“High performance horn antenna design (II)”

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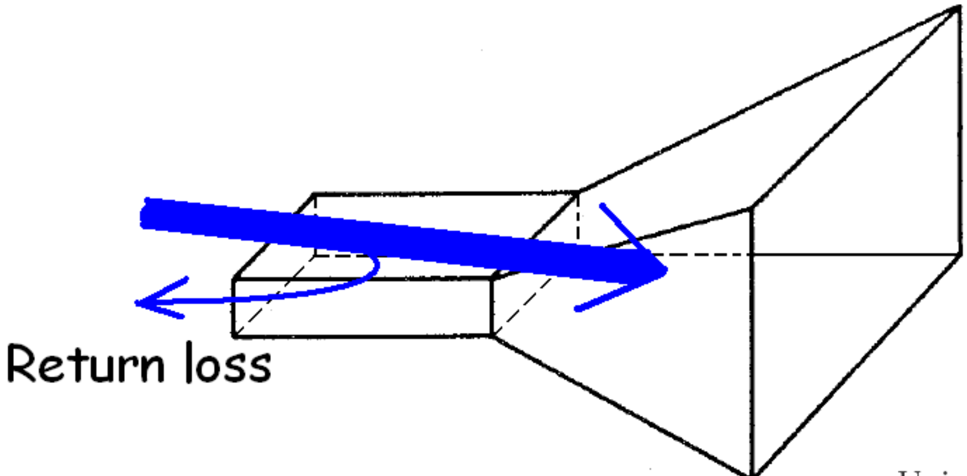
Feed-horns

Feed-horns

- Feed-horns are widely used in microwave and millimeter wave bands because they provide moderate to high gain, low return loss, wide bandwidth and they are usually relatively easy to manufacture
- Feed-horn theoretical simulations are extremely similar to measurements, so feed-horn behavior can be easily predicted prior to be manufactured



Feed-horns

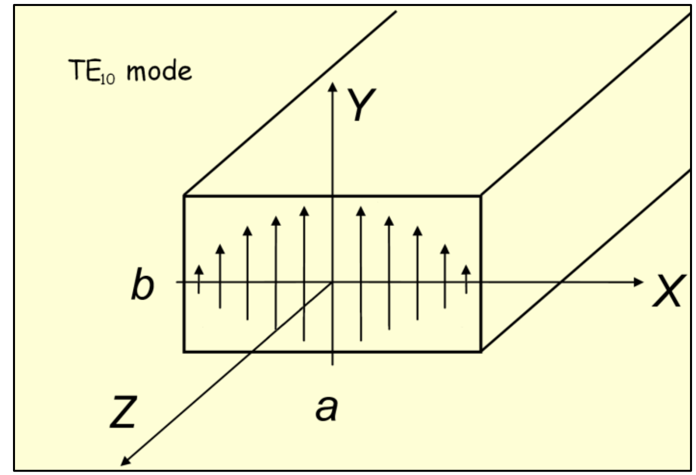
- Feed-horns can be classified:
  - Rectangular feed-horns:
    - Sectoral feed-horns (E-plane and H plane)
    - Pyramidal feed-horns
  - Conical feed-horns:
    - Smooth-walled conical feed-horns
    - Corrugated conical feed-horns
  - Profiled feed-horns
    - Multimode smooth-walled feed-horns
    - Corrugated profiled feed-horns

Rectangular feed-horns

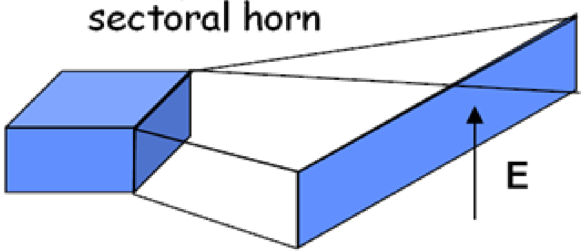
Rectangular feed-horns

- Rectangular feed-horns are fed with the fundamental TE_{10} mode of a rectangular metallic waveguide:

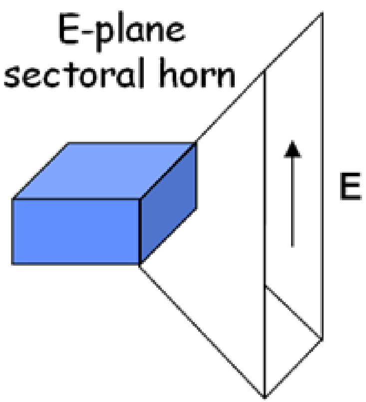
$$\vec{E}(x, y) = E_0 \cdot \cos\left(\frac{\pi \cdot x}{a}\right) \cdot \vec{u}_y$$



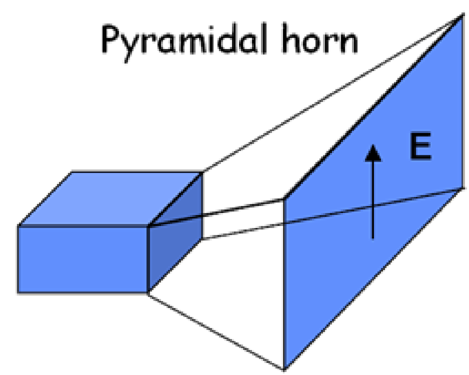
H-plane sectoral horn



E-plane sectoral horn



Pyramidal horn



H-plane sectoral feed-horns

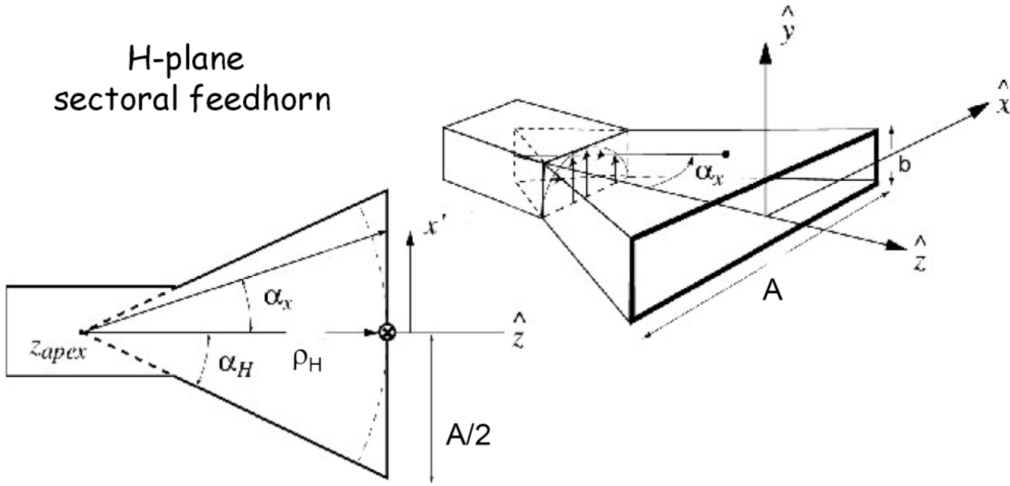
Rectangular feed-horns

- An H-plane sectoral feed-horn is the one where the wider dimension of the input waveguide is broadened remaining constant the other dimension
- The aperture field is affected by a phase error in the H-plane:

$$\vec{E}(x, y) = E_0 \cdot \cos\left(\frac{\pi \cdot x}{A}\right) \cdot e^{-j \cdot 8 \cdot \pi \cdot t \cdot \frac{x^2}{A^2}} \cdot \vec{u}_y$$

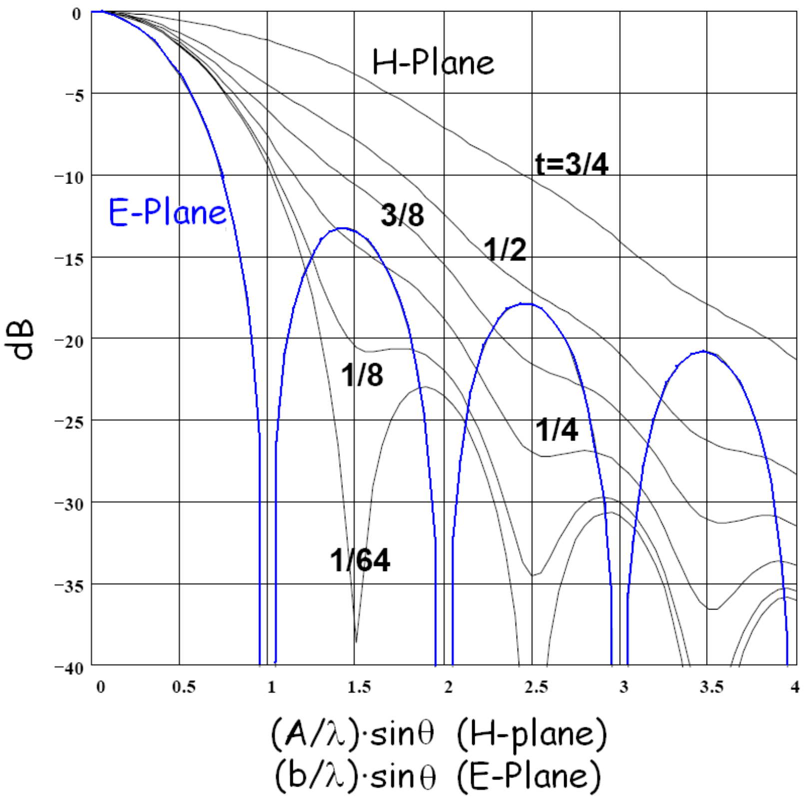
where t is the phase error at the aperture (in turns),

$$t = \frac{A^2}{8 \cdot \lambda \cdot \rho_H}$$



Rectangular feed-horns

- The universal radiation patterns for the H-plane sectoral feed-horn are represented with the phase error as parameter for H-plane
- E-plane radiation pattern is just a “Sinc” as a result of applying the Fourier transform to a pulse
- Phase error elevates the side-lobe level filling the nulls between adjacent side-lobes



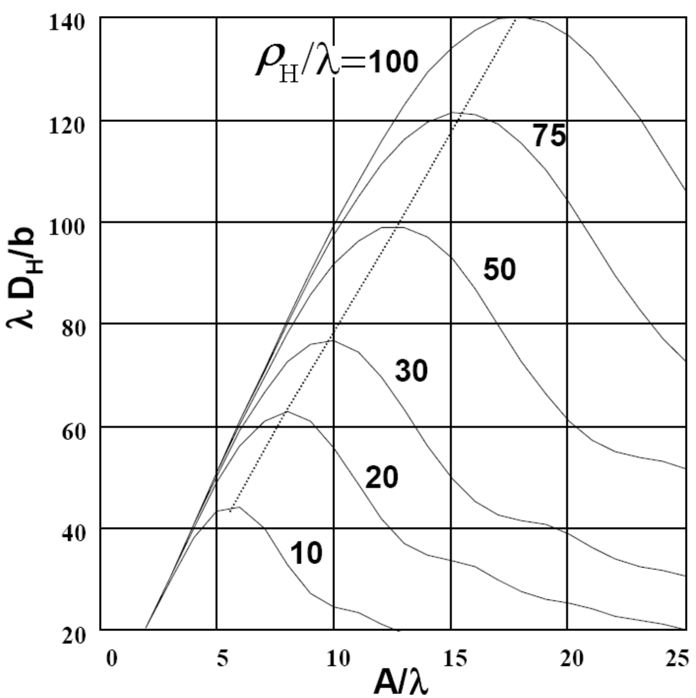
Rectangular feed-horns

- The directivity, (D_H), of the H-plane sectoral horn is obtained integrating the power at the aperture
- For every ρ_H value, there is an optimum aperture width (A) that gives maximum directivity
- Optimum aperture satisfy the equation:

$$A = \sqrt{3 \cdot \lambda \cdot \rho_H}$$

these optimum feed-horns present a phase error of:

$$t_{opt} = \frac{A^2}{8 \cdot \lambda \cdot \rho_H} = \frac{3}{8}$$



E-plane sectoral feed-horns

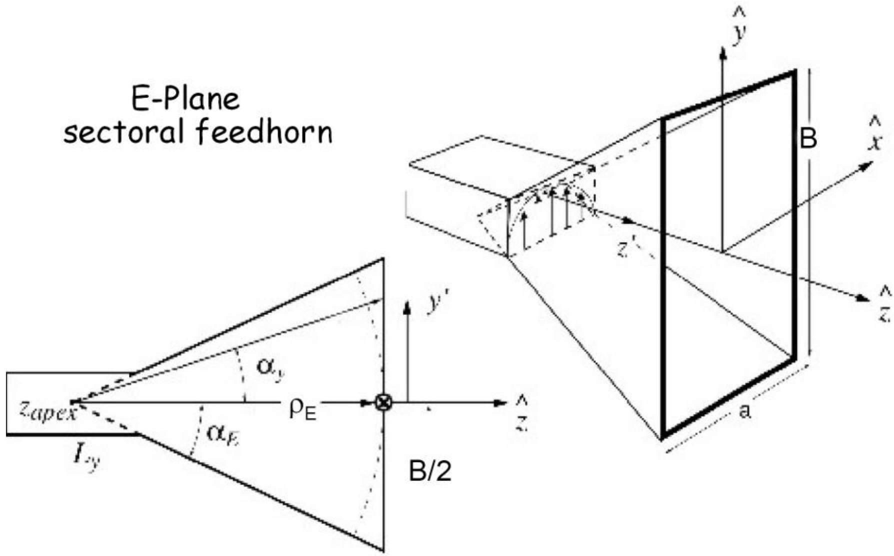
Rectangular feed-horns

- An E-plane sectoral feed-horn is the one where the narrower dimension of the input waveguide is broadened remaining constant the other dimension
- The aperture field is affected by a phase error in the E-plane

$$\vec{E}(x, y) = E_0 \cdot \cos\left(\frac{\pi \cdot x}{A}\right) \cdot e^{-j \cdot 8 \cdot \pi \cdot s \cdot \frac{y^2}{B^2}} \cdot \vec{u}_y$$

