

IC1301 –WiPE >>>



WiPE Efforts at the ECE Department of the University of Nicosia

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CYPRUS



1st MC Meeting, Edinburgh
25th March 2014

cost



cost
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY



Agenda

- » The research work at the University of Nicosia related to WiPE will be presented.
- » The topics are the following:
 - 1.Design of New Types of RFID Tags (WG1),
 - 2.Antennas with Liquid Crystals (WG3),
 - 3.Biomedical & Healthcare Applications (WG4)
 - 4.EM Radiation & SAR (WG5).
- » In conclusion, future plans and prospects of research within the WiPE will be discussed.



WG1: Design of New Types of Tags

- » Tag antenna synthesis
- » Choice of initial antenna compatible to the chip
- » Improvement of the antenna by using an optimization technique



New Types of Tags

Genetic Algorithm (Artificial Bee Colony _ ABC)

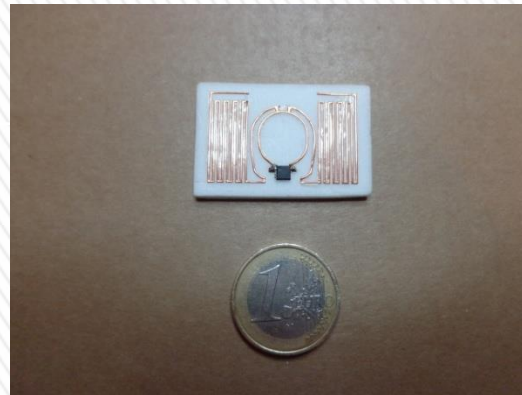
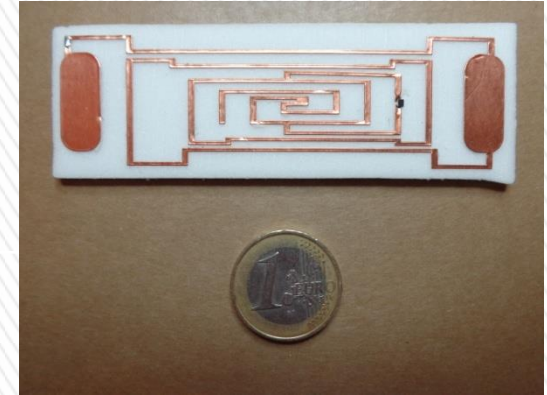
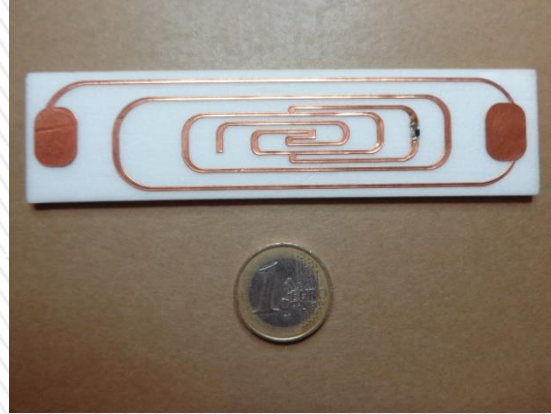
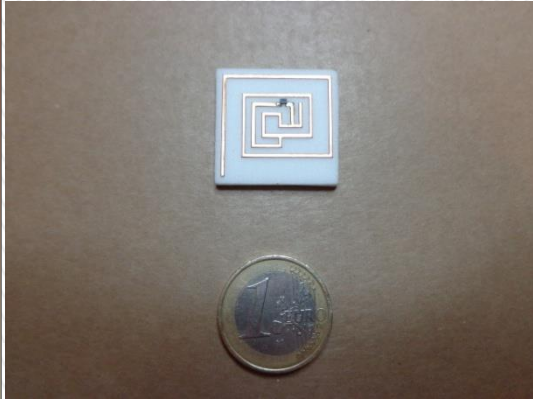
Fitness Function

$$F(\bar{\mathbf{x}}) = -A_s(\bar{\mathbf{x}}) + \Xi \times \left| \max(0, |\Gamma| - 0.3) \right|$$

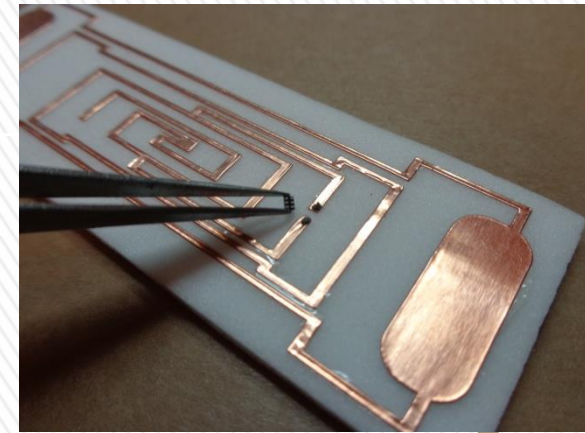
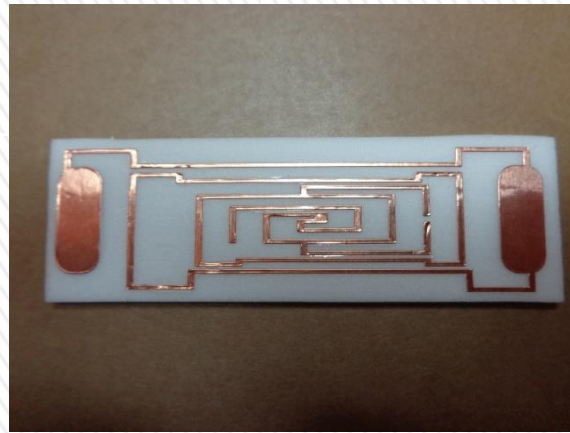
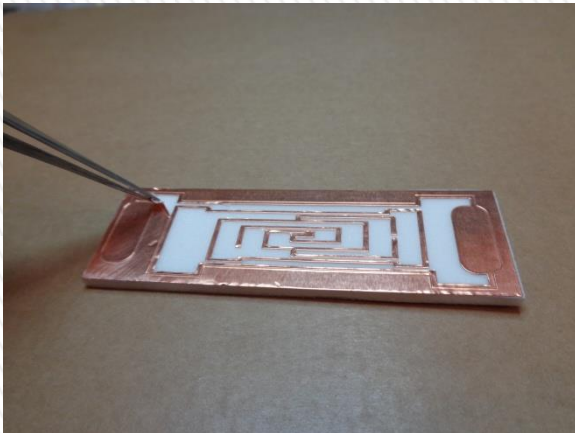
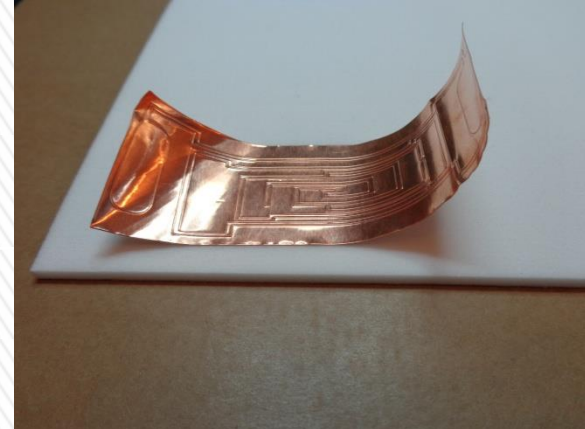
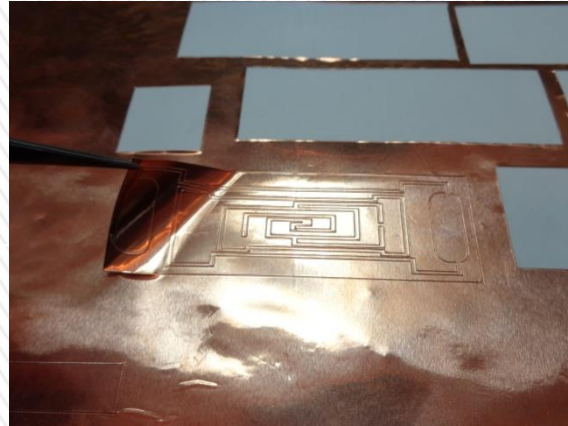
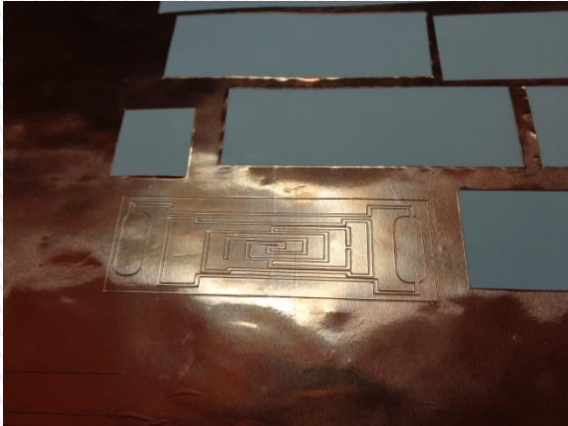
$$\Gamma = \frac{Z_{in,chip} - Z_a^*}{Z_{in,chip} + Z_a}$$

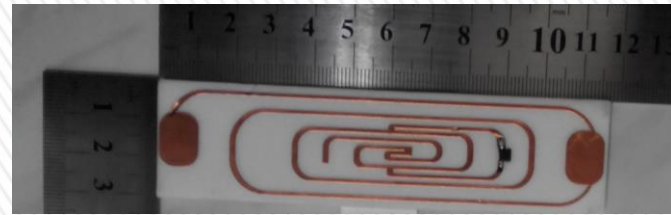
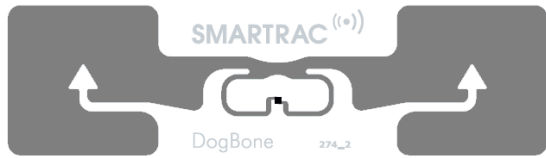


