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Radio approval 24GHZ-L-C

LPR antenna characteristics

Distribution list: KMTKI RF Sensors

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	0.1	2017-10-04	C.Ouzounis	Updated antenna list
	0.2	2018-01-03	C.Ouzounis	Differentiation between HART and FF/PA standard

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1 Purpose

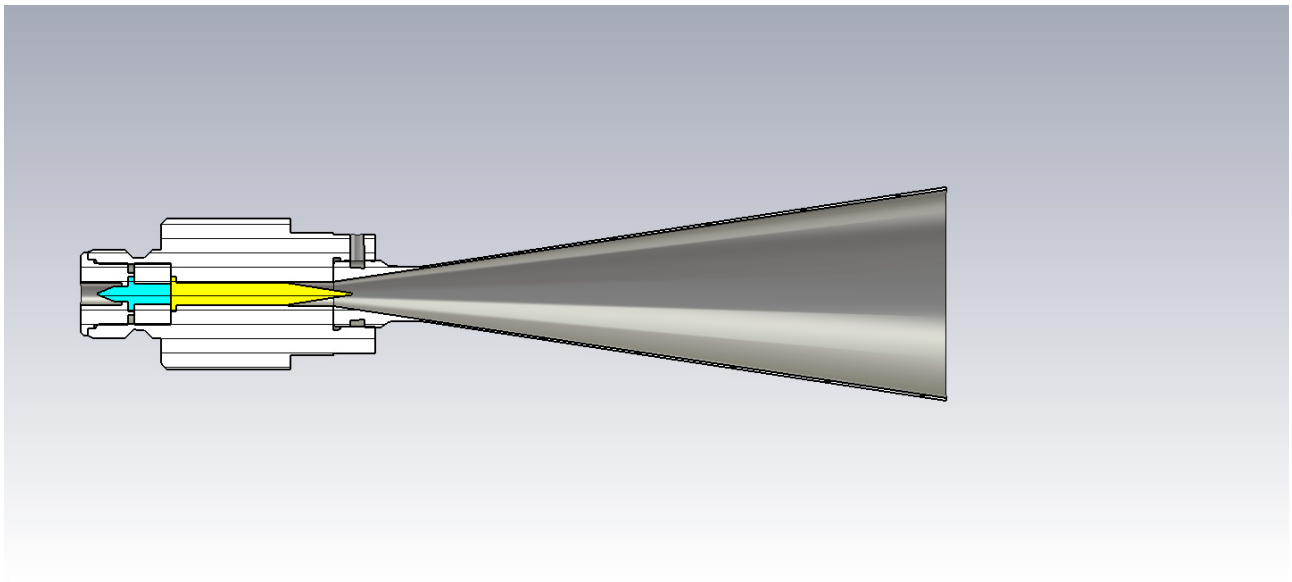
In the following measurements several characteristics of LPR antennas have been performed, like

- Radiation pattern in E-plane and H-plane
- Main lobe magnitude
- Angular width (3 dB)

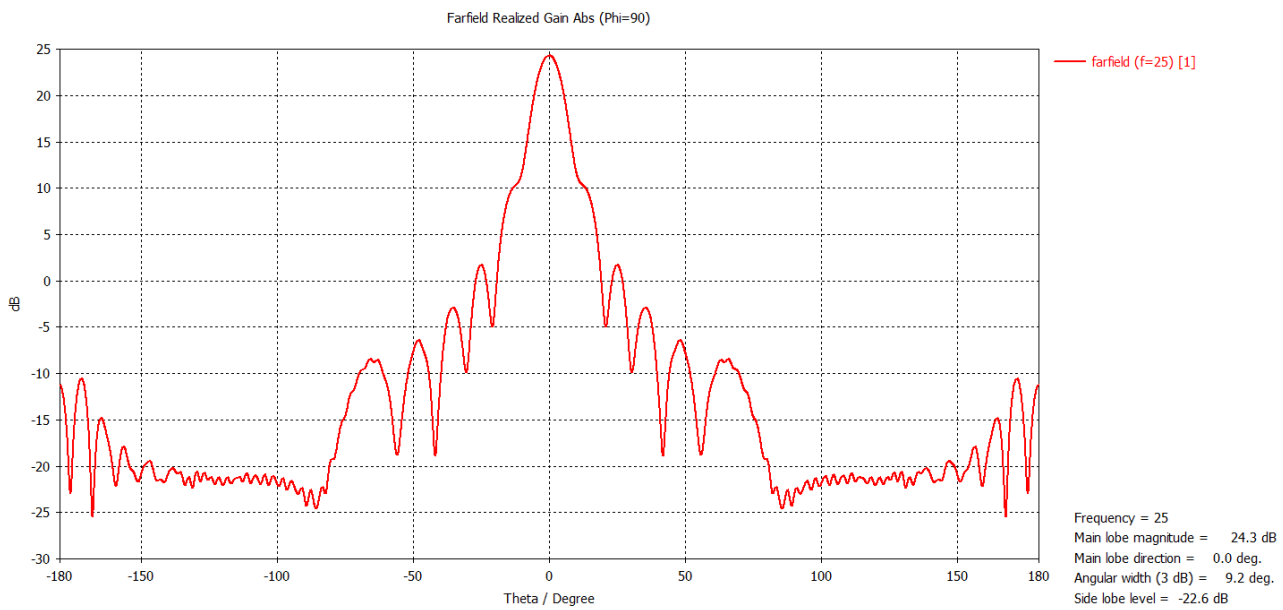
The antenna list is valid for HART devices (PMN: “OPTIWAVE x400 series”) and FF/PA devices (PMN: “OPTIWAVE x400 FF-PA series”).

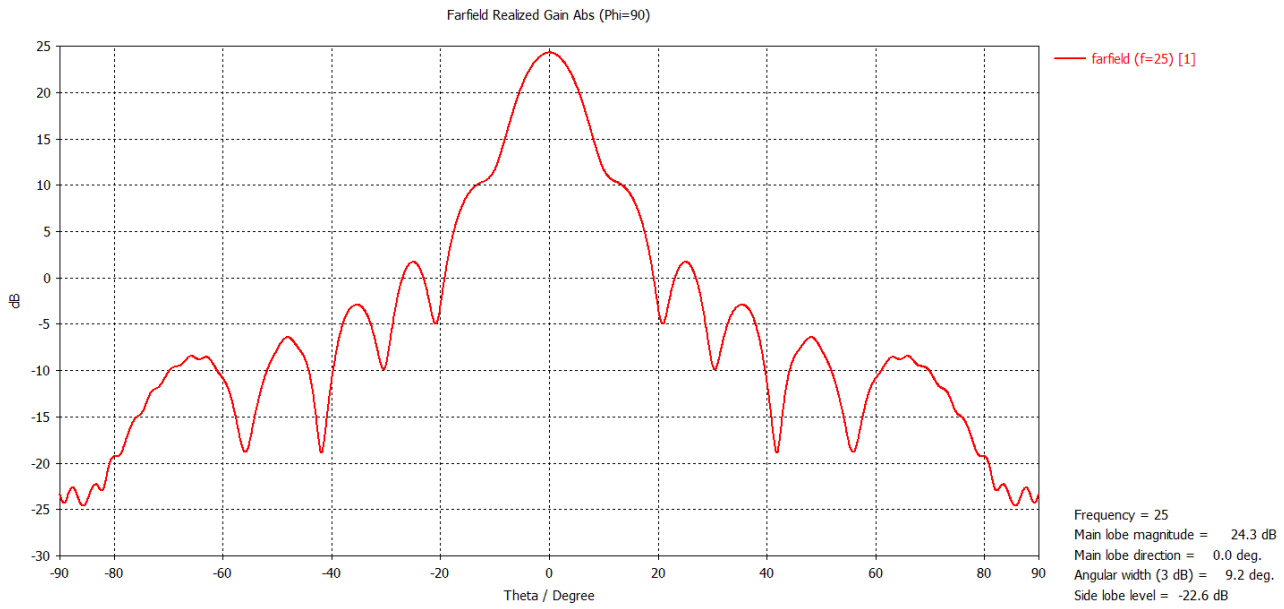
2 Antenna characteristics

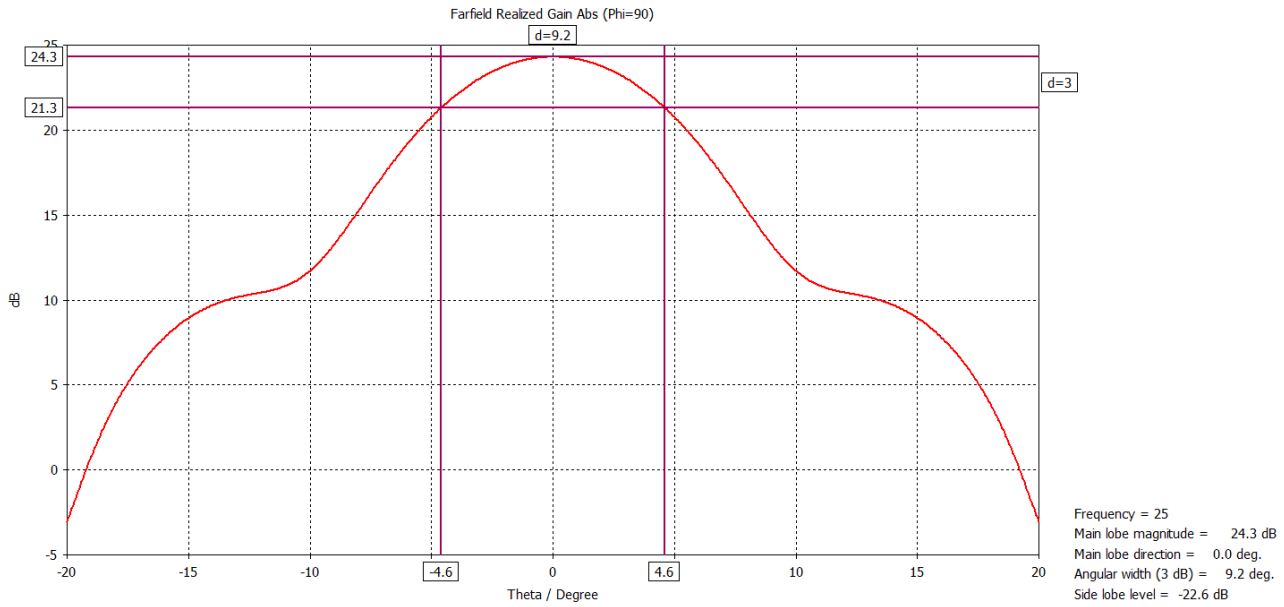
2.1 316L / DN80 (3”) Metallic Horn



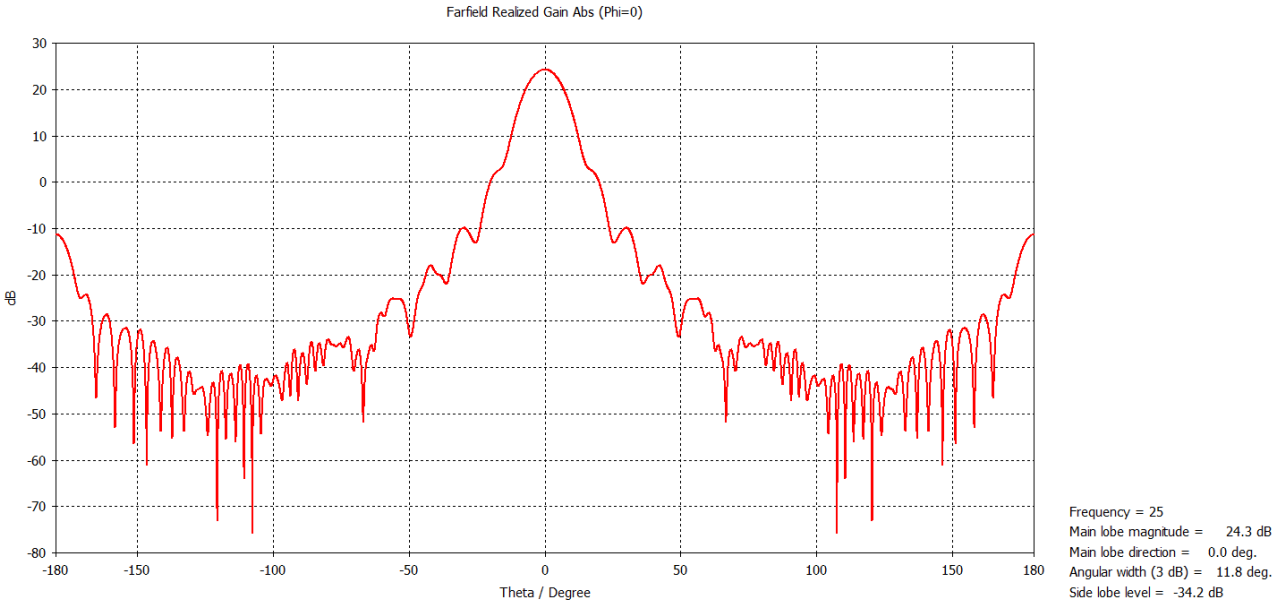
2.1.1 Radiation pattern in E-plane

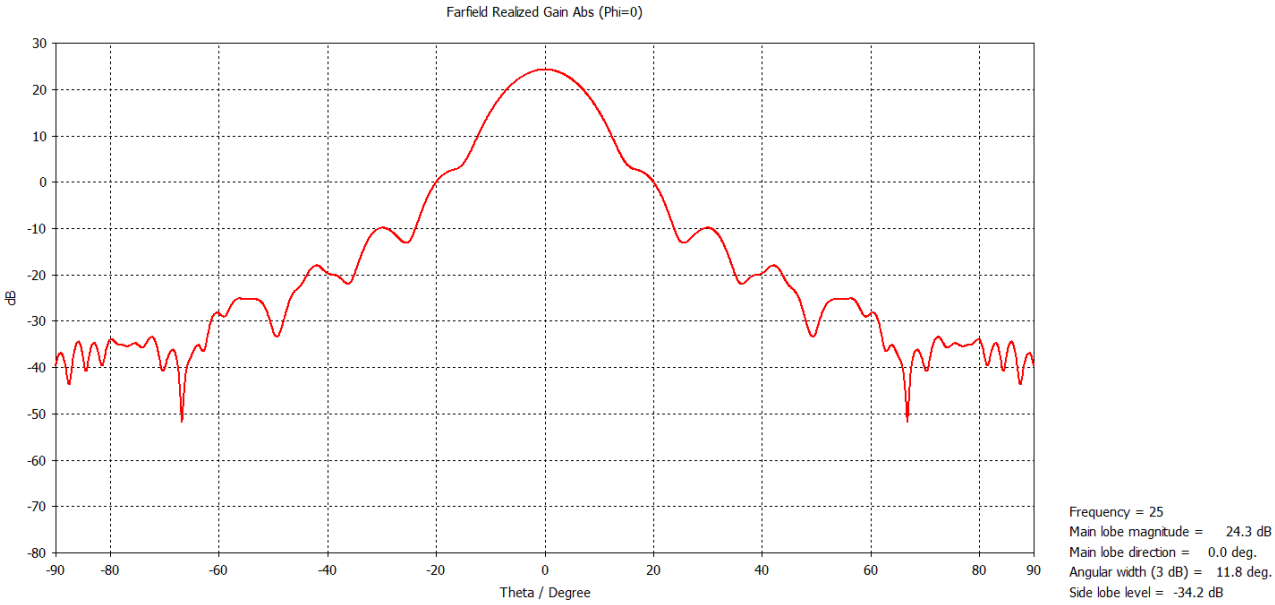


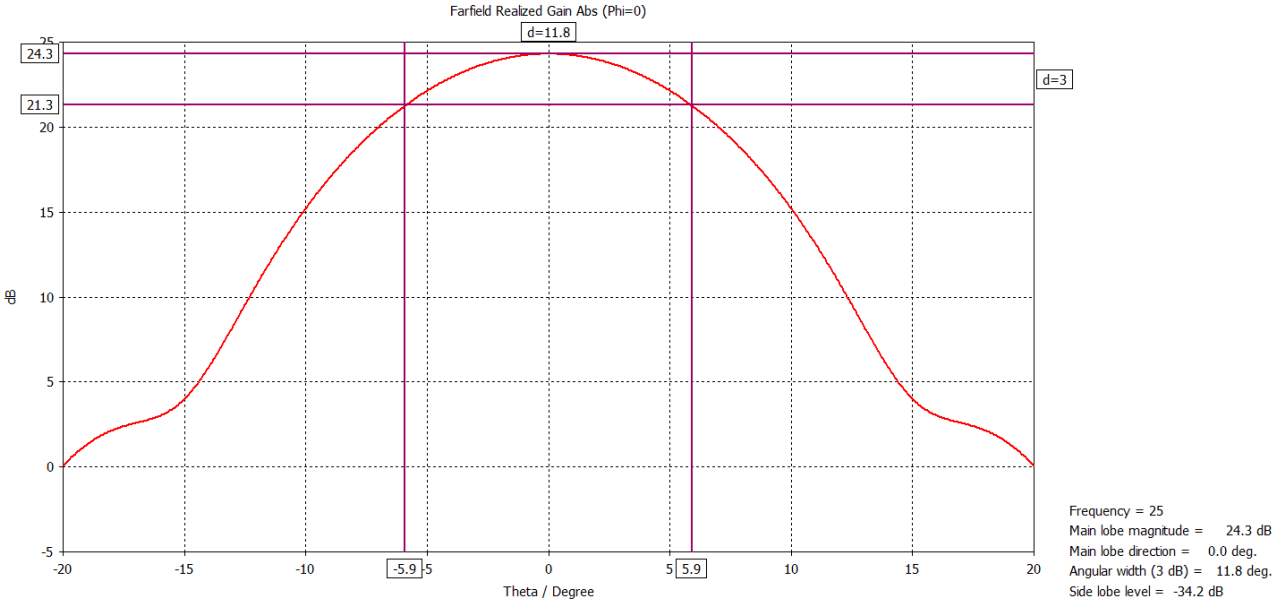

Farfield Realized Gain Abs (Phi=90)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 24.3 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 9.2 deg.
Side lobe level = -22.6 dB


Farfield Realized Gain Abs (Phi=90)
d=9.2
24.3
21.3
d=3
-4.6
4.6
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 24.3 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 9.2 deg.
Side lobe level = -22.6 dB

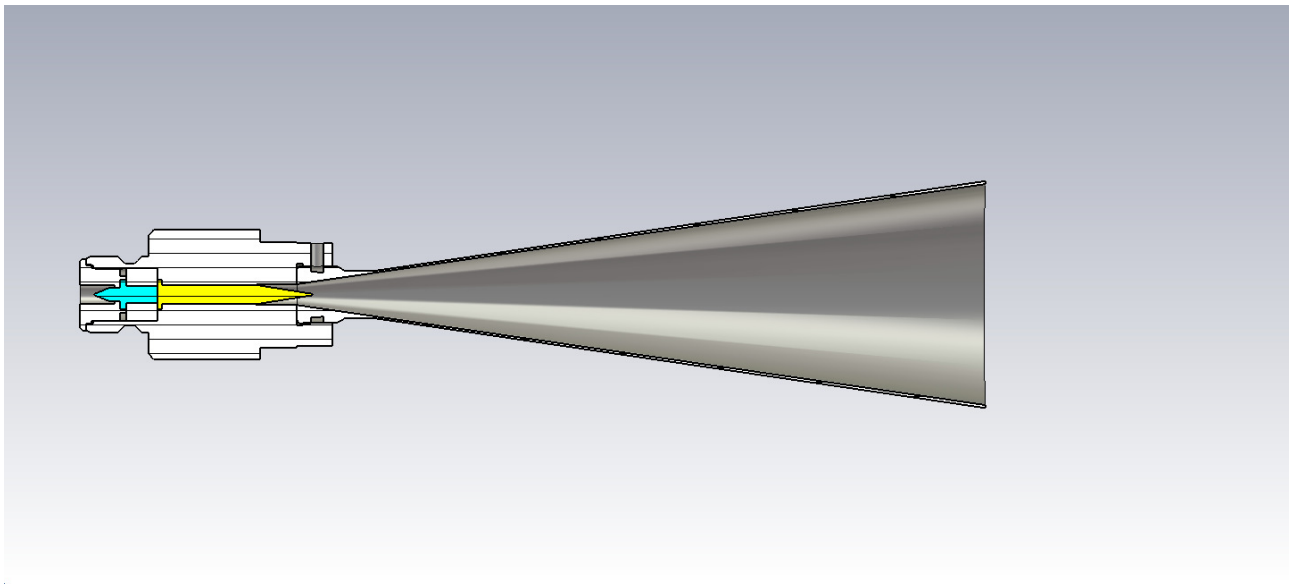
2.1.2 Radiation pattern in H-plane



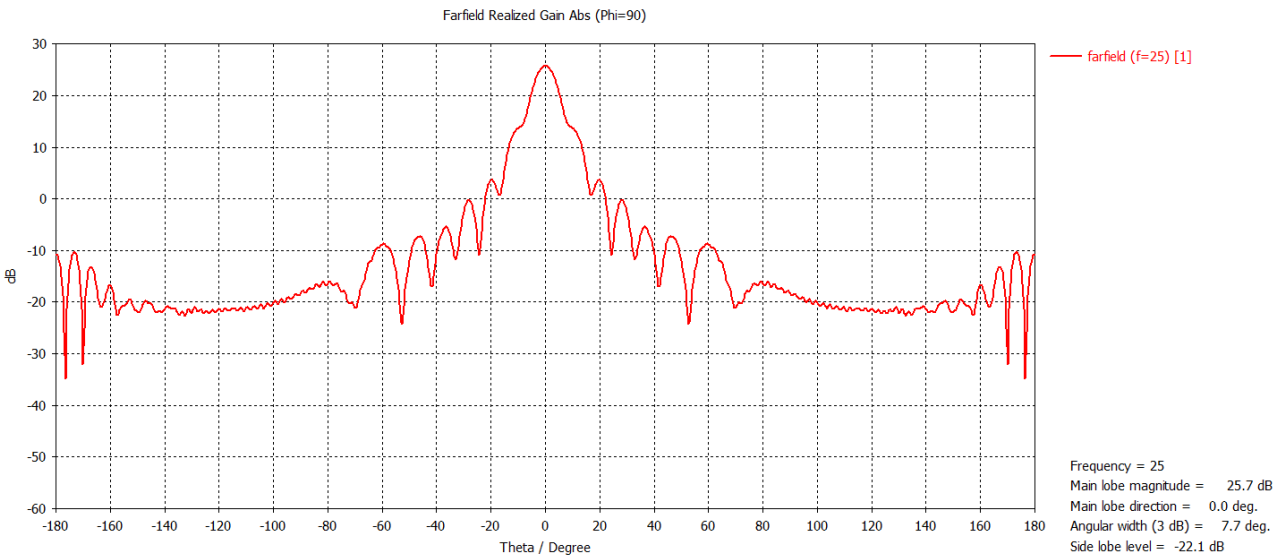


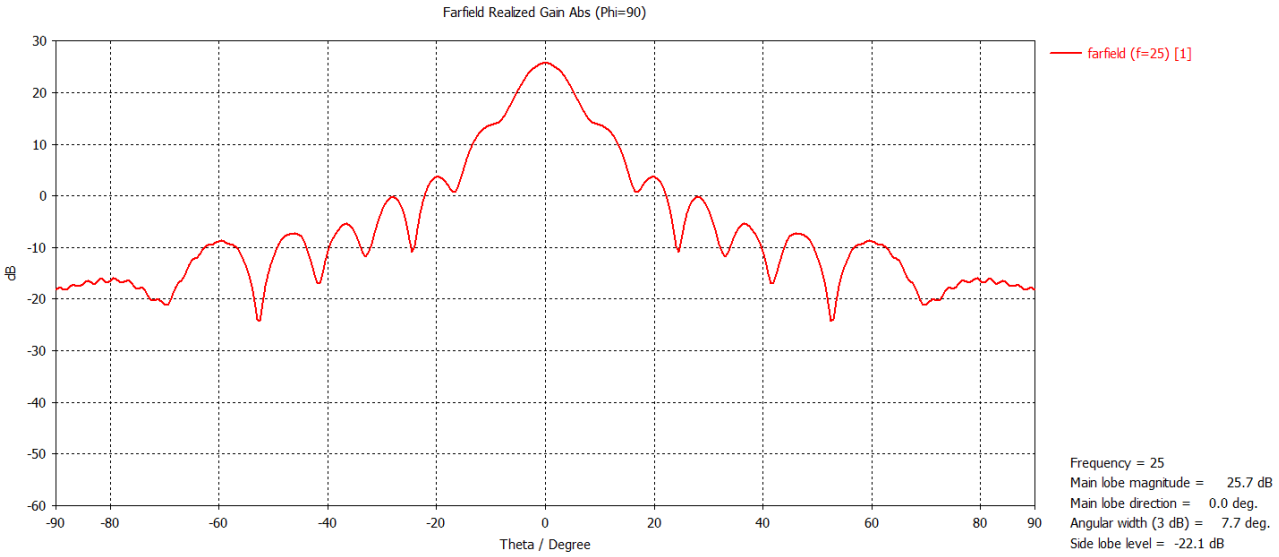

Farfield Realized Gain Abs (Phi=0)
d=11.8
24.3
21.3
d=3
dB
25
20
15
10
5
0
-5
-20
-15
-10
-5.9
-5
0
5
5.9
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 24.3 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 11.8 deg.
Side lobe level = -34.2 dB

