Acoustical Measurement of Sound System Equipment according IEC 60268-21

符合IEC 60268-21的音響系統聲學測量設備

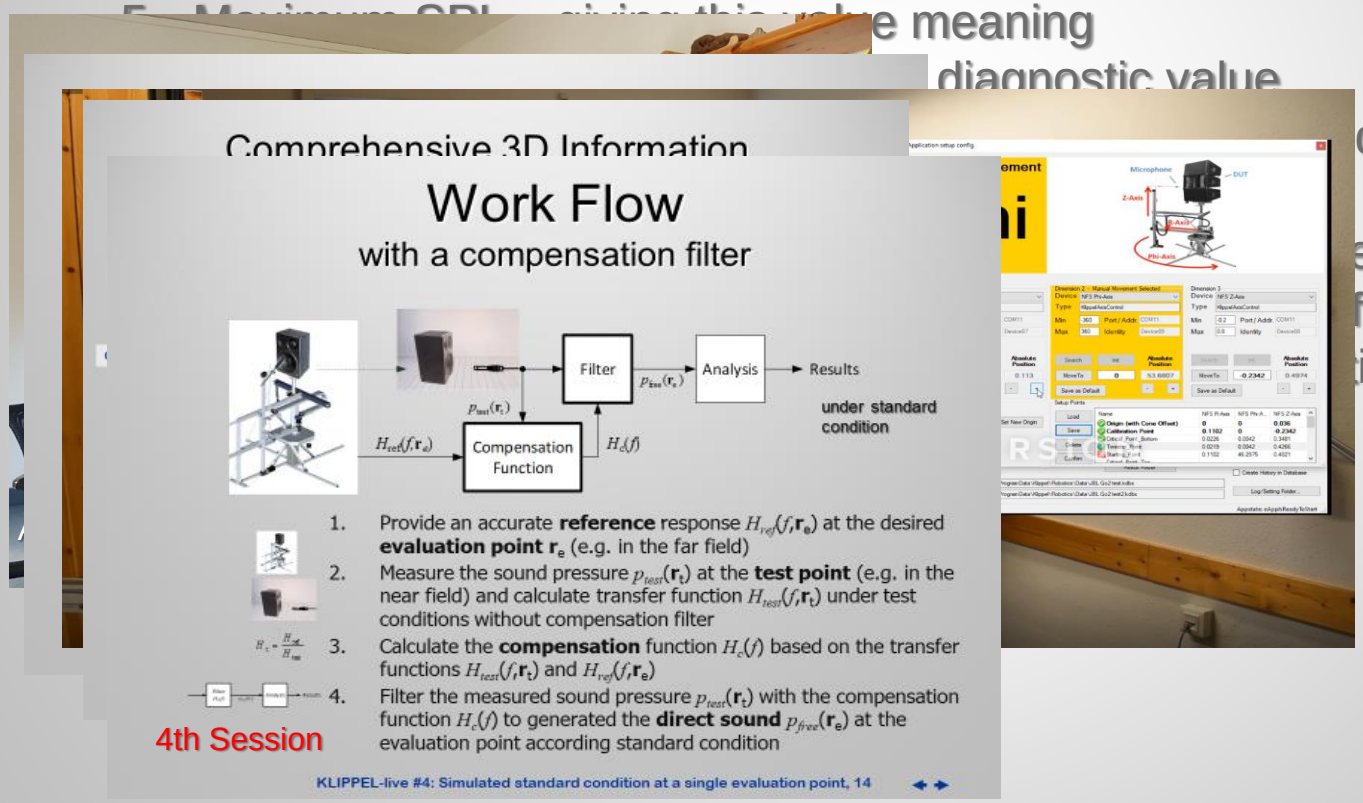
KLIPPEL- live

a series of webinars presented by

Wolfgang Klippel

Previous Sessions

1. Modern audio equipment needs output based testing
2. Standard acoustical tests performed in normal rooms
3. Drawing meaningful conclusions from 3D output measurement
4. Simulated standard condition at an evaluation point



Ask Klippel

First Question:

在沒有復雜的測試箱或基於近場/遠場測量設置的測試箱的情況下，品檢上是否有一個好的解決方案。

Is there a good solution for on-line QC without complex testing box or testing chamber based on near field / far field measurement setting.

Response WK:

否，對於傳感器和小型系統（例如智能手機），因為屏蔽環境噪聲非常有用。

NO, for transducers and small system (e.g. smart phones) because the shielding against ambient noise is very useful.

是的，較大的系統（條形音箱，專業設備，電視……）需要不同的解決方式

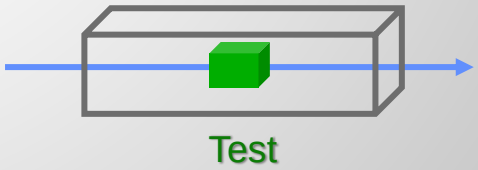
Yes, larger systems (sound bars, professional equipment, TVs …) need a different solution considering the following points:

- **進行近場測量（與環境噪聲相比，SNR更高，SPL更高）**

Performing a near-field measurement (better SNR, higher SPL compared to ambient noise)

- **在終端測試處使用圍繞測試站的吸收牆。 圍繞組裝線建造測試環境的最佳解決方案。**

Using absorbing walls around the test station at the end of line. Best solution building a tunnel around the assembling line.



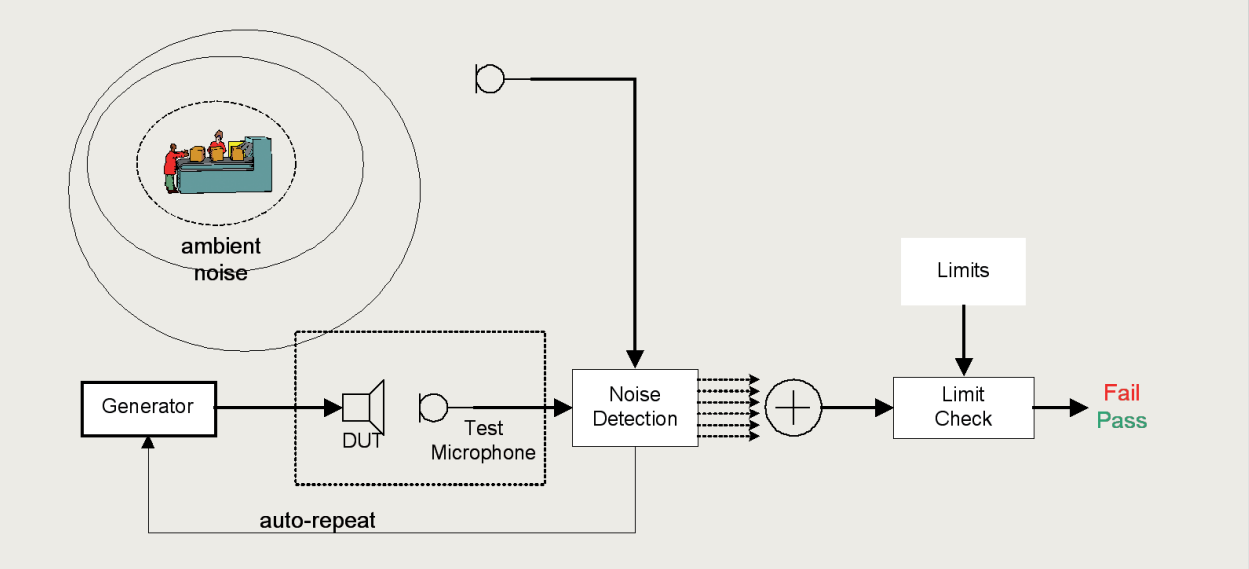
- **在遠場使用第二個麥克風來檢測損壞的測量並確保環境抗擾性。**

Using a 2nd microphone in far field to detect a corrupted measurement and to ensure ambient noise immunity.

Professional Test Boxes

Photos by courtesy of Phase Design

Solution: Ambient Noise Microphone



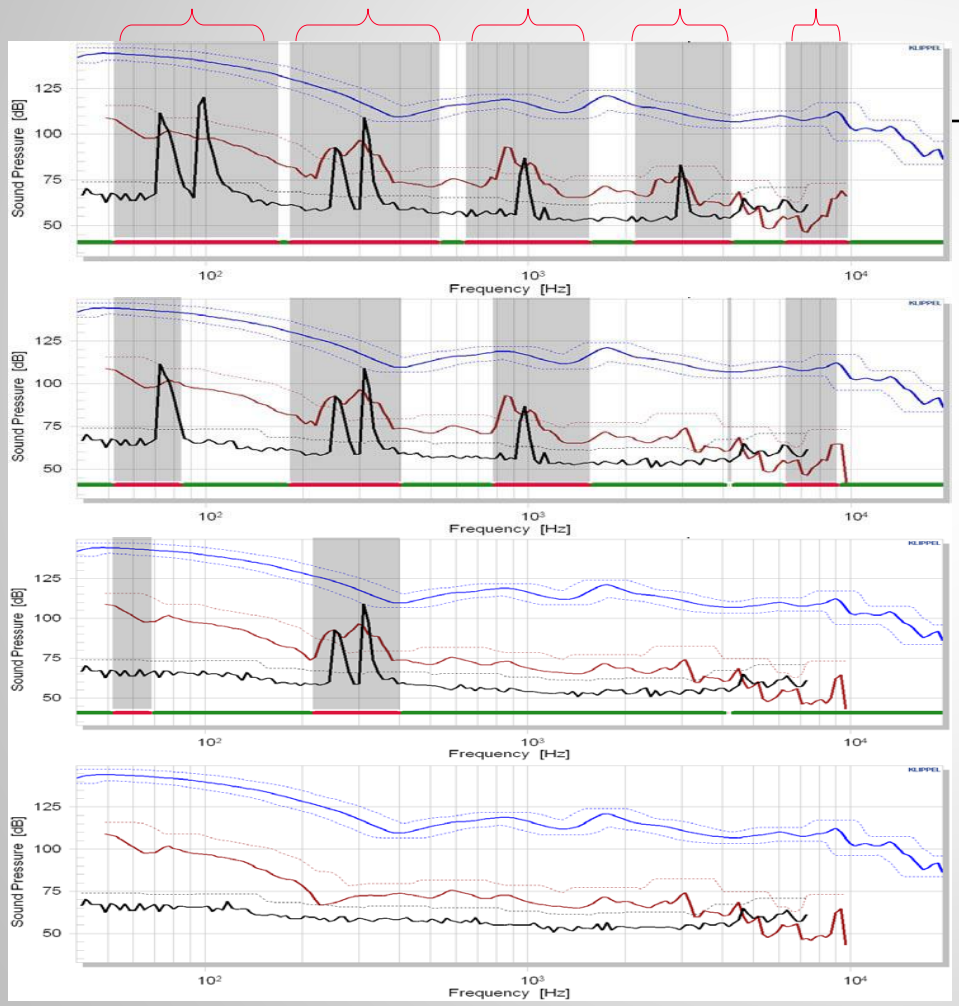
- Measure loudspeaker in the near field
- Measure noise / vibration in the far field
- Predict noise at test microphone
- Calculate impact on measured characteristics
- Store valid part of the measurement
- Repeat measurement automatically

