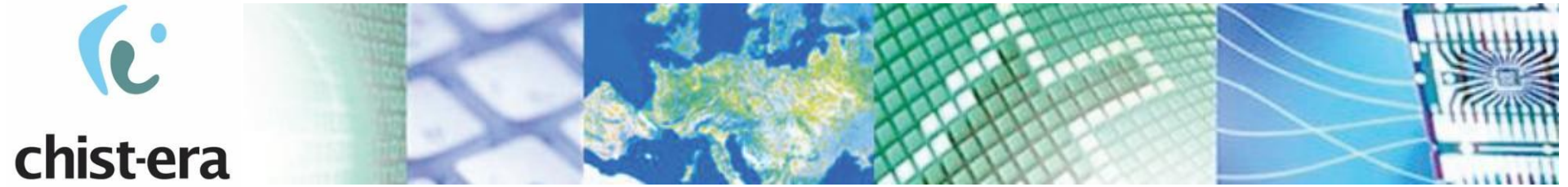


CHIST-ERA Projects Seminar
Cross Topics
Topic TMCS 2015

G. Ducournau

Bucharest, April 4th, 2019

Programme co-funded by the
EUROPEAN UNION

Introduction: Projects of the topic

- **TMCS: terahertz (THz) band for fast wireless communications**
- **Goal: demonstrate the use of 'terahertz' band for higher capacity (data-rate)**

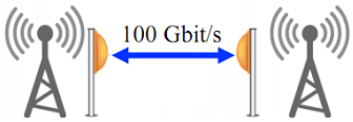
⇒ **Need developments at componants AND system level**

- **Why?**

- We all need to communicate, faster and faster

- If we take into account the user needs for bandwidth, actual systems can't handle this (radio ressources over crowded)

- this is driving the 5G implementation and beyond 5G research



- **How? THz communications scenarios studied in TMCS:**

TERALINKS
WISDOM

- Long range, Fixed link (point to point), advanced technology (feed by fiber networks)
- Short range: adjustable link (mobile user), cheaper technology, steerable antenna)

Introduction of the domain

❖ What is THz? A domain between electronics or optics!

✓ There remains a lack of sources at the THz frequency range.

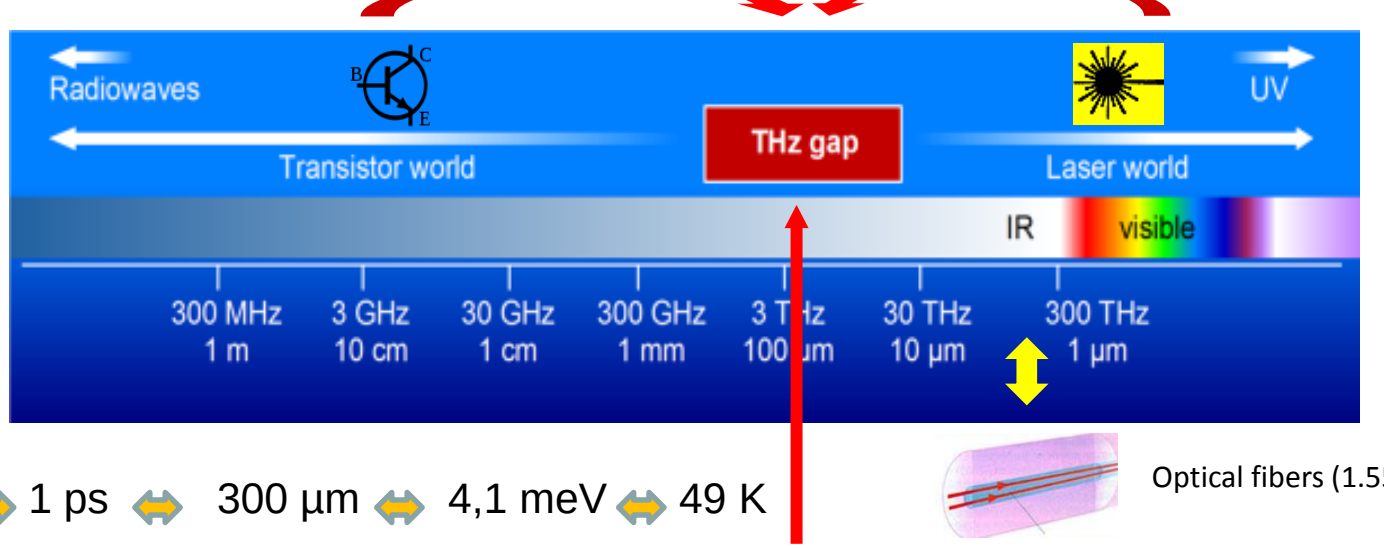
➢ Or direct generation (but bulky, lab = OK, Datacom: difficult!)

