Effect of Modes on THz Wireless Channels inside Metal Enclosures

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Outline

- Introduction & Motivation
- Previous Work
- Measurement Scenarios
- Mode Sensitivity
- Results and Discussion
- Conclusion

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Introduction & Motivation

- Data communications between the components inside the computing devices presently operate through wire connections which pose a limitation on further scaling.

- Current Wireless communications frequencies cannot match the required data rates within the computing system.

- Use of **THz frequency bands in chip- to- chip wireless** communications is preferred.

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Previous Work

- Wireless Interconnects at THz frequencies are preferred as compared to wired interconnects [1], [2]
- On-board THz wireless communication channel characterization has been conducted in [3]
- Measurements have been collected inside the rectangular metallic cavity which resembles the practical computer desktops [4]
- A path loss model which consists of the traveling loss, resonant modes-based power variation, and the loss due to the radiation pattern of the equipped directional antennas has been proposed in [5]
- For short range wireless communications between on-board components, a statistical channel model has been proposed in [6].

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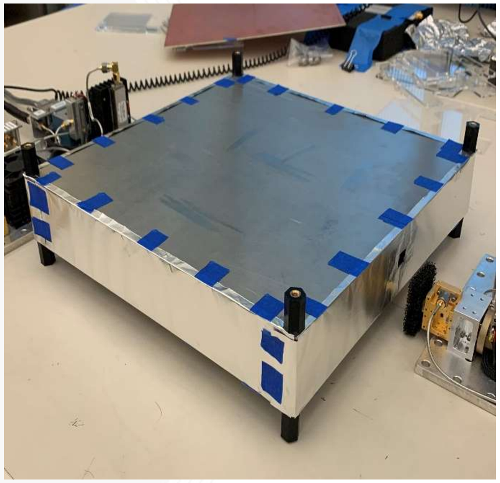
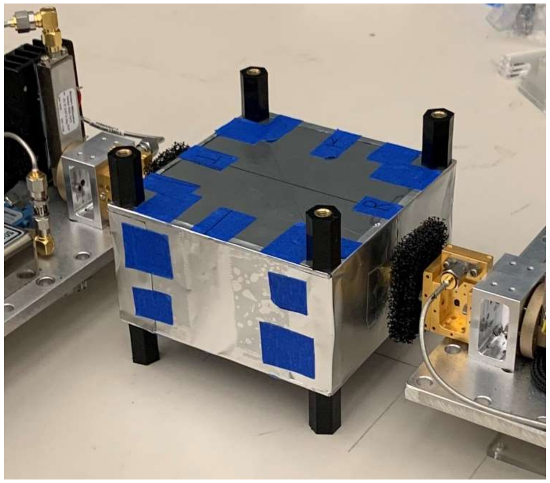
Measurement Scenarios

Two metallic cavities corresponds to different desktop sizes



(a) larger cavity dimension 30.5×30.5×5cm



(b) small cavity dimension 11×11×5cm.

Smaller cavity has a size close to Intel-NUC mini-desktop

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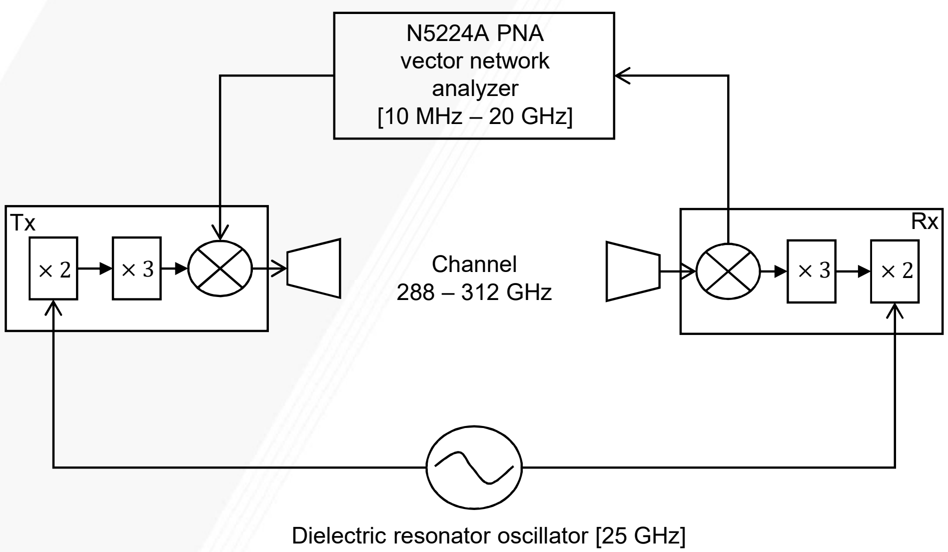
Measurement Scenarios

- THz Measurement Setup
  - N5224 VNA
  - VDI Transmitter (Tx210) and VDI receiver (Rx148)
  - Directional horn antennas with 3 dB beamwidths of 12° and the gain varies between 22 and 23 dBi.



