BNAM2012

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BREKKE STRAND

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Music Room Acoustics

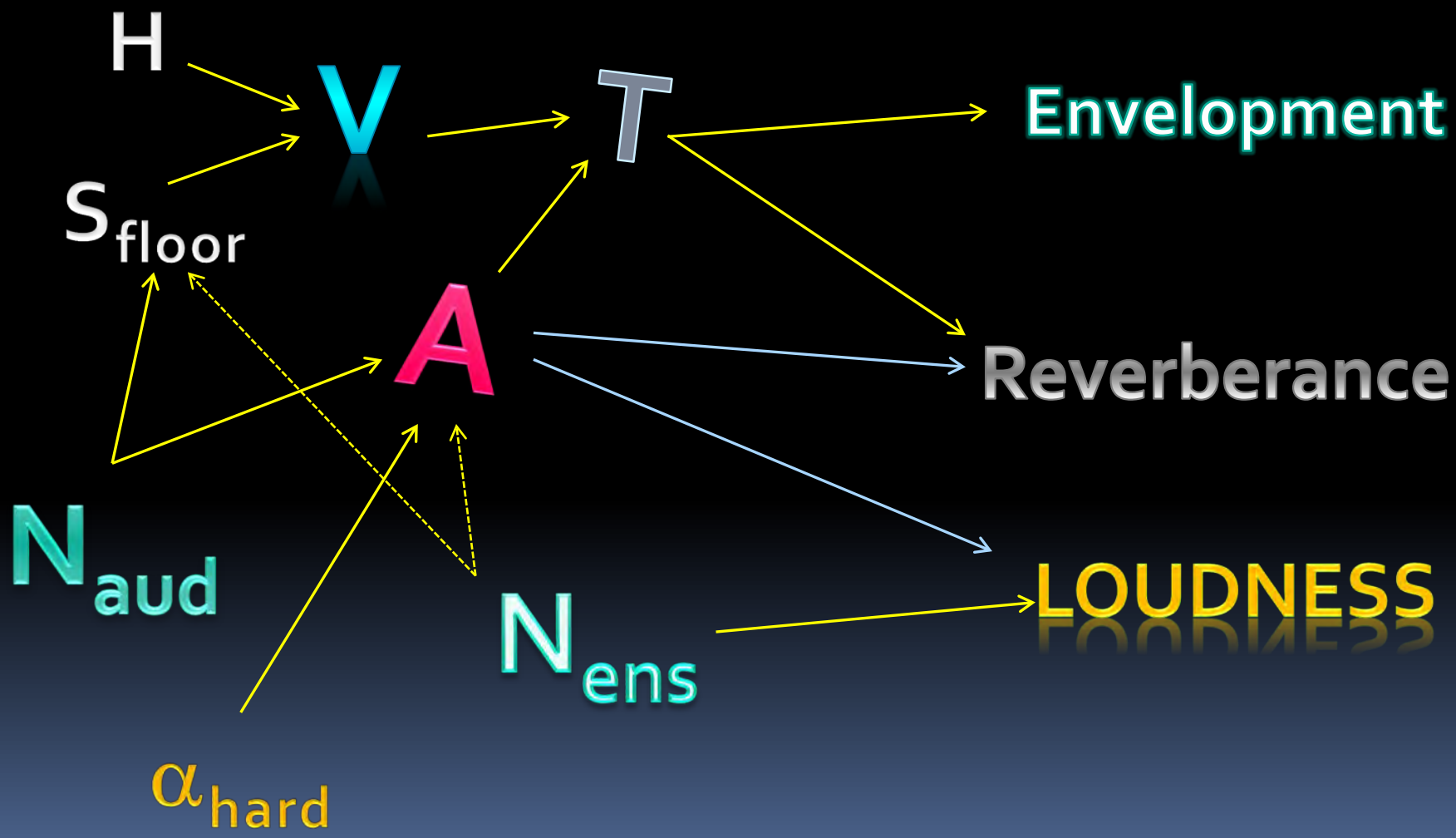
CRITICAL PARAMETERS PART 1

BNAM Odense 19 June 2012

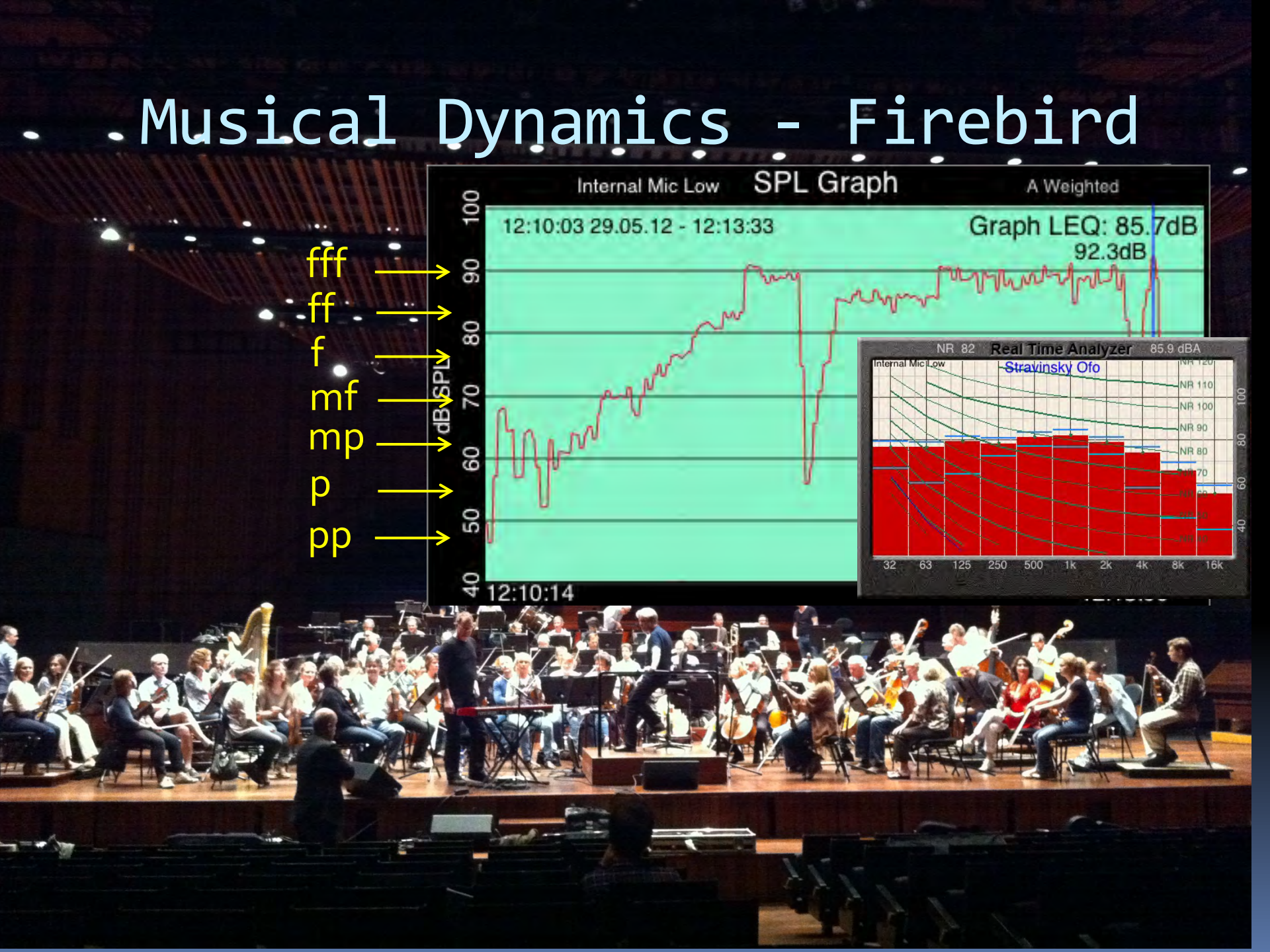
Music Room Acoustics

- Major challenge: Enormous variation
  - Volume — V (m^3) = 100 – 30.000
  - Reverberation — T (s) = 0.6 – 2.3
  - Absorption area — A (m^2) = 16 – 2000
  - Gain — G (dB) = 3 – 25
  - Ensemble size — N = 2 – 120
- Research dominated by Big Concert Hall Acoustics
  - special case T=2.0+, G=3-5dB, V=15000+, N=80+
- Need to review music-acoustical aspects and critical parameters valid for Medium and Small cases, too
  - Reverberance measure when T<<2.0s , Running Reverb, G_{late} , others?
- Proper Loudness is critical, calling for Ensemble-related G
- Medium size Multipurpose halls expected with unbound flexibility
- Toward new Norwegian standard
- This talk: Global parameters T, V, A, α_{hard} >0.1, N, N_{aud}

Some dependencies



