Level balance between Self, Others and Reverb, and its significance to noise exposure as well as mutual hearing in orchestra musicians

by Magne Skålevik

This paper was presented at Euronoise 2015 in Maastricht

ABSTRACT

In order to gain more insight in ensemble issues as well as noise issues, it is proposed to analyze the sound at the ears of musicians in three components, namely the Dry Self, Dry Others and Reverb. Simulation in Odeon and several measurement series in different typical situations have been carried out during 2014. Dry Self represents 50-60% of the energy density at the ear of musicians in all situations investigated so far, except for violinists in individual rehearsal, where Dry Self represents approximately 80%. This means that commonly suggested noise and health measures in the musicians' acoustical environment is not effective, but instead are likely to more harm than good to ensemble conditions. Suggested balance parameters Foreground-Background-Balance and Dry-Reverb balance exhibit consistent results through changing situations. These are interesting features will be pursued in further work, as they could potentially tie together podium acoustics and rehearsal room acoustics. Click to go to full paper

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Magne Skålevik
Brekke & Strand, Oslo
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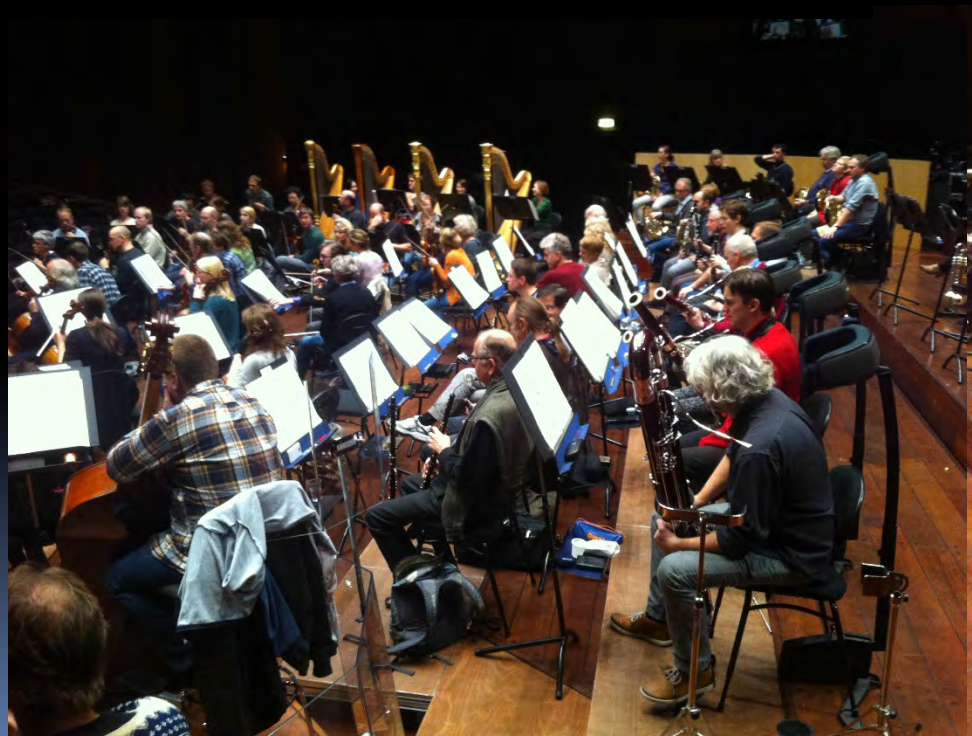
On noise exposure and mutual hearing in orchestra musicians

LEVEL BALANCE BETWEEN SELF, OTHERS AND REVERB

Euronoise 2015 Maastricht, Tuesday 2nd June 2015

Noise? – NO
Sound? - YES



Outline

- Sound components at orchestra musician's ear
- Simulations – violin in 4 different situations
- Measurements in orchestra musicians
- Corrective measures
- Conclusions

Sound at musician's ear

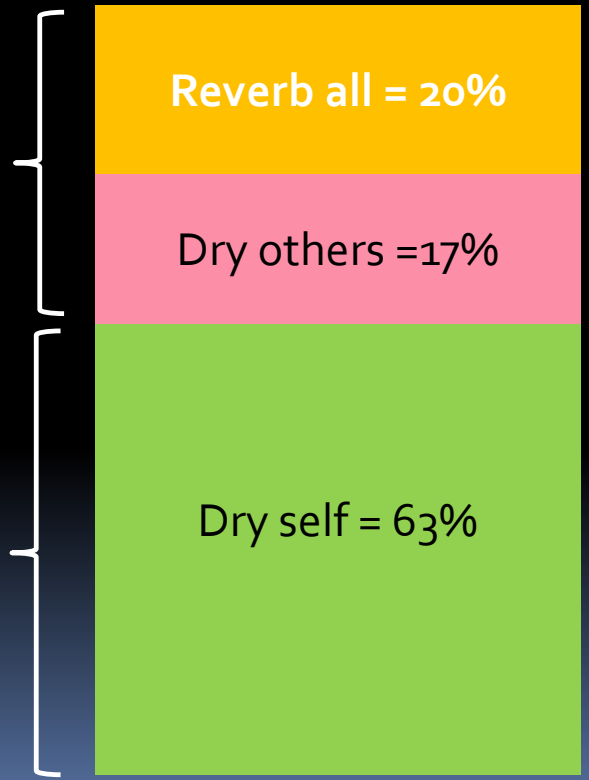
Total sound = Self + Others + Reverb

- Self = anechoic sound from own instrument
- Others = anechoic sound from other instruments
- Reverb = reverberant sound from all instruments

Components and Balance

Component	Foreground-Background-Balance Components	Dry-Reverb-Balance Components
Self	Foreground	Dry
Others	Background	
Reverb		Reverb

Components' energy fractions example



BACKGROUND = -4dB

FOREGROUND = -2dB

REVERB = -7dB

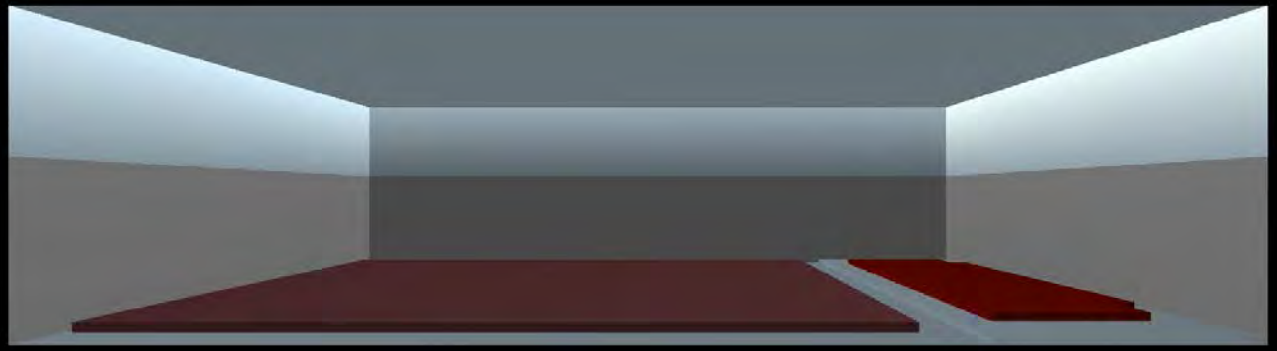
DRY = -1dB

Foreground-Background = +2dB

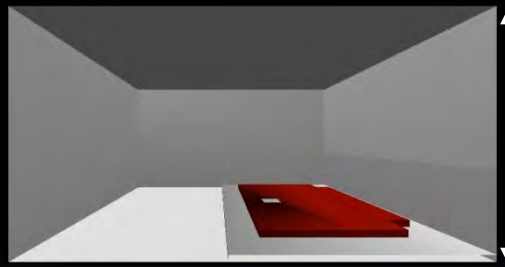
Dry - Reverb = 6dB

Significance of Components and Balance

- To a musician, Self, Others and Reverb could be
  - Important information (Signal)
  - Masker (Noise)
  - Harmfully loud
  - Harmless
- Self, Others and Reverb play ALTERNATING ROLES as Signal and Masker
- Level balance and prominent sound components
  - Crucial when choosing any correcting measures
- Poor Balance can drive musicians to play HARDER
  - Long term escalating effect



