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Logaritmisch-Periodische Antennen

by Thomas Zwick

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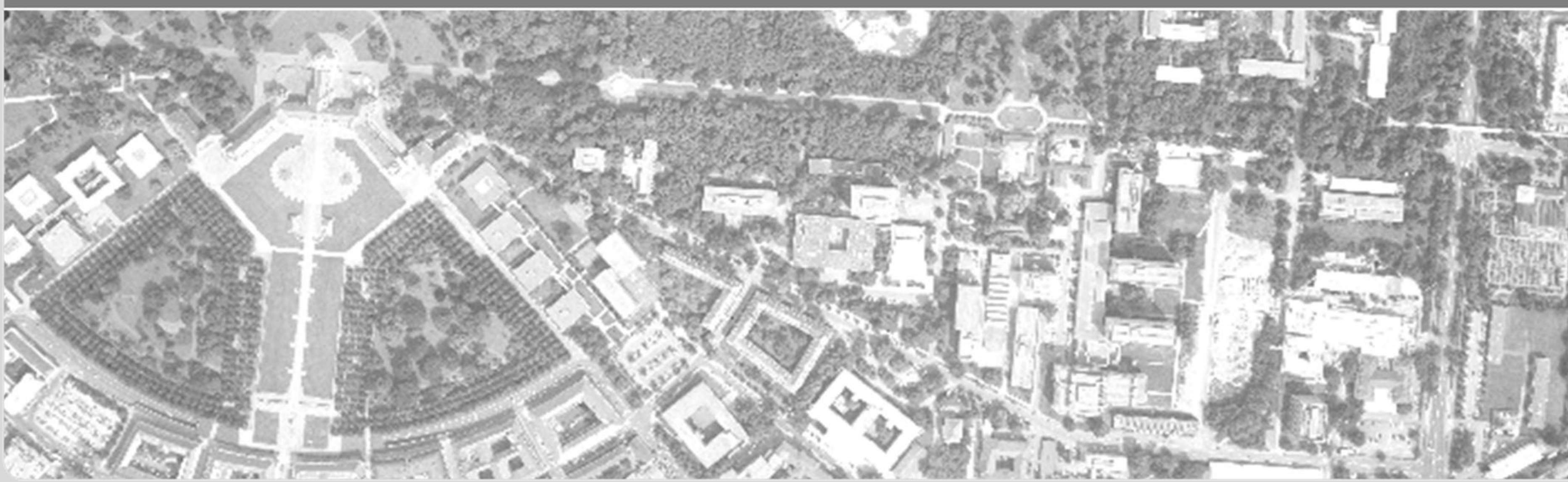
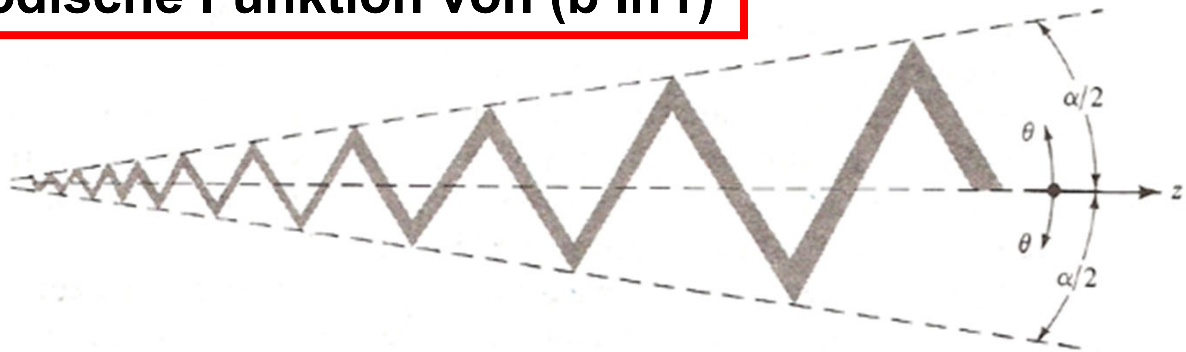
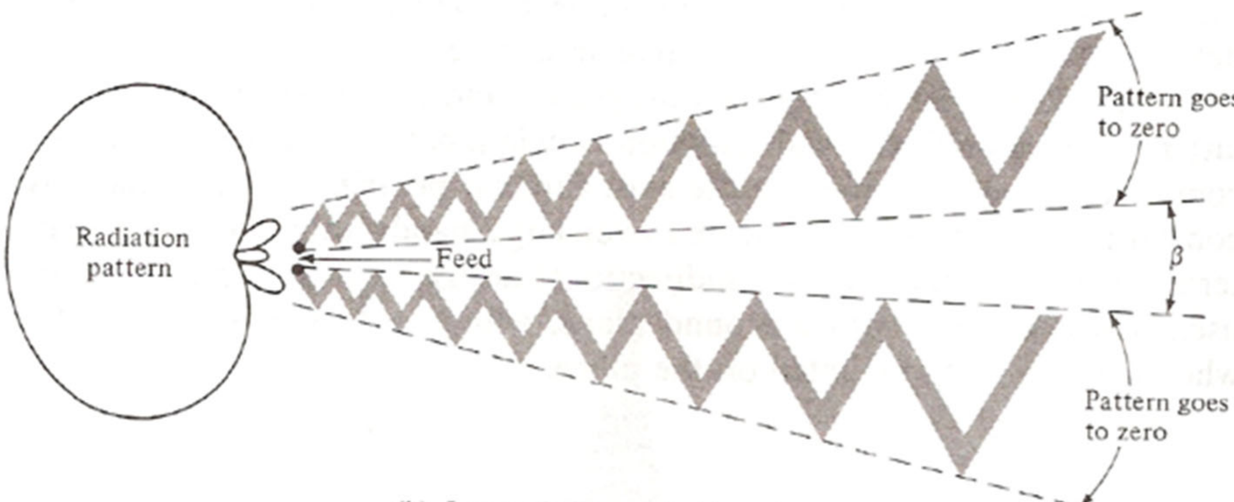


Logarithmisch-Perirodische Antenne (Log-Per-)

Θ = periodische Funktion von (b ln r)



(a) Metal strip log-periodic configuration

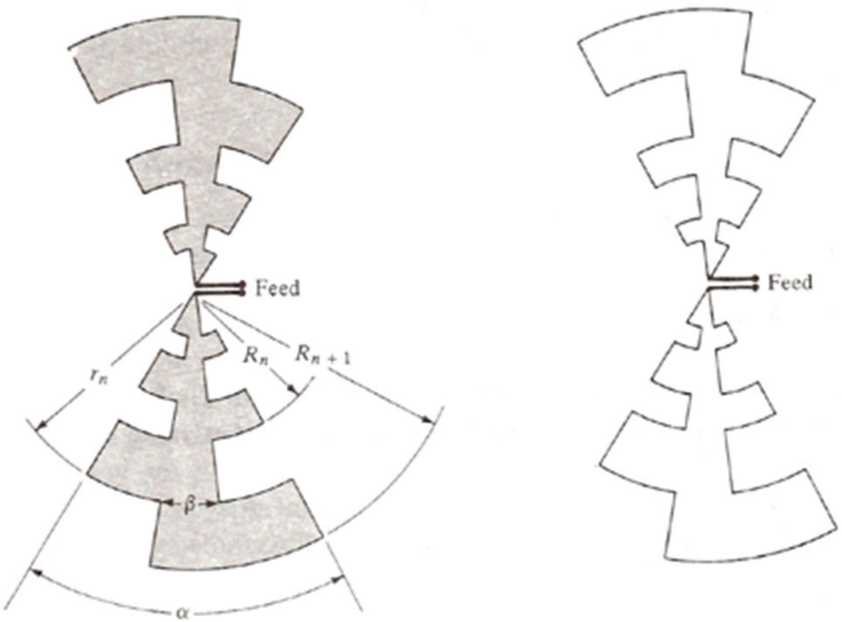


(b) Log-periodic metal strip antenna

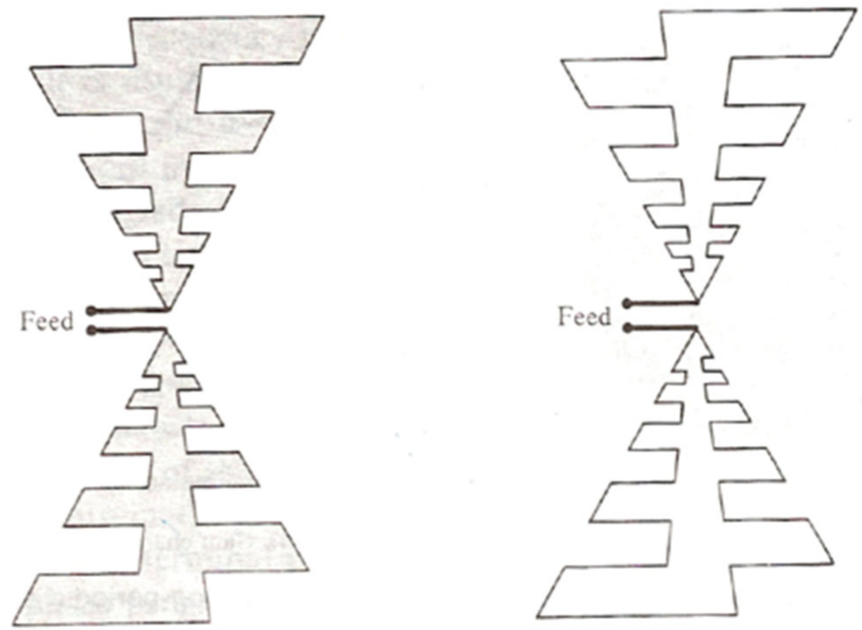
Quelle: Antenna Theory (Balanis)

Logarithmisch-Periodische Antenne (Log-Per)

Θ = periodische Funktion von (b ln r)



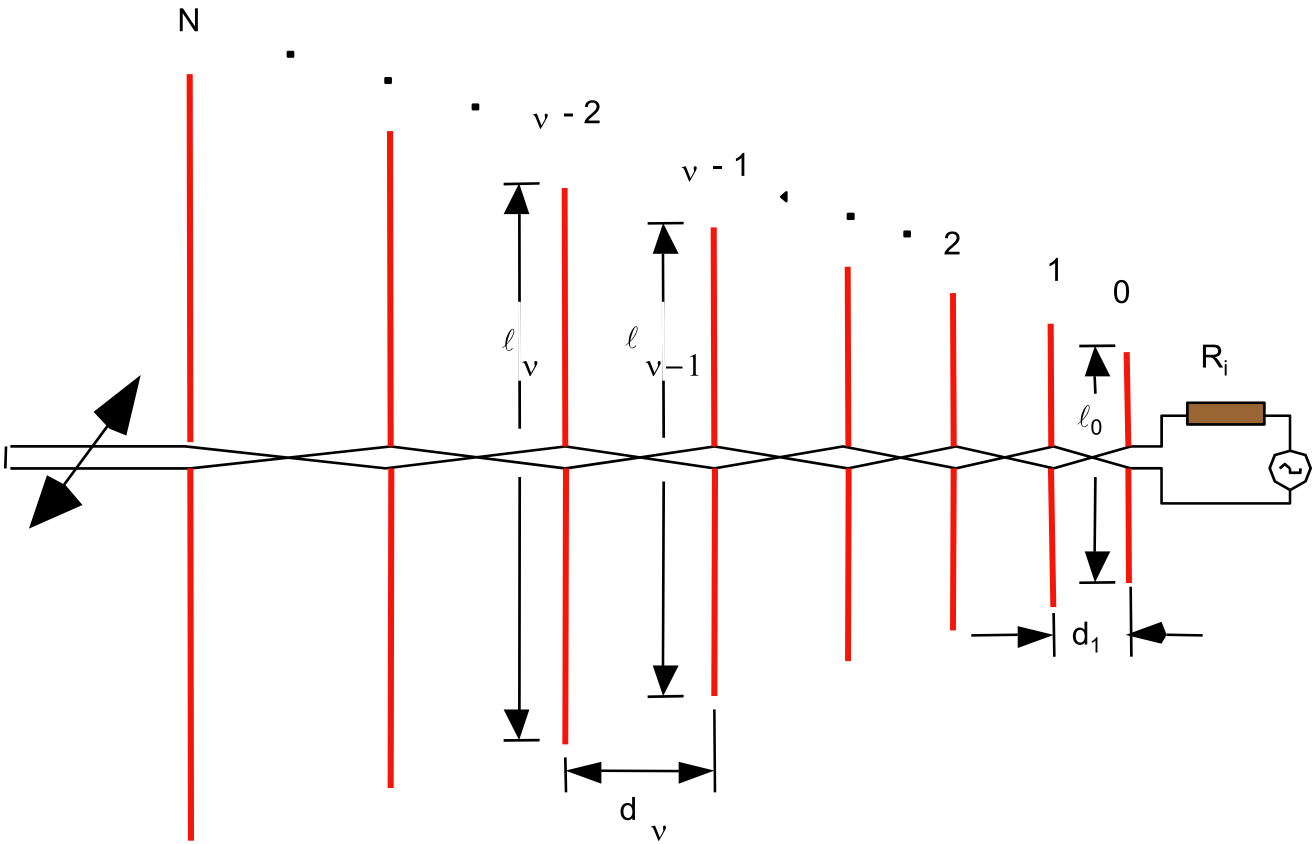
(a) Planar (b) Wire



(a) Planar (b) Wire

Quelle: Antenna Theory (Balanis)

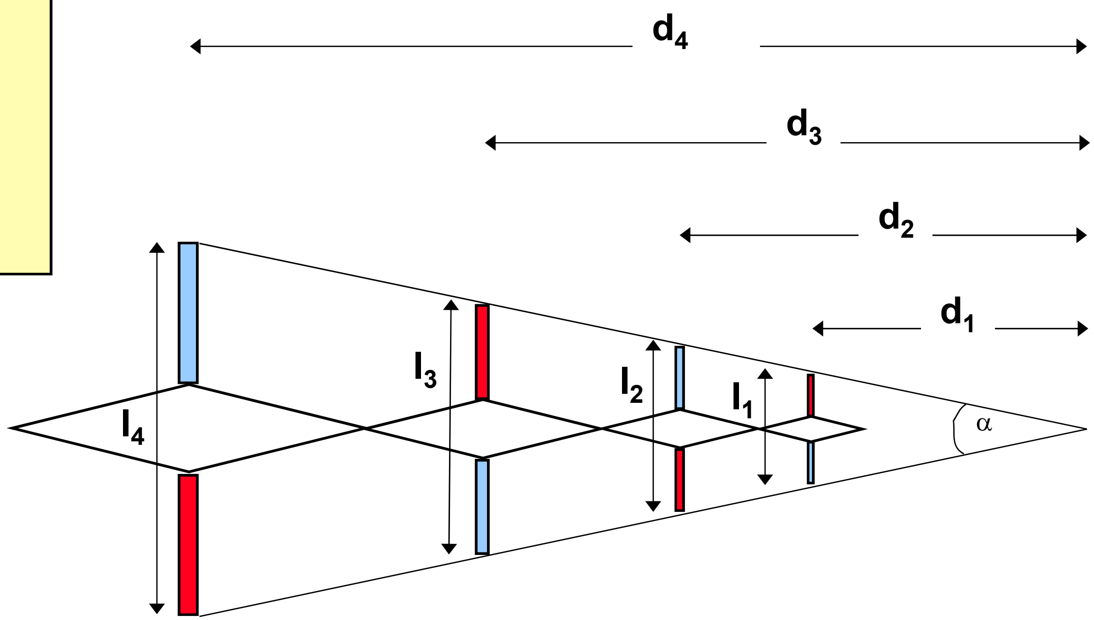
Logarithmisch-Periodisches Dipol-Array



Log-Per-Dipolantenne

4 Designparameter:

- **Dipolbreite w**
- **Dipollänge l**
- **Skalierungsfaktor τ**
- **Abstand d**



$$\sigma = \frac{d_n}{2 l_n}$$

$$\alpha = 2\arctan\left(\frac{1-\tau}{4\sigma}\right)$$

$$\tau = \frac{l_1}{l_2} = \frac{l_n}{l_{n+1}} = \frac{d_1}{d_2} = \frac{d_n}{d_{n+1}} = \frac{w_1}{w_2} = \frac{w_n}{w_{n+1}}$$

$$\log \frac{l_\upsilon}{l_0} = \upsilon \cdot \log C$$

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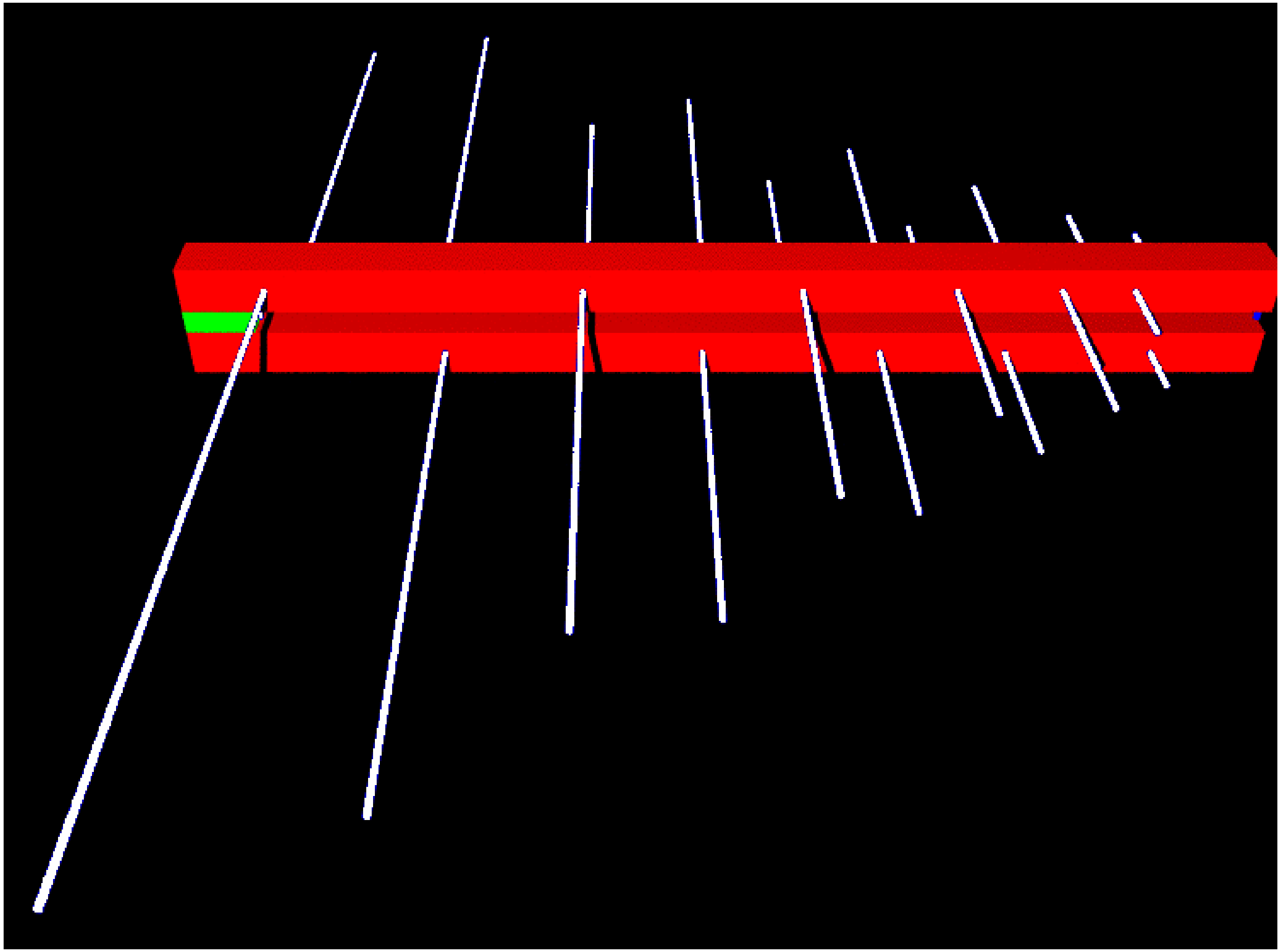
Breitbandantennen (3)



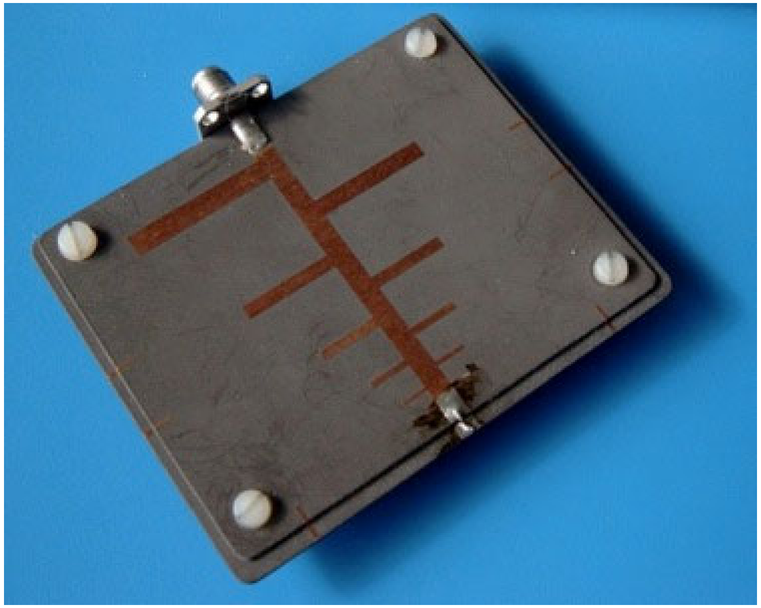
Realisierung für 3 - 10 GHz

Vorgaben

- Antenne für 3 - 10 GHz
- Bauweise: quadratisch kompakt
- max. Gewinn
- Anpassung, breitbandig

Parameter

- L_N = 44.3 mm, L_1 = 4.8 mm
- S = 44.3 mm
- τ = 0,80, σ = 0,112
- N = 11
- l/w = 12,5

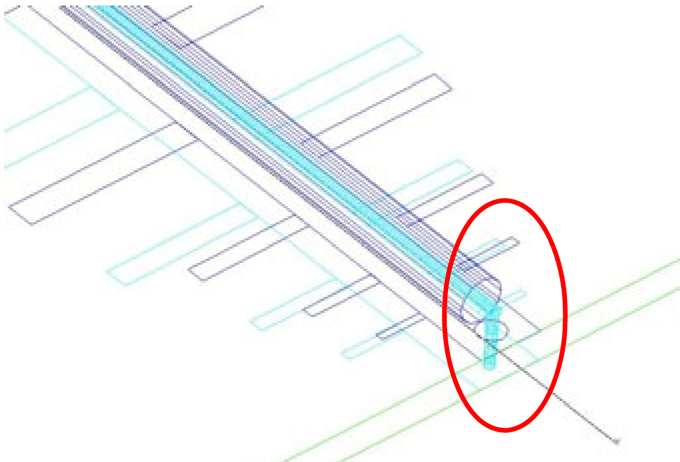


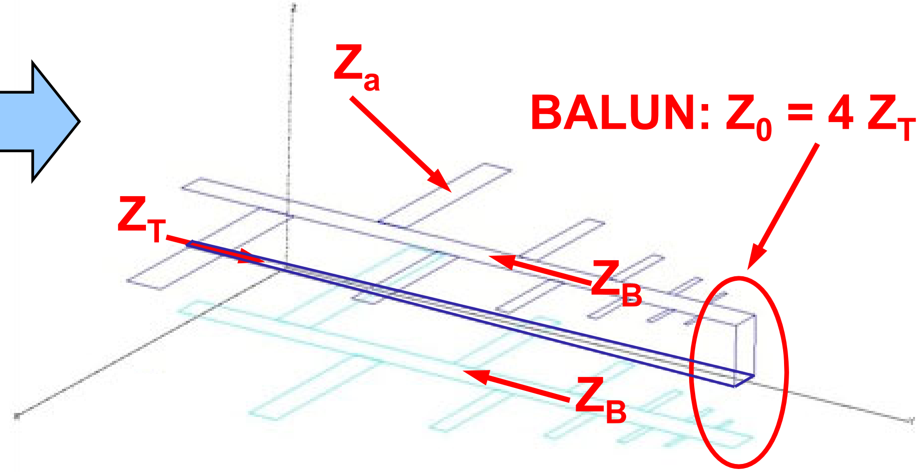
(Material: Duroid 5880, ε_r=2,2)

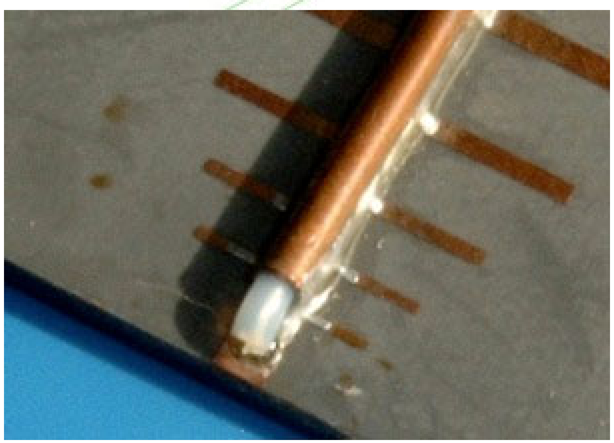
Speisung und Anpassung

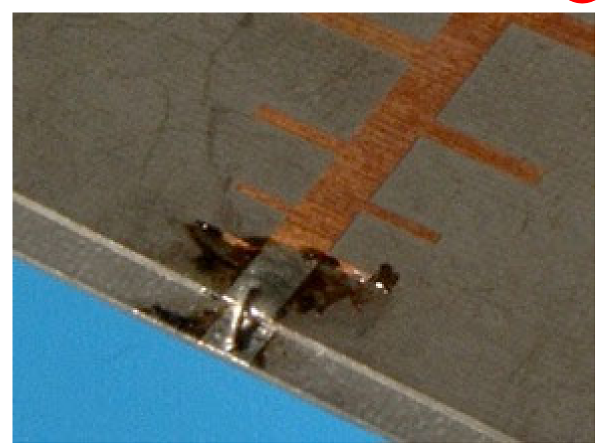
übliche Speisemethode

Speisung mit Triplate-Leitung

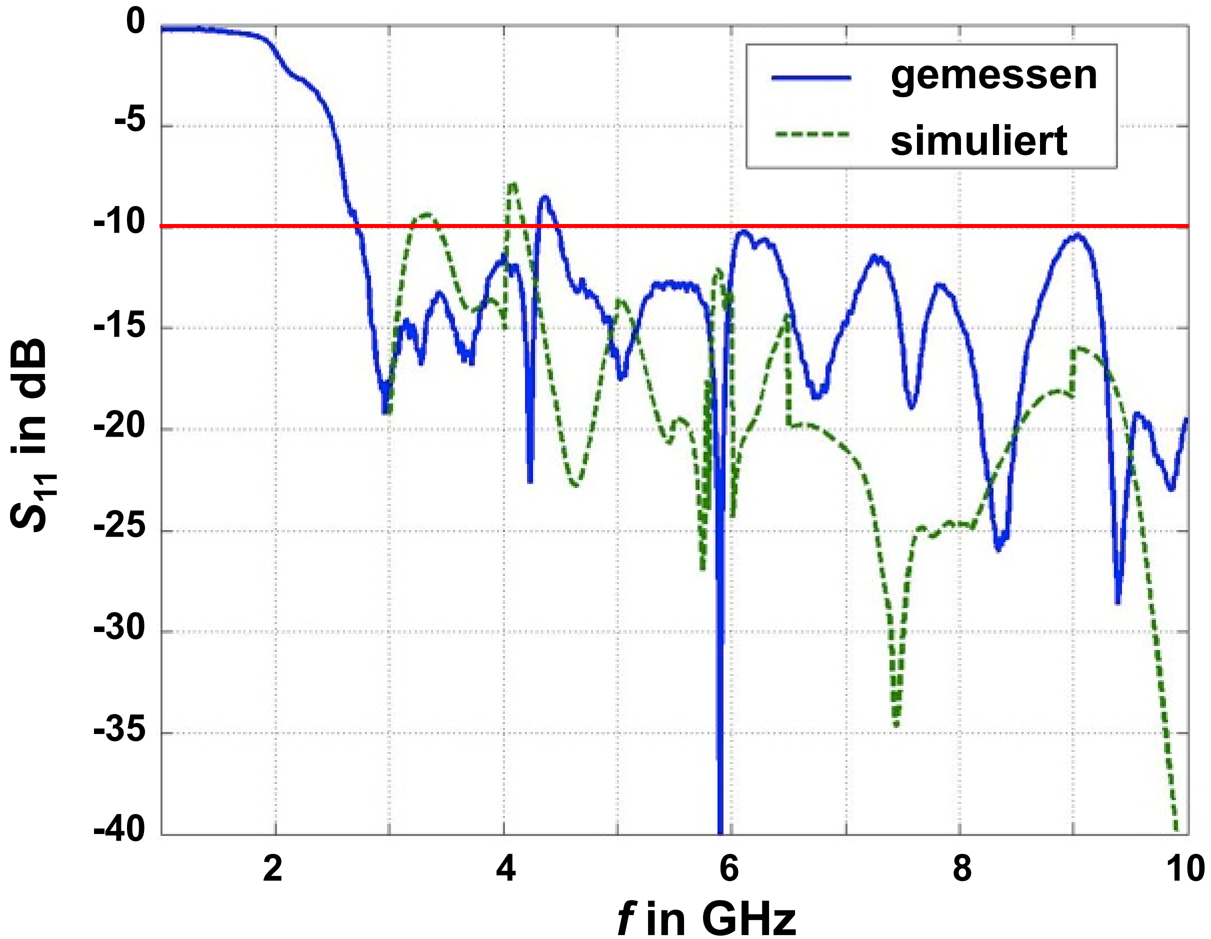






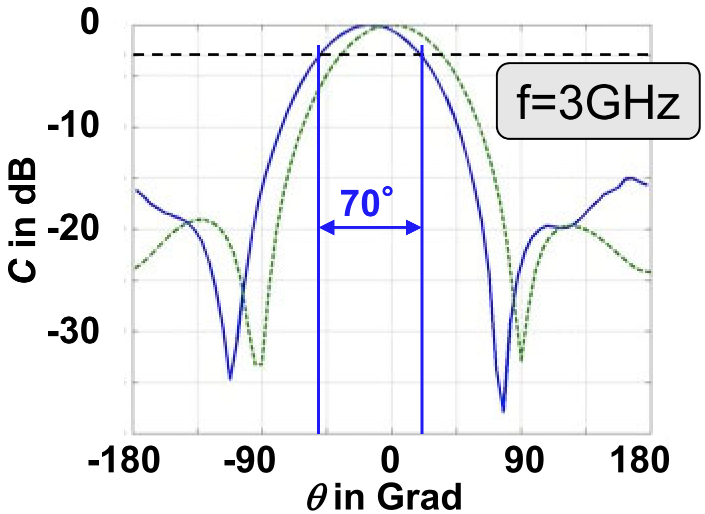


Anpassung



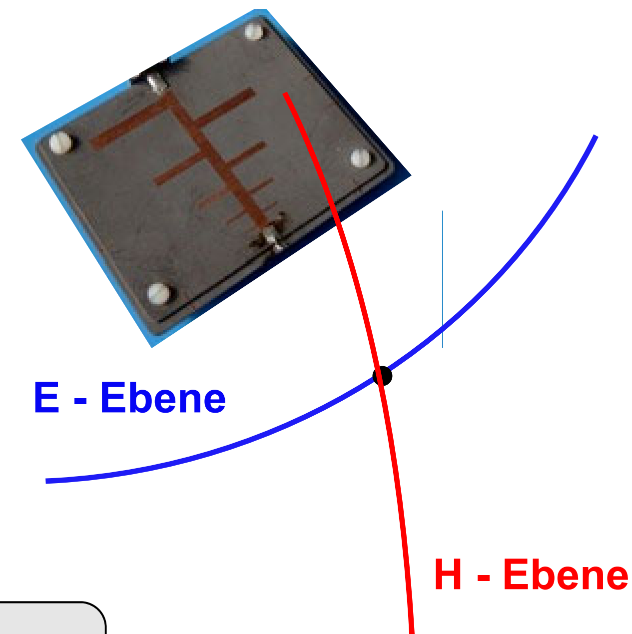
0
-5
-10
-15
-20
-25
-30
-35
-40
2
4
6
8
10
S_{11} in dB
f in GHz
gemessen
simuliert

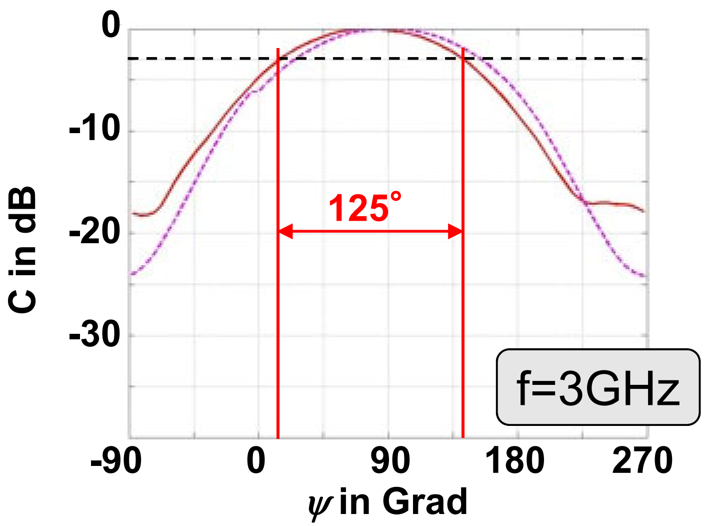
Richtcharakteristiken *C(θ, ψ)*



gemessen
simuliert

E - Ebene



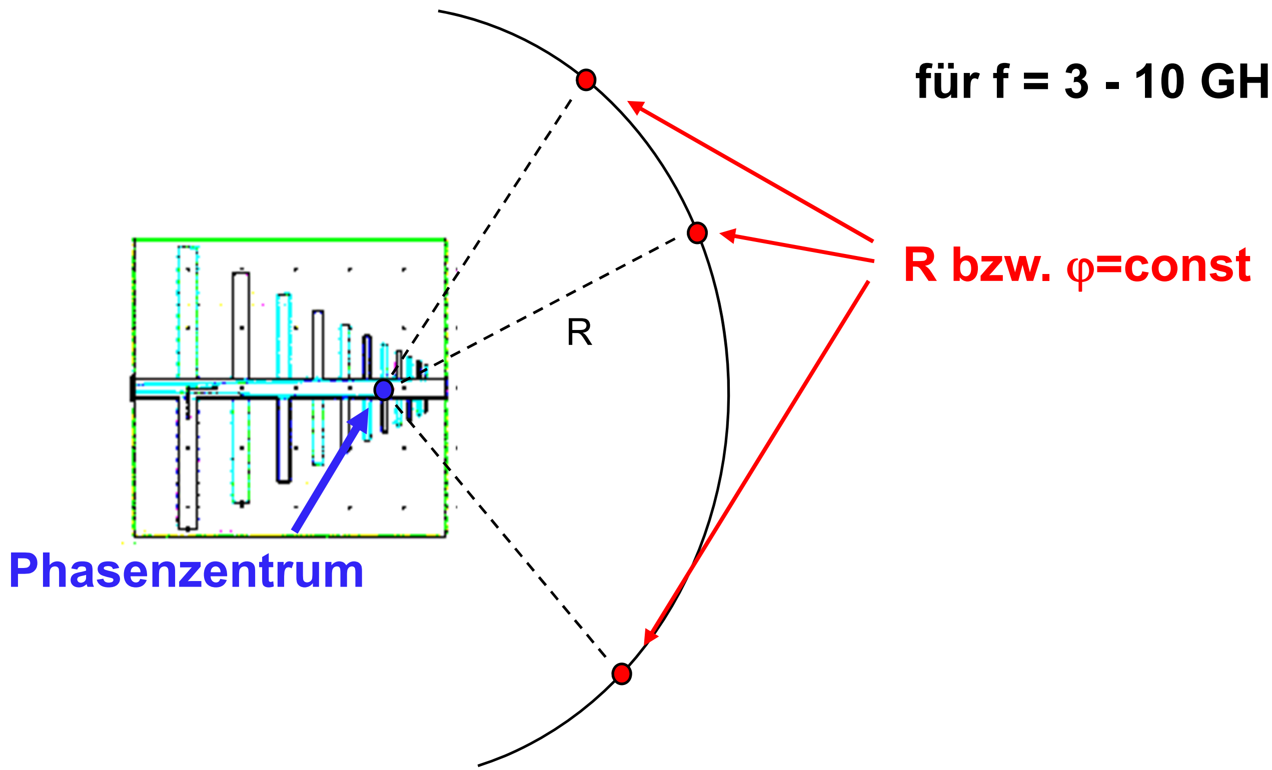


H - Ebene

gemessen
simuliert

Erläuterung des Phasenzentrums

Phasenzentrum: Ersatzkugelstrahler mit gegebener Richtcharakteristik



für f = 3 - 10 GHz:

Phasenzentrum nicht konstant

↓

Zeitversatz

↓

Dispersion

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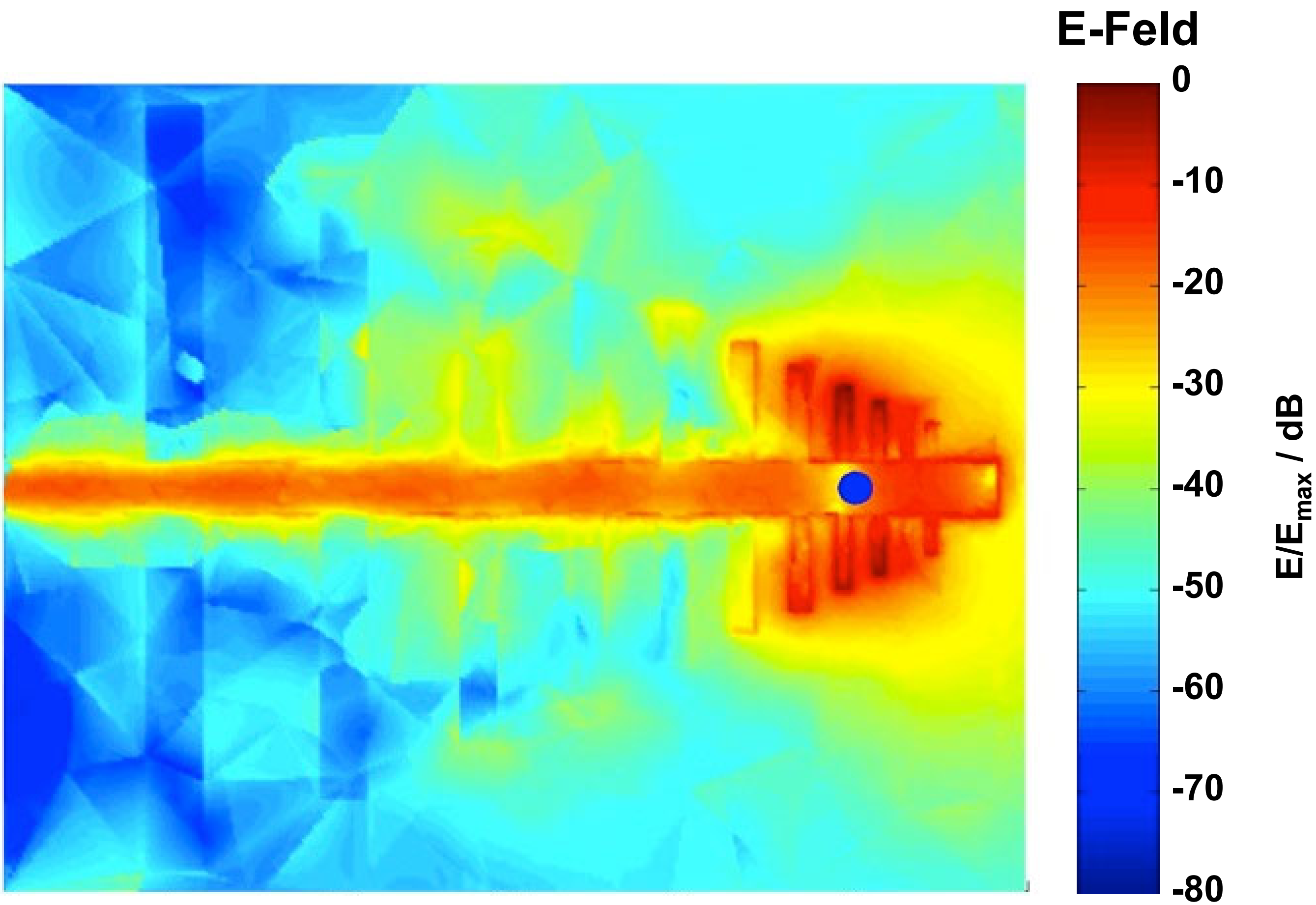
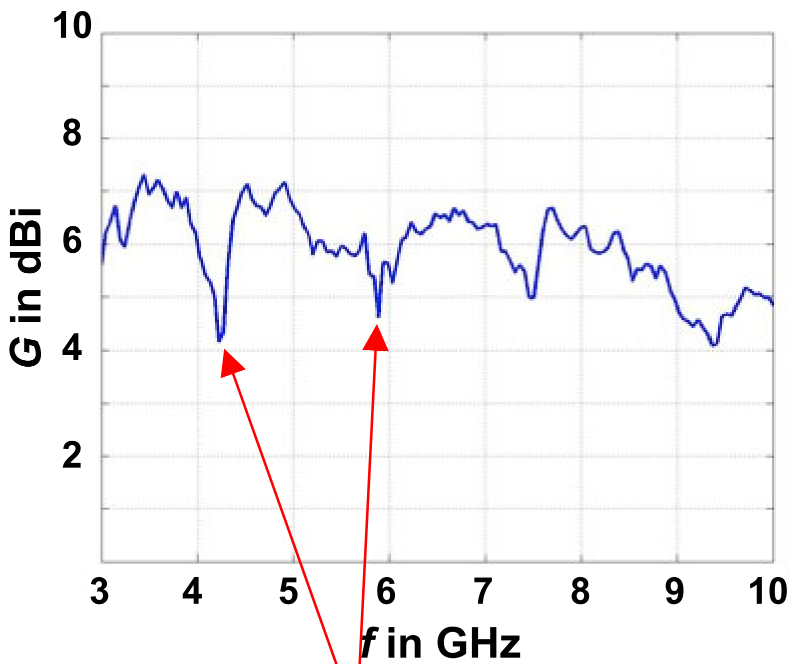
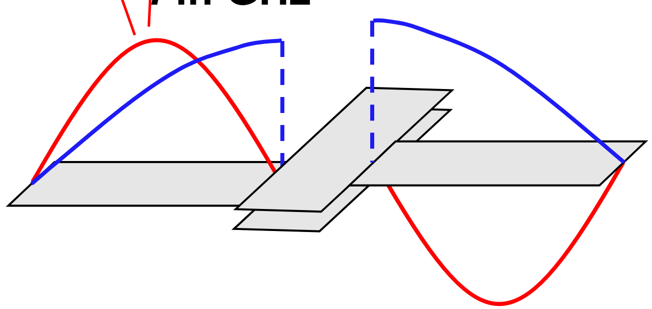
Wanderndes Phasenzentrum



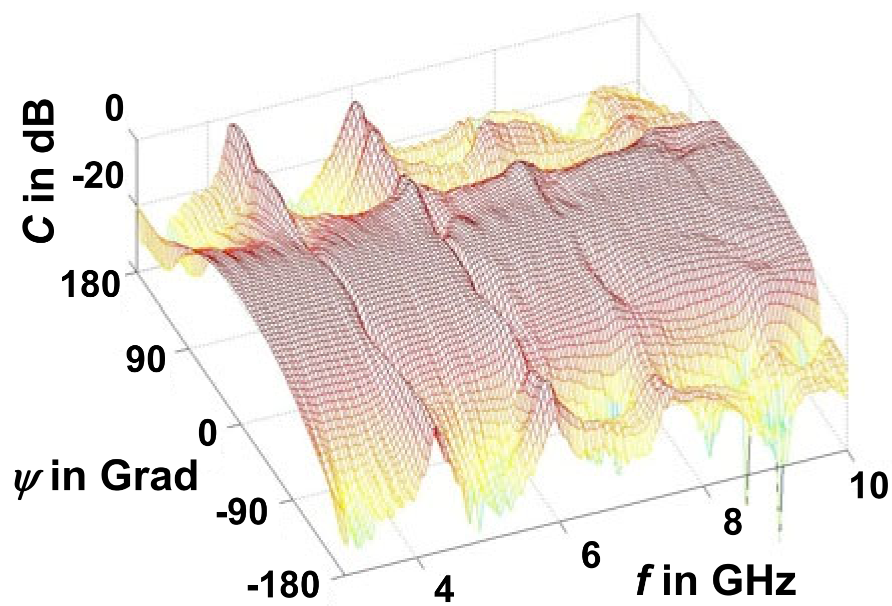
f = 10 GHz

Gewinn über dem Frequenzbereich

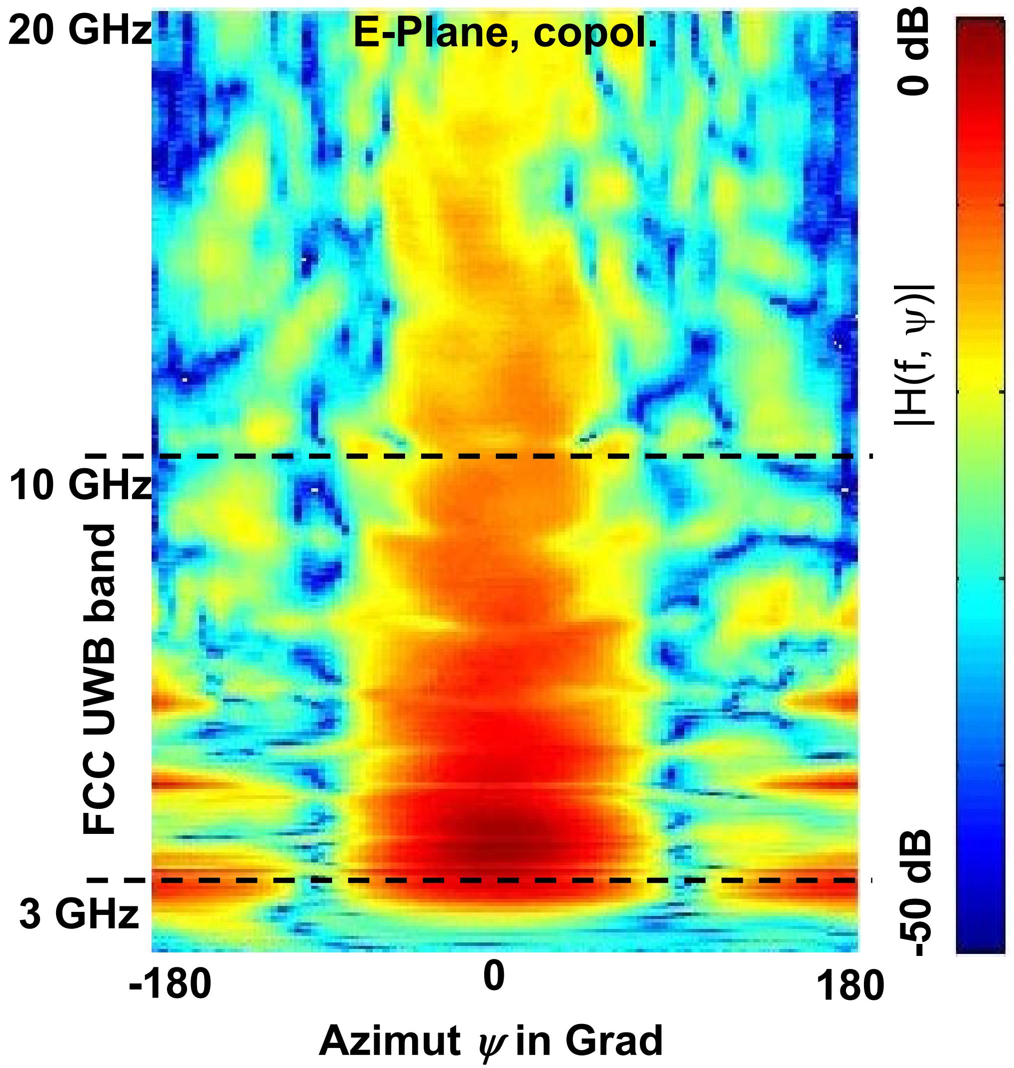




Richtcharakteristik f = 3 - 10 GHz



LogPer-Antennen Transfer Funktion H_n



Transfer function:

$$\vec{H}_n(f,\theta,\psi)$$

â **linear model for radiated far field depends on:**

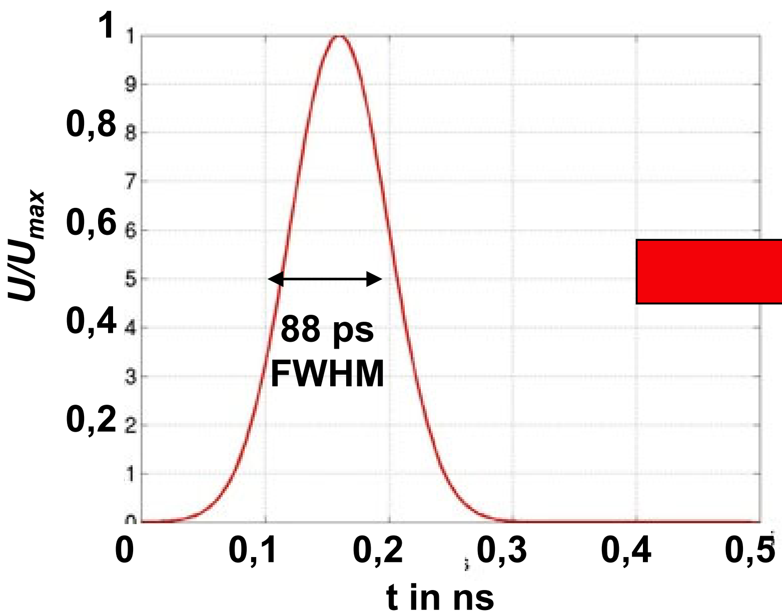
- **direction**
- **polarization**
- **frequency**

