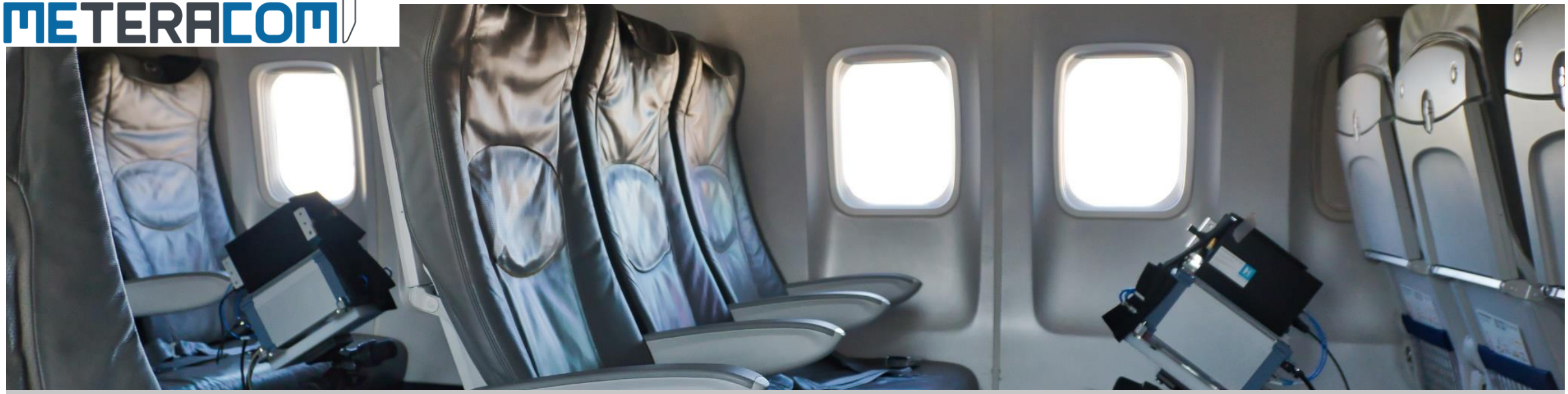
Funded by
DFG Deutsche Forschungsgemeinschaft
German Research Foundation

