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Test
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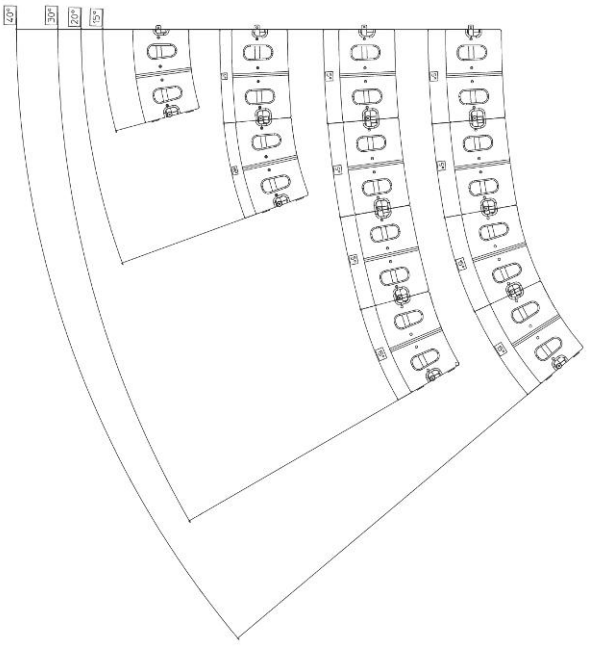
Plug&Play Line-Array

Voice Acoustic Ikarray-8

"Plug&Play Line-Array" is what they call the Ikarray-8 at Voice-Acoustic. With pre-configured units with 5 and 15 degrees it is supposed to offer a quick and simple set-up without the need for special software to figure out the configuration.

Ikarray-8 *without front grille, on the left the two 8" drivers with a short horn, on the right the tweeter system, where the waveguides of the four drivers work on a horn surface with 100° horizontal opening angle.*

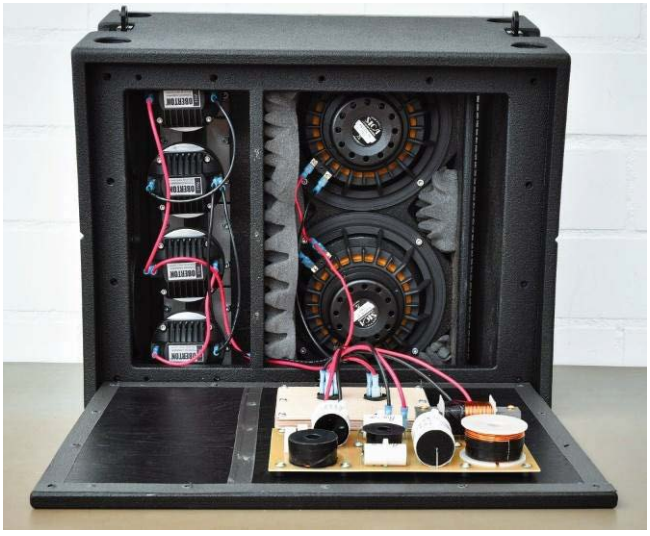


Array variants *of the Ikarray-8, up to four units can be mixed in one array or used homogeneously - the picture shows some possible configurations (Fig. 1)*

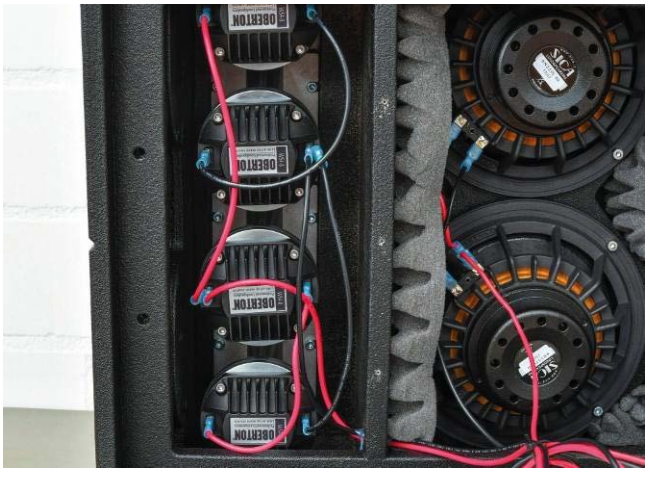
Text and measurements: Anselm Goertz | Photos: Anselm Goertz, Voice Acoustic

Normally some kind of software by the manufacturer, or the well known EASE Focus, will be used to determine the array configuration and splay angles for each unit. As a result such software will output the mechanical setting for curving the array, as well as rigging points, center of gravity, mechanical stress etc. Some programs go even further and will also calculate suitable eq-settings. In case electronic beam-forming is required in addition to mechnical curving, then those filters will also be computed (usually as FIR-filters). The underlying input data requires cross-sections and floor plans of all areas that need to be covered or spared. Well known software like EASE Focus, Array-Calc, Display or Soundvision offer a wide field of activity and allow for planning and sounding of complete venues like arena's or festivals.

