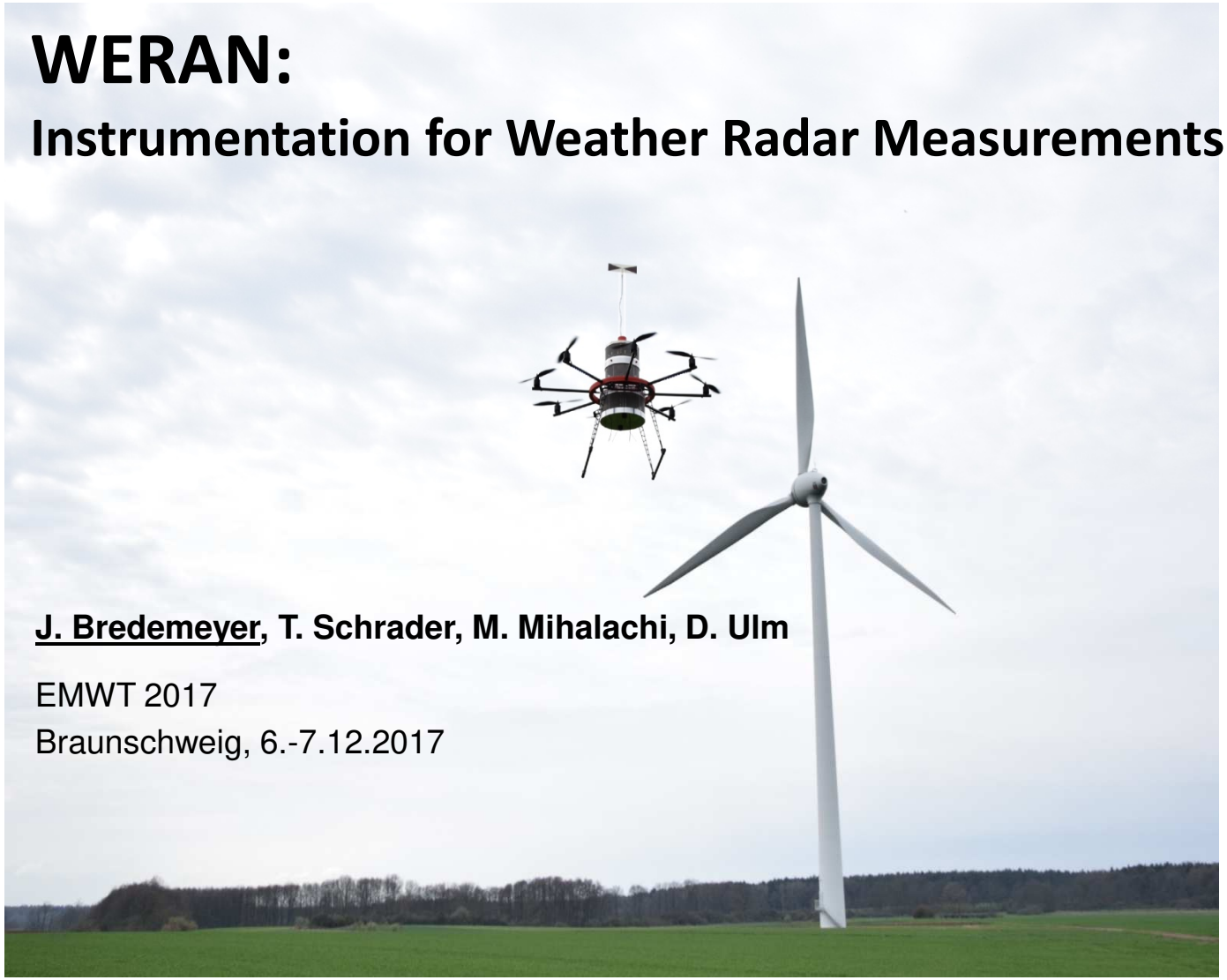
Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
National Metrology Institute

Flight Calibration Services

WERAN:

Instrumentation for Weather Radar Measurements



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des Deutschen Bundestages

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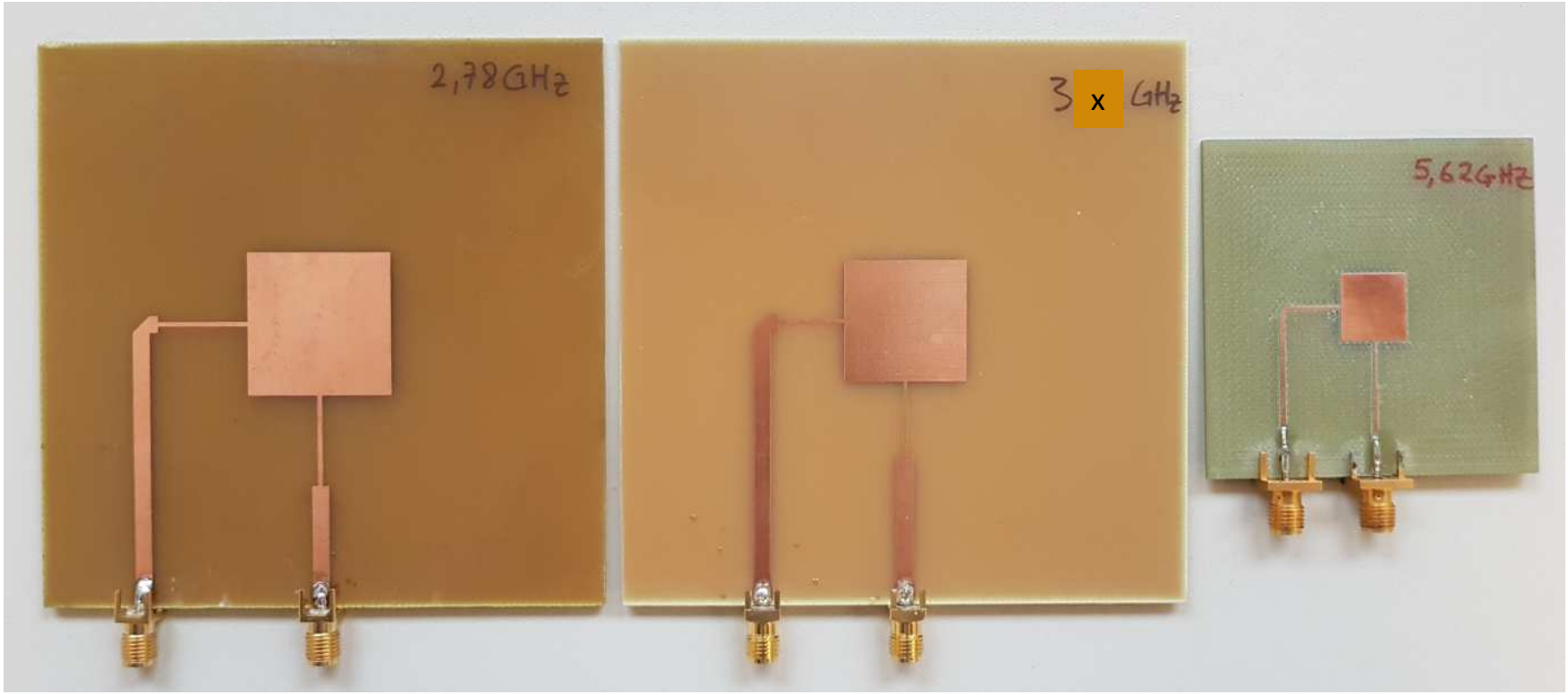
Tasks in WERAN

