

# Czech-French Cooperation in Science: success stories and opportunities

*French testimony*

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**iemmn**

Institut d'Electronique, de Microélectronique  
et de Nanotechnologie

UMR CNRS 8520



Université  
de Lille





**iemn**

Institut d'Electronique, de Microélectronique  
et de Nanotechnologie

UMR CNRS 8520

**IEMN** UMR 8520

Institut for Electronics, Microelectronics and Nanotechnology

Created on 01/01/1992

Trustees: CNRS, University of Lille, University of Valenciennes  
and Hainaut Cambrésis, Yncrea-Lille, Ecole Centrale de Lille

Belongs to CNRS - Institute of Engineering Sciences and Systems

Also linked to CNRS - Institute of Physics

Partner of RENATECH-RTB since 2003



## 5 RESEARCH FACILITIES

- Micro Nano Fabrication (1600m<sup>2</sup> mixed 100/1000)
- HF and MEMS/NEMS Characterization
- Near Field Microscopy
- Telecom
- ElectroMagnetic Compatibility



## 5 RESEARCH DEPARTMENTS

*22 research groups; appr. 450 employees of which  
173 with a research position & about 200 PhD & postdocs:  
47 CNRS & 126 (Assistant) Professors*

- Materials & Nanostructures
- Micro & Nano Systems
- Micro Nano Opto Electronics
- Circuits & Communication Systems
- Acoustics



# The THz Photonics group

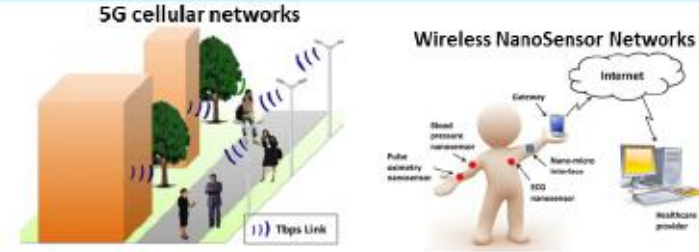
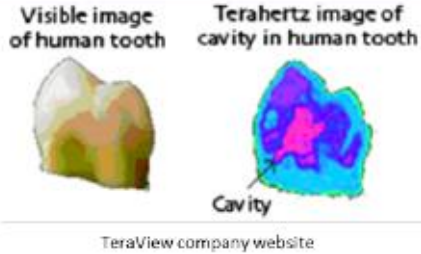
Permanent members: Stefano Barbieri (DR arrived 2016), Guillaume Ducournau (MCF→Pr 2018), Jean-François Lampin (DR 2015), Romain Peretti (CR hired 2018), Emilien Peytavit (CR), Mathias Vanwolleghem (CR)

Created in 2012 (previously the THz activity was in the EIPHY group)  
2013: 4 permanent, 2016: 5 permanent, 2018: 6 permanent (4 HDR)



2018: 10 PhD, 4 Post-docs + Engineers, M/F: 4:1

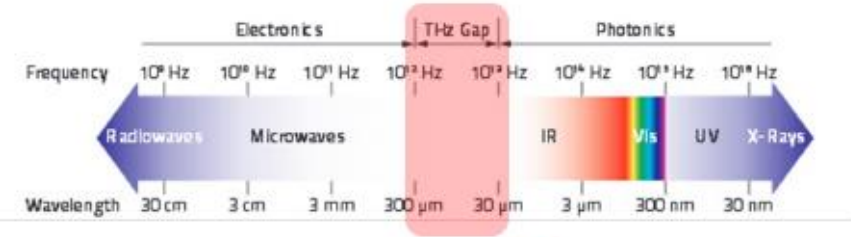
# Terahertz Range



J.F. Akyildiz, et al., *Phys. Comm.* 12 (2004)

## Medical, biomedical applications

## Wireless communication



**THz range**  
0.1 – 10 THz

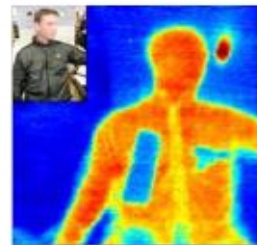
- Non-ionizing
- Higher carrier freq. comp. to microwaves
- High interaction with polar molecules

## Imaging → security, process, quality monitoring

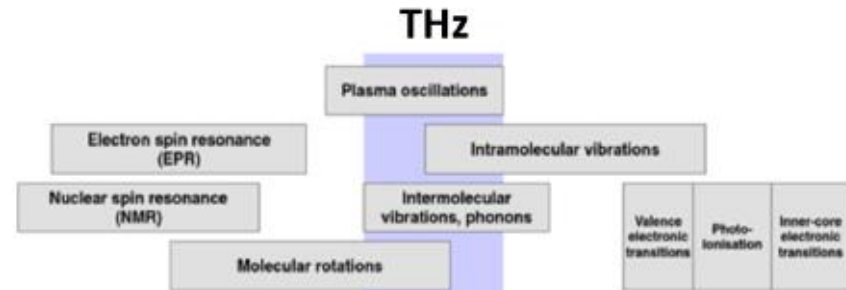
## Spectroscopy



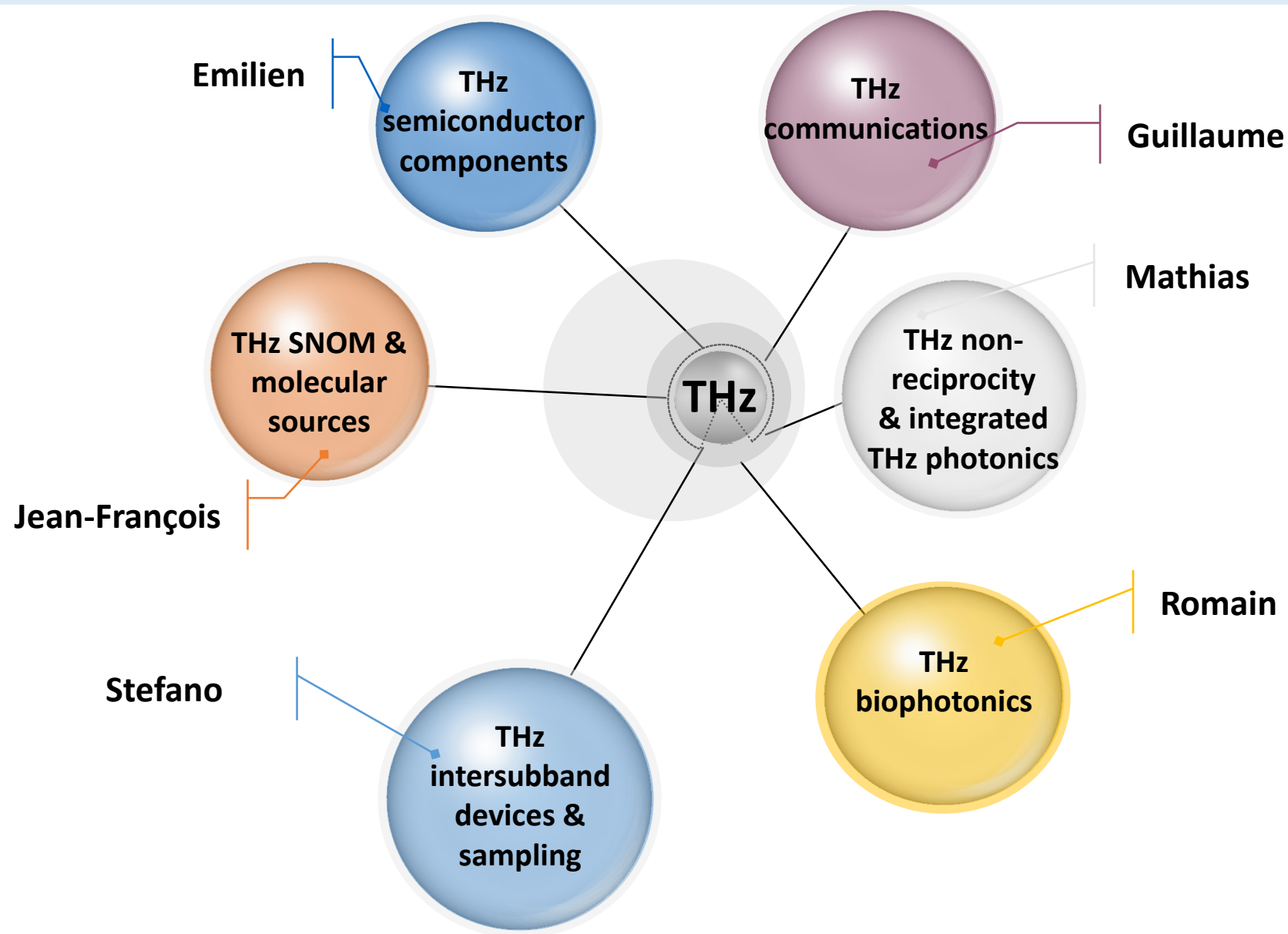
N. Karpowicz, et al., *Appl. Phys. Lett.* 86 (2005)



C. R. Dietlein, et al., 4<sup>th</sup> ESA Workshop on Mm.-wave Tech. and Appl. (2006)



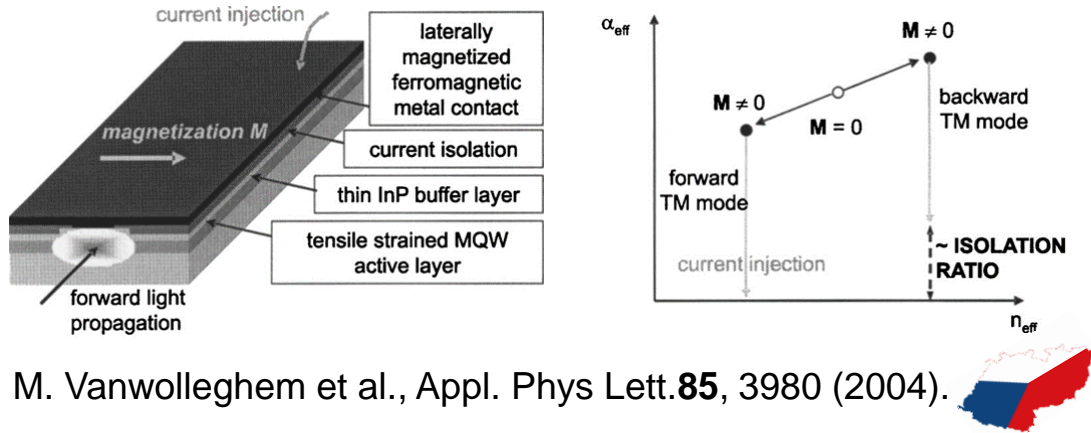
# Main research topics



# Leitmotiv for over 10 years: Nonreciprocal electromagnetic phenomena

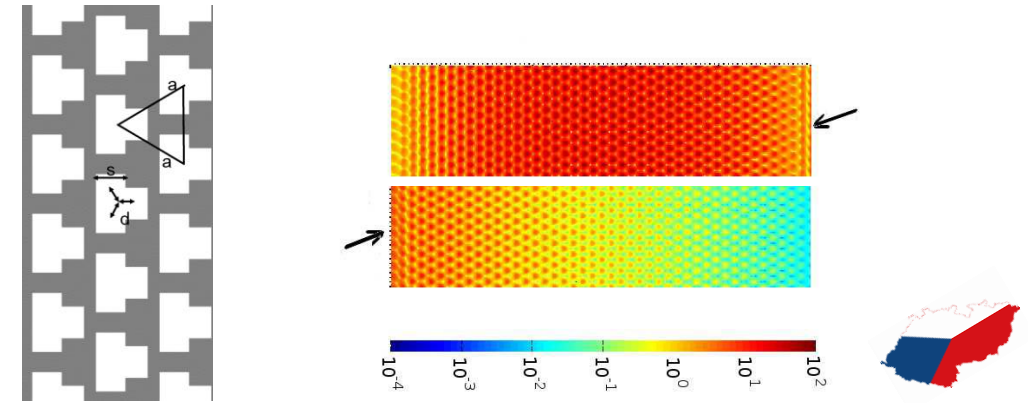
from the visible down to mm-waves, from devices to basic theory, from numerical modelling to testing and fabrication

PhD 2005 UGent (BE): InP monolithic integrated optical isolator



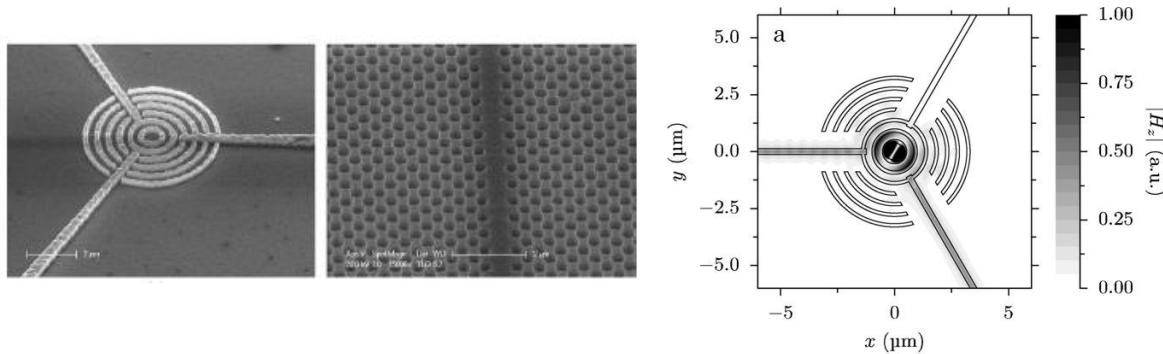
M. Vanwolleghem et al., Appl. Phys Lett. **85**, 3980 (2004).

Postdoc PSud IEF (FR) '05-'06: MO PhC



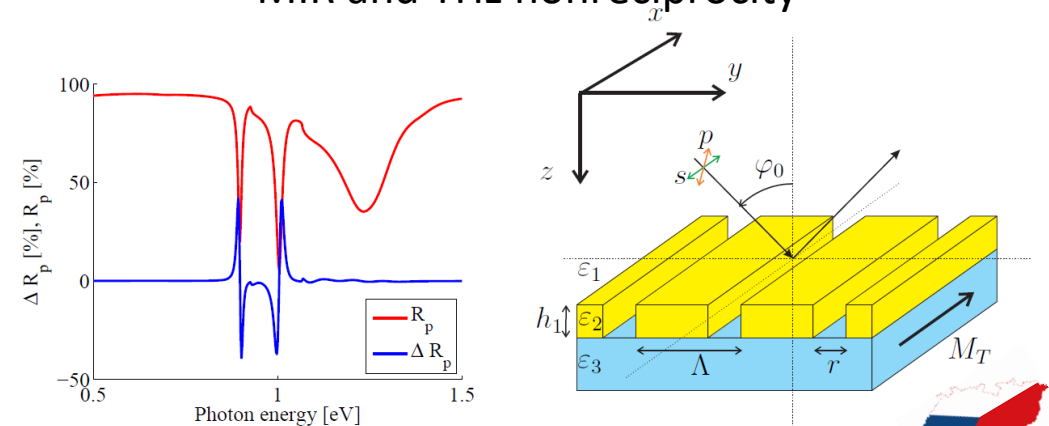
M. Vanwolleghem et al., Phys. Rev. B **80**, 102121(R) (2009).

CNRS researcher (IEF 2007-2012): next gen. IR nonreciprocal nanostructures



W. 'Smigaj et al., Opt. Lett. **35**, 568 (2010).

CNRS researcher (IEMN 2013-...): towards MIR and THz nonreciprocity



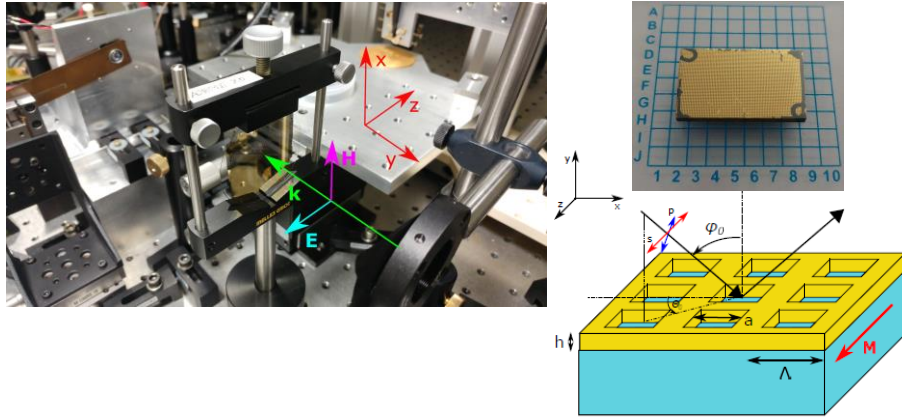
L. Halagačka et al., Opt. Express **21**, 21741 (2013).

L. Halagačka et al., Opt. Express **26**, 31554 (2018).



Since 2013 at IEMN: THz photonics (nonreciprocity, sources, spectroscopy, spintronics,...) & even more intensifying CZ collaboration (3 Master students, 4 PhD students, EU projects ...)

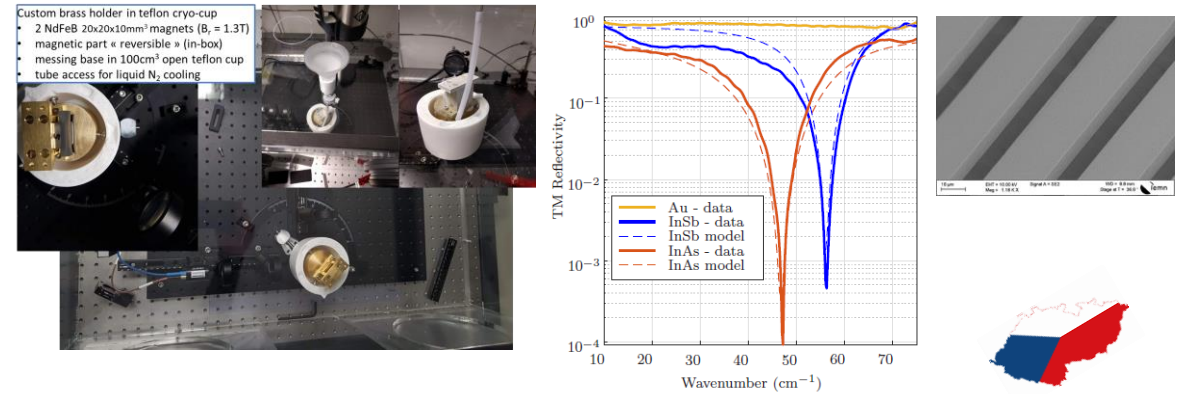
### hexaferrite THz isolators



T. Horák et al., IEEE Trans. on Terahertz Science and Technology, vol. 7, no. 5 (2017).

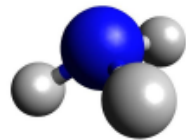
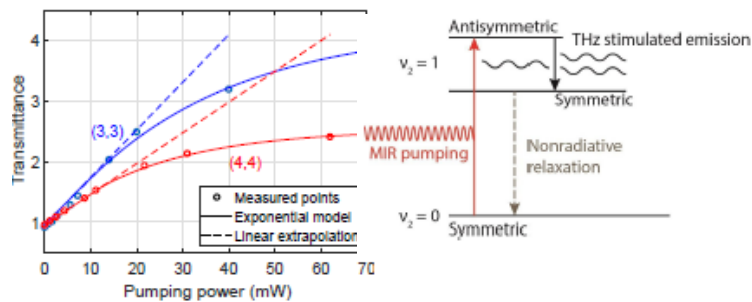


### InSb THz magnetoplasmonics



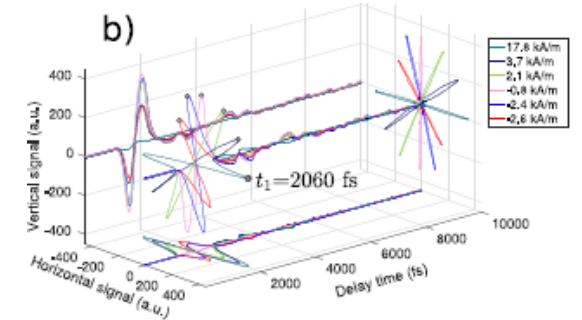
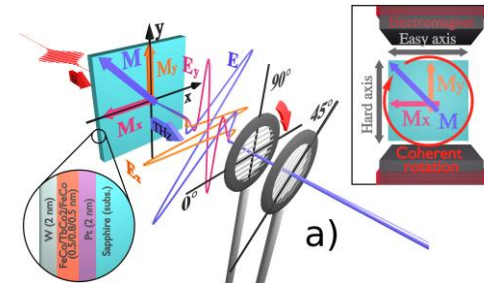
Jan Chochol, et al. AIP Advances, 6(11):115021, 2016.

### new THz laser sources



Mičica, et al. (2018) Optics Express, 26 (16), pp. 21242-21248.

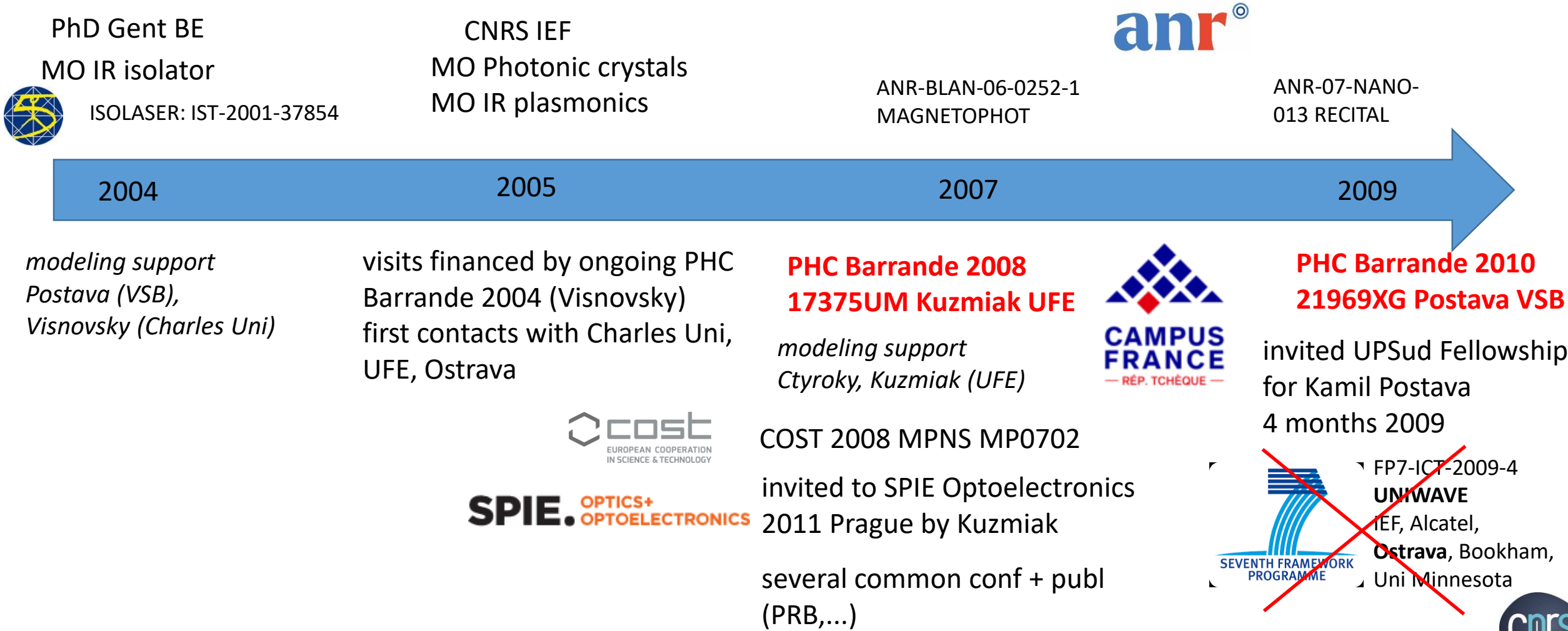
### THz spintronics



P. Koleják, et al. arXiv:2111.07118 (2021)



# my history with CZ



# my history with CZ



ANR-07-NANO-013 RECITAL



~~FP7-ICT-2011-3.5  
MAGNOLIA  
IEF, Alcatel,  
CEA, Ostrava, Oclaro,  
Uni Osnabruck~~

move to CNRS IEMN  
THz MO  
THz sources



ANR-14-CE26-0006 TENOR



~~FETOPEN-2015-686821  
TOPDEVICE  
Nijmegen, IEMN, TUO,  
Gemac Versailles, Wurzburg,~~

2009



2010



2013



2015

**PHC Barrande 2010**  
**21969XG Postava VSB**  
*modeling support +  
MO material  
characterization expertise*

invited UPSud Fellowships  
for Kamil Postava  
4 months 2009

1 PRL ; many conf

Barrande Fellowship 2010  
**Lukas Halagacka** IEF + VSB  
defence 12/2014  
NOW Researcher IT4 TUO  
*novel one-way IR MO plasmonics*

3 OPEX ; many top conf  
(CLEO, SPIE, ...)



~~PHC Barrande 2012  
26565ZF Veis  
Charles University~~



Master jury VSB  
**Tomas Horak**

2 OPEX ; many top conf  
(IRMMW, SPIE, ...)



Full ULille PhD  
2014  
*THz MO hexaferrites*  
defence 12/2017

**PHC Barrande 2014**  
**31377YB Hrabovsky**  
Nanotechnology Center  
Ostrava  
*modeling support +  
THz characterization  
expertise (FTIR, TDS)*  
- cotutored Chochol VSB  
- several top publications  
(Sci rep. AIP Advances.)



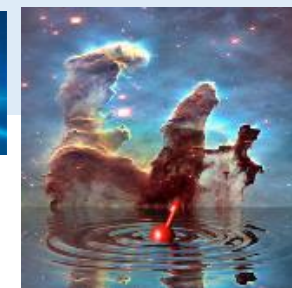
# my history with CZ



European Union  
European Regional  
Development Fund

**ERDF**  
IT4Innovations– **path to exascale**  
**2017-2022**

invited external expert 10%  
tutored Masters (Pierre Kolejak...)  
ultrafast THz measurements  
assistance bench construction (420k€)



FET-Open 2020 No. 863155  
s-NEBULA  
IEMN, LPENS, THALES, IT4i Ostrava, Mainz  
Uni, Freie Uni Berlin, Fraunhofer, Upssala Uni  
3.4M€ (350k€ Ostrava)

2015



2017



nanoOstrava 2017 meeting  
organizer THz symposium

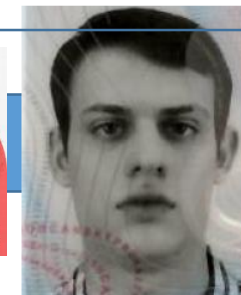
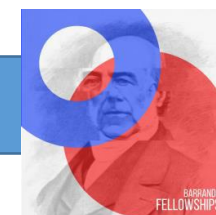
2019



**PHC Barrande 2019**  
**42793TA Legut**  
IT4Innovations

*modeling*  
*supercomputer on*  
*novel THz materials +*  
*THz characterization*  
*expertise (FTIR, TDS)*

2020



Barrande Fellowship 2020  
**Pierre Kolejak**

IEMN + IT4 Ostrava  
*novel THz spintronics*  
*fully involved FET Open*  
- complementary expertise  
ultrafast THz (IT4) + THz  
photonics (IEMN)  
- already 2 top papers  
(ACS Photonics, APL)

Barrande Fellowship 2015  
**Martin Micica** IEMN + IT4 Ostrava  
defence 1/2020  
now postdoc LPENS Paris  
*novel THz solid state &*  
*gas laser sources*  
- complementary expertise  
THz spectro (IT4) + THz  
photonics (IEMN)  
- 2 OPEX ; many top conf  
(IRMMW, SPIE, ISMS)



# 15 years CZ collaboration – « balance sheet »

collaborated with 3 research groups :

- Dept. Physics of Charles University
- Institute of Electronics and Photonics (UFE)
- **Technical University Ostrava** (later Nanotechnology Center and IT4i)

published with all of them :

- 15 journal papers (PRB, PRL, Sci Rep, APL, Opt Exp, ...)
- 30 refereed international conference proceedings
- 3 invited conference talks

and cosupervised 3 Master Students and 5 PhD students (of which **3 Barrande Fellowships**)

**Most of this would not have been possible without the exchange visits in 4 PHC Barrande programs**

But that is only the start

... exchange of ideas can only foster with extra financial support from national and EU instruments

... **continuous & huge effort**

... with many setbacks: at least 3 large EU projects were rejected and several FR & CZ national projects – *even Barrande* ;-)

... but perseverance always pays off: **Path to Exascale & FET Open H2020 s-NEBULA** (but almost 10 years to obtain)

**CZ groups have been involved (without funding) in 3 of my FR ANR**  
**I have been involved (without funding) in 2 CSF projects**

Crucial foundation

# 15 years CZ collaboration – are there secrets for succes ??

the easy answer is NO ... it is mainly persevering and being passionate about the science  
of course that is too much of a cliché and also not entirely true

5 key elements  
(personal opinion)

- “PERSEVERANCE”
- **COMPLEMENTARITY:**
  - PhD: Charles University (theory of MO)
  - IEF: Charles Uni & UFE missing modeling and theory expertise for the experimental setups
  - IEF & IEMN: Ostrava crucial very advanced spectroscopy measurements in several ANR projects (unfinanced!)
- **Trust the Czech style!** “some stubbornness” but always rigourous!
- Be ready to work **UNFINANCED:** both ways (builds reputation in the long term)
- **EVOLVE** and **ADAPT**
  - my own THz activities in IEMN (THz hexaferrites and InSb) followed the evolution of the equipment portfolio in Ostrava and vice versa (spin research)

even if there are dry periods → always other fallouts

- conference invitations
- jury participations (! important; PhD & Master)
- project review invitations (discover landscape and new opportunities)
- seminar organizations (invite CZ collaborators → create visibility)
- guest researcher opportunities (invited prof etc)

not concrete research funding  
but long term payoff