Introduction

The Tempest-X2 is a 15" long-throw, low distortion driver from Exodus Audio. It is tailored to applications that require high output in the lowest octaves. The Tempest-X2 works great in a range of enclosures both sealed and ported. The Tempest-X2 is well suited for Infinite Baffle applications also. This paper will outline our recommendations for how best to utilize the Tempest-X2.

About the Simulations

All simulations are done with our production T/S parameters using LspCAD Pro. It's our experience that these get you close as long as your construction skills are good. If you build a weak, leaky ported cabinet it is likely to be off. If you brace it well, and build it skillfully, you will likely get results very close to the models.

All room simulations are done with an 8.5' (H) x 18' (W) x 21' (D) room with the sub position near a corner, offset by a meter or so. The listening position is centered on the width of the room 2/3 back and showing a seated (39") listening position. All room calculations are done with 1/6th octave smoothing and normalized to 1M. Don't take room simulations too seriously, they vary considerably room to room but this give a GENERAL idea of what to expect.

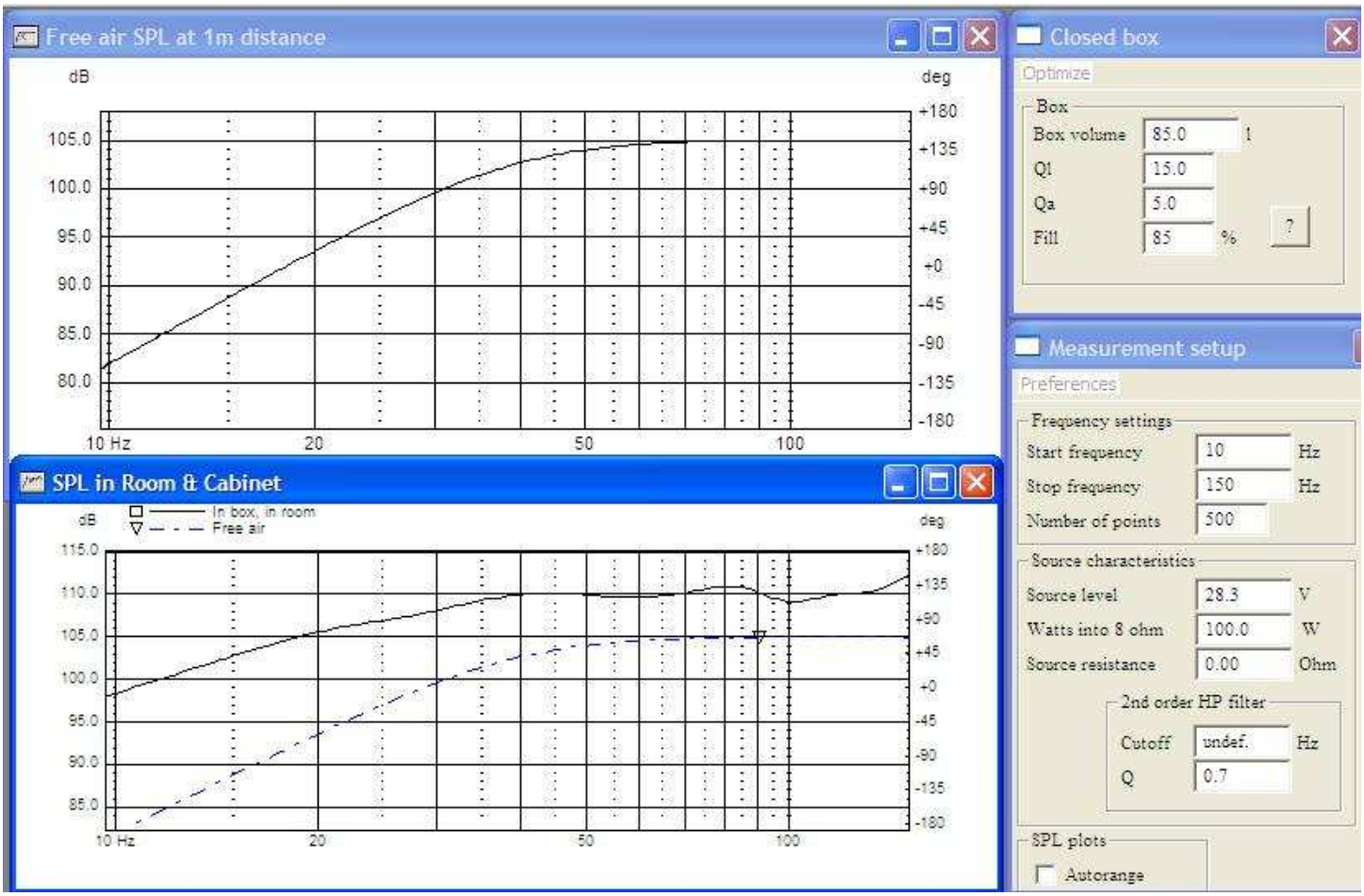
Sealed Enclosure Designs

Sealed enclosures have a lot of advantages. They are simple to build and make an ideal first time DIY project. They have very predictable low-frequency attributes, low group delay, excellent transient response and good extension into the lower octaves.

Sealed enclosures can be sized to achieve different low-frequency attributes. There are some general descriptions of these attributes that become quite technical. We will keep it simple and recommend a couple enclosures and give you a good idea of what to expect from each.