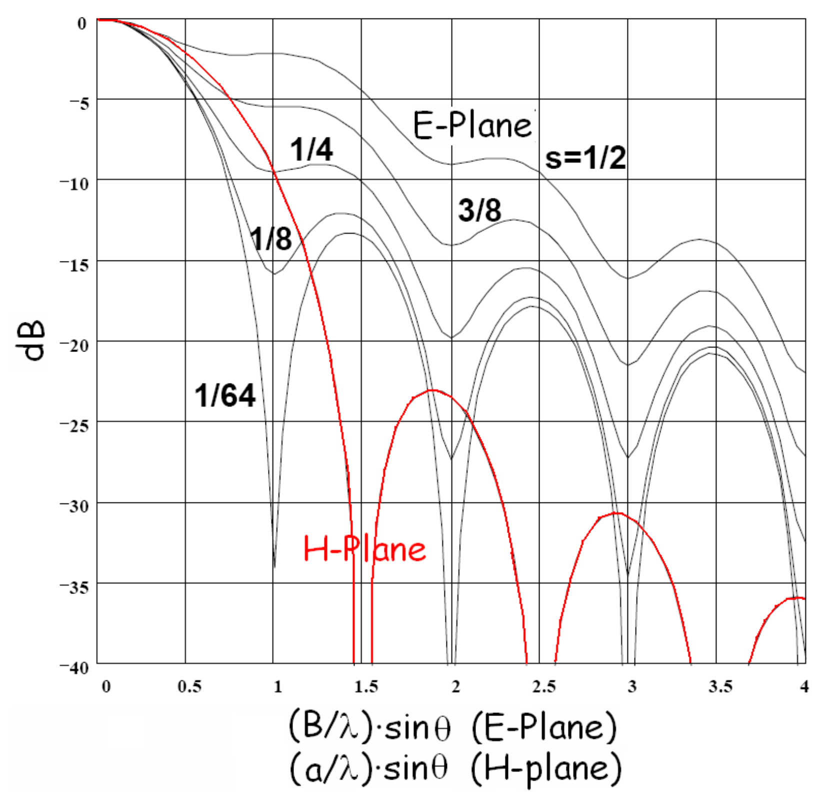
where *s* is the phase error expressed in turns:

$$s = \frac{B^2}{8 \cdot \lambda \cdot \rho_E}$$



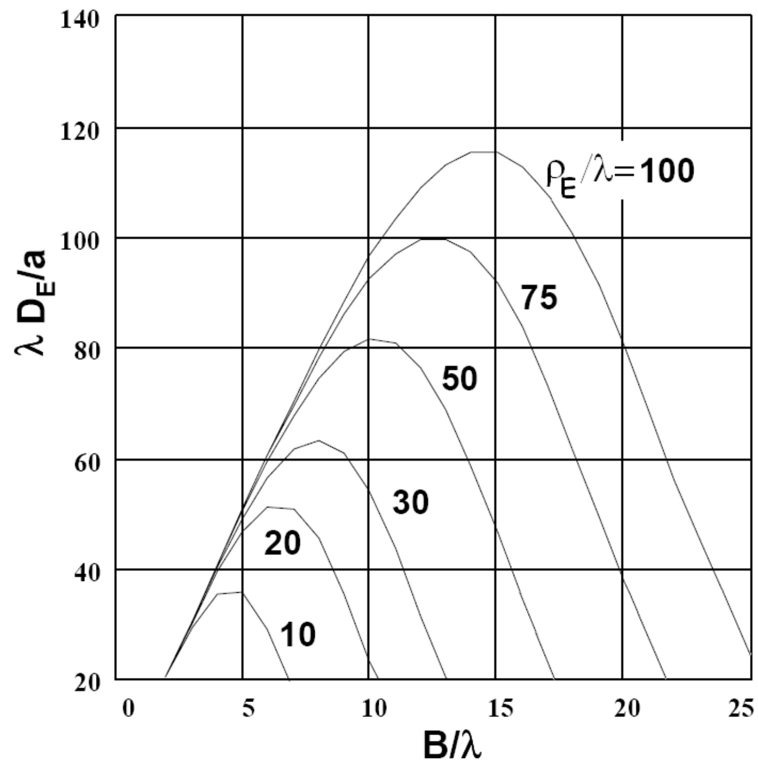
Rectangular feed-horns

- The universal radiation patterns for the E-plane sectoral feed-horn are represented with the phase error as parameter for E-plane
- H-plane radiation pattern results by applying Fourier transform to a cosine windowed pulse (lower side-lobes than a Sinc function)
- Phase error elevates the side-lobe level filling the null between adjacent side-lobes



Rectangular feed-horns

- The directivity, (D_E), of the E-plane sectoral horn is obtained integrating the power at the aperture
- For every ρ_E value, there is an optimum aperture width (B) that gives maximum directivity
- Optimum aperture satisfy the equation: $B = \sqrt{2 \cdot \lambda \cdot \rho_E}$



- These optimum feed-horns present a phase error of:

$$s_{opt} = \frac{B^2}{8 \cdot \lambda \cdot \rho_E} = \frac{1}{4}$$

Pyramidal feed-horns

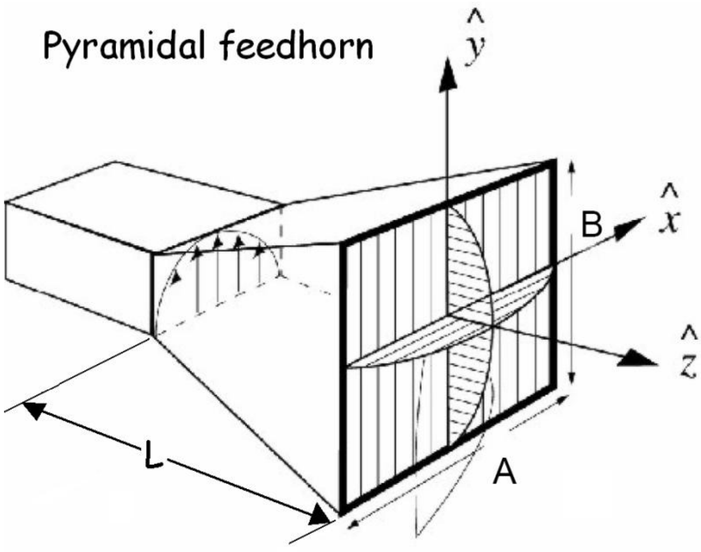
Rectangular feed-horns

- An pyramidal feed-horn is the one where both dimensions of the input waveguide are broadened
- The aperture field is affected by a phase error in both planes

$$\vec{E}(x,y) = E_0 \cdot \cos\left(\frac{\pi \cdot x}{A}\right) \cdot e^{-j \cdot 8 \cdot \pi \cdot t \cdot \frac{x^2}{A^2}} \cdot e^{-j \cdot 8 \cdot \pi \cdot s \cdot \frac{y^2}{B^2}} \cdot \vec{u}_y$$

- These feed-horns must satisfy geometrical condition:

$$\rho_H \cdot \left(1 - \frac{a}{A}\right) = \rho_E \cdot \left(1 - \frac{b}{B}\right) = L$$



Rectangular feed-horns

- The radiation pattern of a pyramidal horn can be directly obtained from the universal radiation patterns of sectoral E and H-plane feed-horns
- The directivity of a pyramidal horn can be expressed as a combination of the directivities of the sectoral feed-horns:

$$D_p = \frac{\pi}{32} \cdot \left(\frac{\lambda}{A} \cdot D_E \right) \cdot \left(\frac{\lambda}{B} \cdot D_H \right)$$

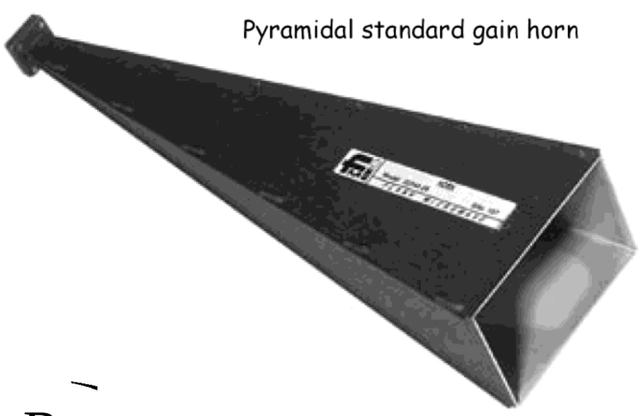
where the terms between parentheses can be obtained directly from the curves of directivity of sectoral feed-horns changing *a* with *A* and *b* with *B*

Rectangular feed-horns

- Pyramidal feed-horns are usually used as standard gain horns serving as reference for gain measurements
- Pyramidal standard gain horns are usually designed under the optimum condition:

$$A = \sqrt{3 \cdot \lambda \cdot \rho_H} \qquad B = \sqrt{2 \cdot \lambda \cdot \rho_E}$$

- The effective aperture of these pyramidal feed-horns is around 50% of its physical size, so:



$$G = \varepsilon_{ap} \cdot \frac{4 \cdot \pi}{\lambda^2} \cdot A_p = \frac{1}{2} \cdot \frac{4 \cdot \pi}{\lambda^2} \cdot (A \cdot B)$$

Rectangular feed-horns

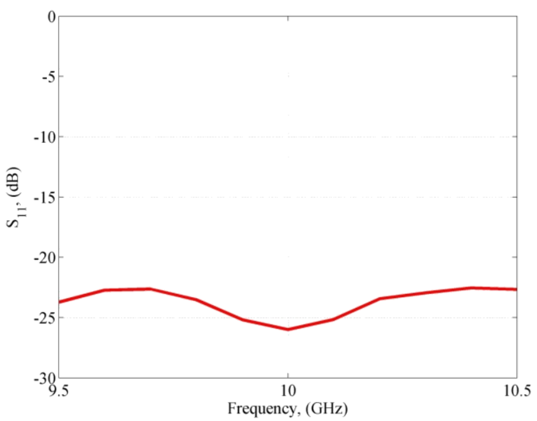
- Example: Design a 20 dB gain pyramidal horn at 10 GHz under optimum condition with equal E and H planes beam-width and with WR-90 standard waveguide as feeding waveguide
  – First we calculate the A·B area of the aperture by using approximate gain formula that relates gain and aperture surface:

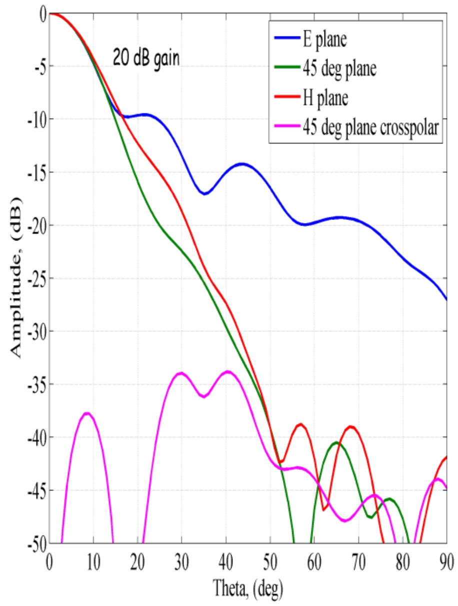
$$A \cdot B = 14323.94\ \mathrm{mm}^2$$

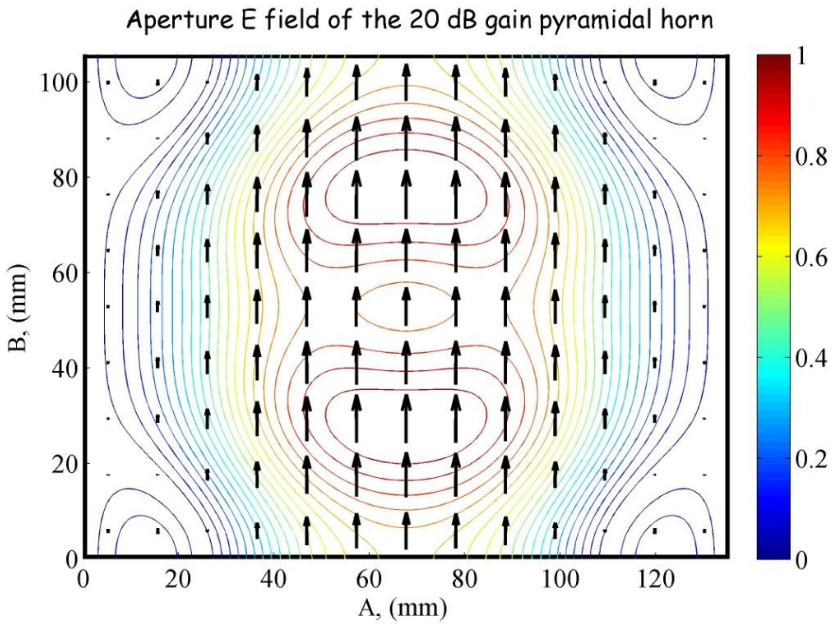
  – For a metallic horn antenna with no dielectric material inside, gain and directivity can be considered to be the same
  – WR-90 standard waveguide has a=23 mm and b=10mm as internal dimensions

Rectangular feed-horns

- If we calculate for optimum condition the dimensions of the pyramidal horn satisfying its geometrical condition we obtain the following dimensions:
- A = 135.4 mm, B = 105.8 mm, ρ_H = 203.6 mm, ρ_E = 186.6 mm
- Resulting in a total length of L = 169 mm



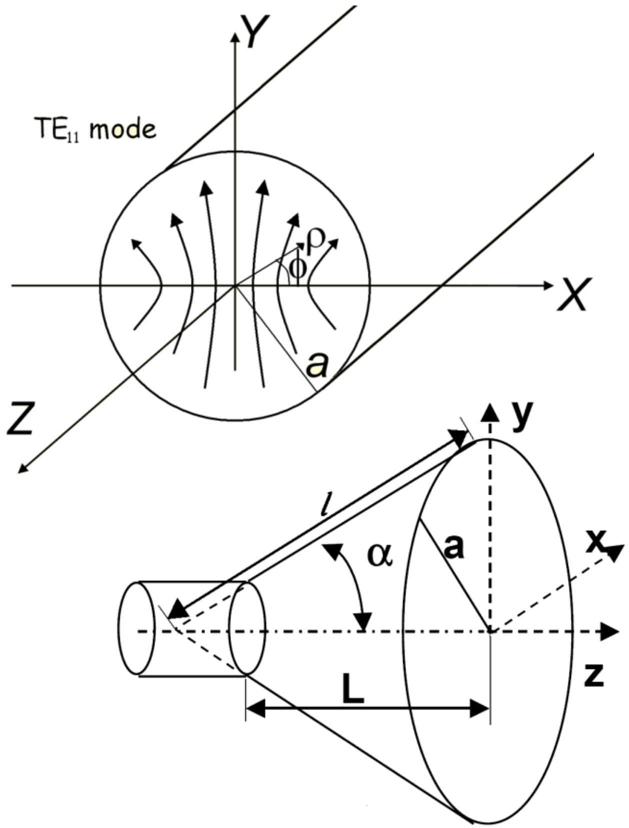




Conical feed-horns

Conical feed-horns

- Conical feed-horns are fed with a metallic circular waveguide in mono-mode operation with the fundamental TE_{11} mode:



- The main inconvenient of TE_{11} mode is that it doesn't present polarization purity

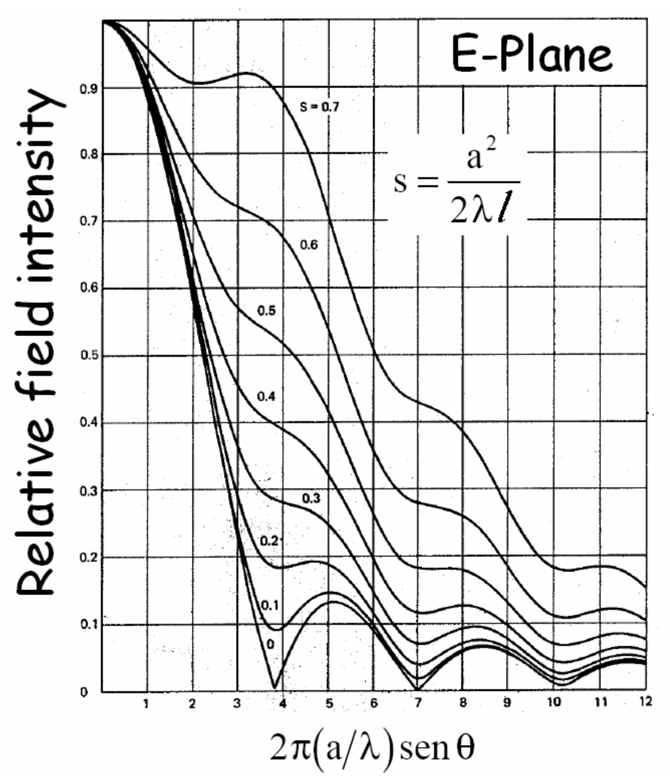
$$E_\rho = E_0 \cdot \frac{1}{\rho} \cdot J_1\left(1.841 \cdot \frac{\rho}{a}\right) \cdot \sin\phi$$

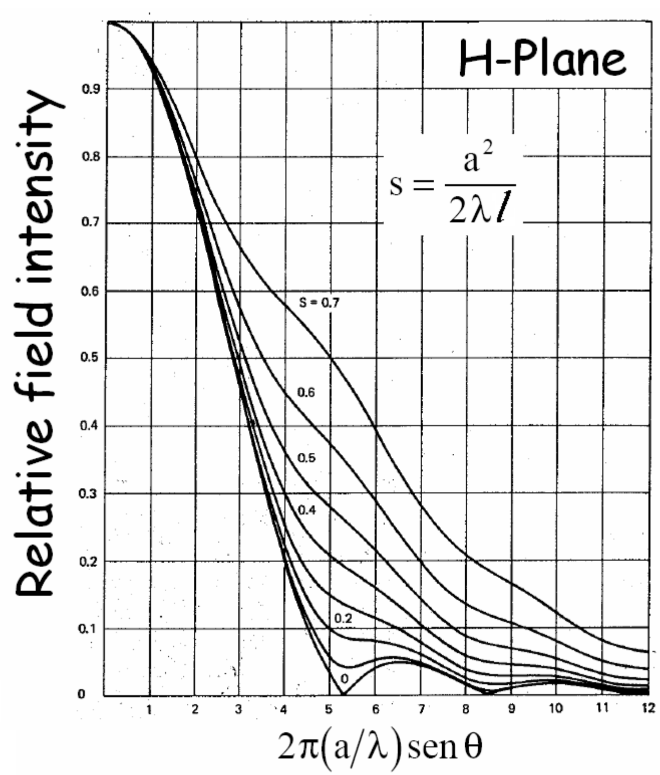
$$E_\phi = E_0 \cdot \frac{1}{\rho} \cdot \frac{\partial}{\partial\rho}\left(J_1\left(1.841 \cdot \frac{\rho}{a}\right)\right) \cdot \cos\phi$$

Smooth-walled conical feed-horns

Conical feed-horns

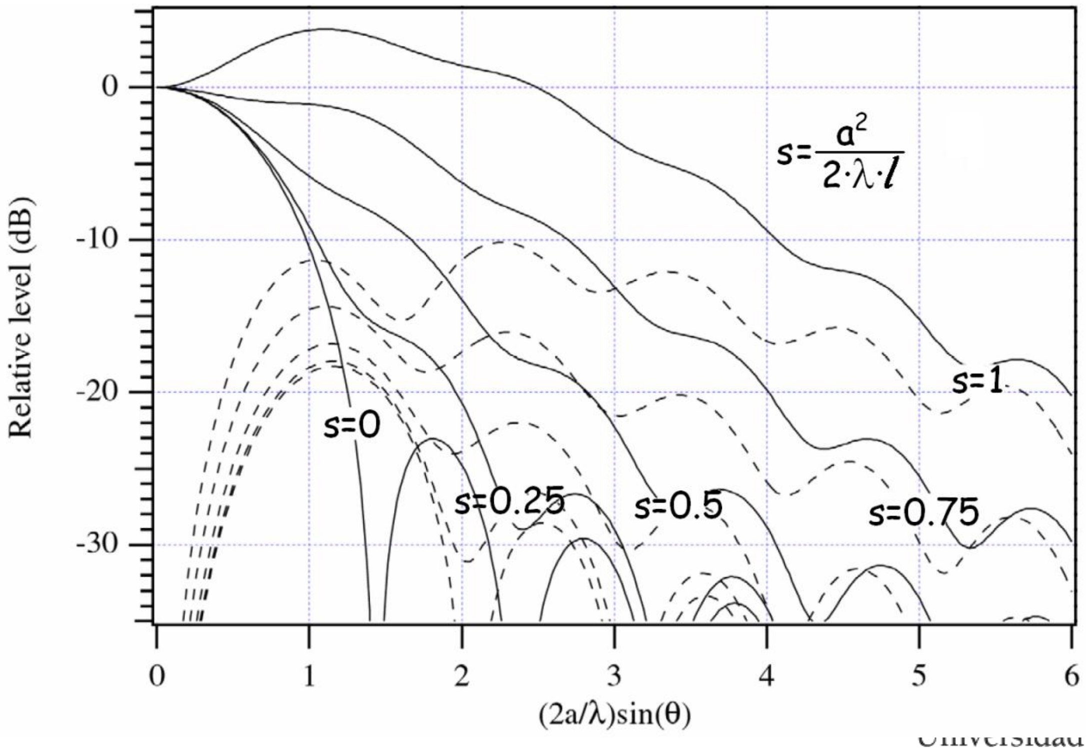
- The universal radiation patterns for the conical feed-horn are represented with the phase error as parameter for both planes:





Conical feed-horns

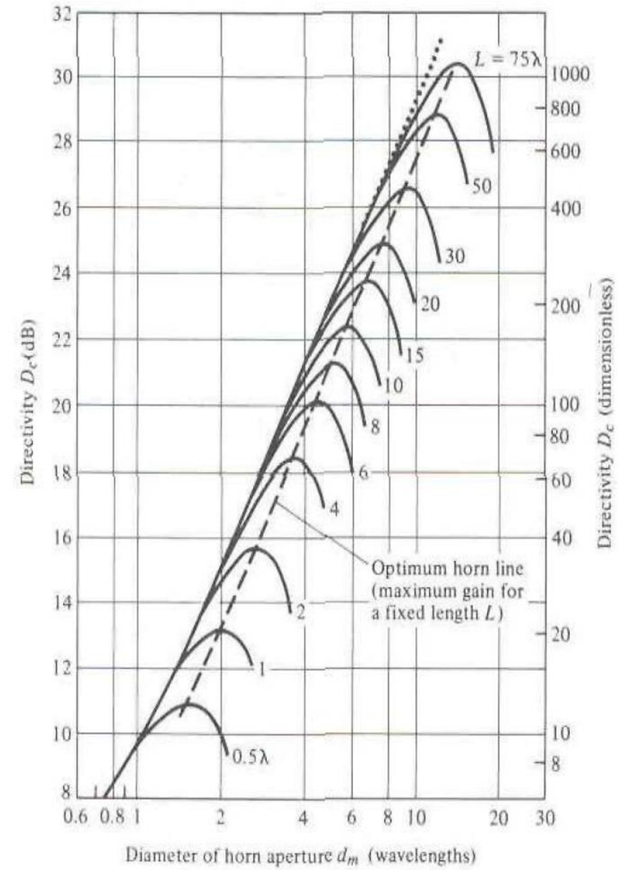
- Also, the universal radiation pattern for the conical feed-horn for ϕ=45 deg with the phase error as parameter is represented
- Cross-polar level for ϕ=45 deg is also represented



Conical feed-horns

- The directivity of the conical feed-horn is obtained integrating the power at the aperture
- For every length, (L), there is an optimum aperture diameter ($d_m=2\cdot a$) that gives maximum directivity
- Optimum aperture satisfy the equation:

$$d_m = 2\cdot a \approx \sqrt{3\cdot l\cdot \lambda}$$



- These optimum feed-horns present a phase error of $s=3/8$.
- The effective aperture of these pyramidal feed-horns is also around 50% of its physical size, so:

$$G = \varepsilon_{ap}\cdot\frac{4\cdot\pi}{\lambda^2}\cdot A_p = \frac{1}{2}\cdot\frac{4\cdot\pi}{\lambda^2}\cdot\ \pi\cdot a^2$$

Conical feed-horns

- Example: Design a 20 dB gain conical feed-horn at 10 GHz under optimum condition with equal E and H planes beam-width and with *a*=11.7 mm circular waveguide radius as feeding waveguide.
  - First we calculate the radius of the aperture by using approximate gain formula that relates gain and aperture surface:

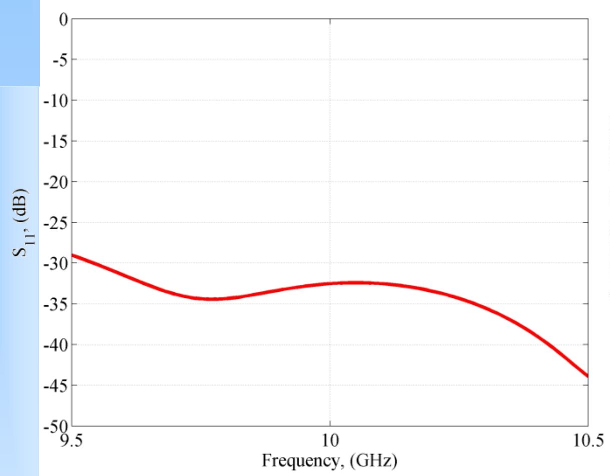
$$a = 67.5 \text{ mm}$$

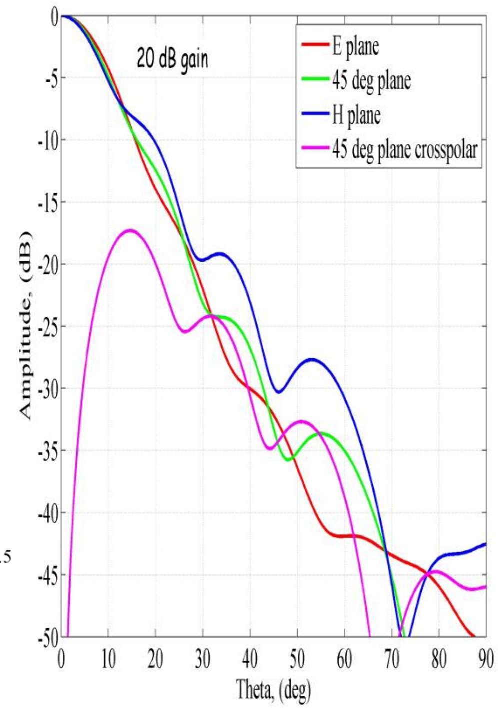
  - For a metallic horn antenna with no dielectric material inside, gain and directivity can be considered to be the same.
  - Now, we can calculate for optimum condition the error parameters, *l*, of the conical feed-horn:

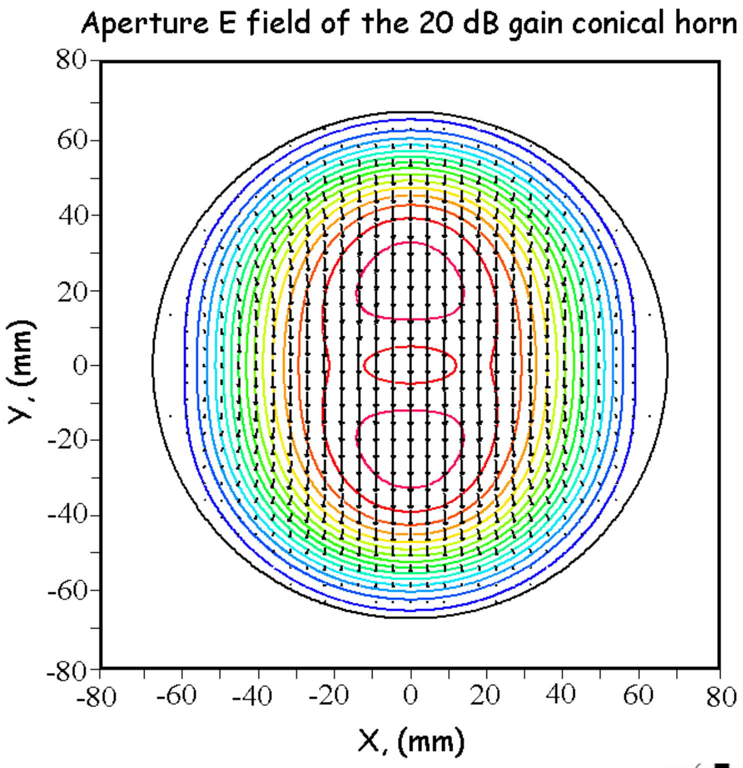
$$l = 202.6 \text{ mm}$$

Conical feed-horns

- The rest of physical dimensions are easily calculated using trigonometric relations:
- a = 67.5 mm, l = 202.6 mm, α =19.5º, L = 158 mm







