

Measurements and Room Acoustic Analysis with the ITA-Toolbox for MATLAB

Introduction

Intelligent Data Objects

- Automatic transformation between time and frequency domain
- Integrated plot and playback functionality

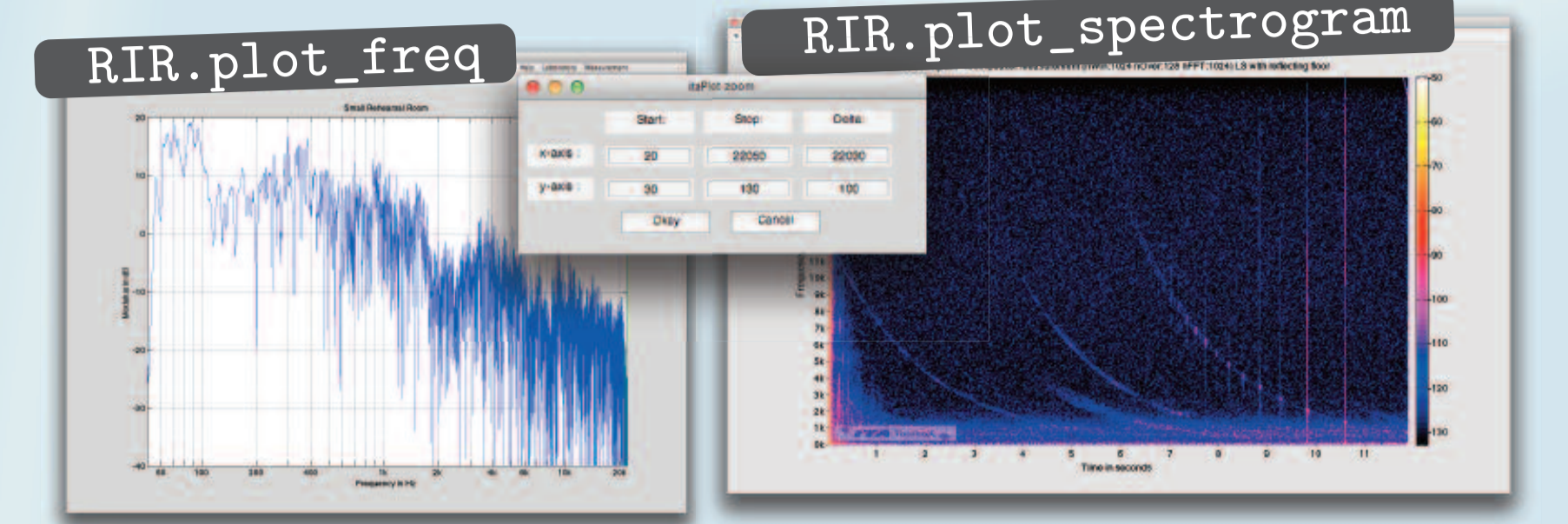
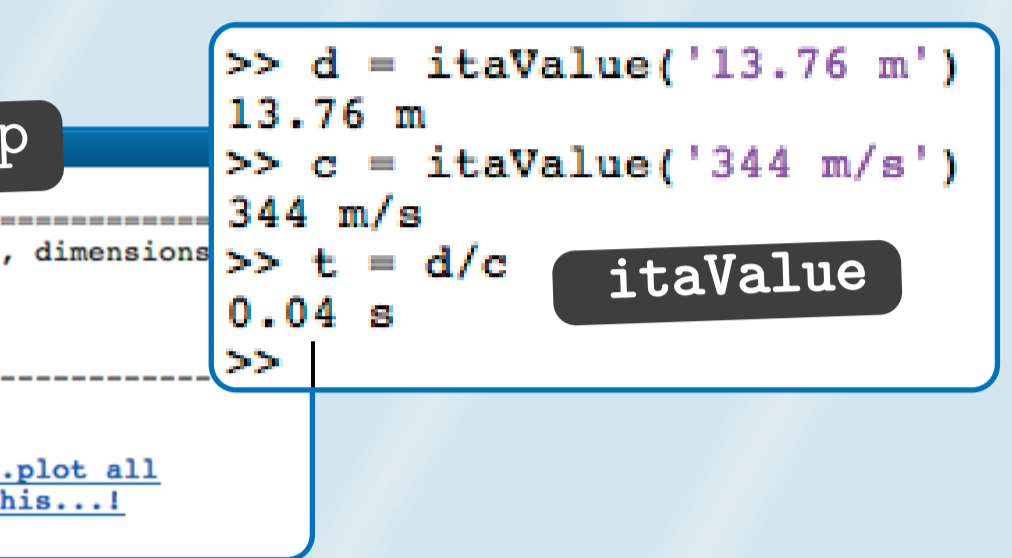
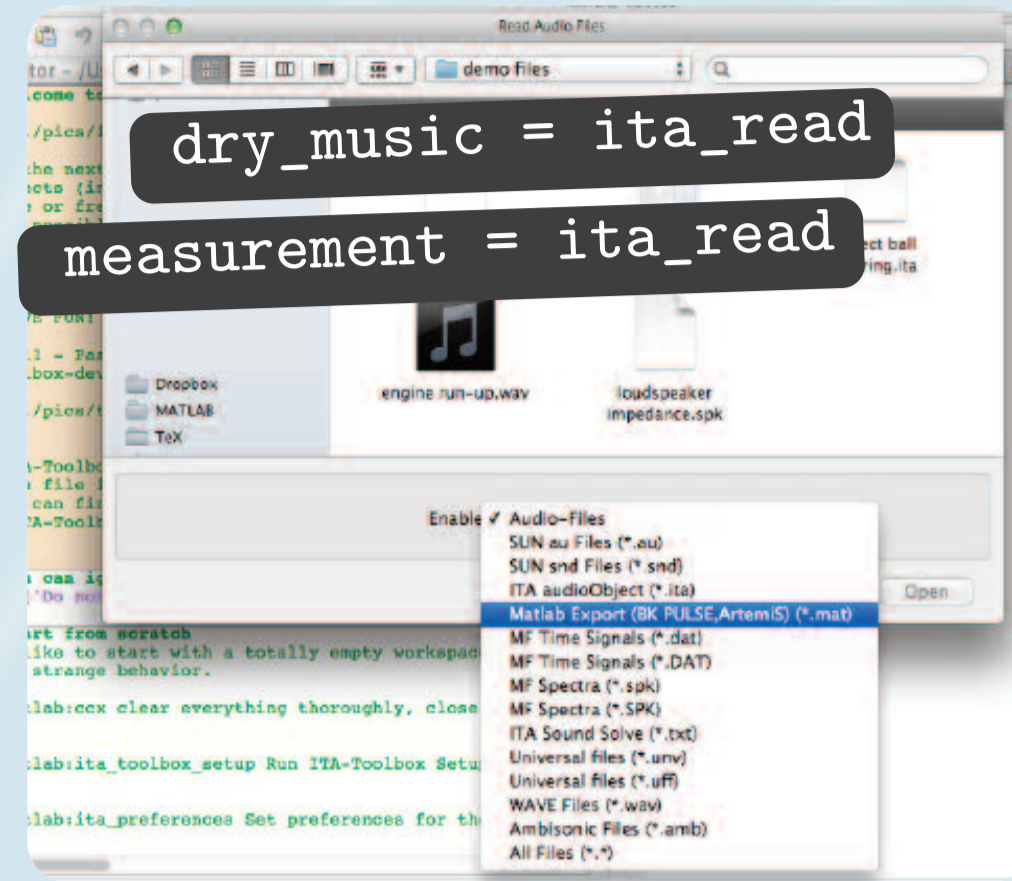
RIR = measurement/sweep

auralization = dry_music*RIR

a = itaAudio

sweep = ita_generate_sweep

```
>> d = itaValue('13.76 m')
13.76 m
>> c = itaValue('344 m/s')
344 m/s
>> t = d/c
0.04 s
>>
```



