The 17th European Conference on Antennas and Propagation (EuCAP)
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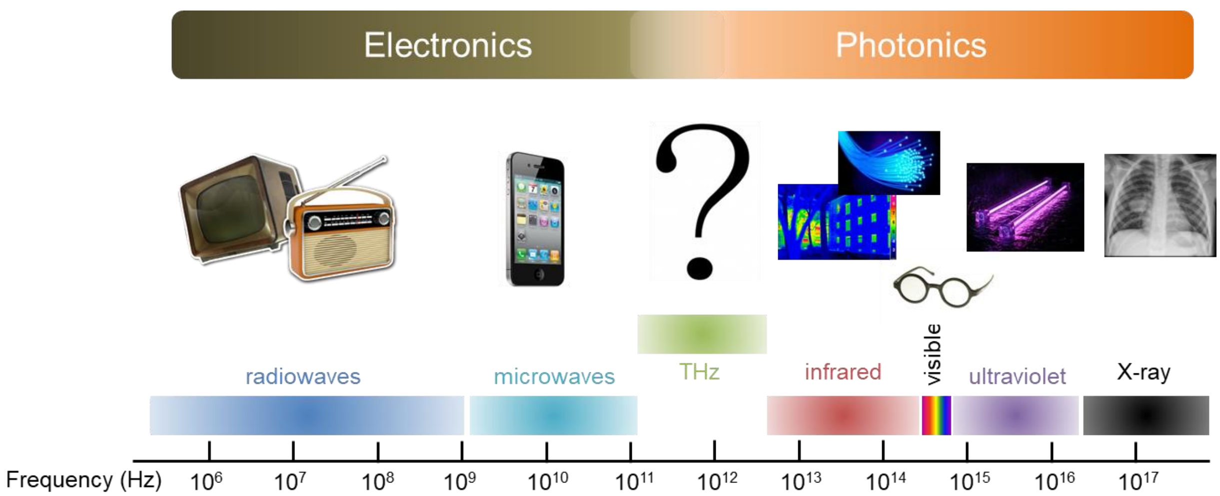
# Introduction to THz Technology, Instrumentation and Applications

**Abstract**

Wireless communications are irremediably moving into millimetre-waves and THz; evidence of this is the IEEE 802.15.3d-2017 standard. THz is also becoming key for security screening, quality control and medical imaging because of its excellent balance between spatial resolution and material penetration. Unquestionably, THz will play a major role in coming years and this has been noticed by EurAAP and IEEE, among other entities, which are taken action accordingly. In this context, engineers need to be well aware of the current technology and the challenges related to THz in order to wangle the next generation of THz components and systems.

**Graphical abstract**




**Recommended prerequisites**

Microwave engineering and semiconductor physics.

## Learning objectives

1) Classify the different commercial THz instruments according to their THz generation and detection mechanism
2) Reflect upon the attendee' beliefs about the challenges in THz technology
3) Assess the suitability of time-domain (pulsed) vs. frequency-domain (CW) approach to test components
4) Adopt a critical attitude towards scaling down/up microwave/optical designs for THz
5) Understand the technical details in THz product brochures
6) Follow-up topics introduced in this Short Course by participating in other specialized Short Courses on THz

## Course outline

### Aims

This Short Course aims to provide an opportunity for attendees to familiarize with THz technology (CW and pulsed). The storyline of the Short Course will build upon the presenter's research in THz devices and experience with the commercial instruments ABmm VNA (CW), Keysight N5247B PNA-X with VDI extenders (CW), TPS Spectra 3000 from Teraview (pulsed), TERA K15 from Menlo Systems (pulsed) and TeraFlash Pro Dual from Toptica (pulsed), and with an in-house (University College London) near-field time-domain-spectrometer (TDS) system. PowerPoint presentation, youtube videos and group discussions (if time permits) will be used in this Short Course. It intends to assist participants to:

1- Acquire an understanding of different THz sources (CW and pulsed) and detectors
2- Become more insightful about the commercially available test instruments
3- Become aware of the challenges in designing THz components

### Sections

- Why THz now? Historic introduction of THz science and technology. Current applications, trends and potential opportunities. Challenges from the material point of view. Considerations for modelling/simulations. [~30 min]
- THz technology: Passive components. THz sources (thermal, electrical and optical/laser based). THz detectors (thermal, coherent, others). Commercial instruments. My own experience with THz instruments. TeraHertz facilities at University of Birmingham. [~1h 30 min]
- Applications: non-destructive testing and radar. [~30 min]
- Discussion and interactive voting (laptop/tablet/mobile phone needed): applications, product brochures, etc. [~30 min]

## Instructor – biography

Miguel Navarro-Cía (IEEE S'08–M'10-SM'15) received the MEng and PhD degrees in Telecommunication Engineering, and MRes degree in Introduction to Research in Communications from Universidad Pública de Navarra (UPNA), Spain, in 2006, 2010 and 2007, respectively.
He is a Reader in TeraHertz Science and Engineering at University of Birmingham, UK. He is also affiliated with Imperial College London as a Visiting Researcher. Previously, he was a Research & Teaching Assistant at UPNA (2010-2011), a Research Associate at Imperial College London (2011-2012) and University College London (2012) and a Junior Research Fellow at Imperial College London (2012-2015). He worked as a Visiting Researcher at University College London (2013-2015), University of Pennsylvania (2010), Imperial College London (2008, 2009 and 2010), and Valencia Nanophotonics Technology Center (2008).
He is the coauthor of 2 book chapters (one of them, 'Principles of THz generation', published by Wiley-IEEE Press in 2015), 100+ journal papers, and 300+ conferences papers. He is an editorial board member for IET Microwaves, Antennas & Propagation, Advanced Electromagnetics, Radiophysics and Electronics, and Frontiers in Photonics.
His current research interests are THz spectroscopy/microscopy, quasi-optics, plasmonics, metamaterials, antennas and frequency selective surfaces.

## Key bibliography

**General about THz:**

1. G. Carpintero, E. Garcia-Muñoz, H. Hartnagel, S. Preu, A. Raisanen Semiconductor TeraHertz Technology: Devices and Systems at Room Temperature Operation, Wiley-IEEE Press (2015)
2. J.-L. Coutaz, F. Garet, V. P. Wallace, Principles of Terahertz Time-Domain Spectroscopy, CRC Press (2018)
3. M. Naftaly, Terahertz Metrology, Artech House (2014)
4. Y.-S. Lee, Principles of Terahertz Science and Technology, Springer (2009)
5. S. L. Dexheimer, Terahertz Spectroscopy: principles and applications, CRC Press (2008)
6. The Terahertz Wave eBook, Zomage Corporation

**Specific to the short course:**

1. **http://www.abmillimetre.com/**
2. **https://www.keysight.com/en/pdx-2815126-pn-N5247B/pna-x-microwave-network-analyzer-67-ghz?cc=GB&lc=eng**
3. **https://teraview.com/terapulse/**
4. **https://www.menlosystems.com/products/thz-time-domain-solutions/**
5. **https://www.toptica.com/products/terahertz-systems/**