STI Stimulus Generation for B&K's DIRAC

Set description & Manual

Qick guides for print out on the last two pages

This document consists of:

- Content of the Kit
- Difference between the 2 iteration templates
- Manual how to use the template(s)

Content of the kit

The kit for building DIRAC stimuli consist of:

- The **set description** - what you are reading just now
- The **manual** - the second and main part of this file / document
- A document explaining the technical challenges «**Technical Background Information**…»
- **2 templates** for generating the shape table data for the SFD process. These templates lead you through the iteration process, where the SFD shape table content get refined for best possible precision:
  - In the sense of the EN 60268-16 requirements,
  - For best possible low end bandwidth economy to get the highest possible signal level out of the small loudspeaker
  - and low end and high end frequency response management to keep the measurement phase out of side band effects during the deconvolution work DIRAC does during a measurement.
- **A template to visualize the speakers linearity** «Einfluss Pegel auf LS 2.xlsx»

Difference between the 2 templates in detail (I)

At one glance one can see a difference between the two templates: The upper has pale brown blocks; the lower only ones in violet. *Pale brown iteration block simulate the loudspeakers impact; while the violet iteration blocks require the loudspeaker to be in a measurement loop.*

The upper template is for the development phase, where one is still learning to get to know the speakers qualities, still learning how to use DIRAC and its SFD, learning how to handle the low end cuts and how to handle the noise rests in the IR measured made in an anechoic chamber when determination of the speaker frequency response.

The development template has also2 violet iteration blocks allowing to completely finish the stimulus process; but typically one will start freshly using the second template.

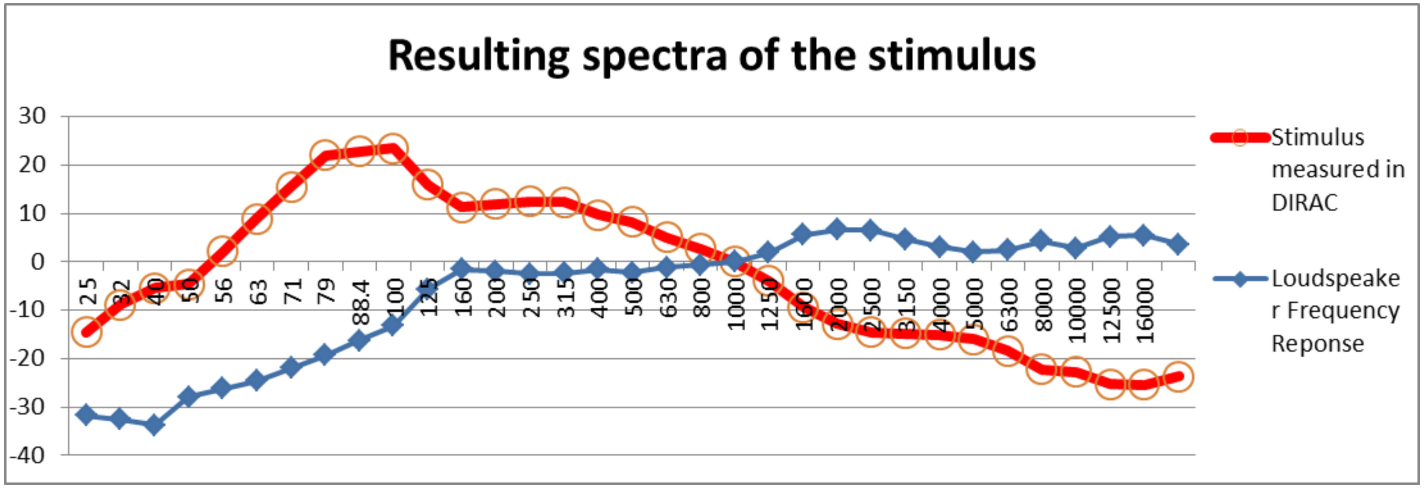
Stimulus improvement Iterations									Cut low-end					High end side band management					BlueBox 4 2016-07-01						
IR:		BlueBox 3 FG 74 dBA.wav		Path:			Average		given by the standard					These fields are for stimulus generation based on calculation					These fields are for measurement in the anechoic chamber						
Freqency	STI Male	Loudspeaker Frequency Reponse	Stimulus measured in DIRAC	Resulting Error 1	Hz	2. Shape table data input	Stimulus measured in DIRAC	Resulting Error 2: Error of Stimulus V1	Hz	3. Shape table data input	Stimulus measured in DIRAC	Resulting Error 3	Hz	4. Shape table data input	Stimulus measured in DIRAC	Resulting Error 4	Hz	5. Shape table data input	Result measured in the anechoic chamber	Resulting Error	Hz	6. Shape table data input	Result measured in the anechoic chamber	Final Resulting Error	1/3 octave STI male target value
		-58.29	Offsets	-72.92		Offset of this block		-131.48		Offset of this block		-131.58		Offset of this block		-134.34		Offset of this block		-134.70		Offset of this block		-134.70	
25	-50	-31.78	58.35	3.65	25	-50	-14.55	3.67	25	-50	-14.55	3.67	25	-50	-134.34	-116.12	25	-50	-134.70	-84.7	25	-50	-134.70	-84.7	
32	-45	-32.54	64.1	3.64	32	-45	-8.8	3.66	32	-45	-8.8	3.66	32	-45	-134.34	-121.88	32	-45	-134.70	-89.7	32	-45	-134.70	-89.7	
40	-40	-33.72	67.57	0.93	40	-40	-5.33	0.95	40	-40	-5.33	0.95	40	-40	-134.34	-128.06	40	-40	-134.70	-94.7	40	-40	-134.70	-94.7	
50	-35	-27.95	68.32	2.45	50	-35	-4.58	2.47	50	-35	-4.59	2.46	50	-35	-134.34	-127.29	50	-35	-134.70	-99.7	50	-35	-134.70	-99.7	
56	-30	-26.25	74.845	5.68	56	-30	2.175	5.93	56	-30	2.17	5.92	56	-30	-134.34	-130.59	56	-30	-134.7	-104.7	56	-30	-134.7	-104.7	
63	-20	-24.55	81.37	3.90	63	-20	8.93	4.38	63	-20	8.93	4.38	63	-20	-134.34	-138.89	63	-20	-134.70	-114.7	63	-20	-134.70	-114.7	
71	-10	-21.935	88.345	3.49	70	-10	15.485	3.55	70	-10	15.48	3.54	70	-10	-134.34	-146.28	70	-10	-134.7	-124.7	70	-10	-134.7	-124.7	
79	0	-19.32	95.32	3.08	80	0	22.04	2.72	80	0	22.03	2.71	80	0	-134.34	-153.66	80	0	-134.70	-134.7	80	0	-134.70	-134.7	
88.4	10	-16.26	96.185	-2.99	88.4	10	22.78	-3.48	88.4	10	22.68	-3.58	88.4	10	-134.34	-160.60	88.4	10	-134.7	-144.7	88.4	10	-134.7	-144.7	
100	10	-13.20	97.05	0.93	100	9.07	23.52	0.32	100	8.75	23.33	0.13	100	8.62	-134.34	-157.54	100	166.16	-134.70	-144.7	100	310.86	-134.70	-144.7	58.4
125	10	-5.69	89.89	1.28	125	8.72	15.9	0.21	125	8.51	15.7	0.01	125	8.5	-134.34	-150.03	125	158.53	-134.70	-144.7	125	303.23	-134.70	-144.7	58.4
160	10	-1.53	84.46	0.01	160	9.99	11.36	-0.17	160	10.16	11.45	-0.08	160	10.24	-134.34	-145.87	160	156.11	-134.70	-144.7	160	300.81	-134.70	-144.7	58.4
200	10	-1.97	84.76	-0.13	200	10.13	11.97	0.00	200	10.13	11.98	0.01	200	10.12	-134.34	-146.31	200	156.43	-134.70	-144.7	200	301.13	-134.70	-144.7	58.4
250	10	-2.42	85.29	-0.05	250	10.05	12.5	0.08	250	9.97	12.46	0.04	250	9.93	-134.34	-146.76	250	156.69	-134.70	-144.7	250	301.39	-134.70	-144.7	58.4
315	10	-2.37	84.94	-0.05	315	10.35	12.3	-0.07	315	10.42	12.32	-0.05	315	10.47	-134.34	-146.71	315	157.18	-134.70	-144.7	315	301.88	-134.70	-144.7	58.4
400	8	-1.57	82.51	0.02	400	7.98	9.67	0.10	400	7.88	9.61	0.04	400	7.84	-134.34	-143.91	400	151.75	-134.70	-142.7	400	294.45	-134.70	-142.7	56.4
500	6	-2.24	81.11	-0.05	500	6.05	8.25	0.01	500	6.04	8.24	0.00	500	6.04	-134.34	-142.58	500	148.62	-134.70	-140.7	500	289.32	-134.70	-140.7	54.4
630	4	-1.09	77.95	-0.06	630	4.06	5.09	0.00	630	4.06	5.08	-0.01	630	4.07	-134.34	-139.43	630	143.5	-134.70	-138.7	630	282.2	-134.70	-138.7	52.4
800	2	-0.61	75.63	0.10	800	1.90	2.67	0.06	800	1.84	2.63	0.02	800	1.82	-134.34	-136.95	800	138.77	-134.70	-136.7	800	275.47	-134.70	-136.7	50.4
1000	0	0.00	72.92	0.00	1000	0.00	0	0.00	1000	0.00	0	0.00	1000	0	-134.34	-134.34	1000	134.34	-134.70	-134.7	1000	269.04	-134.70	-134.7	48.4
1250	-2	1.90	69.1	0.08	1250	-2.08	-3.94	-0.04	1250	-2.04	-3.93	-0.03	1250	-2.01	-134.34	-130.44	1250	128.43	-134.70	-132.7	1250	261.13	-134.70	-132.7	46.4
1600	-4	5.60	64.06	0.74	1600	-4.74	-9.36	0.24	1600	-4.98	-9.5	0.10	1600	-5.08	-134.34	-124.74	1600	119.66	-134.70	-130.7	1600	250.36	-134.70	-130.7	44.4
2000	-6	6.64	60.17	-0.11	2000	-5.89	-12.76	-0.12	2000	-5.77	-12.71	-0.07	2000	-5.7	-134.34	-121.70	2000	116	-134.70	-128.7	2000	244.7	-134.70	-128.7	42.4
2500	-8	6.57	58.28	-0.07	2500	-7.93	-14.53	0.04	2500	-7.97	-14.54	0.03	2500	-8	-134.34	-119.77	2500	111.77	-134.70	-126.7	2500	238.47	-134.70	-126.7	40.4
3150	-10	4.74	58.01	-0.17	3150	-9.83	-14.74	0.00	3150	-9.83	-14.75	-0.01	3150	-9.82	-134.34	-119.60	3150	109.78	-134.70	-124.7	3150	234.48	-134.70	-124.7	38.4
4000	-12	3.05	57.77	-0.10	4000	-11.90	-15.02	0.03	4000	-11.93	-15.04	0.01	4000	-11.94	-134.34	-119.29	4000	107.35	-134.70	-122.7	4000	230.05	-134.70	-122.7	36.4
5000	-14	2.07	56.73	-0.12	5000	-13.88	-16.05	0.02	5000	-13.90	-16.06	0.01	5000	-13.91	-134.34	-118.27	5000	104.36	-134.70	-120.7	5000	225.06	-134.70	-120.7	34.4
6300	-16	2.36	54.45	-0.11	6300	-15.89	-18.39	-0.03	6300	-15.86	-18.38	-0.02	6300	-15.84	-134.34	-115.98	6300	100.14	-134.70	-118.7	6300	218.84	-134.70	-118.7	32.4
8000	-18	4.33	50.89	0.30	8000	-18.30	-22.23	0.10	8000	-18.40	-22.3	0.03	8000	-18.43	-134.34	-112.01	8000	93.58	-134.70	-116.7	8000	210.28	-134.70	-116.7	30.4
10000	-20	2.80	50.49	0.37	10000	-20.37	-22.73	0.07	10000	-20.44	-22.77	0.03	10000	-20.47	-134.34	-111.54	10000	91.07	-134.70	-114.7	10000	205.77	-134.70	-114.7	28.4
12500	-20	5.20	47.87	0.15	12500	-20.15	-25.32	-0.12	12500	-20.03	-25.26	-0.06	12500	-19.97	-134.34	-109.14	12500	89.17	-134.70	-114.7	12500	203.87	-134.70	-114.7	
16000	-20	5.48	48.42	0.98	16000	-20.98	-25.35	0.13	16000	-21.11	-25.43	0.05	16000	-21.16	-134.34	-108.86	16000	87.7	-134.70	-114.7	16000	202.4	-134.70	-114.7	
20000	-20	3.68	49.91	0.67	20000	-20.67	-23.69	-0.01	20000	-20.66	-23.69	-0.01	20000	-20.65	-134.34	-110.66		90.01	-134.70	-114.7			-134.70	-114.7	

Stimulus improvement Iterations									Cut low-end					High end side band management					My speaker xxxx						
IR:		My speakers IR.wav		Path:			Average		given by the standard					These fields are for stimulus generation based on calculation					These fields are for measurement in the anechoic chamber						
Freqency	STI Male	Loudspeaker Frequency Reponse	Result measured in the anechoic chamber	Resulting Error 1	Hz	2. Shape table data input	Result measured in the anechoic chamber	Resulting Error 2: Error of Stimulus V1	Hz	3. Shape table data input	Result measured in the anechoic chamber	Resulting Error 3	Hz	4. Shape table data input	Result measured in the anechoic chamber	Resulting Error 4	Hz	5. Shape table data input	Result measured in the anechoic chamber	Resulting Error	Hz	6. Shape table data input	Result measured in the anechoic chamber	Final Resulting Error	1/3 octave STI male target value
		-63.29	Offsets	6.22		Offset of this block		-59.87		Offset of this block		-59.87		Offset of this block		-59.87		Offset of this block		-59.87		Offset of this block		-59.87	
25	-30	-45.25	-40.88	5.34	25	-40	-38.28	1.72	25	-40	-38.27	1.73	25	-40	-38.09	1.91	25	-40	-35.10	4.9	25	-40	-59.87	-19.87	
32	-30	-45.09	-35.67	0.55	32	-30	-29.79	0.21	32	-30	-29.78	0.22	32	-30	-29.78	0.22	32	-30	-29.65	0.35	32	-30	-59.87	-29.87	
40	-20	-38.63	-27.35	-1.13	40	-20	-21.52	-1.52	40	-20	-21.6	-1.60	40	-20	-21.90	-1.90	40	-20	-21.77	-1.77	40	-20	-59.87	-39.87	
50	-20	-34.09	-26.14	0.08	50	-20	-19.96	0.04	50	-20	-20	0.00	50	-20	-19.99	0.01	50	-20	-19.91	0.09	50	-20	-59.87	-39.87	
56	-20	-31.605	-23.195	3.03	56	-20	-16.835	3.17	56	-20	-16.865	3.14	56	-20	-16.87	3.13	56	-20	-16.83	3.175	56	-20	-59.87	-39.87	
63	-20	-29.12	-20.25	5.97	63	-20	-13.71	6.29	63	-20	-13.73	6.27	63	-20	-13.75	6.25	63	-20	-13.74	6.26	63	-20	-59.87	-39.87	
71	-10	-26.755	-11.205	5.02	70	-10	-4.96	5.04	70	-10	-4.985	5.02	70	-10	-5	5.00	70	-10	-4.99	5.01	70	-10	-59.87	-49.87	
79	0	-24.19	-2.16	4.06	80	0	3.79	3.79	80	0	3.76	3.76	80	0	3.75	3.75	80	0	3.76	3.76	80	0	-59.87	-59.87	
88.4	10	-22.16	0.78	-3.00	88.4	10	6.89	-3.11	88.4	10	6.87	-3.13	88.4	10	6.87	-3.13	88.4	10	6.875	-3.125	88.4	10	-59.87	-69.87	
100	10	-19.93	3.72	-0.06	100	10.06	9.99	-0.01	100	10.07	9.98	-0.02	100	10.09	9.99	-0.01	100	10.1	9.99	-0.01	100	10.11	-59.87	-69.87	58.4
125	10	-17.47	3.69	-0.09	125	10.09	9.99	-0.01	125	10.10	9.98	-0.02	125	10.12	9.99	-0.01	125	10.13	10.00	0	125	10.13	-59.87	-69.87	58.4
160	10	-14.90	3.62	-0.16	160	10.16	9.96	-0.04	160	10.20	9.98	-0.02	160	10.22	9.99	-0.01	160	10.23	9.99	-0.01	160	10.24	-59.87	-69.87	58.4
200	10	-14.27	3.63	-0.15	200	10.15	9.98	-0.02	200	10.17	9.99	-0.01	200	10.18	9.99	-0.01	200	10.19	10.00	0	200	10.19	-59.87	-69.87	58.4
250	10	-14.82	3.55	-0.23	250	10.23	10	0.00	250	10.23	10.01	0.01	250	10.22	10.00	0.00	250	10.22	10.01	0.01	250	10.21	-59.87	-69.87	58.4
315	10	-14.15	3.24	-0.54	315	10.54	9.86	-0.14	315	10.68	9.95	-0.05	315	10.73	9.97	-0.03	315	10.76	9.99	-0.01	315	10.77	-59.87	-69.87	58.4
400	8	-15.03	1.62	-0.16	400	8.16	8.03	0.03	400	8.13	8.02	0.02	400	8.11	8.01	0.01	400	8.1	8.01	0.01	400	8.09	-59.87	-67.87	56.4
500	6	-14.88	-0.32	-0.10	500	6.10	5.95	-0.05	500	6.15	5.97	-0.03	500	6.18	5.98	-0.02	500	6.2	5.99	-0.01	500	6.21	-59.87	-65.87	54.4
630	4	-15.25	-2.24	-0.02	630	4.02	3.97	-0.03	630	4.05	3.99	-0.01	630	4.06	3.99	-0.01	630	4.07	4.00	0	630	4.07	-59.87	-63.87	52.4
800	2	-14.99	-4.18	0.04	800	1.96	2.01	0.01	800	1.95	1.99	-0.01	800	1.96	1.99	-0.01	800	1.97	2.00	0	800	1.97	-59.87	-61.87	50.4
1000	0	-14.33	-6.22	0.00	1000	0.00	0	0.00	1000	0.00	0	0.00	1000	0	-0.01	-0.01	1000	0.01	0.00	0	1000	0.01	-59.87	-59.87	48.4
1250	-2	-14.11	-8.35	-0.13	1250	-1.87	-2.07	-0.07	1250	-1.80	-2.04	-0.04	1250	-1.76	-2.02	-0.02	1250	-1.74	-2.00	0	1250	-1.74	-59.87	-57.87	46.4
1600	-4	-13.59	-10.28	-0.06	1600	-3.94	-3.94	0.06	1600	-4.00	-3.99	0.01	1600	-4.01	-4.00	0.00	1600	-4.01	-4.00	0	1600	-4.01	-59.87	-55.87	44.4
2000	-6	-14.06	-12.37	-0.15	2000	-5.85	-5.86	0.14	2000	-5.99	-6	0.00	2000	-5.99	-6.02	-0.02	2000	-5.97	-6.00	0	2000	-5.97	-59.87	-53.87	42.4
2500	-8	-13.63	-14.35	-0.13	2500	-7.87	-7.81	0.19	2500	-8.06	-7.99	0.01	2500	-8.07	-8.00	0.00	2500	-8.07	-8.00	0	2500	-8.07	-59.87	-51.87	40.4
3150	-10	-12.47	-16.27	-0.05	3150	-9.95	-9.88	0.12	3150	-10.07	-10.03	-0.03	3150	-10.04	-10.01	-0.01	3150	-10.03	-10.01	-0.01	3150	-10.02	-59.87	-49.87	38.4
4000	-12	-14.54	-18.16	0.06	4000	-12.06	-11.8	0.20	4000	-12.26	-12	0.00	4000	-12.26	-12.00	0.00	4000	-12.26	-12.01	-0.01	4000	-12.25	-59.87	-47.87	36.4
5000	-14	-16.41	-20.16	0.06	5000	-14.06	-13.71	0.29	5000	-14.35	-13.97	0.03	5000	-14.38	-13.99	0.01	5000	-14.39	-14.00	0	5000	-14.39	-59.87	-45.87	34.4
6300	-16	-14.18	-22.22	0.00	6300	-16.00	-15.93	0.07	6300	-16.07	-16.04	-0.04	6300	-16.03	-16.01	-0.01	6300	-16.02	-16.01	-0.01	6300	-16.01	-59.87	-43.87	32.4
8000	-18	-11.62	-24.3	-0.08	8000	-17.92	-17.97	0.03	8000	-17.95	-18.03	-0.03	8000	-17.92	-18.01	-0.01	8000	-17.91	-18.00	0	8000	-17.91	-59.87	-41.87	30.4
10000	-20	-11.73	-26.27	-0.05	10000	-19.95	-19.83	0.17	10000	-20.12	-19.97	0.03	10000	-20.15	-19.99	0.01	10000	-20.16	-19.99	0.01	10000	-20.17	-59.87	-39.87	28.4
12500	-20	-11.26	-26.72	-0.50	12500	-19.50	-19.89	0.11	12500	-19.61	-20.01	-0.01	12500	-19.6	-20.01	-0.01	12500	-19.59	-20.00	0	12500	-19.59	-59.87	-39.87	
16000	-20	-10.91	-26.57	-0.35	16000	-19.65	-19.92	0.08	16000	-19.73	-20.03	-0.03	16000	-19.7	-20.02	-0.02	16000	-19.68	-20.00	0	16000	-19.68	-59.87	-39.87	
20000	-20	-16.42	-26.32	-0.10	20000	-19.90	-19.74	0.26	20000	-20.16	-19.98	0.02	20000	-20.18	-20.00	0.00	20000	-20.18	-20.00	0	20000	-20.18	-59.87	-39.87	

Difference between the 2 templates in detail (II)

Development template:

- *One is not dependent on an anechoic chamber in the learning phase after the speakers frequency response has been measured* at few signal levels (e.g. from 60 to 75 dB in 3 dB steps).
- It is easier to understand; since the stimulus gets analysed and not a measurement, where the deconvolution process gets skipped.
- Work is faster
- It has a chart (below) with clear information on the low and high end response of the stimulus, making corrections simple.
- Sine Diracs measurement capabilities and the speaker is not in use, in parallel a check can get done, that no deconvolution side bands problem occur**.

