ARTA EQA scheme #3 - Interim evaluation (11/2022)

1. Foreword

Acoustic measurement technology is a prerequisite for loudspeaker development above a certain level. A measurement by one person, however, only includes a set of hardware and know-how - incorrect results due to incorrectly chosen methodology, operating errors, hardware defects, environmental influences, etc., can never be completely ruled out, even when using high-quality hardware and meticulous, informed work.

The community project "ARTA round robin" offers the possibility to create your own, at a fixed / The expectation is that a statistical mean with good coverage of multiple data sets will emerge which can serve as a reference for "correct measurement". The expectation is that a statistical mean with good coverage of several data sets will emerge, which can serve as a reference for "the correct measurement" - thus either giving the participant confidence in their own measurement data, or showing them where there is room for improvement.

Comprehensive information on EQAS #3 (program, test object, ...) can be found in the corresponding info sheet:

ARTA round robin #3 info sheet download (backup link)

2. Participant

The interim evaluation 11 / 2022 includes 5 data sets from 4 participants:

1. *Swany*

Software: REW

Hardware: miniDSP Umik-2

Measurement methodology: Tripod measurement fenestrated far field, joined to non-Bafflestep-corrected
"simple" near-field measurement (microphone tip between diaphragm and port)

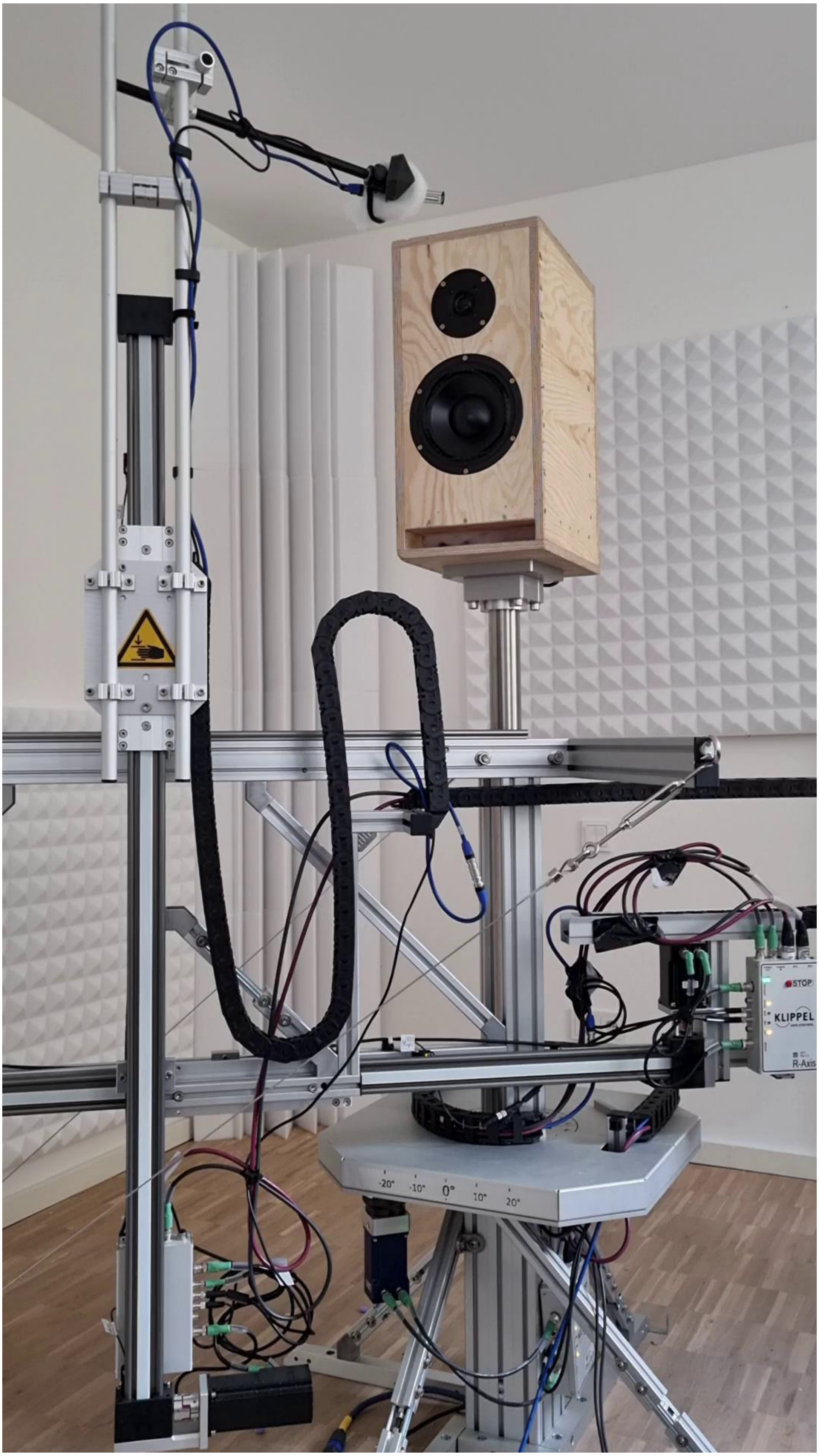
Measuring environment: Indoor, living room

2. *Dausend Acoustics*

Software: Klippel dB Lab

Hardware & measurement methodology: Klippel Near Field Scanner, with microphones
GRAS 46 BE for NFS Scan & MTG MK255 for in-situ distortion measurement

Measuring environment: Indoor


STOP
KLIPPEL
R-Axis
-20°
-10°
0°
10°
20°

3. Ste_Pa

Software: ARTA

Hardware: Microphone Img ECM-40, Preamp Behringer Shark DSP 110, Interface EMU-202

Measurement methodology: GPM (Ground Plane Measurement) fenestrated far field, joined to bafflestep corrected combined near field measurement

Measurement environment: Indoor, living room; GPM on tiles

4. Stoneeh

Software: ARTA

Hardware: Mic Isemcon EMX-7150, SPL Calibrator Isemcon SC-1, Preamp Img MPA-102, Interface Creative X-Fi USB HD

Measurement Methodology & Environment #1: GPM Far Field Outdoor

Measurement Methodology & Environment #2: Tripod measurement fenestrated far field indoor, joined to Bafflestep-corrected combined near field measurement indoor

Further comments on the participants' measurements:

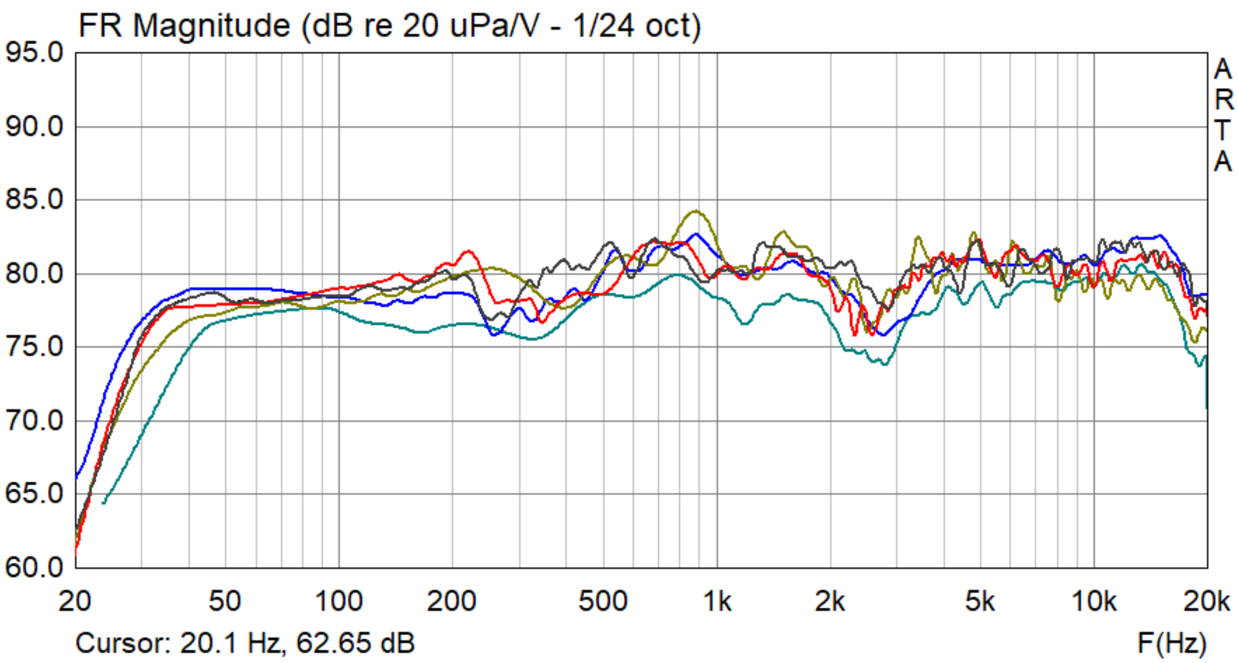
- all impulse responses of the participants, including the respective microphone calibration files, were transmitted to the organization in a format that can be imported into ARTA. The rest of the measurements are available as a graphic export.

- the combined near-field measurements of the users Ste_Pa and Stoneeh were performed according to method & level adjustment "Formula New" from *"Combined Near-Field Measurement - Practical Test & Re-evaluation of Established Methods"*, Stoneeh, 2022; for details see point #9 of this interim evaluation

- Since the organizer is at the same time a participant, in order to ensure an uninfluenced collection of his measurement data (see info sheet point 10), his measurement was carried out first, and for protection in unalterable form was placed in trust with an uninvolved third party.

