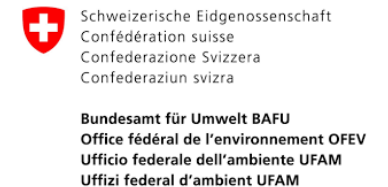


Clinical study of the effects of 5G on human skin

SEAWave-Clin

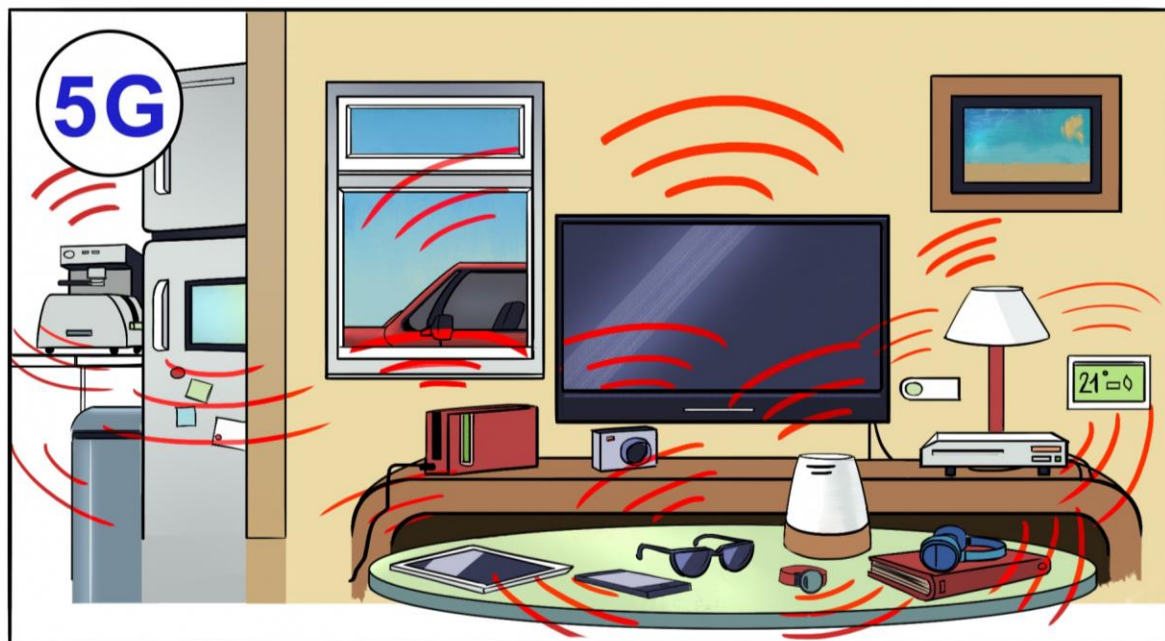
Zhouxing Su, PhD student

Prof. Olivier Gaide, MD-PhD
Christine Pich-Bavastro, PhD

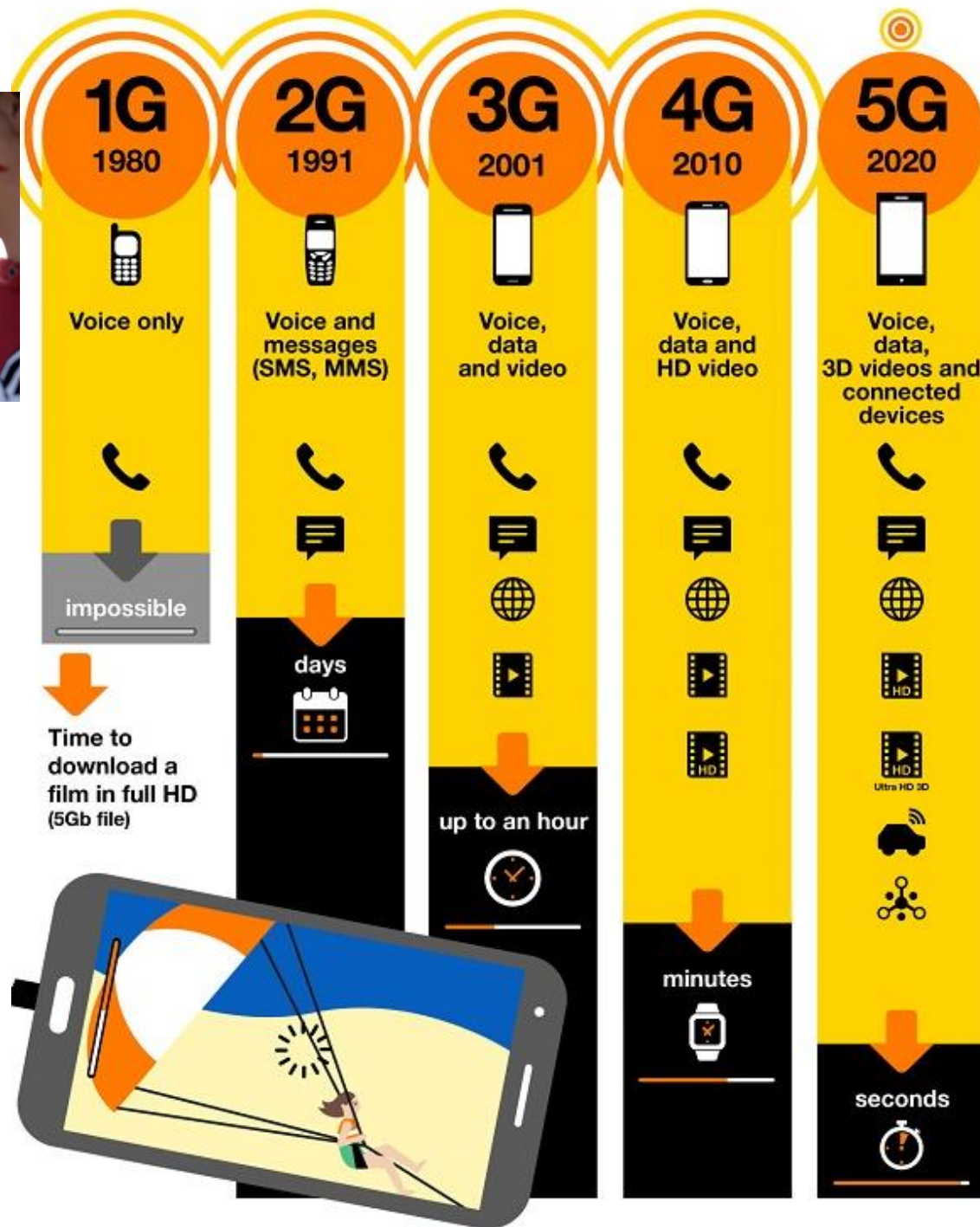


5G

The 5th
Generation of
mobile network



