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Subject: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Thu, 17 Dec 2009 04:57:19 GMT

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G'day Gents,

I have 4 Pi derivative speakers made with JBL 4507 utility cabs (2226H), DE250, 4 Pi Eminence horn and 4 Pi X/O. The 4507 have all four ports open, which tunes the box to 40Hz.

When asked to comment on 4 pi VS 7 Pi Wayne wrote,

'The midhorn takes the load off the woofer, so it doesn't run as wide bandwidth. This reduces IMD and makes midrange smoother'.

Is this the main difference, or one of a few? I'm also curious to learn about how the two different sized cabinets and X/Os reproduce bass with the same model woofer; would you describe the bass produced as being more similar or different?

Thanks.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Thu, 17 Dec 2009 15:44:11 GMT

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To me, they definitely sound more alike than different. All my speakers have basically the same tonal balance, and they're all designed to generate a uniform pattern. They all use the same

DE250 drivers, you have two speakers that sound very much alike. They're exactly the same above 2kHz and depending on placement, exactly the same from 50Hz to 200Hz too. The only real difference is between 200Hz and 2kHz. Of course, that's a real important region, arguably the most important one.

radiating 2226 sounds more like a very accurate FET. Without analyzing distortion or spectral balance, that's how I'd best describe them. The 2226 is very clear sounding when run through the midrange, no hint of breakup or anything like that. But the midhorn sounds silky smooth. Both are actually very low in distortion and smooth in response, so neither is a clear "winner" in terms of either metric. Both are excellent.

Remember too, the placement environment. That's actually the biggest thing, in my opinion, to influence the sound. Do a little experiment: Take a radio or speaker and listen to it when it is sitting out in the open, radiating into freespace. Now walk with it while still playing and sit it right next to the wall, perhaps on a window sill facing you. Listen to the difference in sound as you get close to the wall. Now take the same radio and sit it in a trihedral corner. Hear the big difference in sound? It gets louder, its tonal balance changes and even the ambient room "echo" is different.

When a speaker is put in the corner, it is louder overall and usually sounds like the bass is a bit more prominent. This is all a result of directivity, as the sound coming from the speaker is forced

into a pattern set by the walls. It cannot radiate omnidirectionally, even at low frequencies, because the wall angles force it into the room, just like a horn. The smaller the speaker (baffle), the more pronounced the effect because on larger speakers, the baffle itself limits the radiating angle to at least half space, the larger the baffle, the lower the frequency before it becomes omnidirectional.

When a speaker is put in the corner, it is louder overall and usually sounds like the bass is a bit more prominent. This is all a result of directivity, as the sound coming from the speaker is forced into a pattern set by the walls. It cannot radiate omnidirectionally, even at low frequencies, because the wall angles force it into the room, just like a horn. The smaller the speaker (baffle), the more pronounced the effect because on larger speakers, the baffle itself limits the radiating angle to at least half space, the larger the baffle, the lower the frequency before it becomes omnidirectional.

The repercussions of this are profound. What it means is that when a speaker is designed to be placed in the corner, it should be voiced to compensate for the spectral shift that happens when placed in the corner, i.e. slight tilt upward in the bass. It also means that the sound at very low frequencies will have constant directivity all the way down, to the limits of the room. The room is the largest acoustic feature in the listening environment, and you're usually "fighting it" to get

(waveguide and) matched-directivity two-way speakers can only provide constant directivity above only by the room modes below the Schroeder frequency.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [tom-m](#) on Fri, 18 Dec 2009 00:32:24 GMT

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Hi,

I may be building one of these soon. In your description of the midrange, what do "SET" and "FET" mean?

Thanks,  
Tom

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Fri, 18 Dec 2009 01:16:17 GMT

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Wayne, thank you for taking the time to explain the design parameters. Answers my question... and more!

I'd also like some descriptive clarification on the difference between FET and SET. Detailed

versus smooth?

I already have 7 Pi crossovers from you. All I would have to do is get the Delta 10s and build the cabs. I'm running a valve amp for the mains. A SS amp drives two 3 Pi subwoofers. Really satisfied with the 4 Pi bass response, but am curious what midwoofers would do for mids.

Merry Christmas to all.

Ant

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Fri, 18 Dec 2009 01:28:29 GMT

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tom-m wrote on Thu, 17 December 2009 18:32 I may be building one of these soon. In your description of the midrange, what do "SET" and "FET" mean?

SET is an abbreviation for single ended triode. FET is field effect transistor. I was trying to describe the difference as being like a high quality Class A tube amp compared with a high quality Class A solid state amp.

Psychoacoustic wrote on Thu, 17 December 2009 19:16 I'd also like some descriptive clarification on the difference between FET and SET. Detailed versus smooth?

