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Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Monitoring absolute calibration of a polarimetric weather radar

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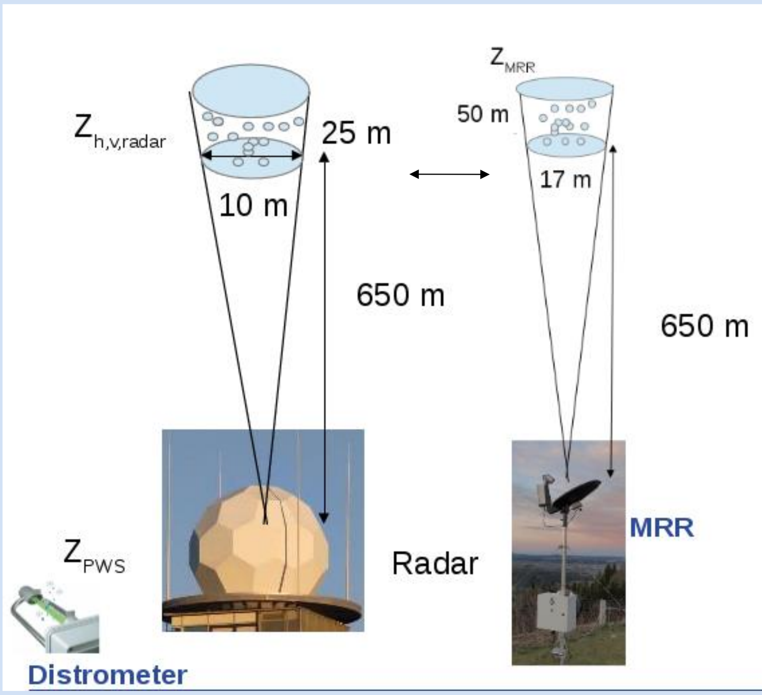
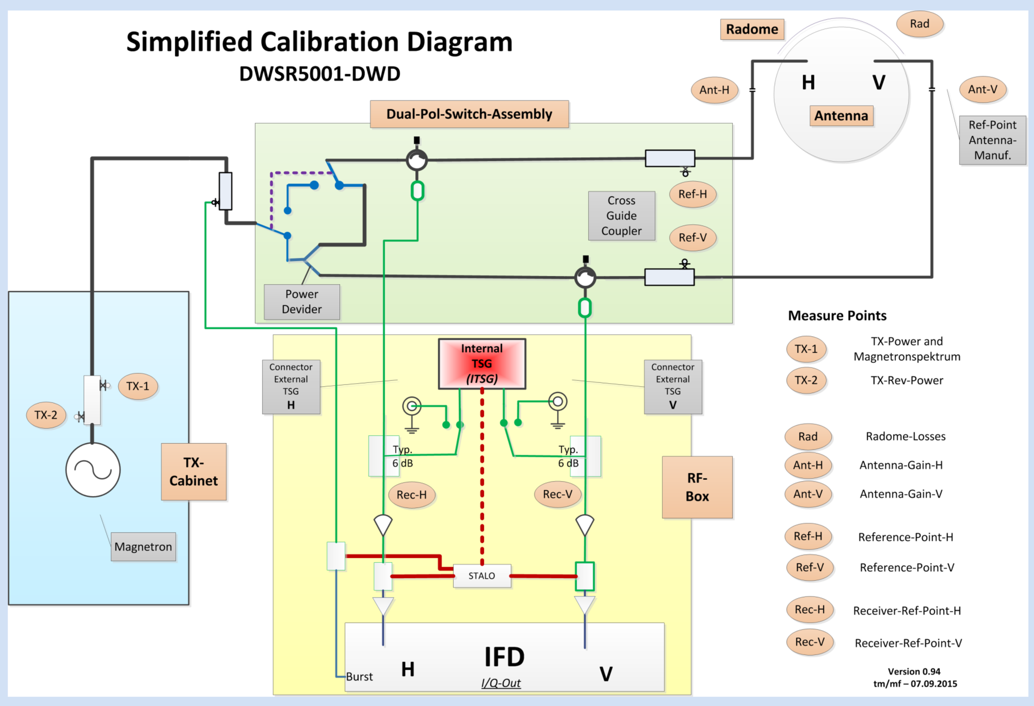
Monitoring absolute calibration using disdrometer data and C-band radar data from birdbath scan showed promising results (Frech, 2013). Reflectivity data from the first far field range bin at 650 m height are related to disdrometer measurements close to the surface, assuming spatial and temporal homogeneity. This assumption is verified using MRR measurements which can fill the gap between the far field and the surface. We show results from the "warm" season 2014 (April – November). This study uses data from the research radar of the German Meteorological Service (DWD) at Hohenpeißenberg, which is the research system of the DWD weather radar network which consists of 18 identical C-Band systems (including the research radar; EEC DWSR5001/SDP/CE).

