THM
TECHNISCHE HOCHSCHULE MITTELHESSEN

TECHNISCHE UNIVERSITÄT DARMSTADT

Room Temperature Broadband Terahertz Detectors for Particle Accelerator Beam Characterization and Diagnostic

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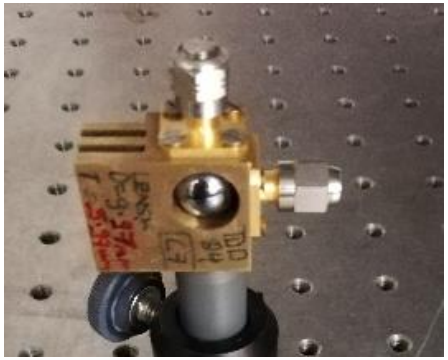
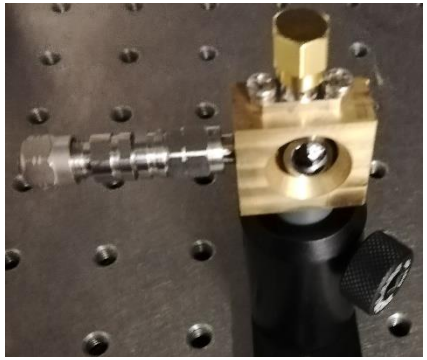
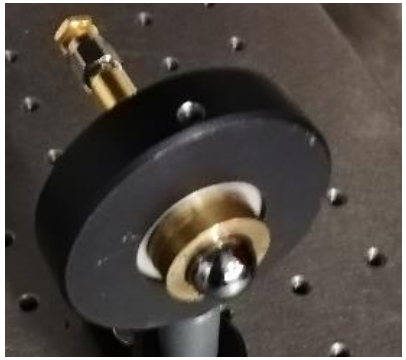
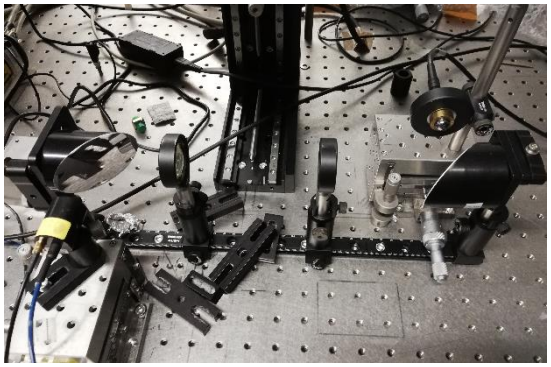


