UltiSat, Inc.
Special Temporary Authorization ("STA")

Technical Appendix

I. Radiation Hazard Analysis

II. BB45 Off-Axis EIRP Spectral Density Patterns

III. BB45 Gain Patterns

I. Radiation Hazard Analysis

BB45Ku

This analysis predicts the radiation levels around a proposed earth station complex, comprised of a single panel type antenna. This report is developed in accordance with the prediction methods contained in OET Bulletin No. 65, Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, Edition 97-01, pp 26-30. The maximum level of non-ionizing radiation to which employees may be exposed is limited to a power density level of 5 milliwatts per square centimeter (5 mW/cm^2) averaged over any 6 minute period in a controlled environment and the maximum level of non-ionizing radiation to which the general public is exposed is limited to a power density level of 1 milliwatt per square centimeter (1 mW/cm^2) averaged over any 30 minute period in a uncontrolled environment. Note that the worse-case radiation hazards exist along the beam axis. Under normal circumstances, it is highly unlikely that the antenna axis will be aligned with any occupied area since that would represent a blockage to the desired signals, thus rendering the link unusable.

Earth Station Technical Parameter Table

Antenna Aperture Size	0.45meters
Antenna Effective Diameter	0.45 meters
Antenna Surface Area	0.159 sq. meters
Antenna Isotropic Gain	34.6 dBi
Number of Identical Adjacent Antennas	1
Nominal Antenna Efficiency (ε)	70%
Nominal Frequency	14.25 GHz
Nominal Wavelength (λ)	0.0211 meters
Maximum Transmit Power / Carrier	40.0 Watts
Number of Carriers	1
Total Transmit Power	40.0 Watts
W/G Loss from Transmitter to Feed	4.0 dB
Total Feed Input Power	15.9 Watts
Radome Losses	1.0 dB
Effective RF Power at radome	12.7 Watts
Near Field Limit	$R_{nf} = D^2/4\lambda = 2.4$ meters
Far Field Limit	$R_{ff} = 0.6\ D^2/\lambda = 5.8$ meters
Transition Region	R_{nf} to R_{ff} = 2.4 meters to 5.8 meters

In the following sections, the power density in the above regions, as well as other critically important areas will be calculated and evaluated. The calculations are done in the order discussed in OET Bulletin 65.

1.0 At the Antenna Surface

The power density at the reflector surface can be calculated from the expression:

$PD_{as} = 4P/A =$ **40.1** mW/cm^2 (1)

Where: P = total power at feed, milliwatts

A = Total area of reflector, sq. cm

In the normal range of transmit powers for satellite antennas, the power densities at or around the reflector surface is expected to exceed safe levels. This area will not be accessible to the general public.

This antenna will incorporate a radome which has 1.0 dB of loss. The worst case power density at the surface of the radome is shown below:

$PD_{radome}=4P_{rad}/A$ = **31.81** mW/cm² (2)
Where: Prad = total power at feed less radome losses, milliwatts
A = Total area of reflector, sq. cm (this would represent worst case)

Operators and technicians should receive training specifying this area as a high exposure area. Procedures must be established that will assure that all transmitters are rerouted or turned off before access by maintenance personnel to this area is possible.

2.0 On-Axis Near Field Region

The geometrical limits of the radiated power in the near field approximate a cylindrical volume with a diameter equal to that of the antenna. In the near field, the power density is neither uniform nor does its value vary uniformly with distance from the antenna. For the purpose of considering radiation hazard it is assumed that the on-axis flux density is at its maximum value throughout the length of this region. The length of this region, i.e., the distance from the antenna to the end of the near field, is computed as Rnf above.

The maximum power density in the near field is given by:

$PD_{nf} = (16\varepsilon P)/(\pi D^2)$ = **22.3** mW/cm² (3)
from 0 to 2.4 meters

Evaluation
Uncontrolled Environment: **Does Not Meet Controlled Limits**
Controlled Environment: **Does Not Meet Uncontrolled Limits**

3.0 On-Axis Transition Region

The transition region is located between the near and far field regions. As stated in Bulletin 65, the power density begins to vary inversely with distance in the transition region. The maximum power density in the transition region will not exceed that calculated for the near field region, and the transition region begins at that value. The maximum value for a given distance within the transition region may be computed for the point of interest according to:

$PD_{tr} = (PD_{nf})(R_{nf})/R$ = dependent on R (4)
where: PD_{nf} = near field power density
R_{nf} = near field distance
R = distance to point of interest
PD_{tr} = **22.3** mW/cm²
For: 2.4 < R < 5.8 meters

4.0 On-Axis Far-Field Region

The on- axis power density in the far field region (PD_{ff}) varies inversely with the square of the distance as follows:

$PD_{ff} =$ $PG/(4\pi R^2)$ = dependent on R (5)
where: P = total power at feed
G = Numeric Antenna gain in the direction of interest relative to isotropic radiator
R = distance to the point of interest
For: $R > R_{ff} =$ 5.8 meters
$PD_{ff} =$ **11.06** mW/cm^2 at R_{ff}

We use Eq (5) to determine the safe on-axis distances required for the two occupancy conditions:

Evaluation

Uncontrolled Environment Safe Operating Distance,(meters), R_{safeu} : See Section 3
Controlled Environment Safe Operating Distance,(meters), R_{safec} : See Section 3

5.0 Off-Axis Levels at the Far Field Limit and Beyond

In the far field region, the power is distributed in a pattern of maxima and minima (sidelobes) as a function of the off-axis angle between the antenna center line and the point of interest. Off-axis power density in the far field can be estimated using the antenna radiation patterns prescribed for the antenna in use. Usually this will correspond to the antenna gain pattern envelope defined by the FCC or the ITU, which takes the form of:

$G_{off} = 32 - 25\log(\Theta)$
for Θ from 1 to 48 degrees; -10 dBi from 48 to 180 degrees
(Applicable for commonly used satellite transmit antennas)

Considering that satellite antenna beams are aimed skyward, power density in the far field will usually not be a problem except at low look angles. In these cases, the off axis gain reduction may be used to further reduce the power density levels.

For example: At two (2) degrees off axis At the far-field limit, we can calculate the power density as:

$G_{off} = 32 - 25\log(2) = 32 – 7.52$ dBi = 280.2 numeric

$PD_{2\text{ deg off-axis}} = PD_{ff} x\ 280.2/G =$ **0.8** mW/cm^2 (6)

6.0 Off-Axis power density in the Near Field and Transitional Regions

According to Bulletin 65, off-axis calculations in the near field may be performed as follows: assuming that the point of interest is at least one antenna diameter removed from the center of the main beam, the power density at that point is at least a factor of 100 (20 dB) less than the value calculated for the equivalent on-axis power density in the main beam. Therefore, for regions at least D meters away from the center line of the dish, whether behind, below, or in front under of the antenna's main beam, the power density exposure is at least 20 dB below the main beam level as follows:

$PD_{nf(off\text{-}axis)} = PD_{nf}/100 =$ **0.22** mW/cm^2 at D off axis (7)

See Section 7 for the calculation of the distance vs. elevation angle required to achieve this rule for a given object height.

7.0 Evaluation of Safe Occupancy Area in Front of Antenna

The distance (S) from a vertical axis passing through the dish center to a safe off axis location in front of the antenna can be determined based on the dish diameter rule (Item 6.0). Assuming a flat terrain in front of the antenna, the relationship is:

$S = (D/\sin\alpha) + (2h - D - 2)/(2\tan\alpha)$ (8)

Where: α = minimum elevation angle of antenna
D = dish diameter in meters
h = maximum height of object to be cleared, meters

For distances equal or greater than determined by equation (8), the radiation hazard will be below safe levels for all but the most powerful stations (> 4 kilowatts RF at the feed).

For	D =	0.45 meters
	h =	2.0 meters, delta between antenna and object >1 m
Then:		
	α	S
	10	1.3 meters
	15	0.9 meters
	20	0.7 meters
	25	0.6 meters
	30	0.5 meters

8.0 Summary of Results

The earth station site will be protected from uncontrolled access by virtue of the fact that it will be mounted on the roof of a vehicle. There will also be proper emission warning signs placed and all operating personnel will be aware of the human exposure levels at and around the earth station.

The table below summarizes all of the above calculations.

Parameter	Abbr.		Units	Formula
Antenna Effective Diameter	Df	0.450	meters	
Antenna Centerline	h	2	meters	
Antenna Surface Area	Sa	0.159	$meter^2$	$(\pi*Df^2)/4$
Antenna Ground Elevation	GE	2	meters	
Frequency of Operation	f	14.25	GHz	
Wavelength	λ	0.0211	meters	
HPA Output Power	P_{HPA}	40	watts	
HPA to Antenna Loss	L_{Tx}	4	dB	
Radome Loss	L_{Rad}	1	dB	
Transmit Power at Flange	P	15.92	watts	$P/10Log^{-1}(L_{Tx}/10)$
Effective Power after Radome		12.65	watts	$P/10Log^{-1}$(Radome Loss/10)
Antenna Gain	G_{es}	35.64	dBi	does not include radome loss
Antenna Aperature Efficiency	η	70%	n/a	
1. Reflector Surface Region Calculations				
Antenna Surface Power Density	Pdas	400.5	W/m^2	$(16 * P)/(\pi * D^2)$
		40.05	mW/cm^2	
Power at Radome Surface	Pdrad	318.1	W/m^2	$(16 * P)/(\pi * D^2)$
(outside radome)		31.81	mW/cm^2	**Does not meet controlled limits**
				Does not meet uncontrolled limits
2. On Axis Near Field Calculations				
Extent of Near Field	Rn	2.40	meters	$D^2 / (4 * \lambda)$
		7.87	feet	
Near Field Power Density	PDnf	222.7	w/m^2	$(16 * \eta *P)/(\pi * D^2)$
		22.27	mW/cm^2	**Does not meet controlled limits**
				Does not meet uncontrolled limits
3. On Axis Transition Region Calculations				
Extent of Transition Region (min)	R_{Tr}	2.405	meters	$D^2 / (4 * \lambda)$
Extent of Transition Region (min)		7.890	feet	
Extent of Transition Region (max)	R_{Tr}	5.771	meters	$0.6 * D^2 / \lambda$
Extent of Transition Region (max)		18.934	feet	
Worst Case Transition Region Power Density	PD_{tr}	222.7	w/m^2	
		22.27	mW/cm^2	**Does not meet controlled limits**
				Does not meet uncontrolled limits
Uncontrolled enviorment safe operating distance	Rsu	53.6	meters	$(PD_{nf})/R_{nf})/Rsu$
Controlled enviorment safe operating distance	Rsc	10.7	meters	$(PD_{nf})/R_{nf})/Rsc$
4. On Axis Far Field Calculations				
Distance to Far Field Region	Rf	5.77	meters	$0.6 * D^2 / \lambda$
		18.93	feet	
On Axis Power Density in the Far Field	PD_{ff}	110.6	W/m^2	$(G_{es} * P) / (4 * \pi * Rf^2)$
		11.06	mW/cm^2	**Does not meet controlled limits**
				Does not meet uncontrolled limits
5. Off-axis Power Density in the Far Field Limit and Beyond				
Antenna Surface Power Density	PDs	8.5	W/m^2	$(G_{es} * P) / (4 * \pi * Rf^2) * (Goa/Ges)$
Goa/Ges at a sample angle of θ=2 degrees		0.077		Goa = 32 - 25*log(θ)
		0.8	mW/cm^2	
6. Off Axis Power Density in the Near Field and Transitional Region Calculations				
Power Density of Wn/100 for 1 diameter	PDs	2.23	W/m^2	$[(16 * \eta *P)/(\pi * D^2)] / 100$
removed		0.223	mW/cm^2	**Meets controlled limits**
				Meets Uncontrolled limits
7.0 Off-axis Safe Distances from Earth Station				
minimum elevation angle of antenna	α	10	degree	
hieght of object to be cleared	h	2	meter	
Groun elevation delta antenna-obstacle elevation ang	**GD**	**S**		
	10	1.3	meter	S=(D/sinα) + (2h - D- 2) / (2tanα)
	15	0.9	meter	
	20	0.7	meter	
	25	0.6	meter	
	30	0.5	meter	
Note: Maximum FCC power density limits for 6GHz is 1mW/cm2 for general population exposure as per FCC OS&T				

II. BBIG45Ku
EIRP Spectral Density (ESD) Data

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Table of Contents

TABLE OF FIGURES

TABLE OF TABLES

REVISIONS LOG

REV	CHANGE ORDER	DATE	DESCRIPTION	AUTHOR
1.0	n/a	2017/11/30	First edition	R. Eleuteri

1 SCOPE

This document summarizes the BBIG45Ku performance in terms of maximum allowable EIRP Spectral Density (ESD) as per the applicable FCC regulations.

2 APPLICABLE DOCUMENTS

2.1 Customer documents

N/A

2.2 Applicable standards

[AD1] FCC 25.227 - Blanket licensing provisions for ESAAs operating with GSO FSS space stations in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz, and 14.0-14.5 GHz bands.

2.3 Skytech documents

N/A

3 ACRONYMS

Abbreviation	Meaning
AZ	Azimut
EIRP	Effective Isotropic Radiated Power
EL	Elevation
ESD	EIRP Spectral Density
Hpol	Horizontal Polarization
OMT	Ortho-Mode Transducer
Vpol	Vertical Polarization

4 ESD Data

The BBIG45Ku ESD performance has been assessed with respect to the FCC 25.227 standard considering the four transmitting frequencies 13.75 GHz, 14.00 GHz, 14.25 GHz and 14.50 GHz, in both the Horizontal and Vertical polarization. The antenna radiation patterns used for the ESD patterns calculation have been measured at the test facilities of "Politecnico di Torino" University.

The computed ESD patterns are reported in the following sections with the superimposition of the limit masks provided in Figure 1, Figure 2 and Figure 3 (applied to Azimut co-polar cuts, Elevation co-polar cuts and Azimut & Elevation cross-polar cuts, respectively).

$15-25 \log_{10}\theta$	dBW/4 kHz	for 1.5° ≤ θ ≤ 7°.
−6	dBW/4 kHz	for 7° < θ ≤ 9.2°.
$18-25 \log_{10}\theta$	dBW/4 kHz	for 9.2° < θ ≤ 19.1°.
−14	dBW/4 kHz	for 19.1° < θ ≤ 180°.

Figure 1: ESD limits superimposed to the Azimut co-polar cuts

$18-25 \log\theta$	dBW/4 kHz	for 3.0° ≤ θ ≤ 19.1°.
−14	dBW/4 kHz	for 19.1° < θ ≤ 180°.

Figure 2: ESD limits superimposed to the Elevation co-polar cuts

$5-25 \log_{10}\theta$	dBW/4 kHz	for 1.8° < θ ≤ 7°.

Figure 3: ESD limits superimposed to the cross-polar cuts

4.1 Horizontal polarization ESD

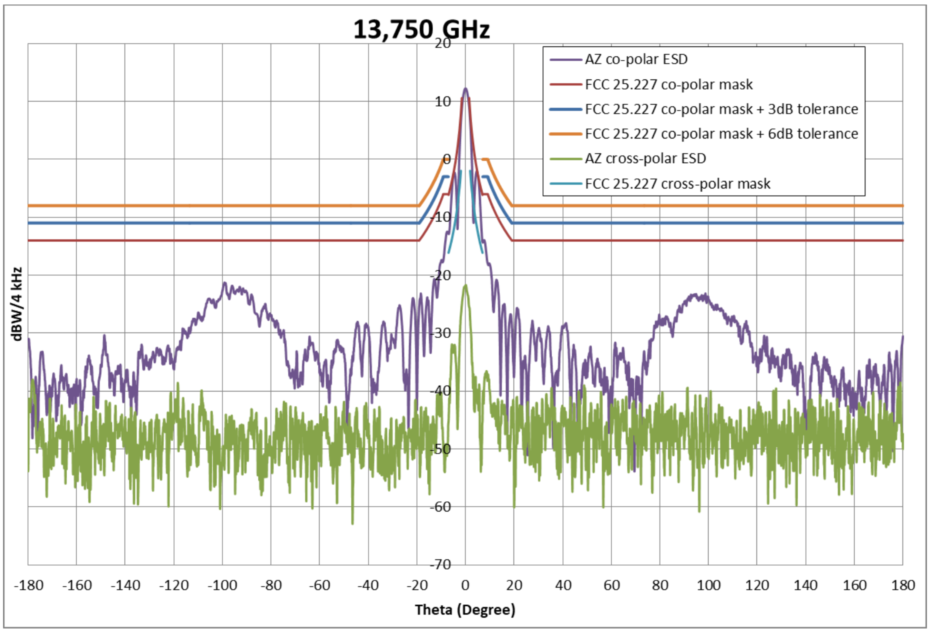

Figure 4: Co-polar and cross-polar ESD @13.75 GHz (Hpol, Azimut cut)

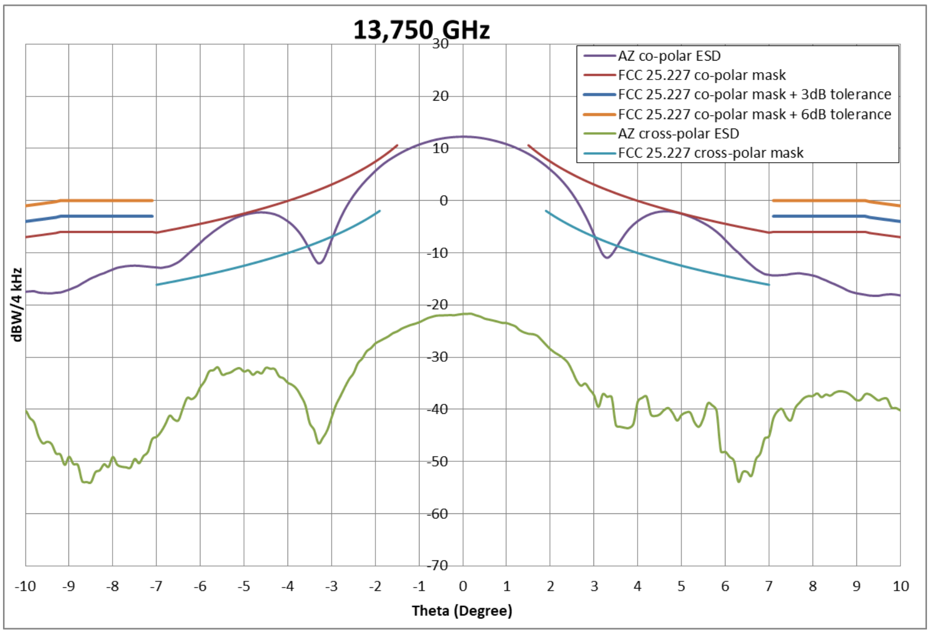

Figure 5: Co-polar and cross-polar ESD @13.75 GHz (Hpol, Azimut cut) - zoom

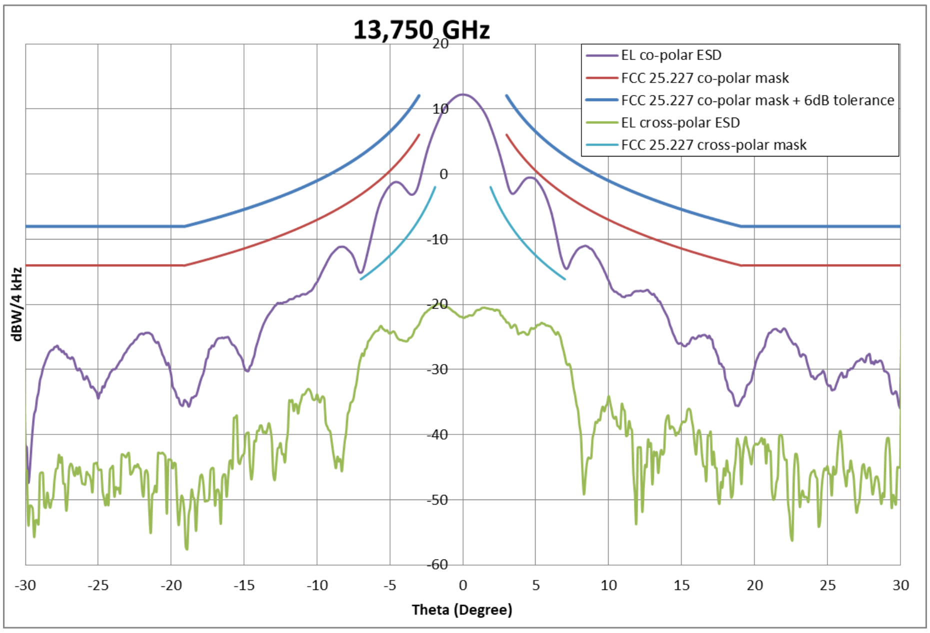

Figure 6: Co-polar and cross-polar ESD @13.75 GHz (Hpol, Elevation cut)

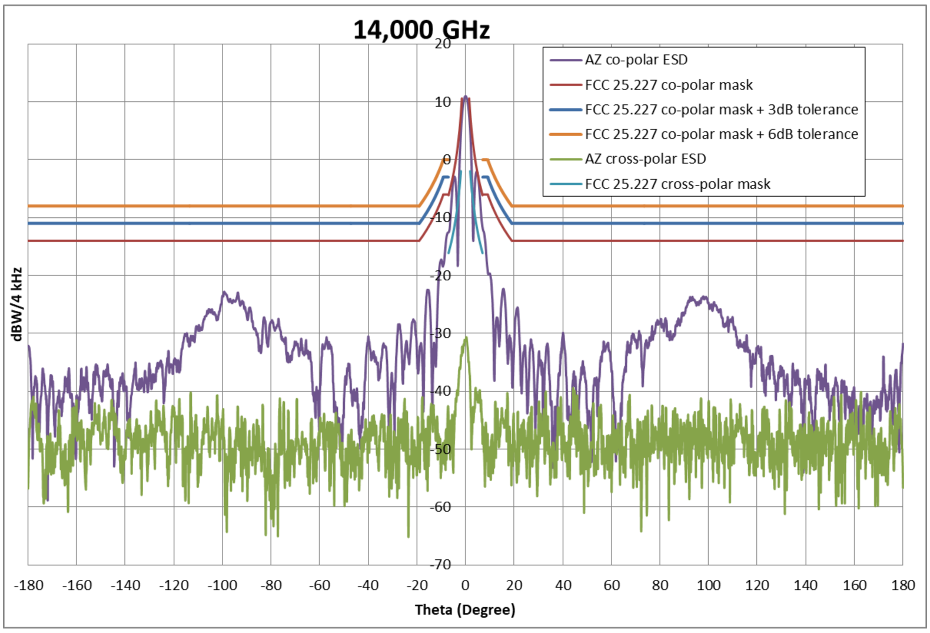

Figure 7: Co-polar and cross-polar ESD @14.00 GHz (Hpol, Azimut cut)

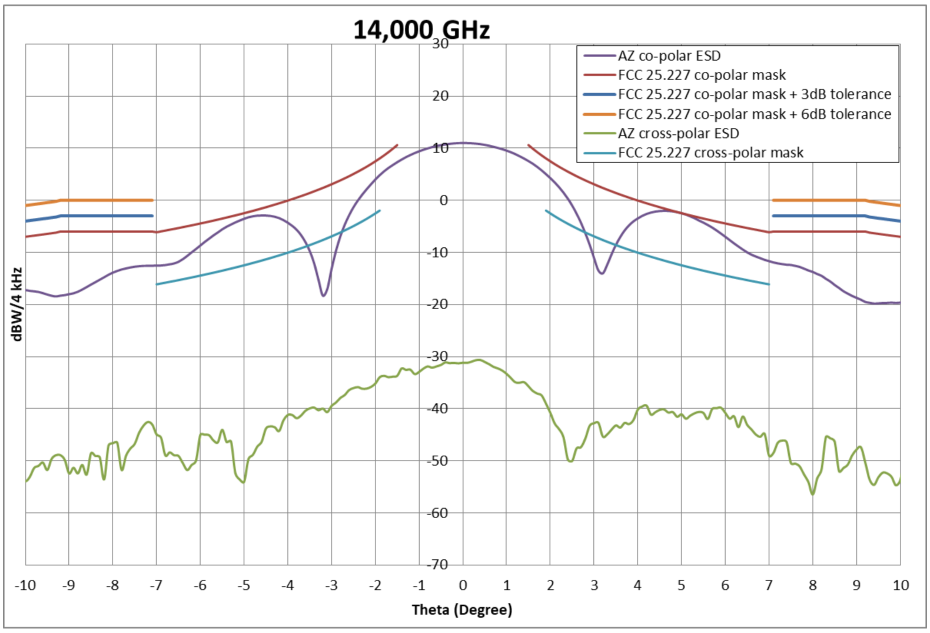

Figure 8: Co-polar and cross-polar ESD @14.00 GHz (Hpol, Azimut cut) – zoom

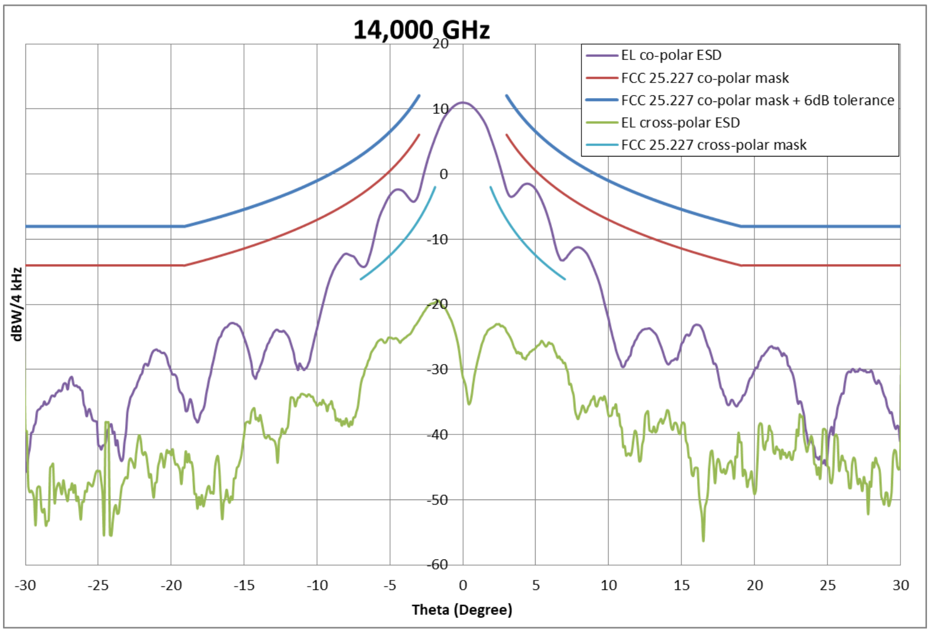

Figure 9: Co-polar and cross-polar ESD @14.00 GHz (Hpol, Elevation cut)

