



Scientific Computing in Information Technology

Gert Frølund Pedersen

Antennas, Propagation and Radio Networking section
Department of Electronic Systems
Aalborg University

Outline

1. FDTD software development at APNet
2. PET study – dosimetry
3. TETRA project – dosimetry
4. Spherical array of monopoles
5. Room electromagnetics
6. Parallel FDTD code



1. The AAU 3rd Generation FDTD Code

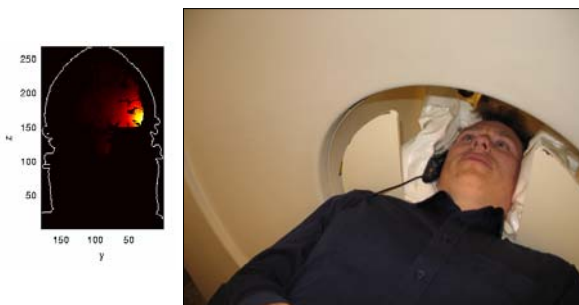
- User interface, preprocessing and postprocessing in Matlab
- Computational kernel in Fortran 2003

2. Dosimetry for the PET Study

- A group of volunteers has been examined on a PET scanner under exposure from a common type of mobile phone and their brain metabolic activity has been observed.

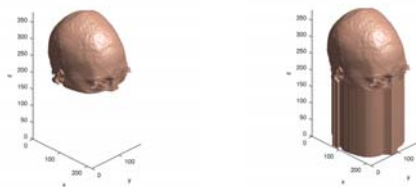


- The objective of this APNet part of work is to find the power deposition in brain based on FDTD simulation of electromagnetic field.



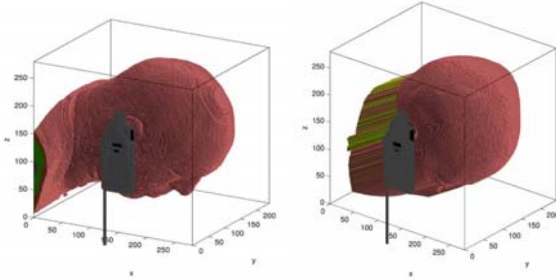
PET Study volunteers

- The volunteers have been scanned by MR scanner, but only the brain part
- First, segmentation of the MRI images have been performed
- Segmented data have been assigned proper tissue parameters to obtain electromagnetic model of the head
- The last slice has been elongated to avoid distortion of fields

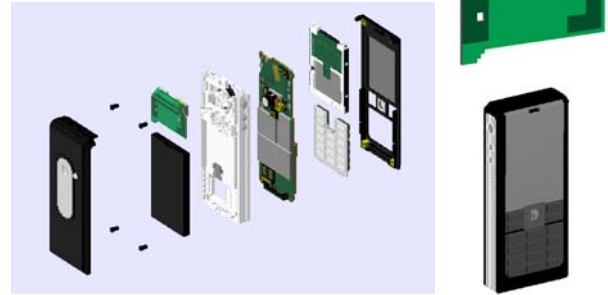


Simulation setup

- Heads have been rotated instead of the phone, to keep the phone model aligned to the grid – avoiding the staircasing error on the phone



