Does the Human Body Alter Measurement Uncertainty of A Multi-Band Wearable Distributed Radio Frequency Exposure Meter?

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I. Introduction & Aim

Human exposure to radio frequency (RF) radiation is usually measured by personal exposimeters (PEMs). The main issue of PEMs is that the presence of the human body results in large uncertainties up to 35 dB [1].

For the first time, a multi-band multi-node wearable distributed RF exposure meter (MBWE) is designed and calibrated on body. The goal is to reduce the influence of human body on measurements of the MBWE. This is achieved in terms of on-body calibrations. Moreover, the MBWE is calibrated on five human subjects to assess the influence of human body on its measurement uncertainty.

II. Methods

The MBWE is designed to measure the actual incident power densities ($S_{inc}$) for 11 frequency bands and consists of 22 nodes distributed in an optimal way on the front and back of the body torso. Each node is a textile antenna equipped with a receiver circuit. The nodes are integrated into an outdoor garment and a master node controlling the whole system.

The locations of the nodes are optimized by calibrating the MBWE on a 28-year-old male subject.

The calibrations are performed in an anechoic chamber; The subject is rotated 360° around his axis perpendicular to the ground floor of the anechoic chamber in the far field of a transmitting horn antenna. The free space $S_{inc}$ values were also measured in absence of the subject. From these measurements, an effective on-body AA is determined per frequency band and location. These AA values will be used to calculate $S_{inc}$ during the measurements in a real environment. A similar procedure is repeated for four male and female subjects with an age range of 28 to 61.

III. Results and Discussion

Using the MBWE, we obtain a reduction of 22 dB in uncertainty (defined as 68% confidence interval of AA, CI$_{68}$) over the considered frequency bands, compared to classical single exposimeters. Moreover these results are much lower (4-12 dB) than CI$_{68}$ of a PEM calibrated on body. The results are consistent over all subjects. The MWBE also showed CI$_{68}$ of 0.1-3.2 dB for five different people in all frequency bands which is one fourth of the similar value for a PEM.

IV. Conclusions

A MWBE is designed and calibrated on body for five human subjects. The MBWE showed a reduction to 22 dB for the measurement uncertainty in presence of human body and to one fourth for five different body morphologies.

Acknowledgment

The research was funded by the Research-Foundation Flanders (FWO-V) under grant agreement NO G003415N and ANSES (2015/2RF/07) as part of Project ACCEDERA.

Conflict of interest

The authors declare that they have no conflict of interest.

References