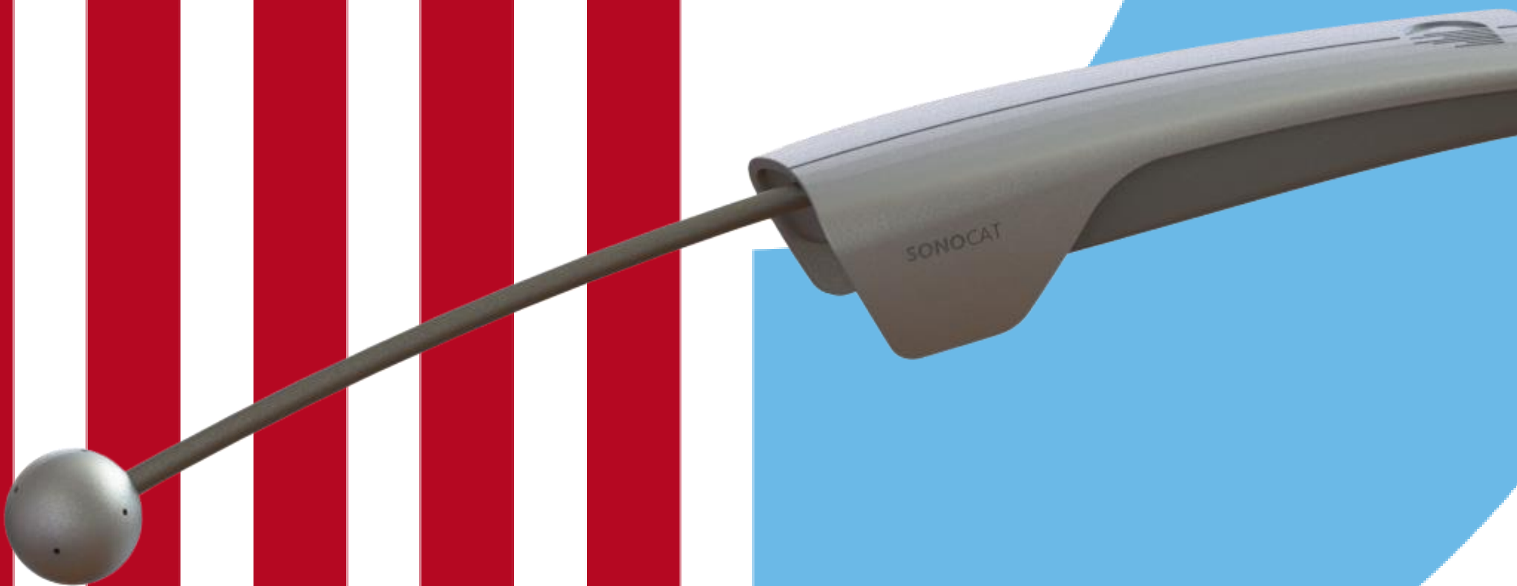

Sonocat

Finding the dominant acoustic sound sources in a driving vehicle

Introduction

To assess a noise issue inside a car, several Sonocat measurement scans were conducted inside the vehicle while driving on one of the Testing Locations for NVH. The Sonocat measurement device used in the experiments is shown in Figure 1. The measurements were performed on a sunny and warm day. Initially, some point measurements were performed to roughly measure the acoustics inside the vehicle and get acquainted with the problem. Secondly, measurement scans were performed covering the suspected interior areas. These measurements took about ½ hour to perform. Afterwards, the scans were processed and the major noise emitting surfaces were identified.

Figure 1. The Sonocat measurement device.

Measurements

In Figure 2, the labelled some of the areas where measurements were made are shown. These labels indicate the scan number and description of each of the scanned area, which correspond to the measurements files shown in Figure 3. (One may have to zoom into the photo to see the scan numbers).

Figure 2. Some of the scan areas inside the vehicle.

