EAW

ADAPTive™ systems Application Guide

ADAPTive™ systems

About Adaptive Performance™

Adaptive Performance™ is an EAW technology that allows FOH engineers and system technicians to easily provide ideal coverage in any environment or audience geometry. Utilizing proprietary software and hardware, Adaptive Systems such as Anya, Anna, and Otto provide users with the remarkable ability to define (and redefine) their coverage in situ, after the system has been deployed or even mid-show. Should the audience size increase or decrease, the systems engineer can affect changes in seconds – simply by entering the desired coverage and uploading these parameters to the arrays. Adaptive Systems accomplish this while also providing extraordinary output, consistency and fidelity at all volume levels and coverage patterns.

This Application Guide will provide users with information on Adaptive System application and design concepts, system integration, and examples using typical venues.

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Overview

About Adaptive Arrays

Adaptive arrays are designed using only three module types: Anya, Anna, and Otto. Each column in an array can only consist of one module type, and columns of Anya and Anna can be combined to create mixed, multi-column arrays. Since the vertical coverage of the system is adaptable from 90° down to 90° up, supplemental “downfill” or “upfill” enclosures are unnecessary. Attention should be paid to the horizontal coverage requirements as Anya/Anna does not increase or decrease coverage in the horizontal plane via DSP. This is achieved by attaching additional columns to the array.

Anya Driver Compliment

LF – Dual 15” direct radiating with Offset Aperture™ loading

MF – Six 5” horn-loaded with CSA™ apertures and Radial Phase Plugs™

HF – Fourteen 1” horn-loaded on proprietary waveguide

Each component within an Anya module is independently powered and processed using state-of-the-art electronics. These electronics are contained in each module’s Power Plant, providing 22 channels of amplification, 22 channels of DSP, and all necessary networking components in a field-replaceable highly weather-resistant package.

Anya Nominal Coverage

Horizontal – 70° when used as a single column. Columns array on 60° centers (10° overlap total, 5° overlap from each column) to minimize the transition from one column to another.

Vertical – Completely Variable

It should be noted that the vertical coverage of Anya, as calculated by Resolution software, will almost always be asymmetrical. Vertical coverage is never derived from fixed Q (i.e. 45°, 60°, 90°, aimed at 10° down) but will be contoured to provide the most consistent coverage possible. This means that the pattern will be complex.

Anna Driver Compliment

LF – Dual 10” direct radiating with Offset Aperture™ loading

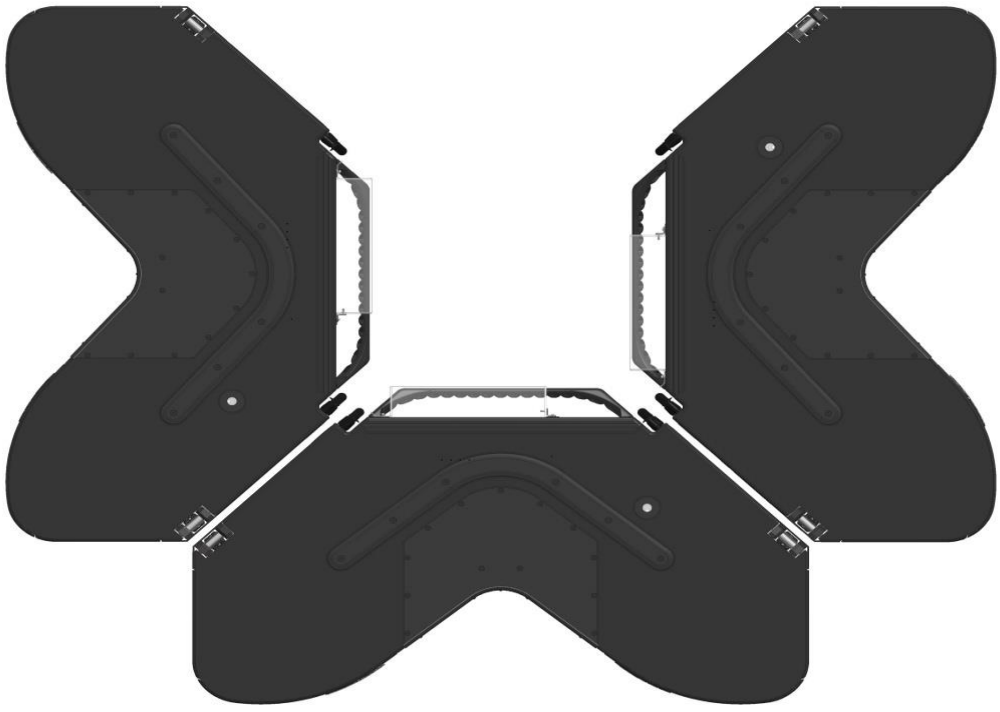
MF – Four 5” horn-loaded with CSA™ apertures and Radial Phase Plugs™

HF – Eight 1” horn-loaded on proprietary waveguide

Each component within an Anna module is independently powered and processed using state-of-the-art electronics. These electronics are contained in each module’s Power Plant, providing 14 channels of amplification, 14 channels of DSP and all necessary networking components in a field-replaceable highly weather-resistant package.

Anna Nominal Coverage

Horizontal – 100° when used as a single column. Columns array on 90° centers (10° overlap total, 5° overlap per column) to minimize the transition from one column to another.



Vertical – Completely Variable

About Otto

Otto arrays are designed with a single module type. Each Otto module includes Offset Apertures in all four corners and two independently-processed 18” woofers to generate a variety of coverage patterns, even from only a single module.

Otto modules are designed to be tight-packed, with interlocking flybars and IR transceivers on all faces. “Shotgun” or end-fire arrays, “delay-arc” or broadside arrays, and simple single-column stacks are all readily achievable depending on the performance and logistical requirements of a given event or venue.

Otto is designed to both extend and augment the low-frequency response of any Adaptive product. Depending on the system configuration and performance needs, engineers may choose to low-pass Otto simply to provide additional extension, or may overlap Otto and other Adaptive products to supplement both extension and output.

Otto Driver Compliment

VLF – Dual 18” woofers with Offset Aperture™ loading. As with all Adaptive products, each driver is independently powered and processed. All amplification and processing electronics are housed in the unit’s Power Plant.

Array and Overall System Design

Adaptive arrays are constructed in two different ways. The vertical coverage is completely variable regardless of the number of modules in the column, meaning that the number of modules deployed is determined by the SPL and directivity requirements only. The horizontal coverage is increased by physically adding columns to the array. Resolution software's "Array Assistant" is designed to assist in creating a 3-dimensional coverage prediction based on the number of modules physically available. Simply define the venue as a model in Resolution, launch the Array Assistant, and it will guide you to the final result. Modifications to the result are certainly possible, and both coverage requirements and the number of modules used can be redefined or adjusted at any time. Each time a change is made in Resolution the parameters are automatically recalculated and the results displayed for review. Once it is confirmed that the model represents your intentions, simply upload the new settings to the Adaptive arrays and the system will be ready.

Array Coherency

Producing a coherent wavefront from multiple enclosures containing multiple transducers represents the primary challenge in system design, especially when these enclosures are arrayed in both the vertical and horizontal planes. Fortunately, Anya and Anna were designed from the beginning to maximize coherency by allowing each column in an array to be physically configured in only one way. Modules hang straight without any "J" curvature and combine horizontally with their cabinet faces completely closed. This removes any opportunity for physically mismanaged arrays and provides a highly predictable physical design from which to model.

Subwoofers

Although the use of subwoofers is optional, certain music types and environmental conditions may require additional subwoofer support. If additional subwoofer support is desired, EAW Otto should be utilized as the ideal match for Anya and Anna. This subwoofer extends Adaptive Performance into the sub-bass range, providing the optimal low-frequency coverage pattern for the venue.

System Design Practices

Designing with Anya and Anna

The number of modules used in any Adaptive array is predicated on a number of factors. Since the vertical dispersion of the array is determined by EAW Resolution software and any sized column can be adjusted anywhere within a 180° vertical beamwidth, the factors to be considered in defining an Adaptive array design are simplified to the following:

1) **Horizontal coverage** – The horizontal coverage for Anya is defined by how many columns are assembled in each array. Columns are arrayed in 60° arc segments (60°, 120°, 180°, 240°, 300°, 360°). Horizontal coverage for Anna is also defined by the number of columns in the array. Columns are arrayed in 90° arc segments (90°, 180°, 270°, 360°). Additionally, EAW Resolution applies processing to align multiple columns for the smallest column-to-column seam possible.

2) **Overall SPL requirement** – As one would expect, the overall available SPL for an Adaptive array is determined by the number of enclosures in the array. Often, systems are designed around

the demands for SPL at the mix position. Most professional Front-Of-House (FOH) engineers have a sense of what sound levels they will need for their particular artist. Adaptive modules are easily added or removed from arrays, and a wide variety of SPL calculations performed to assist in accurately determining the right number of modules needed for a given SPL requirement. Additionally, Resolution's Array Assistant is designed to assist the designer in balancing coverage, output and consistency given a certain number of available modules and any physical restrictions (maximum height and minimum trim).

3) **Directivity** – Anya, Anna, and Otto adhere to classic line source theory when discussing directivity. Like any true line source, the frequency at which directivity begins is determined by the overall physical length of the line. More simply: the longer the array, the lower in frequency the array can control the directivity. Directivity can have significant benefits in controlling spill onto the stage, noise control in outdoor venues, minimizing reflections indoors, and "throw" distance.

Using EAW Resolution™

EAW Resolution is the key to determining the optimal array configuration for any application. Rooted in EAW's proprietary FChart modeling and calculation engine, Resolution allows users to easily model any venue and visualize a wide variety of array designs to determine what particular array configuration is best suited to the venue.

Users simply need to define the array position, allowable trim, minimum clearance, and quantity of modules available and use the Array Assistant to determine the optimal array configuration for a given venue. In many situations no further prediction work will be necessary for optimal results. Users can also adjust the results after running the Array Assistant by manually adding/removing modules or adjusting coverage and observing changes in predicted results. In this way Adaptive arrays can be optimized for any application.

Additionally, Resolution interfaces directly with Adaptive Systems via the Dante protocol, allowing users to easily upload the processing parameters for their system directly from their model to the physical array, adjust equalization and coverage, and monitor all Adaptive components in real time. No additional software is necessary to use Adaptive systems.

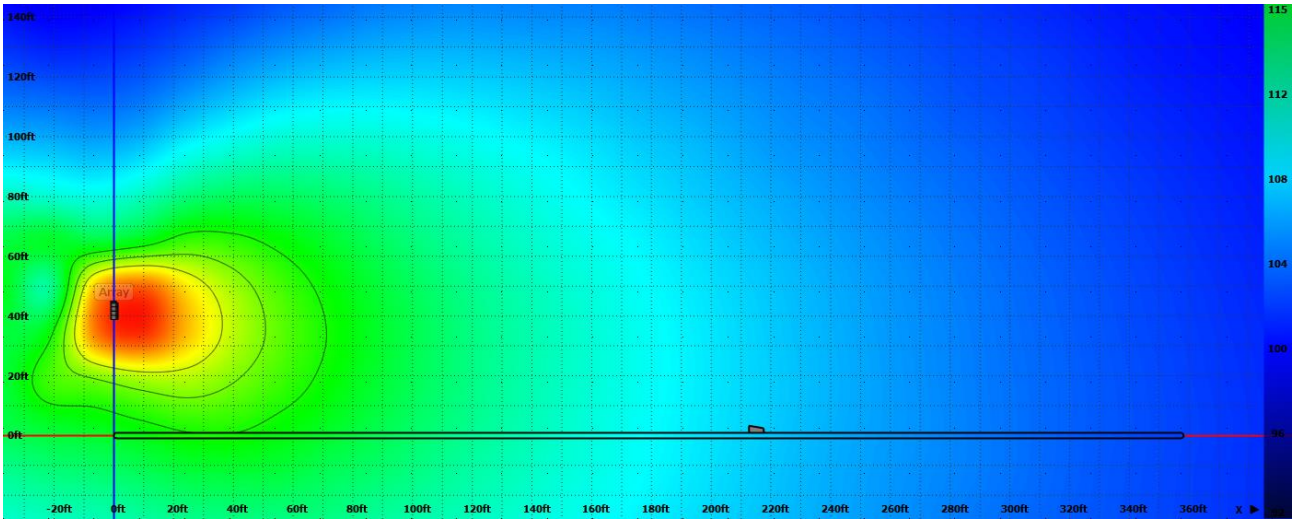
Please visit www.eaw.com to download the latest version of Resolution.