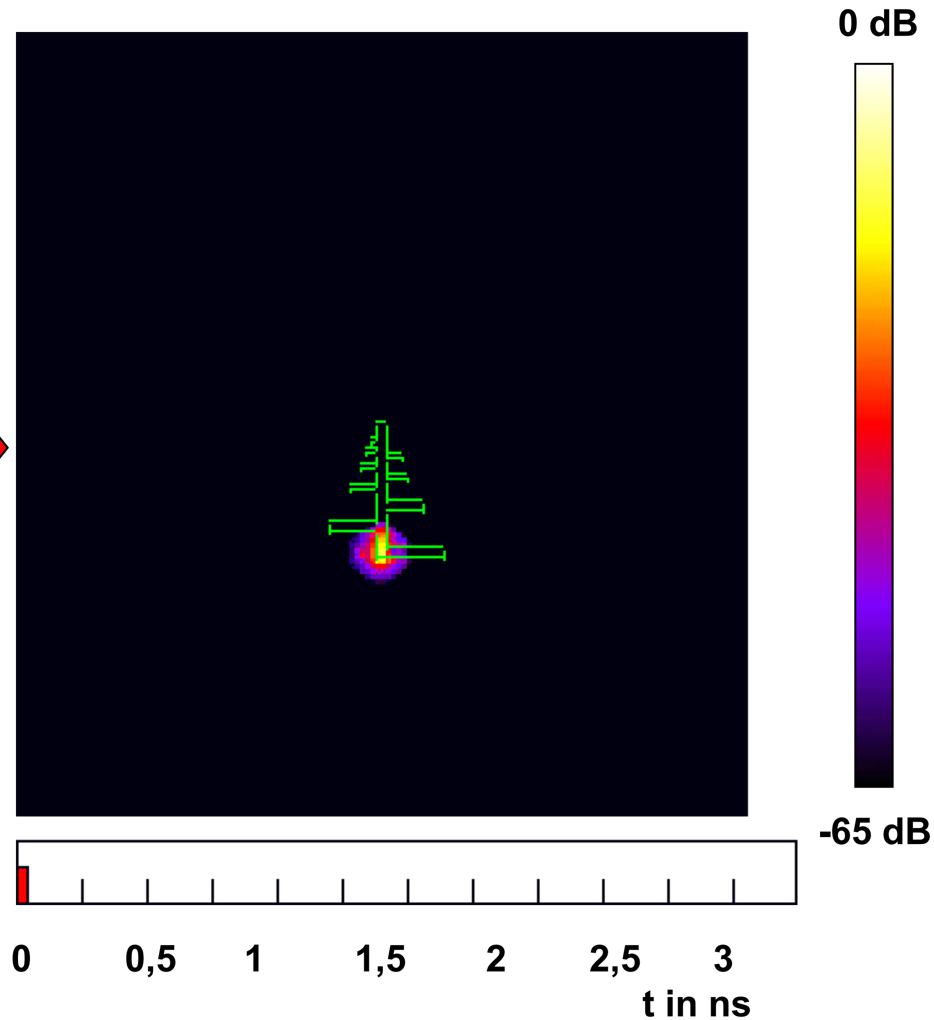
Antenna gain and transfer function:

$$G(f,\theta,\psi) = \frac{4\pi f^2}{c^2} \left|\vec{H}_n(f,\theta,\psi)\right|^2$$

Log-Per Antenna Simulation in Time Domain

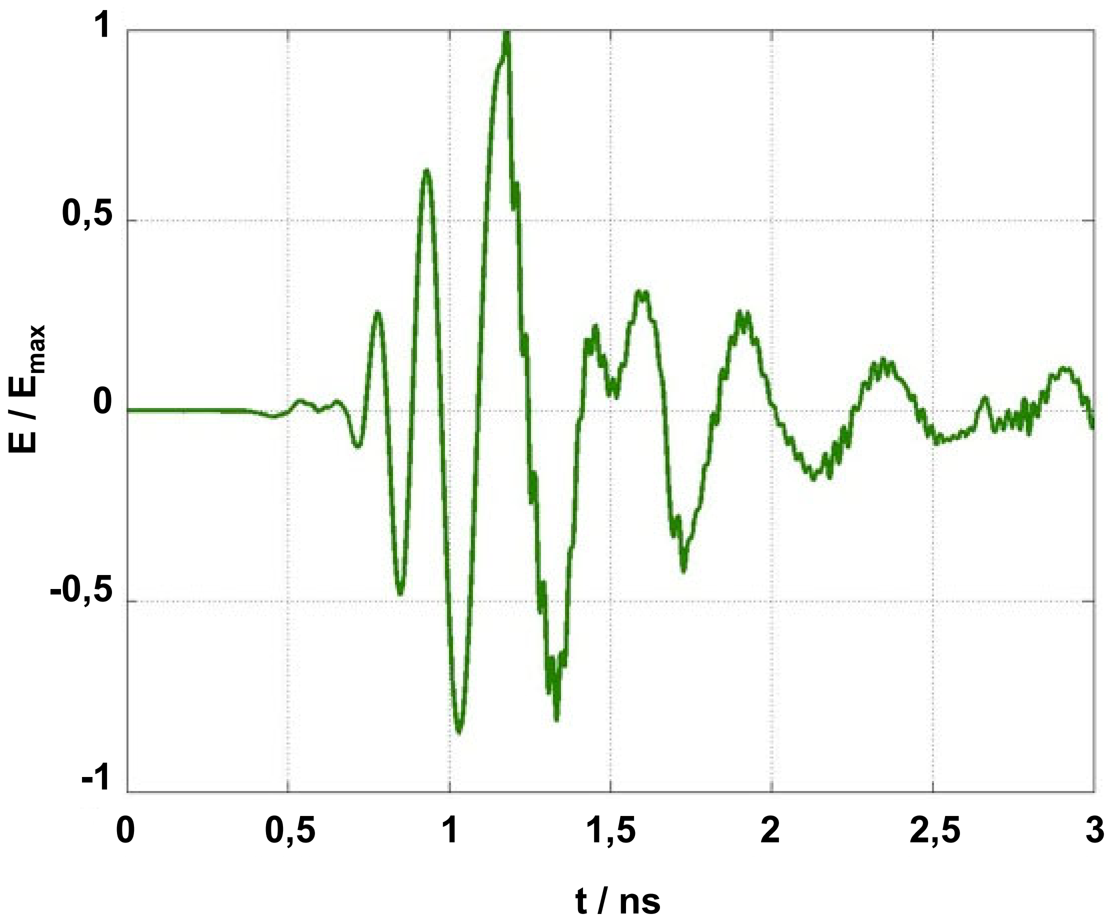
Normalized excitation voltage





FWHM: **F**ull **W**idth at **H**alf **M**aximum

Zeitlicher Verlauf des E-Feldes



Resonanzstruktur der Antenne

Impulsfolge wird abgestrahlt

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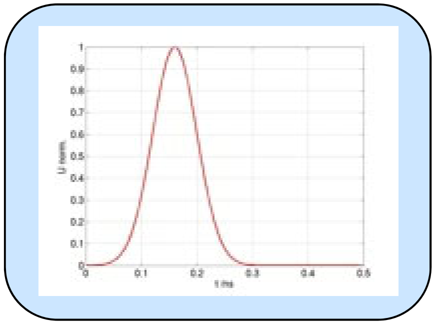
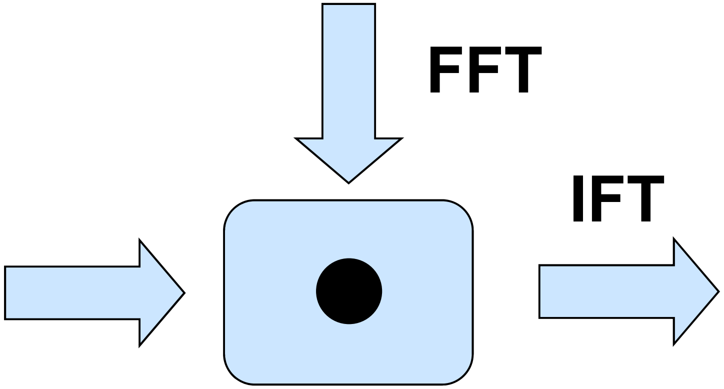
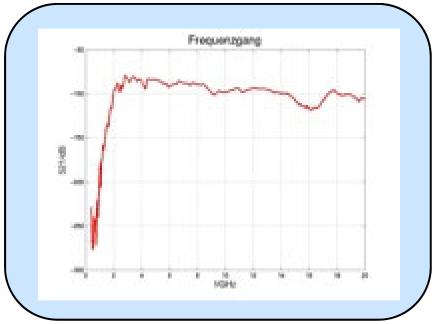
Transformation der Messdaten

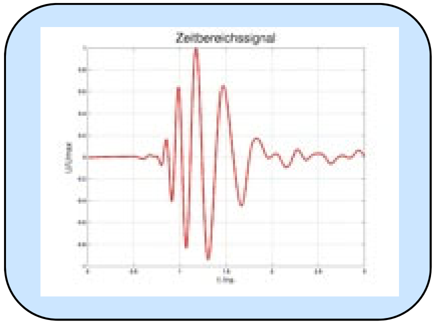


Anregungsfunktion $U_0(t)$



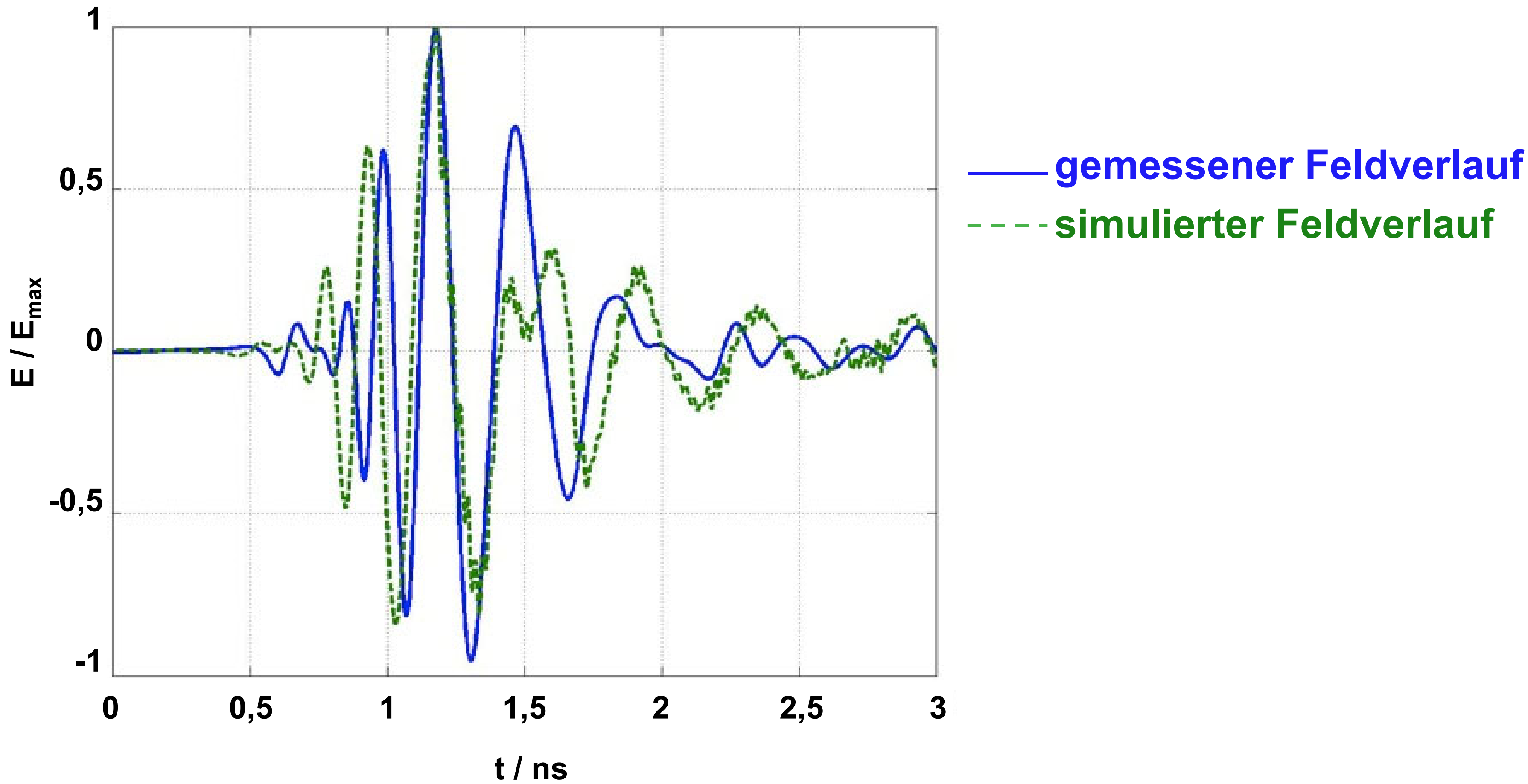


Messung im Frequenzbereich
(801 Frequenzpunkte)



zeitlicher Verlauf
der Feldstärke

Vergleich Simulation ⇔ Messung



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Vivaldi Antennen

by Thomas Zwick

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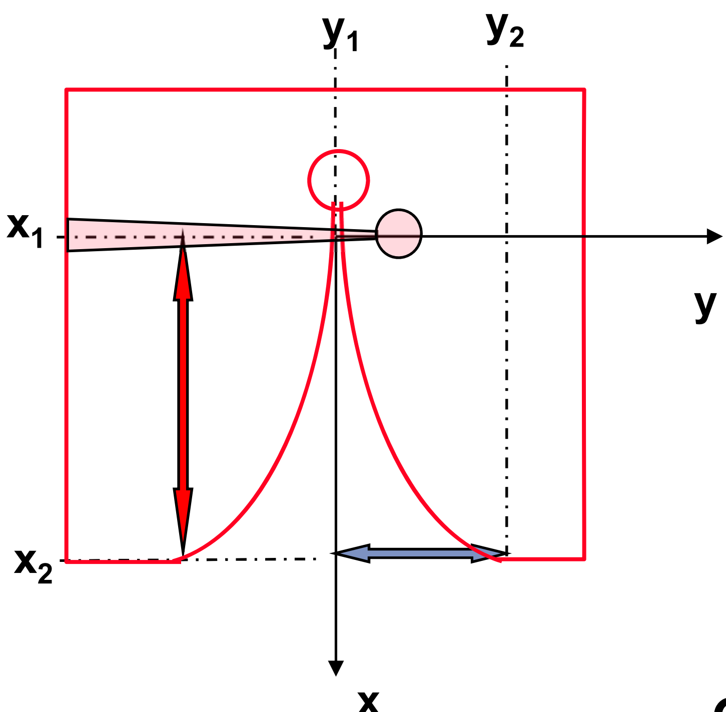
Vivaldi Antenna: Exponentially Tapered Slot Antenna



Exponential taper design:

$$y(x) = A \cdot e^{Rx} + B \qquad \textit{with}$$

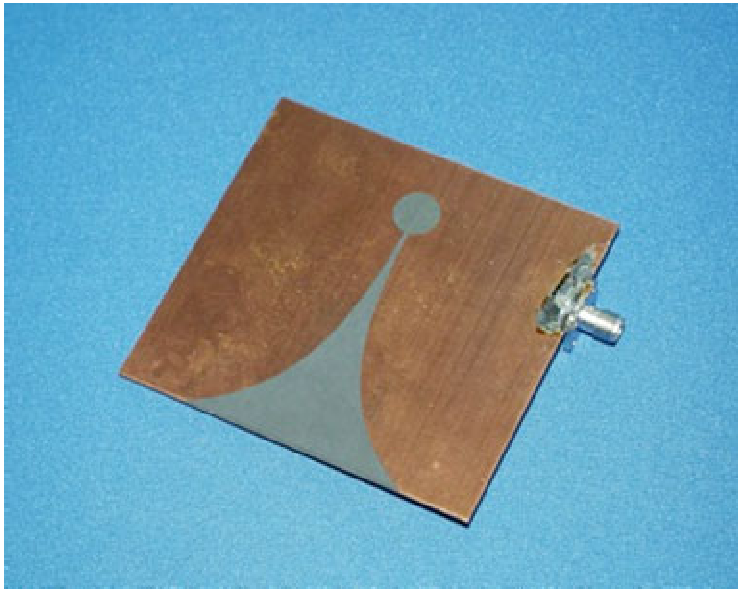
$$A = \frac{y_2 - y_1}{e^{Rx_2} - e^{Rx_1}}$$

$$B = \frac{y_1 \cdot e^{Rx_2} - y_2 \cdot e^{Rx_1}}{e^{Rx_2} - e^{Rx_1}}$$

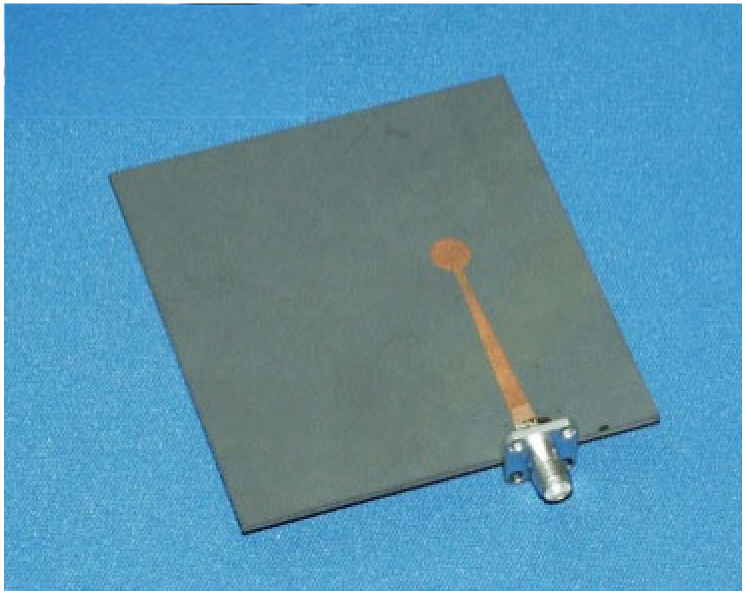
$$R = 0{,}8/\mathrm{mm}$$

Opening Rate *R* determines curvature.