→ Full noise immunity for random ambient noise

Merging Technique

repeating measurement automatically and accumulating valid parts

Ambient noise generated by permanent hand clapping



→ 28 % valid

→ 62% accumulated

→ 85% accumulated

→ **100% valid** →

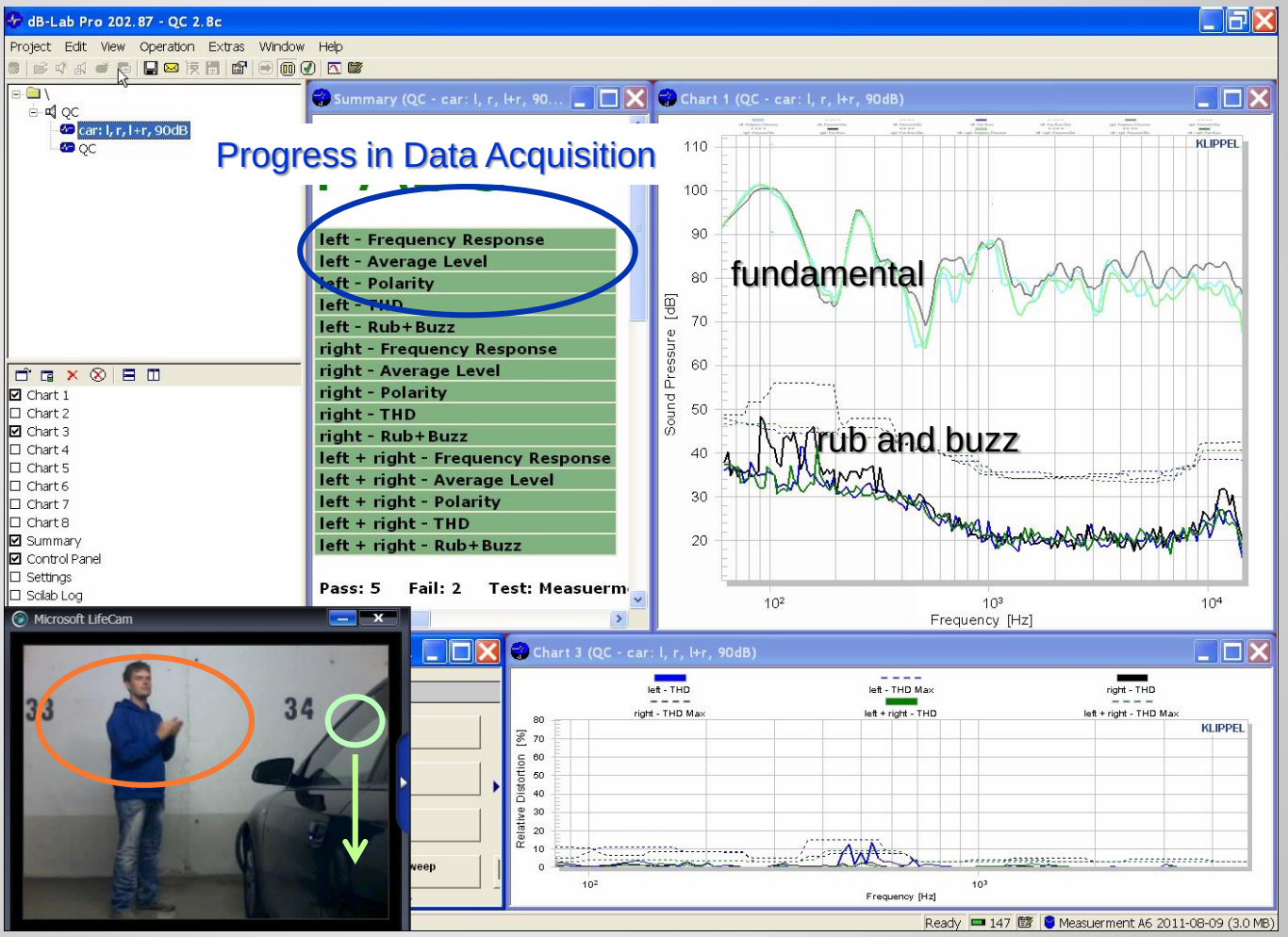
PASS

Frequency Response
Average Level

Full immunity against random noise

Sound Quality in the Car Interior

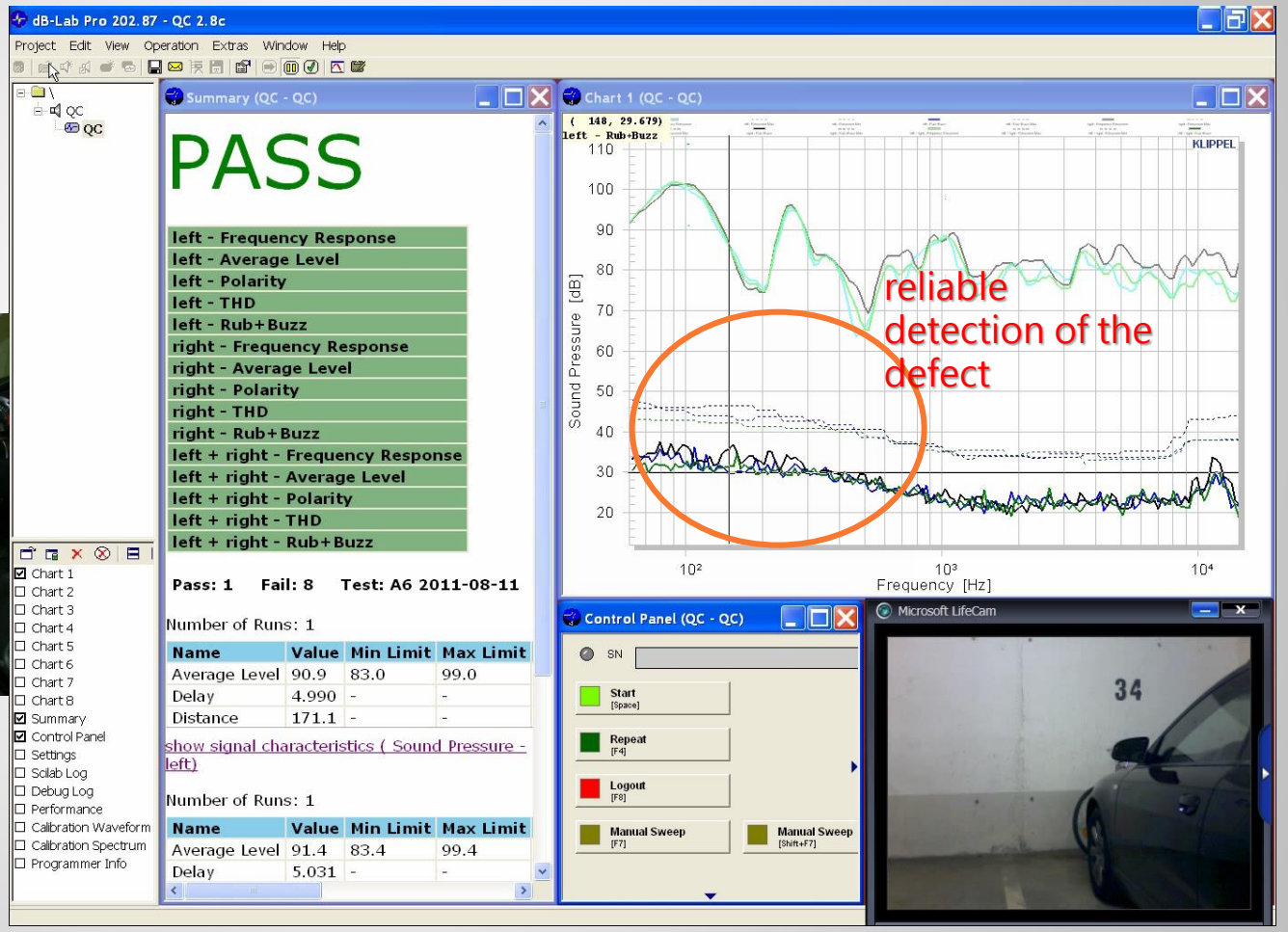
Noise immunity at a car assembling line



ambient noise source

test microphone inside the car

Simulation of Door Buzzing



Ask Klippel

Second Question:

當有多個揚聲器時，如何最好地在產品規格表中的定義全向揚聲器或線陣列最大聲壓?
How to best define a max SPL when there is more speaker. example omni-directional speaker or line array in product specification sheet?

Response WK:

- 考慮產品的特殊性。 首先生成一組綜合測量（3D聲音，非線性失真，壓縮，感知評估）

Consider the particularities of the product. Generate first a set of comprehensive measurement (3D sound, nonlinear distortion, compression, perceptual evaluation)

- 使用IEC 60268-21提供的自由度來搜索最佳測試條件。 選擇評估點的有效位置和距離（> 3 m）

Search for the best test condition using the freedom provided by IEC 60268-21. Select a useful position and distance of the evaluation point (>3 m)

- 生成最大SPL的建議。

Generate a proposal for max SPL.

- 在100小時的測試中驗證最大SPL

Verify the max SPL in a 100 h test.

- 說明測量條件。

State the measurement condition.

KLIPPEL live

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Standard distortion measurements
2nd-part

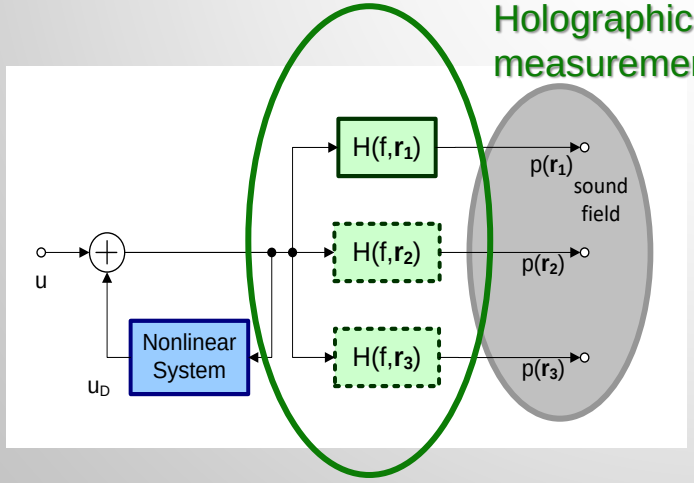
3rd-part

Ask Klippel

Third Question:
是否可以使用holographic來量測speaker操作在nonlinear下的音場?
Is it possible to use holographic technique to measure the sound field of a speaker which operates in the nonlinear region?

Response WK:
是的，可以應用。 但是，必須考慮以下幾點:
Yes, It can be applied. However, the following points have to be considered:

全息技術基於線性模型（波擴展），該模型描述了聲輻射以及基波和非線性失真的傳播。
The holographic techniques is based on a linear model (wave expansion) which describes the sound radiation and propagation of the fundamental and nonlinear distortion.



非線性系統還引起高振幅的振幅壓縮。
The nonlinear system also causes an amplitude compression at high amplitudes.

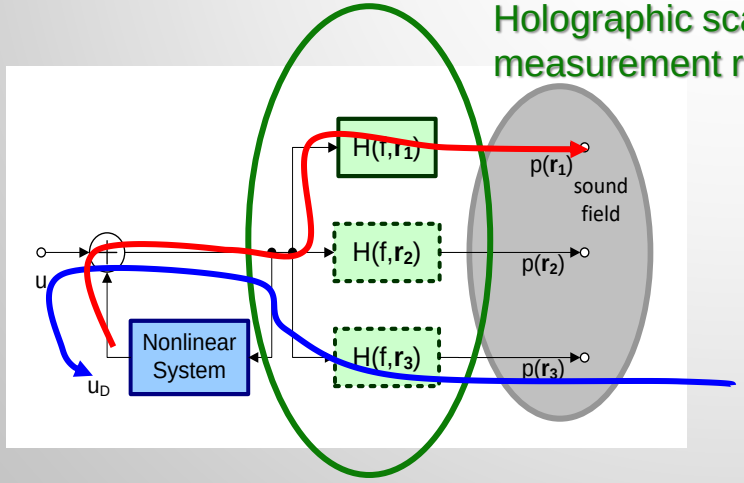
建議：以小幅度測量傳遞函數
RECOMMENDATION: Measure the transfer function at small amplitudes

Ask Klippel

Third Question:
是否可以使用holographic來量測speaker操作在nonlinear下的音場?
Is it possible to use holographic technique to measure the sound field of a speaker which operates in the nonlinear region?

Response WK:

如果您對主要的非線性失真的方向性感興趣，則可以使用全息掃描結果來預測聲場中任何點的非線性失真（THD）
If you are interested in the directivity of the the dominant nonlinear distortion you can use the Holographic Scanning Results to predict the Nonlinear distortion (THD) at any point in the sound field



Prediction of the nonlinear distortion at any point

+

非線性特徵（THD，壓縮）需要在某一點進行測量以獲得等效的輸入失真（EHID）
Nonlinear symptoms (THD, compression) requires measurement at one point to get equivalent input distortion (EHID)

Ask Klippel

Fourth Question:

如果想要量測手機立體聲道的音場，要用怎樣的測試訊號?
If we would like to measure the sound field of a mobile phone which has dual speakers, what kind of stimulus is suitable for this test?

左右聲道是否是相同的訊號?
Should we use the same stimulus for left and right channels?

Response WK:

- 通常，我將使用相同的激發來測試兩個聲道。

In general, I would use the same stimulus for testing the two channels.

- 如果單體不同（接收器和主揚聲器），則對激發進行調整

Apply shaping of the stimulus if the transducers are different (receiver and main loudspeaker)

Ask Klippel

Fourth Question:

Should we measure left and right simultaneously or separately?

Response WK:

- 如果一直同時操作兩個換能器（單信號，相同信號），則可以對全息測量使用相同的設置。

If you always operate the two transducers in parallel (mono, same signal) you can use the same setup for the holographic measurement.

- 如果您向兩個換能器提供不同的信號（DSP的立體聲，3D音效），則應分別測量兩個揚聲器的3D聲音傳遞功能。 好處：您擁有在DSP中進行調諧的所有重要數據！

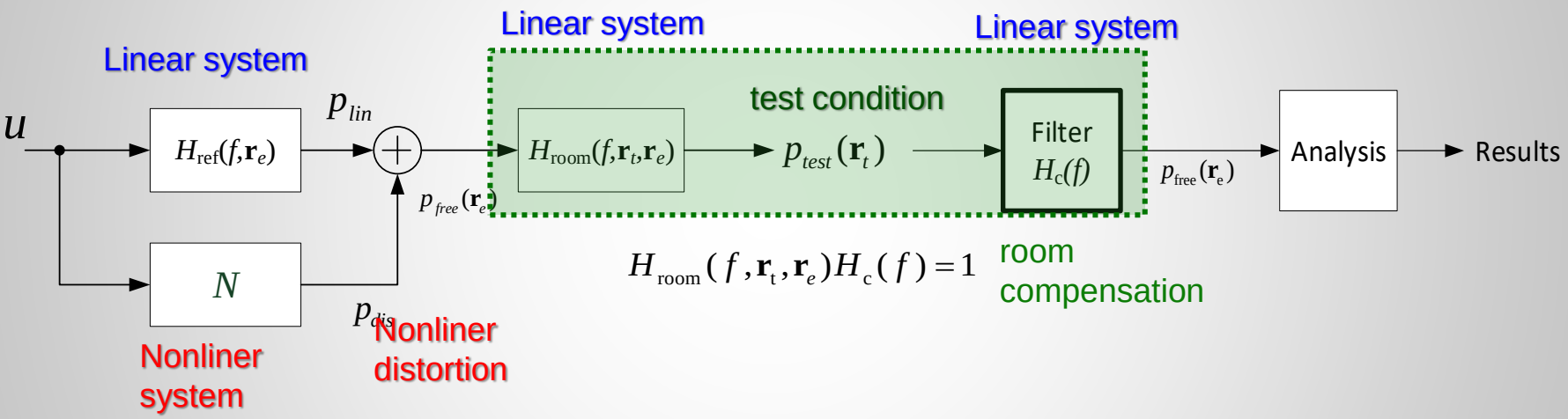
IF you supply different signals to the two transducers (stereo, 3D sound effects by DSP) then you should measure the 3D sound transfer function of the two speakers separately. Benefit: You have all important data for tuning in DSP!

Ask Klippel

Fifth Question:

完成 Near Field Scanning取得room compensation之後，是否可以提高輸入電壓在一般房間量測speaker在非線性區域的表現?

After we finish the Near Field Scanning and obtain the room compensation, could we increase input voltage and measure the performance of a speaker operating in the nonlinear region in a normal room?



- 您應該在非線性失真可忽略的小信號域中生成房間校正函數Hc（f）。 然後確認房間校正函數Hc（f）是正確的，並且可以完美地補償線性轉移函數Hroom（f）。

You should generate your room correction function $H_c(f)$ in the small signal domain where the nonlinear distortion are neglibible. Then room correction function $H_c(f)$ is correct and compensate the linear tranfer function Hroom(f) perfectly.

- 正確的房間補償函數Hc（f）適用於任何激發（音樂，語音，人工測試信號）和振幅（較小和較大的信號域）。

The correct room compensation function $H_c(f)$ works for any stimulus (music, speech, artificial test signal) and amplitude (small and larger signal domain).