How Array Length Affects Directivity

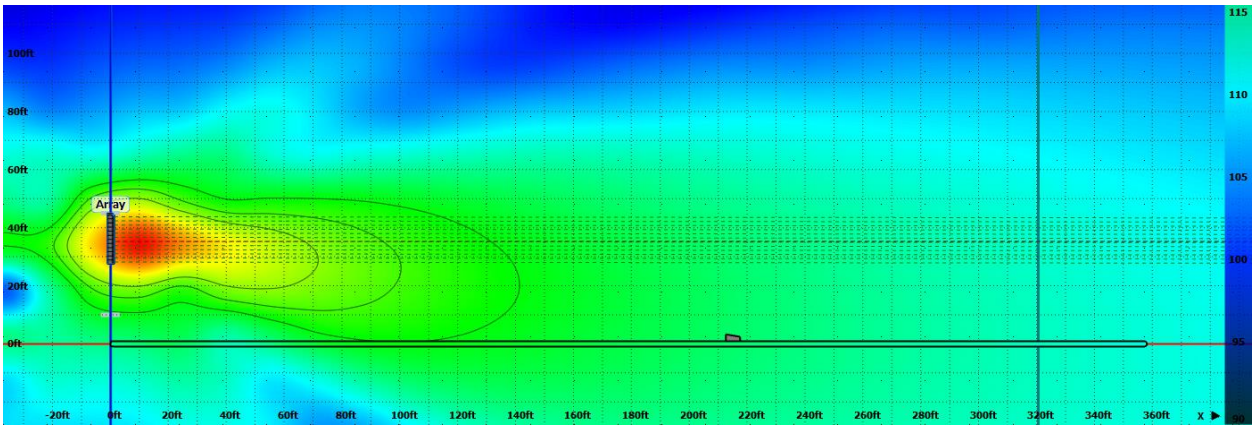
It would be beyond the scope of this guide to go into the physics of how line arrays behave. Regarding vertical directivity, Anya and Anna behave similarly to any true line source. The difference with Adaptive products is their ability to define that directivity dynamically and across the entire audible spectrum.

The key to directivity is array length. This should not be confused with the number of drivers. A properly designed line array system will exhibit the same directivity from the same physical length regardless of whether this length is made up of 8”, 10”, 12” or 15” components. The determining factor is the length of the array itself and how that length affects the wavelength being produced.

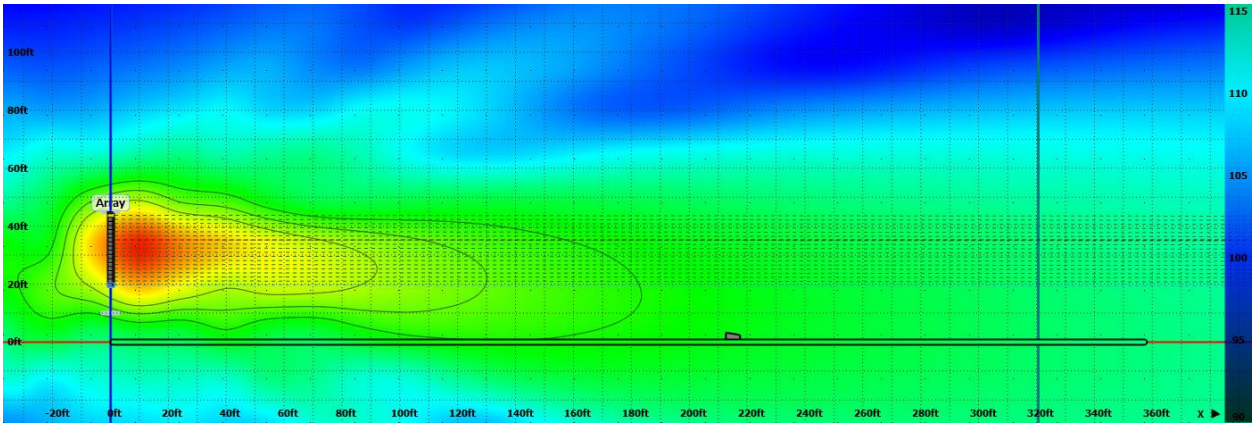
The samples below show three array types in the same venue. The first array is very short with only 4 x Anya modules being deployed. The contour line feature in Resolution has been used to clearly show the definition of the vertical contour at 125Hz. It is clear that with this array length, the 125Hz frequency is seeing only slight directivity control.



The second image demonstrates what would happen with the same frequency in the same venue but with an Anya array of 12 modules instead of 4. It is quite clear how much more directive the vertical has become in this image and if we continue to add modules to the array, the effect will become more pronounced.



Finally, we see the result when the maximum number of Anya enclosures is suspended (maintaining a 10:1 design factor). This 18-module column of Anya produces an extremely tight vertical pattern at 125Hz across this listening area. If directivity at lower frequencies is required for the application, array length must be considered.



Below, a table relating array size, low-frequency pattern control and effective “throw” distance is provided as a rule-of-thumb guide. This assumes a flat audience surface and an array suspended at a typical trim height (i.e. approximately 10m/32 feet). More complex audience geometries will produce different results and should be studied in Resolution.

Anya: LF Control and ‘Throw’

Array Length (modules)	Typical LF Control Cutoff (Hz)	Typical Throw (ft)*	Typical Throw (m)*
2	800	50-75	15-25
4	400	100-125	30-40
6	265	150-200	45-60
8	200	200-275	60-85
10	160	250-325	75-100
12	130	300-400	90-120
14	115	350-475	105-145
16	100	400-550	120-170
18	85	450-600	140-180

***** Assumes nominal 10m/32-foot trim height. Depending on actual trim as well as SPL and consistency requirements, maximum throw distances may be greater or less than as stated.

Anna: LF Control and ‘Throw’

Array Length (modules)	Typical LF Control Cutoff (Hz)	Typical Throw (ft)*	Typical Throw (m)*
2	1150	35-50	10-15
4	600	50-75	15-25
6	400	75-100	25-30
8	300	100-150	30-45
10	240	150-200	45-60
12	200	200-250	60-75
14	175	250-300	75-90
16	150	300-350	90-105
18	130	350-400	105-120

***** Assumes nominal 10m/32-foot trim height. Depending on actual trim as well as SPL and consistency requirements, maximum throw distances may be greater or less than as stated.

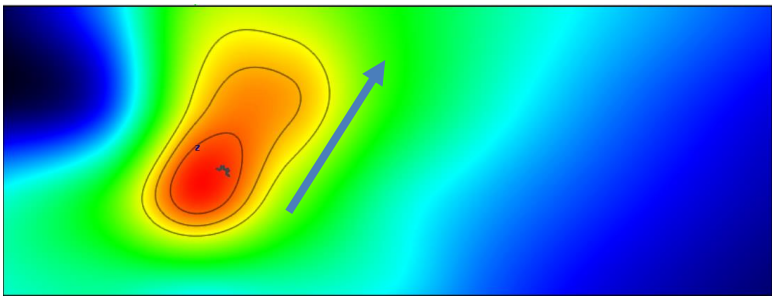
How Adaptive Systems Handle Horizontal Coverage with Multiple Columns

One of the major advantages of Adaptive Systems is the integration of multiple columns for smooth, consistent, precise horizontal coverage at all frequencies.

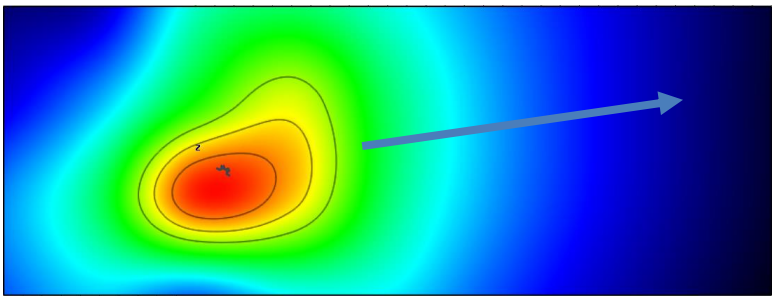
With traditional line array systems, multiple horizontal arrays (i.e. mains and out-fills) are physically separated and independent. During setup, engineers choose a location to align them, accepting the consequences of misalignment at other locations. With Adaptive Systems, tight-packed multi-column arrays are fully integrated, working together as a singular entity to achieve a coverage solution throughout the entire horizontal and vertical coverage range *of the entire array, not just each individual column*.

Great benefit of this can be seen at lower frequencies, where the horizontal energy of an array is adjusted to benefit the greatest number of seats possible.

In the below example, an array of three columns of 4 Anya modules each clearly can be seen to manipulate the low-frequency pattern to provide optimal coverage of the venue, allocating the available low-frequency energy from all three columns down the long-throw side of the coverage area. No physical changes are made between the two examples – it is only the enabling and disabling of the LF correction algorithm.



Above, an array without LF correction – Low-frequency energy is directed through centerline of array, diagonally. This is the 'natural' response of this array geometry.



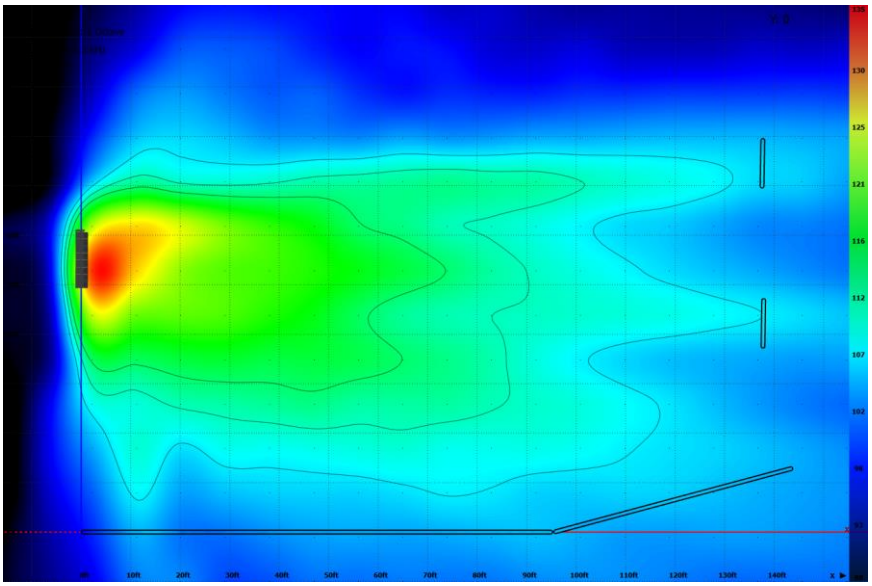
Above, an array with LF correction to shift the low-frequency energy towards the majority of the audience (on the right side of the venue), reducing excess bass energy behind the array and in the side audience areas. No physical changes have been made to produce this benefit – it is an inherent component of how Adaptive Systems work.

Split Coverage to Avoid Balcony Faces and Other Obstacles

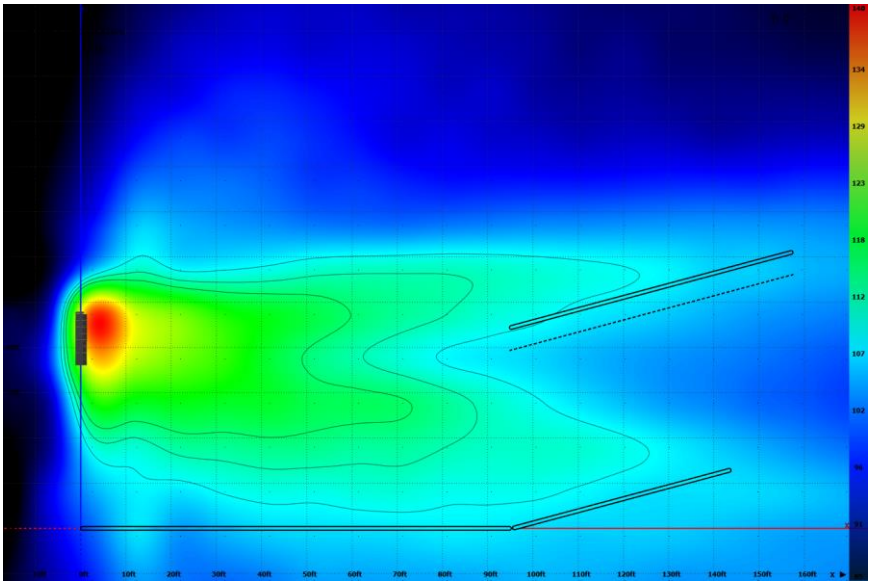
Adaptive arrays automatically “split” coverage to avoid balcony faces and other obstacles to reduce slap-back. No additional steps are required of the user.

Inherently, Adaptive Systems minimize energy directed where there is no audience surface; anywhere not explicitly covered has minimal energy to due to the excellent off-axis performance of these systems. The precise amount of attenuation possible will depend on the model geometry, array length, frequency and coverage start and stop.