Concert Hall,
height=18m



Rehearsal Studio,
height=14m

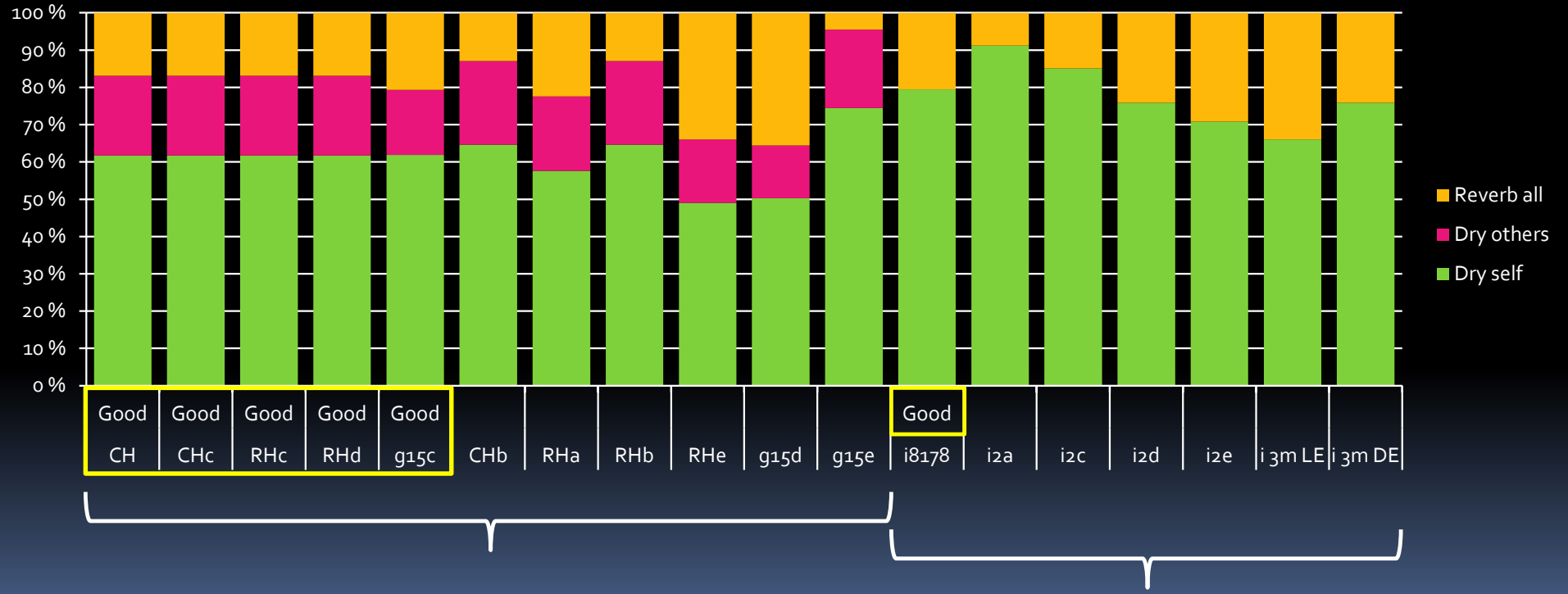
Group rehearsal room
height=5.0m

Individual rehearsal room
height=2.5-2.7m

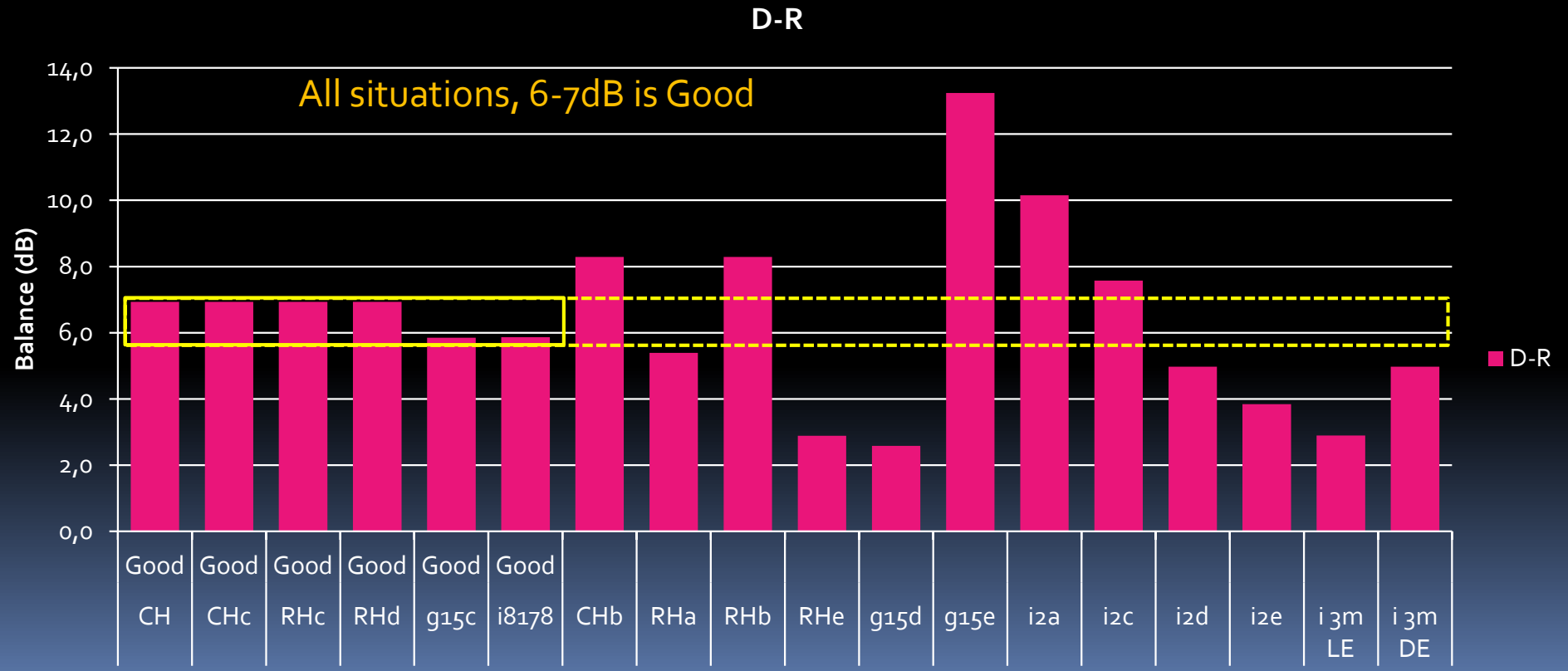
4 Odeon models
4 situations

in the orchestra musician's daily life

Simulated 4 situations violin



Dry-Reverb Balance Violin



Measurements in-ear

- Self, Others and Reverb calculated from measurements

T=0.4
G_r=25

Small rehearsal room

T=0.7
G_r=15

Big rehearsal room

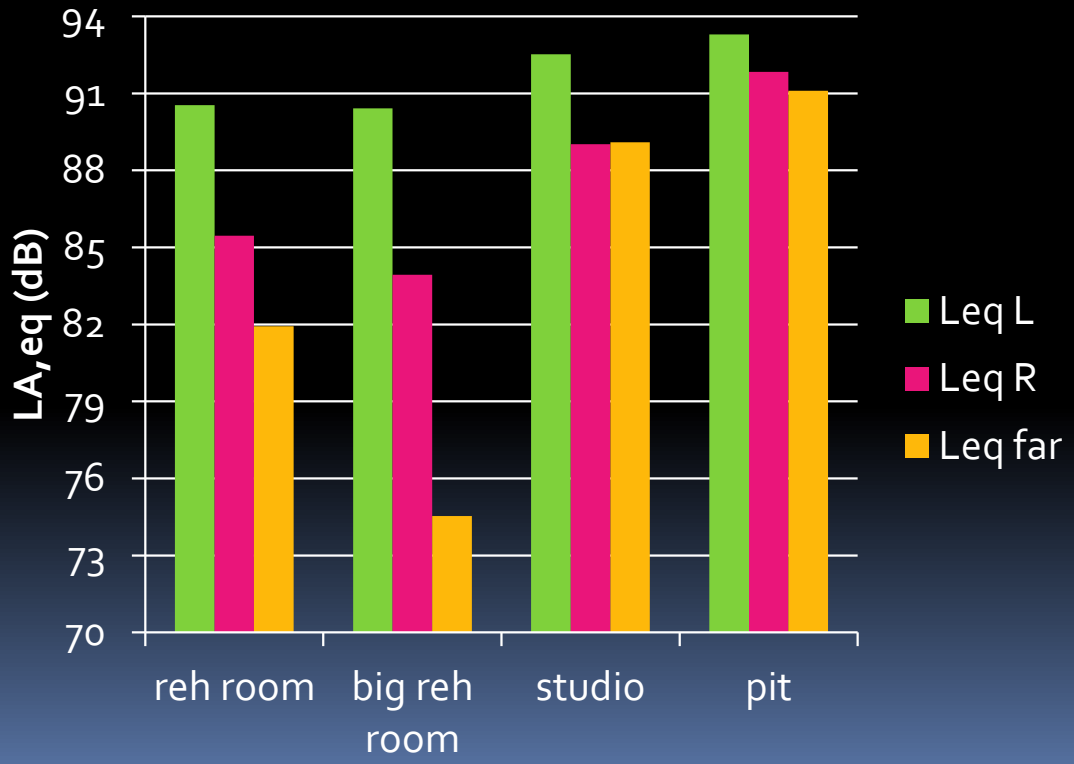
T=1.0
G_r=8

Orchestra Rehearsal Studio

T=2.1
G_r=6

Opera House Orchestra Pit

At ear $L_{A,eq}$ (216s at ff)

