Hochschule für Technik Stuttgart

Institute of Applied Sciences
- Acoustics -

Test Report No. 122 002 14T-413/2

Measurements of sound absorption for ECHOJAZZ EchoTower Round L®

Measurements of sound absorption in the reverberation room according to DIN EN ISO 354

Applicant: ECHOJAZZ AG
Ringstrasse 25
CH-6010 Kriens

Project-No.: 122 002 14T-413

1 Task

Sound absorption measurements were carried out on November 30th, 2022 in the reverberation room of the acoustics test facilities of the University of Applied Sciences Stuttgart (HFT Stuttgart), Centre for Building Physics, Pfaffenwaldring 10a, 70569 Stuttgart-Vaihingen.

2 Measurements of sound absorption in the reverberation room

2.1 Sampling

The test specimens were delivered by Mr. Bonnard of the ECHOJAZZ AG and set up from Mr. Bonnard and the staff of the HFT Stuttgart in the reverberation room.

2.2 Measurement

Client: ECHOJAZZ AG, CH-6010 Kriens
Producer: ECHOJAZZ AG, CH-6010 Kriens
Test specimen: 1 EchoTower Round L®

Test specimen 1.1: Two EchoTower Round L® (see picture 1)

- Two elements EchoTower Round L® placed in the center of the reverberation room
- Dimensions of one element: 367 (diameter) x 1800 mm
  Surface of the test specimen: 2 x 2,2 m² = 4,4 m²

Test specimen 1.2: Two EchoTower Round L® (see picture 2)

- Two elements EchoTower Round L® placed in the corners of the reverberation room. Distance to the walls 100 mm.
- Dimensions of one element: 367 (diameter) x 1800 mm
  Surface of the test specimen: 2 x 2,2 m² = 4,4 m²

Test specimen 1.3: Two EchoTower Round L® (see picture 3)

- Two elements EchoTower Round L® placed in the corners of the reverberation room. Distance to the walls 0 mm
- Dimensions of one element: 367 (diameter) x 1800 mm
  Surface of the test specimen: 2 x 2,2 m² = 4,4 m²

3 Execution of the measurements

The measurements were realised in a reverberation room according to DIN EN ISO 354, issue 12/2003 considering annexes A, B and ZA. The method was applied with disconnected noise. The test specimens were characterized as discrete absorbers according to chapter 6.2.2.

The equivalent sound absorption area A_{Obj} for discrete absorbers was determined by the following equation:

$$A_{Obj} = A_T/\text{number of objects}$$

The sound absorption coefficient α_s for laminar absorbers was determined by the following equation:

$$\alpha_s = A_T/S$$

with:

$$A_T = A_2 - A_1 = 55.3\ V\ (1/c_2T_2 - 1/c_1T_1) - 4\ V\ (m_2 - m_1)$$

that means: A_T = equivalent sound absorption area of specimen in m²;
A_1 = equivalent sound absorption area of the empty reverberation room in m²;

A_2 = equivalent sound absorption area of the reverberation room incl. test specimen in m²;
S = the area of the test specimen in m²;
V = volume of the empty reverberation room in m³;
c_1 = sound velocity in the air in m/s at temperature T_1;
c_2 = sound velocity in the air in m/s at temperature T_2;
T_1 = reverberation time of the empty reverberation room in s;
T_2 = reverberation time of the reverberation room after positioning the test specimen in s;
$m_{1/2}$ = air absorption coefficient in 1/m, calculated with the existing climate terms during the particular measurements.

The evaluation of the sound absorption coefficient is carried out according to DIN EN ISO 11654, issue 7/1997.