Ask Klippel

Sixth Question:
鋼琴音會造成微型喇叭嚴重的失真，是否有適合的測試方式來評估鋼琴音失真?
Piano sound causes serious distortion on a micro speaker. Are there suitable test items to evaluate piano distortion?

Response WK:
Piano music generates critical nonlinear distortion in smart phones with a side fire port. KLIPPEL GmbH is doing research on this topic:

- 可以用非線性模型來解釋

It can be explained by a nonlinear model

- 可以通過使用人工測試信號（單音，兩音，多音測量值）進行評估

It can be evaluated by using artificial test signals (single tone, two tone, multi-tone measuremetns

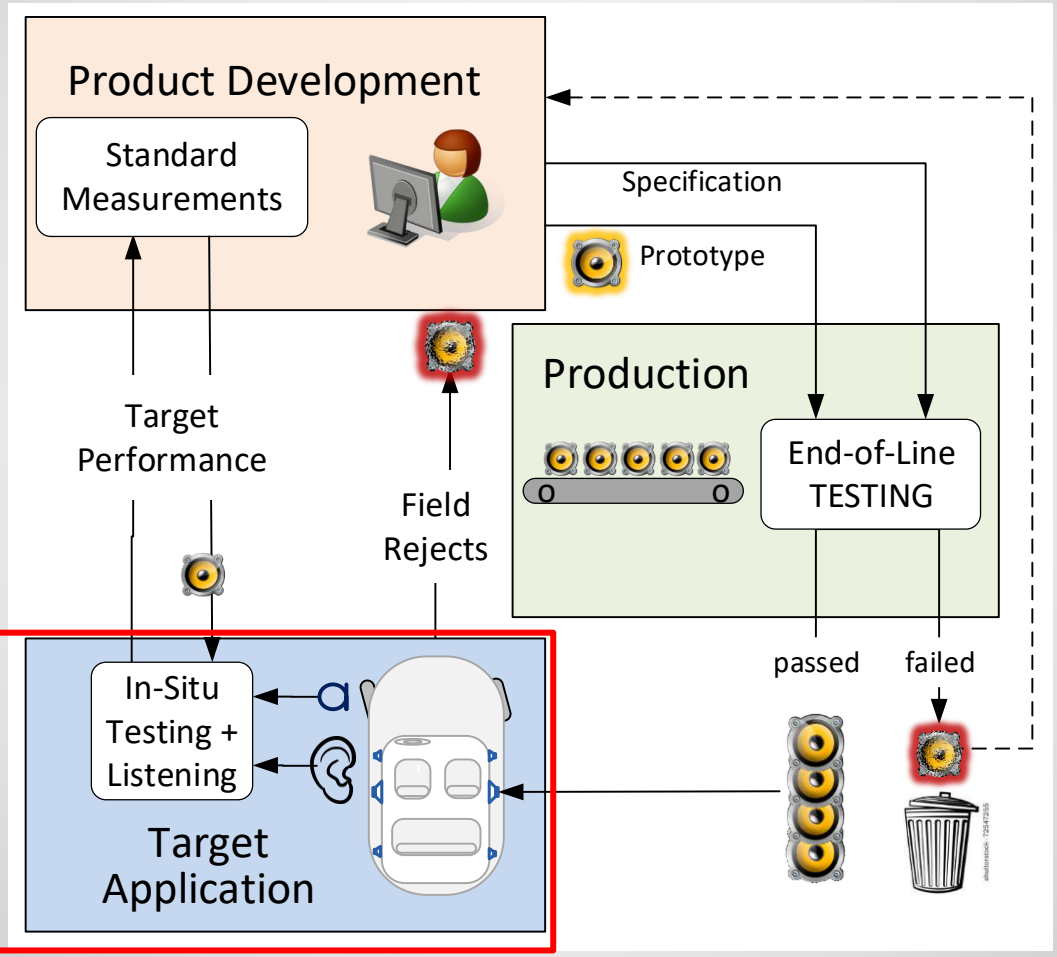
- 可以使用鋼琴音樂通過聽覺化技術對其進行評估

It can be evaluated by auralization techniques using piano music

- 可以通過自適應非線性控制（KLIPPEL控制的聲音KCS）進行主動補償

It can be compensated actively by adaptive nonlinear control (KLIPPEL controlled sound KCS)

Life Cycle of an Audio Device



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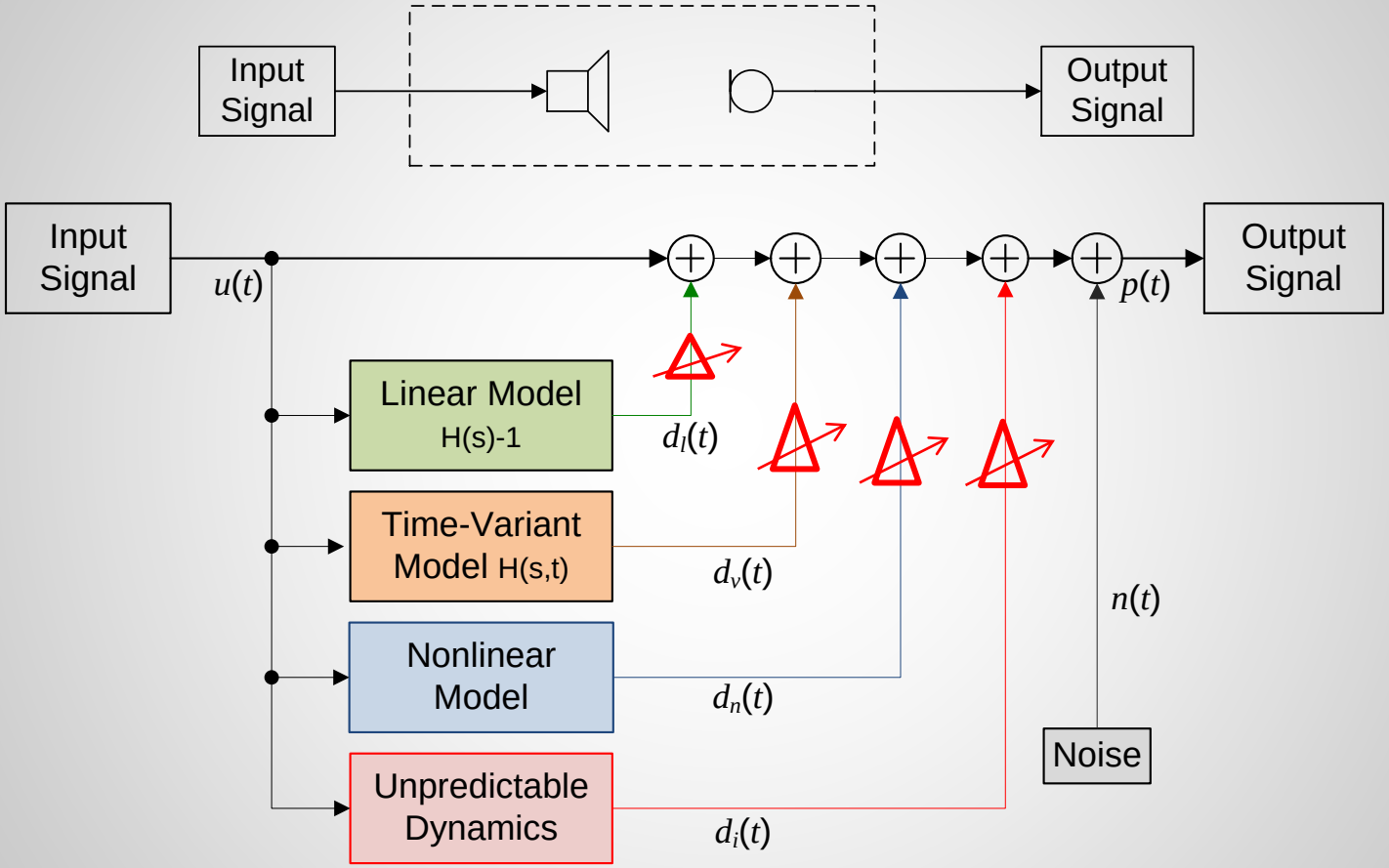
Standard distortion measurements
2nd-part

3rd-part

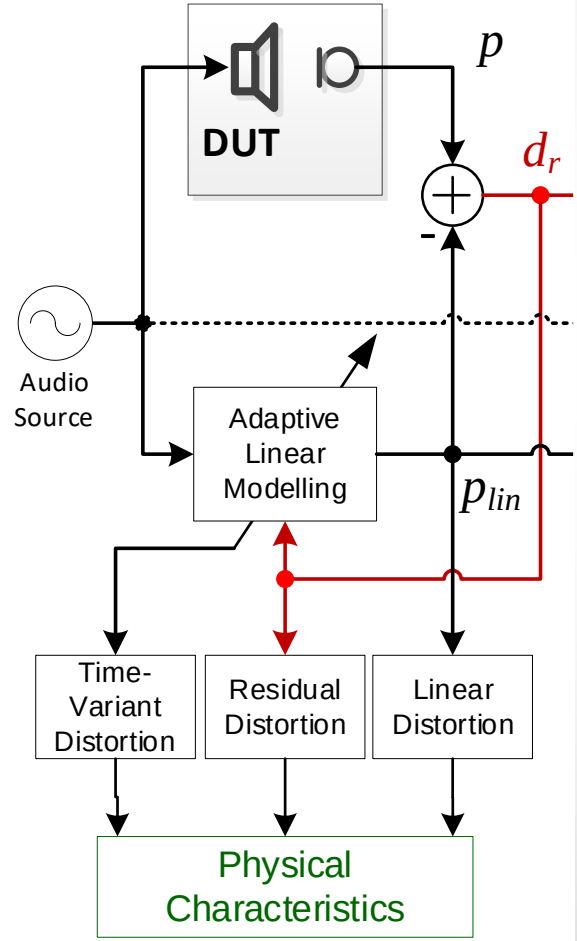
Auralization of Signal Distortion



OBJECTIVE:
Virtual enhancement or attenuation of the distortion components

How to separate the Signal Distortion in Common Audio Signals?

Typical or most critical programme material



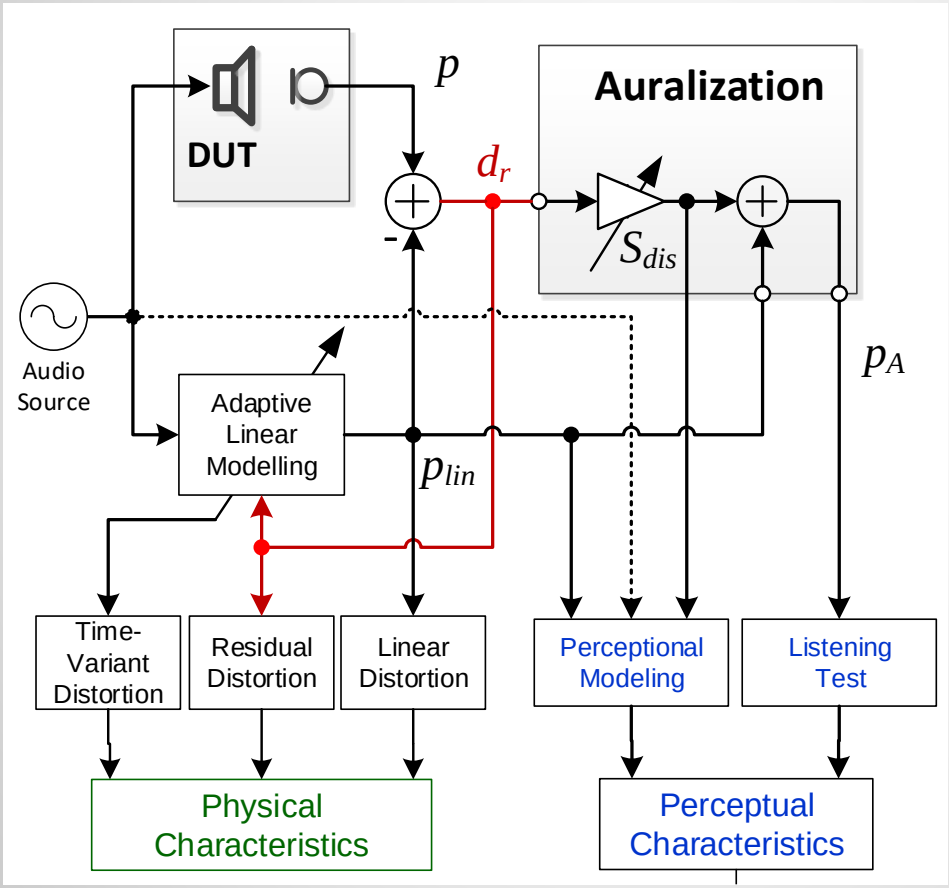
DUT in normal environmen

Residuum $d_r(t)$ of adaptive linear modeling contains

- regular nonlinear distortion (Bl(x), Kms(x), L(x), …
- Irregular distortion (e.g. rub&buzz)
- noise