Radar Hohenpeißenberg



Concept to monitor absolute calibration: relate farfield range bin from birdbath scan to disdrometer: Assumption: temporal and spatial homogeneity of the precipitation process
MRR is used to verify the assumptions.



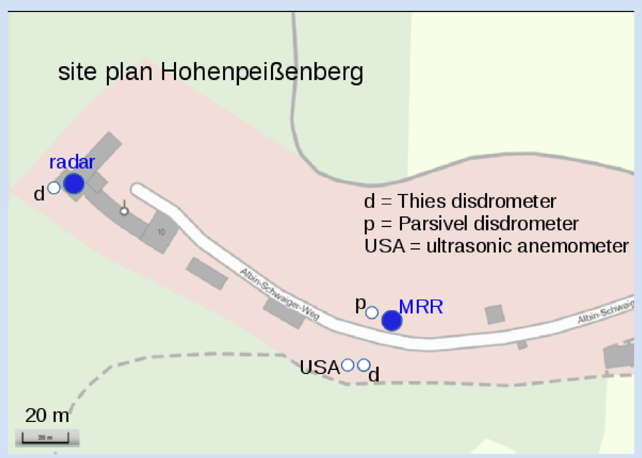
Simplified calibration diagram illustrating the transmit and receive path of the DWD radar system, including relevant elements which have to be characterized for an accurate engineering calibration. Z of the H and V channel should be within +/- 1 dB.

Birdbath scan configuration

Every 5 Minute following the volume scan
Sweep 1: STAR Mode, PW 0.4 µs PRF 2400 Hz
Sweep 2: STAR Mode, PW 0.8 µs PRF 1500 Hz
AZ rate 48 °/s, DAS = 5°, Δz = 25 m

Operational utilization of birdbath scan:

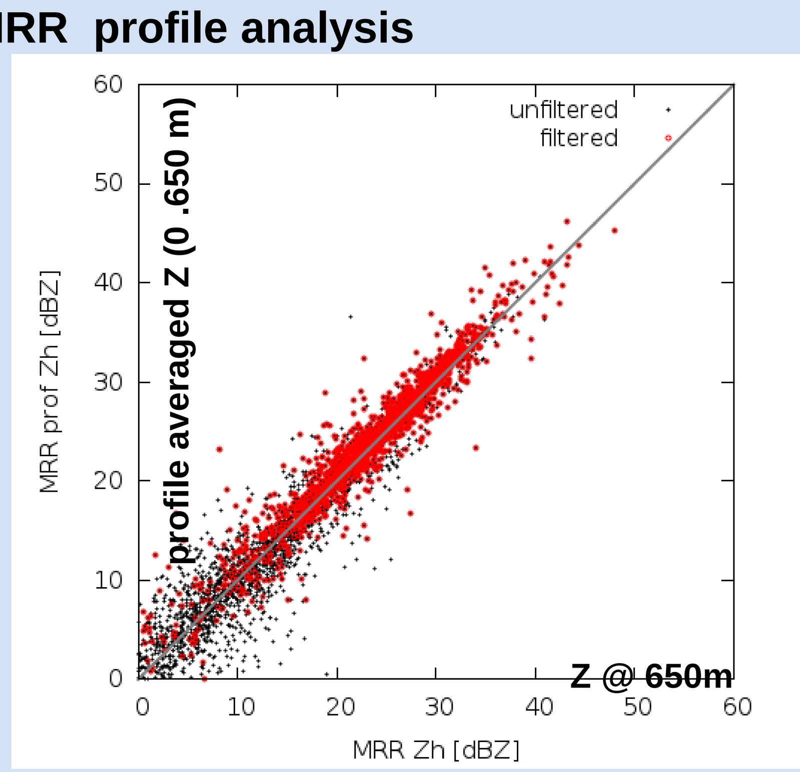
- high resolution "profiler" observation of weather events (see e.g. Frech and Steinert, 2015)
- Monitoring of ZDR and PhiDp offset
- Monitoring absolute calibration
- Monitoring of rx and tx path (hardware)