The reverberation room has the following dimensions:

(L x W x H): 7.89 m x 5.54 m x 4.65 m; $V_{reverberation\ room}$ = 203,3 m³

Following measuring instruments were used:

Analyser:	Manufacturer: Sinus	Type: Soundbook	SN: 07296
Amplifier:	Manufacturer: Falm	Type: PA1000	SN: 280121
Loudspeaker:	Manufacturer: Norsonic	Type: 229	SN: 15013
4 x preamplifier:	Manufacturer: MicroTech Gefell	Type: MV210	SN: 13643 SN: 13644 SN: 13668 SN: 13674
4 x microphone:	Manufacturer: MicroTech Gefell	Type: 1220	SN: 4016 SN: 4017 SN: 4018 SN: 4019
Calibrator:	Manufacturer: Larson	Type: Cal200	SN: 7237
Climate measurement:	Manufacturer: Extech Instr.	Type: SD700	SN: 026717

Test sound was pink noise.

The used airborne sound measurement chain was DAkkS calibrated and bears the calibration mark *2022*.

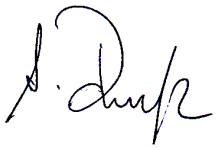
4 Measuring results

Tables 1 to 3 show the average values of the reverberation times and the equivalent absorptions areas of one element (object). In Annex 1 to 6 the measured equivalent sound absorption area A_{Obj} and the sound absorption coefficients α_s for the objects are represented. The values of the equivalent sound absorption area A_{Obj}, the sound absorption coefficients α_s and the practical absorption coefficients α_p are shown next to the diagram.

The report contains: 4 pages text
3 tables
3 pictures
6 annexes

Stuttgart, the 21st of December 2022

Issuer:



Dipl.-Ing. (FH) Andreas Drechsler

Laboratory Manager:

Prof. Dr.-Ing. Berndt Zeitler

test specimen 1.1

frequency [Hz]	T_1 [s]	T_2 [s] specimen 1.1	A_{Obj} [m²] specimen 1.1
100	11,89	8,08	0,65
125	12,45	8,43	0,63
160	12,47	7,01	1,03
200	12,28	6,41	1,23
250	11,39	5,19	1,73
315	11,06	4,75	1,98
400	9,57	4,29	2,12
500	7,99	3,64	2,47
630	7,04	3,38	2,54
800	7,38	3,40	2,61
1000	7,20	3,30	2,70
1250	6,66	3,19	2,69
1600	5,96	3,02	2,68
2000	5,37	2,90	2,59
2500	4,56	2,62	2,63
3150	3,79	2,39	2,47
4000	3,02	2,07	2,39
5000	2,21	1,63	2,45
temperature [°C]	17,1	16,8	
humidity [%]	49,0	48,0	
air pressure [hPa]	964,6	964,4	

Table 1: Climate data at the time of the measurements and the average values of the reverberation time T_1 in the empty reverberation room respectively T_2 in the reverberation room with the test specimen 1.1. Additionally, the values of the equivalent sound absorption area A_{Obj} are shown.

test specimen 1.2

frequency [Hz]	T_1 [s]	T_2 [s] specimen 1.2	A_{Obj} [m²] specimen 1.2
100	11,89	6,90	1,00
125	12,45	5,93	1,46
160	12,47	5,30	1,79
200	12,28	5,43	1,69
250	11,39	5,31	1,66
315	11,06	5,24	1,65
400	9,57	4,52	1,92
500	7,99	4,10	1,96
630	7,04	3,89	1,90
800	7,38	3,98	1,91
1000	7,20	3,92	1,91
1250	6,66	3,79	1,87
1600	5,96	3,61	1,80
2000	5,37	3,46	1,69
2500	4,56	3,12	1,64
3150	3,79	2,72	1,66
4000	3,02	2,29	1,69
5000	2,21	1,80	1,60
temperature [°C]	17,1	16,9	
humidity [%]	49,0	48,5	
air pressure [hPa]	964,6	964,4	