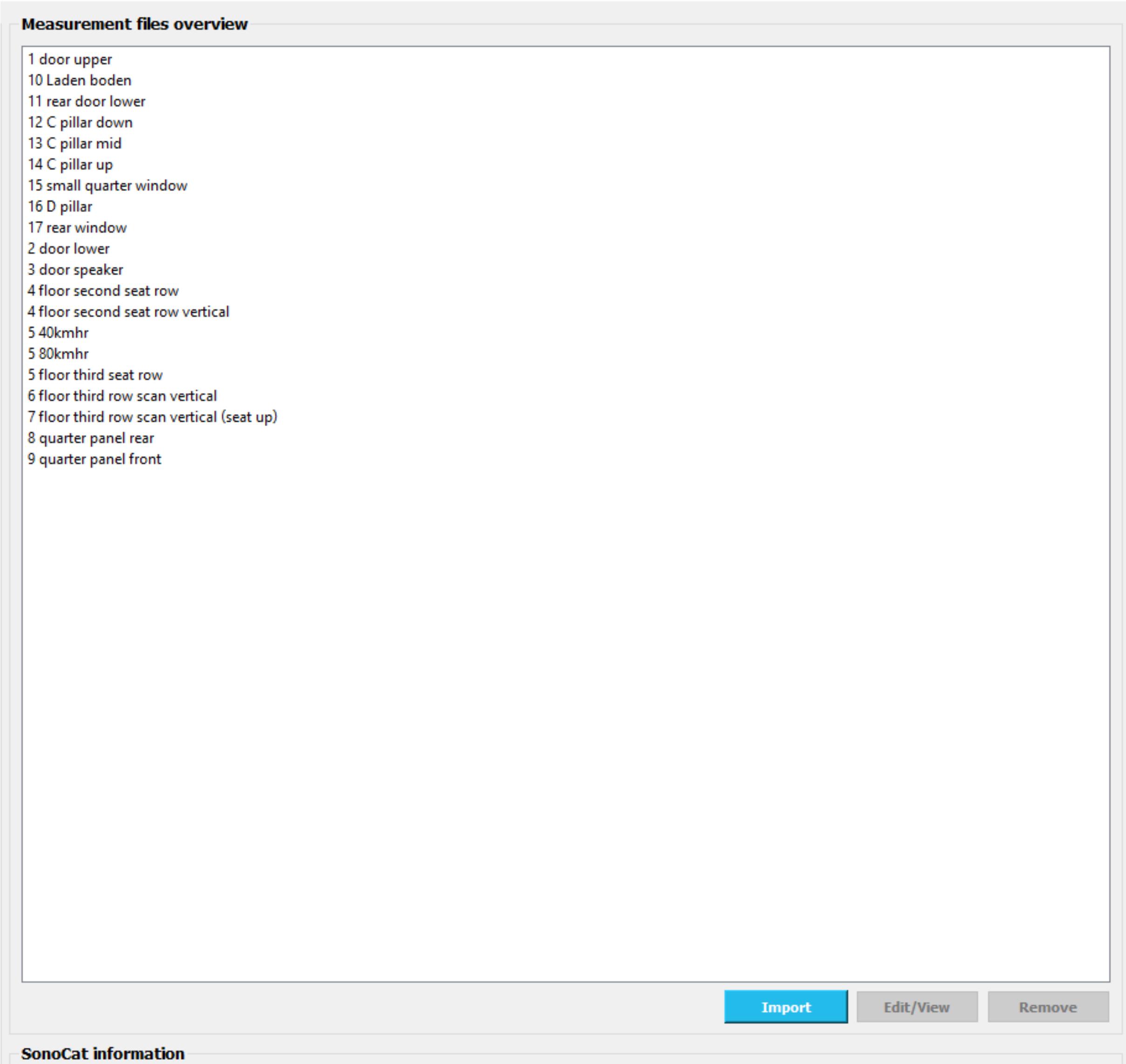

Figure 3. Overview of the measurement files, as shown in the Sonocat software, indicating all the measurement scans.

Results

Using the Sonocat and Sonocat software, the active power (= incident acoustic power flowing through the scanned area – reflected acoustic power flowing through that same area) has been measured as well as the absorption/emission coefficient (= the ratio between the active power and incident/emitted power). For convenience, the absorption and emission coefficient are plotted in the same figure, Figure 4, where we have used the convention that absorption coefficients are positive and emission coefficients are negative.

Thus, if the active power is negative, sound is emitting from the scan area and for more negative values of the emission coefficient this emission is also more efficient. Hence, the most dominant noise coming into the cabin is from areas for which the emission coefficients are most negative. (One will be able to plot the emitted power as well, in the upcoming release update of the Sonocat software).

The measured absorption/emission coefficients are shown in Figure 4 in 1/3-octave bands for the frequency range of interest (between 400 and 1000 Hz).

Clearly, one observes large negative values of the emission coefficient for the floor third row scan vertical (seat up), as well as but less dominant, the floor third row scan vertical (where the back seat was folded down). Other surfaces show less emission and even absorption of the sound incident on that scan area.

