



Sargent 600 740

Passport 1000 P2 & IN120 custom antenna
measurements

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Revision History

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3 Acronyms, Abbreviations and Definitions

Table 1. Acronyms

Acronym	Description
dB _i	deci-Bel relative isotropic
VSWR	Voltage Standing Wave Ratio
XY	The common plane of the X and Y axis of a cartesian coordinate system. In this report constituting the azimuth plane.
XZ	The common plane of the X and Z axis of a cartesian coordinate system. In this report constituting the “side view” elevation plane
YZ	The common plane of the Y and Z axis of a cartesian coordinate system. In this report constituting the “front view” elevation plane

4 Introduction

4.1 Scope

The present document presents measurements on the custom dual band WiFi antenna integrated into Passport 1000 P2 and IN-120 (with and without metal wings) mounted on wooden and metal foiled doors. The results are presented as total power in the azimuth plane and two orthogonal elevation planes. The total power is also presented as a 3-D pattern. The vertical and horizontal polarizations are also presented in the azimuth plane and two orthogonal elevation planes.

4.2 Intended Audience

Assa Abloy Sargent engineers, project managers and regulatory compliance officials.

4.3 Reference plane definitions

The measurements were made in a number of cutting planes. The azimuth plane is denoted XY-plane and shows the antenna gain in the horizontal plane. The elevation plane denoted XZ shows the power as a function of elevation in the plane that includes the front and back of the door. The elevation plane denoted YZ shows the power as a function of elevation in the plane that includes the right- and left sides of the door. Two additional planes denoted 45° and 135° are used for the 3-D visualization of total power and are not presented separately in 2-D plots. Reference Figure 1 for cutting plane definitions.

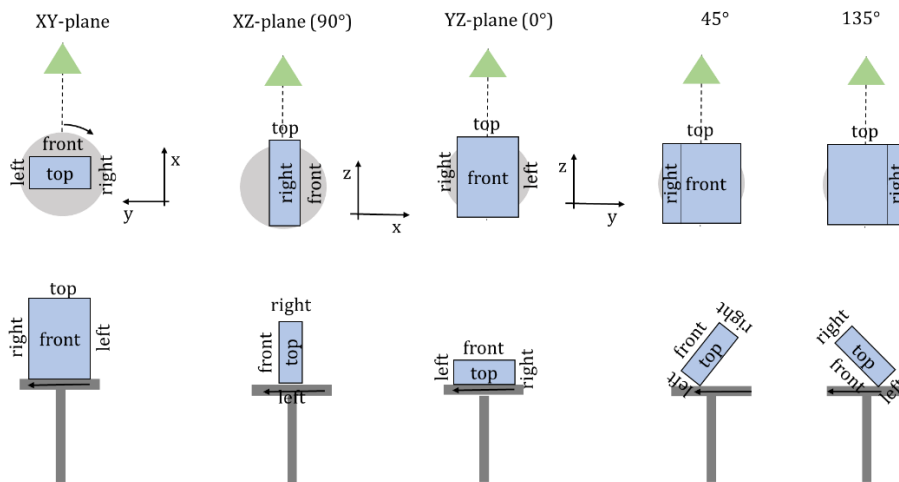


Figure 1 Reference measurement planes. Top row: birds-eye view turn table and measurement antenna; Bottom row: view from measurement antenna.

4.4 3-D visualization reference

The antennas radiation patterns are also shown as a 3-D visualizations in 6.3 and 8.3. The total power as measured in 4 elevation planes are plotted as a surface in a spherical coordinate system. The X, Y and Z axis' are shown red, green and blue axis'. The gain and colour mapping are with reference to the peak gain of the antenna. Figure 2 shows a 3-D representation of an ideal half wave dipole aligned with the Z-axis.

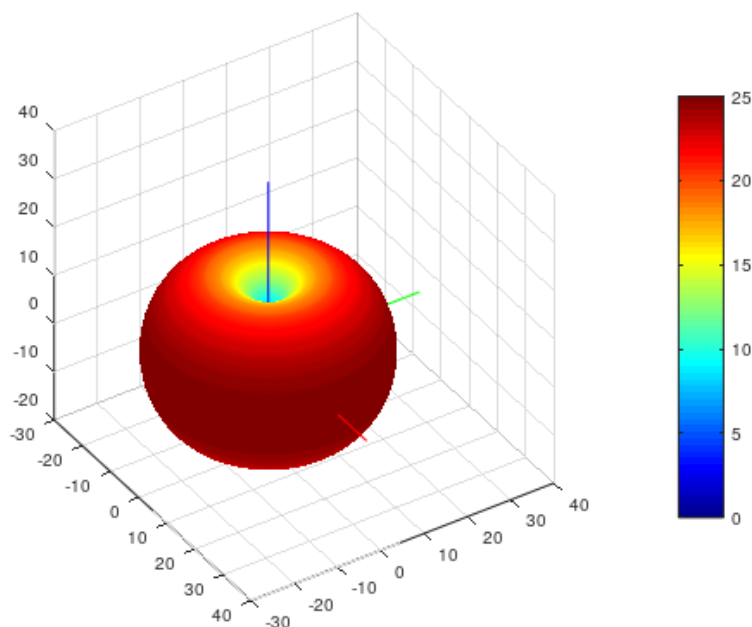


Figure 2 Reference 3-D visualization of an ideal dipole radiation pattern.

5 VSWR

The custom antenna element developed for the IN100 and Passport 1000 P2 was verified for VSWR mounted in the full mechanical assembly mounted on a door mock-up.

VSWR is a measure of how well the antenna impedance is matched to a reference characteristic impedance (often 50 Ω). If the antenna impedance differs from the characteristic impedance, reflections causing loss of power transfer occurs at the interface. Impedance mismatch can also cause a transmitter to e.g. generate more harmonic power.

The VSWR of the custom antenna in each of the products are shown in Figure 1.

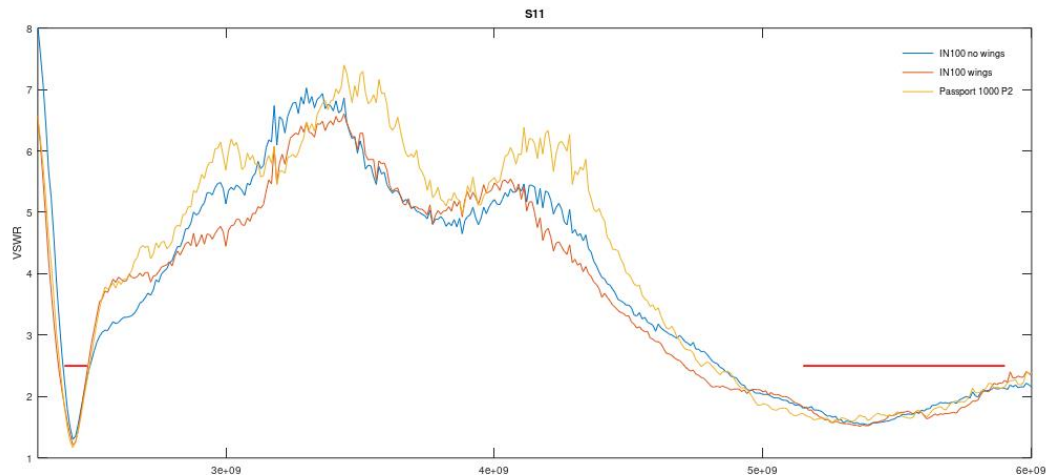


Figure 3 VSWR custom antenna. Red limit line at VSWR=2.5 in 2.4 GHz and 5 GHz WLAN bands.

A VSWR < 2.5 means that more than 81.6 % of the available RF energy is delivered to the antenna. Of the power delivered to the antenna part of it is radiated and part of it is lost in ohmic losses. The radiated energy is radiated differently in different directions. The directional property is characterized in a radiation diagram, see 6-9.

6 Total power 2.4 GHz

6.1 Peak gain and efficiency

Antenna efficiency is a measure of how much of the power available at a reference impedance the antenna radiates. The power that is not radiated is lost due to impedance mismatch and ohmic losses in the antenna. The antenna efficiency is presented in Table 2. The total power peak gain is presented in Table 3.

Table 2 Antenna efficiency 2.4 GHz.

f [MHz]	Efficiency [dB]					
	Passport 1000 P2		IN 120		IN 120 Wings	
	Wood	Foil	Wood	Foil	Wood	Foil
2400	-7,8	-8,7	-7,1	-5,6	-7,0	-6,1
2440	-7,5	-8,7	-6,0	-4,8	-5,7	-5,6
2483	-8,2	-8,9	-6,2	-4,6	-5,5	-5,0

Table 3 Total Power Peak Gain for azimuth and elevation planes at 2.4 GHz.

Plane	f [MHz]	Total Power Peak Gain [dBi]					
		Passport 1000 P2		IN 120		IN 120 Wings	
		Wood	Foil	Wood	Foil	Wood	Foil
XY	2400	-3,3	-2,0	-1,3	2,4	-1,8	0,7
	2440	-2,2	-3,2	-2,1	2,9	-1,1	0,0
	2483	-1,8	-0,4	-2,2	2,3	-1,7	0,4
XZ	2400	-2,2	-2,1	-2,3	2,0	-1,1	1,4
	2440	-2,0	-2,3	-0,1	3,0	0,6	2,0
	2483	-2,4	-1,6	-0,3	2,9	1,1	1,9
YZ	2400	-3,8	-6,1	-2,3	-3,9	-4,1	-3,7
	2440	-3,2	-5,9	-1,6	-4,0	-2,8	-2,4
	2483	-3,8	-5,9	-1,4	-3,7	-2,5	-2,2

6.2 Gain in azimuth and elevation planes

The gain is plotted in the Azimuth plane (XY) and in elevation planes XZ (side view) and YZ (front view).