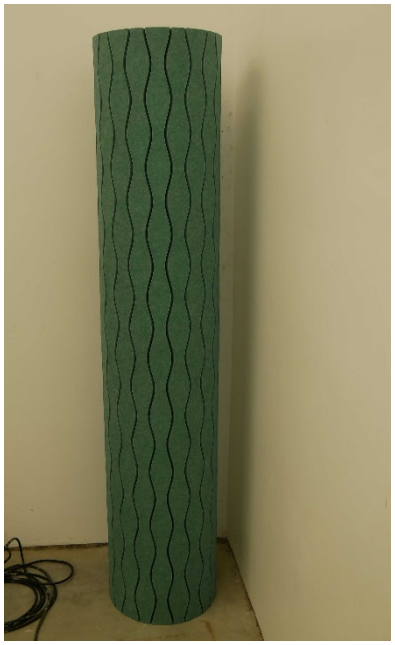
Table 2: Climate data at the time of the measurements and the average values of the reverberation time T_1 in the empty reverberation room respectively T_2 in the reverberation room with the test specimen 1.2. Additionally, the values of the equivalent sound absorption area A_{Obj} are shown.

test specimen 1.3

frequency [Hz]	T_1 [s]	T_2 [s] specimen 1.3	A_{Obj} [m²] specimen 1.3
100	11,89	6,37	1,20
125	12,45	4,76	2,14
160	12,47	4,80	2,11
200	12,28	4,85	2,05
250	11,39	4,90	1,92
315	11,06	4,97	1,83
400	9,57	4,49	1,95
500	7,99	4,10	1,96
630	7,04	3,99	1,79
800	7,38	4,14	1,75
1000	7,20	4,23	1,61
1250	6,66	4,09	1,55
1600	5,96	3,82	1,54
2000	5,37	3,63	1,46
2500	4,56	3,35	1,28
3150	3,79	2,89	1,33
4000	3,02	2,41	1,33
5000	2,21	1,87	1,29
temperature [°C]	17,1	17,0	
humidity [%]	49,0	48,5	
air pressure [hPa]	964,6	964,5	

Table 3: Climate data at the time of the measurements and the average values of the reverberation time T_1 in the empty reverberation room respectively T_2 in the reverberation room with the test specimen 1.3. Additionally, the values of the equivalent sound absorption area A_{Obj} are shown.

Picture 1: Test specimen 1.1 in the reverberation room.



Picture 2: Test specimen 1.2 in the reverberation room.

Picture 3: Test specimen 1.3 in the reverberation room.

