

Microphone Recording for 3D-Audio/VR



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expertise in audio media



Heinut
Witte
17.11.2016

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- Contents: Two main questions:
 - For a 3D-Audio reproduction, how **real** does the sound field have to be?
When do we want to **copy** the sound field?
How much **likeness/similarity** to the sound field in the recording room do we need?
 - Which **3D microphone recording techniques** are appropriate for recording a spatial sound field?

- 3D-Audio formats
- Copying the sound field
- The „Uncanny Valley“
- Stereo layers for 3D
- Stereo basics
- ORTF-3D

Spatial sound reproduction techniques:

- Real source
- Stereophony
- Sound field reconstruction
- Binaural

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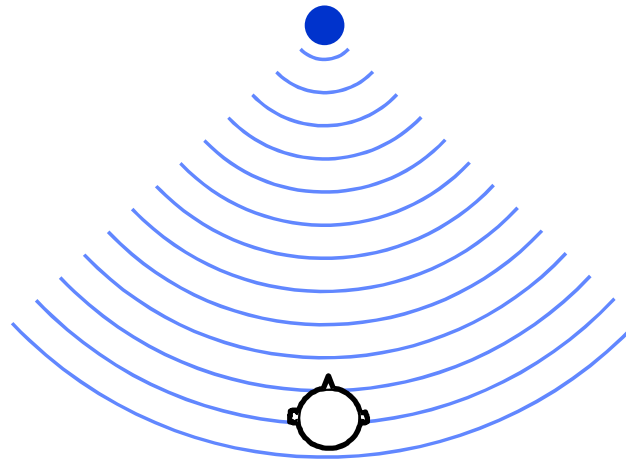
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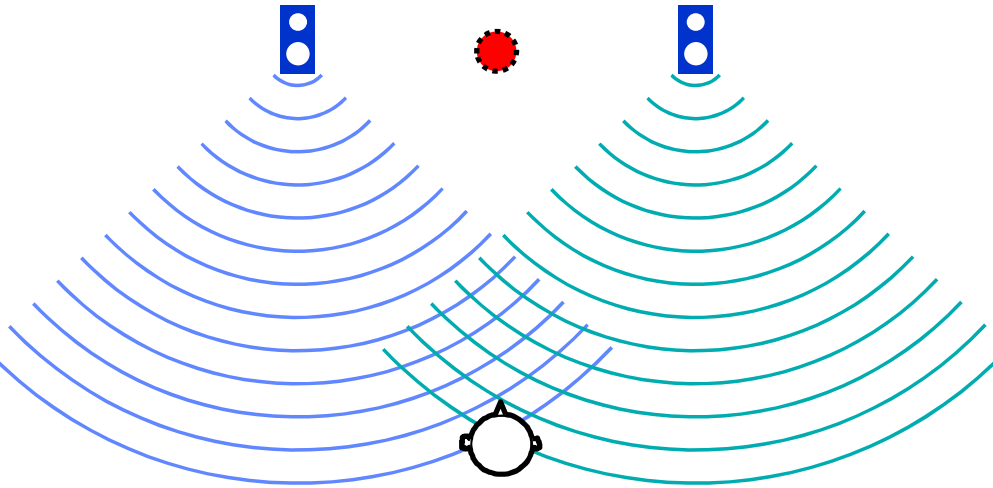
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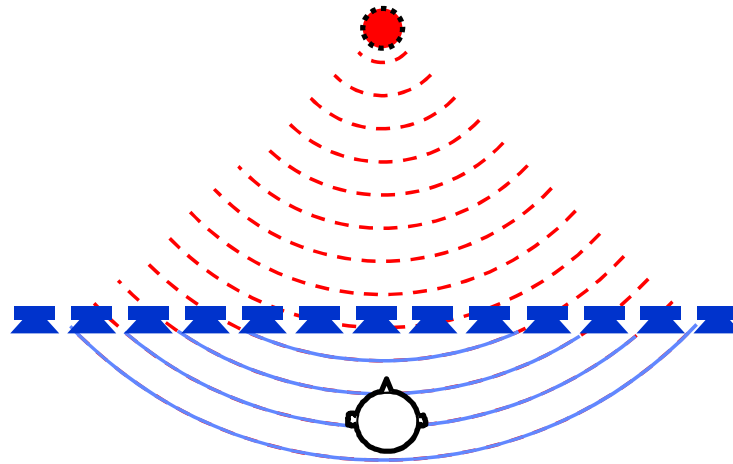
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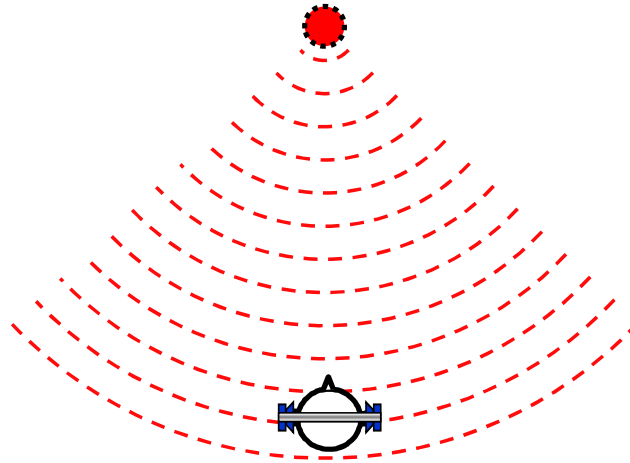
- Real source
- Stereophony
- **Sound field reconstruction***
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* The term „Sound field reconstruction“ includes techniques like WFS or HOA

Spatial sound reproduction techniques:

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- **Binaural**



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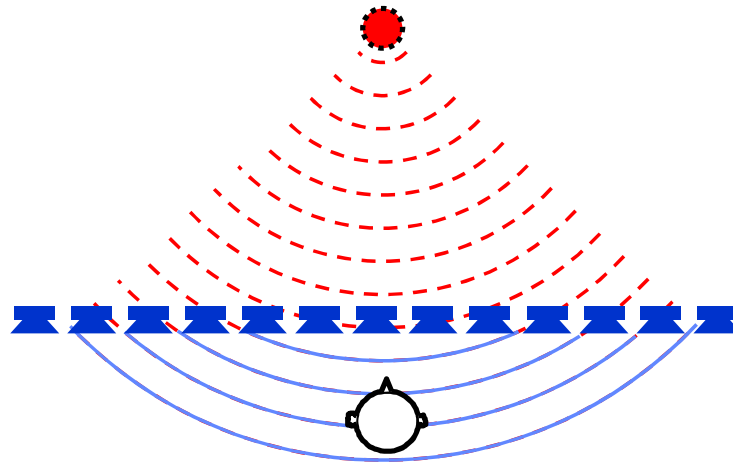
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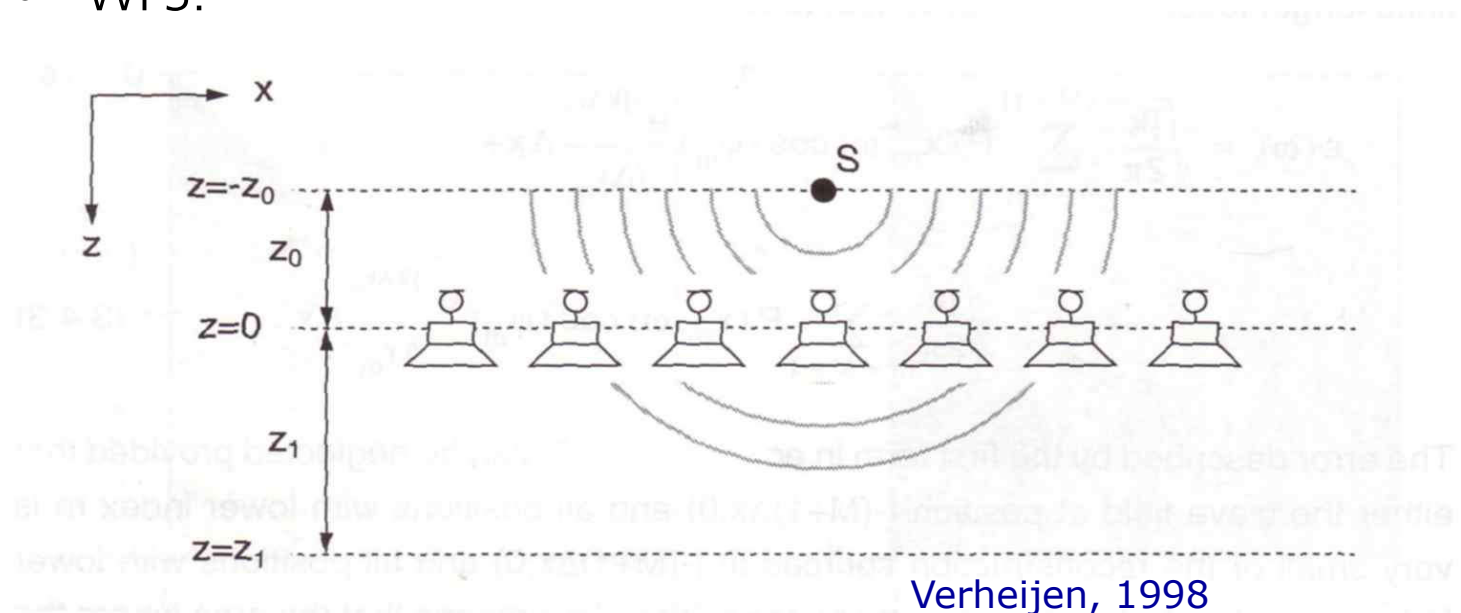
Copying the sound field:

- Real source
- Stereophony
- **Sound field reconstruction***
- Binaural



* The term „Sound field reconstruction“ includes techniques like WFS or HOA

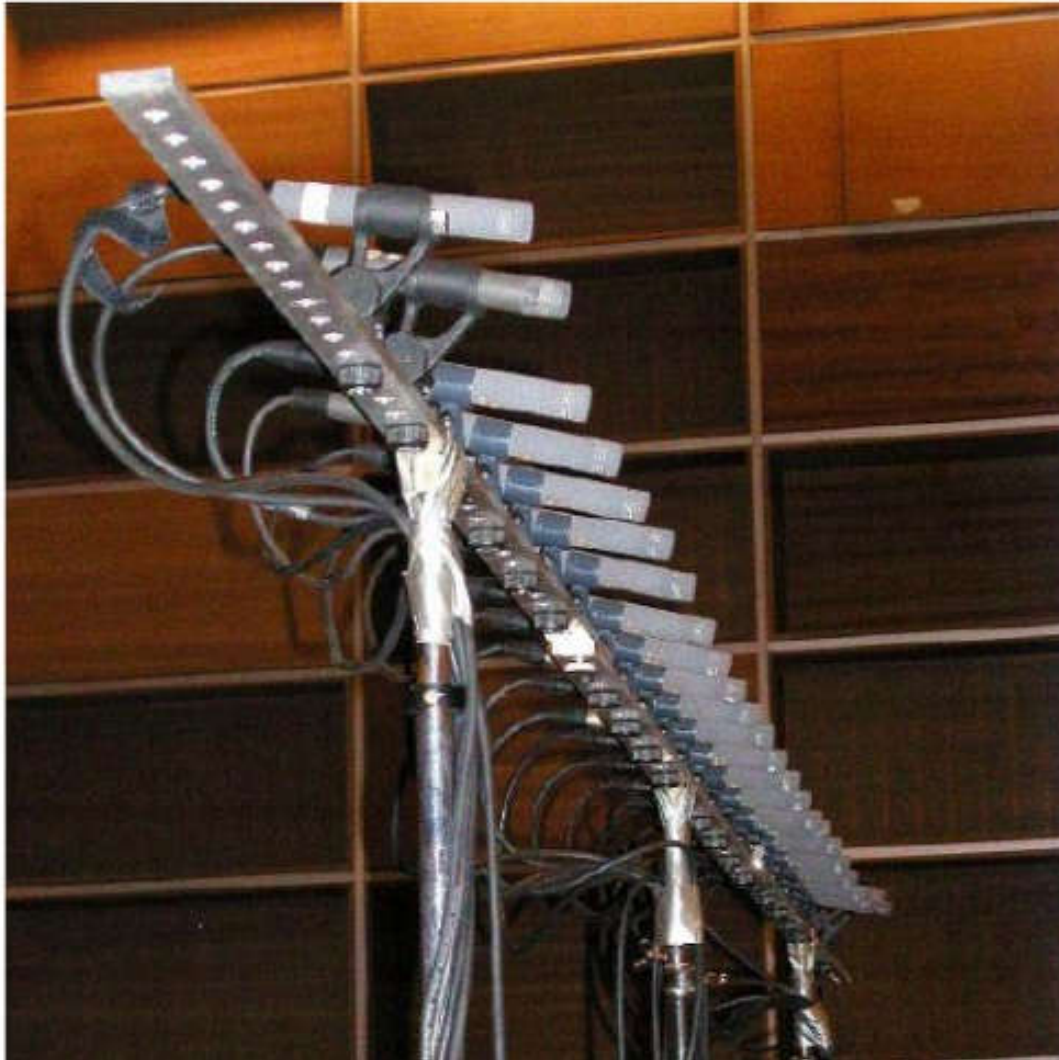
- Copying the sound field: Spatial Sampling → Spatial Reproduction
- WFS:



Verheijen, 1998

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- Copying the sound field: Spatial Sampling → Spatial Reproduction
- WFS:



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- Copying the sound field: Spatial Sampling → Spatial Reproduction
- Ambisonics:



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- Ambisonics:



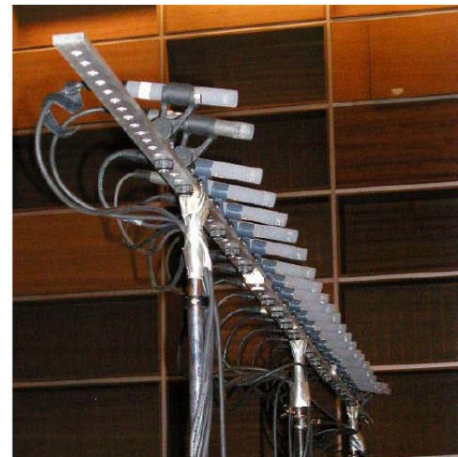
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- Copying the sound field: Spatial Sampling → Spatial Reproduction
- Spatial Sampling does never work 100%
- Artefacts of „spatial sampling“ recording techniques:
 - Too low resolution
 - Small space: compromised hardware
 - Perceptually not sufficient
 - No aesthetic mix, no sound engineering involved



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- The „Uncanny Valley“
 - Formulated for Graphical Design in 1970 by Dr. M.Mori
 - Suggested for Spatial Audio by Francis Rumsey



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- 0% likeness, 0% familiarity

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- 10% likeness, 50% familiarity

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- 50% likeness, 80% familiarity

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- 90% likeness, **-50** % familiarity

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- 100% likeness, 100% familiarity

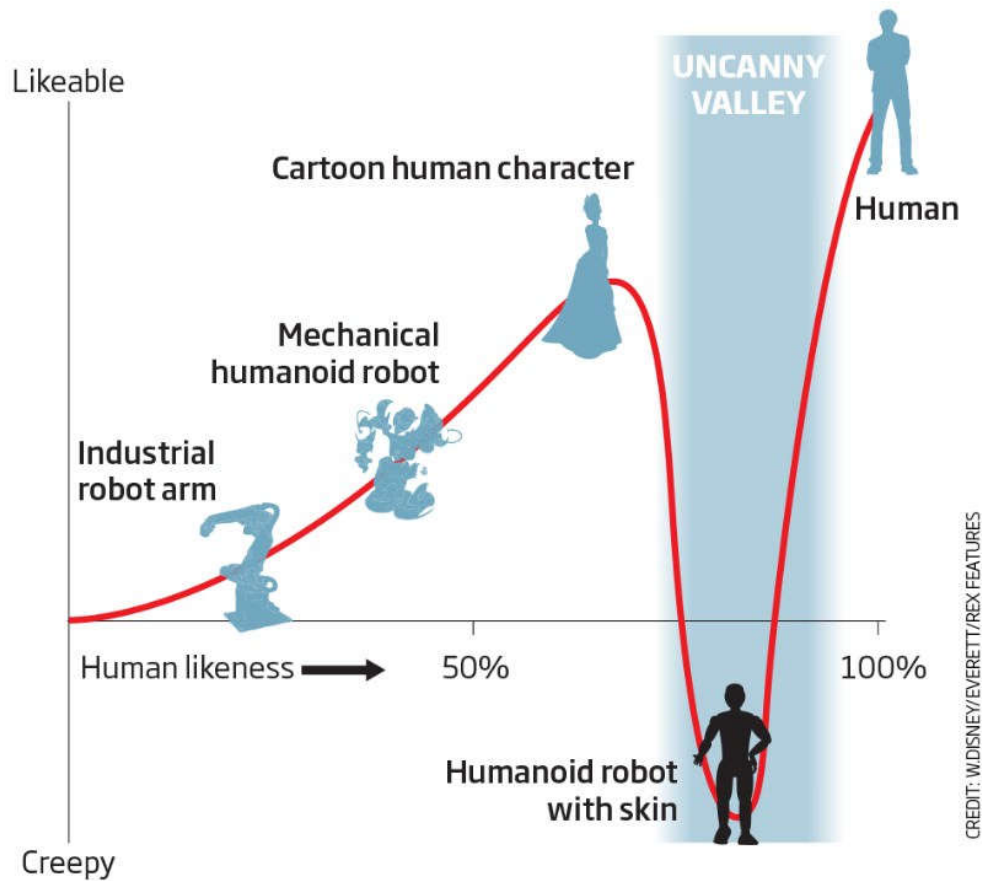
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- The „Uncanny Valley“
 - Formulated in 1970 by Dr. Masahiro Mori
 - Suggested for Spatial Audio by Francis Rumsey (ICSA, 2013)



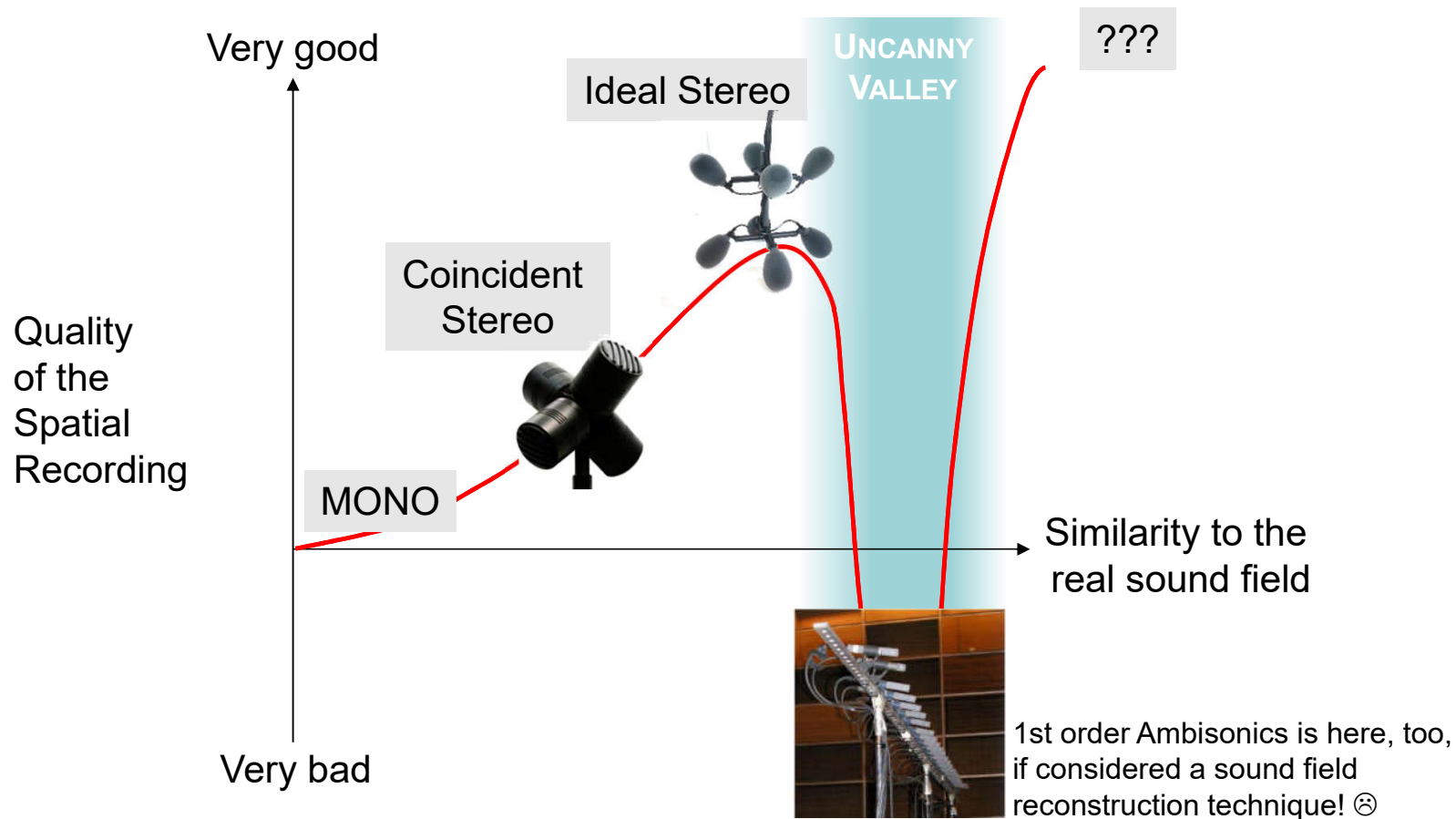
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- The „Uncanny Valley“ of 3D-Audio recording:
(unproven hypothesis!)