➢ From Electronics

➢ From OPTICS

WISDOM

TERALINKS

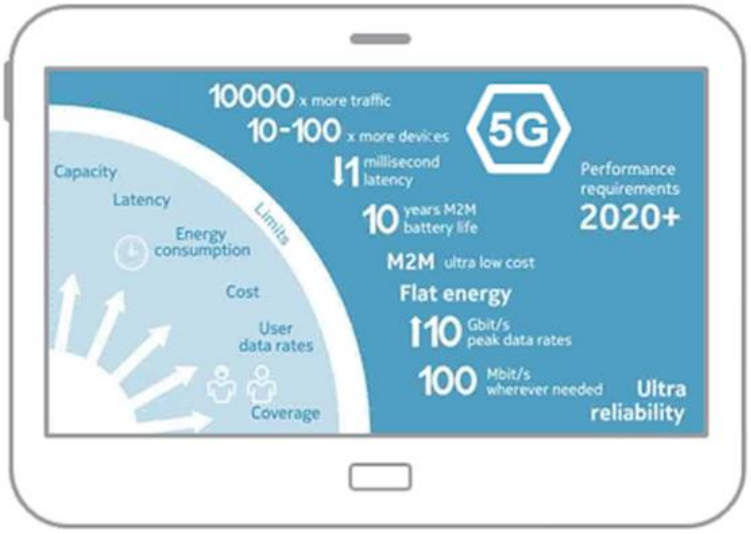


1 THz ⇔ 1 ps ⇔ 300 µm ⇔ 4,1 meV ⇔ 49 K

Optical fibers (1.55 µm)

Introduction of the domain

❖ Why should we use the THz bands?



Massive data + Beyond 5G -> 10 Gbps per user… (2025?)

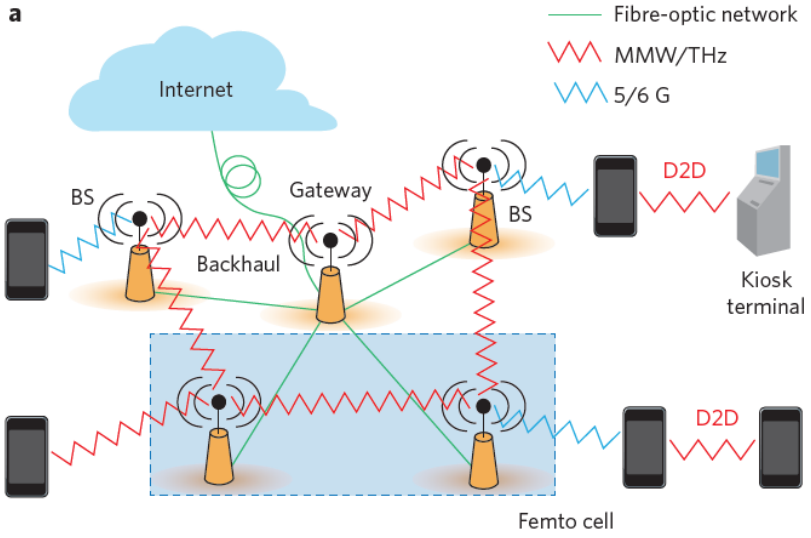
Urban case: > 100 user/cell, 10 Gbps (target), per user:

Needs Tbps/cell! (km² size)

… Tbps per base station?

Existing solutions can't do it.