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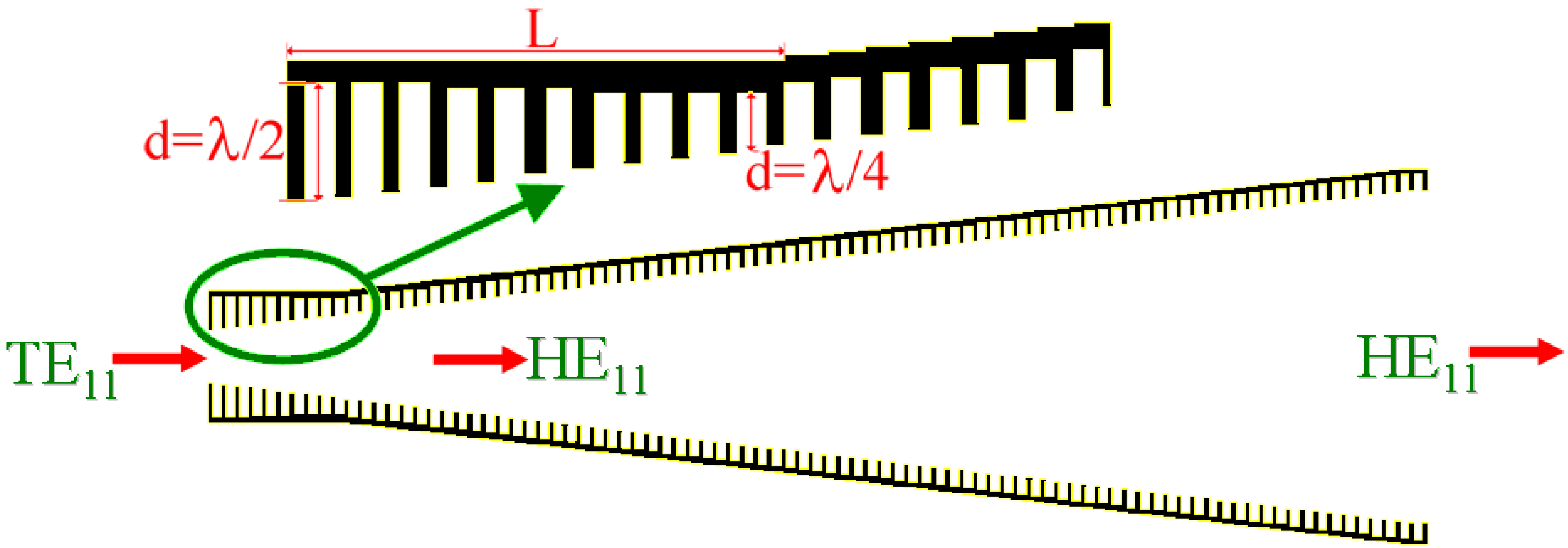
Conical corrugated feed-horns

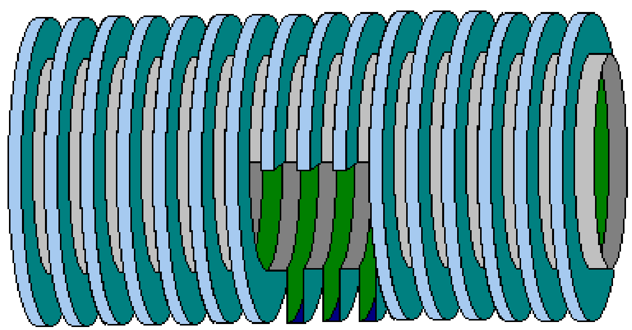
Conical feed-horns

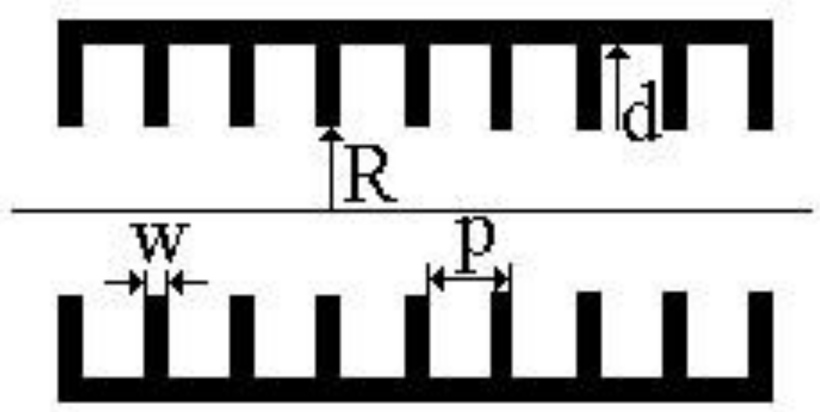
- Smooth-walled conical feed-horns present the main problem of the high cross-polar level
- Conical corrugated feed-horns overcome this problem:



Conical feed-horns

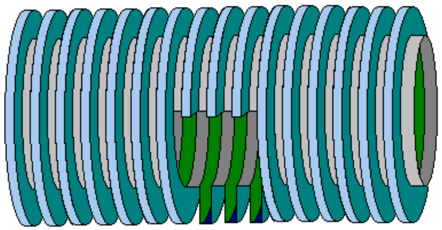
- A corrugated waveguide is defined by a series of smooth waveguides with different diameters (periodical structure):
  - R defines de inner diameter
  - d the corrugation depth
  - Corrugation pitch is defined by p (period) and w (width of corrugation)

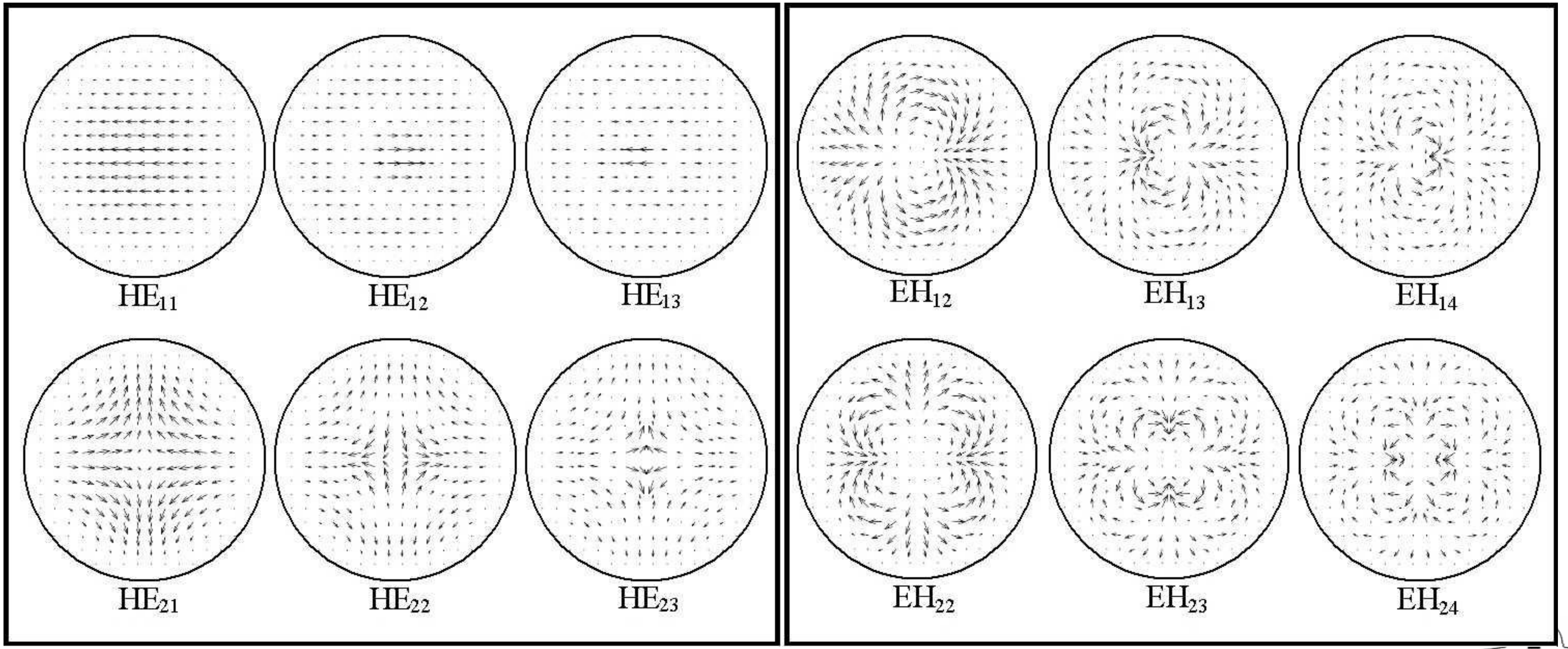




Conical feed-horns

- A corrugated waveguide can be defined by the TE_{mn} and TM_{mn} smooth circular mode family at each position, or in terms of HE_{mn} and EH_{mn} hybrid modes

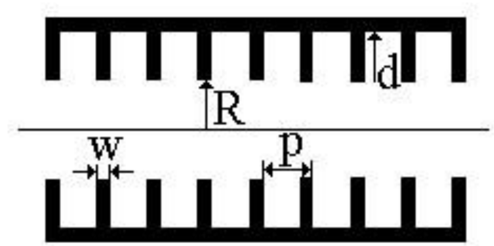




Conical feed-horns

- The condition of zero cross-polarized field $E_y = 0$ can be obtained if:

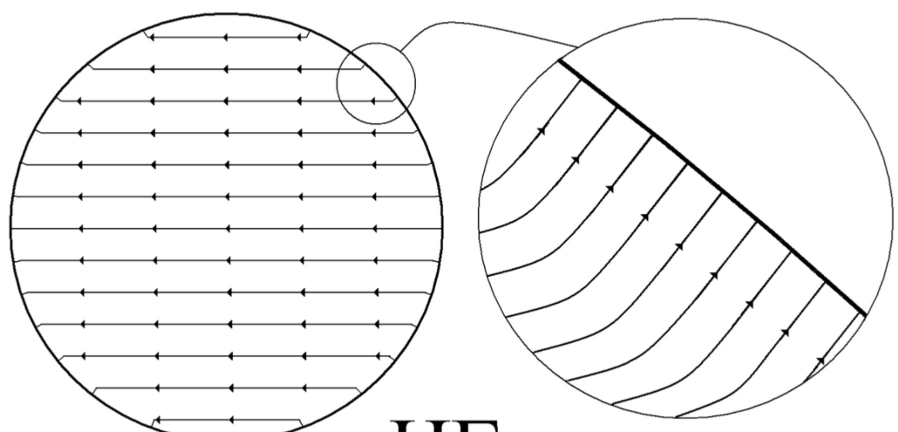
$p < \lambda/3$ & $d \approx \lambda/4$ → Balanced Hybrid Condition



- The fundamental mode of a corrugated waveguide (HE_{11}) at an inner diameter can be expressed as:

$$E_x(r,\phi) = A_0 J_0\left(\frac{2.4808\ r}{R}\right)$$

$$E_y(r,\phi) = 0$$



HE_{11}

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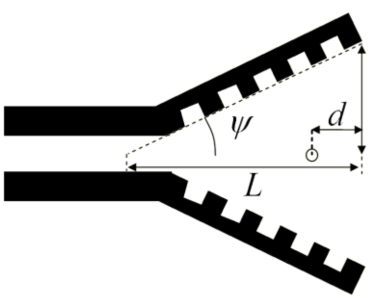
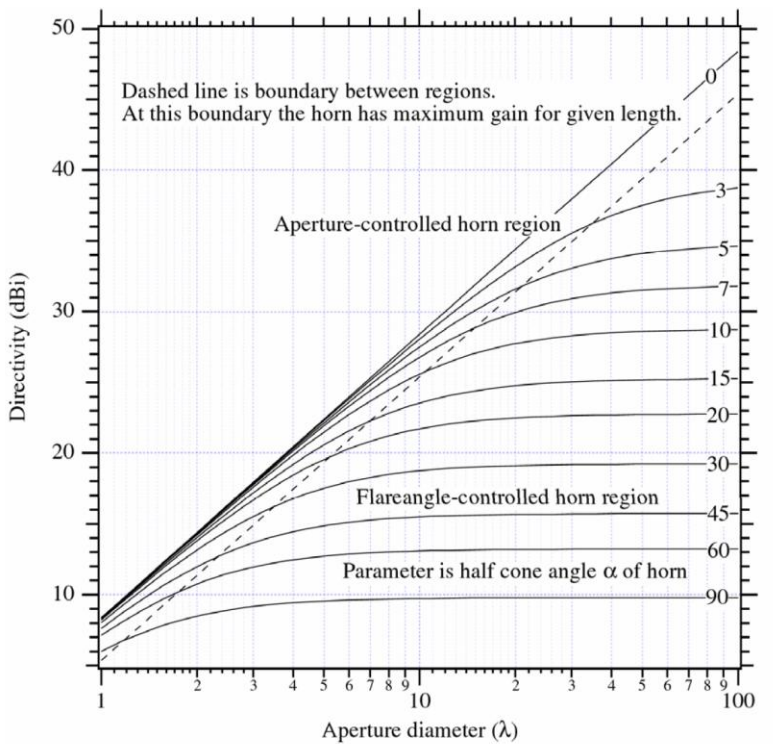
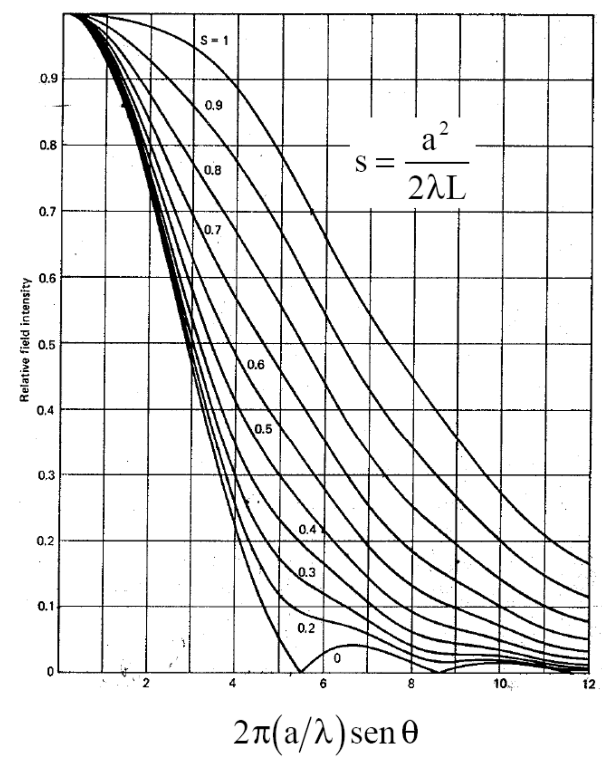
Conical feed-horn

