Antenna design considerations

A quick overview

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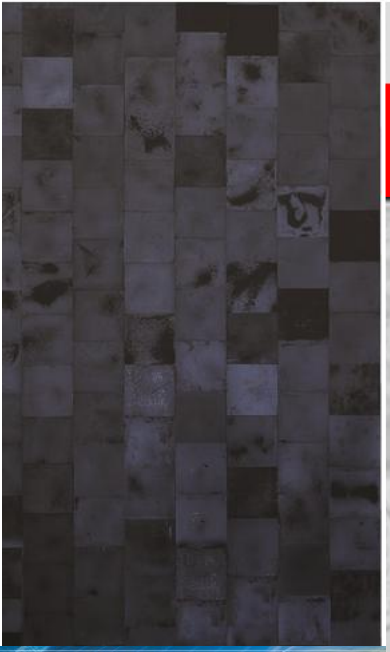
P. Dijkstra



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 antennes
  - Vivaldi antennes
  - Log per antennes
- 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)

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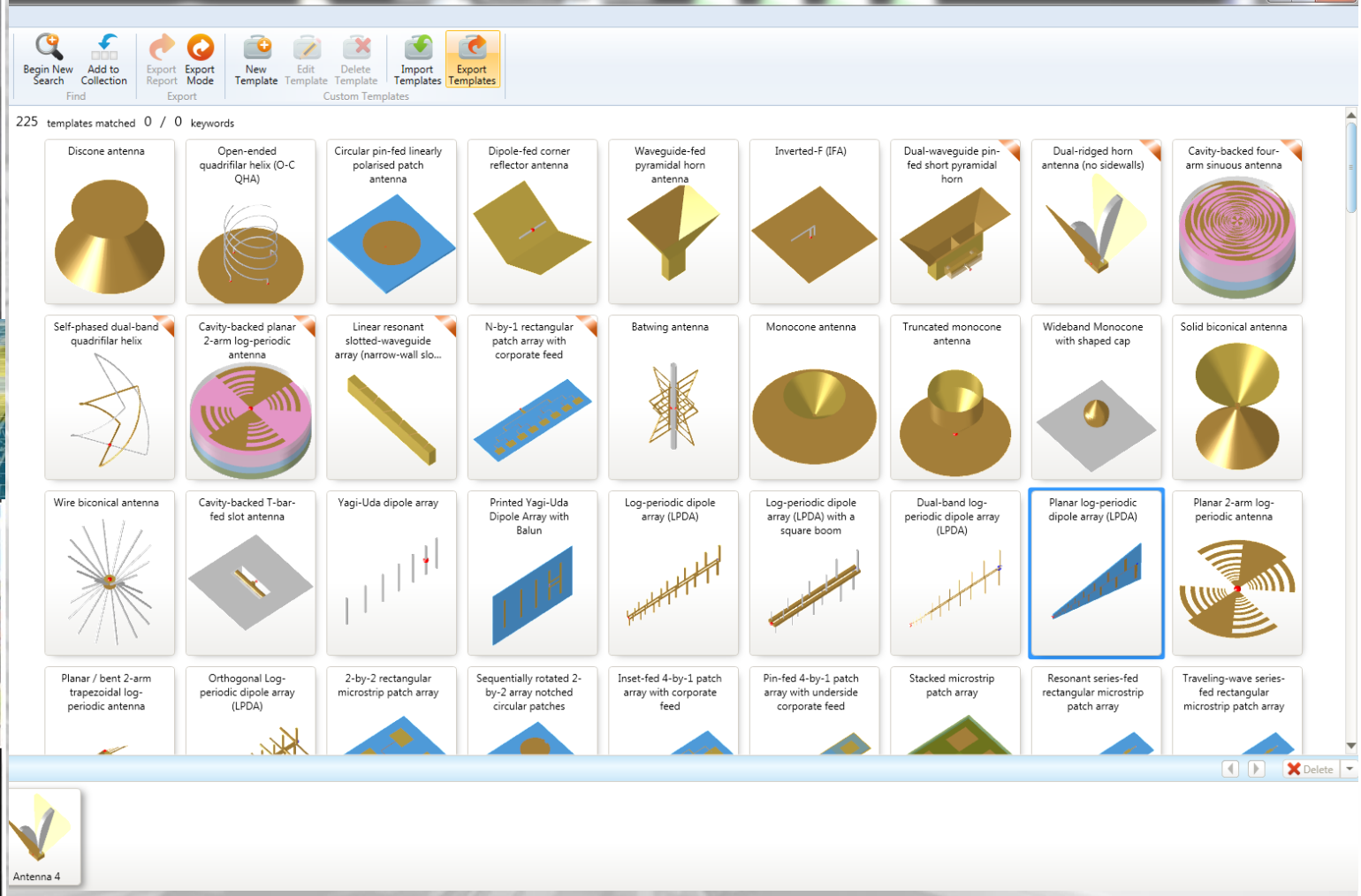
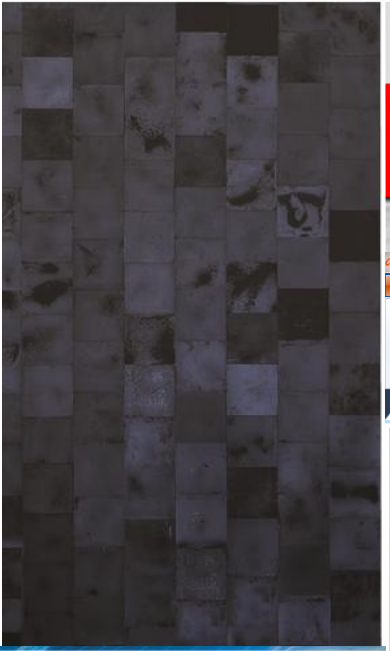
Measure the Difference

Antenna selection



Vivaldi antenna design



Antenna Magus 4.5.1 (Professional)

Home | Libraries | Toolbox

Cut | Copy | Paste | Edit

Find | Design | Array Synthesis | Magus

Open Info Browser | Add to Info Browser | Reference

New Design | Design | Estimate Performance | New Tweak | Delete Design/Tweak | Design

Export Report | Export Mode | Export

Sketches and Design Guidelines | Estimated Performance

Vivaldi antenna

Designs and Tweaks

Design 2

Design 3

Design Objectives - Group 3

fmin	750 MHz
fmax	4 GHz

New Design | Design

Parameters - Design 3

Hf	219.8 mm
Lf	419.7 mm
Hc	279.8 mm
Ws	2.667 mm
Dc	79.94 mm
Sc	79.94 mm
Sf	4 mm
Ls	8 mm
Ft	7.5

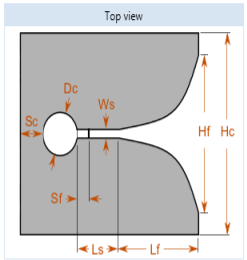
New Tweak | Estimate Performance

Derived Quantities - Design 3

X	0 m

Sketches

Top view



Model Preview

Design Guidelines

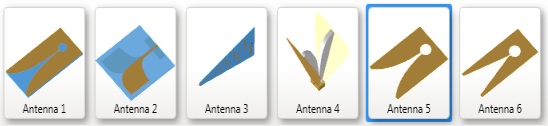
Magus designs a Vivaldi antenna in free space which provides a good impedance match when referenced to 150Ω.

The upper frequency objective in Magus only specifies the upper boundary of the frequency range over which the antenna performance will be estimated. It is not the upper cut-off frequency of the antenna.