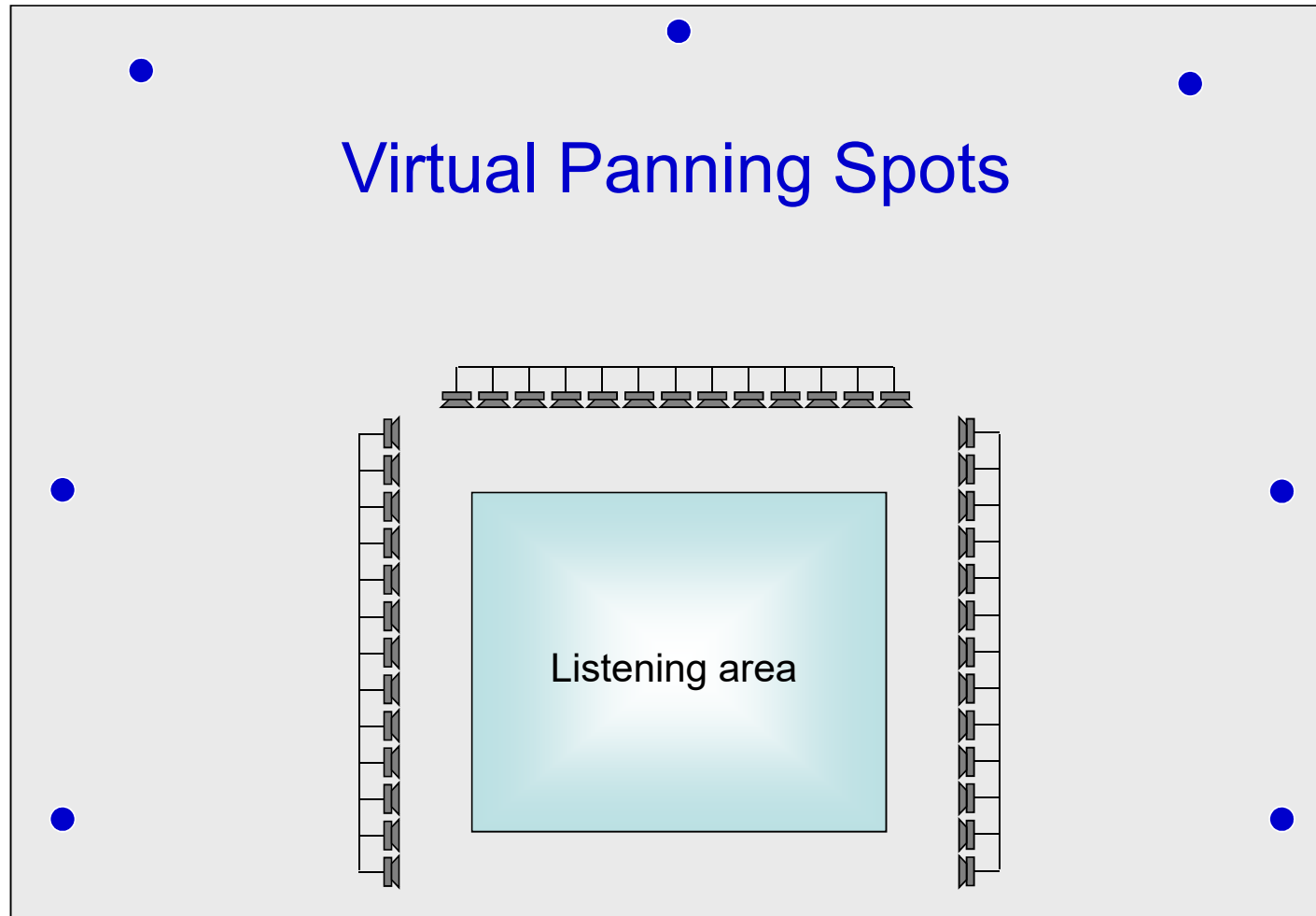
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- Alternative:
 - „Stereophonic sublayer“ under any 3D-Audio format („Virtual Panning Spots“)
 - Avoid **trying to copy** the sound field, instead use proper stereophonic spatial imaging
- Ambisonics, 1st order or HOA:
 - Inappropriate copying of the sound field leads to undesired artefacts:
 - **1st order** Ambisonics is physically inappropriate, but it also can be interpreted as coincident Stereo → the artefacts are: narrow spatial sound
 - Capturing HOA („Higher Order Ambisonics“) with a high enough order **at the whole frequency spectrum** would be appropriate → however there is no microphone capturing system of this kind available
 - HOA as a storage and mixing system is appropriate!

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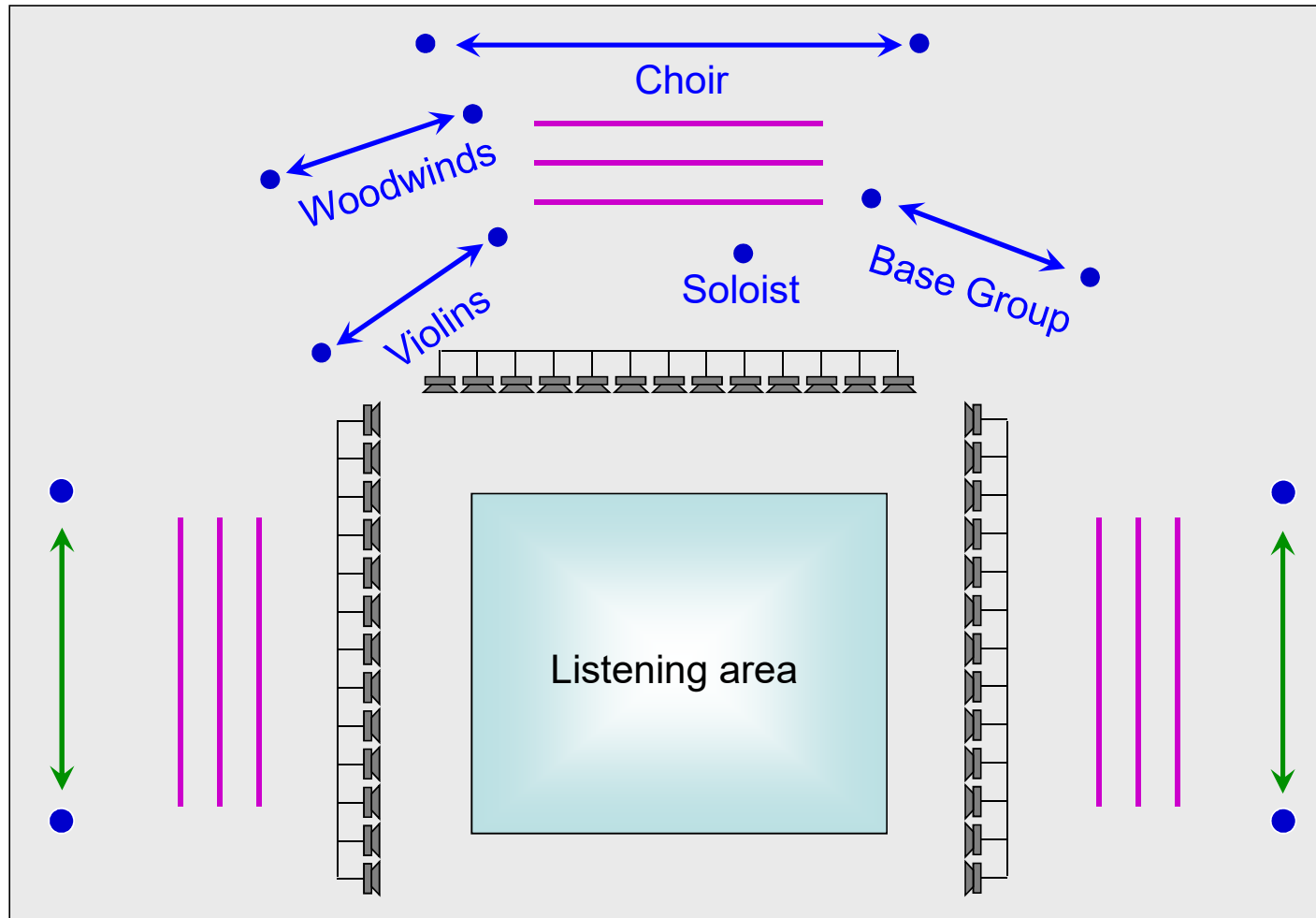
- Alternative: Stereophonic sublayer = Virtual Panning Spots



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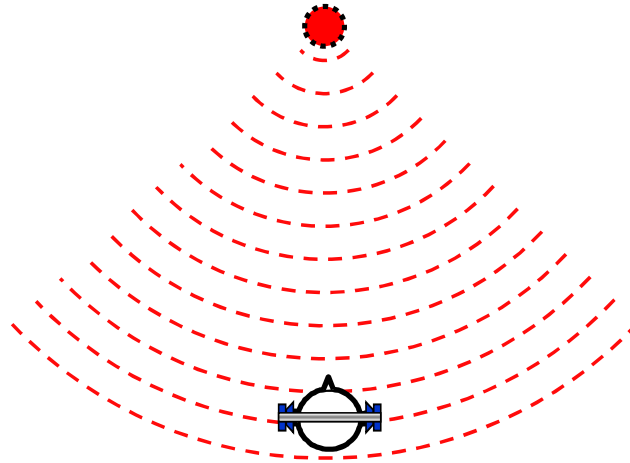
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- Copying the sound field: Spatial Sampling → Spatial Reproduction
- Binaural without headtracking:



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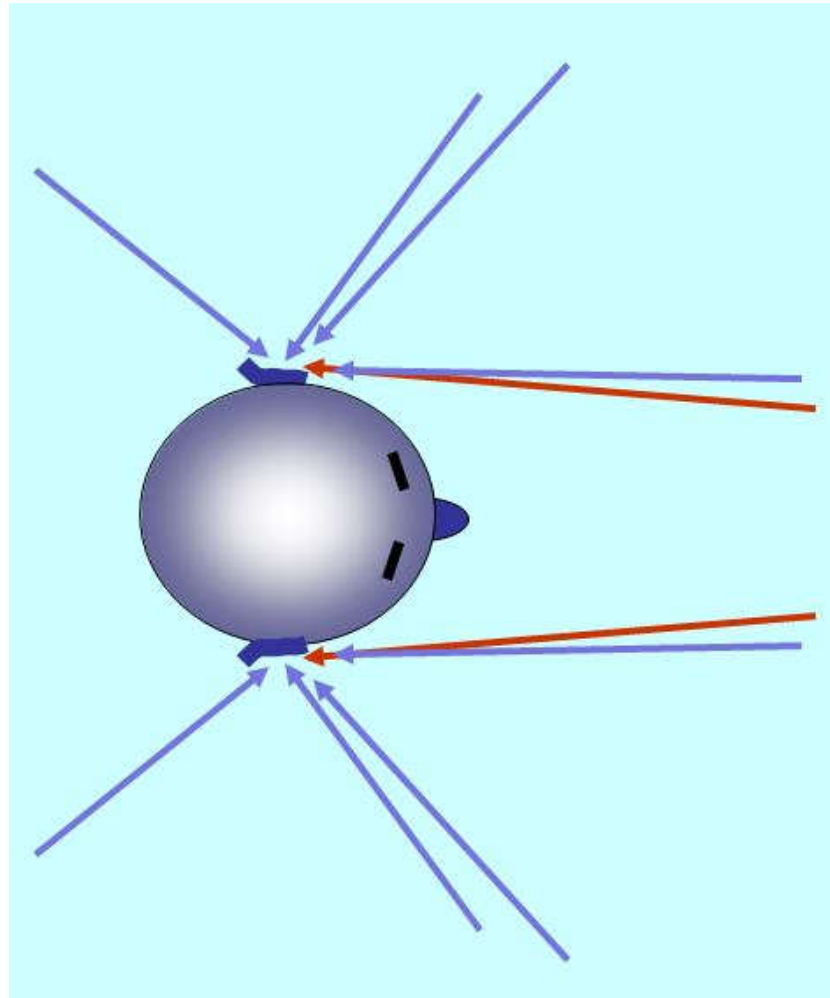
- Head rotations/tracking required for appropriate reproduction

- Direct sound:

- $\Delta t = 0 \text{ ms}$
 - $\Delta L = 0 \text{ dB}$

- Lateral reflections:

- $\Delta t, \Delta L (\phi)$



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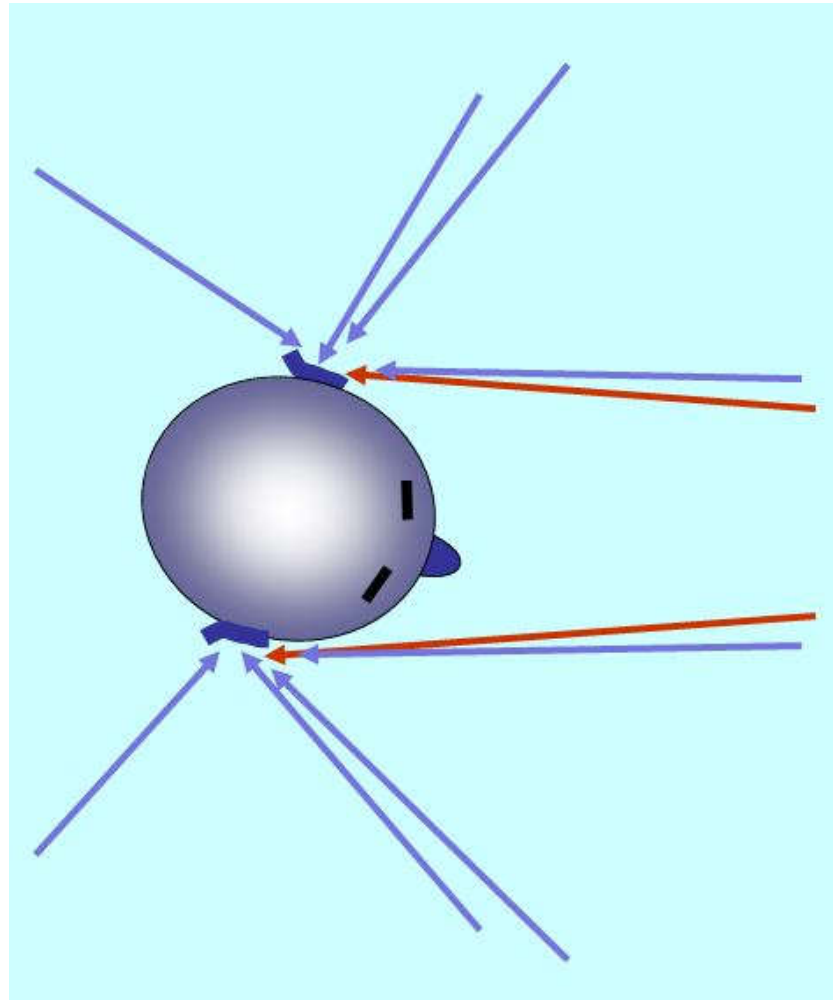
- Head rotations/tracking required for appropriate reproduction

- Direct sound:

- $\Delta t > 0 \text{ ms}$
 - $\Delta L < 0 \text{ dB}$

- Lateral reflections:

- $\Delta t, \Delta L (\phi)$



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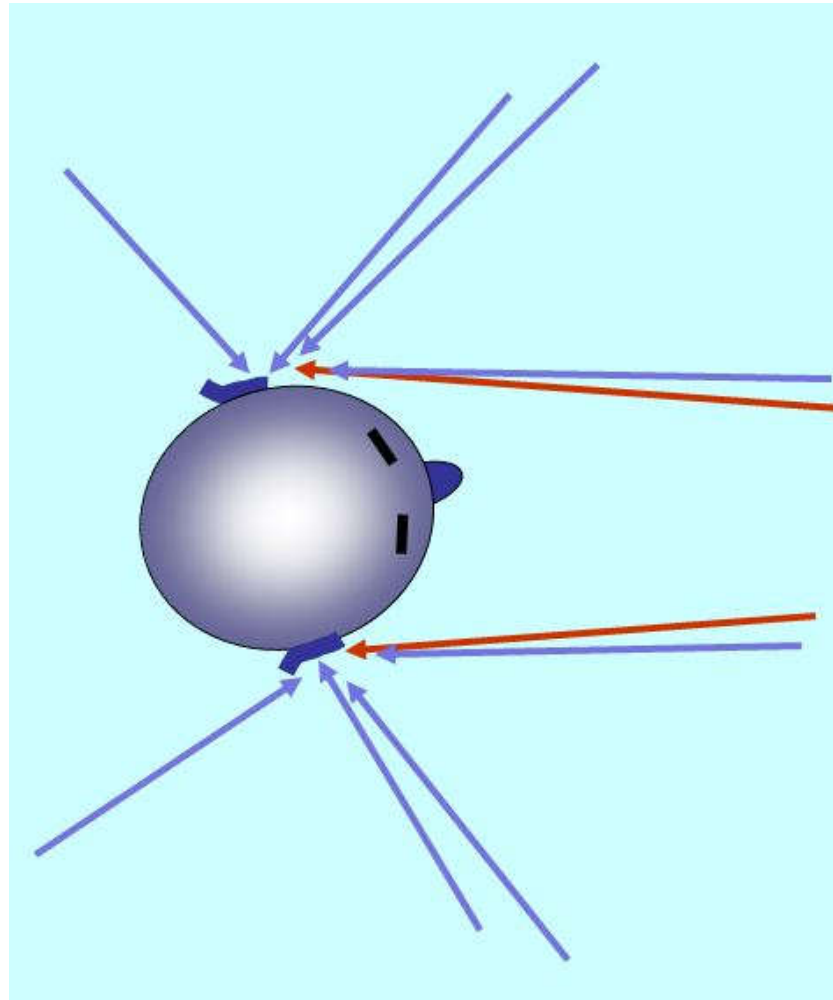
- Head rotations/tracking required for appropriate reproduction

- Direct sound:

- $\Delta t < 0 \text{ ms}$
 - $\Delta L > 0 \text{ dB}$

- Lateral reflections:

- $\Delta t, \Delta L (\phi)$



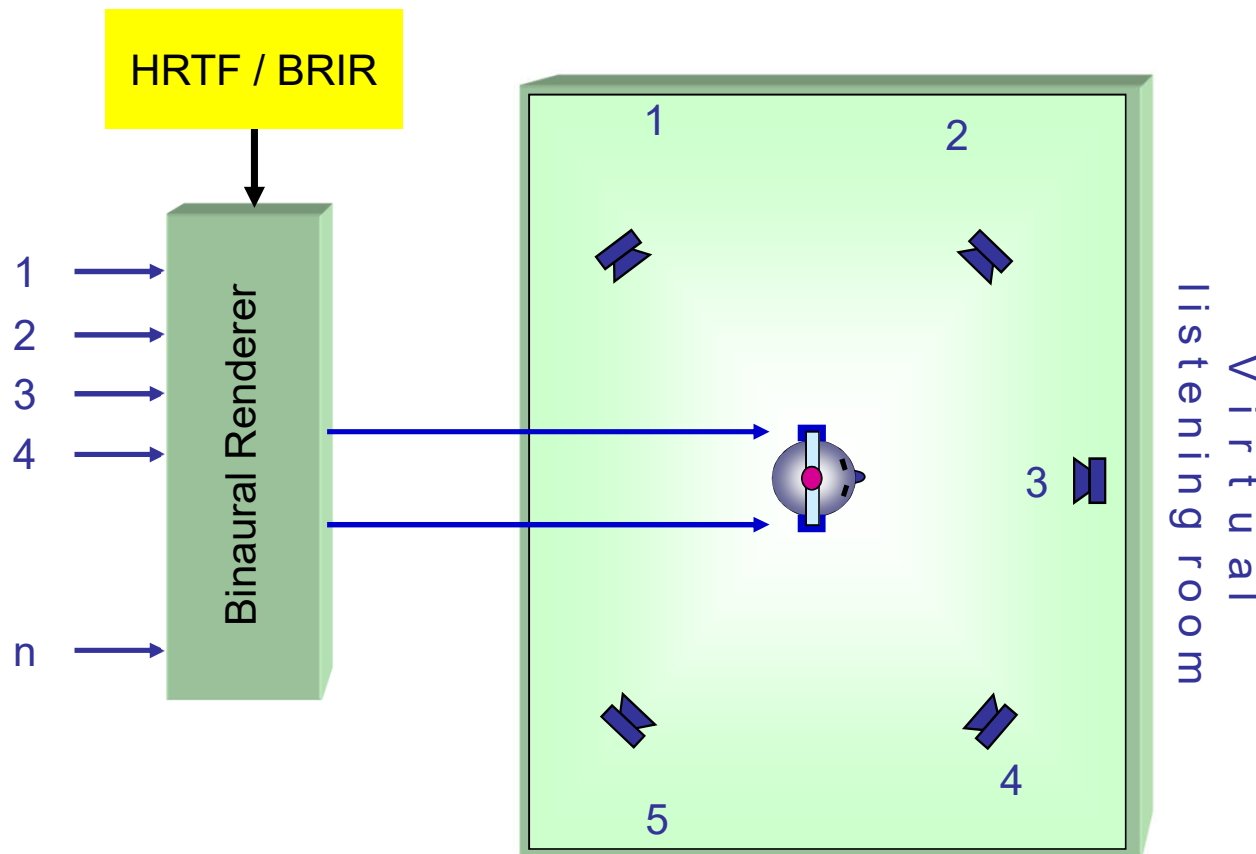
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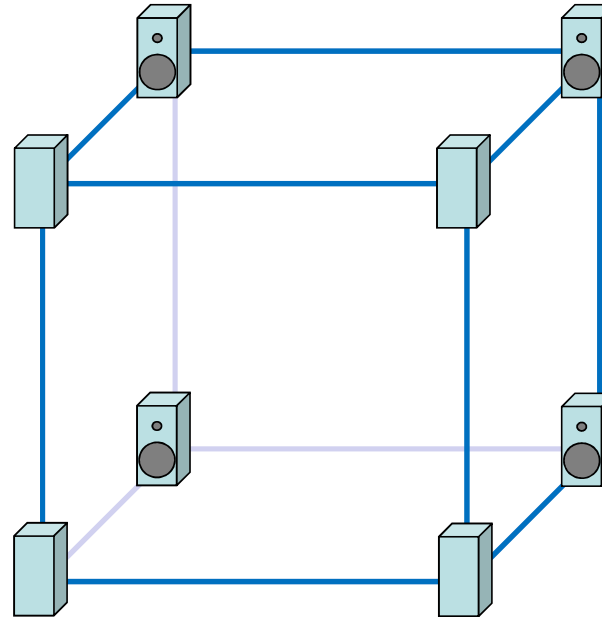
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- Stereo sublayer or „Virtual Panning Spots“ in Binaural
- Similar to IRTs invention „Binaural Room Synthesis“
= **Binauralizing** a stereo setup)



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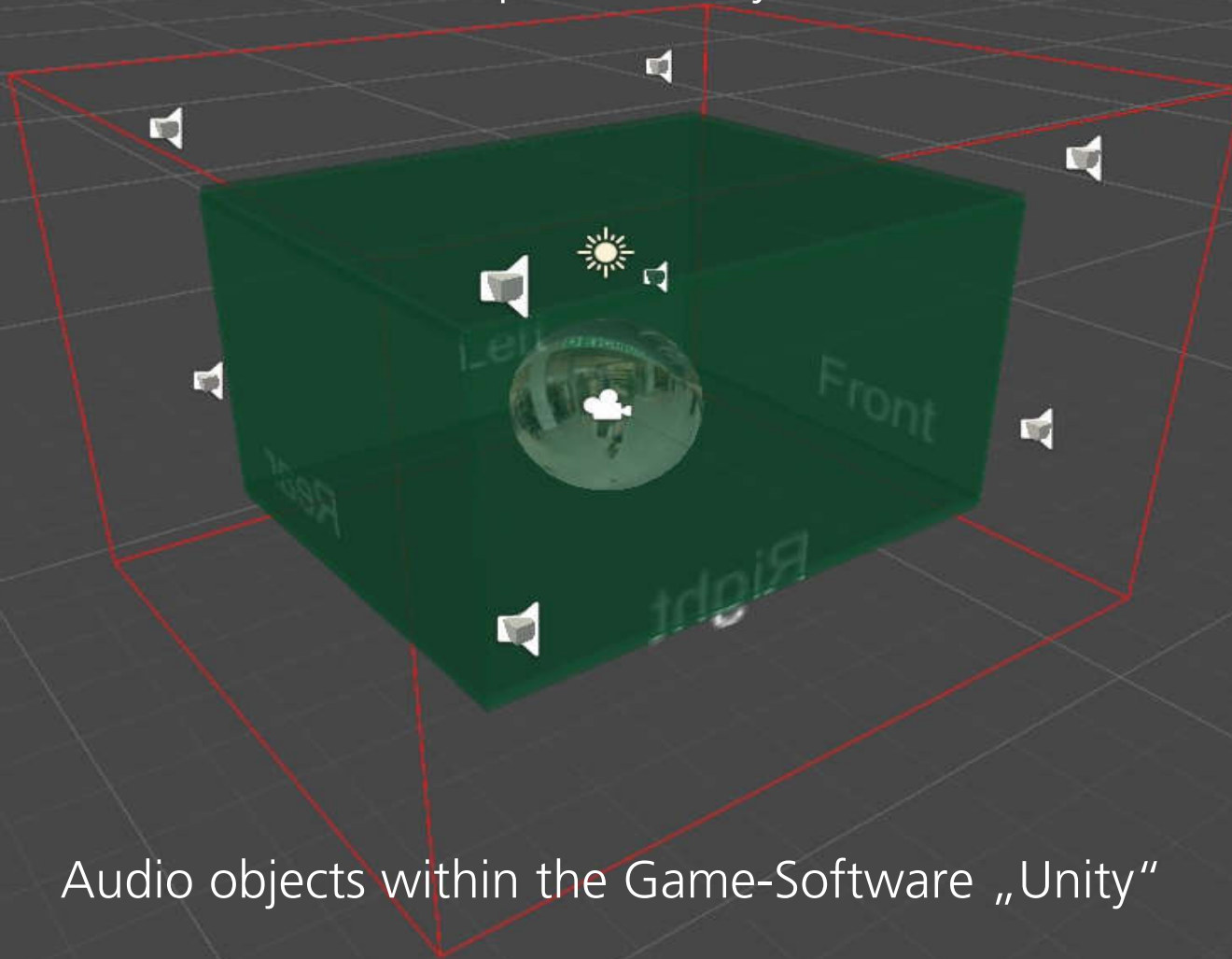
- Stereo sublayer or „Virtual Panning Spots“ in Binaural
 - Cubical Virtual Loudspeaker array



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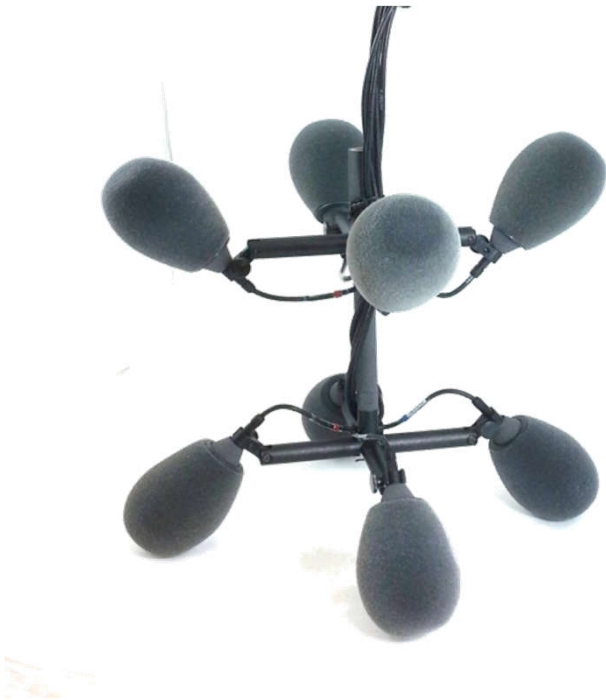
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Audio objects within the Game-Software „Unity“

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- „ORTF-3D, First Prototype“ (© Theile, Wittek)



