Preparing for 5G:

Evolution of RF-EMF Compliance Standards and Regulations for Mobile Devices

MWF
Mobile & Wireless Forum

About the MWF

- The MWF is an international non-profit association of telecommunications equipment manufacturers with an interest in mobile or wireless communications.

GARI
GLOBAL ACCESSIBILITY
REPORTING INITIATIVE

EMF & Health

SAR

spot a fake phone.com

MWF
Mobile & Wireless Forum

5G: Promise and Challenge

- Meets the huge growth in data and connectivity*
  - Globally 5.7B subscribers and 7.9B subscriptions;
  - Smartphones account for more than 60 percent of all mobile phone subscriptions;
  - 1.9 billion 5G subscriptions by the end of 2024.
- Increased speed, responsiveness and capacity
- Key infrastructure for IoT and emerging technologies,
  - e.g. autonomous vehicles, smart manufacturing, virtual reality
- Conformity challenges to be addressed, e.g.
  - Beamforming and MIMO make RF exposure highly variable in time and space;
  - Compliance of multiple IoT systems.

* Ericsson Mobility Report, June 2019

MWF
Mobile & Wireless Forum

5G: Not Only Above 6GHz

- Below 6GHz - ”sub-6”
  - Operate in same way as existing networks.

- Above 24GHz - ”mmWaves”
  - Existing uses of mmWaves include:

MWF
Mobile & Wireless Forum

Research Relevant for 5G-Frequencies

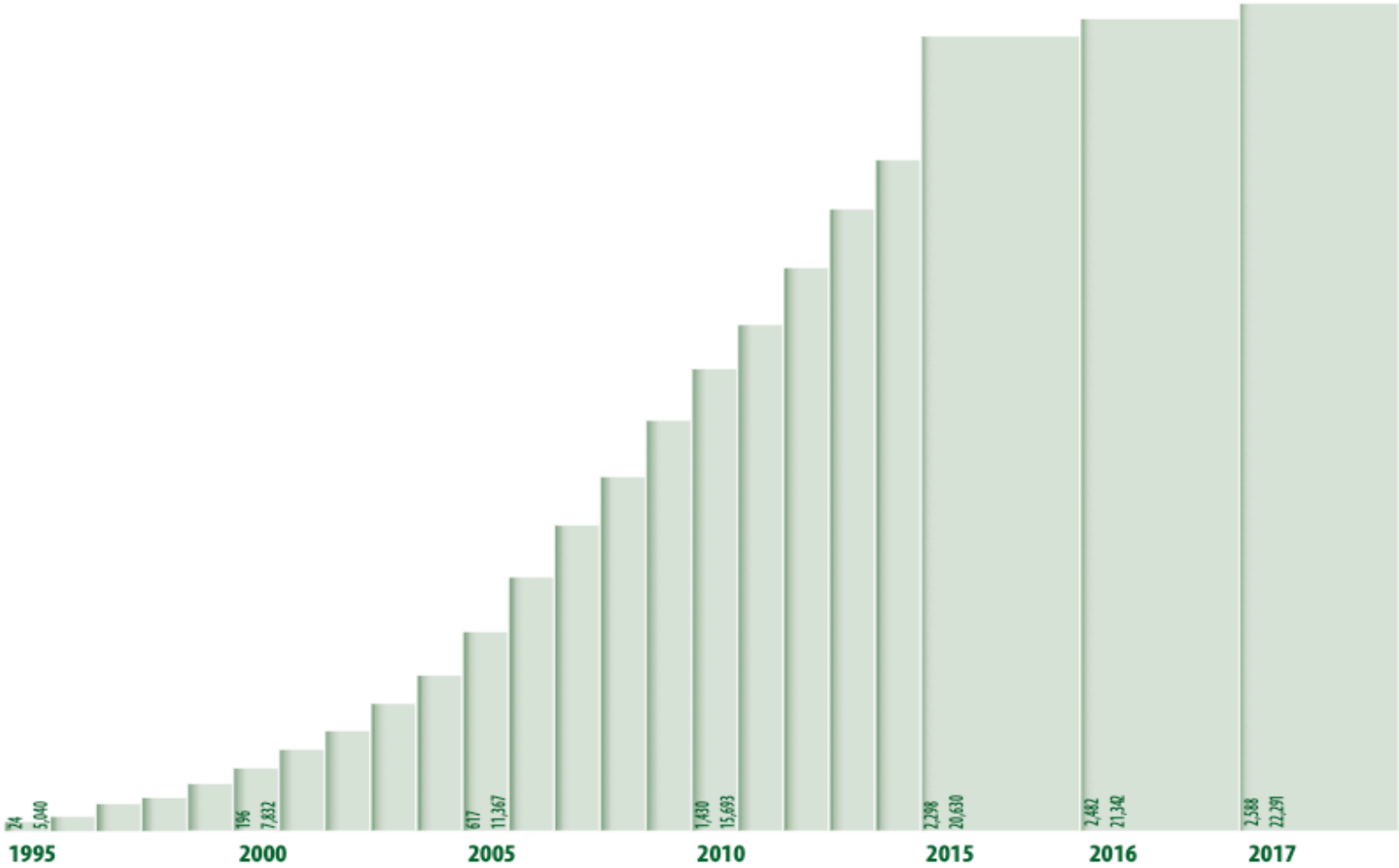
- EMF Research has been undertaken for 60+ years.

- Below 6GHz (sub-6):
  - EMF-Portal: 28,000 published scientific articles on the biological and health effects of EMF and 2,500 studies on mobile communications.

- Above 24GHz (mmWaves):
  - Recent review identified 470 studies @ mmWaves
  - Conclusions:
    - mmWaves are entirely absorbed in the epidermis and the dermis
    - Effects = thermal

MWF
Mobile & Wireless Forum

Growing Body of Scientific Evidence



Source: www.emf-portal.org (status December 2017); lower number refers to 'mobile communications' studies, larger number to 'all topics' and 'all frequency ranges'

Overview of MWF Research Efforts

http://www.mwfai.org/docs/eng/2018_05_MWF_20YearsofResearch.p

MWF
Mobile & Wireless Forum

Specific Absorption Rate (SAR) Limit
and
Established Adverse Health Effect

MWF
Mobile & Wireless Forum

What's the Threshold?

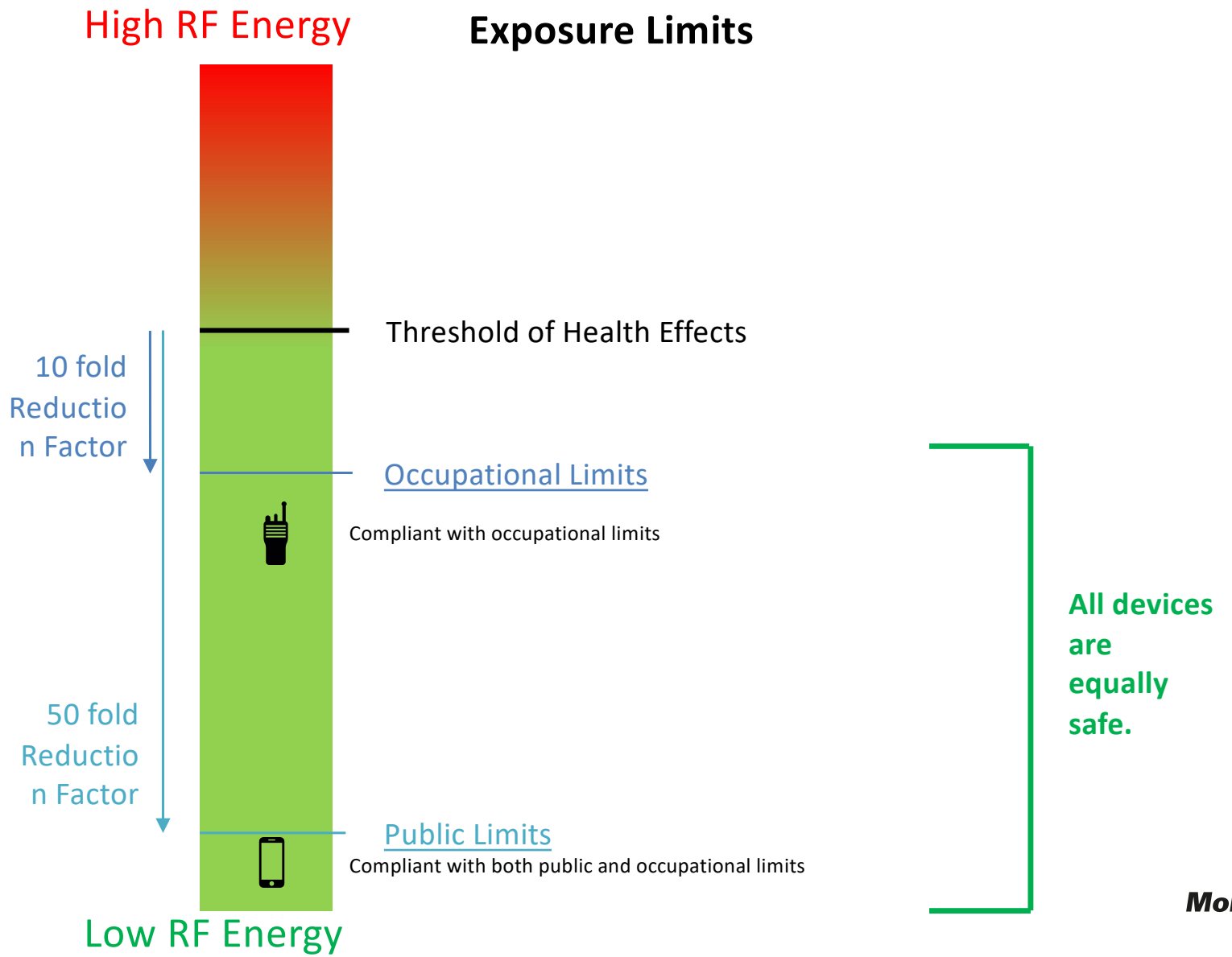
Established biological and health effects in the frequency range from 10 MHz to a few GHz are consistent with **responses to a body temperature rise of more than 1°C.**

This level of temperature increase results from exposure of individuals under moderate environmental conditions to **whole-body SAR of approximately 4 W kg^{-1} for about 30 min**. A **whole-body average SAR of 0.4 W kg^{-1}** has therefore been chosen as the restriction that provides **adequate protection for occupational exposure**. An **additional safety factor of 5** is introduced for exposure of the **public**, giving an **average whole-body** is **SAR limit of 0.08 W kg^{-1}**.

ICNIRP Exposure Guideline 1998, doc page 16 / publication page 509

MWF
Mobile & Wireless Forum

Exposure Limits



MWF
Mobile & Wireless Forum

WHO supports ICNIRP 1998 Limits for Mobile Phones

To date, **no adverse health effects** have been established as being **caused by mobile phone use**.

https://www.who.int/en/news-room/fact-sheets/detail/electromagnetic-fields-and-public-health-mobile-

MWF
Mobile & Wireless Forum

How to assess:

Compliance of Mobile Devices up to 6 GHz (SAR)

MWF
Mobile & Wireless Forum

Mobile Phones:
SAR Measurement

- IEC/EN 62209-1 Ed.2
  - **Measurement** procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - **Part 1: Devices used next to the ear (frequency range of 300 MHz to 6 GHz**)
- IEC/EN 62209-2:2010+AMD1:2019 CSV
  - Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - **Part 2: Procedure to determine** the specific absorption rate (**SAR**) for wireless communication **devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)**

Mobile Phones:
SAR Compliance Testing

- Mobile phone compliance is **tested at highest power level** possible.
- Intended use position
  - next to the **ear**: EN 50360:2017
  - **body-worn**: EN 50566:2017 up to 5 mm
- Reasonably foreseeable conditions
  - Article 3(1)a in conjunction with Article 17(1) Radio Equipment Directive

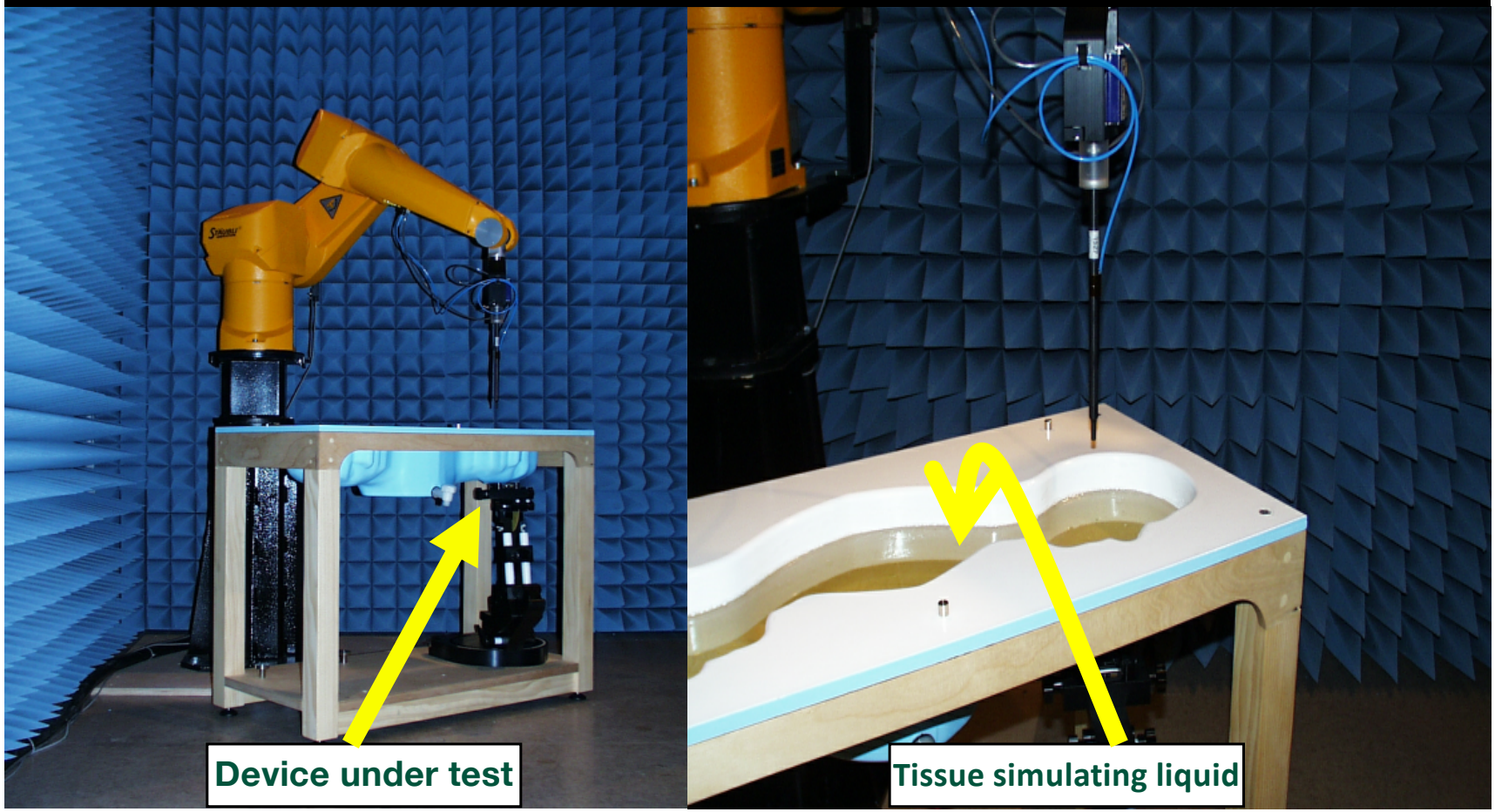
SAR Measurement - Next Level: IEC/IEEE 62209-1528*

- Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure (4 MHz – 10 GHz)
- Fully harmonising SAR measurement (IEC & IEEE dual logo)
- **Specifies** protocols and test procedures for **SAR testing** with
  - **single or multiple transmitters,**
  - **proximity sensors,**
  - **time averaging,**
  - **fast SAR and test reduction,**
  - **uncertainty analysis**
- Representative for **entire population** including children
- Use of **hand-held or body-worn** wireless communication devices when used next to the **ear**, in front of the **face** or mounted on the **body**

*Current status: Final Draft International Standard; once adopted, it will supersede IEC 62209-1 (ear), 62209-2 (body) and IEEE 1528 (head only).

MWF
Mobile & Wireless Forum

SAR Measurement Equipment



SAR measurement video: http://www.emfexplained.info/?ID=25593

How to assess:

EMF compliance for devices > 6 GHz

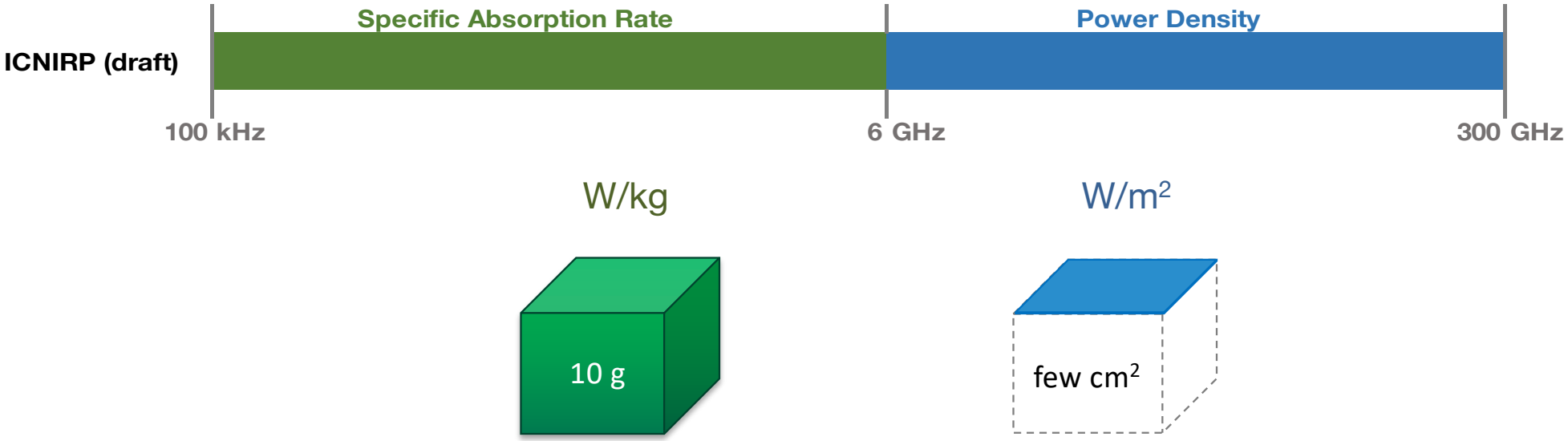
MWF
Mobile & Wireless Forum

EMF compliance challenges for devices > 6 GHz

- Change of exposure metric
- Assessment of incident power density in close proximity of a device
- Efficiency of compliance assessment methods