License & Requirements

- Open-source code, commercial use allowed
- MATLAB R2010a+ with Signal Processing Toolbox on Windows, Mac OS X or Linux
- Basic MATLAB knowledge

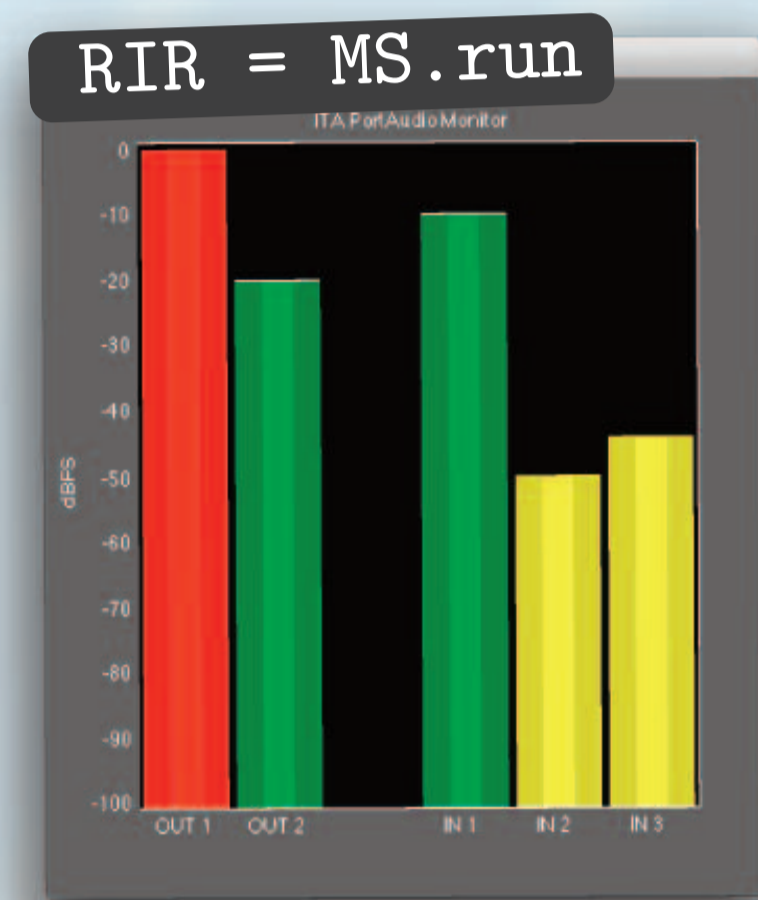
References

DIETRICH ET AL., *ITA-Toolbox – An Open Source MATLAB Toolbox for Acousticians*, DAGA 2012