FOR 2863 Meteracom
Metrology for THz Communications

METERACOM

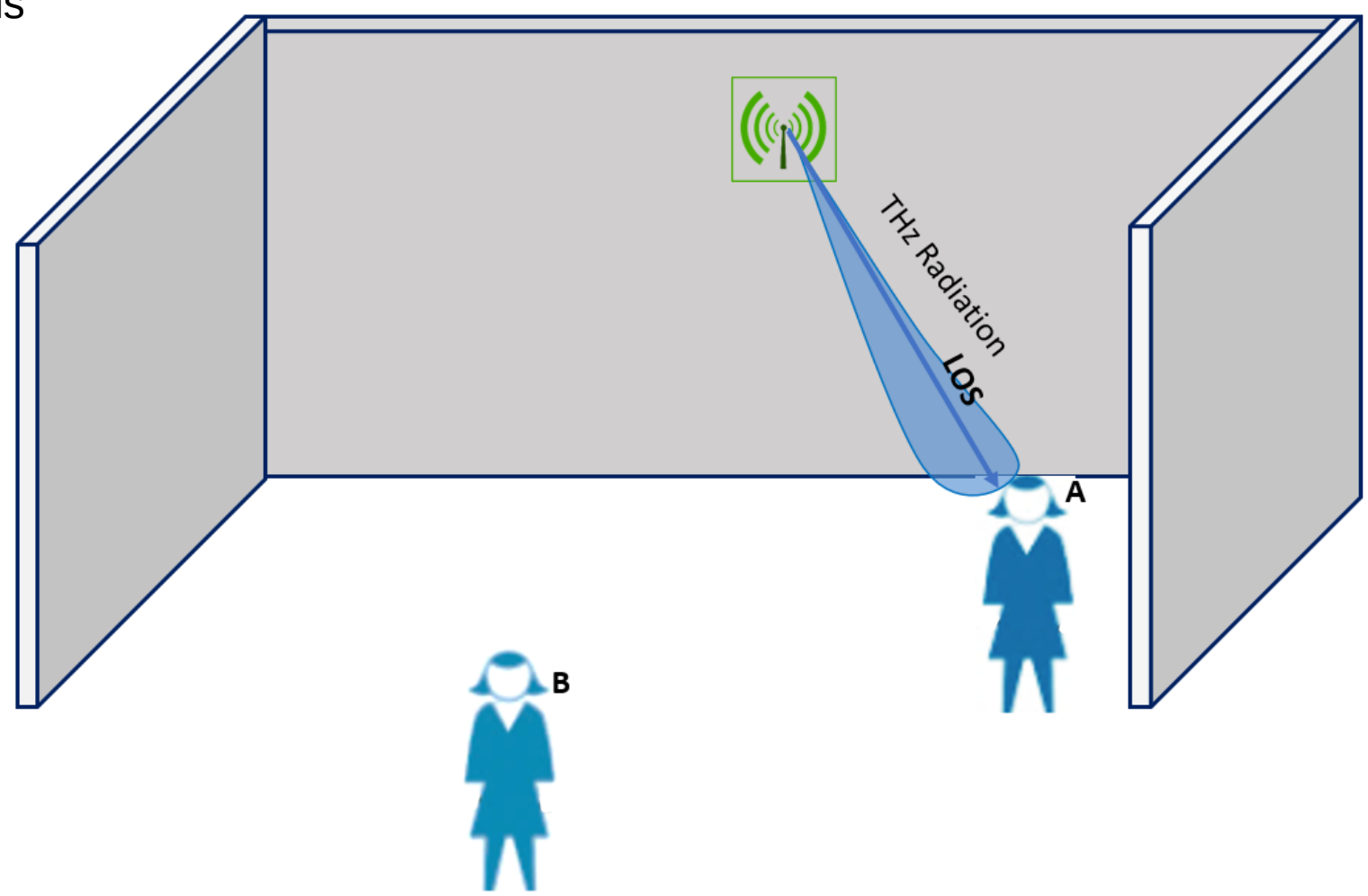


Characterization of building materials in the THz range

Fatima Taleb
G.G. Hernandez-Cardoso ,E. Castro-Camus, M. Koch
Faculty of Physics, Philipps-Universität Marburg, Renthof 5, 35032 Marburg, Germany
1st International Workshop on Metrology for THz Communications, Braunschweig, 28 June 2022

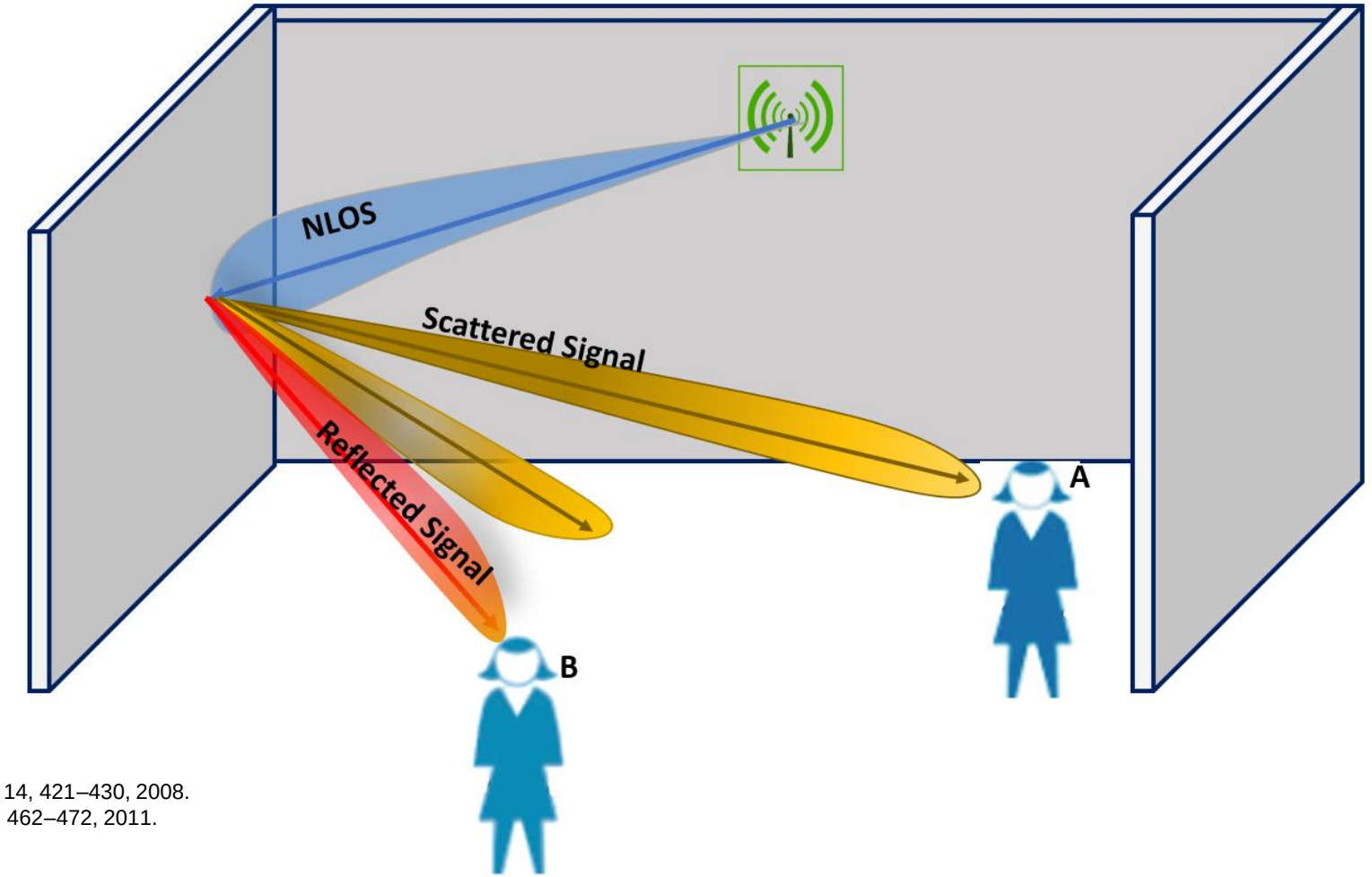
Motivation

Propagation Channel Models



Motivation

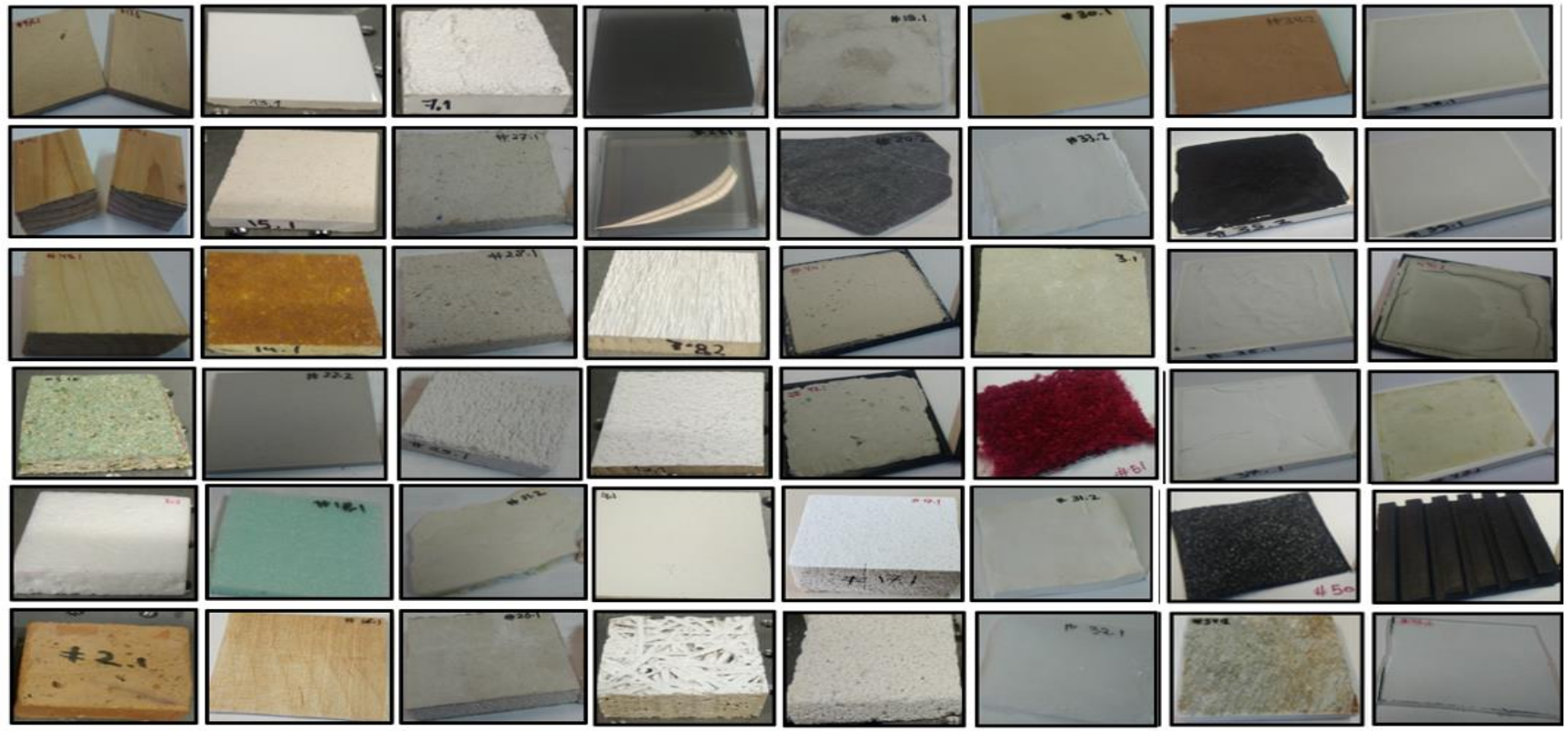
Propagation Channel Models



Piesiewicz, et al. IEEE Journal of Selected Topics in Quantum Electronics, 14, 421–430, 2008.
Jansen, et al, IEEE Transactions on Terahertz Science and Technology, 1, 462–472, 2011.
Ma et al. APL Photonics, 3, 051601,2018.

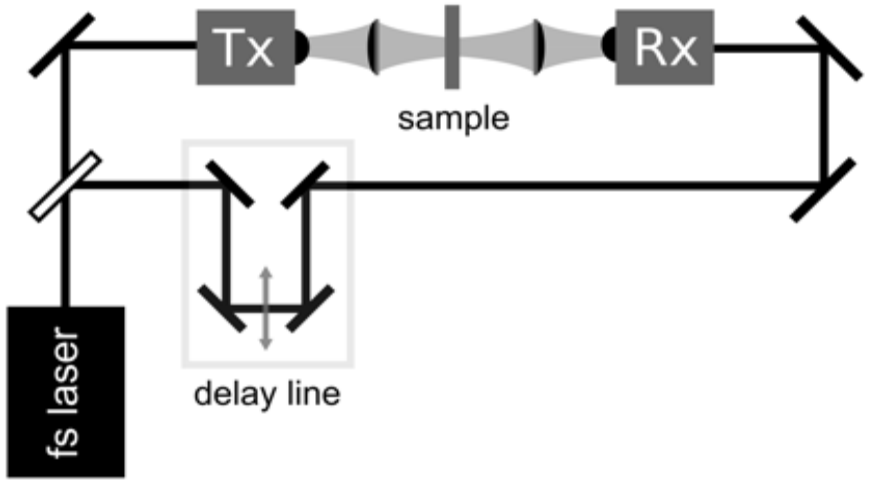
Building Materials (50 samples)

- Plastic
- Wood
- Glass
- Ceramic
- Cement
- Brick



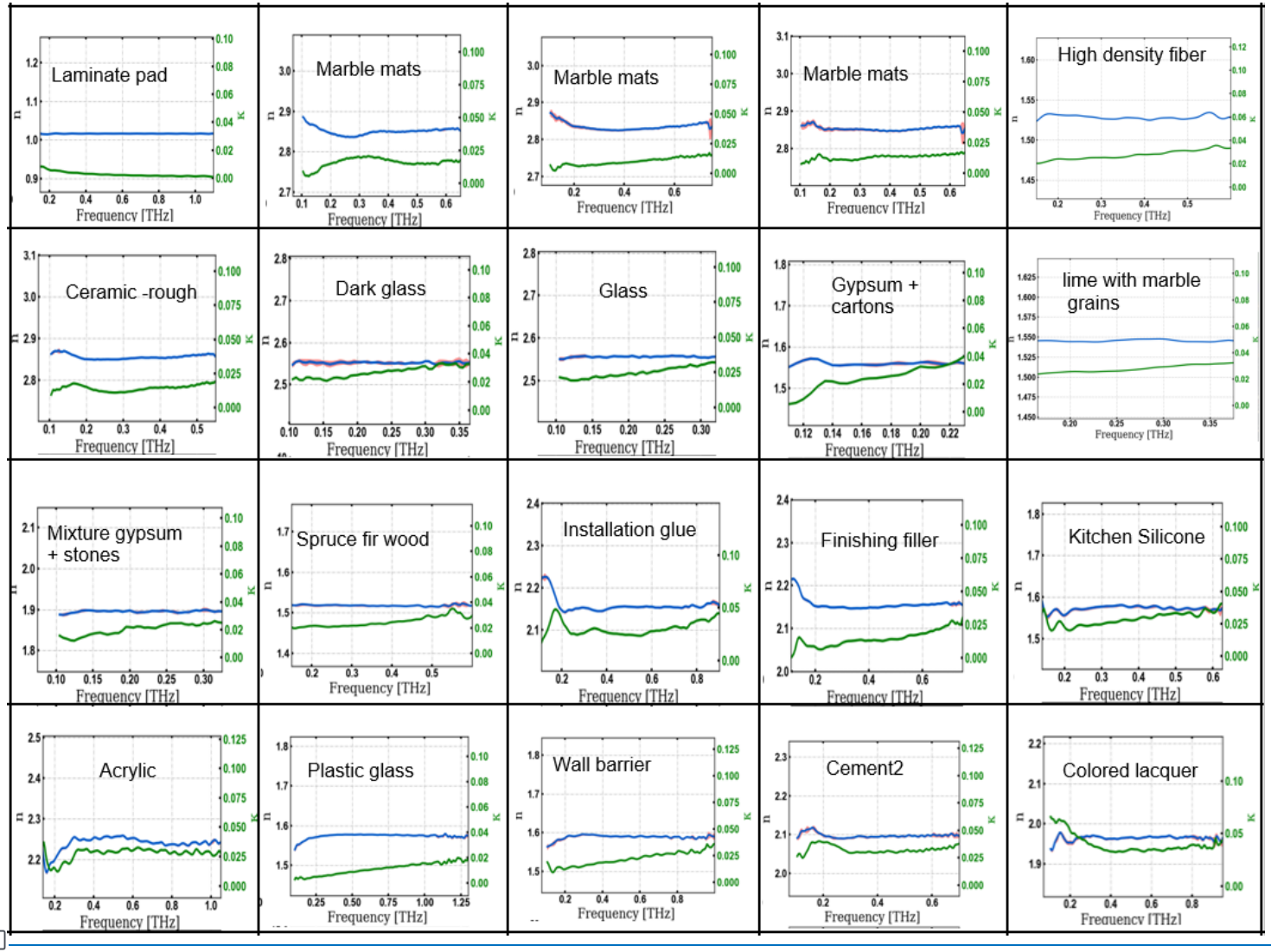
Material Characterization

Calculate the optical parameters (refractive index & absorption) in Transmission setup