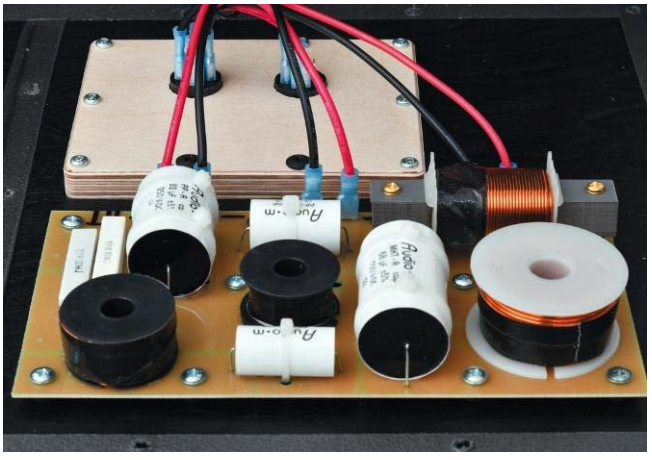
For a lot of more simple tasks, and they're not few, the approach is that the band or rental company arrive at a club, a town hall, or a city festival and then quickly need a set-up for their line-array. This kind of operation is more fitting for "fixed-curve" arrays where array elements are optimised for a certain angle. Ikarray-8 is configured as a "Plug&Play Line-Array": In this case Plug&Play means you make a simple estimate of desired vertical coverage and distance and then compile the system. One array consists of up to 4 elements which can cover a vertical aperture from 15° to 60°. That means the configuration is not achieved by setting splay angles between cabinets, but instead simply by choosing the sequence and type of the two different elements with 5° or 15° vertical coverage.



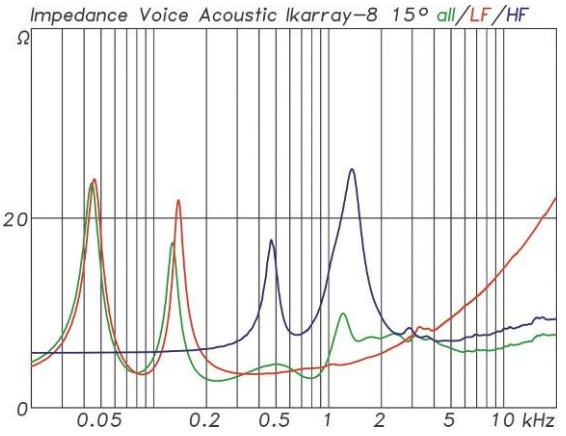
Interior view *of the Ikarray-8, possible service work can easily be carried out from the open rear side.*



Oberton compression drivers *and SICA 8" woofers*



Passive Ikarray-8 crossover *with heavy-duty components*

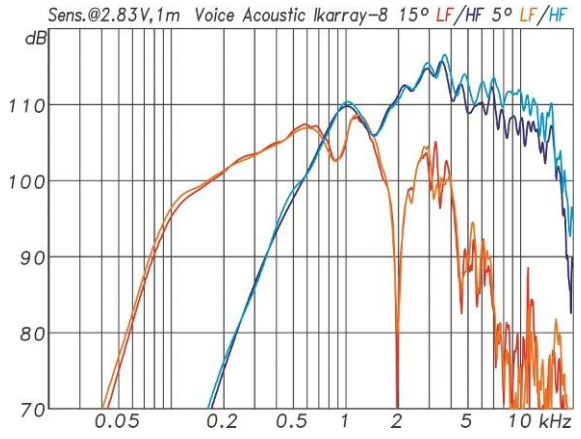


Impedance curves *exemplary for the 15° variants of the Ikarray-8. Green the complete system with passive crossover. Individual channels LF (red) and HF (blue) measured directly at the driver without crossover. The tuning frequency is approximately 80 Hz. The nominal impedance is 4 Ω. The minimum impedance at 230 Hz is 2.9 Ω (Fig. 2)*

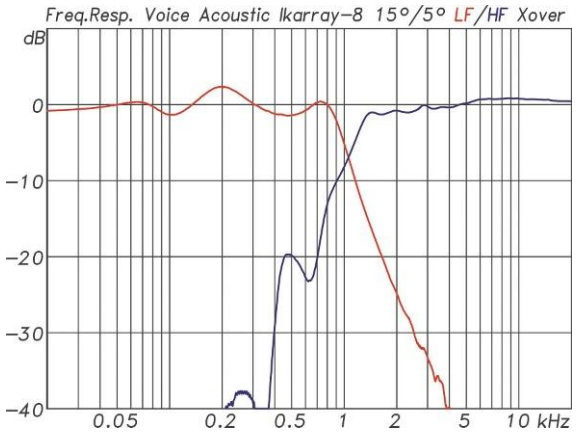
Taking a closer look reveals that an Ikarray-8 element basically consists of two 'simple' line-array speakers packed into one housing which form either a 5° or 15° degree system via four individually angled waveformers and compression drivers per cabinet. The desired advantage is that the pre-defined "bends" between each waveformer are small and cause only very minor secondary sound sources. One or two Ikarray-8 can be put on a tripod, bigger arrays with a maximum of four elements are flown. Both can be done with the 2-in-1 flying-polemount which can be attached to the top or the bottom of the array with only two fixing points. On a tripod the mounting point of the adapter can always be positioned below the center of gravity. That means that no tilting tendency will occur. A truss clamp can be attached to the frame for flying. A clamping sleeve is located within the frame for precise adjustement of vertical tilt.

Array construction

Let's take a look at the speakers themselves. Both variants of Ikarray-8 each contain two 8" woofers made by the italian manufacturer SICA.