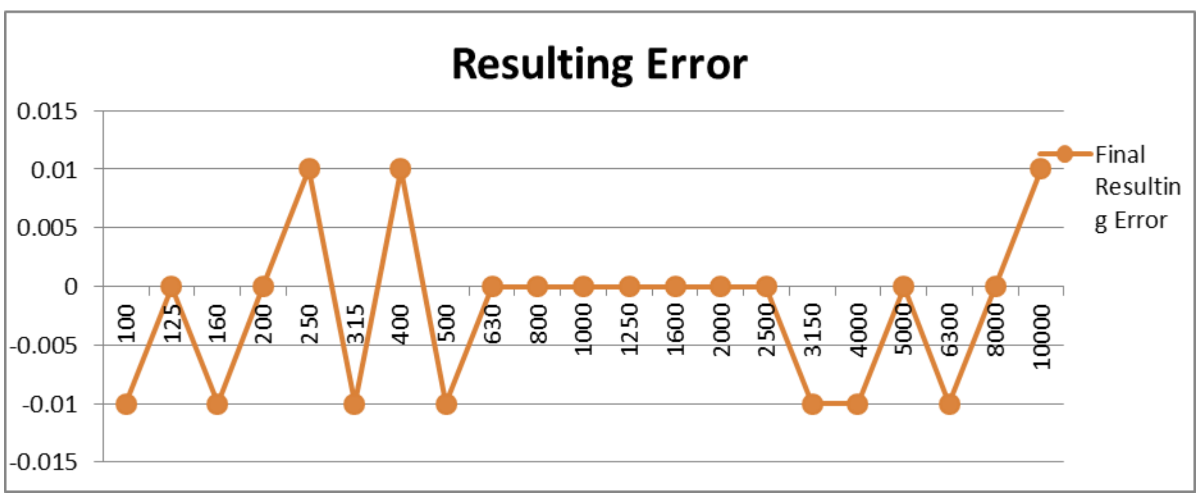


** e.g. having the speaker in the room, the microphone in a quit neighbour room - a STI < 0.2 situation.

Difference between the 2 templates in detail (III)

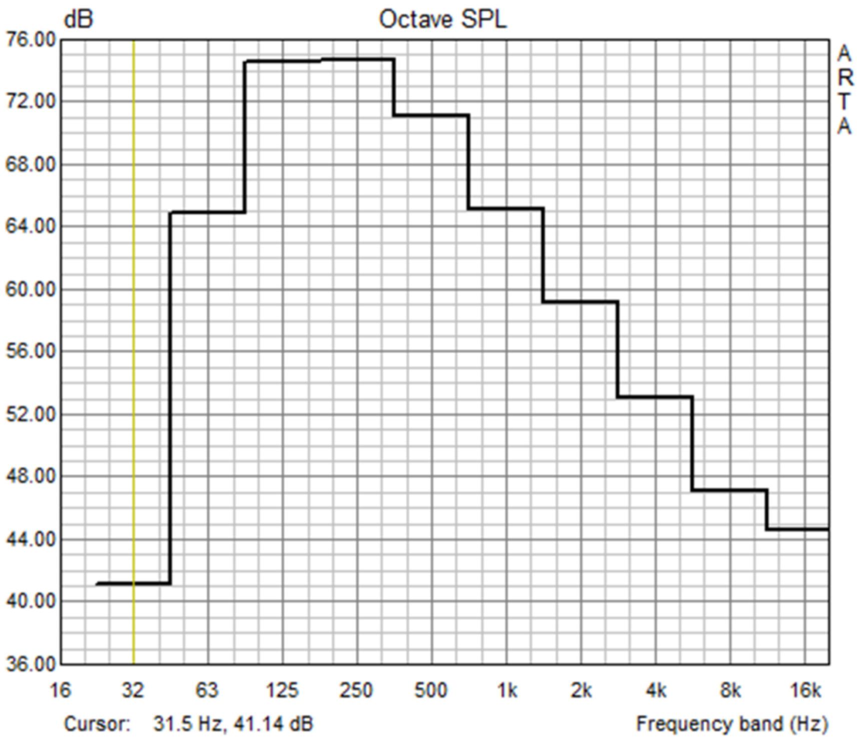
Production template:

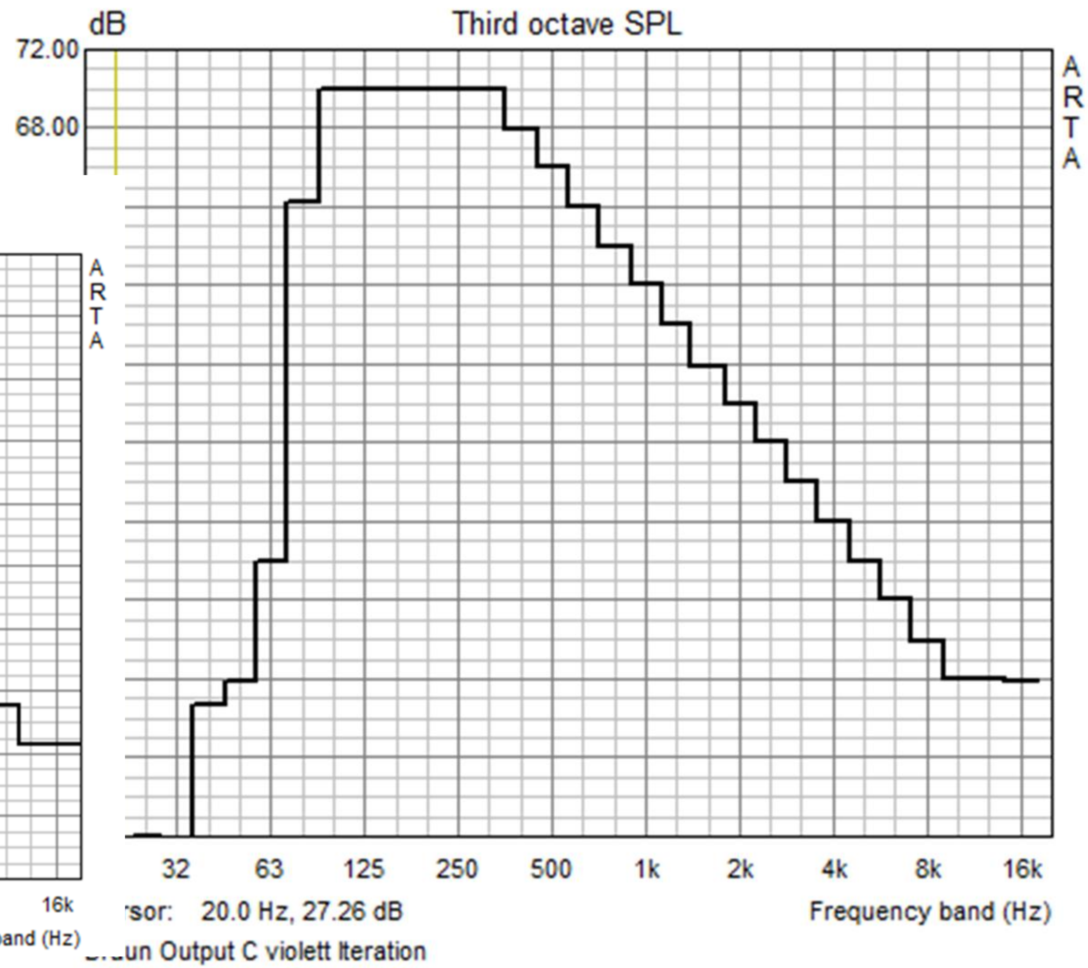
- *Straightest way to a precise result (When it is clear, which IR (signal level ! - THD contra SNR !) should get used).* See the picture below: Residual error after 5 iteration steps using a (40 year old) Braun Output C loudspeaker.
- Further is required, that no open questions are here, regarding the low end and high end frequency response cuts. The column «B» in the template should be already finally tuned; elsewise the other template would be easier to use.
- If you use the offset corrections (yellow fields) in a level-minded way; you get automatically the stimulus level calibration done at the same time.



Do a final check in the anechoic chamber with an other tool to be sure no wrong settings got used in Dirac: Use a class 1 *sound level meter* (class 0 filters preferred) or a class 1 acoustic test suite.

Result of the process as in the productive template, using a Braun Output C speaker.





Template Update to tV7

The slides of the manual are based on tV6. tV7 has a small change, the yellow windows as described in the next slide.

Update info for template tV7

The new template tV7 has a few new fields - the yellow fields. The template has no changes in its functionality, but is newly optimized for supporting not only **Parameters** measured my **Magnitude**, but also by **Leq**. Using Leq the spectra's are no more scaled to 0 dB, can show varying values. Therefore the offset correction is no more «hard coded», but can get changed using the yellow fields. Import the data from the Parameter dialog to the «FR of speaker» or «helper table TAB» as usual, then set the corresponding yellow field to zero-

Stimulus improvement Iterations									Cut low-end				High end side band management					Genelec 8100 Nr 1 (Grey)								
IR:		Genelec Nr 1 FG 60 dBA.wav		Path:			Average		given by the standard				These fields are for stimulus generation based on calculation						These fields are for measurement in the anechoic chamber							
Freqency	STI Male	Loudspeaker Frequency Reponse	Stimulus measured in DIRAC	Resulting Error 1	Hz	2. Shape table data input	Stimulus measured in DIRAC	Resulting Error 2: Error of Stimulus V1	Hz	3. Shape table data input	Stimulus measured in DIRAC	Resulting Error 3	Hz	4. Shape table data input	Stimulus measured in DIRAC	Resulting Error 4	Hz	5. Shape table data input	Result measured in the anechoic chamber	Resulting Error	Hz	6. Shape table data input	Result measured in the anechoic chamber	Final Resulting Error	1/3 octave STI male target value
		-55.70	Offsets	[illegible]		Offset of this block		[illegible]		Offset of this block		-134.38		Offset of this block		-134.34		Offset of this block		-134.70		Offset of this block		-134.70	
25	-40	[illegible]	71.52	12.62	[illegible]	-40	-10.86	12.54	[illegible]	-40	-134.38	######	25	-40	-134.34	-110.94	25	-40	-134.70	[illegible]	25	-40	-134.70	[illegible]	
32	-45	-22.30	75.28	15.68	32	[illegible]	-7.1	15.60	32	-45	-134.38	######	32	-45	-134.34	-111.64	32	-45	-134.70	-89.7	32	-45	-134.70	[illegible]	
40	-50	-32.40	74.73	10.03	40	-50	[illegible]	9.95	40	-50	-134.38	######	40	[illegible]	-134.34	-116.74	40	-50	-134.70	-84.7	40	-50	-134.70	-84.7	
50	-40	-24.60	72.51	5.61	50	-40	-9.87	[illegible]	50	-40	[illegible]	######	50	-40	-134.34	-118.94	50	-40	-134.70	-94.7	50	-40	-134.70	-94.7	
56	-30	-18.7	[illegible]	3.40	56	-30	-7.67	3.63	[illegible]	-30	-134.38	######	56	-30	[illegible]	-123.04	56	-30	-134.7	-104.7	56	-30	-134.7	-104.7	
63	-25	-12.80	[illegible]	6.18	63	-25	-5.47	6.73	63	[illegible]	-134.38	######	63	-25	[illegible]	-122.14	63	-25	-134.70	-109.7	63	-25	[illegible]	-109.7	
71	-10	-8.9	[illegible]	2.08	70	-10	1.06	2.16	70	-10	[illegible]	######	[illegible]	-10	-134.34	[illegible]	70	-10	-134.7	-124.7	70	-10	[illegible]	-124.7	
79	0	-5.00	[illegible]	2.99	80	0	7.59	2.59	80	0	-134.38	######	80	[illegible]	-134.34	[illegible]	80	0	-134.70	-134.7	[illegible]	0	[illegible]	-134.7	
88.4	10	-3.1	[illegible]	-3.37	88.4	10	9.37	-3.73	88.4	10	-134.38	######	[illegible]	10	[illegible]	-147.44	[illegible]	10	-134.7	-144.7	[illegible]	10	[illegible]	-144.7	
100	10	-1.20	93.76	0.26	100	9.74	11.15	-0.05	100	9.79	-134.38	######	100	[illegible]	[illegible]	-145.54	[illegible]	300.91	-134.70	-144.7	[illegible]	445.61	[illegible]	-144.7	58.4
125	10	2.90	89.9	0.50	125	9.50	7.13	0.03	125	9.47	-134.38	######	125	150.95	[illegible]	[illegible]	125	[illegible]	-134.70	-144.7	[illegible]	437.09	[illegible]	-144.7	58.4
160	10	4.80	87.45	[illegible]	160	10.05	5.08	-0.12	160	10.17	-134.38	######	160	149.75	-134.34	[illegible]	[illegible]	[illegible]	-134.70	-144.7	[illegible]	433.99	[illegible]	-144.7	58.4
200	10	2.30	89.75	[illegible]	200	10.25	7.62	-0.08	200	10.33	-134.38	######	200	152.41	-134.34	[illegible]	200	[illegible]	[illegible]	-144.7	200	439.15	-134.70	-144.7	58.4
250	10	1.00	90.91	[illegible]	250	10.39	8.96	-0.04	250	10.43	-134.38	######	250	153.81	-134.34	-143.34	250	[illegible]	[illegible]	-144.7	250	[illegible]	-134.70	-144.7	58.4

Adjust the frequency response here for 0 dB @ 1 kHz

Set the resulting error @ 1 kHz to zero

Manual: How to use the template

Qick guides for print out on the last two pages

The slides of the manual are based on tV6. tV7 has a small change, the yellow windows s described before.

See also the document «Technical Background…»

Note: When starting this process for an additional speaker, do not reuse a used template; start with a new one and copy/ paste column «C», if that what you want to use. This because, if in an iteration the low/ high end cut data gets changes, the formulas get deleted.

How to create a EN 60268-16 compliant stimulus - tV6 template version

Overview:

This document describes a method to generate stimulus of high quality. It integrates 3 different demands into one process: Iterations for higher precision, side band management to keep out of side band problems in the measurement phase and fine tuning of the spectra at the 88 Hz STI low end knee for keeping unwanted low end energy away. Last point is relevant to get the highest possible signal level out of the small speaker.
The integration of all 3 issues into done in one process, reducing the dB dynamics that SFD must can handle by about 30 db.
This leads to cleaner, more precise stimuli of exceptionally smooth sound, free of start or end plops, free of clicks, no spikes or other oddities in the measurement result. Also the resulting stimulus signal level does not vary much from one speaker stimulus to other speaker before calibration.

Conceptual aspects:

DIRAC support / offers two very different methods for measuring STI:

- With the stimulus as mentioned before
- Sending a pink MLS signal to the speaker and doing all spectra corrections in post processing. For this no stimulus is required, but a System Calibration of the speaker in (high quality) free field or in a reverberation chamber.

The second method is not part of this documentation.
Be aware, both methods have cons and pros; the stimulus method is more powerful in situations with a lot of low frequency noise; the System Calibration is more robust in high frequency noise situations.
Measuring (not all too noisy) empty rooms; both methods work same precise. The System Calibration based method, mainly developed for EN 3382-3 Open Plan Office measurements, has the advantage to can automatically measure the distance between speaker and microphone and can automatically generate charts with distance depending results (STI, SPL).

How to create a EN 60268-16 compliant stimulus

Prelude:

Measuring room acoustics is about the inverse process, to what gets done in mastering studios: In room measurements a colourless sound gets sent into the room and the room-coloured sound, captured by the microphone, gets process to a document, describing the rooms acoustic behaviour - the IR (Impulse response). In master studios, recordings made in colourless studios (high sound absorbance, microphones close to the instruments) get processed by a process called auralization to sound as if recorded in a specific room (e.g. an orchestra in a cathedral, or a band playing in a cave) by convolving the recording with an IR describing the room.

Making a stimulus, both processes get combined; the measurements process to capture the speakers sound, for applying the inverse "sound of the speaker" to the stimulus - to end up with an uncoloured speaker-emitted sound. DIRAC's SFD does all of this, further applies the 60268-16 male speech spectra (or any other) and has options to handled undesired side bands, which can appears, when making measurements using the self generated stimulus. Measurements are deconvolution processes - a kind of division of the sent out and received spectra's; and if weak signals get divide by extremely weak signals, the result „explodes" (e.g. dividing 0.1 by 0.0001 ends with 1000), making the result worthless - because the dynamics from 0.0001 to 1000 is simply too much.

The process described here enhances SFD to achieve a more robust side band management, has a „collateral advantage" of reducing the signal dynamics a lot, making the convolution / auralization step more precise, reducing the needs on iteration cycles. This process does not use the low end cut filter of SFD; so the frequency cut below 88 Hz gets managed in the same process/ steps.

How to create a EN 60268-16 compliant stimulus

Introduction & Summary of the process concept:

- *For a high stimulus precision, an iterative process is required* - also when not using the process explained here. When testing a newly generated stimulus over the whole chain; that means the emitted spectra of the speaker in a anechoic chamber, then the deviation to the EN 60268-16 spectra gets (by the template) calculated and applied as correction to the last used SFD shape table data from 25 Hz to 20 kHz. (As input for the next iteration loop).
- ***Already for the first SFD pass, the iteration Excel template gets used***. Instead of using DIRACS (the standards) 100 Hz – 10 kHz (octave: 125 Hz – 8 kHz) SFD shape table entry, the data from columns A and B of the iteration template gets used (25 Hz – 20 kHz) - in the tab "SFD steps". With this data, the dynamics of the SFD output comes down dramatically (typically about 30 dB) - making the SFD & convolution steps more focussed and precise.
- The data in column B, from 100 Hz to 10 kHz, **is initially** (and get modified in each loop - appearing in the additional columns further right) from **the spectra of the standard**. The data from *25 Hz to 80 Hz you must initially estimate*; in each loop you can fine tune it (mostly not required). Same for the data from 12 kHz upwards; but there activities are only required, if the speaker has a strong frequency response drop.
- For the data from 25 to 80 Hz; the rule is simple: Put in column B (=goal spectra for the signal level) values, that take the spectra from 25 to 50 Hz level down the 1 kHz level - this taking in account, that SFD will - due to its frequency response correction approach - pump up the signal level to that extent, as the frequency response of the speaker drops. *If you don't feel comfortable about handling this, just use to start the default values of the template.*

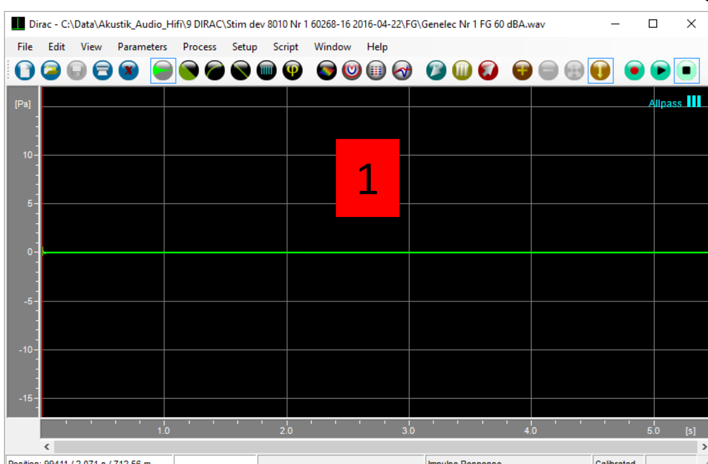
How to create a EN 60268-16 compliant stimulus (I)

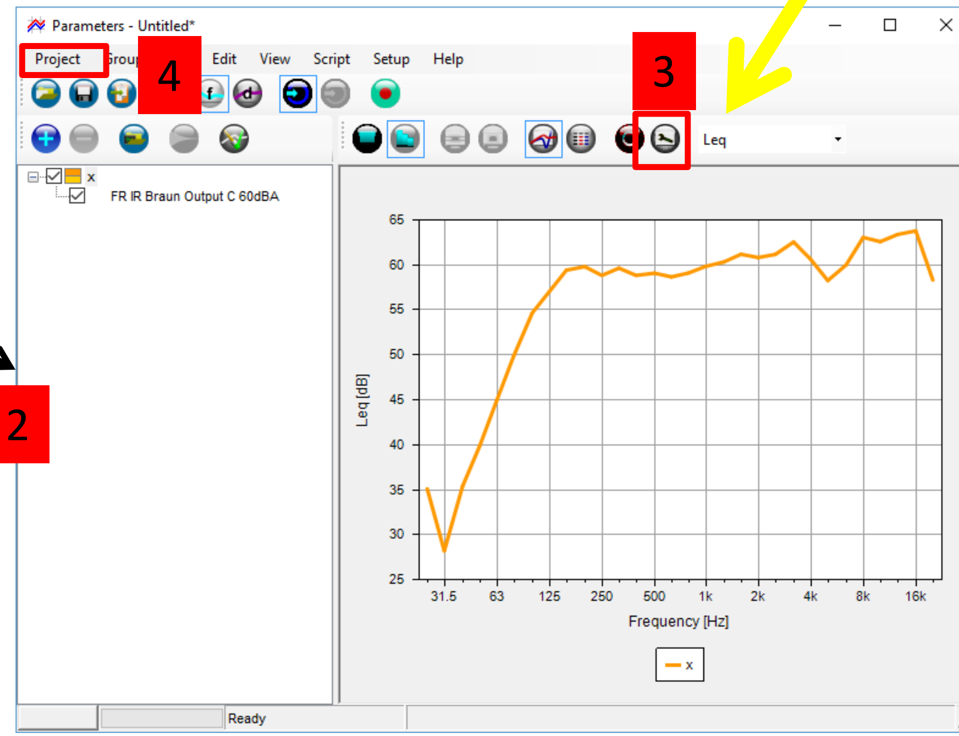
This step is identical for both templates

This process assumes, that you have measured already the speaker frequency response IR (with PinkMLS or eSine) at several levels and have decide which is the best IR for the stimulus generation

If you don't know yet, which of your IR's has the best THD / SNR for the process, *use the Excel «Einfluss Pegel auf LS 2.xlsx» template of the set to analyse the THD / SNR trade-off of each level. Check IR quality -> as in DIRAC's Help.*
If have not made the speaker frequency response IR measurements yet, *do them in a high quality anechoic chamber @ 1.00 meter distance. Use EDIT ROTATE to check the distance; Store each with a self-explaining name including signal level and date. Start with 60 dBA, make further measurements in 3 dB steps up to about 75 dBA. Set speaker and microphone in the chamber fairly in the centre, in a «untidy arrangement» with nothing in parallel to the walls.*
No one should be in the chamber during the measurements.

1. Open the IR of the loudspeaker measurement
2. Measure its frequency response using „Leq“ (in the Parameter dialog) 
3. Set display to 1/3 Hz resolution and full bandwidth 25 – 20 kHz
4. Use PROJECT -> COPY TABLE





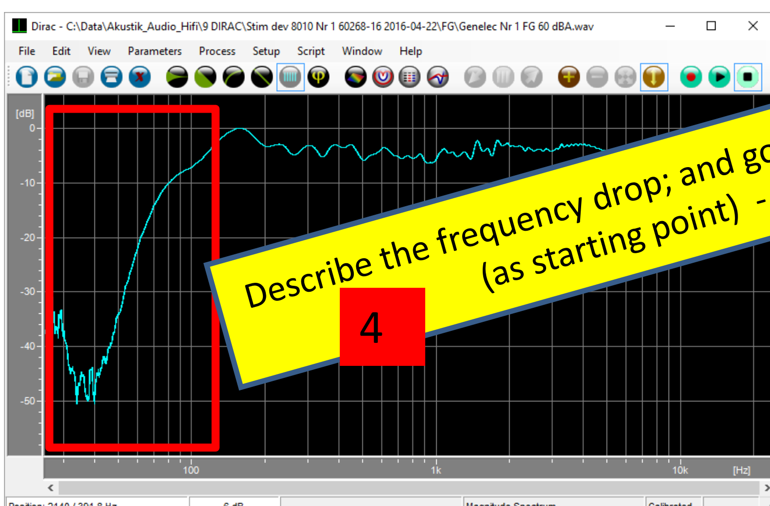
How to create a EN 60268-16 compliant stimulus (II)

This step is identical for both templates

Now we have measured the frequency response and must get the template to know it; plus prepare the low end cut.

