WORKPLACE SPECIFIC EXPOSURE ASSESSMENT AND DOSIMETRY

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CONTENT

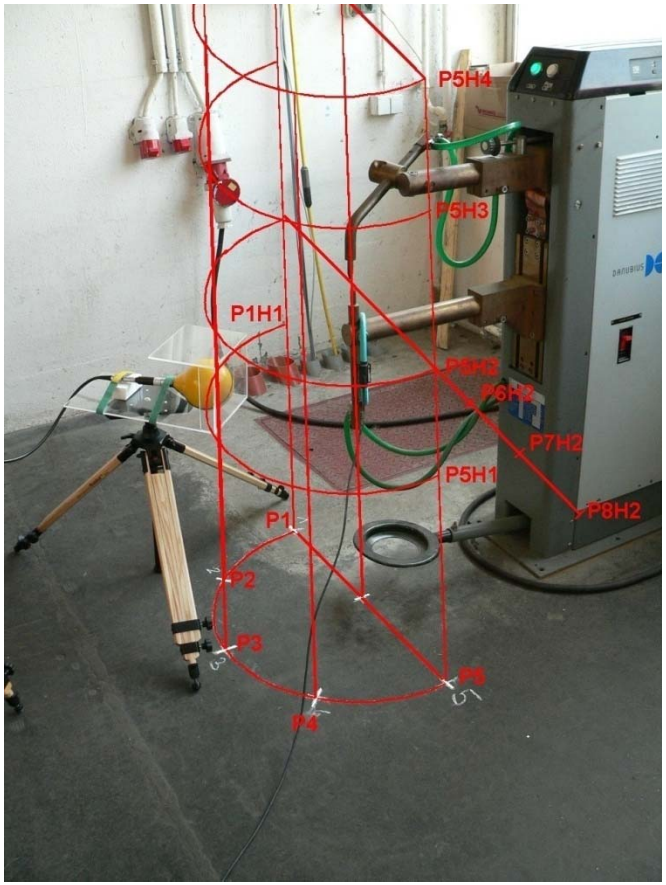
- Occupational exposure scenarios – differences to general public exposure
- Examples of workplace exposure scenarios
- Challenges in exposure assessment LF (up to 10 MHz)
- Challenges in exposure assessment RF (> 100 kHz)
- Workers bearing implants
- Conclusions

OCCUPATIONAL EXPOSURE SCENARIOS – DIFFERENCES TO GENERAL PUBLIC EXPOSURE ASSESSMENT

- For most workplaces (> approx. 90%, e.g., office, in public areas, …)
  ⇒ **NO significant difference** to GP exposure
- For the remaining minority of workplaces (< approx. 10%):
  ⇒ **Specific assessment methods may be required**, due to
  - **Specific devices**
    - specific frequencies
    - specific time characteristics (pulsed, **transients**, …)
  - **Close distances** to the devices (EM sources)
    - higher field strength
    - high field gradients
    - highly localized exposure (particularly hand, fingers)

EXAMPLES OF WORK PLACES (DEVICES) OF POTENTIAL INTEREST

- **Welding (arc welding / resistance welding): DC – kHz**



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- **EAS Deactivators (1.6 kHz, 58 kHz, 8.2 MHz)**

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- EAS Deactivators (1.6 kHz, 58 kHz, 8.2 MHz)
- Power Substations (50/60 Hz)
- **Base Station / Broadcast Towers (RF / MW)**
- **……..**

PRESENT CHALLENGES

IN WORKPLACE-SPECIFIC EXPOSURE ASSESSMENT (LF)

➢ ***HIGH FIELD GRADIENTS AND HIGHLY LOCALIZED EXPOSURE ABOVE REFERENCE LEVELS***

Most important:

- **ICNIRP 1998** focused (in LF range) on **central nervous system (CNS)** only
- **ICNIRP 2010** provides basic restrictions (BR) for **CNS <u>and</u> peripheral tissues**