- The universal radiation patterns for the conical corrugated feed-horn are represented with the phase error as parameter (the radiation patterns are rotationally symmetric, independent of ϕ plane):

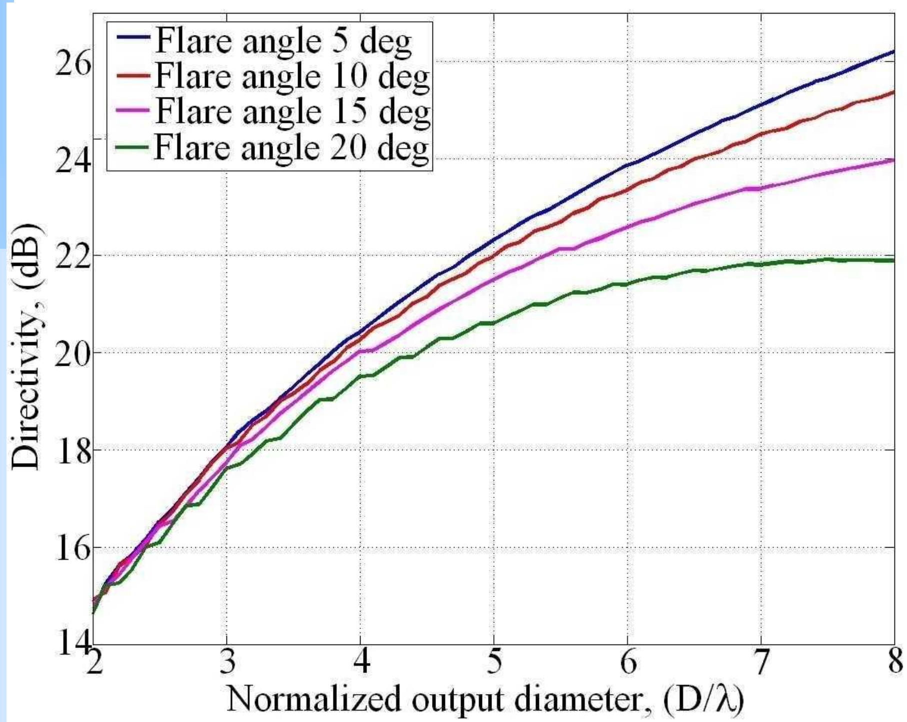


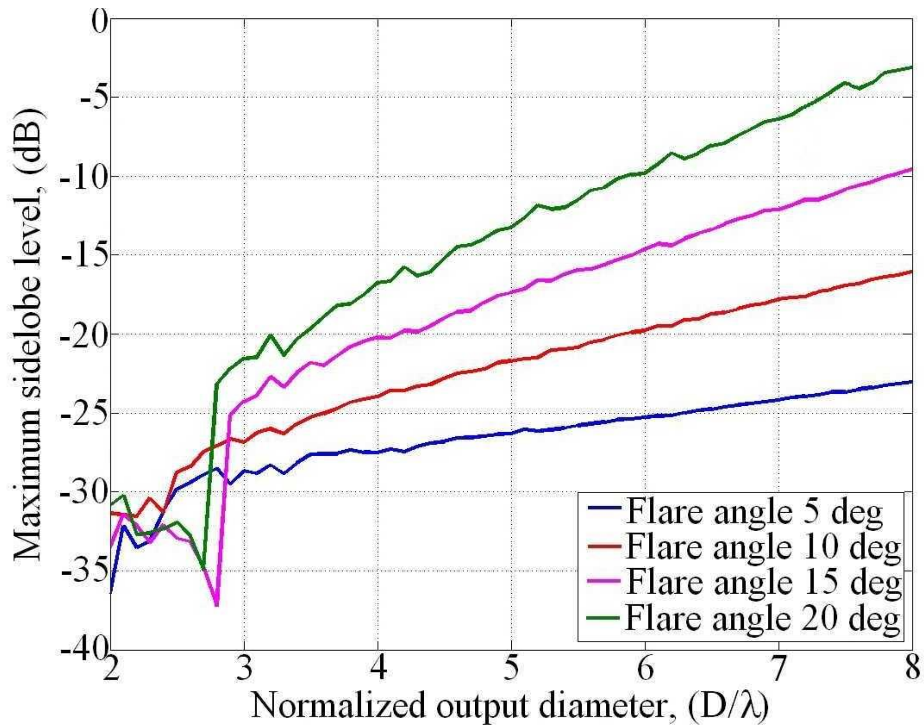




Conical feed-horns

- For small flare angles these figures can also be used
- In these figures also the side-lobe level can be selected





Conical feed-horns

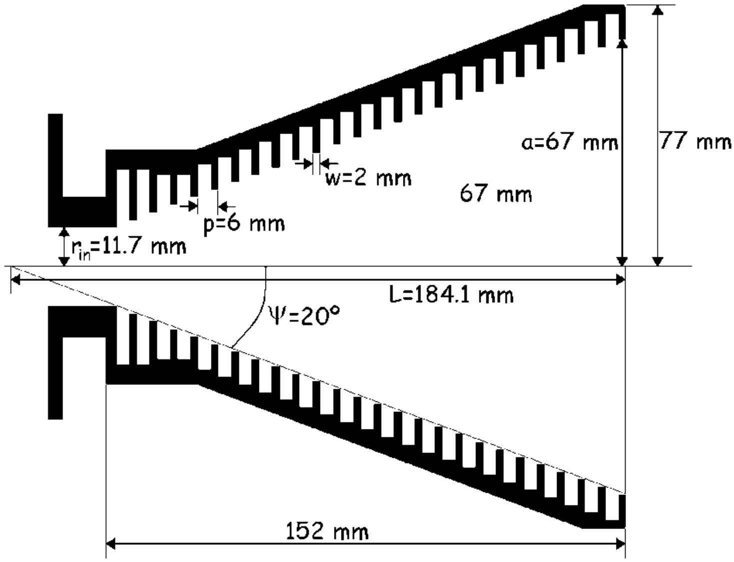
- Example: Design a 20 dB gain conical corrugated feed-horn at 10 GHz under optimum condition with equal E and H planes beam-width and with a=11.7 mm circular waveguide radius as feeding waveguide
  - First we calculate the radius of the aperture, from figures:

$$a = \frac{4.5 \cdot \lambda}{2} \approx 67 \text{ mm}$$

  - Then we select the flare angle for optimum condition: $\psi = 20 \deg$
  - After that we can select the corrugation parameters:

$$p = 6\ mm,\ w = 2\ \text{mm},\ d = 7.5\ \text{mm}$$

  - The feed-horn length of 152 mm



Conical feed-horns

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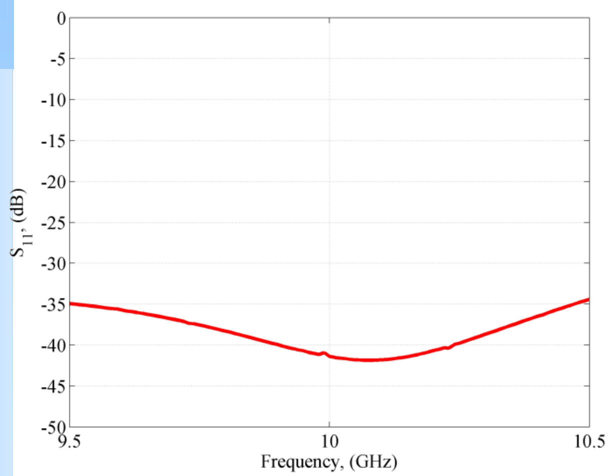
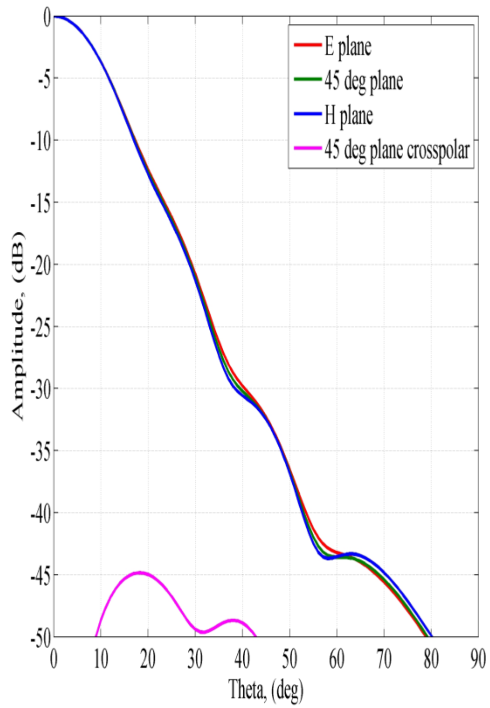
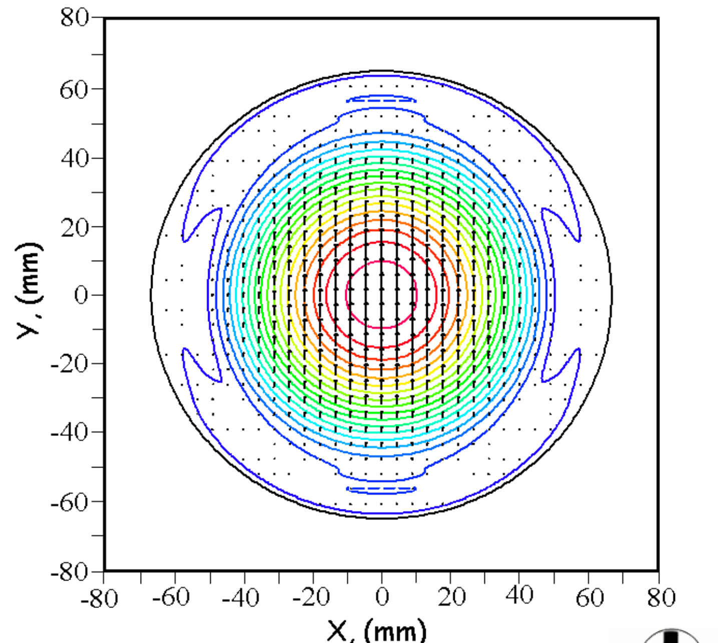
- Conical corrugated feed-horns present a very low cross-polar level, a rotationally symmetric radiation pattern and good matching
- They are also easy to design but more complicated to manufacture than a normal smooth-walled conical horn (a lathe is usually necessary)



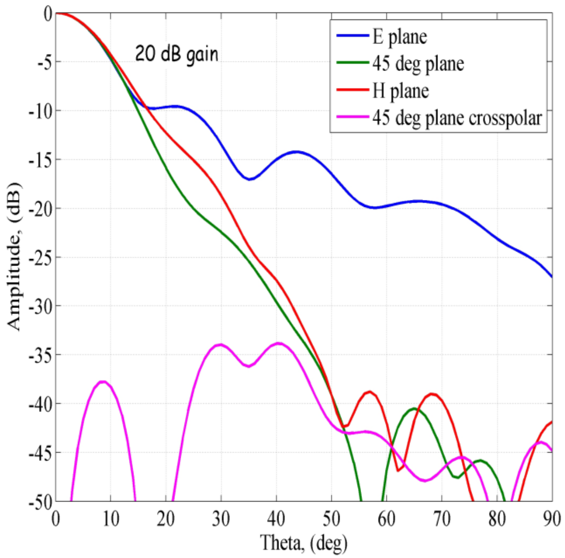


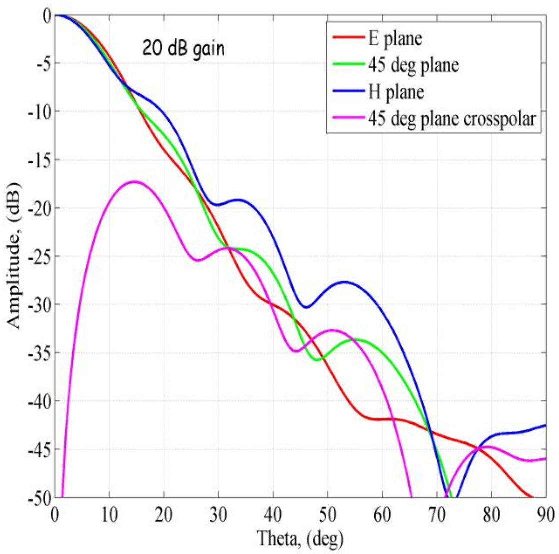
Aperture E field of the 20 dB gain corrugated horn

