URSI GASS 2020
29 AUGUST - 5 SEPTEMBER
SAPIENZA UNIVERSITY CAMPUS, ROME, ITALY

A Study of Antipodal Vivaldi Antenna for Microwave Imaging of Thermal Ablation

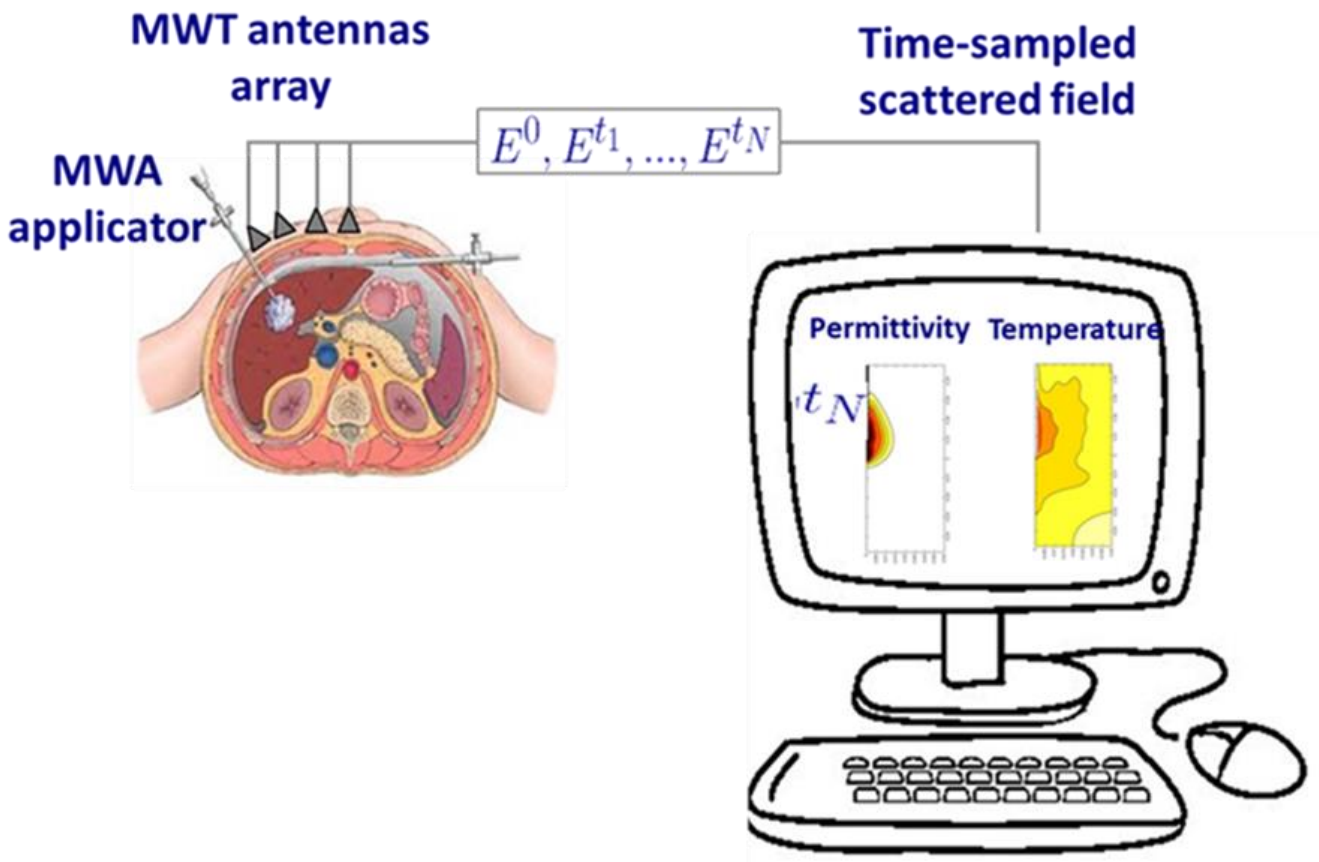
Mengchu Wang [1,2], Lorenzo Crocco [1], Marta Cavagnaro [1,2]

[1] CNR-IREA National Research Council of Italy, Institute for Electromagnetic Sensing of Environment, Napoli, Italy