Musical Dynamics - Firebird



Multi-purpose, multi-mismatch

Client and User expect unbound flexibility in one room, calling for 16-20dB G-adjustment

- Flexible absorbers may offer only 2dB adjustment
- Music school concert, solo, 8-10dB too weak
- Once a year: Big orchestra visit, 8-10dB too loud

Proper Loudness, Proper G

- Proper loudness relates to musical intention
  - 80dB can be proper, and so can 100dB, if intended
  - Proper impression of «forte» can not be acheived..
    - by playing harder in too low G, or
    - by playing softer in too high G
  - Listening to a «forte» part of a recording at perfect volume:
    - Turning volume down does not make it «mp»
    - Turning volume up does not make it «ff», but wrong
  - Tolerance for proper loudness is small, ±1.5dB ?

Matching choir size and room

Same piece, at «forte», different choir, different rooms, equal loudness

Size N	$L_{w,o}$ (dB)	10·lgN (dB)	G (dB)	SPL (dB)
4	92	9	21	82
32	92	18	12	82
256	92	27	3	82

Good

Same piece, at «forte», different choir, same room, different loudness

Size N	$L_{w,o}$ (dB)	10·lgN (dB)	G (dB)	SPL (dB)
4	92	9	12	73
32	92	18	12	82
256	92	27	12	91

Bad

$SPL = L_{w,o} + 10 \cdot \lg(N) + G$

power of average singer, at forte, is assumed $L_{w,o} = 92dB$

Even worse, singers adapt

Same piece, different choirs, adapting to same room, equal SPL

Size N	$L_{w,o}$ (dB)	10·lgN (dB)	G (dB)	SPL (dB)	
4	101	9	12	82	ff
32	92	18	12	82	f
256	83	27	12	82	mp-mf

Equal SPL does not mean equal impression

$SPL = L_{w,o} + 10 \cdot \lg(N) + G$

where $L_{w,o}$ is the power of the average singer

Litterature, size-related G

Papers by e.g. Nagata, Beranek, Hyde, Nijs

- Karajan: «Musikverein too loud for full orchestra»
- Full orchestra, large symphonic performances: G=3-5dB is OK, G=6-7dB is too much
- Nagata (1989):
  - too weak is unsatisfactory
  - too loud is unbearable

Loudness control suggestions

Matching N and G, performance spaces

- Ensemble gain: $G + 10 \cdot \lg(N) = 23\text{-}25$ dB
- Equivalent requirements:
  - A/N = 16
  - V/N = 100T
  - N = V/(100T) Acoustical ensemble capacity

Rehearsal rooms, A.C. Gade (2012):