Need new frequency ressources: THz



TERALINKS in a nutshell

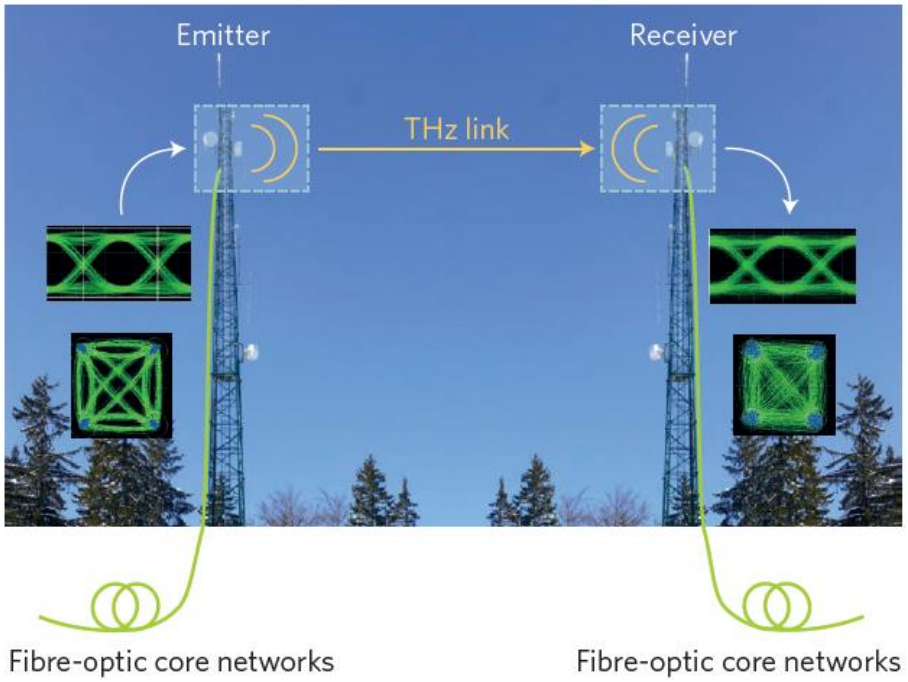
❖ TERALINKS: main goals

- ✓ Achieve the first outdoor THz link, with 40 Gbps data-rate real-time
- ✓ Combine photonics, tube amplifier and smart antennas (never been done!)

❖ Distinctive features

- ✓ Push and interconnect different technologies towards a real functionnal system for back-haul links

Example:
1 km targeted system with 40 Gbps



Partners:
Univ Lille [FR], Lancaster Univ [UK], Queen Mary College [UK], Univ. Nice [FR], Univ public of Navarra [SP]

WISDOM in a nutshell

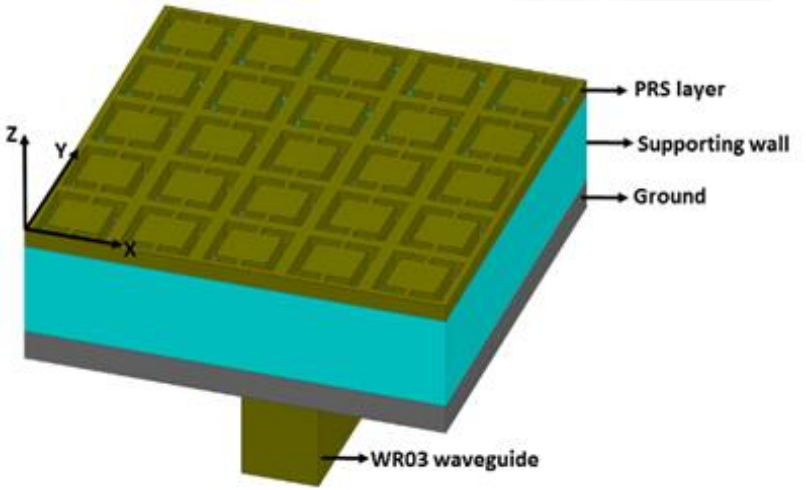
❖ WISDOM: main goals

- ✓ Use 3D techniques for fast fabrication THz passive/active antennas
- ✓ Combine 3D and CMOS devices toward power combining/antenna arrays

