EM-Art: Electromagnetic artificial human - paradigm shift in dosimetry for 5G and beyond

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IETR: A. Boriskin, M. Zhadobov, R. Sauleau (contact: maxim.zhdobov@univ-rennes.fr)

IRISA: M. Ferro, C. Pacchierotti, P. Robuffo-Giordano (contact: claudio.pacchierotti@irisa.fr)

Home page: https://project.inria.fr/emart

Summary

Future wireless networks (5G+/6G/xG) will operate in the FR2 frequency range (above 24GHz) that has never been used before for public network. This raises public concerns and requires reliable methods for testing new wireless devices with respect to the user exposure limits defined by ICNIRP and IEEE.

Because of the fundamental limitations related to the shallow penetration of mmWave radiation in biological tissues and equivalent human models, the conventional dosimetry and compliance testing techniques (developed for 3G/4G devices operating in FR1 frequency range below 6GHz) cannot be scaled to FR2.

EM-ART project explores a fundamentally new approach addressing challenges in terms of accurate and realistic dosimetry measurements in FR2 range.

The project relies on the complementary expertise and know-how of IETR and IRISA in advanced mmWave technologies, bioelectromagnetics, and sensor-based robotics to pave the way towards a new generation of dosimetry systems for 5G and beyond.

Context

Smartphones, tables, and laptops are just a few examples of handheld devices operating in close vicinity of the human body. The bi-directional interaction of such devices with human body may produce an important impact on the device performance as well as on the user exposure.

Radiated power of such devices may vary from tens to hundreds of mW depending on the country, resulting in high exposure levels, due to the near-field exposure scenarios and localized absorption of mmWave radiation.

To ensure the user safety, all new wireless devices undergo the user level exposure compliance testing and certification procedures before commercialization.

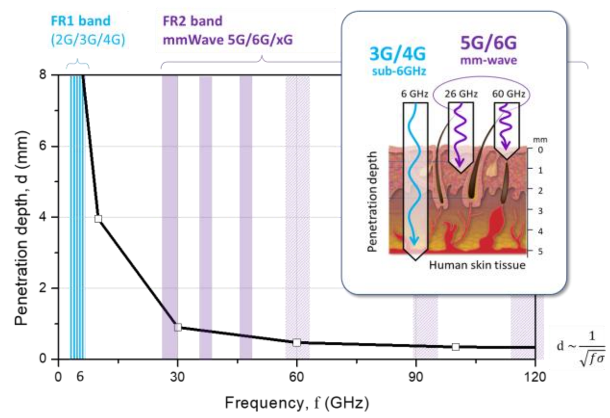
Project objectives

- ✓ Design, optimization, fabrication & experimental validation of the innovative reflectivity-based electromagnetic phantoms, reproducing the EM scattering characteristics of human body in FR2.
- ✓ Development of an experimental setup for fast APD* dosimetry measurements, based on high-resolution IR imaging.
- ✓ Development of a method and system for real-time exposure tracking and smart worst-case exposure scenario identification in realistic use-case scenarios, using a robotic arm manipulator with active sensing.

* - Absorbed power density (APD) is a main dosimetric quantity in FR2 range according to recommendations of the International Commission on Non-ionizing Radiation Protection [ICNIRP-2020].

Motivation

The mass deployment of mmWave-5G/6G public networks (operating in FR2) is ongoing worldwide. According to ANFR, all big cities and transport infrastructure in Europe shall be covered by FR2 networks already in 2025. However, the lack of reliable dosimetry methods/systems raises important public concerns about the user safety.