Measurement

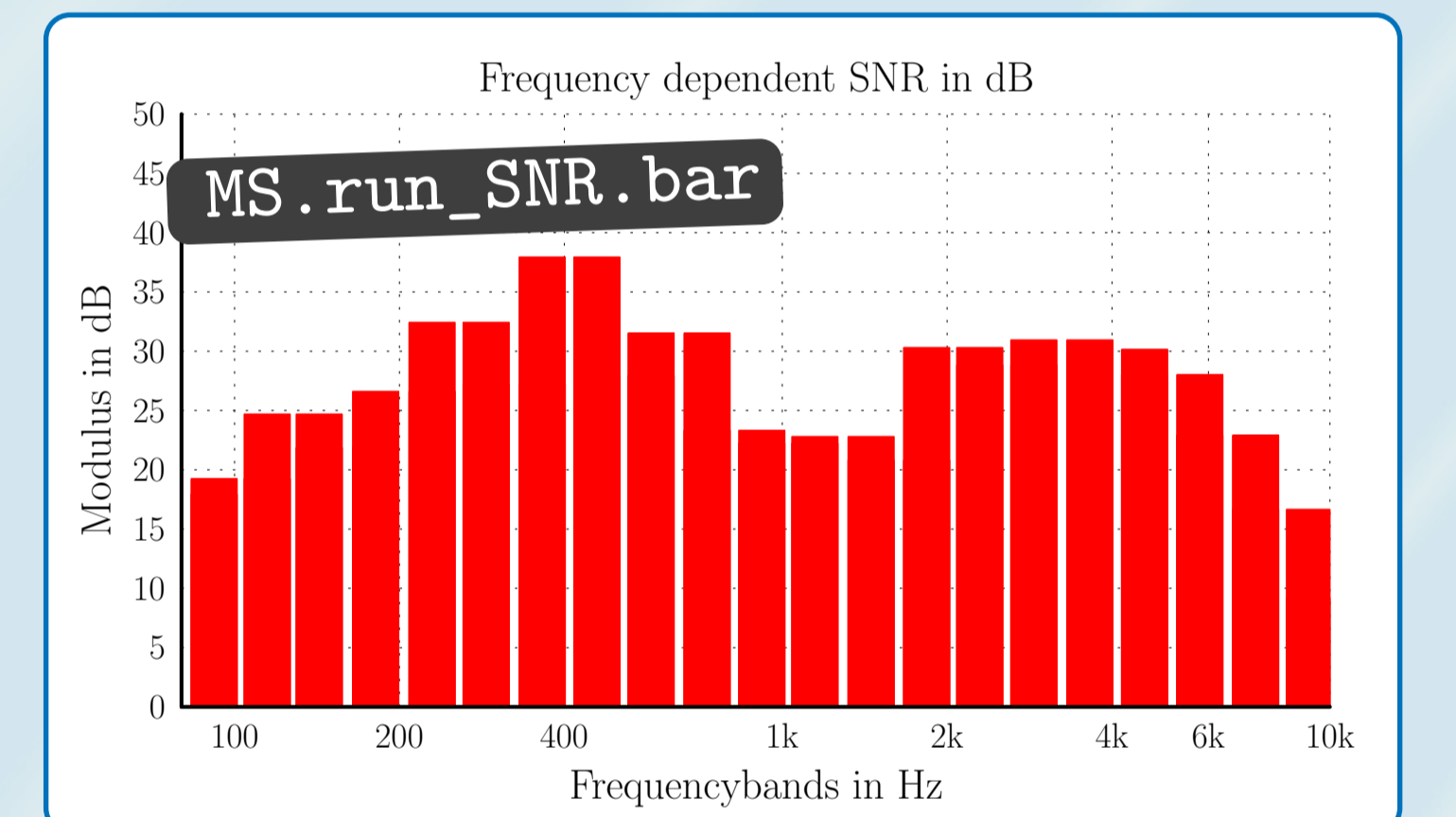
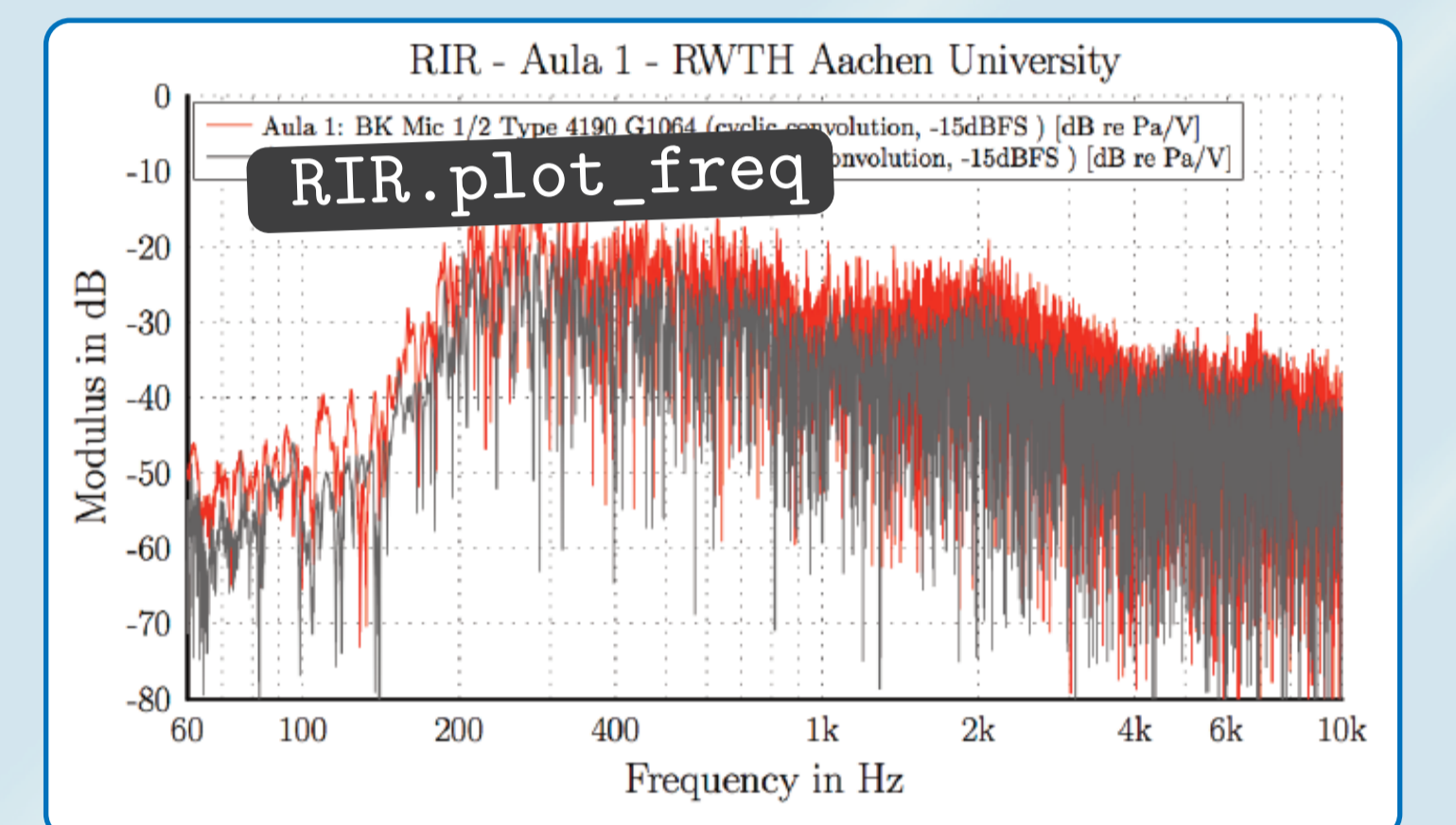
