



Radar Interference Mitigation Strategies; Advances and Key Challenges

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Innovate UK

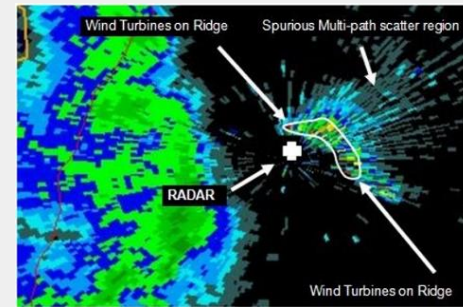
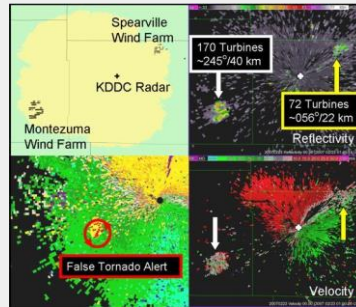
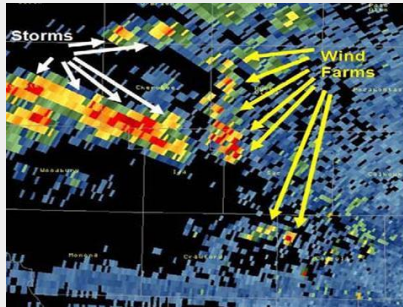




Background and challenges

Background

- Large radar cross-section (RCS) of wind turbines interfere with airport and weather radar
- This can be in the form of clutter and/or shadowing
- Military bases also object due to loss of radar vigilance and danger during training missions



Left: <http://meteorologynews.com/meteorology/windmills-interference-causing-problems-for-doppler-radar-signals/> Image Credit: NOAA

Middle and right: <https://wattsupwiththat.com/2018/04/29/noaa-nws-document-wind-turbines-affect-weather-radar-create-false-storm-impressions/> Image credit: NOAA

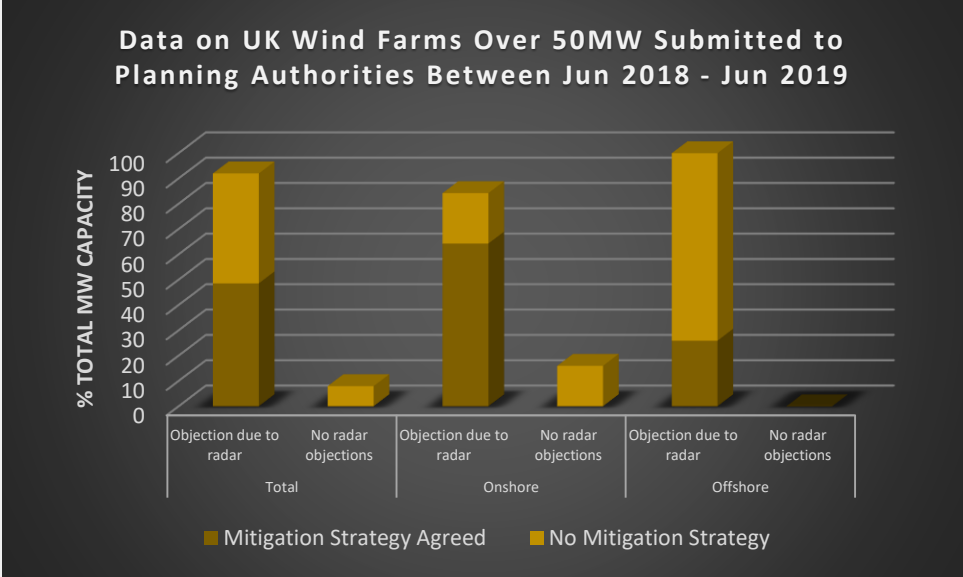
Challenges

Ever increasing background 'noise' (EM clutter)



Challenges

92% of the MW capacity of all windfarm applications in the UK between Jun 2018 – Jun 2019 met objections due to radar



*Data from UK government's 'Renewable Energy Planning Database' quarterly extract (Jun 2019)

A biplane is silhouetted against a bright, golden sunset sky. The plane is flying from the left towards the right. Below the horizon, dark, jagged clouds are visible, suggesting a storm or rough seas. The overall mood is dramatic and evocative.