New Types of Tags

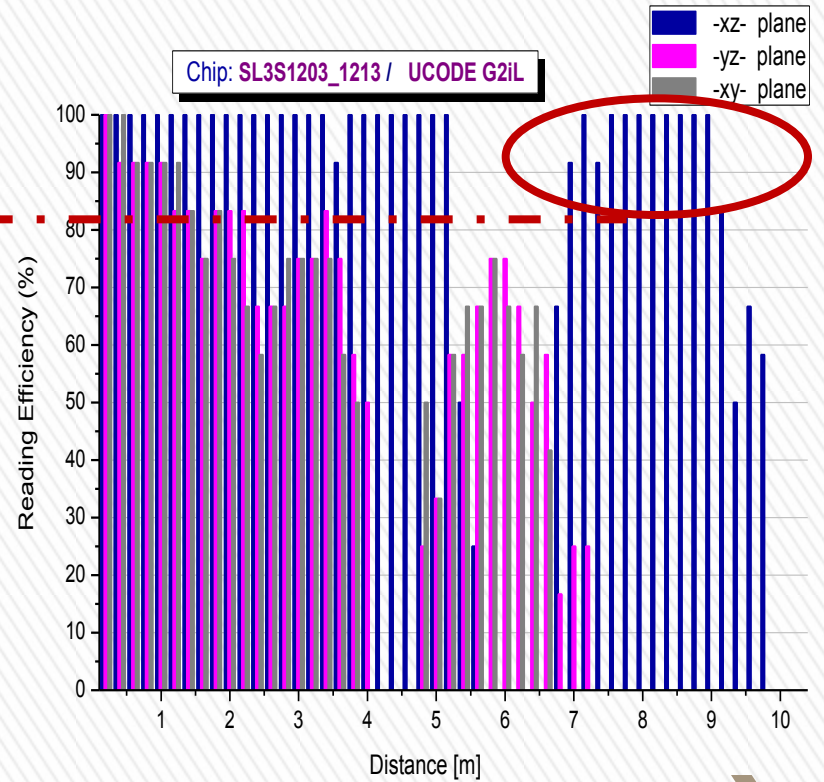
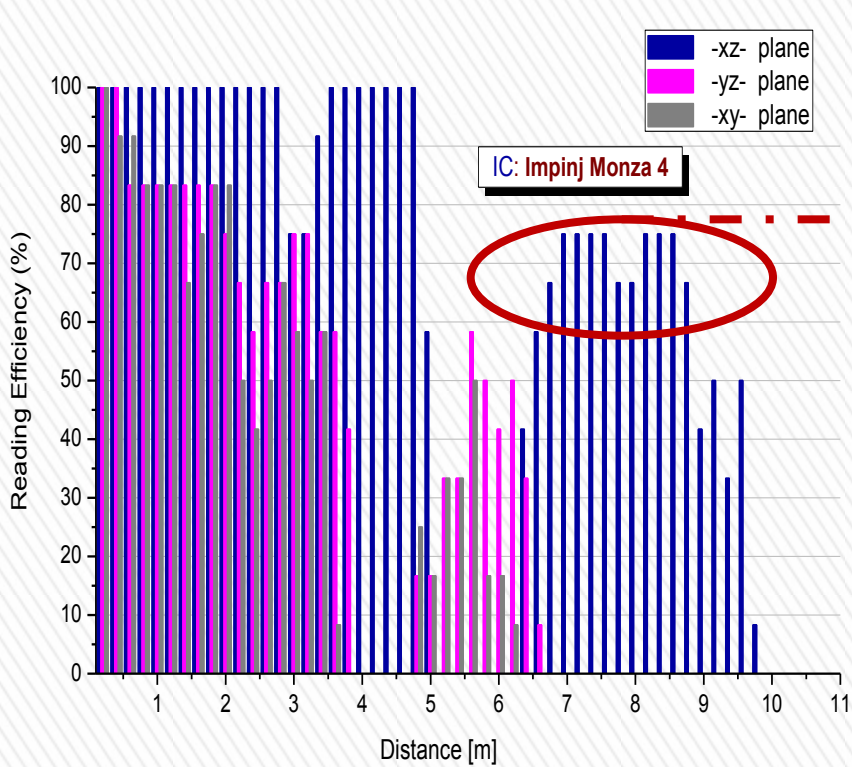


New Types of Tags



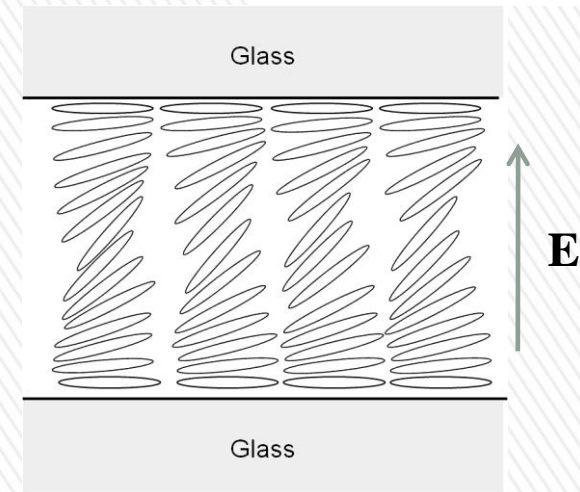
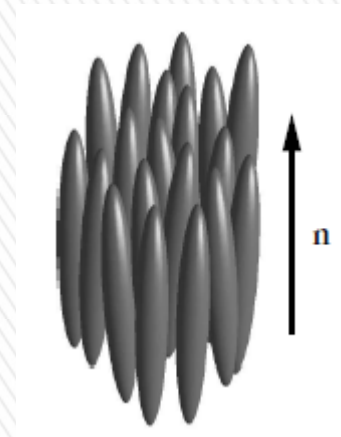


Dimensions: 26m x 115mm

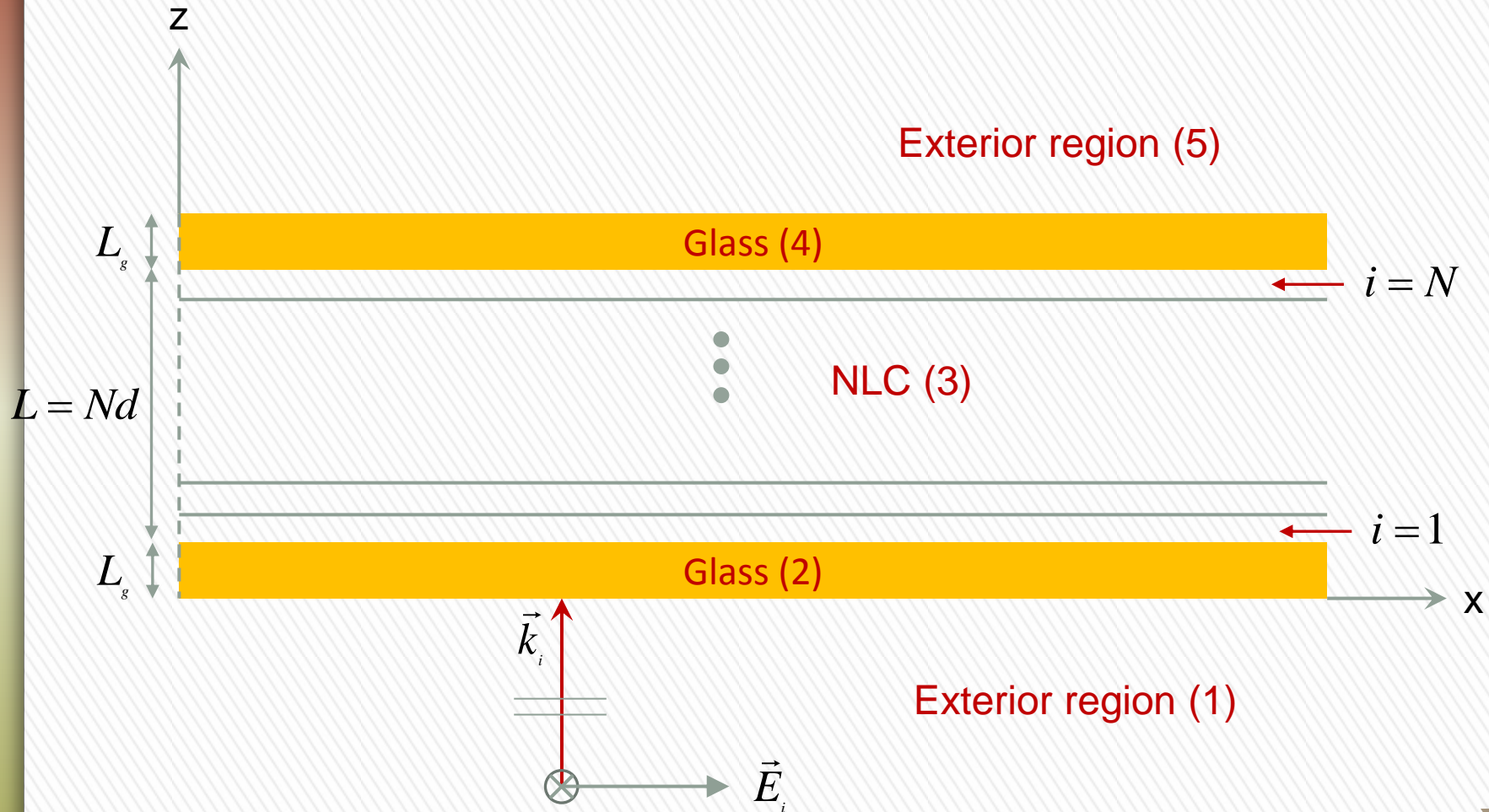


WG3: Antennas with Liquid Crystals (LC)

- » LC are non-homogeneous & anisotropic.
- » The molecules of LCs are rod-like or disc-like whose orientation depends on the electric field.
- » The dielectric tensor entries of the LC are dependent on the orientation of the molecules (directors).
- » Modeling of LC mandates solution of a non-linear EM problem.