Parameter	Symbol	Value
Measurement points	N	801
Intermediate frequency bandwidth	Δf_{IF}	20 kHz
Average noise floor	P_N	-90 dBm
Input signal power	P_{in}	0 dBm
Start frequency	f_{start}	10 MHz
Stop frequency	f_{stop}	12 GHz
Bandwidth	B	11.99 GHz
Time domain resolution	Δt	0.083 ns
Maximum excess delay	τ_m	40 ns

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Mode Sensitivity

For the electrically large cavity of given volume V, the number of modes can be approximated as [7]:

$$N(f) \approx \frac{8\pi f^3 V}{3c^3}$$

$$\frac{\Delta f}{f} = \frac{\lambda^3}{8\pi V}$$

- λ is the free space wavelength. For the cavities shown in Fig. 1, the Δf at 300GHz is 2.56 and 19.71KHz respectively
- Larger value of Δf for the smaller cavity points to the less mode interference and consequently less path loss variation with frequency.

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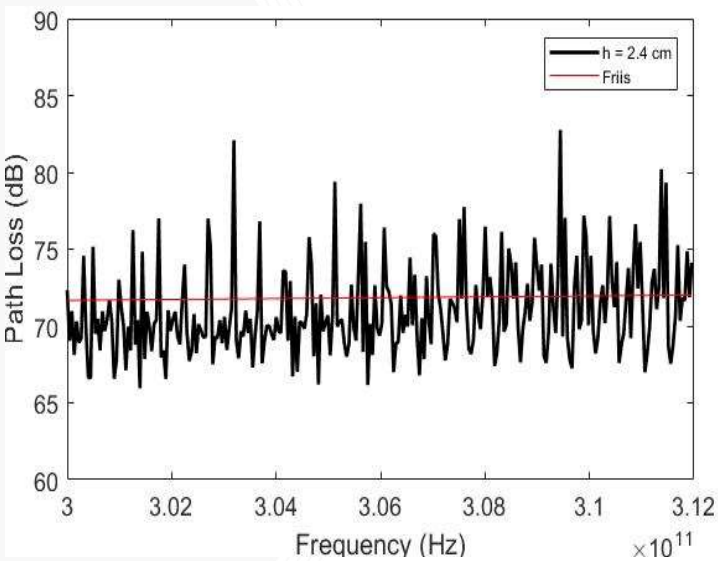
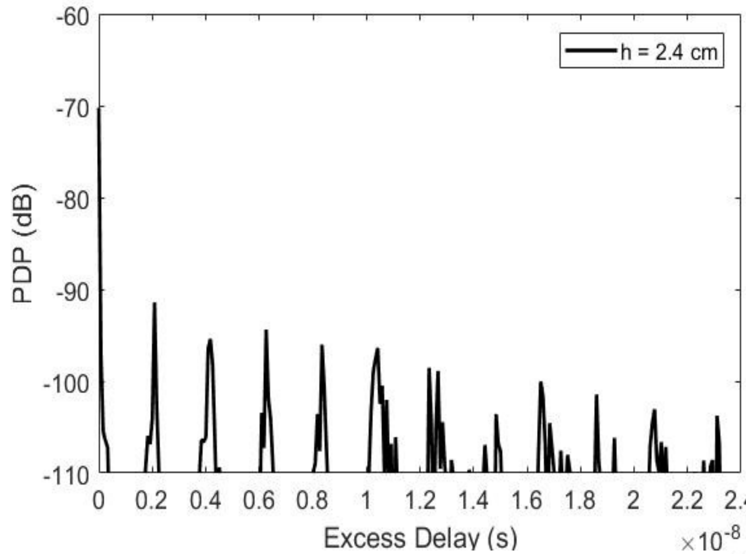
Results and Discussions

Path loss vs frequency



measured PDP for a cavity



Metallic cavity dimension 30.5 cm × 10 cm × 10 cm.

Stronger multipath as compare to original cavity presented in [4]