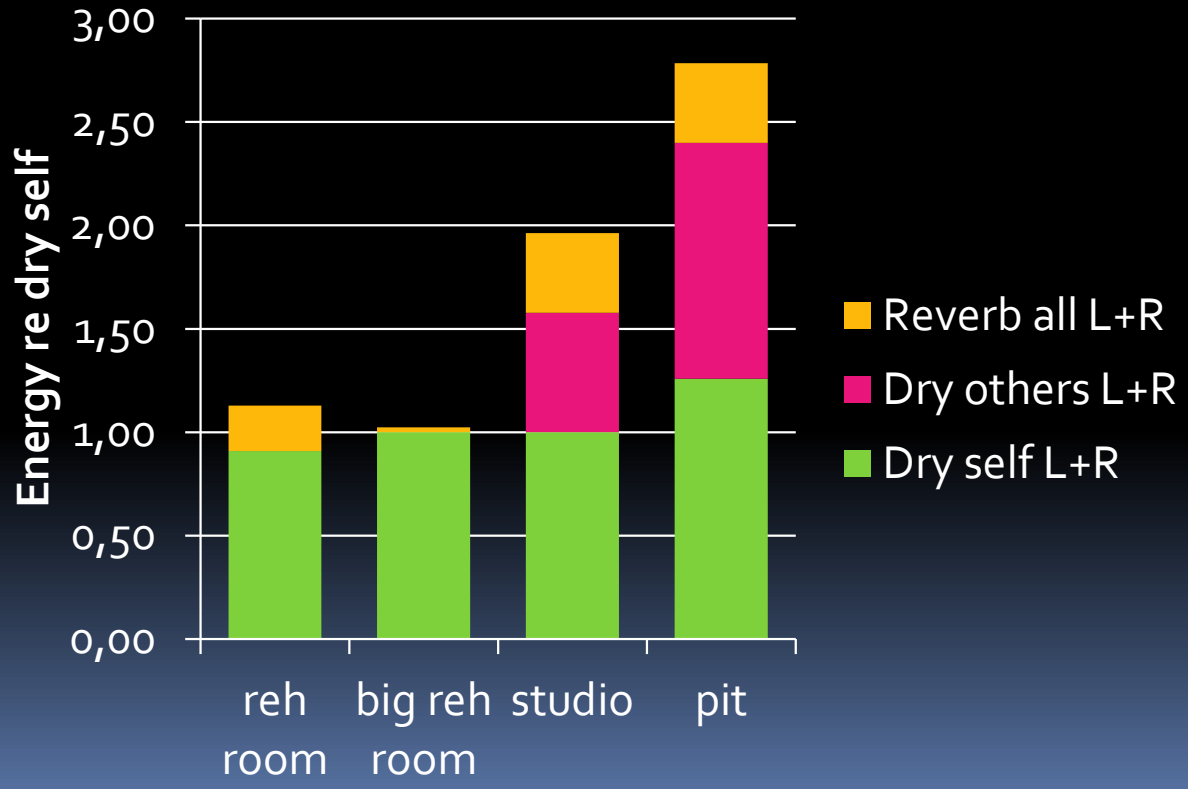


L = Left ear canal entrance
R = Right ear canal entrance

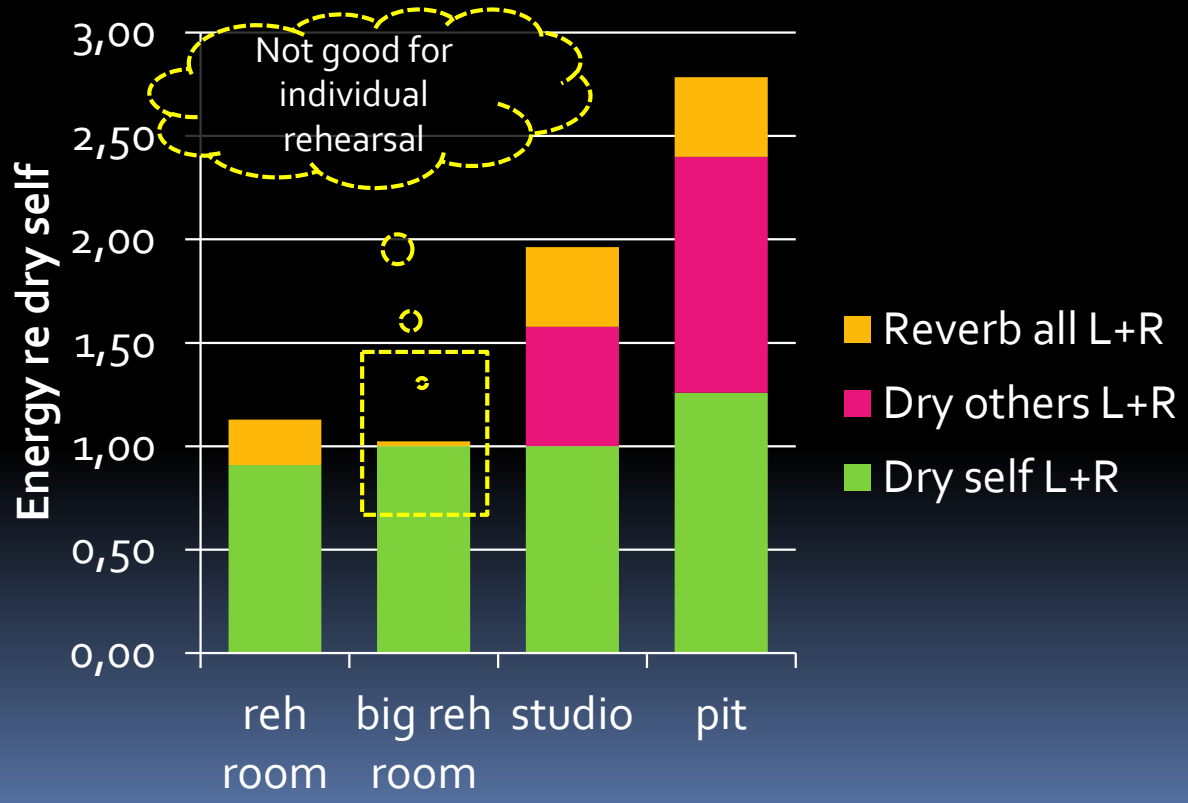
far = behind the back, i.e. screened from own instrument