In the extreme example below, it is clear that even with no additional effort from the user other than to enter the audience areas, coverage is tailored very precisely to provide energy only where surfaces are present, with deep attenuation everywhere else:

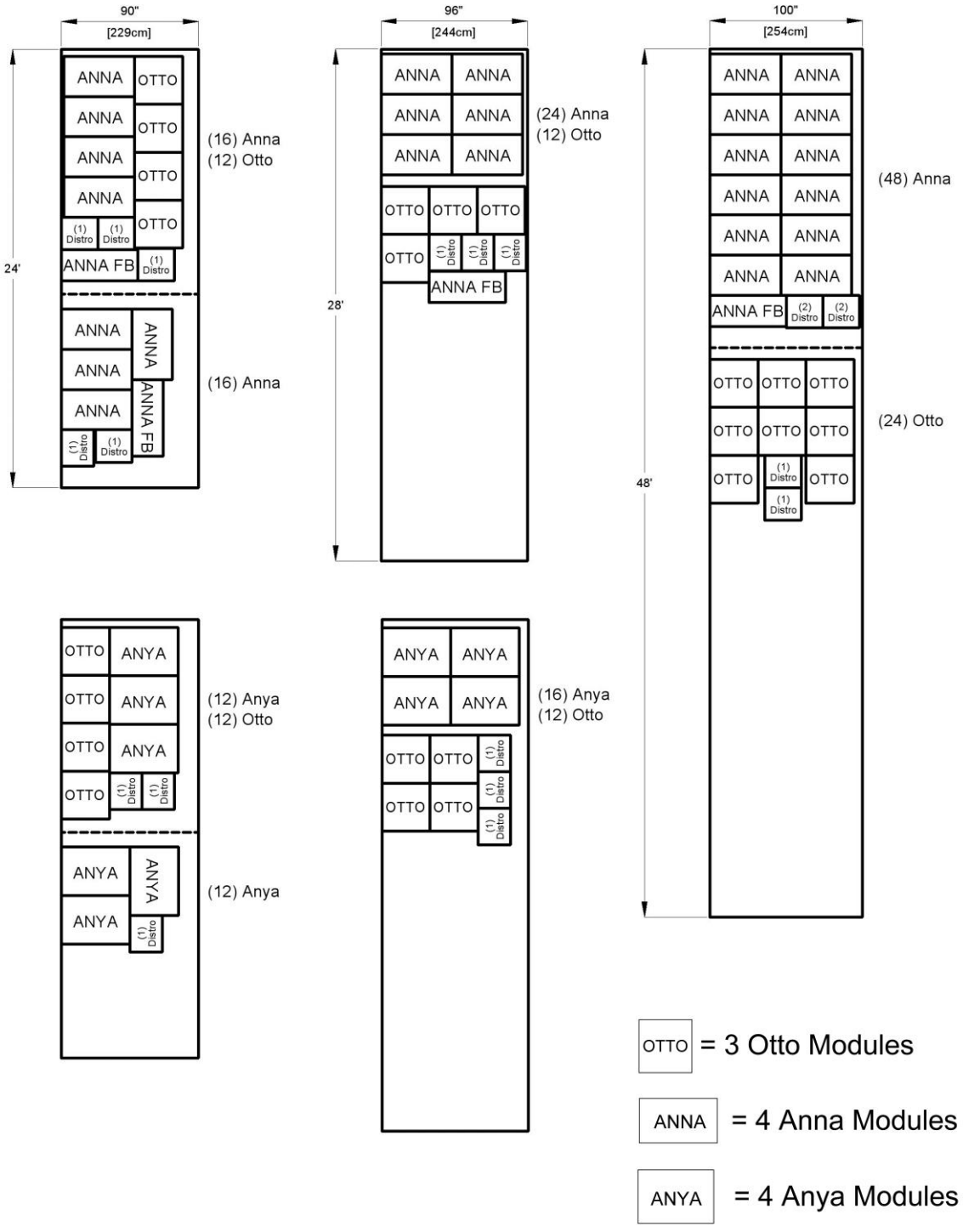


Even with a less complicated venue, such as a single-balcony theater or contemporary house of worship, energy is minimized on balcony faces and under-balcony rear walls:



Truck Pack Examples

Several example truck pack configurations are displayed below, and show recommended packing configurations for various Adaptive systems. These configurations are based on product pallet dimensions, and typical truck interior dimensions.



Integrating Otto with Anya and Anna

Adaptive systems were designed for seamless integration of Otto subwoofers with Anya and Anna. Leveraging the same core Adaptive Performance™ technology, Anya, Anna, and Otto systems are designed to be used together to provide ideal broadband coverage of any venue.

The recommended ratio of Otto modules to complement an Anya or Anna system vary by musical genre, desired LF "bump" relative to mid- and high-frequency output, and overall output level relative to available headroom . The following ratios should serve as a general rule in sizing Adaptive systems, representing the relative subwoofer/full-range balance at full output of both systems. Note that in some cases Anya/Anna arrays may have sufficient low-frequency headroom such that no Otto subwoofers are necessary.

Otto:Anya Ratio	Typical Usage
0:1 (No Otto)	Classical, Light Jazz, Light Rock
1:3	Typical Rock, Pop or Jazz
1:2	Heavy Rock or Pop
1:1	EDM, Hip-Hop, or Heavy Metal

Otto:Anna Ratio	Typical Usage
1:3	Classical, Light Jazz, Light Rock
1:2	Typical Rock, Pop or Jazz
1:1	Heavy Rock or Pop
1.5:1	EDM, Hip-Hop, or Heavy Metal

Venue Design Examples

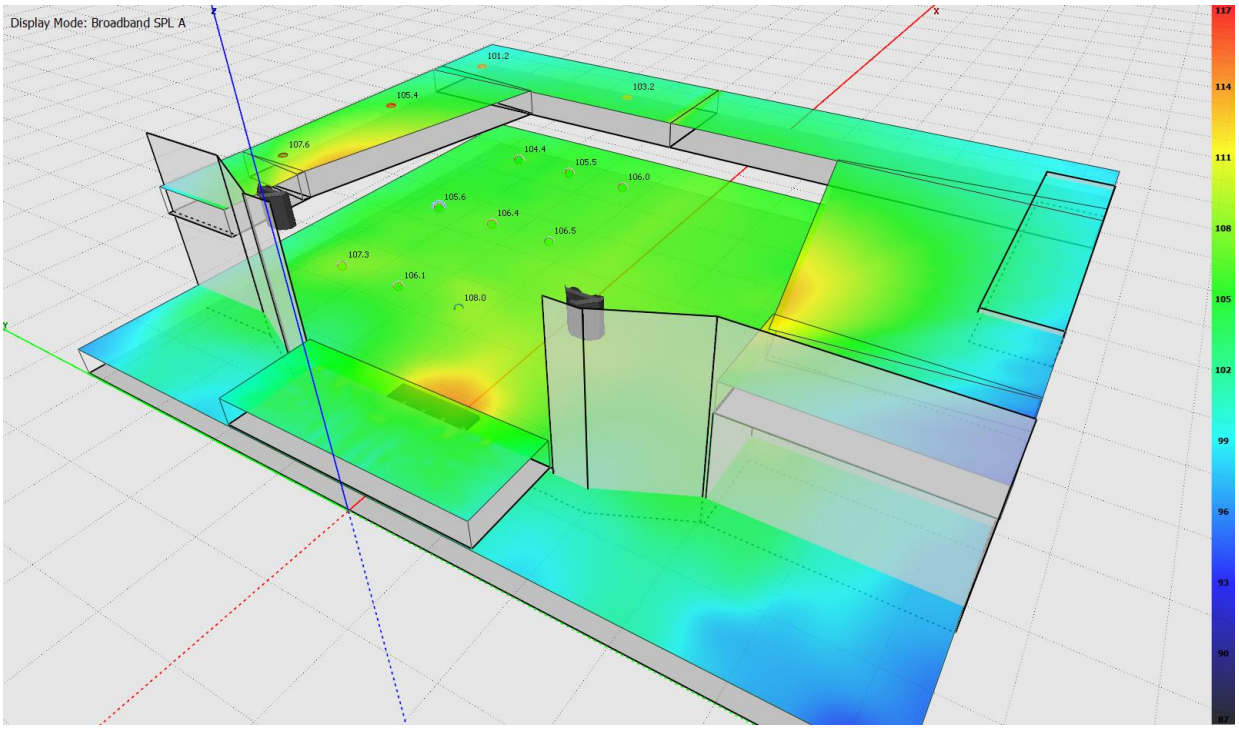
The following section contains a variety of venue examples with recommended systems for each. The venue type, capacity, recommended system size and expected SPL levels are summarized in the table below. These are not hard-and-fast rules, but should serve as a starting point or benchmark for similar system and facility designs.

Venue Type	Capacity (people)	System Size (modules)	Continuous SPL (dBA)
Live Club	1,000	(8) Anna + (4) Otto	104-108
House of Worship - Fan	1,500	(12) Anna + (6) Otto	102-105
Theater	2,500	(12) Anna + (4) Otto	103-107
Arena	15,000	(20) Anya + (12) Anna + (12) Otto	103-107
Shed	20,000	(36) Anna + (16) Otto	101-105
Stadium	55,000	(36) Anya + (28) Anna + (24) Otto	103-107
Outdoor Festival	100,000	(56) Anya + (32) Otto	105-109

Note: SPL values provided are *continuous*. Peak values are 6 dB higher (i.e. 106 dB continuous = 112 dB peak).

Venue: Live Club

Perspective Venue View

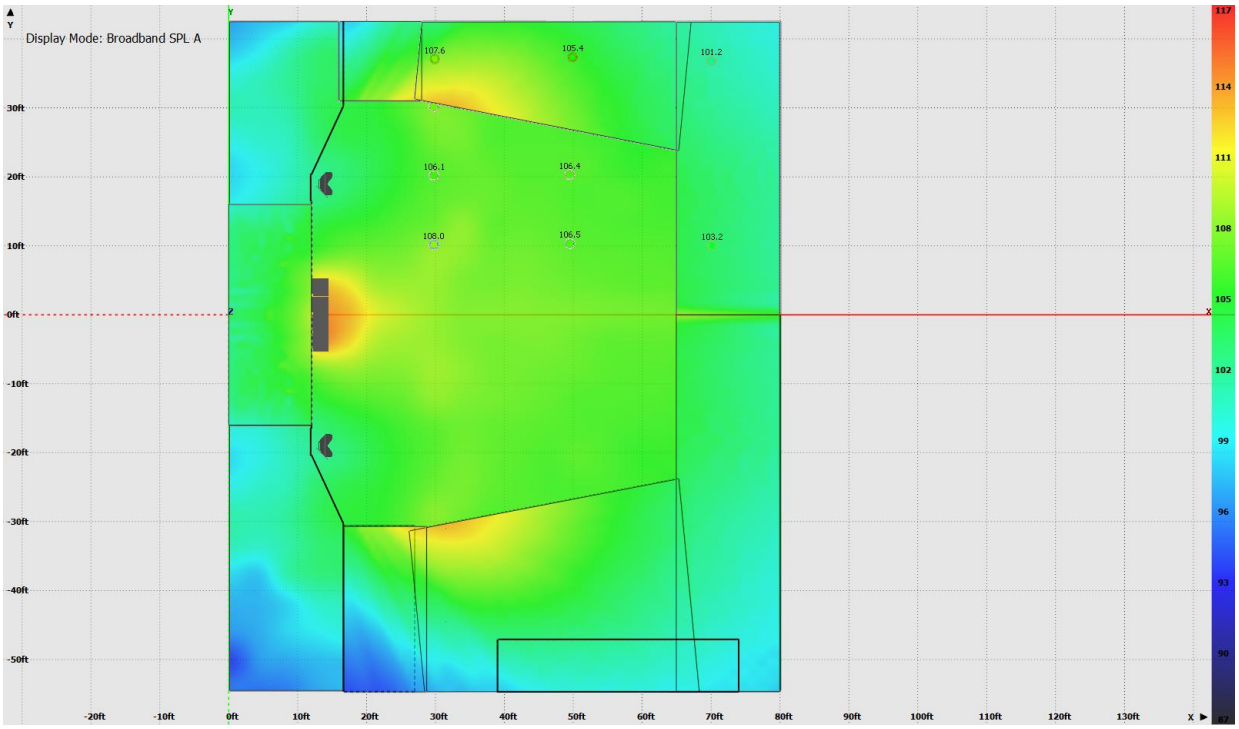


With two arrays of 4x modules each, Anna provides consistent coverage and very high SPL throughout the club.

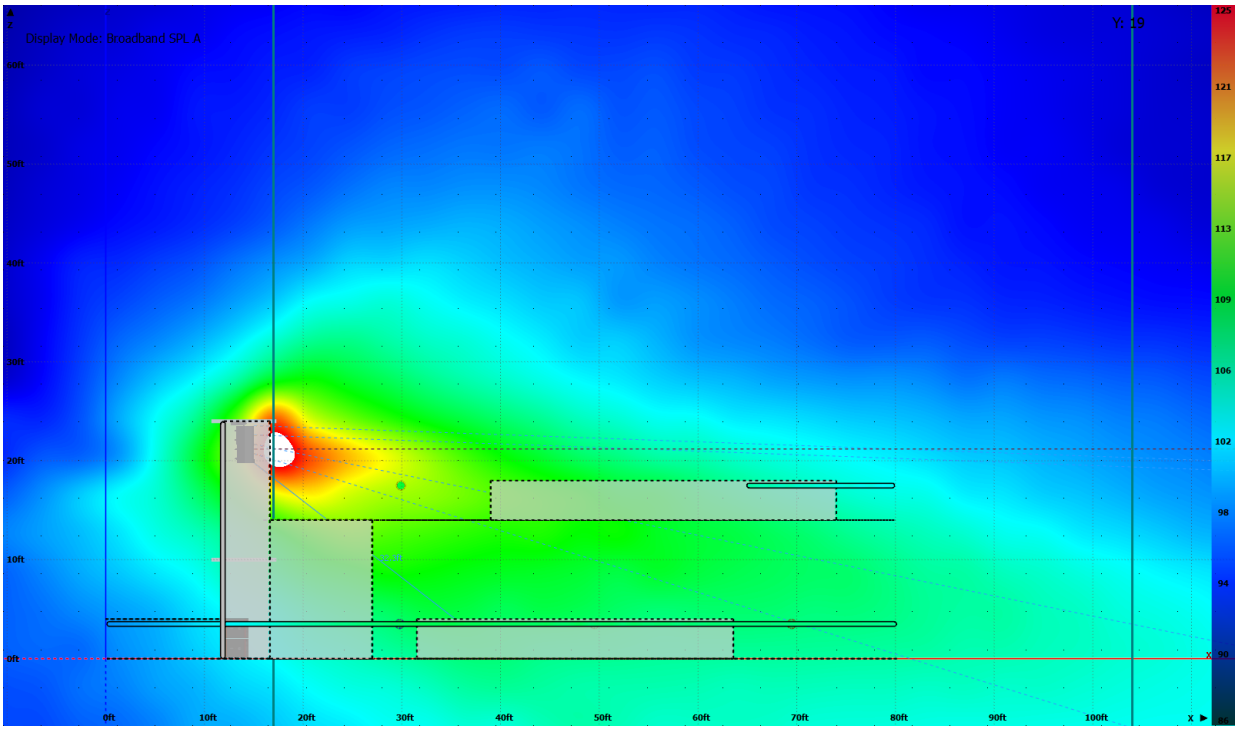
Otto subwoofer modules can also be ground-stacked for maximum low frequency impact on the dance floor. Adaptive processing will still work to optimize output and directivity to the extent possible, even with a ground-stacked configuration.