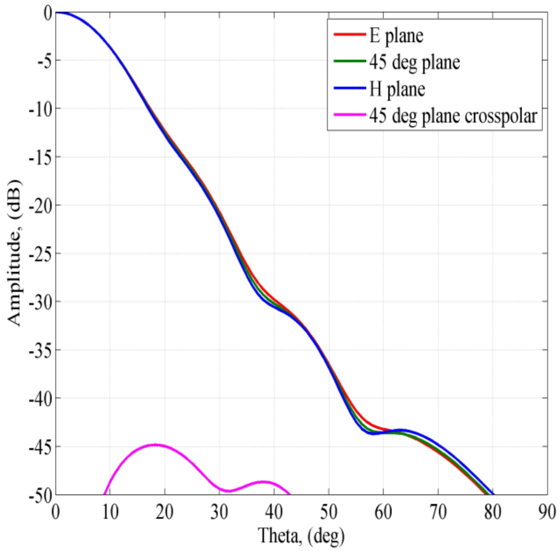


Comp.: Pyramidal vs Conical

- Pyramidal feed-horns present much lower cross-polar levels than smooth-walled conical ones, but higher side-lobes (spillover)
- The size of Pyramidal feed-horns is slightly bigger that the size of conical feed-horns
- Conical corrugated horn is the best out of this three models but its weight will be higher



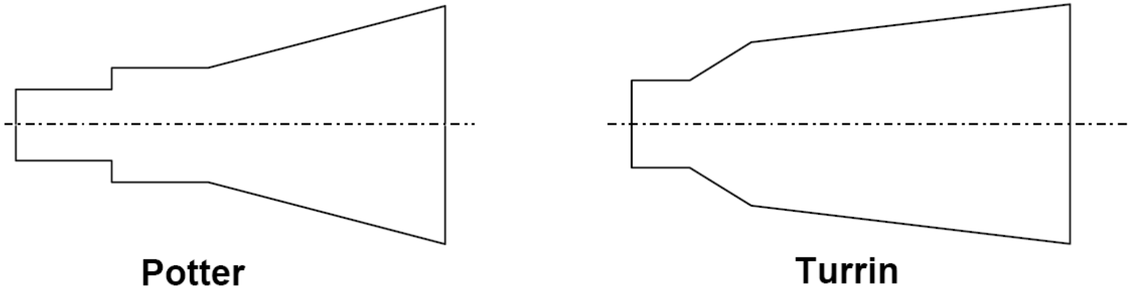




Profiled feed-horns

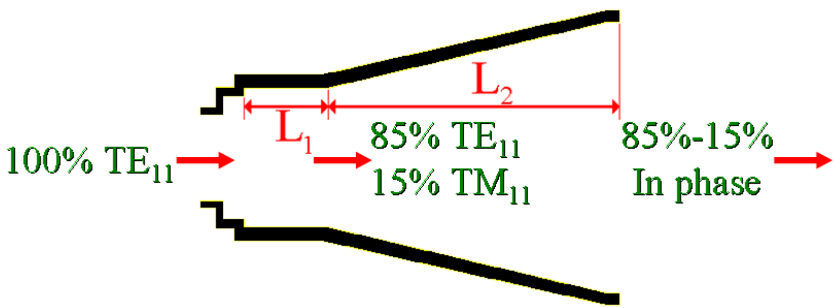
Profiled feed-horns

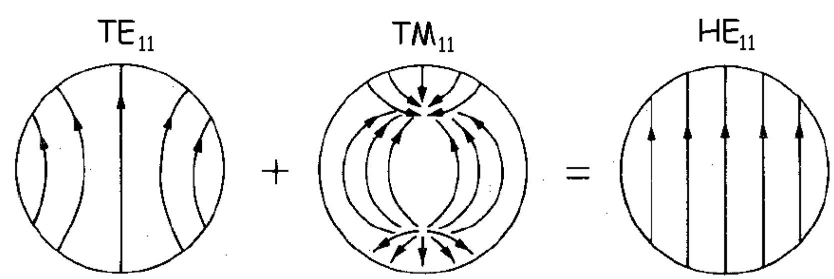
- There are other feed-horn types where the profile is not linear.
- The idea of these ones is to make compact designs with nice radiation characteristics.
- There are a lot of models available, in smooth waveguide and in corrugated waveguide, the different between them is that corrugated waveguide models are wide bandwidth and smooth-walled models are narrow band .



Profiled feed-horns

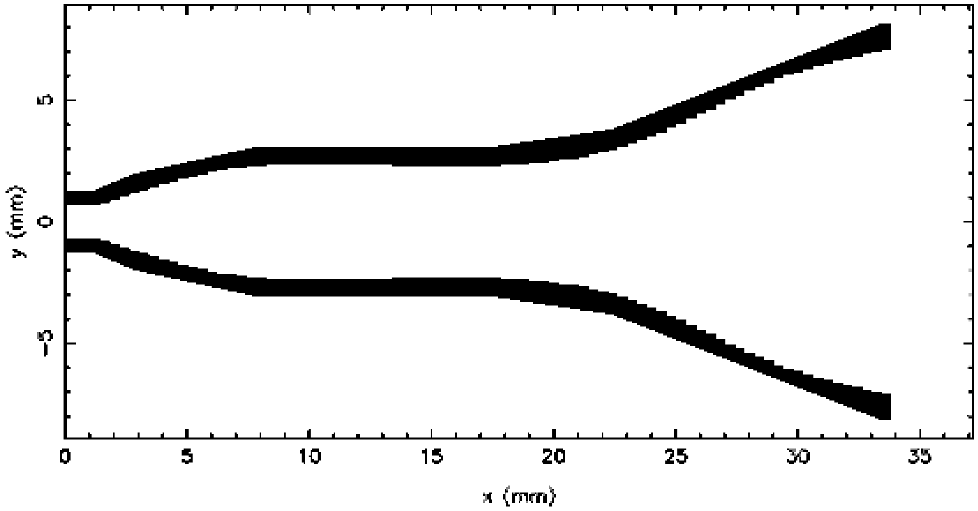
- The Potter type horn is the best known of multimode horns in smooth-walled waveguide.
- Its performance is very nice in a reduced bandwidth (5 to 8%) approximating to the performance of corrugated horn.
- By means of a proper step or taper in the horn radius, the right amount of TM_{11} (amplitude and phase) is excited.
- A smooth conical taper of a determined length after the step drives the mode mixture to the correct phasing at the aperture.

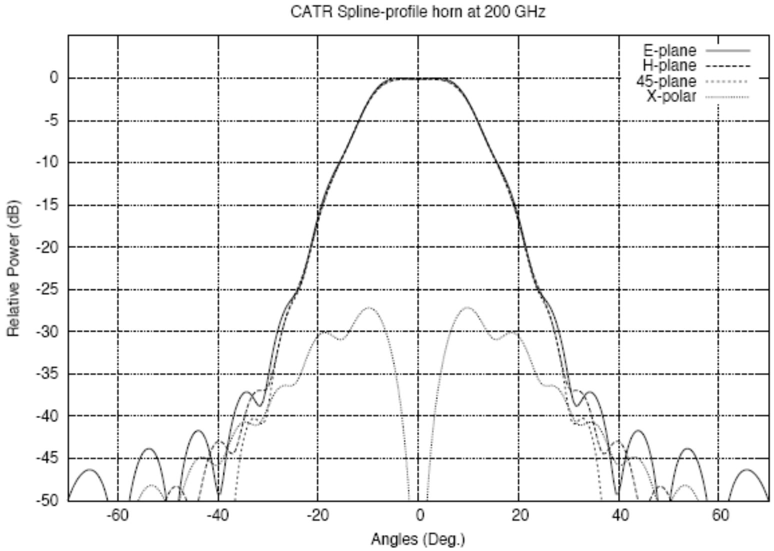




Profiled feed-horns

- The are other special types of smooth-walled multimode profiled horns.
- In fact, a horn antenna profile can be adjusted with very complicate geometries.
- These feed-horns usually pursue a particular type of radiation pattern.
- Bandwidth of this feed-horns is usually very poor.

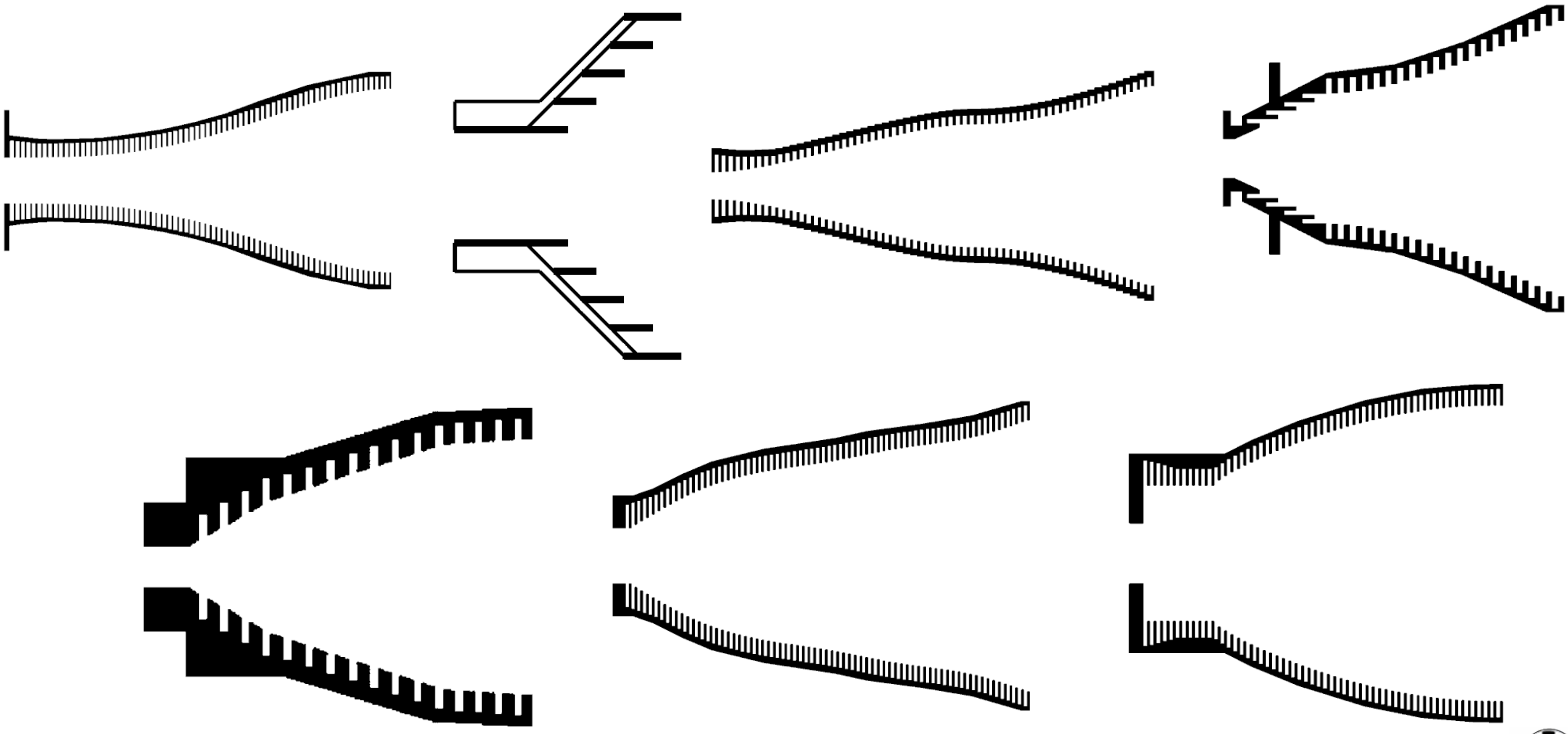




Corrugated profiled feedhorns

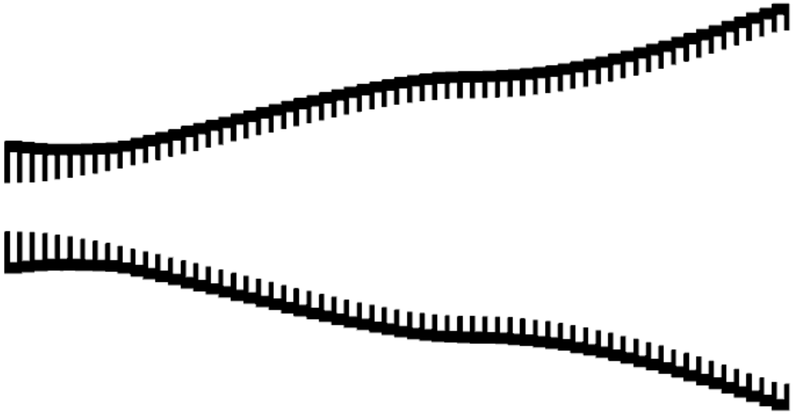
Profiled feed-horns

- The are a lot of models of corrugated profiled feed-horns, in fact, every research group in corrugated horn antennas have their own preferences.



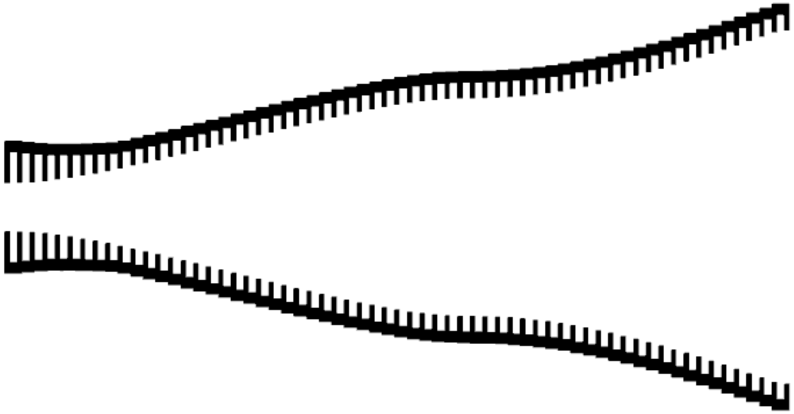
Profiled feed-horns

- One of the best performance profiled corrugated horns is the so called “Gaussian Profiled Horn Antenna” or GPHA
- To overcome the radiation limitations of the HE_{11} mode, a new profile to optimise the matching between the field travelling along the horn antenna and free space was developed.