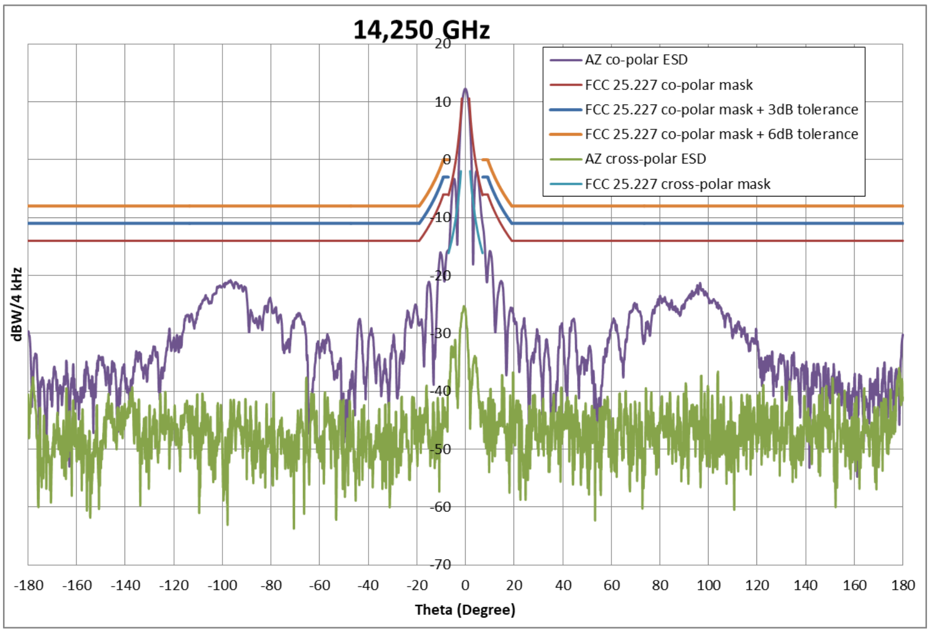

Figure 10: Co-polar and cross-polar ESD @14.25 GHz (Hpol, Azimut cut)

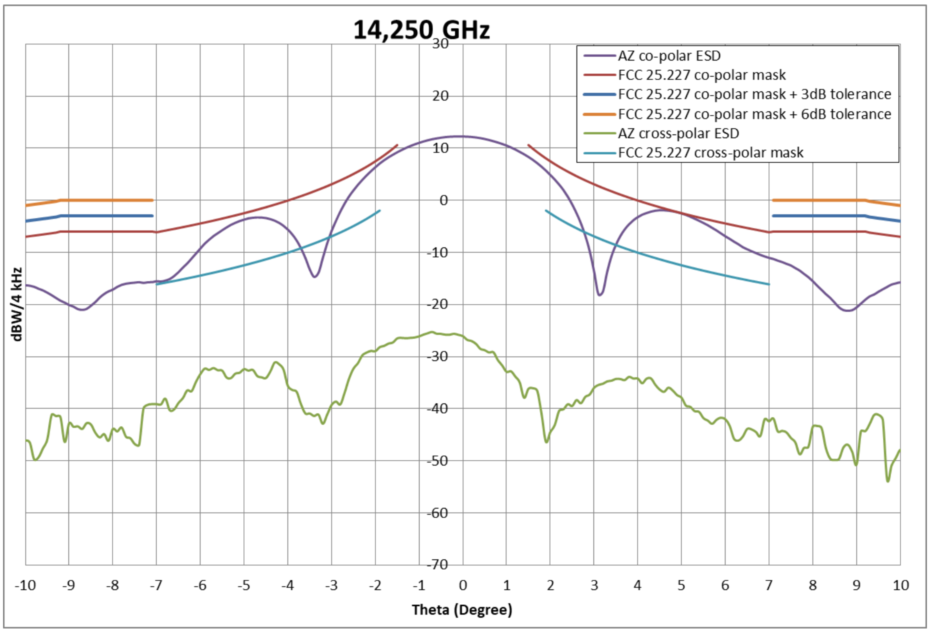

Figure 11: Co-polar and cross-polar ESD @14.25 GHz (Hpol, Azimut cut) - zoom

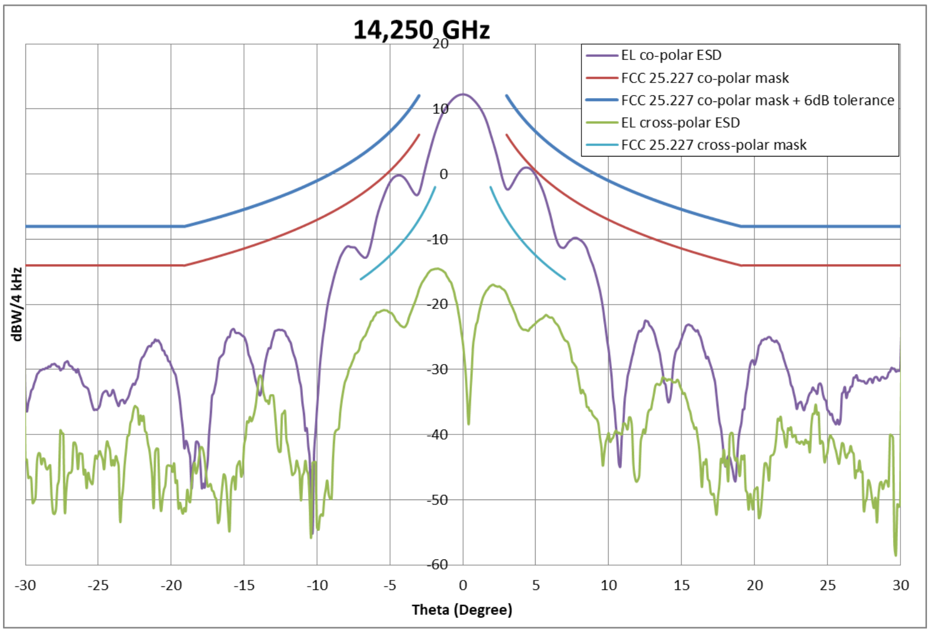

Figure 12: Co-polar and cross-polar ESD @14.25 GHz (Hpol, Elevation cut)

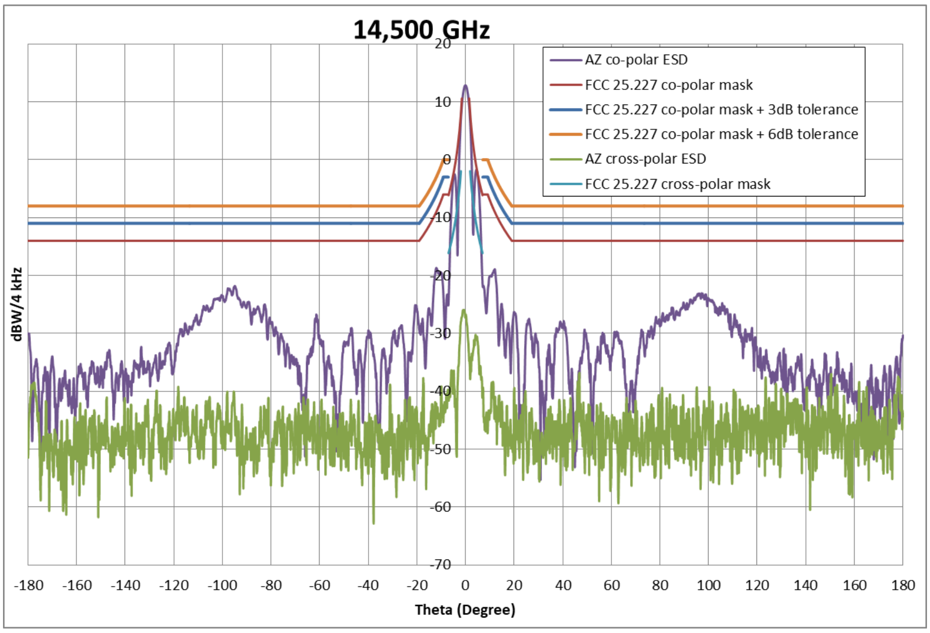

Figure 13: Co-polar and cross-polar ESD @14.50 GHz (Hpol, Azimut cut)

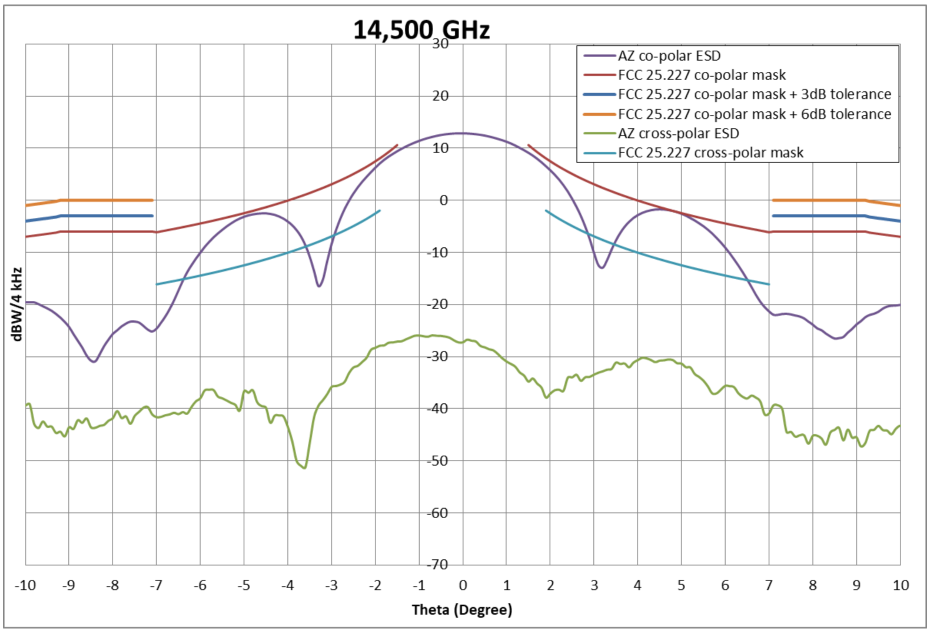

Figure 14: Co-polar and cross-polar ESD @14.50 GHz (Hpol, Azimut cut) - zoom

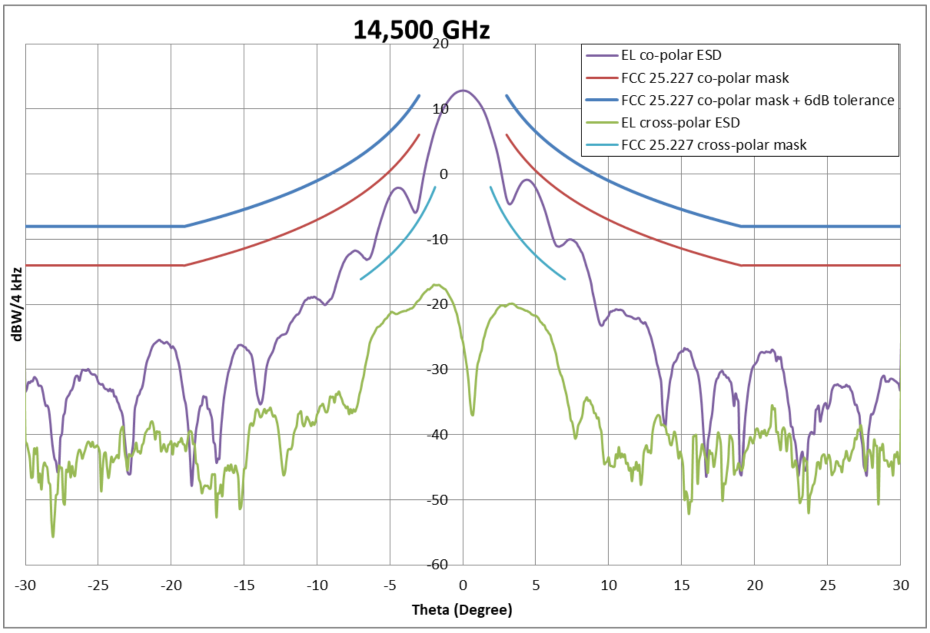

Figure 15: Co-polar and cross-polar ESD @14.50 GHz (Hpol, Elevation cut)

4.2 Vertical Polarization ESD

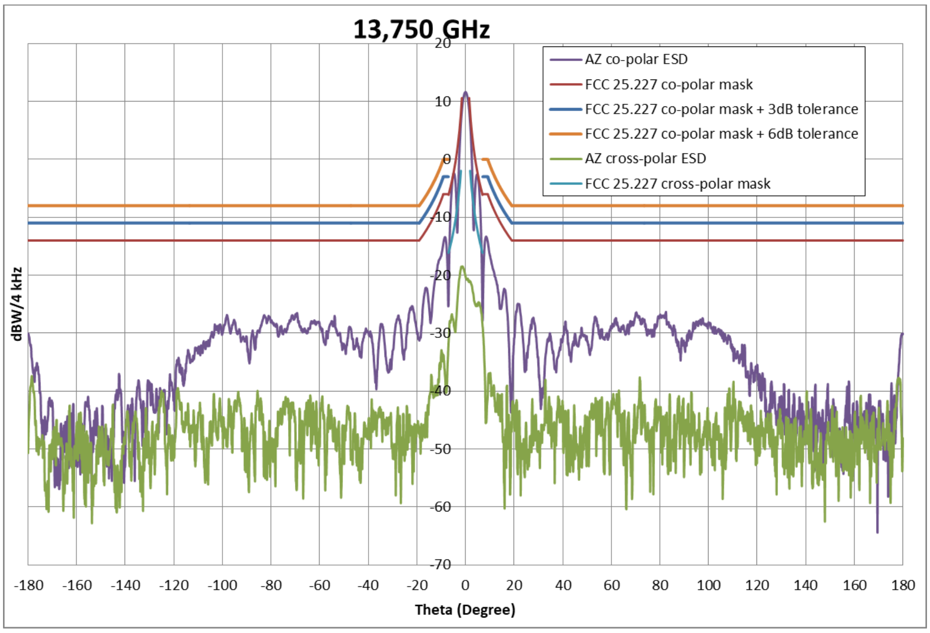

Figure 16: Co-polar and cross-polar ESD @13.75 GHz (Vpol, Azimut cut)

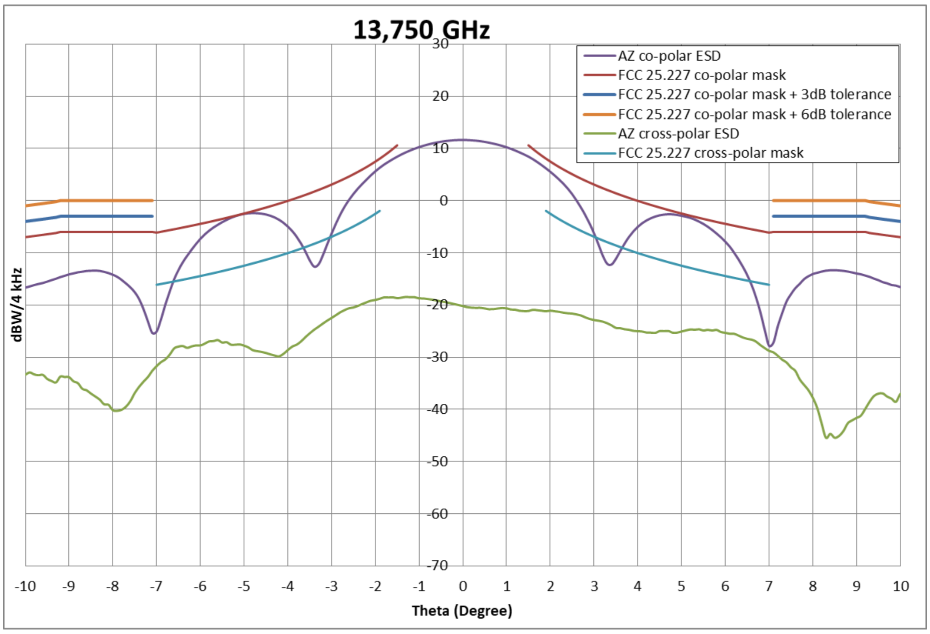

Figure 17: Co-polar and cross-polar ESD @13.75 GHz (Vpol, Azimut cut) - zoom

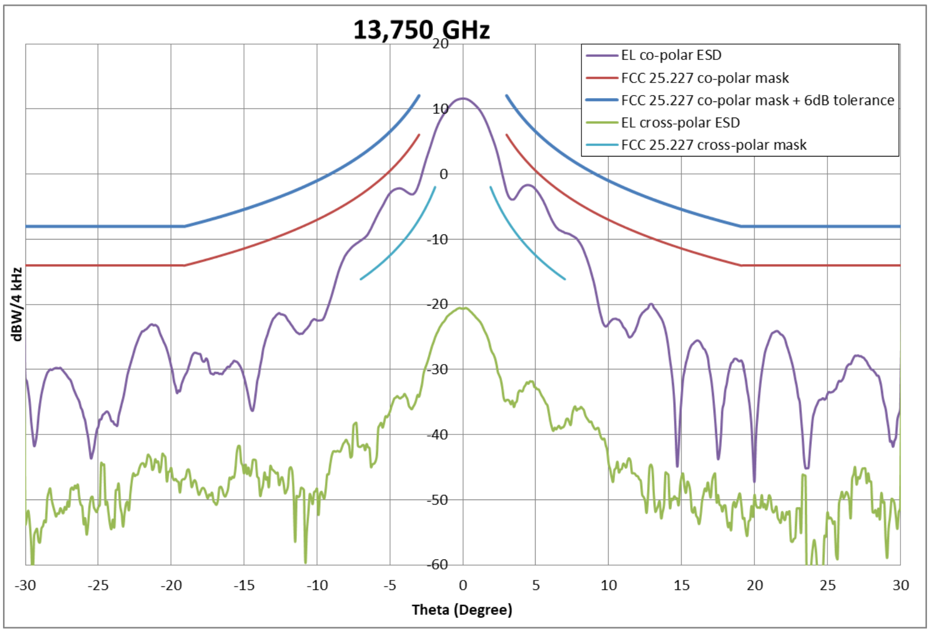

Figure 18: Co-polar and cross-polar ESD @13.75 GHz (Vpol, Elevation cut)

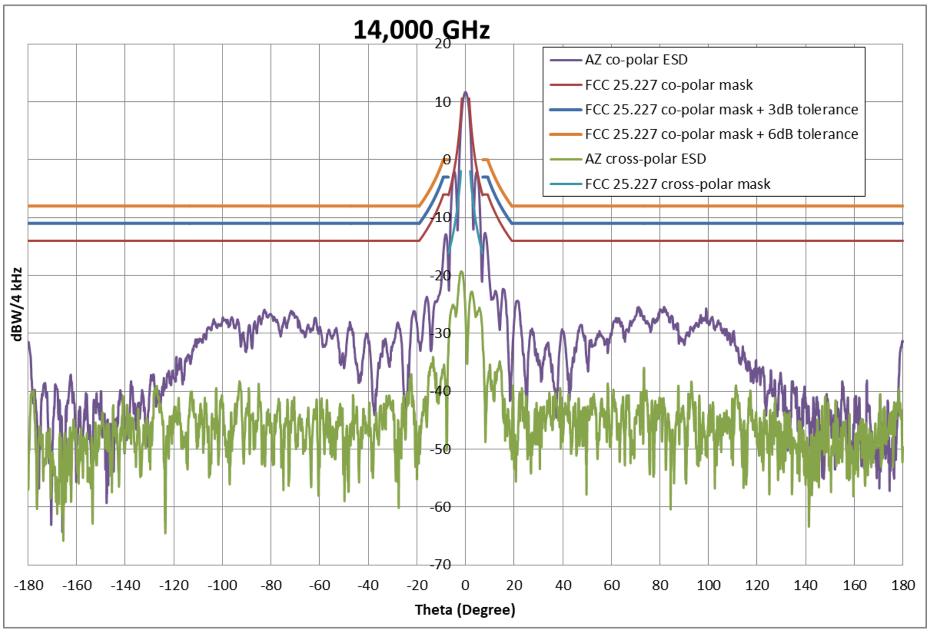

Figure 19: Co-polar and cross-polar ESD @14.00 GHz (Vpol, Azimut cut)

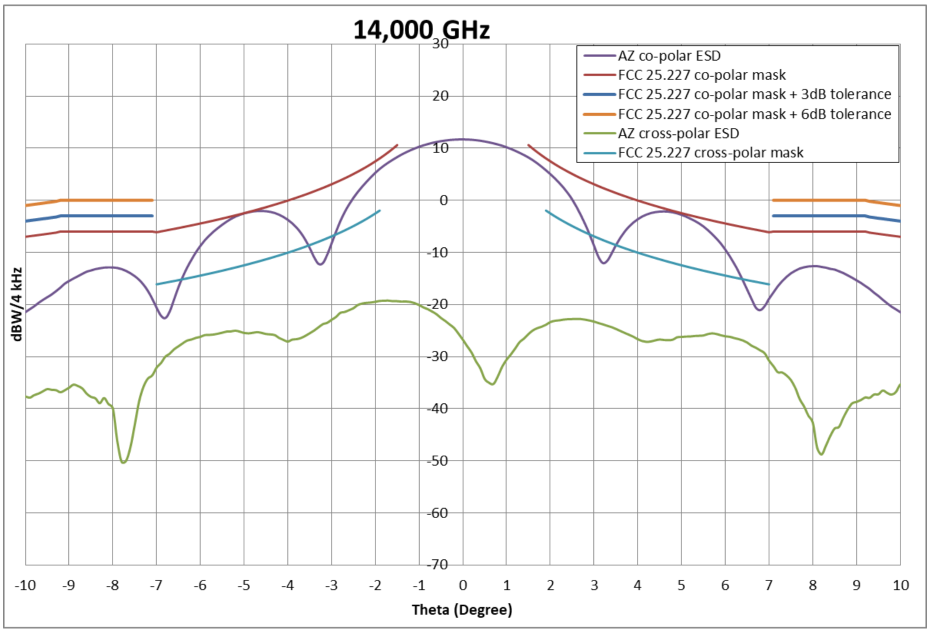

Figure 20: Co-polar and cross-polar ESD @14.00 GHz (Vpol, Azimut cut) - zoom

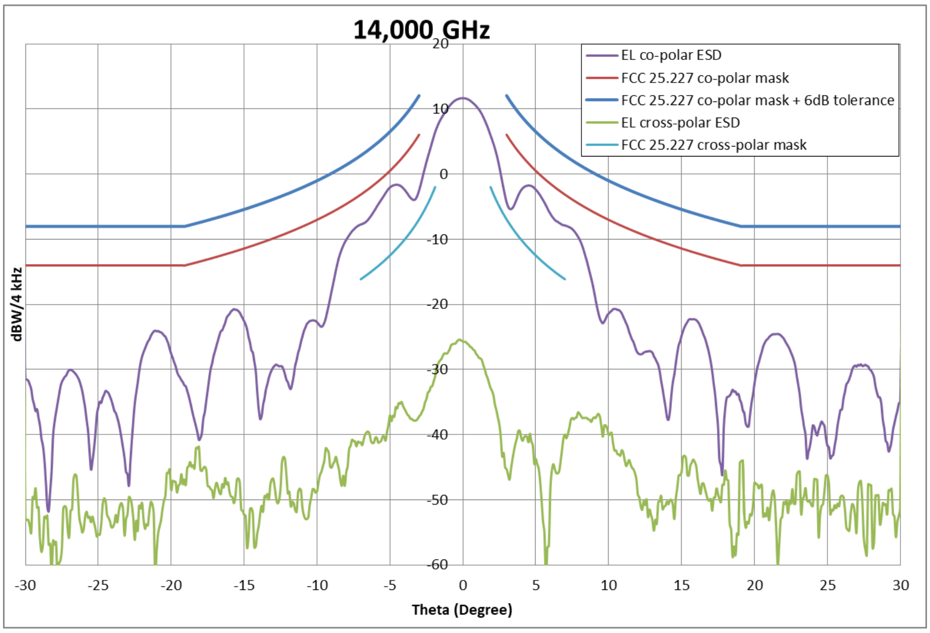

Figure 21: Co-polar and cross-polar ESD @14.00 GHz (Vpol, Elevation cut)

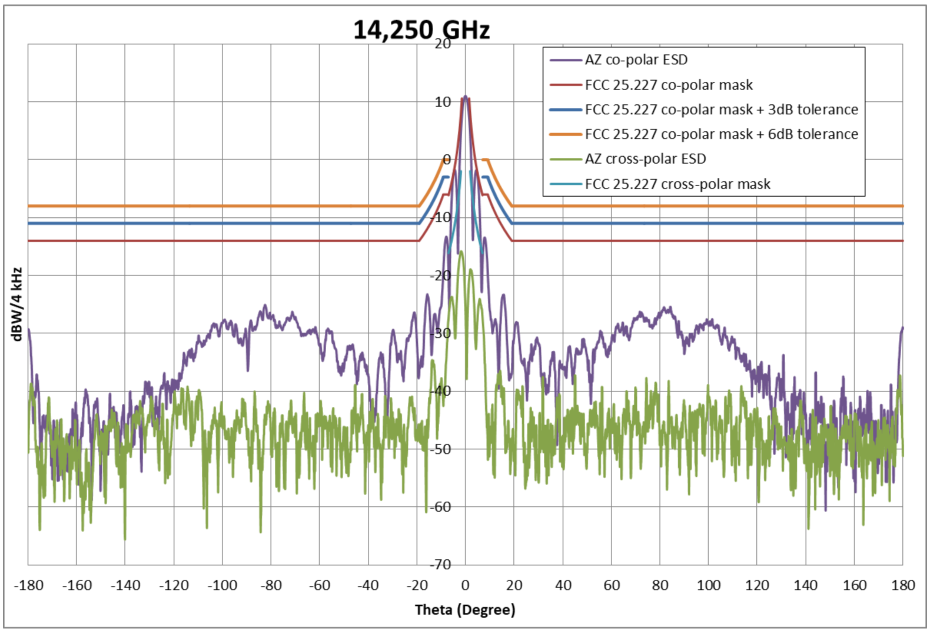

Figure 22: Co-polar and cross-polar ESD @14.25 GHz (Vpol, Azimut cut)

