RADAR IN ACTION 02.03.2021

Parasol

Fraunhofer FHR

PARASOL

PAssives RAdar basierte Schaltung der Objektkennzeichnung für die Luftfahrt

Passive Radar based Switching of Object Identification Units for Aviation

Presented by

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AND

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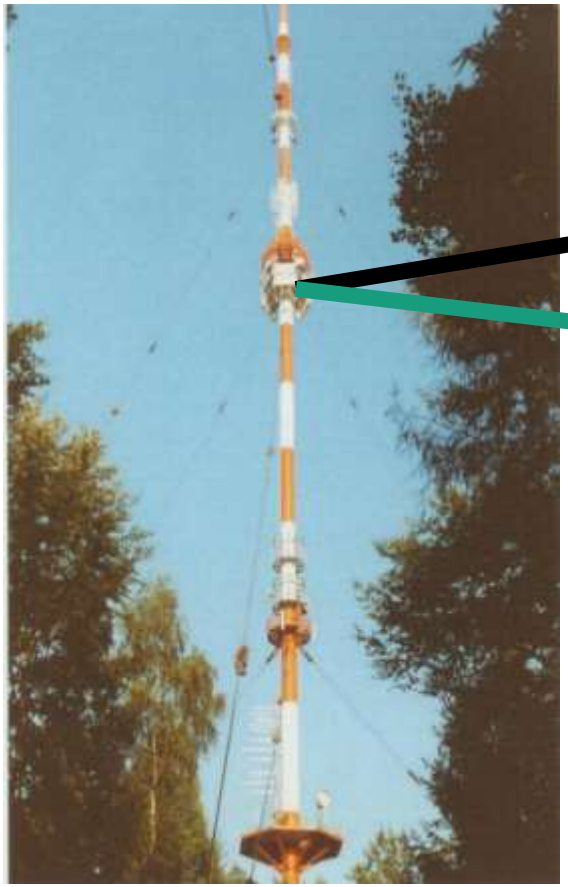
MOTIVATION

- New German Law for all wind turbines over 100 meters
- Loss of acceptance
- Anti Wind Power groups
- Bird strike
- Support of renewable energy

AIR SURVEILLANCE
ACTIVE OR PASSIVE ?

ACTIVE	*PASSIVE*
Electromagnetic Emissions	Zero Emissions
Location Dependent Frequency License required	Location Dependent Frequency License NOT required
Easy planning	Complex planning
High ranges achievable	Comparable low range
Cone of Silence	No Cone of Silence
Low-Altitude Targets hardly detectable	Good performance in low altitudes

FUNCTION BASICS OF PASSIVE RADAR
- SIGNALS AND GEOMETRY -



FUNCTION BASICS OF PASSIVE RADAR
- SIGNALS -

- DAB(+) 170-230 MHz – E.I.R.P. 4 kW
- DVB-T 470-690 MHz – E.I.R.P. 50/100 kW
- Single-Frequency-Network

- Bandwidth 1.7 MHz @ DAB – Range resolution of about 175m
- Bandwidth 8 MHz @ DVB-T – Range resolution of about 38m
- COFDM-coded signals – ability for compensation of channel errors by reconstruction
- Max. unambigous Range limited by symbol lengths (up to 140 km @ DVB-T)

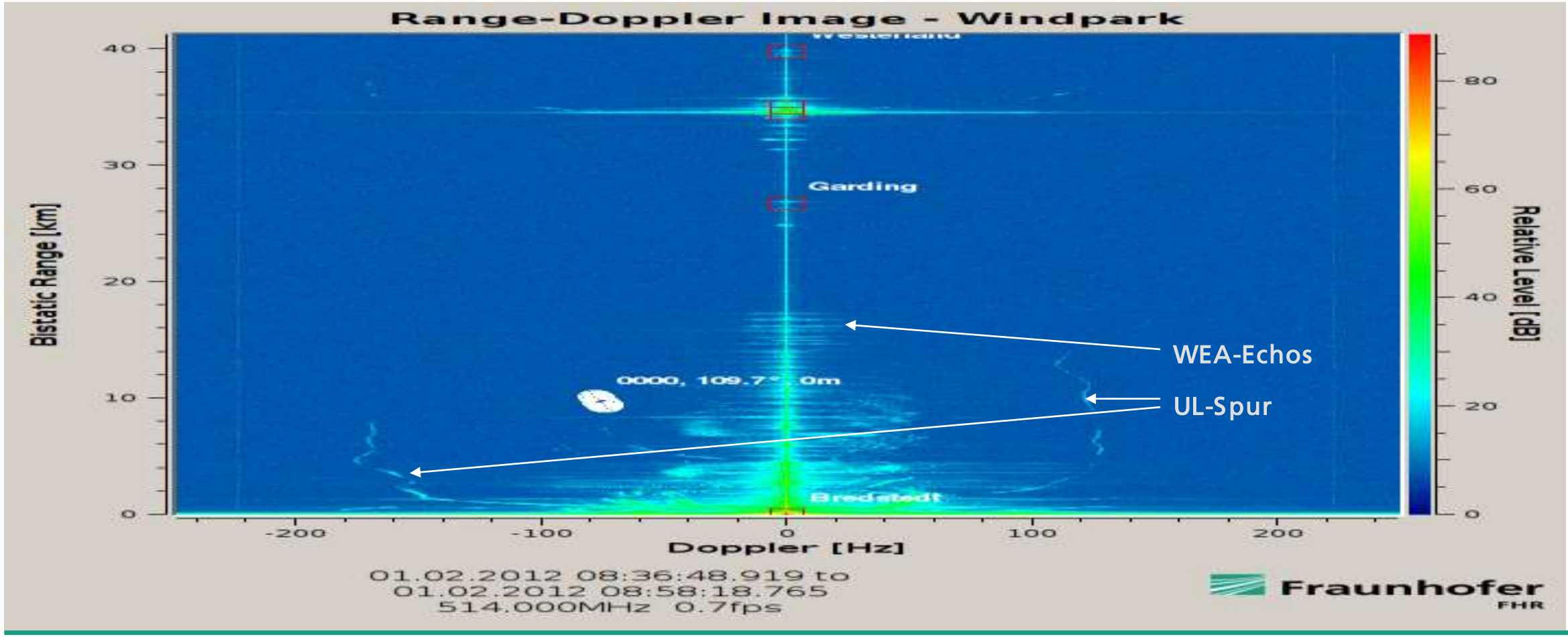
FUNCTION BASICS OF PASSIVE RADAR
- SPECIALTIES -

- GPS – referenced transmitters enable coherent signal processing
- Tx patterns are tilted slightly below the horizon -> less energy at higher elveations -> height limit for detections
- Single-Frequency-Network -> all transmitters send the same signal at the same frequency at the same time -> targets cause multiple reflections

FUNCTION BASICS OF PASSIVE RADAR
- RECEIVED SIGNALS -

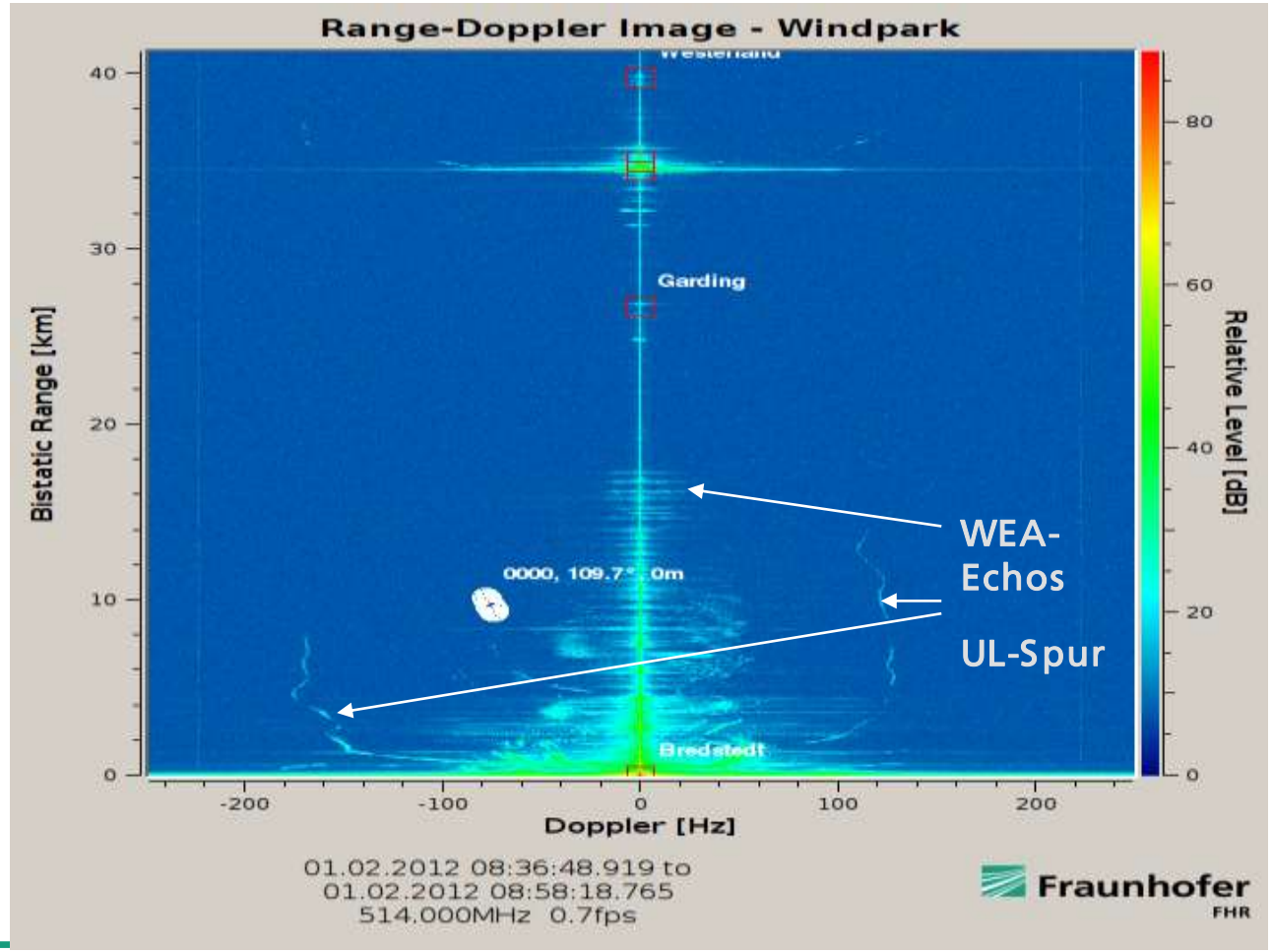
- Weak target signal at the receiver
- Strong direct signal at the receiver
- Problem: High Dynamic in the receiver is needed (especially in the ADC) to capture the target signal
- Solution: Receive Direct signal and Target signal with two different, directed antennas – e.g. YaGi antennas or Log-periodic antennas

FUNCTION BASICS OF PASSIVE RADAR
- DETECTION AND TRACKING -



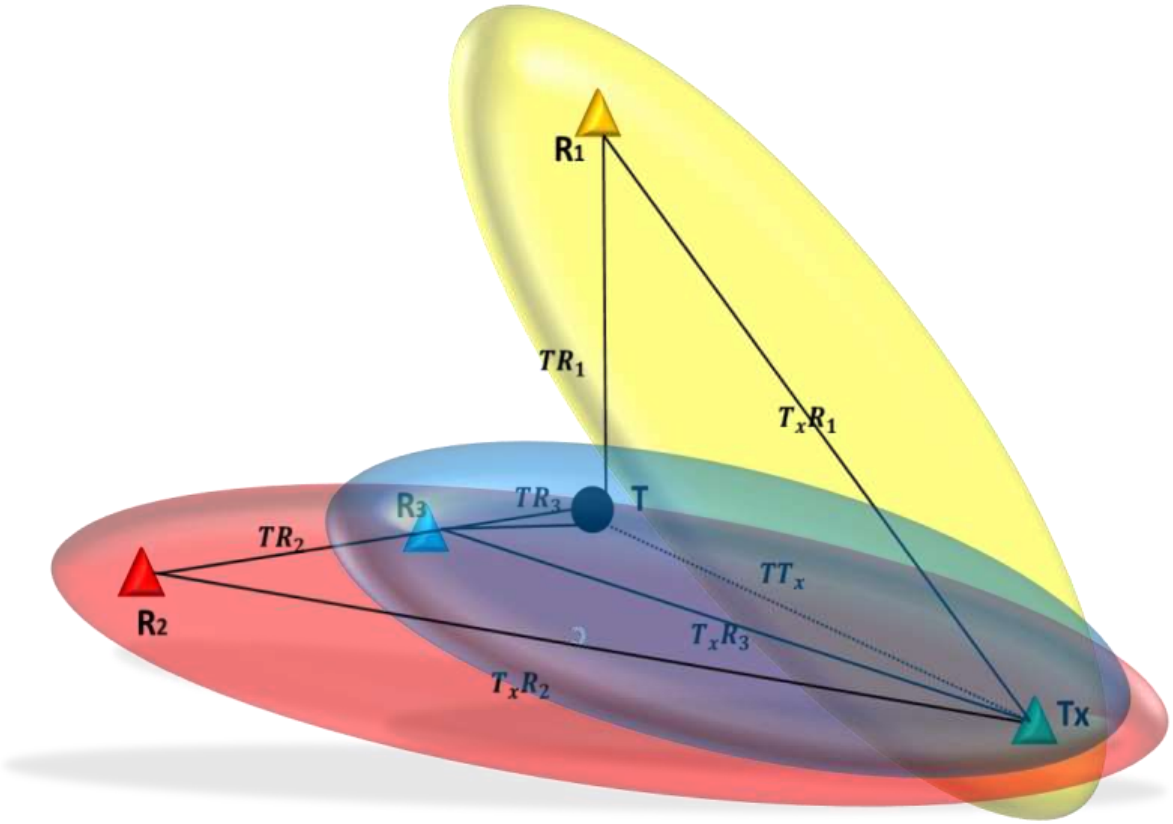
FUNCTION BASICS OF PASSIVE RADAR - DETECTION AND TRACKING -

- Patented method to suppress wind-turbine-echoes
  - Every range cell is observed in small time slices
  - If these time slices are chosen correctly, we see ONLY the target, because the turbine blade disappears in doppler-zero
  - This method is applied onto every range slice separately => track is kept



FUNCTION BASICS OF PASSIVE RADAR
- SIGNAL PROCESSING – SUMMARY -

- Using one DVB-T(2) channel of 8 MHz
- Direct signal synchronization
- Reference signal reconstruction
- „Range compression“ via Reciprocal Filter
- Range-Doppler-Processing
- Clutter-Map to reduce False Alarms
- Patented method for turbine blade suppression
- CFAR detection in Range-Doppler
- Blind Beamforming
- Ellipsoid-Intersection for localization
- Cartesian Tracking



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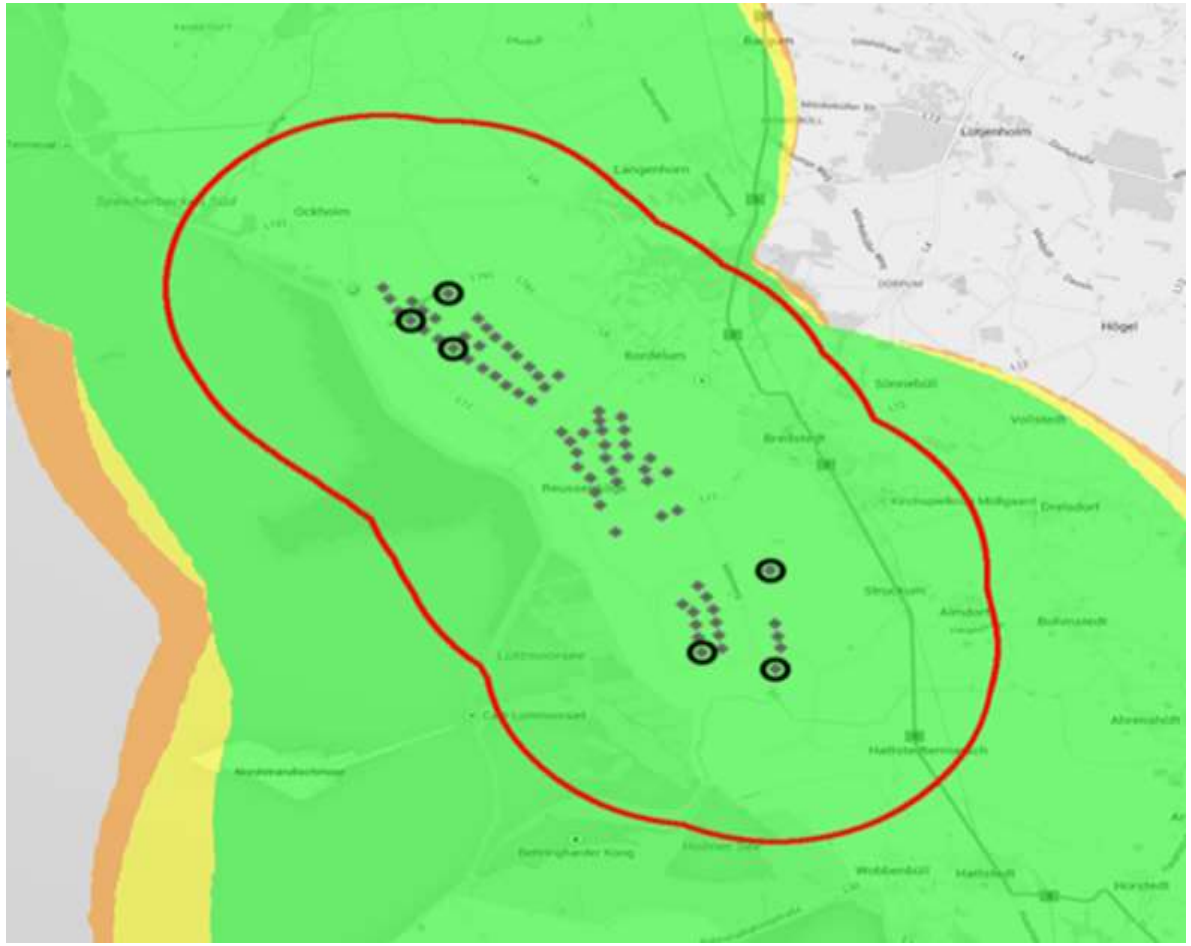
FUNCTION BASICS OF PASSIVE RADAR
- LOCATION PLANNING -