1. Open the Excel template, the **tab „FR of speaker“**. Put the cursor into the yellow field. Copy the data using CONTRL-V.
2. Open the Excel **tab „SFD steps“,**.
3. Change in DIRAC the loudspeaker IR into the FR view and look at the decay below 100 Hz.
4. Reflect this decay in the numbers in the black fields. *The default values there could be already a good choice.*

3



4

Describe the frequency drop; and go from 50 to 25 Hz about 10 dB lower (as starting point) - or use default values.

Initial Frequency Respo

1

Magnitude pink [dB]	
	x
Frequency [Hz]	Ch.1 Avg
25.00	-42.97
31.50	-43.23
40.00	-40.15
50.00	-34.43
63.00	-31.29
80.00	-26.02
100.00	-20.03
125.00	-12.43
160.00	-8.05
200.00	-8.65
250.00	-9.16
315.00	-9.11
400.00	-8.23
500.00	-8.96
630.00	-7.75
800.00	-7.26
1000.00	-6.82
1250.00	-4.87
1600.00	-1.07
2000.00	0.00
2500.00	-0.13
3150.00	-1.98
4000.00	[illegible]
[illegible]	[illegible]
[illegible]	-1.32
16000.00	-1.26
20000.00	-2.74

5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
-45.00
-50.00

2

Stimulus improvemen

IR: BlueBox 3 FG 80 dBA.wav

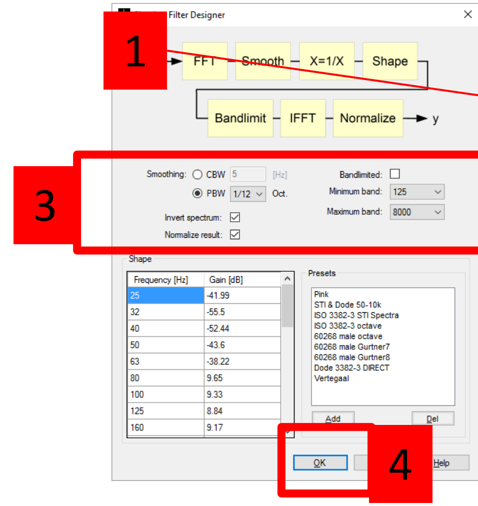
Frequency	STI Male	Loudspeaker Frequency Reponse	Stimulus measured in DIRAC	Resulting Error 1
25	-50	47.06	-30.47	1.83
32	-45	44.62	-30.04	-0.30
40	-40	40.25	-28.46	0.65
50	-35	34.72	-28.86	0.78
56	-30	33.04	-22.15	4.17
[illegible]	-20	31.36	-15.44	2.56
[illegible]	-10	-28.695	-9.51	1.16
79	0	26.03	-3.58	-0.25
88.4	5	-23.015	-1.79	-0.45
100	10	-20.00	0	-0.64
125	10	-12.38	-5.97	1.01
160	10	-8.02	-11.48	-0.14
200	10	-8.50	-11.1	-0.24
250	10	-9.00	-10.64	-0.28
315	10	-8.86	-11.09	-0.59
400	8	-8.02	-13.51	-0.17

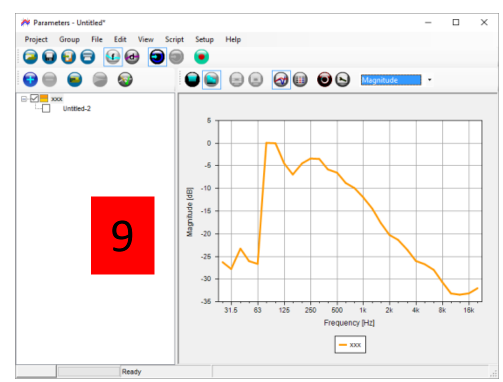
How to create a EN 60268-16 compliant stimulus (III)

This step is identical for both templates

Now we are transferring the male spectra and low end cut to SFD; SFD knows the speakers FR out of the IR and will correct it automatically

1. Copy / paste the numbers from the template out of column „A“ and „B“ **to SFD**, from 25 Hz to 20 kHz
2. Make sure, the first entry field got set correctly as „25“. (By pressing ENTER).
3. Set all the other SFD parameter as shown in the next slide
4. Press o.k.
5. Look at the newly generated IR by changing to the frequency response view Does it look healthy ? Sharp cut at 89 Hz ? No side band effects ? (here none). **Correct the black fields and repeat the steps so far   -   jf required.**
6. Put window as in picture 5 back into the IR view, Convolve (see overnext slide), the using a Pink MLS block (e.g. PinkMLS18). **Use PROCESS -> CONVOLVE**
7. **Apply EDIT -> NORMALIZE**
8. **Store the just generated stimulus as result of first build step („Stimulus mySpeakerXY step 1 <date>“).**
9. Next step is dependent on template's field colour.





Sti

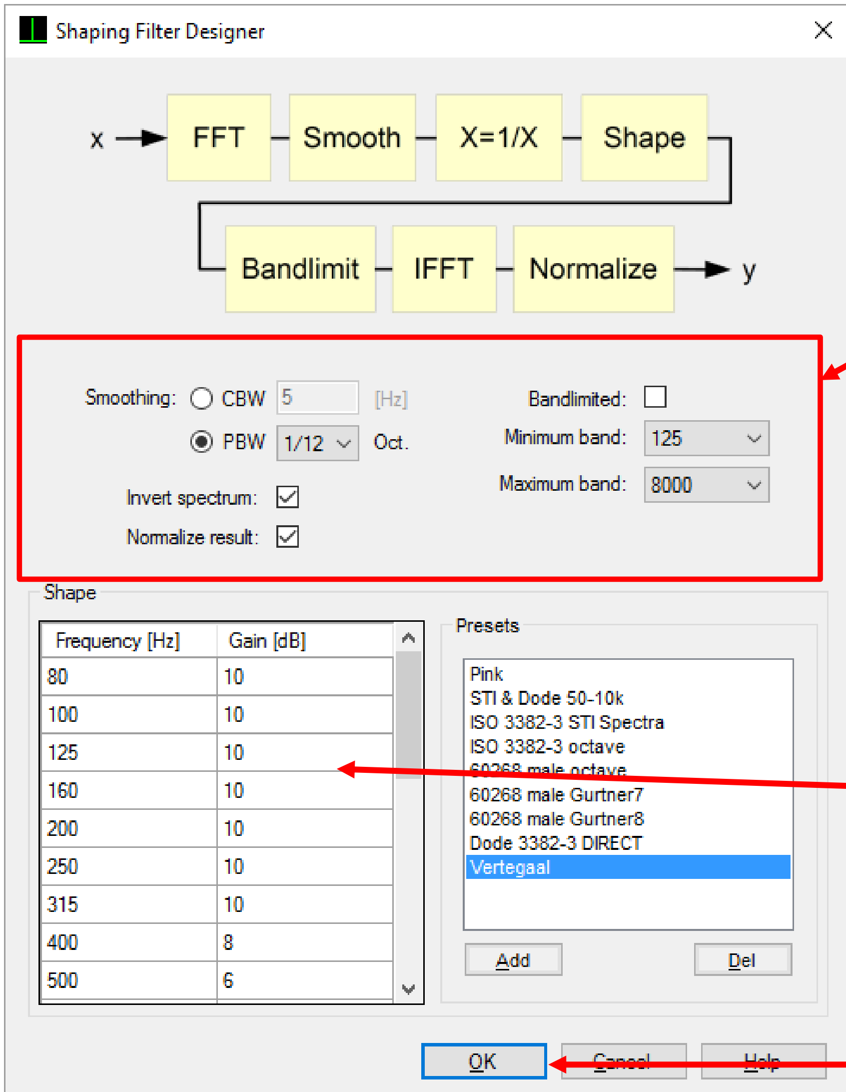
IR:

Freqency	STI Male
25	-50
32	-45
40	-40
50	-35
56	-30
63	-20
71	-10
79	0
88.4	5
100	10
125	10
160	10
200	10
250	10
315	10

How to create a EN 60268-16 compliant stimulus (IV)

Details regarding the content of the last slide

This step is identical for both templates



Set the options as shown (as starting rule; adjust according your experience - if you want).
As explained elsewhere, for e.g. the Fostex 6301 loudspeaker the PBW should / could be 1/3 octave for best results. In general, 1/12 or 1/24 octave is (likely) best choice.

The standard requires in no way, that within the 1/3 octave blocks the frequency response gets smoothed.

Enter (copy) data from template, tab «SFD steps», fields A4 to B33 (for first pass). Make sure, the field left top gets also copied by pressing ENTER before OK.
Here the hot stuff happens. These values get revised during the iterations to get max precision and fine tuning of the low (and maybe high) end cut.

Press «o.k.».

Coffee time (first cup) - Or taking time to get aware what happened and must go on (I)

What did we do so far ?
SFD requires an IR as input and delivers an IR as result, since for the convolution process we need an IR. We could just have entered an IR (made by EDIT ->GENERATE -> dirac impulse) and male spectra data to the shape table - then we would have got an IR as output, capable to make a stimulus with male spectra, but without speaker frequency response correction. This would be exactly the way one may want to go, if one must test e.g. a speech room with equalized loudspeaker - equalized by speaker DSP or an equalizer elsewhere in the system. Or if one has a Nti TalkBox and wants to reuse it with DIRAC.

But we want to correct also the speaker frequency response; therefore an IR of the speaker got used and the option «Invert Spectrum» gets set. Sad to say, that IR includes also the noise during the measurement and speaker non-linearity's. But that we tried to minimalize this by using a really quite anecdotic chamber, and running the speaker at a level were the template «Einfluss Pegel auf LS 2.xlsx» showed less than e.g. 0.1 dB of non-linearity's. The quieter the chamber is , the weaker the IR we use may be.

We entered also data below 100 Hz and above 10 kHz to shape the low and high end cuts, to make sure, that later during measurements no deconvolution side bands will run up to disturbing levels. Here we started with best guess values and the template will show after the first pass, if any corrections are needed.

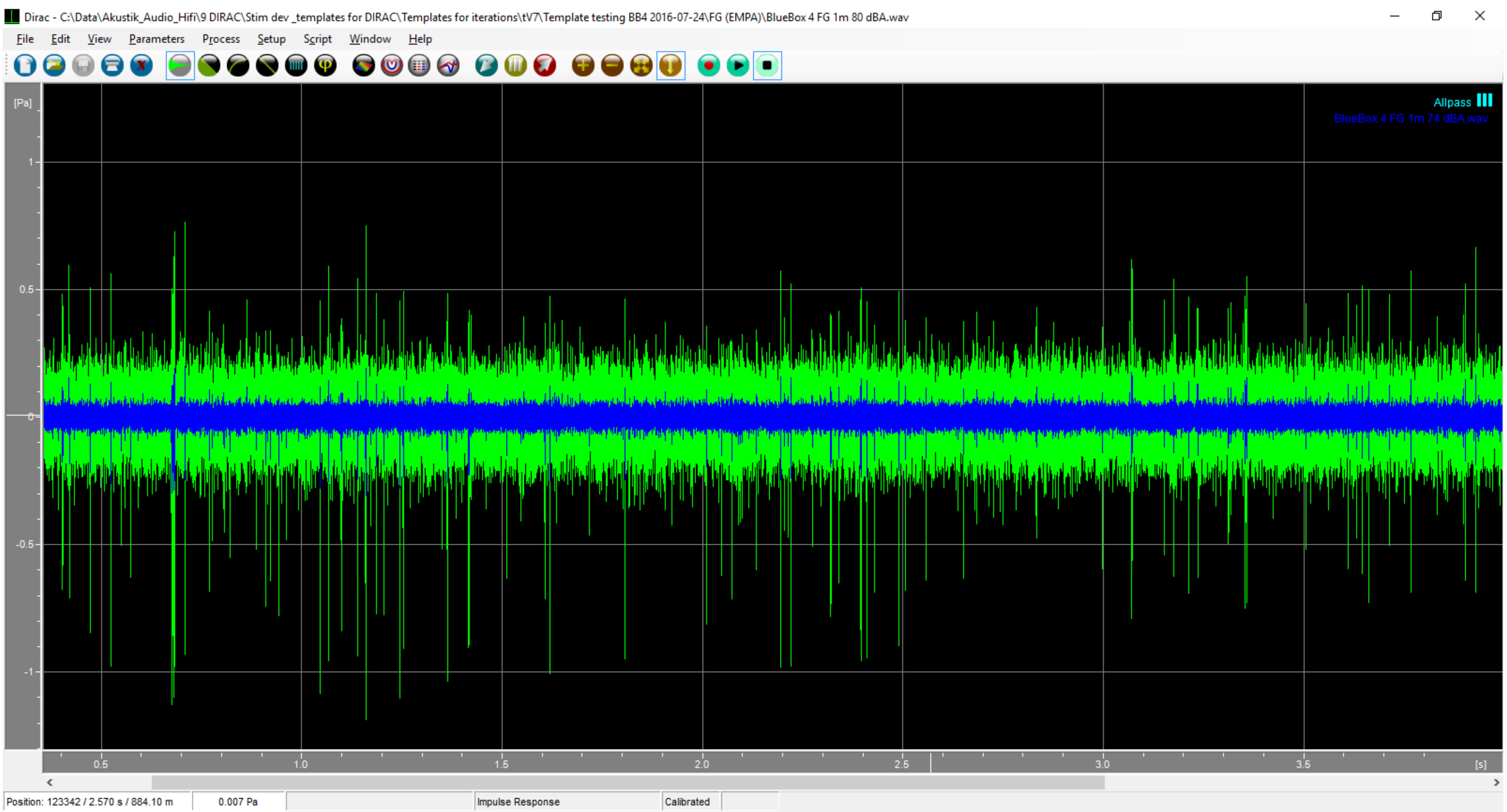
We have made already the first stimulus version (slide 6 steps 6 - 8). If we are in Simulation (=using brown fields), then the template will calculate how good the result is based on the frequency response measurement made already. This simulation of the speaker leads, due to speaker non-linearities, to a loss in precision.
If we are tuning the errors by measurement - that means we have the speaker online in the chamber, and measure during each iteration newly to capture any changes in any non-linearity's of the speaker, then we get fully precise data. For that we play the newly made stimulus using the measurement window - as if we were making an STI measurement.

Coffee time (first cup) - Or taking time to get aware what happened and must go on (II)

In addition to use the file «Einfluss Pegel auf LS 2.xlsx»

Don’t forget to use the traditional ways to qualify the IR regarding distortions and noise. In DIRAC’s Help and White Papers you find detailed information.

Here a short illustration: The IR of the BlueBox at 60 dBA @ 1m PinkMLS signal level and at 74 dBA: As one sees, the spikes drop a lot - in level and in amount of them.

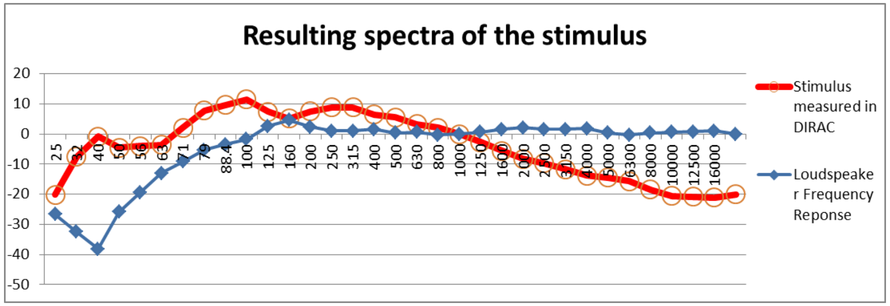


Coffee time (second cup) - Or taking time to get aware what happened and must go on

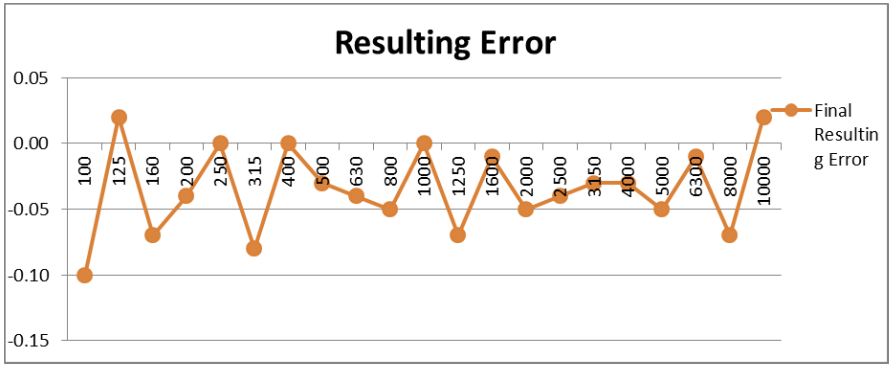
What has to come yet ?

The refinement of the speakers frequency response happens automatically by the formulas - you don't need to care about that. Same for any non-perfect implementation of the shape table.

Is the low cut o.k fine ? This you see best using the template with the pale brown fields. It is ideal for getting to learn the speaker and can get used completely independent of an anechoic chamber. The template gives you a view as right side up, which allows to judge the quality of the cuts. They looks o.k.; but better would be a lower level between 60 and 40 Hz and no dip at 25 Hz. Then one should measure the speaker in a quite and very poor STI situation (< 0.2 STI) to check, that no strong deconvolution side bands get generated.



Surveiiling the iteration process will take place in parallel:



Coffee time (with brandy) - Or taking time to get aware what happened and must go on

Back to the big picture

As you know, two templates exist; the brown fields do not require an anechoic chamber and violet fields do. The first is for development work, the second for productive calibration work.

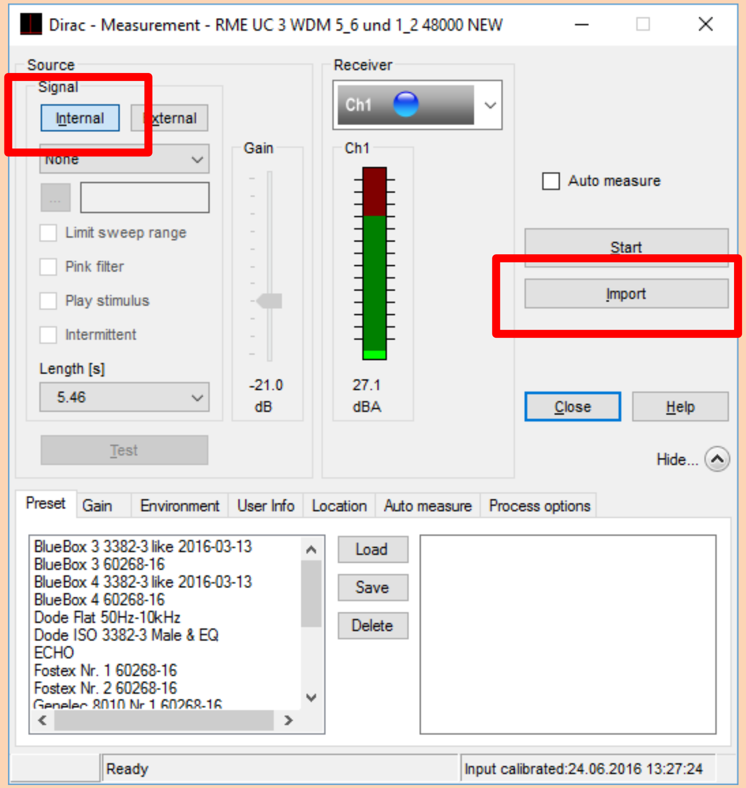
There are very good reasons to use most of the time only the development template , and change - when everything has gone well - for the final work to the productive template having only violet fields. Then all iteration must get repeated, costing about 1/ hour.

You have to optimize the low end cut; check for freedom of deconvolution side bands and - with high probability go through all steps with more than one speaker IR, since only at the end of all steps it gets clear, how clean (MTF / MTI) the IR measured at 69 dBA is when compared with the one measured at 66 dBA. And always the deconvolution risk should get checked requiring a very different microphone / speaker setup as in the chamber.

For deconvolution checks you do not need to use chamber.

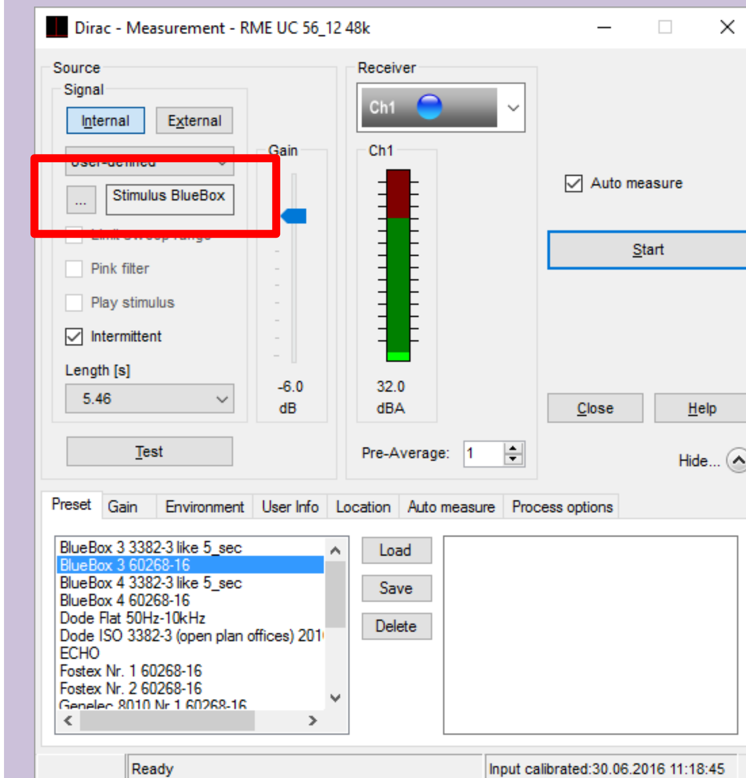
The next slide shows the different process details when using brown and violet blocks; the violet blocks in both template have the same functionality.