3. Evaluation of amplitude frequency response (level calibrated, 2.83 Vrms, 1m 4pi)

Turquoise curve Swany, blue Dausend Acoustics, golden yellow Ste_Pa, red Stoneeh tripod & comb. NF, grey-black Stoneeh GPM:



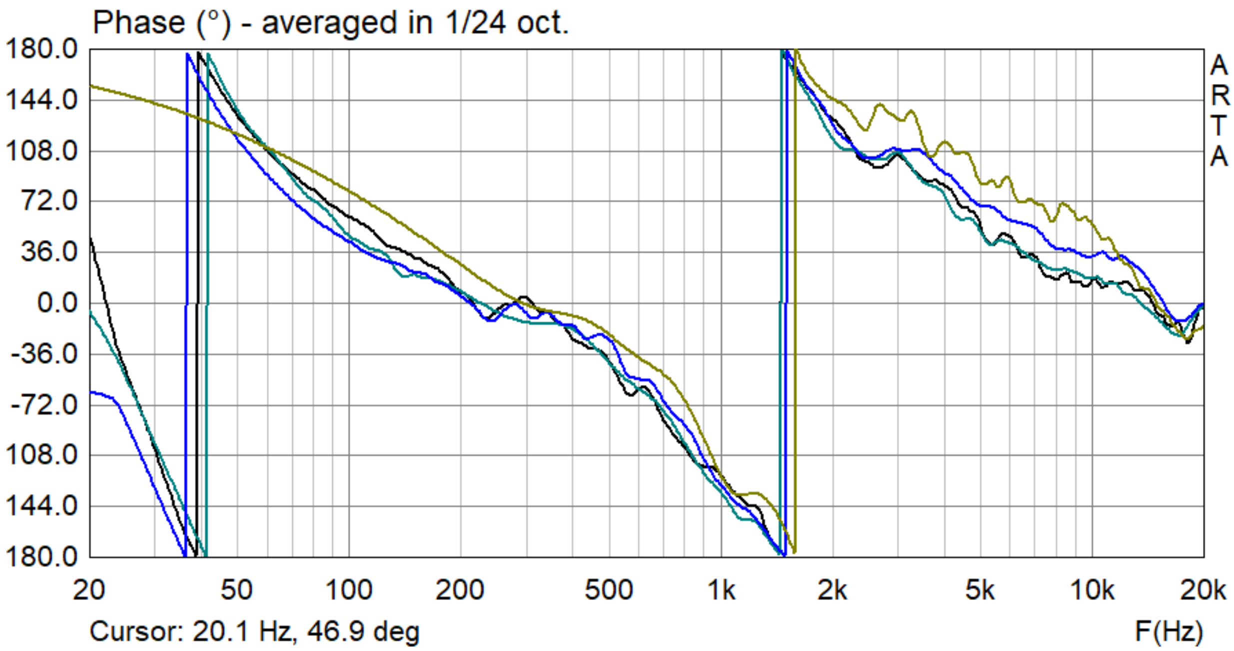
Dausend Acoustics' NFS scan and Stoneeh's both methodologies show very good coverage, with <1 dB SPL deviation on average.

Swany's curve is largely similar, but is on average 2 dB lower. In addition, the bass range, especially the lower edge, deviates from the rest, probably due to the simplified variant of the near field measurement.

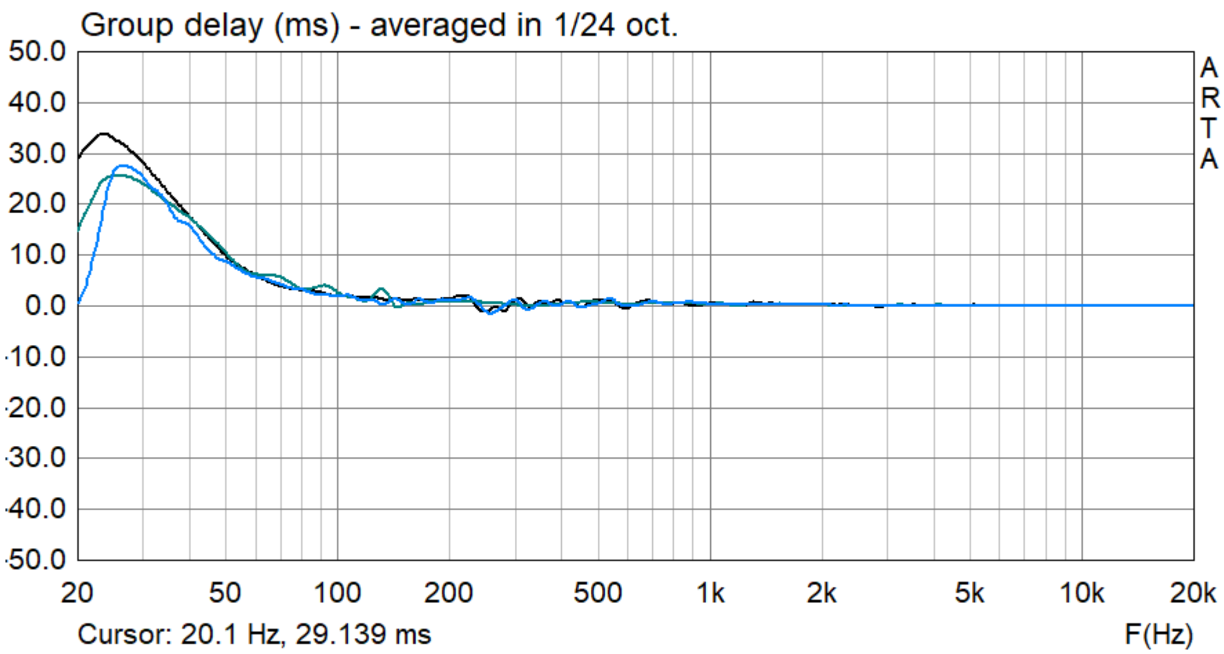
Ste_Pa's data set shows moderate deviations at the upper and lower end of the frequency band, which could be traced back to a partially defective sound interface after intensive consultation or diagnosis with the participant.

4. Evaluation of phase frequency response

Coloring as before; Ste_Pa's curve = GPM fenestrated (valid from ~200 Hz):