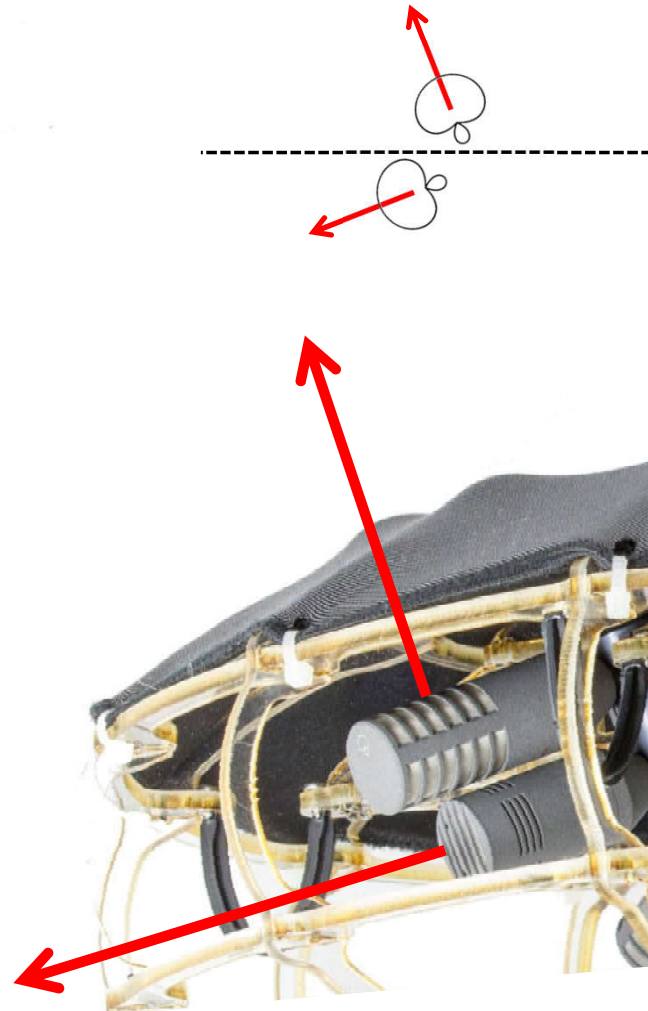
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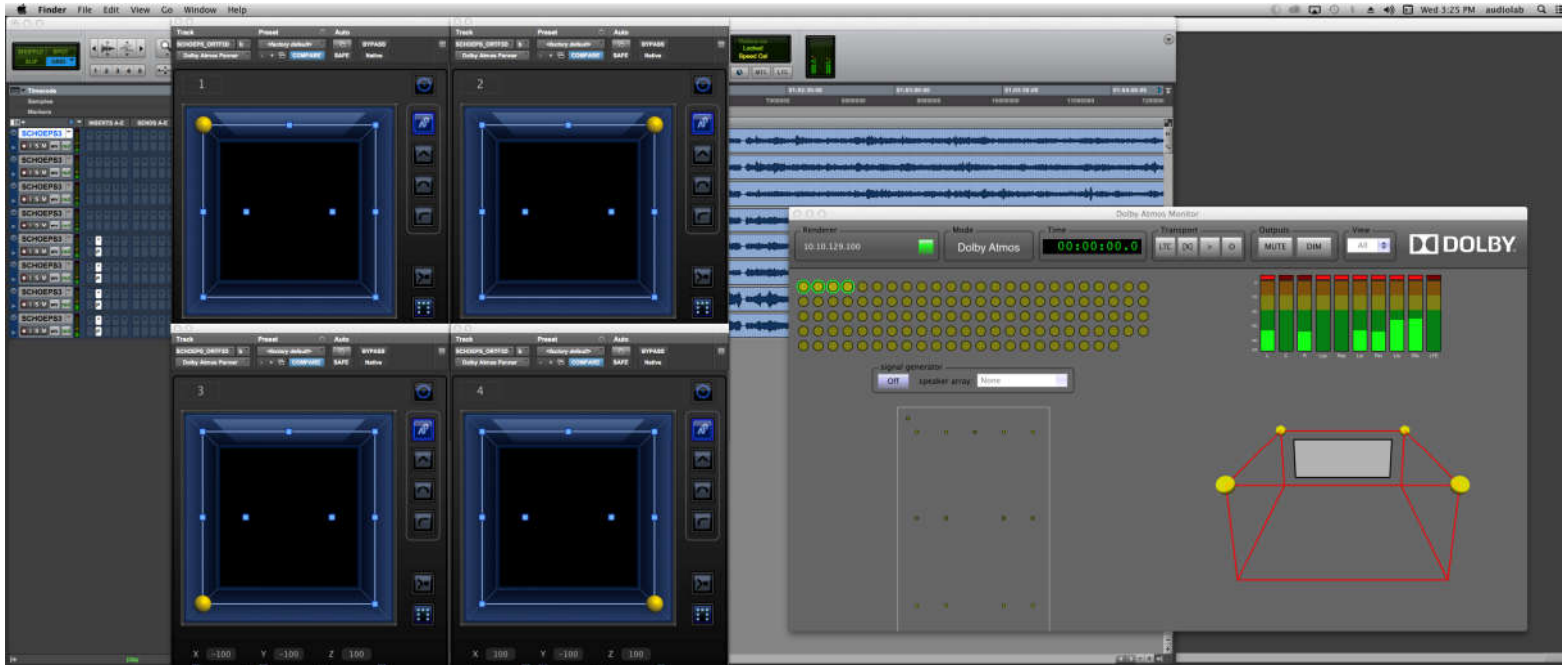
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- Working for Stereo+Height, Dolby Atmos, Auro3D, ...

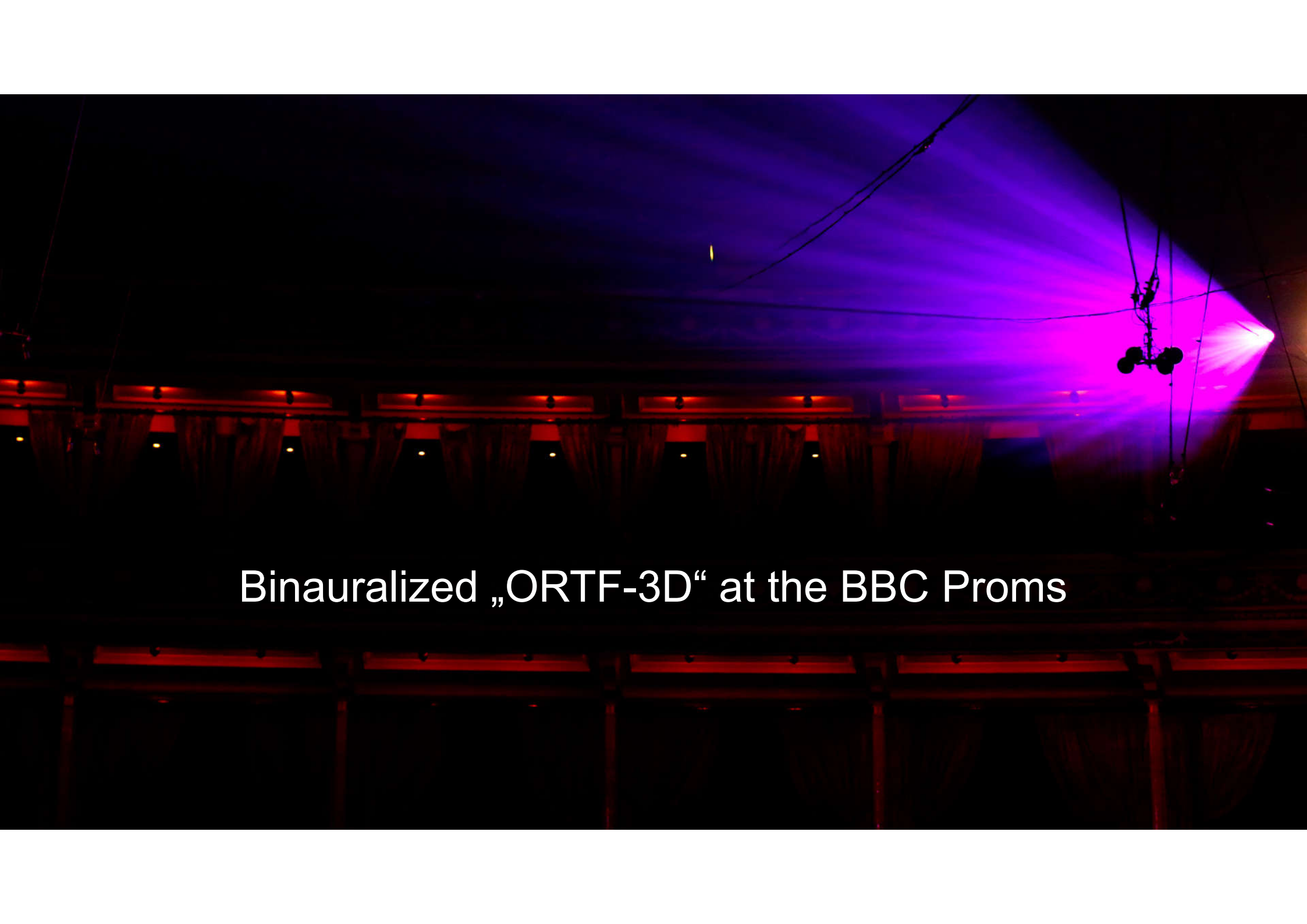


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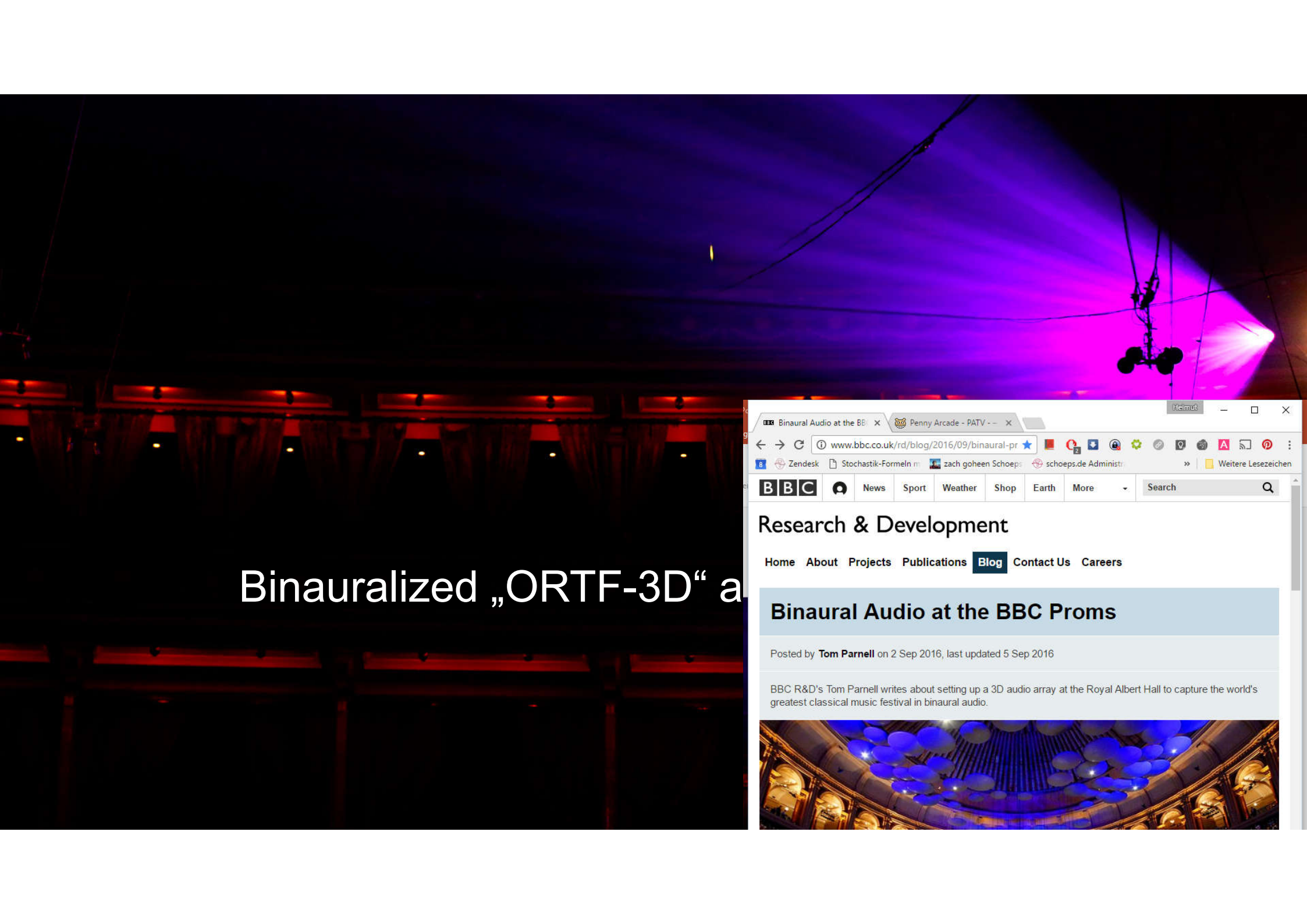
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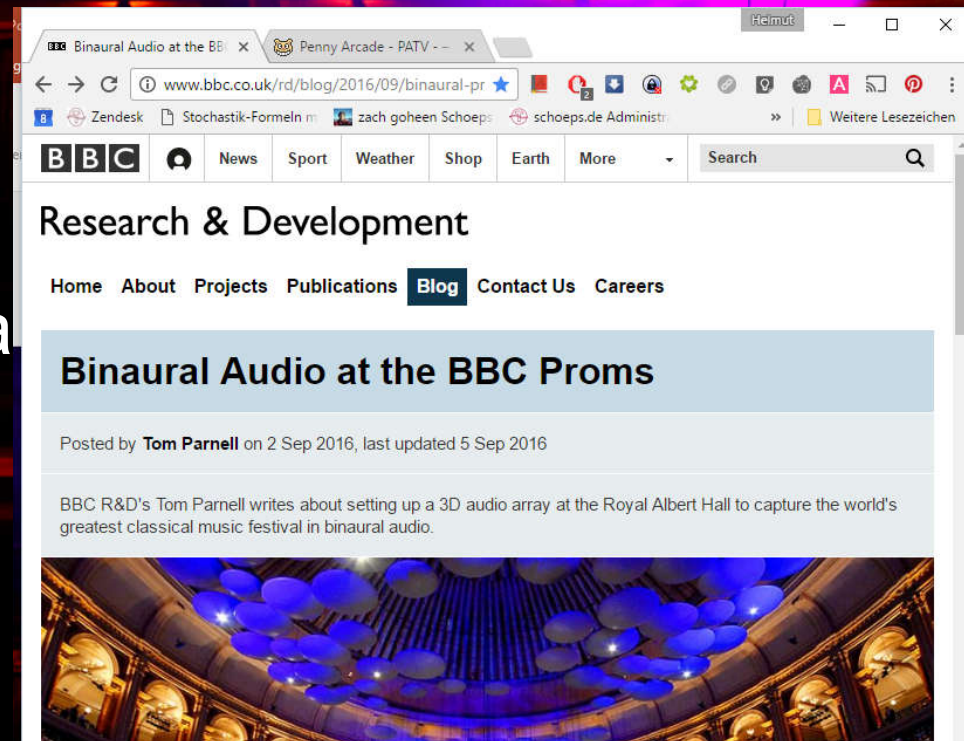
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Binauralized „ORTF-3D“ at the BBC Proms



