DIRECTIONAL HEARING

Study aid for learning of Communications Acoustics

VIHIM 000

Prof. Fülöp Augusztinovicz

BME Dept. of Networked Systems and Services

fulop@hit.bme.hu

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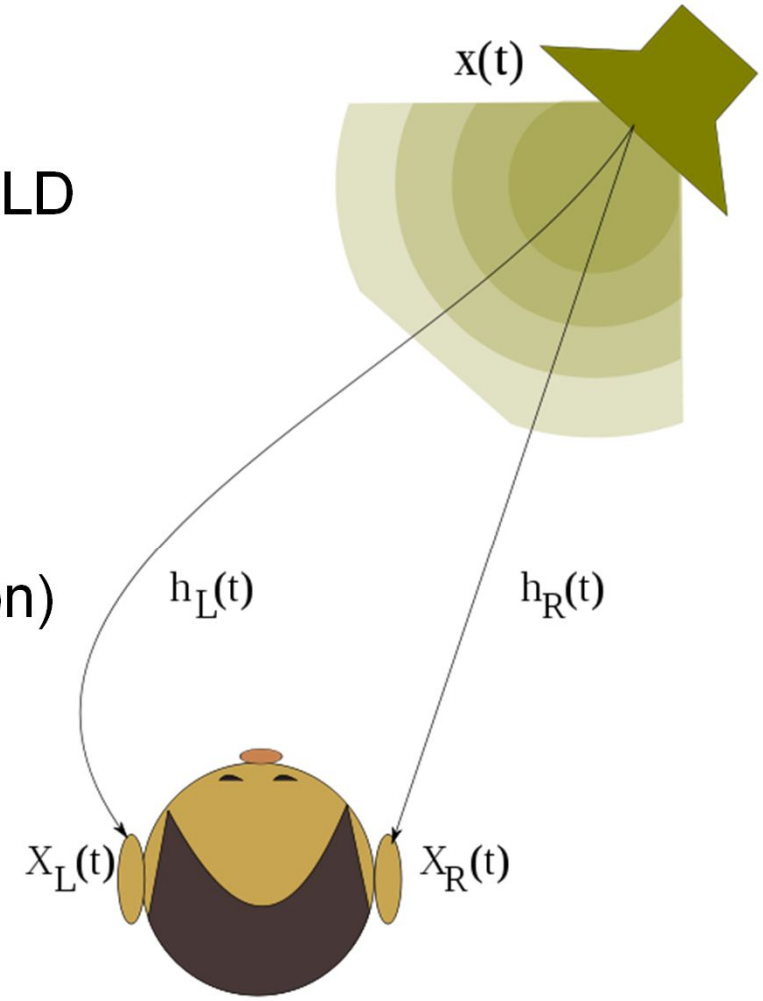
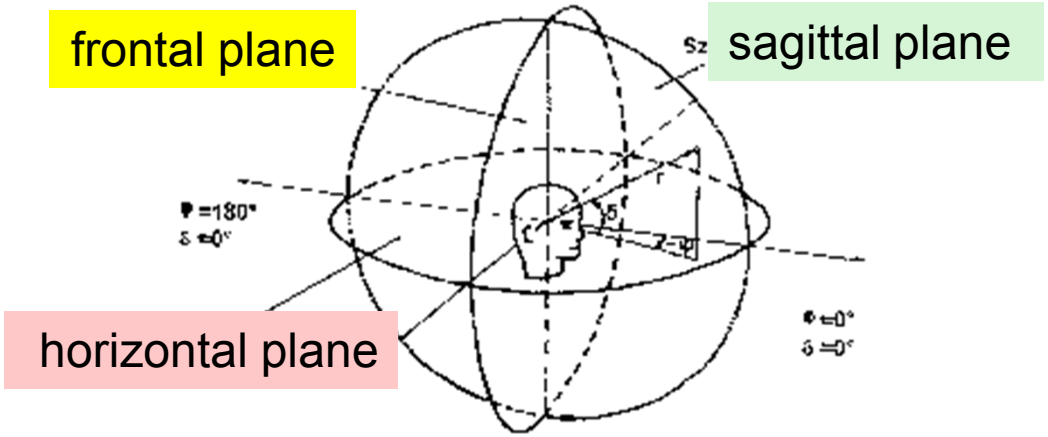
Basics of the directional hearing

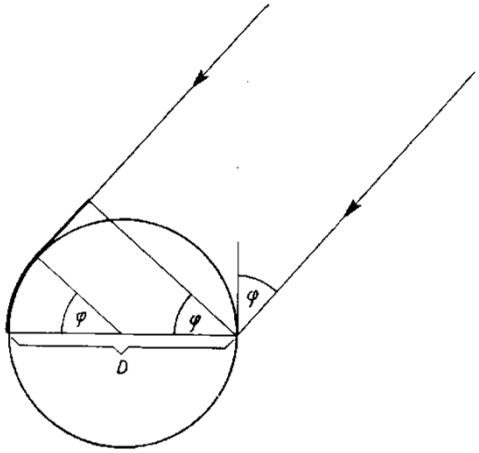
- Two differences:
  - inter-aural time difference, ITD
  - inter-aural intensity difference, ILD
- Implication:
  - Distinct transmissions from source to left & right ears
  - Ratio of the two FRFs: HRTF (Head Related Transfer Function)



Basics of directional hearing

- Geometry of directive hearing





Directional hearing

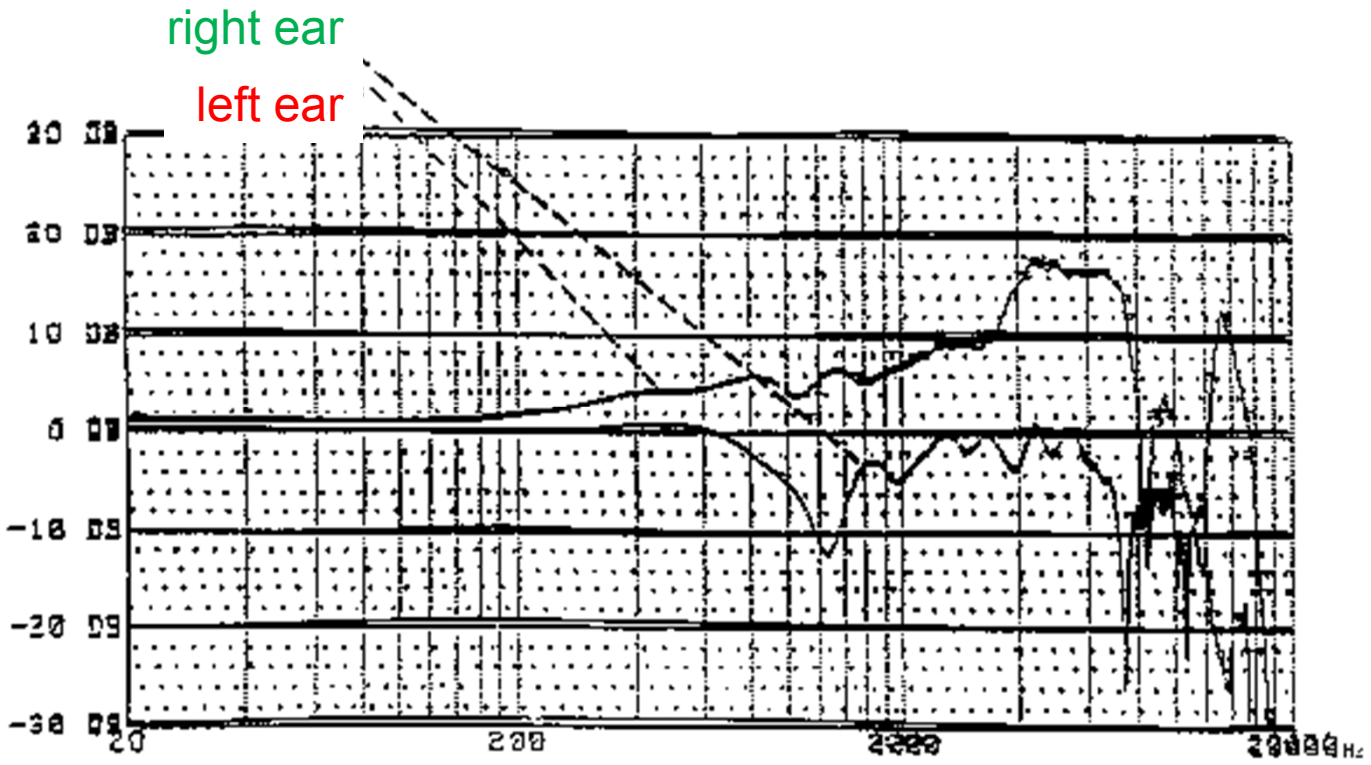
- Operating mechanisms for various frequencies:
  - For low frequencies the relative intensity differences are not relevant (due to the diffraction effect)
  - For high frequencies the phase differences are not relevant/useful, if the travel time delays are in the order or magnitude of the wavelength, or higher

Therefore

- For low frequencies it is ITD while for high frequencies it is ILD which is more appropriate
- Unfortunately, according to newer experiments the problem is not so simple

HRTF

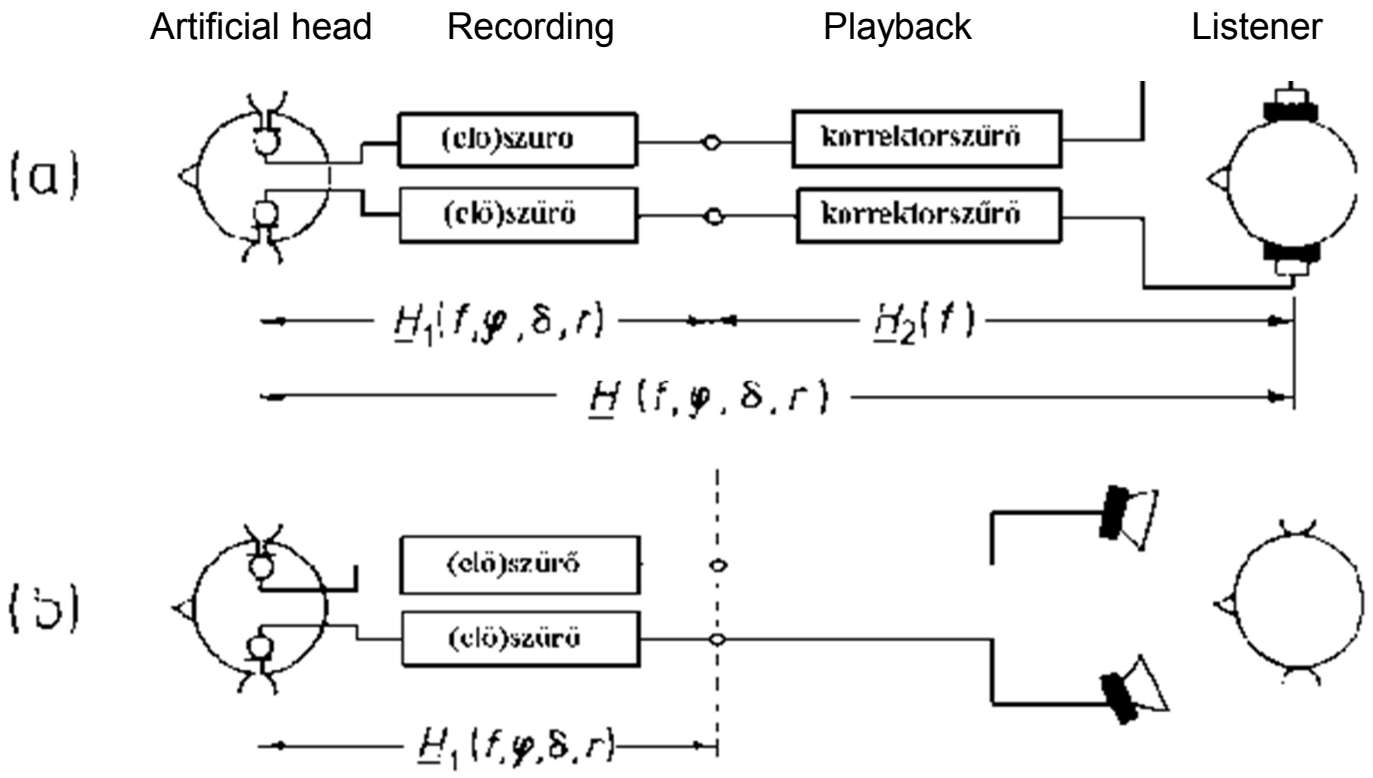
- Source at -60°, transfer function to the two ears



Problems with application of HRTFs

- The „world” rotates together with the headset/user
- Solution: head tracker

Ensuring directional hearing: binaural recording/playback



Artificial head

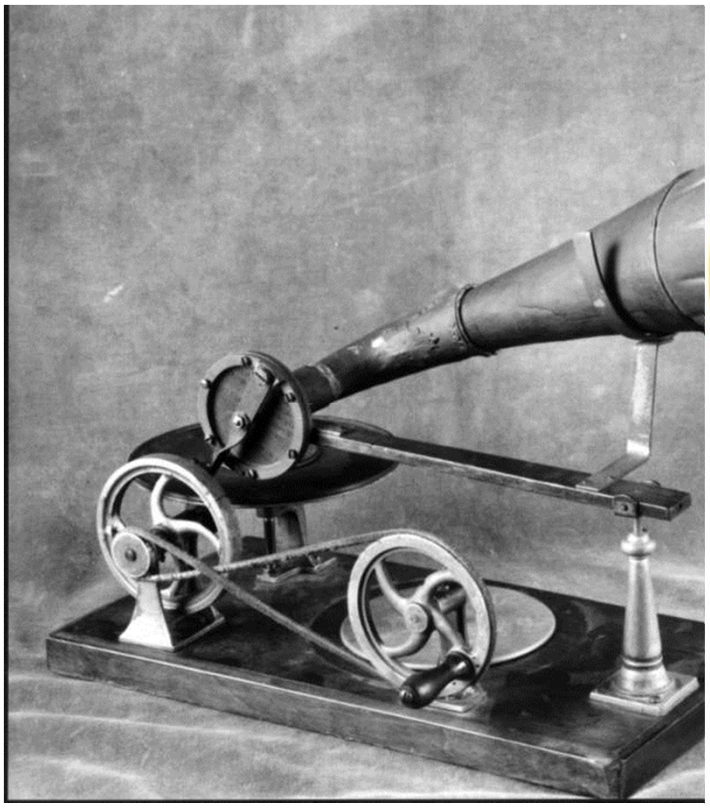
- For sound recordings and high-fidelity measurements (primarily in NVH)

Directional hearing aids

A short history of stereo sound recording

- 1877 First recording by Thomas A. Edison, *Mary Had A Little Lamb.*
- 1888 The Gramophone, invention of Emile Berliner, American inventor: the flat record
- 1898 Invention of the magnetic sound recording (Valdemar Poulsen, Denmark)
- 1931 Stereo record (inventor Alan D. Blumlein, US)
- 1933 Bell Labs realizes the first stereo concert broadcast on a telephone line from Philadelphia to Washington
- 1940 Walt Disney first uses stereo sound for his movie *Fantasia c.*
- 1954 The stereo tape recorder is commercialized for home users
- 1958 Stereo LP record by using V-cut
- 1961 Outset or stereo radio broadcast
- 1969 Outset of the quadrophone (4-ch) radio broadcast
- 1970 Record industry changes entirely to stereo technology

Some early recorders



Berliner's Gramophone (1885-88)

Th. A. Edison's „Perfected phonograph" (1888)

http://en.wikipedia.org/wiki/Phonograph_cylinder

Mono

Sztereo

https://www.youtube.com/watch?v=aMTBDxJzu5w

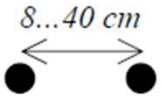
1967, … as from 32:20

Stereo microphone techniques

A koincidens technika a tér egy pontját veszi több mikrofonnal, a mikrofonok közötti elválasztást az eltérő iránykarakterisztikák adják

Coincident method

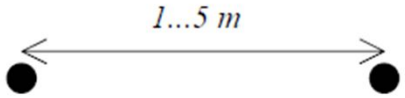
Distinction is given by differing directional characteristics of mics



A közel-koincidens technika a tér közeli pontjait veszi több mikrofonnal, a mikrofonok közötti elválasztást az iránykarakterisztikák mellett az eltérő pozíciókból adódó fáziseltérések határozzák meg.

Nearly coincident method

Distinction is given both by differing directional characteristics of mics and phase deviations

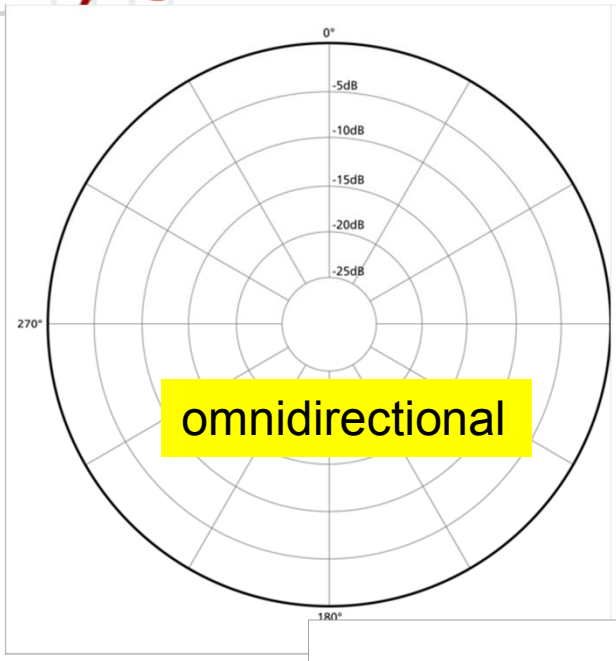


A távol helyezett vagy AB-technika a tér távolabbi pontjait veszi több mikrofonnal, a mikrofonok lényegesen különböző, szinte független jeleket vehetnek még ugyanarról a hangforrásról is.

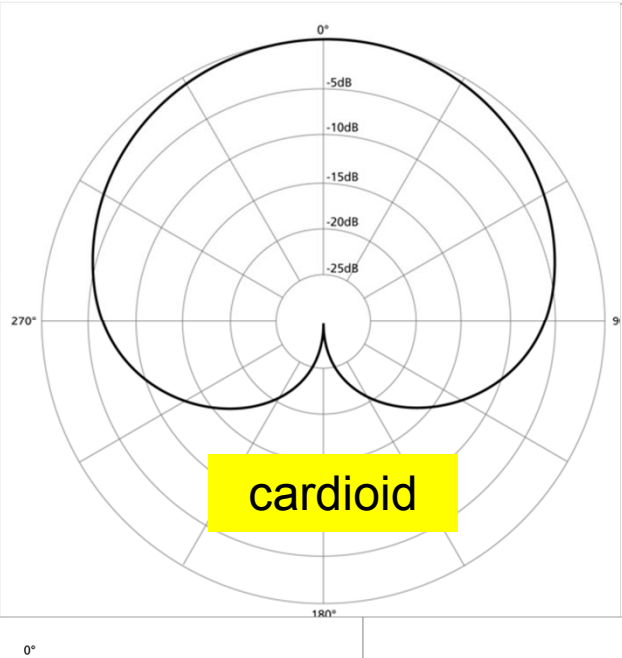
Faraway configuration

Mics record nearly independent signals

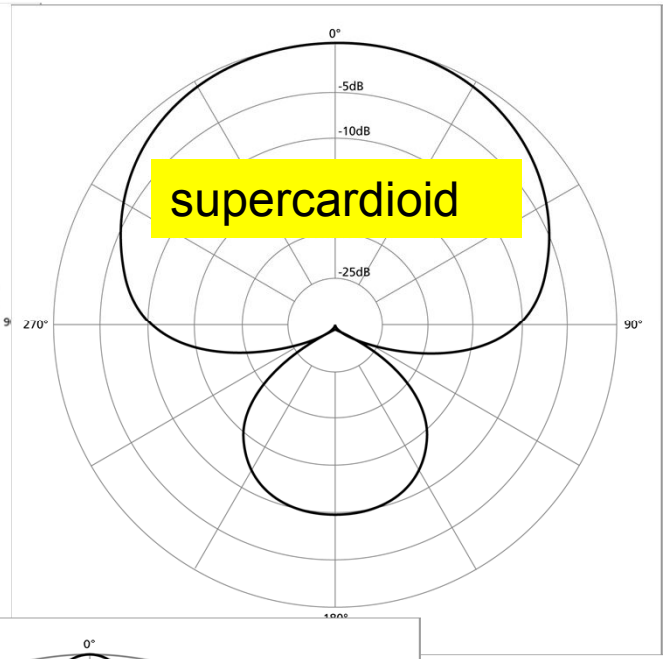
Directivity patterns of microphones



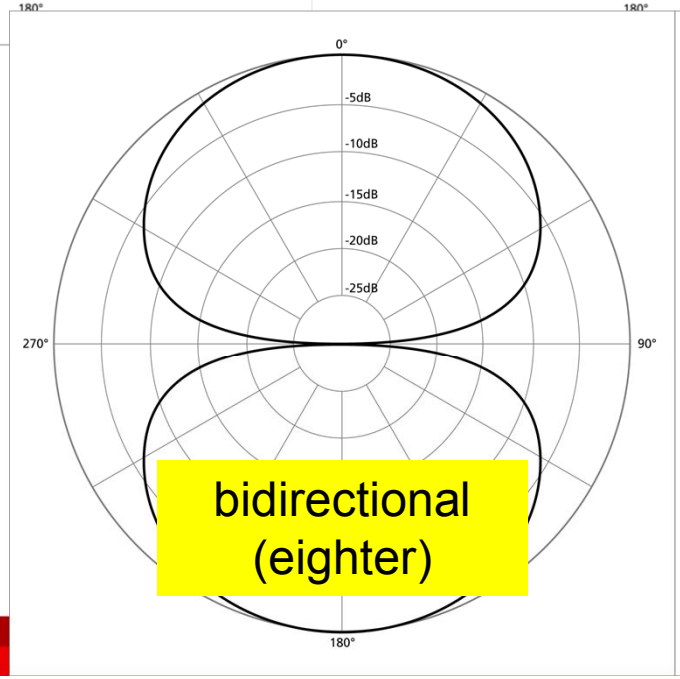
omnidirectional



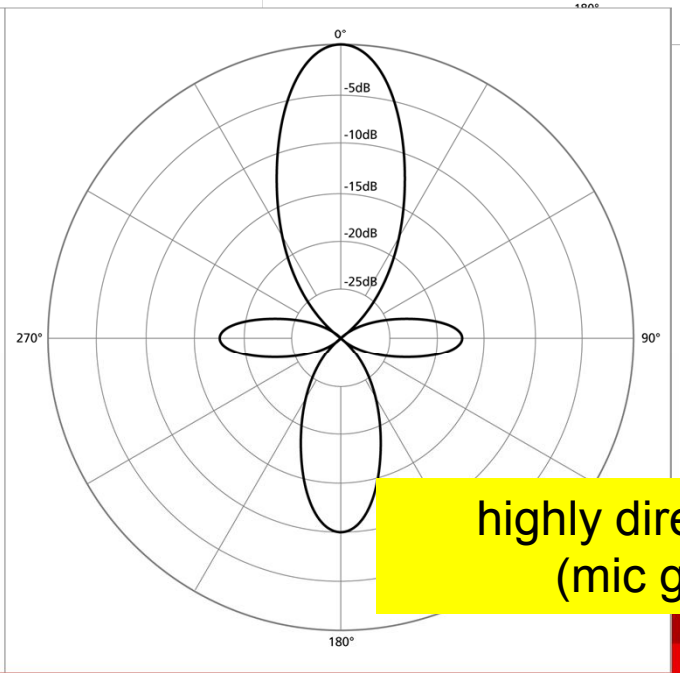
cardioid



supercardioid



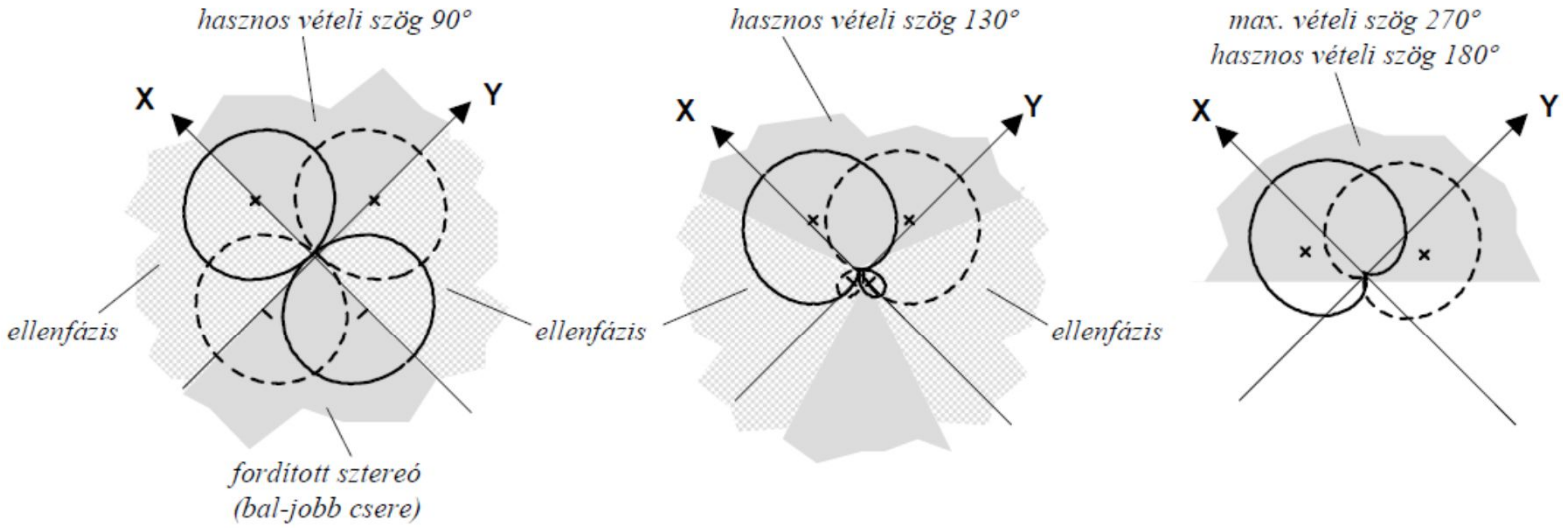
bidirectional
(eighter)



highly directional
(mic gun)

Stereo microphone techniques

- XY microphones (intensity stereophony)



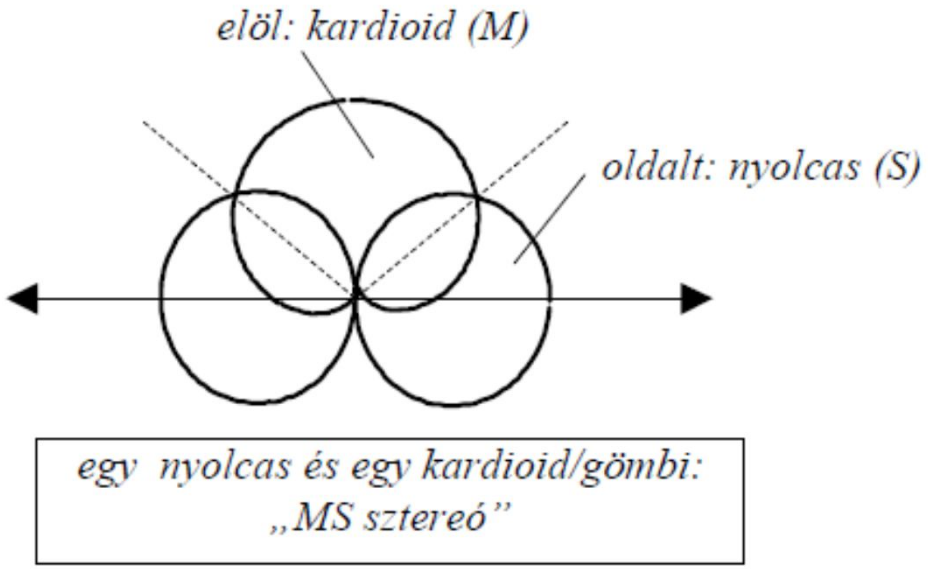
két nyolcas, 90°:
„STEREOSONIC"

két szuperkardioid

két kardioid 135°:
„XY sztereó"

Stereo microphone techniques

- M-S (mid – side) microphone

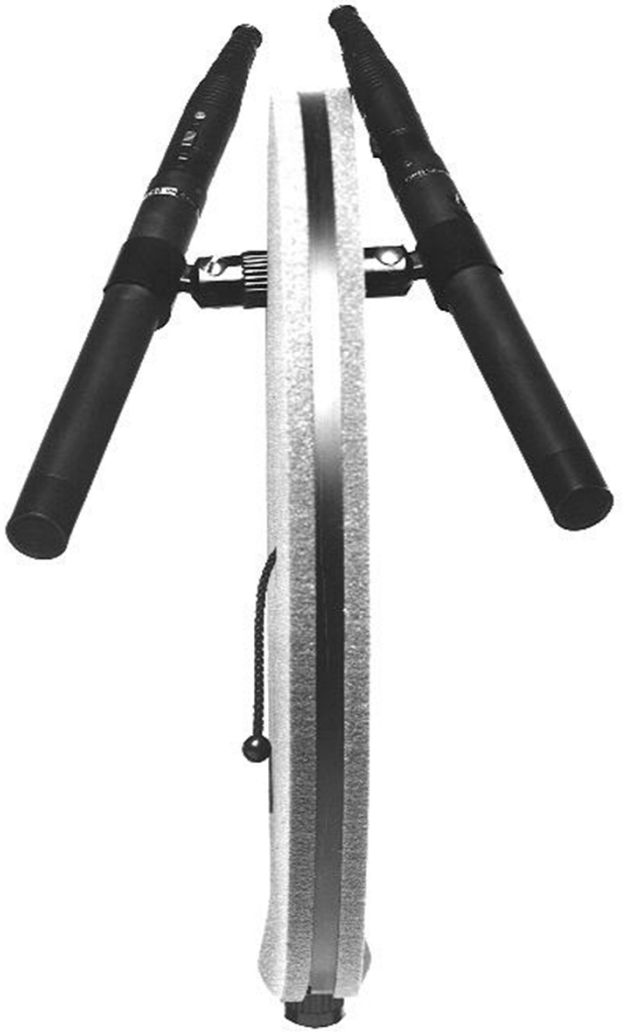


$$L(\text{eft}) = M + S$$

$$R(\text{ight}) = M - S$$

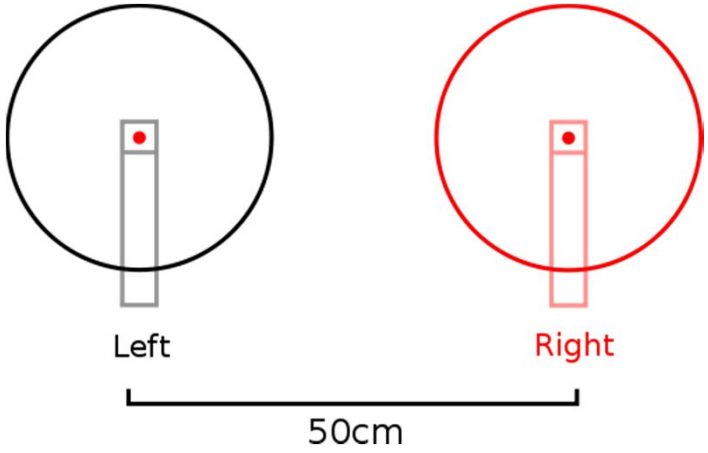
Stereo microphone techniques

- Nearly coincident: the Jecklin.disc



Stereo microphone techniques

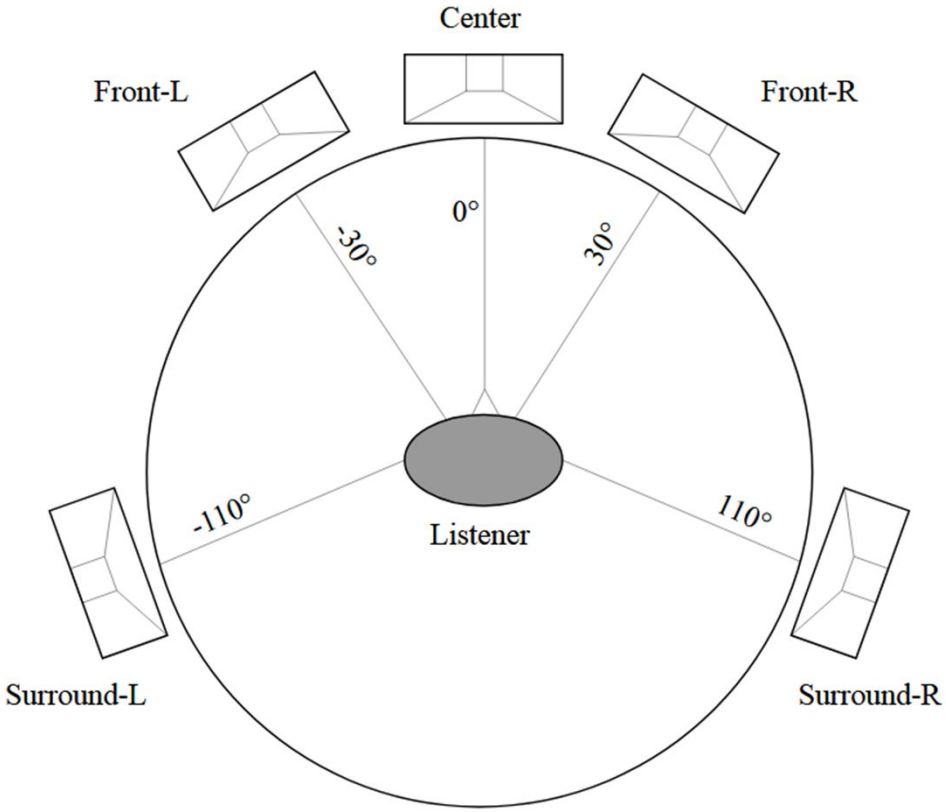
- A-B microphone configuration



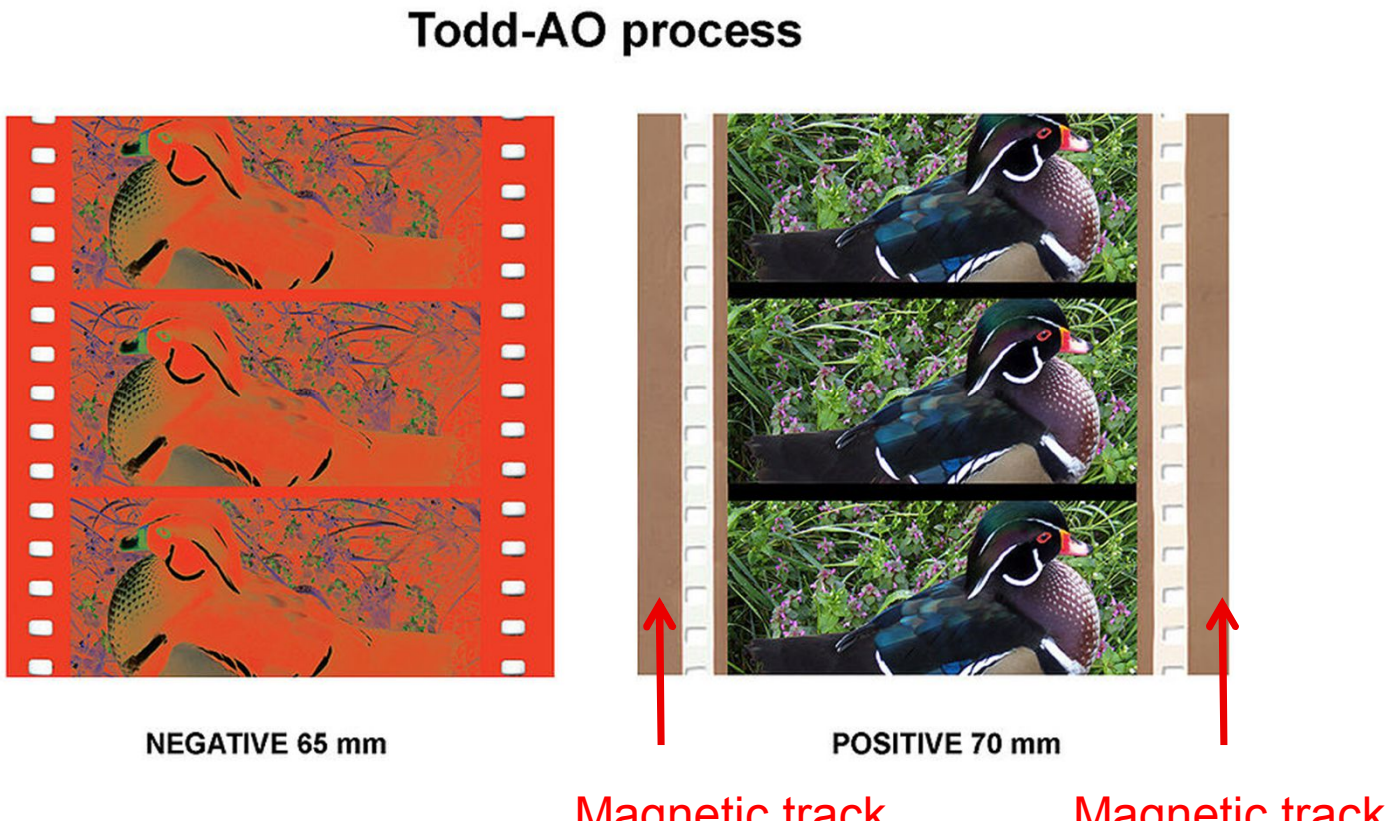
Highly directive microphones

Surround sound

- 6-channel (5.1) sound recording and reproduction system, mainly used for home cinema

