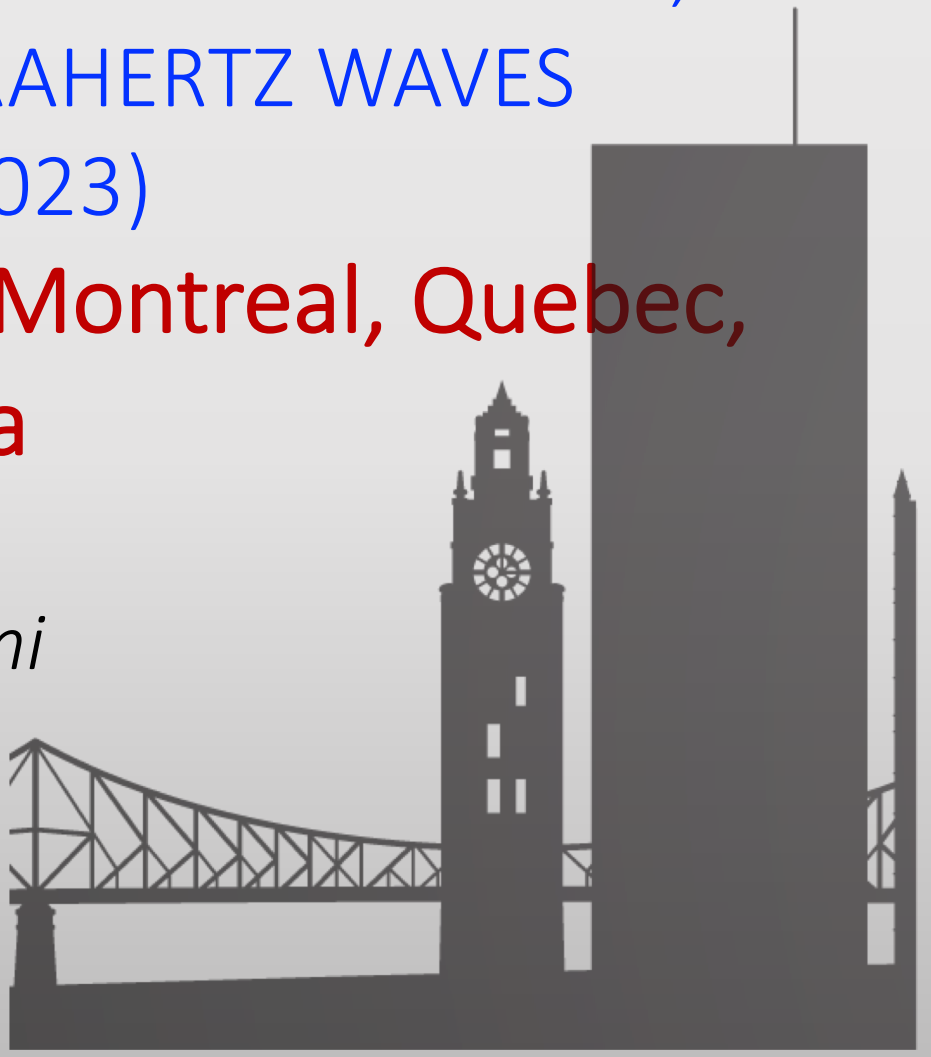
Report on 48th CONFERENCE ON INFRARED, MILLIMETER, AND TERAHERTZ WAVES (IRMMW2023)

17 -22 September 2023 Montreal, Quebec, Canada

M. Zerbini



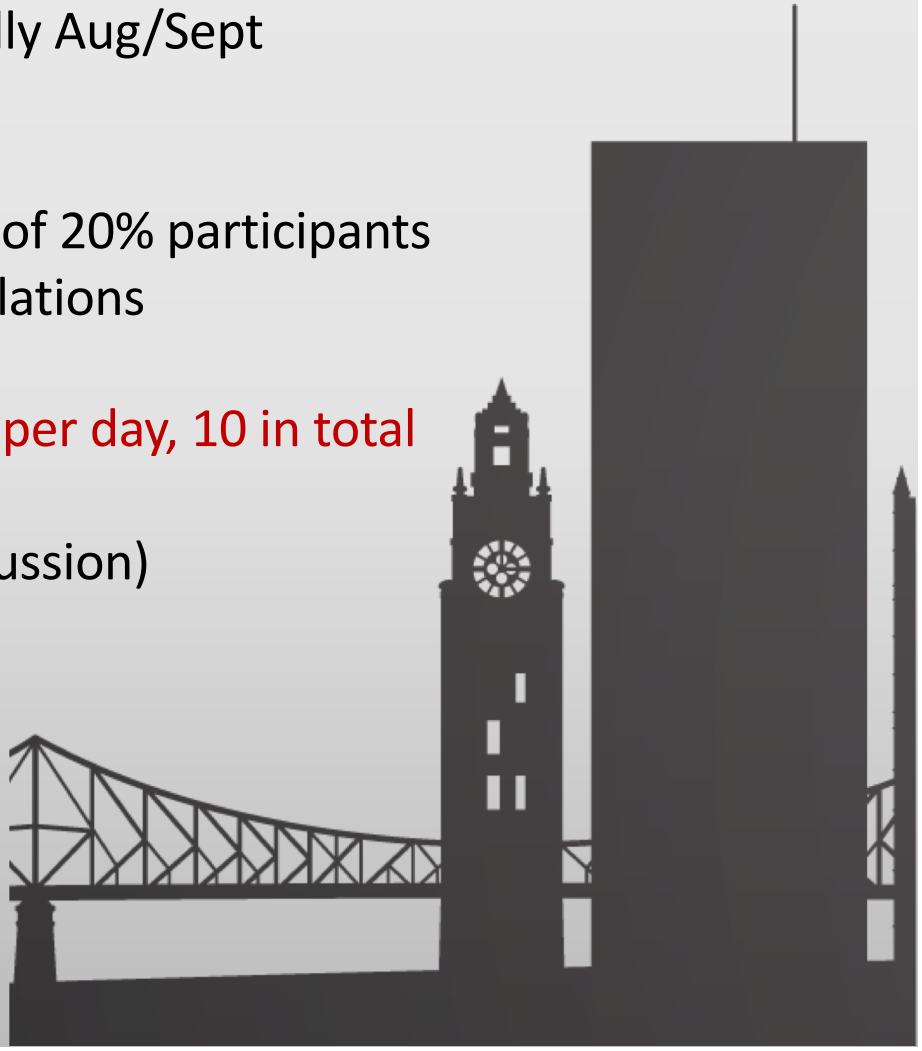
WIP 6 Novembre 2023, Frascati

Structure and Size

- Annual conference (used to be every 2 years), usually Aug/Sept
- Last time in Rome was 2010 (record of attendance)
- Large size: between 600 and 1000 participants
- This year reduced size (< 600). Sudden cancellation of 20% participants (all Chinese) due to change in Visa regulations

PLENARY TALKS 45 min. (40 min. 5 min. discussion): 2 per day, 10 in total
KEYNOTE TALKS 30 min. (25 min. + 5 min. discussion)
STANDARD ORAL TALKS 15 min. (12 min. + 3 min. discussion)

+ Poster sessions
+ Tech Exhibitors room



Past, Present & Future.....

IRMMW-THz 2025 (50th): Aug. 17-22, Helsinki, Finland
IRMMW-THz 2024 (49th): Sept. 1 - 6, Perth, Australia

IRMMW-THz 2023 (48th): *Sept. 17-22, Montreal, Canada*

IRMMW-THz 2022 (47th): Aug. 28 - Sept. 2, Delft, The Netherlands (hybrid)
(Frascati Plenary presentation on FIR, uW and THz Plasma Diagnostics: la prima in 30 anni)

IRMMW-THz 2021 (46th): Aug. 29 - Sept. 3, Chengdu, China (virtual)
IRMMW-THz 2020 (45th): Nov. 8 - 13, Buffalo, NY, USA (virtual)

IRMMW-THz 2019 (44th): Sept. 1 - 6, Paris, France
IRMMW-THz 2018 (43th): Sept. 9 - 14, Nagoya, Japan

IRMMW-THz 2017 (42th): Aug. 27 - Sept. 1, Cancun, Mexico
(Grande partecipazione di Frascati ”Gli Eroi di Cancun”)

Selected Plenary presentations (Invited)

Boyd (the Book chap), non linear optics.
Useful slide with comparison of radiation-matter interaction in different walength range (FIR, light etc.). Phonons
Adopt great color scheme for equations slides.

Jamison: THz driven particle accelerators. Complete but not too useful for us. See if of some use for FEL.

Plenary Mathias Hoffman THz Pump/X-ray LCLS
LINAC
Bragg X-ray (1895)
lambda=1.24 Angstrom (f=2.42 e18 Hz)

Plenary Martin Dressel winner of Button Prize (deadline next nomination April 15 2024)
The talked missed a general overview of the point of doing his measurements
Superconductors key issue

Plenary, Hannah Joyce: Nanowires In Terahertz Photonics: Harder, Better, Stronger, Faster
Interesting intro: thanking orgazation to let her talk about <title of the talk>
Nanowires as semiconductors

Hall effect measurements, source-drain.

