AUDIO PERFORMANCE
SIMPLY THE BEST PRO SOUND SYSTEMS

DLA6 Line Array 2Way Active & SUB6-amp Subwoofer Series

DSP controlled – Ethernet Networking

User configurable loudspeaker system

USER GUIDE

Version 2.0
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1 DLA6 and SUB6-amp Characteristics

LINE ARRAY Series

Compact 2Way active line array system

Audio-Performance Line DLA6

The DLA6 Compact Line Array Loudspeaker is a Light, Simple and Versatile product designed to deliver Great Sound into medium and even large venues.
The two way full range Loudspeakers consist of 2 x 6.5" low frequency cone driver and a 1.4" exit, 3" voice coil compression driver mounted in a complex Audio Performance Wave Guide that constrains the horizontal directivity into a 100° angle.
The specific conception enables the DLA6 to reach 55 Hz without the need of a subwoofer and to deliver a flat frequency response up to 18kHz (+/- 3dB).
The versatility of the DLA6 stand in the externally amplification possibilities. It can be used either in a fully 2 way active mode or bi-amplified with the SUB6-amp. Each SUB6-amp integrates two AP D2SP amp's modules that together deliver a total of 5'000W RMS (4 x 1'250W), of which one is a dedicated DSP controlled Amp Module that can feed four DLA6.
The simplicity of the unique patent pending Three Points Rigging system offers easy stacking as well as easy flying and fits in any situation. Setting up the array angle is very easy with the exclusive bended back plate. Angles extension: 0° to 8° for each DLA6 (Angle Step: 0.5° until 4°, 1° until 8°). A support in array configuration is provided by the Audio Performance "EasySpray" software.
The use of a SUB6-amp doesn't demand additional frames, neither in flying or in stacking. A DLA6 array can be build on your own.
The DLA6 is perfectly suitable for touring and fixed applications.

No compromise between size and sound, It's just Small and Powerfull!!

IDEAL FOR

Medium
Scale sound
Reinforcement

Concert halls
Clubs

Stadiums
Theatres

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LINE ARRAY Series

Line DLA6 Specifications

ACOUSTICAL

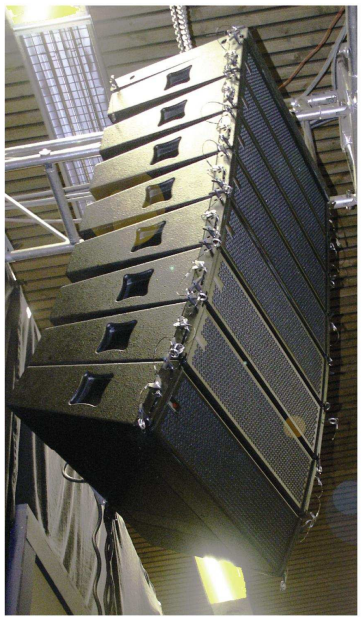
Frequency response (1)	55Hz - 18'000Hz
Phase response	350Hz - 10KHz + / - 45°
Maximum peak SPL (2)	128dB
Coverage	Horizontal: 100° Vertical: Varies with array lenght and array configuration
Crossover (3)	890Hz

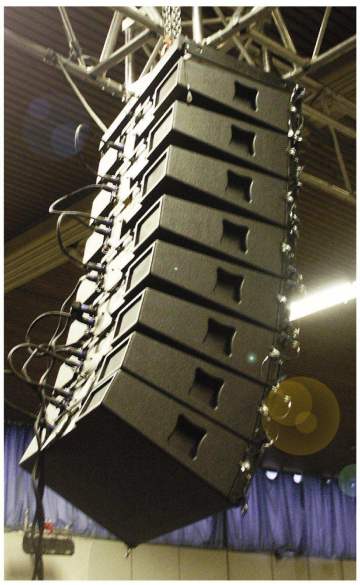
TRANSDUCERS

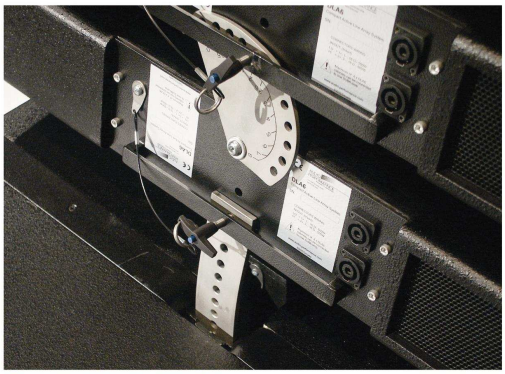
Low frequency	2 x 6.5" long excursion, low distortion cone driver
Nominal impedance	16 ohms
Power Handling	250W RMS (AES) (4)
High frequency	1 x 1,4" exit, 3" diaphragm compression driver, loaded with patented waveguide
Nominal impedance	16 ohms
Power Handling	150W RMS (AES) (4)
Connectors	2 x Neutrik Speakon NL4MP (wired in parallel) 1+/- = Low; 2+/- = High

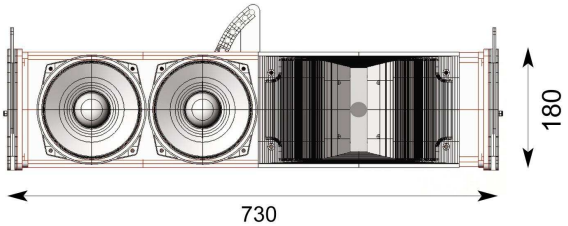
MECHANICAL

Cabinet size (WxHxD)	730 x 180 x 460mm
Cabinet finish	15 mm plywood, black epoxy painted, other colours on request
Rigging	Patent pending Three Point Rigging system
Protective grill	Removable perforated 1,6mm steel, foam cover
Weight	25Kg









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LINE ARRAY Series

Self-Powered high-SPL subwoofer for Line DLA6 line array
PC remote controlled with networking

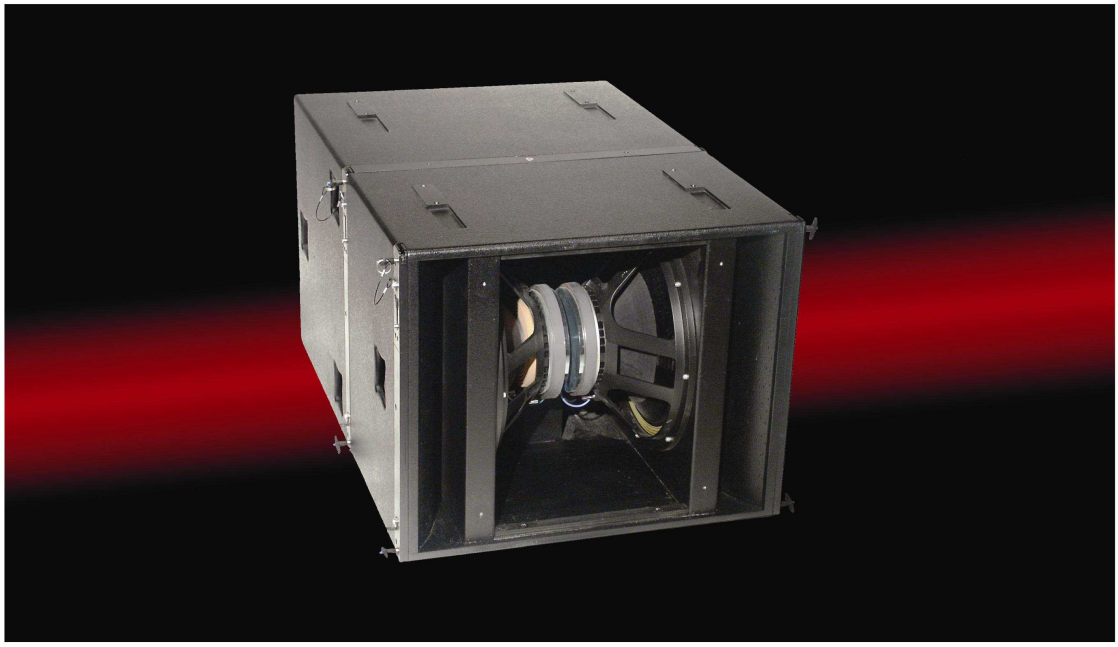
Audio-Performance Line SUB6-amp

The SUB6-amp as been designed to complete and achieve a really High Standard Full Range Line Array in combination with DLA6 Line array cabinets.
The SUB6-amp is composed of two 18" low frequency cone drivers mounted in a manifold configuration. The complex elliptic bass reflex design reinforces the bass in order to achieve a flat frequency response down to 35Hz.
The patent pending Rigging System allows to fly or stack DLA6 with SUB6 and to fly SUB6 under SUB6. With his unique Rigging Belt, only one bumper is needed to fly a whole array. Plus, the Bumper can also directly hang the DLA6 array, as DLA6 and SUB6-amp foot print is similar.
In Ground Stacking uses, the Belt, in addition with the special Curtain Pole, allows to set up the array very easily with a Positive or a Negative Start Angle in order to fulfil most of directivity needs.
The mighty SUB6-amp loads two Audio Performance DSP controlled D2SP Amplifer Modules of which one is dedicated to power up to four DLA6 Loudspeakers and the other to supply SUB6-amp. Together the amplifiers can deliver 5'000W in total and each SUB6-amp's driver is fed with a proper channel.
Should no amplified products be needed, the SUB6 or SUB06 (without rigging) has been engineered in order for you to be able to build a Complete Active Line Array System.
Mainly developed for Line Array purposes, the SUB6-amp will fit perfectly any time a large bass reinforcement is needed.

