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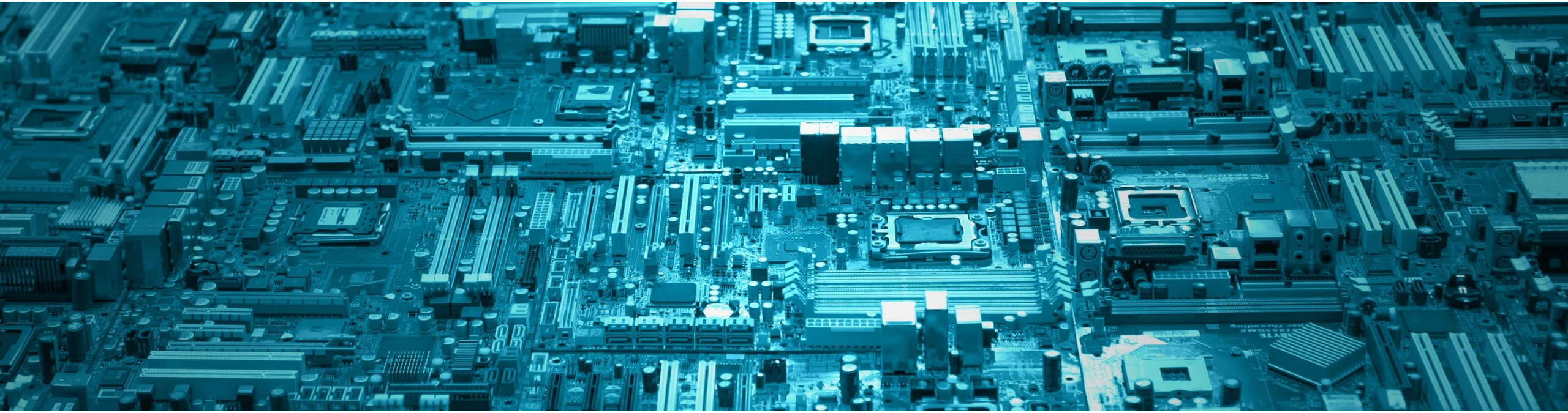
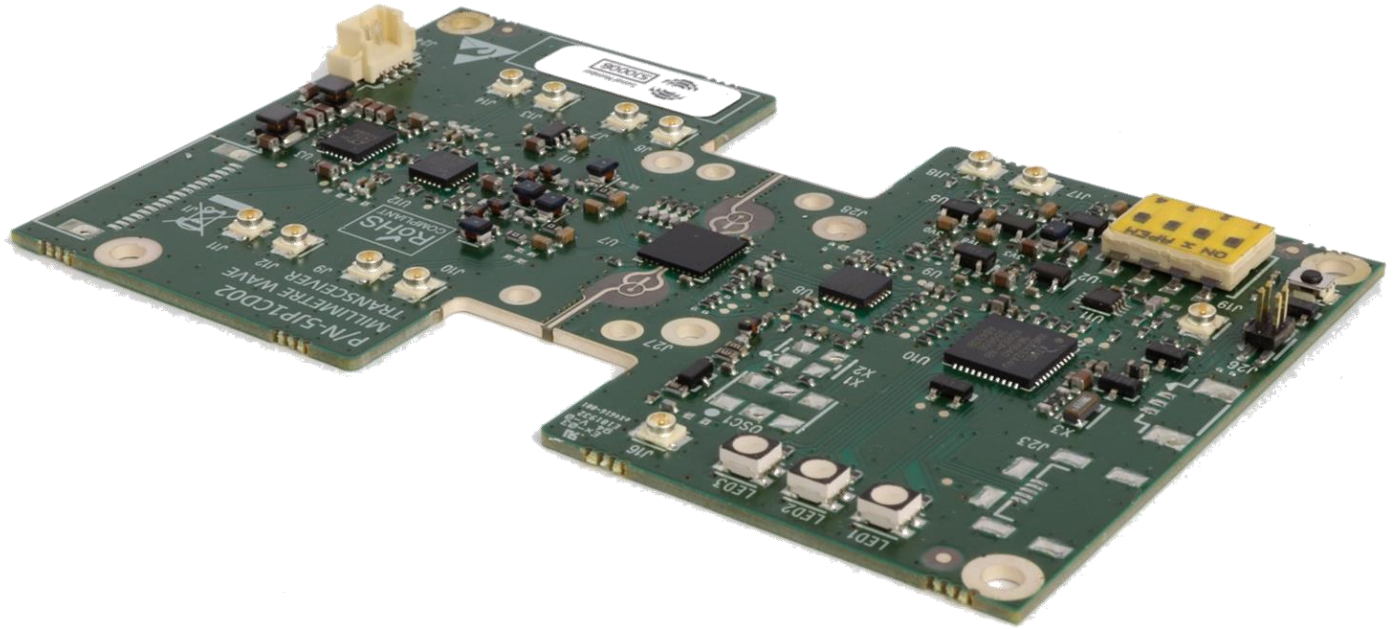


Design Considerations for the Realisation of Cost-Effective, High-Performance mmWave PCBs

James Henderson, Consultant Engineer, Plextek

What is the presentation about?

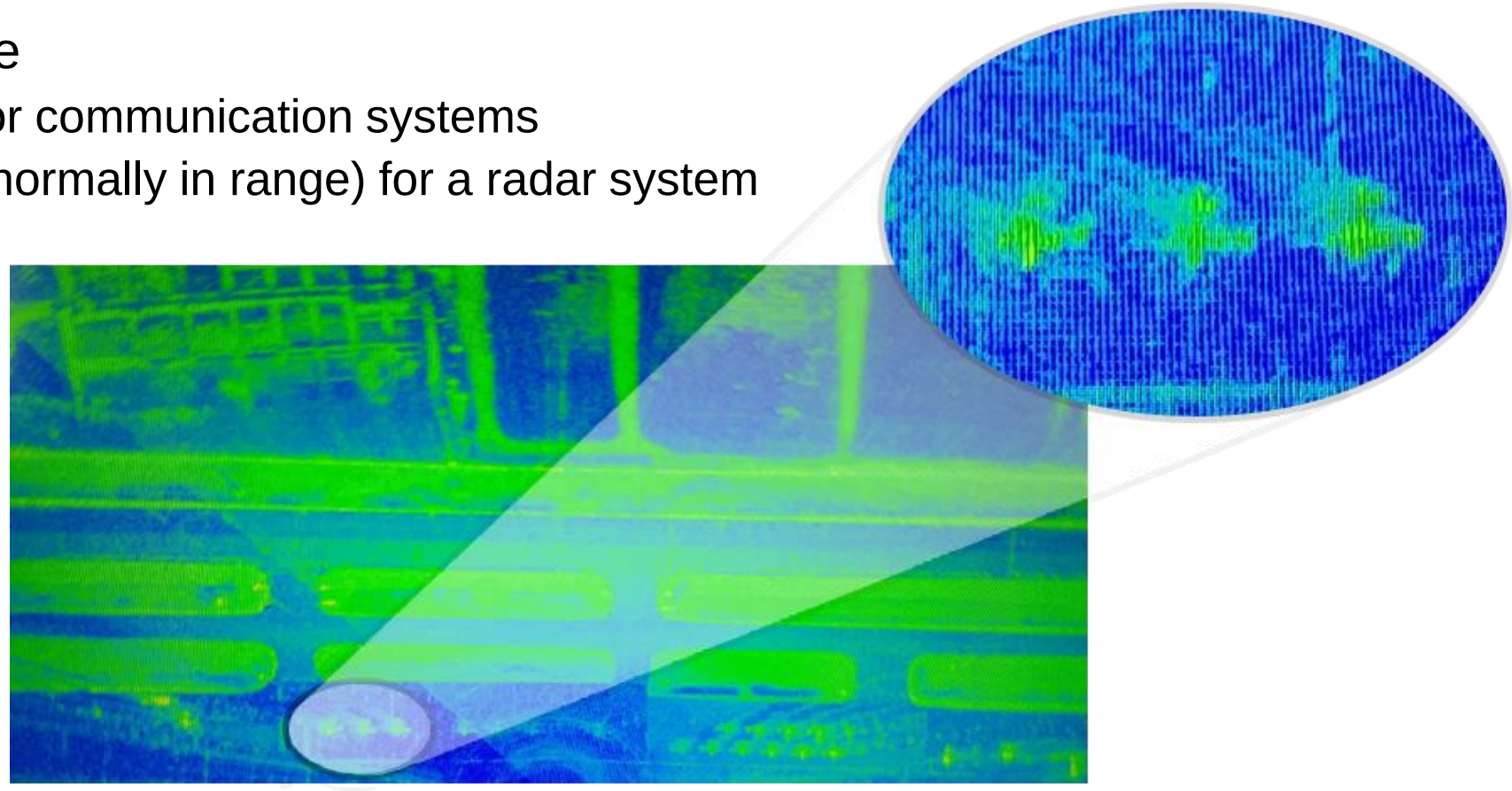
- Experience with designing mmWave PCBs for a variety of different applications
- The challenges faced with producing designs at this frequency range that will work and can actually be manufactured!
- What is the future of mmWave circuit design



This Slide Again!

Why Operate at mmWave?

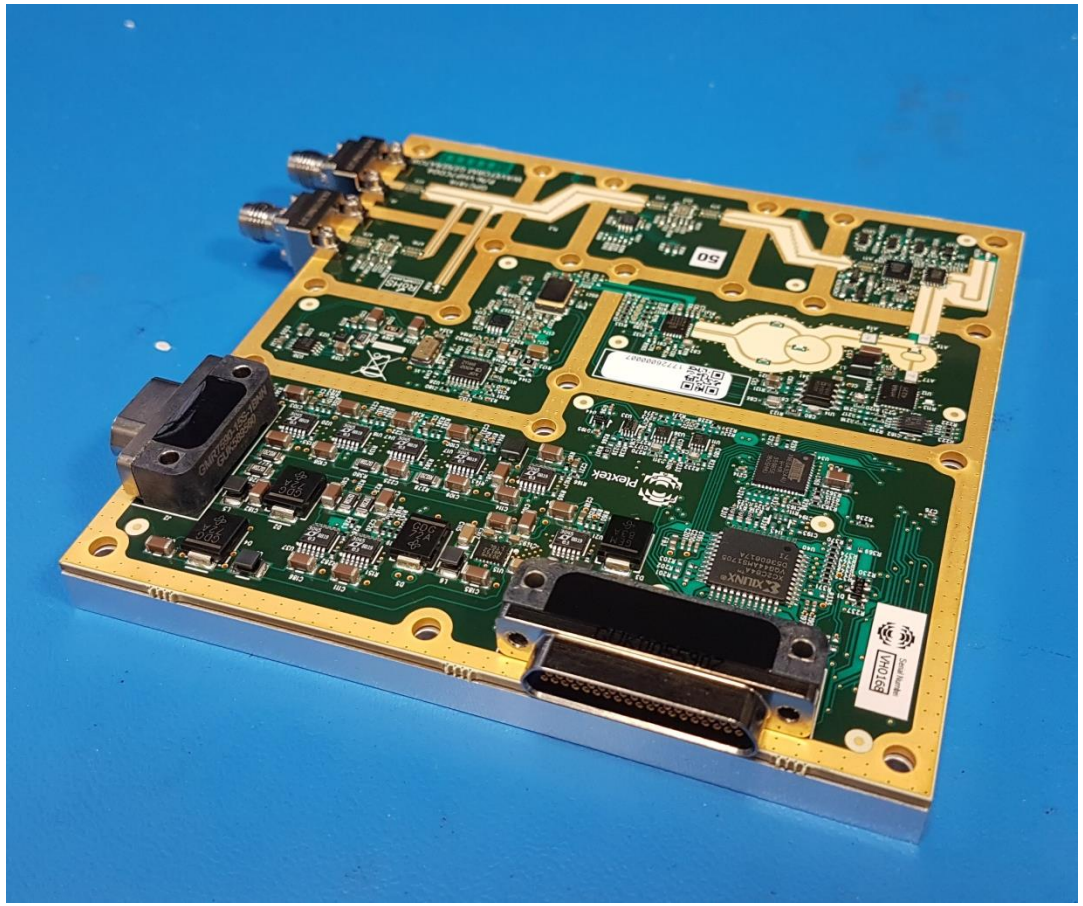
- Large bandwidth available
  - Offers high data rates for communication systems
  - Allows high resolution (normally in range) for a radar system
- Short wavelength
  - Allows compact, highly directive arrays
- Free-space wavelength measured in millimetres
  - 1 mm to 10 mm
  - 30 GHz to 300 GHz



