

CLIO 在室内声学与建筑声学的应用

欧码艾瑞声亚洲公司
(Audiomatica Srl & EAV Audio)



室内声学与建筑声学

- 室内声学与建筑声学的参考标准
- 应用：
 - 脉冲响应的测量
 - 声学参数的评估
 - 语音传输指数
 - 室内声学的小波分析
 - 室内声学的 ETF 能量时间频率分布
 - 隔音率 R' 的测量
- 测试器材的相关标准

室内声学与建筑声学

- 参考标准：

- ISO 18233:2006. Acoustics — Application of new measurement methods in building and room acoustics
- ISO 3382. Acoustics — Measurement of room acoustic parameters
 - Part 1:2009. Performance spaces
 - Part 2:2008. Reverberation time in ordinary rooms
- IEC 60268. Sound system equipment
 - Part 16:2003. Objective rating of speech intelligibility by speech transmission index
- ISO 140 series. Acoustics — Measurement of sound insulation in buildings and of building elements
- ISO 717 series. Acoustics — Rating of sound insulation in buildings and of building elements

室内声学

- 室内的声学特性可用室内脉冲响应导出的一套声学参数来描述
- ISO3382 国际标准定义了这些参数：
 - 混响时间 (EDT, RT20, RT30, RTU)
 - 早期 / 晚期能量比 (C50, C80, D, ts)
 - 声压级和力度 (G)
 - 背景噪声
- 语音传输指数是描述人声传输质量很重要的一个因素

室内脉冲响应

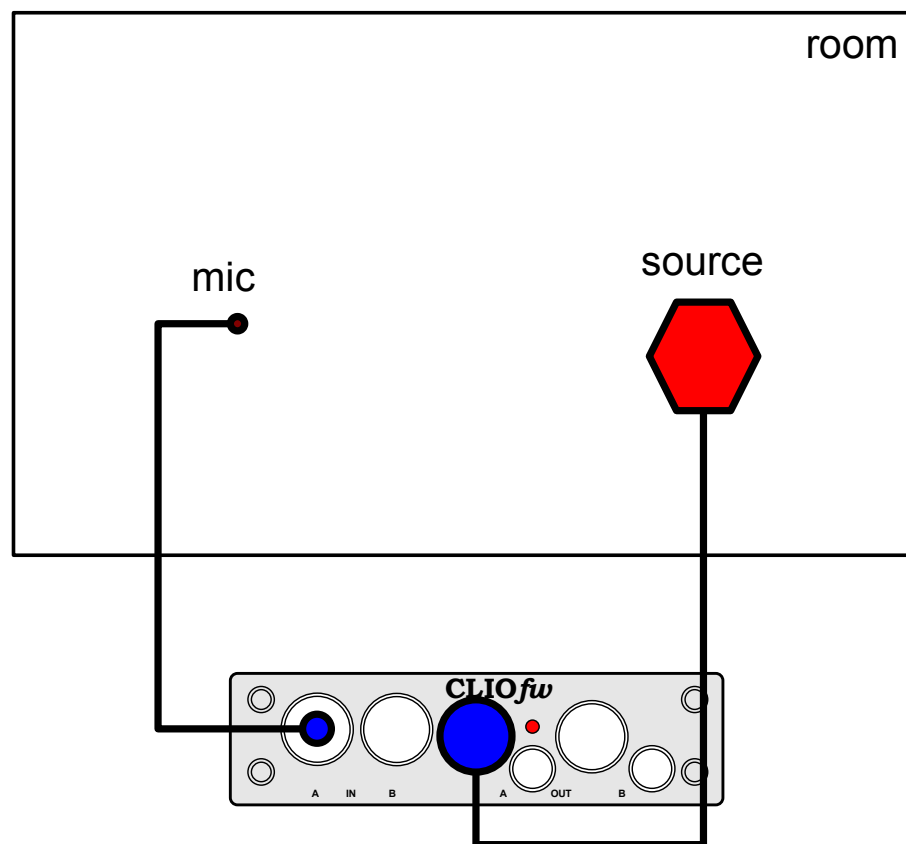
- 室内的声音传输可视为一个线性系统，音源到麦克风的脉冲响应可用不同的方式测得：
 - 最长序列 MLS (ISO3382 & ISO18233)
 - 正弦波扫描 SS (ISO3382 & ISO18233)
 - 脉冲音源直接测量 (ISO3382)

现场典型应用



MLS 与对数正弦波速度扫描

- 室内脉冲相应可用扬声器为音源以 MLS 最长序讯或正弦波扫描法测得



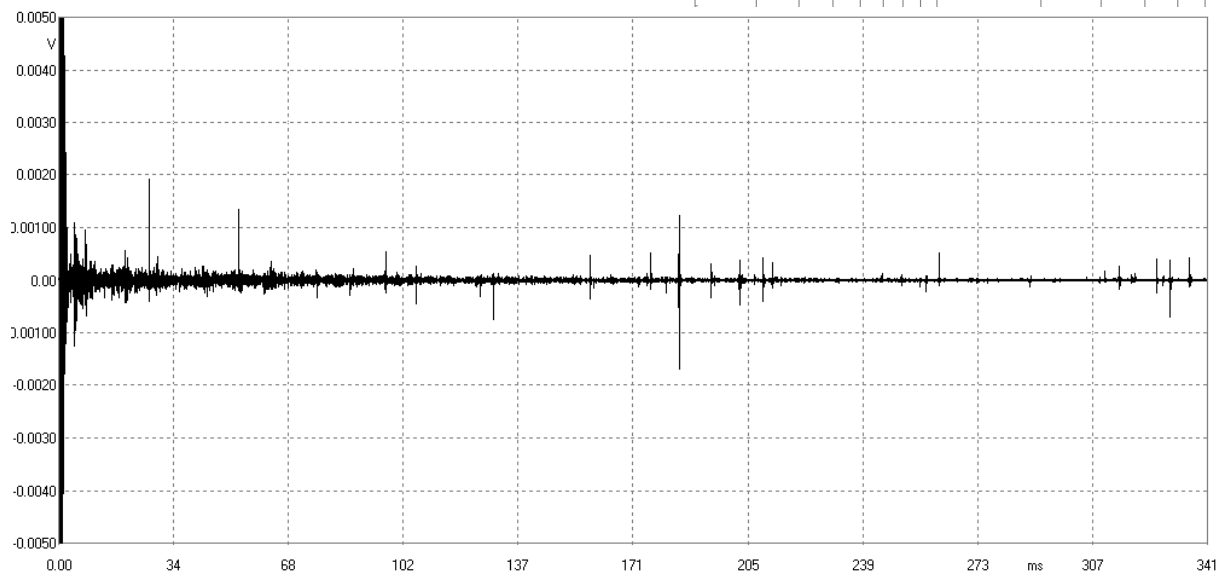
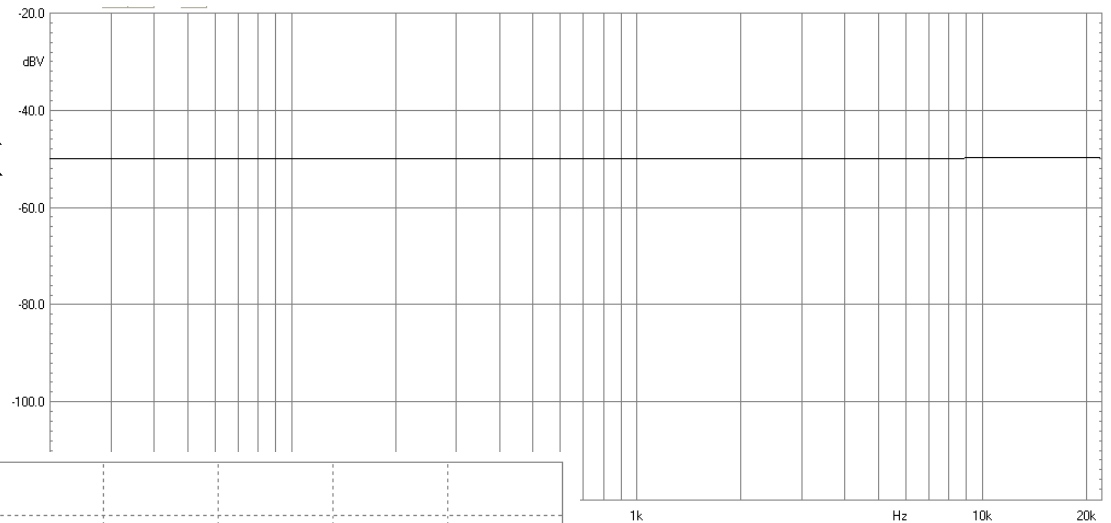
用 CLIO 10 测脉冲响应

