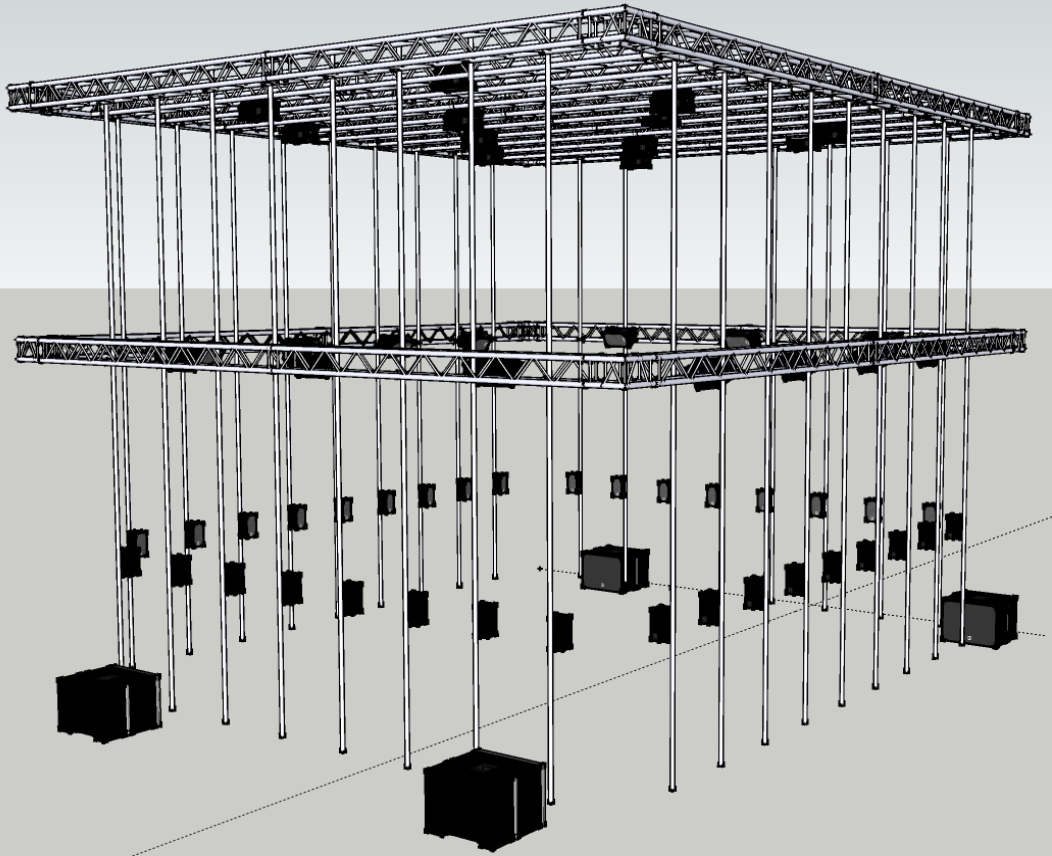
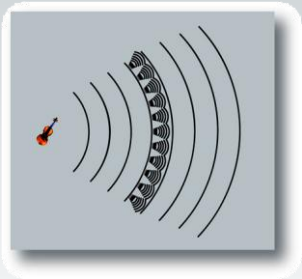
UNIVERSITEIT GENT

Art & Science Lab: Wavefield Synthesis

Bart Moens – Bart.moens@ugent.be – 25/11/2017





Dante™

BARCO Visibly yours

IOSONO the future of spatial audio

DE KROOK

Contents

- Part 1: Introduction to Wavefield Synthesis & 3D audio
- Part 2: Barco's IOSONO devicve
- Part 3: Hands-on session & documentation
  - Usecase 1: fixed sound positions
  - Usecase 2: adaptable sound positions
    - OSC protocol
    - Ableton Live Plugin for IOSONO
    - Max MSP
  - Practical issues: sharing the core

