Comparison of Horn Contours

Content

Motivation

In addition to its external dimensions, a horn is characterized by its contour. In the following, we will investigate how different contours behave with regard to radiation.

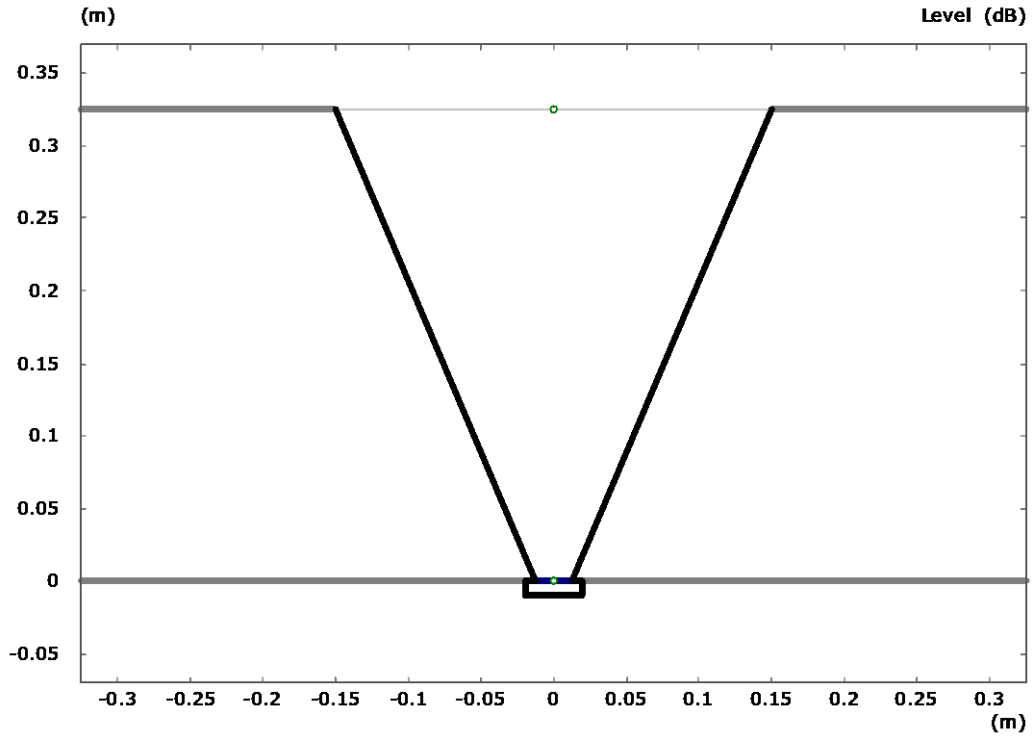
Rotationally symmetrical horns were simulated using BEM. The dispersion behavior has been normalized to 0°. So, it is assumed that the speakers point to the listening position. For each simulation the following diagrams are shown:

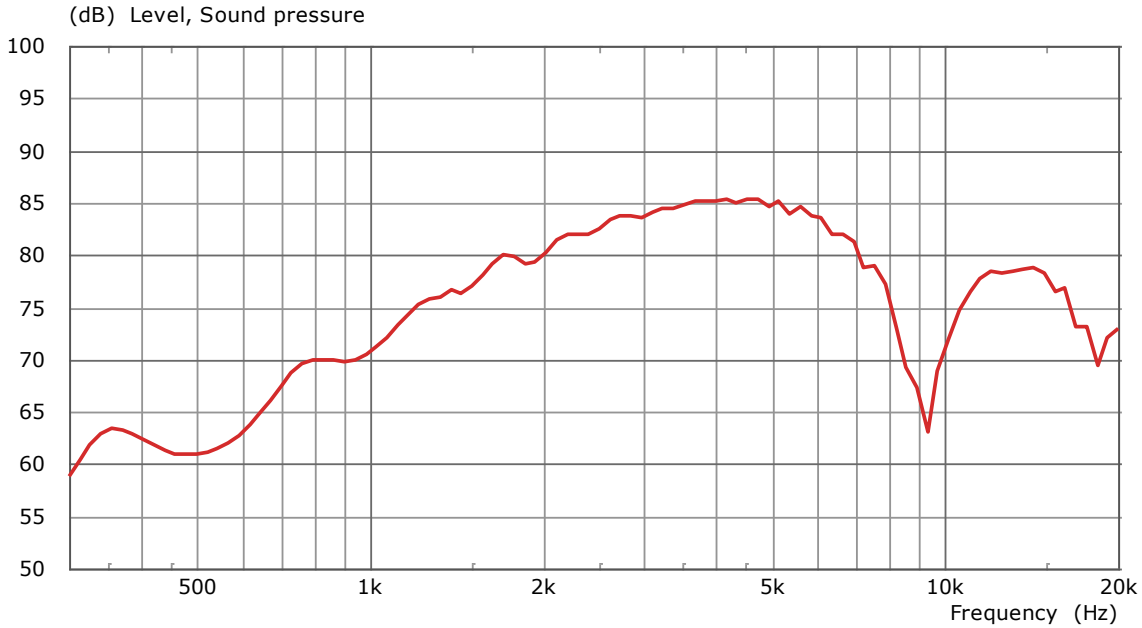
1. Amplitude response at 0°
2. Normalized directvity
3. Directivity index

