May 10th, 11:00 AM - 1:00 PM

Quasi-optical Measurement for Low Loss Material Characterization in Submillimeter Wave Range

Ha Khiem Tran
Portland State University, tranha@pdx.edu

Thanh Ngoc Dan Le
Portland State University

Branimir Pejcinovic
Portland State University, pejcinb@pdx.edu

Quasi-optical measurement for low loss material characterization in submillimeter wave range

By Ha Tran, Thanh Le, Prof. Branimir Pejcinovic

Portland State UNIVERSITY

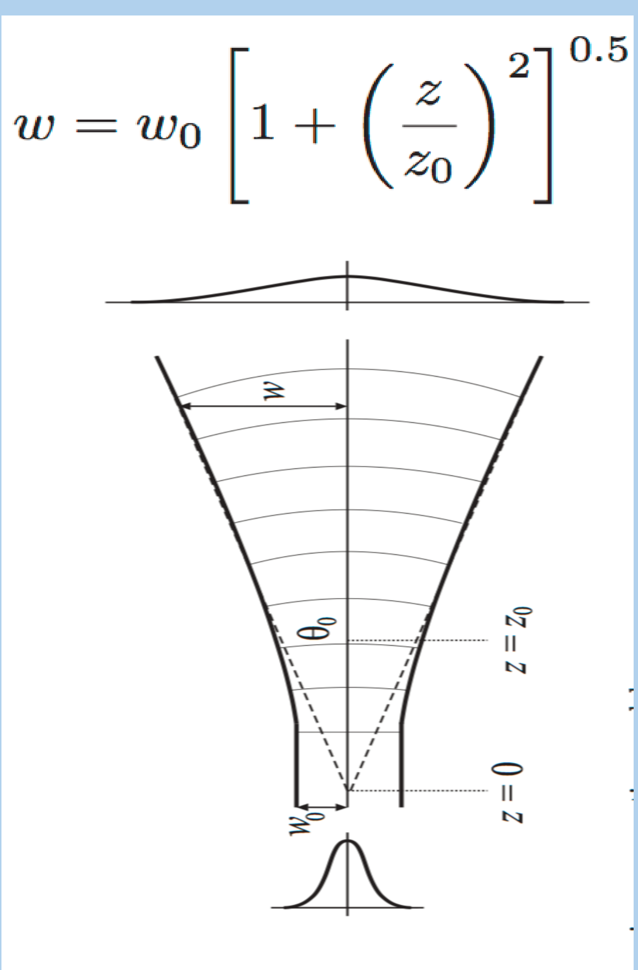
Introduction

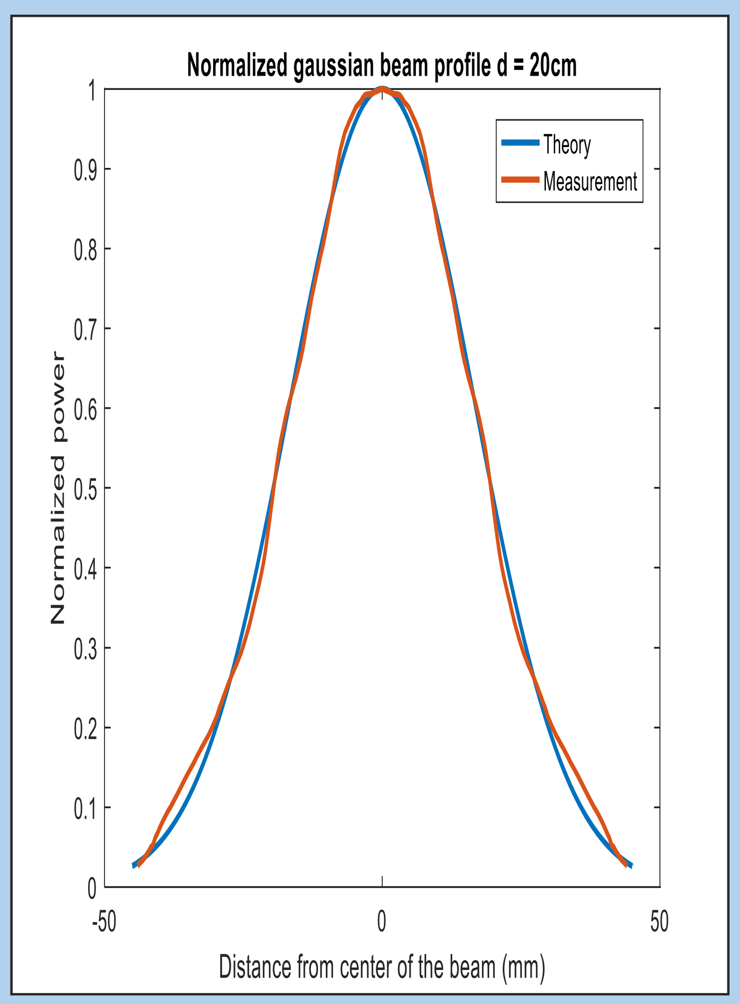
Quasi-optical measurement setup consists of a pair of horn antennas operated as feed for two off-axis parabolic mirrors. Once a collimated beam is generated, we measure its characteristics using Gaussian beam mode analysis. The sample under test is inserted between the two mirrors where the beam is collimated.