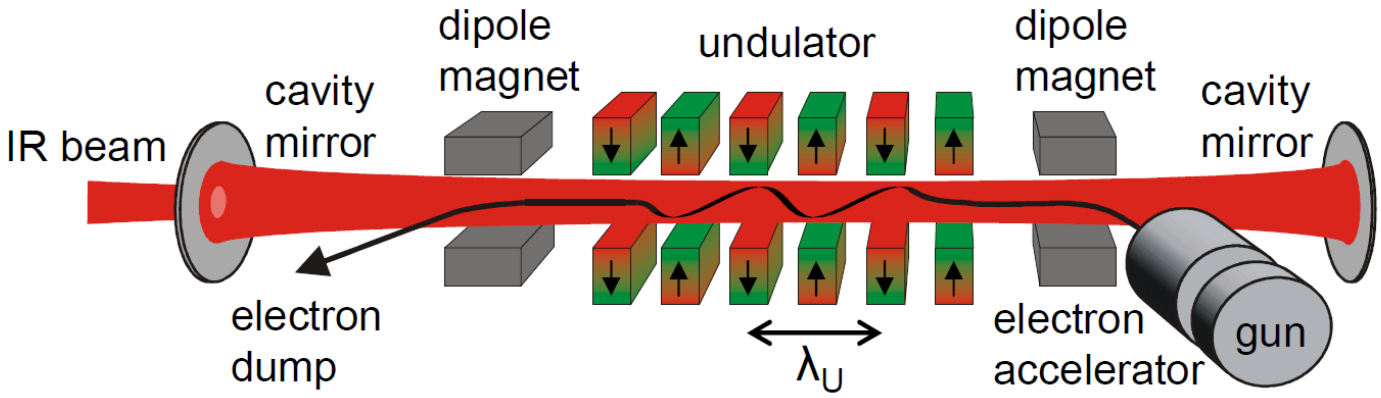




OUTLINE

- Motivation
- Zero-Bias Schottky Diode THz detector
- FET THz detector





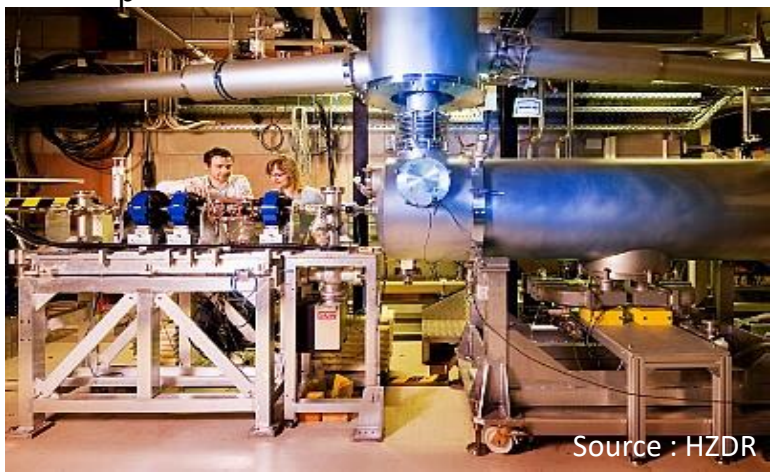
Source : HZDR

MOTIVATION

High speed electrical Terahertz (THz) detectors

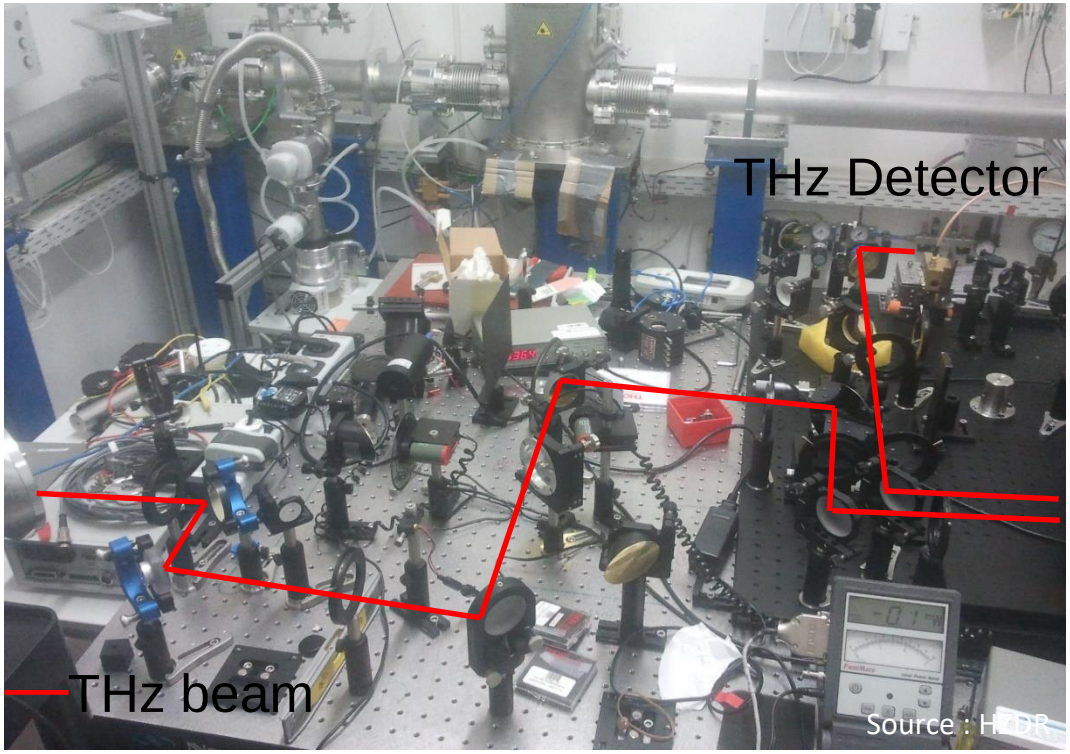
Exemplary parameters

- f =1.315 THz
- t_p= 14.8ps



Superconducting accelerator ELBE:

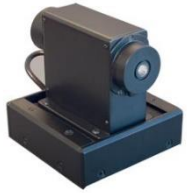
Electron Beam Accelerator with high Brilliance and low Emittance



MOTIVATION

High speed electrical Terahertz (THz) detectors

High power detectors → Thermal →



SLOW

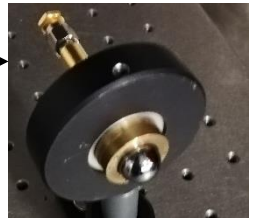
Source: Microtech Inst. Inc.