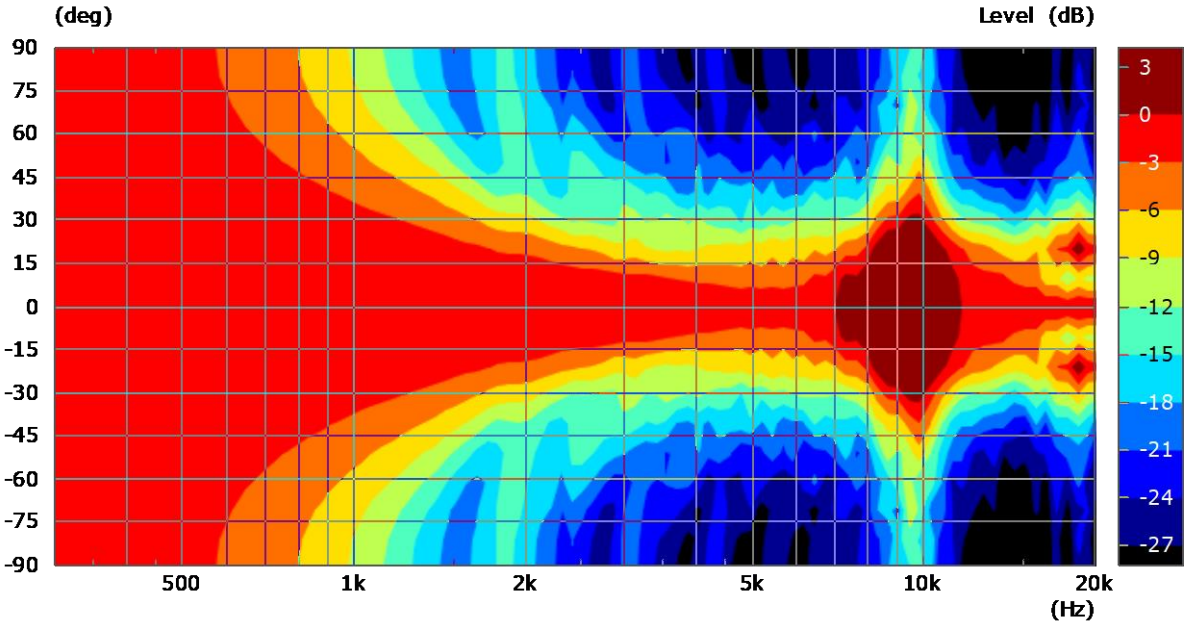
The height and width were kept constant at 32.5 cm and 30 cm respectively. The reason for this is the Tractrix horn, whose formula specifies a rigid relationship between radius and height. Only the hand-optimized contour has been made a little shorter. Manual optimization was carried out iteratively by increasing or decreasing the radius of individual elevation points.

