

# **ASSESSMENT TECHNIQUE FOR THE CUMULATIVE EXPOSURE OF MOBILE PHONES IN REAL NETWORKS**

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## **INTRODUCTION**

Cumulative exposure from cellular phones during use on a network is a function of the magnitude and anatomical distribution of SAR (SAR<sub>distr</sub>), which are determined for the maximum power level (PWC<sub>max</sub>), average power control level (PWC<sub>avg</sub>), which depends on network properties and transmission mode, and the duration of exposure (t). We assume that for a phone always operated at the same position on the head, cumulative exposure represents a dose that can be expressed as

$$\text{Dose} = \text{SAR}_{\text{distr}} * \text{PWC}(\text{avg})/\text{PWC}(\text{max}) * t .$$

SAR magnitudes and their distribution in tissue are strongly dependent on the phone design. Radiation effectiveness, a measure of efficiency in converting RF power into useful radiated power, is also greatly affected by phone design. Since power control is a function of the received signal strength at the base station, radiation effectiveness is expected to be a parameter that indirectly determines dose through an effect on PWC<sub>avg</sub>.

## **OBJECTIVE**

The objective of this study was to develop a methodology for assessment of the cumulative does posed by a particular mobile phones in real networks.

## **METHODS**

The system is based on the SAM head phantom filled with tissue simulating liquid and a phone holder/positioner which is either lossless or simulating a lossy hand. One sensor at each side of the head is immersed inside the tissue simulating liquid 4 mm behind the ear. The SAR values measured at these two locations are correlated with the spatial peak SAR assessed following the standardized procedures for compliance testing. The signal of the sensor is amplified with a modified DAEasy4 and evaluated with an EASY4 (SPEAG, Switzerland). The integrated GPS enables not only to determine the data with respect to time but also with respect to the geographical location. The system specifications for SAR measurements were:

- sampling rate: > 3000 samples/s per channel (rise/fall time < 0.3ms)
- dynamic range: > 33dB (> 48dB for whole system with different sensor lengths)
- cross talk attenuation: > 34dB
- linearity: < 0.2dB deviation
- noise: < 1mW/kg
- temperature range: 10 - 40 °C (<< 1dB)
- humidity: 0 - 90%
- location tracking: resolution provided by standard GPS
- battery and DC operated

## **RESULTS**

The developed measurement system enable to evaluate the performance of handsets in actual networks. The parameters which can be assessed as function of time and location are PWC level, handover from base station to base station, handover between modes (e.g., GSM, DCS, UMTS), drops of calls, etc. Up to four phones can be evaluated in parallel. The measurements are correlated in time and location domain (GPS data are collected and superimposed with a map). If the location from the base station are available, the performance can be evaluated as a function of the distance to the closest base stations, etc.