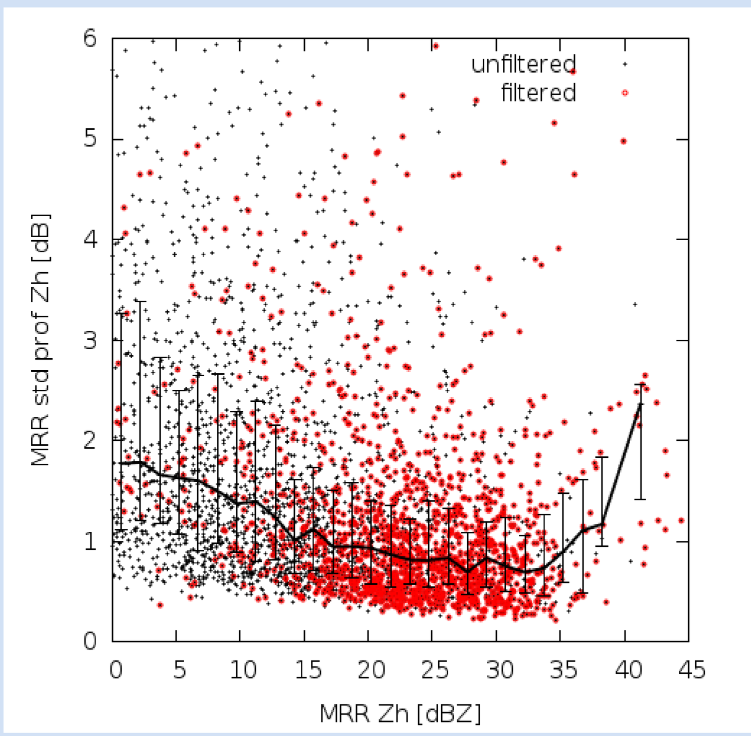
Micro-Rain-Radar MRR

Vertical pointing MRR with a range resolution of 50 m. The MRR is a FM-CW radar and operates at 24 GHz. Standard MRR signal processing for rain is used, including path attenuation correction and Mie-to-Rayleigh scattering adjustment. Vertical air motion related to mountain flow is neglected at the reference height of 650 m above site.

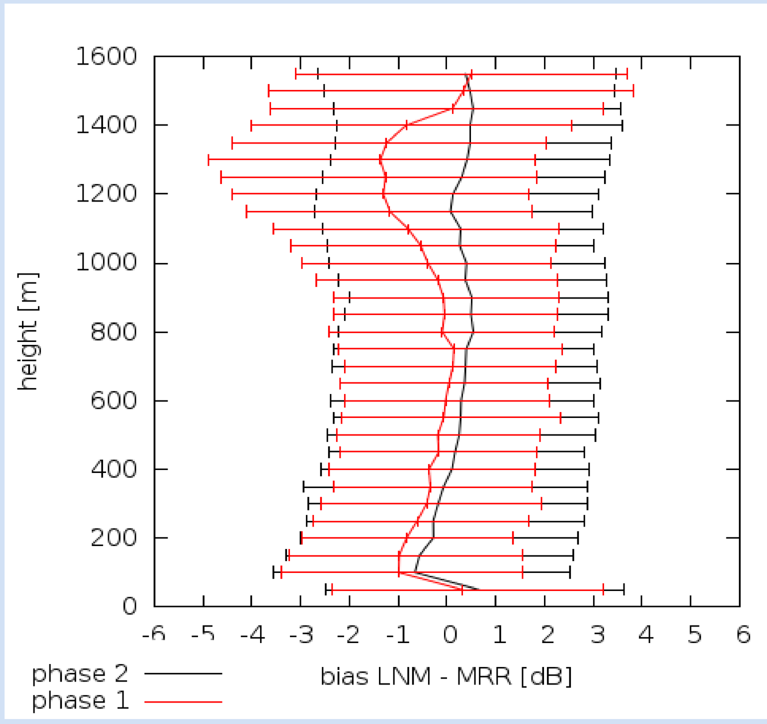
MRR profile analysis



Mean Z in the profile between 0 – 650 m against Z at 650 m . Largest scatter found for Z < 15 dBZ indicating larger vertical variability in Z.

