updating needed.

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Target 2: Establish a method for separation of infrastructure and rolling stock noise contributions:

Achievements:

•Three *separation methods have been proposed and tested* against four sets of measured data.

•These methods can be used either to transpose a vehicle to a different track or to transpose to another vehicle on the same track.

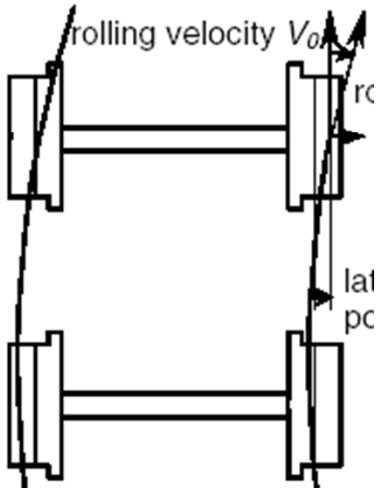
•The concept has been extended to a proposal for transposing measured results to a virtual reference track.

Future work:

•T*ransposition methods require further validation* before they can be used reliably for certification purposes.

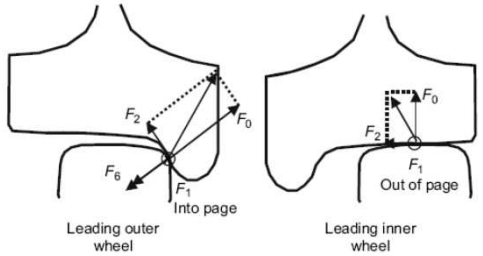
•The concept of a *virtual reference track* requires further study.

Target 3: Establish measurement procedures for new running conditions, specifically braking and curving



Achievements :

- A new procedure for type testing vehicles for curving noise is proposed, including an on board occurrence test procedure combined with trackside pass-by test.
- Statistical indicators have been proposed that take the variability and tonal content into account.
- For breaking noise, improvements have been proposed to the EN ISO 3095:2013 procedure.
- The procedures developed can be made available for standardization.



Future work:

- Further evaluation by field tests are required prior to standardization.
- For the long term, computational models both for curve squeal and braking noise might be a solution to reduce the testing effort.

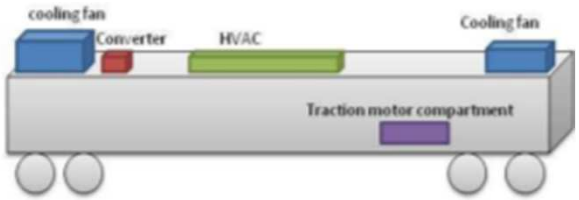
Target 4: Develop procedures to obtain inputs for the European Noise Directive (END)

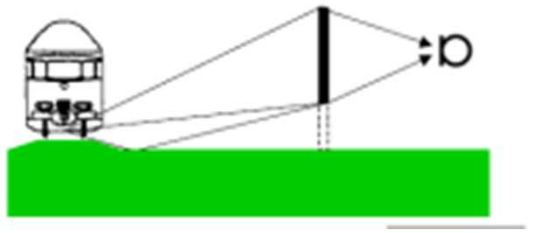
Achievements:

•A procedure to use”virtual testing” models for the definition of equivalent noise sources for the END noise mapping has been established.

•This procedure leads to realistic vehicle source power allocation without costly testing within application of the END.

•The models derived enables simulation of effects of way-side barriers.





Future work:

•Analysis of the effect of ”ageing” for typical rail sources needed.

Summary

- A framework for Virtual Certification is established, including definition of three different modes of application.
- A dedicated tool for virtual modeling of TSI tests has been developed.
- Testing and modeling procedures for characterization of significant vehicle and track sources are developed and evaluated.
- The concept has been tested for application on a standstill and a running regional vehicle.
- More work is needed to validate and refine the concept and to detail the validation of reference vehicles, including modelling updating procedures and best-practicre for source representations.
- Cost-benefit analysis of different virtual testing scenarios needs to be made.

Questions?

http://www.acoutrain.eu/