- Major goal: to improve predictions about the impact of wind turbines on weather radar

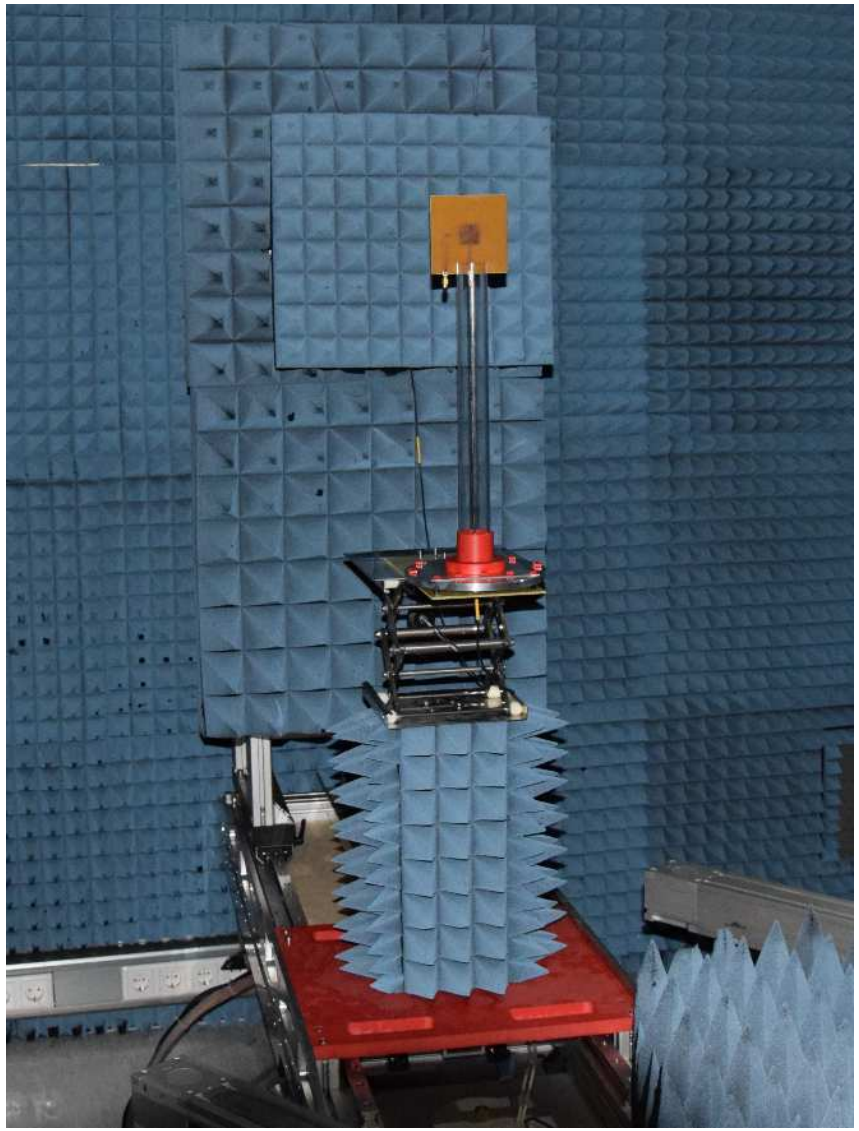
To be achieved by means of

- Measurements of scatter effects
- Separation of single WT contributions
- Evaluation of polarization impact

