

Atelier 3 : Design des signaux de mesure pour la caractérisation des sources

Antonin Novak



Exact #5 - 8 mars 2023

Synchronized Swept Sine for distortion measurement

(an introduction)

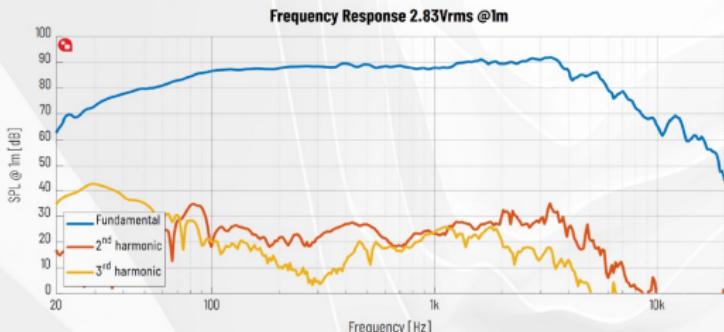
PTT6.5W04 DATA SHEET



KEY SPECIFICATIONS

- ⦿ Negligible Force Factor Modulation and Surround Radiation Distortion
- ⦿ Low Magnetic Hysteresis Distortion
- ⦿ "Real" long-stroke performance: distortion remains low over full excursion
- ⦿ Uncompromised midrange performance

Driver size	6.5"
DC resistance, R_{DC}	3.6 Ω
Resonance freq., f_0	30 Hz
Total Q factor, Q_{ts}	0.29
Effective piston area	133 cm ²
Equivalent volume, V_{as}	26 L
SPL@2.83V _{rms} /1m	88.5 dB
Linear X_{max}	+/- 10.0 mm
Mechanical X_{max}	+/- 14.5 mm
IEC Power handling	350 W
Cone material	Proprietary Fibre Mix



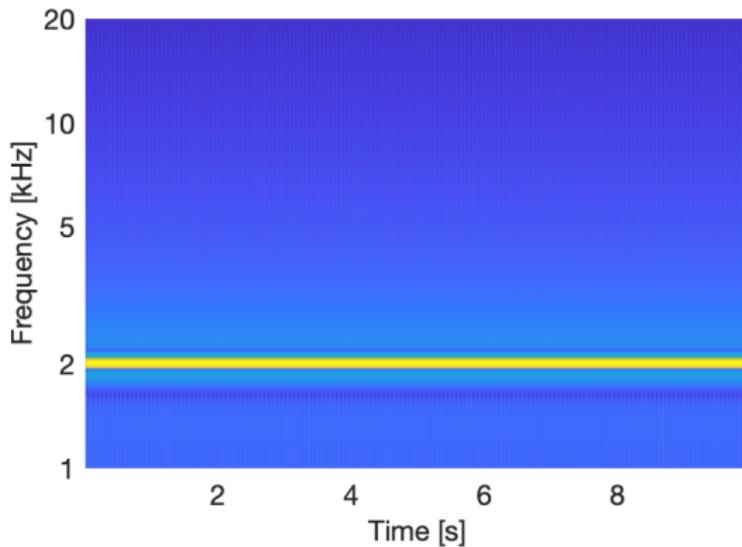
... a synchronous swept-sine ...

a signal that can be easily used for both
analysis of nonlinear systems
nonlinear **model** estimation