3x PLUS D'OBJETS CONNECTÉS = 3x PLUS EXPOSÉ

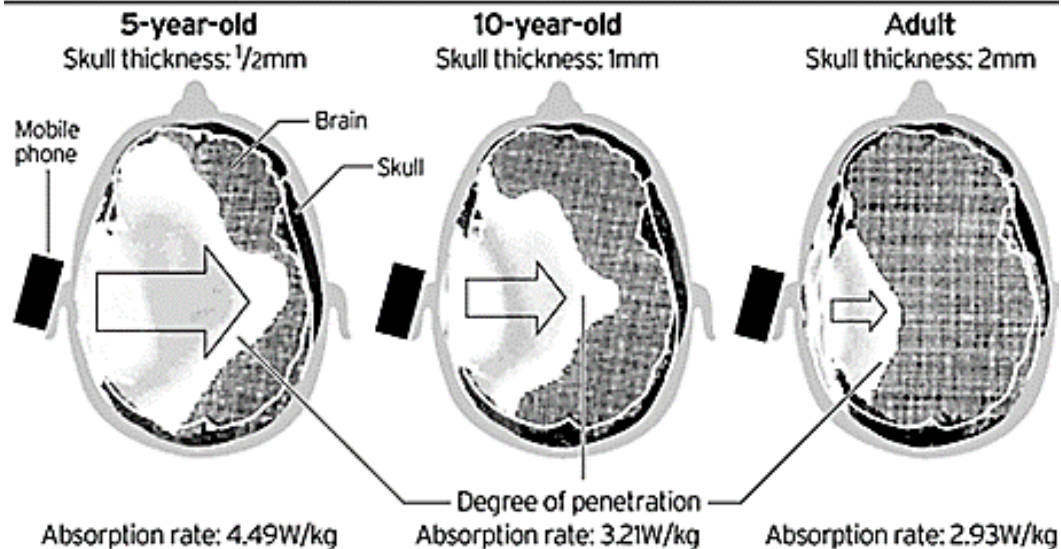


The risk associated with 5G technology in comparison to its predecessors

- 5G are **electromagnetic waves (EMW)** : frequency ranged from 0.41GHz – 100GHz
 - FR1: < 6GHz (well studied)
 - FR2: 24.25 – 71.0 GHz (unknown)