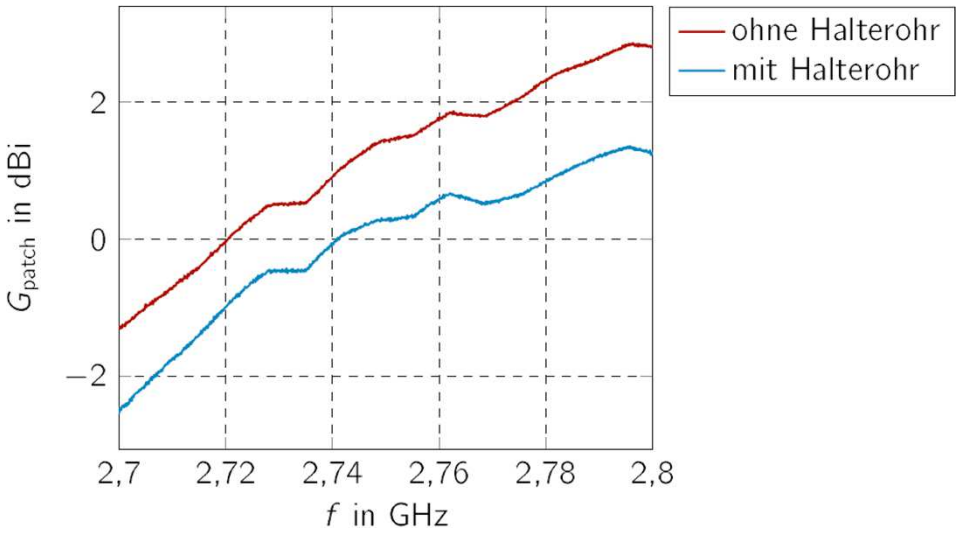
Dual-polarized patch antennas



Gain measurements in antenna scanner

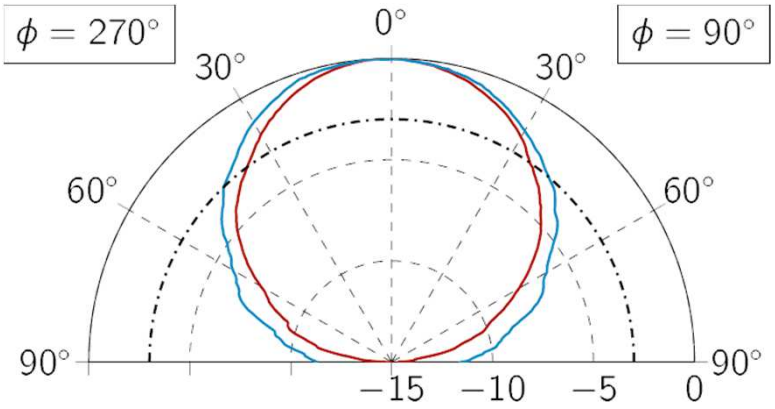


Antenna installed performance with mast

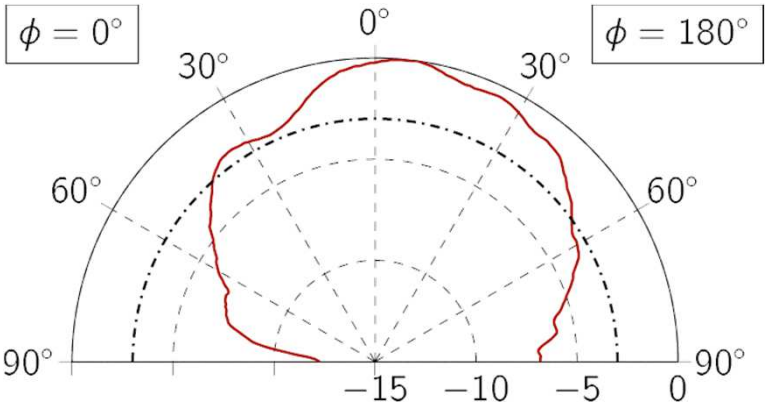


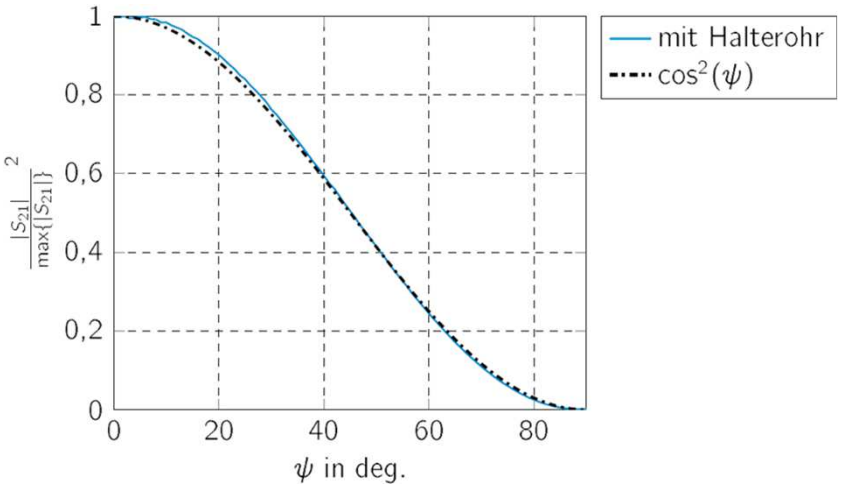
Antenna patterns

horizontal



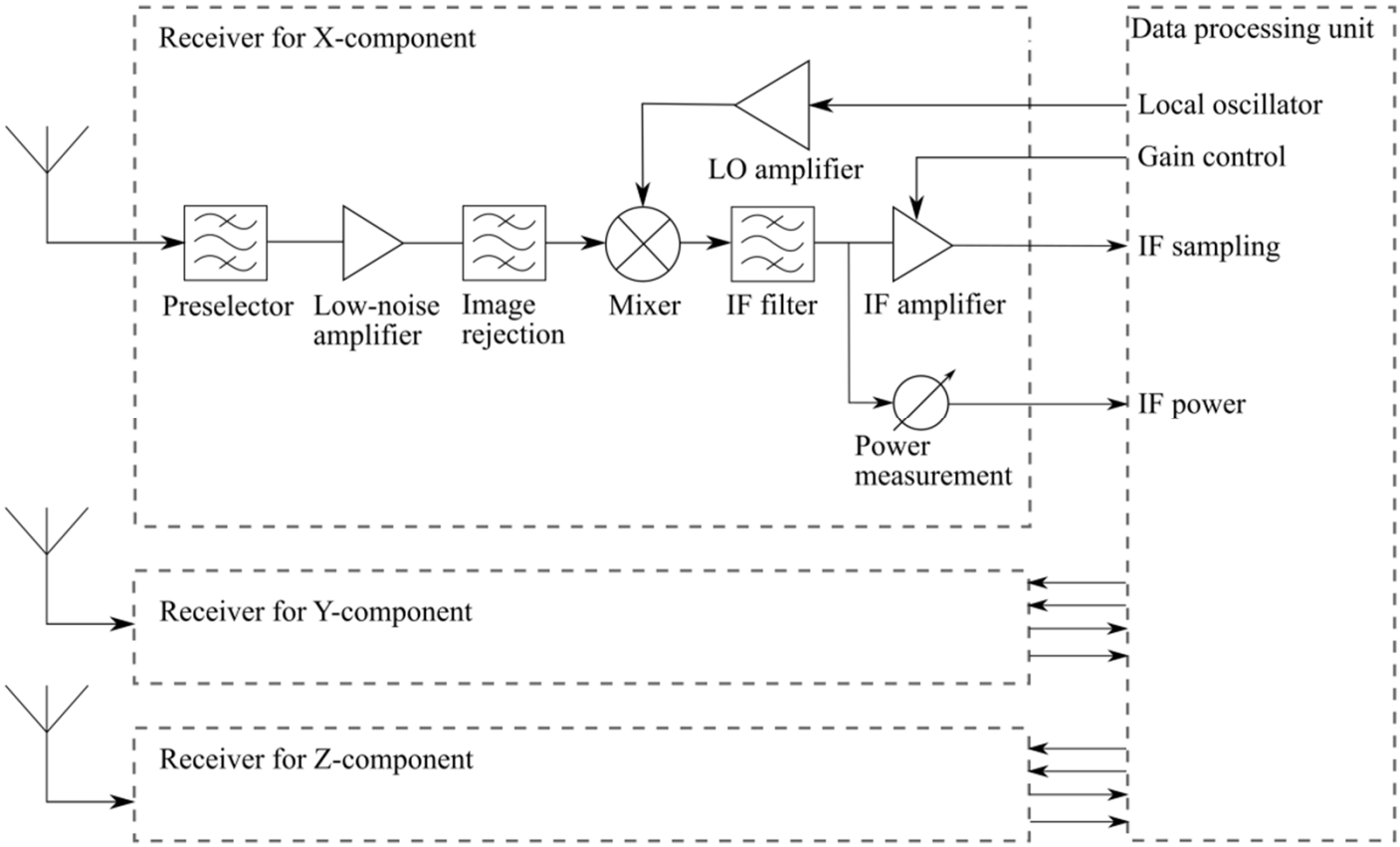
vertical





Deviation from nominal polarization

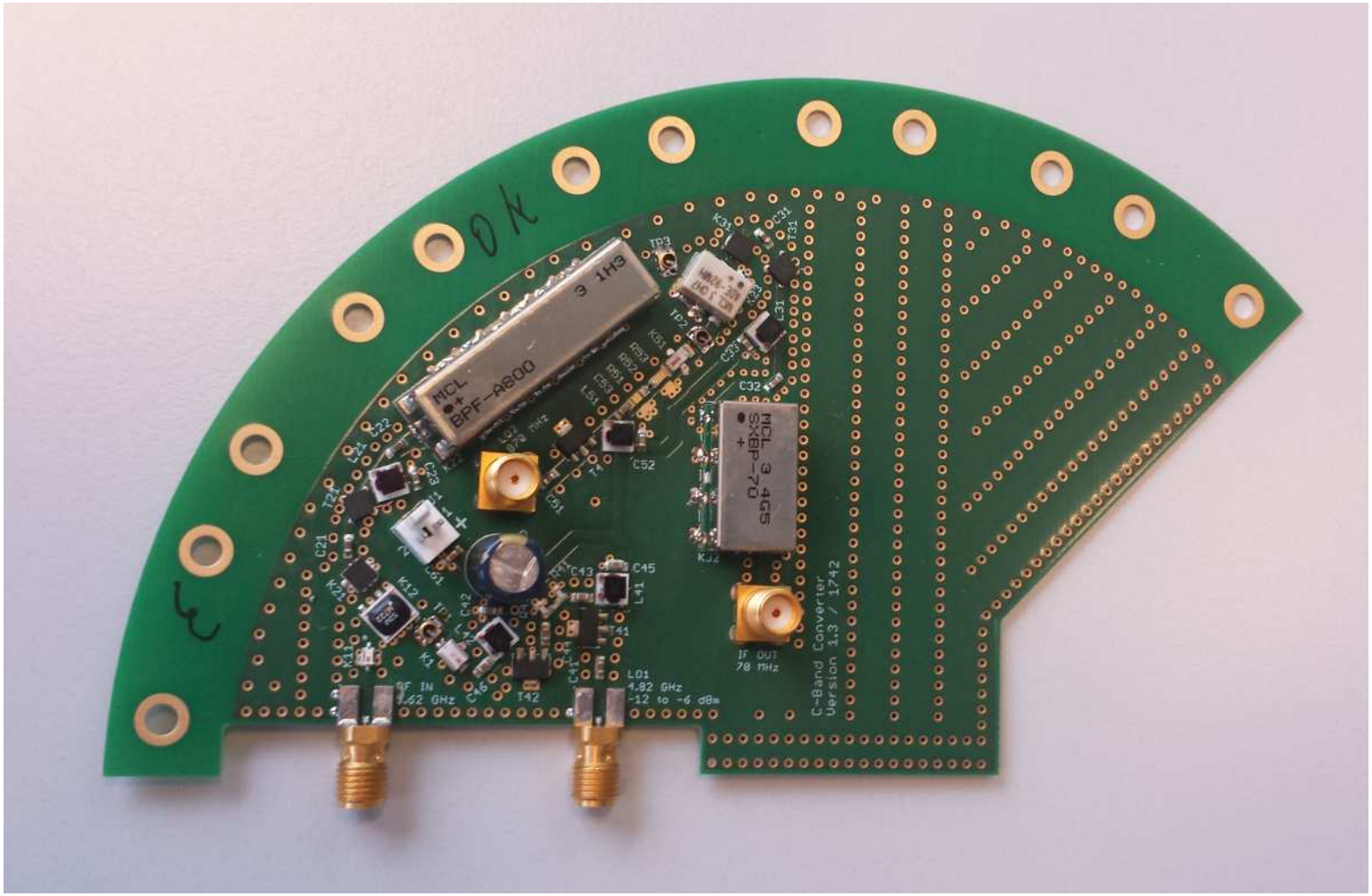
Multichannel RF frontend



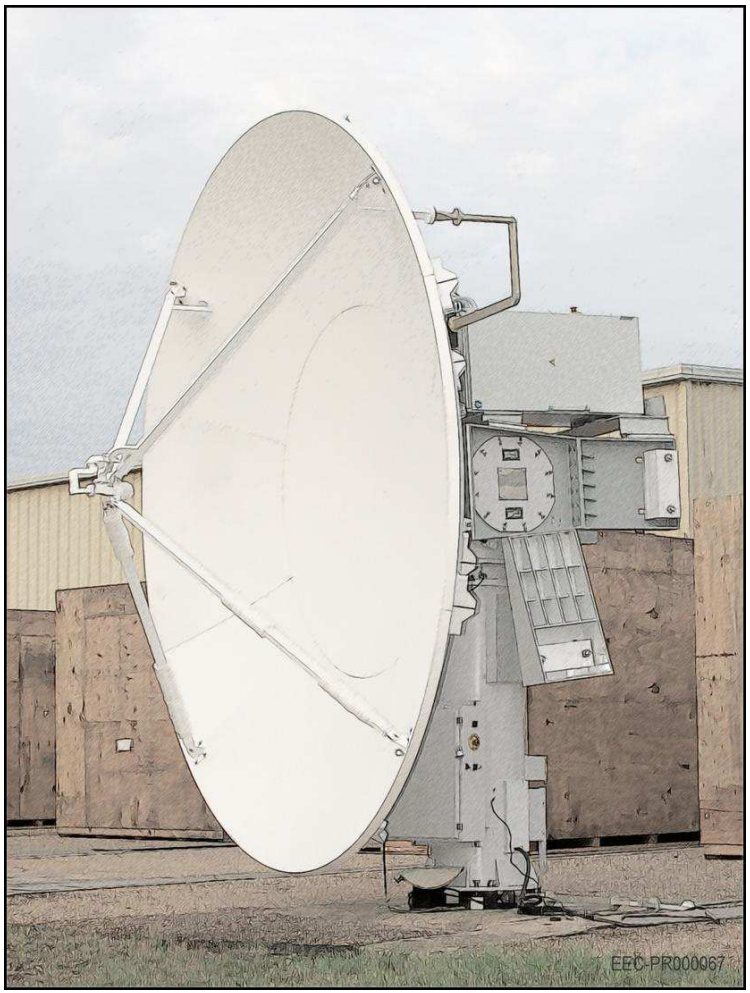
