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Assessment of RF-EMF Exposure Induced by Cellular Wireless Networks in Public Transportation Facilities of the Paris Region

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Abstract— Wireless communications are increasingly common, but concerns about health risks persist. Consequently, exposure monitoring has become a critical area of investigation. The research detailed in this contribution was conducted as part of the EU project Seawave and the French Project Beyond5G. Exposure assessment was performed using personal dosimeters, specifically the MVG EME spy. Measurements were conducted over various frequency bands (700 MHz-3500 MHz) in different modes of public transportation, including RER, metro, tram, bus, and train, operating in the Paris region. The collected measurements were analyzed based on frequency bands, types of public transportation, and environmental conditions.

I. INTRODUCTION

Today, wireless communication utilizing radiofrequency electromagnetic fields (RF-EMF) has become increasingly prevalent. The widespread use of wireless communication, particularly with the rise of 5G networks, has led to concerns about radiofrequency electromagnetic field (RF-EMF) exposure [1]. Despite established protection limits and standardized methods, public perception of risk remains high. Efforts in the last decade focused on EMF exposure assessment, standardization, and monitoring, with various EU projects addressing these concerns. This contribution details measurements conducted in Paris public transportation, emphasizing the need for RF-EMF exposure monitoring.

II. MEASUREMENT PROTOCOL

This study aims to assess exposure levels in public transportation, particularly during crowded peak hours. To achieve this, we opted for the EME Spy Evolution exposimeter, a portable and less bulky alternative to complex systems. Equipped with a tri-axial electric field (E-field) probe, the device captures accurate measurements in three dimensions across 15 cellular frequency bands in the 80 MHz to 6 GHz range, tailored for the French context. The recording period varies from 2 to 255 seconds, depending on the selected frequency bands. For our study, we chose a minimum recording period of 4 seconds for 7 cellular bands (downlink bands from 700 MHz to 3500MHz), most of which are primarily allocated for use in 4G or 5G networks. Sensitivity varies across bands, and the upper detection limit is 6 V/m. Exposure assessment with the personal exposimeter can result in blocking phenomena and coupling with the user's body, which may affect accuracy [2]. A correction phase has been adopted by comparing the results obtained by the exposimeter and a reference system (Tektronix). Experimenters, carrying a PEM in a small bag

close to their bodies, alternated between walking, sitting, or standing during public transportation journeys. The measurements, totaling approximately 17,000 frequency-selective measurements, were conducted following the described protocol in different types of public transportation. To assess EMF exposure during these commutes, we selected transportation modes in the Paris region such as the Regional Express Network (RER), Regional Express Train (TER), metro, bus, and tram, as well as indoor facilities like train stations and airports.

III. RESULTS AND CONCLUSIONS

Exposure measurements across frequency bands (700 MHz to 3500 MHz) reveal root mean square (RMS) values ranging from 0.18V/m to 0.43V/m, with notable dispersion indicated by coefficient of variation values (Std./Mean) ranging from 2 to 3.5. Maximum and 95th percentile exposure levels remain low and well below ICNIRP guidelines [3]. Train stations and airports exhibit the highest mean exposure values, all below 1 V/m. Notably, 5G deployment at 3500 MHz is limited, particularly in underground locations like the metro. Figure 1 depicts the RMS value of the E-field across all frequencies in various scenarios. The data illustrates higher exposure levels in indoor scenarios, while underground transportation modes exhibit lower exposure compared to on-ground/semi-underground transports.

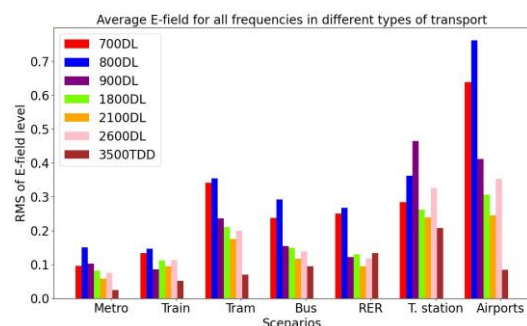


Fig. 1. Barplot of average E-field level in different scenarios

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