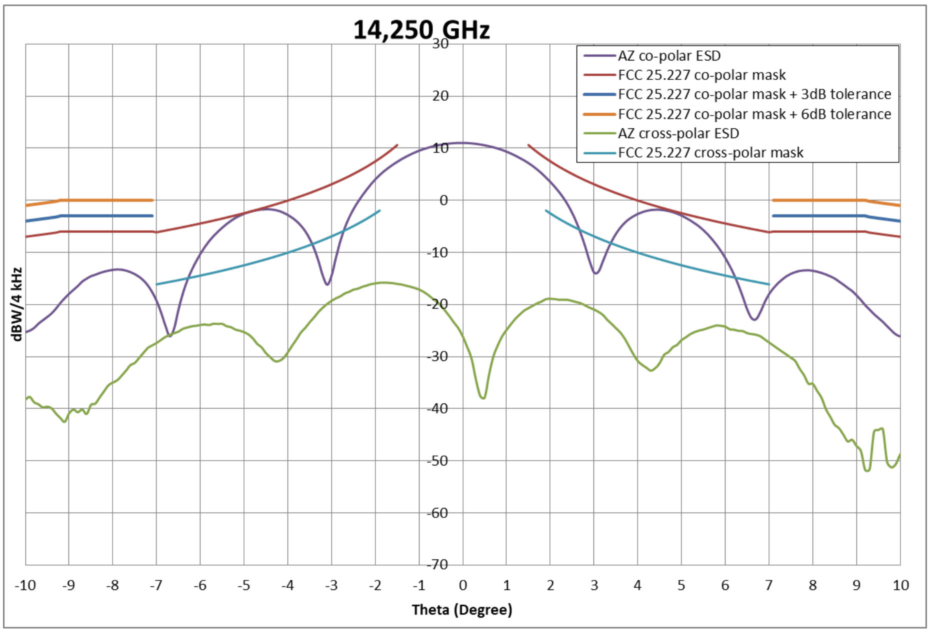

Figure 23: Co-polar and cross-polar ESD @14.25 GHz (Vpol, Azimut cut) - zoom

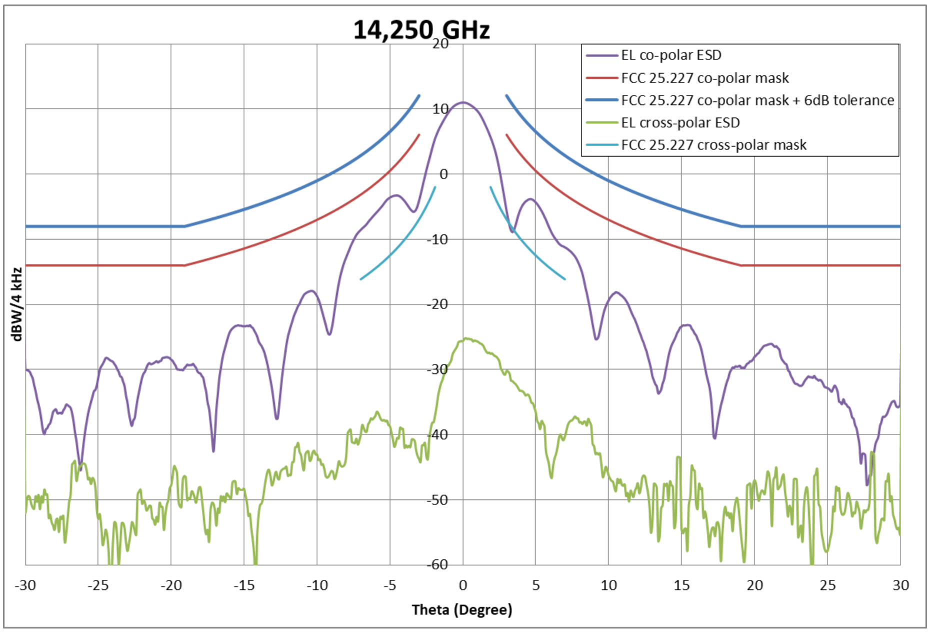

Figure 24: Co-polar and cross-polar ESD @14.25 GHz (Vpol, Elevation cut)

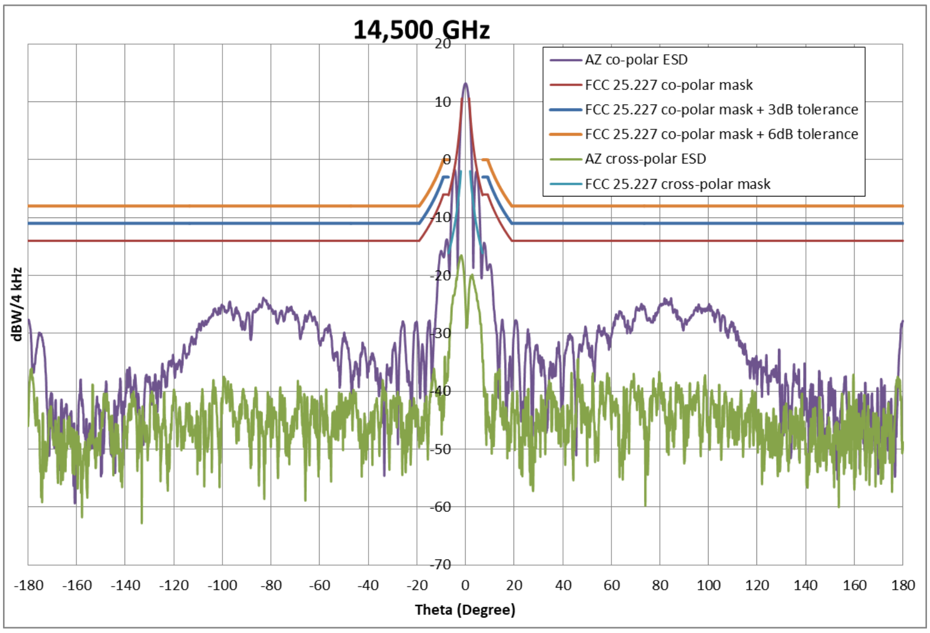

Figure 25: Co-polar and cross-polar ESD @14.50 GHz (Vpol, Azimut cut)

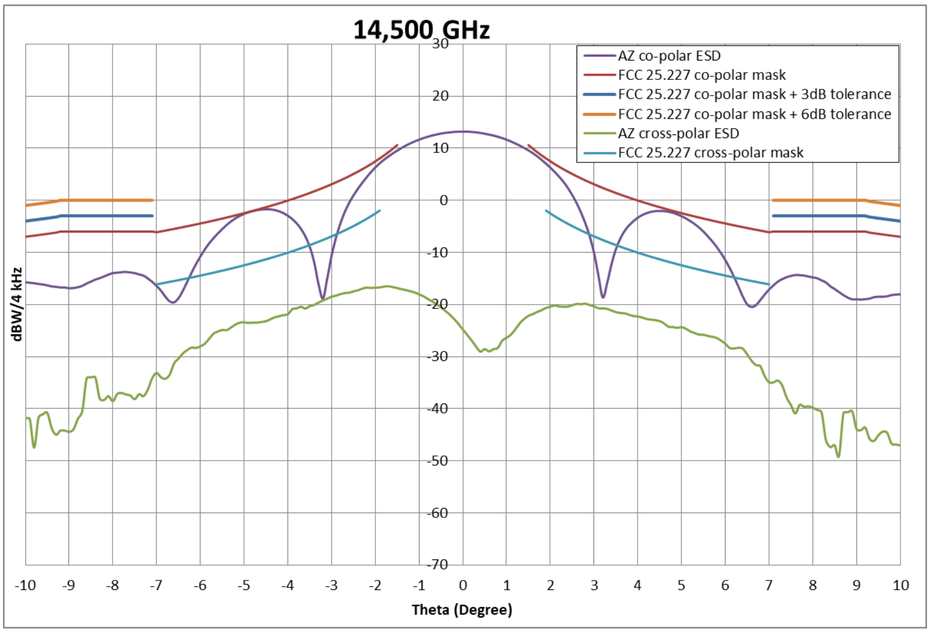

Figure 26: Co-polar and cross-polar ESD @14.50 GHz (Vpol, Azimut cut) - zoom

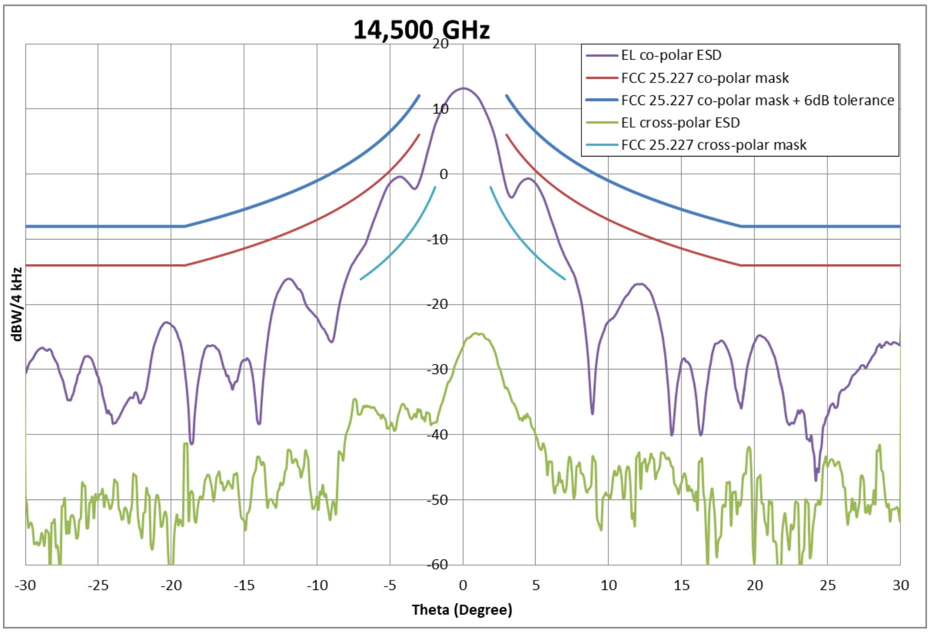

Figure 27: Co-polar and cross-polar ESD @14.50 GHz (Vpol, Elevation cut)

4.3 Input and Output maximum ESD

Table 1 shows the maximum input and output ESD computed on the basis of the ESD patterns reported in the previous sections, highlighting the worst case. The input ESD is intended as applied to the coaxial port of the OMT.

Table 1: Recap of maximum input and output ESD

Frequency (GHz)	Polarization	Max Input ESD (dBW/4 kHz)	Max Output ESD (dBW/4 kHz)
13.75	H	-21.4	12.2
13.75	V	-21.7	11.6
14.00	H	-22.7	10.9
14.00	V	-21.7	11.6
14.25	H	-21.6	12.2
14.25	V	-22.7	11.0
14.50	H	-21.3	12.8
14.50	V	-20.8	13.2

III. Gain Patterns of SkyTech BBIG45Ku antenna.

ID	*TRGD04_12/17*
Authors	*G. Dassano*
Date	*29/12/2017*
Version	*1*
Classification (*)	*CO*

Summary*:*

This report deals with the measurements of the radiation pattern of a sample of the parabolic reflector antenna BBIG45Ku manufactured by SkyTeck, operating in Ku band: The measurements were carried out in November 2017 in the Politecnico di Torino Antenna Laboratory (LACE). Measurements of radiation patterns have been carried out on the two transmission and the two reception antenna ports, for H and V polarizations, at two frequencies bands; in the frequency range 10.95-12.75 GHz (RX) and in the frequency range 13.75-14.5 GHz (TX).

**Classification: PU-Public, LI-Limited, CO-Company Confidential*

Document history

Version	***Date***	***Description***	***Authors***
1	December 29, 2017	Gain, XPD and patterns in RX and TX band for V and H polarizations (1st draft)	G. Dassano

Distribution list

Name	***Company***
R. Eleuteri	*SkyTech*
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R. Maggiora	*Politecnico di Torino*
M. Orefice	*Politecnico di Torino*

TABLE OF CONTENTS ***page 3***

1. INTRODUCTION

In this document are reported the results of the tests (carried out on November 2017) on a 30cm parabolic reflector antenna for Ku band satellite communication, indicated as **BBIG45Ku,** manufactured by SkyTech. The antenna has a circular aperture with a diameter of 45 cm.

For this antenna the results shown in this report are:

In the RX and TX bands: the frequency swept maximum gain for the co-polarization on axis, and the XPD factor evaluated on axis.

The radiation pattern cuts (co- and cross-polarization) in the principal (Azimuth and Elevation) planes:

- *in RX band, in the angular range ±180° for AZ and ±30° for EL planes, and both polarizations ports (H and V), at 3 frequencies: 10.95, 11.85 and 12.75 GHz;*
- *in TX band, in the angular range ±180° for AZ and ±30° for EL planes, and both polarizations ports (H and V), at 4 frequencies, 250MHz spaced, from 13.75 to 14.5 GHz;*

All the measurements were carried out in LACE's outdoor far field test range, with a distance SRC-AUT of 150 m.

2. MEASUREMENTS FACILITIES DESCRIPTION

2.1 Gain and pattern measurements

The measurements have been performed in the outdoor test range of the Laboratory (see fig.1).

The present test range, who has replaced the old one used since the early '60es for pioneering works on space antennas, has been supplied from MI Technologies (formerly Scientific Atlanta) and installed in February 2008.

In this test range the Antenna Under Test (AUT), used as receiver, and the Source (SRC) are placed on the roof of two different buildings, the Department of Electronics and Telecommunications and the Department of Control and Computer Engineering. The two buildings are far apart (more than 150 m) without obstacles in between, and the height of both AUT and SRC is 30 m above the ground; the range is schematically shown in fig.1 (plan and elevation). It is also possible to use a SRC at a slightly lower level, to reduce the scattering from the back of the range.

Due to the elevated range, there are many Fresnel zones without obstacles. The effects of the reflection on the ground can be removed by a time windowing, with some directivity of the source and also considering that the incidence angle on the ground is near to the Brewster angle.

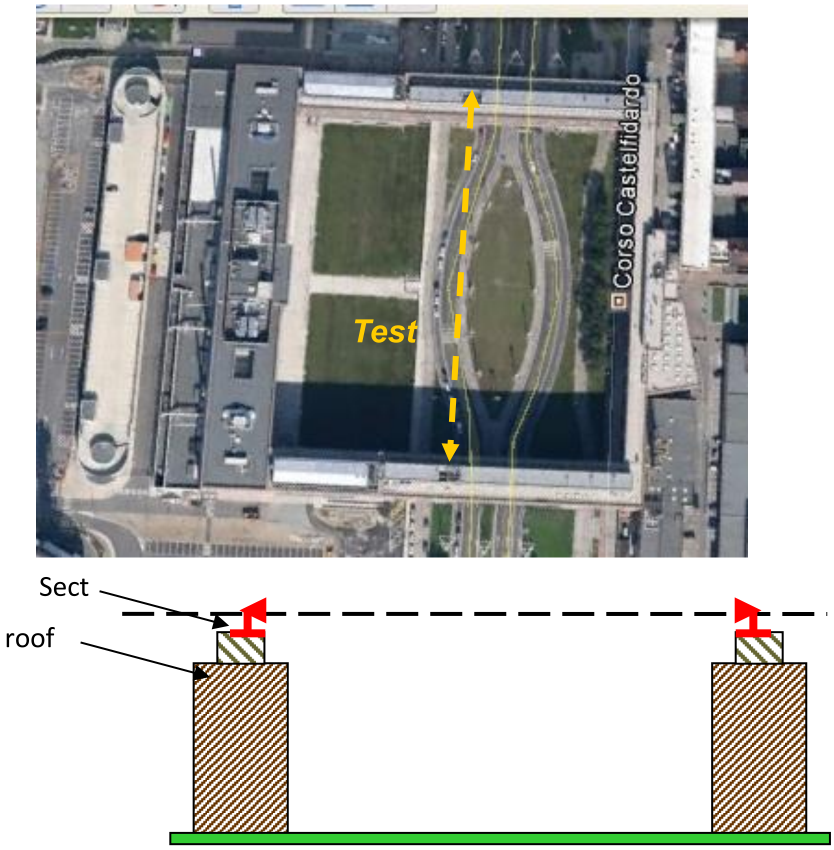


Fig.1: Plan view and vertical section of the outdoor test range

The design frequency interval is 100 MHz-50 GHz (the upgrade from 20 to 40 GHz has been added in 2011; from 40 to 50 GHz in 2015). The distance between SRC and AUT allows to test antennas up to 0.7m diameter at 40 GHz; at lower frequencies the maximum size in meters is given by $D \cong 4.7/f^{1/2}$, where f is the frequency in GHz. Corrections procedures are also available should the distance be less than $2D^2/\lambda$.

The dynamic range is around 90 dB (depending on the frequency). The receiver can handle up to 16 measurements channels, with external switching system, and 1 reference channel measured simultaneously with each signal channel, with 100 dB isolation Channel to Channel (110 dB . Reference Channel to Signal Channel). The accuracy in amplitude (Logarithmic mode) is ±.05 dB/10 dB over the full dynamic range (excluding effects of temperature, cross-talk and noise) and ±0.4 °/10 dB in phase over full dynamic range; the noise figure is 17 dB at 0.1 to 18 GHz. The most recent calibration of the whole system has been in June 2014.

The positioning system of the AUT is a 3-axis system (roll over azimuth over elevation), consisting of: MI53150 Az/El and MI6111 rotary positioner (see fig.2, left). The Az/El accuracies are respectively 0.03° and 0.05° with max load 1136 kg and bending moment 3390 N·m; the roll accuracy is 0.05° with max load 455 kg and bending moment 678 N·m. As a practical guideline, the system can measure antennas up to 2m in size and to 70 kg in weight: actual limits depend however on the shape of the antenna. This positioning system allows to take pattern cuts as well as raster scan of the pattern, and to measure circular and linear polarization.. Examples of measured radiation patterns are shown in fig. 3. The full system cabling diagram is shown in fig. 4.

As source antennas standard gain horns are used. Measurement accuracy for secondary lobe is estimated in about in ±1 dB; for gain in about ±0.5 dB

Fig.2: Outdoor test range: the AUT mount (left) and the upper SRC mount (right).

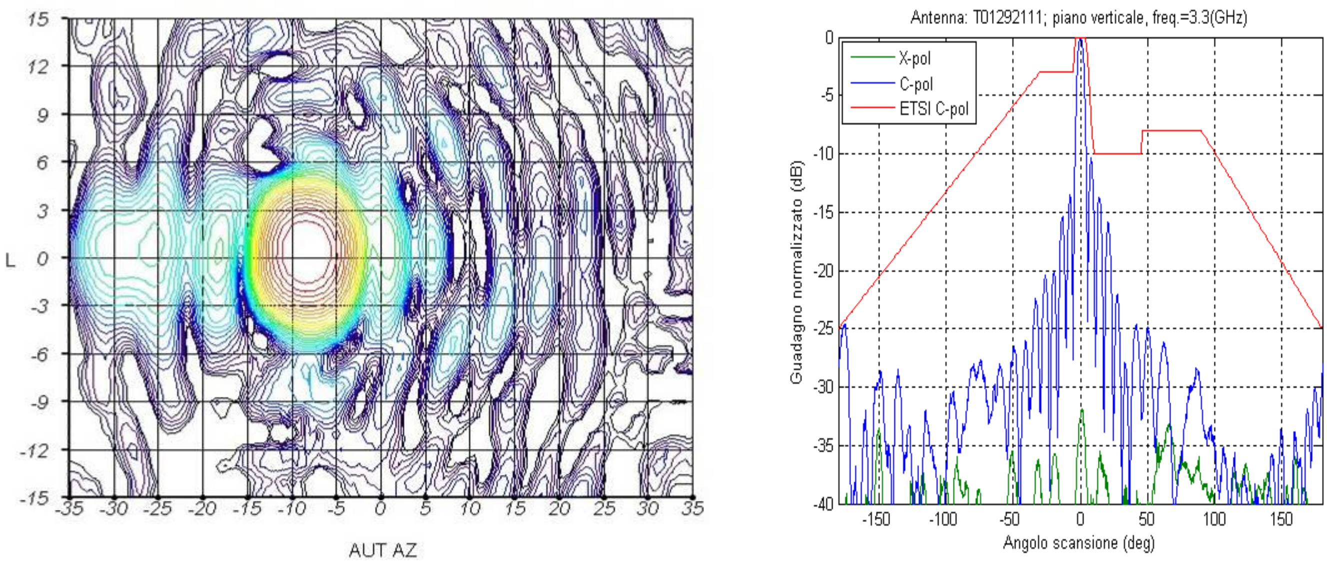


Fig.3: Examples of radiation patterns measured in the Outdoor Test Range.

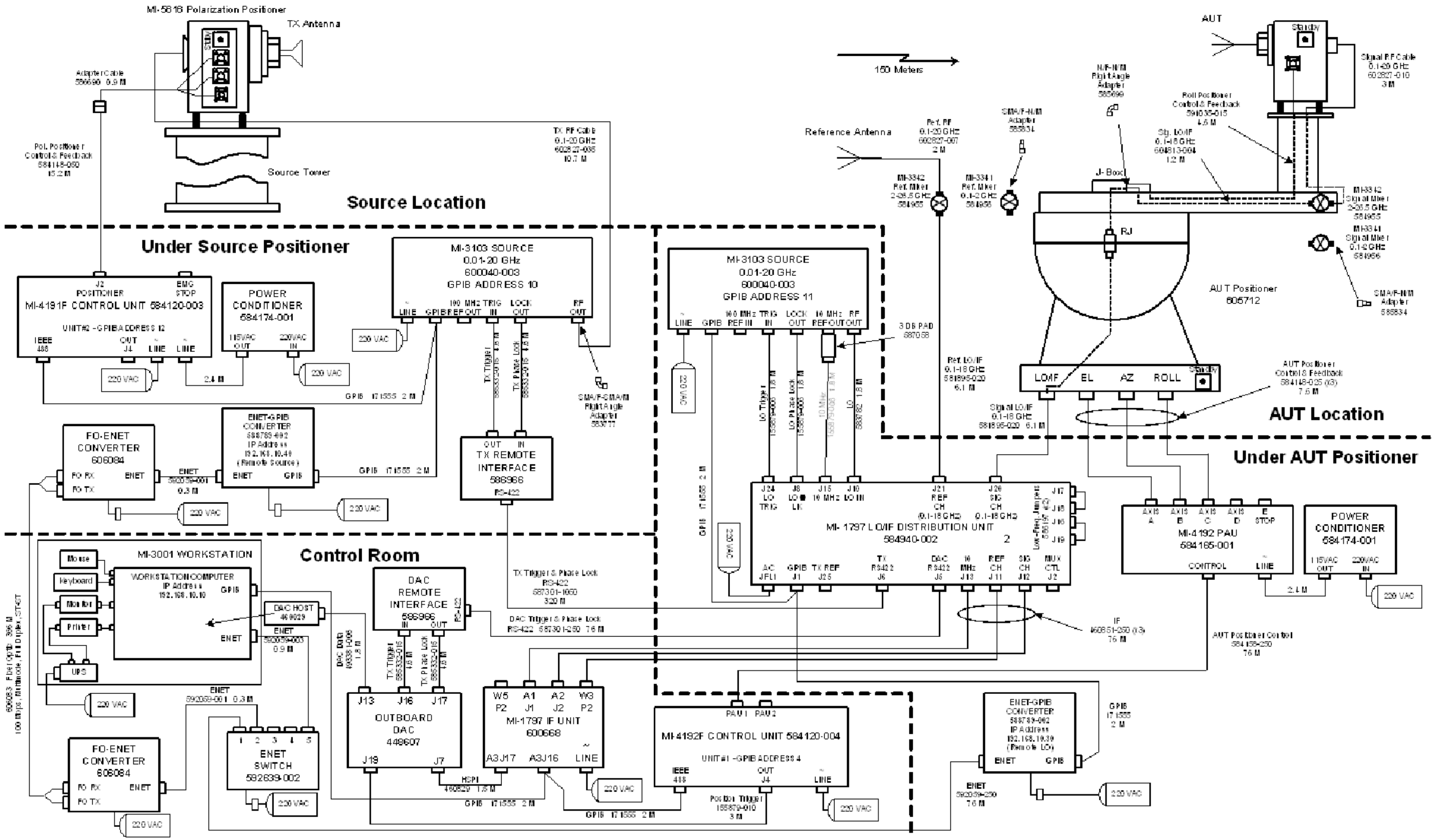


Fig.4: The full system cabling diagram.

3. MEASUREMENTS PROCEDURES

3.1 Gain measurement

The standard procedure for this type of measurement is the "substitution method". The Antenna Under Test (AUT) operates in reception. The maximum signal level received (at all ports) from the AUT, pointed with the maximum to the source antenna, is measured, with a frequency sweep in the required frequency band. Then the AUT is replaced by a Standard Gain Horn antenna (SGH) with known gain, with the maximum to the source antenna, and again the maximum signal level received from is recorded. The Gain of the AUT is derived from the simple formula (in dB)

$G_{AUT} = G_{SGH} + (P_{rAUT} - P_{rSGH})$

The gain vs frequency is plotted in Cartesian plot, in dB scale.

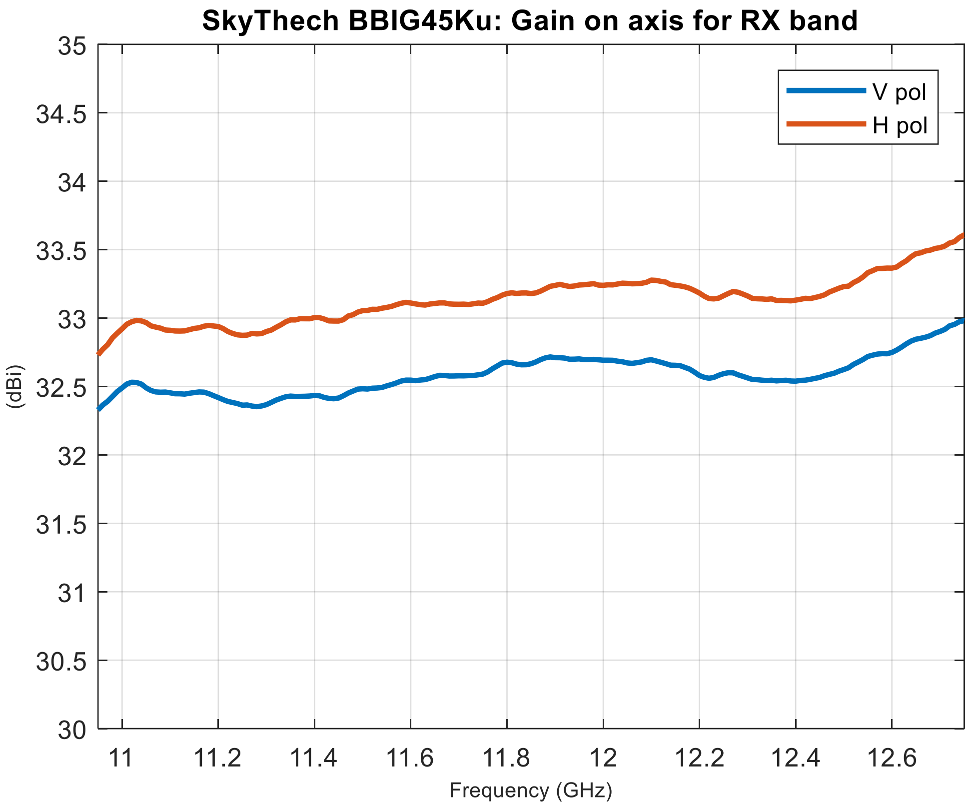
3.2. Radiation pattern measurements

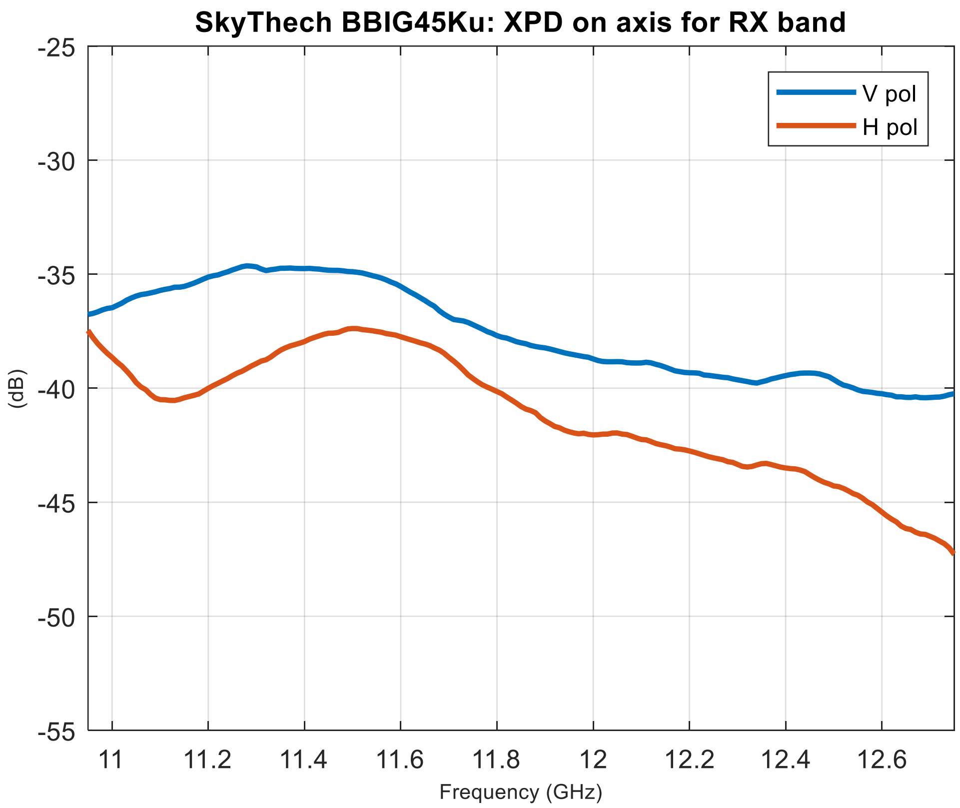
Since the patterns are required in various phi-cuts (azimuth, elevation) as well as in a raster scan around the main beam, the standard procedure is to measure, at discrete frequencies, the received power from the AUT from each port, when transmitting from the source three different linear polarizations (V and H). The radiation patterns are plotted in dB scale, in the desired angular range.