IDEAL FOR

Touring
Concert halls
Discotheques
Sound effects

The SUB6-amp subwoofer system is ideal for any professional application requiring accurate low frequency reinforcement at high sound pressure levels



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LINE ARRAY Series

Line SUB6-amp Specifications

ACOUSTICAL

Frequency response (1)	35Hz - 150Hz
Maximum peak SPL (2)	140dB

TRANSDUCERS

Low frequency	2 x 18 inch, ferrofluid cooled, long excursion low distortion cone driver

AMPLIFIER 1 (SUB)

Output power (low 1) (5)	1'250W RMS
Output power (low 2) (5)	1'250W RMS
THD, DIM, SMPTE	< 0,05%

AMPLIFIER 2 (DLA6)

Output power (low) (5)	1'250W RMS
Output power (high) (5)	1'250W RMS
THD, DIM, SMPTE	< 0,05%

AUDIO INPUT

Type	Analog Differential balanced input circuit
Connectors	Female XLR; Male XLR loop
Nominal impedance	10K ohm
XLR wiring	1: GND, 2: positive, 3: negative

DSP

Sampling rate	96KHz
Basic delay	0.76 ms
Dynamic range	115 dB

REMOTE / NETWORK

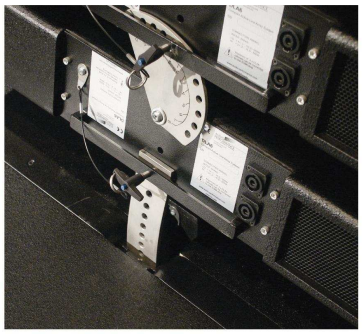
Type	PC and PodWare Software
Connectors	RJ45 female, RJ45 loop

AC power

Connectors	Female PowerCon, in; Male PowerCon loop
Input voltage (EU)	115V - 230V nominal, +/- 10%

MECHANICAL DATA

Enclosure:	18 & 24mm plywood
Finish	Black epoxy painted, other colours on request
Dimensions (W x H x D)	730 x 586 x 1060mm
Grill	Removable perforated 1,6mm steel, foam cover
Weight	98Kg



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2 D2SP Amplifier Module

The two amplifiers modules, which are integrated in the SUB6-amp, are dual channel Class-D amplifier. One module can handle up to 2 x 1'250W RMS into 2Ohms. It incorporates digital signal processor (DSP) providing specific loudspeaker controller functions.

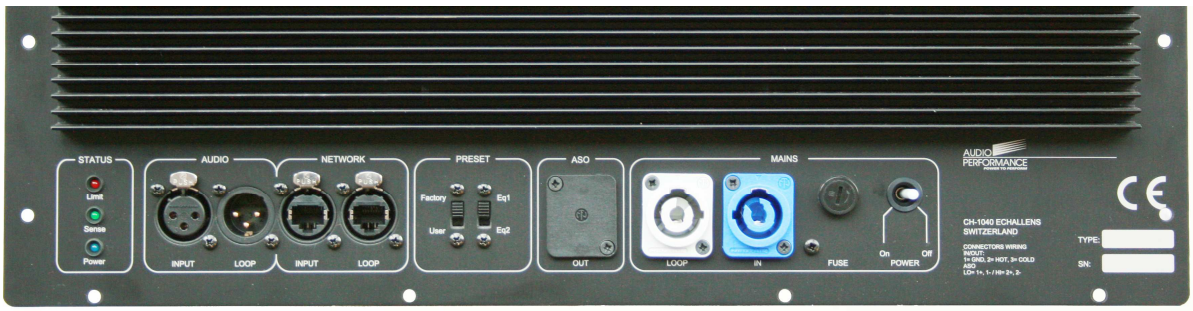

Figure 1 : Illustration of the amplifier module plate

2.1 AC Power:

The amplifier is design to operate at 115V or 230 V AC power supply. Voltage selection is automatic.

The module uses Neutrik Powercon inlet for "Mains" supply and "Loop", respectively blue and white on the panel.

Note: continuous voltages higher than 275V may damage the amplifier unit!

Voltage requirements:

The amplifier has been designed to operate safely and without audio discontinuity when AC voltage stays within the ranges 85-134 V or 165-264 V at 60 or 50 Hz. The system, right after applying AC power, mutes for 4 seconds to avoid noises until nominal power supply value is reached. During Power Up, the 3 Status LED's flash

Note: If the Status Power LED does not illuminate blue or if the system does not respond to audio input after ten seconds, remove AC power to prevent damages from the unit. Experienced electronic technicians can verify proper operation for the power supply and the amplifier regarding the "A. P. Service Manual and Troubleshooting Guide".

2.2 Audio Input:

The audio input is a 10 kOhm balanced input to a three-pin XLR female connector wired with the following convention:

Pin1: GND
Pin2: Hot
Pin3: Cold

Pin2 is hot relative to Pin3, resulting in a positive pressure wave when a positive signal is applied to Pin2. A single source can drive multiple cabinet with paralleled input loop creating an unbuffered hardwired loop. Cascading n number of Self-Powered loudspeaker will produce a balanced input impedance of 10 kOhm divided by n.

To avoid distortions from the source, make sure that the source equipment can drive the total load impedance presented by the paralleled input circuit. For most source equipment it is safe to drive Circuits whose input impedance is not smaller than 10 times its output impedance. For example, cascading 10 Self-Powered loudspeakers produces an input impedance of 1 kOhm. The source equipment should have an output of 100 Ohm or less. This is also the case when connecting in parallel (loop out) Self-Powered Loudspeaker to any other Audio Performance Self-Powered Loudspeaker system.

2.3 Equalization presets:

Factory/User:

Those preset switches allows user to choose between two configurations. Factory means only factory settings, the ones provided with the speaker model. User means factory + user settings made with the PodWare application. The user settings added to those of the factory are internally and permanently stored into the DSP.

This way users have at disposal four complete settings with the permanent possibility to simply reset the original factory settings.

EQ1/EQ2:

The table below shows the two Factory settings for SUB6-amp and DLA6 Self-Powered Loudspeaker.

Model name	EQ1	EQ2	Special user file
DLA6amp	FR	HP	
SUB6amp	FR	FR -6dB	

FR = Product Full frequency Range
FR -3dB = Product Full frequency Range but 3dB lower
FR -6dB = Product Full frequency Range but 6dB lower
HP = High Pass filtered response (for use with a subwoofer)
HP2 = High Pass Filtered response (for use with low-mid speaker)

3 Basics of line arrays

The theory and principles of line arrays are mainly misunderstood and often simplify. The base of the line array theory gives only some leads for implementation and configuration of a line array.

Nothing better than measurements can give an appropriate setting of line arrays. Despite that, acoustics simulation can bring reasonable results to suitable configurations.

As everyone knows, line arrays are widely used nowadays but not always controlled. This user guide will help you getting rid of misunderstanding in many cases and trying to fit your hardware to your needs.

Firstly, a brief theory on the line arrays will be presented and, in a second time, a explanation on how to configure and install a DLA6 array.

3.1 Waves' behaviour:

The first thing that have to be keep in mind is the waves' behaviour. Unless those principle are understood, it is hard to find a highly capable setting for a line array.

Based on theory, the most efficient line array is the theoretical line source. This line source is an infinite, thin and continuous vibrating element which radiates cylindrical waves. Those waves behave so that the SPL looses 3dB with each doubling of the distance in the so-called "near field" and 6dB in the "far field". In the " far field", the waves become spherical.

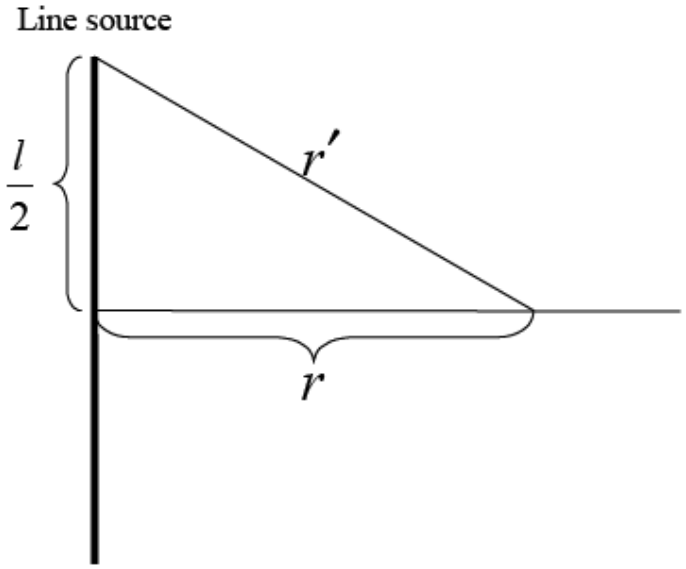

Figure 2: Geometric construction for far field distance

For a uniform line source, the "near field" limit (r) can be obtained, according to [1] and based on the Figure 2, by the equation:

$$r \approx \frac{l^2 f}{700}$$

With the relation above, the "near field" is not to take in consideration for very low frequency. For a 4 meters line source, the length of the "near field" at 40Hz is 0.91 (m). This can be neglected.

