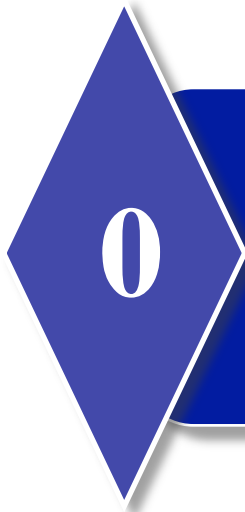


Antenna Design Process with Examples

Tchanguiz RAZBAN

Tomsk December 2017

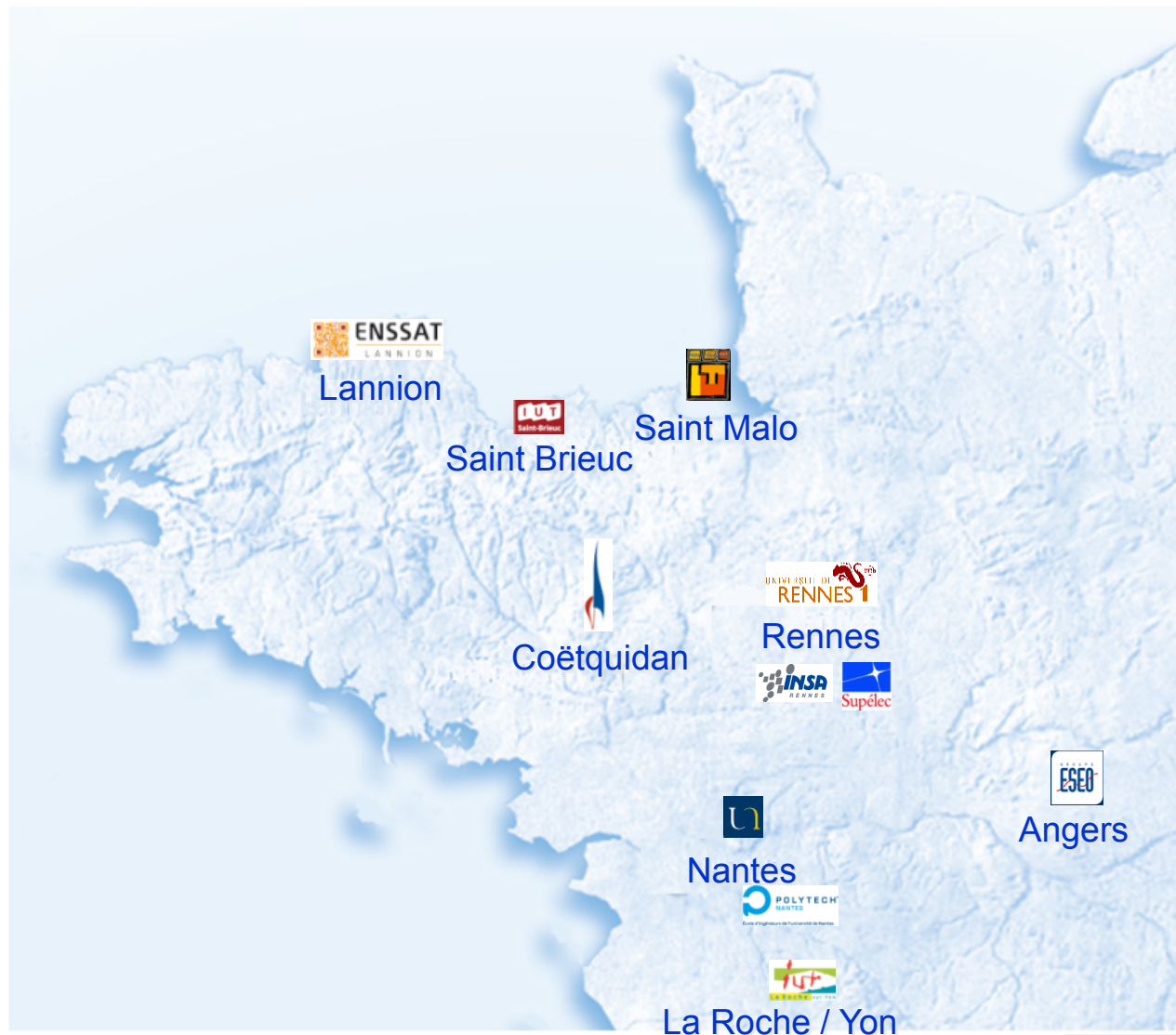
- 0 Presentation of IETR (our Lab)
- 1 Wide Band Dual-Polarized Antenna
- 2 Satellite Receiver Antenna
- 3 Transparent Antenna
- 4 Reduced Size Base-Station Antenna

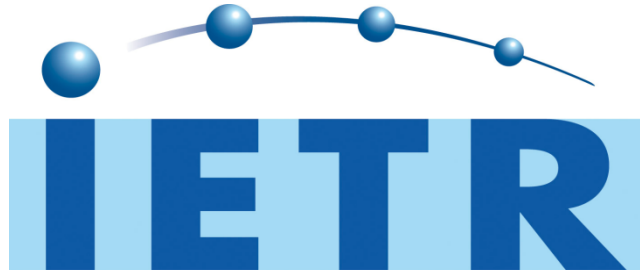


IETR:

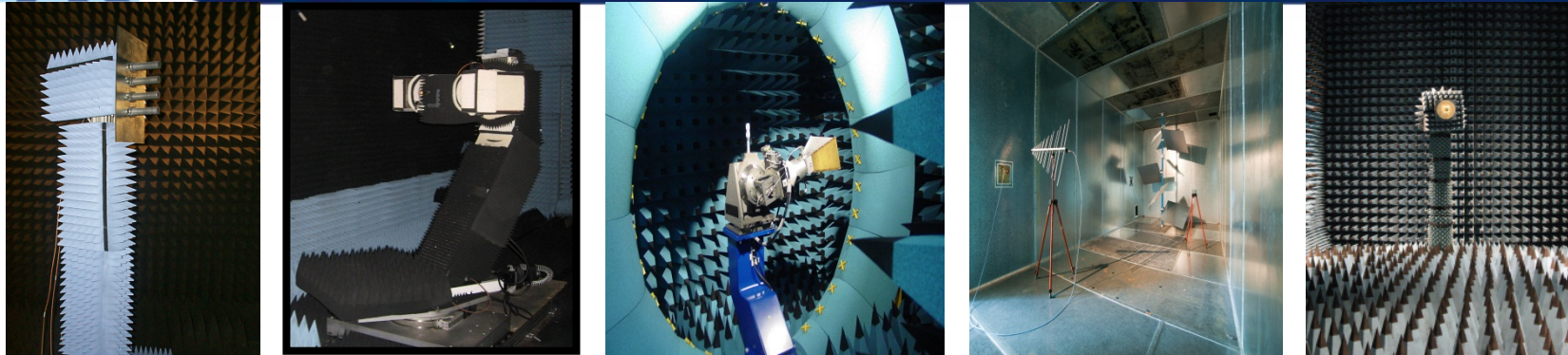
Institute of Electronics & Telecommunications of Rennes

A dispersed Lab in West-France





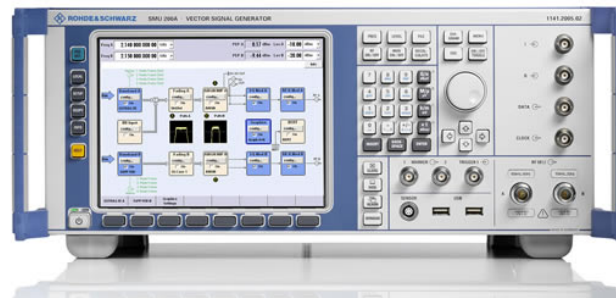
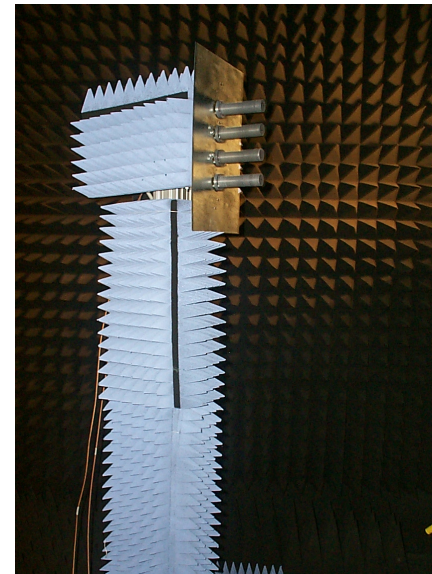
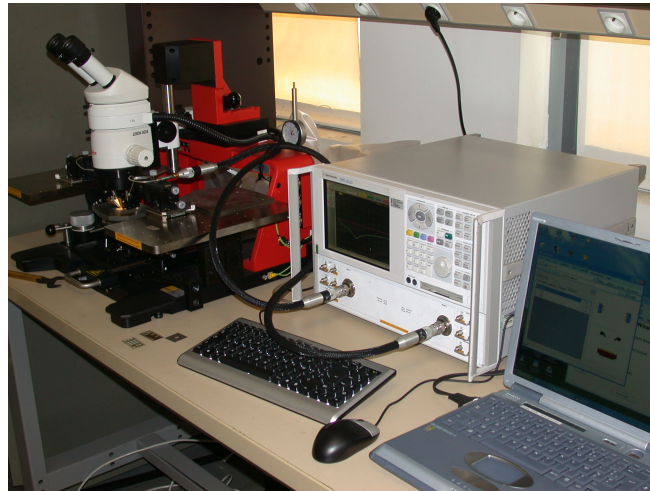
- Lecturers and researchers : 120
- Administrative and technical staff : 40
 - PhD students : 150
- Post-doctoral fellows, Research Engineers : 40
 - Invited researchers : \approx 80

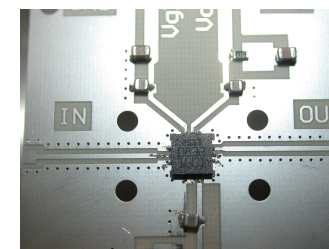
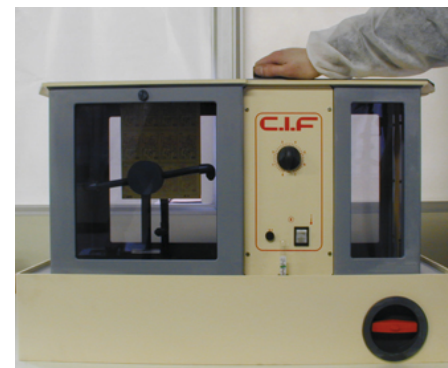


Up to 110 GHz

- ANECHOÏC CHAMBER 1 - 18 GHz – University of Rennes 1
 - ANECHOÏC CHAMBER 1 - 18 GHz – Polytech' Nantes
 - NEAR-FIELD CHAMBER 0,8 - 6 GHz – INSA of Rennes
 - R.C.S CHAMBER 1 - 40 GHz – INSA of Rennes
- ANECHOÏC CHAMBER 26,5 - 110 GHz – University of Rennes 1
 - REVERBERATING CHAMBER – INSA of Rennes
- ELECTRONIC MICROSCOPE SCANNING - IUT of Saint-Brieuc
 - X DIFFRACTOMETER - IUT of Saint-Brieuc
 - CLEAN ROOM – University of Rennes 1
 - EXPERIMENTAL STATION in Monterfil

□ 1GHz-20 GHz







1

Wide Band Dual-Polarized Antenna

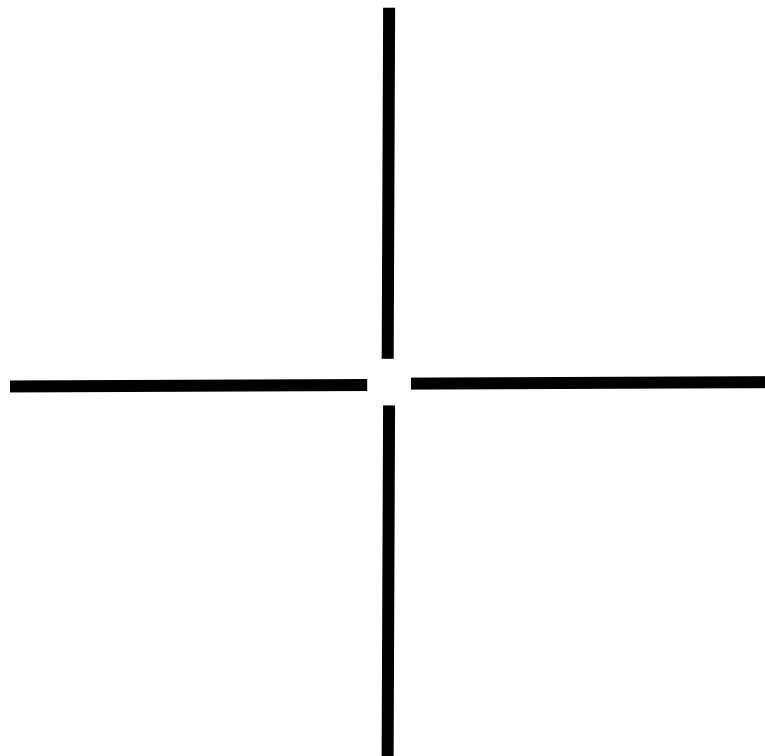
Industrial Research Project

Objectives:

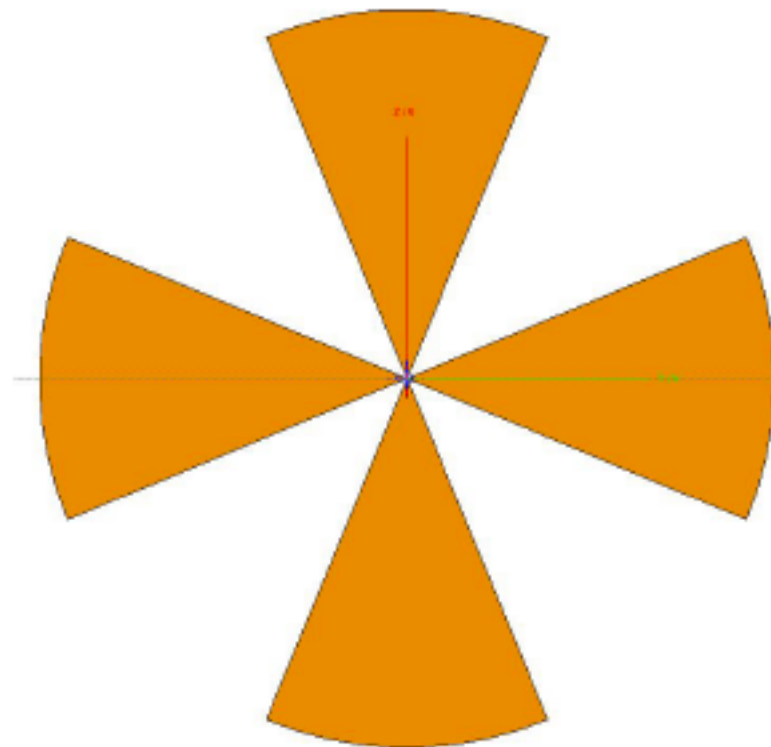
- Very wide band (300 MHz to 3 GHz)
- Dual polarization (Horizontal & Vertical)
- Limited dimension (40 cm *40 cm)

Applications:

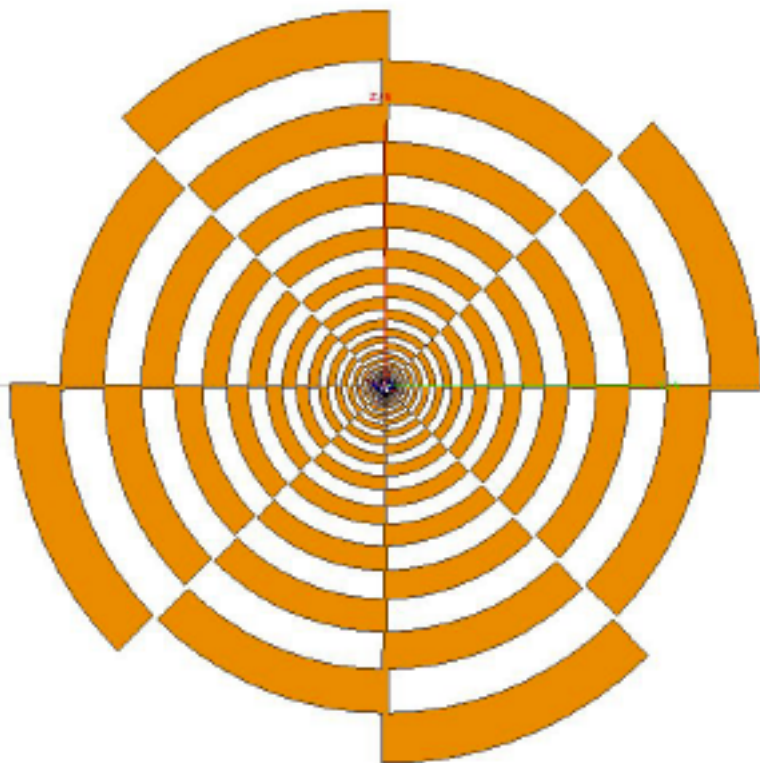
- Receivers for transmission survey
- Civil & Military



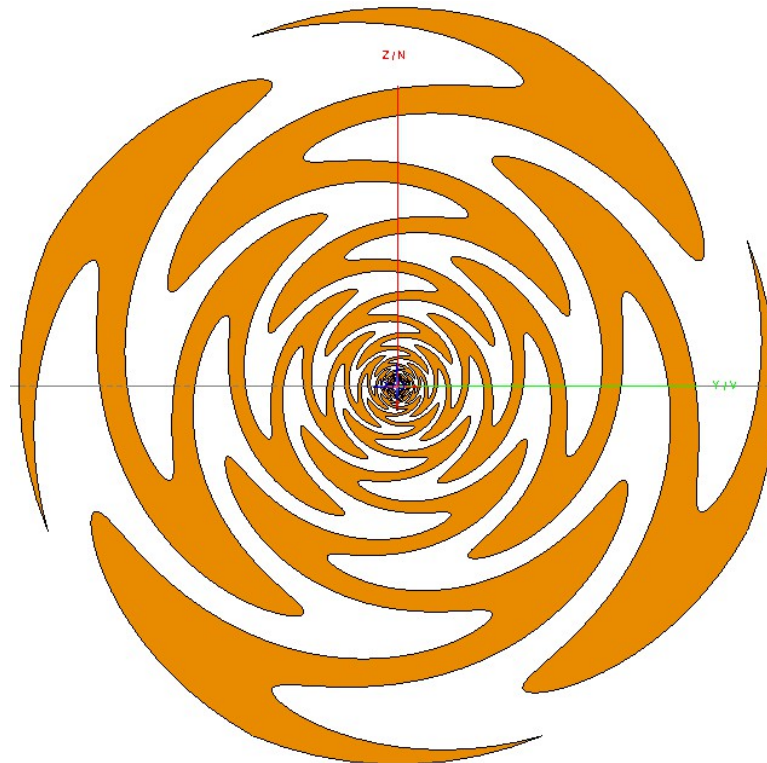
Two Dipole Antennas
For double polarization



Butterfly Antenna
(Papillon)

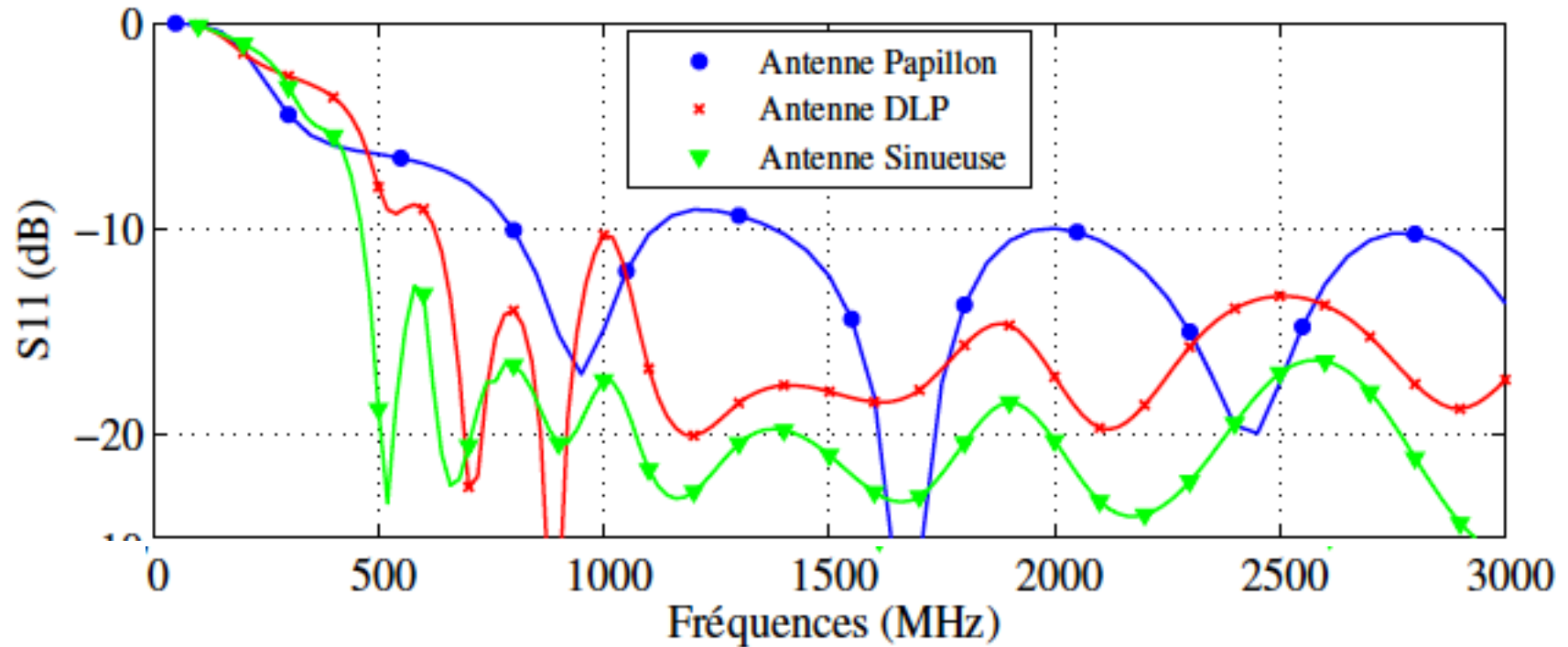


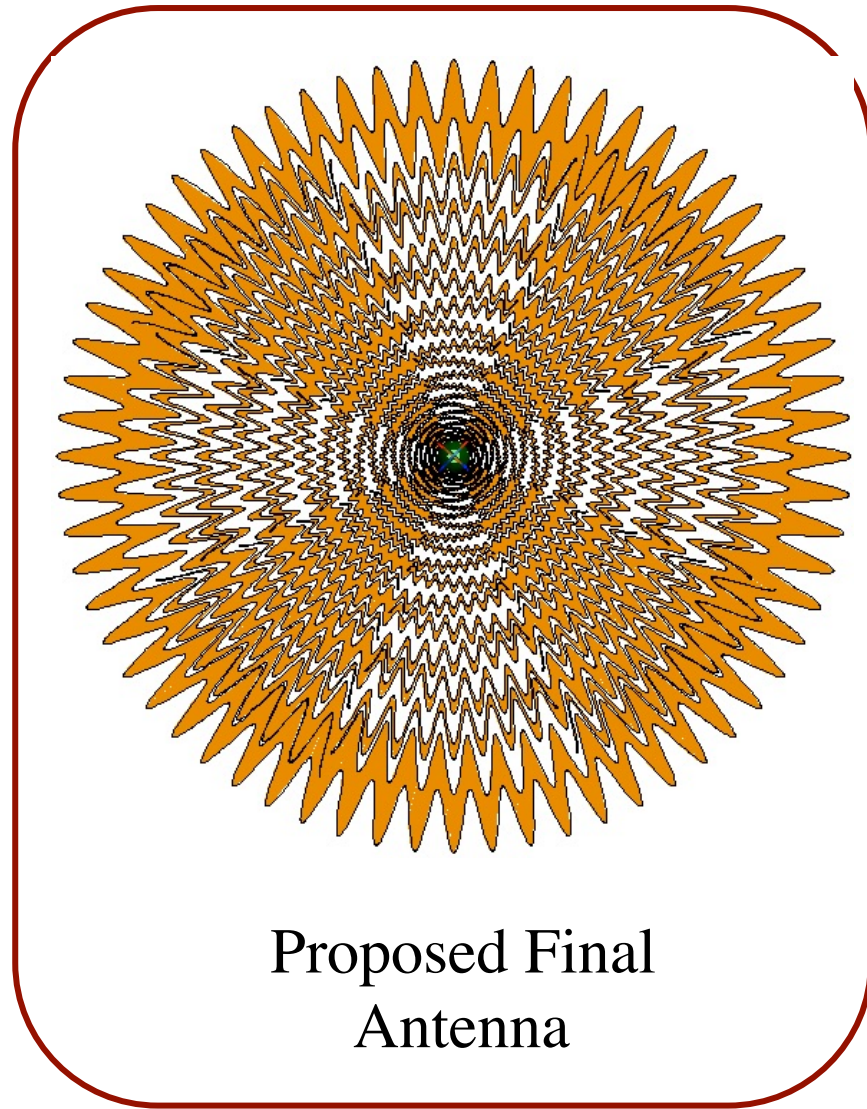
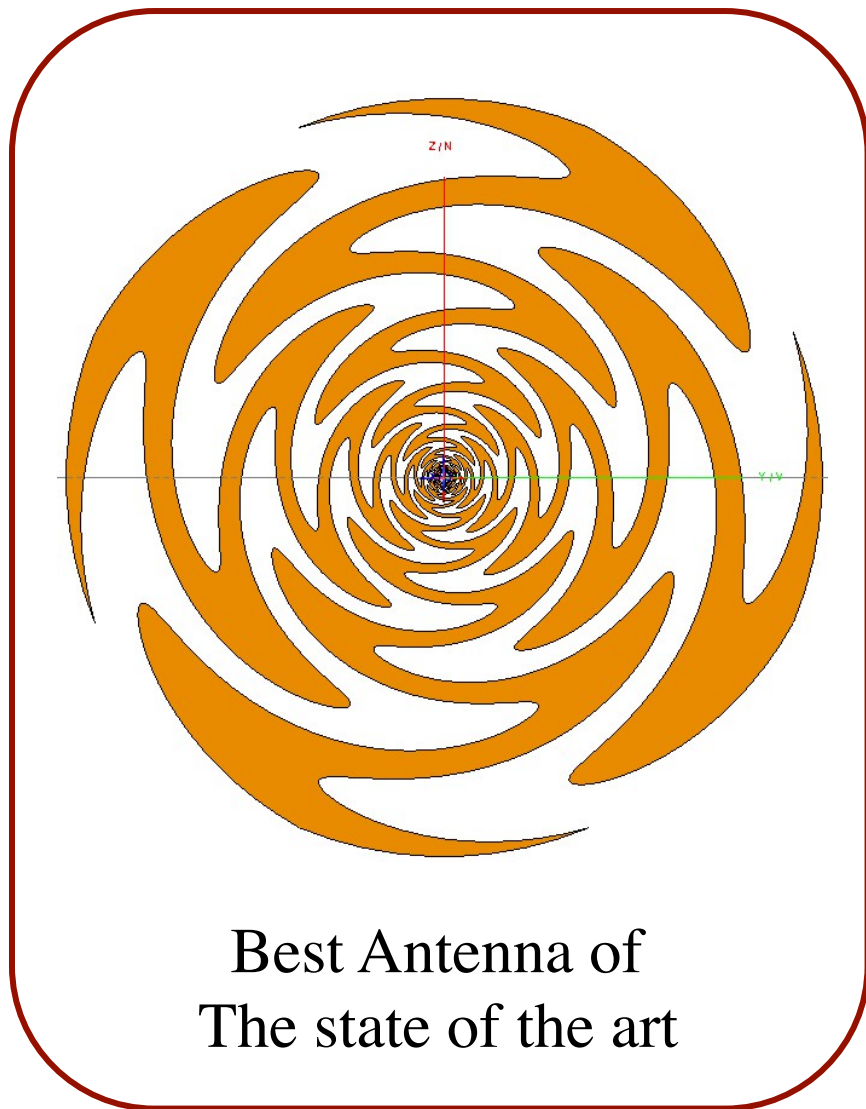
Dental Log-periodic
Antenna (DLP)



