

Room acoustic parameters and their distribution over concert hall seats

Does the average seat exist?

Magne Skålevik

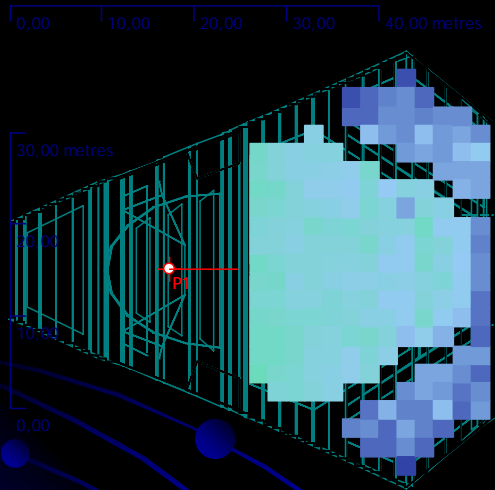
Auditorium Acoustics, Oslo, 05.10.2008

5 listener aspects

Subjective listener aspect	Physical quantity (Parameter) notation and unit	
Subjective level of sound	Sound Strength	G (dB)
Perceived reverberance	Early Decay Time	EDT (s)
Perceived clarity of sound	Clarity	C80 (dB)
Apparent Source Width	Early Lateral Energy Fraction	LF (1)
Listeners Envelopment	Late Lateral Sound Level	LG (dB)

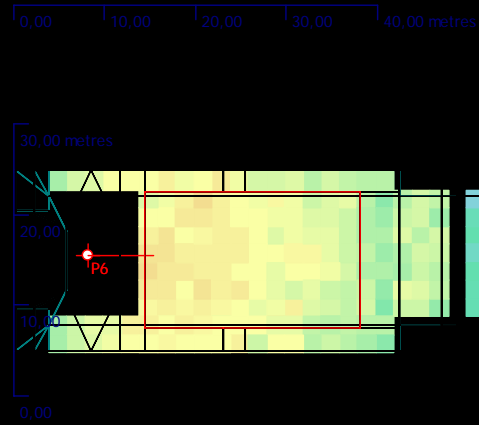
3 concert halls

OSLO



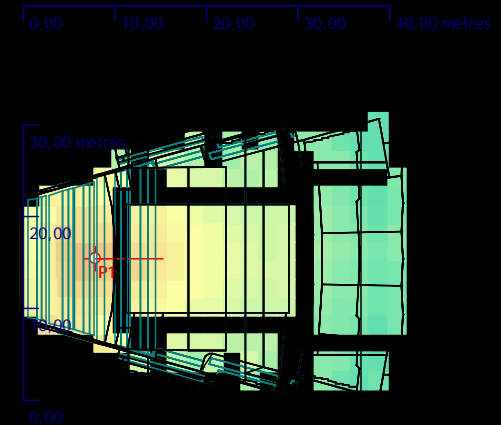
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VIENNA