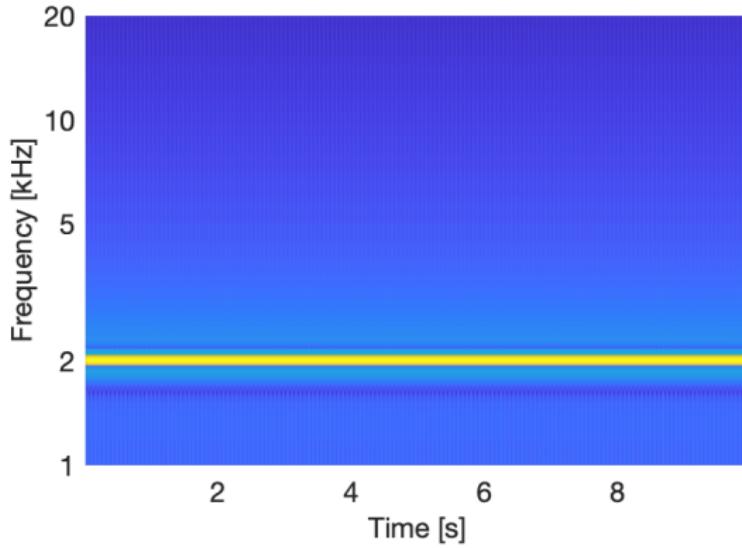
spectrogram quiz

level 1

Question: what it sounds like ?

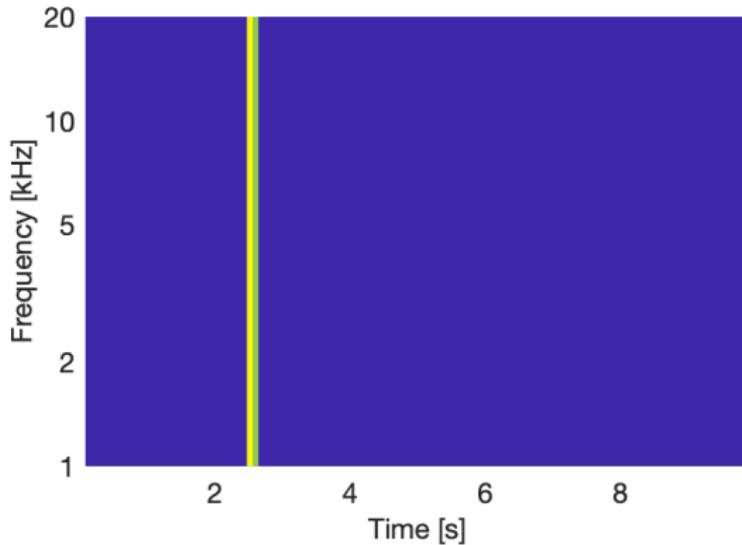


Question: what it sounds like ?

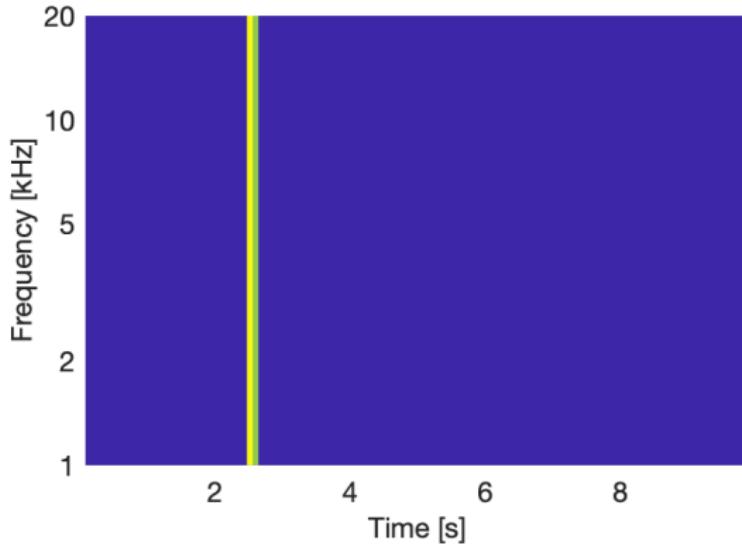


Answer: sine wave

Question: what it sounds like ?