System Components & Configuration	**Predicted Performance**
8 Anna Modules (2x 4 modules)	Average SPL: 106 dB (continuous)
4 Otto Modules (1x 4 modules)	Variation: +/- 2 dB
2 Anna Flybars	
2 Adaptive Distro Racks	**Rigging Configuration**
Accessory Cabling Package	(2) 1-ton motors

Plan Venue View

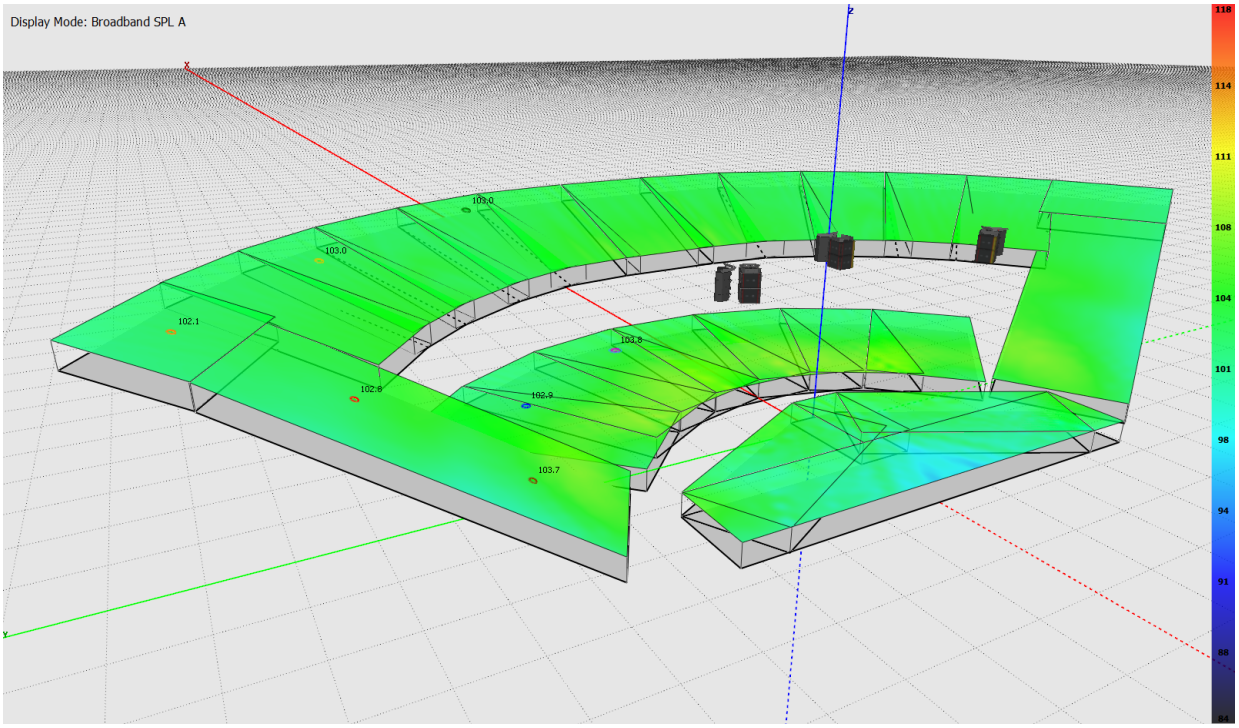


Section Venue View



Venue: House of Worship – Fan

Perspective Venue View



This example represents a fan-shaped venue with a balcony, and sloped seating areas leading from the floor to the balcony on either side of the space. Utilizing three arrays of 4x modules each, Anna is able to provide an average 104 dB to every seat in the house, without supplemental fills. Anna also minimizes reflected energy from the balcony face much more effectively than traditional line arrays or point source clusters. A pair of Otto subwoofers flown immediately behind each array provides low frequency extension, and utilizes Adaptive processing to provide low frequency rejection behind the arrays.

System Components & Configuration

12	Anna Modules (3x 4 modules)
6	Otto Modules (3x 2 modules)
3	Anna Flybars
3	Otto Flybars
3	Adaptive Distro Racks
	Accessory Cabling Package

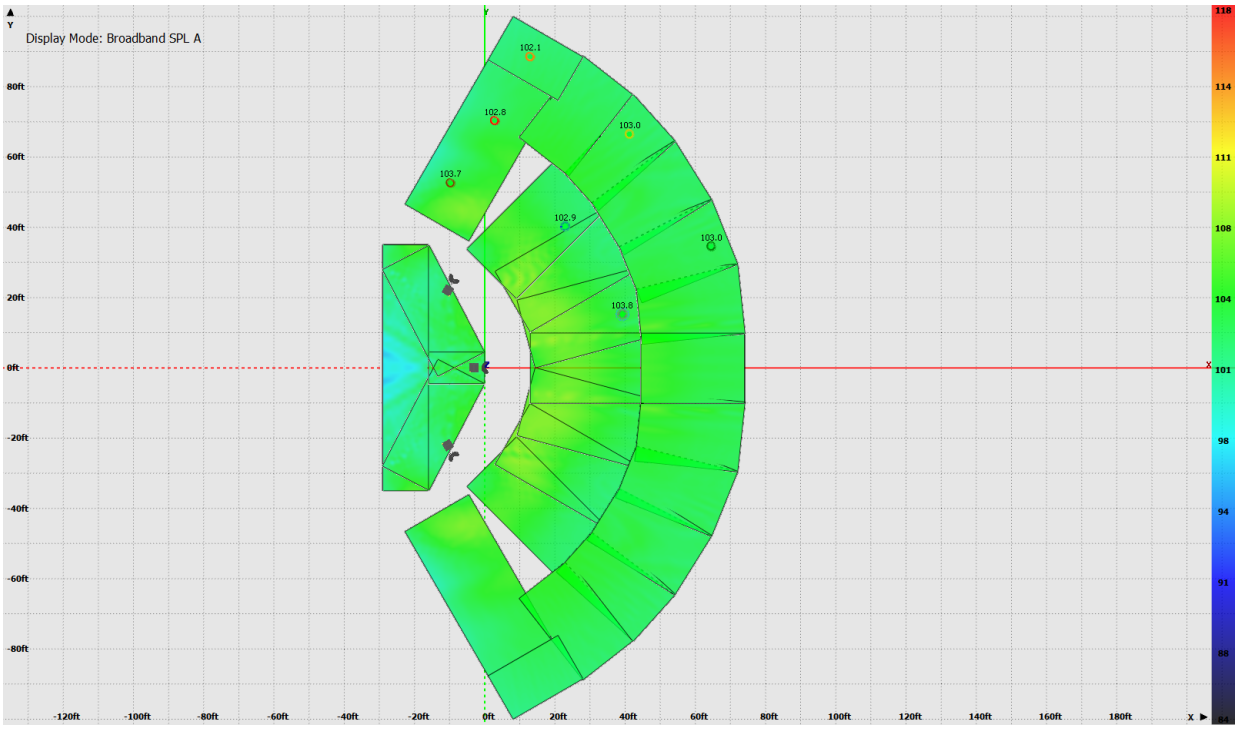
Predicted Performance

Average SPL: 104 dB (continuous)
Variation: +/- 2 dB

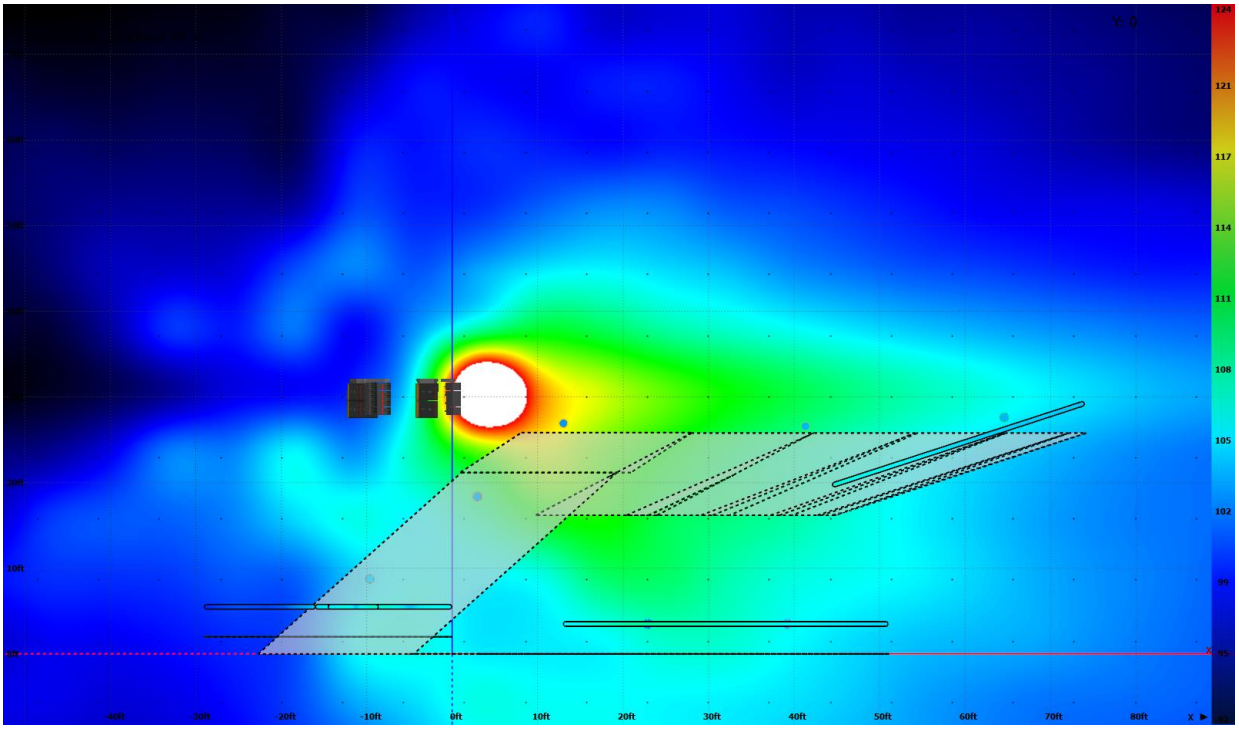
Rigging Configuration

(6) 1-ton motors

Plan Venue View

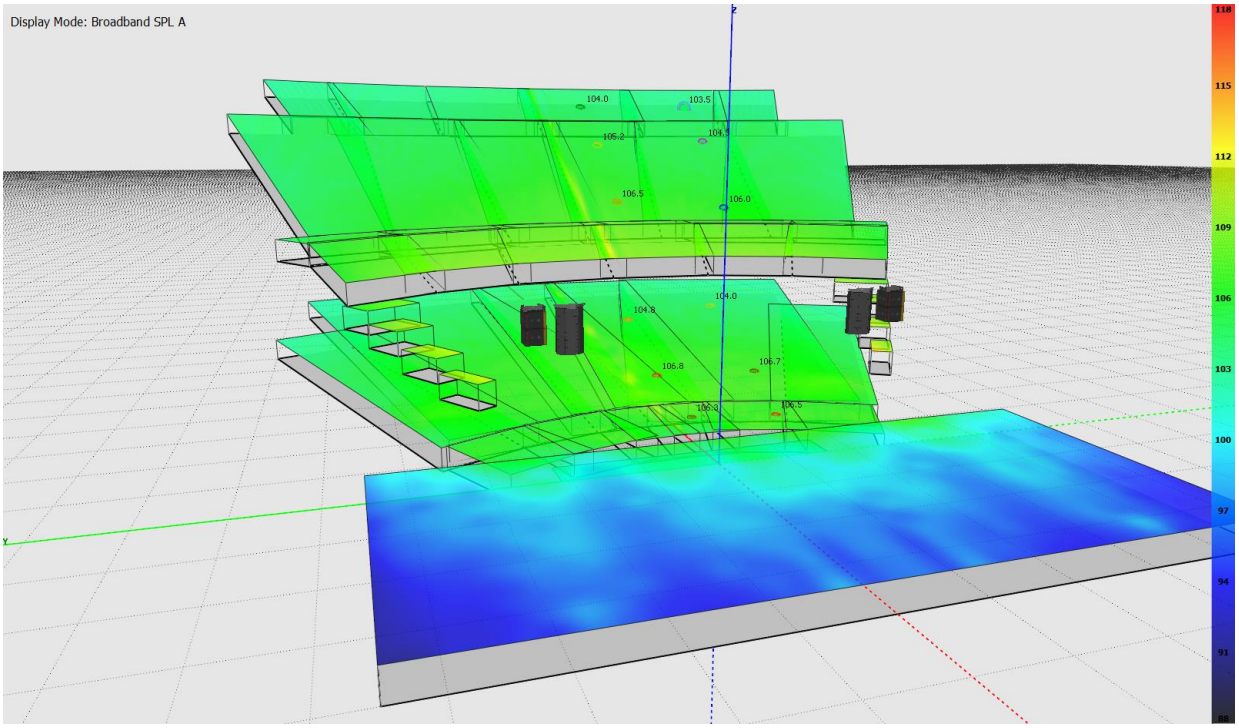


Section Venue View



Venue: Theater

Perspective Venue View



This example represents a typical 2,500-seat proscenium theater with a deep orchestra and under-balcony space, and a steep balcony reaching a height far above array trim. Two arrays of 6x Anna modules, and two arrays of 2x Otto can handle nearly any SPL application necessary for this venue. With an average of 105 dBA, the system is capable of reproducing high SPL program material to every seat in the house, without supplemental fills. This system also provides significant attenuation on-stage.