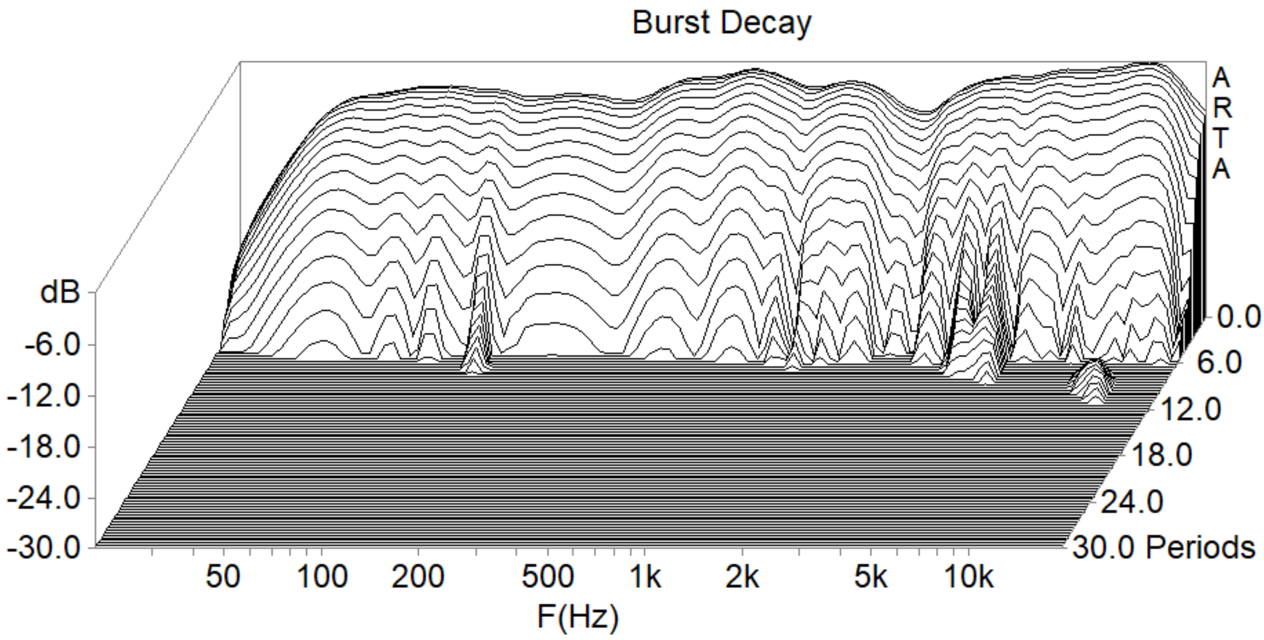


5. Evaluation Group runtime

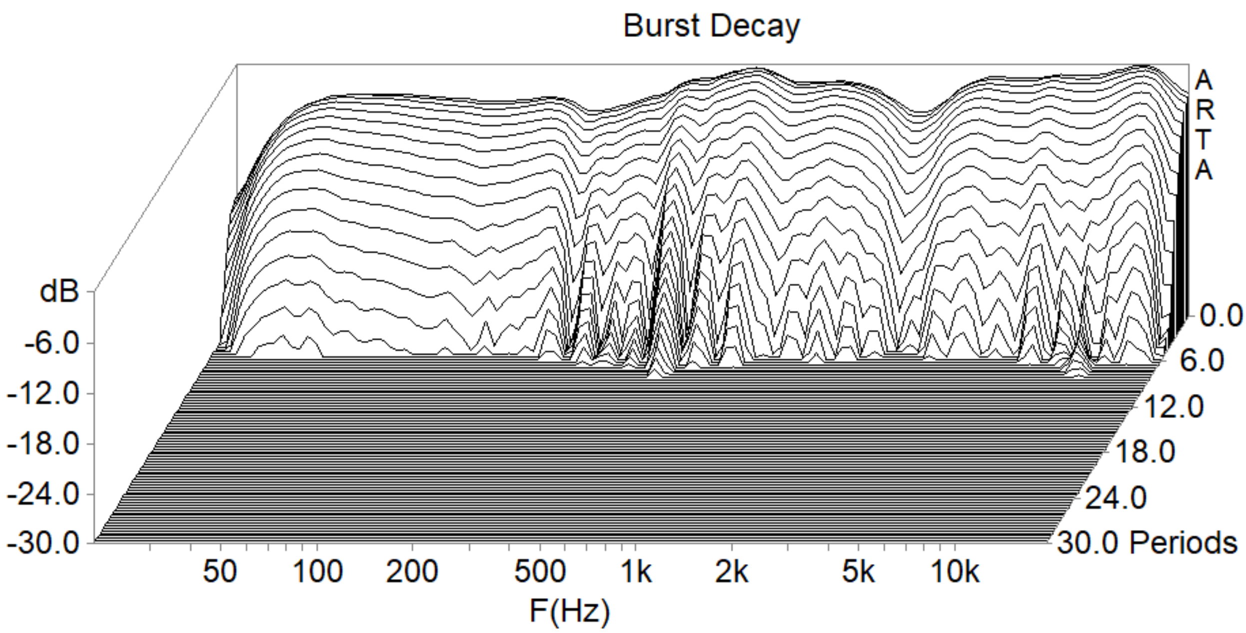


6. Evaluation Waterfall Diagram / Burst Decay

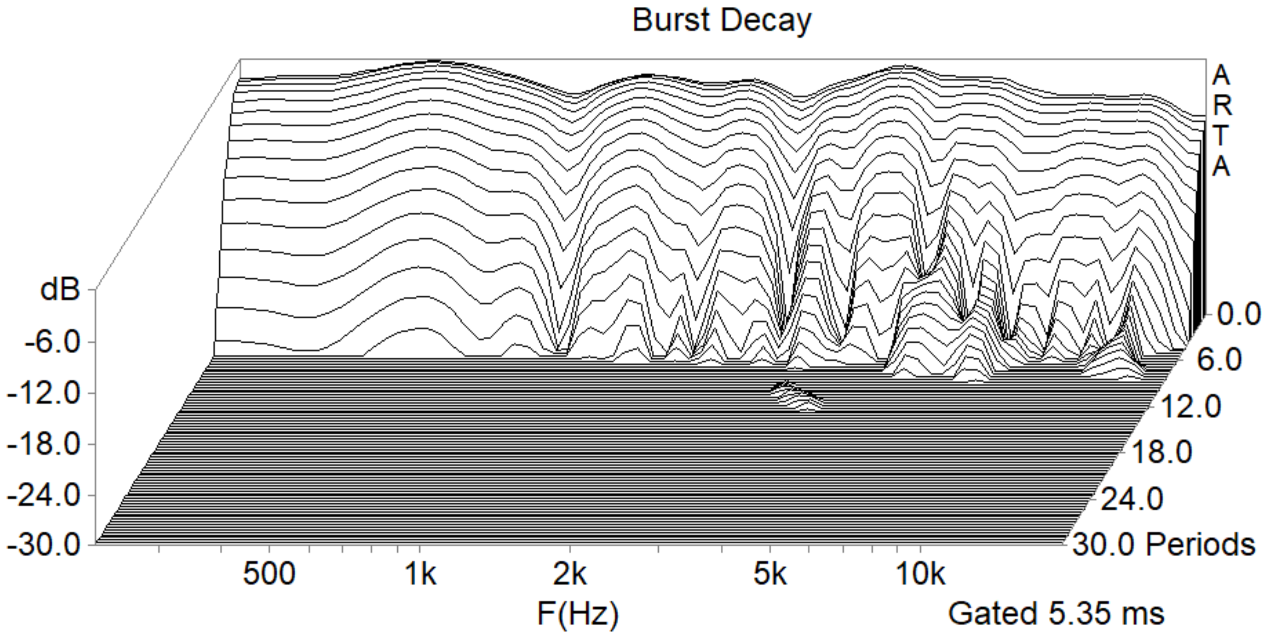
Swany:



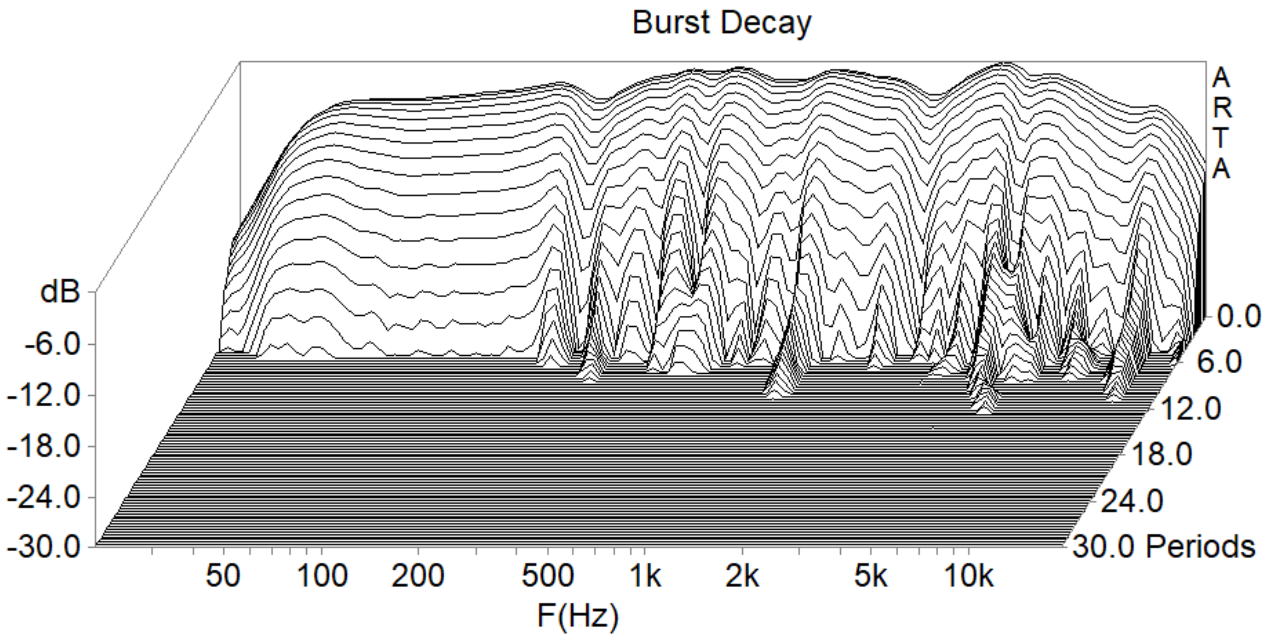
Dausend Acoustics:



Ste_Pa (windowed):



Stoneeh (GPM):

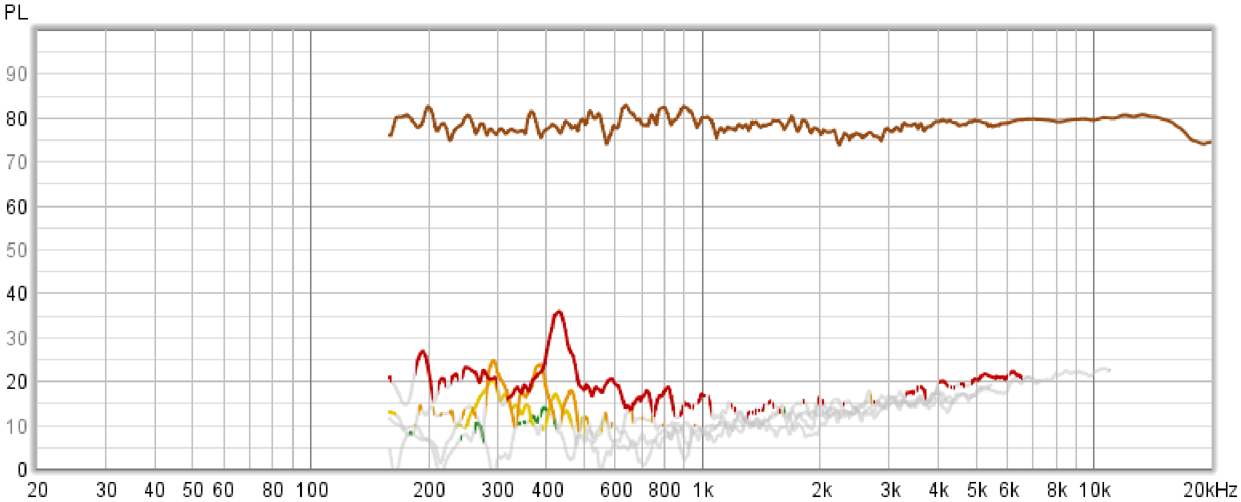


Ste_Pa's windowed display looks very attractive at first glance; however, the background is that the measurement simply loses resolution / temporal information due to windowing.