What can be done on PCB

SMT Technology at mmWave

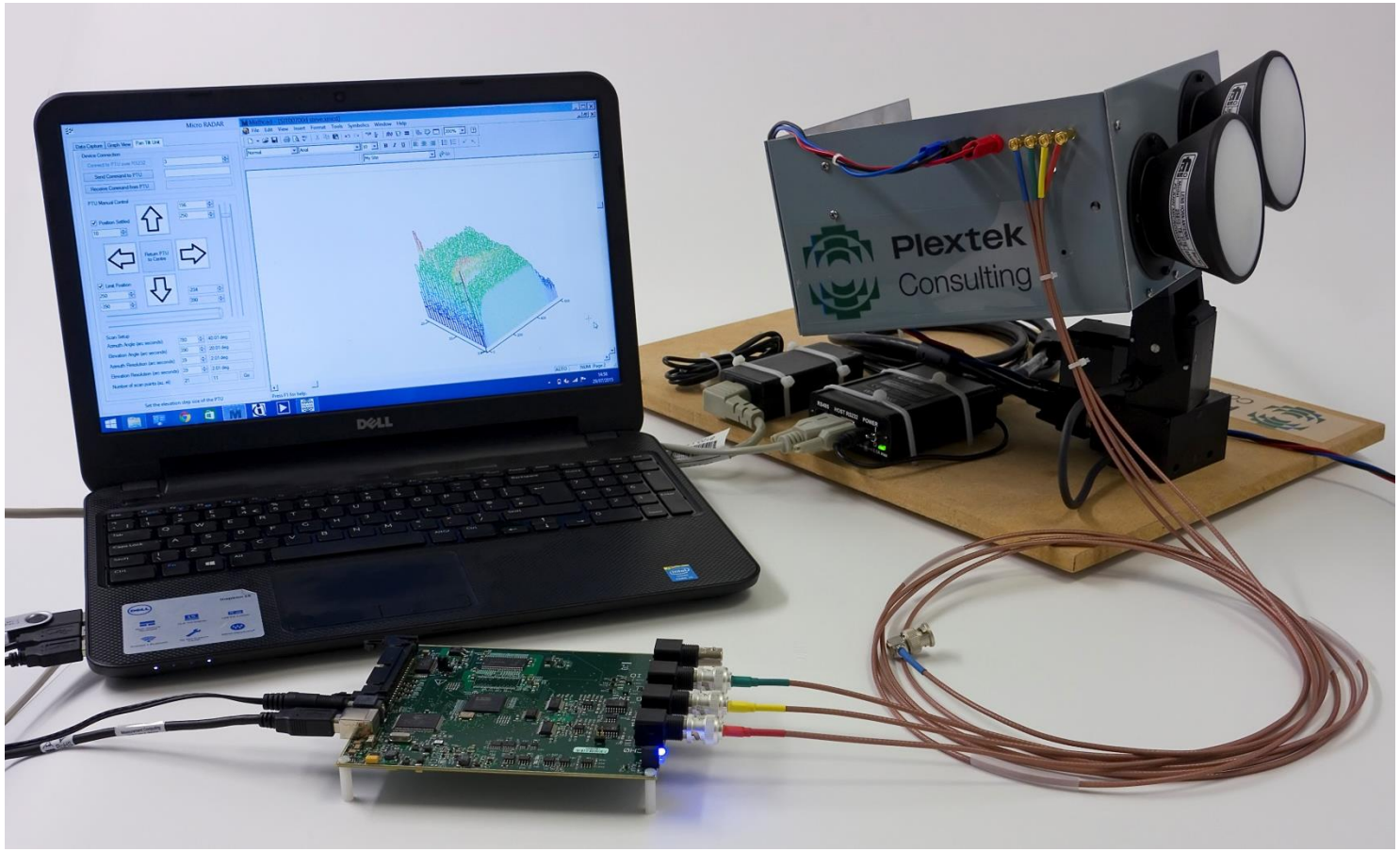
- Packaged devices currently suitable for SMT (surface mount technology) available up to 86 GHz
- Up to 40 GHz techniques akin to microwave design can be used
- Beyond 40 GHz devices tend to be highly integrated



Where Did it Start?

mmWave FMCW Radar Design

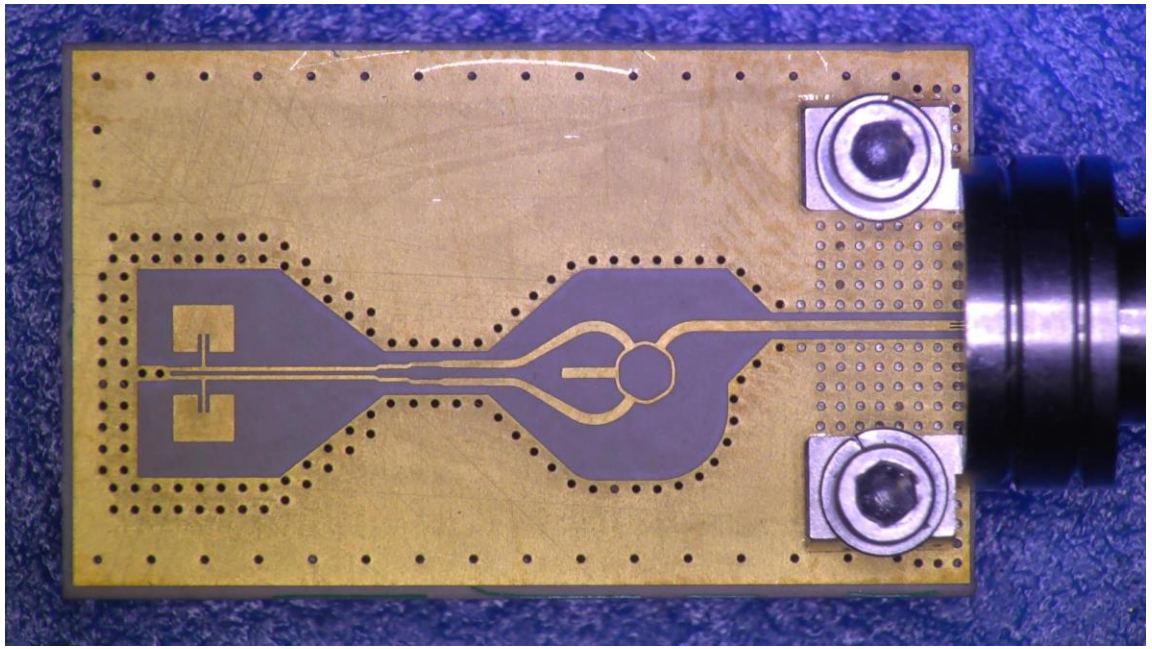
- Can we repurpose automotive radar for use on a small UAV?
- Automotive radars modules are difficult to buy
- Too highly integrated to repurpose for our requirements
- Possible to buy evaluation modules for mmWave chipsets
- Able to develop our own mmWave radar demonstrator



PCB Design Rules

What are the limitations when designing a PCB?