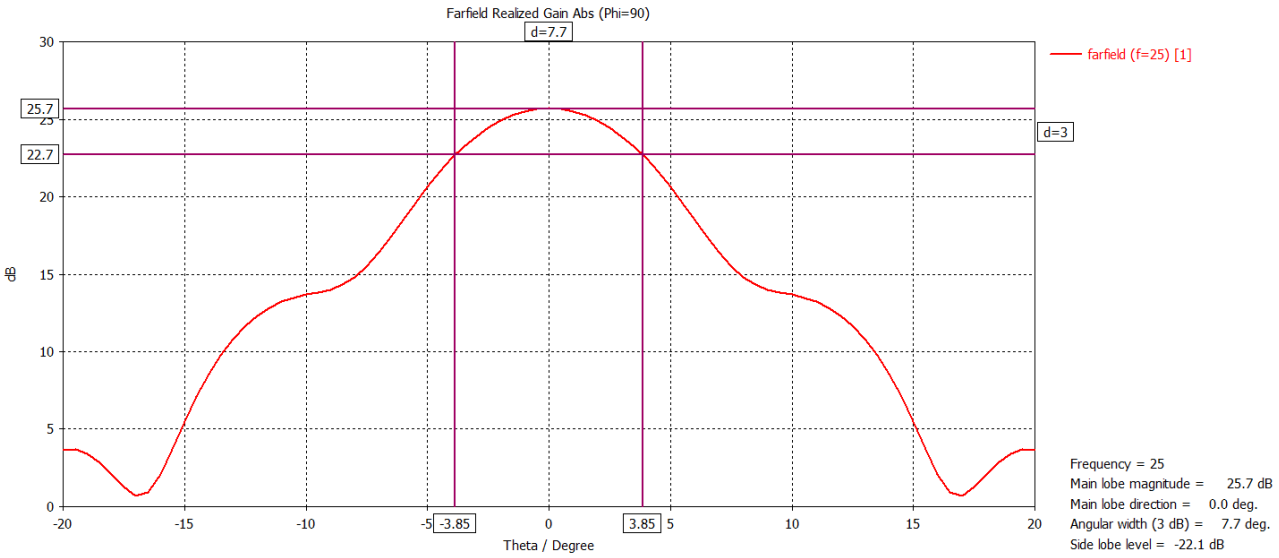
2.2 316L / DN100 (4”) Metallic Horn



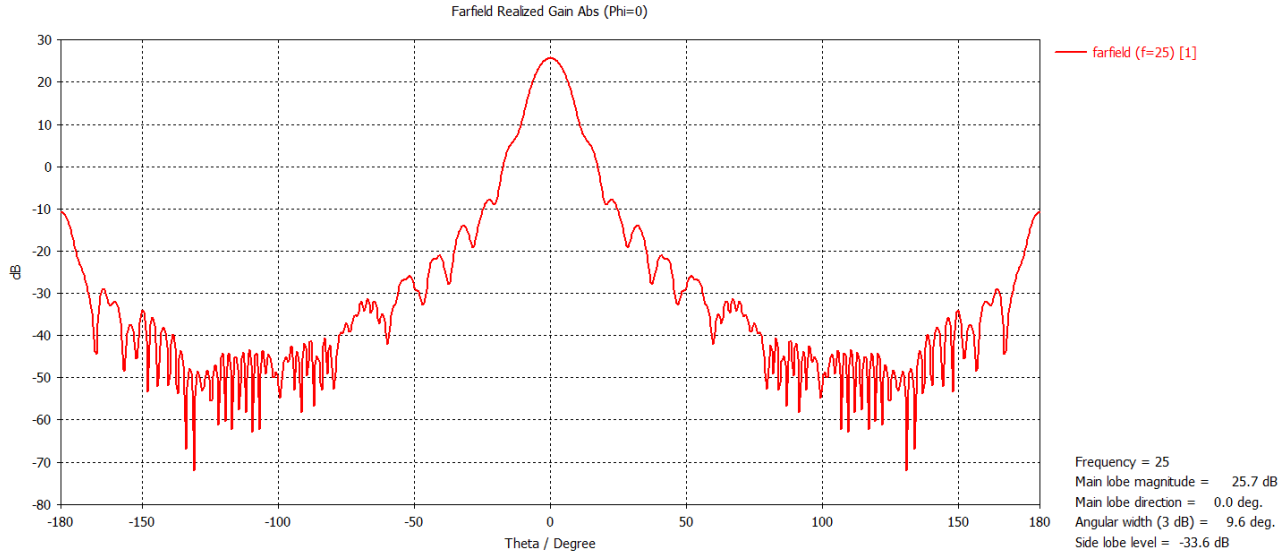
2.2.1 Radiation pattern in E-plane

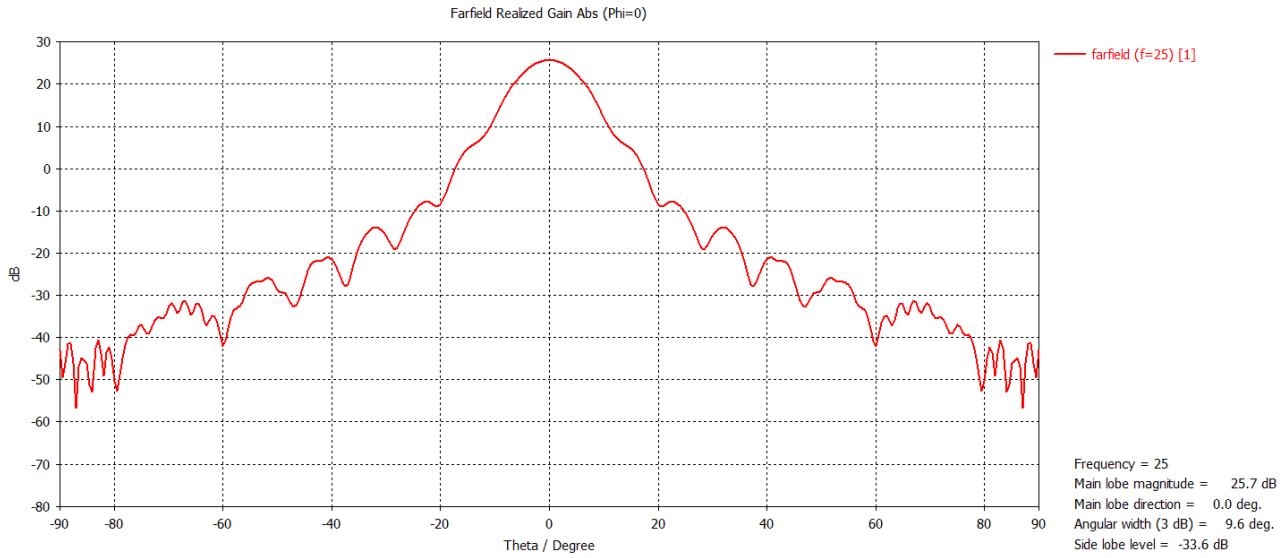


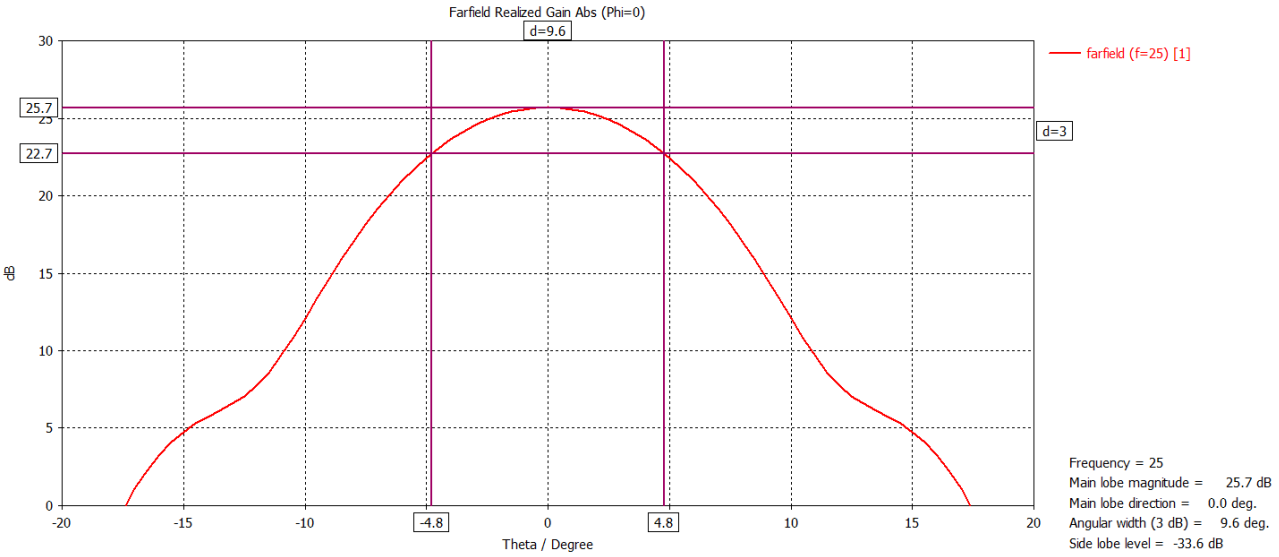

Farfield Realized Gain Abs (Phi=90)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.7 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 7.7 deg.
Side lobe level = -22.1 dB


Farfield Realized Gain Abs (Phi=90)
d=7.7
25.7
22.7
d=3
-3.85
3.85
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.7 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 7.7 deg.
Side lobe level = -22.1 dB

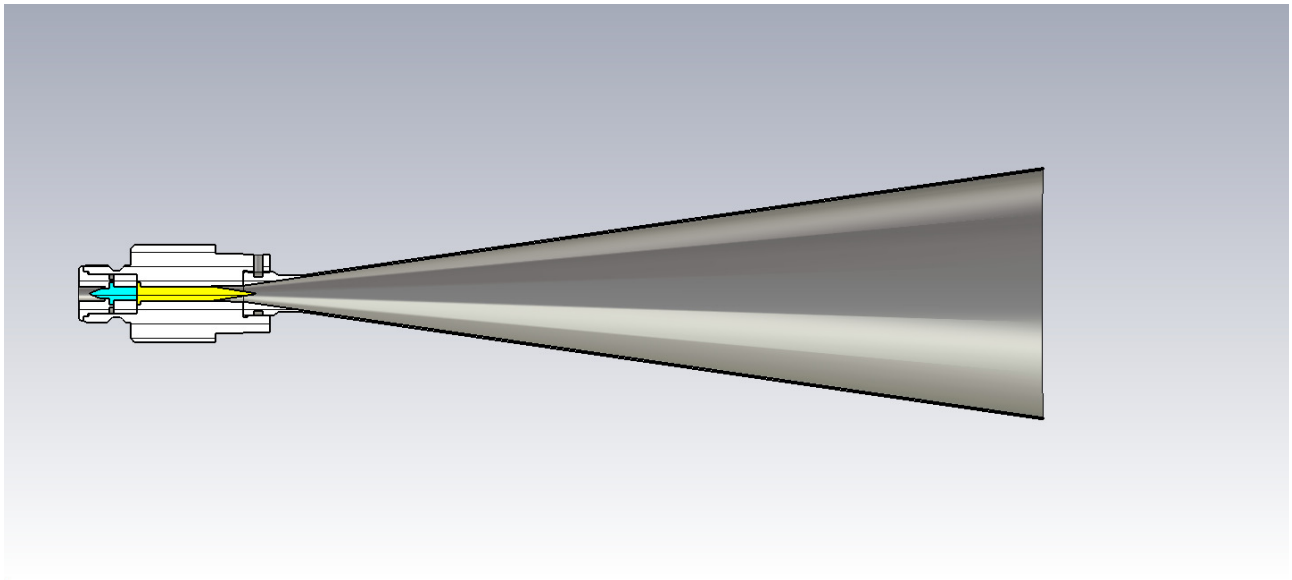
2.2.2 Radiation pattern in H-plane



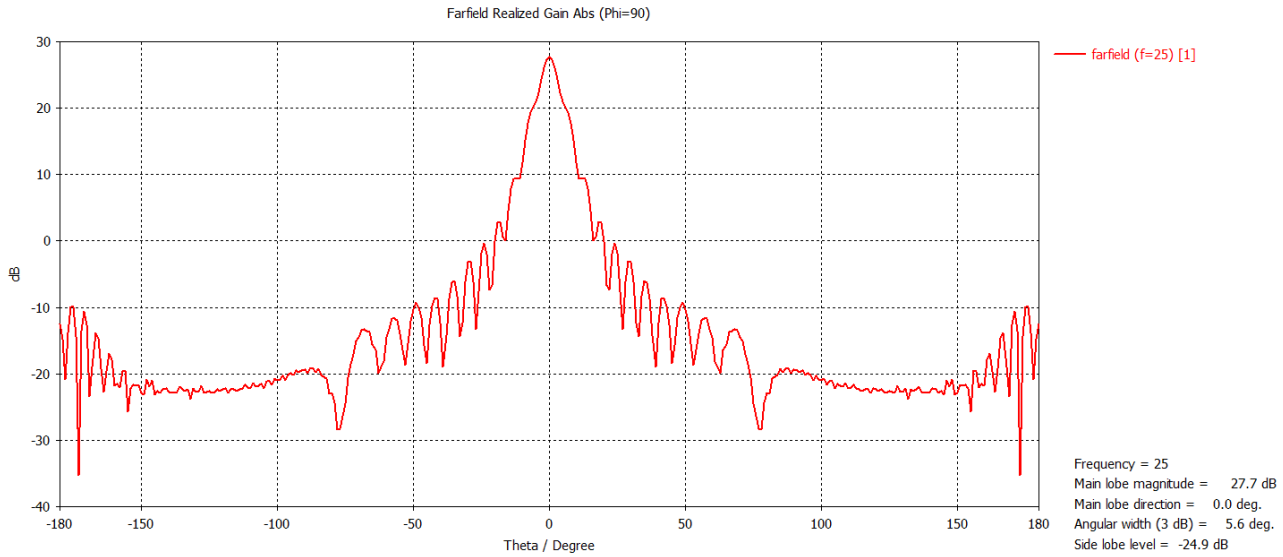


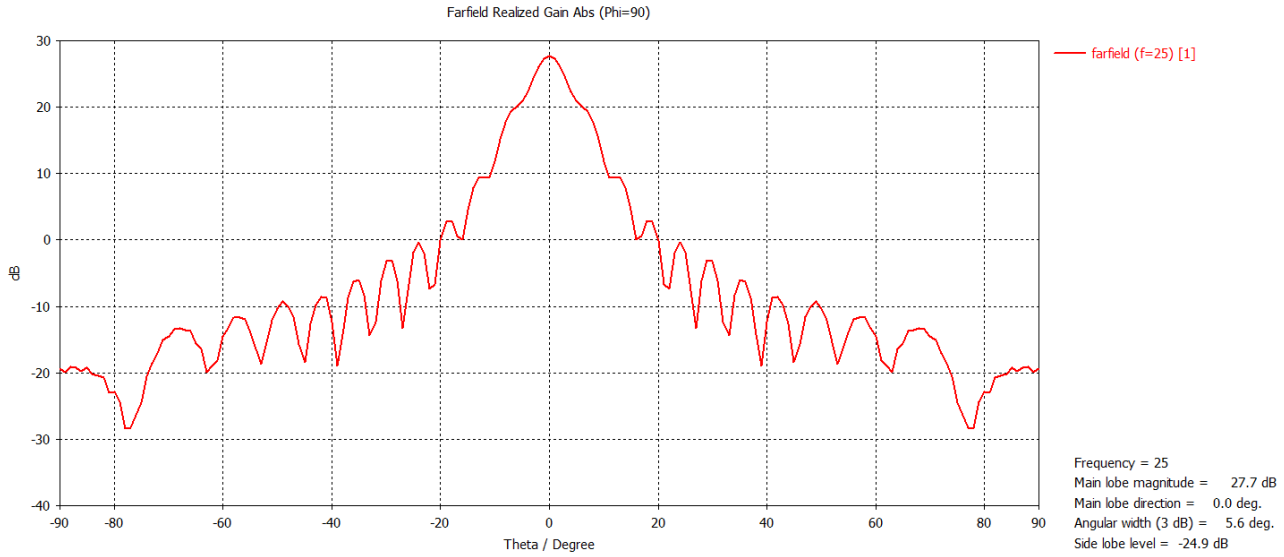

Farfield Realized Gain Abs (Phi=0)
d=9.6
farfield (f=25) [1]
25.7
22.7
d=3
dB
30
25
20
15
10
5
0
-20
-15
-10
-4.8
0
4.8
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.7 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 9.6 deg.
Side lobe level = -33.6 dB

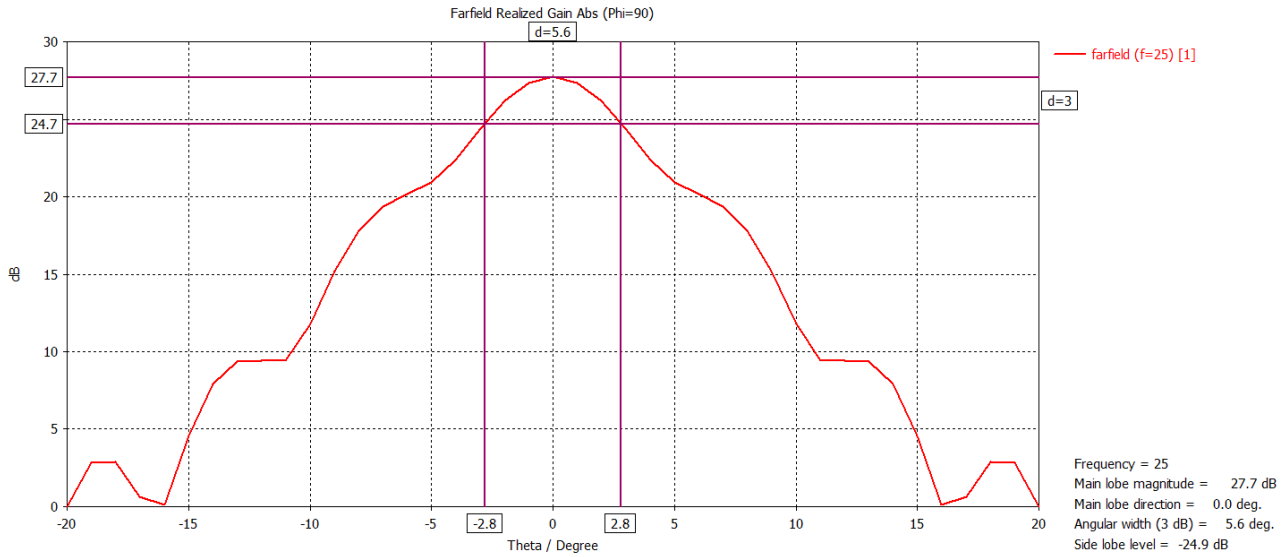
2.3 316L / DN150 (6”) Metallic Horn



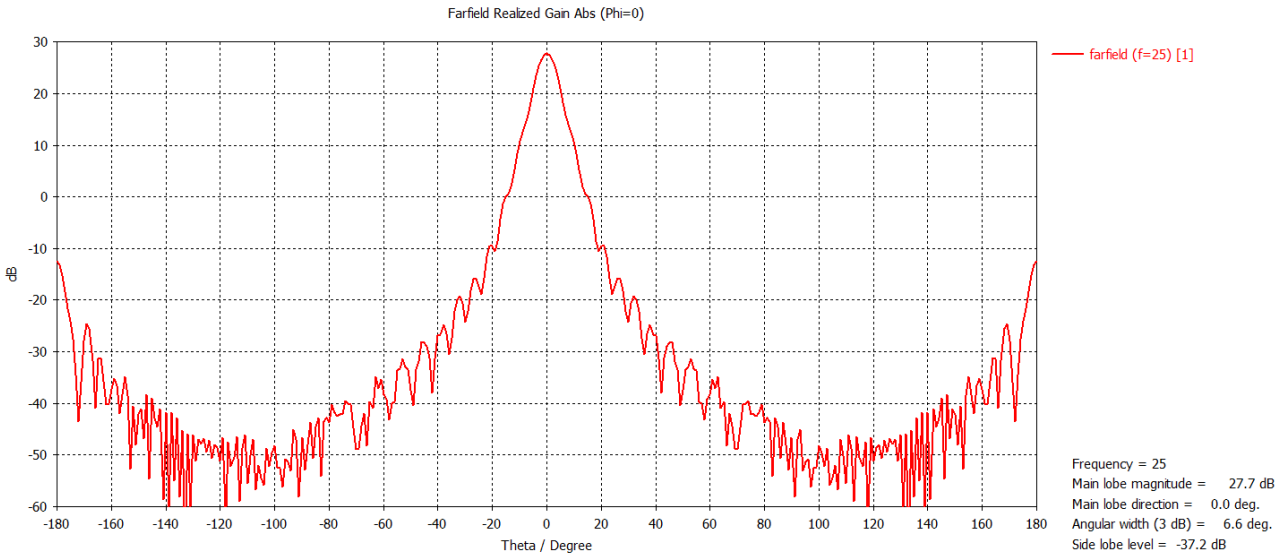
2.3.1 Radiation pattern in E-plane

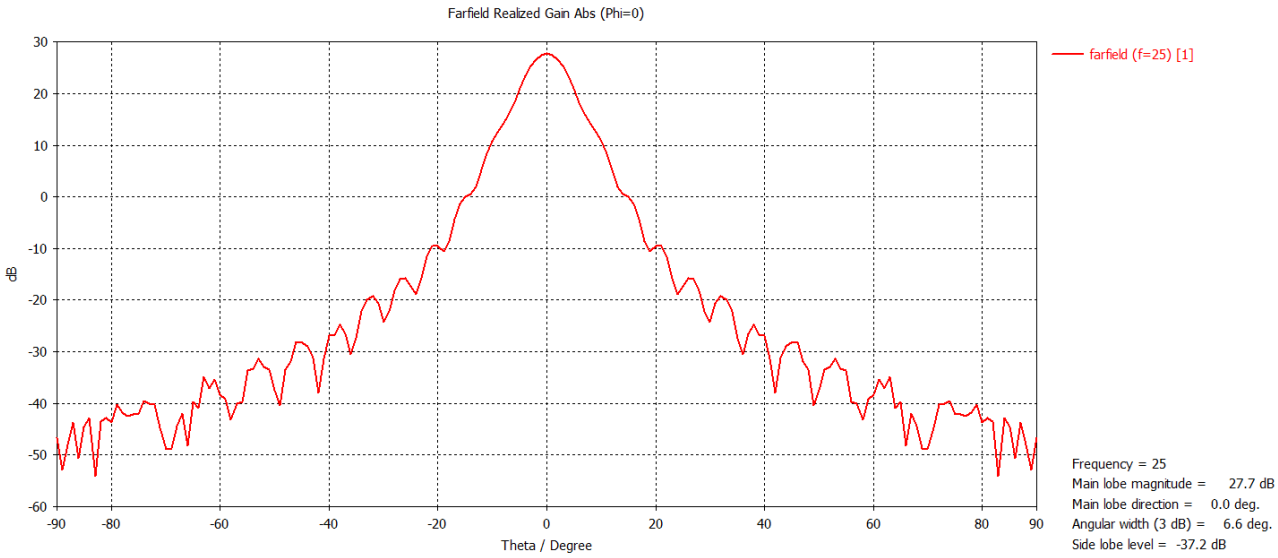


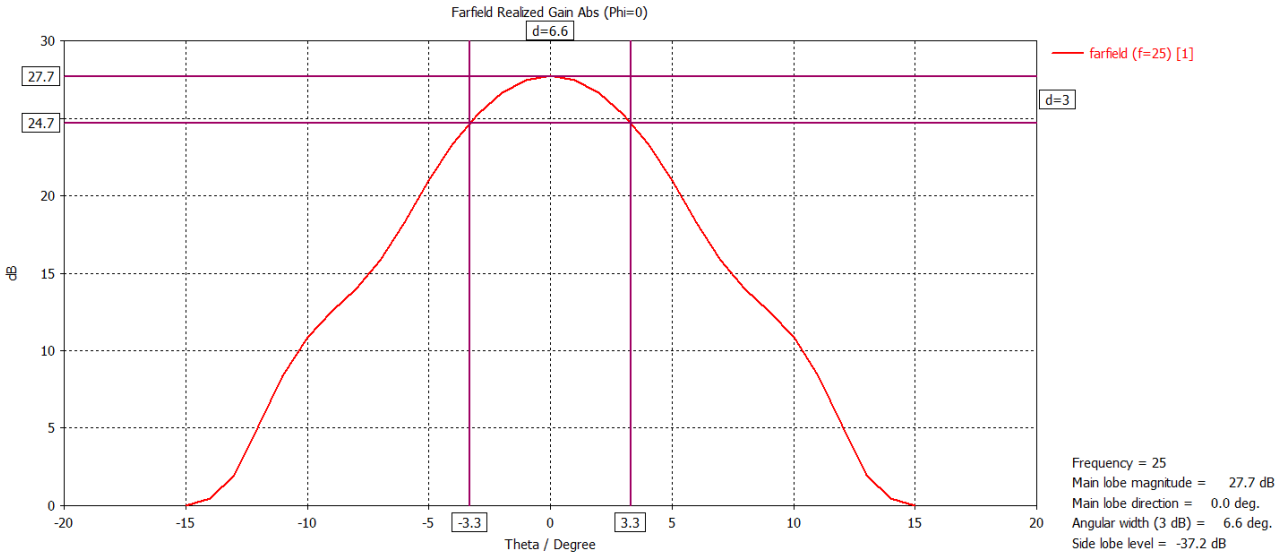

Farfield Realized Gain Abs (Phi=90)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 27.7 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 5.6 deg.
Side lobe level = -24.9 dB


Farfield Realized Gain Abs (Phi=90)
d=5.6
27.7
24.7
d=3
farfield (f=25) [1]
dB
-2.8
2.8
Theta / Degree
Frequency = 25
Main lobe magnitude = 27.7 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 5.6 deg.
Side lobe level = -24.9 dB

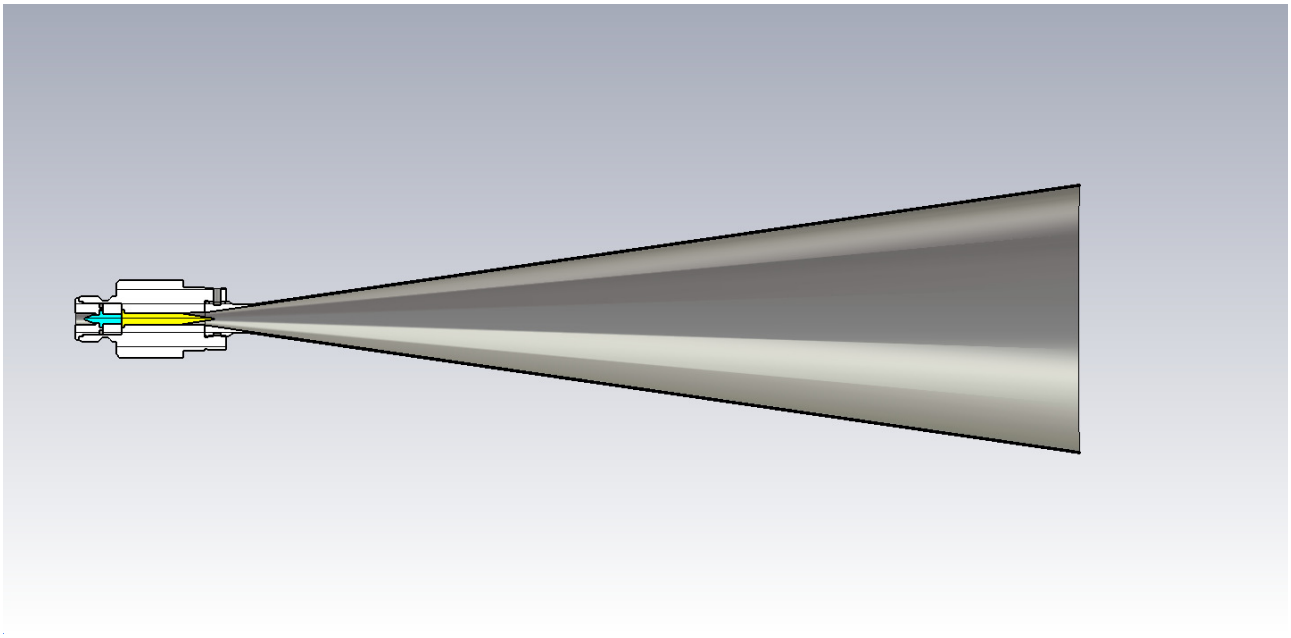
2.3.2 Radiation pattern in H-plane



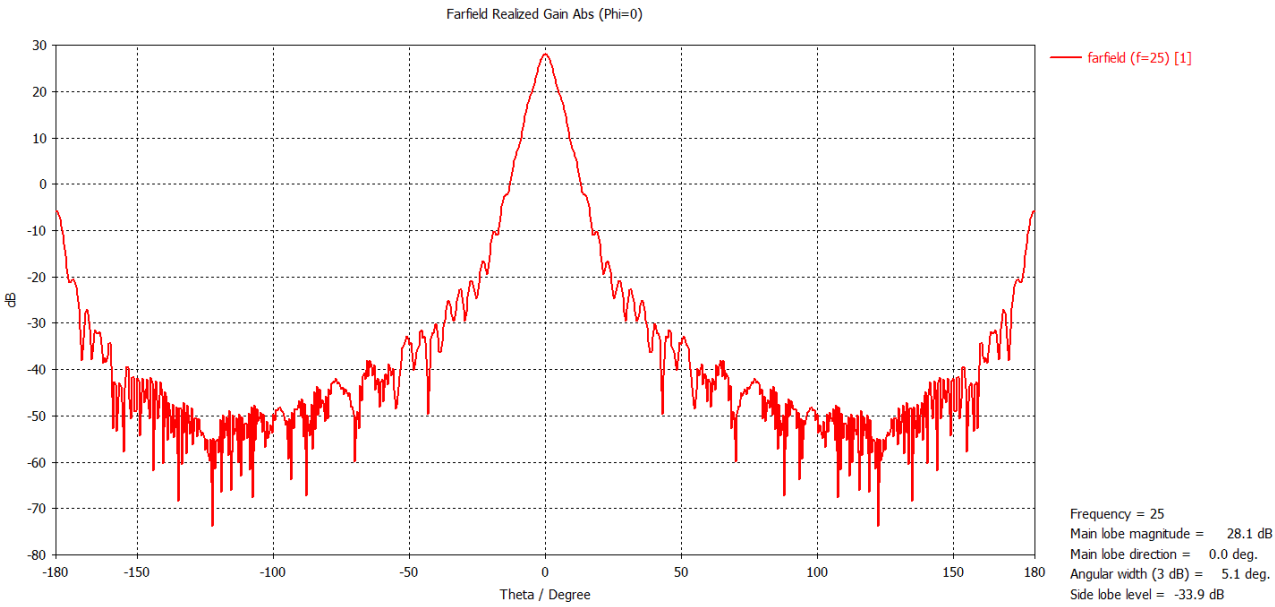


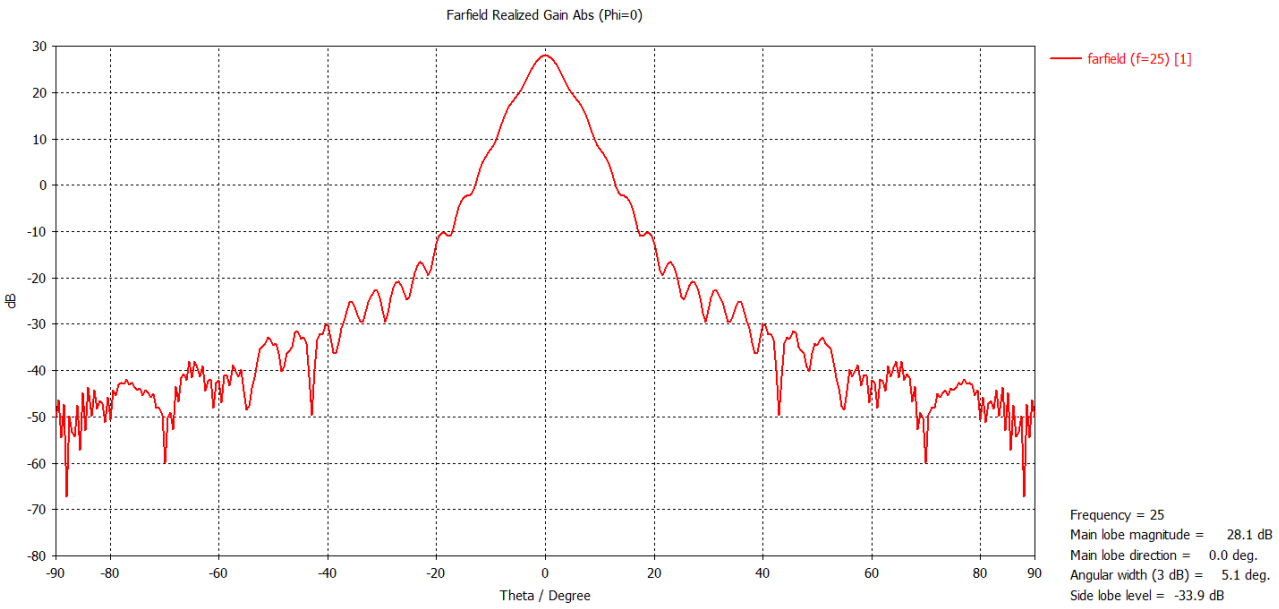

Farfield Realized Gain Abs (Phi=0)
d=6.6
27.7
24.7
d=3
farfield (f=25) [1]
dB
30
20
15
10
5
0
-20
-15
-10
-5
-3.3
0
3.3
5
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 27.7 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 6.6 deg.
Side lobe level = -37.2 dB