- Recording of the complete IF band pass signal 16Bit@160Msps/s
- Post-Processing of all target quantities of interest
- Multiple channels to get field vector from orthogonal antennas

C-band receiver frontend

Single channel PCB board



Weather radar transmit signal



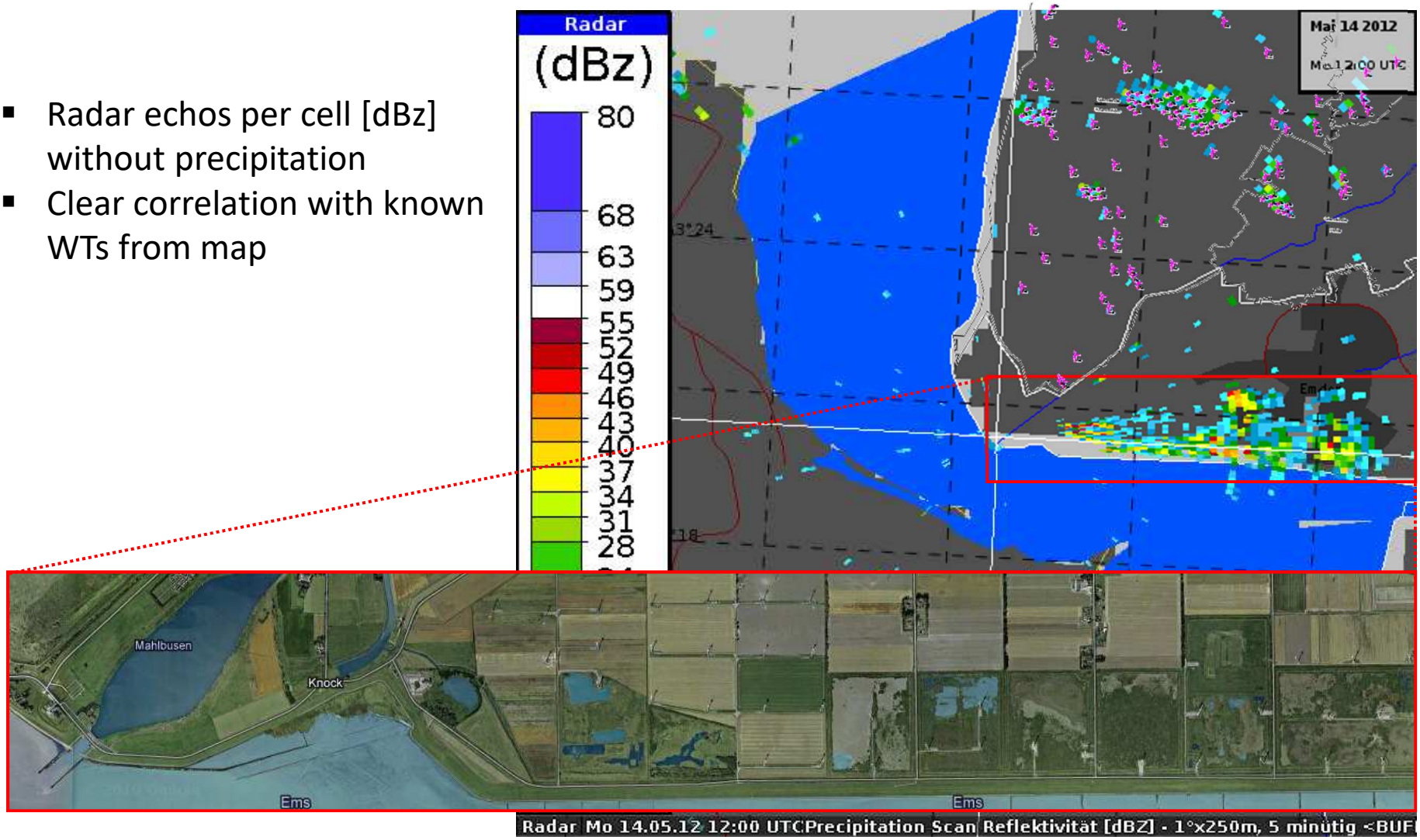
- C-Band (5600 - 5650 MHz)
- Dual-Polarized (H, V)
- Pulse Peak Power: 500 kW
- Pulse witdh 0.4, 0.8, 2.0, 3.0 µs
- 4.27 m-Sandwich-Spiegel, > 45 dBi
- Rotation time 8 rpm
- 1° beam width

No pulse compression in current radar generation!

Next mission at weather radar site Emden

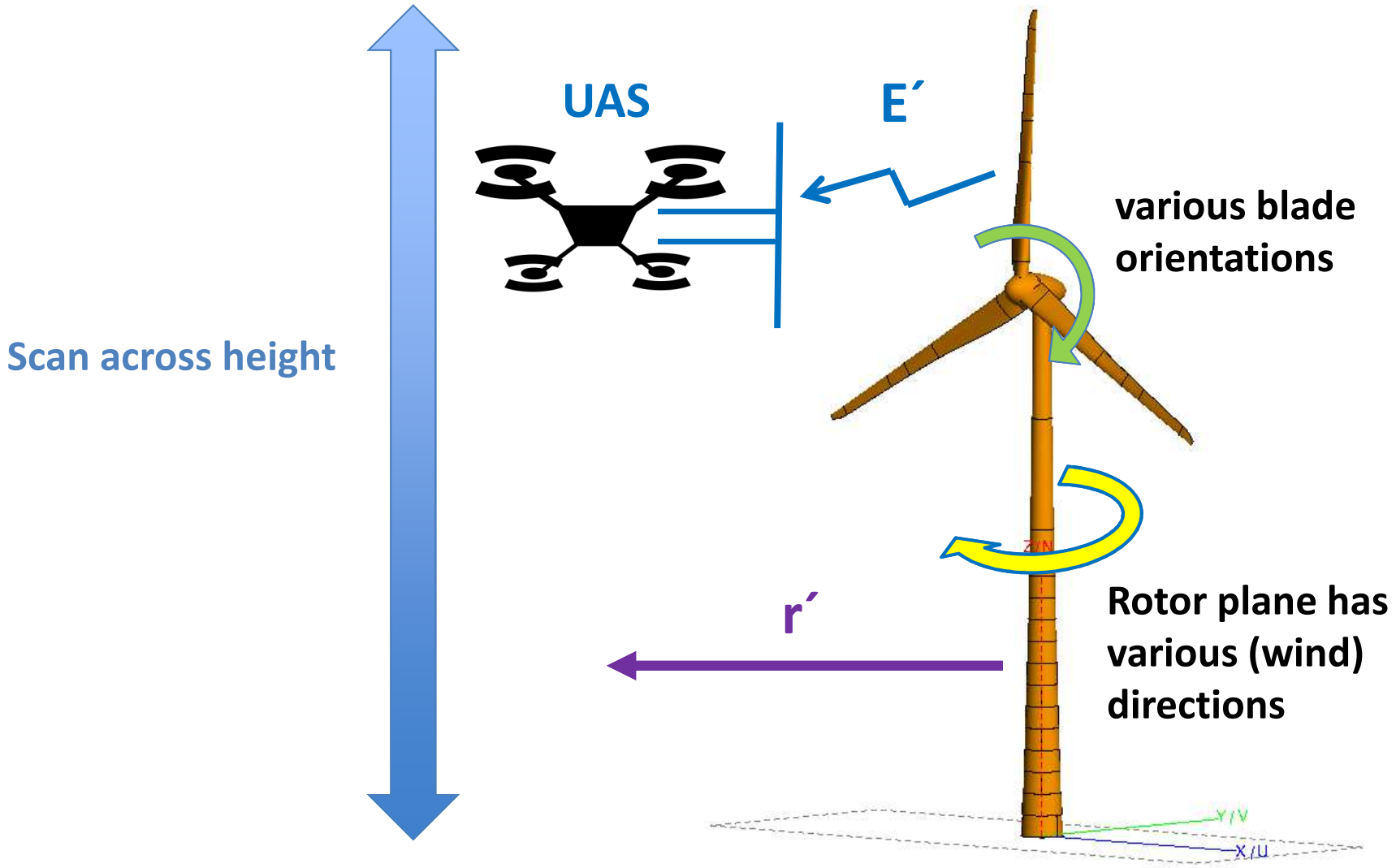
Weather radar degradation effects due to WT

- Radar echos per cell [dBz] without precipitation
- Clear correlation with known WTs from map



