Pre-Fractal Resonant Rings for Compact Spiral Antennas

J. Valleau[1], H. Aubert[1], A. Bellion[2], P. Pouliguen[3], P. Potier[3]

[1]LAAS-CNRS Toulouse, [2]CNES DCT/RF/AN Toulouse, [3]DGA DS/MRIS Bruz

Introduction

Energy harvesting
Wireless Power Transmission → Antennas need to receive energy over wideband

→ Use of UWB antennas required

Issue: Antenna sizes for low frequency applications

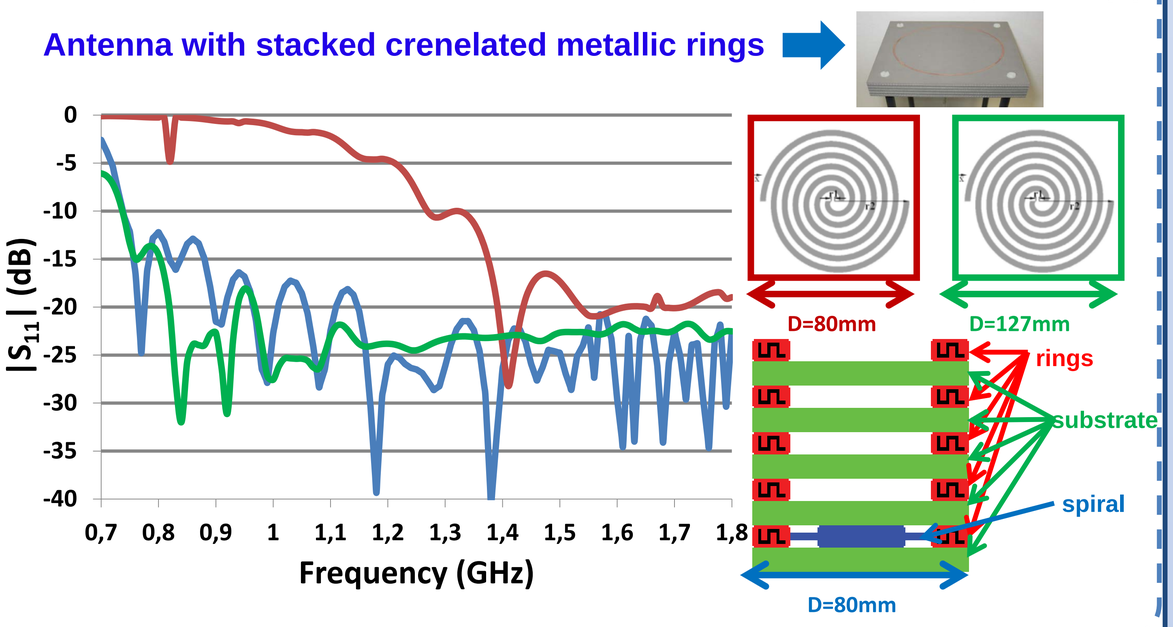
Objective: Miniaturized UWB antennas

State of Art → Pre-fractal profile → Profile Choice → Measures

State of Art

An **innovative architecture** for miniaturization of UWB antenna is reported in [1] :

Antenna with stacked crenelated metallic rings



Principal:

Lowest operating frequency of such an antenna depending on:

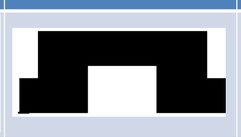
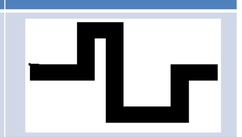
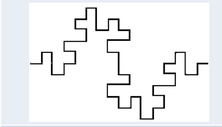
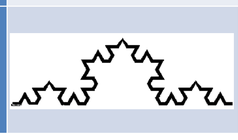
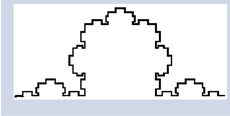
- *Number of stacked metallic rings*
- *Unfolded length L of the ring's contour (or f_{res})*
- *Position of different rings above the spiral*

37% reduction of the antenna
No degradation of the radiating performances

↗ antenna thickness (height=λ/25)
Limitation in f_{res} & miniaturization with crenel profile
Time-consuming EM simulation (difficult optimization)

[1] O. Ripoche, H. Aubert, A. Bellion, P. Pouliguen, P. Potier, "Spiral antenna miniaturization in very high frequency band", Antenna Technology and Applied Electromagnetics (Antem), 25-28 juin 2012

Pre-fractal profiles

Iteration Order	Von-Koch	Hilbert-Inspired (HI)	Peano-Inspired (PI)
1			
2			
3			

New degree of freedom : iteration order

Modified Von Koch (MVK) [2]

New degree of freedom : the sine amplitude

A high number of points required for a good definition

[2] H. Diez, H. Aubert, D. Bellot, A. Takacs, 'Antenne hélice compacte à profil sinusoïdal modulant un motif fractal', french patent pending CNES-CNRS n°04576-01/20.

Choice of Profile

The choice of the most suitable profile in a given application is the results of a trade-off between two criteria

Primary criteria

For a given L, a compromise needs to be made between:

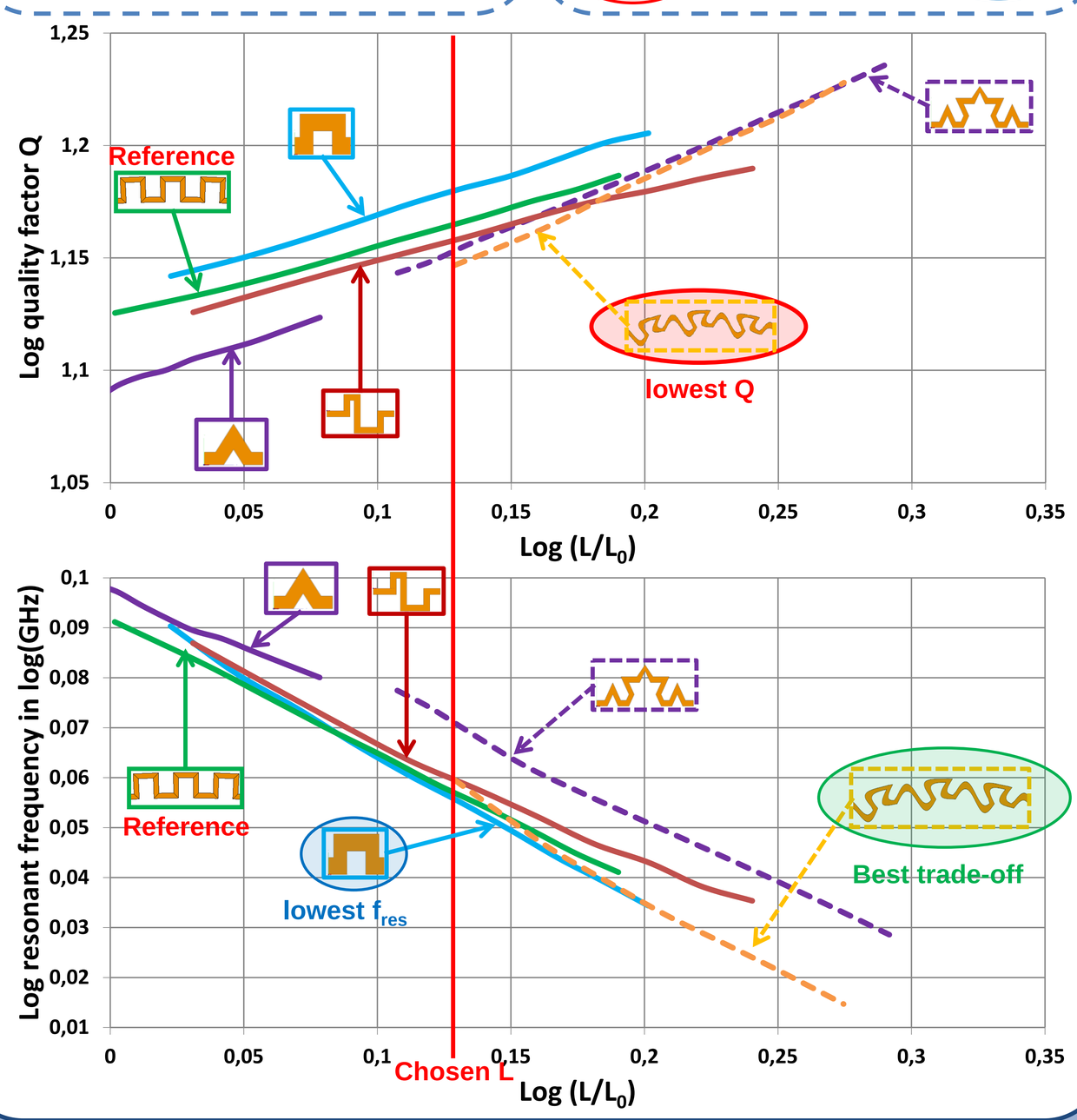
lowest Q — ! — lowest f_{res}

Two antagonist parameters

