



Dosimetry

Joe Wiart

"Il faut de l'imagination pour se représenter la réalité"

Giuseppe Pontiggia

- COSTBM0704
- Standards
- Research programs in France
- Sar vs incident field
- Foetus exposure
- Conclusions



Dosimetry and standards

■ Base station

■ CENELEC

- The in situ measurement standard EN50492 is implemented
- The revised EN50383 has been revised. The EN 50383:2002/FprAA:2009 has been accepted.

■ IEC

- The Pt 62232 (simulation and measurement) is circulating

■ Mobile

■ IEC

- 62209-2 (body worn) under discussion within the NC
- 62209-1 (close to the head) under revision.

■ CENELEC

- Product standard dedicated to body worn will be draft in 2010

■ IEEE

- 1528 standard on simulation is circulating.



Cost action in dosimetry



<http://www.cost-bm0704.org/>

- Working Group 1 experimental dosimetry
- Working Group 1 numerical dosimetry



RF dosimetry: Projects supported by Fondation RFS

- BIOCAPTEO
 - Sonde électro-optique de mesure duale champ électrique / température
- FEMONUM
 - Modèles Numériques de la Mère et du Fœtus pour la Dosimétrie
- RADIO :
 - Amélioration d'un Dosimètre Individuel
- DONUT
 - DOSimétrie NUMérique sTatistique
- + projects linked to epi or biological studies (EPIDOS, RFPro 2 Mxdos)



RF dosimetry in RF supported by ANR

Closed research programs

■ Before 2006

- **COMOBIO** (1999-2002) (<http://www.enst.tsi.fr/comobio>)
- **ADONIS** (2003-2006) (www.enst.tsi.fr/adonis)

■ 2006-2009

- **OP2H** :Prédiction de champ par Navigation Hiérarchique et Homogénéisation de matériaux (<http://op2h.univ-mlv.fr/>)
- **MDP2** : Conception d'un système de test de conformité du DAS des téléphones, compatible avec les impératifs de la production de masse
- **BIORFMOD** (édition 2006) : Développement d'un modèle numérique 3D permettant de déterminer la répartition de température induite dans le corps humain lors de son exposition à un rayonnement RF

On going research programs

■ 2007-2010

- **MULTIPASS** : Multiple sources exposure assessment (<http://multipass.elibel.tm.fr/>)
- **SAMPER** : Système d'Acquisition et de Modélisation pour la Prédiction de l'Exposition Radioélectrique (<http://dae.cstb.fr/>)

■ 2008-2011

- **MERODAS**: mesure sans robot du DAS (<http://whist.institut-telecom.fr/merodas>)

■ 2009-2012

- **KIDPOCKET** : Etudier l'exposition des enfants aux nouvelles technologies et aux nouveaux usages. (<http://whist.institut-telecom.fr/kidpocket>)

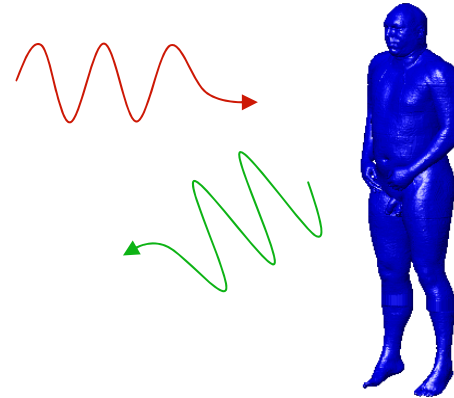
■ Starting 2010



About 8 M€ since 2006

Focus on

- SAR vs incident fields
 - ANR Multipass

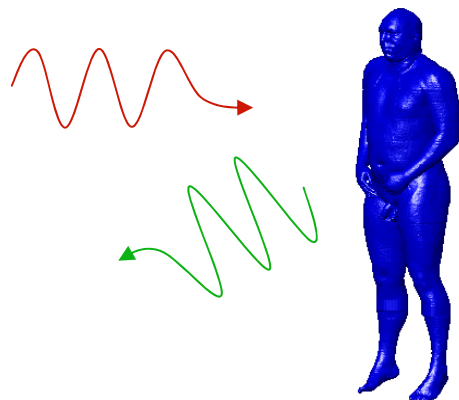


- Fœtus exposure
 - FEMONUM fondation RFS,OL



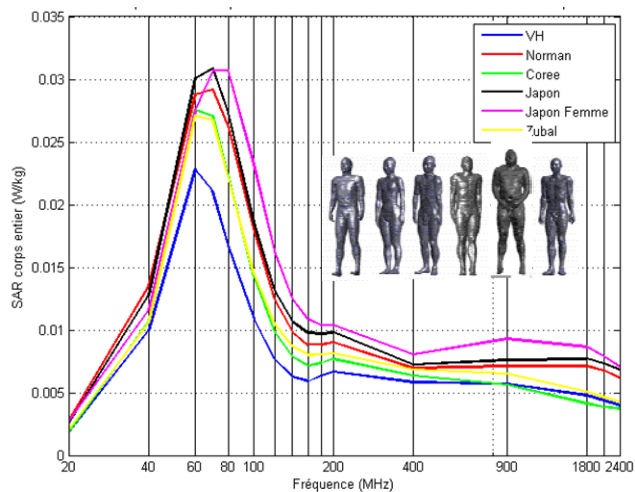


From basic restriction to reference levels.