❖ Distinctive features

- ✓ Demonstration of beam-steerable links for device to device communications

Examples:
A novel high-gain resonant cavity antenna operating at 300 GHz
New unit cell design of the partially reflecting surface layer



Partners:
UniKent [UK], KU Leuven [BE], TU Graz [AT], Univ Warwick [UK]

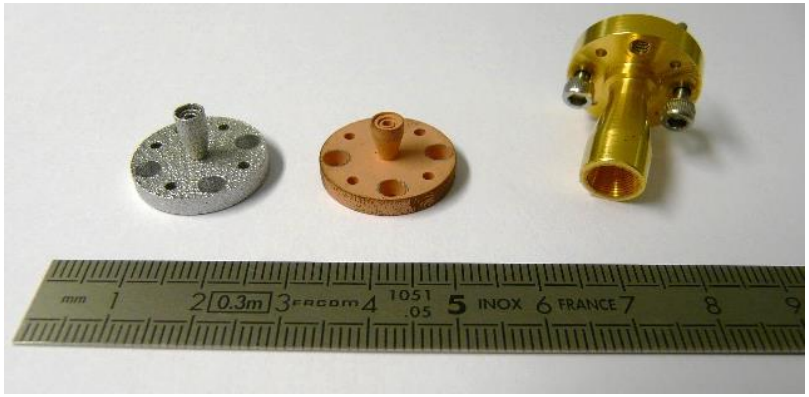
Major achievements and output

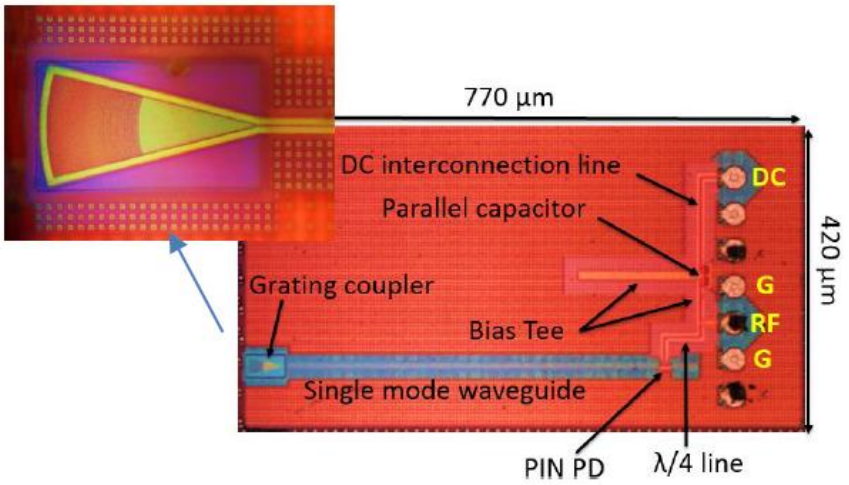
❖ TERALINKS

System Devices

- ✓ THz sources achieved
- ✓ Tube amplifier designed for 240 GHz
- ✓ Many types of antenna fabricated & characterized
- ✓ 50 Gbps system in the lab demonstrated with silicon photodiodes
- ✓ 100 Gbps system in the lab demonstrated with III-V photodiodes

Website for project dissemination (8 journal papers + 15 conferences (2 invited))