6.2.1 Passport 1000 P2

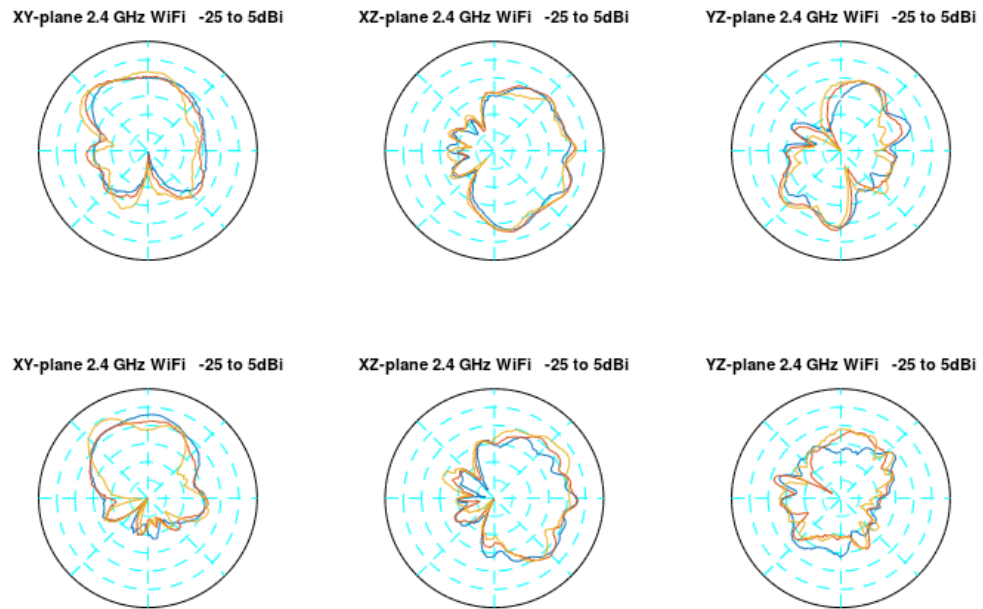


Figure 4 Passport 1000 P2. Top: Wooden door; Bottom: Foiled door

6.2.2 IN120

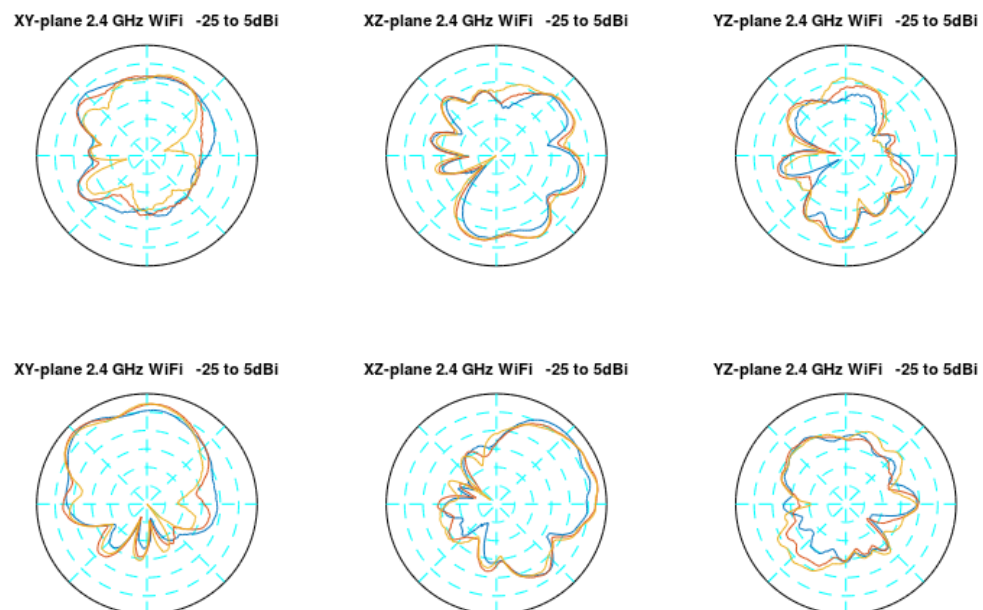
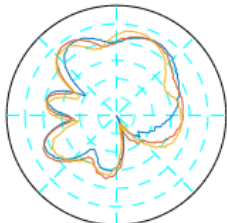


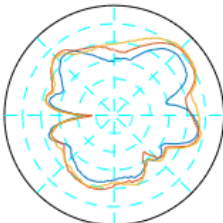
Figure 5 IN 120 . Top: Wooden door; Bottom: Foiled door

6.2.3 IN120 with Wings

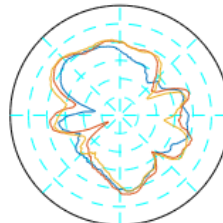
XY-plane 2.4 GHz WiFi -25 to 5dBi



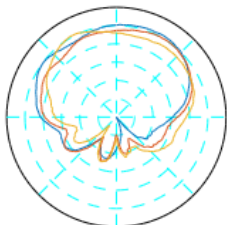
XZ-plane 2.4 GHz WiFi -25 to 5dBi



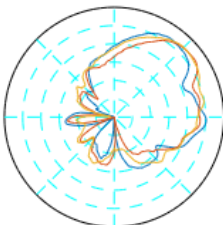
YZ-plane 2.4 GHz WiFi -25 to 5dBi



XY-plane 2.4 GHz WiFi -25 to 5dBi



XZ-plane 2.4 GHz WiFi -25 to 5dBi



YZ-plane 2.4 GHz WiFi -25 to 5dBi

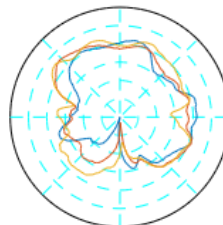


Figure 6 IN 120 with metal wings; Top: Wooden door; Bottom: Foiled door

6.3 3D visualization

The 3D antenna diagrams presented in this section is based on four equidistant measurement cuts of the azimuth planes. The figures presented is at the centre frequency 2.44 GHz.

6.3.1 Passport 1000 P2

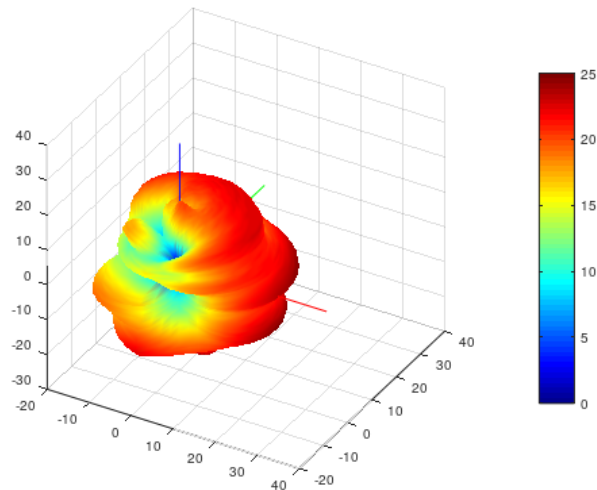


Figure 7 Passport 1000 P2 3D-radiation pattern wooden door.

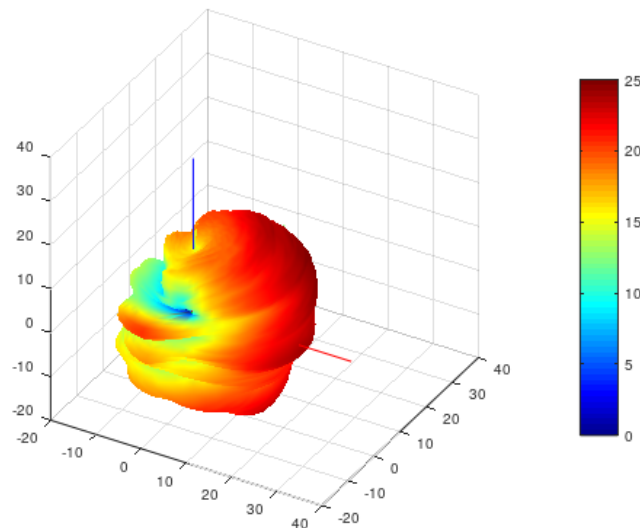


Figure 8 Passport 1000 P2 3D-radiation pattern foiled door.

6.3.2 IN120

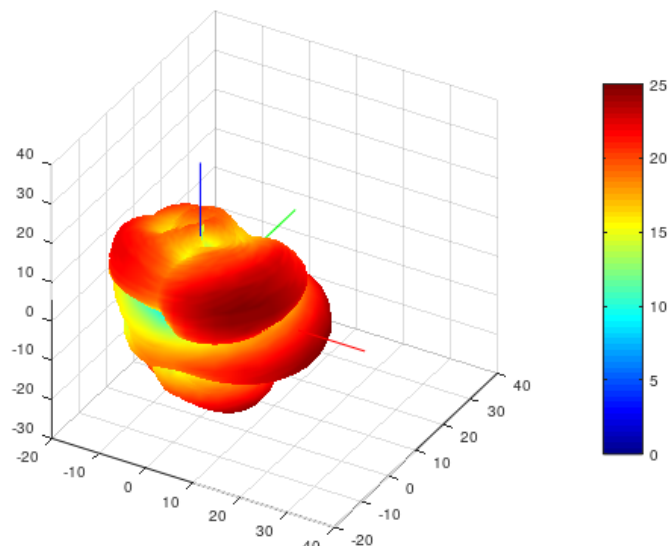


Figure 9 IN-120 3D-radiation pattern wooden door.