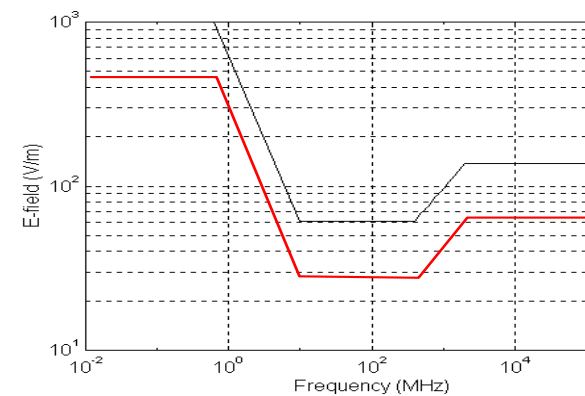


	Grand public	Travailleur
900 MHz	41 V/m	92 V/m
1800 MHz	58 V/m	130 V/m
2100 MHz	61 V/m	137 V/m

Human absorption



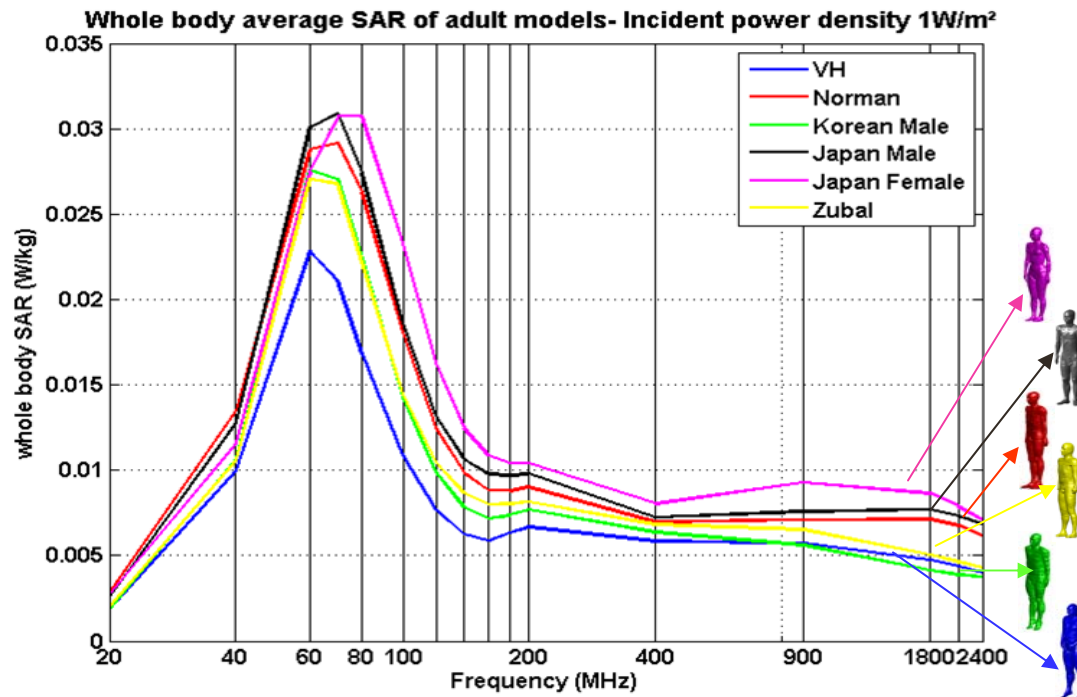
protection





Absorption vs shape and body

Plane wave exposure



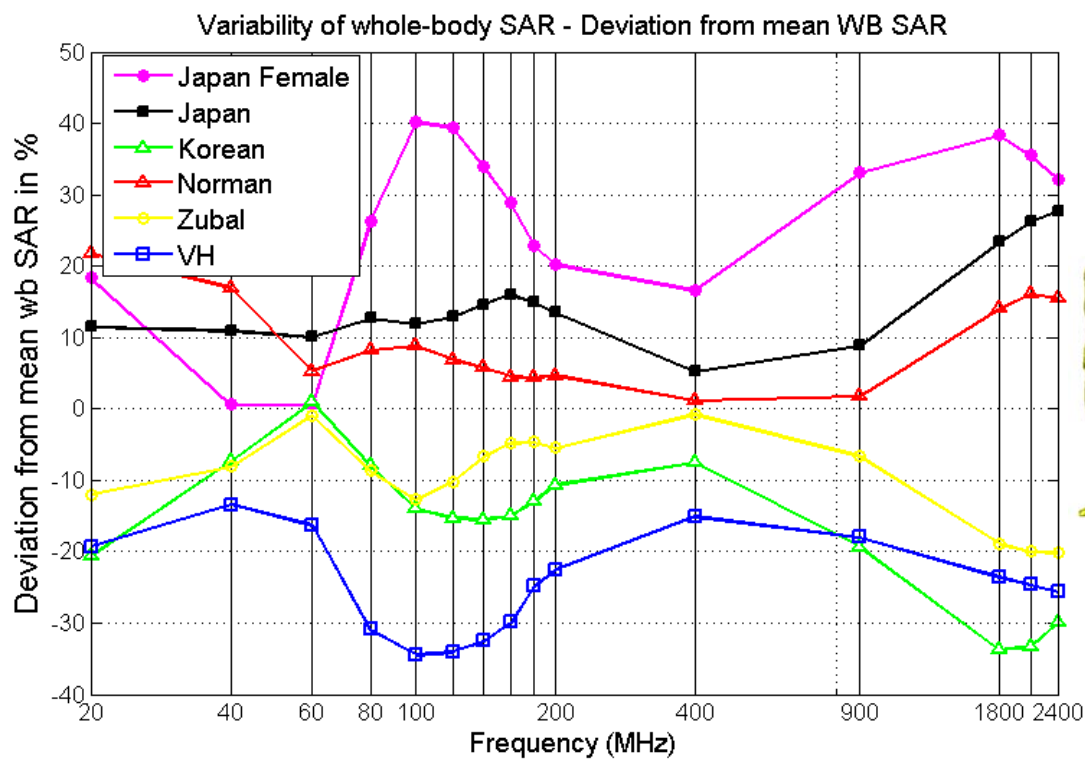
Human absorption depends on

- The frequency
- The posture
- The shape and anatomy
- The incident field structure

- Dimbylow P J 2002 *Phys. Med. Biol.* 47 2835–46
- Dimbylow P J 2007 *Phys. Med. Biol.* 52 6639–49
- Hirata A, et al 2007 *Bioelectromagnetics* 28 484–7
- Findlay RP and Dimbylow *Phys. Med. Biol* 2005
- Lee A, et al 2006 *ETRI J.* 28 107–10
- Nagaoka T et al 2004 *Phys. Med. Biol.* 49 1–15

- Conil E 2008 *Phys. Med. Biol.* 53 (2008) 1511–1525
- Hirata A et al *Bioelectromagnetics* 2007
- Wang J et al *Phys Med Biol* 2005
- Christ, A. et al, *ACES* 2007
- Sven Kühn et al 2009 *Phys Med Biol* 54, 875–890
- Gosselin MC et al *IEEE Trans EMC* . 2009