Sound absorption coefficient α_s according EN ISO 354

Measurement of sound absorption in a reverberation room

Annex 1

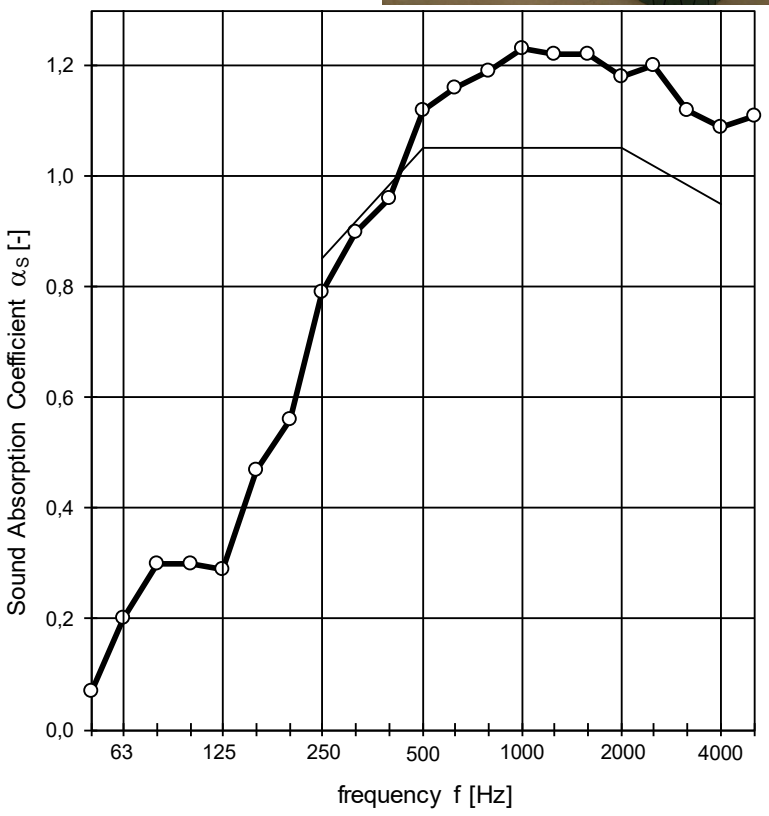
122 002 14T - 413

Client: ECHOJAZZ AG, Ringstrasse 25, CH-6010 Kriens
Producer: ECHOJAZZ AG, Ringstrasse 25, CH-6010 Kriens
Test specimen: **EchoTower Round L®**
Two elements in the center of reverberation room.
Surface area of test specimen: 2 x 2,2 m² = 4,4 m²

Room volume: V = 203,3 m³
Surface of test specimen S = 4,4 m²

Frequency [Hz]	α_S [-]	α_p [-]
50	0,07	
63	0,20	
80	0,30	
100	0,30	
125	0,29	0,35
160	0,47	
200	0,56	
250	0,79	0,75
315	0,90	
400	0,96	
500	1,12	1,10
630	1,16	
800	1,19	
1000	1,23	1,20
1250	1,22	
1600	1,22	
2000	1,18	1,20
2500	1,20	
3150	1,12	
4000	1,09	1,10
5000	1,11	

Excitation signal: Pink noise
Filtering: Third octave band filtering



Ratings according EN ISO 11654: **weighted sound absorption value:** **α_w = 1,05**
Absorption Class according EN ISO 11654: A
Rating according ASTM C 423: **Sound Absorption Average:** **SAA = 1,06**
Classification according ASTM E 1264: **Noise Reduction Coefficient:** **NRC = 1,05**
The determination is based on 1/3 octave laboratory measurement results.

Test Report No.: 122 002 14T - 413
Testing date: 30.11.2022

Hochschule für Technik Stuttgart

Date: 21.12.2022

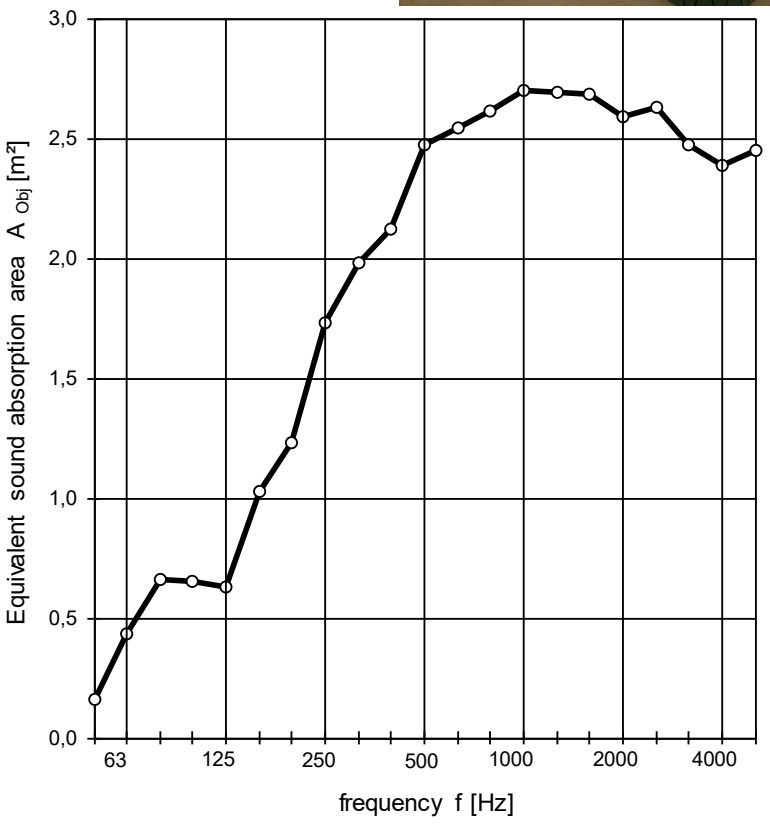
	Equivalent sound absorption area for discrete objects according to DIN EN ISO 354 Measurement of sound absorption in a reverberation room	Annex 2 122 002 14T - 413

Client: ECHOJAZZ AG, Ringstrasse 25, CH-6010 Kriens
Producer: ECHOJAZZ AG, Ringstrasse 25, CH-6010 Kriens
Test specimen: **EchoTower Round L®**
Two elements in the center of reverberation room

Measurable change of the equivalent sound absorption area of the test specimen between 1 m^2 and 12 m^2 is reached at 80 Hz.