Both are detailed, both sound very accurate. But I'd say the 2226 midrange is more towards the analytical, and the midhorn is more, well since I can't say "smooth" (both are smooth), so how 'bout "creamy". Maybe creamy-dreamy.

The midhorn isn't what I'd call laid back, nor is it forward. It's pretty neutral sounding. I dunno. Neither really add anything or take anything away and both can be played very soft and delicate or they can be run full tilt, balls out, louder than hell. They're both very detailed and accurate even when you put the power to them.

Psychoacoustic wrote on Thu, 17 December 2009 19:16 I already have 7 Pi crossovers from you. All I would have to do is get the Delta 10s and build the cabs. I'm running a valve amp for the mains. A SS amp drives two 3 Pi subwoofers. Really satisfied with the 4 Pi bass response, but am curious what midwoofers would do for mids.

Well, that's perfect. My setup is very much like that, Class A FET for the subs and Class A triode woofers and DE250 tweeters. So I get to enjoy both often, daily, for several hours.

the sevens, all the way through the audio range, even in the important midrange. So there isn't a bad seat in the house when you run sevens. Not that the fours lack anything in seat to seat

cornerhorn is the only configuration I know of that delivers constant directivity through the whole audio range from the Schroeder frequency up. The downside is they need a specific room layout to use them properly. If you have the right room, they can't be beat. But if not, I'd rather have four

Imaging, placement and orientation

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Fri, 18 Dec 2009 03:12:50 GMT

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This helps to make an informed decision. Unlike other speakers in the stable, I'm never wanting for anything for the 4 Pi's- just curious about the 7 Pi and in a situation to sate that curiosity. My guess is that my treated room would complement the 7 Pi's intended application. Please see photos:

<http://audioroundtable.com/forum/index.php?t=msg&th=11661&start=0&>

thanks again.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Fri, 18 Dec 2009 15:09:02 GMT

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second one (with blinds for the window) has an opening near the corner that would make them not work right.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [tom-m](#) on Fri, 18 Dec 2009 15:51:00 GMT

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Thanks for the info Wayne. I think I will go for the "creamy" sound of the midhorn.

But with my room, I cannot do cornerhorns. I think I read somewhere that the midhorn and tweeter of the 7 pi could be used with a woofer in a bass reflex box, right? If this will work, I think this is what I will build. A 15" 3 way using your midhorn and tweeter. Would the 7 pi crossover work for this type of speaker?

Thanks,  
Tom

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

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Posted by [Wayne Parham](#) on Fri, 18 Dec 2009 16:41:14 GMT

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Yes, that will work. But when not positioned in the corners, the speakers by themselves can't control the pattern to as low a frequency. The midhorn isn't large enough. Also bear in mind that the position and orientation of the speakers has a lot to do with their performance. For best results, set them up as described in the post below:

Imaging, placement and orientation

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [tom-m](#) on Fri, 18 Dec 2009 22:52:38 GMT

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Is this the correct build specs for the midhorn?

<http://www.audioundtable.com/PiSpeakers/messages/14408.html>

tom

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Sat, 19 Dec 2009 00:44:06 GMT

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Yes, that's it.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Tue, 22 Dec 2009 01:44:32 GMT

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Gents, going to try the Pi 7 midhorns. Delta 10A ordered. Planning to cover the Pi 4 tweeter horn cut out and use the Pi 4 bass cabs with midhorn on top. Understand this is a deviation from Pi 7 design- will build correct bass cab at a later date.

JBL 4507 has tunable ports. What frequency is suggested to simulate Pi 7 cab tuning?

Due to the very different dimensions of the 4507 cab, advice please for facing woofer to the rear or front? Try it and see?

Thanks, Ant.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Tue, 22 Dec 2009 02:55:58 GMT

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pretty much the same thing.

As an aside, most of my cabinets are tuned a smidge low, going for a slightly overdamped alignment. My goal is to have smooth rolloff that generally conjugates room gain and is also an easy blend for subs. It's a friendly alignment that is tolerant of electro-mechanical shifts from heat or high-output impedance. Also tends to keep the speaker from sounding thumpy in its early days when the suspension is brand new and still too stiff.

Room gain, pressure region, modal region and reverberent region

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [feket663](#) on Sun, 27 Dec 2009 17:02:39 GMT

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Dear Wayne! I'd like try the SevenPI cornerhorn, but I can't place the speakers in the corner. Can I use "false corner" like Klipsch recommend his cornerhorn? Recommended size? And next: can you send me a SevenPI plans?

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Sun, 27 Dec 2009 18:12:11 GMT

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You've got mail!

About a false corner, yes, you can do that but please remember that it has to be large to be effective.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [feket663](#) on Sun, 27 Dec 2009 20:53:58 GMT

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Thanks a fast reply. Another question: I have an about 13x16,5 feet room. If I place the corner the 7PI-s will not be too far from each other? This room size enough for 7PI-s or need bigger room. Currently I have 4PI-s and I'm very satisfied with these speakers, but I'm curious the 7PI's magical, creamy midrange...