Problem Geometry



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Problem Formulation

Time-Harmonic Maxwell's curl equations as applied to NLCs:

$$\nabla \times \vec{E} = -j\omega\mu_o\vec{H}$$

$$\nabla \times \vec{H} = j\omega\varepsilon_o\hat{\varepsilon}\vec{E}$$



where $\hat{\varepsilon}(z) = \begin{bmatrix} \varepsilon_{xx} & 0 & \varepsilon_{xz} \\ 0 & \varepsilon_{yy} & 0 \\ \varepsilon_{zx} & 0 & \varepsilon_{zz} \end{bmatrix}$

$$\varepsilon_{xx} = n_e^2 \sin^2 \theta(z) + n_o^2 \cos^2 \theta(z)$$

$$\varepsilon_{xz} = \varepsilon_{zx} = (n_e^2 - n_o^2) \sin \theta(z) \cos \theta(z)$$

$$\varepsilon_{yy} = n_o^2$$

$$\varepsilon_{zz} = n_o^2 \sin^2 \theta(z) + n_e^2 \cos^2 \theta(z)$$

$$-\frac{\partial E_y}{\partial z} = -j\omega\mu_o H_z$$

$$-\frac{\partial E_x}{\partial z} = j\omega\mu_o H_y$$

$$0 = -j\omega\mu_o H_z$$

$$-\frac{\partial H_y}{\partial z} = j\omega\varepsilon_o \left[\varepsilon_{xx} E_x + \overset{0}{\varepsilon_{xy} E_y} + \varepsilon_{xz} E_z \right]$$

$$-\frac{\partial H_x}{\partial z} = j\omega\varepsilon_o \left[\overset{0}{\varepsilon_{yx} E_x} + \varepsilon_{yy} E_y + \overset{0}{\varepsilon_{yz} E_z} \right]$$

$$0 = j\omega\varepsilon_o \left[\varepsilon_{zx} E_x + \overset{0}{\varepsilon_{zy} E_y} + \varepsilon_{zz} E_z \right]$$

...matching the tangential E - & H -fields at the interfaces and re-arranging the terms in the form of a matrix system yields:

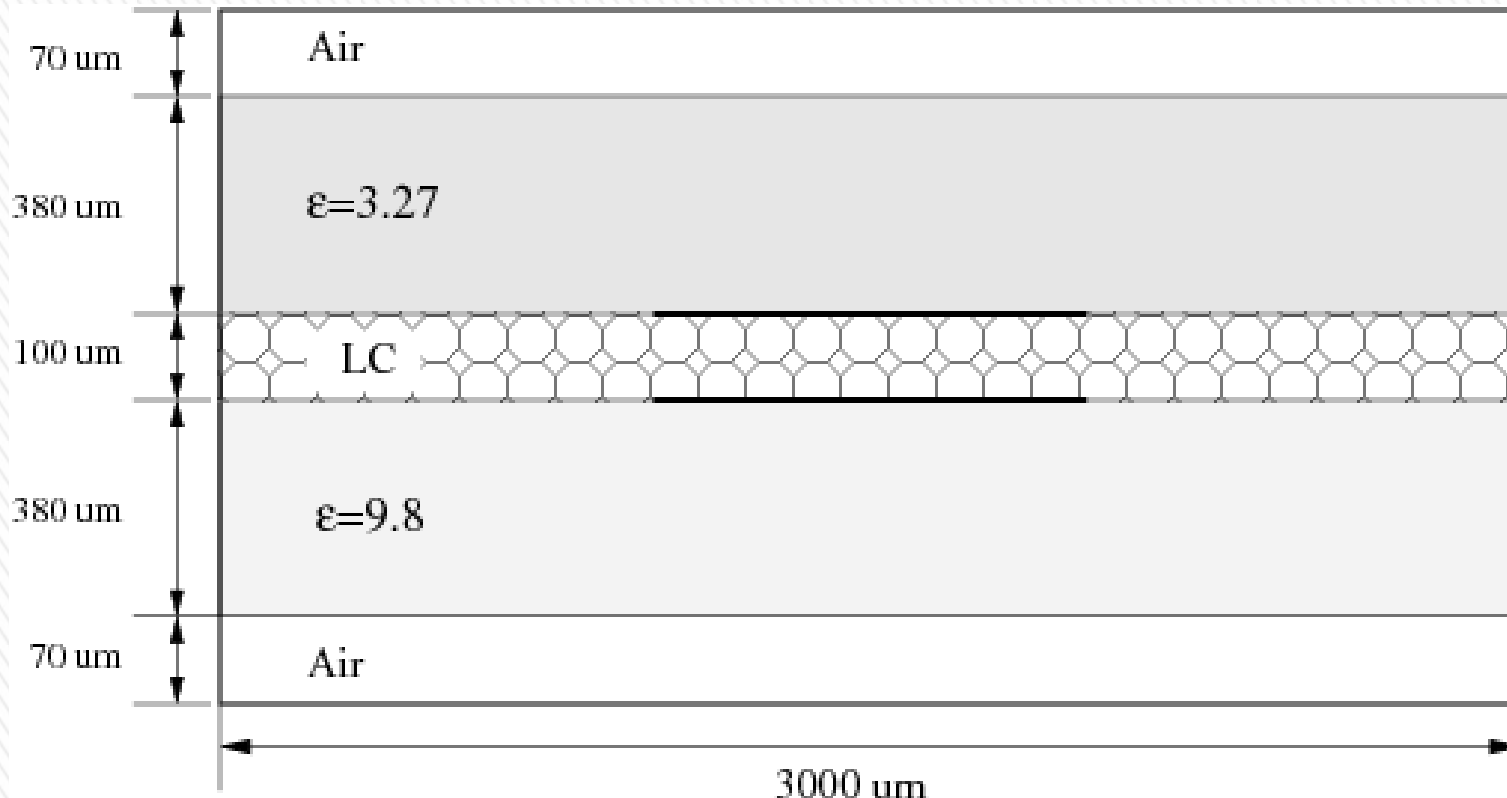
$$\begin{bmatrix} E_o & -e^{jk_o n_g L_g} & -e^{-jk_o n_g L_g} & 0 & 0 & \dots & 0 & 0 & 0 & 0 \\ -E_o & -n_g e^{jk_o n_g L_g} & n_g e^{-jk_o n_g L_g} & 0 & 0 & \dots & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & -1 & -1 & 0 & 0 & \dots & 0 & 0 \\ 0 & n_g k_o / k_{x_1} & -n_g k_o / k_{x_1} & -1 & +1 & 0 & 0 & \dots & 0 & 0 \\ 0 & 0 & 0 & e^{-jk_{x_1} d} & e^{jk_{x_1} d} & -1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & (k_{x_1} / k_{x_2}) e^{-jk_{x_1} d} & (-k_{x_1} / k_{x_2}) e^{jk_{x_1} d} & -1 & 1 & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \dots & 0 & 0 & e^{-jk_o n_g L_g} & e^{jk_o n_g L_g} & -E_o & D_g \\ 0 & 0 & 0 & \dots & 0 & 0 & n_g e^{-jk_o n_g L_g} & -n_g e^{jk_o n_g L_g} & -E_o & T \end{bmatrix} \begin{bmatrix} \Gamma \\ A_g \\ B_g \\ A_1 \\ B_1 \\ \vdots \\ C_g \\ D_g \\ T \end{bmatrix} = \begin{bmatrix} -E_o \\ -E_o \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