How to link perceptual evaluation with physical measurements

Typical or most critical programme material

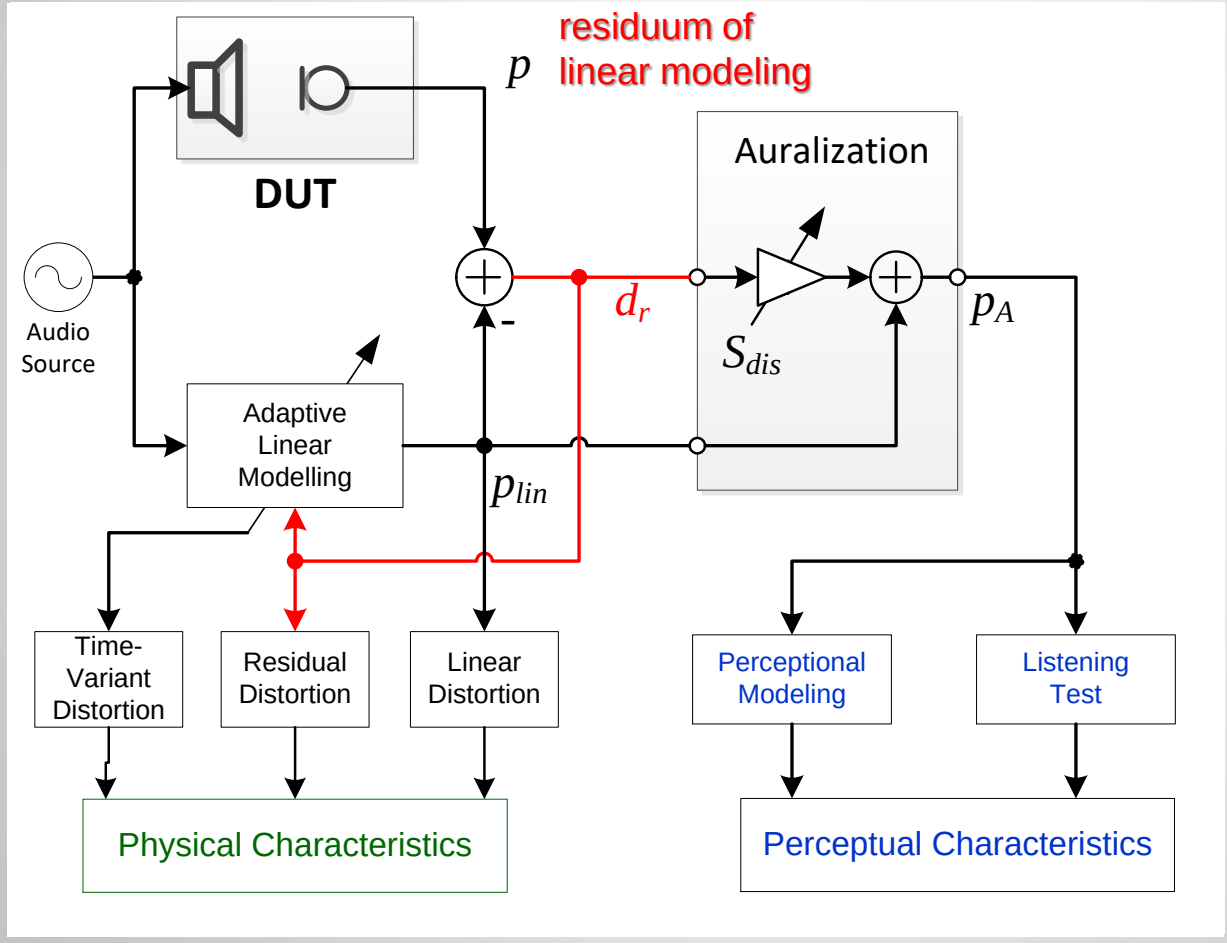


Virtual sound output where the signal distortion are weighted by S_{DIS}

- Sound output without nonlinear distortion (S_{DIS}=0)
- Sound output of the real device (S_{DIS}=1)
- Sound output with enhanced distortion (S_{DIS}>1)

Auralization of Regular and Irregular Nonlinear Distortion

e.g. microspeaker



scaling factor S_{dis} applied to residual distortion

12 dB

6 dB

0 dB

-6 dB

-12 dB

5th KLIPPEL live:
讓最大SPL值有意義
Maximum SPL – giving this value meaning

今日主題Topics today:

- SPLmax與額定激發之間的關係

Relationship between SPL_{max} and the rated stimulus

- 描述激發特性的特徵

Characteristics describing the stimulus properties

- 峰度–波峰因數的有力替代方法

Kurtosis – a powerful alternative for the crest factor

- 主動音頻設備中輸入通道的校準

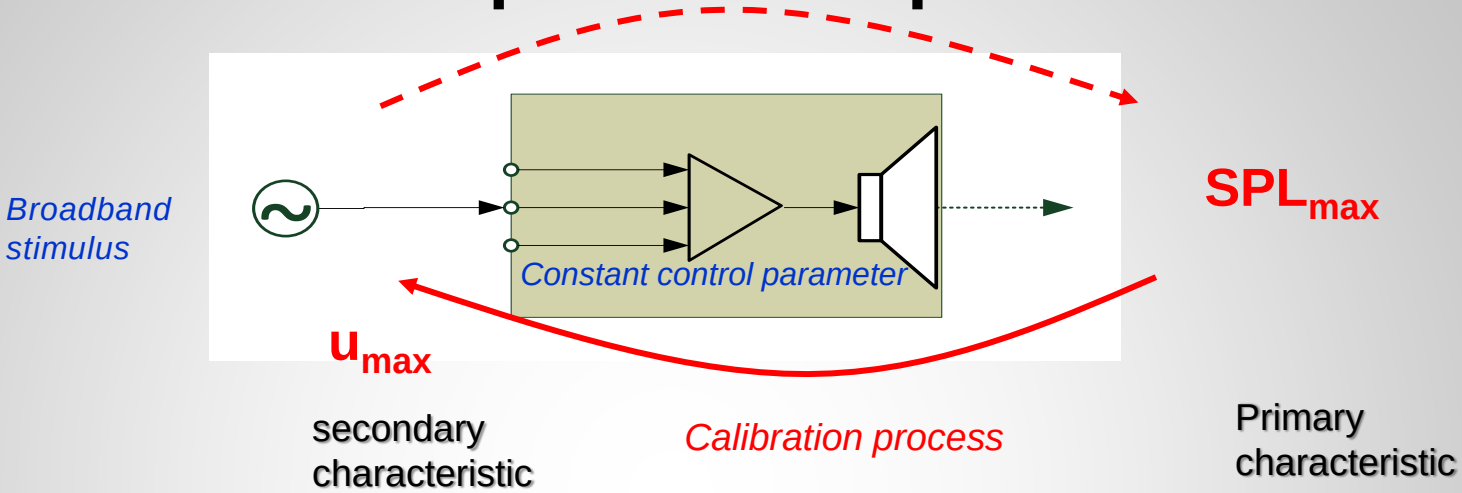
Calibration of the input channel in active audio devices

- 實際示範

Practical demonstration

最大輸入和輸出值
Maximum Input and Output Value

Discussed in 1st Webinar



額定最大輸入電壓umax
Rated maximum input voltage u_{max}

- 適用於具有單個輸入且輸入和輸出之間具有恆定傳遞函數的（被動）系統

Good for (passive) systems with a single input and constant transfer function between input and output

- 取決於輸入通道

Depends on the input channel

- 取決於控制參數

Depends on the control parameter

額定最大（輸出）SPLmax
Rated maximum (output) SPL_{max}

- 被動和主動系統的通用方法

Universal approach for passive and active systems

- 可以應用於任何輸入通道

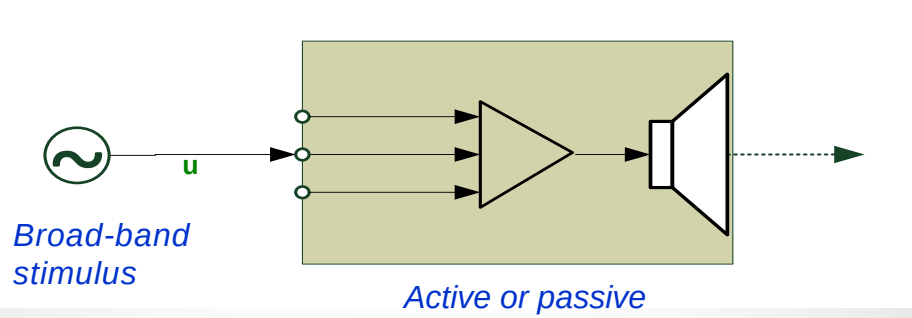
Can be applied to any input channel

- 可以應付增益控制器，均衡器，限制器，保護系統等。

Can cope with gain controllers, equalizers, limiters, protection systems, ect.

誰決定SPL最大值
Who determines the maximum SPL value ?

Discussed in 1st Webinar



$SPL_{max}(r_e)$

Definition by IEC 60268-21

- 製造商評定測量條件（例如激發，位置，環境）

Manufacturer rates the measurement condition (e.g. stimulus, position, environment)

- 製造商根據設計，實際測量和目標應用中的信息分析SPLmax

Manufacturer rates SPL_{max} based on information from design, practical measurements and the target application

需求 Requirement

- DUT可以在額定最大SPL時重現定義的寬帶激勵

DUT can reproduce a defined broadband stimulus at rated maximum SPL

- 100h功率測試期間，激發不會損壞DUT

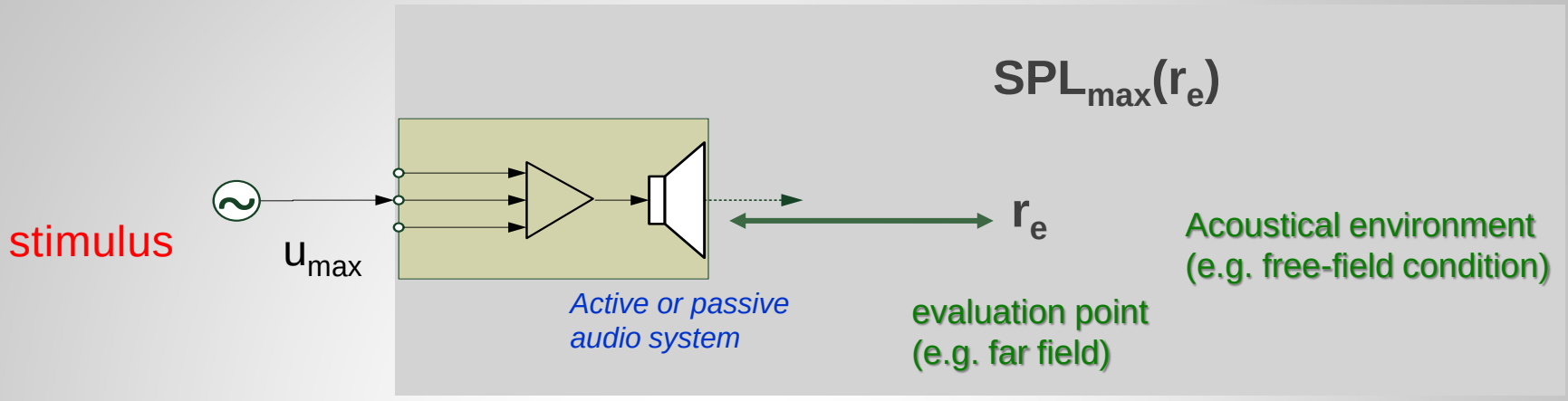
DUT will **not be damaged** by the stimulus during 100h power test

好處 Benefit

- 最大SPL值對於工程，市場營銷，最終用戶而言意義重大

Maximum SPL value is meaningful for engineering, marketing, final user

SPLmax的額定條件
Rated Conditions for SPLmax



網絡課程討論了聲學環境的條件以及音頻系統和麥克風的位置
Webinars 1-3 covered the conditions of the acoustical environment and positioning of the audio system and the microphone

用於評定SPLmax的激發要求
Requirements for the stimulus used for rating SPLmax

- 測試信號代表最終應用中的典型程序

The test signal represents typical program material in the final application

- 相同的測試信號用於校準輸入通道並確定最大輸入電壓umax

The same test signal is used for calibrating the input channel and determining the maximum input voltage u_{max}

- 在100h的長期測試中使用了最大輸入電壓umax下的相同測試信號

Same test signal at maximum input voltage u_{max} is used in a 100 h long-term tests

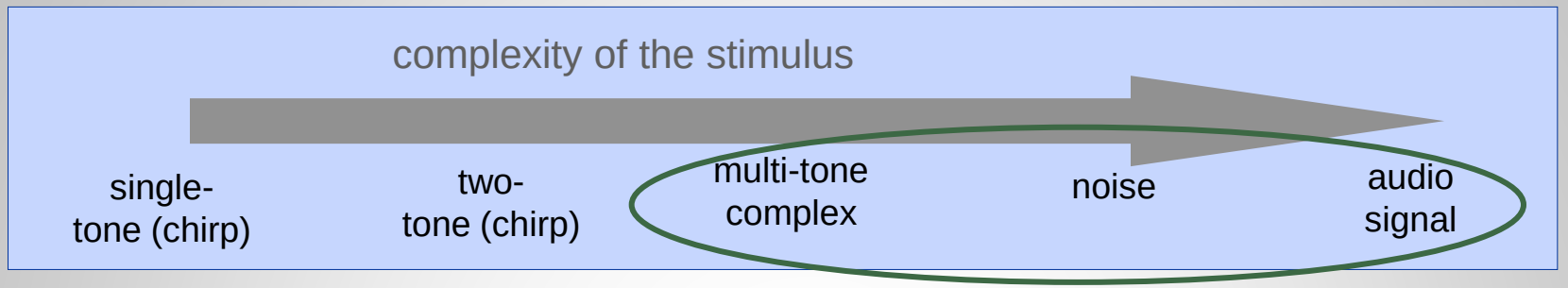
Poll:

您要使用哪種測試信號進行長期測試（100小時功率測試）？

What kind of test signal do you use for your long-term testing (100h power test) ?