- MLS 及 LogChirp 分析：

- 最多 51.2 万点，以 48k Hz 取样可得最长 10.8 秒的脉冲响

- **MLS:**

- 白噪声频谱
- STI 音 指数计算



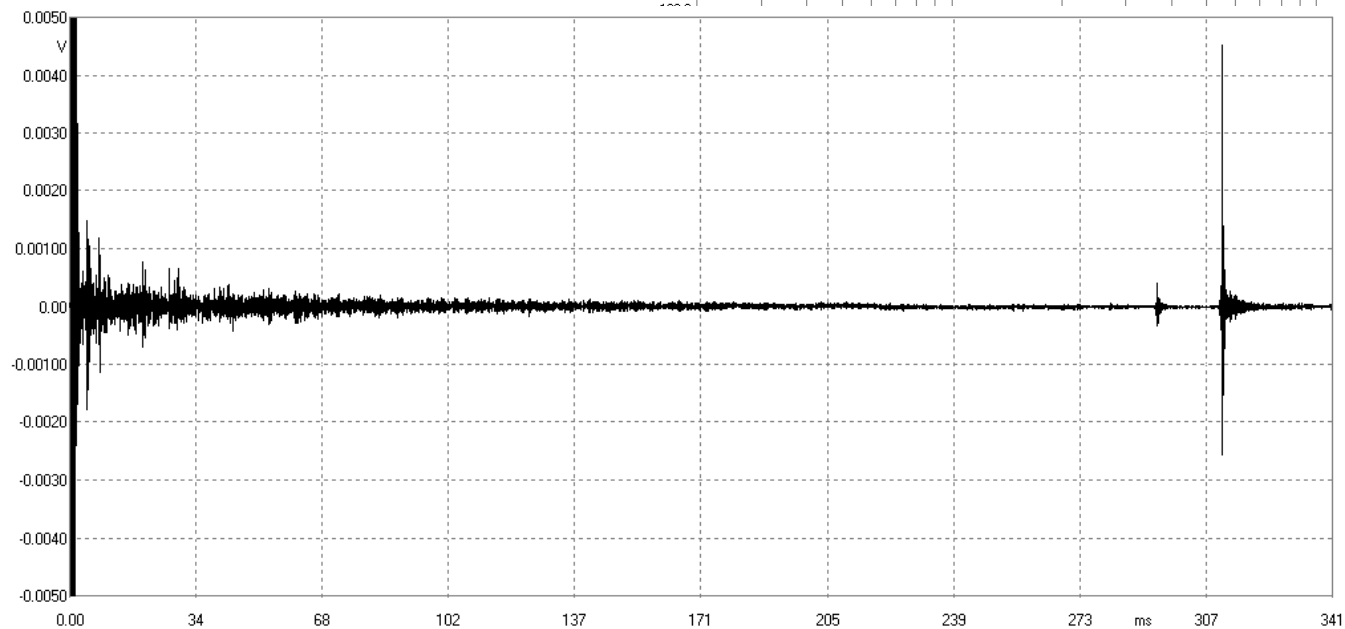
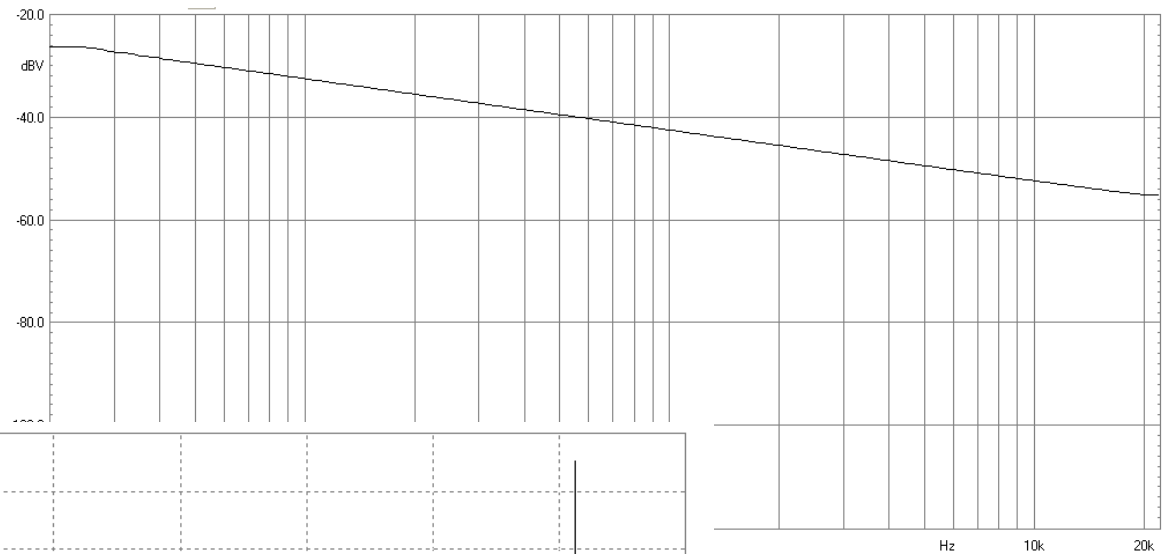
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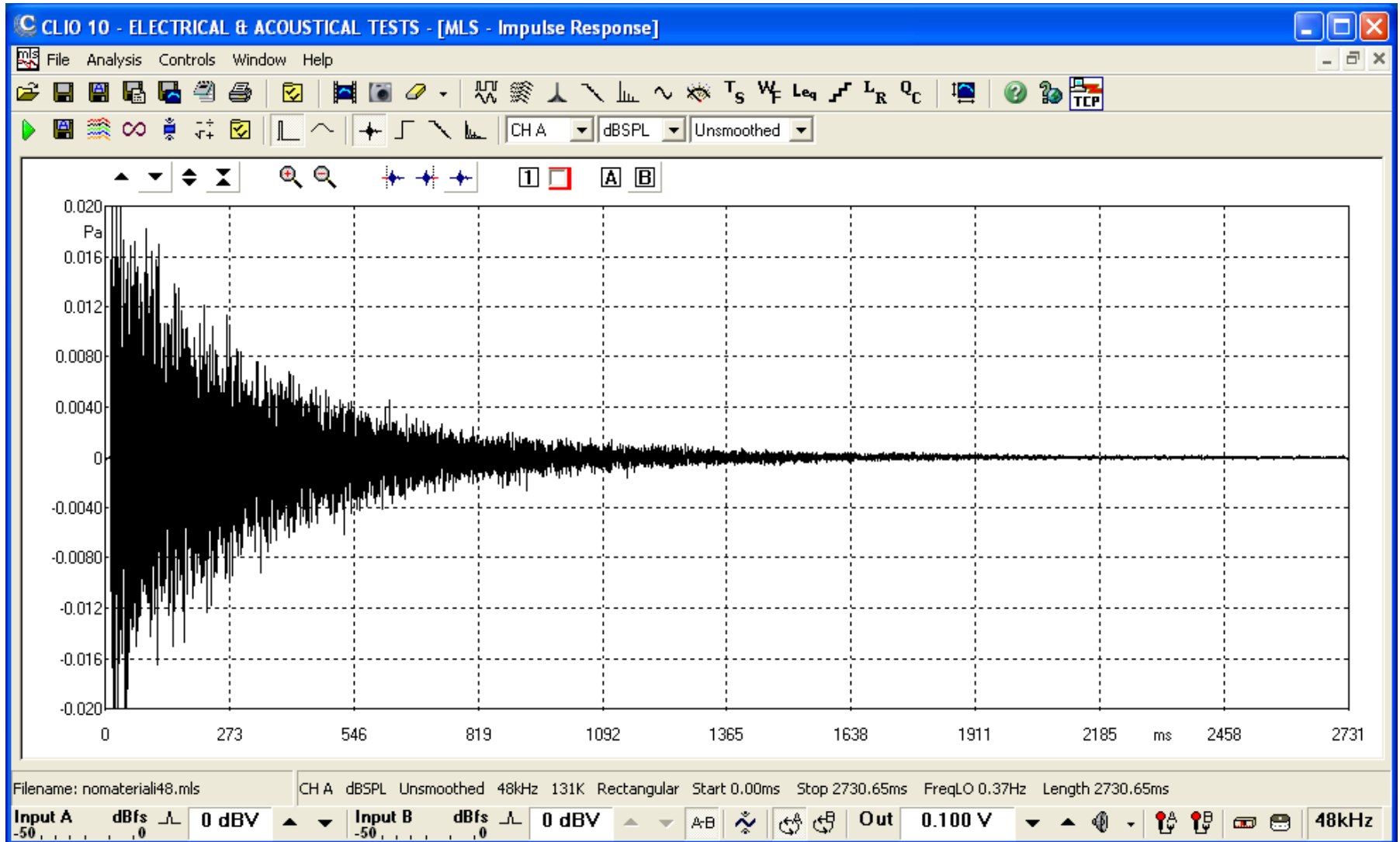
- 对数正弦波扫描