NLC Layer 1

NLC Layer 2

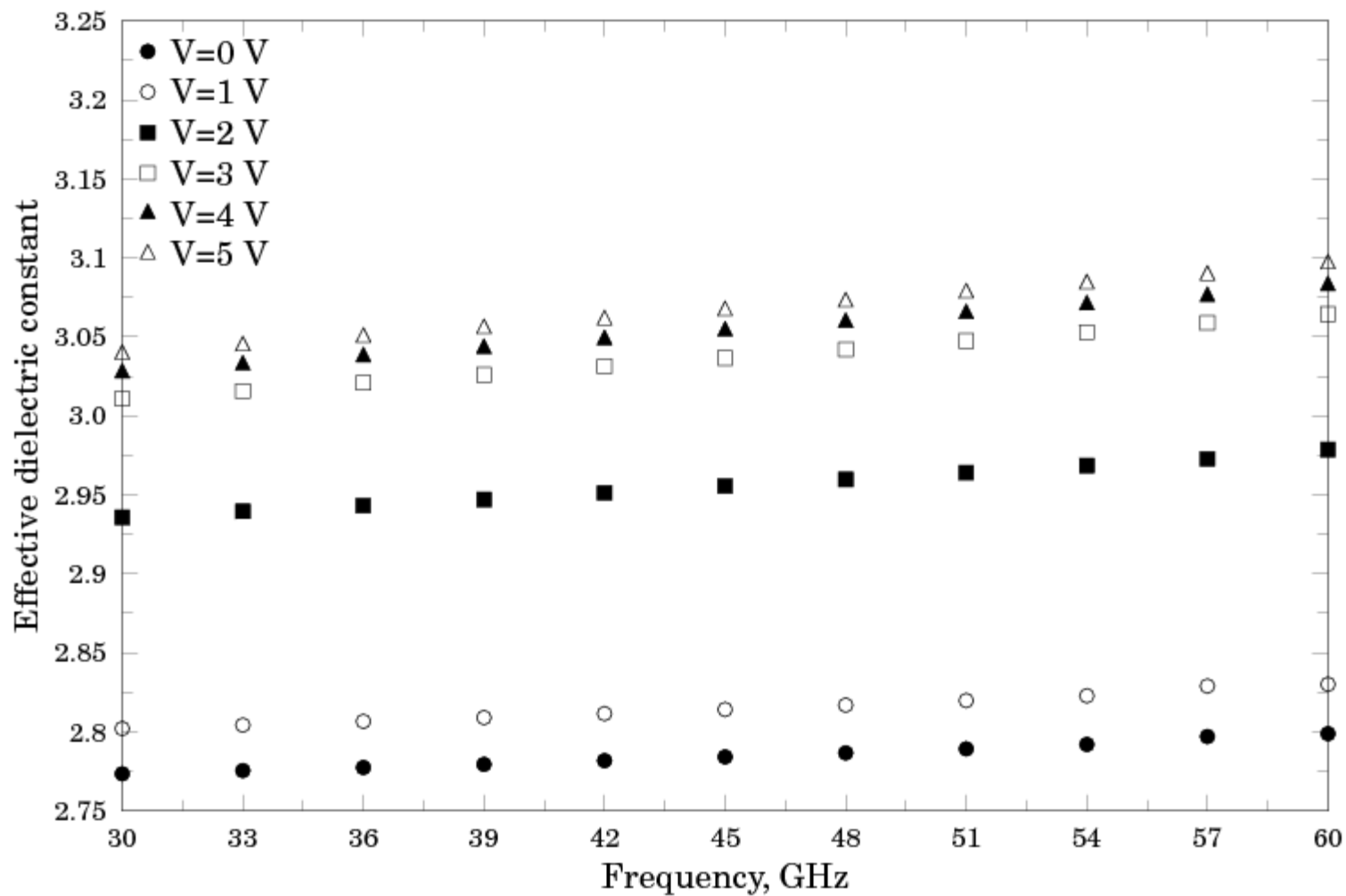


Millimeter-Wave Structures in the Presence of Nematic Crystals



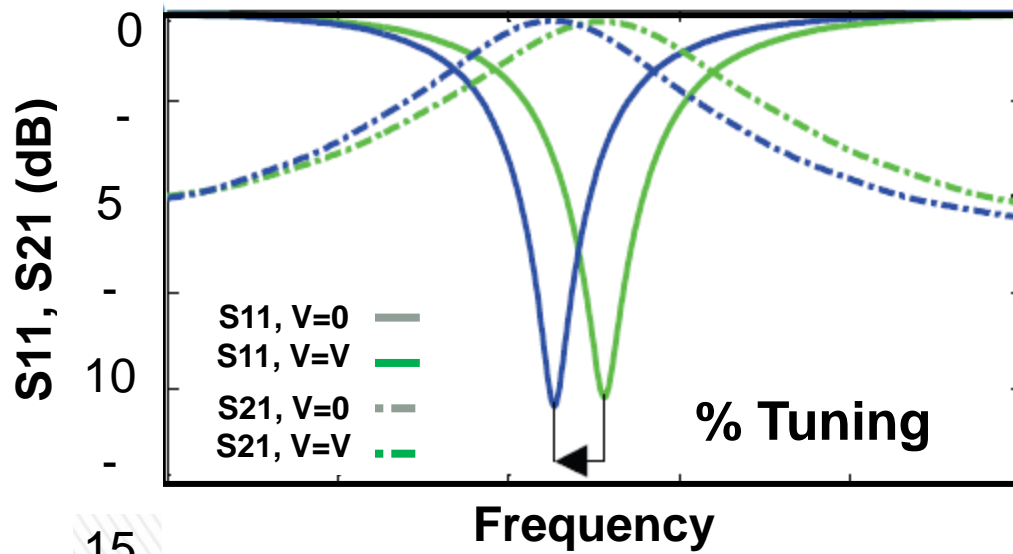
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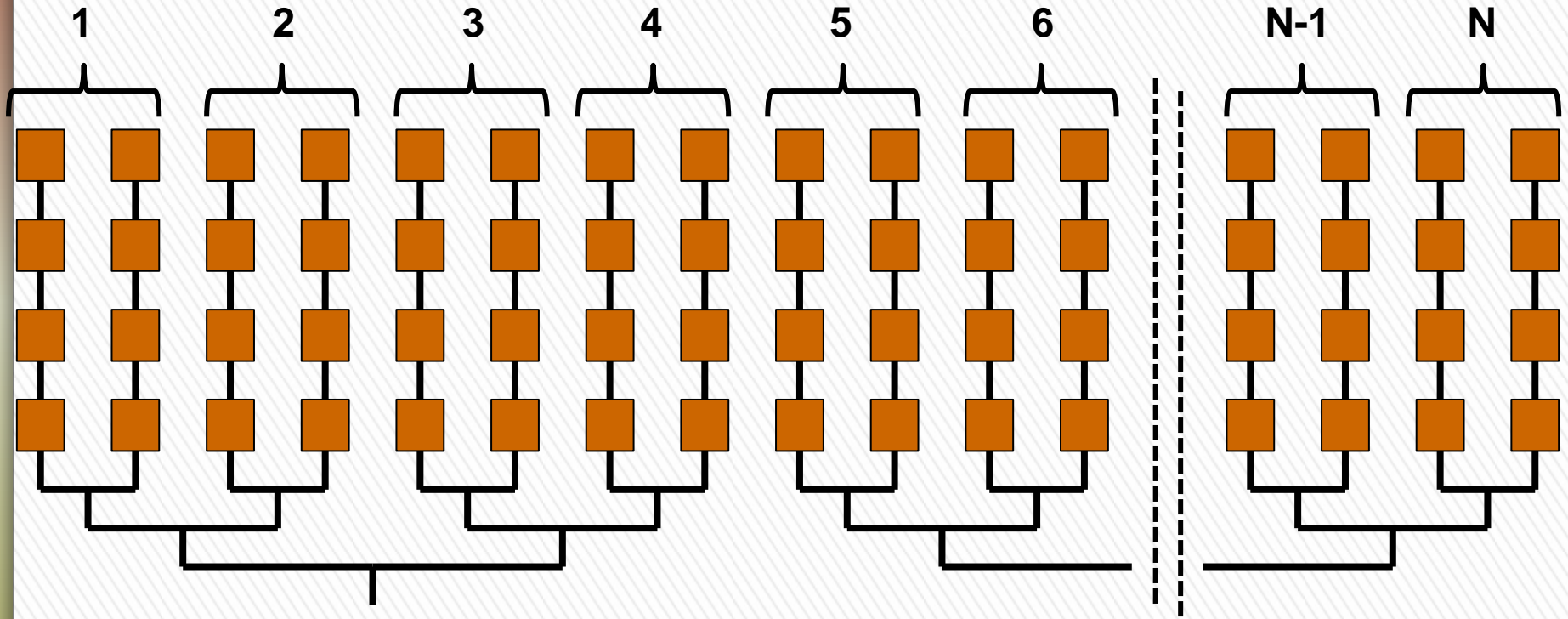




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WG4: Biomedical & Healthcare Applications

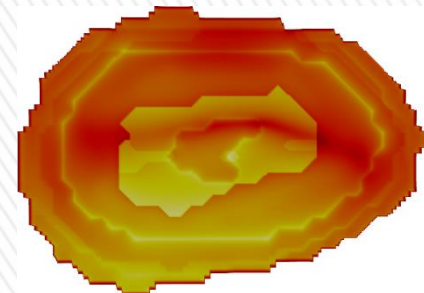
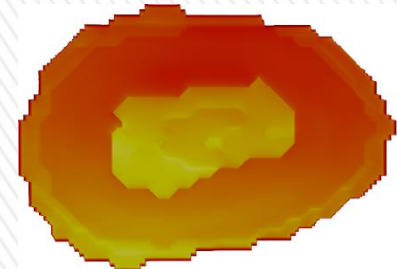
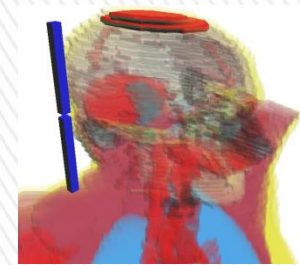
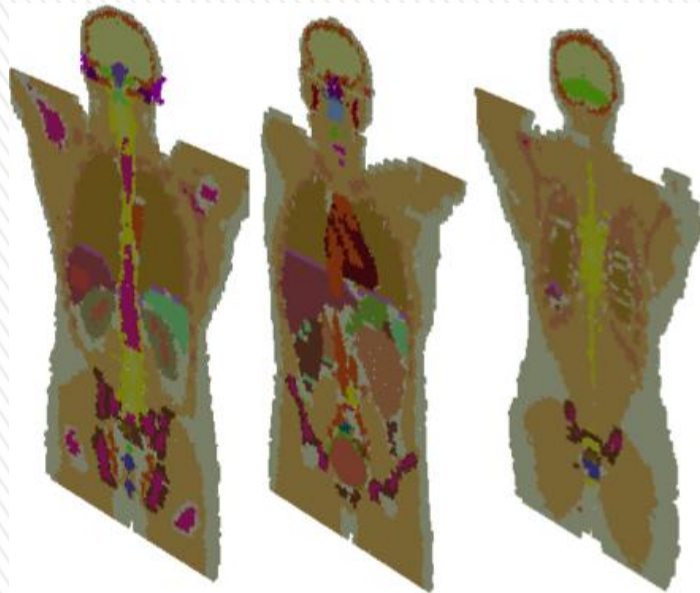
- » **Metallic Implants Effects on the SAR and Temperature Distributions over the Human Body**
- » **Orthogonal Decomposition for the Solution of Forward and Inverse ECG and EEG Related Biomedical Problems**
- » **A Healthcare Application Based on Passive UHF RFID Technology**