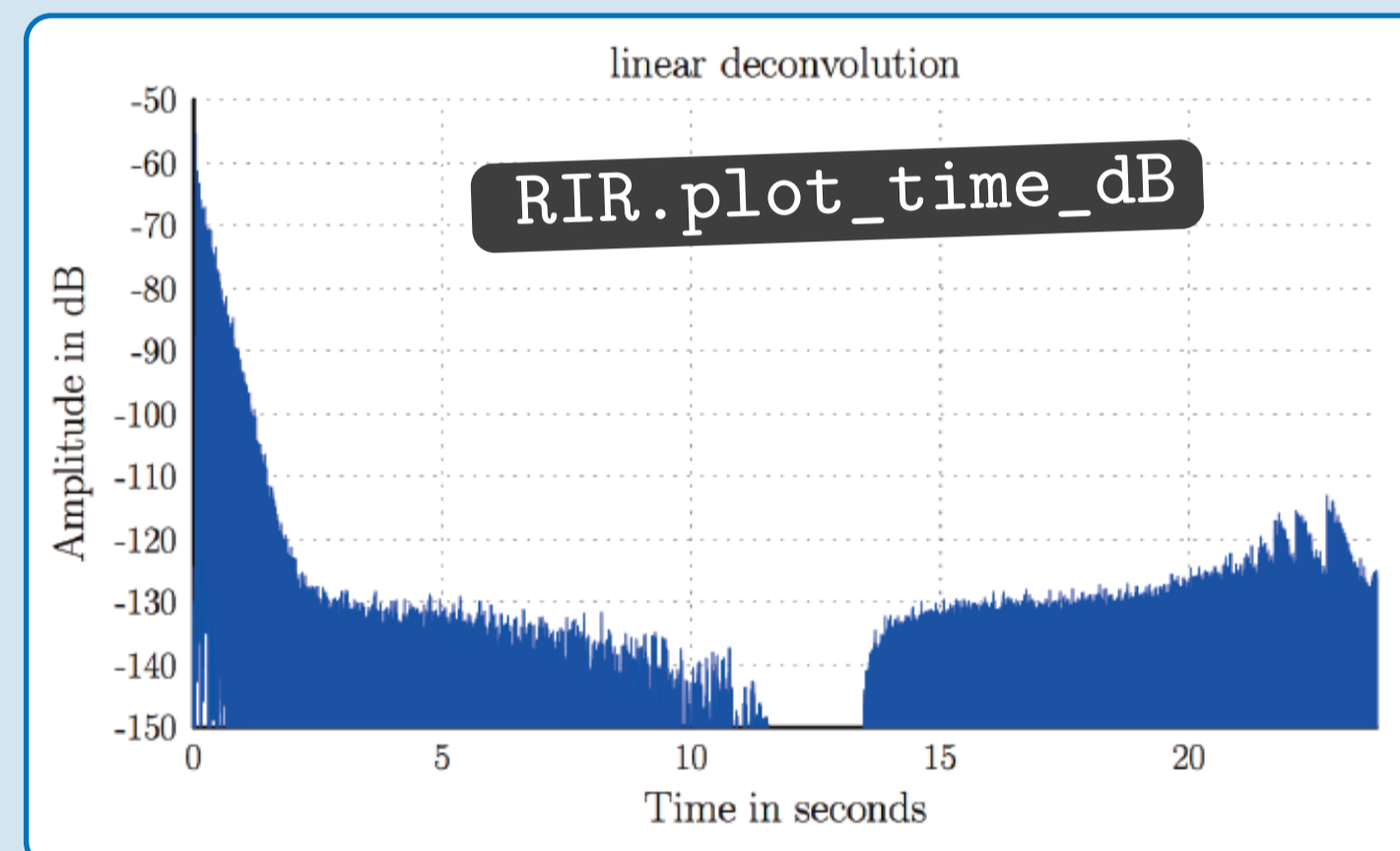
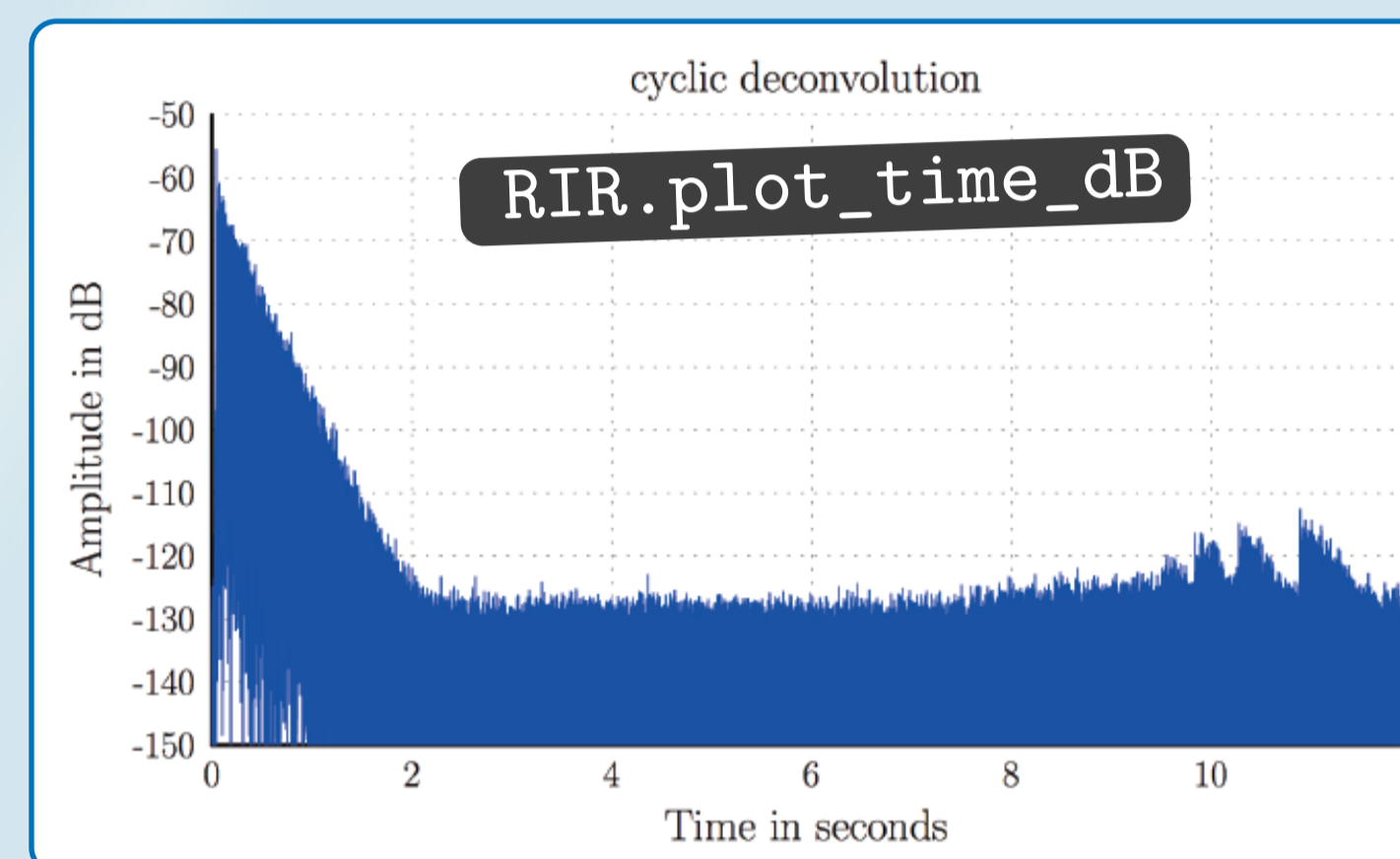
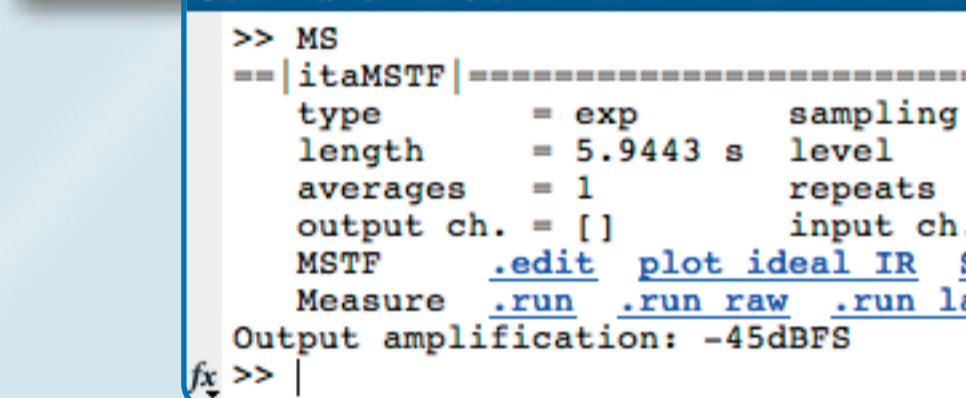