How to 'future-proof' the wind industry with respect to aviation?



Current advances

Current Advances - Overview

- Current solutions include:
 - Radar software upgrade/workaround
 - Radar infill and blanking
 - New radar hardware
 - ‘Stealth windfarms’
- Need to maintain constant surveillance of all relevant air space
- Solution must be **cost effective**



Technology development

Technology Development - RAMs

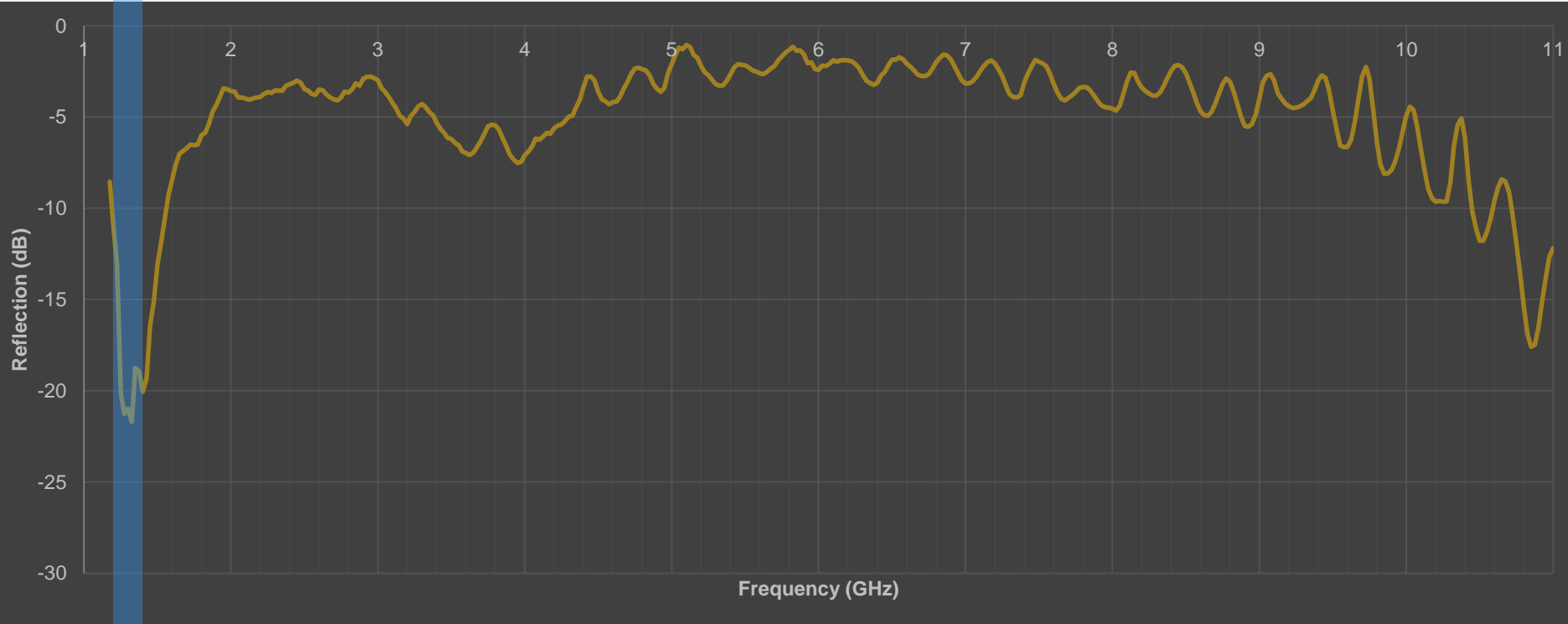
- Knowledge Transfer Partnership initiated between Loughborough University and Trelleborg
- Stealth windfarms held highest promise for research project
- Discussions with key stakeholders in wind industry and military
- RAMs developed to future proof the industry and prevent looming electromagnetic interference saturation point

The Technology Behind Frame

Full Radar Absorbing Materials and Equipment (Frame)

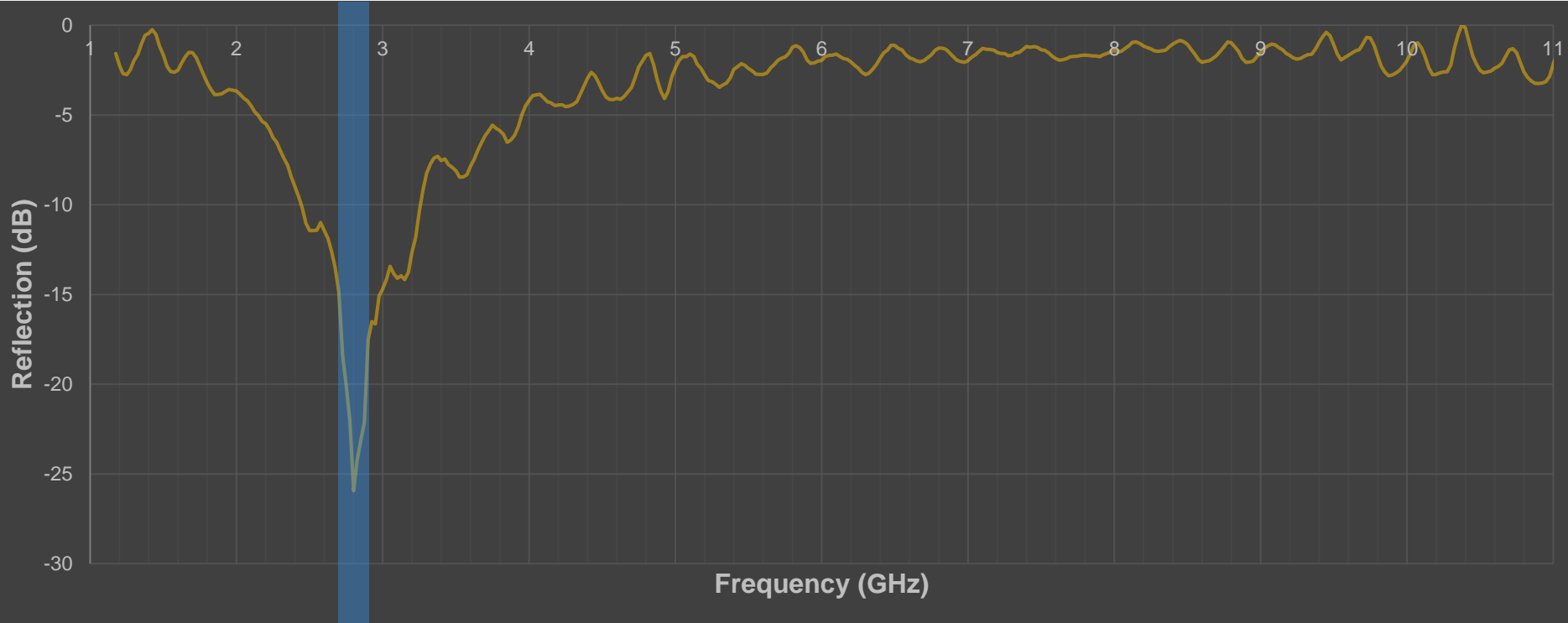
- Research at Loughborough discovered fillers for next gen. RAMs
- Fillers incorporated in polyurethane to give 'Frame' product
- We absorb over 99% of the incident radar wave to make the coated object 'stealthy'

Absorption Range



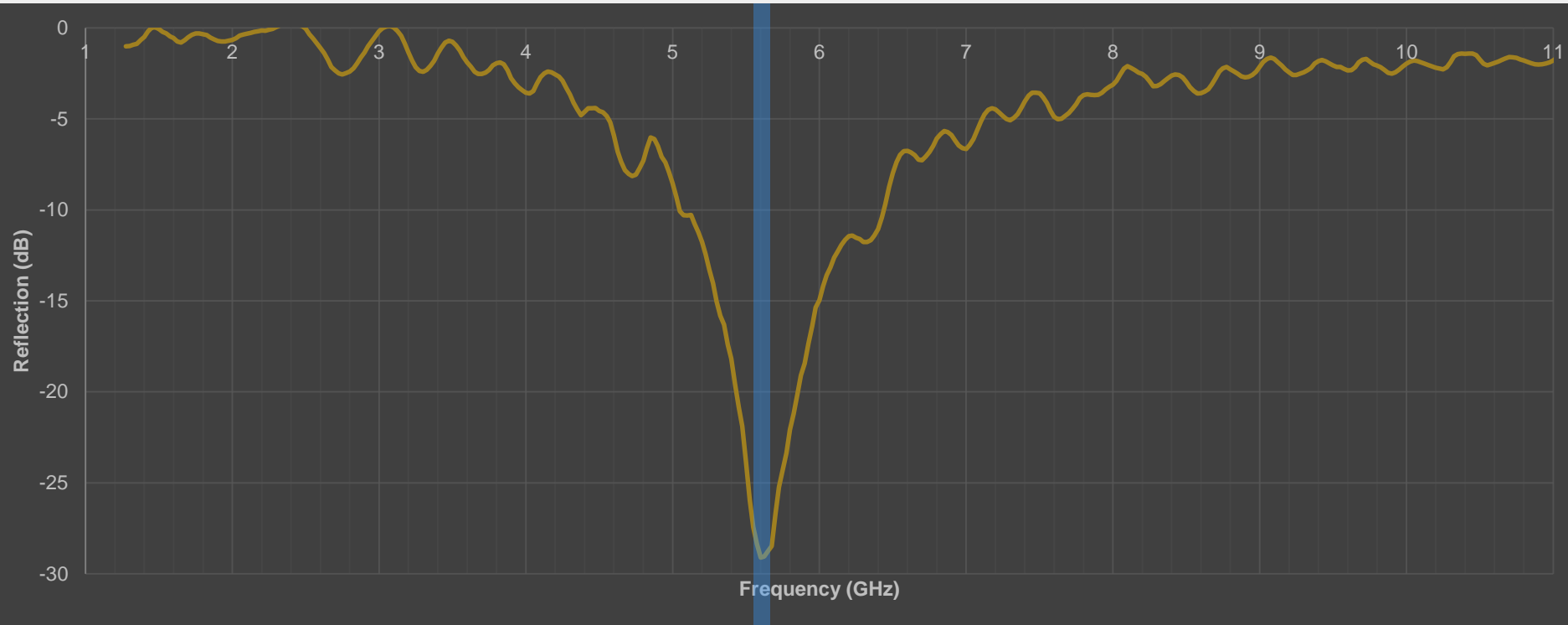
L-Band Air Route Surveillance Radar (1.2-1.4 GHz)

