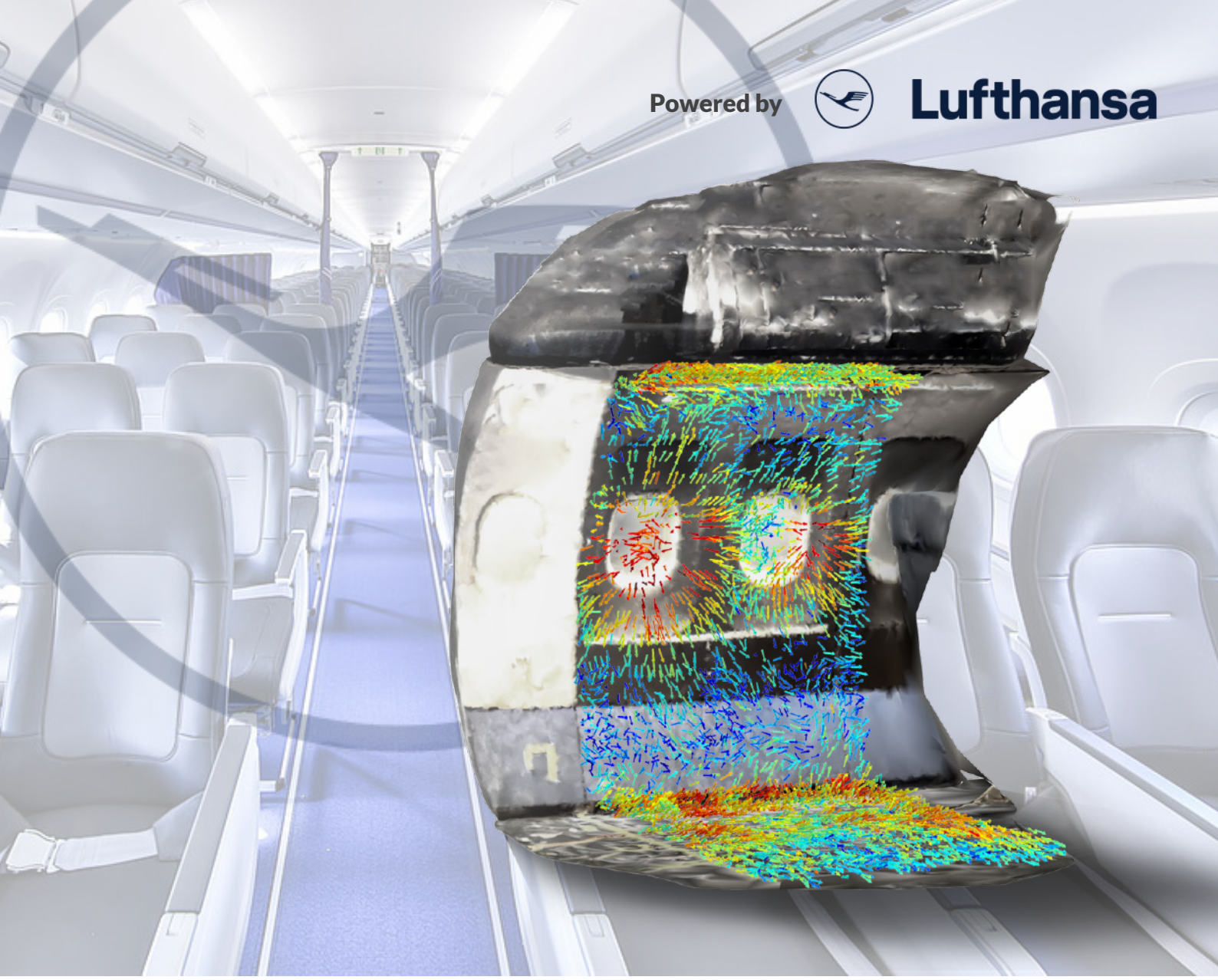


MICROFLOWN TECHNOLOGIES

Case study

AIRPLANE CABIN INTERIOR LEAKAGE DETECTION AND SOURCE LOCALIZATION

Using Microflown Scan&Paint 3D & Voyager

INTRODUCTION

Lufthansa, a globally recognized and prestigious airline, stands as a symbol of excellence and innovation in the aviation industry. With a rich history spanning several decades, Lufthansa has established itself as a leading provider of premium air travel services, catering to millions of passengers worldwide each year. As one of the largest airlines in Europe, Lufthansa operates an extensive network of domestic and international flights, connecting travelers to destinations across the globe.