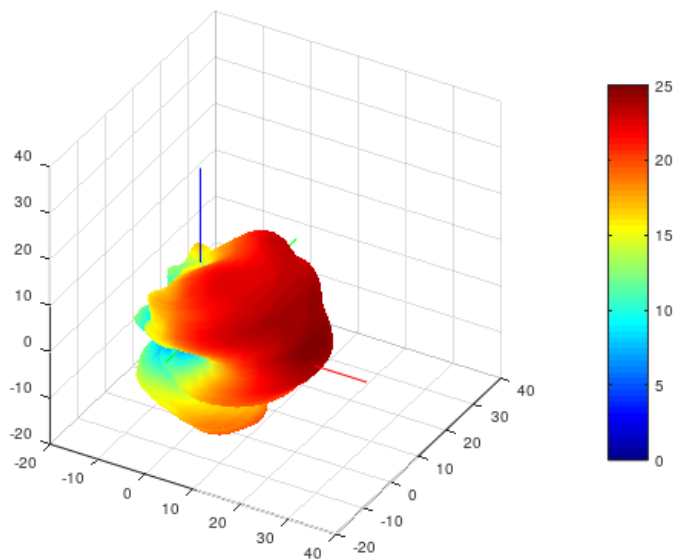


Figure 10 IN-120 3D-radiation pattern foiled door

6.3.3 IN120 with Wings

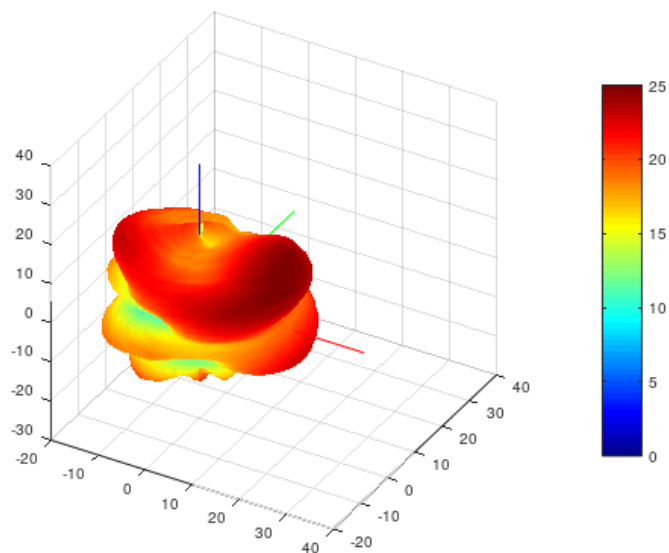


Figure 11 IN-120 with wings 3D-radiation pattern wooden door.

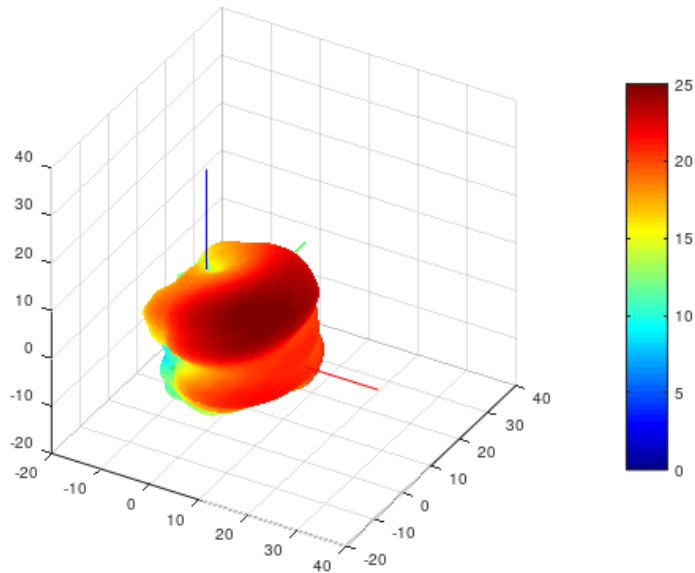


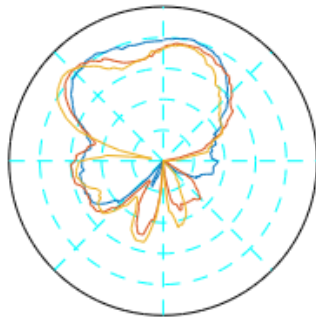
Figure 12 IN-120 with metal wings 3D-radiation pattern foiled door

7 Vertical and Horizontal polarisation 2.4 GHz

7.1 Wooden door

7.1.1 Passport 1000 P2

V-pol XY-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol XY-plane 2.4 GHz WiFi -25 to 0 dBi

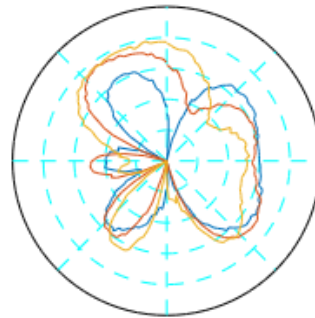
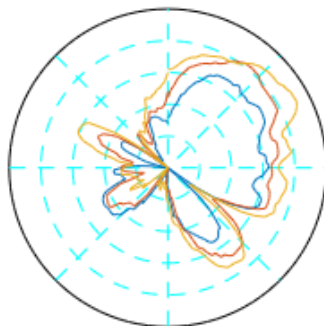


Figure 13 XY-plane, Vertical and Horizontal polarisation Passport 1000 P2 on wooden door.

V-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi

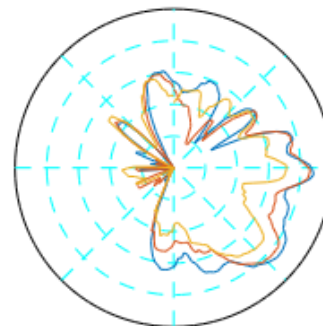
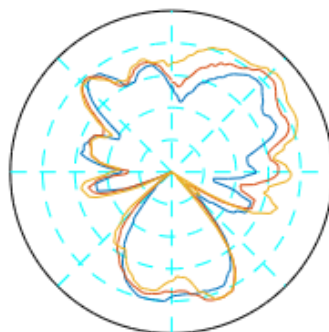


Figure 14 XZ-plane, Vertical and Horizontal polarisation Passport 1000 P2 on wooden door.

V-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi

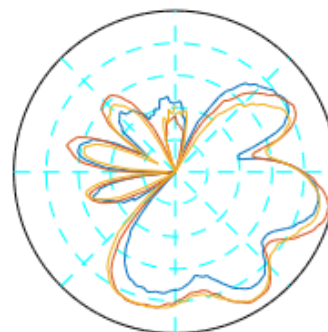
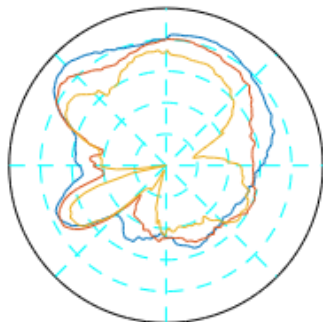


Figure 15 YZ-plane, Vertical and Horizontal polarisation Passport 1000 P2 on wooden door.

7.1.2 IN120

V-pol XY-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol XY-plane 2.4 GHz WiFi -25 to 0 dBi

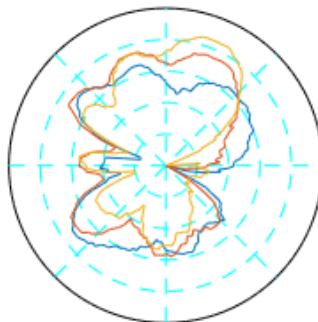
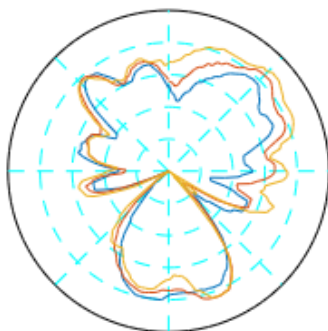


Figure 16 XY-plane, Vertical and Horizontal polarisation IN-120 on wooden door.

V-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi

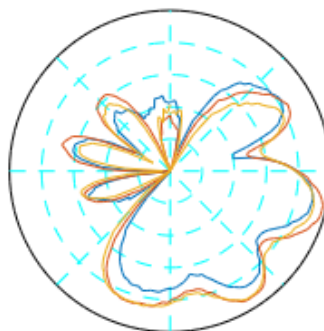
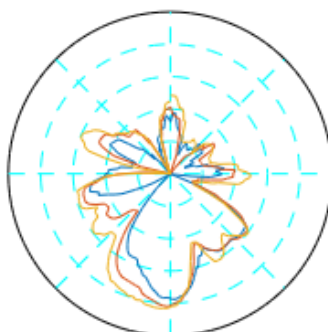


Figure 17 XZ-plane, Vertical and Horizontal polarisation IN-120 on wooden door.

V-pol YZ-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol YZ-plane 2.4 GHz WiFi -25 to 0 dBi

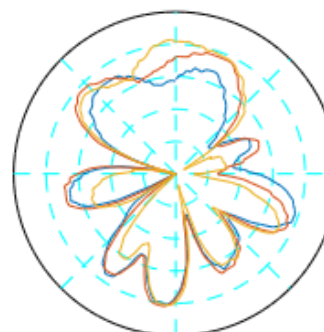
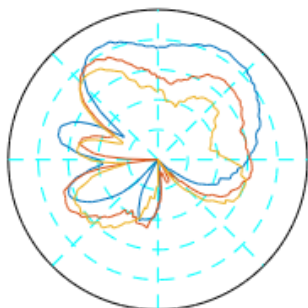


Figure 18 YZ-plane, Vertical and Horizontal polarisation IN-120 on wooden door.

7.1.3 IN120 with wings

V-pol XY-plane 2.4 GHz WiFi -25 to 0 dBi

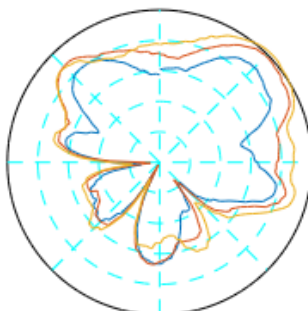


H-pol XY-plane 2.4 GHz WiFi -25 to 0 dBi



Figure 19 XY-plane, Vertical and Horizontal polarisation IN-120 with wings on wooden door.

V-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi

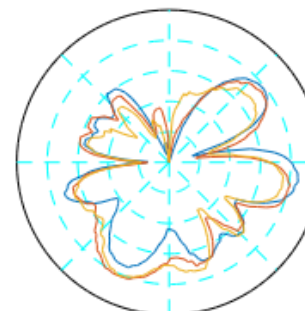
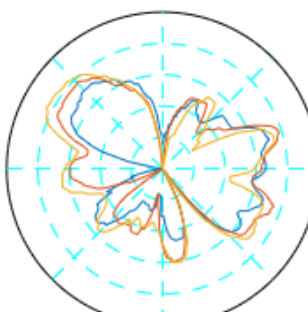


Figure 20 XZ-plane, Vertical and Horizontal polarisation IN-120 with wings on wooden door.