Quelle: Ninjo Batch, Landkreis Aurich, Google Maps

Classification of WT reflections



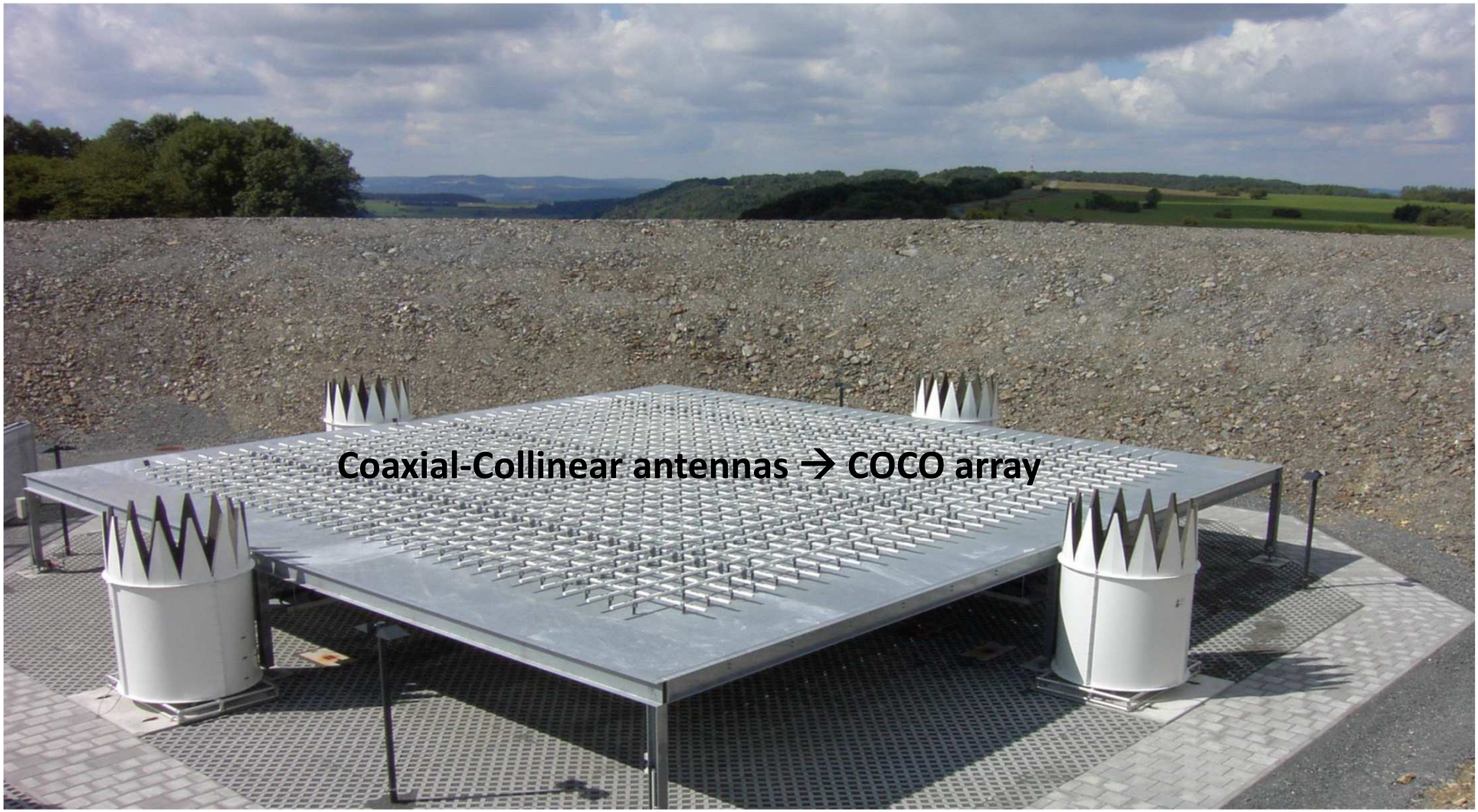
Next steps

- Mission planning for radar Emden
- „Matched filter“ analysis of radar‘s transmitted direct pulse and reflection of scatterer (WT) allows for calculation of reflection properties
- Single WTs can be isolated with temporal separation of reflection of short pulses (no pulse compression!) and corresponding delay runtimes
- Classification of WT reflection properties

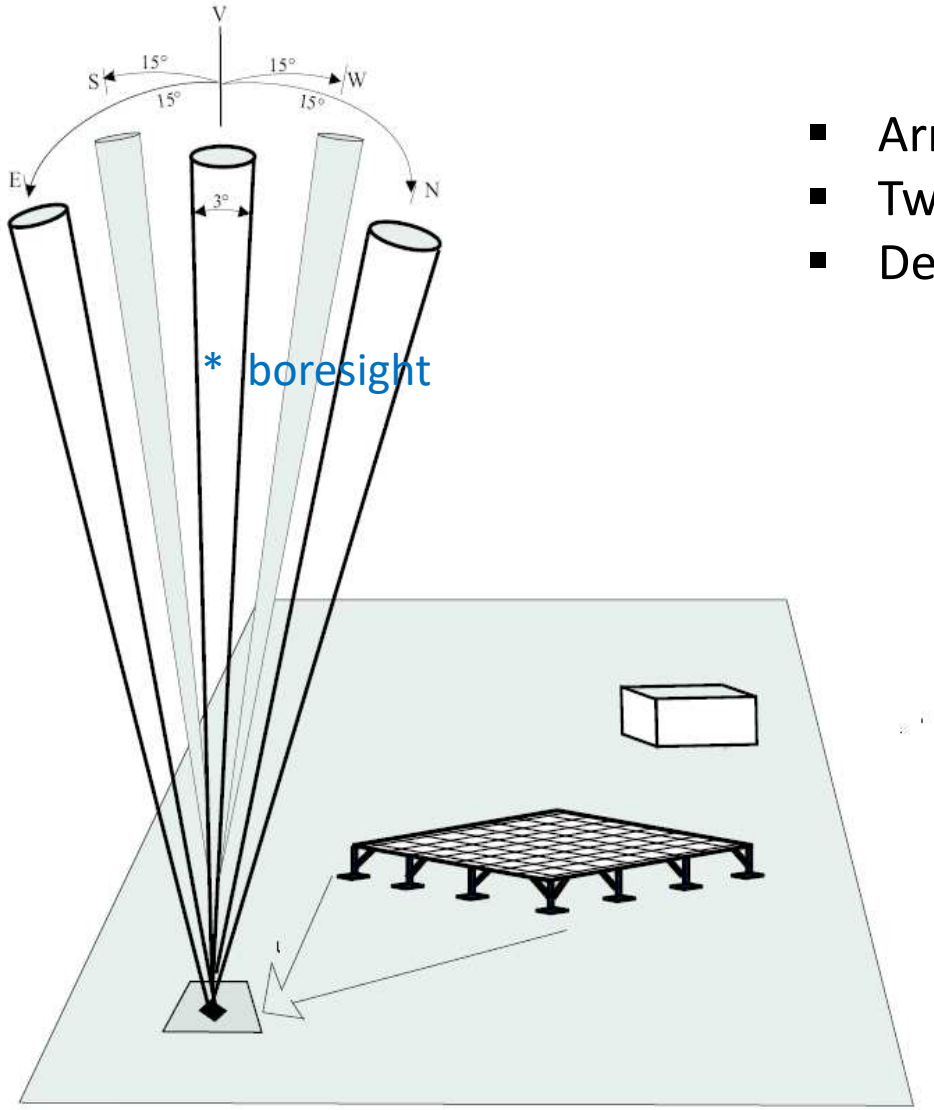
UHF Wind profiler

- Radar to measure wind directions and velocities across altitude
- Operates on TV channel 482MHz in Germany
- Expected degradation from WT: reflections from antenna sidelobes
- Antenna patterns could not be measured in the past
- UAS with appropriate sensor is suitable device for this task

