Radar Design and Signal Processing

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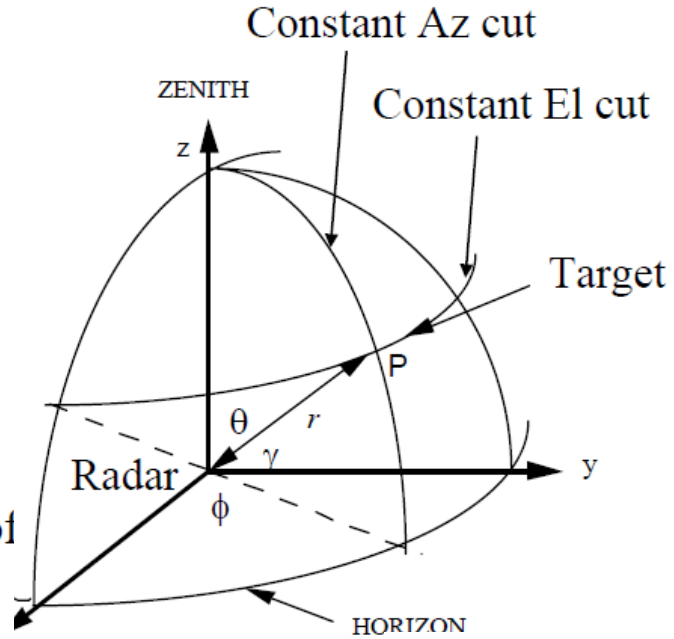
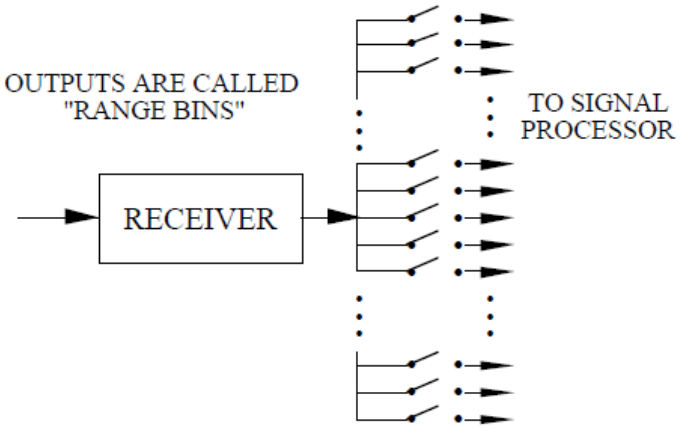
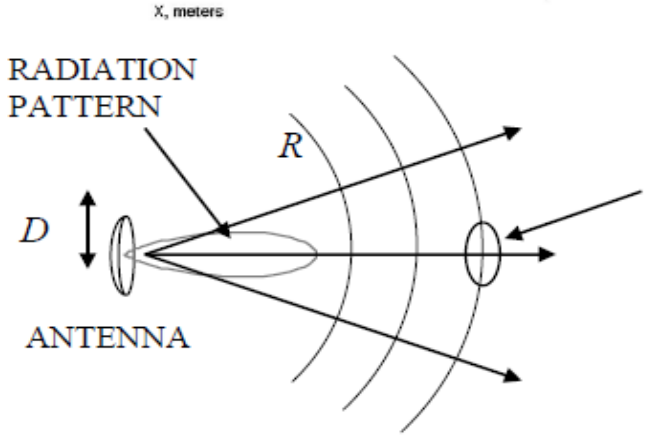
Radar fundamentals

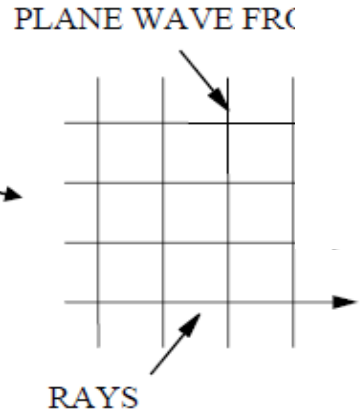
- Normal radar functions:
  1. range (from pulse delay)
  2. velocity (from Doppler frequency shift)
  3. angular direction (from antenna pointing)
- Signature analysis and inverse scattering:
  4. target size (from magnitude of return)
  5. target shape and components (return as a function of direction)
  6. moving parts (modulation of the return)
  7. material composition
- The complexity (cost & size) of the radar increases with the extent of the functions that the radar performs.







