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German Physiks audio reviewer information

This is an edited version of a document that was recently prepared for audio reviewers to give them background on the Walsh driver, the omnidirectional driver that inspired our own German Physiks DDD driver; an overview of other omnidirectional loudspeaker designs and a comparison of the DDD driver with the only other truly omnidirectional driver on the market, the MBL Radialstrahler.

Contents

The origin of the DDD driver

The DDD driver was designed by a German called Peter Dicks. He was a mathematician, engineer and sociologist and originally was not involved in the audio industry. In the 1980s he had become interested in the problems associated with loudspeaker drivers. One particular driver took his interest, the Walsh driver in the American Ohm F loudspeaker – figure 1. This was produced from 1972 to 1984 and was very highly regarded at the time. It used a single Walsh driver to cover the range from 37Hz to 17kHz. The Ohm F still has a dedicated following today, mostly in the US.

Figure 1. Ohm F loudspeaker with Walsh driver

The Walsh driver was designed in 1964 by American engineer Lincoln Walsh, in an attempt to make a full-range driver that avoided the time delay and phase errors that occur with conventional multi-driver loudspeakers. His design, which was referred to as a "*Coherent Wave Transmission Line Driver*", was awarded a US patent in 1969. Although the vibrating surface was conical, the angle of the cone and its mode of operation meant that it acted as a pulsating cylinder and so it was phase coherent over its operating range. Put simply, the phase relationships of all the frequencies in its operating range were accurately preserved.

The orientation of the driver meant that it radiated all frequencies evenly around it and was therefore omnidirectional. This and the driver's phase coherence are what made the Walsh so special.

In 1971, the Ohm Acoustics company was formed in New York and they purchased the rights to use Walsh's design. There are various versions of the Walsh driver, but the one used in the Ohm F loudspeaker is regarded as being the best. Lincoln Walsh passed away in 1971 and sadly did not see the success that his design achieved.

The Walsh driver in the Ohm F stood 30 cm high. The cone was made in three sections.

- The top section was made from 0.064 mm thick titanium foil.
- The centre section was made from 0.076 mm thick tempered aluminium. Tempering is a method of heat treating a metal to change its hardness. Making the material harder increases the speed of sound in the material, which is important for this design.
- The bottom section was made from 0.64 mm thick felted paper, which had a series of circumferential slots cut in it.

The entire cone weighed approximately 125 grams.

At the low end of its frequency range, the Walsh driver worked pistonically, like a conventional driver, where the voice coil and cone moved back and forth together.

At a certain frequency the driver would start to go into bending wave mode, where when the voice coil pressed down on the top of the cone, instead of the entire cone moving down, the wall of the cone would flex and a wave would travel down the cone wall towards the open end. The movement of this wave would then launch a sound wave that travelled away from the cone.

It is the use of bending waves that allowed the Walsh driver to cover such a wide frequency range. A loudspeaker driver produces sound by moving air. If you move an object, in this case a mass of air back and forth, the amount of energy you are putting in to the air depends on how much air you are moving (specifically its mass) and how fast you are moving it.

To produce a useful sound level at low frequencies, you need to move a lot of air, because you are not moving it very fast. To move a lot of air, you simply need a driver with a cone that has a large surface area. This needs to be rigid enough so that the force exerted by the voice coil does not make it flex. If the cone flexes, which is called break-up, its movement is no longer accurately following the driving signal and so distortion will be produced.

A large and rigid cone will be heavy and it will not be possible to move this back and forth fast enough to cover high frequencies without it flexing and breaking up. Bear in mind that you are not just moving the cone, but also the voice coil and the combined weight of these two moving items is called the moving mass. This is an important property of loudspeaker drivers.

At high frequencies, because the air is being moved much more rapidly, to radiate a given amount of energy, you do not need to move so much air and so a driver with smaller and lighter cone can be used. This is why conventional tweeters have small cones or diaphragms. The lighter cone will give such a driver, a lower moving mass.

When the Walsh driver is in bending wave mode, where the sound is produced by a wave traveling down the cone wall, the moving mass is the weight of the voice coil and the cone material in the wave: not that of the whole cone. The effective moving mass is therefore much lower than when it is in pistonic mode where the voice-coil and entire cone moving together and this low moving mass can be moved fast enough to allow the driver to cover high frequencies: up to 17kHz in the case of the Ohm F.