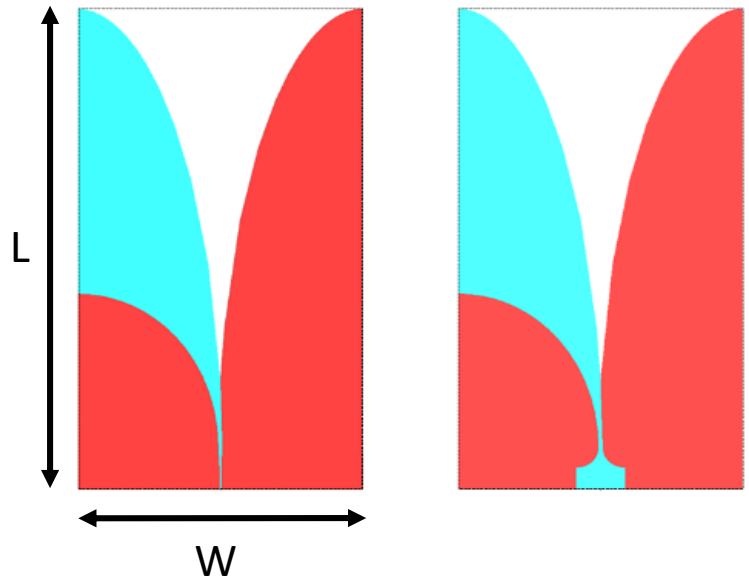
[2] DIET, Sapienza University of Rome, Rome, Italy

System requirement

- Working bandwidth: 0.5GHz-2GHz; possibilities of working at upper frequencies
- Capable of working inside matching medium ε=23
- Compact dimension
- End-fire radiation pattern
- Easy of fabrication
- Low mutual coupling for array configuration



Antenna design

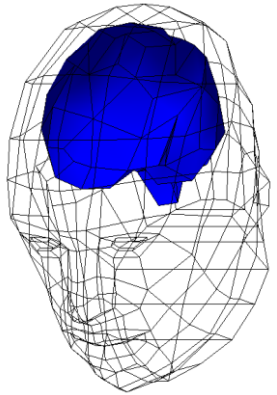


Red part: substrate
Blue part: metallic

- Working frequency: 0.5-3GHz
- Matching liquid permittivity: ε_{mm}=23
- Substrate material: RT/duroid 6010LM (ε_r=10.4)
- Antenna dimension: 70mm×131.5mm

WIPL-D software

WIPL-D d.o.o., Serbia



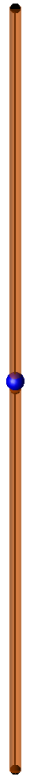
- A software package for electromagnetic simulation of arbitrary 3D structures
- Methods of Moments (MoM) based algorithm
- Accurate computational tool for metallic structure with homogeneous background

Mesh techniques

- *Auto mesh:* an adaptive method which segment the structure according to its shape. It allows coarser mesh elements for homogenously flat surfaces, and finer mesh elements for smaller detailed structures. mesh elements are limited by reference frequency

- *Direct mesh:* a method directly meshed the structure into quads of similar sizes. $\lambda/10$ is the average mesh dimension.

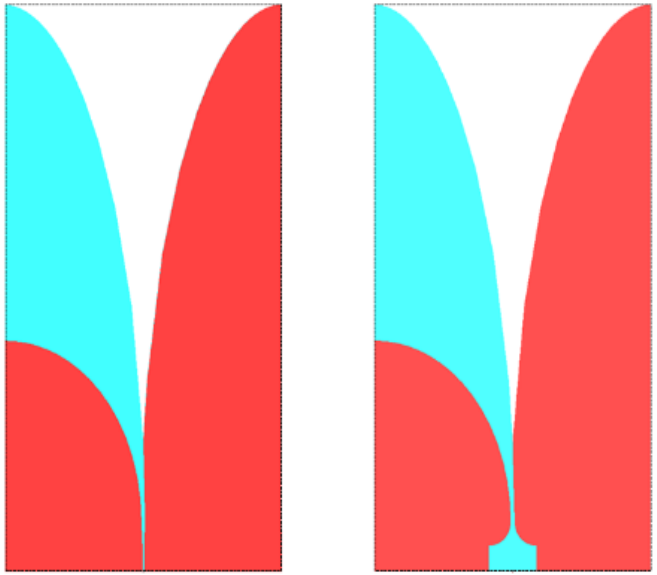
Convergence study
(on a dipole antenna)



- Working frequency: 1.5GHz
- Length: 100mm
- Diameter: 1mm
- Auto mesh reference frequency:

  0.5,1.5,3,7.5 GHz

Convergence study
(on a Vivaldi antenna)