- 粉噪频谱
- 非线性失真分析



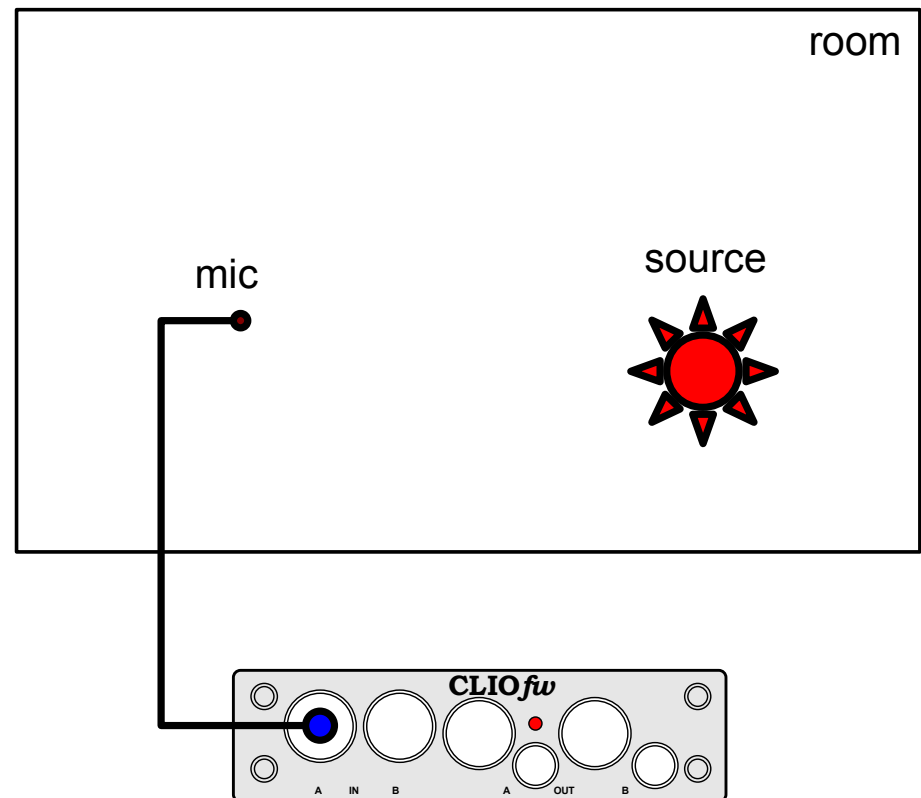
用 CLIO 10 测脉冲响应

- MLS 及 LogChirp 分析：



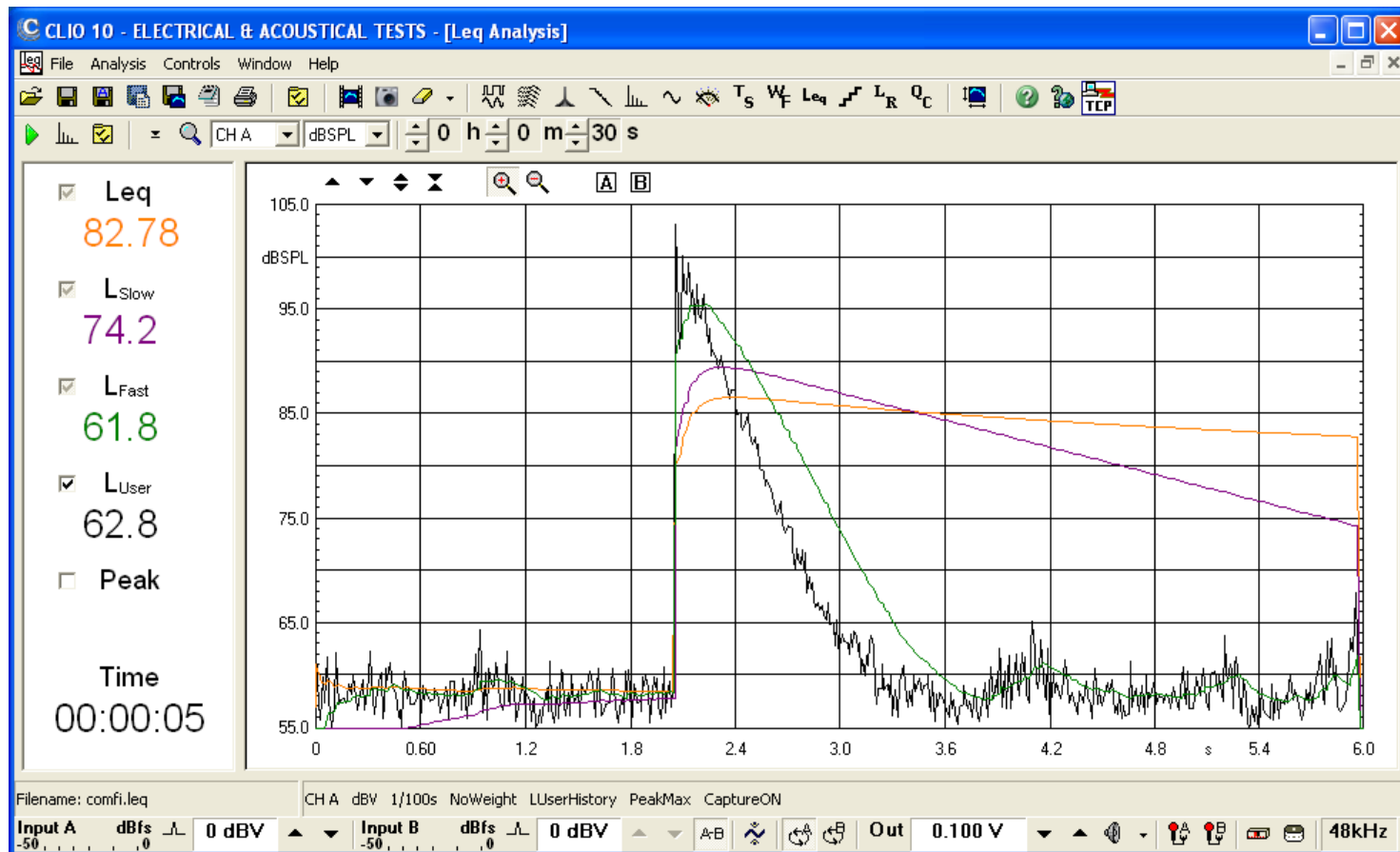
直接测量脉冲声源

- 直接测量脉冲声源：
 - 枪响
 - 气球爆响



用 Clio10 纪录脉冲

- 直接输入给 Clio 用 Leq 音压位准分析功能
- 用外部录音装置
- 脉冲必须存成 .wav 格式档案

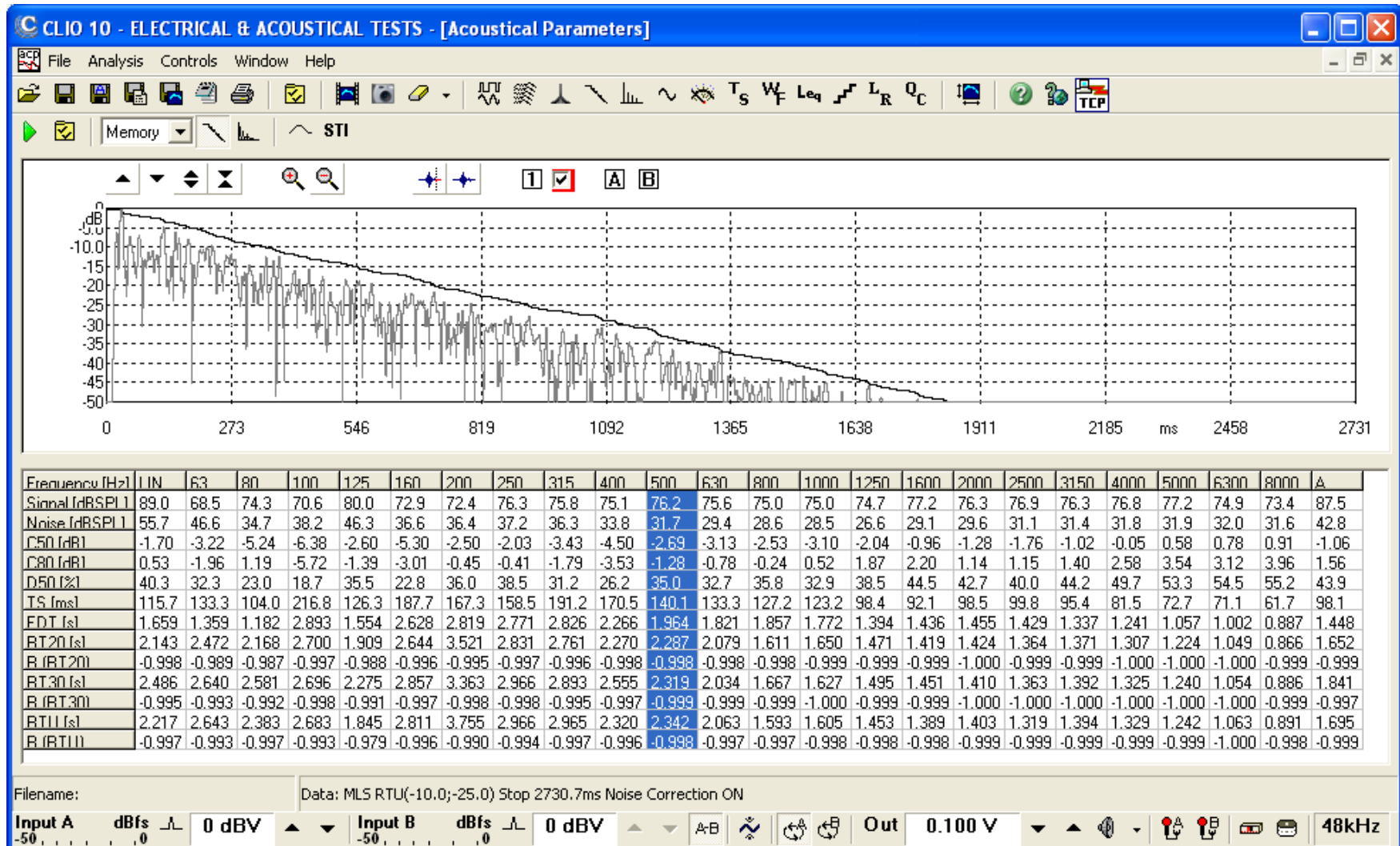


由脉冲到声学参数

- 用测得脉冲响应可计算声学参数
- 每八度或 $1/3$ 八度音程频带的声压衰减曲线以脉冲的逆积分求得
- 可补偿背景噪声
- **CLIO10** 硬件能确保准确知道讯号位准