Binauralized „ORTF-3D“ a



The screenshot shows a web browser window with the BBC Research & Development blog. The page title is "Binaural Audio at the BBC Proms". The post is by Tom Parnell, dated 2 Sep 2016. The text describes the setup of a 3D audio array at the Royal Albert Hall. Below the text is a photograph of the hall's interior, featuring a large, ornate ceiling with many blue, circular light fixtures.

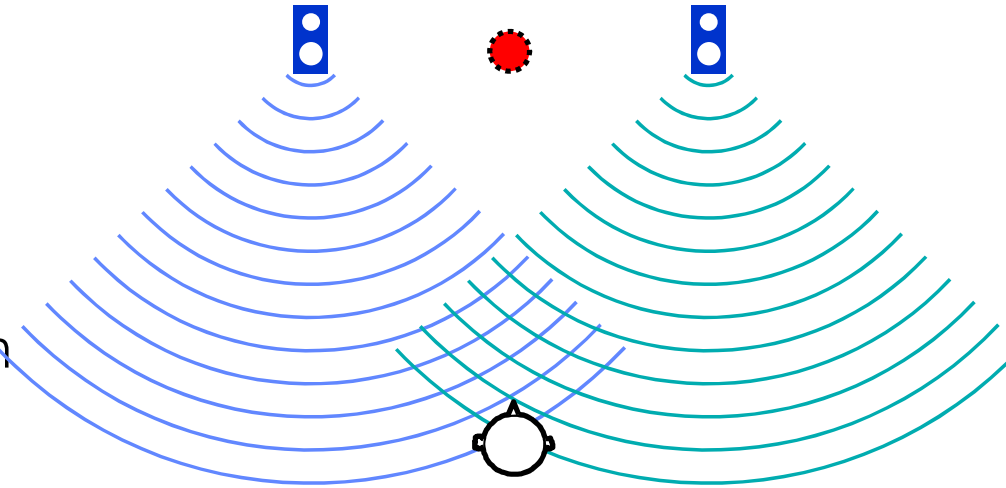
Binaural Audio at the BBC Proms

Posted by **Tom Parnell** on 2 Sep 2016, last updated 5 Sep 2016

BBC R&D's Tom Parnell writes about setting up a 3D audio array at the Royal Albert Hall to capture the world's greatest classical music festival in binaural audio.

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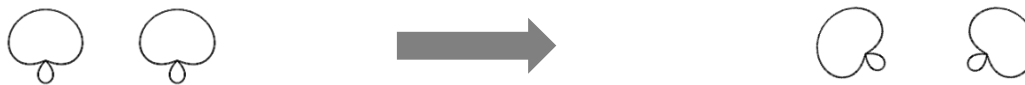
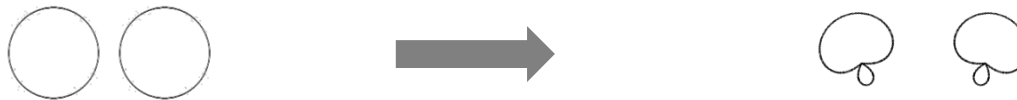
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- Signal separation!



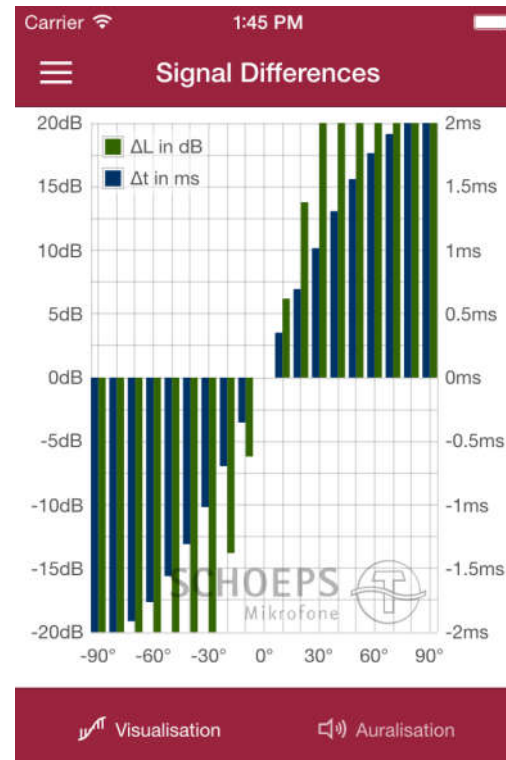
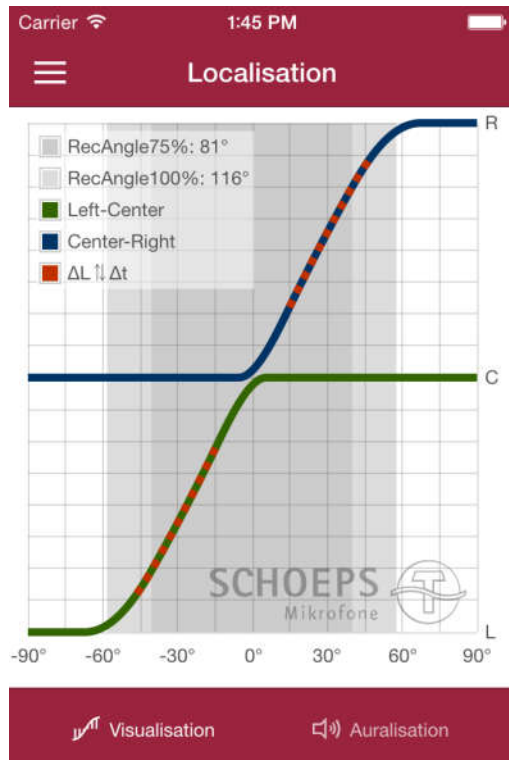
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- SCHOEPS-App "Image Assistant": App Store or ima.schoeps.de