Fast high power detectors → Photon drag →

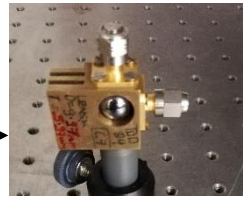
LESS SENSITIVE

Source: Hamamatsu photonics

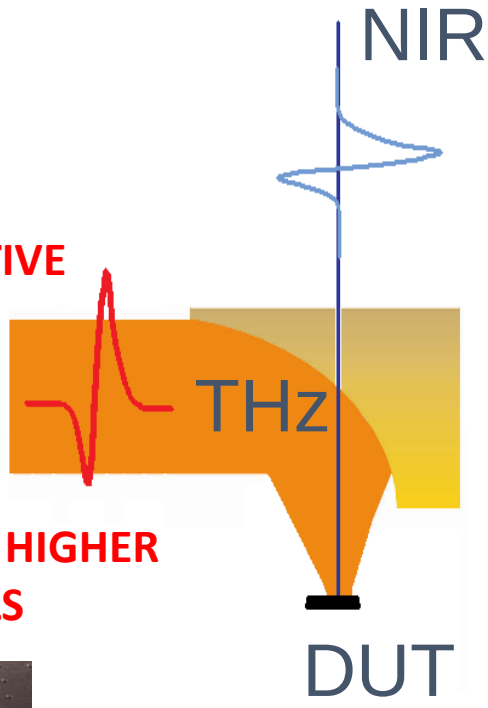
Sensitive detectors → Schottky diodes →



BREAK AT HIGHER THz LEVELS

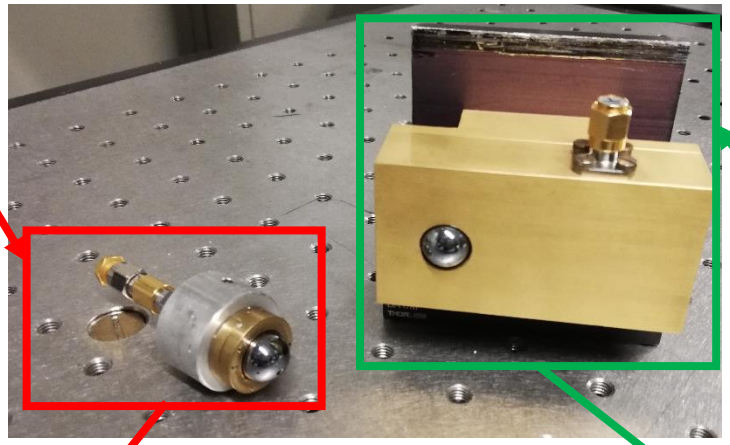


We need something HIGHLY SENSITIVE and STABLE in THz domain

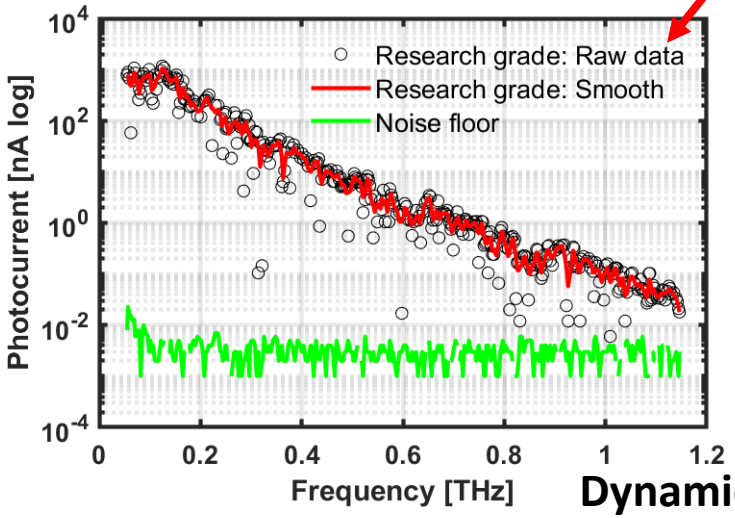


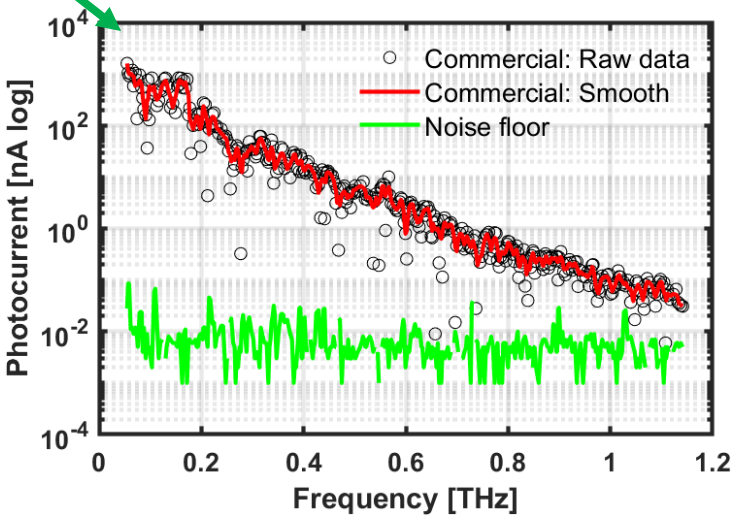
ZERO-BIAS SCHOTTKY DIODE THz DETECTOR

- RF Bandwidth: 0.05 - 2 THz
- Video Bandwidth: 40 GHz



- RF Bandwidth: 0.05 - 2 THz
- Video Bandwidth: 18 GHz





Dynamic range@ 1 THz:

- Research grade: 33 dB

- Commercial: 26 dB

R. Yadav et al.,"Broadband characterization of a compact zero-bias schottky diode detector with a continuous wave THz system" under processing in IBIC 2021