3 ff parts, total duration 216s, Tchaikovski Swan Lake

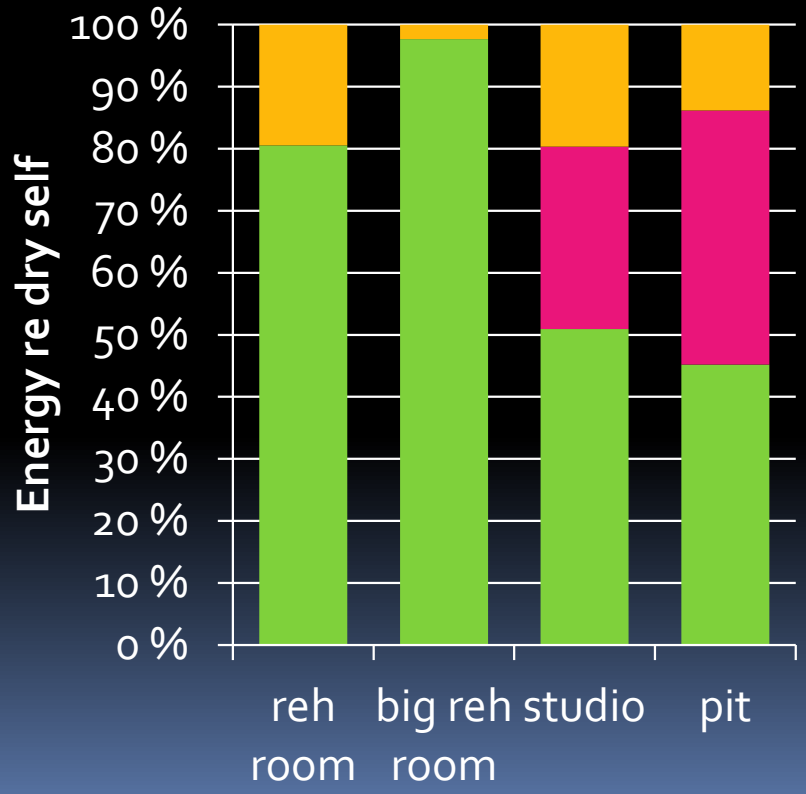
Analysis: energy re self



Analysis: energy re self

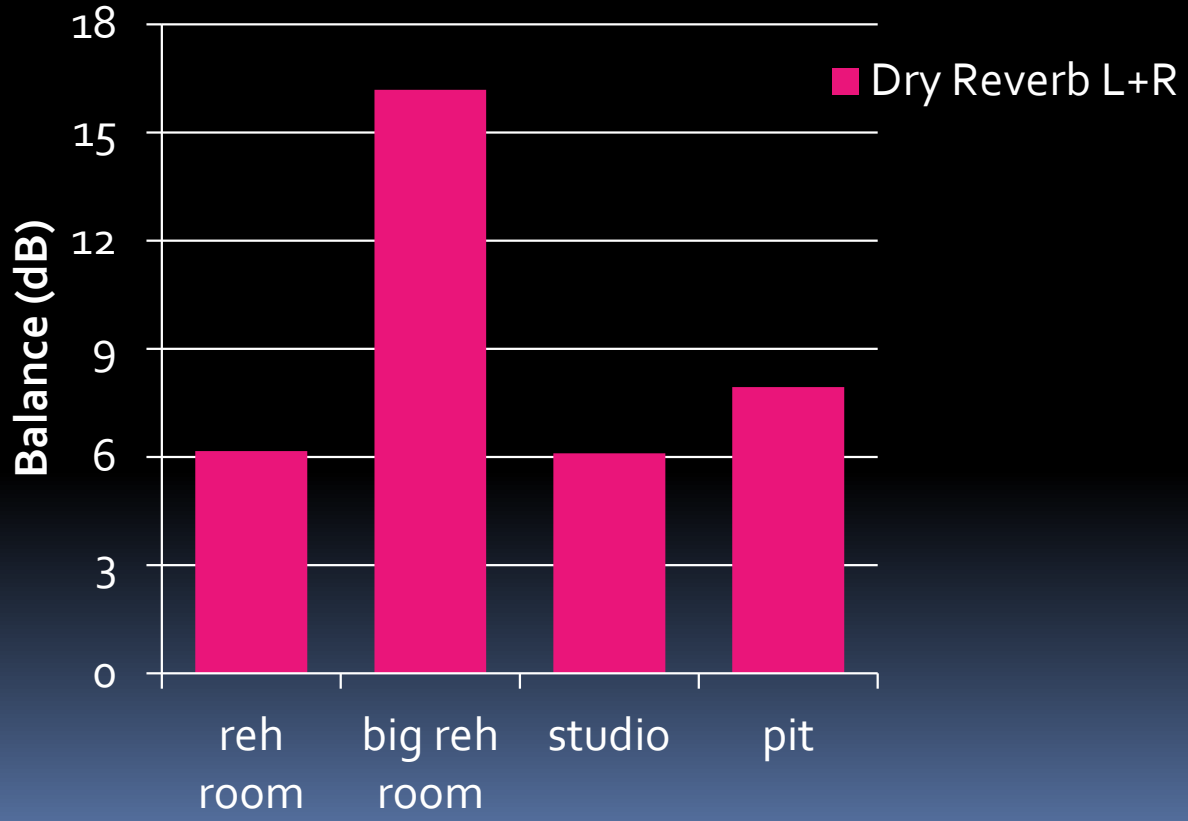


Analysis: energy fractions



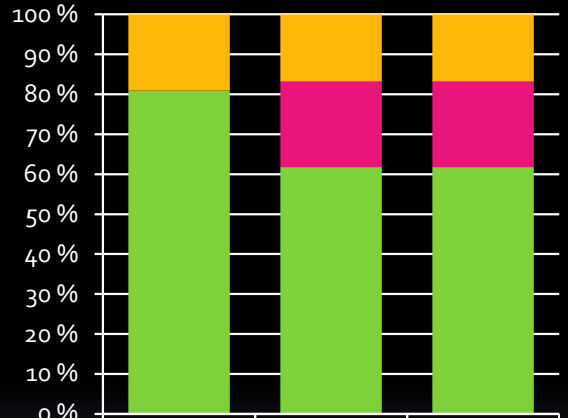
Reverb fraction appears to be consistent
-while self and others alternates in the dry part

Dry-Reverb Balance, Violin



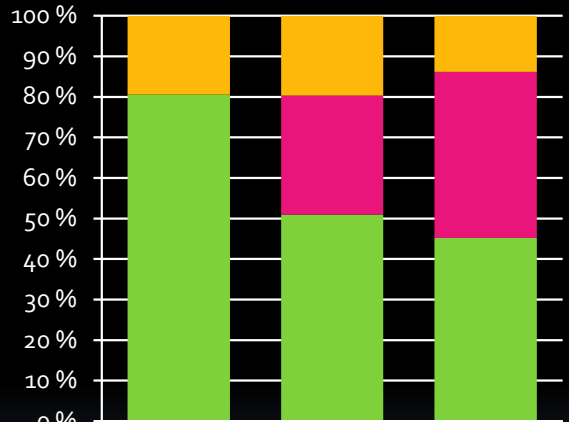
Violin: Rehearsal and Performance

Simulation - Odeon



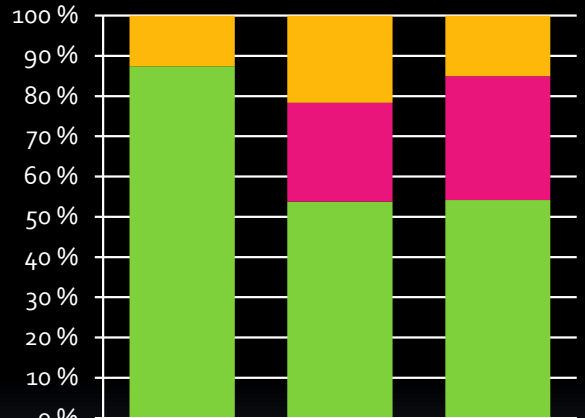
	Reh room	Studio	Stage
reverb	19%	17%	17%
dry others	0%	21%	21%
dry self	81%	62%	62%

Swan Lake



	Reh room	Studio	Pit
reverb	19%	20%	14%
dry others	0%	29%	41%
dry self	81%	51%	45%

Beethoven 5th

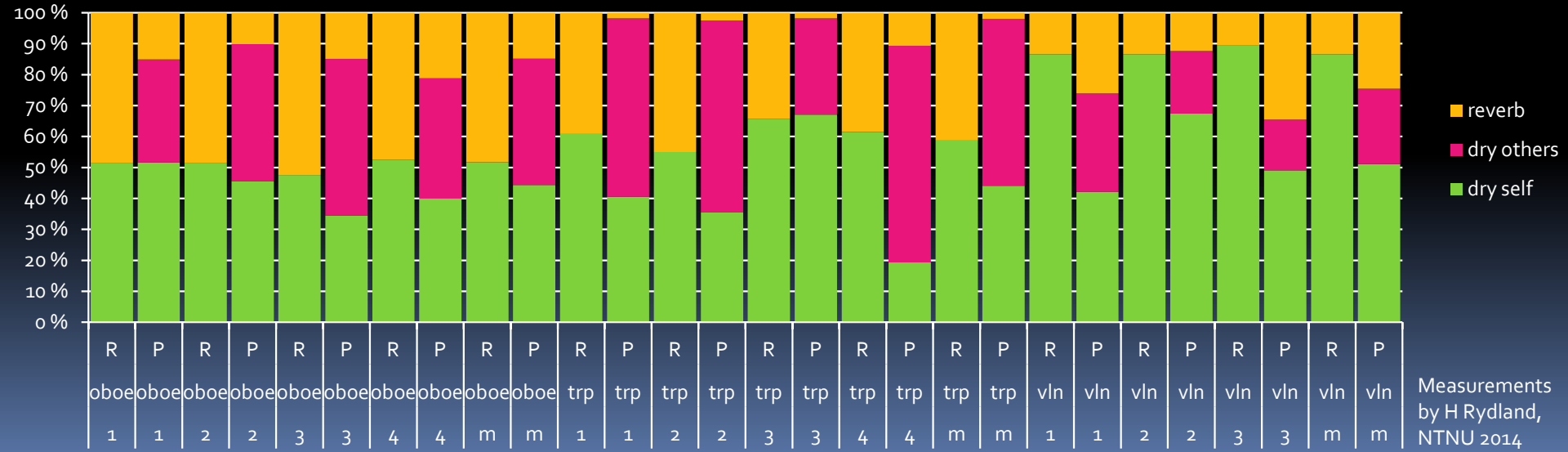


	Reh room	Studio	Stage
reverb	13%	22%	15%
dry others	0%	25%	31%
dry self	87%	54%	54%