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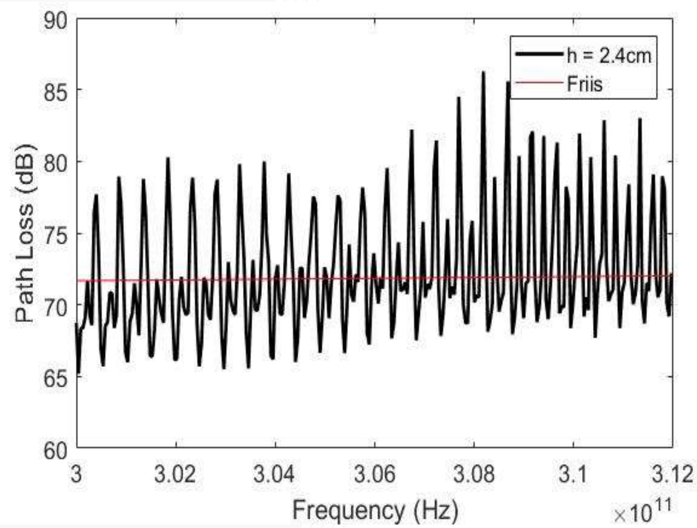
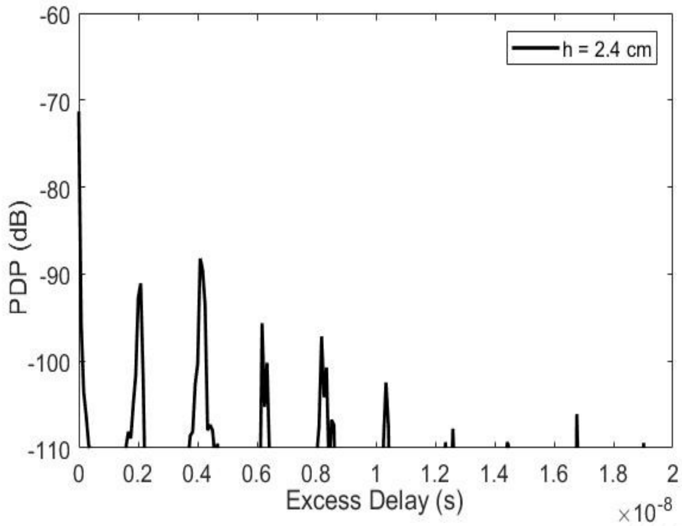
Results and Discussions

Path loss vs frequency



measured PDP for a cavity



Metallic cavity dimension 30.5 cm × 30.5 cm × 5 cm.

stronger variation in path loss as compared with the height of 10 cm [4]

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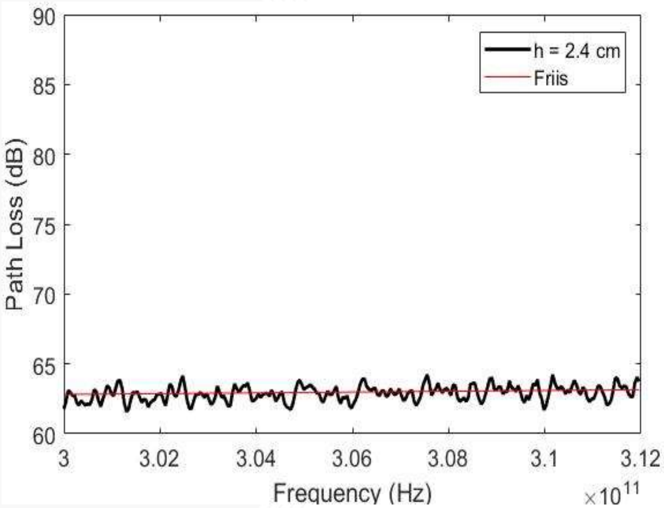
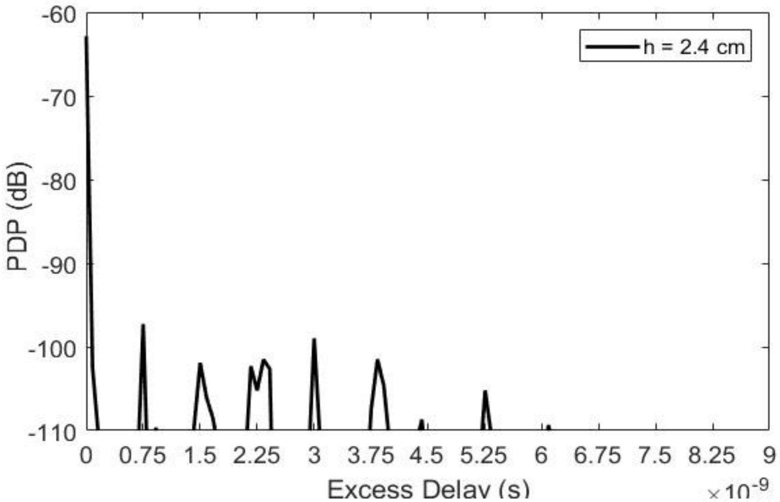
Results and Discussions

Path loss vs frequency



measured PDP for a cavity



Metallic cavity dimension 11 cm × 11 cm × 5 cm.

As compare to larger cavity, average path loss and path loss variation with frequency is reduced.

Conclusions

- The effects of geometrical parameters on the THz wireless channel inside a metallic resonant cavity was presented.
- Transverse dimension of the cavity has stronger effect on multipath as compare to normal dimension.
- We demonstrated that the small size cavity has less path loss variation and less multipath due to increase in the frequency sensitivity.

References

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Thank You !