The Phone Model

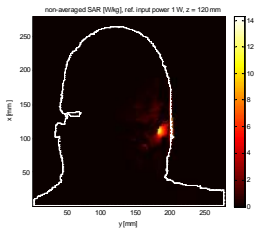


PET Study – whole head

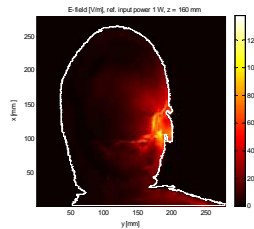
$$SAR = \frac{\sigma |E|^2}{2\rho}$$

σ ... conductivity
 E ... electric field intensity
 ρ ... mass density

Non-averaged (local) SAR

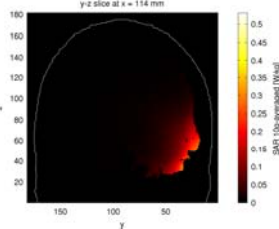


Electric field magnitude

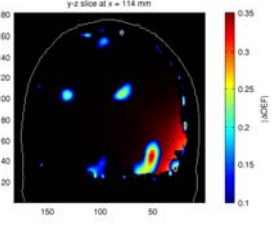


PET Study – brain tissues

SAR 10g-averaged

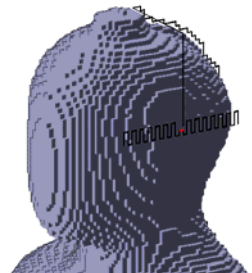
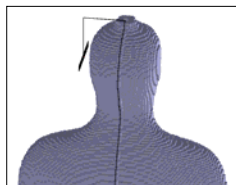


PET overlay



3. Dosimetry for the TETRA Project

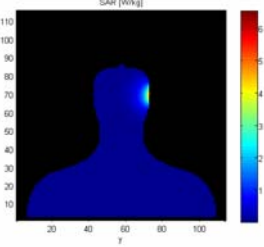
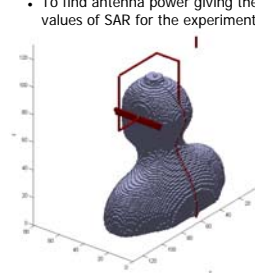
- Investigation of changes in cognitive performance due to radiation from TETRA handsets
- Generic dipole was used – produces the same field as the handset and provides repeatability of the experiment



Aims of the numerical study:

- To ensure an optimum arrangement of the dipole and the cabling so that no additional SAR appears
- To find antenna power giving the safe values of SAR for the experiment

SAR 10g-averaged:



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SAR was measured and simulated using the same homogeneous phantom

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4. Spherical Array of Monopoles

- Design of the antenna was motivated by highest possible flexibility in steering the beam while preserving wide frequency range of operation (3–6 GHz)
- 32 monopoles in quasi uniform pattern
- The monopoles are formed by teflon-coated stubs at the backsides of the SMA connectors mounted inward the sphere
- The specific shape allowed for FDTD simulation in spherical coordinates – more accurate

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Radiation patterns

Monopoles no. 2 and 32 excited

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S-parameters

Coupling between monopoles 31 and 32:

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5. Room Electromagnetics

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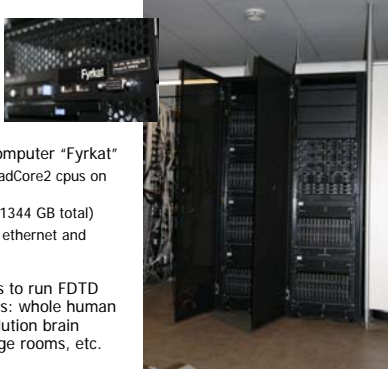
Room radio response

Access point 4

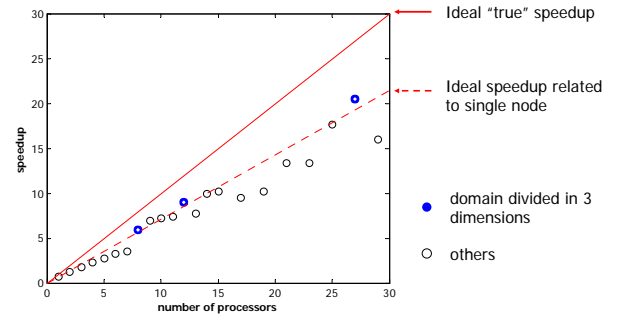
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6. Parallel FDTD Code

- Written in Fortran 2003
- Uses MPI library
- Run on AAU's new supercomputer "Fyrkat"
 - 84 blades, each with 2 QuadCore2 cpus on 2.33 GHz (672 cores total)
 - Memory per blade 16 GB (1344 GB total)
 - Interconnection by gigabit ethernet and Infiniband
- Fyrkat parameters allow us to run FDTD simulations up to 3^{10} voxels: whole human bodies, submillimeter resolution brain models, propagation in large rooms, etc.



Parallel FDTD Code – performance



Thank you!