Lufthansa has consistently sought to enhance its products and services through thorough experimental validation. Recognizing the importance of creating a quiet and comfortable travel experience, They requested a Demo from Microflown to adopt a rigorous approach in identifying and targeting key noise sources inside an airplane cabin. By leveraging Microflown's advanced technology and expertise, Lufthansa aims to overcome the unique acoustic challenges associated with aircraft design and operation, enabling precise localization and mitigation of noise sources to achieve quieter cabins, improved passenger comfort, and an elevated standard of air travel for their valued customers.

GOAL & REQUIREMENTS

Lufthansa seeks to enhance the acoustic environment within the airplane cabin through this feasibility study aimed to drive innovation and improve the overall acoustic environment for a more comfortable travel experience.

- **Detecting sound sources and leakage in an airplane cabin interior**

MEASUREMENT METHODOLOGY

The Voyager
This case study utilized two measuring solutions to tackle acoustic challenges. The Voyager, a portable multi-channel acoustic analyzer, captured data through listening tests conducted by scanning with a PU probe near the cabin panels. The evaluation encompassed sound pressure and particle velocity signals. Real-time filtering tools were employed to concentrate the output on specific frequency bands of interest. Leveraging the distinctive capabilities of particle velocity proved invaluable in the field, particularly for detecting acoustic leakages.

Scan&Paint 3D
The Scan & Paint 3D system incorporates a 3D sound intensity probe. This probe consists of one microphone and three orthogonal particle velocity sensors, enabling comprehensive capture of acoustic information. The probe is fixed to a sphere equipped with IR reflectors, tracked by a stereo camera for precise positioning.

In the case study, an entire cabin section was efficiently scanned in just around 30 minutes using this 3D sound visualization system. To achieve this, multiple measurements were taken of each sub-section individually, with an average measurement duration of approximately 4 minutes. This approach ensured accurate and detailed analysis of the sound field in the cabin, providing valuable insights for effective noise control and troubleshooting efforts.

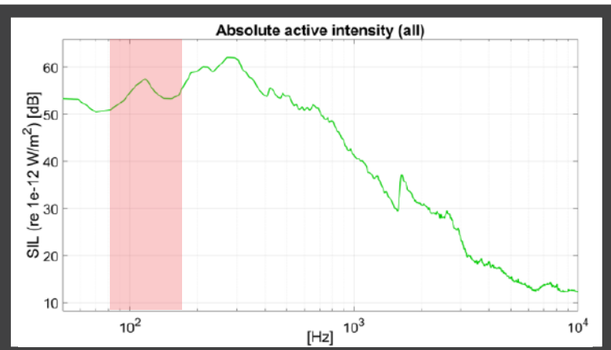
OUTCOME OF THE MEASUREMENT CAMPAIGN

Since Lufthansa had no prior experience with Microflown, a meeting was scheduled to introduce the state-of-the-art technology of particle velocity-based measurement solutions. The objective was to utilize this technology effectively.
After conducting a pre-scan with the Voyager, crucial areas of interest were identified and located. This facilitated the subsequent action of Scan & Paint 3D. Once the 3D measurements were completed, Lufthansa and Microflown obtained a visual reference of the sound field propagation and sound intensity distribution around the cabin. This enabled them to assess the various emitting areas across multiple critical frequency ranges.
Despite the challenging acoustic conditions in the target environment, sound source localization and quantification was performed effectively in the full audible range without introducing any extra absorption material into the cabin.