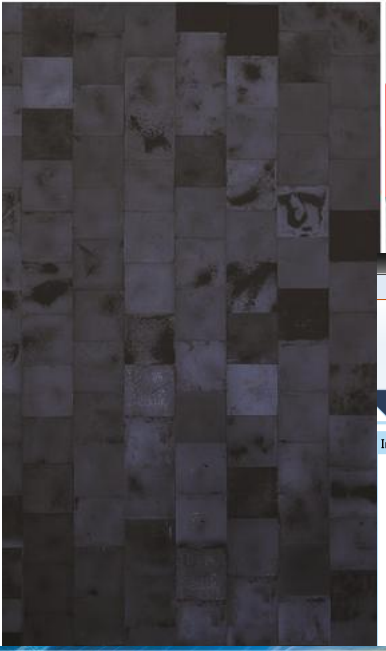
- The flare height should be greater or equal to a half-wavelength at the minimum operating frequency.
- The flare length should be greater or equal to a wavelength at the minimum operating frequency.
- The beamwidth decreases and the directivity increases as the flare length is increased.
- To decrease (increase) the input impedance, decrease (increase) the slotline width.
- The taper factor as defined in [Sutinjo et al] and [Shin et al] influences the impedance match and beamwidths.
- The cavity diameter should be ≈ 0.2λ at the minimum operating frequency.

Collection

Delete



Vivaldi antenna performance



Vivaldi antenna

Impedance vs frequency

Reflection coefficient (20log|Γ|)

Reflection coefficient (dB)

Frequency (GHz)

Gain vs frequency

Gain (Total)

Gain (dBi)

Frequency (GHz)

Radiation pattern (minimum frequency)

Gain (Total - normalised)

Radiation pattern (centre frequency)

Gain (Total - normalised)

Radiation pattern (maximum frequency)

Gain (Total - normalised)

Radiation pattern 3D (minimum frequency)

Total Gain [dBi]
4.041
-1.467
-6.976
-12.48
-17.99

Radiation pattern 3D (centre frequency)

Radiation pattern 3D (maximum frequency)

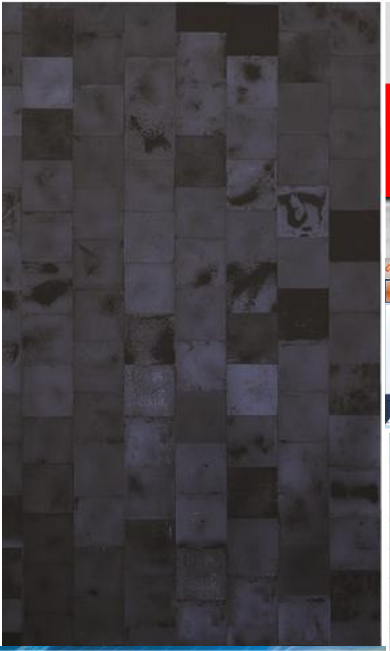
Delete

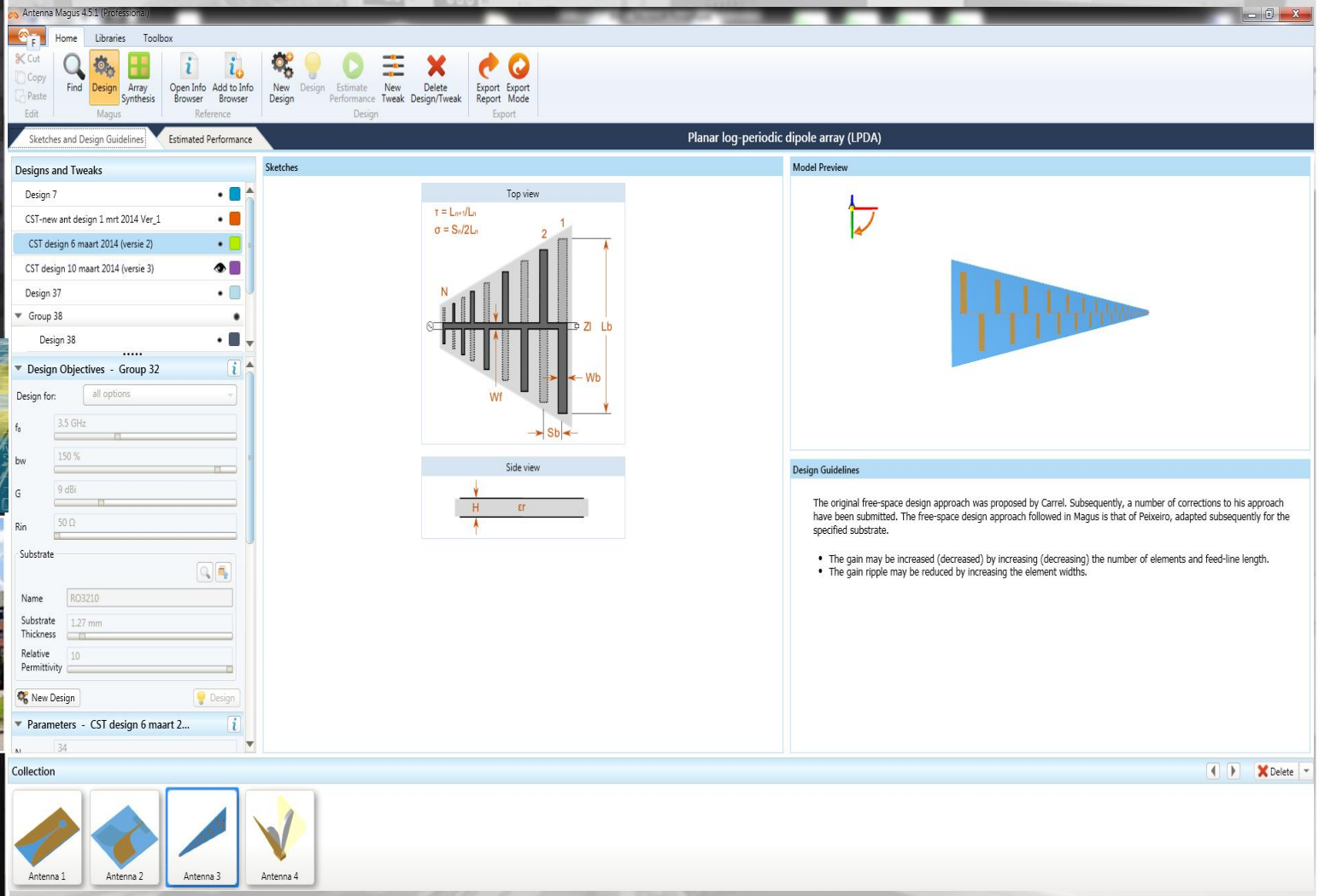
Antenna 4

Antenna 5

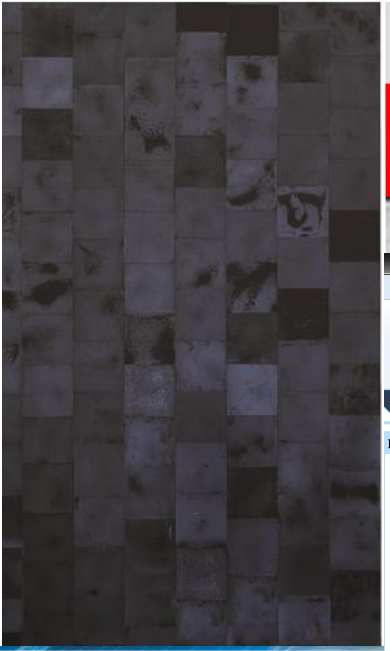
Antenna 6

Log per. antenna design





Log per antenna performance



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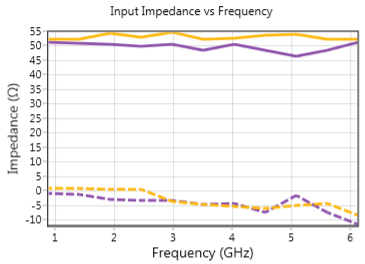
DARE!!
Measure the Difference