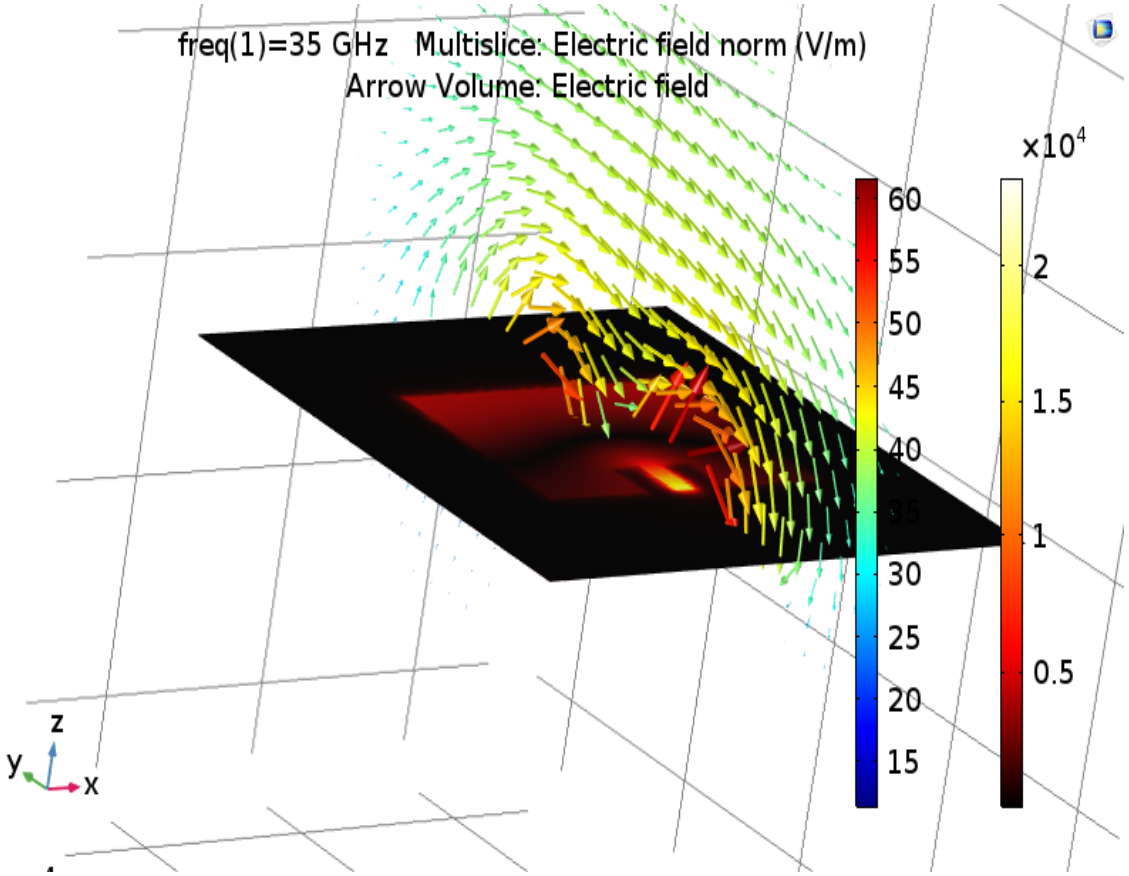
Local region in the far field of the source can be approximated by a plane wave