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WG4: Biomedical & Healthcare Applications

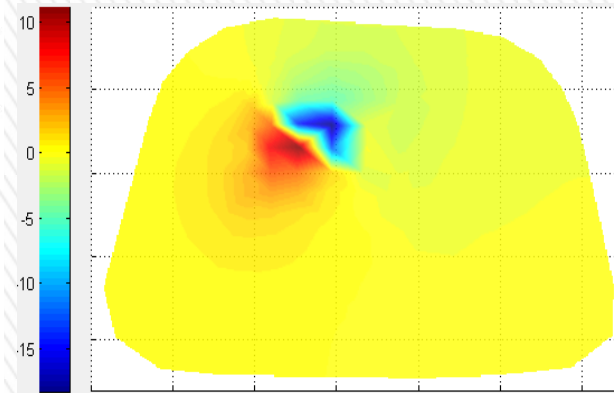
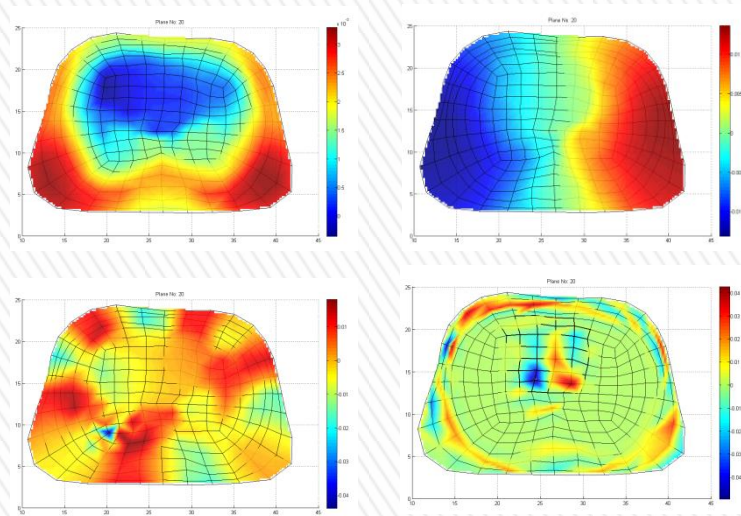
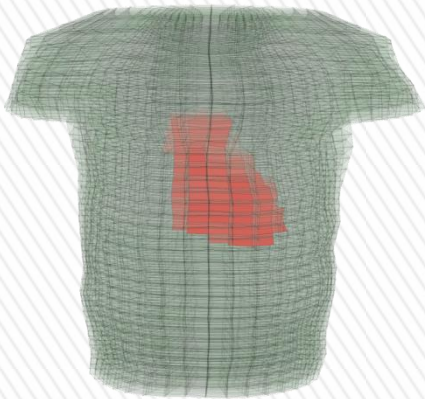
- » **Metallic Implants Effects on the SAR and Temperature Distributions over the Human Body**



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WG4: Biomedical & Healthcare Applications

- » Orthogonal Decomposition for the Solution of Forward and Inverse ECG and EEG Related Biomedical Problems

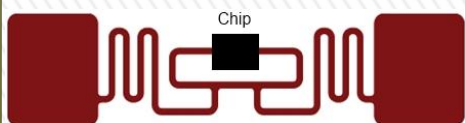


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WG4: Biomedical Applications & Healthcare

» A Healthcare Application Based on Passive UHF RFID Technology

1. Patient Identification
2. Inventory Control & Monitoring
3. Real Time Location Service (RTLS)



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WG5: Monitoring of EM Radiation & SAR Estimation

- » Design of broadband monitoring systems
- » SAR estimation of RFID Readers

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BROADBAND MONITORING SYSTEMS

Can measure the
Electromagnetic Radiation
in the frequency band from
some KHz up to **5 GHz**.

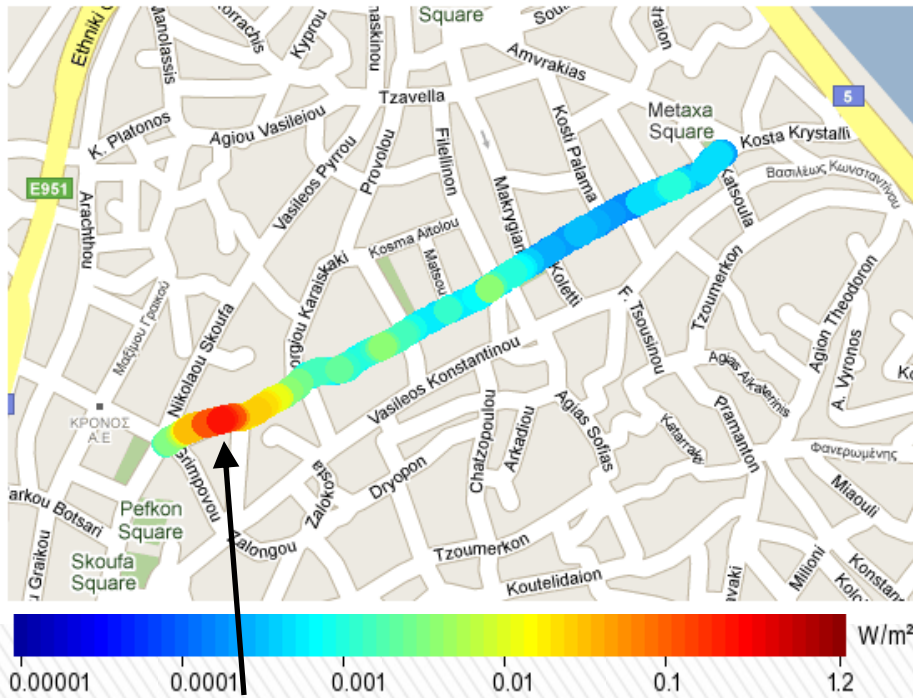


Mobile HERMES

Η υλοποίηση της υπηρεσίας πραγματοποιείται με τη βοήθεια ενός "κινητού" σταθμού μέτρησης και καταγραφής της Η/Μ ακτινοβολίας ραδιοσυχνότητας από διάφορες πηγές, προσαρμόζοντας κατάλληλα ένα μετρητή πάνω σε ένα ειδικά εξοπλισμένο όχημα.