Individual measurements *of the LF and HF paths without the internal passive crossover for the 15° and 5° versions. The two woofer paths are nearly identical. The 5° tweeter unit is approx. 3 dB louder at high frequencies (Fig. 3)*



Filter functions *of the passive crossover for the LF (red) and HF (blue) path, the crossovers of the 5° and 15° versions are identical (Fig. 4)*

The woofer has a big neodymium magnet, an aluminium die-cast frame, capton voice-coil former and a spider vented from the backside which is state of the art of current loudspeaker technology. SICA specifies the powerhandling according to 2 hours AES testing with 300 W. The waterproof cones of these woofers are radiating into a short horizontal horn which selectively increases sensitivity and shapes the directivity towards the desired 100° aperture. The bassreflex vent can be seen directly beside the horn as a long vertical slit from top to bottom.

On the other side is a tightly packed column of four 1" horndrivers. These drivers made by Oberton are already fitted with individual waveformers which transform the drivers circular opening into the vertical slit for the line-source. Oberton is located in the bulgarian city Plovdiv where they have been developing and producing loudspeakers for professional use since 1989, and is enjoying an exceptionally good reputation. Voice-Acoustic designer Henry Dahmen relies on them especially for their very clean high frequencies.

Looking at the Ikarray-8 cabinets from the side the "two-in-one" concept with 5° and 15° curving can be easily noticed. Another prominent feature is the elegant flying hardware which has been integrated into the cabinet and is only visible within the handles where it follows the cabinets curvature.

Therefore the cabinets are always tightly packed and form an array without any gaps in the front or back. This results in a visually inconspicuous and uniform appearance without obtrusive flying hardware. This way an otherwise at times overly technical appearance is skillfully avoided. Fig. 1 shows several examples of different flying array configurations for up to 4 elements. In an array of 4 there will usually be three or two 5° elements on top, complemented by 15° elements below. This way the upper array achives a higher energy density and also a farther throw for more distant listeners. The lower end of the array with it's wider opening angle reduces the energy density for closer parts of the audience.

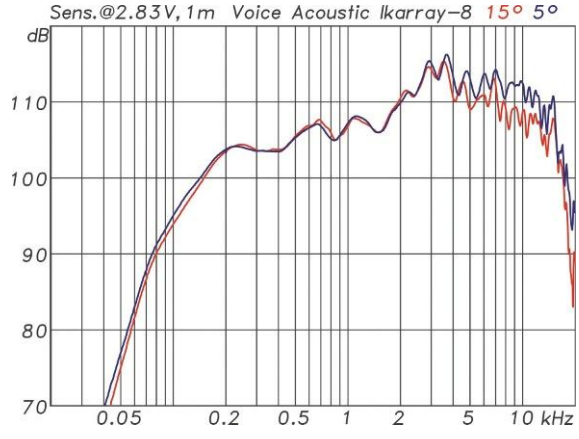
Ikarray-8 is designed as a two-way system and crossed-over internally via passive filters. The woofers have been recessed until the acoustical centers of both channels match which avoids the need for any overly complicated passive all-pass filters. Passive crossovers are identical for both variants, as well as the drivers. The systems are fed via a NL4 connector and have a link output. Attention has to be paid to the routing of the connectors labeled In and Out: Input pins 2 are connected to output pins 1. This way two Ikarray-8 can be connected with two separate systgem-amplifier channels using a 4-pole cable.

Voice Acoustic HDSP 6a

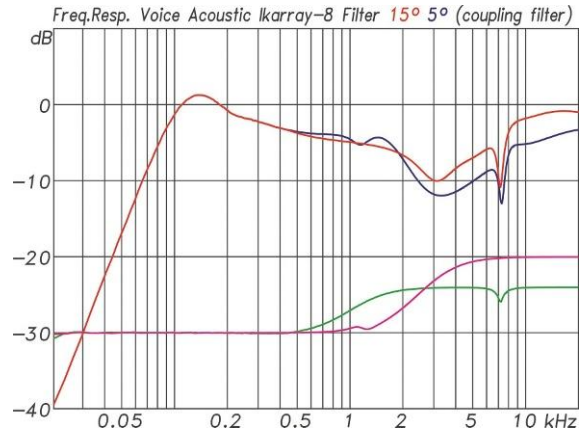
Using two Ikarray-8 in parallel is not intended since the amplifier channels are already at optimum load with 4 Ω rated impedance. Cabinet width is 513 mm and height is 465 mm. Depth is 291 mm. The cabinets weigh 26,2 kg and are easy to handle thanks to two big handles per side.

Ikarray-8 with 5° and 15°

For measurements let's get back to the impedance right away and check Fig. 2 which exemplarily shows the impedance curve for the LF and HF driversection of the



Frequency responses *with sensitivity of the two Ikarray-8 models measured directly without controller. The 1 W/1 m sensitivity is 3 dB lower for the nominal 4- Ω system (Fig. 5)*



Controller functions *for the 15° (red) and 5° (blue) versions. Below are the overlays for correcting the coupling effect in the array, here for arrays with three units (Fig. 6)*