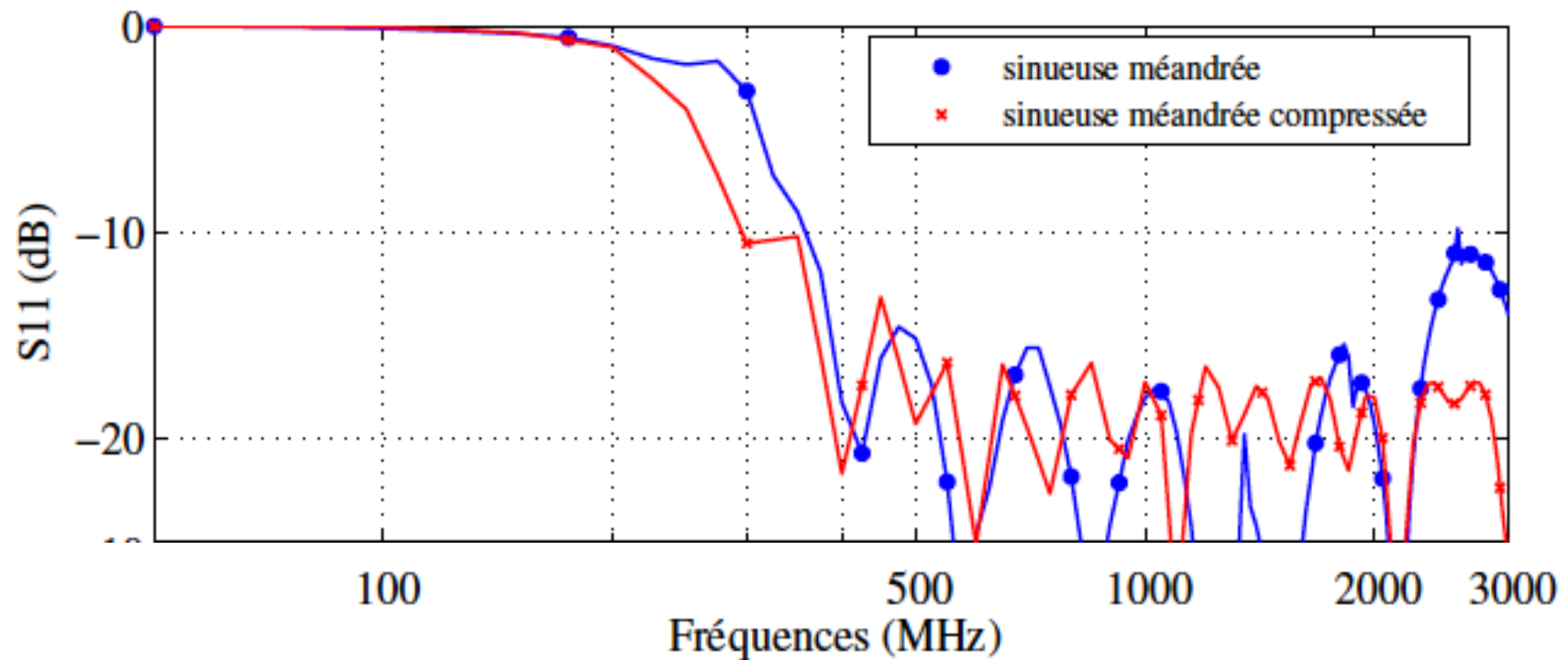
Sinueuse Antenna
(Sinueuse)

Simulation Results

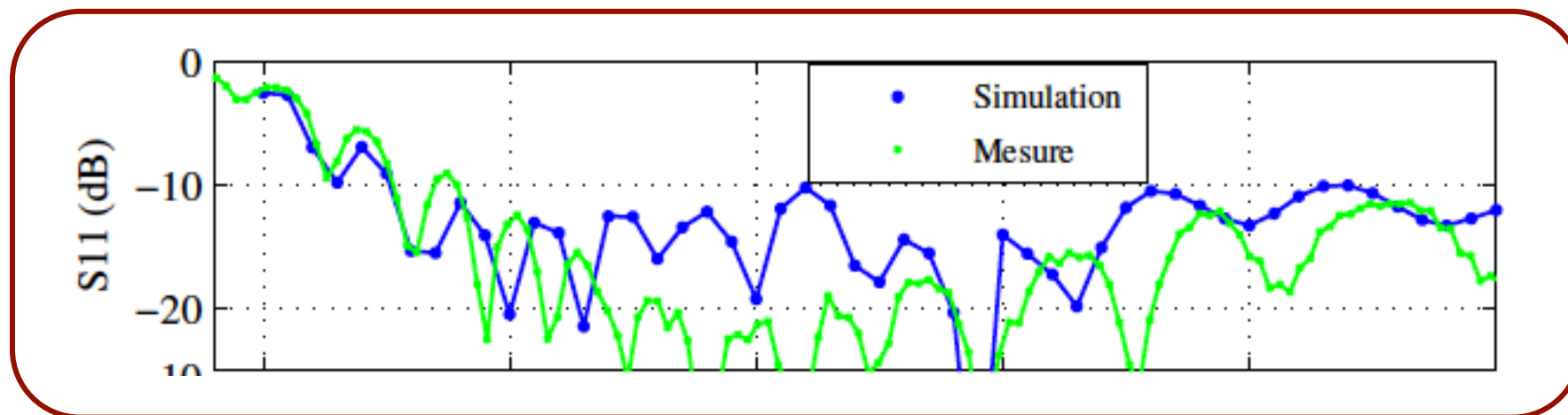




Final Result: 300-3000 MHz



Realization and Measurement



2

Satellite Receiver Antenna





Schwaiger 1 satellite

Dimensions: 55 x 62 cm

Single LNB

Gain: 34 dB

Fixed Position Antenna

For one receiver

Price from 40 €



Selsat parabole plate 1 satellite

Dimensions: 60 à 65 cm

Single Integrated LNB

Double polarization

Gain : 34,5 dB à 12,7 GHz

For one receiver

Price from 200 €

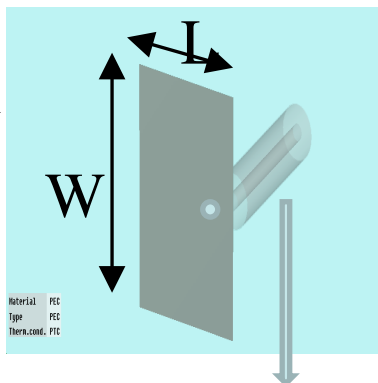
Flat, Discrete, Beam Switchable Antenna

Requirements :

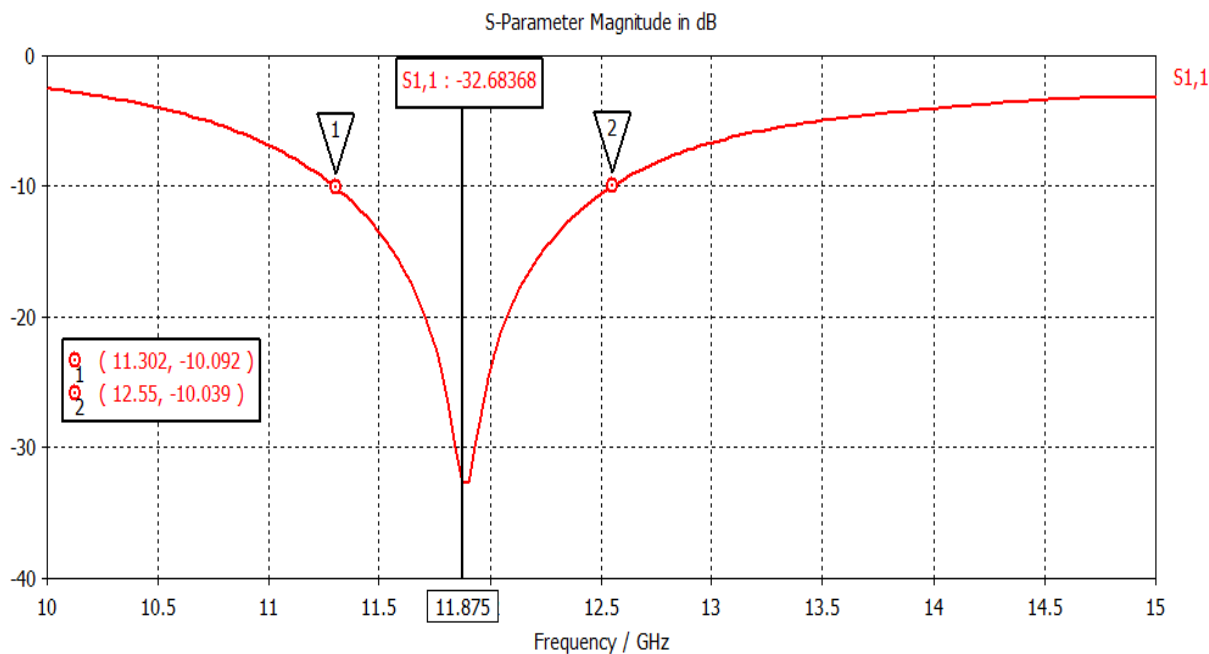
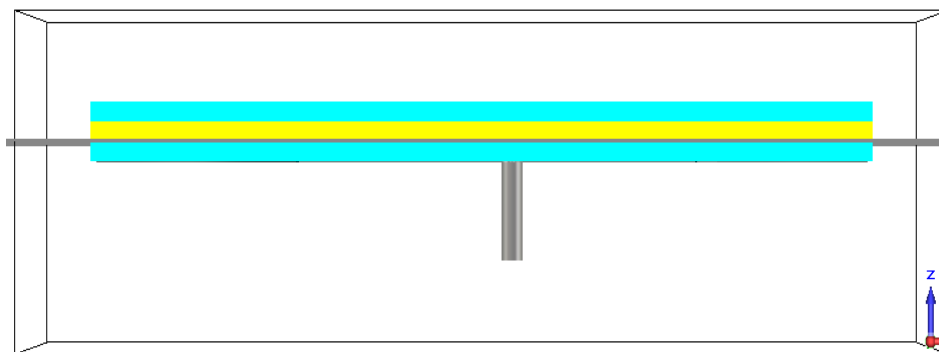
- Wide band : 10.7 to 12.7 GHz
- High gain : 30 to 35 dB (>20 dB)
- Double polarization : Horizontal & Vertical
- Low cross polarization < -20dB

