



Evaluation of the effects of different lightning protection rods on the quality of C-Band weather radars

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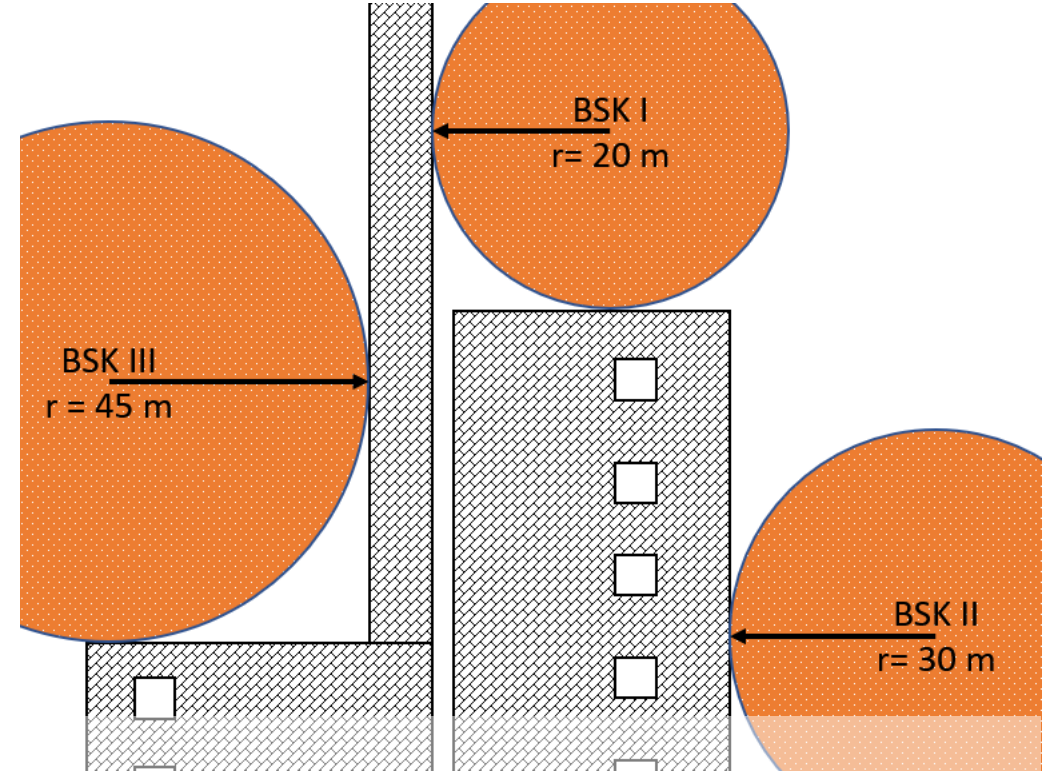
Why lightning protection?

- ➔ Radars are at exposed locations (assumption: 5.22 lightning strikes per km² and year)
- ➔ Protection for expensive equipment
- ➔ Guarantee staff safety
- ➔ It's a regulatory requirement



Defintion of lightning protection

- Roll an imaginary ball over the building
- Place lightning protection rods such that the ball does not touch the building
- The smaller the ball, the higher the lightning protection class
- Requirement for radar towers: „BSK III“