THz time-domain spectroscopy (THz-TDS) technique

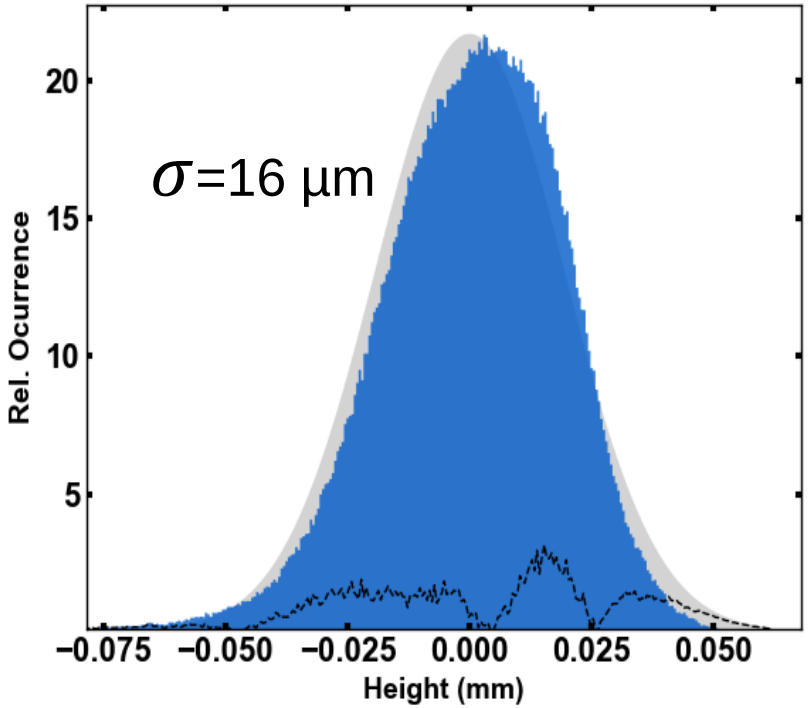
Refractive Index



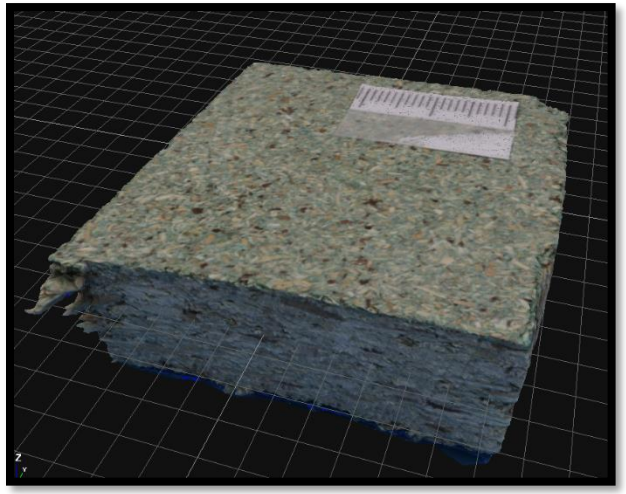
Surface roughness characterisation

Photogrammetry

Surface roughness characterisation



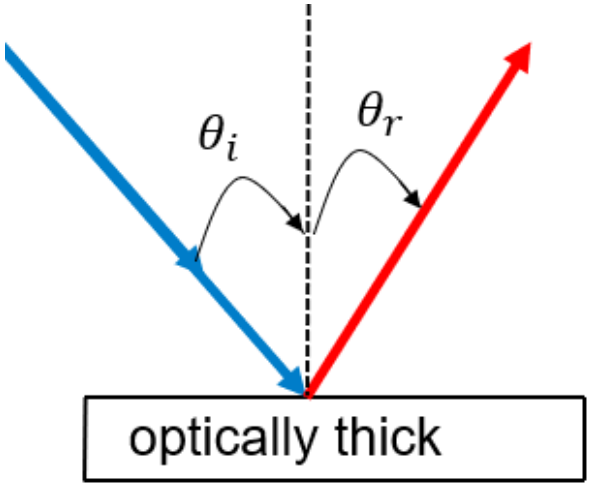
surface height distribution of the sample



Reconstructed Sample

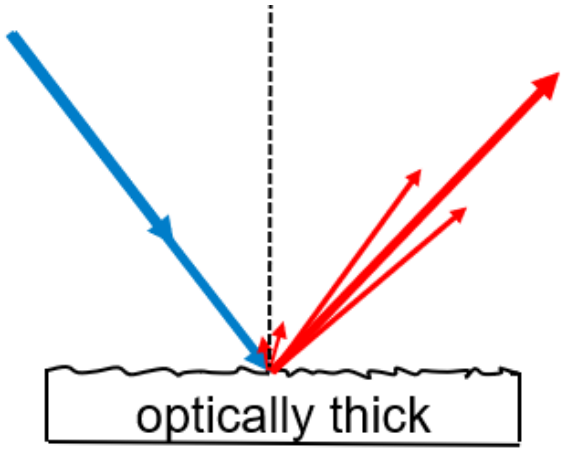
Surface Scattering Models

Smooth surface



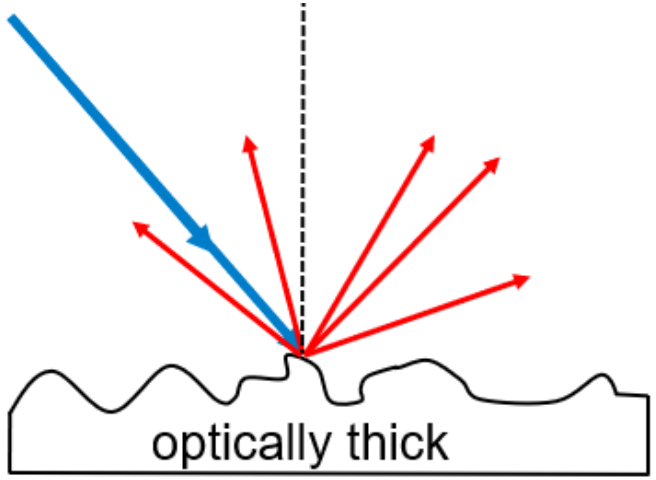
Classical Fresnel equations

Slightly rough surface



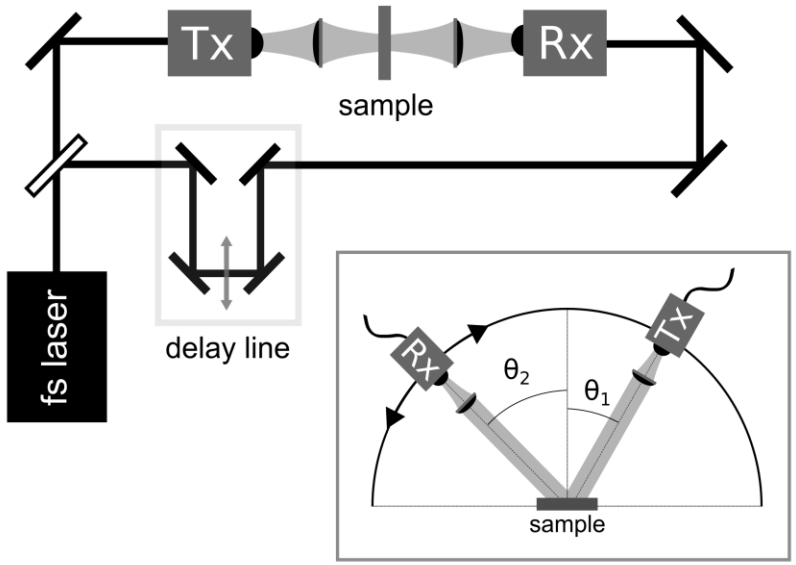
Modified Fresnel equations
Rayleigh roughness factor