System Components & Configuration

12	Anna Modules (2x 6 modules)
4	Otto Modules (2x 2 modules)
2	Otto Flybars
2	Anna Flybars
2	Adaptive Distro Racks
	Accessory Cabling Package

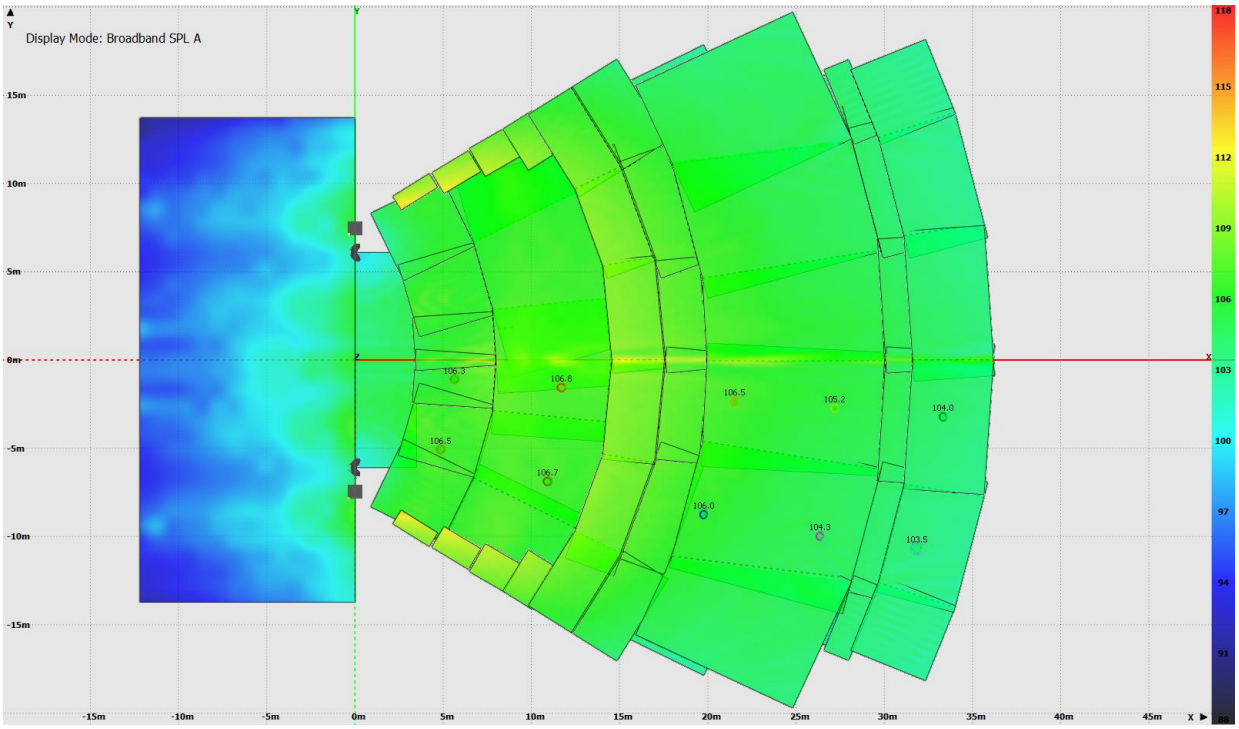
Predicted Performance

Average SPL: 105 dB (continuous)
Variation: +/- 2 dB

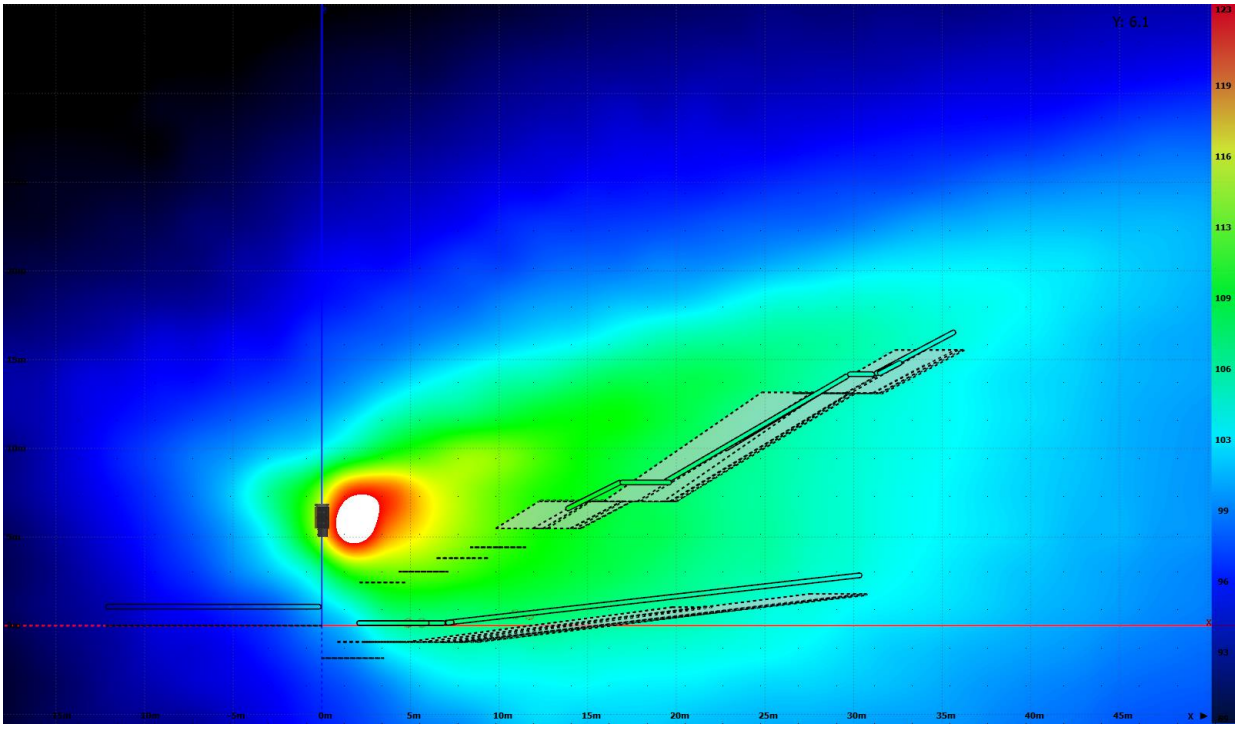
Rigging Configuration

(4) 1-ton motors

Plan Venue View

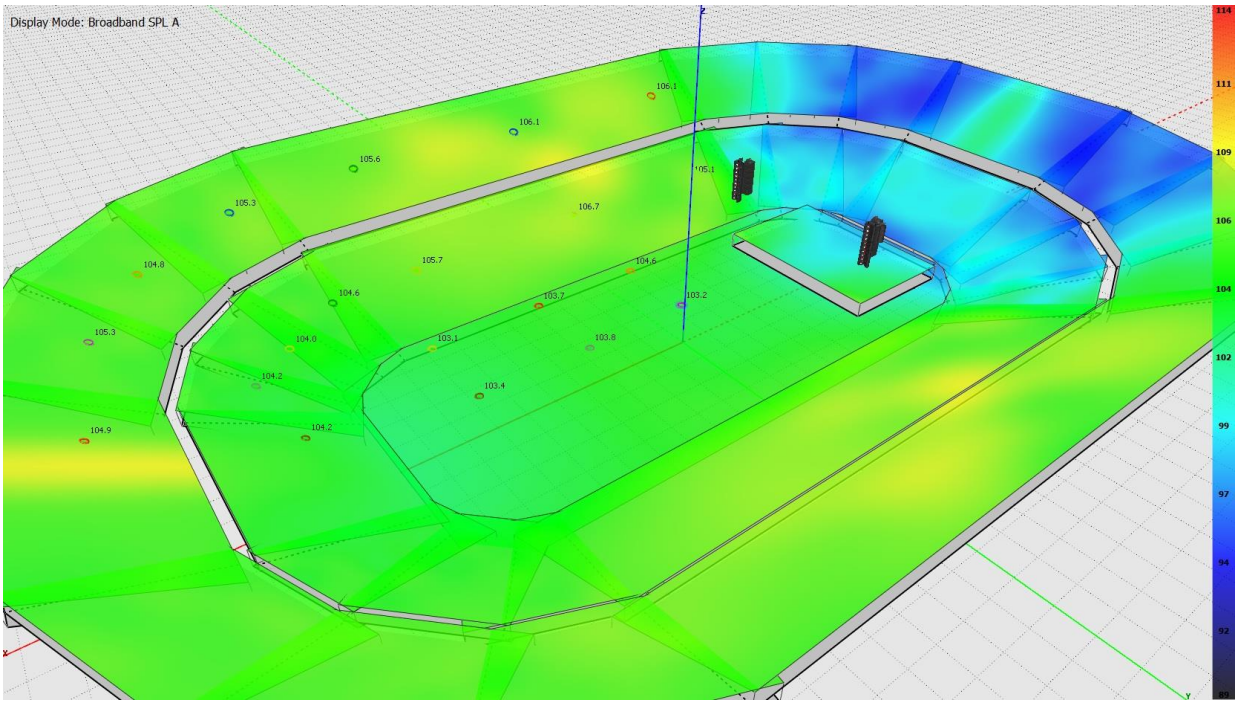


Section Venue View



Venue: Arena

Perspective Venue View



In a typical 15,000-seat arena, a system of 20x Anya, 12x Anna, and 12x Otto will provide consistent 270° coverage, employing two arrays with main columns of 10x Anya modules each and outfill columns of 6x Anna modules each. Low frequency support is supplemented by two arrays of Otto, 6x modules each. Predicted SPL is a consistent 105 dBA, +/- 2 dB.

System Components & Configuration

20 Anya Modules (2x 10 modules)
12 Anna Modules (2x 6 modules)
12 Otto Modules (2x 6 modules)
2 Anya Flybars
2 Anna Flybars
2 Otto Flybars
4 Adaptive Distro Racks
Accessory Cabling Package

