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DELIVERABLE D4.2

AURALISATION AND VR APPLICATION TOOLS

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[1] PU: Public; CO: Confidential, only for members of the consortium (including Commission Services)

[2] https://projects.shift2rail.org/s2r_matrixtd.aspx

Document history

Date	Name	Company	Details of Contribution	Position/Project Role
19/12/2022	All authors	Empa, ISVR, Vibratec, Bandara	Technical work towards the calculation models and software implementation	Technical WP4 contributors
20/12/2022	Reto Pieren, Fotis Georgiou	Empa	Initial document draft	WP4 leader, technical WP4 contributors
22/12/2022	David Thompson, Martin Rissmann	ISVR, Vibratec	Review and corrections	WP4 contributors
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12/01/2023	Kurt Heutschi, Geert De Grande	Empa, KU Leuven	Review	WP4 contributor, SILVARSTAR partner
17/01/2023	Reto Pieren	Empa	Final edits	WP4 leader

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Executive Summary

This report represents Deliverable D4.2 "Auralisation and VR application tools" of the Collaborative Project SILVARSTAR that is funded under the European Union's Horizon 2020 Research and Innovation Programme under the open call S2R-OC-CCA-01-2020 as part of the Cross Cutting Activities of the Shift2Rail Joint Undertaking.

This document briefly describes the software tools developed within workstream 2 of SILVARSTAR. For the auralisation and Virtual Reality of railway pass-bys, two new software tools were created: the SILVARSTAR Auralisation Tool and the SILVARSTAR VR Tool. This work was performed within Work Package 4, where the frameworks described in Deliverable D4.1 were implemented in functional software tools within Task T4.3.

The software tools were successfully tested in demonstrations and at international exhibitions (e.g. InnoTrans 2022). The new tools are made available to the railway industry and academia under an end user license agreement (EULA). The complementary user manual is published separately as Deliverable D4.3.

List of abbreviations, acronyms, and definitions

Abbreviation / Acronyms	Description
Empa	Swiss Federal Laboratories for Materials Science and Technology
EULA	End-user license agreement
EU	European Union
GUI	Graphical Use Interface
HMD	Head Mounted Display
JSON	Human-readable, hierarchical text file format
SILVARSTAR	Soil Vibration and Auralisation Software Tools for Application in Railways
VR	Virtual Reality
WP	Work Package

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1   INTRODUCTION

Two complementary software tools were developed within work stream 2 of the SILVARSTAR project. Using commercial VR hardware, they allow for creating an interactive, immersive user experience of virtual train pass-bys for demonstrating different noise mitigation measures. For instance, at the international trade fair for transport technology InnoTrans 2022 in Berlin, these tools were successfully demonstrated to the public in the Europe's Rail exhibition booth (see Figure 1 and https://twitter.com/EURail_JU/status/1572169536694001664).

The following two sections briefly introduce the two new software tools.

Figure 1: Live demonstration of the new SILVARSTAR Auralisation and VR tools at InnoTrans 2022 in Berlin at the Europe's Rail exhibition booth, with the EU Directorate-General for Mobility and Transport Henrik Hololei using the VR system (photo provided by Europe's Rail).

2   SILVARSTAR AURALISATION TOOL

2.1 SHORT DESCRIPTION

The SILVARSTAR Auralisation Tool was developed within the SILVARSTAR project. It computes the auralisation of a train pass-by based on selectable input parameters. It is based on the latest scientific knowledge on railway noise modelling and physics-based sound synthesis. The tool allows the user to choose between different: train types, speeds, track types, environments, observer locations and noise mitigation measures (e.g. barriers, rail & wheel dampers). As an output it provides calibrated multichannel audio data for different sound reproduction systems, including a VR-ready format to be coupled to the SILVARSTAR VR Tool (see Section 3).

2.2 REQUIREMENTS AND AVAILABILITY

The SILVARSTAR Auralisation Tool is distributed as an installer executable file (.exe) of about 4 MB size. The program has a GUI (see Figure 2) and has to be installed on a computer operating under Windows 10 and with administrator rights. During the installation process an internet connection is needed to download required library files from a server. Further installation instructions and user guidance are provided in the public Deliverable D4.3 with the user manual.