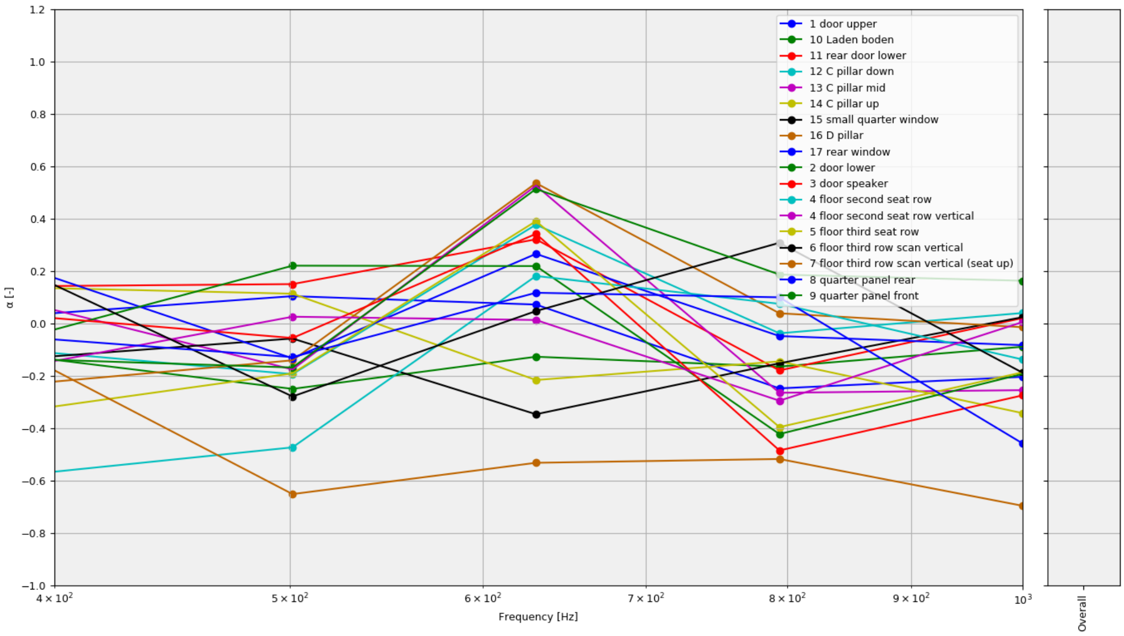

Figure 4. Absorption/emission coefficients for the scanned areas.

In Figure 5, the active sound power is shown for all the measured areas. Indeed, in the 630-1000 Hz 1/3-octave bands, the floor third row scan vertical (seat up) shows the largest emitted power. Also the C-pillar up and small quarter window seem to emit sound power. All other surfaces seem to absorb sound as the active powers are negative (power is flowing into the area – in Figure 5, this is indicated by the hashed bars). It must however be stressed that in this frequency range, the sound field in the cabin is quite diffuse and the active power is small and hard to measure accurately.

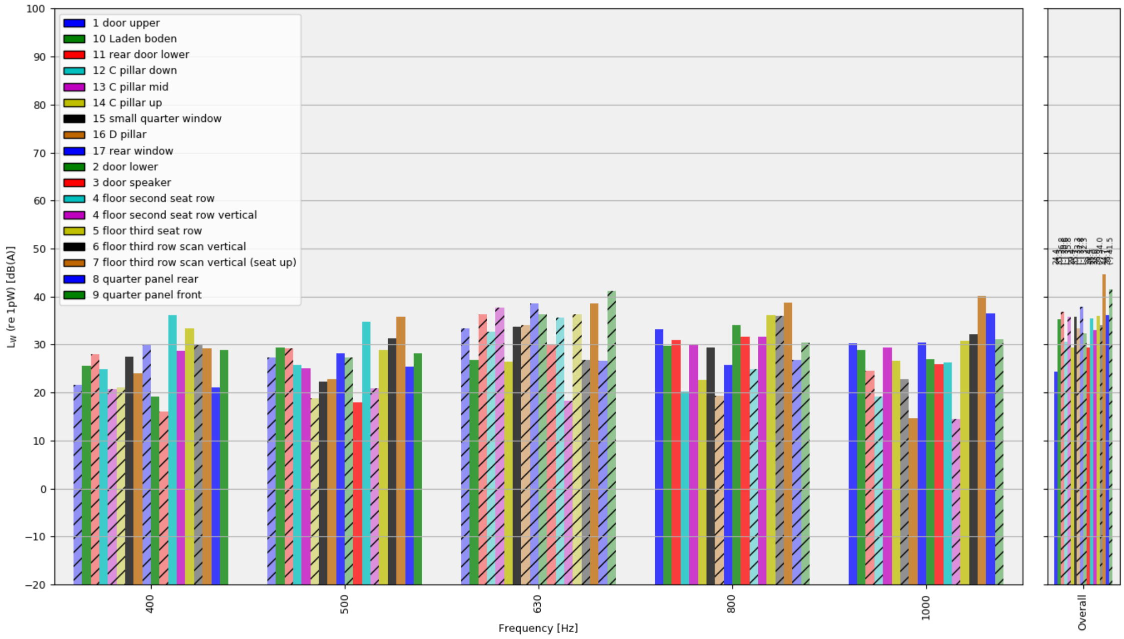

Figure 5. Active power incident on the scanned area (if the color is hashed) or emitted from the scanned area (if a solid color is used).

Conclusion

The Sonocat can be used to assess possible noise issues inside a car cabin. For this specific vehicle, based on a limited number of Sonocat measurements, it is most likely that most sound in the frequency range of interest is entering the cabin through the vertical scan area, just underneath the third row seat. This is in line with the observations of the non-closure of the covering behind/under the third row seat.