# Utilizing state of art measurement techniques and simulation tools for engine exhaust noise analysis

## Introduction

- **Objective:** This study seeks to leverage cutting-edge measurement and simulation tools for engine exhaust noise analysis, with the aim of delivering advanced and effective NVH solutions at the forefront of current technology.
- The study is based on two experiments: one using the main exhaust pipe of the W4L20 medium-speed engine located at VEBIC, and the other using a 3.2 m long plastic pipe.
- The analysis focuses on low-frequency noise in the range of 25 to 500 Hz, which is known to be the least attenuable, by disregarding variations in mean flow and mean temperature.
- **Research Question:** Identify the parameters that affect the accuracy of noise measurements from the perspective to use them to calibrate simulation models

## Methodology

- Hardware-wise, a loudspeaker was utilized to generate random pink noise. The speaker was connected first to a plastic pipe and later to the exhaust pipe for experimentation.
- Each of these experiments demonstrates the feasibility and applicability of the transfer matrix method and the pressure boundary condition approach for predicting noise using GT-POWER simulation.
- Two different sensors were used for both of these experiment. PU probe was used to measure particle velocity and sound pressure in Experiment A. While GRAS 40SC was used to measure the sound pressure inside the pipeline in Experiment B.

## Experiment A

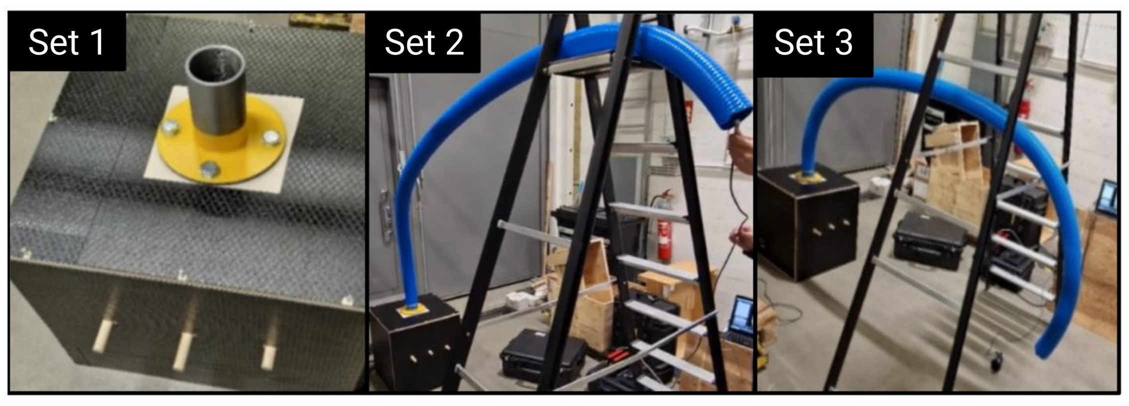
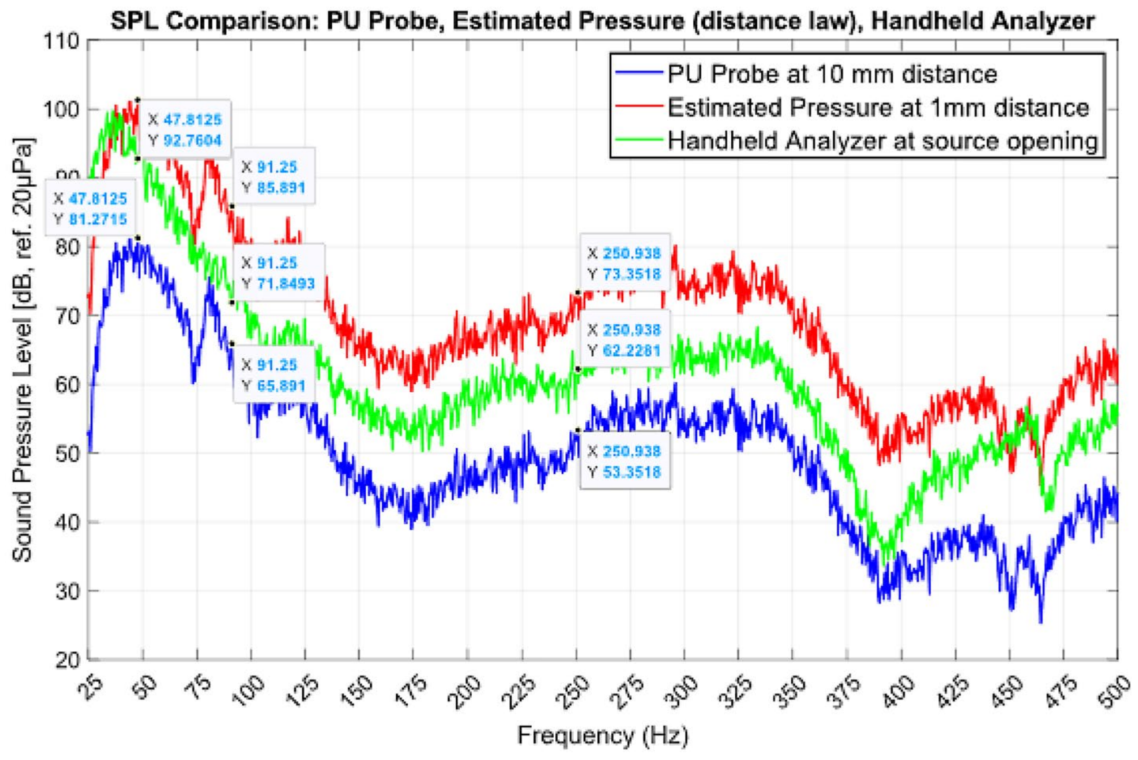