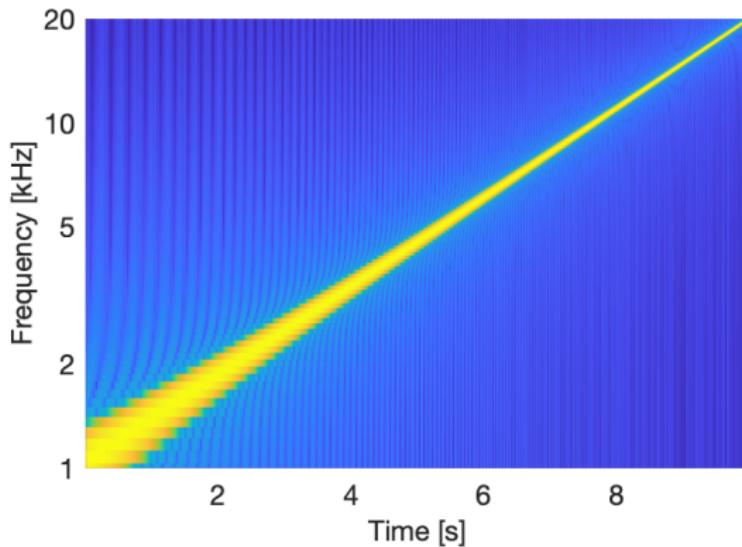


Question: what it sounds like ?

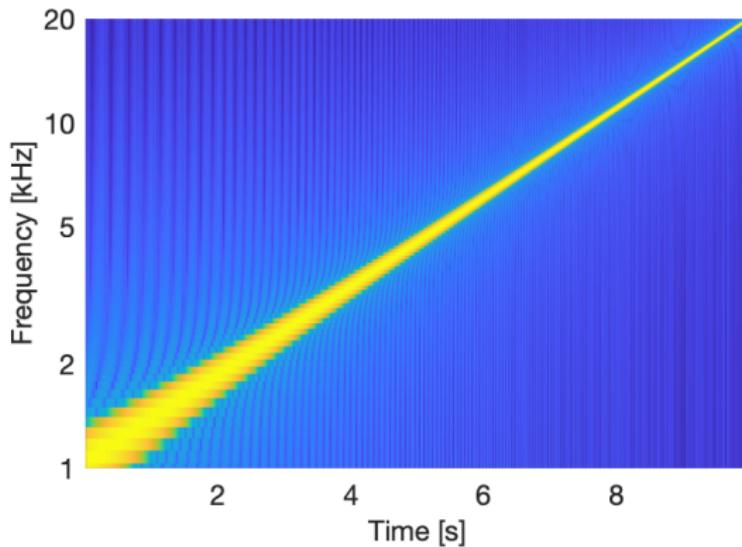


Answer: Dirac impulse (or an impulsive sound)

Question: what it sounds like ?



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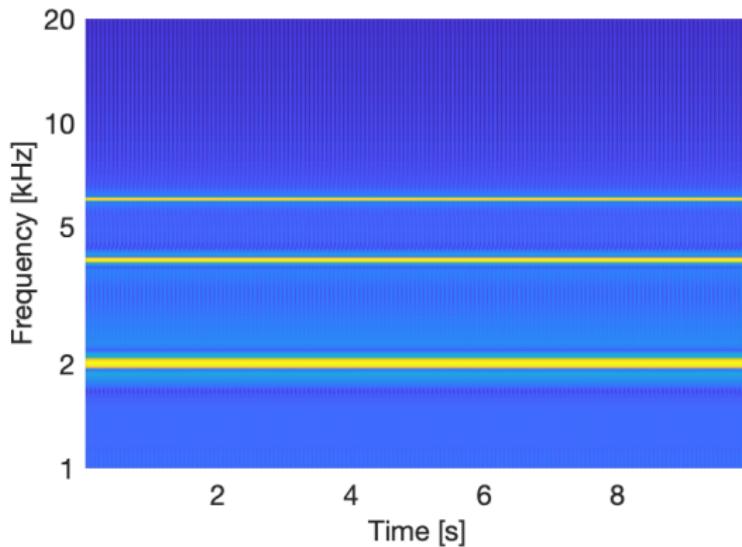