Rough surface



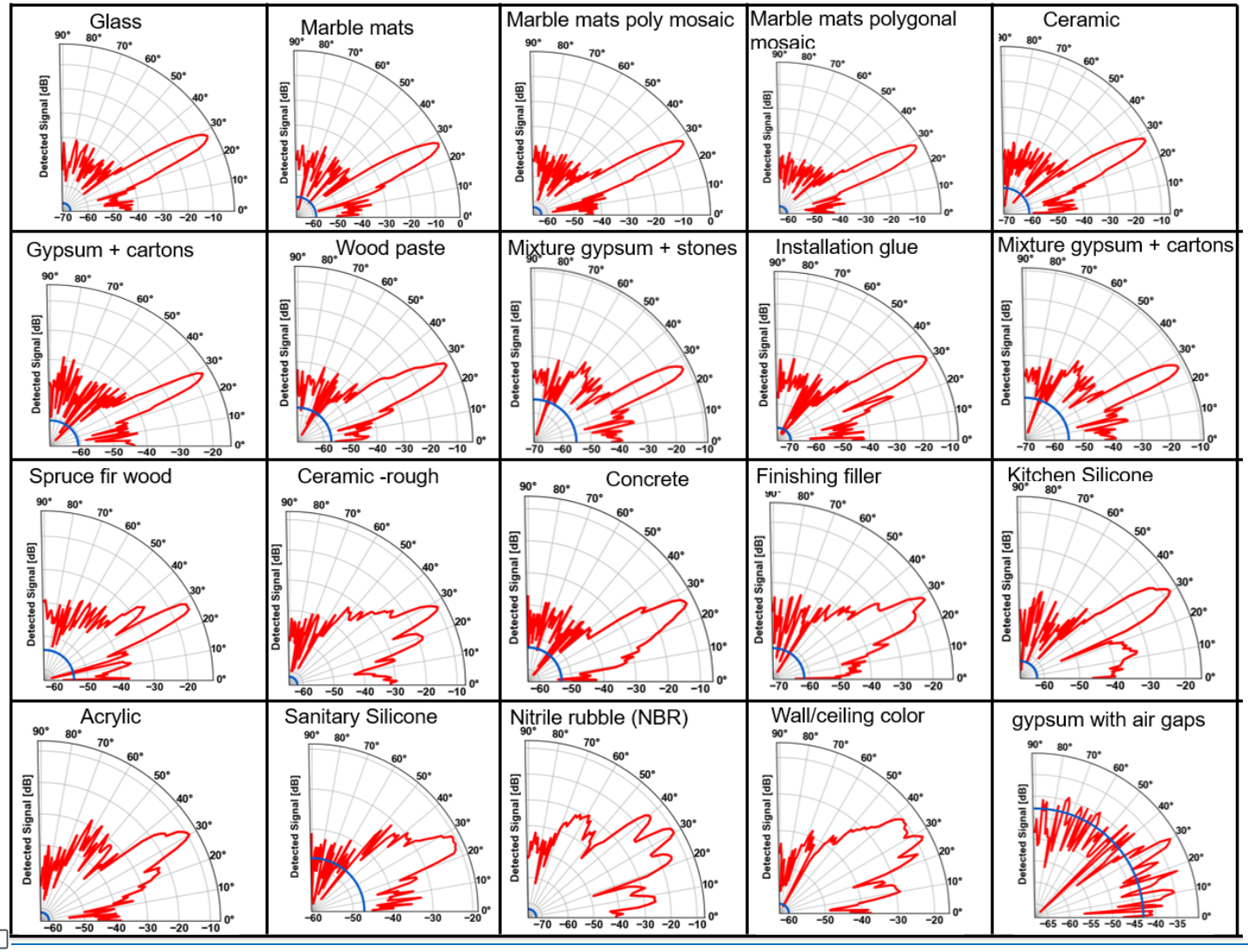
- Kirchhoff approximation
- Small perturbation method
- Radar cross-section
- Integral equation model

Reflection / Scattering Measurements



THz time-domain spectroscopy (THz-TDS) + Goniometer setup

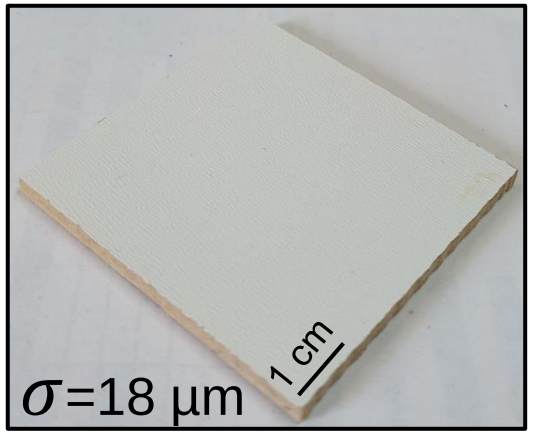
Measured Scattering Power at 300 GHz

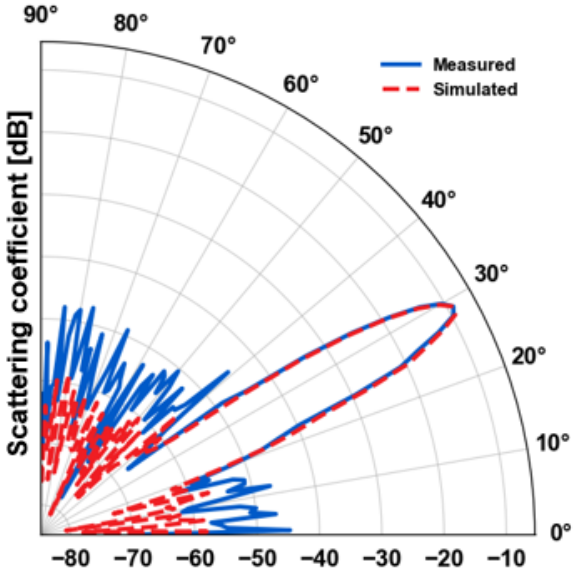


Results

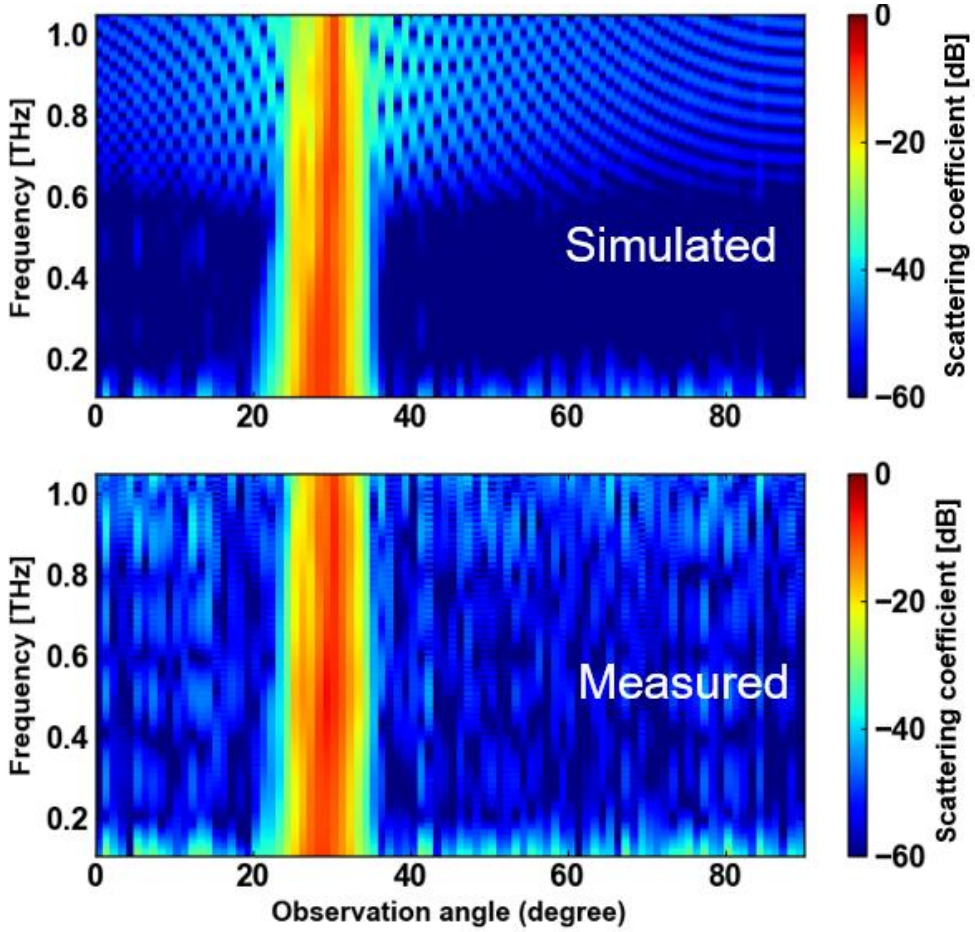
Simulated and measured scattering coefficient at 300 GHz.

