Numerical Assessment of Specific Absorption Rate in the Human Body Caused by NFC Devices

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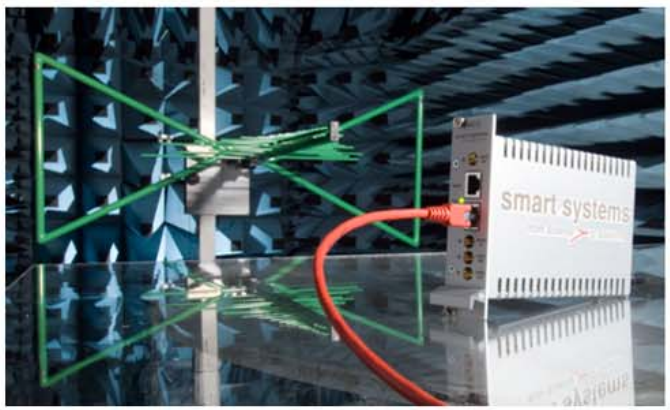

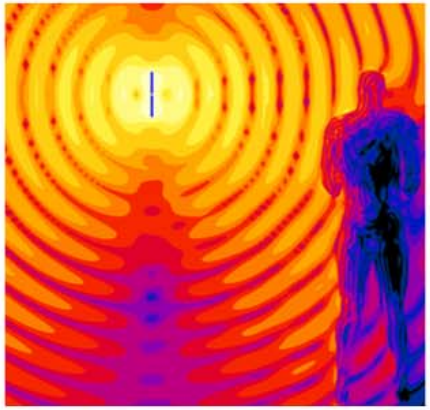
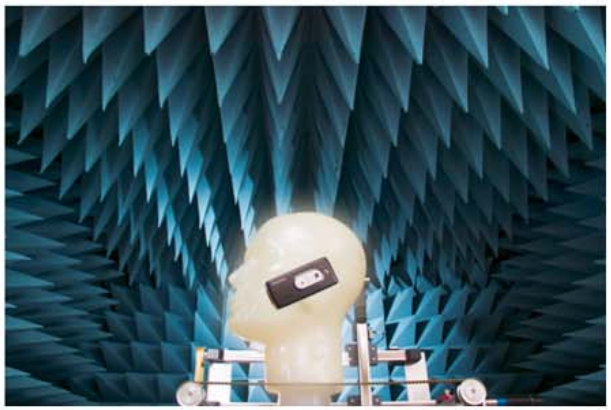

Content

- **Introduction**
- Limit levels for NFC devices
- SAR measurement method
- SAR simulation method
- Investigated scenarios
- Results
- Conclusion

Introduction

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NFC (Near Field Communication) technology

- uses inductive coupling (= magnetic field coupling)
- between transmitter and receiver
- at 13.56 MHz.

The relatively high magnetic field strength

- in the immediate surrounding of NFC devices
- gives rise to the question about **local personal exposure of users**.

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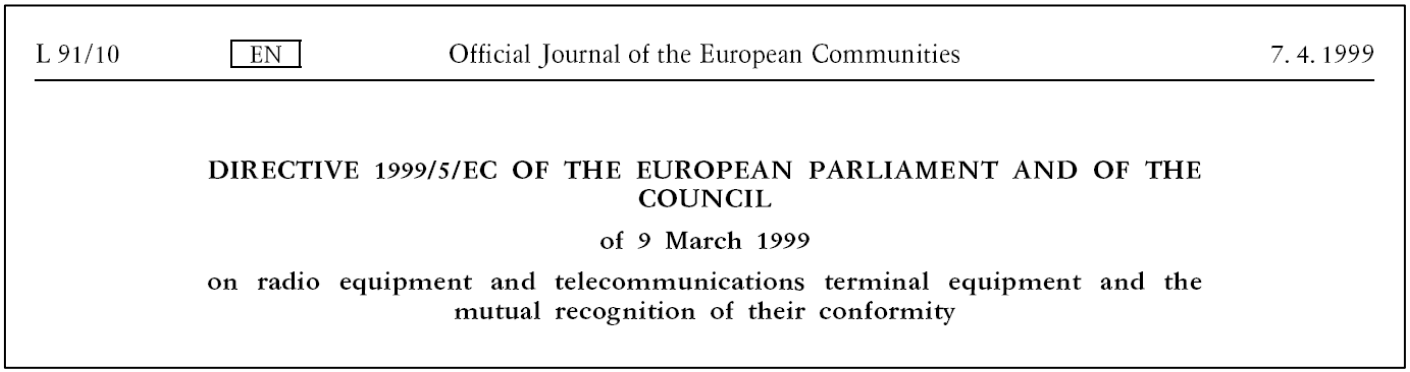
Regulatory framework