Vivaldi-Antenna



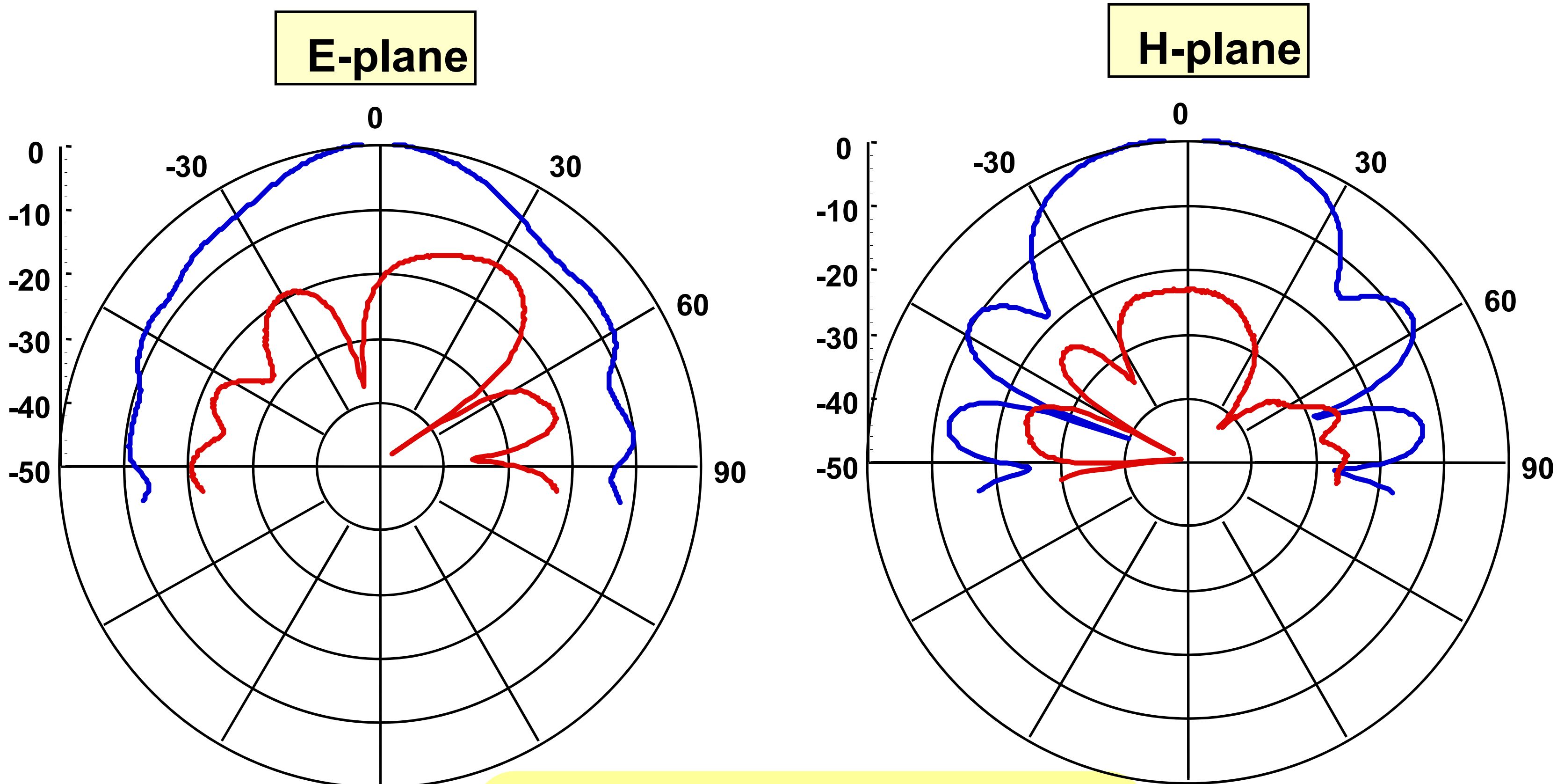
Exponentially tapered slot



Feeding network: Marchand balun

Measured Radiation Patterns of Vivaldi Antenna

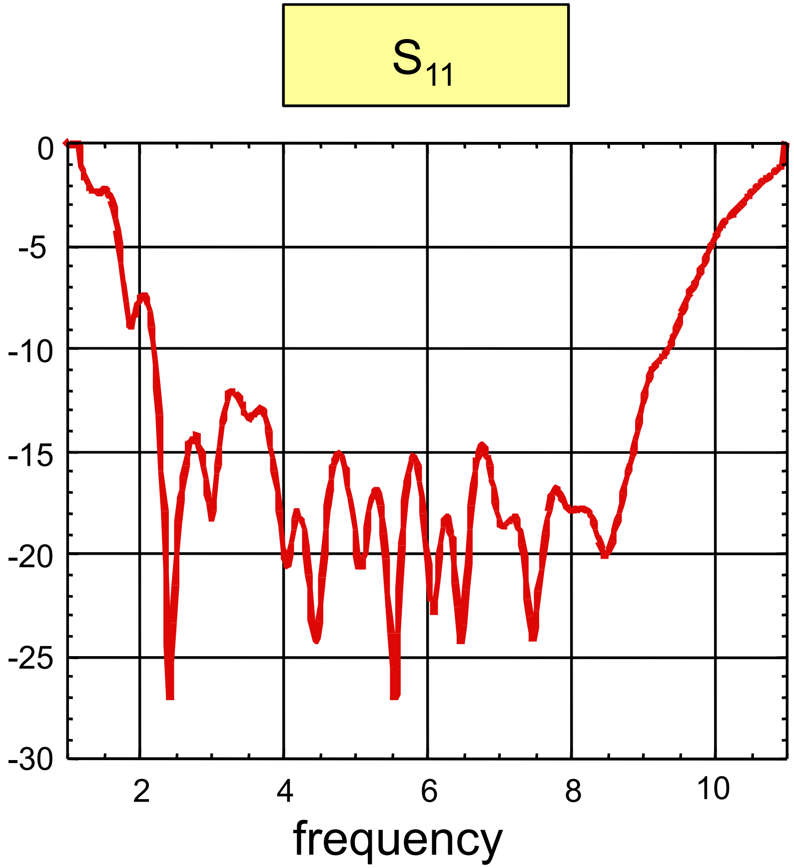
w = 9 cm, l = 7 cm

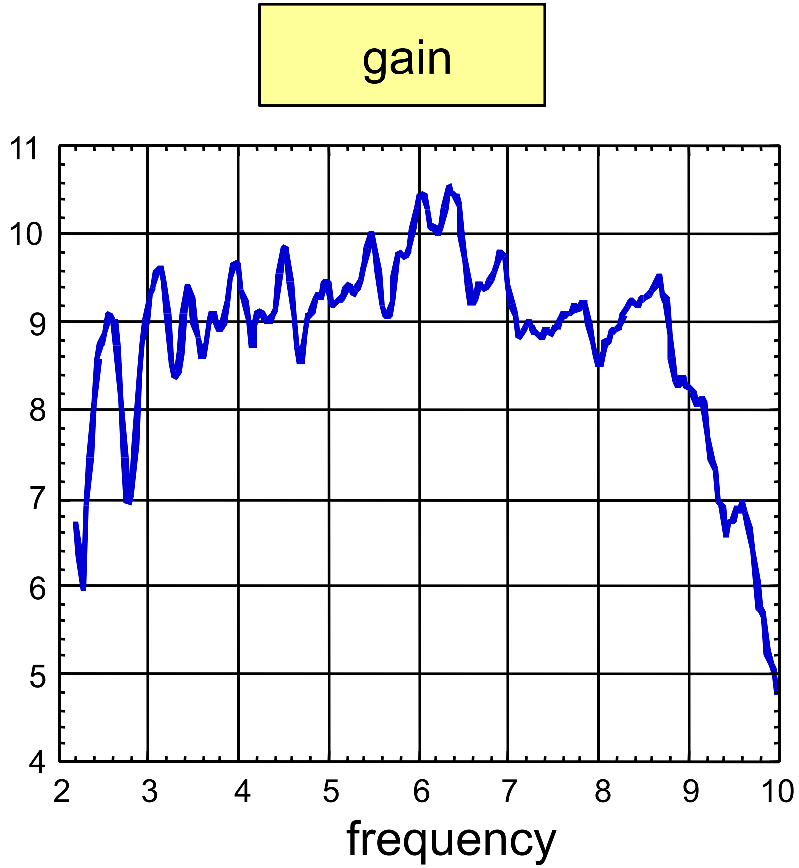


f = 3GHz
Co-polarisation
Cross-polarisation

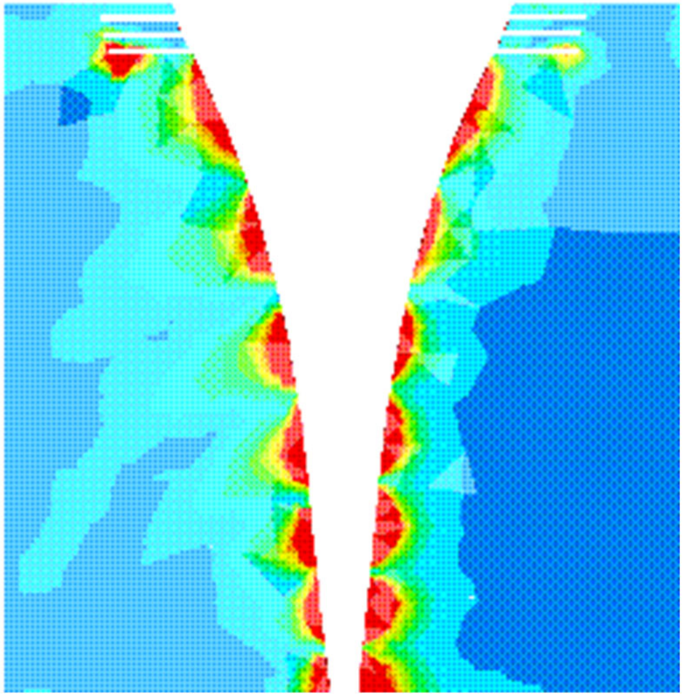
Reflection Coefficient S_{11} and Gain G of Vivaldi Antenna

w = 9 cm, l = 7 cm





Vivaldi Antenne mit Korrugationen



Auslöschung von Randströmen durch Korrugationen

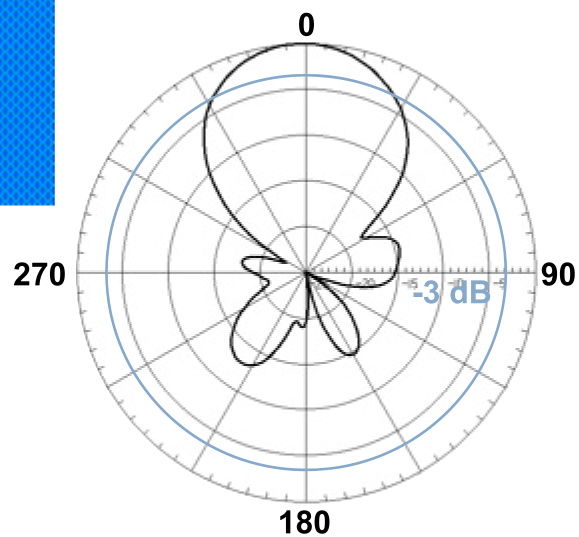
Transformation eines Kurzschlusses in einen Leerlauf

$G_i = 9\ \mathrm{dB}$

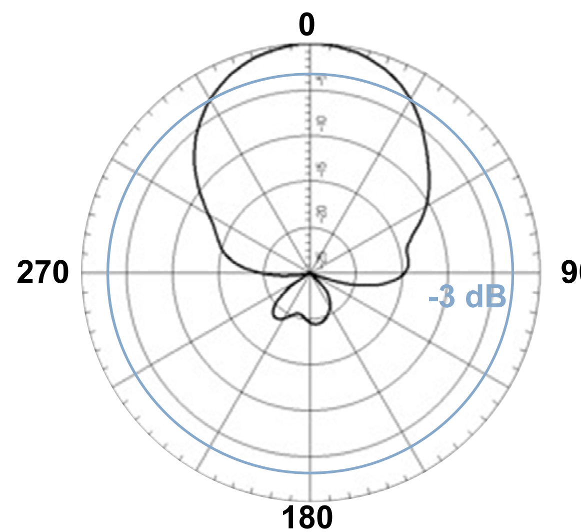
$\theta_{3dB,E} = 60^\circ$

$\theta_{3dB,H} = 60^\circ$

***E*-Ebene**



***H*-Ebene**



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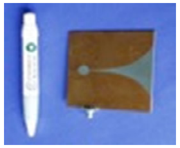
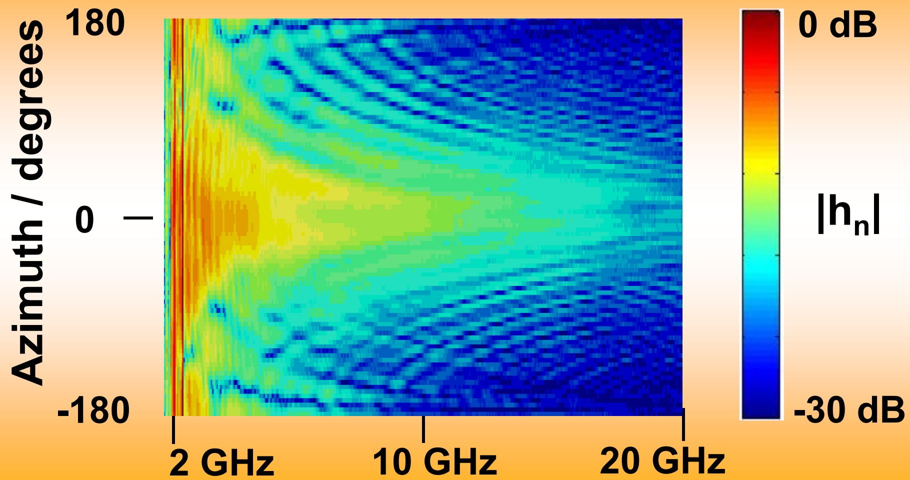
Vivaldi Antenne mit Pulsansteuerung

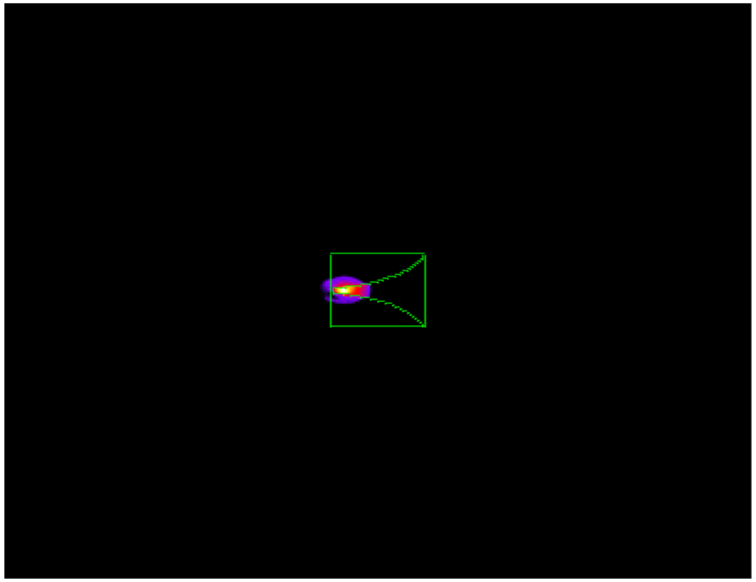


Antennas are dispersive elements. Radiation characteristics depend on frequency!