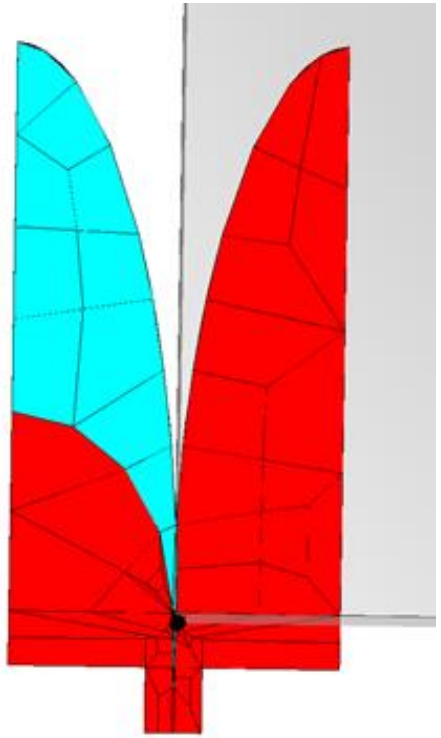


- Working frequency: 0.5-3GHz
- Antenna dimension:

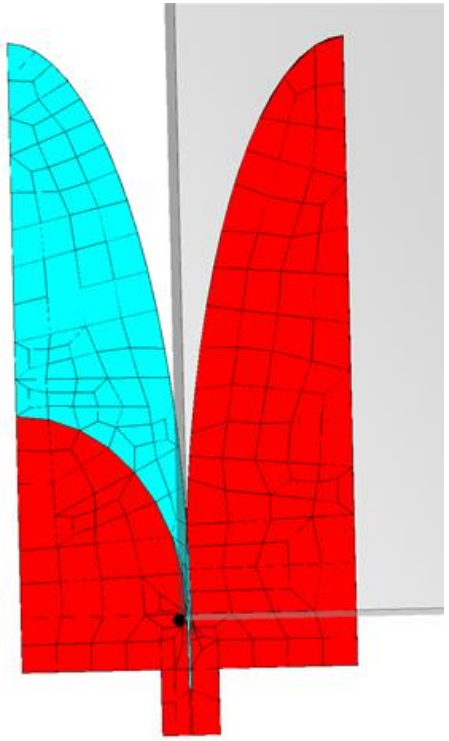
  70mm×131.5mm
- Auto mesh reference frequency:

  5,11,15,17 GHz

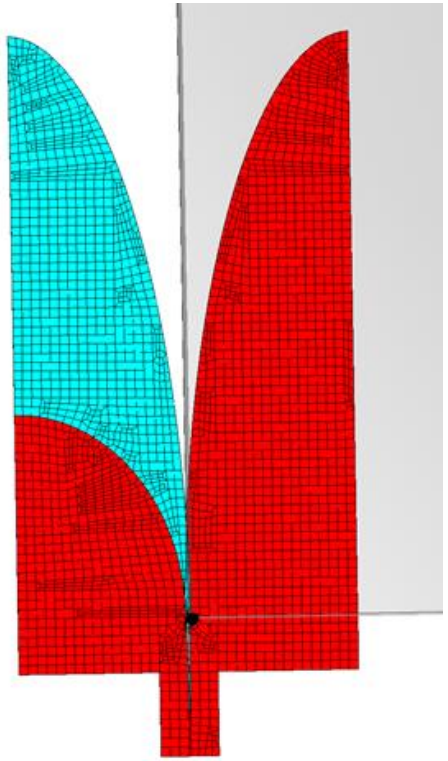
Convergence study
(on a Vivaldi antenna)



