Subject: Re: Uniform Directivity - How important is it?
Posted by Wayne Parham on Mon, 20 May 2013 22:08:18 GMT
View Forum Message <> Reply to Message

To offer a little more information, consider the following sonograms:

First, the ideal directivity pattern would be constant through the entire audio band. A constant directivity cornerhorn comes close to this, because the walls confine the beam down low, and the midhorn and tweeter waveguides set the pattern up high. So basically, the whole room is the "sweet spot."

Of course, that's an idealized sonogram, and in the real world, room modes will break up that nice pretty picture and make pockets of hot and dead spots throughout the room below the Schroeder frequency, around 200Hz or so. That's what flanking subs and distributed multisubs seek to mitigate.

But that's a whole different subject. For now, back to tweeter waveguides.

Now the opposite end of the scale, a sonogram that is audibly deficient. This shows approximately 90° beamwidth up to 1.6kHz, then widening to over 120° to 6kHz, then narrowing to 40° above that.

The problem is the response off-axis. A listener that's sitting on-axis gets a different sonic presentation than a person sitting at 30° off-axis, and another person at 45° gets another completely different presentation. There is no spectral balance for listeners off-axis more than about 20°.

Look at the legend to the right. See the colors, and how they relate to SPL. At 45°, the sound is -6dB compared to the on-axis level below 1.6kHz. It rises nearly to the on-axis SPL, maybe -2dB in the 1.6kHz to 6kHz region, and then falls rapidly above that, being approximately -12dB at 12kHz.

Said another way, imagine the response curve for a listener sitting 40° off-axis. For that person, the response blooms about 4dB from 1.6kHz to 6kHz, and then it falls rapidly down to about -6dB by 12kHz.

This is non-uniform directivity, and it is something I would personally not want.

But now let's look at some popular horn/waveguides that provide good directivity.

This is a horn/waveguide that provide near-ideal beamwidth. As you can see, the sonogram is reasonably flat. It stays locked-on at 45° beamwidth across the band.

But what if there are design features that cause this horn to have 5dB ripple on-axis, as well as

off-axis? In a way, it doesn't matter that the polars are nice and pretty, because there is a lot of ripple no matter where you sit.

Here are some sonograms of horn/waveguides that show some waistbanding, but that are still very good.

In each case, you will notice the beamwidth is 45° from midband up. But down low, there is a little bit of a pinch in the beamwidth.

Examine each chart closely, and look at the legend. Remember that the beamwidth is defined as the angle where response is -6dB down from the on-axis level. So since each of these waveguides is a 90° device, and since each shows some waistbanding down low, look and see what the SPL is in the "pinched" region. What you will notice is that instead of being -6dB, it is a little more, like -8dB from the on-axis level. What you are actually seeing in these charts are devices that have about 2dB less output at 45° off-axis in the waistbanding region.

In some cases, this may be in the crossover overlap region, where the woofer and tweeter directivities blend. If so, the waistbanding may be masked. But even if it isn't, or if it is only partially blended, we're still talking about a relatively minor anomaly. It isn't as though waistbanding is entirely trivial, but it is more important in prosound applications, where arrayability is important. For high-fidelity monitoring applications, I would prefer the waveguide have smooth response through the pattern as its primary design goal.

In the end, the matched-directivity design will look something like this, with woofer and tweeter blended: