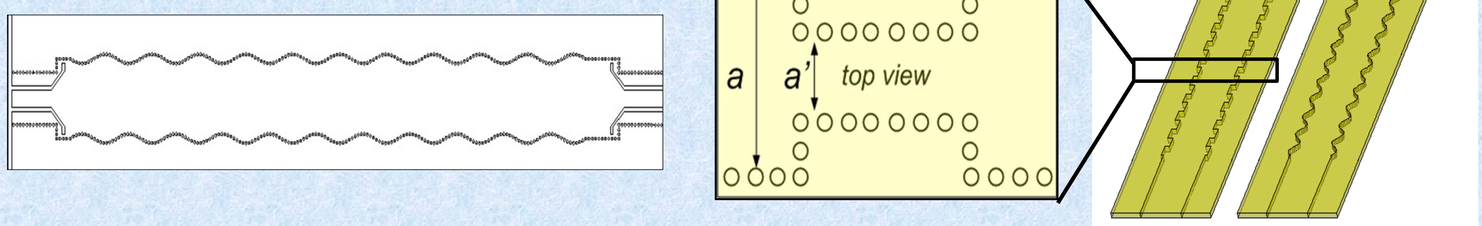
Qunbi Zhuge[1], Joshua D. Schwartz[2], José Azaña[2] and David V. Plant[1]

1-D Uniform and Chirped Electromagnetic Bandgap Structures in Substrate Integrated Waveguides at 60 GHz

Introduction

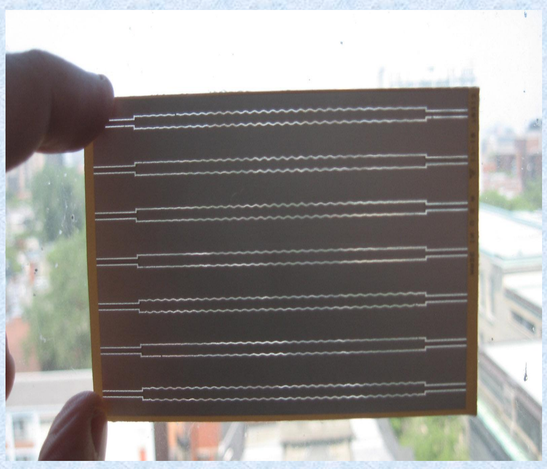
- 60 GHz: target for short-range ultra-wideband (UWB) communication.
- Waveguides are the preferred interconnect at mm-wave frequencies (>30 GHz) for their low loss and high Q-factors.
- Substrate integrated waveguides (SIWs) use closely-spaced vias as "sidewalls".
- Can modulate those sidewalls to perform UWB filtering functions.

Fig: SIW with modulated sidewalls (right, inset); top views end transitions to coplanar waveguide (left)



Design

- A prototype is designed on Rogers RT/duroid 6002 (ε_r = 2.94; tan δ = 0.0012; thickness 0.254 mm) substrate metallized with 1 oz. copper.
- A period of Λ = 2.15 mm targets a bandgap centered at 60 GHz. The waveguide width is set to 2.02 mm and features a modulation depth of 0.1 mm with a symmetric Gaussian apodization window W(z) = having σ = 0.3.
- The linear chirp coefficient is C = 6400 m^{-2}.
- At the endpoints of the structures, broadband transitions to grounded coplanar waveguide (GCPW) are included.



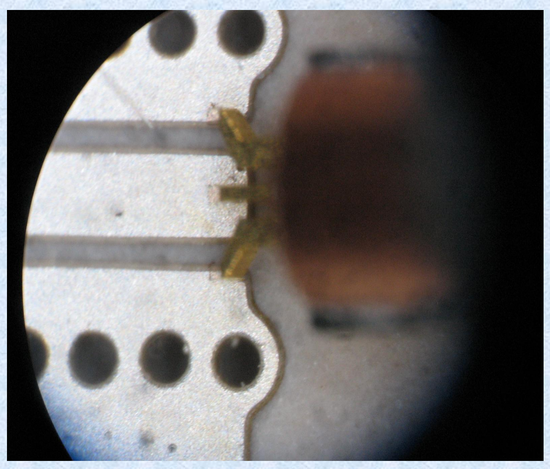


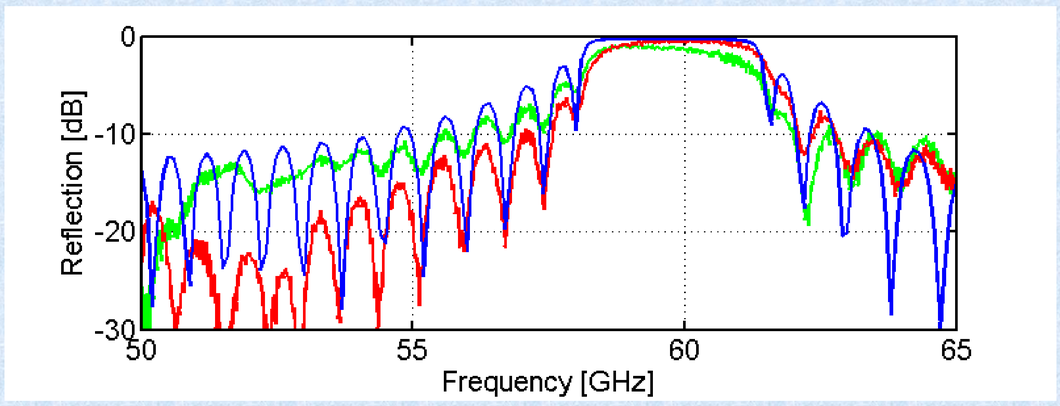
Fig: prototype board with seven SIW test lines (left); coplanar microprobe launch into SIW (right).