ZERO-BIAS SCHOTTKY DIODE THz DETECTOR

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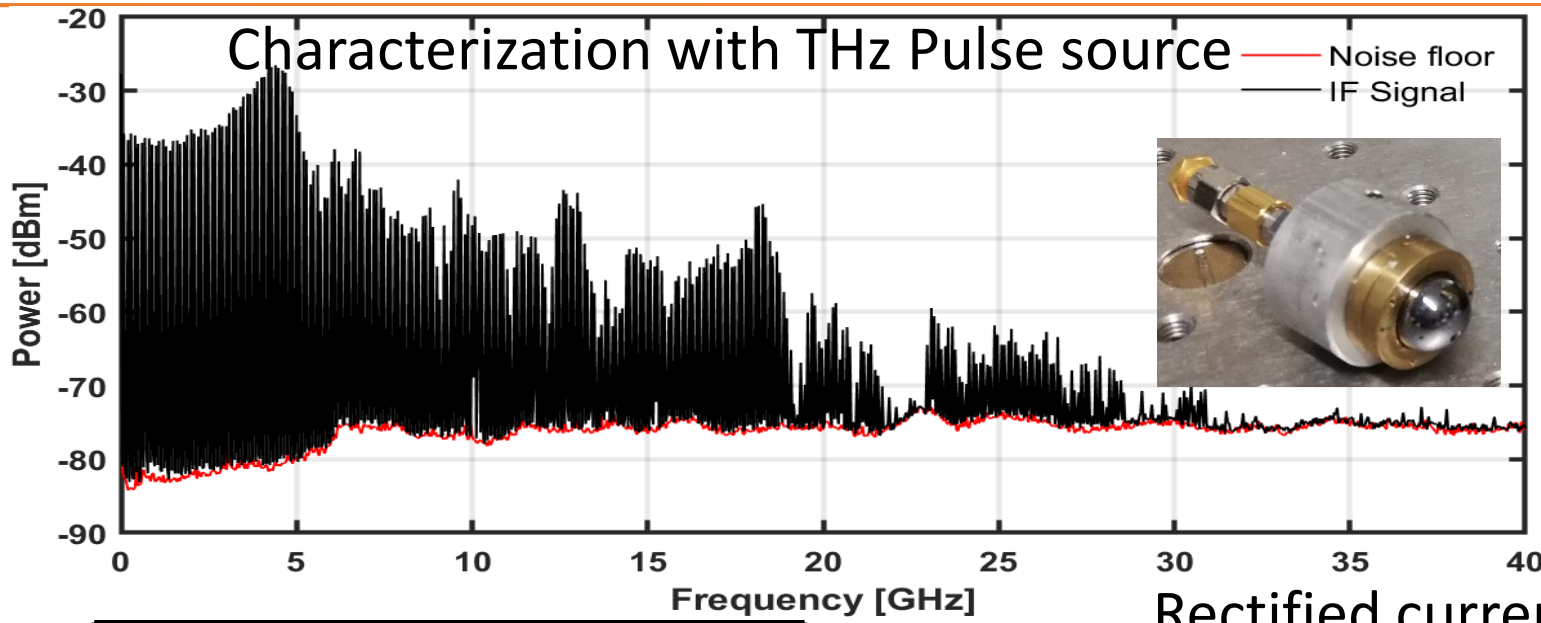
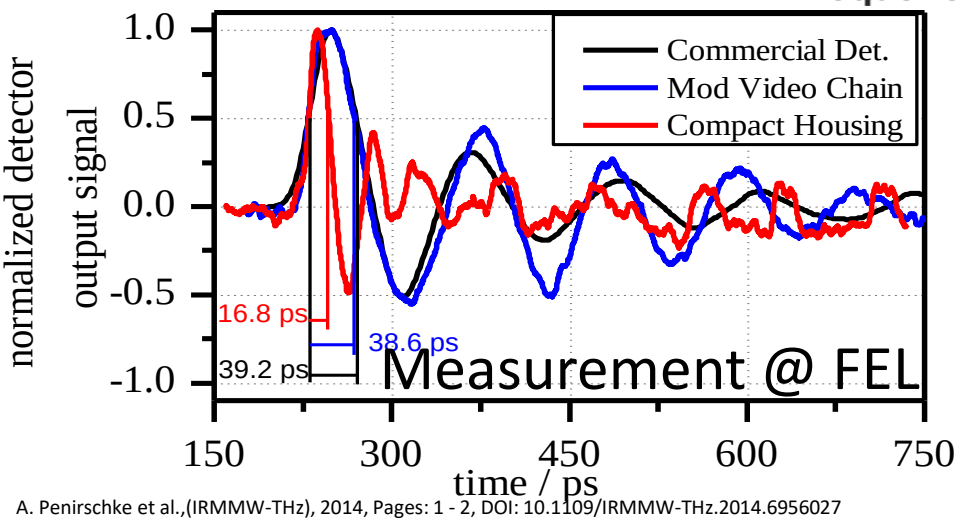
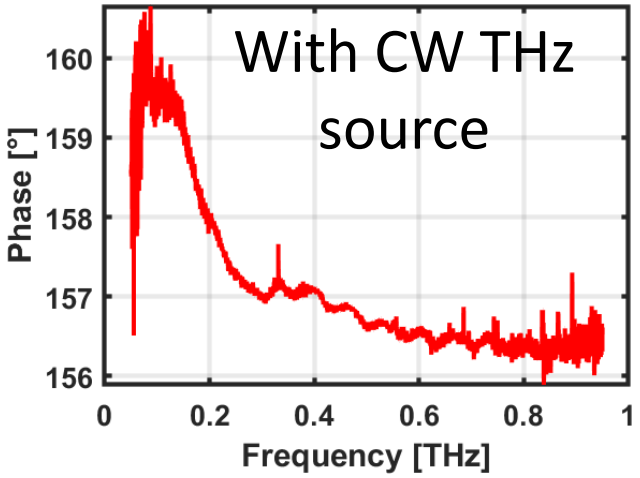