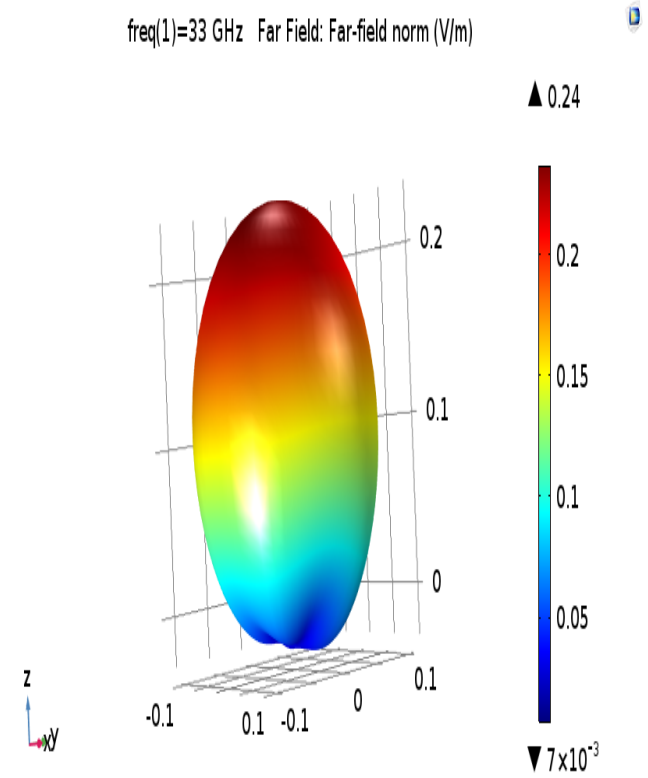


[1] US naval school notes on Radar

Antenna Design with COMOL

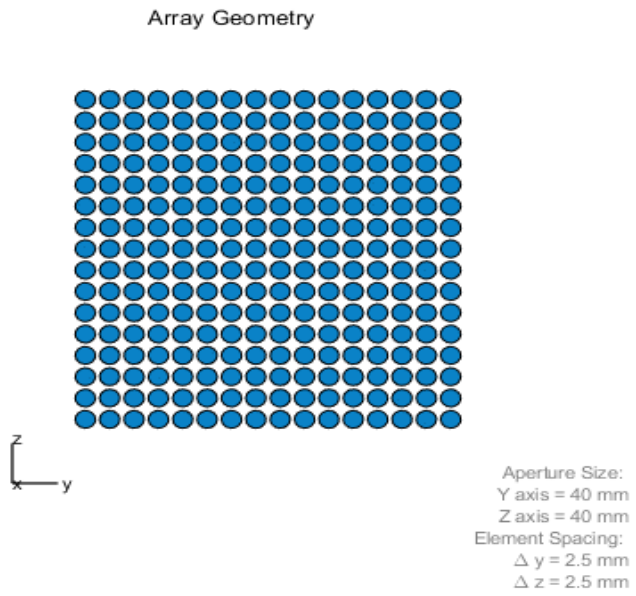
I designed an Antenna that will operate at 5G frequency , which is the next generation domain for communication .