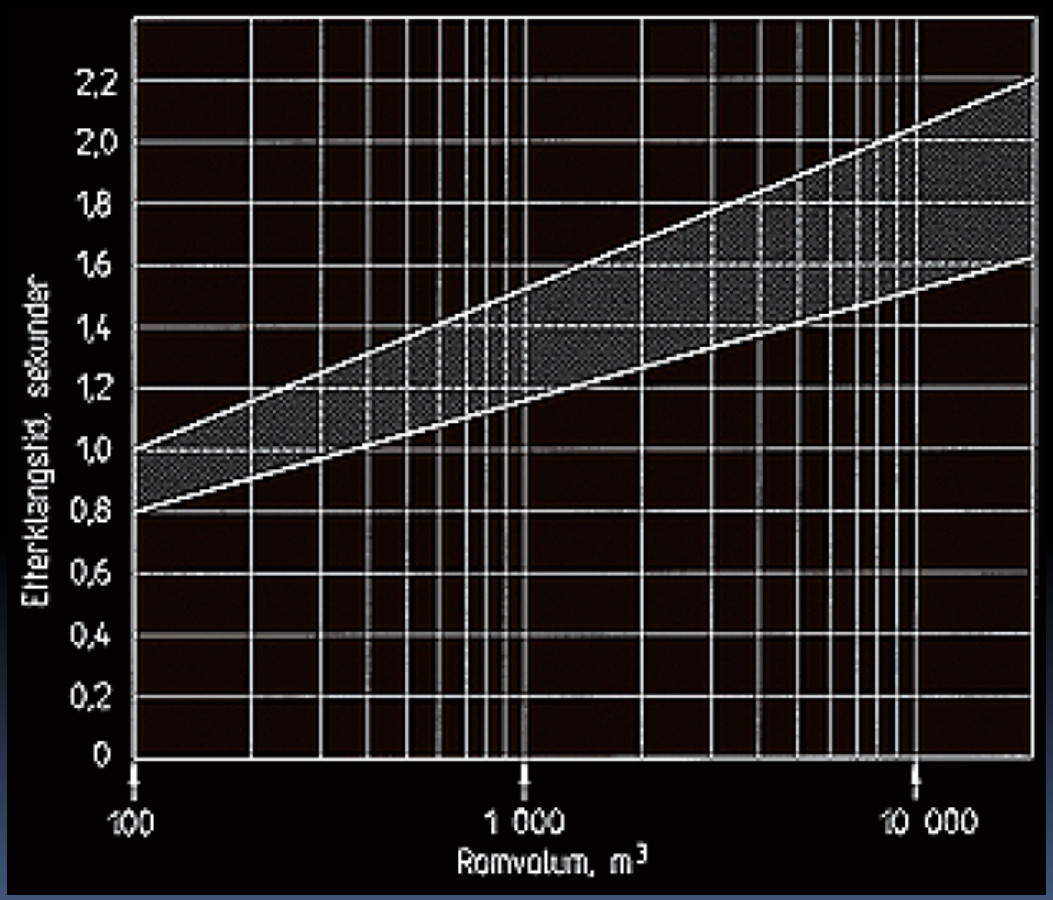
- A/N = 8
- V/N = 50T

Reverberance when T=0.6–1.9s?