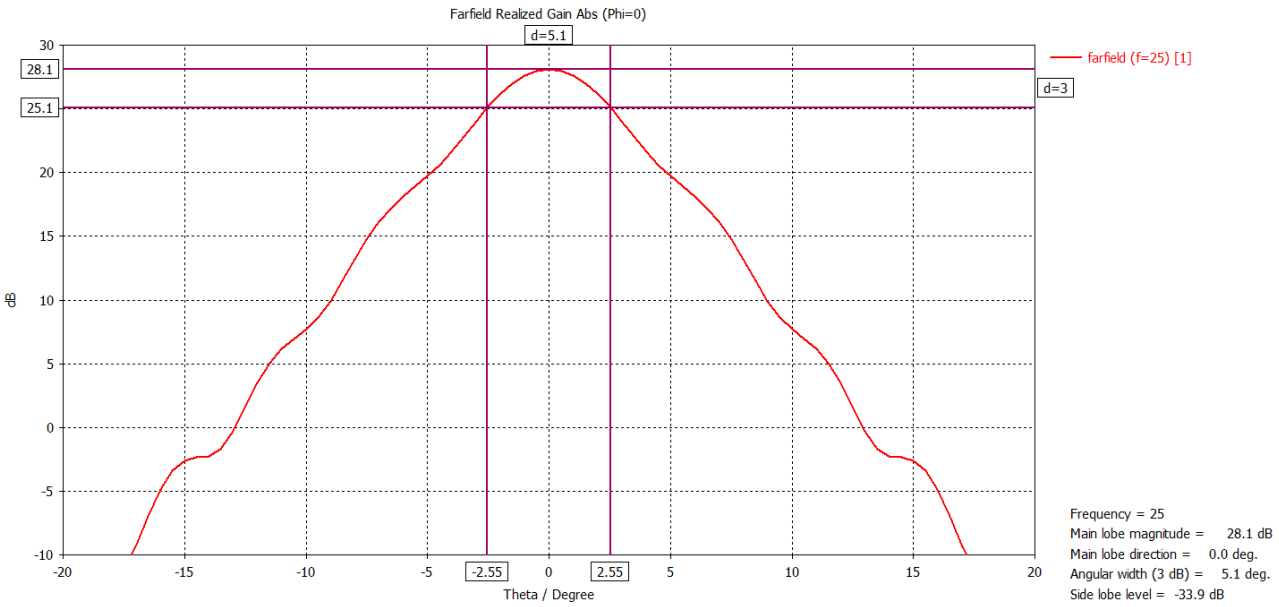
2.4 316L / DN200 (8”) Metallic Horn



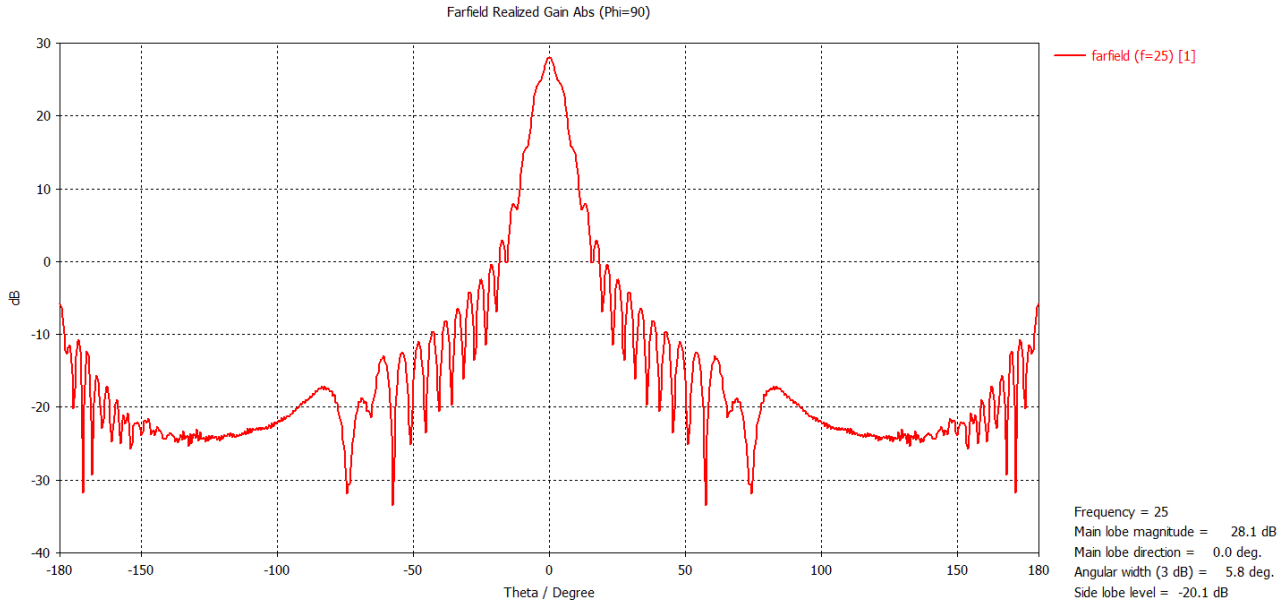
2.4.1 Radiation pattern in E-plane

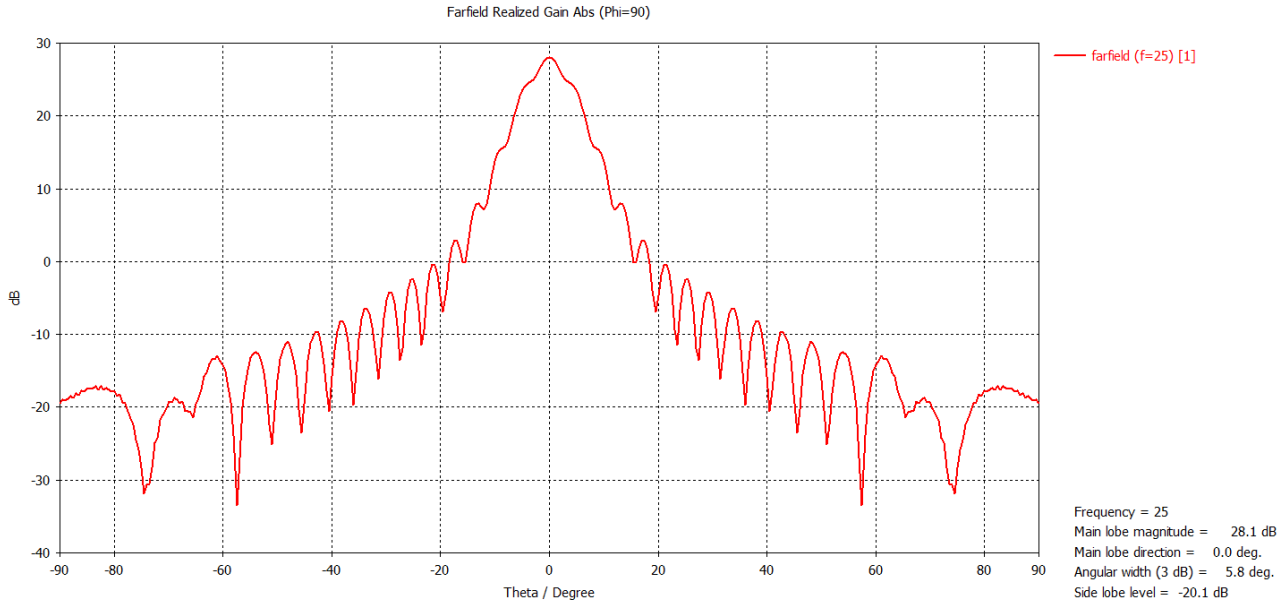


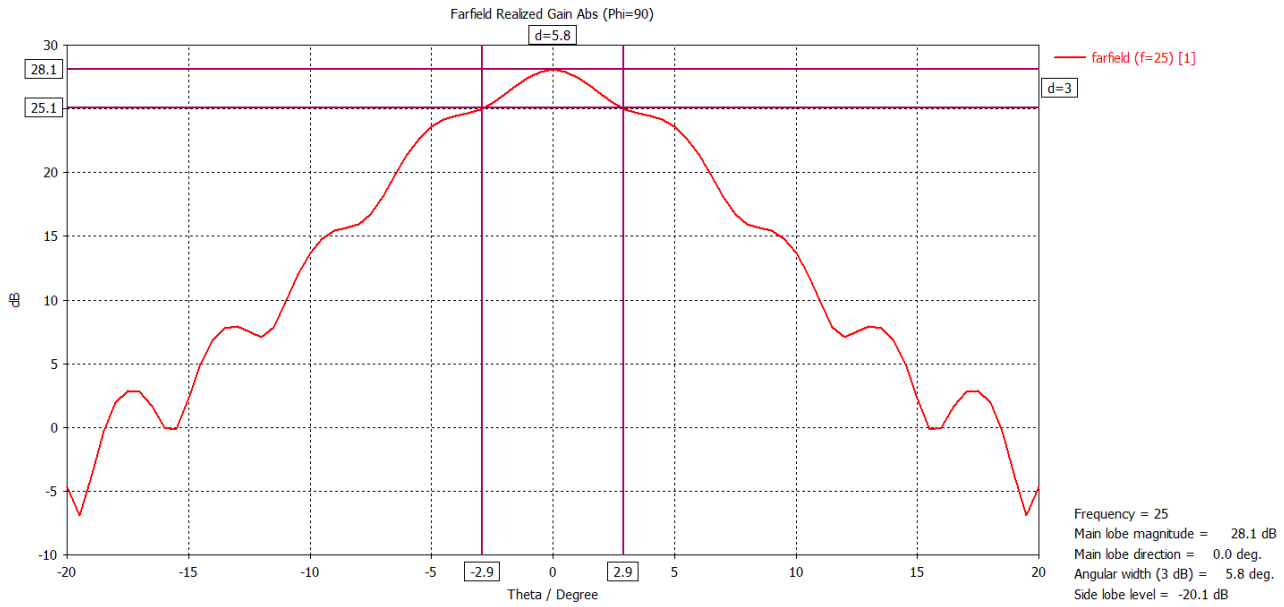

Farfield Realized Gain Abs (Phi=0)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 28.1 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 5.1 deg.
Side lobe level = -33.9 dB


Farfield Realized Gain Abs (Phi=0)
d=5.1
28.1
25.1
d=3
farfield (f=25) [1]
dB
-2.55
2.55
Theta / Degree
Frequency = 25
Main lobe magnitude = 28.1 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 5.1 deg.
Side lobe level = -33.9 dB

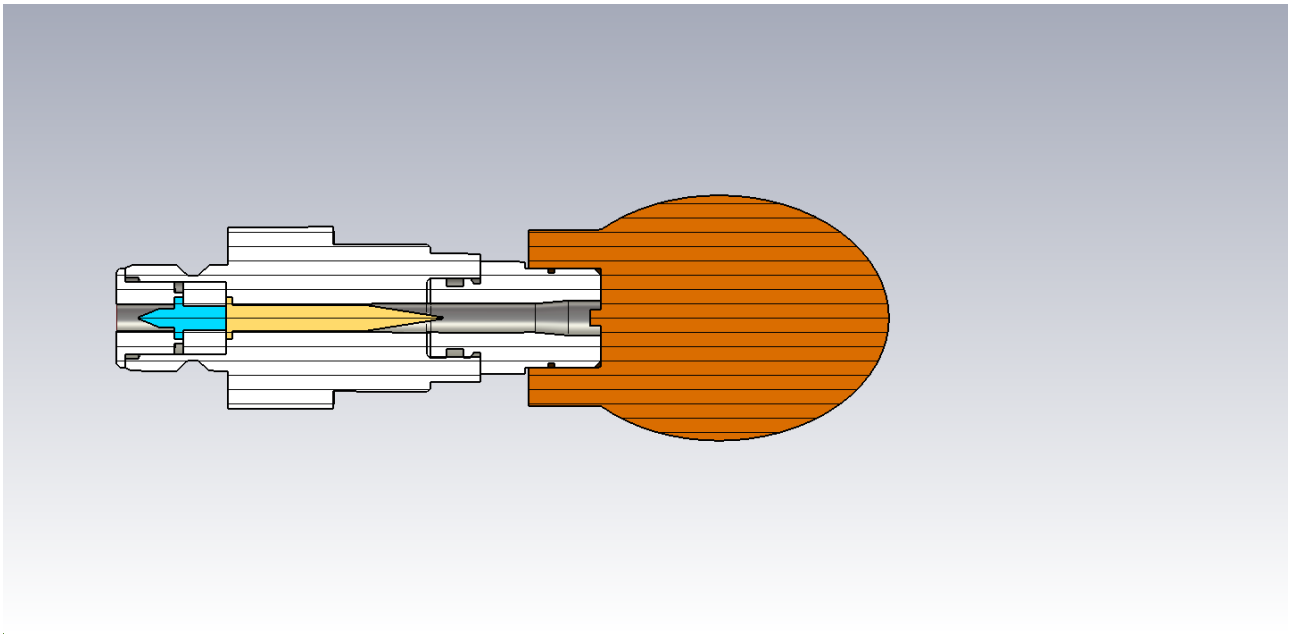
2.4.2 Radiation pattern in H-plane



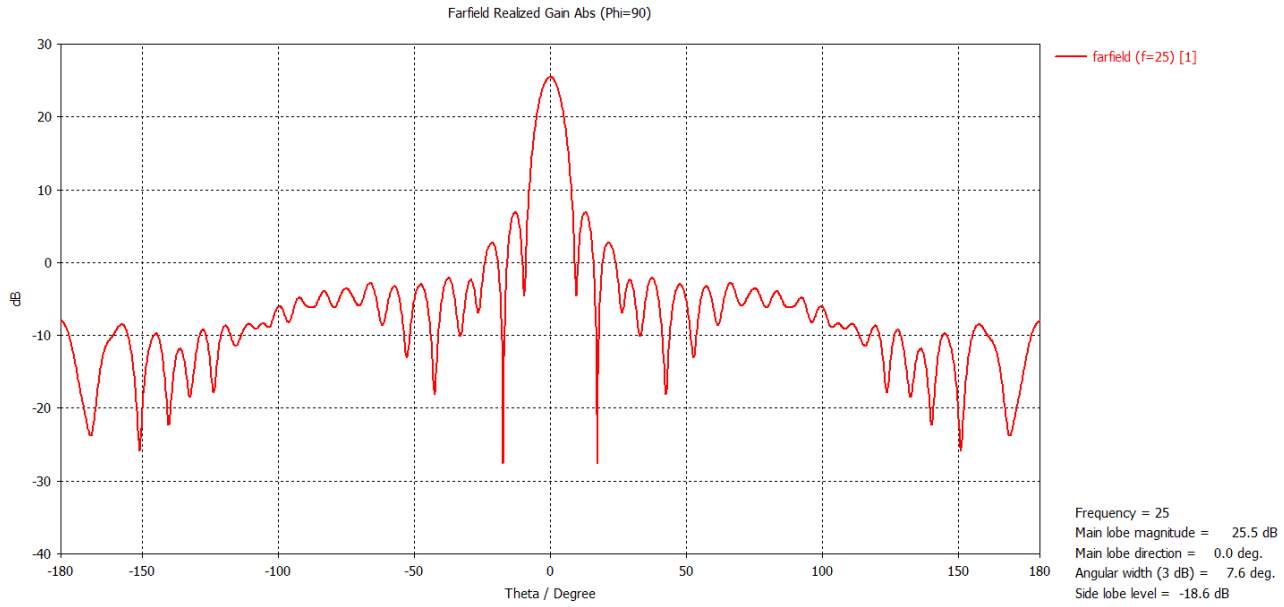


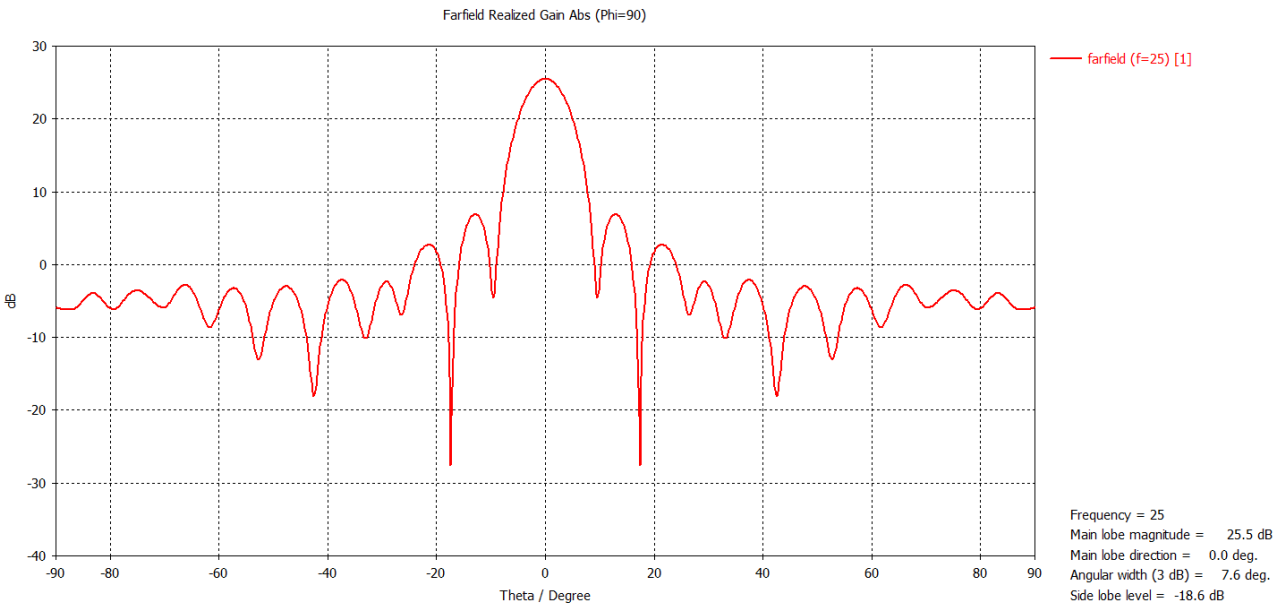

Farfield Realized Gain Abs (Phi=90)
d=5.8
28.1
25.1
d=3
farfield (f=25) [1]
dB
30
20
15
10
5
0
-5
-10
-20
-15
-10
-5
-2.9
0
2.9
5
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 28.1 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 5.8 deg.
Side lobe level = -20.1 dB

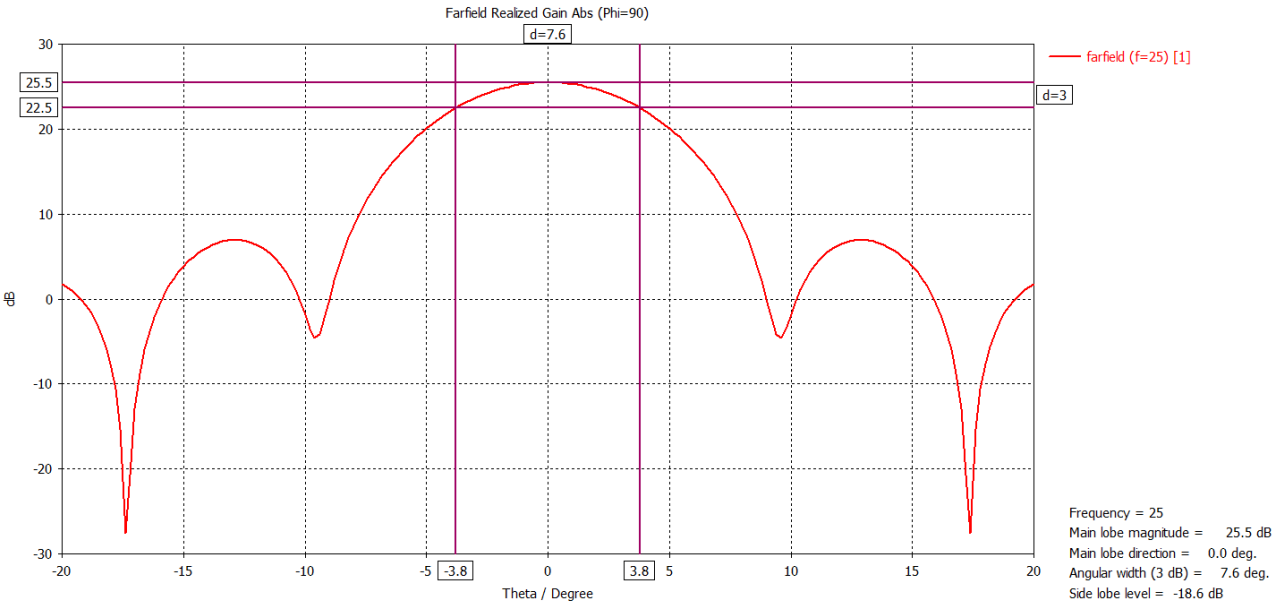
2.5 PTFE / DN80 (3”) Drop



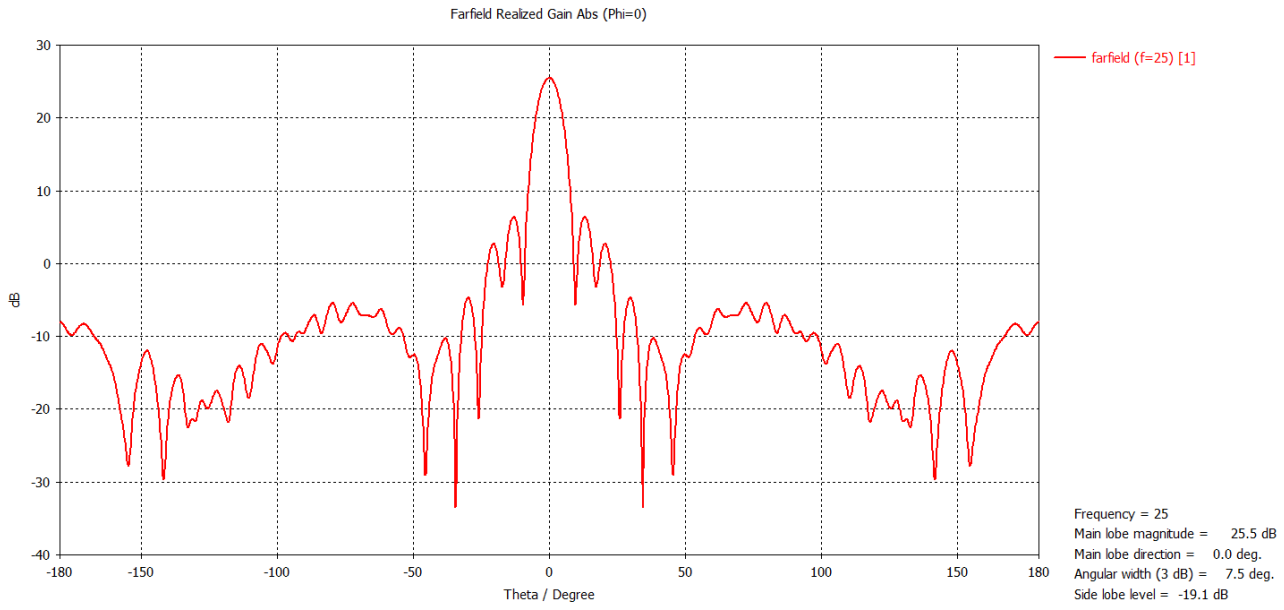
2.5.1 Radiation pattern in E-plane

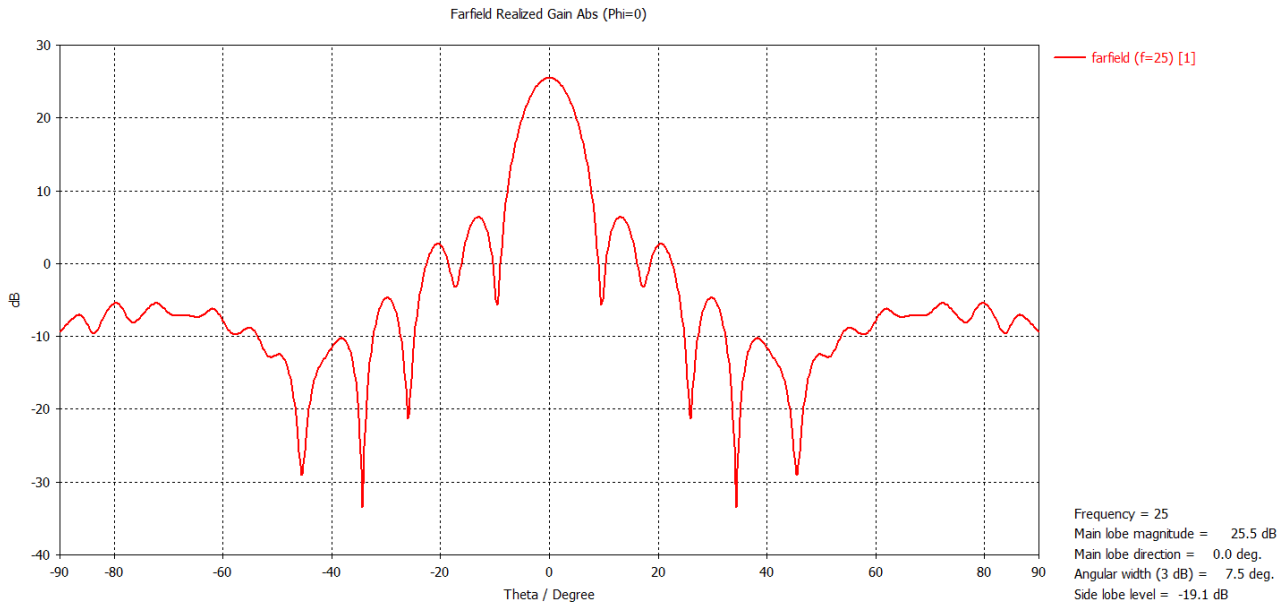


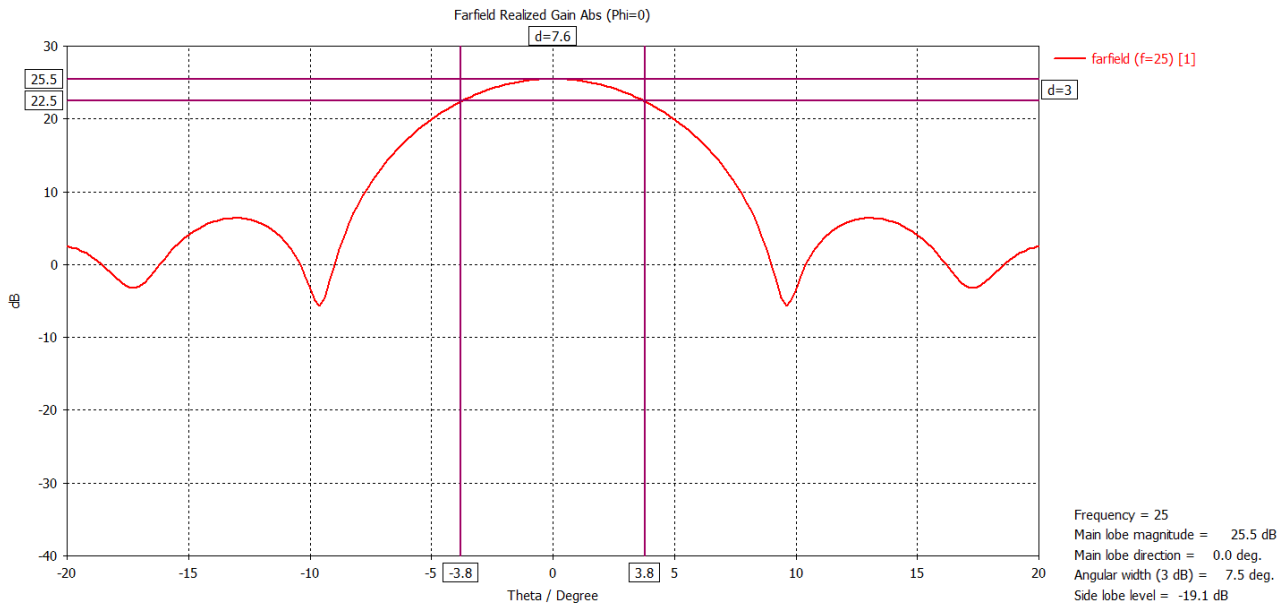

Farfield Realized Gain Abs (Phi=90)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.5 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 7.6 deg.
Side lobe level = -18.6 dB


Farfield Realized Gain Abs (Phi=90)
d=7.6
25.5
22.5
d=3
farfield (f=25) [1]
dB
-3.8
3.8
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.5 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 7.6 deg.
Side lobe level = -18.6 dB