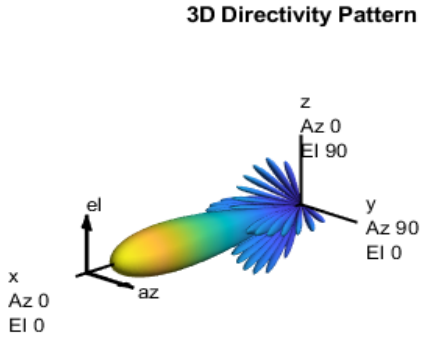


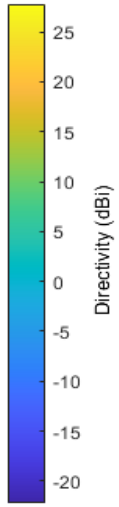


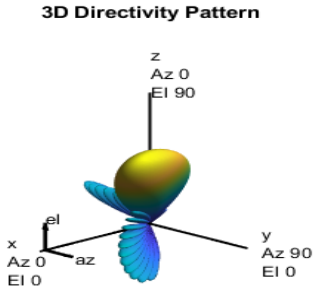
Patch Antenna

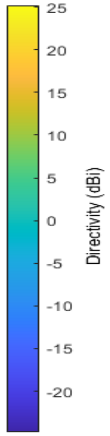
Antenna Array with MATLAB







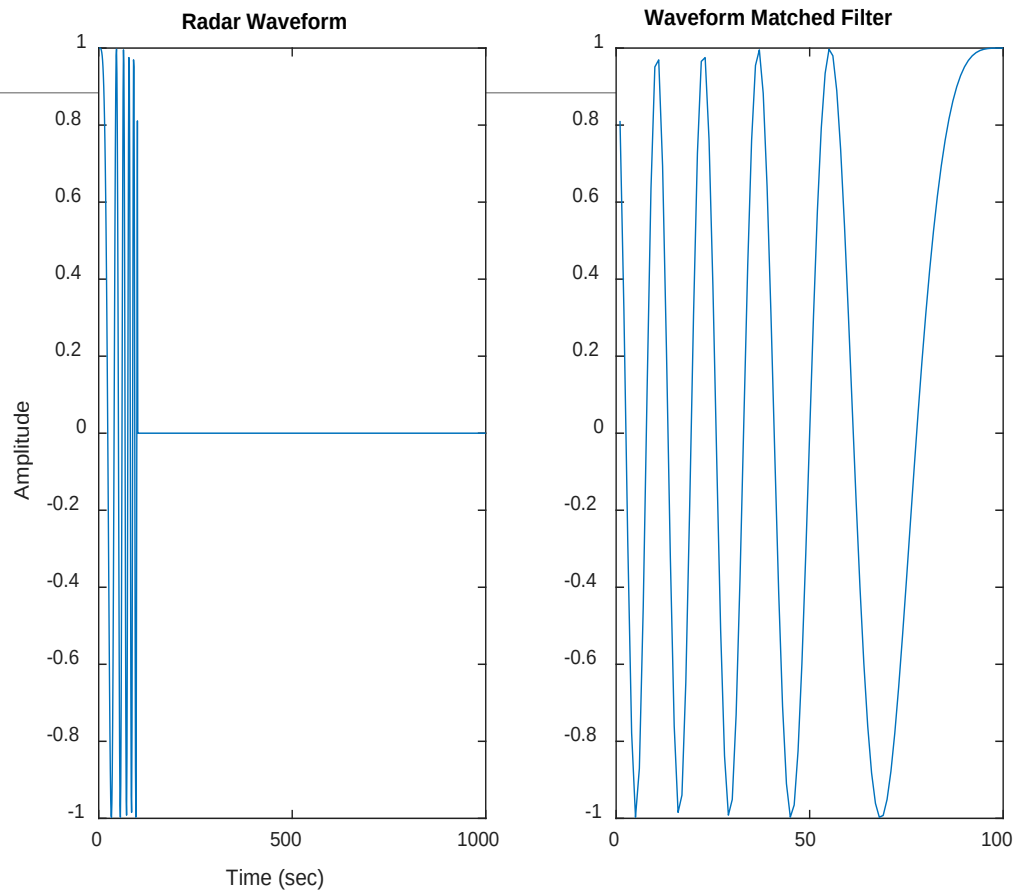




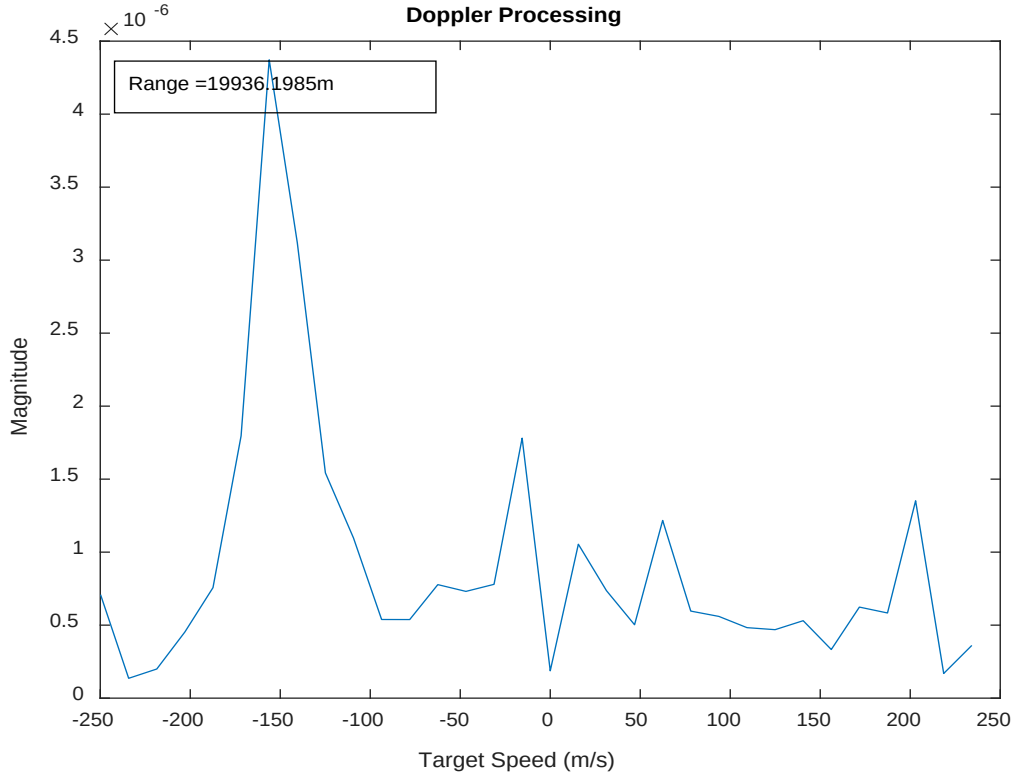
We are interested in “ Pencil “ sharp directivity