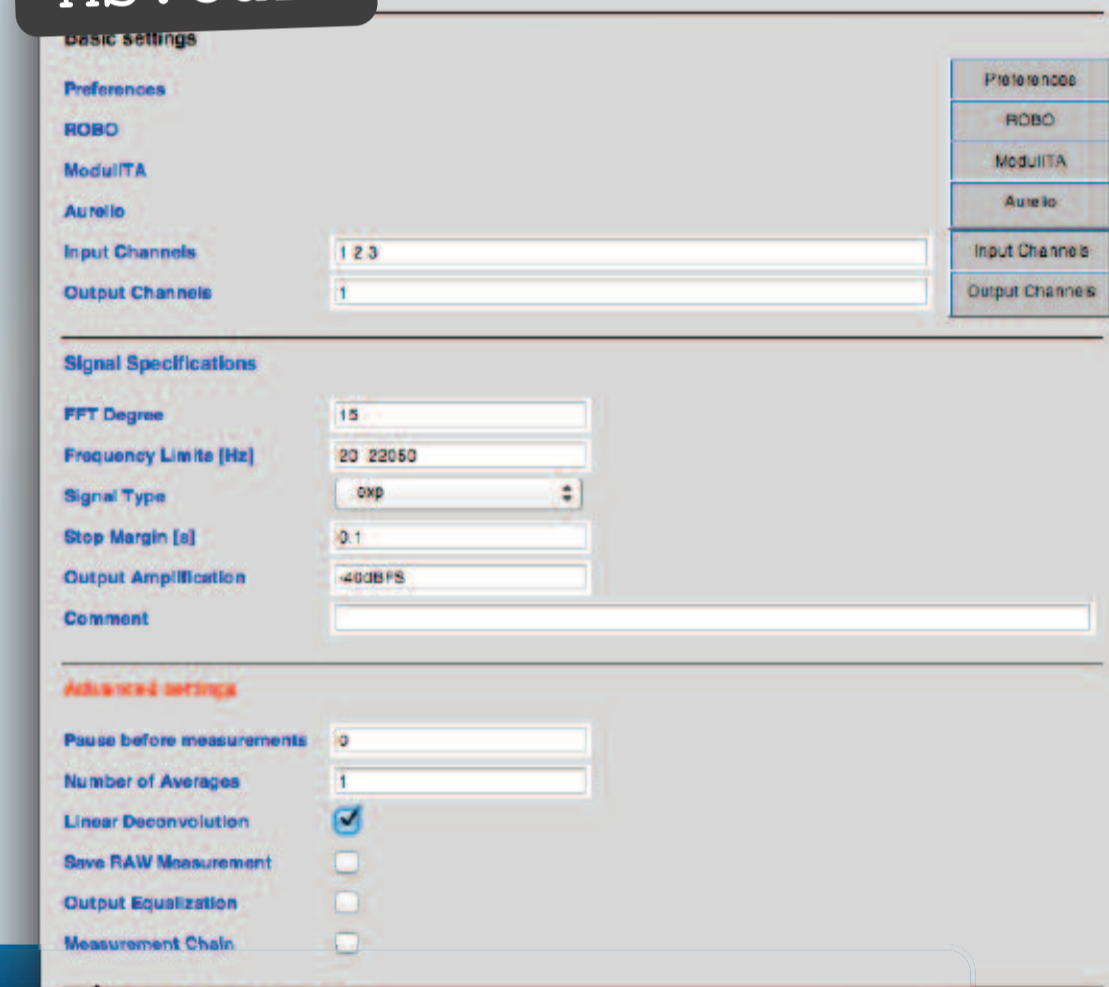
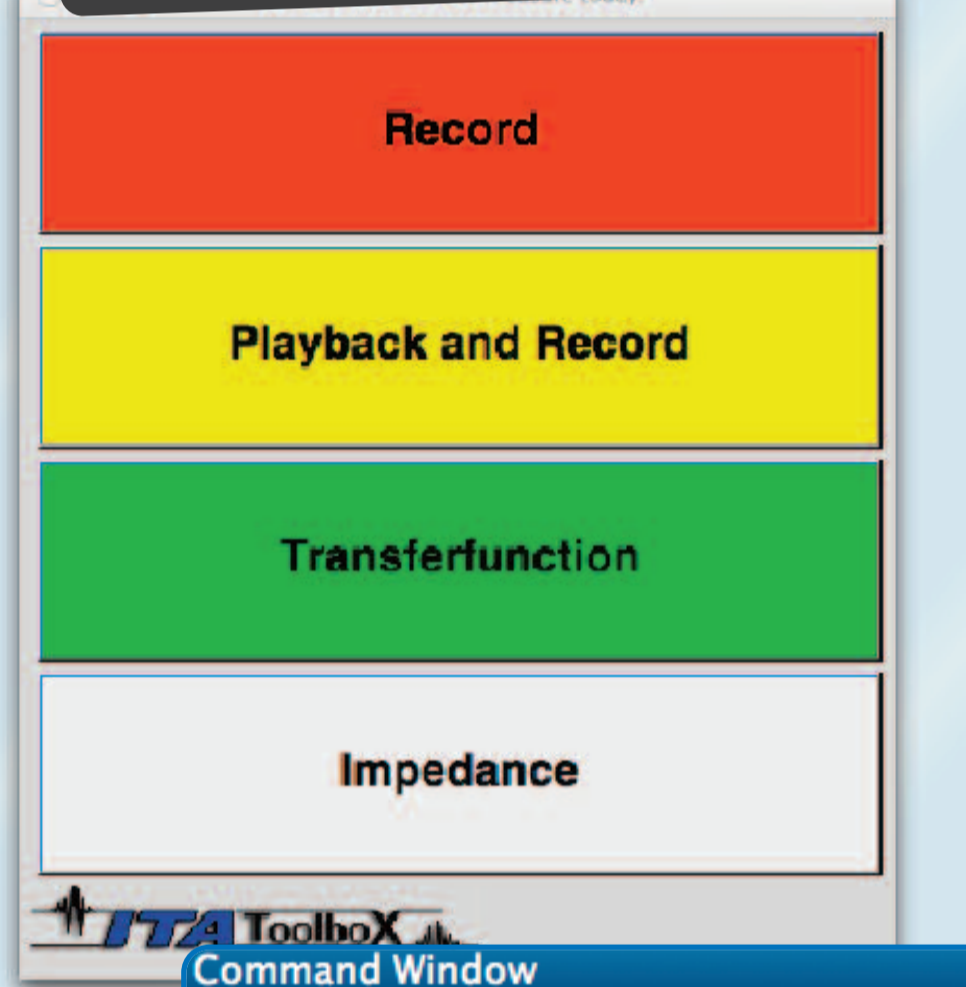
Types of Measurements

