

Directional Early-to-Late Energy Ratios to Quantify Clarity: A Case Study in a Large Auditorium



PERCEPTION
IMMERSIVE 3D EXPERIENCES

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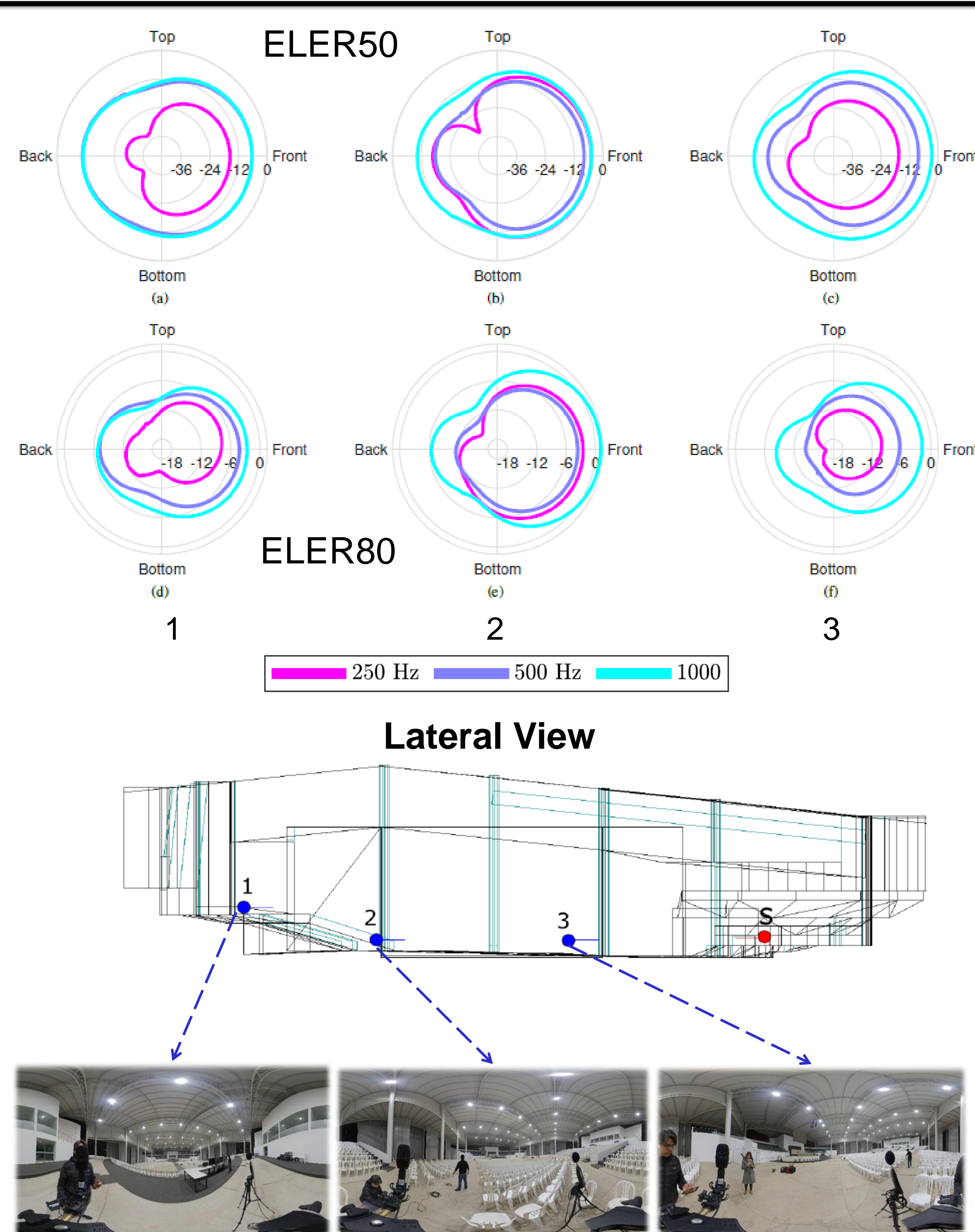