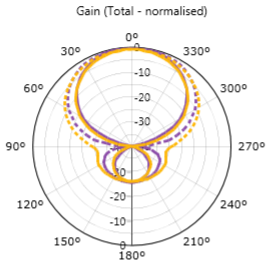
New Design | Design | Estimate Performance | New Tweak | Delete Design/Tweak — Design
Export Report | Export Mode — Export

Planar log-periodic dipole array (LPDA)

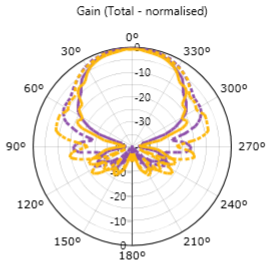
Impedance vs frequency



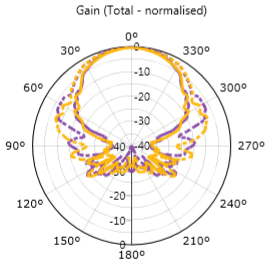
Radiation pattern at the minimum frequency



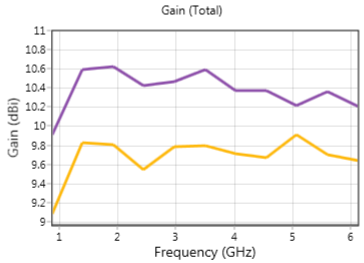
Radiation pattern at the centre frequency



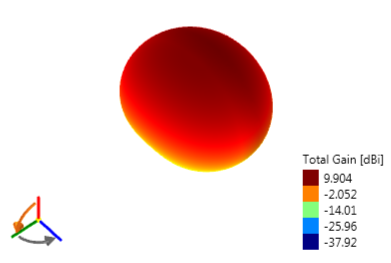
Radiation pattern at the maximum frequency



Gain vs frequency



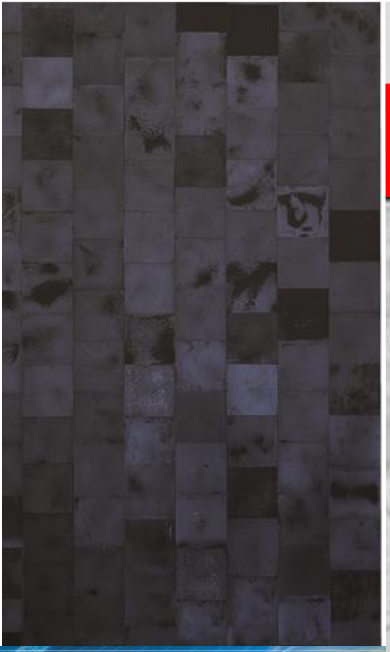
Radiation pattern 3D (minimum frequency)



Radiation pattern 3D (centre frequency)

Radiation pattern 3D (maximum frequency)

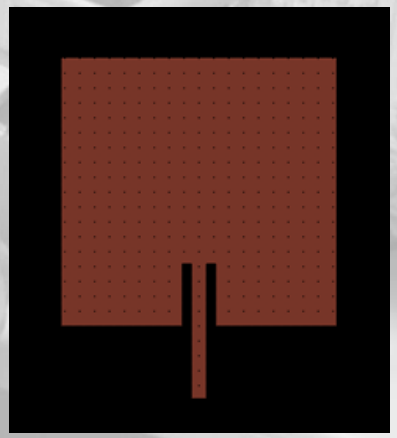
Delete

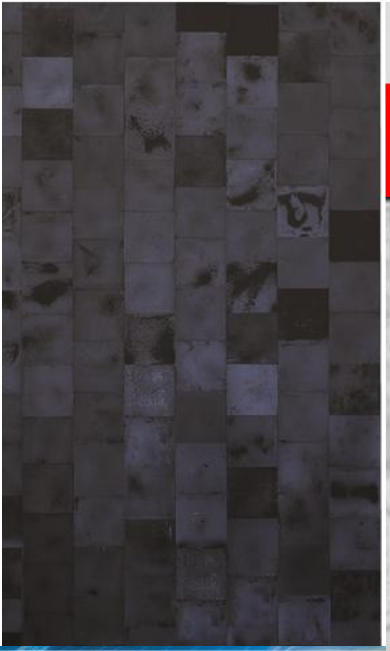


Antenna parameters

1 element patch antenna

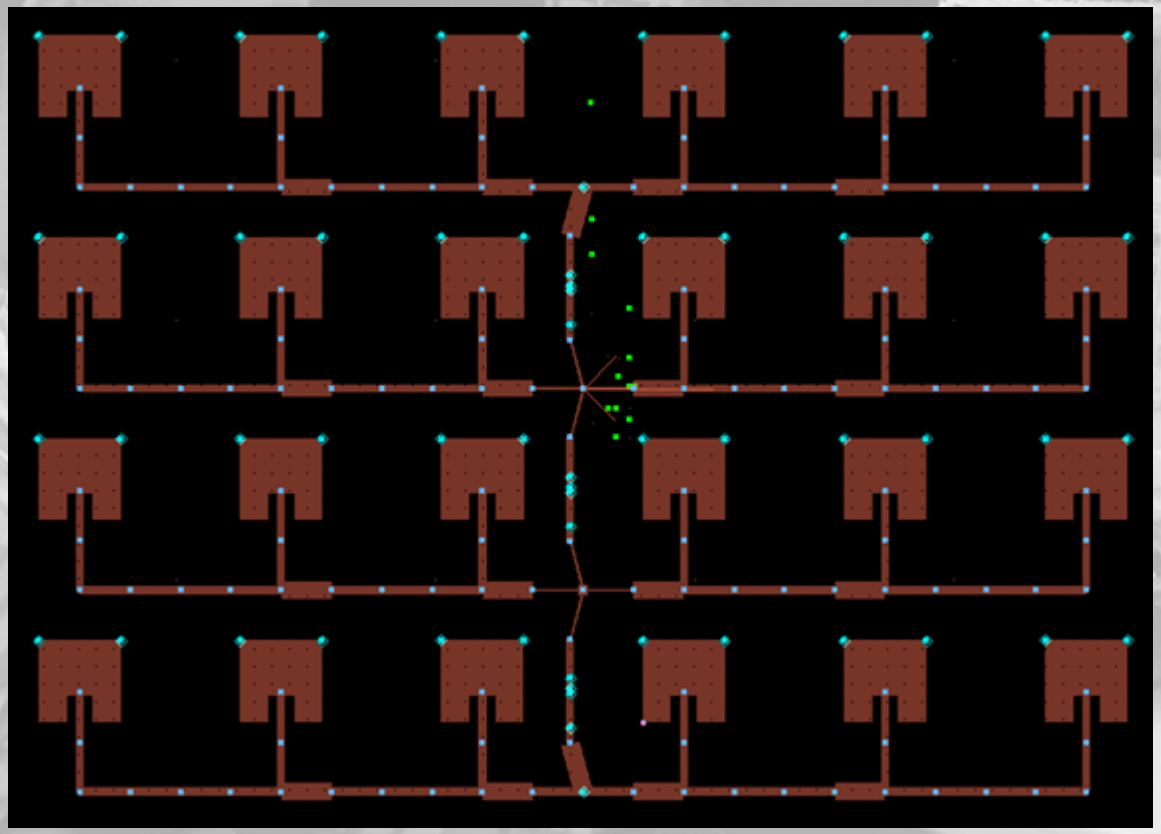
- Antenna dimensions (0.5 wavelength)
- Antenna gain (height above GND)
- Powerbandwidth (NB / BB antenna's)
- Antenna polarization (H/V/RHC/LHC)
- Antenna impedance and matching
  - Insert
  - Quarter wave transformer
- Substrate height