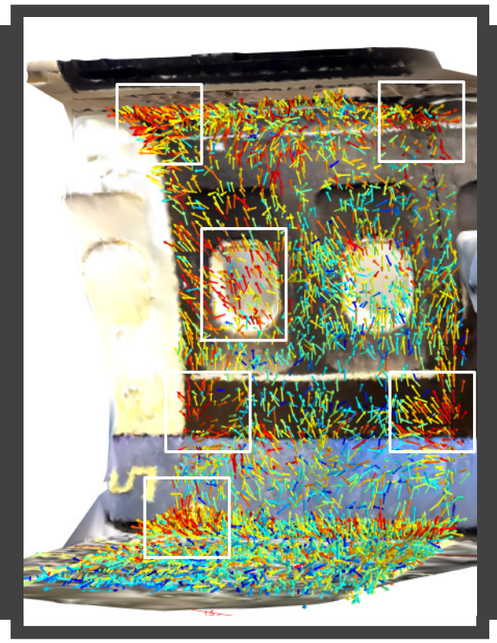
The results were used to inform potential construction changes.

- The Voyager has effectively identified key noise sources and regions of interest.
- The integration of the Voyager with the Scan & Paint 3D solution has facilitated comprehensive identification of noise and leakage sources, providing a visual representation of the entire sound field.
- The most significant radiation/leakage per frequency band is observed at the intersection between the floor and cabin wall. Other source/leakage areas largely coincide with intersections involving other panels, the floor, and windows.
- Faster scanning has demonstrated effectiveness in achieving reliable results

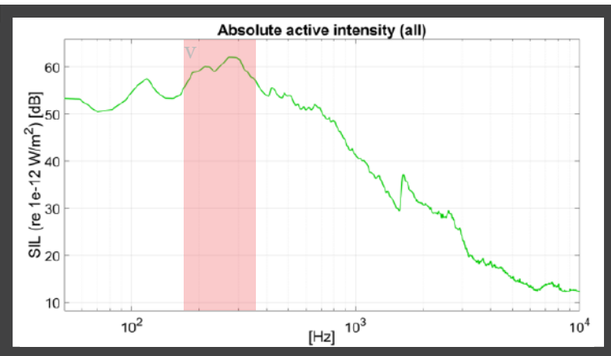
125 Hz octave band



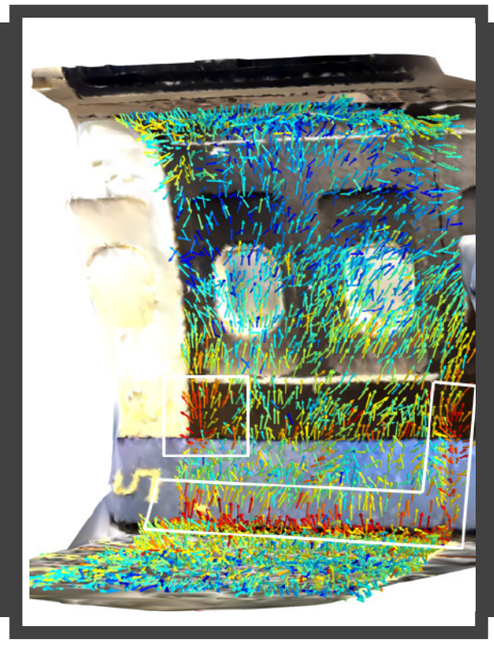
The first significant sound energy propagation starts at the 125 Hz frequency. It is clearly noticeable that since the speaker outside was placed closer to the left side, the radiation over this side is more prominent. Furthermore, it is possible to spot the radiation of the bottom and upper side for the left and right outer panel intersection as well in the floor left side area.