The Figure 3 shows up near field limits for different line source height. Notice that the distance of the frontier between the near and far field increases as the height of the line source increases, as well as with the rise of frequency (Figure 4).

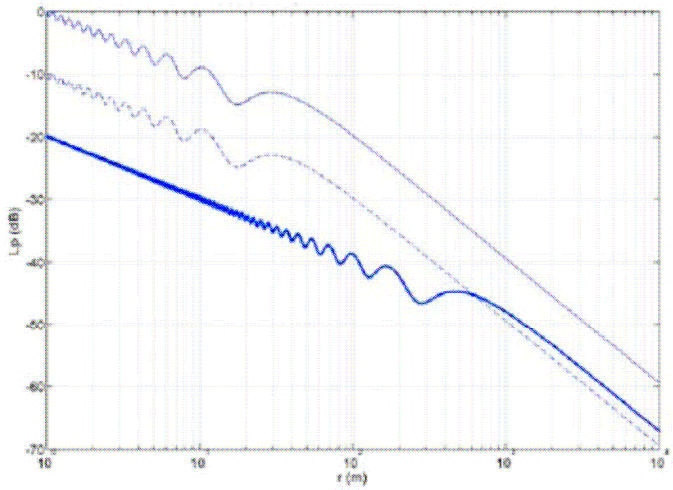

Figure 3: On axis response for a 2, 4 and 8 meters line source at 10kHz. Curves for 4 and 8 meters have been offset respectively by 10 and 20 dB

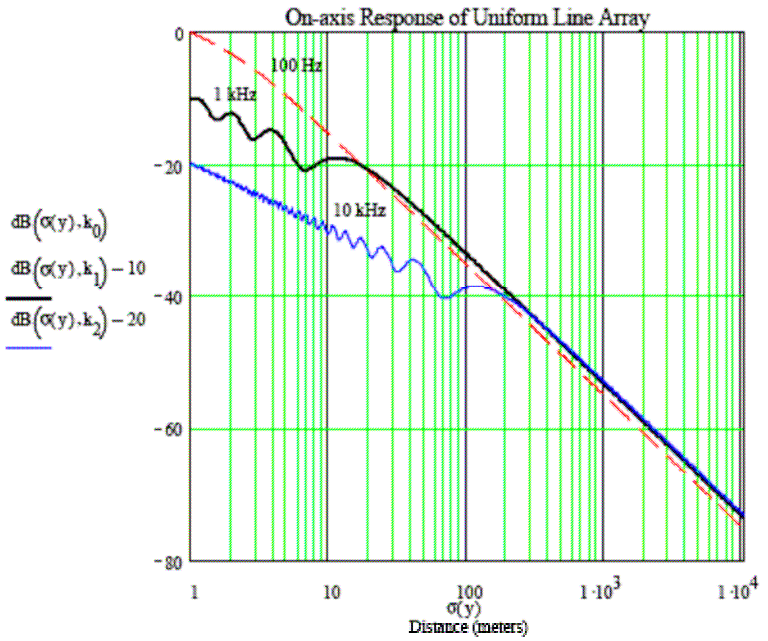

Figure 4: On axis response for a 4 meters long line source at 100, 1k and 10kHz.

Until now, only an ideal representation of the line array has been considered. The next step, to better approach a real representation of a line array, is to take line source with finite element of finite length. It means gap between each radiating element. This approach is more realistic and suitable for the real physical line array.

Every gap between two radiating units involves a zero in the amplitude. By the way, the geometry of the waves is directly affected. These gaps have a real small effect on the primary lobe, it mainly affects side lobes. Low frequency waves are also few distorted.

In higher frequencies, the gaps can seriously damage the behaviour of the line array. The value fixed for the ratio between gap and radiating surface is $\rho \geq 80\%$. This ratio allows to

consider the line array as a line source for high frequency. A complete study can be read in [1].

Figure 5 shows how gaps between sources influence with a non negligible way. Sides lobes have a much more important level with an array than with a line source of the same length. For those simulations, sources have been wilfully chosen as monopole to exaggerate the result. However even if this result is amplified, the phenomenon is not insignificant.

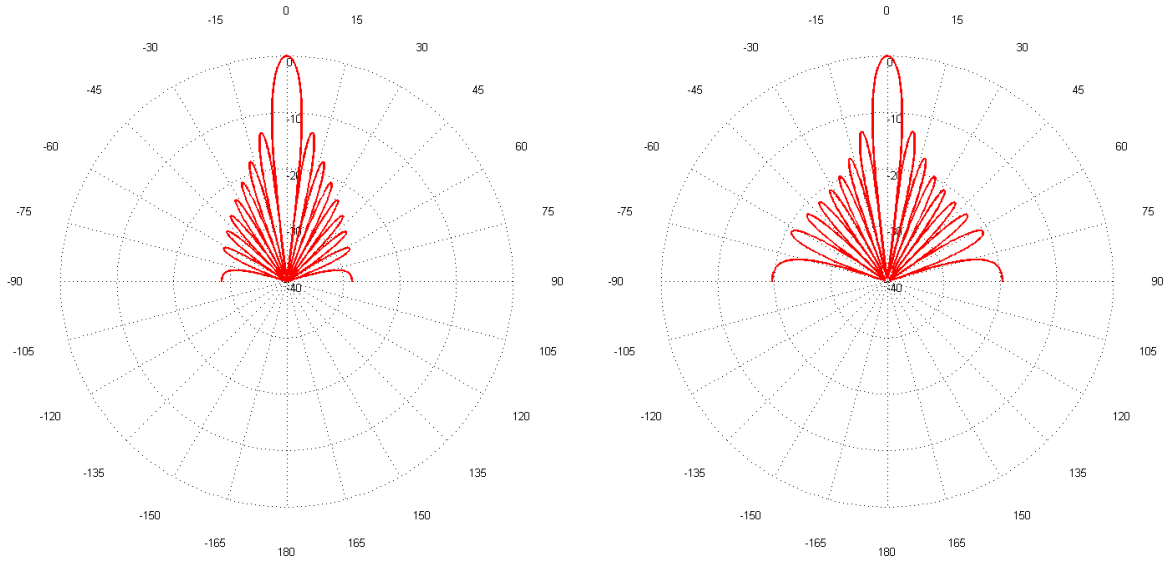

Figure 5 : Comparison of directivities at 1200 Hz of a line source of 2.4 meters high (left) and an array composed of 12 sources spaced by 0.2 m (right)

3.2 Line array aim and tricks

The main goal of a line array system is to push as far as possible the limit of the "near field" while controlling the vertical directivity to spray power only where it is needed. Meaning by this, the control of main and side lobes' level. To achieve this aim, various tricks can be considered.

First trick is to modify the amplitude along the array. It means that if the signals are adjusted according to simple geometrical considerations, the main lobe can be enlarge as well as the amplitude of side lobes can be decreased. The other side of the coin is a loss of the global SPL.

Some trivial amplitude weightings are visible on Figure 6 and results of simulation are shown on Figure 7. All simulations have been done with basic sources named monopoles.

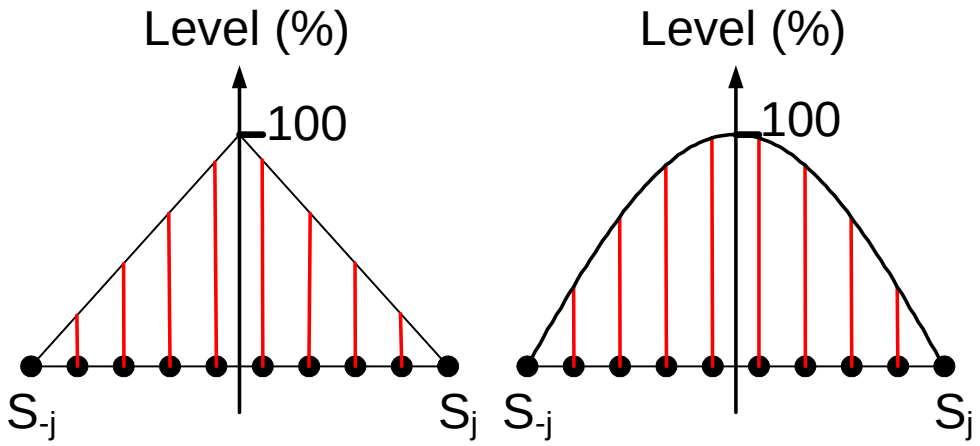

Figure 6 : Trivial amplitude weighting. Triangle weighting (left), cosines weighting (right). Sources are represented by the letter S.