The first 3D-printed reflectivity-based EM human phantoms

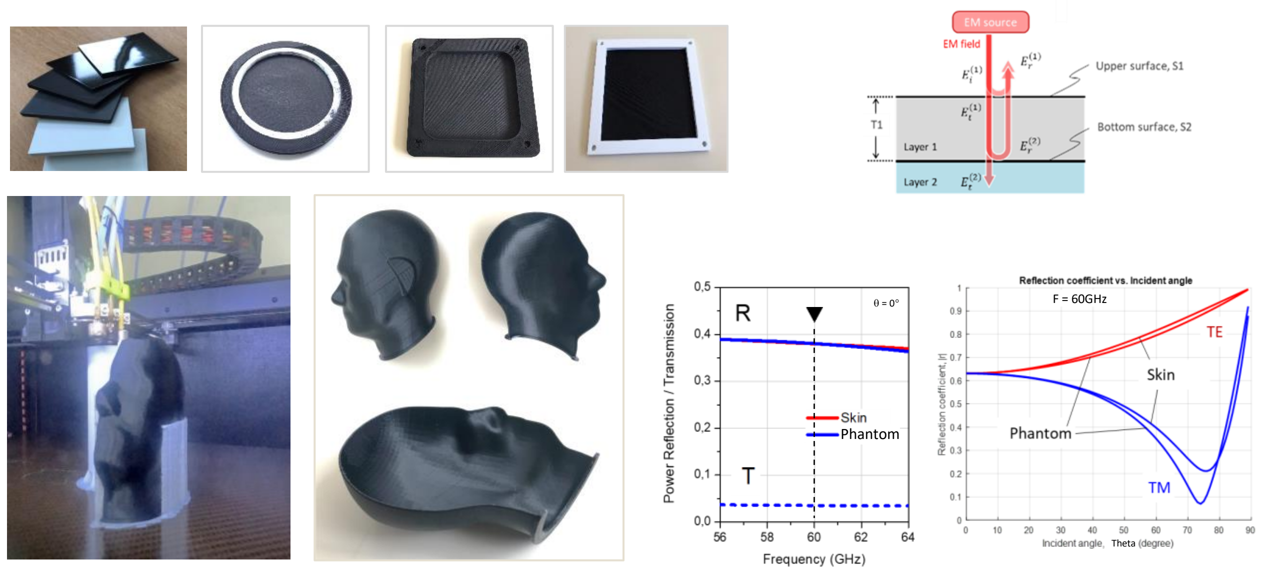


Fig. 1. The first 3D-printed reflectivity-based phantoms (flat and 3D-shaped) reproducing the EM reflection coefficient of the human skin in FR2 band for both TE/TM polarizations.

Experimental setup and PoC for IR-based mmWave dosimetry

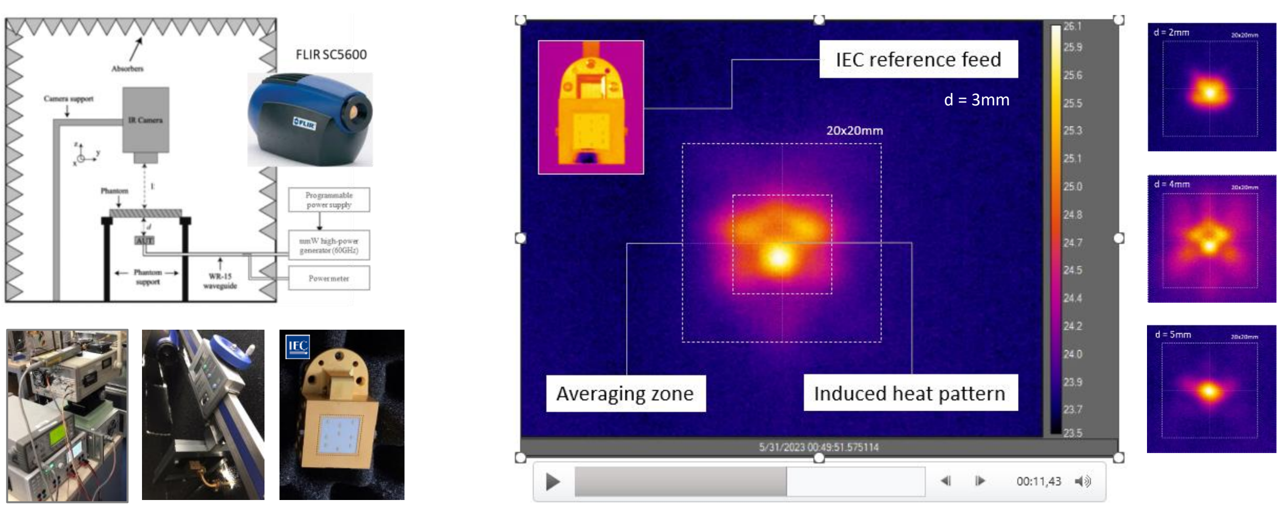


Fig. 2. Setup and IR images of heat patterns induced on back surface of a flat 3D-printed reflectivity-based phantom exposed to 60GHz radiation emitted by an IEC reference antenna (cavity-backed dipole array) with radiated power of 200mW (maxim allowed for handheld devices according to 3GPP).