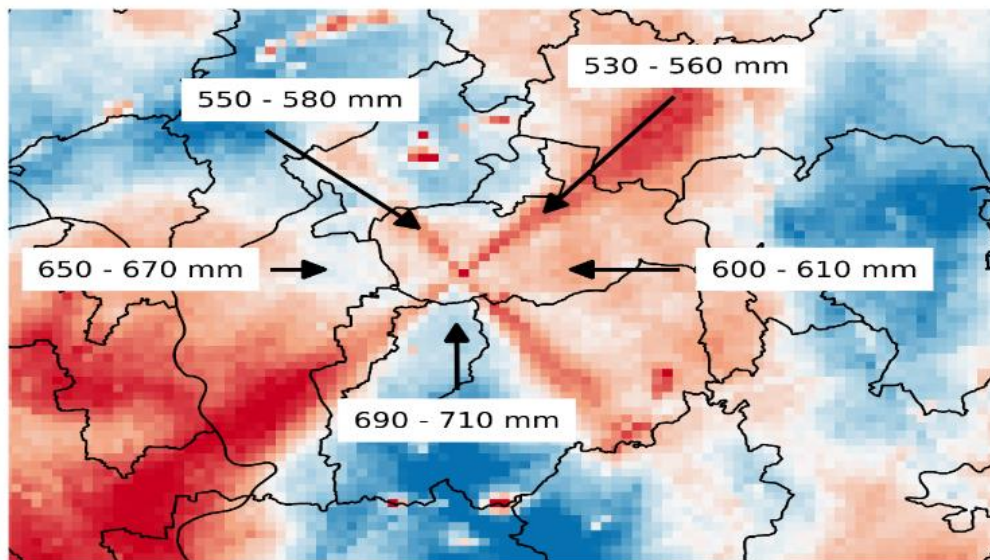
Current lightning protection

- 4 rods with spacing of 90° AZ
- Length: 8m, Diameter: 100mm to 50mm from 0-7m, 10mm in the last meter
- Material: last meter: stainless steel, then aluminium cable covered with fibre glass
- Result: „BSK I“ (required for example for nuclear power plants)
- No time for data evaluation prior to installation



(Negative) Effects of the current rods

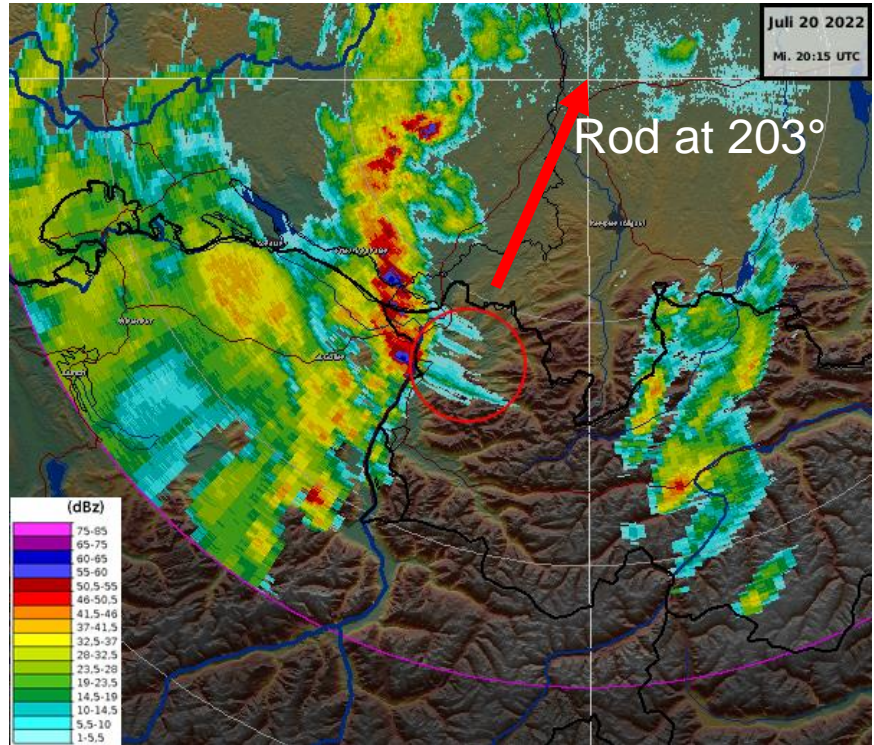
- Beam blockage: removes some of the sent and received power
 - Leads to underestimation of rain rates
 - Visible as „four-leaf clover“ in rain sums
 - Evaluated by calculating precipitation sums



Precipitation sum in mm for 2014 at radar OFT

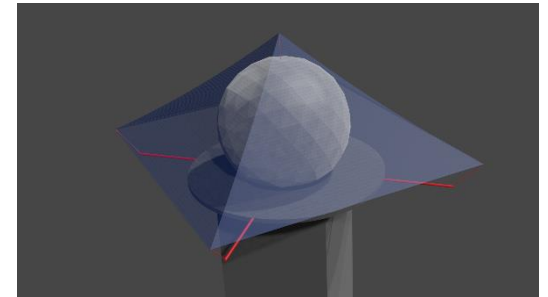
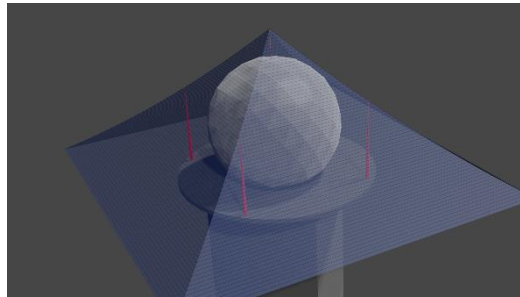
(Negative) Effects of the current rods

- Reflection on send and receive path
 - Makes signals appear where there are none
 - Appears as enhanced side lobe levels in antenna measurements (not property of the antenna!)
 - Evaluated by antenna measurements



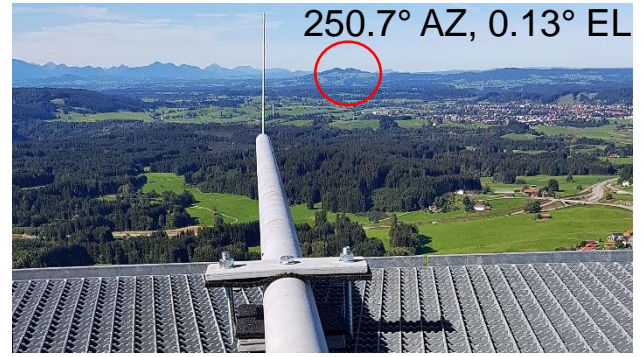
Tested new rods

- Vertical:
 - 16mm and 40mm diameter, 4 pieces, 4m length
- Horizontal:
 - 76mm diameter, 4m length, last meter at 45°
- Both require an additional rod in the radome top panel!



Antenna measurements

- Have an external signal source point at the radar
- Switch radar transmitter off
- Perform a series of high resolution scans
 - 3000Hz PRF, $0.4\mu\text{s}$ PW, 0.05° resolution, 20km range, 1km range resolution
 - Record SNR, ZDR, RhoHV, PhiDP
 - Done with default radar software
 - Raster, PPI and RHI
- Do this with different lightning rods in place



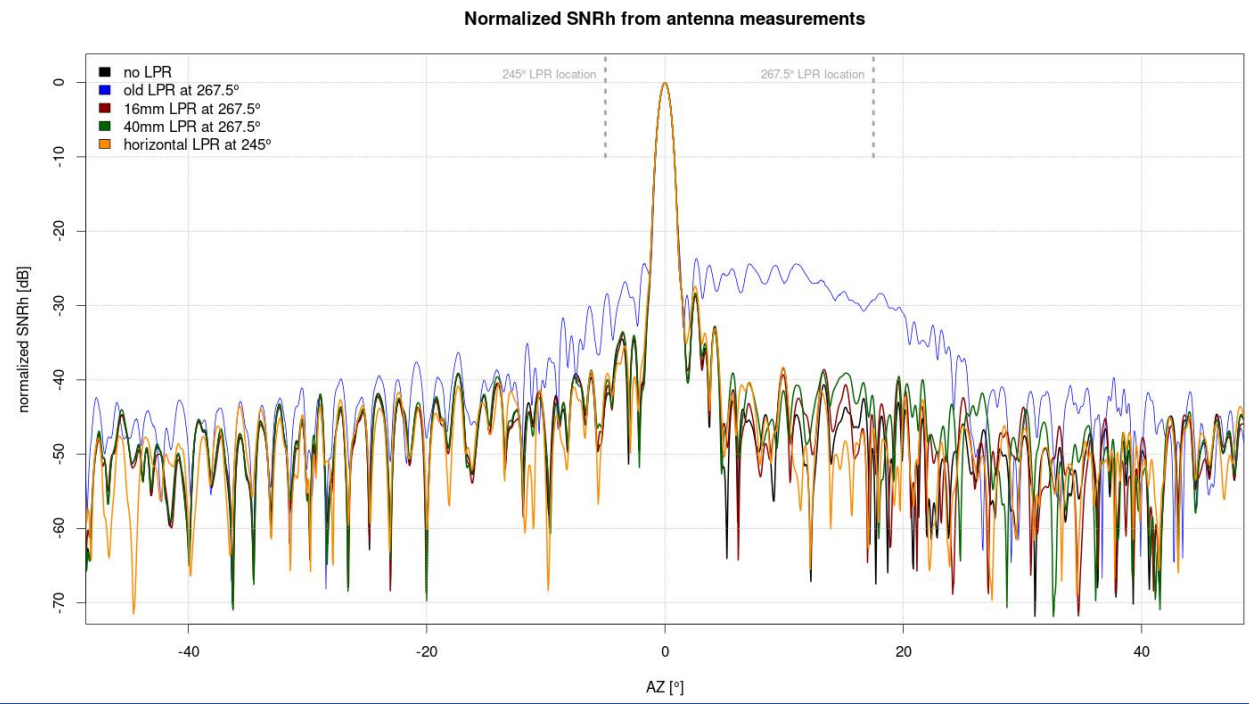
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measurement	LPR	Position	Mode
1	16mm	267.5°	STAR
2	16mm	267.5°	H only
3	none	-	STAR
4	40mm	267.5°	STAR
5	40mm	267.5°	H only
6	16mm	250.7°	H only
7	16mm	250.7°	STAR
8	40mm	250.7°	STAR
9	40mm	250.7°	H only
10	horizontal	245°	H only
11	horizontal	245°	STAR

Approx. 2h per measurement

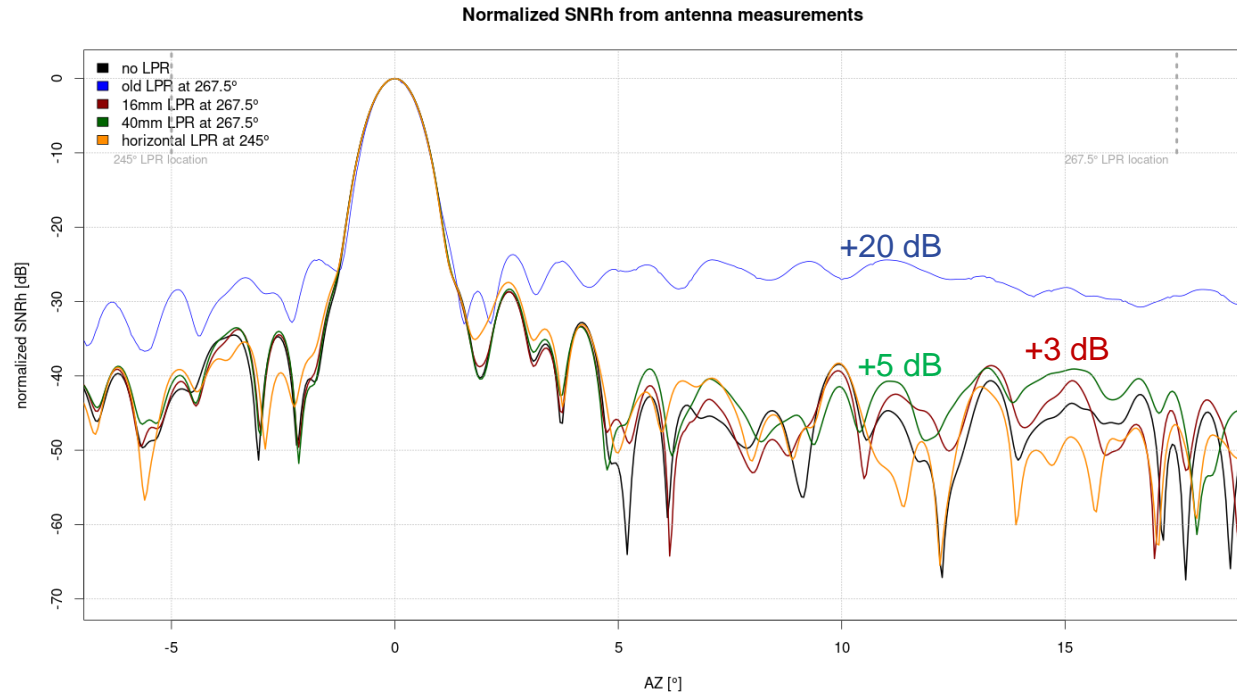
Results – antenna measurements



- ➔ Blue: old rod, black: no rod
- ➔ All tested rods are closer to no rod than to the old one
- ➔ Smallest increase in side lobe levels at horizontal rod (orange)
- ➔ Larger side lobes for 40mm than 16mm rods

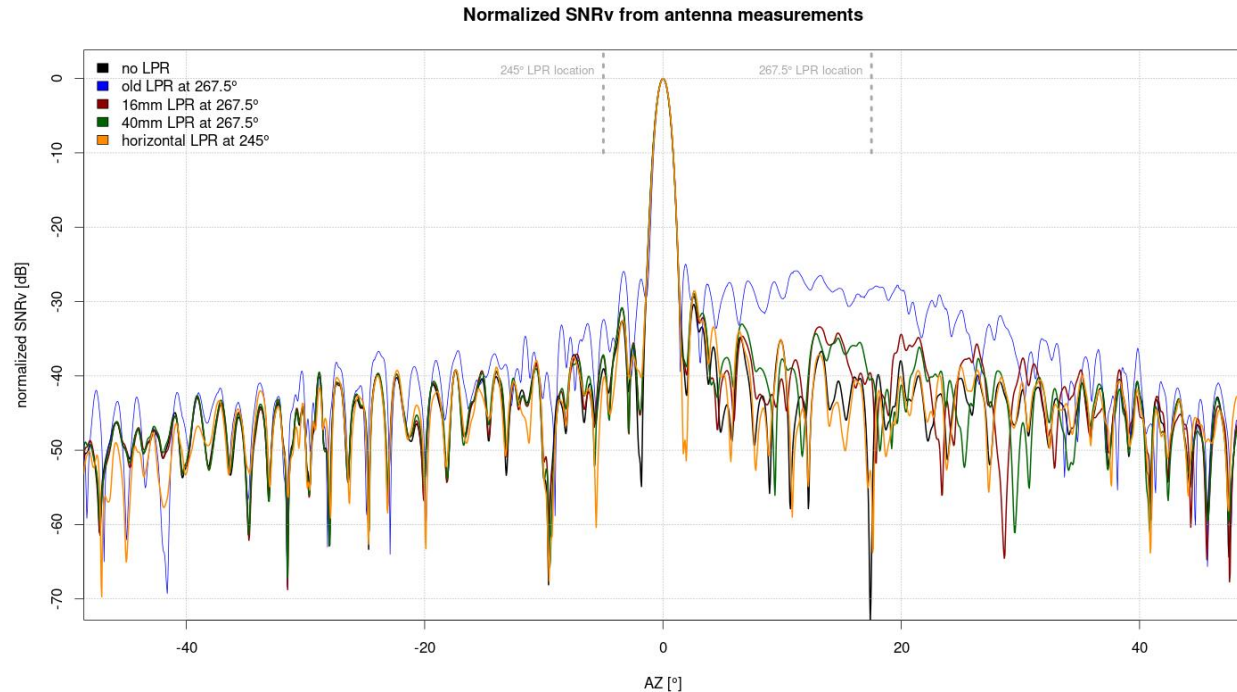


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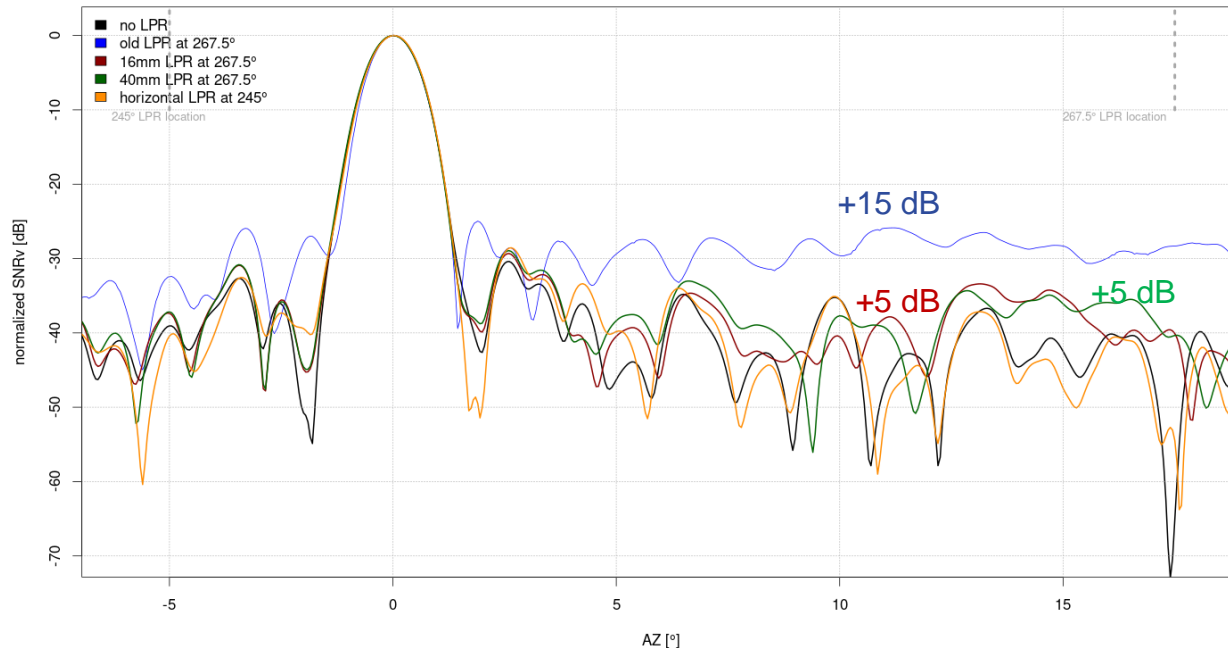
Results – antenna measurements



- ➔ Smaller total differences in vertical channel
- ➔ Results stay the same: all tested setups are better than the old one
- ➔ Assumption: for a vertically polarized wave, the length of the rod is key, not the diameter

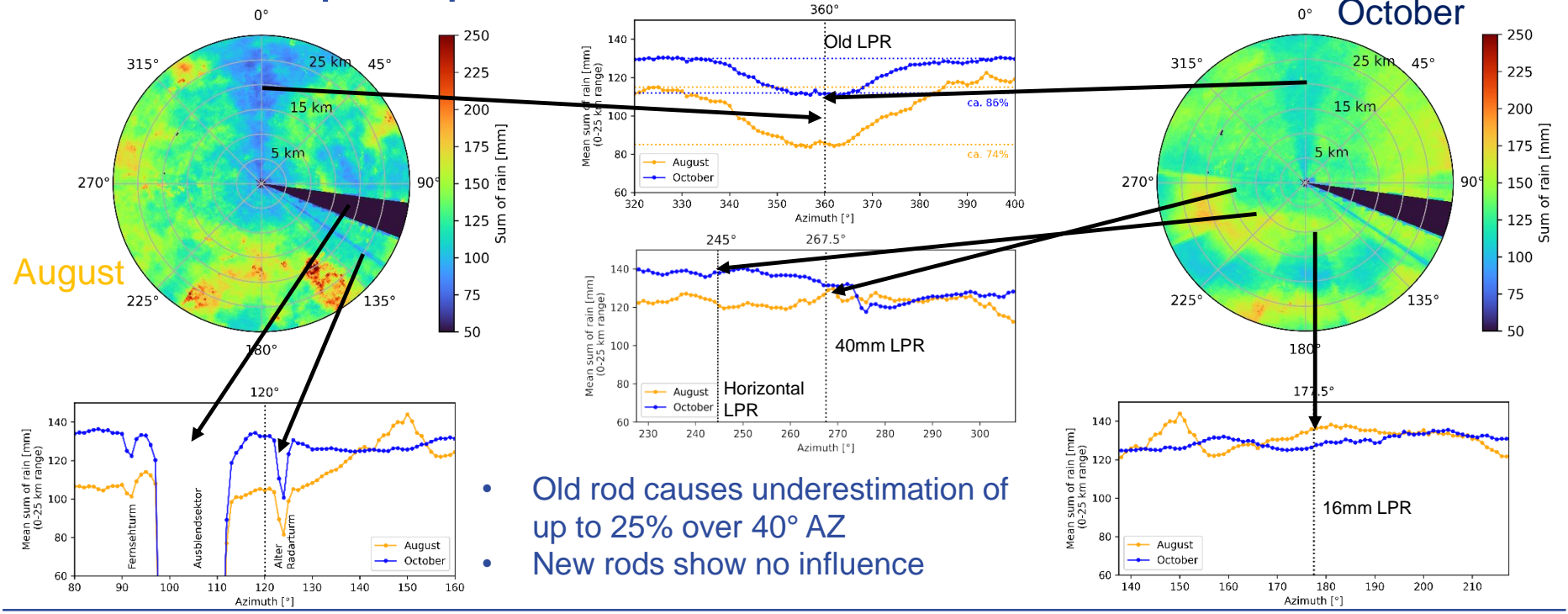
Results – antenna measurements

Normalized SNR_v from antenna measurements



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- ➔ Assumption: for a vertically polarized wave, the length of the rod is key, not the diameter

Results – precipitation sums



- Old rod causes underestimation of up to 25% over 40° AZ
- New rods show no influence

