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TeraFlag – what's behind ?

In fall 2017, EU published a Call for a „Coordination and Support Action (CSA)" (a 1 year, 1 M€ project) to explore the possibillity of a new flagship.

In Dec. 2017 we came up with the idea of a proposal on „THz Science and Technology" – deadline 20 Feb 2018

Existing flagships:

- Graphene
- Human brain

- Quantum technology (just started)
- Battery research (in the pipeline)

Before that, several years of „consultation" resulted in 25 possible topics, for which prospective consortia had been pre-formed.

- 33 CSA proposals were submitted (20 Feb)
- 17 were selected for the second stage (18 Sept)
- 4-6 will be selected for the 1-year CSA

The results of the CSA should be a detailed concept for the flagship

From this, EC will select 1-2 flagships

Selection will be done by FET delegates of member states !

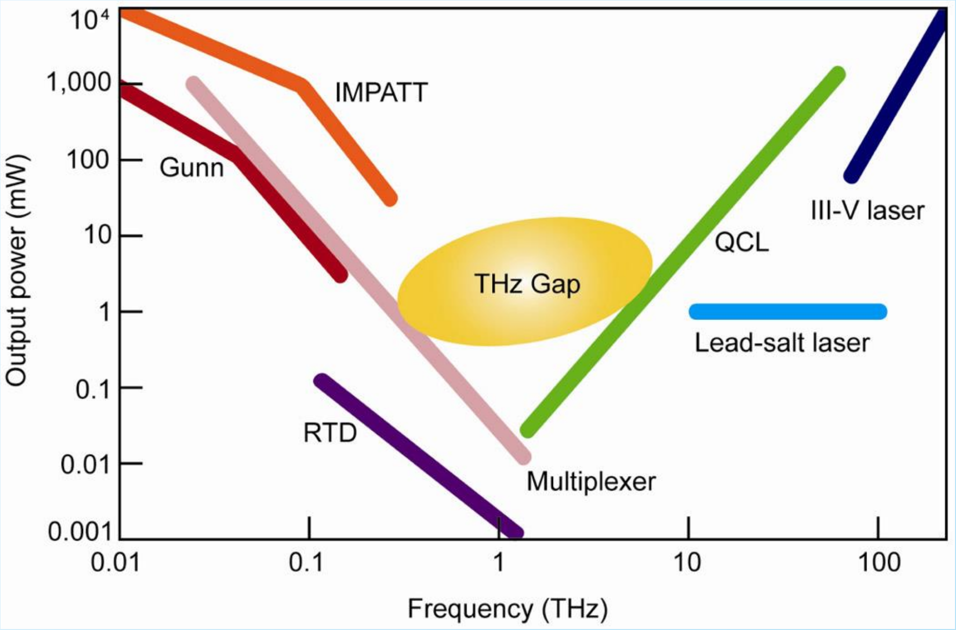
What is the idea ?

The THz gap – and its closing,

at the same time opening this for plenty of new applications

electronics

(classcial charge oscillations)