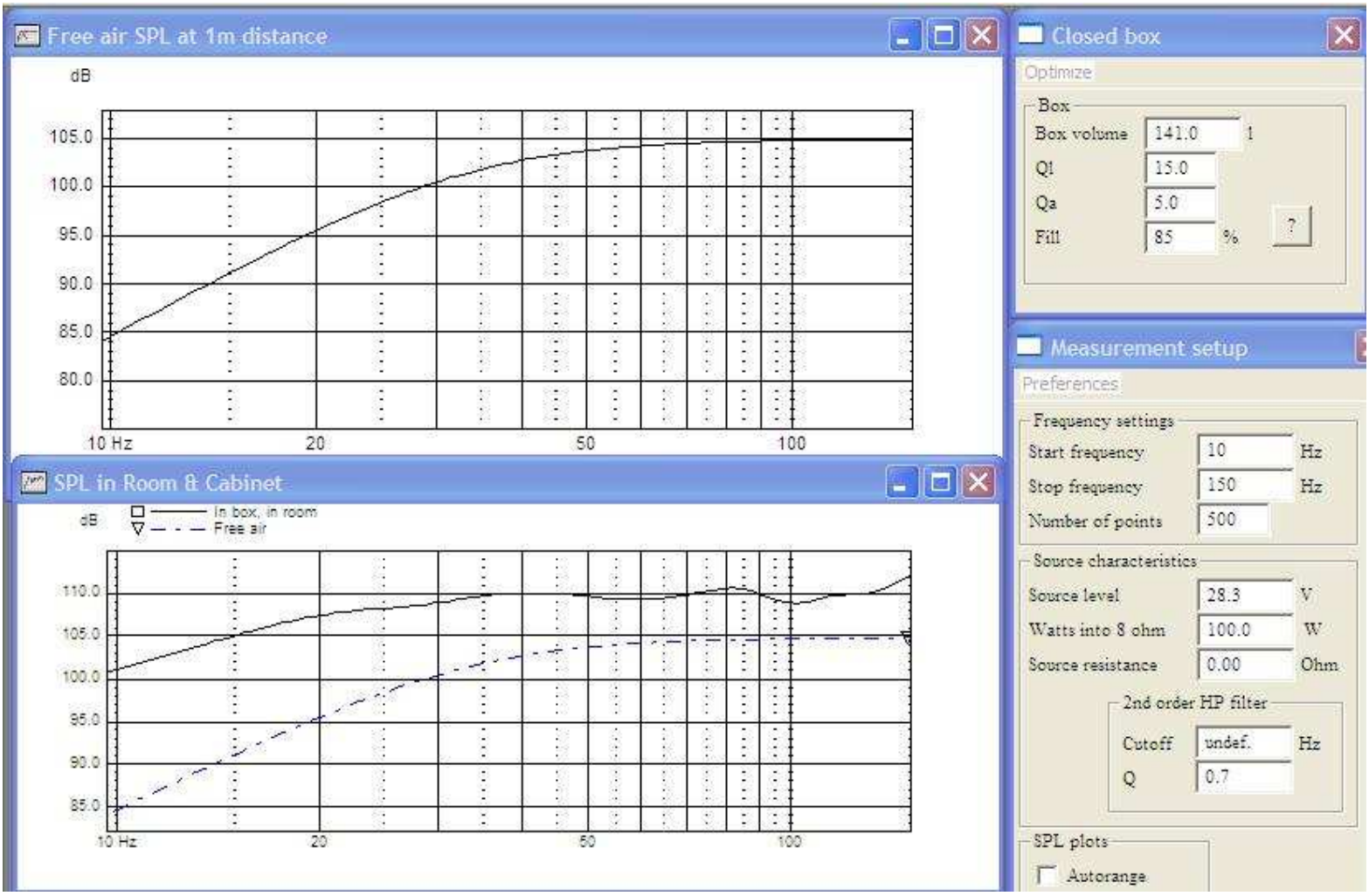
85L (3 cubic feet) with 100% poly-fill

At 3 cubic feet, this is the entry-level point for a sealed Tempest-X2 build. I'd recommend a little boost on the bottom-end, which can be done via a subsonic filter (with high Q), or a single band PEQ that is common in our plate amps. In-room response is good for an enclosure this size. Without EQ, F3 in-room is around 25Hz. This is comparable to most commercial subs which tend to be >30Hz devices. The size of the box is what really limits the extension down low. Companies will tell you that they have a small box subwoofer that plumbs the depths, and it may, but it uses a lot of electronic equalization to get there. I don't recommend >6dB of gain @ 20Hz simply because for each 3dB of gain, you are doubling the power into the device. Use 3dB of gain @ 20Hz in this enclosure, and you will have a very musical sub that reaches deep and has plenty of output. I'd recommend 1000W amp to extend the headroom because down low, you can clip it with the equalization in place.