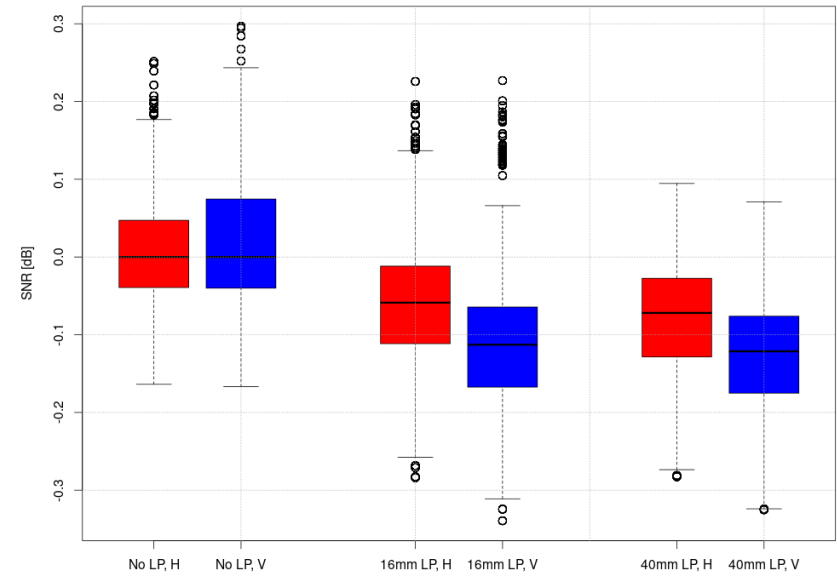


Recommendation

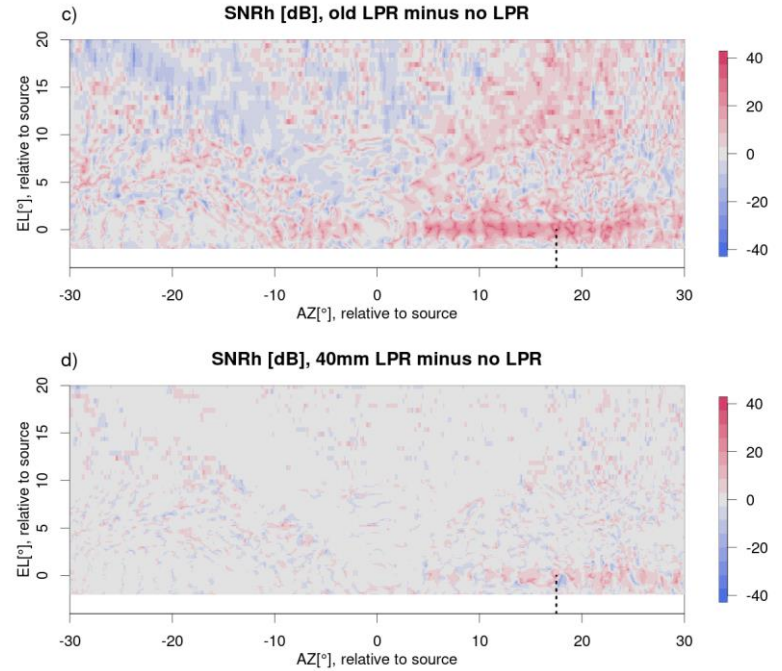
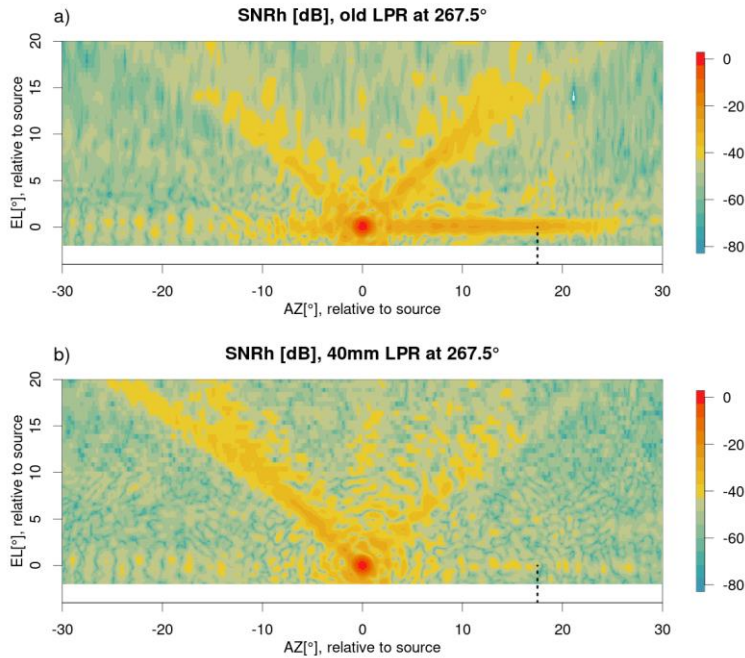
- From a scientist: horizontal rods
 - Least influence on data. Will be used for new towers
- Actual implementation:
 - 40mm vertical rods are the only ones that are structurally safe under the assumption of heavy ice accumulation and people near the towers!
 - Keep diameters below radar wave length.
- Again: all require the top rod in the radome (measurements showed no detrimental effects)
- Paper with more details is in preparation.