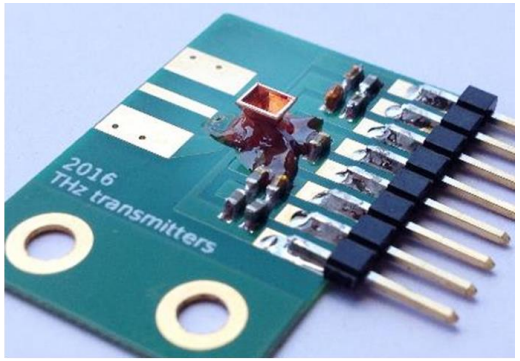


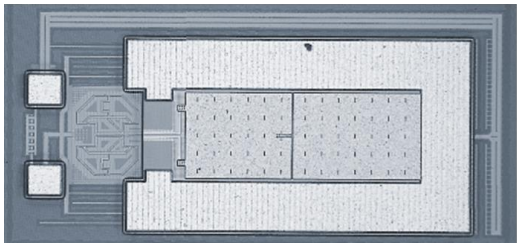


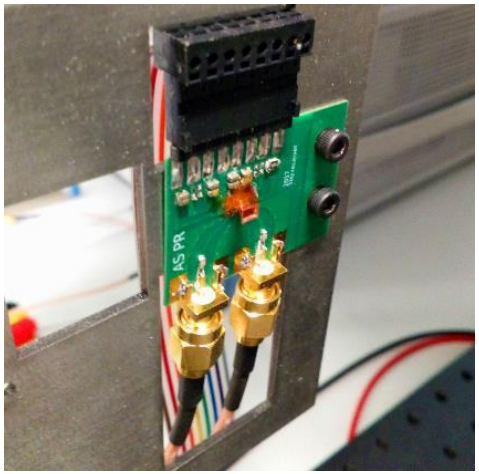
Major achievements and output

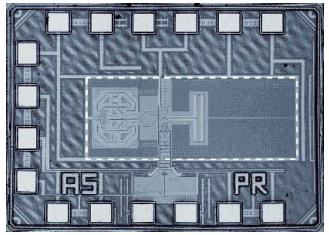
❖ WISDOM

- ✓ 3 types of antennas fabricated and measured up to 300 GHz
- ✓ CMOS transceiver integrated with horn (see figures), IMS 2018
- ✓ Novel design on metamaterial based lens









- 650x250um Active area

Major achievements and output

❖ WISDOM

- ✓ Design of compact 300 GHz antennas (initial prototype validated at 30 GHz
- ✓ 130 GHz in progress