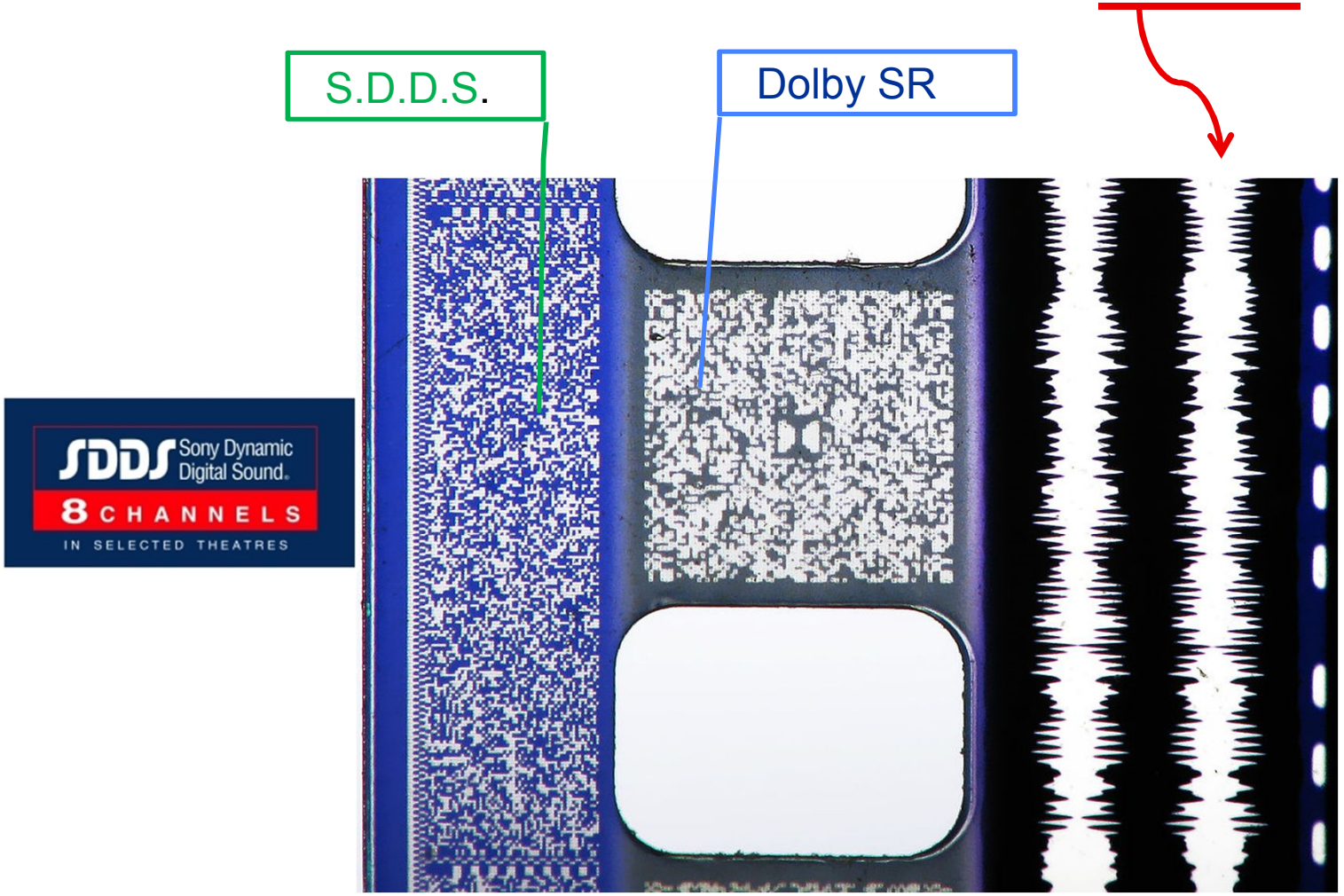


- Originally developed by Dolby Labs for the 70 mm film prints, later on adopted for 35 mm films



Sound of film

- Optical recording: both analogue and digital
- The optical track can be intensional, longitudinal or transversal