The software is distributed as freeware for non-commercial use under an end-user license agreement (EULA) together with a license file (.dat). The software is copyright protected by the developers. The developers are not responsible for the software, its results or the use of it. It was programmed in MATLAB by Reto Pieren and Fotis Georgiou from Empa. Users that use, present or publish simulation results must give credits to the authors, the SILVARSTAR project and cite related scientific publications. The installer file of the software can be downloaded from the website
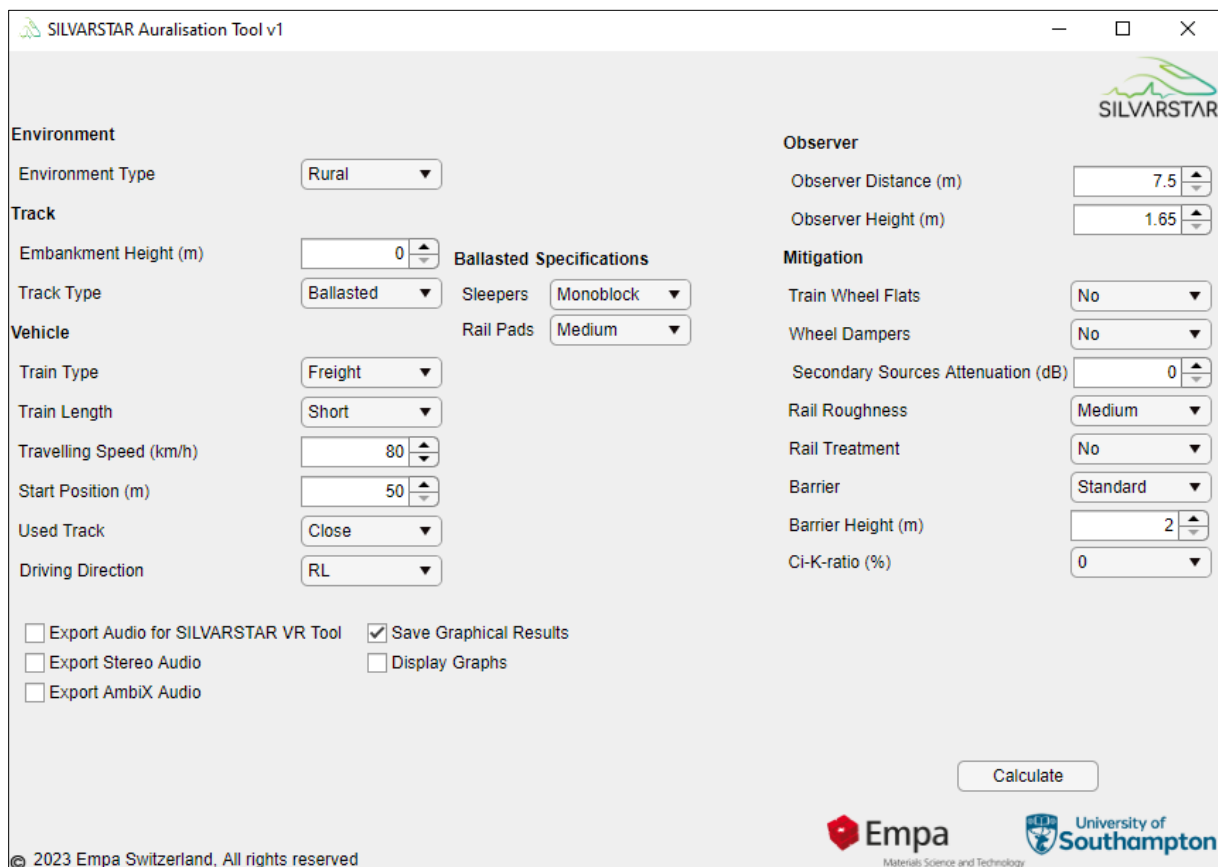
https://www.empa.ch/web/silvarstar/

Figure 2: GUI of the SILVARSTAR Auralisation Tool.

2.3 FURTHER INFORMATION

Further information about the software can be found in the public SILVARSTAR Deliverables D4.1 and D4.3, and scientific publications of the authors (see e.g. references in Section 4).

3 SILVARSTAR VR TOOL

3.1 SHORT DESCRIPTION

The SILVARSTAR VR Tool was developed within the SILVARSTAR project. It is a stand-alone VR tool that allows for an interactive, immersive VR experience of virtual train pass-bys. These audio-visual simulations can be used to demonstrate railway noise mitigation measures to a user wearing a VR headset. Using motion controllers, the user can immediately switch between different scenarios.