Room volume: V = 203,3 m^3
Number of objects: 2

Frequency [Hz]	A_{Obj} [m^2]
50	0,16
63	0,43
80	0,66
100	0,65
125	0,63
160	1,03
200	1,23
250	1,73
315	1,98
400	2,12
500	2,47
630	2,54
800	2,61
1000	2,70
1250	2,69
1600	2,68
2000	2,59
2500	2,63
3150	2,47
4000	2,39
5000	2,45



Excitation signal: Pink noise
Filtering: Third octave band filtering

The determination is based on 1/3 octave laboratory measurement results.

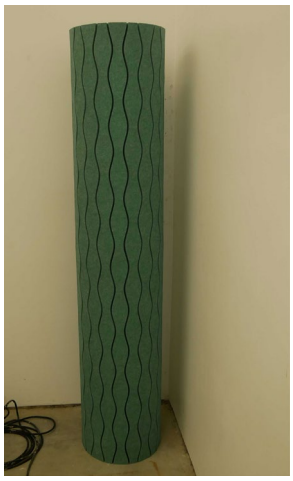
Sound absorption coefficient α_s according EN ISO 354

Measurement of sound absorption in a reverberation room

Annex 3

122 002 14T - 413

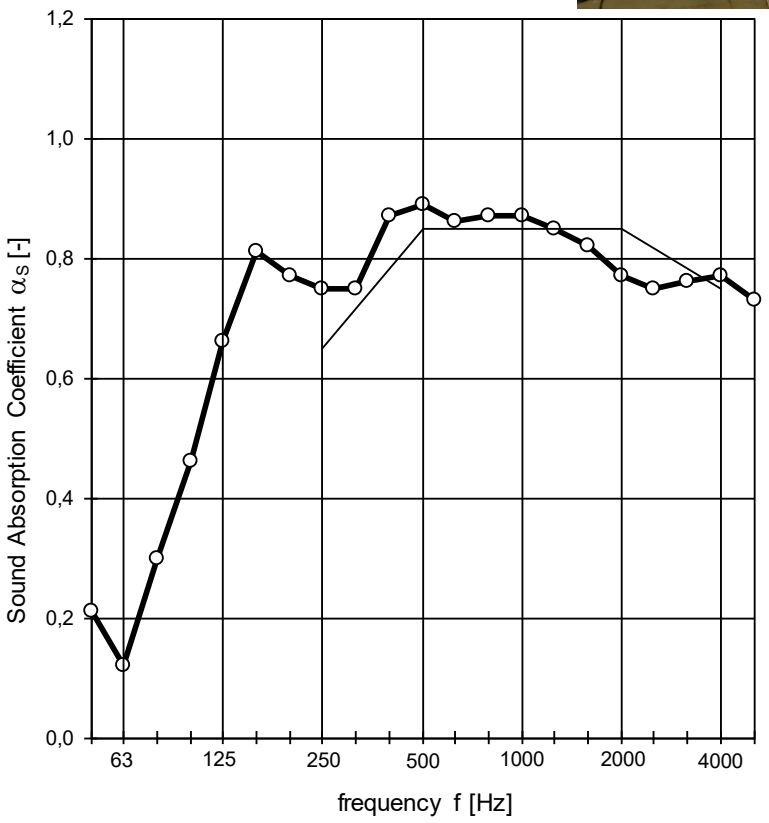
Client: ECHOJAZZ
Producer: ECHOJAZZ AG, Ringstrasse 25, CH-6010 Kriens
Test specimen: **EchoTower Round L®**
Two elements in the corners of reverberation room (distance to wall 100 mm)
Surface area of test specimen: 2 x 2,2 m² = 4,4 m²