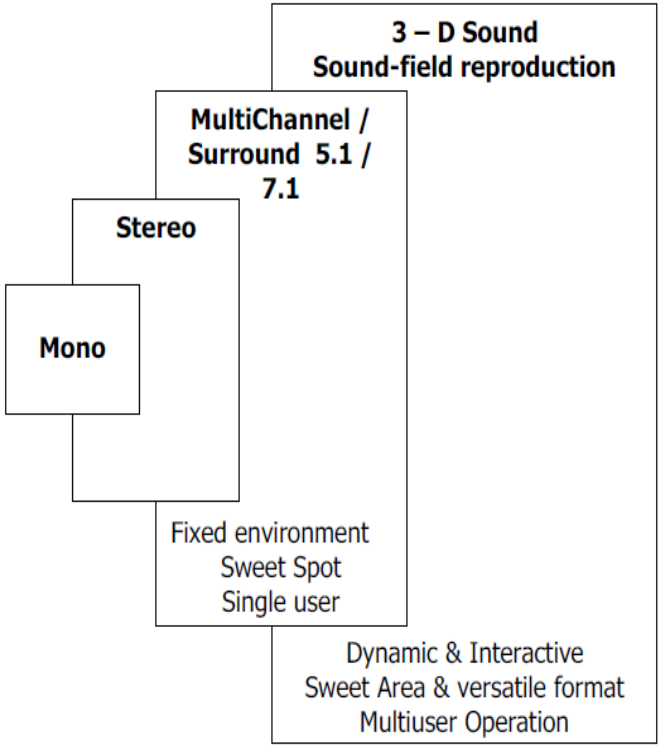
Goal of the workshop

- Disclaimer: I am not an expert in WFS or 3D sound! Some of the presentation is created by IRCAM & SonicMotion.

- The goal is to showcase and share our current knowledge and the IOSONO system

- The idea is to stimulate participants into thinking in 3D sound - generating new ideas, theories, concepts and experiments for the lab

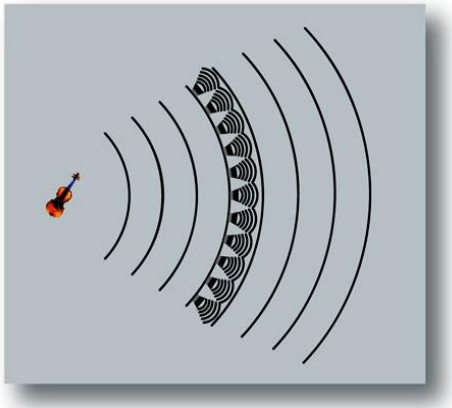
Evolution of Sound (re)production



Wave Field Synthesis (WFS)

- Sound sources emit certain wave fields

- WFS = Reproduction with secondary sources according to Huygens Principle (1678)

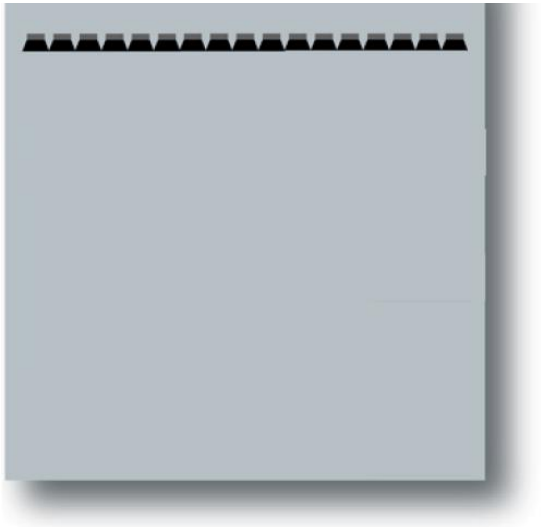


Wave Field Synthesis (WFS)

- Wave field synthesis (WFS) is a spatial audio rendering technique, characterized by creation of virtual acoustic environments and sources.
- Requires speakers placed adjacent to each other, typically called *'transducer array'*
- ***Results in 'holographic 'sounds***

Wave Field Synthesis (WFS)

- WFS produces artificial wave fronts synthesized by a large number of individually driven loudspeakers.



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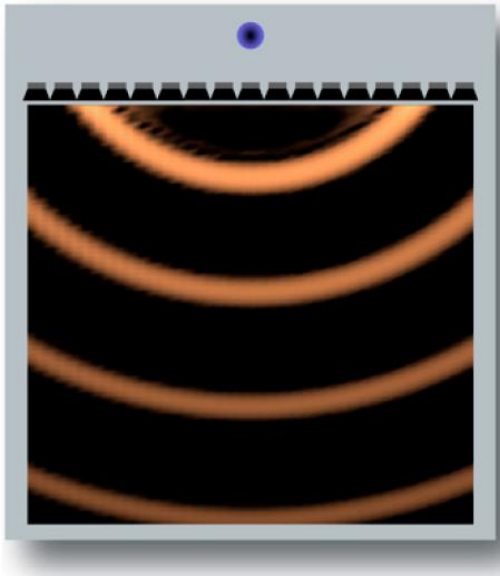
- Wave fronts seem to originate from a virtual starting point: the 'virtual source'.