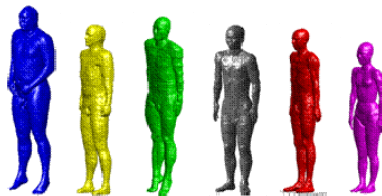
Large variability



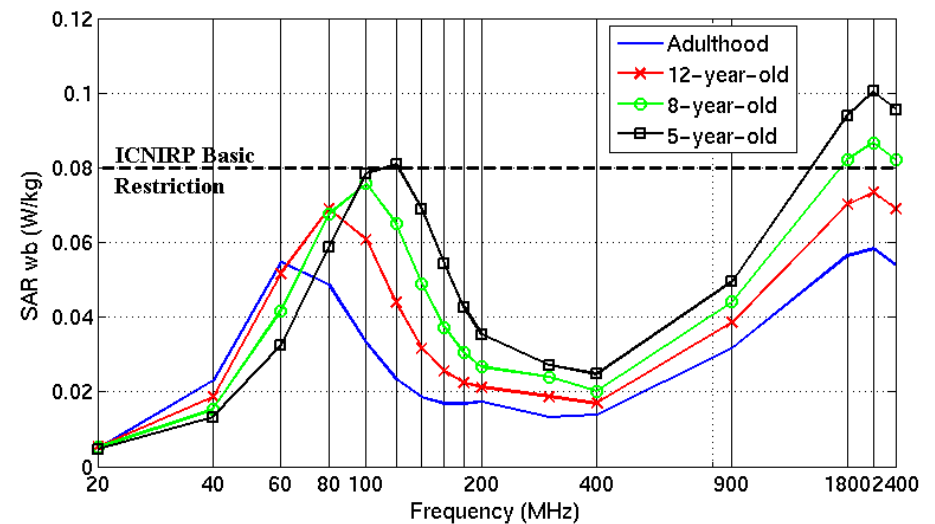
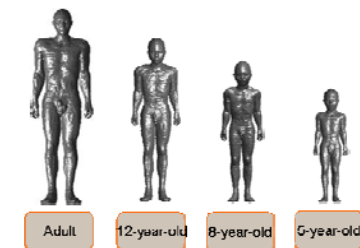
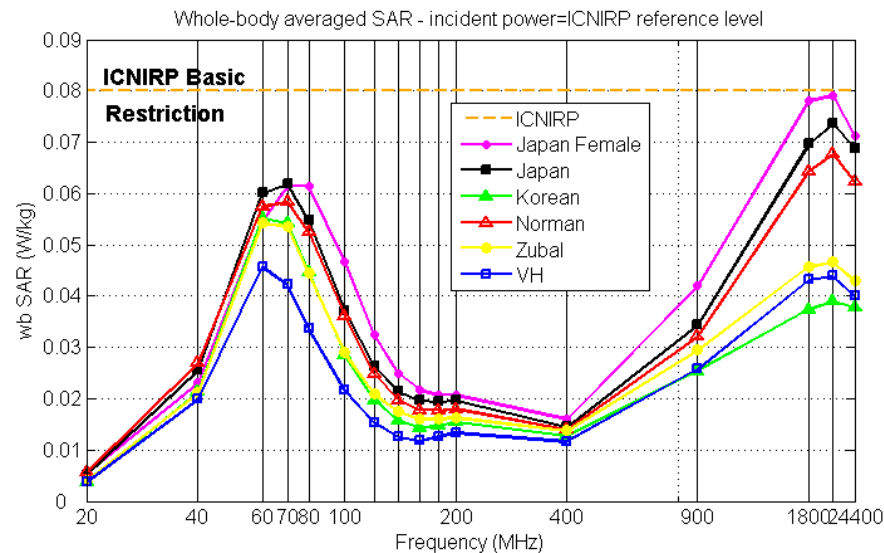


Debate on Whole Body exposure vs Reference Level...

- Reference levels were established with simple model ...
- “small” people seems to have higher WBSAR



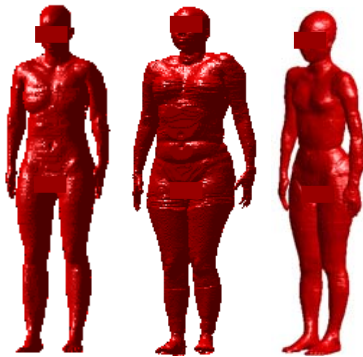
Whole body SAR vs ICNIRP REF Level



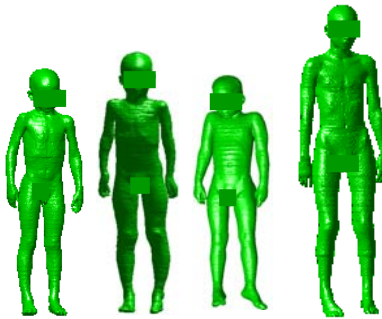
International efforts and cooperation to develop models