- A single tone
- A sinusoidal chirp signal covering a defined frequency band
- Random noise or a multi-tone complex
- Music or other selected audio

SPLmax所需的寬帶激發
"Broad-band" Stimulus required for SPL_{max}



寬帶激發 broad-band stimuli

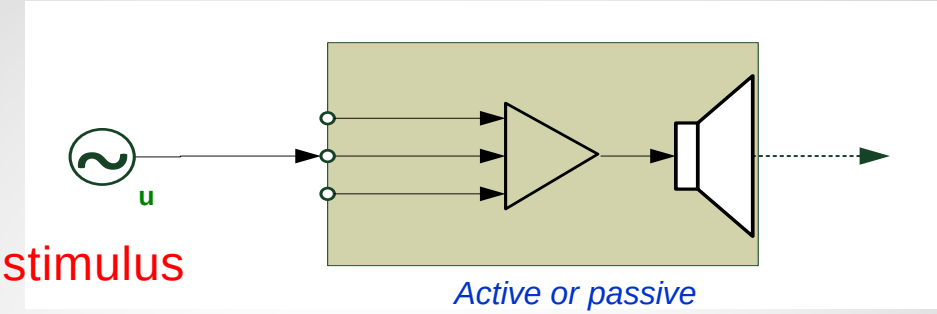
- 考慮SPL頻率依賴性 considers SPL frequency dependency
- 引起所有傳感器非線性 activates all transducer nonlinearities
- 導致典型的音圈發熱 causes typical voice coil heating
- 提供強制對流冷卻 provides force convection cooling
- 開啟DSP（限制，壓縮，主動保護）Activates the DSP (limiting, compression, active protection)

範例 Examples

- 模擬正常程序IEC 60268-21 Simulated normal program material IEC 60268-21
- 符合CTA 2010B的連續寬帶噪聲Continuous, broadband noise according CTA 2010B
- Meyer-Sound提出的M噪聲 M-noise as proposed by Meyer-Sound
- IEC 60268-21建議的複頻 Multi-tone complex as recommended by IEC 60268-21
- 選定的音頻材料（音樂） Selected audio material (music)
- 其他 others

額定條件：測試刺激
Rated Conditions: Test Stimulus

Discussed in 1st Webinar



$SPL_{max}(r_e)$

製造商規定的激發特性（IEC 60268-21）：
Stimulus Properties (IEC 60268-21) stated by the manufacturer:

- 寬帶（粉紅或白噪聲，密集或稀疏的複頻）

Broadband (pink or white noise, dense or sparse multi-tone complex)

- 額定頻段的上下限f_l和f_u

Lower and upper limits f_l and f_u of the rated frequency band

- 功率譜的整形（例如典型的程序IEC 60268-1）

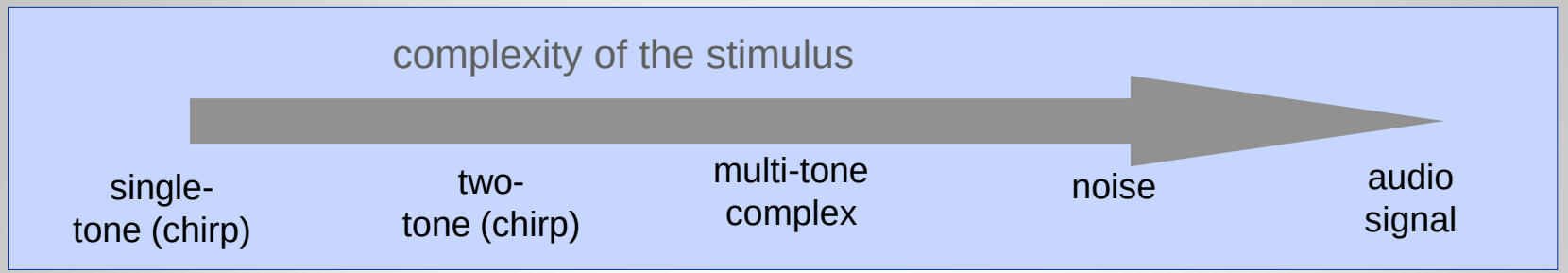
Shaping of the power spectrum (e.g. typical program material IEC 60268-1)

- 波峰因數（峰度） Crest factor (Kurtosis)

修改激發有很多的自由 There is a lot of freedom for modifying the stimulus!

主要目標：測試刺激應代表最終應用中的典型程序!
Main Objective: The test stimulus shall represent the typical program material in the final application !

如何描述激發?
How to Describe the Stimulus ?



光譜分佈Spectral Distribution

- 功率譜

power spectrum

- 1/3倍頻程頻譜

one-third octave spectrum

- 額定頻率範圍（帶通）

rated frequency range (bandpass)

- 塑形功能

shaping function

振幅分佈 Amplitude Distribution

- 概率密度函數（pdf）

probability density function (pdf)

- 峰值 peak value
- 均方根值 rms value
- 波峰因數（峰值/均方根比）

crest factor (peak/rms ratio)

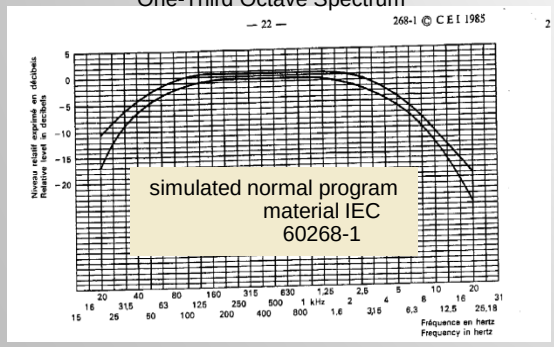
- 高階矩（峰度）

higher-order moments (kurtosis)

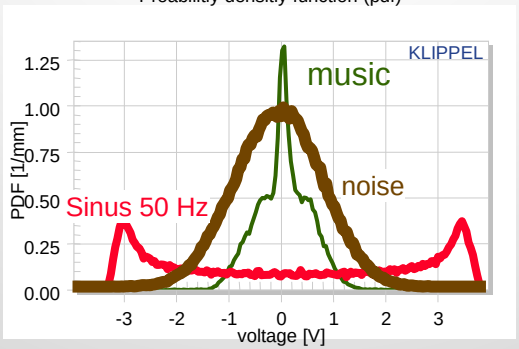
時間特性 Temporal Properties

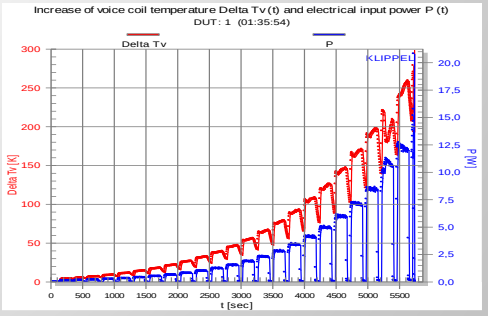
- 平穩性 stationarity
- 自相關 autocorrelation
- 週期性 periodicity
- 調製（開/關週期，幅度步進）
  modulation (on/off cycle, amplitude stepping)

One-Third Octave Spectrum



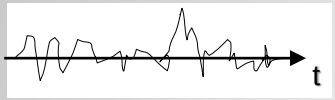
Proabilitiy densitiy function (pdf)



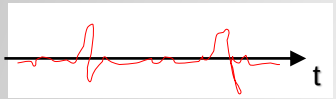


基本信號特徵 Basic Signal Characteristics

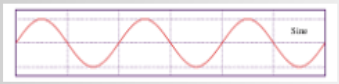
No DC component (zero mean value)



Gaussian noise

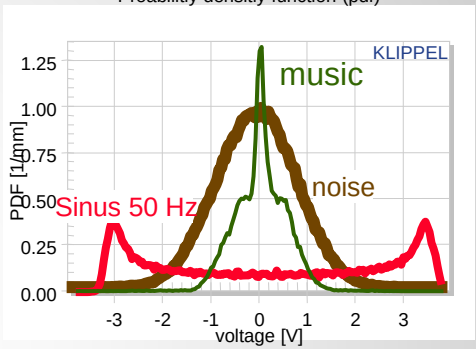


music



Sinusoidal wave

Amplitude Distribution



rms value (standard variation) :

$$x_{rms}^2 \approx \overline{x(t)^2} = \frac{1}{T}\int_{-T/2}^{T/2} x(t)^2\,dt \quad \longleftrightarrow \quad x_{rms}^2 = \int_{-\infty}^{\infty} x^2 p_{pdf}(x)\,dx$$

(2nd-order moment)

peak value:

$$x_{peak} = \underset{-T/2}{\overset{T/2}{Max}} |x(t)|$$

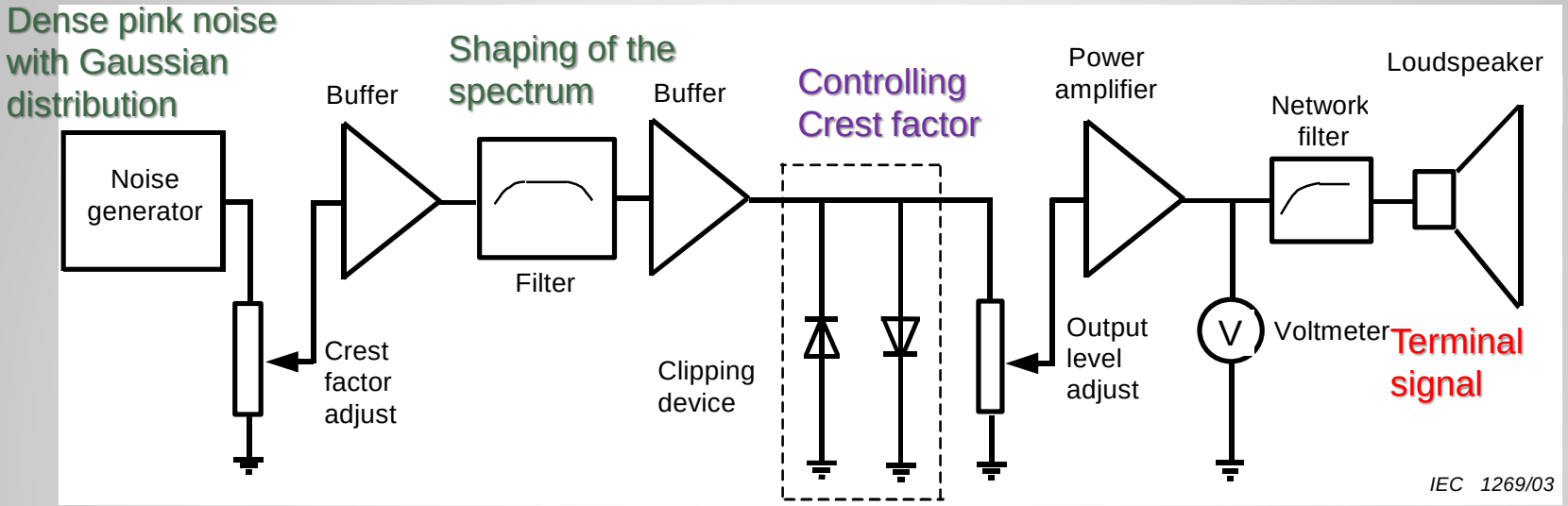
crest factor

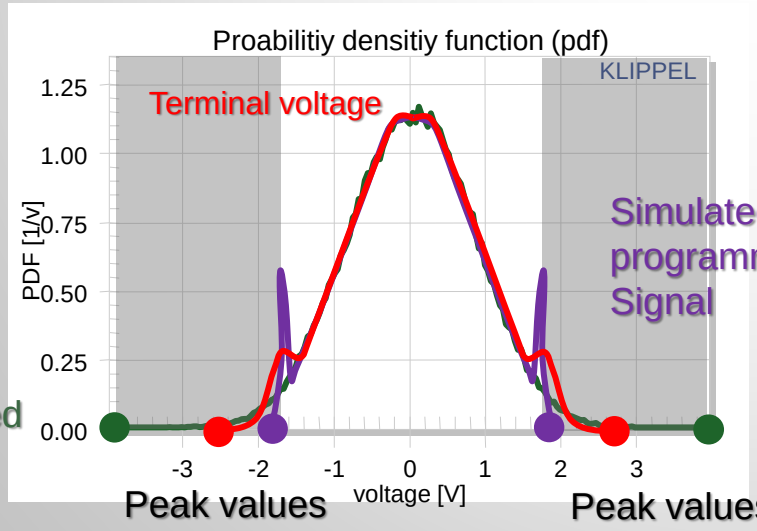
$$C_x = \frac{x_{peak}}{x_{rms}} \qquad C_{x,dB} = 20\lg\left(\frac{x_{peak}}{x_{rms}}\right) dB$$

Problem: Crest factor depends on a (single) peak value !

模擬程序信號Simulated Programme Signal

IEC 60268-21





- 放大器輸入端的受控波峰因數

Controlled Crest factor at amplifier input

- 可以避免放大器削波

Amplifier clipping can be avoided

- 放大器輸出端定義的幅度

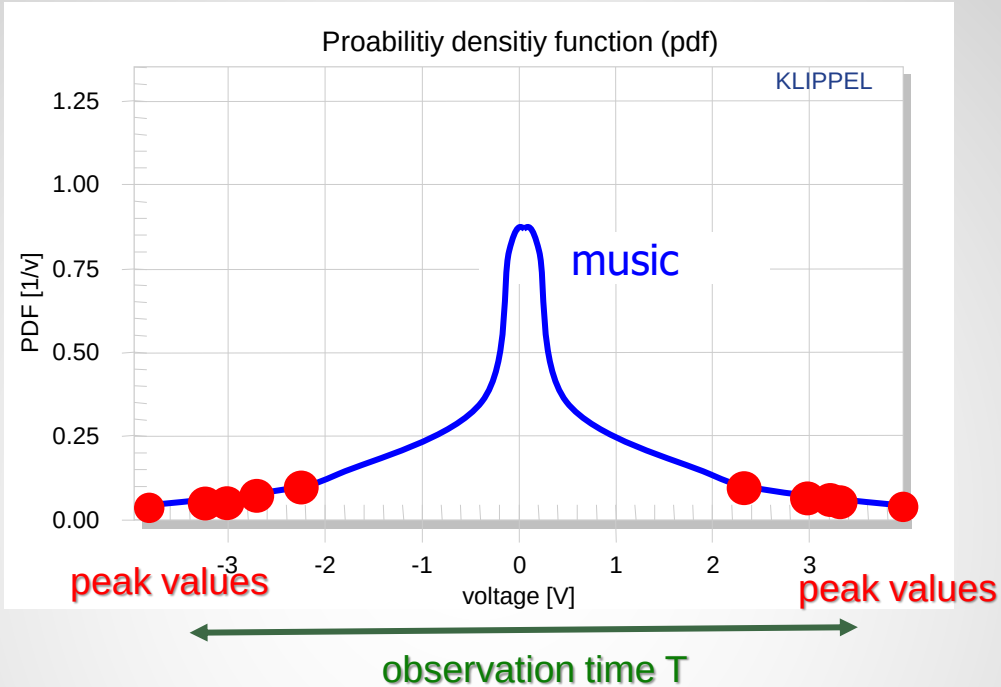
Defined amplitude at amplifier output

Problem:

- 隨後的任何濾波器（分頻器）都會顯著改變波峰因數

Any following filter (crossover) will change the crest factor significantly

波峰因數的意義?
How meaningful is a Crest Factor ?