- Record signals with and without playback
- Correlation measurements with linear or exponential sweeps, noise, music, MLS
- Pre-emphasized excitation signal, e.g. based on equipment or background noise spectrum
- Different deconvolution and regularization techniques



MS = ita_measurement

MS.edit



Intelligent Measurement Objects

- Automatic post-processing, deconvolution and level compensation
- Automatic update of deconvolution after changes of signal type, length, frequency range
- Metadata, e.g. coordinates, comments, channel information is stored in audio object

References

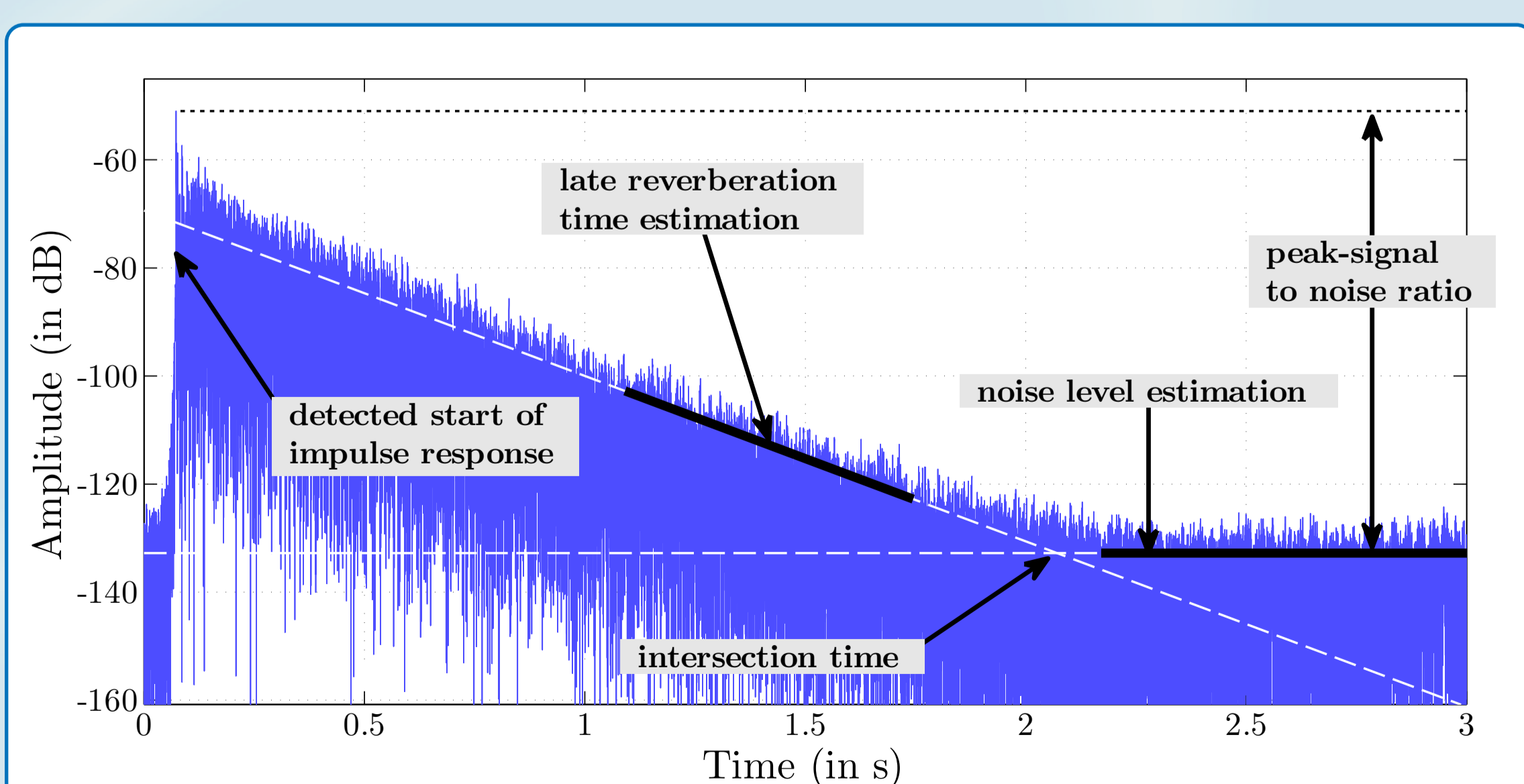
MÜLLER AND MASSARANI, *Transfer-Function Measurements with Sweeps*, JAES 2001
RIFE AND VANDERKOOY, *Transfer-Function Measurement with Maximum-Length Sequences*, JAES 1989
MAJDAK ET AL., *Multiple Exponential Sweep Method for Fast Measurement of Head-Related Transfer Functions*, JAES 2007
NOVAK, *Identification of Nonlinear Systems in Acoustics*, PhD thesis, Maine, France, 2009

Room Acoustics

ISO 3382 Evaluation Methods

- Based on measured or simulated impulse response
- Reverberation Times, Clarity Index, Definition, Center Time, based on SCHROEDER'S energy decay curve, Peak SNR, STI
- Automatic impulse response start detection
- ISO compliant fractional octave band filters
- Noise detection and compensation