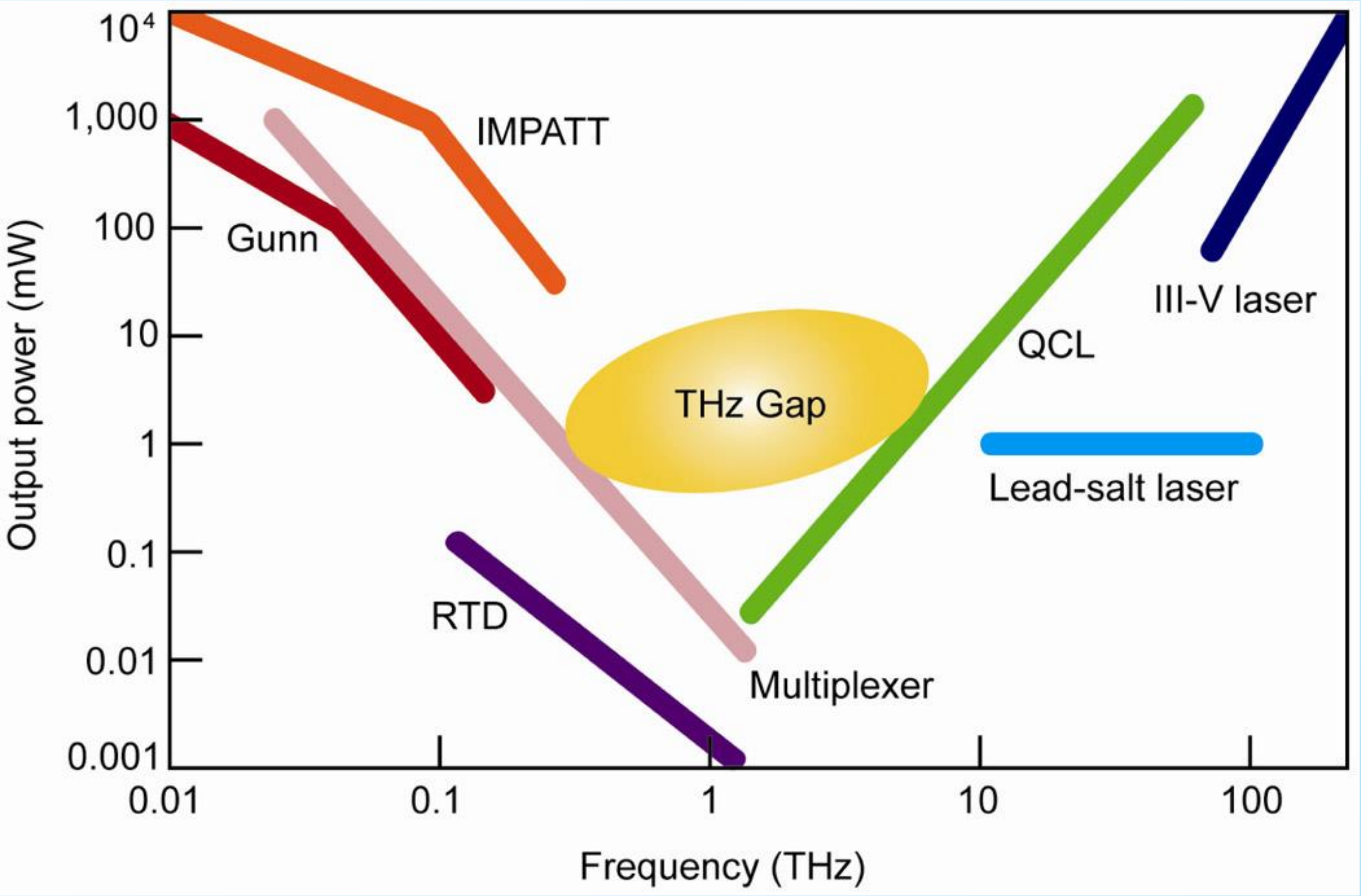
photonics

(quantum transitions)

J. V. Moloney et al. SPIE Newsroom (2011)

0.1 – 10 THz

THz solid state sources – the „THz gap“



RTD: Resonant tunnel diode; IMPATT: Impact ionization avalanche transit-time diode;
QCL: Quantum-cascade laser.

J. V. Moloney et al. SPIE Newsroom (2011)

There are fundamental physical reasons for the THz gap:

Problems of electronic devices at high frequencies:

- transit times
- RC-times
  → ultramall devices necessary
  → low power / thermal management
- losses (e.g. coplanar lines, microwave waveguides)

Problems of photonic devices (semiconductor lasers) at longer wavelengths:

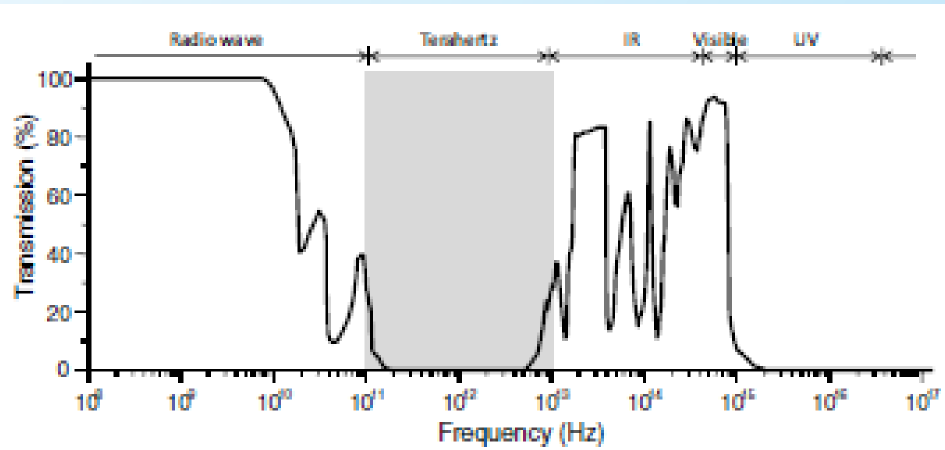
- energy level spacing $< k_B T$ and thermal distribution of carriers
- faster nonradiative recombination (Auger process)
- free carrier absorption ($\sim \lambda^2$)
- problems of guiding the light

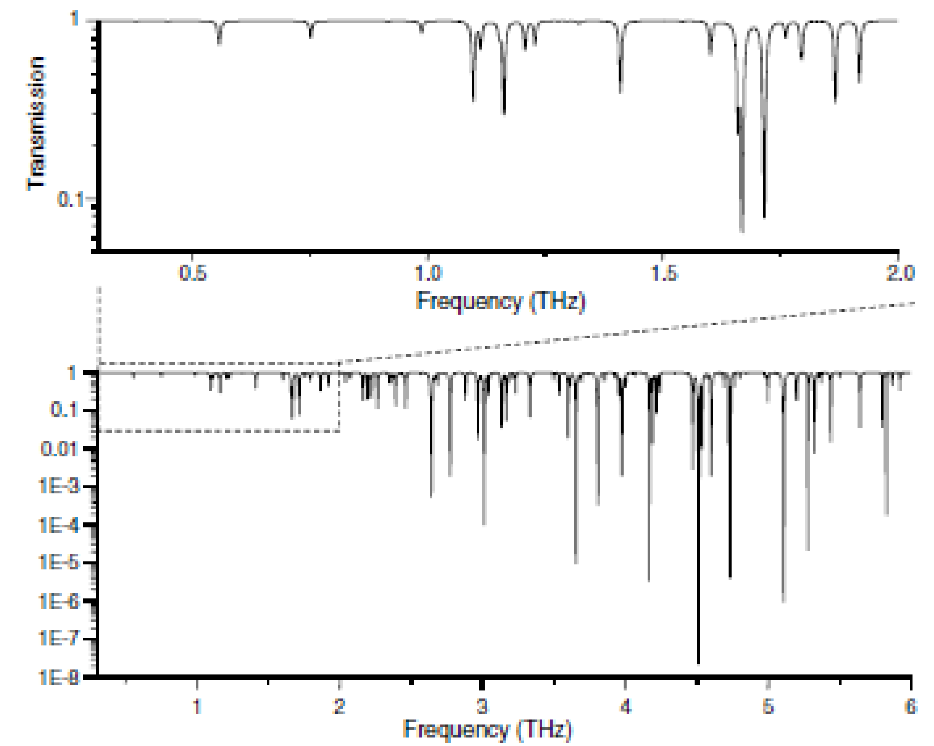
THz allows to combine data transmission with chemical information and imaging

Important properties:

- non ionizing (as opposed to X-rays)
- higher frequency than microwaves: high bandwidth for communication possible
- many materials (plastics, paper, clothes,..) are transparent, but have characteristic absorption lines: chemical information, sensing
- shorter wavelength than microwaves better spatial resolution for imaging, plus spectral information for hyperspectral imaging

Transmission of the atmosphere (water vapor):





