UWB 5G Package-Integrated Antenna Array Design

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Outline

- ❑ Goals & Objectives
- ❑ Prior Work
- ❑ Technical Approach
- ❑ Results & Key Accomplishments
- ❑ Comparison with Prior Art
- ❑ Schedule
- ❑ Summary

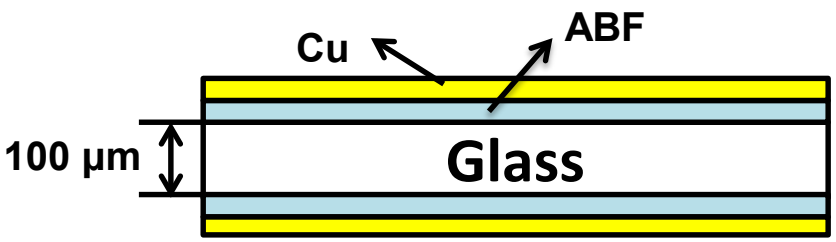
Goals and Objectives

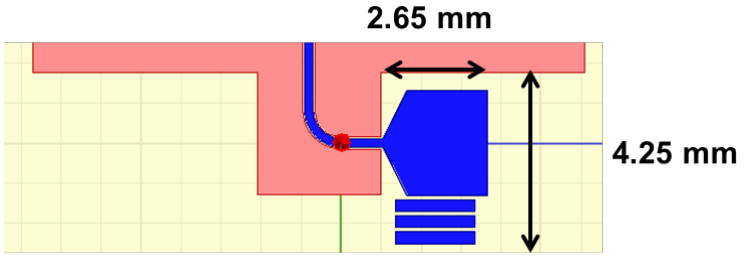
- Modeling and Designing ultra wideband (UWB) Yagi and Horn antenna on thin glass substrates for 5G mm-wave communications.
- Using the designed antennas and phase arrays to implement UWB and high gain antenna arrays.
- Integrating the designed antennas with precision RDL and interconnections to form a fully-functional D&D test vehicles

	Objectives	Prior Art	Challenges	Tasks
Performance (Yagi)	• RL > 10dB • Gain ≈ 4 dBi • **FBW > 49 %** • **24.25 - 40 GHz** • Size < λ/2	• FBW<20%	• UWB matching circuit and balun • UWB radiator	• Task1: UWB matching circuit design • Task2: UWB balun design • Task3: UWB radiator design • Task4: Optimize antenna design
Performance (Horn)	• RL > 10dB • Gain ≈ 4 dBi • **FBW > 49 %** • **24.25 - 40 GHz** • Size: As small as possible	• FBW<20%	• Thin substrate for horn antenna • Broadband design • Size reduction	• Task1: Glass properties effects on the antenna performance • Task2: Embedding cavity design • Task3: Planar corrugated horn structure design • Task4: Broadband Horn to Air Transition Design • Task5: Stack the horn design with the Yagi design to get dual-polarization antennas
Performance (Array)	• RL > 10dB • FBW > 55 % • Phased array design	• FBW<20% • Not phased array	• Precise phase shift for the phase array and feed line • Broadband phase array	• Broadband phase array design

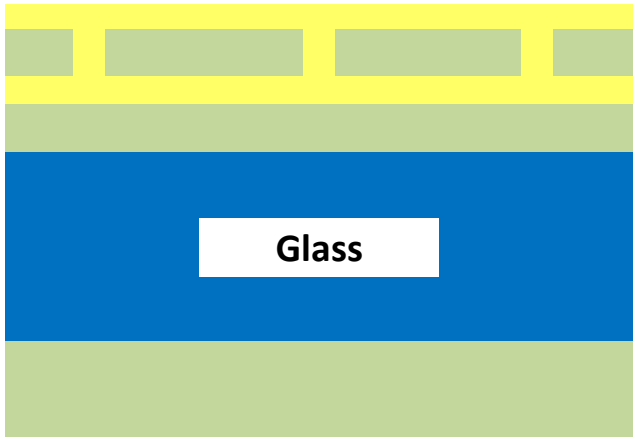
Prior Work

- 100 µm ultra-thin glass package
- Monopole radiator to achieve UWB
- Miniaturization by removing balun and matching circuit
- 24 – 43.5 GHz, FBW > 57.8 %
- S11 < -10 dB
- Realized gain > 4 dBi
- Size: 0.22 λ_0 x 0.35 λ_0





Technical Approach

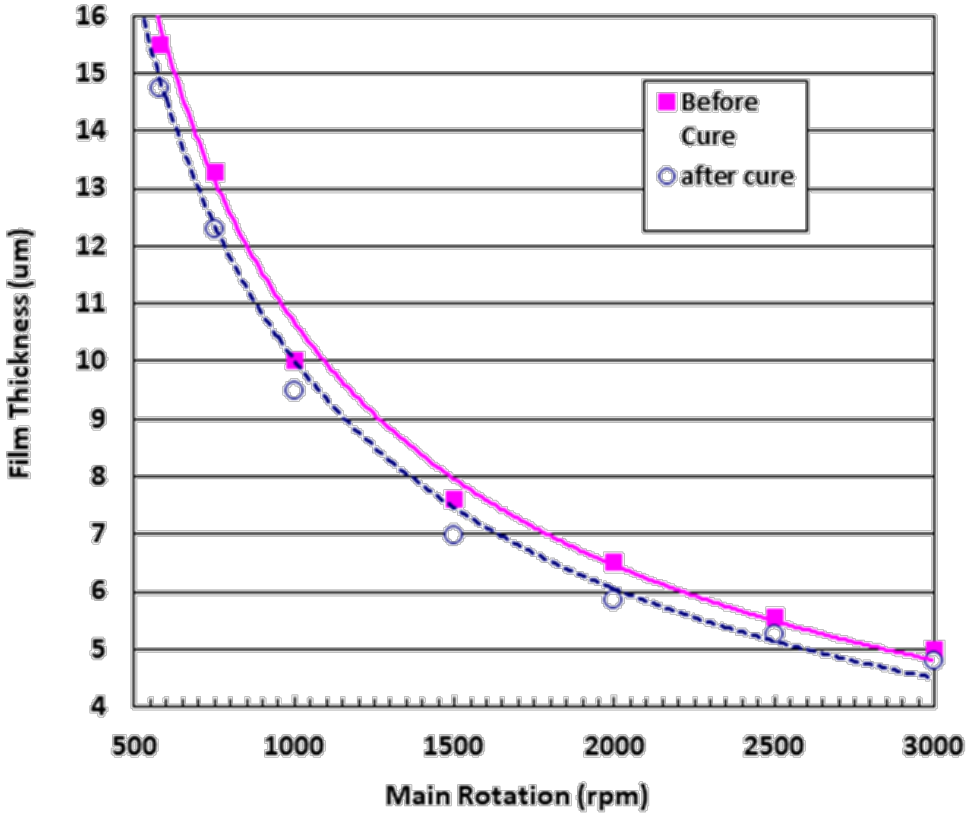


Layer	Details
M1 (Top)	Microstrip Passive Components (5-8 µm)
Dielectric-1	JSR (15 µm)
M2	GND, Dicing Clearance (5-8 µm)
Dielectric-2	JSR (15 µm)
Core-Glass	AGC EN-A1 (100 µm)
Dielectric-3	JSR (15 µm)
Dielectric-4 (Bottom)	JSR (15 µm)

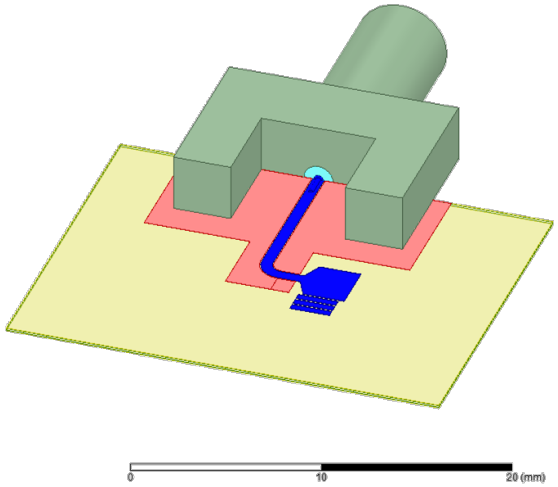
Technical Approach

- JSR materials to reduce warpage
- Precise thickness control to reduce variations
- Include end launch connector into simulation

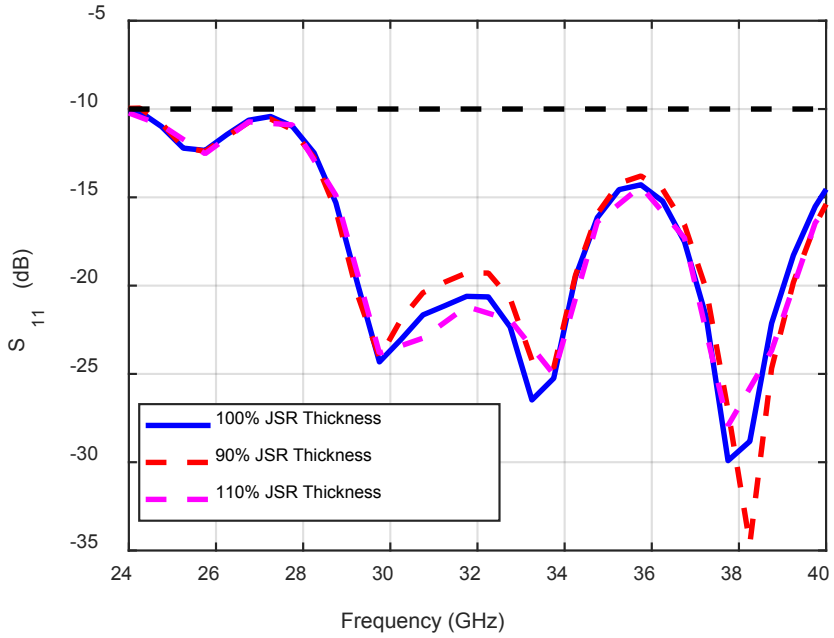
	JSR Material	ABF
Young's Modulus (GPa)	2.8	5
Elongation (%)	55	5.6

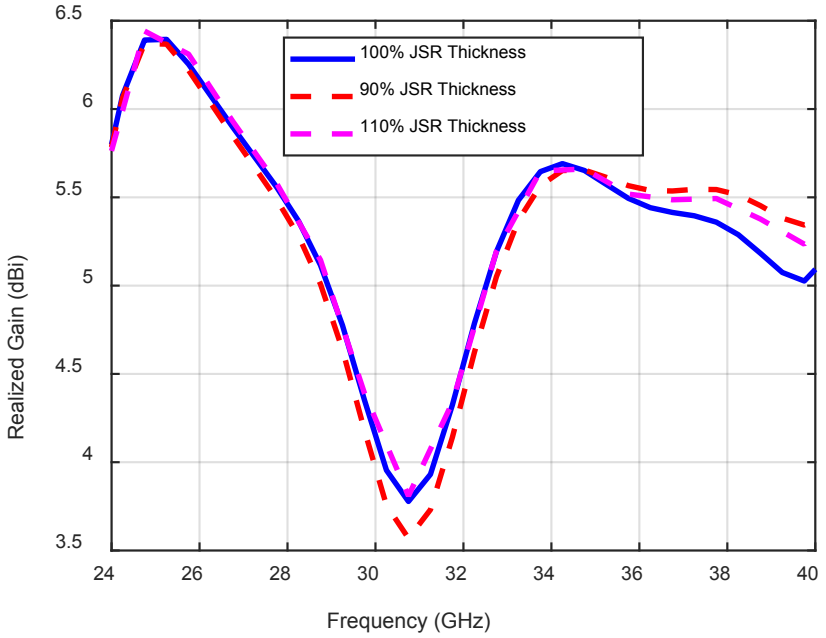


Results & Key Accomplishments

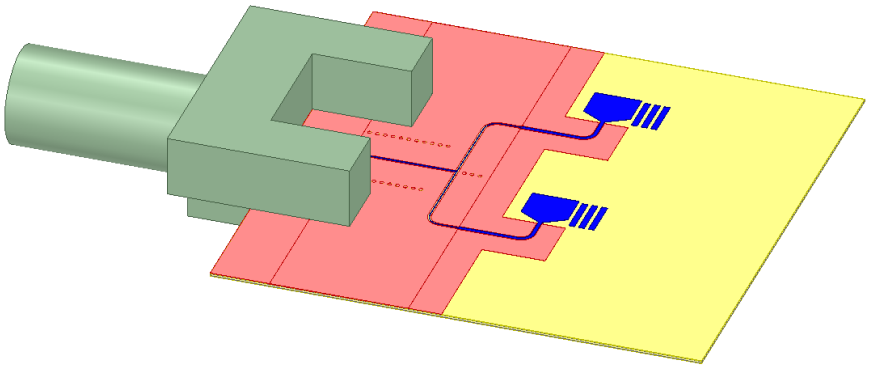


- Operation Band: 24 – 40 GHz
- S11 < -10 dB
- Realized gain > 3.8 dBi
- Good resist to thickness variation

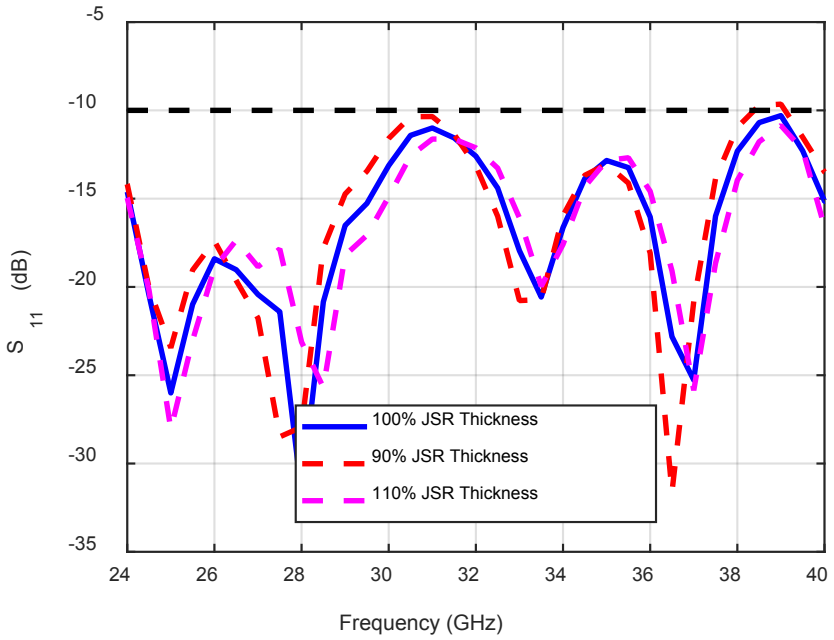


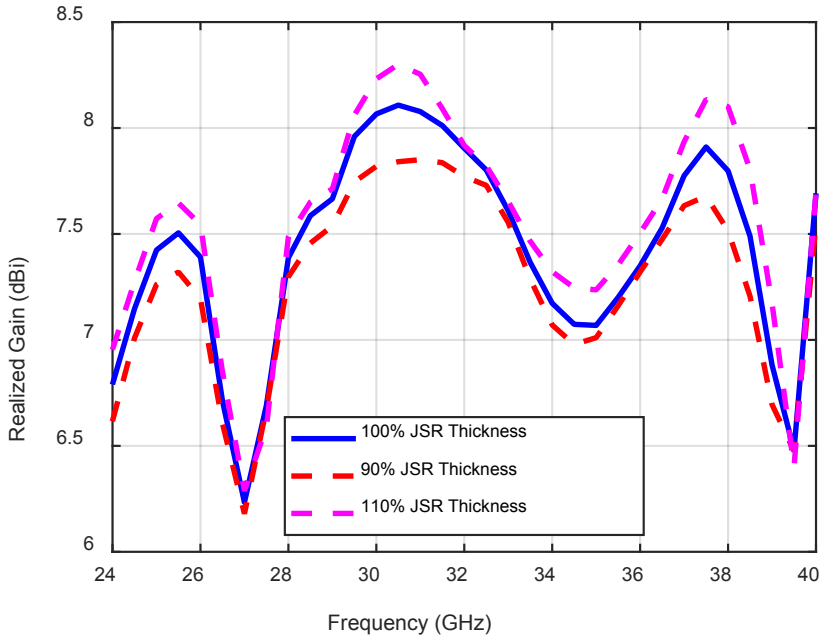


Results & Key Accomplishments



- Operation Band: 24 – 40 GHz
- S11 < -10 dB
- Realized gain > 6.2 dBi
- Good resist to thickness variation

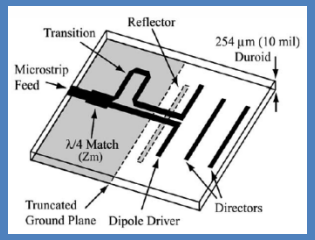
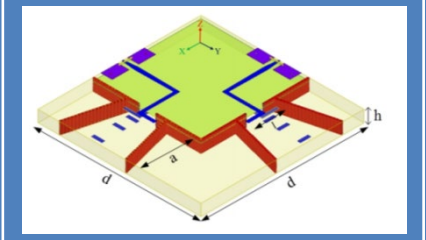