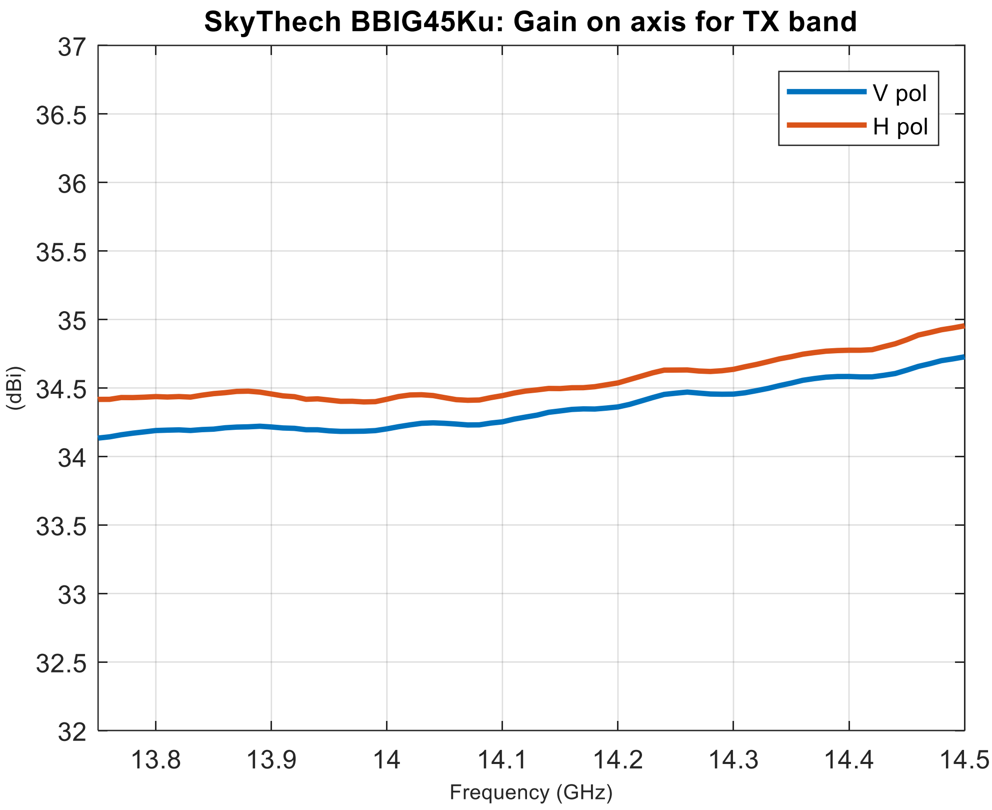
4. Pictures of the measurement campaign.

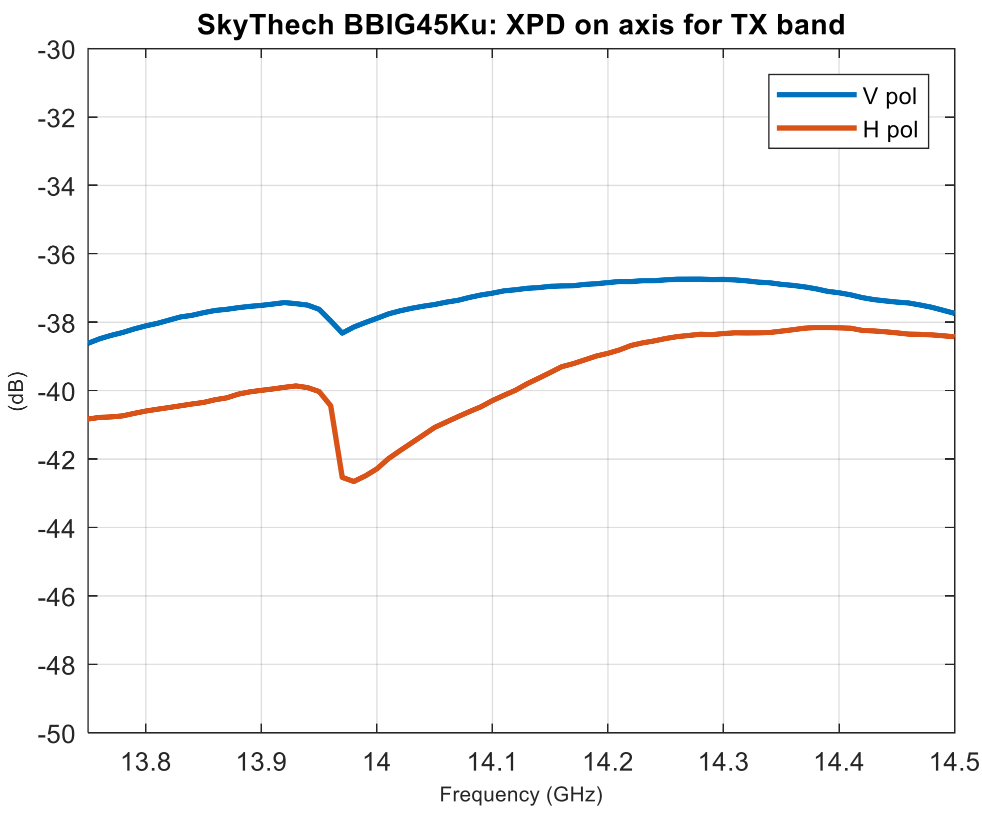
Fig.5: Antenna BBIG45Ku mounted on AUT positioner.

5. Gain and XPD measurements , TX / RX Bands.





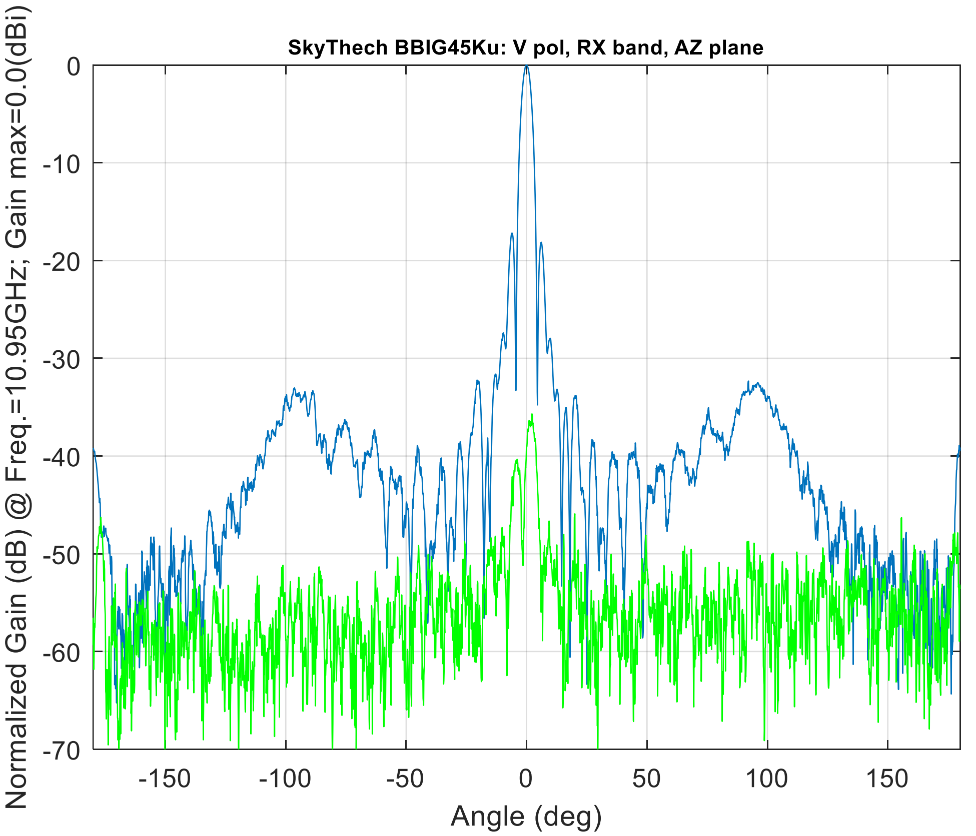

SkyThech BBIG45Ku: Gain on axis for TX band
V pol
H pol
(dBi)
37
36.5
36
35.5
35
34.5
34
33.5
33
32.5
32
13.8
13.9
14
14.1
14.2
14.3
14.4
14.5
Frequency (GHz)

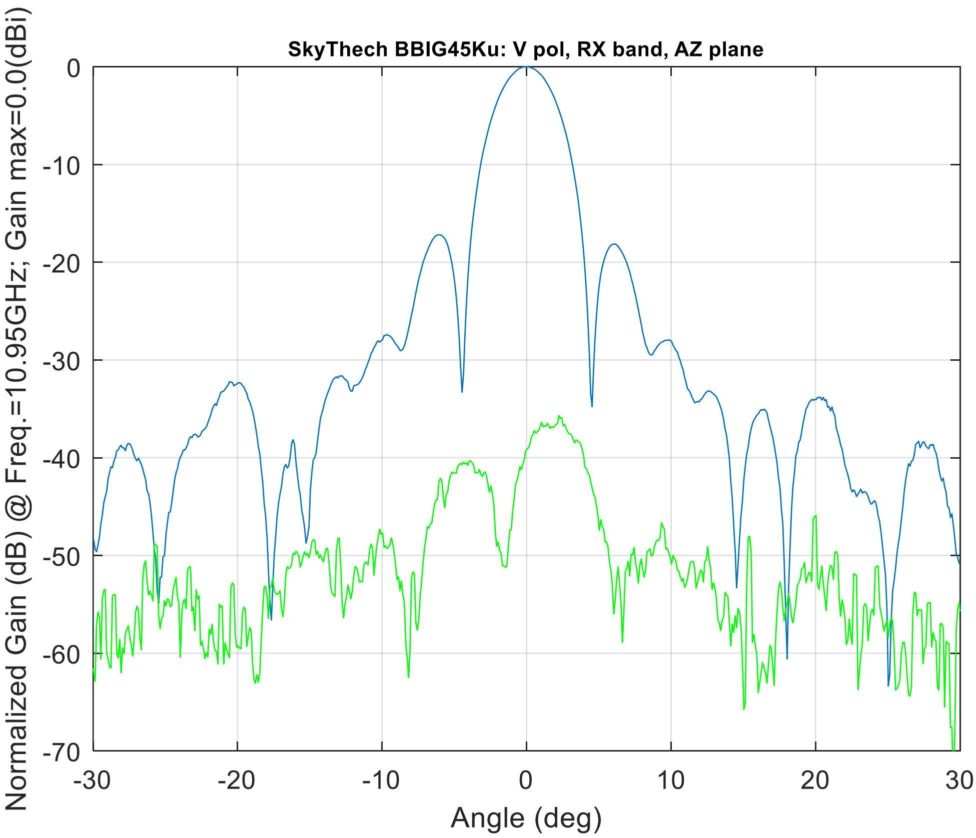

SkyThech BBIG45Ku: XPD on axis for TX band
V pol
H pol
(dB)
-30
-32
-34
-36
-38
-40
-42
-44
-46
-48
-50
13.8
13.9
14
14.1
14.2
14.3
14.4
14.5
Frequency (GHz)

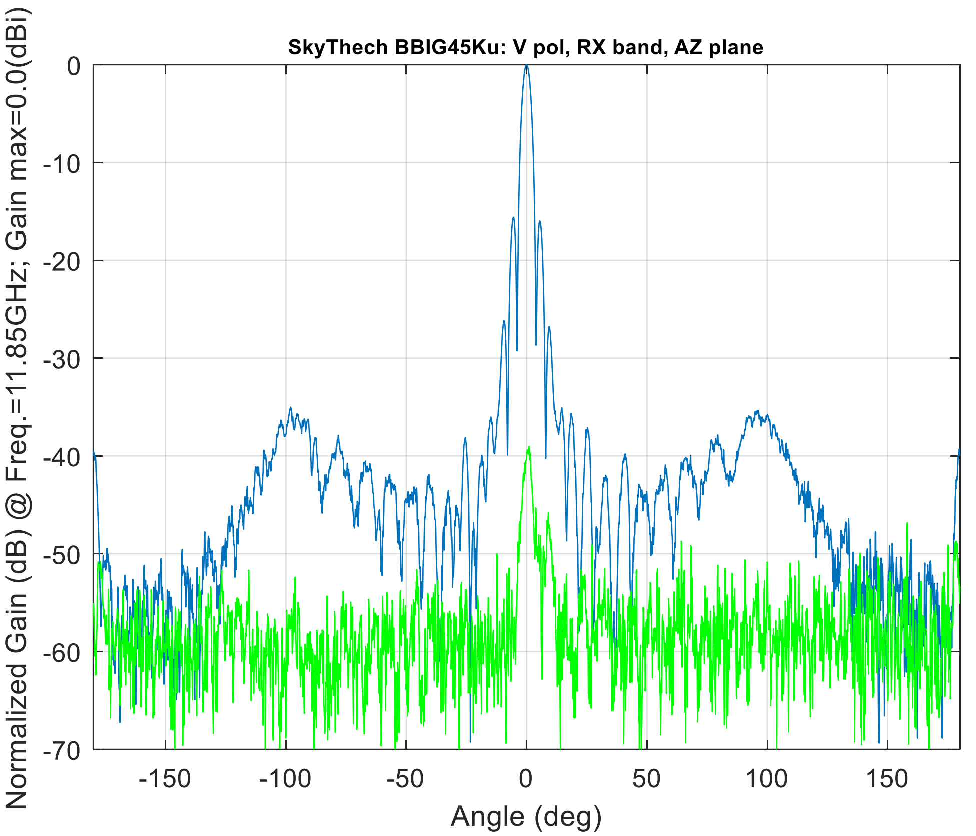
6. Radiation Pattern Measurements.

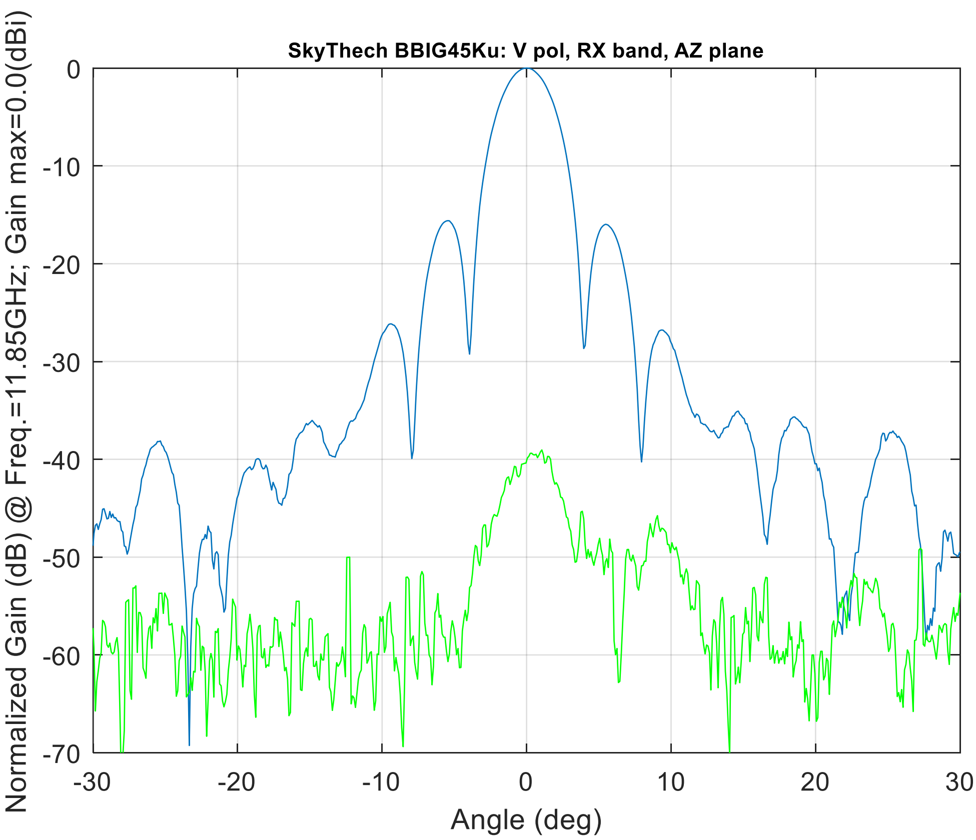
6.1: Radiation patterns in RX band (10.95-12.75 GHz).

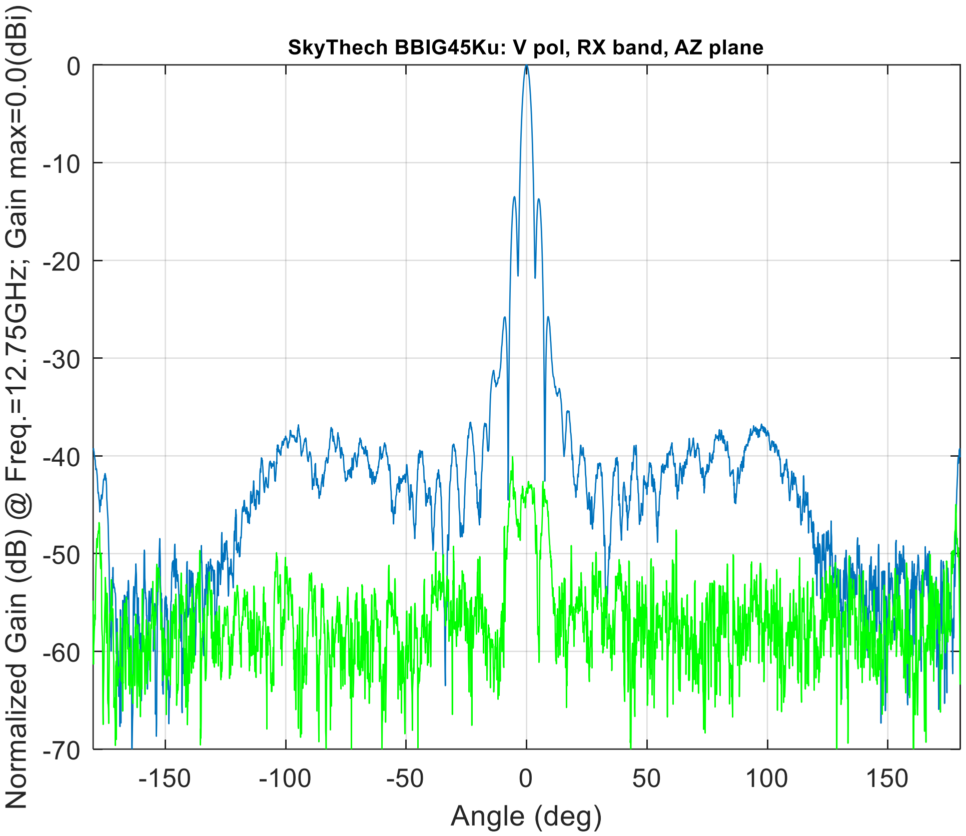
6.1.1: V-pol, AZ and EL plane plots.

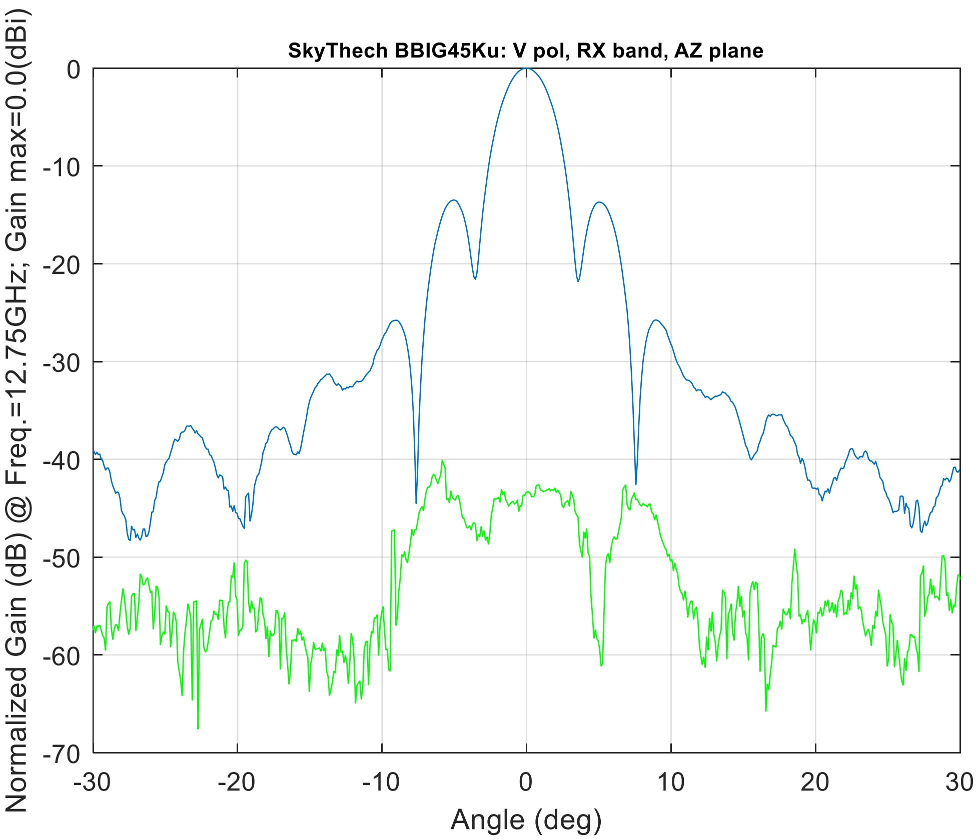


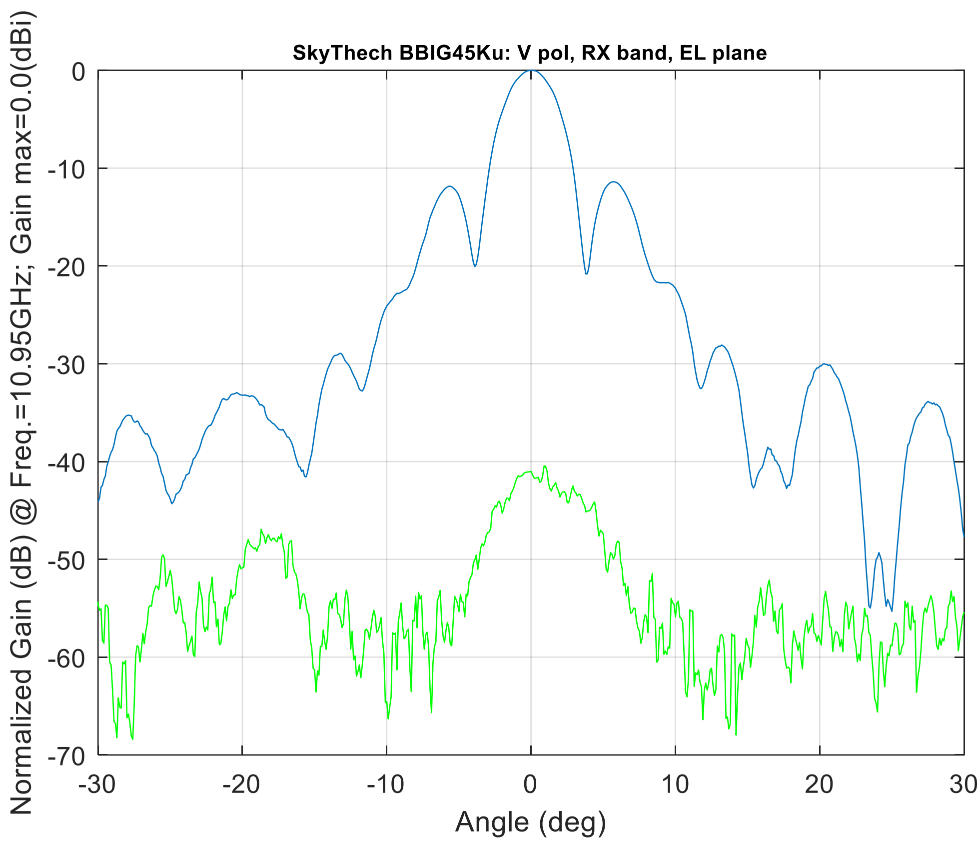


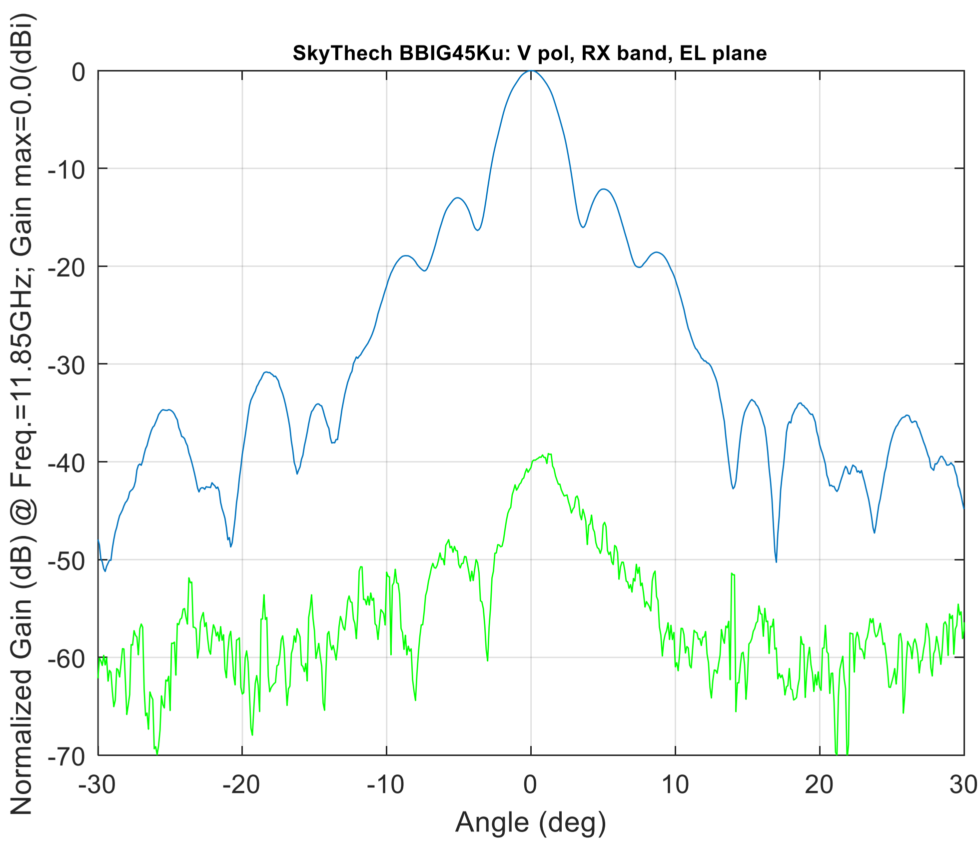

SkyThech BBIG45Ku: V pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150
Angle (deg)

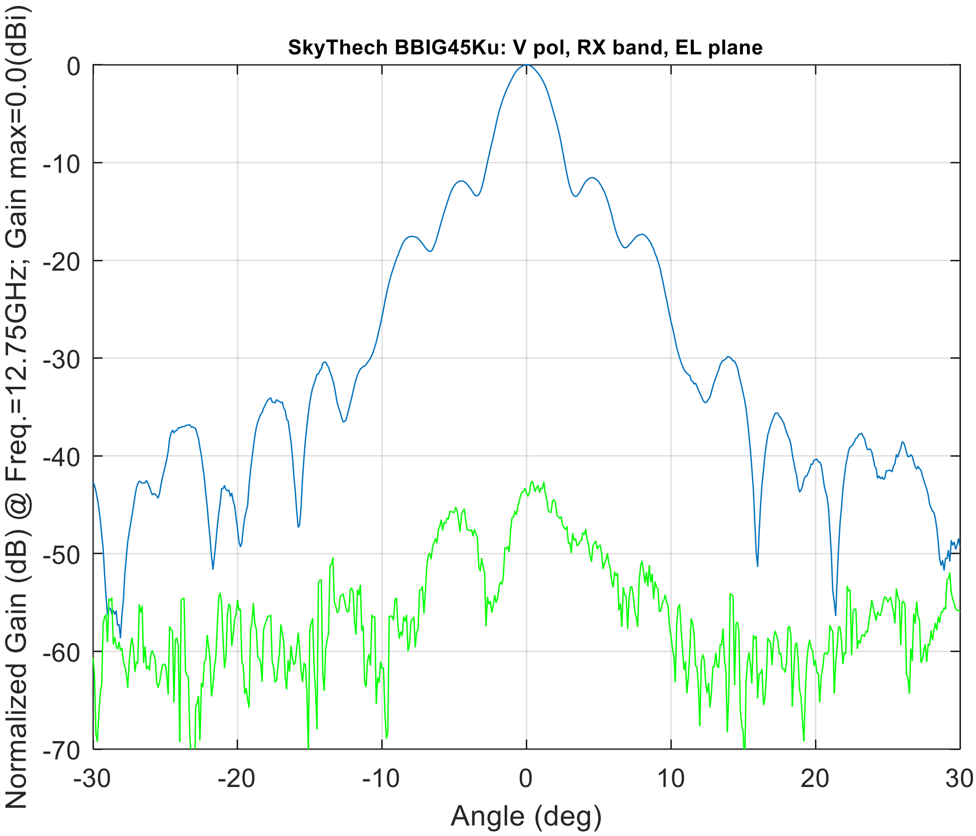

SkyThech BBIG45Ku: V pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)


SkyThech BBIG45Ku: V pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150
Angle (deg)

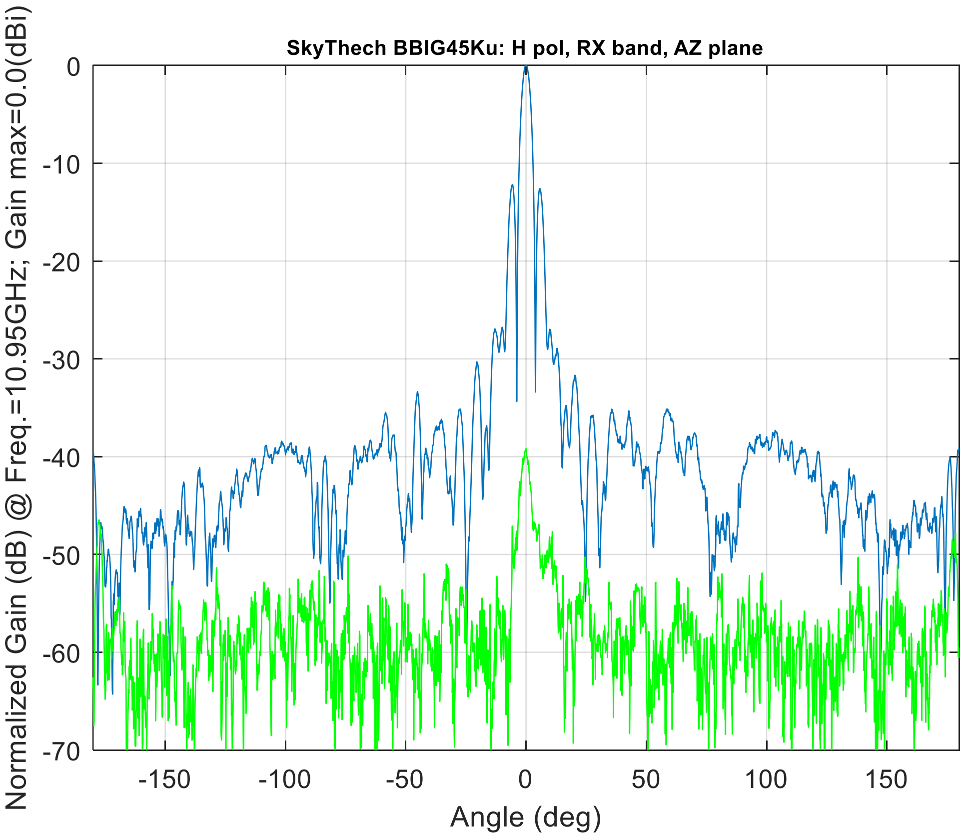

SkyThech BBIG45Ku: V pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)

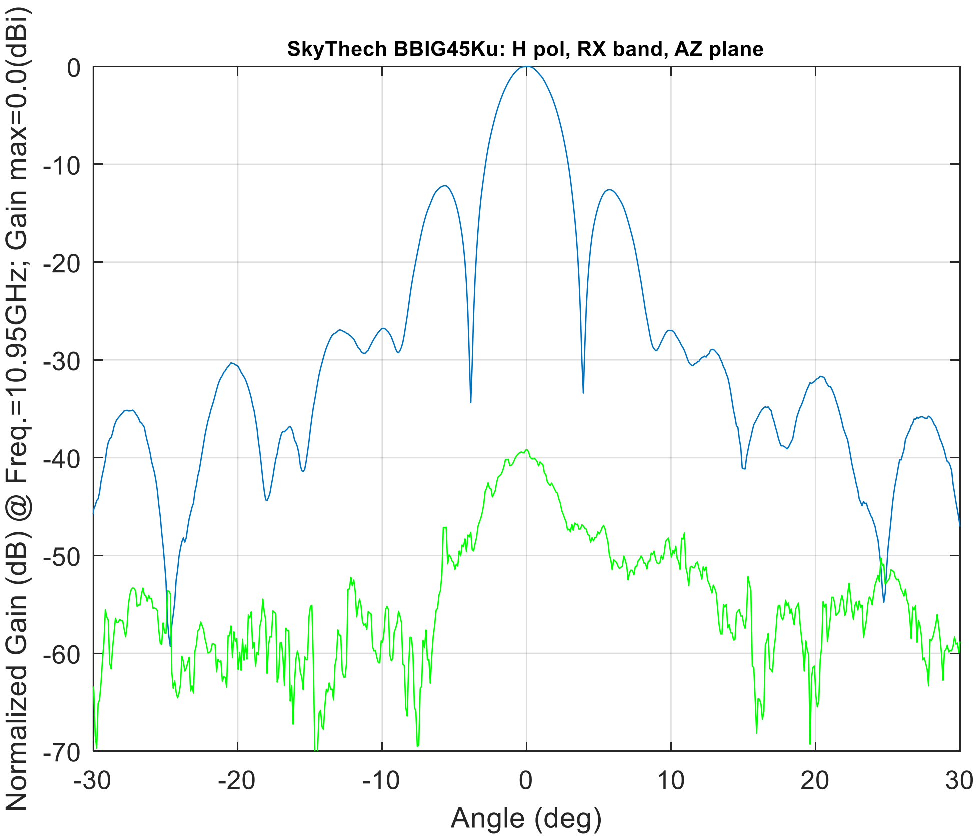

SkyThech BBIG45Ku: V pol, RX band, EL plane
Normalized Gain (dB) @ Freq.=10.95GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)

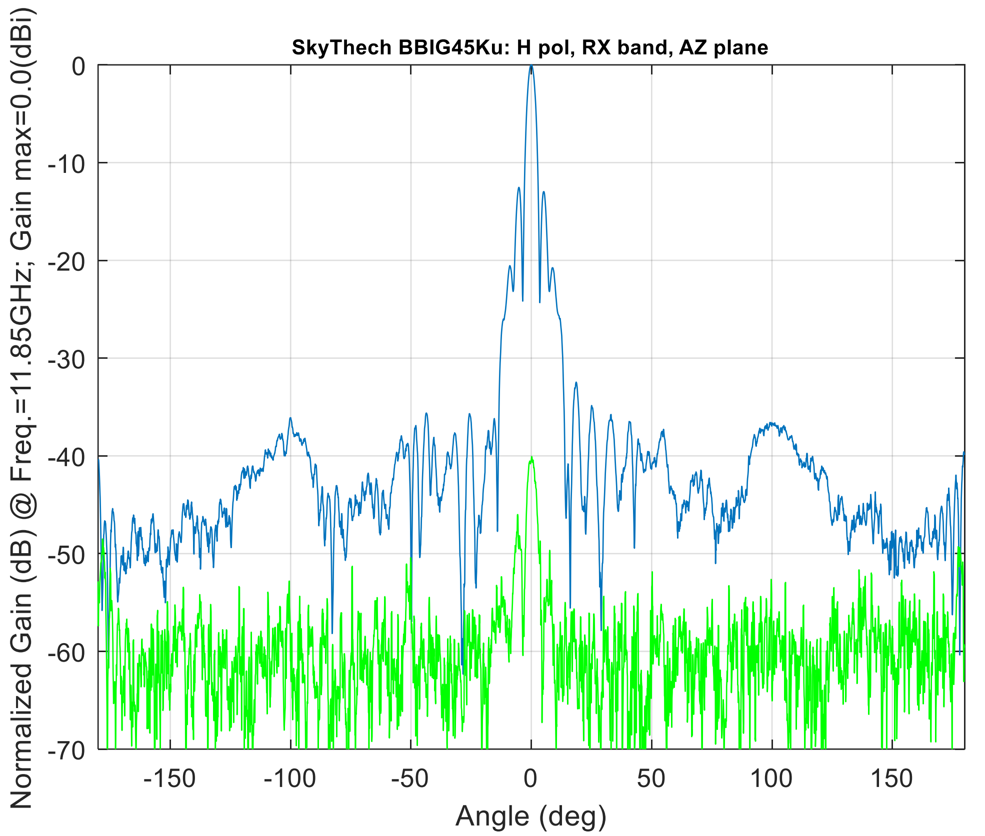

SkyThech BBIG45Ku: V pol, RX band, EL plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)

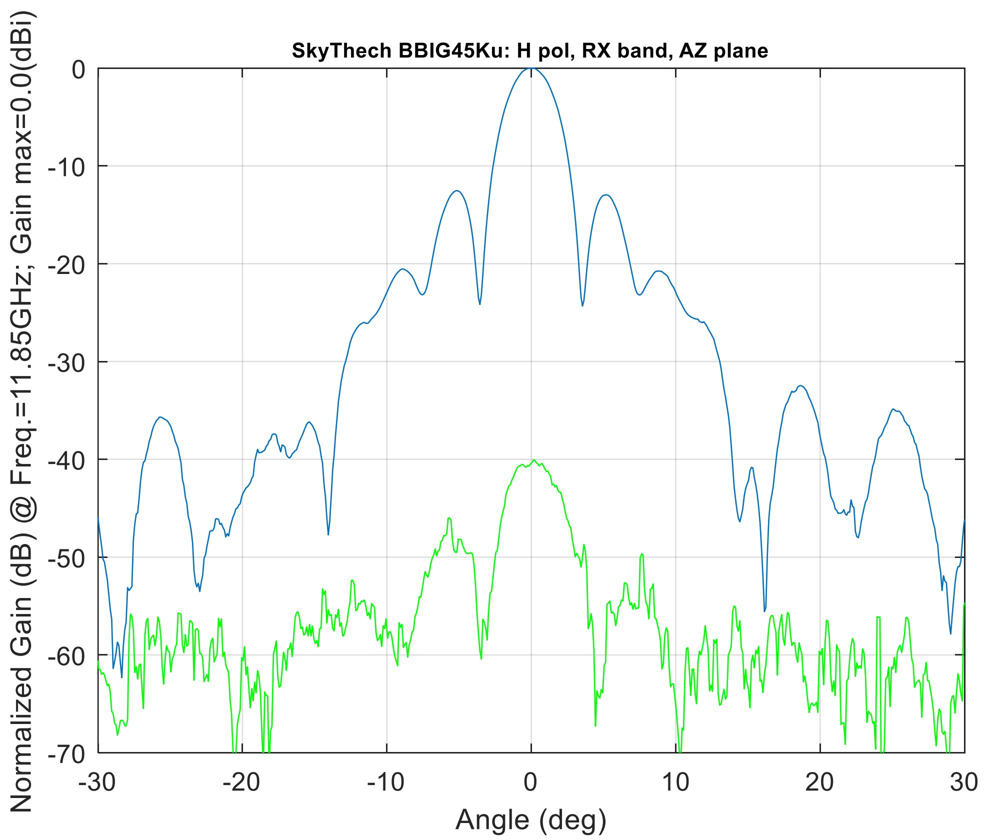

SkyThech BBIG45Ku: V pol, RX band, EL plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

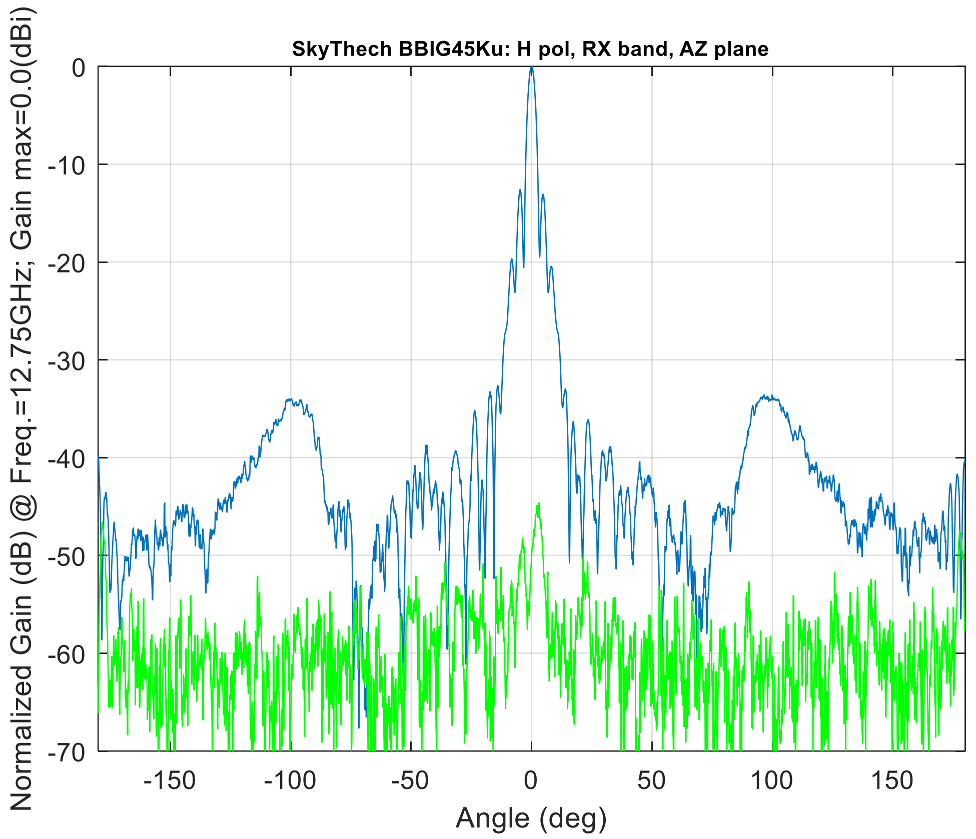
6.1.2: H-pol, AZ and EL plane plots.

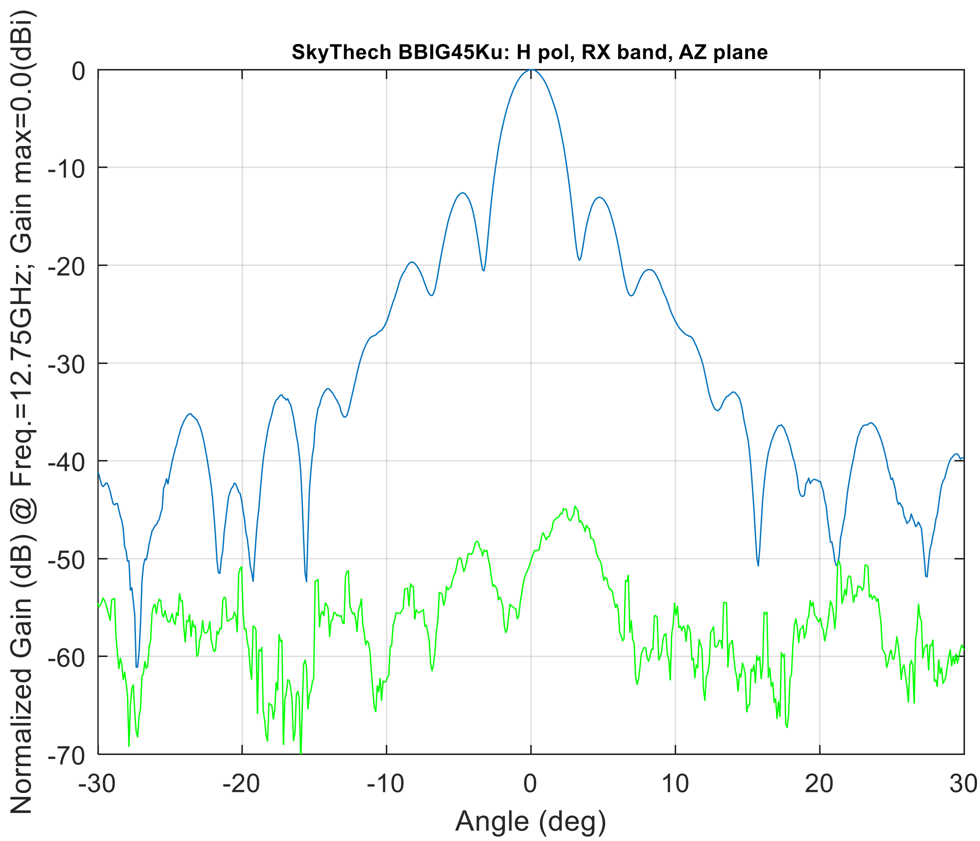


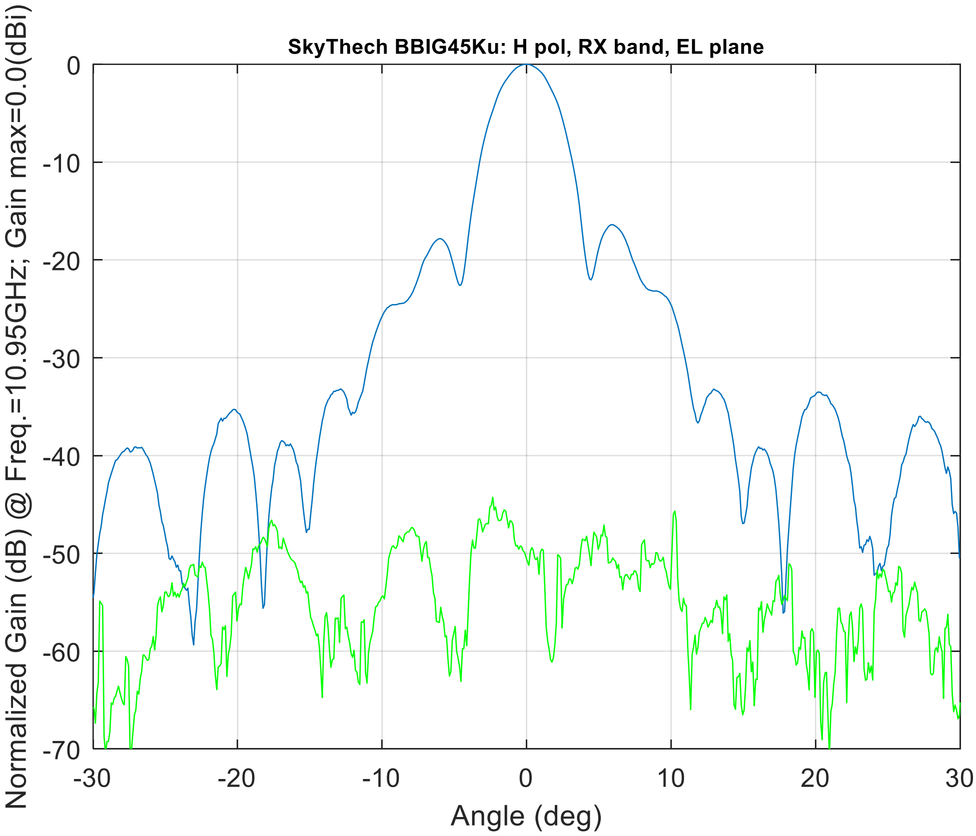


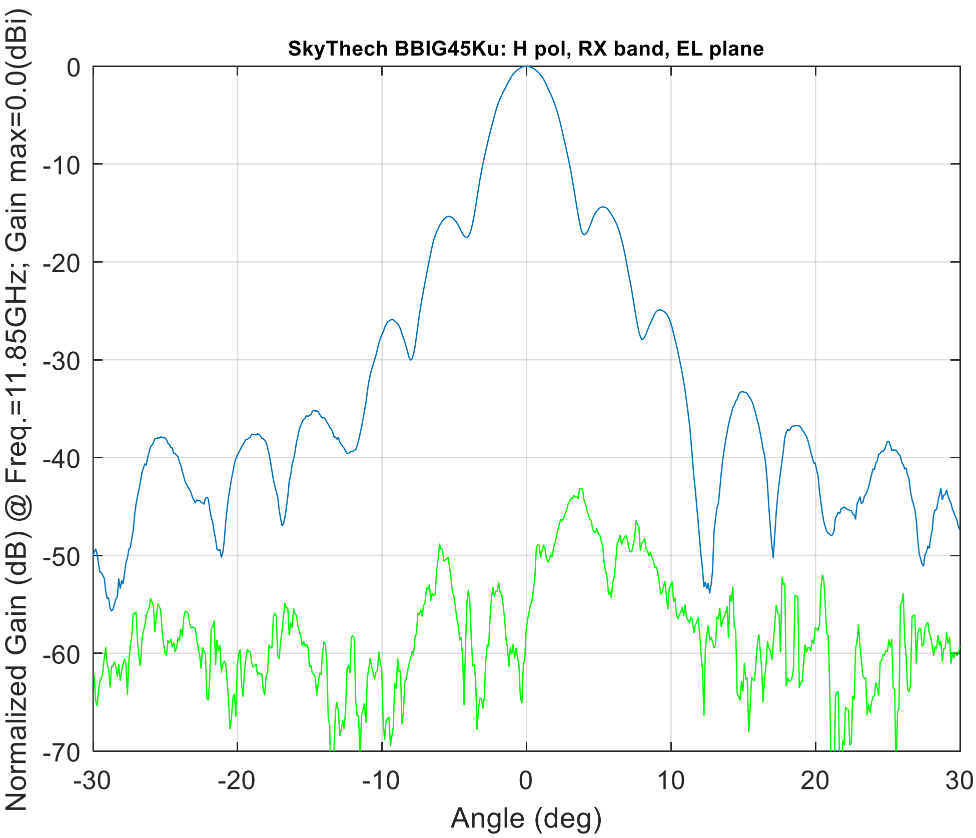

SkyThech BBIG45Ku: H pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150
Angle (deg)