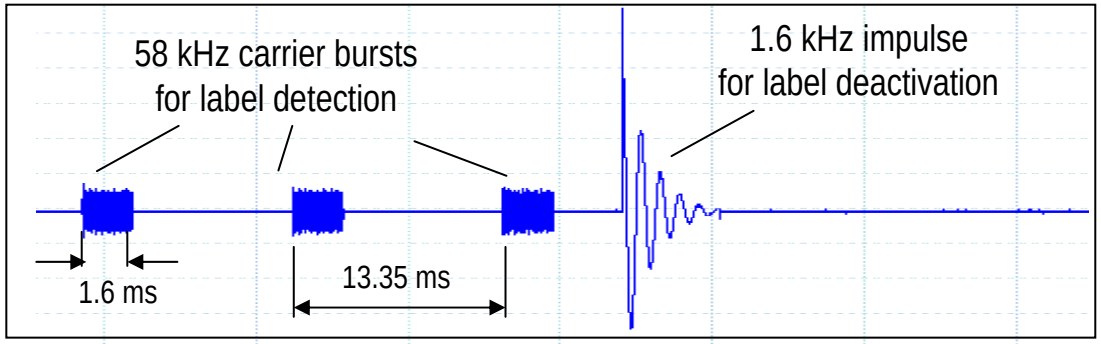
⇒ Exposure of peripheral body parts (limbs) needs to be considered

⇒ assessment of localized exposure in high field gradients becomes essential

PRESENT CHALLENGES
IN WORKPLACE-SPECIFIC EXPOSURE ASSESSMENT (LF)

***Example:* Deactivator for AM EAS-Labels** (1)

- Highly localized and strong (~ 20 - 40 mT) de-magnetization impuls (1.6 kHz) during deactivation
- Cashier has his/her hands close to the deactivator's surface in order to deactivate the labels
- Head and trunk is usually exposed below reference level

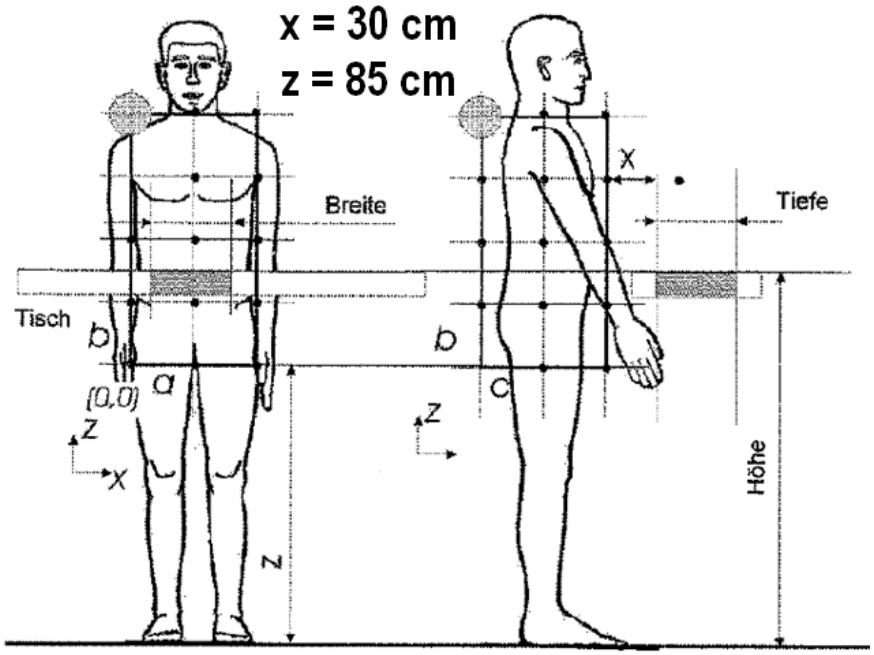


PRESENT CHALLENGES
IN WORKPLACE-SPECIFIC EXPOSURE ASSESSMENT (LF)

Example: ***Deactivator for AM EAS-Labels*** (2)

- Current standardized exposure assessment according to EN 62369-1 for table mounted devices
- Average over body grid to be compared with reference levels of ICNIRP 1998