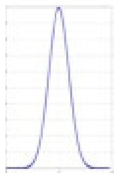
→ **UWB antenna characterisation in frequency and time domain.**

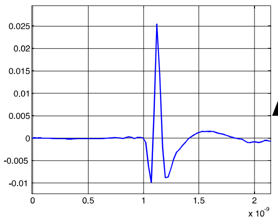
Example: Vivaldi Antenna





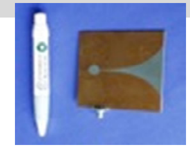
Anregung



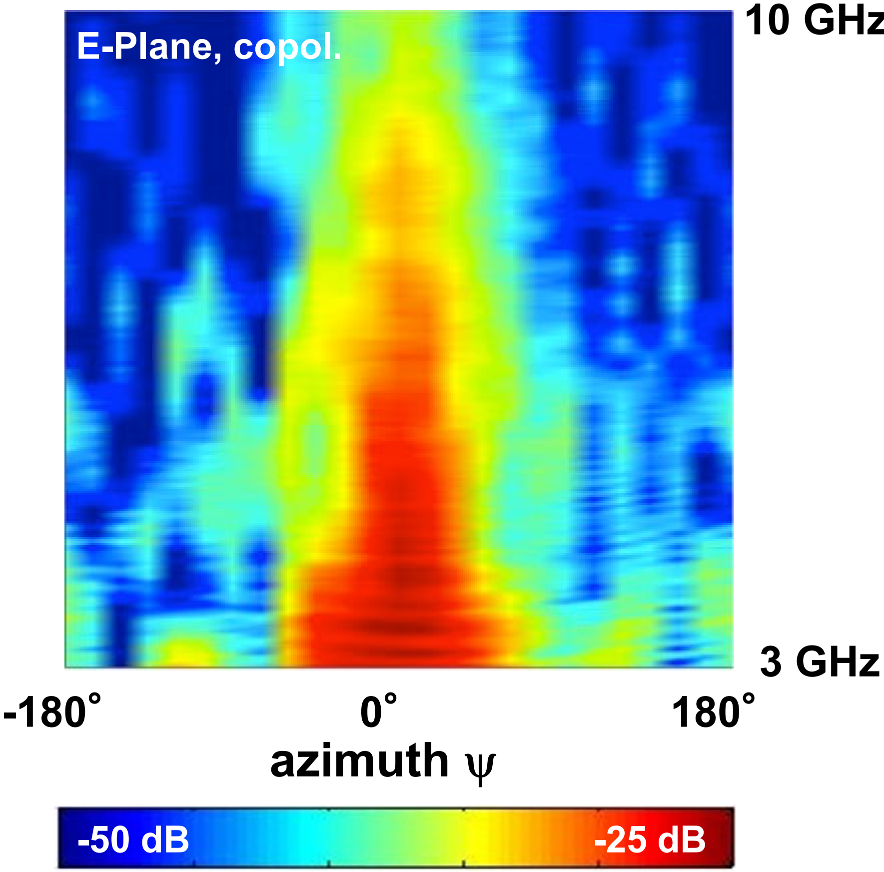


Antwort

Measured Transfer Function H_n and Gain



Transfer function $|H_n(f, \psi)|$



Transfer function:

$$\vec{H}_n(f,\theta,\psi)$$

â **linear model for radiated far field**

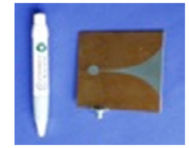
depends on:

- **direction**
- **polarization**
- **frequency**

Antenna gain relation:

$$G(f,\theta,\psi) = \frac{4\pi f^2}{c^2} \left|\vec{H}_n(f,\theta,\psi)\right|^2$$

Measured Transfer Function H_n and Gain



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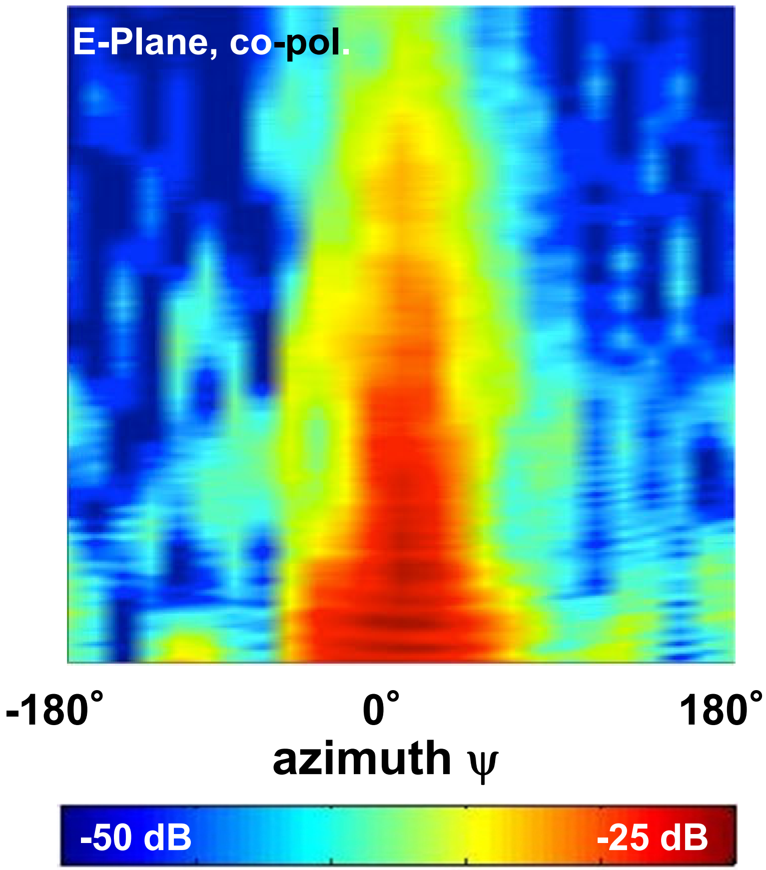
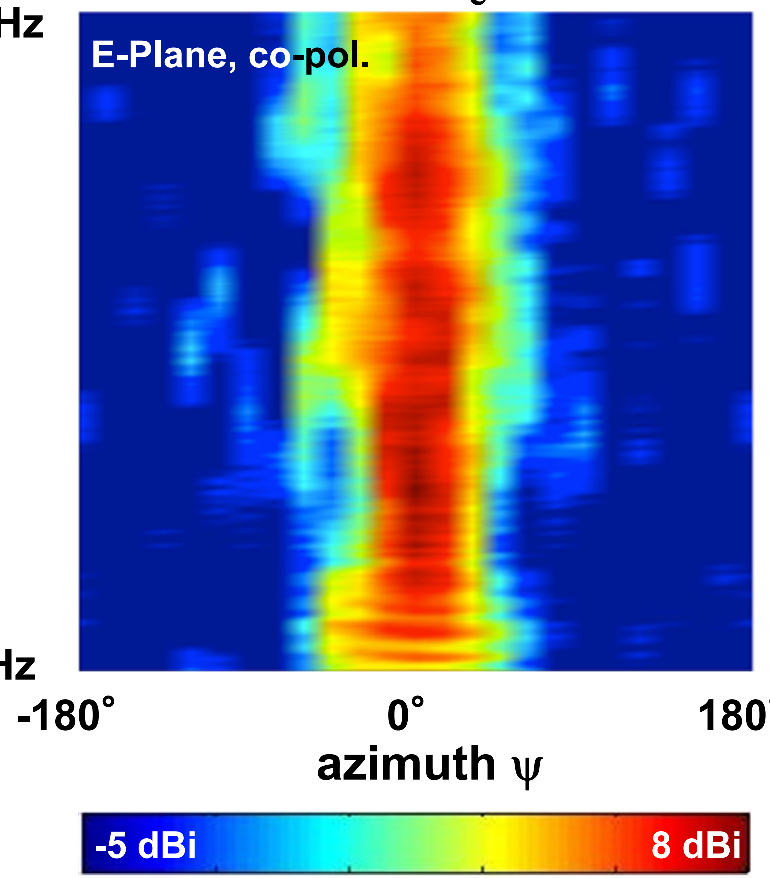
Transfer function $|H_n(f, \psi)|$



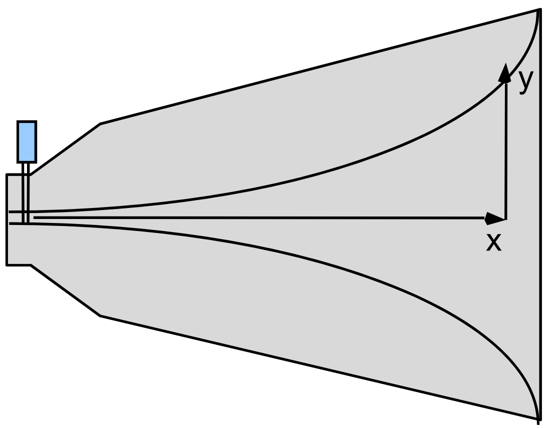
10 GHz

3 GHz

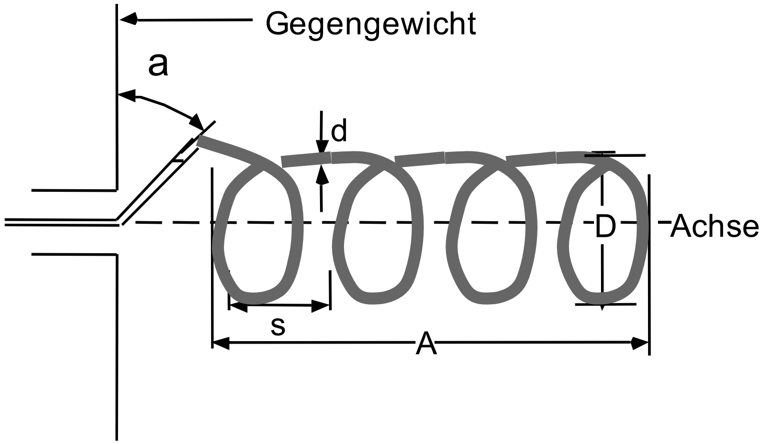
Gain $G(f,\theta,\psi) = \frac{4\pi f^2}{c^2} \left|\vec{H}_n(f,\theta,\psi)\right|^2$



Breitband-Horn-Antenne und Wendelantenne



Exponential Hornantenne



Wendelantenne

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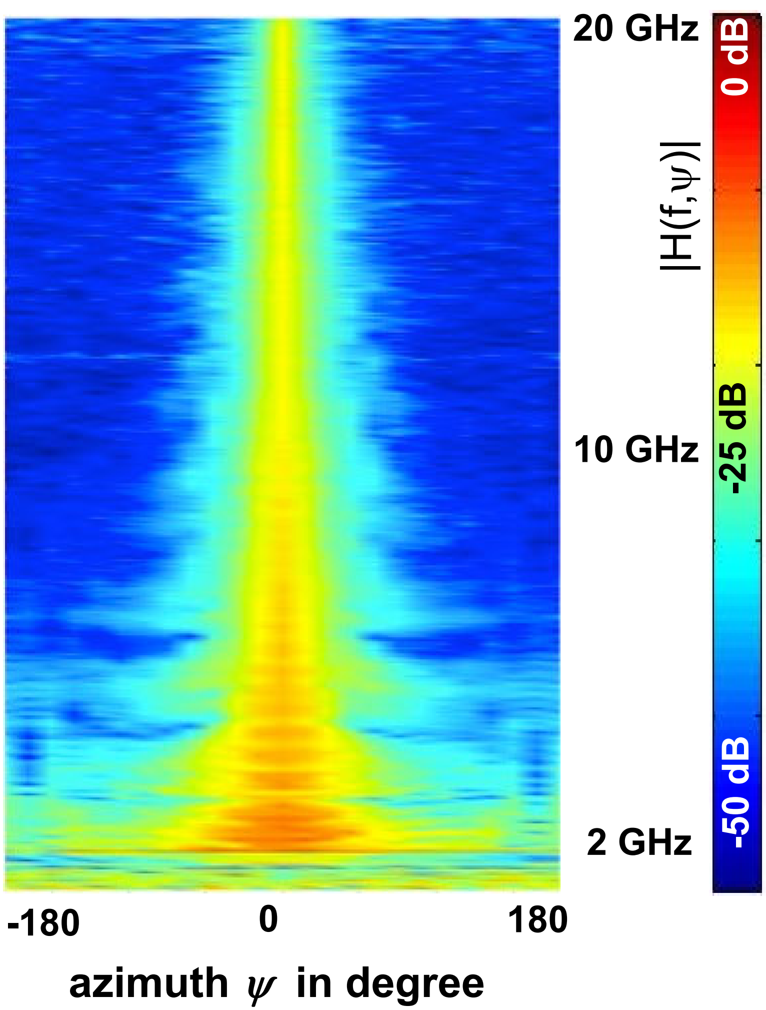
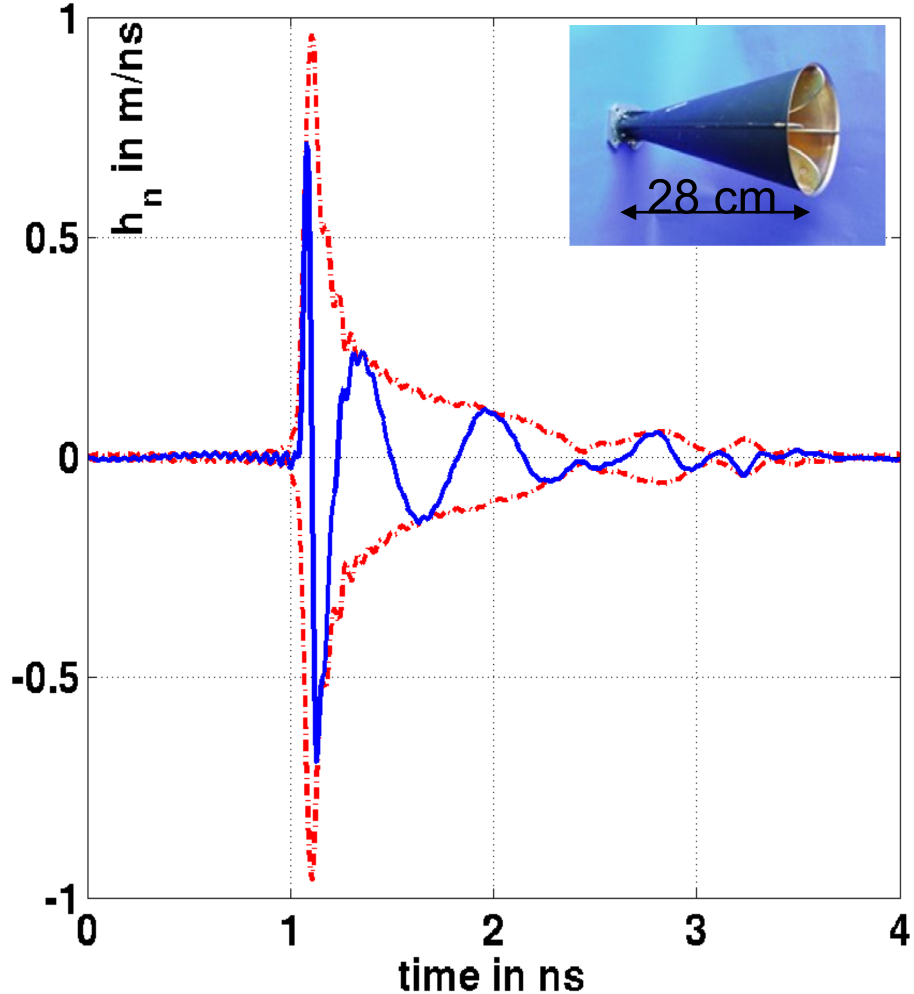
UWB Horn-Antenna Transfer Function $H(f, \psi)$