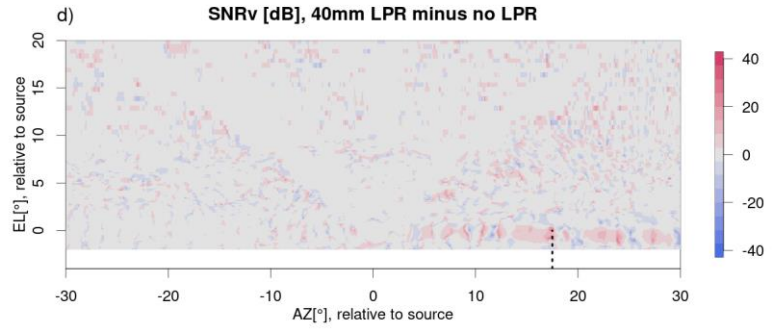
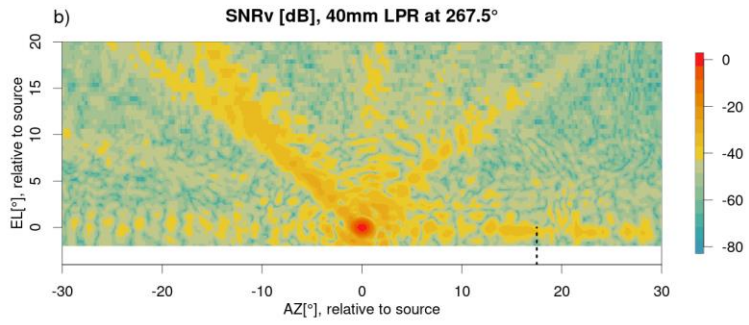
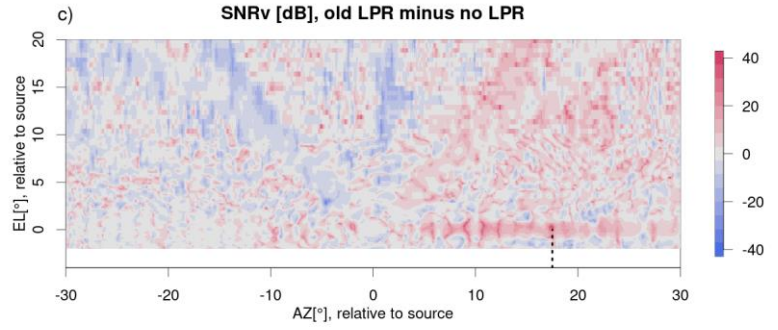
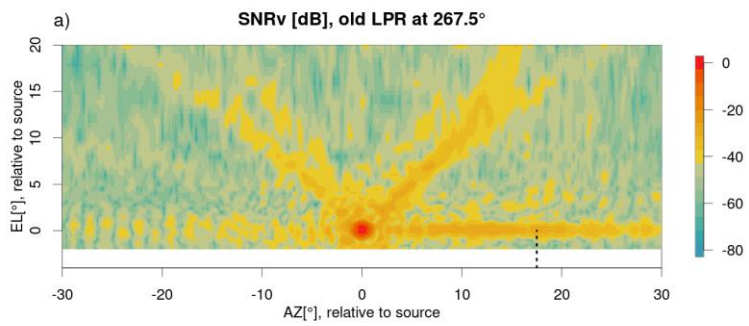
Beam blockage on receive path



Raster scans



Raster scans



A puzzle for the end:

