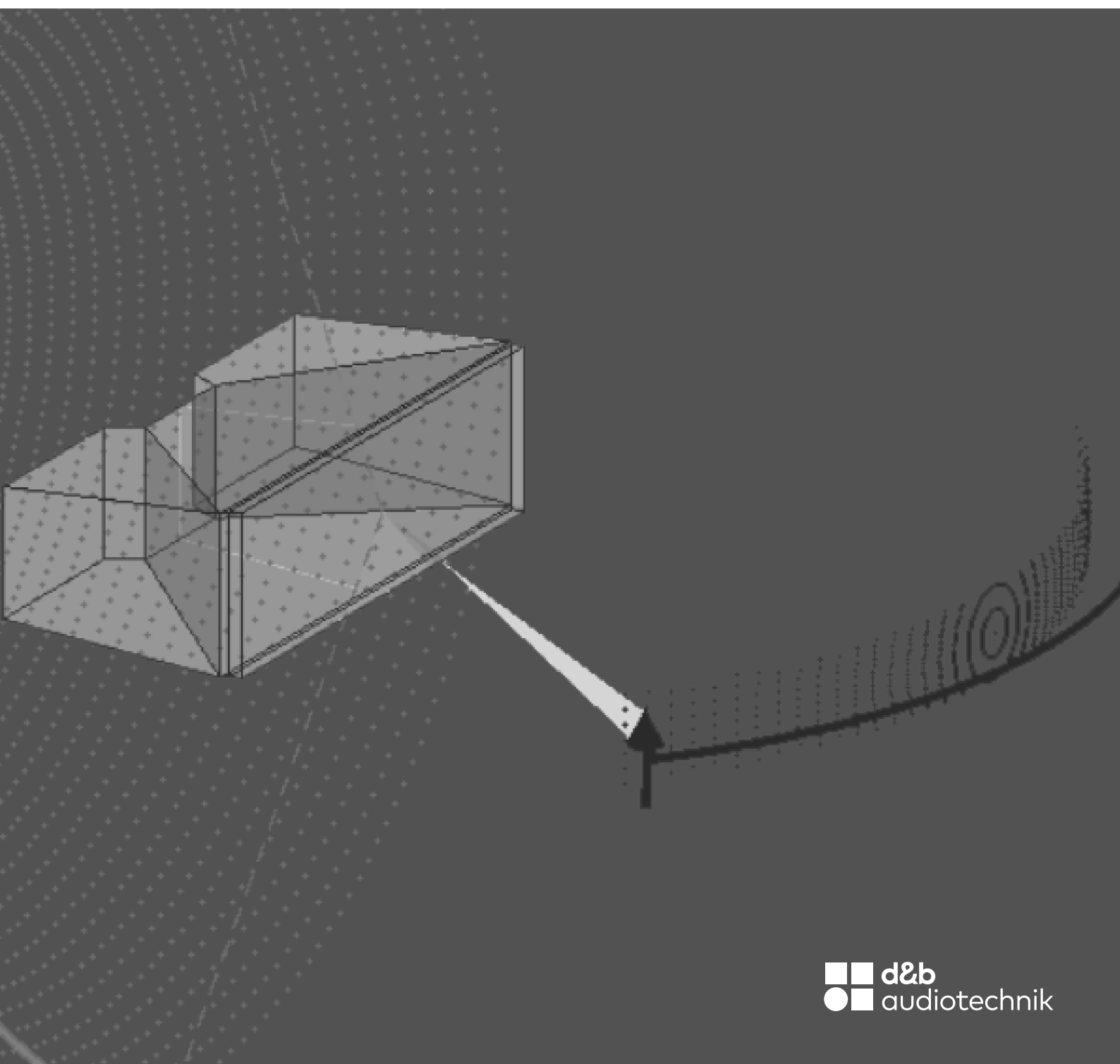


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AN 162 - 1.1 en **Behind the screen...**

Operating loudspeaker systems behind LED screens



Challenge

Contemporary productions face the requirements of having to align the sound reinforcement system with the needs of the visual production design, which is often heavily based on video content. To minimize the visual impact of the sound system, there is often a desire to install it behind LED screens.

For this purpose, there are a variety of LED panels available that use miniaturization and very thin structures to be as transparent to sound as possible. In the following, we will discuss what that means in real-world terms.

Why are LED panels an obstacle to sound propagation?

LED panels are commonly defined by their “pixel pitch”, i.e., the center-to-center distance between neighboring LEDs that each form an image pixel. Common values for high-resolution panels that are used at large scale shows are between 4 and 10 mm, depending on the minimum viewing distance. As a rule of thumb, the minimum viewing distance in meters roughly equals the required pixel pitch in millimeters.

The photograph to the right shows the rear of such a panel (roughly 8 mm pixel pitch) with a human hand for reference. As can be seen by the support structure for the LEDs, a smaller pixel pitch leaves less open area for sound to pass through.

These grates alone present an obstruction in several ways.

- Due to their width, some sound is reflected backwards, leading to less achievable sound pressure towards the audience and possible spill issues behind the panel.
- For any propagation or listening angle that is not perpendicular to the panels, the open area is further reduced by the resulting window blinds effect.