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Dielektrischer Stabstrahler

by Thomas Zwick

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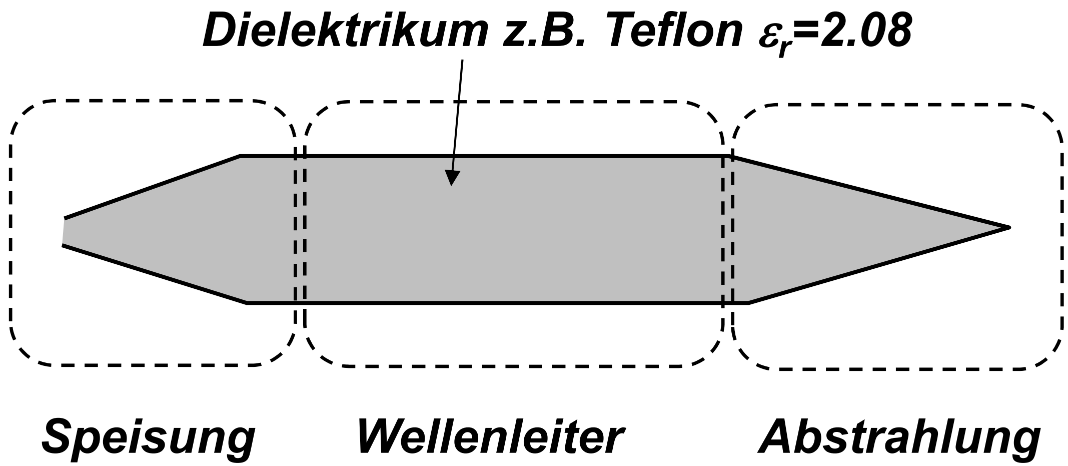
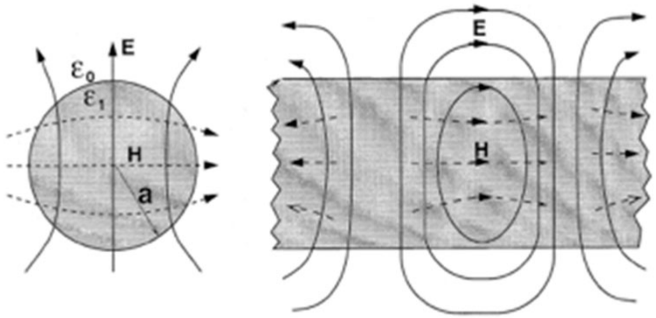
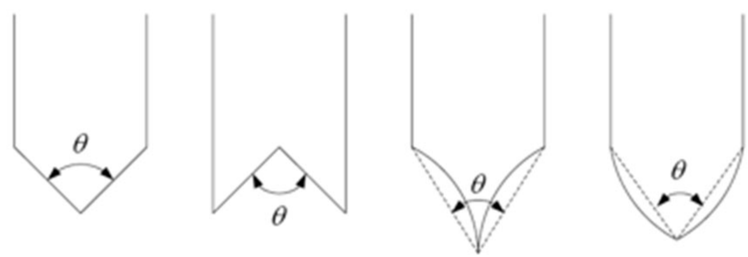
Dielektrischer Stabstrahler





(a) Cross-Section View (b) Side View

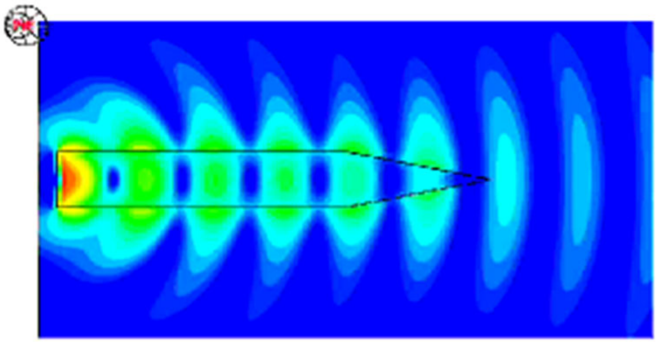
HE11-Mode in Waveguide-Section



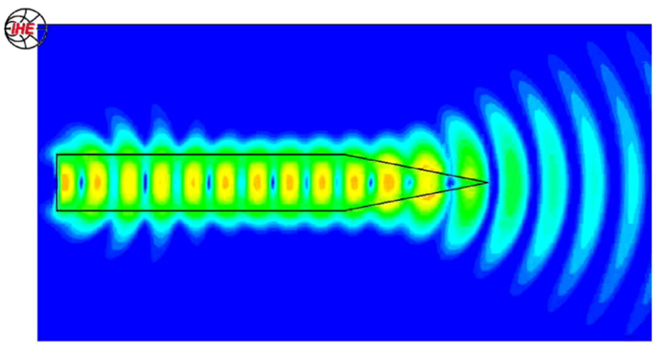
Formen des Strahlers (üblich ein Konus)

Abstrahlung

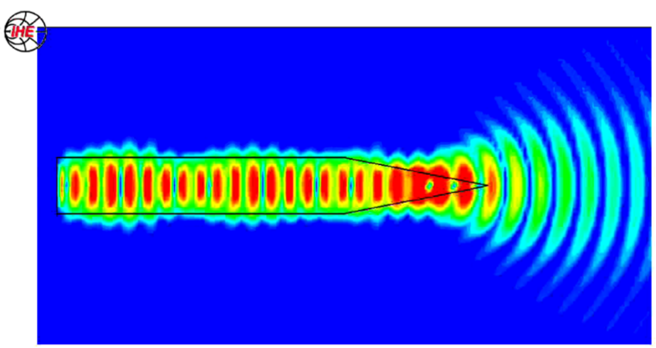
Elektrisches Feld bei:



3 GHz



5.5 GHz



9 GHz

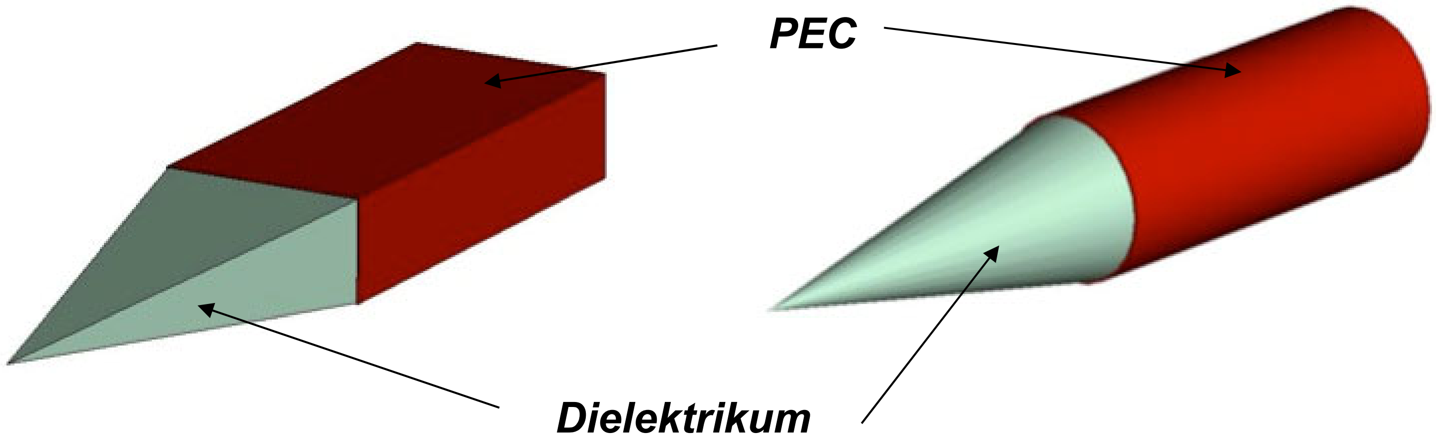
Sehr große Bandbreite

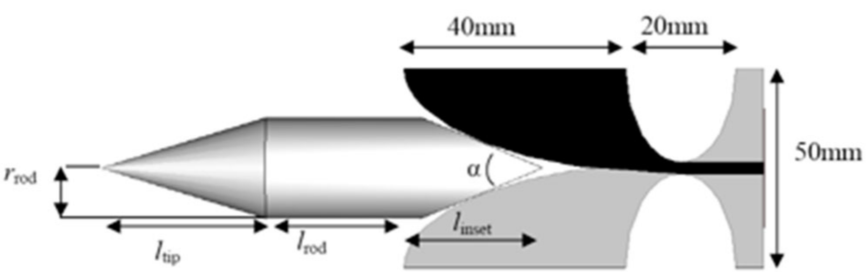
Hohe Direktivität

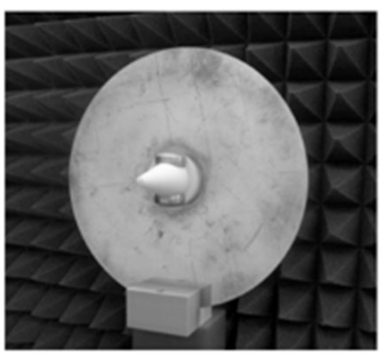
Konstante Richtcharakteristik in breiten Frequenzbereich

Speisung

Hohlleiter





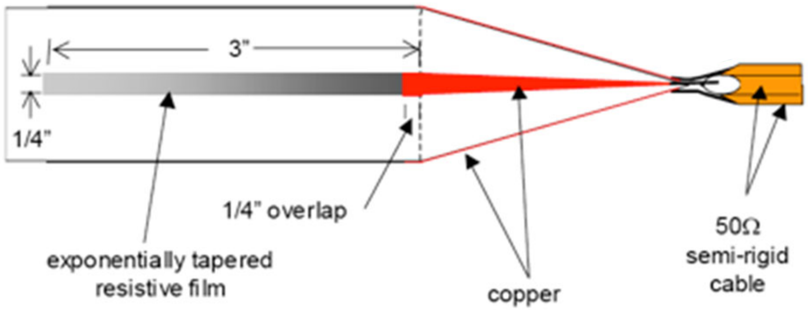


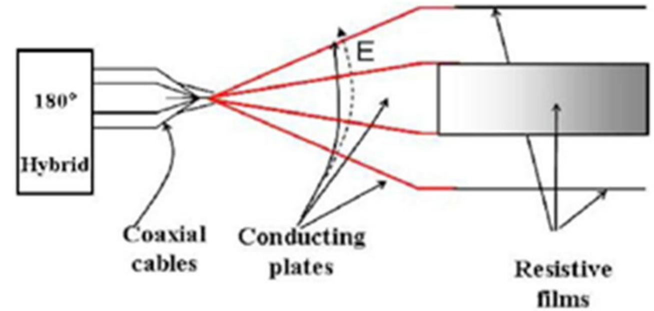
Quelle: IEEExplore

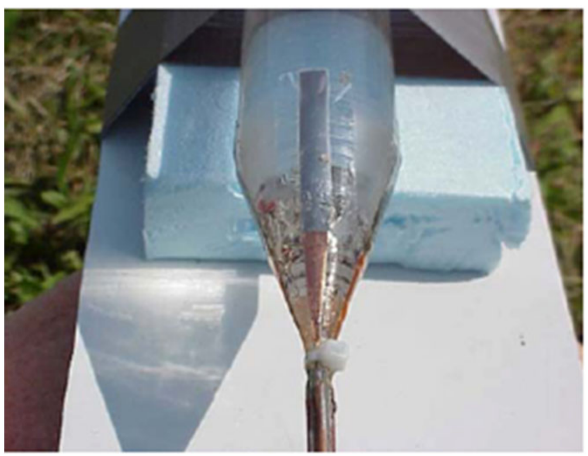
Differentielle Speisung

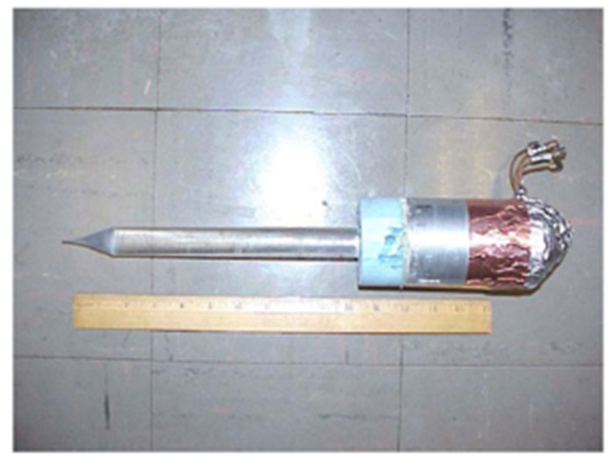
Karlsruhe Institute of Technology

Quelle: IEEEXplore







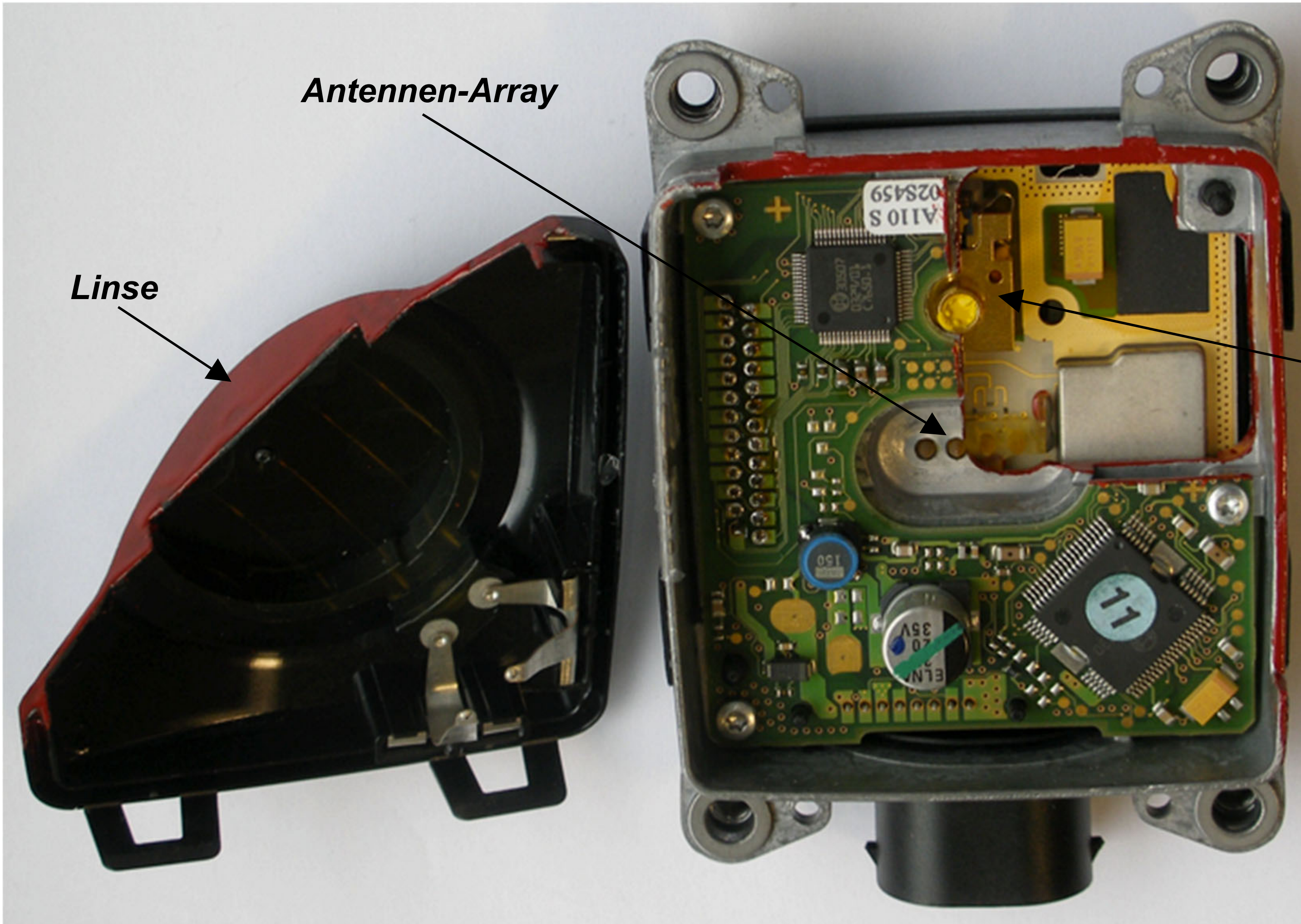


Quelle:„Design of Dielectric Rod Antenna for Near Field Measurement“
Kwan-ho Lee, Chi-Chih Chen, Fernando Teixeira and Robert Lee