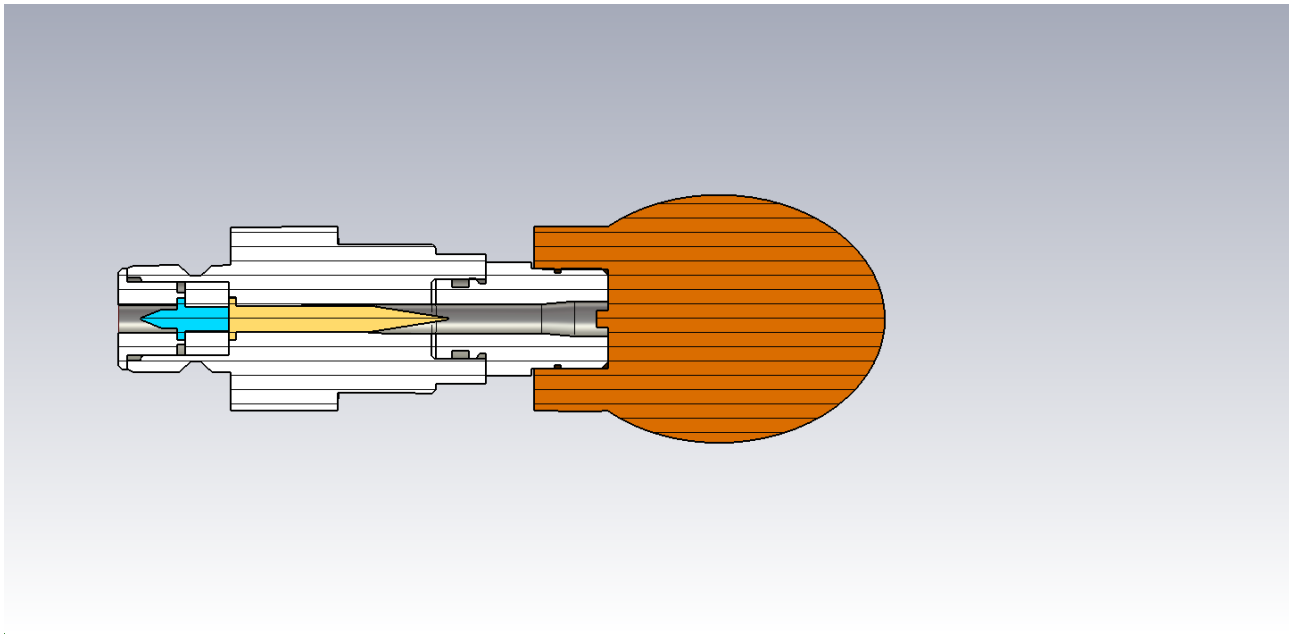
2.5.2 Radiation pattern in H-plane



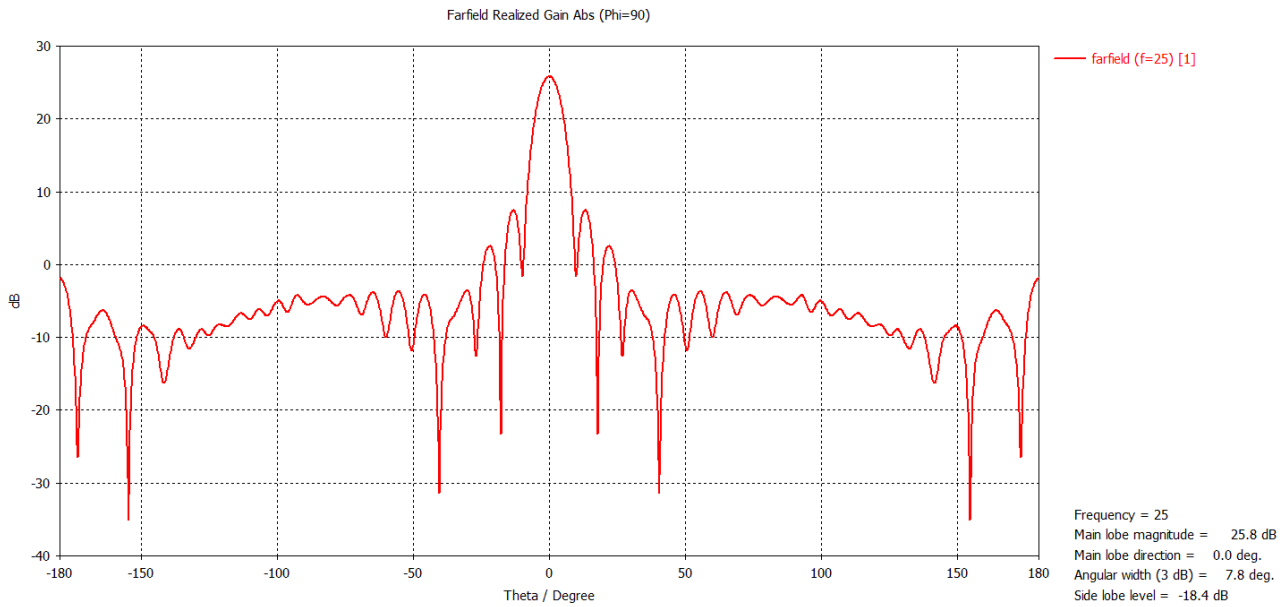


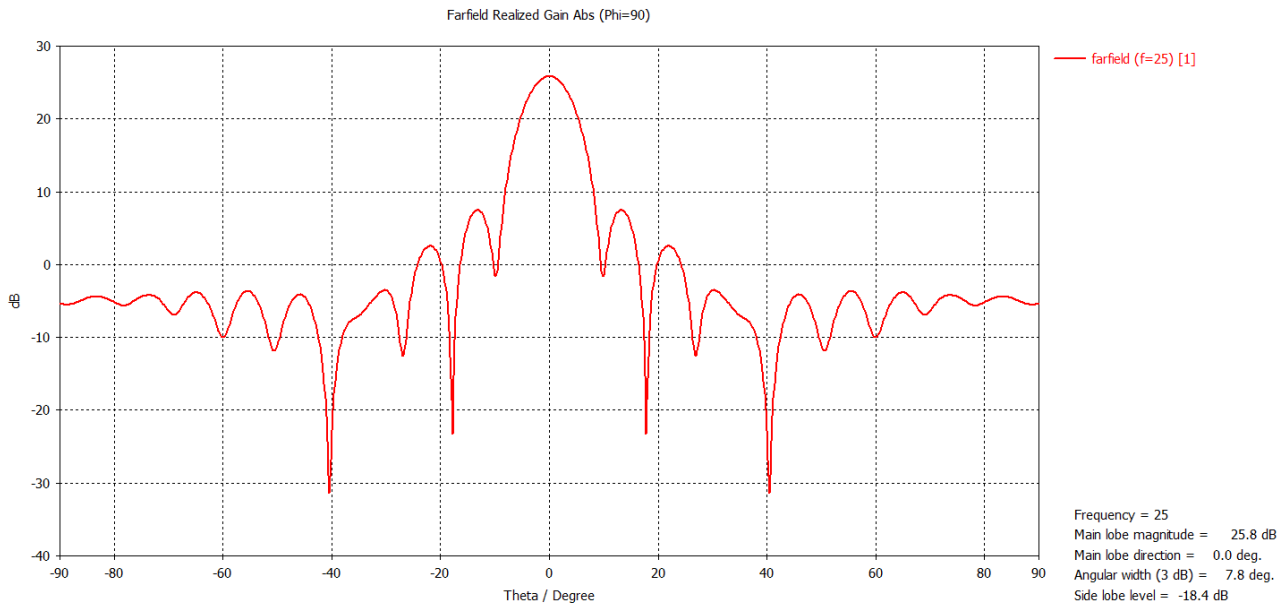

Farfield Realized Gain Abs (Phi=0)
d=7.6
25.5
22.5
d=3
farfield (f=25) [1]
dB
30
20
10
0
-10
-20
-30
-40
-20
-15
-10
-5
-3.8
0
3.8
5
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.5 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 7.5 deg.
Side lobe level = -19.1 dB

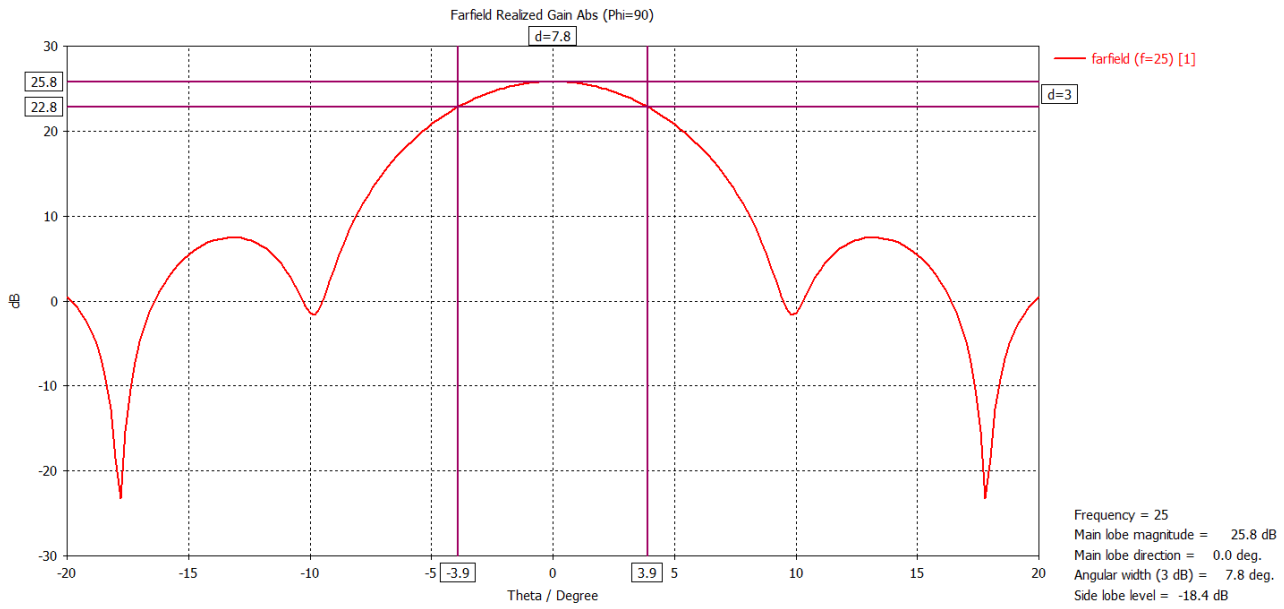
2.6 PP / DN80 (3”) Drop



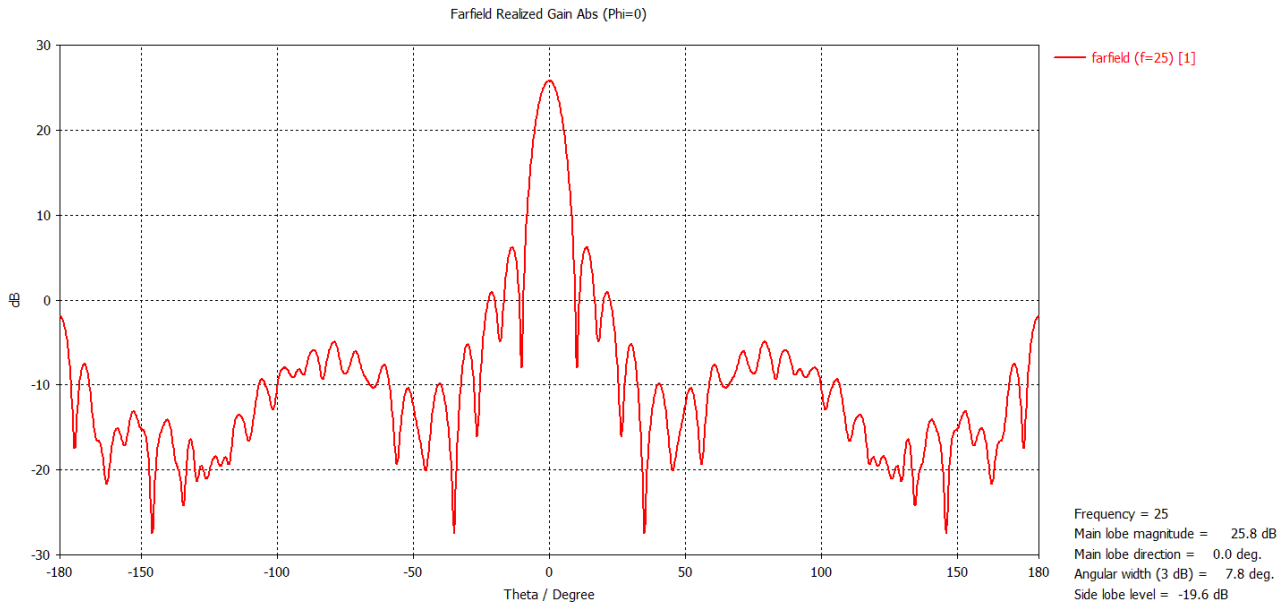
2.6.1 Radiation pattern in E-plane

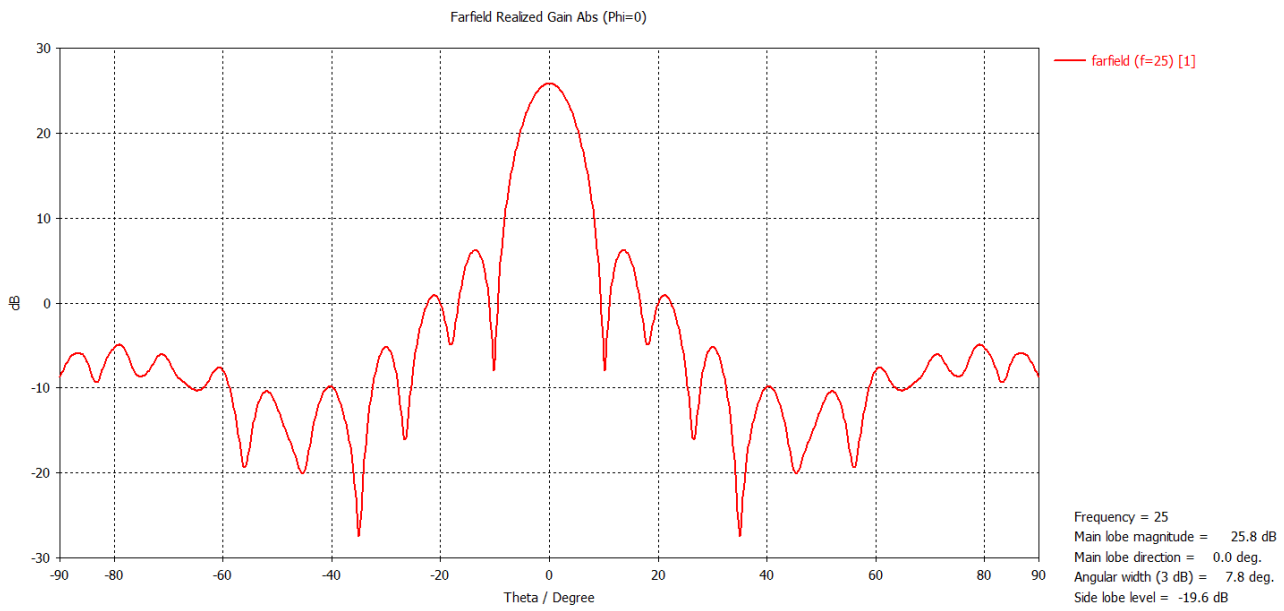


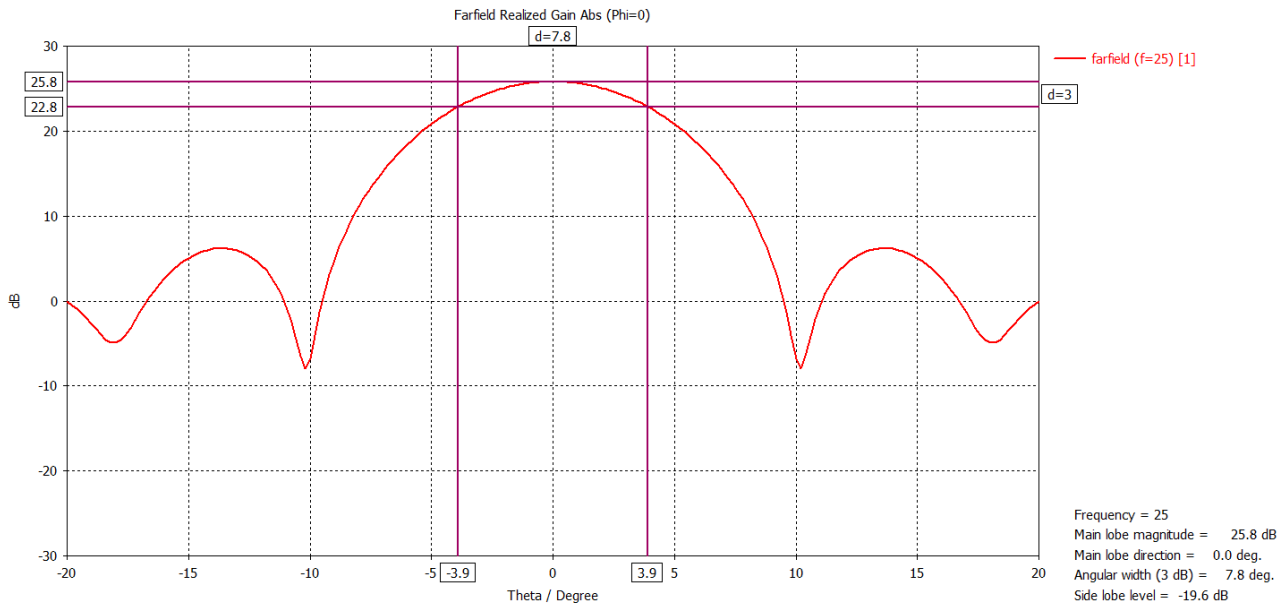

Farfield Realized Gain Abs (Phi=90)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.8 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 7.8 deg.
Side lobe level = -18.4 dB


Farfield Realized Gain Abs (Phi=90)
d=7.8
25.8
22.8
d=3
farfield (f=25) [1]
dB
-3.9
3.9
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.8 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 7.8 deg.
Side lobe level = -18.4 dB

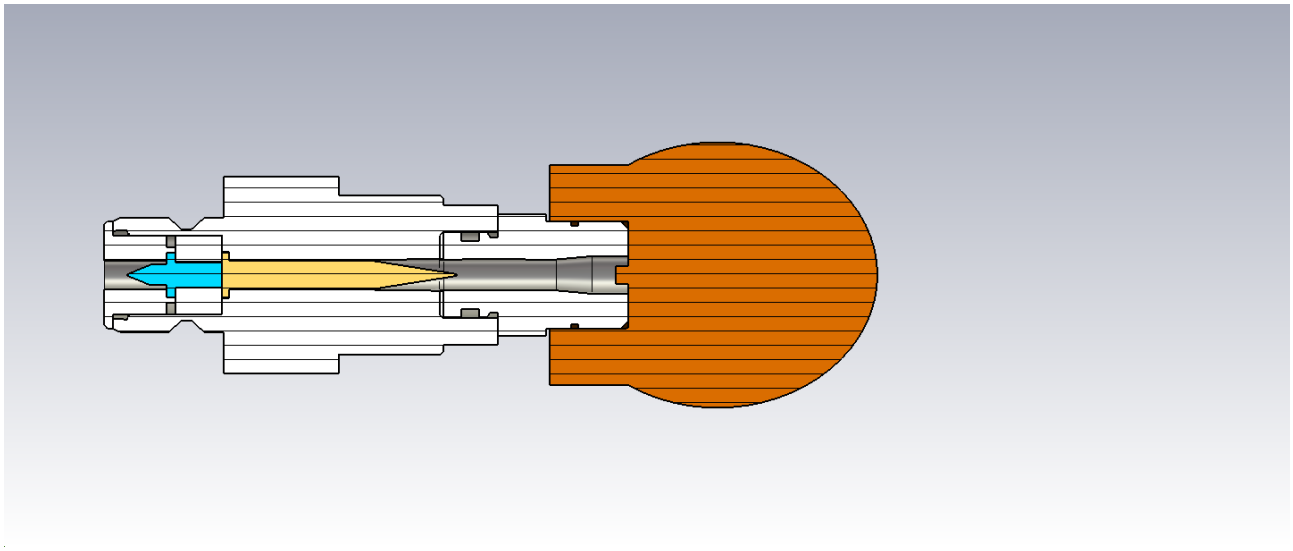
2.6.2 Radiation pattern in H-plane



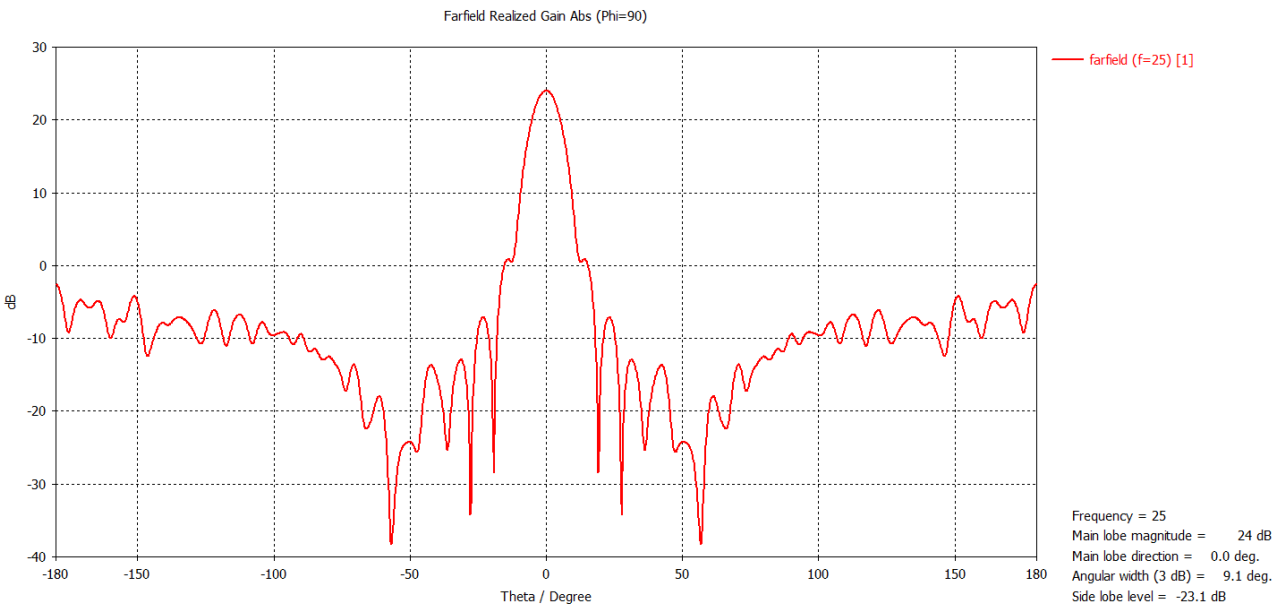


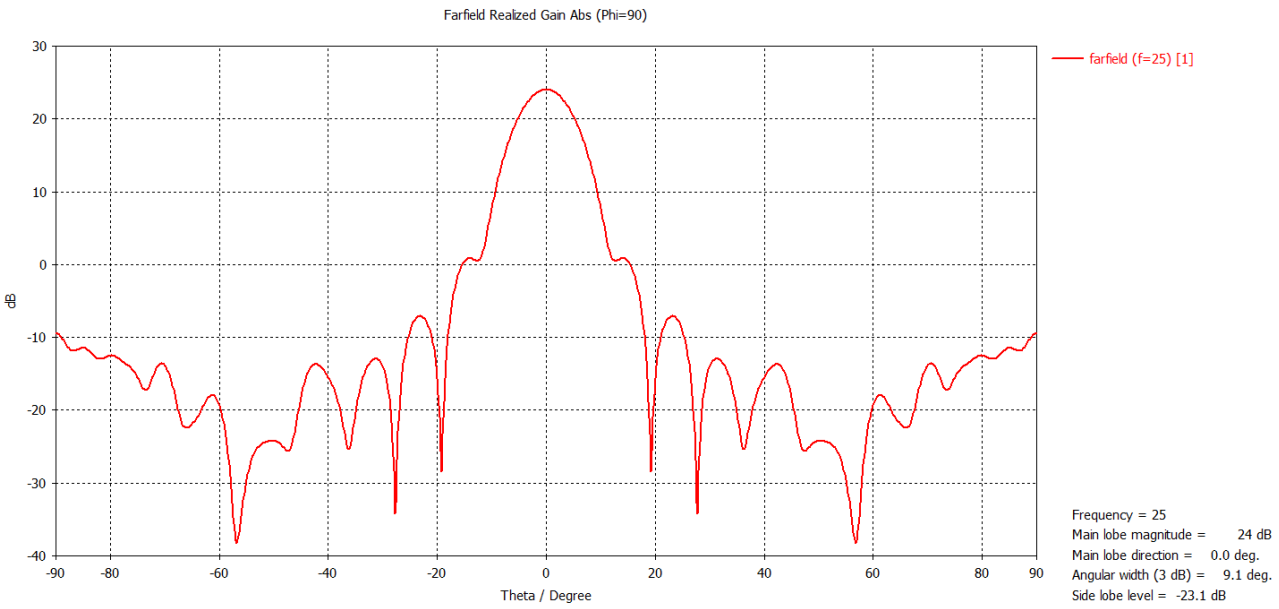

Farfield Realized Gain Abs (Phi=0)
d=7.8
25.8
22.8
d=3
farfield (f=25) [1]
dB
30
20
10
0
-10
-20
-30
-20
-15
-10
-5
-3.9
0
3.9
5
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.8 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 7.8 deg.
Side lobe level = -19.6 dB