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DIRECTIVE 1999/5/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 9 March 1999

on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity

The EU R&TTE Directive 1999/5/EC covers

- all equipment, which uses the radiofrequency spectrum.
- e.g. mobile phones, car door openers, …. and of course **NFC devices**!

The applicable Essential Requirements of the Directive include

- the protection of health and the safety of the user and any other person.

Harmonised standards

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EU Directives refer to

- so called Harmonized Standards which specify
- exposure limits and compliance evaluation methods.

For NFC devices the product standard EN 50364 has to be applied.

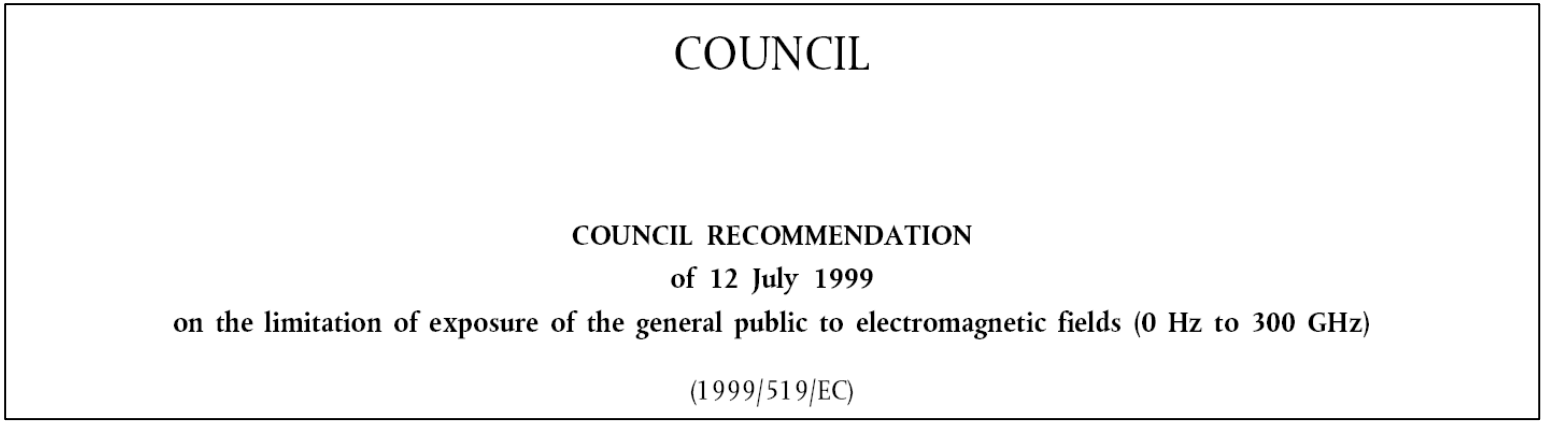
European Standards Organisation (1)	Reference and title of the standard (and reference document)	Reference of the superseded standard	Date of cessation of presumption of conformity of the superseded standard Note 1	Article 1999/5/EC
Cenelec	EN 50364:2001 Limitation of human exposure to electromagnetic fields from devices operating in the frequency range 0 Hz to 10 GHz, used in electronic article surveillance (EAS), radio frequency identification (RFID) and similar applications	None	—	Article 3(1)(a) (and Article 2 2006/95/EC)

Harmonized Standards give a presumption of conformity.

Exposure assessment

The EN 50364 refers

- for general public exposure
- to the Basic Restrictions and Reference Levels from the European Council Recommendation 1999/519/EC.



COUNCIL

COUNCIL RECOMMENDATION
of 12 July 1999
on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)

(1999/519/EC)

The limit levels of the EC council recommendation are equal to the general public ICNIRP limits.

