

Antenna design considerations

A quick overview



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Content

- Design tools (Advantages and differences)
 - Antenna Magus
 - Advanced Design Studio (ADS)
 - CST design studio
- Antenne parameters
 - Antenna gain
 - Power bandwidth
 - Polarization
- PCB Antenna types
 - Patch antennas
 - Vivaldi antennas
 - Log per antennas
- Antenna array simulations
 - Distance between array elements
 - Electrical small / large antenna arrays
- Electronic beam shaping



Design tools

– Antenna Magus

- Antenna type selection
 - Database
 - Typical parameters
- Estimate performance
- Optimizer
- Model builder

—————> CST (3D) or ADS (2D)



Antenna selection

225 templates matched 0 / 0 keywords

Discone antenna	Open-ended quadrifilar helix (O-C QHA)	Circular pin-fed linearly polarised patch antenna	Dipole-fed corner reflector antenna	Waveguide-fed pyramidal horn antenna	Inverted-F (IFA)	Dual-waveguide pin-fed short pyramidal horn	Dual-ridged horn antenna (no sidewalls)	Cavity-backed four-arm sinuous antenna
Self-phased dual-band quadrifilar helix	Cavity-backed planar 2-arm log-periodic antenna	Linear resonant slotted-waveguide array (narrow-wall slo...	N-by-1 rectangular patch array with corporate feed	Batwing antenna	Monocone antenna	Truncated monocone antenna	Wideband Monocone with shaped cap	Solid biconical antenna
Wire biconical antenna	Cavity-backed T-bar-fed slot antenna	Yagi-Uda dipole array	Printed Yagi-Uda Dipole Array with Balun	Log-periodic dipole array (LPDA)	Log-periodic dipole array (LPDA) with a square boom	Dual-band log-periodic dipole array (LPDA)	Planar log-periodic dipole array (LPDA)	Planar 2-arm log-periodic antenna
Planar / bent 2-arm trapezoidal log-periodic antenna	Orthogonal Log-periodic dipole array (LPDA)	2-by-2 rectangular microstrip patch array	Sequentially rotated 2-by-2 array notched circular patches	Inset-fed 4-by-1 patch array with corporate feed	Pin-fed 4-by-1 patch array with underside corporate feed	Stacked microstrip patch array	Resonant series-fed rectangular microstrip patch array	Traveling-wave series-fed rectangular microstrip patch array

Antenna 4

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Vivaldi antenna design

The screenshot displays the Antenna Magus 4.5.1 (Professional) software interface. The main window is titled "Vivaldi antenna" and is divided into several panels:

- Designs and Tweaks:** Shows "Design 2" and "Design 3". Under "Design Objectives - Group 3", the frequency range is set from $f_{min} = 750 \text{ MHz}$ to $f_{max} = 4 \text{ GHz}$. Under "Parameters - Design 3", various dimensions are listed: $H_f = 219.8 \text{ mm}$, $L_f = 419.7 \text{ mm}$, $H_c = 279.8 \text{ mm}$, $W_s = 2.667 \text{ mm}$, $D_c = 79.94 \text{ mm}$, $S_c = 79.94 \text{ mm}$, $S_f = 4 \text{ mm}$, $L_s = 8 \text{ mm}$, and $R_t = 7.5$.
- Sketches:** Displays a "Top view" of the Vivaldi antenna structure with labeled dimensions: D_c (cavity diameter), W_s (slot width), H_f (flare height), H_c (cavity height), S_c (cavity slot width), S_f (slot width), L_s (slot length), and L_f (flare length).
- Model Preview:** Shows a 3D perspective view of the antenna model.
- Design Guidelines:** Provides design rules for the Vivaldi antenna in free space, referenced to 150Ω . It states that the upper frequency objective in Magus only specifies the upper boundary of the frequency range over which the antenna performance will be estimated. The guidelines include:
 - The flare height should be greater or equal to a half-wavelength at the minimum operating frequency.
 - The flare length should be greater or equal to a wavelength at the minimum operating frequency.
 - The beamwidth decreases and the directivity increases as the flare length is increased.
 - To decrease (increase) the input impedance, decrease (increase) the slotline width.
 - The taper factor as defined in [Sutiryo et al] and [Shin et al] influences the impedance match and beamwidths.
 - The cavity diameter should be $\approx 0.2\lambda$ at the minimum operating frequency.
- Collection:** Shows a row of six antenna design icons labeled "Antenna 1" through "Antenna 6", with "Antenna 5" currently selected.

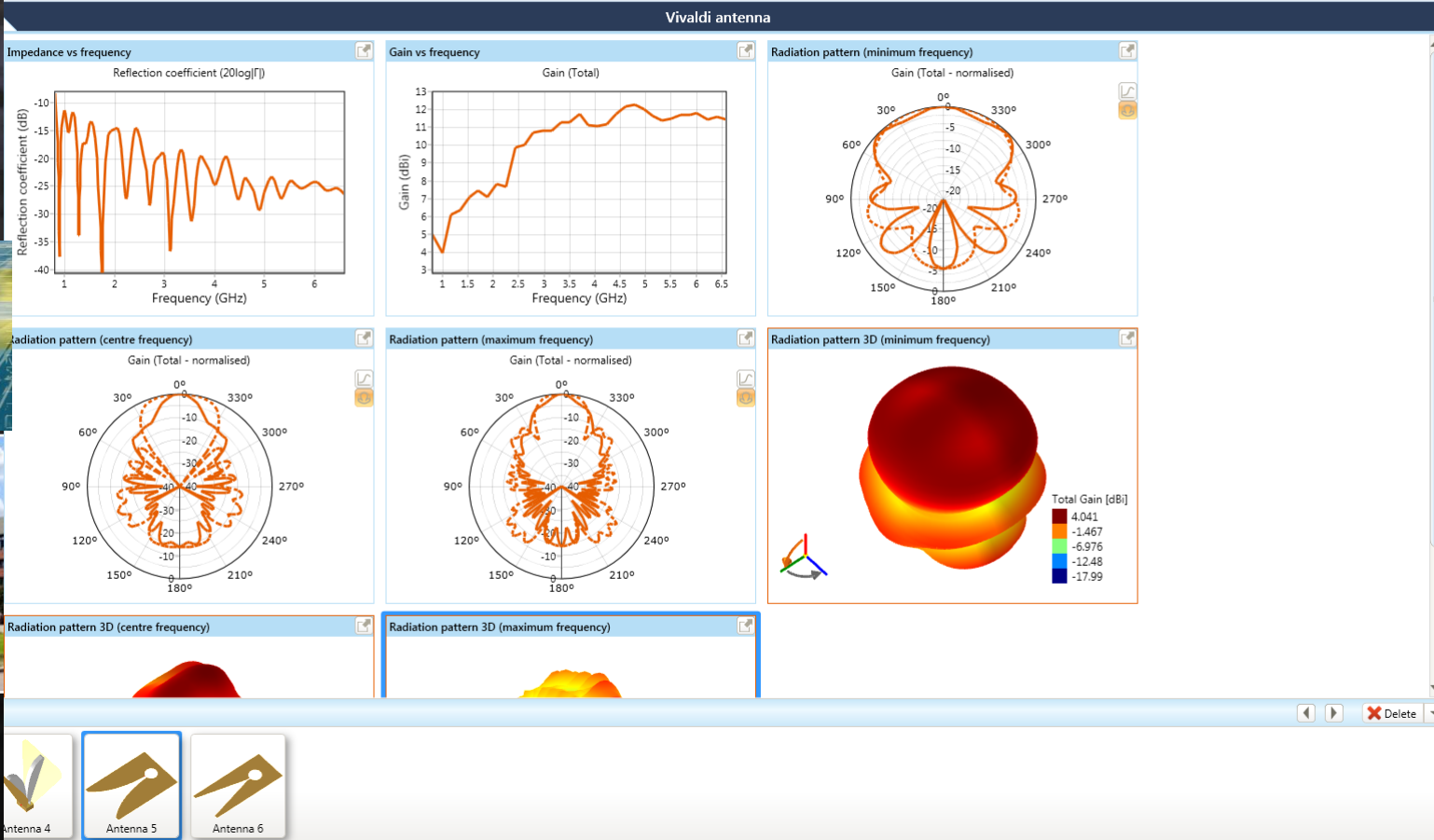
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Vivaldi antenna performance

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Log per. antenna design

Antenna Magus 4.5.1 (Professional)

Home Libraries Toolbox

Cut Copy Paste Edit Find Design Array Synthesis Open Info Browser Add to Info Browser Reference New Design Estimate Performance New Tweak Delete Design/Tweak Export Report Export Mode

Sketches and Design Guidelines Estimated Performance Planar log-periodic dipole array (LPDA)

Designs and Tweaks

- Design 7
- CST-new ant design 1 mrt 2014 Ver_1
- CST design 6 maart 2014 (versie 2)
- CST design 10 maart 2014 (versie 3)
- Design 37
- Group 38
- Design 38
- Design Objectives - Group 32

Design for: all options

f_0 : 3.5 GHz

bw : 150 %

G : 9 dBi

R_{in} : 50 Ω

Substrate

Name: RO3210

Substrate Thickness: 1.27 mm

Relative Permittivity: 10

New Design Design

Parameters - CST design 6 maart 2...

34

Sketches

Top view

$\tau = L_{n+1}/L_n$
 $\sigma = S_n/2L_n$

Side view

Model Preview

Design Guidelines

The original free-space design approach was proposed by Carrel. Subsequently, a number of corrections to his approach have been submitted. The free-space design approach followed in Magus is that of Peixeiro, adapted subsequently for the specified substrate.

- The gain may be increased (decreased) by increasing (decreasing) the number of elements and feed-line length.
- The gain ripple may be reduced by increasing the element widths.

Collection

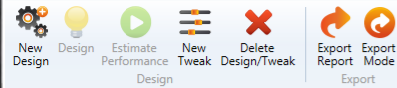
Antenna 1 Antenna 2 Antenna 3 Antenna 4

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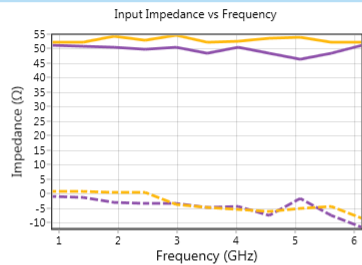
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Log per antenna performance

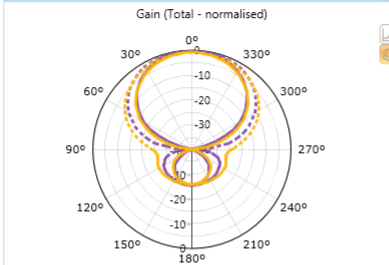


Planar log-periodic dipole array (LPDA)

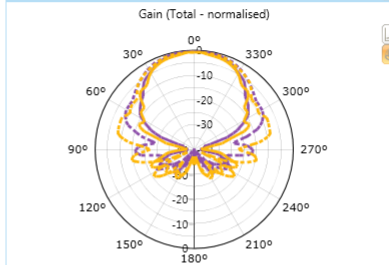
Impedance vs frequency



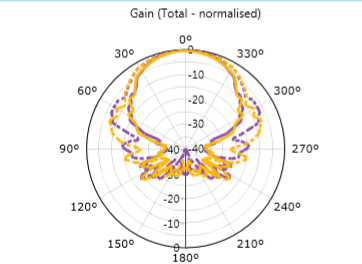
Radiation pattern at the minimum frequency



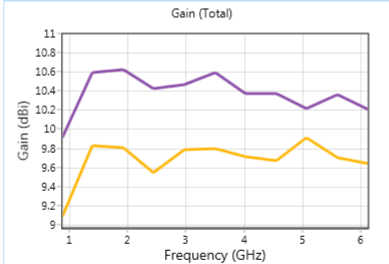
Radiation pattern at the centre frequency



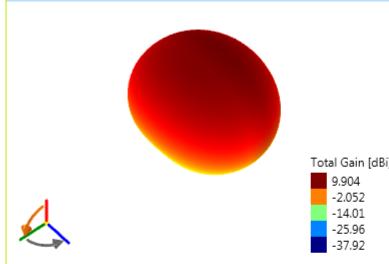
Radiation pattern at the maximum frequency



Gain vs frequency



Radiation pattern 3D (minimum frequency)



Radiation pattern 3D (centre frequency)



Radiation pattern 3D (maximum frequency)



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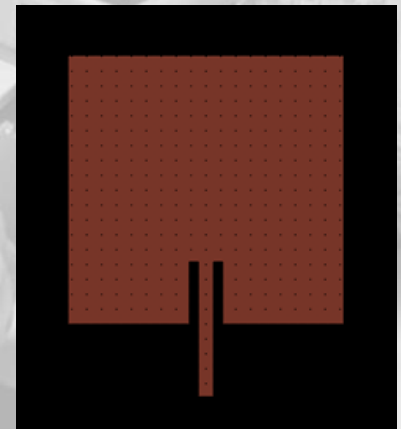


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Antenna parameters

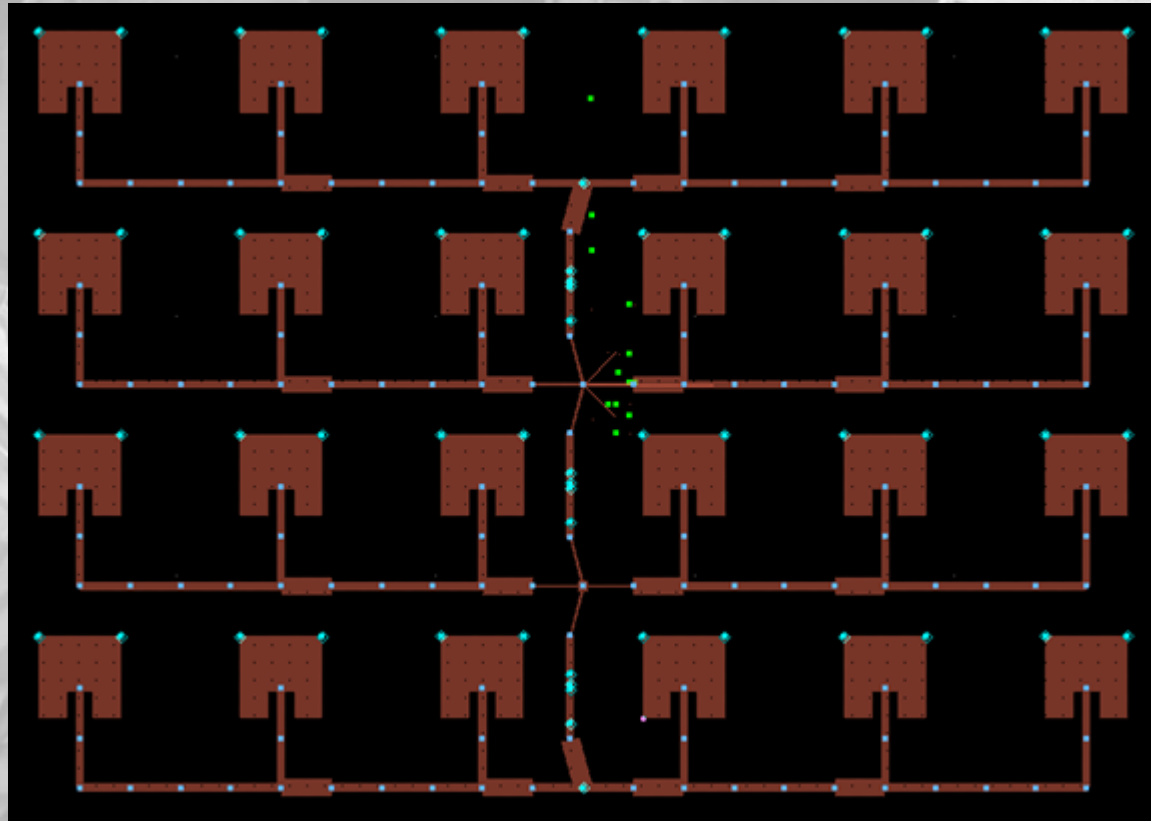
1 element patch antenna

- Antenna dimensions (0.5 wavelength)
- Antenna gain (height above GND)
- Powerbandwidth (NB / BB antenna's)
- Antenna polarization (H/V/RHC/LHC)
- Antenna impedance and matching
 - Insert
 - Quarter wave transformer
- Substrate height



Patch antenna simulations (2D)

- 24 element patch antenna array (Vertical)



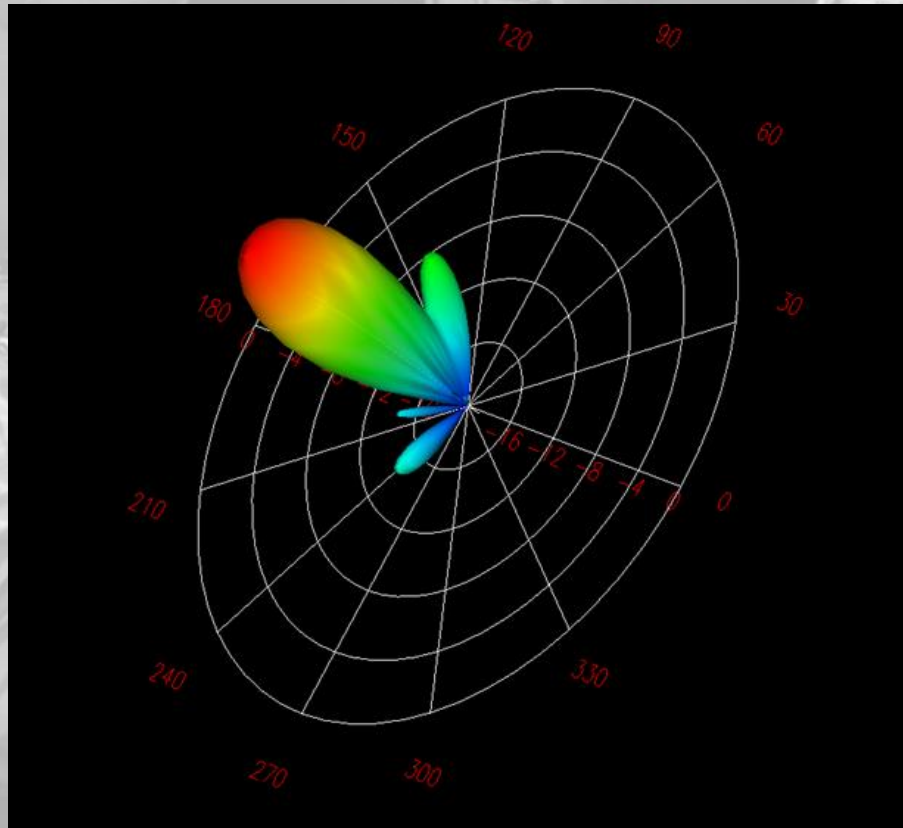
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Radiation pattern

- 24 element patch antenna array (Vertical)



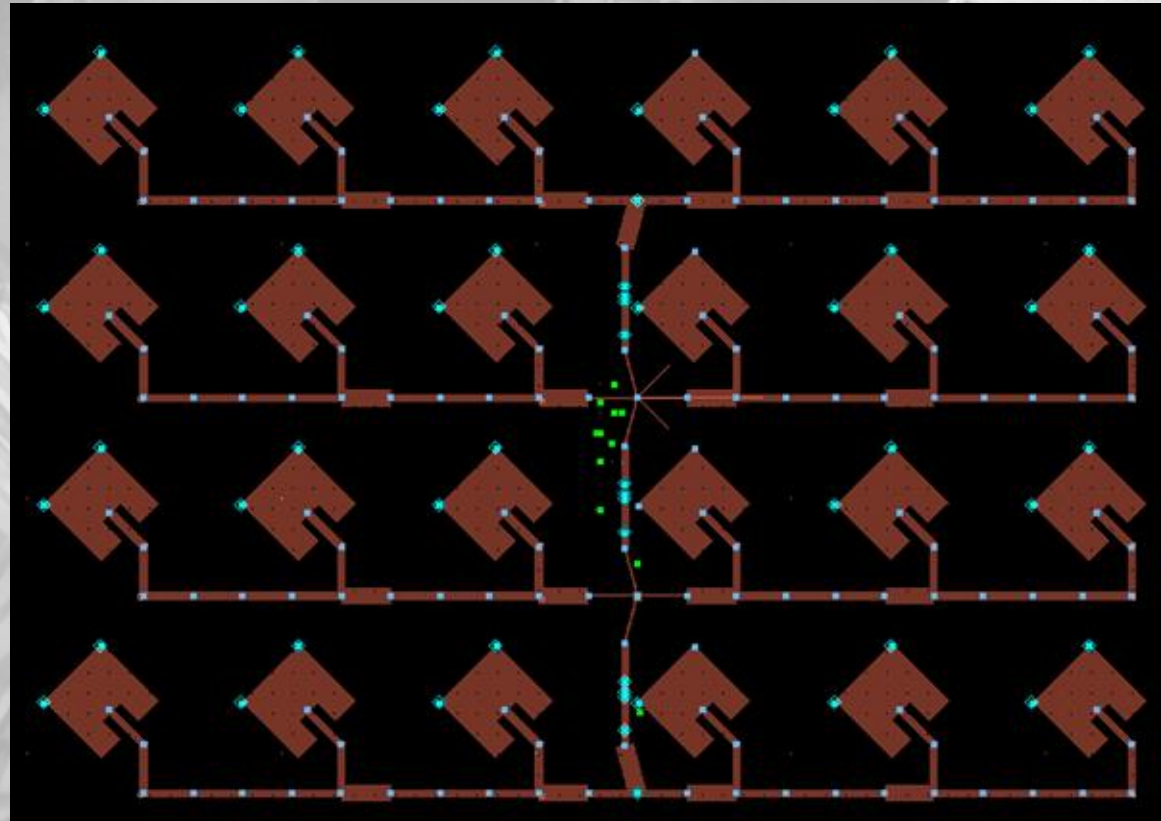
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Optimum polarity

- 24 element patch antenna array (Diagonal)



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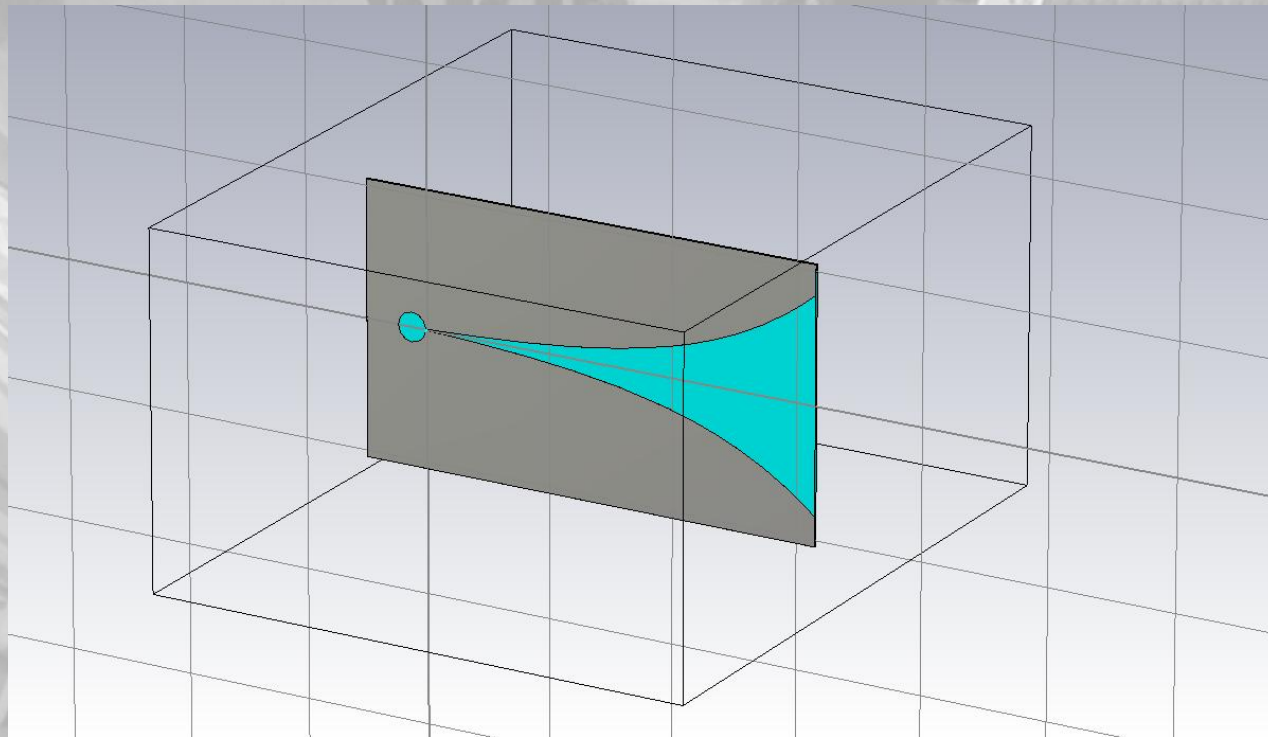


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Vivaldi simulations (3D)

- 1 element Vivaldi



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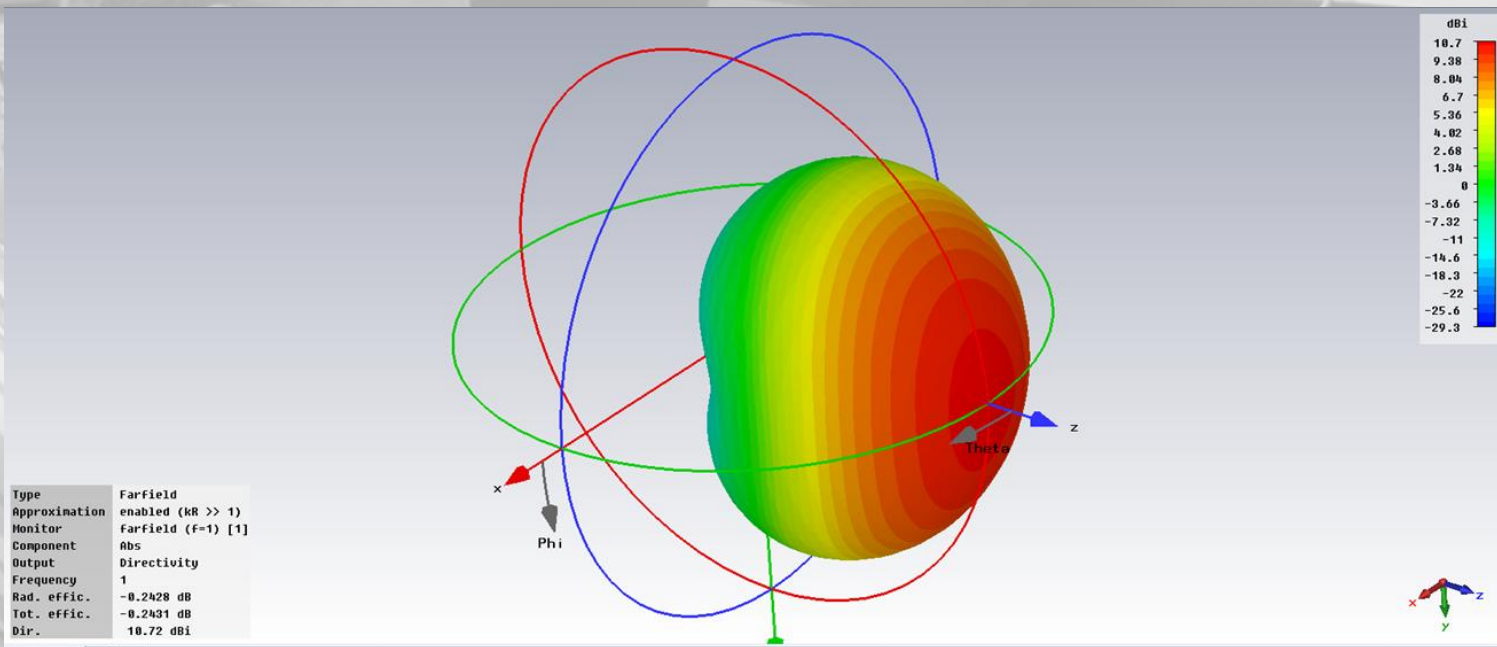


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Radiation pattern

- 1 GHz Vivaldi performance



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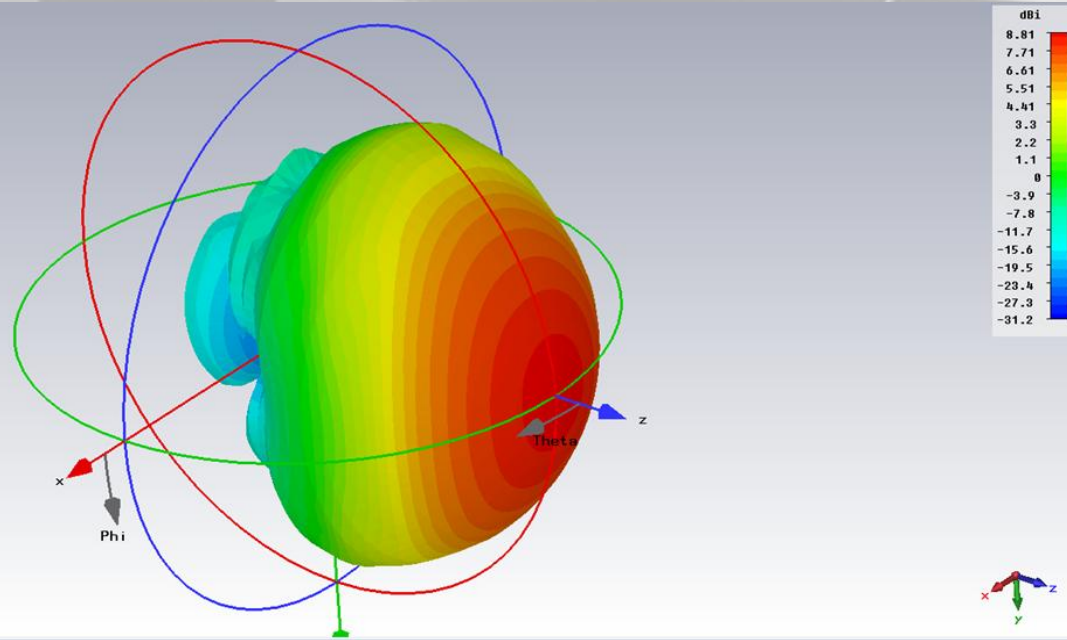


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CST Design studio

- 6 GHz Vivaldi performance



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Antenna array simulations

- Electrical small antenna arrays
- Distance between array elements

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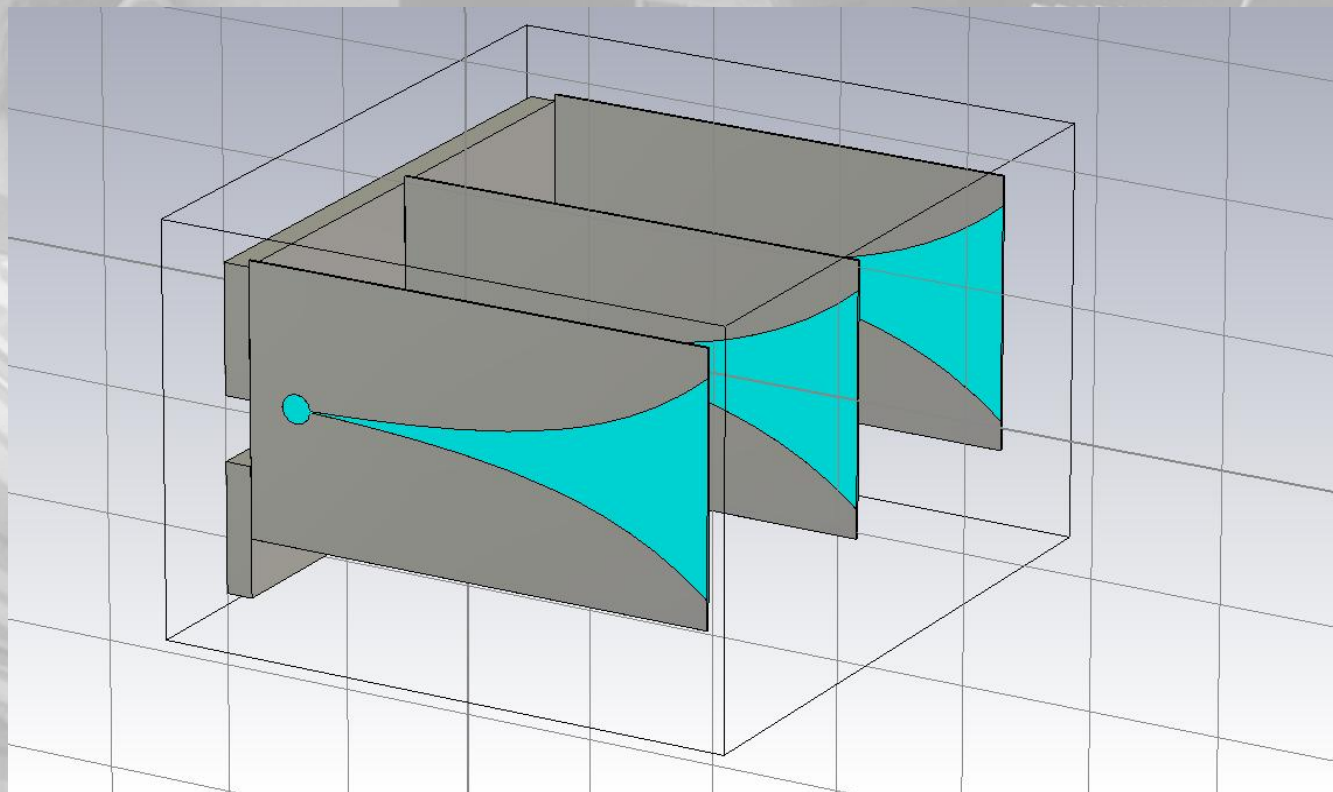


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Vivaldi array

- 3 element Vivaldi array



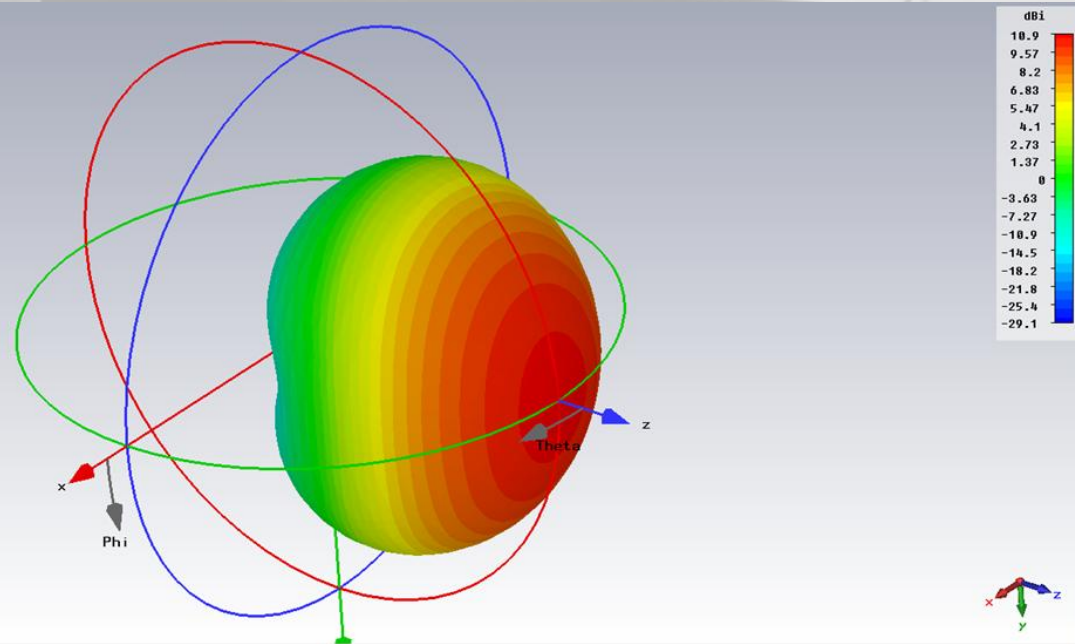
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Vivaldi array

- Radiation pattern @ 1 GHz



Type	Farfield (Array)
Approximation	enabled ($kR \gg 1$)
Monitor	Farfield ($f=1$) [1]
Component	Abs
Output	Directivity
Frequency	1
Rad. effic.	-0.2428 dB
Tot. effic.	-0.2431 dB
Dir.	10.93 dBi

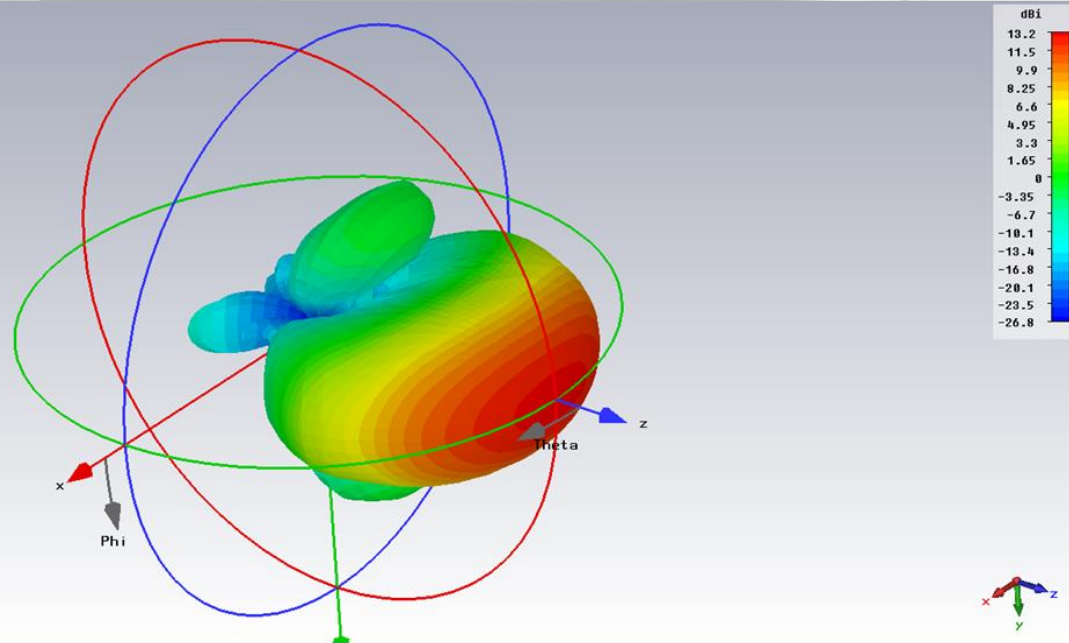
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Vivaldi array

- Radiation pattern @ 6 GHz



Type	Farfield (Array)
Approximation	enabled (kR >> 1)
Monitor	farfield (f=6) [1]
Component	Abs
Output	Directivity
Frequency	6
Rad. effic.	-0.1689 dB
Tot. effic.	-0.2083 dB
Dir.	13.20 dBi

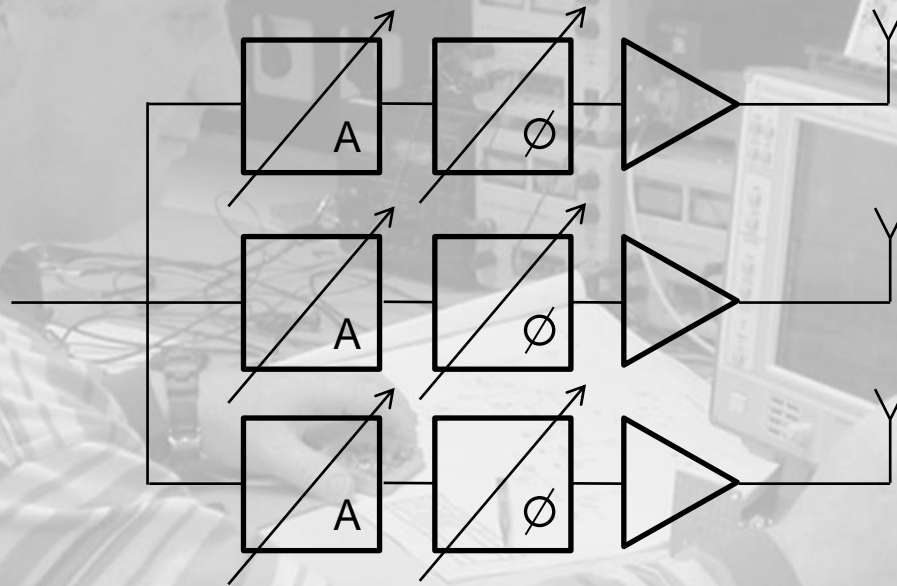
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Electronic beam shaping