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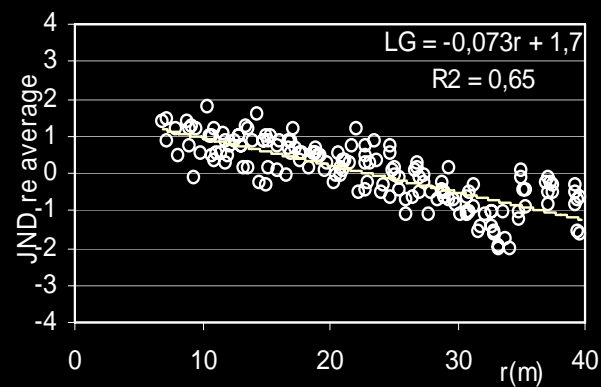
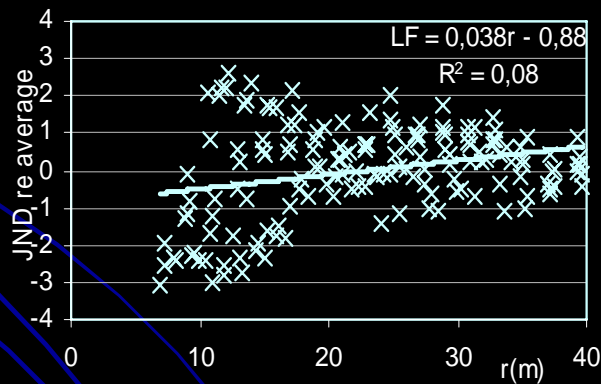
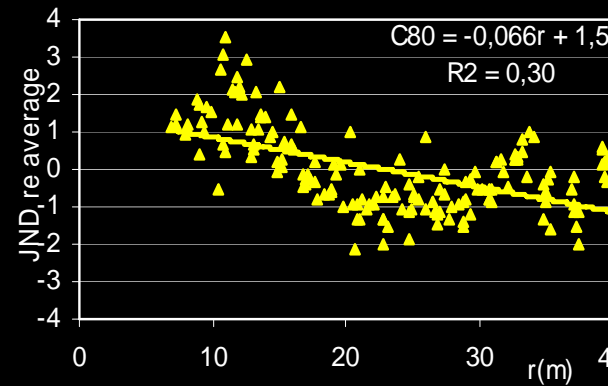
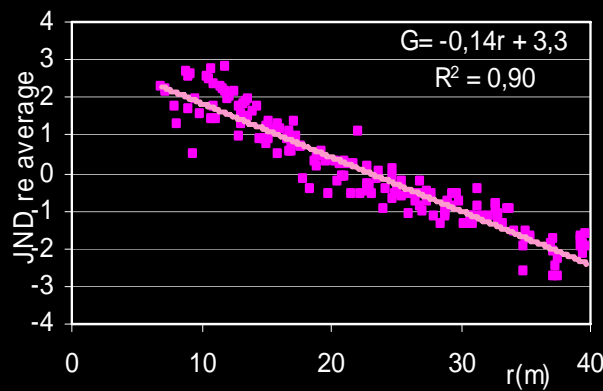
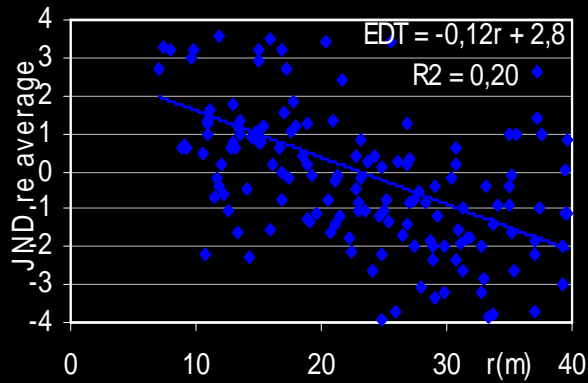
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Seat surface plots of LG (Envelopment)

Vienna – 5 distance plots

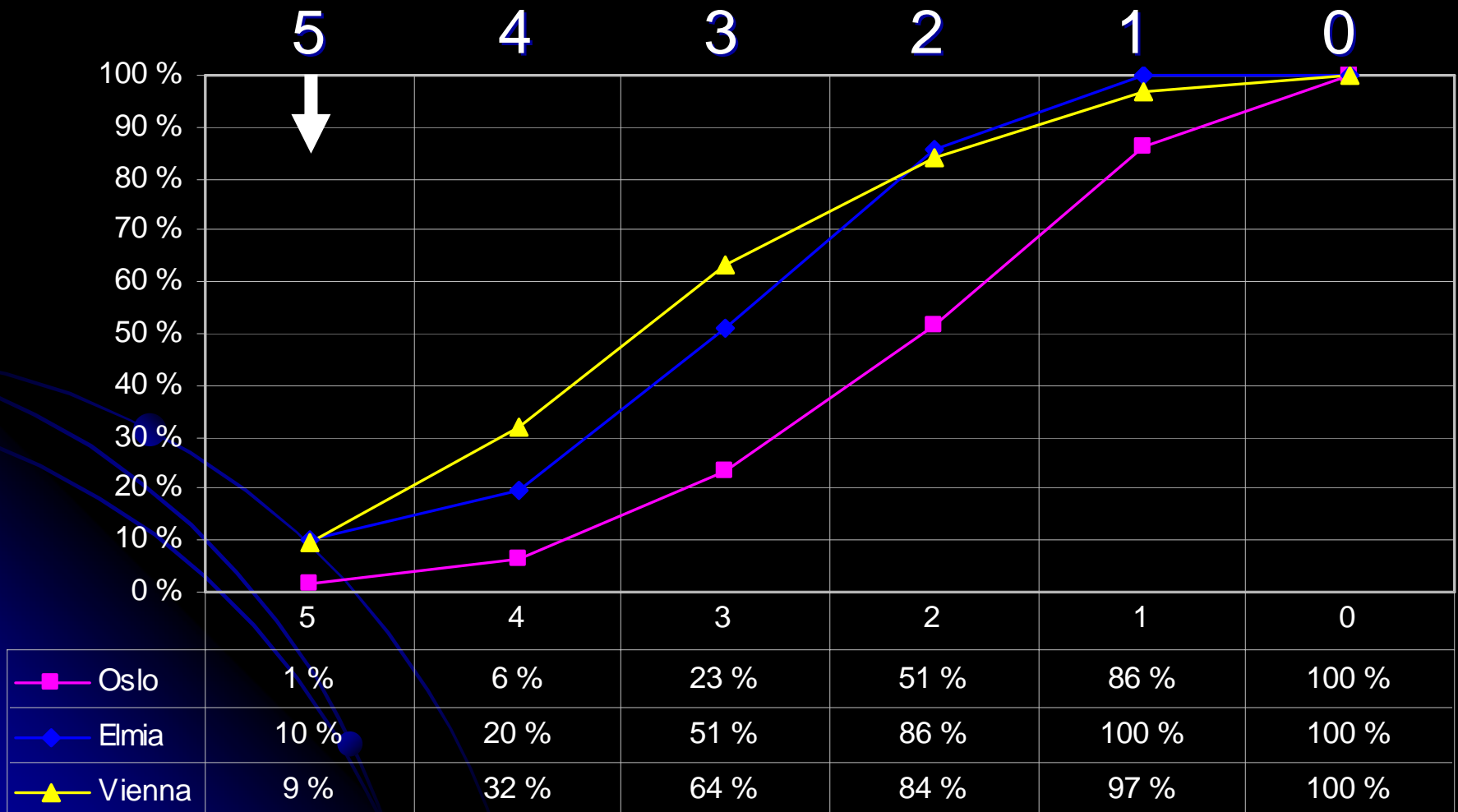


Values in JNDs re hall average (N=159)

