Microphones in theory and practice

Helmut Wittek, 2013

Contents

- **The "Sound" of a microphone and where it comes from**
  - Frequency response, Impulse response
  - Directional microphones, Polar diagram, Off-axis
  - Diffuse field, Pressure gradient 1^{st} order, Diffuse-field frequency response
  - Shotgun principle
- **Around the membrane**
  - Boundary layers, Comb filtering
  - sphere attachments
  - V4 Studio Vocal Microphone
- **Microphone signal**
  - Self noise, Preamp
  - Digital microphone
  - Microphone specifications
- **Disturbances**
  - Wind, Popp
  - Handling noise, suspensions
- **High Directivity**

- Complete support:
  - Accessories, Solutions, Know-how, Custom products, Support, Service, Reliability, Demo loans

- Special accessories for every application
  - Studio, Live, Film, Instrument, Conference, Broadcast, Show, Stereo/Surround, etc.
- Vast variety of stereo and surround microphones
  - Music, Sports, Show, Film, etc.
- Technical and aesthetical know-how and guidance
  - Personal support: Tonmeister, Developer, Workshop, Sales, etc.

- *Colette Modular Series*
  - Modular studio microphone
  - 21 capsules
    - All polar patterns and specific capsules
  - >100 active and passive accessories
    - All types of tubes, goosenecks, table stands, swivels, cables, suspensions, filters, pads, etc.
  - 6 amplifiers
    - Analog, HD analog, battery-powered, for radio transmitters, Digital

- *CCM Compact Series*
  - Compact studio microphone – full studio quality.
  - 18 capsules
    - All polar patterns and specific capsules
  - >100 accessories
    - All types of tubes, goosenecks, table stands, swivels, cables, suspensions, filters, pads, etc.

… further information…

- further information:
  - SCHOEPS website: www.schoeps.de
    - ppt Slides…
    - Infos on the setups
    - Audio Samples
    - Showroom
  - JCE
  - www.hauptmikrofon.de
  - Contact →
    - Wittek “at” schoeps.de
    - Surround “at” schoeps.de

Role of the microphone

- The components of the recording chain:

Sound source

↓

Room

↓

Microphone

↓

Processing devices

↓

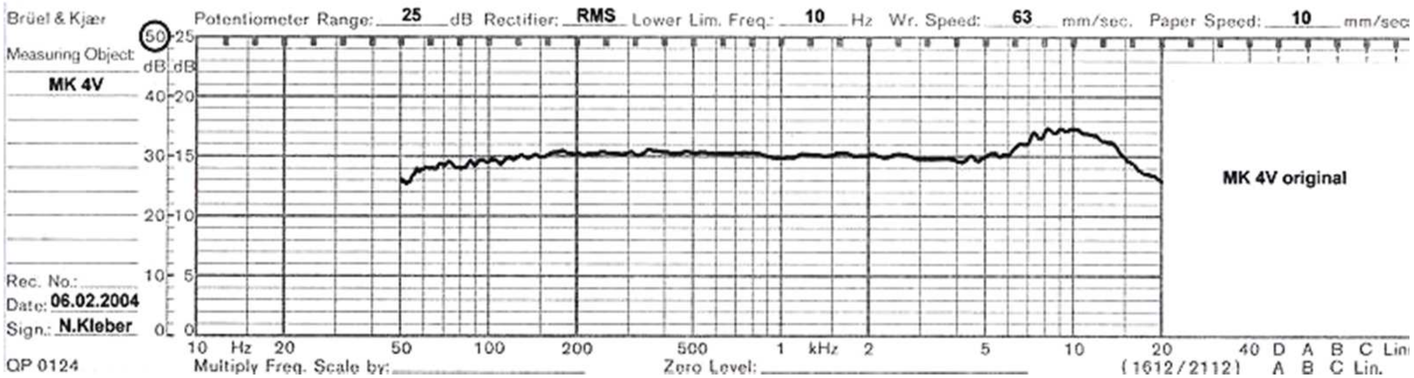
loudspeaker

SCHOEPS Mikrofone

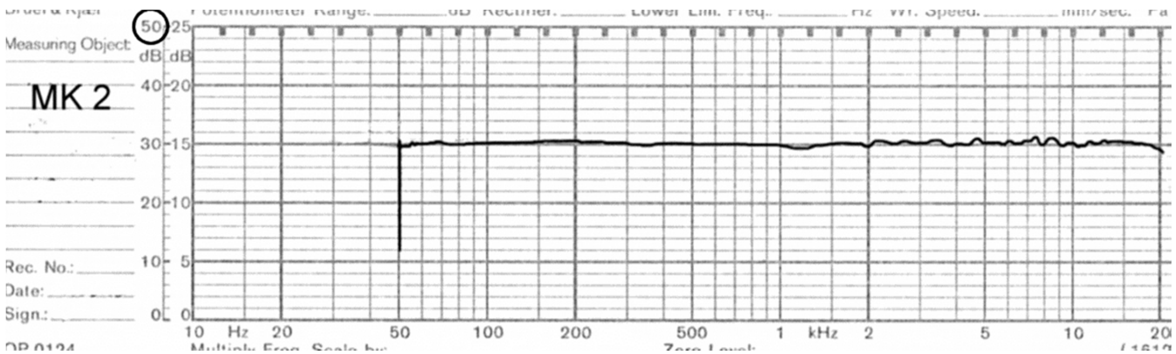
How do I choose a certain microphone?

- **Sound**
- Directivity
- Size, Design
- Practicability, Accessories

- Frequency response:



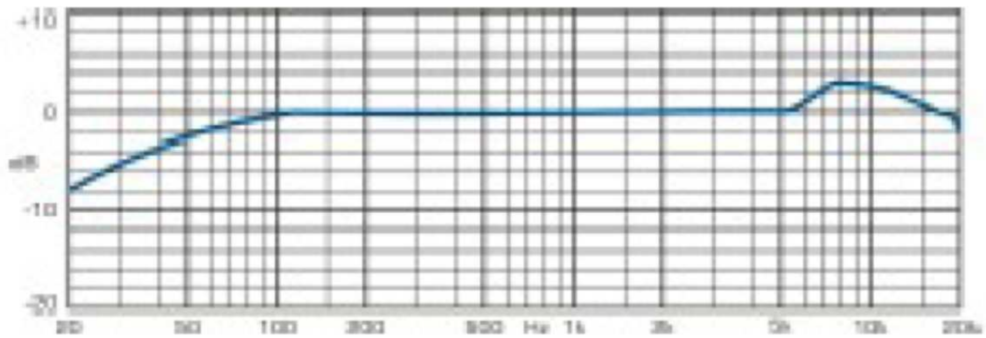
- Flat frequency response:



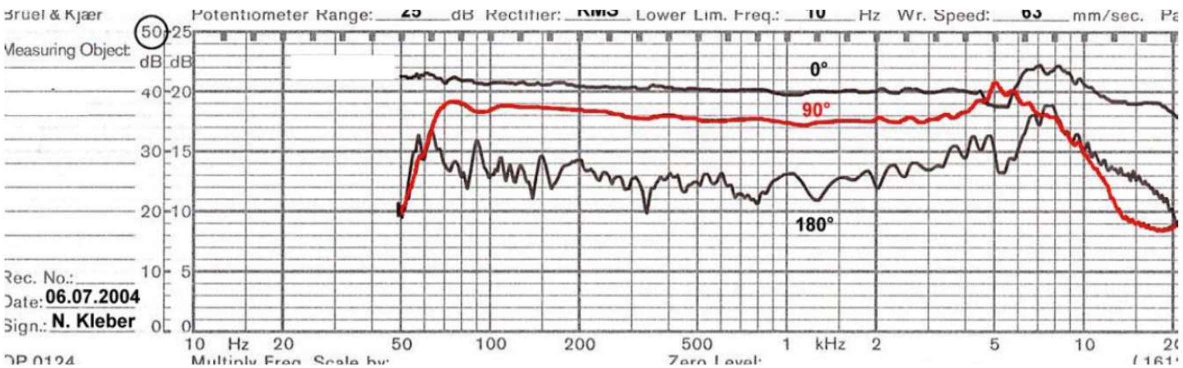
Frequency response

- 0°- or „Free field“-Frequency response
- 0°- Frequency responses of different microphones: www.microphone-data.com
- Fact and fancy: the difference between catalogue and measured data:

- Catalogue *:



- Measurement**:



* Data of a microphone made by an unstated manufacturer
** Measurement of the same microphone at the SCHOEPS company

- What is a good frequency response?

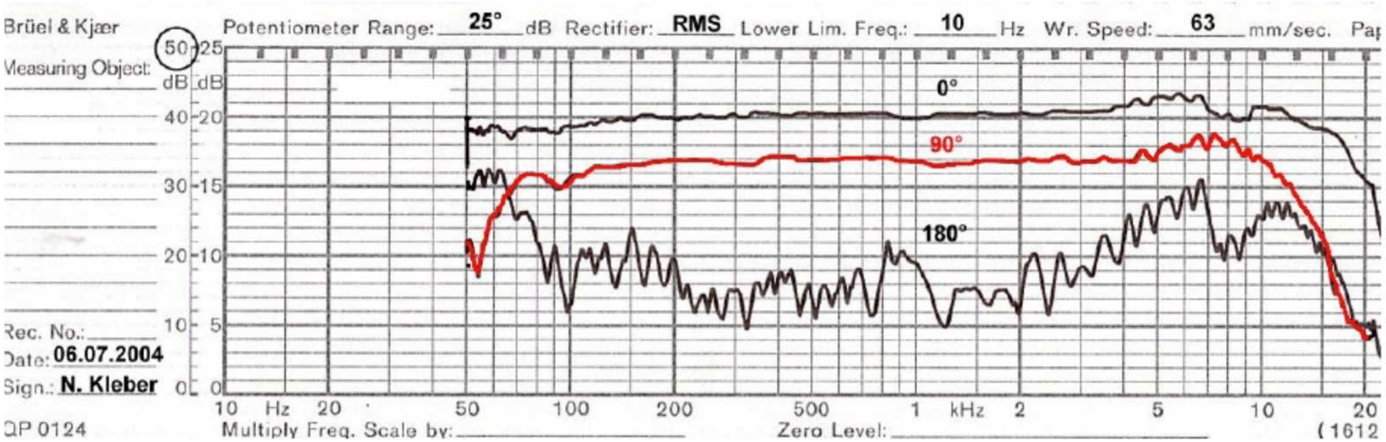


Abb. 13: Freifeld Frequenzgänge Mikrofon 1

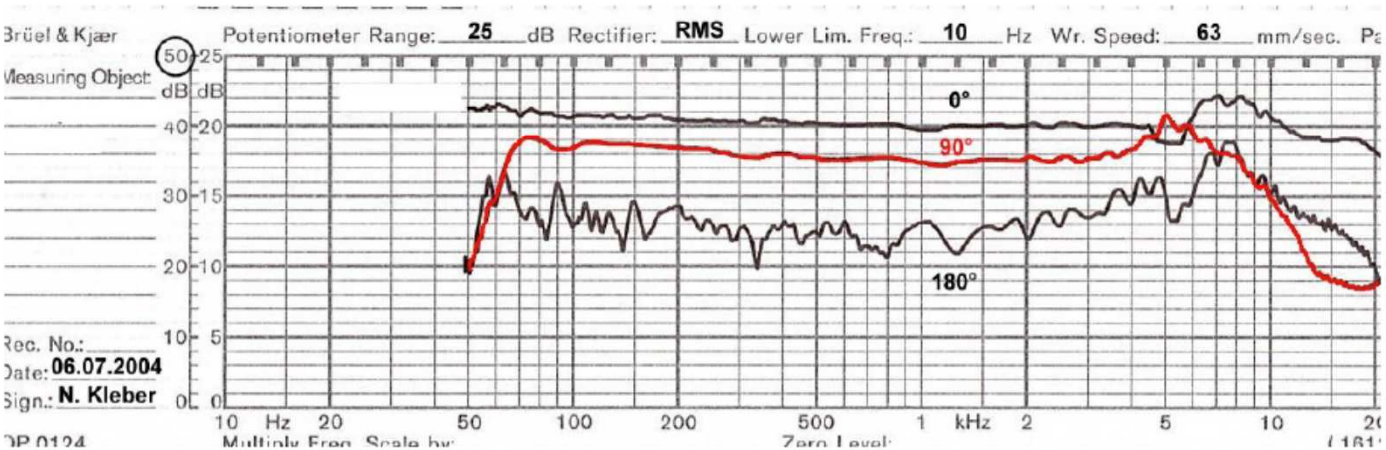


Abb. 14: Freifeld Frequenzgänge Mikrofon 2

Frequency response

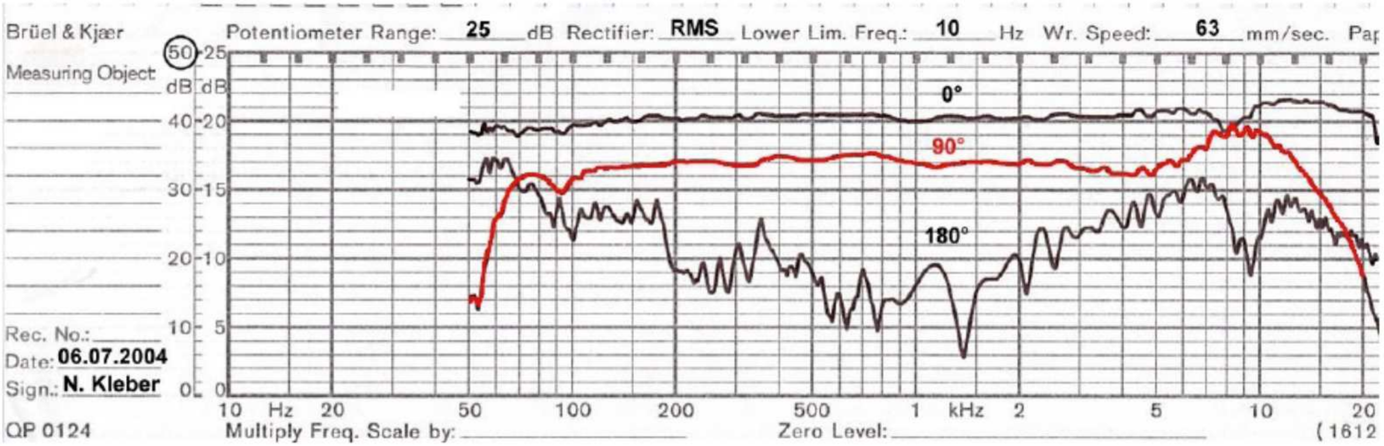


Abb. 15: Freifeld Frequenzgänge Mikrofon 3

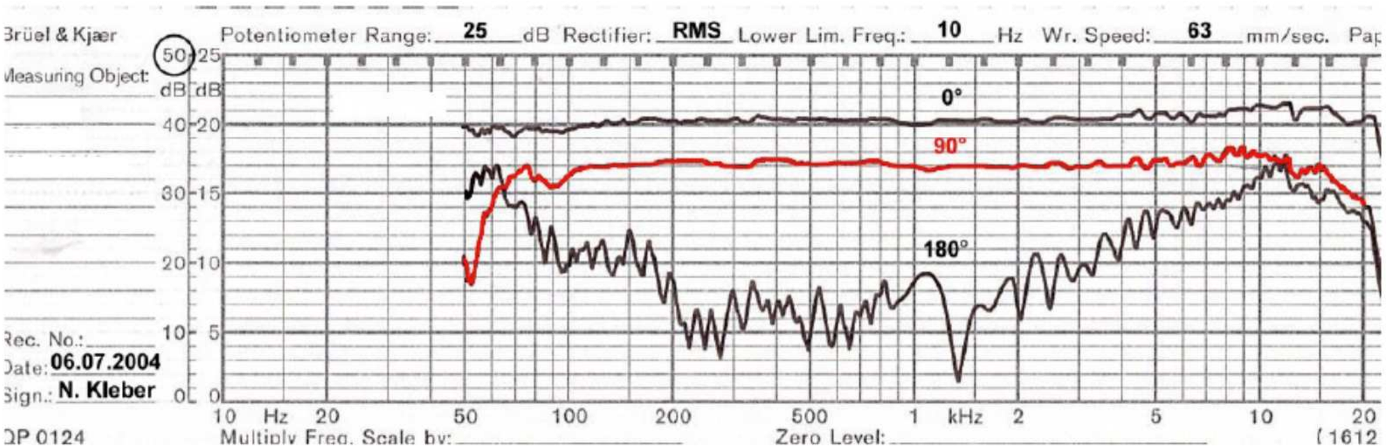


Abb. 16: Freifeld Frequenzgänge Mikrofon 4

Frequency response

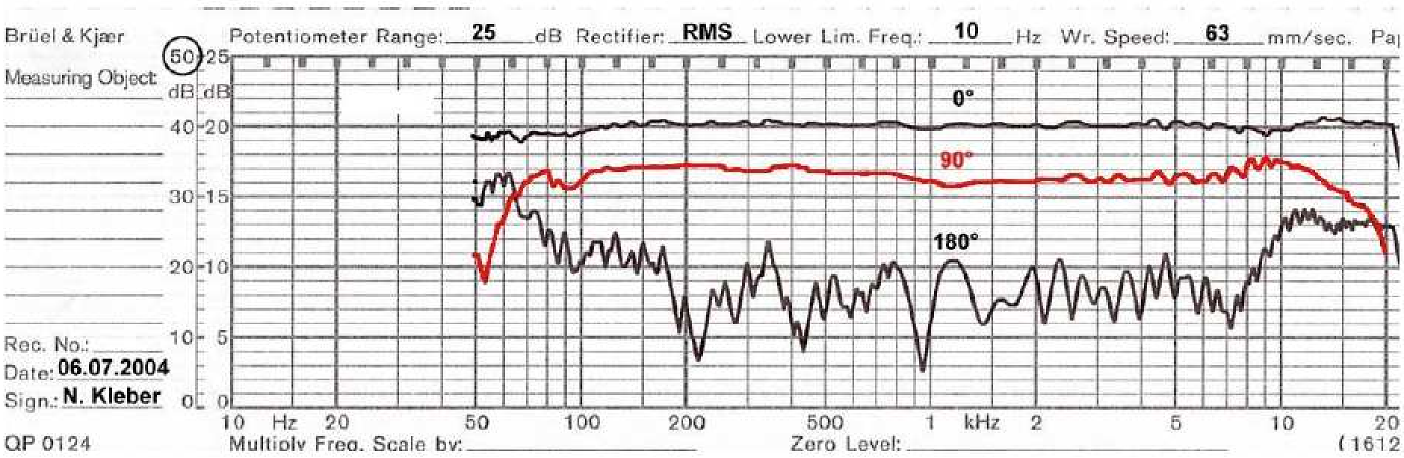


Abb. 17: Freifeld Frequenzgänge Mikrofon 5

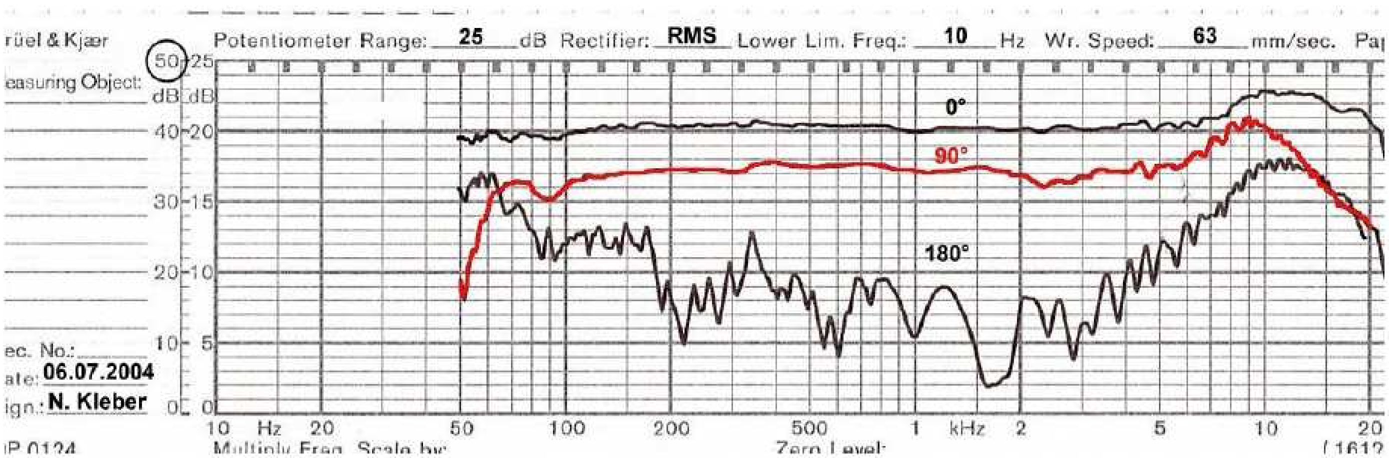


Abb. 18: Freifeld Frequenzgänge Mikrofon 6

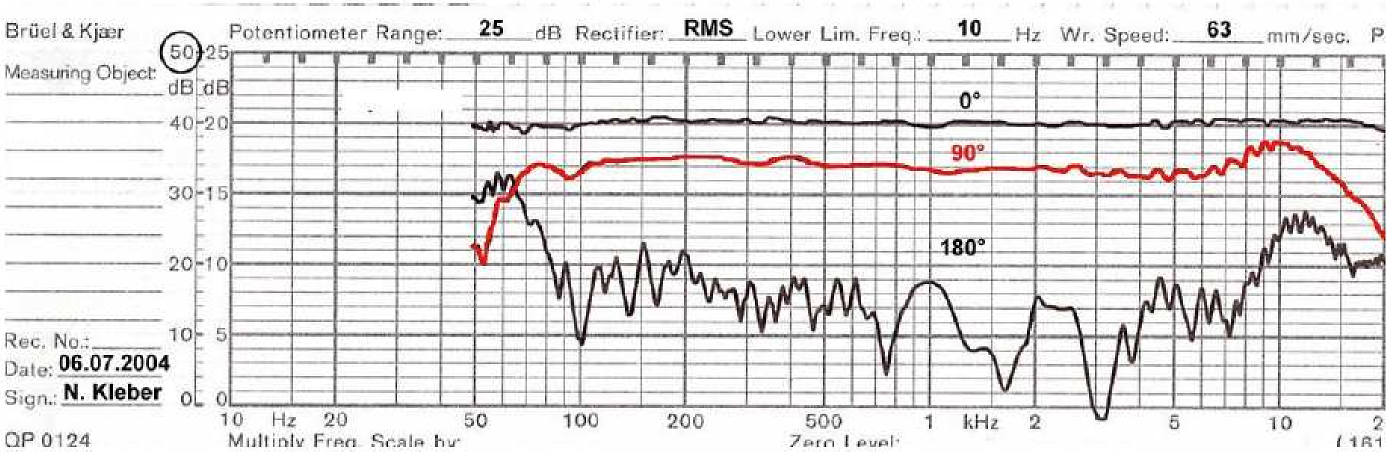


Abb. 19: Freifeld Frequenzgänge Mikrofon 7

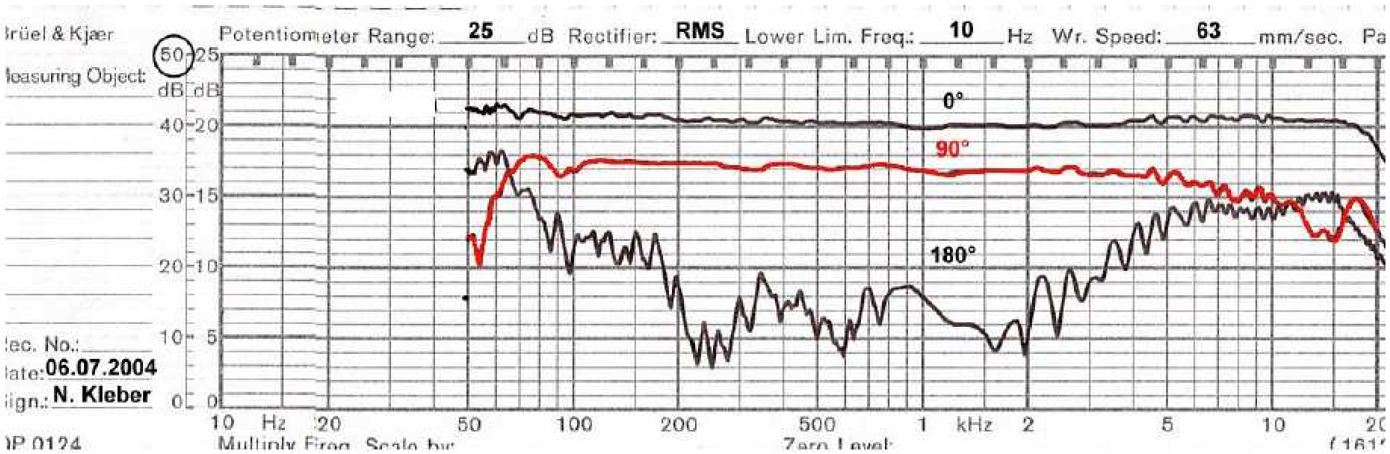


Abb. 20: Freifeld Frequenzgänge Mikrofon 8

Frequency response

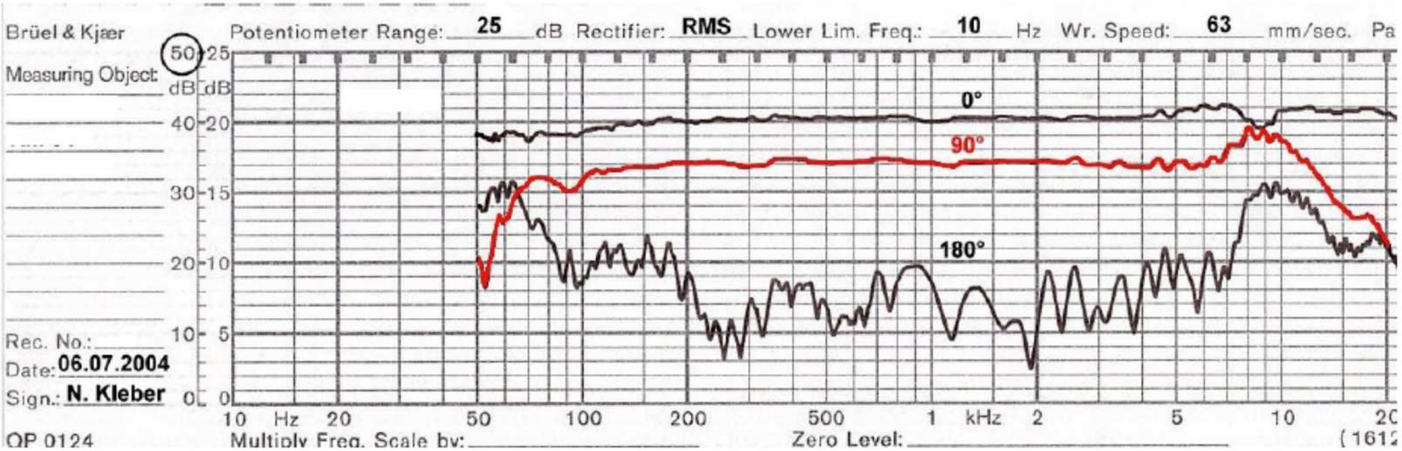
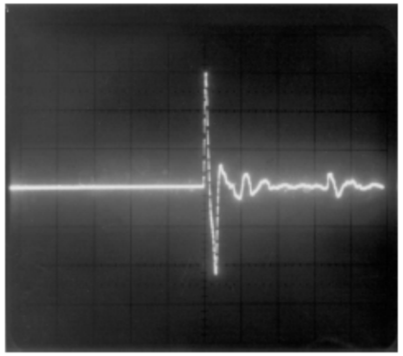


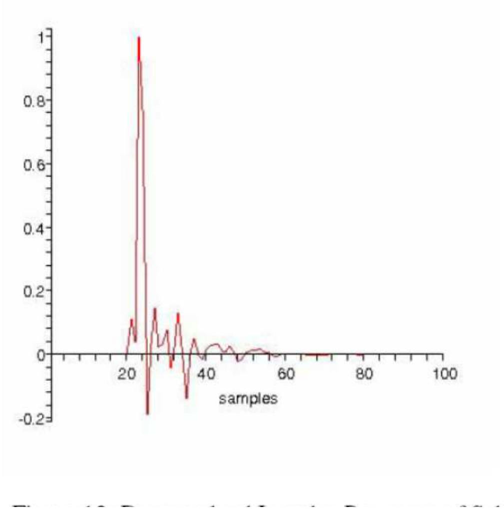
Abb. 21: Freifeld Frequenzgänge Mikrofon 9

Impulsantwort

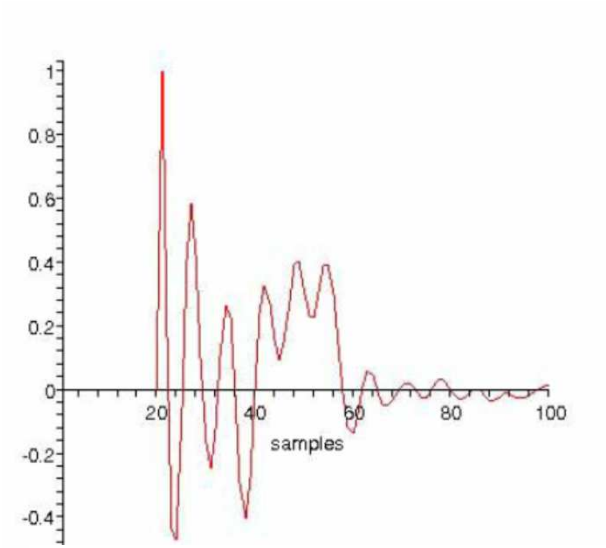
- The temporal properties of a microphone are represented in the frequency response and in the impulse response
- There are significant differences between the microphone types (Condenser/Dynamic) as well as between single and double membrane types



