Project: **SEAWave**

Kick-off meeting and workshop

Work Package:	WP11
Deliverable:	D11.4
Deliverable No.:	D42

Abstract

Deliverable 11.4 is related to the Kick-off Meeting and Research Co-Design Workshop, which took place in Thessaloniki, Greece, on 12 July 2022. Both events were organized by the SEAWave coordinator P1-AUTH with all project partners participating in person and/or online. This report includes the meetings (objectives, content) and includes the agendas of both events together with the corresponding presentations.

Project Details

Project name	SEAWave
Grant number	101057622
Start Date	01 Jun 2022
Duration	36 months
Scientific coordinator	Prof. T. Samaras, Aristotle University of Thessaloniki (AUTH)

Deliverable Details

Deliverable related number	D11.4
Deliverable No.	D42
Deliverable name	Kick-off meeting and workshop
Work Package number	WP11
Work Package name	Project and Consortium Management
Editors	Prof. T. Samaras, AUTH
Distribution	Public
Version	1
Draft/final	Final
Keywords	Kick-off meeting, Research Co-Design Workshop

Contents

1 Introduction

According to Work Package 11, the coordinator of SEAWave, AUTH (Aristotle University of Thessaloniki), organized a kick-off meeting of all the project partners and the members of the External Advisory Board. Both the Kick-off Meeting and an Open Research Co-design Workshop took place in Thessaloniki, Greece on the 12th of July 2022. The participants attended the meeting either physically or through online connection.

2 Kick-Off Meeting

2.1 Objectives

The primary objective of the first meeting of the consortium was to address organizational matters and, in particular:

- Establish the Project Management Office (PMO), which is responsible for (i) liaising with the EC on reporting, administrative, and financial matters; (ii) ensuring compliance with all contractual obligations and any changes introduced by the EC during the course of the project; (iii) establishing/maintaining an effective communication structure within the consortium, (iv) monitoring the progress of the project and ensuring the implementation of decisions, in particular for risk mitigation matters; (vi) monitoring ethical issues and implementing the data management plan.
- Appoint the Data Manager, who is responsible for preparing, implementing, and regularly updating the Data Management Plan (DMP) of the project.
- Appoint the Dissemination Manager, who is responsible for preparing, implementing, and regularly updating the Dissemination and Exploitation Management Plan (DEMP) of the project.
- Form the Project Management Committee (PMC), that includes the coordinator of the project and a staff member of the PMO, all Work Package (WP) leaders, the Data Manager, the Dissemination Manager and the three experts of the External Advisory Board (EAB).

The secondary objective of the Kick-Off meeting was for the WP leaders to bring all other members of the consortium up to date with the state-of-the-art, methodology and objectives of each WP with respect to the work described in the Grant Agreement.

2.2 Agenda - Participants

The Kick-off Meeting and first General Assembly were scheduled according to the agenda included in Appendix A. Along with the project partners, the following were invited to and attended the meeting:

- The members of the External Advisory Board (EAB), (Dr. Clemens Dasenbrock, Dr. Ron Melnick, and Dr. Marvin Ziskin), and
- Colleagues from Japan (Prof. Masao Taki, Dr. Teruo Onishi) and Korea (Dr. Ae-Kyoung Lee) who are willing to collaborate with SEAWave (in the form of associated partners), in particular (but not exclusively) in WP1.

Pictures from the Kick-off Meeting and first General Assembly of SEAWave are included in Appendix B.

2.3 Summary

- The Project Coordinator (Theodoros Samaras) welcomed the participants (25 physically present and 15 online), presented the PMO and gave an overview of the project and the work described in the Grant Agreement (GA), with an emphasis on timeline and first deliverables. The reasons for addressing exposure from all technologies but only research the health risks from 5G NR FR2 exposure (in the millimetre wave frequencies) were clarified.
- The Leader of WP1 (Joe Wiart) presented the methodology for assessing exposures from 5G vs. 2G–4G cellular networks. This is a huge task involving several partners and a large human effort, thus requiring early start and good coordination. There were questions from the partners about assessing uplink exposure and the use of artificial intelligence in the WP. The colleagues from Asia (Japan and Korea) expressed their interest in joining the research effort of the WP, as associate partners, to share data and processing algorithms for assessing exposure of the population.
- The Leader of WP2 (Peter Gajšek) presented the objectives of the WP on assessing occupational exposures from new 5G local networks in workplaces and gave examples from Industry 4.0 installations, where the envisaged methodology can be implemented.
- One of the most challenging tasks of the project is the exposure monitoring from 5G MaMIMO Base Stations, which was presented by the Leaders of WP3 (Luc Martens, Günter Vermeeren).
- The challenges for assessing exposure at the other end of a wireless connection were presented by the Leader of WP4 (Niels Kuster) which aims at standardising the instrumentation and methodology for demonstrating compliance of end user devices with the new exposure guidelines.
- Detailed skin models are essential for the dosimetry during the project (in particular at the millimetre frequency range). The state-of-the-art in this research area and the proposed methodology to further advance dosimetry were presented by the Leader of

WP5 (Theodoros Samaras). The need for collaboration between the medical doctors, biologists and animal experts on the one side and physicists and engineers on the other was stressed for this WP.

- The Leaders of the three WPs (WP6, WP7, WP8) dedicated to the health risk studies that will be conducted within the project gave a detailed account of the protocols that will be used, the biological/health endpoints that will be examined and the combined assessment of the results from all studies to reach conclusions on hazard identification of 5G NR radiation at the high frequency band (millimetre wave frequencies).
    - The Leader of WP6 (Mariateresa Mancuso) explained the animal experimentation facilities at ENEA (Rome) and the preparations for accommodating the necessary equipment, as well as the protocol and timeline of the experiment (animal handing, testing, etc.). She also gave details on the choice of the animal models and all biological endpoints to be investigated apart from those regarding the skin.
    - The Leader of WP7 (Olivier Gaide) described the protocol of the human clinical study, the groups of subjects it will include and the state-of-the-art techniques (e.g., single cell RNA sequencing) that will allow the creation of an individualized proteomic landscape to assess the effects of exposure to 5G NR FR2.
    - The Leaders of WP8 explained (Annette Bitsch, Stella Reamon-Büttner – online participation) the techniques that will be used to study potential epigenetic effects, effects on aneugenicity, as well as the transcriptomic landscape of *in vitro* exposed human skin cells.
    - The experimental setups for health risk studies are already being designed at IT'IS (Switzerland) and the initial ideas were presented by the leader of this effort (Myles Capstick).
- In WP9, led by IARC (Joachim Schüz), a risk assessment will be carried out, by performing an evaluation based on the health risk studies conducted within the project and setting them into the context of recent studies conducted outside the consortium, adapting and applying the procedures used by IARC.
- The Leader of WP10 (Christoph Böhmert – online participation) presented the tasks of the WP that will research exposure perception among the public and the communication of precaution implemented as personal exposure reduction, through a serious game to be designed and created within the project.
- With respect to WP11 tasks (project management) the works finished with the appointment of the Data Manager (Caterina Merla, ENEA) and the Dissemination Manager (Ioannis-Anestis Markakis, AUTH).

3 Open Research Co-Design Workshop

3.1 Objectives

At the start of the SEAWave project, the consortium planned an Open Research Co-Design Workshop, with the following objectives:

- Present the knowledge gaps that led to the design of the R&I activities of the project
- Explain these R&I activities, including data collection/generation methods and protocols for the biological experiments, to close the knowledge gaps.
- Present the challenges involved in performing the planned R&I activities.
- Interact with all stakeholders to get their feedback on the above issues and, potentially, expand or modify R&I activities within the frame of the GA (co-design activity).
- Present an initial review of the literature at the start of the project with respect to carcinogenesis, that will serve as the basis for the risk assessment planned in WP9.

3.2 Agenda - Participants

The agenda of the open workshop is shown in Appendix C. There were 25 people present physically at the workshop and another 25 online from various countries. The workshop was publicized through the news channels of the coordinator (AUTH) and the SEAWave partners.

Pictures from the Open Research Co-Design Workshop are included in Appendix D.

3.3 Summary

The workshop was opened by the project coordinator, Prof. Theodoros Samaras, who gave a brief overview of the objectives of the project and the workshop.

Dr. Giulio Gallo presented, next, the legislation and policy on electromagnetic fields (EMF) at the EU level. Dr. Gallo is the Deputy Head of the DG SANTE Unit C.2 (Health Information and Integration in All Policies) and responsible for the dossier of EMF. He gave a historical overview of the scientific opinions mandated by the European Commission and published by various committees of experts on EMF and health, as well as on the research on this subject funded within previous European Framework Programmes. He also stressed the significance of the SEAWave and the other projects funded within the same call for the European policy on EMF and, in particular, 5G NR and new wireless technologies.

Prof. Theodoros Samaras explained which research gaps and challenges had been identified during the preparation phase of the SEAWave project with respect to the potential health effects of the emerging 5G NR technology, especially for its implementation at the millimetre frequency range. It was shown how the SEAWave consortium aims to respond to these challenges and close the respective knowledge gaps.

Dr. Joachim Schüz is the Head of the Environment and Lifestyle Epidemiology Branch at the International Agency for Research on Cancer (IARC) of the WHO. He presented the literature review focused on cancer, which is the main health endpoint of the SEAWave project. He summarized the new information on this subject (animal studies, UK Million Women study) that has been published after the IARC classification of 2011 and the SCENIHR Opinion in 2015. He also emphasized the importance of several reviews and meta-analyses that have appeared in the literature. Dr. Schüz, based on the existing literature, concluded that:

- On the issue of hazard identification, the possibility of carcinogenicity has been confirmed in large animal experiments, however, exposure of these studies is difficult to translate into cumulative lifetime exposure in humans.
- Concerning the individual risk, there is a possibility of modest risk for glioma in the <5% of heaviest mobile phone users; a risk that can be mitigated by not holding the device directly to the head.
- This individual risk has not given any evidence that it could be detected as a population risk of any type of brain tumour.

Finally, Dr. Schüz underlined the importance of the research within the SEAWave project, since it will explore new frequencies and new types of cancer that have not been widely investigated. He also emphasized the well-designed biological experiments that will allow for a better understanding of the mechanisms of action of the EMF.

Prof. Joe Wiart is the holder of the Chair on Modelling, Characterization and Control of Exposure to Electromagnetic Waves (C2M) at the IMT (Institut Mines-Télécom). He referred to the challenges faced in SEAWave regarding the assessment of the total exposure of the population. He explained the various determinants of exposure which are not limited to the wireless technology used, but also include environmental and individual factors, like the way of using mobile devices. In the case of 5G, the introduction of new technological features makes exposure assessment (both for the downlink signal from the base station to the user, as well as for the uplink signal from the device to the base station) more demanding. The solutions proposed in the SEAWave project are expected to overcome these difficulties and result in the clearest possible picture about the exposure, and its variation in space and time, from all generations of cellular networks, including the emerging ones.

Prof. Niels Kuster is the founding Director of the Foundation for Research on Information Technologies in Society (IT'IS) and world-renowned expert in dosimetry of electromagnetic fields and radiation. He is an active member of many international standardization committees aiming at the production of standards for testing the compliance of wireless devices with exposure guidelines and legally implemented limits. He enumerated the challenges for standardizing compliance testing of base stations for exposure of workers and the public (especially if precautionary limits are enforced) and of handheld devices (increased exposure due to new features such as time averaged PD, TAPD, multiple-input multiple output, MIMO, proximity sensors, motion sensors, light sensors, etc.). He, then, described the methodology and timeline in the SEAWave project for responding to these challenges, in order to improve legal certainty for users, regulators (and the industry).

The presentations of the speakers are included in Appendix E.

In the Q&A session of the workshop there were questions from the online audience whether the project will focus only on the exposure from 5G cellular networks (answered by the coordinator, Prof. Theodoros Samaras) and on the use of artificial intelligence tools for exposure assessment (answered by Prof. Joe Wiart, WP1 Leader).

4 Appendix A

Kick-off Meeting Agenda

Kick-off Meeting and First General Assembly

Mediterranean Palace Hotel, Thessaloniki

12 July 2022

09:00 -	09:05	Welcome – Adoption of agenda *Theodoros Samaras, Project Coordinator*
09:05 -	09:10	Presentation of the Project Management Office *Theodoros Samaras, Project Coordinator*
09:10 -	09:30	Project Overview *Theodoros Samaras, Project Coordinator*
09:30 -	09:40	Exposures from 5G vs. 2G–4G Cellular Networks *Joe Wiart, WP1 Leader*
09:40 -	09:50	Occupational Exposures from New 5G Local Networks in Workplaces *Peter Gajšek, WP2 Leader*
09:50 -	10:00	Exposure Monitoring from 5G MaMIMO Base Stations *Luc Martens, WP3 Leader*
10:00 -	10:10	Exposure Assessment of End-User Devices: Instrumentation and Methodology for Demonstration of Compliance with the New Guidelines *Niels Kuster, WP4 Leader*
10:10 -	10:20	Macro and Microdosimetry in Human and Murine Skin *Theodoros Samaras, WP5 Leader*
10:20 -	10:35	Health Risk Studies: Animal Study on Skin Carcinogenicity and Other Endpoints of FR2 Exposure *Mariateresa Mancuso, WP6 Leader*
10:35 -	11:00	*Coffee Break*
11:00 -	11:15	Health Risk Studies: Biological Effects of FR2 Exposure on Human Skin *Olivier Gaide, WP7 Leader*
11:15 -	11:30	Health Risk Studies: Biological Effects of FR2 Exposure on Human-Derived Skin Cells *Annette Bitsch, WP8 Leader*

11:30 -	11:45	Experimental setups (in vitro, in vivo, clinical study) in SEAWave *Myles Capstick, IT'IS Foundation*
11:45 -	12:00	Risk Assessment *Joachim Schüz, WP9 Leader*
12:00 -	12:15	Risk Communication *Christoph Böhmert, WP10 Leader*
12:15 -	12:20	Appointment of Data Manager *General Assembly*
12:20 -	12:30	Appointment of Dissemination Manager *General Assembly*
12:30 -	12:40	Establishment of Project Management Committee (PMC) *General Assembly*
12:40 -	13:30	Discussion and next deliverables (web site, DMP, DEMP, next meetings, European cluster on EMF and Health, etc.) *All*
13:30 -	14:30	*Light Lunch*

5 Appendix B

Kick-off Meeting Pictures


imec
WP3 - EXPOSURE MONITORING FROM
5G MAMIMO BASE STATIONS
LUC MARTENS, GÜNTER VERMEEREN
MEDITERRANEAN PALACE
MEDITERRANEAN PALACE

6 Appendix C

Open Research Co-Design Workshop Agenda

Open Research Co-Design Workshop

Mediterranean Palace Hotel, Thessaloniki

12 July 2022

Streamed online at
https://authgr.zoom.us/j/94245967008?pwd=TTFiOEp2aHU5VW5sUzZUYStKVE56Zz09

Passcode: 700666

14:30 -	14:35	Opening *Theodoros Samaras, AUTH, SEAWave Coordinator*
14:30 -	14:40	Legislation and policy on EMF at the EU level *Giulio Gallo, European Commission DG SANTE*
14:40 -	14:50	Research gaps – The SEAWave response *Theodoros Samaras, AUTH*
14:50 -	15:10	Literature review on risk assessment – First results *Joachim Schüz, IARC*
15:10 -	15:20	Exposure monitoring and assessment of mobile networks – Challenges *Joe Wiart, Institut Polytechnique de Paris / Institut Mines Telecom*
15:20 -	15:30	Standardization of 5G devices – Challenges *Niels Kuster, IT'IS Foundation*
15:30 -	16:00	Q&A Round

7 Appendix D

Open Research Co-Design Workshop Pictures


Literature review on risk assessment – First results


SEAWave

8 Appendix E

Open Research Co-Design Workshop Presentations

Scientific-based **E**xposure and risk **A**ssessment of radiofrequency and mm-**Wave** systems from children to elderly (5G and Beyond)

Identified knowledge gaps and how to fill them

Funded by the European Union

Theodoros Samaras
Aristotle University of Thessaloniki
theosama@auth.gr

Gap #1: Exposures from Cellular 5G vs. 2G–4G Networks

- New applications enabled by 5G
  (virtual reality, mobile big data, autonomous support, etc.)
- Increased number of mobile devices
- Change in the usage pattern of mobile devices
- Denser network of base transceiver stations (FR2)
- MaMIMO

These patterns of usage must be quantified and forecasted for children, adolescents, adults, workers and elderly persons for each exposure scenario to enable appropriate risk assessment and communication.