7 adult male
models



3 adult female models



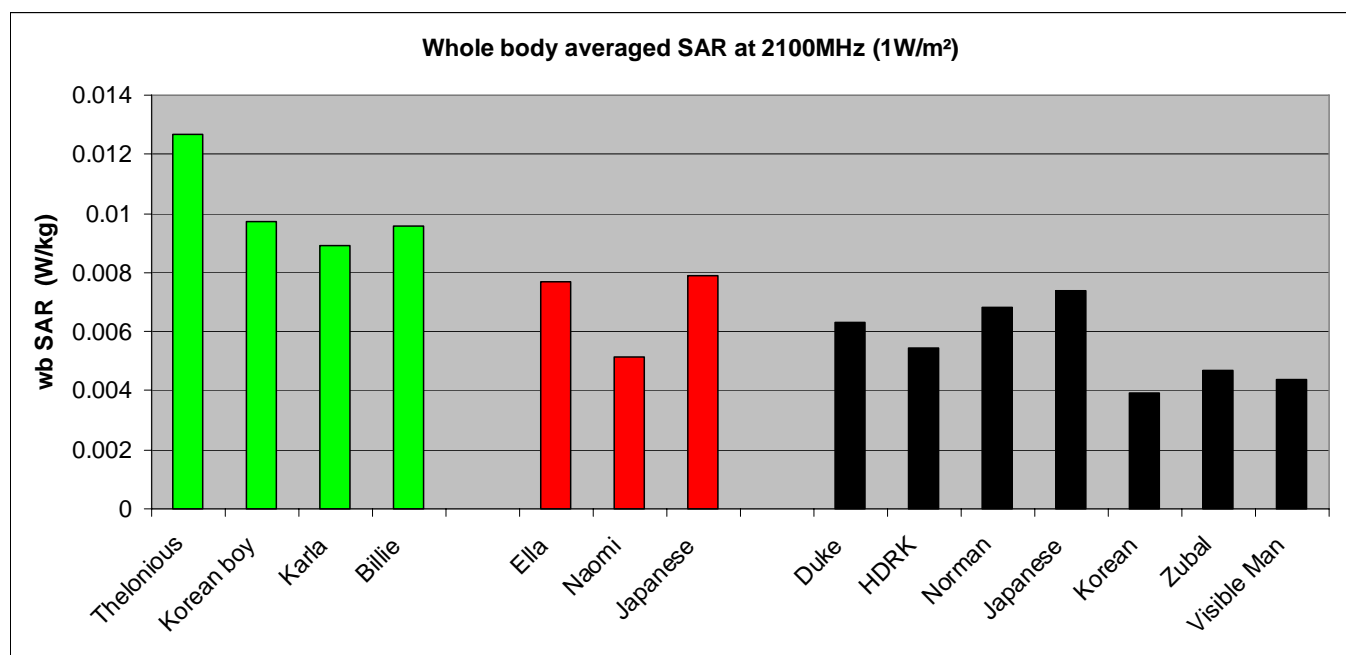
8 child
models



WBSAR @ 2100 MHz PW polar V

Child models

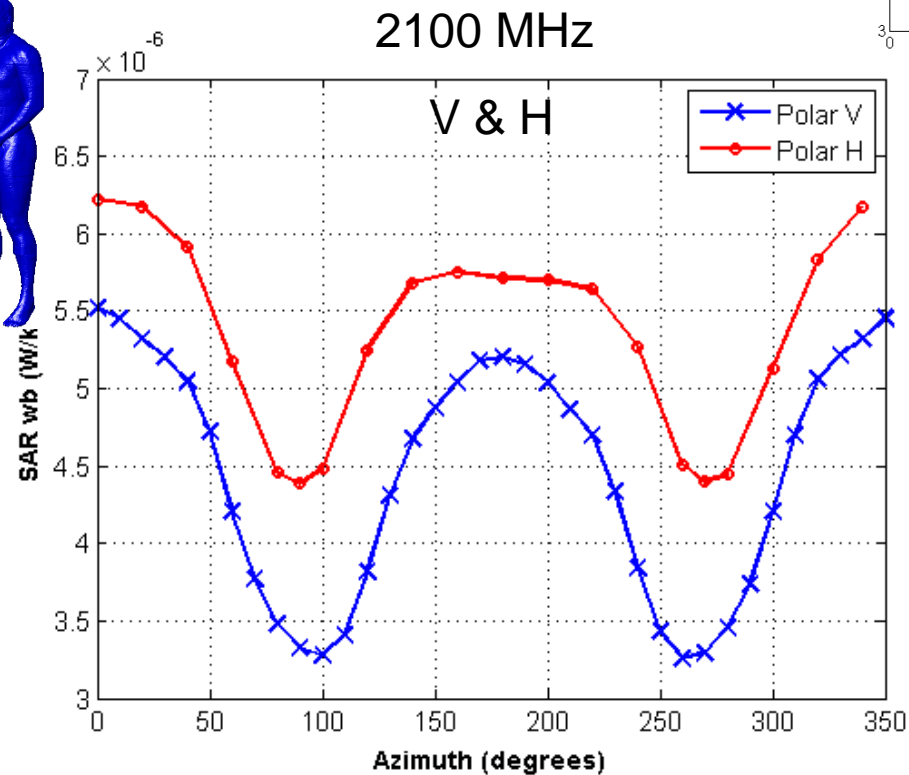
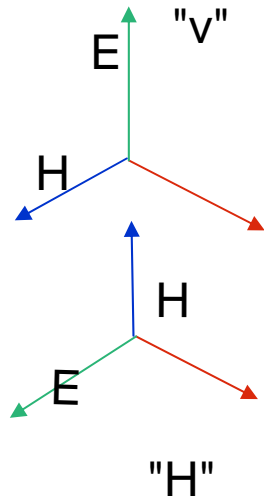
Adult models



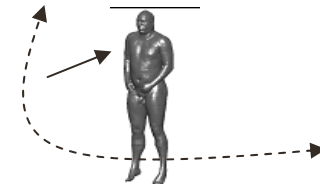
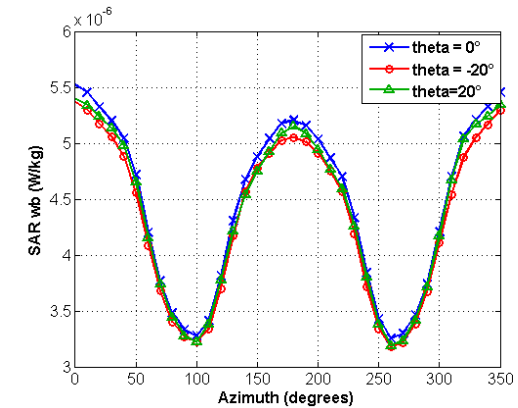
Adult std 25%; All std 35%



Vertical polarization vs Horizontal..