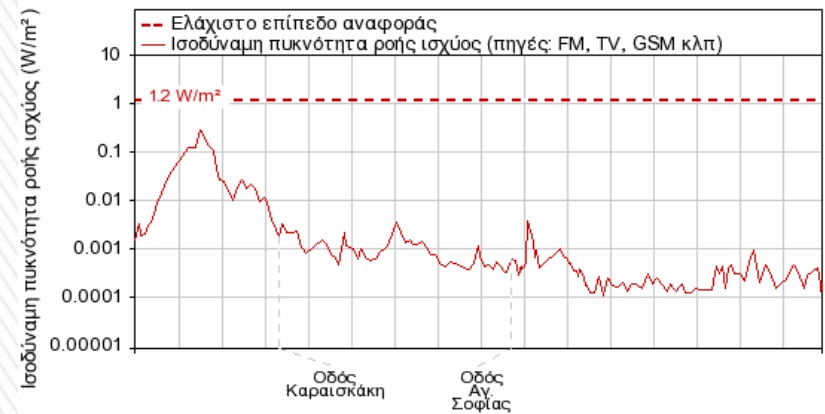


HERMES PROJECT



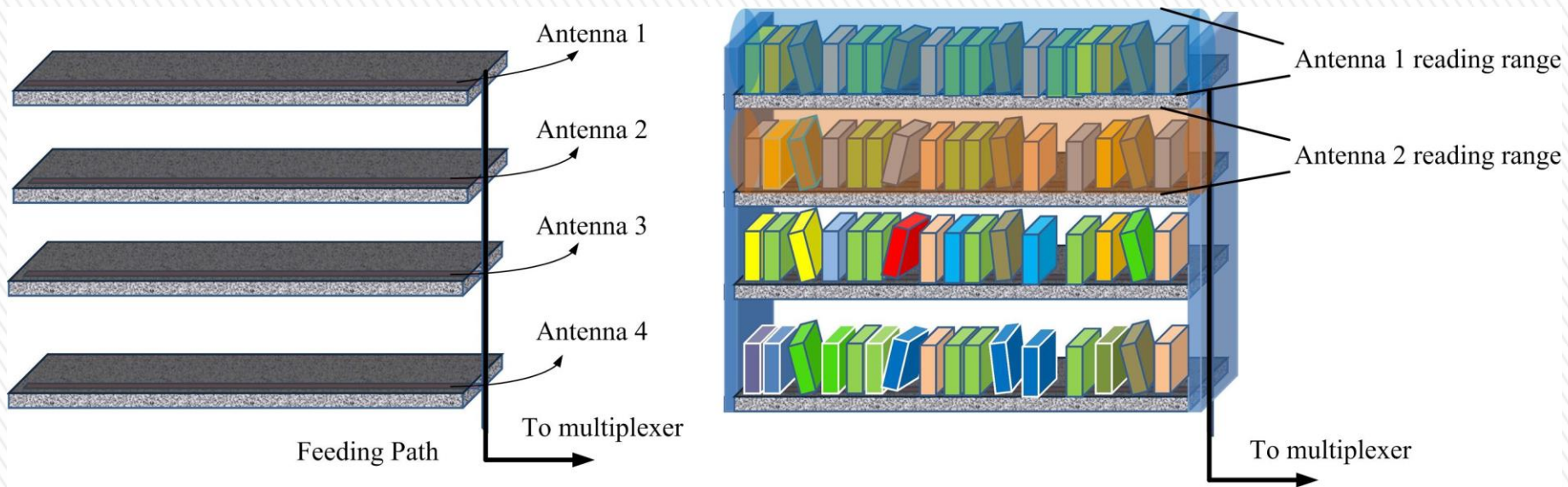
Localization of EM Sources

Κατανομή της πυκνότητας ροής ισχύος



WG5: Monitoring of EM Radiation & SAR Estimation

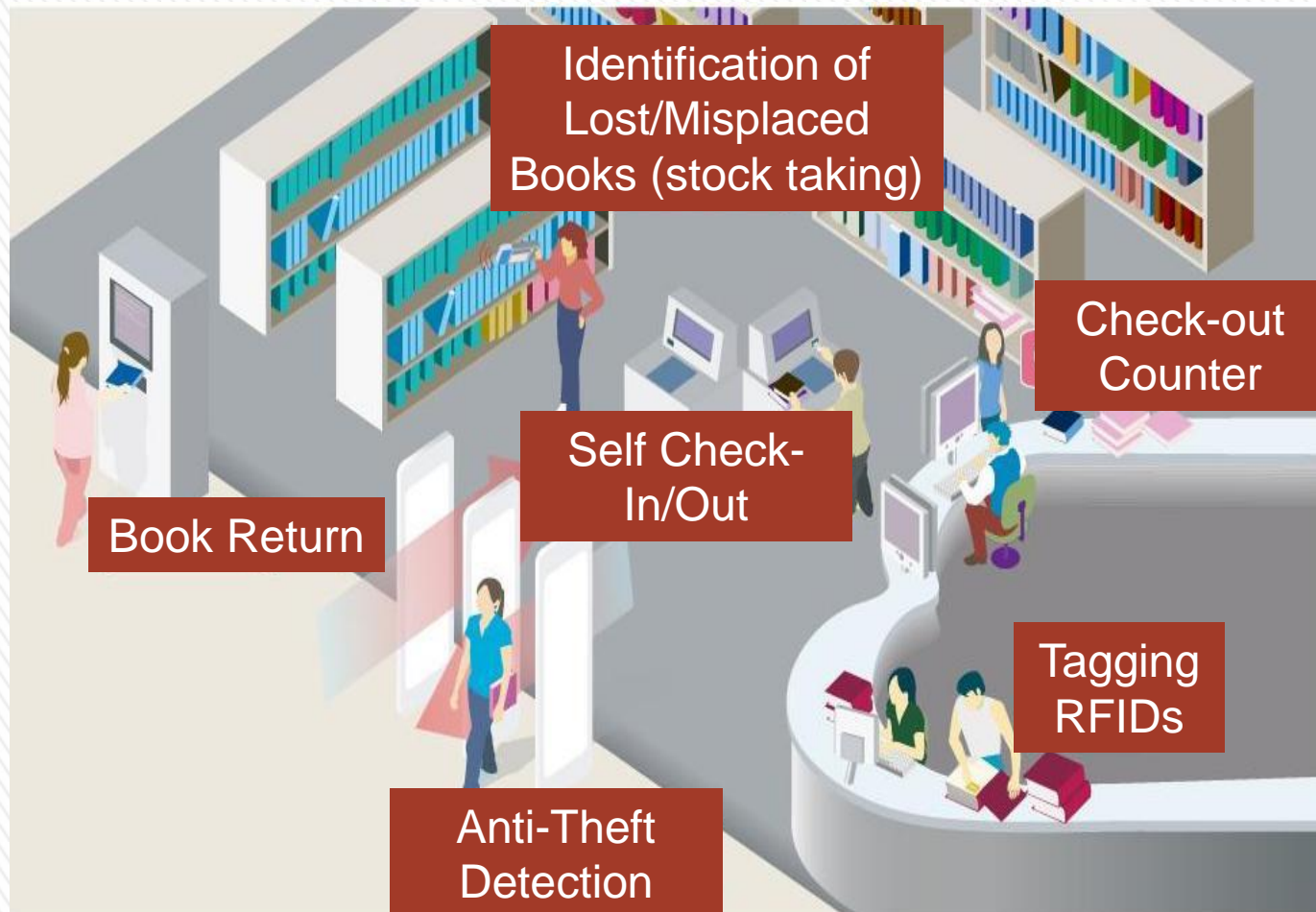
» SAR estimation of RFID Readers



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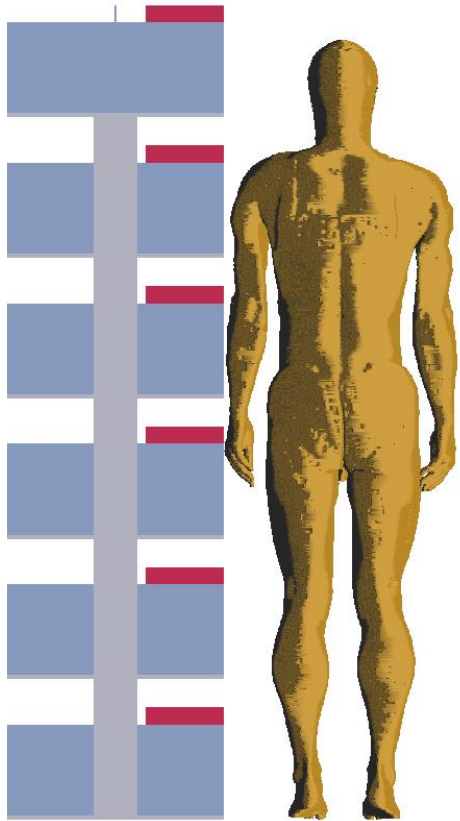


Suggestion: Identification using RFID

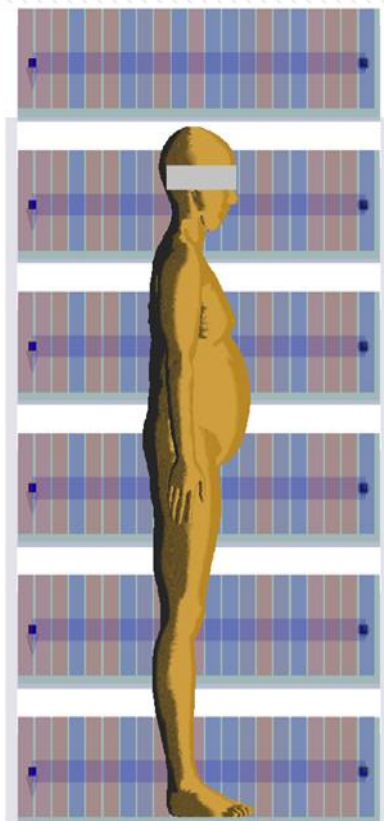




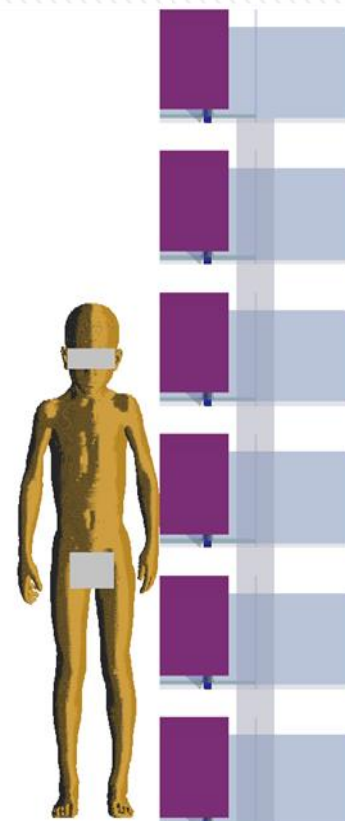
- **Three different models were examined:**
 - Duke (male 34 years old)
 - Ella (female 26 years old) at 7 months gestational age
 - Thelonious (male 6 years old)
- **The resolution of the models was 1 mm x 1 mm x 1 mm**