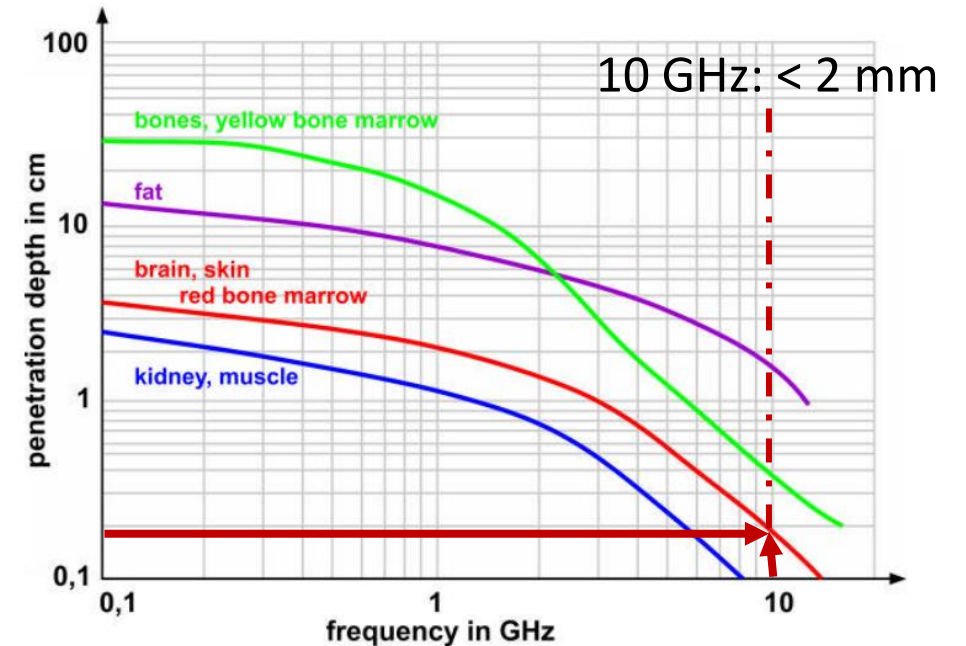
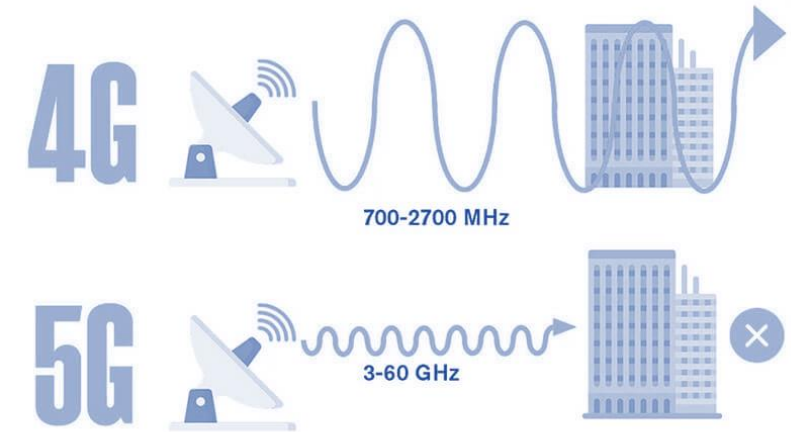
Previous generations

How mobile phone radiation penetrates the brain



Source: Institute of Electrical and Electronic Engineers' journal on Microwave Theory and Techniques

Cell and Smart Phones.



EMF-Portal | Radio frequency (10 MHz–300 GHz).

Skin: the largest organ, the first barrier

Radiations

UV > 750 THz



Visible light > 350 THz



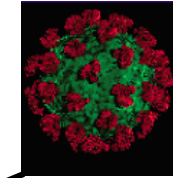
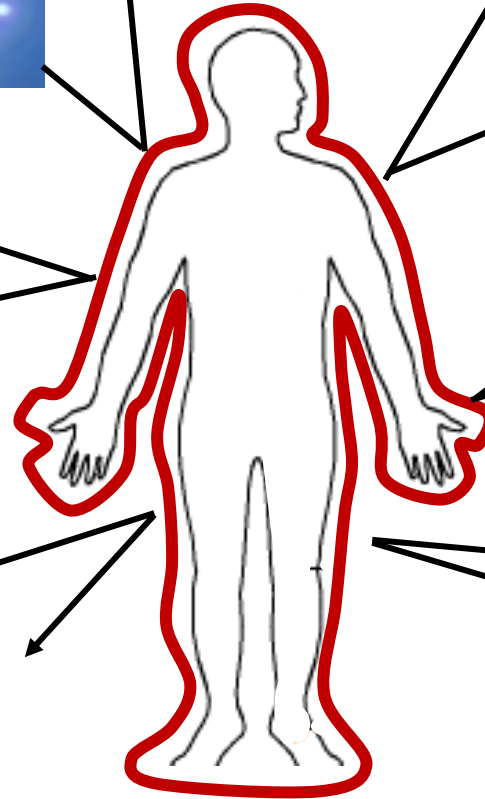
5G FR2 25-72 GHz