Absorption Range



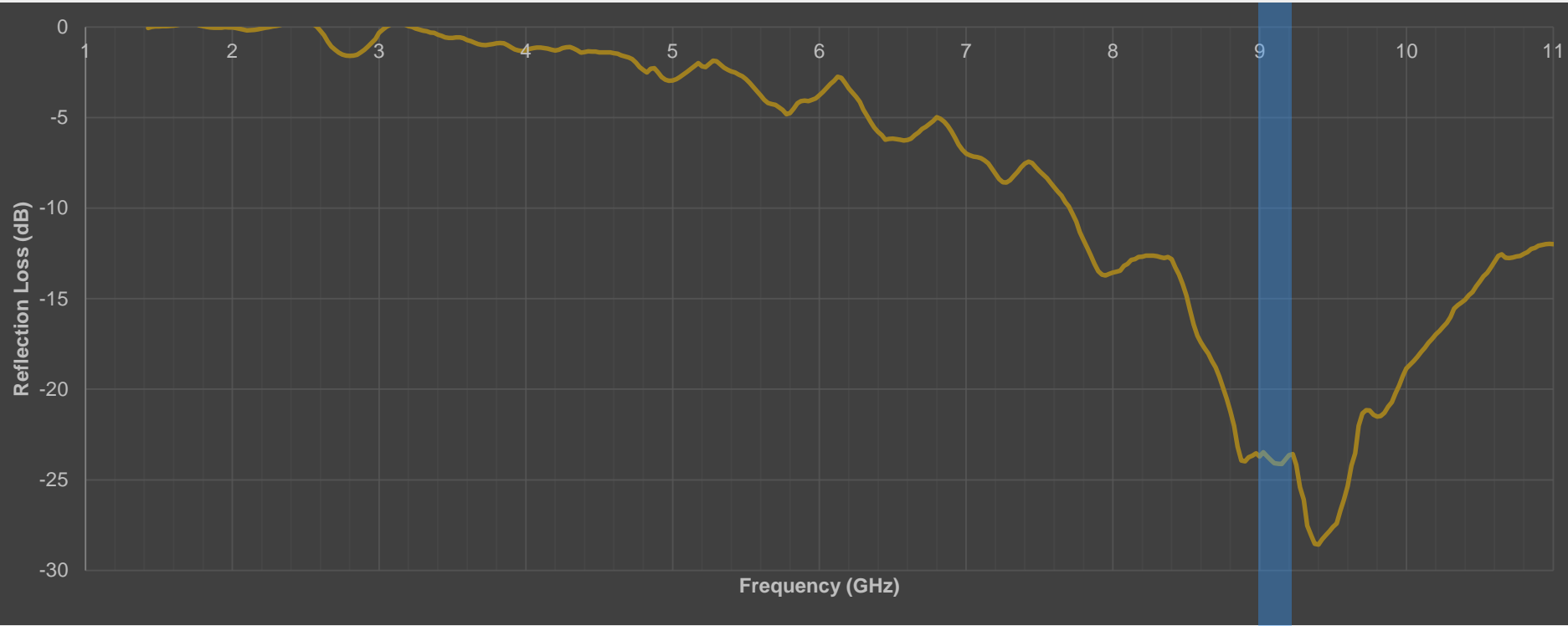
S-Band Primary Surveillance Radar (2.7-2.9 GHz)

Absorption Range



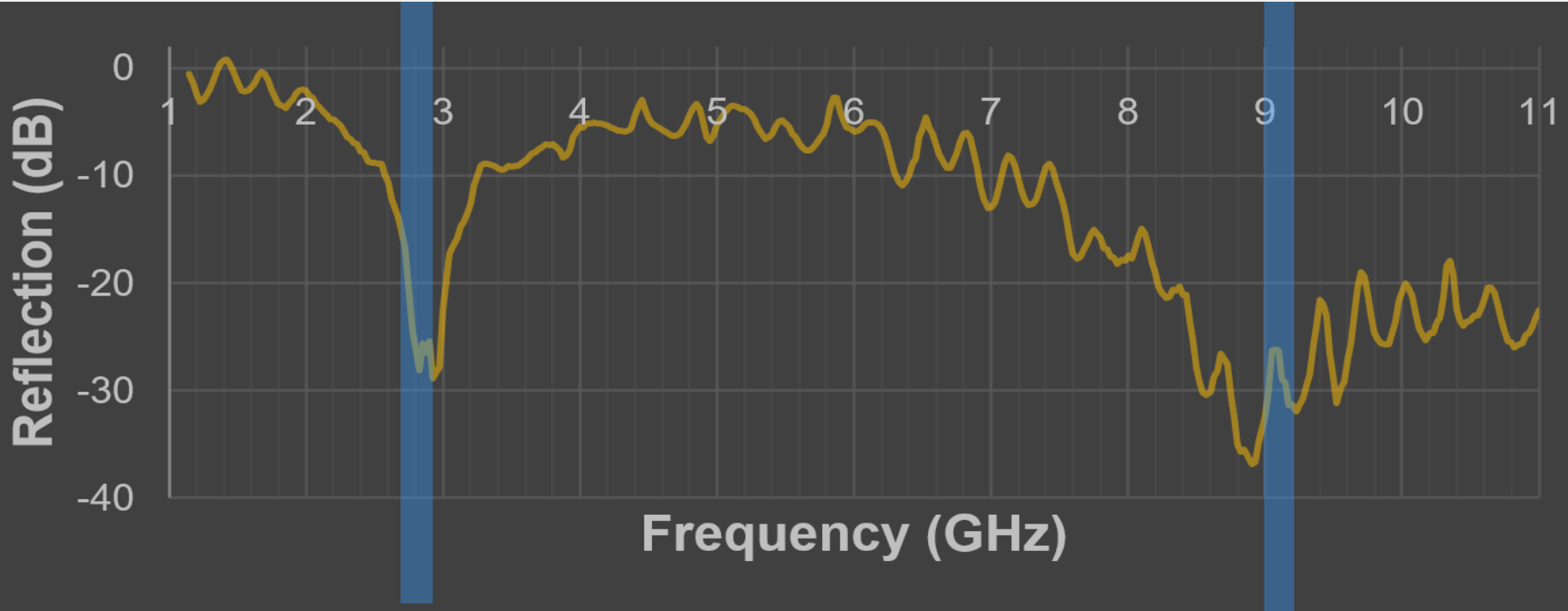
C-Band Terminal Doppler Weather Radar (5.6-5.65 GHz)