Auto model mesh view:
Reference frequency
5GHz



Auto model mesh view :
Reference frequency
15GHz



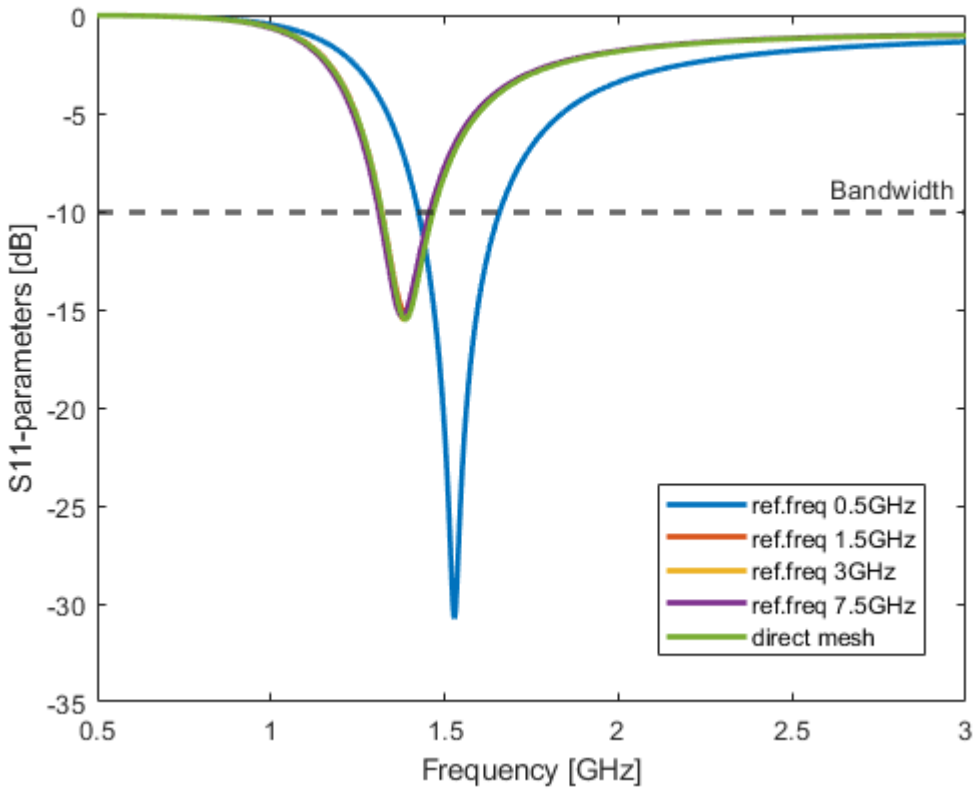
Direct mesh view :
Mesh dimension 2mm

Convergence study

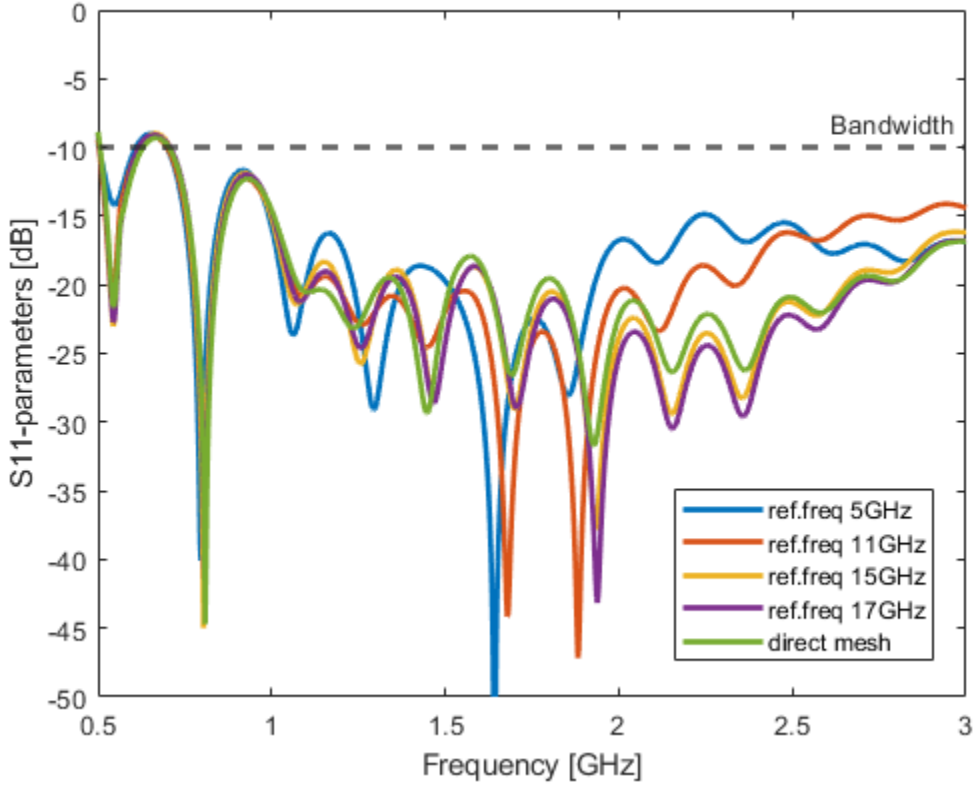
Mesh Settings and Corresponding Number of Unknowns

	Meshing technique	**Auto mode**				**Direct technique (Mesh size $\lambda/10$)**
Dipole	Reference frequency(GHz)	0.5	1.5	3	7.5	N/A
	Number of unknown	1	3	5	9	5
Vivaldi antenna	Reference frequency(GHz)	5	11	15	17	N/A
	Number of unknown	12438	36173	58789	73922	29656

Convergence study



S11 (dB) of a half-wavelength dipole



S11 (dB) of the Vivaldi antenna

Result convergence: reference frequency > 1.5GHz

Result convergence: reference frequency > 15GHz

Conclusion

- *Direct mesh technique* offers accurate result for complex structure with fewer meshes
- *Auto mesh technique* offers accurate result for simple structure with fewer meshes

Thank you for your attention!

If you have any questions, please contact me through email:
wang.m@irea.cnr.it