Limit levels

Basic restrictions* for general public exposure:

- Local SAR limits are understood as averaged over 10g of contiguous tissue and over a 6 minute time interval

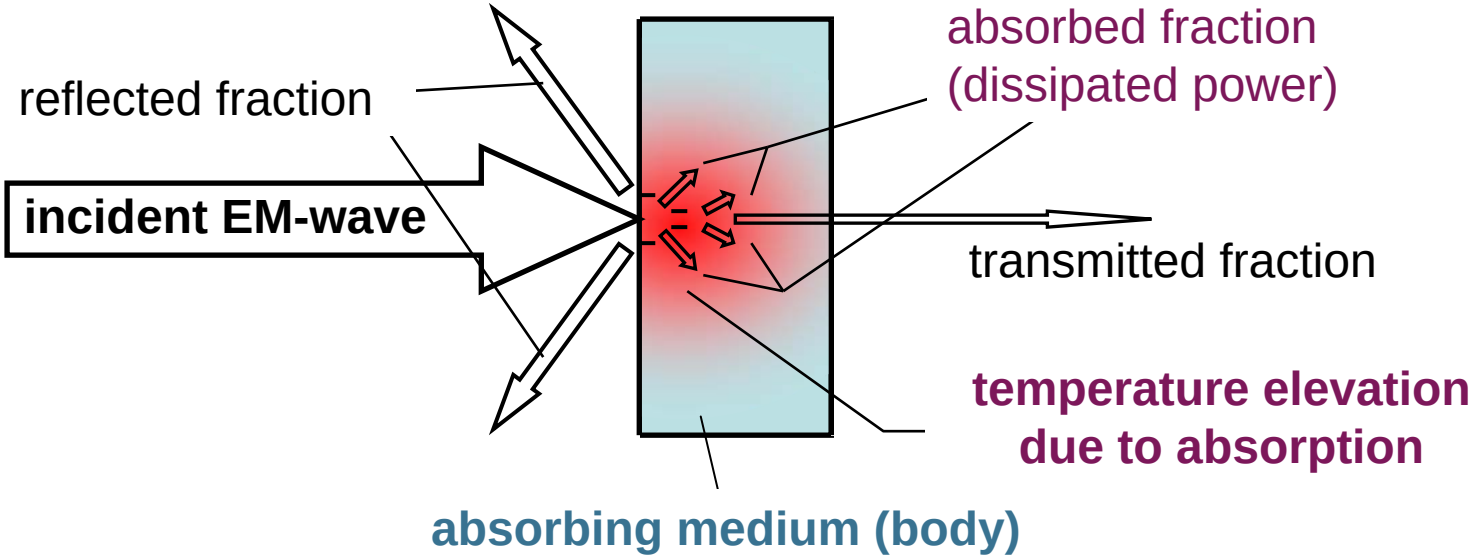
Frequency range	Magnetic flux density (mT)	Current density (mA/m^2) (rms)	Whole body average SAR (W/kg)	Localised SAR (head and trunk) (W/kg)	Localised SAR (limbs) (W/kg)	Power density, S (W/m^2)
100 kHz-10 MHz	—	f/500	0,08	2	4	—
10 MHz-10 GHz	—	—	0,08	2	4	—
10-300 GHz	—	—	—	—	—	10

*) Basic restrictions for the general public according to EC council recommendation and ICNIRP recommendation.

For SAR values below the basic restrictions it can be assumed that there are no adverse health effects.

What is SAR?

SAR … Specific Absorption Rate [W/kg]



- Physical quantity for tissue heating due to absorption of electromagnetic power:

$$SAR = \sigma \frac{|\underline{E}|^2}{\rho}$$

σ...conductivity of the lossy medium [S/m]

ρ...mass density [kg/m³]

E...electric field strength inside the tissue [V/m]