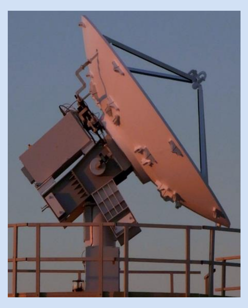


The standard deviation of Z in the profile below 650 m for a given Z measurement at 650 m. The standard deviation is about 1 dB in a range between ~ 10 and 35 dBZ . Red data points relate to data with fall velocities < -2 m/s.



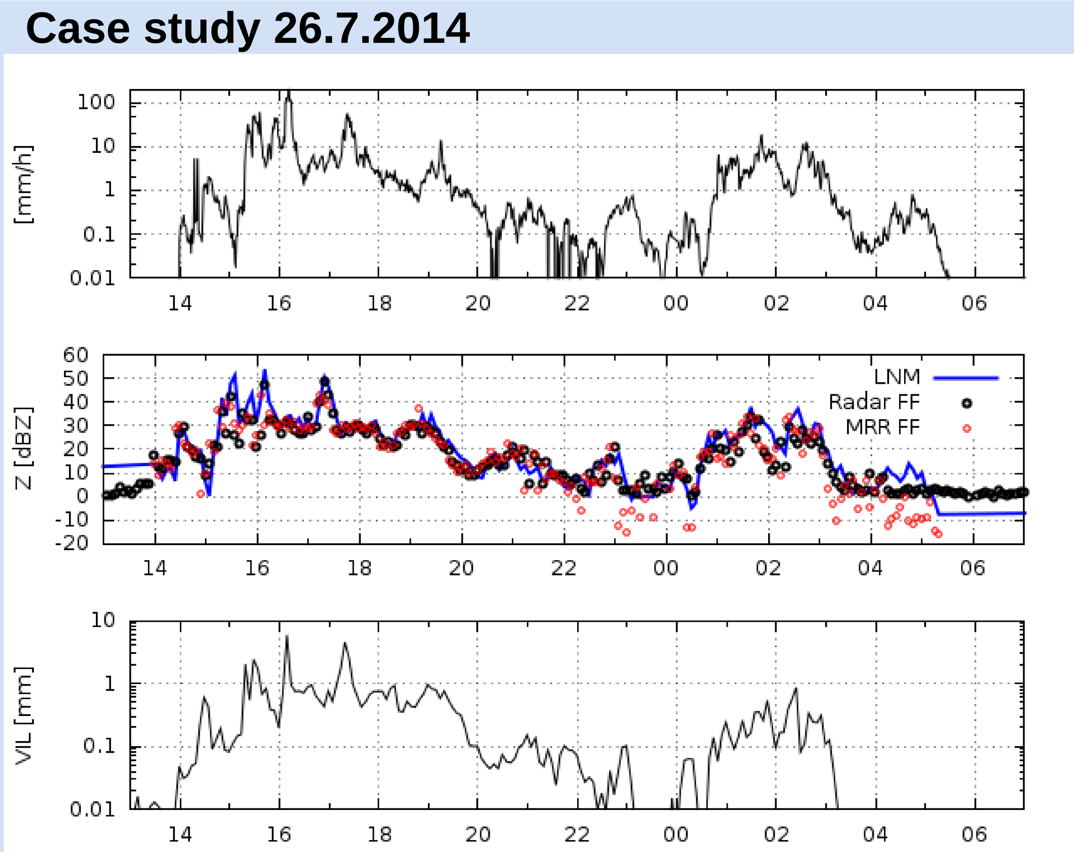
The bias of MRR Z measurement relative to the disdrometer data as a function of measurement height. The bias profile considers simple time correction to relate disdrometer with elevated radar measurements.