⇒ **inadequate for assessment according to ICNIRP 2010**

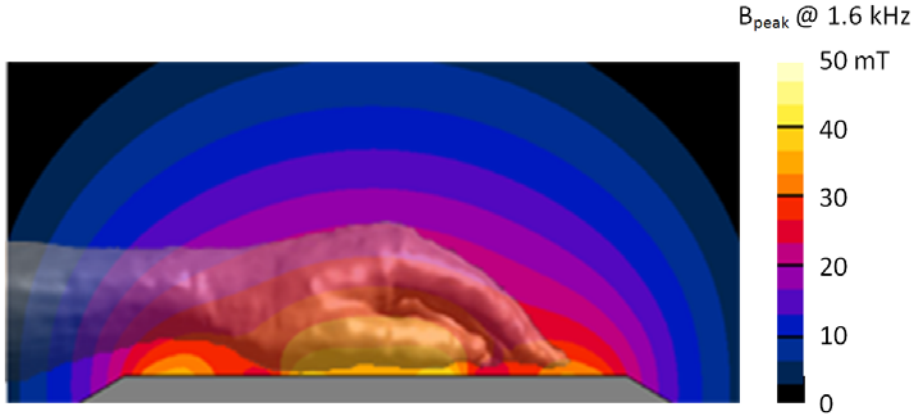


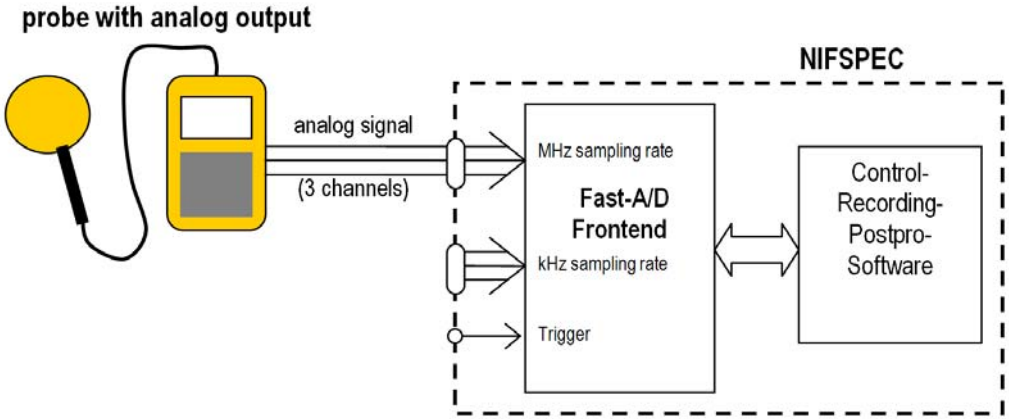
Measurement grid for table mounted devices acc. to EN 62369-1

PRESENT CHALLENGES
IN WORKPLACE-SPECIFIC EXPOSURE ASSESSMENT (LF)

Example: ***Deactivator for AM EAS-Labels*** (3)

- Detailed field distribution along the surface of the deactivator needs to be measured with **sufficiently small probes**
- Peak values are relevant (not only RMS values)