Wind profiler antenna



Wind profiler beam steering

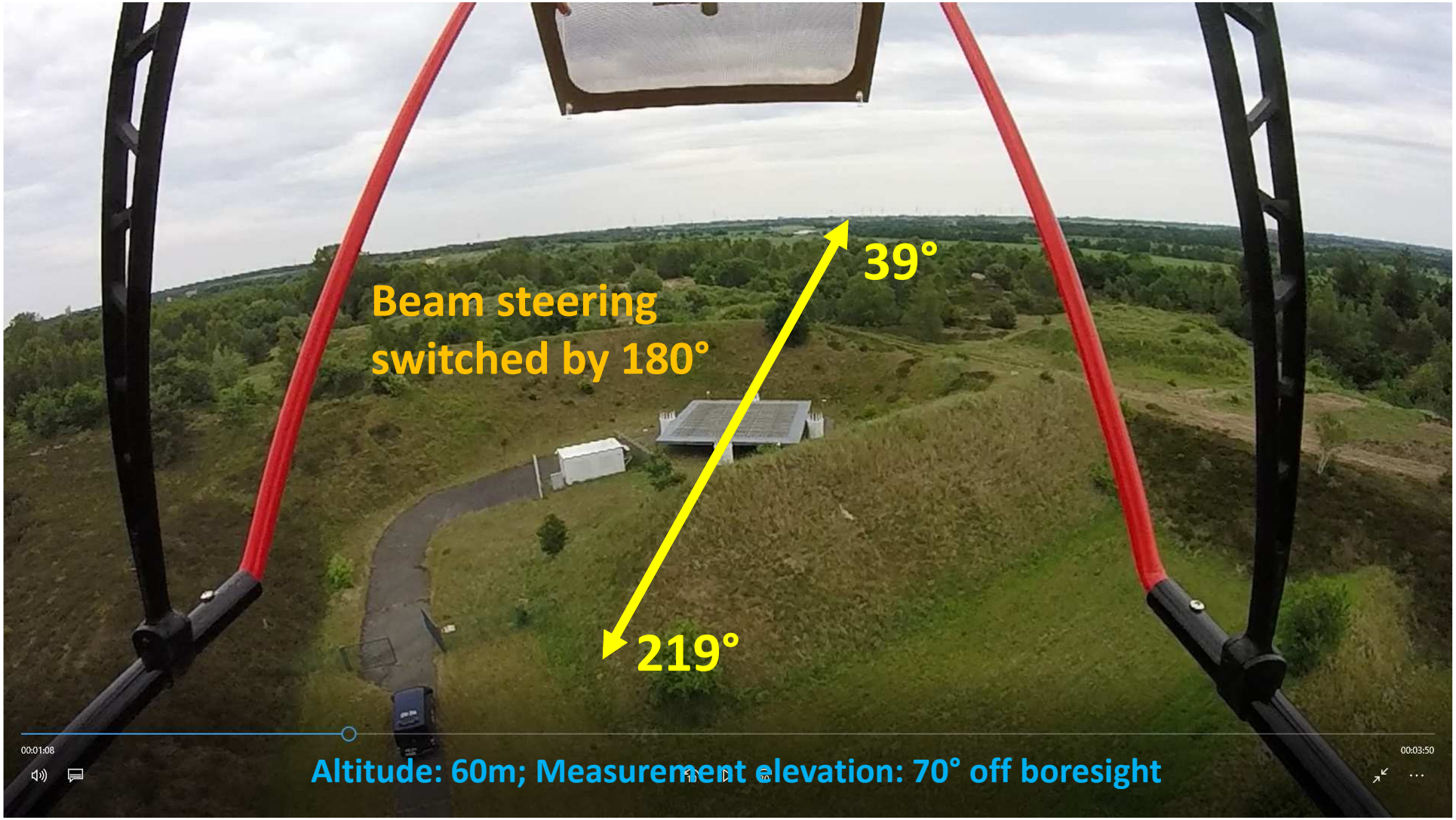


- Array has 2 x 3 fixed beam directions
- Two orthogonal steering directions
- Deviation 15° from boresight