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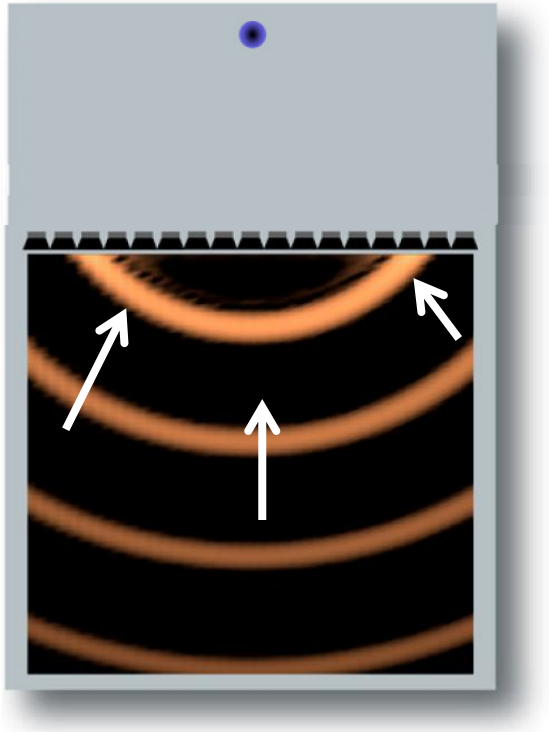
- Contrary to traditional spatialization techniques such as stereo or surround sound, **the localization of virtual sources in WFS does not depend on or change with the listener's position**



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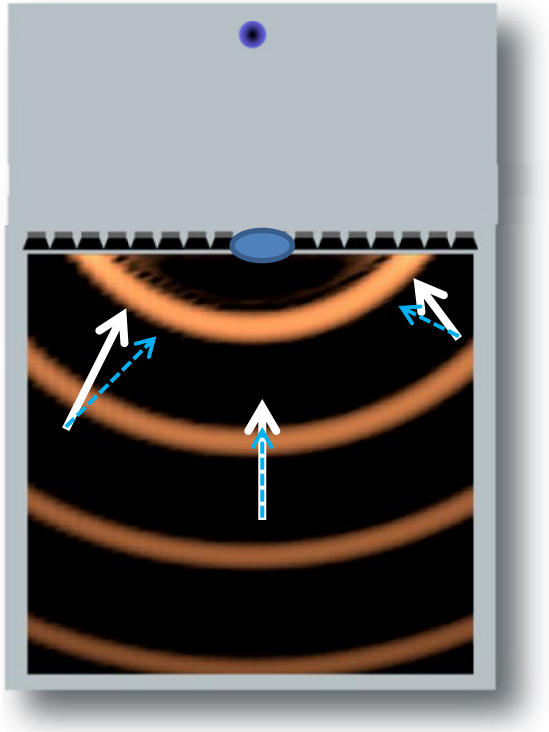
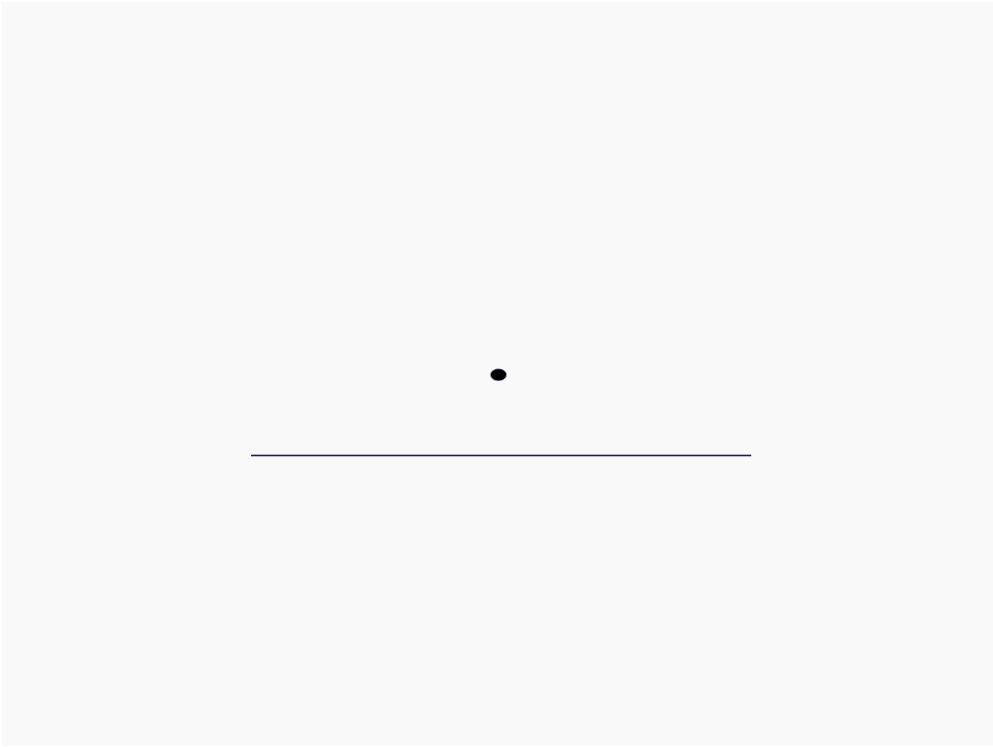