High density fiber board



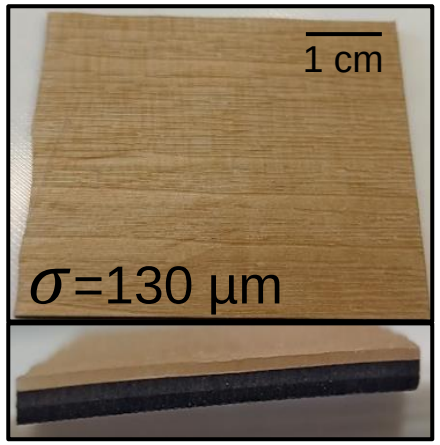


Simulated and measured scattering coefficient

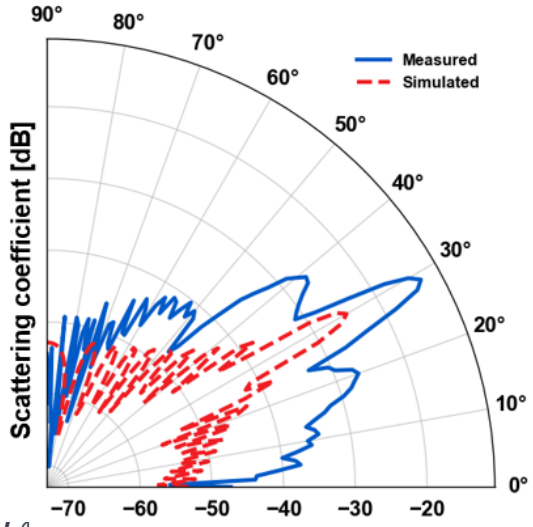


Results

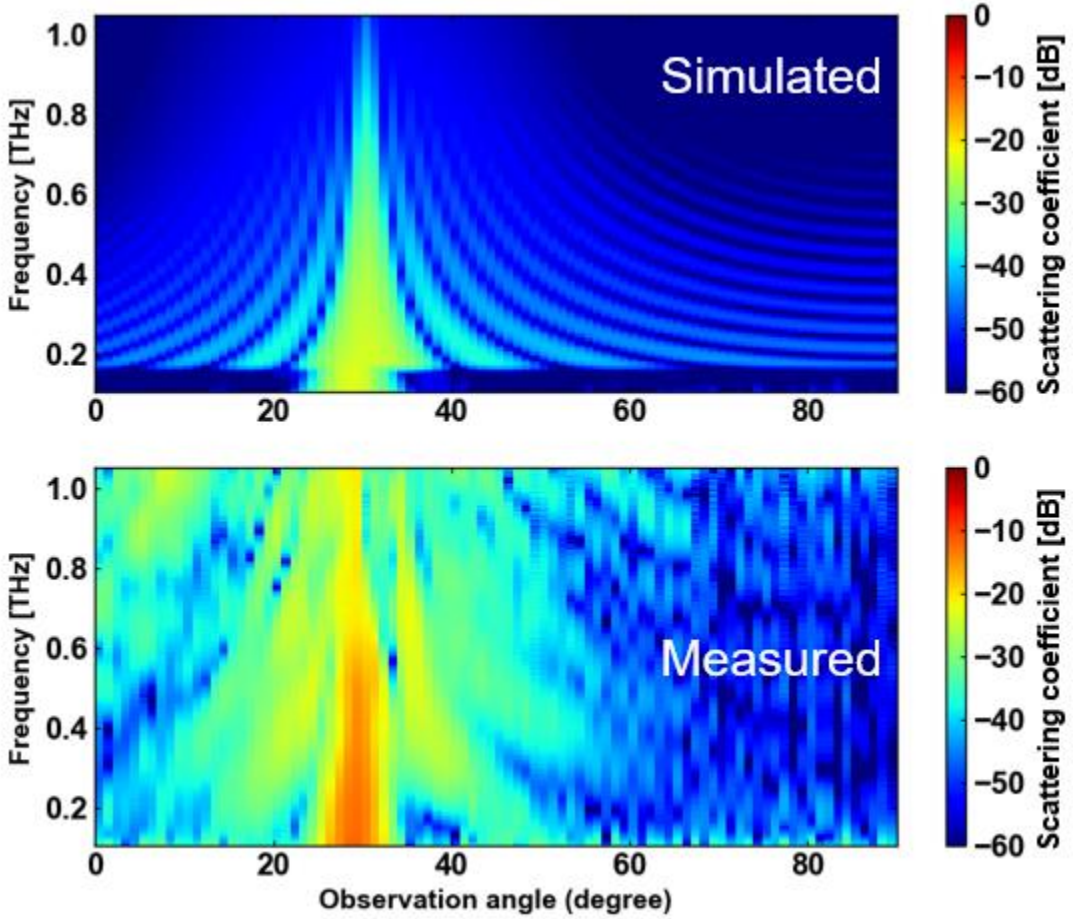
polyurethane (PU) coating



Simulated and measured scattering coefficient at 300 GHz

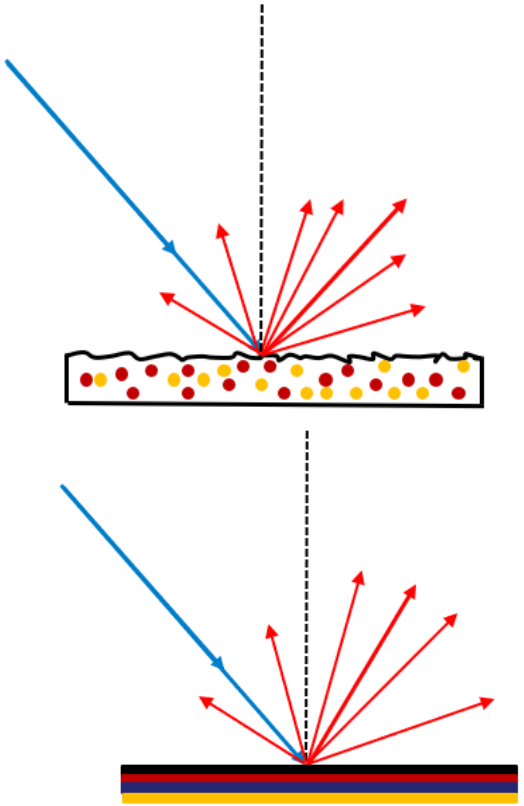


Simulated and measured scattering coefficient



CONCLUSION

- We characterize 50 samples building materials. These models are for required for a reliable channel simulation
- The angle-dependent scattering patterns of building materials with smooth or rough surfaces can easily be determined by Fresnel, Rayleigh or Kirchhoff models.
- More complex geometries, for example, a multilayered composition and/or a microscopic anisotropic structure can lead to a strong multiple reflection behavior.
- For these complex samples, the "traditional" scattering theories are not enough to describe the reflection properties and, further refinement of the models is required.



Thank you very much for your Attention

E-Mail: t.kuerner@tu-bs.de

Funded by
DFG Deutsche Forschungsgemeinschaft
German Research Foundation