Answer: swept-sine

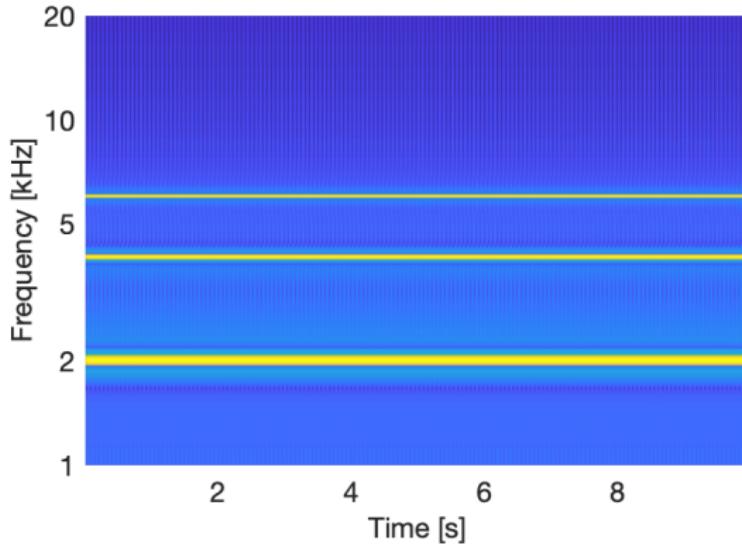
spectrogram quiz

level 2

Question: what it sounds like ?



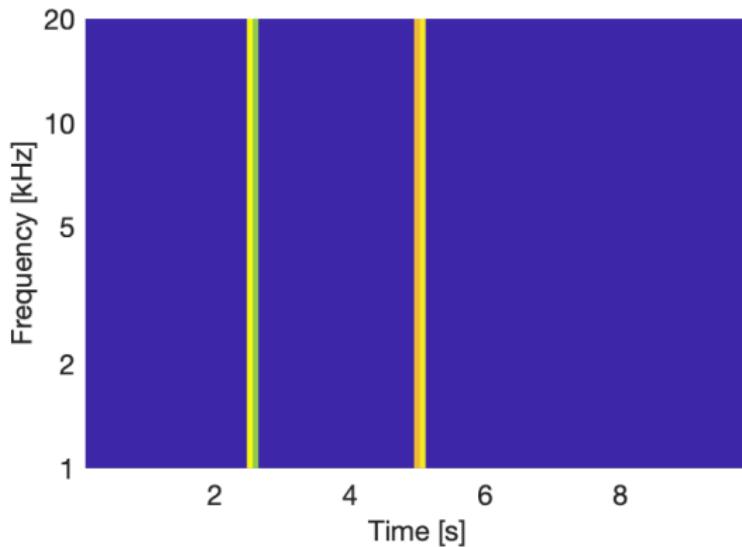
Question: what it sounds like ?



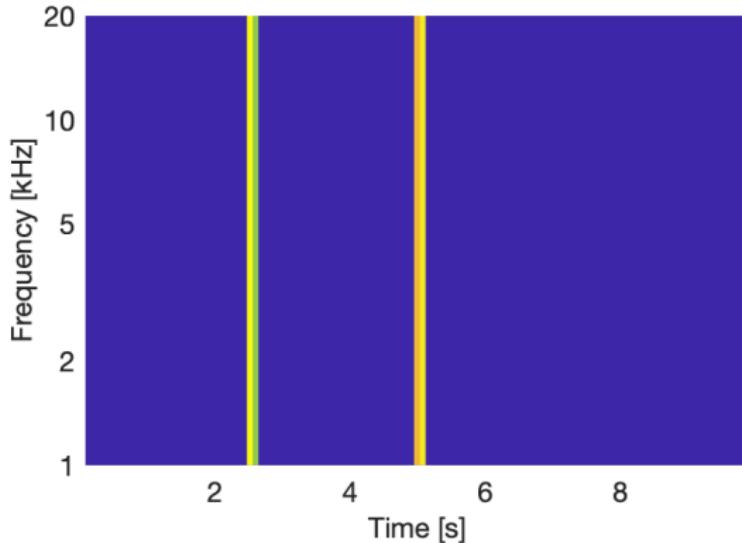
Answer 1: three independent tone signals

Answer 2: distorted sine wave

Question: what it sounds like ?



