Onsite dualpol antenna performance verification

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

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Introduction

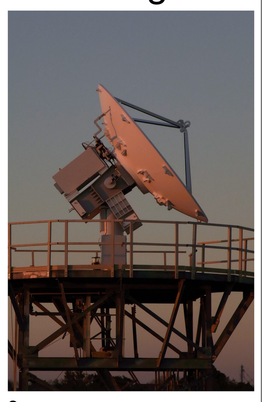
The quality of dualpol moments is sensitive to the quality of the antenna and its proper characterization. The compliance with specification of the antenna is proven through antenna patterns which are usually provided by the antenna manufacturer as cuts through the main planes of the antenna only. In the course of DWD's antenna acceptance tests it turned out that the proof of the requirements is limited by the equipment on a the antenna manufactures test range.

We therefore test the antennas on the radar manufactures test site making use of the capabilities of the new radar system with its sensitive receiver and high pointing accuracy. Those tests are carried out during factory acceptance tests (FAT) for EEC's DWSR-5001C/SDP/CE radar system.

A unique effort in this project are onsite antenna tests. Those tests have two main goals. One is to prove that the onsite antenna assembly procedures guarantee the same antenna performance as shown during FAT. The second aspect is related to the combined performance of the antenna and the radome which in the end determine the operational data quality of the new dualpol radar system (see Frech et al, 2011b). Here we focus on the antenna performance without radome.

Antenna requirements

For dualpol applications a good match of the H and V antenna characteristics in all planes is a prerequisite for a satisfactory performance of the radar system. Furthermore, we are aiming at low side-lobe levels in all planes including the struts. The influence of low side lobe levels are important and may affect the data quality in e.g. low reflectivity situations or in case of strong spatial reflectivity gradients.



The following specifications for the dualpol antenna were established:

Beam width < 1° , Match of beam width better < 0.03°

Beam squint < 0.08°

Gain > 45 dB, difference gain H/V < 0.1 dB

Side lobe < -30 dB in +/- 10° around the main beam; side lobe < -43 dB in > +/- 10°;

Crosspol isolation: < -32 dB

Dish: 4.3 m diameter, center-fed parabolic antenna from Seavey.

Antenna test

Basic test setup in spring 2011: transmitter is positioned in the far field of the antenna. Three source sites are used in order to obtain reference data for the radome acceptance tests and to identify site specific artifacts.

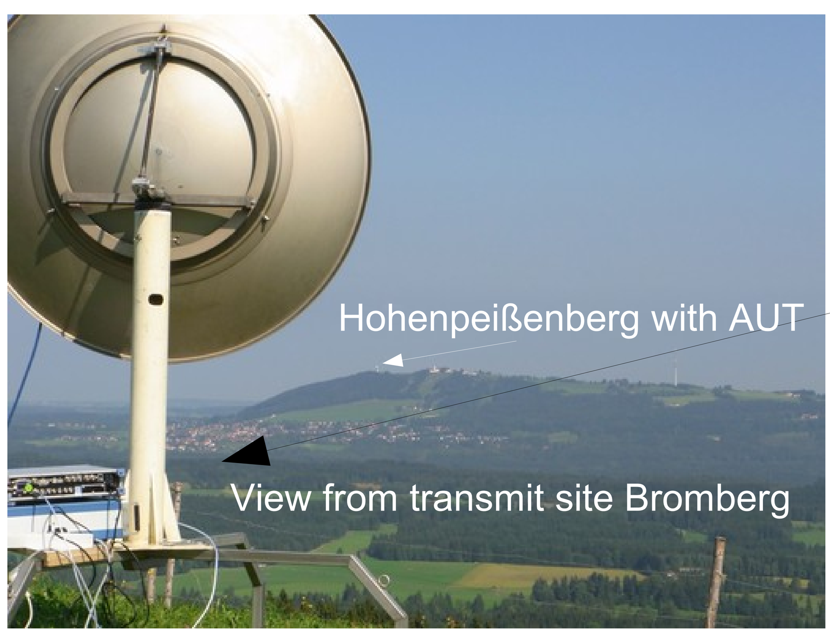
A single-pol feed is used in the transmitter assembly, which is manually adjusted for optimum crosspol separation and STAR-mode transmission

For data acquisition we employ the new radar system and DWD's operational radar software MURAN. The volume scan is specified as follows:

- sweeps in elevation range -2° to 30°, elevation steps 0.1° in the main beam area,
- increasing elevation steps (0.1 to 0.5 °) up to 30°, every 10 sweeps a sweep through the main beam.
- PRF 3000 Hz, AZ speed 6°/s, range 20 km, raw range bin resolution 25 m, range averaging to 1km.
- Dynamic angle syncing 0.05°; SNRh, SNRv, Φ_{dp}, UZDR are acquired.

- A data volume consists of about 130 sweeps from which the antenna pattern is determined and analyzed.
- Acquisition time 2 ½ hrs for one polarization
- Standard gain horn near the radar system monitors the stability of the transmitter signal.

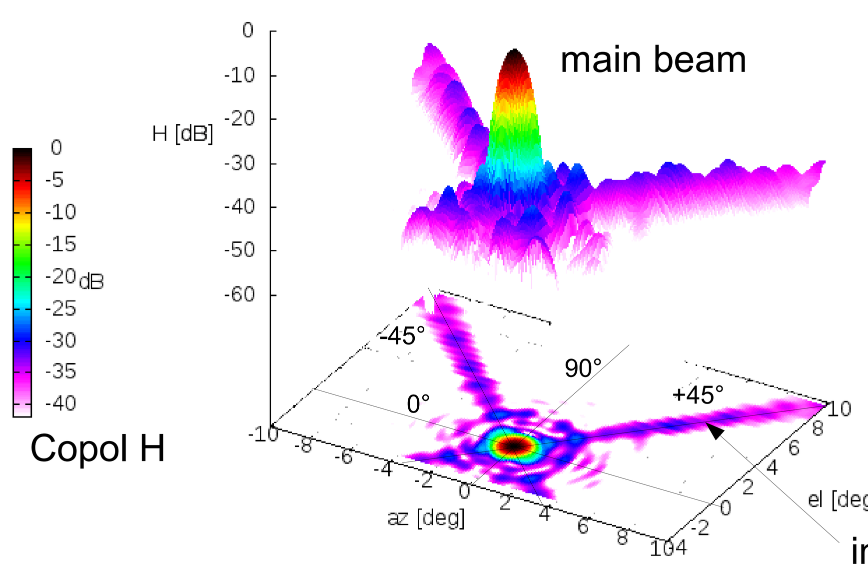
Priniciple setup of the measurements

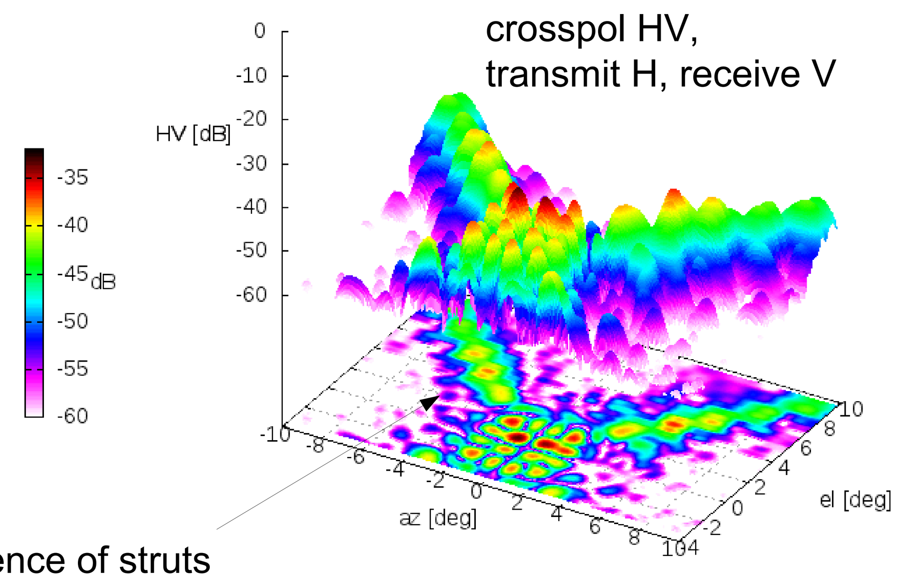


Distance 8.5 km

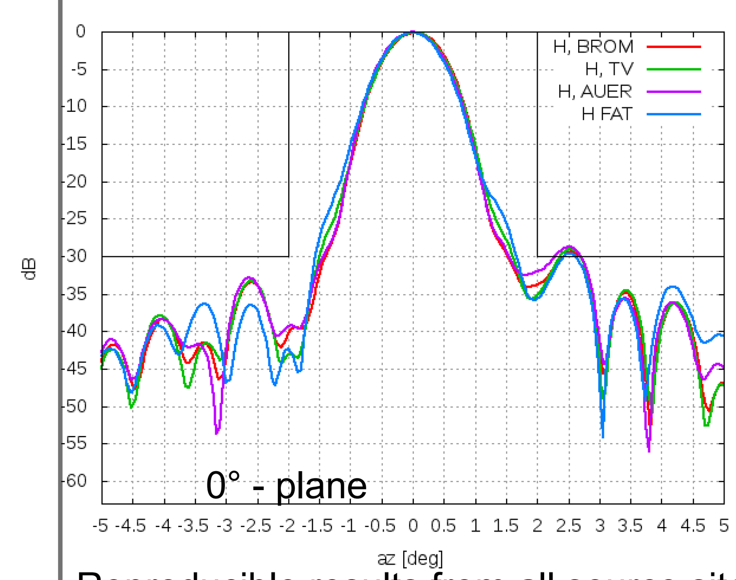
Results