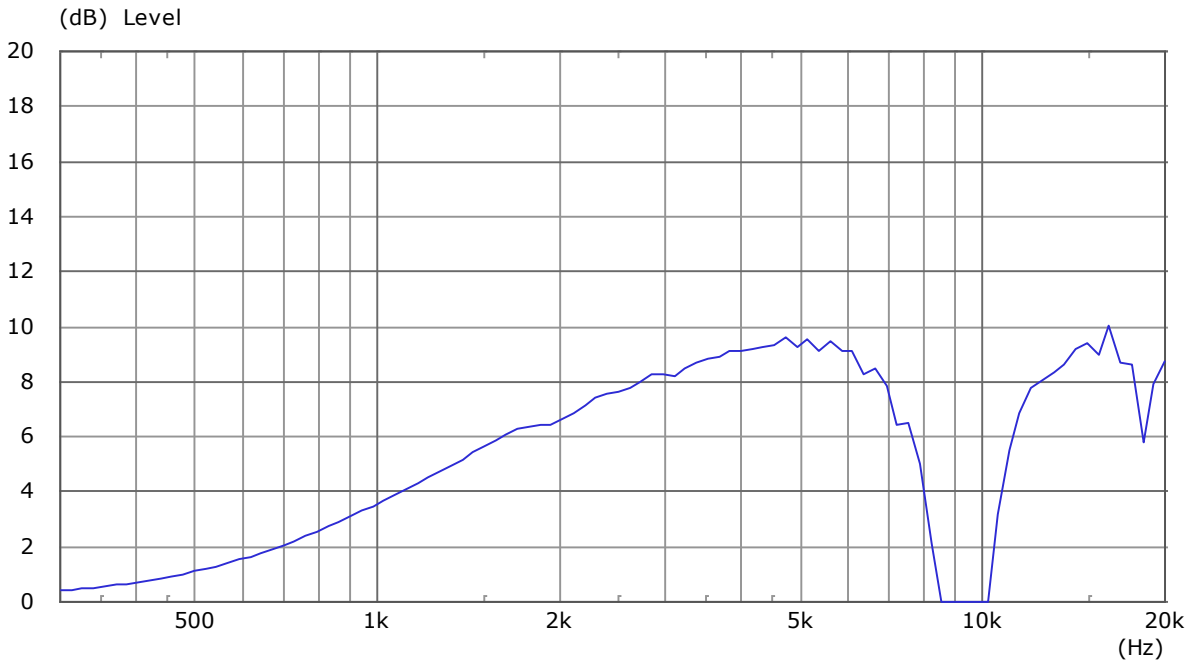
Contours

Conical

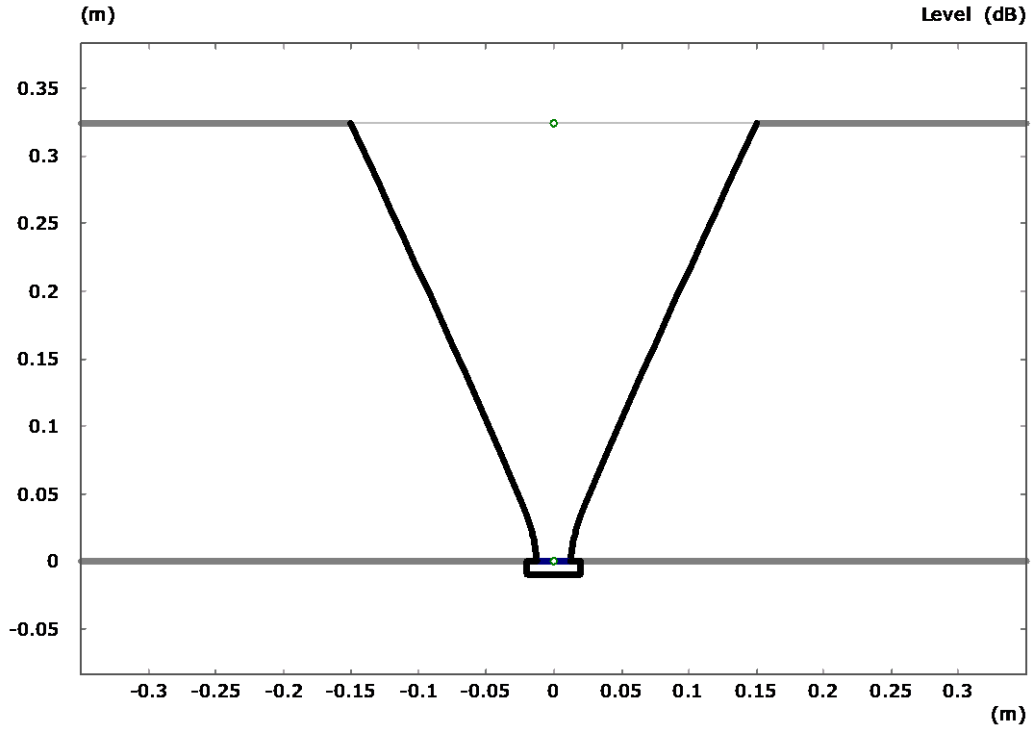


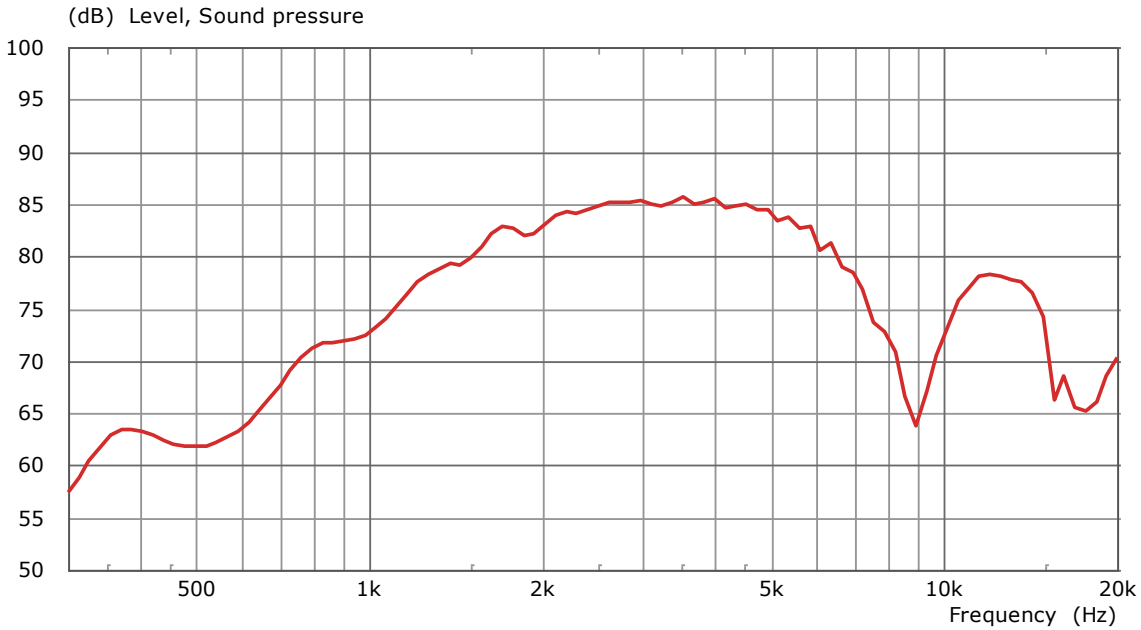


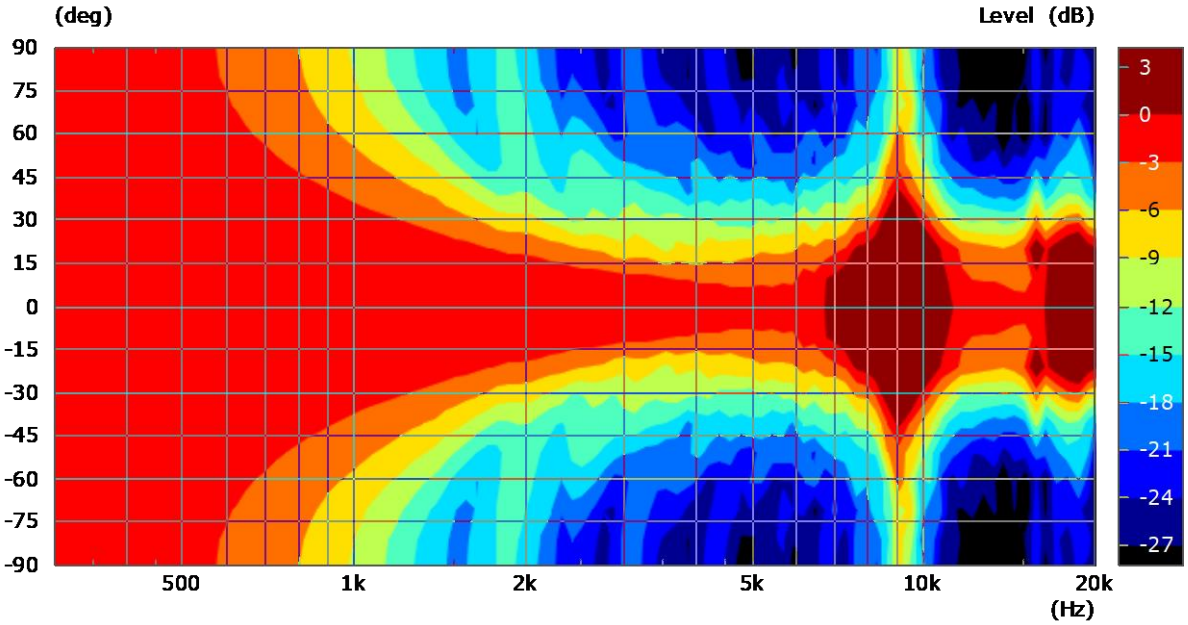

(deg)
Level (dB)
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
3
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
500
1k
2k
5k
10k
20k
(Hz)