Long time average 219 s 420 s

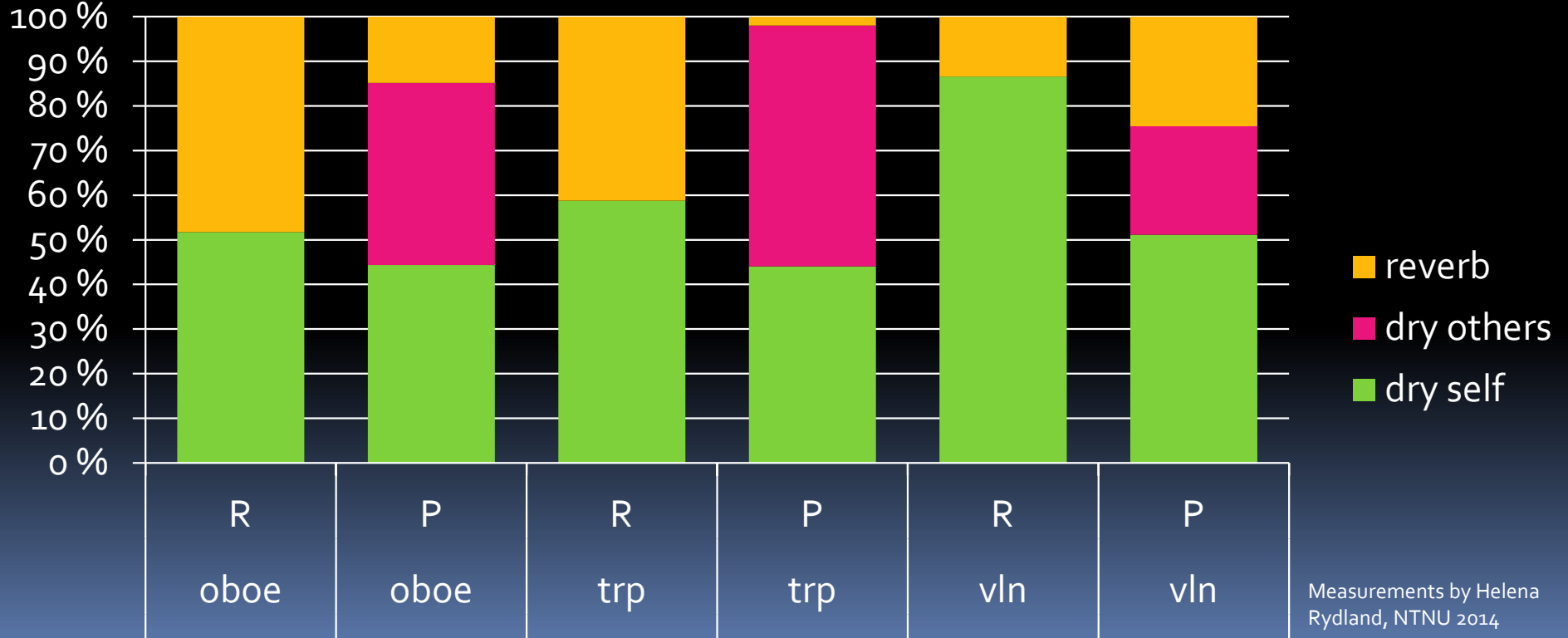
Rehearsal and Performance

Oboe Trumpet Violin



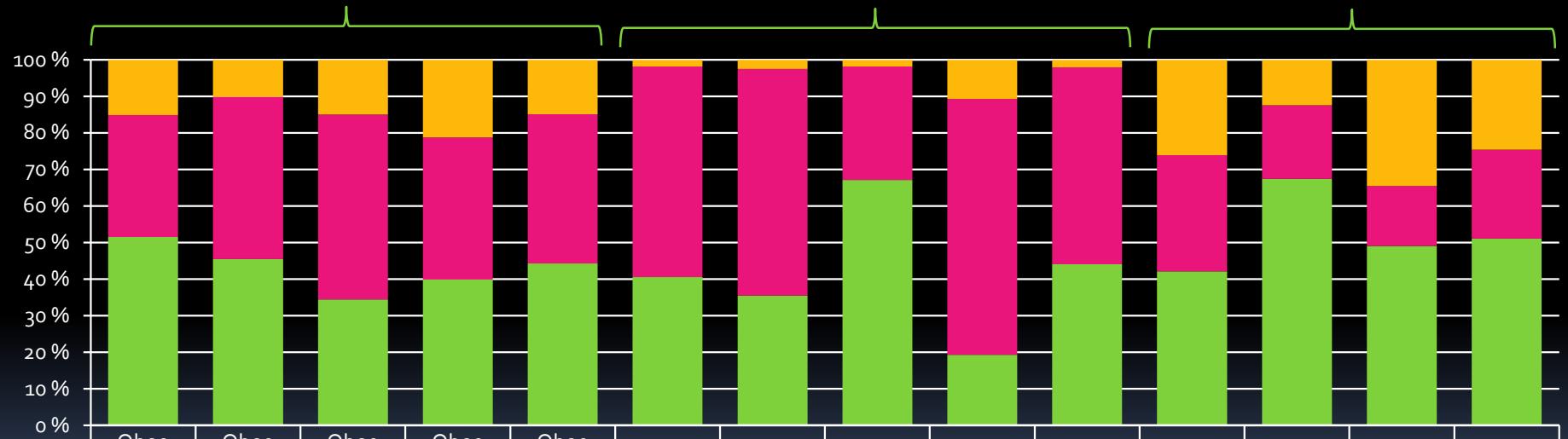
Measurements by H Rydland, NTNU 2014

Oboe, Trumpet, Violin averages: Rehearsal (R) and Stage Performance (P)



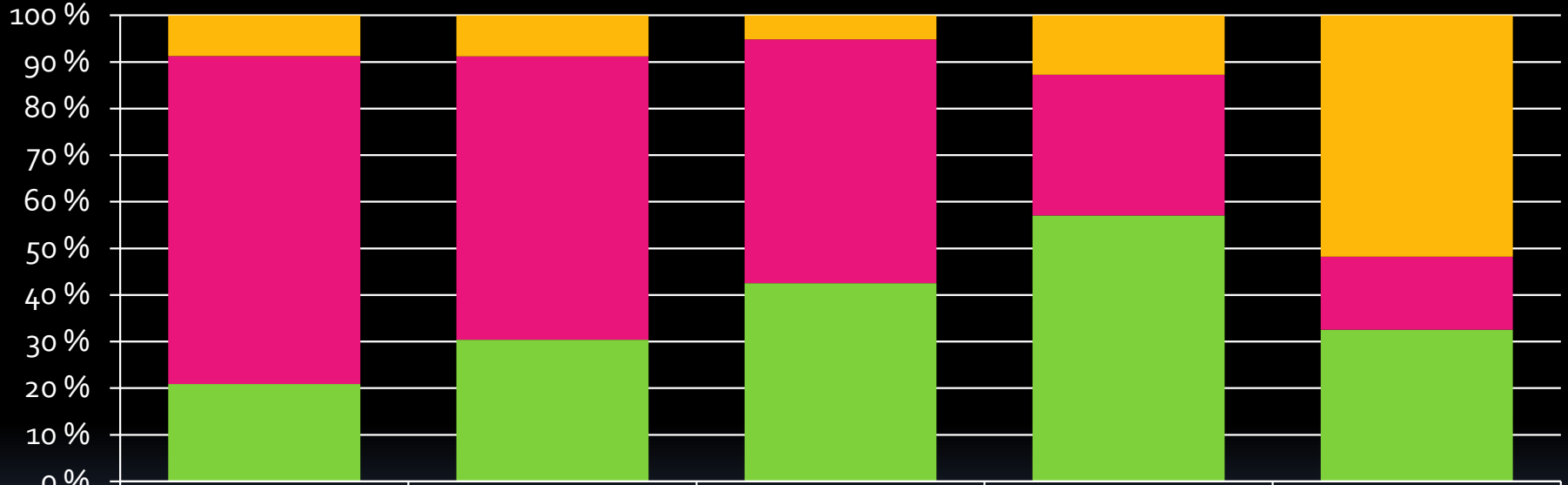
Measurements by Helena Rydland, NTNU 2014

Stage performance, 3-4 takes and mean



	Oboe Stage 1	Oboe Stage 2	Oboe Stage 3	Oboe Stage 4	Oboe Stage m	Trp Stage 1	Trp Stage 2	Trp Stage 3	Trp Stage 4	Trp Stage m	Vln Stage 1	Vln Stage 2	Vln Stage 3	Vln Stage m
reverb	15%	10%	15%	21%	15%	2%	2%	2%	11%	2%	26%	12%	35%	25%
dry others	33%	44%	51%	39%	41%	58%	62%	31%	70%	54%	32%	20%	16%	24%
dry self	52%	45%	34%	40%	44%	41%	36%	67%	19%	44%	42%	67%	49%	51%