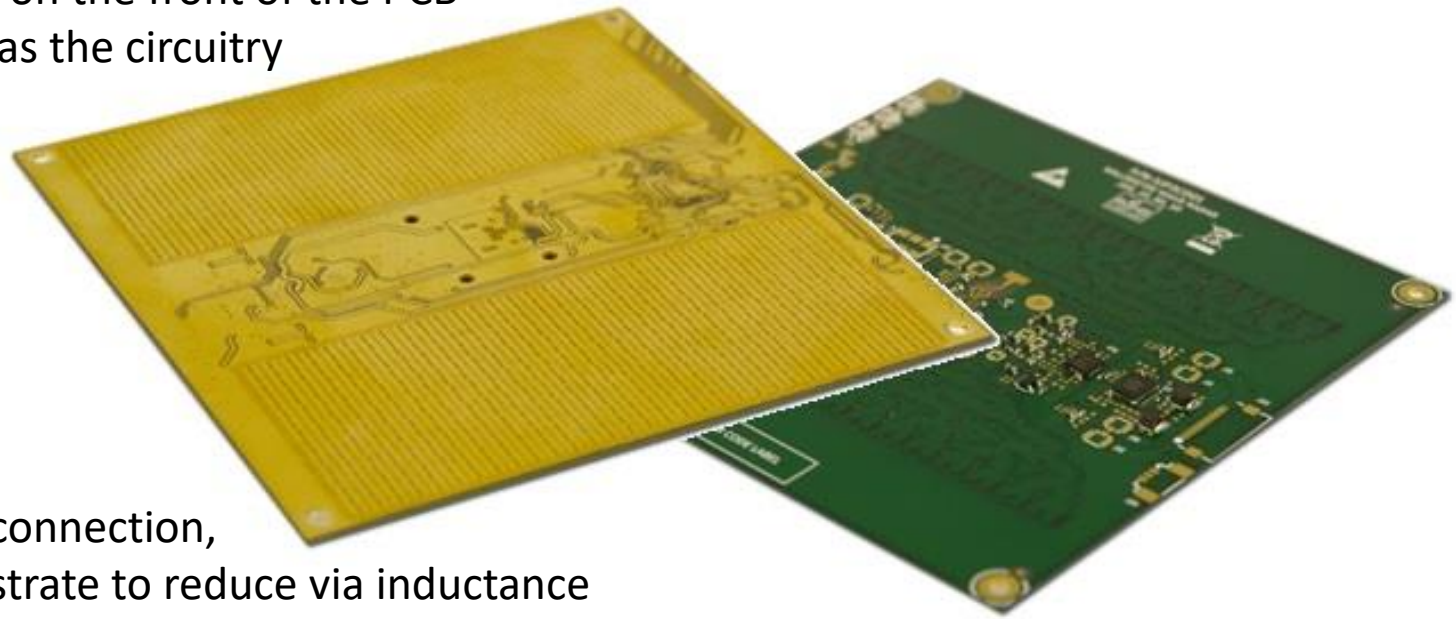
- Minimum track width
- Minimum copper gap
- Location of vias
- Via connections
- PCB substrates
- Copper losses