- 統計信息取決於單個值（如何定義峰值？）Statistics depends on a single value (How to define a peak value ?)
- 波峰因數值增加以延長觀察時間T Crest factor value increases for longer observation time T
- 音頻信號（音樂）的測量波峰因數差異很大 High variance of measured crest factor for audio signals (music)
- 不太適合評估加熱，機械負載，疲勞，老化 Less suitable for assessing heating, mechanical load, fatigue, aging

問題：我們需要一個更強大的統計特性!

Problem: We need a more robust statistical characteristic !

解決方案：評估分佈質量（四階矩→峰度）！

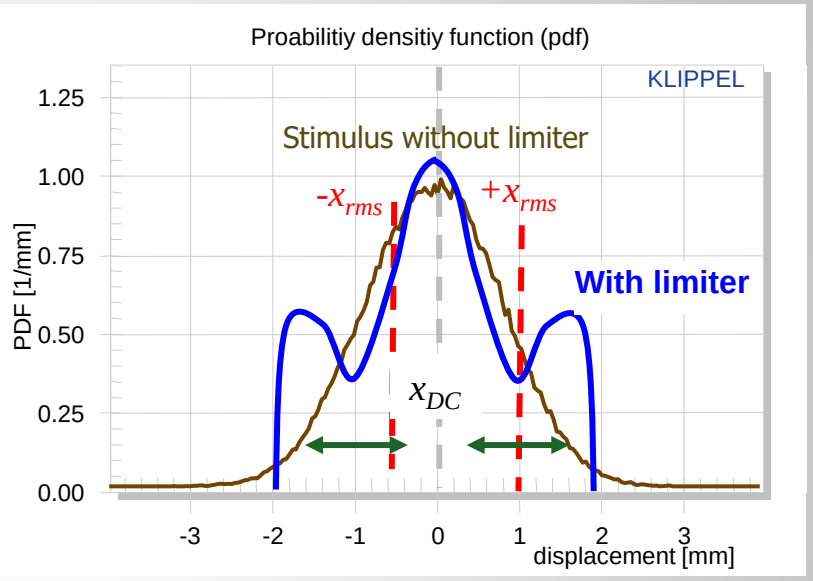
Solution: Evaluate the distribution mass (4th-order moment → **Kurtosis**) !

峰度-一個重要特徵
Kurtosis – An important characteristic

Kurtosis (fourth standardized moment):

$$\kappa = \overline{\left(\frac{x(t)}{x_{rms}}\right)^4} = \frac{1}{T}\int_{-T/2}^{T/2}\left(\frac{x(t)}{x_{rms}}\right)^4 dt$$

$$\kappa = \int_{-\infty}^{\infty}\left(\frac{x}{x_{rms}}\right)^4 p_{pdf}(x)dx$$



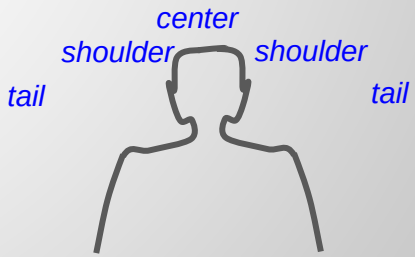
解釋 Interpretation:

- **峰度是x在均方根值x_{rms}周圍的離散度的度量（Moors 1986）**

kurtosis is a measure of the dispersion of x around the rms value values x_{rms} (Moors 1986)

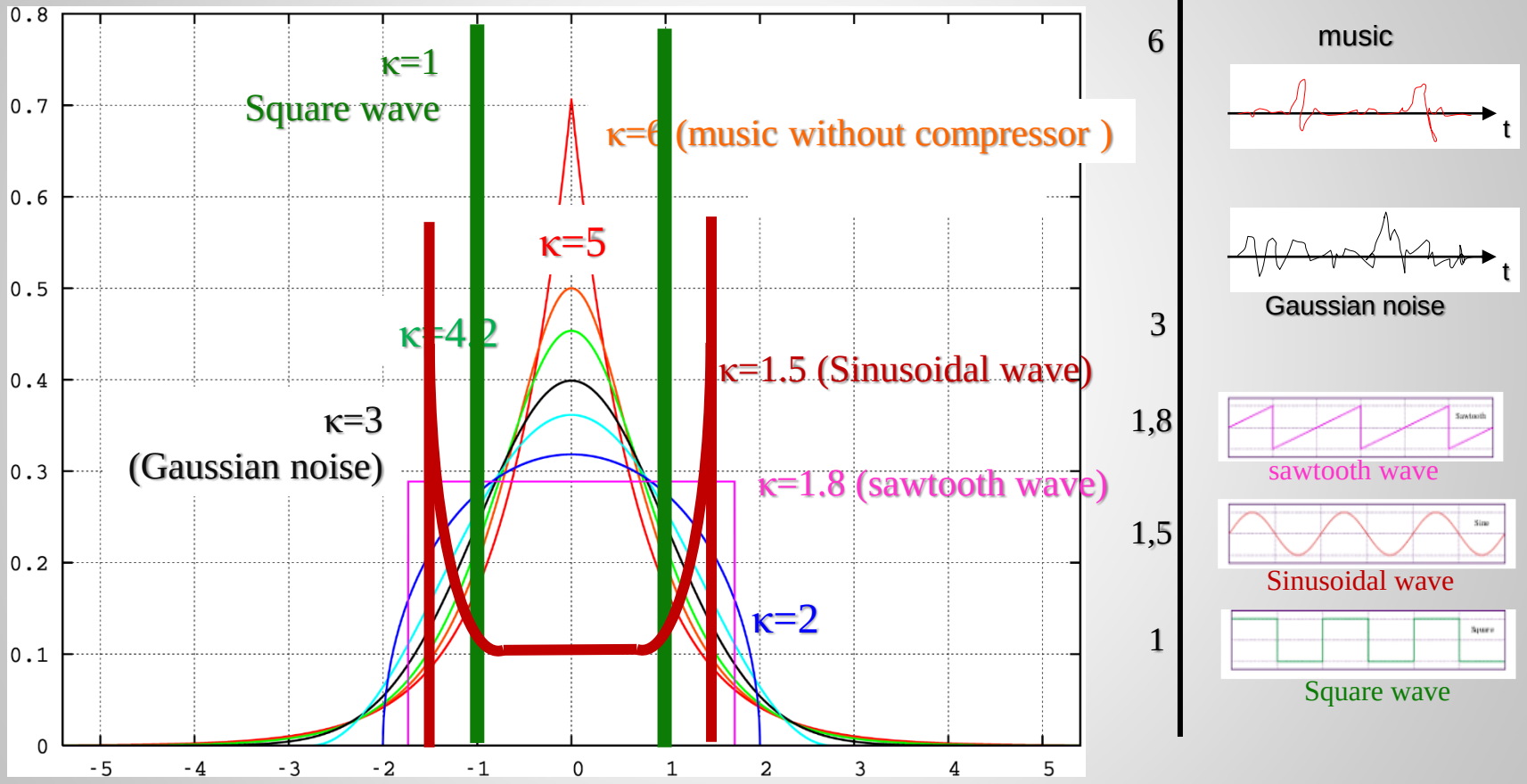
- **如果概率質量從分佈的肩膀移動到分佈的中心和尾部，則峰度變高（Balanda和MacGillivray 1988）**

kurtosis becomes higher if probability mass is moved from the shoulders of a distribution into its center and tails (Balanda and MacGillivray 1988)



常見信號峰度 Kurtosis of Common Signals

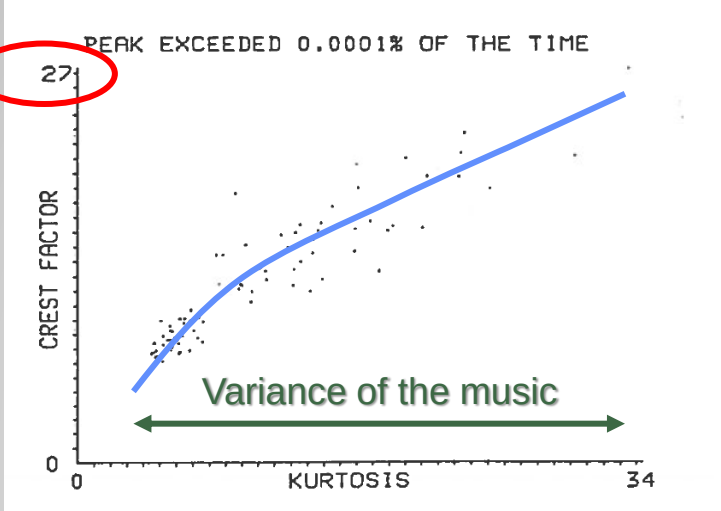
fourth standardized moment

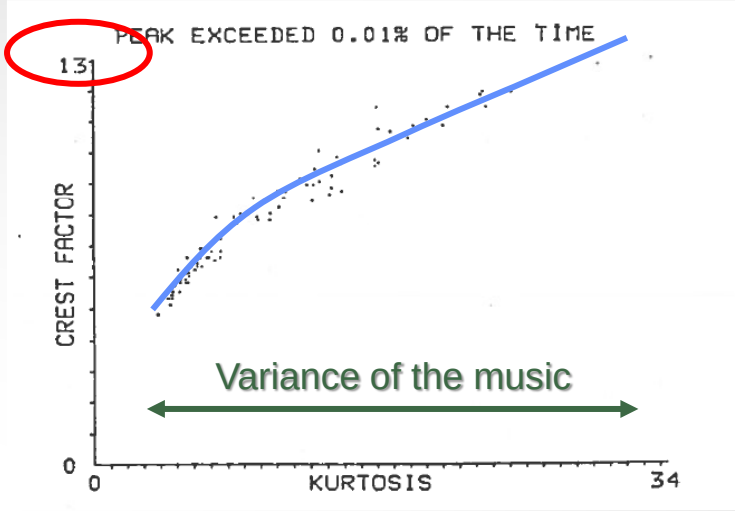


Probability density functions for selected distributions with mean 0, variance 1 and different kurtosis

波峰因數峰度 Crest Factor contra Kurtosis

Same data but other peak value definition





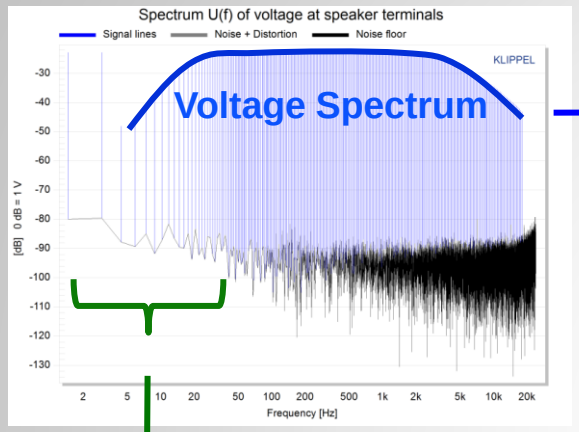
Mark Steven Everett: The Temporal and Spectral Properties of Recorded Music, PhD thesis, Coventry, KEF, 1988

分析100多種流行和古典音樂唱片（流行，爵士，搖滾，歌手，鋼琴，管弦樂隊，合唱和室內音樂）的CD
Analysis of more than 100 CD of popular and classic music recordings (pop, jazz, rock, vocalists, piano, orchestra, choral, chamber music)

結論Conclusion:

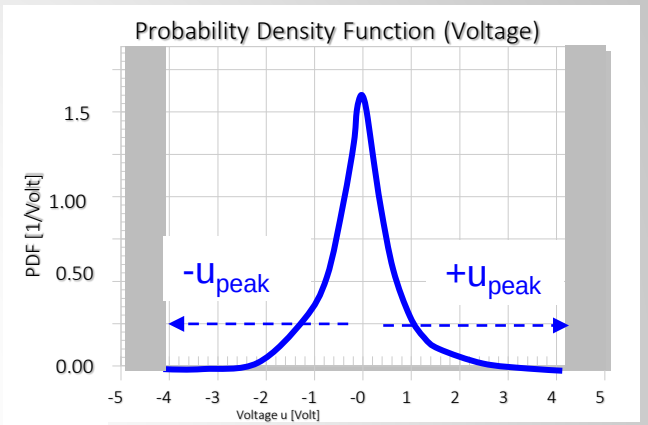
- 在波峰因素和峰度中發現較大的差異
Large variance found in crest factor and kurtosis
- 波峰因數隨峰度增加
Crest factor rises with kurtosis
- 波峰因數值取決於觀察時間和峰值定義
Crest factor values depend on observation time and peak value definition
- 峰度是可靠且定義明確的特徵（如均方根值）
Kurtosis is a reliable and well defined characteristic (like rms-value)