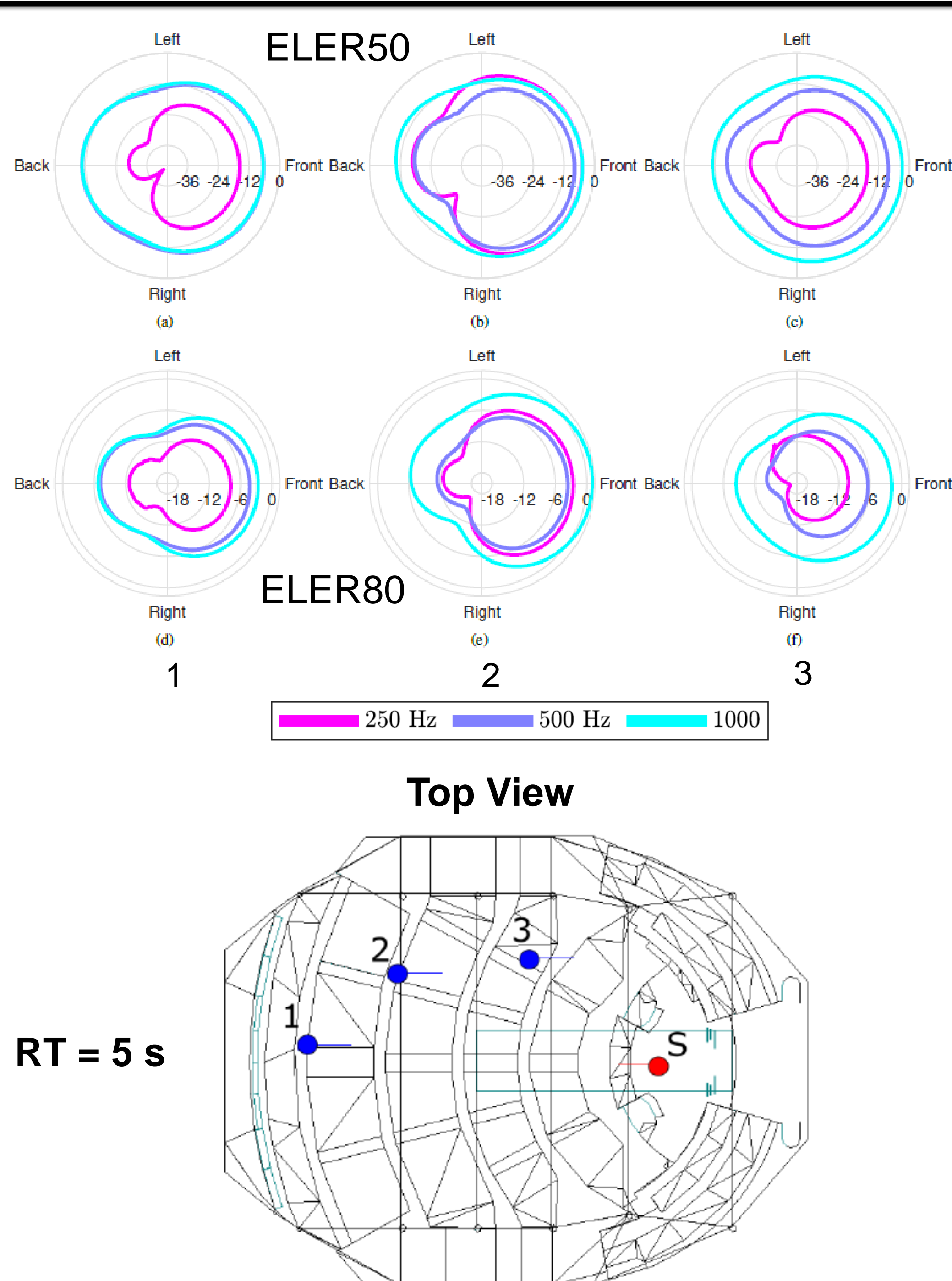
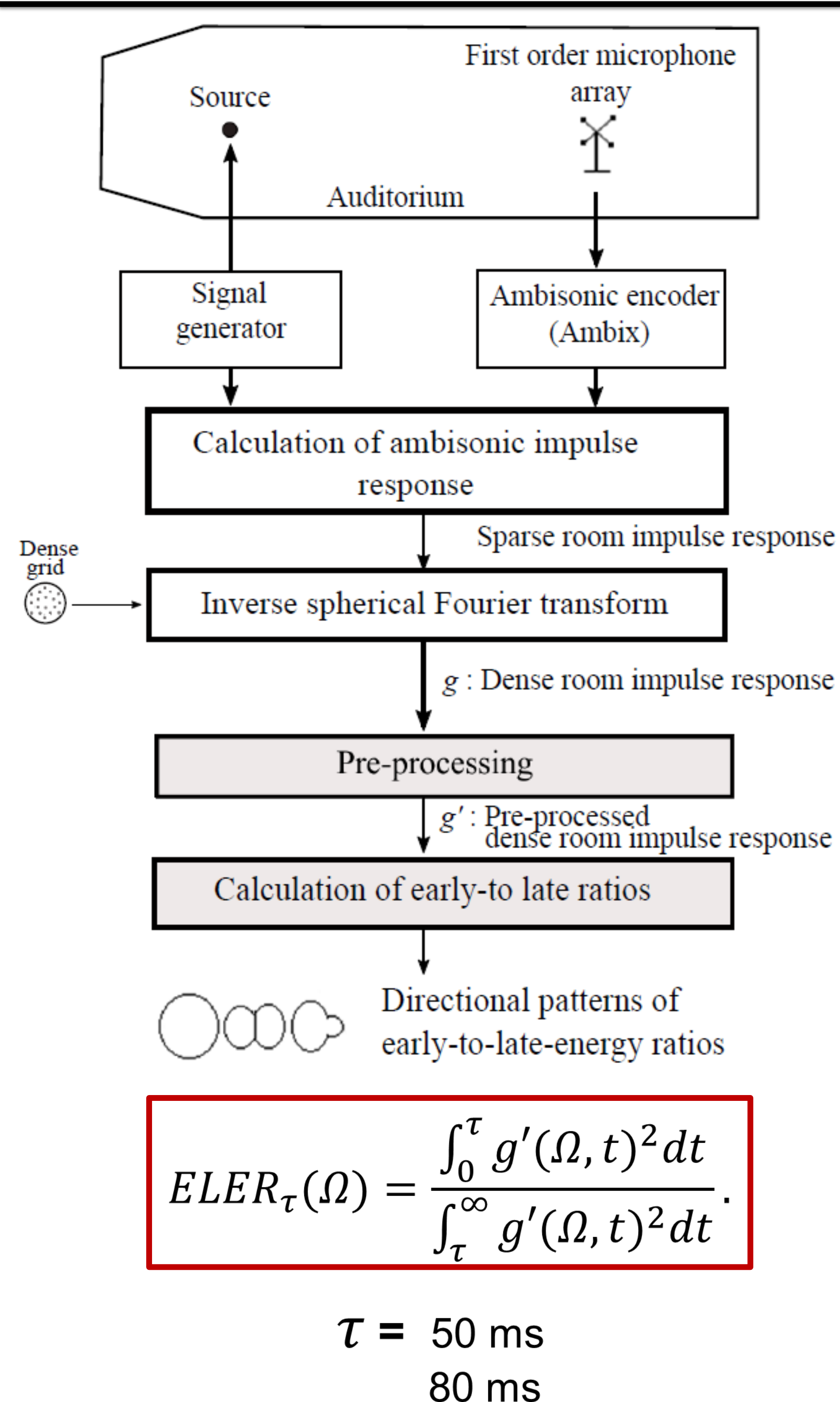
1. Introduction