Microwave ≈ 4.2 GHz



Radio < 30 MHz



Virus



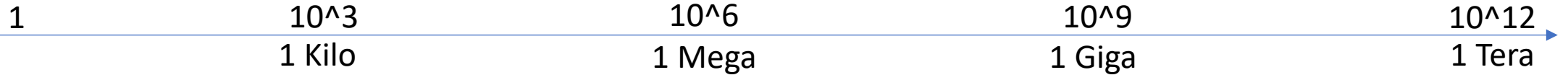
Bacteria



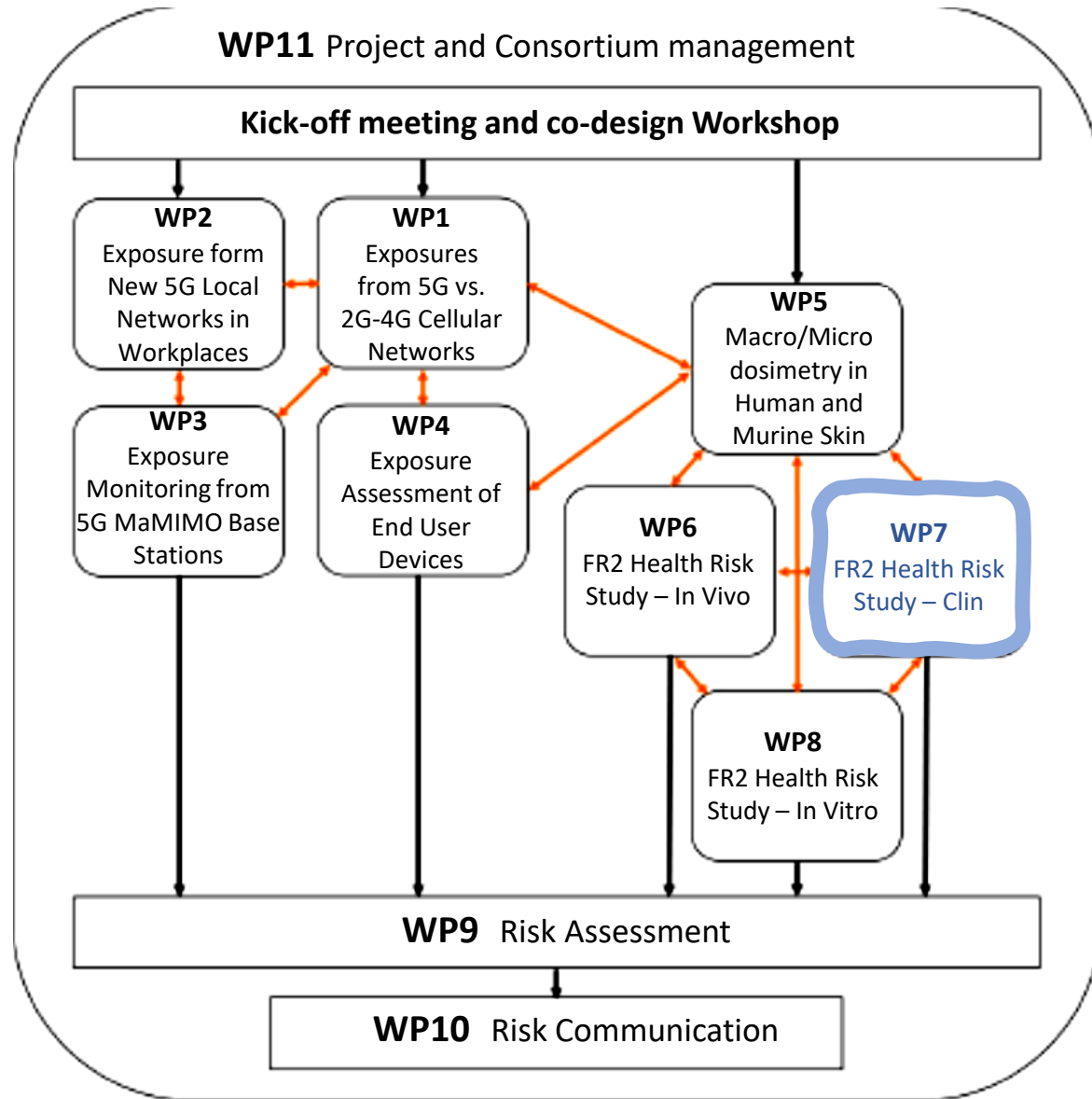
Fungi



Parasites



SEAWave project



Project profile

- Start : June 1st, 2022
- Duration : 36 months
- Budget: 9'842'331 €



Protocol (CHUV)

1) Determination of skin thickness by OCT

2) Double-blind exposure

27.5 GHz, 20 W/m², 20 min exposure
IT^{VS} FOUNDATION provided and certified

3) Biopsies by punch at 1h and 24h

↓ Single cell preparation

4) Single cell RNA sequencing

Frozen material for later validation

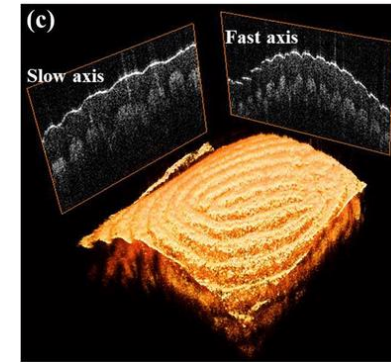


Noninvasive examination of the skin

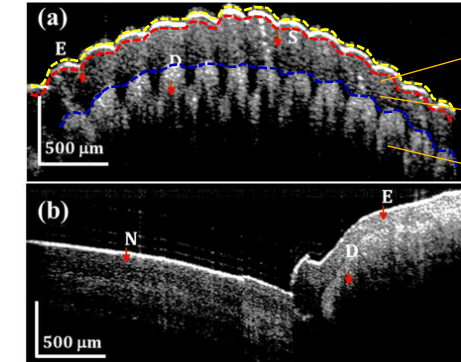
1) Determination of skin thickness by optical coherence tomography OCT