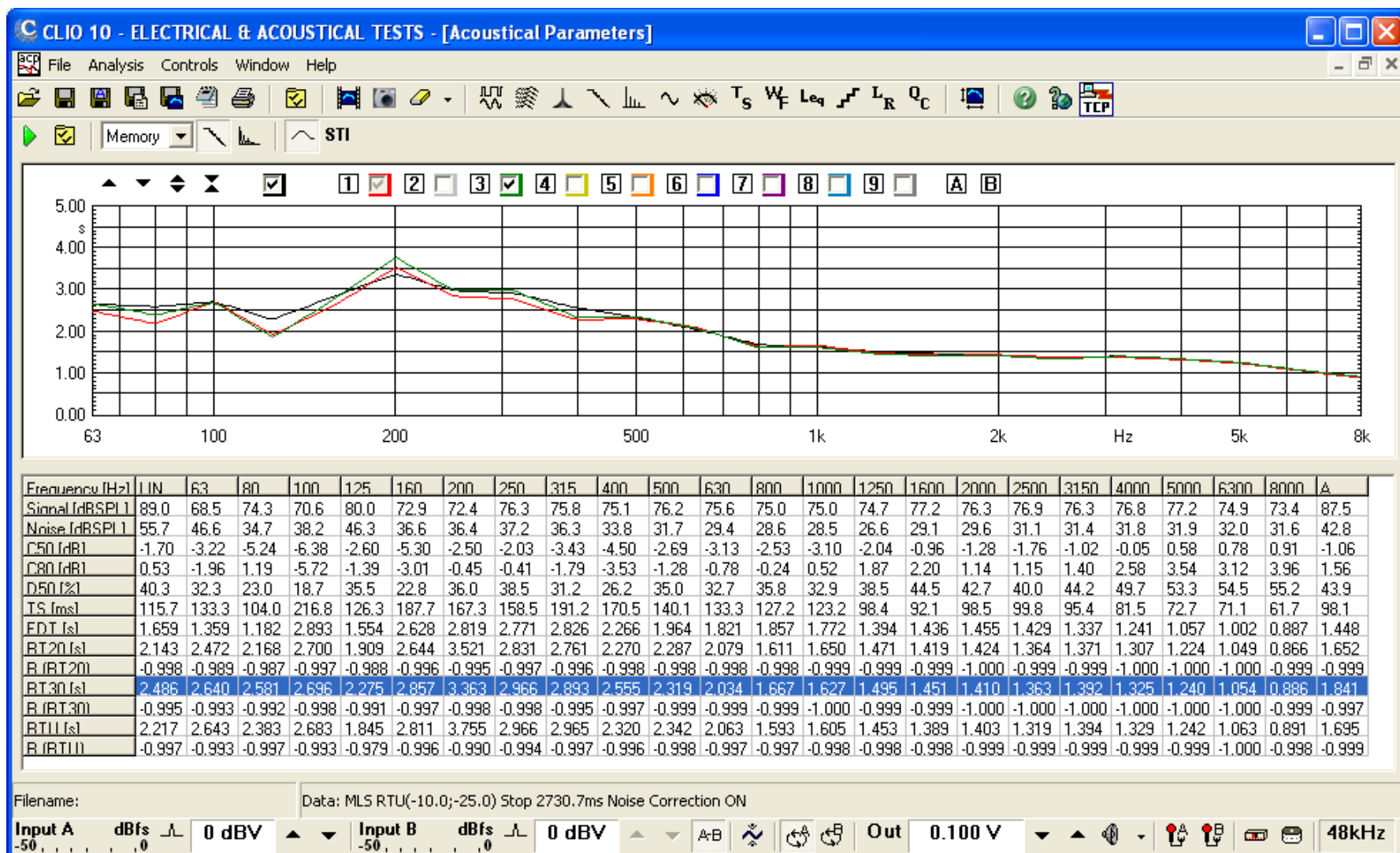
衰减分析

- CLIO 可分析每个频段的衰减情形



声学参数

- CLIO 可显示声学参数对不同频率的变化



STI (语音传输指数)

- 若用 MLS 测脉冲响应可计算不同频率的语音传输指数 (D. Rife, "Modulation Transfer Function Measurement with Maximum-Length Sequences", JAES Volume 40 Issue 10 pp. 779-790; October 1992)

----- STI index -----							
Oct. Band	125	250	500	1k	2k	4k	8k
f1=0.63	0.745	0.811	0.761	0.813	0.829	0.880	0.972
f2=0.80	0.686	0.739	0.688	0.747	0.755	0.801	0.890
f3=1.00	0.644	0.686	0.633	0.699	0.699	0.741	0.827
f4=1.25	0.579	0.604	0.556	0.635	0.616	0.651	0.733
f5=1.60	0.523	0.536	0.510	0.592	0.553	0.581	0.661
f6=2.00	0.477	0.478	0.485	0.558	0.501	0.521	0.602
f7=2.50	0.415	0.404	0.458	0.525	0.431	0.438	0.527
f8=3.15	0.345	0.338	0.434	0.504	0.362	0.353	0.461
f9=4.00	0.298	0.302	0.427	0.455	0.235	0.166	0.373
f10=5.00	0.353	0.260	0.421	0.405	0.204	0.090	0.361
f11=6.30	0.442	0.144	0.368	0.415	0.317	0.363	0.462
f12=8.00	0.563	0.493	0.447	0.493	0.450	0.548	0.650
f13=10.00	0.400	0.392	0.379	0.495	0.403	0.505	0.687
f14=12.50	0.372	0.298	0.340	0.477	0.272	0.379	0.507