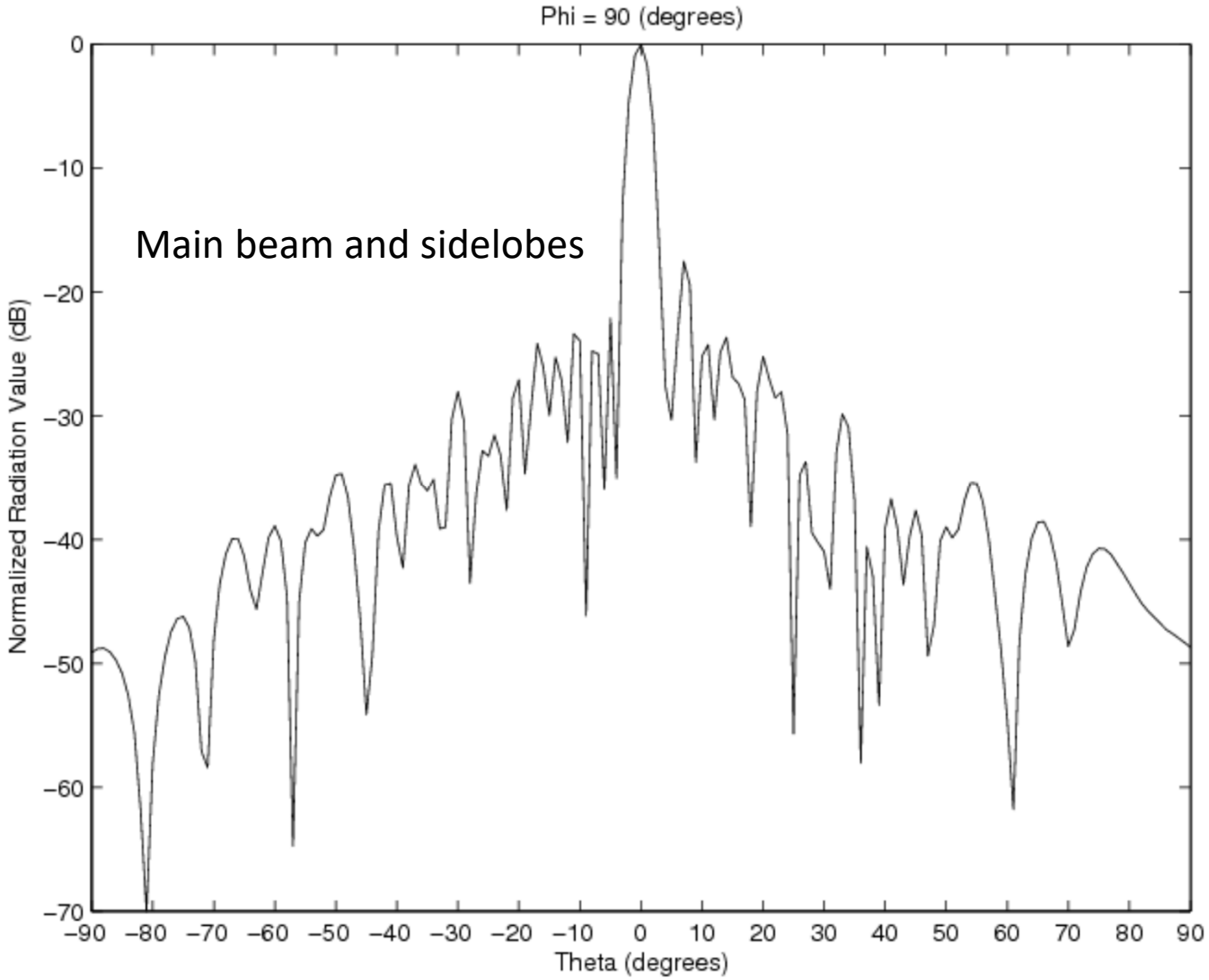
Wind profiler at Nordholz

Octocopter at Wind profiler Nordholz

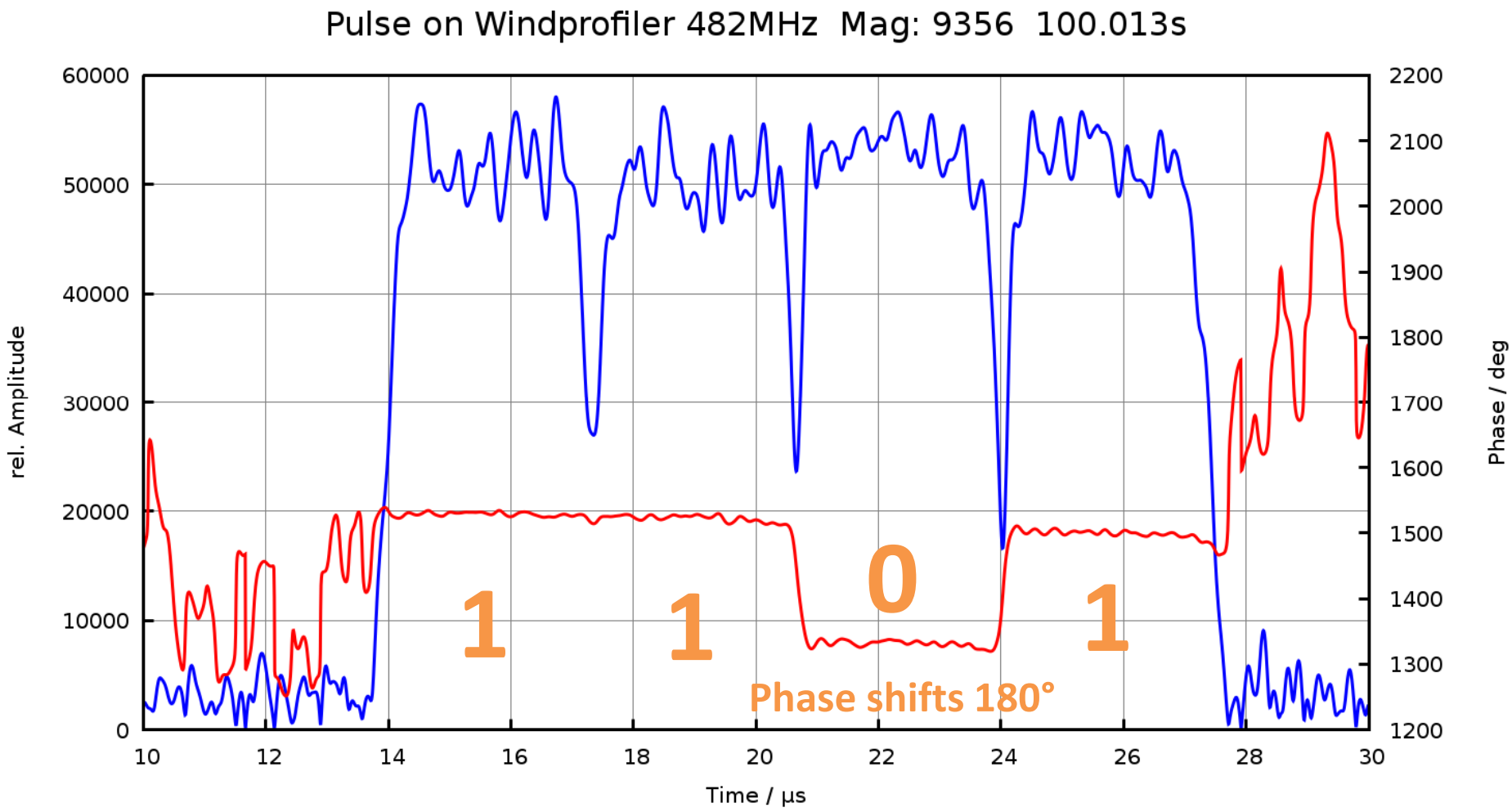
Octocopter at Wind profiler Nordholz



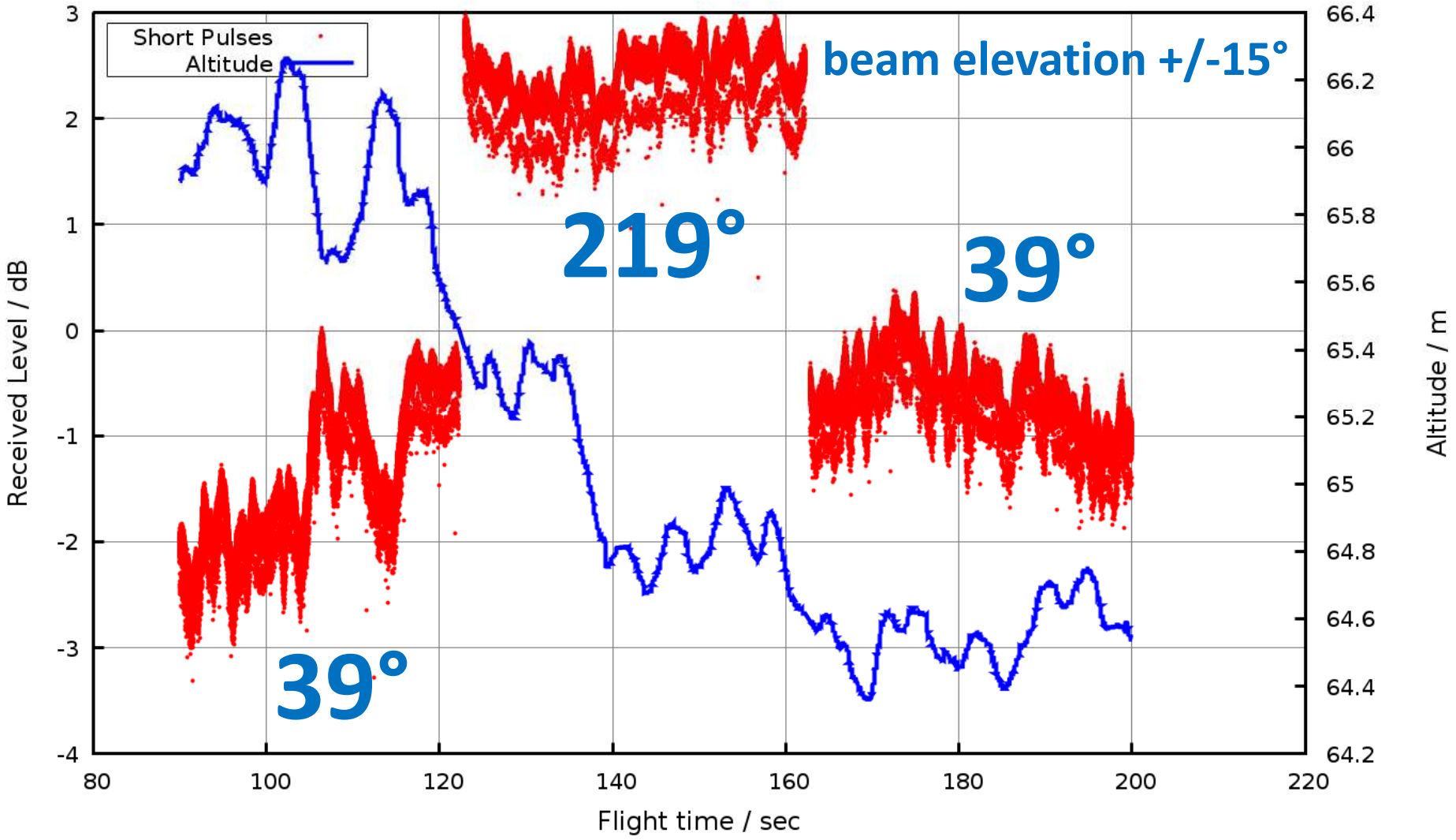
Wind profiler vertical pattern



Wind profiler Pulse in „High Mode“



Wind profiler beam switches



Wind profiler summary

- Test measurements from octopter flights at Nordholz validates sensor concept

Results so far:

- Low sidelobe field strength difference 3dB due to beam switch +/-15°
- Expected >5dB

Things to do:

- Upgrade to dual-polarized antenna and two-channel receiver
- Mission planning for full sidelobe characterisation