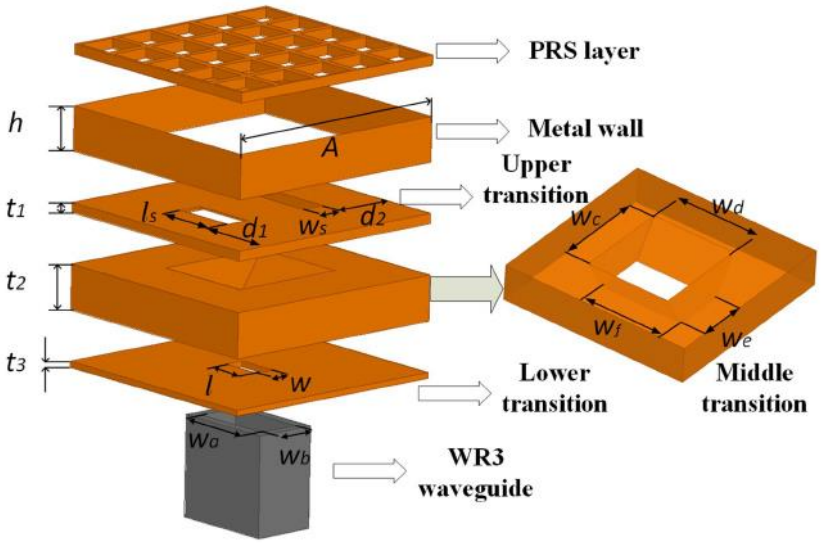


Fig. 3 *Detailed antenna configurations*

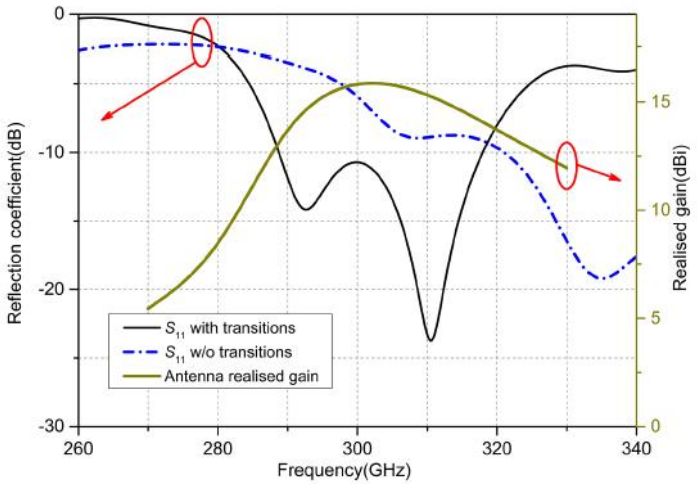


Fig. 4 *Simulated reflection coefficient and gain*

Challenges for the TMCS projects

	Real-time capacity	Integration	Energy efficiency	3D tech.	CMOS tech.	Silicon-photonics based tech.	III-V tech.
TERALINKS	X	X	X	X		X	X
WISDOM		X	X	X	X		

+ … update from 2018:

Testing in «real-life» (increased TRL of the system)
Accurate characterization benches, methods and suitable metrics towards system-level measurements (cross comparison of data, reproducibility, …)

Outcome: THz link in ‘real life’