音頻設備的實際結果
Practical Consequences for Audio Devices

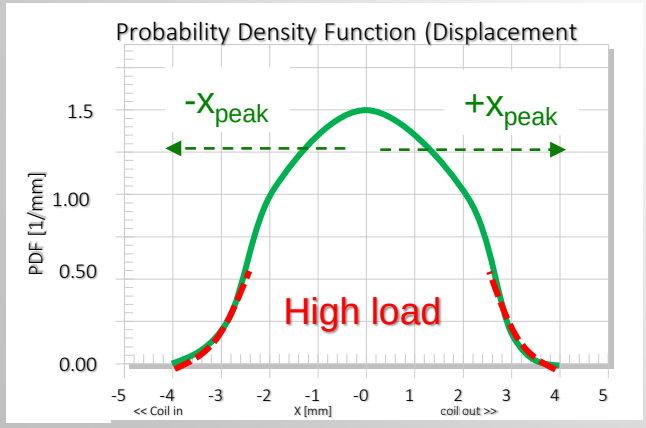


Voltage at Terminals

Amplifier limits peak voltage u_{peak}



DISPLACEMENT (Low pass filtering by transducer)



peak displacement x_{peak}, crest factor C_x kurtosis κ_x,

power spectrum $S_X(f)$, rms displacement x_{rms}, apparent mechanical power P_{am}

peak u_{peak}, crest factor C_u kurtosis κ_u

rms voltage u_{rms}, input powers P_{real},

nonlinearities, distortion

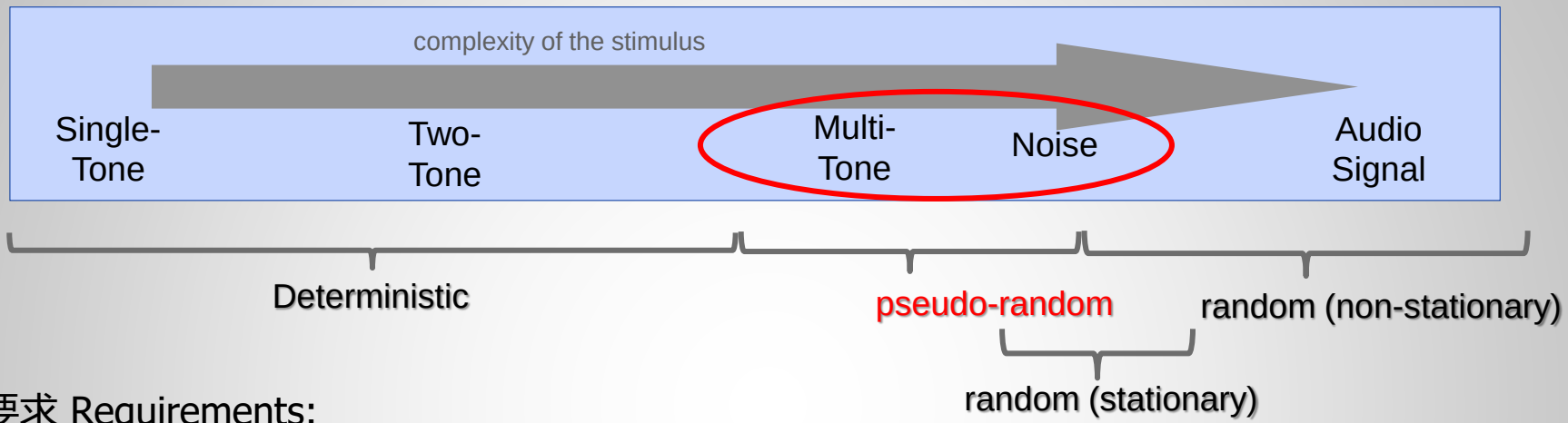
heating, thermal overload

mechanical overload, fatigue, aging,

Transducer

需要標準測試信號 Need for a Standard Test Signal

representing relevant audio stimuli



要求 Requirements:

- 可比較，可再生性和可重複性

Comparability, reproducibility and repeatability

- 生成具有模擬隨機屬性的激發

Generating a deterministic stimulus with pseudo-random properties

- 代表典型的音頻素材或激進的素材（導致DUT過載，老化，疲勞和缺陷

Representing typical audio program material or aggressive program material (causing overload, aging, fatigue and defects of the DUT)

- 長期測試（100小時功率測試，耐久性，可靠性，氣候影響）

Long-term testing (100h power test, endurance, reliability, climate influence)

- 使用額定SPLmax快速校準輸入通道

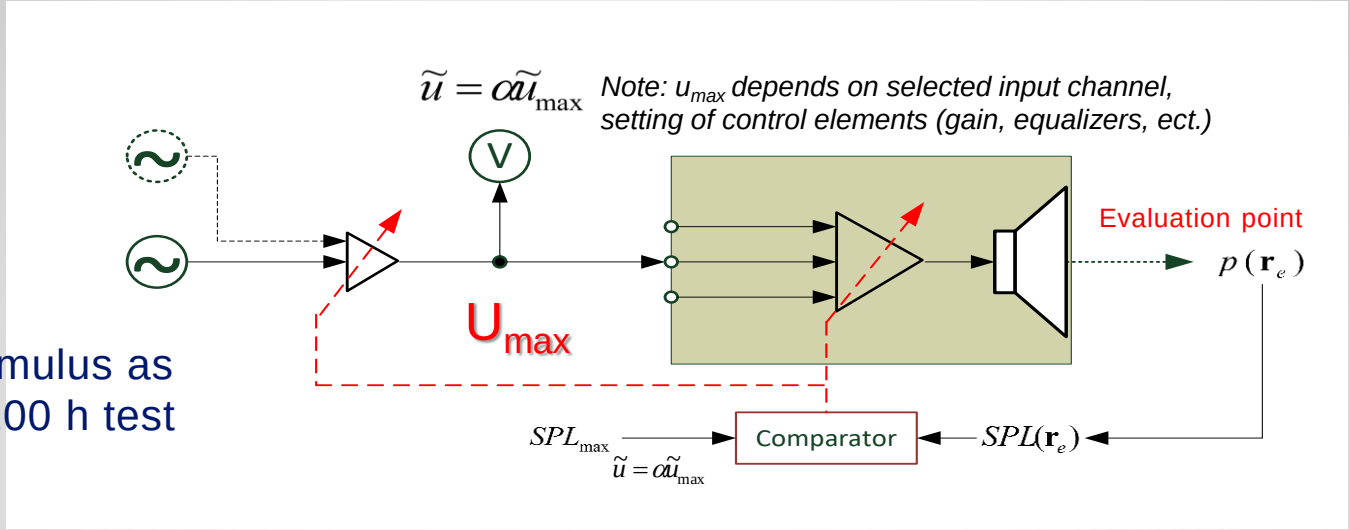
Fast calibration of the input channel using rated SPLmax

- 在線監測輸出（失真，壓縮）和內部狀態（位移，溫度）

On-line monitoring of output (distortion, compression) and internal states (displacement, temperature)

校正輸入信號Calibration of the Input Signal

based on SPL_{max} rated by manufacturer (IEC 60268-21)



校準過程的目標 Objectives of the calibration process

- 基於SPL_{max}快速確定最大輸入值u_{max}

Fast determination of the maximum input value u_{max} based on SPL_{max}

- 使用umax校准其他測試刺激

Using u_{max} for the calibration of other test stimuli

- 使用活動系統的任何輸入通道（模擬，數字等）的完全靈活性

Full flexibility for using any input channel of the active system (analogue, digital, ect.)

- 簡單的技術可提供高重現性的結果

Simple technique giving high reproducible results

IEC 60268-21 recommends a multi-tone stimulus for calibration and long-term testing!

Sparse Multi-tone Stimulus

Defined in IEC 60268-21

MT激發的優點：Advantages of MT Stimulus:

- 確定性過程生成的偽隨機屬性（基於一些種子參數）

Pseudo-random properties generated by a deterministic process (based on a few seed parameters)

- 快速測試（1 MT複雜設備）以校準輸入通道，以測量失真和熱動力學（時間常數）

Fast testing (1 MT complex) to calibrate input channel, to measure distortion and thermal dynamics (time constant)

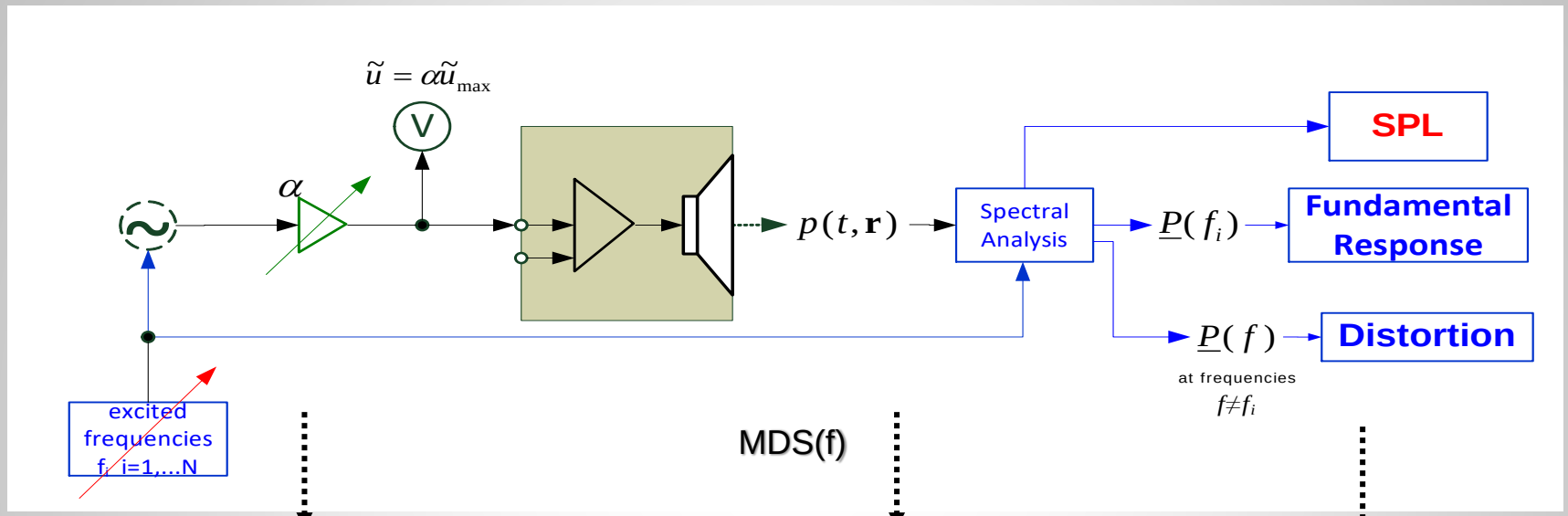
- 通過循環一個或多個MT絡合物進行長期測試（100 h）

Long-term testing (100 h) by looping one or more MT complexes

- 生成單個刺激（隔行音調複合物）以在一間房間中對多個DUTS進行聲學測量

Generating individual stimuli (interlaced tone complexes) for acoustical measurements of multiple DUTS in one room