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SAR measurement

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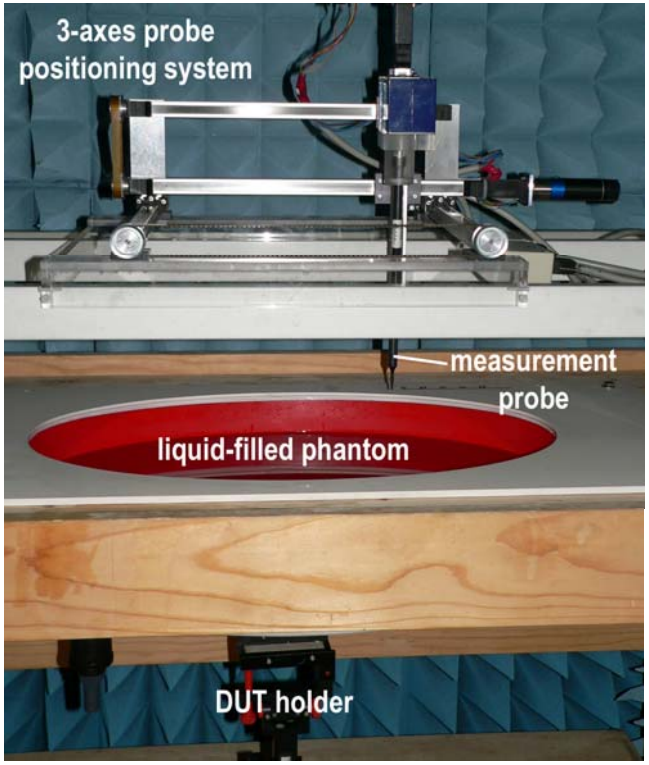
procedure uses

- a real device (DUTs)
- operated at its maximum output power.
- Simplified, homogeneous body models (phantoms)
- filled with tissue simulating liquid.
- Isotropic miniature probes
- mounted to a 3-axes positioning system.

- Measurement results are conservative estimates for SAR values in the real body!
- SAR cannot be measured in vivo!



SAR-measurement setup, accredited EMC test laboratory Seibersdorf

Spatial SAR distributions

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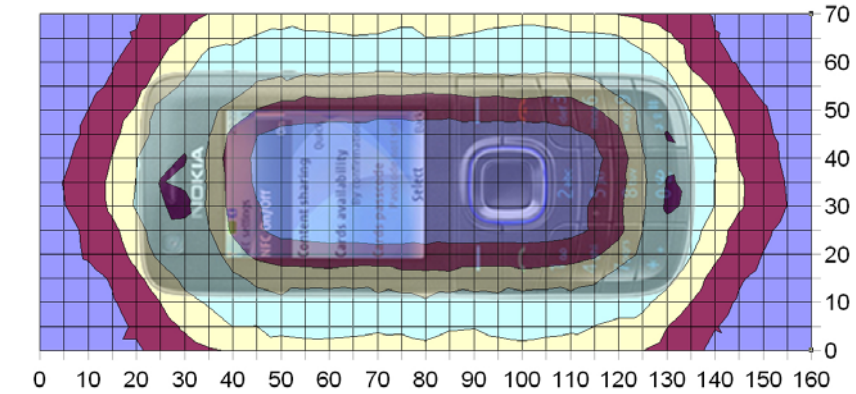
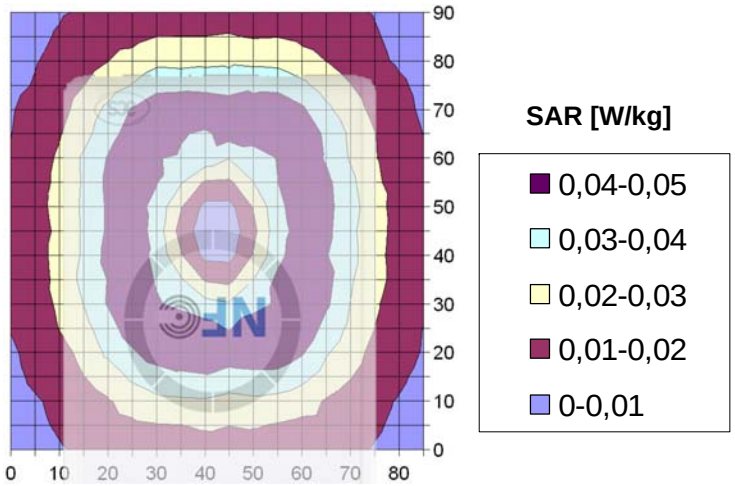
inside the tissue simulating liquid were measured for

Nokia 6212c: Cell phone with integrated NFC interface



ACR* 122: Stationary NFC smart card reader



For each device the worst case was considered: device touching the phantom bottom
Based on this spatial SAR distribution the 10g-averaged SAR can be computed.