Funded by the European Union

Gap #2: Exposures from New 5G Local Networks in Workplaces

- Both FR1 and FR2 frequencies ranges within industrial environments (Industrial IoT, IIoT, distributed actuator networks, 'Factory of the Future')
- Absence of a model for highly modular environments
- Other workplaces (office workers, 'Smart Buildings')

It is necessary to describe the various wireless systems, especially in FR1, make measurements, create a parametric model for calculating EMF in the industrial environment, validate the model and extent it to FR2.

SEAWave

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Gap #3: Exposure Monitoring from 5G MaMIMO Base Stations

- Monitoring instrumentation and exposure assessment procedures have been established for fixed antenna patterns
- There are challenges for exposure characterization from fixed antennas with dynamically changing radiation patters

For fixed monitoring networks measurements could be combined with AI algorithms and stochastic techniques. The exposure assessment procedures (experimental and numerical need to be standardised.

SEAWave

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Gap #4: Exposure Assessment of End User Devices

- Recent guidelines and standard
- New dosimetric quantities
- New proposed mitigation methods for the exposure using a combination of proximity sensors and time-averaging

Methods for assessing exposure need to be tested, validated and proposed in the standards.

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Gap #5: Macro and Microdosimetry in the Human Skin

- Microstructures in the skin and their role in FR2
- Complicated structure of the skin and arrangement of the microstructures
- Problematic dielectric properties for various materials
- Absence of human models that reflect health condition and age
- Absence of murine skin models

Create human models for statistical dosimetry and calculate its uncertainty though sensitivity analysis.

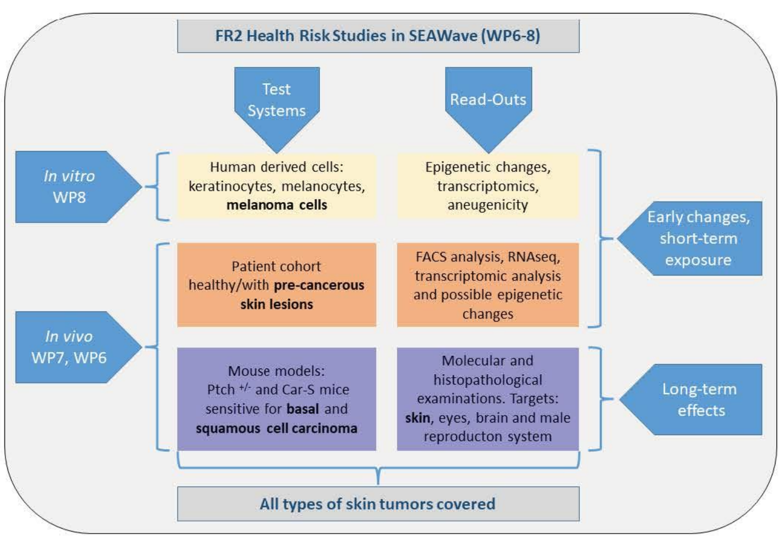
Funded by the European Union

Gap #6: FR2 Health Risk Studies – Skin Cancer & Other Skin Disease Modulation

- Skin is the main target of 5G FR2.
- Scarce information about skin cancer/skin diseases from millimetre waves radiation

Study evidence for all lines of evidence (in vitro, animals, humans).

Gap #6: FR2 Health Risk Studies – Skin Cancer & Other Skin Disease Modulation



Gap #7: Citizens´ Perceived Exposure

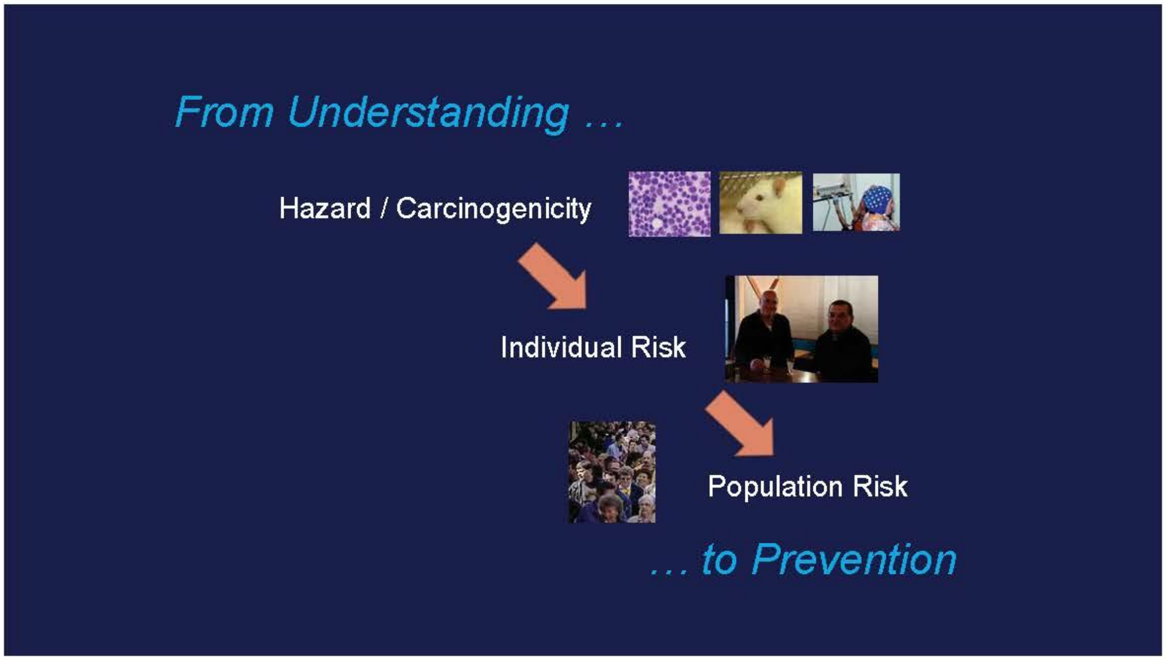
- Is 5G exposure is perceived in a different way as exposure with 2G–4G technology, and why?

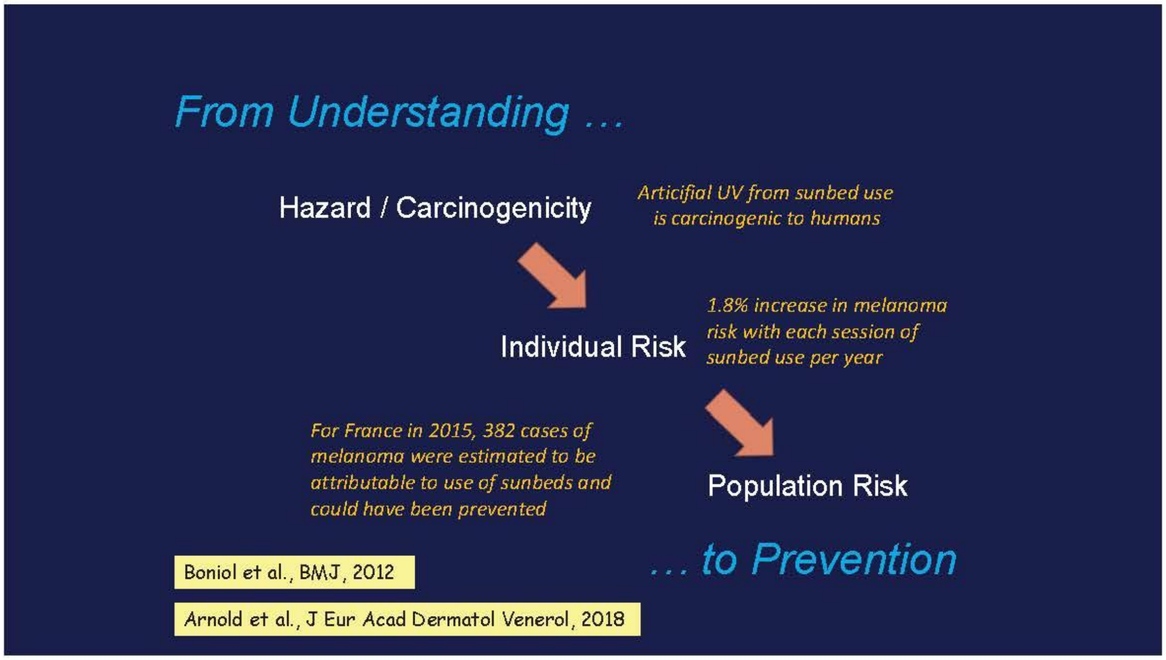
- How can we communicate the exposure and risk of FR2?

Work together with policy makers and regulators. Resort in gamification?

Funded by the European Union

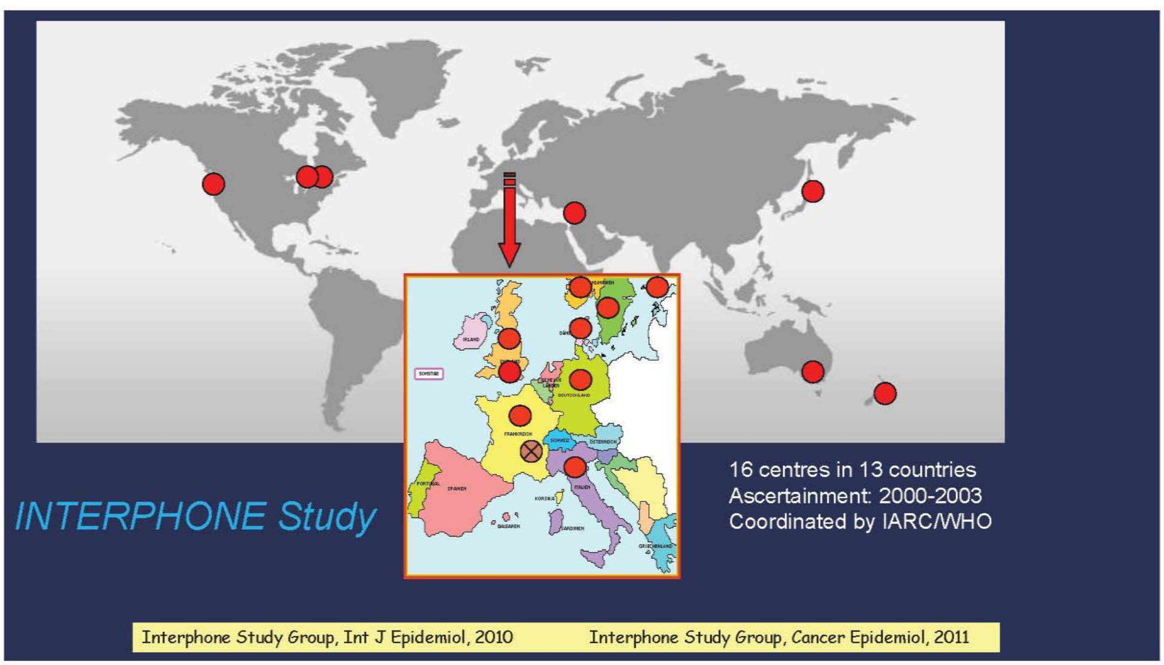

Literature review on risk assessment – First results
Dr Joachim Schüz
Head, Environment and Lifestyle Epidemiology Branch
International Agency for Research on Cancer
World Health Organization
Co-Design Workshop of SEAWave
Thessaloniki, 12 July 2022

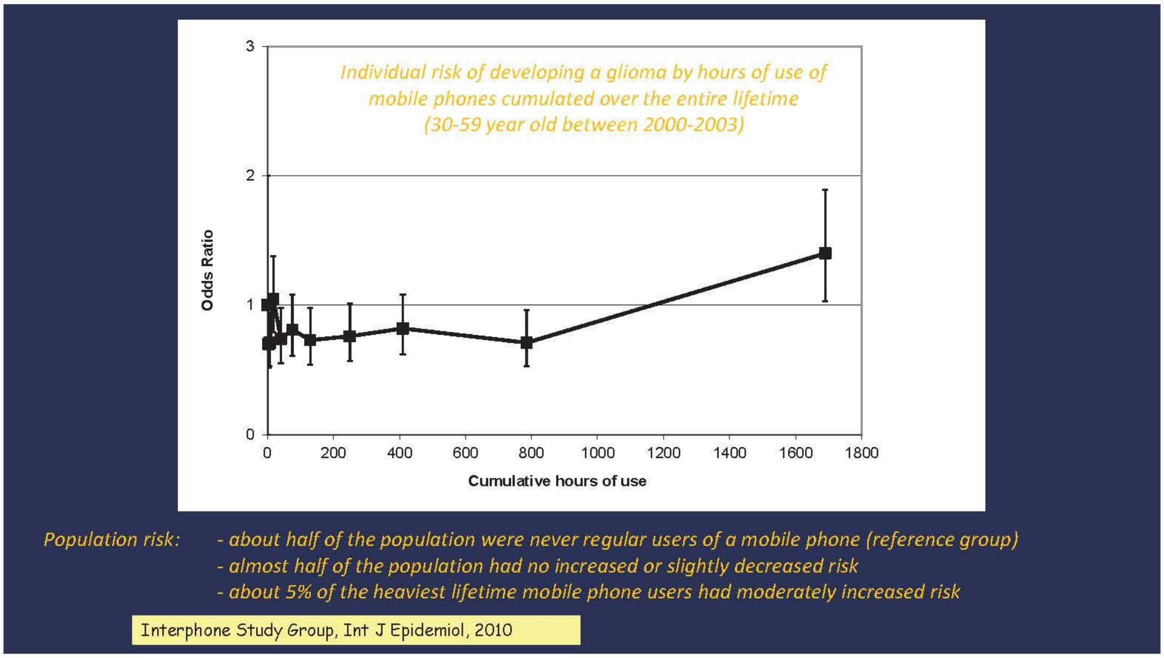

From Understanding …
Hazard / Carcinogenicity
Individual Risk
Population Risk
… to Prevention