Electron Cyclotron Emission diagnostics for next generation Nuclear Fusion experiments (DEMO)

Marco Zerbini, M. Alonzo, G. Rocchi

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Electro-Optical determination of the Spectral Characteristics of components for THz-based Plasma Diagnostic

A. Taschin, L. Senni, G. Galatola-Teka, M. Alonzo, A. Doria, E. Giovenale, and M. Zerbini⚄

ENEA, Fusion and Nuclear Safety Department, C. R. Frascati, Via E. Fermi 45, 00044 Frascati (Roma), Italy

INTRODUCTION

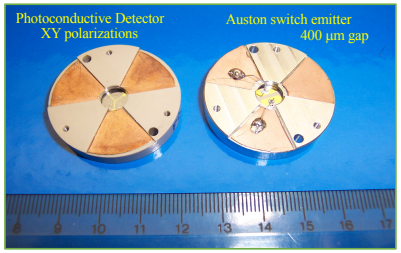
THz-TDS measurements of plasma parameters [Jamison 2003] good option for nuclear fusion experiments.

Far Infrared and microwave diagnostics (0.1-4000 THz) are the most important measurement tool for plasma density and temperature in Nuclear Fusion [Zerbini 2022].

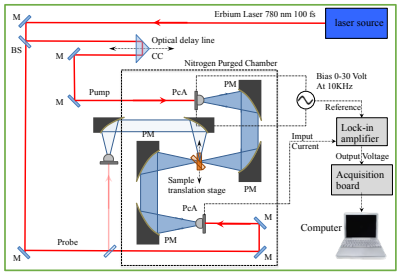
THz-TDS multi-functional device, easy machine access.

Electro-Optical (EO) and Photoconductive (PH) THz-TDS spectrometry measurements of materials and components for FIR and THz Plasma Diagnostics.

EXPERIMENTAL SETUP AND RESULTS

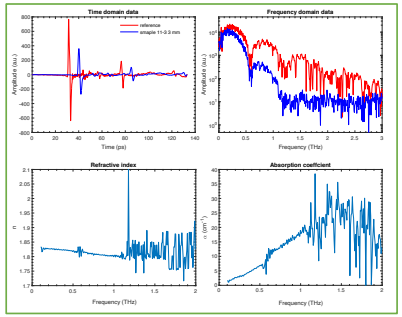


Below: THz Electro Optical spectrometer: Coherent MIRA 800 nm pump and gate laser. PcA=photoconductive antenna on LTG-GaAs substrate (source/detection). PM=Parabolic Mirrors.

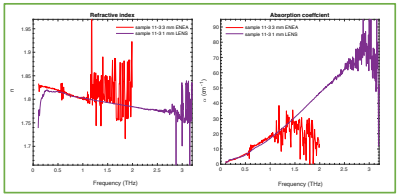


Measurement of properties of materials and components used to collect and manage THz radiation:

- Quartz and TPX (*Poly-4 methyl pentene-1*):
- FIR and mm-waves filters, radiation polarizers.
- Other materials: special polymer for aerospace industry



Above: properties of the 3mm thickness polymer sample, measured with EO setup.



Above: comparison of the measured optical properties of the polymer sample as obtained with EO and PH.

The EO setup, although not suitable in itself for the diagnostic system where more compactness is required, thanks to its reliability and flexibility will be extremely useful for laboratory tests and to characterize different optical configurations of the diagnostic itself.

SELECTED REFERENCES (SEE PAPER FOR MORE)

S. P. Jamison *et al.*, "Plasma characterization with terahertz time-domain measurements," *J. Appl. Phys.*, vol. 93, no. 7, pp. 4334–4336, 2003, doi: 10.1063/1.1560564.

M. Zerbini, "Sailing on Far Infrared and Submillimeter Waves Plasma Diagnostics, towards THz-TDS and beyond," in *2022 47th International Conference on Infrared, Millimeter and Terahertz Waves (IRMMW-THz)*, Aug. 2022, pp. 1–4, doi: 10.1109/IRMMW-THz50927.2022.9895916.

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Selecting hazelnuts by coupling a self-organizing map (SOM) and an experimental system operating in transmission configuration

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An experimental setup operating in transmission configuration in the frequency range between 18 and 40 GHz is described. This study shows how the system is able to distinguish healthy and rotten hazelnuts. In addition, a Self-Organizing Map (SOM) trained with the Kohonen algorithm was used to classify fifty random hazelnuts according to their quality.

Experimental setup and samples

Millimeter-wave measures on hazelnuts were made by using an experimental setup operating in transmission configuration, with a frequency range between 18 and 40 GHz. In this study millimeter-wave measurements were performed on five apparently healthy and five rotten hazelnuts belonging to the Tonda gentile romana species.