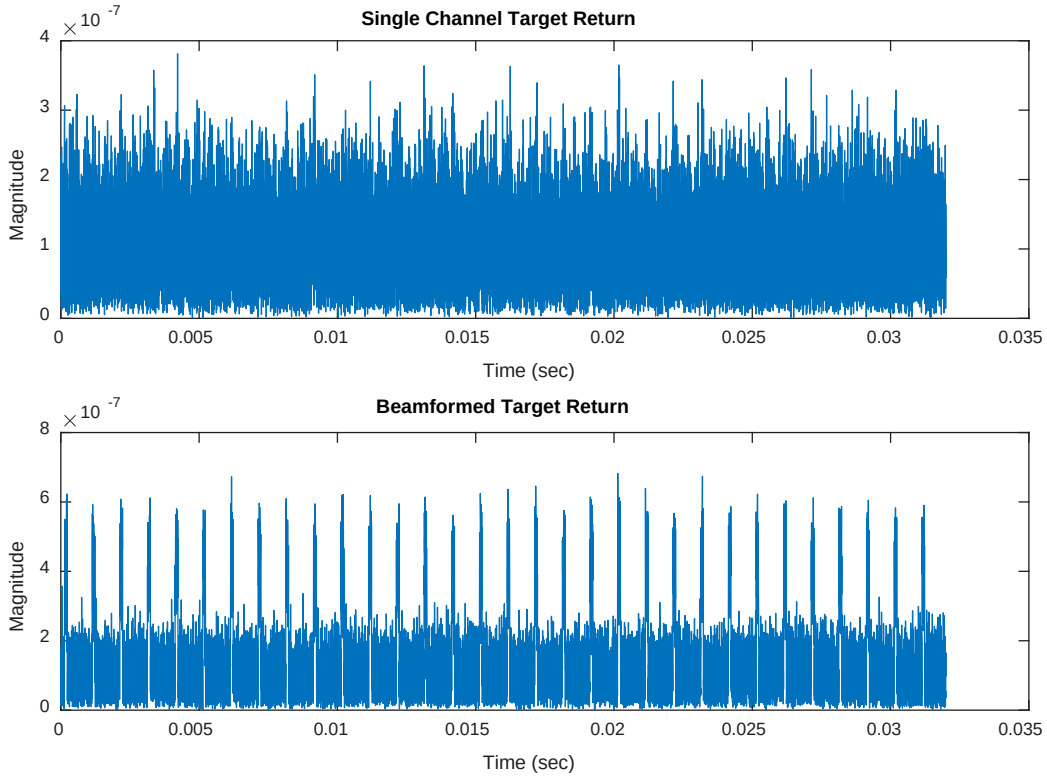
Code from Mathworks : RadarCubePart2

```
 ...
Transmitter Specs
TX=phased.Transmitter('Gain',20);

% Platform Specs
PlatformModel=phased.Platform;
PlatformModel.InitialPosition = tgtpos;
PlatformModel.Velocity = tgtvel;

% Channel Specs
ChannelModel = phased.FreeSpace;
ChannelModel.TwoWayPropagation=true;

% Tx ans Rx Specs

txArray = phased.Radiator(...
    'Sensor',antenna,...
    'OperatingFrequency',432e6); [2]
```