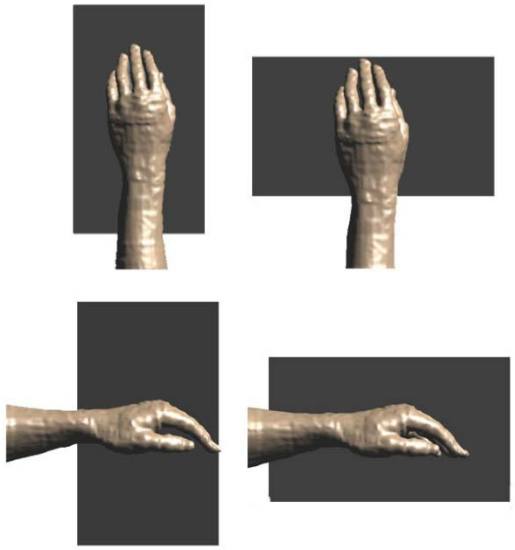


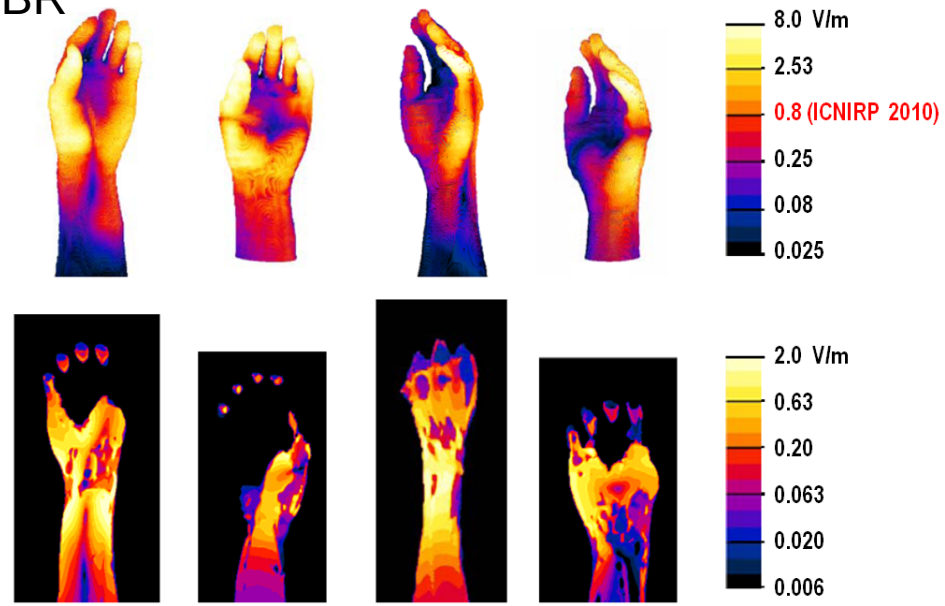


PRESENT CHALLENGES
IN WORKPLACE-SPECIFIC EXPOSURE ASSESSMENT (LF)

Example: ***Deactivator for AM EAS-Labels*** (4)

- Numerical computations using a validated numerical source model are required for comparison with BR



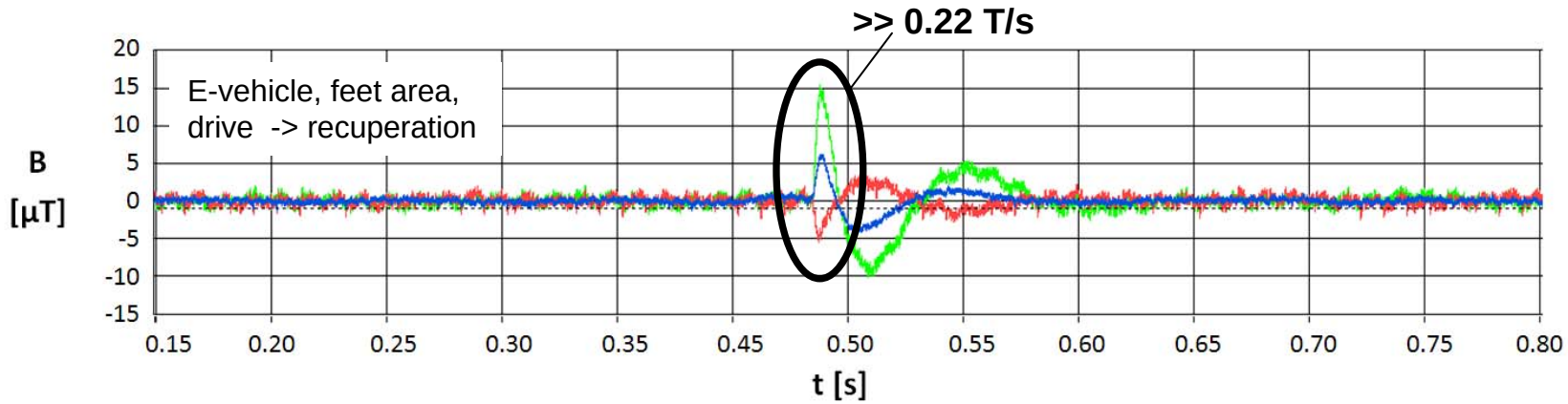


⇒ **The above requirements for assessment procedures apply also in many cases of welding, induction heating, electric melting, ….**

