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On the used of EMIR® method to realize 3D characterization of radio wave fields

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Abstract

Since the pioneering works of Iizuka [1] and Gregoris [2] and thanks to the work of a few research groups, the EMIR® (ElectroMagnetic-InfraRed) technique progressively improves its performances, making possible to visualize in real-time, with a high spatial resolution and a very large bandwidth, Continuous Wave (CW), modulated, or pulsed electromagnetic fields [3-5].

The EMIR method combines the use of an infrared thermography camera and of a screen made of a photothermal film transforming a fraction of the electric or magnetic field into heat, producing a 2-D tomography that is an image of the field intensity.

The observation of CW fields is very sensitive. The photothermal film can be placed in planes perpendicular to the propagation direction. An IR camera records the thermal response of the film during a square-shaped illumination by the studied EM source. Norgard et al. [3] show that this field imaging technique has the advantages of accuracy, simplicity, speed, and portability over existing hard-wired probe methods and produces a 2D picture of the near field or the far field.

In this paper, we extend this technique to realize a 3-D characterization of a UHF (0.3 to 3 GHz) radio wave antenna in an anechoic chamber (up-to-now the technique has been mainly applied to microwaves and recently to millimetric fields). The film (1 m x 1 m) is placed between the antenna and an IR bolometric camera (7-15 µm). The antenna emits (0.5, 0.75, 1 GHz, 20 V/m) during several seconds and the camera records the temperature-time evolution of the film. The experiment is repeated for various source-screen distances (3, 6, 9, 12, 15 and 18 cm) (cf. figure 1). Various data processing of the thermograms are possible, leading to the production of thermographic images of the field intensity. Finally 3-D maps of the electromagnetic field are obtained (confer figure 2). This approach allows to decreasing the influence of the radiato-convective heat losses, which tend to distort the field shape.

These results must be considered as preliminary. In the future the quality and accuracy of the images could be improved by introduction of a modulation of the source and use of a lock-in thermographic system [6]. Finally, calculation and results must be compared.

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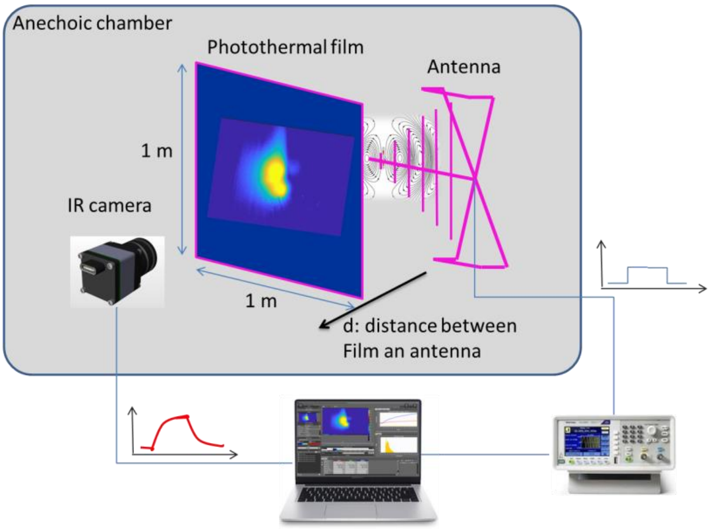

Fig. 1. *Presentation of the anechoic chamber: the photothermal film is placed successively at different distances from the antenna and the IR camera records the temperature map of the film.*

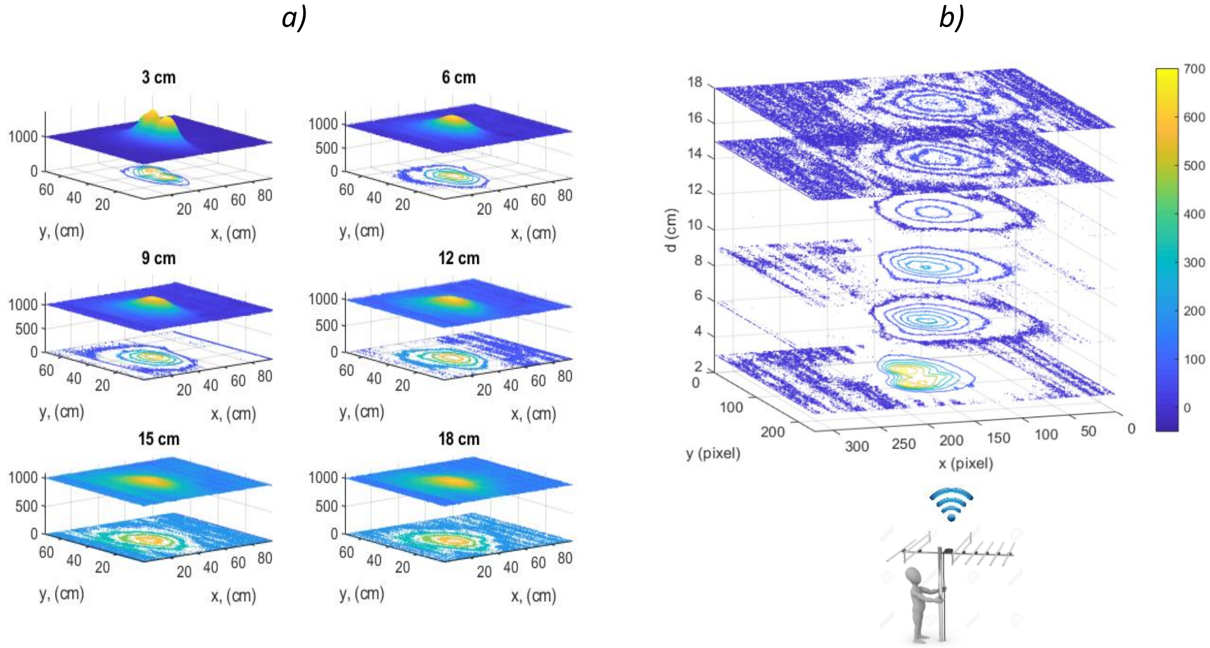

Fig. 2. *Presentation of some results f = 750 MHz: a) IR images (3-D relief maps and 2-D isothermal contours) obtained in steady state conditions for different distances between film and antenna (3, 6, 12, 15, 18 cm), b) isothermal curves for 3-D representation of the electromagnetic field (antenna is at d = 0 cm)*