Begin with a Rectangular Patch

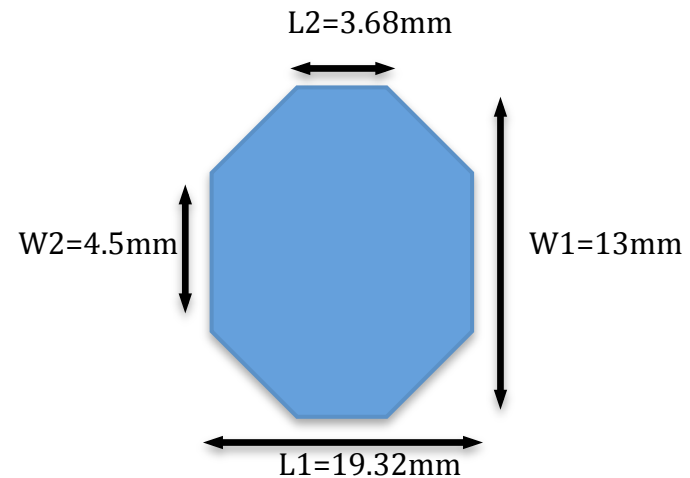
W= 9.622 mm
L= 6.623 mm



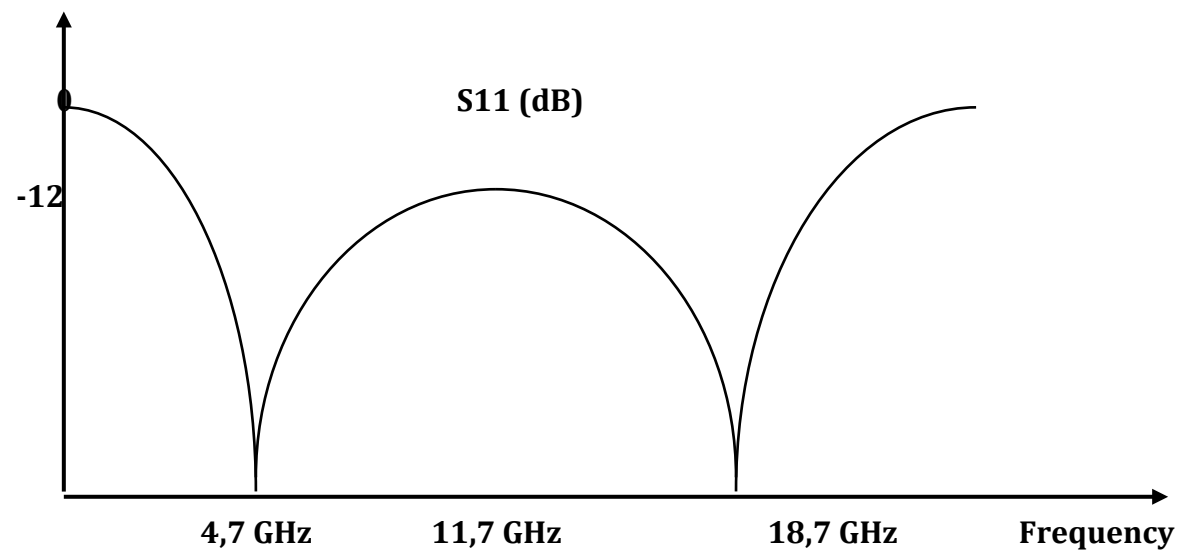
Méthode d'excitation:
Câble coaxial

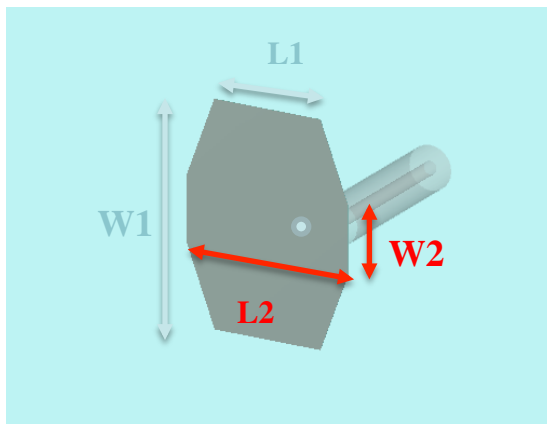


Choose $L1$ & $L2$ for 50Ω
 Obtain a hexagon

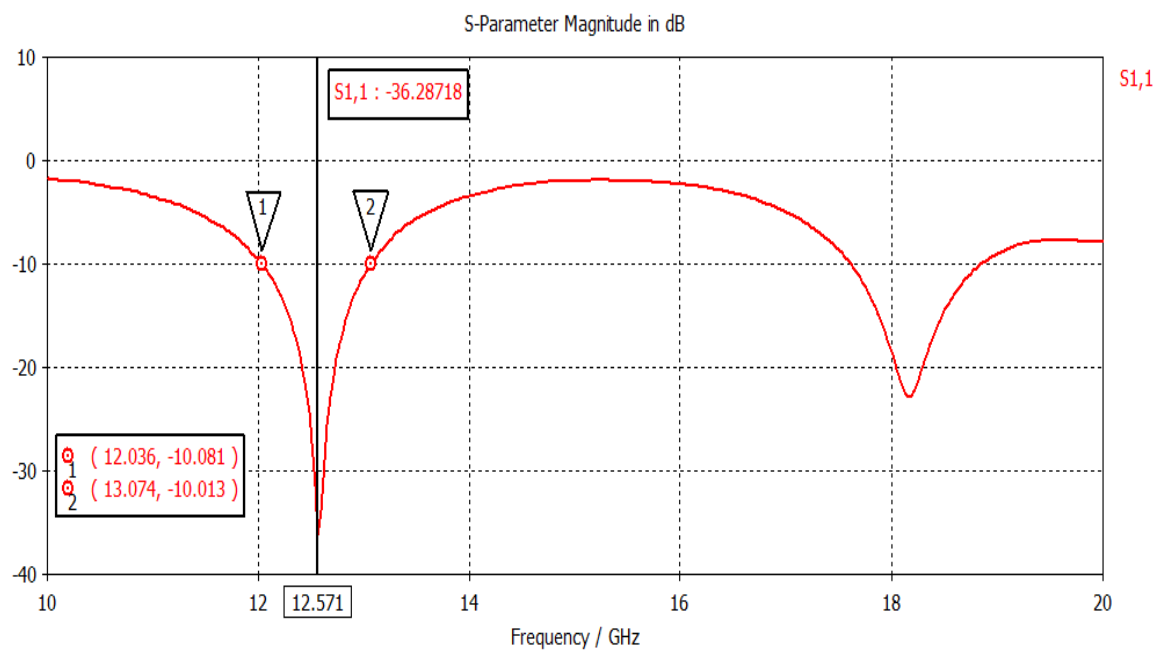


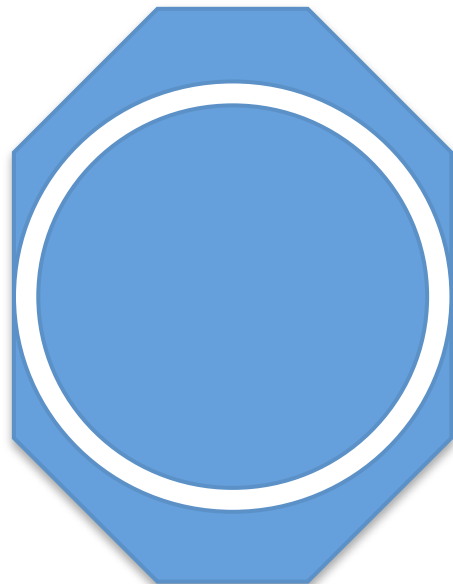
Expected
 Result



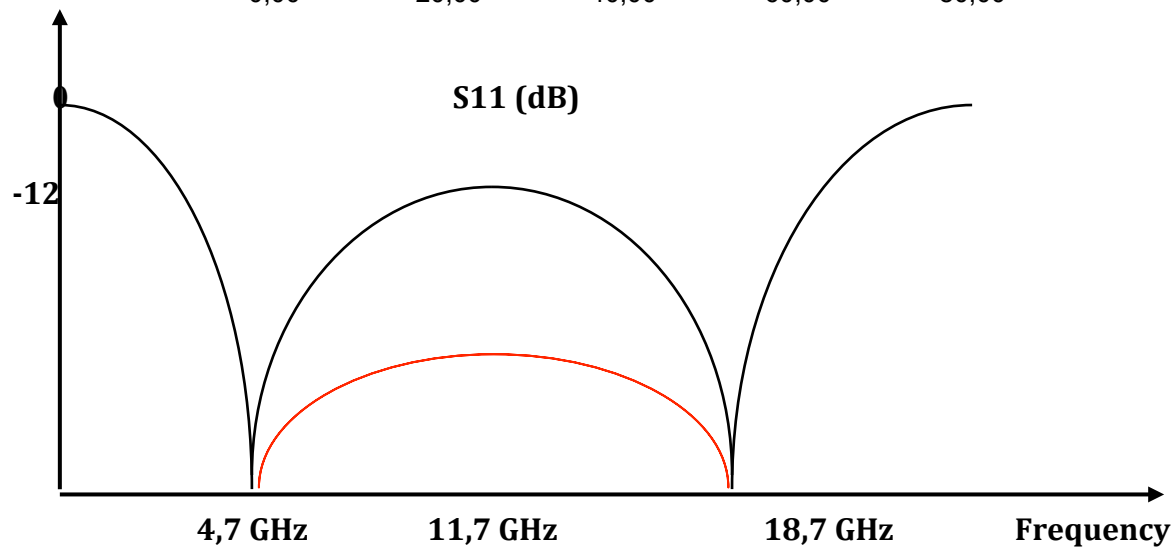
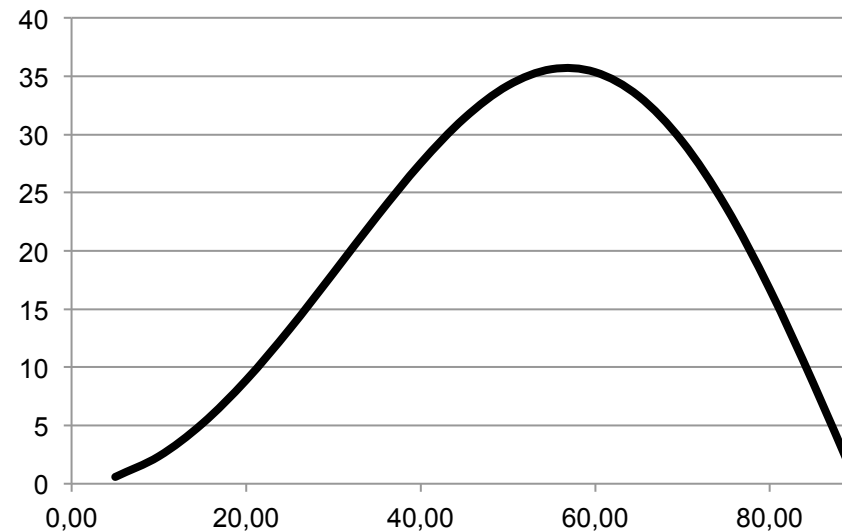