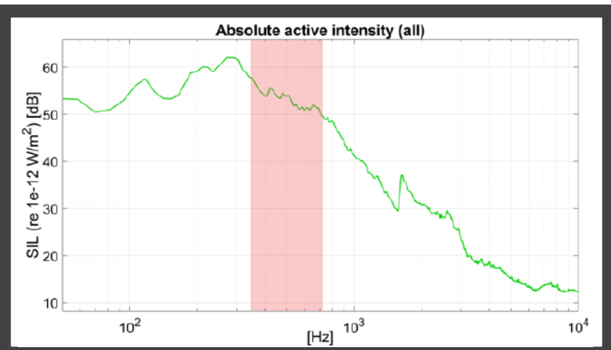
250 Hz octave band



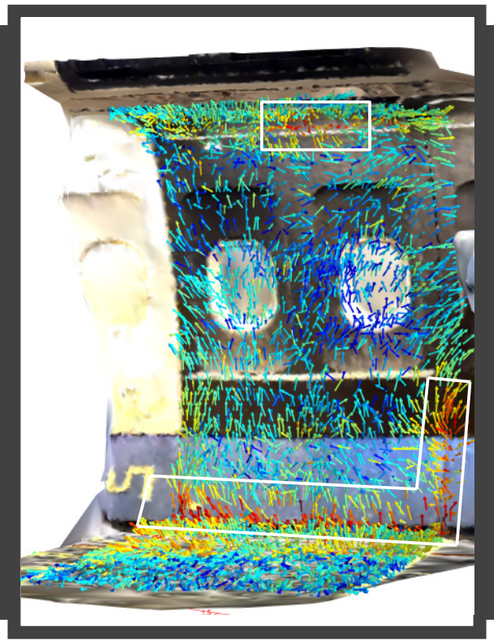
For this spectral region, which is also the higher level in the whole spectrum, the dominant areas are located at the intersection of the floor with the cabin wall panel. As well on the edge of the right bottom side, which is also an intersection point between wall panels just as on the left side right below the window.



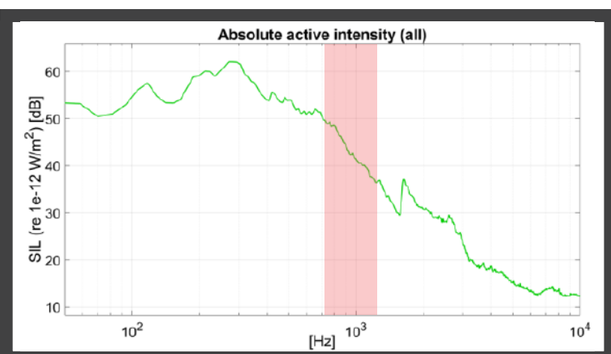
500 Hz octave band



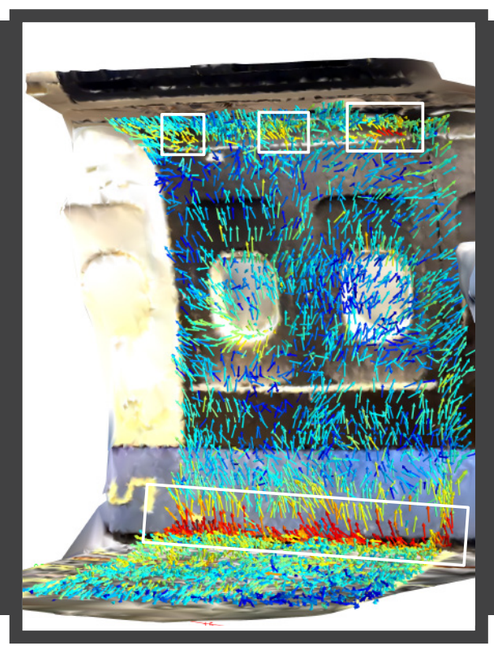
The results of this region are very similar to the previous band, the radiation area is located at the intersection of the floor with the cabin wall panel. But with the difference that at the top and very centralized there is a prominent radiation spot coming from the partition between the wall and the luggage carrier.