V-pol YZ-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol YZ-plane 2.4 GHz WiFi -25 to 0 dBi

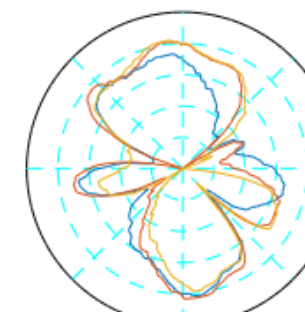
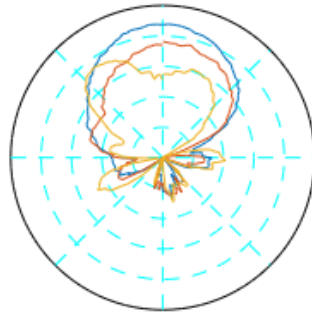


Figure 21 YZ-plane, Vertical and Horizontal polarisation IN-120 with wings on wooden door.

7.2 Foiled door

7.2.1 Passport 1000 P2

V-pol XY-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol XY-plane 2.4 GHz WiFi -25 to 0 dBi

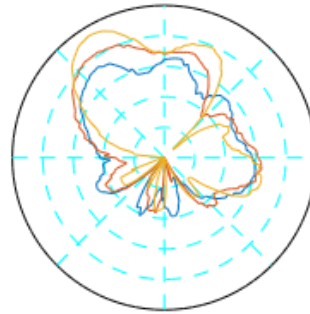
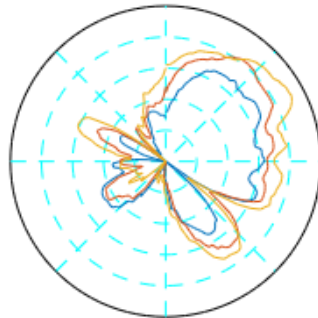


Figure 22 XY-plane Vertical and Horizontal polarisation Passport 1000 P2 on foiled door.

V-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi

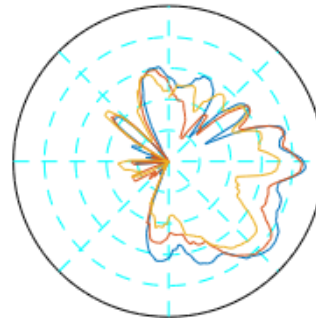
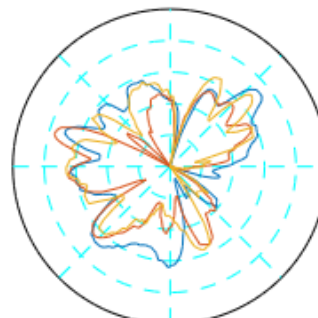


Figure 23 XZ-plane, Vertical and Horizontal polarisation Passport 1000 P2 on foiled door.

V-pol YZ-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol YZ-plane 2.4 GHz WiFi -25 to 0 dBi

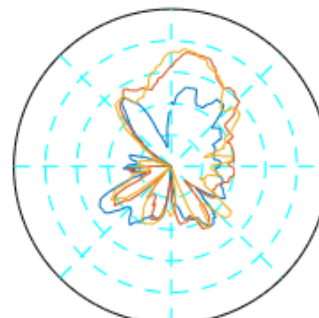
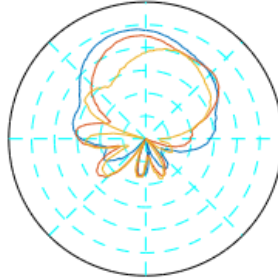


Figure 24 YZ-plane, Vertical and Horizontal polarisation Passport 1000 P2 on foiled door.

7.2.2 IN120

V-pol XY-plane 2.4 GHz WiFi -25 to 5 dBi



H-pol XY-plane 2.4 GHz WiFi -25 to 5 dBi

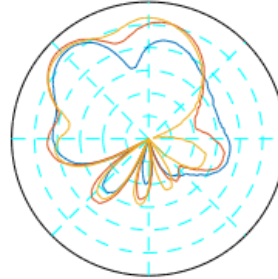
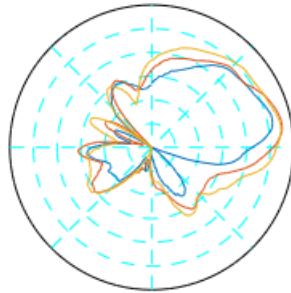


Figure 25 XY-plane Vertical and Horizontal polarisation IN-120 on foiled door.

V-pol XZ-plane 2.4 GHz WiFi -25 to 5 dBi



H-pol XZ-plane 2.4 GHz WiFi -25 to 5 dBi

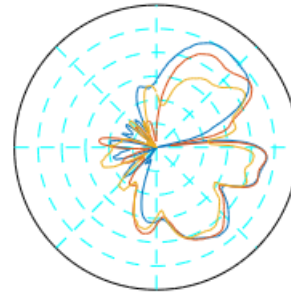
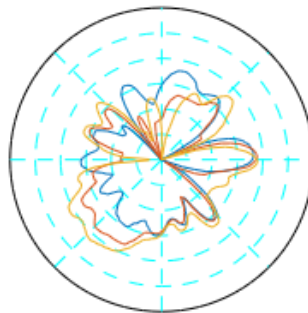


Figure 26 XZ-plane Vertical and Horizontal polarisation IN-120 on foiled door.

V-pol YZ-plane 2.4 GHz WiFi -25 to 5 dBi



H-pol YZ-plane 2.4 GHz WiFi -25 to 5 dBi

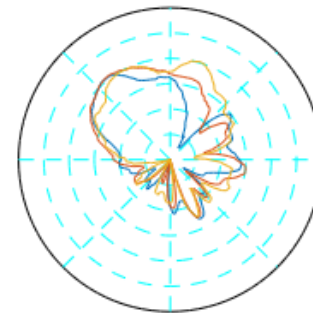
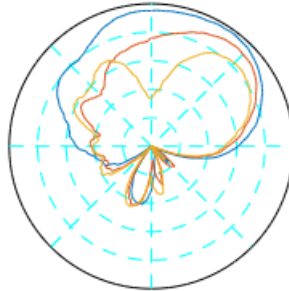


Figure 27 YZ-plane Vertical and Horizontal polarisation IN-120 on foiled door.

7.2.3 IN120 with wings

V-pol XY-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol XY-plane 2.4 GHz WiFi -25 to 0 dBi

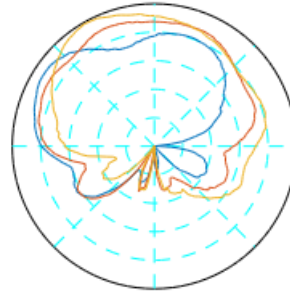
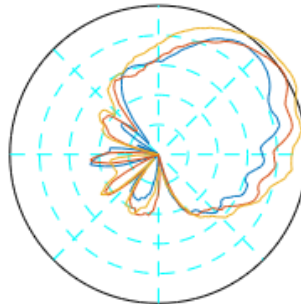


Figure 28 XY-plane Vertical and Horizontal polarisation IN-120 with wings on foiled door.

V-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol XZ-plane 2.4 GHz WiFi -25 to 0 dBi

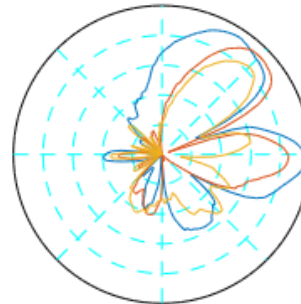
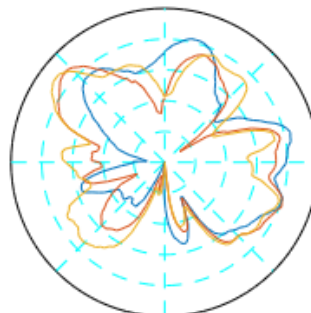


Figure 29 XZ-plane Vertical and Horizontal polarisation IN-120 with wings on foiled door.

V-pol YZ-plane 2.4 GHz WiFi -25 to 0 dBi



H-pol YZ-plane 2.4 GHz WiFi -25 to 0 dBi

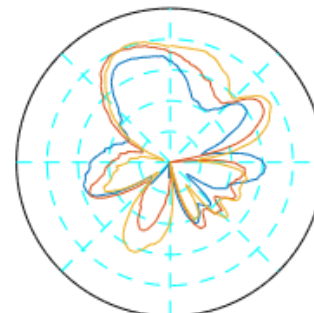


Figure 30 YZ-plane Vertical and Horizontal polarisation IN-120 with wings on foiled door.

8 Total Power 5GHz

8.1 Peak gain and efficiency

Antenna efficiency is a measure of how much of the power available at a reference impedance the antenna radiates. The power that is not radiated is lost due to impedance mismatch and ohmic losses in the antenna. The antenna efficiency is presented in Table 4. The total power peak gain is presented in Table 5.

Table 4 Antenna efficiency at 5 GHz.

f [MHz]	Efficiency [dB]					
	Passport 1000 P2		IN 120		IN 120 Wings	
	Wood	Foil	Wood	Foil	Wood	Foil
5100	-4,4	-6,3	-0,9	-2,8	-3,7	-3,3
5300	-3,6	-6,5	-0,7	-2,6	-3,3	-2,5
5500	-4,0	-6,5	-0,5	-2,7	-4,4	-3,1
5700	-4,0	-6,1	-0,9	-2,2	-3,7	-2,5
5800	-4,6	-6,1	-1,5	-3,5	-5,0	-3,8

Table 5 Total Power Peak Gain for azimuth and elevation planes at 5 GHz.

Plane	f [MHz]	Total Power Peak Gain [dBi]					
		Passport 1000 P2		IN 120		IN 120 Wings	
		Wood	Foil	Wood	Foil	Wood	Foil
XY	5100	0,0	6	6,9	5,8	3,8	6,8
	5300	-2,0	4,1	6,8	4,7	2,0	3,9
	5500	-0,7	3	6,5	3,6	-1,0	3,3
	5700	-5,1	3,4	4,7	3,2	-0,6	1,0
	5800	3,8	6,1	6,1	4,9	0,0	3,5
XZ	5100	0,3	1,1	2,6	3,2	0,9	4,8
	5300	2,7	3,2	4,5	4,2	3,6	5,5
	5500	3,3	3,9	5	5,0	2,5	4,7
	5700	3,2	5,4	5,4	6,7	4,9	7,6
	5800	1,8	2,5	3,3	2,8	2,6	5,5
YZ	5100	-0,9	-11	3,1	0,4	-1,4	-1,5
	5300	0,7	-10	2	-1,0	-0,2	-0,8
	5500	-1,6	-9,8	1,2	-1,7	-2,3	-1,6
	5700	-0,1	-9,2	-0,8	-0,1	-1,4	-2,3
	5800	-1,4	-5,9	1,3	0,0	-0,4	-0,3

8.2 Gain in Azimuth and elevation planes

The gain is plotted in the Azimuth plane (XY) and in elevation planes XZ (side view) and YZ (front view).

8.2.1 Passport 1000 P2

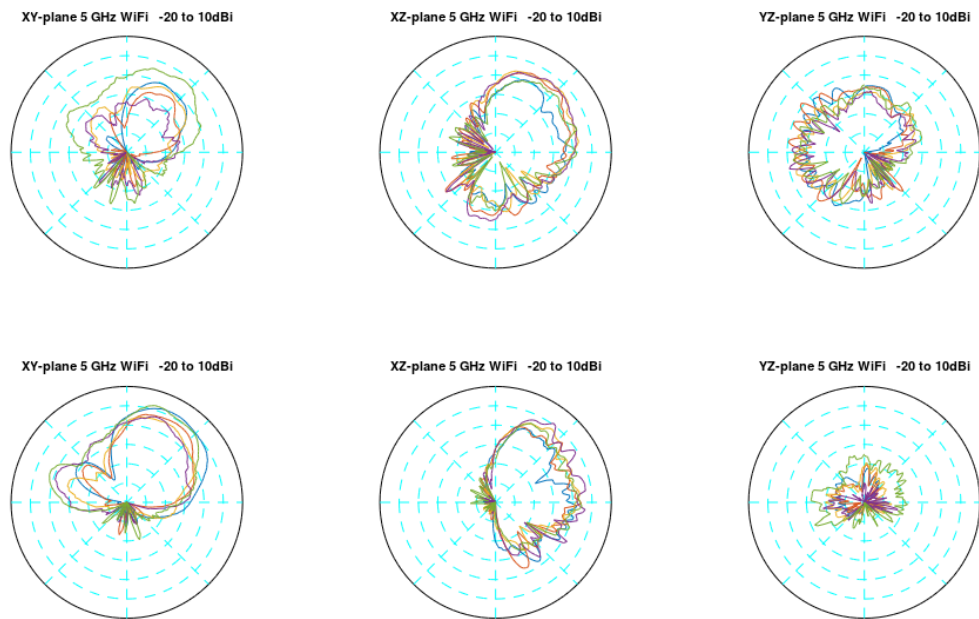


Figure 31 Passport 1000 P2, Top: wooden door, Bottom: foiled door.

8.2.2 IN 120

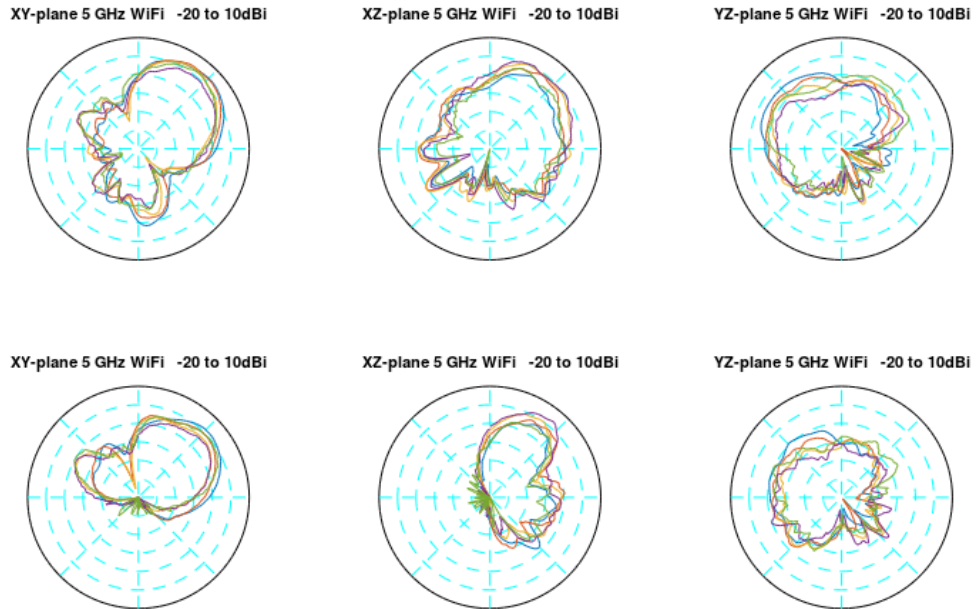


Figure 32 IN 120 , Top: wooden door, Bottom: foiled door.

8.2.3 IN 120 with wings

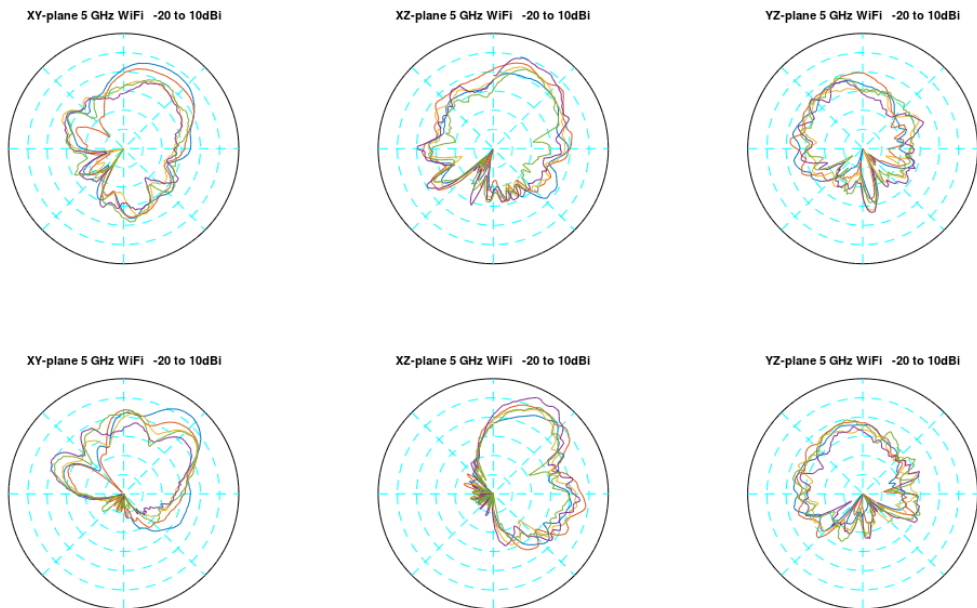


Figure 33 IN 120 with wings, Top: wooden door, Bottom: foiled door.

8.3 3D visualization

The 3D antenna diagrams presented in this section is based on four equidistant measurement cuts of the azimuth planes. The figures presented is at the centre frequency 5,5 GHz.

8.3.1 Passport 1000 P2

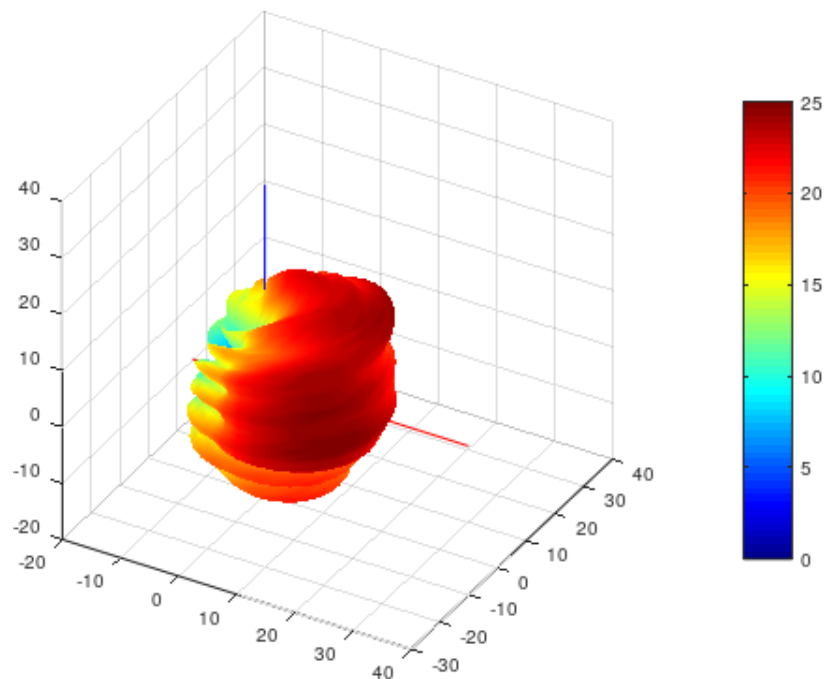


Figure 34 Passport 1000 P2 3D-radiation pattern wooden door.

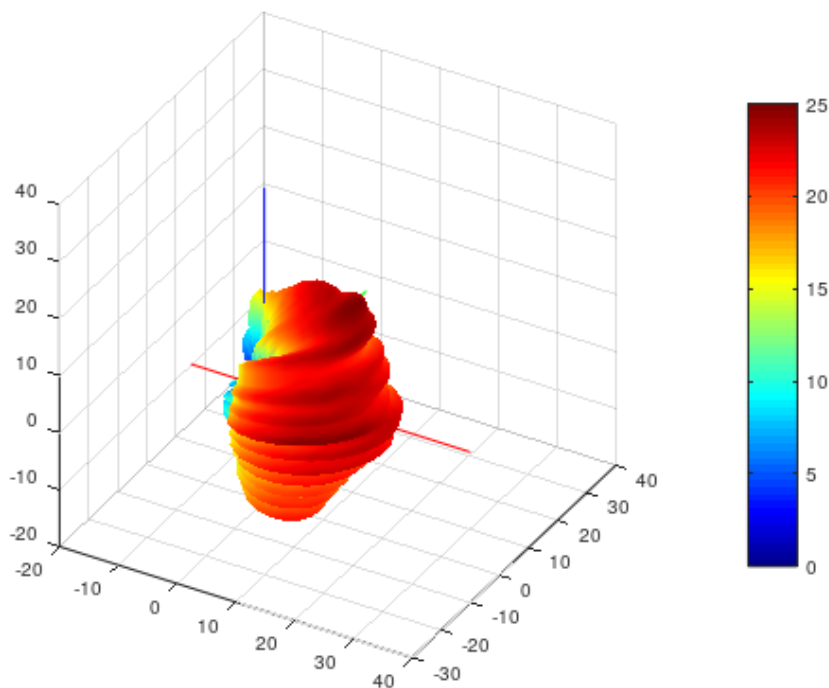


Figure 35 Passport 1000 P2 3D-radiation pattern foiled door.