PRESENT CHALLENGES
IN WORKPLACE-SPECIFIC EXPOSURE ASSESSMENT (LF)

➢ ***TRANSIENTS***

- observable during **switching processes** (On/Off, changes of load, …)
- gradient coils (MRI), eletcric melting, induction heating, E-/Hybrid vehicles, …



- **requires appropriate time domain measurements**
- **often difficult to detect, monitoring of whole work cycle required**

PRESENT CHALLENGES

IN WORKPLACE-SPECIFIC EXPOSURE ASSESSMENT (RF)

➢ ***HIGH FIELD GRADIENTS AND HIGHLY LOCALIZED EXPOSURE ABOVE REFERENCE LEVELS***

- relatively **small RF-source** with relatively low power, i.e., inherent compliance to WB-SAR limit is given.

Examples: *Test facilities for RFID Transponders, RF-EAS Deactivators (8,2 MHz), …*

⇒ **SAR measurements** in body phantom to check compliance with local SAR limits ✓

PRESENT CHALLENGES

IN WORKPLACE-SPECIFIC EXPOSURE ASSESSMENT (RF)

- Large RF-sources (> approx. 15-20 W) (1)

Examples: *Workers in/on antenna masts, roof work close to antennas, plastic welding, wood drying, …*

⇒ **SAR measurements** not feasible !

PRESENT CHALLENGES

IN WORKPLACE-SPECIFIC EXPOSURE ASSESSMENT (RF)

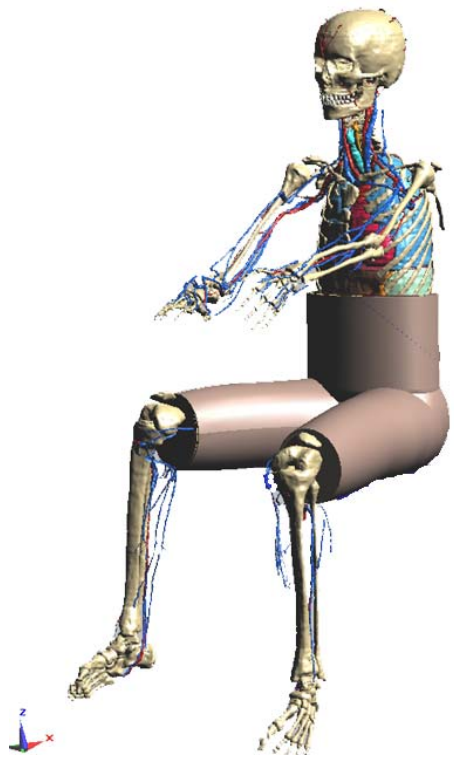
- Large RF-sources (> approx. 15-20 W) (2)

⇒ Detailed measurement of E-/H-field distribution required

⇒ Measurements of body currents (clamps) in some cases (approx. < 30 MHz) can provide additional useful information

In case of locally exceeded reference levels:

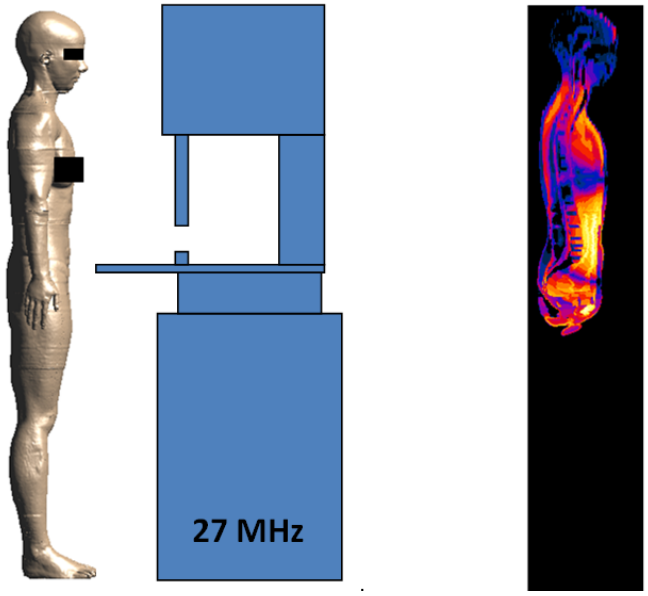
⇒ Numerical computation of localized and WB-SAR with **validated** source models



