We01B-1

A 220-300 GHz Vector Modulator in 35 nm GaAs mHEMT Technology

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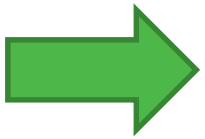
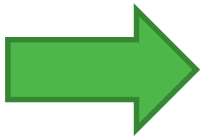
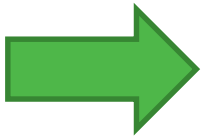
Outline

- Motivation
- Topology Choice
- Biasing
- Technology
- Results
  - Attenuator
  - Vector Modulator
- Conclusion

Motivation

- Smartphones generated 54.8% of global internet traffic. It is more than 56.8 exabytes every month and this value is constantly growing.
- Industry embed IoT to the production stages, which require reliable highspeed datalink
- Consumer IoT devices become widespread and consume lots of bandwidth

6G

Mobile network improvements required to fulfil a fast-growing demand

Motivation: Phased Array Antenna

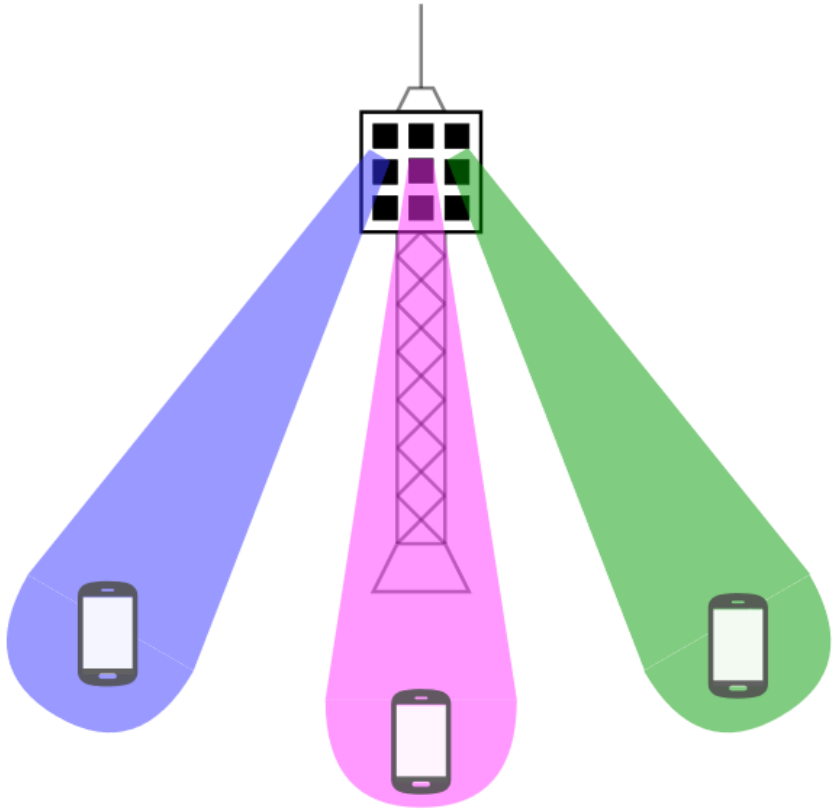
Moving towards mm-wave communication is a challenge:

- ❑ Atmospheric attenuation
- ❑ Environment absorption

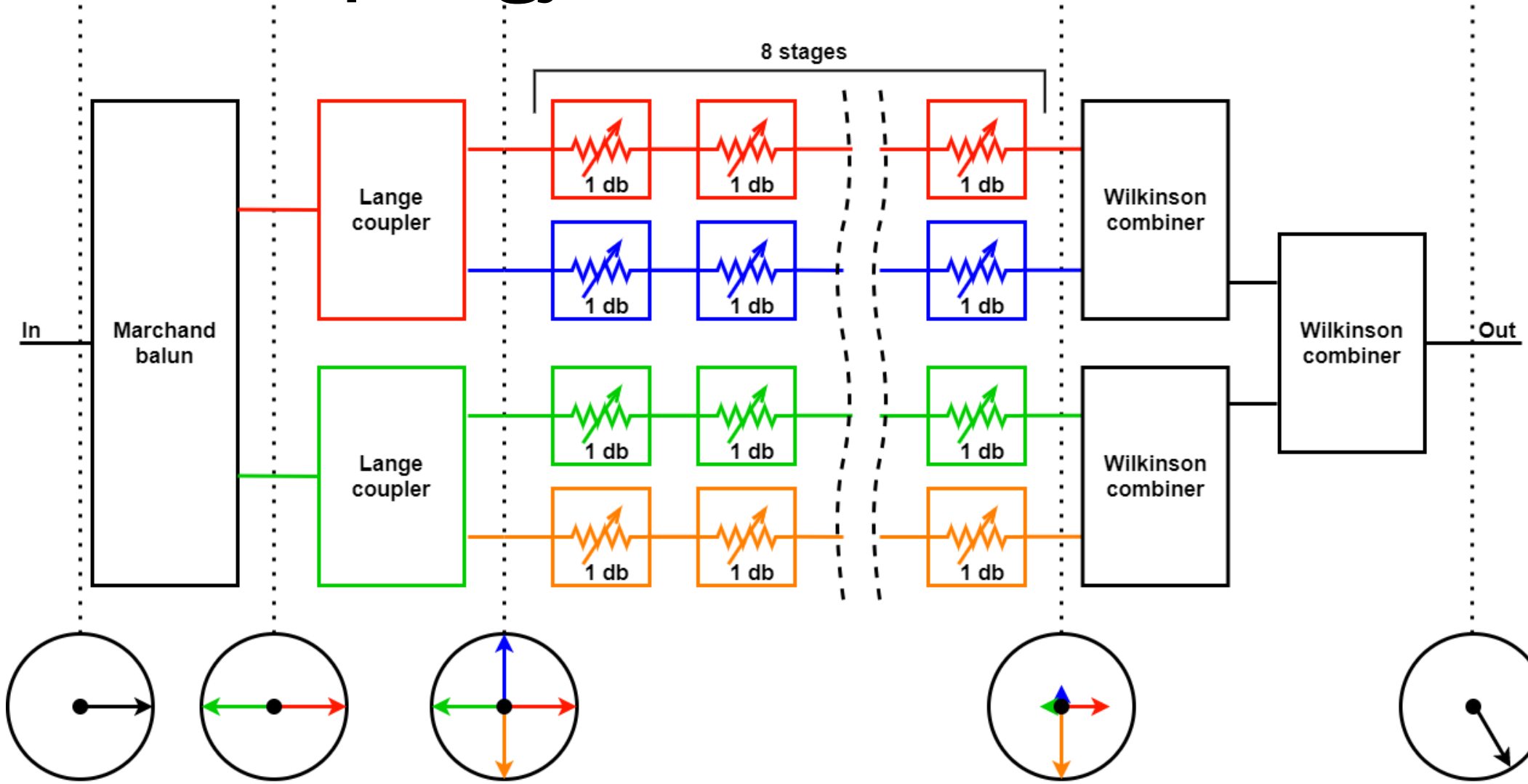
Solution: Phased Array Antennas

- ❑ Increase of signal strength
- ❑ Directional control

Development of the phased array antenna components for the mm-wave communication

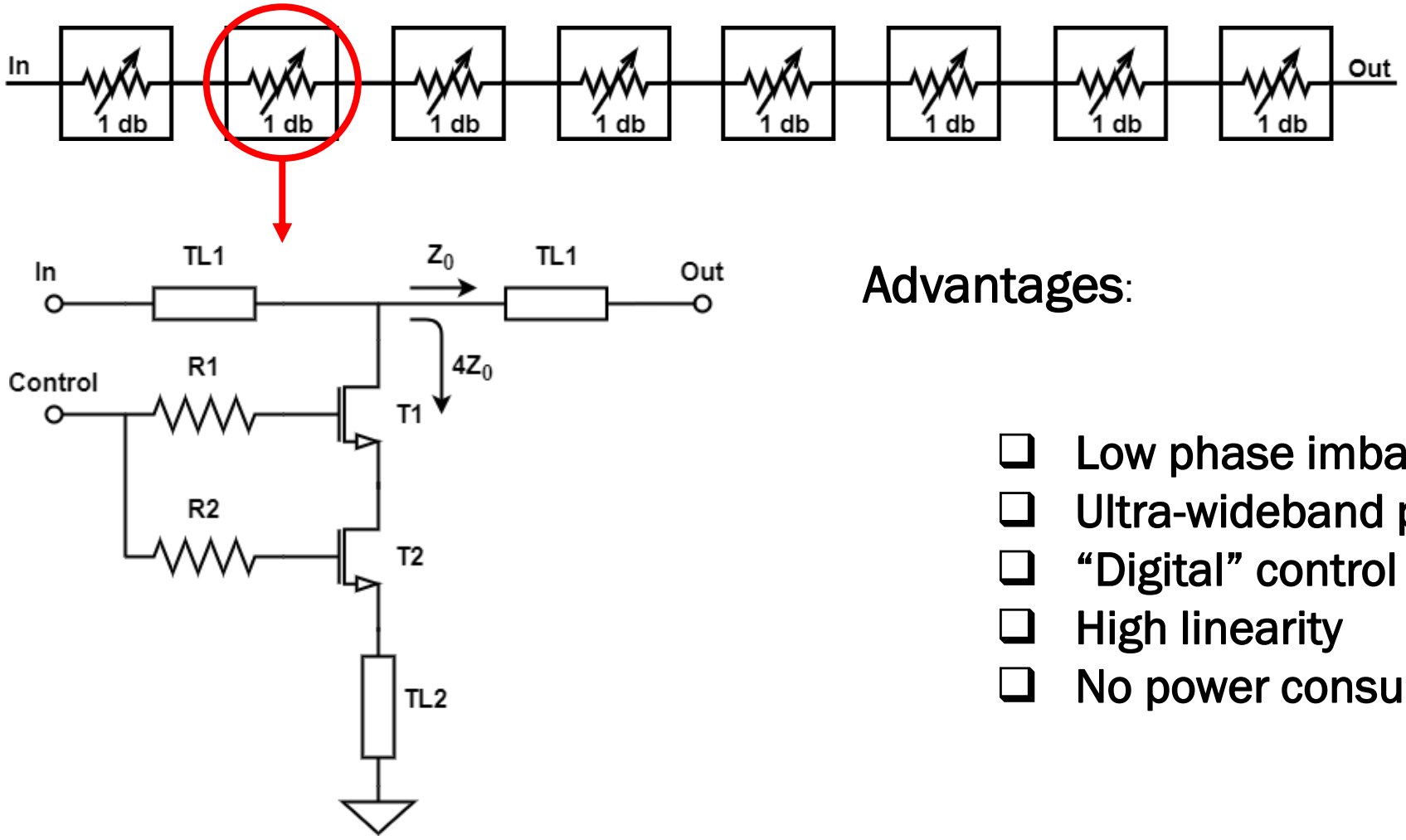


Topology of Vector Modulator



Chosen topology of the vector modulator

Topology: Distributed Attenuator

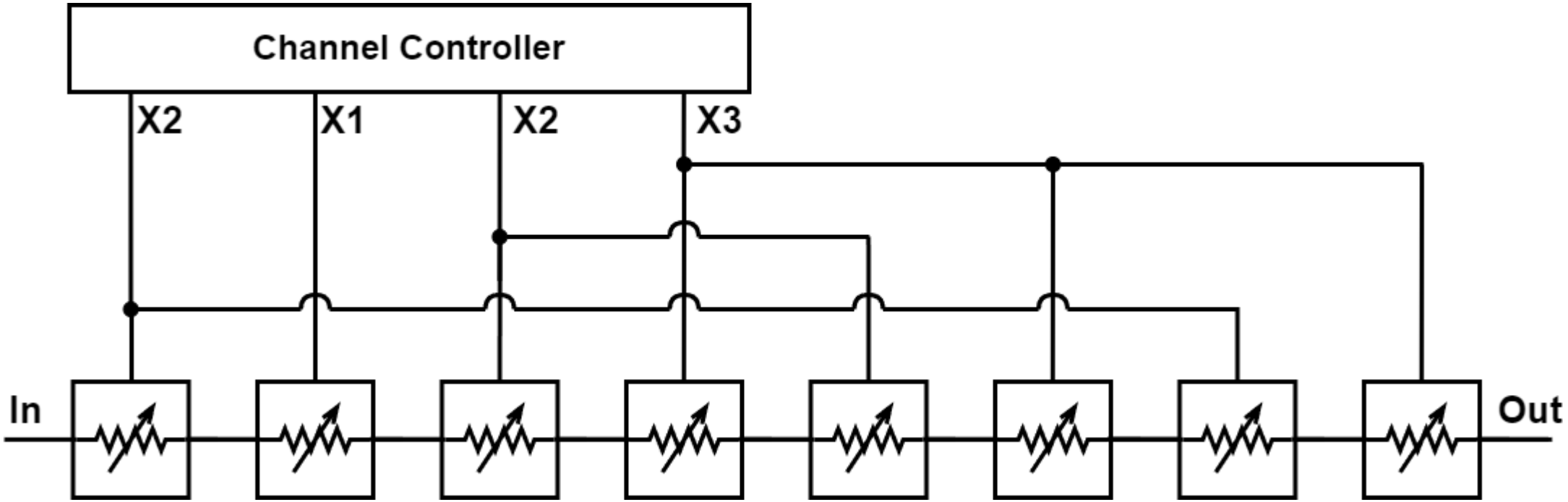