- Importance.** Quantifying the directional features of speech and music clarity is important for:
 - The positioning of acoustic materials and sound sources in rooms.
 - To distinguish the directional dependence of early and late reflections to investigate clarity of speech and music.
- Contribution.** In this research, omnidirectional clarity metrics have been reviewed to identify the ones based on early-to-late energy ratios (ELER) and extend them to their directional versions.

2. Review of Omnidirectional Clarity

Source Material	Name	Metric
Speech	Speech Clarity	$C_{50} = \frac{\int_{0ms}^{50ms} h'(t)^2 dt}{\int_{50ms}^{\infty} h'(t)^2 dt}$
Speech	Speech Transmission Index	$STI = \sum_{k=1}^7 \alpha_k * MTI_k$
Music	Music Clarity	$C_{80} = \frac{\int_{0ms}^{80ms} h'(t)^2 dt}{\int_{80ms}^{\infty} h'(t)^2 dt}$
Music	Center Time	$T_s = \frac{\int_{0ms}^{\infty} t * h(t)^2 dt}{\int_{0ms}^{\infty} h(t)^2 dt}$

3. Directional ELER Patterns Captured in a Large Auditorium with an Ambisonic Microphone



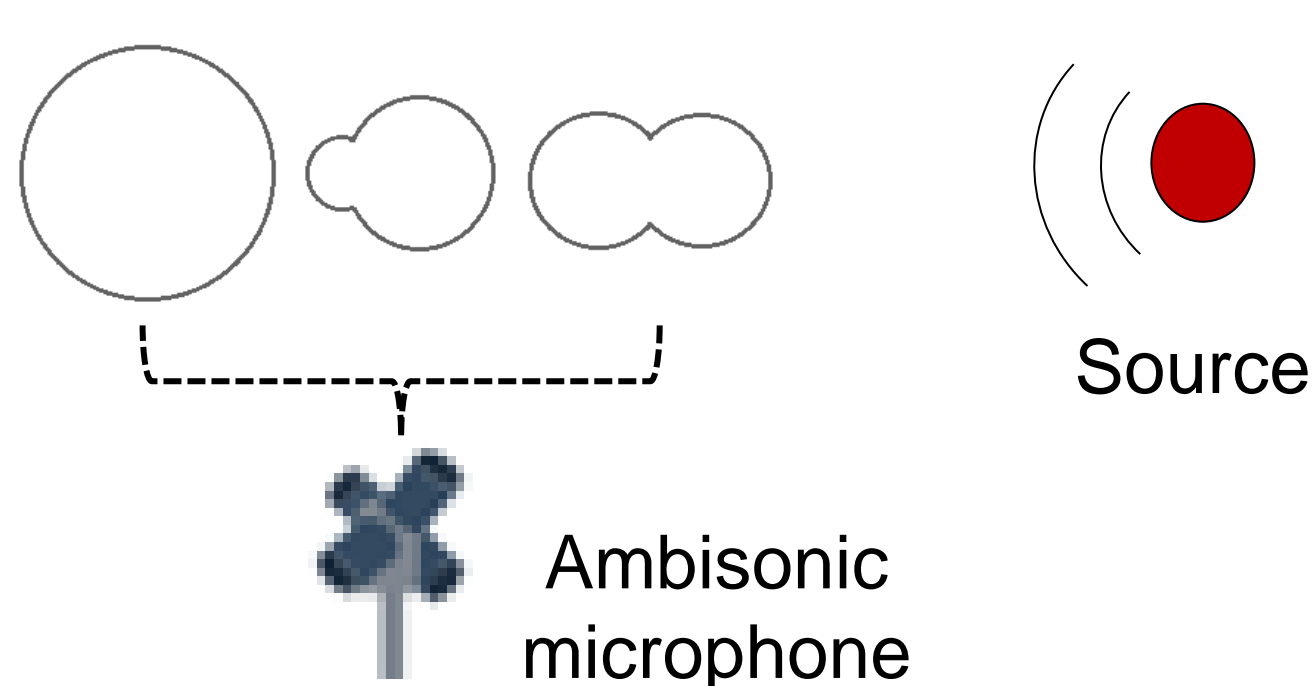
4. Conclusion

We propose to extend the current omnidirectional metrics of clarity to include directional information.