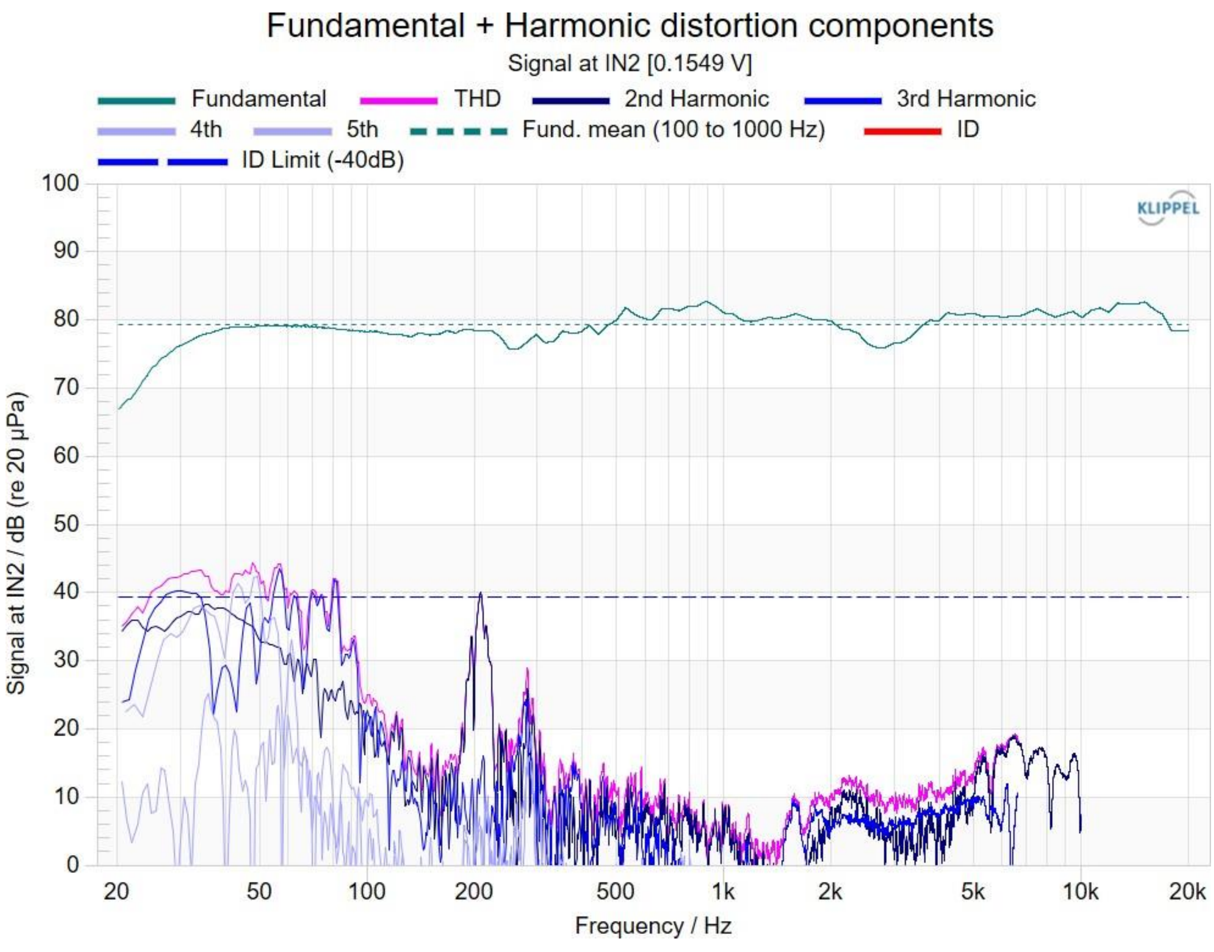
Stoneeh's outdoor GPM shows slight reverberations especially in the high frequencies - possibly remnants of floor reflections.

7. Evaluation Distortion (2.83

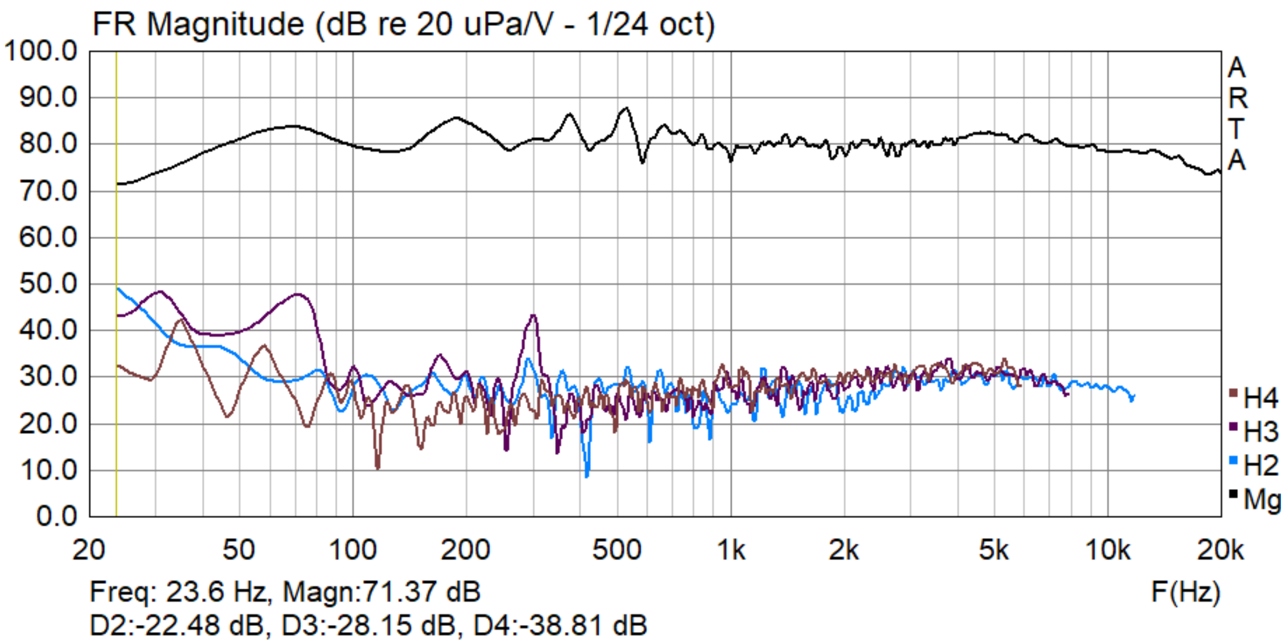
Vrms) Swany:



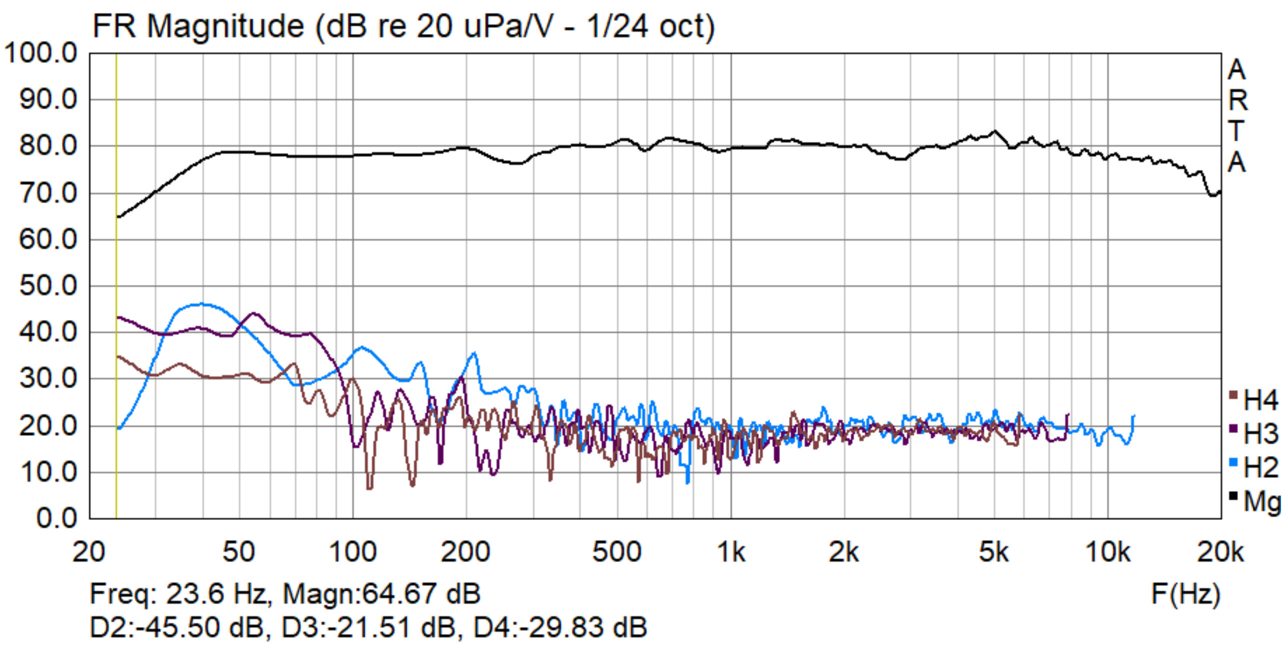
Dausend Acoustics:



Ste_Pa:



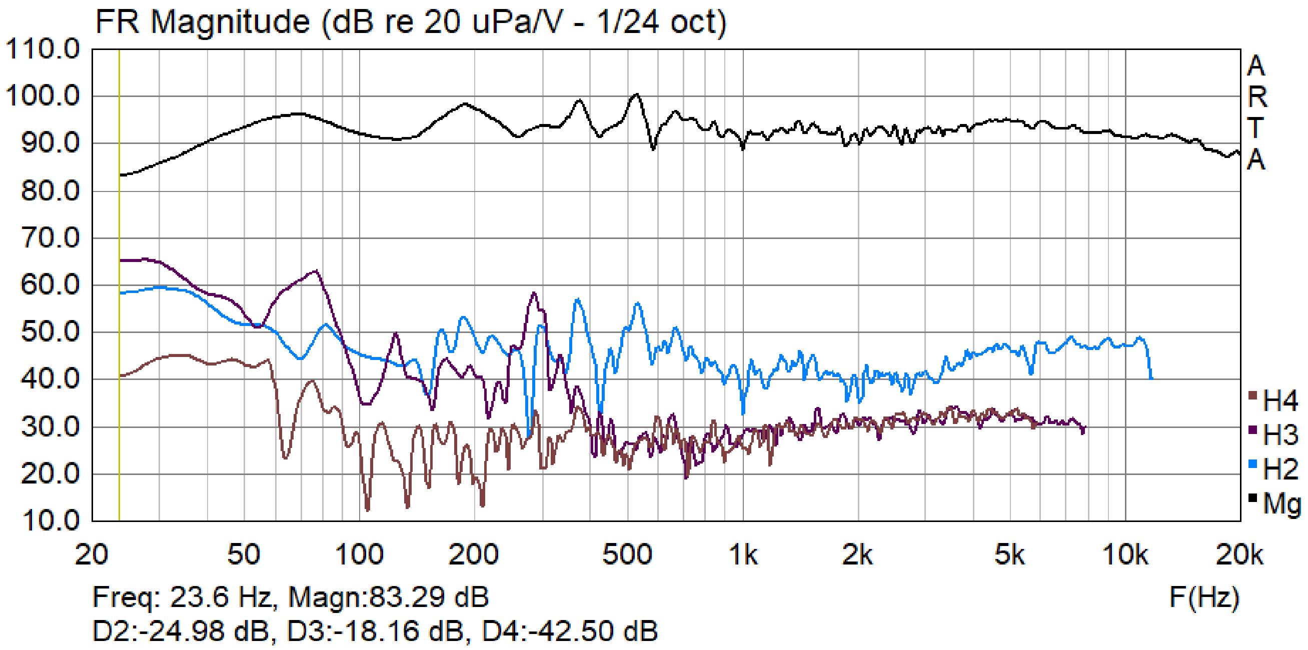
Stoneeh (GPM):



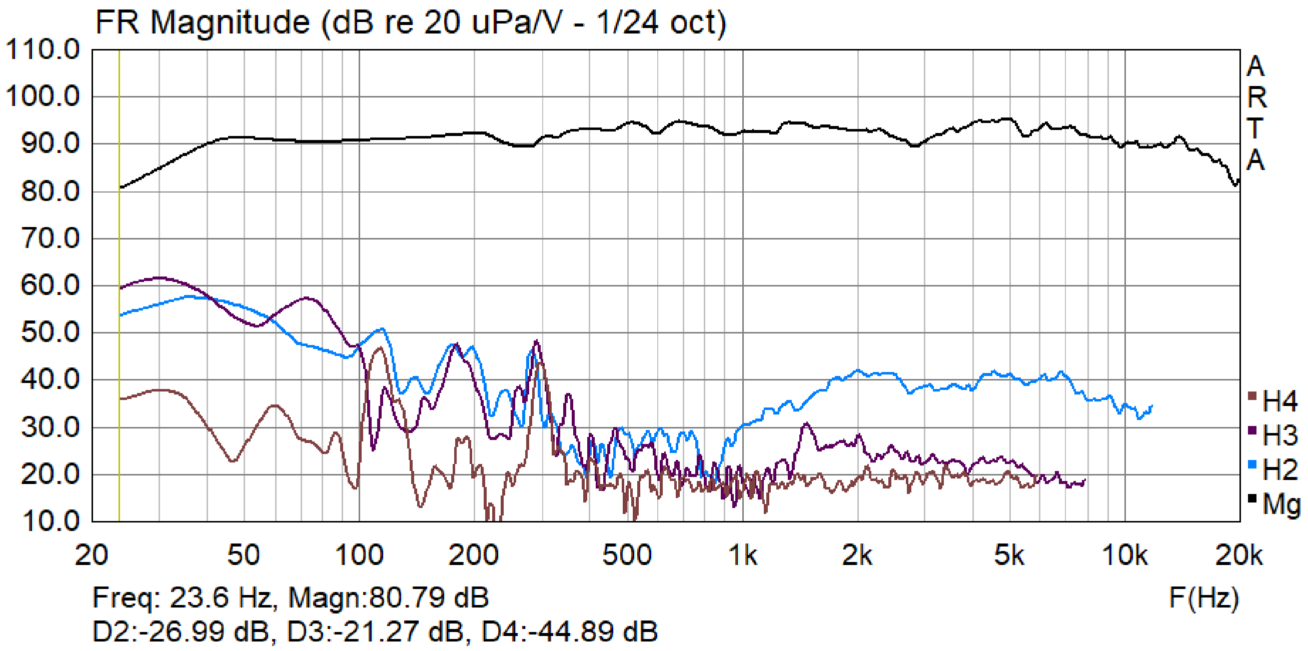
Due to the exceptionally low distortion of the test object at small signal, the harmonic distortions in three of the four data sets are largely masked by the noise floor of the signal chain.
Only Dausend Acoustics' reference microphone/electronics are capable of fully reproducing the actual distortion of the loudspeaker.

8. Evaluation optional measuring program

distortion 11,32V Ste_Pa:

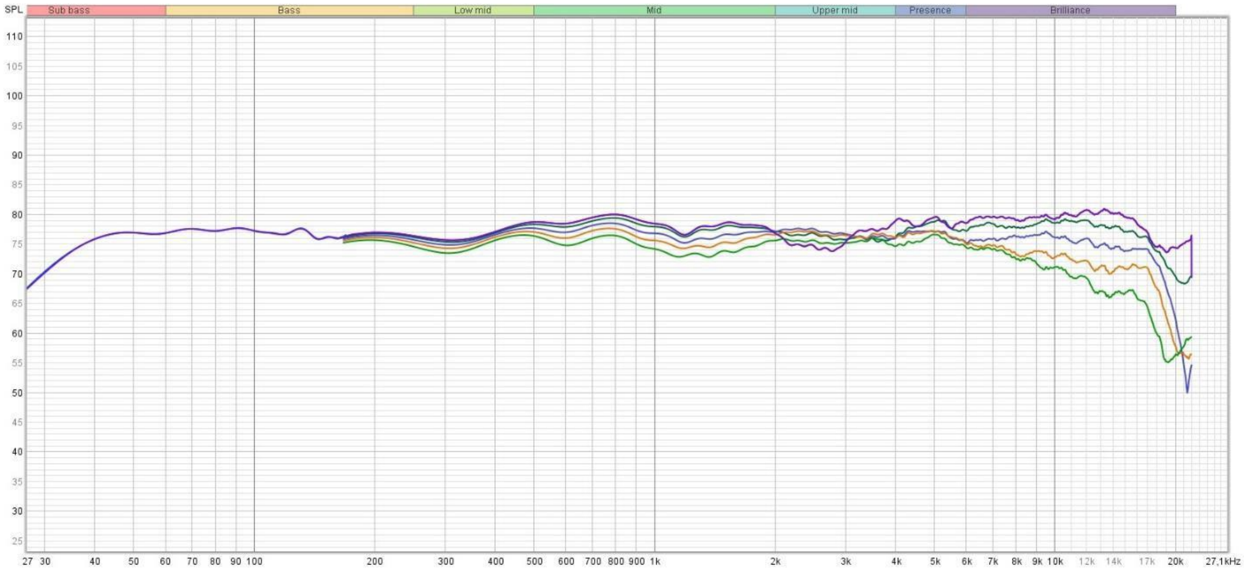


Klirr 11.32V (GPM) Stoneeh:

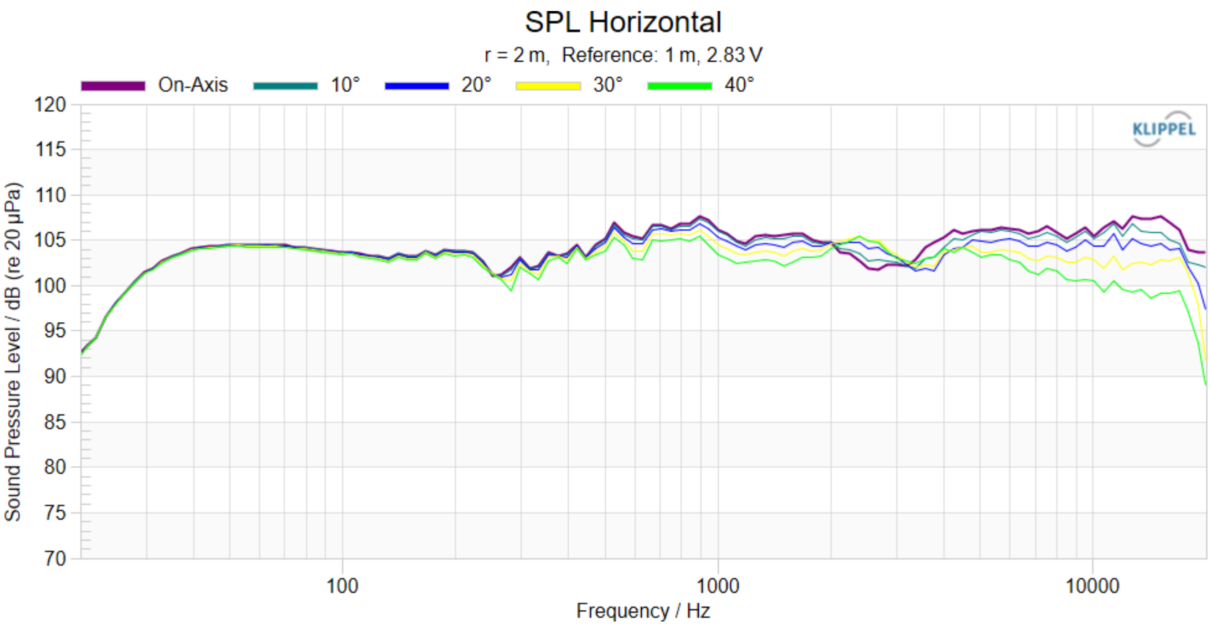


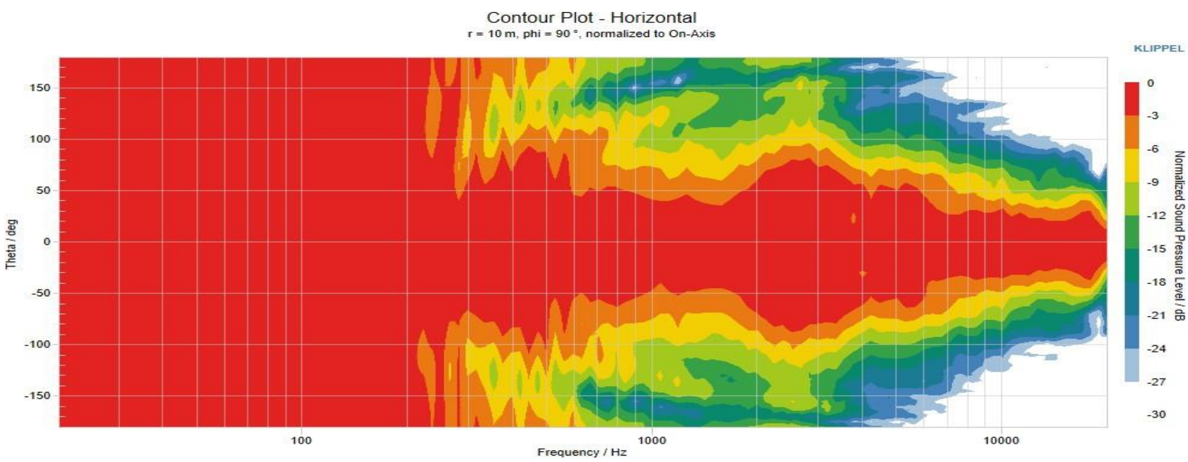
Increased inherent distortion & noise floor Ste_Pa's ECM-40 vs. Stoneeh's EMX-7150; where the higher distortion orders still seem to be in the noise floor even with Stoneeh.

Angle measurements Swany:



Angle measurements Dausend Acoustics (not level calibrated):



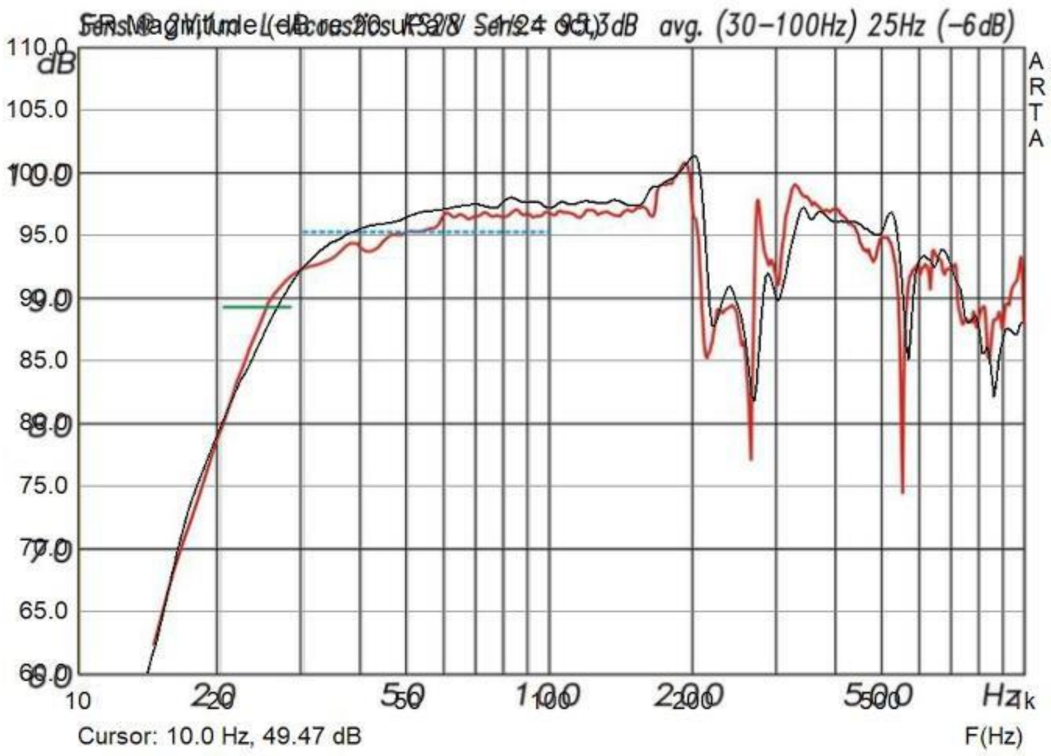


9. Addendum

- External adjustment:

Participant Stoneeh has compared his measurements of commercial loudspeakers with those of trade magazines several times in the past.

The graph attached shows in black Stoneeh's frequency response/efficiency measurement of a L'Acoustics KS28, in red that of the trade magazine Production Partner, carried out by Prof. Dr. Anselm Goertz, with Bruel & Kjaer Messtechnik.
The conditions for both measurements are GPM, 2 Vrms amplifier voltage, SPL scaled to 1m 4pi.
As the measured data of the PP were not available in raw form, it was not possible to evaluate them uniformly within one software, but the two corresponding graphic exports with identical scales were graphically superimposed:



In the bass range, there is a quasi-perfect match, with less than 1 dB SPL deviation on average.
The corresponding peaks in the amplitude response of the fundamental frequencies, which are affected by cabinet and port resonances, appear differently pronounced, probably due to the different frequency resolution of the two softwares used; however, one can still speak of an excellent agreement on average.

In general, this external adjustment can serve as a further validation - but demonstrates, as already learned within the interlaboratory comparison, that a certain tolerance always remains between measurement data not determined under exactly the same conditions.

- Detailed view of combined near-field measurement in the low frequency range:

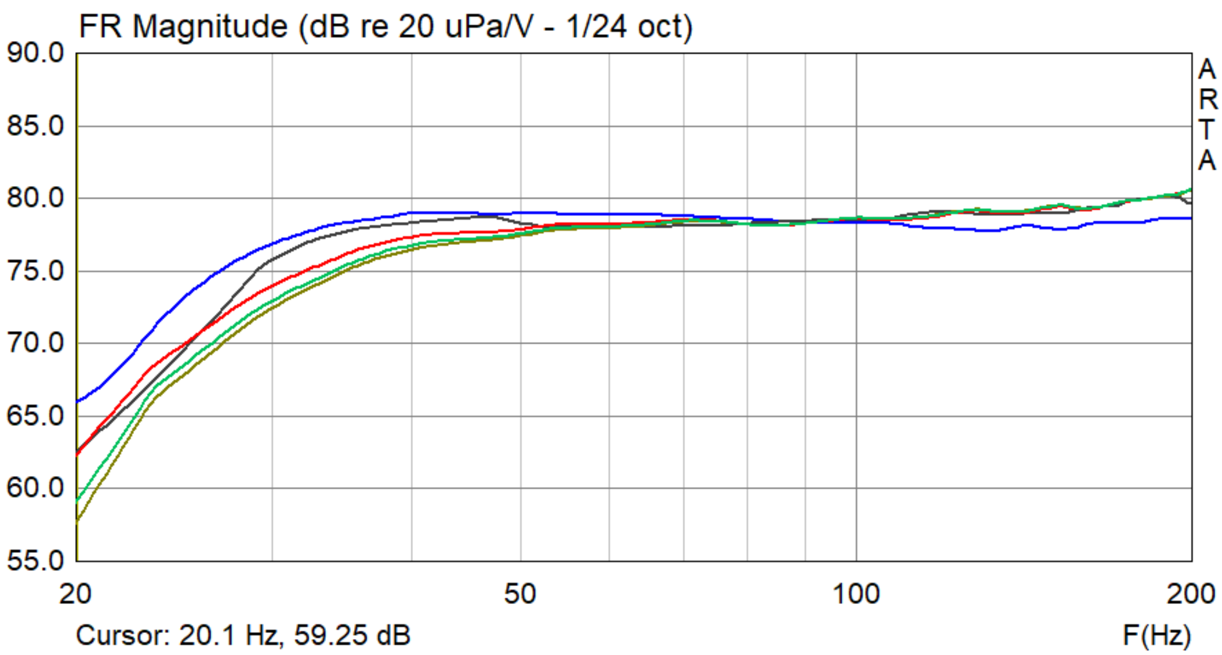
(Combined) near-field measurements are one of the few possibilities to measure the bass range of loudspeakers in normal sized living rooms with high precision, ignoring room influences. However, the methodology is anything but trivial - a meaningful result depends on correct, informed, meticulous procedures in all respects.

A limitation, which has so far only allowed limited confidence in this measurement method, was that it has not undergone comprehensive empirical validation since its introduction in 1973 (Low-Frequency Loudspeaker Assessment By Nearfield Sound-Pressure Measurement, D.B. Keele, AES). The basis of objective truth-finding is, as already taught to every citizen in compulsory education, testing theories against practice.