Bosch ACC Radar

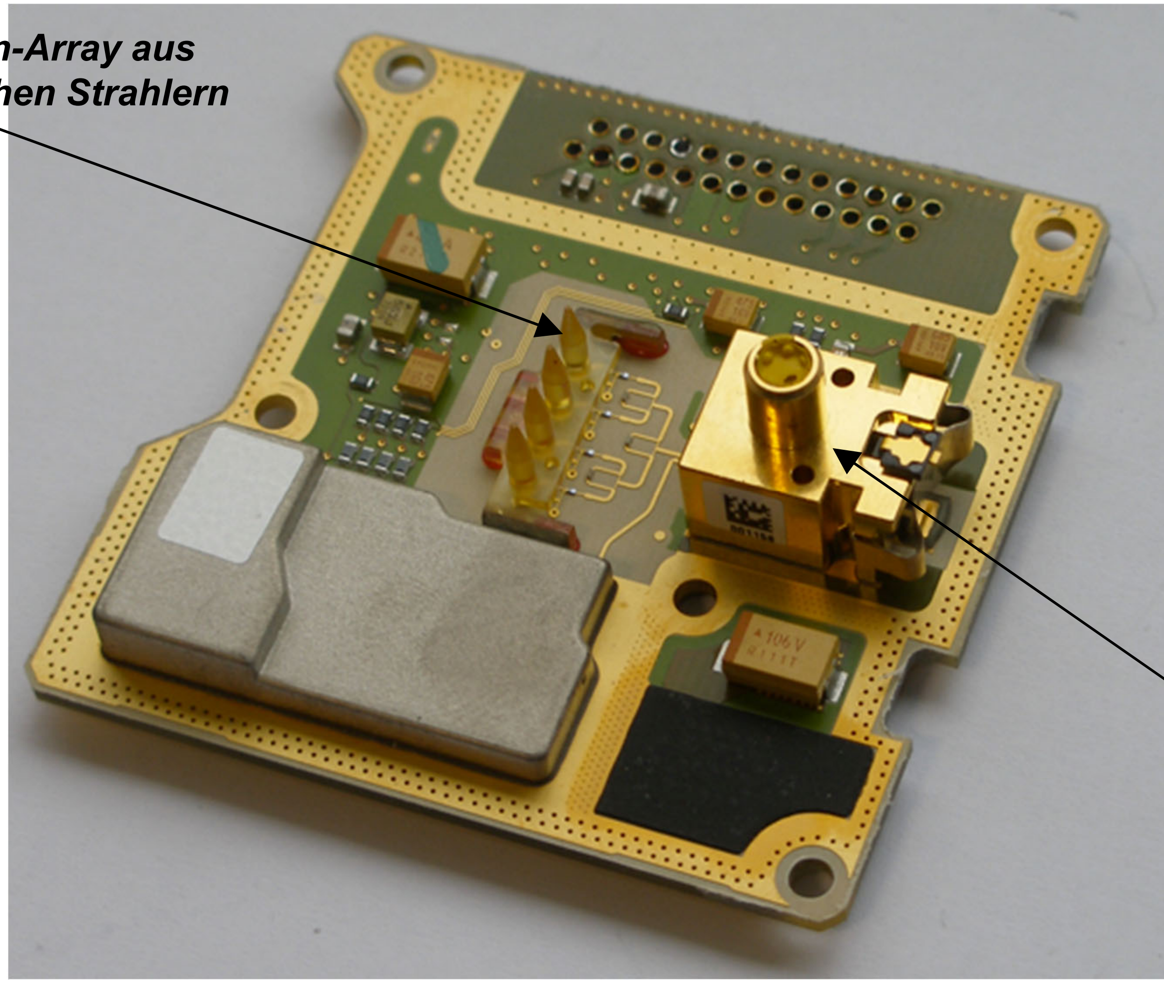
Courtesy
Bosch

Bosch ACC Radar - Antennensystem



Courtesy Bosch

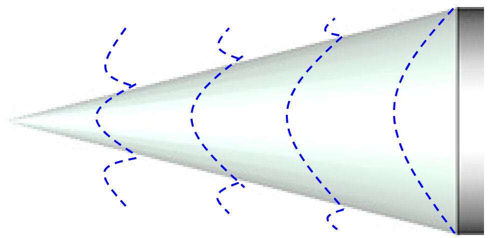
Bosch ACC Radar - HF Frontend

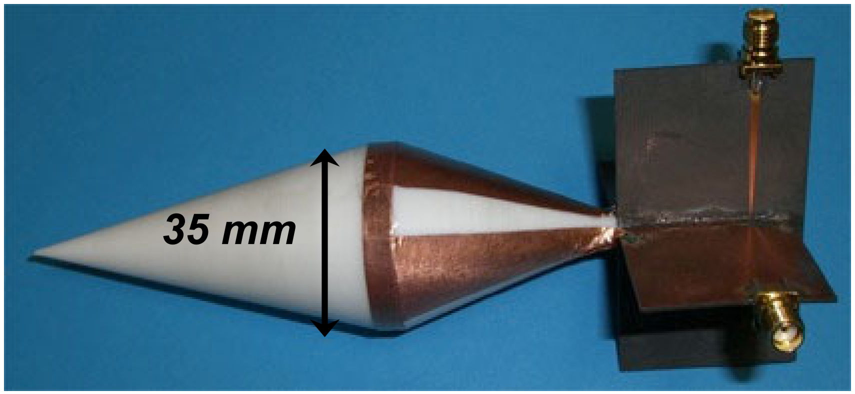


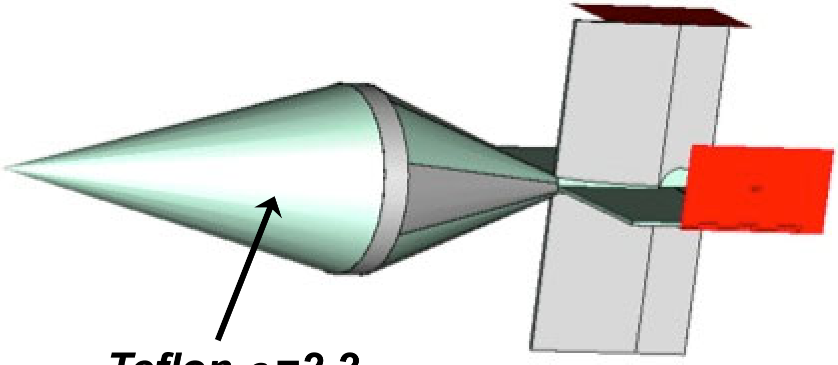
Courtesy Bosch

Institut für Hochfrequenztechnik und Elektronik

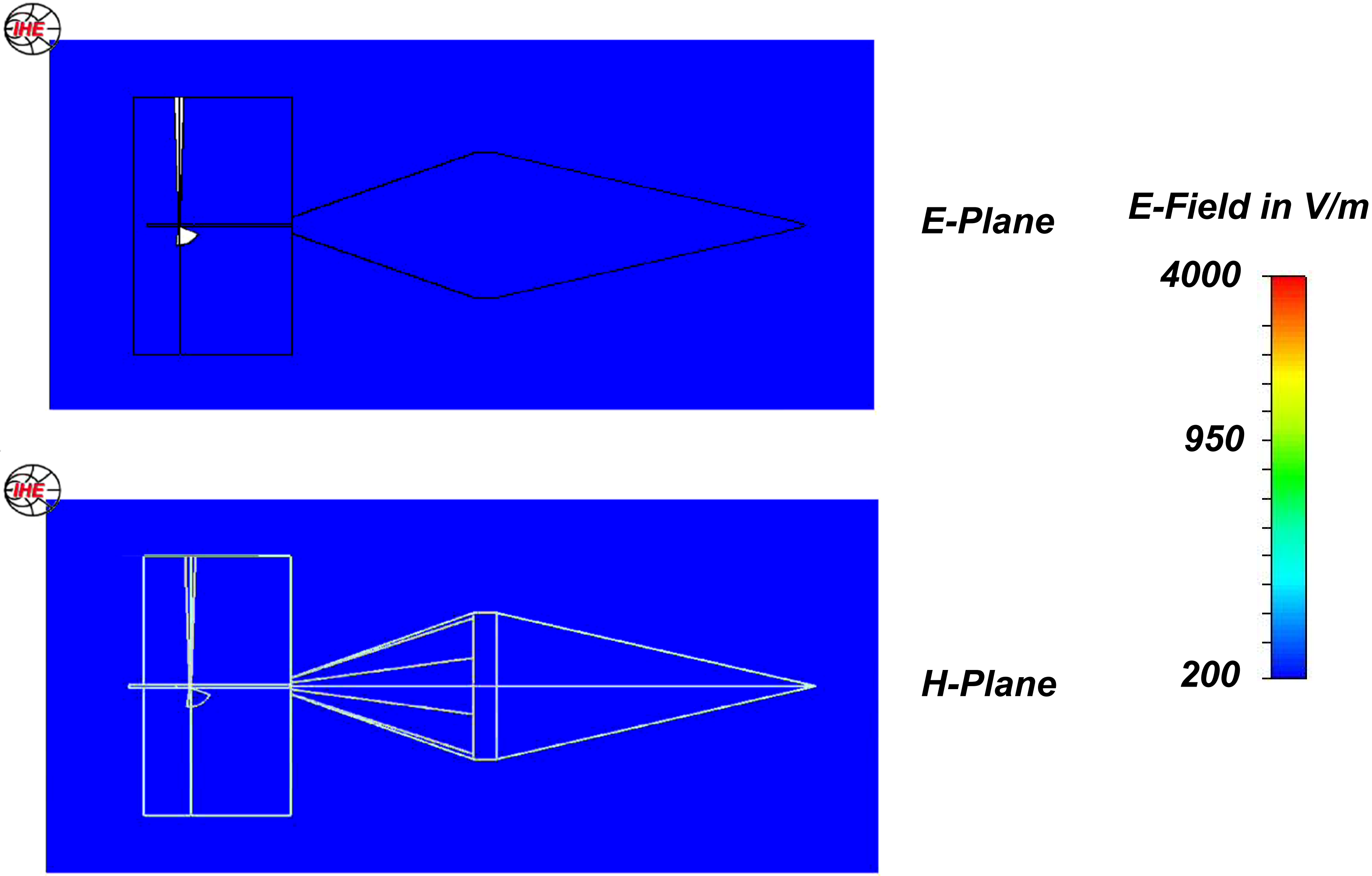
Dual Polarized Dielectric Rod Antenna



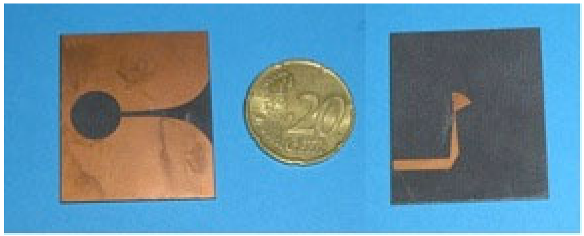


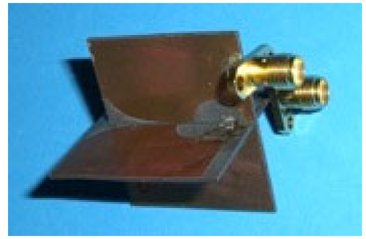


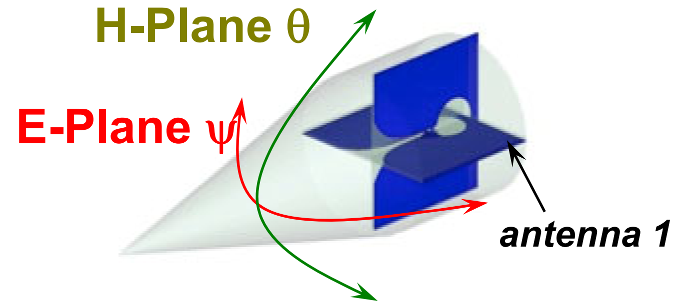
Radiation Principle in Time Domain

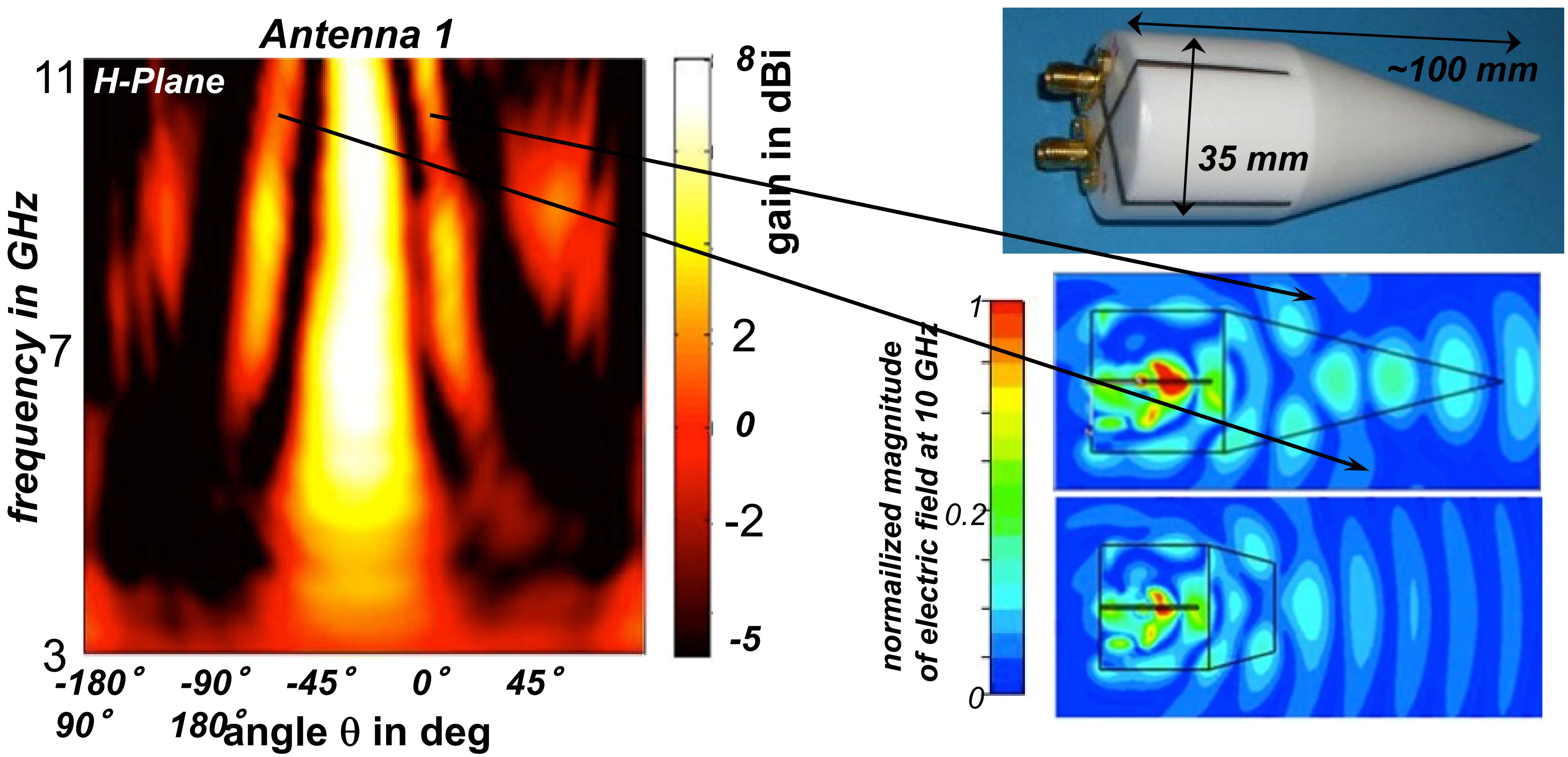


Integration of the Feed

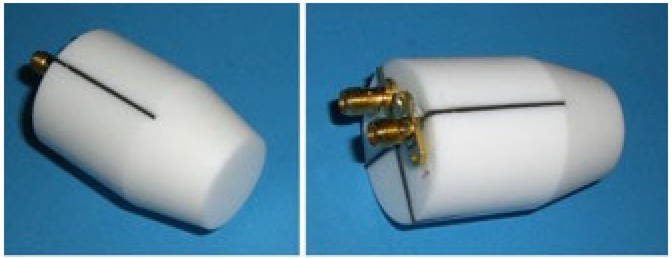


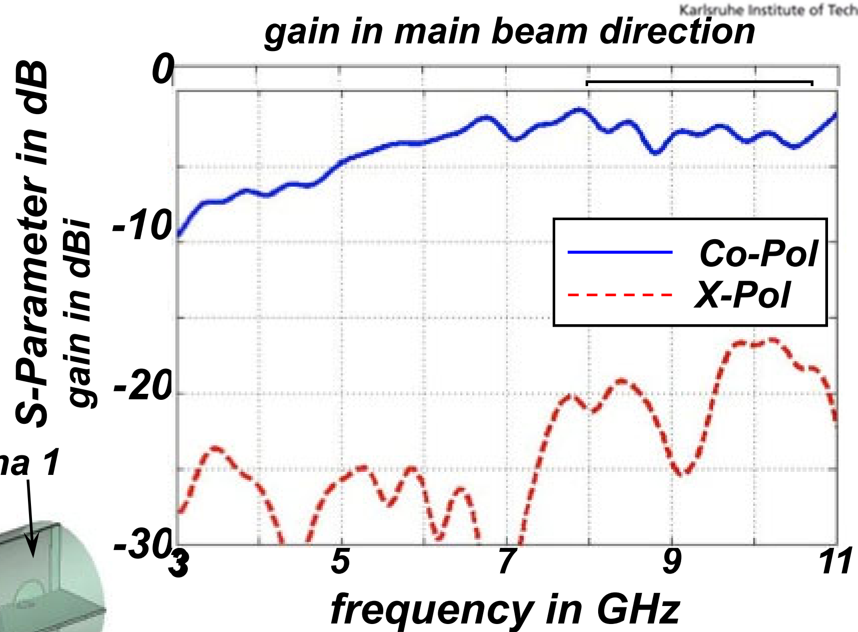






Optimization of the Characteristics





- ✓ very compact dimensions:
  - Ø 35 mm
  - length 53 mm
- ✓ suitable for the UWB antenna array