2-in-1 *flying and tripod hardware*

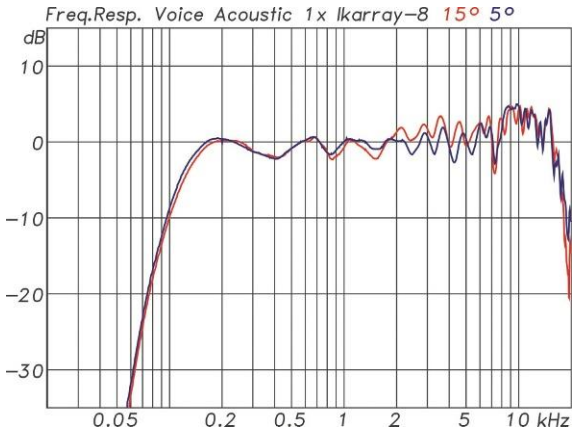
15° version without passive filters, as well as the box as a whole (green). Both 8 Ω woofers are connected in parallel to form a 4 Ω unit, and four 8 Ω tweeters are connected in a parallel-series wiring scheme to form an 8 Ω unit. Impedance minimum is 2,9 Ohm at 230 Hz. This is not fully compliant with the standard which would allow a minimum of 3,2 Ω, but this is of no concern for operators due to the system-amplifiers. Another information is rendered by the diagram, an 80 Hz tuning frequency of the bass-reflex resonator. This makes Ikarray-8 fullrange-suitable only to some degree. Speech, vocals, acoustical instruments etc. should pose no problem. For powerful bass subwoofers are mandatory, more on this later.

Alongside impedances also pure frequency responses of boths ways were taken, without crossover. The graphs of the low-end sections of 15° and 5° versions are almost identical as expected. The small deviation below 150 Hz should be attributed to slightly different cabinet volumes.

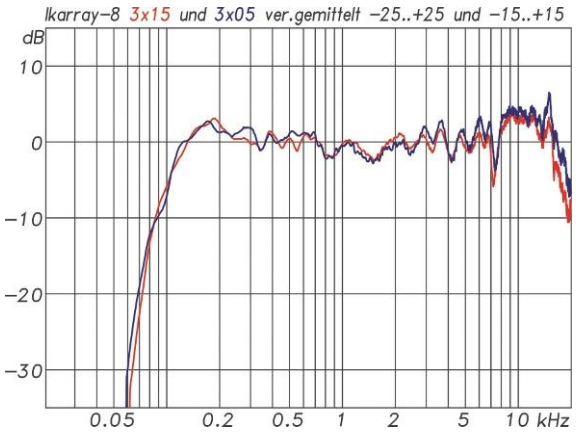
Side view *of the Ikarray-8 in the 5° version (left) and in the 15° version (right)*

At 2 kHz there is a sharp cancellation which is due to the chamber into which the woofers are built and which covers part of the woofers to form a better line-source. Hoever this cancellation is outside the working range. Below 1,5 kHz the short horn in front of the woofers shows very good results. Sensitivity of both 8" woofers is rising from roughly 97 dB at 100 Hz continuously to 108dB. Only a small dip at 900 Hz differs a little bit. However in summation with the tweeters this dip is levelled out again. The high frequency unit is operating with a sensitivity of over 110 dB over a wide range and offers good conditions for a line-array where the high frequencies have to be boosted with increasing length of the array to compensate the coupling effect which only benefits the woofers.

The crossover of the passive filters is just above 1 kHz. An impedance correction is compensating for resonances that occur due to an interaction between tweeter impedance and crossover. Filter slope is around 18 dB/oct. Besides the main high-pass and low-pass filter functions there are some more smaller fluctuations, especially on the low-frequency side, which also result from interaction of speaker impedance and passive filters. Henry Dahmen is using film capacitors with 150 V and 250 V exclusively and air- or bar-coils. Air-coils do not show any saturation effects, bar-coils only very minor ones. Both are well suited for high current and won't create saturation related distortion.



Frequency responses *measured with controller. An additional subwoofer is required for the range below 100 Hz (Fig. 7)*



Frequency response for arrays with three units *each of Ikarray-8 for 15° (red) and for 5° (blue, Fig. 8)*

Fig. 5 shows the interaction of the complete loudspeaker. Tweeters and woofers complement each other very well. The 5° unit achieves a 3 dB higher sensitivity at high frequencies due to its more narrow directivity (energy density) compared to the 15° unit.

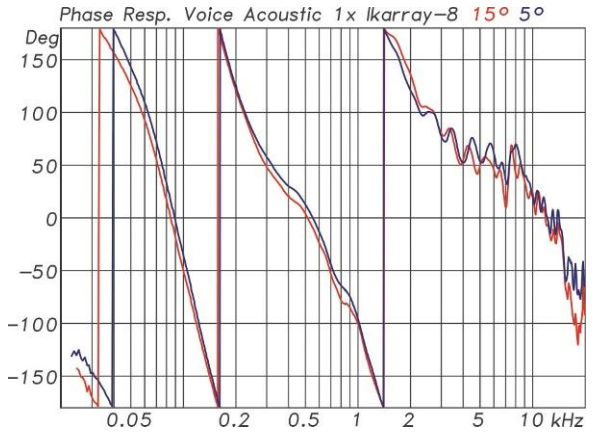
Electronics

There are two amplifier/controller variants for operation of Ikarray-8. It can be either one of the HDSP-type systemamplifiers, or one of the self-powered subwoofers which have identical amplification and controlling inside. One possible combination could be with a Paveosub-118sp. The self-powered version offers a 3-channel amplifier module with a powerful 1.580 W/8 Ω (2.400 W/4 Ω) channel for the subwoofer itself, and another two 800 W/4 Ω channels for external use. The controller provides the needed presets for combination with tops. Both "small" channels can power one Ikarray-8 each while the big channel will supply the sub itself and optionally another paassive sub in parallel which will reach optimal power configuration of all units.