Gaussian Beam in mm-wave domain

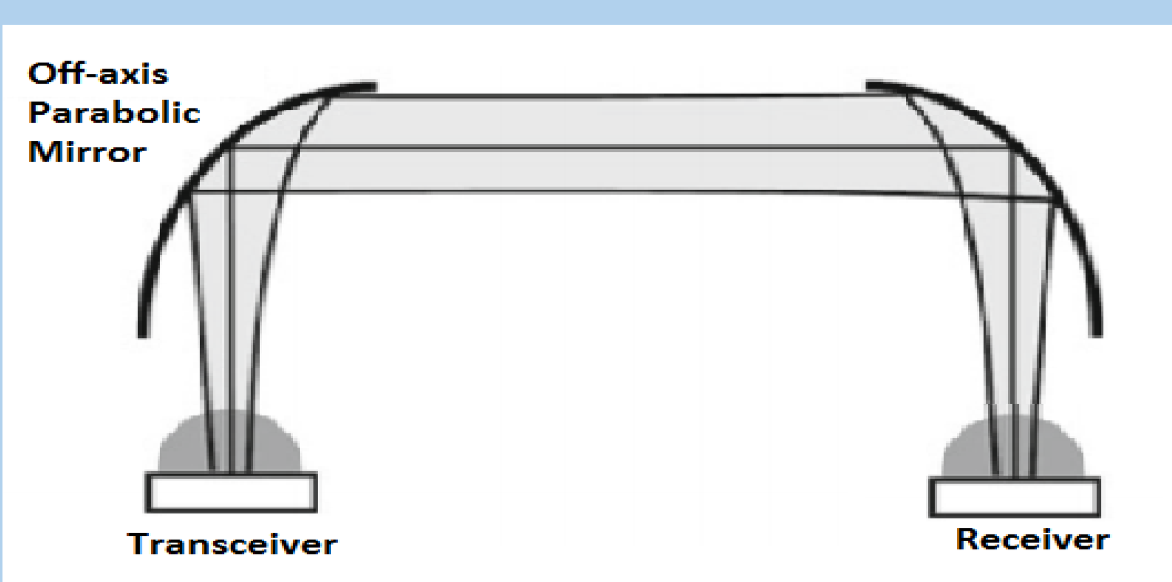
Analytical Study (Left figure): Beam radius (ω) is calculated with the Rayleigh distance (z_0) and minimum beam waist (ω_0) [1]

Measured amplitude distribution (Right figure): Far-field measurement of Gaussian beam profile was done using the receiver mounted on top of a translation stage as probe.