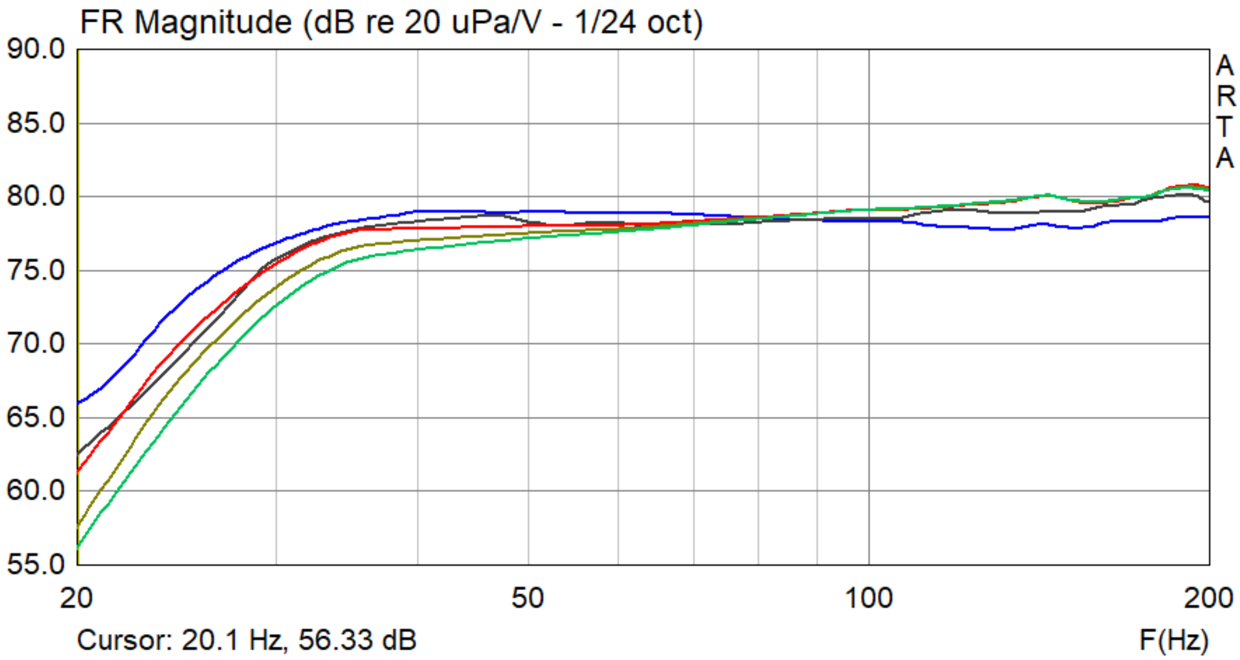
It was not until 2022 that this was aptly made up for by the organizer of the round robin in his publication Combined Near Field Measurement - Practical Test & Re-evaluation of Established Methods (+ How-To in ARTA).
In text form comprising 23 pages, a short summary of this technical paper is not possible - but it should be noted that with correct procedure, the (combined) near-field measurement in the assessable frequency range (bass) achieves excellent agreement with a free-field measurement in the far field.

Within the aforementioned work, a slightly improved formula for the level adjustment of the sound sources (membrane and bass reflex port) was presented based on further empirical findings. This is now compared again with the established methods using the round robin test object.

Combined near field measurement *Ste_Pa* - level adjustment "Formula new Stoneeh (source)" red, "Keele formula" ((Sv/Sd)^0.5; source) golden yellow, volume flow method (source, page 122). green; for reference blue Dausend's NFS measurement, black Stoneeh's outdoor GPM:



Combined near-field measurement *Stoneeh* - colouring identical to Ste_Pa's graph:

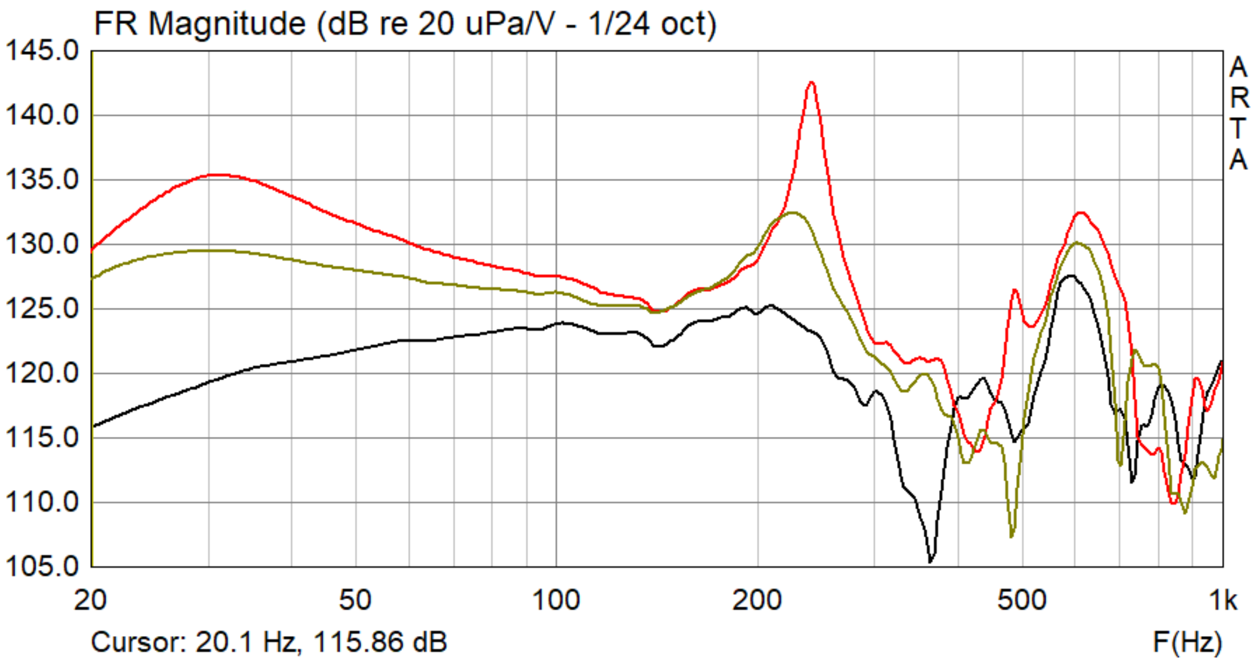


The "Formula new" shows for both users the best agreement with both the real
free field measurement, as well as the highly technically calculated one of the Klippel Near Field Scanner.

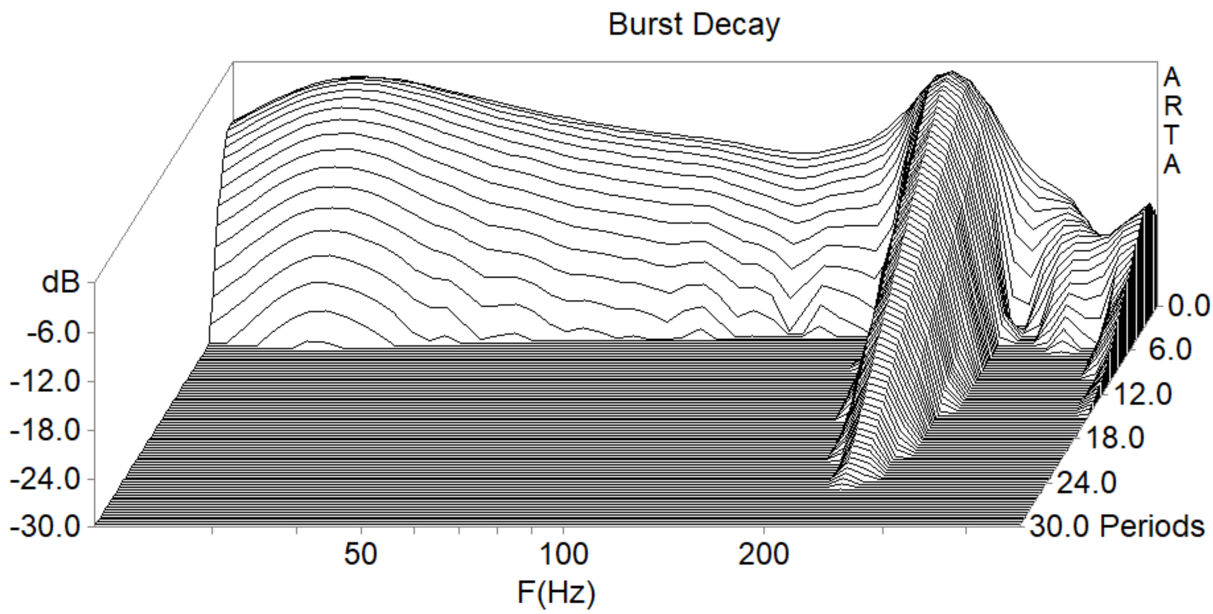
- Case study attenuation & angulation of the bass reflex port on the round robin test object:

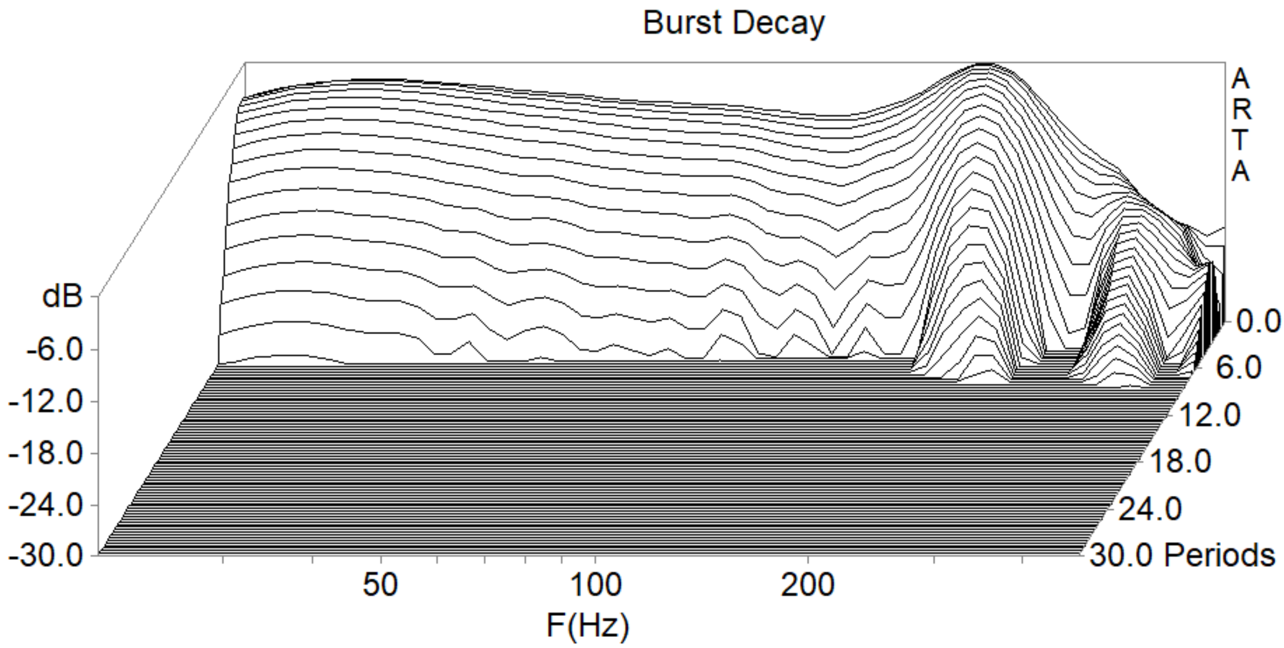
In order to be able to represent nuances of differences in the respective measuring technique, environment and methodology, the test object should be capable of reproducing as wide a frequency range as possible with the utmost fidelity to the signal.
This was achieved, among other things, by a low (BR) tuning, which, with practicable cross-sectional areas, results in a very long bass reflex channel.
In addition, cabinet resonances as well as natural resonances of the bass reflex channel were suppressed by damping.

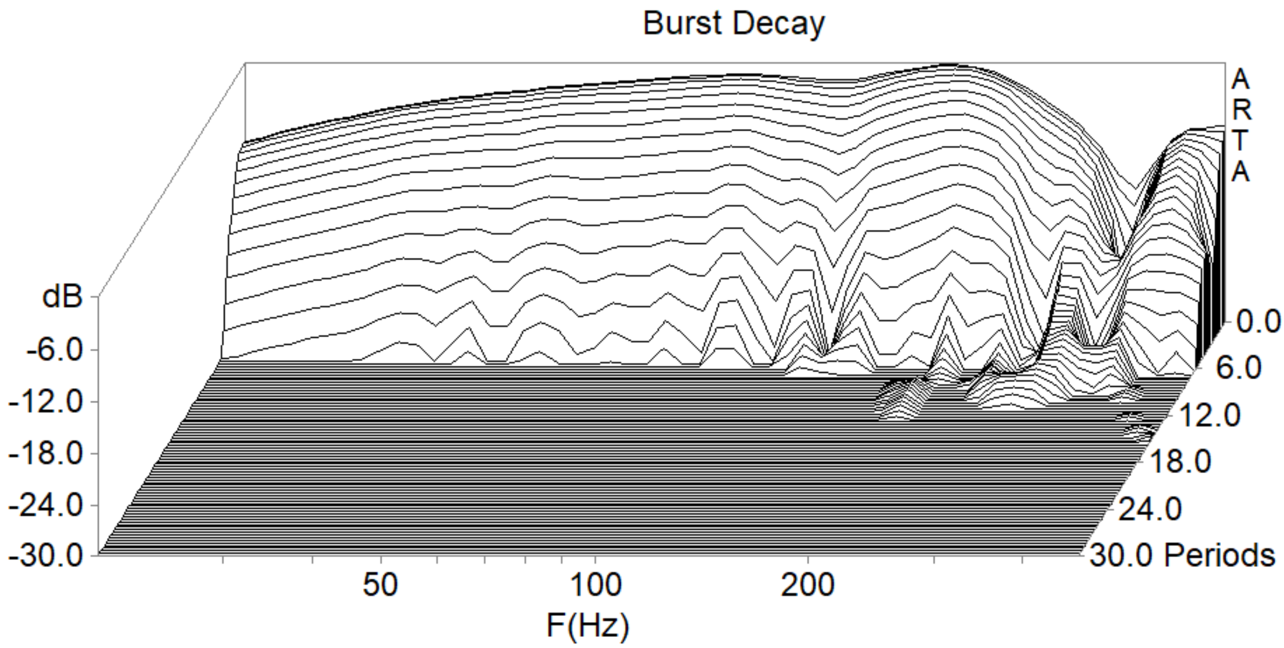
For damping the BR channel a full fill with damping wool (not shown) as well as a partial fill (shown on previous page) was tried. The measurement results are as follows - frequency response nearfield red un-, golden yellow partially-, black fully damped:



Waterfall diagrams first diagram no damping, second diagram partial damping, third diagram full damping:





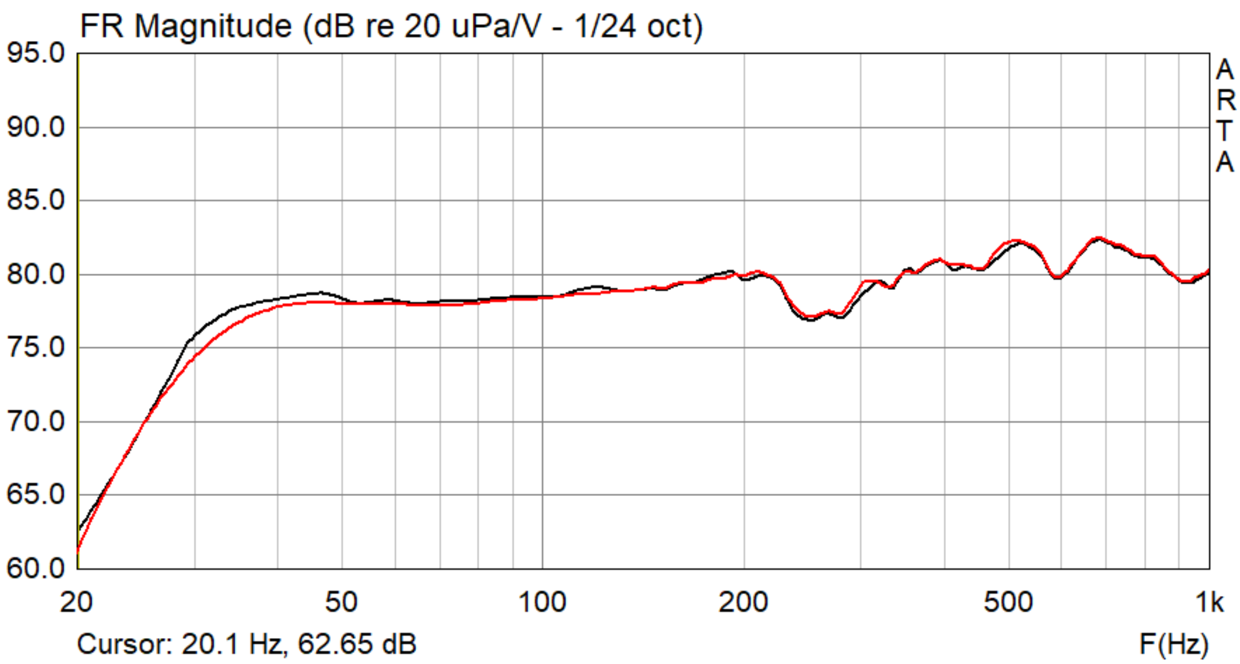


In the empty channel the port's own resonance @ ~250 Hz comes through uninhibited. In the partially damped version it is still visible, but with a significantly lower quality, and thus no longer detectable in the waterfall diagram by disturbingly long resonance. The resonance is completely eliminated in the duct that is completely filled with damping wool.

Unfortunately, damping is associated with a loss of sound pressure level at or around the tuning frequency. The partially damped version represents, as can be seen, an acceptable compromise depending on the requirements; the level loss was compensated in the test object via equalization in the DSP of the active module. The fully damped version is unusable in this respect - the port loses most of its function.

With angled bass reflex channels, one would intuitively expect a large signal to obstruct the Flow through the "kink", and thus a restriction in the Max. SPL, expect.

For diagnosis a frequency response measurement, excitation sine sweep, was performed at small signal (2.83V = 1 Watt) black vs. large signal (22.64V = 64 Watt) red, curves manually superimposed. A dip of the large signal curve @ fb (~30 Hz) would indicate port compression:



Minor, essentially irrelevant port compression in the range of <1 dB SPL is detectable. However, this can (also) be caused by the damping of the channel, which certainly also impedes the flow in this channel to a certain extent.
No relevant disadvantages directly attributable to this can be determined, which is why angled ports can be given an unqualified recommendation.

10. Conclusion

The hoped-for goal of a statistical mean with high coverage of multiple data sets, specifically 3 out of 5, in the frequency response/efficiency measurement, was achieved. An external alignment (Pt. #9) of one participant in this mean further confirms that this, neglecting small unavoidable remaining tolerances, represents the correct measurement.
The other 2 participants also deviated only slightly to moderately from this mean in some areas; they have now gathered valuable clues for further improvement on the basis of this comparison.

The distortion of the test object, which was very demanding in this respect, could only be recorded completely meaningfully by 1 of 4 participants.

- Stoneeh, for the speaker DIY community; 11/2022