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?  
Posted by [Wayne Parham](#) on Sun, 27 Dec 2009 23:52:23 GMT  
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The room size isn't the problem, I don't think. I would prefer them along the short wall though. If speakers instead. You can put them just about anywhere.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?  
Posted by [tom-m](#) on Mon, 28 Dec 2009 19:00:14 GMT  
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Hi Wayne,  
I did a rough build of a midhorn, to get a perspective on its size, and to see if I ran into any problems. I just made it with butt joints, using 0.75 in plywood. The butt joints don't meet flat, I guess because of the flare of the horn. I used the dimensions from the link I posted a few replies up. Does the full 7pi plans have more detailed construction of the midhorns? If so, I may need them.

Also, I will probably buy 7pi crossovers from you, but wanted to know what is the crossover point between the woofer and midhorn?

Here are 2 pics of my rough build midhorn.

Thanks,  
Tom

#### File Attachments

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- 1) [horn01.jpg](#), downloaded 7647 times
  - 2) [horn02.jpg](#), downloaded 7482 times
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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?  
Posted by [Wayne Parham](#) on Mon, 28 Dec 2009 19:10:04 GMT  
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You're right about the butt joints, obviously you'd need to angle them if you wanted the edges flush with the throat plate. However, what you've done is fine, especially for a one-off build. Just assemble the horn with PL adhesive which expands to fill in the gap. Find a way to clamp it together while the adhesive sets up and then afterwards, file the seam of hardened glue to make

the throat nice. Be sure the throat area is 4.5" square too.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [feket663](#) on Mon, 28 Dec 2009 20:56:28 GMT

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Wayne Parham wrote on Mon, 28 December 2009 00:52

The room size isn't the problem, I don't think. I would prefer them along the short wall though. If speakers instead. You can put them just about anywhere.

Here is my room's schematic. Is this good place for the 7PI?

I do not want to put boxes on the opposite side of the room, because there is not enough the bass. I think the little part of room reduce the bass.

Sorry for quality...

#### File Attachments

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1) [room.JPG](#), downloaded 13280 times

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Tue, 29 Dec 2009 03:41:03 GMT

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feket663 wrote on Mon, 28 December 2009 14:56

Here is my room's schematic. Is this good place for the 7PI?

I do not want to put boxes on the opposite side of the room, because there is not enough the bass. I think the little part of room reduce the bass.

Yes, you could do that. If the false wall is large enough it will work pretty well. My concern is it speakers.

does work out, you can build the proper bass bins. This will let you try out the basic sound without going through all the trouble of building the bass bins at first. If you like it, build the bass bins



which will move the midhorn and tweeter up higher.

One more thing I'd like to mention. Give the multisub approach a try. This will completely change the character of the bass in your room. You will find that you may be able to put the speakers in the corners closest to the green couch in your drawing, and then pull it over to the other side. Using a couple of subs, you'll increase extension as well as smoothing the room modes. I'd probably do that first, because you can use the subs with fours or sevens. It will improve them both.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Thu, 31 Dec 2009 23:37:19 GMT

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Mmmm, no low-fat, reduced calories here! Seems like a few of us have a taste for some double dollop, creamy sound...

Tom- big empathy thumbs up for the horn flares! Try cutting a 15 degree angle on your side pieces. Well, that's the angle that worked for me. I just used a circular saw and a guide to ensure a straight cut.

You blokes in the US should campaign for the midhorn flat packs!

Will report back on the 4 Pi / Jersey-rich goodness midhorn combo... soon...

Anyone contemplating the multi-sub gig should commit. HUGE improvement to the room. Do wonders for the Pi speakers and help bring out the full potential of my Yamahas.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Fri, 01 Jan 2010 14:39:43 GMT

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We've had those midhorn flat pack kits off the shopping cart way too long. Should be available again very soon though. I'll announce here when we can start taking orders.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Wed, 13 Jan 2010 04:39:04 GMT

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Finished the 7 Pi midhorn over the winter break. Gained some new woodworking skills, that's for sure! For example, take cursed thing to old mate down at the woodyard... put it through the tree-ripping bandsaw. Problem solved.

Had the crossovers built by Wayne on hand, mounted them in boxes. Removed the HF gear from this project <http://audioroundtable.com/forum/index.php?t=msg&th=11661&start=0&> (4 Pi derivative), made a cover plate for the hole. Mounted the HF unit in box and... SHA-ZAAM!

Have a couple of queries, if I may.

My three-year-old son has already made gestures towards reaching up and poking the dust caps. It's embarrassing to hear a grown man scream like a girl. Would acoustically-transparent cloth glued to the inside of the horn throat square be a problem?