Secondly, LED panels usually feature some sort of reinforced frames, mounting rods, and power supplies, which are far more massive than the LED grates. Depending on how the panels are mounted in front of the loudspeakers, these constructional elements present additional obstacles and reflective surfaces.

Finally, depending on the density, overall screen size and placement relative to the loudspeaker system and other structures, the LED screen may form an acoustic resonator due to its only partial transparency which may further influence the sound directed at the audience.



Evaluation of typical influences

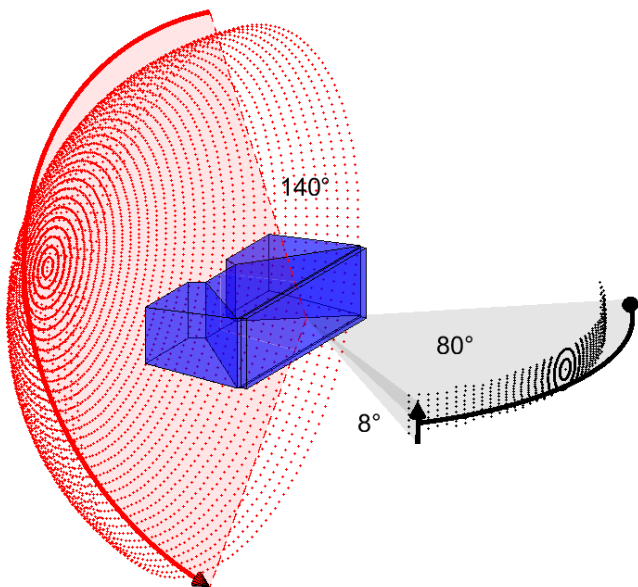
Magnitude response aberration

Measurements with a resolution of two degrees were performed using an assembly of a single line array cabinet mounted behind high-transparency LED panels, which in turn was mounted to a robotic arm to allow an all-aspect evaluation.

Measurements were performed for relevant areas of interest:

- In front of the cabinet, an 80 by 8-degree sector was sampled, representing the typical nominal coverage of the HF section of a large-scale line array element to evaluate the influence on the audience coverage.
- Behind the cabinet a conical 140-degree sector was sampled to evaluate possible reflections due to the presence of the panels.

Since all LED panels share the characteristics described in the previous section, the results described in the following can be generally expected for panels other than the measured make and model.

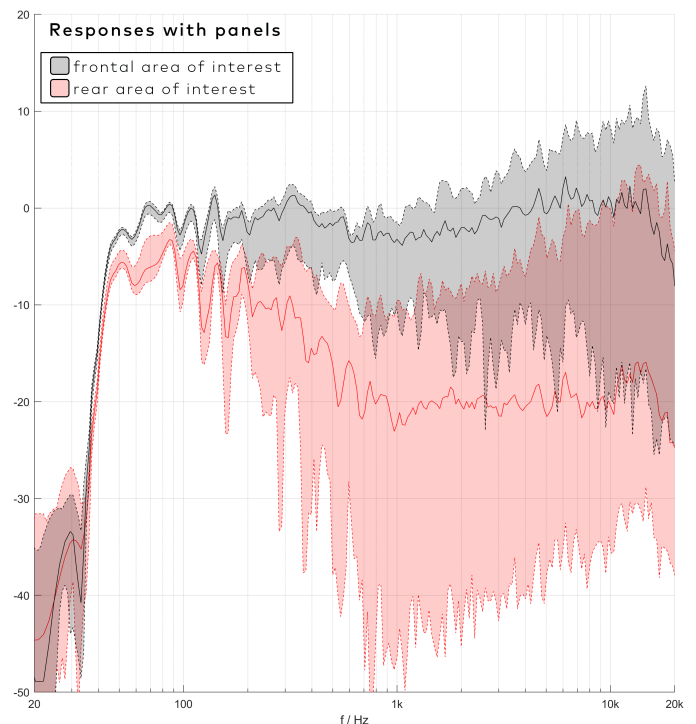
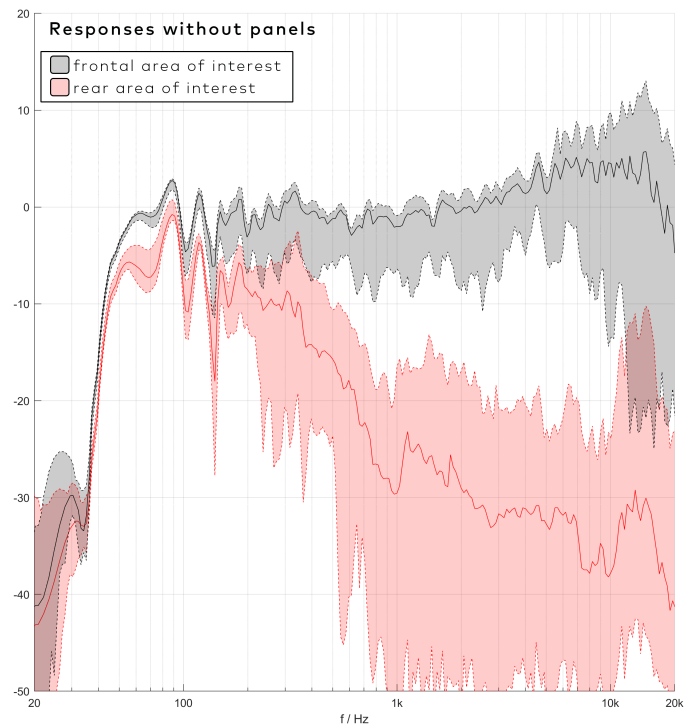


In the graphs on the right, the grey-shaded areas represent the envelope of all magnitude responses in both horizontal and vertical direction from the frontal area of interest.