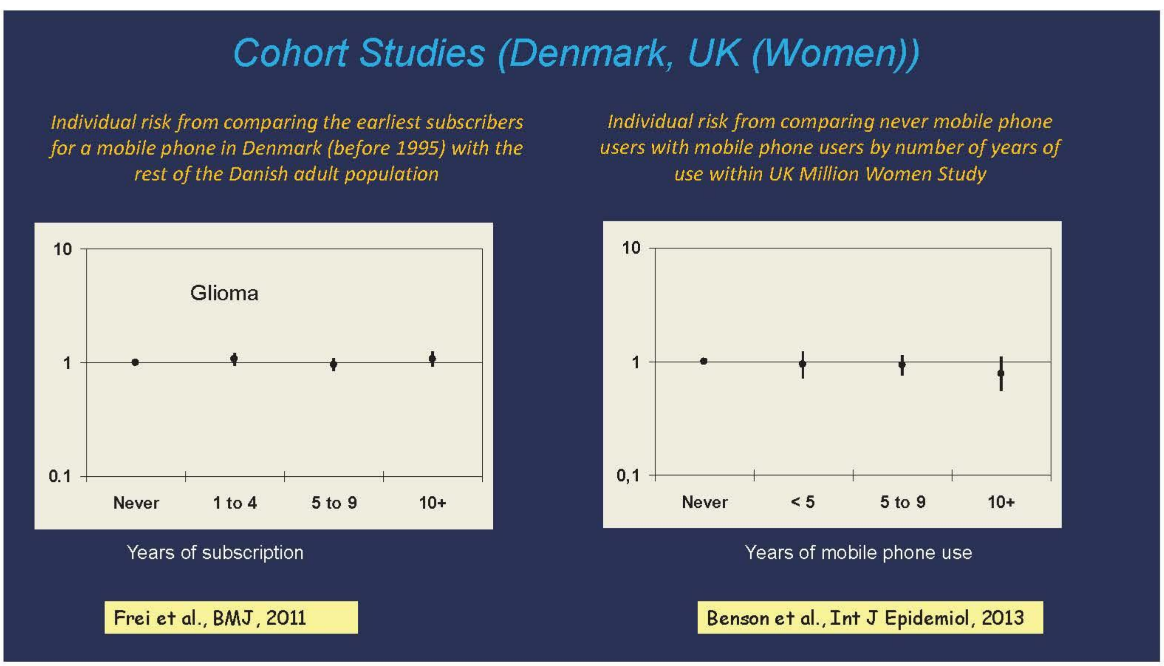

From Understanding …
Hazard / Carcinogenicity
Artificial UV from sunbed use is carcinogenic to humans
Individual Risk
1.8% increase in melanoma risk with each session of sunbed use per year
For France in 2015, 382 cases of melanoma were estimated to be attributable to use of sunbeds and could have been prevented
Population Risk
… to Prevention
Boniol et al., BMJ, 2012
Arnold et al., J Eur Acad Dermatol Venerol, 2018


International Agency for Research on Cancer
World Health Organization
PRESS RELEASE
N° 208
31 May 2011
IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS
Lyon, France, May 31, 2011 -- The WHO/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer[1], associated with wireless phone use.
Monograph Meeting - Volume 102
24/05/2011 -
Dr Christopher Wild, Director, IARC, opens Monograph meeting on Non-Ionizing Radiation, Part II: Radiofrequency Electromagnetic Fields [includes mobile telephones]
Listen to Podcast , Read Introduction to the IARC Monographs Volume 102


Scientific Committee on Emerging and Newly Identified Health Risks
SCENIHR
Opinion on
Potential health effects of exposure to electromagnetic fields (EMF)
Scientific Committees
SCENIHR adopted this Opinion at the 9th plenary meeting on 27 January 2015
Overall, the epidemiological studies on mobile phone RF EMF exposure do not show an increased risk of brain tumours. Furthermore, they do not indicate an increased risk for other cancers of the head and neck region. Some studies raised questions regarding an increased risk of glioma and acoustic neuroma in heavy users of mobile phones. The results of cohort and incidence time trend studies do not support an increased risk for glioma while the possibility of an association with acoustic neuroma remains open. Epidemiological studies do not indicate increased risk for other malignant diseases, including childhood cancer.


INTERPHONE Study
16 centres in 13 countries
Ascertainment: 2000-2003
Coordinated by IARC/WHO
Interphone Study Group, Int J Epidemiol, 2010
Interphone Study Group, Cancer Epidemiol, 2011


Individual risk of developing a glioma by hours of use of mobile phones cumulated over the entire lifetime (30-59 year old between 2000-2003)
Odds Ratio
3
2
1
0
0
200
400
600
800
1000
1200
1400
1600
1800
Cumulative hours of use
Population risk:
- about half of the population were never regular users of a mobile phone (reference group)
- almost half of the population had no increased or slightly decreased risk
- about 5% of the heaviest lifetime mobile phone users had moderately increased risk
Interphone Study Group, Int J Epidemiol, 2010


Cohort Studies (Denmark, UK (Women))
Individual risk from comparing the earliest subscribers for a mobile phone in Denmark (before 1995) with the rest of the Danish adult population
Individual risk from comparing never mobile phone users with mobile phone users by number of years of use within UK Million Women Study
10
Glioma
1
0.1
Never
1 to 4
5 to 9
10+
Years of subscription
10
1
0,1
Never
< 5
5 to 9
10+
Years of mobile phone use
Frei et al., BMJ, 2011
Benson et al., Int J Epidemiol, 2013

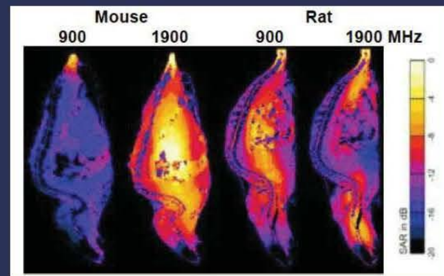
What is new – Animal data?

Carcinogenic hazard in rats (Ramazzini study):
~19 hrs of exposure each day with varying levels 0.001-0.1 W/kg

Increase in heart schwannoma in male rats at highest dose
No increase in female rates

Suggestive evidence for carcinogenicity but unclear what it means for individual risk in humans

Falcioni et al., Environ Res, 2018



Carcinogenic hazard in rodents (NTP Studies):
~9 hrs of exposure each day with varying levels between 1.5 – 6 W/kg

Increase in heart schwannoma in male rats at highest dose – no increase in female rates, in male mice or in female mice
Indications of higher occurrences of tumours of brain and adrenal gland

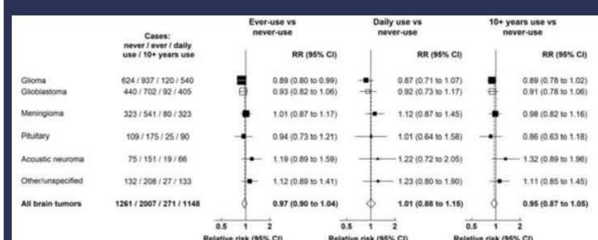
Suggestive evidence for carcinogenicity but unclear what it means for individual risk in humans

National Toxicology Program Reports, 2018

What is new – Human data?

Update of individual risk from comparing never mobile phone users with mobile phone users by number of years of use within UK Million Women Study

No association with ever use, daily use, 10+ years of use or specifically with tumours in the most exposed area of the brain (temporal and parietal)



Schüz et al., J Natl Cancer Inst, 2022

Not „new" in terms of data

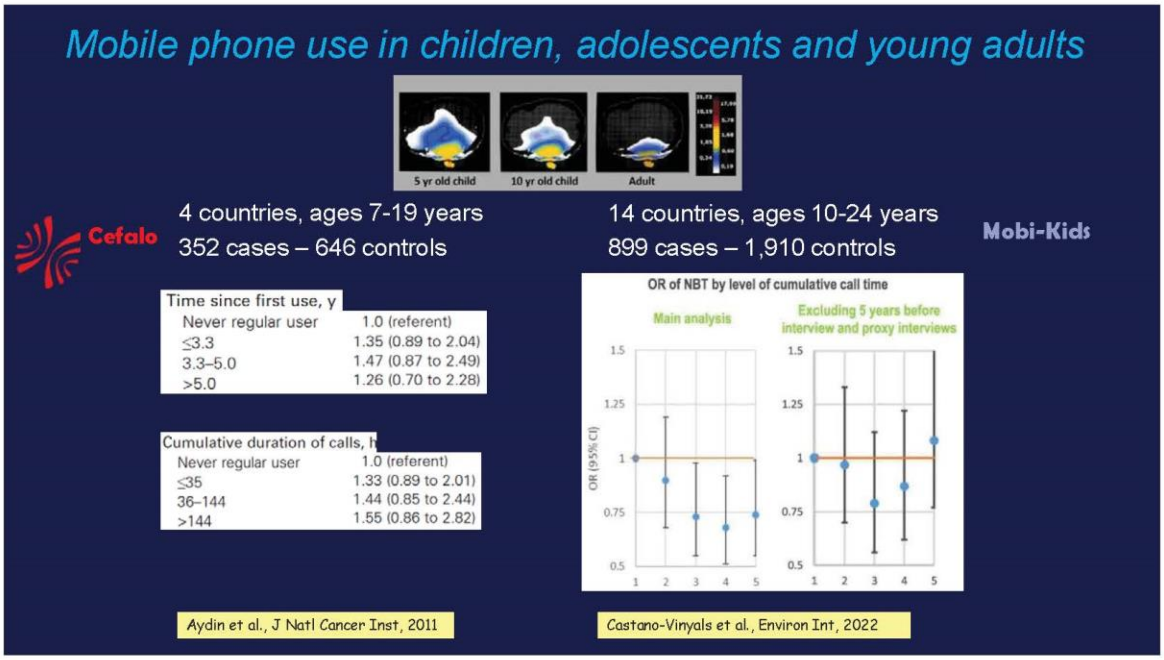
Several reviews & meta-analyses

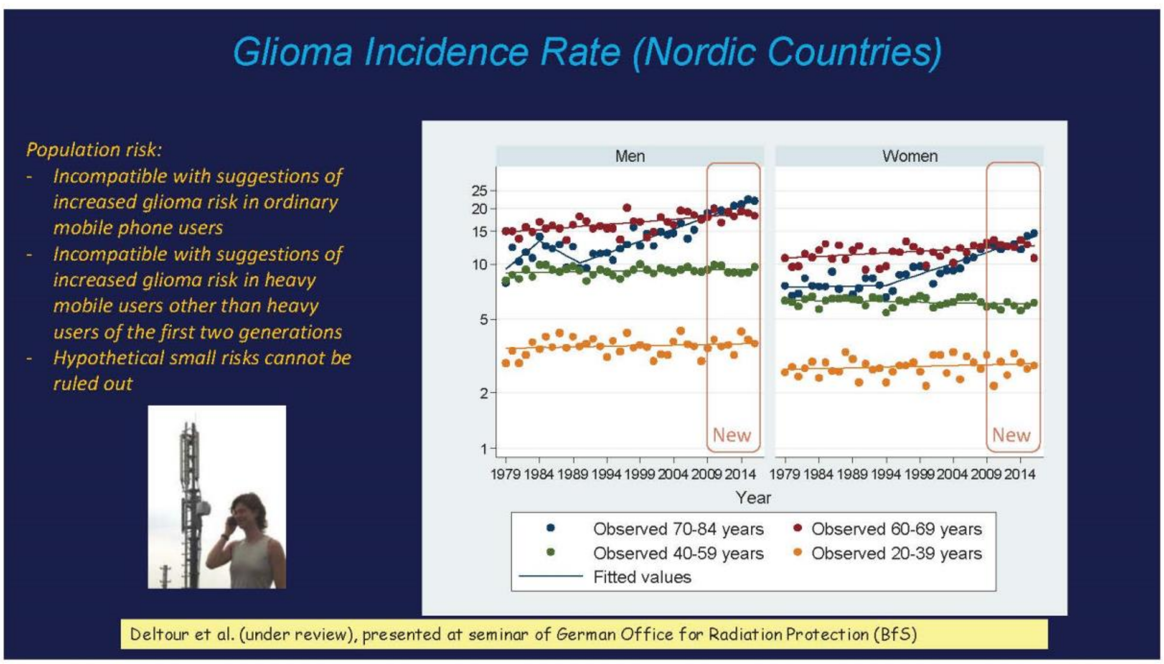
Wang & Guo, J Cancer Res Therap, 2016
Bortkiewicz et al., Int J Occup Med Env Health, 2017
Prasad et al., Neurological Sci, 2017
Yang et al., PLoS ONE, 2017
Wang et al., World Neurosurg, 2018
Röösli et al., Environ Int, 2019
Choi et al., Int J Env Res Publ Health, 2020

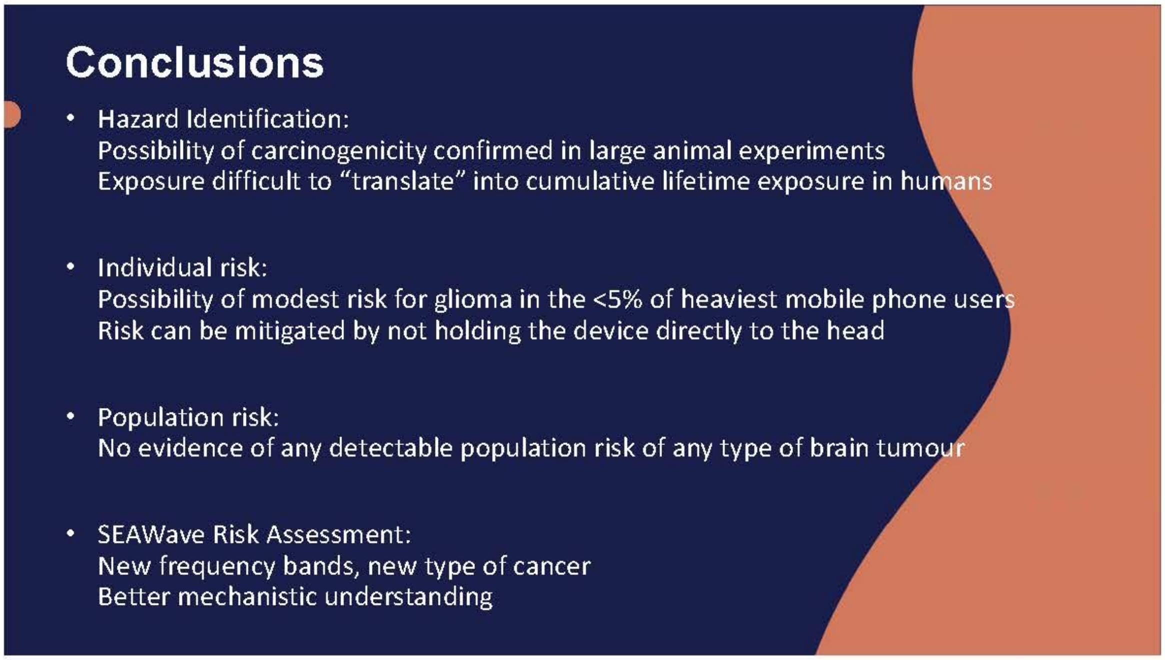
Overall confirmation of previous conclusions by the IARC and SCENIHR, as more or less based on same data

Differences mainly due to how the risk of bias was interpreted

Meta-analyses unlikely to reveal new insights


Mobile phone use in children, adolescents and young adults
5 yr old child
10 yr old child
Adult
Cefalo
4 countries, ages 7-19 years
352 cases – 646 controls
14 countries, ages 10-24 years
899 cases – 1,910 controls
Mobi-Kids
Time since first use, y
Never regular user 1.0 (referent)
≤3.3 1.35 (0.89 to 2.04)
3.3–5.0 1.47 (0.87 to 2.49)
>5.0 1.26 (0.70 to 2.28)
Cumulative duration of calls, h
Never regular user 1.0 (referent)
≤35 1.33 (0.89 to 2.01)
36–144 1.44 (0.85 to 2.44)
>144 1.55 (0.86 to 2.82)
OR of NBT by level of cumulative call time
Main analysis
Excluding 5 years before interview and proxy interviews
OR (95% CI)
Aydin et al., J Natl Cancer Inst, 2011
Castano-Vinyals et al., Environ Int, 2022


Glioma Incidence Rate (Nordic Countries)
Population risk:
- Incompatible with suggestions of increased glioma risk in ordinary mobile phone users
- Incompatible with suggestions of increased glioma risk in heavy mobile users other than heavy users of the first two generations
- Hypothetical small risks cannot be ruled out
Men
Women
New
New
Year
Observed 70-84 years
Observed 60-69 years
Observed 40-59 years
Observed 20-39 years
Fitted values
Deltour et al. (under review), presented at seminar of German Office for Radiation Protection (BfS)


Conclusions
Hazard Identification:
Possibility of carcinogenicity confirmed in large animal experiments
Exposure difficult to "translate" into cumulative lifetime exposure in humans
Individual risk:
Possibility of modest risk for glioma in the <5% of heaviest mobile phone users
Risk can be mitigated by not holding the device directly to the head
Population risk:
No evidence of any detectable population risk of any type of brain tumour
SEAWave Risk Assessment:
New frequency bands, new type of cancer
Better mechanistic understanding

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Exposure monitoring and assessment of mobile networks – Challenges