8.3.2 IN120

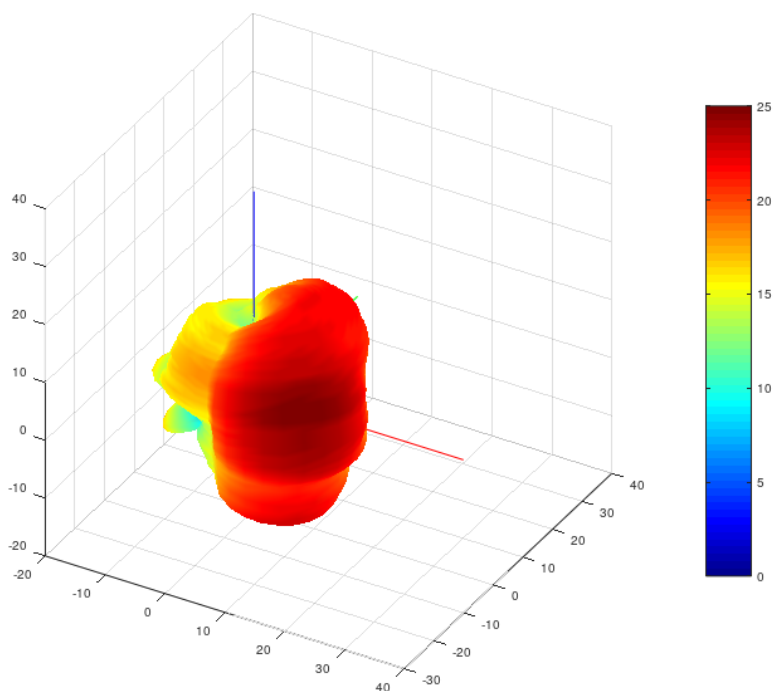


Figure 36 IN-120 3D-radiation pattern wooden door.

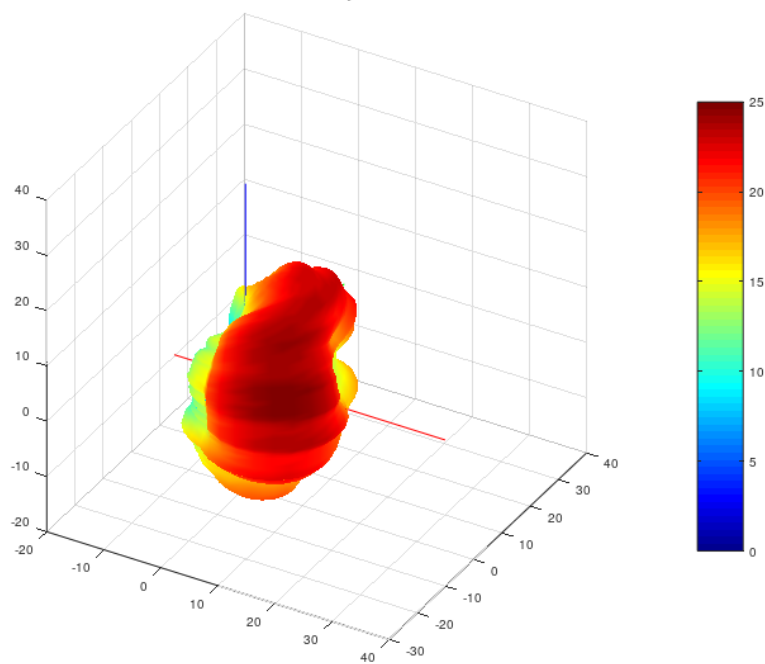


Figure 37 IN-120 3D-radiation pattern foiled door

8.3.3 IN120 with Wings

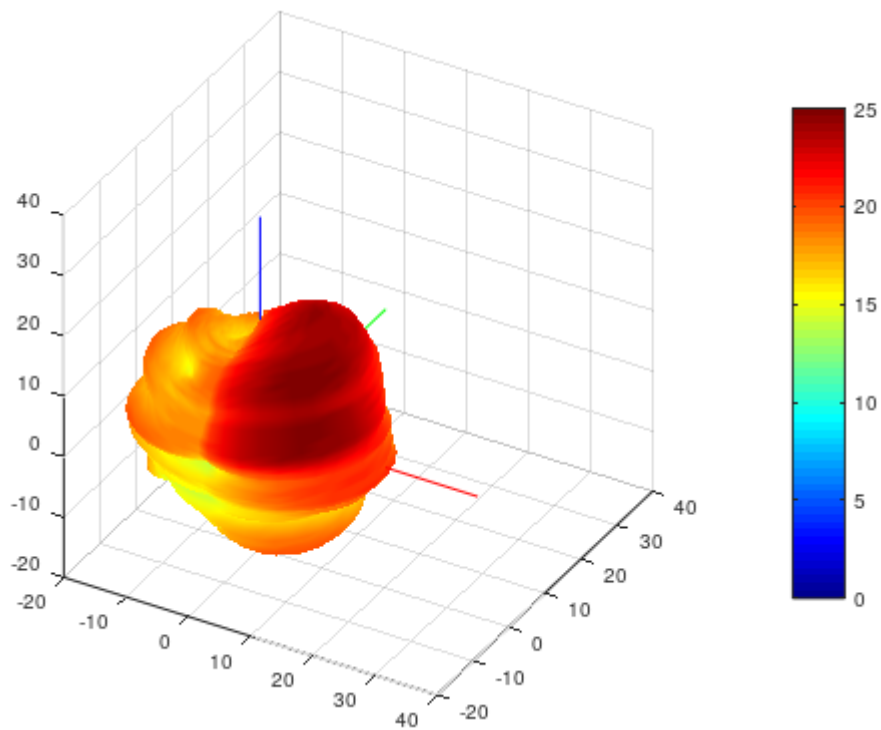


Figure 38 IN-120 with wings 3D-radiation pattern wooden door.

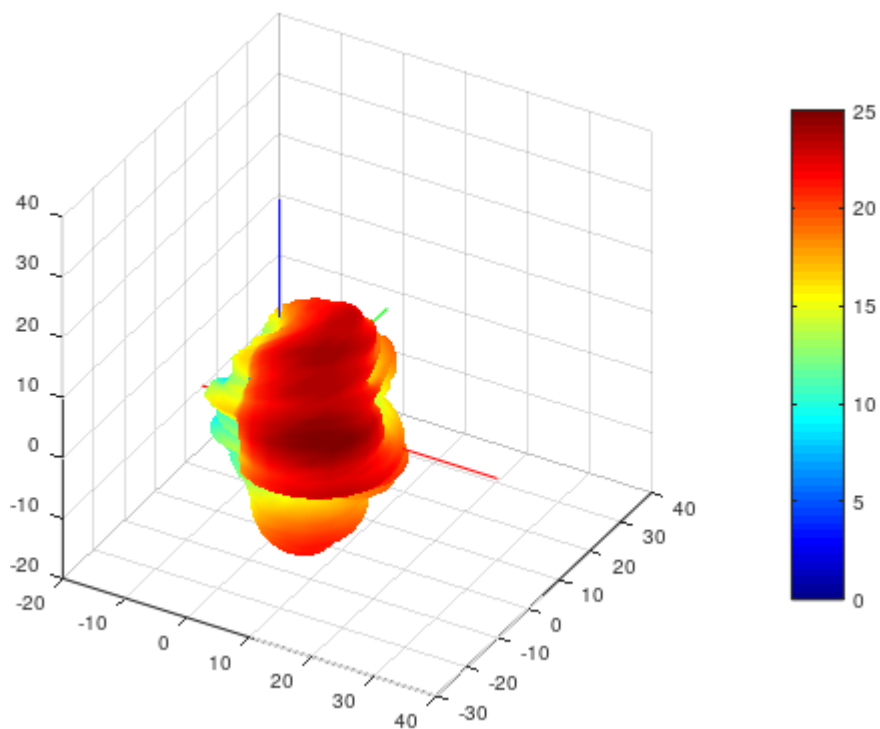
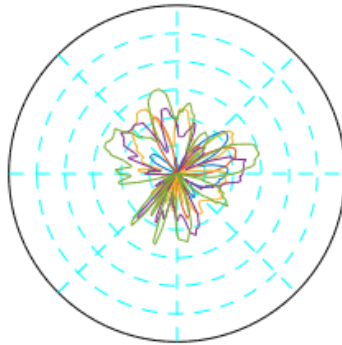


Figure 39 IN-120 with metal wings 3D-radiation pattern foiled door

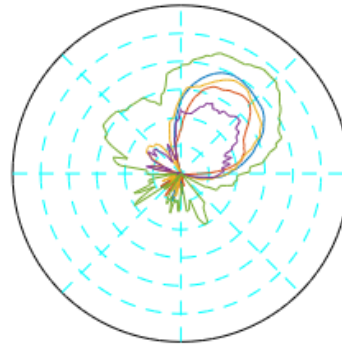
9 Vertical and Horizontal partial gain 5 GHz

9.1 Passport 1000 P2

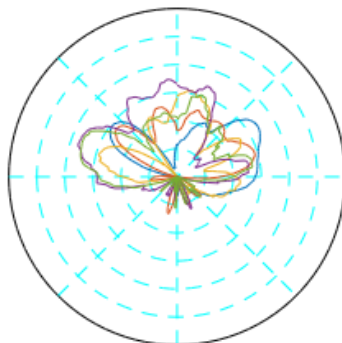
V-pol XY-plane 5 GHz WiFi -20 to 10 dBi



H-pol XY-plane 5 GHz WiFi -20 to 10 dBi



V-pol XY-plane 5 GHz WiFi -20 to 10 dBi



H-pol XY-plane 5 GHz WiFi -20 to 10 dBi

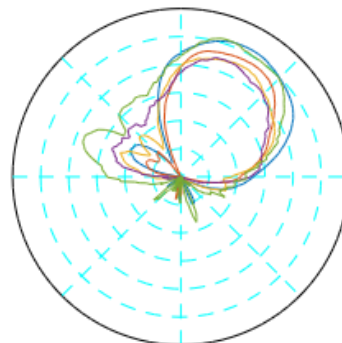
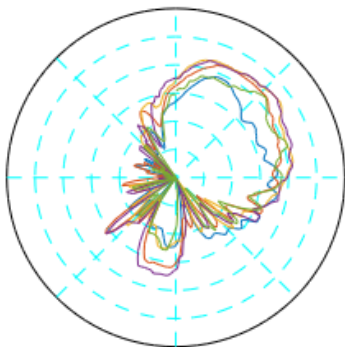
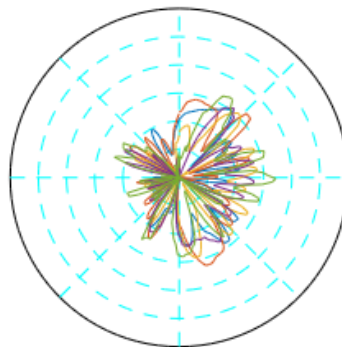


Figure 40 Passport 1000 P2, XY-plane Vertical and Horizontal partial gain. Top: wooden door, Bottom: foiled door.