The red-shaded areas represent the same for the rearward area of interest. Marked in bold is the respective average response of all considered measurement points.

When comparing the responses with and without panels, the following effects are obvious:

- In the frontal area of interest, there is a pronounced loss in the vocal and harmonics range above 1 kHz. This comparative loss approaches and sometimes exceeds 10 dB. The average response across all measurement points suffers a broadband loss of about 5 dB.
- In the rear area of interest, the level rises drastically due to reflections, approaching that normally expected only in front of the cabinet.



Directivity balloon aberrations

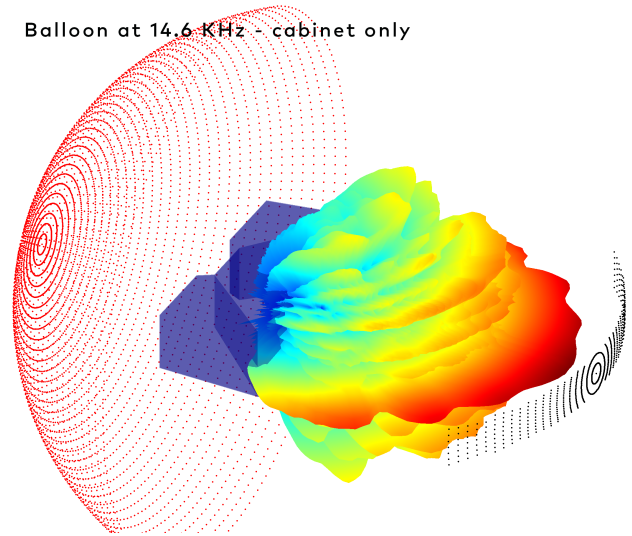
The representation of results presented in the previous section quantitatively illustrates the change in overall magnitude response. Linked to that, and of no lesser importance, is the influence that LED panels as an obstacle have on the three-dimensional dispersion behavior of a cabinet, and consequently, an array.

The two graphs on the right show the full balloon data of the cabinet without (upper graph) and with LED panels mounted in front of it (lower graph) for an example frequency of 14.6 kHz. The sample points used before are only shown for reference.

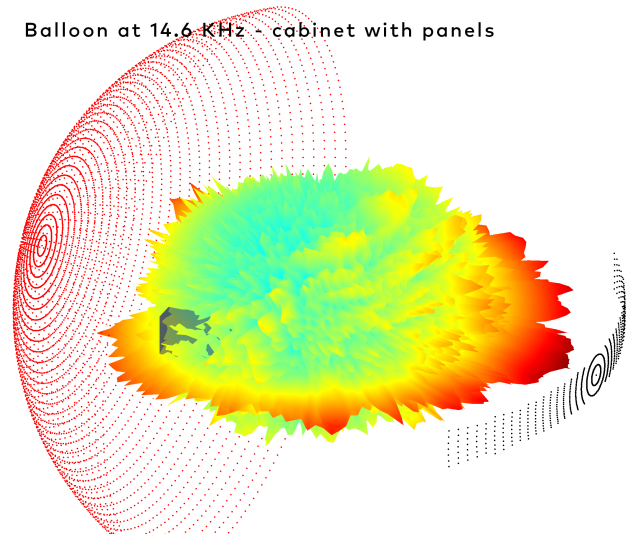
- With the panels in place, only a very narrow vertical and horizontal angular section around the on-axis direction retains some characteristics of the measurement without panels, even though it already shows a much less uniform dispersion over angle. The rest of the frontal hemisphere suffers drastic deformations in directivity and a pronounced loss of average level.
- The rear hemisphere emits many reflections which were previously not present, and which approach the level of the frontal hemisphere. In essence, the nominal and expected directivity behavior of the system is completely lost.

As all electroacoustic prediction software (in our case, ArrayCalc, and often EASE) relies on accurate balloon data, prediction results generated with such software can no longer be relied on with LED panels in place. This is exacerbated for systems that use electronic optimization such as ArrayProcessing, which ultimately depends on a deterministic dispersion behavior.

Balloon at 14.6 kHz – cabinet only



Balloon at 14.6 kHz – cabinet with panels



Conclusion

Mounting LED panels of any kind in front of loudspeaker systems results in a severe degradation of its three-dimensional directivity performance and output which is generally unacceptable if high quality audio reproduction is desired. For the same reason, it also renders simulation results obtained with prediction software unusable for performance evaluation.

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