Joe Wiart, Institut Polytechnique de Paris/Institut Mines Telecom

Scientific-Based Exposure and Risk Assessment of Radiofrequency and mm-Wave Systems from children to elderly (5G and Beyond)

Grant Agreement-101057622

"Out of clutter, find simplicity. From discord, find harmony. In the middle of difficulty lies opportunity."
Albert Einstein

Wireless communications are intensively used

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Wireless communications are widely used

	Hommes	Femmes	Total FR
Connexion Internet	89%	87%	**88%**
Téléphone mobile (tous types)	94%	95%	**95%**
Smartphone	77%	77%	**77%**
Téléphone fixe	81%	80%	**80%**
Ordinateur	78%	75%	**76%**
Tablette	40%	44%	**42%**
Assistants vocaux	10%	8%	**9%**
Consoles de jeux			

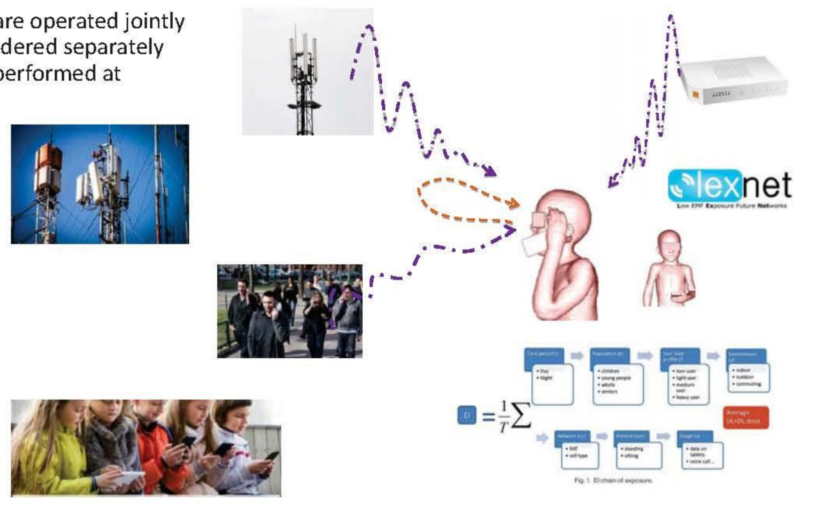
Phone use in France

	12-17 ans	18-24 ans	25-39 ans	40-59 ans	60-69 ans	70 ans et +	Total FR
Connexion Internet	100%	100%	98%	93%	81%	58%	88%
Téléphone mobile (tous types)	[illegible]	99%	99%	97%	93%	[illegible]	95%
Smartphone	86%	98%	95%	50%	62%	[illegible]	77%
Téléphone fixe	86%	[illegible]	[illegible]	[illegible]	[illegible]	89%	80%
Ordinateur	91%	82%	73%	83%	76%	58%	76%
Tablette	37%	36%	49%	45%	47%	29%	42%
Objets connectés	31%	25%	21%	17%	9%	5%	16%
Assistants vocaux	15%	14%	10%	9%	7%	5%	9%
Consoles de jeux							

	Indépendant	Cadre	Prof.inter	Employé	Ouvrier	Au foyer	Retraité	Autre Inactif	Total Fr
Connexion Internet	100%	99%	97%	96%	93%	75%	66%	98%	88%
Téléphone mobile (tous types)	100%	98%	99%	97%	98%	93%	88%	93%	95%
Smartphone	89%	90%	90%	85%	84%	68%	48%	89%	77%
Téléphone fixe	80%	79%	75%	79%	72%	76%	90%	81%	80%
Ordinateur	85%	90%	80%	79%	70%	64%	65%	89%	76%
Tablette	49%	57%	53%	45%	37%	34%	35%	38%	42%
Objets connectés									16%
Assistants vocaux	5%	18%	10%	11%	8%	7%	4%	13%	9%
Consoles de jeux									

EMF exposure and wireless communications

Mobiles and base station are operated jointly but for EMF they are considered separately and compliance tests are performed at maximum power emitted.



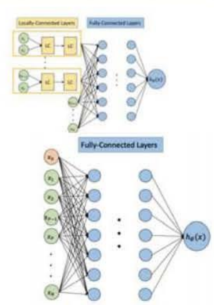
Down Link Exposure Monitoring. Combine information using Artificial Intelligence

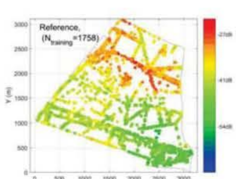
Exposure assessment is performed via spot measurement or via EMF sensor networks

	Nombre de mesures						50 % (médiane)					
	2014	2015	2016	2017	2018	2019	2014	2015	2016	2017	2018	2019
Rural	472 16%	421 12 %	364 12%	425 16 %	578 19%	526 17%	0,26* V/m	0,23* V/m	0,24* V/m	0,25* V/m	0,23* V/m	0,22* V/m
Urbain	2483 84%	3154 88 %	2629 88%	2166 84 %	2490 81%	2494 83%	0,43 V/m	0,40 V/m	0,41 V/m	0,40 V/m	0,48 V/m	0,45 V/m
Intérieur	1797 61%	2387 67 %	2046 67%	1666 64%	1952 64%	2059 68%	0,31* V/m	0,36* V/m	0,30* V/m	0,31* V/m	0,33* V/m	0,38 V/m
Extérieur	1158 39%	1190 33 %	947 33%	914 36%	1116 36%	961 32%	0,53 V/m	0,56 V/m	0,56 V/m	0,52 V/m	0,62 V/m	0,56 V/m
Total	2955	3577	2993	2591	3068	3020	0,38 V/m	0,36* V/m	0,38 V/m	0,36* V/m	0,4 V/m	0,38 V/m

- Location of base stations
- Type of environnement

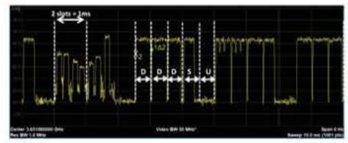
Measurements in France





Exposure assessment.
Take into account the variability of 5G

- With 5G Ma MiMO base station the pattern antenna is varying in time and space



Up Link Exposure challenges:
Design a measurement system and use AI

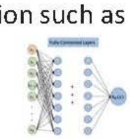
Actual Power emitted depends on usage and environment

- Network (density, 2G/3G/4G/5G)
- location (indoor/outdoor)
- Environnement (urban/rural)
- Apps (what is done with the mobile)

Perform exposure assessment using "trace mobile" and Devin.

Use AI tools to combine information such as

- distance to base stations
- application used
- environment



Design a new version of DEVIN covering FR1 band (3.5 GHz) and WiFi (6 GHz)) with a slimmer casing and improved battery autonomy

Monitoring of exposure from nearby sources and bystanders

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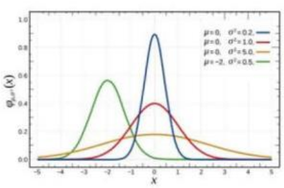
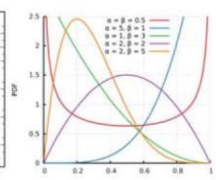
Build a statistical model

- Measure and forecast the statistical distribution (e.g.Normal, Beta)





Assess the global exposure via the index of exposure

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- Determine absorbed power (SAR or APD) induced by UP and DL

Determine the exposure index accordingly to the ICT use

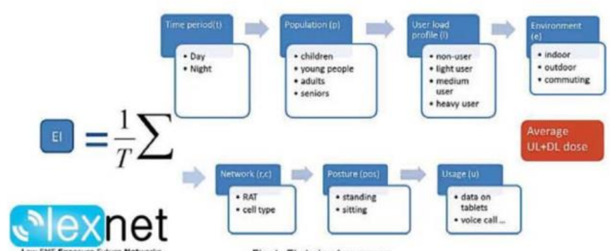

Fig. 1. EI chain of exposure.