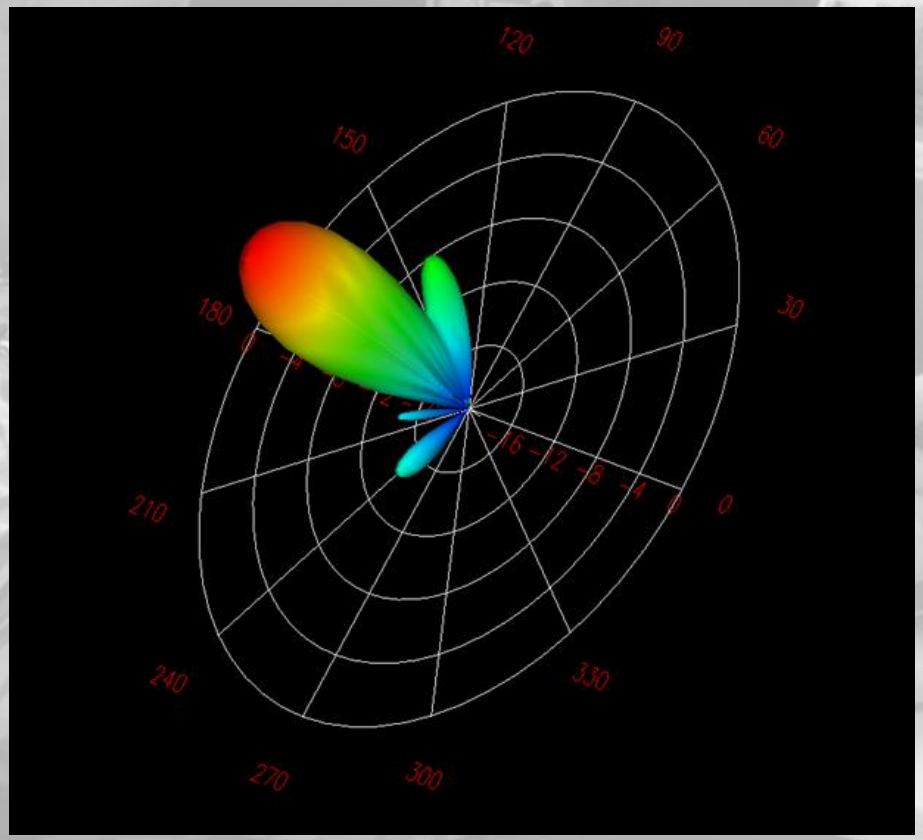
Patch antenna simulations (2D)

- 24 element patch antenna array (Vertical)



Radiation pattern

- 24 element patch antenna array (Vertical)



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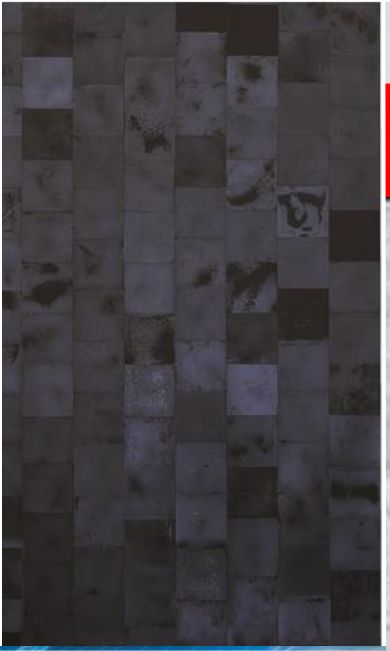
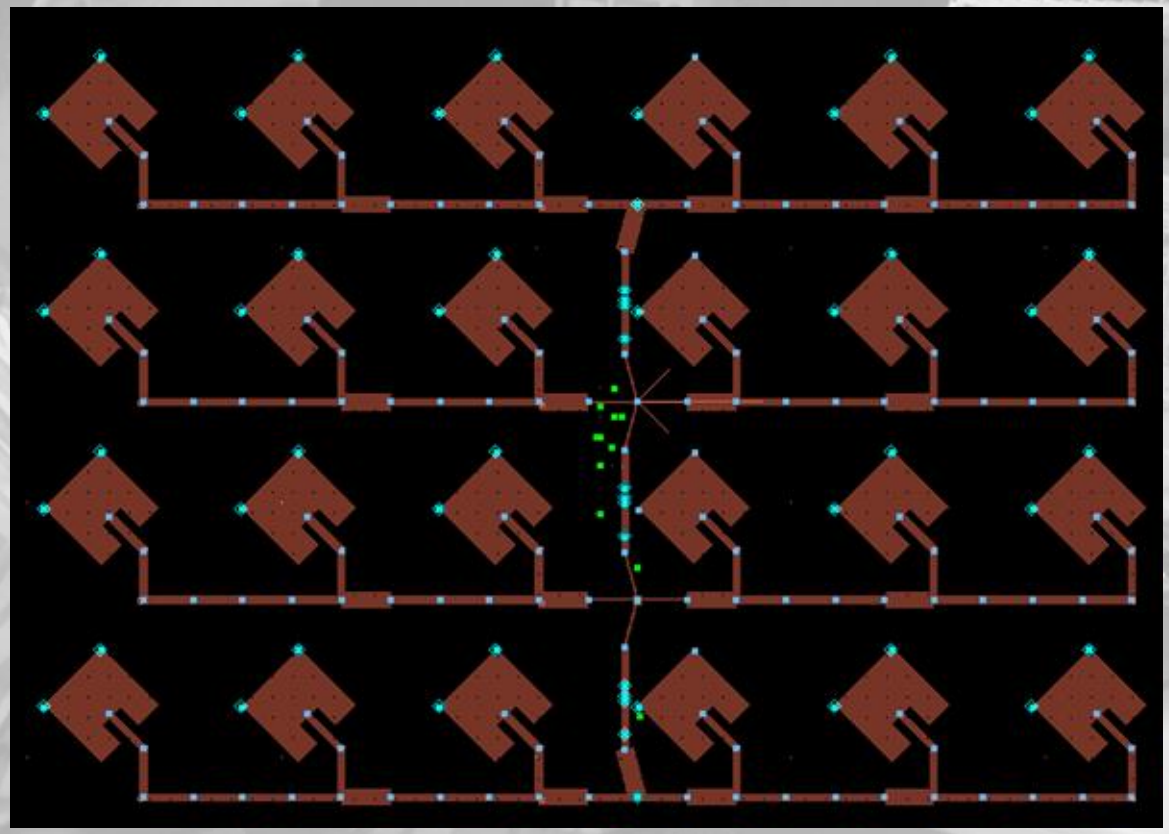