Duke



Ella



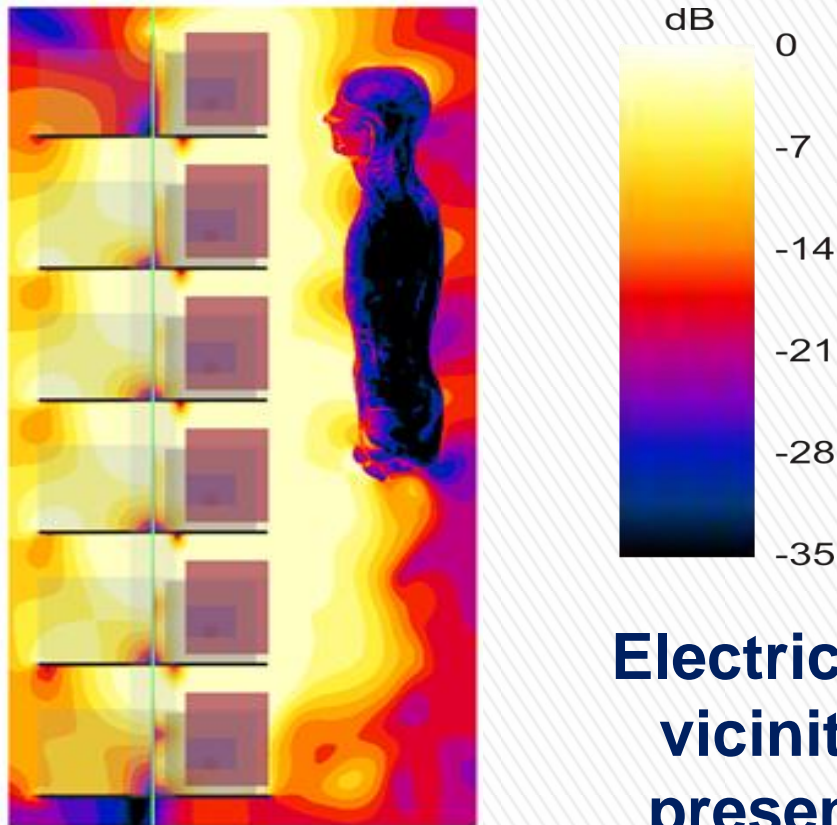
Thelonious



Two simulation scenarios examined:

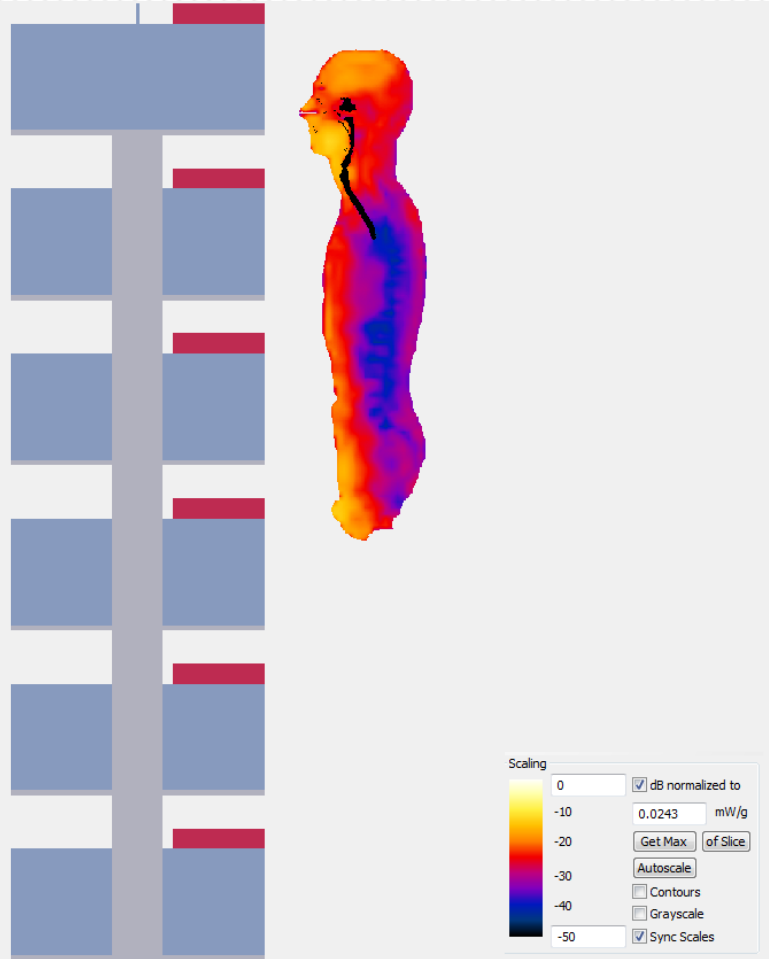
- ❑ The human model facing the cabinet at a distance of 10 cm
- ❑ The human model is nearly touching the cabinet (5 mm away) with its arm

Simulations were performed with or without books in the cabinet!!!

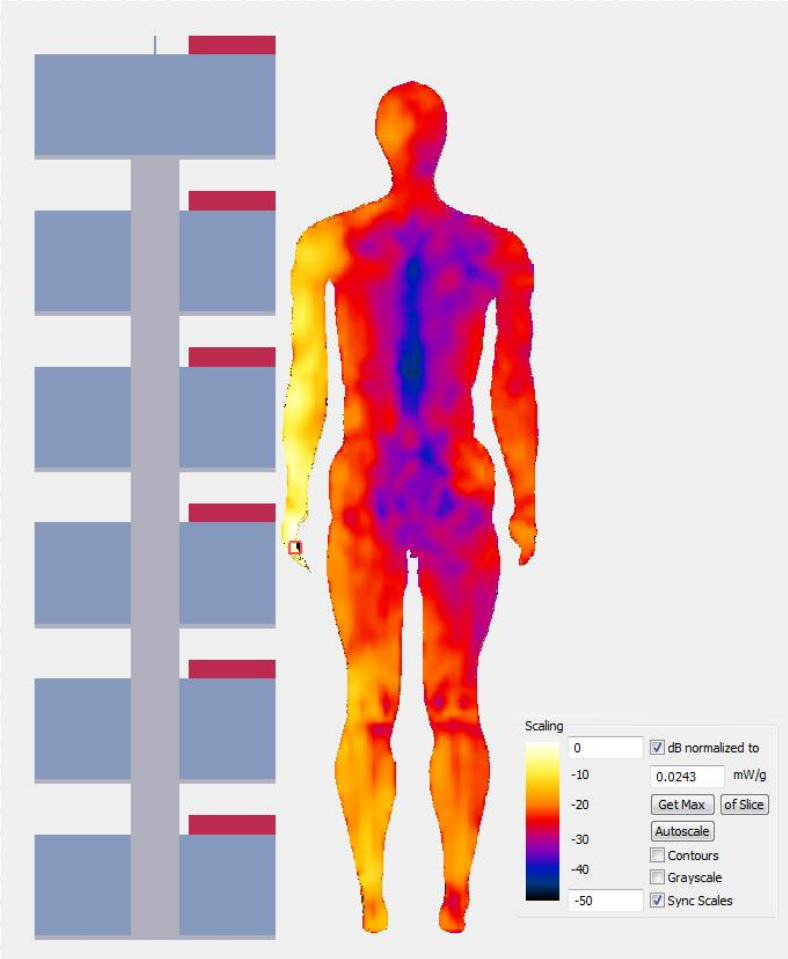


Electric field distribution in the vicinity of the cabinet in the presence of a human model.