Room volume: V = 203,3 m³
Surface of test specimen S = 4,4 m²

Frequency [Hz]	α_S [-]	α_p [-]
50	0,21	
63	0,12	
80	0,30	
100	0,46	
125	0,66	0,65
160	0,81	
200	0,77	
250	0,75	0,75
315	0,75	
400	0,87	
500	0,89	0,85
630	0,86	
800	0,87	
1000	0,87	0,85
1250	0,85	
1600	0,82	
2000	0,77	0,80
2500	0,75	
3150	0,76	
4000	0,77	0,75
5000	0,73	

Excitation signal: Pink noise
Filtering: Third octave band filtering



Ratings according EN ISO 11654: **weighted sound absorption value:** **α_w = 0,85**
Absorption Class according EN ISO 11654: B
Rating according ASTM C 423: **Sound Absorption Average:** **SAA = 0,82**
Classification according ASTM E 1264: **Noise Reduction Coefficient:** **NRC = 0,80**
The determination is based on 1/3 octave laboratory measurement results.

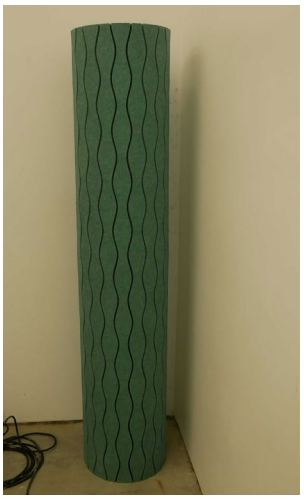
Test Report No.: 122 002 14T - 413
Testing date: 30.11.2022

Hochschule für Technik Stuttgart

Date: 21.12.2022

	Equivalent sound absorption area for discrete objects according to DIN EN ISO 354 Measurement of sound absorption in a reverberation room	Annex 4 122 002 14T - 413

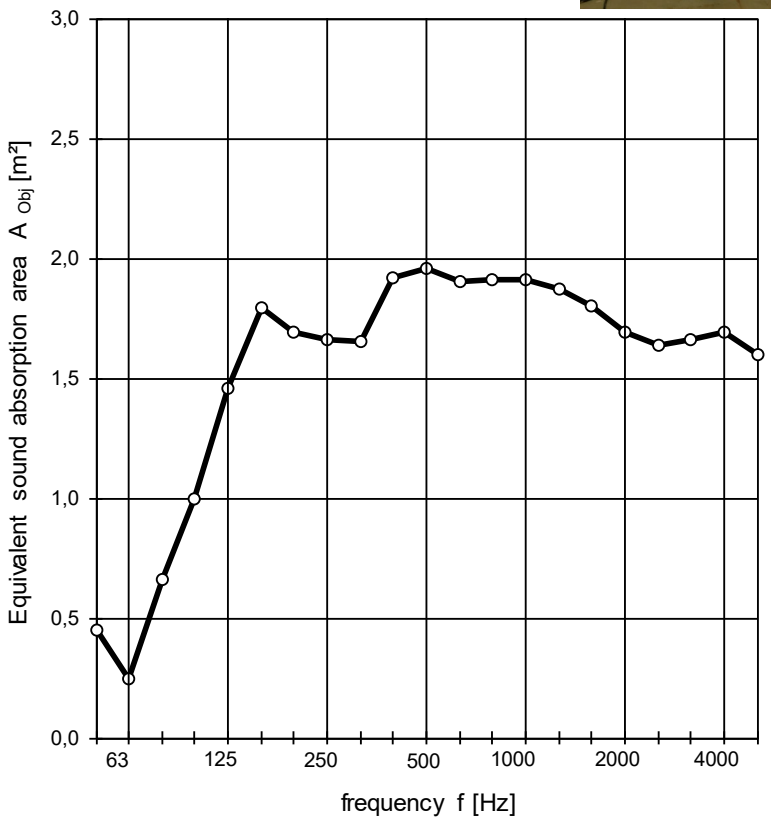
Client: ECHOJAZZ AG, Ringstrasse 25, CH-6010 Kriens
Producer: ECHOJAZZ AG, Ringstrasse 25, CH-6010 Kriens
Test specimen: **EchoTower Round L®**
Two elements in the corners of reverberation room (distance to wall 100 mm)



Measurable change of the equivalent sound absorption area of the test specimen between 1 m^2 and 12 m^2 is reached at 80 Hz.