What is the theory behind the 'backward' facing woofer? Is this to utilise the corner principle, negate floor bounce? In theory or practise, would a forward facing woofer as I currently have sound any different?

As pictured, the walls (to the left, curtains covering ancillaries, to the right window curtains) would diffract sonic reflections from the midhorn (and tweeter)- yes? Currently in the process of constructing doors to cover both of these curtained areas (due to a desire to secure the hi-fi gear and dust is a big problem on these components from the curtains). Which surface would be optimal- a diffractive, reflective, absorptive (i.e. rigid fibreglass acoustic panel) or combination from the above?

## File Attachments

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- 1) [before.JPG](#), downloaded 6276 times
  - 2) [woodshop.JPG](#), downloaded 6431 times
  - 3) [close up.JPG](#), downloaded 13401 times
  - 4) [room 7 Pi.JPG](#), downloaded 6346 times
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Subject: Cornerhorn Ruminations

Posted by [Wayne Parham](#) on Wed, 13 Jan 2010 14:56:15 GMT

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Nice looking midhorns! Congratulations!

We will have the midhorn flat pack kits back on the shopping cart in about a month or six weeks

(finally!) I met with the cabinetmaker on Sunday and we discussed it at length.

You can keep stuff out of the midhorn using a grill cloth or mesh stretched across the throat. It should be as acoustically transparent as possible, of course.

The idea behind the rear facing woofer is it puts it as close to the corner apex as possible. This is also the case for the midhorn because at low frequencies, it is close enough to the side walls they act as extensions of the flare. As frequency rises, the midhorn becomes more directional and the corner isn't really important. Same with the tweeter, it is acoustically distant because of the smaller wavelengths involved, but it has directivity control through its passband and doesn't need any "assistance" from the corner like the woofer and midhorn do.

The goal, in a nutshell, is to keep the sound source acoustically close at frequencies where it is not very directional. This makes the walls, themselves, become the directivity control device. They form a large waveguide. Being acoustically close, they aren't creating reflections, they're a launch point, part of the source. At higher frequencies, the horns used will provide the directivity control and this reduces reflections. It still doesn't hurt to line the walls with absorbent material, as this will reduce reflections even further.

The corner expansion really works for us in the lower midrange region, from about 100Hz to a few hundred Hertz, 300Hz to 500Hz or so. This is the range we're looking for. Below that, room modes take over and the directivity that may have been provided from corner loading (in a larger room or outdoors) is defeated by the self-interference from room modes. That's where multi-sub's can help. Above a few hundred Hertz, the sound sources become acoustically distant from the walls, so they would start to cause early reflections if they were not directional by themselves. That's why it is really important that the midrange and tweeter be horns. They provide directivity and reduce early reflections.

As an aside, I've built cornerhorns in many varieties over the years, some with direct radiating mids and some even with direct radiating tweeters. I've even built some that had rear-firing mids and tweeters. This creates a healthy dose of reflected sound, and makes them sound very full. It is an interesting sound, full of ambience. The reverberent field is uniformly charged, so that part is right, but I think the increased early reflections make it sound "busier". It is interesting to listen to at first - a real crowd pleaser at shows - but I think it sounds much better to use horns that provide the directivity control from the midrange up, to reduce early reflections.

Towards this aim, ideally you want to set the cornerhorns on walls that are straight and lacking features that would cause reflections, things like rafters or small shelves, etc. You're using the expansion of the corner from the apex as a large horn, so the same things you'd want in a horn are what you want in the walls. There is one exception, the walls don't need to be rigid, and really shouldn't be. We have competing priorities here - Normally, you want horn walls to be rigid, but in this case, we want the room walls to provide some damping. The perfect walls would be rigid down to the Schroeder frequency (around 100Hz to 150Hz) and then would be flexible below that, absorbing some of the bass energy and damping room modes.

Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Thu, 14 Jan 2010 00:14:39 GMT

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Wayne, thank you for the informative response re. rear facing woofer theory.

Bass cabinets will be a walk in the park compared to the midhorns!

2 X 3 Pi subs in operation.

I know that Wayne has recently addressed this topic in "False wall bass traps", but thought a brief discussion of wall surfaces specific to 7 Pi cornerhorns might be informative. Apologies if the questions are limited to my situation, hope the discussion may be generalised.

Unfortunately, still no equipment for taking room measurements... anyhoo...