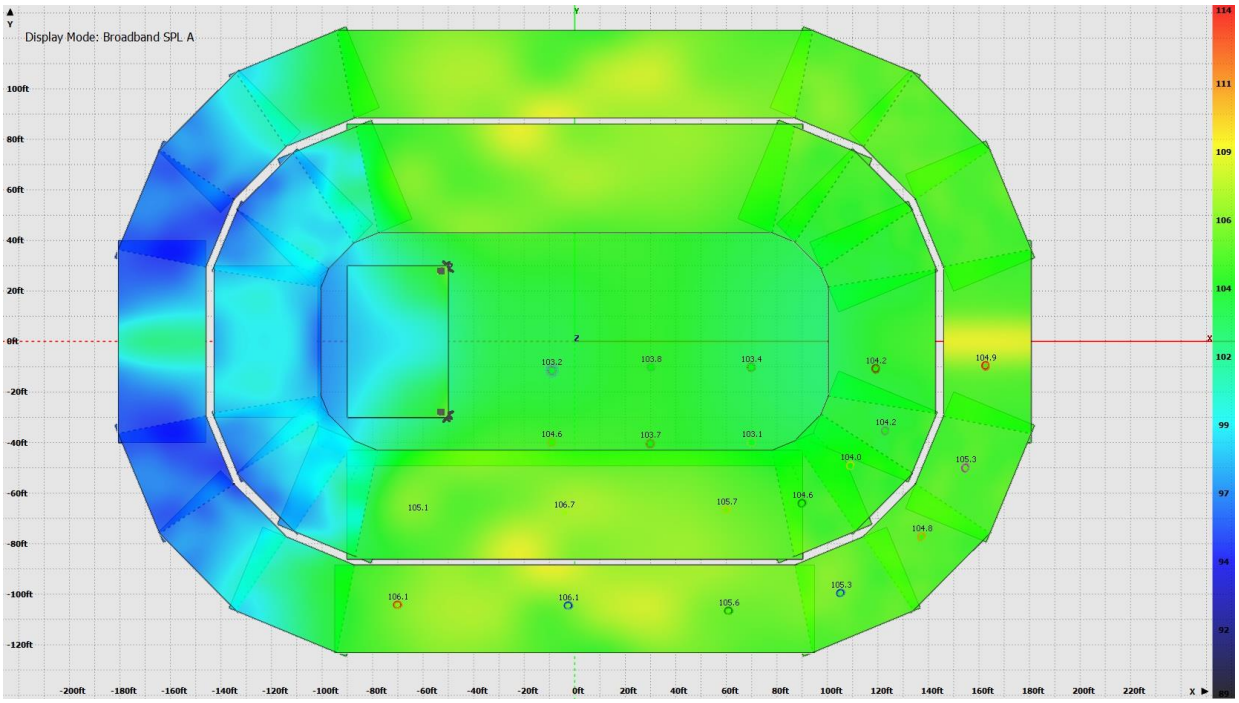
Predicted Performance

Average SPL: 105 dB (continuous)
Variation: +/- 2 dB

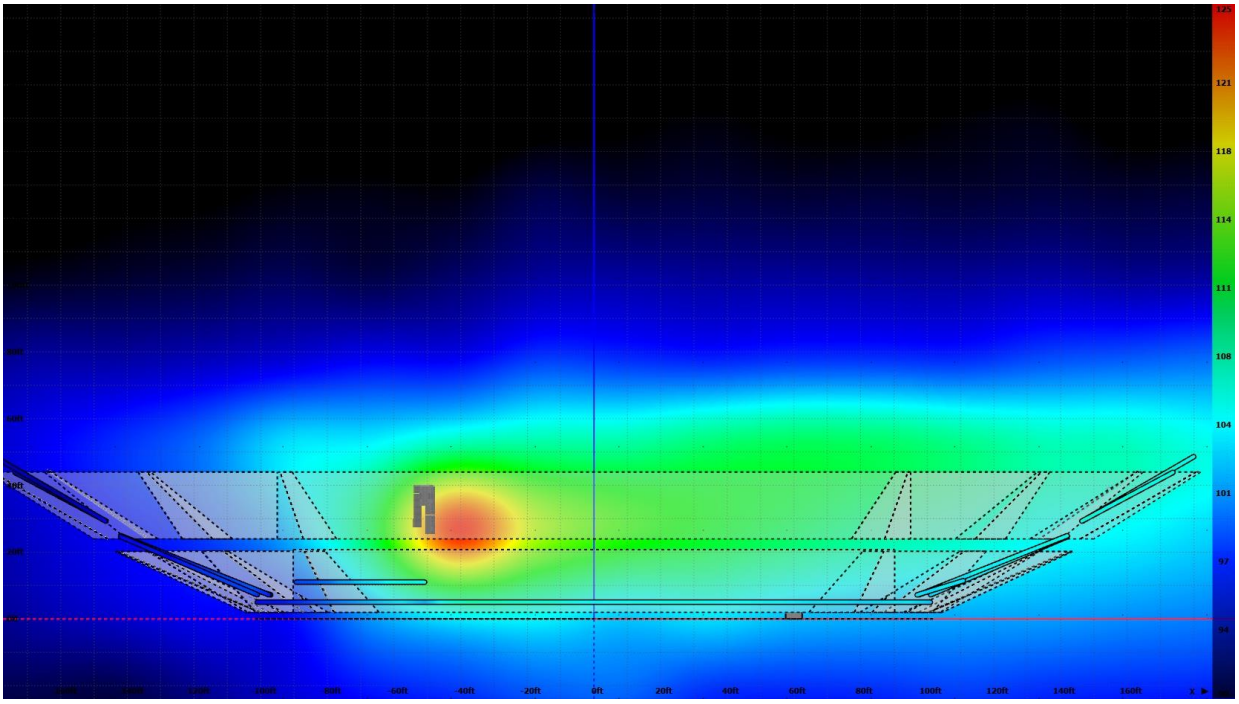
Rigging Configuration

(2) 2-ton motors – Anya
(4) 1-ton motors – Anna & Otto

Plan Venue View

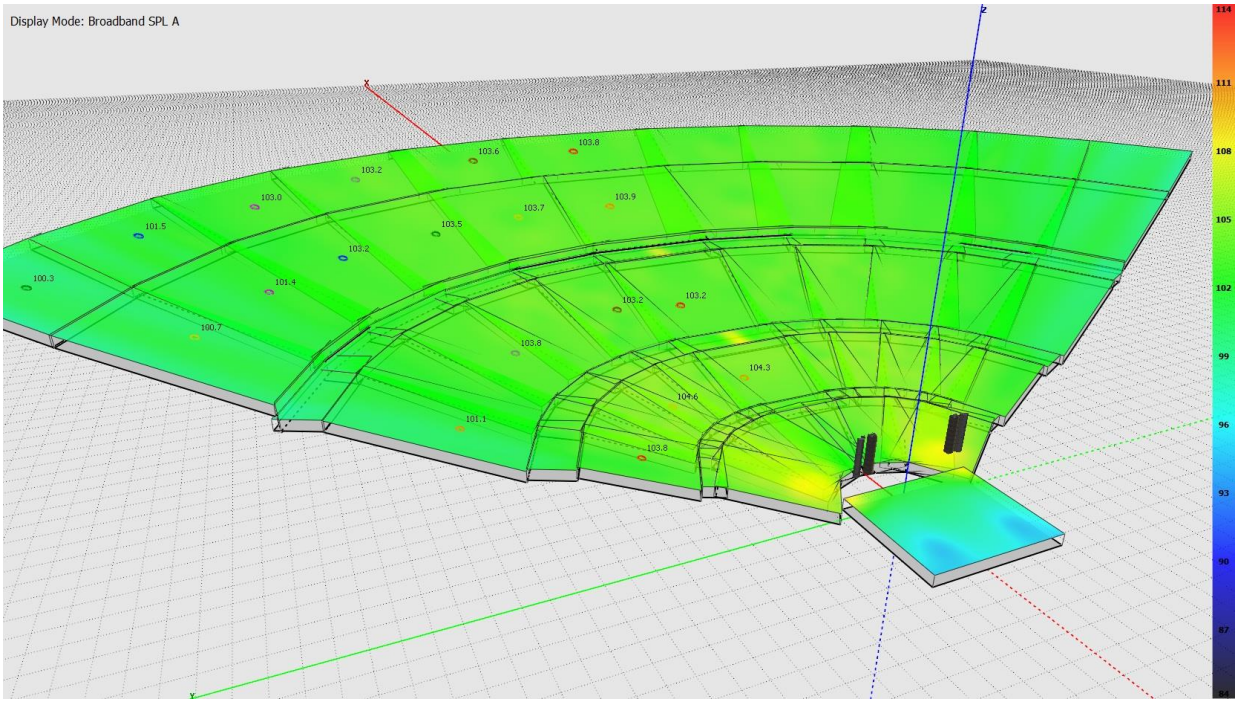


Section Venue View



Venue: Shed

Perspective Venue View

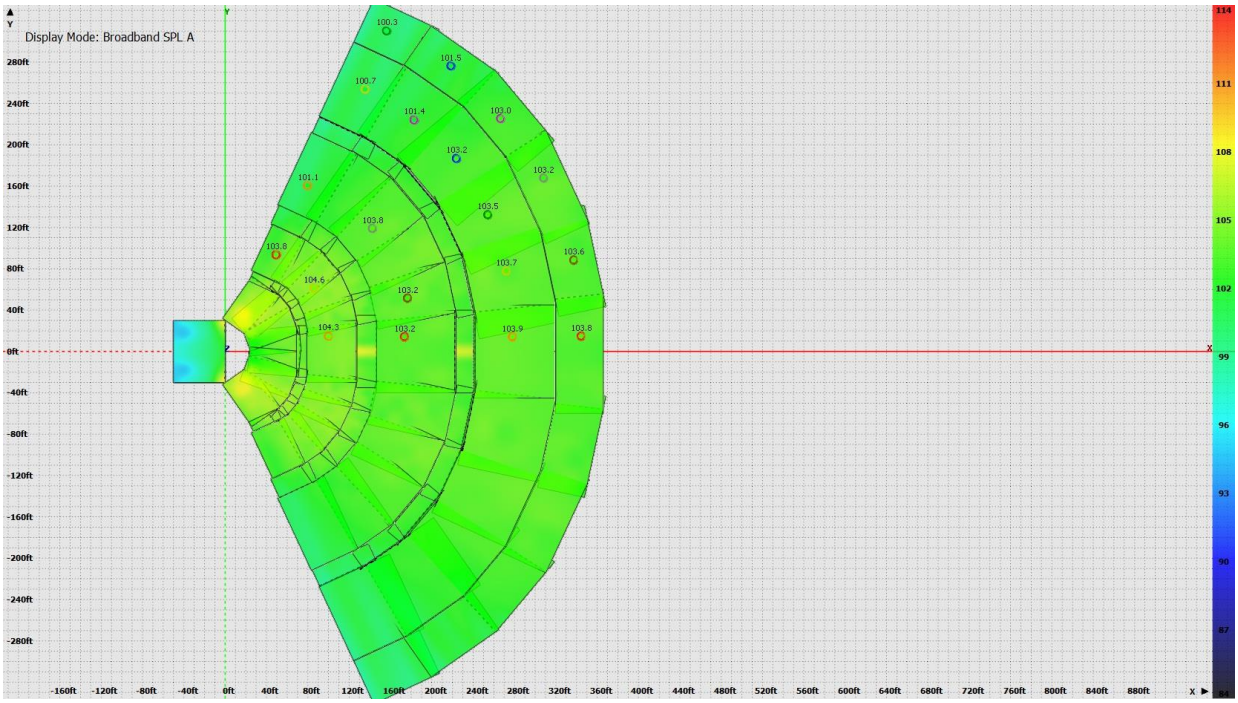


This example represents an outdoor “shed”-style venue, including a heavily-raked seating bowl and capacity of approximately 20,000 attendees. The system utilizes two arrays of 18x Anna modules each, and two arrays of 8x Otto modules each.

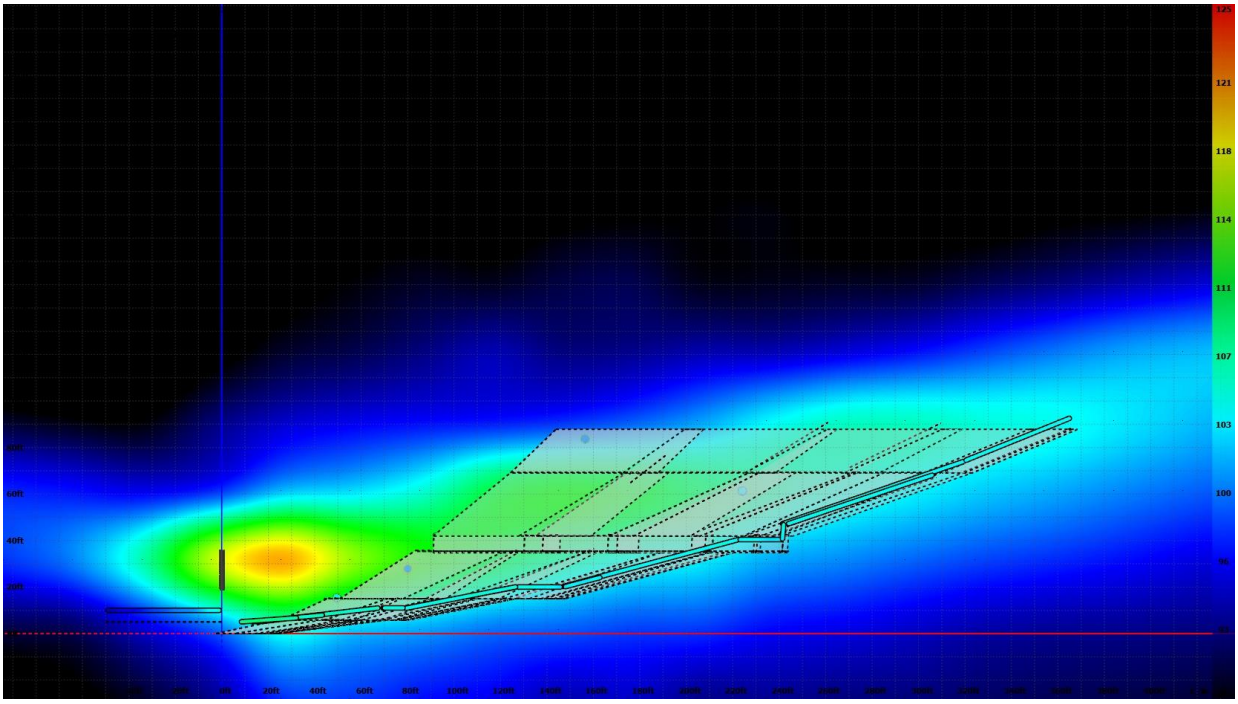
Often situated in suburban areas, shed venues can be the source of community-sensitive noise issues. Compared to traditional line array products, Anna and Otto provide a tremendous advantage in controlling noise spill to adjacent neighborhoods with their ability to adjust coverage through a few clicks in software. The engineer can direct the system to reduce coverage as needed throughout an event, even mid-show, without any physical changes to the arrays.