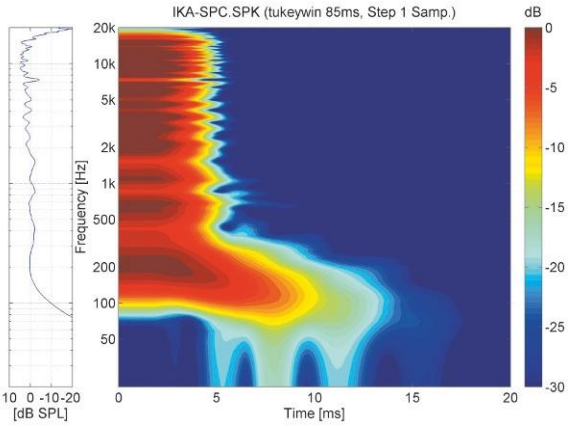
Another option is using one of the in-house HDSP amplifiers. The devices are manufactured at Voice-Acoustic and equipped with well known Pascal X-Pro modules. Corresponding to available module types with one, two or three amplfiers there are HDSP amplifiers with two, four and six channels which are equipped with two X-Pro modules.

HDSP-2 offers 2 x 1,5 kW/8 Ω. HDSP-4 does too but with additional 2 x 450 W/8 Ω on the remaining channels. The maximum configuration with X-Pro modules is reached with HDSP-6 where there are 4 x 450 W/ 8 Ω additional channels. All amplifiers are available as type A with only analogue inputs, or type D with additional digital inputs for AES/EBU format. HDSP-6 with its two 3-channel X-Pro modules seems ideal for Ikarray-8 and can power four Ikarray-8 and four Paveosub-118. The solution with active subwoofers is surely more compact and simple. But in comparison external HDSP amplifiers offer higher flexibility, can be used for other systems as wellas subwoofers, or can simply remain in stock if they're not needed.

Controller presets for Ikarray-8 provide settings for 5° and 15° units for all array combinations and lengths (see shelving filter Fig. 6). Fig. 7 shows single elements of both types with controller. Crossover to subwoofers is just above 100 Hz. The filter settings shown where still preliminary according to Henry Dahmen and some minor changes due to finetuning should be expected. The notch-filter at 7,3 kHz was set purely by listening tests as it was not corresponding well with measurements. Filter settings of a single Ikarray-8 element are mostly based on their on-axis frequency response. According to Henry Dahmen Array-coupling filters however have been derived by averaging frequency responses of different array lenghts over their rated vertical coverage.



Phase responses measured *with controller. The 15°- and the 5°-version play together perfectly (Fig. 9)*



Impressive spectrogram *of the Ikarray-8 with no irregularities that would need to be corrected later (Fig. 10)*

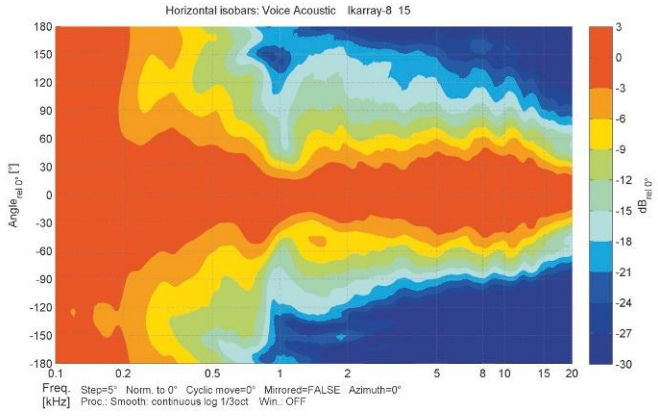
That's why the curves in Fig. 8 were averaged vertically from -25° to +25° (3 x 15°) and -10° to +10° (3 x 5°). Resulting curves look plausible, easy to use and don't require additional settings from the operator, just like you would expect from a "Plug&Play" system.

Fig. 9 shows the phase belonging to the amplitudes of Fig. 7. Attention has to be paid to a relative comparison of the phase of 5° and 15° versions besides the general trend. If both systems are supposed to complement each other as a coherent line-source then their phase responses should preferably be indentical.

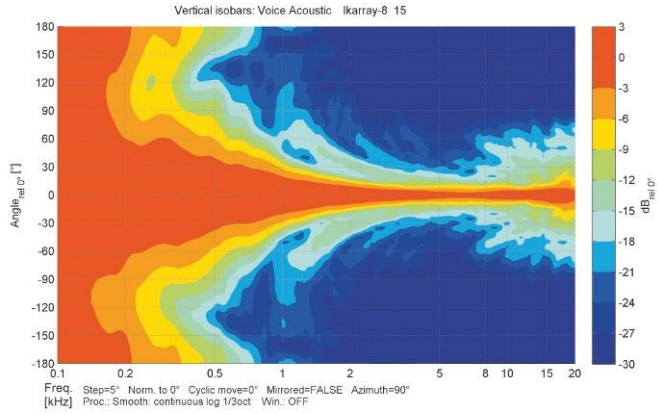
The Ikarray-8 elements satisfy this requirement perfectly. On the whole, they show phase responses that are to be expected from a 2-way system with their acoustical and electrical high-pass filters.

Finally we have to look at the spectrogram in Fig. 10. There are no peculiarities in the sense of resonances. However, what sounds rather incidental is anything but self-evident. Especially line-arrays with complex waveformer/horn combinations, as well as hornloaded woofers tend to show resonances, which simply can not be found here. Subsequently controller functions are rather simple since they don't have to remedy any resonances.