Having one driver produce the entire audio range results in outstanding coherence, as it avoids the time delays that result when multiple drivers are used as in conventional designs, and it also eliminates distortion and discontinuities caused by crossovers. Most importantly, the wide operating range eliminates the need for a crossover point in the mid-range that conventional loudspeakers must have. It is an unfortunate consequence of the physics of conventional pistonic drivers that there will be a crossover point in the mid-range. At this point is a range of frequencies where the crossover fades one driver out and another driver in. Our hearing is most sensitive in the mid-range, probably because this is the range of frequencies that makes human speech intelligible, and so any problems or discontinuities here are all but impossible to hide. Many designers of conventional loudspeakers do an excellent job here, but it can never be perfect. You only really appreciate this when you listen to a design that does not have this problem, such as the Ohm F, or a German Physiks design.

Because of the way that the cone of the Walsh driver is orientated, the driver is omnidirectional, i.e., it radiates all frequencies evenly, horizontally around the driver. The resulting reflections create a more natural and enveloping sound field, more like the one you will experience in a concert hall, where about 80% of the sound you hear is reflected. Consequently, the stereo image is also more like the one you will hear in the concert hall, which you can enjoy from a wide range of positions in the room, not just in a small sweet-spot, as is the case with conventional loudspeakers. This is due to the way pistonic drivers concentrate their radiation into a beam that gets progressively narrower with rising frequency.

The Ohm F loudspeaker with its Walsh driver received numerous excellent reviews and was frequently praised for its natural sound. Here is a selection of quotes from reviews available on the Ohm loudspeakers web site. Follow the links to read the full reviews. They make interesting reading and are a testament to how clever Lincoln Walsh's design was.

"… a pair of Ohm Fs can re-create a live musical performance free of the usual spatial limitations imposed by conventional loudspeakers."
FM Guide Toronto December 1976

"… we are happy to report that the Ohm F is amongst the very best we have heard."
Stereo Buyers Guide, no date available.

"The Ohm Fs are in a class by themselves. The sound is most unusual inasmuch as it is complete, full, natural and transparent. The bass reproduction is clean and perfect. The sound picture has a certain similarity to quadraphonic equipment, at least as far as cleanliness and perspective is concerned."
HiFi Sterophonie, October, 1974

"As to whether or not the Ohm F is therefore the "best" speaker available – we will leave that to the ears of audiophiles; we are prepared to say, however, without reservations, that it is easily one of the best."
Stereo Review, November 1973

The Walsh driver was not without its problems
The lack of the powerful magnets we have today meant that the Walsh driver in the Ohm F needed a powerful amplifier to make it perform at its best. Many contemporary reviews commented on this. At the time it was in production, there will have been fewer high-power amplifiers available then there are today and they will have been quite expensive.

It could also suffer from resonances, which were probably due to some of the energy from the bending wave being reflected at the joins of the different sections of the cone.

The complex construction of the driver made it very fragile and easy to break. This usually occurred when enthusiastic listeners were playing them at high volume. The complex construction made the driver difficult to manufacture and this and the difficulty of supporting the driver caused Ohm to cease production of the F in 1984.

Compared to conventional drivers, the physics of the Walsh driver were very complex, both in terms of the mathematics involved, as well as the fact that a large number of parameters had to be optimised. These included the physical properties of the cone material, the cone material thickness, the magnet strength, the cone shape – height, angle, minimum and maximum diameters and the properties of the cone termination. Trying to optimise so many parameters by experiment will have been impossible, so although the Walsh design's concept was brilliant, its potential was never realised: until Peter Dicks came along.

Peter used his mathematical and engineering skills to make a computer model of the Walsh design. With this he was able to fully understand how the Walsh driver was working and what the problems were. Then he worked towards a new design, optimising the many parameters involved, until he had a working prototype that he was happy with. This process took several years and involved:

- Producing an initial computer model to allow him to understand how the Walsh driver was working.
- Adjusting parameters in the model to provide improved theoretical performance.
- Building a prototype driver based on the new model.
- Measuring the performance of the prototype to see how it compared with the computer model.
- Adjusting the model so that it more accurately predicted the prototype driver's behaviour, then making adjustments to improve the theoretical performance of the modelled driver.
- Building a new prototype based on the updated model and repeating the measure, update the computer model, make new prototype cycle until the computer model accurately predicted the prototype's behaviour and he was happy that the design had been optimised. This was a process that took several years, as a large number of prototypes were made, testing different designs and materials and as he had a full-time job, he was only able to pursue this in his spare time.

