# On the Use of Numerical Phantoms in the Study of the Human-Antenna Interaction Problem

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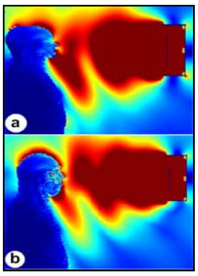
## Abstract

The use of numerical methods and phantoms is a common way to attack complex dosimetric problems, such as the near-field interaction between human and radiobase antennas (RBA), which is a relevant topic for employees involved in RBA maintenance. The rigorous problem solution, however, is difficult, both using experimental methods, where the use of homogeneous phantoms deserves a careful estimation of the introduced approximation error, and using numerical methods, where a huge memory and CPU time requirement must be satisfied and accurate numerical phantoms are needed. In this framework, the authors have recently developed an FDTD parallel method, described in (Catarinucci, Palazzari and Tarricone, IEEE Trans. MTT, March 2003). In the present work, this FDTD approach is adopted to compare dosimetric evaluations attained by using different numerical phantoms. The effects of the phantom shape and structure are studied, as well as the error induced by the use of homogeneous phantoms, instead of accurate heterogeneous ones.

For the sake of brevity only the results for six different phantoms are shown here: the well known Yale and Brooks Phantoms (YP and BP), and two couples of homogeneous phantoms, with the same shape of respectively YP and BP, and attained by using the averaged YP parameters on the former couple ($YH_1P$ and $BH_1P$, with $\varepsilon_r$ =46.33 and $\sigma$=0.73 S/m) and the averaged BP ones on the latter ($YH_2P$ and $BH_2P$, with $\varepsilon_r$ =34.32 and $\sigma$=0.63 S/m). Thus, for instance, $BH_1P$ has the shape of Brooks phantom, and $\varepsilon_r$ and $\sigma$ attained as average values inside Yale phantom. The phantoms have been exposed to the same source, the Kathrein RBA 730678 (working frequency 900 MHz), varying the human-RBA distance and using emitted power of 32 W.




| 1-g SAR and 10-g SAR: peak values [W/Kg] | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dist | type | YP | $YH_1P$ | $YH_2P$ | BP | $BH_1P$ | $BH_2P$ |
| 20 cm | 1g | 30.3246 | 29.5250 | 27.8730 | 18.4290 | 27.6260 | 25.7077 |
| | 10g | 15.3094 | 16.6297 | 15.2104 | 11.8857 | 18.8416 | 17.2059 |
| 30 cm | 1g | 12.6115 | 11.7294 | 11.4564 | 13.3806 | 19.5851 | 17.8272 |
| | 10g | 6.3243 | 6.6411 | 6.2494 | 8.6443 | 13.4448 | 12.0284 |
| 40 cm | 1g | 10.6837 | 9.9847 | 9.6198 | 6.1333 | 9.6302 | 9.1622 |
| | 10g | 5.3198 | 5.6239 | 5.2419 | 4.1630 | 7.1555 | 6.5020 |
| 50 cm | 1g | 5.3187 | 4.8766 | 4.7711 | 4.7905 | 7.0089 | 6.7971 |
| | 10g | 2.6331 | 2.7527 | 2.5955 | 3.1065 | 5.2943 | 4.7935 |

Fig. 1: YP (a) and BP (b) exposure and the obtained peak SAR for 6 different numerical phantoms

From Fig. 1 it is quite apparent the different shape between Yale and Brooks phantoms, and the consequent differences in the field distribution. This causes relevant differences in the SAR estimation, as evidenced in the table, where the peak values of 1-g and 10-g SAR are reported for the six phantoms. From the reported results, it can be summarised that:
- differences of up to 40 % are observed when comparing the two heterogeneous phantoms;
- small differences are observed on the peak SAR when comparing YP with $YH_1P$ and $YH_2P$; nonetheless, larger differences are observed when comparing local SAR value (results not here shown);
- differences of up to 40 % are observed when comparing BP with $BH_1P$ and $BH_2P$;

In conclusion, substantial differences are observed when estimating the peak values for SAR with two different accurate numerical phantoms. A substantial error is also induced when each heterogeneous phantom is approximated by a homogeneous one (as in many experimental set-ups), thus requiring a special care when performing such simplifications.