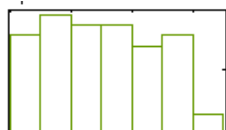
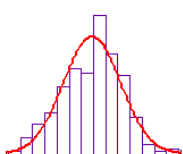


2100 MHz
Vertical

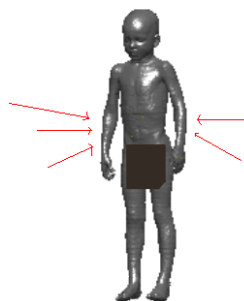


Multi plane waves vs plane wave.

Rays having normal distribution of the amplitude and uniform distribution of the angle of arrival and phase

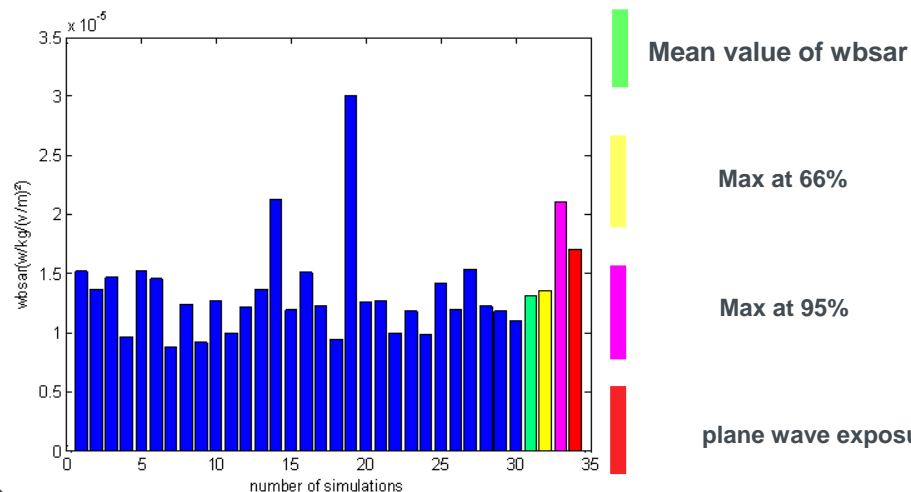


vertical polarization



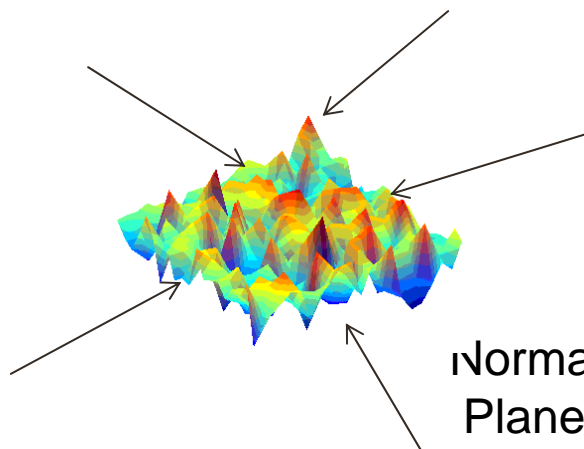
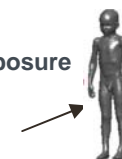
Theloniouss