Right **Ikarray-8** *with grid in the 15° version and on the left in the back view the 5° model*



Horizontal isobars *of Ikarray-8, the shape is almost identical for both variants (Fig. 11)*



Vertical Isobars *of Ikarray-8 15°-Version (Fig. 12)*

Horizontal/vertical: Directivity

The directivity of a line array is defined in the horizontal plane by the radiation pattern of the respective elements and in the vertical plane by the array as a whole, i.e. by its length and curving. Most line array loudspeakers are therefore designed with a kind of one-dimensional horn function for the horizontal plane. In the vertical plane the standard approach is to either create a perfectly flat wavefront or to apply a controlled pre-curving which then results in a coherent array. Ikarray 8 is specified with a 100° horizontal aperture. Vertical aperture is pre-defined by the 5° and 15° directivity of the "two-in-one" elements. Inside their cabinets the individual waveformers are angled to each other at either 3,75° (15° element) or 1,25° (5° element). The 3 possible combinations of two elements (15° +15°, 15°+5° and 5°+5°) result in 3,75°, 2,34° and 1,25° angles between the outer waveformers of adjacent cabinets leads to a smooth transition.

Let's start with the horizontal dispersion behavior, which does not differ for a line array element from that of a normal loudspeaker. The loudspeaker is fixed to a rotating device inside the anechoic chamber and then fully rotated from -180° to +180° in the plane to be measured. The measurement is typically carried out in 5° steps, so that one plane is recorded with 73 individual measurements. Resolution can be increased to 2° or 1° for very narrow radiating systems. The horizontal isobars of Ikarray-8 are shown in Fig. 11. -6 db transition, relative to the 0° axis, is represented by the transition from orange to yellow.

With a certain fluctuation the nominal 100° angle is reached from approx. 500 Hz upwards. Due to the side by side arrangement of tweeter and woofer, a slight narrowing occurs in the horizontal plane at the crossover frequency of around 1 kHz.

Several isobaric measurements are required for the vertical of a line array. Again it is necessary to first examine a single element and in further measurements several elements in an array. In an individual measurement, the isobars ideally present themselves as curves that are becoming more and more narrow, preferably without almost any lateral secondary maxima. Now there is no single element in the Ikarray-8 in the actual sense. Therefore, one always measures at least two elements with two tweeters each, whose internal angle from tweeter to tweeter is 1.25° in the 5° version and 3.75° in the 15° version. The corresponding isobars can be found in Figs. 12 and 13. The expected behaviour is exemplary: The nominal angle is plausible and the isobars show a continuous narrowing without conspicuous side maxima or other artifacts.

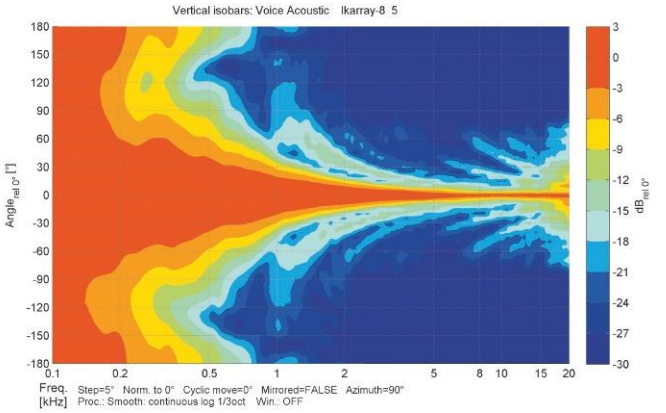
Concluding on the topic of directivity, measurements of the vertical isobars of three Ikarray-8/15 and three Ikarray-8/5 systems each were carried out. The expected opening angles for the complete arrays should then be approx. 45° and 15°. The isobars measured for this purpose in Figures 14 and 15 each show slightly wider progressions of 60° and 20°, which are caused by the already relatively big length of the array in relation to the measurement distance.

All in all, however, the isobars in both configurations run in an exemplary even and straight line. At this point, the advantage becomes apparent if a line array element can be optimally designed for a fixed curving and does not have to function flexibly for a larger angular range. If a line array element is to function well at 0° and even at an angle of 15° to the adjacent box, then inevitably compromises have to be made which do not exist if a certain angle is fixed from the outset.

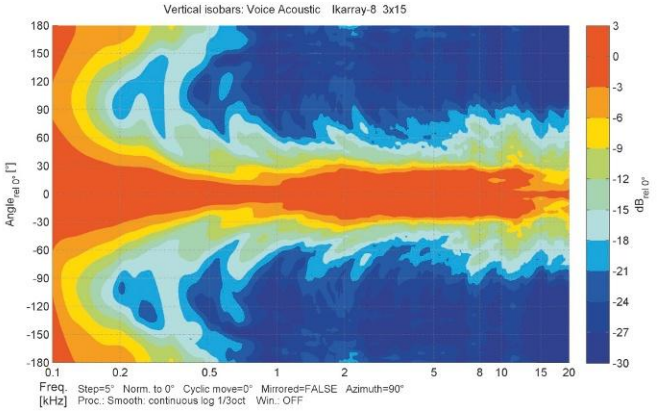
Below 1 kHz an amplified focusing, hardly recognizable for the array 3 × 5° and somewhat more distinct for the array 3 × 15°, can be observed, which leads to a constriction compared to the angle set at high frequencies. This principle-based low-mid beam is caused by increased overlap of the individual sources at low frequencies, which now no longer subdivide the angle range cleanly, but act as a large source again, which then focuses according to its extent. This effect can only be avoided by additional electronic beamforming, as is the case with DSP-controlled lines. However, for the Ikarray-8 with a maximum length of four units, it can be assumed that the constriction of the low-mid beam is not yet relevant in actual application.