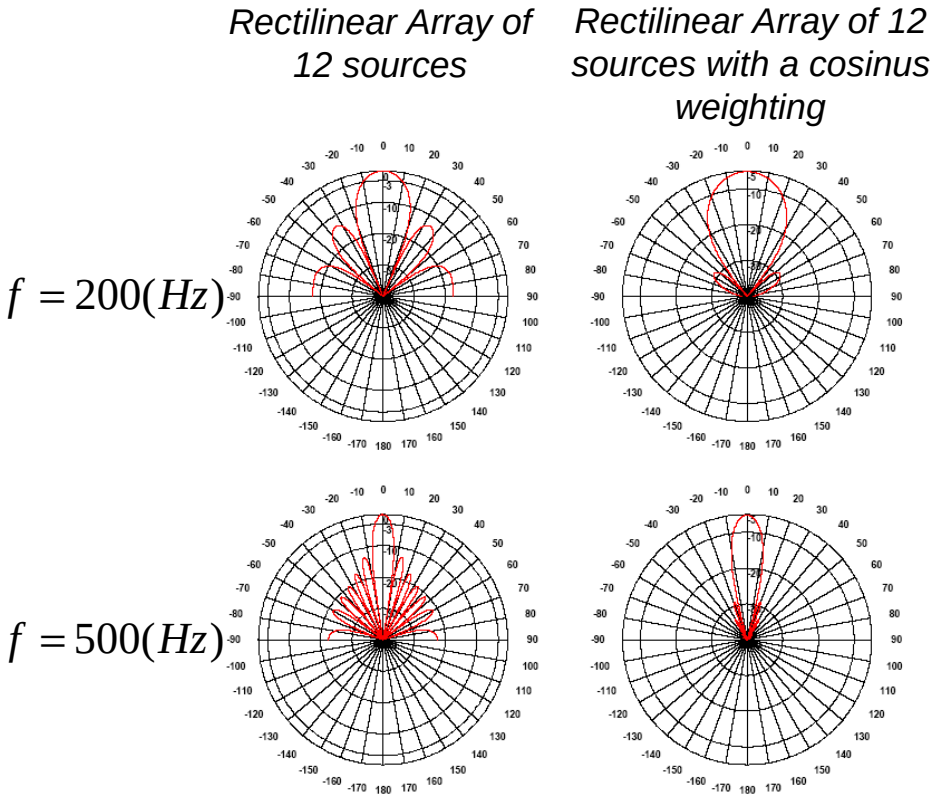

Figure 7 : Comparison between an uniform array (right) and a balanced array (left). Results for 200 and 500 Hz.

Another artifice is to apply a delay time between each sources of the array. Applying delays is like changing virtually the orientation of the array. It could be a time saving manner of changing the geometry of an array when this one is already mounted and you don't have the possibility to physically change the cabinets' arrangement. You can find respectively on Figure 8 and Figure 9, a simple representation of the virtual displacement and simulation results due to delays.

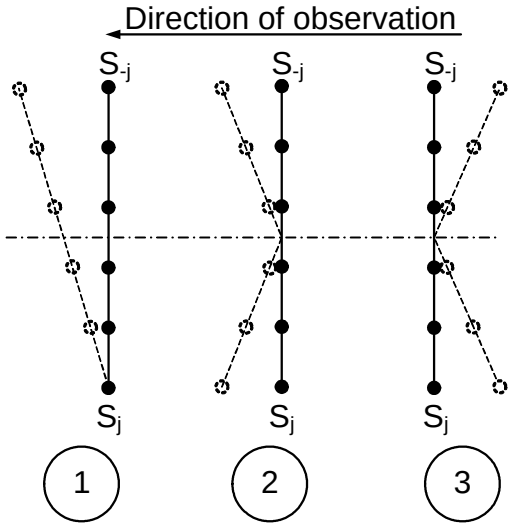

Figure 8 : Virtual displacement of sources along an array when using delays. 1) rotation effect, 2) diverging effect and 3) converging effect.

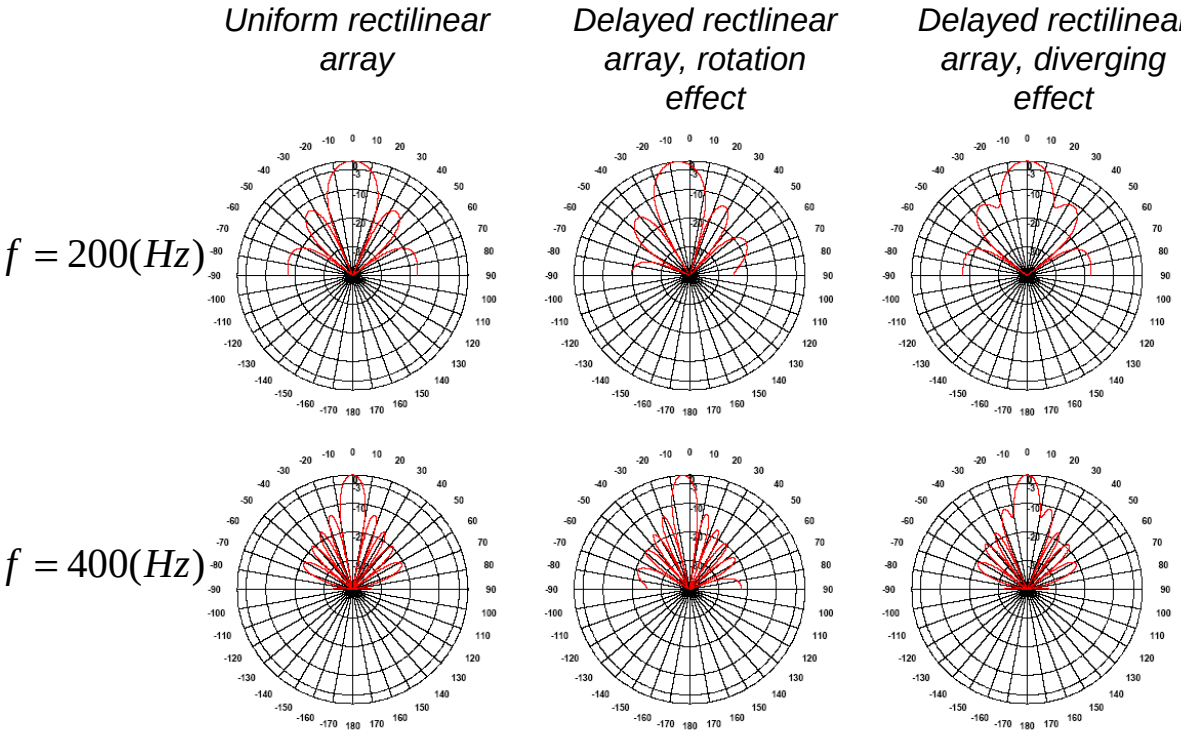

Figure 9 : Comparison simulation results between an uniform rectilinear array and delayed arrays with a rotation effect and diverging effect. Results displayed for 200 and 500 Hz

3.3 P.A System requirements

As it exists a multitude of different venue types (open air, hall, etc), a perfect system could not be designed to suit every room architecture.

The pa system issues are mainly the room geometry, acoustical quality (RT60, reverberations), maximum SPL admitted and listener space distribution.

The main goal of pa system is to cover all the listening area and to offer each listener the same SPL, a simple drawing can be seen on Figure 10.

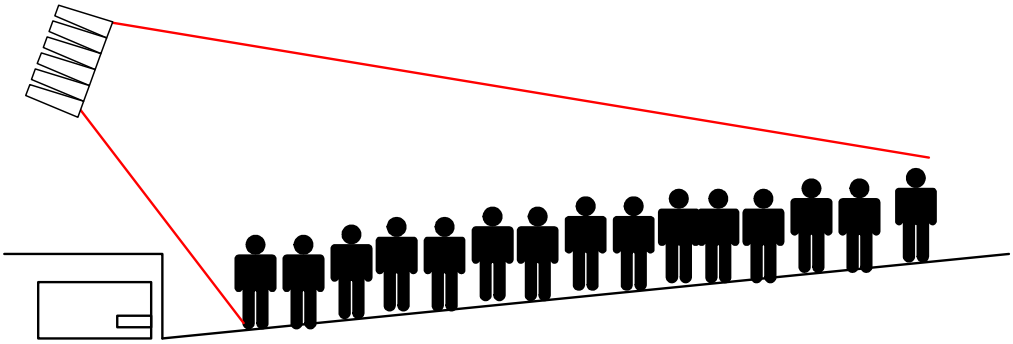

Figure 10 : Ideal public coverage

Don't have to mention that this is just impossible to achieve and that the pa system configuration will be based on compromises.

Previously, we have intentionally limited the discussion to the use of the theoretical monopole. In fact, a real source radiates energy in a non-uniform way. This has as consequence to make more difficult the understanding of the array's behaviour. The fact that waves are loosing power together with increasing distance, is also an issue.

Simulation's softwares, like Audio Performance "Easy Spray", could give really good advices for setting up an array. Further improvements can be made with a measurement system directly in the venue.

Starting of that and taking into account what has been previously said, an array can be build up in good conditions.

4 Building a DLA6 array

The DLA6 and SUB6amp array has been designed to offer a variety of configurations in order to fulfil the most of the needs. As it can be seen it the data of the SUB6amp, the amplifiers are DSP controlled. It means that the crossover and optimisation's filters are already integrated. However, a external controller has to be used for some assemblies to allow a more effective directivity control (delays, equalization).
The right configuration for a venue can be obtained and optimised with the "Easy Spray" software. A way to obtain equalization files for some usual arrangements can be found in the equalization paragraph.