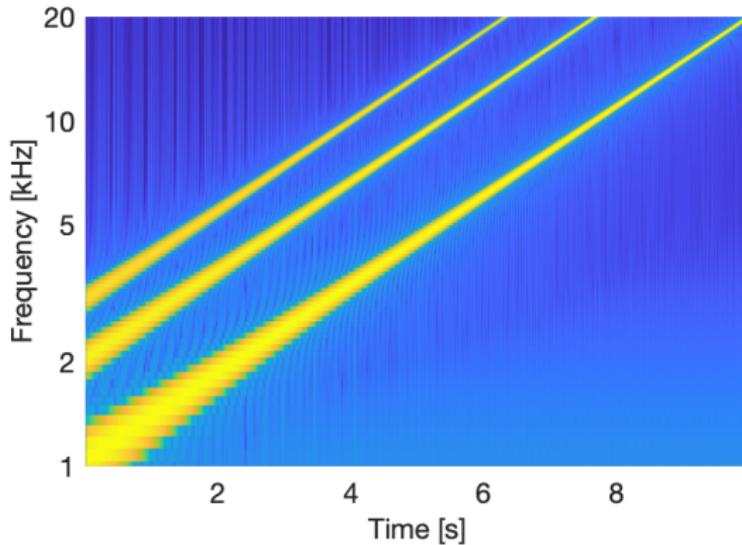
Question: what it sounds like ?



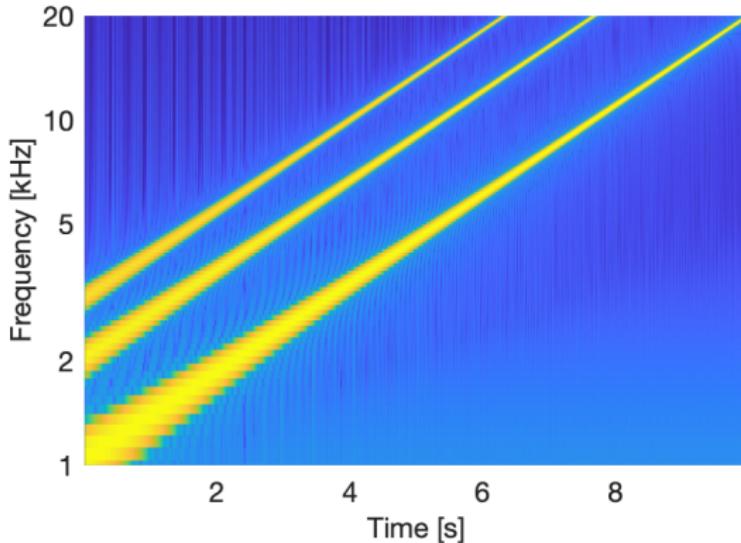
Answer 1: two independent impulses

Answer 2: impulse passed through a linear system
(direct sound and a reflection)

Question: what it sounds like ?



Question: what it sounds like ?



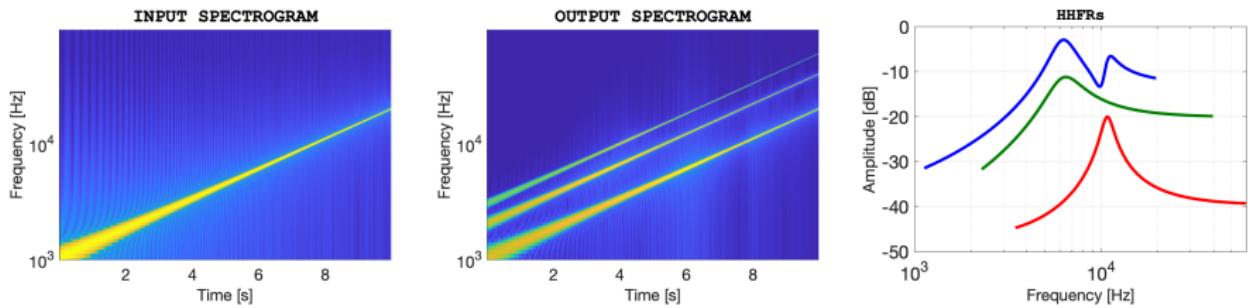
Answer 1: three independent swept-sines

Answer 2: swept-sine passed through a linear system
(direct sound and two reflections)