Thanks

Compliance Challenges

- compliance of base stations, in particular, if precautionary limits are enforced
- compliance of base stations for workers
- compliance of handheld device (increased exposure due to new features such as time averaged PD (TAPD), multiple-input multiple output (MIMO), proximity sensors, motion sensors, light sensors, etc.)
- INCIRP 1998 is not protective for near-field exposures

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Basic Restrictions

Limit according to	Av. Time	Av. Area	Gen. Pub.	Occ.	Frq. [GHz]
PD [W/m^2], ICNIRP 1998 [6]	6 min (10 GHz) to 10 s (300 GHz)[a]	20 cm^2 1 cm^2	10 200	50 1000	10 – 300
APD [W/m^2], ICNIRP 2020 [1], IEEE 2019 [2]	6 min	4 cm^2 1 cm^2	20 40	100 200	6 – 300 30 – 300
wbSAR [W/kg], ICNIRP 2020 [1], IEEE 2019 [2]	6 min		0.08	0.4	6 – 300
PD [W/m^2], IEEE 2005 [7]	see Section 2.2	1 m^2 (3 GHz) to 100 cm^2 (30 GHz) 1 cm^2	10 10 (100 GHz) to 100 (300 GHz)[b] 1000	100 100 1000	3 – 100 100 – 300

[a] The averaging time decreases from 6 minutes at 10 GHz to 10 seconds at 300 GHz with $(68/f_{GHz})^{1.05}$ minutes with f_{GHz} as the frequency in GHz.

[b] The limit scales as a linear function with the frequency.

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Reference Levels

PD limit according to	Averaging Time	Averaging Area	Gen. Pub. [W/m^2]	Occ. [W/m^2]	Frq. [GHz]
ICNIRP 1998 [6]	6 min (2 GHz) to 10 s (300 GHz)[a]	whole body	10	50	2 – 300
ICNIRP 2020, [1] IEEE 2019 [2]	30 min 6 min	whole body 4 cm^2 square 1 cm^2 square	10 40 (6 GHz) to 20 (300 GHz)[b] 80 (6 GHz) to 40 (300 GHz)[b]	50 200 (6 GHz) to 100 (300 GHz)[b] 400 (6 GHz) to 200 (300 GHz)[b]	2 – 300 6 – 300 30 – 300
IEEE 2005 [7]	see Section 2.2	1 m^2 (3 GHz) to 100 cm^2 (30 GHz) 1 cm^2	10 10 (100 GHz) to 100 (300GHz)[c] 1000	100 100 1000	3 – 100 100 – 300

[a] The averaging time is 6 minutes for frequencies up to 10 GHz. Above 10 GHz, it decreases to 10 s at 300 GHz with $(68/f_{GHz})^{1.05}$ minutes with f_{GHz} as the frequency in GHz.

[b] The reference levels scale with $f_G^{-0.177}$ with f_G as the frequency in GHz.

[c] The limit scales as a linear function with the frequency.

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Current Compliance Method

- peak spatial incident power density
  - reconstruction by plane-to-plane reconstruction
  - reconstruction by source reconstruction on device

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Bioelectromagnetics 41:348–359 (2020)

Limitations of Incident Power Density as a Proxy for Induced Electromagnetic Fields

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The most recent safety guidelines define basic restrictions for electromagnetic field exposure at frequencies more than 6 GHz in terms of spatial- and time-averaged transmitted power density inside the body. To enable easy-to-perform evaluations in situ, the reference levels for the incident power density were derived. In this study, we examined whether compliance with the reference levels always ensures compliance with basic restrictions. This was evaluated at several distances from different antennas (dipole, loop, slot, patch, and helix). Three power density definitions based on integration of the perpendicular real part of the Poynting vector, the real part of its three vector components, and its modulus were compared for averaging areas of $\lambda^2/16$, 4 cm^2 (below 30 GHz) and 1 cm^2 (30 GHz). In the reactive near-field ($d < \lambda/(2\pi)$), the transmitted power density can be underestimated if an antenna operates at the free space exposure limit. This underestimation may exceed 6 dB (4.0 times) and depends on the field source due to different coupling mechanisms. It is frequency-dependent for fixed-size averaging areas (4 and 1 cm^2). At larger distances, transmission can be larger than the theoretical plane-wave transmission coefficient due to backscattering between the body and field source. Using the modulus of the incident Poynting vector yields the smallest underestimation. Bioelectromagnetics. 2020;41:348-359. © 2020 Bioelectromagnetics Society.

Keywords: millimeter wave exposure; incident power density; basic restrictions and reference levels; near-field coupling; compliance with exposure limits

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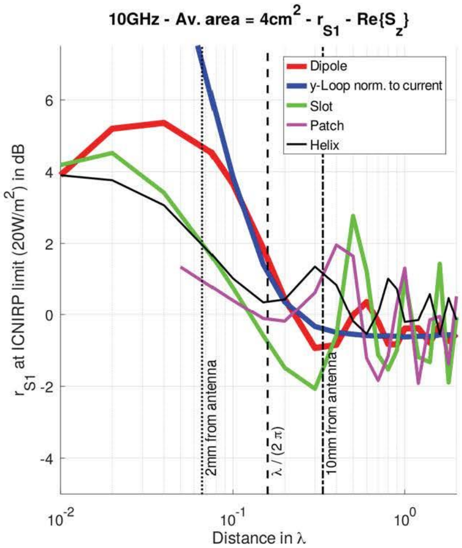

Ratio of APD to Incident PD (10 GHz)

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Conclusions: Reference Limits vs. Basic Restrictions

- PD is only a good proxy of APD in the far-field
- MIMO will increase the near-field complexity and the ambiguity
- as well as other features such as TAPD, proximity sensors, motion sensors, etc.
- assessment of the APD will remove ambiguity

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Measurement Procedure for Absorbed Power Density

- IEC Publicly Available Specification (PAS)
  - "Assessment of the Absorbed Power Density of Human Exposure to Radio Frequency Fields From Wireless Devices in Close Proximity to the Head and Body – Frequency Range of 6 GHz to 10 GHz"
- based on IEC/IEEE 62209-1528
- PAS defines
  - conversion factor
  - system validation & target values
- DPAS approved by 100% but with 50 comments
- expected to be resolved by end of September 2022
- important step!
- no solution >10 GHz

f [MHz]	ε_r	σ [S/m]
6000	35,1	5,48
6500	34,5	6,07
7000	33,9	6,65
7500	33,3	7,24
8000	32,7	7,84
8500	32,1	8,46
9000	31,6	9,08
9500	31,0	9.71
10000	30,4	10,40

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WP4: 1.AUTH, 3:SPEAG, 4:IT'IS, 6:IU, 10:CEA, 11:IMEC, 12:TP-IPP, 14:ANFR

- **Task 4.1**. [M0–M3] Preliminary evaluation of FR2-enabled devices [**P4**, P1, P3, P6, P10] to provide input to WP5–7 with respect to exposure signal characteristics through theoretical considerations and experimental evaluation of FR2-enabled devices.
- **Task 4.2**. [M0–M18] Prototype development of probe & procedure (incl. MIMO transmitters with TAPD) [**P3**, P4, P11]
- **Task 4.3**. [M19–M30] Revision of prototype, building 0-series, integration in DASY8 [**P3**, P4]
- **Task 4.4**. [M31–M33] Evaluation of the latest FR2-enabled devices [**P3**, P4], characterization of the latest FR2-enabled devices as input to WP8–11
- **Task 4.5**. [M1–M36] Dissemination to IEC JWG11 and FCC, ISED [**P4**, P3, P12, P13, P14], and regular updates of the CENELEC working group

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Standardization Solutions by SEAWAVE

- APD evaluations will improve legal certainty for users, regulators and (industry)
- goal is to make the technology available for scientific-sound demonstration of compliance to all stakeholders before the end of the third year of the project (commitment of P3)
- P1, P3, P4, P11, P12, P13, P14 are members in the IEC / CENELEC standardization working group
- in addition, dissemination to government agencies/regulators (FCC, ISED, NICT, RRA)
- keeping industry informed
- some regulators show great interest in APD (Telec, ISED, FCC)
- project risks
  - small technical risks
  - timing is critical
  - regulatory risks: (i) slow adoption by standards/regulators; (ii) reluctance by industry to adapt new procedures

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