Combined Antenna Array and Electronic Circuitry

Design

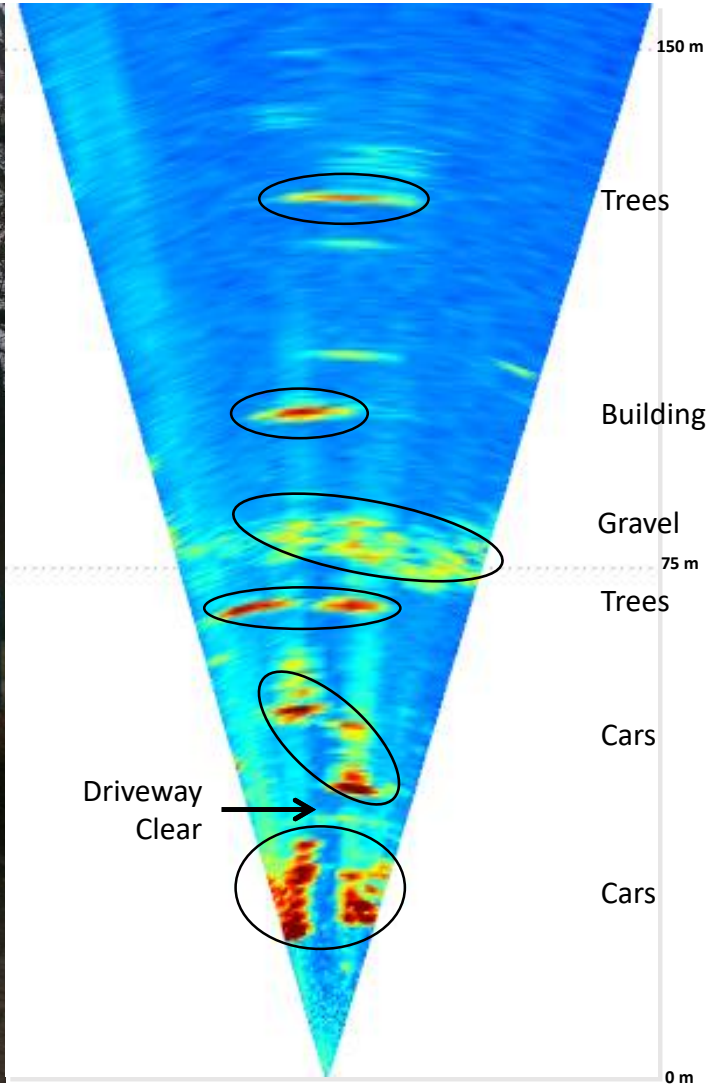
- Electronical circuitry on the back of the PCB
- Two 512-element (32 x 16 element) arrays on the front of the PCB
- Corporate feed network on the same side as the circuitry
- mmWave signal fed through the board to the elements on the front
- Single transceiver up-converts the signal to mmWave so the only mmWave inputs/outputs were the Tx and Rx ports



Challenges

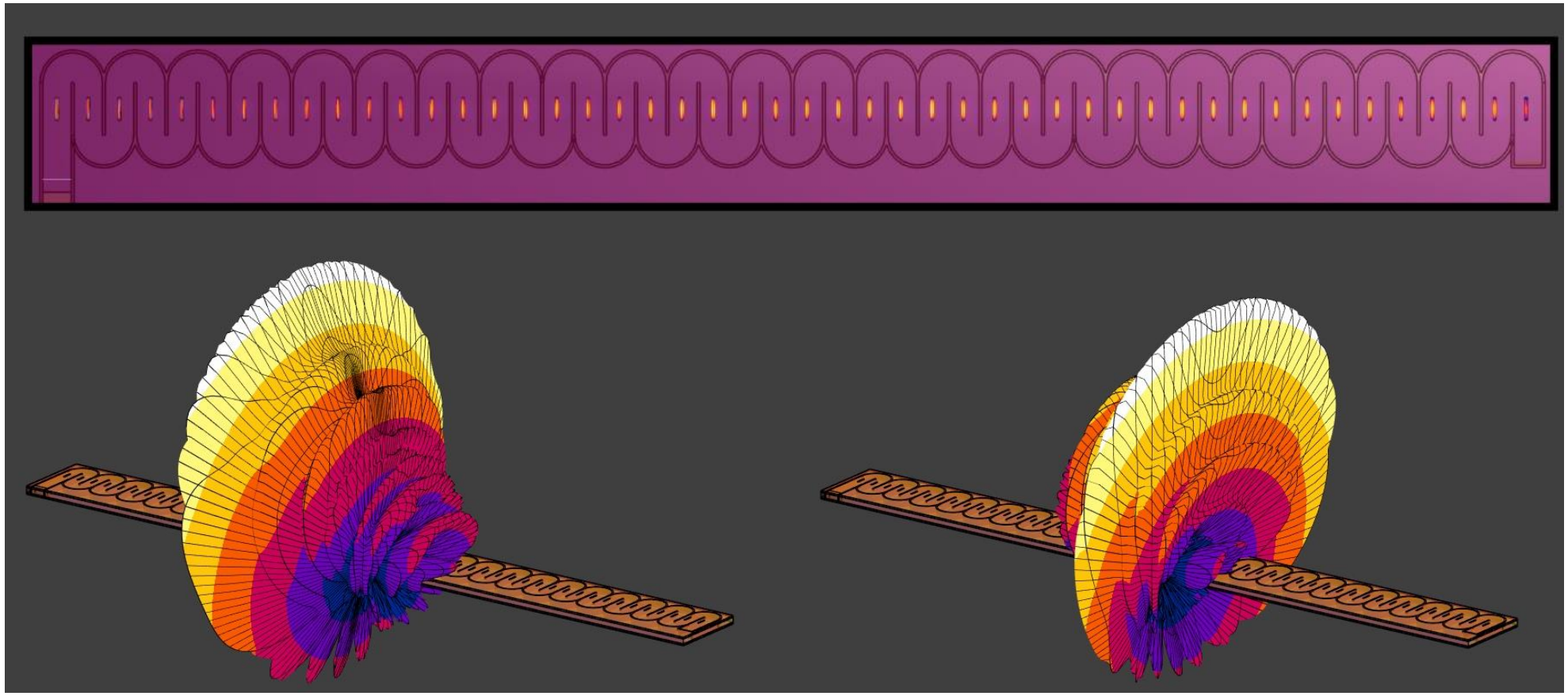
- mmWave chipset requires a good ground connection, therefore, it must be placed on a thin substrate to reduce via inductance
- Thin substrates not ideal for transmission lines and antenna designs
  - High insertion loss on transmission lines
  - Often highly tuned narrowband antenna response