Results & Key Accomplishments

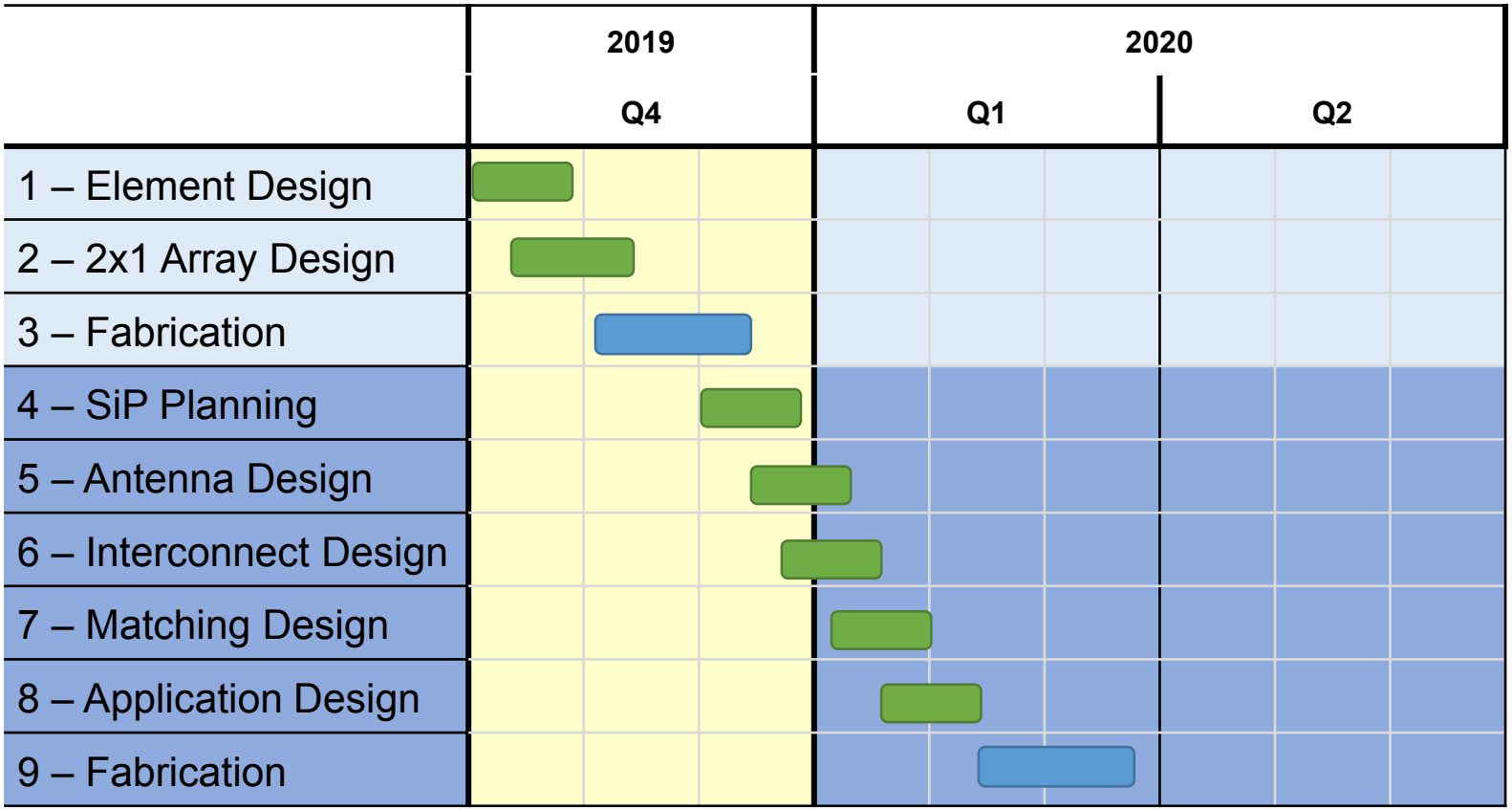
Panel Design Figure
Coming Soon

Comparison with Prior Art

			**This work**
Fabrication method	Laminate	LTCC	Glass
Band (GHz)	24	37.5 – 42	24 – 40
Bandwidth (GHz)	< 1	4.5	16
FBW (%)	3	12.5	49
Thickness (µm)	254	832	176
Realized Gain (dBi)	9.3	5	3.8
Size	0.45 λ_0 x 1.12 λ_0	0.48 λ_0 x 0.63 λ_0	0.13 λ_0 x 0.24 λ_0

Schedule

done
done
progress



Light blue: UWB 5G Array Design
Dark blue: UWB 5G System Design
Light Yellow: Current time window

Design
Fabrication

Summary

- Designed UWB and miniaturized Yagi antenna element
- Covered both 5G band simultaneously
- Consider effects of end launch connector and thickness variation
- Panel design for fabrication

Future Work

- Prototype fabrication and characterization
- UWB 5G modules utilized the designed antenna (array)