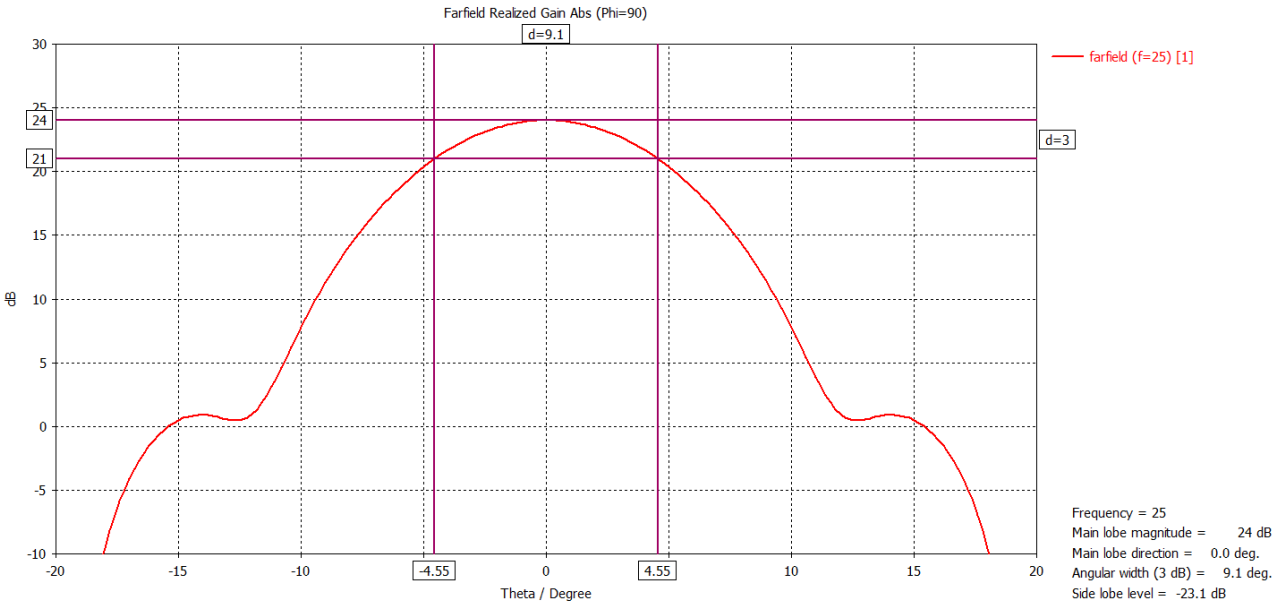
2.7 PEEK / DN80 (3”) Drop



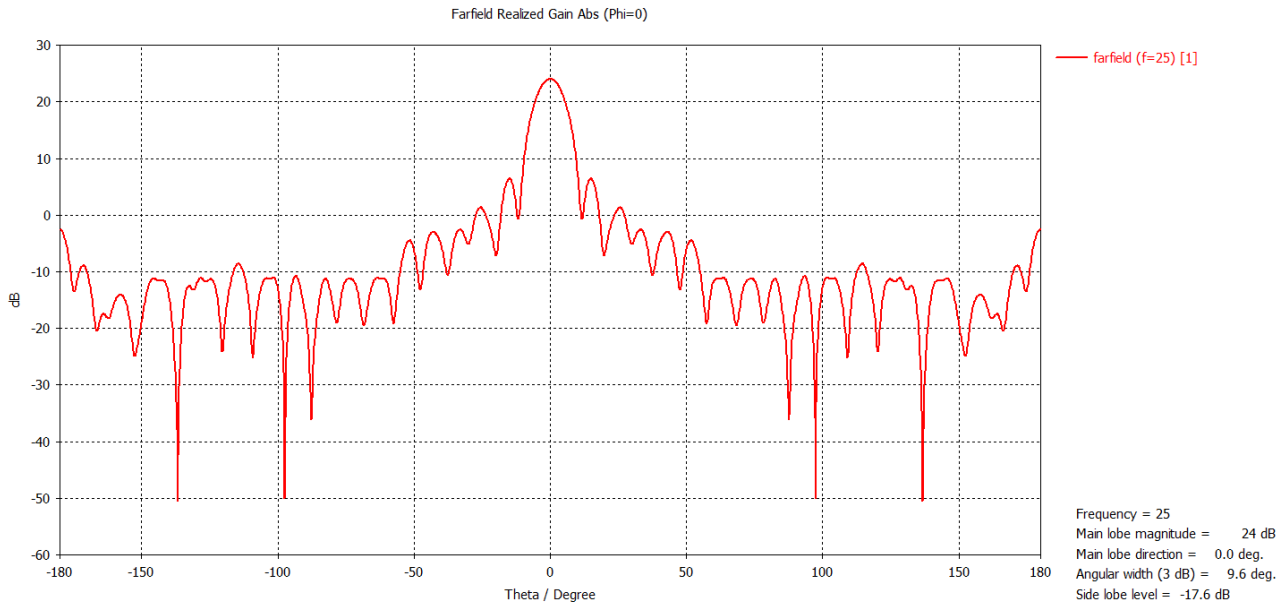
2.7.1 Radiation pattern in E-plane

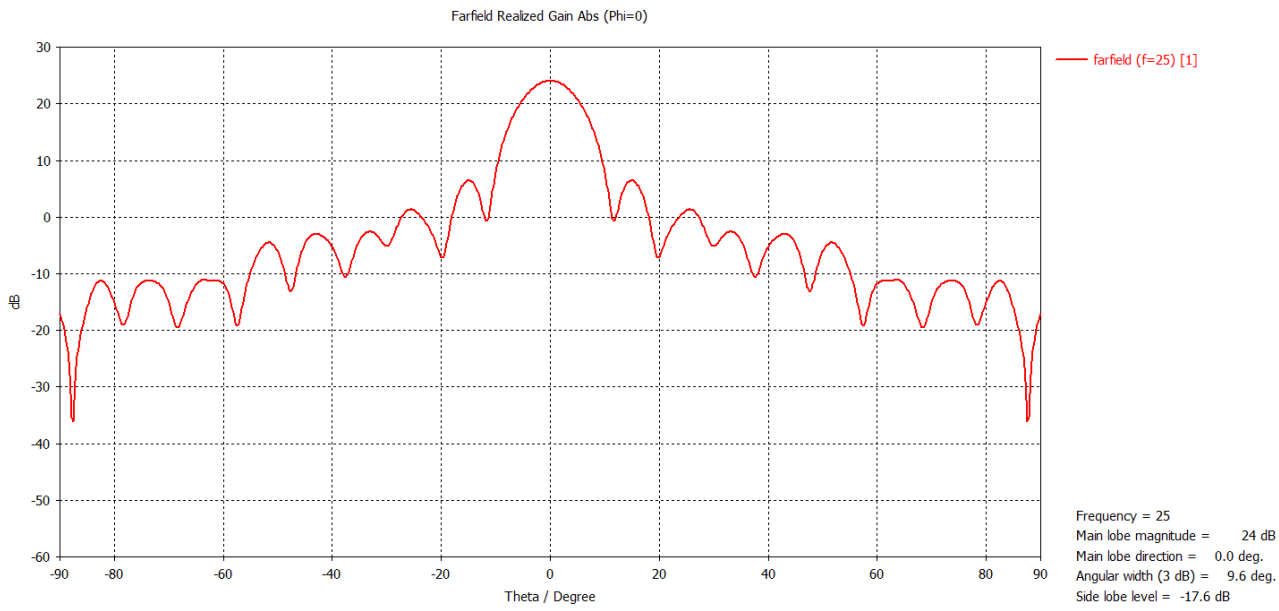


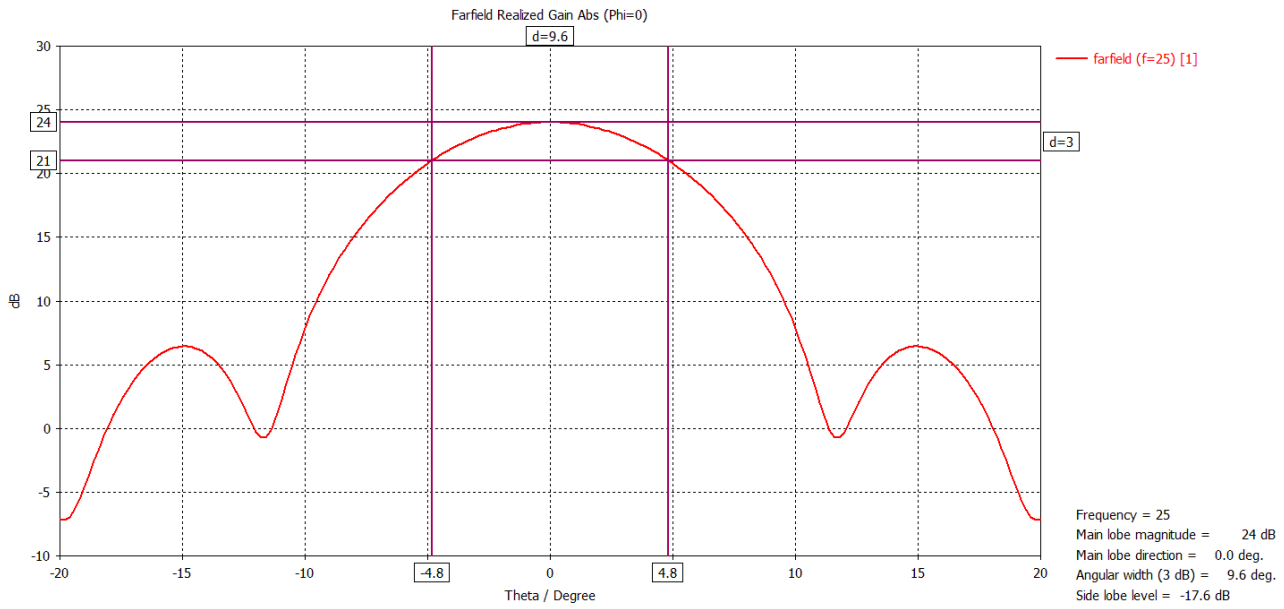

Farfield Realized Gain Abs (Phi=90)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 24 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 9.1 deg.
Side lobe level = -23.1 dB


Farfield Realized Gain Abs (Phi=90)
d=9.1
d=3
24
21
-4.55
4.55
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 24 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 9.1 deg.
Side lobe level = -23.1 dB

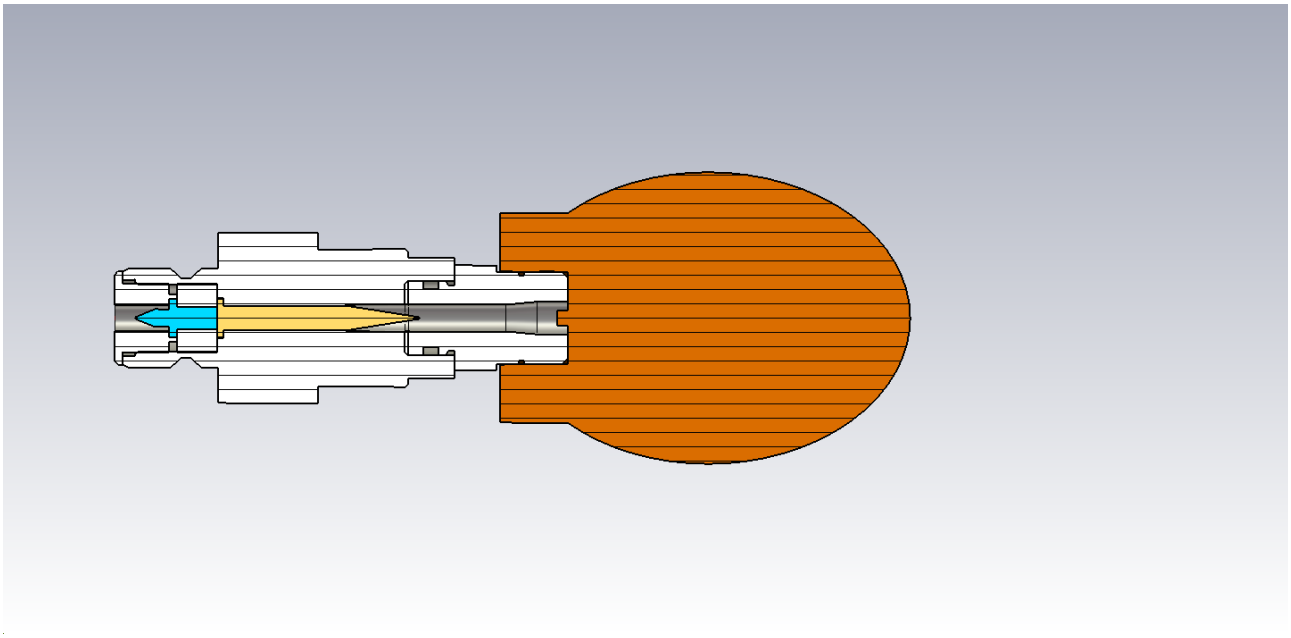
2.7.2 Radiation pattern in H-plane



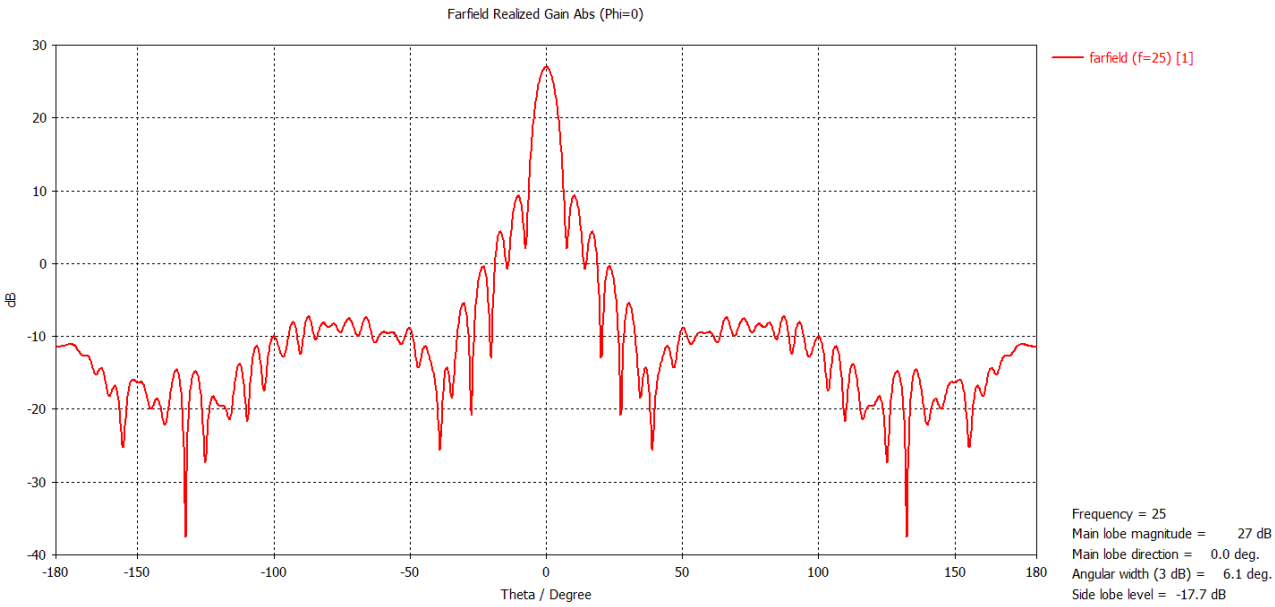


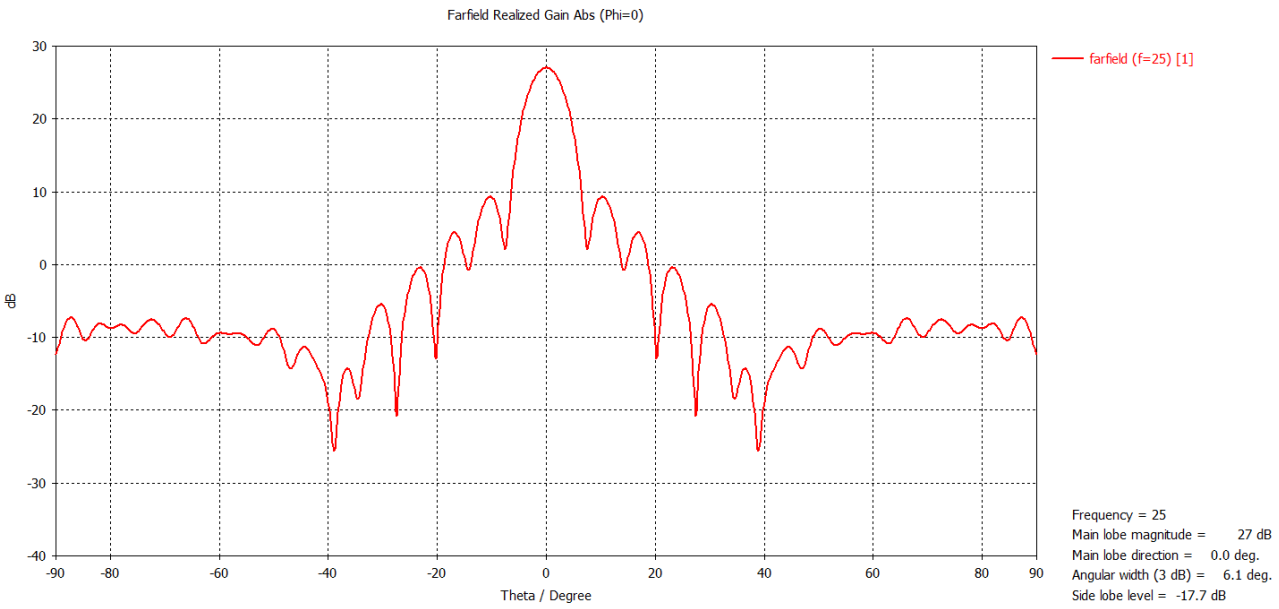

Farfield Realized Gain Abs (Phi=0)
d=9.6
farfield (f=25) [1]
d=3
24
21
dB
30
25
20
15
10
5
0
-5
-10
-20
-15
-10
-4.8
0
4.8
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 24 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 9.6 deg.
Side lobe level = -17.6 dB

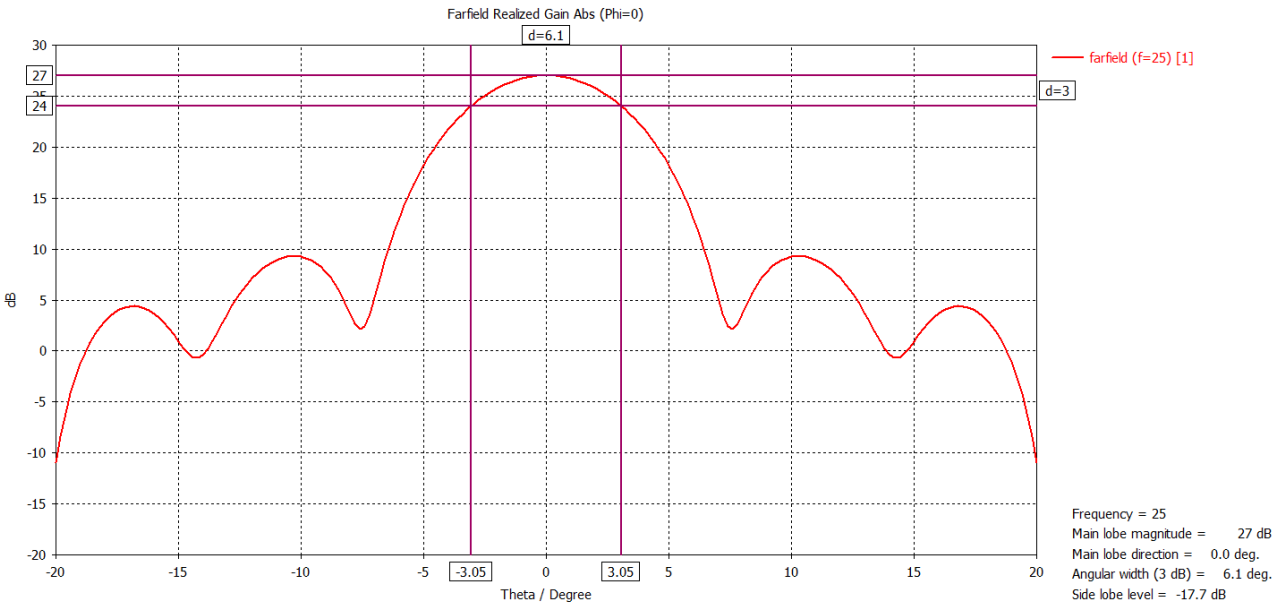
2.8 PTFE / DN100 (4”) Drop



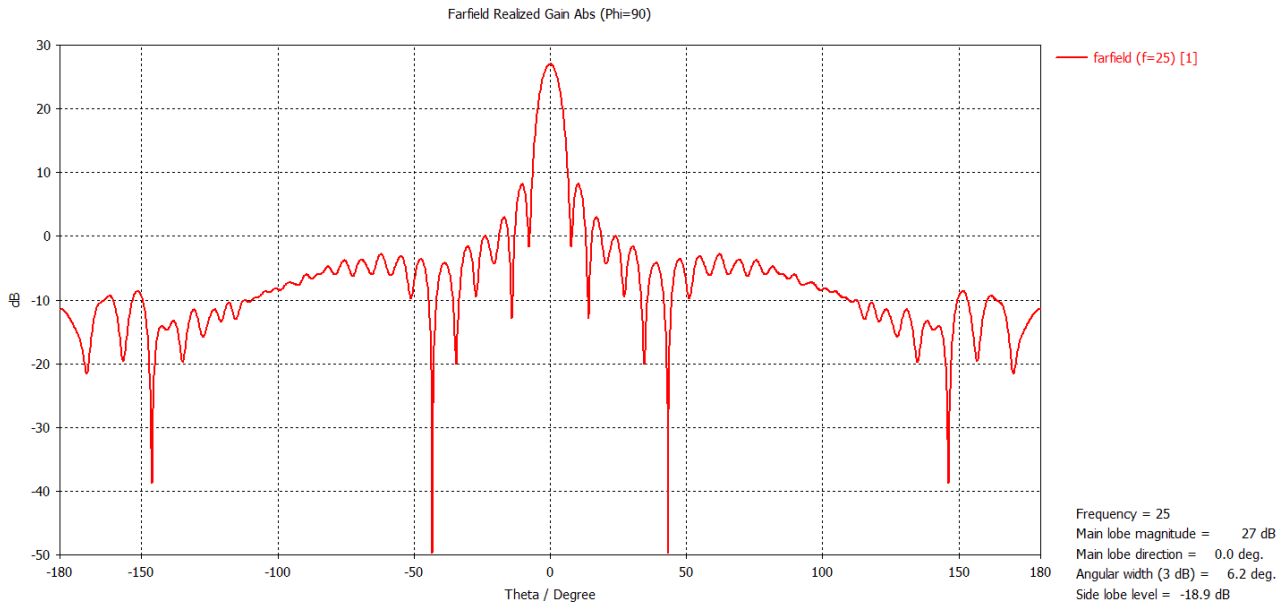
2.8.1 Radiation pattern in E-plane

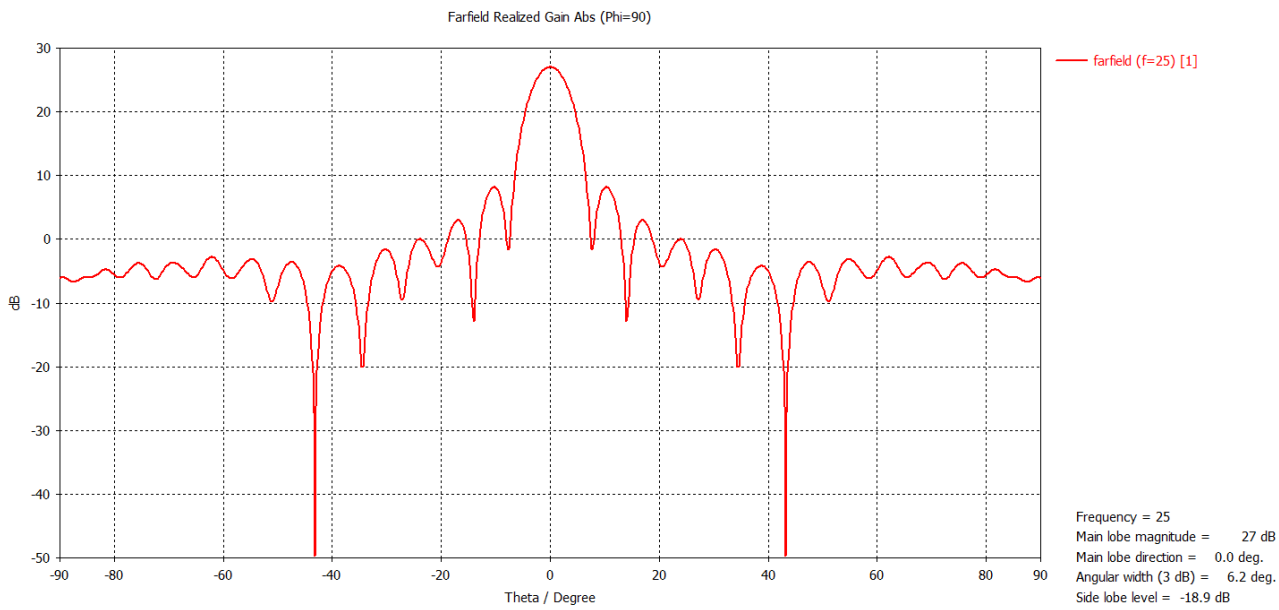


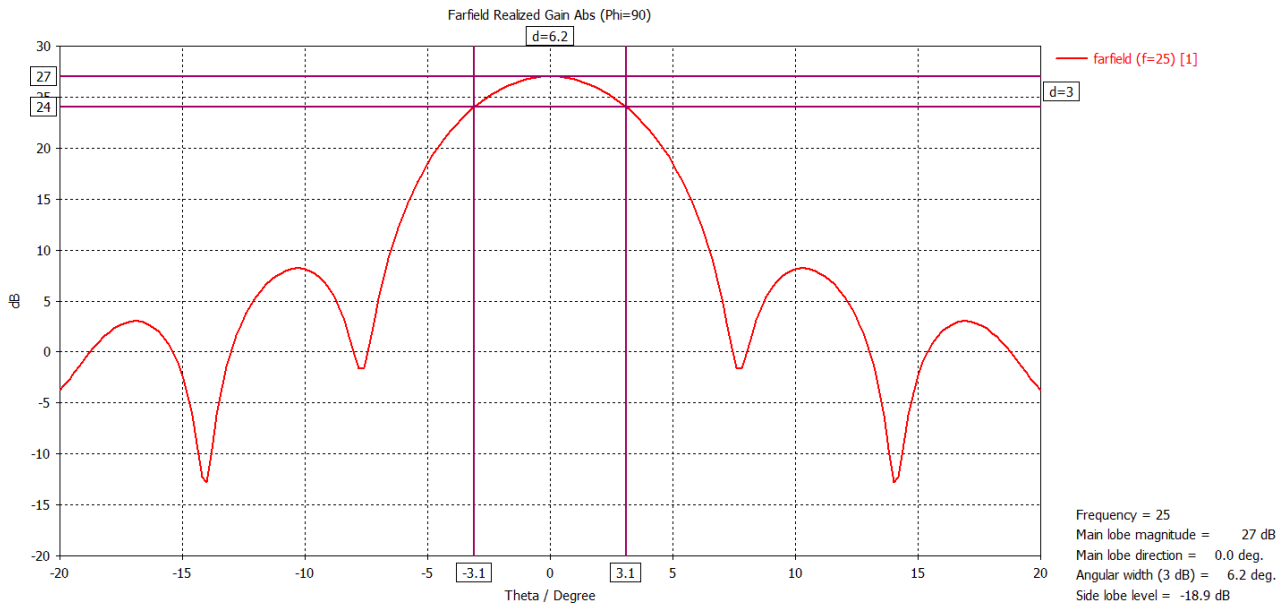

Farfield Realized Gain Abs (Phi=0)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 27 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 6.1 deg.
Side lobe level = -17.7 dB


Farfield Realized Gain Abs (Phi=0)
d=6.1
27
24
d=3
farfield (f=25) [1]
dB
-3.05
3.05
Theta / Degree
Frequency = 25
Main lobe magnitude = 27 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 6.1 deg.
Side lobe level = -17.7 dB

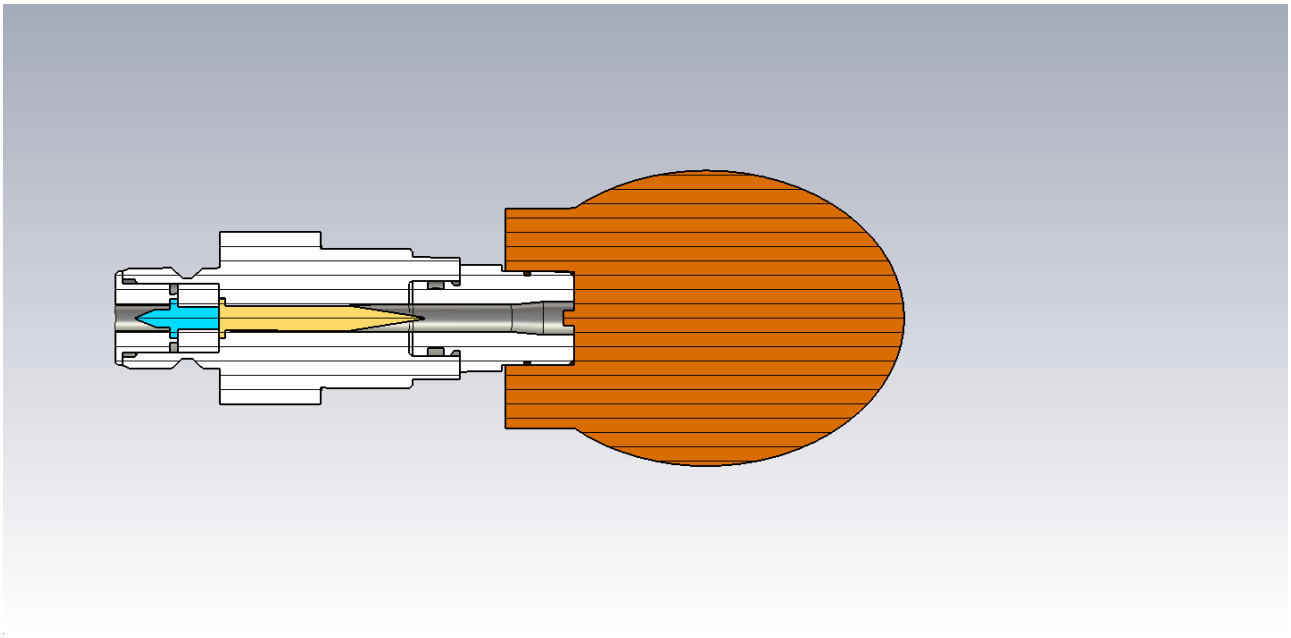
2.8.2 Radiation pattern in H-plane



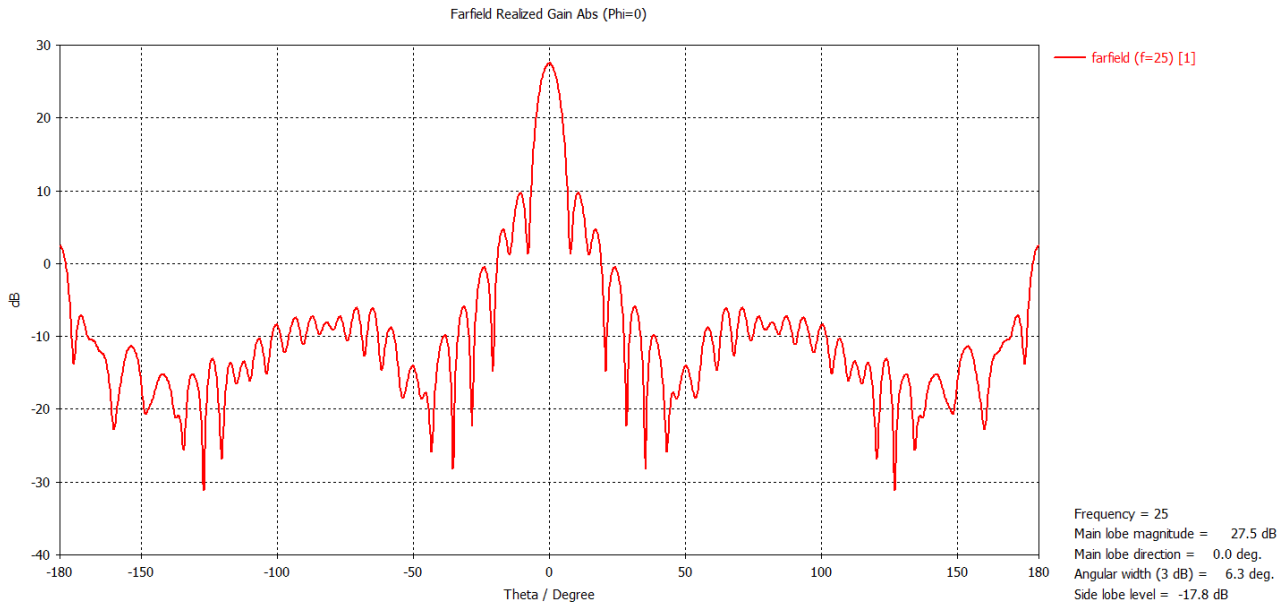


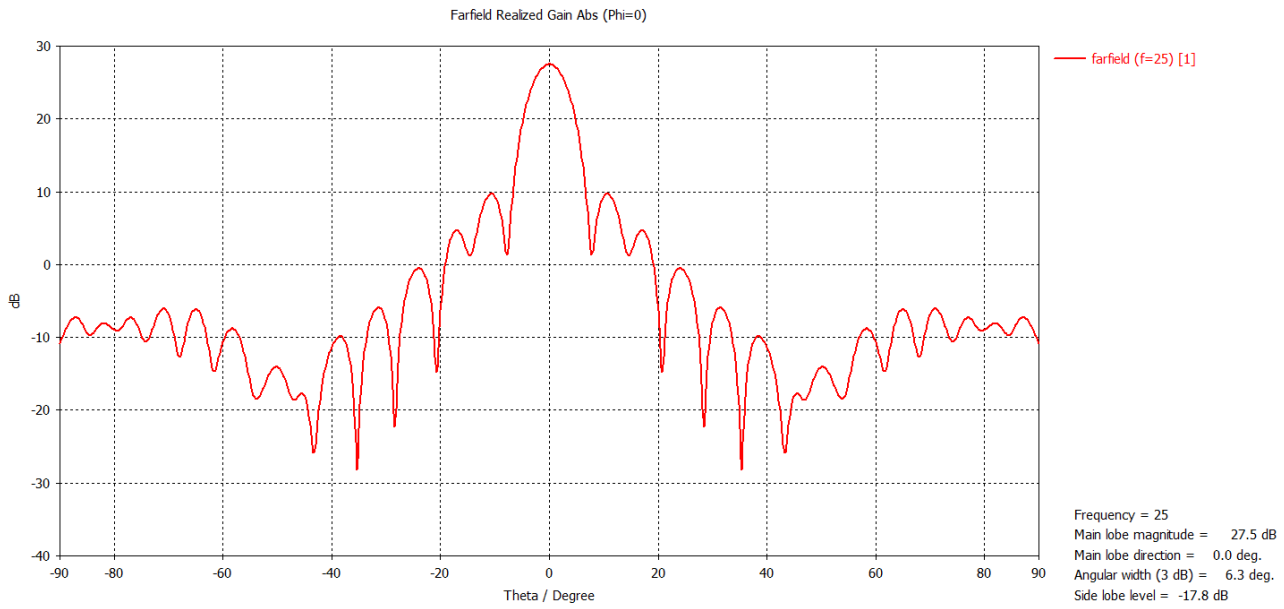

Farfield Realized Gain Abs (Phi=90)
d=6.2
27
24
d=3
farfield (f=25) [1]
dB
30
20
15
10
5
0
-5
-10
-15
-20
-20
-15
-10
-5
-3.1
0
3.1
5
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 27 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 6.2 deg.
Side lobe level = -18.9 dB