6 Yo 19 kg, 1.19 m



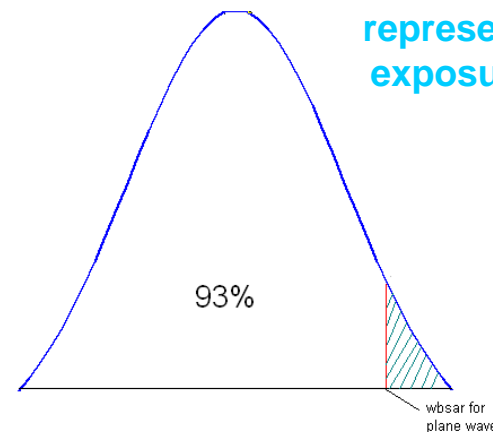
Whole Body SAR

plane wave exposure



Normalised to the Plane wave field strength

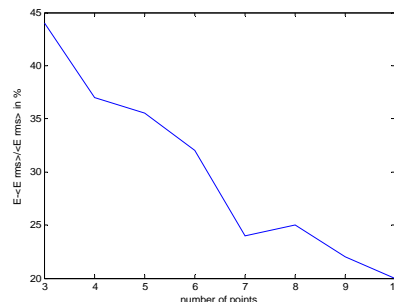
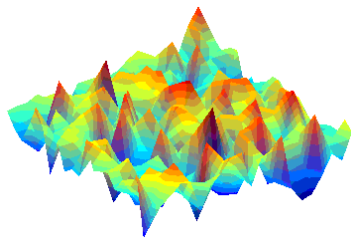
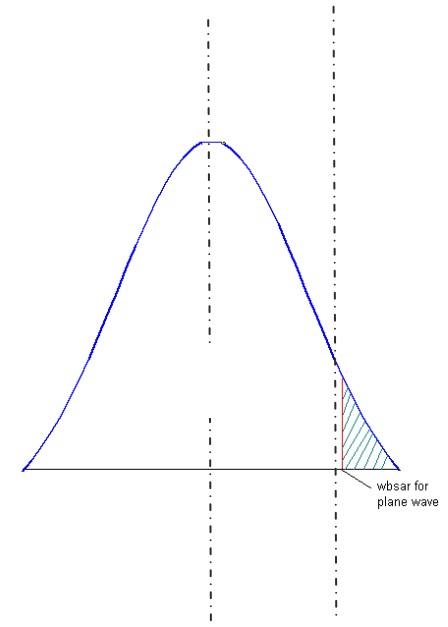
The plane wave represent the maximum exposure in 93% of the case





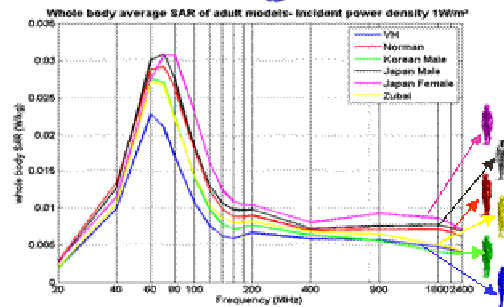
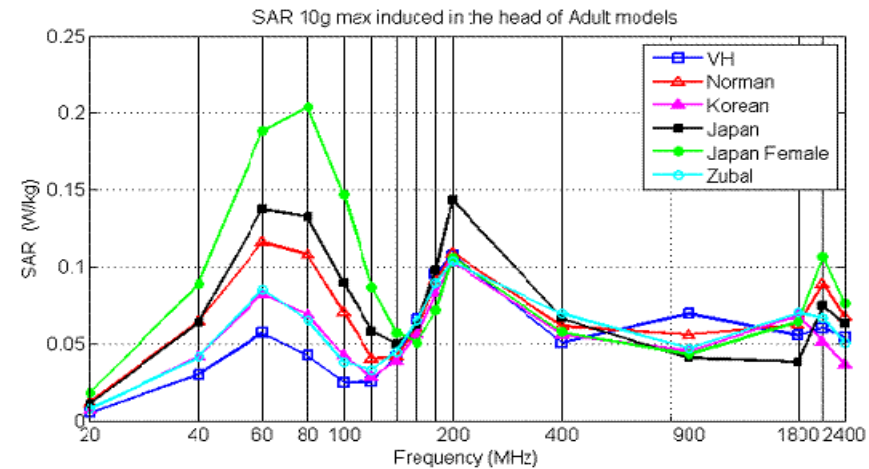
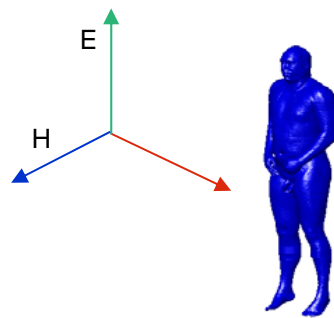
SAR vs Reference level...

- Smaller people can have higher whole body SAR
- In case of multiple plane wave
 - the mean exposure is 30% below the exposure induced by a frontal plane wave.
 - The frontal plane wave exposure can be exceeded in about 5% of the case
- The uncertainty of the experimental E field assessement depend on the number of point