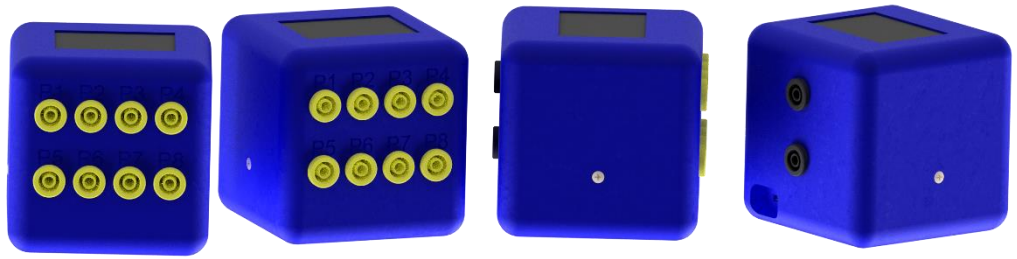
Attenuator cell topology with 1 dB attenuation

Advantages:

- ❑ Low phase imbalance
- ❑ Ultra-wideband performance
- ❑ “Digital” control
- ❑ High linearity
- ❑ No power consumption

Biasing: Control Circuit



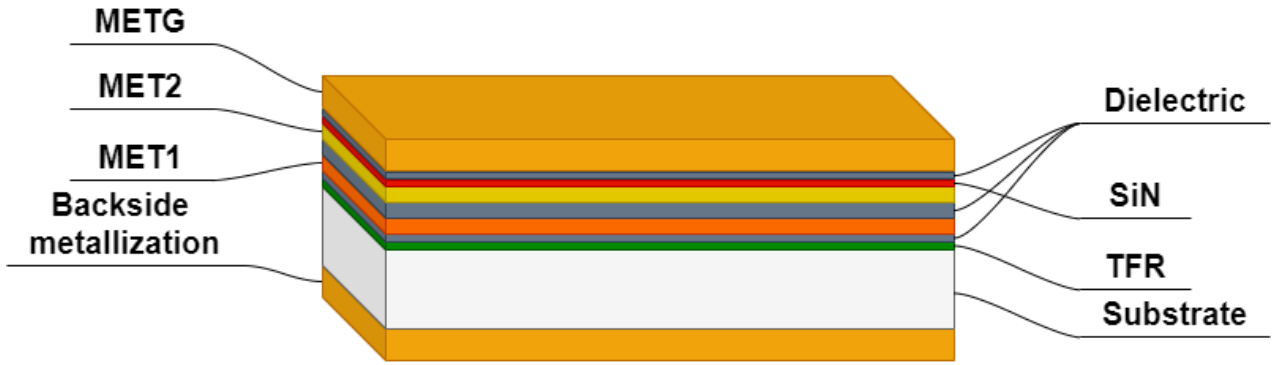


Bias modules

Technology

This work uses Fraunhofer IAF metamorphic high electron mobility transistor (mHEMT) technology with 35 nm gate length