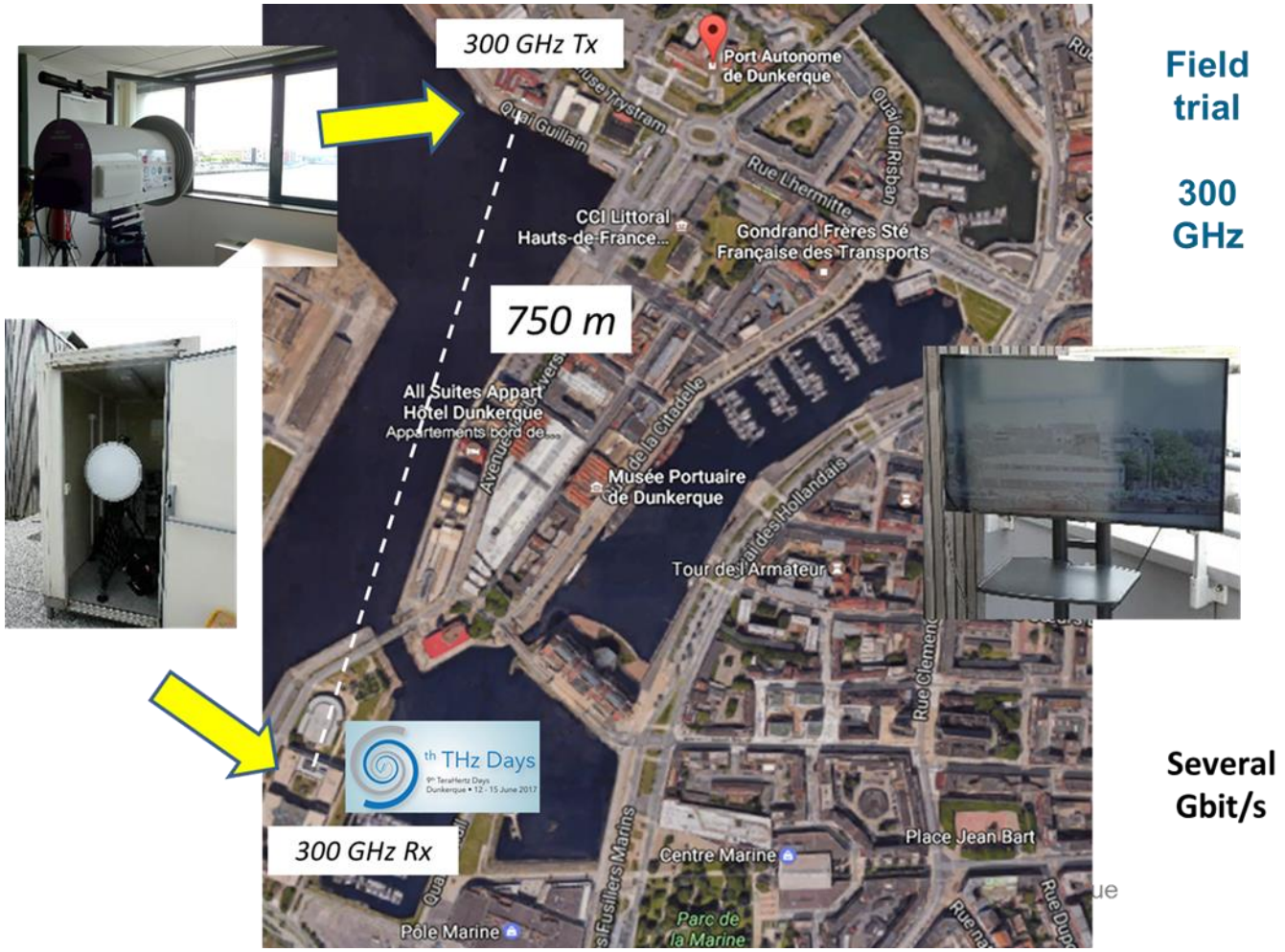
Example of outdoor test

Realized within **Teralinks**

In France (Dunkerque)

First live demo of real-time THz link!

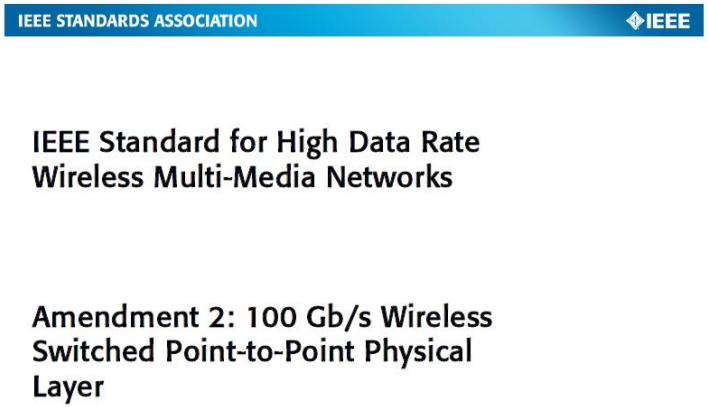
750 m!



Role of the CHIST-ERA support

- **Helps to establish transnational/interdiscipinary relationships towards THz applications**

- **Fully in line with european strategy towards THz datacom beyond H2020 programs**
  - ✓ Chistera is a good step towards EU proposals (H2020, ICT)
  - ✓ Chistera helps Europe to contribute in this field (strategic due to recent new IEEE standard 802.15.3d



  - ✓ New topic suggestions:
    - **beyond 5G research / sustain the user connectivity**
    - **Next generation internet application**

Enabling EU project via CHIST-ERA

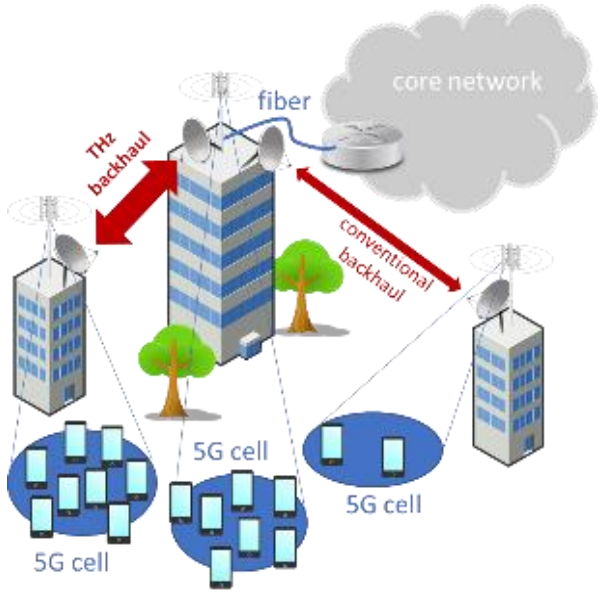
- **Helps transnational/interdiscipinary relationships towards THz applications**

- **In line with european strategy towards THz datacom beyond Horizon Europe program**

  - ✓ Chistera **anticipated THz topic as emerging field** => Two partners from **TERALINKS are now in 2 EU projects** in H2020 (THOR and ULTRAWAVE project) in the TMCS topic.