Figure 1. Set 1 depicts the source setup, Set 2 illustrates the plastic pipe with a 90° bend angle, and Set 3 showcases a setup with a 180° pipe bend

SPL Deviation




DAQ SYSTEM

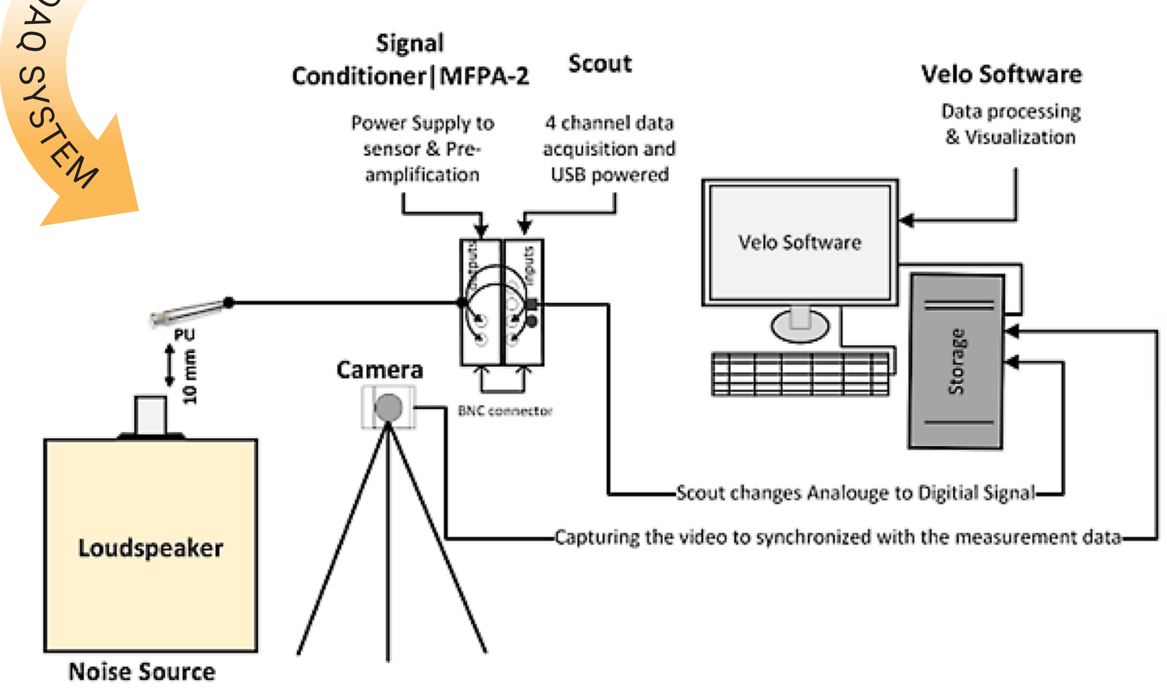