From a prototype DDD driver to a commercial product

Peter showed his working protype driver to a number of European loudspeaker makers, but none showed any interest. It was only in the early 1990s, when he showed the driver to Holger Mueller, that things changed. For several years previously, Mueller had been running a company in Maintal near Frankfurt in Germany, called Mainhattan Acustik. They manufactured loudspeaker drivers and complete loudspeaker systems. They also marketed software for measuring loudspeakers. Customers for their drivers included one very well know US high-end loudspeaker maker and their drivers were also used in a very well-known German compact car.

Mueller was also very familiar with the Ohm F. He had first heard a set during a business trip to New York some years earlier. Talking about this experience he said, *"The tonal and dynamic weaknesses of this driver were undeniable, but what I heard, I had previously only ever dreamed of. The Ohm-F made the entire room the sound stage and I became part of the recording. Even today I get goose bumps when I think about it."* Mueller later bought a set of Ohm Fs for his personal use.

Seeing the potential of Peter's driver, Mueller licensed the design and together they spent the next two years working to refine the design to turn it into a commercial product. In 1992 they were ready and Mueller founded a new company to exclusively make loudspeakers using the new driver, which by then had acquired the ungainly name of the DDD driver – the initials standing for Dicks Dipole Driver. The company was based in Maintal and it was called appropriately, DDD Manufactur GmbH. The first product was the Borderland Mk I.

Figure 2. German Physiks Borderland Mk I

The Borderland Mk I used a single DDD driver with a cone made entirely from titanium foil. This covered the range from 270Hz to 21,500Hz and two 20cm woofers in an isobaric arrangement took the bass down to 28Hz. There was immediate interest from markets in the Far East, which had traditionally been more open to unconventional designs. Sales steadily, grew as did the German Physiks range. This currently comprises 11 models, all using the DDD driver.   Please follow this link to see the full range of German Physiks loudspeakers.

The Borderland remains in production and has consistently been our most popular model. Now in its Mk IV form, it uses the latest carbon fibre DDD driver to cover the range from 190Hz to 24,000Hz and a single 12-inch woofer takes the bass down to 28Hz.

The DDD driver basic facts

Figure 3.   Titanium DDD driver   Carbon fibre DDD driver

The DDD driver cone stands about 15 cm tall and is about 12.5 cm in diameter. The original version used a cone made entirely from titanium foil 0.025mm thick. Sonically, this worked very well, but it was fragile and time consuming to manufacture. In 2008 we introduced a new version that used a cone made from specially treated carbon fibre sheet. This is much more rugged and can probably withstand more physical abuse than any other loudspeaker driver currently on the market. Please watch this video to see what I mean. In the 11 years I have worked for German Physiks I have seen very few instances of the carbon fibre DDD driver failing. From time to time, we are contacted by customers with loudspeakers with the old titanium foil DDD driver that has failed, usually due to someone trying to clean the cone. We can either repair these, or supply a replacement that is matched to the measurements made when the customer's loudspeakers were manufactured. On German Physiks loudspeakers that use a single DDD driver, fitting a replacement is a simple process that takes no more than 10 minutes.

In the Walsh design, Lincoln Walsh had tried to control how the wave travelled on the cone surface by using different materials. With the benefit of his computer model, Peter Dicks was able to optimise this behaviour, by selecting the appropriate cone material and dimensions.

As well as being physically more rugged and easier to manufacture, the carbon fibre DDD driver offered significant performance advantages over original titanium version. The upper frequency limit of the carbon fibre DDD driver is higher: 24,000Hz vs 21,500kHz for the titanium version.

The lower frequency limit for the carbon fibre version is lower, but comparisons are a little difficult due to the format of the figures I have not being identical. At 70Hz the carbon fibre DDD driver can be driven continuously with 50W, while the titanium DDD driver can only tolerate 20W at 120Hz, a lower power at a higher frequency.