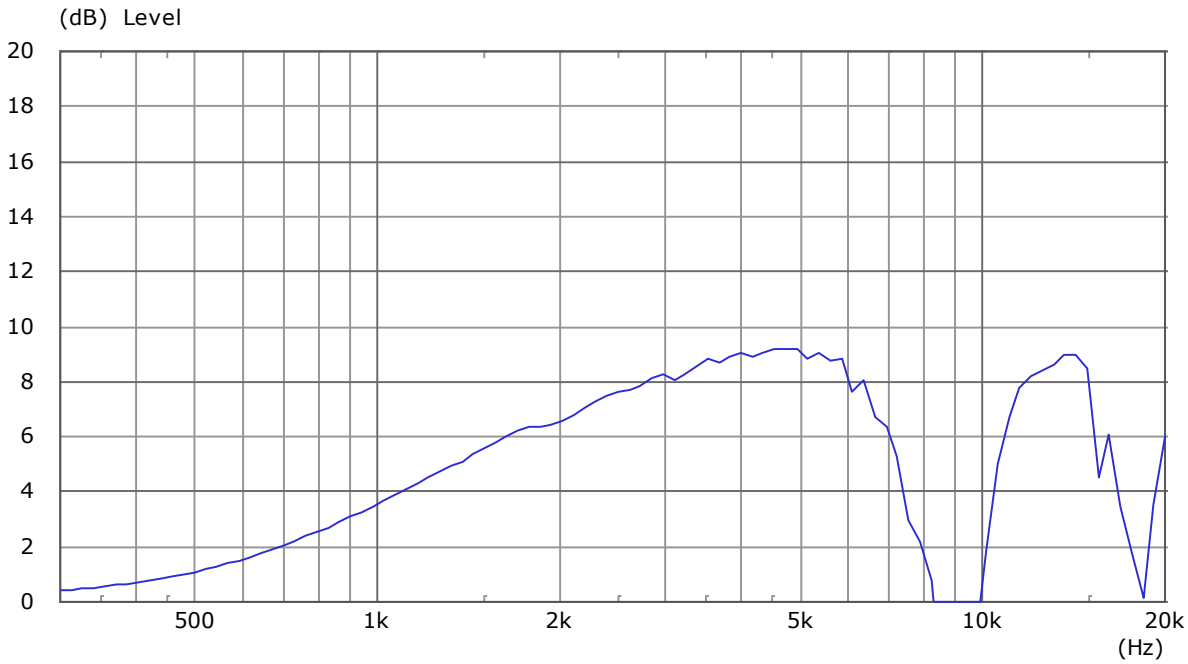

(dB) Level
20
18
16
14
12
10
8
6
4
2
0
500
1k
2k
5k
10k
20k
(Hz)