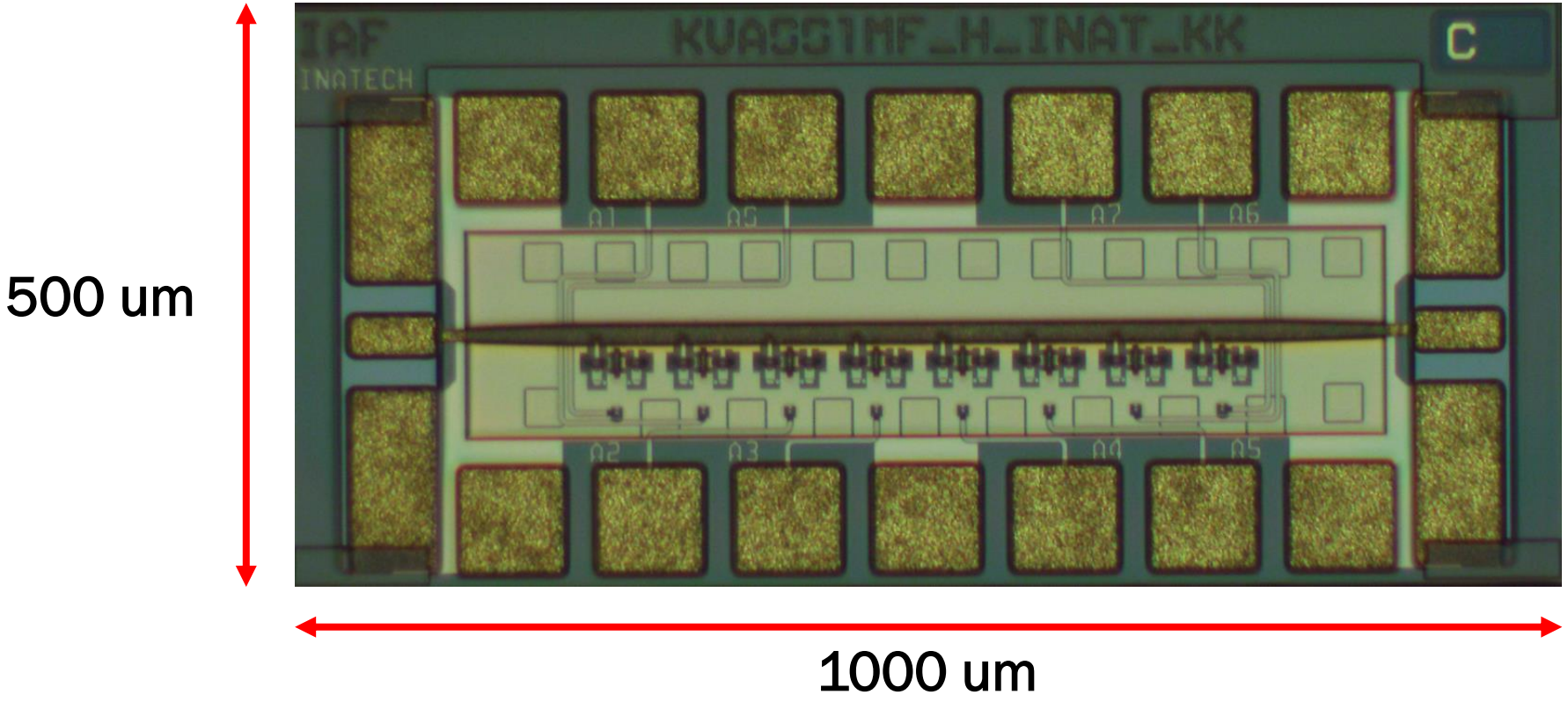
- 35 nm gate length
- f_T > 500 GHz
- f_{max} > 1 THz