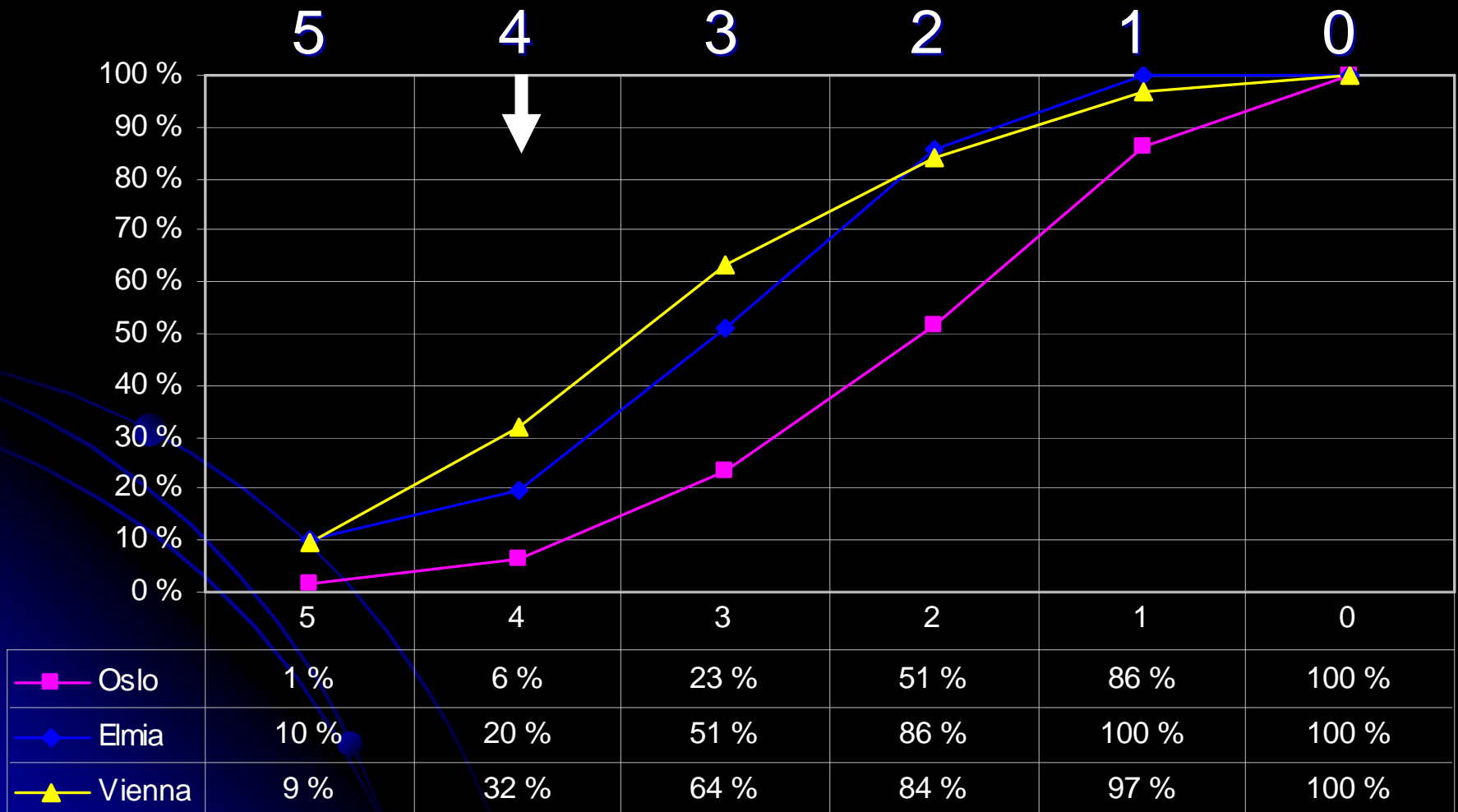
The average parameter value

- Simplifies data
- Single-value representation of hall acoustics
- Often related to preference for halls (e.g. Beranek's hall-ranking)
- Assuming the set of 5 hall-averages represents the acoustics of a hall: - How many seats have representative acoustics?

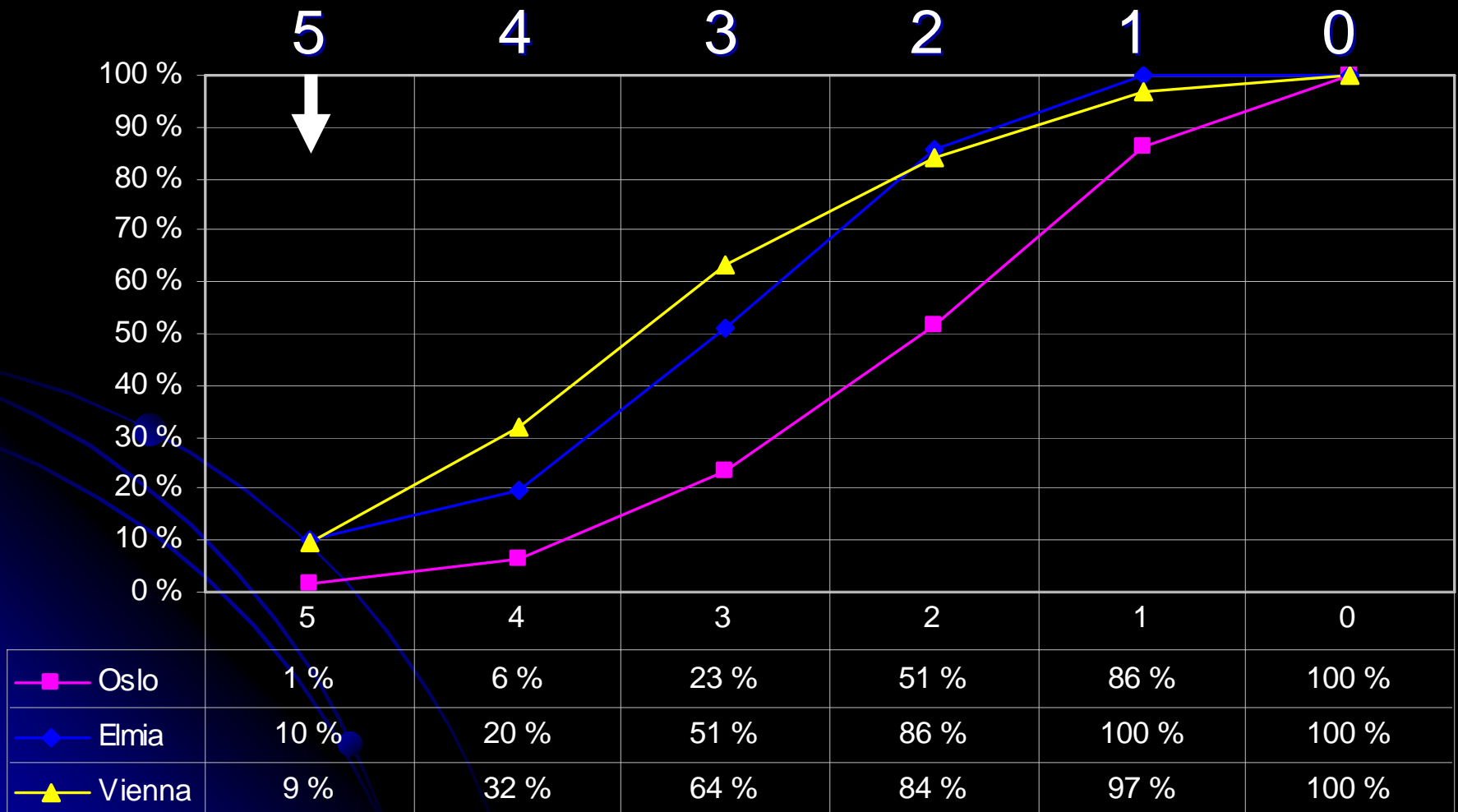
Percentage of seats with all 5 parameters close (\pm jnd) to average