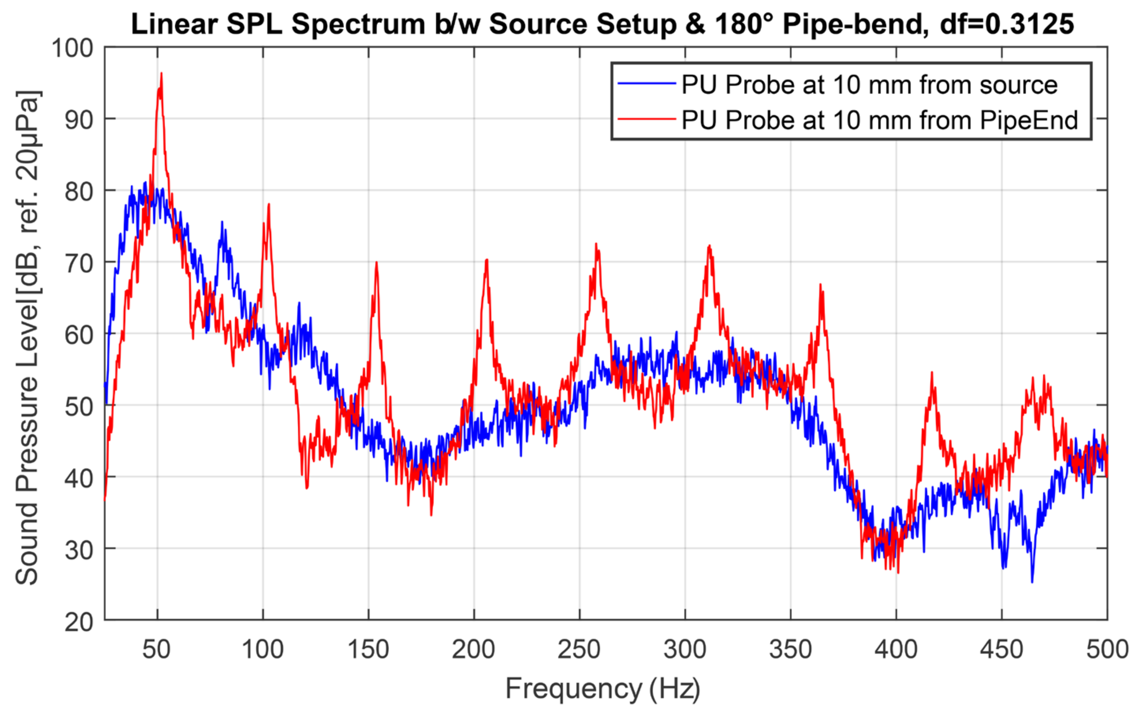
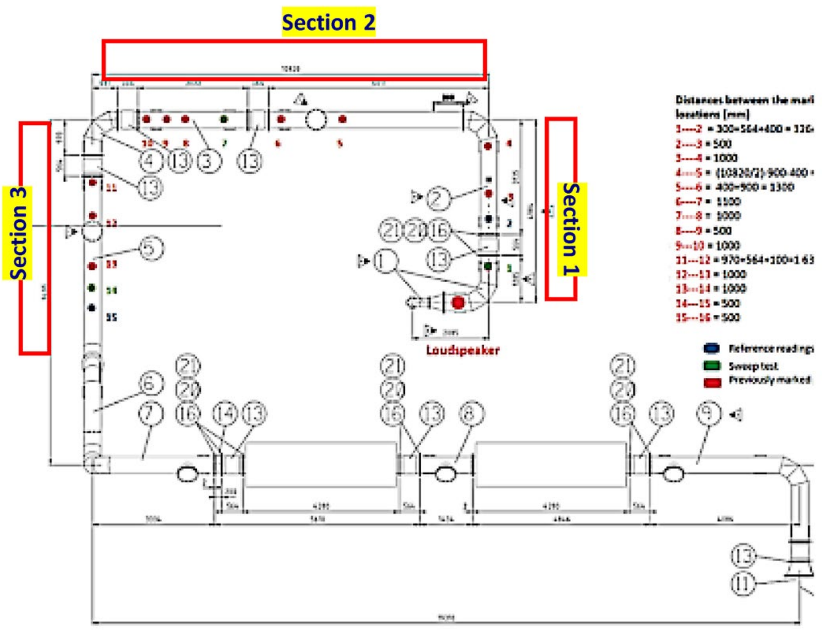



Figure 2 illustrates a schematic diagram of the PU probe capturing pressure and particle velocity signals from the source setup and passing through various stages