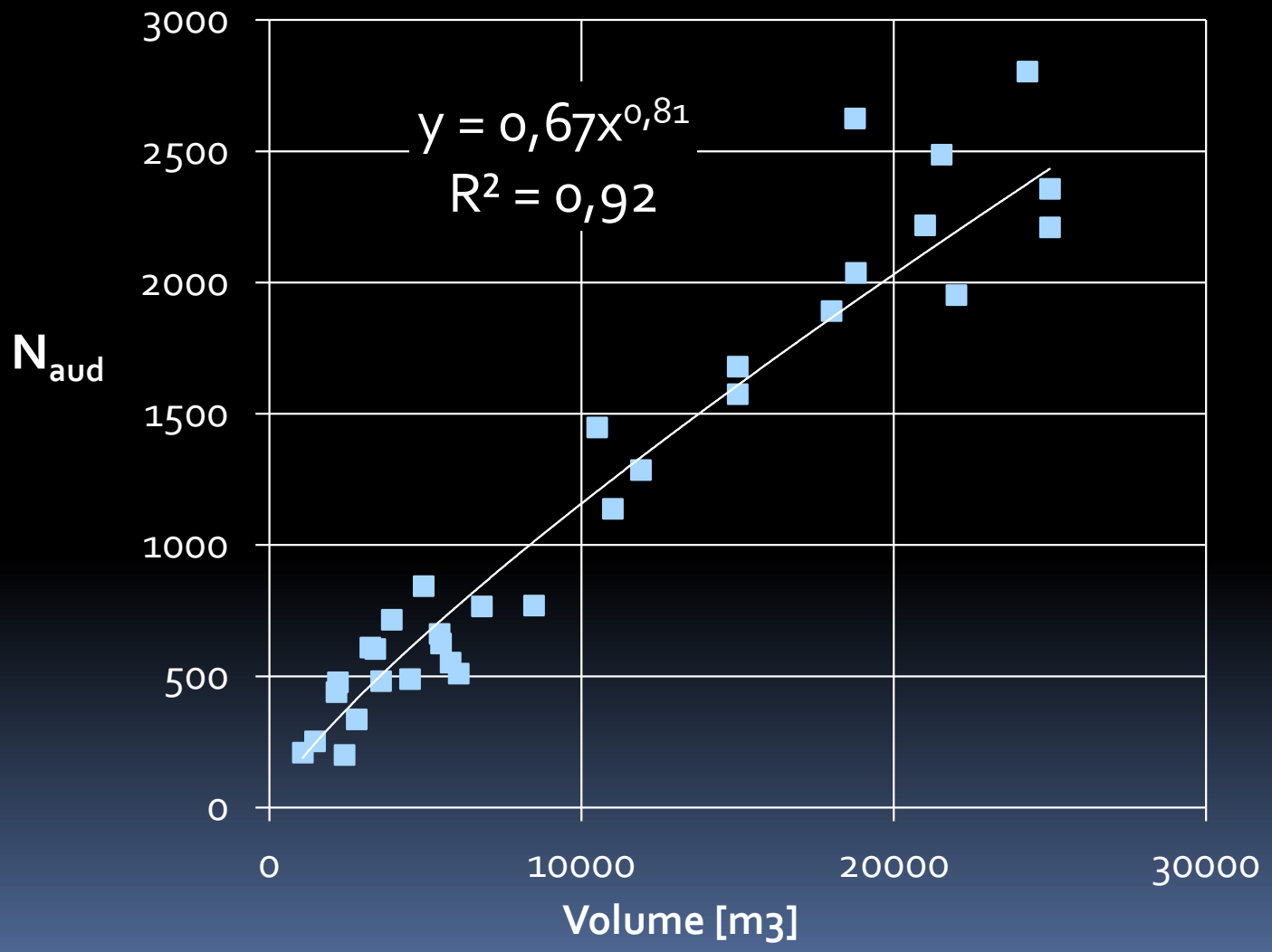
- EDT <<2.0 is not assumed to be good
- Performers reverberance ST_{late} ?
- Running Reverberation (Griesinger)?