From measurements w/wo Others, concert hall

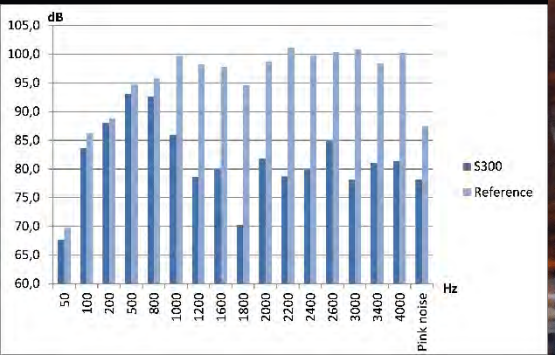


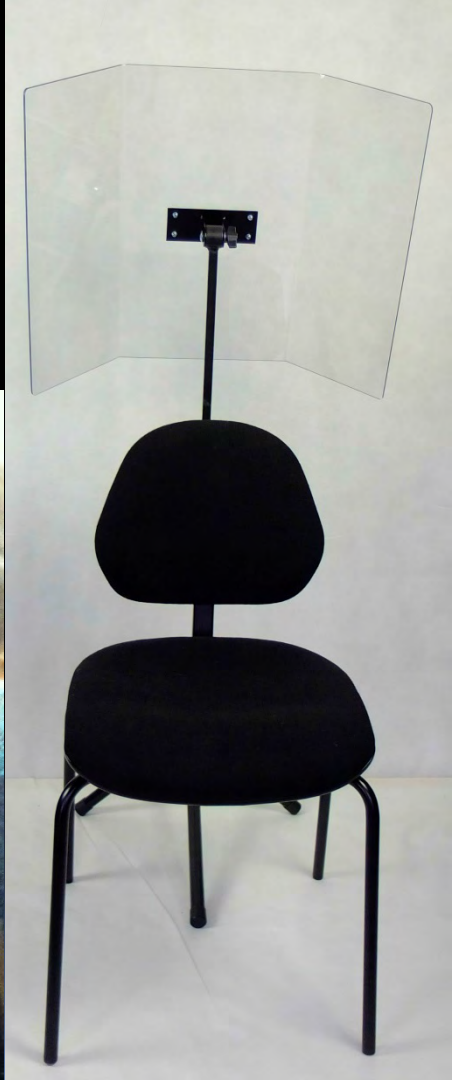
	Oboe Brahms N=3	Oboe Ravel N=4	Trumpet Ravel N=5	Violin misc N=5	Cello misc N=3
Reverb	9%	9%	5%	13%	52%
Others	70%	61%	52%	30%	16%
Self	21%	30%	43%	57%	33%