Copol and crosspol antenna pattern



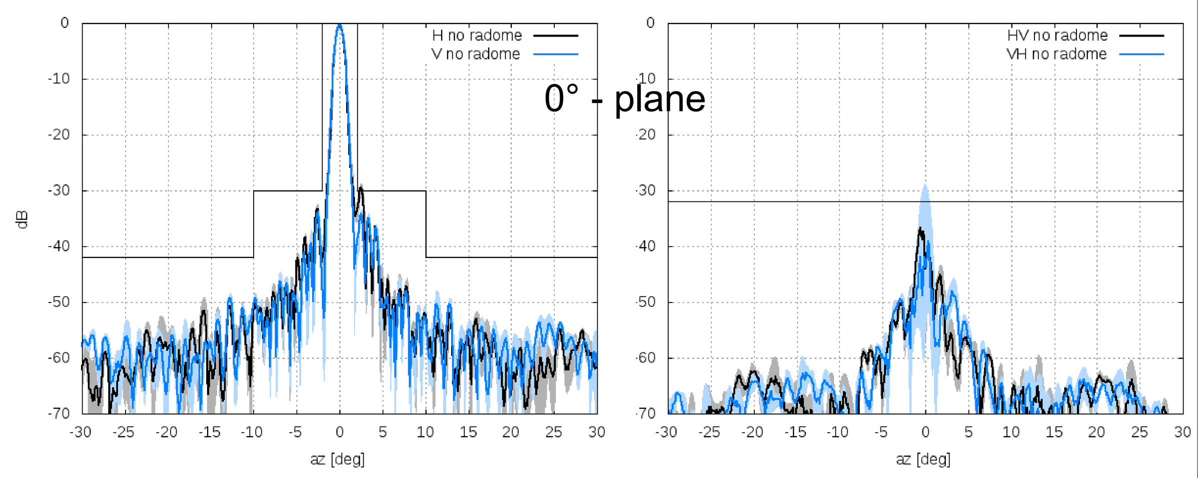


Slices through the main planes

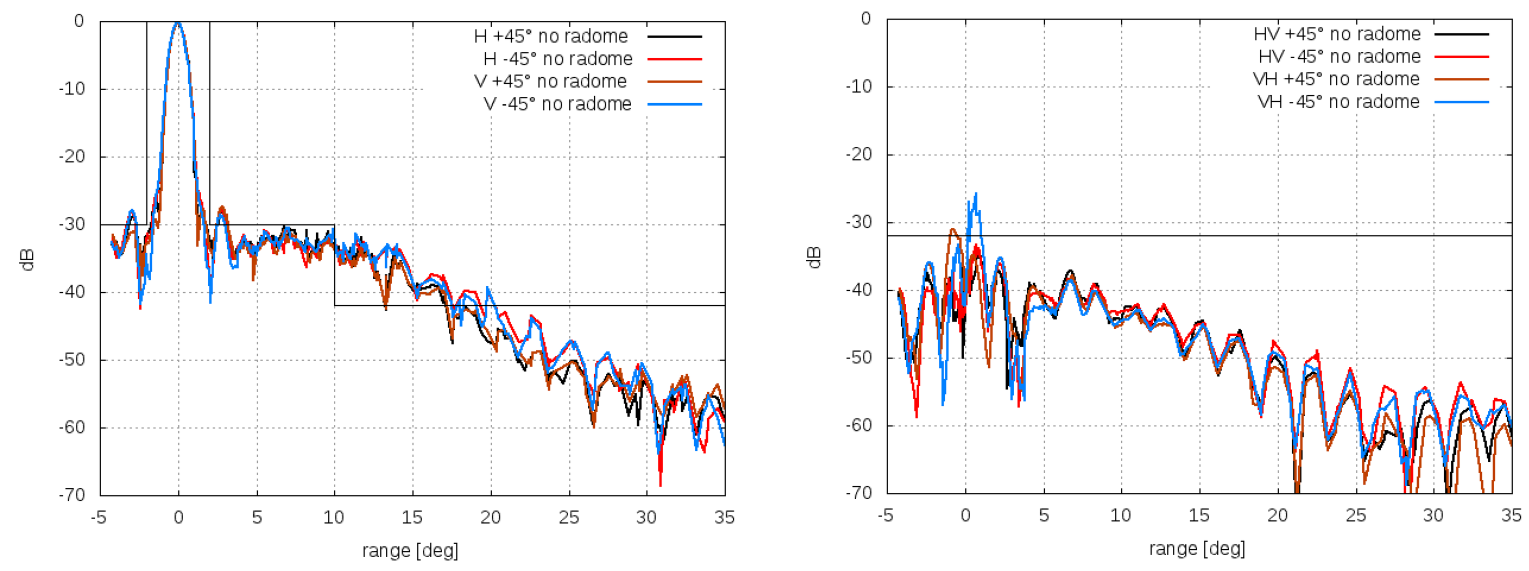


Reproducible results from all source sites („BROM, TV, AUER, FAT“) during SAT and FAT prove good test range conditions.

Variability of on-site measurements



The shown range of the data is based of up to 60 sweeps through the main beam. The crosspol variability in the main beam area mainly related to test range conditions.