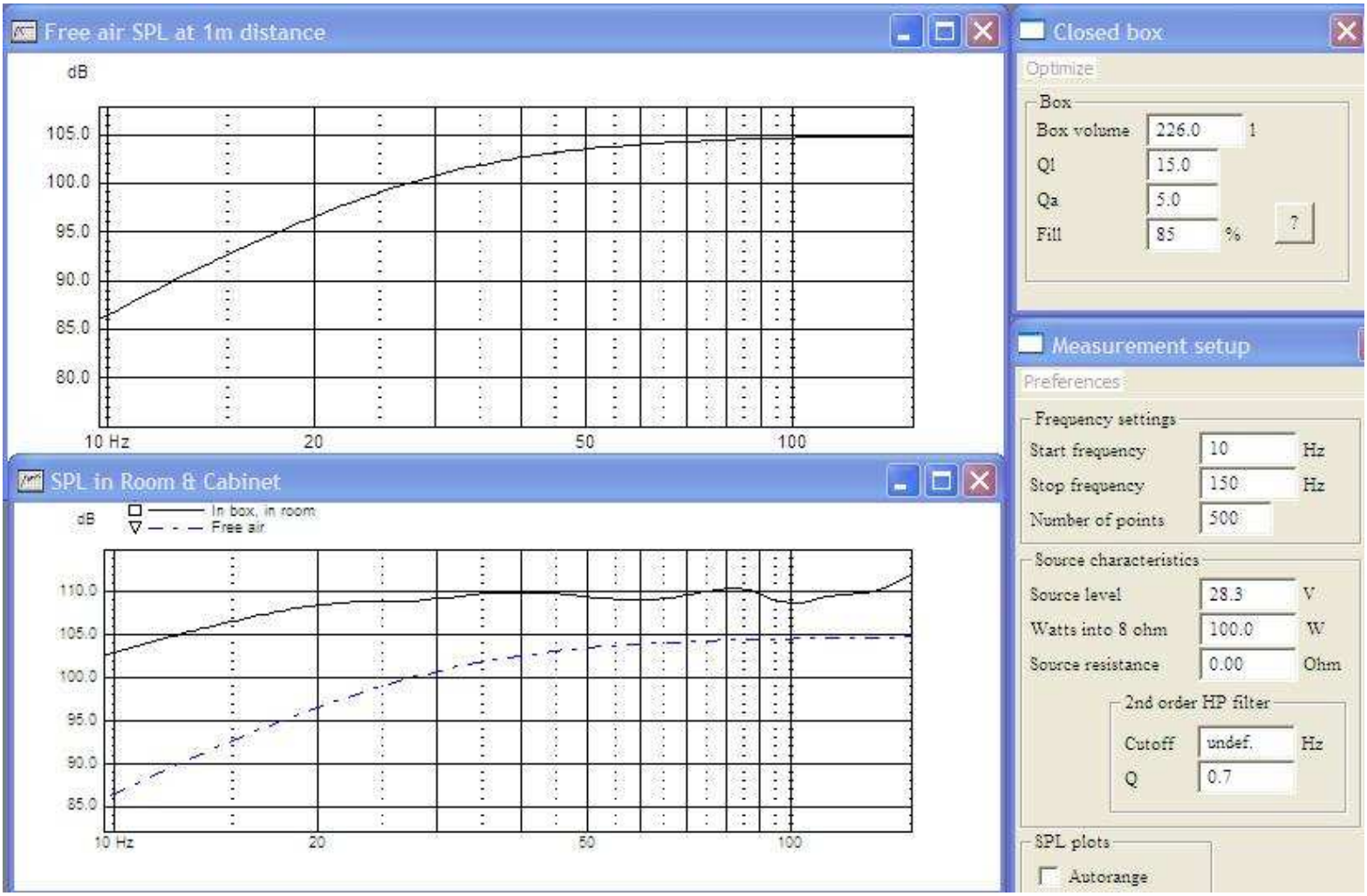
141L (5 cubic feet) Sealed with 100% poly-fill.

If you can accept the larger enclosure, you gain a few dB of output @ 20Hz compared to a 3 cubic foot enclosure. The less you have to equalize the system, the more headroom you will have and the less power needed to drive the subwoofer at lower frequencies. That is a good thing from an engineering standpoint, because you have less power compression, and less overall stress on the driver. This box may or may not need any equalization; depending on how much room gain you have in your particular installation. This represents a good compromise between size and extension with an in-room F3 of around 18-20Hz. We recommend either a 500W or for more headroom, 1000W plate or pro-amp. Since you don't need a subsonic filter, any amplifier with the appropriate power will work.