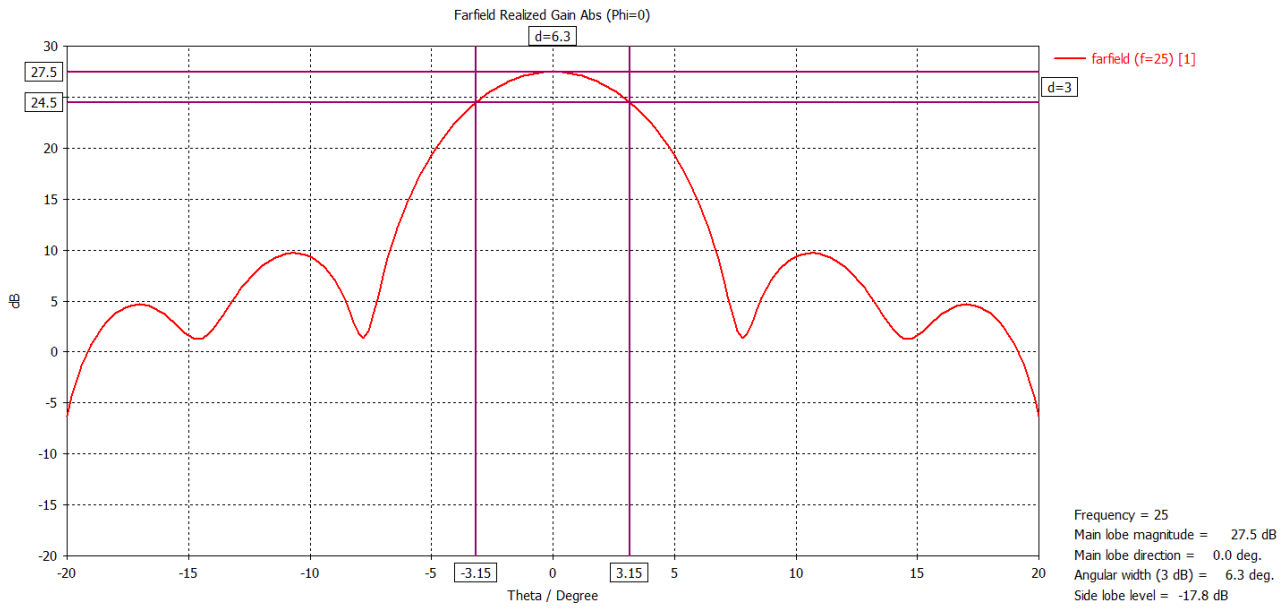
2.9 PP / DN100 (4”) Drop



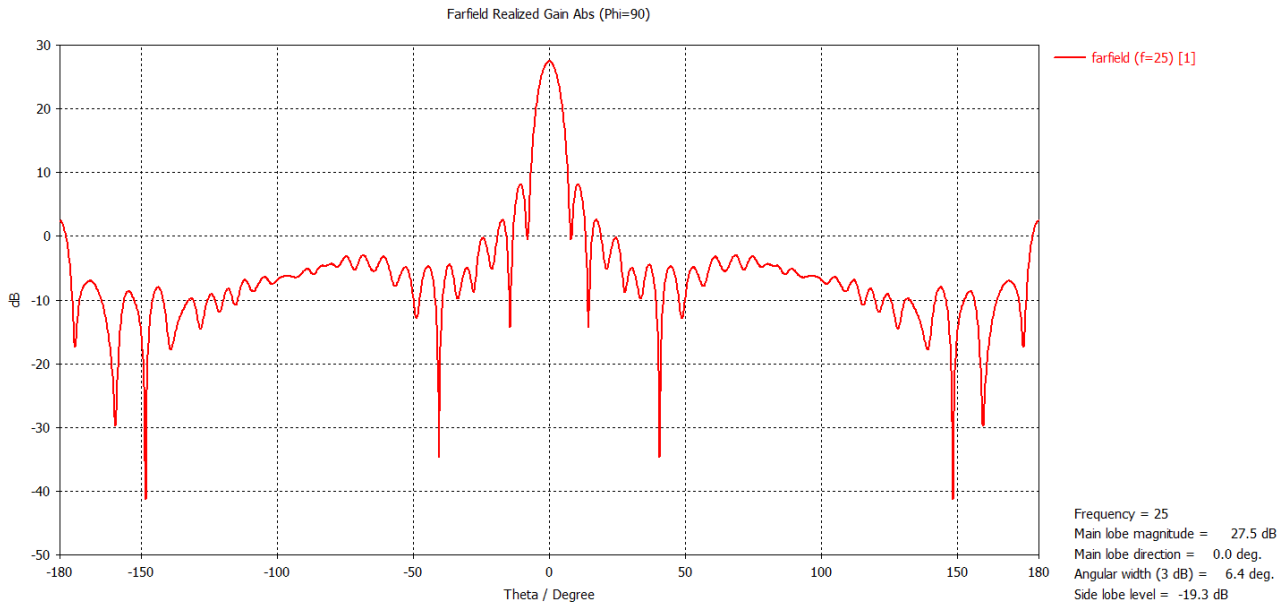
2.9.1 Radiation pattern in E-plane

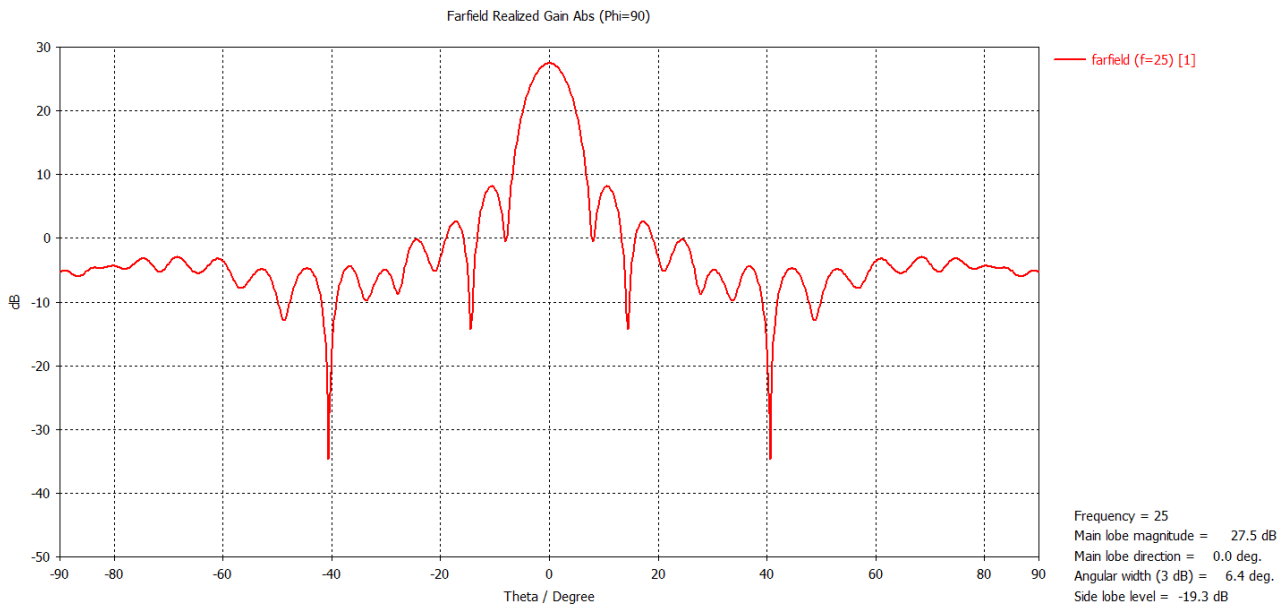


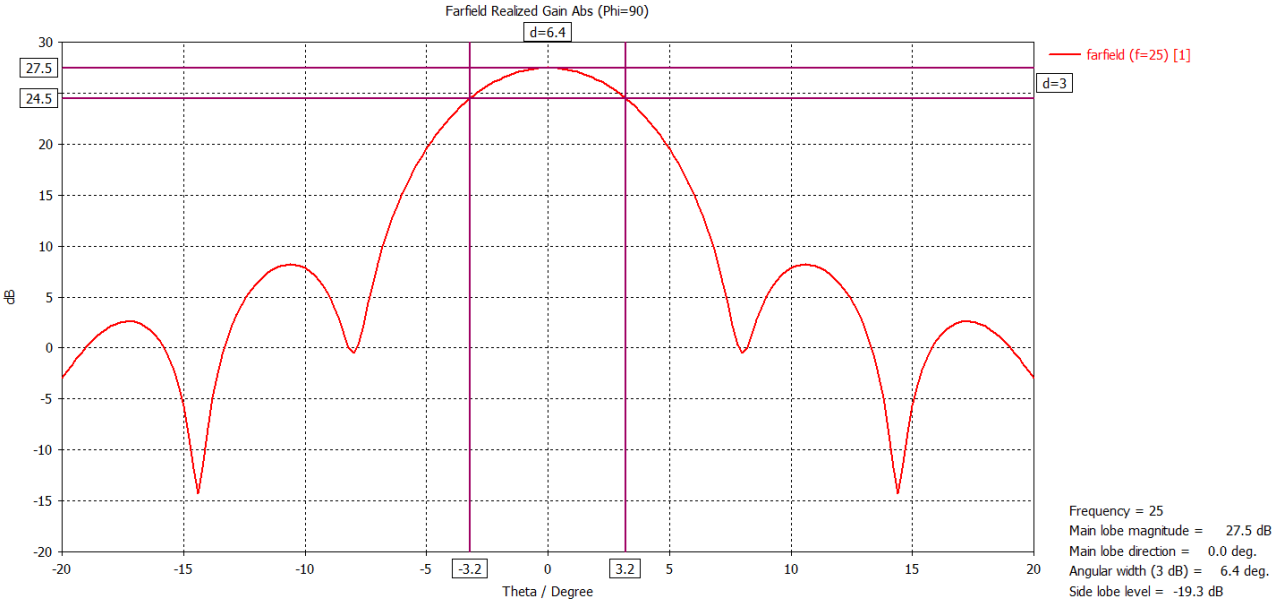

Farfield Realized Gain Abs (Phi=0)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 27.5 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 6.3 deg.
Side lobe level = -17.8 dB


Farfield Realized Gain Abs (Phi=0)
d=6.3
27.5
24.5
d=3
farfield (f=25) [1]
dB
-3.15
3.15
Theta / Degree
Frequency = 25
Main lobe magnitude = 27.5 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 6.3 deg.
Side lobe level = -17.8 dB

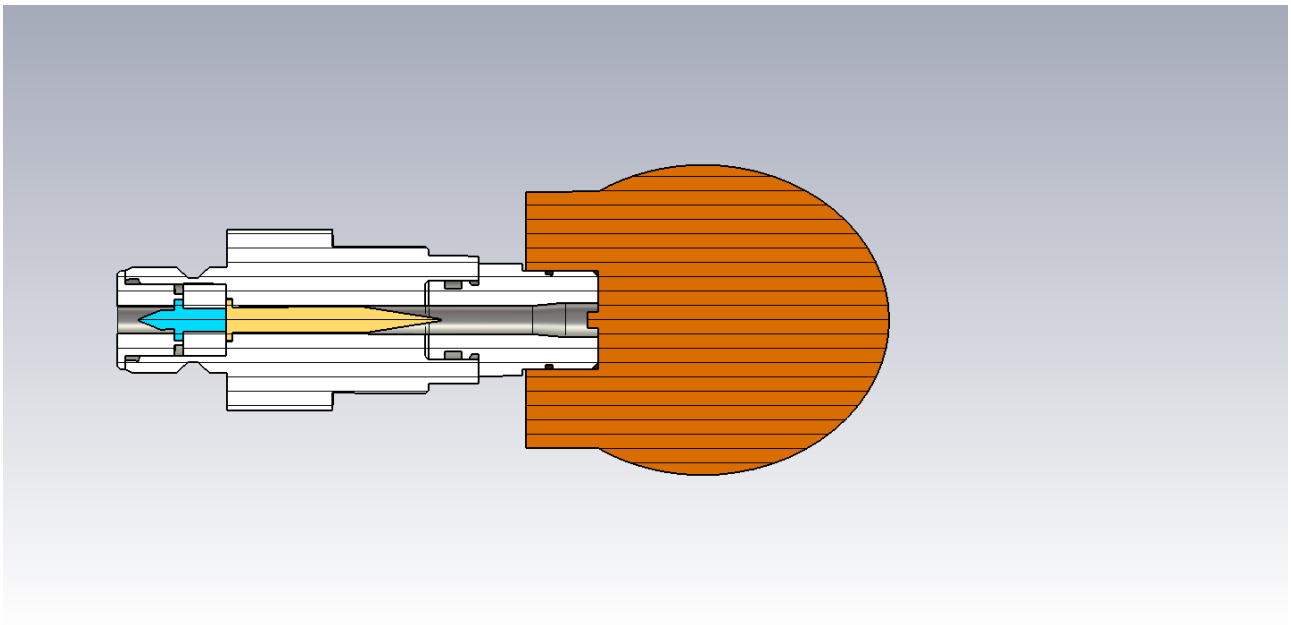
2.9.2 Radiation pattern in H-plane



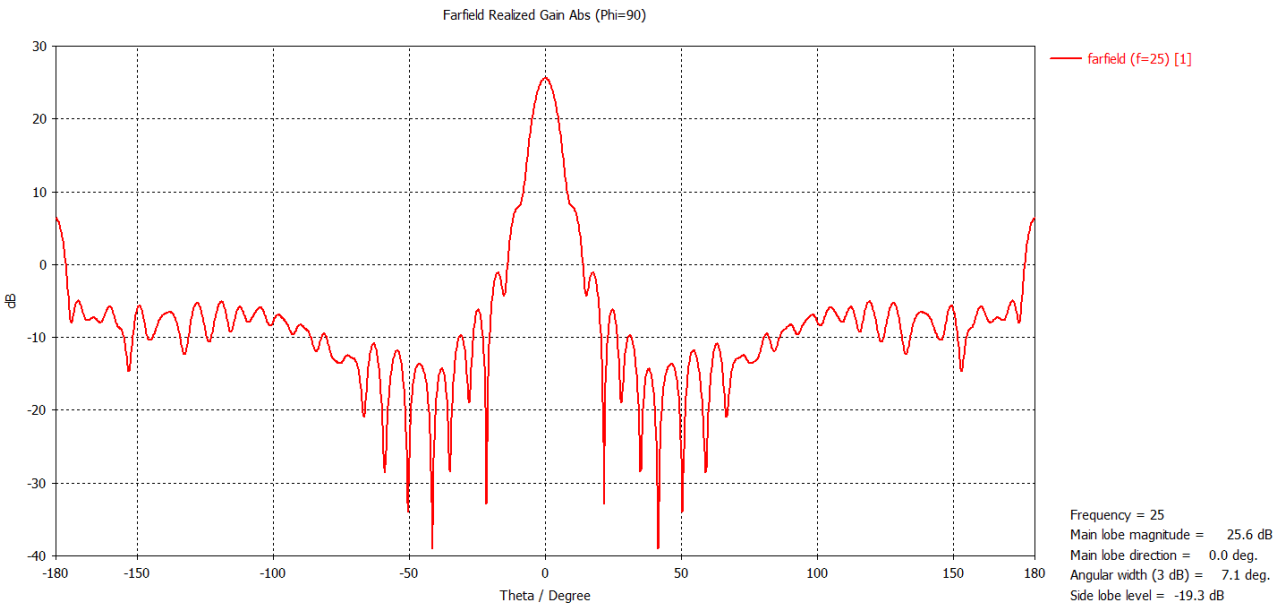


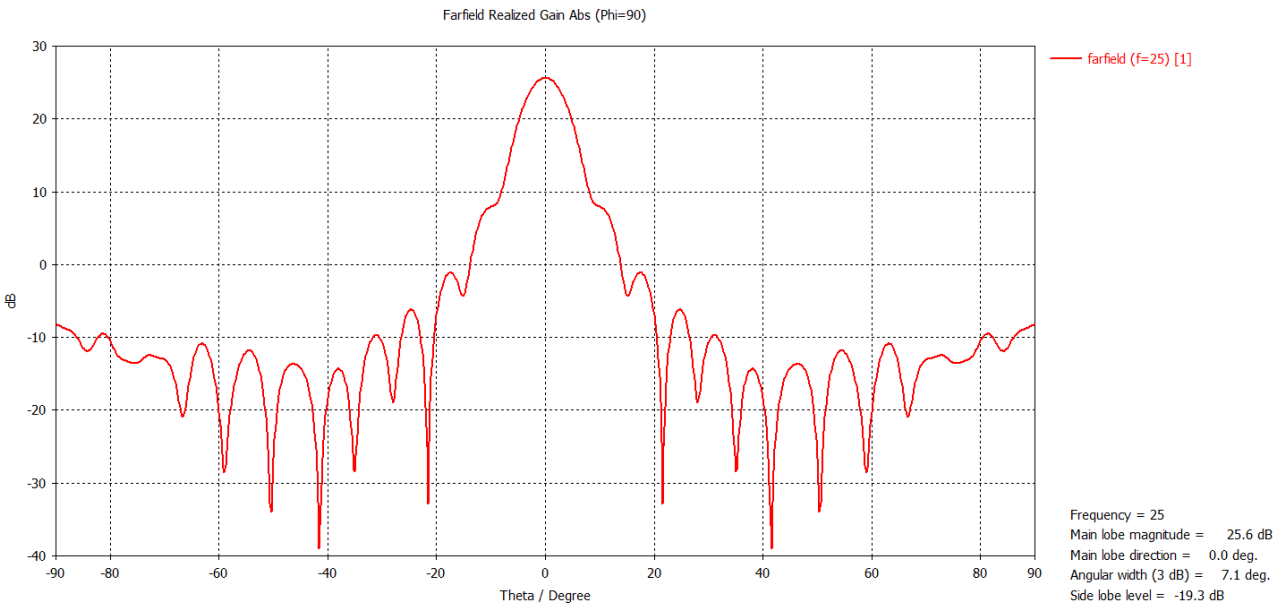

Farfield Realized Gain Abs (Phi=90)
d=6.4
27.5
24.5
d=3
farfield (f=25) [1]
dB
30
20
15
10
5
0
-5
-10
-15
-20
-20
-15
-10
-5
-3.2
0
3.2
5
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 27.5 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 6.4 deg.
Side lobe level = -19.3 dB

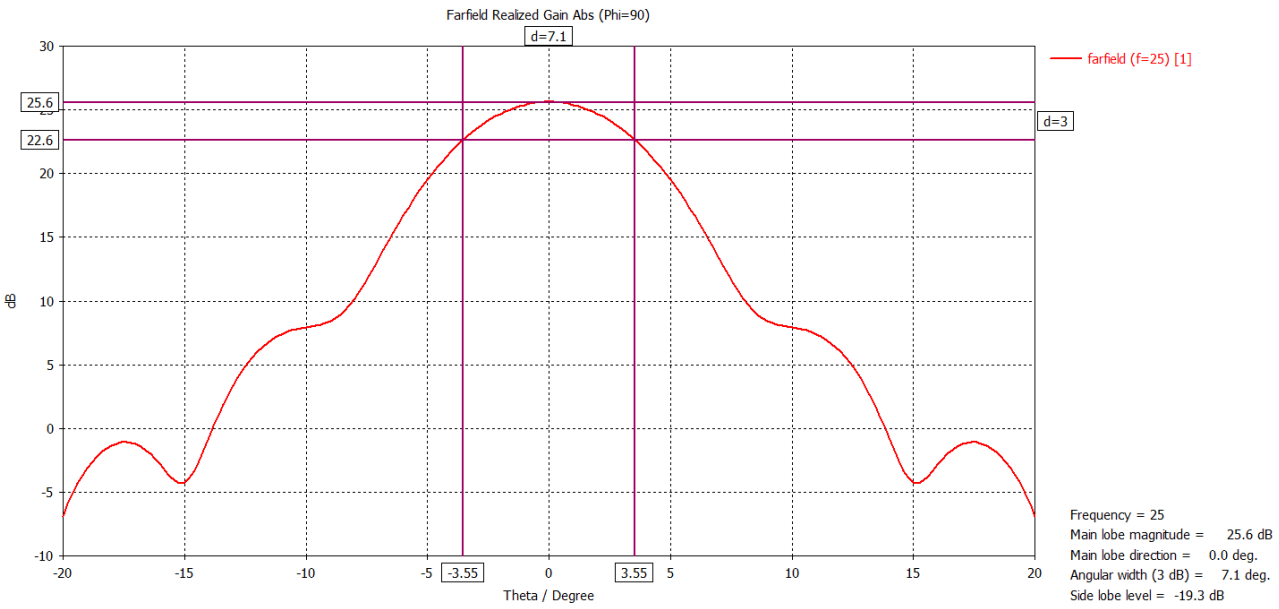
2.10 PEEK / DN100 (4”) Drop



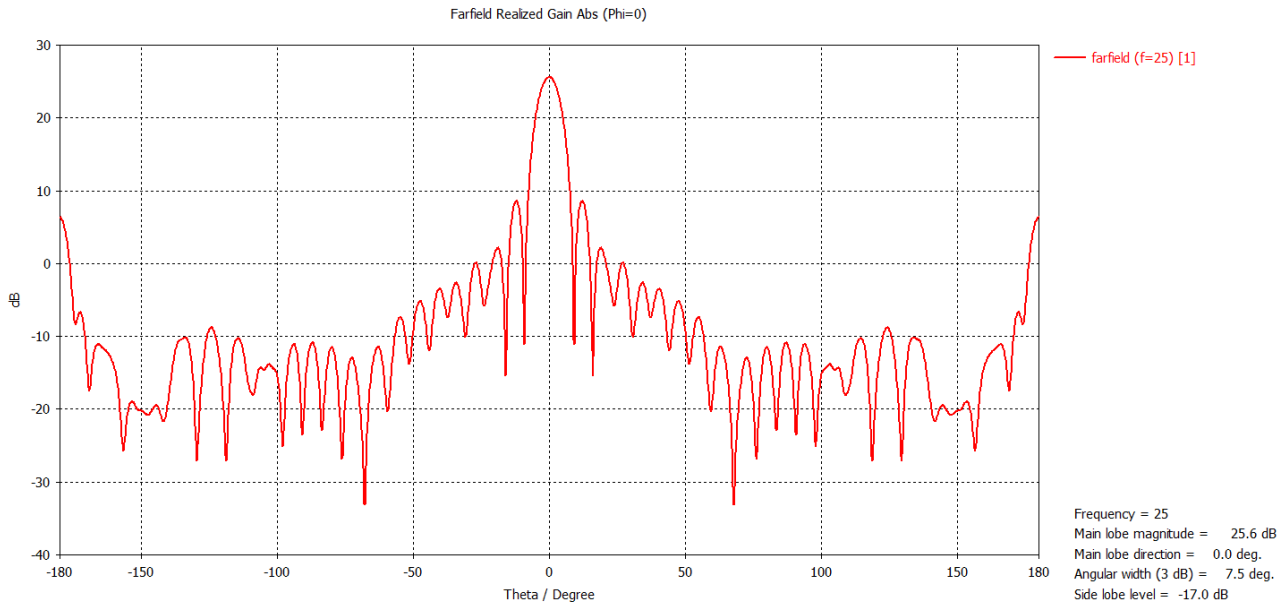
2.10.1 Radiation pattern in E-plane

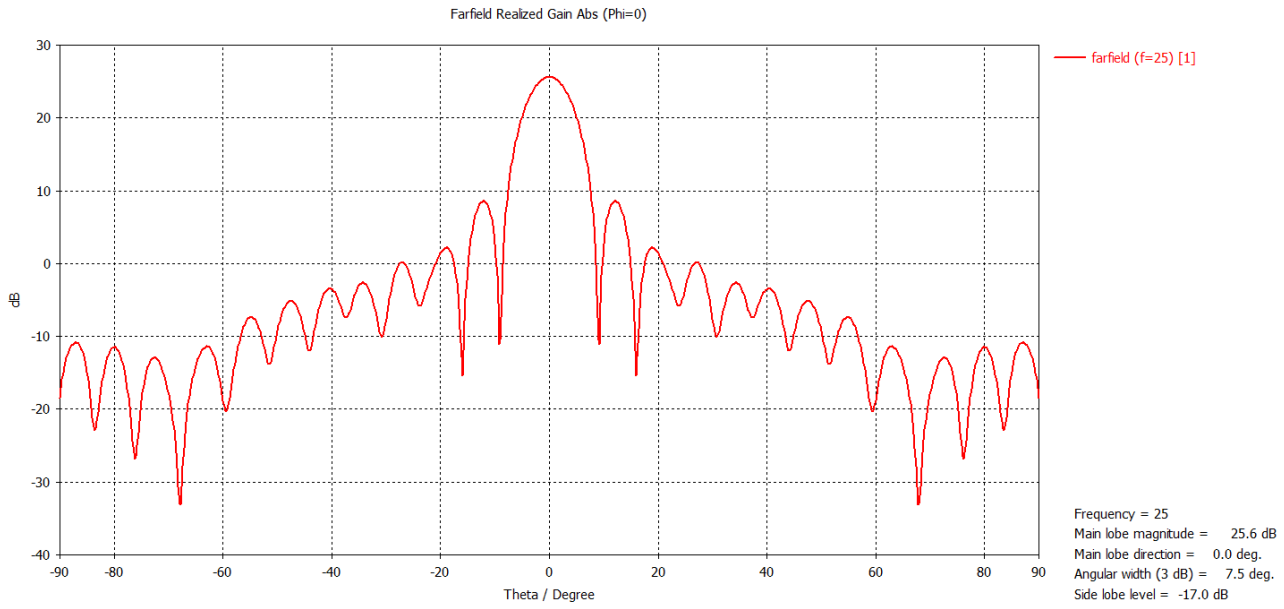


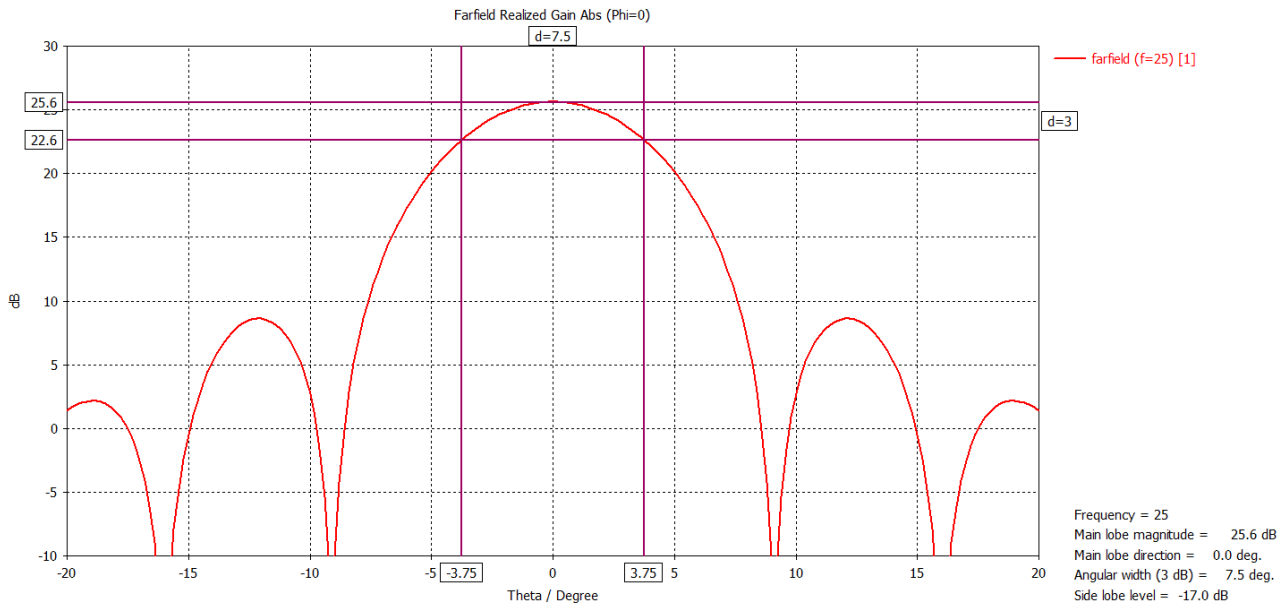

Farfield Realized Gain Abs (Phi=90)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.6 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 7.1 deg.
Side lobe level = -19.3 dB