All German Physiks loudspeaker designs bar one operate the DDD driver from about 200Hz at the low end, up to 24,000Hz. The carbon fibre DDD driver will produce useful output up to about 30,000Hz, but we start to roll it off at 24,000Hz, as the response above this point starts to become a little uneven.

The range below 200Hz is handled by a bass system using one or more conventional pistonic woofers.

On one model, the Unicorn Mk II, a single carbon fibre DDD driver covers the range from 40Hz to 24,000Hz. This is over 9 octaves. The low-end extension is achieved by coupling the pistonic radiation from the back of the DDD driver to a horn system. A low-end roll-off of 40Hz may sound rather unimpressive, but due to the speed and clarity of its bass, the Unicorn can actually make a pretty good job of heavy rock tracks such as Edgar Winter's Frankenstein.

Figure 4. German Physiks Unicorn Mk II

The way the DDD driver operates is broadly similar to the Walsh, in that is uses pistonic and bending wave radiation, however it also uses modal radiation. Looking at the Walsh design it is very unlikely that it used modal radiation. Also, there is no mention of modal radiation in any of the literature I have seen related to the Walsh driver or the Ohm F. It is possible that it was either unknown, or at best poorly understood at the time the driver was designed, as computer modelling to predict it, or laser interferometry to measure and demonstrate it, did not appear until many years after Walsh died.

To recap, the modes of radiation used by the DDD driver are:

1. Pistonic: This is employed at low frequencies up to about 200Hz. This is the same as is used in the drivers that make up the conventional design loudspeakers that presently dominate the market, where the voice-coil and the driver cone move back and forth together in unison.

2. Bending wave: At around 200Hz, because the DDD driver cone material is very thin and therefore very flexible, when the voice coil presses down, the cone wall flexes and a wave is launched down the cone wall towards the open end. Because of the very high velocity of this wave, it in turn causes a sound wave to be launched that travels outwards and away from the cone. The transition from pistonic to bending wave radiation occurs progressively over a range of several hundred Hz.

3. Modal radiation: At about 5,000Hz, a standing wave is established on the cone wall, and the cone goes into break-up, however rather than causing distortion as it would in a pistonic driver, this is exploited to allow the frequency response to be extended. To give a simplified explanation, when the driver is radiating modally, patterns that look like to concentric rings of ripples you see when you drop a stone into water are established on the cone surface. Each one of these acts like an individual sound radiator. The small amount of cone material involved in each one means that the effective moving mass of each one is very small. As the frequency rises, the number of these individual radiators increases and thus their size and so their moving mass gets smaller. This allows the DDD driver to have a much high upper frequency limit than the Walsh. Ultimately, the stiffness of the cone material prevents these "radiators" getting any smaller and this limits the upper operating frequency.

For a more detailed explanation of the development and working of the DDD driver please follow this link.

Advantages of the DDD driver

The very wide operating frequency range of the DDD driver, its omnidirectional radiation characteristic and its construction, gives German Physiks loudspeakers a number of important advantages over conventional designs.

- Exceptionally coherent and natural sound.
- Realistic stereo images more like those you experience in the concert hall.
- Stereo imaging enjoyable in almost all positions in the room – like in the concert hall.
- Exceptional dynamics.
- Very accurate portrayal of musical instruments' tonal characteristics.
- Very quick and easy to set up and less sensitive to room position.
- The DDD driver is less likely to excite cabinet vibrations.
- Physically extremely rugged and resistant to abuse.

These points are described in more detail on the German Physiks web site here.

Differences between German Physiks loudspeakers and the Ohm F

How has the DDD driver improved on the Walsh?

1. The DDD driver is physically much smaller, coming closer to the ideal driver and so offers better coherence. The Walsh driver does set a very high bar here however.

2. Having a cone made entirely from carbon fibre, it is simpler and easier to manufacture and more reliable. It is designed for a long operating life – 20 years plus. As far as we are aware most of the first DDD drivers made are still in regular use and none are showing any degradation of their components, such as is seen with the foam damping inside the Walsh's cone.

3. The carbon fibre driver is very rugged and will withstand considerable physical abuse, well beyond what would destroy any other driver we are aware of.