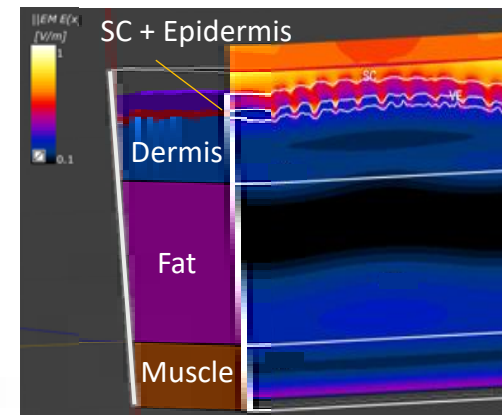
Confocal and optical coherence tomography (OCT)



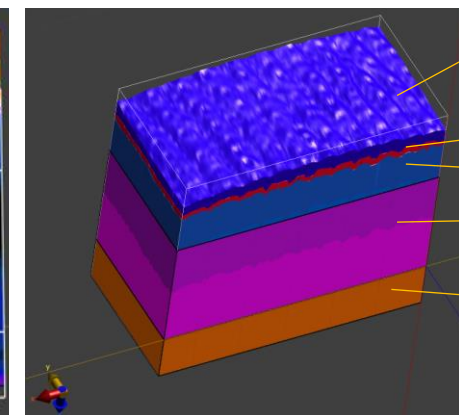
In-vivo OCT images of human fingers.



Stratum corneum
Epidermis
Dermis



3D skin human finger model and 5G radiation simulation.



Stratum corneum
Epidermis
Dermis
Fat
Muscle

WP5

Macro/Micro dosimetry in Human and Murine Skin

Protocol (CHUV)

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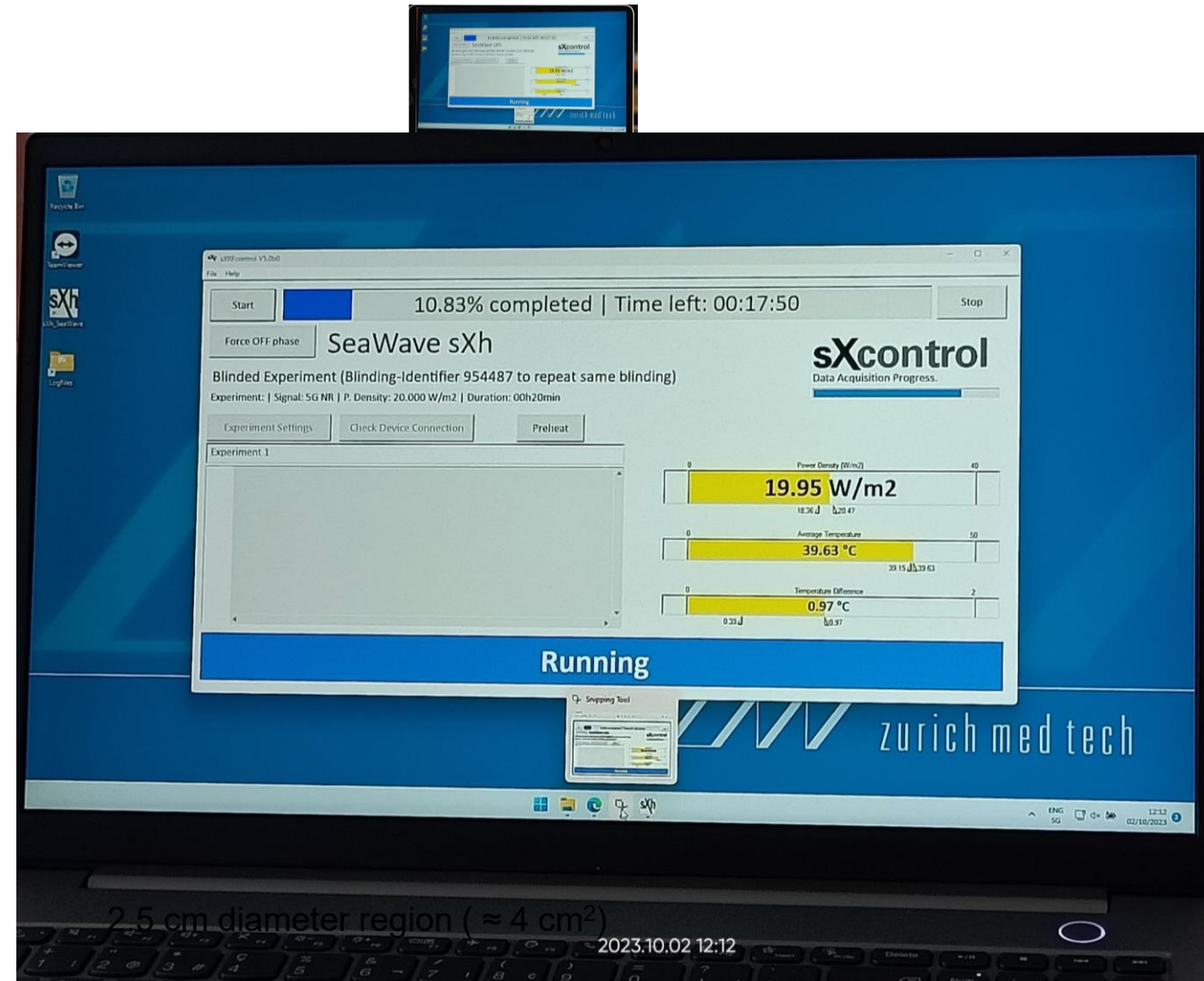
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5th Generation (5G) New Radio cellular system