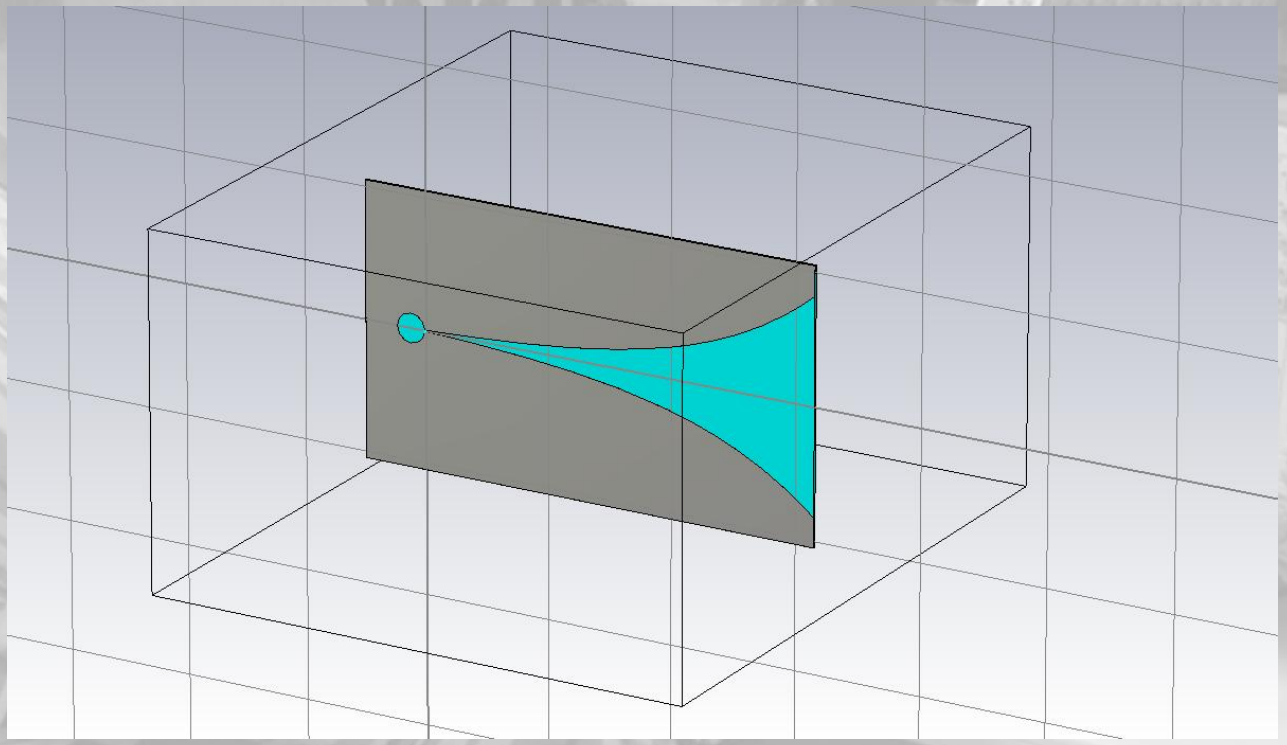
Optimum polarity

- 24 element patch antenna array (Diagonal)



Vivaldi simulations (3D)

- 1 element Vivaldi



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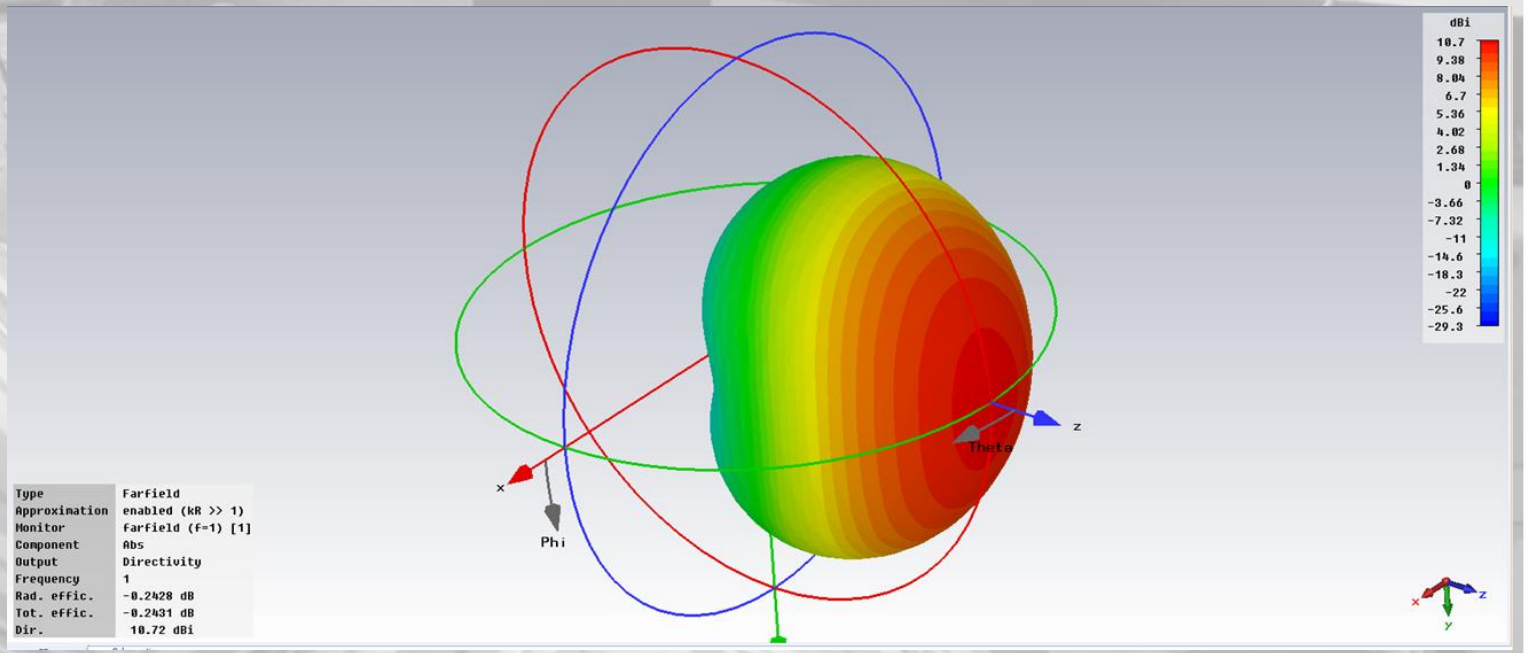
Measure the Difference