Maximum spl: How loud can it go?

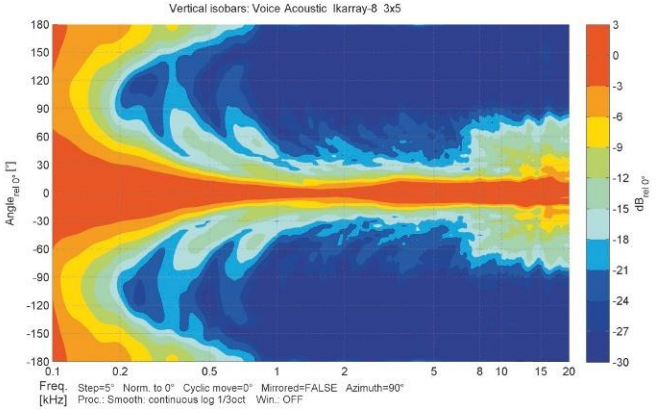
In our test reports we have been using two methods to technically assess the maximum sound level of loudspeakers for quite some time in order to obtain results that are as relevant as possible for daily sound reinforcement practice. First, we have the measurement with 185 ms long sinusoidal burst signals. Here, the level is increased with a sinusoidal signal for one frequency until a certain amount of distortion, typically 3% or 10%, is reached. The measured sound pressure level, which is the average level for the duration of the measurement, is recorded as the measured value. This measurement is carried out over a defined frequency range in steps of 1/12 octaves. Figures 16 and 17 show this measurement for Ikarray-8 in 15° and 5° versions as a single system (Fig. 16) and as an array of three systems each (Fig. 17). The overall characteristics and uniformity of the curves indicate frequency ranges in which a loudspeaker has strengths and weaknesses and whether there are any potential local weak points. Ikarray-8 does not have any of the latter in particular.



Vertical Isobars *of Ikarray-8 5°-Version (Fig. 13)*



Vertical Isobars *of an array of three 15° units (Fig. 14)*

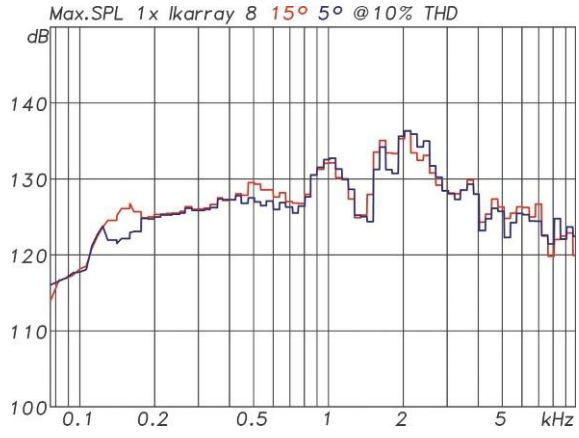


Vertical Isobars *of an array of three 5° units (Fig. 15)*

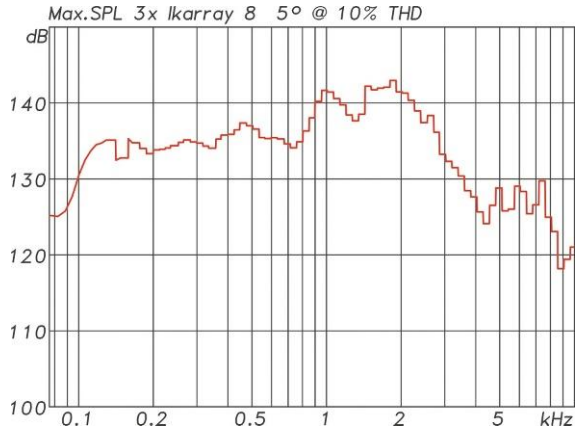
The second type of maximum level measurement is the multi-tone measurement, which captures all harmonic distortion (THD) and intermodulation distortion (IMD), which are collectively referred to as total distortion (TD). The basis of the multitone signal consists of 60 sinusoidal signals with random phase, whose spectral weighting can be adjusted at will. For the subsequent measurement in Figures 18 and 19, the weighting of an average music signal (green curve) was selected. The crest factor of the synthesized measurement signal, which describes the ratio of the peak value to the RMS value, is a practice oriented value of 4 corresponding to 12 dB.

Similarly, on the acoustic side, there is the sound pressure level as the mean level Leq, which is determined for a defined period of time as the energy equivalent continuous sound level, and then there is the peak level Lpk. It is important to note that for acoustic measurements always the mean level Leq is used to evaluate the maximum achievable level of loudspeaker systems. For the distortion value derived from this type of measurement, all spectral lines that are not present in the excitation signal are added together, i.e. that have been added as harmonic distortions or intermodulation distortions. With this type of measurement, the level is also increased until the total distortion component (TD) reaches a limit of 10%. Under these conditions, a single Ikarray-8 15° system for a typical music spectrum according to EIA-426B reaches a peak level of 137 dB at a distance of 1 m in free field (full-space) conditions. The average level is 124 dB. The data sheet gives values of 131 dB and 137 dB, which then refer to a signal with only 6 dB crest factor. The values achieved for the 5° version were 1 dB higher, but are not shown here.

