# GROUNDSTACKING

## Dealing With Floor Reflections

When groundstacking arrays, it is important to consider the effects of floor reflections on the coverage pattern.

If an array is stacked on or near a hard reflective surface, the effect is the same as for a light source sitting on a mirror:  there is a mirror image of the array in the floor.  This reflected ("virtual") array affects the radiated sound in exactly the same way as if the floor were absent and a real array were located in its place.  This is illustrated in Figure 1.

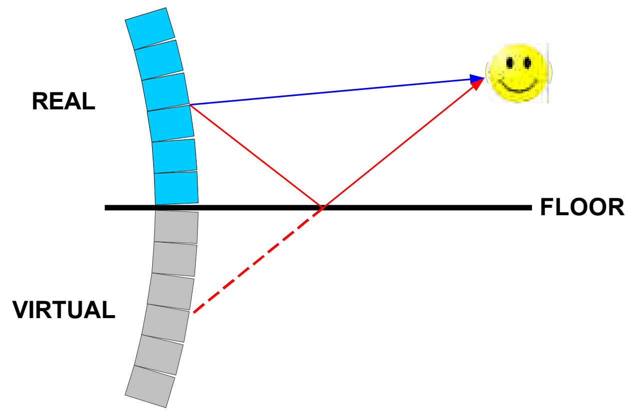


Figure 1.  Real and virtual line arrays

If the floor is not totally reflective (e.g. covered with carpeting, seats, and/or people), then the strength of the virtual array will be reduced, usually in a frequency-dependent manner.  In most cases, the virtual array will be much weaker in the high frequencies than the real one.

In designing groundstacked arrays, it is important to keep the virtual array in mind.  For example, Figure 2 shows the coverage of a groundstacked six-element array of EV XLE line array loudspeakers in a flat-floor venue.  The virtual array is NOT included.

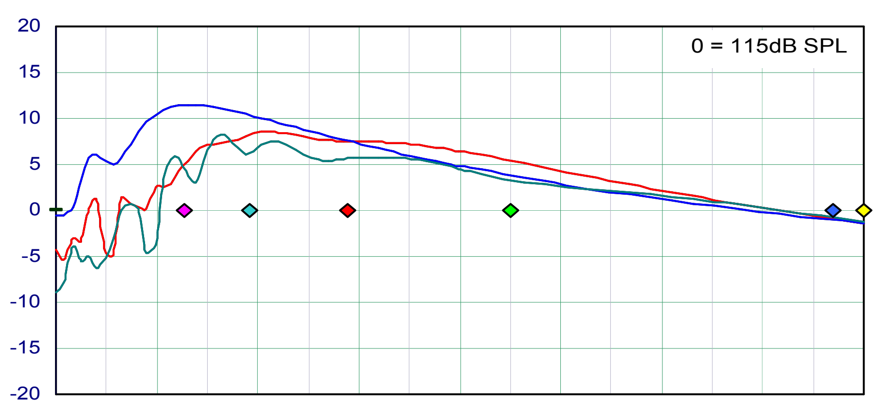


Figure 2.  Six XLE-181 Groundstacked in 100 ft (30m) flat venue.
No virtual array.

In contrast, Figure 3 shows the same array, except that the virtual array IS included. In addition, the stacking angle has been adjusted to provide a smooth transition from real to virtual array.

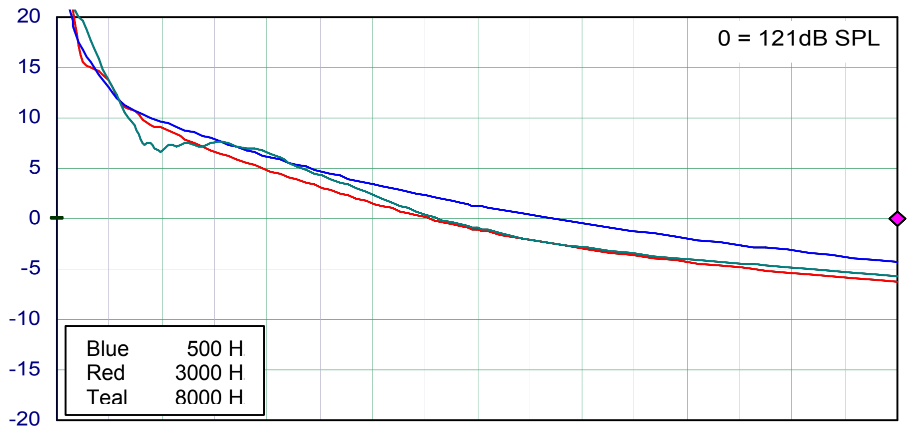


Figure 3. Six XLE-181 groundstacked in 100fr (30m) flat venue.
Virtual array included.

As this example shows, the action of the virtual array is often beneficial. This is to be expected, since longer line arrays are usually better. However, floor reflection makes the choice of array tilt angle more complex.

Consider Figure 4. The bottom loudspeaker of the real array is tilted down about 16°. With the virtual array included, the overall result is a rather strangely shaped sound source.