Percentage of seats with at least 4 parameters close (\pm jnd) to average



In Vienna, the set of 5 average values is perceived by only 9%



Preliminary conclusions

- The set of 5 average parameter values in a hall is perceived by only 1-10% of the audience in the hall
- The high reputation of the Vienna hall cannot be explained by its set of 5 average parameter values:

EDT	G	C80	LF	LG
1,9	3	2	0,20	-3

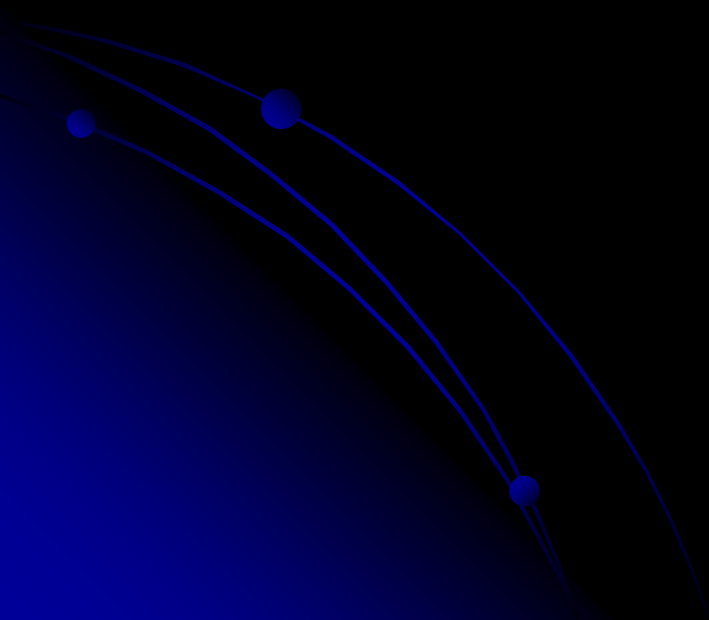
..since these conditions apply to only 9% of seats