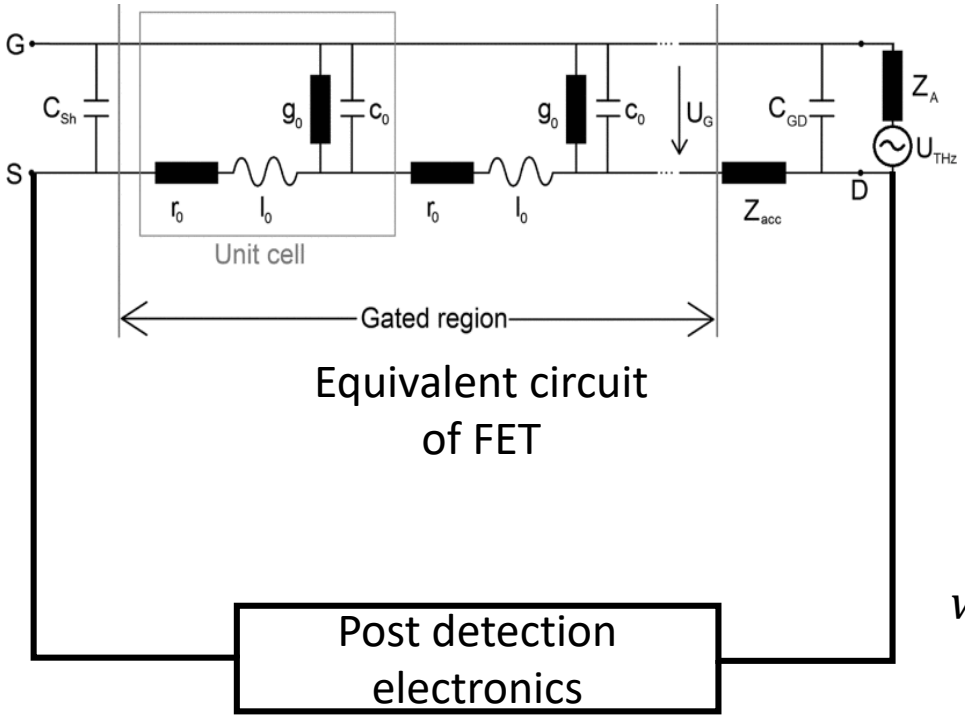
A. Penirschke et al.,(IRMMW-THz), 2014, Pages: 1 - 2, DOI: 10.1109/IRMMW-THz.2014.6956027