Next steps using the brown fields in the template



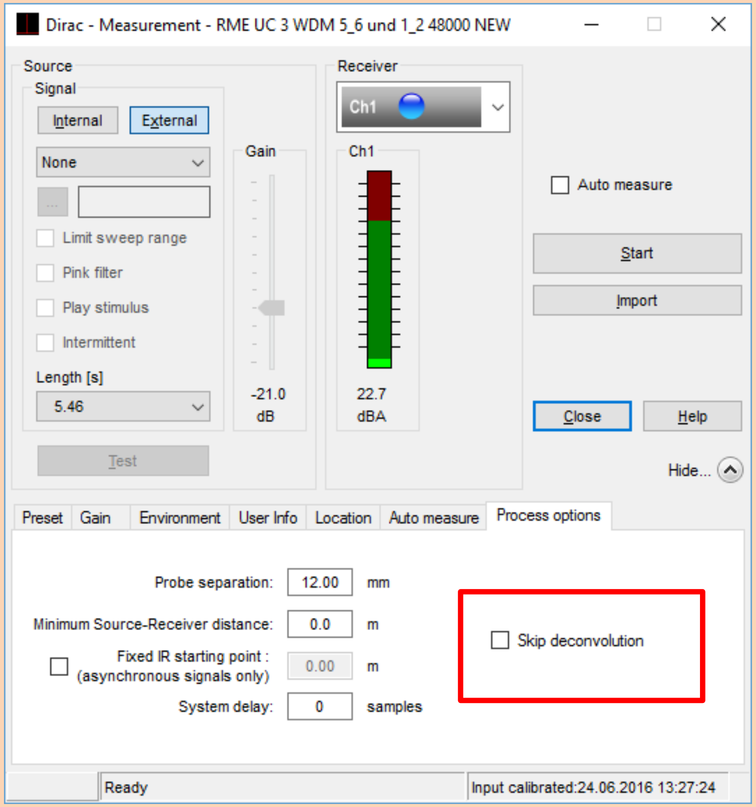
- Measure the “Leq” Parameter spectra of the stimulus by first importing the lusing the “None” setting and the IMPORT button. Set the PARAMETER dialog to Leq, 1/3 octve, 25 – 20kHz.
- Use PARAMETER COPY TABLE and paste the data to the template tab „Helper TABLE“, first entry, cursor on the yellow field.
- The data of 10) gets copied automatically into column „D“ (or further right) of tab „SFD steps“.

Next steps using the violet fields in the template



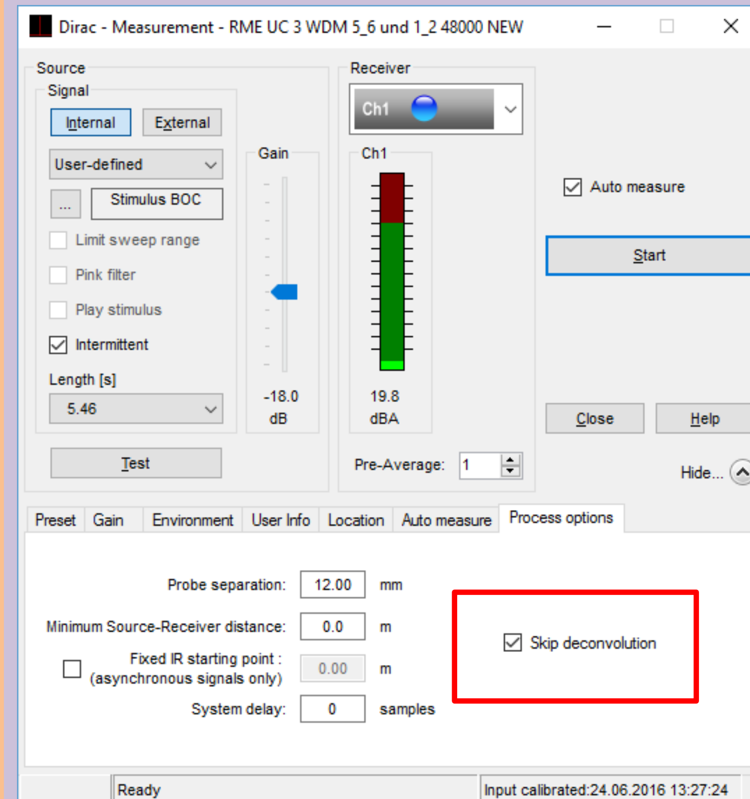
- Make a measurement with newest step of stimulus. See next page for further details
- Use PARAMETER dialog, Leq for 1/3 octave and 25 – 20kHz.
- Use COPY TABLE to paste the data to the template tab „Helper TABLE“, first entry, cursor on the yellow field. (Later iteration further using right hand blocks).
- This gets data copied automatically into column „D“ (or further right during itertaions) of tab „SFD steps“.

Next steps using the brown fields in the template



- Since no measurement via the Measurement Window get made, the convolution setting do play no role.
- So best to leave them as they are required for STI measurements

Next steps using the violet fields in the template



- Set under PROCESS OPTIONS: Skip deconvolution. This because we want to measure the emitted spectra.

Iterations

Use of yellow fields

		-59.78	Offsets	-47.72		Offset of this block		-128.34
25	0	-19.19	68.9	1.99	**25**	0	-128.34	#######
32	-10	-25.62	65.94	2.60	**32**	-10	-128.34	#######
40	-30	-39.85	64.36	6.79	**40**	-30	-128.34	#######
50	-20	-39.88	66.24	-1.36	**50**	-20	-128.34	#######
56	-20	-38.8	67.865	1.35	**56**	-20	-128.34	#######
63	-20	-37.72	69.49	4.05	**63**	-20	-128.34	#######

- Use the yellow fields to set the error column just now of relevance at 1 kHz to zero.

		-6.58	Offsets	-53.20		Offset of this block		-60.43
25	-40	28.46	15.08	1.88	**25**	-40	-23.67	16.33
32	-30	21.56	23.97	0.77	**32**	-30	-29.46	0.54
40	-20	28.76	31.75	-1.45	**40**	-20	-21.6	-1.60
50	-20	33.23	33.24	0.04	**50**	-20	-20.55	-0.55
56	-20	35.77	36.27	3.07	**56**	-20	-17.35	2.65
63	-20	38.31	39.3	6.10	**63**	-20	-14.15	5.85

- The standard defines the signal level to be at 1 kHz 53.2 dB. But we are using here 1/3 octave; therefore the signal level must be 4.77 dB lower. So the goal value is 48.33 dB.
- With this automatically the correct calibration value of the stimulus signal level gets achieved.
- For other distances then 1 m this level must get adjusted.
- **Nominal value for 1m and 60 dB(A) is 48.43 dB.**

Understanding the Excel template

For first pass

For iterations; brown at the desk; pink area for iterations using the whole chain and anechoic chamber

Stimulus improvement Iterations — IR: BlueBox 3 FG 80 dBA.w — Path: Average

Cut low-end — given by the standard

High end side band management — For stimulus generation based on calculation

BlueBox 4 / 80 dBA — For measurement in the anechoic chamber

Frequency	STI Male	Loudspeaker Frequency Response	Stimulus measured in DIRAC	Resulting Error 1	Hz	2. Shape table data input	Stimulus measured in DIRAC	Resulting Error 2: Error of Stimulus V1	Hz	3. Shape table data input	Stimulus measured in DIRAC	Resulting Error 3	Hz	4. Shape table data input	Stimulus measured in DIRAC	Resulting Error 4	Hz	5. Shape table data input	Result measured in the anechoic chamber	Resulting Error	Hz	6. Shape table data input	Result measured in the anechoic chamber	Final Resulting Error	1/3 octave STI male target value
25	-50	47.06	30.47	1.8	25	-50	-30.79	1.85	25	-50	-30.68	2.14	25	-50	0	38.34	25	-50	0	50	25	-50	0	50	
32	-45	44.62	30.04	-0.3	32	-45	-30.37	-0.29	32	-45	-30.41	-0.15	32	-45	0	35.78	32	-45	0	45	32	-45	0	45	
40	-40	40.25	28.46	0.6	40	-40	-28.79	0.66	40	-40	-28.92	0.71	40	-40	0	35.15	40	-40	0	40	40	-40	0	40	
50	-35	34.72	28.86	0.7	50	-35	-29.18	0.80	50	-35	-29.36	0.80	50	-30	0	35.68	50	-30	0	35	50	-30	0	35	
56	-30	33.04	22.15	4.1	56	-30	-22.47	4.19	56	-30	-22.645	4.20	56	-15	0	32.36	56	-15	0	30	56	-15	0	30	
63	-20	31.36	15.44	2.5	63	-20	-15.76	2.58	63	-20	-15.93	2.59	63	0	0	24.04	63	0	0	20	63	0	0	20	
71	-10	-28.695	-9.51	1.1	70	-10	-9.83	1.18	70	-10	-10.005	1.18	70	5	0	16.71	70	5	0	10	70	5	0	10	
79	0	26.03	-3.58	-0.2	80	0	-3.9	-0.23	80	0	-4.08	-0.23	80	10	0	9.37	80	10	0	0	80	10	0	0	
88.4	5	-23.015	-1.79	-0.4	88.4	5	-1.95	-0.27	88.4	5	-2.04	-0.18	88.4	10	0	7.385	88.4	10	0	-5	88.4	10	0	-5	
100	10	20.00	0	-0.6	100	10.64	0	-0.30	100	10.94	0	-0.12	100	11.06	0	5.4	100	5.66	0	-10	100	15.66	0	-10	58.4
125	10	12.38	-5.97	1.0	125	8.99	-6.91	0.41	125	8.58	-7.3	0.20	125	8.38	0	13.02	125	-4.64	0	-10	125	5.36	0	-10	58.4
160	10	8.02	11.48	-0.1	160	10.14	-11.84	-0.16	160	10.30	-11.96	-0.10	160	10.4	0	17.38	160	-6.98	0	-10	160	3.02	0	-10	58.4
200	10	8.50	-11.1	-0.2	200	10.24	-11.19	0.01	200	10.23	-11.35	0.03	200	10.2	0	16.9	200	-6.7	0	-10	200	3.3	0	-10	58.4
250	10	9.00	10.64	-0.2	250	10.28	-10.65	0.05	250	10.23	-10.84	0.04	250	10.19	0	16.4	250	-6.21	0	-10	250	3.79	0	-10	58.4
315	10	8.86	11.09	-0.5	315	10.59	-10.92	-0.08	315	10.67	-11.04	-0.02	315	10.69	0	16.54	315	-5.85	0	-10	315	4.15	0	-10	58.4
400	8	8.02	13.51	-0.1	400	8.17	-13.6	0.08	400	8.09	-13.82	0.04	400	8.05	0	19.38	400	-11.33	0	-8	400	-3.33	0	-8	56.4
500	6	8.88	14.64	-0.1	500	6.16	-14.81	0.01	500	6.15	-15	0.00	500	6.15	0	20.52	500	-14.37	0	-6	500	-8.37	0	-6	54.4
630	4	7.66	17.78	-0.0	630	4.08	-18.04	0.00	630	4.08	-18.23	-0.01	630	4.09	0	23.74	630	-19.65	0	-4	630	-15.65	0	-4	52.4
800	2	7.21	19.97	0.1	800	1.82	-20.41	0.08	800	1.74	-20.64	0.03	800	1.71	0	26.19	800	-24.48	0	-2	800	-22.48	0	-2	50.4
1000	0	6.77	22.59	0.0	1000	0.00	-22.95	-0.02	1000	0.02	-23.11	0.00	1000	0.02	0	28.63	1000	-28.61	0	0	1000	-28.61	0	0	48.4
1250	-2	3.72	27.61	0.0	1250	-2.03	-27.96	0.02	1250	-2.05	-28.14	0.02	1250	-2.07	0	33.68	1250	-35.75	0	2	1250	-37.75	0	2	46.4
1600	-4	0.85	-32.5	0.0	1600	-4.01	-32.82	0.03	1600	-4.04	-33	0.03	1600	-4.07	0	38.55	1600	-42.62	0	4	1600	-46.62	0	4	44.4
2000	-6	0.00	35.65	-0.2	2000	-5.71	-35.73	-0.03	2000	-5.68	-35.89	-0.01	2000	-5.67	0	41.4	2000	-47.07	0	6	2000	-53.07	0	6	42.4
2500	-8	0.00	37.67	-0.3	2500	-7.69	-37.7	0.00	2500	-7.69	-37.86	0.02	2500	-7.71	0	43.4	2500	-51.11	0	8	2500	-59.11	0	8	40.4
3150	-10	1.17	38.44	-0.2	3150	-9.75	-38.52	0.01	3150	-9.76	-38.7	0.01	3150	-9.77	0	44.23	3150	-54	0	10	3150	-64	0	10	38.4
4000	-12	2.92	38.56	-0.1	4000	-11.88	-38.75	0.03	4000	-11.91	-38.94	0.02	4000	-11.93	0	44.48	4000	-56.41	0	12	4000	-68.41	0	12	36.4
5000	-14	4.13	39.31	-0.0	5000	-13.92	-39.54	0.03	5000	-13.95	-39.73	0.02	5000	-13.97	0	45.27	5000	-59.24	0	14	5000	-73.24	0	14	34.4
6300	-16	4.24	41.27	-0.1	6300	-15.85	-41.48	-0.02	6300	-15.83	-41.63	0.01	6300	-15.84	0	47.16	6300	-63	0	16	6300	-79	0	16	32.4
8000	-18	1.62	-45.7	0.0	8000	-18.04	-46.01	0.07	8000	-18.11	-46.23	0.03	8000	-18.14	0	51.78	8000	-69.92	0	18	8000	-87.92	0	18	30.4
[illegible]	[illegible]	3.67	-45.9	-0.2	10000	-19.79	-46.01	0.02	10000	-19.81	-46.18	0.03	10000	-19.84	0	51.73	10000	-71.57	0	20	10000	-91.57	0	20	28.4
12500	-20	[illegible]	[illegible]	-0.4	12500	-19.59	-48.71	-0.09	12500	-19.50	-48.82	-0.02	12500	-19.48	0	54.32	12500	-73.8	0	20	12500	-93.8	0	20	
16000	-20	[illegible]	[illegible]	0.2	[illegible]	[illegible]	-49.35	0.07	16000	-20.32	-49.51	0.09	16000	-20.41	0	55.12	16000	-75.53	0	20	16000	-95.53	0	20	
20000	-20	[illegible]	[illegible]	0.26	20000	-20.26	-48.46	0.02	20000	-20.28	-48.65	0.01	20000	-20.29	0	54.18		-74.47	0	20			0	20	

The pink fields are for the measurements in the anechoic chamber; the fields further left for the desk preparation work - where the speakers impact gets calculated and not measured.

- The frequency response appaeras here after entring it into the tab "FR of Speaker".
- **Data, as given by the standard - the male spectra shape.**
- **Data to control the** low **end response - to keep out of side band problems and have a nice and sharp knee at 89 Hz. Chabes made here get automatically copied to the later iteration; where the may be overwritten**
- **Data to control the** high **end response - to keep out of side band problems** (mostly only required with speakers having massive FR drop at 20 kHz)
- **After stimulus generation, its spectra measure in DIRAC (using the *Properties dialogue*).**
- **Resulting error of the stimulus (of the first step)**
- **The data to be copied to the SFD shape table *for the (first or next) iteration***

Understanding the Excel template

Iteration phases

Stimulus improvement Iterations | **Cut low-end** | High end side band management | **BlueBox 4 / 80 dBA**

IR: BlueBox 3 FG 80 dBA.wav | Path: | Average | given by the standard | For stimulus generation based on calculatio | For measurement in the anechoic chamber

Freqency	STI Male	Loudspeaker Frequency Reponse	Stimulus measured in DIRAC	Resulting Error 1	Hz	2. Shape table data input	Stimulus measured in DIRAC	Resulting Error 2: Error of Stimulus V1	Hz	3. Shape table data input	Stimulus measured in DIRAC	Resulting Error 3	Hz	4. Shape table data input	Stimulus measured in DIRAC	Resulting Error 4	Hz	5. Shape table data input	Result measured in the anechoic chamber	Resulting Error	Hz	6. Shape table data input	Result measured in the anechoic chamber	Final Resulting Error	1/3 octave STI male target value
25	-50	-47.06	-30.47	1.83	25	-50	-30.79	[illegible]	25	-50	-30.68	2.14	25	-50	0	38.34	25	-50	0	50	25	-50	0	50	
32	-45	-44.62	-30.04	-0.30	32	-45	-30.37	[illegible]	32	-45	-30.41	-0.15	32	-45	0	35.78	32	-45	0	45	32	-45	0	45	
40	-40	-40.25	-28.46	0.65	40	-40	-28.79	[illegible]	40	-40	-28.92	0.71	40	-40	0	35.15	40	-40	0	40	40	-40	0	40	
50	-35	-34.72	-28.86	0.78	50	-35	-29.18	[illegible]	50	-35	-29.36	0.80	50	-30	0	35.68	50	-30	0	35	50	-30	0	35	
56	-30	-33.04	-22.15	4.17	56	-30	-22.47	[illegible]	56	-30	-22.645	4.20	56	-15	0	32.36	56	-15	0	30	56	-15	0	30	
63	-20	-31.36	-15.44	2.56	63	-20	-15.76	[illegible]	63	-20	-15.93	2.59	63	0	0	24.04	63	0	0	20	63	0	0	20	
71	-10	-28.695	-9.51	1.16	70	-10	-9.83	[illegible]	70	-10	-10.005	1.18	70	5	0	16.71	70	5	0	10	70	5	0	10	
79	0	-26.03	-3.58	-0.25	80	0	-3.9	[illegible]	80	0	-4.08	-0.23	80	10	0	9.37	80	10	0	0	80	10	0	0	
88.4	5	-23.015	-1.79	-0.45	88.4	5	-1.95	[illegible]	88.4	5	-2.04	-0.18	88.4	10	0	7.385	88.4	10	0	-5	88.4	10	0	-5	
100	10	-20.00	0	-0.64	100	10.64	0	[illegible]	100	10.94	0	-0.12	100	11.06	0	5.4	100	5.66	0	-10	100	15.66	0	-10	58.4
125	10	-12.38	[illegible]	1.01	125	8.99	-6.91	[illegible]	125	8.58	-7.3	0.20	125	8.38	0	13.02	125	-4.64	0	-10	125	5.36	0	-10	58.4
160	10	-8.02	-11.48	-0.14	160	10.14	-11.84	[illegible]	160	10.30	-11.96	-0.10	160	10.4	0	17.38	160	-6.98	0	-10	160	3.02	0	-10	58.4
200	10	-8.50	[illegible]	-0.24	200	10.24	-11.19	[illegible]	200	10.23	-11.35	0.03	200	10.2	0	16.9	200	-6.7	0	-10	200	3.3	0	-10	58.4
250	10	-9.00	[illegible]	-0.28	250	10.28	-10.65	[illegible]	250	10.23	-10.84	0.04	250	10.19	0	16.4	250	-6.21	0	-10	250	3.79	0	-10	58.4
315	10	-8.86	[illegible]	-0.59	315	10.59	-10.92	[illegible]	315	10.67	-11.04	-0.02	315	10.69	0	16.54	315	-5.85	0	-10	315	4.15	0	-10	58.4
400	8	-8.02	[illegible]	-0.17	400	8.17	-13.6	[illegible]	400	8.09	-13.82	0.04	400	8.05	0	19.38	400	-11.33	0	-8	400	-3.33	0	-8	56.4
500	6	-8.88	[illegible]	-0.16	500	6.16	-14.81	[illegible]	500	6.15	-15	0.00	500	6.15	0	20.52	500	-14.37	0	-6	500	-8.37	0	-6	54.4
630	4	-7.66	-17.78	-0.08	630	4.08	-18.04	[illegible]	630	4.08	-18.23	-0.01	630	4.09	0	23.74	630	-19.65	0	-4	630	-15.65	0	-4	52.4
800	2	-7.21	-19.97	0.18	800	1.82	-20.41	[illegible]	800	1.74	-20.64	0.03	800	1.71	0	26.19	800	-24.48	0	-2	800	-22.48	0	-2	50.4
1000	0	-6.77	-22.59	0.00	1000	0.00	-22.95	[illegible]	1000	0.02	-23.11	0.00	1000	0.02	0	28.63	1000	-28.61	0	0	1000	-28.61	0	0	48.4
1250	-2	-3.72	-27.61	0.03	1250	-2.03	-27.96	[illegible]	1250	-2.05	-28.14	0.02	1250	-2.07	0	33.68	1250	-35.75	0	2	1250	-37.75	0	2	46.4
1600	-4	-0.85	-32.5	0.01	1600	-4.01	-32.82	[illegible]	1600	-4.04	-33	0.03	1600	-4.07	0	38.55	1600	-42.62	0	4	1600	-46.62	0	4	44.4
2000	-6	0.00	-35.65	-0.29	2000	-5.71	-35.73	[illegible]	2000	-5.68	-35.89	-0.01	2000	-5.67	0	41.4	2000	-47.07	0	6	2000	-53.07	0	6	42.4
2500	-8	0.00	-37.67	-0.31	2500	-7.69	-37.7	[illegible]	2500	-7.69	-37.86	0.02	2500	-7.71	0	43.4	2500	-51.11	0	8	2500	-59.11	0	8	40.4
3150	-10	-1.17	-38.44	-0.25	3150	-9.75	-38.52	[illegible]	3150	-9.76	-38.7	0.01	3150	-9.77	0	44.23	3150	-54	0	10	3150	-64	0	10	38.4
4000	-12	-2.92	-38.56	[illegible]	4000	-11.88	-38.75	[illegible]	4000	-11.91	-38.94	0.02	4000	-11.93	0	44.48	4000	-56.41	0	12	4000	-68.41	0	12	36.4
5000	-14	-4.13	-39.31	[illegible]	5000	-13.92	-39.54	[illegible]	5000	-13.95	-39.73	0.02	5000	-13.97	0	45.27	5000	-59.24	0	14	5000	-73.24	0	14	34.4
6300	-16	-4.24	-41.27	[illegible]	6300	-15.85	-41.48	[illegible]	6300	-15.83	-41.63	0.01	6300	-15.84	0	47.16	6300	-63	0	16	6300	-79	0	16	32.4
8000	-18	-1.62	-45.7	[illegible]	8000	-18.04	-46.01	[illegible]	8000	-18.11	-46.23	0.03	8000	-18.14	0	51.78	8000	-69.92	0	18	8000	-87.92	0	18	30.4
10000	-20	-3.67	-45.9	[illegible]	10000	-19.79	-46.01	[illegible]	10000	-19.81	-46.18	0.03	10000	-19.84	0	51.73	10000	-71.57	0	20	10000	-91.57	0	20	28.4
12500	-20	-1.08	-48.69	[illegible]	12500	-19.59	-48.71	[illegible]	12500	-19.50	-48.82	-0.02	12500	-19.48	0	54.32	12500	-73.8	0	20	12500	-93.8	0	20	
16000	-20	-0.28	-48.83	[illegible]	[illegible]	[illegible]	-49.35	[illegible]	16000	-20.32	-49.51	0.09	16000	-20.41	0	55.12	16000	-75.53	0	20	16000	-95.53	0	20	
20000	-20	-1.22	-47.88	[illegible]	20000	-20.26	-48.46	[illegible]	20000	-20.28	-48.65	0.01	20000	-20.29	0	54.18		-74.47	0	20			0	20	

Data in 1/6 octave steps get calculated (average of value from higher and lower frequency level value). Between 50 and 100 Hz the stimulus target value gets set in 1/6 octave steps for fine tuning the 88 Hz knee area.