Explain high reputation

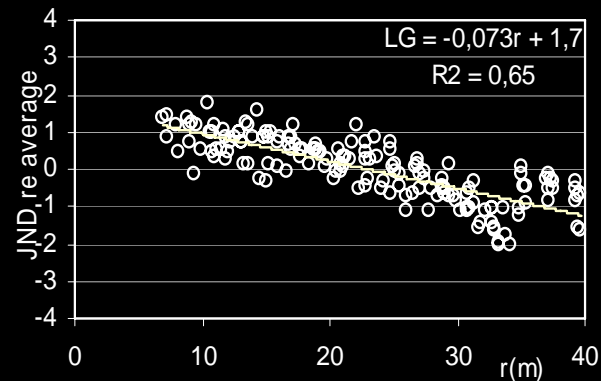
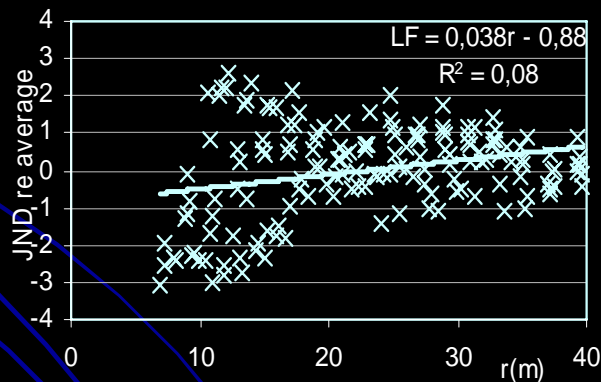
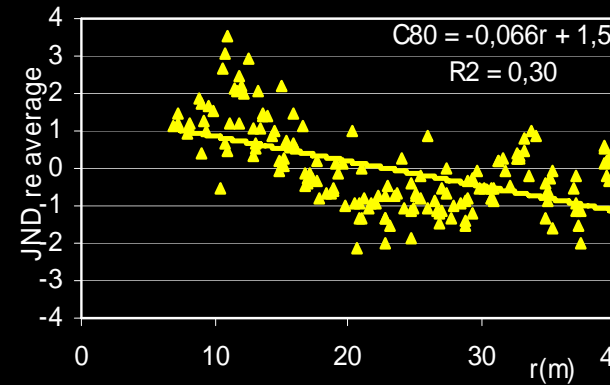
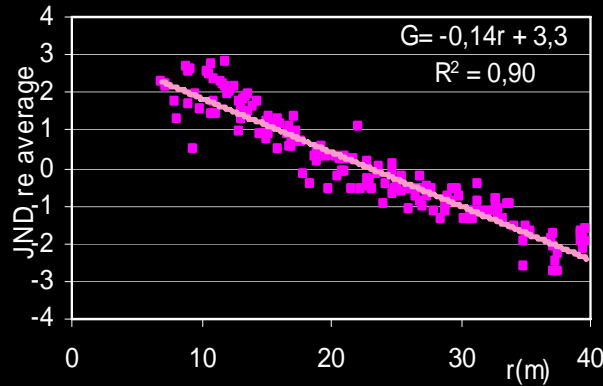
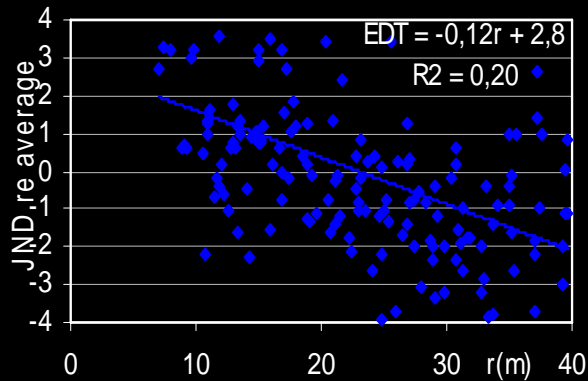
- What combinations of parameter-values represents a majority of Vienna seats?
- 1: At 67% of the seats, parameters differ less than $\pm 2.5jnd$ from hall average
- 2: At 47% of the seats, average deviation from hall averages is less than 1jnd.
- Both explanation attempts are unsettling

Distance-related references

- M Barron: Loudness reference decreases with distance (ICA 2007)
- G decreases -0.1dB/m if $T=1.8\text{s} \Rightarrow 1\text{JND}$ per 10m



Distance-related references, Vienna



JNDs re hall average (N=159)

Vienna revisited

- Distance-related references (instead of average value reference) =>
 - All 5 parameter-values deviate less than 1 JND from reference at 44% of seats (improved from 9%)
 - G, C80, LF and LG deviate less than 1JND from reference at 62% of seats (improved from 29%)
 - Average deviation of all 5 parameters is less than 1JND at 76% of seats (improved from 47%)
- Conclusion: distance-related reference improves explanation by 29-35%

Distance-related references

- From linear regression, distance-related references in Vienna (at 12, 22 and 32m)
- Golden combinations from Goldener Saal?
- Global references?

R (m)	EDT (s)	G (dB)	C (dB)	LF (1)	LG (dB)
12	2,0	5	3	0,18	-2
22	1,9	3	2	0,20	-3
32	1,8	2	1	0,22	-4

Discussion

- Correlation between simulated and measured in Oslo:
- EDT $r^2=0.59$
- C80 $r^2=0.75$
- G $r^2=0.98$
- G,late $r^2=0.97$
- Calculated values scatter more than measured when early sound is dominant
- Real measurements may exhibit less deviations from distance-related reference-values

Conclusion and Further work

- Introducing distance-related reference values significantly improves explanation of Vienna hall reputation
- The analysis should be verified with real measurements
- Analysis with simulations should be extended to more halls
- Simulation advantage: can provide many points in occupied condition

Thanks for your attention!

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