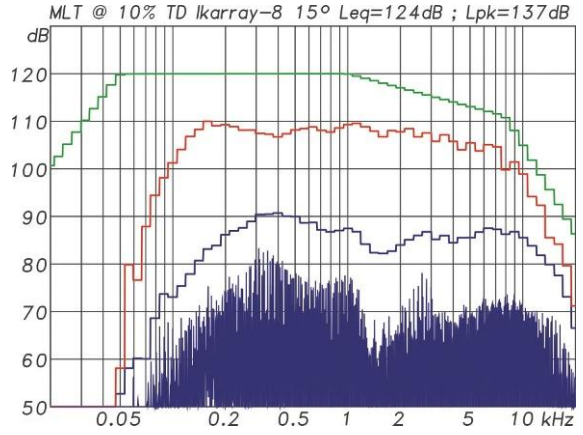
In an array with three Ikarray-8 in 15° the system gains significantly. This results in 132 dB as Leq and 144 dB Lpk, which qualify the system even for larger applications. A good 100 dB Leq can thus be achieved at a distance of 40 m in free field. Since in live operation a little more headroom is usually required than the 12 dB assumed here, the value may be somewhat overestimated. However, it shows well the potential of the Ikarray-8 system.



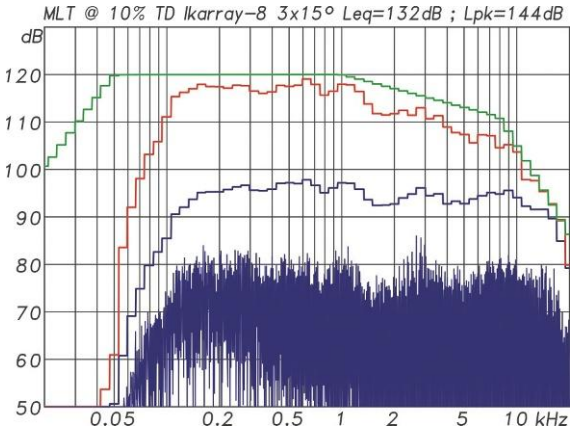
Maximum spl *for maximum 10% distortion for a single Ikarray-8 system with 15° angle (red) and 5° angle (blue). The measurement was performed with 185 ms long sinus bursts (Fig. 16)*



Maximum spl *for maximum 10% distortion for an array of three systems with 5° beam angle. The measurement was performed with 185 ms long sinus bursts (Fig. 17)*



Multitone measurement *for a single Ikarray-8 15°. With a maximum of 10% distortion (THD+IMD) for a signal with EIA-426B spectrum (green) and 12 dB crest factor 124 dB as Leq and 137 dB Lpk are achieved. Total signal spectrum in red and distortion components in blue (Fig. 18)*



Multitone measurement *for an array of three Ikarray-8 15°. For a signal with EIA-426B spectrum (green) and 12 dB crest factor, 132 dB a ls Leq and 144 dB Lpk are now achieved with maximum 10% distortion (THD+IMD). Total signal spectrum in red and distortion components in blue (Fig. 19)*

Voice Acoustic also offers the Ikarray-8 in complete sets with basic, standard and large size versions. The basic set includes two tops, two subwoofers and a three-channel power amplifier as well as various accessories for 16.914 €. For stereo operation, the basic set with the two subwoofers is operated as a mono sum sub. The standard set doubles the number of components, such as four tops, four subwoofers and a six-channel power amplifier. This is also available with accessories for 32.206 €. The maximum expansion stage of the large-size set then consists of eight tops and just as many subwoofers together with two six-channel power amplifiers for 61.713 €. All sets can also be operated with active selfpowered Paveosubs instead of separate power amplifiers. The price for the selfpowered sets differs only slightly from those with separate power amplifiers.

Conclusion

Headquartered in Dörverden, northern Germany, loudspeaker manufacturer Voice-Acoustic is bringing a breath of fresh air to the compact line array market with its "Plug&Play Line-Array" Ikarray-8. If you look around at the trade fairs, you will see that the popular 8" Line Array models in particular have a very large range to choose from and have become a kind of universal tool for sound companies. 90% of the applications are likely to relate to smaller events up to 30 m away.

This is exactly what the Ikarray-8 was designed for. The "two in one" principle with two fixed angles means that most tasks can be covered well with a maximum of four of these double systems. The combination in the array can be estimated with some sense of proportion - without having to use further software. The assembly then proceeds safely and quickly thanks to the simple 2-point mechanism. From an acoustic point of view, the systems with fixed angles of 5° or 15° and the tailor-made housings and waveguides also offer a number of advantages, since no constructive compromises have to be made for a larger angle range. The associated system power amplifiers or self-powered subwoofers, with their ready-made setups and clear cabling, also provide the desired plug & play feeling, which is not only easy to operate, but also provides a high degree of operational reliability. Ikarray-8 was able to demonstrate its technical performance in the measurement lab well. A high maximum sound pressure level, respectively little distortion and an even and well controlled dispersion behaviour turned out to be the strengths of the system. In terms of workmanship and accessories, Voice Acoustic has already been in the upper category for some time now, so that all wishes and requirements can be fulfilled here as well. In terms of price, the Ikarray-8 is in the middle class, which definitely puts it in a very good position.