Farfield Realized Gain Abs (Phi=90)
d=7.1
farfield (f=25) [1]
25.6
22.6
d=3
dB
-3.55
3.55
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.6 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 7.1 deg.
Side lobe level = -19.3 dB

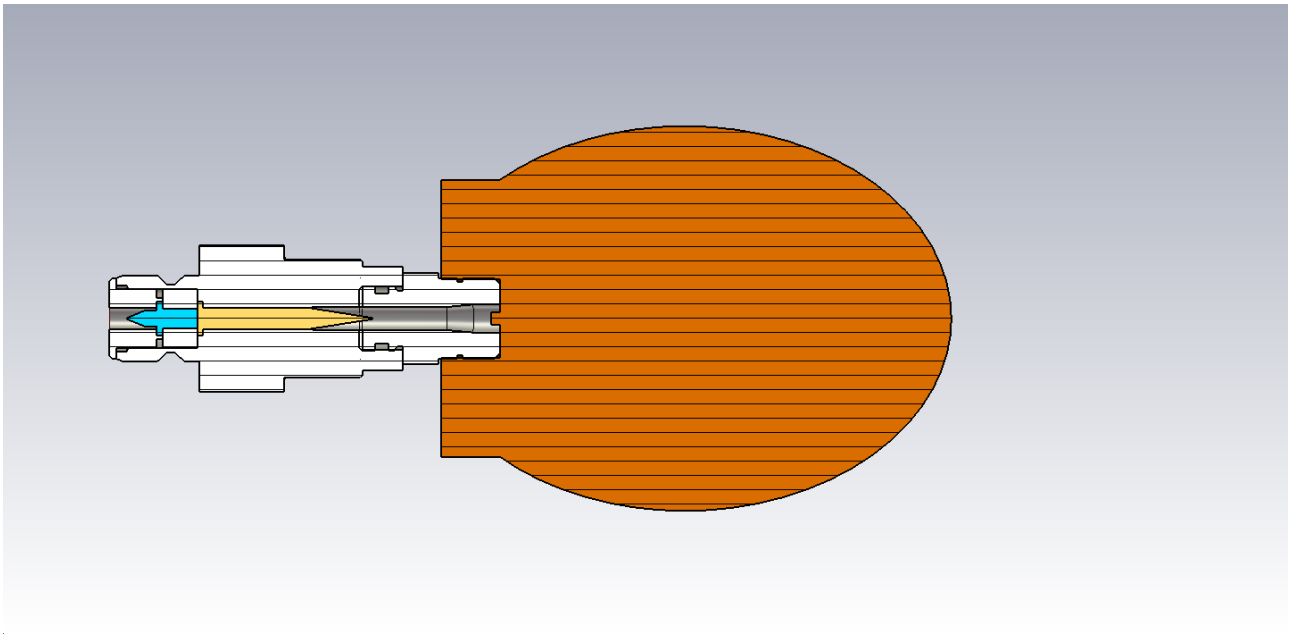
2.10.2 Radiation pattern in H-plane



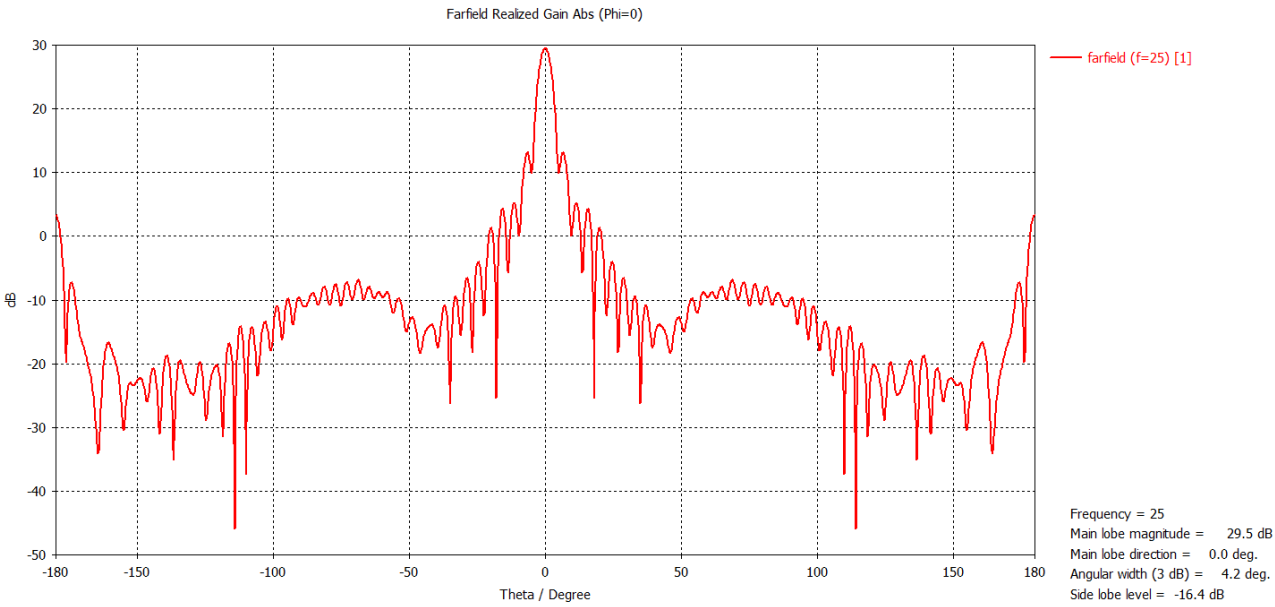


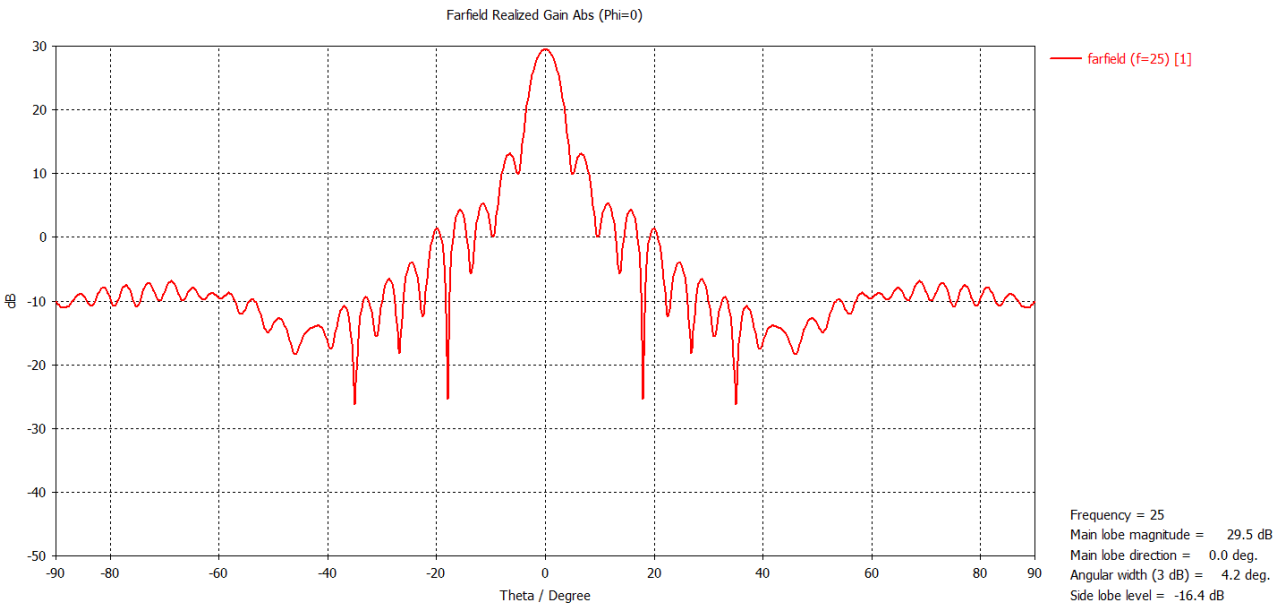

Farfield Realized Gain Abs (Phi=0)
d=7.5
farfield (f=25) [1]
25.6
22.6
d=3
dB
30
20
15
10
5
0
-5
-10
-20
-15
-10
-5
-3.75
0
3.75
5
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 25.6 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 7.5 deg.
Side lobe level = -17.0 dB

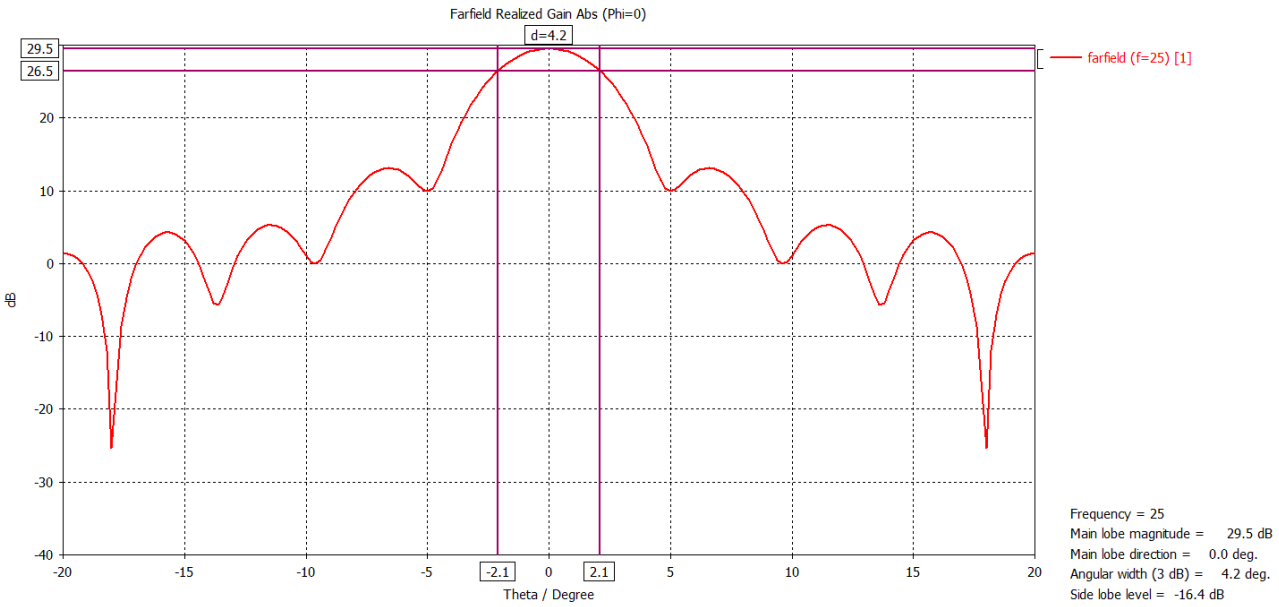
2.11 PTFE / DN150 (6”) Drop



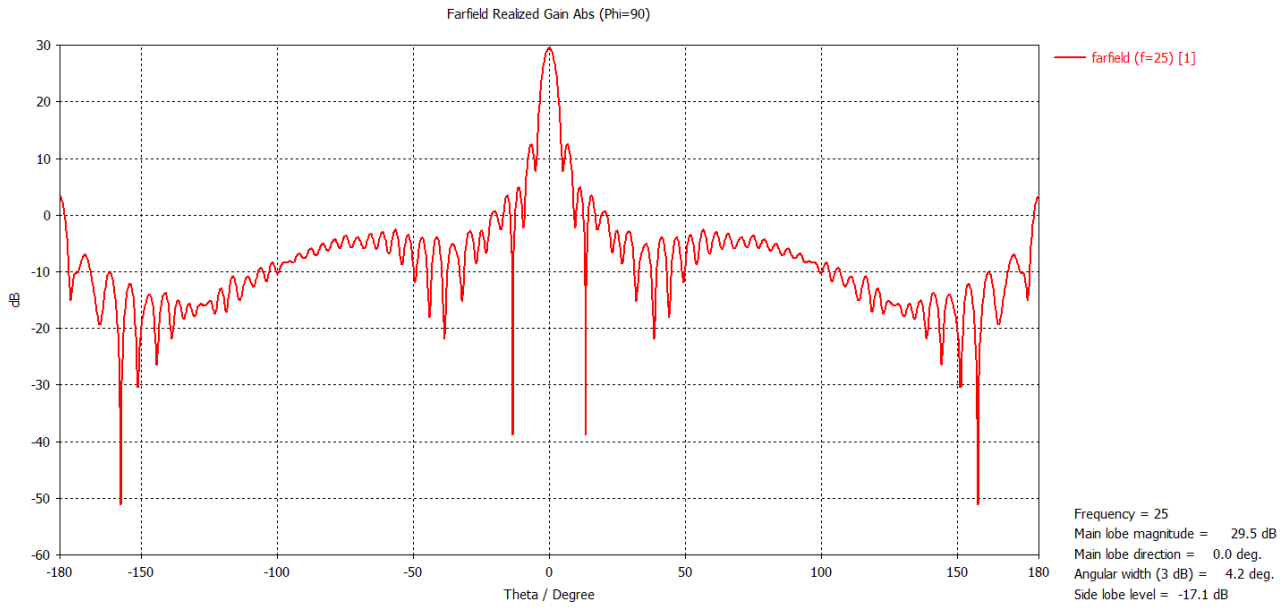
2.11.1 Radiation pattern in E-plane

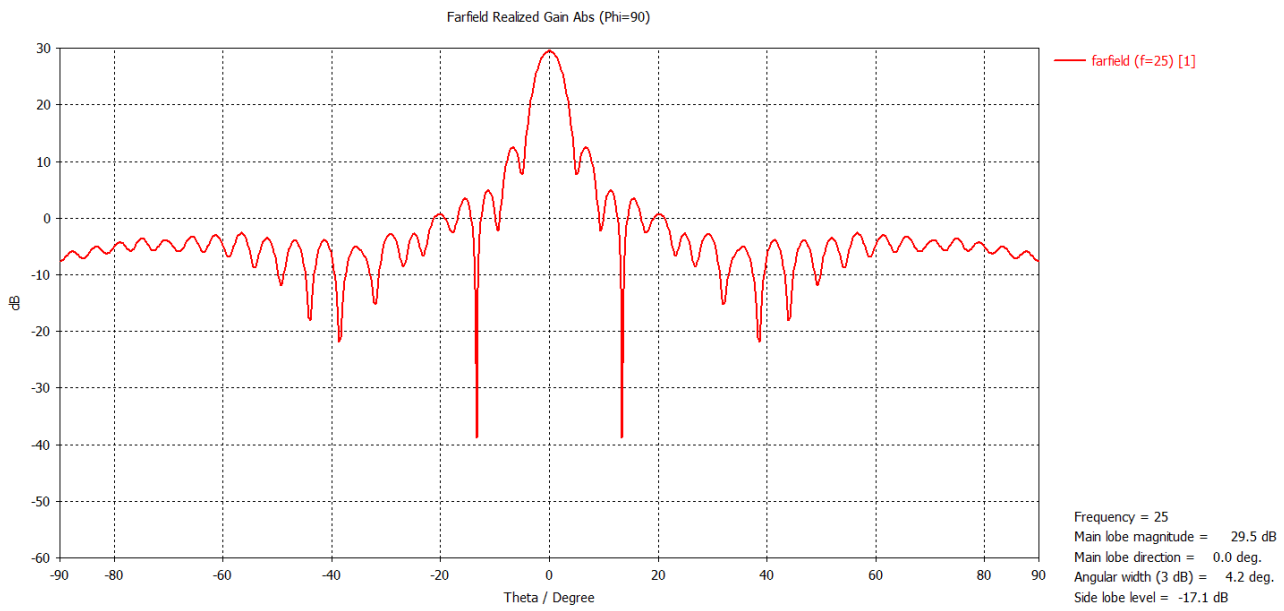


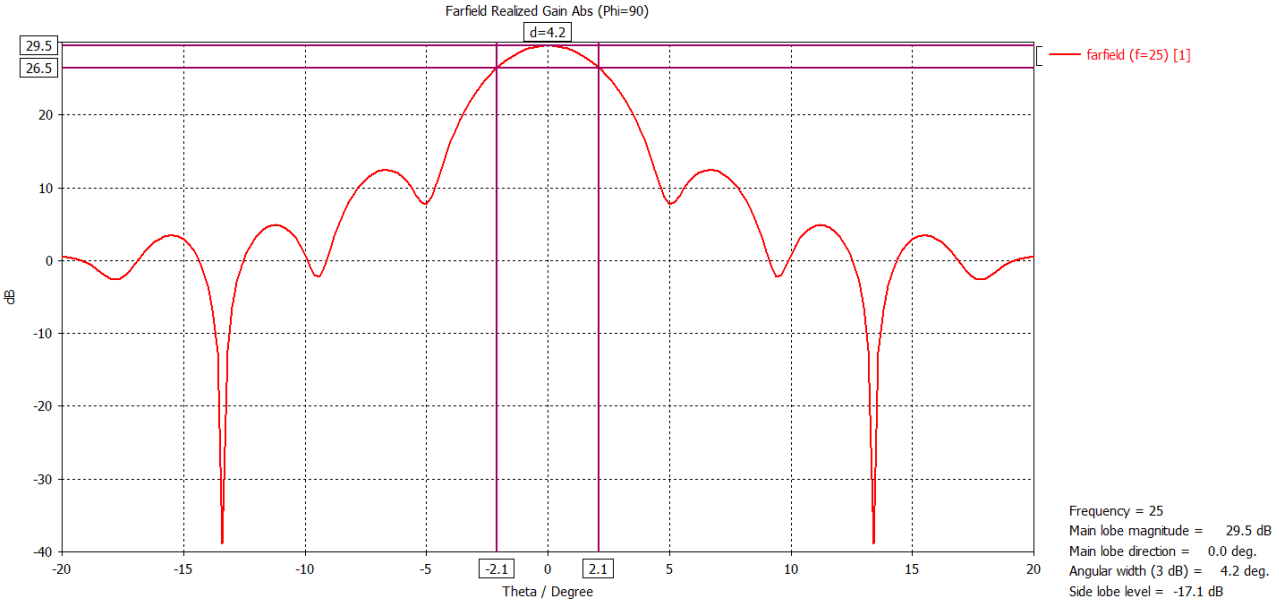

Farfield Realized Gain Abs (Phi=0)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 29.5 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 4.2 deg.
Side lobe level = -16.4 dB


Farfield Realized Gain Abs (Phi=0)
d=4.2
29.5
26.5
farfield (f=25) [1]
dB
-2.1
2.1
Theta / Degree
Frequency = 25
Main lobe magnitude = 29.5 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 4.2 deg.
Side lobe level = -16.4 dB

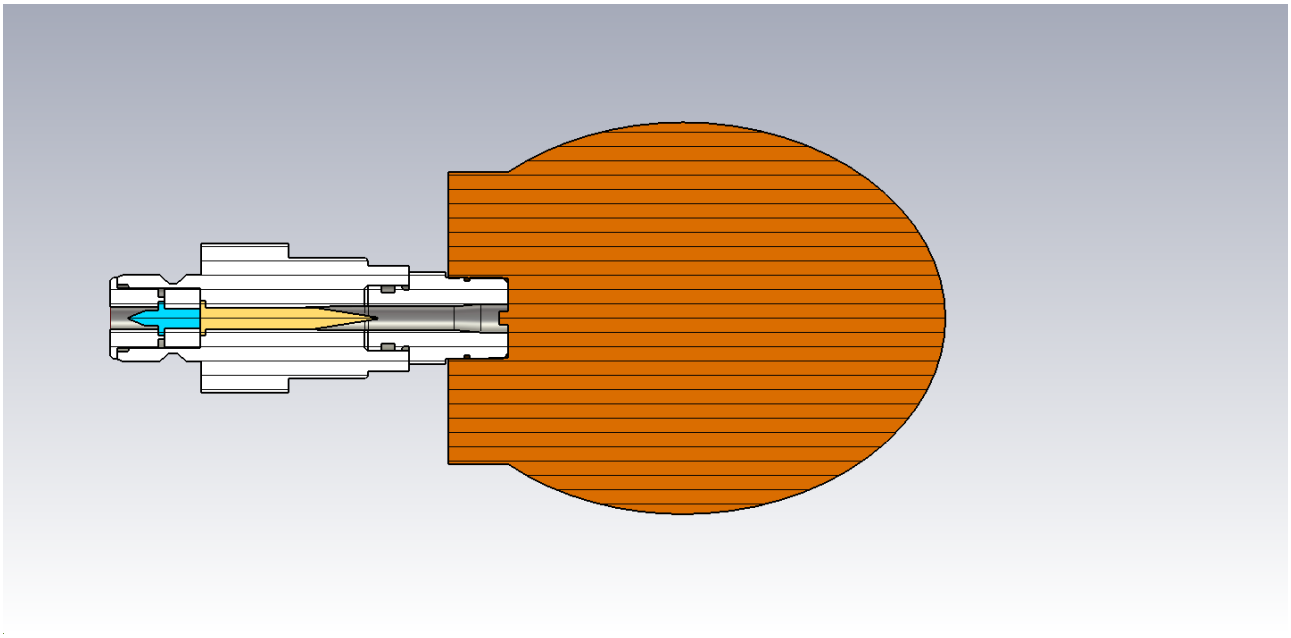
2.11.2 Radiation pattern in H-plane



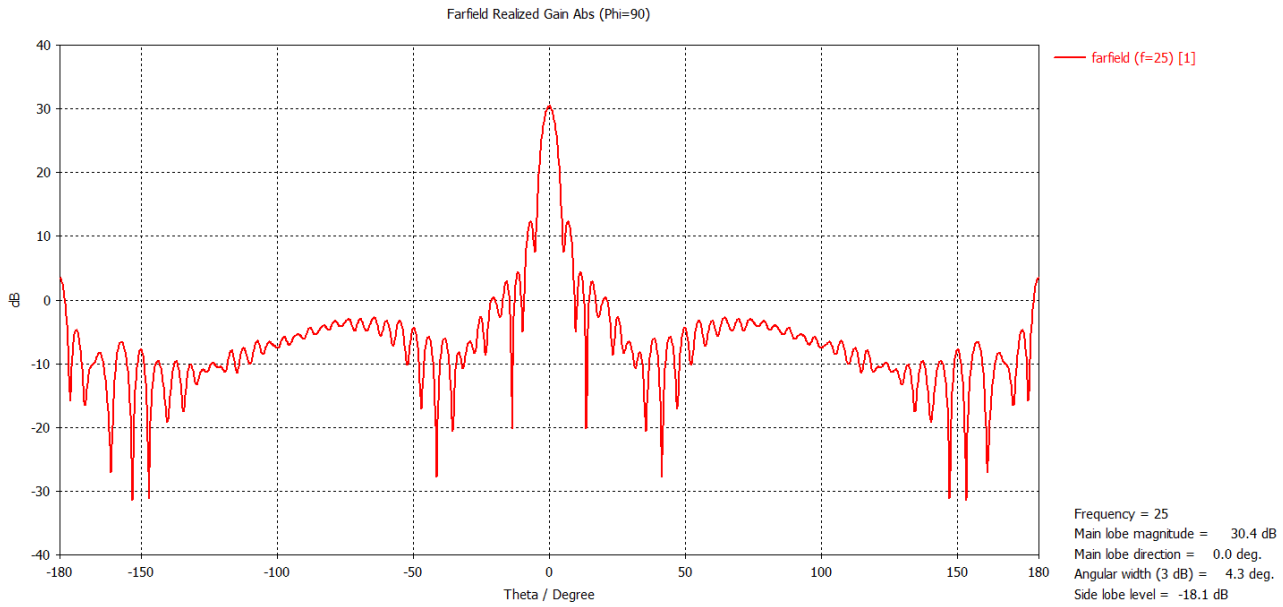


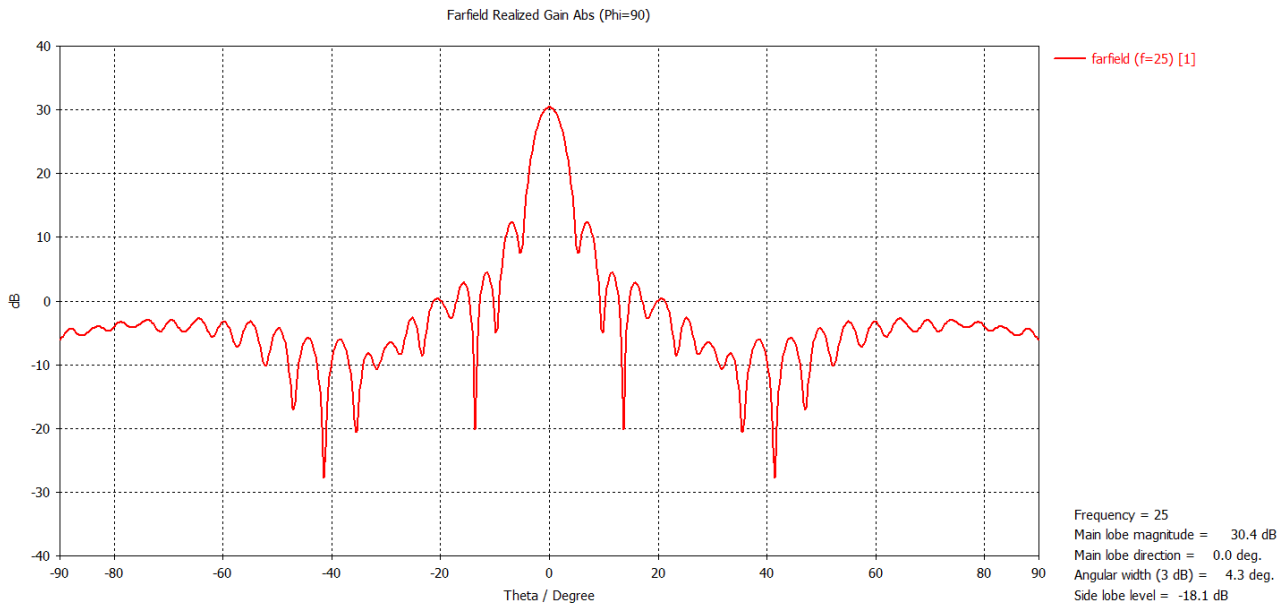

Farfield Realized Gain Abs (Phi=90)
d=4.2
29.5
26.5
farfield (f=25) [1]
dB
20
10
0
-10
-20
-30
-40
-20
-15
-10
-5
-2.1
0
2.1
5
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 29.5 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 4.2 deg.
Side lobe level = -17.1 dB