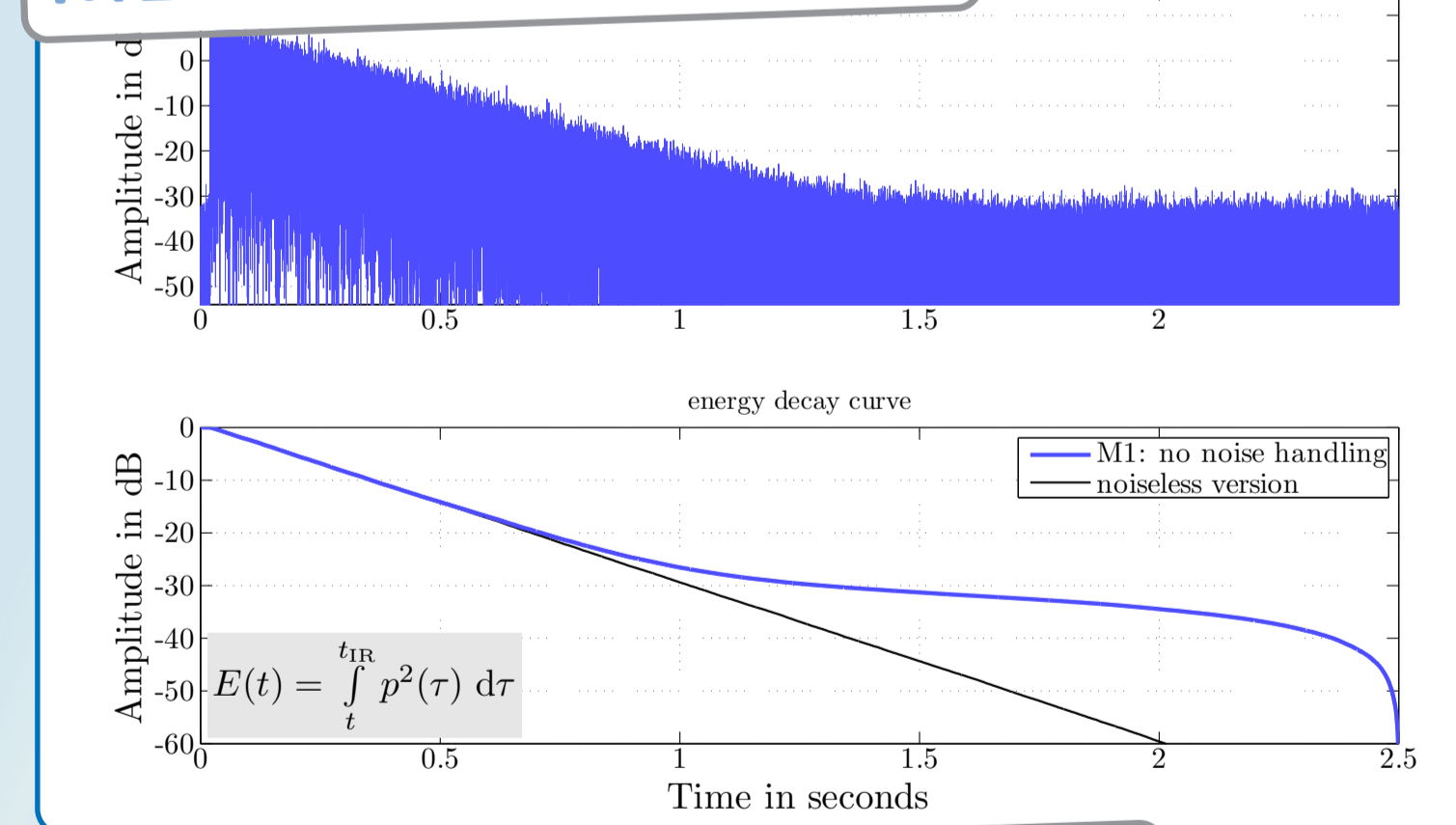
D_{50} C_{80}
 EDT
 T_{20} T_{30}
 STI



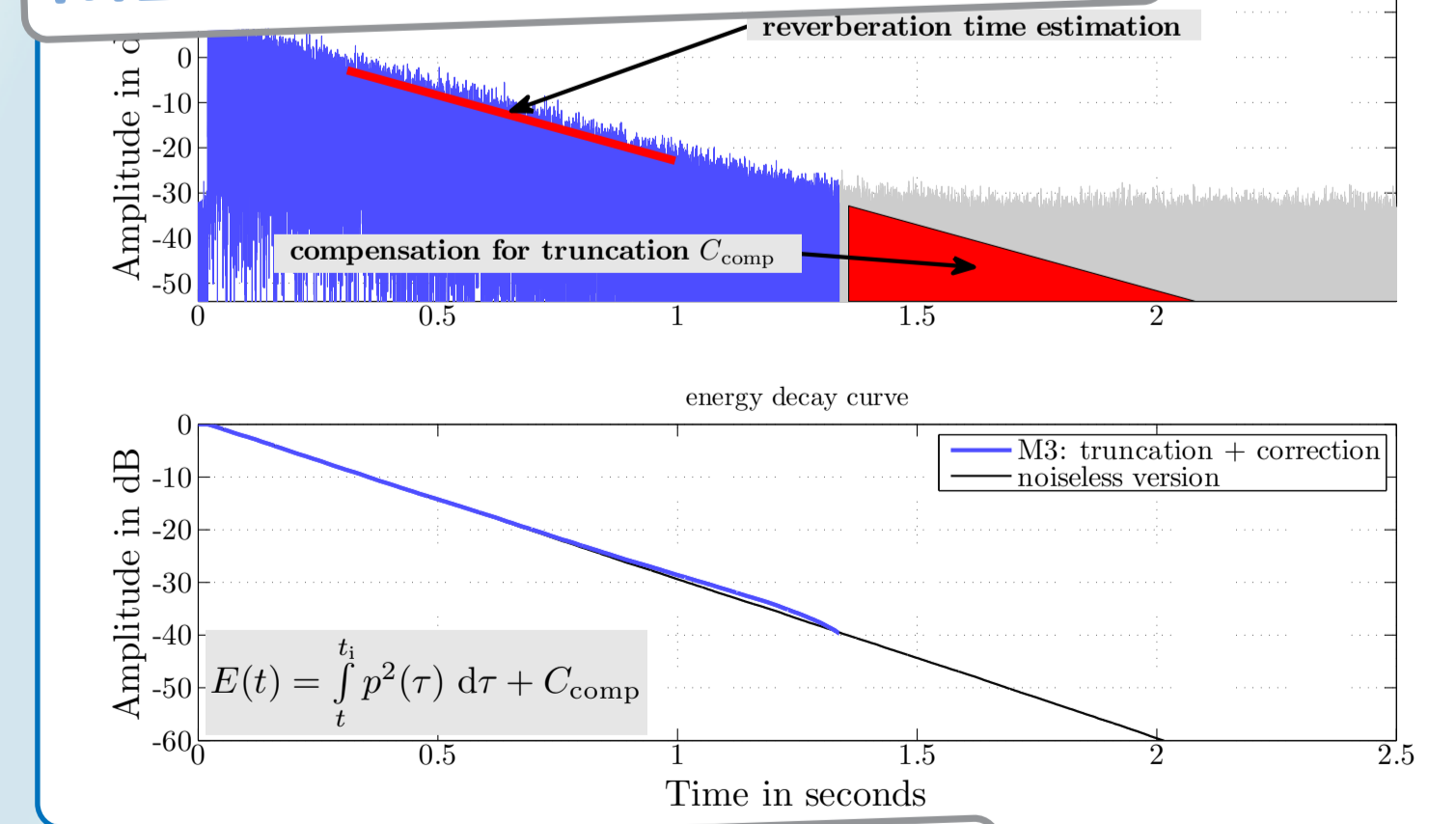
Noise Handling Methods

- LUNDEBY noise detect according to ISO 3382 and iterative detection of intersection time between impulse response and noise
- Different noise handling methods – three ISO 3382 methods (M1–M3) and two additional methods (M4–M5)