  - ✓ TMCS topic identified as an ICT key topic for next FP9 (Horizon Europe).

  - ✓ Chistera projects helped us to pass from national to trans-national projects then EU funded.



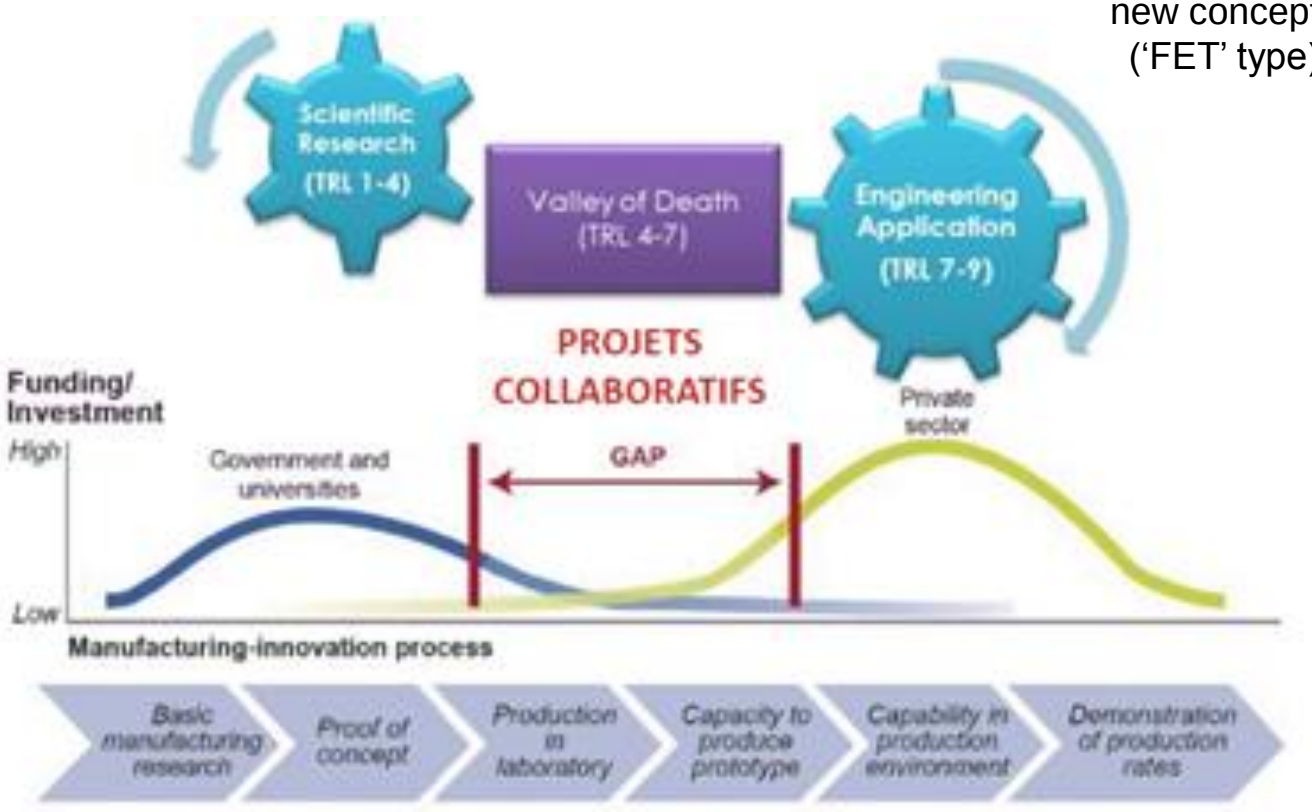
An example as chist-era role

chist-era

Horizon 2020

Enabling ICT with new concepts ('FET' type)

Using these concept towards applications!



My view of Era-net role

ANR «COM'TONIQ»
National level

2017
TERALINKS

2018-21
EU THOR project

Connection with indus partners
Deutche Telekom (EU)
NEC, NICT (Japan)

2013

TRL level

High

Low

New proposal / 2019

A new research «loop»

Questions

Questions ?