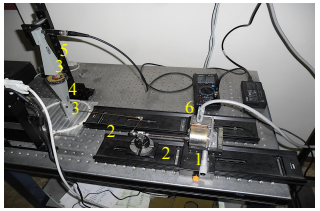
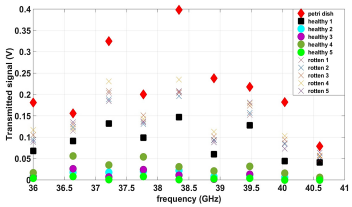


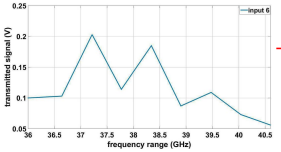
Image of the experimental setup. 1) YIG Source; 2) transmission line; 3) launching horn; 4) petri dish with an eccosorb layer and hazelnuts sample; 3) collecting horn; 5) Schottky diode; 6) multimeter.

Experimental Results at 36-40GHz

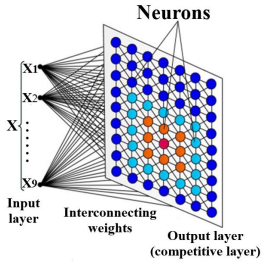


Five healthy hazelnuts and five rotten ones were examined by modulating the frequency between 36 and 40 GHz. The second "supposedly healthy" hazelnut (highlighted in the diagram by the black squares) showed transmission values as the rotten hazelnuts.

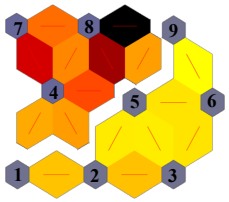
Experimental setup



Input

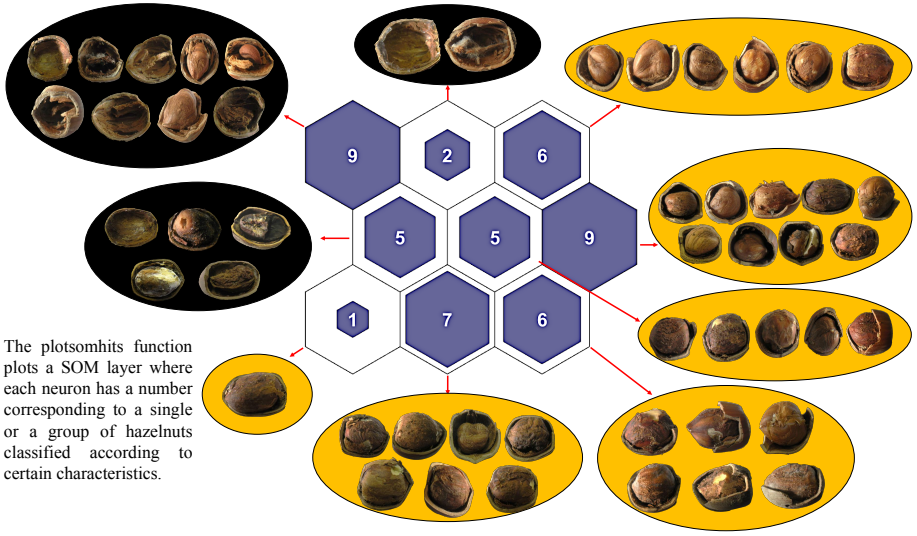


Neural network operating principle



The SOM Neighbour Weight Distances appears to recognize a well-defined cluster (neurons with smaller distances) highlighted by yellow colour and a non-homogeneous group of neurons highlighted by dark colours.

Self-Organizing Map (SOM)



The plotsomhits function plots a SOM layer where each neuron has a number corresponding to a single or a group of hazelnuts classified according to certain characteristics.

Conclusions

The experimental system operating in the frequency range between 18 and 40 GHz has proved to be a valid tool for the selection of hazelnuts. Self-organizing neural network was created to be tested in the selection of hazelnuts. From the first results it is evident how the network has created a homogeneous cluster relating to healthy hazelnuts highlighted by yellow colour and a non-homogeneous one relating to rotten ones highlighted by dark colours.

Other presentations

Peter Uhd Jepsen: Single-shot Waveform Detection Of Air-plasma Based THz Sources
Single shot as in previous talk.
Trick: detector capable to take a photo with best SNR
Single shot more in the sense of taking it in one go, without scan, than exhaustive inf in one shot

JLH: Multi-pixel Addressable Photoconductive Arrays For THz Beam Shaping And Polarization Control
JLH for Chopra: Active Multipixel Photoconductive Emitter Technology For THz Beam Shaping And Steering

Interesting tutorials, very similar (could have been just one)

Photolitography
Multipixel Emitter 4x4 pixels, 2x2 mm max, near-field, far-field beam concepts
Fiber use: beam collimator after fiber to flash pixels at once
OAP: 3 possible configurations to combat aberrations (find reference)

Additional information

Full collections of proceedings article available

Fight for plenary, or others will get them

Conference wide horizon: FIR & THz, but beyond that with applications

Companies contacted:

- VDI (Virginia Diodes)
- Toptika
- MENLO Systems