Testing with a Multi-tone Stimulus

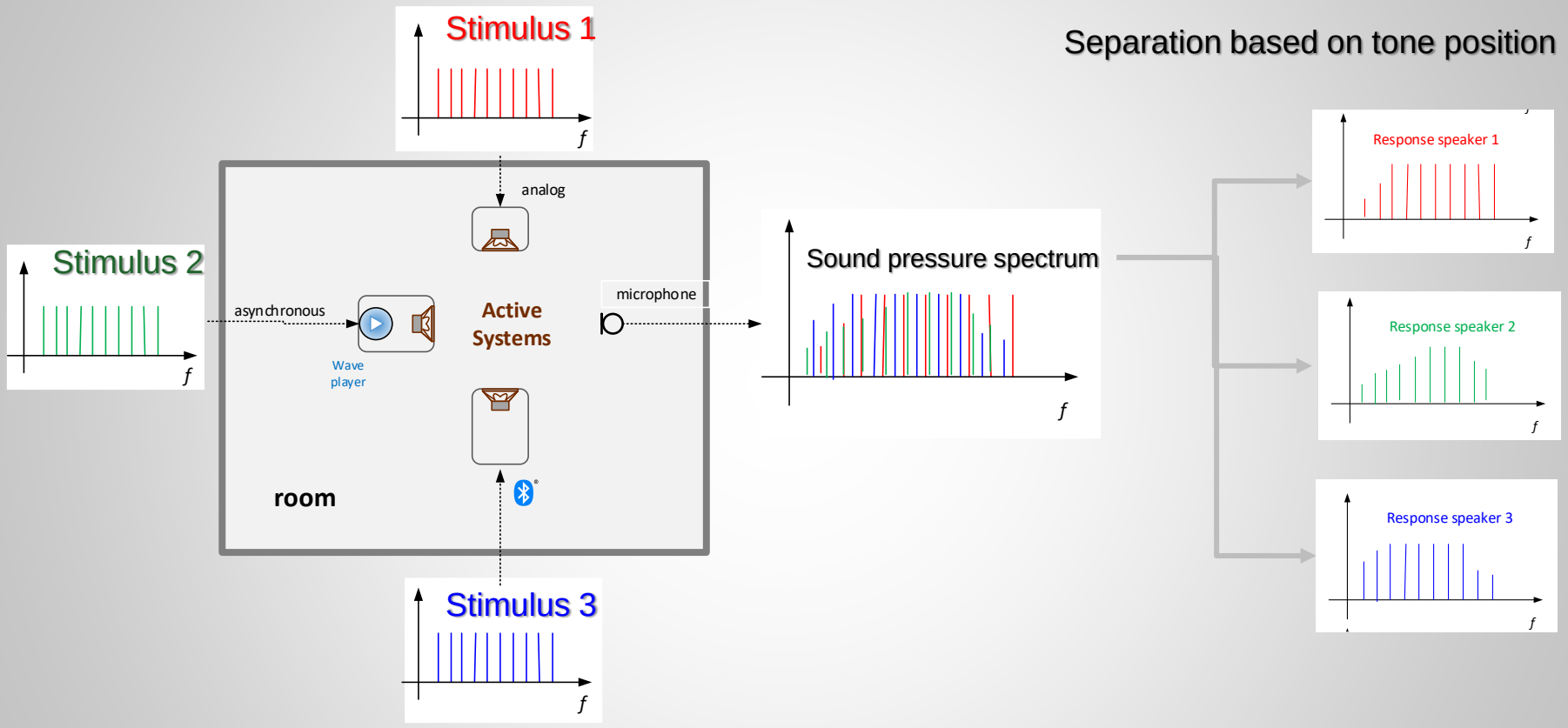


Sparse multi-tone complex

Spectrum of distortion

Standard IEC 60268-21 defines the measurement with multi-tone signals

Interlaced Multi-tone Testing



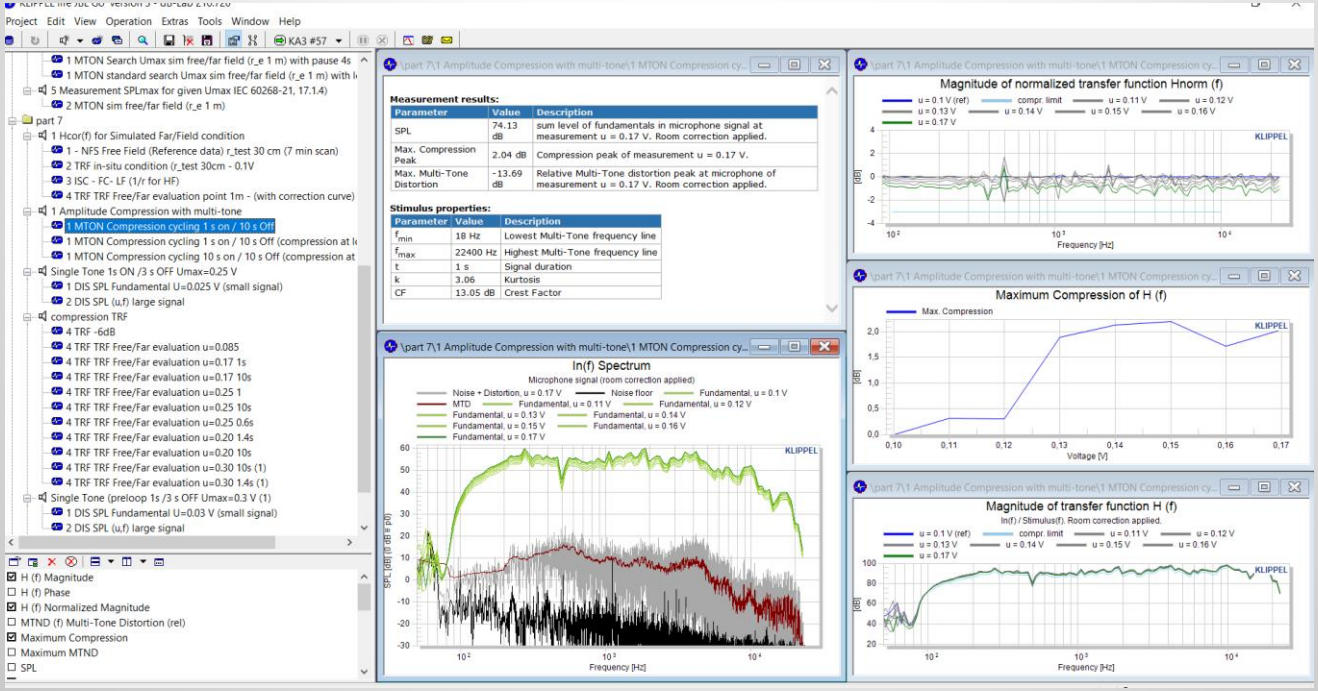
- 每個激發在多音譜中使用不同的音調 Each stimulus uses different tones in the multi-tone spectrum
- 聲學測量適用於在一間室內運行的多個DUT Acoustical measurement applicable to multiple DUTs operated in one room
- 無法同時測量多個DUT產生的非線性失真

Simultaneous measurement of nonlinear distortion generated by multiple DUTs is not possible

Demo: Multi-Tone Test

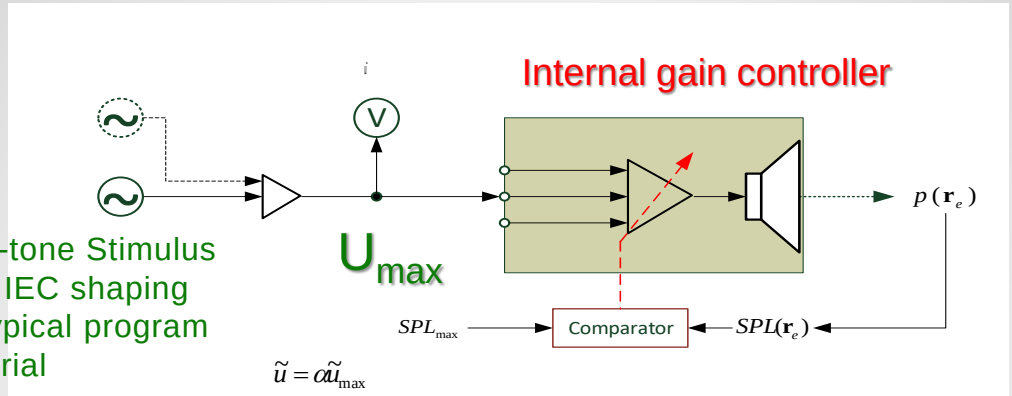
simulated Free/Far Field Condition

Tool: Using a dedicated software module MTON (multi-tone) of the KLIPPEL Analyzer



校正輸入通道Calibration of the Input Channel

First Method: adjusting the internal gain controller



製造商規定的特性 Characteristics stated by the manufacturer

1. 寬帶刺激的屬性（模擬程序材料） Properties of the broad-band stimulus (simulated program material)
2. 聲學條件（模擬自由場）Acoustical condition (simulated free-field)
3. 評估點re = 1m（模擬遠場條件） Evaluation point $\mathbf{r}_e$ = 1m (simulated far field condition)
4. 額定最大聲壓級SPLmax Rated maximum sound pressure level SPL_{max}

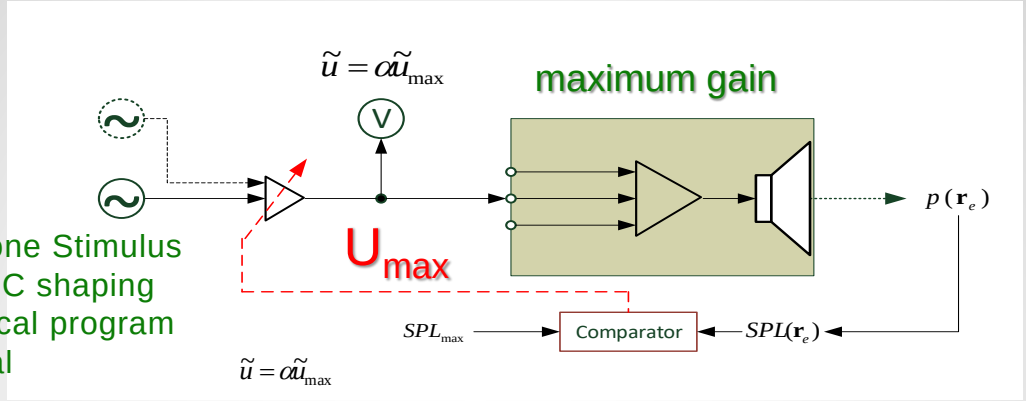
校正Calibration

設置內部增益，以使模擬輸入端的Umax = -20 dBV產生最大SPL值

Setting of the internal gain that the U_{max} = -20 dBV at the analog input generates the maximum SPL value SPLmax

校正輸入通道Calibration of the Input Channel

Second Method: Measuring U_{max} at maximum internal gain



製造商規定的特性 Characteristics stated by the manufacturer

1. 激發是符合IEC的模擬程序 Stimulus is simulated program material according IEC
2. 內部增益調整為最大 Internal gain is adjusted to maximum
3. 聲學條件（模擬自由場） Acoustical condition (simulated free-field)
4. 評估點re = 1m（模擬遠場條件）Evaluation point $\mathbf{r}_e$ = 1m (simulated far field condition)
5. 額定最大聲壓級 Rated maximum sound pressure level

校正 Calibration

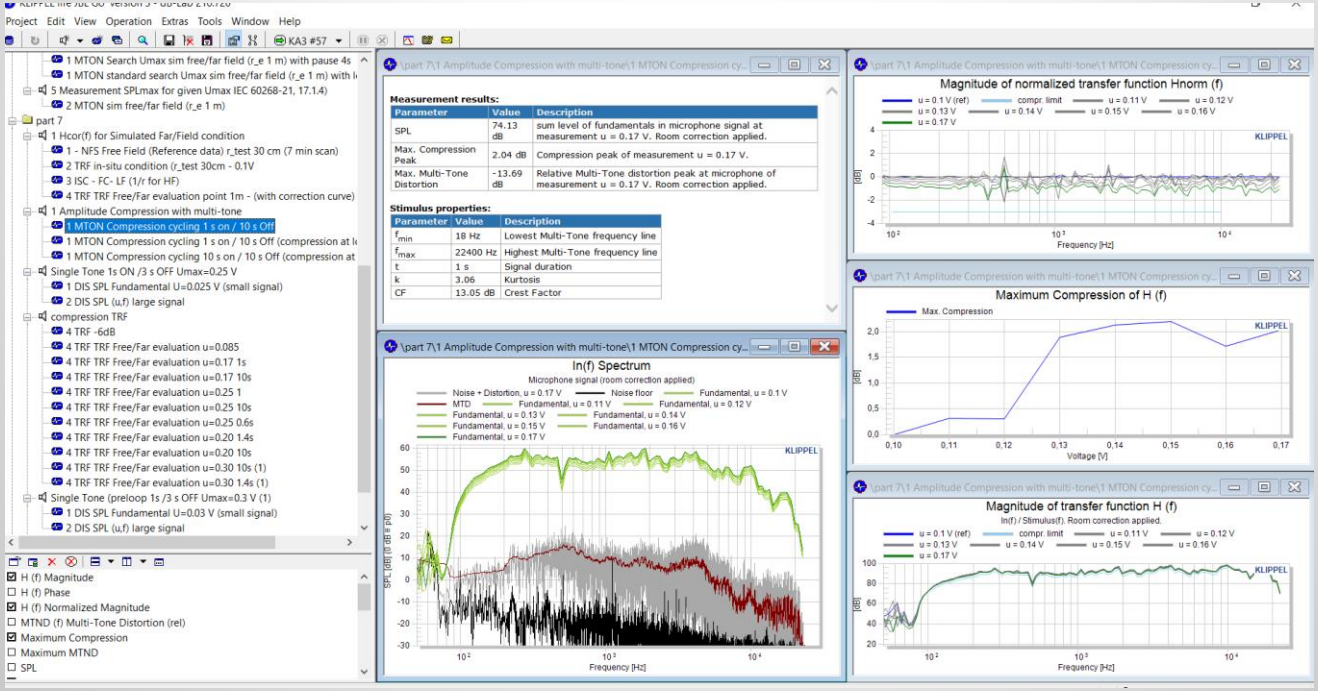
Searching for U_{max} at the analog input that generates SPLmax

We are ready for a practical demonstration!

Demo: InputCalibration

Method 2: Searching for U_{max}

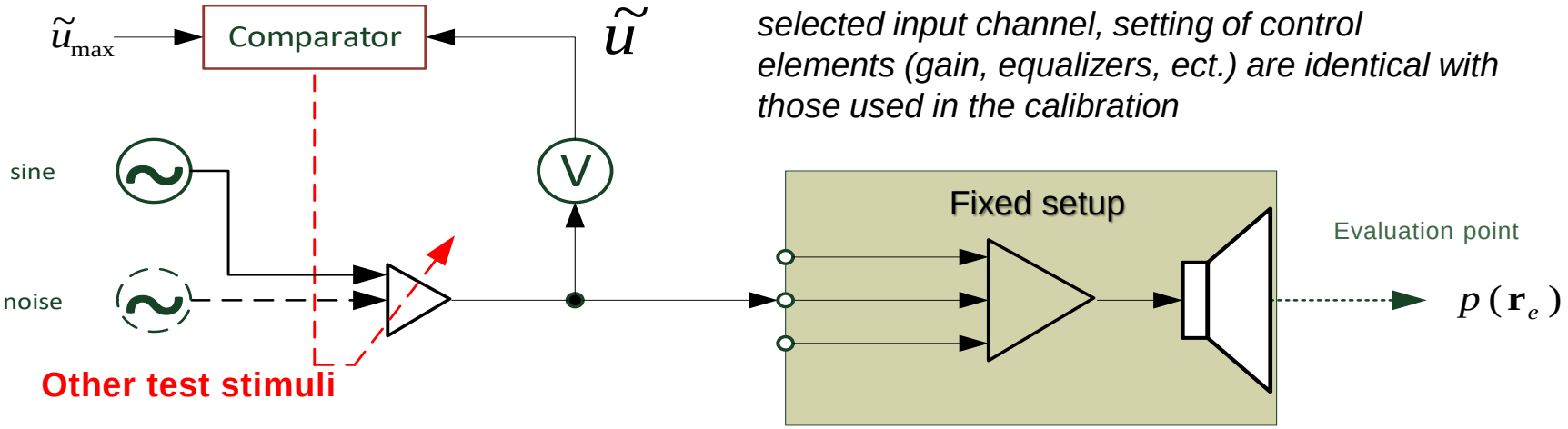
Tool: Using a dedicated software module MTON (multi-tone) of the KLIPPEL Analyzer



如何校正其他測試激發
How to Calibrate Other Test Stimuli

based on maximum input u_{max} (IEC 60268-21)?

Maximum input value



selected input channel, setting of control elements (gain, equalizers, ect.) are identical with those used in the calibration

優點 Benefits:

- 其他測試刺激的振幅調整 Amplitude adjustment of other test stimuli
- 簡化自動測試 Simplifies automatic testing
- 小信號域$u_{max} < 0.1\ u_{max}$的清晰定義 Clear definition of small signal domain $u_{max} < 0.1\ u_{max}$
- 避免DUT意外過載 Avoiding unintended overload of the DUT

總結Summary

- 額定值SPLmax取決於所選寬帶激發的特性

The rated value SPLmax depends on the properties of the selected broad-band stimulus

- 峰度描述是描述激發特性的重要特徵

Kurtosis describes is an important characteristic for describing the properties of the stimulus

- 在校正過程和100h長期測試中使用相同的激發

The same stimulus is used in the calibration process and in the 100h long term test

- Multi-tone是評估SPLmax的有趣激發

Multi-tone stimulus is an interesting stimulus for evaluating SPLmax

- 主動音頻系統的輸入校準可以在幾秒鐘內完成

The input calibration of active audio systems can be accomplished in a few seconds

2nd-part KLIPPEL live

1. Modern audio equipment needs output based testing
2. Standard acoustical tests performed in normal rooms
3. Drawing meaningful conclusions from 3D output measurement
4. Simulated standard condition at a single evaluation point
5. Maximum SPL – giving this value meaning
6. Selecting measurements with high diagnostic value
7. Amplitude Compression – less output at higher amplitudes
8. Harmonic Distortion Measurements – best practice
9. Intermodulation Distortion – music is more than a single tone
10. Impulsive distortion - rub&buzz, abnormal behavior, defects
11. Benchmarking of audio products under standard conditions
12. Auralization of signal distortion – perceptual evaluation
13. Setting meaningful tolerances for signal distortion
14. Rating the maximum SPL value for product
15. Smart speaker testing with wireless audio input