1, why choose 27.5 GHz?

- 5G are **electromagnetic waves (EMW)** at frequency ranged from 0.41GHz – 100GHz
 - FR1: < 6GHz (well studied)
 - FR2: 24.25 – 71.0 GHz (unknown)

frequency bands for FR2-1

- n258 spectrum adopted by European Commission
- n257 and n258 are mostly used worldwide
- n260, and n261 adopted by major US carriers

the frequency range 26.5 – 27.5 GHz is common to bands n257, n258 and n261
- used throughout USA and Europe

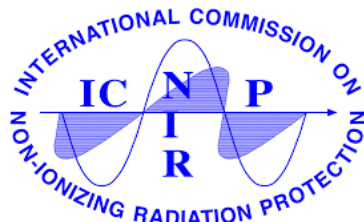
27.5 GHz

| Designation | | Frequency Range |
|-------------|--------------------|-----------------------|
| | FR1 | 410 MHz – 7125 MHz |
| FR2 | FR2-1 | 24.25 GHz – 52.60 GHz |
| | FR2-2 (unlicensed) | 52.60 GHz – 71.00 GHz |

| sub band | NR FR2 band | frequency range (GHz) | bandwidth (GHz) |
|----------|-------------|-----------------------|-----------------|
| FR2-1 | n257 | 26.50 – 29.50 | 3.00 |
| | n258 | 24.25 – 27.50 | 3.25 |
| | n259 | 39.50 – 43.50 | 4.00 |
| | n260 | 37.00 – 40.00 | 3.00 |
| | n261 | 27.50 – 28.35 | 0.85 |
| | n262 | 47.20 – 48.20 | 1.00 |
| FR2-2 | n263 | 57.00 – 71.00 | 14.00 |

ICNIRP GUIDELINES

FOR LIMITING EXPOSURE TO
ELECTROMAGNETIC FIELDS (100 kHz TO 300 GHz)



5th Generation (5G) New Radio cellular system

2, Why choose PD (power density) = 20 W/m²

ICNIRP Guidelines ● ICNIRP

491

Table 2. Basic restrictions for electromagnetic field exposure from 100 kHz to 300 GHz, for averaging intervals ≥ 6 min.^a

| Exposure scenario | Frequency range | Whole-body average SAR (W kg ⁻¹) | Local Head/Torso SAR (W kg ⁻¹) | Local Limb SAR (W kg ⁻¹) | Local S _{ab} (W m ⁻²) |
|-------------------|------------------|----------------------------------------------|--------------------------------------------|--------------------------------------|--------------------------------------------|
| Occupational | 100 kHz to 6 GHz | 0.4 | 10 | 20 | NA |
| | >6 to 300 GHz | 0.4 | NA | NA | 100 |
| General public | 100 kHz to 6 GHz | 0.08 | 2 | 4 | NA |
| | >6 to 300 GHz | 0.08 | NA | NA | 20 |

27.5 GHz

$$S_{ab} = 20 \text{ W/m}^2$$

ICNIRP GUIDELINES

FOR LIMITING EXPOSURE TO
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Frozen material for later validation

Clinician CHUV
Biopsy punch, OCT

Pr Olivier Gaide

IT'IS foundation
Device design and fabrication

Dr Myles Capstick



Dr Christine Pich-Bavastro

Investigator CHUV
Sample processing, data analysis

The design of experiment process

1) Healthy (6M/6F)



18-25 years old

No skin disease or fam. history
Photo-protected

2) Thin/aged skin (6M/6F)



60-80 years old

Dermatoporotic skin
Sun exposed

2 Arms:

Double-blind exposure

2 Biopsies:

1h, 24h

**168 samples
for scRNA seq**

3) Cancer prone (3M/3F)



Skin tumor syndromes
18-80 years old

4) Pre-inflamed (6M/6F)



Atopic Dermatitis
18-80 years old

42 Volunteers:

30 (SEAWave, EU) + **12** (FOEN, CH)