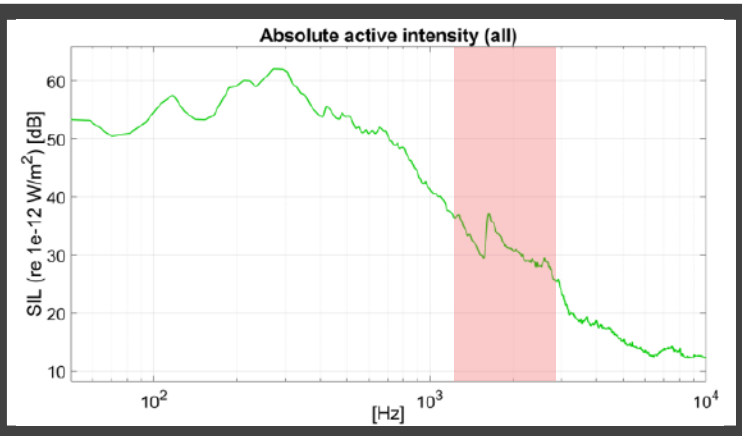
1 kHz octave band



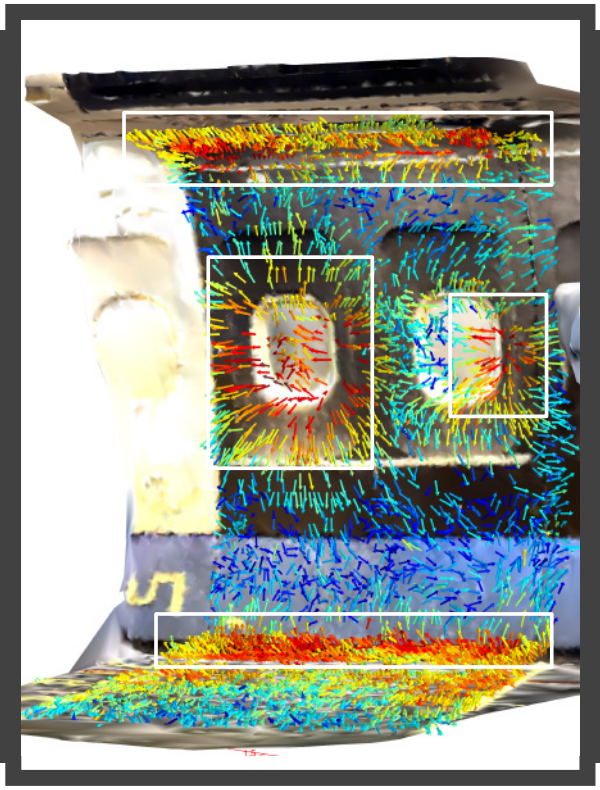
The main radiation area remains located at the intersection of the cabin floor and wall panel. However, the radiation spot originating from the partition between the wall and the luggage carrier is no longer at the center, and has shifted towards the right. Despite this, several radiation spots are still visible on both sides and in the top middle area.



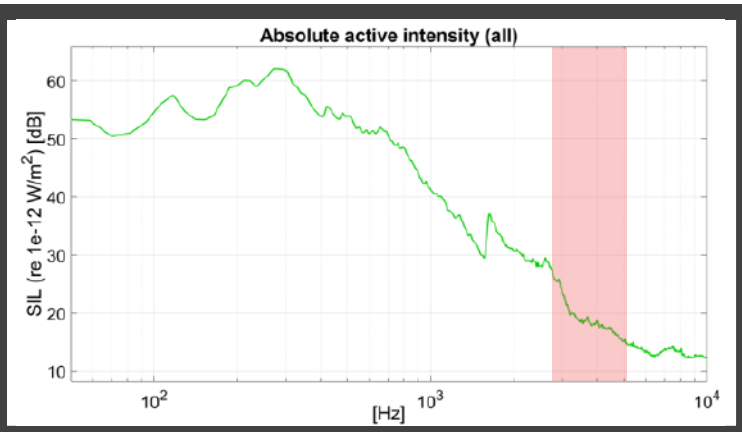
2 kHz octave band



The radiation areas are easily seen in the 2 kHz band, starting from where the wall meets the luggage carrier and extending to where the wall panel meets the floor, including both windows. The left window emits sounds due to its proximity to the outside speaker, while the right window seems to be a radiation or leakage area possibly caused by the attachment to the wall.



4 kHz octave band



The upper and lower sections show similar behavior to previous bands. The left window, close to the outside speaker, is a significant radiation area for this frequency band too. Radiation/leakage is concentrated around the bottom sides of the window. Particularly, there is a specific area at the far right where the panel bottom walls intersect, showing strong radiation.