Fraunhofer IAF GaAs 35 nm mHEMT

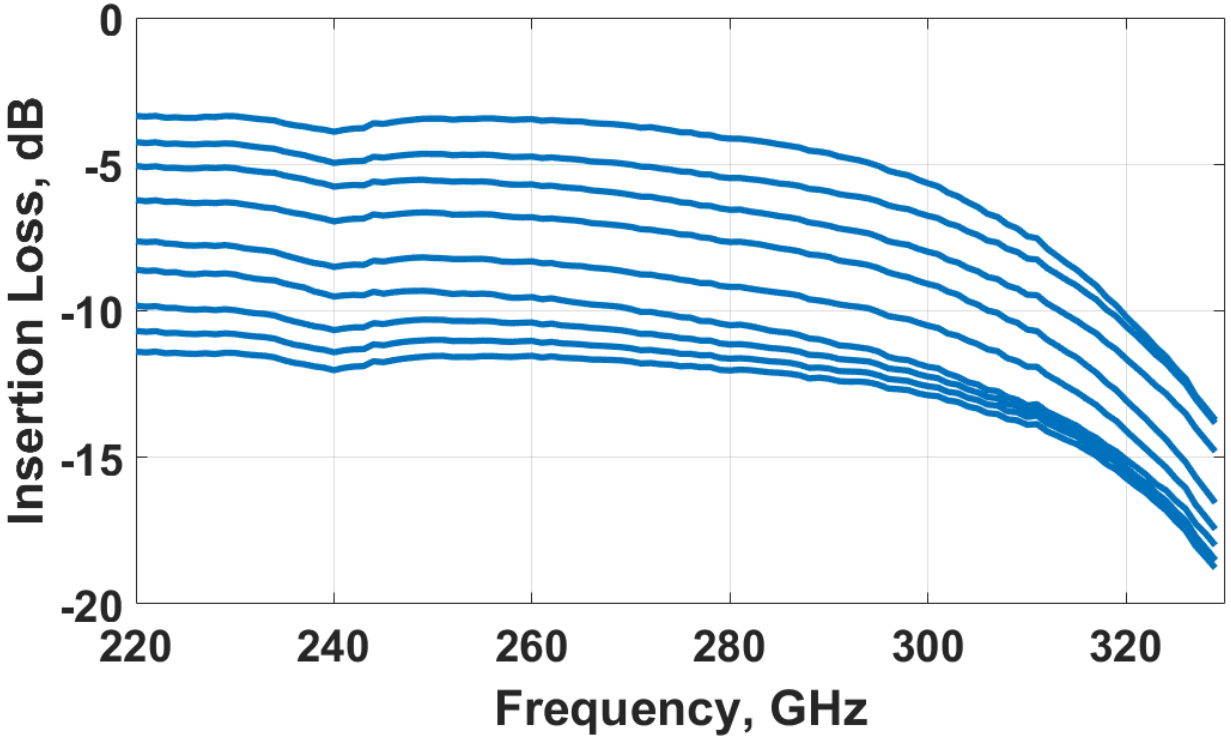
Fraunhofer IAF

Results: Attenuator

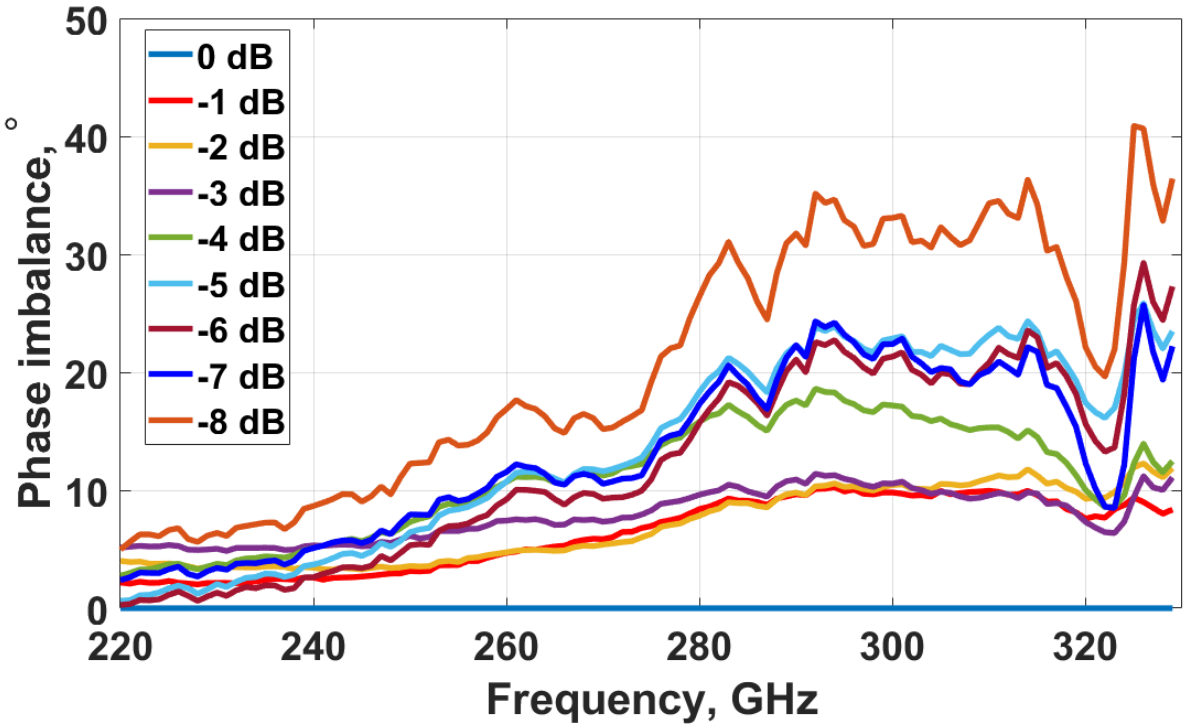


Chip Photo of the Distributed Attenuator

Results: Attenuator

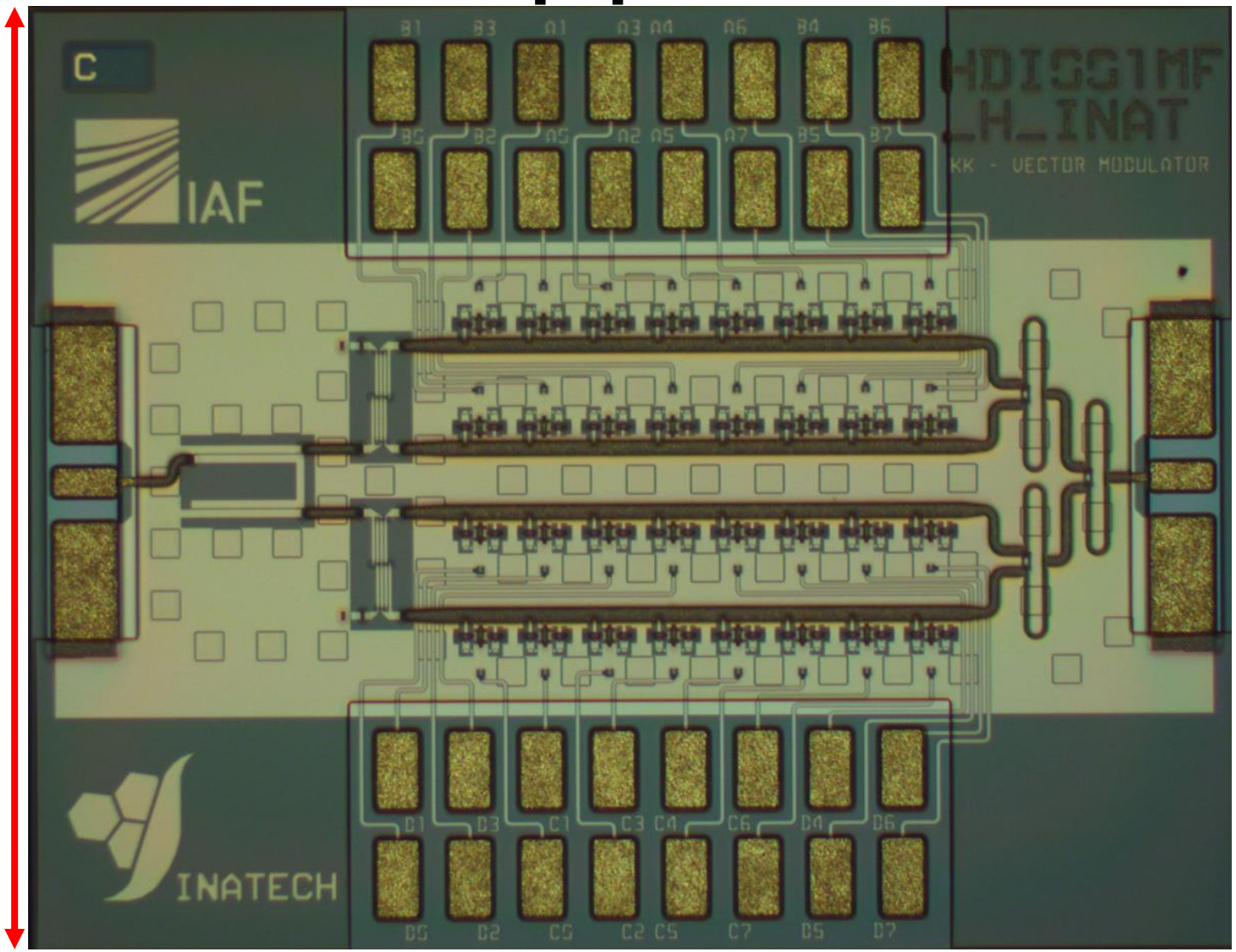


Measured phase imbalance of attenuator states as a function of frequency relative to the through-state