MTI	0.489	0.463	0.493	0.558	0.473	0.501	0.623

STI=0.512 ALcons=10.6% rated Fair							

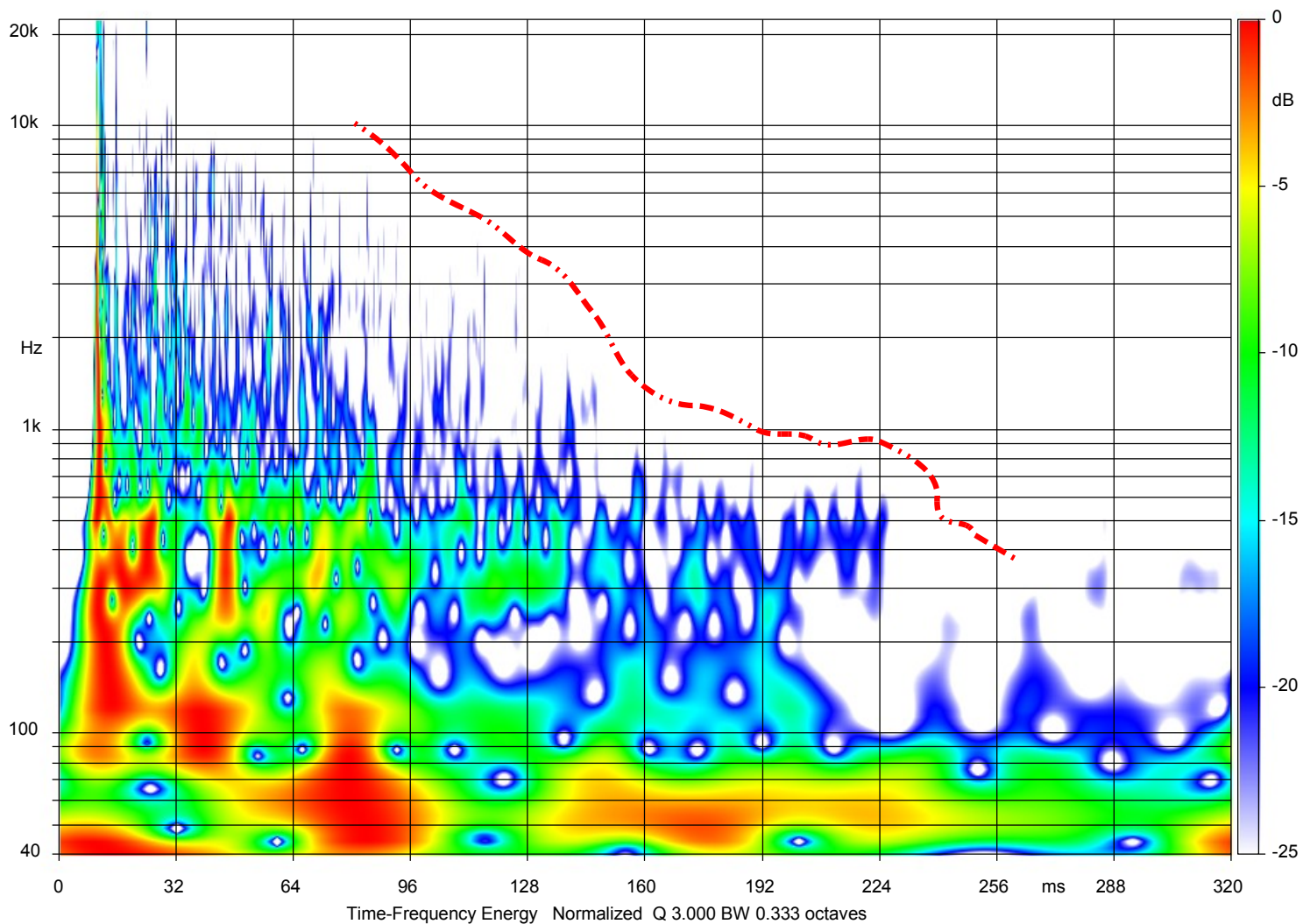
小波分析

- 小波分析是可应用于室内声学评价的强大工具
- 测得脉冲响应可于时间 - 频率面同时检视
- 下列例子可见用吸音与扩散方式控制回响与共振的效果

小波分析

Wavelet Analysis

9-20-2008 4.31.33 PM

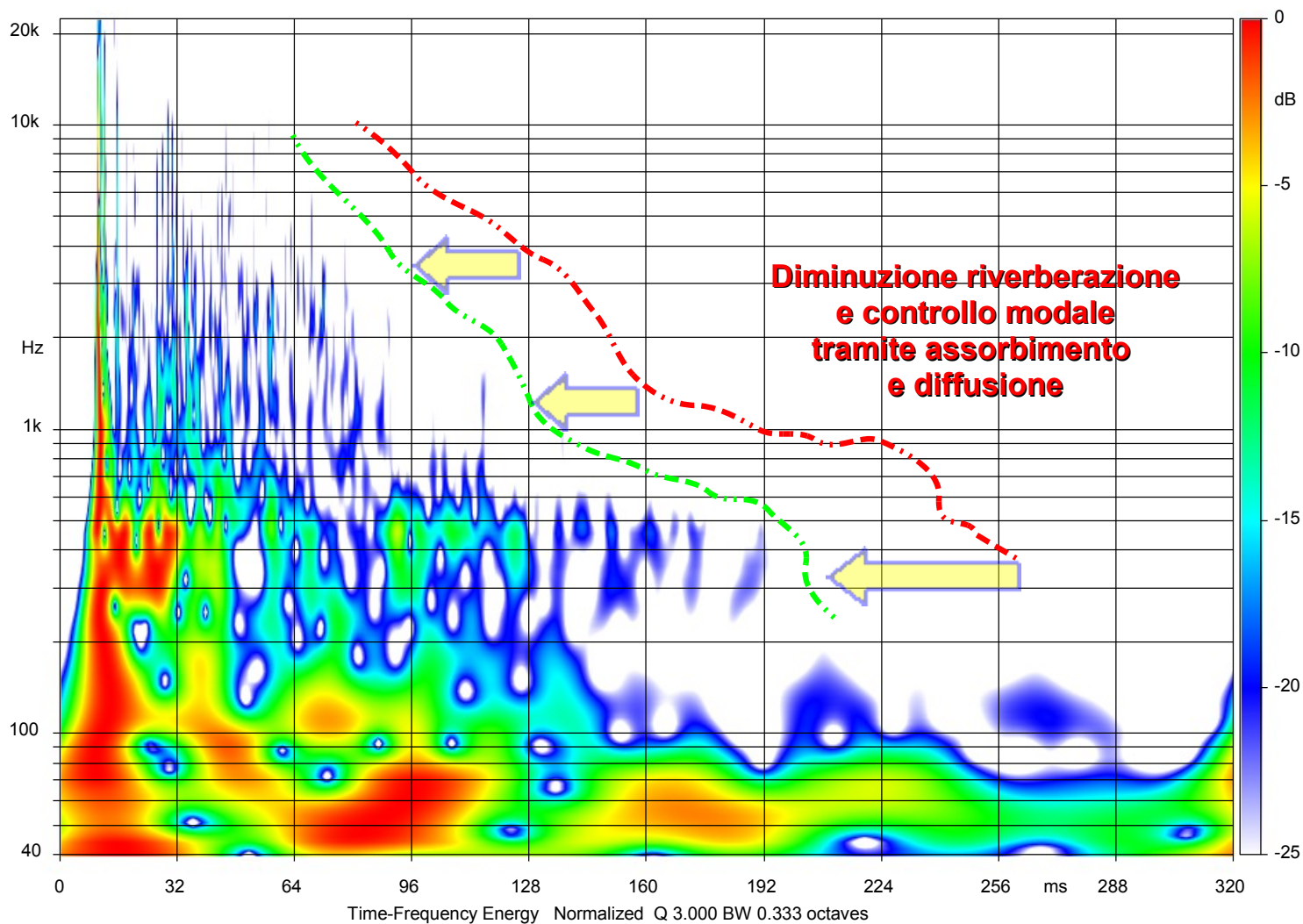


File:

小波分析

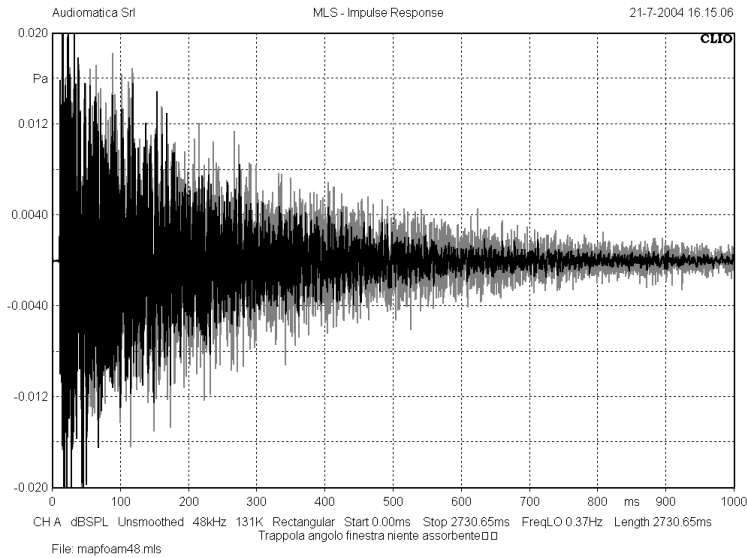
Wavelet Analysis

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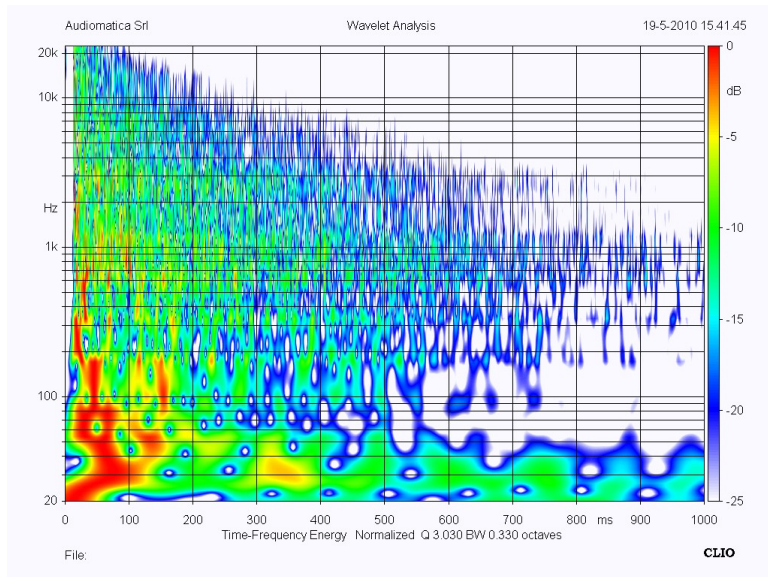


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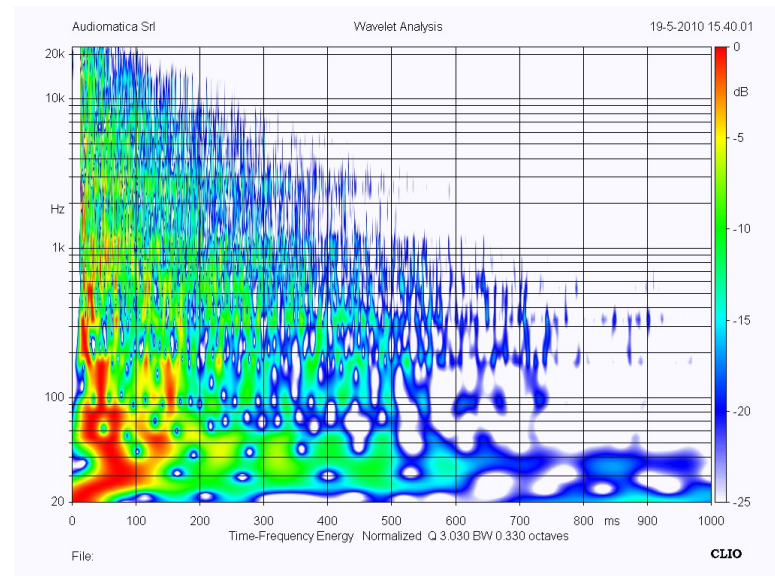
室内声学