PRESENT CHALLENGES
IN WORKPLACE-SPECIFIC EXPOSURE ASSESSMENT (RF)

- Large RF-sources (> approx. 15-20 W) (3)

⇒ Numerical computation of localized and WB-SAR with validated source models

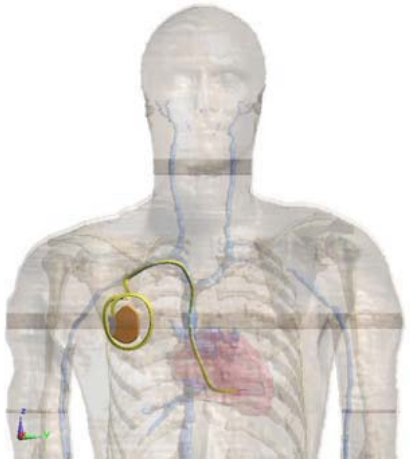


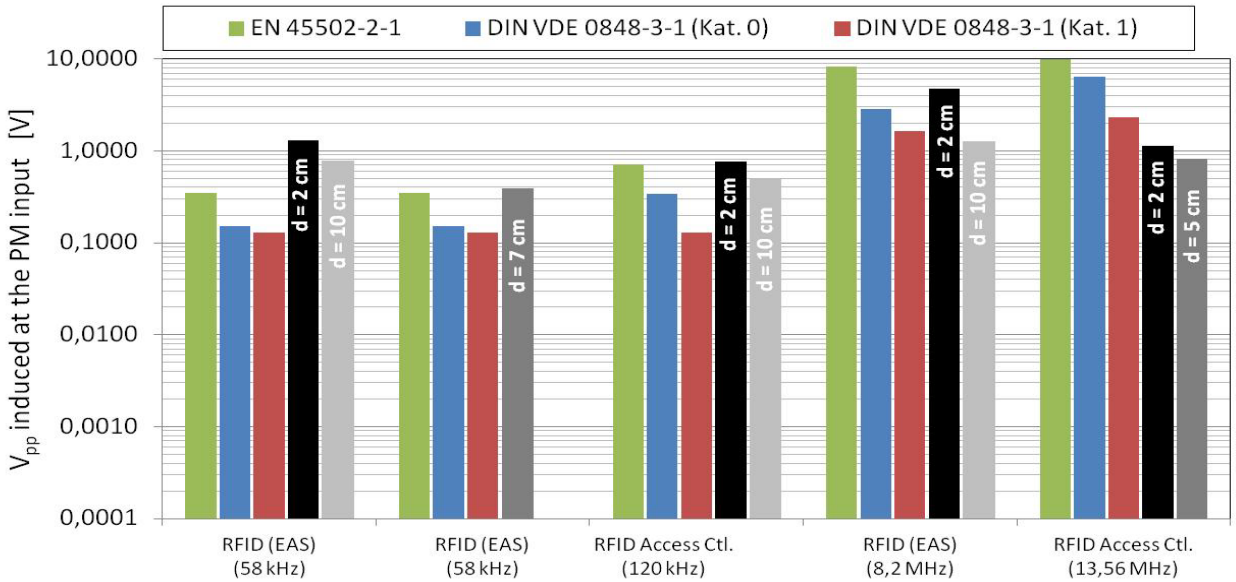
Main difficulties in practice:

- Varying posture of the body (hands, fingers, etc.)
- realistic worst case time averaging (6 min)