In the following paragraphs, some different arrays are presented only for one side. That induce the fact that the same configuration has to be done for the other side. First of all, a description on how the patented pending rigging systems works.

Please take note that DLA6 and SUB6 illustrations' colours are different that those in real.

4.1 Rigging system

The DLA6/SUB6 complete rigging system has been defined to offer a great variety in configuration and simplicity. The unique DLA6 three point patent pending and the versatile bumper give the best way to achieve users' goals.

Figure 11 shows the assembly of the DLA6 hanging under the bumper. This set up allows user to set a starting angle for the first cabinet using the bumper's special bended plate. The next DLA6 box , can be hung with an different angle thanks to the DLA6's bended back segment.

Only four front pin-lock (two each side) and two rear pin-lock are needed to achieve the assembly.

Figure 12 and Figure 13 show in more detailed views the back and front rigging system.

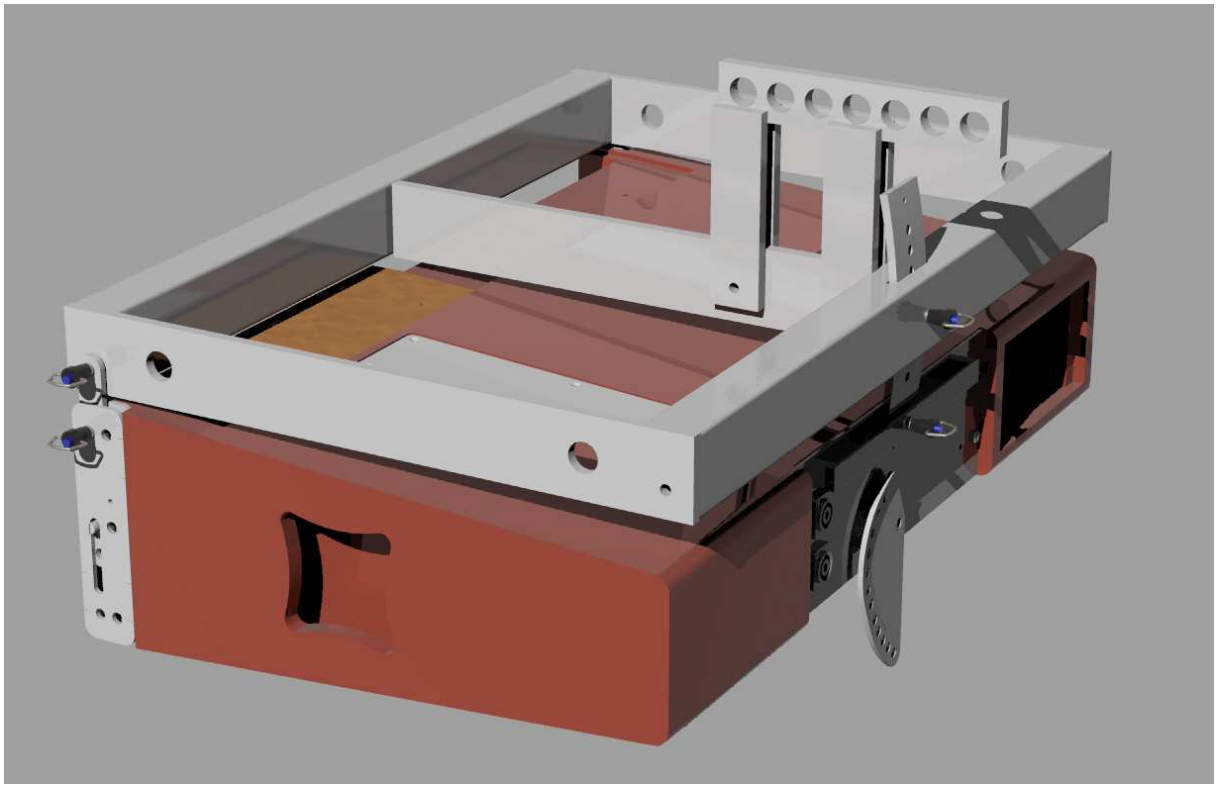

Figure 11 : DLA6 general flying view

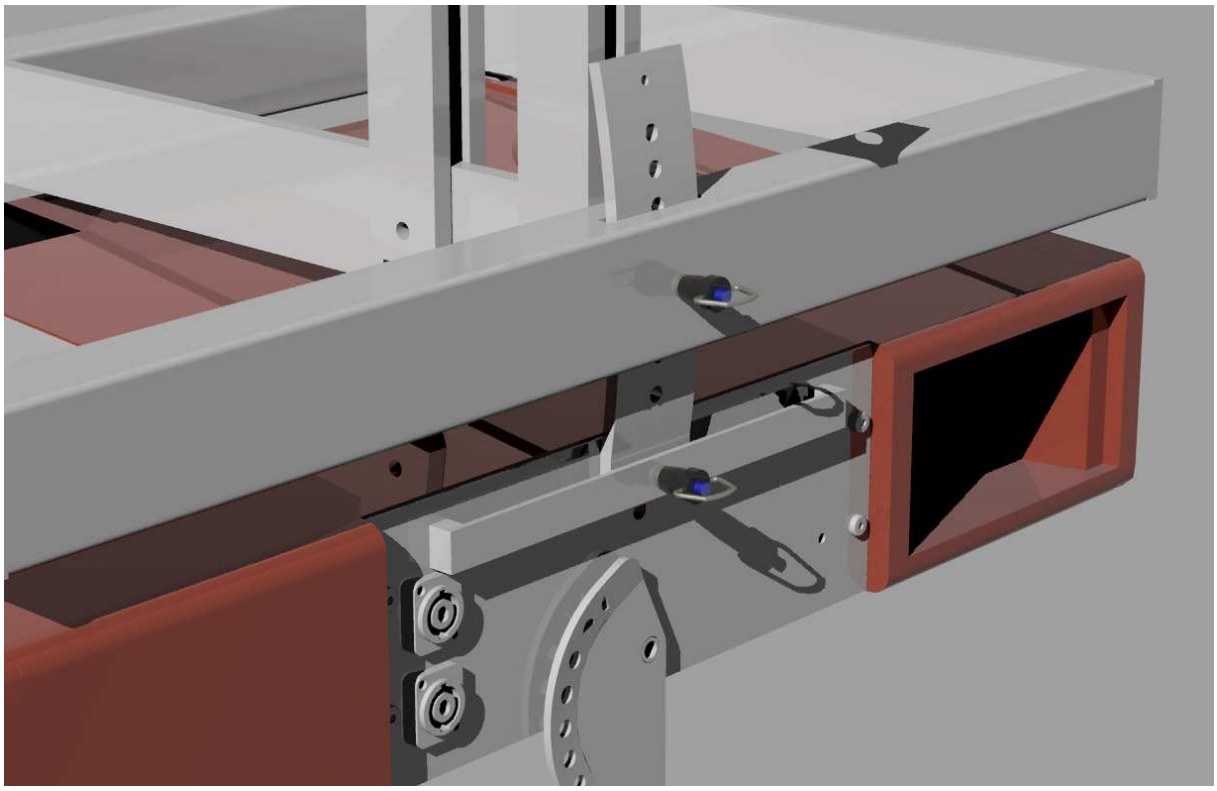

Figure 12 : DLA6's back rigging system detailed view

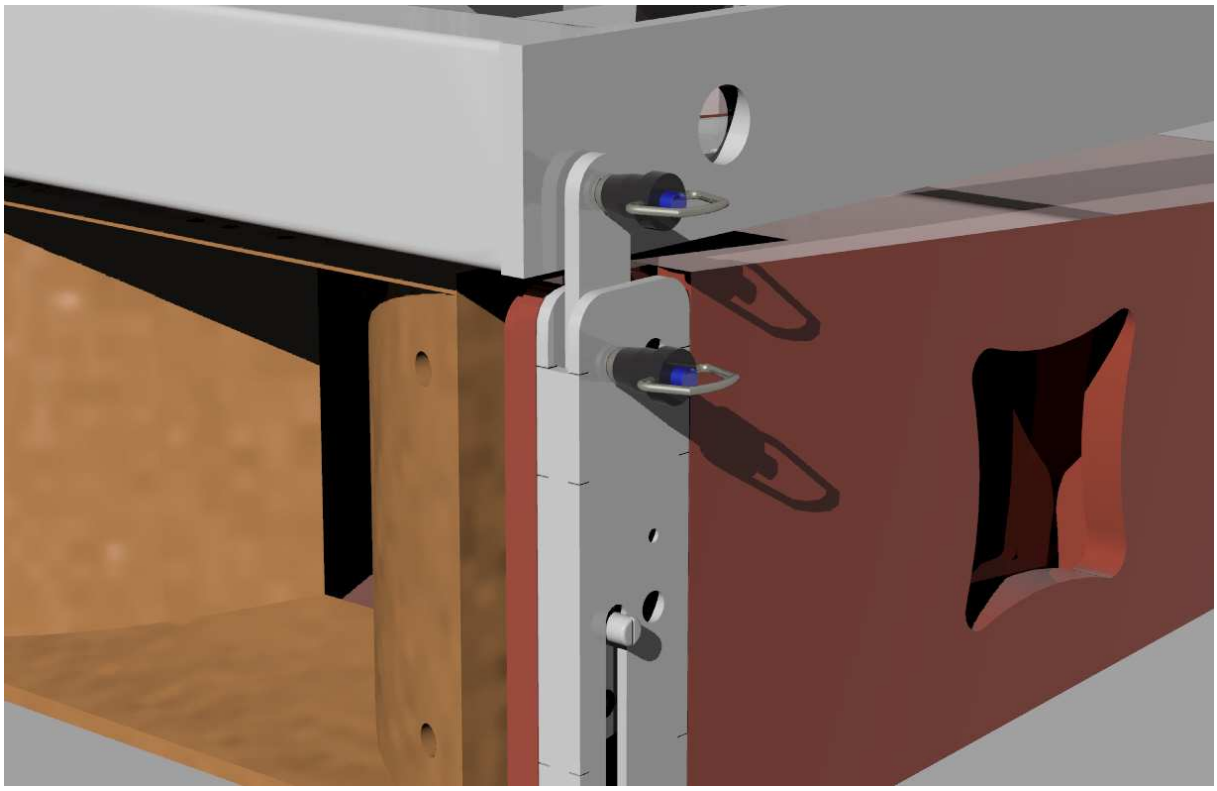

Figure 13 : DLA6's front rigging system detailed viewFigure 14 illustrates the SUB6 directly hanging under the bumper. The bumper is the same as in the assembly described above. For the SUB6, the system is an easy four point system. Figure 15 is a zoom view of the rigging assembly.

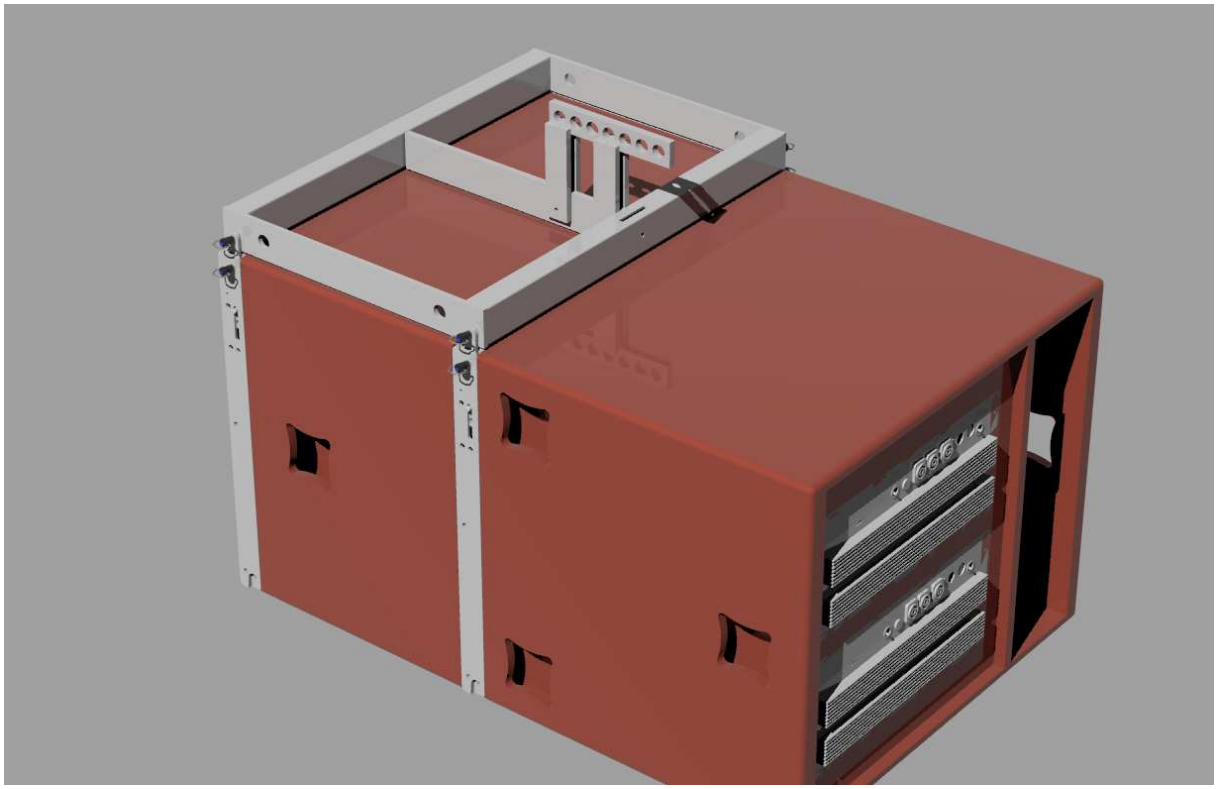

Figure 14 : SUB6 general flying view

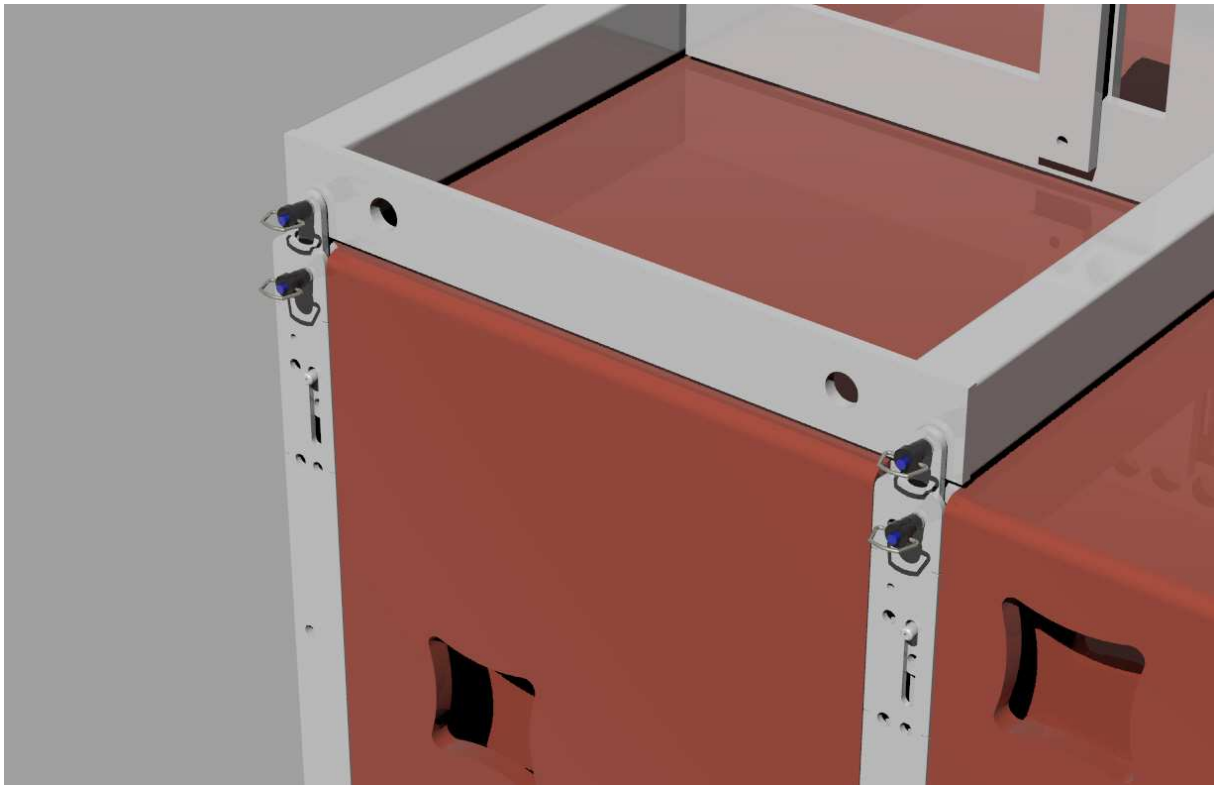

Figure 15 : SUB6's rigging parts detailed view.

The next step, to better understand the versatility of the DLA6/SUB6 rigging system, is an assembly composed of one DLA6 under one SUB6 in the "fly" configuration. The DLA6 is locked on the SUB6 with the three point system and the angle can be easily set up with the SUB6 incorporated bended plate. For arrays, composed with more than four DLA6 cabinets, two SUB6 can be hung together with their four point locker.