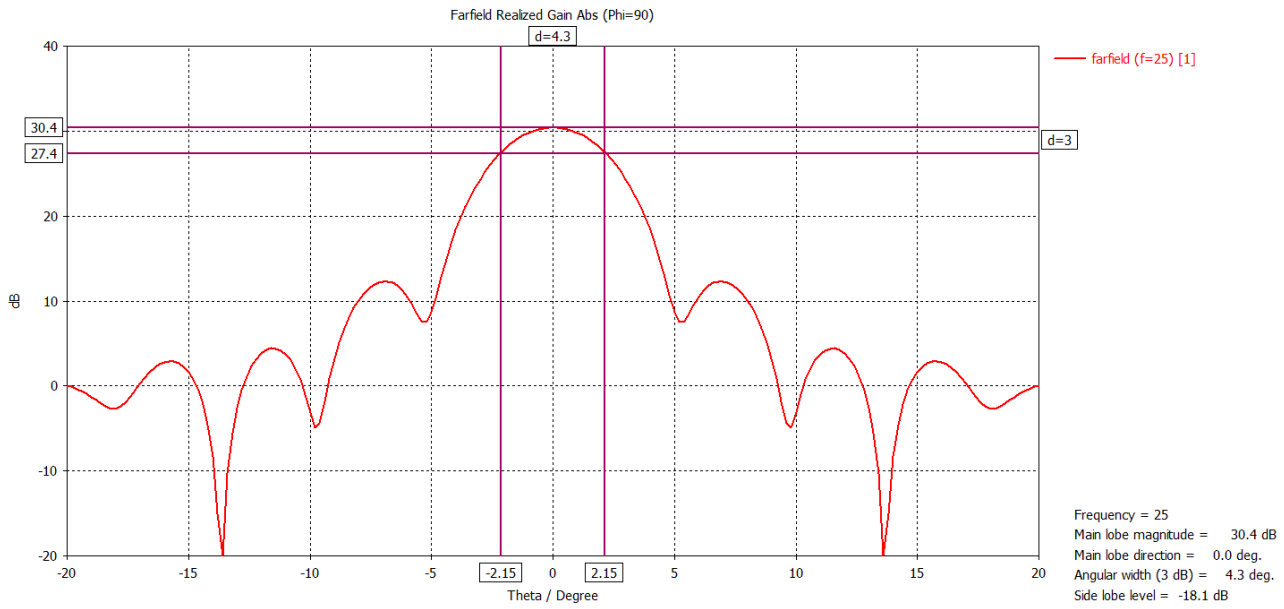
2.12 PP / DN150 (6”) Drop antenna



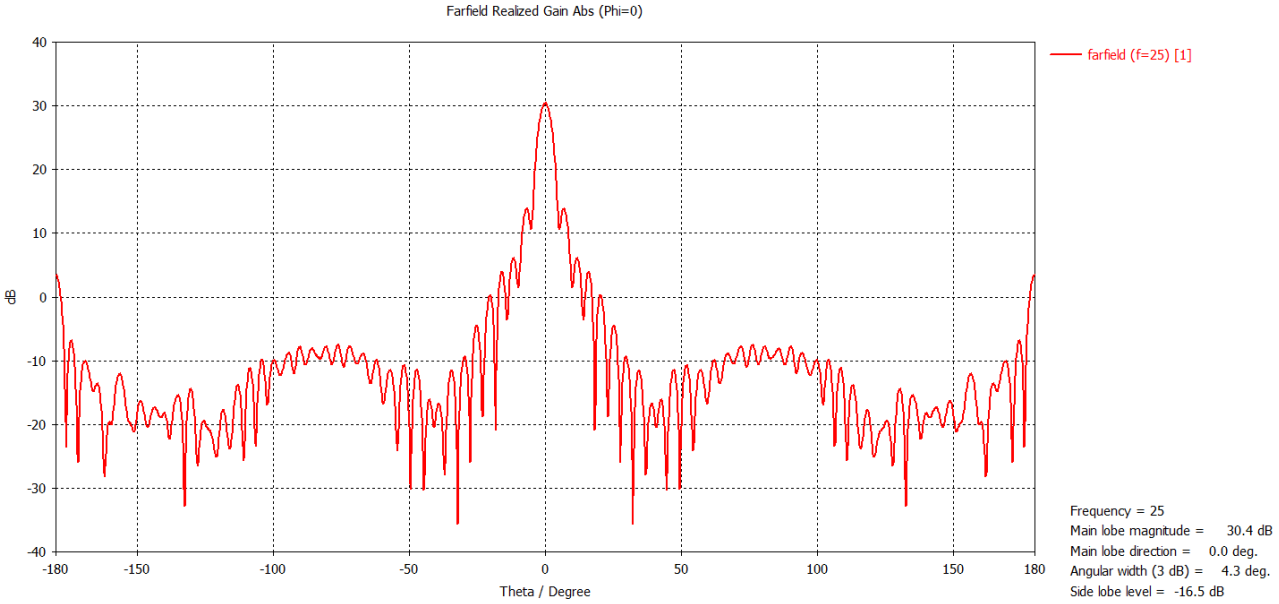
2.12.1 Radiation pattern in E-plane

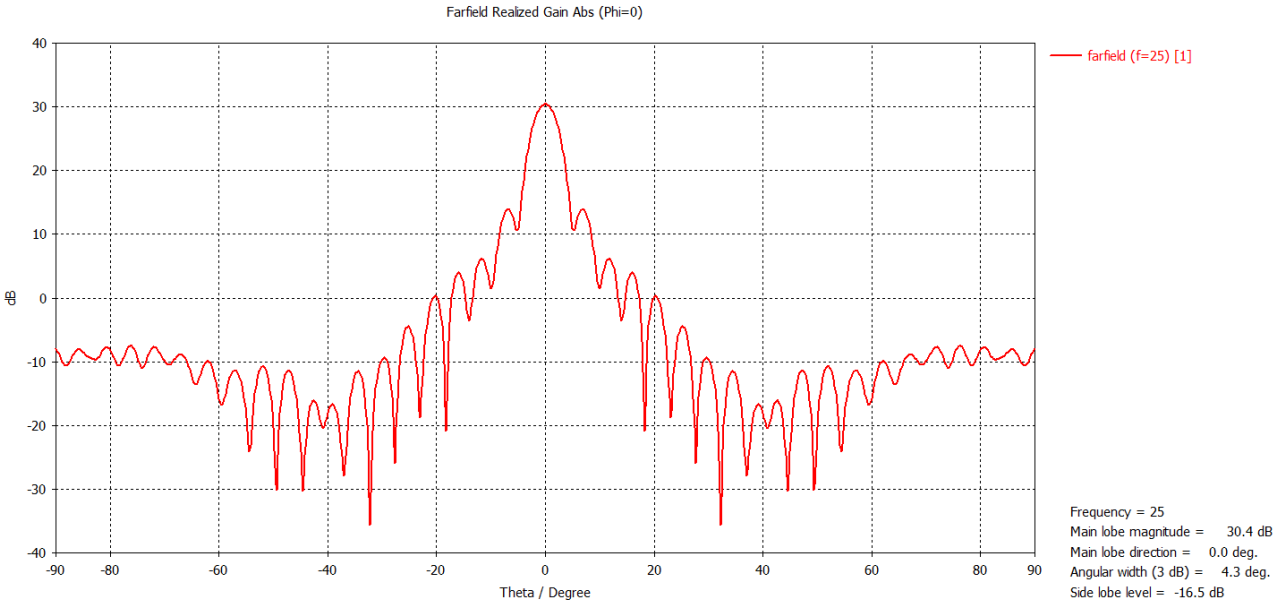


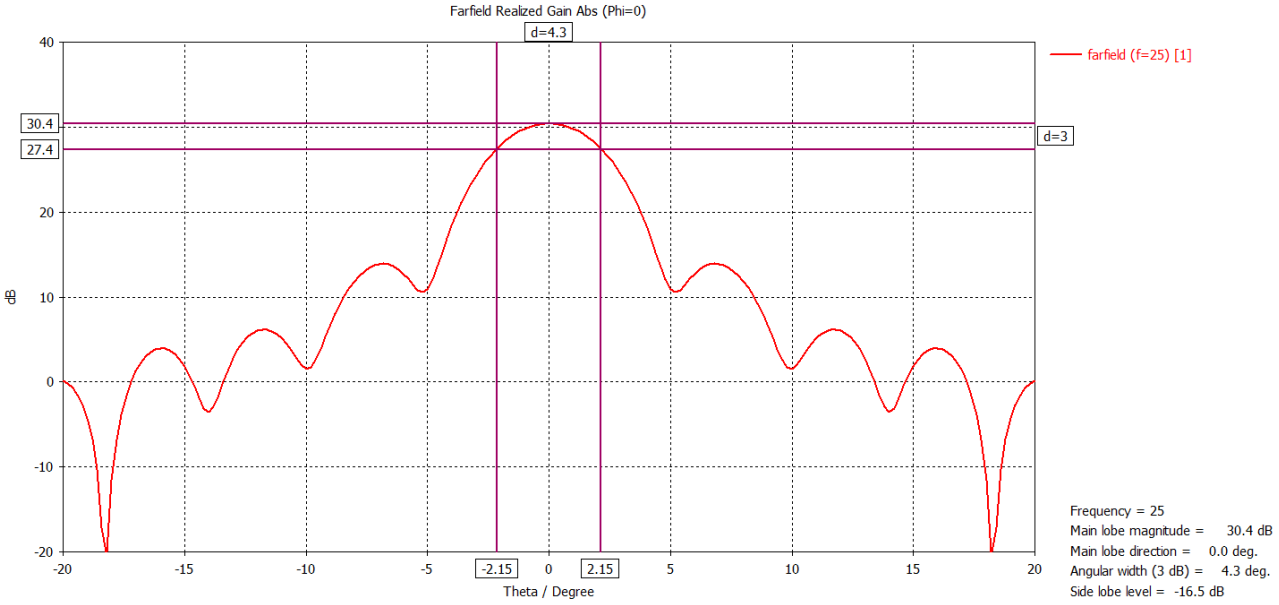

Farfield Realized Gain Abs (Phi=90)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 30.4 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 4.3 deg.
Side lobe level = -18.1 dB


Farfield Realized Gain Abs (Phi=90)
d=4.3
30.4
27.4
d=3
farfield (f=25) [1]
dB
-2.15
2.15
Theta / Degree
Frequency = 25
Main lobe magnitude = 30.4 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 4.3 deg.
Side lobe level = -18.1 dB

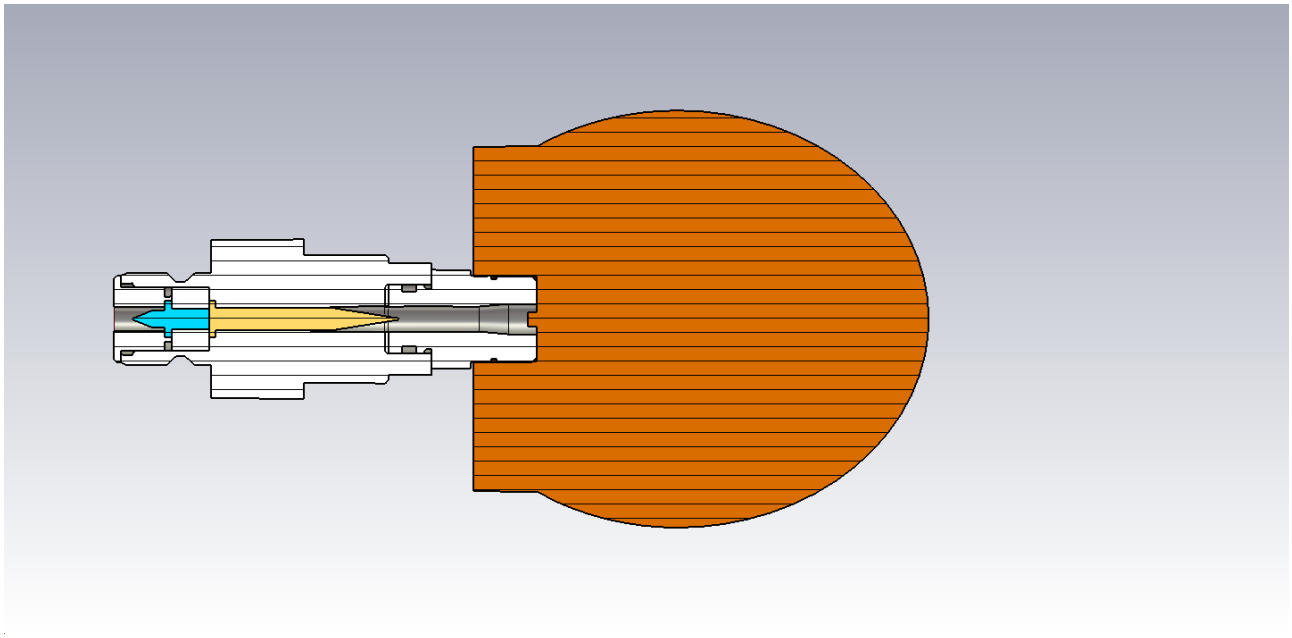
2.12.2 Radiation pattern in H-plane



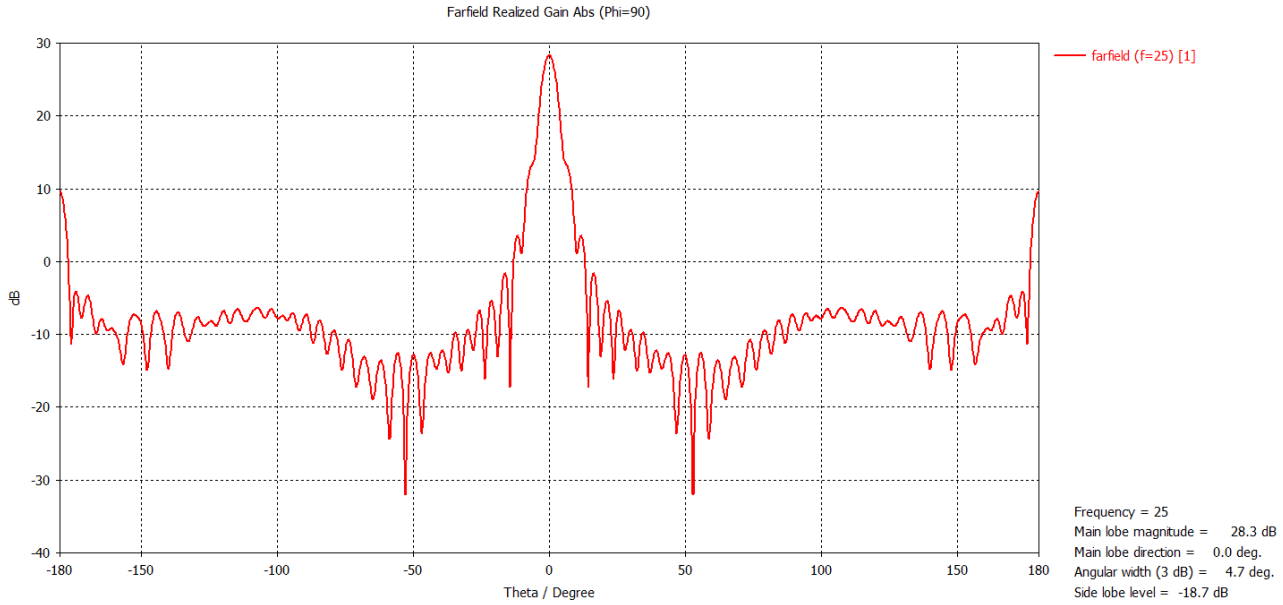


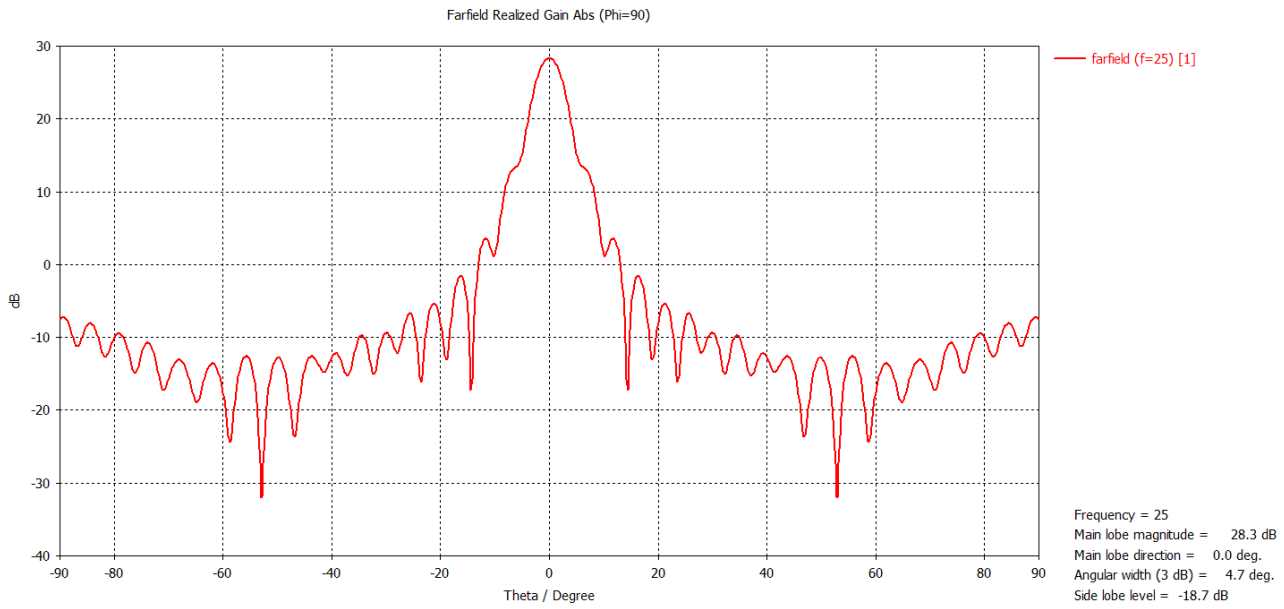

Farfield Realized Gain Abs (Phi=0)
d=4.3
farfield (f=25) [1]
30.4
27.4
d=3
dB
40
20
10
0
-10
-20
-20
-15
-10
-5
-2.15
0
2.15
5
10
15
20
Theta / Degree
Frequency = 25
Main lobe magnitude = 30.4 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 4.3 deg.
Side lobe level = -16.5 dB

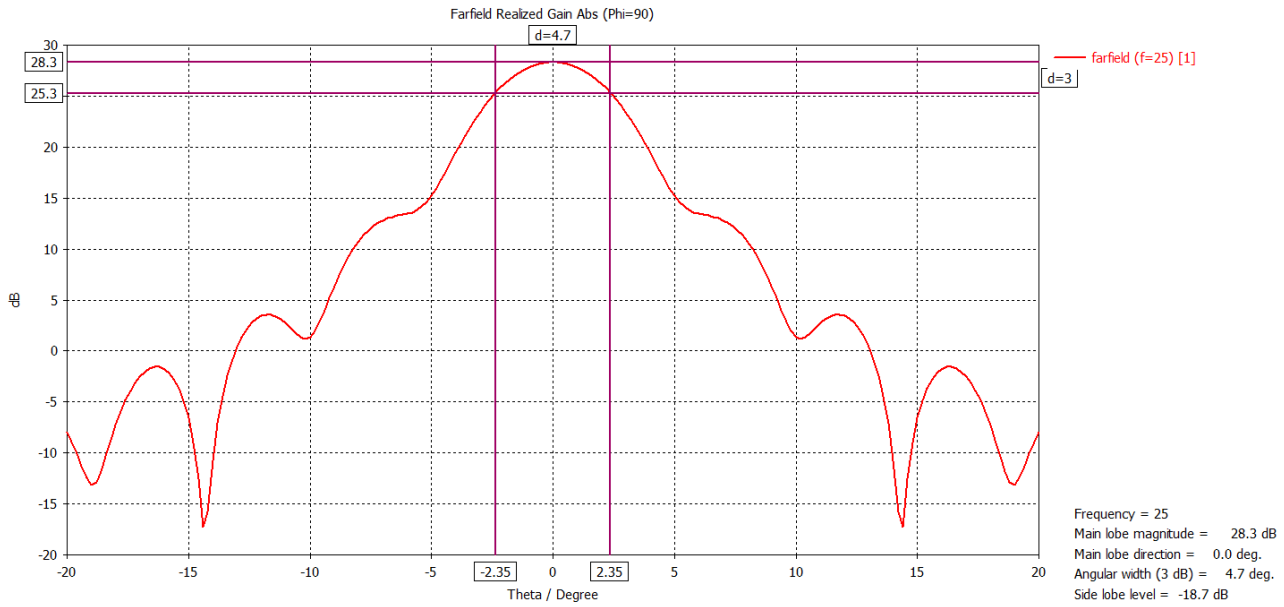
2.13 PEEK / DN150 (6”) Drop



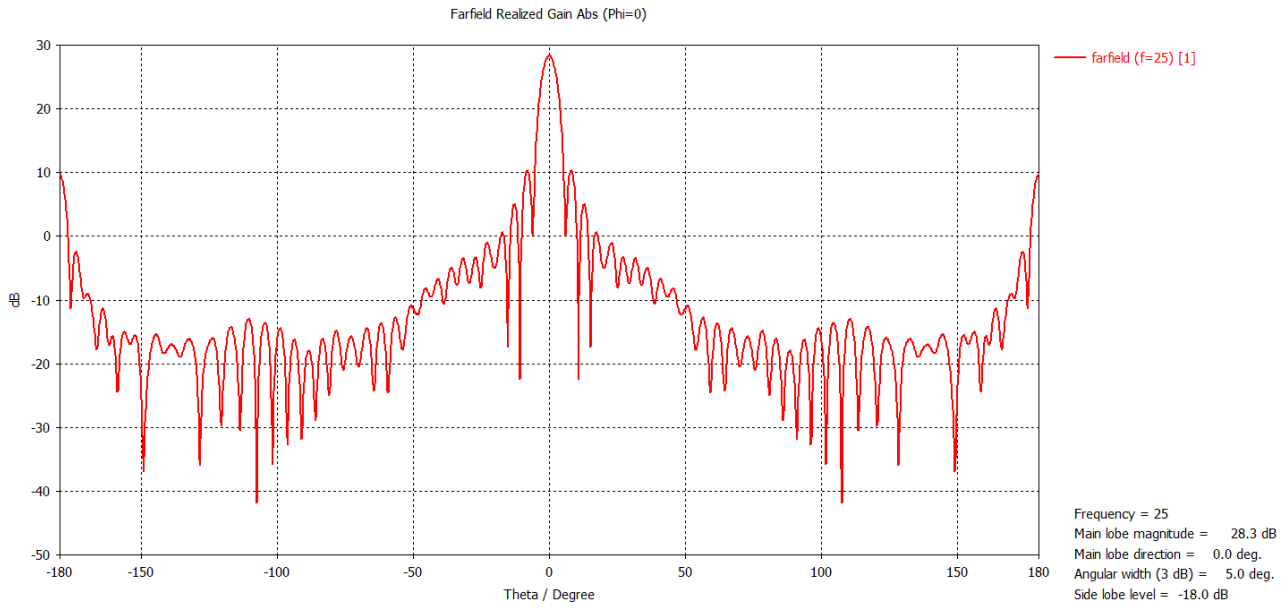
2.13.1 Radiation pattern in E-plane

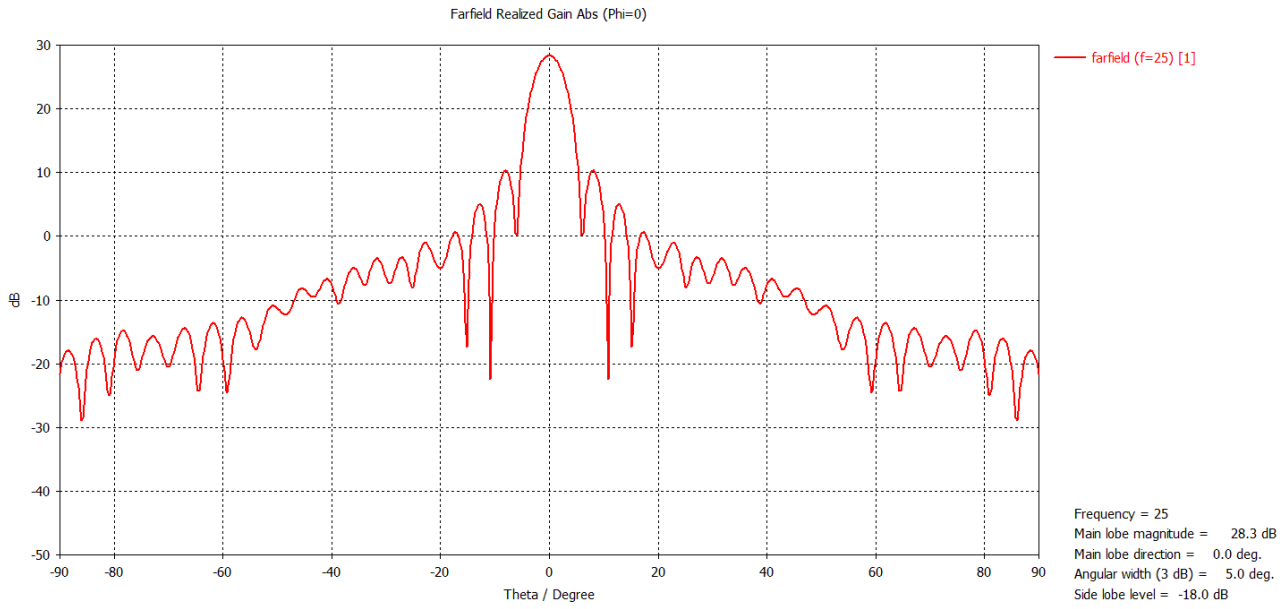


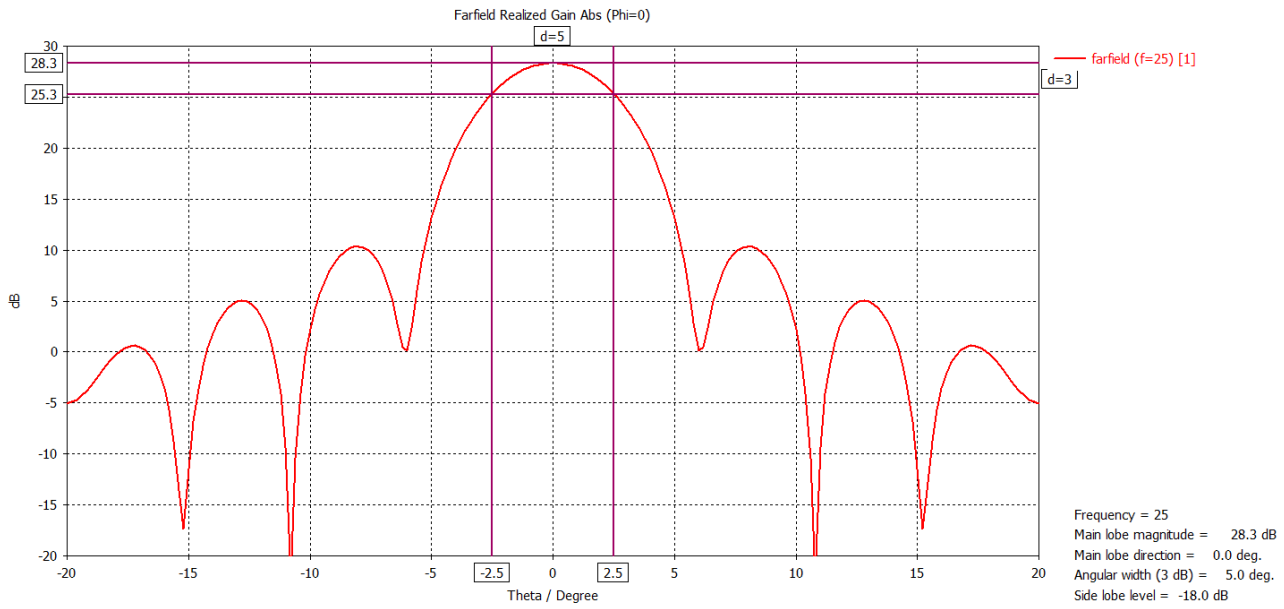

Farfield Realized Gain Abs (Phi=90)
farfield (f=25) [1]
dB
Theta / Degree
Frequency = 25
Main lobe magnitude = 28.3 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 4.7 deg.
Side lobe level = -18.7 dB


Farfield Realized Gain Abs (Phi=90)
d=4.7
28.3
25.3
d=3
farfield (f=25) [1]
dB
-2.35
2.35
Theta / Degree
Frequency = 25
Main lobe magnitude = 28.3 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 4.7 deg.
Side lobe level = -18.7 dB

2.13.2 Radiation pattern in H-plane






Farfield Realized Gain Abs (Phi=0)
d=5
28.3
25.3
d=3
farfield (f=25) [1]
dB
Theta / Degree
-2.5
2.5
Frequency = 25
Main lobe magnitude = 28.3 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 5.0 deg.
Side lobe level = -18.0 dB

2.14 Overview of LPR antennas

Type	Gain [dB]	Angular width E- / H-plane [°]
316L / DN80 (3”) Metallic Horn	24.3	9.2 / 11.8
316L / DN100 (4”) Metallic Horn	25.7	7.7 / 9.6
316L / DN150 (6”) Metallic Horn	27.7	5.6 / 6.6
316L / DN200 (8”) Metallic Horn	28.1	5.1 / 5.8
PTFE / DN80 (3”) Drop	25.5	7.6 / 7.5
PP / DN80 (3”) Drop	25.8	7.8 / 7.8
PEEK / DN80 (3”) Drop	24.0	9.1 / 9.6
PTFE / DN100 (4”) Drop	27.0	6.1 / 6.2
PP / DN100 (4”) Drop	27.5	6.3 / 6.4
PEEK / DN100 (4”) Drop	25.6	7.1 / 7.5
PTFE / DN150 (6”) Drop	29.5	4.2 / 4.2
PP / DN150 (6”) Drop	30.4	4.3 / 4.3
PEEK / DN150 (6”) Drop	28.3	4.7 / 5.0