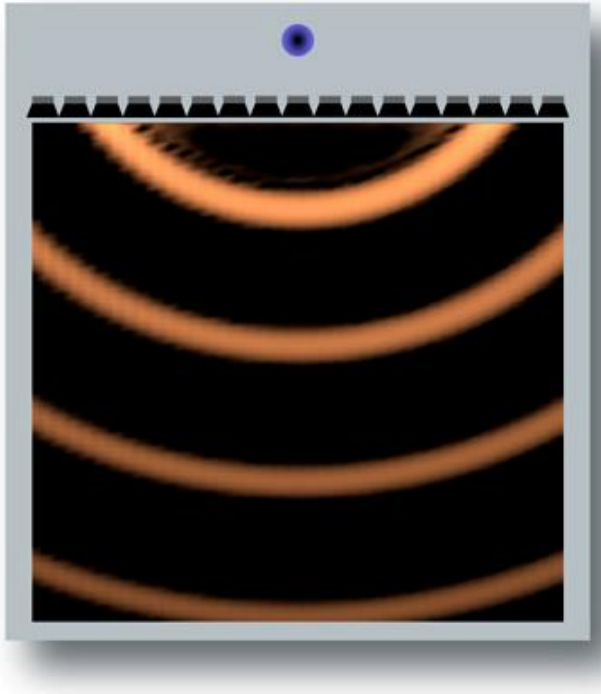
Wave Field Synthesis (WFS)

- Think ‘sound object’ or source instead of sound.
  - The sound object includes ‘positional data’
  - https://en.wikipedia.org/wiki/Wave_field_synthesis



WFS: Virtual point source

- Perceived at a precise position.
- Natural variation of localization cues with listener movements



WFS: Plane Wave

- Perceived everywhere from the same angular direction.
- Unlike point sources, monitoring of direction instead of position
- “Follows” the listener movements