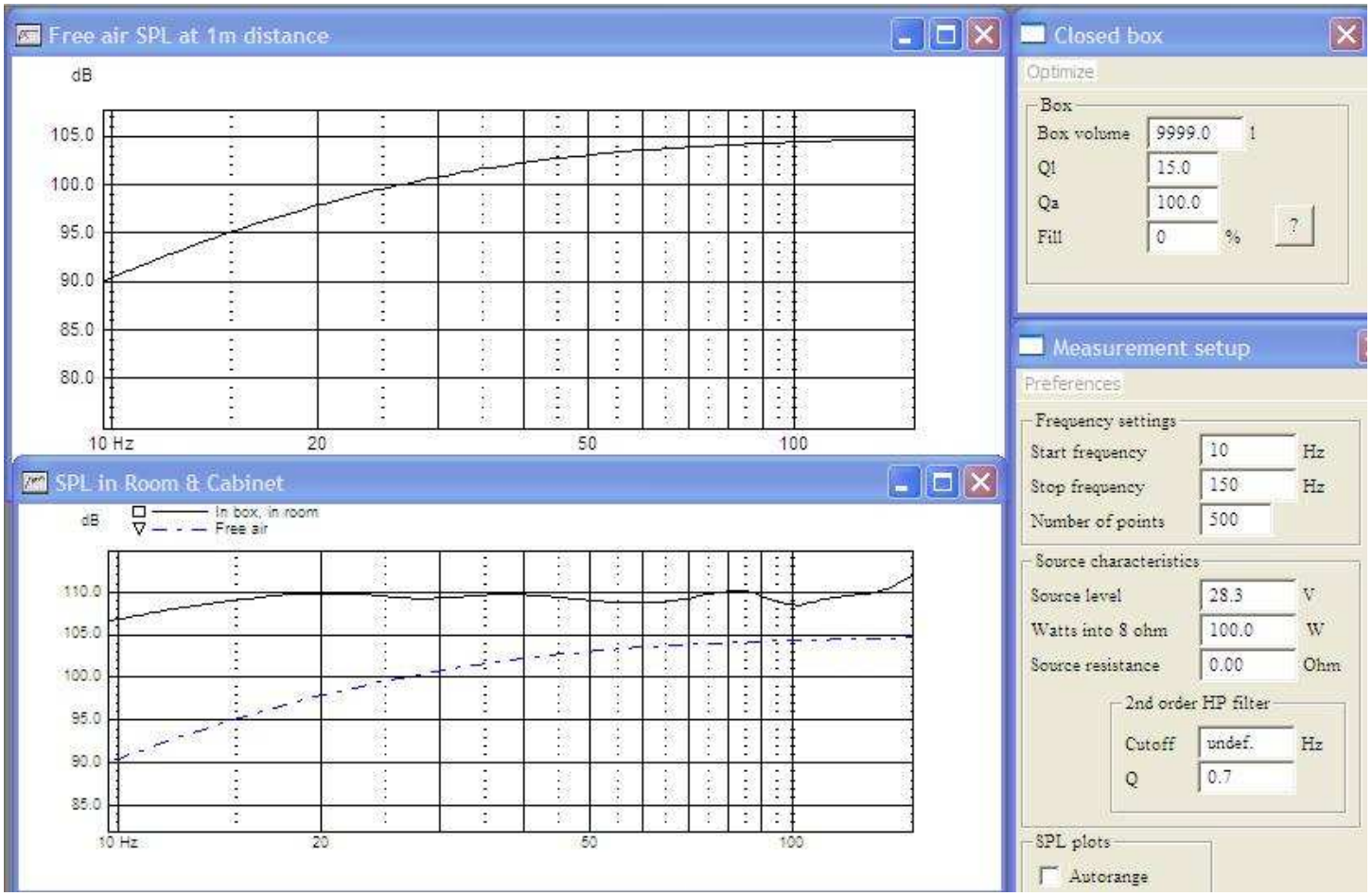
226L (8 cubic feet) Sealed – 100% fill

If you build it big, you get lots of deep natural bass. The effect of a larger enclosure is that the subwoofer becomes more efficient at lower frequencies. There isn't a hard and fast line where this happens; it just continually gets more efficient at lower frequencies. The box, not the driver determines this behavior contrary to what many well-intentioned enthusiasts will tell you. This sub plays deep and any 500W-1000W amplifier will provide exceptional performance without the need for equalization, or subsonic filters.



Infinite Baffle Sealed

An Infinite Baffle subwoofer is really nothing more than a sealed design, with an almost infinitely large box. They are characterized by great extension and modest power requirements. Stealth builds where the drivers are hidden from the listening room are easy to achieve and they can offer stunning bass when done correctly. Typically, you use a pair of drivers in a manifold that exits into the listening room. The rear of the driver exits into an adjoining space like a garage, attic etc… Only about 500W or less per driver is needed in these types of applications. Bass extension is down into the single digits with a typical room-gain curve.



Ported Enclosures

Everyone loves to get something for nothing. Most of the time it's an illusion, you don't get anything for free. With ported subs, it's ***almost*** true. You can significantly extend the bandwidth of your sub with a port. You gain a good half octave or more of extension and at the lower frequencies you can achieve higher SPL at lower distortion. This is the reason so many commercial subs use ported alignments, its all about output.

Of course it isn't really free. Ports have their disadvantages too. They require careful design, sizing the port to the application. Subwoofers with lots of output need ports sized to match their output. If you build them undersize, they will chuff, make noise and performance will suffer. Done right though, ported subs can provide great performance.

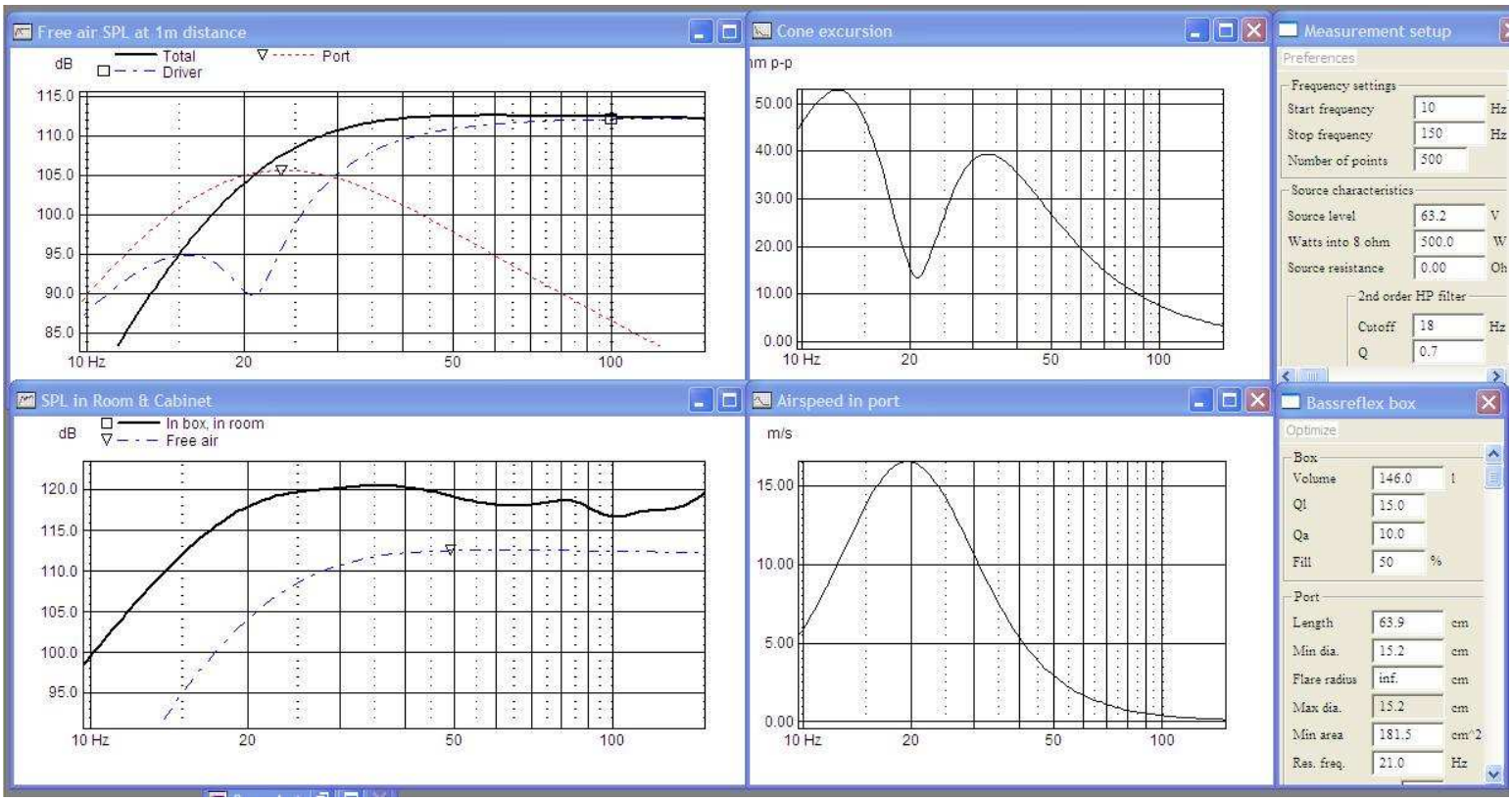
A word about ported subs, they are easier to damage. Below the port tuning frequency the driver unloads. Its not protected by the "air cushion" like a sealed design. As a consequence, it's a good idea to use a special filter on ported subs. This subsonic filter will help protect the driver from ultra-low frequencies that it just cannot reproduce. We recommend plate amps, that are designed for ported subwoofers and that have the appropriate filter in place for ported builds. Follow our recommendations, and you will get great results.