In the rear corners and to the left and right of the speakers in the pictured listening room are low and mid frequency panel bass traps constructed from Ethan Winer's designs

<http://www.ethanwiner.com/acoustics.html#fiberglass%20traps>

These are intended to absorb the hump around 100 Hz - 150 Hz, which I presume is the Schroder frequency often referred to. Would it be advantageous to incorporate the same, sealed bass traps in 50% (or more) of the wall surfaces immediately next to (in front of) the speakers (where curtains are currently located)? I think this application would address the notion of '...we want the room walls to (have the same things you'd want in a horn and) provide some damping'. I presume we do not want high frequency damping in this location if the walls are intended to act as extensions of the horns and provide directivity.

There are high frequency, rigid fibreglass absorption panels in the centre of three walls of the room. Two more optimisation questions. There is a log roof joist right above the speakers and there are windows behind them. Would these things cause interference? Can't do much about the joist, except relocate speakers to the back of the room (where they were originally intended to go!!) but then I lose my mountain view! Feel a bit claustrophobic, too. Any 7 Pi specific comments on ceiling treatments directly above the speakers?

For the windows behind the speakers, it would be possible to build removable wall 'panels', as high as the glass and 1 metre (plus) wide to partially cover the windows for the purposes of increased bass absorption and to better act as '... directivity control device(s)'. Thoughts on the necessity/effectivity of this idea in relation to the rear-facing woofer?

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Subject: Room Treatments

Posted by [Wayne Parham](#) on Thu, 14 Jan 2010 03:25:04 GMT

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Those panel traps are probably the best thing you can do to tame room modes. You can't hurt yourself putting them on every wall. If you're lucky, framed drywall will come close, but even then, the extra damping won't hurt. They really help rooms with rigid walls like brick, concrete or stucco. Walls made of material like that have virtually no damping, so room modes are severe. That's where panel bass traps are most needed.

As for high frequency absorption, it's generally a good idea too although directional speakers help a great deal in that regard. The pattern is approximately 90°x40°, so ceiling slap is greatly reduced, as are side wall reflections. You don't want the room to be too lively, as it will sound like

a gymnasium. If you clap your hands in the room and hear a sharp ringing sound, then you may want to add some absorbent wedges or at least some extra curtains. On the other hand, rooms that are too dead often don't sound natural either. You'll know it if you go too far, as the room will sound sort of "sterile".

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Thu, 14 Jan 2010 04:58:34 GMT

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Cheers!

To revisit the 4 Pi vs 7 Pi theme: the first thing that struck me with the midhorn during the first few sessions was that singers' vocals become more centrally projected; the 'image' of the performer was just 'there'. It did not take any imagination or visual suppression (closing eyes) to 'believe' where the sound was coming from. The 4 Pi was great with this too, and I don't doubt that a bloke could be very satisfied with that model. But I feel (even at this early stage) that the imaging with 7 Pi is something else again.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [tom-m](#) on Thu, 14 Jan 2010 05:22:43 GMT

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Looks like you are having a good time. I would like to see the back of the mid horn after you used the big saw. And how well did the 12x12 mounting plate fit? Do you have any pics of that?

I am still considering building a 15" 3-way using this mid horn and tweeter. I want to use the 7pi crossover, with some modification to the crossover point between the woofer and mid horn.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Thu, 14 Jan 2010 23:30:31 GMT

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Sorry tom-m, no 'after' pics. The band saw leaves the MDF with fairly deep ridges, which we allowed for in measurements. That section was then planed smooth, and we obtained a very accurate fit for the driver mounting plate. It took quite some effort to construct an accurate wedge to support the horn securely in the hydraulic clamps. The wedge isn't shown in the pictures. What 15" woofer are you considering?

Wayne, just out of curiosity, may we see some photos of your own 7 Pi in their natural habitat? It would be interesting to learn what ancillaries you use, too. Is there any particular music you would play to demonstrate these speakers?

Just for fun- midhorn first audition playlist (all vinyl):

Joni Mitchell- Blue  
Bert Jansch- Jack Orion  
Black Sabbath- S.T. (this is when things started to happen!)  
Vanilla Fudge- S.T.  
Black Mountain- In The Future  
Pink Mountaintops- Outside Love  
Neil Young- Everybody Knows this is nowhere  
    Tonight's The Night  
Beethoven's 9th symphony  
Pink Floyd- Atom Heart Mother  
    Meddle  
Led Zep- I

'Twas a big night!

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Posted by [Wayne Parham](#) on Fri, 15 Jan 2010 01:32:11 GMT  
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A close-up view:

Another close-up:

At an angle:

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?  
Posted by [tom-m](#) on Fri, 15 Jan 2010 21:31:22 GMT  
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Hi Psychoacoustic,

That is a fun mix of music you have listed.

The 15" woofer I will be using is the AE TD15M. I purchased a pair about 6 months ago. I knew I wanted a 15" 3-way using pro woofers and compression drivers, but did not know the exact design. Also, because I do not have measuring equipment, I would be hard for me to design a crossover from scratch. So after a lot of research, I think a modified Pi 4 would work well for me. And I can purchase the Pi 7 crossovers from Wayne.

Wayne, the high res pictures of the Pi 7 is helpful to see how you finished out the mid horn. Thanks.

Tom

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Fri, 15 Jan 2010 22:55:00 GMT

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Understand your hesitation to build a crossover without a reliable measurement system. Have been in the same predicament.

Can you compare response graphs between the woofers you have and those used in the 7 Pi design? Perhaps that would help?

A complete guess- integrating a woofer in a three-way system might be easier than a two-way?

Questions for the experts.

Best luck with it!

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [tom-m](#) on Sat, 16 Jan 2010 04:01:48 GMT

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Wayne,

With the mid horn being 24" wide, but not using it in the corner, What is the lowest frequency that the horn will control the directivity? I have no idea, but my guess would be about 600-700 Hz?

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Subject: Cornerhorns and constant directivity

Posted by [Wayne Parham](#) on Sat, 16 Jan 2010 05:50:34 GMT

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You're about right. I wouldn't expect much directivity control below 500Hz in freespace. The corners set the pattern for a couple octaves below that. In my opinion, this is the biggest benefit from corner placement: It gives the loudspeaker designer the opportunity to create a pattern

having constant directivity all the way down to the Schroeder frequency.

On a related aside, I love good horn loaded loudspeakers and have always built them. But it cracks me up to watch people talk about cornerhorns and focus on the acoustic loading of a truncated basshorn. To me, that is trivial compared to the possibility of constant directivity. To build a loudspeaker designed to be placed in a corner and fail to incorporate constant directivity horns or waveguides is a huge mistake. The biggest benefit of a cornerhorn is how it directs the sound field above the Schroeder frequency, not below it. A good cornerhorn is probably the only configuration I know of that can provide constant directivity all the way down to the Schroeder frequency, approximately 100Hz or so.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Sat, 13 Mar 2010 10:56:31 GMT

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Just curious- the 7 Pi is shown on the Pi website as a '600 watt speaker'. Is there any potential at loud volume levels to damage the DE-250 ('120 watt continuous program power capacity') with amps rated over 200 W RMS per channel? Also, is there any problem with heat dissipation when the crossover is mounted in a small, sealed box? Thanks.

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Subject: Crossover considerations - power handling, frequency, slope, etc.

Posted by [Wayne Parham](#) on Sat, 13 Mar 2010 16:35:54 GMT

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All of my speakers, and the components used within (crossovers, drivers, etc.) are rated to take the full listed power. One of the things I take as a design requirement is that the crossover deliver signals that the drivers can handle with respect to bandwidth, crossover slope, etc. I never publish a design that requires a driver or component to be derated due to power - instead, I design the system so it can be used to its maximum potential. Not only does this help protect them, but it also usually makes them sound better because they aren't stressed. Distortion is usually much lower and the overall sound is better when the system is designed this way.

I've examined this in some detail, various crossover types (first through third order, with and without compensation, Zobel's, notch filters, etc.) and I've shown an analysis of the voltage (power) levels across each component in the document below:

Speaker Crossover Document Drivers usually have to be limited on the lower end (frequency and slope) to protect from overexcursion. Through the passband and approaching their upper range, drivers are more vulnerable to thermal overload, getting so hot the voice coil adhesive fails, unwinds and begins to rub or buzz. Another thing I consider a design requirement is that the components used in the crossover have sufficient voltage and current capacity to handle the full rated power. This usually means selecting capacitors with sufficient voltage limits and choosing resistors with appropriate power ratings. Coils aren't usually an issue, because if they aren't large



enough to handle the current, they'll modify the transfer function due to excessive resistance. Most times, if the coil is large enough to sound good, it is large enough to take the current.

To answer your specific question about the DE250, or any of the compression drivers used in my designs, there are two issues to consider where power handling is concerned and my loudspeaker designs address them both quite fully. One is the thermal limit, set by passband power level, and the other is the maximum excursion, usually occurring near the lower cutoff point.

The passband power level is reduced 10dB by the crossover, mostly to match sensitivity with other drivers and to allow passive equalization for mass rolloff. A side effect of this is that it means power input to the loudspeaker system can be 10dB higher than the driver alone could handle. When the loudspeaker system is presented a signal at ~2kHz that would result in 600

tweeter and sets the level, ultimately presenting a much lower signal that dissipates approximately 60 watts in the tweeter. So it is quite safe, nowhere near its limits.

The lower frequency excursion limits are a little more complicated, in that the horn provides acoustic loading and this sets the lower limit to some degree. At frequencies high enough that the horn is providing acoustic loading, excursion is reduced. Below that point, excursion rises rapidly and one thing compression drivers cannot handle is excessive excursion. The diaphragm will literally hit the phase plug and begin to make a clacking sound, sometimes even shatter. Long before that occurs, distortion goes through the roof, so this isn't something you want.