*) Advanced Card Systems Ltd., Hong Kong

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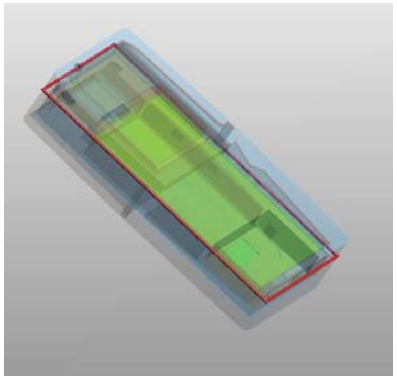
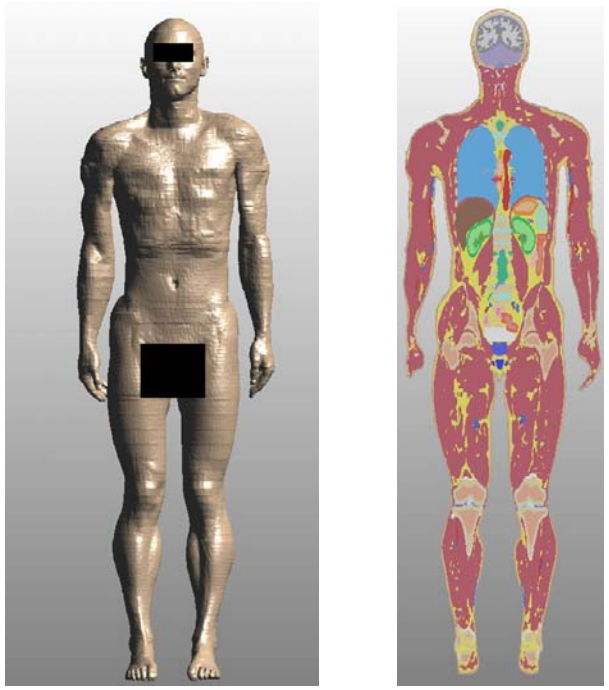
SAR simulation

Numerical computations use

- 3D full wave simulation platform SEMCAD X based on the Finite Differences in Time Domain (FDTD) method.
- MRI-based anatomically correct body models
- with approx. 85 different tissues characterised
- by their dielectric properties at 13.56 MHz.
- Numerical models of the NFC devices.



Simulation model of the NFC mobile



Human body model „Duke“

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Investigated scenarios

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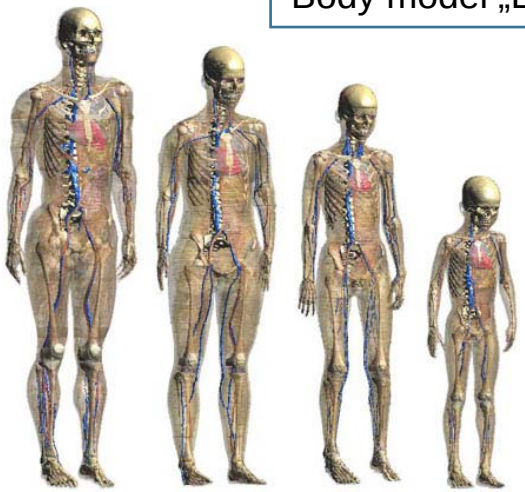
4 different scenarios were simulated:

- NFC mobile in the hand of „Louis“ while connecting a NFC reader
- NFC mobile on the ear of „Louis“ while phoning and NFC active
- NFC reader on the chest of „Duke“ with 20 mm distance to the coil
- NFC reader on the hip of „Duke“ with 5 mm distance to the coil

Body model „Duke“: male, 34 years, 70 kg, 174 cm
Body model „Louis“: male, 14 years, 50 kg, 165 cm

Duke



The Virtual Family

Louis

The Virtual Classroom

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Results (1)