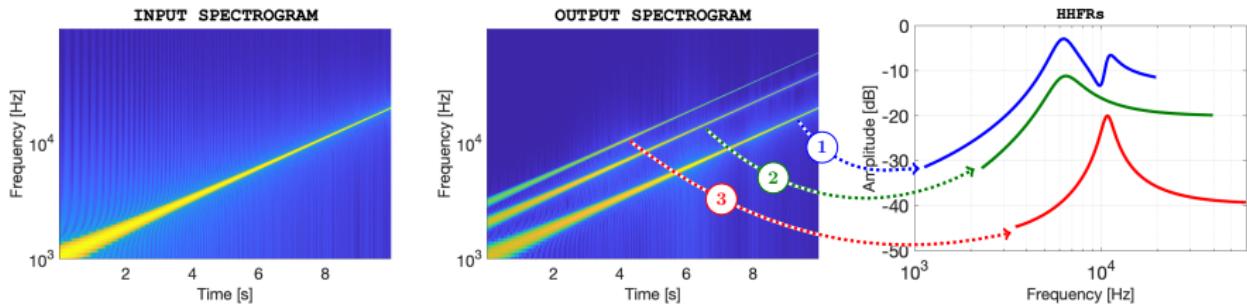
Answer 3: distorted swept-sine

Higher Harmonic Frequency Response (HHFR)