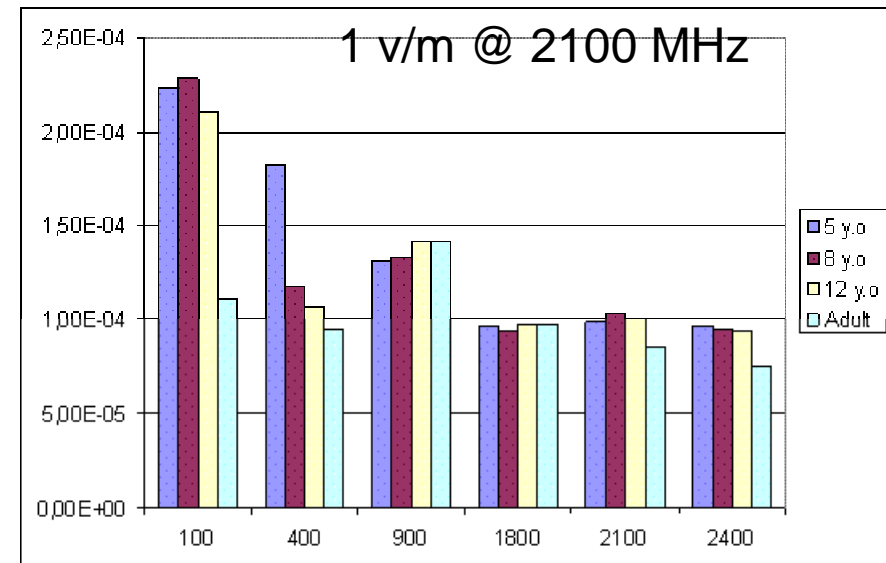




Brain exposure induced by far sources



0.1 v/m induced in the brain 10^{-6} w/kg



Fœtus exposure

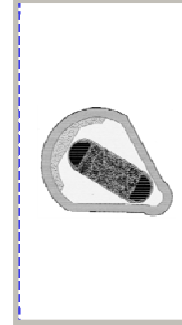
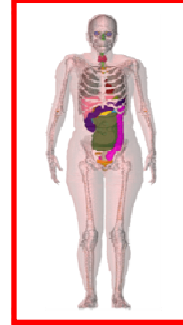
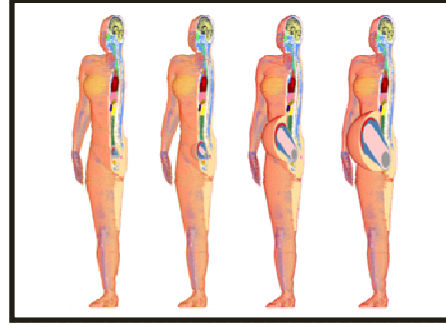
- Research on fœtus exposure is recommended by several expert group.
- Preliminary studies have been carried out



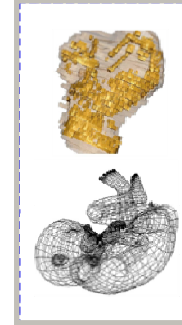
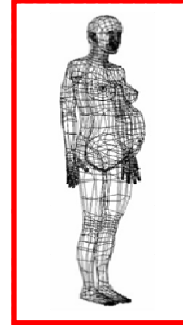


Existing Foetus model

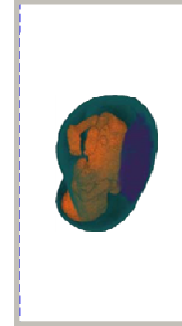
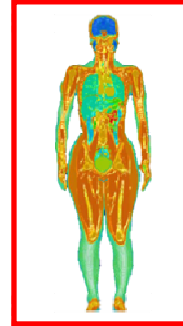
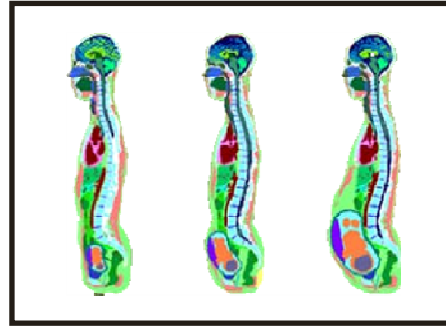
Dimbylow 07



Tanarenko 08



Nagaoka 08





Fœtus models developed at Telecom Paris Tech

Image From US or MRI



9 SA



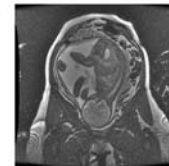
13 SA



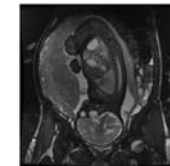
22 SA



26 SA



30 SA



34 SA



13 WA (US)



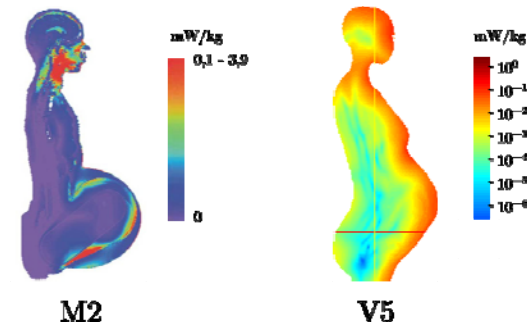
23 WA (MRI)



31 WA (MRI)

Next step

- The studies that have been conducted report low exposure of the fetus but they must be extended to other age and posture.
- The exposure depends on
 - the foetus age
 - The foetus posture
 - The shape of the mother's organs
 - The mother posture
- Further researches are needed to investigate these questions
- Japanese and French teams are planning under the umbrella of ANR and JST common research under the on
 - New foetus models
 - Deformation tools
 - sensibility analysis





Thanks,

**“Les hommes construisent trop de murs et pas assez de
ponts.”**

Isaac Newton