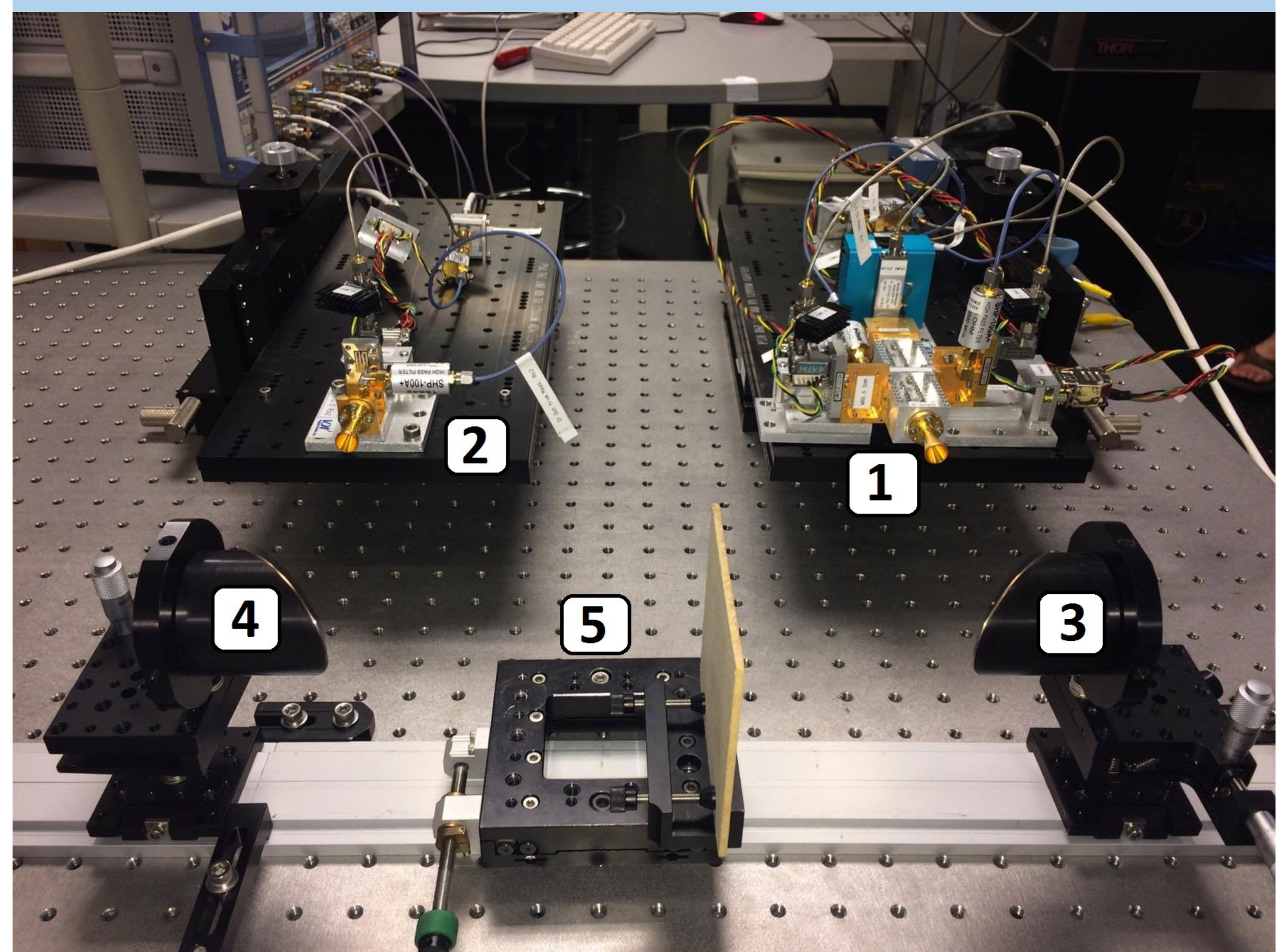




THz optical path: Two 90^0 off-axis parabolic mirrors are used to collimate and refocus the Gaussian beam.



Measurement Setup



Quasi-optical measurement setup for WR-6.5 band:

(1): Transceiver Module

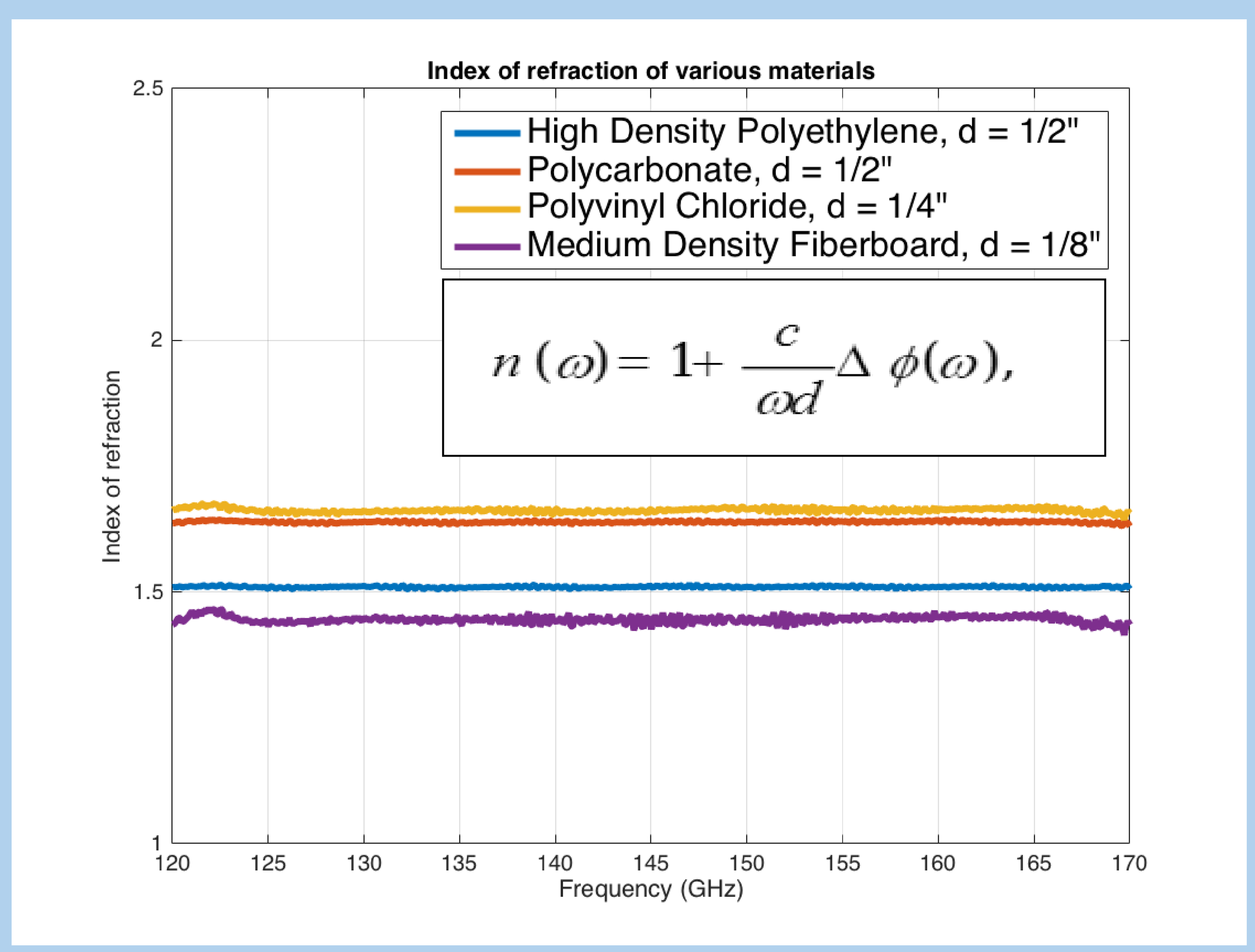
(2): Receiver Module

(3),(4): Off-axis parabolic mirrors

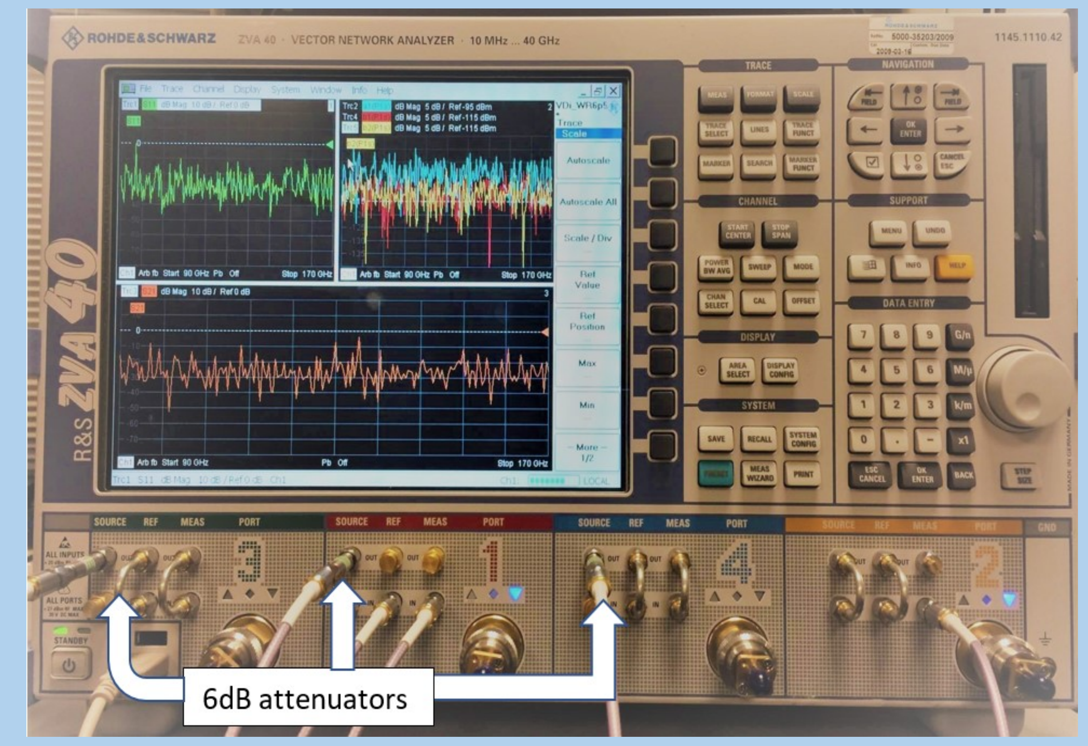
(5): Sample holder

Index of Refraction

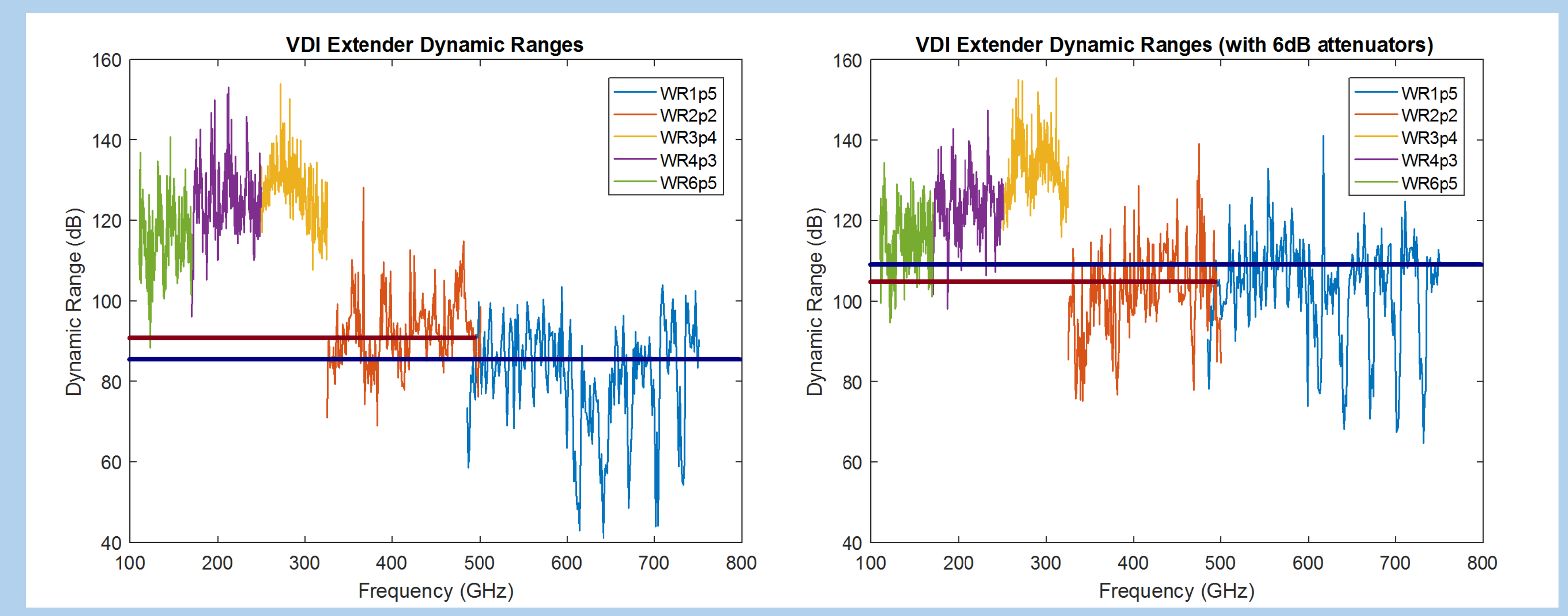
Index of refraction is calculated based on the intrinsic phase shift $\Delta\phi(\omega)$ and sample thickness d [2].



VDI Extender Module Dynamic Range



- Dynamic range (DR) is measured by taking the ratio between signal and noise.
- We also use 6dB attenuators to improve the overall performance of the system.



DR Improvement:

- 15 dB improvement in WR-2.2 range
- 25 dB improvement in WR-1.5 range

Future Work

For further investigation, we would like to:

- Take measurement for higher frequency bands.
- Extract imaginary part of electric permittivity from S_{11}.
- Take account of multiple reflections inside the material slabs (Farby-Perot effect) into the extraction algorithm.

Reference

[1] A. Kazemipour, et al. "The Horn Antenna as Gaussian Source in the mm-Wave Domain," *J. Infrared Millim. Terahertz Waves*, vol. 35, no. 9, pp. 720–731, Sep. 2014.

[2] J. O. Tocho and F. Sanjuan, "Optical properties of silicon, sapphire, silica and glass in the Terahertz range," in *Latin America Optics and Photonics Conference (2012), paper LT4C.1*, 2012, p. LT4C.1.