- **The data to be copied to the SFD shape table *for the first (=step 2) iteration***
- **Result of the first iteration (step 2 build) loop.**
- **Input for the second iteration loop (3rd step / build)**
- Up to 4 iteration can get made with the template as it is (5 stimulus builds), based on the calculated impact of the loudspeaker. For best precision, the further iterations should no more calculated the speakers impact, but measure it. That gets done in the pink blocks; they use different formulas.
- In these two blocks the final fine tuning iteration get done (add further columns to the template as required by cut and paste). In these iterations the whole chain must gets used, including speaker, microphone. The graph «Error development» shows the progress.

Making Iterations - a generic process going from left to right.

For first pass

For iterations; brown at the desk; pink area for iterations using the whole chain and anechoic chamber

Stimulus improvement Iterations

IR: BlueBox 3 FG 80 dBA.wav | Path: | Average

Cut low-end – given by the standard

High end side band management – For stimulus generation based on calculation

BlueBox 4 / 80 dBA – For measurement in the anechoic chamber

Freqency	STI Male	Loudspeaker Frequency Reponse	Stimulus measured in DIRAC	Resulting Error 1	Hz	2. Shape table data input	Stimulus measured in DIRAC	Resulting Error 2: Error of Stimulus V1	Hz	3. Shape table data input	Stimulus measured in DIRAC	Resulting Error 3	Hz	4. Shape table data input	Stimulus measured in DIRAC	Resulting Error 4	Hz	5. Shape table data input	ult measured in the anechoic chamber	Resulting Error	Hz	6. Shape table data input	ult measured in the anechoic chamber	Final Resulting Error	octave STI male target value
25	-50	-47.06	-30.47	1.83	25	-50	-30.79	1.85	25	-50	-30.68	2.14	25	-50	0	38.34	25	-5							
32	-45	-44.62	-30.04	-0.30	32	-45	-30.37	-0.29	32	-45	-30.41	-0.15	32	-45	0	35.78	32	-4							
40	-40	-40.25	-28.46	0.65	40	-40	-28.79	0.66	40	-40	-28.92	0.71	40	-40	0	35.15	40	-4							
50	-35	-34.72	-28.86	0.78	50	-35	-29.18	0.80	50	-35	-29.36	0.80	50	-30	0	35.68	50	-3							
56	-30	-33.04	-22.15	4.17	56	-30	-22.47	4.19	56	-30	-22.645	4.20	56	-15	0	32.36	56	-1							
63	-20	-31.36	-15.44	2.56	63	-20	-15.76	2.58	63	-20	-15.93	2.59	63	0	0	24.04	63	0							
71	-10	-28.695	-9.51	1.16	70	-10	-9.83	1.18	70	-10	-10.005	1.18	70	5	0	16.71	70	5							
79	0	-26.03	-3.58	-0.25	80	0	-3.9	-0.23	80	0	-4.08	-0.23	80	10	0	9.37	80	10							
88.4	5	-23.015	-1.79	-0.45	88.4	5	-1.95	-0.27	88.4	5	-2.04	-0.18	88.4	10	0	7.385	88.4	10							
100	10	-20.00	0	-0.64	100	10.64	0	-0.30	100	10.94	0	-0.12	100	11.06	0	5.4	100	5.6							
125	10	-12.38	-5.97	1.01	125	8.99	-6.91	0.41	125	8.58	-7.3	0.20	125	8.38	0	13.02	125	-4.6							
160	10	-8.02	-11.48	-0.14	160	10.14	-11.84	-0.16	160	10.30	-11.96	-0.10	160	10.4	0	17.38	160	-6.9							
200	10	-8.50	-11.1	-0.24	200	10.24	-11.19	0.01	200	10.23	-11.35	0.03	200	10.2	0	16.9	200	-6.							
250	10	-9.00	-10.64	-0.28	250	10.28	-10.65	0.05	250	10.23	-10.84	0.04	250	10.19	0	16.4	250	-6.2							
315	10	-8.86	-11.09	-0.59	315	10.59	-10.92	-0.08	315	10.67	-11.04	-0.02	315	10.69	0	16.54	315	-5.8							
400	8	-8.02	-13.51	-0.17	400	8.17	-13.6	0.08	400	8.09	-13.82	0.04	400	8.05	0	19.38	400	-11.							
500	6	-8.88	-14.64	-0.16	500	6.16	-14.81	0.01	500	6.15	-15	0.00	500	6.15	0	20.52	500	-14.							
630	4	-7.66	-17.78	-0.08	630	4.08	-18.04	0.00	630	4.08	-18.23	-0.01	630	4.09	0	23.74	630	-19.							
800	2	-7.21	-19.97	0.18	800	1.82	-20.41	0.08	800	1.74	-20.64	0.03	800	1.71	0	26.19	800	-24.							
1000	0	-6.77	-22.59	0.00	1000	0.00	-22.95	-0.02	1000	0.02	-23.11	0.00	1000	0.02	0	28.63	1000	-28.							
1250	-2	-3.72	-27.61	0.03	1250	-2.03	-27.96	0.02	1250	-2.05	-28.14	0.02	1250	-2.07	0	33.68	1250	-35.							
1600	-4	-0.85	-32.5	0.01	1600	-4.01	-32.82	0.03	1600	-4.04	-33	0.03	1600	-4.07	0	38.55	1600	-42.							
2000	-6	0.00	-35.65	-0.29	2000	-5.71	-35.73	-0.03	2000	-5.68	-35.89	-0.01	2000	-5.67	0	41.4	2000	-47.							
2500	-8	0.00	-37.67	-0.31	2500	-7.69	-37.7	0.00	2500	-7.69	-37.86	0.02	2500	-7.71	0	43.4	2500	-51.							
3150	-10	-1.17	-38.44	-0.25	3150	-9.75	-38.52	0.01	3150	-9.76	-38.7	0.01	3150	-9.77	0	44.23	3150	-5							
4000	-12	-2.92	-38.56	-0.12	4000	-11.88	-38.75	0.03	4000	-11.91	-38.94	0.02	4000	-11.93	0	44.48	4000	-56.							
5000	-14	-4.13	-39.31	-0.08	5000	-13.92	-39.54	0.03	5000	-13.95	-39.73	0.02	5000	-13.97	0	45.27	5000	-59.							
6300	-16	-4.24	-41.27	-0.15	6300	-15.85	-41.48	-0.02	6300	-15.83	-41.63	0.01	6300	-15.84	0	47.16	6300	-6							
8000	-18	-1.62	-45.7	0.04	8000	-18.04	-46.01	0.07	8000	-18.11	-46.23	0.03	8000	-18.14	0	51.78	8000	-69.							
10000	-20	-3.67	-45.9	-0.21	10000	-19.79	-46.01	0.02	10000	-19.81	-46.18	0.03	10000	-19.84	0	51.73	10000	-71.							
12500	-20	-1.08	-48.69	-0.41	12500	-19.59	-48.71	-0.09	12500	-19.50	-48.82	-0.02	12500	-19.48	0	54.32	12500	-73							
16000	-20	-0.28	-48.83	0.25	16000	-20.25	-49.35	0.07	16000	-20.32	-49.51	0.09	16000	-20.41	0	55.12	16000	-75.53	0	20	16000	-95.53	0	20	
20000	-20	-1.22	-47.88	0.26	20000	-20.26	-48.46	0.02	20000	-20.28	-48.65	0.01	20000	-20.29	0	54.18		-74.47	0	20			0	20	

Result column: Adjust the formula in the fields to get 0.00 dB at 1 kHz

Copy these fields to SFD after opening the speakers frequency response IR (again).

Generate a new release of the stimulus

Measure the result with the new stimulus. Put it into the Helper Table TAB; it appears also here. For each iteration move one block to the tight.

When going over to measuring the whole chain in the anechoic chamber, go for the pink blocks

Repeat until the precision is sufficient (e.g. +/- 0.2 dB).

How to use the graphs

1. Click into the graphs below, first the brown curve and then shift its Excel fields frame in the table to column „E“. Make sure not to shift the frame up or down. For each iteration it gets shifted manually 4-column-wise to the right. (88.4 – 12.5k Hz)
2. Same for the graph on the right; red is the overall spectra as sent into the loudspeaker; blue the frequency response of the loudspeaker
3. So far, we only tested the stimulus quality by simulation; the template takes the frequency response numerically into account and calculates the emitted spectra. But for best precision a measurement over the whole chain in an anechoic chamber is required. The pink fields are for that; but the better approach is to change to the productive template when the data in column C has become stable.

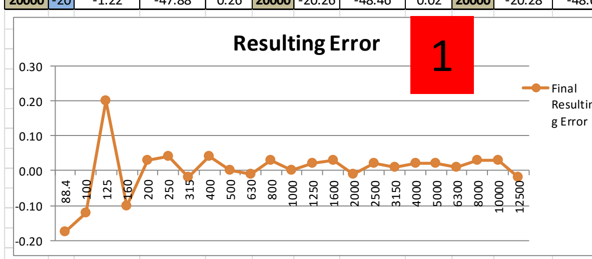
For first pass

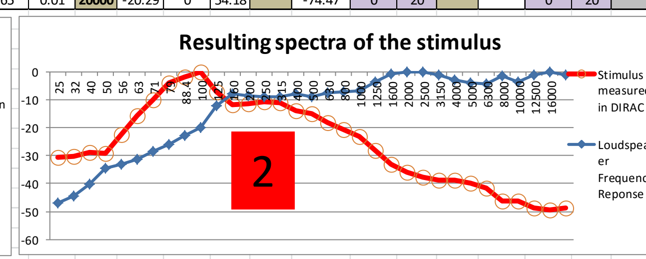
For iterations; brown at the desk; pink area for iterations using the whole chain and anechoic chamber

Stimulus improvement Iterations | **Cut low-end** | High end side band management | **BlueBox 4 / EMPA / 80 dBA**

IR: BlueBox 3 FG 80 dBA.wav | Path: Average | given by the standard | For stimulus generation based on calculation | For measurement in the anechoic chamber

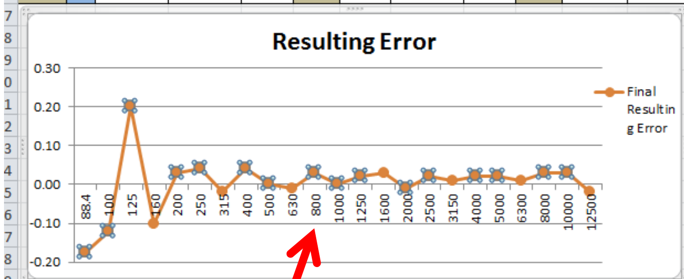
Freqency	STI Male	Loudspeaker Frequency Reponse	Stimulus measured in DIRAC	Resulting Error 1	Hz	2. Shape table data input	Stimulus measured in DIRAC	Resulting Error 2: Error of Stimulus V1	Hz	3. Shape table data input	Stimulus measured in DIRAC	Resulting Error 3	Hz	4. Shape table data input	Stimulus measured in DIRAC	Resulting Error 4	Hz	5. Shape table data input	Result measured in the anechoic chamber	F… r		6. Shape table data input	Result measured in the anechoic	Fin… rror	1/3 octave STI male target value
25	-50	-47.06	-30.47	1.83	25	-50	-30.79	1.85	25	-50	-30.68	2.14	25	-50	0	38.34	25	-50	0	50	25	-50	0	50	
32	-45	-44.62	-30.04	-0.30	32	-45	-30.37	-0.29	32	-45	-30.41	-0.15	32	-45	0	35.78	32	-45	0	45	32	-45	0	45	
40	-40	-40.25	-28.46	0.65	40	-40	-28.79	0.66	40	-40	-28.92	0.71	40	-40	0	35.15	40	-40	0	40	40	-40	0	40	
50	-35	-34.72	-28.86	0.78	50	-35	-29.1[illegible]	0.80	50	-35	-29.36	0.80	50	-30	0	35.68	50	-30	0	35	50	-30	0	35	
56	-30	-33.04	-22.15	4.17	56	-30	-22.47	4.19	56	-30	-22.645	4.20	56	-15	0	32.36	56	-15	0	30	56	-15	0	30	
63	-20	-31.36	-15.44	2.56	63	-20	-15.76	2.58	63	-20	-15.93	2.59	63	0	0	24.04	63	0	0	20	63	0	0	20	
71	-10	-28.695	-9.51	1.16	70	-10	-9.83	1.18	70	-10	-10.005	1.18	70	5	0	16.71	70	5	0	10	70	5	0	10	
79	0	-26.03	-3.58	-0.25	80	0	-3.9	-0.23	80	0	-4.08	-0.23	80	10	0	9.37	80	10	0	0	80	10	0	0	
88.4	5	-23.015	-1.79	-0.45	88.4	5	-1.95	-0.27	88.4	5	-2.04	-0.18	88.4	10	0	7.385	88.4	10	0	-5	88.4	10	0	-5	
100	10	-20.00	0	-0.64	100	10.64	0	-0.30	100	10.94	0	-0.12	100	11.06	0	5.4	100	5.66	0	-10	100	15.66	0	-10	58.4
125	10	-12.38	-5.97	1.01	125	8.99	-6.91	0.41	125	8.58	-7.3	0.20	125	8.38	0	13.02	125	-4.64	0	-10	125	5.36	0	-10	58.4
160	10	-8.02	-11.48	-0.14	160	10.14	-11.84	-0.16	160	10.30	-11.96	-0.10	160	10.4	0	17.38	160	-6.98	0	-10	160	3.02	0	-10	58.4
200	10	-8.50	-11.1	-0.24	200	10.24	-11.19	0.01	200	10.23	-11.35	0.03	200	10.2	0	16.9	200	-6.7	0	-10	200	3.3	0	-10	58.4
250	10	-9.00	-10.64	-0.28	250	10.28	-10.65	0.05	250	10.23	-10.84	0.04	250	10.19	0	16.4	250	-6.21	0	-10	250	3.79	0	-10	58.4
315	10	-8.86	-11.09	-0.59	315	10.59	-10.92	-0.08	315	10.67	-11.04	-0.02	315	10.69	0	16.54	315	-5.85	0	-10	315	4.15	0	-10	58.4
400	8	-8.02	-13.51	-0.17	400	8.17	-13.6	0.08	400	8.09	-13.82	0.04	400	8.05	0	19.38	400	-11.33	0	-8	400	-3.33	0	-8	56.4
500	6	-8.88	-14.64	-0.16	500	6.16	-14.81	0.01	500	6.15	-15	0.00	500	6.15	0	20.52	500	-14.37	0	-6	500	-8.37	0	-6	54.4
630	4	-7.66	-17.78	-0.08	630	4.08	-18.04	0.00	630	4.08	-18.23	-0.01	630	4.09	0	23.74	630	-19.65	0	-4	630	-15.65	0	-4	52.4
800	2	-7.21	-19.97	0.18	800	1.82	-20.41	0.08	800	1.74	-20.64	0.03	800	1.71	0	26.19	800	-24.48	0	-2	800	-22.48	0	-2	50.4
1000	0	-6.77	-22.59	0.00	1000	0.00	-22.95	-0.02	1000	0.02	-23.11	0.00	1000	0.02	0	28.63	1000	-28.61	0	0	1000	-28.61	0	0	48.4
1250	-2	-3.72	-27.61	0.03	1250	-2.03	-27.96	0.02	1250	-2.05	-28.14	0.02	1250	-2.07	0	33.68	1250	-35.75	0	2	1250	-37.75	0	2	46.4
1600	-4	-0.85	-32.5	0.01	1600	-4.01	-32.82	0.03	1600	-4.04	-33	0.03	1600	-4.07	0	38.55	1600	-42.62	0	4	1600	-46.62	0	4	44.4
2000	-6	0.00	-35.65	-0.29	2000	-5.71	-35.73	-0.03	2000	-5.68	-35.89	-0.01	2000	-5.67	0	41.4	2000	-47.07	0	6	2000	-53.07	0	6	42.4
2500	-8	0.00	-37.67	-0.31	2500	-7.69	-37.7	0.00	2500	-7.69	-37.86	0.02	2500	-7.71	0	43.4	2500	-51.11	0	8	2500	-59.11	0	8	40.4
3150	-10	-1.17	-38.44	-0.25	3150	-9.75	-38.52	0.01	3150	-9.76	-38.7	0.01	3150	-9.77	0	44.23	3150	-54	0	10	3150	-64	0	10	38.4
4000	-12	-2.92	-38.56	-0.12	4000	-11.88	-38.75	0.03	4000	-11.91	-38.94	0.02	4000	-11.93	0	44.48	4000	-56.41	0	12	4000	-68.41	0	12	36.4
5000	-14	-4.13	-39.31	-0.08	5000	-13.92	-39.54	0.03	5000	-13.95	-39.73	0.02	5000	-13.97	0	45.27	5000	-59.24	0	14	5000	-73.24	0	14	34.4
6300	-16	-4.24	-41.27	-0.15	6300	-15.85	-41.48	-0.02	6300	-15.83	-41.63	0.01	6300	-15.84	0	47.16	6300	-63	0	16	6300	-79	0	16	32.4
8000	-18	-1.62	-45.7	0.04	8000	-18.04	-46.01	0.07	8000	-18.11	-46.23	0.03	8000	-18.14	0	51.78	8000	-69.92	0	18	8000	-87.92	0	18	30.4
10000	-20	-3.67	-45.9	-0.21	10000	-19.79	-46.01	0.02	10000	-19.81	-46.18	0.03	10000	-19.84	0	51.73	10000	-71.57	0	20	10000	-91.57	0	20	28.4
12500	-20	-1.08	-48.69	-0.41	12500	-19.59	-48.71	-0.09	12500	-19.50	-48.82	-0.02	12500	-19.48	0	54.32	12500	-73.8	0	20	12500	-93.8	0	20	
16000	-20	-0.28	-48.83	0.25	16000	-20.25	-49.35	0.07	16000	-20.32	-49.51	0.09	16000	-20.41	0	55.12	16000	-75.53	0	20	16000	-95.53	0	20	
20000	-20	-1.22	-47.88	0.26	20000	-20.26	-48.46	0.02	20000	-20.28	-48.65	0.01	20000	-20.29	0	54.18		-74.47	0	20			0	20	

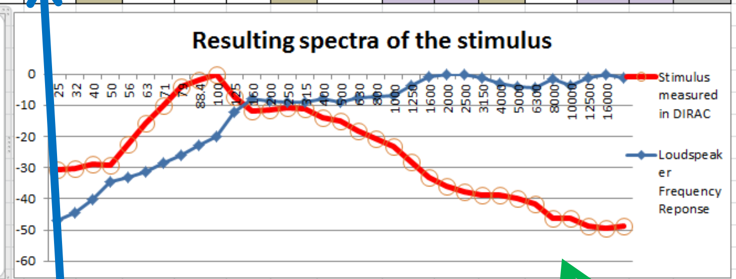




How to use the graphs

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
6	200	10	-8.50	-11.1	-0.24	200	10.24	-11.19	0.01	200	10.23	-11.35	0.03	200	10.2	0	16.9	200	-6.7	0	-10	200	3.3	0	-10	58.4
7	250	10	-9.00	-10.64	-0.28	250	10.28	-10.65	0.05	250	10.23	-10.84	0.04	250	10.19	0	16.4	250	-6.21	0	-10	250	3.79	0	-10	58.4
8	315	10	-8.86	-11.09	-0.59	315	10.59	-10.92	-0.08	315	10.67	-11.04	-0.02	315	10.69	0	16.54	315	-5.85	0	-10	315	4.15	0	-10	58.4
9	400	8	-8.02	-13.51	-0.17	400	8.17	-13.6	0.08	400	8.09	-13.82	0.04	400	8.05	0	19.38	400	-11.33	0	-8	400	-3.33	0	-8	56.4
0	500	6	-8.88	-14.64	-0.16	500	6.16	-14.81	0.01	500	6.15	-15	0.00	500	6.15	0	20.52	500	-14.37	0	-6	500	-8.37	0	-6	54.4
1	630	4	-7.66	-17.78	-0.08	630	4.08	-18.04	0.00	630	4.08	-18.23	-0.01	630	4.09	0	23.74	630	-19.65	0	-4	630	-15.65	0	-4	52.4
2	800	2	-7.21	-19.97	0.18	800	1.82	-20.41	0.08	800	1.74	-20.64	0.03	800	1.71	0	26.19	800	-24.48	0	-2	800	-22.48	0	-2	50.4
3	1000	0	-6.77	-22.59	0.00	1000	0.00	-22.95	-0.02	1000	0.02	-23.11	0.00	1000	0.02	0	28.63	1000	-28.61	0	0	1000	-28.61	0	0	48.4
4	1250	-2	-3.72	-27.61	0.03	1250	-2.03	-27.96	0.02	1250	-2.05	-28.14	0.02	1250	-2.07	0	33.68	1250	-35.75	0	2	1250	-37.75	0	2	46.4
5	1600	-4	-0.85	-32.5	0.01	1600	-4.01	-32.82	0.03	1600	-4.04	-33	0.03	1600	-4.07	0	38.55	1600	-42.62	0	4	1600	-46.62	0	4	44.4
6	2000	-6	0.00	-35.65	-0.29	2000	-5.71	-35.73	-0.03	2000	-5.68	-35.89	-0.01	2000	-5.67	0	41.4	2000	-47.07	0	6	2000	-53.07	0	6	42.4
7	2500	-8	0.00	-37.67	-0.31	2500	-7.69	-37.7	0.00	2500	-7.69	-37.86	0.02	2500	-7.71	0	43.4	2500	-51.11	0	8	2500	-59.11	0	8	40.4
8	3150	-10	-1.17	-38.44	-0.25	3150	-9.75	-38.52	0.01	3150	-9.76	-38.7	0.01	3150	-9.77	0	44.23	3150	-54	0	10	3150	-64	0	10	38.4
9	4000	-12	-2.92	-38.56	-0.12	4000	-11.88	-38.75	0.03	4000	-11.91	-38.94	0.02	4000	-11.93	0	44.48	4000	-56.41	0	12	4000	-68.41	0	12	36.4
0	5000	-14	-4.13	-39.31	-0.08	5000	-13.92	-39.54	0.03	5000	-13.95	-39.73	0.02	5000	-13.97	0	45.27	5000	-59.24	0	14	5000	-73.24	0	14	34.4
1	6300	-16	-4.24	-41.27	-0.15	6300	-15.85	-41.48	-0.02	6300	-15.83	-41.63	0.01	6300	-15.84	0	47.16	6300	-63	0	16	6300	-79	0	16	32.4
2	8000	-18	-1.62	-45.7	0.04	8000	-18.04	-46.01	0.07	8000	-18.11	-46.23	0.03	8000	-18.14	0	51.78	8000	-69.92	0	18	8000	-87.92	0	18	30.4
3	10000	-20	-3.67	-45.9	-0.21	10000	-19.79	-46.01	0.02	10000	-19.81	-46.18	0.03	10000	-19.84	0	51.73	10000	-71.57	0	20	10000	-91.57	0	20	28.4
4	12500	-20	-1.08	-48.69	-0.41	12500	-19.59	-48.71	-0.09	12500	-19.50	-48.82	-0.02	12500	-19.48	0	54.32	12500	-73.8	0	20	12500	-93.8	0	20	
5	16000	-20	-0.28	-48.83	0.25	16000	-20.25	-49.35	0.07	16000	-20.32	-49.51	0.09	16000	-20.41	0	55.12	16000	-75.53	0	20	16000	-95.53	0	20	
6	20000	-20	-1.22	-47.88	0.26	20000	-20.26	-48.46	0.02	20000	-20.28	-48.65	[illegible]	20000	-20.29	0	54.18		-74.47	0	20			0	20	





Shows the deviation of the **emitted** signal relative to the EN 60268-16 standard. Can be used for orange or violet iteration blocks,

Click into the interesting graph to shift the displayed iteration; use the mouse (standard Excel handling).