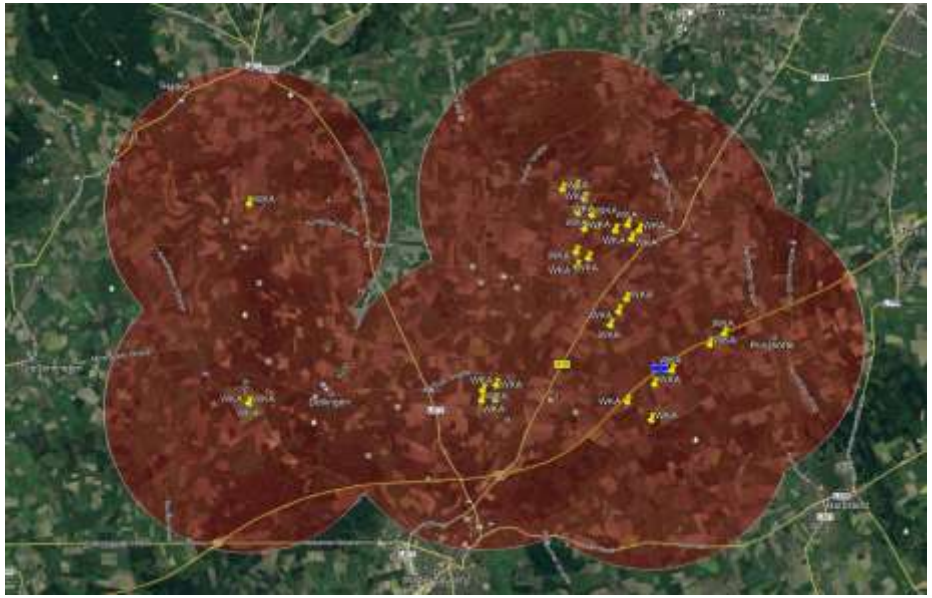
- Step 1: Office dislocation of the area
- Step 2: Real-Test on side of the area
- Step 3: Installation of Parasol
- Step 4: Recognition works with the German flight safety (DFS)

- Picture description:
- Grey dots = Wind turbines (WEC)
- Round dots = Parasol places
- Red Line = space around the WEC of 4KM
- Green field = monitored area

FUNCTION BASICS OF PASSIVE RADAR
- PROJECT EXAMPLE-

- Parasol Project Oldenburg Germany:

- Central partner for all wind farms
- Cooperation with companies on side
- Detection Area of 440Km²
- Parasol helps to find more neighbors wind parcs
- Division of the costs by the number of turbines
- High-resolution 3D tracking - for really dark nights



FUNCTION BASICS OF PASSIVE RADAR - PROJECT RECOGNITION WORKS-

- Commissioning of the system on side
- Parasol has to due a Flight test
  - Arrivals and departures from at least 18 different directions
  - flight at two heights (450m and 600m)
- Approval by the German flight safety (DFS)
- Change of building permit of the turbine

- **DEMAND-DRIVEN NIGHT IDENTIFICATION ACTIVE**

PROJECT PARTNERS

Fraunhofer FHR

DIRKSHOF

Parasol

BREEZER® AIRCRAFT

TRUMPF

VR Energieprojekte Dötlingen Verwaltungs GmbH

Bürgerwindpark Reußenköge

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EVOLUTION
IN THE BEGINNING…

EVOLUTION
…AND HOW IT LOOKS LIKE TODAY

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Thank you very much for your attention !

Jochen Schell

Passive und störfeste Radarverfahren

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