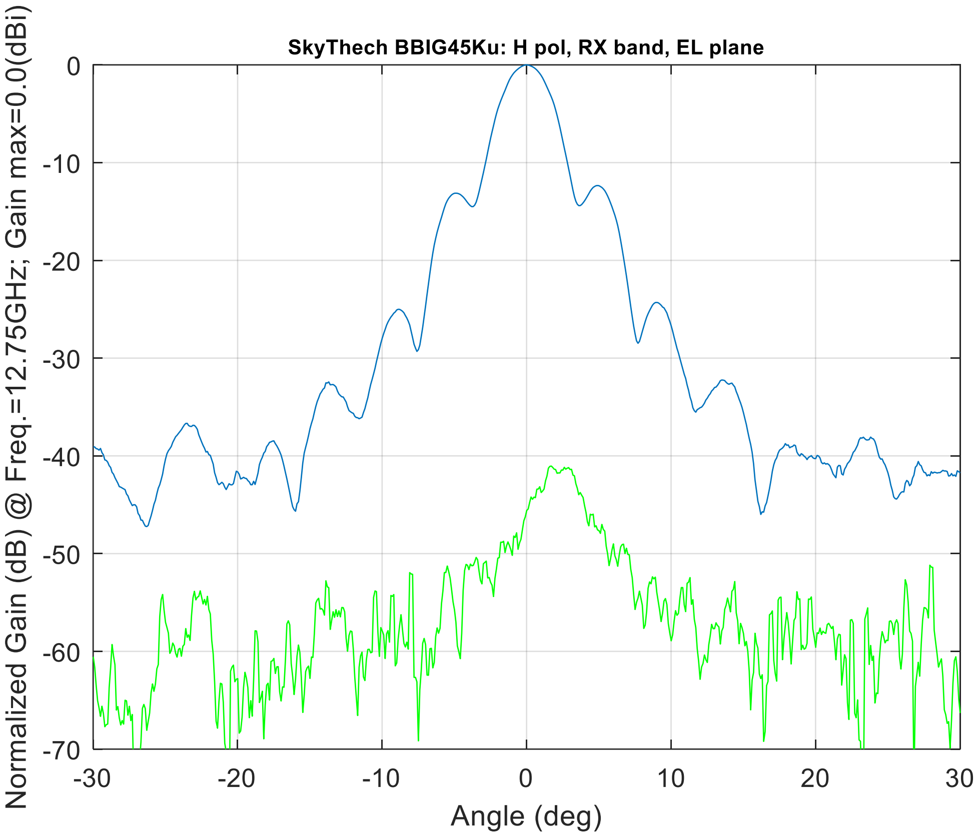

SkyThech BBIG45Ku: H pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)


SkyThech BBIG45Ku: H pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150
Angle (deg)


SkyThech BBIG45Ku: H pol, RX band, AZ plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)


SkyThech BBIG45Ku: H pol, RX band, EL plane
Normalized Gain (dB) @ Freq.=10.95GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

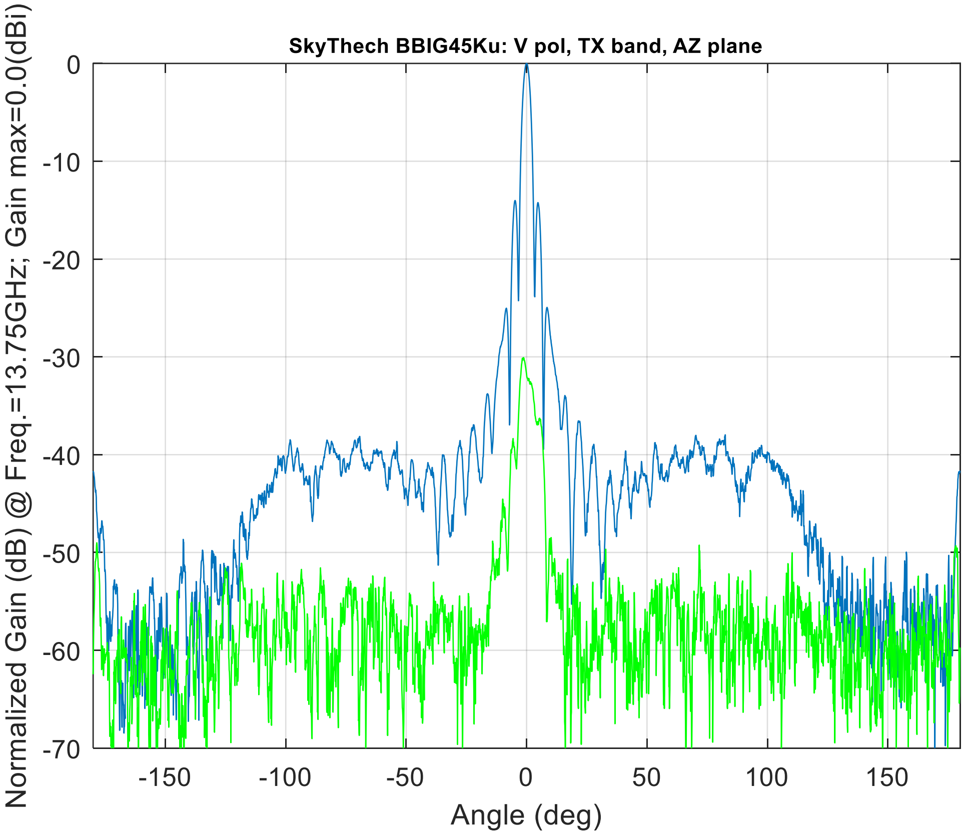

SkyThech BBIG45Ku: H pol, RX band, EL plane
Normalized Gain (dB) @ Freq.=11.85GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

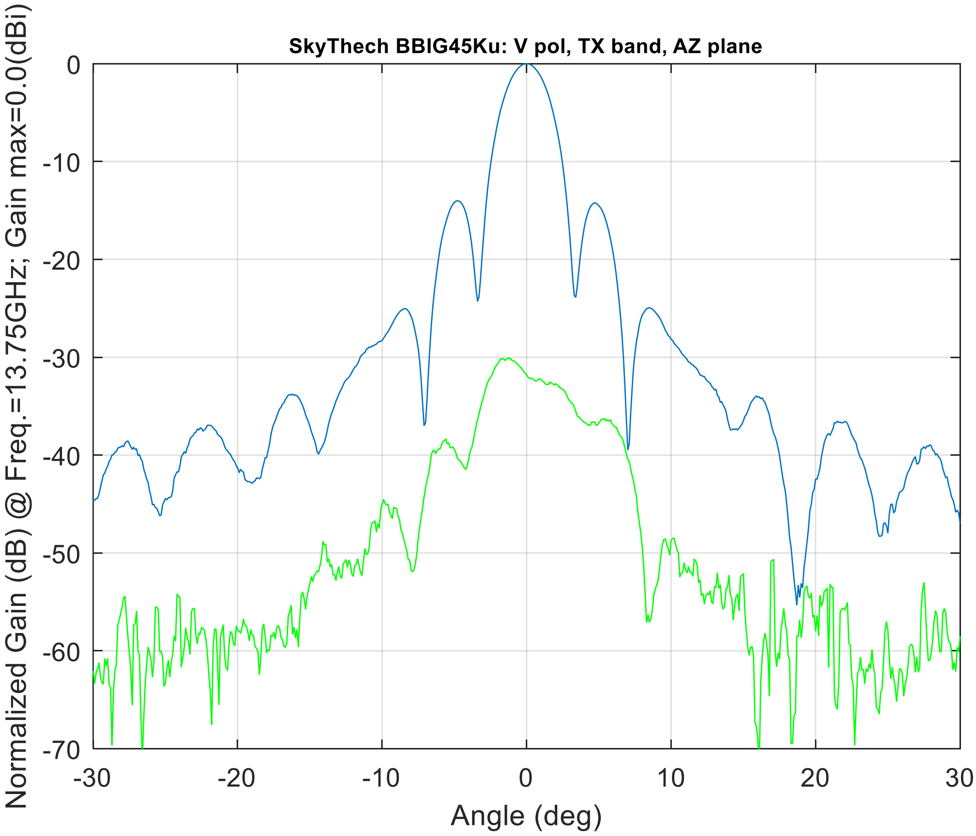


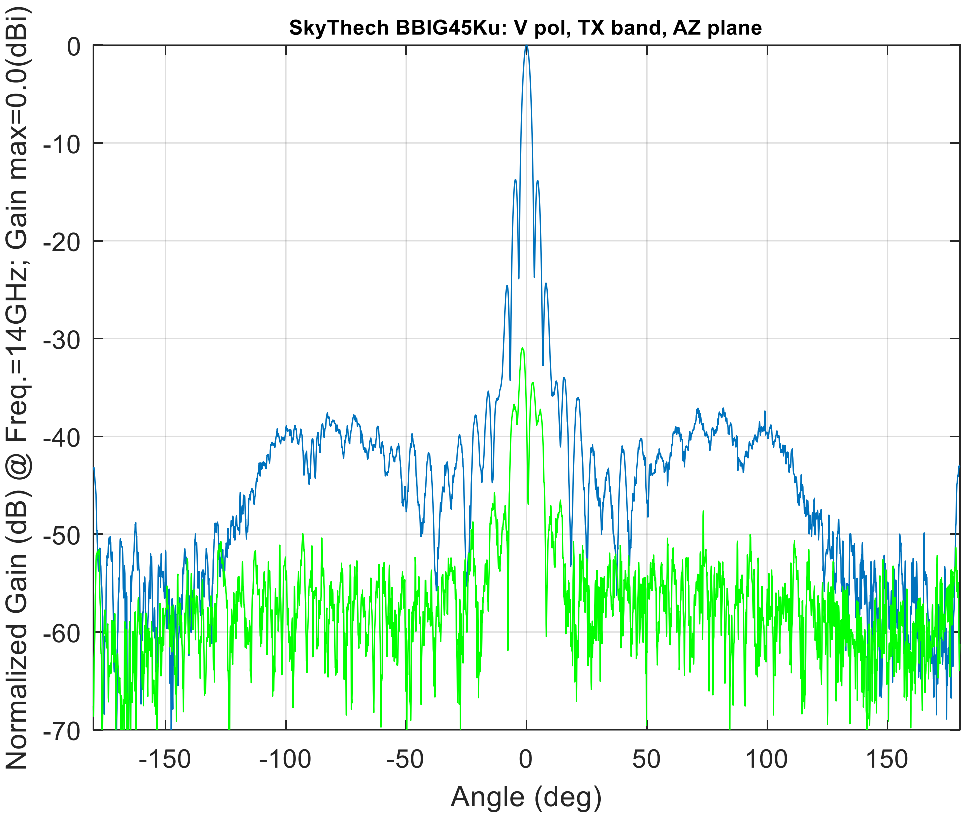
SkyThech BBIG45Ku: H pol, RX band, EL plane
Normalized Gain (dB) @ Freq.=12.75GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)

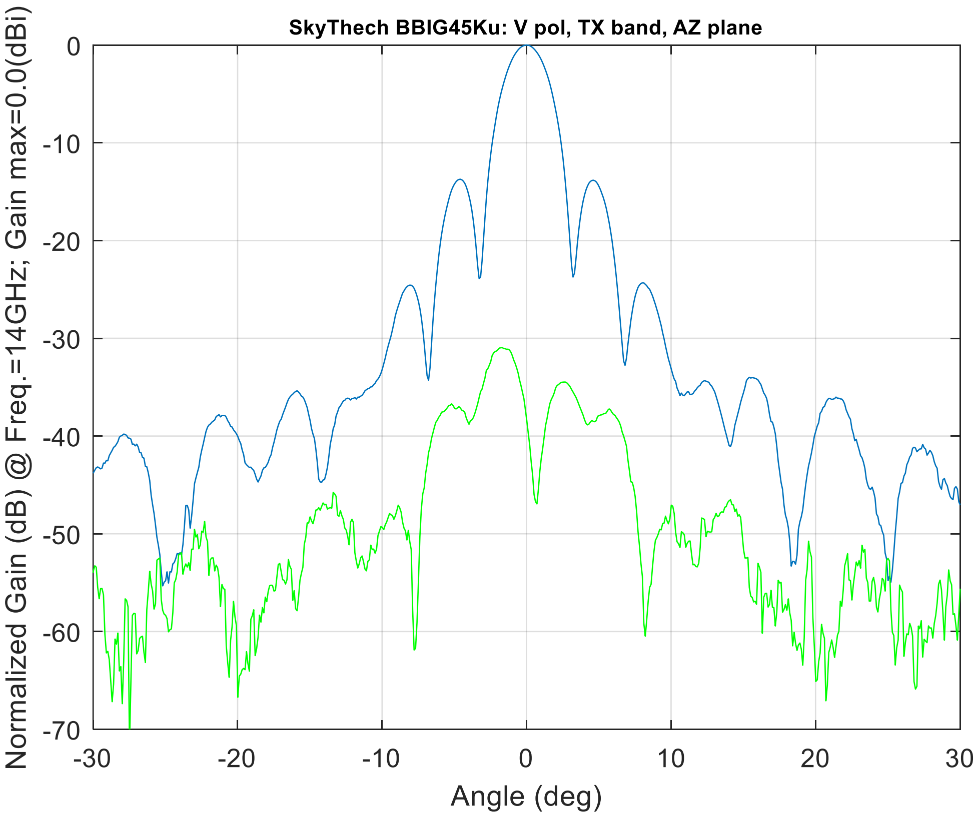
6.2: Radiation patterns in TX band (13.75-14.5 GHz) .

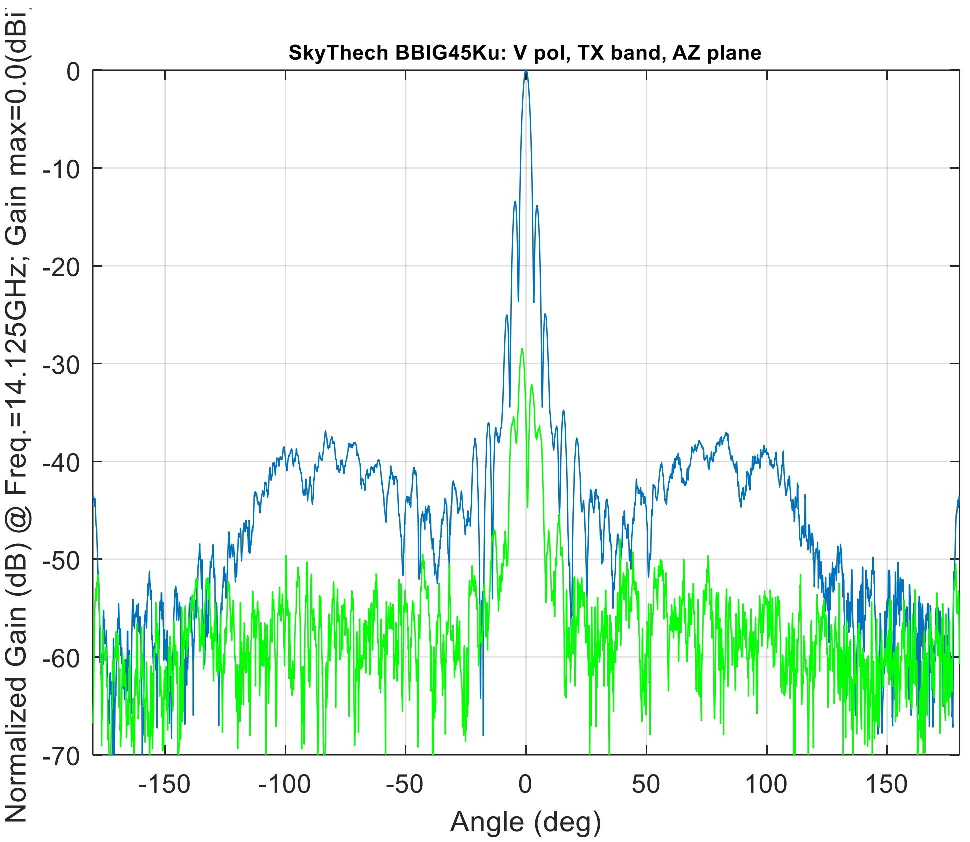
6.2.1: V-pol, AZ and EL plane plots.