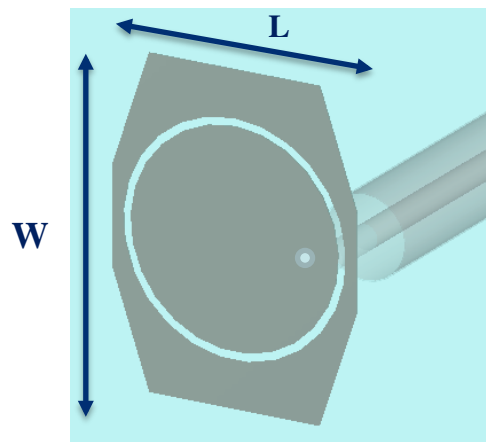
Simulation with CST program



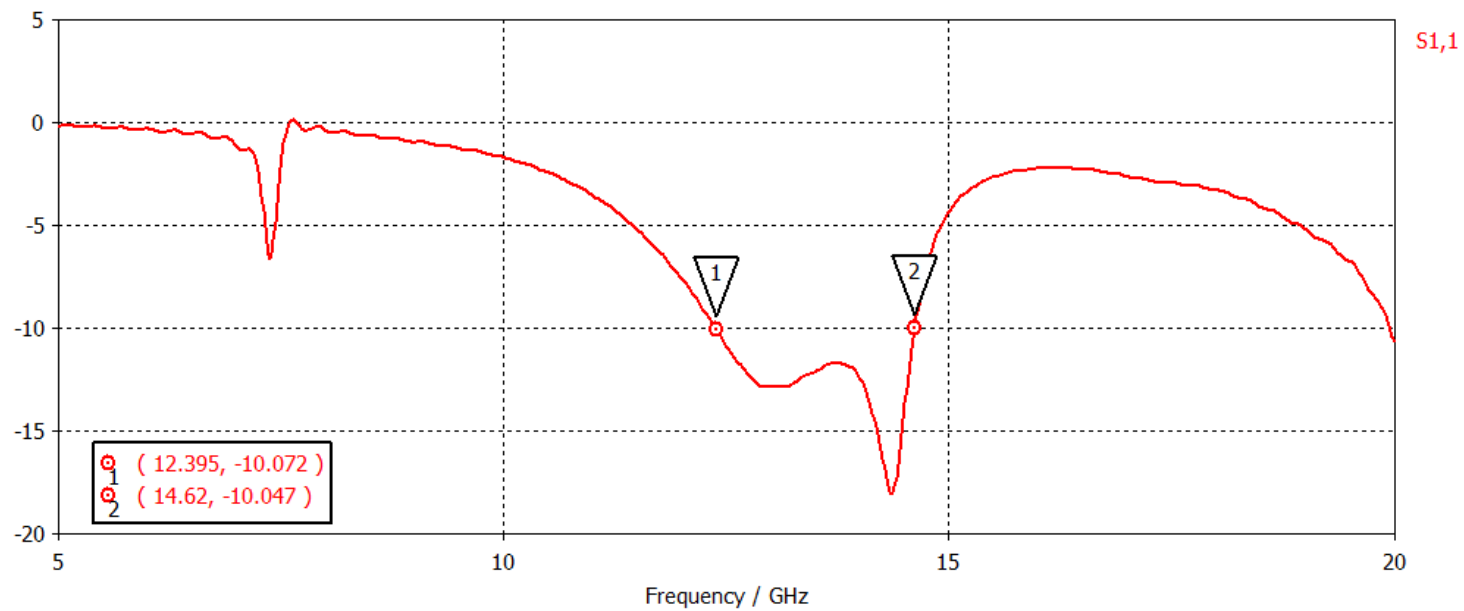


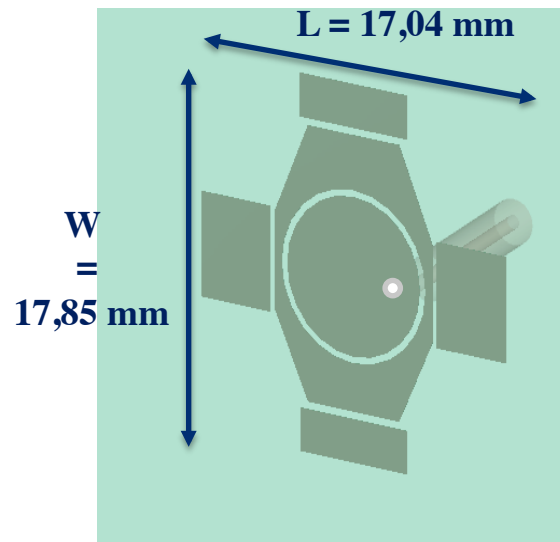
Expected
Result



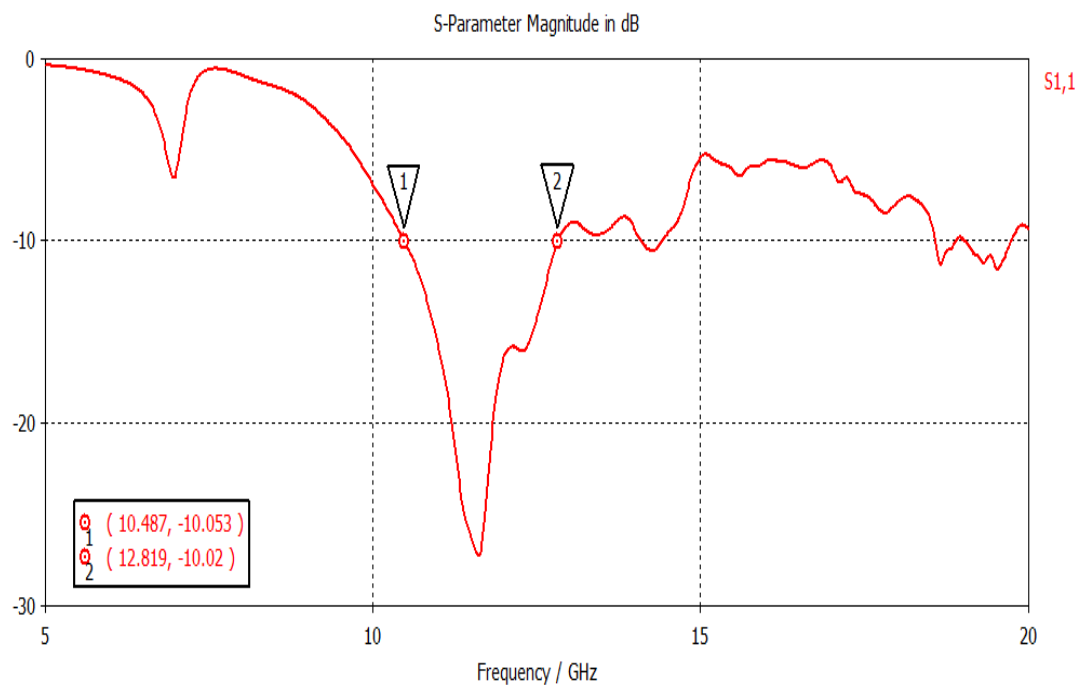


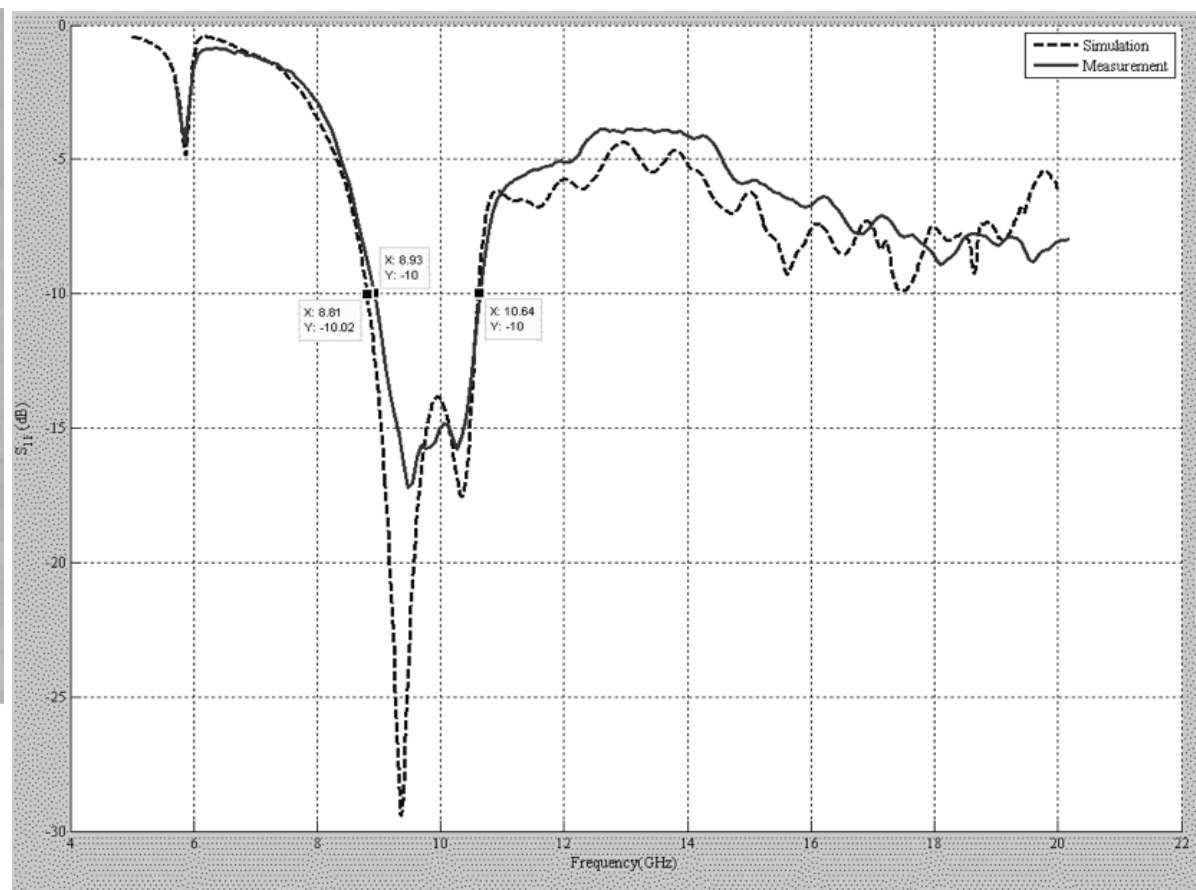
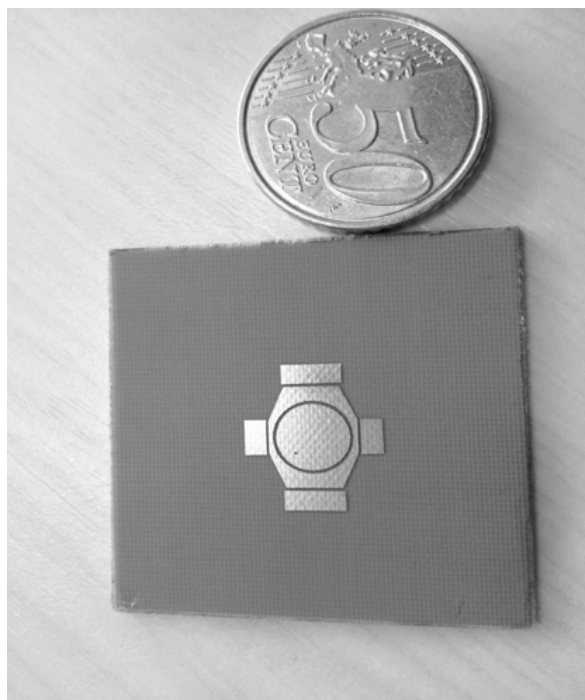
S-Parameter Magnitude in dB





... by adding Rectangles

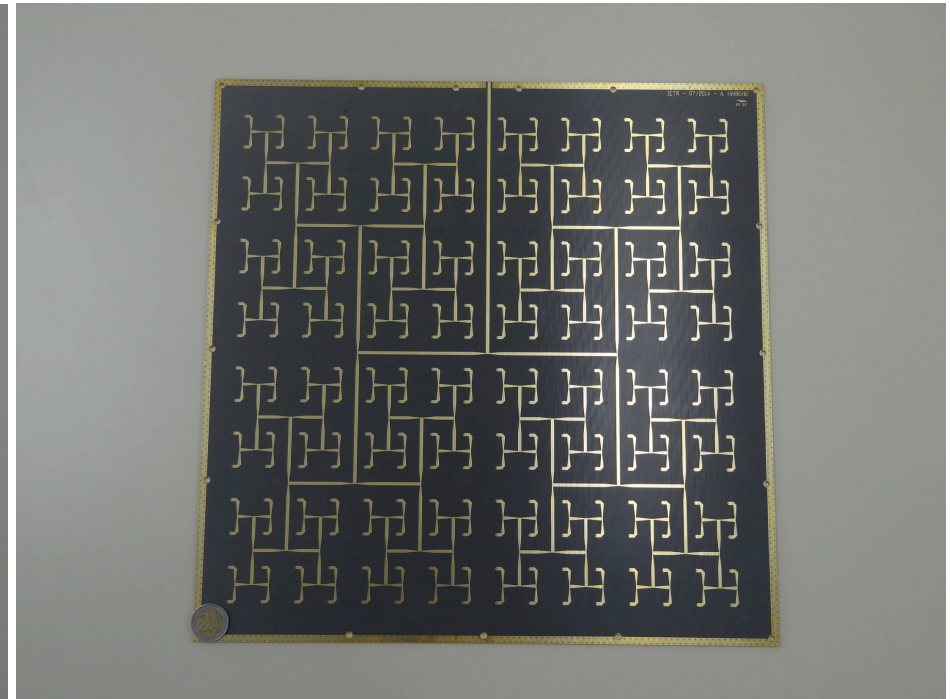
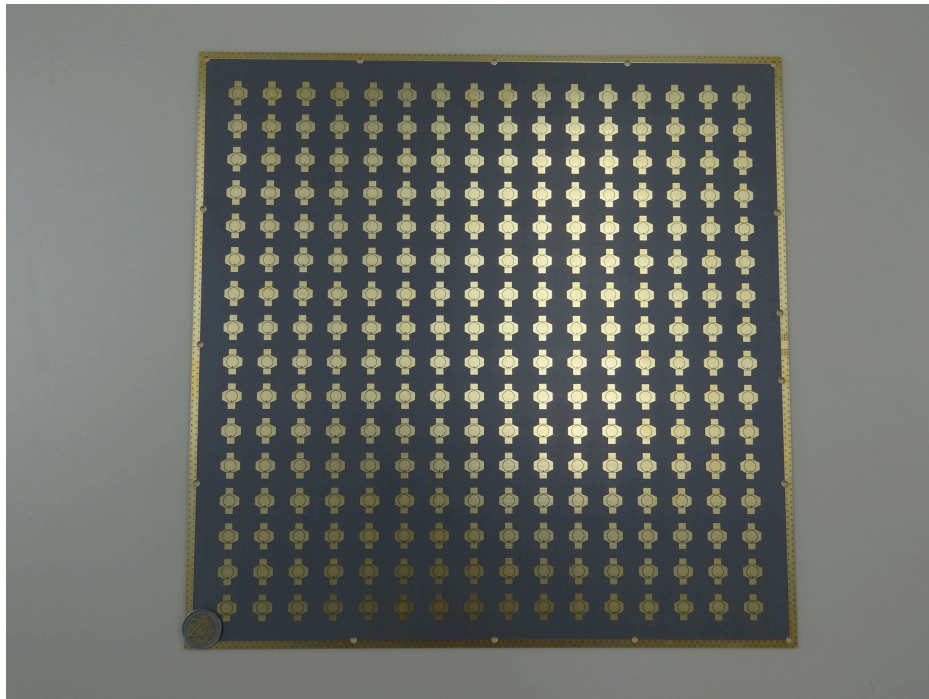




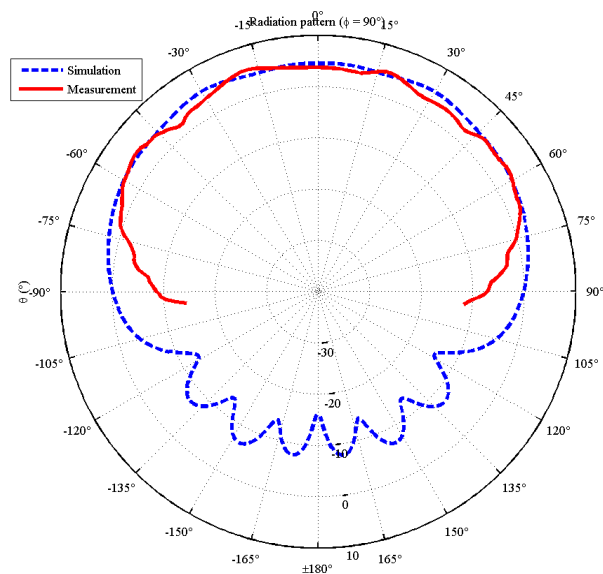
Antenna array

256 = 16x16 antennas are used to realize an array

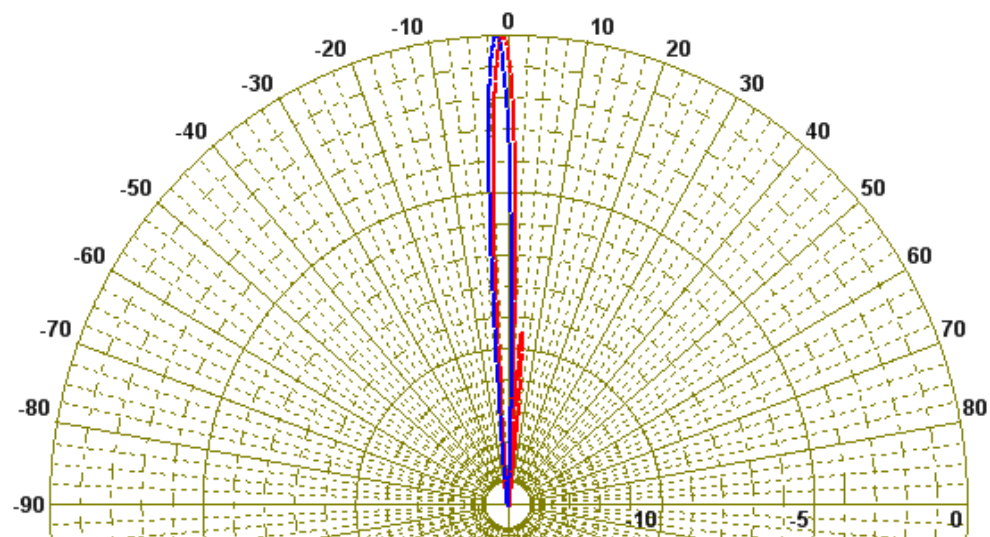
Gain: 29 dBi



Simulated et measured radiation pattern

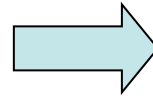


For one antenna

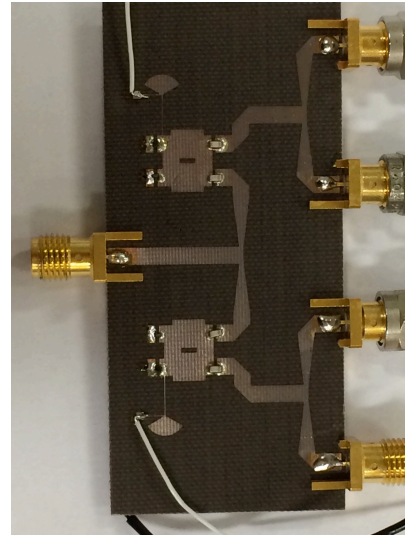
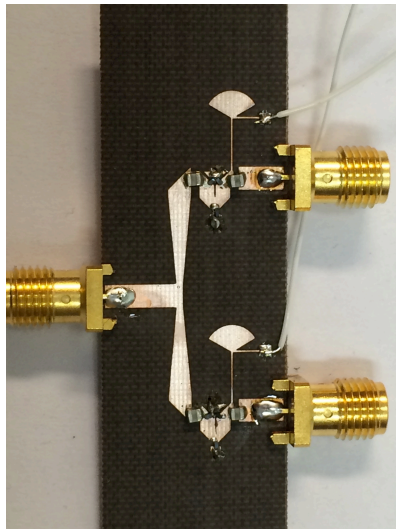


For the array (256 antennas)