T(V) from litterature

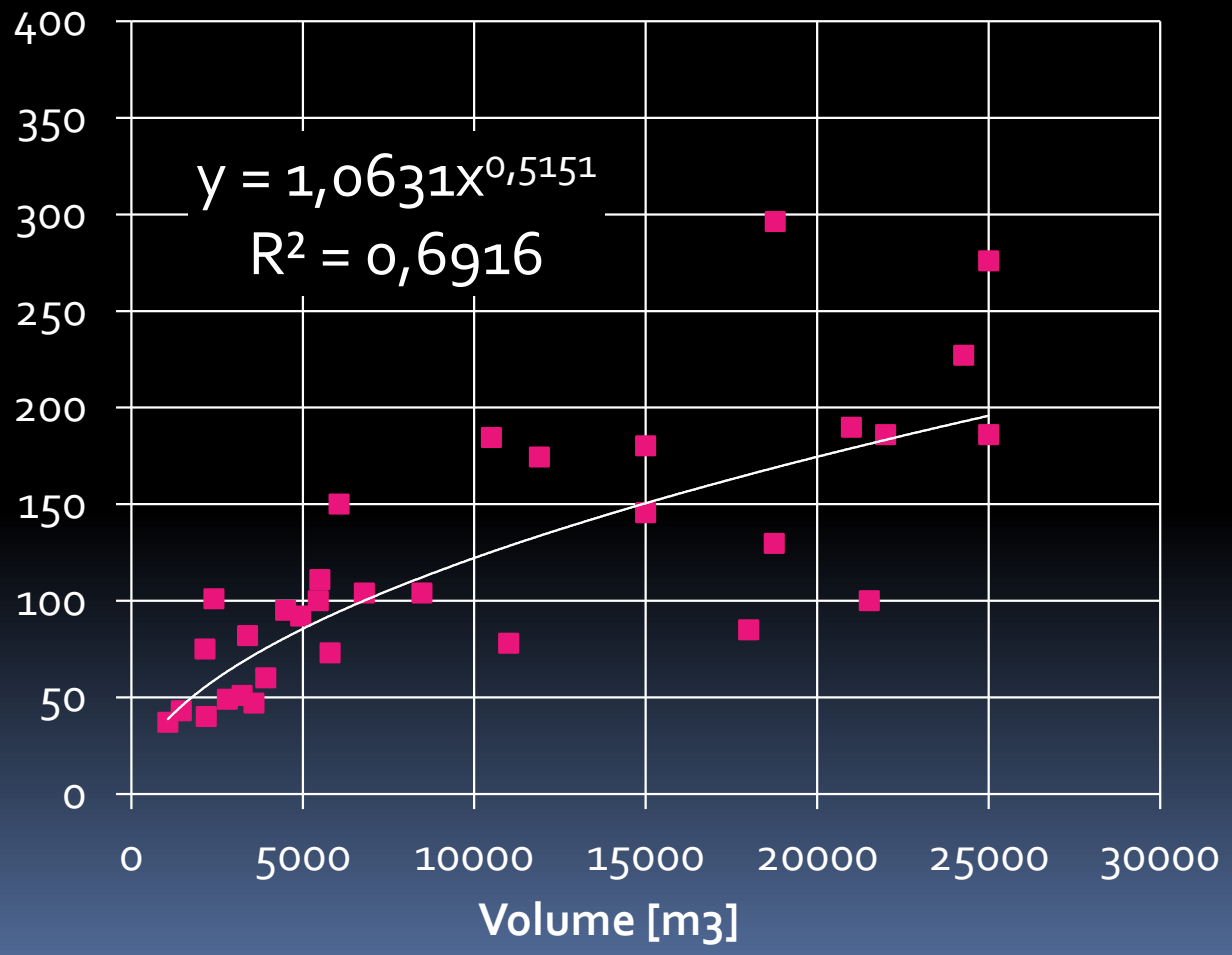
Recommended T as a function of V



Empircal seat count N_{aud}



Empircal Stage Area (per V) => maximum ensemble size N



Tying it all together

	α_{hard} >0.1	result	empiric input	result	result	result
V	**T**	**V/(TN)**	**N**	**G**	**G +10lgN**	**RR160**
200	0.72	69	4	20	26	0.38
400	0.80	63	8	17	26	0.40
800	0.95	60	14	15	26	0.42
1600	1.1	62	23	12	26	0.44
3200	1.3	69	35	10	25	0.46
6400	1.6	75	53	7	25	0.48
12800	1.9	84	80	5	24	0.49
15000	2.0	86	87	4	24	0.49