- Block diagram



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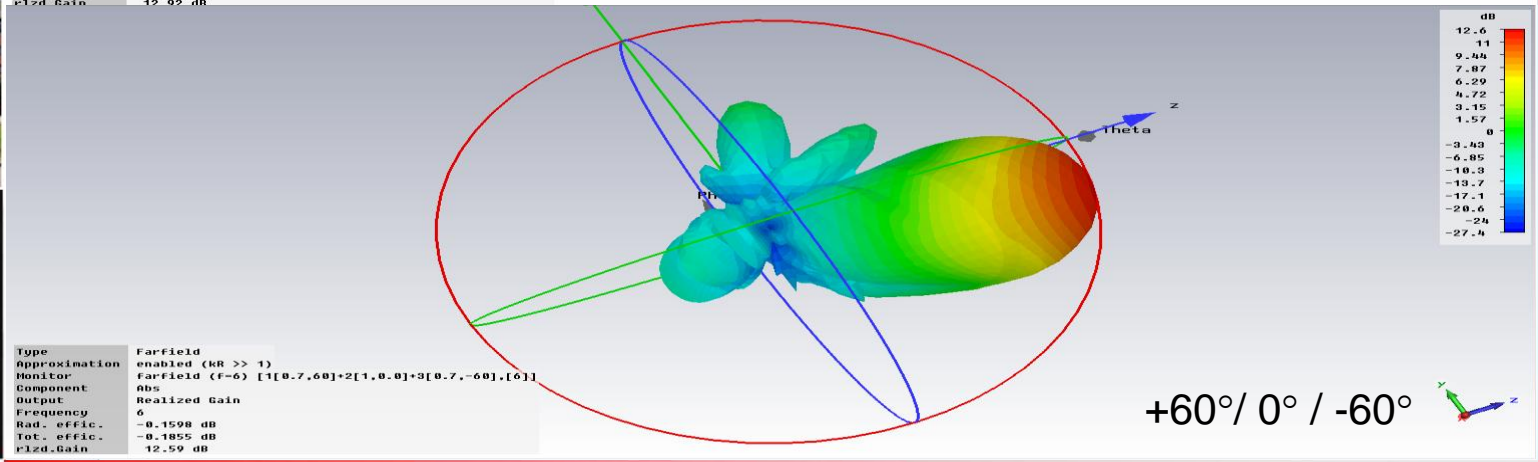
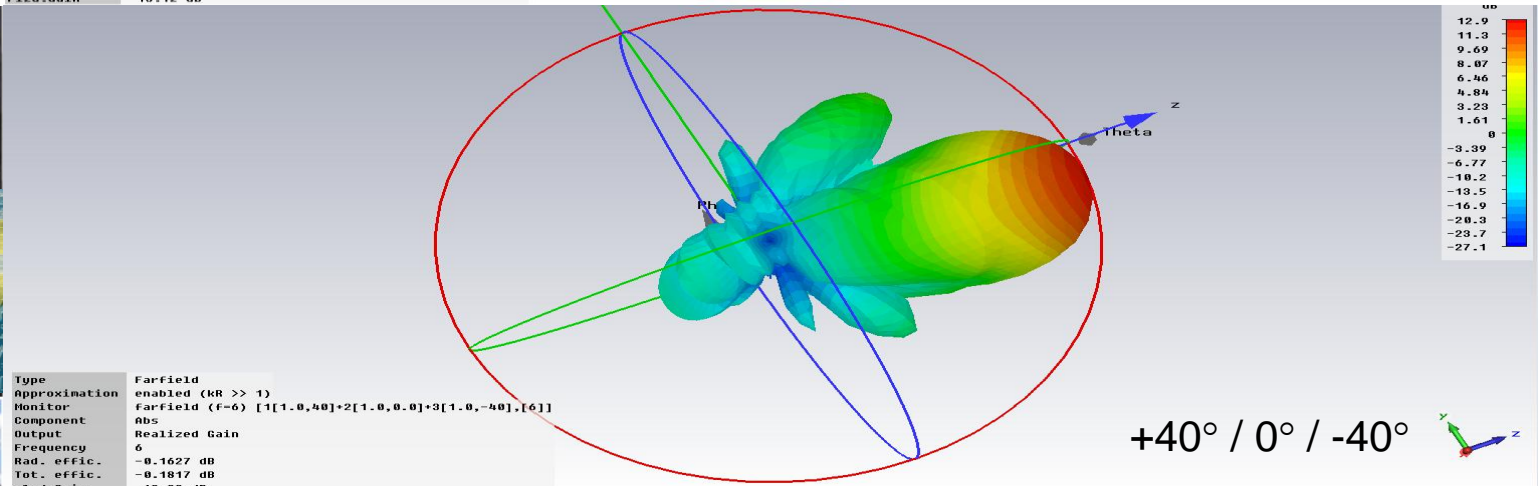
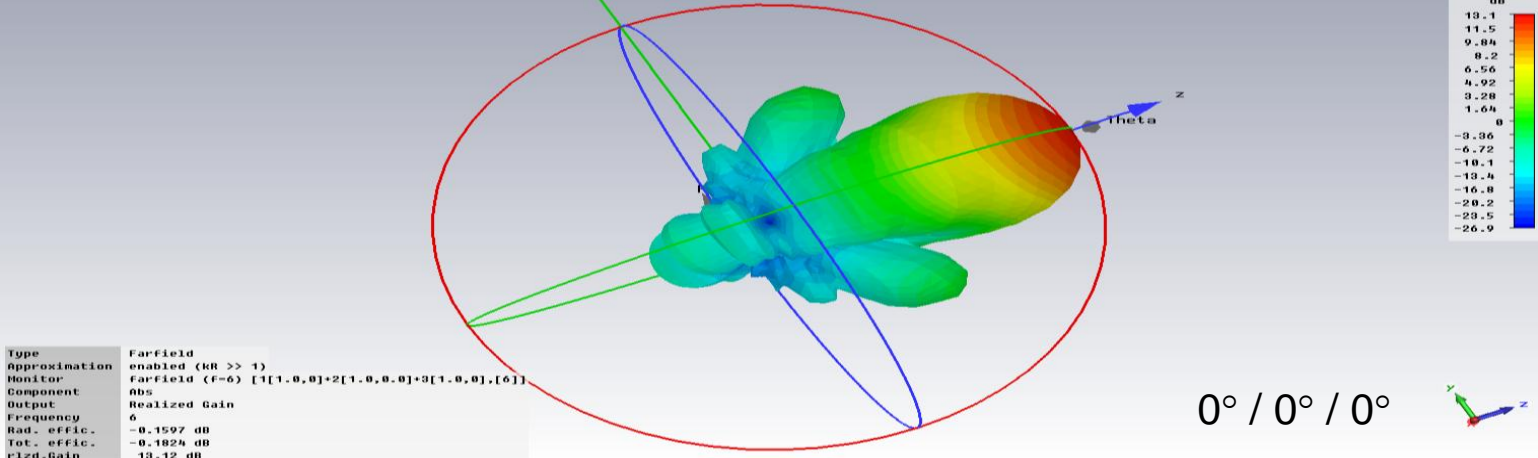
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Questions

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