Summary

- At 60 GHz this work represents one of the highest reported frequencies for a chirped EBG in the native electrical medium.
- For a uniform EBG structure, a measured 3-dB reflection bandwidth of 3.3 GHz is reported, while
- For a chirped EBG structure, we realize a reflection bandwidth of 5.3 GHz exhibiting a group delay slope of approximately 0.15 ns/GHz.

Measurements

Measurements of the structures were taken with an Anritsu 37397D (65GHz) vector network analyzer using 65 GHz coplanar probes.



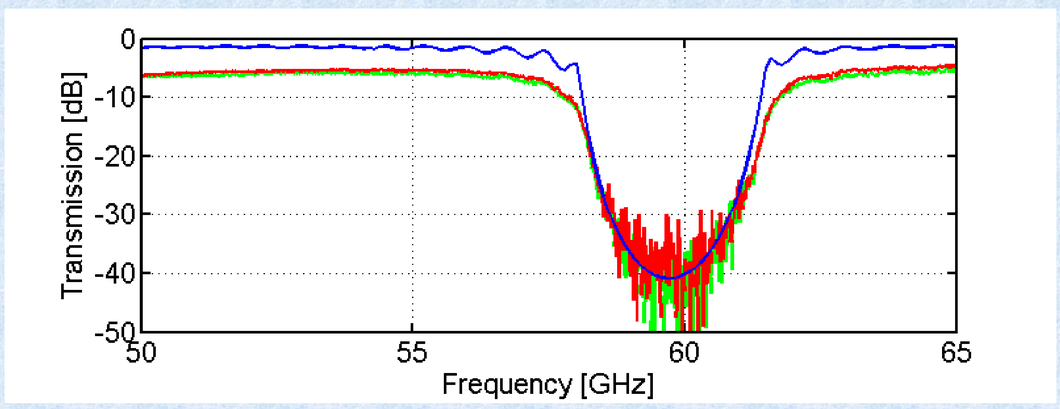
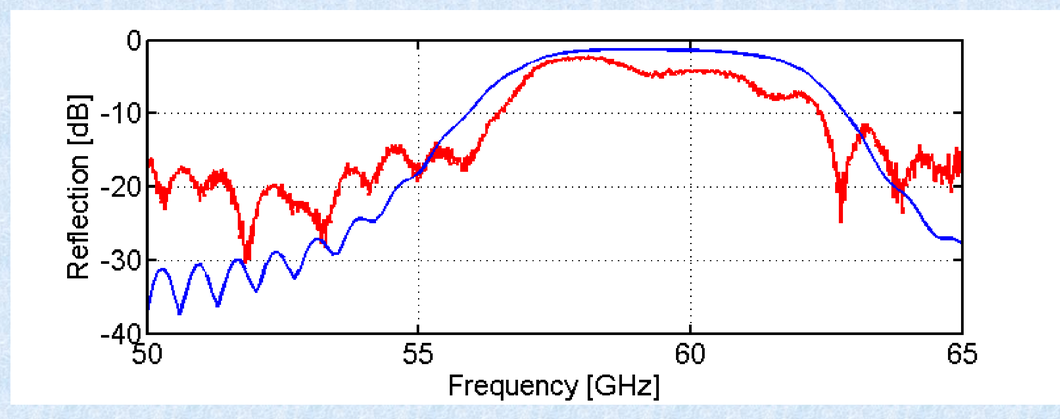


Fig. Reflection |*S11*| (top) and transmission |*S21*| (bottom) for the **uniform** EBG structure. (Ansoft's HFSS simulation – blue; measurement excluding transition – red; measurement including the transition – green).



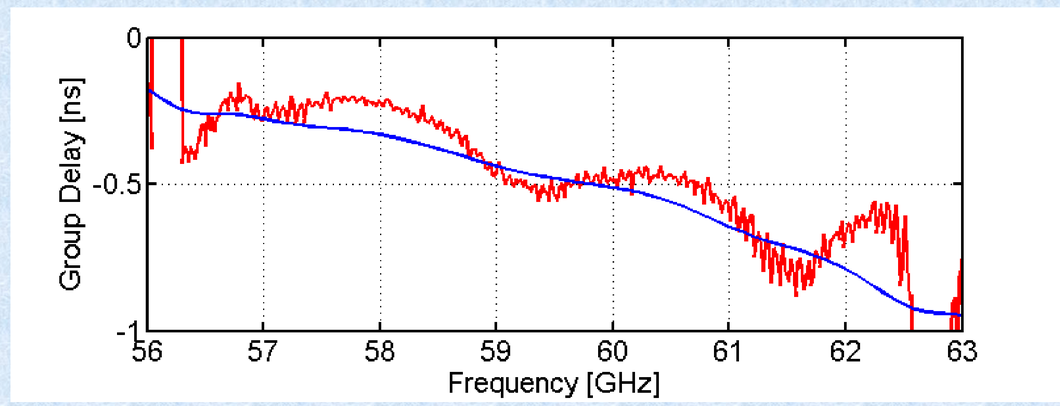


Fig. Reflection |*S11*| (top) and group delay for port1 (bottom) for the **chirped** structure. (Simulation – blue, measurement excluding transition – red).

1 : McGill University, Photonics Systems Group; qunbi.zhuge@mail.mcgill.ca
2 : Institut National de la Recherche Scientifique – Énergie, Matériaux, et Télécommunications (INRS-EMT)

McGill
Université du Québec
Institut national de la recherche scientifique