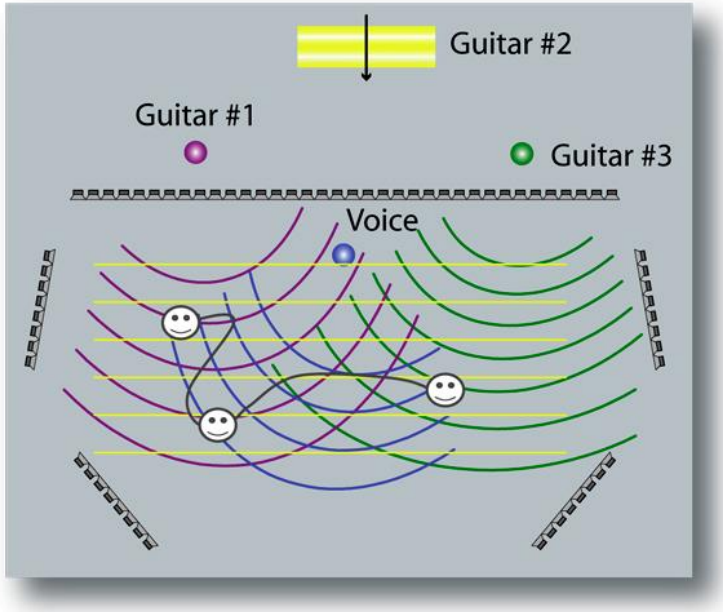
WFS: focus source

- **Point source inside listeners area**

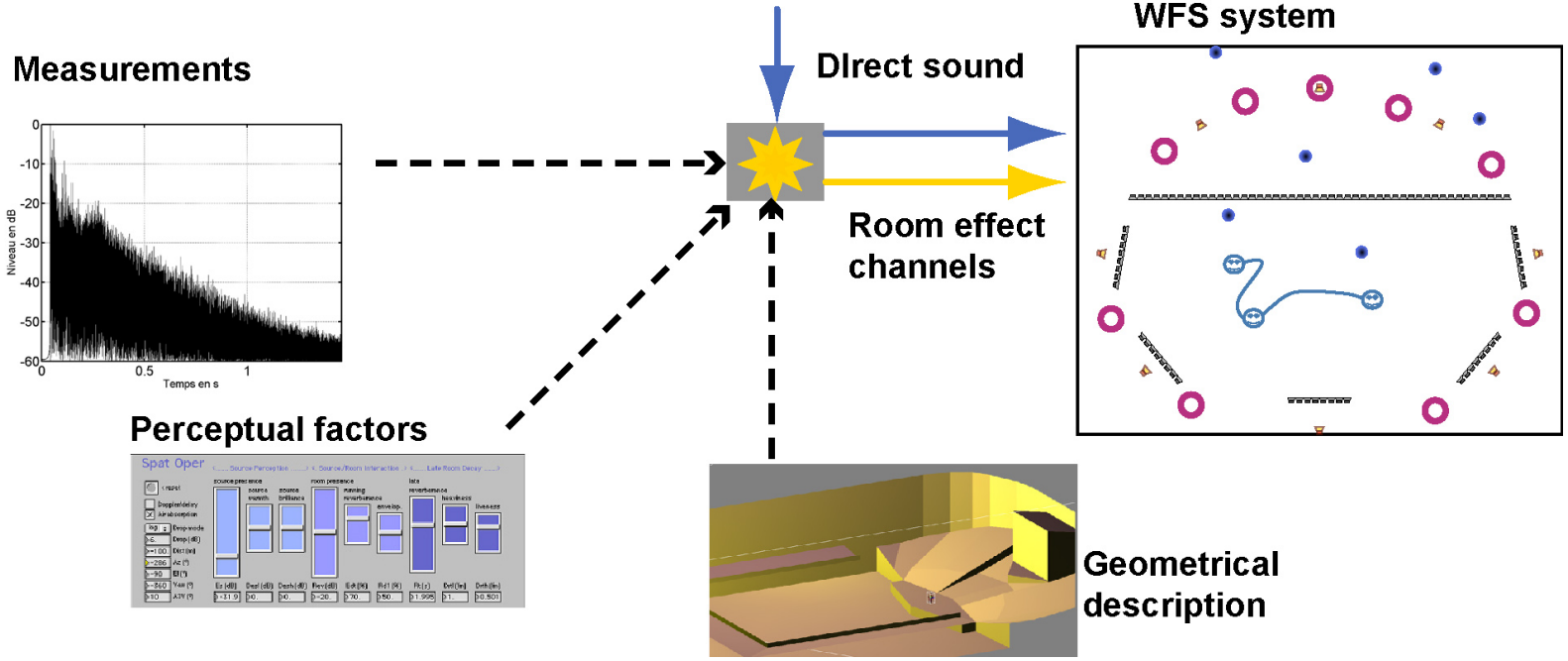
- Perceived everywhere from the same point in the room
- Using simulated reflections
- Most ‘tricky’ source due to unwanted acoustic interference/reflections

WFS to create sound perspective

- Combine sources to create Immersive sound scene
- During navigation the listener experiences a multi-sensorial spatial situation (Augmented Reality)
- Variation of auditory cues remains coherent with listener movements throughout the sound installation.
- Elicits “presence”, learning and memorization of sound scene spatial organization



WFS to create room effect synthesis (IRCAM showcase)

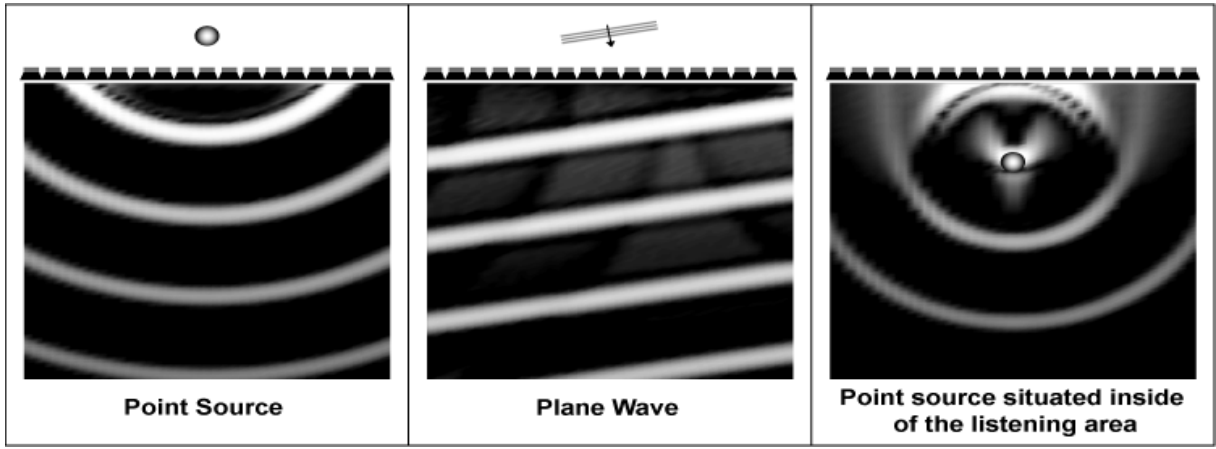


WFS: Audio format

- Impractical to store >64 individual audio channels for a simple sound stream.
- Room independant storage (play it elsewhere on WFS system)
- **Solution? Store 'raw' audio *and* sound type and position**