Oblate Spheroid

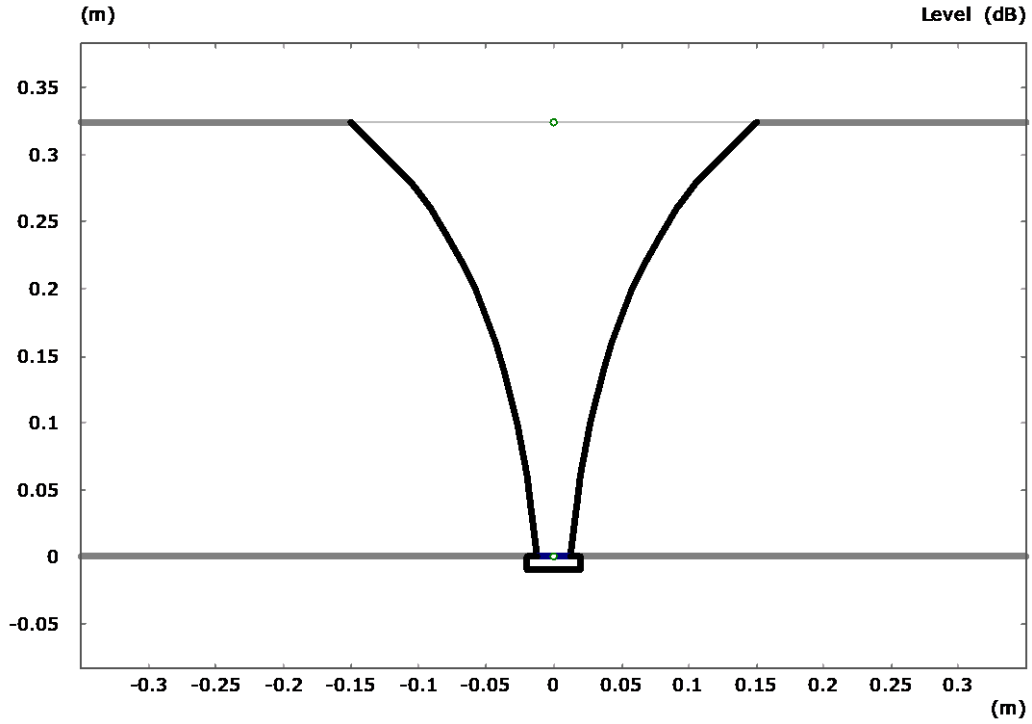


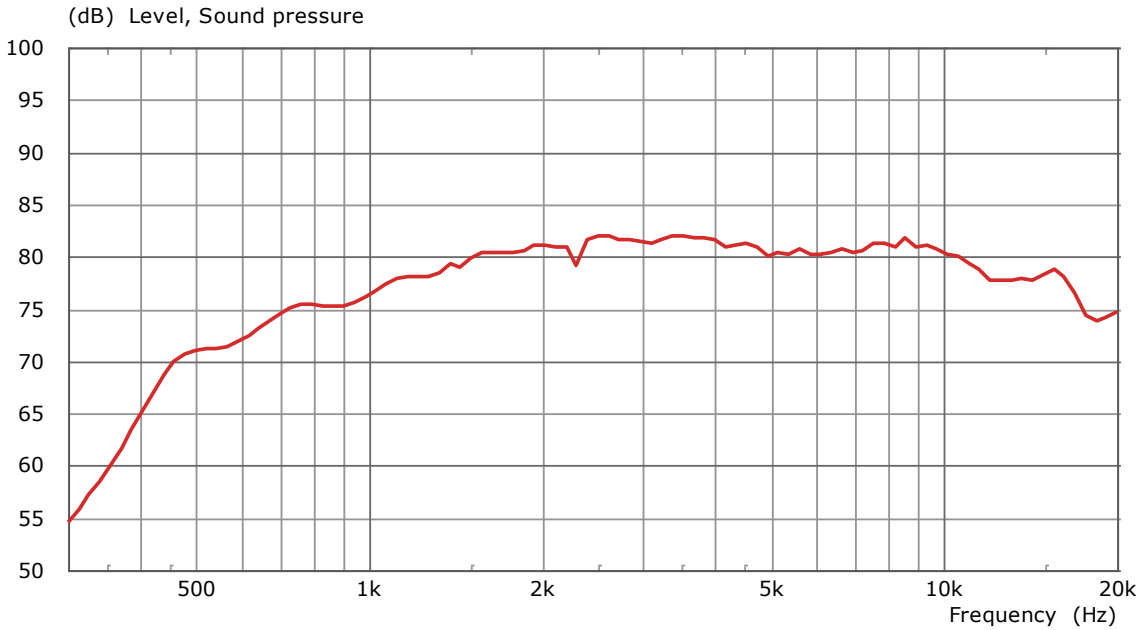


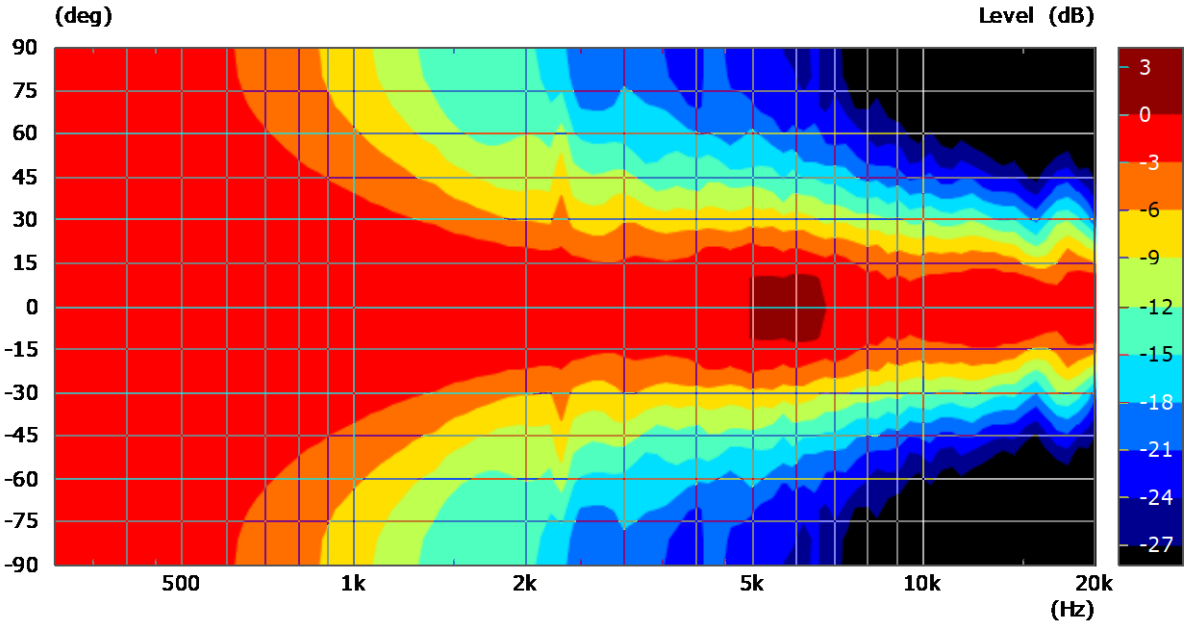

(deg)
Level (dB)
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
3
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
500
1k
2k
5k
10k
20k
(Hz)

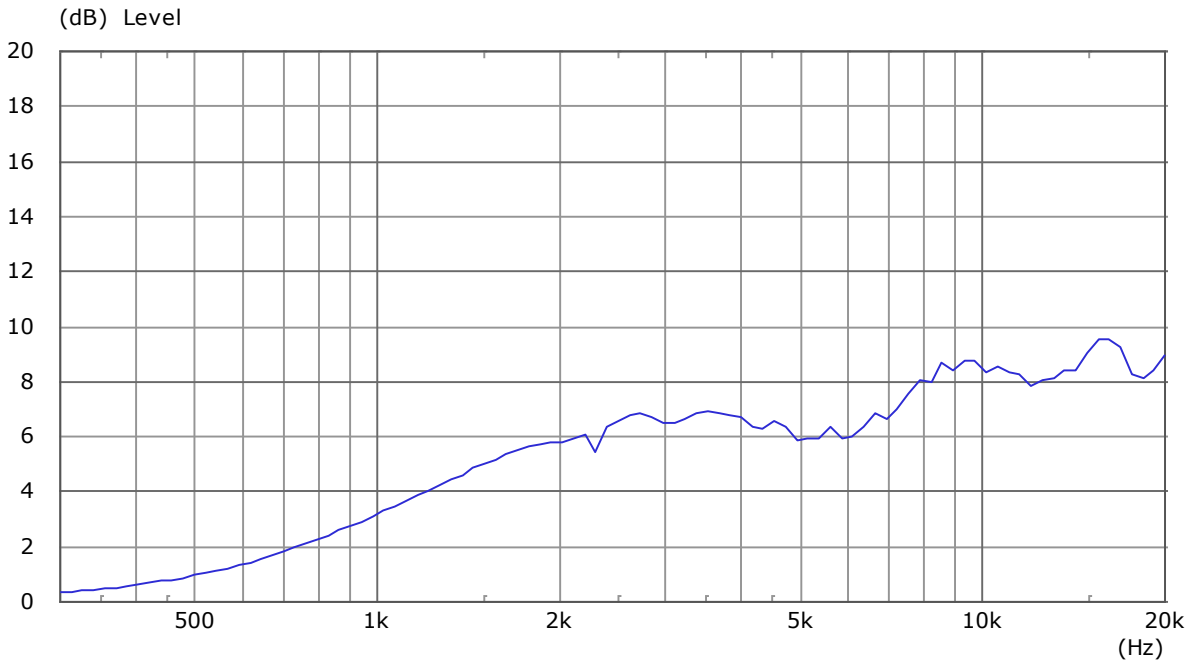

(dB) Level
20
18
16
14
12
10
8
6
4
2
0
500
1k
2k
5k
10k
20k
(Hz)