4. The DDD driver can produce much higher sound levels. The Borderland Mk IV with its single DDD driver can produce sound levels up to 108dB. I don't have any figures for the Walsh, but I am pretty certain than any attempt to drive a Walsh to this level would destroy it. Playing a Walsh driver at high levels was the main cause of failures.

5. The small size of the DDD driver makes it easy to pack several closely together in an array, such the Loreley Mk III or Gaudi, where 4 DDD drivers are used and this realises sound levels up to 120dB. I have seen a picture where someone has stacked one Ohm F upside down on top of another to produce a loudspeaker with a higher output level, and also presumably to be able to drive the Walsh units at a lower level and reduce the risk of failure.

6. The mass of the Walsh's cone in the Ohm F was approximately 125 grams. The moving mass of the carbon fibre DDD driver is under 3 grams. This comparable to the moving mass of many tweeters, yet it can move as much air as a conventional 6.5" pistonic driver.

7. The carbon fibre DDD driver upper frequency limit is higher at 24,000Hz vs 17,500Hz for the Walsh driver in the Ohm F.

8. The Walsh had a lower low frequency limit, 37Hz, but this was at the expense of a much larger and heavier cone, reducing efficiency and coherence. The smaller and lighter cone of the DDD driver offers better efficiency and coherence and although the DDD driver is generally only operated down to about 200Hz, whereas the Walsh driver in the Ohm F operated to 37Hz, the phase changes due to the small path differences between the DDD driver and the bass systems at these low frequencies are insignificant and not noticeable in practise.

Other omnidirectional loudspeakers

The idea of omni directional loudspeakers is not new. The earliest one that we are aware of is the American Eico HSF-2, from 1958. This used a vertically mounted 8.5-inch woofer with a diffuser mounted directly over the cone to defect the sound waves outwards. The back of the woofer was coupled to a folded horn to handle the low frequencies. Directly above the woofer was mounted a tweeter, which had a cone shaped rather like a lily flower and set inside this was a plug that deflected the radiation outwards. The price in 1958, 63 years ago, was just $139.95.