Implication of the

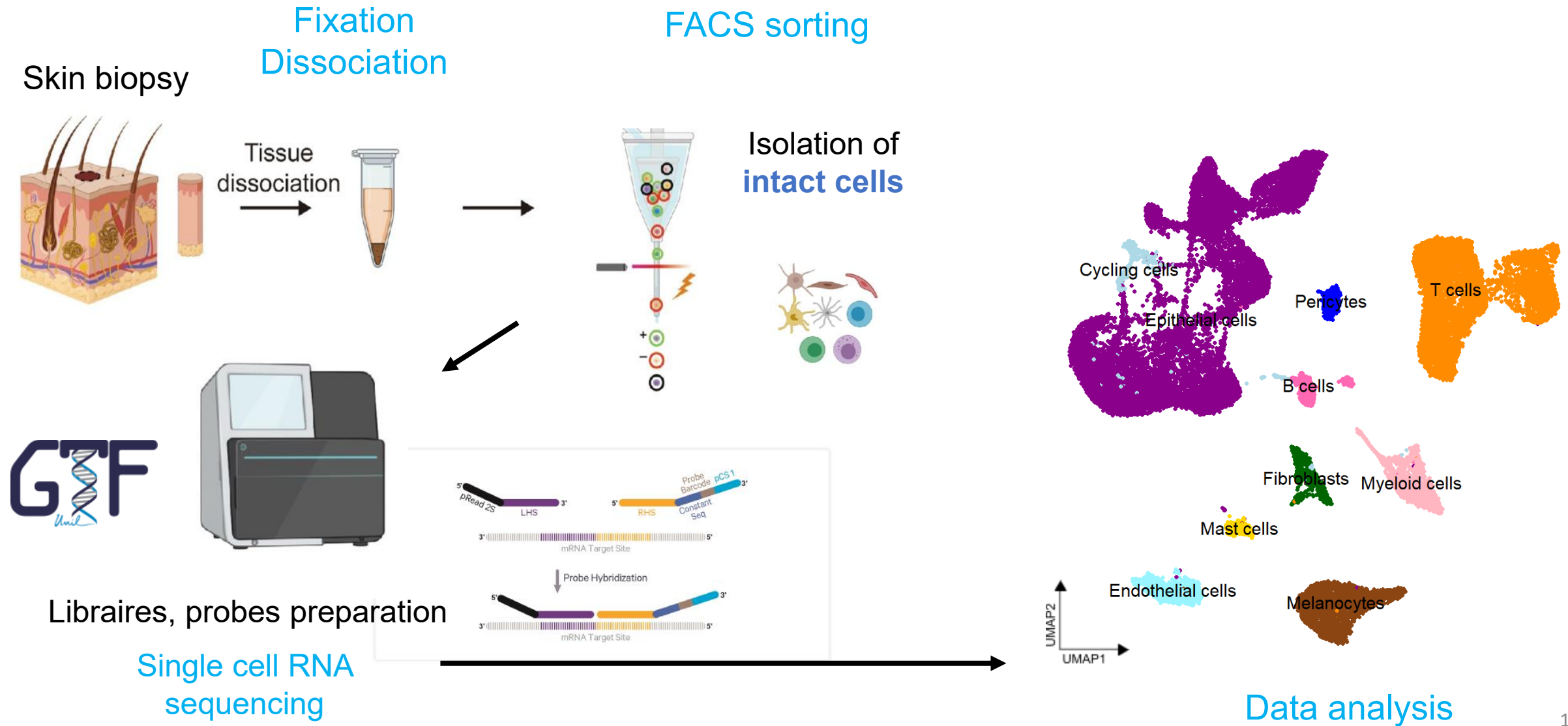


Swiss Institute of
Bioinformatics

1, Huge amount of data will be stored on the SIB servers
e.g. a dataset of 5 samples = 2.3 Gb

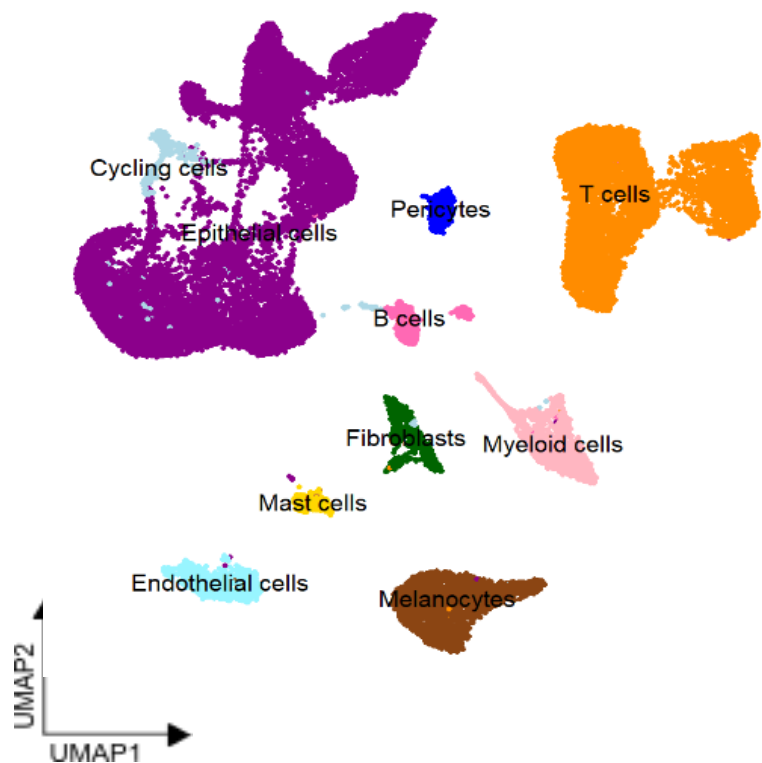
2, SIB can provide help for the biostatistics