Exponential

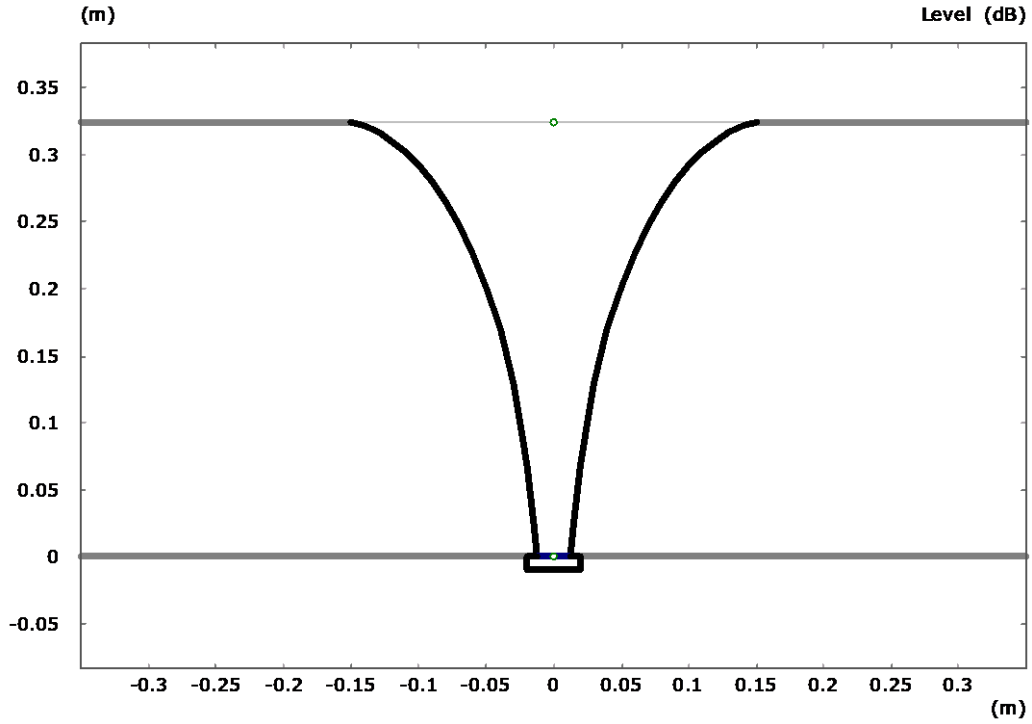


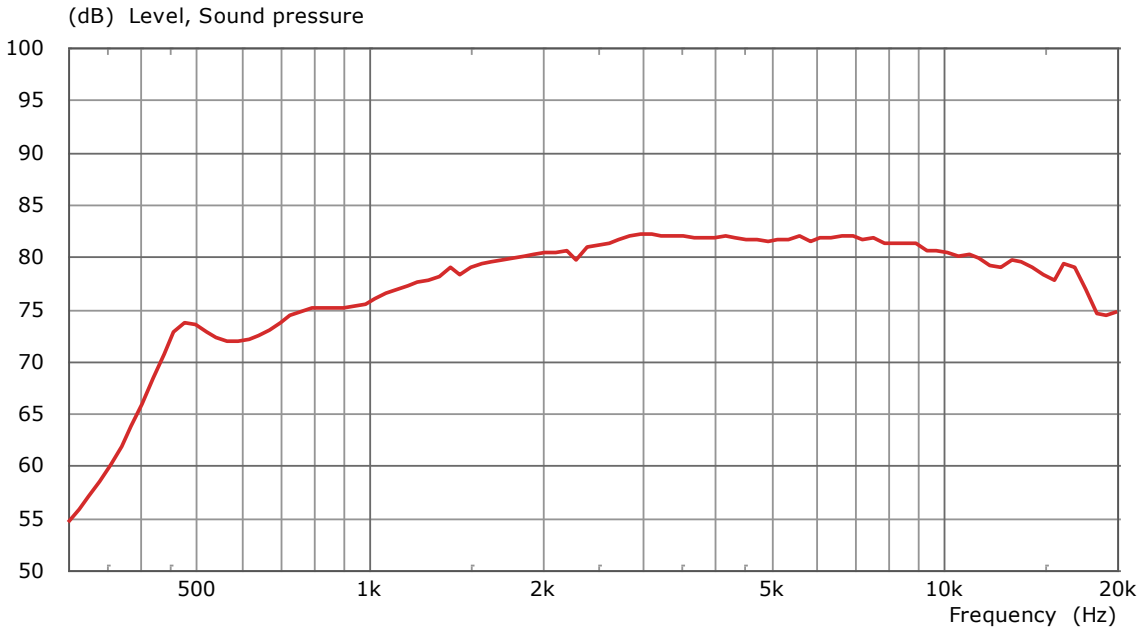


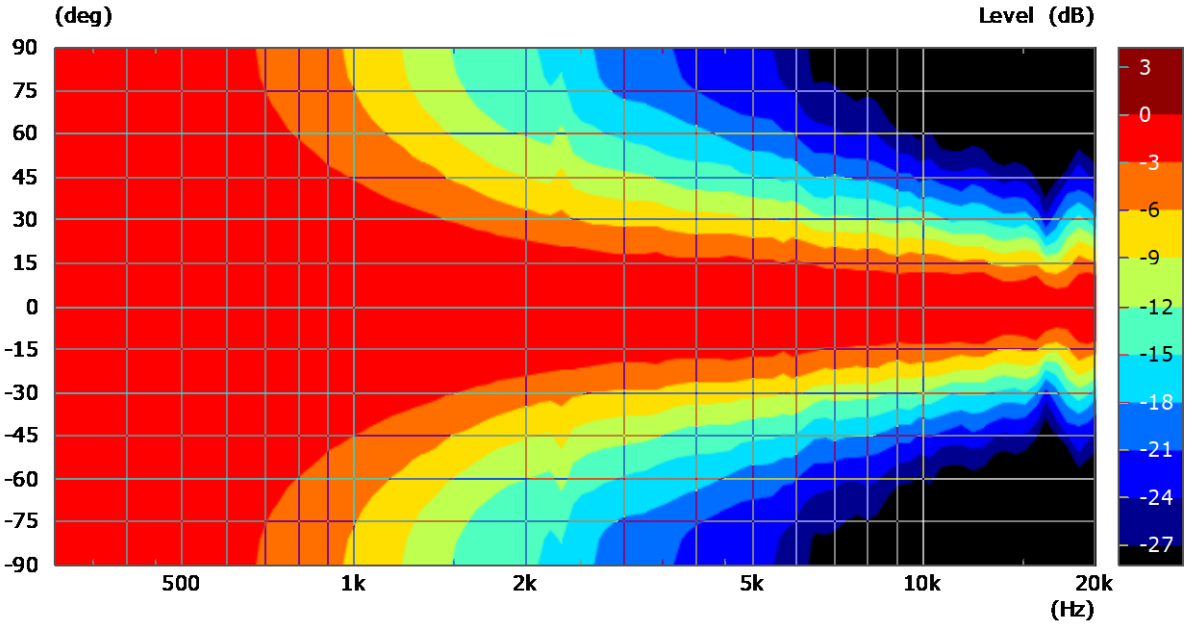

(deg)
Level (dB)
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
3
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
500
1k
2k
5k
10k
20k
(Hz)