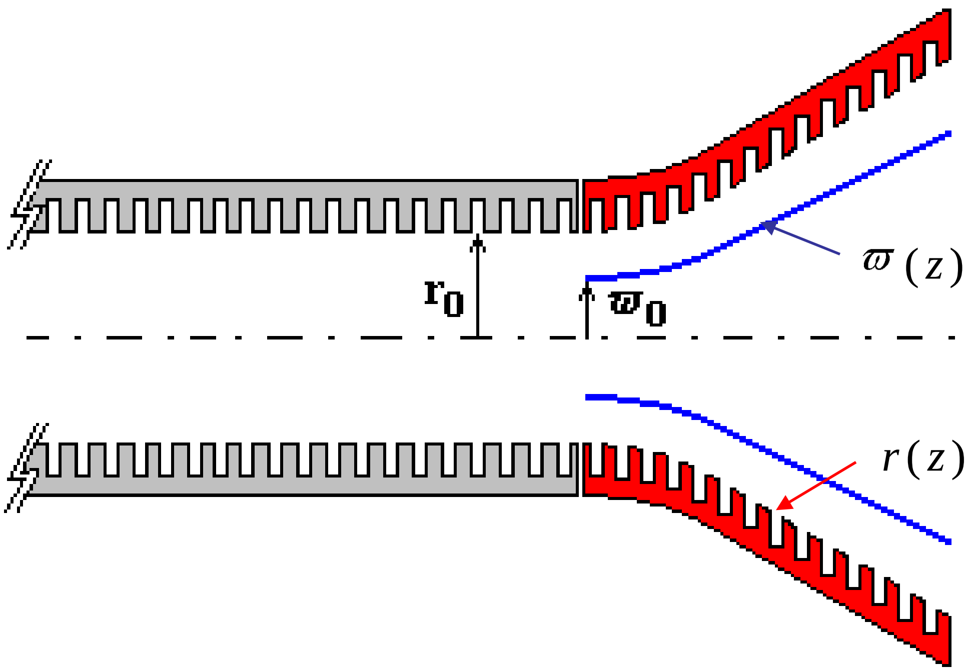
Profiled feed-horns

- GPHA's consist in the addition of a gaussian profiled corrugated part to any waveguide or horn antenna in which the HE_{11} mode is being propagated to improve its radiation characteristics.
- Corrugated GPHA are now-a-days one of the best choices to add at the end of any corrugated horn antenna for high requirement applications where low side-lobes and wide bandwidth are needed.



Profiled feed-horns

- The Gaussian Profiled Horn Antenna (GPHA) is defined following the propagation of a Gaussian beam:

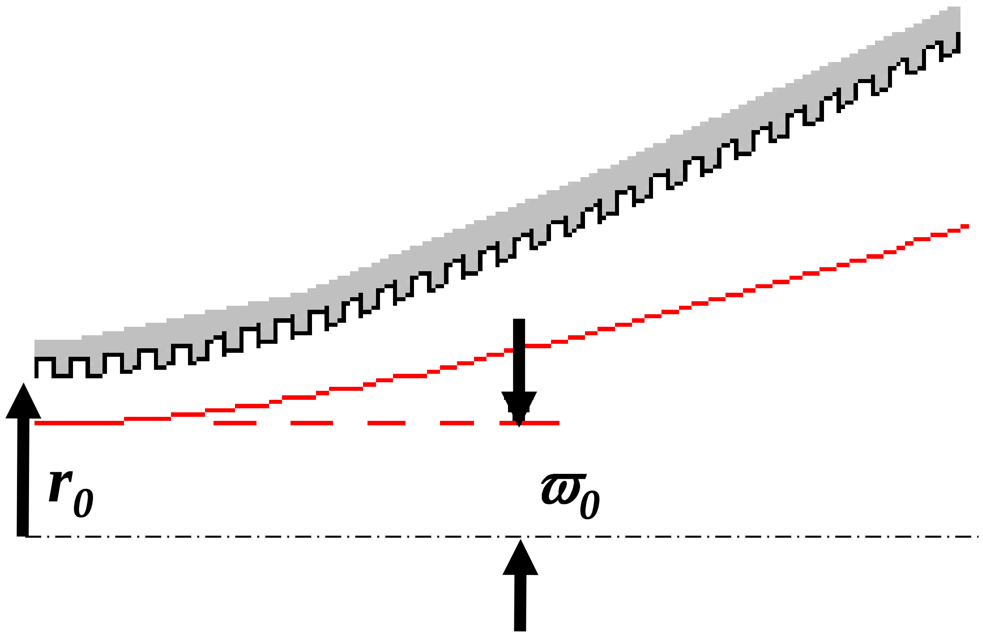


$$\varpi(z) = \varpi_0 \sqrt{1 + \left(\frac{2z}{k\varpi_0^2}\right)^2}$$

$$r(z) = r_0 \sqrt{1 + \left(\frac{2z}{k\varpi_0^2}\right)^2}$$

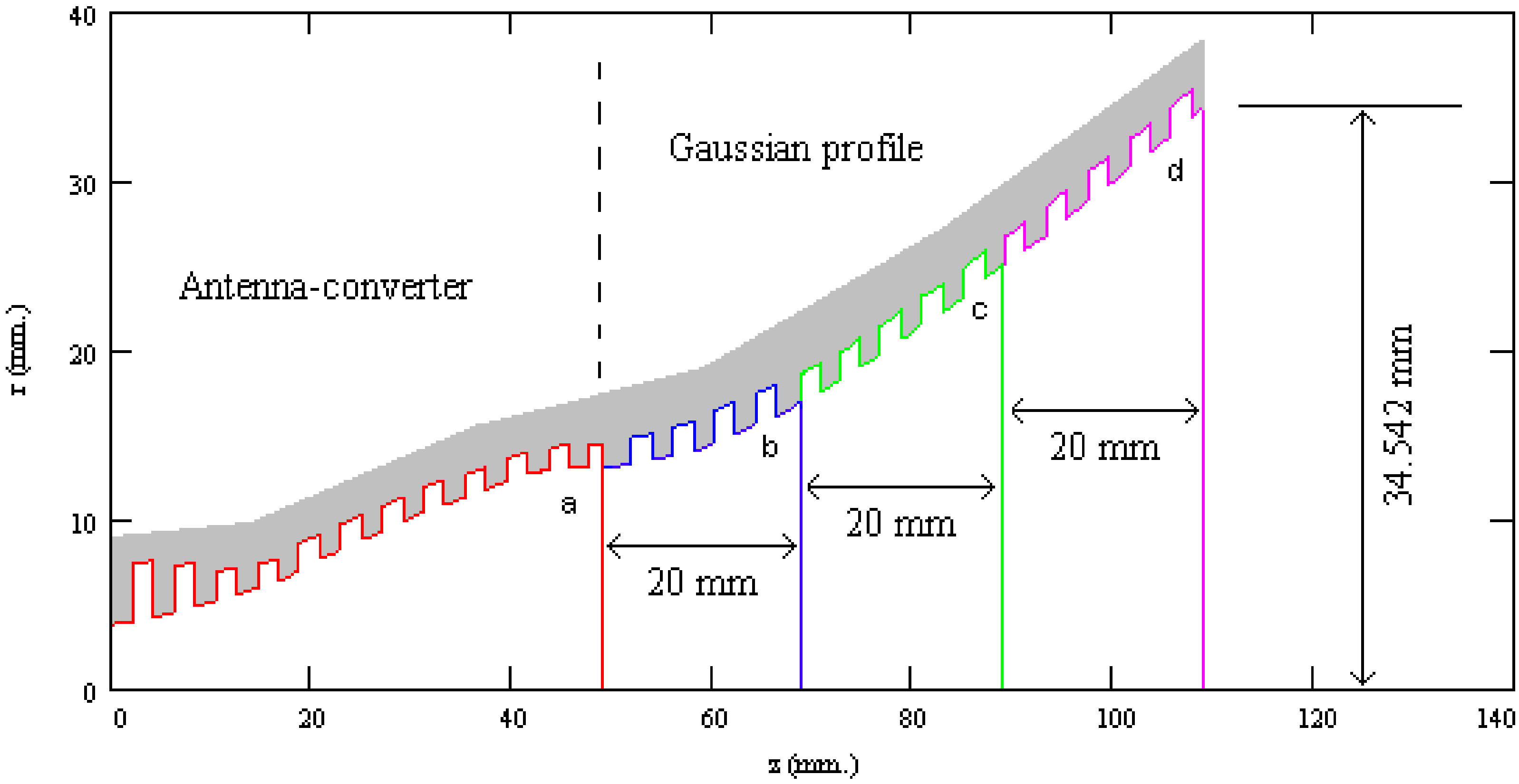
Profiled feed-horns

- To feed the corrugated GPHA, an HE_{11} mode or similar input field is necessary at its input aperture.

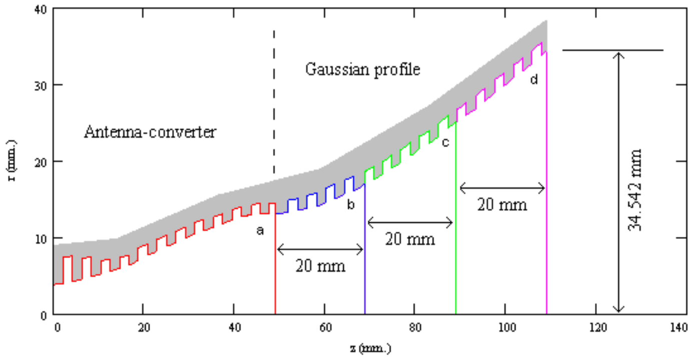


Profiled feed-horns

- Let's do an experiment:

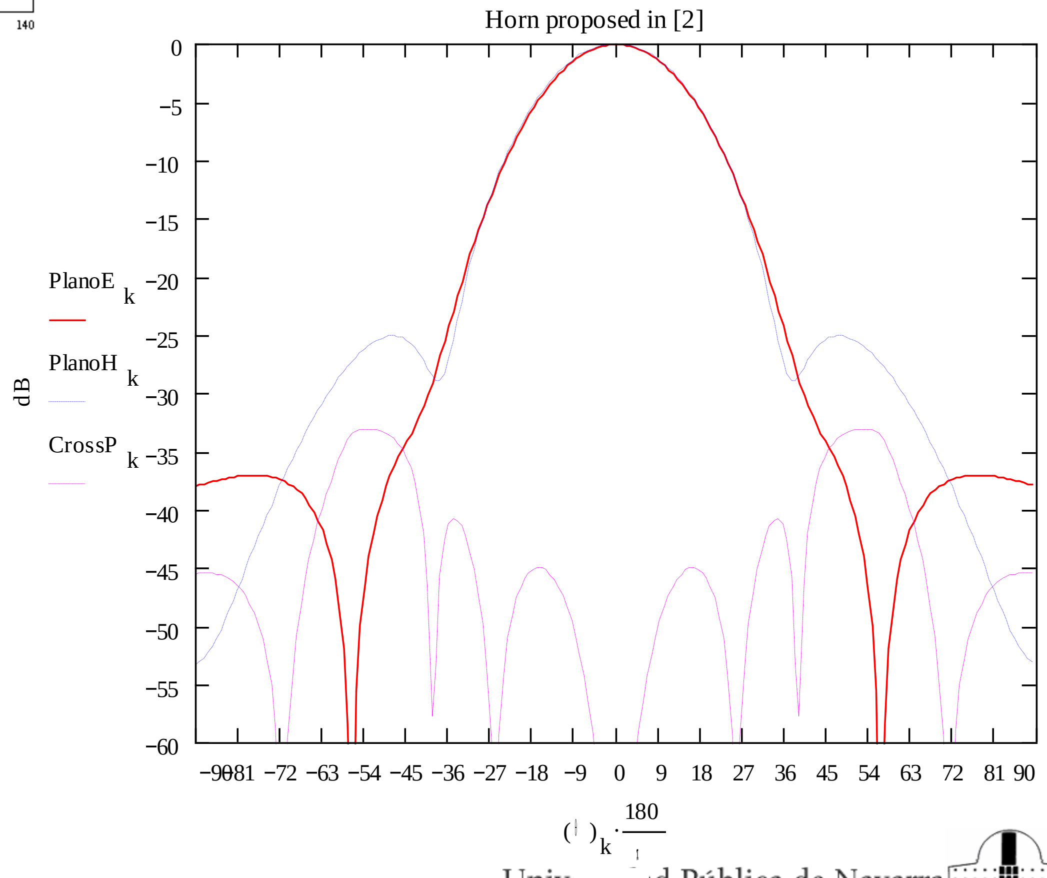


Profiled feed-horns



Modes	*Power(%)*	*Phase(º)*
TE_{11}	86.1188	-64.8973
TE_{12}	0.5952	-128.8639
TM_{11}	11.9079	-52.644