WFS: Summary

- Holographic sound
- Different audio sources
- Audiodata includes spatial data



Part 2: Barco's IOSONO

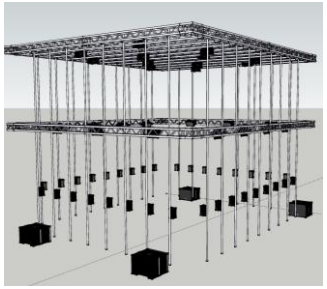
Barco IOSONO

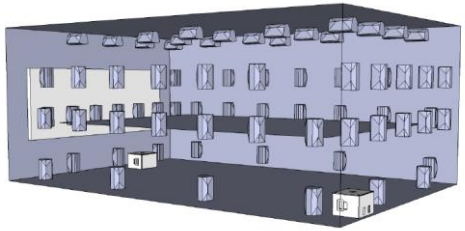
- 'IOSONO Core' is a device from Barco which implements WFS
- *IPEM & IMEC share one IOSONO core for two labs*

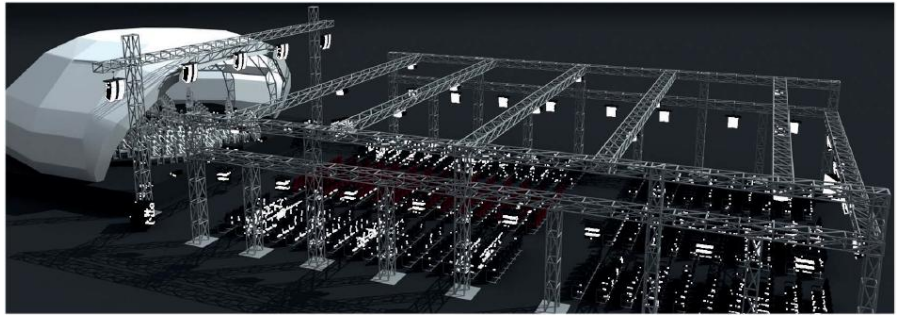
- IOSONO calculates all discrete speaker signals
  - Send audio and positional data and the IOSONO calculates which speaker should make which sound at what time

IOSONO vs WFS

- WFS requires speakers placed adjacent to each other
  - IOSONO's implementation *promises* higher speakers distance
  - Larger audiences & better cost-return ratio.
- User-friendlynes: 'outsource' all calculations
- Room-independent: easily transpose composition to different room by changing speaker setup