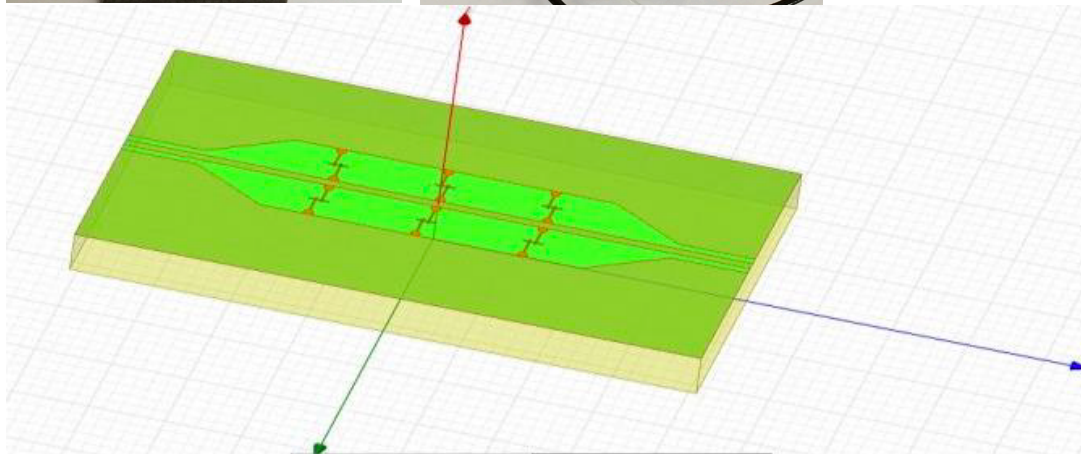
Radiation control



Phase shifter design



Phase shifters using varactors
In Ku band : 10,7-12,7 GHz



Phase shifter using
ferroelectric materials



3 Transparent Antenna

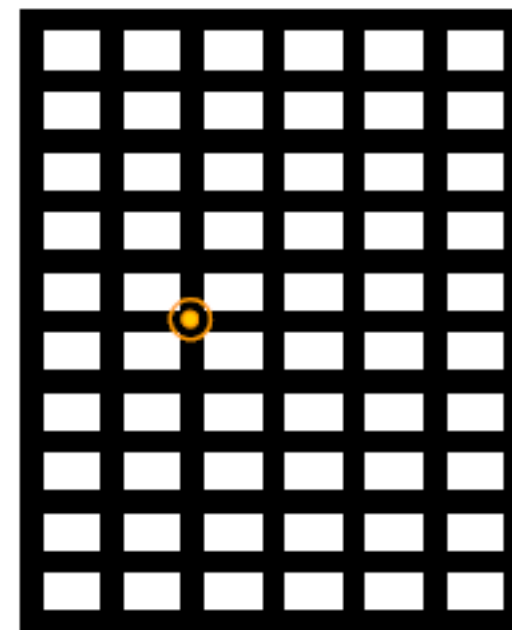
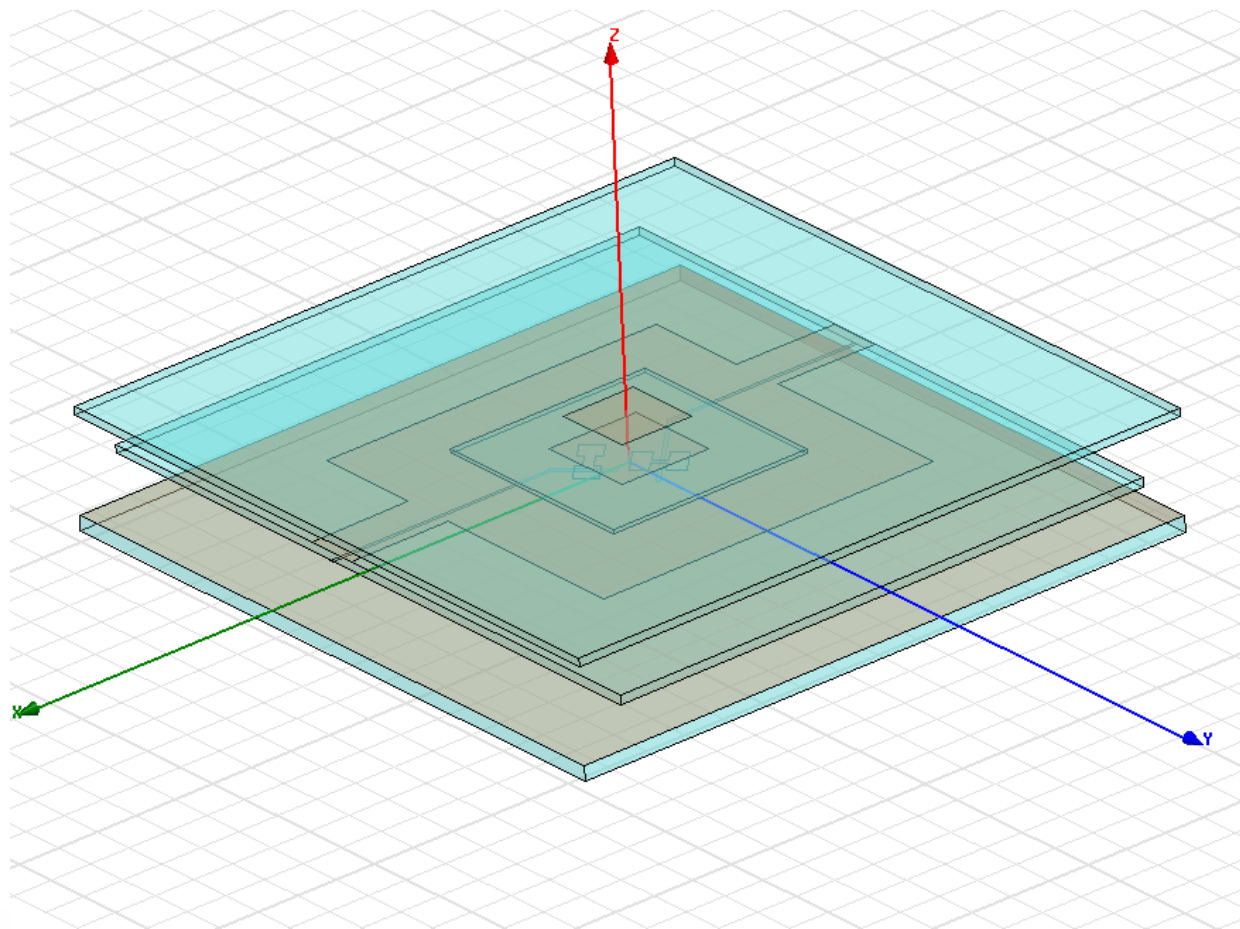
Flat & Discrete Antenna for Base Stations

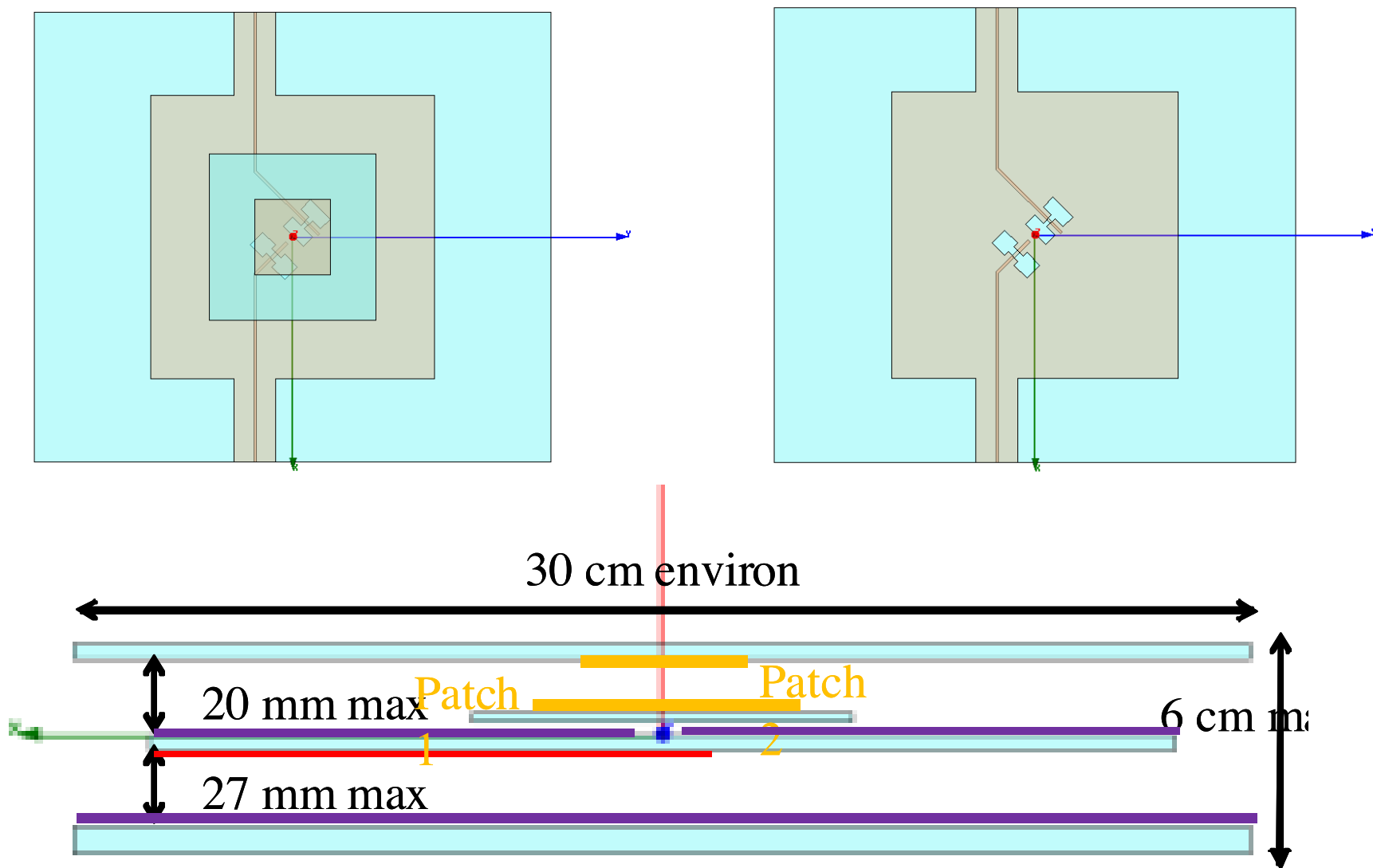
Industrial Project

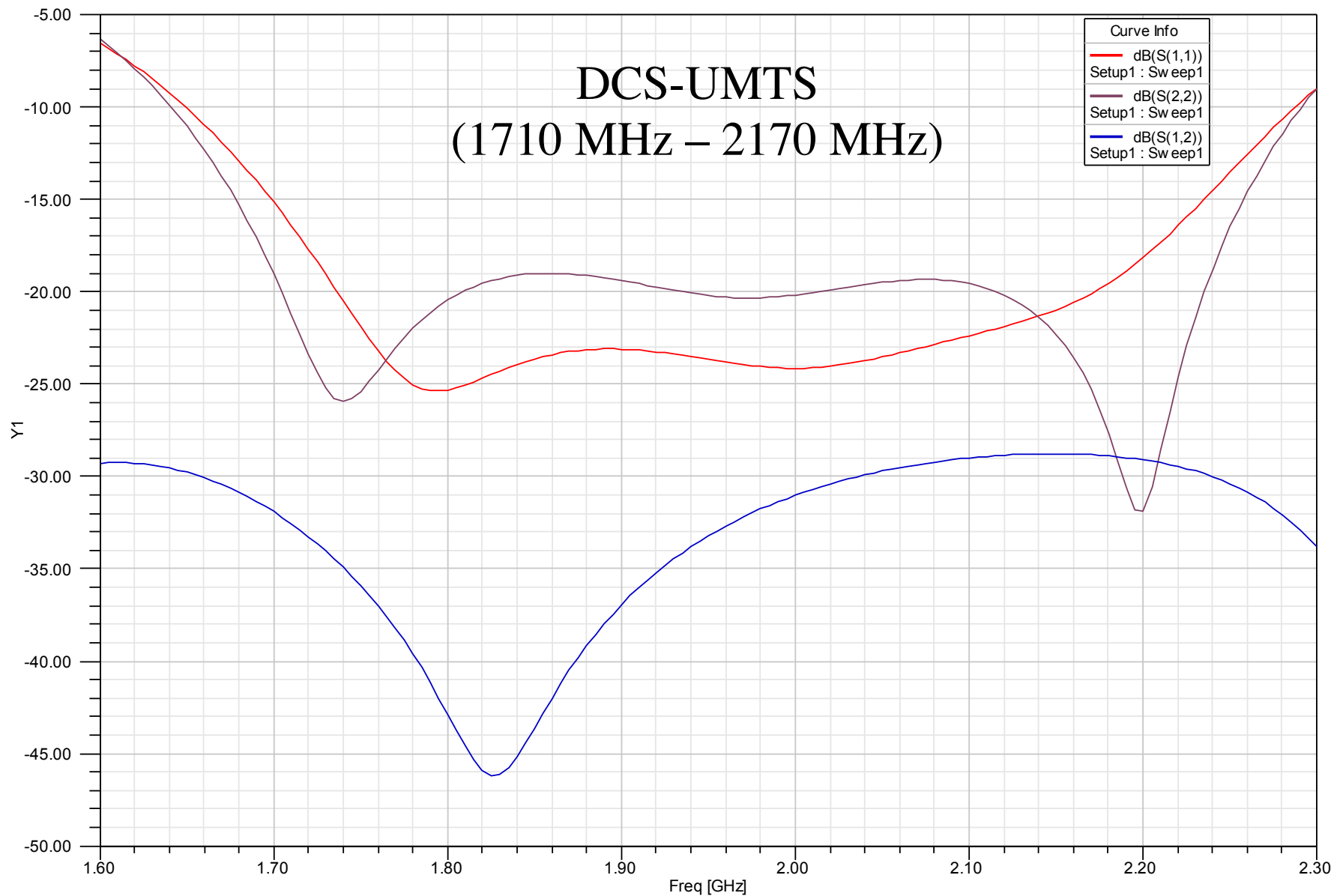
Requirements :