FTT

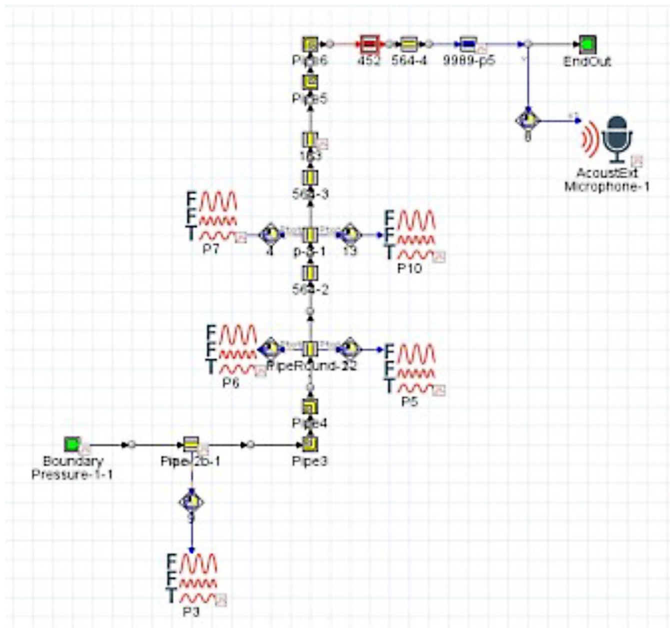



## Experiment B




← Figure 3. Layout diagram of the exhaust pipeline pointing multi-pressure measurement locations

→ Figure 4. GT-Model of exhaust pipe using pressure boundary conditions at point 2.



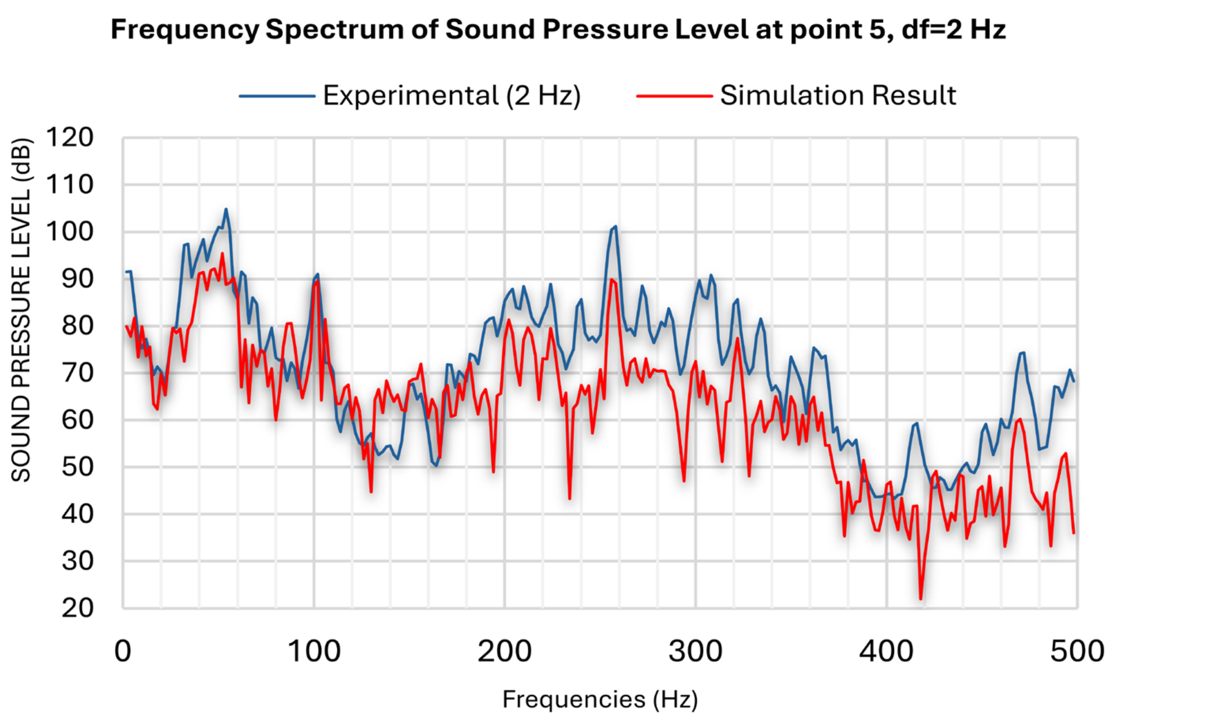



Figure 5. Graph demonstrates the validation of GT-Model results against the value SPL measured at point 5 by using the pressure boundary condition.

## Conclution

- Sound pressure level outside the pipe is highly sensitive to sensor position, with a 10 dB difference measured by shifting the sensor just 9 mm
- The transfer matrix approach in simulation introduces uncertainties stemming from the measuring point.
- The pressure boundary condition (BC) approach yields superior accuracy and results by conducting measurements inside the pipes.
- Bends exhibit negligible effects on Sound Pressure Level (SPL) in the plane wave propagation mode.

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