Overview graph on the unequalised frequency response of the speaker and the stimulus.
Click into graph to can shift which iteration shall be shown.

How to create a SFD based stimulus - Iteration Steps:

Back to the big picture:

- **Starting point is the IR on the frequency response of the loudspeaker.** It does not need to be measured at 60 dB(A) ! Measure the speakers frequency response at 1 m distance in a anechoic chamber with Pink MLS or (log) sine sweep at different levels (e.g. 60, 70 and 80 dB). **Select the cleanest IR of all measurements.**

- Copy the columns „A“ **and** „B“ from the SFD Steps tab, from 25 Hz to 20‘000 Hz.

- If no PinkMLSxx block comes along with DIRAC, just make one your self using either Dirac's MLSxx blocks and the EDIT –> Filter -> -3 dB filter or using the EDIT -> Generate.

- ***Only After* all iterations, the stimulus must get level calibrated.** DIRAC has only 3 dB steps with its slider; fine tuning must get done by using EDIT -> AMPLIFY. You may only reduce the signal level, not increase it. So the slider should be at a position delivering something like 61.34 dB(A); for cutting the 1.34 dB away use EDIT -> AMPLIFY as explained.

- **Store the stimulus, the PRESET and make a short documentation on your process.** You will be glad, in someone drops the speaker and you need to go through the process again.

When have we done sufficient Iteration Steps ?

- **With good low end / high end bandwidth management the iteration progress speed is high:** Good bandwidth management reduced the dynamics SFD must handle a lot and this speeds up the SFD progress - Often after one single pass the tolerance of the EN 60268-16 is already reached - at least with 2-way speakers.

- There is no goal for the **amount of loops**: Only a goal which residual error shall still be acceptable.

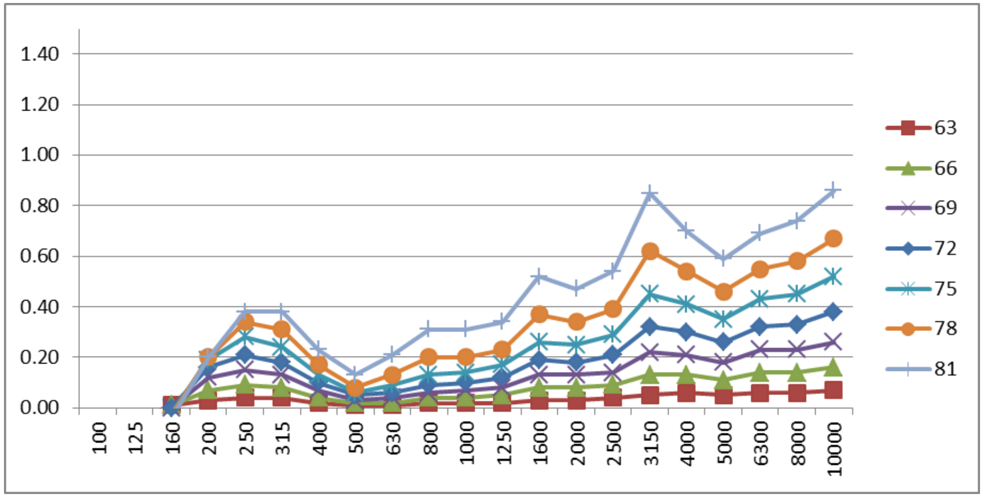
- If we go the strict way, and say all errors must stay within +/- 1 dB as the STI standard says, they we will have fun: Alone the climate impact on speakers can have about +/- 0.5 dB; class 1 microphones have tolerances quite often up to +/-0.25 dB up to 10 kHz - but he microphone standard allow much more. Regarding the anechoic chambers we may need to count with +/- 0.3 dB impact; we have also reflection on microphone stands etc etc. So you see, although all these values add up only geometrically; not much spare room is here. At least in this strict way to look at tolerances'.

- ***Common sense is required:*** Since SFD can reach 0.1 dB and better with ease - we are here talking about results using the chamber / violet template parts - there is no reason to say no to an approach, where iterations shall be repeated, until the error as calculated by the template drop below e.g. 0.05 dB.

Words for on the way (I)

So far, a strong focus was on using, at first, the **development** template (brown blocks). Using the **measurement** based template / fields, you are dependent on the chamber and mostly there is time pressure to not occupy it too long. But it is important to take the required time to have a well defined 89 Hz knee and signal level from 25 to about 50 Hz. Further to make deconvolution tests in critical measurement setup is a must.
It is much more efficient to do such work not en bloc, but from time to time spend an hour until one has made up his mind. With the simulation template / brown fields this is easy possible.

But: It is absolutely necessary that the final iteration loops are made in the way, that the speaker is in the measurement loop (using the violet fields). Only to measure the speaker's IR an do all the rest only by template - as possible with the brown fields - will lead to much poorer precision. With challenging speakers the results will be no more within the standards tolerances.



The left-hand picture shows how the speakers frequency response start tilting, with higher signal levels. The frequency respond drops (the picture is invers) from 100 Hz to 10 kHz by nearly 1 dB when the sound level increases from 60 to 81 dB. Furtherthe sensitivity @ 1 kHz drops by 0.3 dB.

Words for on the way (II)

Originally the author wanted just to make one template - using the development template with the several brown and 2 violet fields - and extend the violet fields by about 4 further blocks. But it got very soon clear, that on-going horizontal scrolling would be required, which disturbs a lot. So the decision was made, to brake up the process it in 2 phases:

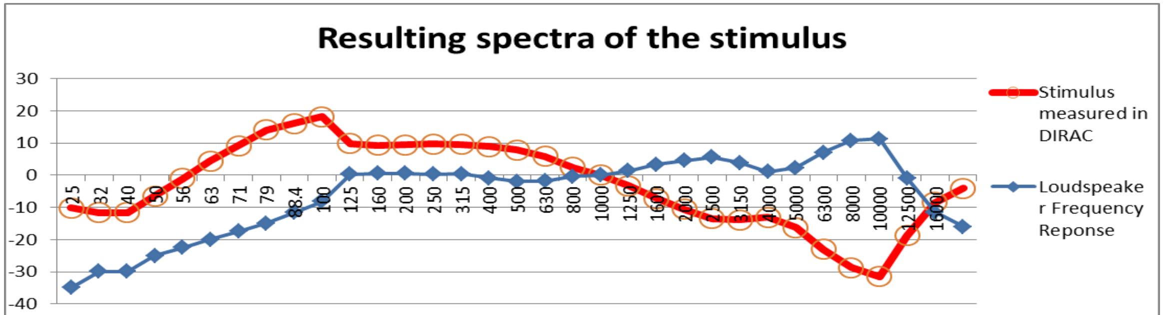
- Clarify with the development template: With IR shall be used, how should the 89 Hz knee gets set and the low end signal level. (**Development template**)
- **And then do in the chamber all steps again** using the **productive** template with its violet fields without then needing to reflect about settings. With everything prepared, this is done in 30 minutes. Since renting chambers is costly, the working process described here is cost efficient.

Next picture shows, that for the low end signal level setting the differences from one speaker to an other are less relevant than noise in the anechoic chamber.

Example of low end cut values - a good mooded situation as long as no noise is present in the measurements

Hz	Gen 8010 copy 1	Gen 8010 copy 2	BlueBox 3	BlueBox 4	Fostex 6301B copy 1	Fostex 6301B copy 2	BlueBox 4 at 18 dB lower test signal level with much low end noise
25	-40	-50	-50	-50	-20	-20	0
32	-45	-45	-45	-45	-20	-20	-10
40	-50	-40	-40	-40	-20	-20	-30
50	-40	-35	-35	-35	-20	-20	-20
56	-30	-30	-30	-30	-20	-20	-20
63	-25	-20	-20	-20	-20	-20	-20
71	-10	-10	-10	-10	0	0	-10
79	0	0	0	0	0	0	0
88.4	10	10	10	10	10	10	10
100	10	10	10	10	10	10	10

The care required here is dependent on how critical the situations are, you are going into when measuring. The author used situations much more demanding than his typical field situations - and roughly selected values worked well.



Be aware, that only the development template shows a relevant view for the low end cut deign (above). The 25 to about 50 Hz part of the red curve (= stimulus spectra as sent to the speaker) shall have a level similar to the 1 – 2 kHz part. Use this at least as starting values, tune depending on deconvolution side band of the measurement phase. Low & high end must stay in the middle field of the red curve; maybe a little higher.

Looking more into Details of the Process

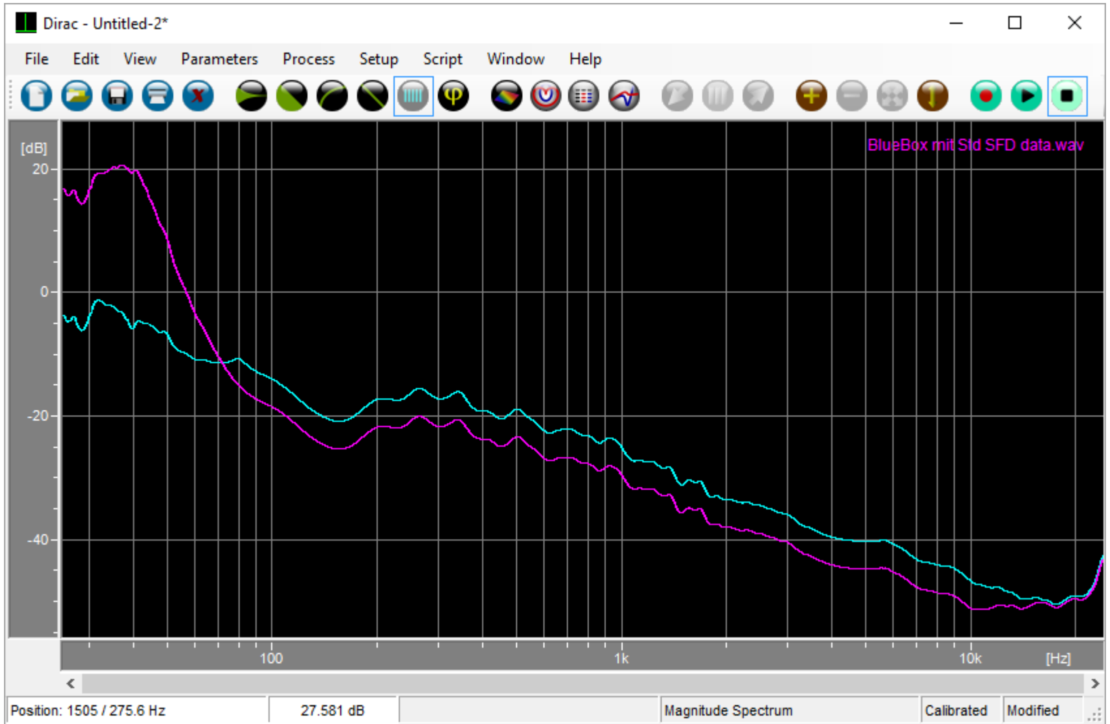
How to create a SFD based stimulus

Why not to start with the EN 60268-16 spectra - as prepared in Dirac:

Using the method as explained here, the low / highcut filters of SFD do not get used. More precise: In some cases - and the author of this document was mostly in that situation, the low cut filter led to problems like side bands or spikes or clicking sounds. So the low cut gets done by the data in the template in the fields 25 – 80 Hz (and the high cut accordingly - but mostly needs no change).

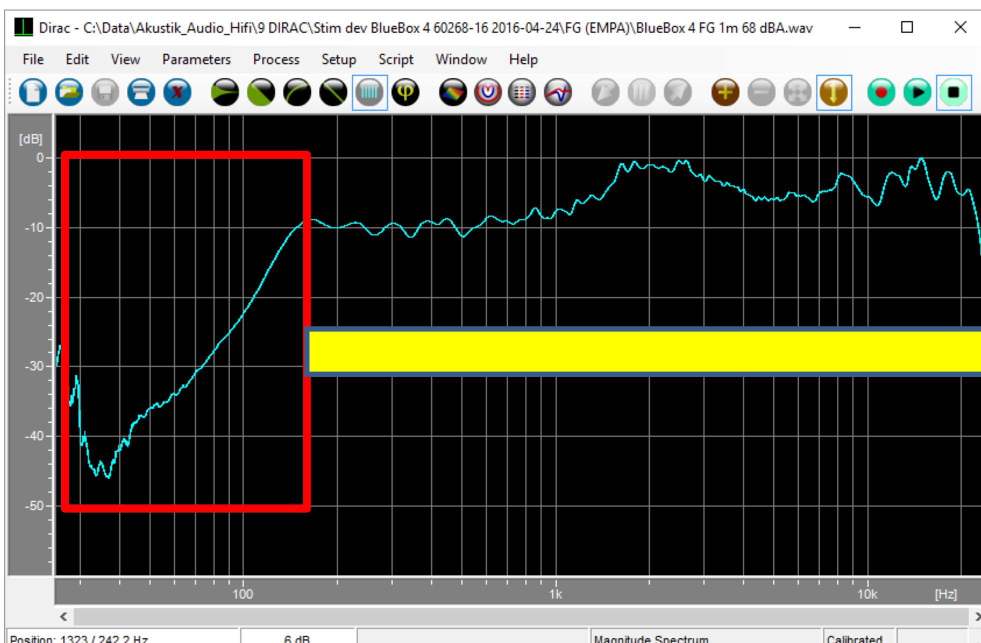
The cut is maybe not as sharp as Diracs low cut filter; but sufficient - as you will see later. And most important of all: The dynamics reduction is just as good; and the low end drop is not that „unlimited“ as with the filter.

The method proposed here delivers the blue curve; leaving filters and low low end management away leads to the red curve.



Explanation - How to avoid side bands in the measurement deconvolution step:

- Below 80 Hz the response level of small speakers breaks away; SFD‘s frequency response correction will boost that area - what can lead to problems. Therefore enter in the fields „B4“ to „B9“ values which compensate for that. (Just try and correct; the values here are not critical - 5 to 10 dB more or less should work about same well).
- Same can happen at the high end; so also correct there.
- The „BlueBox“ speaker here - own development based on a Visaton chassis type B80 - requires no such compensation at the high end.



Stimulus improvemen

IR: **BlueBox 3 FG 80 dBA.wav**

Freqency	STI Male	Loudspeaker Frequency Reponse	Stimulus measured in DIRAC	Resulting Error 1
25	-50	-47.06	-30.47	1.83
32	-45	-44.62	-30.04	-0.30
40	-40	-40.25	-28.46	0.65
50	-35	-34.72	-28.86	0.78
56	-30	-33.04	-22.15	4.17
[illegible]	-20	-31.36	-15.44	2.56
71	-10	-28.695	-9.51	1.16
79	0	-26.03	-3.58	-0.25
88.4	5	-23.015	-1.79	-0.45
100	10	-20.00	0	-0.64
125	10	-12.38	-5.97	1.01
160	10	-8.02	-11.48	-0.14
200	10	-8.50	-11.1	-0.24

3. Iteration Element: Optimizing the cut below about 89 Hz

3. Iteration element: Optimizing the cut below about 89 Hz

Beside frequency response correction and deconvolution side band management (avoidance), the here proposed iteration model allows also to fine tune the cut below about 89 Hz. 89 Hz is the low end shoulder frequency of the 100 Hz 1/3 octave band - and it should not show any frequency response break away.

The next slide shows in red the stimulus spectra after first iterations steps; the blue curve is then the optimized result.

The big benefit of the sharper cut is, that the speaker gets less low end stress. Low frequencies give the cone a big deflection movement, which deteriorates the MTF in the 125 Hz band and elsewhere.

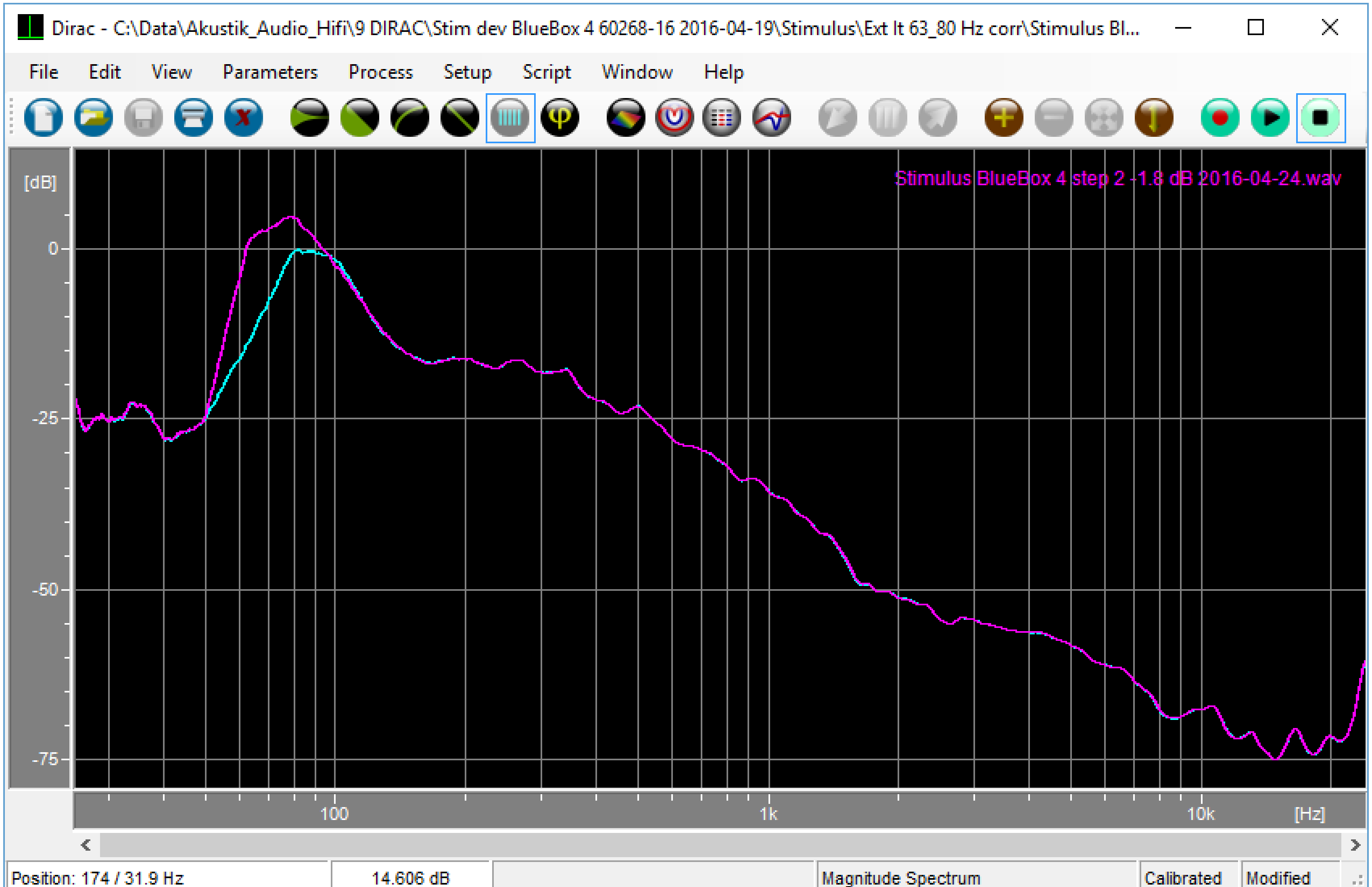
Adjust the goal frequency response (column B in the templates iteration table) in the for the best result.

It is   - never the less   -   a trade off between minimal frequency response error at 89 Hz and best possible MTF / MTI quality in the 125 band.

Reducing the signal bandwidth at the low end improves the MTI quality of the measurements in the 125 Hz band. Very nice is, how sharp SFD can cut the frequency response.

Example of poor adjustment:

- For the blue curve, the 125 Hz band will have a too low signal level.
- The pink curve goes not only too low, but also too high below 88 Hz.



The Advanced Art of Building Stimuli (handling mediocre IR‘s)

The Advanced Art of Building Stimuli (I)

Maybe you also have experienced, that you ended up, when measuring the frequency response of the test speaker, with some frequency responses IR‘s being very clean, but having a frequency response, which is partly not correct (e.g. low end due to a too small anechoic room). Further you may have some other test results having correct frequency response, but too much noise or too much distortion.

With the iteration model proposed here, you can get the best out of both world: You use the clean IR for the SFD process and the frequency response of the other measurements for the iteration process - as input to SFD‘s shape table.. (do details correction in the tab “FR of Speaker”; you will need to adjust that tab accordimg to yout need. The result must be available in the same column as now).

See next slide for an example.