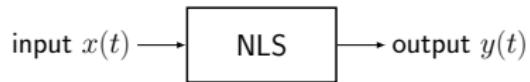
Synchronized Swept-Sine → HHFRs



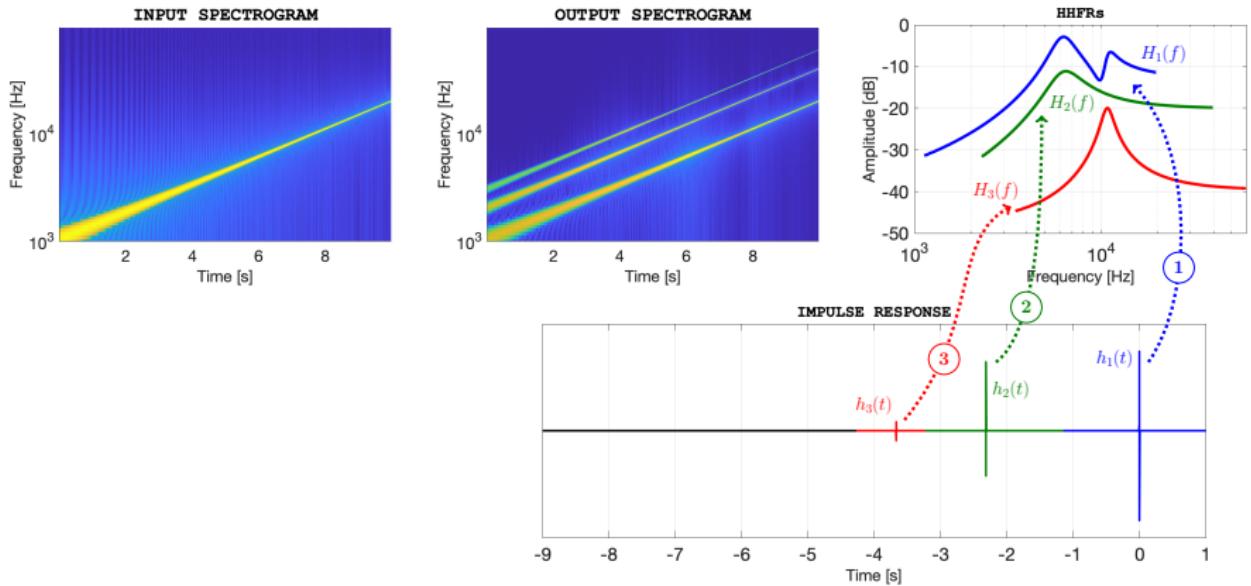
Synchronized Swept-Sine → HHFRs

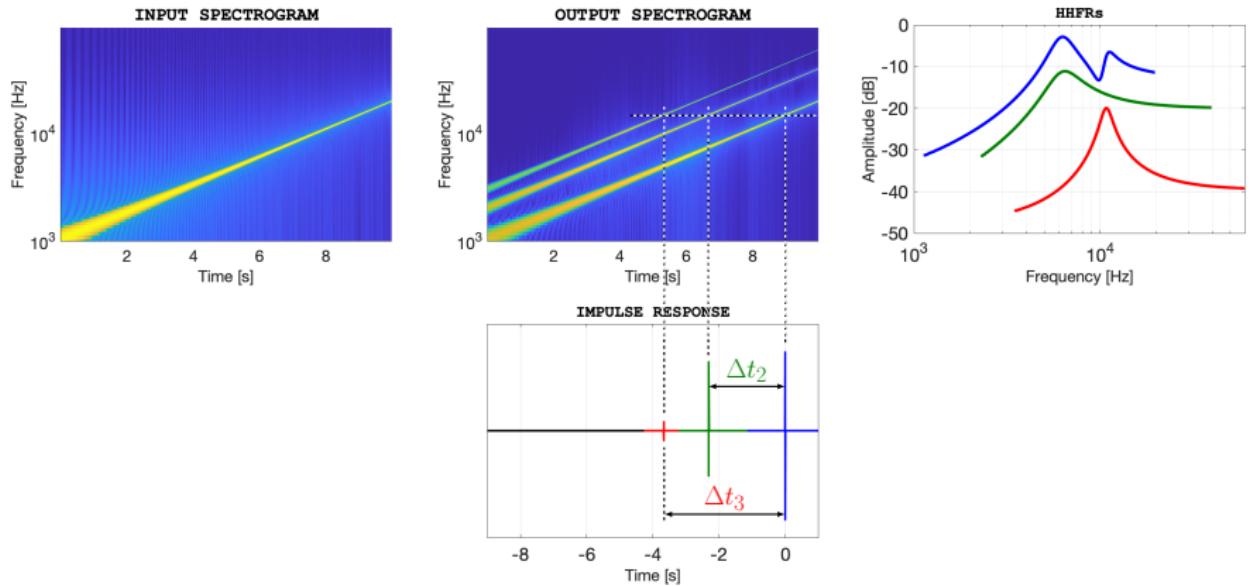


... how it works ? ...



- 1) generate a swept-sine $x(t)$
- 2) record $y(t)$
- 3) calculate FT $X(\omega)$, $Y(\omega)$ and $h(t) = \text{FT}^{-1} \left\{ \frac{Y(\omega)}{X(\omega)} \right\}$







- 1) generate a swept-sine $x(t)$
- 2) record $y(t)$
- 3) calculate FT $X(\omega)$, $Y(\omega)$ and $h(t) = \text{FT}^{-1} \left\{ \frac{Y(\omega)}{X(\omega)} \right\}$
- 4) separate impulse response $h(t)$ to $h_m(t)$
- 5) calculate FT $H_m(\omega) \leftarrow \text{HHFRs}$

... the remainder is planed for the workshops ...

References

<https://ant-novak.com/>

A. Novak, P. Lotton & L. Simon (2015), "Synchronized Swept-Sine: Theory, Application and Implementation", Journal of the Audio Engineering Society. Vol. 63(10), pp. 786-798.

A. Novak, F. Kadlec, L. Simon & P. Lotton (2010), "Nonlinear system identification using exponential swept-sine signal ", Instrumentation and Measurement, IEEE Transactions on. Vol. 59(8), pp. 2220-2229.