SCHOEPS-Omni
spark measurement



SCHOEPS-Omni
Deconvolved IR



Double membrane microphone
Deconvolved IR

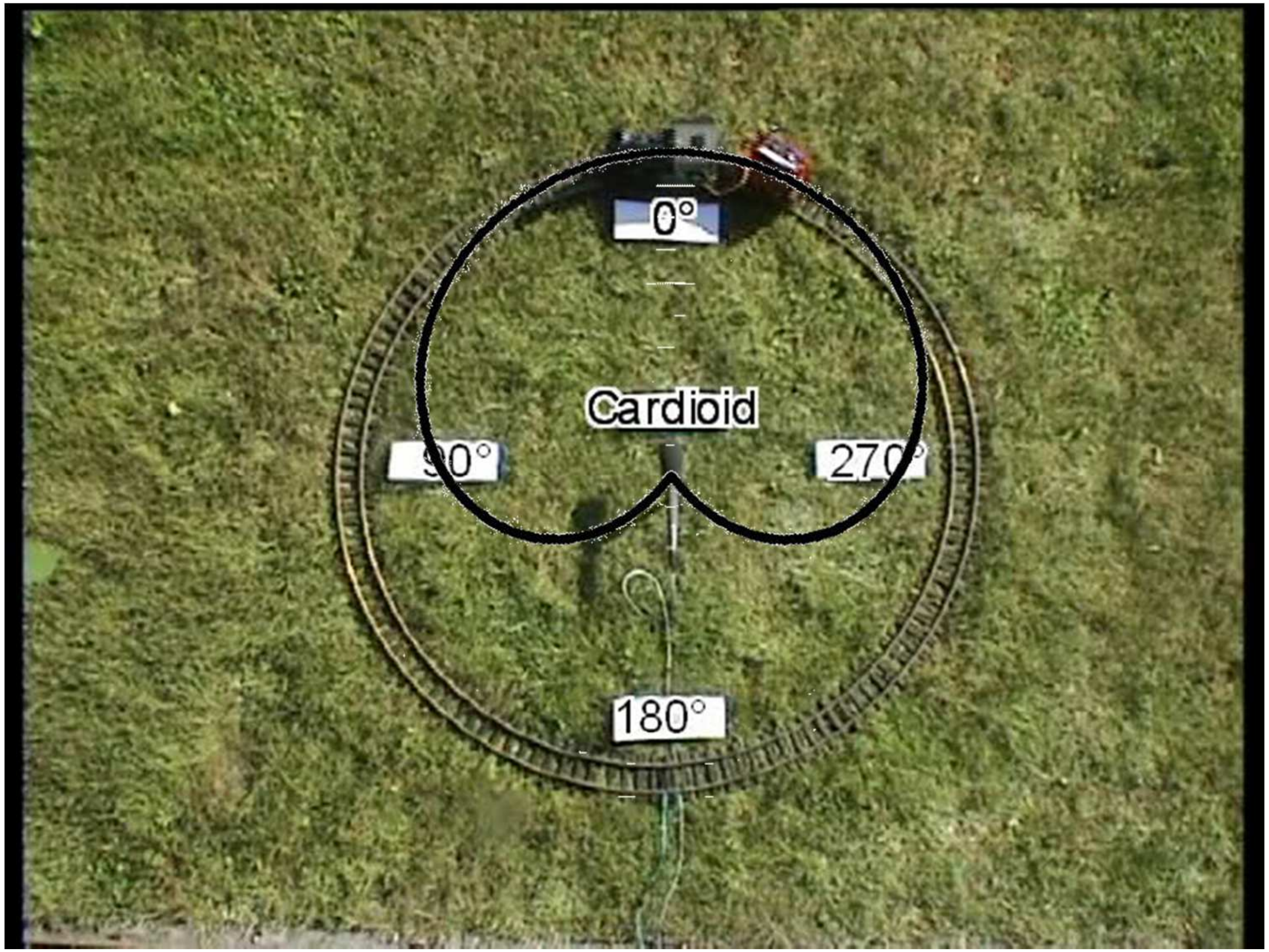
Quelle und **LIT** *C.Langen:* „Demystifying the Measurement of Impulse Response in Condenser Microphones - Part I", *AES-Preprint, 2007. weitere Literatur von Neumann.Berlin (Funkenknall-Messungen)*

How do I choose a certain microphone?

- Sound
- **Directivity**
- Size, Design
- Practicability, Accessories

Polar diagram, Off-axis frequency response

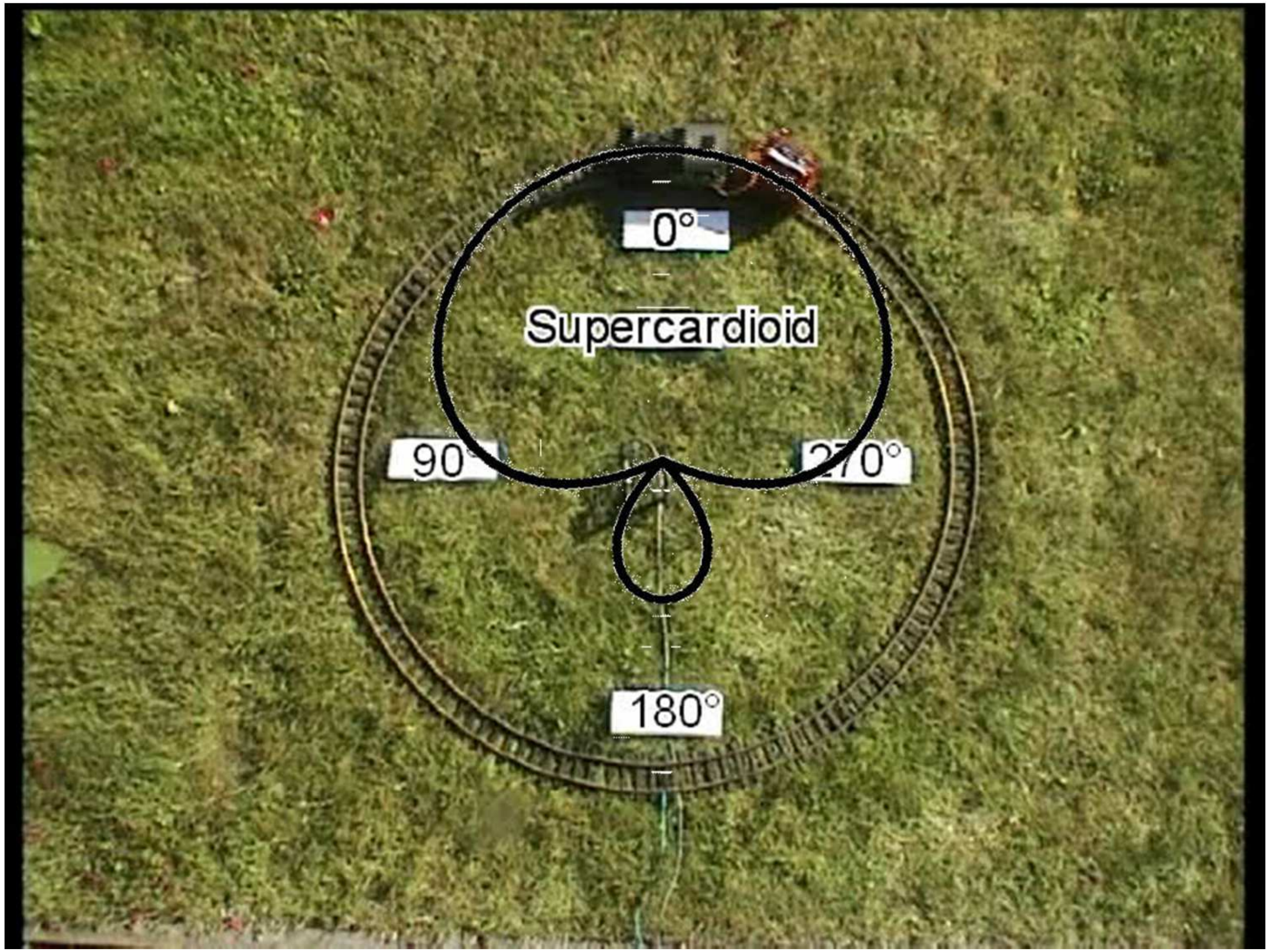
- Cardioid:



Quelle: J. Wuttke

Polar diagram, Off-axis frequency response

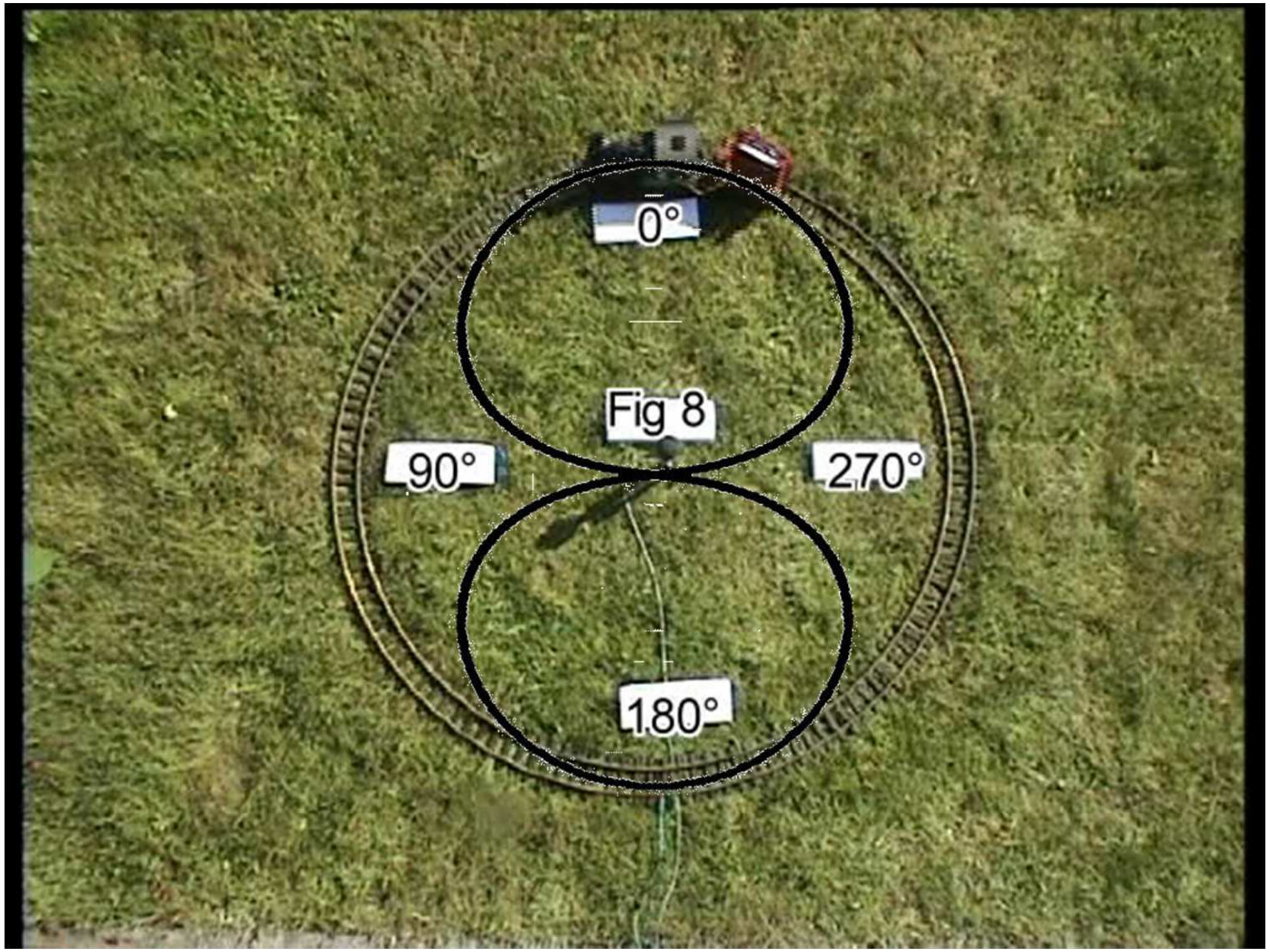
- Super cardioid:



Quelle: J. Wuttke

Polardiagramm, Off-axis Frequenzgang

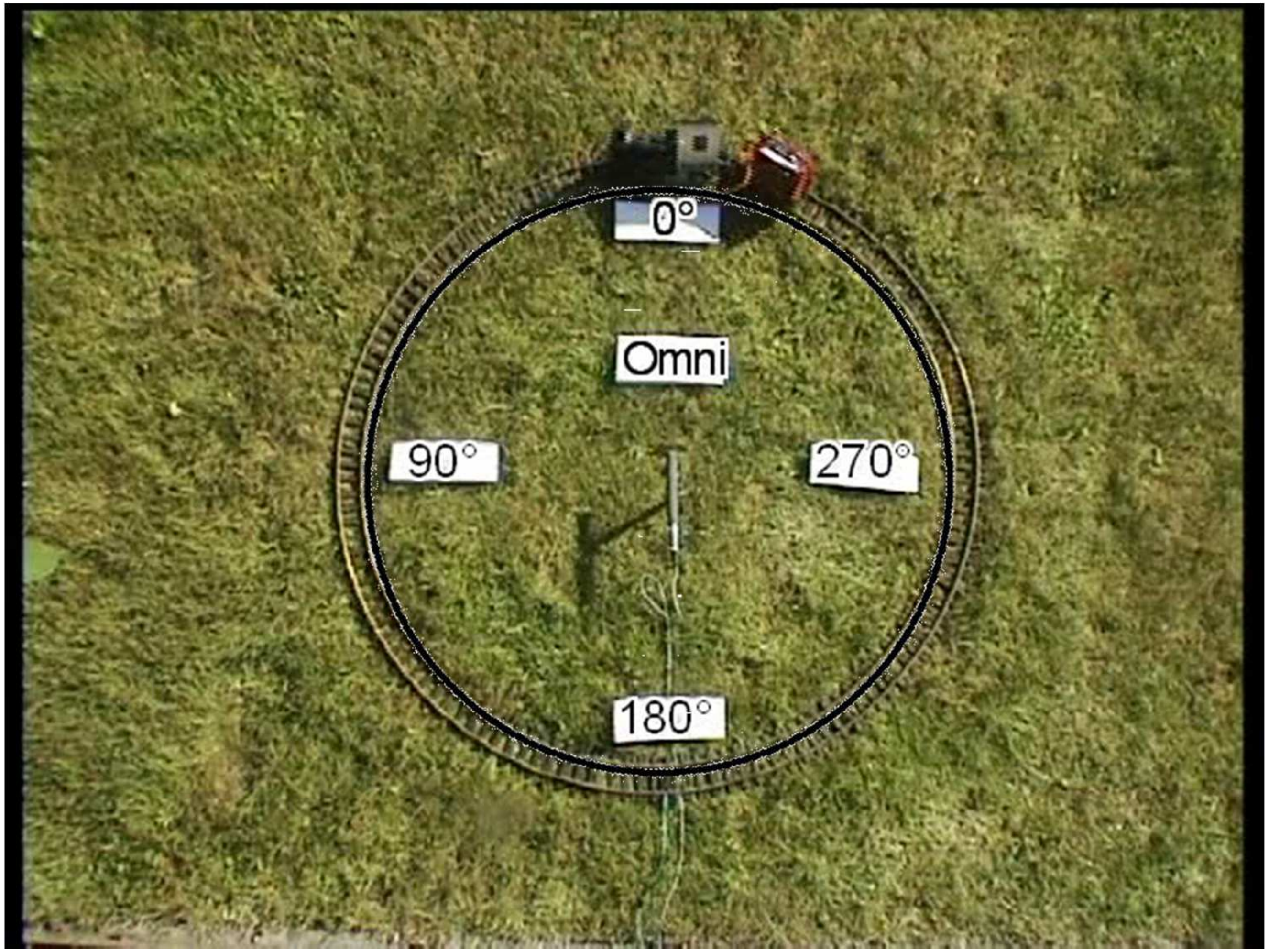
- Figure-8:



Quelle: J. Wuttke

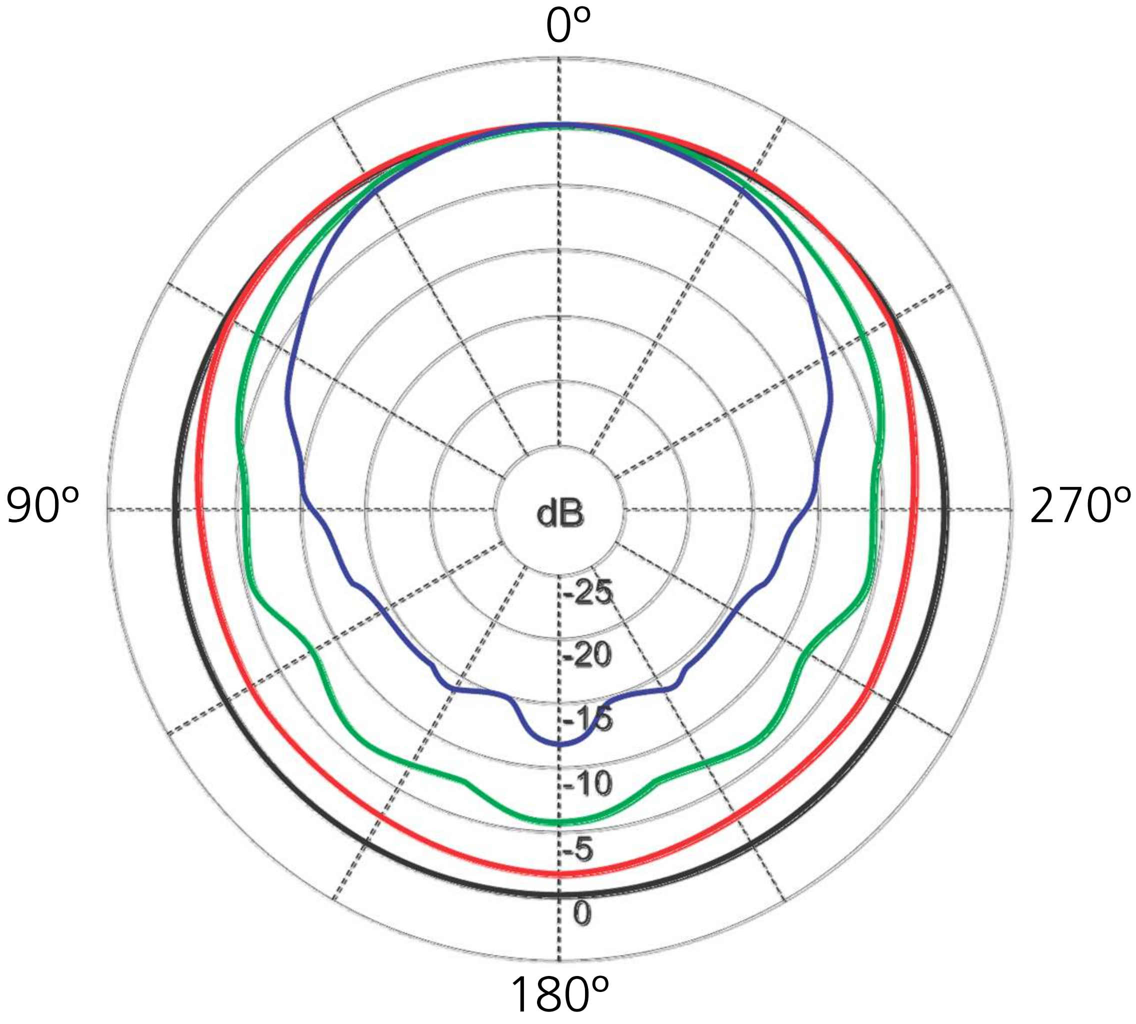
Polar diagram, Off-axis frequency response

- Omni-directional:



Quelle: J. Wuttke

Polar diagram, Off-axis frequency response



The Polar diagram

of an omni at

20 Hz - 2 kHz

4 kHz

8 kHz

16 kHz

Quelle: J.Wuttke

Polardiagramm, Off-axis Frequenzgang

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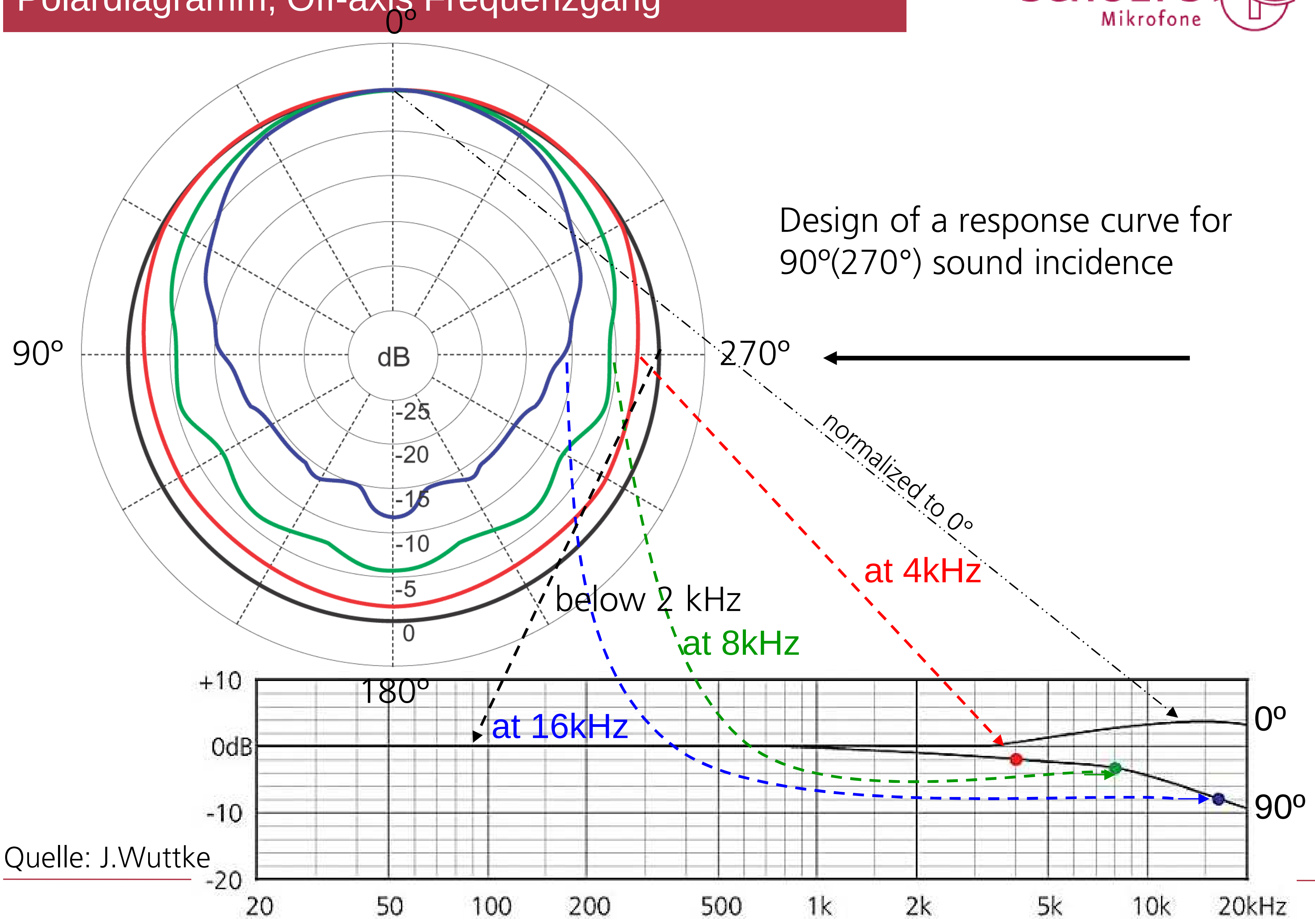


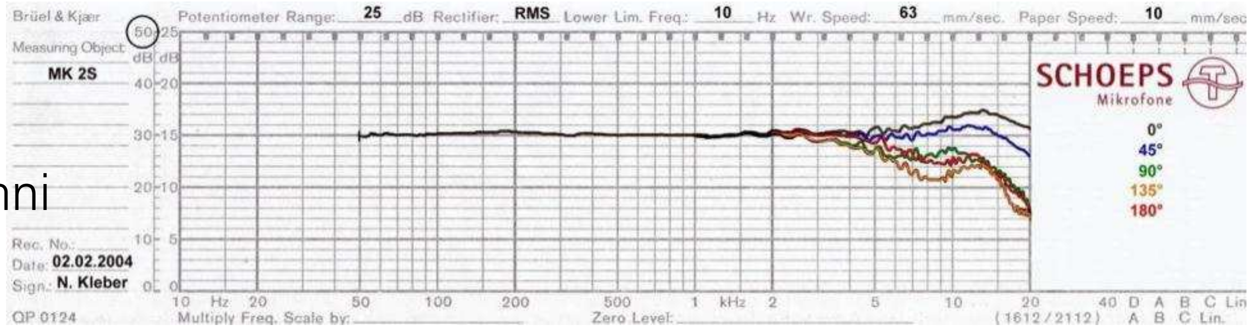
Design of a response curve for 90°(270°) sound incidence

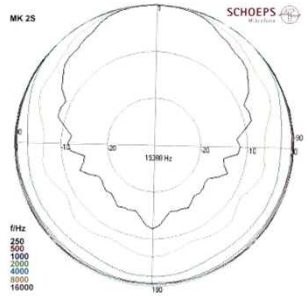
Quelle: J.Wuttke

Polardiagramm, Off-axis Frequenzgang

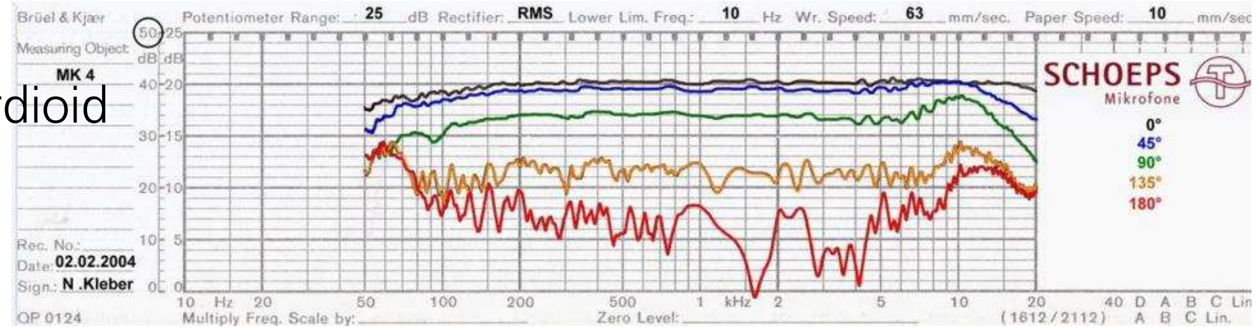
Pattern:

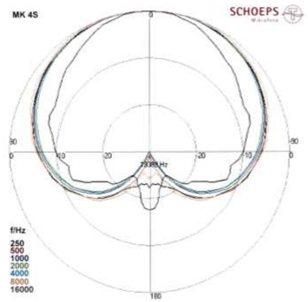
Kugel / Omni



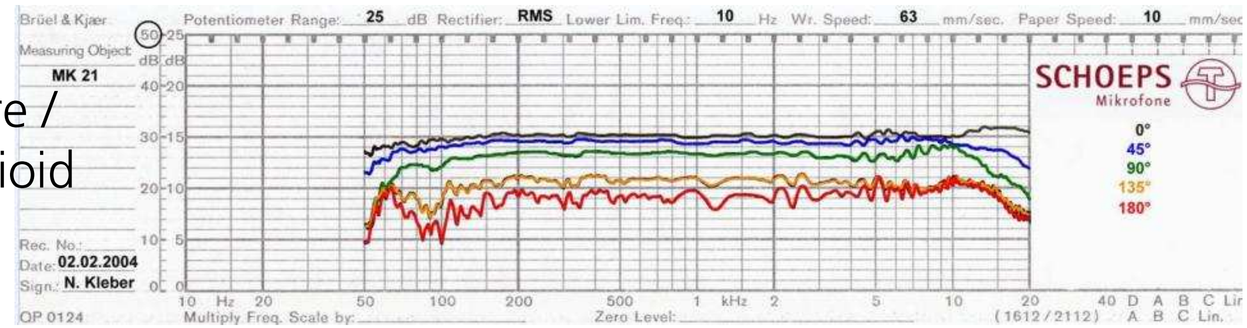


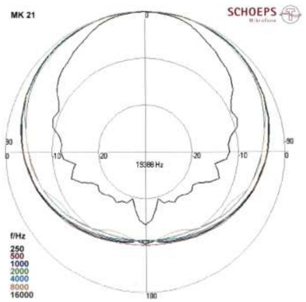
Niere / Cardioid





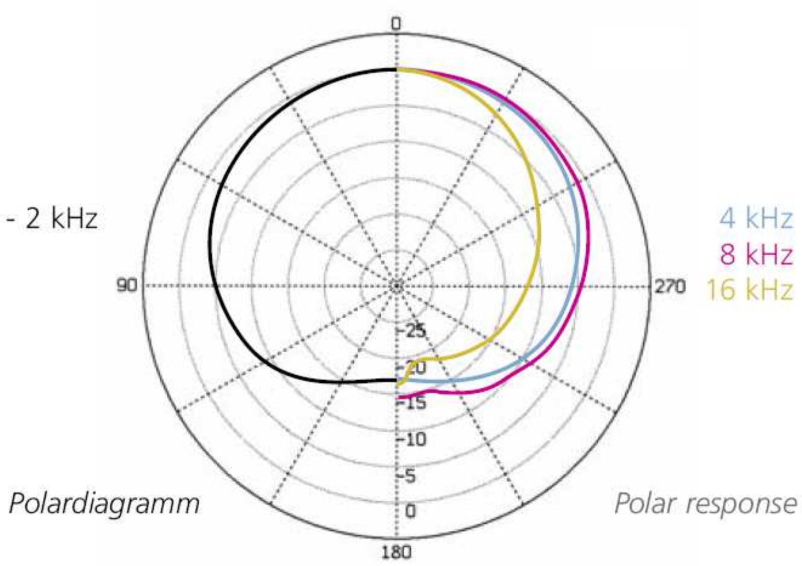
breite Niere /
Wide cardioid



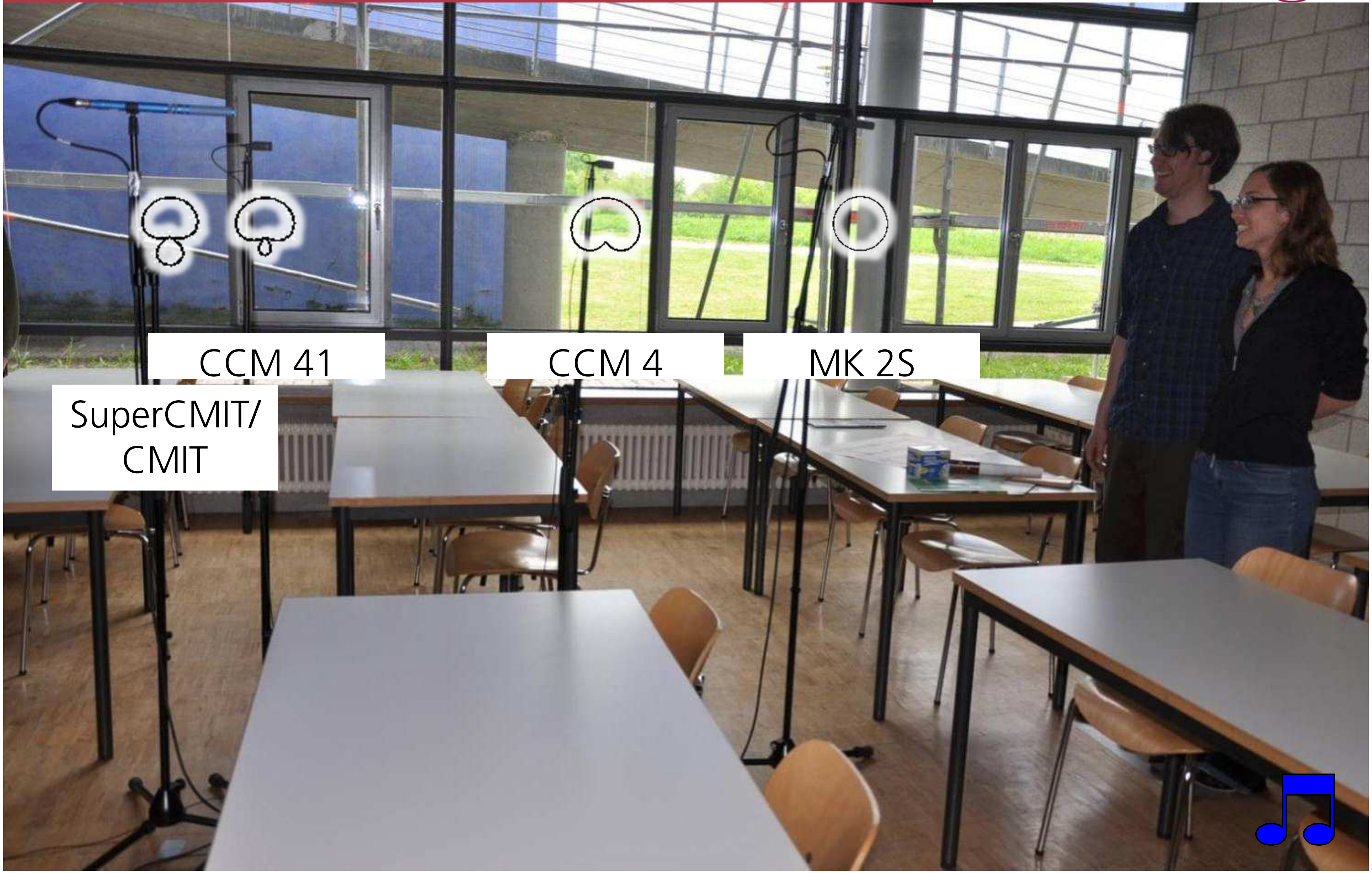


Polardiagramm, Off-axis Frequenzgang

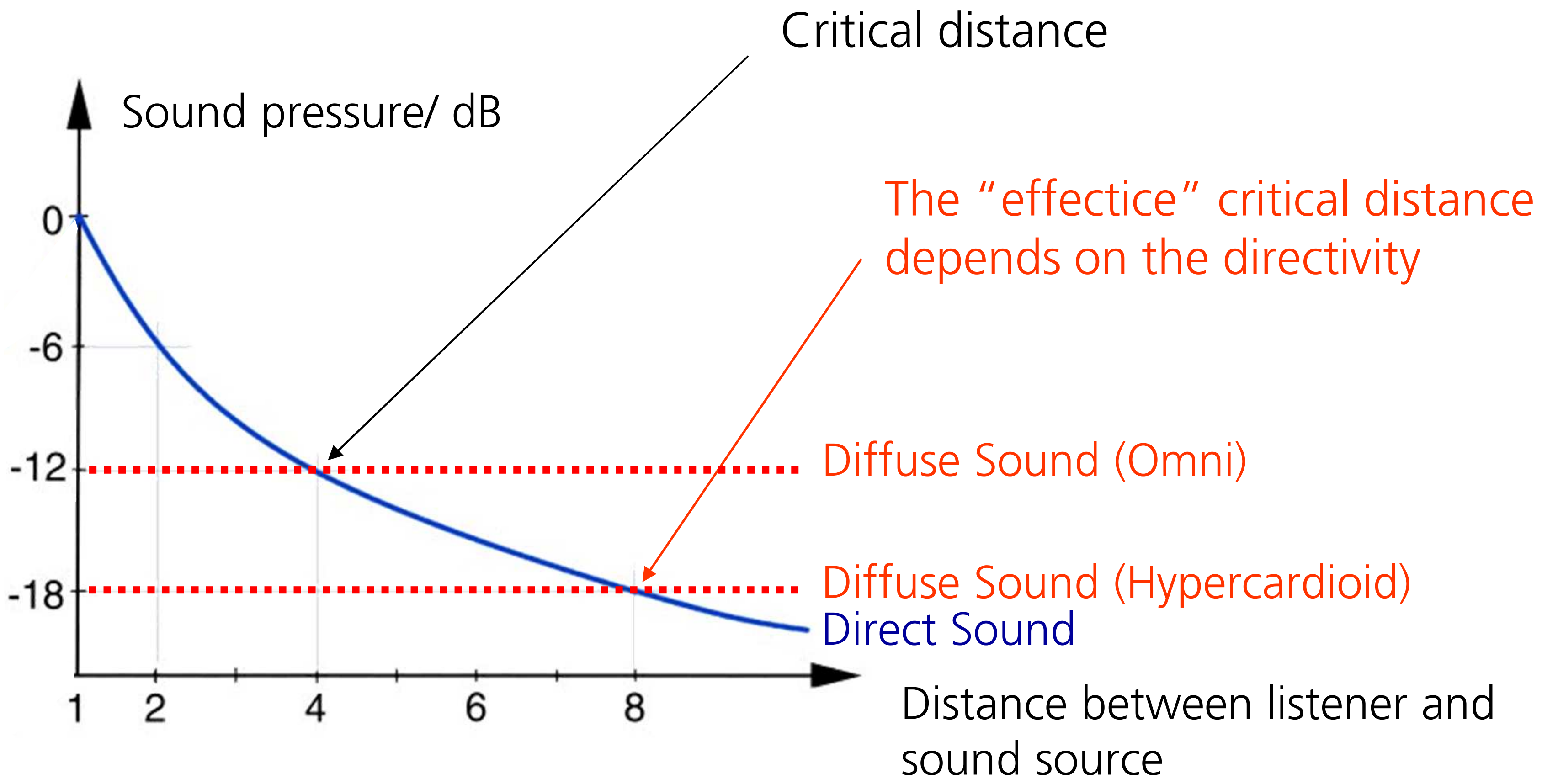
„Open Cardioid"



Distance factor, Directivity index



Direct sound/ Diffuse sound



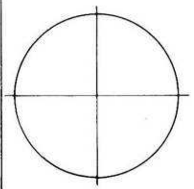
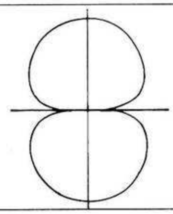
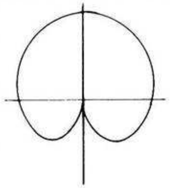
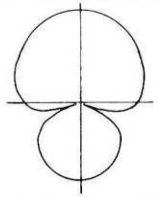
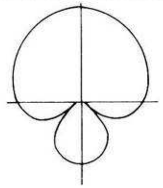
A directional microphone boosts the desired 0°-signal by two measures:

- attenuation of the off-axis sound sources
- attenuation of the diffuse sound

Microphone types: Pressure gradient, 1st order

SCHOEPS

JULY/AUGUST 1976, VOLUME 24, NUMBER 6

CHARACTERISTIC	OMNIDIRECTIONAL	BIDIRECTIONAL	CARDIOID	HYPERCARDIOID	SUPER-CARDIOID
POLAR RESPONSE PATTERN					
a + (1-a) cos Φ	1	COS θ	1/2(1+COS θ)	1/4(1+3COS θ)	.37+.63COS θ
PICKUP ARC 3 dB DOWN (θ3)	360°	90°	131°	105°	115°
PICKUP ARC 6 dB DOWN (θ6)	360°	120°	180°	141°	156°
RELATIVE OUTPUT AT 90° (dB)	0	−∞	−6	−12	−8.6
RELATIVE OUTPUT AT 180° (dB)	0	0	−∞	−6	−11.7
ANGLE AT WHICH OUTPUT = 0 (θ_0)	—	90°	180°	110°	126°
Directivity index	**0 dB**	**-4,8 dB**	**-4,8 dB**	**-6 dB**	**-5,7 dB**
DISTANCE FACTOR (DSF)	1	1.7	1.7	2	1.9

① MINIMUM RANDOM ENERGY EFFICIENCY FOR A FIRST ORDER CARDIOID
② MAXIMUM FRONT TO TOTAL RANDOM ENERGY EFFICIENCY FOR A FIRST ORDER CARDIOID

Quelle: W. Schullein, AES paper

Fig. 18. Microphone directivity patterns.

First-order pressure-gradient microphones

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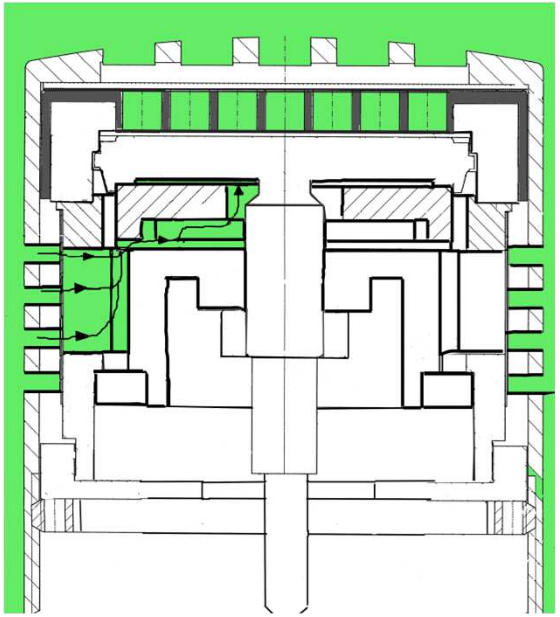


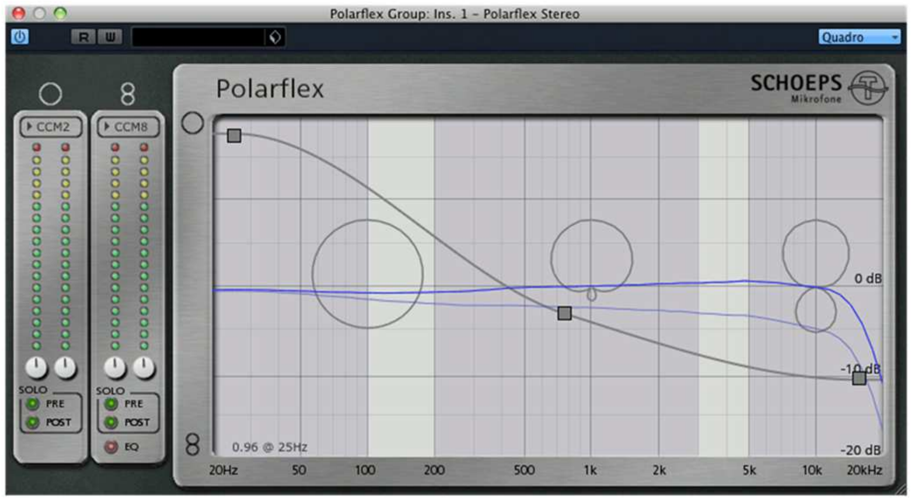
- Various different patterns between Omni and Cardioid
- Directivity index (DI) between 0 dB and 6 dB
  → Double M/S demo

Available for free!

Polarflex plug-in

→ download at http://www.schoeps.de/en/products/polarflex

- Mix Omni and Fig-8
- In three frequency bands
- Variation of the diffuse field response



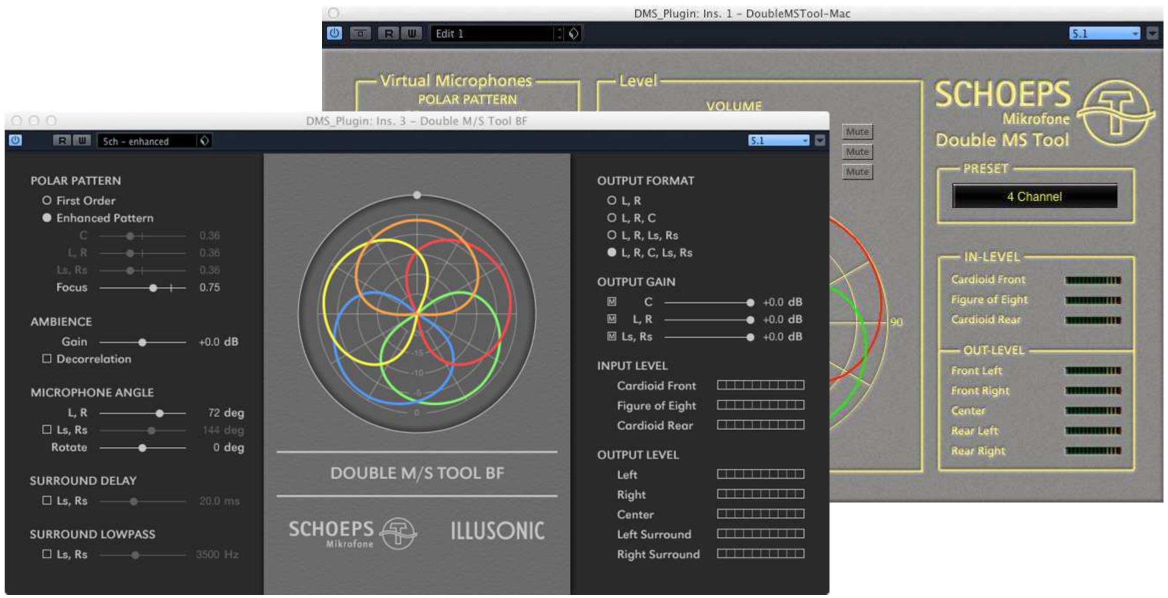
Available for free!

SCHOEPS Mikrofone

Double M/S with 2 plug-ins available at
http://www.schoeps.de/en/products/dms_plugin

Version 2 ("BF") offers new functionalities:

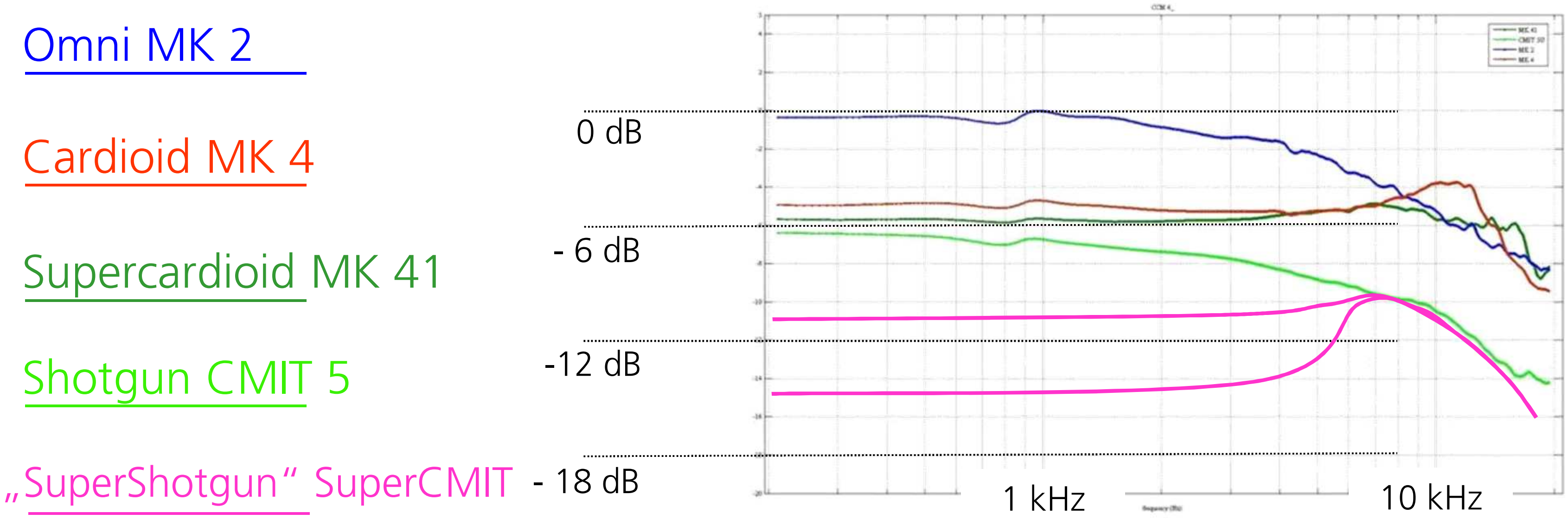
- higher directivity
- less correlation
- variable diffuse sound level



- Important for the sound colour of the microphone:

  Diffuse field-frequency response

  = frequency response of the microphone in the diffuse sound field



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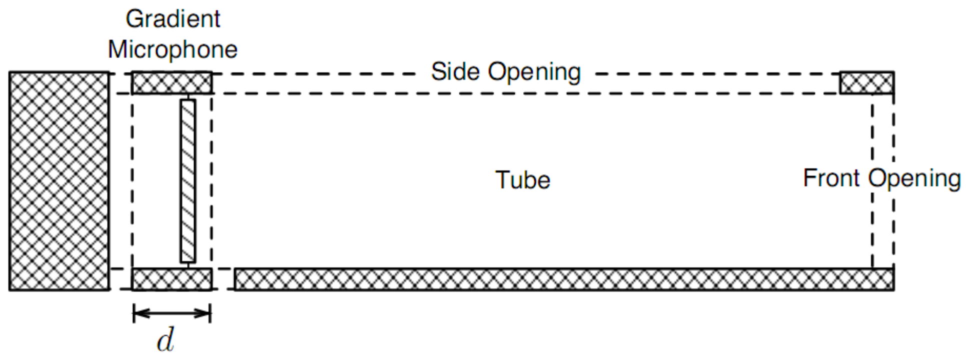
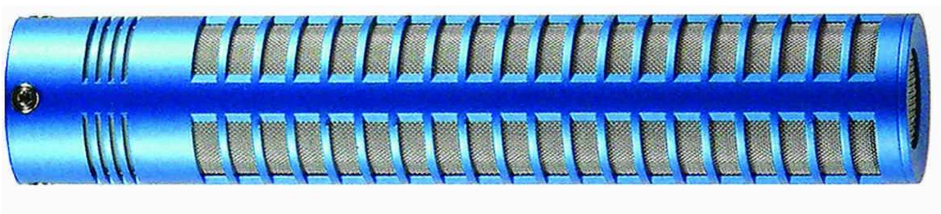
Shotgun vs. Supercardioid

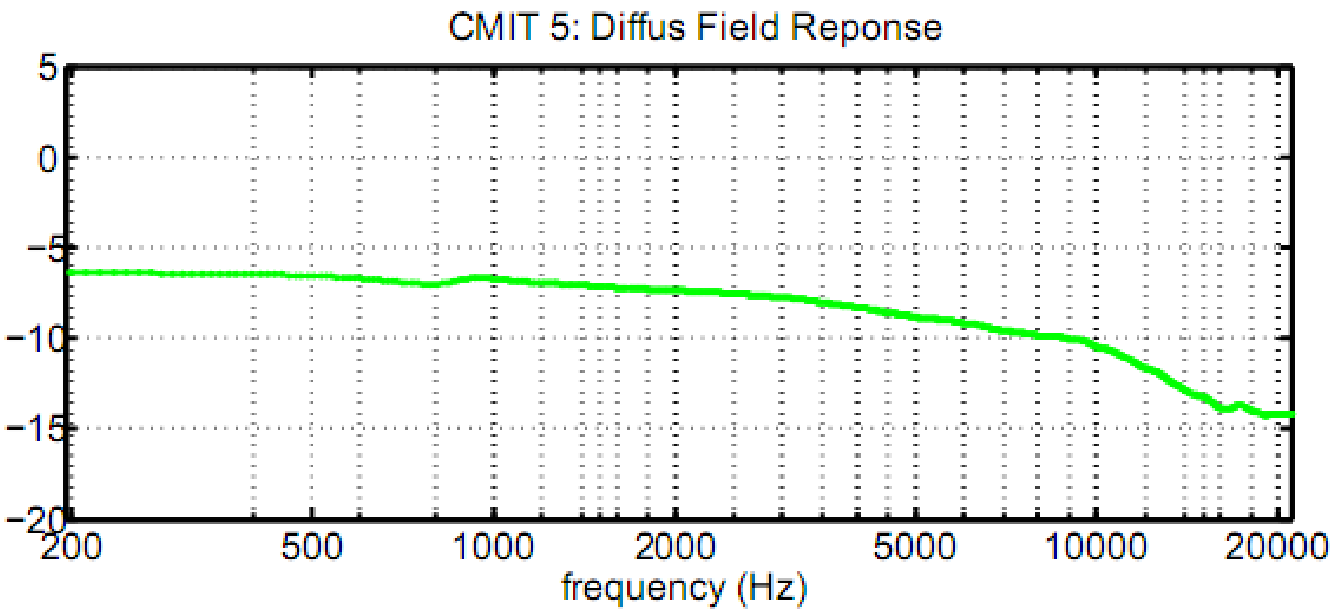
Existing principles of directive microphones

- Existing principles for directional microphones:
  - First-order pressure-gradient microphones
  - Higher-order gradient microphones
  - Interference tube microphones (“shotgun microphones”)
  - Adaptive Systems
  - Parabolic mirrors





- Frequency-dependent directivity:



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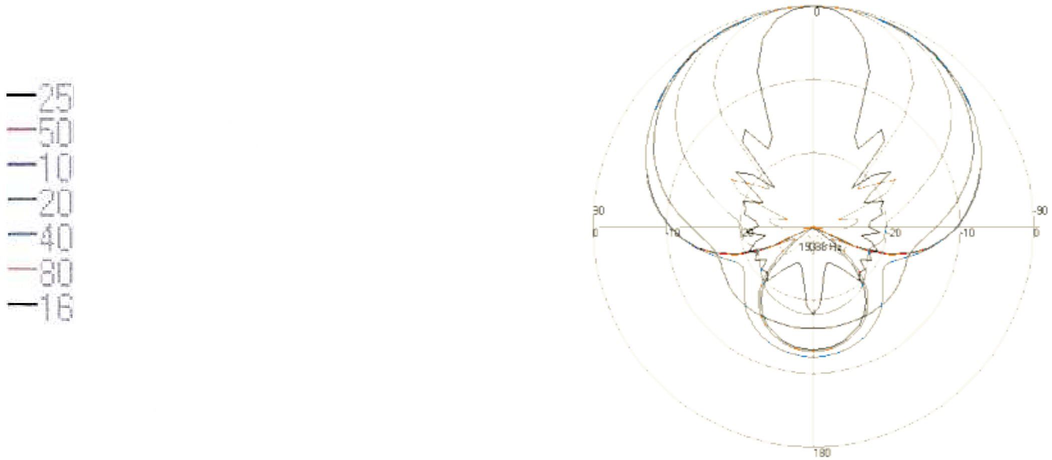
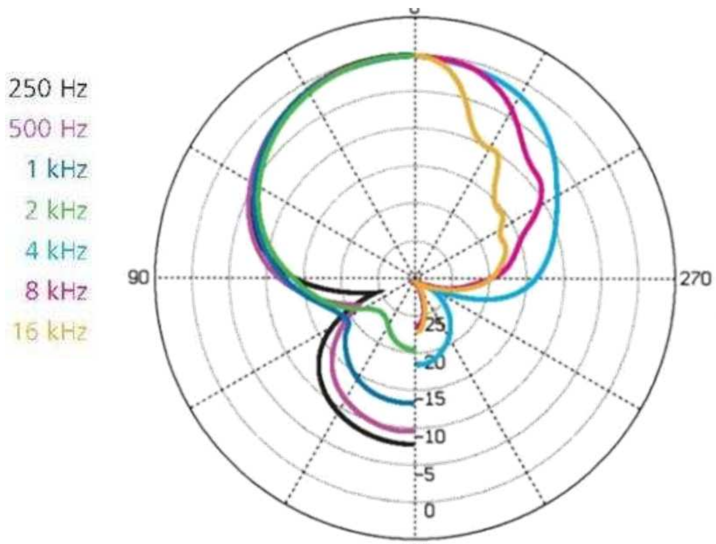
- Frequency-dependent directivity:



Sennheiser MKH 416



SCHOEPS CMIT 5

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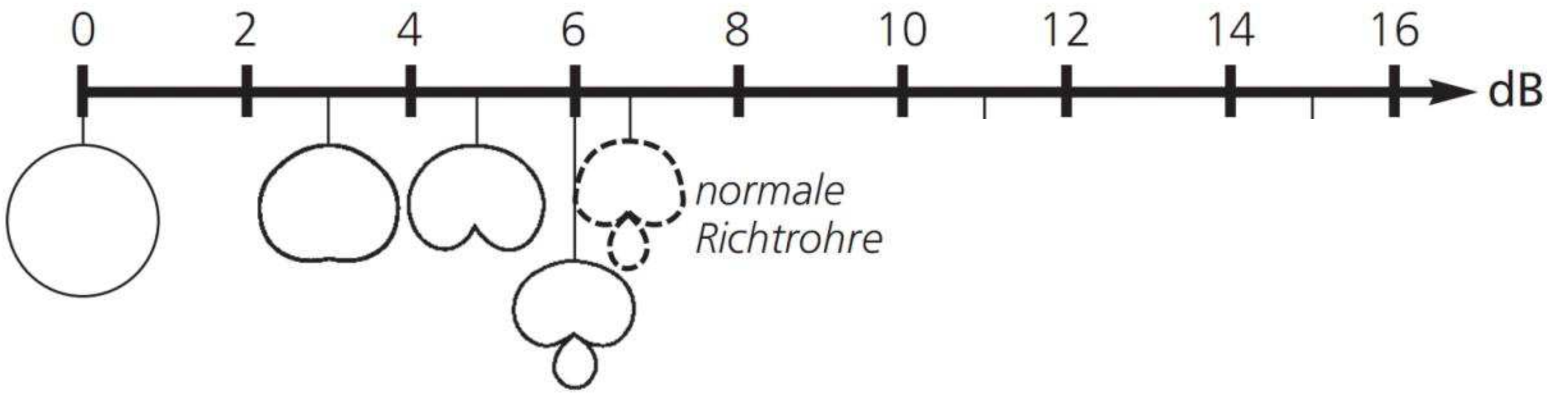
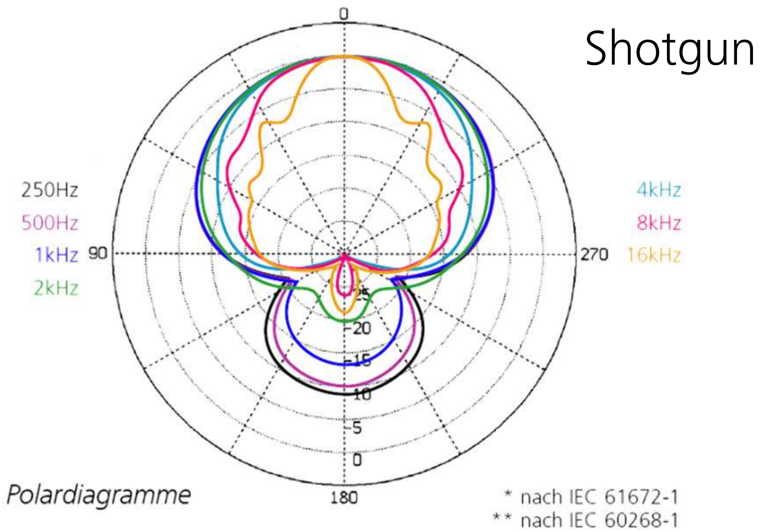
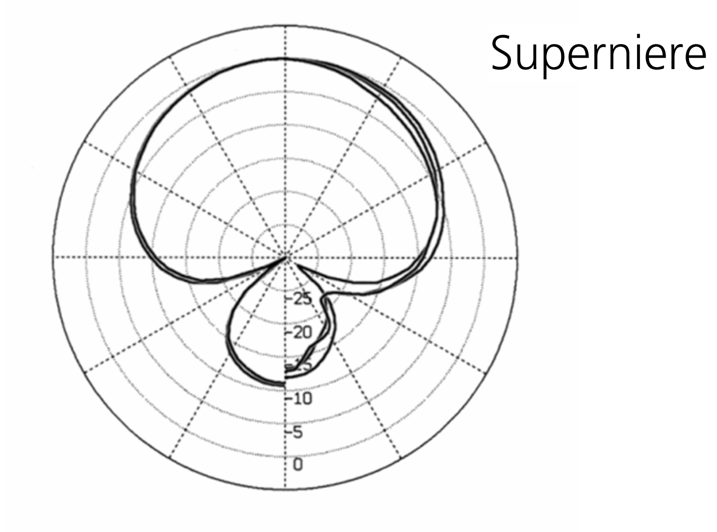
Directivity index (< 2kHz):