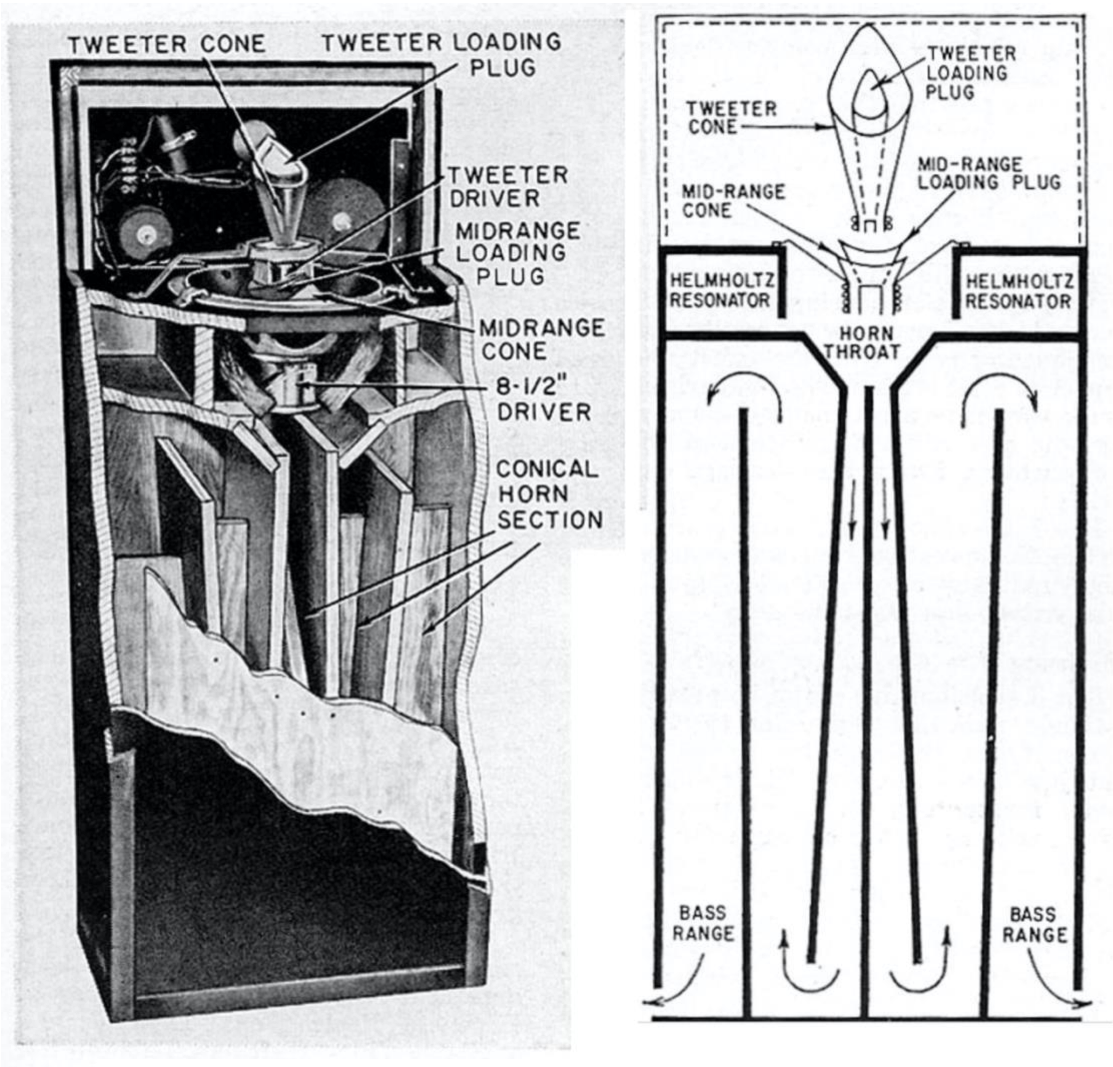

Figure 5. Eico HSF-2

In 1960, Harman Kardon launched their Citation X at the New York Audio Show. This used a vertically mounted, modified 6.5-inch Lowther driver with a diffuser made of plaster, placed directly over it to deflect the sound waves outwards in an omnidirectional pattern. The back of the driver was coupled to a horn that vented through a slot in the base of the cabinet. Harman Kardon followed this with other omnidirectional designs using a similar diffuser technique.

Figure 6. Harman Kardon Citation X

Figure 7: Diffuser on Harman Kardon Citation X

In the 1960s a number of other manufacturers launched omnidirectional designs using diffusers in a similar manner, including Zenith (USA), Sansui (Japan) and Pioneer (Japan). Even Tannoy had an omnidirectional loudspeaker, their Orbitus 1, which they launched in 1971.

Figure 8: Zenith Circle of Sound. 1968.

Figure 9: Pioneer CS-05. 1968.

Figure 10 Dueval Planets Dueval Venus

The use of a diffuser in conjunction with a conventional driver to create an omnidirectional sound field can be found today in a number of designs, the best known of which are those from the German company Dueval. On their entry level Planets model, they use a 6-inch woofer and a 1-inch tweeter, located side by side and facing upwards with individual spherical metal diffusers placed above to deflect the sound waves.

Their other models, such as the Venus shown above, uses a vertically opposed woofer and tweeter, with a shaped wooden diffuser to deflect the sound wave outwards.

The MBL Radialstrahler

The MBL Radialstrahler
The only other company currently manufacturing a loudspeaker that uses drivers that are naturally omnidirectional, besides German Physiks, is MBL, also from Germany. Germans do appear to like omnidirectional loudspeakers. MBL's Radialstrahler driver, is an ingenious design that uses a number of leaf-like elements formed together in a shape like a rugby ball. The gaps between the leaves are sealed with a flexible polymer to make the assembly air-tight.

The leaves at one end are fixed and those at the other end are attached to a voice coil, which is set in the gap of a fixed magnet like a conventional loudspeaker driver. When the voice coil moves towards the fixed end, the leaves move outwards and when it moves away from the fixed end, they move inwards. The Radialstrahler thus acts like a pulsating sphere.

There are three types of Radialstrahler, each covering a different frequency range, but only their top two models, MBL 101 E and the MBL 101 Extreme, use all three. The MBL 101 E is equivalent to our Borderland Mk IV model, which is the next model up from our HRS-130, so in order to compare the Radialstrahler with the DDD driver I will talk about the MBL 101 E.