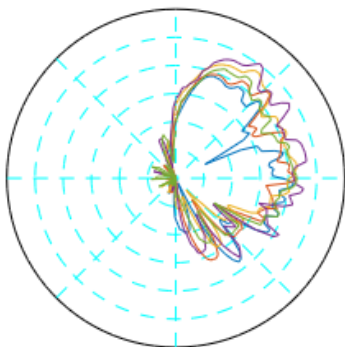
V-pol XZ-plane 5 GHz WiFi -20 to 10 dBi



H-pol XZ-plane 5 GHz WiFi -20 to 10 dBi



V-pol XZ-plane 5 GHz WiFi -20 to 10 dBi



H-pol XZ-plane 5 GHz WiFi -20 to 10 dBi

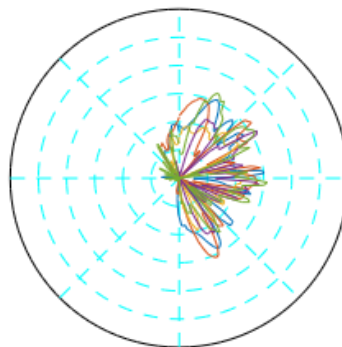


Figure 41 Passport 1000 P2, XZ-plane Vertical and Horizontal partial gain. Top: wooden door, Bottom: foiled door.

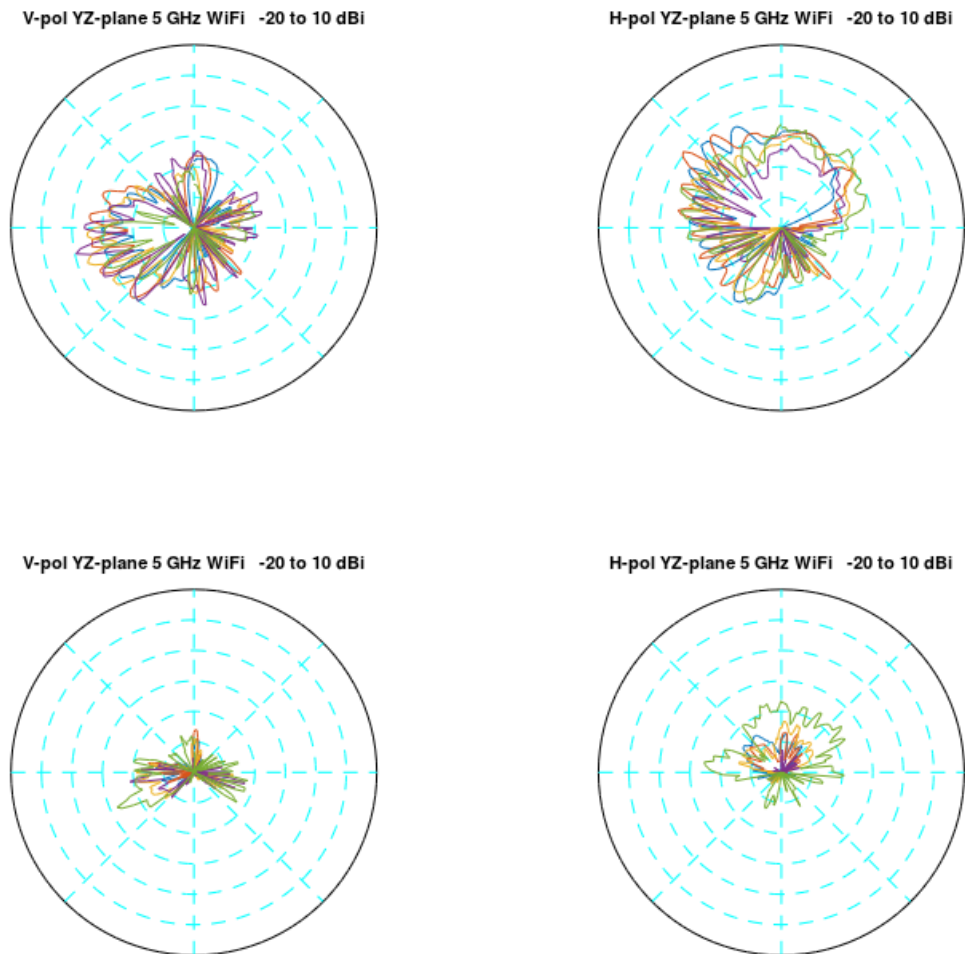
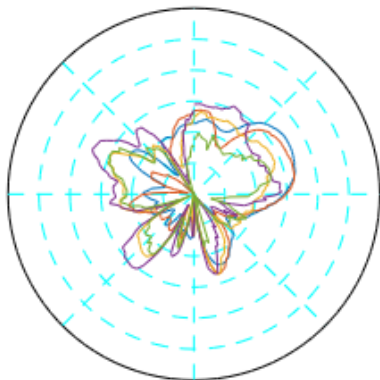


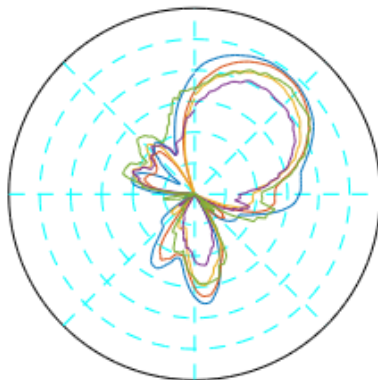
Figure 42 Passport 1000 P2, YZ-plane Vertical and Horizontal partial gain. Top: wooden door, Bottom: foiled door.

9.2 IN-120

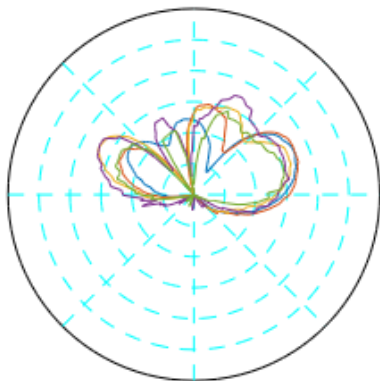
V-pol XY-plane 5 GHz WiFi -20 to 10 dBi



H-pol XY-plane 5 GHz WiFi -20 to 10 dBi



V-pol XY-plane 5 GHz WiFi -20 to 10 dBi



H-pol XY-plane 5 GHz WiFi -20 to 10 dBi

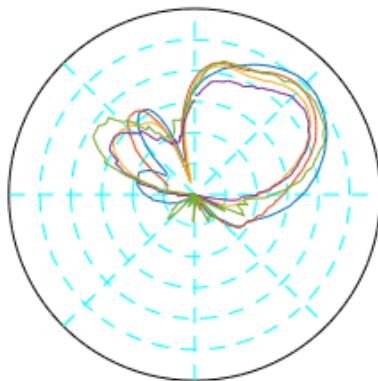
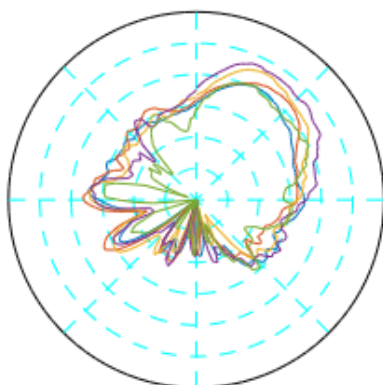
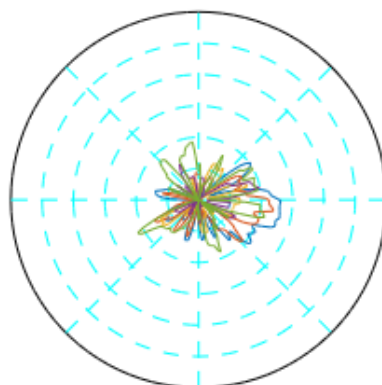


Figure 43 IN-120, XY-plane Vertical and Horizontal partial gain. Top: wooden door, Bottom: foiled door.