The tool renders an animated 3D visual environment reproduced over a head mounted display (HMD). Corresponding binaural sound is reproduced over calibrated headphones. The tool has a GUI (see Figure 3) allowing the operator to guide the user, who is wearing the VR headset, through different virtual scenes. The scenes and their sequence can be configured using an input file (.json). The corresponding required VR-ready multichannel audio files are provided by the complementary SILVARSTAR Auralisation Tool (see Section 2).
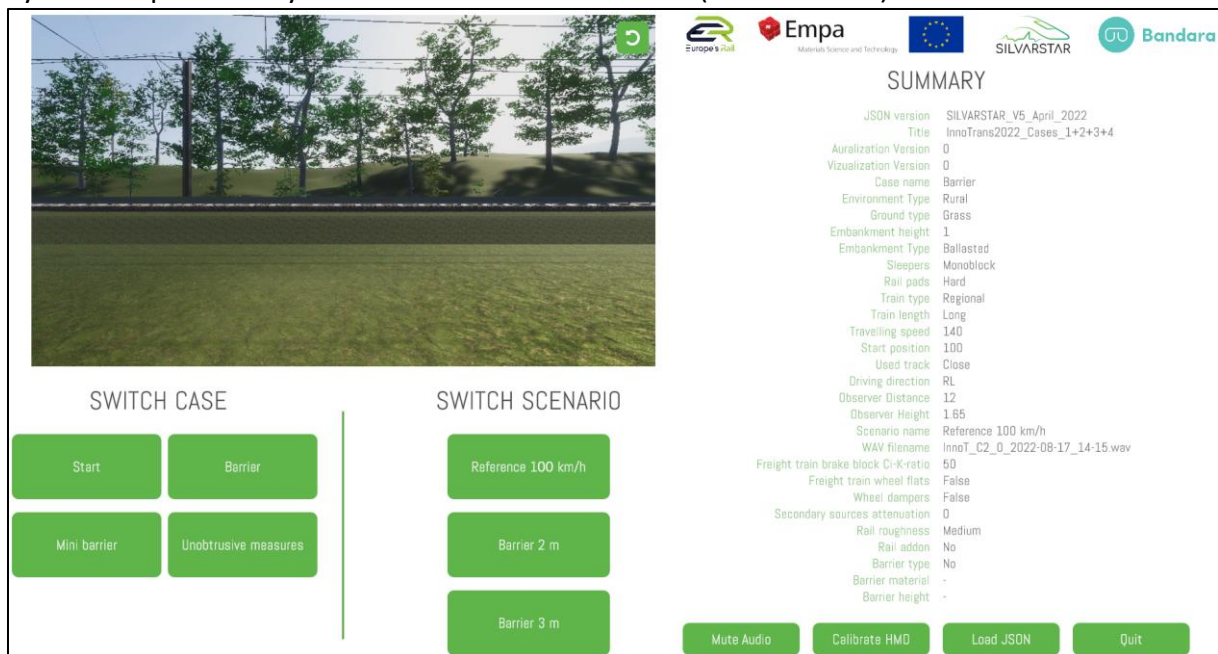

Figure 3: Main operator view while the SILVARSTAR VR Tool is playing back the audio-visual-stimuli to the subject.

3.2 REQUIREMENTS AND AVAILABILITY

The SILVARSTAR VR Tool is distributed as a stand-alone executable file (.exe) which does not need installation. In order to ensure high quality video and audio reproduction the following requirements shall be met:

- Hardware:
    - PC with NVIDIA GeForce RTX 2080 graphics card or higher
    - VR headset and motion controllers Oculus Meta Quest 2 (of any disk size)
    - Oculus link cable
    - Meta Quest 2 elite strap (recommended for better and quicker fit)
    - Sennheiser HD650 headphones
    - External audio interface with gain control
    - AC voltage meter (for sound level calibration)
- Operation System and software
    - Windows 10 or 11
    - JSON file editor (e.g. Notepad++)
    - Oculus-App

All the input parameters for the simulated Case/Scenarios are specified and written in a human-readable, hierarchical text file (.json) which in turn is loaded in the VR tool in order to playback the audio-visual stimuli. A template for the editing of the JSON file, which also includes comments to help the user in editing it, has been created and will be provided to the end users.

The SILVARSTAR VR Tool was developed by Empa and Bandara VR. The software is distributed as freeware for non-commercial use and is copyright protected by the developers. The developers are not responsible for the software, its results or the use of it. It is developed and programmed in Unity 3D by Dario Sala from Bandara VR and by Fotis Georgiou from Empa. Users that use, present or publish simulation results must give credits to the authors, the SILVARSTAR project and cite related scientific publications. The software can be downloaded from the website

https://www.empa.ch/web/silvarstar/

3.3 FURTHER INFORMATION

Further information about the software can be found in the public SILVARSTAR Deliverables D4.1 and D4.3, and scientific publications of the authors (see e.g. references in Section 4).

4 REFERENCES

Pieren R., Georgiou F., Thompson D., Heutschi K., Squicciarini G., Rissmann M. & Bouvet P. (2021). Methodology for auralisation and virtual reality of railway noise. Technical report, SILVARSTAR project, Deliverable D4.1, Report to the EC.

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