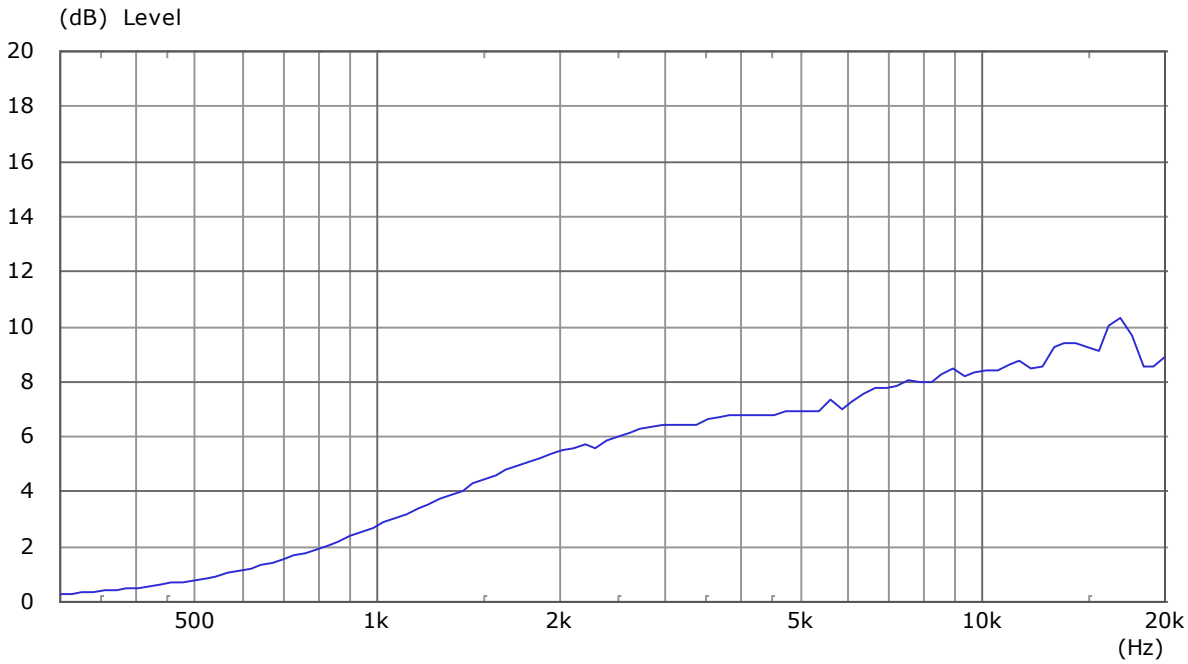

(dB) Level
20
18
16
14
12
10
8
6
4
2
0
500
1k
2k
5k
10k
20k
(Hz)

Tractrix

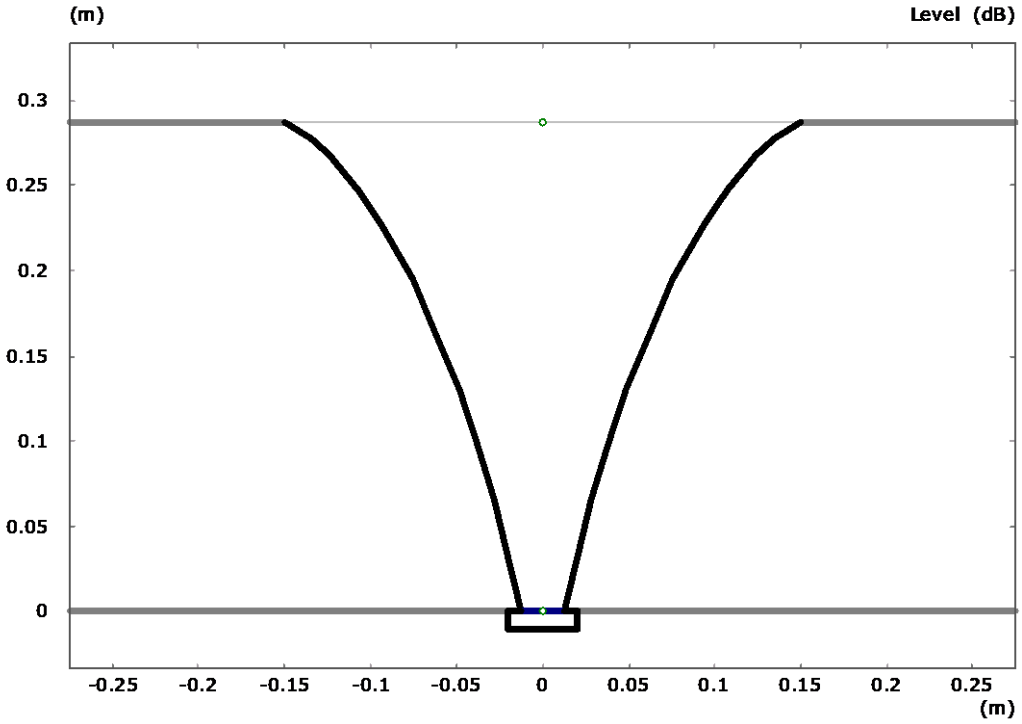

(m)
Level (dB)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.3 -0.25 -0.2 -0.15 -0.1 -0.05 0 0.05 0.1 0.15 0.2 0.25 0.3
(m)

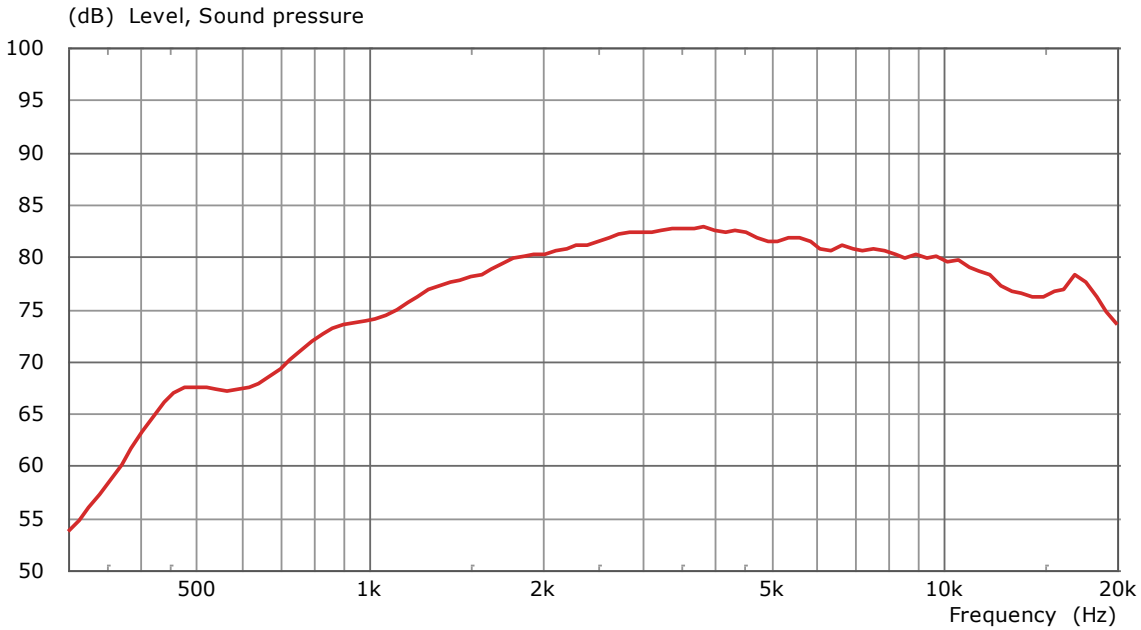

(dB) Level, Sound pressure
100
95
90
85
80
75
70
65
60
55
50
500
1k
2k
5k
10k
20k
Frequency (Hz)