Measurements by Helena Rydland, NTNU 2015

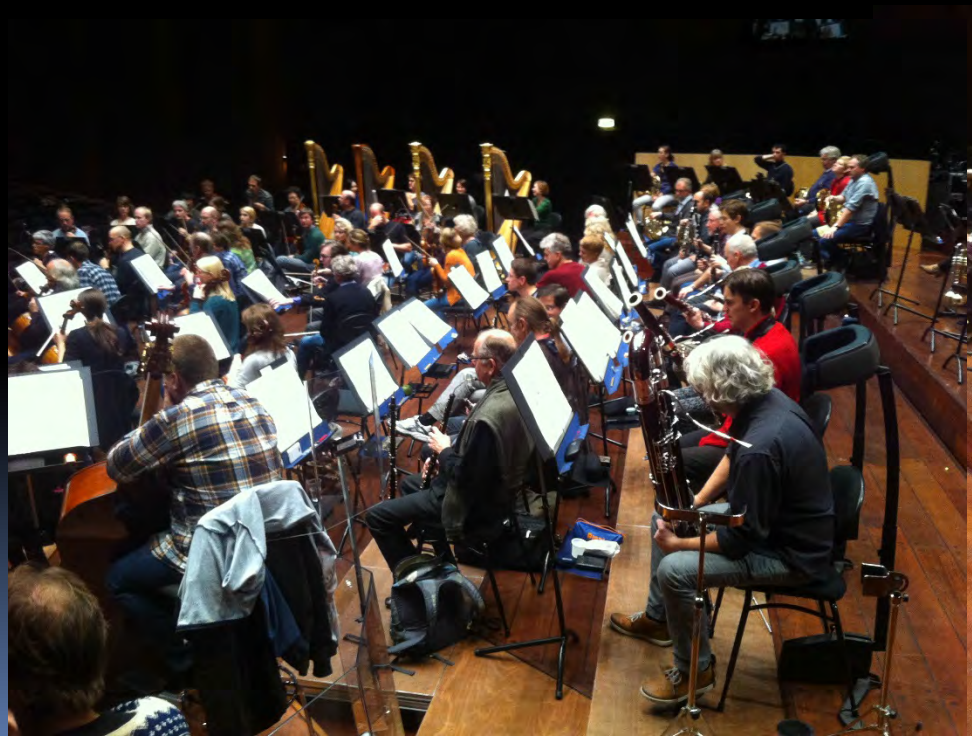
Invisible sound shield

Provide better Foreground-Background-Balance





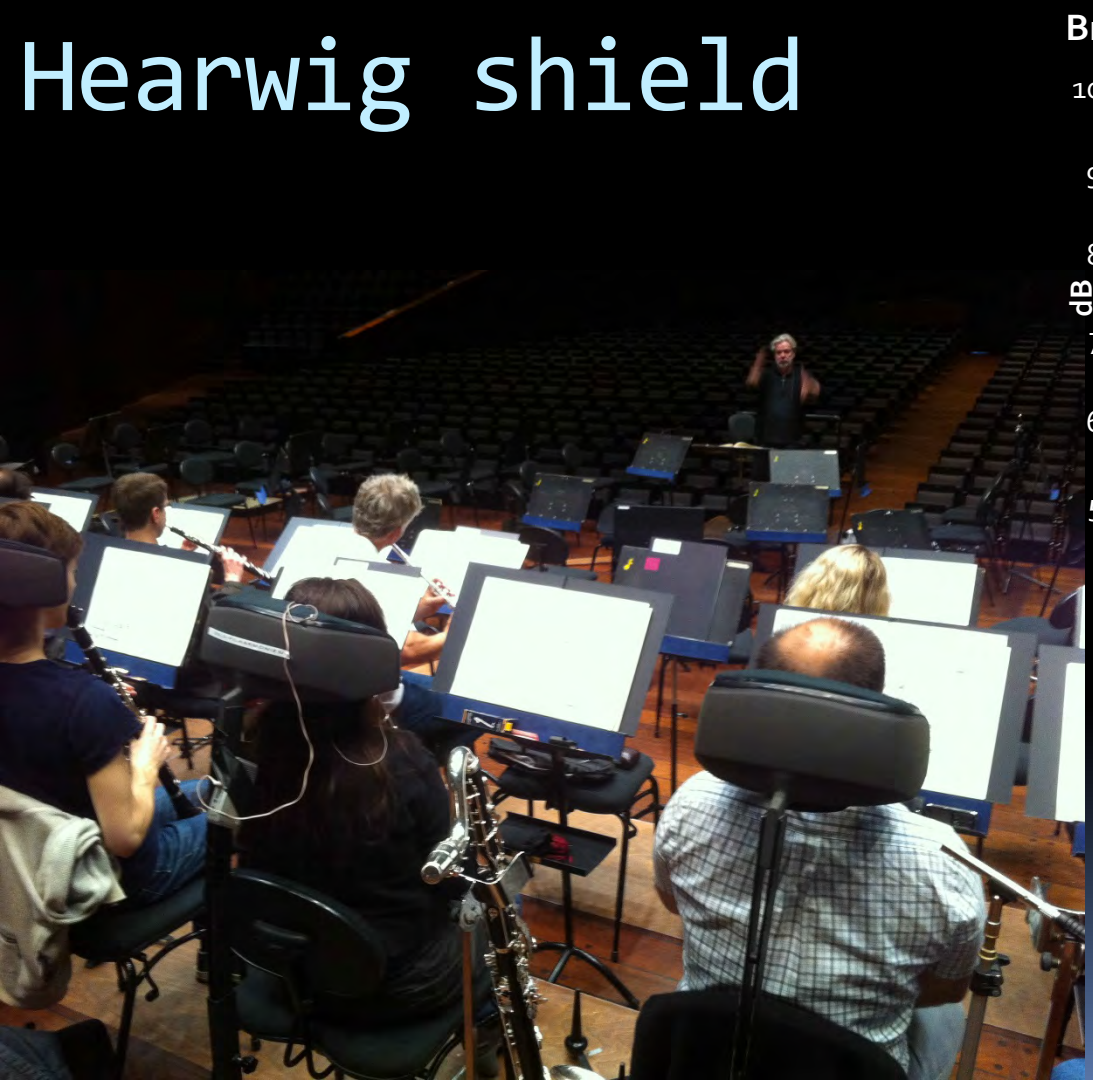
Sound shield for Brass protection



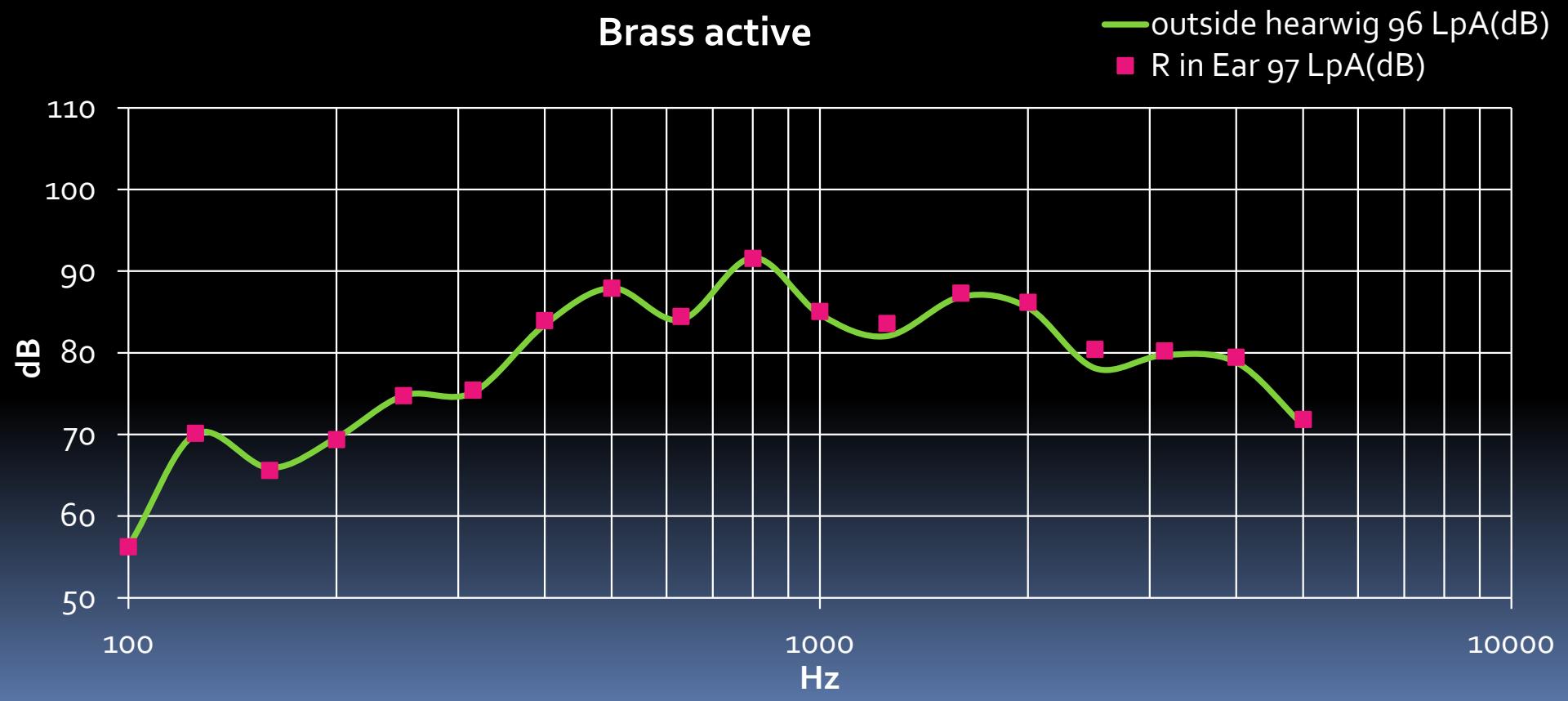
Sound shield for Brass protection

Improving Foreground-Background-Balance
But not reducing exposure level (How come?)