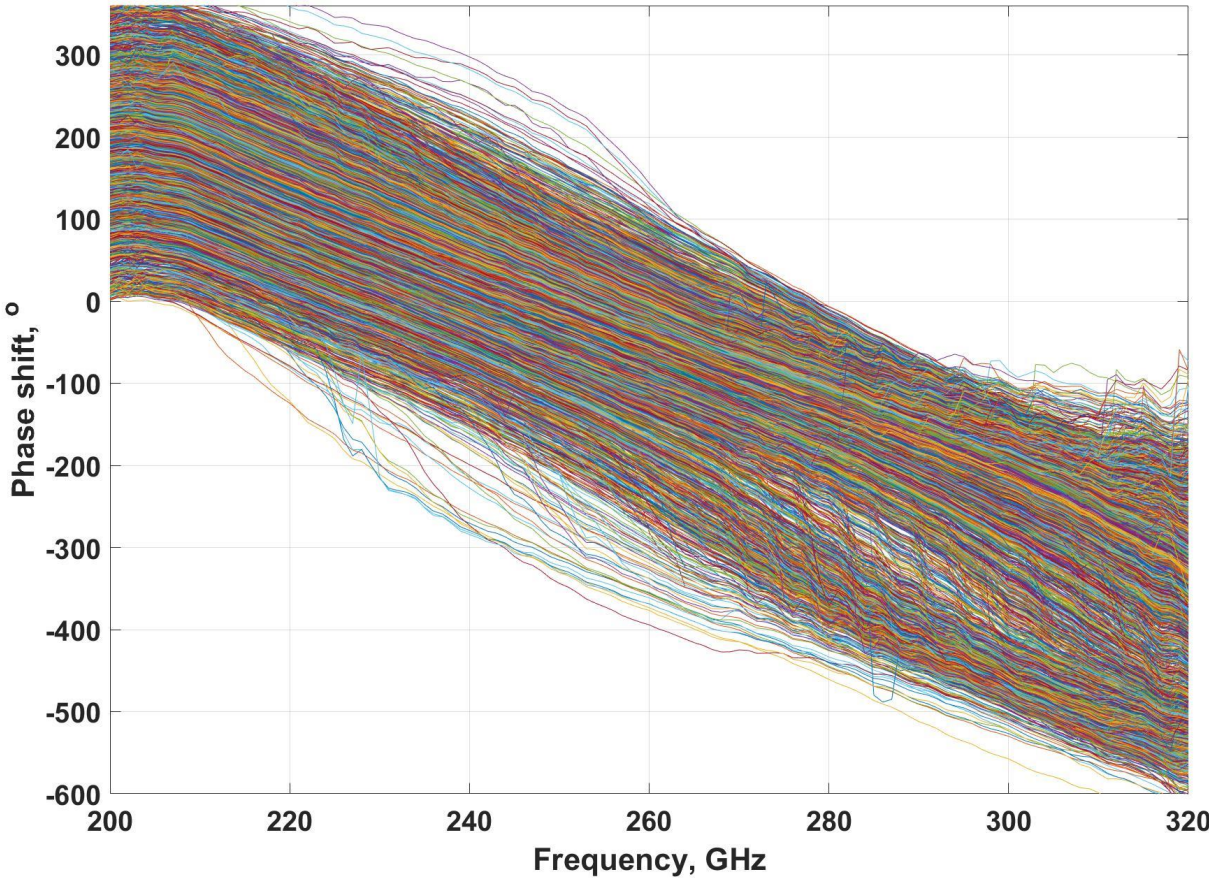


Measured insertion loss of attenuator as a function of frequency for every attenuation state from through-state to 8 active stages.