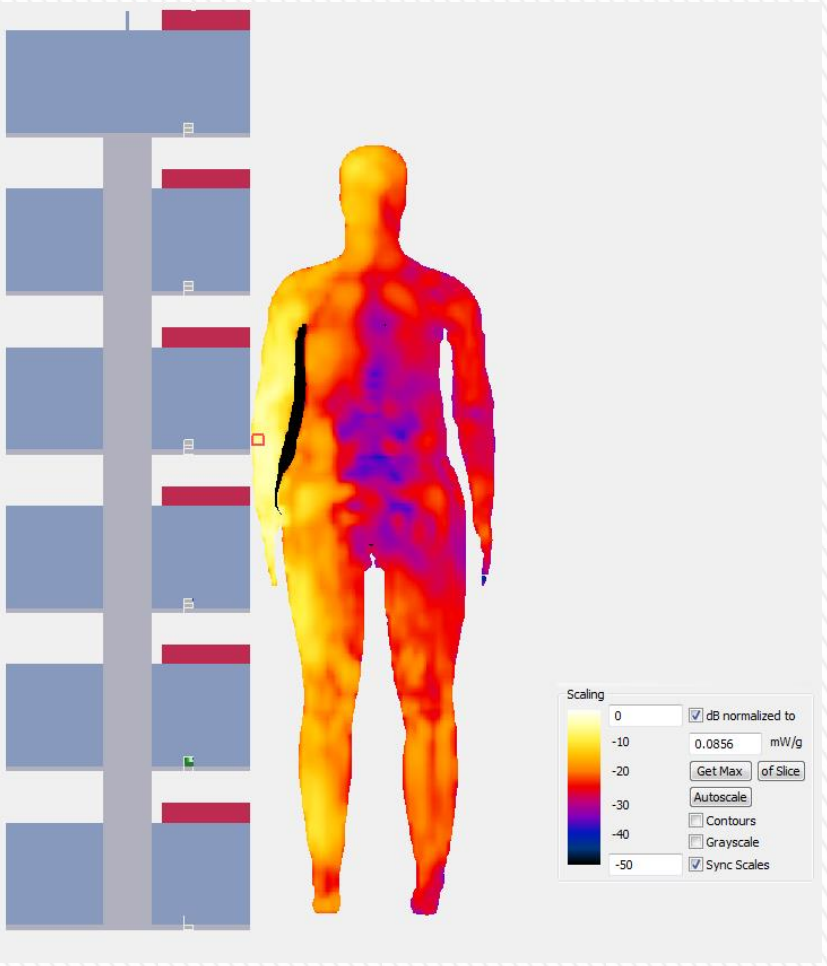


Duke facing the cabinet in the presence of the patch antenna

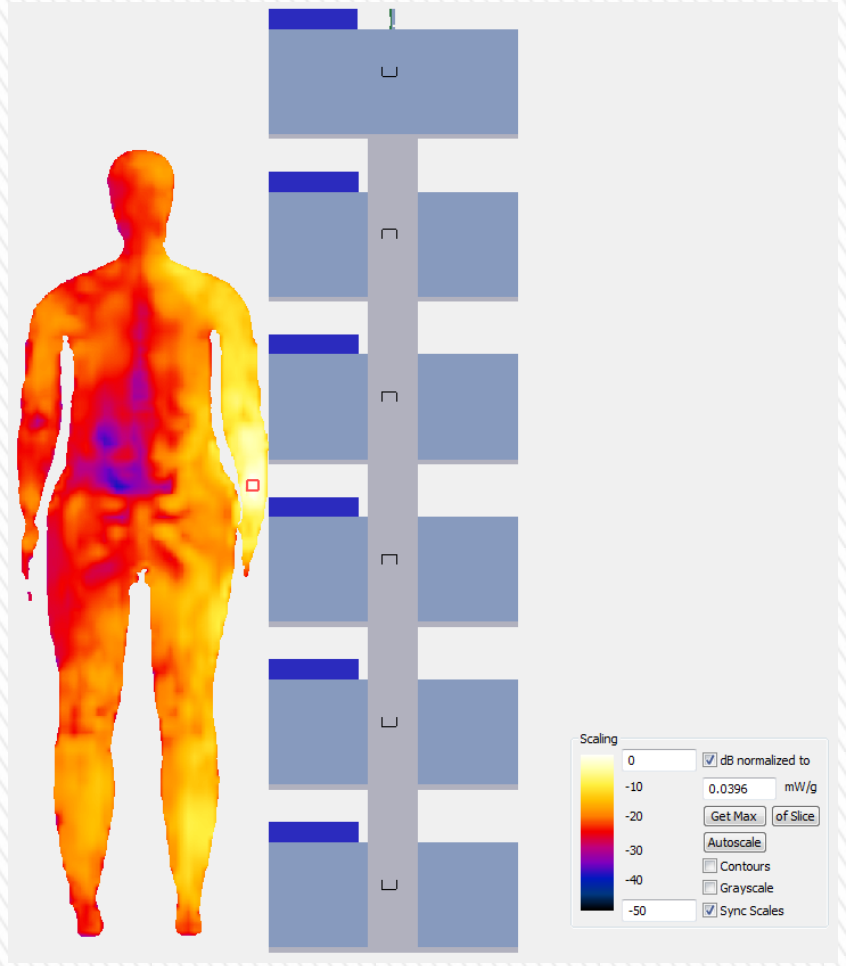


Duke standing sideways of the cabinet in the presence of the patch antenna





Ella standing sideways of the cabinet in the presence of a horizontally placed microstrip



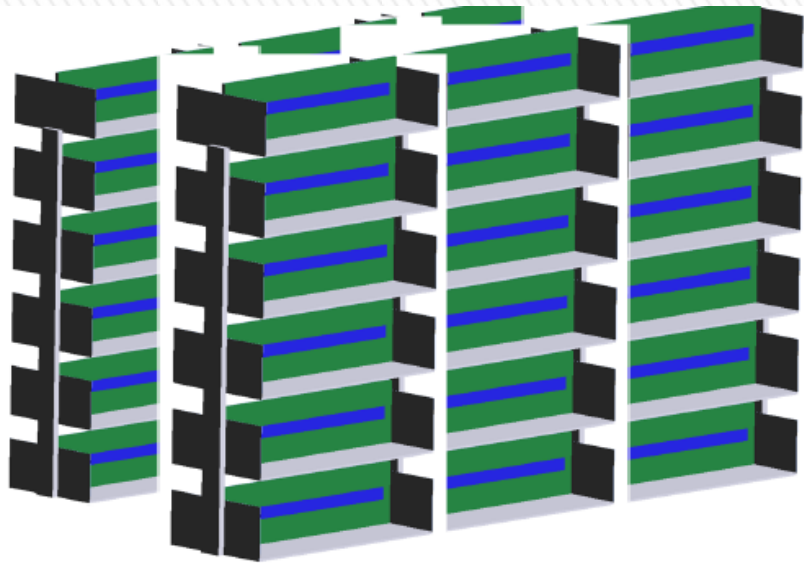
Ella standing sideways of the cabinet in the presence of a vertically placed microstrip



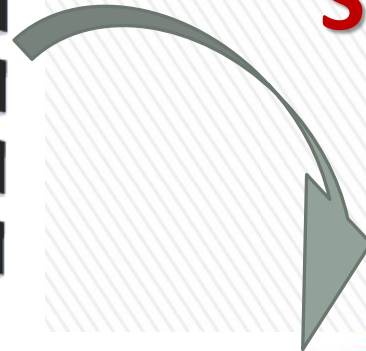
Peak spatial SAR (“psSAR10g”) averaged over 10g of human tissues

model name	Distance		Books		psSAR10g (W/kg)				
	5mm	10cm	YES	NO	antenna type & orientation				
					stripline vertical	stripline horizontal	2 patch antennas	single patch LP	single patch CP
Duke	x		x		0,090	0,363	0,147	0,271	0,117
	x			x	0,077	0,080	0,086	0,077	0,028
		x	x		0,012	0,021	0,015	0,076	0,013
		x		x	0,015	0,028	0,085	0,050	0,004
Ella 7 months	x		x		0,119	0,256	0,236	1,192	0,213
	x			x	0,036	0,046	0,156	0,370	0,046
		x	x		0,036	0,048	0,038	0,068	0,019
		x		x	0,029	0,034	0,077	0,039	0,013
Thelonious	x		x		0,124	0,439	0,147	0,545	0,169
	x			x	0,027	0,041	0,128	0,106	0,045
		x	x		0,028	0,027	0,066	0,097	0,017
		x		x	0,031	0,036	0,074	0,034	0,005

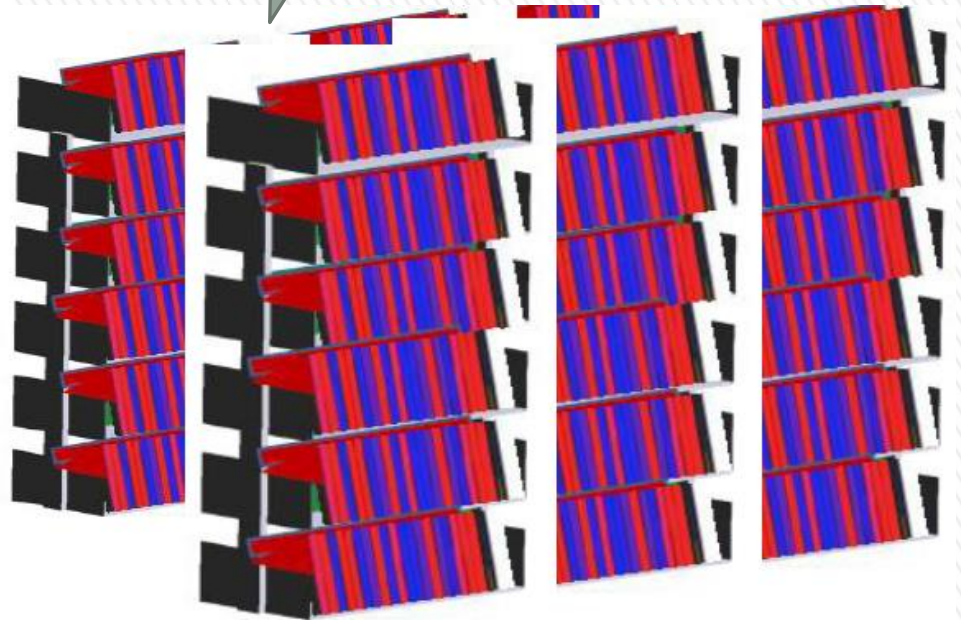
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SMART



**BEST COVERAGE
~100%**



**REDUCED
SPILL-OVER E-FIELD**

MIN SAR



SEAWIND: Sound Exposure Assessment of Wireless Network Devices



The SEAWIND Project

Exposure Assessment

- We will investigate the current and future technologies designed to wirelessly transmit wireless large amounts of data between mobile devices (phone, laptop, etc.) and fixed transmitters (access points, etc.), including wireless network systems such as WLAN, WIMAX and WPAN.
- Short-term (6 minutes) and long-term (several hours to several days) exposures will be assessed by applying and improving the most advanced instrumentations, methodologies and procedures.
- Extrapolation models between different technologies will also be developed.



WLAN has entered schools almost everywhere

Dosimetry

- Since the external fields are not directly related to the potential biological effects, the fields induced by these external fields in human tissues must be determined.



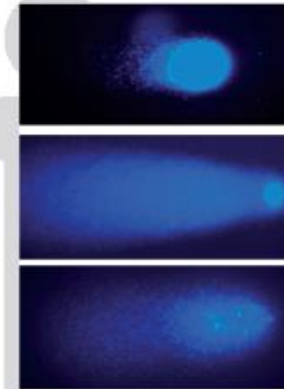
Computer simulation of the field distribution induced in the head tissues by a mobile phone

- This dosimetric evaluation is performed by computer simulations based on the external fields determined in the exposure assessment and by applying the most advanced human models representing the human populations. These includes female and male adults of various weights and heights, children of various ages and infants.
- The objective is to determine the maximum and average induced fields generated by the wireless local area network devices.



Biology & Risk Evaluation

- These specific exposures, although similar to other RF exposures, will be investigated by screening for potential biological sensitivities at the molecular, developmental and functional levels in cells. The effect of specific exposure conditions on cells and DNA will be tested with isolated cell lines and animals.



Comet assay is one of the tests to evaluate DNA integrity in human cells after exposure

- Based on the findings of this project a combination of the current body of literature, an evaluation a combination of the safety and risks of the investigated technologies will be performed.



Project website: www.seawind-fp7.eu

Questions?

Thank you!