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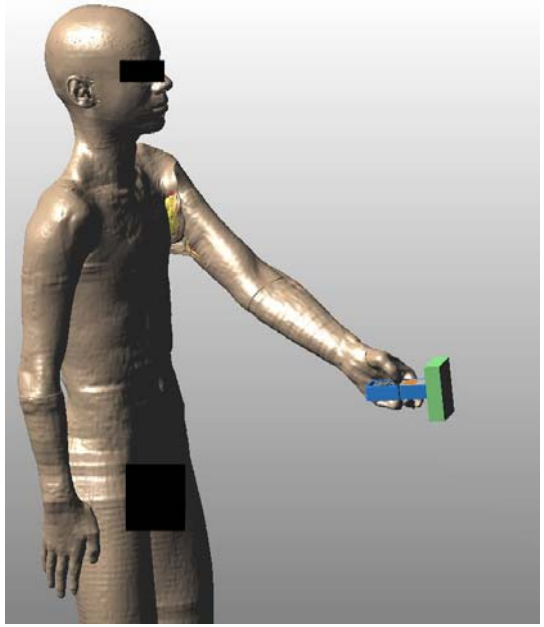
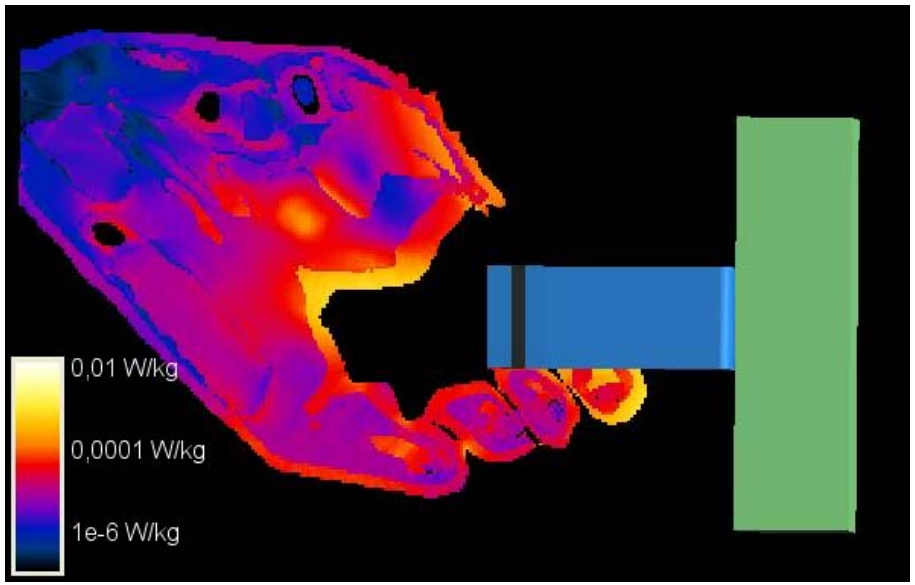
Scenario „NFC mobile in the hand while connecting a NFC reader“