没吸音



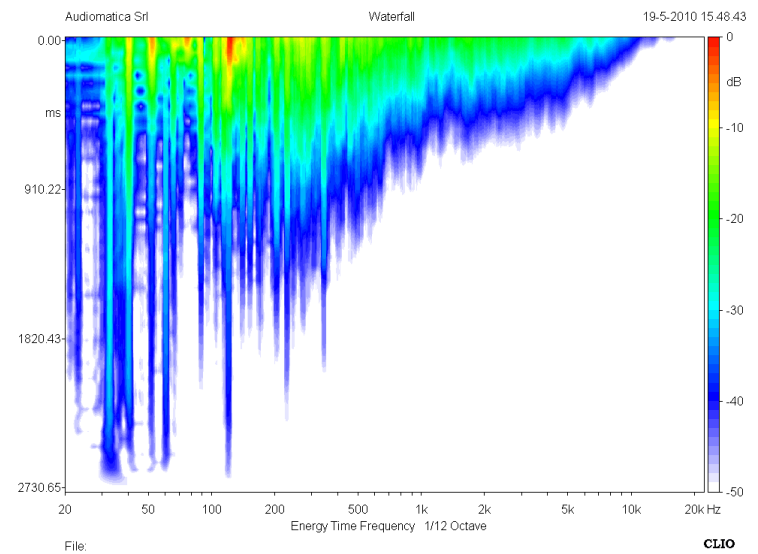
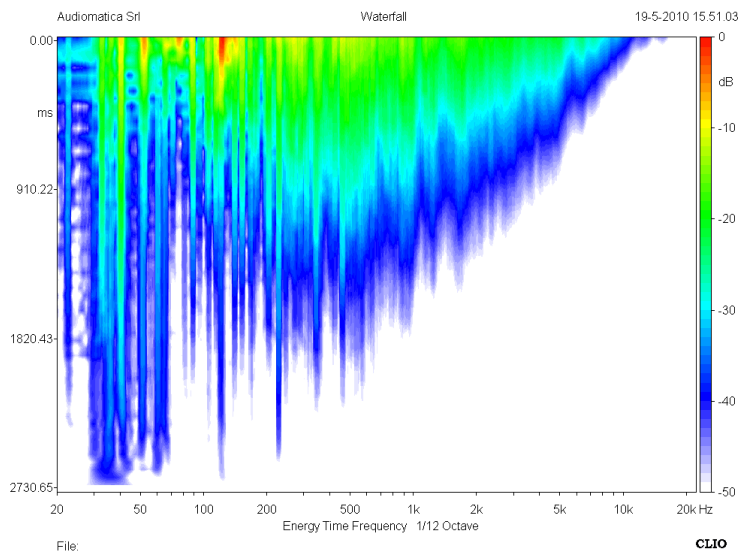
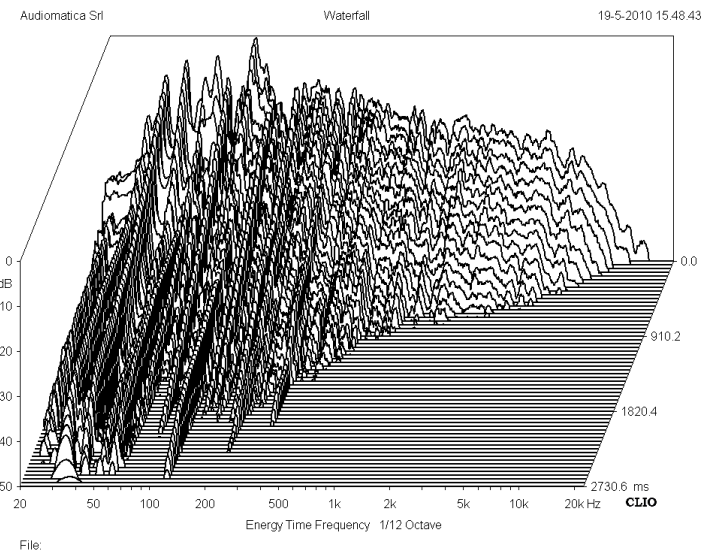
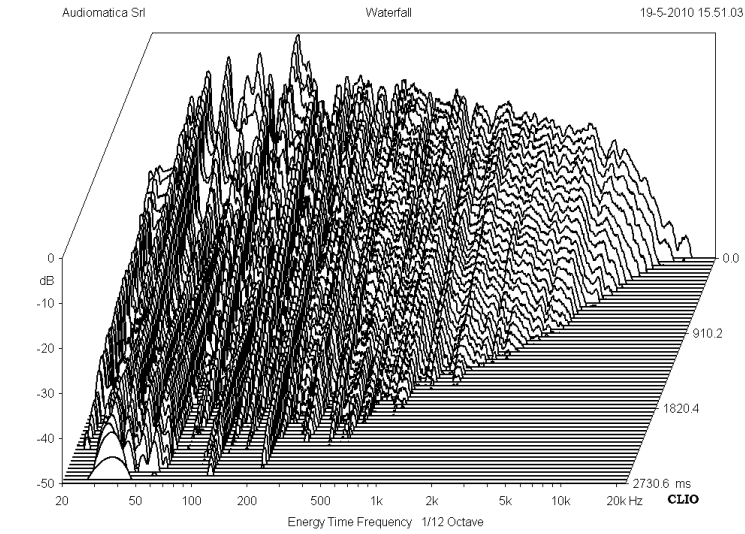
有吸音



能量时间频率分析

没吸音

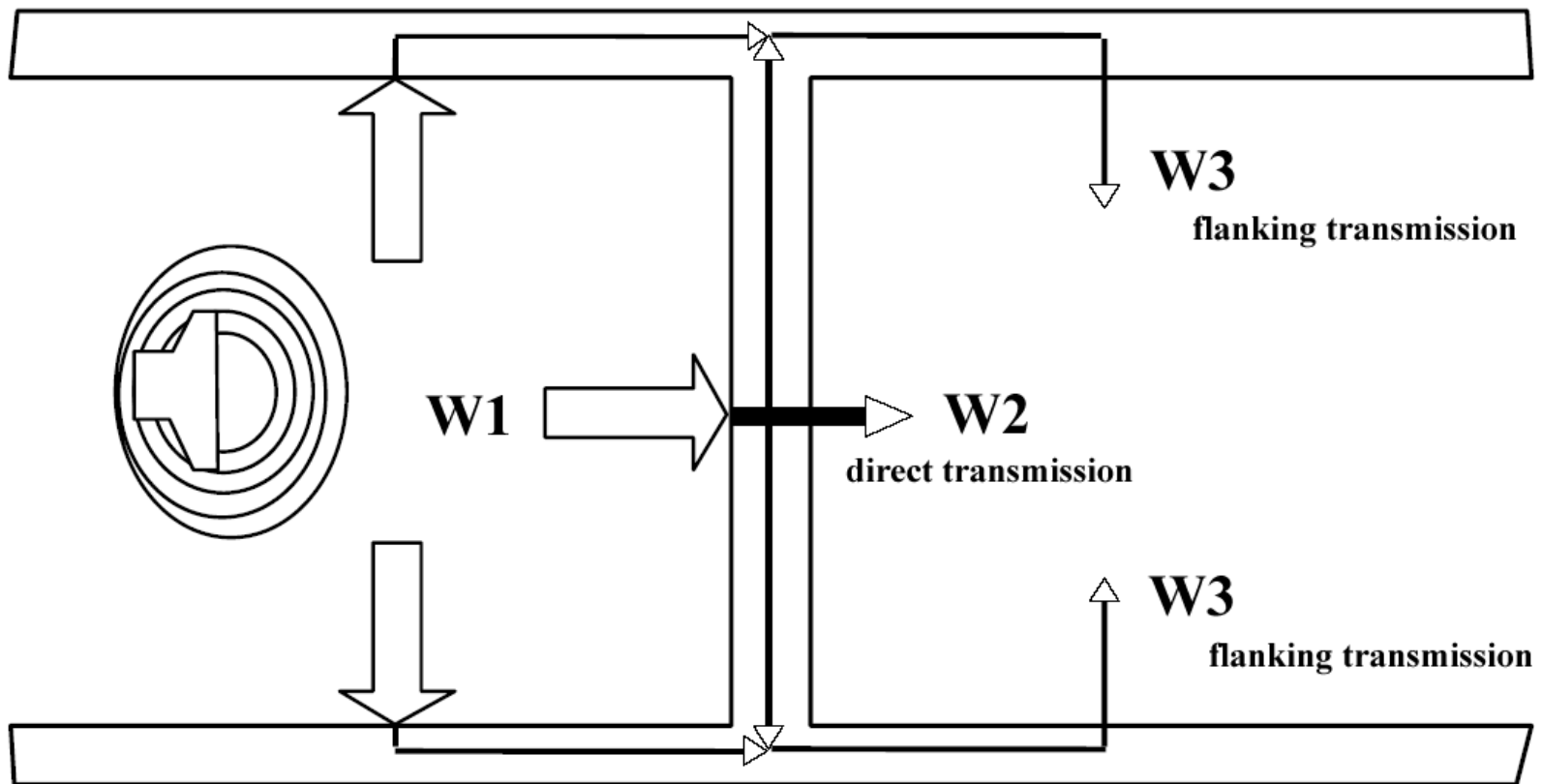
有吸音



建筑声学

空气隔声

测量显明声音减少指数 R'