Room volume: V = 203,3 m^3
Number of objects: 2

Frequency [Hz]	A_{Obj} [m^2]
50	0,45
63	0,25
80	0,66
100	1,00
125	1,46
160	1,79
200	1,69
250	1,66
315	1,65
400	1,92
500	1,96
630	1,90
800	1,91
1000	1,91
1250	1,87
1600	1,80
2000	1,69
2500	1,64
3150	1,66
4000	1,69
5000	1,60



Excitation signal: Pink noise
Filtering: Third octave band filtering

The determination is based on 1/3 octave laboratory measurement results.

Sound absorption coefficient α_s according EN ISO 354

Measurement of sound absorption in a reverberation room

Annex 5

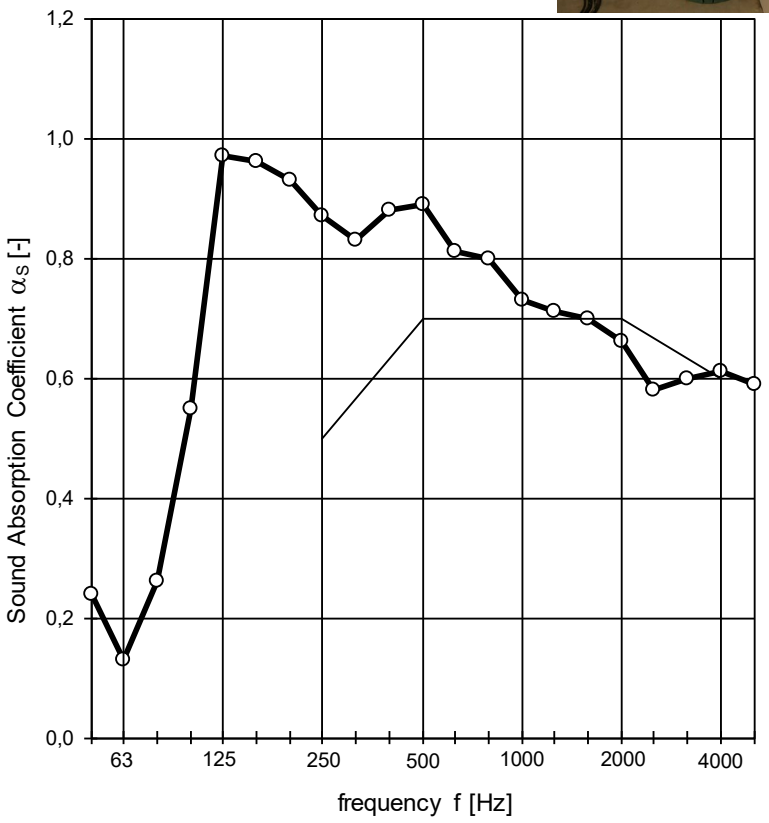
122 002 14T - 413

Client: ECHOJAZZ
Producer: ECHOJAZZ AG, Ringstrasse 25, CH-6010 Kriens
Test specimen: **EchoTower Round L®**
Two elements in the corners of reverberation room (distance to wall 0 mm)
Surface area of test specimen: 2 x 2,2 m² = 4,4 m²

Room volume: V = 203,3 m³
Surface of test specimen S = 4,4 m²

Frequency [Hz]	α_S [-]	α_p [-]
50	0,24	
63	0,13	
80	0,26	
100	0,55	
125	0,97	0,85
160	0,96	
200	0,93	
250	0,87	0,90
315	0,83	
400	0,88	
500	0,89	0,85
630	0,81	
800	0,80	
1000	0,73	0,75
1250	0,71	
1600	0,70	
2000	0,66	0,65
2500	0,58	
3150	0,60	
4000	0,61	0,60
5000	0,59	