MWF
Mobile & Wireless Forum

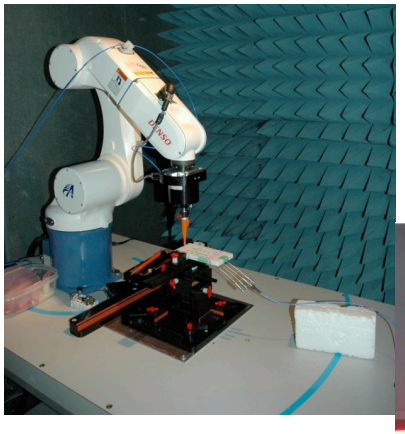
SAR & Power Density: Metric and Frequency

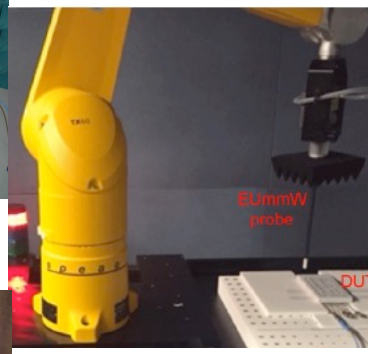


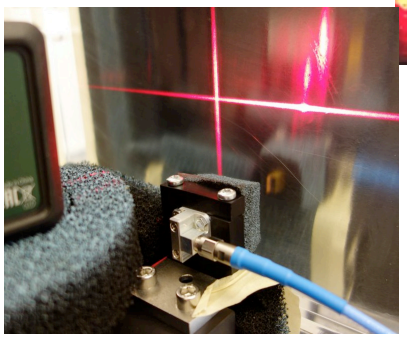
MWF Mobile & Wireless Forum

Assessment of Incident Power Density in close proximity of a device

- Different methods available (IEC Technical Report 63170), e.g.:
  - Measurement of both electric and magnetic fields **on** the evaluation surface
  - Measurement of the amplitude of the electric fields **on** the evaluation surface (phase reconstruction)
  - Measurement of the electric fields (amplitude and phase) **at a larger distance** of the evaluation surface (field back-projection)



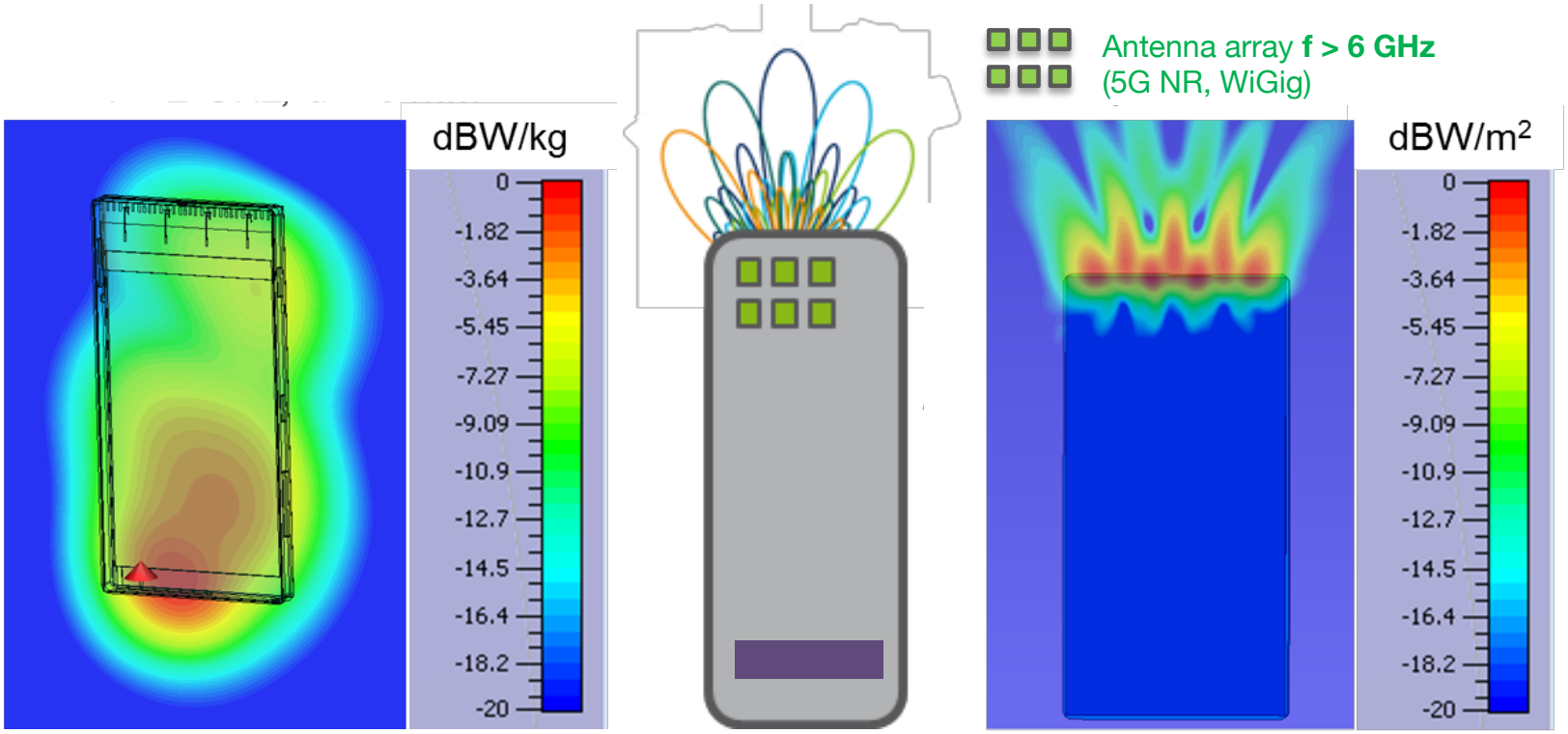




Photos: TR 63170

MWF
Mobile & Wireless Forum

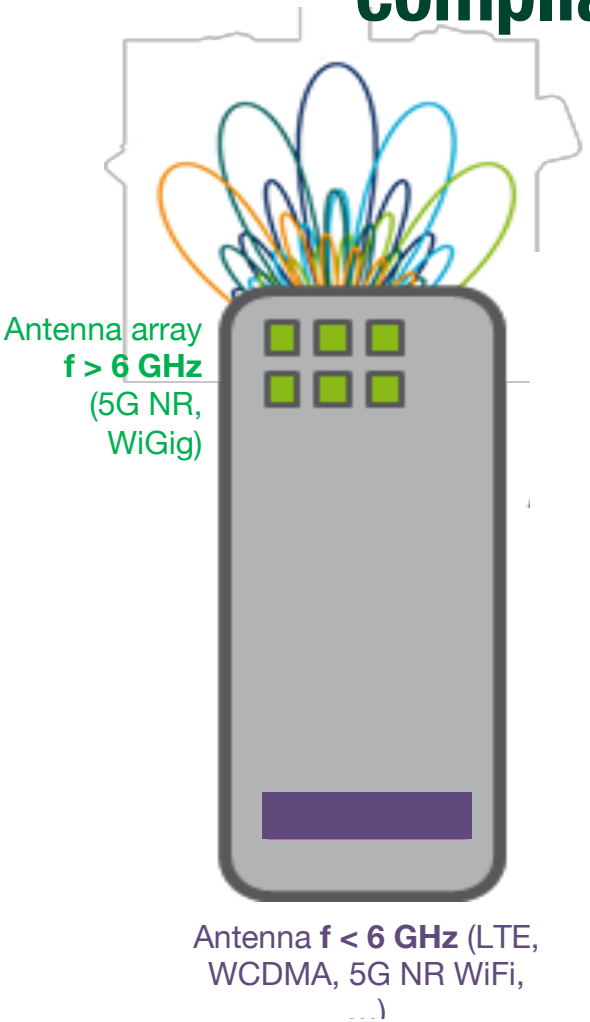
Complexity of compliance assessment



http://emfhealth.info/docs/eng/8%5FChallenges%20in%20standardization%20related%20to%20EMF%20compliance%20above%206%20GHz%2E

MWF
Mobile & Wireless Forum

Complexity of compliance assessment



- Measurements are extremely **time-consuming**.
- Multiple transmitters **below and above 6 GHz**
  - Antenna arrays require **combination of fields**
  - **Total exposure ratio** includes contributions from below and above 6 GHz
- Compliance tests for 5G devices require a large number of field combinations and configurations.
- **Need to combine numerical methods and measurements.**

MWF
Mobile & Wireless Forum

Mobile Devices: Incident Power Density (1)

- IEC Technical Report 63170:2018
  - **Measurement** procedure for the evaluation of **power density** related to human exposure to radio frequency fields from wireless communication devices operating between **6 GHz and 100 GHz**
    - Published in 2018
- Content:
  - State of the art **measurement techniques and test approaches** for evaluation of local and spatial-average incident power density in close proximity to the user
  - **Guidance for testing** portable devices in applicable operating position(s) **near the human body** (methods may also apply to exposures in close proximity to base stations)
  - How to assess **exposure from multiple simultaneous transmitters** operating **below and above 6 GHz, including combined exposure of SAR and power density**

MWF
Mobile & Wireless Forum

Mobile Devices: Incident Power Density (2)

- IEC / IEEE 63195 Ed1
  - **Measurement** procedure for the assessment of **power density** of human exposure to radio frequency fields from wireless devices operating in close proximity to the head and body – Frequency range of **6 GHz to 300 GHz**
    - Publication expected in early 2021
- IEC / IEEE 62704-5 Ed1
  - Determining the power density of the electromagnetic field associated with human exposure to wireless devices operating in close proximity to the head and body **using computational techniques**, **6 GHz to 300 GHz**
    - Publication expected in early 2021
    - most likely published as 'IEC / IEEE 63195 – part 2'