System Components & Configuration	**Predicted Performance**
36 Anna Modules (2x 18 modules)	Average SPL: 103 dB (continuous)
16 Otto Modules (2x 8 modules)	Variation: +/- 3 dB
2 Otto Flybars	
2 Anna Flybars	**Rigging Requirements**
6 Adaptive Distro Racks	(2) 2-ton motors - Anna
Accessory Cabling Package	(2) 1-ton motors - Otto

Plan Venue View

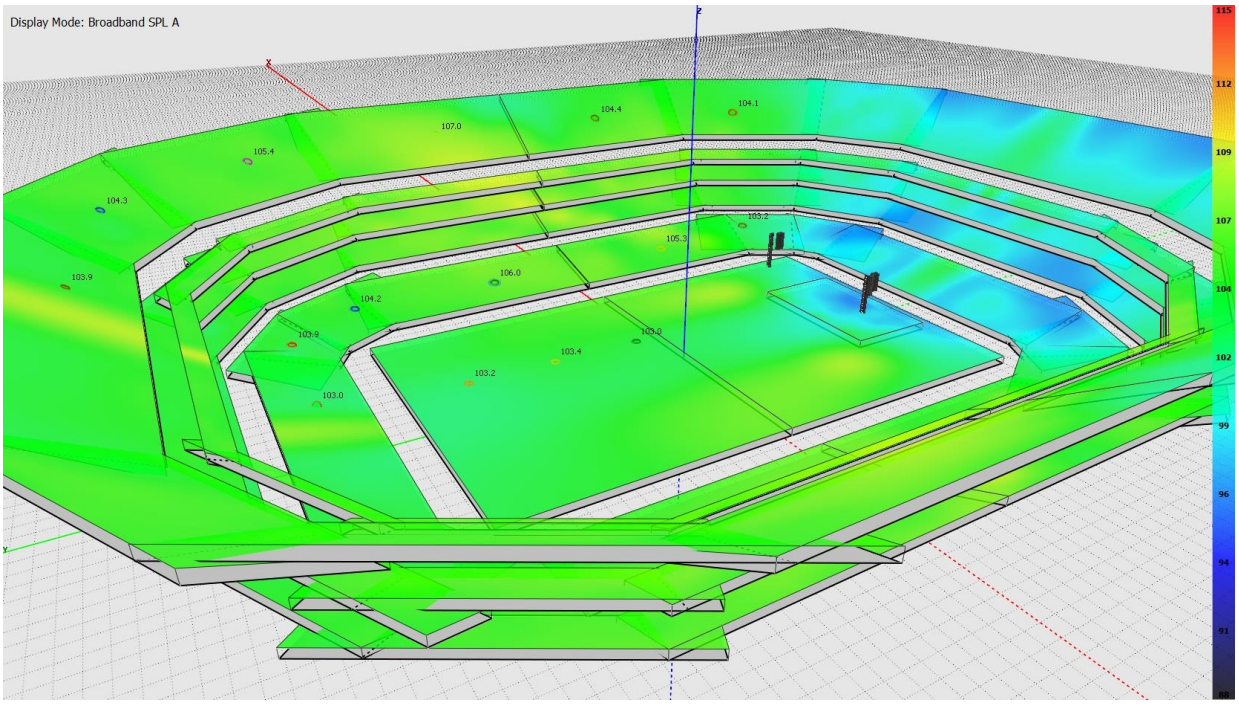


Section Venue View



Venue: Stadium

Perspective Venue View



This example illustrates a large stadium with the stage configured at one end, and seating wrapping around 270°. Each array consists of two columns: one of 18x Anya modules for the 'long-throw', and another column of 14x Anna modules for outfill. Even with a large throw distance differential between columns, SPL is remarkably consistent. Low frequency support is provided by 24x Otto.

System Components & Configuration

36 Anya Modules (2x 18 modules)
28 Anna Modules (2x 14 modules)
24 Otto Modules (4x 6 modules)
2 Anya Flybars
2 Anna Flybars
4 Otto Flybars
8 Adaptive Distro Racks
Accessory Cabling Package

Predicted Performance

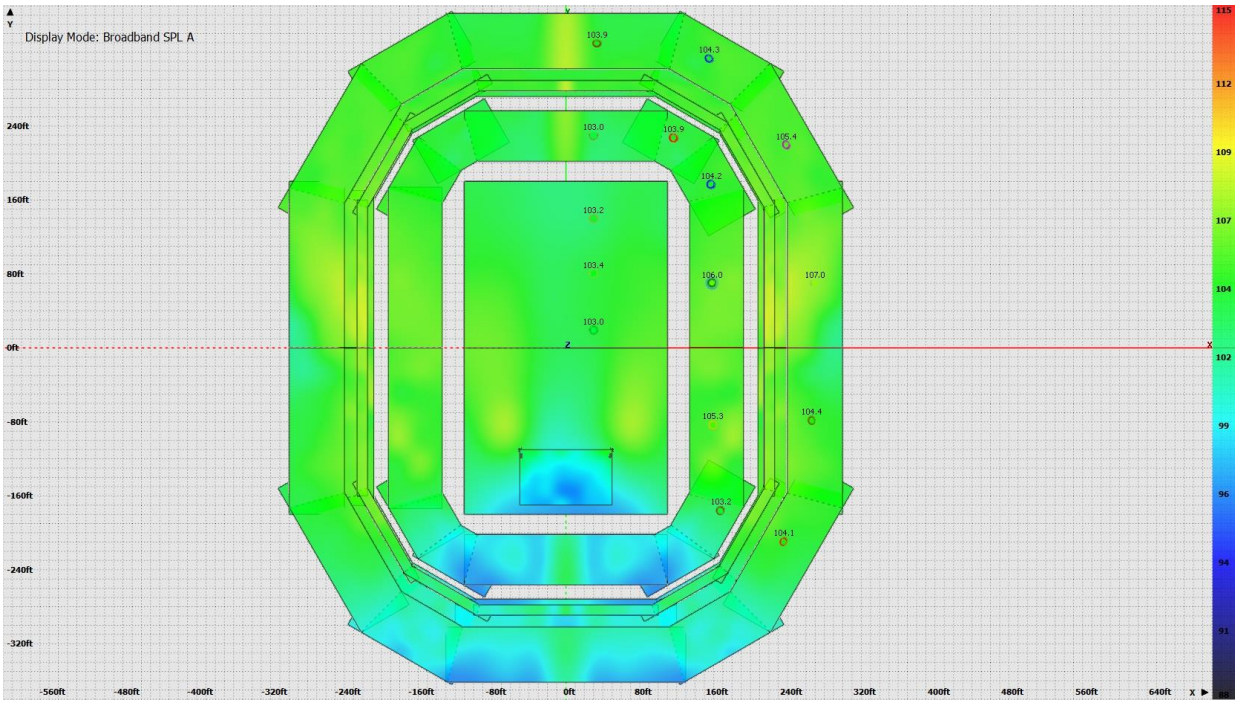
Average SPL: 105 dB (continuous)
Variation: +/- 2 dB

Rigging Requirements

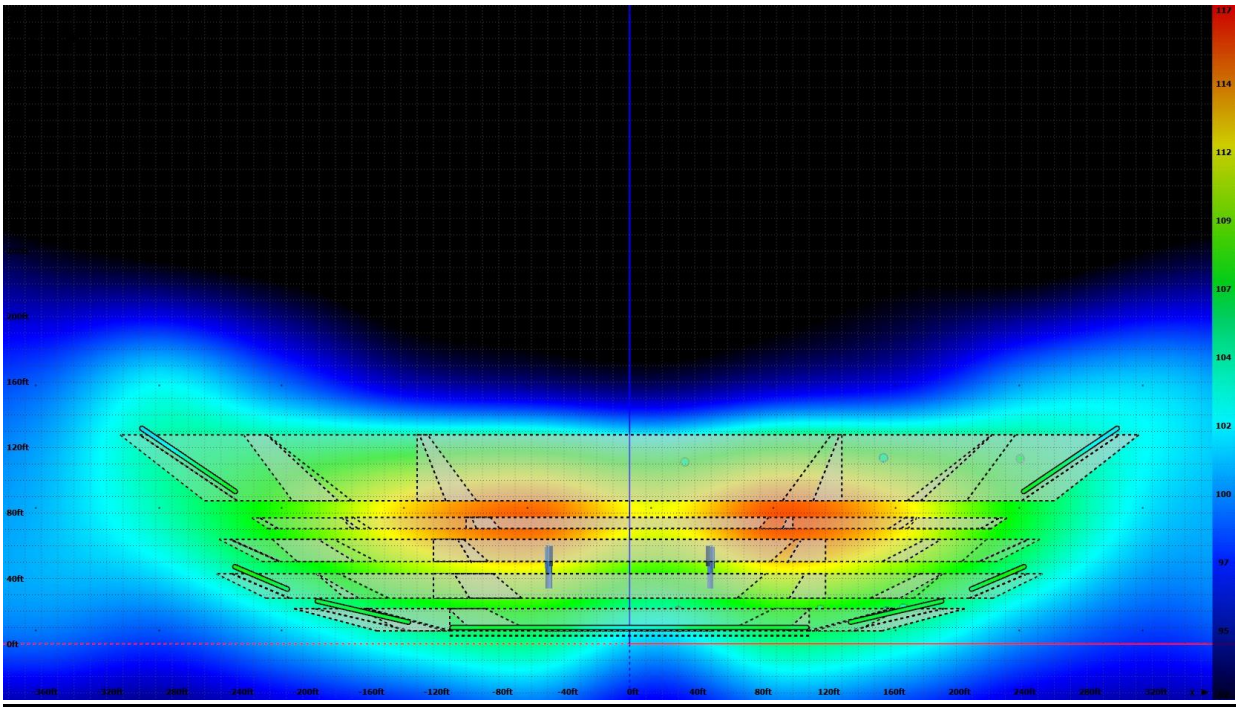
(4) 2-ton motors* - Anya
(6) 1-ton motors – Anna and Otto

* Assumes two 2-ton motors for each 18-module Anya column.

Plan Venue View

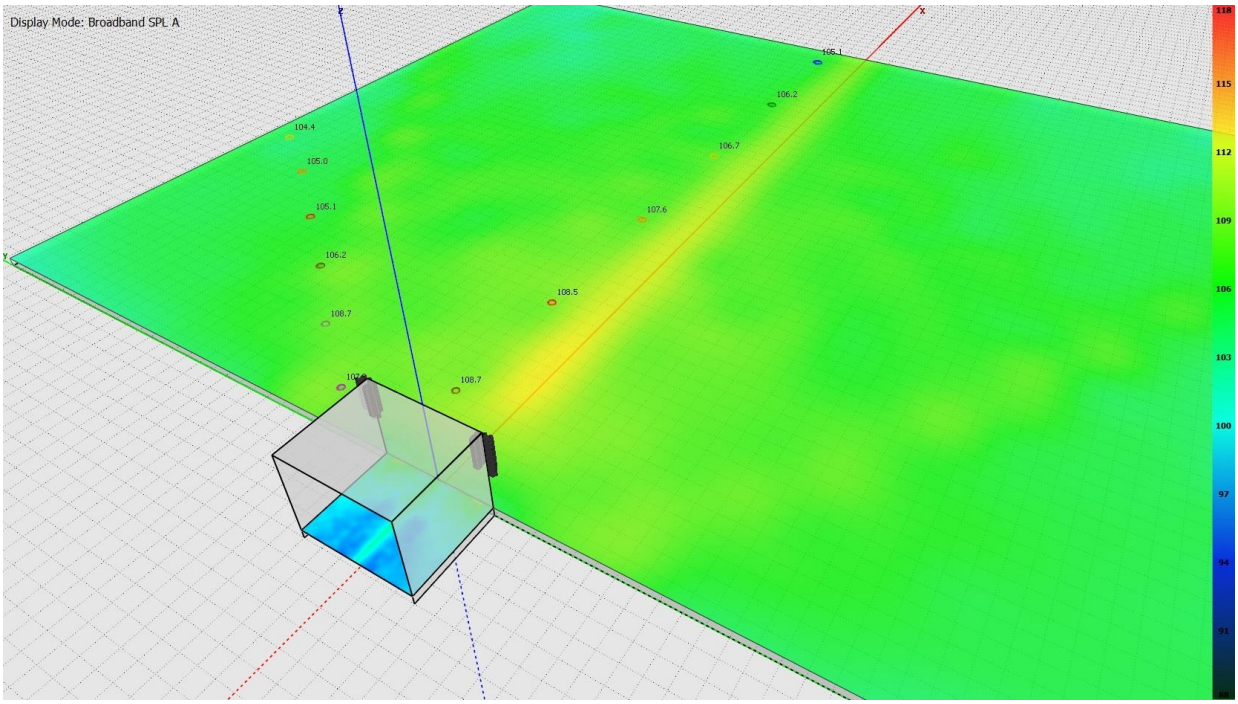


Section Venue View



Venue: Outdoor Festival

Perspective Venue View



Outdoor festivals include a number of inherent challenges. First and foremost, the typical audience areas and throw distances are very large. The following example shows a large concert area (550’ deep x 650’ wide) for a well-known festival in the UK. The design uses two arrays, each with one main column of 16x Anya modules and one outfill column of 12x modules. The system is clearly capable of addressing the 500+ foot throw without any need for delay towers, delivering consistent coverage to the most distant listeners.

As mentioned before, a major advantage with Anya over any other pro-touring system on the market is its ability to tailor coverage in-situ. It is no secret that major outdoor festivals endure the wrath of surrounding neighborhoods on a regular basis and noise control is of paramount importance to festival promoters and city government.