DWSR5001/SDP/CE



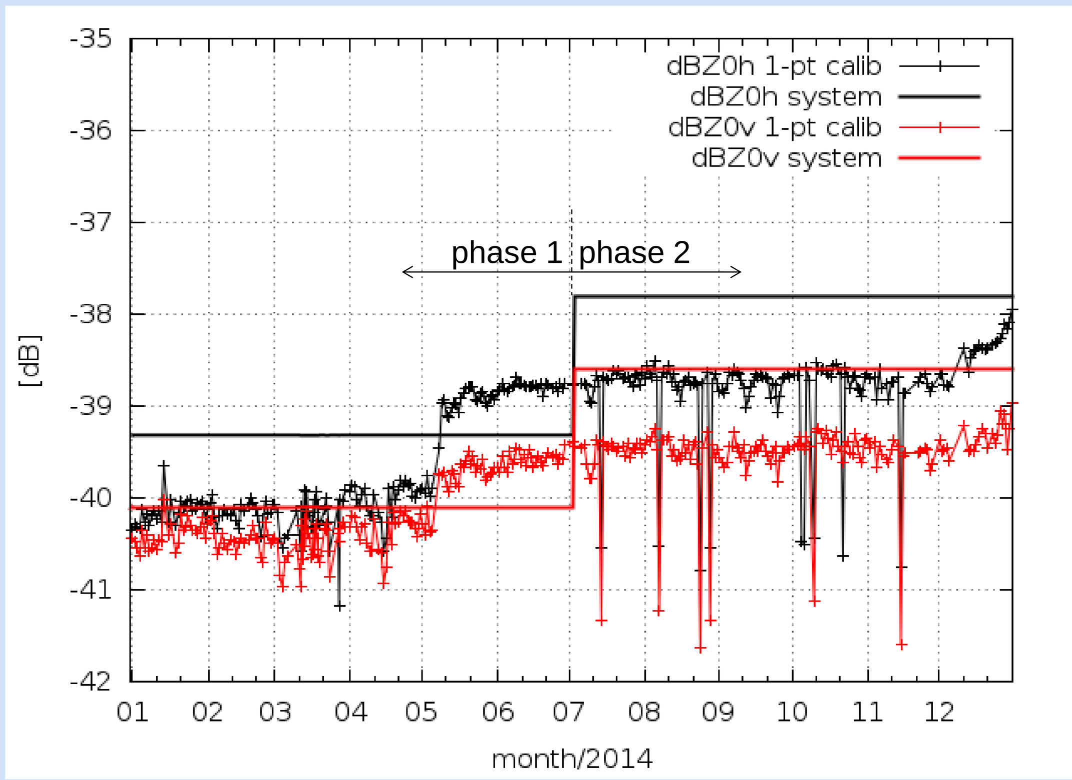
- Magnetron transmitter, 500 kW peak power, pulse widths: 0.4 & 0.8 µs, simultaneous Tr/Rx
- parabolic antenna beam width 1°, gain 45 dB, side lobes < -30 dB, crosspol isolation < -32 dB
- Enigma3p signal processor, linux based (GAMIC)
- AFC stealth radome, optimized for dualpol applications.
- receiver over elevation, dynamic range > 105 dB
- Pedastal unit: positioning accuracy < 0.05°

Case study 26.7.2014



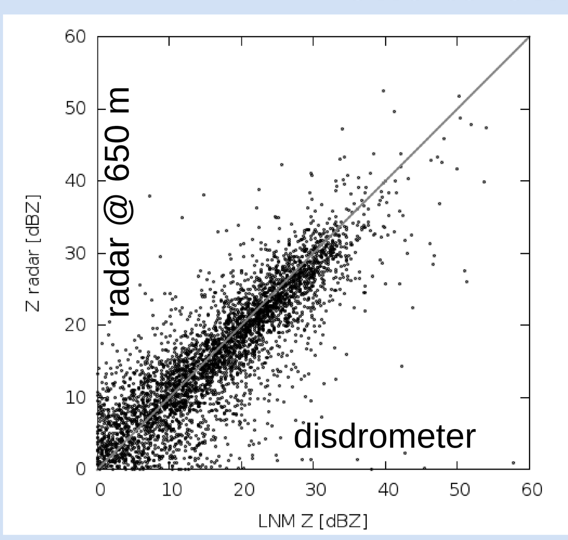
Timeseries of precipitation rate (upper panel, disdrometer data), a comparison of the reflectivity factor Z based on radar and MRR (650 above ground, in the farfield (FF) of the radar antenna, and Z computed from the DSD measured by the disdrometer (middle panel), and VIL computed from the birdbath scan (lower panel). Z agrees particular well for 15 < z < 30 dBZ, stratiform conditions. 55.9 mm precipitation was measured during this event.