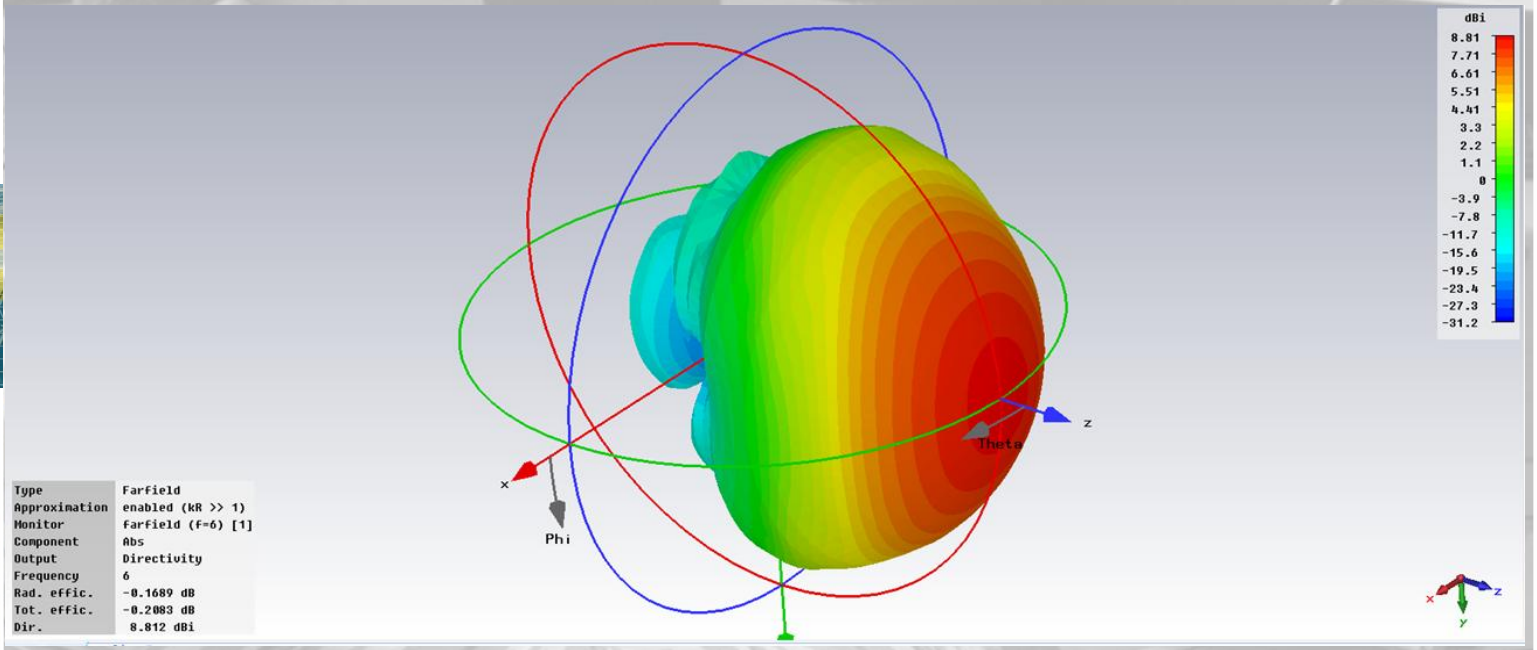
Radiation pattern

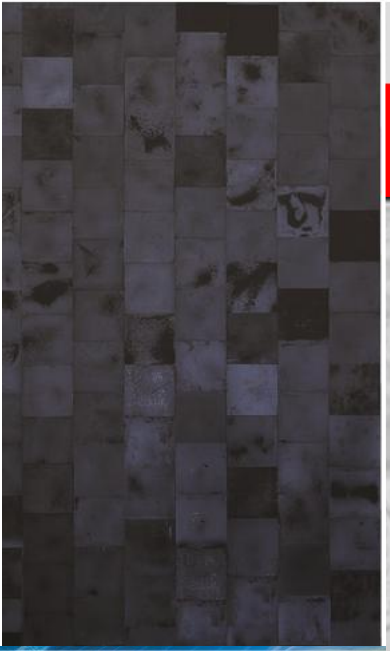
- 1 GHz Vivaldi performance



CST Design studio

- 6 GHz Vivaldi performance



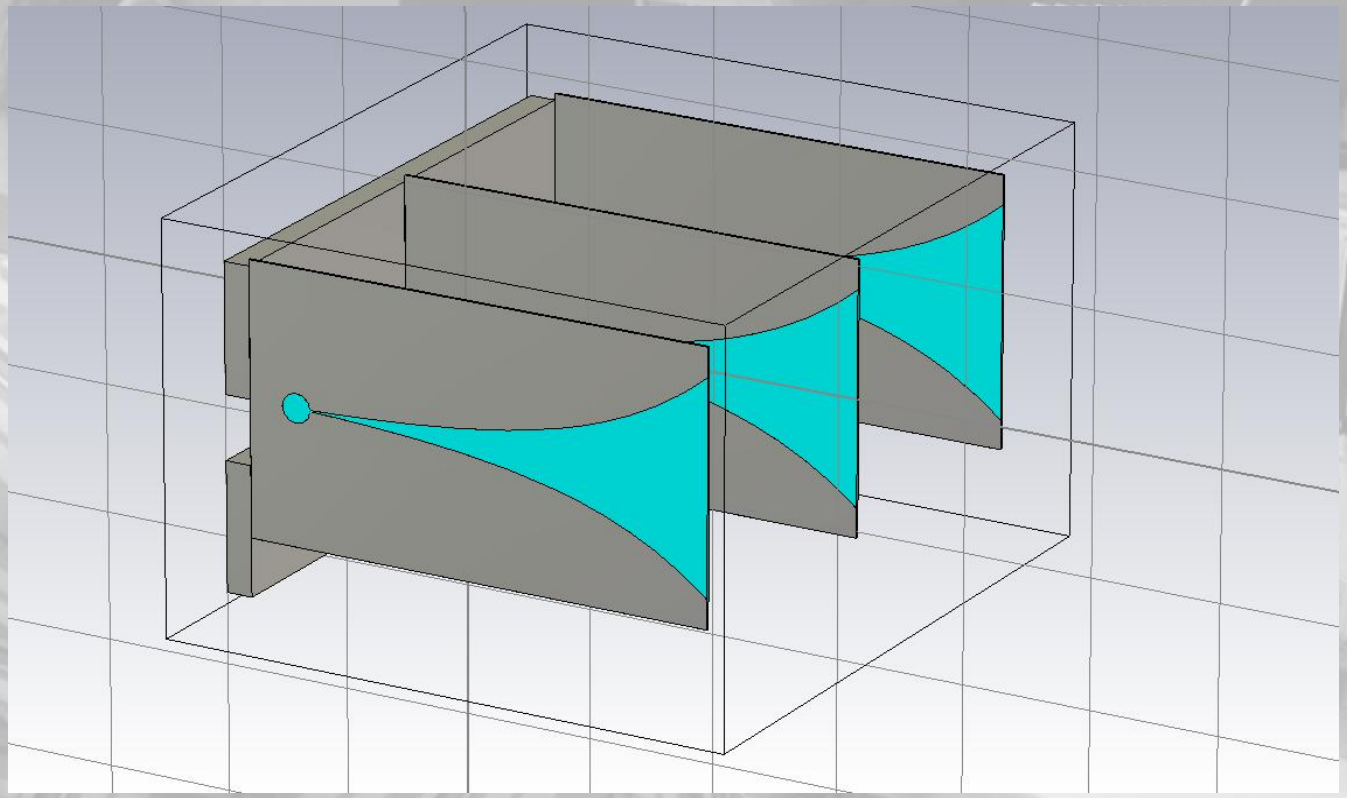


Antenna array simulations

- Electrical small antenna arrays
- Distance between array elements

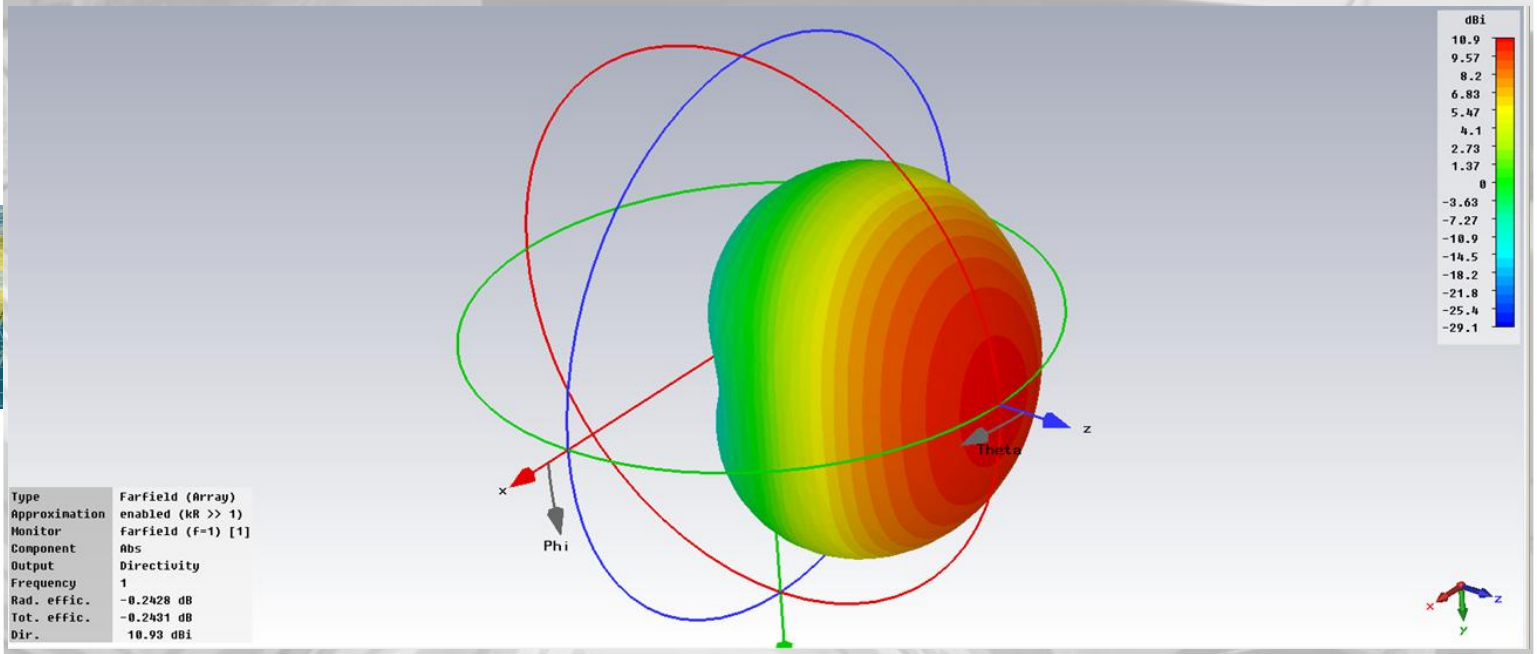
Vivaldi array

- 3 element Vivaldi array



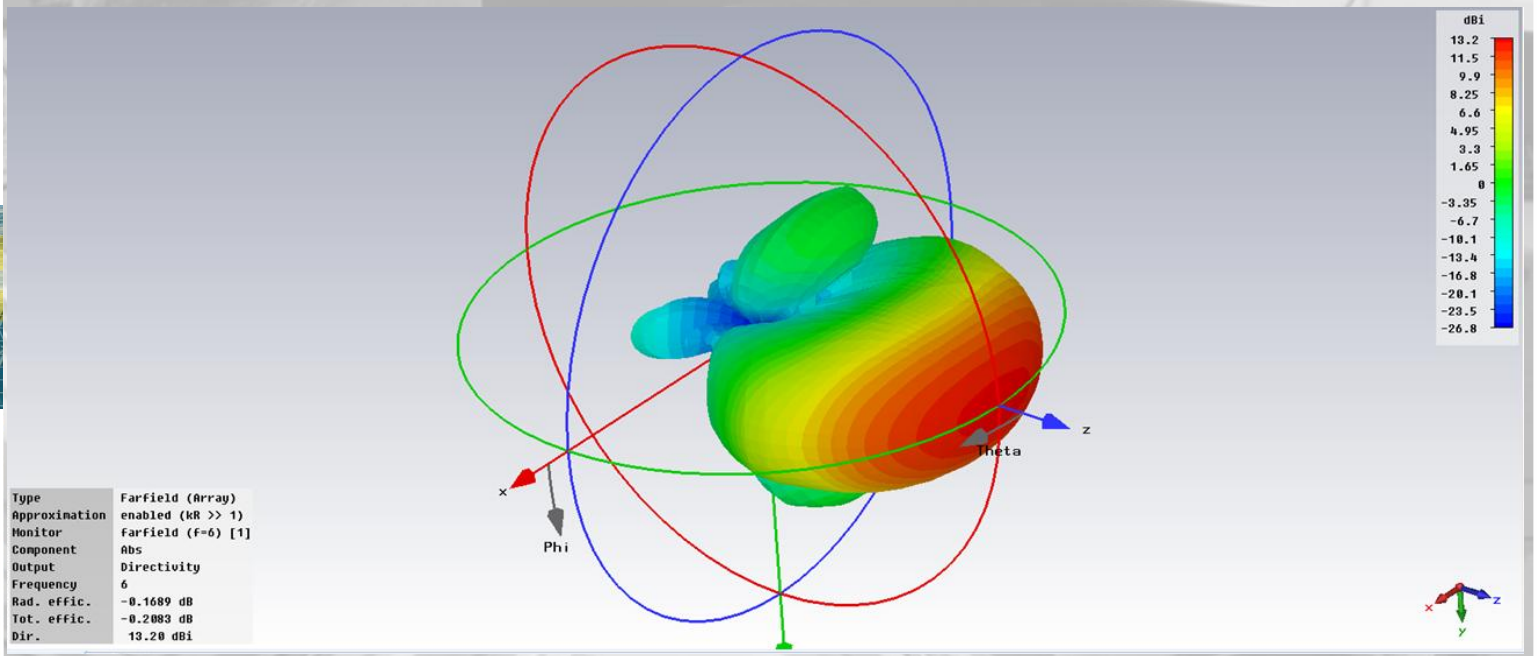
Vivaldi array

- Radiation patern @ 1 GHz