Excitation signal: Pink noise
Filtering: Third octave band filtering



Ratings according EN ISO 11654: **weighted sound absorption value:** **α_w = 0,7 (L)**
Absorption Class according EN ISO 11654: C
Rating according ASTM C 423: **Sound Absorption Average:** **SAA = 0,78**
Classification according ASTM E 1264: **Noise Reduction Coefficient:** **NRC = 0,80**
The determination is based on 1/3 octave laboratory measurement results.

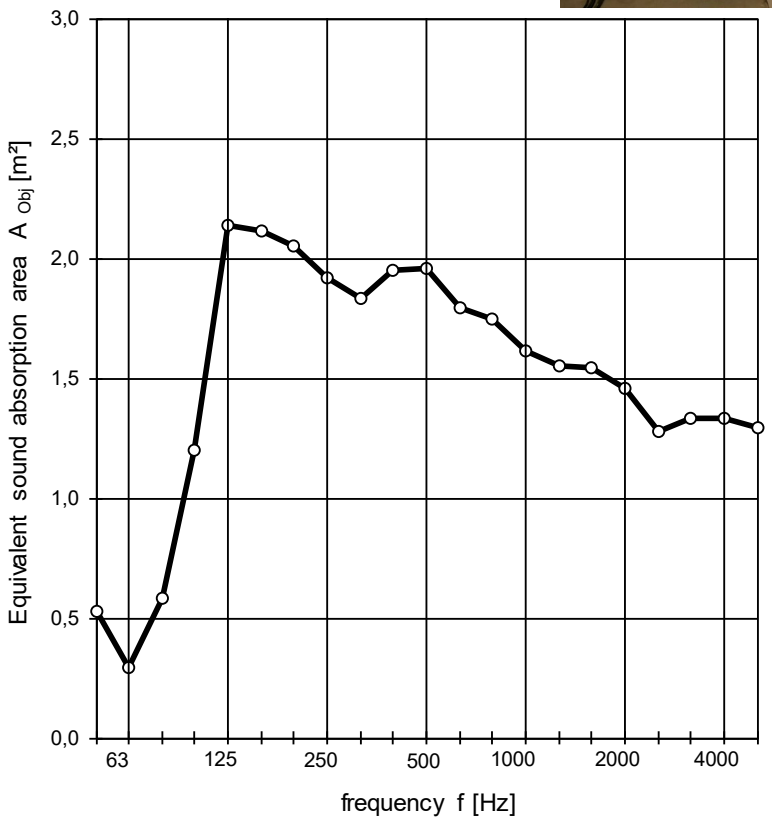
	Equivalent sound absorption area for discrete objects according to DIN EN ISO 354 Measurement of sound absorption in a reverberation room	Annex 6 122 002 14T - 413

Client: ECHOJAZZ AG, Ringstrasse 25, CH-6010 Kriens
Producer: ECHOJAZZ AG, Ringstrasse 25, CH-6010 Kriens
Test specimen: **EchoTower Round L®**
Two elements in the corners of reverberation room (distance to wall 0 mm)

Measurable change of the equivalent sound absorption area of the test specimen between 1 m^2 and 12 m^2 is reached at 80 Hz.

Room volume: V = 203,3 m^3
Number of objects: 2

Frequency [Hz]	A_{Obj} [m^2]
50	0,53
63	0,29
80	0,58
100	1,20
125	2,14
160	2,11
200	2,05
250	1,92
315	1,83
400	1,95
500	1,96
630	1,79
800	1,75
1000	1,61
1250	1,55
1600	1,54
2000	1,46
2500	1,28
3150	1,33
4000	1,33
5000	1,29



Excitation signal: Pink noise
Filtering: Third octave band filtering

The determination is based on 1/3 octave laboratory measurement results.