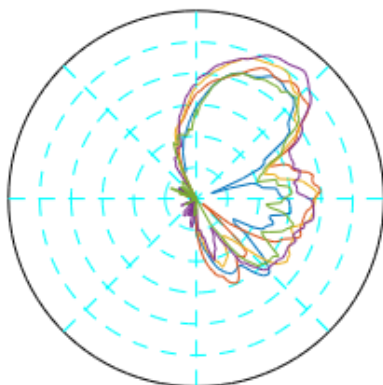
V-pol XZ-plane 5 GHz WiFi -20 to 10 dBi



H-pol XZ-plane 5 GHz WiFi -20 to 10 dBi



V-pol XZ-plane 5 GHz WiFi -20 to 10 dBi



H-pol XZ-plane 5 GHz WiFi -20 to 10 dBi

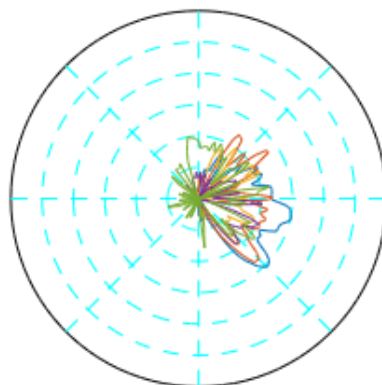
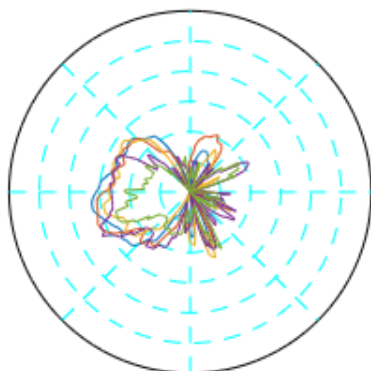
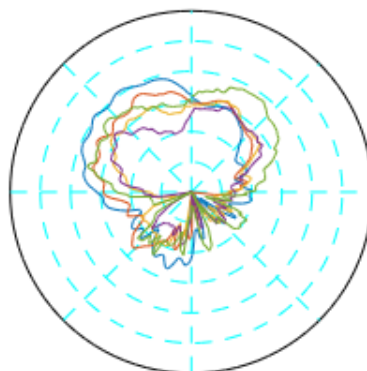


Figure 44 IN-120, XZ-plane Vertical and Horizontal partial gain. Top: wooden door, Bottom: foiled door.

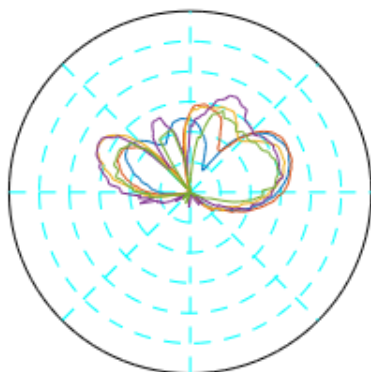
V-pol YZ-plane 5 GHz WiFi -20 to 10 dBi



H-pol YZ-plane 5 GHz WiFi -20 to 10 dBi



V-pol YZ-plane 5 GHz WiFi -20 to 10 dBi



H-pol YZ-plane 5 GHz WiFi -20 to 10 dBi

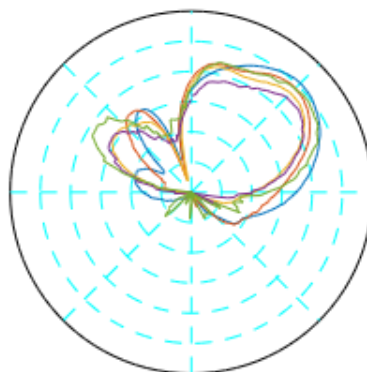
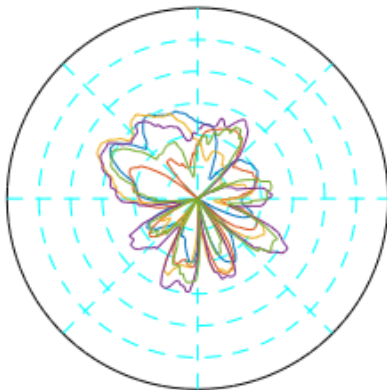


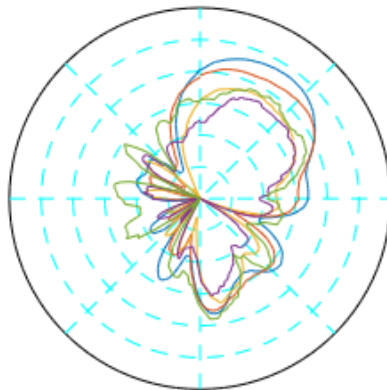
Figure 45 IN-120, YZ-plane Vertical and Horizontal partial gain. Top: wooden door, Bottom: foiled door.

9.3 IN-120 with Wings

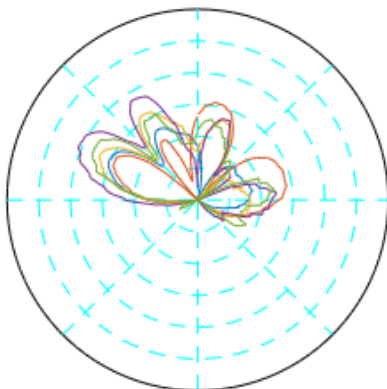
V-pol XY-plane 5 GHz WiFi -20 to 10 dBi



H-pol XY-plane 5 GHz WiFi -20 to 10 dBi



V-pol XY-plane 5 GHz WiFi -20 to 10 dBi



H-pol XY-plane 5 GHz WiFi -20 to 10 dBi

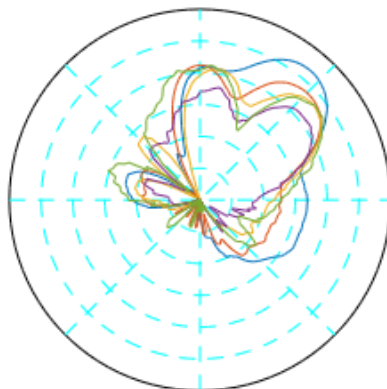
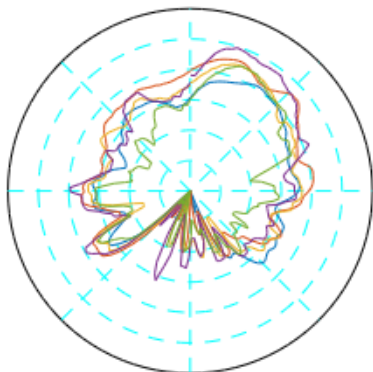
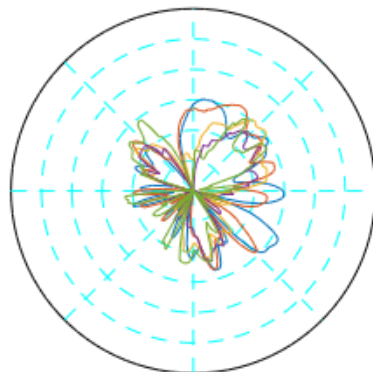


Figure 46 IN-120 with Wings, XY-plane Vertical and Horizontal partial gain. Top: wooden door, Bottom: foiled door.

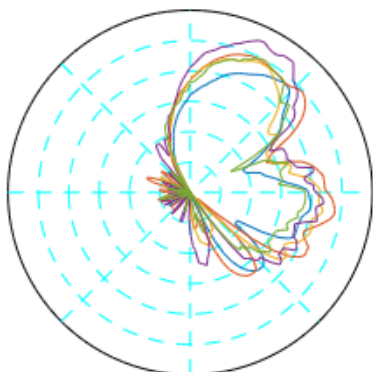
V-pol XZ-plane 5 GHz WiFi -20 to 10 dBi



H-pol XZ-plane 5 GHz WiFi -20 to 10 dBi



V-pol XZ-plane 5 GHz WiFi -20 to 10 dBi



H-pol XZ-plane 5 GHz WiFi -20 to 10 dBi

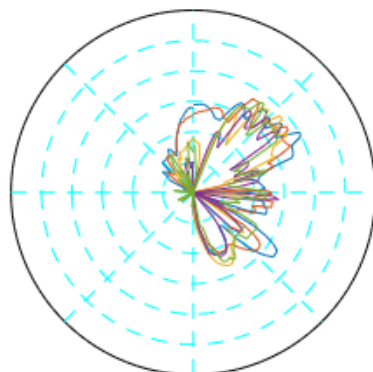
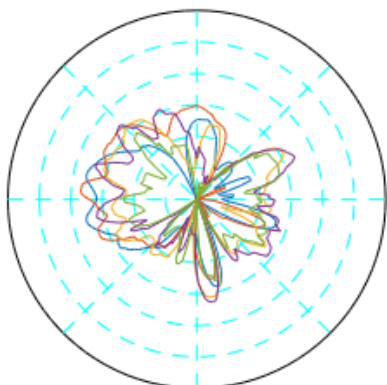
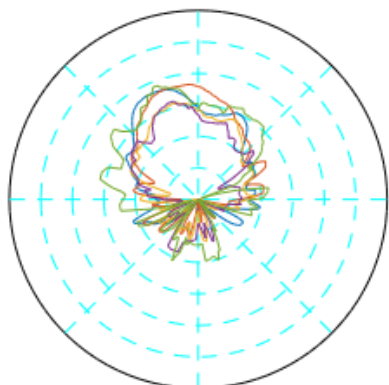


Figure 47 IN-120 with Wings, XZ-plane Vertical and Horizontal partial gain. Top: wooden door, Bottom: foiled door.

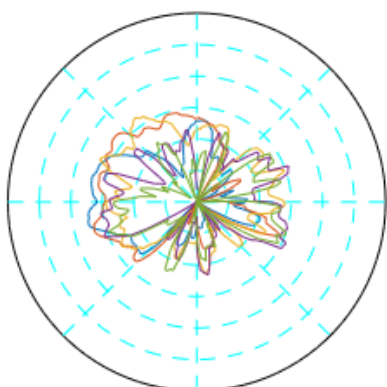
V-pol YZ-plane 5 GHz WiFi -20 to 10 dBi



H-pol YZ-plane 5 GHz WiFi -20 to 10 dBi



V-pol YZ-plane 5 GHz WiFi -20 to 10 dBi



H-pol YZ-plane 5 GHz WiFi -20 to 10 dBi

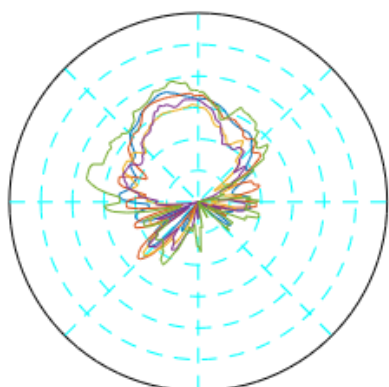


Figure 48 IN-120 with Wings, YZ-plane Vertical and Horizontal partial gain. Top: wooden door, Bottom: foiled door.