The other consideration with ported subs is of course the port itself. Ports for high output subs need to be large. Large ports can pass lots of air, providing massive output. Small ports cannot. The other issue that we have is that as a port is increased in diameter, it needs to be longer to maintain the same tuning frequency. We run into some problems with high output subwoofers and small boxes due to this relationship. There is no such thing as a high-output ported sub, in a small box where the tuning frequency is anywhere near 20hz. The math just doesn't work out in our favor. Due to this, our ported designs tend to be larger than the sealed designs, with the smallest HT sub, in the 5 cubic foot category.

146L (5.1 cubic feet) Ported and tuned to 21Hz with 40oz. Poly-fill

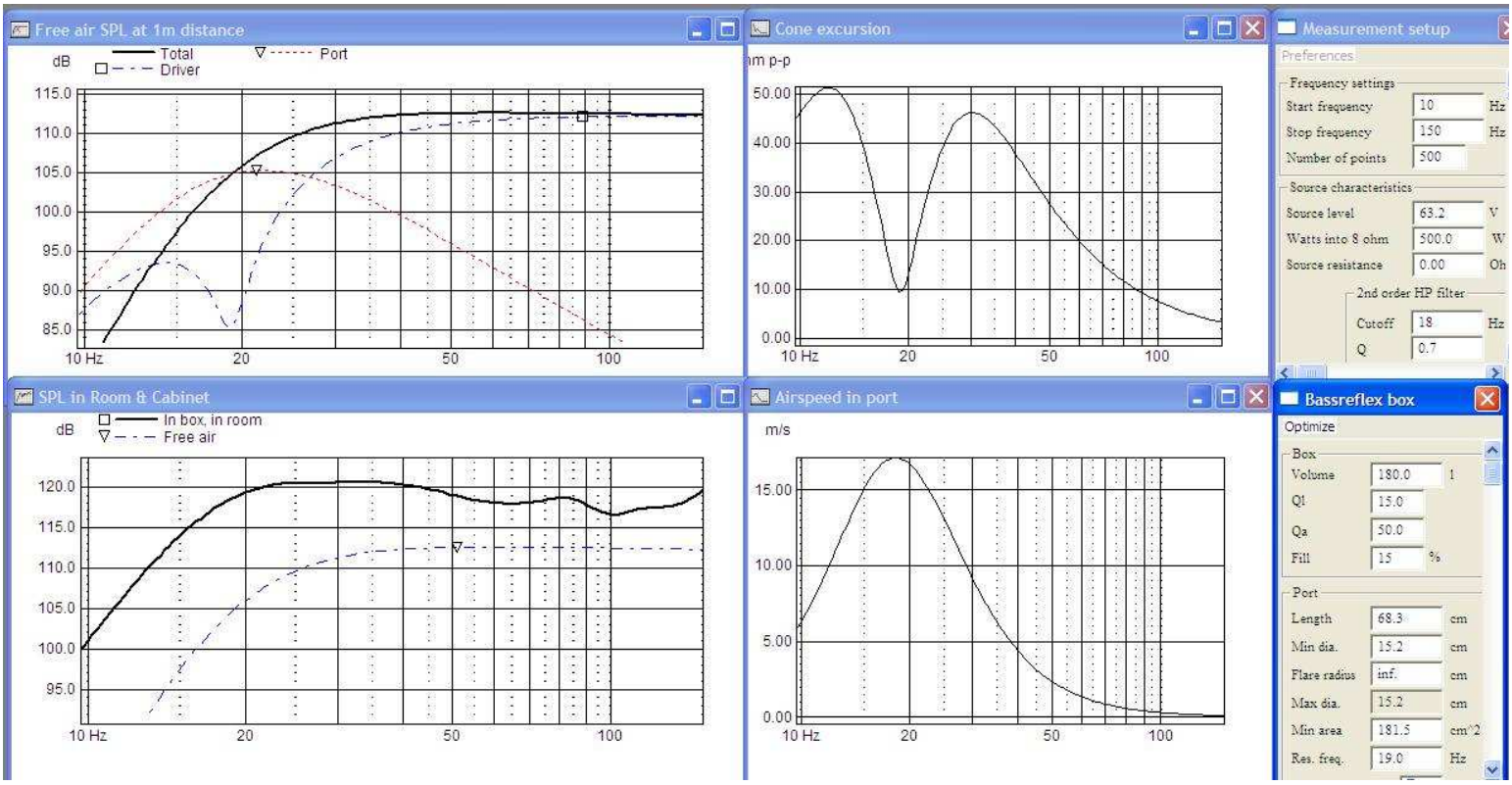
This is a reasonable sized sub that can be built out of a single sheet of 4x8 MDF (about $20). It has great extension providing exceptional output in the first octave. These ported designs are a little "hotter" than the sealed designs in that they have more 1st octave output and rely less on room gain for their output from 20-40hz. For Home Theater, this is the bomb because most of the special effects and bass in movie sound tracks lies in the 25Hz-60hz range. When you keep in perspective that most movie theaters have sound systems that are not capable of <30hz output, this will provide most HT enthusiast with output far superior to what they hear from their local theater experience.

As with most ported subs, this needs to be used with an amplifier that has the proper subsonic filter, in this case, we are using a 18Hz subsonic filter provided by our recommended plate amplifier, the 500W or 1000W models.



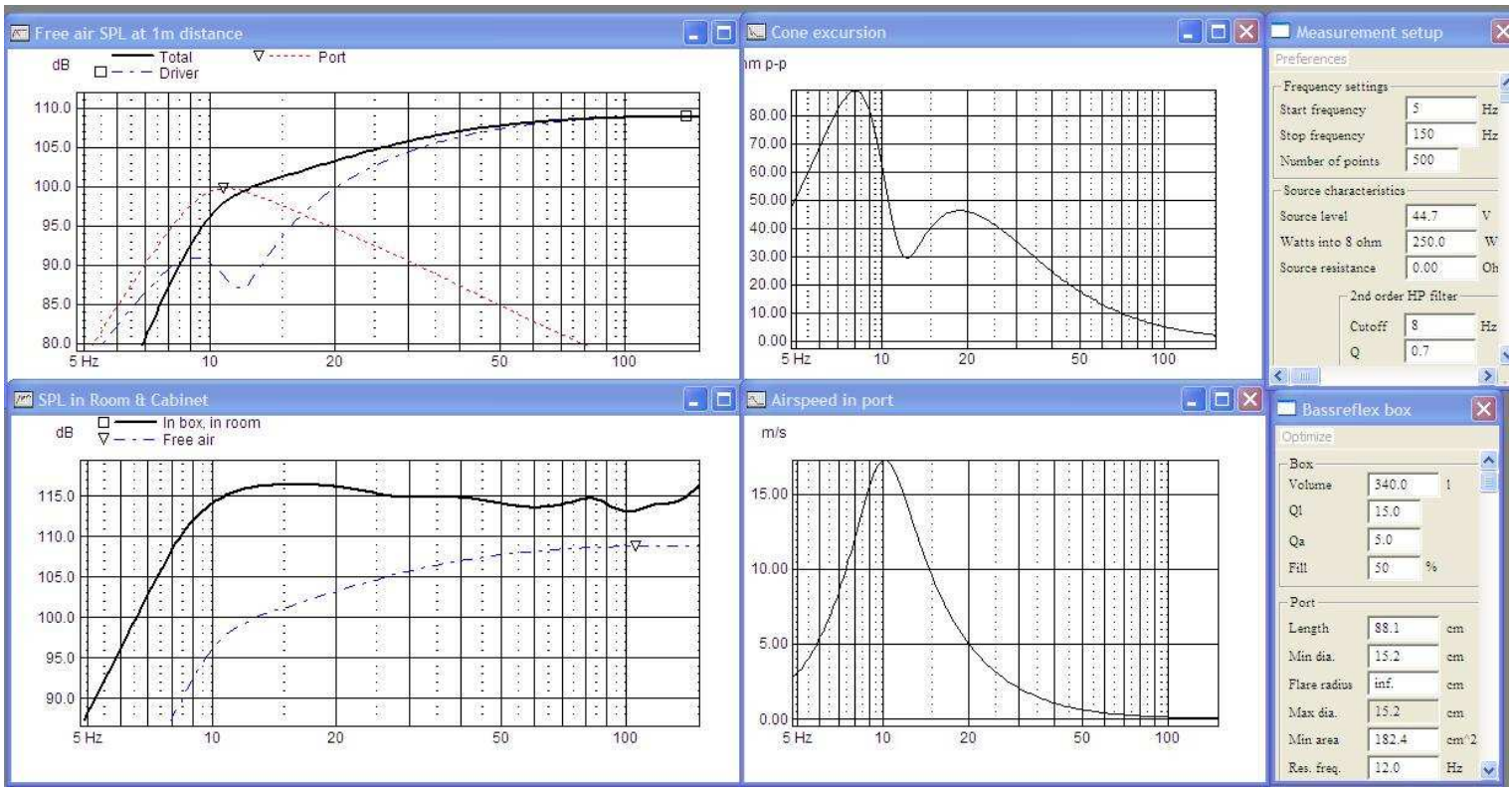
180L (6.35 cubic feet) Ported and tuned to 19Hz with 15% poly-fill

As you increase the box size, you can fit larger ports and still tune it relatively deep. You also gain a little extension and it requires less power for the same SPL down low. This is not drastically better than the 5 cubic ft. enclosure but it is an improvement in both extension, and with a larger port, output.



LLT (340L – 12 cubic feet) Tuned 12Hz

This is a large build, using a low tuning frequency and no subsonic filter. This is a design popularized by Steve Callas of Home Theater Shack fame. It is similar in concept to an EBS alignment and the general idea is that you use the port extremely low in frequency so that no subsonic filter is needed. The port is of little value with output >20Hz so most of the output is handled by the driver, rather than a combination of driver + port in most standard ported designs. This sub goes deep, but for the 20-40Hz range, it will have less output than a sub with a higher tuning frequency. For deep in-room response though, the only competition is from IB subs. If you can live with the size, this is an awesome HT sub that can plumb the depths unlike any commercial subwoofer available. It will sound less exciting, due to the loss of output 20-40Hz but if you don't need the extra output, or can build multiple subs (one in each corner), you can have the best of all worlds. Due to the large enclosure size the port can also be upsized such that it won't compress as much at full output. Since the tuning frequency is at 12Hz, most of the output is significantly lower in SPL compared to the content above 20hz. In most cases, port chuffing is a non-issue.

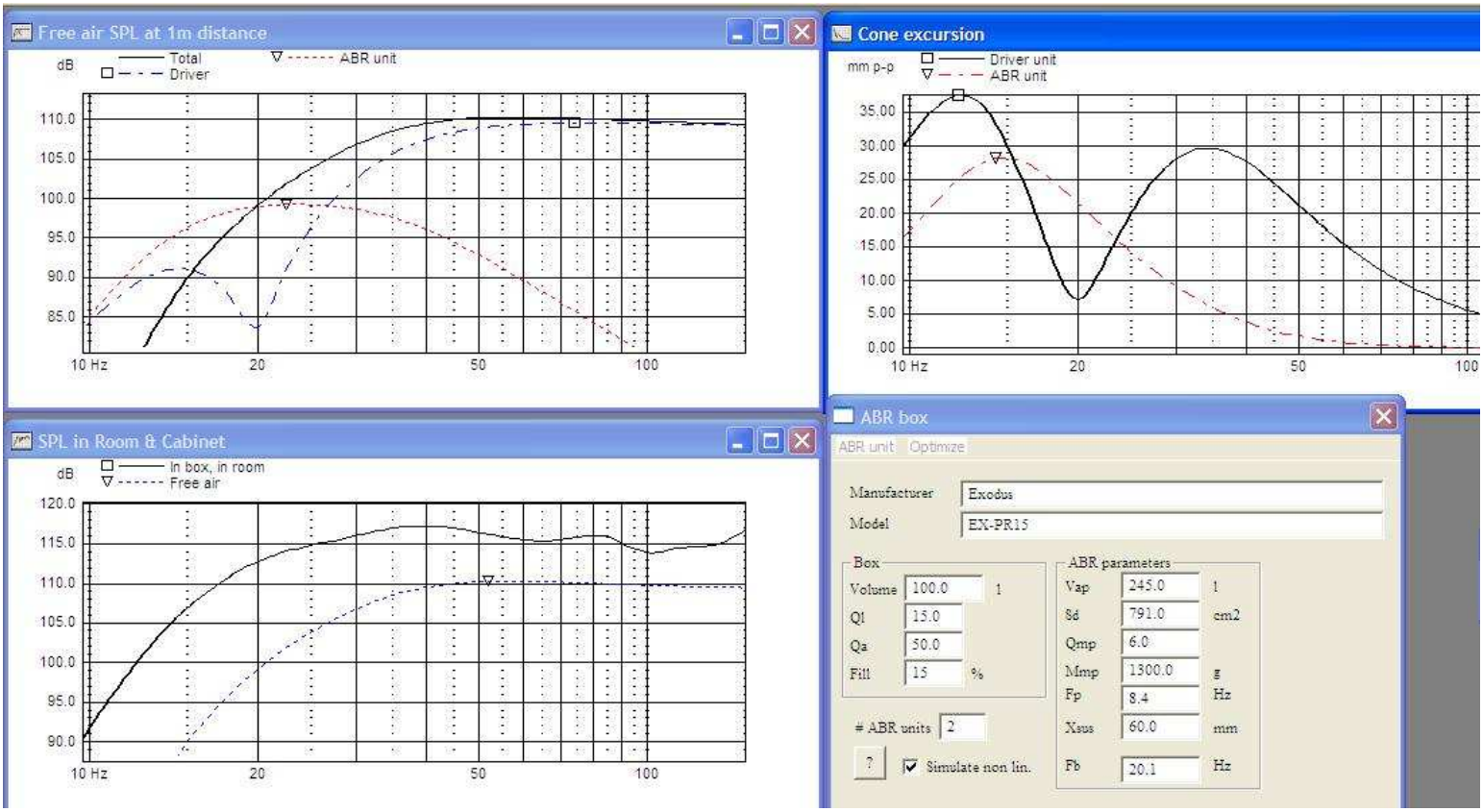


Sonotube (round concrete forms) make the idea enclosure for LLT designs. They don't require bracing, are much lighter than MDF and their form-factor, makes very efficient use of floor space. A 20" Sonotube, 72" tall would be large enough for this example.

Passive Radiator Designs

Passive Radiators are another form of resonant enclosure similar in concept to a ported design. Rather than having a port, with an air chamber resonating to give the output, the passive radiator acts in the same way. The advantages of the Passive Radiator, is that it doesn't require enclosure space or volume (the enclosure can be smaller) and a properly sized Passive Radiator won't chuff, make noise or compress at its limits. They still have limitations, but by proper sizing and usage, they have the potential to outperform undersized ported designs at high output levels and keep box size smaller relative to ported builds. The downside? You have to buy passive radiators which are almost always more expensive than a hole in a box (port).

100L (3.5 cubic feet) with two PR-15s 15% fill – 20Hz tune

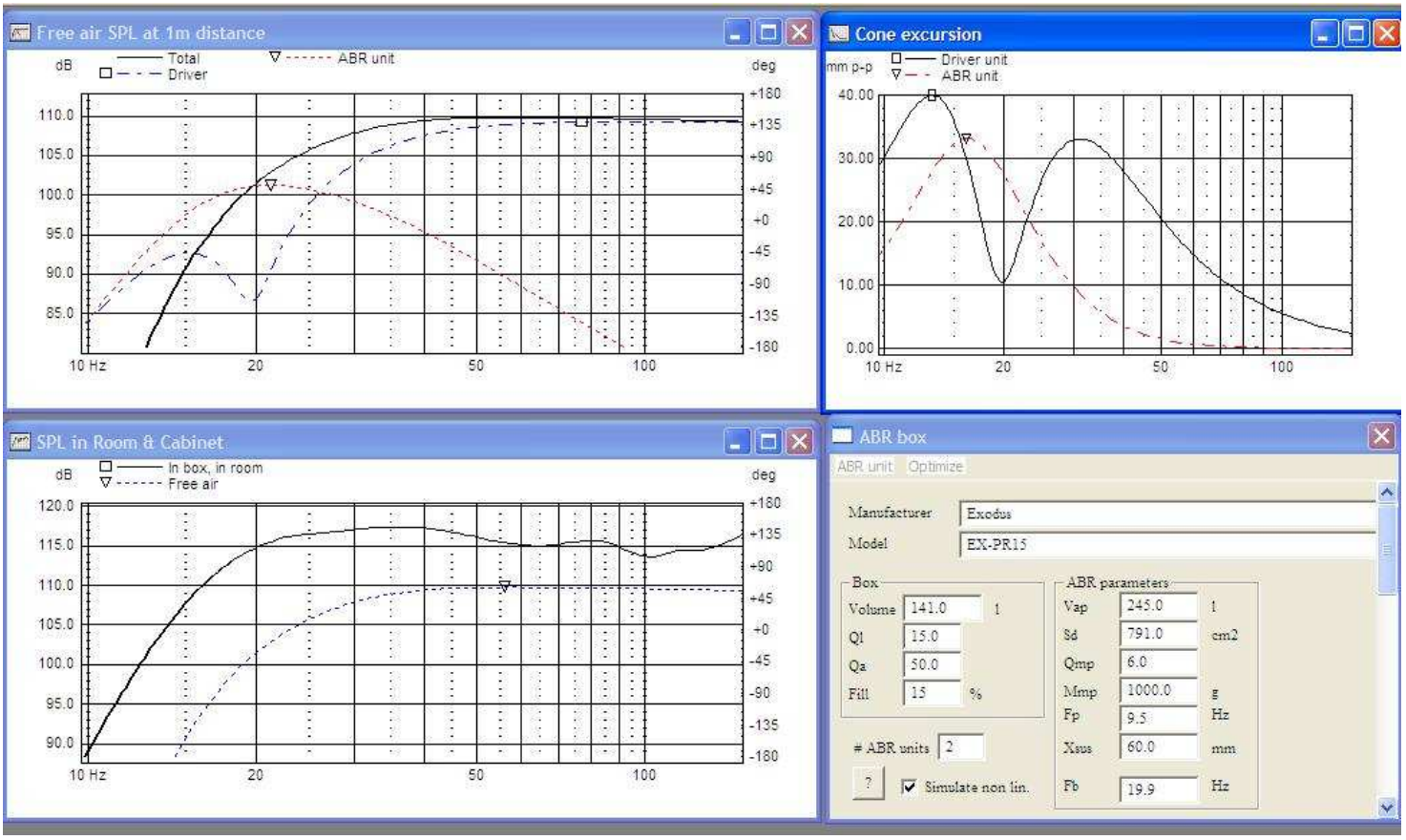


This is about as small as I'd go. Mainly because by the time you stick three 15" drivers on three sides of the enclosure, you are pretty close to 3.5 cubic ft. There is no magic provided by the PR though. Anytime you choose a smaller box, you are giving up bandwidth

down deep and this is no exception. This build uses 15% fill, with a pair of PR-15s, with a total of 1300g of mass on each Passive Radiator. With the recommended 500W amplifier, it has the necessary 18Hz subsonic filter providing protection for the main driver. This has roughly a F3 of 22Hz in-room. You could use a little EQ, maybe 2dB @ 20hz and get slightly better low frequency extension. If you use EQ, we recommend stepping up to the 1000W amplifier.

141L (5 cubic feet) with two PR-15s 15% fill – 20Hz tune

If you are willing to increase the size slightly, you are rewarded with better extension. This design uses the same two PR-15s, with 1000g of mass on each. The same 18Hz subsonic filter is used and the in-room F3 drops into the teens. You will find this comparable to the ported design of roughly the same enclosure volume, as we would expect. You save the volume occupied by the port, and you have no port limitation problems as you would see with the smaller ported designs where we are straddling the port limitations.



180L (6.35 cubic feet) with two PR-15s 15% fill – 20Hz tune

This should be getting fairly predictable by now. Larger enclosure = more extension down low without need for equalization. This simulation is using the same 18Hz subsonic filter used in other builds.