Traceable measurement of field strength and SAR for the Physical Agents Directive

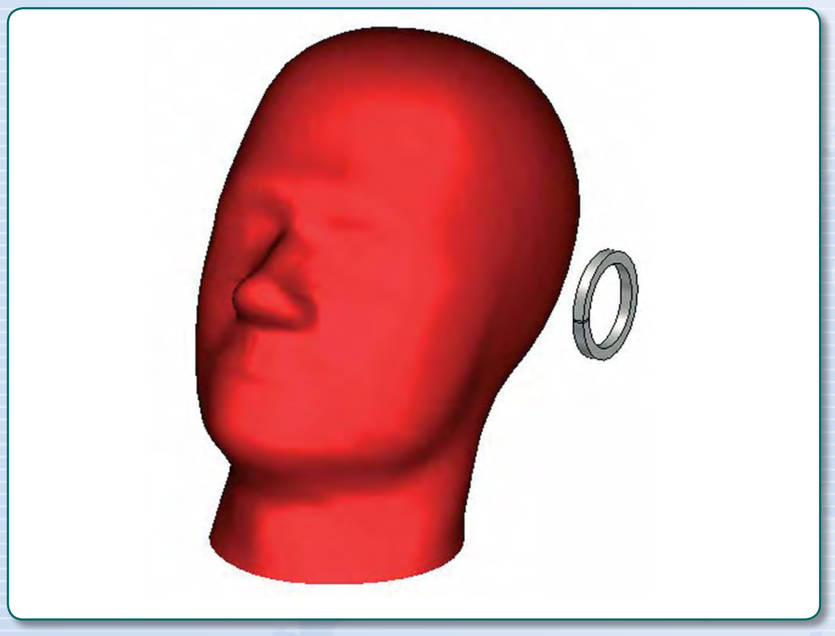
EURAMET
European Association of National Metrology Institutes

The need for the project

There are minimum requirements for the protection of workers from risks arising from the exposure to electromagnetic fields (EMF) and waves – as laid down by the European Physical Agents (Electromagnetic Fields) Directive 2004/40/EC.

These requirements limit the specific absorption rate (SAR) of radio frequency (RF) power between 100 kHz and 10 GHz, and the incident power flux density (PFD) from 10 GHz to 300 GHz.

Existing standards do not comprehensively cover SAR and PFD at these ranges, and so this project aimed to provide traceable measurements of SAR and EMF strength at the most widely used frequencies.



Specific Anthropomorphic Mannequin (SAM), Filling liquid: σ = 0.33 S/m, εr = 76, δ = 1000 kg/m³, Source: loop-antenna (radius = 25 mm) with a unitary impressed current, located 4 cm by the side of SAM, Working frequency: 100 MHz.

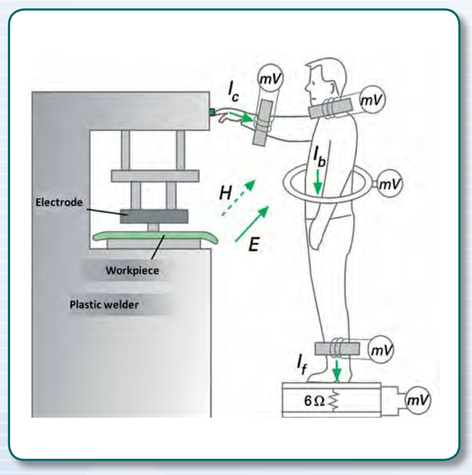
Technical achievements

Response measurements were obtained for field sensors exposed to pulsed, multi-frequency and digitally modulated signals. In addition, digital signal properties were assessed (error vector magnitude) and reference liquid and phantom material properties were characterised. These measurements are important for radar and airport EMF systems.

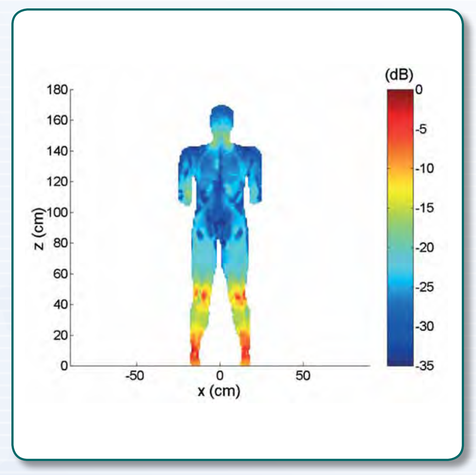
New broadband sensors, based on spiral and toothed antennas with diode sensors covering 40 GHz to 300 GHz, and thermal sensors, based on a fibre-coupled semiconductor thermometer for field strength measurements in free-space, were developed and validated.

SAR measurement setups were developed and characterised for the assessment of communication signals and reference liquid dielectric material properties. Existing measurement setups and theoretical models (e.g. relating surface currents to internal fields during MRI scanning) were optimised and inter-comparisons on SAR calibrations, on specific heat measurements and on theoretical calculations, were performed.