WFS: IOSONO

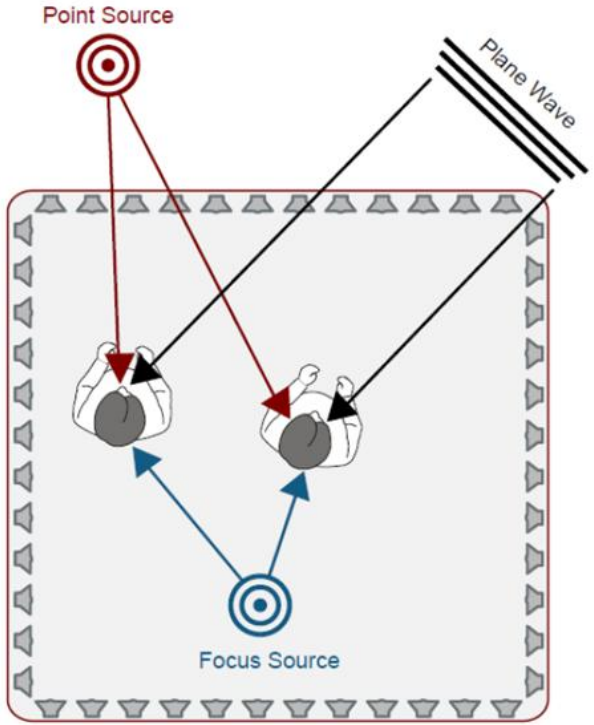
Wave Field Synthesis

..evokes different perceptual effects for the listeners inside the audience

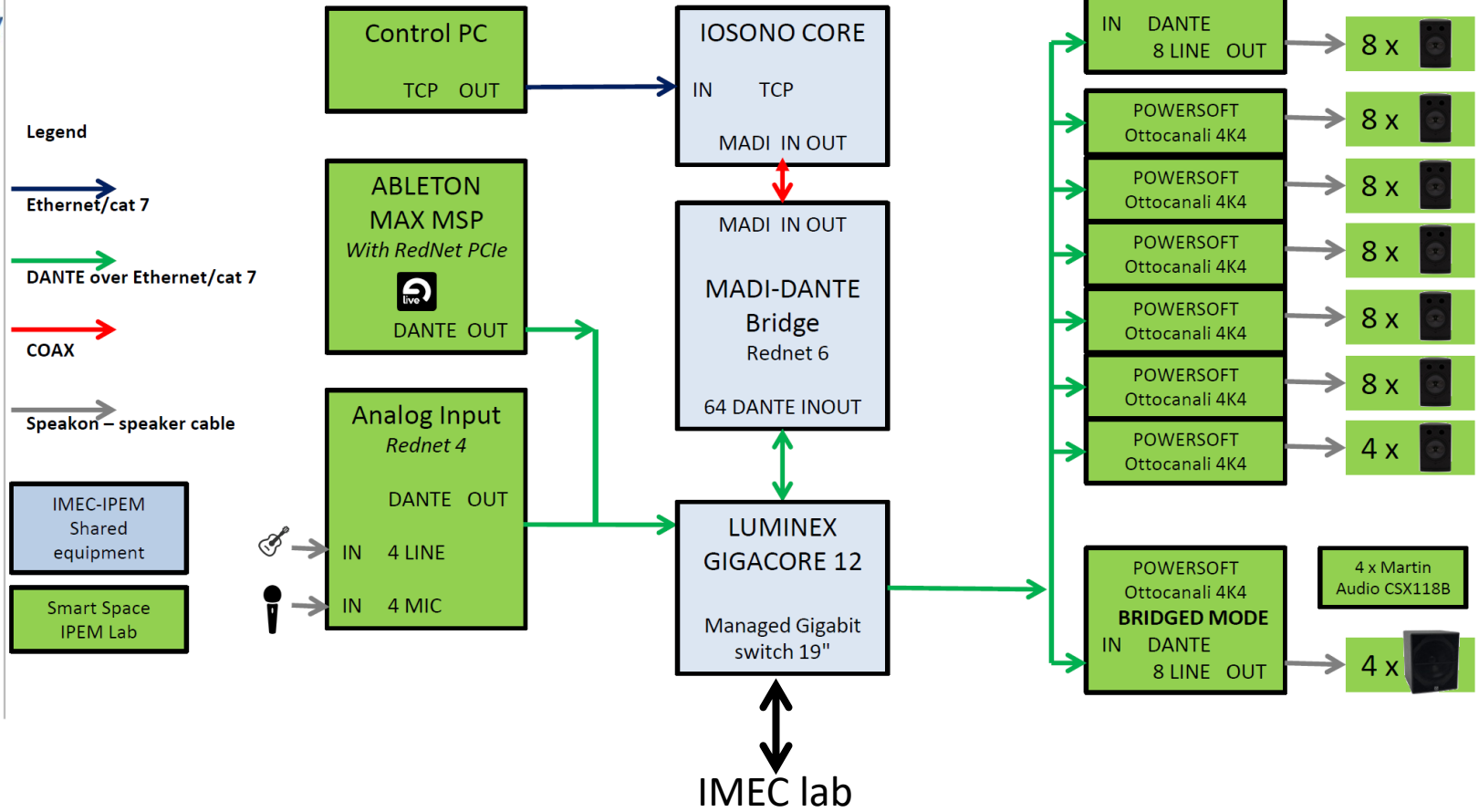
Plane Wave
identical direction of a sound