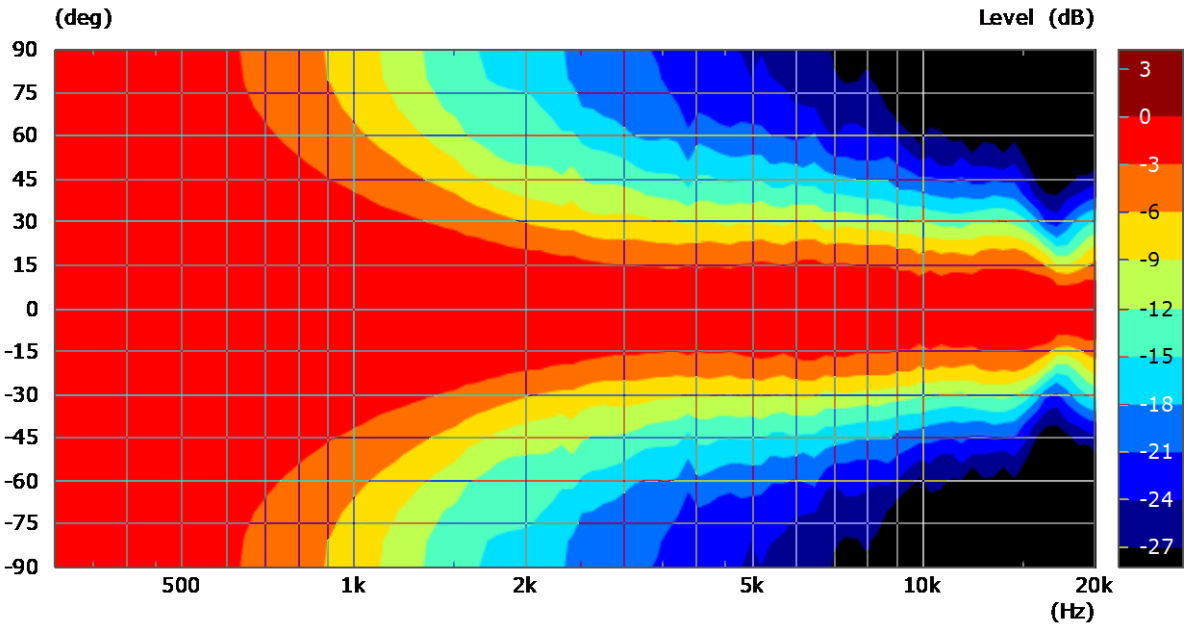

(deg)
Level (dB)
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
3
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
500
1k
2k
5k
10k
20k
(Hz)

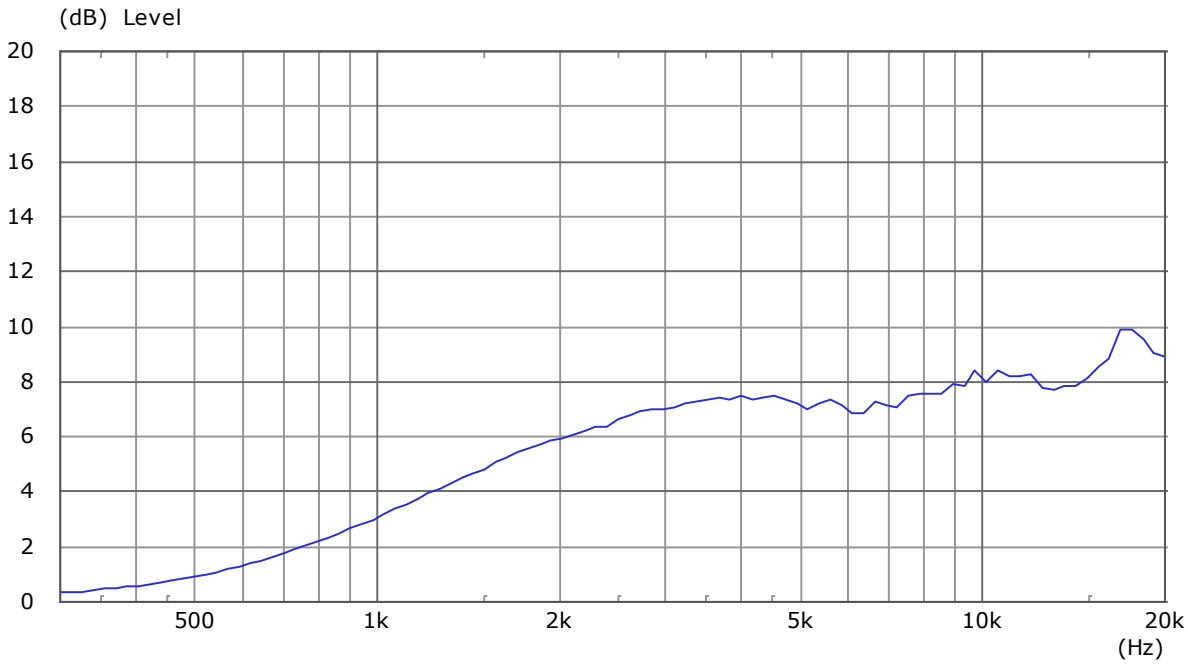

(dB) Level
20
18
16
14
12
10
8
6
4
2
0
500
1k
2k
5k
10k
20k
(Hz)

Hand-optimized






(deg)
Level (dB)
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
3
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
500
1k
2k
5k
10k
20k
(Hz)


(dB) Level
20
18
16
14
12
10
8
6
4
2
0
500
1k
2k
5k
10k
20k
(Hz)

Result

None of the formula-based contours exhibit constant dispersion. The conical and oblate spheroid also show strong dips at 0°, which lead to a widening. To be fair, it must be said that oblate spheroid horns are not listened to at 0° and thus the standardization has little practical relevance.

The hand-optimized contour shows how the dispersion can be improved compared to Exponential and Tractrix. The optimization was aborted at a certain point. If more time were invested, an even better result could certainly be achieved.