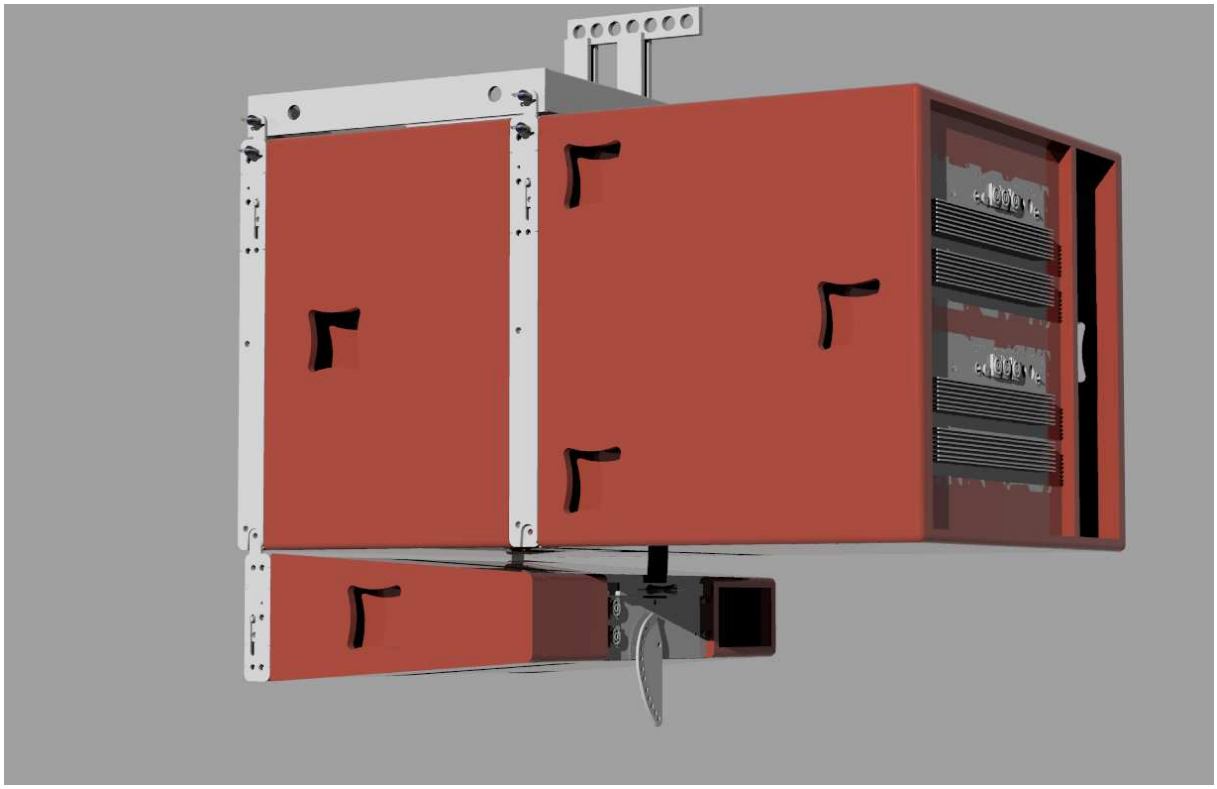

Figure 16 : DLA6/SUB6 flying assembly

4.2 4.0 Configuration

The DLA6 can reach real low frequencies without any bass reinforcement, so the simplest configuration is to fly only DLA6 boxes with external amplifiers and a digital controller AP-P214D or AP-P216D

The suggested amplifier is the AP1800 two channels amplifier or for application where high power is not necessary, the AP2400 four channels amplifier can be used. In case of the AP1800, one amp will feed four DLA6 boxes and the AP2400 will be able to supply up to eight DLA6 boxes. When using those amplifiers, the wiring must be done with very carefuly. The correct wirings can be seen on Figure 17.

The correct wiring demands a digital controller to separate low and high frequencies which are separately amplified and connected as shown to the first DLA6 box. With the AP2400, the wiring uses two amp's outputs for a four boxes group and the two other amp's outputs for the next four boxes.

For left/right AP-P214D wiring, please use for **First side: INA, OUT1 (Hi), OUT2 (Low)** and for **Second side: INB, OUT3 (Hi), OUT4 (Low).**

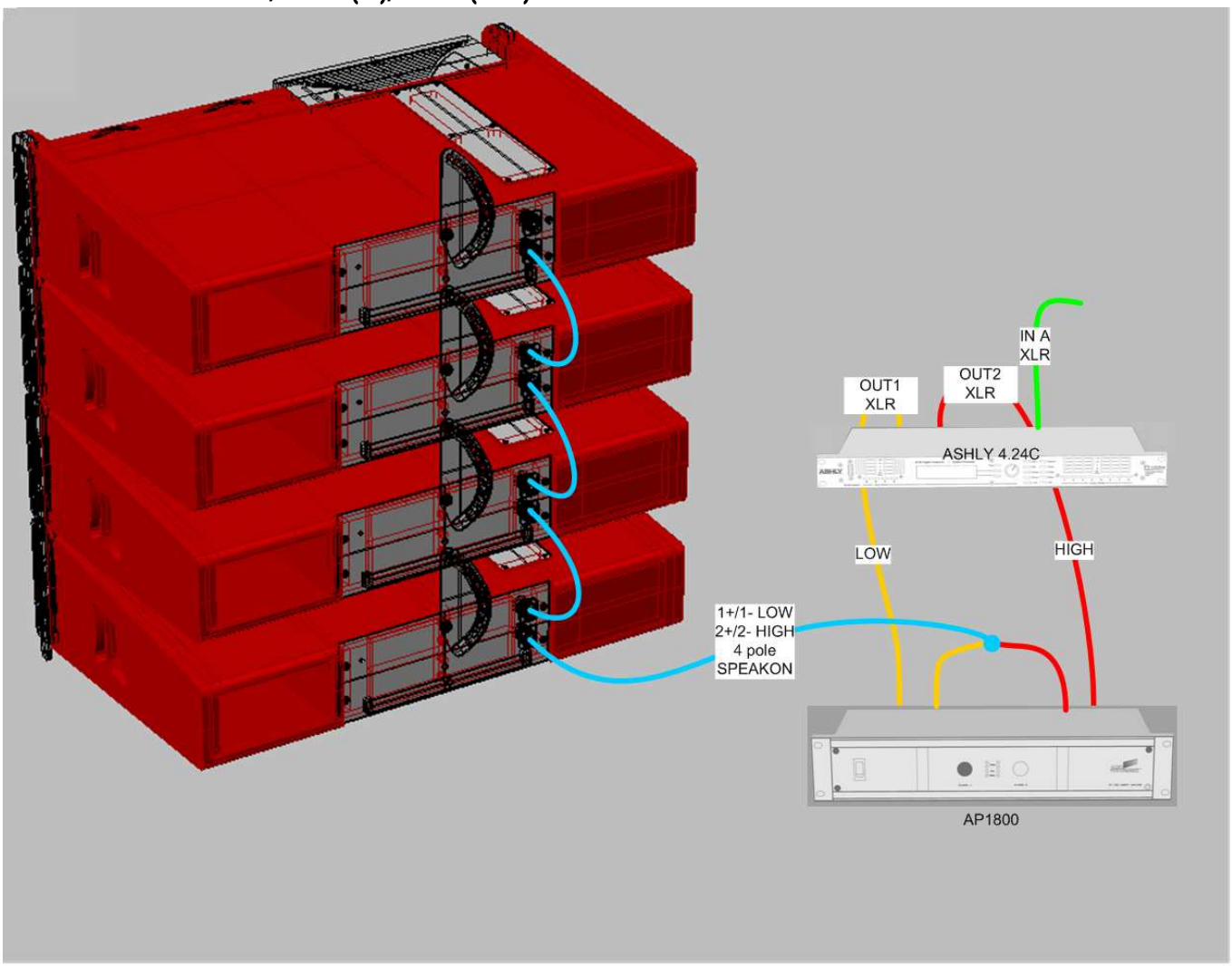

Figure 17 : Simple DLA6 configuration and wiring

4.3 4-1 Configuration

The next Step is the basic 4-1 configuration composed of four DLA6 boxes and one SUB6-amp. This configuration as well as the 8-2 configuration can be done in a "flown" or "ground stacked" manner. An external controller could be added to the system, which is visible on Figure 18 in a "ground stacking" arrangement.

The two amplifier's modules are fed with full range audio signals. However for best matching sounds needs, the controller can processed signals with high shelving on the one dedicated to the DLA6 amp and/or some slight low boost for the signals sending to SUB6-amp's amp.

NOTE: For venues where bass are not an issue, the complete system should be flown. Where more bass reinforcement is needed, Audio Performance recommend to stack the SUB6 on the floor in order to obtain a valuable gain.