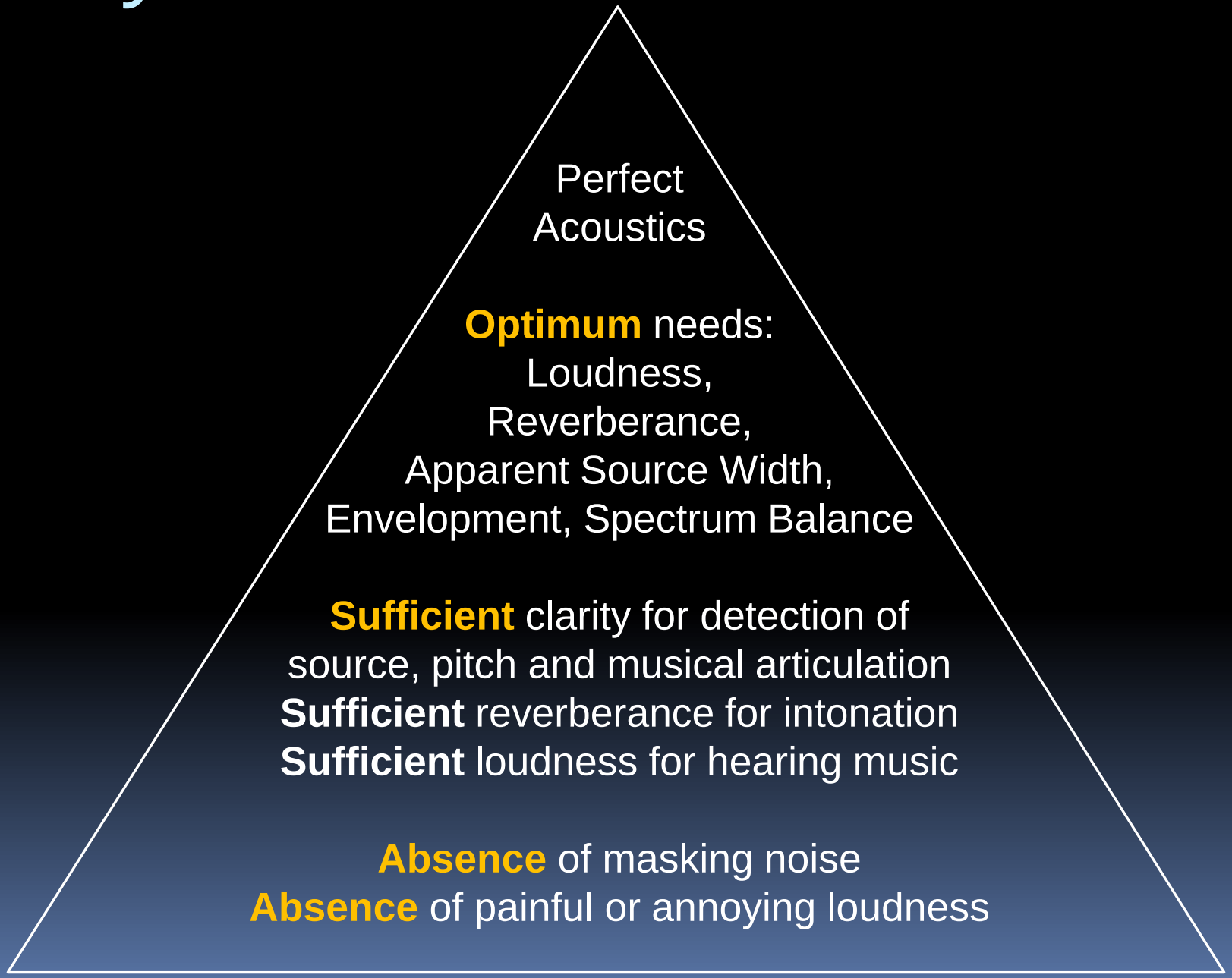
Summary

- Consistency seems acheivable in wide volume range
- Remember α_{hard} >0.1
- Don't mess with the musical dynamics
- Volume requirements suggested
  - $V = 100 \cdot N \cdot T$ in performance spaces (Skålevik)
  - $V = 50 \cdot N \cdot T$ in rehearsal spaces (Gade)

Preventing 80-90% of all volume mismatch, my estimate

- RR - promising descriptor of reverberance
- When assessing ensemble acoustics, use
  - $G + 10 \cdot \lg N$
  - $ST + 10 \cdot \lg N$
- Small performance space ≈ large rehearsal room
- Further improvements wanted for V<1000

Pyramid of Acoustical Needs



Thank you

Full paper: http://www.akutek.info/Papers/MS_Music_Rooms.pdf

More info?

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

www.akutek.info

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