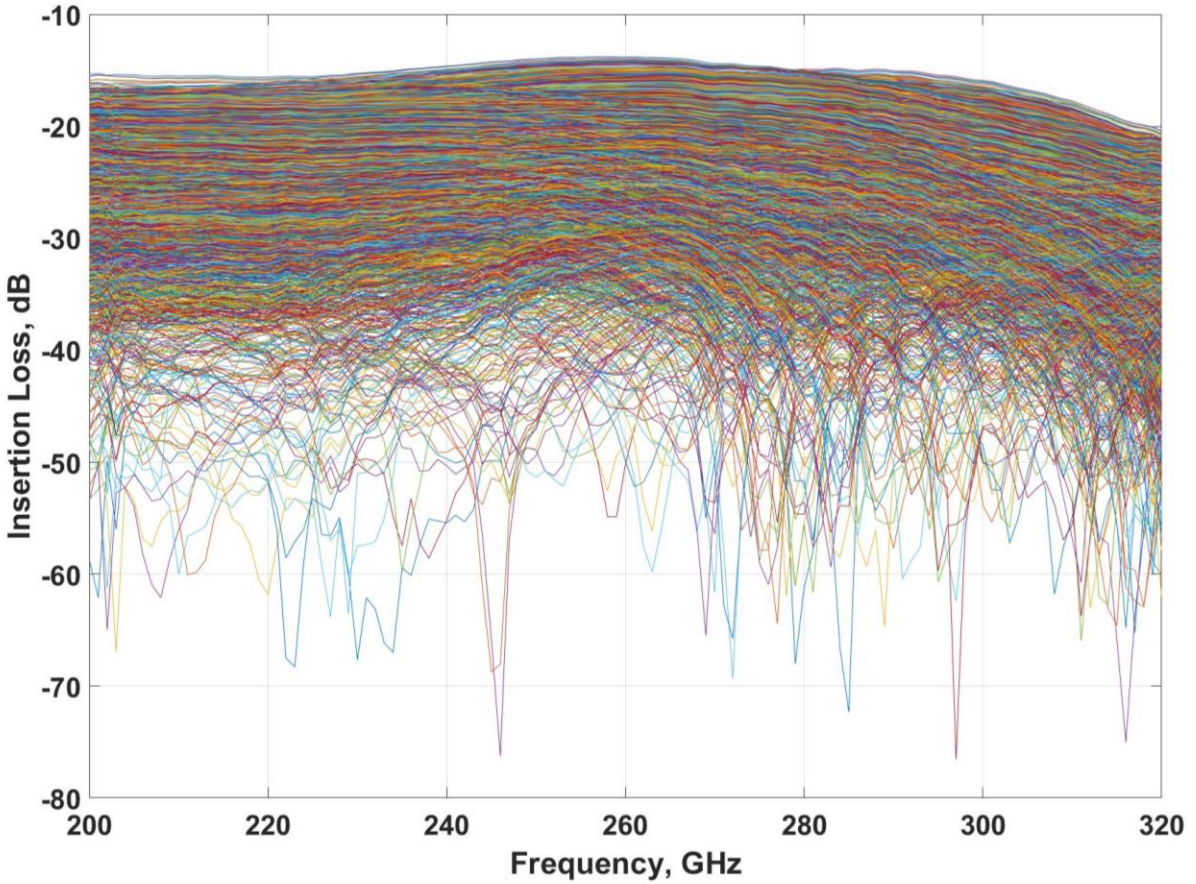
Results: Chip photo



Result: Vector Modulator

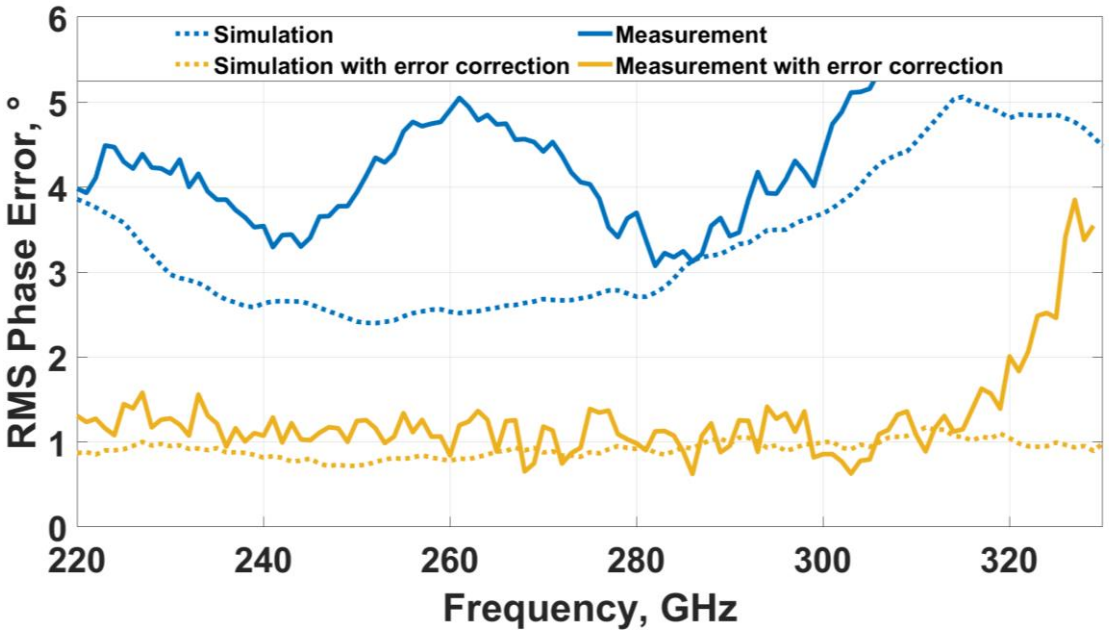


Measured phase shift over frequency for every possible attenuator state combination

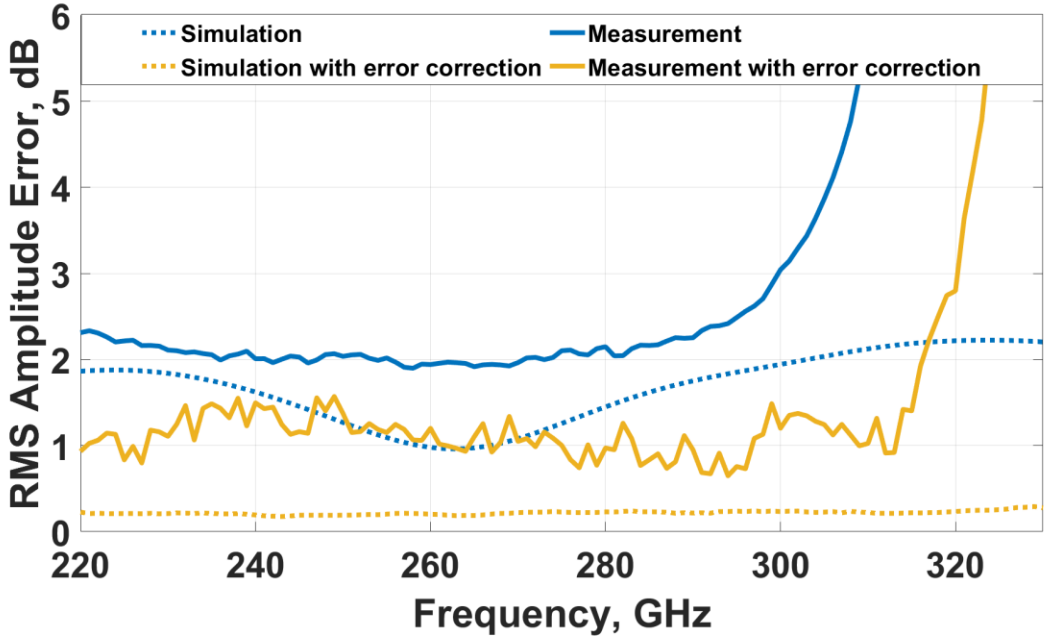


Measured insertion loss over frequency for every possible attenuator state combination