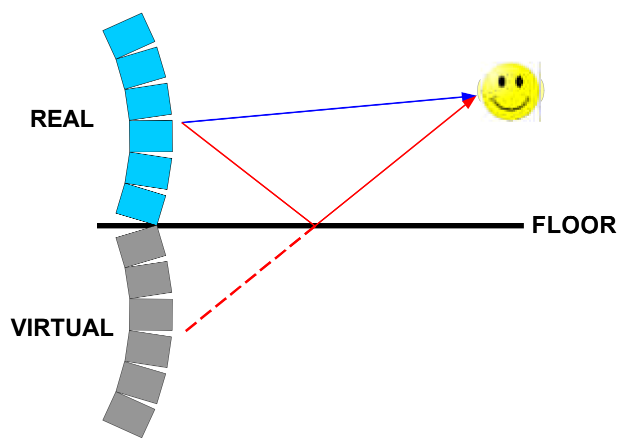


Figure 4. Tilted groundstacked array with virtual array included.

Figure 5 through Figure 8 show the coverage of the array in a small auditorium, with and without the virtual array included. Without the array, the design looks good. With the array included, however, the coverage is rather irregular.

As noted above, the problems will be less severe in actual practice, because the floor is an imperfect reflector. Figure 8 shows the coverage with the virtual array 6dB quieter than the real one.

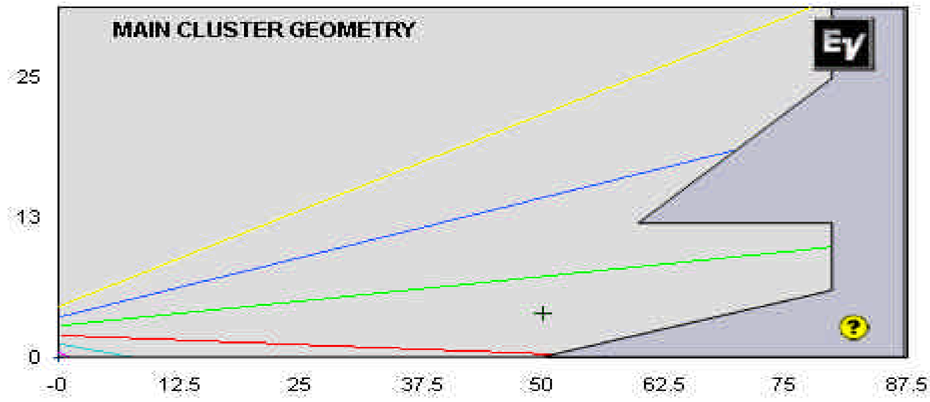


Figure 5[1]. Small auditorium.
Front to back distance = 87.5 feet (26.5m). Height = 25 feet (7.5m).

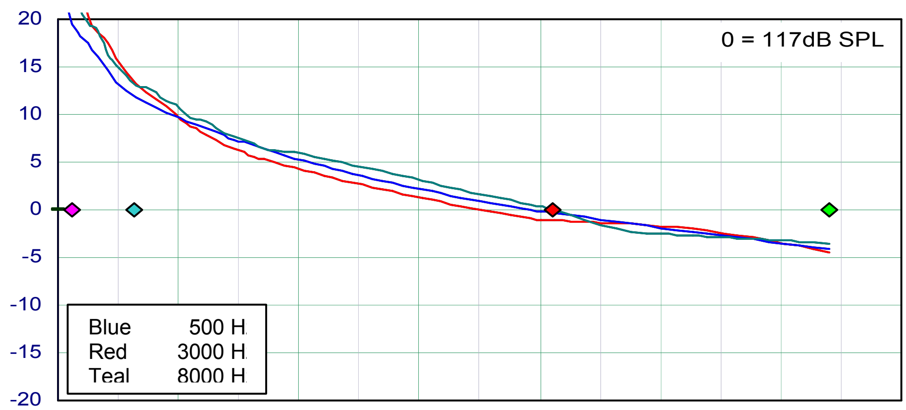


Figure 6. SPL vs distance. Virtual array NOT included.

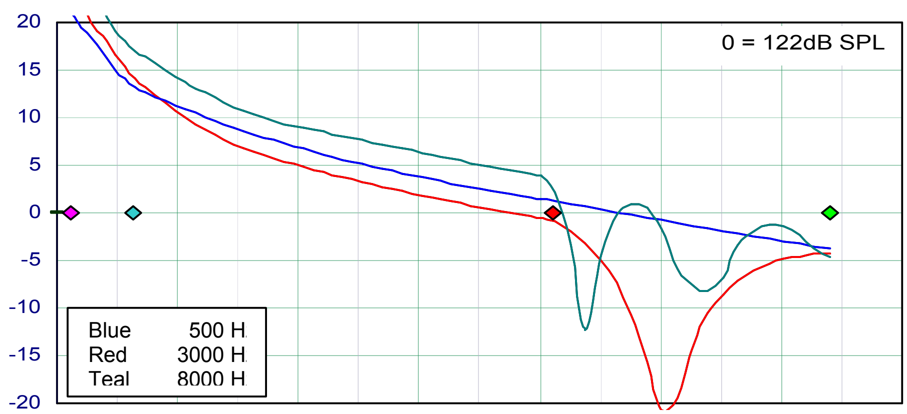


Figure 7. SPL vs distance. Virtual array included.