- Maximum 10g-averaged SAR: 6.52 mW/kg



Nokia 6212c in the hand of „Louis“

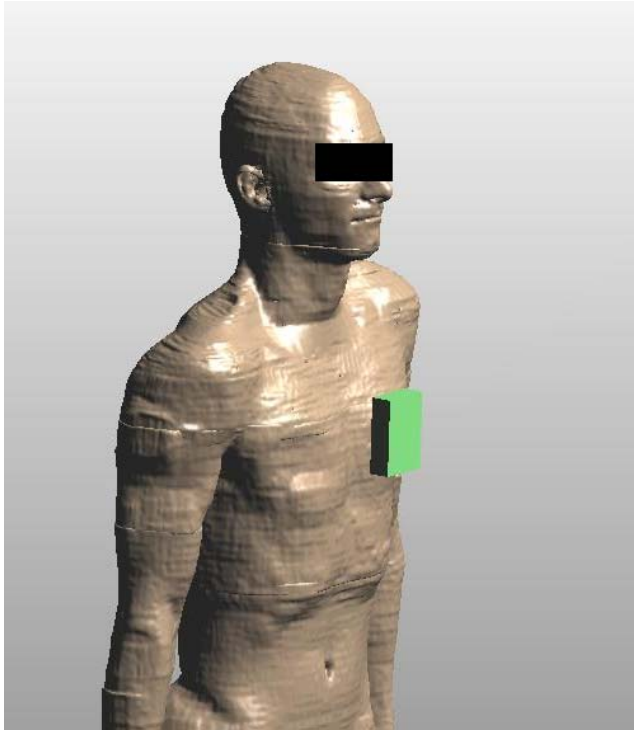


SAR distribution in a cross section through the hand

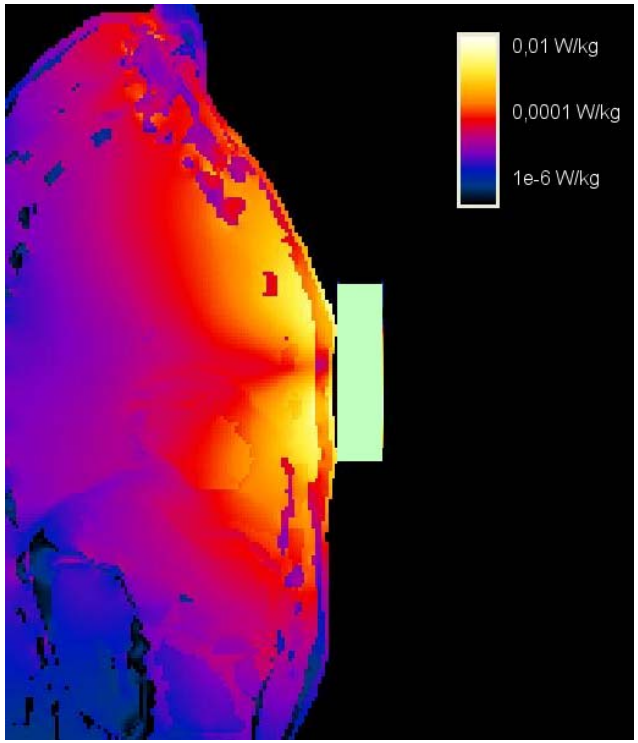
Results (2)

Scenario: „NFC reader on the chest“

- Maximum 10g-averaged SAR: 1.52 mW/kg



ACR 122 on the chest of „Duke“



SAR distribution in a cross section of „Duke“

Results (3)

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The 13.56 MHz magnetic fields

- cause induction of RF currents inside body parts close to a NFC device => dissipation of electric power in the tissue

The simulation results showed

- maximum 10g-averaged SAR-values more than 2 orders of magnitude below the limit levels (2 W/kg for head and trunk, 4 W/kg for limbs).

Scenario	10g-averaged SAR	
NFC mobile in hand near reader	6.52 mW/kg	
NFC mobile on ear	0.26 mW/kg	
NFC reader on chest	1.52 mW/kg	**d=20mm**
NFC reader on hip	11.18 mW/kg	**d=5mm**

The given SAR values correspond to a continuous field generation. Averaging over a 6 minute time interval will lead to significant lower SAR values because of duty cycles <1 in reality!

Comparison with measurements

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The measurement results

- confirm the conservativity of the SAR measurements because the 10g-averaged SAR values are higher compared to the simulations.

Scenario	10g-averaged SAR
NFC mobile with front side touching the phantom	2.5 mW/kg
NFC mobile with back side touching the phantom	0.65 mW/kg
NFC reader with top side touching the phantom	24.7 mW/kg

Measurement results are conservative estimates for SAR values in the real body!

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Conclusion

Experimental and numerical results showed that

- maximum 10g-averaged SAR values
- caused by the considered NFC devices and exposure scenarios
- were more than 2 orders of magnitude below the SAR limit levels.

=> Personal exposure due to NFC devices cause SAR levels far below the limits.

=> No evidence that the fields of NFC devices can cause adverse health effects.

Important:

- Manufacturers have to demonstrate the compliance with personal exposure limits in their conformity assessment procedure for NFC devices (CE marking of compliant equipment)!

Thank you for your attention!

This project was carried out in cooperation with AIT business unit Biomedical Systems.

DI Dr. Kurt Lamedschwandner, MBA
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