Single cell RNA sequencing



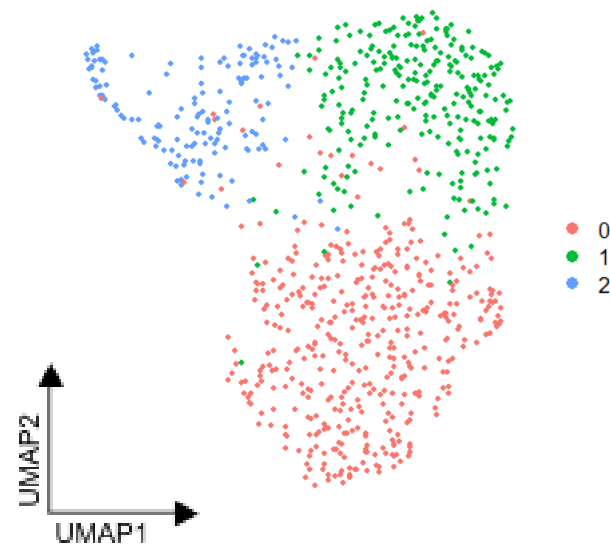
Single cell RNA sequencing

5 Unfixed human BCC



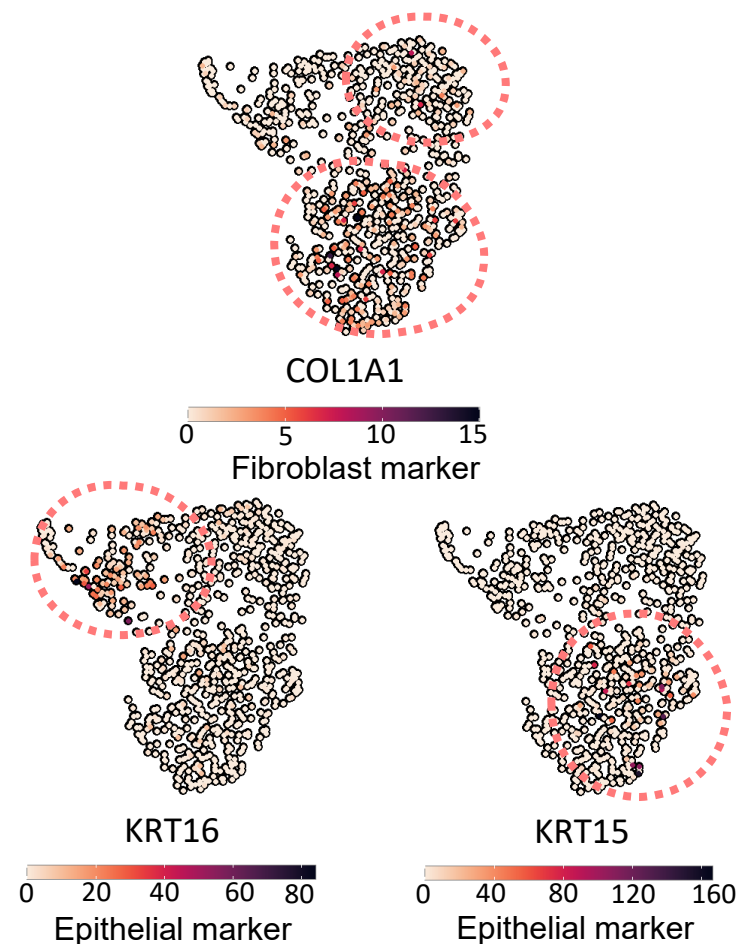
30 800 cells $\xrightarrow{\text{filtering}}$ 28 800 cells
 → Remove cells
 percent.mt > 20
 nFeature_RNA > 3000

4 Fixed human BCC



C0: Fibroblasts + Epithelial cells
 C1: Fibroblasts
 C2: Epithelial cells

1 915 cells



1 915 cells $\xrightarrow{\text{filtering}}$ 829 cells
 → Remove cells
 percent.mt > 20
 nFeature_RNA > 3000




Thank you for your
attention

Zhouxing Su, PhD student

Prof. Oliver Gaide, MD-PhD
Christine Pich-Bavastro, PhD



 Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Umwelt BAFU
Office fédéral de l'environnement OFEV
Ufficio federale dell'ambiente UFAM
Uffizi federal d'ambient UFAM