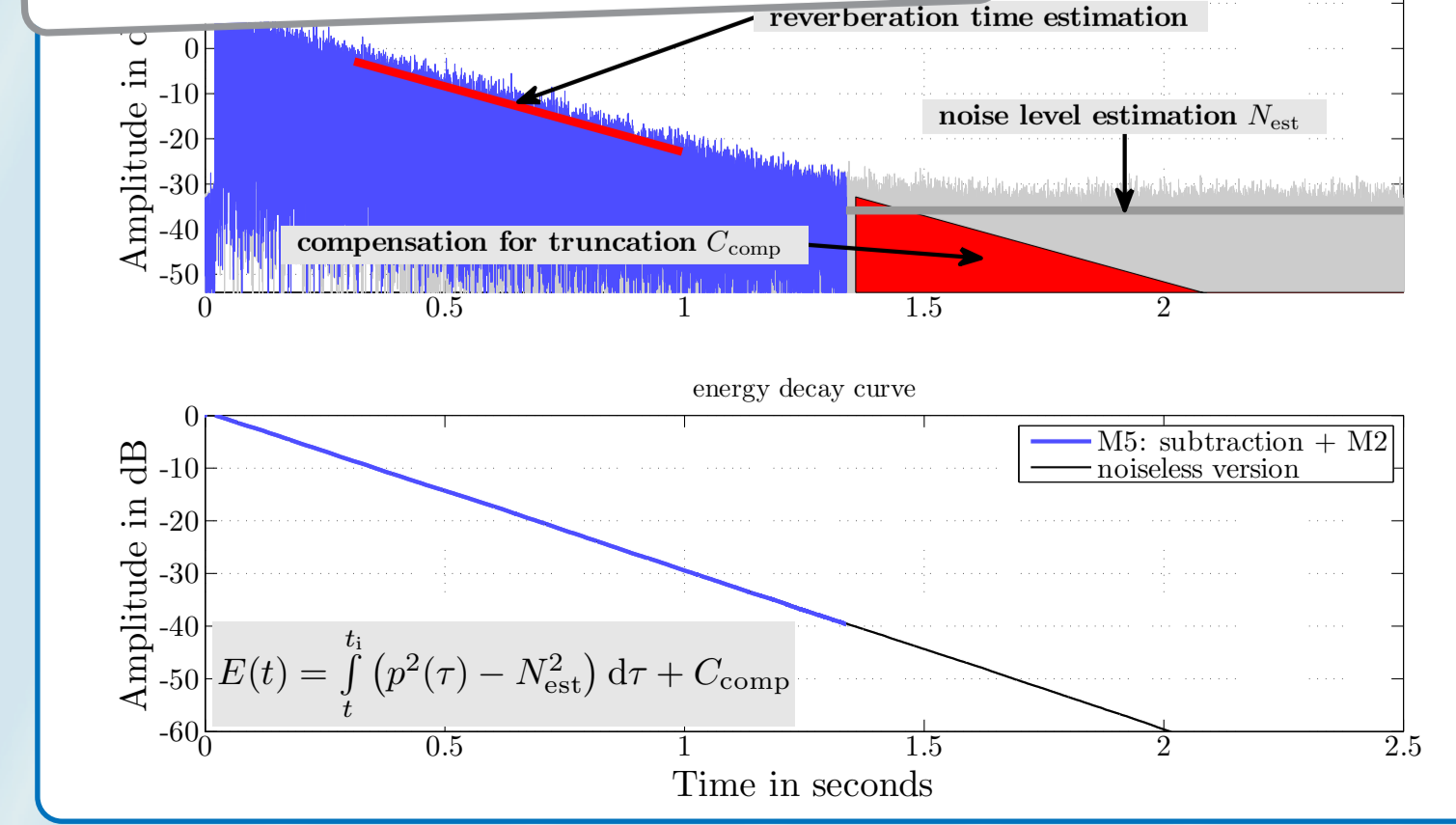
M1: no noise handling



M2: truncation+correction

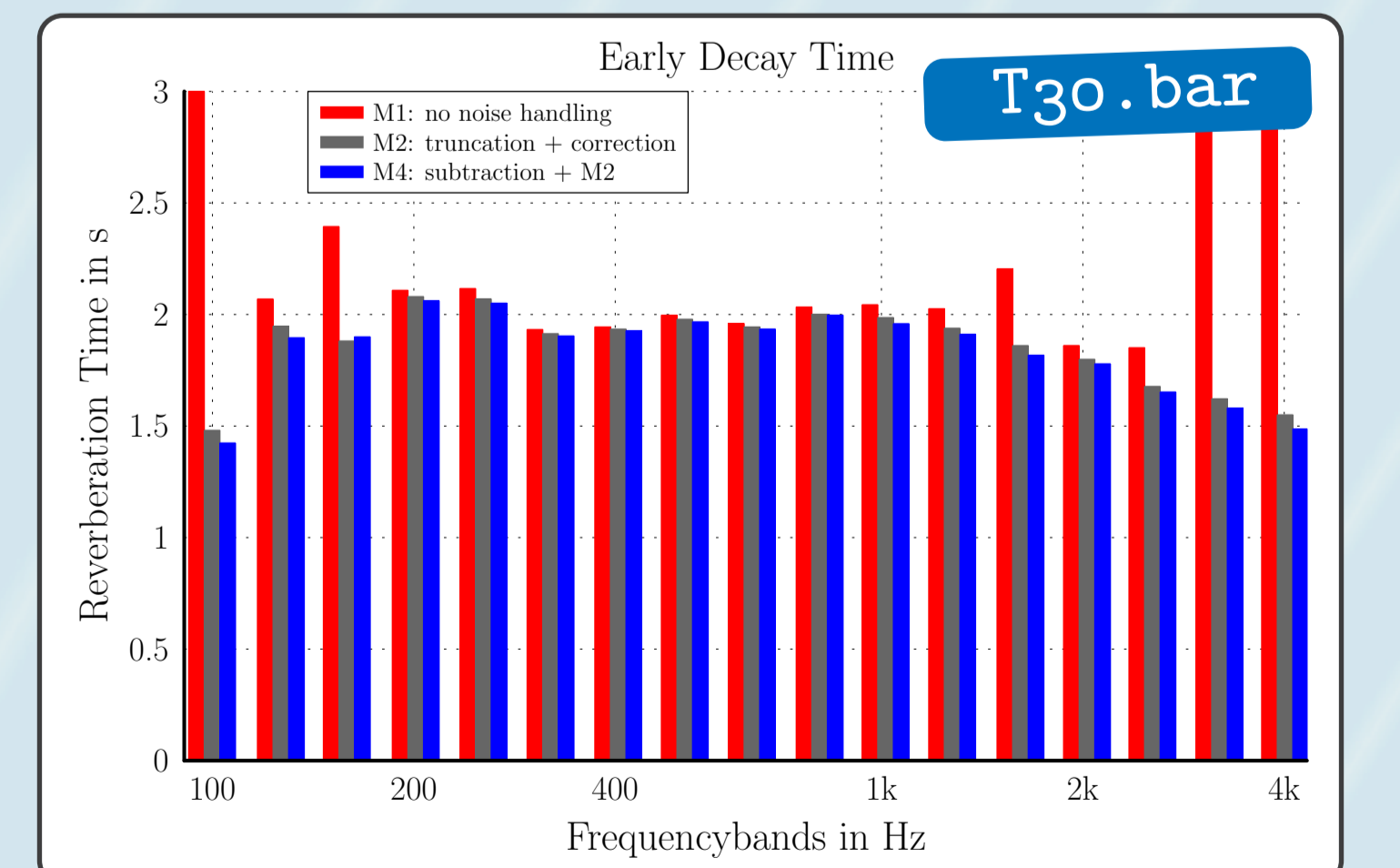


M4: subtraction + M2



Future Perspective / Application

- Implementation of spatial and binaural parameters, e.g. IACC, LF, etc.
- Investigation of uncertainty contributions with emulated measurement chain (SNR, non-linearities)
- Fully automatic evaluation scripts without user interaction and hence high repeatability
- Application in laboratory measurements



References

ISO 3382-1:2009, *Acoustics – Measurement of Room Acoustic Parameters – Part 1*, 2009
LUNDEBY ET AL., *Uncertainties of measurements in room acoustics*, Acta Acustica, 1995
GUSKI ET AL., *Measurement Uncertainties of Reverberation Time caused by Noise*, DAGA 2013
DIETRICH ET AL., *Influence of Loudspeaker Distortion on Room Acoustic Parameters*, DAGA 2013