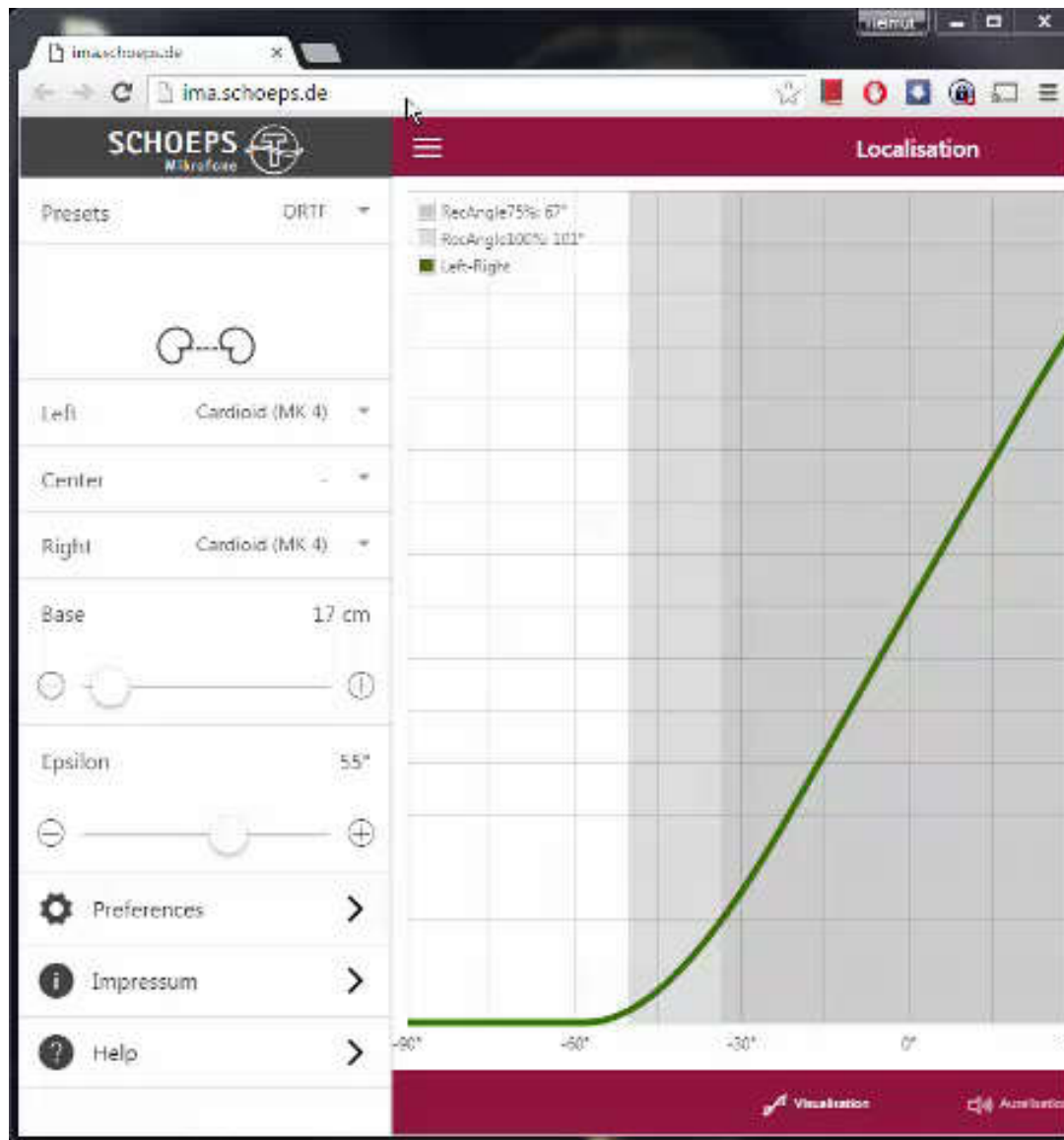


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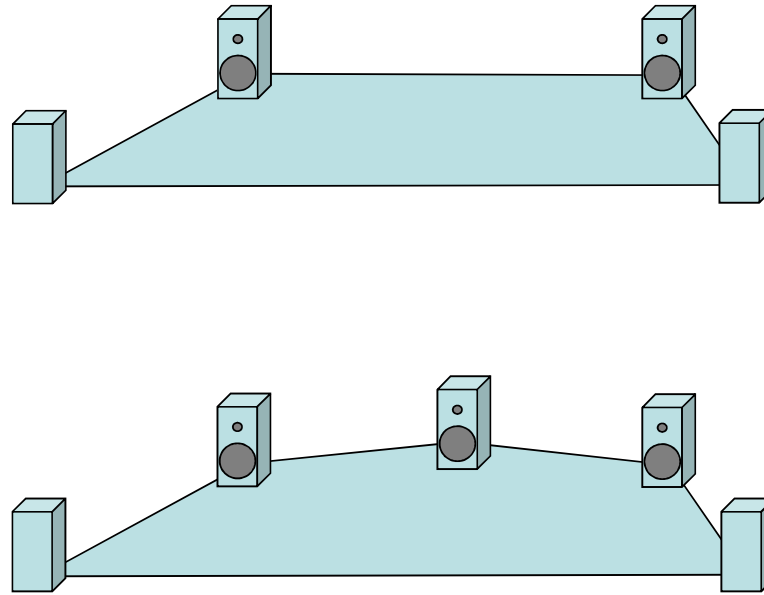
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- 3D-Audio: Stereo+Height
- Auro3D 9.1
- Dolby Atmos 5.1.4

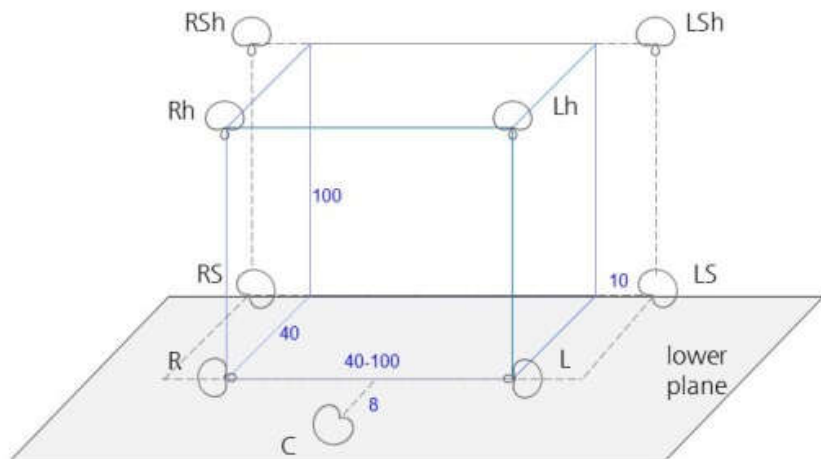


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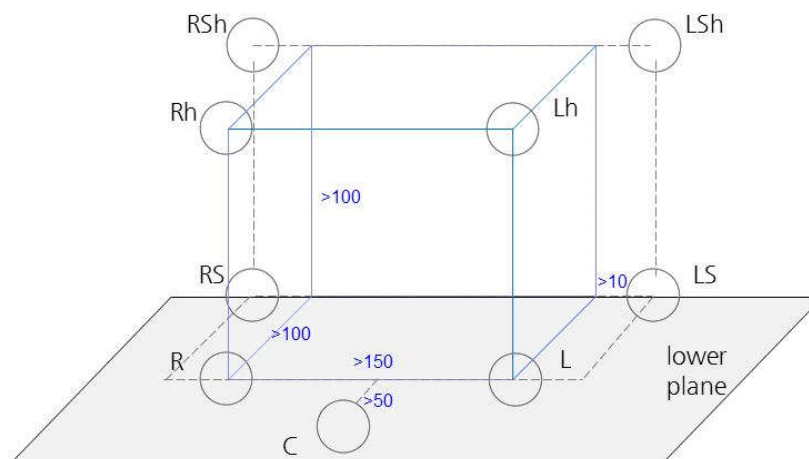
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- Δt or ΔL

ORTF - type techniques



A/B - type techniques



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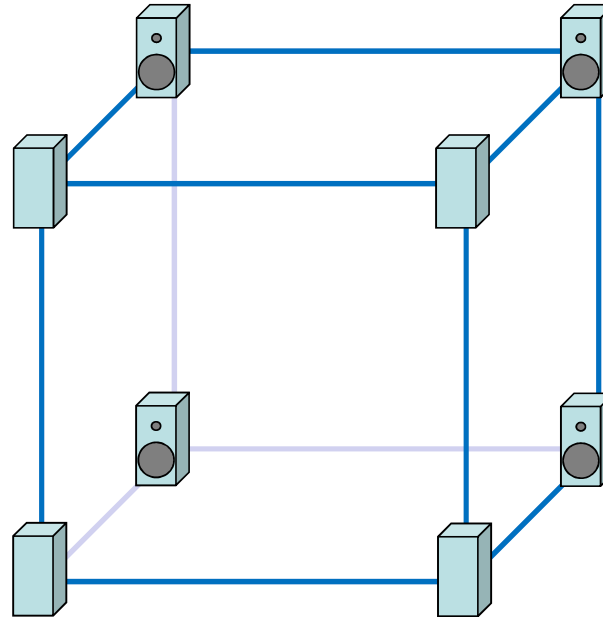
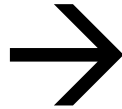
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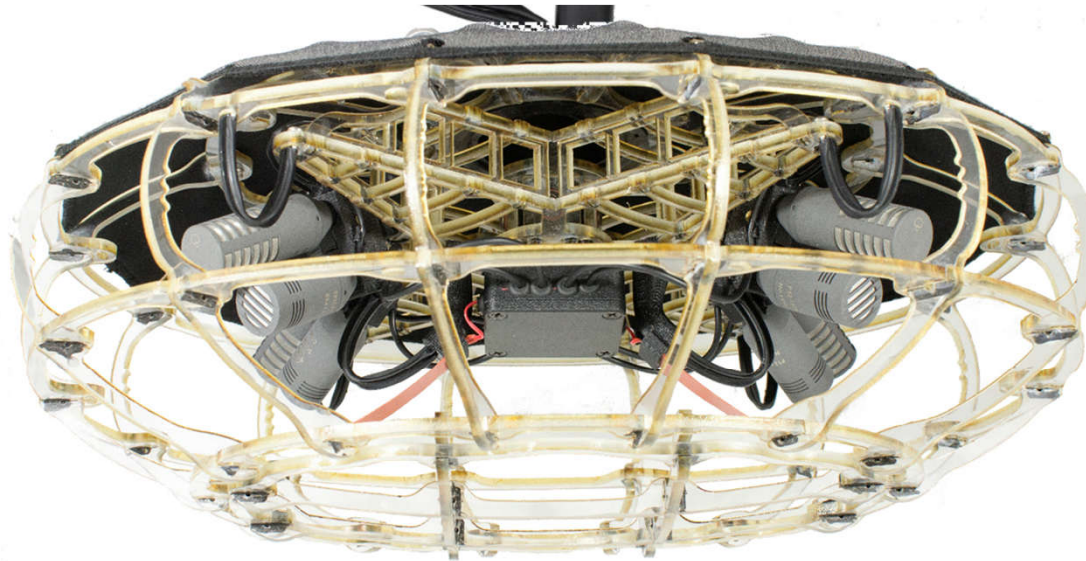
- Conclusions
 - Sound engineers: **trust your ears**, don't believe in „scientific“ approaches without skepticism
 - Better make **good Stereo** than bad unperfect physical reproduction
 - An unperfect physical reproduction can sound much worse than a good Stereo recording (Example: First Order Ambisonics is worse than a good 9.1 Decca Tree)
 - Use **Stereo layers** for ambient sources and spatial recording in a WFS/Ambisonics/Binaural reproduction (Example: 9ch Decca-Tree recording on a Auro3D 9.1 preset put in a binaural renderer)
 - Use Stereo to be able to work in a sound engineering way, caring for **aesthetical** aspects
 - The **ORTF-3D** microphone is a good approach for recording a 3D ambience for all formats

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Thank you!

- wittek@schoeps.de
- www.hauptmikrofon.de

tmt29
expertise in audio media

Microphone recording
for 3D-Audio

- 3D-Audio formats
- Copying the sound field
- The „Uncanny Valley“
- Stereo layers for 3D
- Stereo basics
- ORTF-3D

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