Even where the horn loads the diaphragm, excursion still rises as frequency goes down. So even though the horn is providing acoustic loading, even if it is used above cutoff, this is still not a guarantee that the driver won't reach its excursion limit. Excursion limits are so small many compression drivers rate them as having 0mm  $x_{max}$ , which isn't really the case, of course, they have to move to make sound. But the point is they are designed to move very little.

It is important to design the crossover so the crossover point is high enough and the slope great enough to reduce low frequency energy. This is what limits excursion - don't allow low frequency signals to be developed across the compression driver. You can get away with first-order slopes on a dome tweeter with wide surround, it has relatively large suspension travel (for a tweeter, anyway) and no phase plug to hit. But you really can't do this with a compression driver, at least not if you plan to ever use more than 10 watts. Granted, 10 watts is plenty loud on a driver like this, but still, I think it's important to design a speaker to allow it to reach its full potential. It lets you crank it up without fear, and even if you never do that, it still is better with respect to distortion.

Of course, all this has to be juggled with other competing priorities. The crossover isn't there just to protect the driver. It also has to achieve flat response on-axis, and to provide the right phase relationships between sound sources to put the forward lobe and vertical nulls where you want them to be. Getting all these things right simultaneously is not trivial. But it is possible, and really should be done, in my opinion. Anyone can throw together a crossover that works, but to build a really great loudspeaker, you have to pay attention to all these details, to get them all right.

Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Sat, 13 Mar 2010 23:38:29 GMT

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Sensei- Thank you for taking the time, once again, to answer a question so informatively.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Infrasonic](#) on Tue, 16 Mar 2010 22:54:51 GMT

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Hi Wayne. 2nd time poster, long time lurker.

I have done tons of research on your site and I am getting close to ordering a trio of Pi4's (DE250+2226H) for new LCR's in my home theater. Similar to what some other recent posts have wrote.

I saw this thread and had a couple questions. For HT use would there be any benefit using the Pi7's over the Pi4? I won't be using any cornerhorns. Unfortunately, I don't have that option right now. I saw this pic and thought it was really cool:

Could the Pi7 work with a forward firing woofer section? I know the JBL has nice midrange though so I am unsure. I don't want to complicate my build anymore than it needs to be but if there are benefits I'd like to know.

Thanks.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Tue, 16 Mar 2010 23:29:23 GMT

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They have two big advantages, first is the corner sets the pattern constant all the way down in frequency, clear down to the Schroeder frequency. This is where room modes begin to take over, making pockets that sort of overrule the launch directivity. Standing waves within the room modify the wavefront that would have existed outdoors or in a very large room. But from about 150Hz up, the cornerhorn makes a pattern with constant directivity, and I know of no other configuration that can do this. The second advantage is you split up the mids and bass, which improves IMD and also gives some smoothing of the upper modal region.

So if you have the right corners, use them. But if you don't, the DI-matched speakers are very close, especially when combined with multiple subwoofers. More info at the link below:

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Infrasonic](#) on Wed, 17 Mar 2010 00:06:49 GMT

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So if I weren't using the corners would there be much of an advantage to going with a front firing Pi7 over the Pi4? From what I read about the midrange on here is that there really isn't a crossover from the bass to mids and that they "blend" together to get the response. I may have just read too much material and mixed things up. I was just curious cause the speakers sure look badass with the midrange horn on there. I'm sure I will be super happy with Pi4's anyway.

Thanks, Wayne

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Wed, 17 Mar 2010 02:15:31 GMT

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or a similar three-way speaker having the same midhorn and a front-firing woofer. The midhorn was really designed to be used in a corner, and while it doesn't lose all directivity control outside a corner, it can't maintain the horizontal below about 500Hz. It actually starts losing control around 750Hz and by 400Hz, the pattern has doubled in width, basically acting pretty much like a large flat baffle at that frequency. That's still decent control, over an octave lower than without the midhorn, and there is the matter of distributed sound sources in the upper modal region. So there are some benefits, even when used outside corners.

loudspeaker is pretty attractive, having its own set of merits. For the difference in cost, you can

unobstructed corners and distance between them that allows their forward axes to cross in front of the listening position. That's the only problem with the cornerhorns - you need a specific room layout to use them, and not every room has that.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Infrasonic](#) on Wed, 17 Mar 2010 05:50:21 GMT

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Ah, that's just what I needed to hear. I wasn't sure if the enhanced directivity of your midrange kit would be of extra benefit in my situation. For now, I won't worry about the extra steps required for

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a modified Pi7 if I don't need it per your recommendation. I really like the Pi4's so I know I will enjoy them in my theater room.