Rectified current's phase

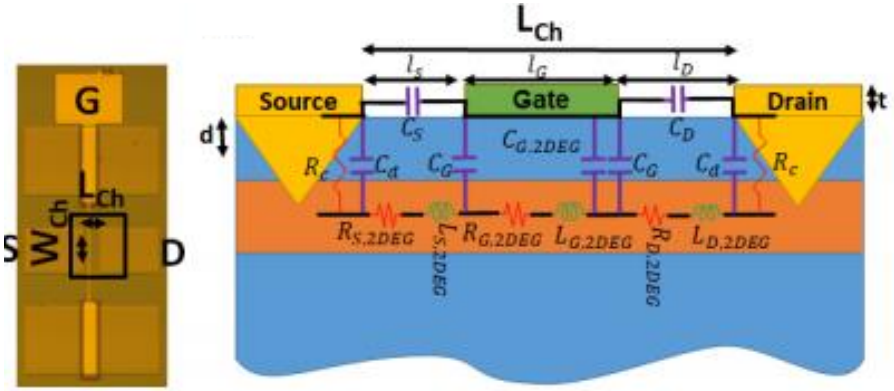


FET THz DETECTOR

Schematic diagram of FET



Equivalent circuit of FET



$$R_{i,2DEG} = r_0 \cdot l_i$$

$$L_{i,2DEG} = l_0 \cdot l_i$$

$$C_{i,2DEG} = c_0 \cdot l_G$$

$where, l_i$ is the length and i=D, S or G

r_0 is resistance per unit length

l_0 is inductance per unit length

c_0 is capacitance per unit length of 2DEG

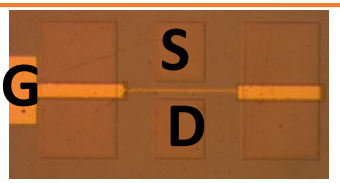
l_G is the length of the gate

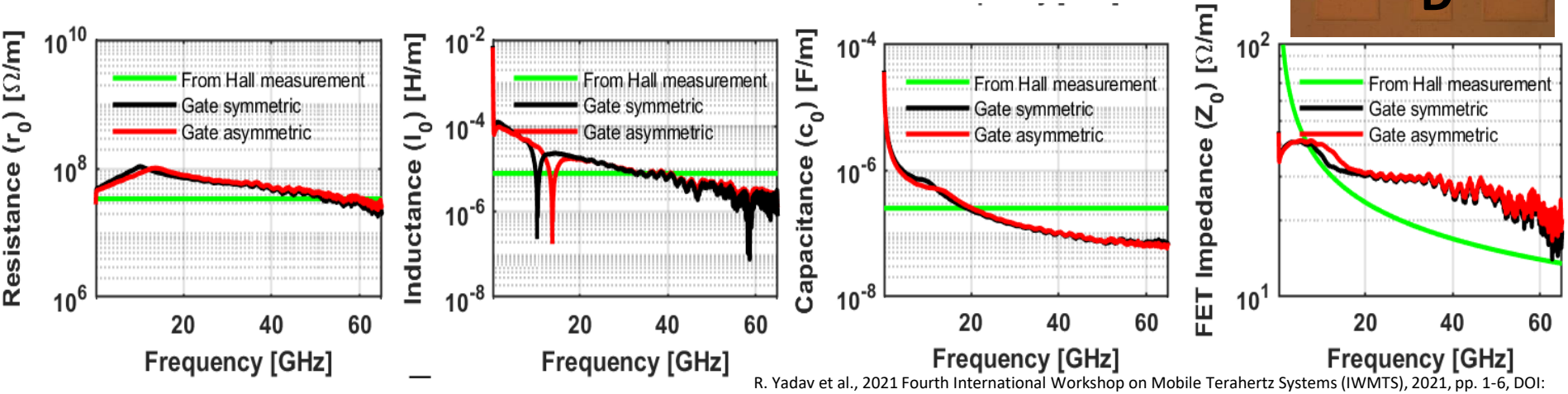
S. Regensburger et al., IEEE Transactions on THz Science & Technology
DOI: 10.1109/TTHZ.2018.2843535