$$R' = 10 \lg \frac{W_1}{W_2 + W_3} \text{ dB}$$

建筑声学

测量显明声音减少指数 R'

$$R' = 10 \lg \frac{W_1}{W_2 + W_3} \text{ dB}$$

$$R' = D + 10 \lg \frac{S}{A} \text{ dB}$$

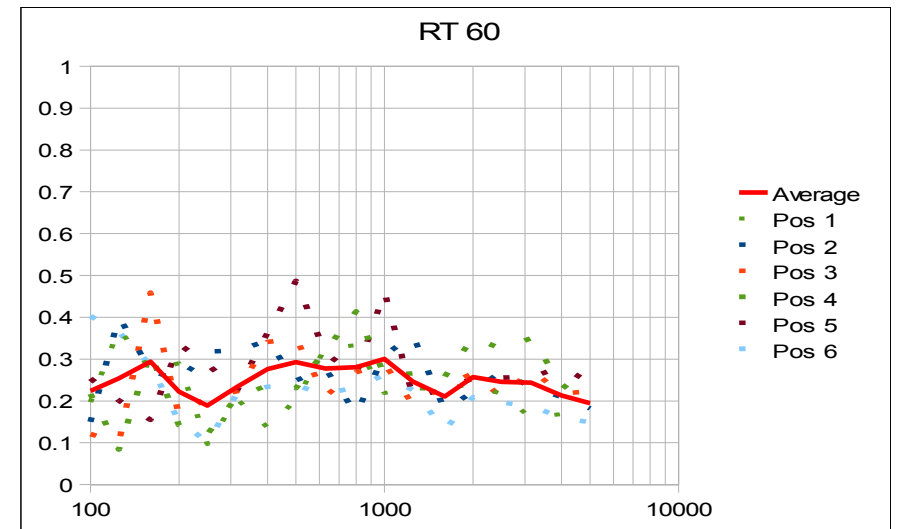
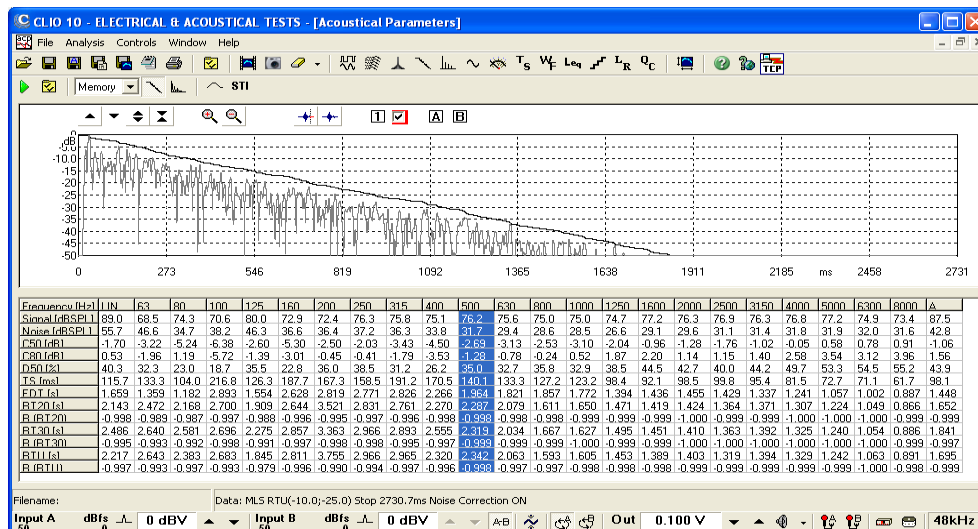
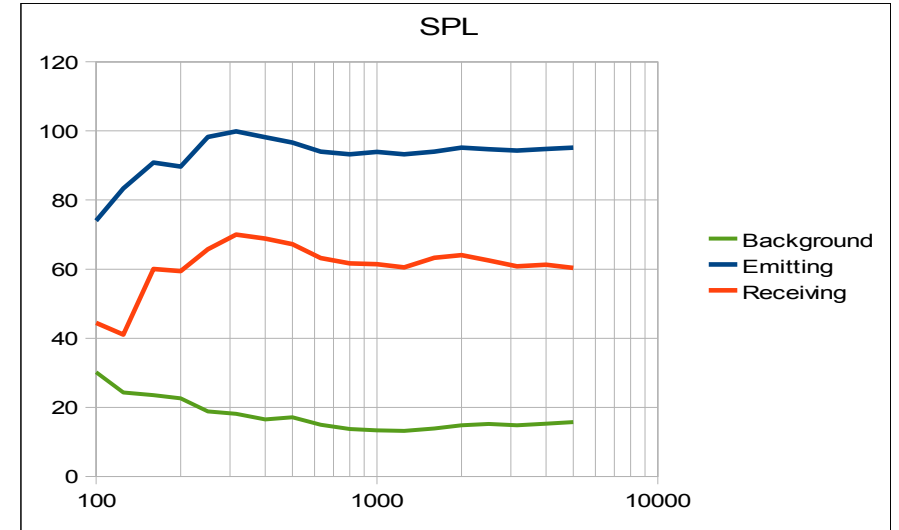
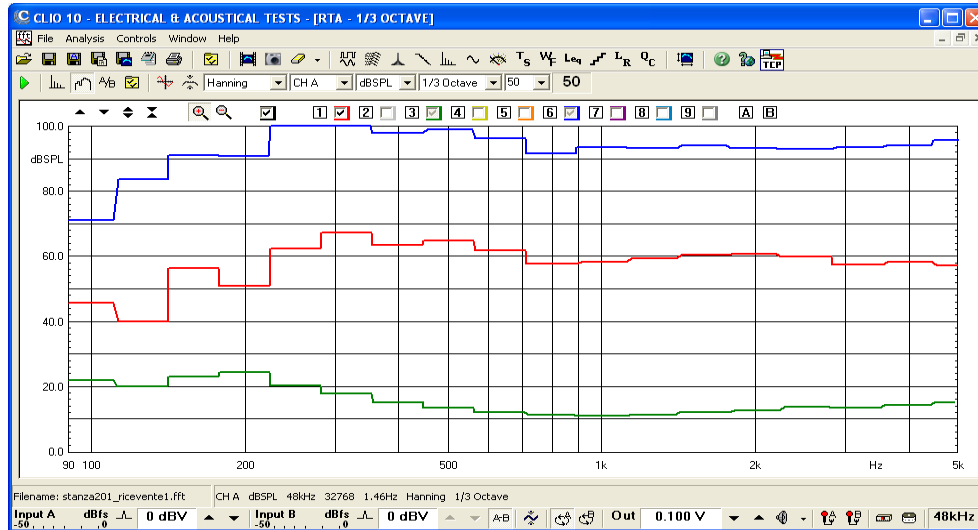
$$D = L_1 - L_2$$

R' 的测量取决于

- L_1 : 发射音压级
- L_2 : 接收音压级
- 背景噪声
- S : 隔音面
- A : 接收吸音系数

建筑声学

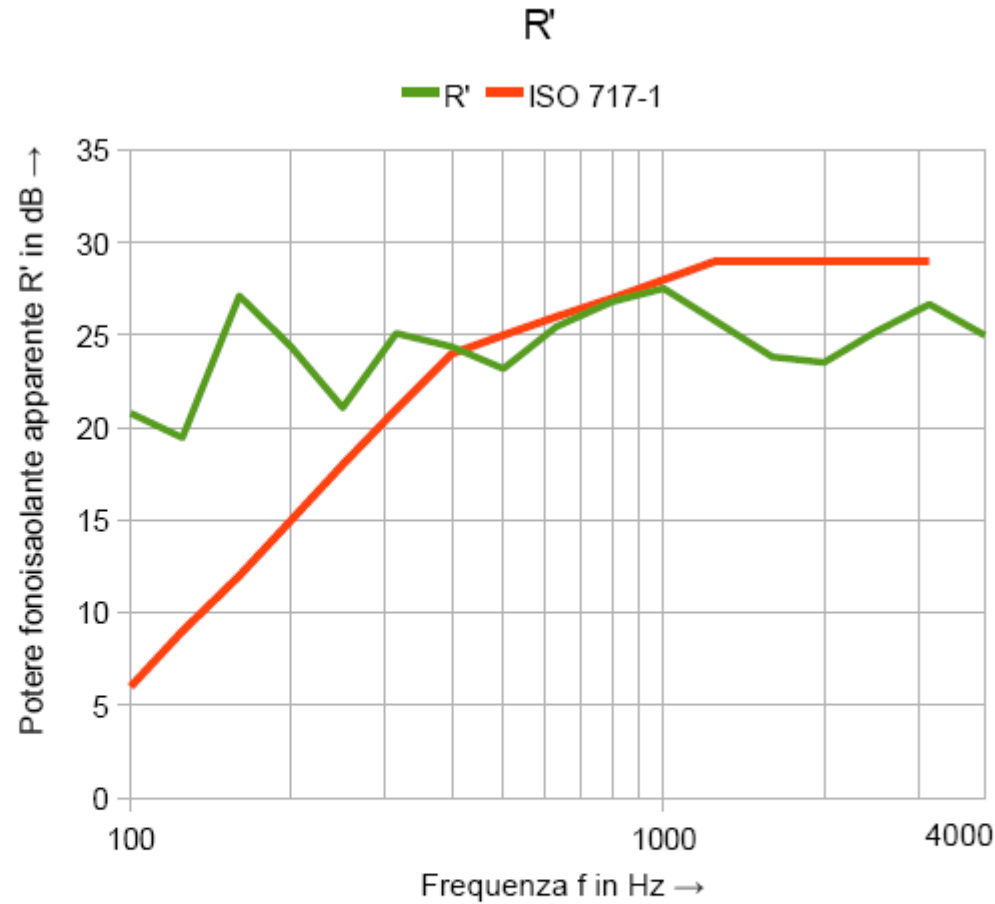
测量显明声音减少指数 R'