MWF
Mobile & Wireless Forum

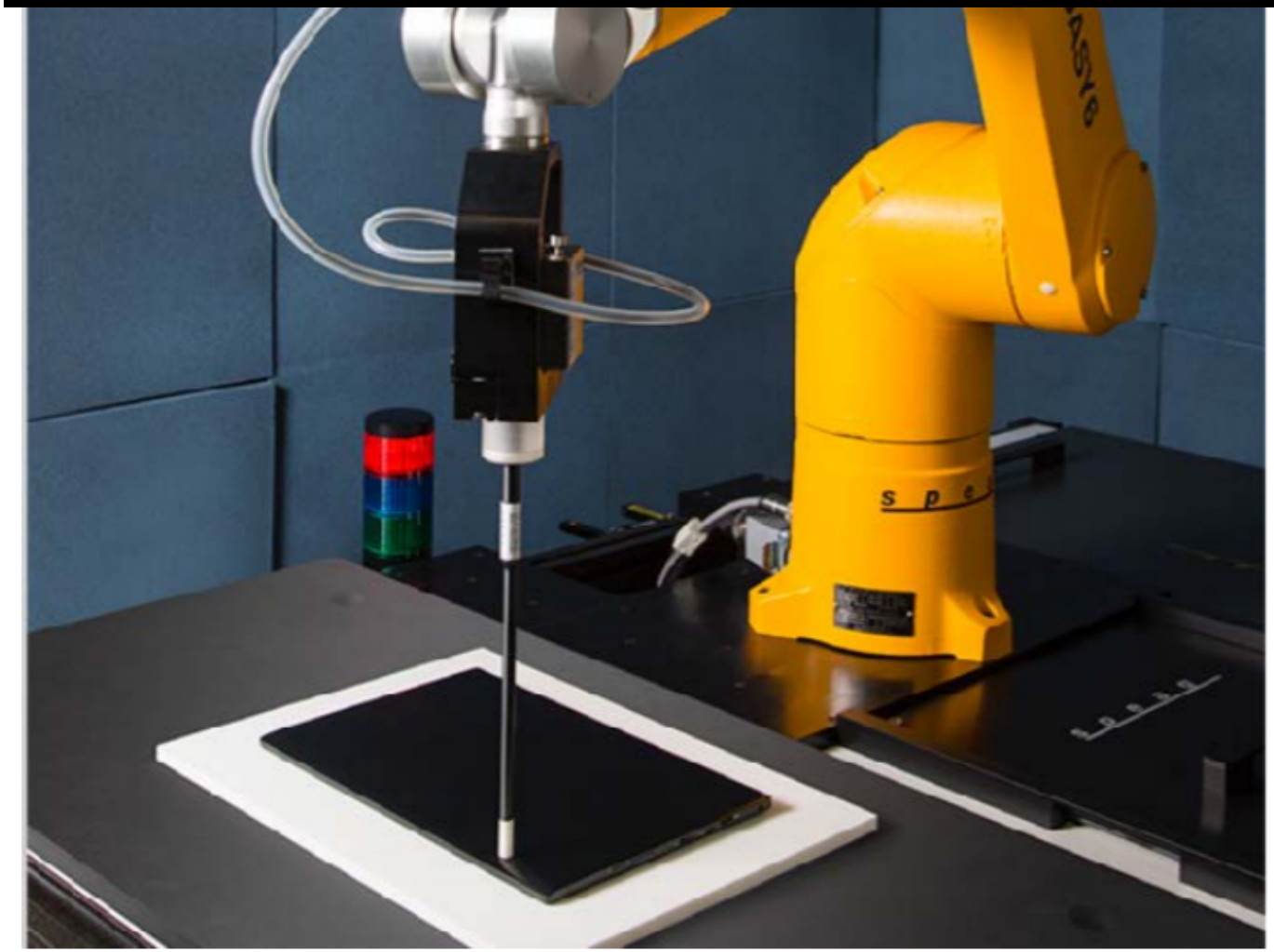
Mobile Devices: Incident Power Density (3)

- IEC/IEEE 63195 and IEC/IEEE 62704-5 are inter-dependant.
  - Measurement standard 63195 to validate simulations.
  - Simulation standard 62704 to define conservative cases for measurements.