For left/right AP-P214D wiring, please use for **First side: INA, OUT1 (DLA6), OUT2** and for **Second side: INB, OUT3 (DLA6), OUT4.**

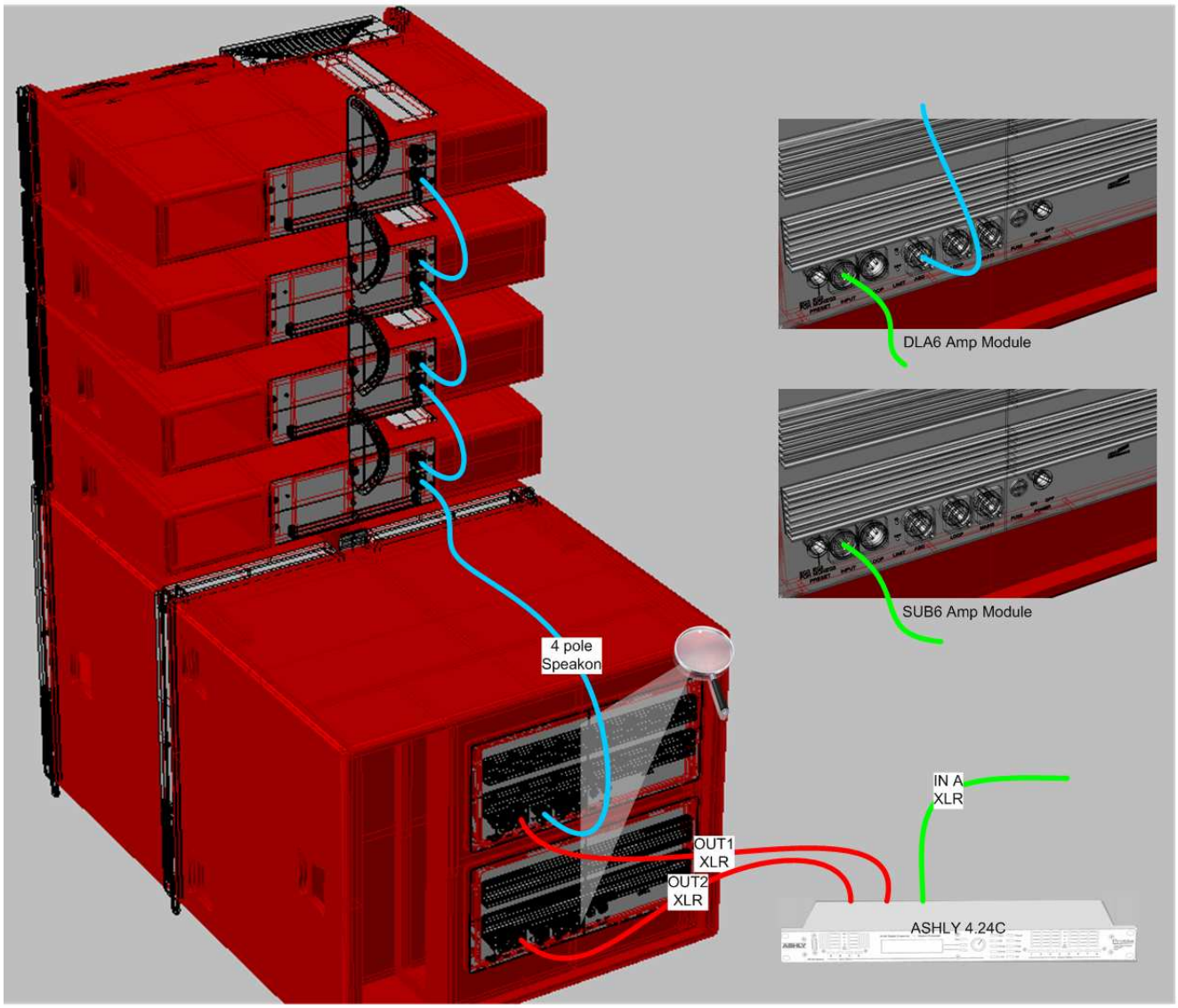

Figure 18 : 4-1 Configuration wiring

4.4 8-2 Configuration

The 8-2 configuration is the "complete" DLA6/SUB6-amp system. Actually this configuration is the double of the 4-1 configuration. In case of applying different equalization to DLA6 boxes, attention must be paid regarding the group wiring.

The four amplifier modules are fed with full range audio signals. However for best matching sounds needs, the controller can processed signals with high shelving on the ones dedicated to the DLA6 amps and/or some slight low boost for the signals sending to SUB6-amp's amps.

NOTE: For venues where bass are not an issue, the complete system should be flown. Where more bass reinforcement is needed, Audio Performance recommend to stack the SUB6s on the floor in order to obtain a valuable gain.

For one channel AP-P216D wiring , please use: **INA, OUT1 (DLA6), OUT2 (SUB6), OUT3 (DLA6), OUT4 (SUB6)**

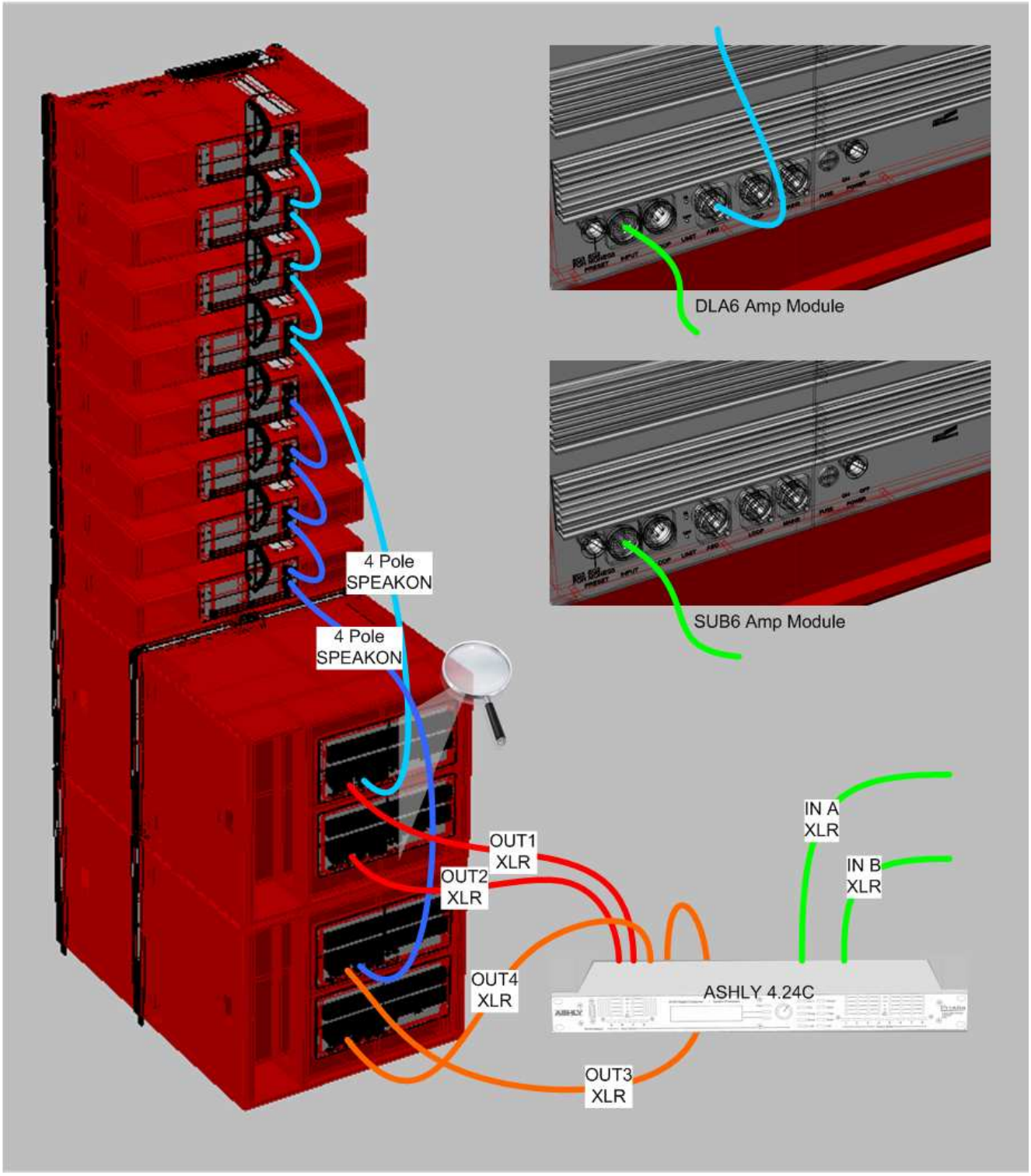

Figure 19 : 8-2 Configuration wiring

4.5 Custom Configuration

With the above explanations, any configuration could be proceeded. **Keep always in mind that one SUB6-amp can only handle up to four DLA6 boxes and not more**. For large DLA6 number arrays (12 and more), more bass reinforcement will be needed, please take contact with the factory to be directed to the right subwoofer configuration. In fact, the max SPL of line array is depending of the height of the line therefore the number of boxes. More boxes induce more power.

Every wiring shall be done with many care as Audio Performance can not be taken as responsible for any damage due to an improper wiring.

4.6 Equalization

On the Audio Performance website (http://www.audio-performance.com), some equalization files for configurations presented in this paper can be downloaded, more will be added soon. **Those files are for the AP-P214D and AP-P216D.**

The name of the basic equalization files are listed below:

4.0 configuration file name: DLA6_4_0
4.1 configuration file name: DLA6_4_1
8.2 configuration file name: DLA6_8_2

In case of using an other controller type, please take contact with the factory in order to obtain the equalization parameters needed for your configuration.

5 Related bibliography

[1] Mark S. Ureda, "Line Arrays: Theory and Applications", presented at the 110th convention of the Audio Engineering Society, J. Audio Eng. Soc., 2001 may 12-15.

[2] Siegrist Mathieu, "Directivité de réseaux de sources sonores", October 2005, école d'ingénieur de Genève. URL : http://www.acousticeig.unige.ch/