POSSIBLE INTERFERENCE WITH IMPLANTS

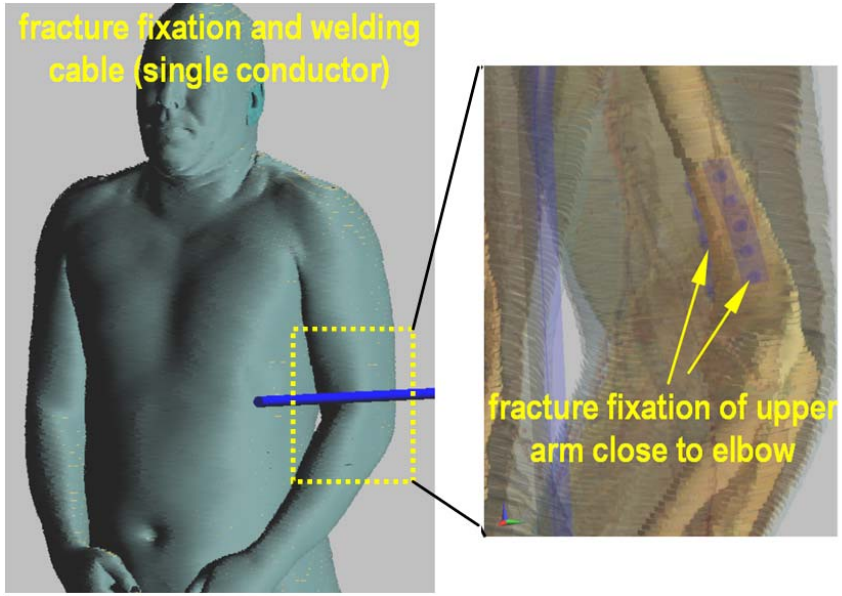
- Increasing number of implants in working population (pacemakers, prosthesis, fracture fixation…)
- Possibility of **functional interference**, e.g. on pacemakers
  - ➢ paricularly **pulsed LF magnetic fields** (EAS, RFID, welding, etc.) are expected to be potential interferers

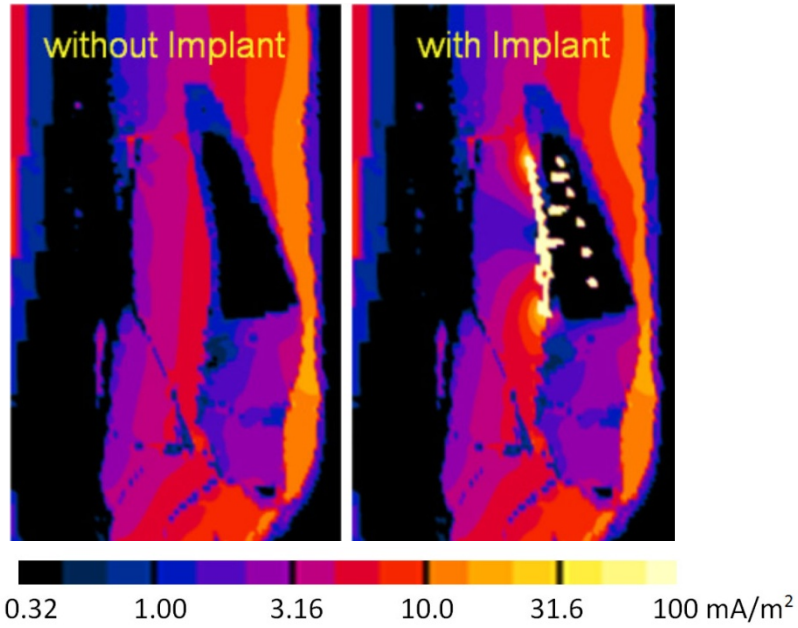




POSSIBLE INTERFERENCE WITH IMPLANTS

- Possibility of increased **current density / SAR** at edges, tips, … of metallic implants
  - paricularly **strong ELF/LF magnetic fields in situations with high exposure** even without the implant are of interest





CONCLUSIONS

- In several cases workplace specific exposure requires well-considered assessment procedures due to
  - highly localized exposure above the reference levels
  - high field gradients
  - specific time characteristics (transients, pulses)
- In the LF-range (up to 10 MHz) time domain measurements at high spatial resolution (small probes) are often required to accurately obtain the exposure (hands, fingers, ..)
- Numerical computations of induced electric field strength and/or SAR are essential in several cases
- Remaining difficulties: varying posture (fingers, hands),
  realistic worst case averaging time for SAR assessment
- Situation of workers bearing implants needs to be carefully taken into account

THANK YOU !