C50 → ELER50

C80 → ELER80

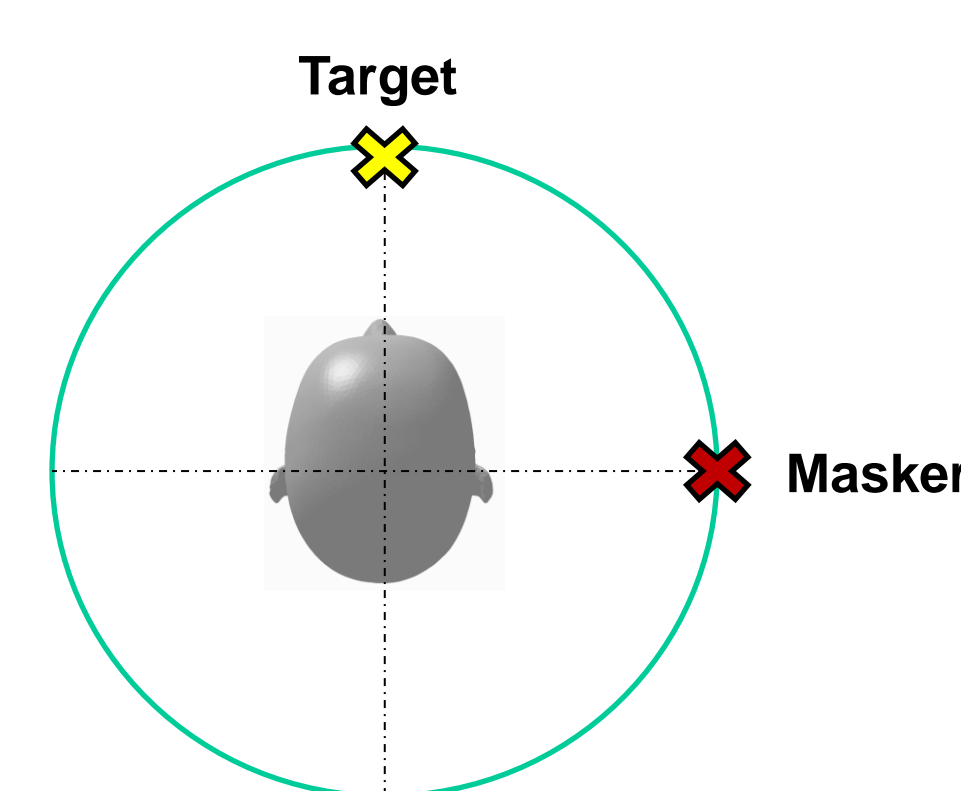
Three patterns were identified: an omnidirectional pattern, a dipole pointing forward and backward, and a cardioid shape pointing towards the source.



The differences found in the dynamic range between frequency bands fluctuates over the usual JND between 1 and 3 dB.

ELER	Dynamic Range
$ELER_{50}$	- 44 dB to 0 dB
$ELER_{80}$	-20 dB to 0 dB

Extension to this work might consider BRIR and the paradigm of SRM.



BRIR: Binaural Room Impulse Response
SRM: Spatial Release from Masking

References:

[1] ISO 3382-1:2009. [2] Dick *et al.*, JASA, 145(4), 2795–2809, 2019. [3] Amengual *et al.*, JASA, 141(4), EL369–EL374, 2017. [4] Salvador *et al.*, IEEE/ACM TASLP, 26(3), 461–474, 2018.