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RF-EMF exposure induced by distributed antenna system in the subway station

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Abstract

We aim in the present paper to address the impact of installing indoor distributed antenna system (distAS) on the human exposure to radio-frequency electromagnetic field (RF-EMF). We note that distAS aims to extend coverage and improve wireless communication quality. We performed measurement campaigns in subway stations, where distAS are deployed. The impact of distAS on the exposure is studied by considering two scenarios where distAS are turned either on or off. The electric field strength is measured at different distances to the distAS, for all the frequency bands and operators. The results show that the DL exposure induced by distAS is very low and far away from the standard limits of ICNIRP.

1. Introduction

The tremendous developments on the wireless communication technologies and the explosion on the number of user equipment are always accompanied with public concerns on health impact of radio-frequency electromagnetic field (RF-EMF). Accordingly, human exposure to RF-EMF should be monitored and complied with international standard limits [1]. In [2, 3], measurement campaigns have been conducted in outdoor environments to characterize the impact of small cells on the RF-EMF exposure. Recently, wireless sensor network is deployed in France to monitor the time-variation of the RF-EMF exposure in public places. The corresponding monitored data is also used to predict an exposure map over a given area, by exploiting artificial neural networks [4].

We aim in the present work to assess the RF-EMF exposure induced by distributed antenna system (DistAS) [5], which intends to extend the coverage and improve the wireless communication quality. To this end, we conducted measurement campaigns in two subway stations, where distAS has been installed. The impact of DistAS on the EMF exposure is addressed by considering two different scenarios, where the DistAS has been turned either on or off. The downlink (DL) exposure due to the RF emissions of the DistAS is measured at different distances with respect to the DistAS.

2. Measurement equipment

The DL exposure is assessed through measuring the electric field (E-field) strength using a real time spectrum analyzer, i.e., Tektronix RSA306B. The measurement equipment is shown in Figure 1. Isotropic measurements is achieved using a broadband tri-axial antenna with 50MHz - 6GHz frequency range. This tri-axial antenna is connected to the '*one-port*' spectrum analyzer through a switch. The latter is controlled by an Arduino (i.e., a microcontroller), in such a way that all the bands are first measured on a single axis, and then switched to the other axis. The total E-field is thus the root-mean squared of the E-field measured on each axis.

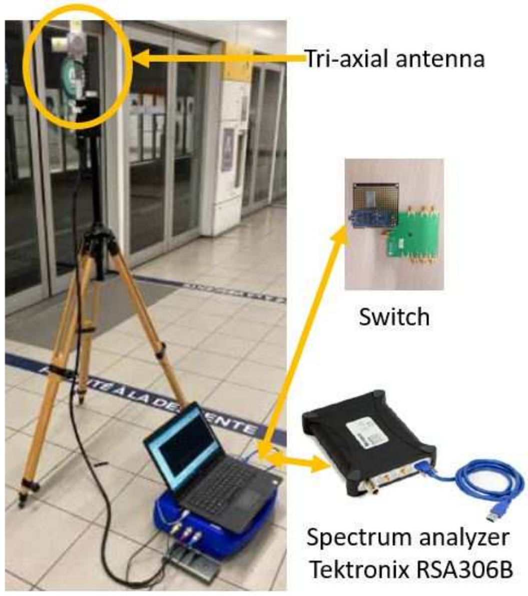

Figure 1. The measurement equipment.

3. Measurement description

Measurement campaigns have been carried out in two subway stations in France, where distAS has been deployed in order to cover users on the platform or other floors in the stations. Most of the distASs are directional and deployed on the wall, except of one omnidirectional antenna deployed on the ceiling. We measured the E-field strength at the height of 1.5 m and at different positions covering different distances to the distAS. For each measurement position, we record the E-field over almost 10 min, considering all the frequency bands of all the 4 French operators. Moreover, we consider two different scenarios, where the distAS has been turned either on or off. This allows evaluating their impact on the RF-EMF exposure.

4. Results and discussion

For each measurement position, we compute the average E-field recorded over almost 10 min for different frequency bands and operators. Then, we aggregate all the average E fields for different positions in the two subway stations and plot the corresponding cumulative distribution function (CDF), while differentiating between distAS on or off. The results in Fig. 2 show that deploying an indoor distAS will increase the DL exposure, while the values are very far away from the standard limits of International Commission on Non-Ionizing Radiation Protection (ICNIRP). We note that the high values of the E-field correspond to locations very close to the distAS, if the latter is on. For distAS off, the high values are due to outdoor base stations. In future works, we will discuss the impact of DistAS on the UL exposure.

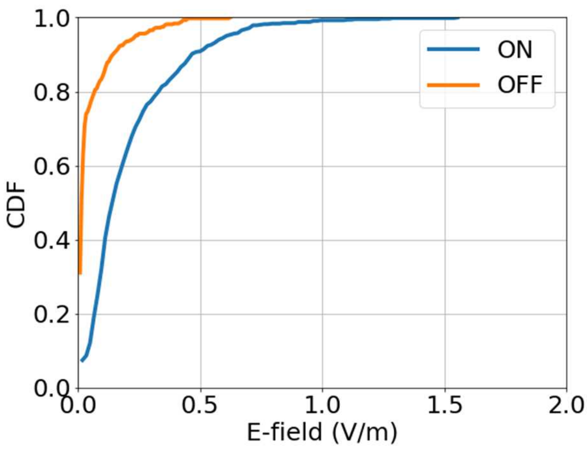

Figure 2. The statistical distribution of the E-field for distributed antenna system .

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