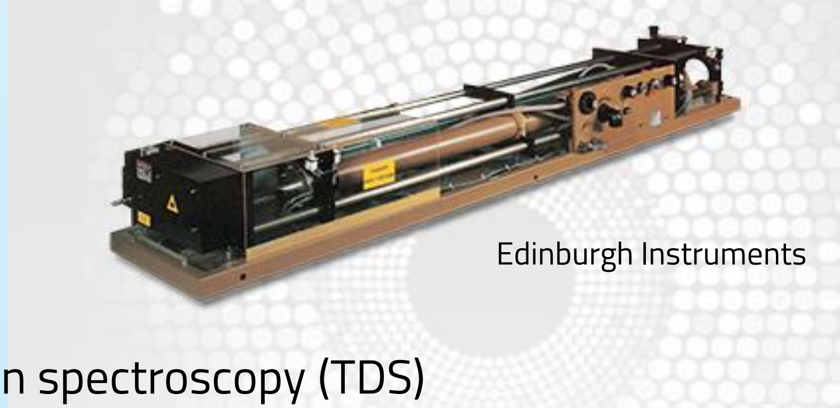
Y.-S. Lee, Principles of THz Science & Technology (Springer)

Why now ? – A history of THz (sources)

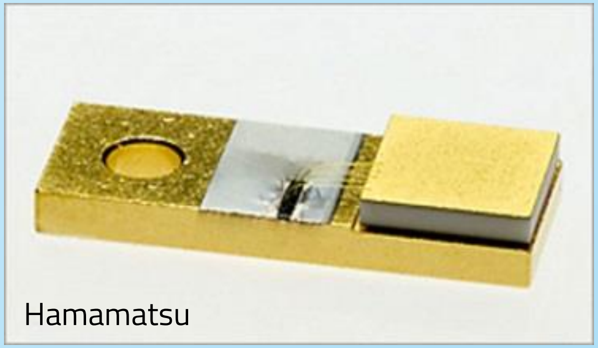
The photonic side:

- 1970: CO_2 laser pumped FIR gas laser was invented (0.3 to 8 THz):

  Basically is the same today,
  half a century later



- Around 1990: begin of THz time-domain spectroscopy (TDS)
  (and the use of word „THz“)



- 1994 the quantum cascade laser was invented, and
  2002 demonstrated in the THz region

Some road blocks kept industrial use down:
- Size/cost of TDS systems
- No room-temperature operation of THz-QCLs

The electronics side:

Transistor frequencies have continuously increased towards 1 THz and beyond,

initially only III-V semiconductors, now also SiGe BiCMOS

Today, electronics and photonics move together to close the THz gap !

In order not to miss this opportunity, the two – often still largely separated communities – should work together !

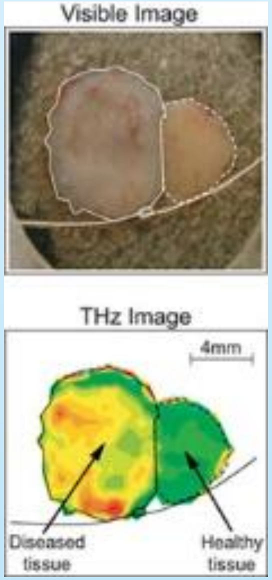
THz value chain from

- Materials and process technology
- Devices and components technology
- Subsystem integration and system design

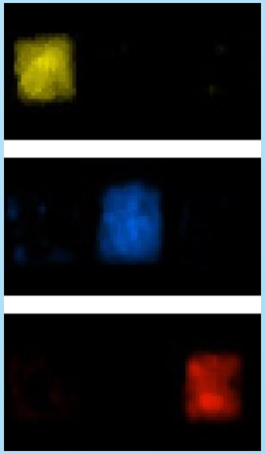
7 application areas:

- Future connectivity
- Radar and sensing for mobility
- Manufacturing and robotics
- Security
- Health
- Space exploration and climate change
- Food and agriculture
    - + open science track

TeraView Ltd.



Der Spiegel 47 (2002), p.179



K. Kawase et al., Opt. Express 11, 2549 (2003)

Mapping these 7 applications areas to 5 technology strands:

- Future connectivity and radar sensing
- Manufacturing and non-destructive sensing
- Integrated THz systems for security and health
- Satellite and airborne instrumentation
- Future materials and technologies

Thank you !