Most festivals begin early in the day and run late into the evening. The first half of the day is usually light on festival attendees relative to the number that can be expected for the headliners later in the evening. Still, with conventional systems, there is no way to tailor the coverage. The mains will run all day long in full coverage regardless of how many attendees are present. While delay rings may be turned off until they are required later in the evening the mains cannot be altered

Anya has the ability to alter the coverage to whatever the needs are at any time. Coverage could be 0 to 50 feet at the beginning and 20 to 300 in the evening or anywhere in between. The ability to tailor the coverage in such a way minimizes unnecessary spill to the surrounding areas. The key is that even reducing the coverage of the system does not disrupt the directivity control. With a traditional system to attempt this would mean turning off sections of the arrays which would reduce its ability to control

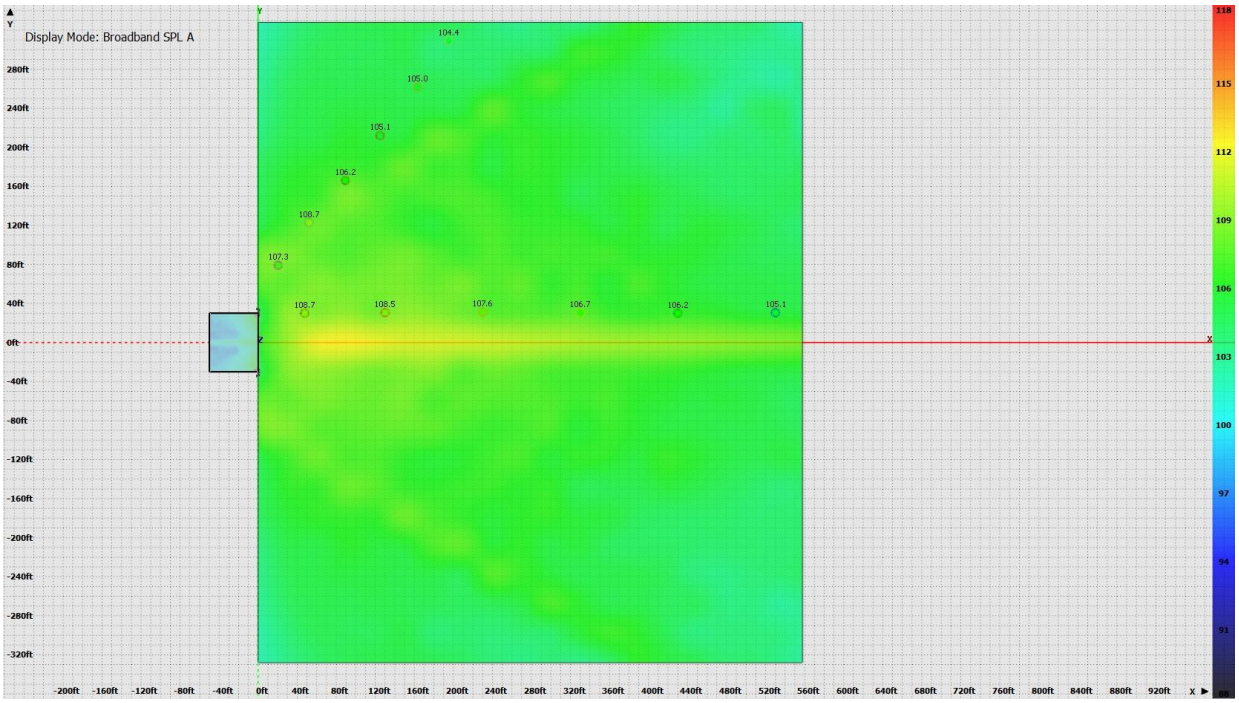
low frequencies. With Adaptive systems, the array's total output is available wherever coverage is defined. In the examples below, both 'full-coverage' and 'reduced-coverage' options are presented. In the 'reduced-coverage' scenario, SPL in the coverage zone is increased because the entire array is now being applied to a smaller area.

System Components	**Predicted Performance**
56 Anya Modules (2x 16+12 modules)	Average SPL: 107 dB (continuous)
32 Otto Modules (4x 8 modules)	Variation: +/- 2 dB
4 Otto Flybars	
4 Anya Flybars	**Rigging Requirements**
8 Adaptive Distro Racks	(6) 2-ton motors*- Anya
Accessory Cabling Package	(4) 1-ton motors - Otto

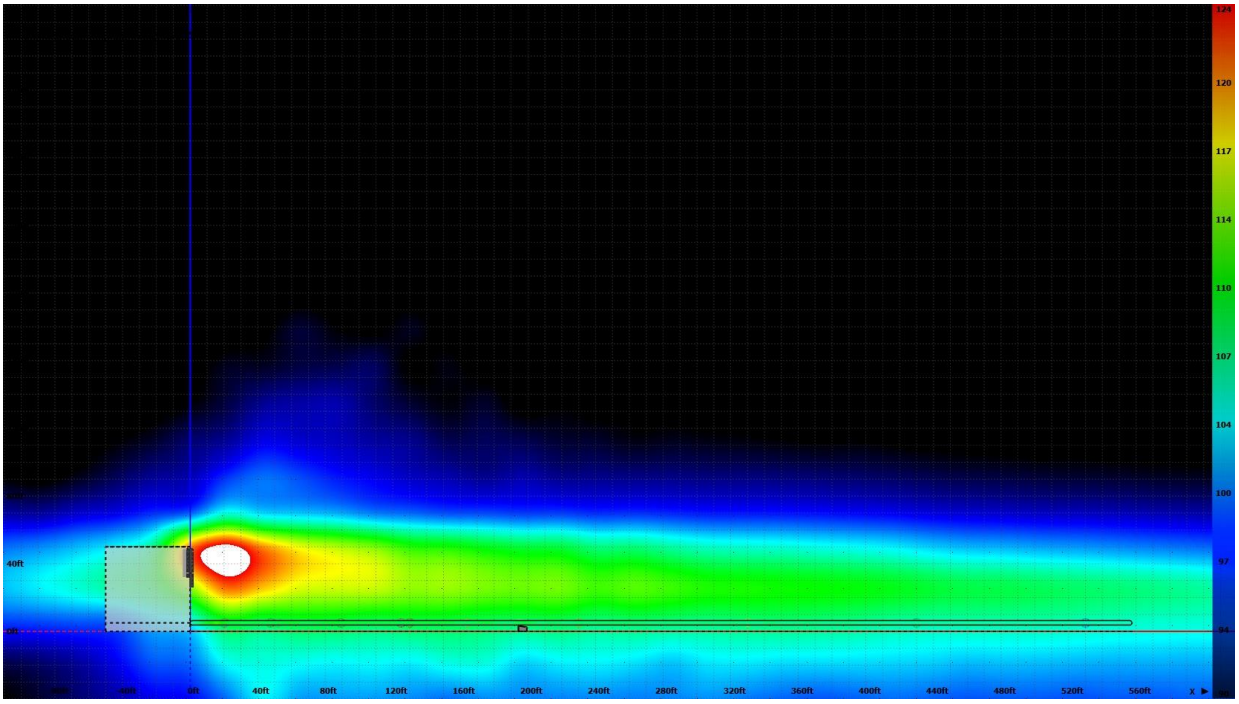
* Assumes two 2-ton motors for each 16-module Anya column.

(Continued on next page)

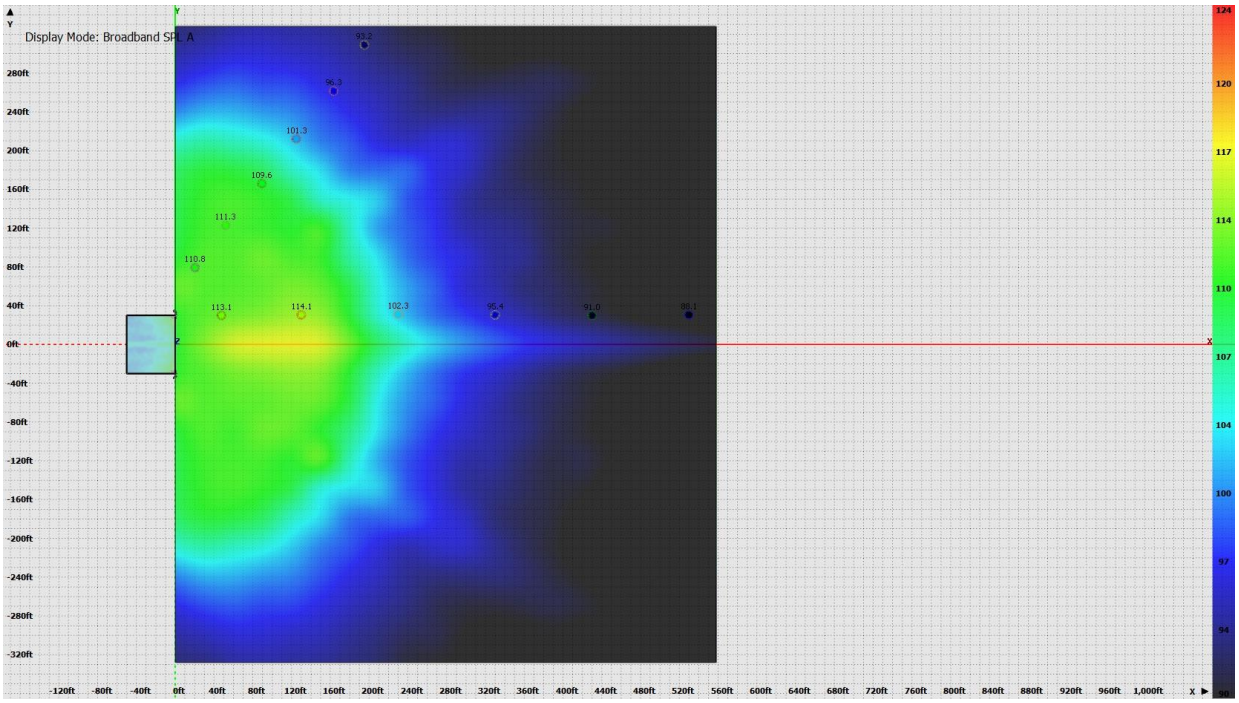
Plan Venue View – Full Coverage



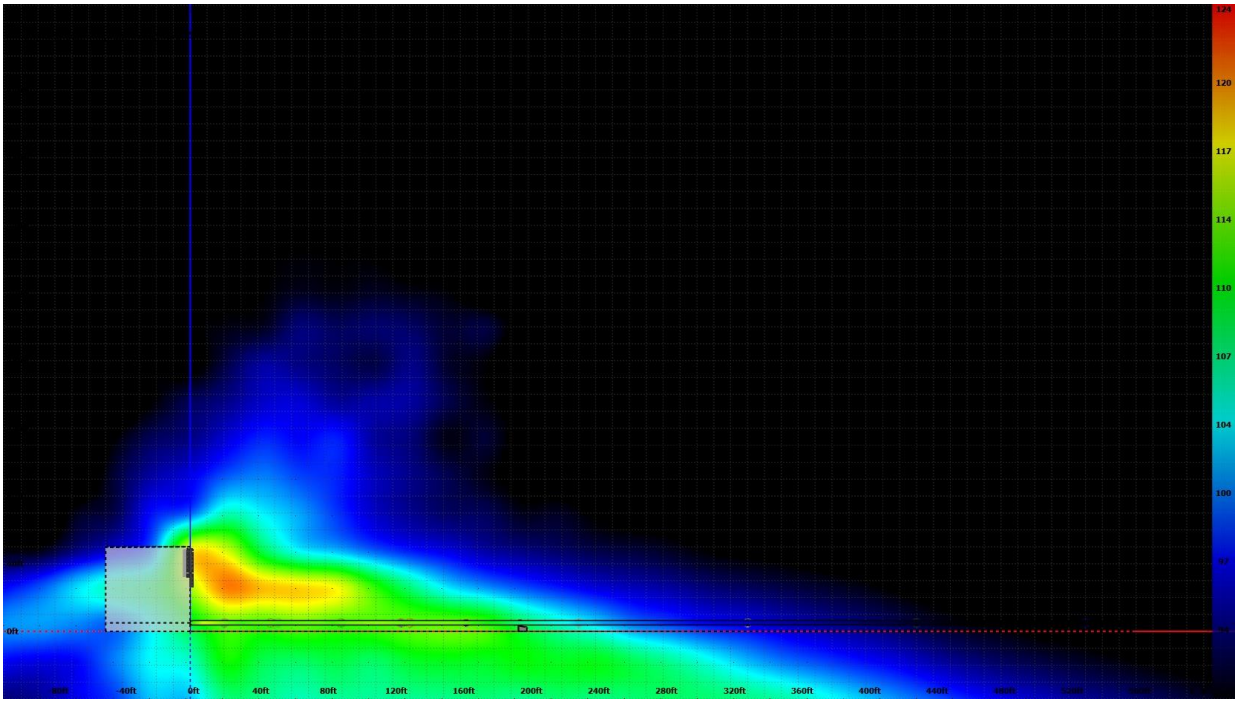
Section Venue View – Full Coverage



Plan Venue View – Reduced Coverage



Section Venue View – Reduced Coverage



Contacting EAW

We have attempted to make this document as thorough as possible. However, feel free to contact the Application Support Group for any further questions about Anya, Anna, Otto or EAW products in general.

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