mmWave Radar PCB Performance



±20° Azimuth Scan
Beam 4° Azimuth, 9° Elevation

Meanderline Antenna Design



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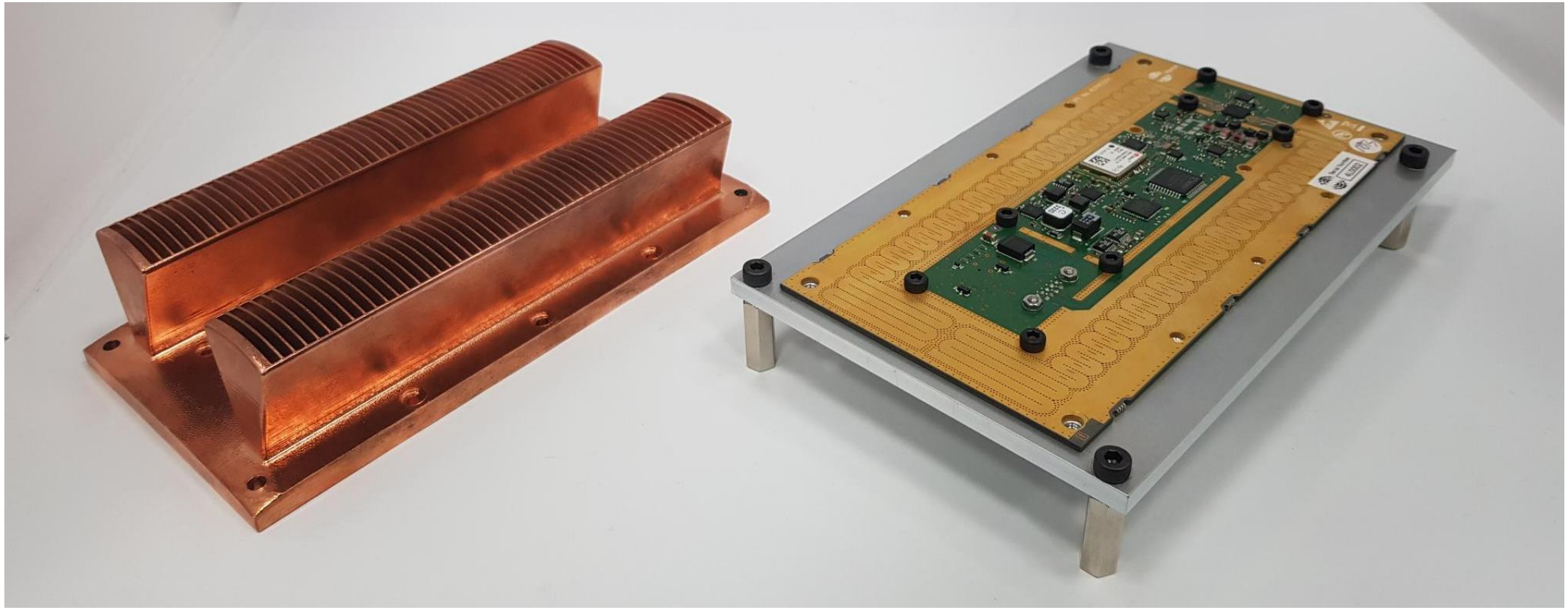
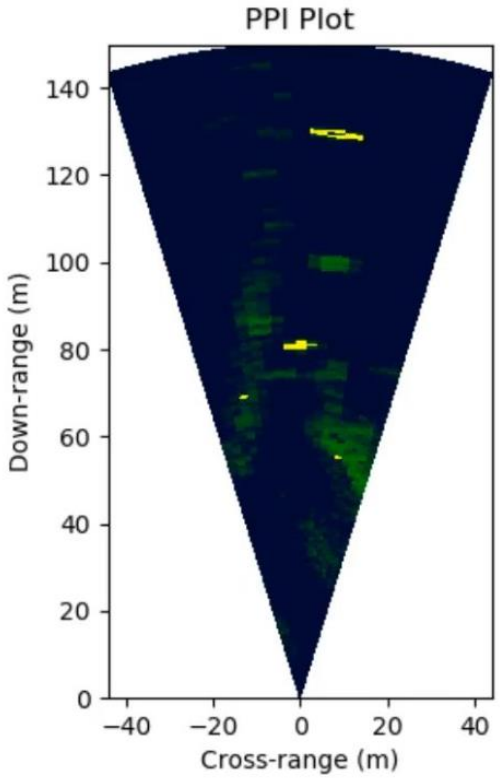
Design of an Electronically Scanned Radar

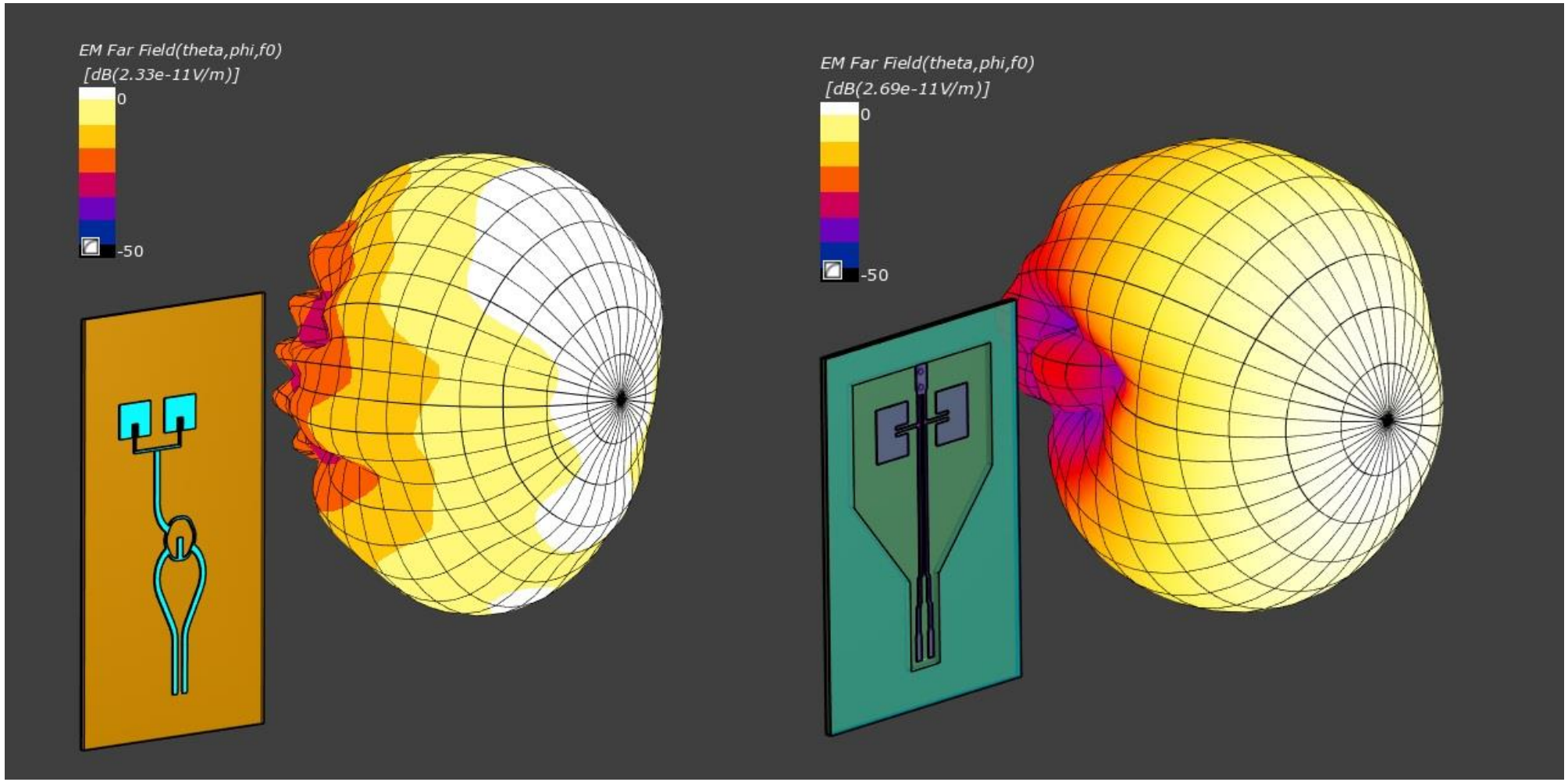


Electronically Scanned Radar Performance



Plextek **Millimetre Wave μ-Radar** A day/night, all weather situation awareness sensor

Subsequent Designs – Communication Systems



Conclusions

It is possible to design high performance and low cost mmWave PCBs

Whilst challenging, mmWave PCBs do offer a cheaper solution for operation in some mmWave bands to other techniques

Only by considering all aspects of the design can the optimum solution can be understood

Some of the best solutions are the unusual ones, so its good to think outside the box