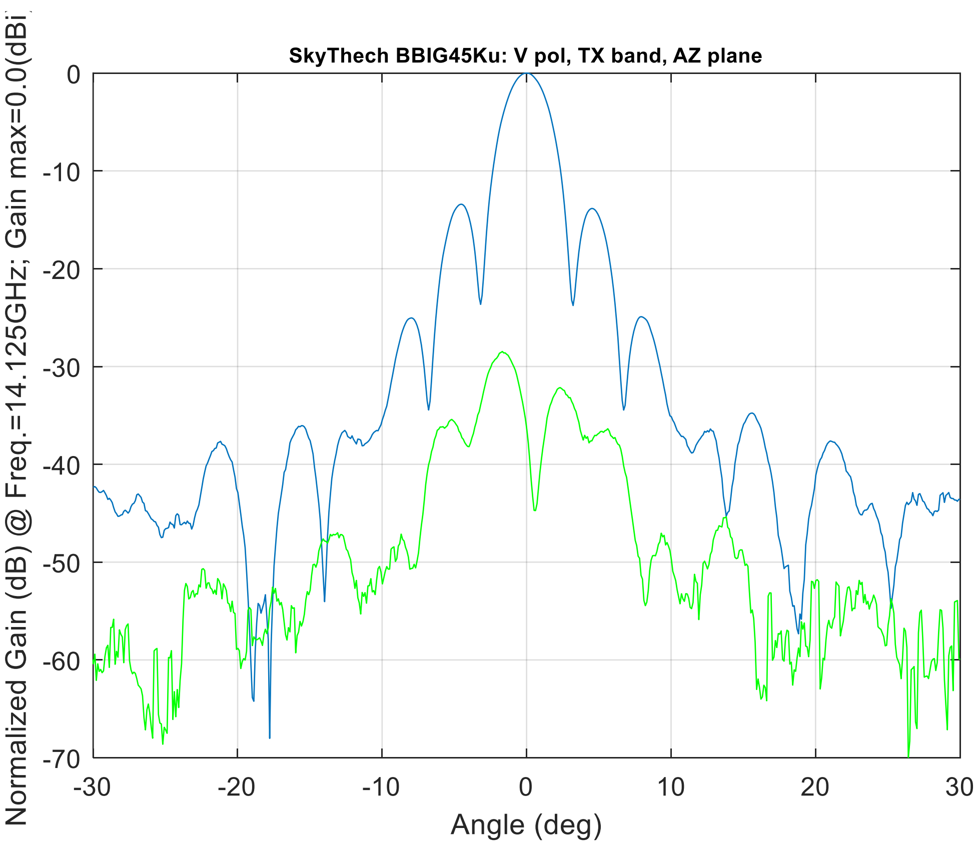


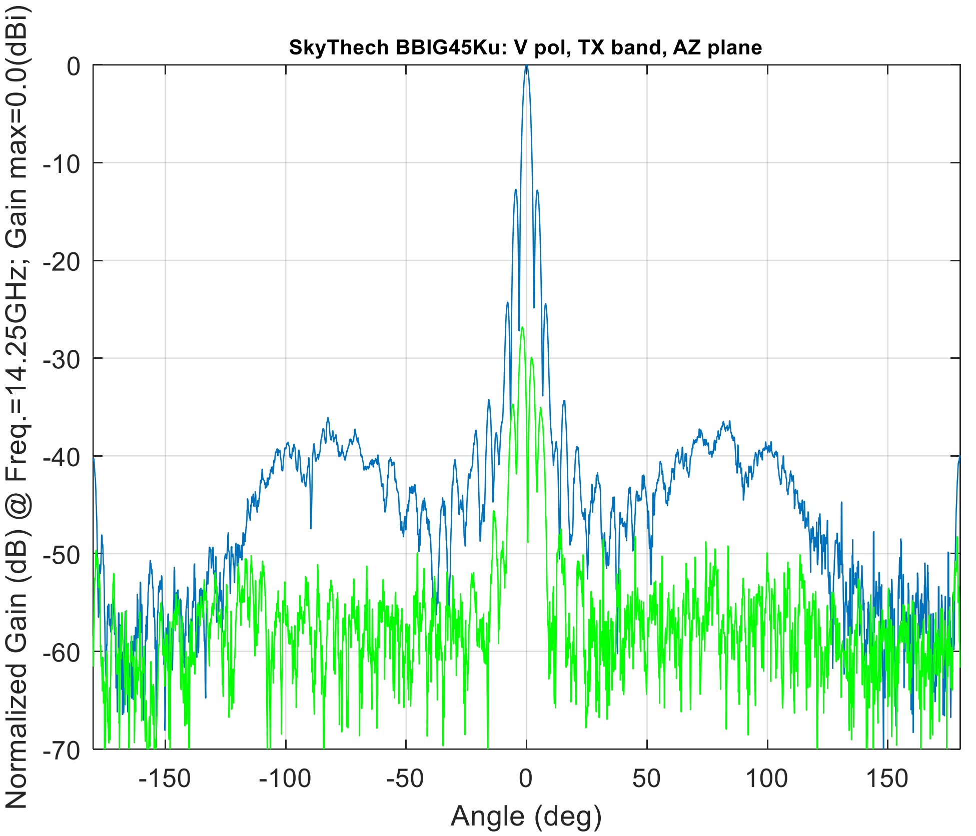


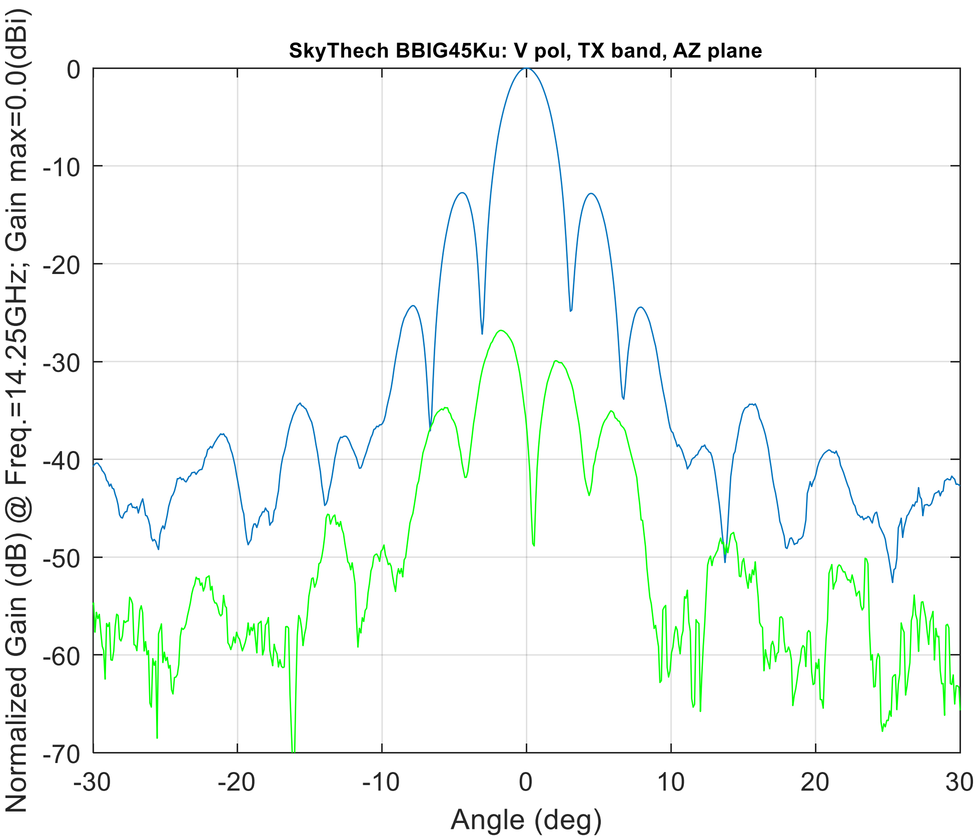

SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150

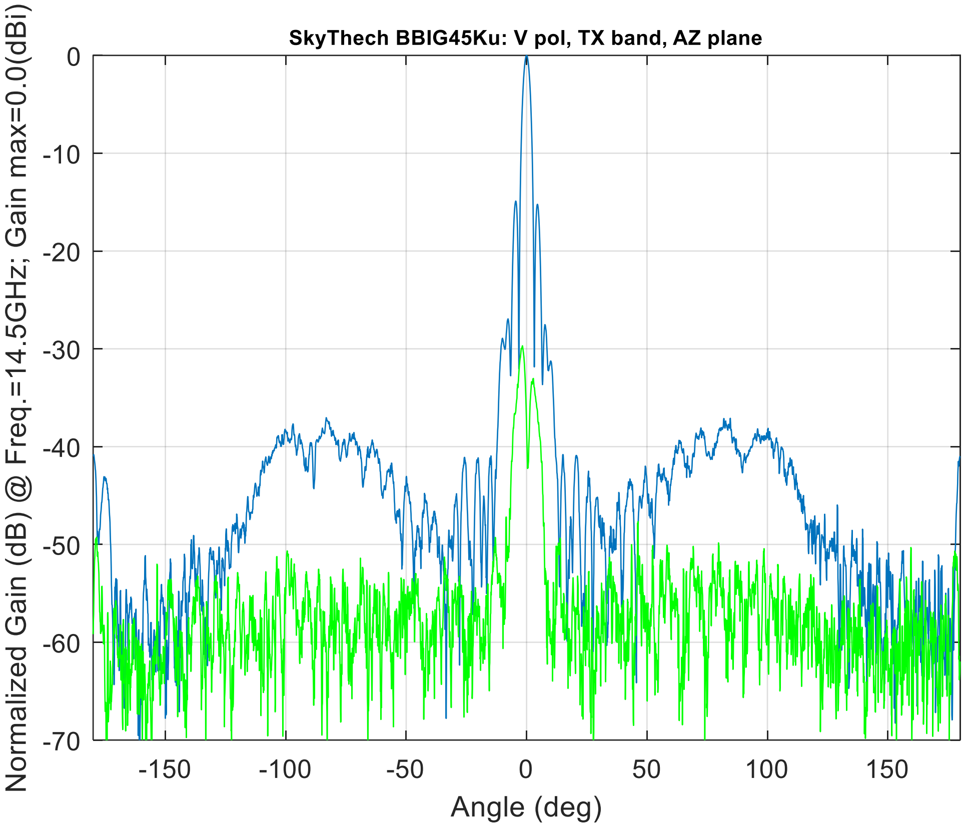

SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

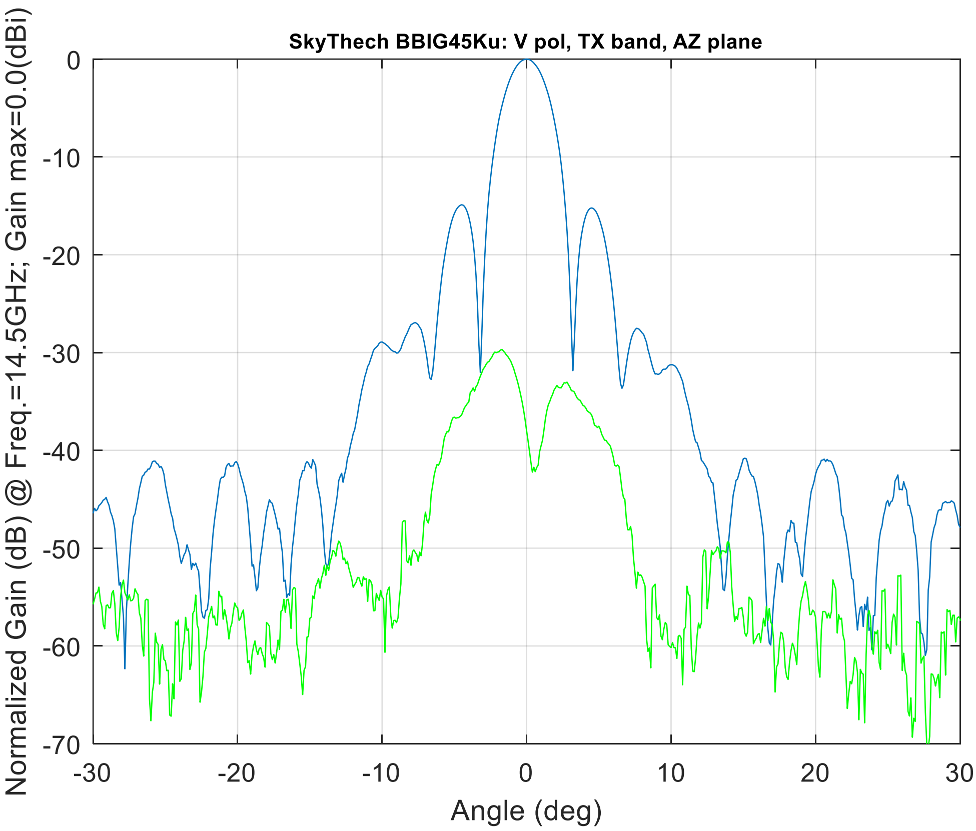

SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150

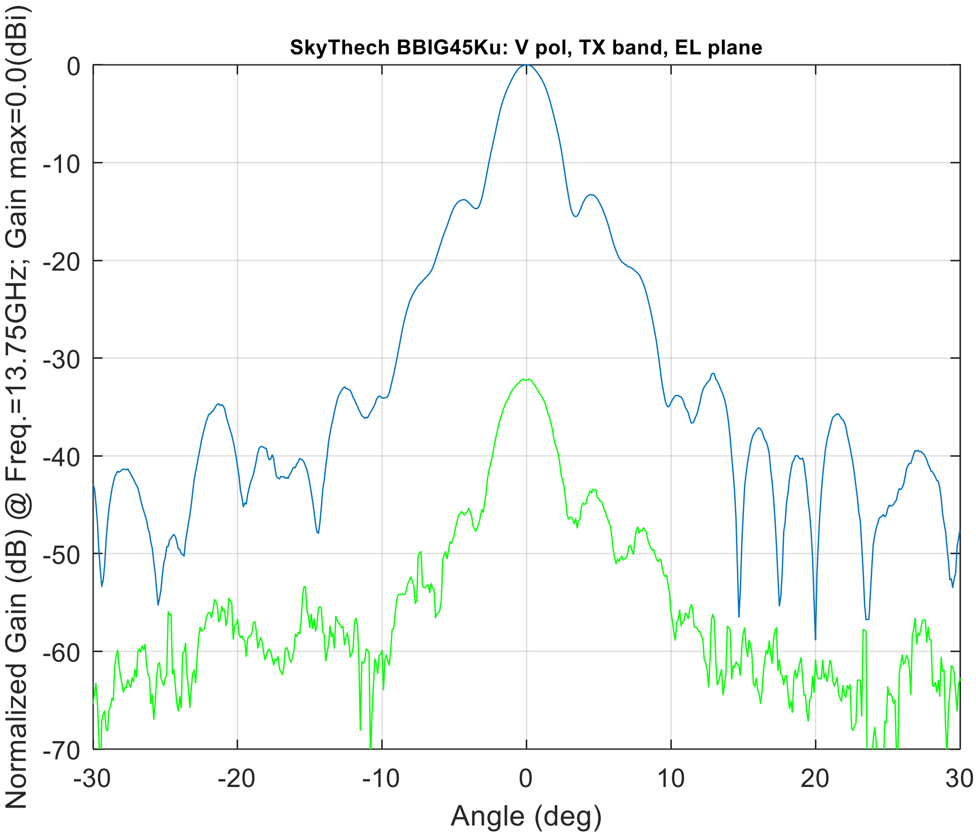

SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

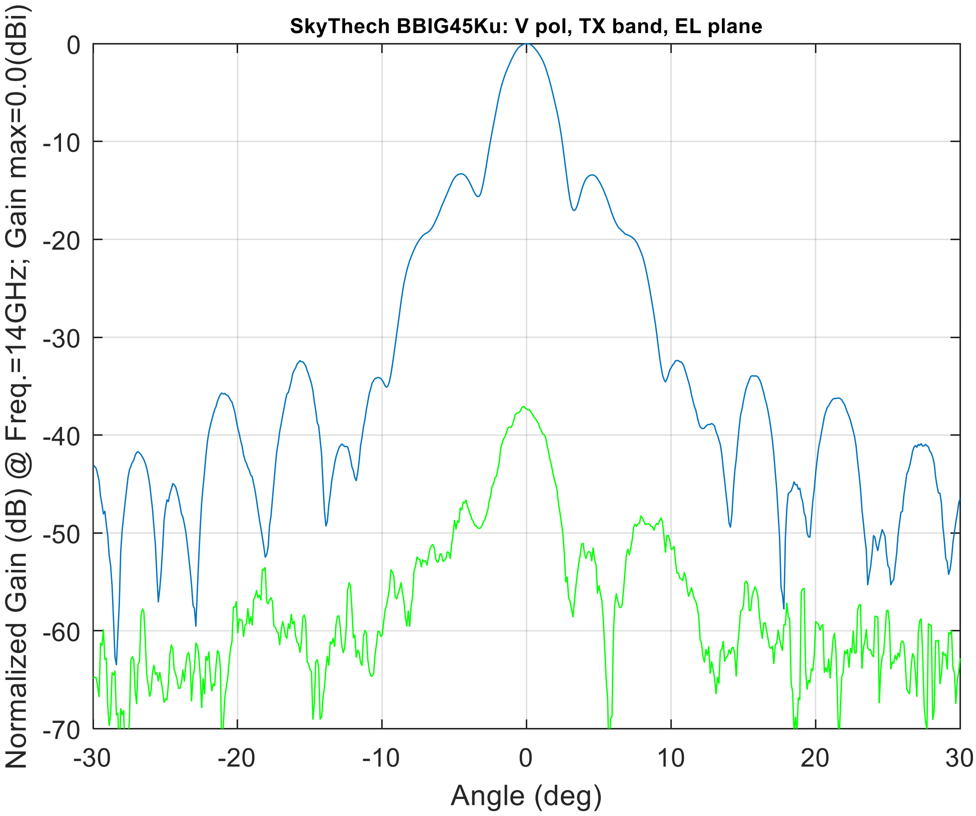

SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.25GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150

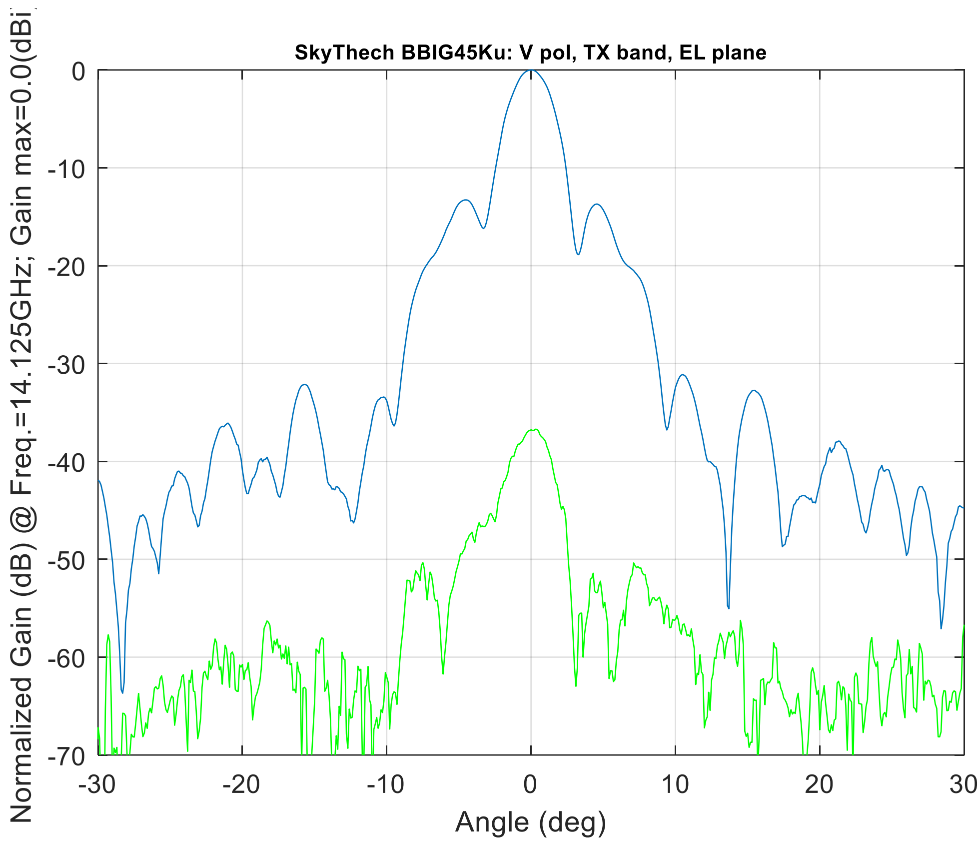

SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.25GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

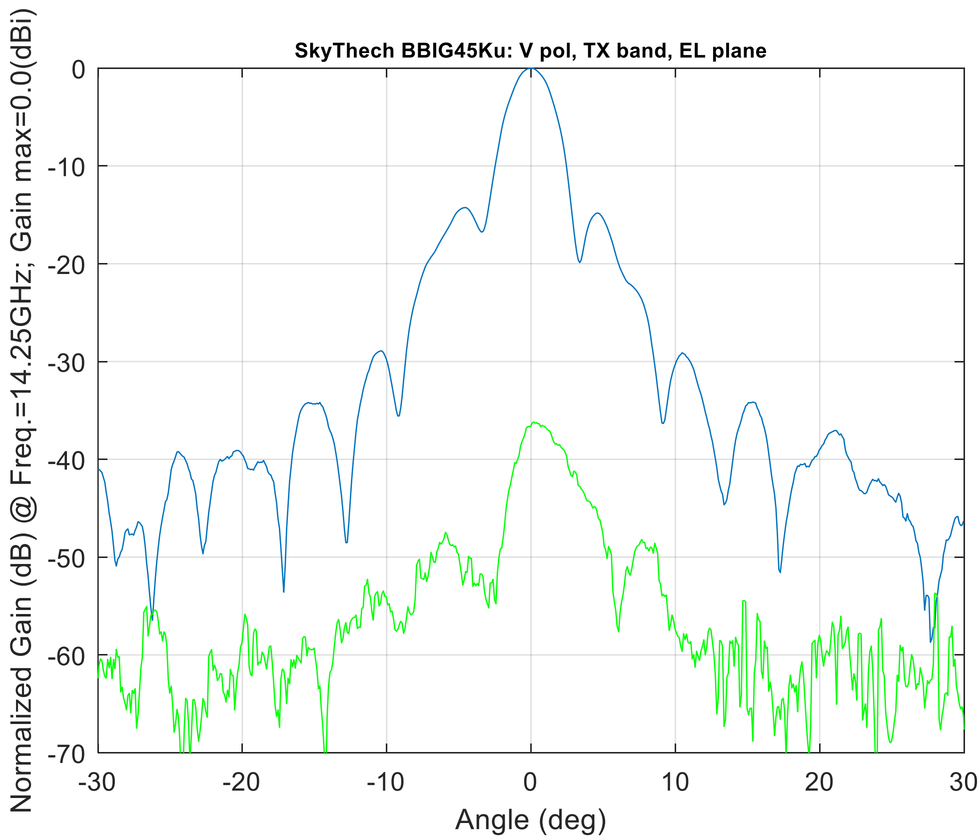

SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.5GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150

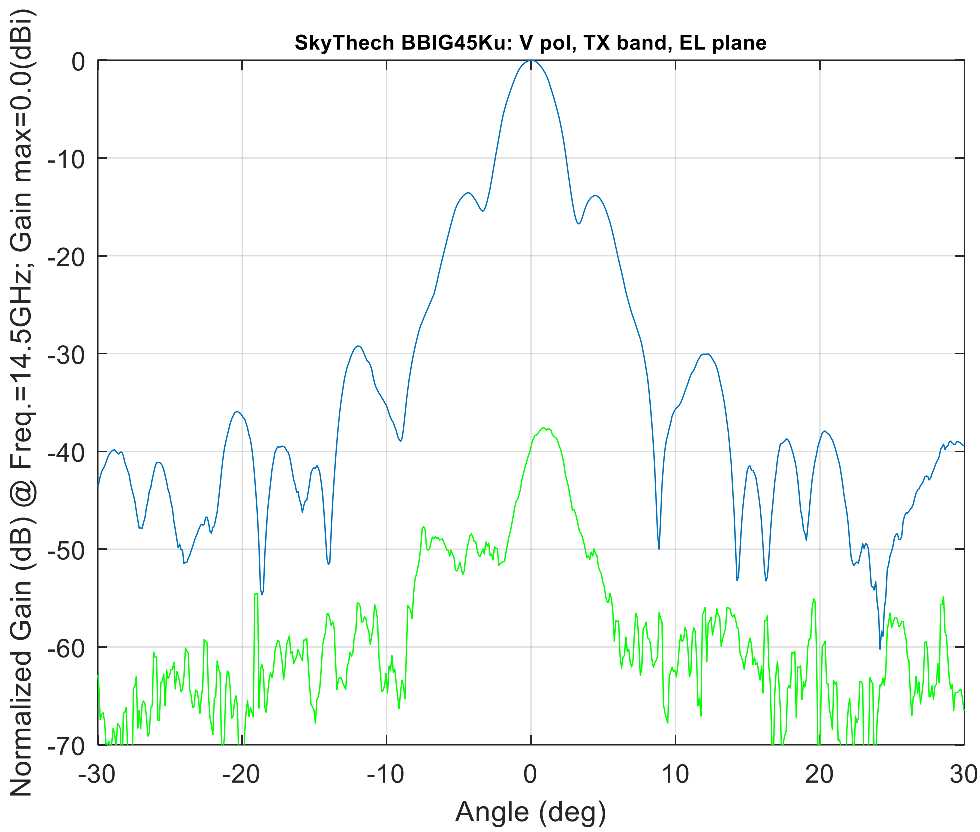

SkyThech BBIG45Ku: V pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.5GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30


SkyThech BBIG45Ku: V pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=13.75GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)

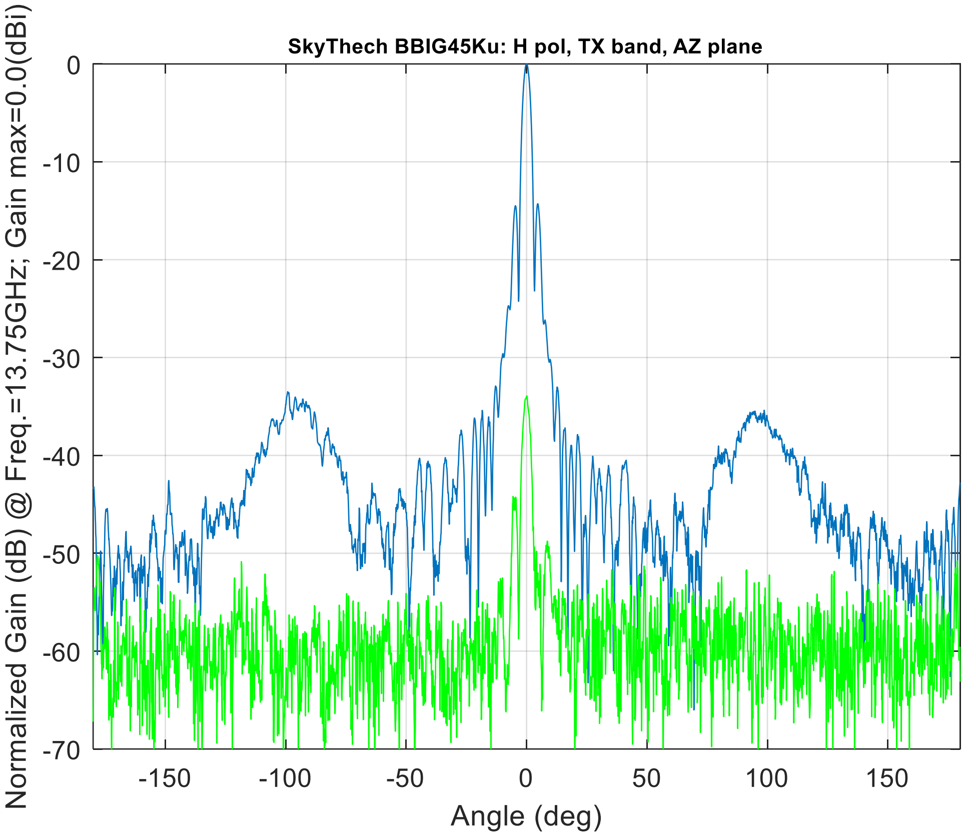

SkyThech BBIG45Ku: V pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)

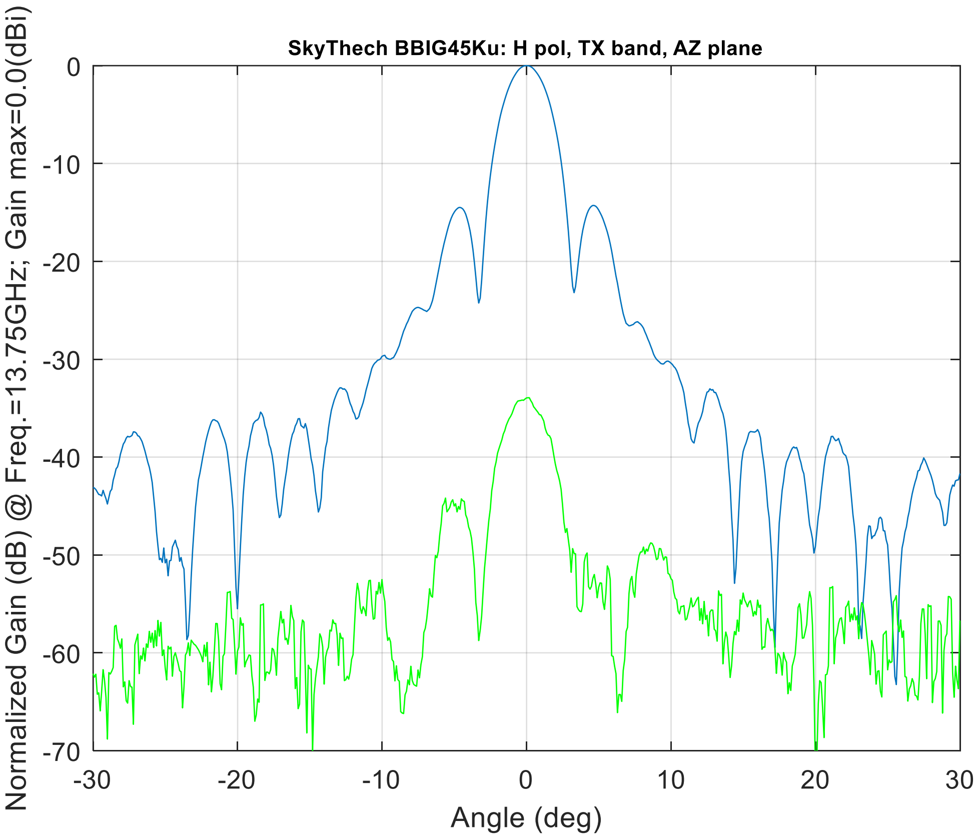

SkyThech BBIG45Ku: V pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

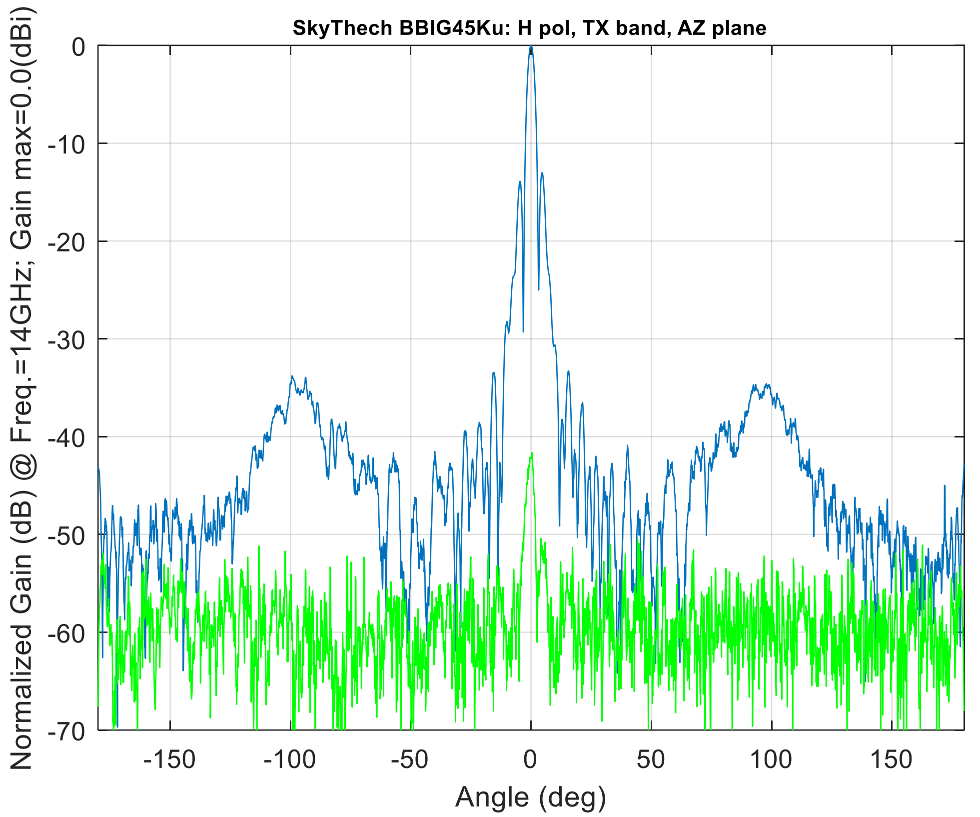

SkyThech BBIG45Ku: V pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14.25GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

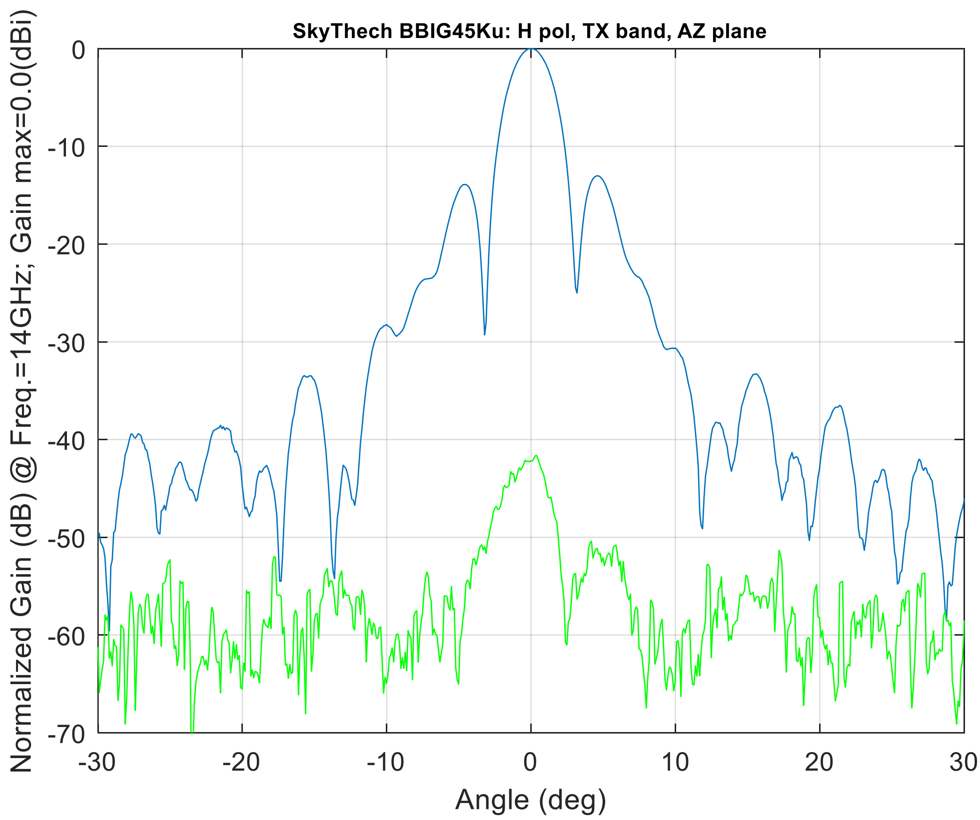

SkyThech BBIG45Ku: V pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14.5GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)

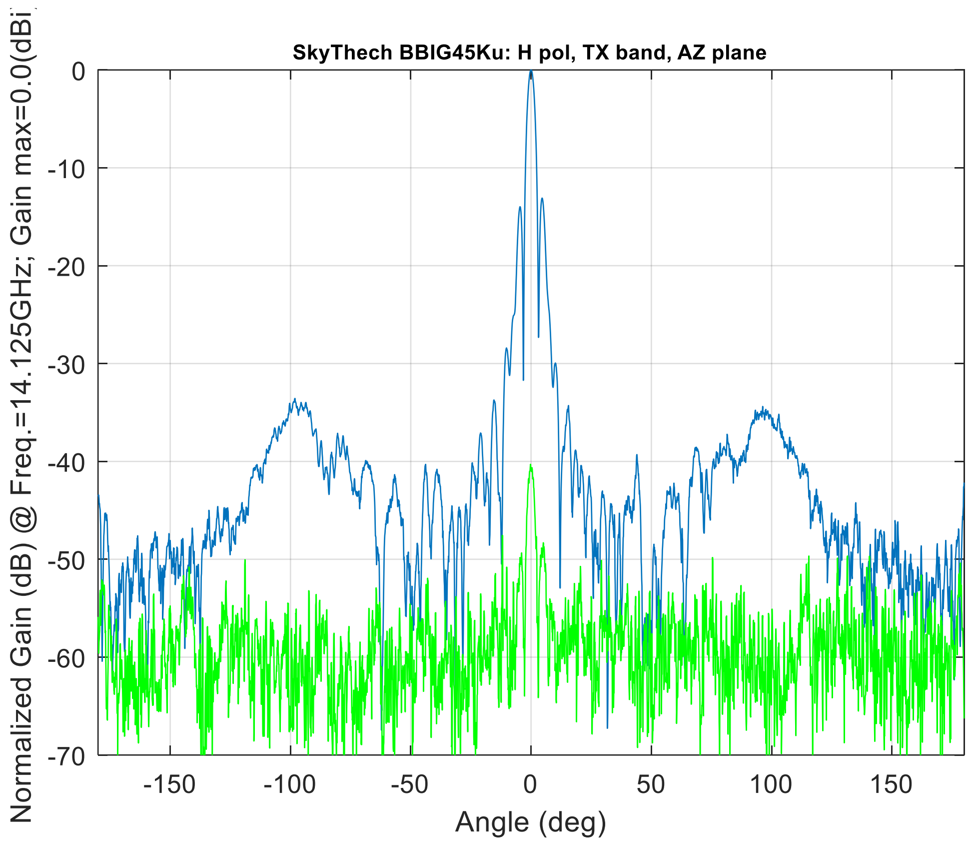
6.2.2: H-pol, AZ and EL plane plots.