The leaves on the mid-range Radialstrahler (MT50) and tweeter Radialstrahler (HT37) appear to be constructed from strips of a carbon fibre material and these units are used on all the MBL line loudspeakers.

The woofer version of the Radialstrahler (TT100) is considerably more complex and presumably more expensive to manufacture, which may be why it is only used on the MBL 101 E and MBL 101 Extreme. I have not been able to find any detailed information on the construction of this driver on the MBL web site, but according to a review in the July 2021 of HiFi News, the leaves are made from an alloy of magnesium, aluminium and silicon. Each leaf is re-enforced with two copper rods.

Figure 11. Woofer, mid-range and tweeter Radialstrahler drivers on an MBL 101 E.

Differences between the MBL Radialstrahler and the German Physiks DDD driver

There are two important differences between the MBL Radialstrahler and the German Physiks DDD driver.

1. Bandwidth

The MBL Radialstrahler works over a much smaller bandwidth than the DDD driver. This is illustrated in the diagram below, that compares the bandwidth of the carbon fibre DDD driver in the German Physiks Borderland Mk IV (top) with the three Radialstrahlers in the MBL 101 E (bottom).

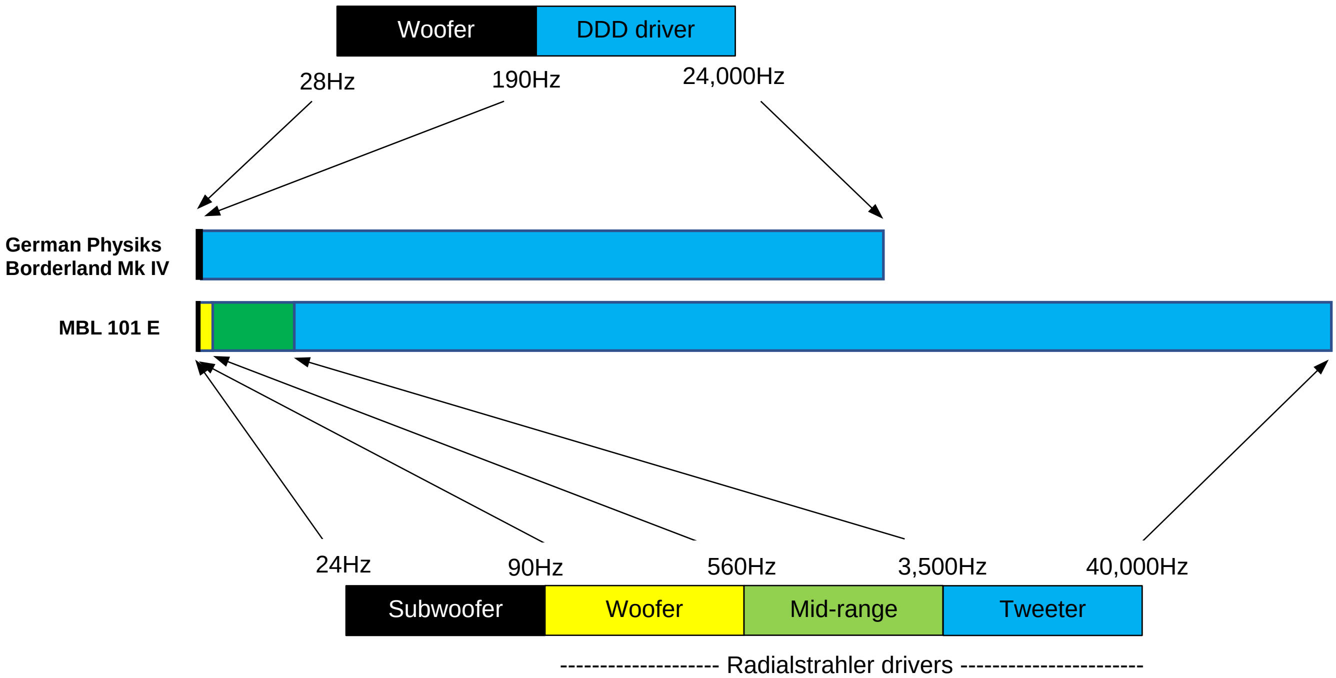

Figure 12. Comparative frequency ranges of the drivers on the German Physiks Borderland Mk IV (top) and the MBL 101 E (bottom).

The Borderland's carbon fibre DDD driver covers the range from 190Hz to 24,000Hz, almost the entire audio range – taking the usually accepted range for human hearing as 20Hz to 20,000Hz. The range from 190Hz down to 28Hz is covered by a single 12-inch woofer.

It takes three different types of Radialstrahler to cover the same range as the DDD driver.

Note: MBL does not appear to publish specifications for the MBL 101E on their web site. The figures for the crossover frequencies are taken from a review in the UK magazine HiFi News published in July 2021 and I assume that these are up to date. The figures for the lower and upper frequency limits are from data published by MBL in 2006. The current figures may be different, but are probably not so different as to make my illustration here invalid.

2. Physical size

The DDD driver, as well as covering a very wide bandwidth, is also very compact. The array of three MBL Radialstrahlers on the MBL 101 E stands approximately 65 cm high. The cone on the carbon fibre DDD driver stands 15 cm high – less than one quarter of the height of the MBL array. The maximum diameter of the DDD driver's cone is 12.5 cm.

This difference is clearly shown in figure 13 where I have set an MBL 101 E next to a Borderland Mk IV. The sizes in the image are not precisely matched, but the image serves to show the large difference in size between the two types of driver.

Figure 13. Difference in relative size between the array of three Radialstrahlers on the MBL 101 E and the carbon fibre DDD driver on the German Physiks Borderland Mk IV.

What is the significance of these differences?

1. Because the carbon DDD driver covers such a wide frequency range (nearly 7 octaves) and it is physically very compact, and also because of the way it works, the time alignment of the frequencies in its operating range is to all intents and purposes perfect. This gives exceptionally good coherence, which is noticeable on harmonically complex signals such as piano, percussion and female vocal.

The Radialstrahler array is physically much larger and the radiating surfaces of the three drivers are not lined up, so the time alignment of the range of frequencies covered by each driver will not be as good as the DDD driver. The Radialstrahler is good, but the carbon fibre DDD driver is better.

2. Each of the three Radialstrahlers in the array must have its own crossover section. This creates a greater possibility for discontinuities in the frequency response than with the DDD driver which, because of its very wide frequency range only needs one crossover section.

3. The narrow bandwidth of the Radialstrahler makes it necessary to have a crossover point at 3,500Hz. This in the mid-range, albeit at the upper end. At this point, there is a range of frequencies where the mid-range driver is faded out and the tweeter is faded in and both drivers are radiating the same range of frequencies simultaneously. Because of their physical separation, the outputs from these two drivers will not integrate perfectly and because our hearing is most sensitive in the mid-range, this join cannot be made seamless. Many loudspeaker designers do an excellent job here, but perfection is not possible.

The DDD driver, because of its very wide operating frequency range, avoids this problem altogether, which further improves coherence.

This problem and the advantage of the DDD driver's wide bandwidth was very clearly described by the US reviewer Dick Olsher, when he reviewed another German Physiks model, the Unlimited, for the magazine *Stereophile*. This uses the same DDD driver as all other German Physiks loudspeakers. He wrote:

> *"It only took me a few seconds to realize that this is a superbly coherent loudspeaker whose wavelaunch more closely mimics live music than the disjointed presentation of a typical multi-way speaker. While I don't intend to condemn all multi-way designs, the truth is that the great majority simply fail to coalesce into a coherent whole. That's a direct consequence of slicing and dicing the music spectrum into pieces for consumption by tweeters, mids, and woofers arrayed on a large baffle. Such speakers may integrate reasonably well at a few points in space but move the measuring mike or your head a few inches and the balance shifts significantly."*

You can read the full review here.

The MBL 101 E is an exceptionally good loudspeaker, as are all of their other models. The German Physiks DDD driver is however technically superior to the MBL Radialstrahler and this gives German Physiks loudspeakers the advantage sonically. This is also why we think that we can justifiably claim that German Physiks are the world's most advanced audiophile omnidirectional loudspeakers.