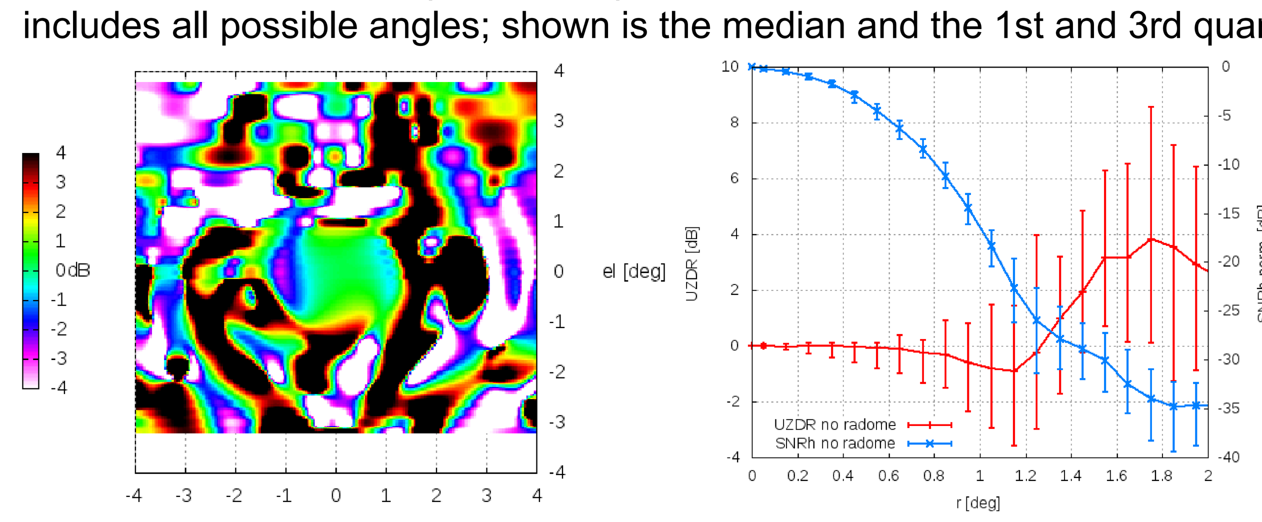


Cut through the strut plane: copol levels are above the specifications

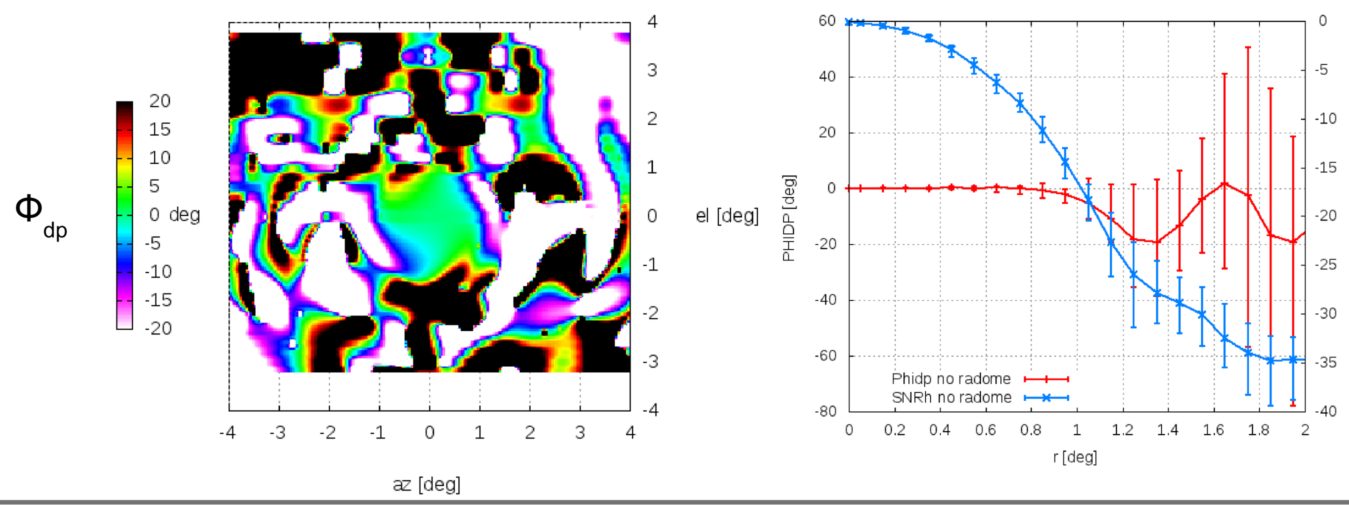
STAR-mode results

Focus on differential phase and differential power: a good beam symmetry over the main beam down to ~-25 dB is needed (e.g. Bringi et al., 2011).

Analysis: evaluate the differential power and phase as a function of radius, this includes all possible angles; shown is the median and the 1st and 3rd quartiles



Up to ~ 0.5°, ZDR approx const., Δ ZDR ~0 .7 dB at r = 1°.



Up to ~ 1°, Φ_{dp} approx. const.

Feed alignment and the center-feed antenna design may contribute to the deviations with increasing radial distance.

Conclusions

The basic measurement set up and analysis procedure has been introduced. Antenna specifications could be verified on-site. Some of the specifications are not fulfilled in the strut plane. The expected data quality based on these measurements is currently analyzed.

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