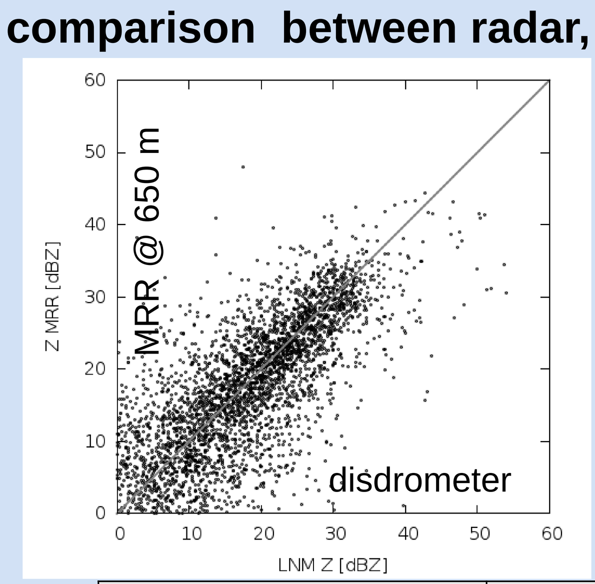
Internal 1-point calibration results 2014

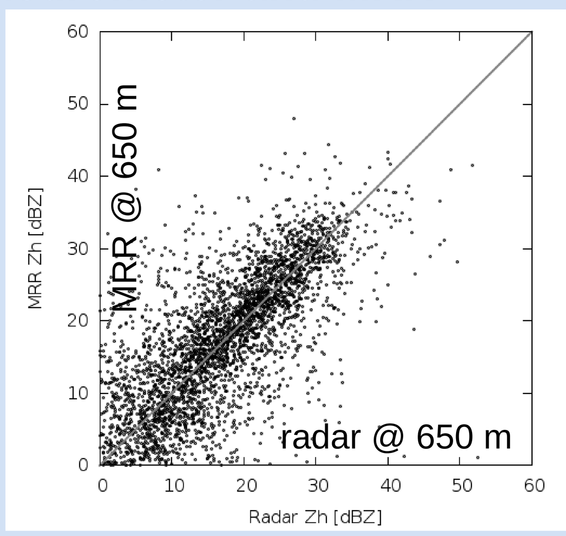


System dBZ0h,v and resulting dBZ0h,v from 1-point calibration (using ITSG, twice a day). Adjustment of dBZ0h,v was done July 1st. A new calibration constant beginning of May explains the increase of dBZ0 derived from internal calibration (~1 dB in H; losses, tx power etc. were measured, see simpl. calibration diagram). The necessity to adjust the calibration is not indicated by the internal 1-point calibration. The adjustment of the calibration is suggested based on disdrometer - radar data comparison (see the table on this poster).
Large deviations in dBZ0 relate to unstable power input by the ITSG.

One-to-One comparison between radar, disdrometer and MRR







data from 04/14 – 07/14 (07/14 – 11/14 data in brackets), only for w < -2 m/s (radar Doppler velocity measurements), 15 < Z < 35 dBZ, and T > 4 °C to exclude melting layer effects. A simple time correction (assume constant average fall speed 4 m/s) is applied to correct for the time offset when relating a measurement at 650 m with disdrometer measurements. Adjustment of radar calibration 1.7.2014 based on this evaluation.

Corresponding statistics (Zh):

	Disdro – radar (dB)	Disdro – MRR (dB)	Radar – MRR (dB)
1st quartile	-0.3 (-1.3)	-2.1 (-2.3)	-3.4 (-2.7)
median	1.8 (0.7)	0.1 (0.3)	-1.7 (0.2)
3rd quartile	3.8 (2.4)	2.2 (3.0)	0.1 (2.2)

Summary & Conclusion

- Absolute calibration can be monitored using a co-located disdrometer.
- The MRR is used to validate the assumptions of the disdrometer – radar comparison.
- Advantage of the approach is the consideration of the *full* tx and rx-path of a radar system.
- Internal calibration is independent from weather, but considers only parts of the radar system.
- The approach here is one element of a multi-source monitoring of absolute calibration

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