Results: Vector Modulator

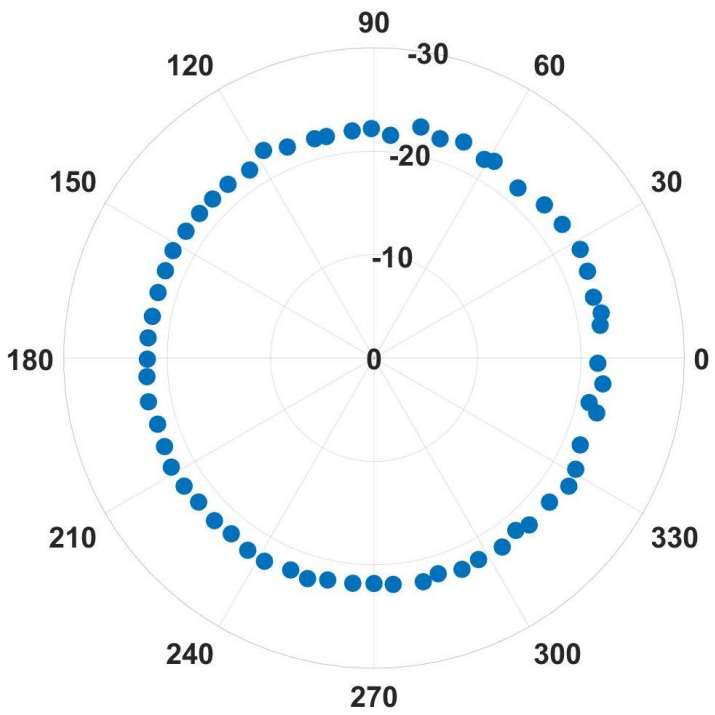


Comparison between measured and simulated RMS phase error

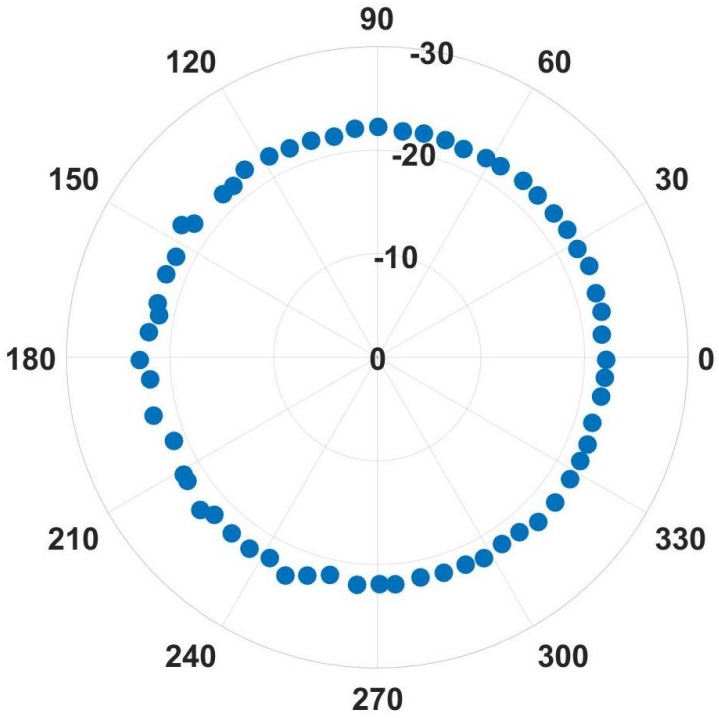


Comparison between measured and simulated RMS phase error

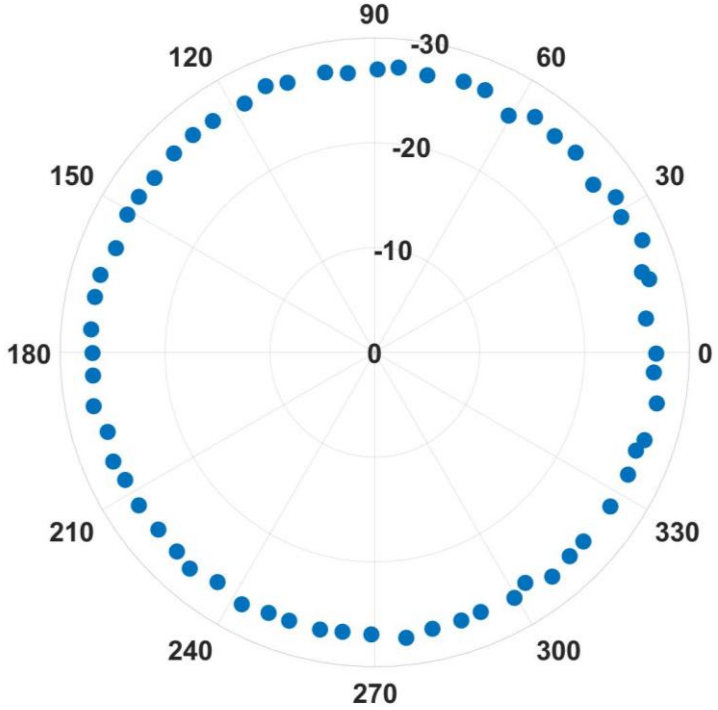
Results: Vector Modulator



Measured constellation diagram at 200 GHz with 6-bit resolution



Measured constellation diagram at 250 GHz with 6-bit resolution



Measured constellation diagram at 300 GHz with 6-bit resolution

Conclusion

An vector modulator was developed which offers:

- ❑ 200 GHz – 300 GHz bandwidth
- ❑ 6–bit resolution
- ❑ RMS Phase error below 4°
- ❑ RMS Amplitude error below 2 dB
- ❑ Flexible error correction