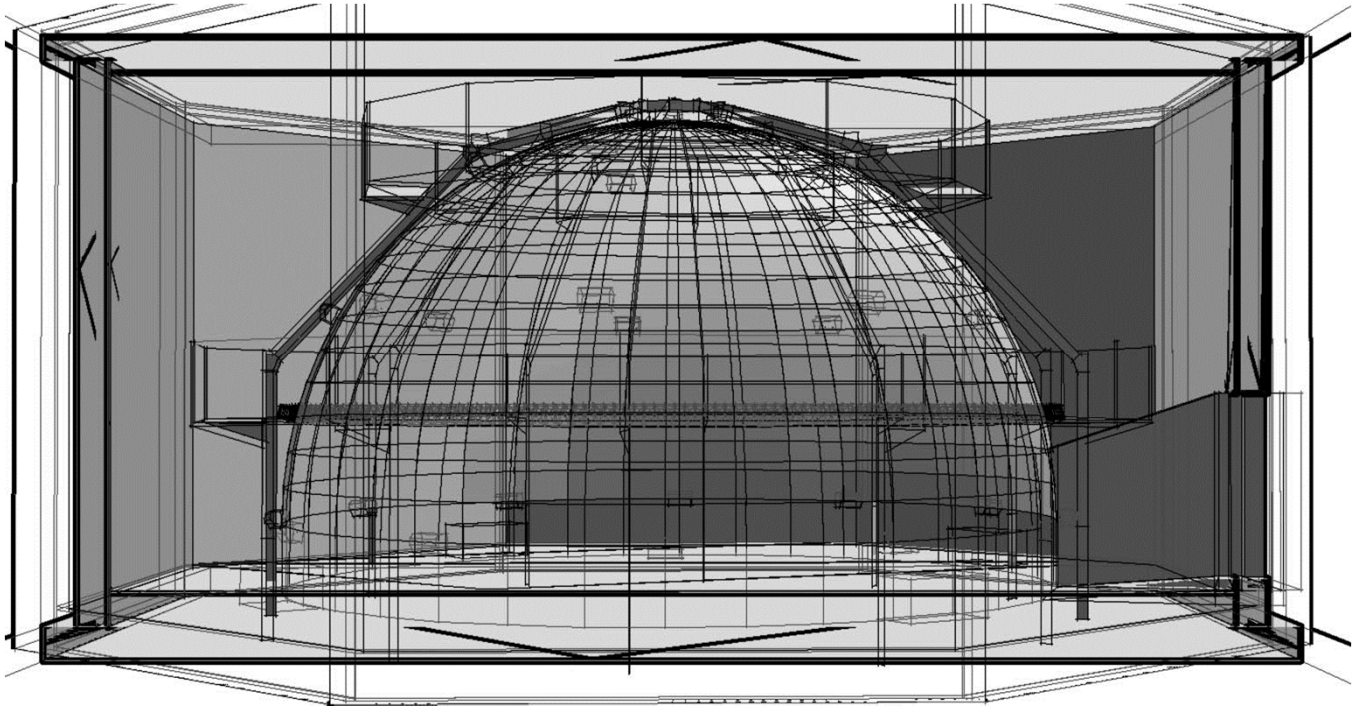


Other surround systems

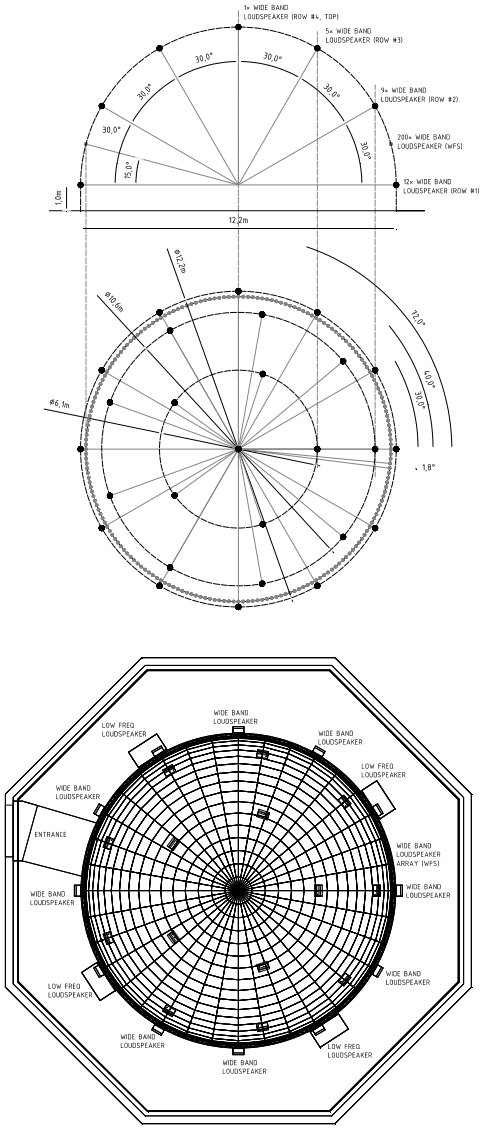
- CDS: Cinema Digital Sound
- DTS: Digital Theater Systems (later: Dedicated To Sound)
- THX: a quality assurance system for the acoustics of cinema
- 7.1: two extra surround channel in the back
- Multichannel sytems

House of Music (in construction)

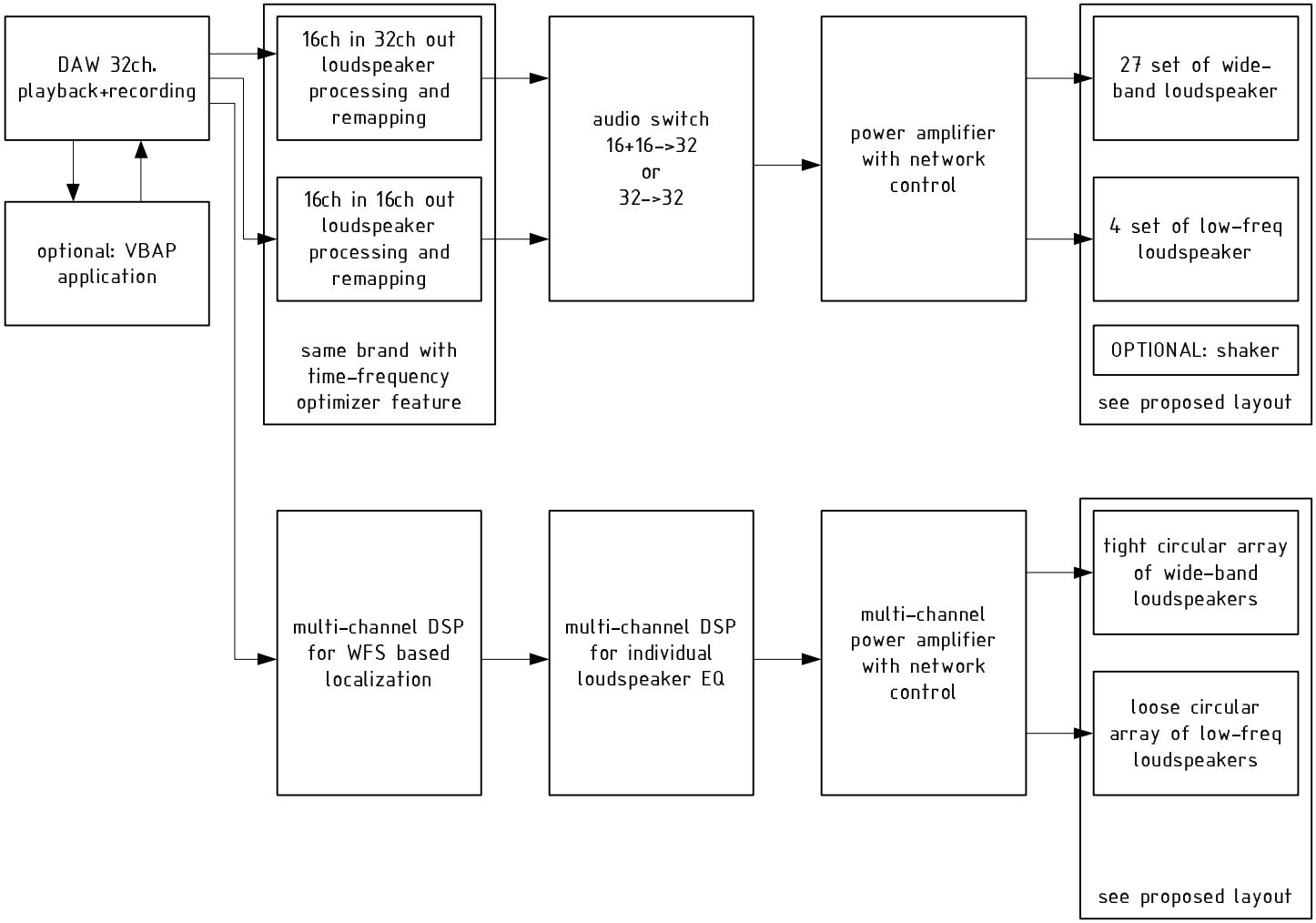
- To be built in the Népliget



Speaker layout



Block diagram



The Loudness War

- https://en.wikipedia.org/wiki/Loudness_war
- https://www.youtube.com/watch?v=3Gmex_4hreQ