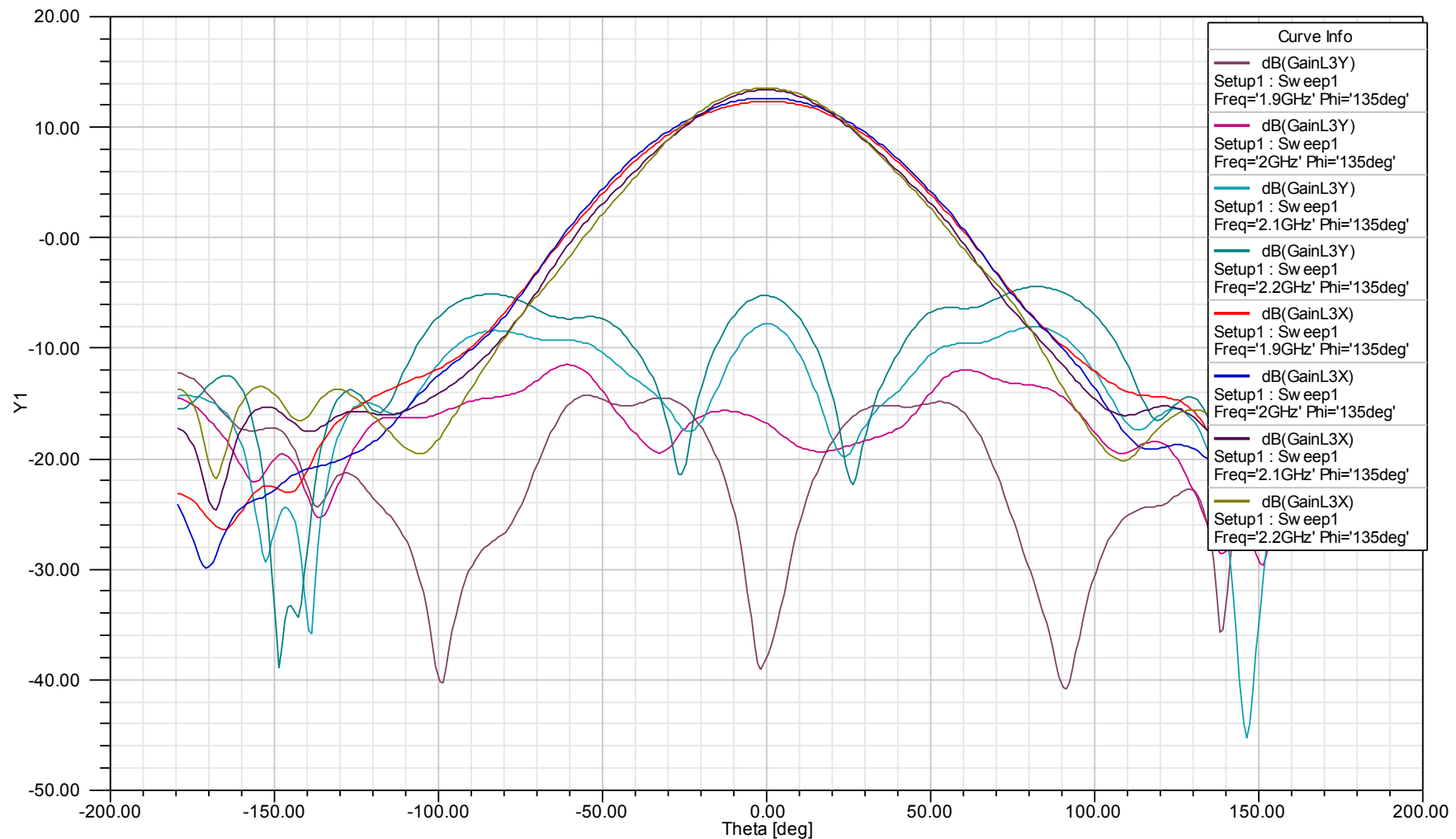
- Wide band : 1.7 to 2.2 GHz
- High gain : 17 dBi
- Double polarization : Horizontal & Vertical
- Low cross polarization < -20dB

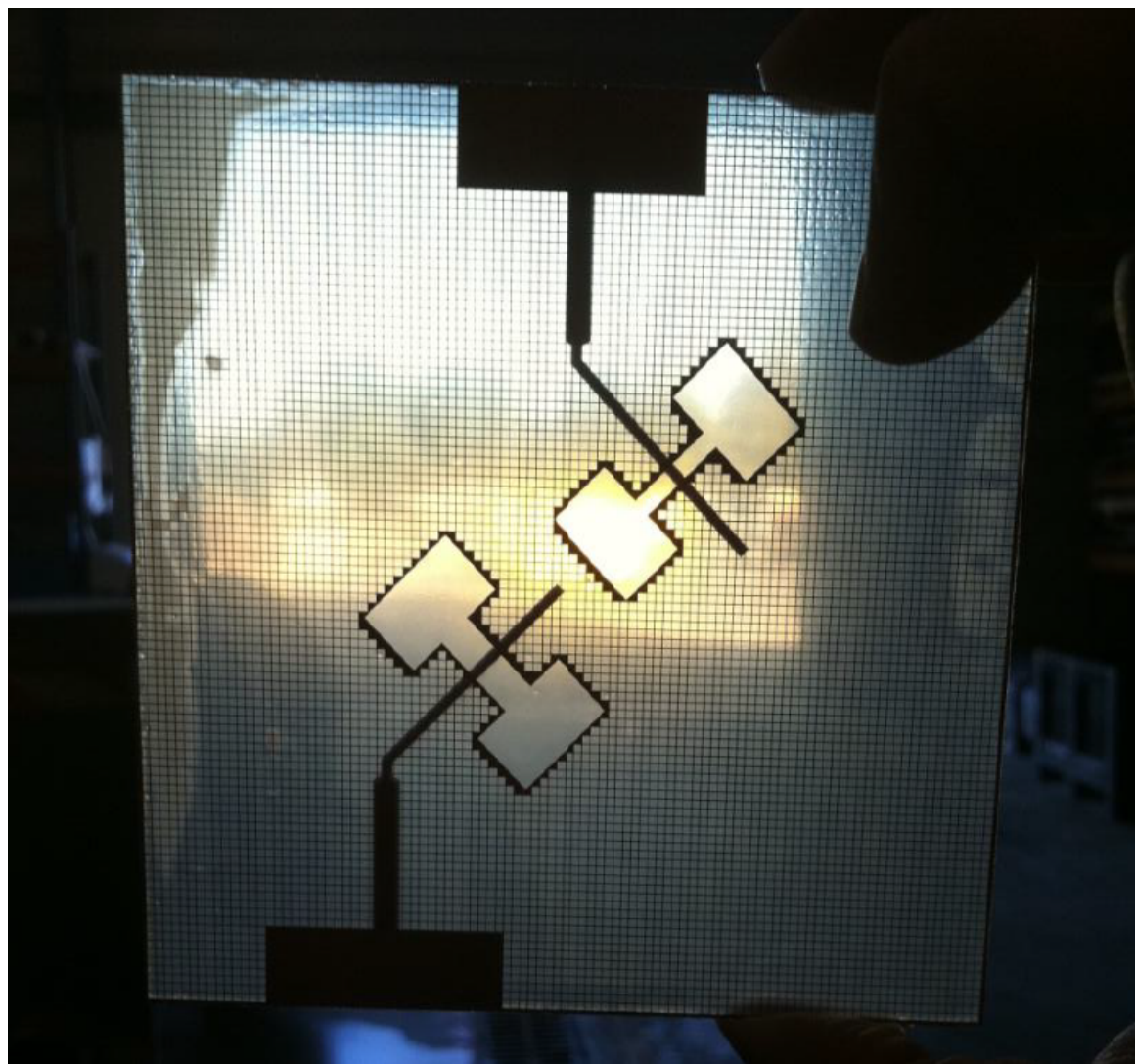
Multi-layer, Glace Substrate, Grid Metal













International Patent:
PCT/EP2012/076316

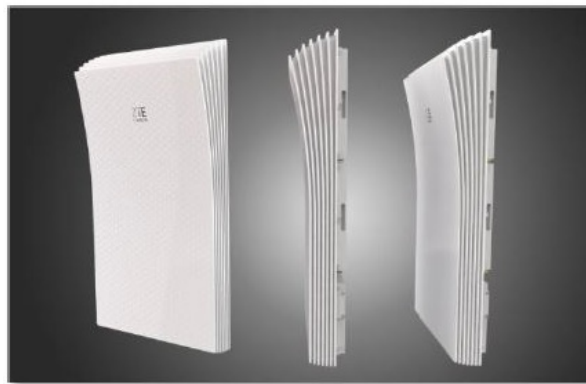


4

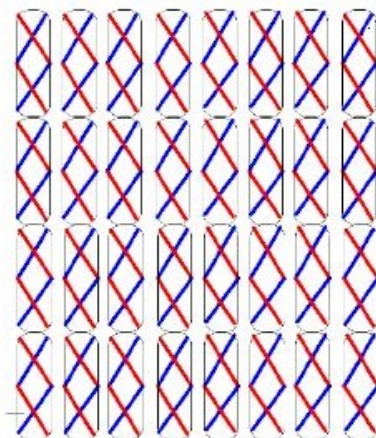
Reduced size Base station antenna



New antennas for 5G

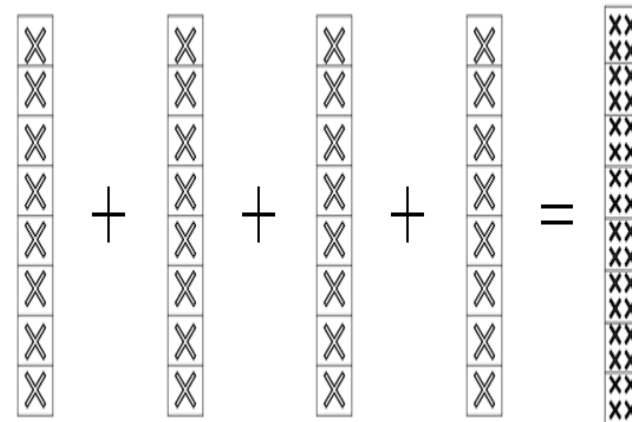


Architecture

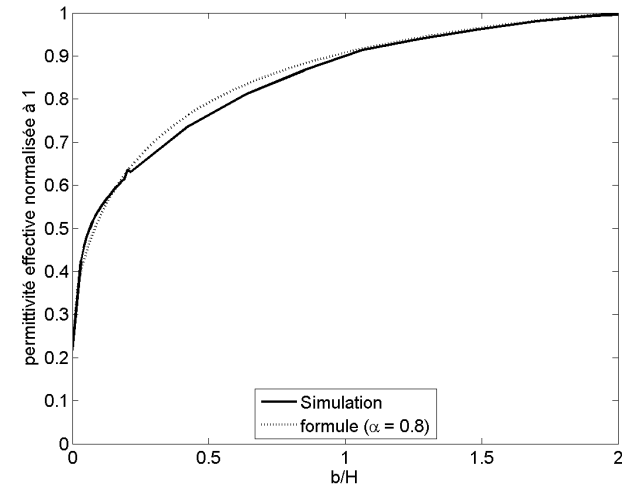
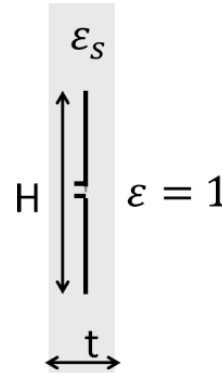


4Row x 8Column x Dual Polarization

Our objective:
Reduction of the size
of each antenna
For a compact MIMO

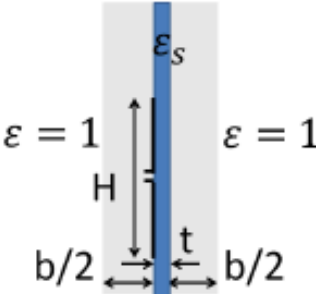
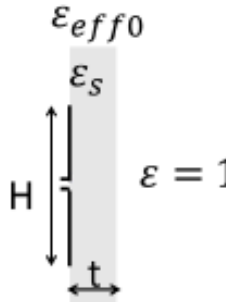
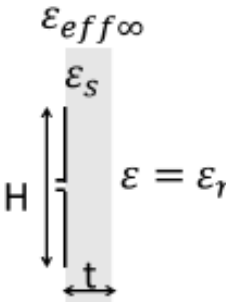


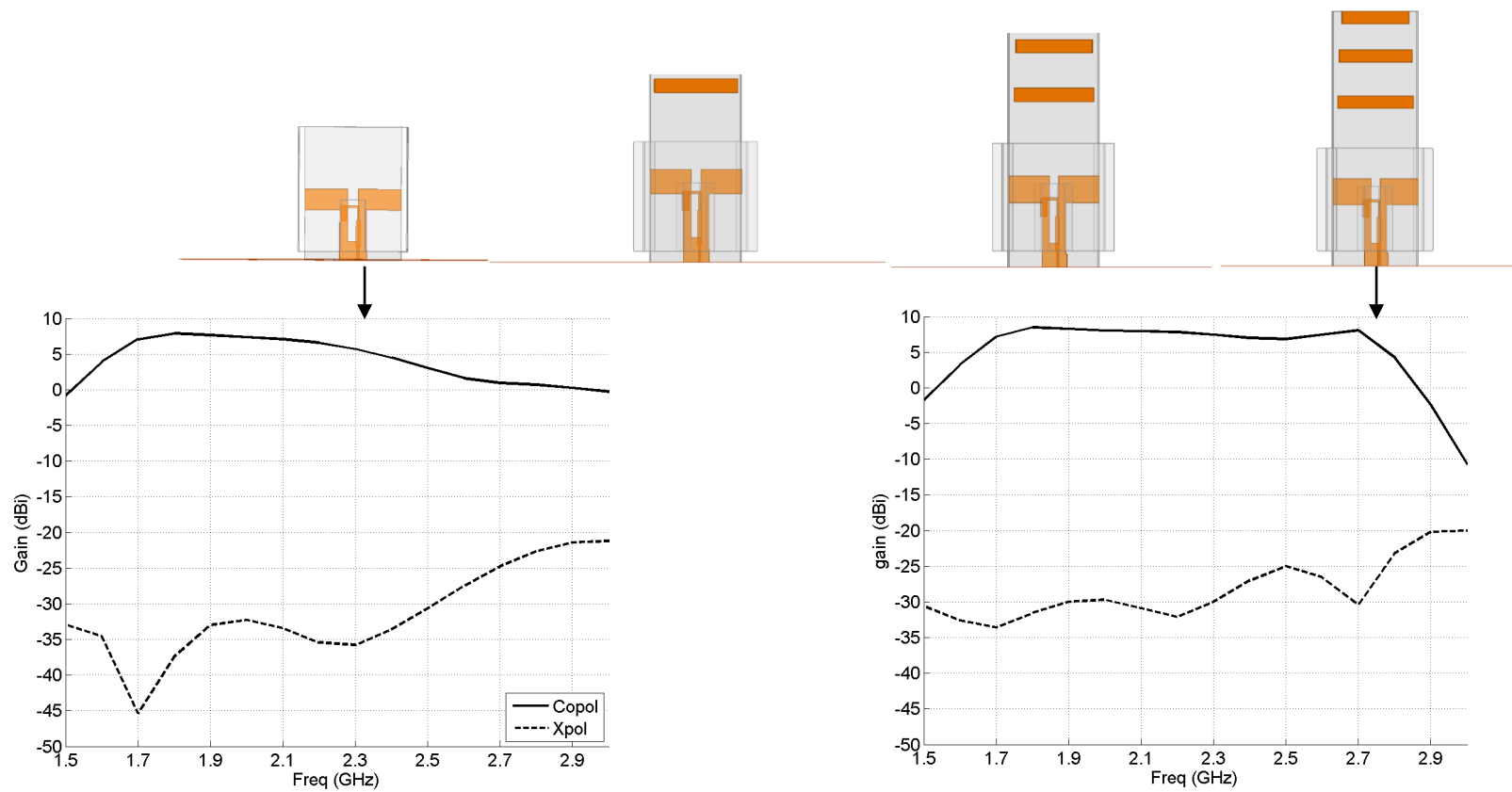
If a dipole is buried inside a dielectric:
Its length is reduced