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测量显明声音减少指数 R'

Freq.	R'
100	20,79
125	19,47
160	27,12
200	24,39
250	21,08
315	25,1
400	24,38
500	23,2
630	25,46
800	26,81
1000	27,54
1250	25,77
1600	23,83
2000	23,53
2500	25,19
3150	26,67



$$R'_w (C; C_{tr}) = 25(0; -0,1) \quad (\text{ISO 717-1})$$

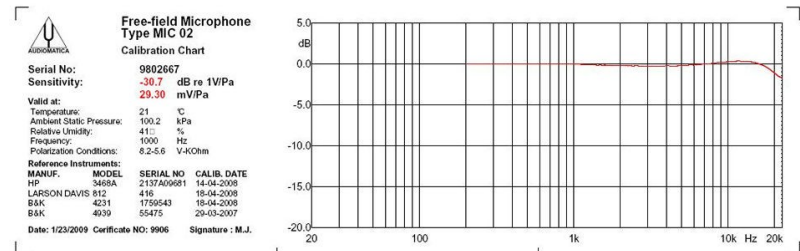
室内声学与建筑声学

测量设备

- 参考标准：
 - IEC 61672:2003. Electroacoustics — Sound level meters. (replacing former IEC 651, Sound level meters and IEC 804, Integrating-averaging sound level meters)
 - IEC 61260:2001. Electroacoustics — Octave-band and fractional-octave-band filters

室内声学与建筑声学 测量设备

实验室与工程用



室内声学与建筑声学

测量设备 一类验证器材

SIT SERVIZIO DI TARATURA IN ITALIA
Calibration Service in Italy

Il SIT è uno dei Servizi dell'Azienda Multinazionale della European co-operative for Accreditation (EA) per il metro-riconoscimento dei certificati di taratura.
SIT is one of the agencies in the International Agreement of EA for the mutual recognition of calibration certificates.

CENTRO DI TARATURA N. 56
Calibration Centre

istituto da
established by

FIRENZE TECNOLOGIA

Laboratorio Metrologico (Centro CE TA CE.)
Via di Capella, 11
50041 CALZANZANO (FI)
Tel. +39 055 8874062; Fax +39 055 8811830

Azienda Speciale della Camera di Commercio

CERTIFICATO DI TARATURA N. 04-599
Certificate of Calibration No.

Il presente certificato di taratura è rilasciato in base all'accreditamento SIT N. 56 concesso dall'Istituto Metrologico Primario competente in attuazione della Legge n. 272/1991 che ha istituito il Sistema Nazionale di Taratura (SNT). Tale Istituto, nei campi di misura ed entro le incertezze precisate nell'accertamento stesso, garantisce:

- il mantenimento della rintracciabilità dagli apparecchi usati dal Centro a campioni nazionali delle unità del Sistema Internazionale delle Unità (SI);
- la certezza metrologica delle procedure di misura adottate dal Centro.

This certificate of calibration is issued in accordance with the accreditation SIT No. 56 guaranteed by the relevant Primary Metrological Institute in implementation of the law No. 272/1991 which has established the National Calibration System. The Institute, for the measurement ranges and within the uncertainties stated in the approval, guarantees:

- the maintenance of the traceability of the apparatus used by the Centre to national standards of the International System of Units (SI);
- the accuracy of the measurement procedures used by the Centre.

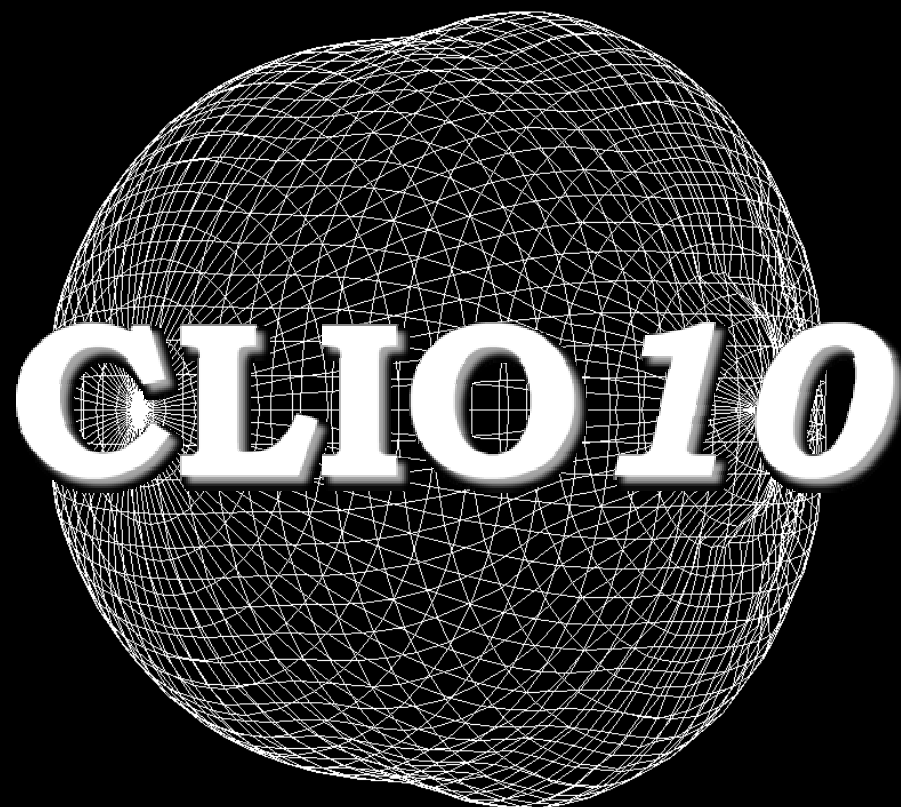
Funzione generatore di tensione alternata

N	Canale generatore	Tensione impostata (frequenza 1 kHz)	Valore (U)	Incertezza relativa
1	A	3,000 V	2,9986 V	3,0 · 10 ⁻⁴ + 0,25 mV/U
2	A	2,000 V	1,9992 V	come sopra
3	A	1,000 V	0,99953 V	3,0 · 10 ⁻⁴ + 26 µV/U
4	A	0,775 V	0,77462 V	come sopra
5	A	0,100 V	99,986 mV	3,0 · 10 ⁻⁴ + 10 µV/U
6	A	0,020 V	49,977 mV	come sopra
7	A	0,020 V	19,993 mV	come sopra
8	A	0,010 V	9,996 mV	3,0 · 10 ⁻⁴ + 8 µV/U
9	A	0,005 V	4,998 mV	come sopra

Funzione misuratore di tensione alternata

N	Canale	Portata	Letture	Valore (U)	Frequenza	Incertezza relativa
1	A	100 V	99,81 V	90,00 V	1 kHz	1,0 · 10 ⁻²
2	A	100 V	29,942 V	30,000 V		come sopra
3	A	30 V	27,969 V	28,000 V		come sopra
4	A	30 V	9,990 V	10,000 V		8 · 10 ⁻⁴
5	A	10 V	8,991 V	9,000 V		5 · 10 ⁻⁴
6	A	10 V	2,997 V	3,000 V		come sopra
7	A	3 V	2,799 V	2,800 V		come sopra
8	A	3 V	1,000 V	1,000 V		3,0 · 10 ⁻⁴ + 1,0 µV/U
9	A	1 V	0,900 V	0,900 V		come sopra
10	A	1 V	0,775 V	0,7750 V		come sopra
11	A	1 V	0,300 V	0,300 V		come sopra
12	A	0,3 V	279,85 mV	0,28000 V		1,0 · 10 ⁻²
13	A	0,3 V	100,002 mV	100,000 mV		2,0 · 10 ⁻⁴
14	A	0,1 V	89,994 mV	90,000 mV		3,0 · 10 ⁻⁴ + 10 µV/U
15	A	0,1 V	29,997 mV	30,000 mV		come sopra
16	A	0,03 V	27,998 mV	28,000 mV		come sopra
17	A	0,01 V	4,997 mV	5,000 mV		3,0 · 10 ⁻²





谢谢

欧码艾瑞声亚洲公司
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