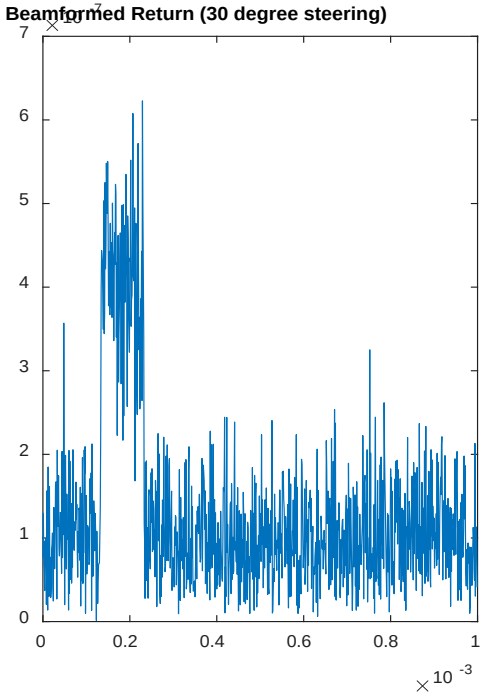


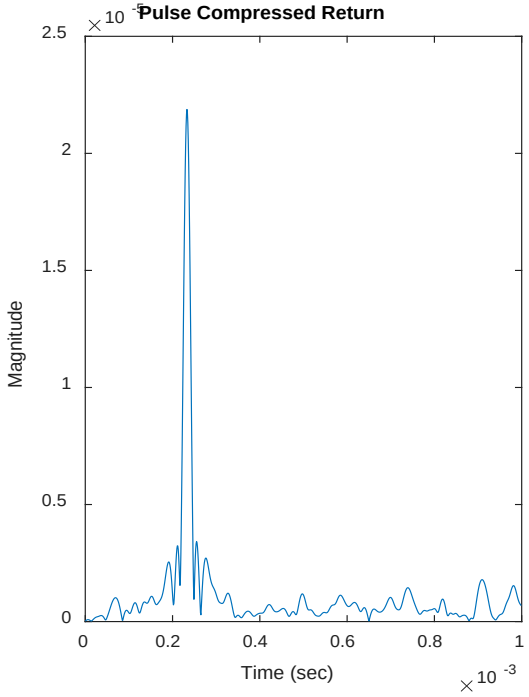
Speed Characteristics f=432MHz

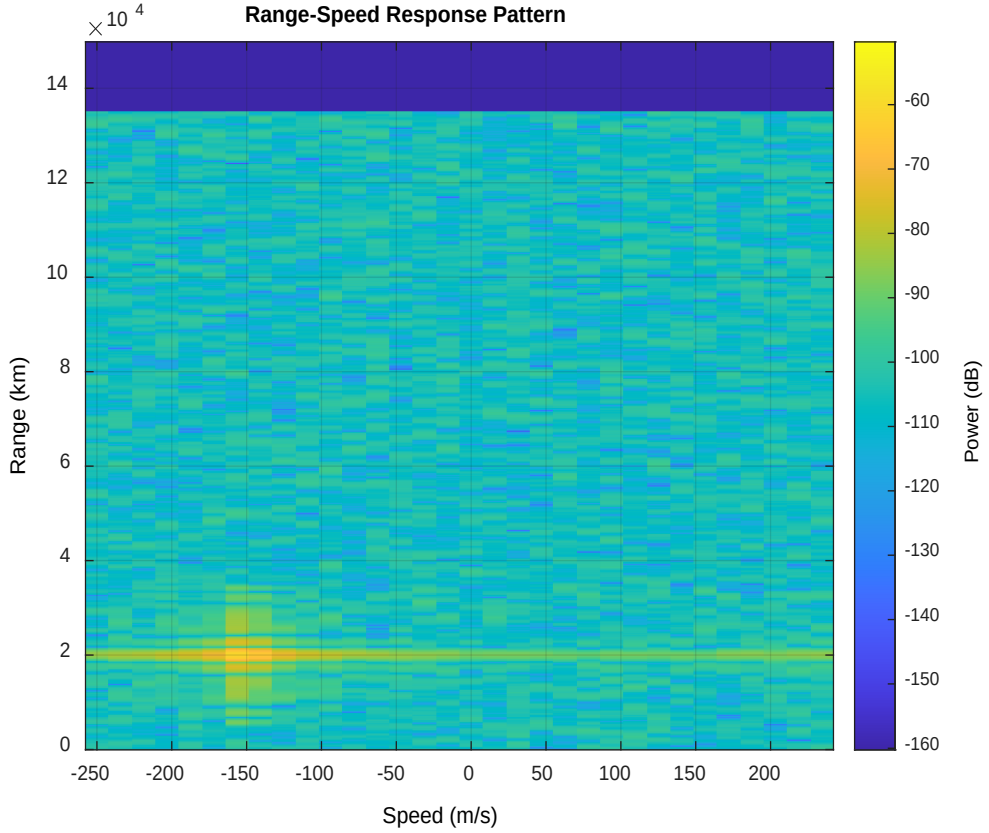




More Results







Conclusion

-We have shown how smart Antenna are designed at Fundamental level with COMSOL Multiphysics.

-We have assembled these antennas at System level to create arrays which are used for high directivity

-We have outlined analyzed signals from a typical Radar device

-We are interested in addressing issues with Controls for Radar and Lidars

References

[1] Notes from US Naval school on Radars

[2] Mathworks (Matlab code)

Acknowledgments

We are very grateful for the continuous support of Ohio Space grant Consortium and for our College of Professional studies who have always supported us to push for quality research and student engagement.