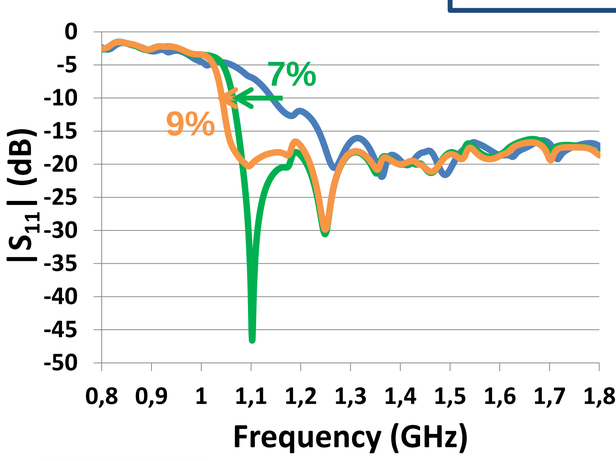
Application criteria

In a given application, a profile needs to be realizable and limit the computation time. We will choose a profile with :

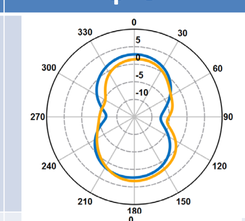
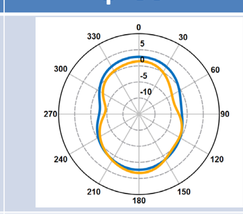
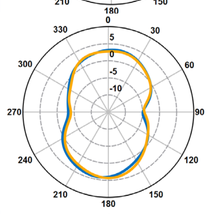
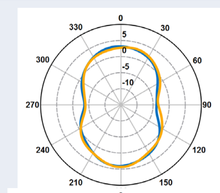
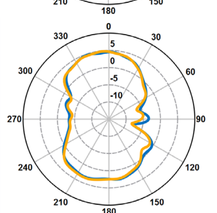
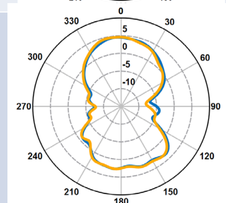
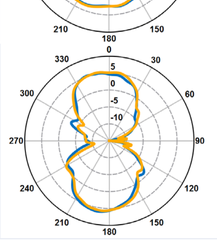
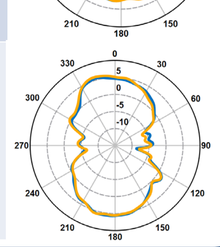
lowest fractal iteration — lowest number of replicas



Measures



9% diminution of the lowest operating frequency with the MVK profile without deteriorating the radiation performances

Gain (dBi)	ϕ=0°	ϕ=90°
Lowest frequency		
1,8 GHz		
3 GHz		
5 GHz		

Conclusions

- Characterization of new profiles
- Comparison of their resonant frequency and quality factor to the crenel
- Definition of criteria to choose the most suitable profile depending on the application
- Measures of an antenna with the selected profile:
  9% diminution of the lowest operating frequency without deteriorating radiation performances
  Greater reduction expected with more stacked rings