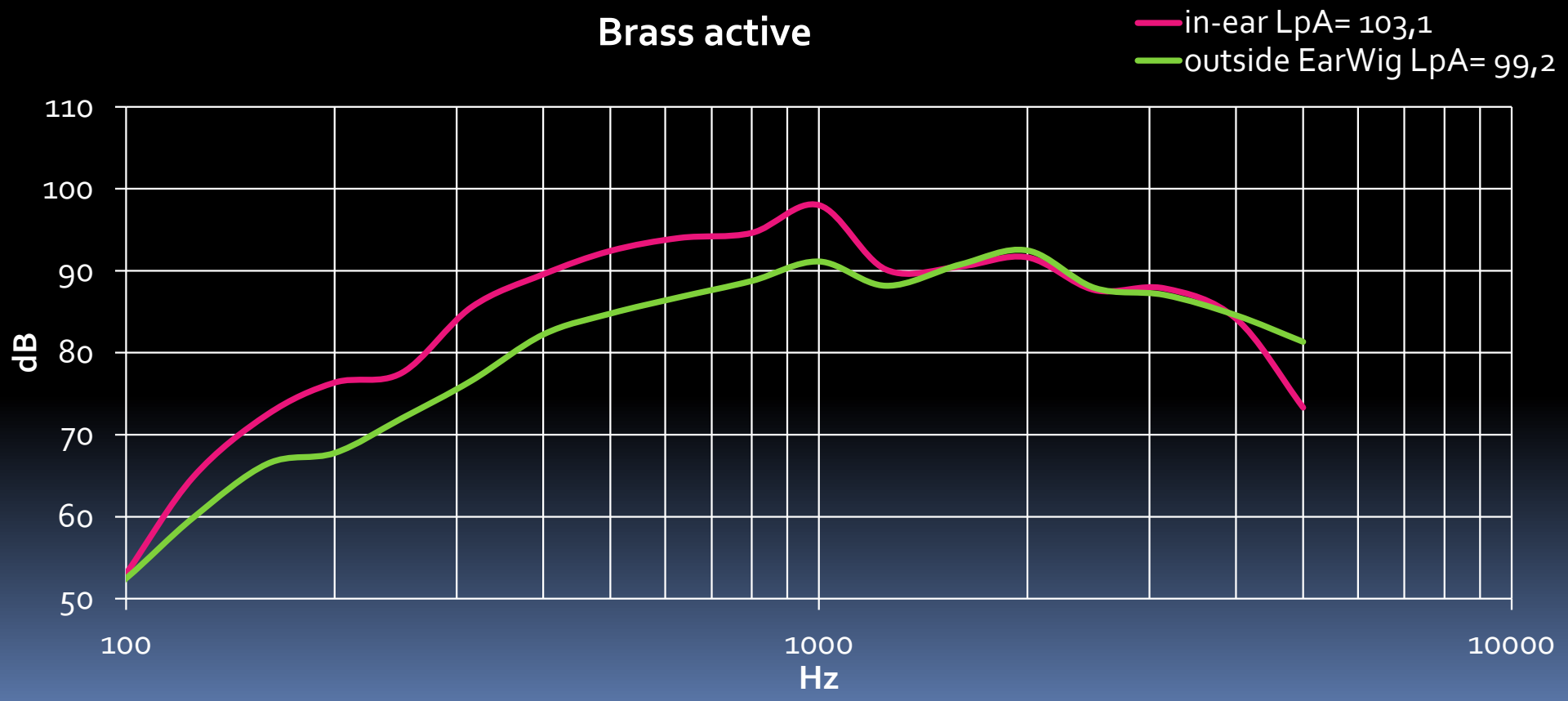
Hearwig shield



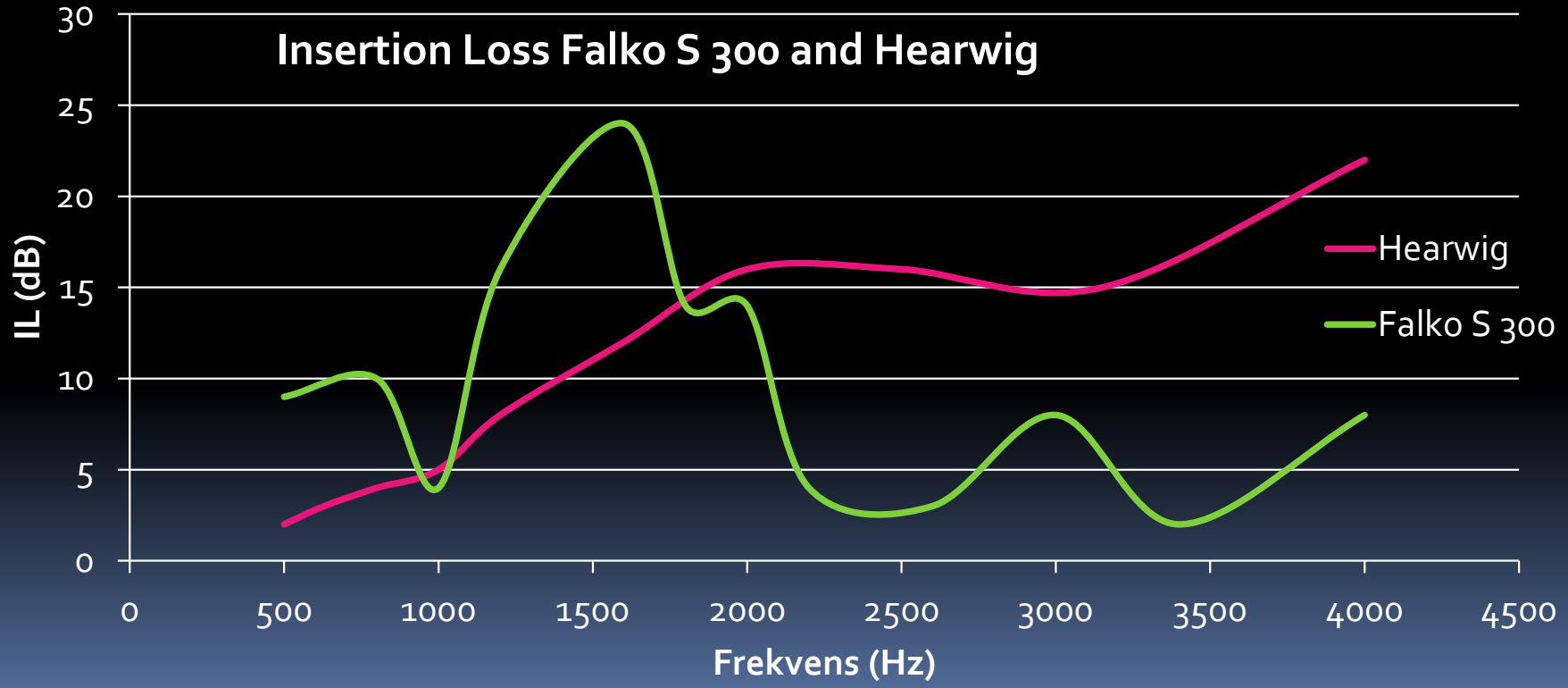
Passive, shielded clarinet player



Active, shielded clarinet player



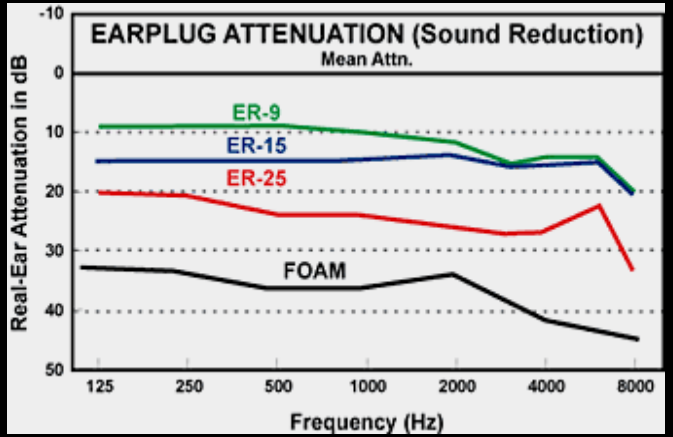
Sound shields, Insertion Loss, lab-data



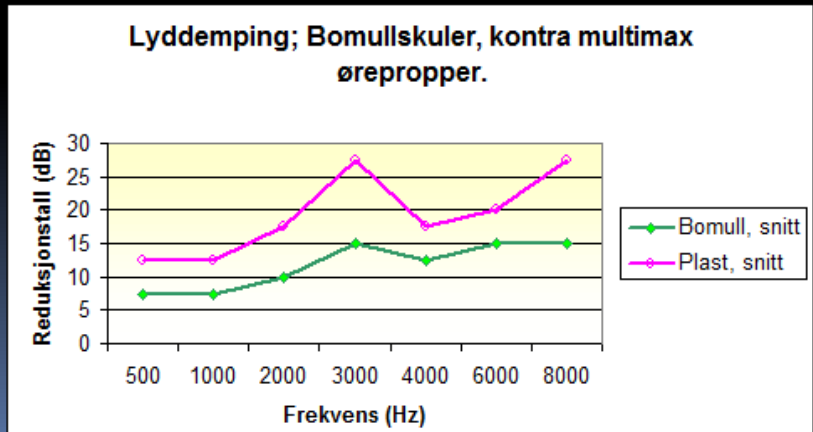
Ear plugs

Who to protect?	Harmful Source:	ER•9	ER•15	ER•25
Small strings	Own instrument, other strings	•	•	
Large strings	Brass	•	•	
Woodwinds	Brass, percussion		•	
Brass	Own instrument, other brass		•	•
Flutes	Percussion		•	
Percussion	Own instruments, other percussion		•	•

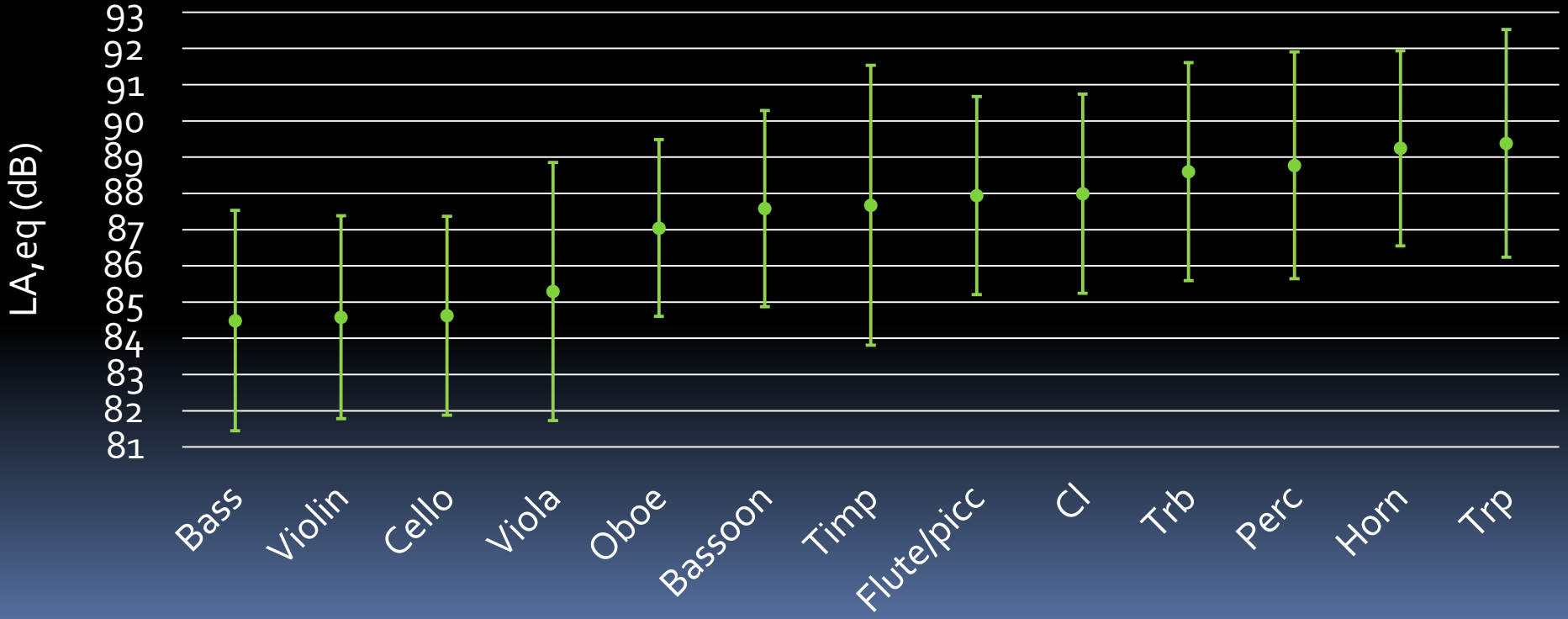
Etymotic 9dB, 15dB, 25dB



Multimax and cotton ball (custom)



4000+ hours of dosimetry, μ and σ , Queensland / O'Brien 2004-2007



Conclusions

- Self, Others and Reverb have been defined
  - Simulations and measurement examples presented
- Relevant for artistic and hearing issues
  - In rehearsal as well as performance situations
- Self-fraction and balance varies with instrument type
  - Due to ear-to-instrument distance *r'* and orchestral neighbourhood
  - Strong Self-fraction seen in violin due to small *r'* and quiet neighbourhood
- Key data should be collected in large amounts
- There are measurement technical issues
- Sound shields alter balance but not exposure
- Ear plug attenutation should not be exessive
- Future work to include more instruments and statistic analysis

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Thank you

More info?

The www center for search, research and open sources in acoustics

www.akutek.info

magne.skalevik@brekkestrand.no

More free sharing in acoustics available on www.akutek.info

Related papers:

Sound exposure and the hearing of musicians by Dance and Dymock

The influence of Room Acoustic Aspects on the Noise Exposure of Symphonic Orchestra Musicians by Wenmaekers and Hak

A Model for the prediction of Sound Levels within a Symphonic Orchestra based on measured Sound Strength by Wenmaekers and Hak

Noise exposure of musicians: The own instrument's sound compared to the sound from others (paper) (presentation) by Wenmaekers and Hak

Level balance between Self, Others and Reverb, and its significance to noise exposure as well as mutual hearing in orchestra musicians (paper) (presentation) by M Skålevik

Rehearsal room acoustics for the orchestra musician, by M Skålevik

Consistency in music room acoustics (paper) (presentation) by M Skålevik

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