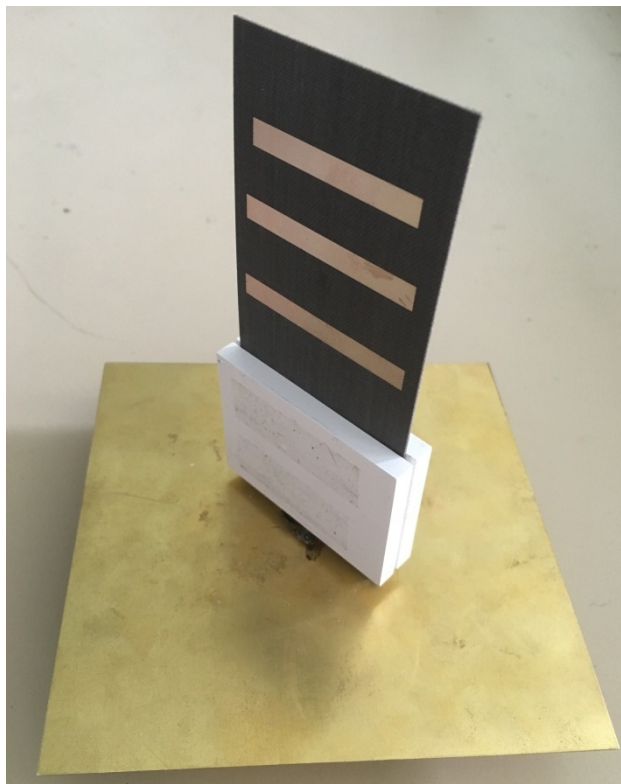


$$L = \frac{L_0}{\sqrt{\epsilon_{eff}}}$$

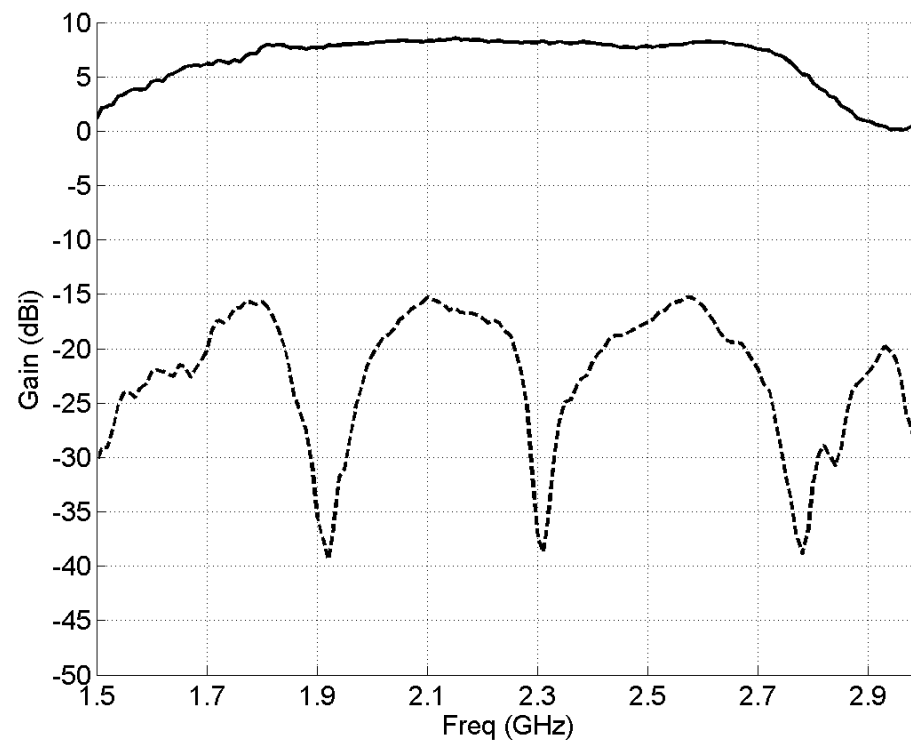
$$\epsilon_{eff} = 1 + \frac{\epsilon_s - 1}{\sqrt{1 + \frac{\alpha H}{t}}}$$

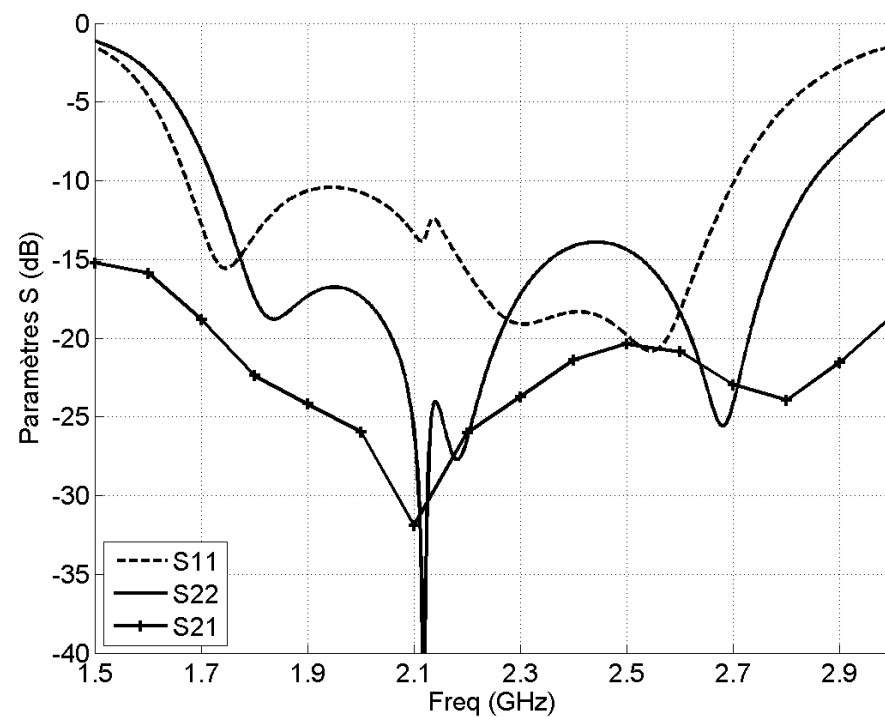
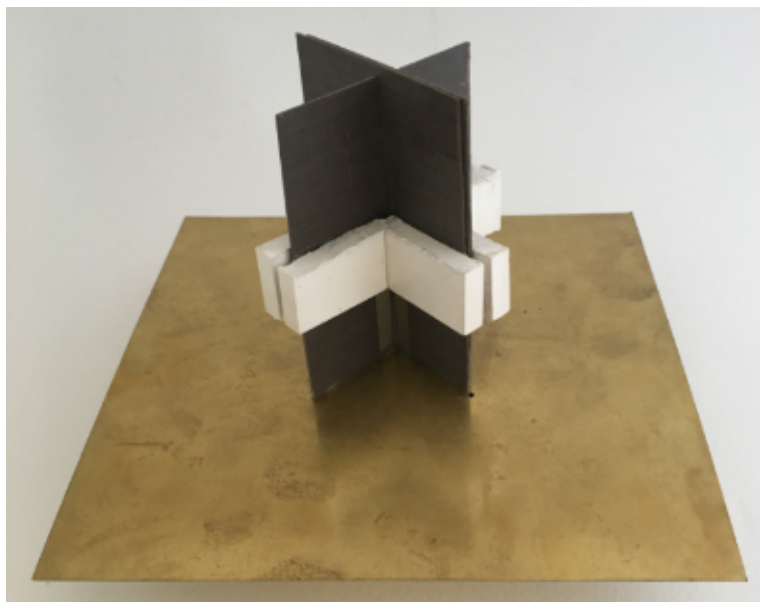
<p>hétérogène complète</p>		$\epsilon_{eff} = \epsilon_{eff0} + \frac{\epsilon_{eff\infty} - \epsilon_{eff0}}{\sqrt{1 + \frac{\alpha H}{b}}}$
<p>hétérogène initiale</p>		$\epsilon_{eff0} = 1 + \frac{\epsilon_s - 1}{\sqrt{1 + \frac{\alpha H}{t}}}$
<p>hétérogène finale</p>		$\epsilon_{eff\infty} = \epsilon_r + \frac{\epsilon_s - \epsilon_r}{\sqrt{1 + \frac{\alpha H}{t}}}$

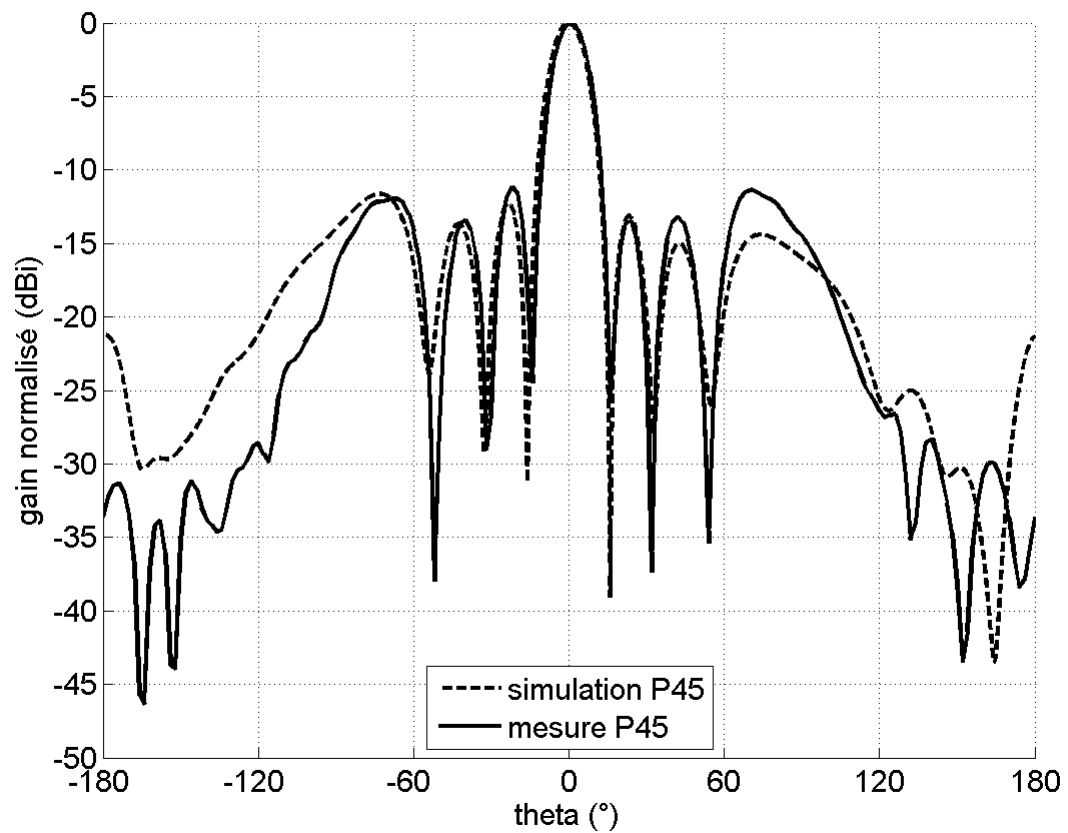
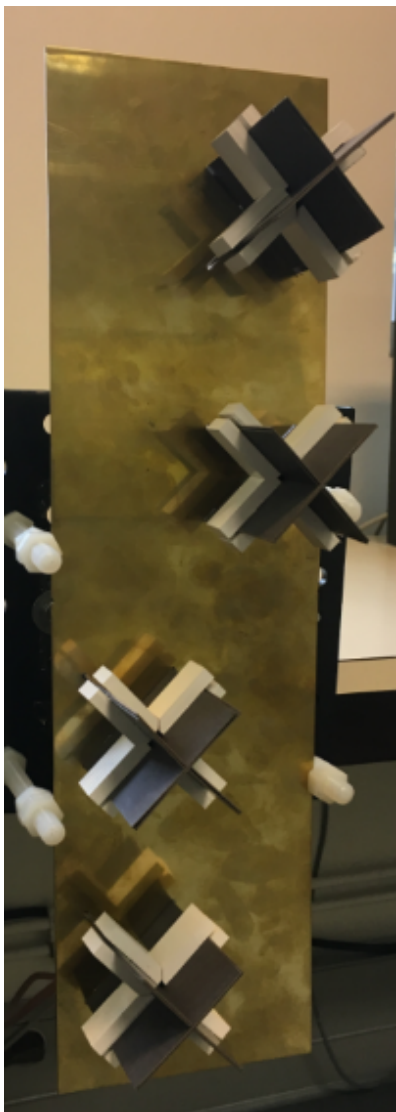




← 12 cm →







Thank You