Polardiagramm: Shotgun, „Richtrohr“



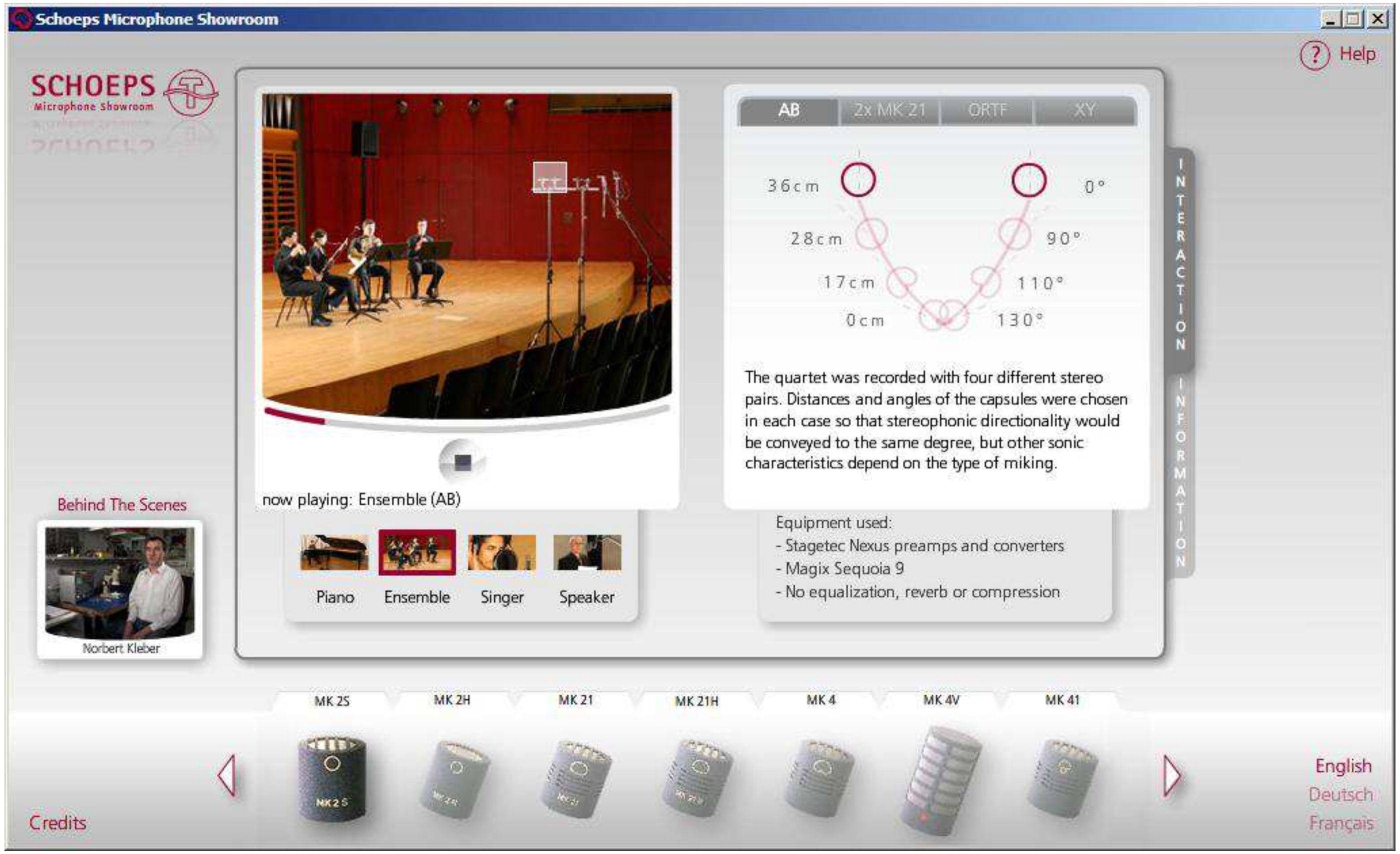


LIT *www.schoeps.de: [Microphone Showroom]* **EXP** *Unterscheidung zwischen CMIT und CCM 41*

Showroom

- *SCHOEPS Microphone Showroom:* www.schoeps.de/showroom

provides an interactive comparison between microphone techniques and models…



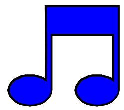


Table microphones: Newsroom

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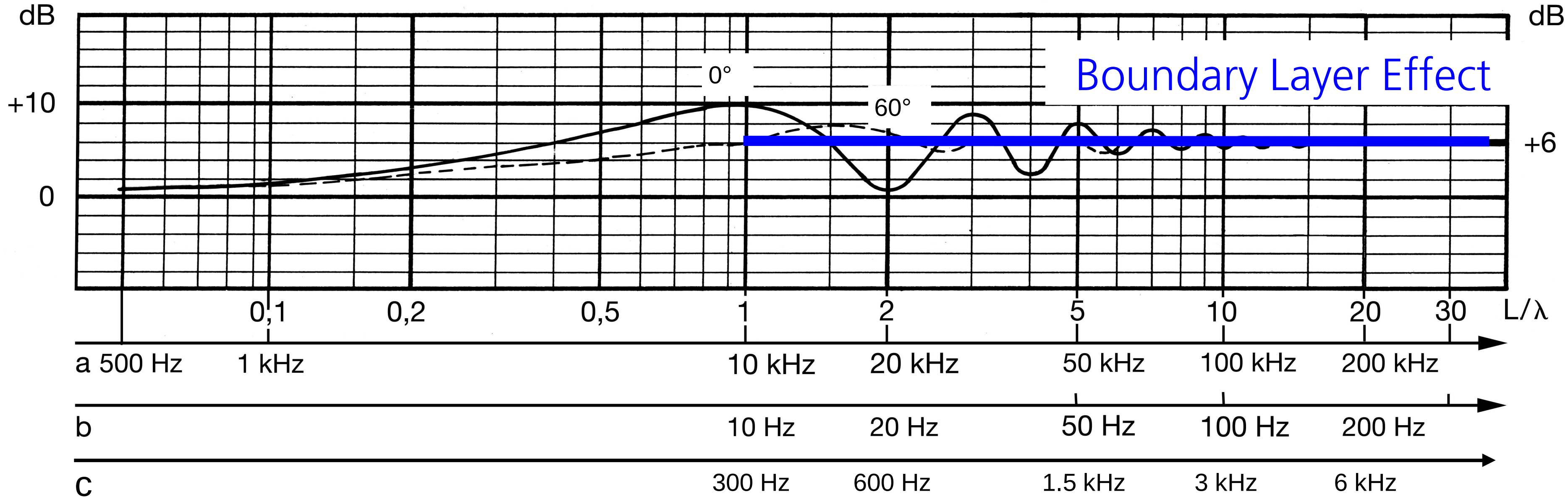
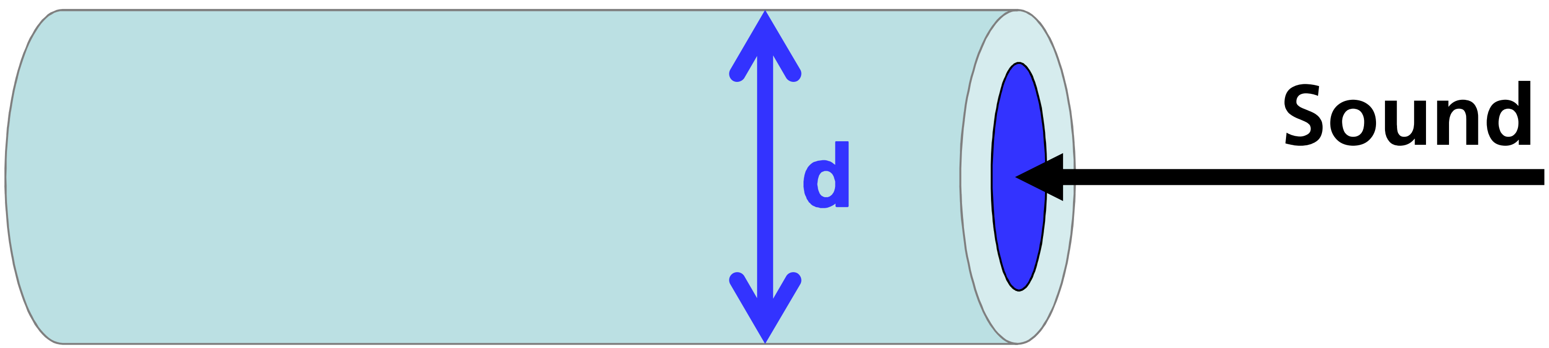
- German News show „Tagesschau“:

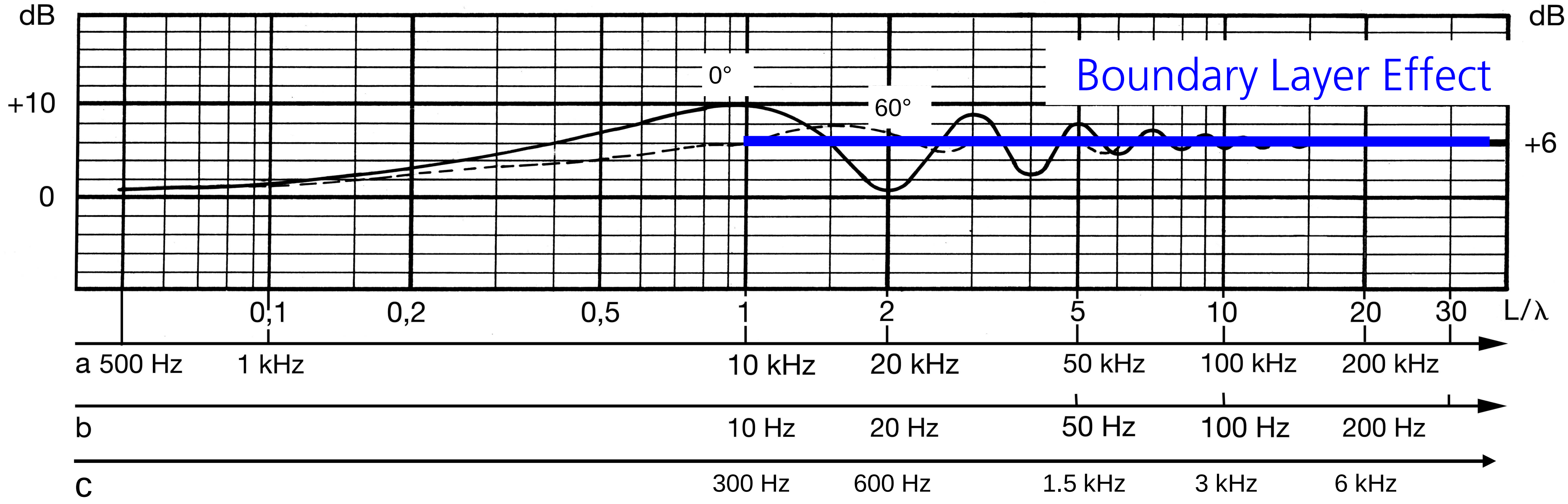
- What do the two microphones record?

SCHOEPS Mikrofone





SCHOEPS Mikrofone



Pressure in the center of the front of a reflecting obstacle (cylinder) in the sound field.

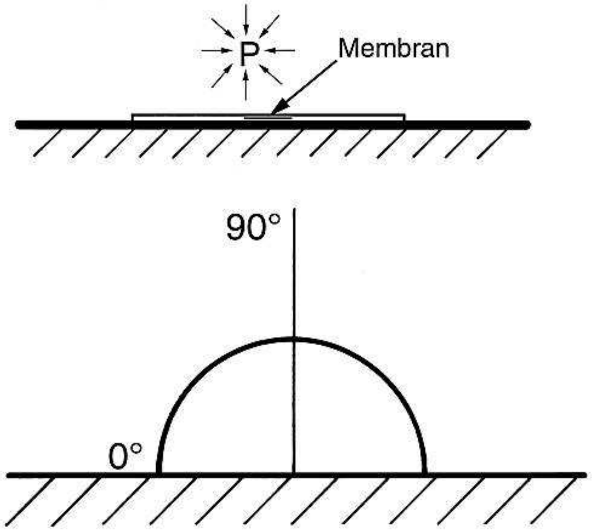
a) frequency scale for Ø 34 mm diameter

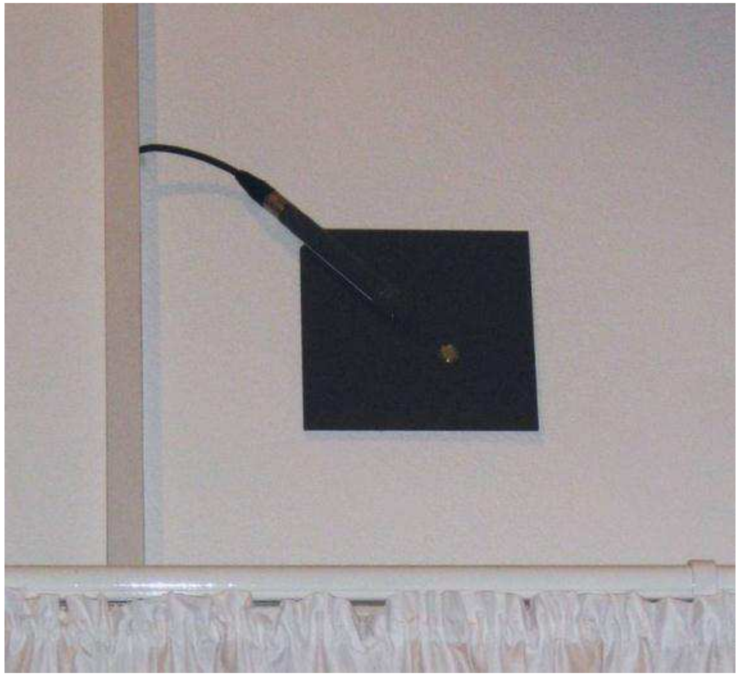
b) frequency scale for Ø 34 m surface (boundary-layer technique)

c) frequency scale for Ø 1 m surface (on the table)

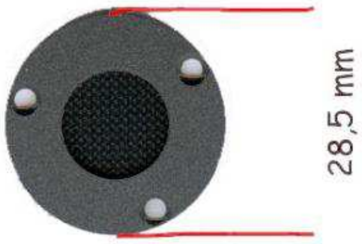
full line: 0° perpendicular sound incidence, dashed line: 60° sound incidence

L = diameter of the obstacle, λ = wavelength, see **LIT**: Olson





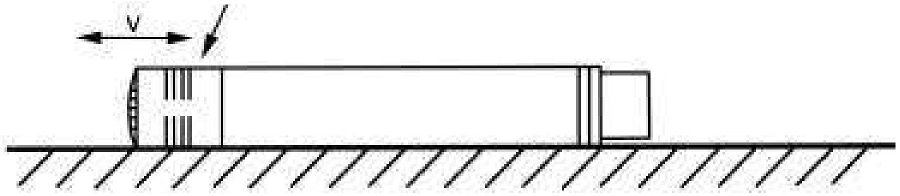
Advantage: similar pressure congestion at all frequencies!

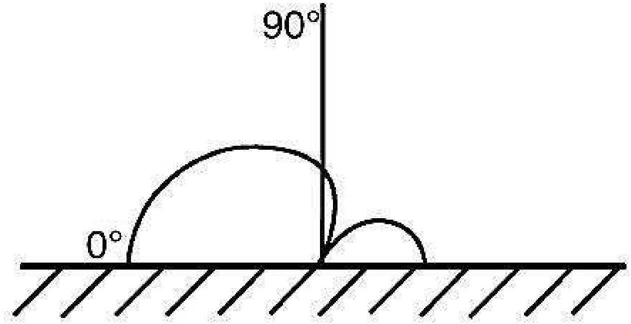


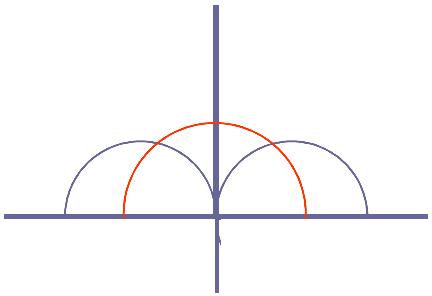
~~**EXP** *Variation der Grenzfläche zwischen 2 cm und 5 m*~~

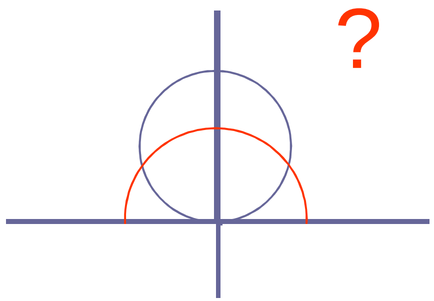
Microphone types: Boundary Layer Microphones

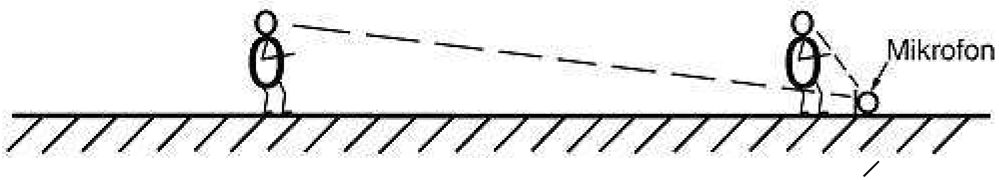
Cardioid or Supercardioid











EXP *1. Vergleich gerichtete Grenzfläche BLC + CCM 41 mit normaler CCM 41: Pegelverlauf*
2. Richtwirkung in y-Richtung durch Grenzfläche verhindern

SCHOEPS Mikrofone

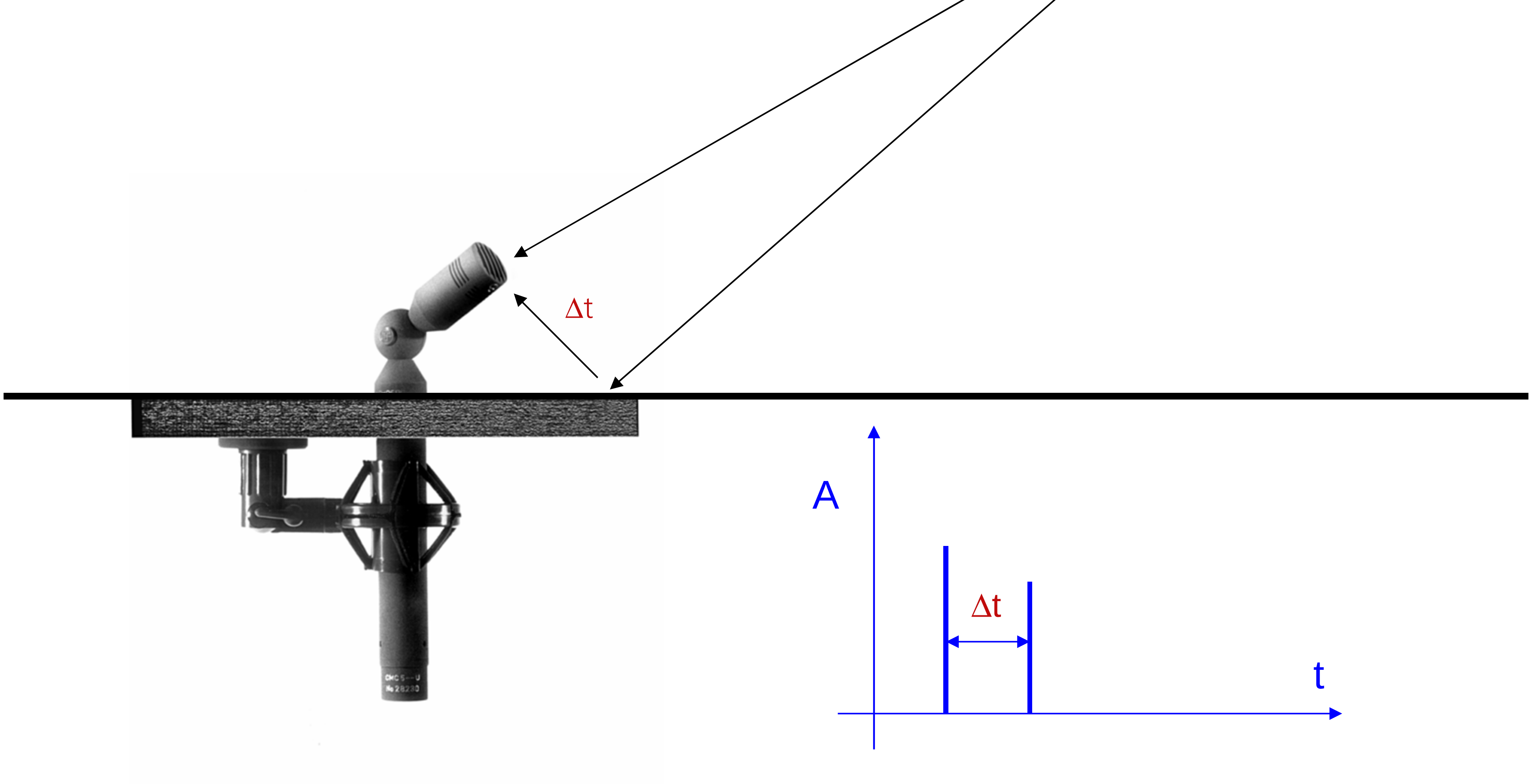
- Omni
- Wide Cardioid
- Cardioid
- Supercardioid
- Supercardioid + boundary layer
- Figure-8
- Shotgun (Interference tube)
- Super shotgun

Microphone types: Boundary Layer Microphones

SCHOEPS Mikrofone

Sound

Both boundary layer and comb filtering



EXP *optimalen Abstand/Winkel in der Praxis ermitteln (CCM 41, CCM 4, STR/RG12)*

SCHOEPS Mikrofone

Δs in mm

0

14

28

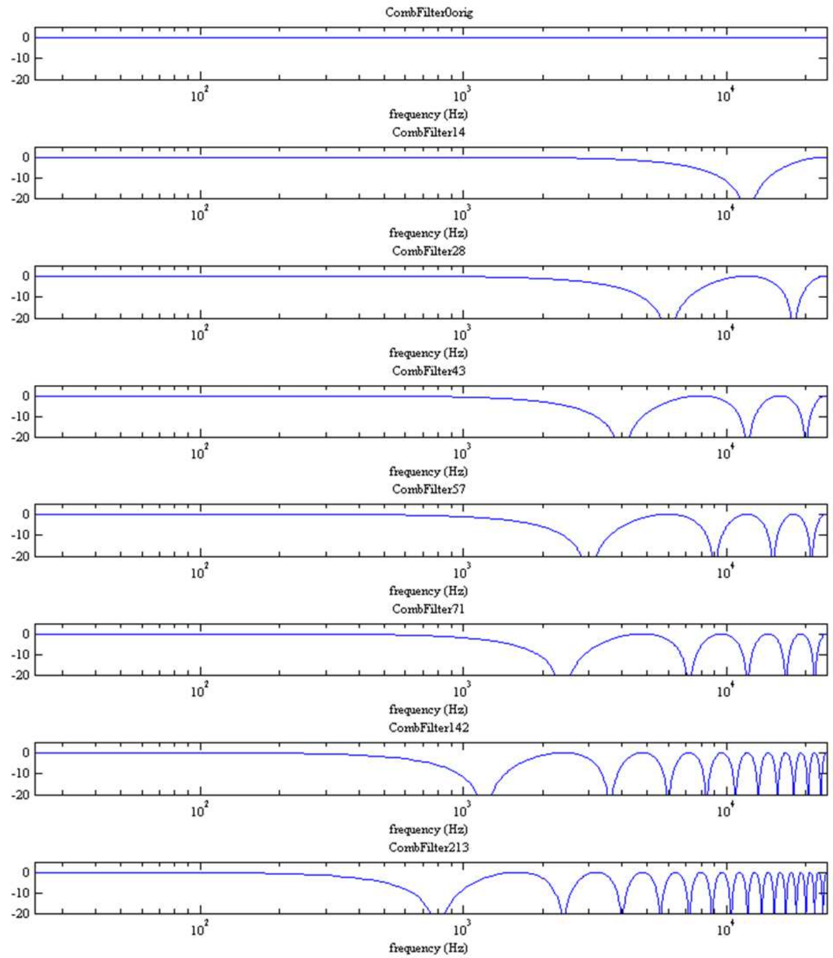
43

57

71

142

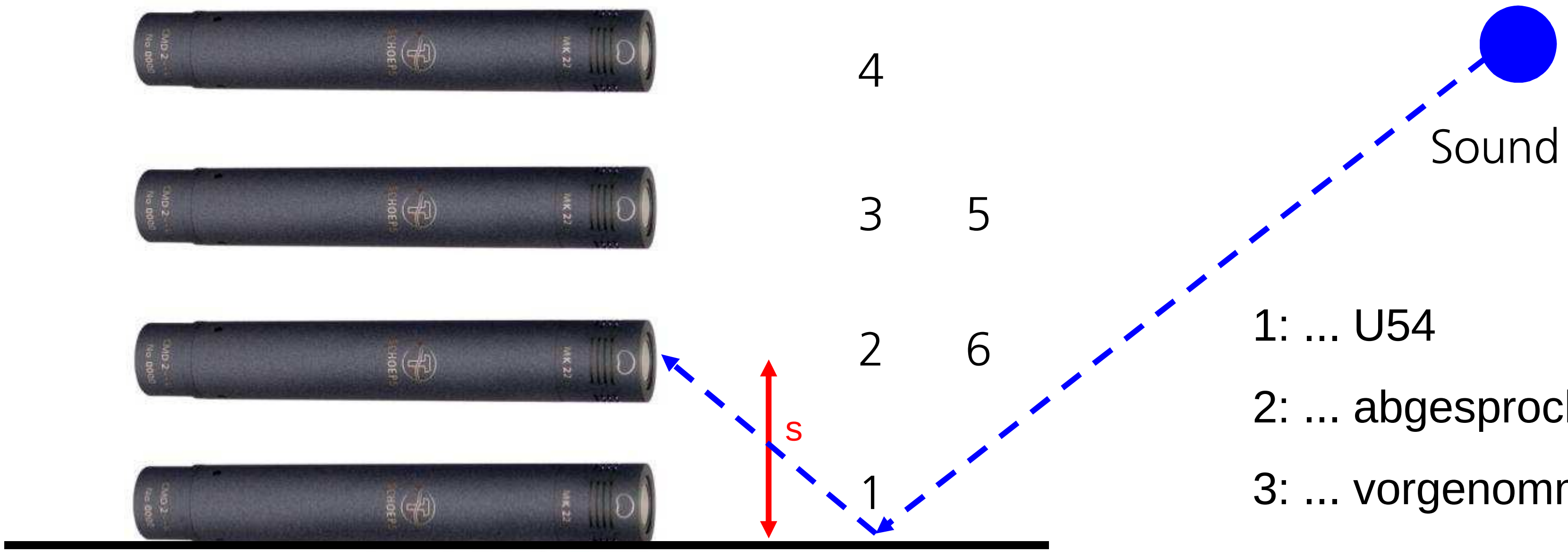
213



Microphone types: Boundary Layer Microphones

SCHOEPS Mikrofone
Sound

Comb filtering, boundary layer:



1: ... U54

2: ... abgesprochen werden

3: ... vorgenommen werden

4: ... sein muß.

5: ... zulässig.

6: ... entnommen werden.

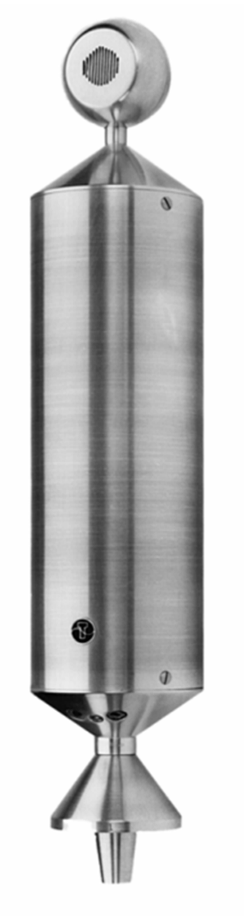
EXP *optimalen Abstand/Winkel in der Praxis ermitteln (CCM 41, CCM 4, STR/RG12)*

SCHOEPS Mikrofone

- What do the two microphone record?
- Boundary Layer microphone: Pressure Doubling and increased directivity only above ~ 300 Hz, because of the small size of the table.
- Supercardioid:
  below 1 kHz: Boundary Layer microphone, because the distance to the table is small. The boundary layer avoids the vertical beaming!
  above 1 kHz: comb filtering

Microphone types: sphere shapes

SCHOEPS Mikrofone

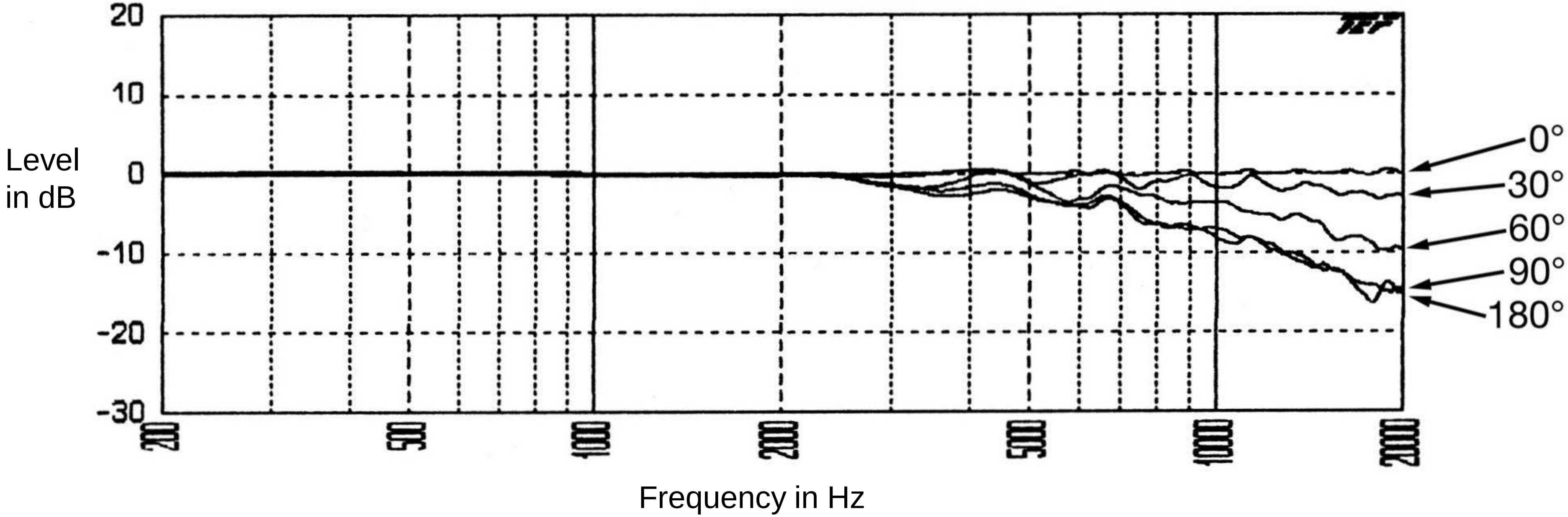


SCHOEPS CMV 50/2 (1948)

Neumann M 50 (nowadays: TLM 50)

SCHOEPS MK 2 H with sphere attachment KA 50 (50 mm)

Microphone types: sphere shapes

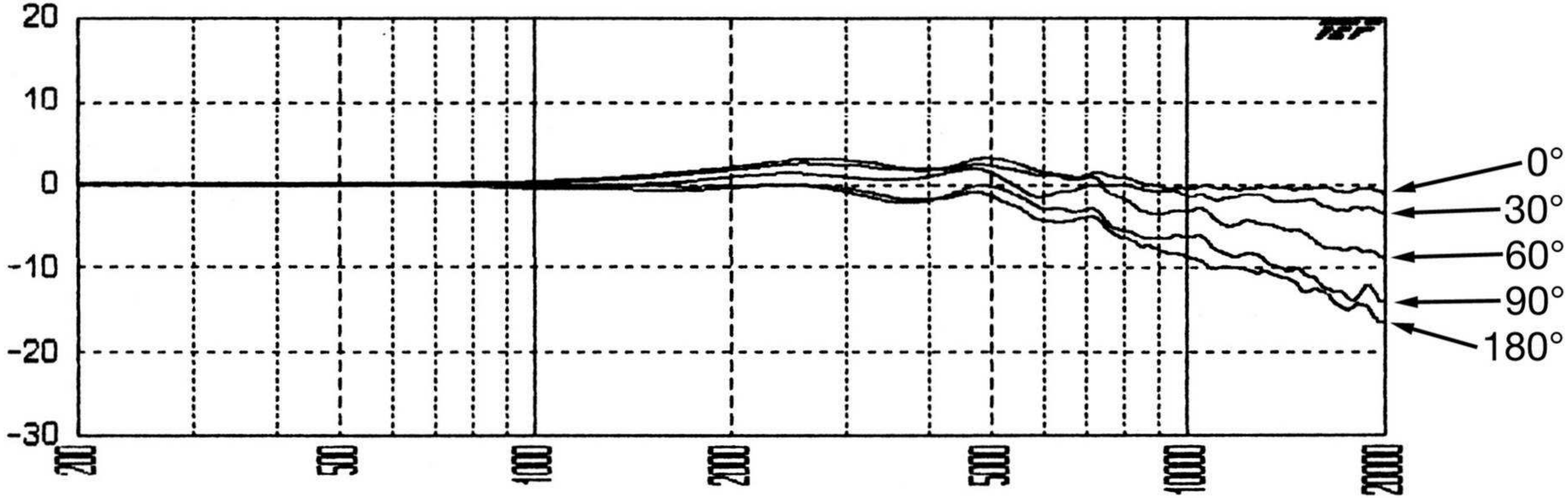


Frequency response of MK2 capsule for different angles of sound incidence

Microphone types: sphere shapes

SCHOEPS Mikrofone

+ KA 50



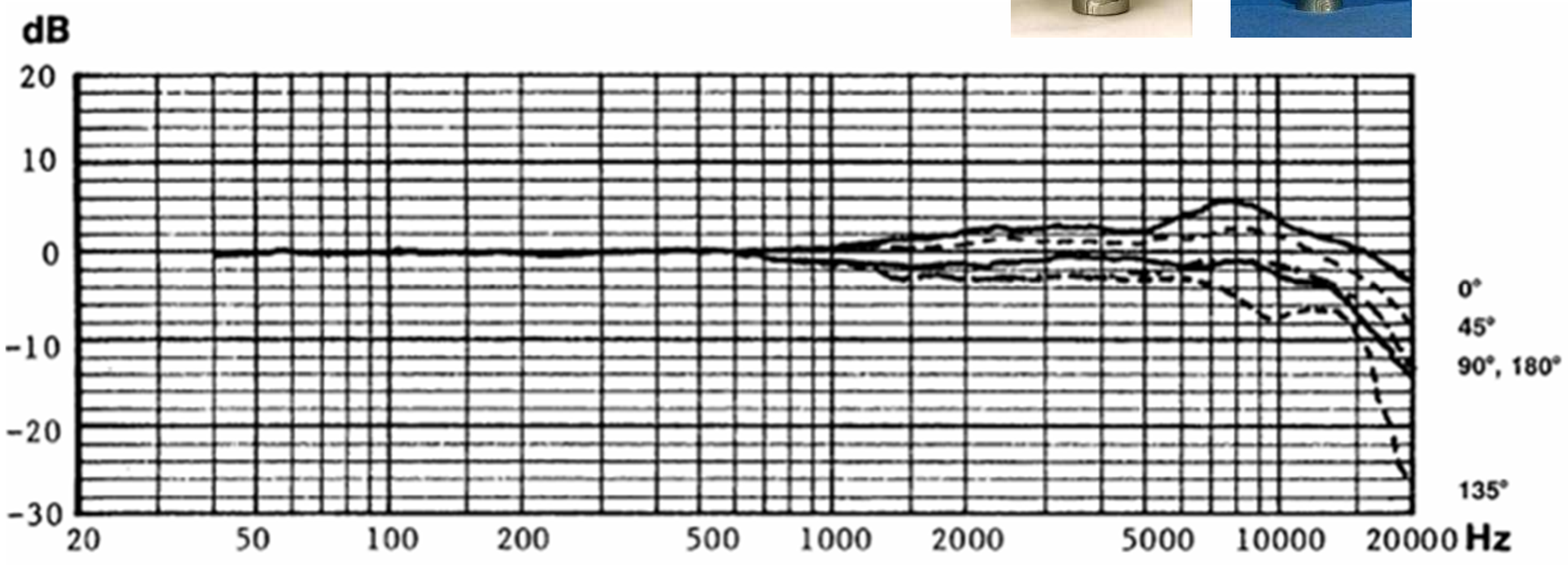
Level
in dB

Frequency in Hz

Frequency response of MK2 capsule for different angles
of sound incidence + KA 50

Microphone types: sphere shapes

Neumann M 50:



Big microphones!

What is the ideal **Studio Vocal Microphone**?

- Our **sonic ideal**:
  - Transparent sound
  - Studio room sound:
    pleasant, unobtrusive, damped
- The according **technical parameters**:
  - Cardioid with uniform *polar patterns*
  - Flat *0°-freqency response* between 50Hz and 20kHz
  - Flat *diffuse-field response* with high frequency roll-off

SCHOEPS Mikrofone

- Desired **technical parameters**:
  1. Cardioid with uniform *polar patterns*
  2. Flat *0°-freqency response* between 50Hz and 20kHz
  3. Flat *diffuse-field response* with high frequency roll-off

- 1 and 2 require a decent **small-diaphragm** capsule
- 3 seems to call for a **large-diaphragm** capsule!

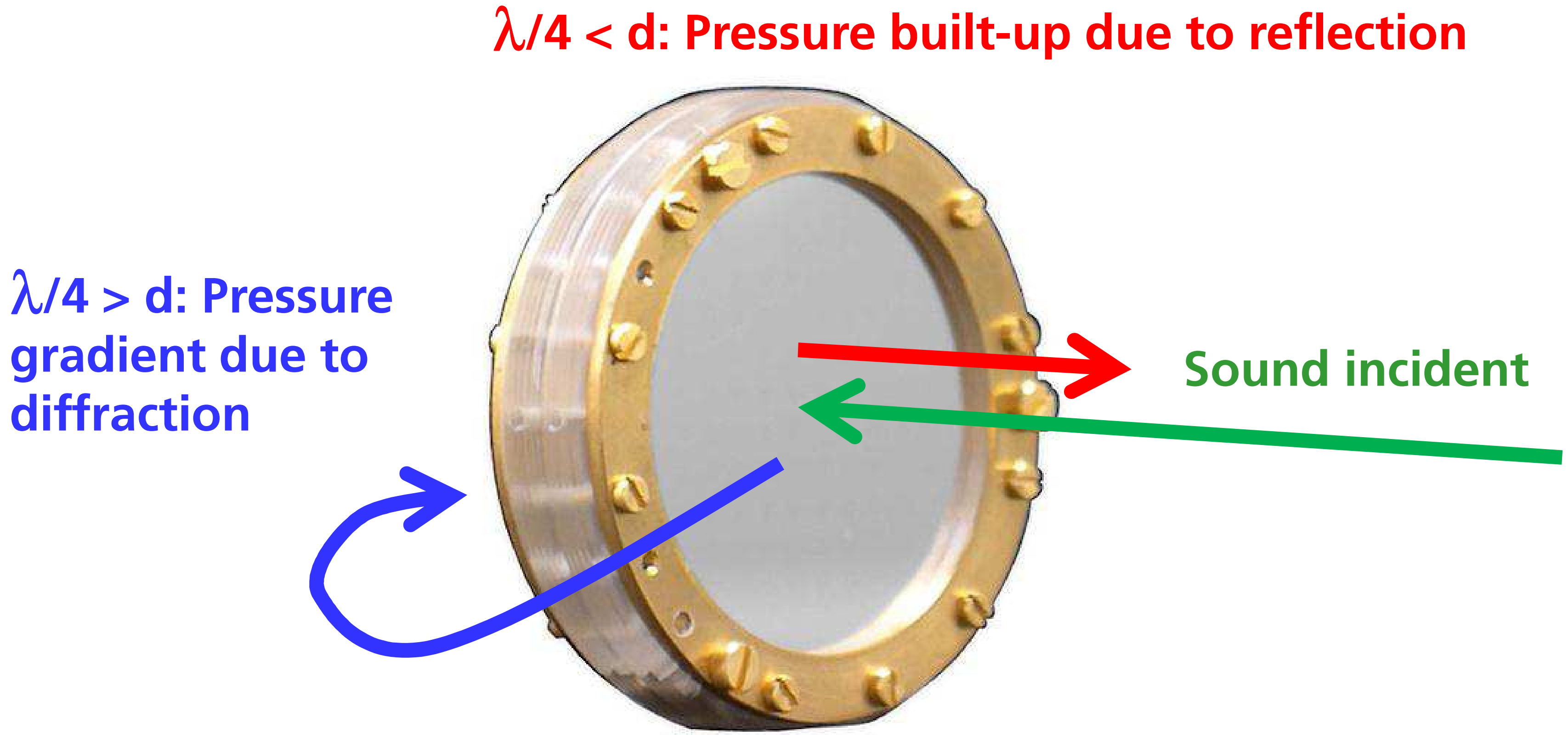
- What is the principal difference between large and small membrane capsules?

Membrane > 20mm

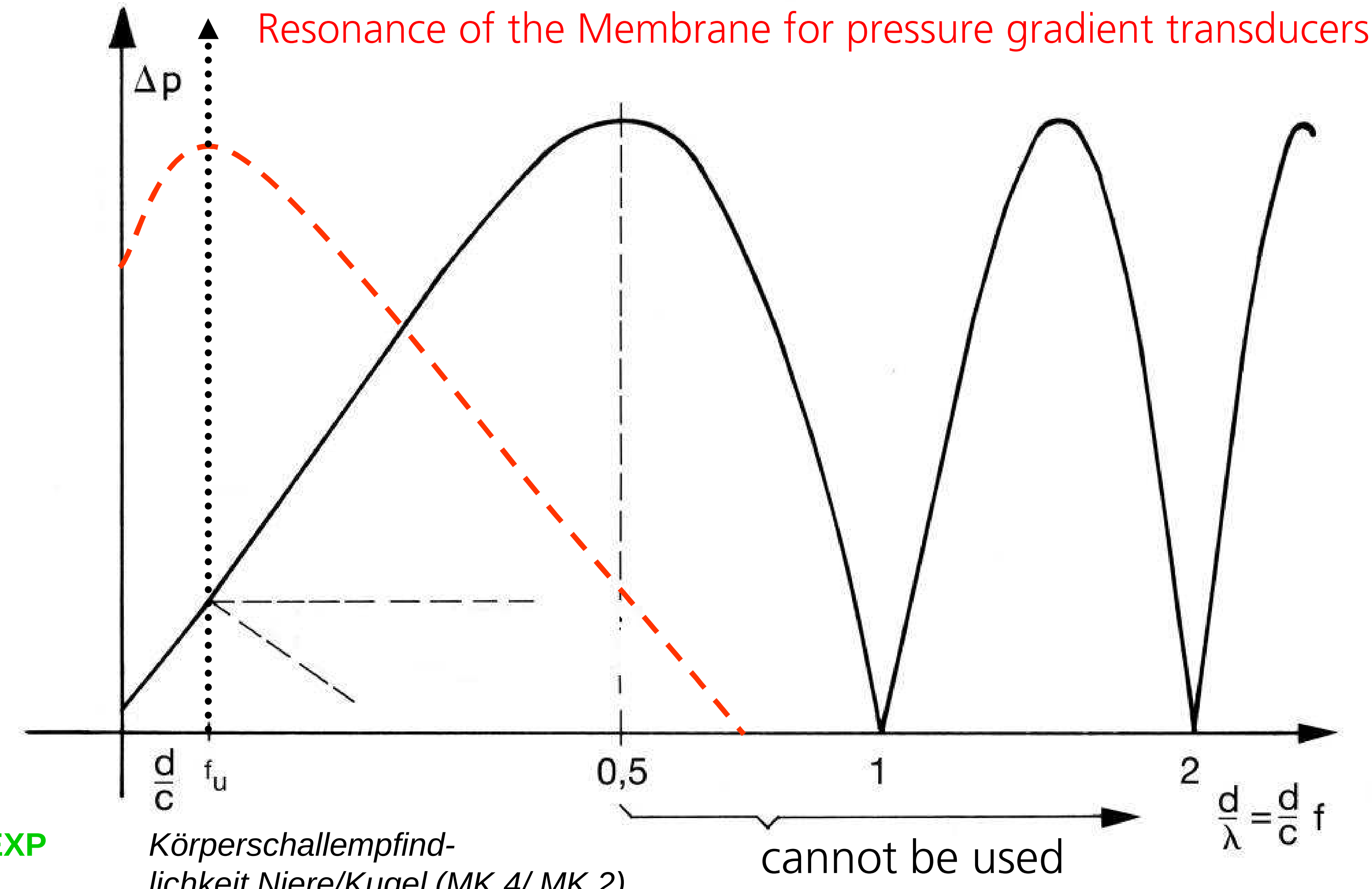
Membrane < 15mm

SCHOEPS Mikrofone

- What is the principal difference between large and small membrane capsules?



Pressure gradient = pressure difference between front and back of the membrane: (Druckgradient_Applet)



EXP

Körperschallempfind-lichkeit Niere/Kugel (MK 4/ MK 2)

SCHOEPS Mikrofone

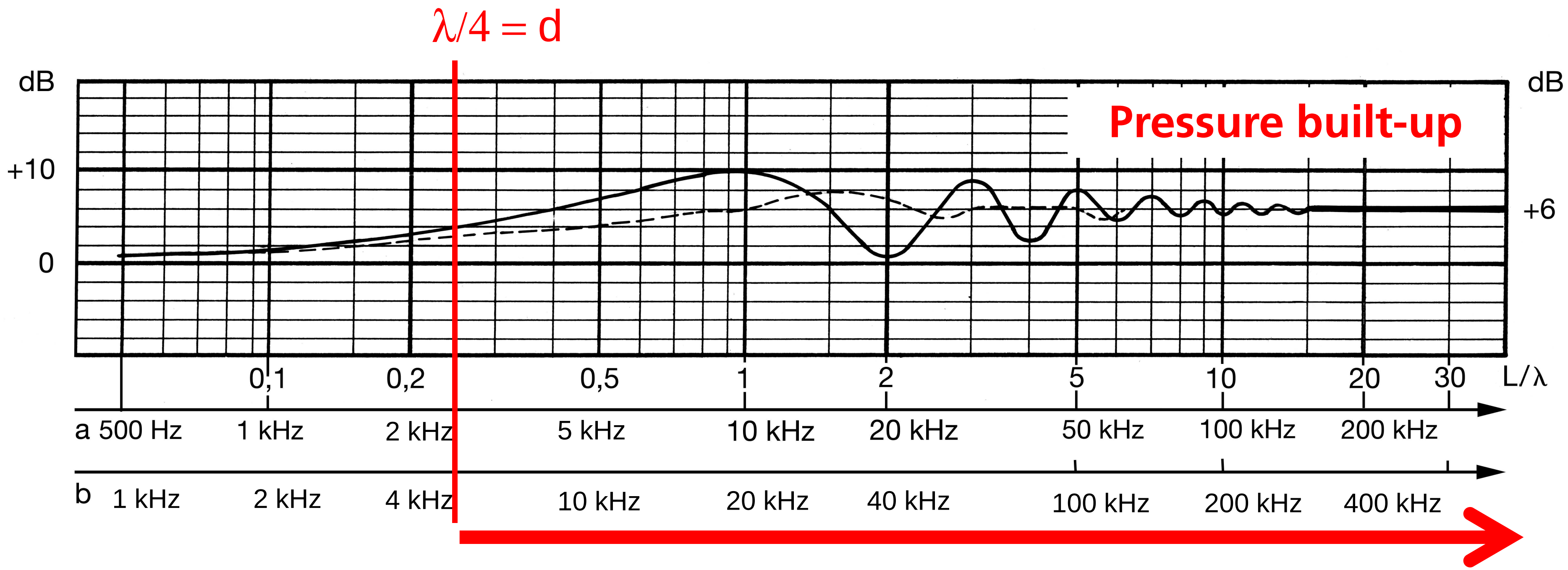
- What is the principal difference between **large and small membrane** capsules?
  → **Pressure gradient** (λ/4 > d) and **Pressure built-up** (λ/4 < d)

a) Diameter = 34mm

b) Diameter = 17mm

a) Pressure built-up > 2,5 kHz

b) Pressure built-up > 5 kHz



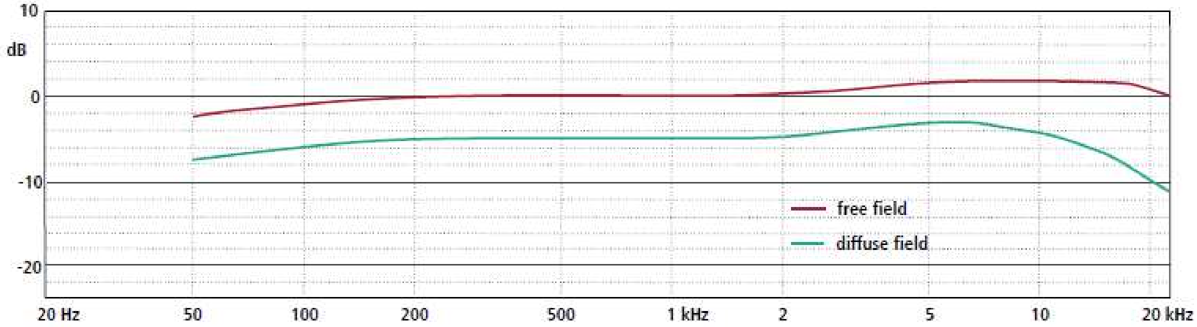
V4 U

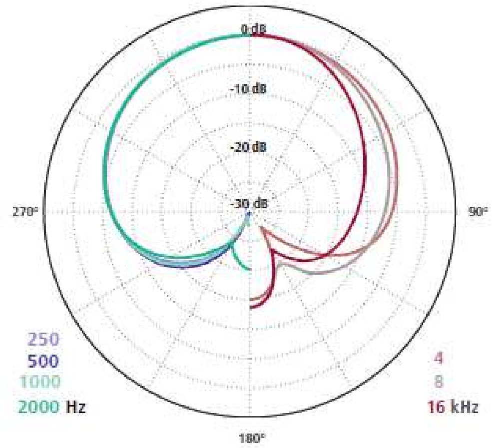
- Realisation in the V4 U: 33-mm bevelled collar around a small membrane

- Small-membrane properties:
  even frequency responses, uniform polar patterns
- Large-membrane properties:
  early pressure built-up due to large diameter, higher directivity at high frequencies, roll-off of the diffuse-field curve

Studio Vocal Microphone **V4 U**

Available in December 2013





Outstanding technical performance:

- Optimal on-axis frequency response featuring a mild high-frequency lift.
- Very smooth polar response; carefully-controlled narrowing of the pattern at high frequencies.
- Diffuse-field response parallel to the 0 ° response, with a gentle roll-off at high frequencies.
- Newly designed electronics offer a very high maximum sound pressure level.

V4 U

The Electronics

- Newly-developed bridge-type balanced output circuit.
- Maximum sound pressure level of 144 dB SPL, corresponding to an output level of 4.8 V.
- Output stage transformerless and free of coupling capacitors.
- The resulting output impedance is low and constant with frequency, while the symmetry is very high.
- Symmetrical, balanced output, the entire audio circuit is symmetrical from the output of the FET onward.
- High immunity to interference, with gapless shielding and a modern RFI filter at the output; very good electromagnetic compatibility.

V4 U

Applications:

- Studio recording
- Radio

V4 U

V4 with
SGV

V4 with USM-V4

External interference

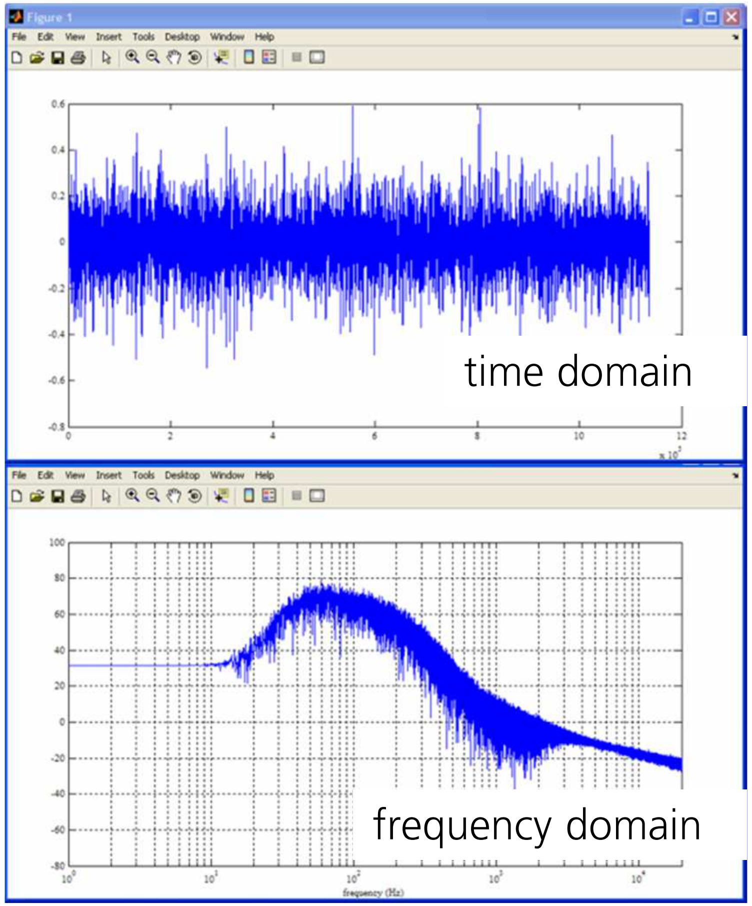
- Wind
- Popp
- „Handling Noise“
- „EMC“: Electromagnetic interference (e.g. radio frequencies, Wifi, power chords)

External interference

- **Wind**
- Popp
- „Handling Noise"
- „EMC": Electromagnetic interference (e.g. radio frequencies, Wifi, power chords)

Wind

SCHOEPS Mikrofone

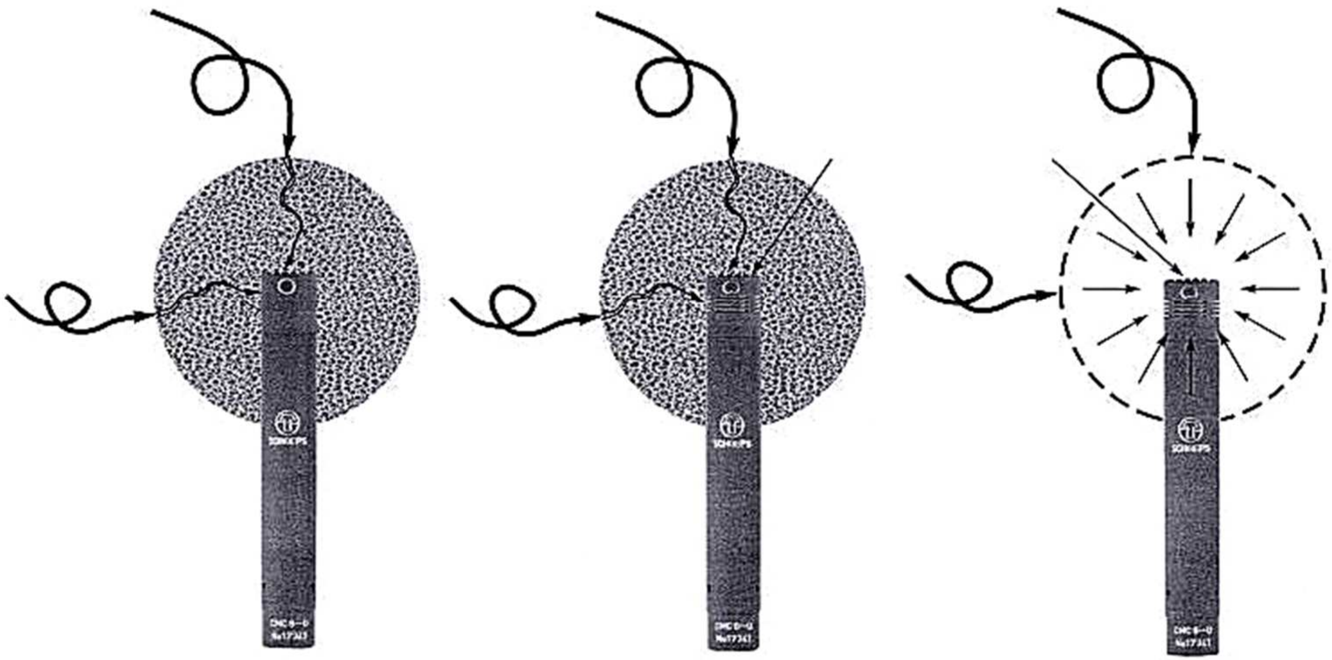


MK 41 - **no** wind screen

MK 41 - wind screen **W 5 D** (**replay level plus 40 dB**)

SCHOEPS Mikrofone

The functional principles of different types of windshields on a pressure-gradient microphone



Omni
+ Foam

Cardioid
+ Foam

Cardioid
+ Volume

Quelle und **LIT** *J.Wuttke: „Mikrofonaufsätze“, www.schoeps.de*

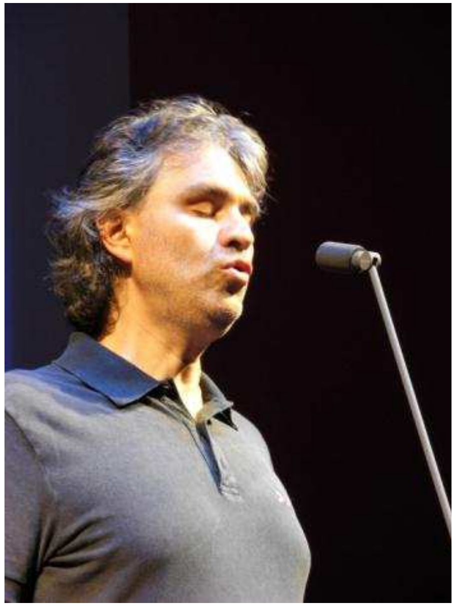
Wind

- Wind spectrum: the maximum is < 100 Hz
- Disturbances depend on the type of transducer
- Measure: Wind screen, foam, Low Cut filter

Windshields

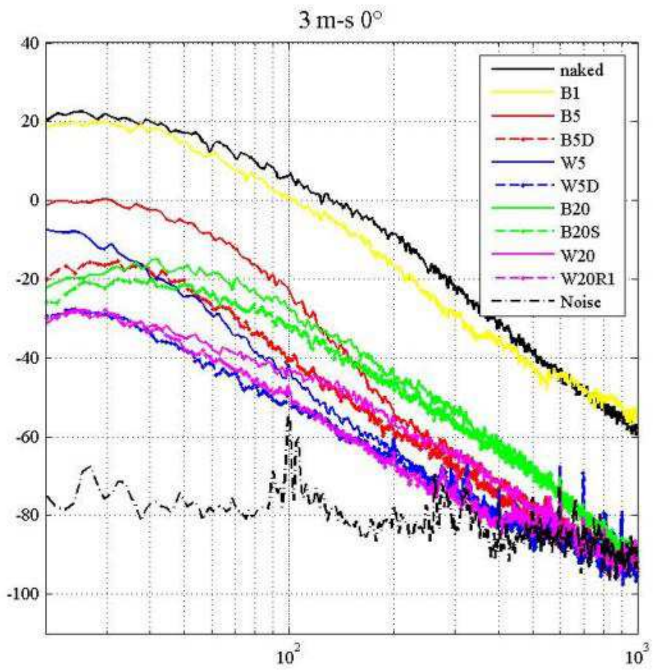
B 5 D

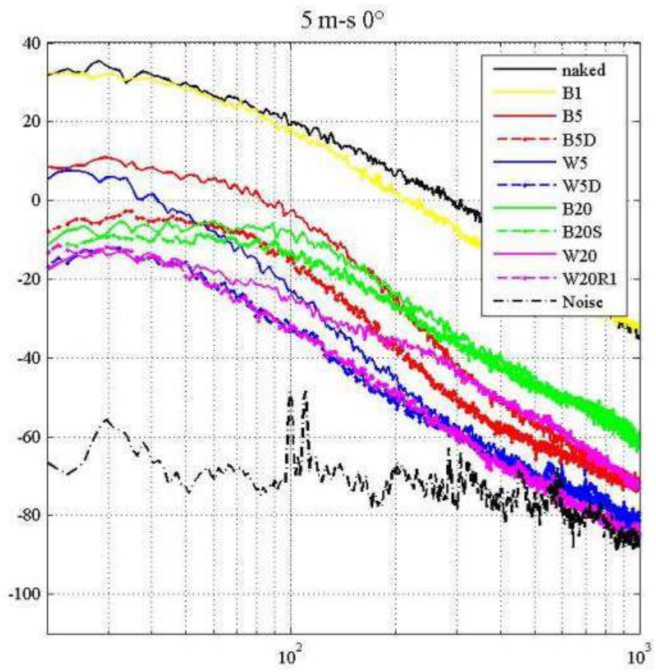
B 1 D



SCHOEPS Mikrofone

- Ohne Windschutz
- Hohlraum-Schaumstoff mittel
- Hohlraum-Schaumstoff groß
- Korb klein
- Korb klein mit Gaze
- Schaumstoff dünn
- Schaumstoff mittel
- Schaumstoff dick
- Korb mittel
- Korb mittel mit Fell





SCHOEPS Mikrofone

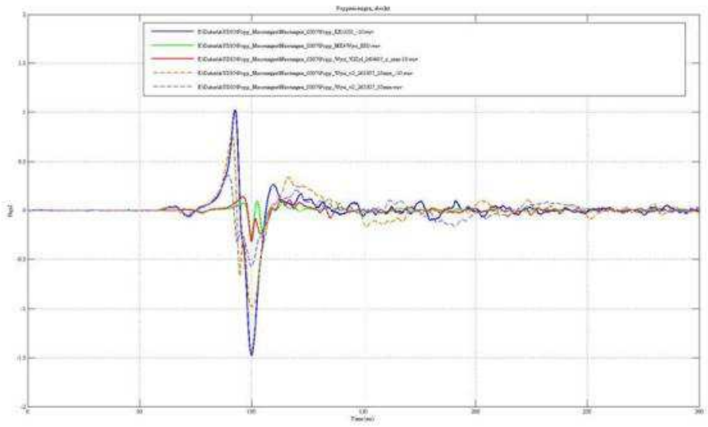
- Windshield SCHOEPS WSC Piano:

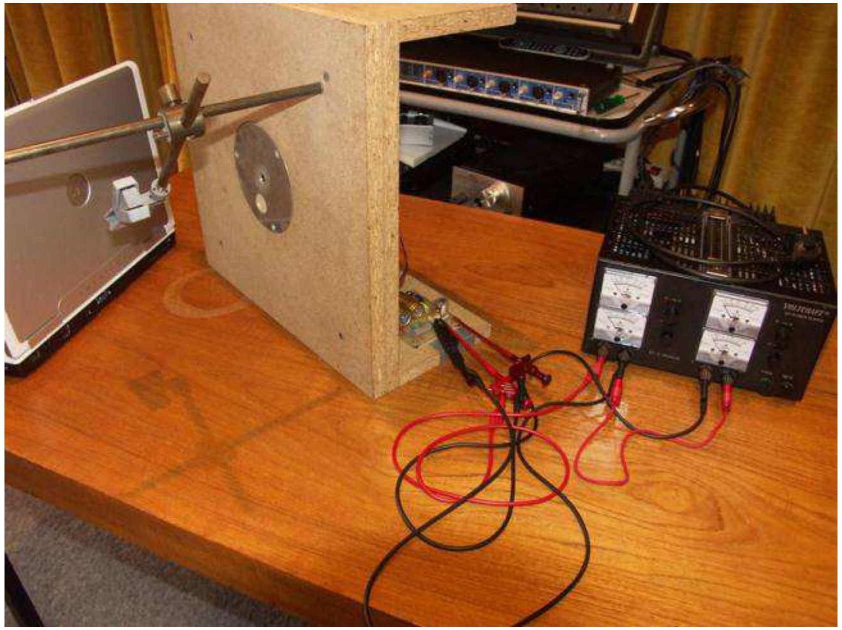
SCHOEPS Mikrofone

- Wind
- **Popp**
- „Handling Noise"
- „EMC": Electromagnetic interference (e.g. radio frequencies, Wifi, power chords)

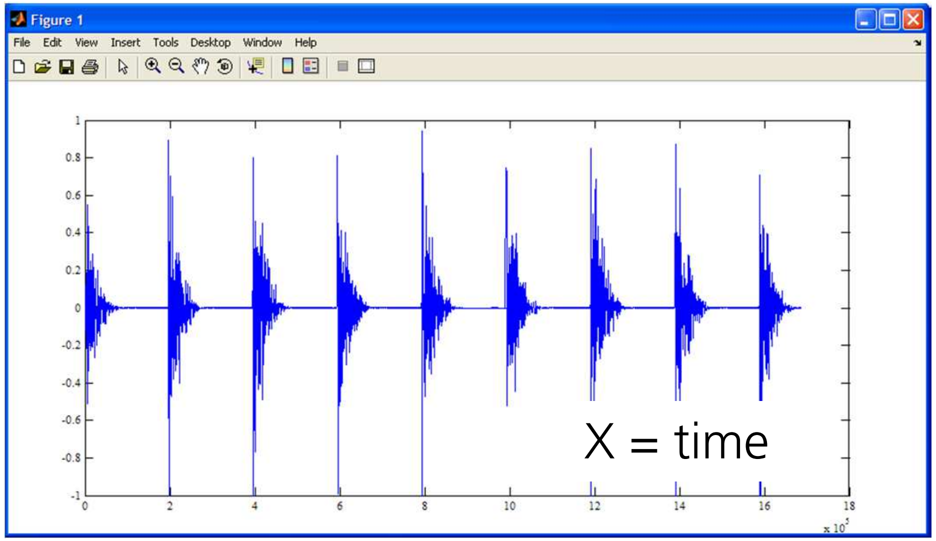
Poppgeräusche

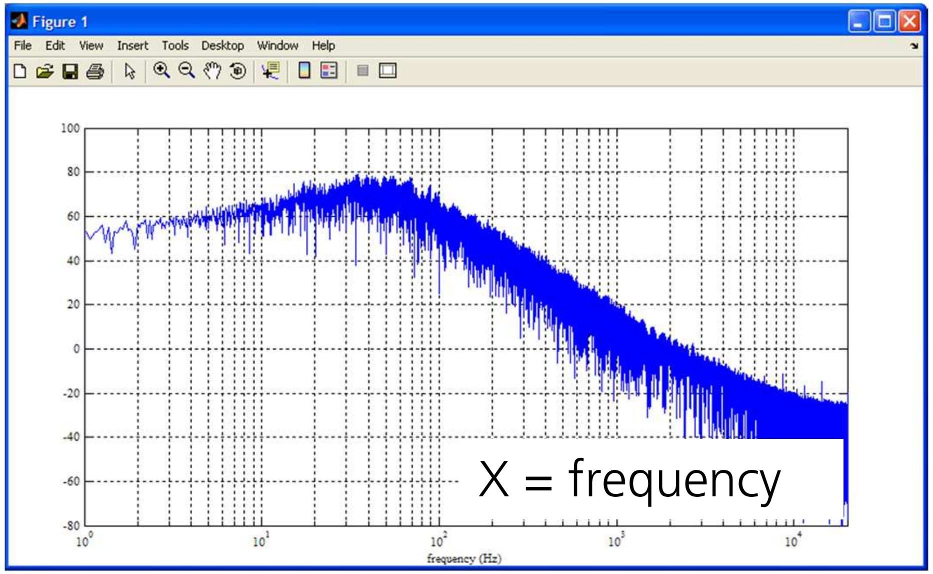
- Plosive Sounds cause high level air impulses
- Measure: Popp protection



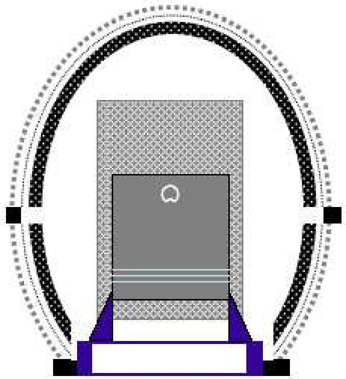


- Cardioid without protection





- The popp protection should not influence the sound (F-response) → no use of thick fabrics (e.g. foam) and solid bodies (e.g. clamps)



Quelle: Poppschutz-Test in tools4music

EXP *Kugel/Niere mit/ohne Poppschutz (MK 2/ MK 4)*

External interference

– Wind
– Popp
– **„Handling Noise“**
– „EMC“: Electromagnetic interference (e.g. radio frequencies, Wifi, power chords)

- The diaphragm is exposed to excitations, that have to be attenuated
- Principles: soft suspension (low, attenuated resonance) with springs, rubber bands or bending principles
- classical studio suspensions („Circus tents“) are effective through their mass or even not at all…

CCM 41

- CCM 41 an der OSIX/MINIX

SCHOEPS Mikrofone

- CCM 41 an der OSIX/"MINIX CCM LL"
  Windschutz B5 D ist optimal an der Angel

Handling noise

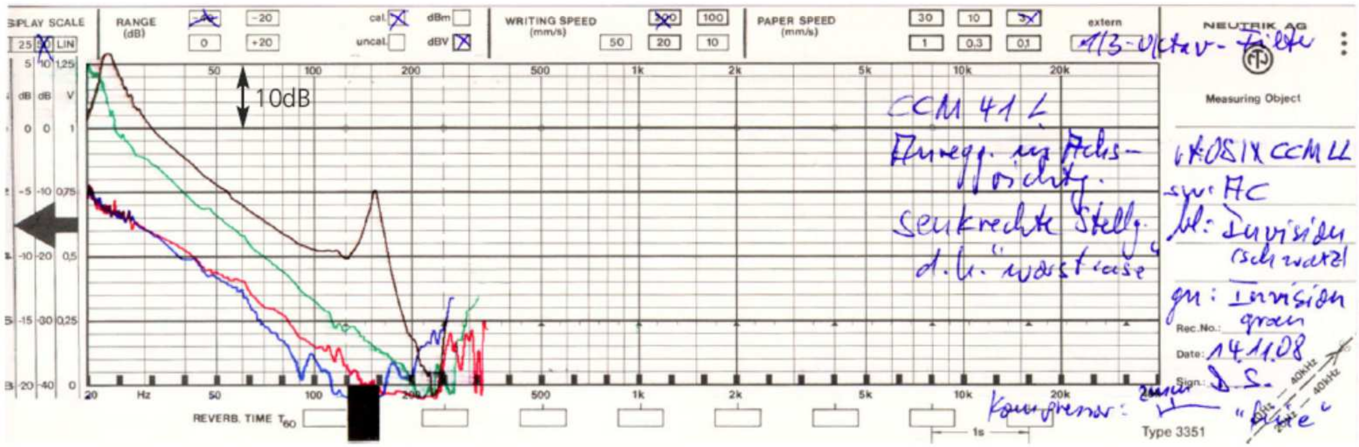
- different solutions (Rycote/Cinela):

SCHOEPS
AC

Ryote
Invision, hart

Cinela
OSIX CCM

Rycote
Invision, weich



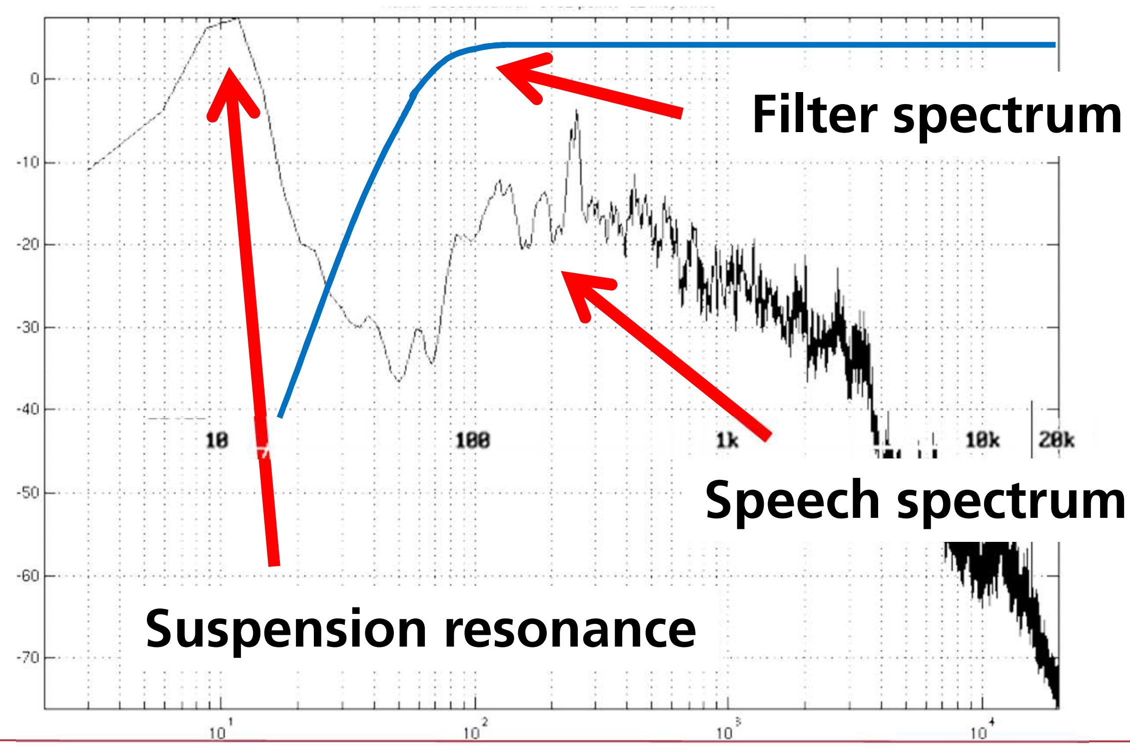
schwarz: AC
grün: Invision hart (graue Lyre; 82 Shore, hart)
rot: OSIX CCM LL
blau: Invision weich (schwarze Lyre; 72 Shore, weich)

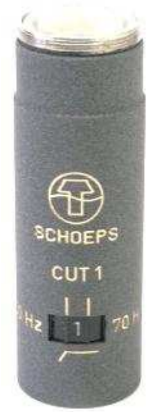
EXP *Angel mit verschiedenen Aufhängungen (MK 41, B 5 D, OSIX, A 20)*

SCHOEPS Mikrofone

Low-Cut 3rd order

is necessary to eliminate audible interference from suspensions: (suspension resonance + wind)





CUT 1

LC 60

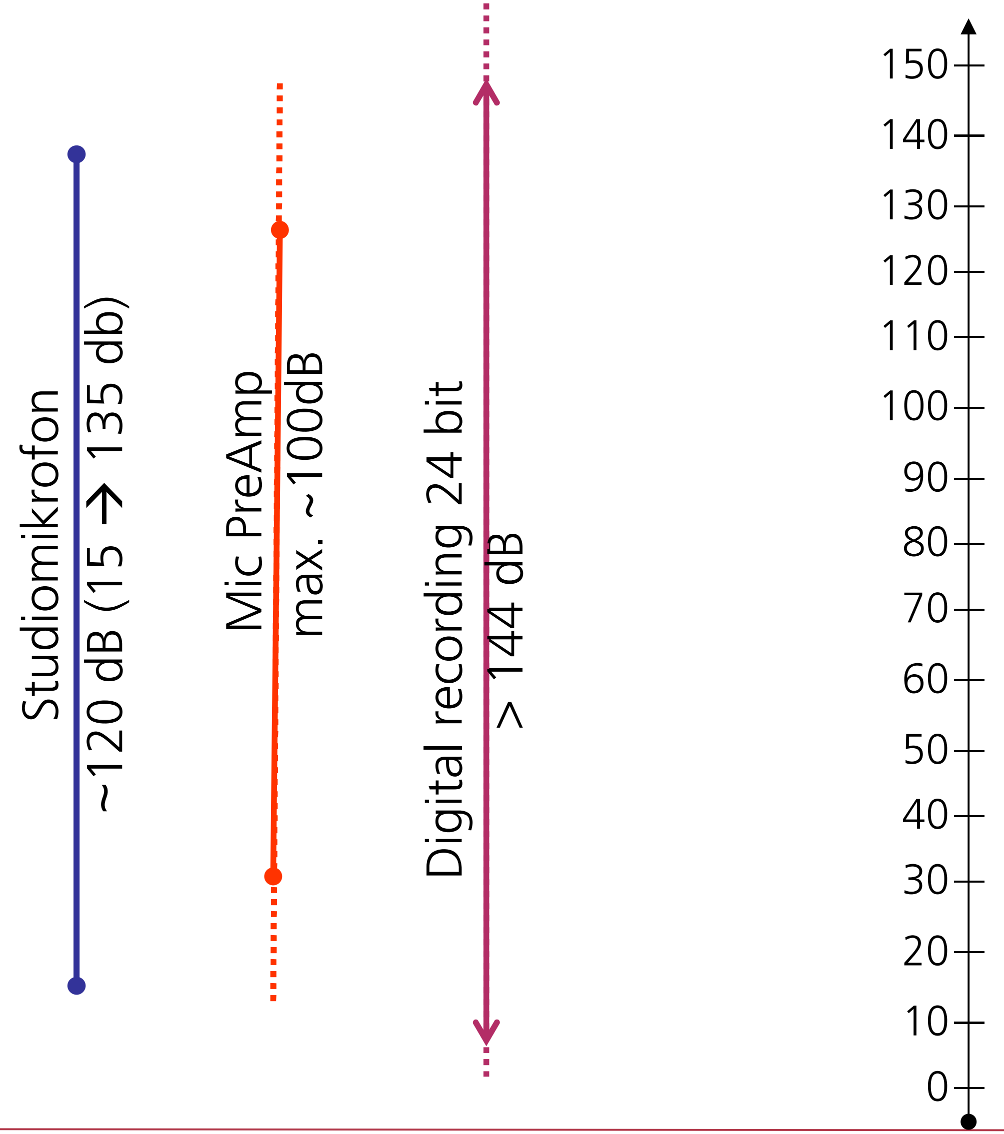
SCHOEPS Mikrofone

Digital microphones

Self noise, distortions, max. SPL

SCHOEPS Mikrofone

Dynamics = max.SPL – self noise

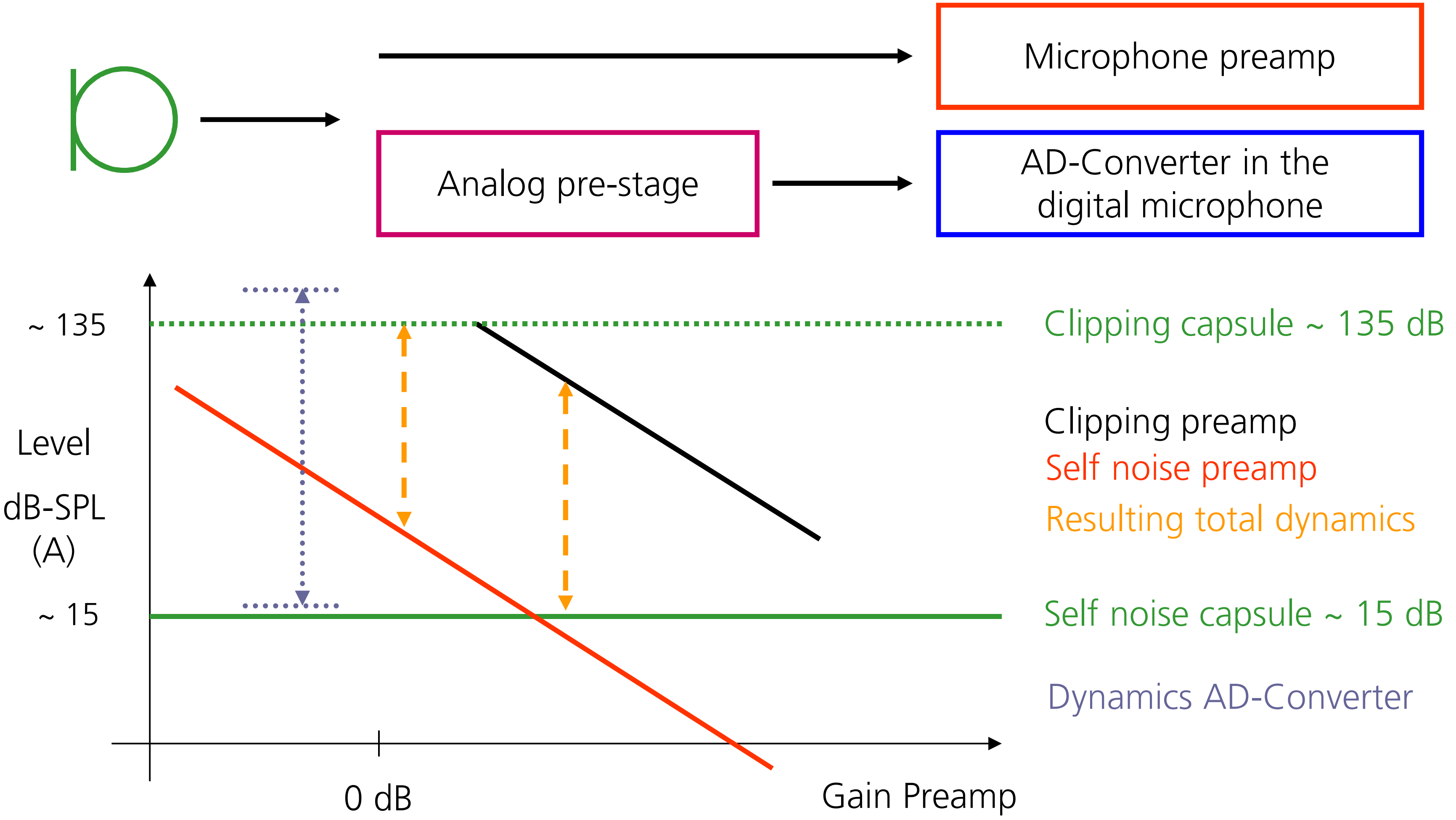


Situation und Schallquelle	Schalldruck *p* Pascal	Schalldruck-pegel L_p dB re 20 µPa
Theoretische Grenze für Schallwelle bei 1 Atmosphäre Schalldruck	100.000 Pa	194 dB
Krakatau Explosion 160 km Entf.	20.000 Pa	[1] 180 dB
M1 Garand Gewehr aus 1 m Entf.	5.000 Pa	168 dB
Jet in 30 Meter Entfernung	630 Pa	150 dB
Gewehr aus 1 m Entfernung	200 Pa	140 dB
Schmerzschwelle	100 Pa	134 dB
Gehörschäden bei kurzfristiger Einwirkung	20 Pa	ab 120 dB
Düsenflugzeug 100 m entfernt	6,3 - 200 Pa	110 - 140 dB
Presslufthammer, 1 m entfernt / Diskothek	2 Pa	100 dB
Gehörschäden bei langfristiger Einwirkung	0,63 Pa	ab 90 dB
Hauptverkehrsstraße, 10 m entfernt	0,2 - 0,63 Pa	80 - 90 dB
Pkw, 10 m entfernt	0,02 - 0,2 Pa	60 - 80 dB
Fernseher in Zimmerlautstärke 1 m entfernt	0,02 Pa	ca. 60 dB
Normale Unterhaltung, 1 m entfernt	$2 \cdot 10^{-3}$ - $6{,}3 \cdot 10^{-3}$ Pa	40 - 60 dB
Sehr ruhiges Zimmer	$2 \cdot 10^{-4}$ - $6{,}3 \cdot 10^{-4}$ Pa	20 - 30 dB
Blätterrauschen, ruhiges Atmen	$6{,}3 \cdot 10^{-5}$ Pa	10 dB
Hörschwelle bei 2 kHz	$2 \cdot 10^{-5}$ Pa	0 dB

Quelle: Wikipedia

SCHOEPS Mikrofone

- Digital microphones can handle nearly the whole dynamics of the microphone capsule. A preamp stage can often be avoided.



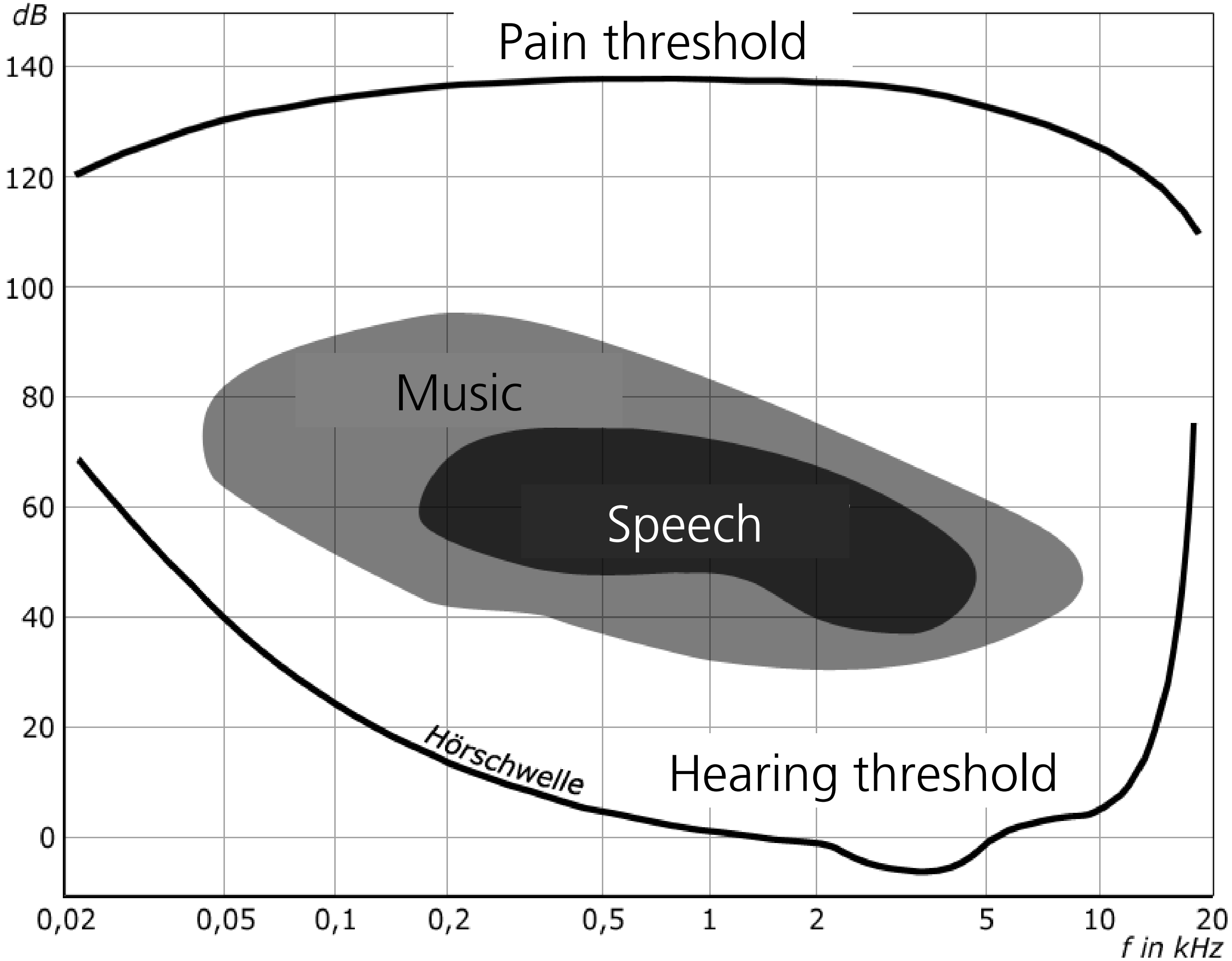
SCHOEPS Mikrofone

SCHOEPS Amplifier family with CMC 6 and *CMD 2 (discontinued)*

- A digital microphone can:
  - increase dynamics
  - avoid interference on long analog cables
  - realize new features on DSP
- but:
  - the standard AES-42 is young
  - there are not many interfaces
  - current consumption is high
  - even now there exist incompatible devices
  - new investment is often not plausible

SCHOEPS Mikrofone

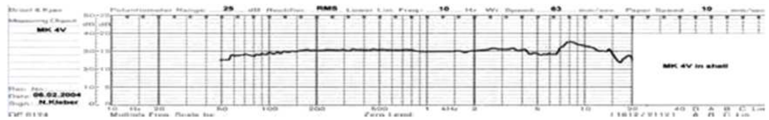
What we hear:

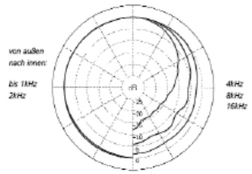


Quelle: Wikipedia

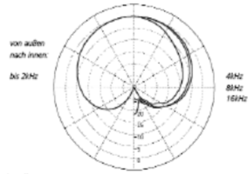
- The self noise of the microphone is given as the „**Equivalent noise level ENL**“. This is the sound pressure level of a sound source in db(A) or dB(CCIR, quasi-peak) that causes the same microphone level as the self noise of the microphone.
- Concluding: The Equivalent noise level does **include the sensitivity** of the microphone! You don’t have to care for the sensitivity when you know this value.
- ENL:
  - 0 dB-A. No noise
  - > ~ 6 dB-A: Large diaphragm microphone, studio quality
  - > ~ 10 dB-A: Small diaphragm microphone, studio quality
  - > ~ 20 dB-A: Microphones in semi-professional quality
  - > ~ 25 dB-A: Subminiature microphones

Microphone specifications

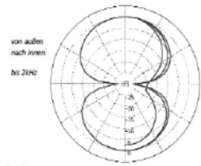




Polardiagramm



Polardiagramm



Polardiagramm

- Frequency response + tolerance range
- (Diffuse field response)
- Polar diagram
- „Frequency range": 20Hz – 20kHz
- Sensitivity: e.g. 17 mV/Pa = - 35 dBV/1Pa
- Equivalent Noise Level (for studio microphones < 15db(A) or < 24db(CCIR))
- Microphone Dynamics (eq.ENL) = 94 dB – ENL (94db SPL = 1 Pa)
- Maximum Sound Pressure Level:
  - THD of 0.5 or 1% or „before clip"
  - Different philosophies of different manufacturers
- Output impedance: studio microphones: < 200 Ω for all frequencies

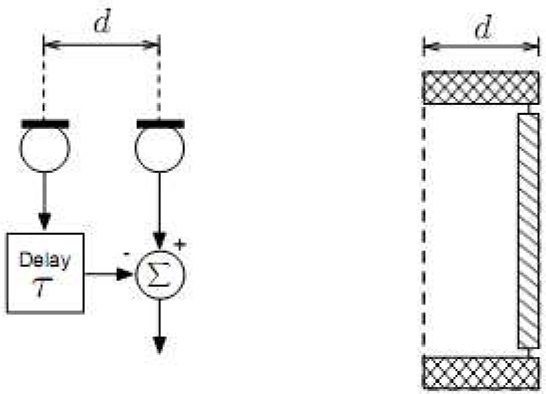
Further properties

- Further properties of a good microphone:
  - Equality of the same mic types, matching
  - Long lifecycle
  - Functional reliability
  - Long-term compatibility, maitaining of modular series
  - Downwards compatibility
  - Service, guarantee and long-term repair
  - Neutral advice and support

Highly directional microphones

Existing principles of directive microphones

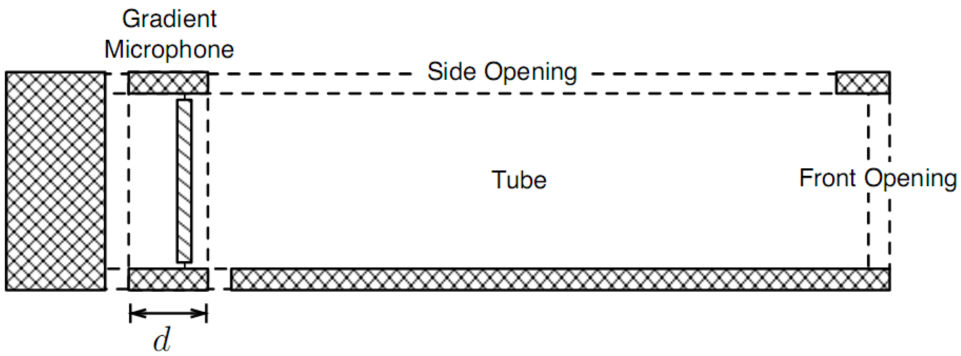
- Existing principles for directional microphones:
  - First-order pressure-gradient microphones
  - Higher-order gradient microphones
  - Interference tube microphones (“shotgun microphones”)
  - Adaptive Systems
  - Parabolic mirrors

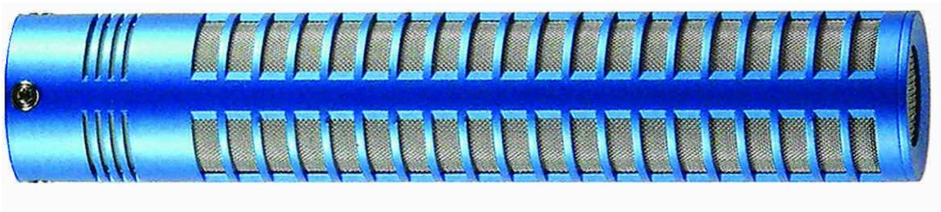


(a) (b)

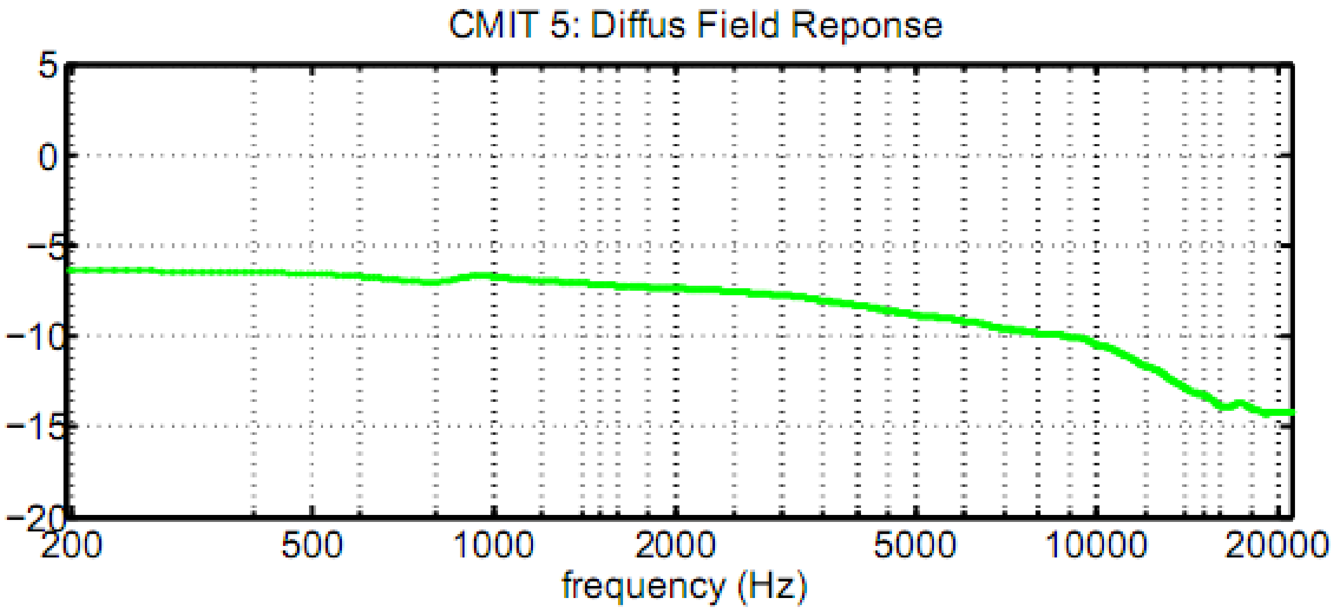
Existing principles of directive microphones

- Existing principles for directional microphones:
  - First-order pressure-gradient microphones
  - Higher-order gradient microphones
  - Interference tube microphones ("shotgun microphones")
  - Adaptive Systems
  - Parabolic mirrors

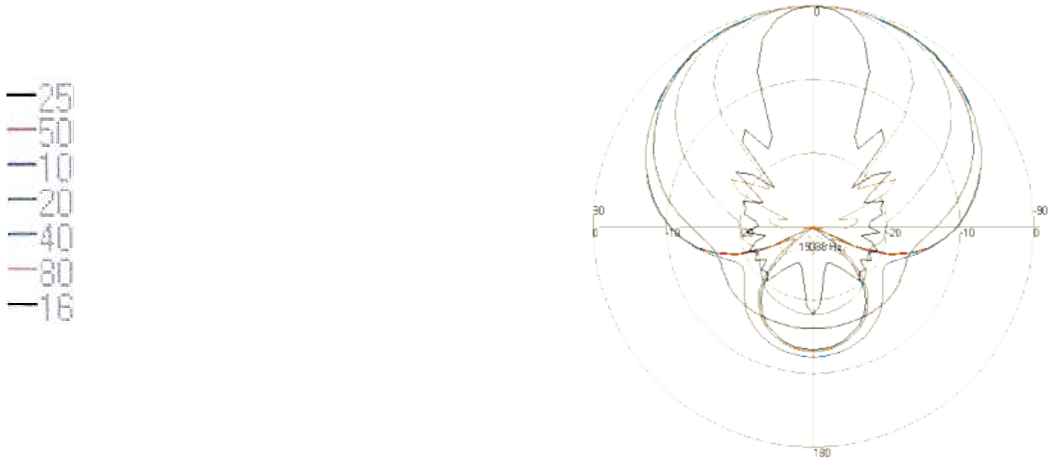




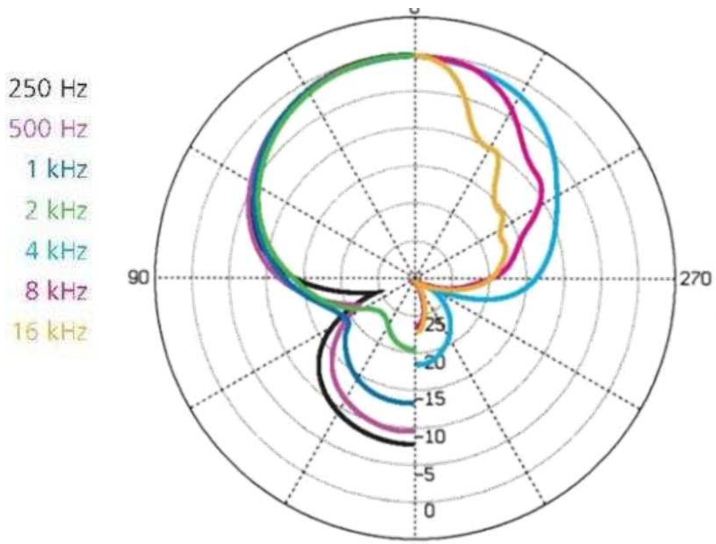
- Frequency-dependent directivity:



- Frequency-dependent directivity:



Sennheiser MKH 416



SCHOEPS CMIT 5

Existing principles of directive microphones

- Existing principles for directional microphones:
  - First-order pressure-gradient microphones
  - Higher-order gradient microphones
  - Interference tube microphones ("shotgun microphones")
  - Adaptive Systems
  - Parabolic mirrors

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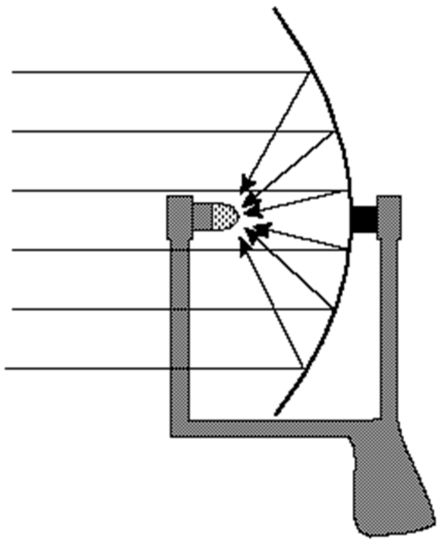
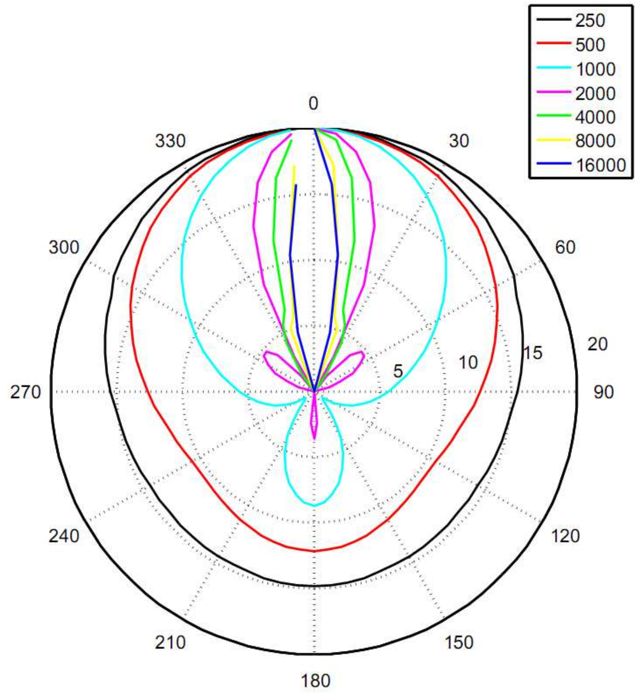
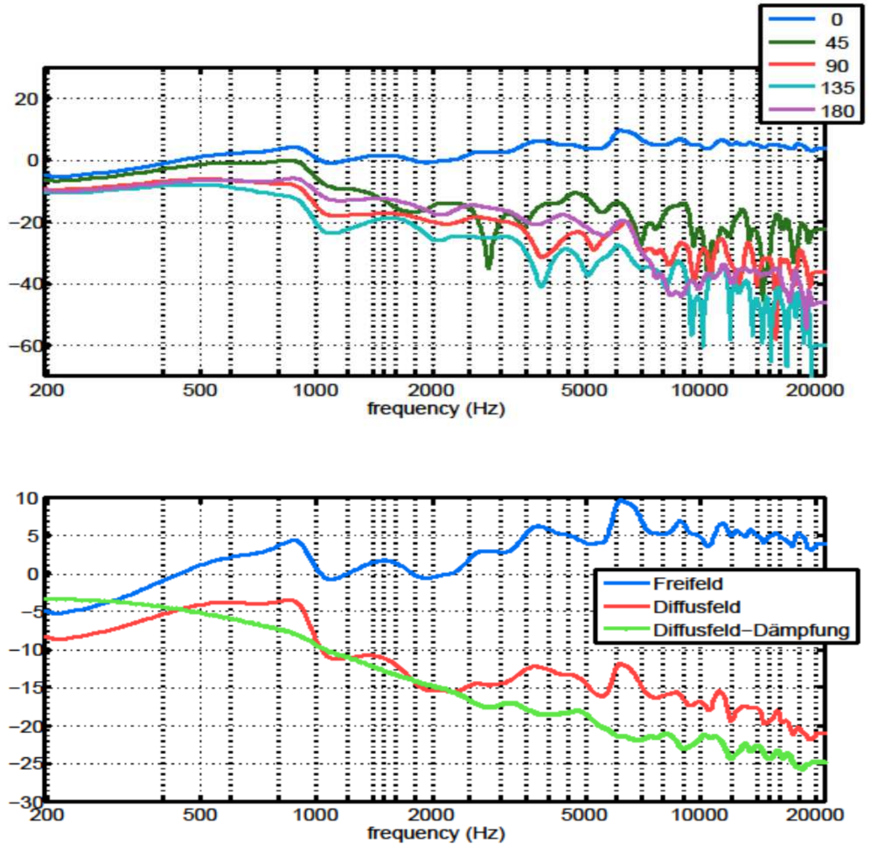
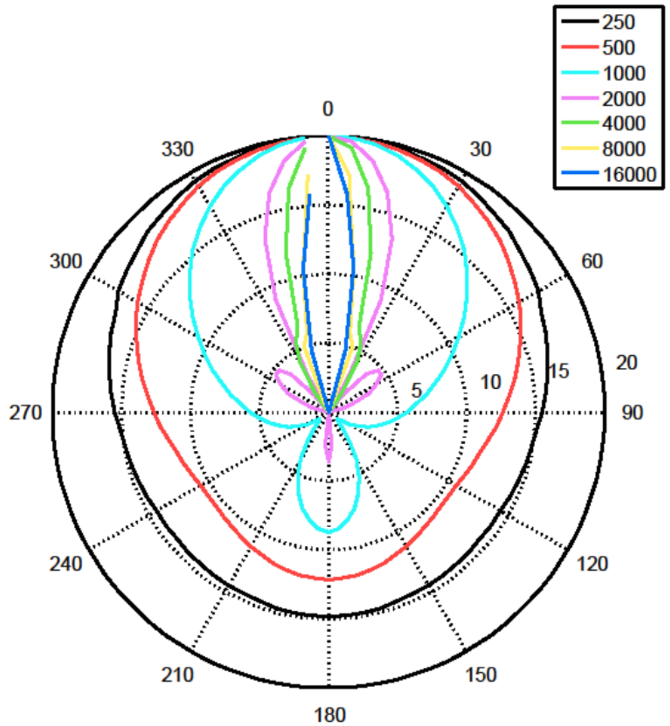




Parabolic mirror

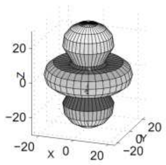
- Frequency-dependent
- High Signal-Noise ratio at high and medium frequencies





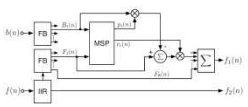
Existing principles of directive microphones

- First-order pressure-gradient microphones
  - \+ compact size, easy to manufacture
  - \+ excellent performance and sound color
  - – limited directivity

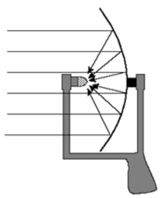


- Higher-order pressure-gradient microphones
  - \+ higher and potentially variable directivity
  - – problems at low and high frequencies → self noise, aliasing

- Interference tube microphones (“shotguns”)
  - \+ compact size, easy to manufacture
  - – frequency-dependant directivity, only 1st order at low freq.



- Adaptive Systems
  - \+ separation of discrete and diffuse sound
  - – can create artifacts



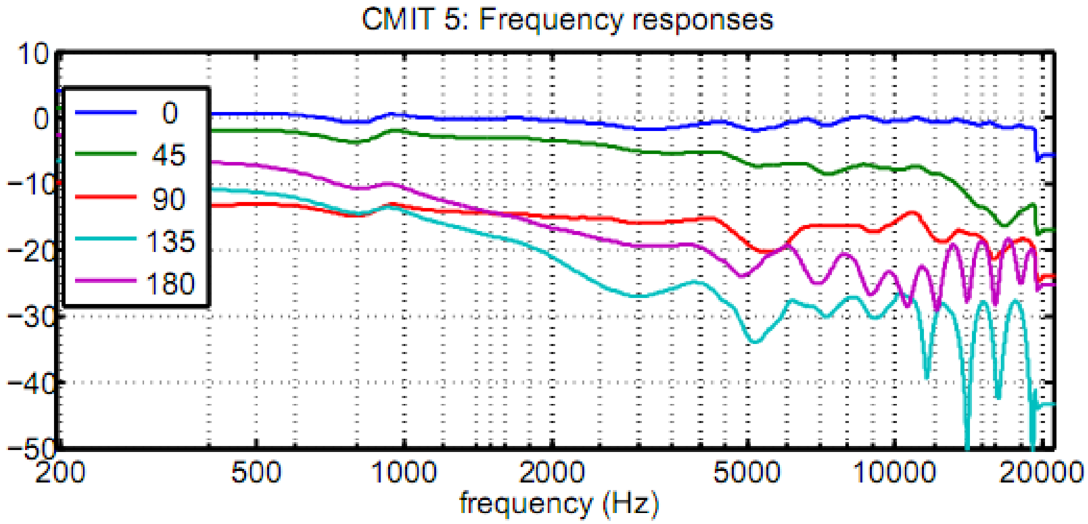
- Parabolic mirrors
  - \+ high signal, low noise
  - – big, not very practical
  - – frequency-dependant directivity, < 1st order directivity at low freq.

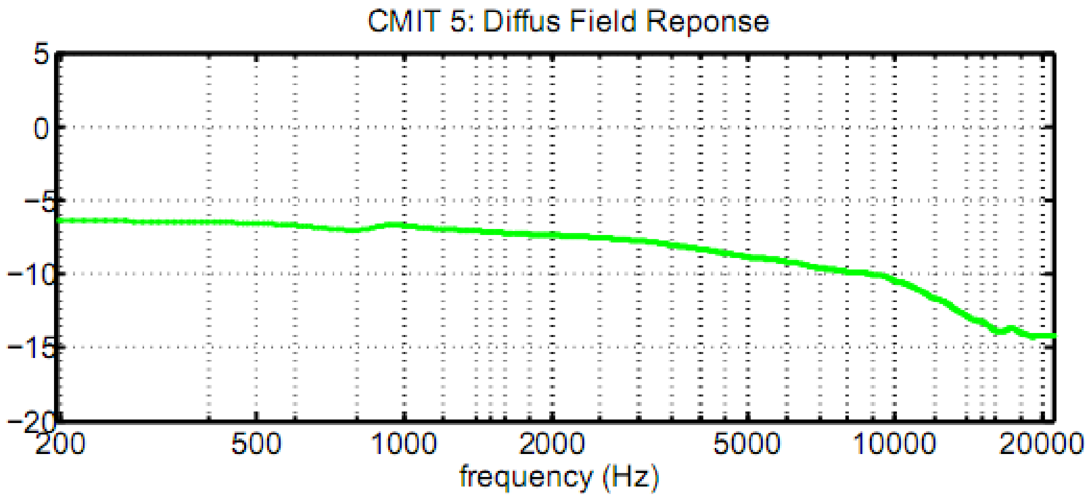
SuperCMIT

SCHOEPS Mikrofone

- "Super"- shotgun SCHOEPS SuperCMIT
  - 2 membranes
  - digital signal processor with beamforming
  - digital output (AES42/Mode-1 = *AES3 + 1*
  - 2 output channels:
    - ch1: SuperCMIT
      - Preset 1 (normal DSP mode)
      - Preset 2 (strong, take care!)
    - ch2: conventional shotgun signal

- Weakness of the conventional shotgun microphone:





SuperCMIT

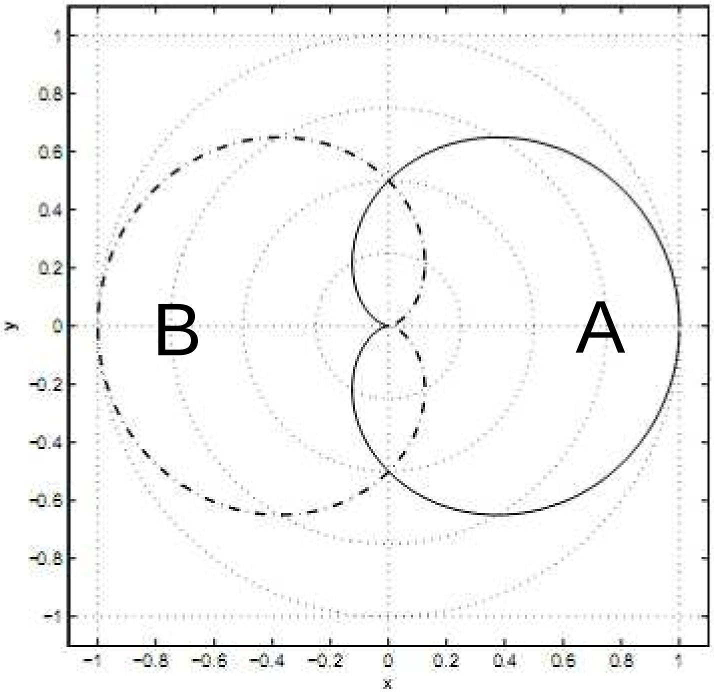
- Combining shotgun and beamforming approach:

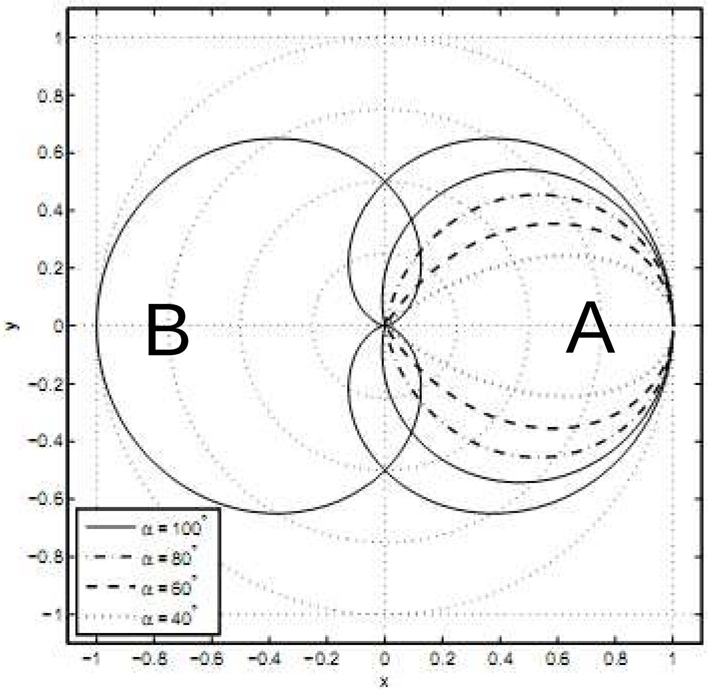
- A 2nd capsule (cardioid) is placed behind the shotgun capsule
- These two capsules form a “beamforming” array
- Beamforming increases the *directivity* and suppresses diffuse *sound*

- Above 5 kHz only the shotgun signal is used

New approach 1

- Utilize Beamforming
  - using two cardioids in a back-to-back configuration
  - A can be predicted with/from B
  - the predicted signal can be subtracted from A
  - Subtraction is limited to a maximum to decrease effect

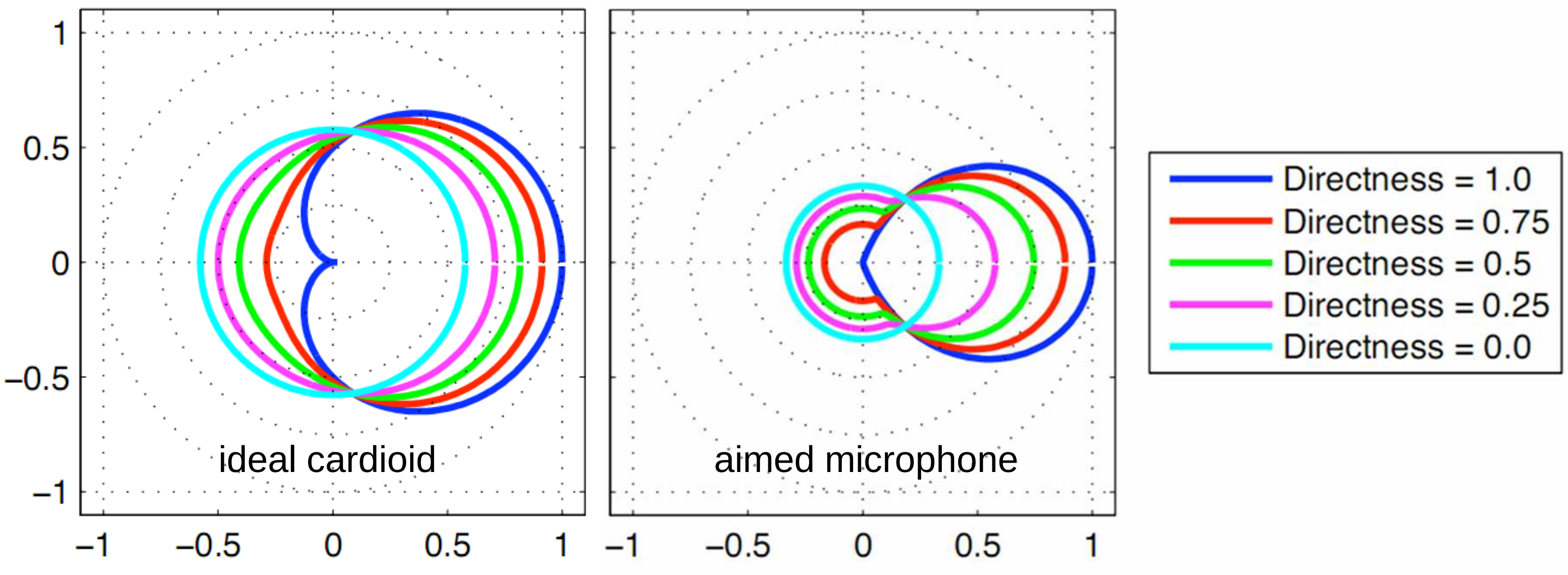




New approach 2

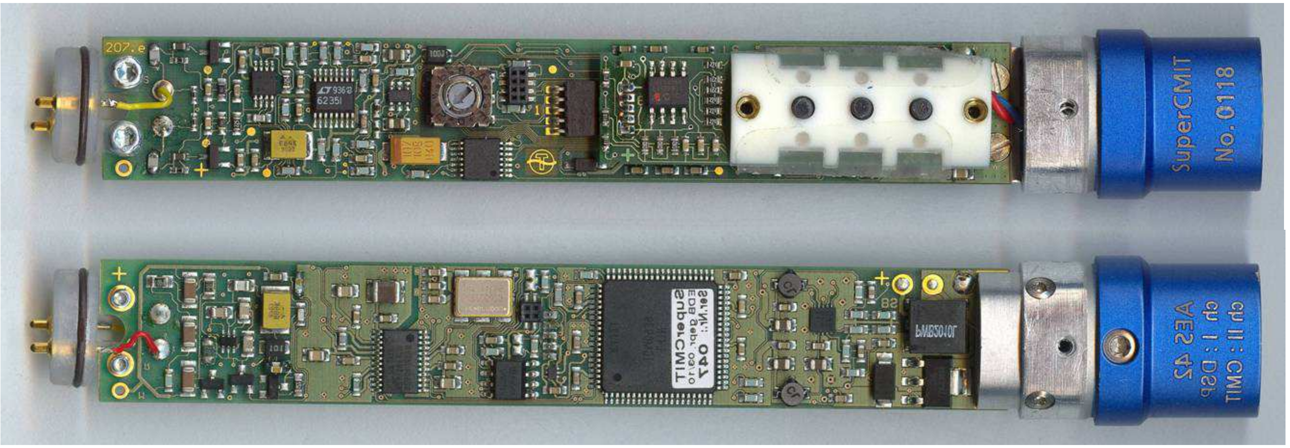
- Adjusting the diffuse field level
  - Time-Frequency processing enables to find coherent/incoherent signals
  - The diffuse field level can be tuned according to the resulting beam

Directional response at different "*Directness*" levels:



SCHOEPS Mikrofone

- SuperCMIT: Hardware design



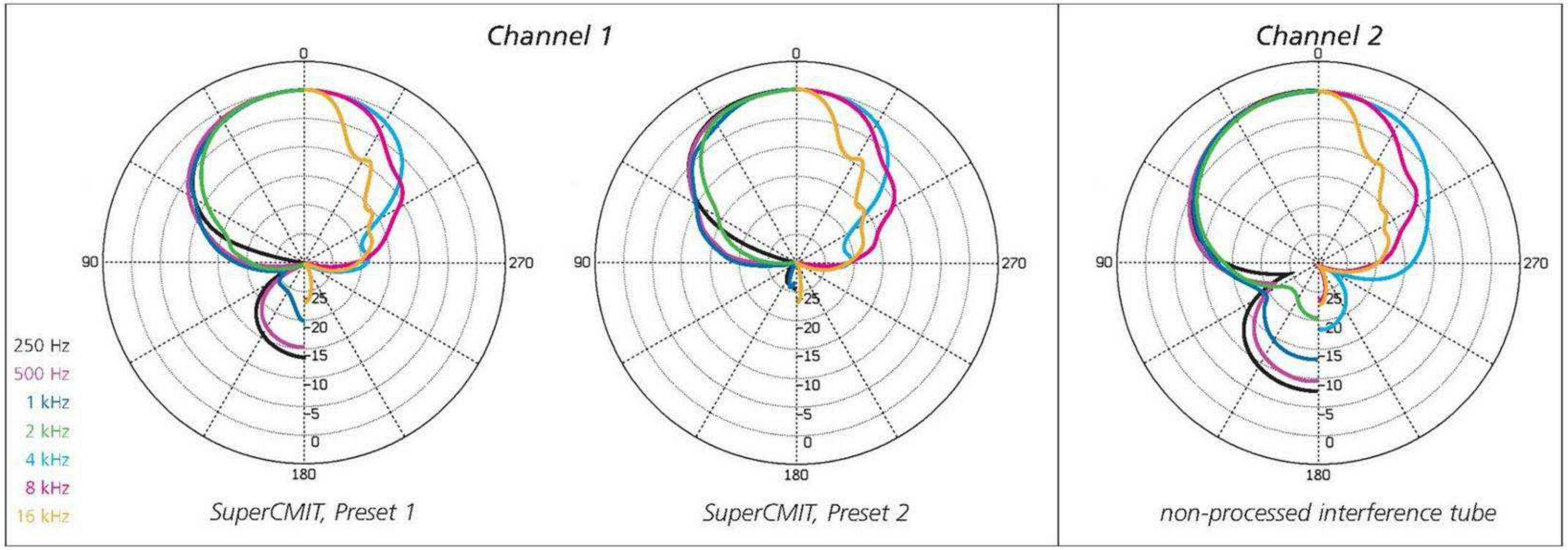
front view

back view

- Weight: 112 grams (4 ounces)
- Length: 280 mm

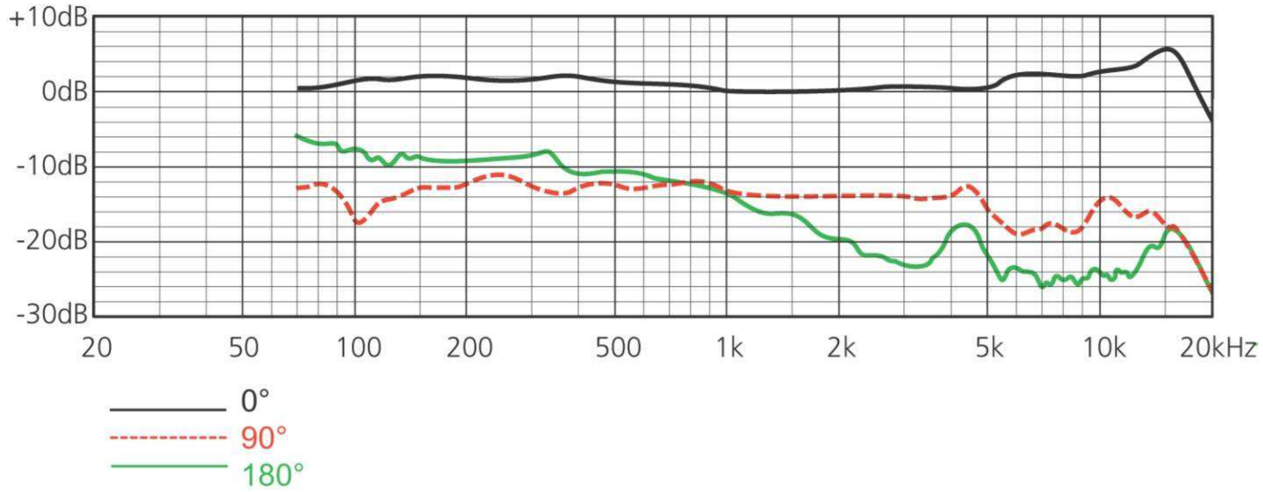
SCHOEPS Mikrofone

- SuperCMIT: Polar diagrams



SuperCMIT

- SuperCMIT: Frequency responses



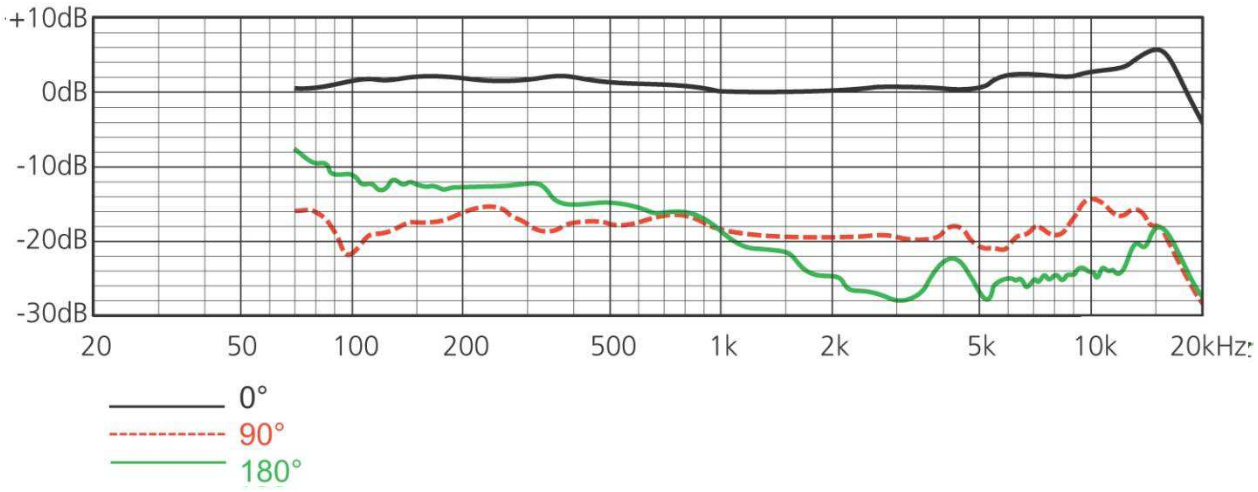
SuperCMIT ch2 (unprocessed)

SuperCMIT, ch1, Preset 1

SuperCMIT, ch1, Preset 2

SuperCMIT

- SuperCMIT: Frequency responses



SuperCMIT ch2 (unprocessed)

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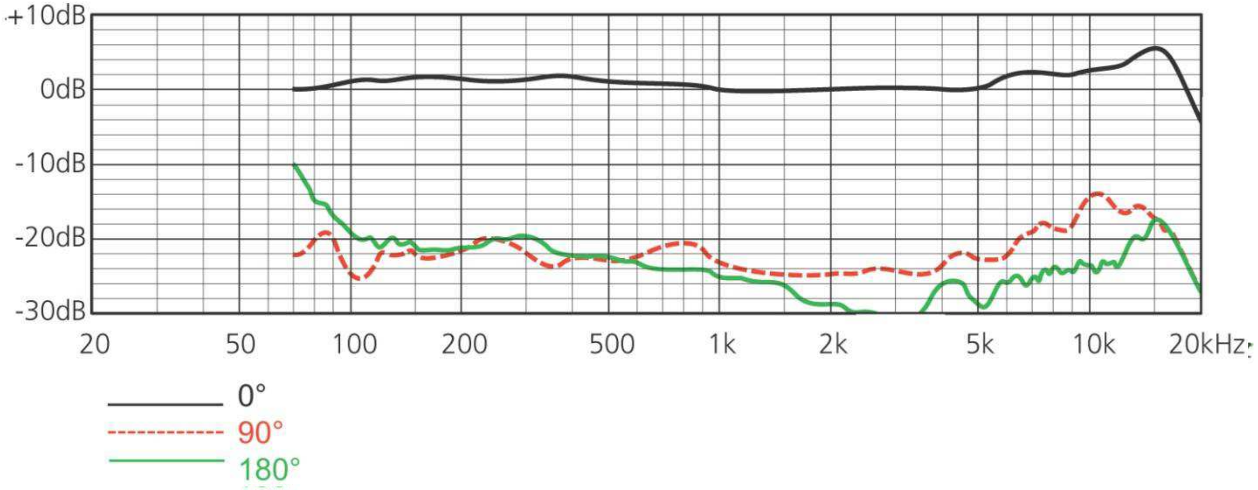
SuperCMIT

- SuperCMIT: Frequency responses



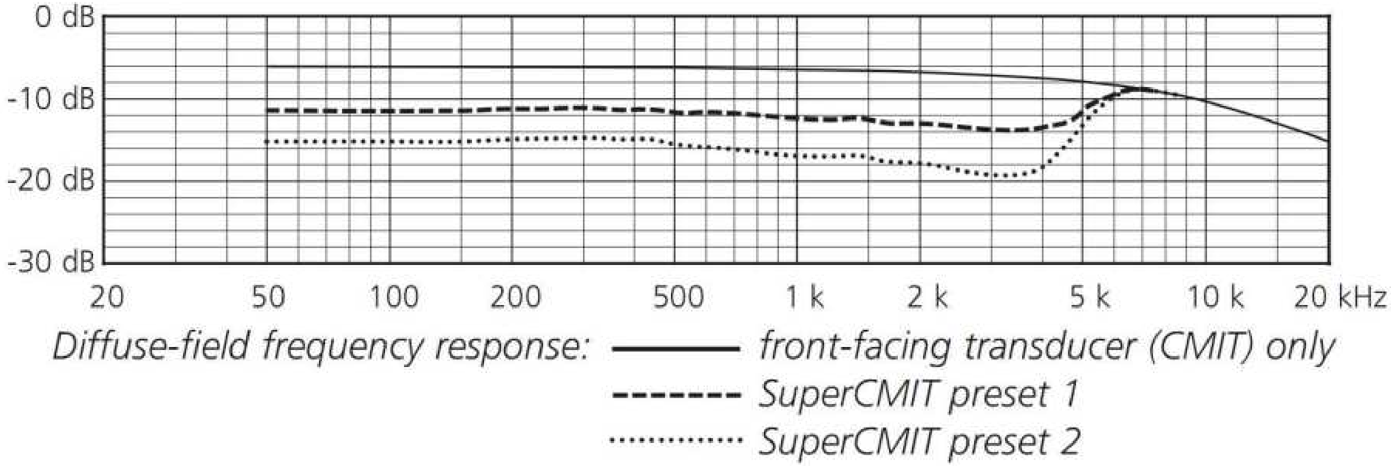
SuperCMIT ch2 (unprocessed)

SuperCMIT, ch1, Preset 1

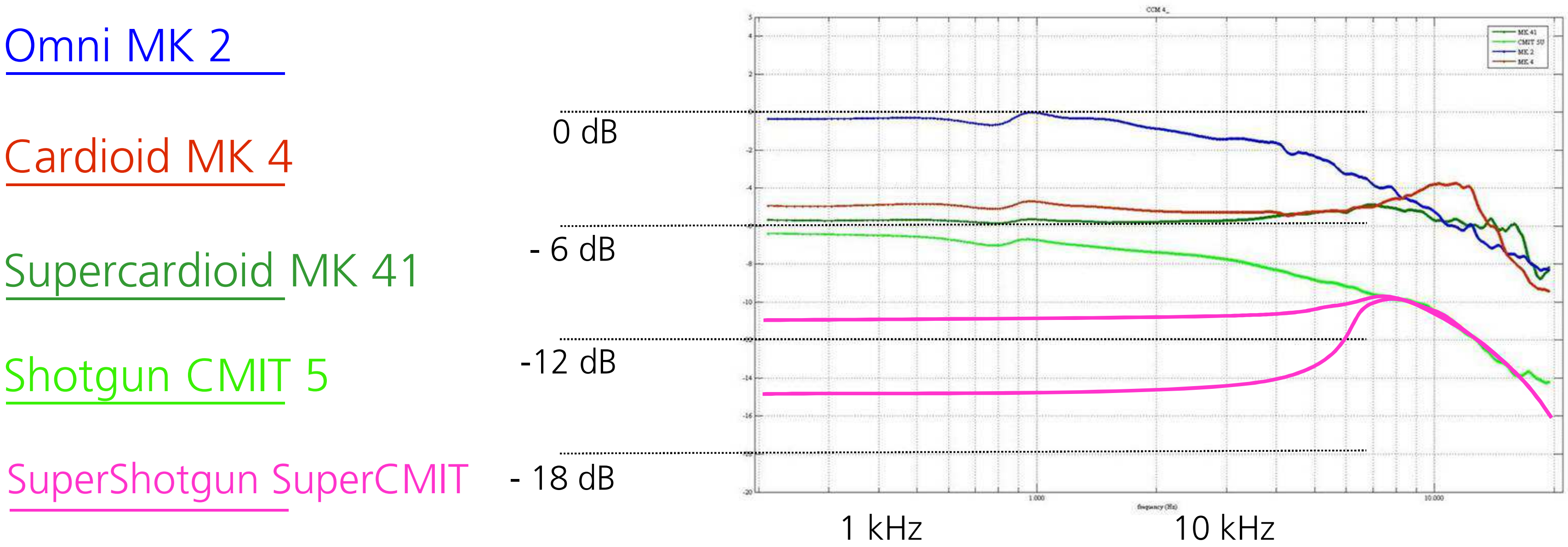
SuperCMIT, ch1, Preset 2

- SuperCMIT: Diffuse Field Frequency response

Diffuse Field frequency reponse:



- Diffuse Field Frequency responses:



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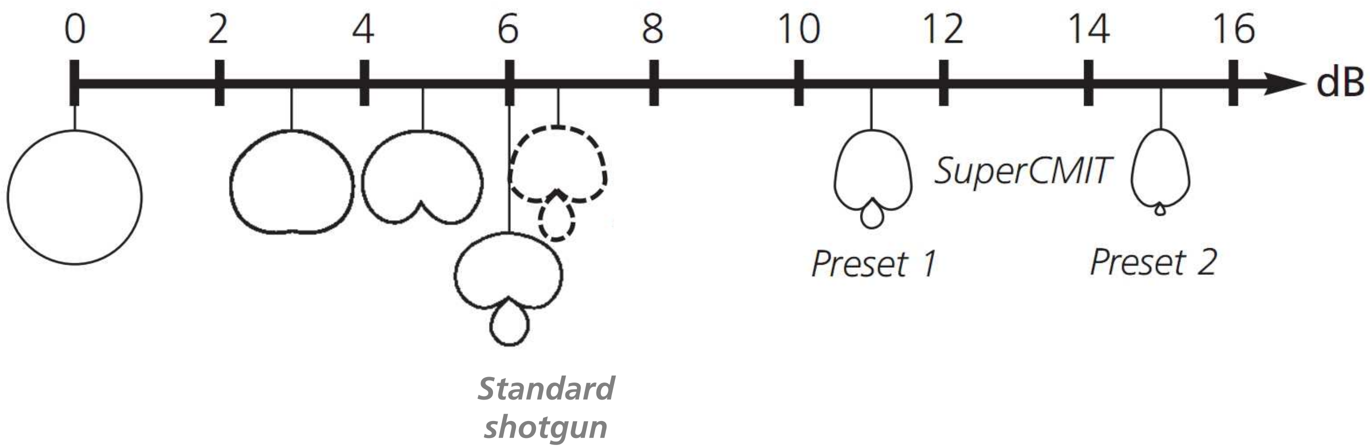
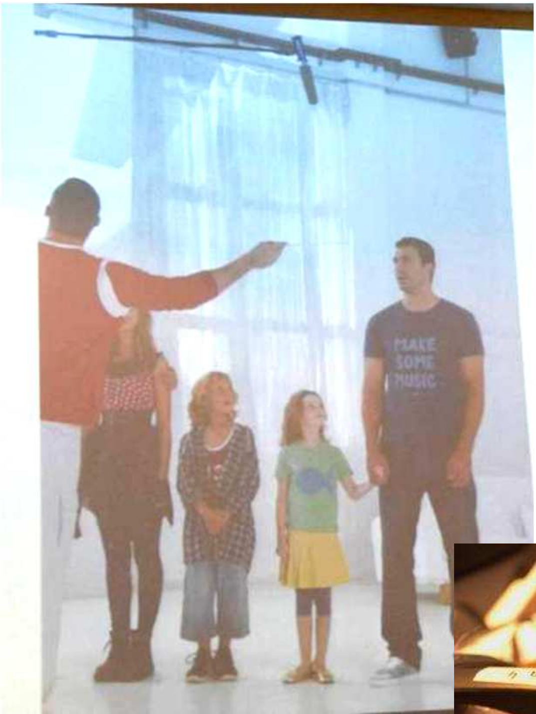
- SuperCMIT: Directivity index (= level of the diffuse sound at low frequencies)



(some…) Applications

SCHOEPS Mikrofone



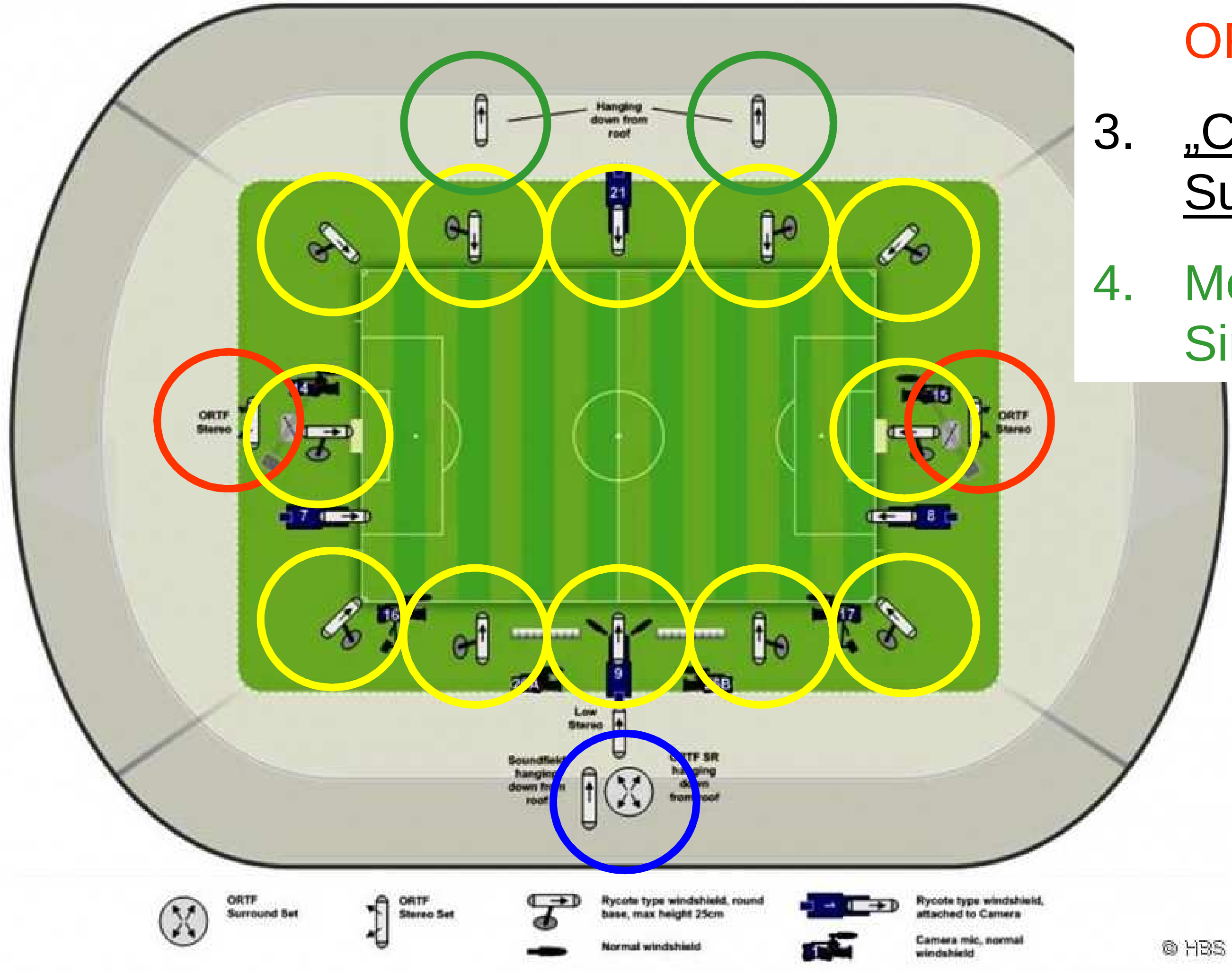
- Location sound
- Sports
- Theatre, Opera
- on a lectern
- in churches

(some…) Applications

SCHOEPS Mikrofone

ORTF Surround: Soccer World Cup 2010

- ORTF Surround + ORTF Stereo + SuperCMIT



The standard multilateral microphone plan

1. Main ambience: ORTF Surround
2. Stereo spots: ORTF Stereo
3. „Close-Ball“: SuperCMIT
4. Mono spots: Single CCM

Application

- 3 Pushbuttons on the microphone:
  - High-frequency boost (+5 dB at 10 kHz)
  - Steep Low-Cut (18dB/Oct)
  - Preset button:
    - Preset 1: normal
    - Preset 2: strong; recommended only for special applications
- Available accessories
  - Basket Windscreen with suspension (Rycote Kit 295)
  - Foam windscreen W 170
  - Rycote Softie 18cm
  - Cinela OSIX CMIT

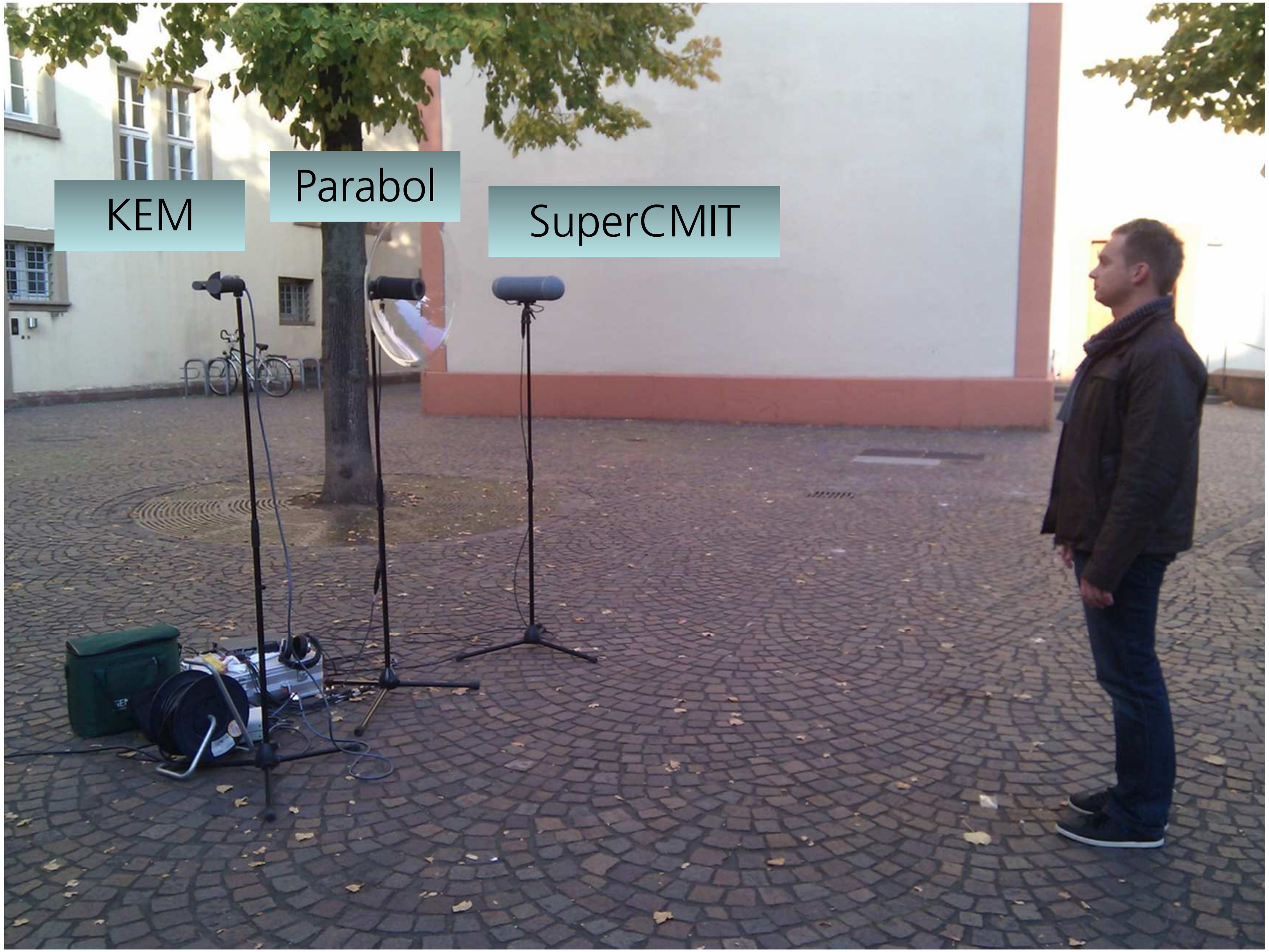
Interfacing

- Output format of the SuperCMIT: AES42, Mode 1
  = AES3 + 10V digital phantom power.

- You have different options of interfacing the SuperCMIT:
  - **Adapters** (SCHOEPS Mini-DA42 or PSD 2U):
    10V powering /and analog output
    (comes with the microphone)

  - **Portable recorders** (SoundDevices 788T + 664, AETA 4Minx, Zaxcom Nomad)
  - **Consoles** and **interfaces** (Digigram, RME DMC 842, Lake People DAC 462, etc.)
  - **Wireless** (Zaxcom)
  - **Complete list** of interfacing options for the SuperCMIT:
    http://digital.schoeps.de/en/products/supercmit/application

Simultaneous test recording



SCHOEPS Mikrofone

Thank you for your attention!

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Helmut Wittek