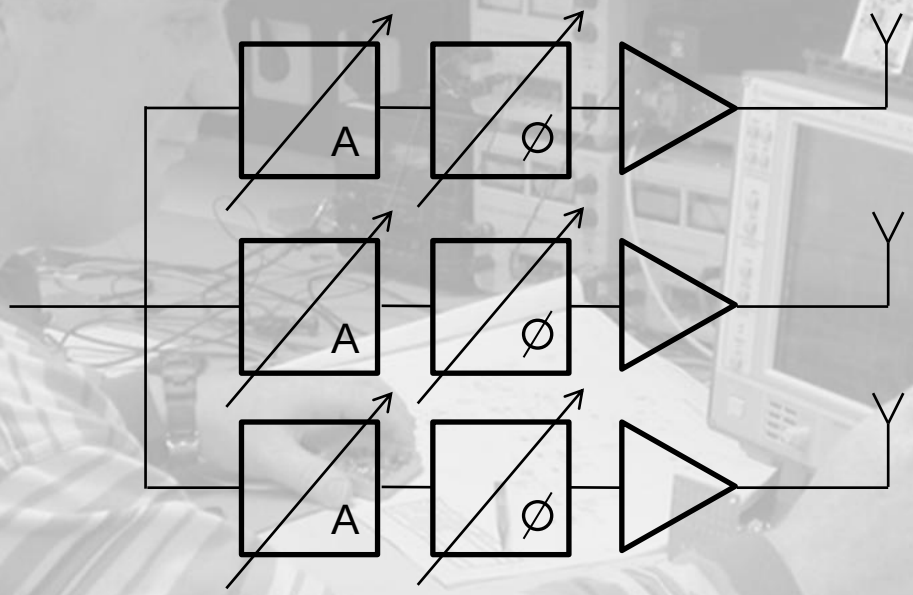
Vivaldi array

- Radiation patern @ 6 GHz



Electronic beam shaping

- Block diagram



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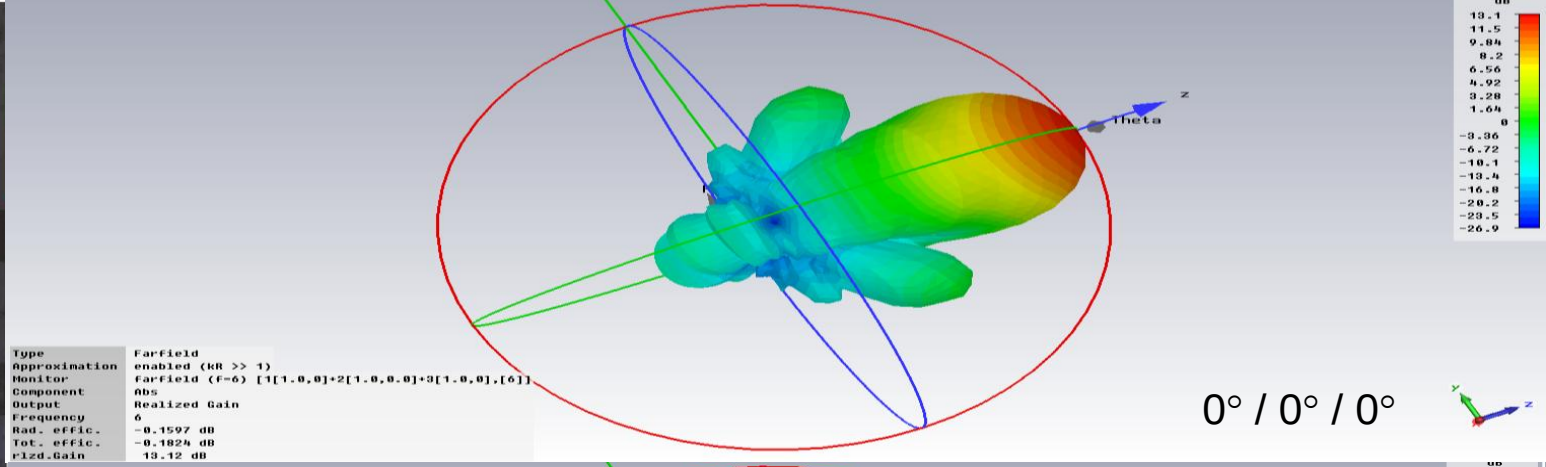
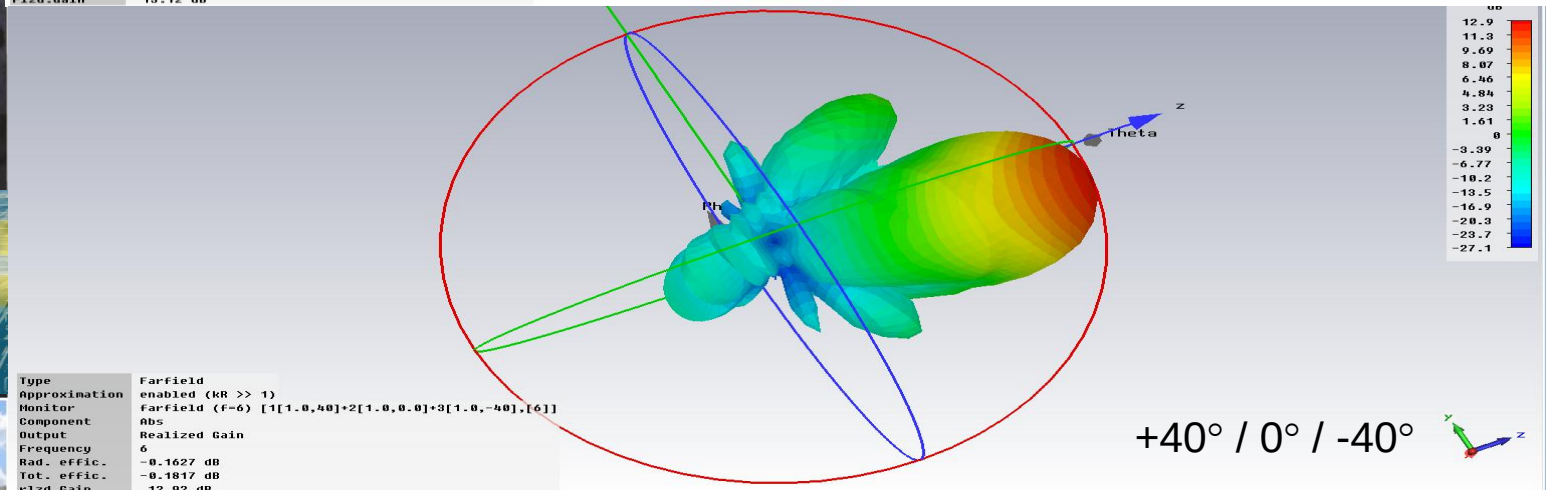


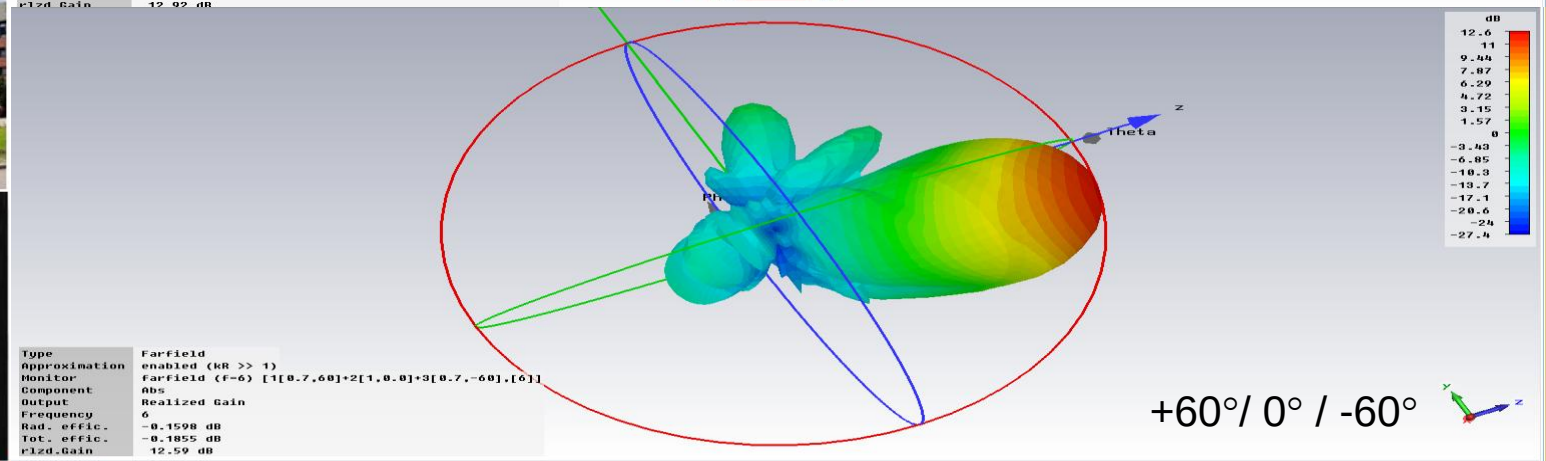
Type	Farfield
Approximation	enabled (kR >> 1)
Monitor	farfield (f=6) [1[1.0,0]+2[1.0,0.0]+3[1.0,0],[6]]
Component	Abs
Output	Realized Gain
Frequency	6
Rad. effic.	-0.1597 dB
Tot. effic.	-0.1824 dB
Rlzd.Gain	13.12 dB

0° / 0° / 0°



Type	Farfield
Approximation	enabled (kR >> 1)
Monitor	farfield (f=6) [1[1.0,40]+2[1.0,0.0]+3[1.0,-40],[6]]
Component	Abs
Output	Realized Gain
Frequency	6
Rad. effic.	-0.1627 dB
Tot. effic.	-0.1817 dB
Rlzd.Gain	12.92 dB

+40° / 0° / -40°



Type	Farfield
Approximation	enabled (kR >> 1)
Monitor	farfield (f=6) [1[0.7,60]+2[1,0.0]+3[0.7,-60],[6]]
Component	Abs
Output	Realized Gain
Frequency	6
Rad. effic.	-0.1598 dB
Tot. effic.	-0.1855 dB
Rlzd.Gain	12.59 dB

+60°/ 0° / -60°

Questions

Any questions?