R. Yadav et al., 2021 Fourth International Workshop on Mobile Terahertz Systems (IWMTS), 2021, pp. 1-6,
DOI: 10.1109/IWMTS51331.2021.9486796

FET THz DETECTOR

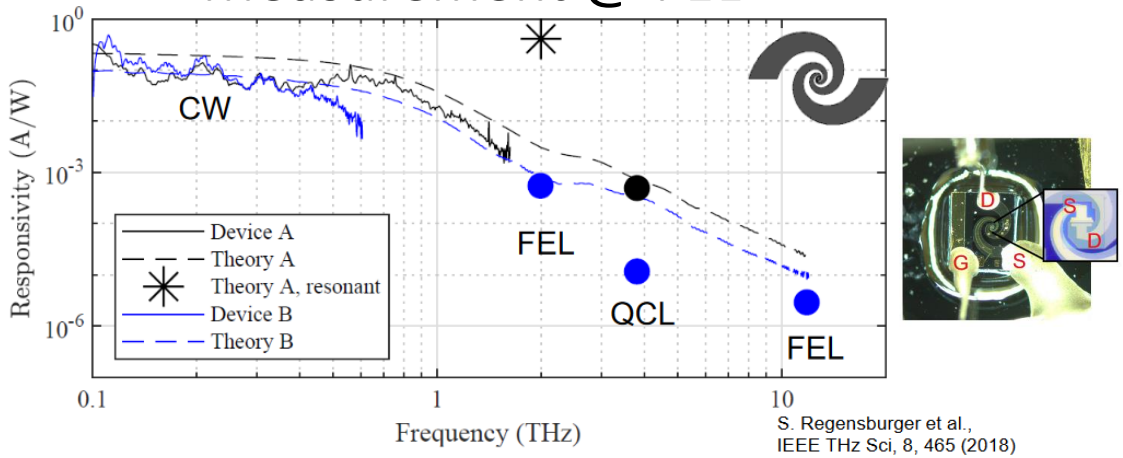
Lumped elements comparison for FET





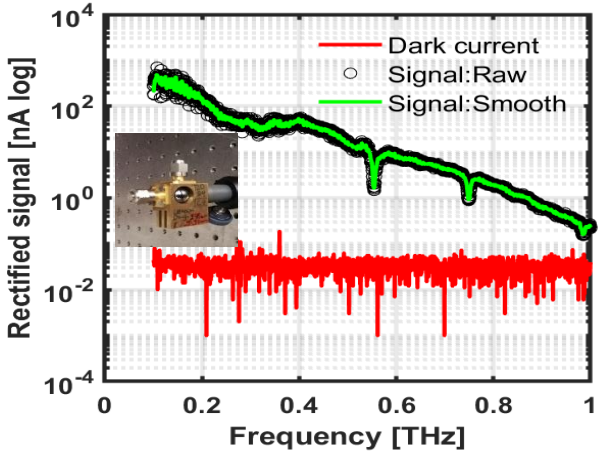
R. Yadav et al., 2021 Fourth International Workshop on Mobile Terahertz Systems (IWMTS), 2021, pp. 1-6, DOI: 10.1109/IWMTS51331.2021.9486796

Measurement @ FEL



S. Regensburger et al., IEEE THz Sci, 8, 465 (2018)

With CW Source



THANKS

The research team

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