1 All coverage graphs are from the EV line array modeling program LAPS II, downloadable for free at www.electrovoice.com.

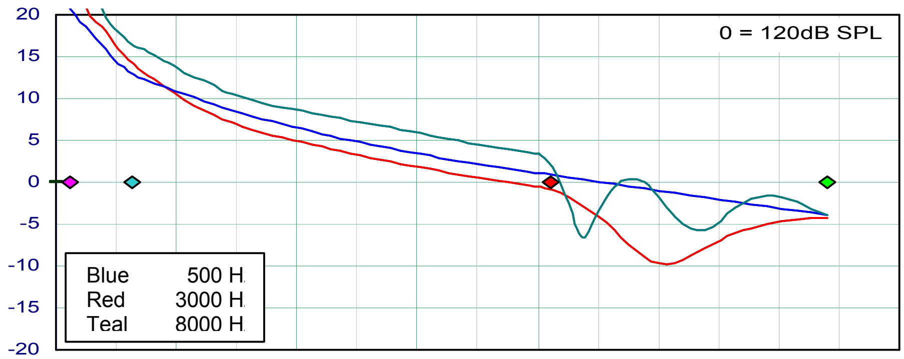


Figure 8. SPL vs distance. Virtual array included, 6dB quieter.

Figure 9 shows the same six-element array as in the above examples, but tilted back so as to make a smooth transition to the virtual array, as shown in Figure 1. Considered by itself, this array would be tilted back too much, but it works well in conjunction with the virtual array.

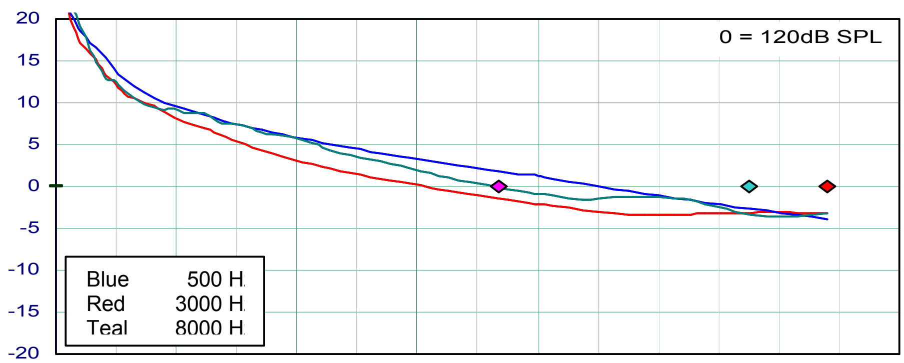


Figure 9. Smooth transition between real and virtual array.

Sometimes, groundstacked arrays are raised a few feet off the floor -- by stacking atop subwoofers, for instance. If the floor is reflective, this may not be a very good idea. Figure 10 shows the same array as in Figure 9, but raised two feet. With equalization, the results would be marginally usable, but tonal balance would not be good at the rear of the room.

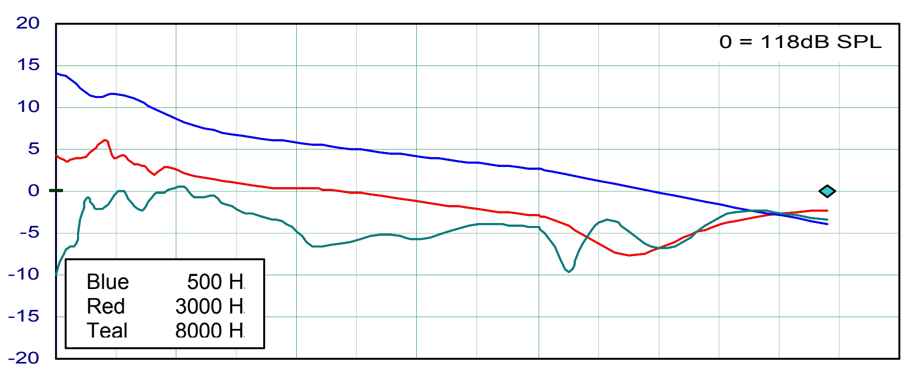


Figure 10. Real array raised two feet (670cm) off the floor.

Despite this issue, production requirements sometimes require the use of raised arrays. Most often, this occurs when either the main arrays or high-output frontfill arrays must be stacked on the front edge of the stage.

The frontfill case is seen frequently in large outdoor shows, the stage is often fairly high. In this situation, the array is far from the ground, the reflection effects described above are not as much of a factor,. To cover the front rows effectively, it is often necessary to point the array down quite a bit. Sometimes custom bracing will be required to achieve sufficient downtilt. Too often, we have seen onstage frontfill stacks projecting sound over the heads of the front rows!

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