Right now I have two large, low tuned subwoofers each with an eighteen inch subwoofer. It is a very capable system, I must say. I do have two more eightteens on hand though and I will convert to a quad sealed set up in the near future. I first want to see how the vented subs work with you Pi4's once I build them before I go all sealed.

Thanks so much for the info and sorry if I cluttered this thread.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Sun, 06 Jun 2010 11:25:59 GMT

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Well, FINALLY got the Pi 7 bass cabs built. Have been using JBL 4507 cabs since December last year- quite satisfactorily, I must say. Not knowing too much about acoustics, I was somewhat anxious that the reduction in cabinet volume would result in less extension or 'punch'. But, if both are tuned to the same frequency, then performance must be similar in that regard, right?

So, I did the experiment. Used two window braces above and below the woofer, port was simple and I was able to finish both (MDF was cut at the hardware store), in a day. Initial impression was the the bass had tightened up and was as smooth and full as with the 5 cubic feet cabs. Most notable was an improvement in midrange balance- NICE! Won't ramble on too much until I've become accustomed to the change.

In summary, I think the most accurate statement that I can make is that I share a similar taste in speaker voicing to Wayne. I also run two Pi 3 subwoofers using the adapted car subwoofer crossover suggested by Wayne on the forum. Have used a valve amp with the Pi 7 but am preferring a Yamaha pro-amp now.

A big thanks to Mr Parham!

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Sun, 06 Jun 2010 14:22:48 GMT

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Thanks for the update. Post pics, if you can!

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Tue, 08 Jun 2010 01:19:17 GMT

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'You want it? You got it!' (from The Kills Keep on Your Mean Side 2003.)

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Crappy photo to camoflaug nasty MDF:

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### File Attachments

1) [tudor-lodge-tudor-lodge-inside.jpg](#), downloaded 5977 times

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Tue, 08 Jun 2010 02:01:56 GMT

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Nice, looks great! Gonna veneer or paint?

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Tue, 08 Jun 2010 02:11:06 GMT

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Thanks for the great design!

Not sure about the finish yet. Had an idea to paint white then transfer a picture of an album cover on the front- something like one of these on each:

BTW- has anyone got a beat-up or in any used condition, single 2226H to sell by any chance?

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### File Attachments

1) [tudor-lodge-tudor-lodge-inside.jpg](#), downloaded 5881 times

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Tue, 08 Jun 2010 13:17:34 GMT

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Oh, wow, what a trip! That would be a cool looking set of speakers!

About woofers, I only stock new 2226 drivers. But I'll bet you can find some baskets on eBay and recone them.

You probably already know this, but just in case, don't buy third-party recone kits. Get the factory replacement parts. They sound much better. I've had luck with aftermarket pole piece covers, but don't like third-party cones.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Psychoacoustic](#) on Thu, 28 Nov 2013 02:16:00 GMT

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Wayne Parham wrote on Tue, 16 March 2010 21:15

or a similar three-way speaker having the same midhorn and a front-firing woofer. The midhorn was really designed to be used in a corner, and while it doesn't lose all directivity control outside a corner, it can't maintain the horizontal below about 500Hz. It actually starts losing control around 750Hz and by 400Hz, the pattern has doubled in width, basically acting pretty much like a large flat baffle at that frequency. That's still decent control, over an octave lower than without the midhorn, and there is the matter of distributed sound sources in the upper modal region. So there are some benefits, even when used outside corners.

loudspeaker is pretty attractive, having its own set of merits. For the difference in cost, you can

unobstructed corners and distance between them that allows their forward axes to cross in front of the listening position. That's the only problem with the cornerhorns - you need a specific room layout to use them, and not every room has that.

Adding on to this older thread so that the Pi journey is documented.

Wayne, would you mind explaining a little more about how to compliment/augment 7Pi with 2X 3Pi subs as in the quote above? For example, (obviously) the subs cannot be placed behind the 7Pi as they could the 4Pi. And you have written that the 7Pi mid-woofer is fine on its own due the nature of its corner bass reinforcement, so that means that the two subs act as flanking subs that help smooth the overall room acoustics? Basically correct? Specifically, I wish to fill in the lower-end of bass response that the JBL mid-woofer doesn't cover. More rumble and bass-slam from subs in a remote, flanking context possible? I've tried many configurations but would appreciate your thoughts, please.

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Subject: Re: 4 Pi and 7 Pi bass response- More similar or different?

Posted by [Wayne Parham](#) on Thu, 28 Nov 2013 15:35:41 GMT

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A constant directivity cornerhorn doesn't suffer self-interference anomalies from nearest boundaries. So there is no need for flanking subs. Instead, you would want to setup the subwoofers as distributed subs, a little further from the mains and low-passed lower. That way

they can smooth room modes at lower frequency.

Speaker placement and wavefront launch  
Room modes, multisubs and flanking subs

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