Point Source
identical sound location

Focus Source
energy peak inside the system



IOSONO setup IPEM LAB



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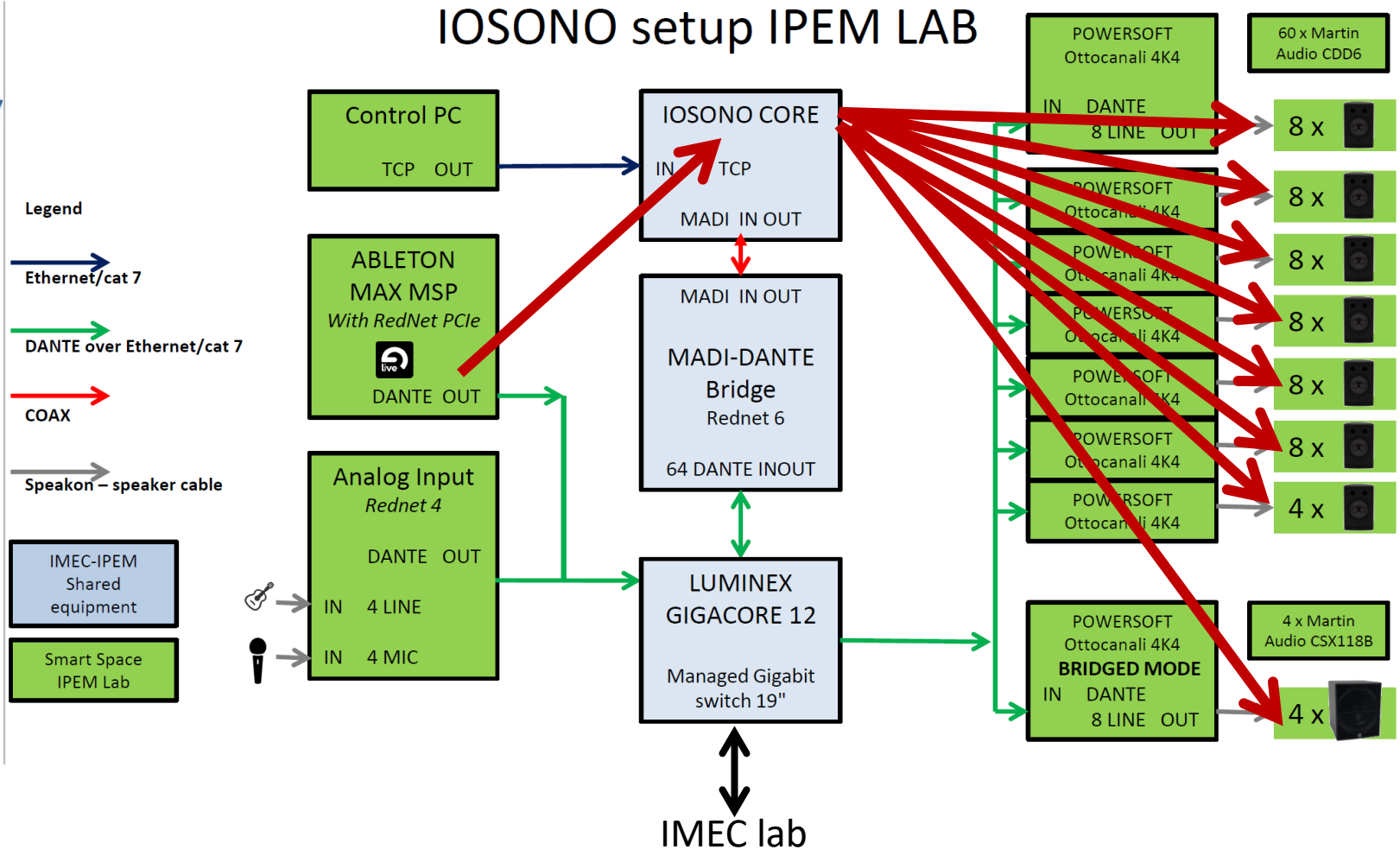


Theory vs practice? Demo-time!

IOSONO 'perks'

- Some things we noticed already:
  - Iosono lacking distance attenuation (far sources sound equally loud as near sources)
  - Focus source doesn't work as advertised (due to acoustics/reflections/lack of calibration)
  - Obstruction between virtual source & speakers dilute the effect (eg listener stands between speaker & virtual source -> no effect)

IOSONO plans

- **Acoustic treatment of the room (reduce reflection)**
- **Calibrate the system**
  - Matching the speakers so they sound exactly the same at central focus point (using FIR/FFR/attenuate)
- Both should improve the effect!

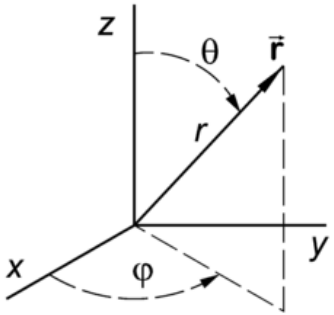
Thank you for your attention!

- Questions?

- Next up: practical hands-on session
  - Usecase 1: fixed sound positions
  - Usecase 2: adaptable sound positions
    - OSC protocol
    - Ableton Live Plugin for IOSONO
    - Max MSP
  - Practical issues: sharing the core

IOSONO 'Cheat Sheet'

- IP Adress: 10.100.20.10
  - Configure your IP manually
  - subnet 255.255.255.0
  - Download software at core IP
- Coordinate system: Spherical, radians!
- This presentation and demo's:
  - https://github.com/ArtScienceLab/LabDocumentation
  - https://github.com/ArtScienceLab/Iosono4Live
  - https://github.com/ArtScienceLab/Iosono4MaxMSP
- OSC command: send the following at 100hz to the core:



$$x = \rho \sin\varphi \cos\theta$$
$$y = \rho \sin\varphi \sin\theta$$
$$z = \rho \cos\varphi$$

$$\text{Radians} = \left(\frac{\pi}{180^{0}}\right) \times \text{degrees}$$

$$\text{Degrees} = \left(\frac{180^{0}}{\pi}\right) \times \text{radians}$$

/iosono/renderer/version1/src channel sourcetype theha phi r volume lowpassfilter delay scaling screen spread trait

Input channel (int)	type (int) 4 = point 5 = plane	Angle Radians! (float) -3.14 -> 3.14	Radius Straal Float 0.0 -> 10.0 'meters'	Set volume to 1.0 (float) Lowpass to 0.0 (float) Delay to 0.0 (float) Scaling to 0 (int) Spread to 0.0 (float) Trait to 0 (int)