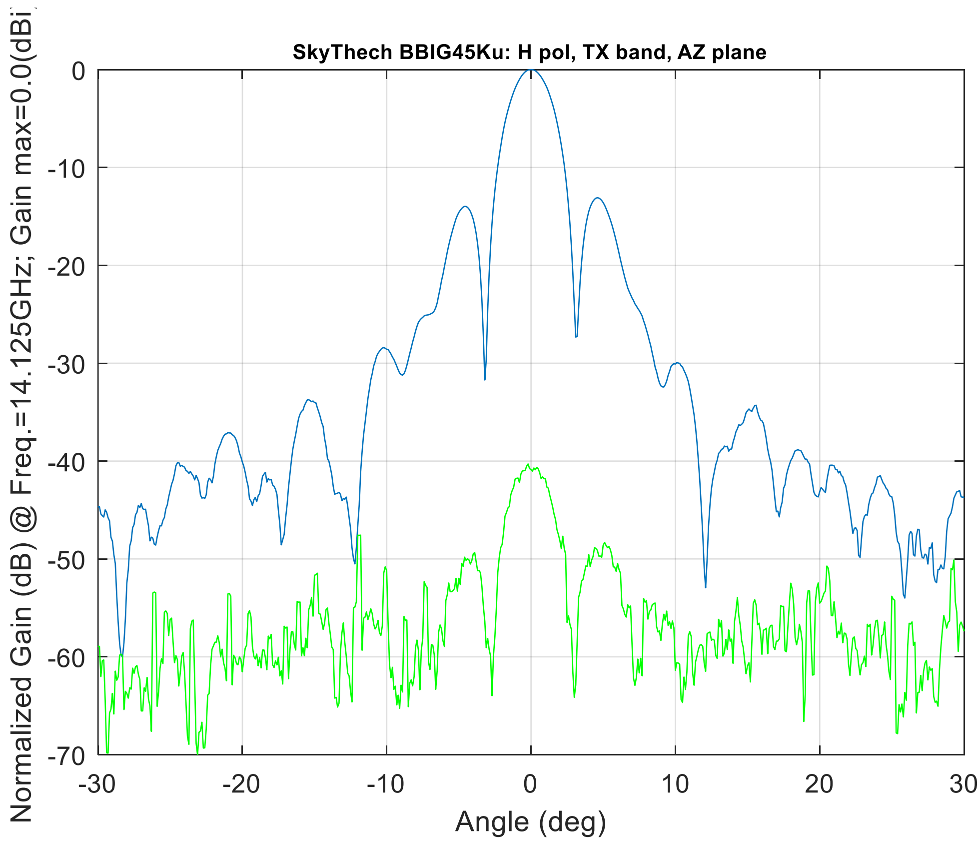


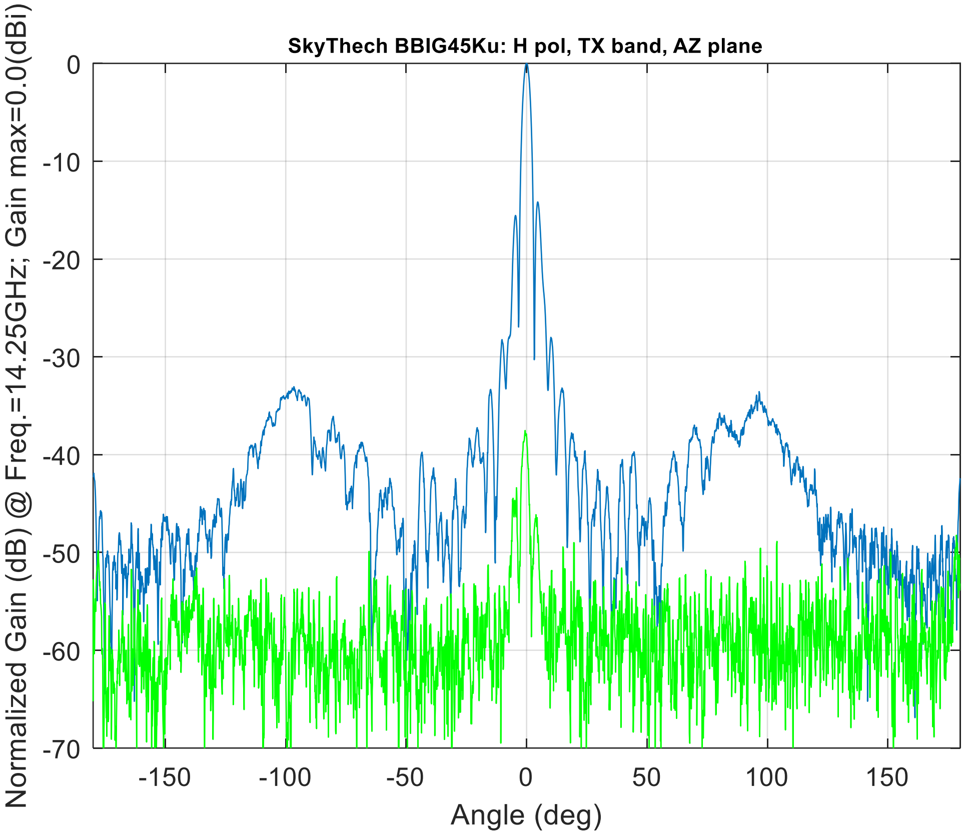


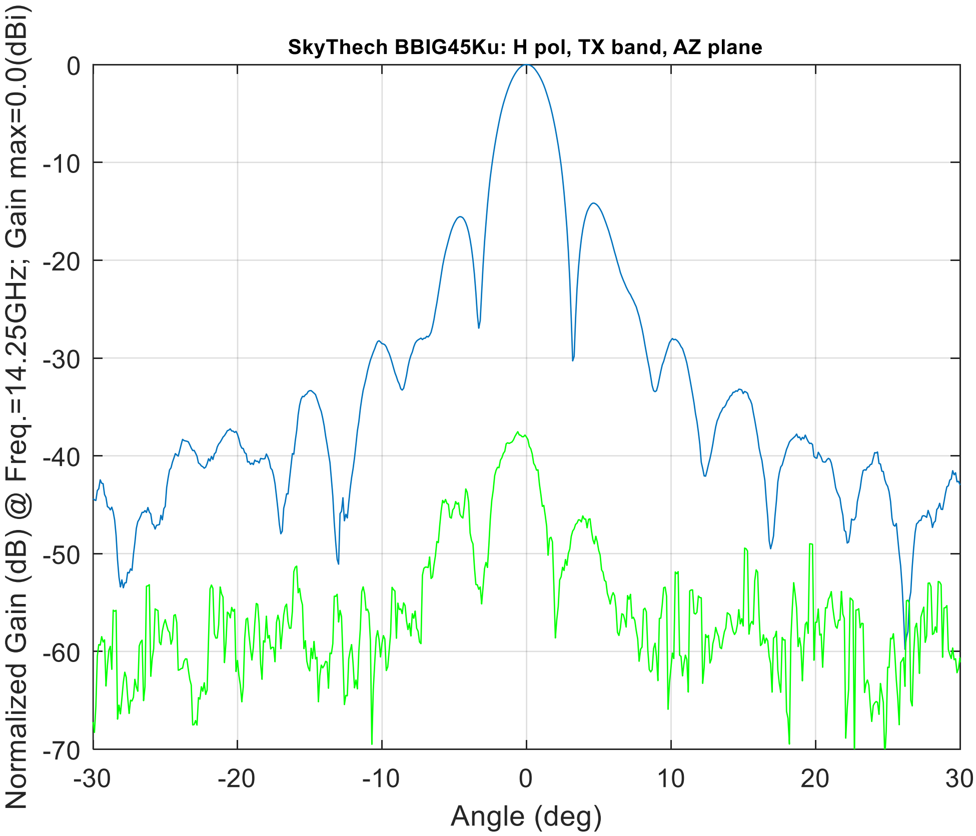

SkyThech BBIG45Ku: H pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150

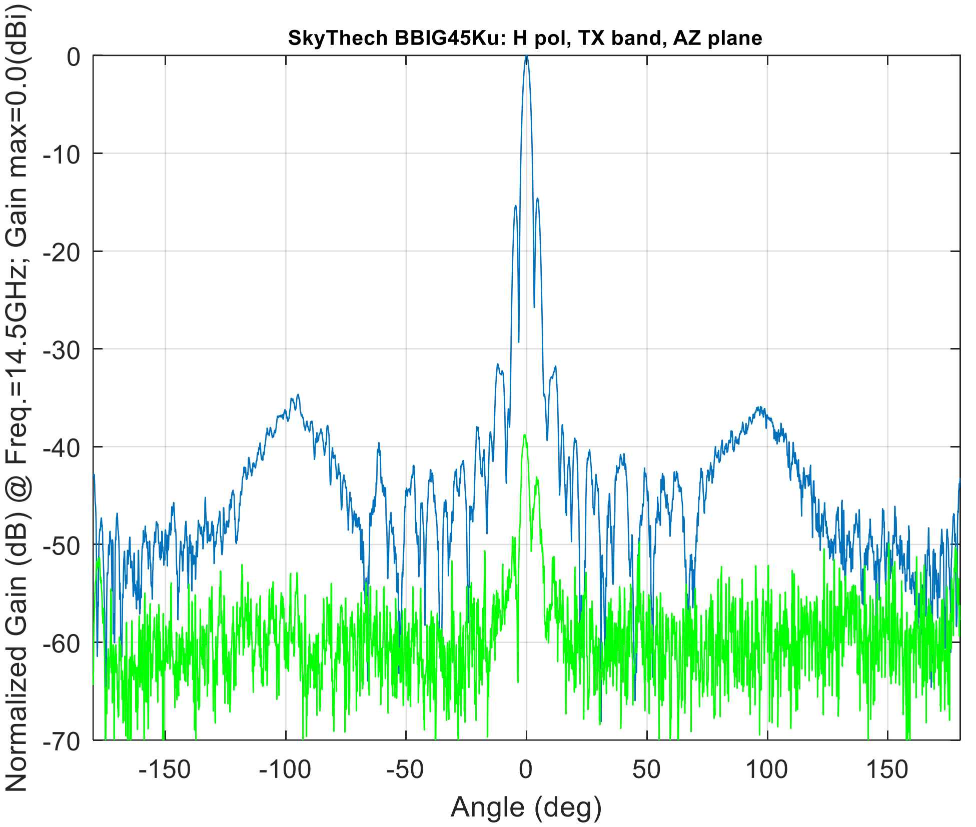

SkyThech BBIG45Ku: H pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

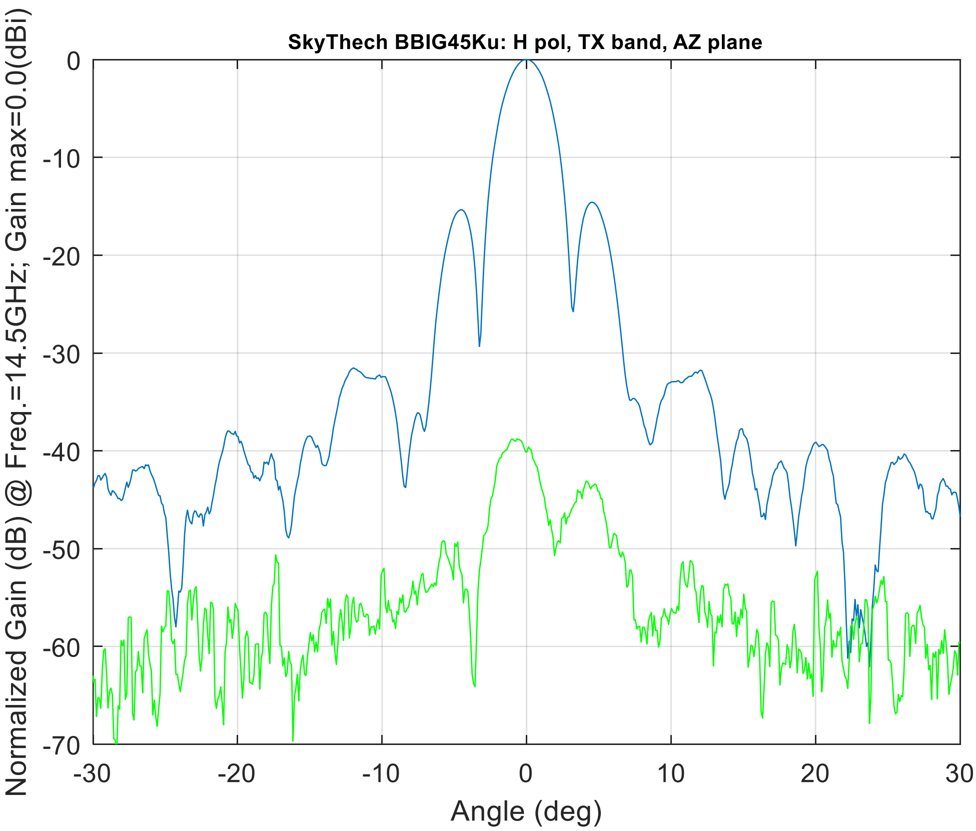

SkyThech BBIG45Ku: H pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150
Angle (deg)

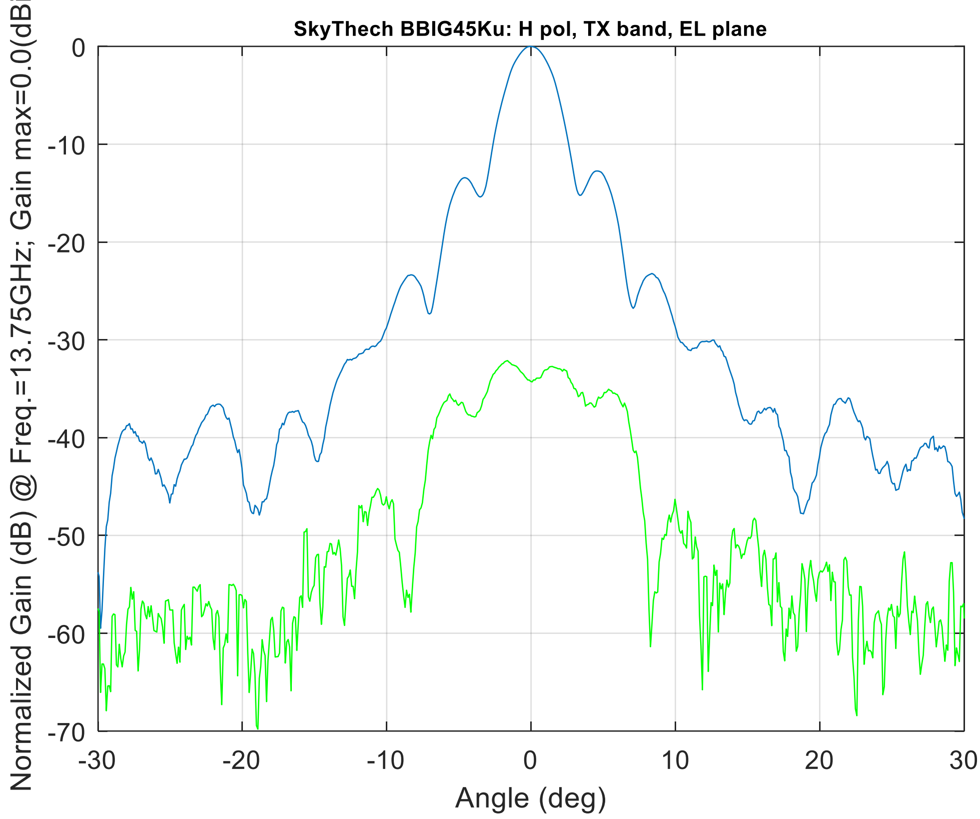

SkyThech BBIG45Ku: H pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)

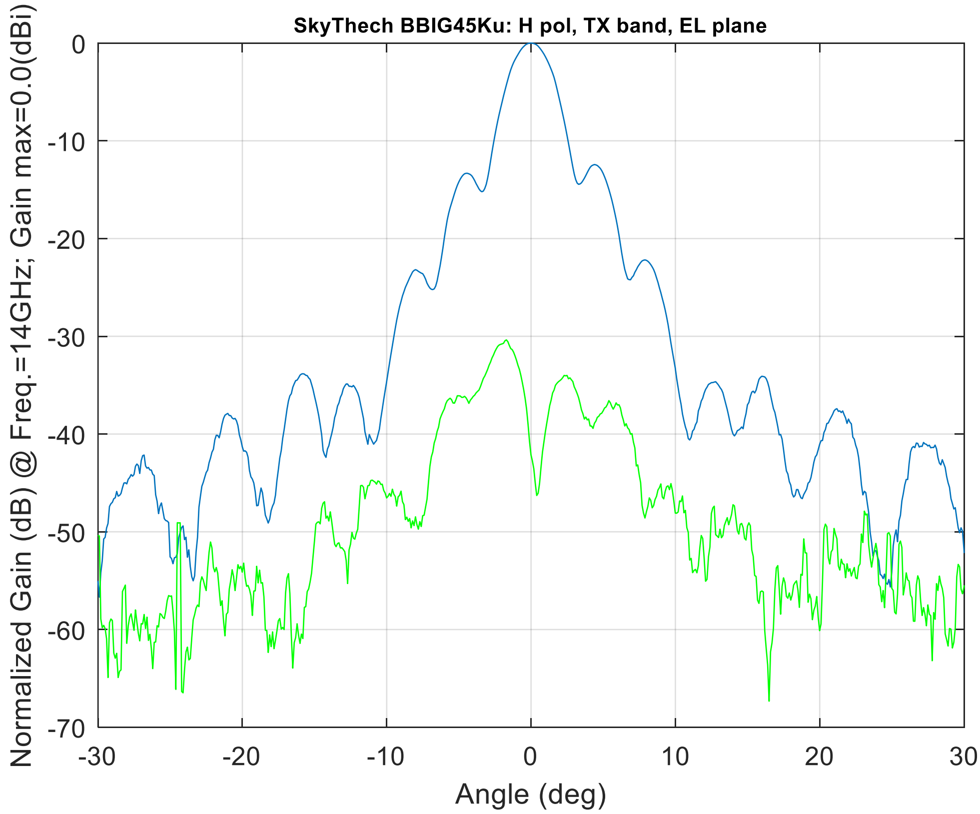

SkyThech BBIG45Ku: H pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.25GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150

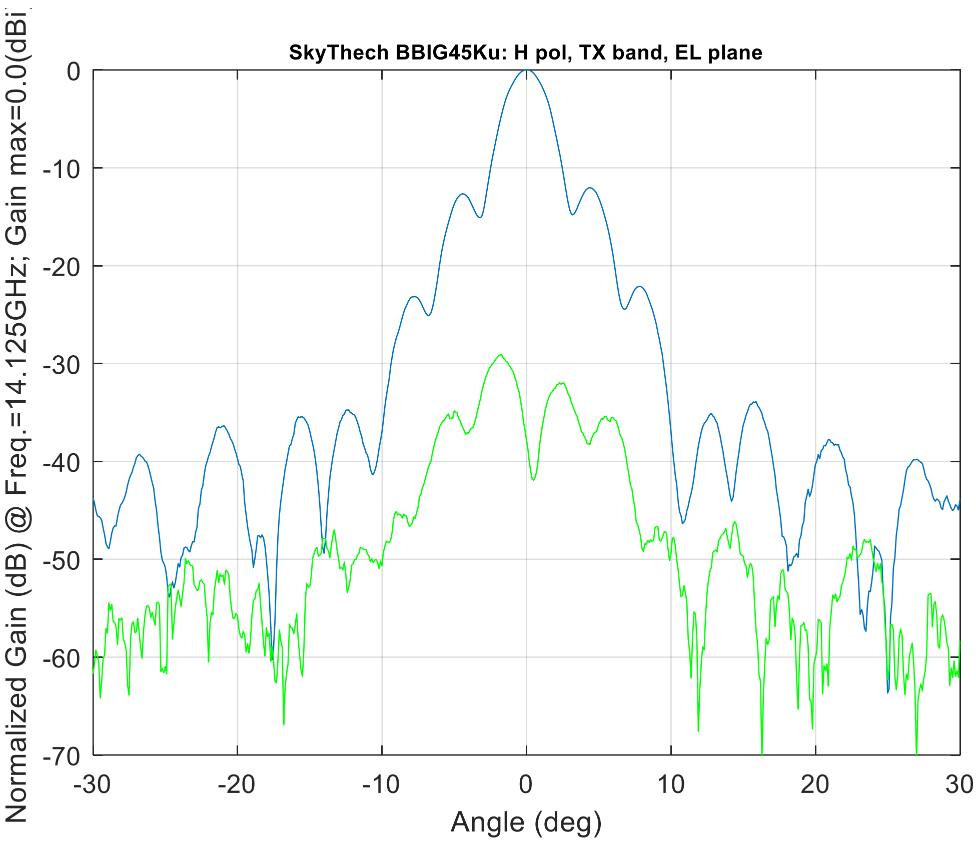

SkyThech BBIG45Ku: H pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.25GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30

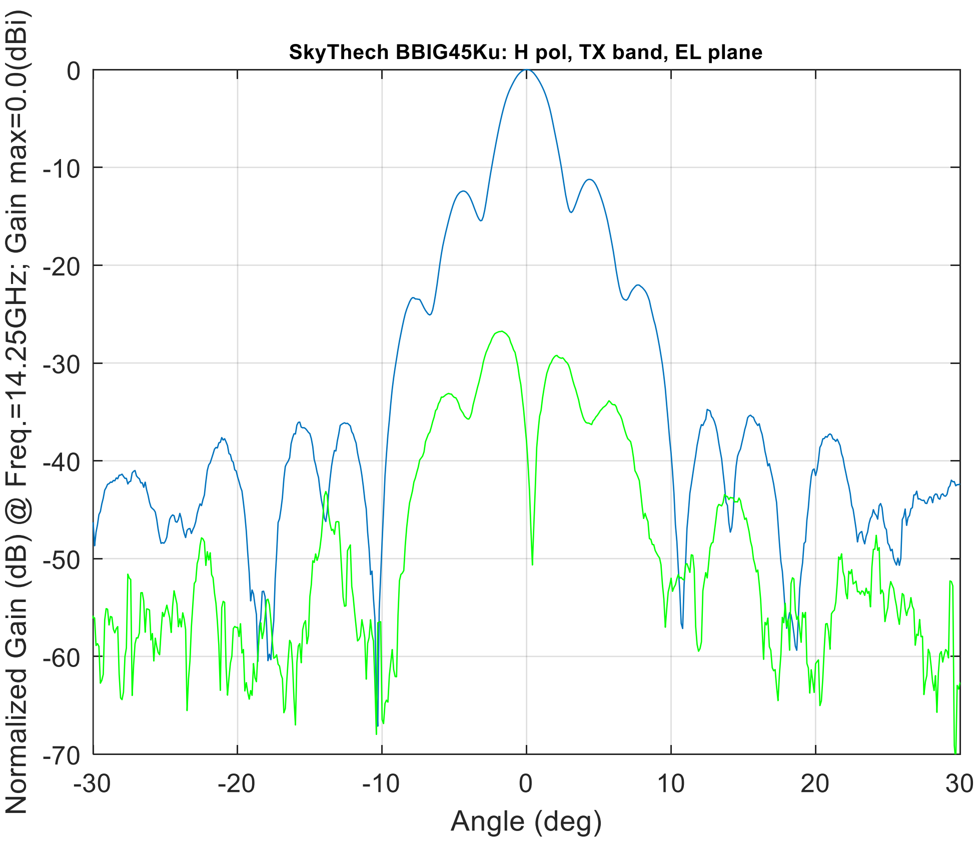

SkyThech BBIG45Ku: H pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.5GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-150
-100
-50
0
50
100
150

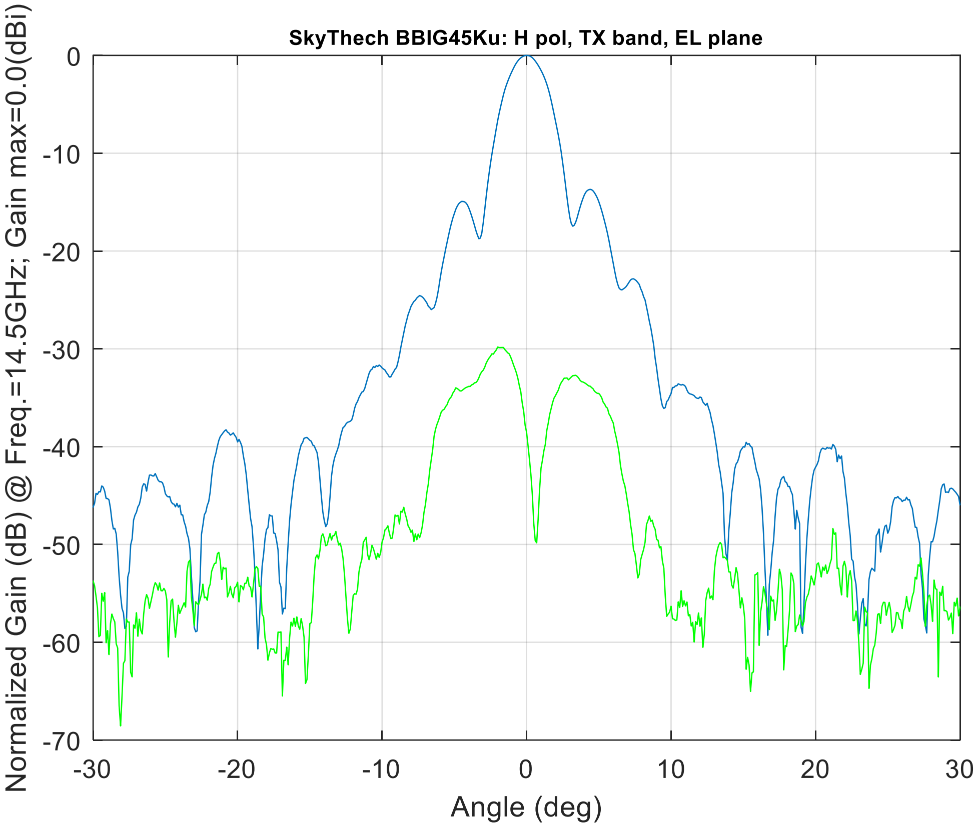

SkyThech BBIG45Ku: H pol, TX band, AZ plane
Normalized Gain (dB) @ Freq.=14.5GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30


SkyThech BBIG45Ku: H pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=13.75GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30


SkyThech BBIG45Ku: H pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30


SkyThech BBIG45Ku: H pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14.125GHz; Gain max=0.0(dBi
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30


SkyThech BBIG45Ku: H pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14.25GHz; Gain max=0.0(dBi)
Angle (deg)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30


SkyThech BBIG45Ku: H pol, TX band, EL plane
Normalized Gain (dB) @ Freq.=14.5GHz; Gain max=0.0(dBi)
0
-10
-20
-30
-40
-50
-60
-70
-30
-20
-10
0
10
20
30
Angle (deg)