Absorption Range



X-Band Precision Approach Radar (9-9.2GHz)

Absorption Range – Multi-band Absorption



S-Band & X-Band Primary Surveillance Radar & Precision Approach Radar
(2.7-2.9 GHz & 9-9.2GHz)

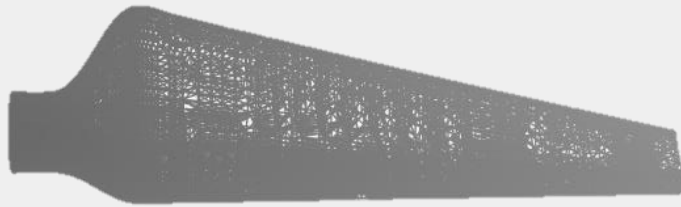
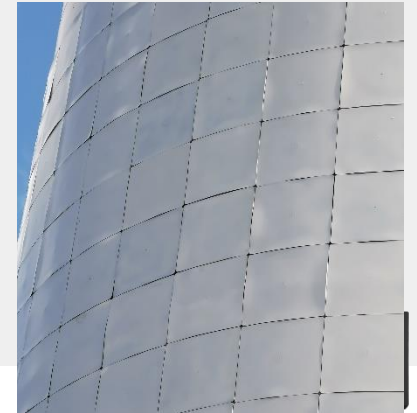
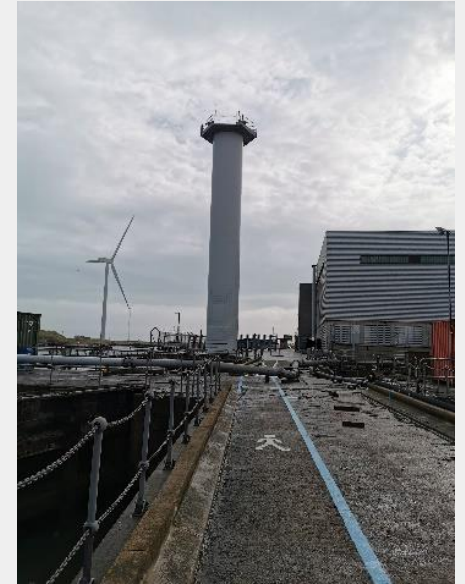


Technology Demonstration and testing

ORE Catapult Demonstration

Stealth Wind Tower

Developer	ORE Catapult
Manufacturer	N/A
Technology	L-band stealth
Date of completion	2019 (Sept.)
Tower Application	Tile/Coating
Blade Application	Fibreglass Impregnation





Summary

Summary

- Radar interference of wind turbines is an urgent issue
- No single strategy applicable for all scenarios
- Stealth materials exhibited extreme potential to solve some of these complex issues
- Our research project has demonstrated the ability to provide multi-band absorption at a low cost
- We are working with Trelleborg to provide this as a cost effective solution to wind turbine radar interference

Summary

Low input required from developer
No change of radar hardware/capabilities required
One-off upfront cost

AND

Ground up research minimises cost
Multi-band absorbers developed
Lightweight material for tower, impregnated layup for blade

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Thank you for your time