- Power density compliance assessment requires simulations.
  - Many antennas involved, antenna array, beam forming and steering options, assessing devices that use frequencies below and above 6 GHz, including combined assessment of SAR and PD

MWF
Mobile & Wireless Forum

PD Measurement Equipment



How to create trust:

Transparency and Compliance Reporting

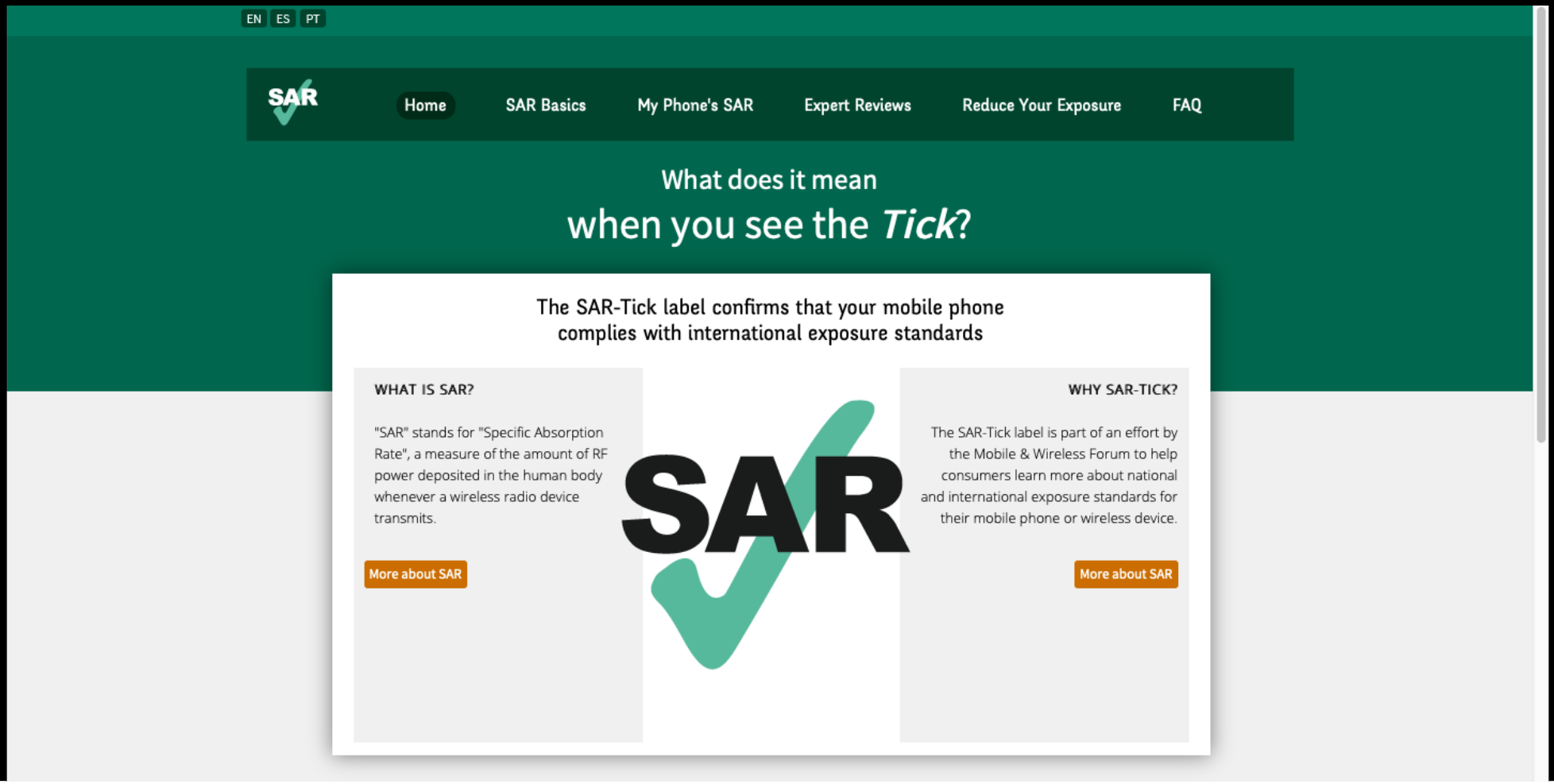
Mobile & Wireless Forum

MWF Recommendation on 'SAR Reporting'

- 2001 – 2010: Phase 1
  - SAR value in user manuals and on dedicated websites
- 2011 – 2019: Phase 2
  - SAR-Tick website
  - Mobile phone user manual:
    - Additional note on SAR in the front part of the user manual
    - Extended text with Head-SAR and Body-SAR details
    - World Health Organisation advice for concerned users
- 2020 onwards: Phase 3
  - User manual with additional note on Power Density (PD)

MWF
Mobile & Wireless Forum

SAR-Tick.com


EN ES PT
SAR
Home
SAR Basics
My Phone's SAR
Expert Reviews
Reduce Your Exposure
FAQ
What does it mean
when you see the *Tick*?
The SAR-Tick label confirms that your mobile phone complies with international exposure standards
WHAT IS SAR?
"SAR" stands for "Specific Absorption Rate", a measure of the amount of RF power deposited in the human body whenever a wireless radio device transmits.
More about SAR
SAR
WHY SAR-TICK?
The SAR-Tick label is part of an effort by the Mobile & Wireless Forum to help consumers learn more about national and international exposure standards for their mobile phone or wireless device.
More about SAR

Michael Milligan

Thank you

Secretary General, Mobile & Wireless Forum
Michael.milligan@mwfai.org | www.mwfai.org

MWF
Mobile & Wireless Forum