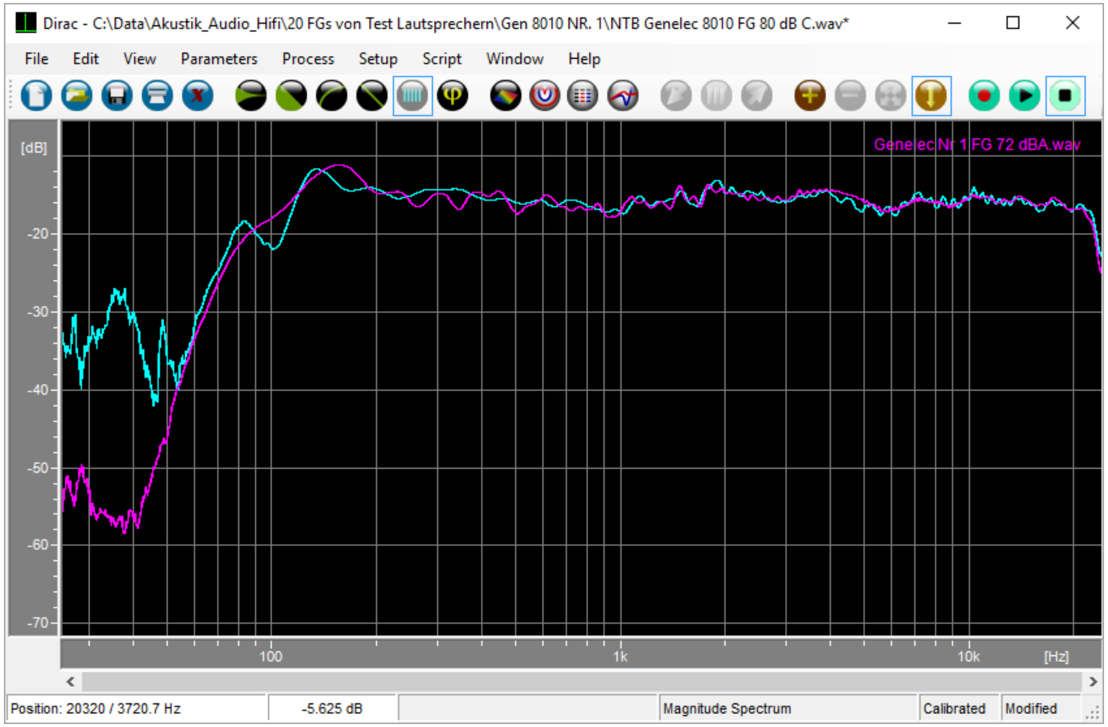
Principally one can go even one step further: If you have no clean IR, but correct data regarding the frequency response, you can use a perfectly clean IR made by EDIT -> GENERATE, and shape the spectra by using correct frequency response data in the iteration template as goal frequency response.

The Advanced Art of Building Stimuli (II)

The technics described here can also get used only for analytical reasons. Imagine you have a small speaker with - due to its small size - a lot of frequency response loss at 100 and shows very quickly above 60 dBA non linear behaviour. Further imagine, the chamber you use has a lot of noise in the 50 – 200 Hz area - e.g. more than 15 dB above the 50 mV/Pa class 1 microphone there.

Likely you will start wondering, if going into that famous chamber some 643 km away could solve your problem.

Making a speaker IR in the test tube - using a dirac impulse and shaping it by SFD to the frequency response as the speaker has - allows you to go partly through the same process as 643 km away - having no noise whatever. You can then build the stimulus using the brown template fields and make then a measurement with your speaker. If then - and that is well possible when having such problems - the speaker it not able to deliver clean MTF / MIT, the conclusion is maybe clear: It is not the right loudspeaker.



Here the same loud speaker copy got tested in 2 different anechoic chambers. In blue a small chamber with identical length and width, having rather high noise level, but very good pyramid shaped absorbers.

The pink curve comes from a chamber, using Broadband-Compact-Absorbers, having very low surrounding noise and about 3 times as much volume.

Both IR are not ideal; but the pink curve IR has much less noise included. Both have low enough distortions.

The chamber of the blue curve has pyramid absorbers, showing less «reflection» impacts in some parts of the frequency response.

The solution could be, to use the pink curve IR and use in the iteration template from 200 Hz to 2 kHz the frequency response of the blue curve.   If test data from the chamber evaluation is available, it can maybe also get used for fine tuning in the range 50 to 200 Hz. Best overall is a chamber, not showing such effects.

Important to know about measuring loudspeakers

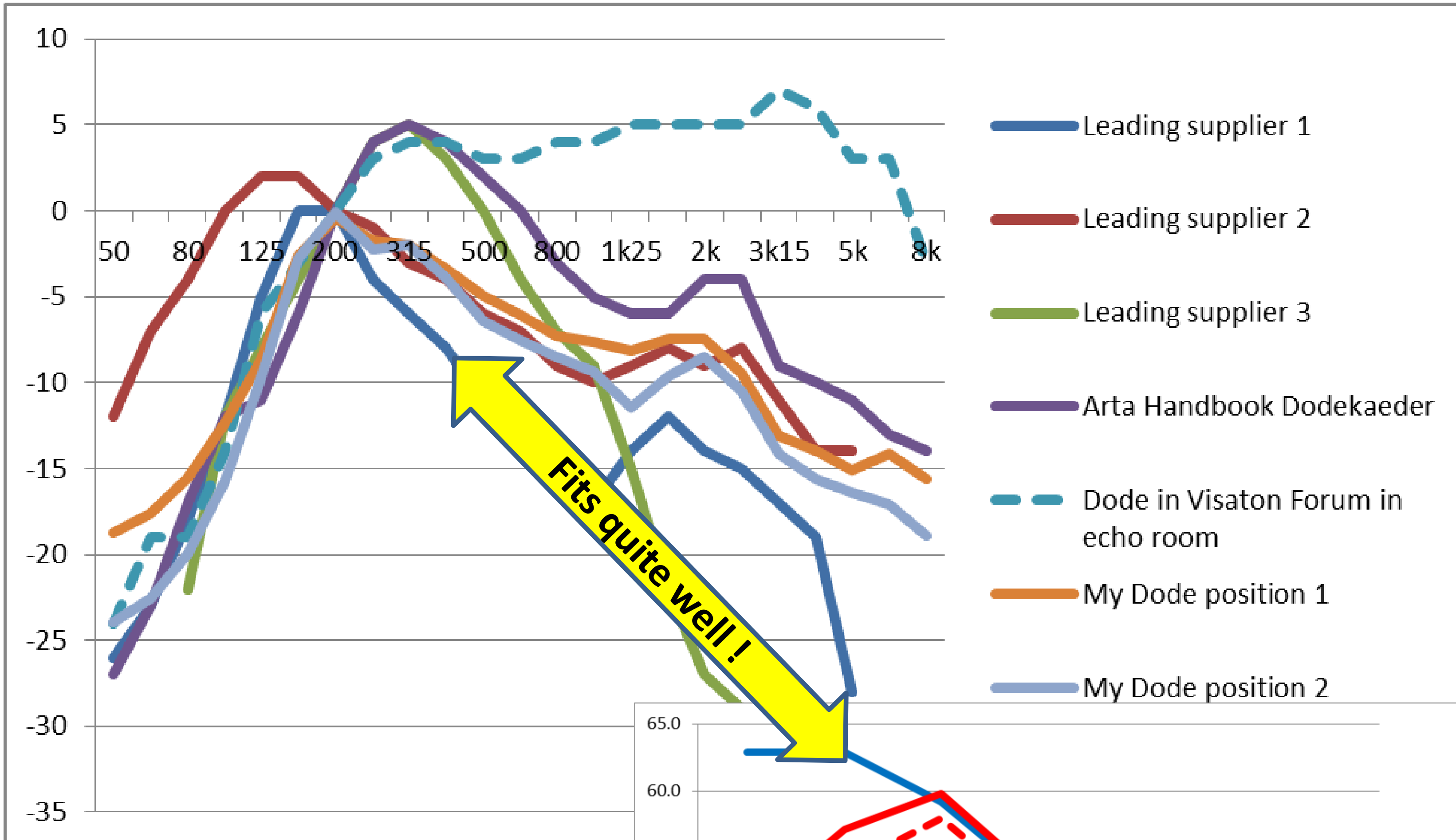
Important to know about Omni Speakers (dodecahedral types)

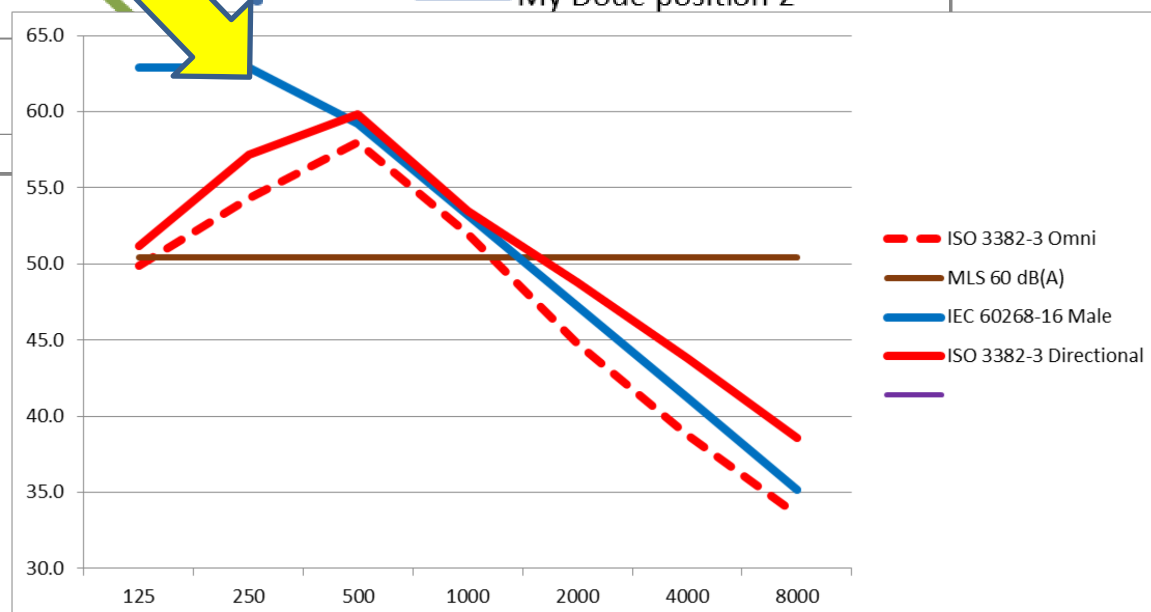
The Omni‘s gets used with STI mostly in the context of the EN 3382-3 standard for Open Plan Offices***. Else-wise Omni‘s get used for sound Isolation, reverberation and other measurements; and there the demand is typically to have a flat frequency response to get more energy in the low and high frequency regions.

For EN 3382-3 STI measurements, Omni have often a very nice frequency response „error“; the hill like shaped frequency response is not very different from the 3382-3 UniSex spectra. That can vary depending on the chosen Omni model; but often this will help to cope with environmental noise during measurements. Dirac used Pink MLS as signal for 3382-3 type measurements (requiring a system calibration); and the Omni radiates due - to its frequency response close to UniSex spectra - a stimulus not much off the UniSex spectra, which EN 3382-3 uses.

This is important, because the STI calculation schema has limited dynamics regarding noise and when a noise reduction must get calculated in post processing, then precision can become an issue.

*** = In class rooms, for the teacher standing at the black board and talking, Omni's get used some times; this reflects the uncertain directivity of a teacher speaking when writing on the black board.





Many Omni's produce with Pink MLS a spectra similar to the 3382-3 Unisex spectra - a good situation for post processing; makes results in noise environment more reliable.

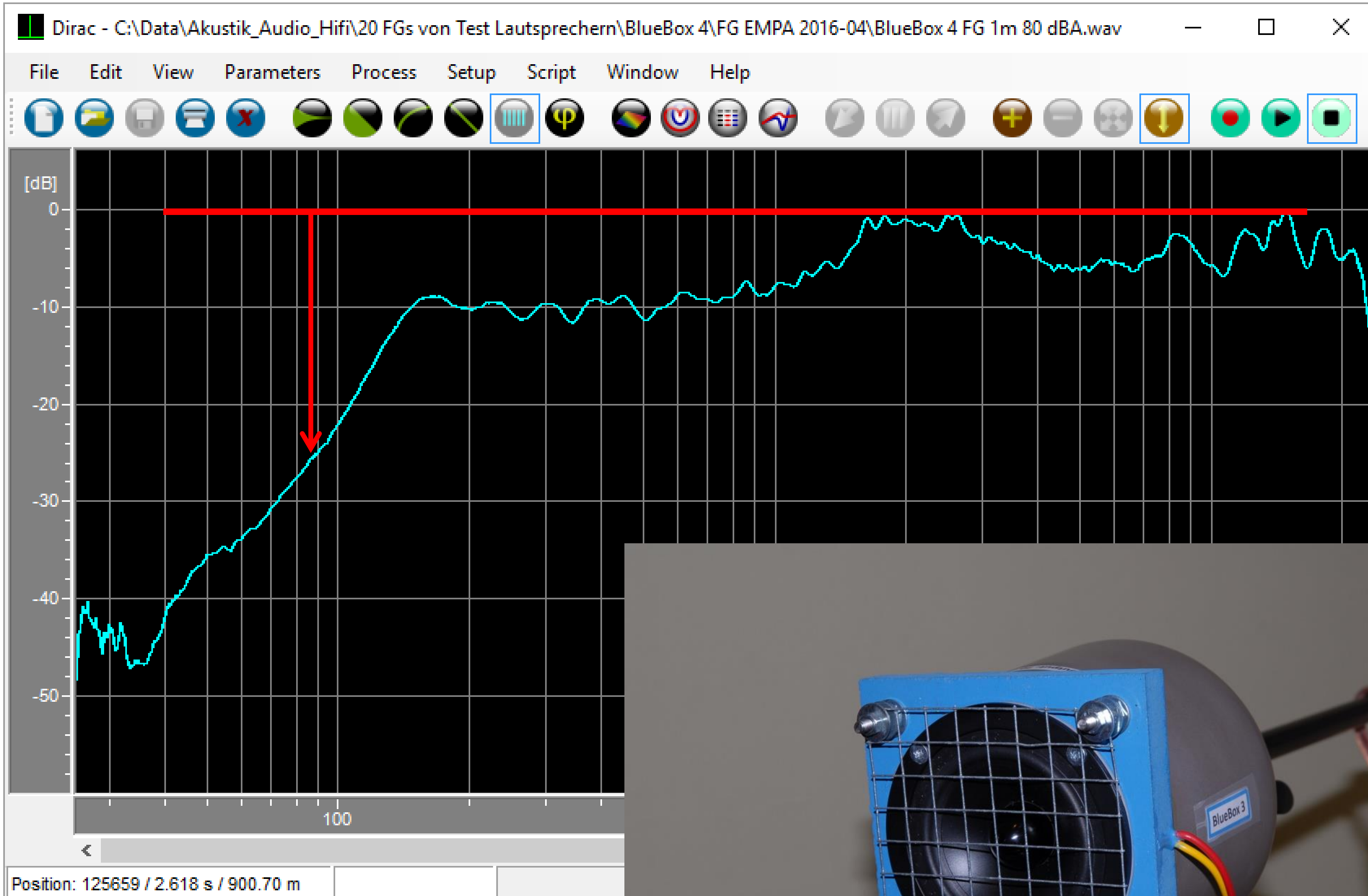
Important to know about Small Broadband Speakers

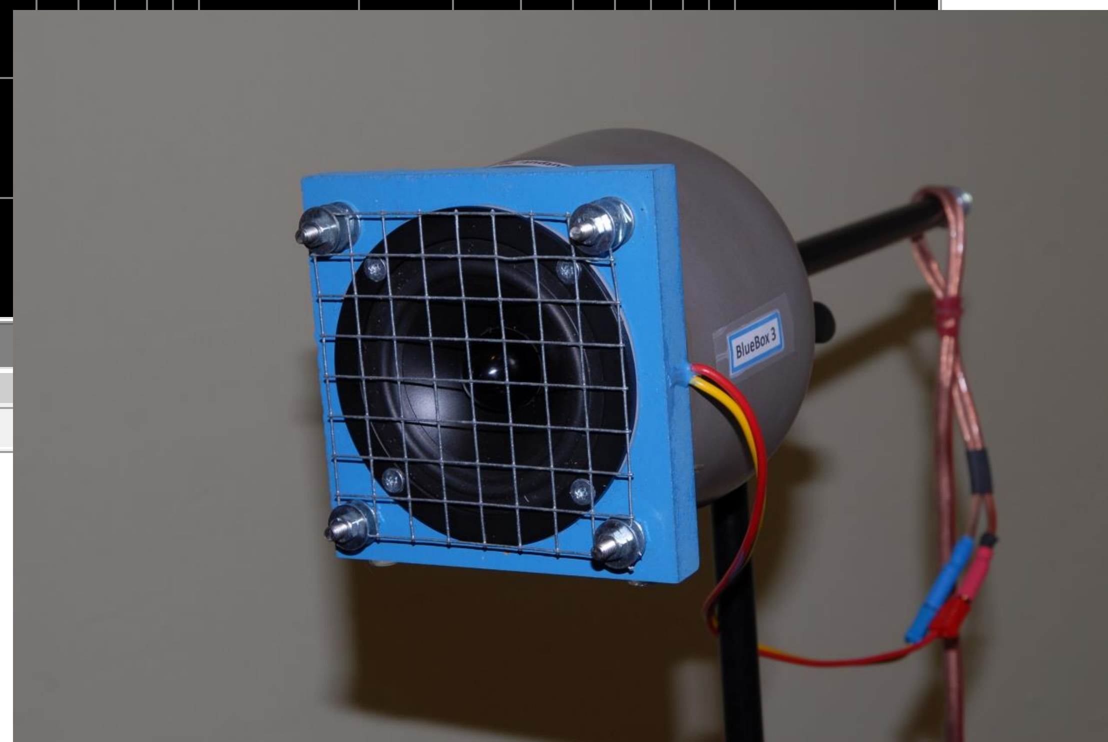
On the next slide the frequency response of a small speaker with about 6.5 cm active cone diameter is shown. The author of this article developed this speaker as a compromise:

- To be as small as possible; to better achieve a mouth like directivity, than with a 10 cm cone, according to EN 60268-16 standard.
- But the speaker must can deliver a clean MTI at 125 Hz (Clean = No negative impact of **STI** result).

- For a small speaker the bass level of the male STI spectra can be a real challenge (Lombard SPL); the speaker and its stimulus must be designed carefully to achieve this. Key issues are
  - The Stimulus may not have unnecessary energy below 89 Hz, because that leads to unwanted cone deflection, reducing the MTI.
  - Enough voluminous to keep the bass frequency response loss moderate; maybe to use bass reflex design.
  - Not too much damping of the speaker.

Because the market offering for complete speakers (in housings) as described here is small, making ones own development can make sense.





This loss in low end energy is a disadvantage for both test signal types; Stimulus and System Calibration's PinkMLS. Try to minimize this by speaker choice, enclosure size (length) and no excessive damping.

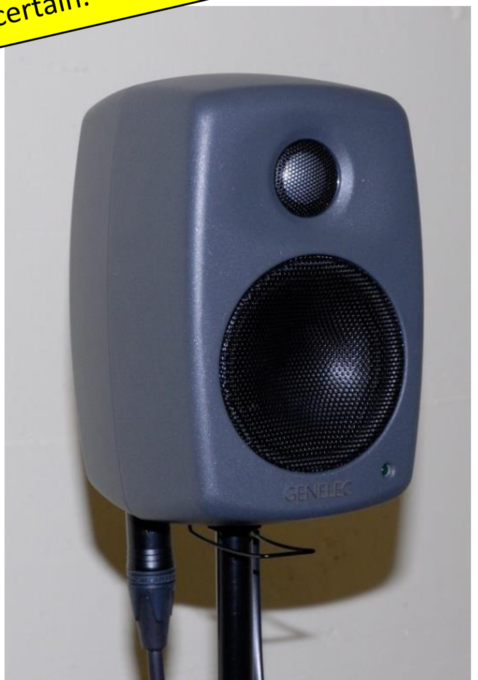
Important to know about 2-way Speakers

Be aware: Using 60268-16 's back door of a 100 mm cone, you will have in situations, where directivity is important (e.g. very large rooms), for certain an error. Using a 2-way speaker there are some residual risks, but none for certain.

The EN 60268-16 standard does not allow 2-way test speakers. But in practical work measuring STI in rooms, 2-way speakers show - the authors experience - no disadvantages. The standard EN 60268-16 covers also situations, where the test speaker injects the test signal into a operator / push-button microphone of the PA- / emergency- information system - and there 2-way speakers are clearly a No-Go.

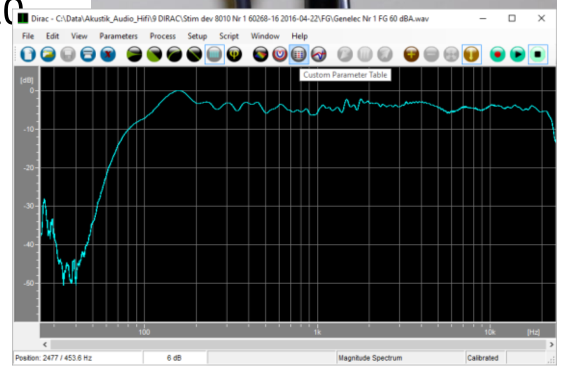
Else-wise, 2-way speakers can have strong benefits:

- Much better frequency response requiring less correction
- Cleaner signal at increased signal levels (70 dB, Lombard level etc.)
- Much better directivity



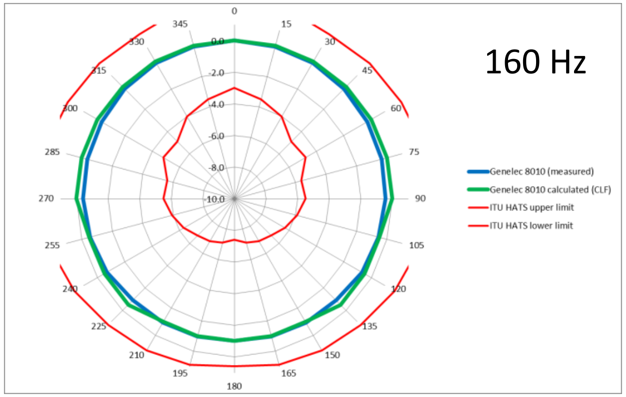
Here - see next slide - as an example the Genelec 8010 speaker (shown right). It has a 19 mm tweeter and a horizontal directivity nearly perfect to what the ITU standard requires for a HATS (Head and torso simulators; a dummy „person" with mouth and ears).

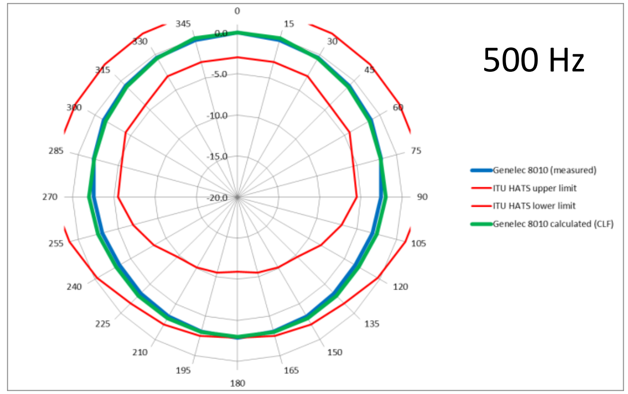
The good result is in no way a surprising. ITU-p.51 Mouth Simulators have 20 mm openings and the 8010 has a size and shape similar to a human head - just upside down.