A field generator for a sample container containing fluorescent dyes was produced. Calculations of SAR distribution in artefact standards, phantoms and biological material monolayers, as required for micro-dosimetry, were also performed. Finally, a setup for spatially resolved measurements in a thin film on top of the coplanar waveguide was built and subsequently monitored by thermal tomography.



Measurement of induced body currents.



SAR induced by the simulated plastic welder.

New standards

Provided traceable standards, where there were previously none, for the sensor calibration of multi-frequency signals, signals with large bandwidths and pulse-modulated signals.

Produced artefact standards for SAR and dielectric properties with an extended frequency range up to 10 GHz. These will be used by wireless communication companies to demonstrate compliance of communication devices with the defined exposure limits.

New calibration facilities

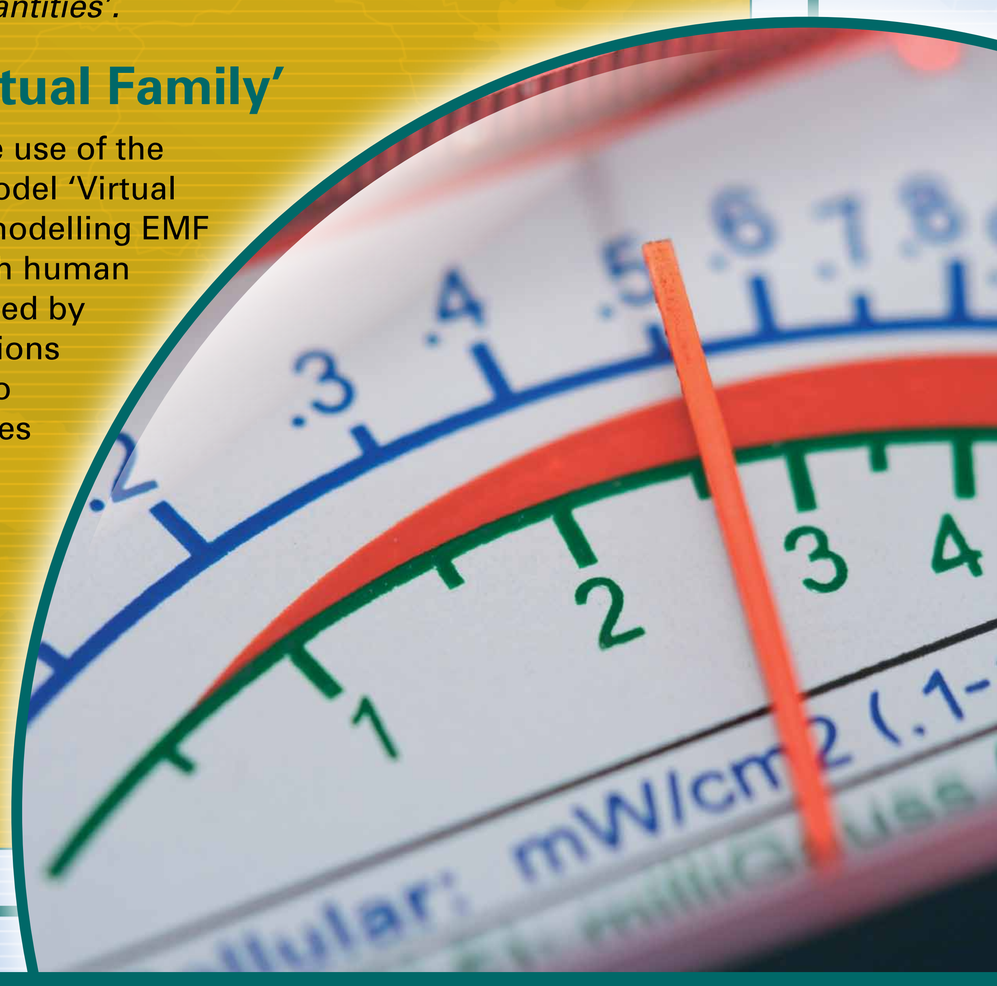
Established facilities for calibrating commercial probes, and extending the frequency range from 45 GHz to 300 GHz.

Input into existing standards

Input into international standards: Institute of Electrical and Electronics Engineers, Inc. (IEEE) 1309 *'Calibration of Electromagnetic Field Sensors and Probes, Excluding Antennas, from 9 kHz to 40 GHz'* and national guidelines: VDI (The Association of German Engineers) VDI/VDE/DGQ/DKD 2622 *'Calibration of measuring equipment for electrical quantities'*.

The 'Virtual Family'

Validated the use of the computer model 'Virtual Family' for modelling EMF and SAR with human subjects – used by communications companies to design devices such as body-worn antennas.



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