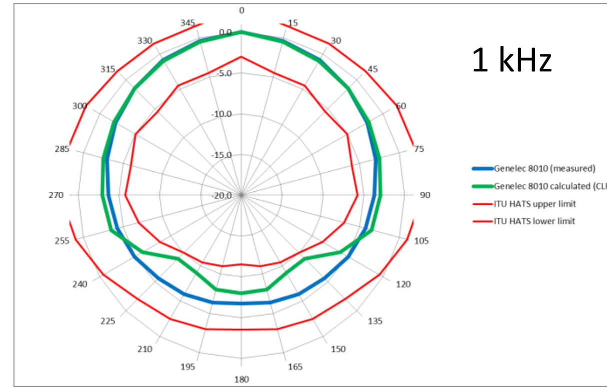


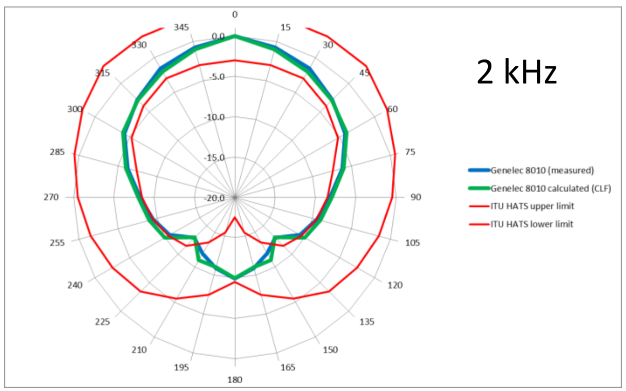
Next slide shows the directivity as specified by the supplier; further the ITU p.58 limits.

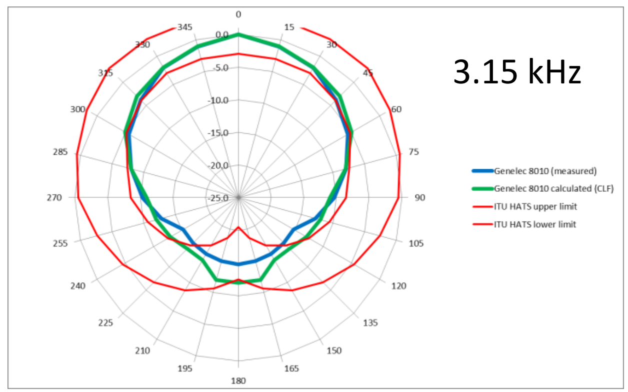
Polar diagram, horizontal plane, compared to ITU p.58 requirements

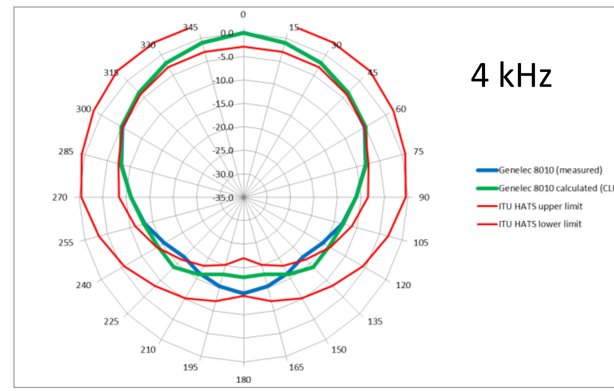


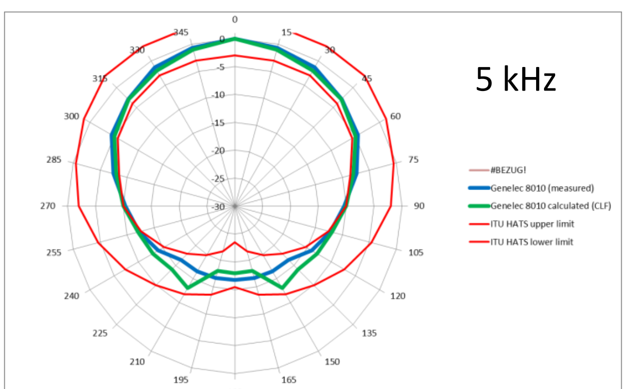


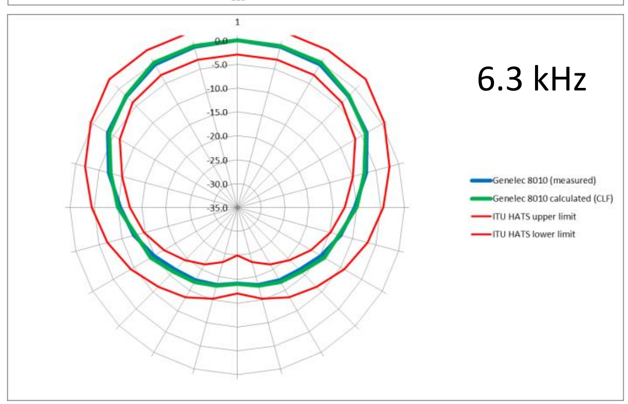


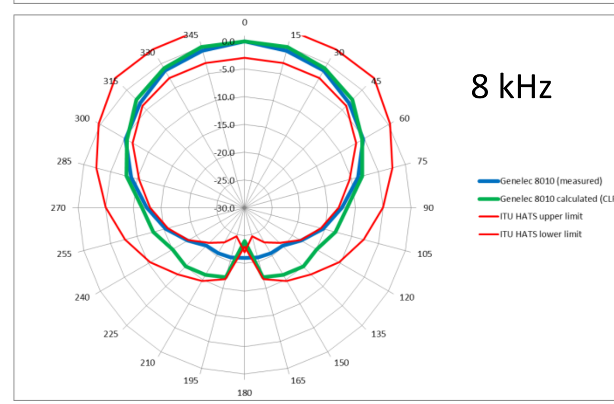










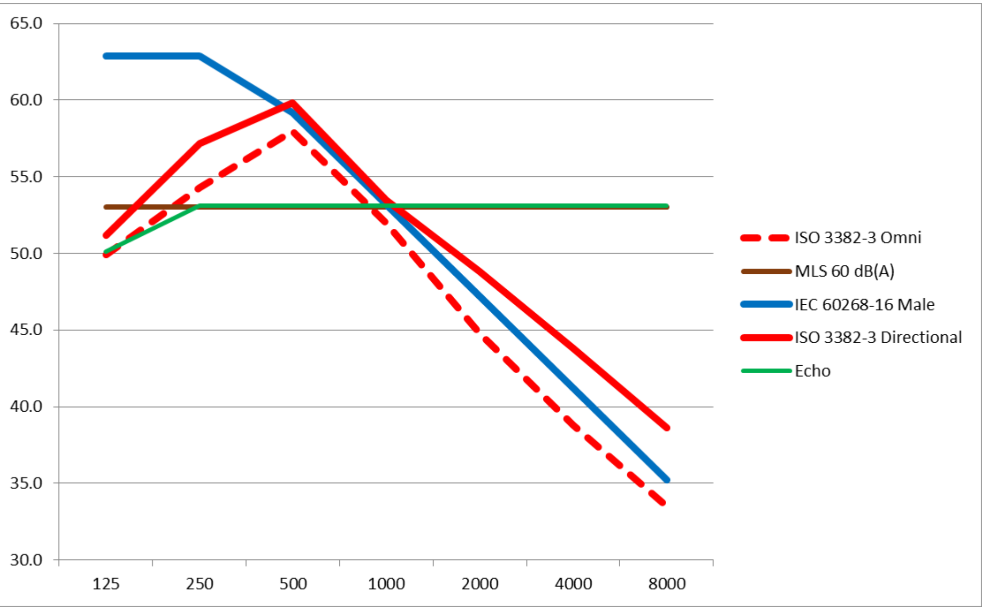


Looking into Precision Aspects more in Detail

Looking at Precision Aspects more in Detail (I)

One needs to be aware, especially when using DIRACs intelligence of STI model conversion - e.g. from EN 3382-3 to 60268-16 calculation schema - that the difference between the stimulus spectra as in the EN standards, and, as emitted by the speaker, can have a naughty impact on precision, when high surrounding noise exists.

Base of all are the very different reference spectra's of the standards, on which the SSNR calculations are based:



As one sees, especially in the low end region the standards differ a lot. DIRAC uses in the System Calibration mode Pink MLS as signal, bringing in an additional element one needs to be aware of. Using the EN 60268-16 spectra, the test signal is very robust against noise in the low end area; while the high end has very little energy.

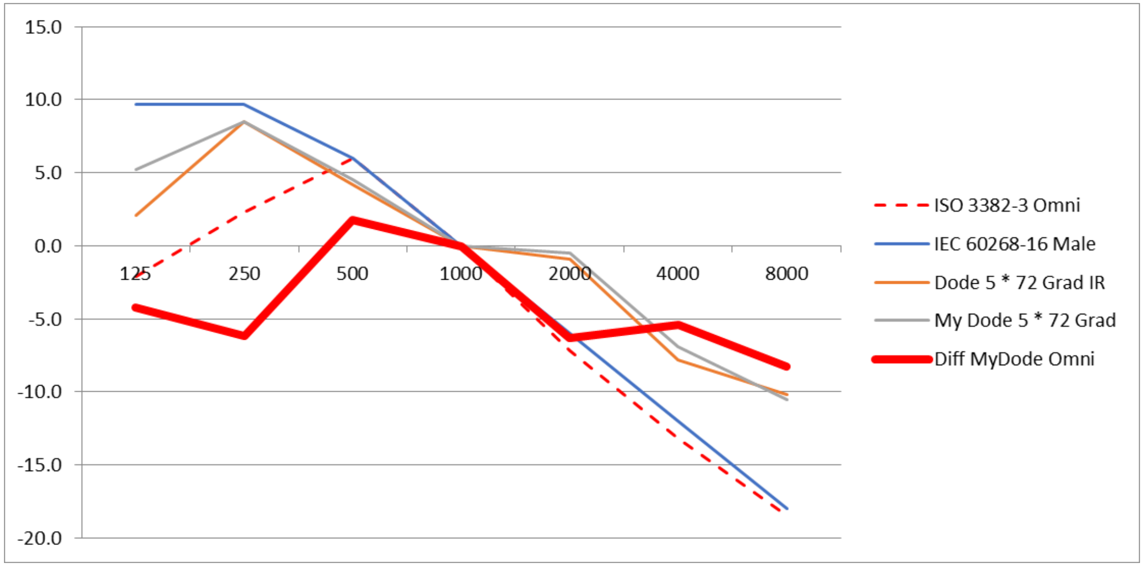
The DIRAC ECHO speaker covers the low and high end areas of EN 3382-3 very well, while the mid areas is below and especially the EN 60268-16 low end. But ECHO has a 12 dB increases sound level mode, compensating most of the missing coverage.

But the BlueBox with Pink MLS, as shown in this document, has no flat low end spectra and a loss of over 10 dB there. So the sound level must get increased - at max as much as the speaker can stand up (with good MTF @ 125 Hz) to is allowed.

Post processing can well recalculate the measurements from one standard to an other when the test signal is louder than the noise; in a invers situation the calculation **can** loose precision. This is a complex area, going far beyond the scope of this document.

Looking at Precision Aspects more in Detail (II)

But that is only a part of the story; 3382-3 uses a simplified psychoacoustic model, easing the situation. And as mentioned before, the frequency response of the Omni plays a interesting role in the precision game:



EN 3382-3 UniSex spectra and the Omni frequency response add up well in that sense, that - depending on the Omni model - the Omni delivers with Pink MLS stimulus a emitted spectra not so much off the UniSex spectra. The red curve shows the difference for the omni he uses (own development, based on FR10 speakers from Visaton; ca. 35 cm diameter).

But the key responsibility of the Dirac user stays: He must always check *that IR and SNR in the octave bands are sufficient according to the reference spectra model,* else wise try to improve the SNR by higher stimulus level or one the tricks which can get applied.

When measuring according to the base standard in noisy surroundings, test loudspeakers with larger cones do better. That is the hour of speakers like the Genelec 8010 speaker. In many situations it plays no role, if the speaker is of 2-way design; 2 way speaker can also shine regarding directivity; the 19 mm tweeter of the 8010 is a close match to the demands of mouth simulators standards (ITU p.58) and speaker shape does not differ much from the shape of a human head.

Looking at Precision Aspects more in Detail (III)

So in the end, it can make a lot of sense to have different test loudspeakers - depending on what STI situation one is working on. Which speaker then gets used, can be situation dependent. If the customer wants 100% compatibility to the base standards EN 60268-16, then using a stimulus (not with DIRACs System Calibration mode) and a very small speaker or even a mouth simulator (if it is capable to deliver 60 dB(A) with clean MTF results also in the 125 Hz band, what not all Mouth Simulators on the market are capable of) is the answer.

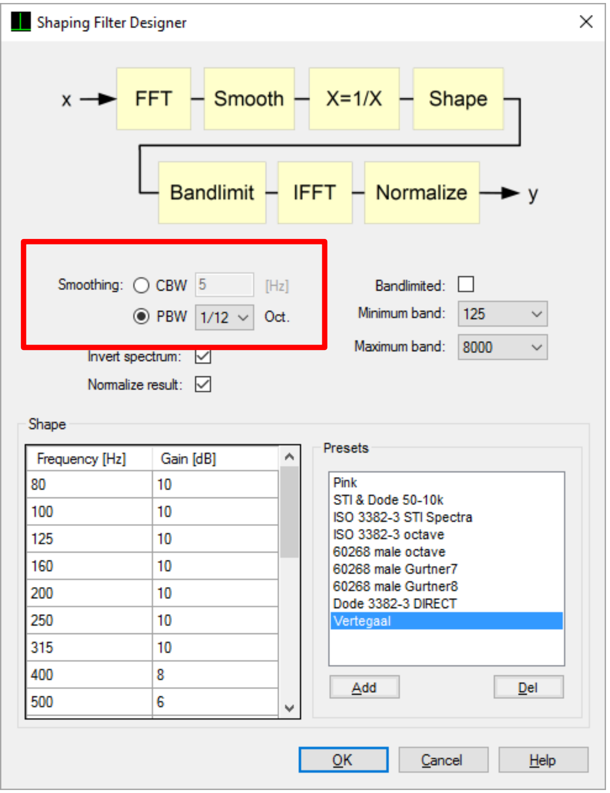
But there are good reasons not to stick like a slave to the standard. (The author of this documents finds, it lacks on requirements differentiations, and is rather much driven by embedded STIPA thinking).

Please be aware:

- Speakers like ECHO (or - what some DIRAC owner also have - NTi-Audio‘s TalkBox) **are ready to use**. Making a stimulus using SFD requires time and an easy access to a high quality anechoic chamber. Already choosing a suitable loudspeaker product can be a challenge.
- Speakers like ECHO and the Genelec 8010 do not compete; neither can replace the other. In the end - in very demanding situations - , one likely needs both types of loudspeakers.
- If interested in distance depending measurements; using the EN 3382-3 compatibly System Calibration of DIRAC is very comfortable, automatically measuring the distance and having prepared reports for that. But that only works, when driving the speaker by wire.
- The ideal speaker for STI measurements does not exist.

Using the SFD Smoothing Option.

Using the SFD Smoothing Option:



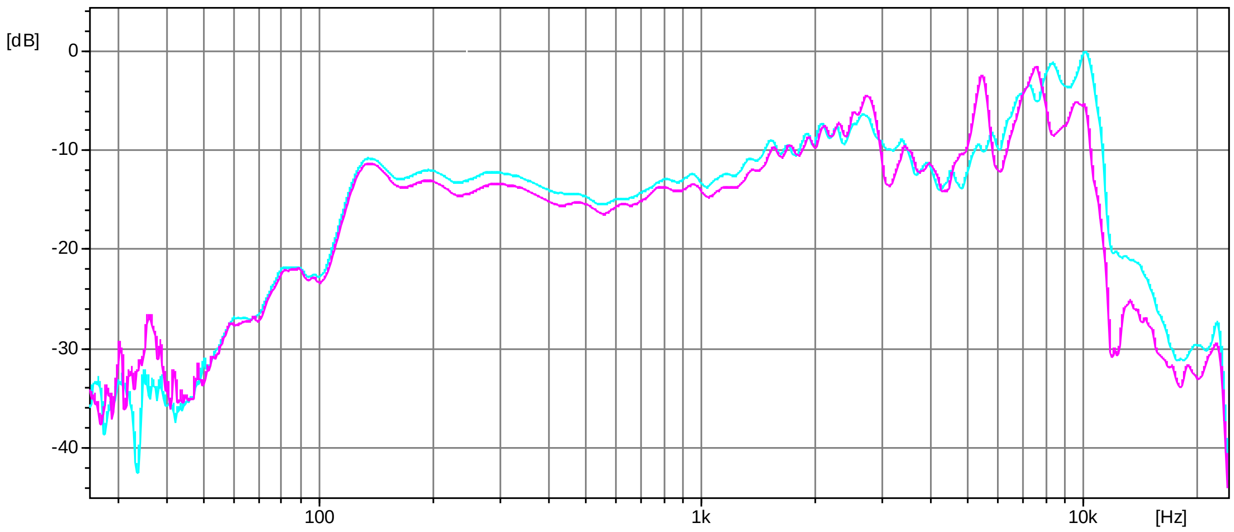
SFD allows to smooth the spikiness of a loudspeaker frequency response before correcting it.

In general good results got achieved with 1/12 or 1/24 flattening.

With the Fostex 6301B speaker the experience got made - especially with a copy having narrow and deep dips in its frequency response curve, that if they do not get flattened, a clean Lombard level (70 dbA) MTF is not possible in the 8 kHz band.

This got obvious, because these speaker got used for several years with a equalizer (Monacor DEQ-230) achieving clean MTF at 70 dB(A). At first - with DIRAC and 1/24 octave smoothing - this was not possible.

Using the SFD Smoothing Option:



The reason for the effect is not fully clear. SFD will pump up the signal level in the dip zones on the frequency response and that somehow seems to stress the speaker - maybe some intermodulation effects.

Anyway, with finer smoothing than 1/3 octave the MTF signal quality in the 8 kHz band dropped with the Lombard signal level of 70 dB(A) - the voice level people tend to use in emergency situations - from 1.000 to about 0.92 (speaker with the red curve @ 1/24 octave smoothing). With the blue curve speaker the effect is also here, but much less. Using 1/3 octave smoothing, both speakers show a MTF value of 1.000 @ 8 kHz.

Some remarks on the Fostex 6301B speaker

There are not many small active loudspeakers on the market suitable for being used as a STI test loudspeaker. The M 52 from Klein + Hummel could of been one, but it is out of production for several years. It came along with a specified, reasonably narrow frequency response (internally partly equalized).

The Fostex 6301B is popular in acoustical engineering; several German measurement companies promote it for STI measurements   - what they suggest to flatten its frequency response the author does not known.

Some remarks on the Fostex 6301B speaker

Con’t:

It is an easy to use device, very robust and capable to make quite some noise. But it is somewhat “akward” to move about in a room, due to its weight and a missing 3/8 inch thread for mounting it solidly on a microphone stand.

As the picture shows, some kind of adapter for microphone stand mounting is required. Best would be to glue a «Quick-change snap-In» tripod adapter from Manfrotto or an other tripod company directly onto the housing. The requirement was, that the adapter would need to be easy demountable - so a more complicated solution resulted, requiring more care when shifting in the room.

When equalized per SFD as described in this chapter, with the two copies in use no restriction relative to the 60268-16 standard got obvious - with the copies in use also @ 70 dB.

In the mean time the updated 6301Nxxx version is on the market. No relevant test articles have yet (2016-06) appeared on the market. Other than the older model, it has a grounded mains connector - so one should check for ground loop risks.

Template:

Below you find the template as embedded object. Just double click it for opening. (Not available in the PDF version of this document).

It is also available here: http://www.acoustics-engineering.com/html/blog.html

This document fits to the template version 6 («Stimuls generation iteration template V6.xlsx»).

If you have questions, don't understand the slides, have Improvement suggestions, critics or just comments - please mail them to: alastair.gurtner@sunrise.ch

Remarks regarding the hardware side (design or choice of speakers, measurement setup, requirements from the standards) are also welcome. So far, for about 10 different loudspeakers stimulus were generated - to test the suitability of different speaker concepts.

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Quick Guide - for handy use (brown fields in tV7 templates):

1. Measure the speakers frequency response in an anechoic chamber @ 1m distance. Use different signal levels form 60 dBA in 3 dB steps up to 75dB or even more.
2. *Evaluate the IRs using the included template, looking at the IR as described in DIRAC's help.*
3. *Decide which IR to use; plan (not now) to use also IRs recorded at higher and lower levels*
4. *Open the IR of choice, measure with the PARAMETER dialog its Leq and copy the data to the Excel tab «FR of Speaker».*
5. *Look at the FR of the speaker, decide on any changes needed to the low end values in the templates black fields of the SFD steps tab. Only change them in column B (auto-copy).*
6. *Copy from the SFD tab the columns A and B, from 25 – 20k Hz to SFD shape table of the opened speaker FR IR as mentioned above.*
7. *Run SFD, then convolve with PinkMLSxx, normalize and store under a informative name.*
8. *Measure the Leq of the just created stimulus file by: First importing it, using DIRAC's measurement window with the «none» signal setting; then using the Parameter dialog for Leq (with 25 – 20k Hz in 1/3 octave mode settings). Use the COPY TABLE functionality in the Parameter window to finally get the data.*
9. *Paste the data into the Helper table tab of the Excel; far left for the first pass.*
10. *Open a DIRAC window with the speakers IR as before, start SFD and copy the columns F and G - as under 6) - to SFD's shape table. The build again an stimulus as under 7). With copying columns F and G into STD's shape tabel, you have just started the first iteration; the SFD shape table data just got refined. Complete the build stimulus steps.*
11. *When finished with all iterations, adjust the signal level for measurements using the measurement widows slider and fine tuning the stimulus's level using EDIT -> Amplify.*

Quick Guide - for handy use (pink fields in tV7 tempaltes):

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6. *Copy from the SFD tab the columns A and B, from 25 – 20k Hz to SFD shape table of the opened speaker FR IR as mentioned above.*
7. *Run SFD, then convolve with PinkMLSxx, normalize and store under a informative name.*
8. *Make a measurement Preset using the just generated stimulus. Run the mesurement with skiped deconvolution.*
9. *Measure the Leq of the measurement result by using the Parameter dialog for Leq from 25 – 20k Hz in 1/3 octave mode. Use COPY TABLE in the Parameter menu to copy the result to the Helper tab.*
10. *Open a DIRAC window with the speakers IR as before, start SFD and copy the newly generated SFD steps tab data to SFD's shape table (columns F & G) .*
11. *Build a new stimulus; same steps as under 7).*
12. *With columns F and G you did the first iteration input for SFD; the data in SFD shape table is now refined. Later iteration will use the same data field types further right. Repeat as 7).*
13. *When finished with all iterations, adjust the signal level for measurements using the measurement widows slider and fine tuning the stimulus's level using EDIT -> Amplify.*