R_{out}=13.356mm ω_0=8.9485mm.
Gain=17.2 dBi z_o=L
η_E=97.2% η_H=97.4%



Profiled feed-horns

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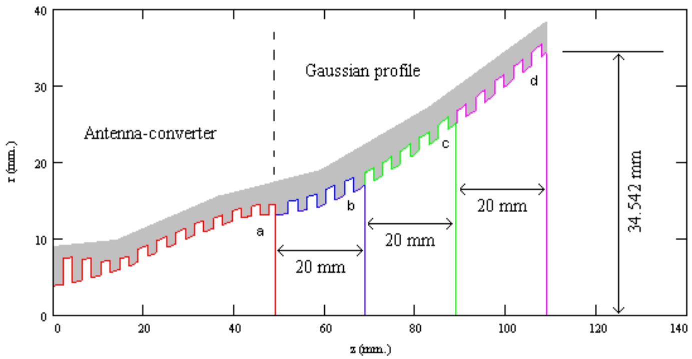
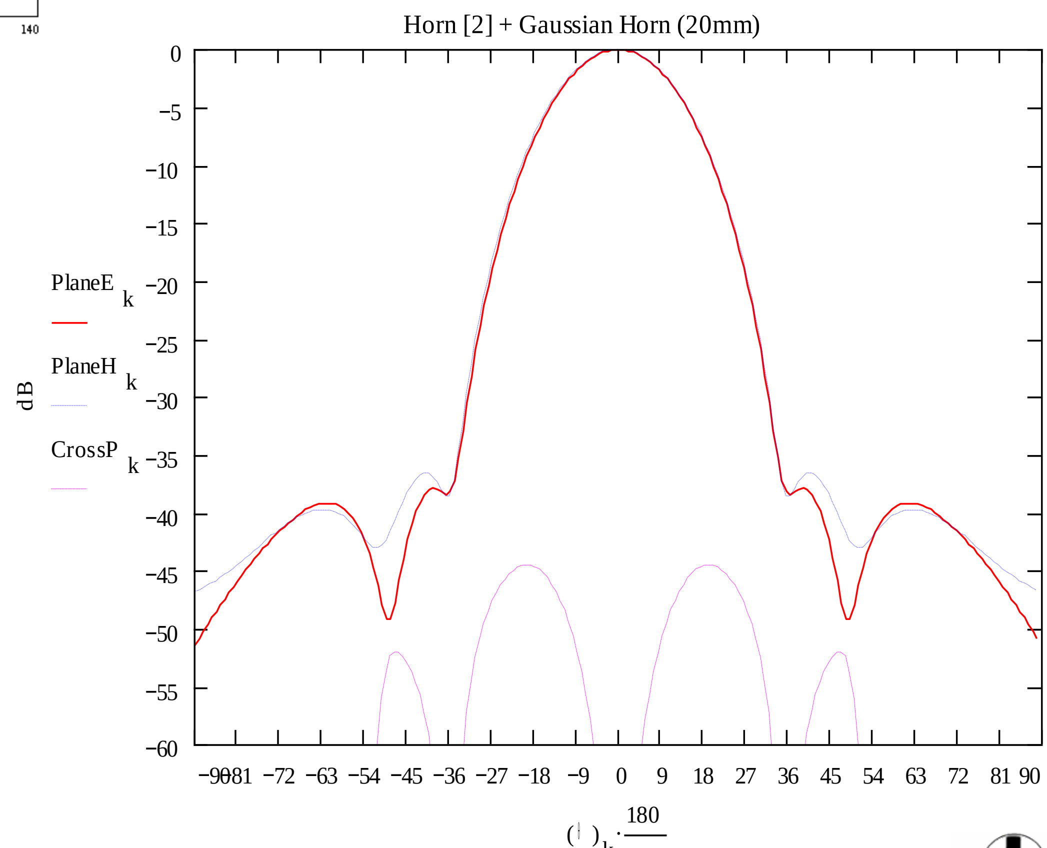
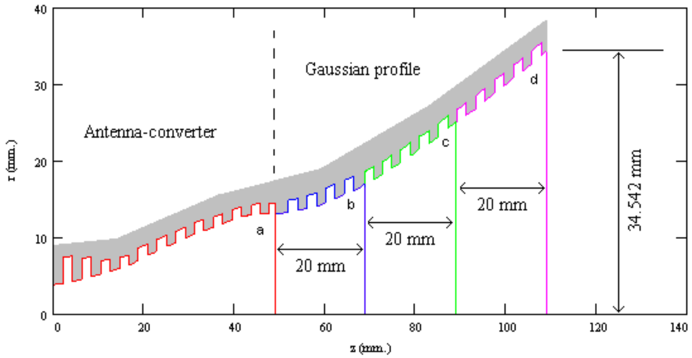


R_{out}=17.063mm
Gain=18.6 dBi
η_E=98.9%
ω_0=10.15056mm.
z_o=L+20
η_H=98.9%

Modes	*Power(%)*	*Phase(º)*
TE_{11}	81.1053	-39.1864
TE_{12}	1.246	161.1546
TE_{13}	0.0373	-125.8252
TM_{11}	17.3833	-33.5072
TM_{12}	0.0697	-56.33
TM_{13}	0.1181	-44.3379



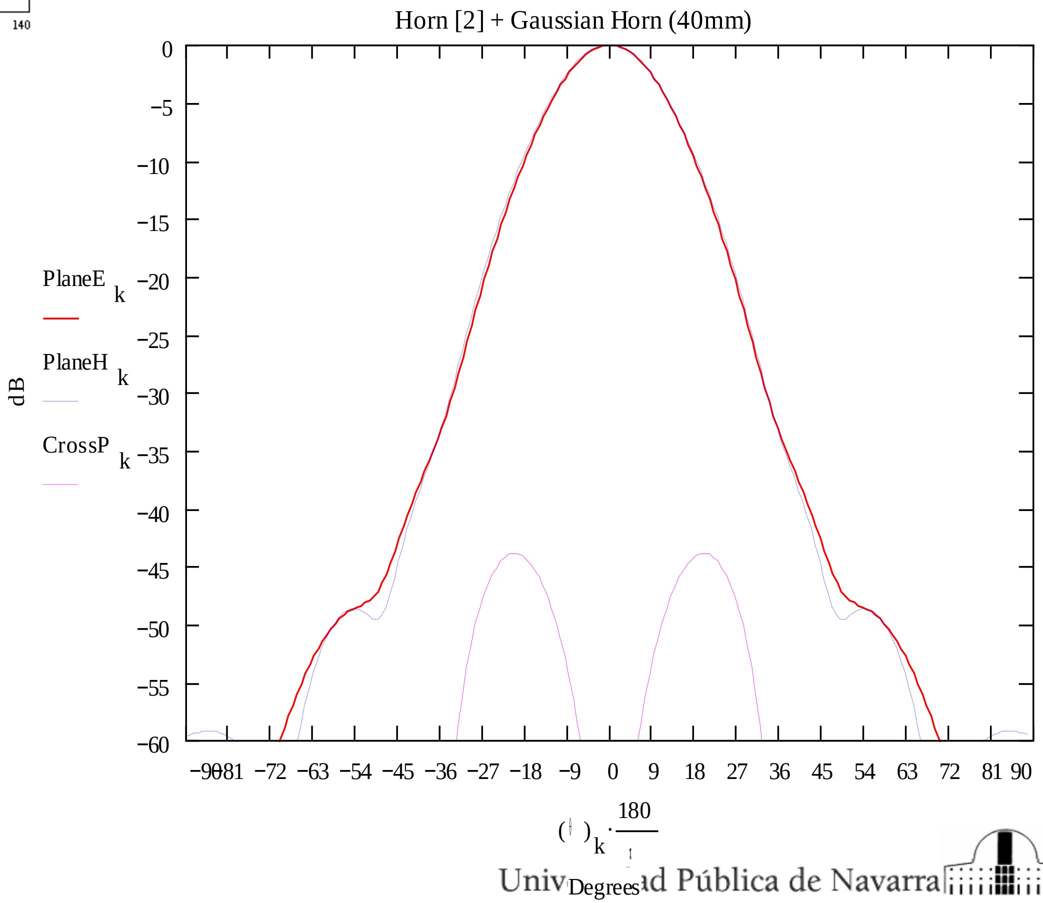
Profiled feed-horns



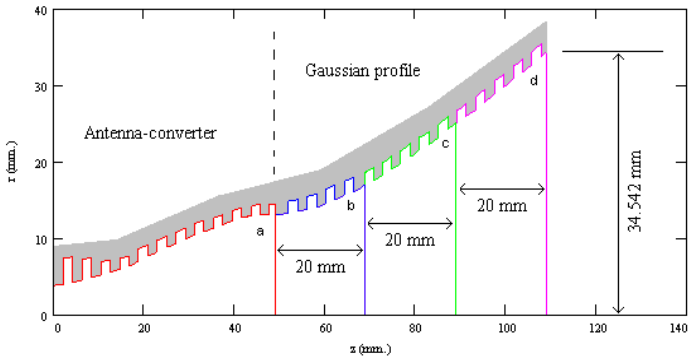
R_{out}=25.087mm
Gain=19.6 dBi
η_E=99.9%

ω_0=10.41768mm.
z_o=L+40
η_H=99.8%

Modes	*Power(%)*	*Phase(º)*
TE_{11}	56.0597	-33.3415
TE_{12}	12.6842	-174.13
TE_{13}	0.3934	87.1243
TE_{14}	0.0064	79.0973
TM_{11}	28.4174	-17.2304
TM_{12}	2.3396	-139.6503
TM_{13}	0.0677	168.4064
TM_{14}	0.008	148.4184

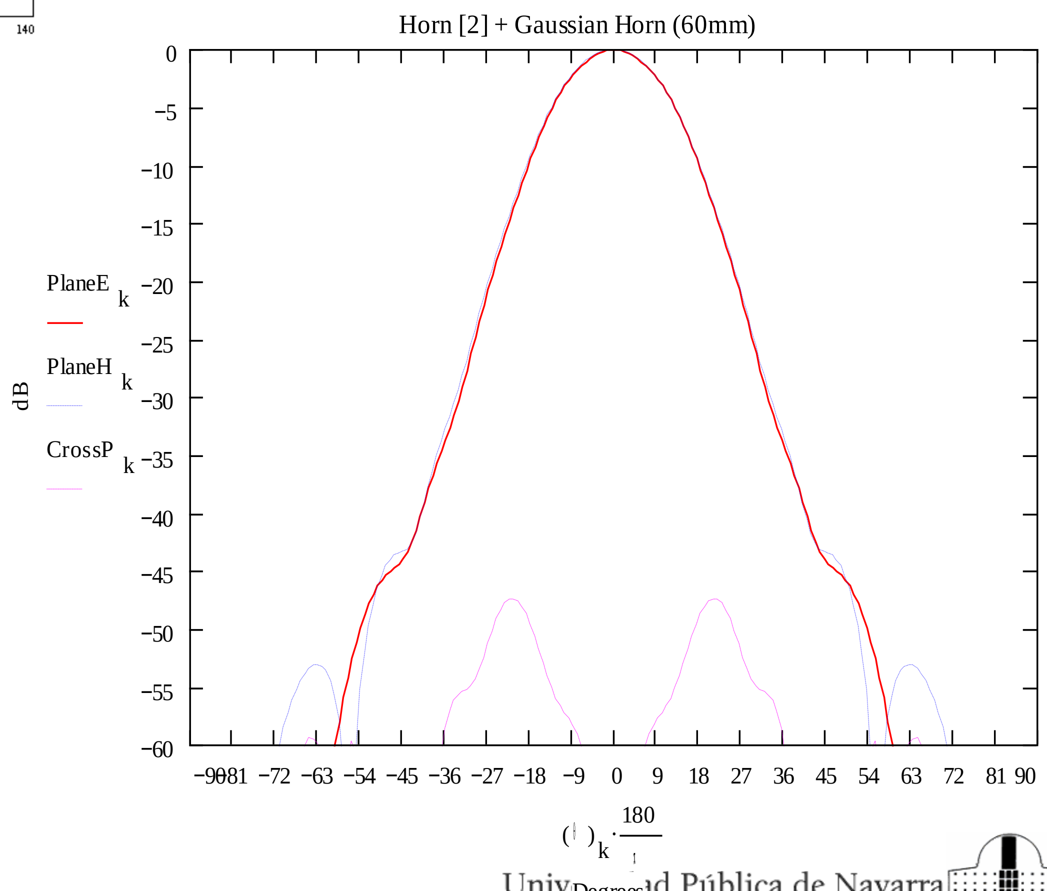


Profiled feed-horns



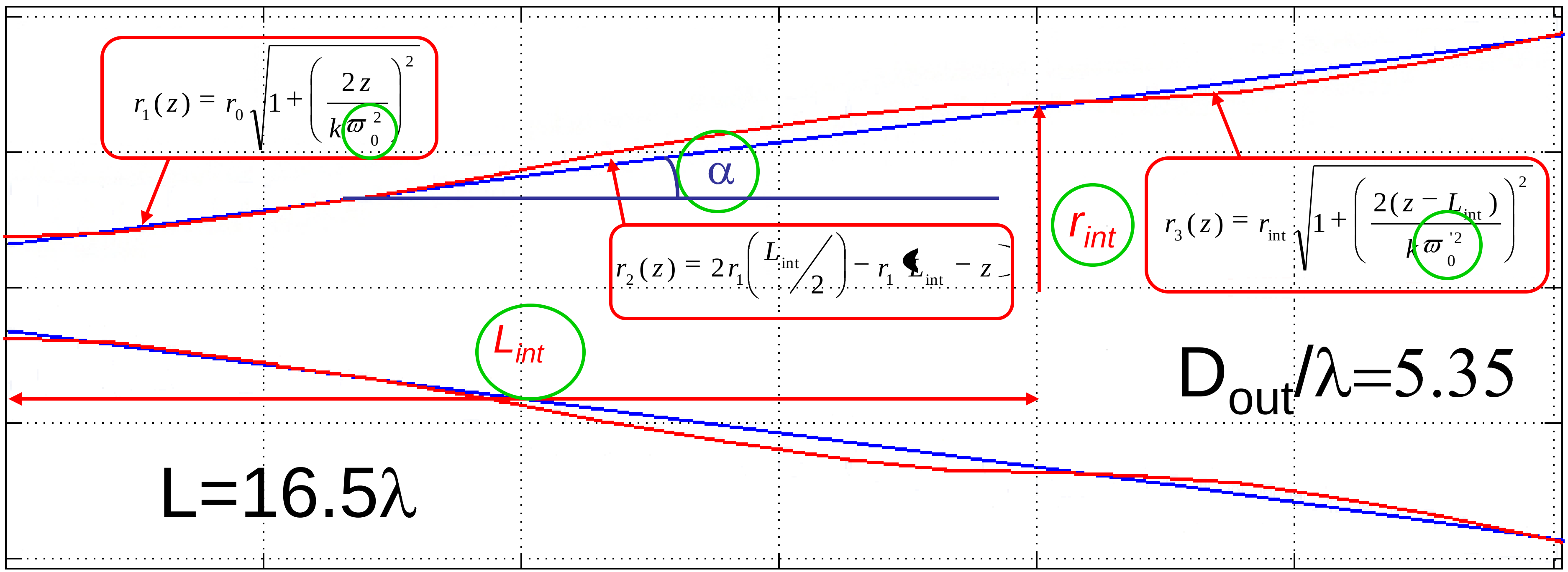
Modes	Power(%)	Phase(º)
TE_{11}	33.9487	-34.5662
TE_{12}	21.7407	-171.996
TE_{13}	3.8836	80.7423
TE_{14}	0.2659	10.2575
TE_{15}	0.0159	-13.5281
TM_{11}	29.7269	-14.157
TM_{12}	9.3439	-138.6633
TM_{13}	0.9579	130.5057
TM_{14}	0.0629	85.7041
TM_{15}	0.01	62.5564

R_{out}=34.541mm ω_0=10.41768mm.
Gain=17.2 dBi z_o=L+60
η_E=99.9% η_H=99.8%



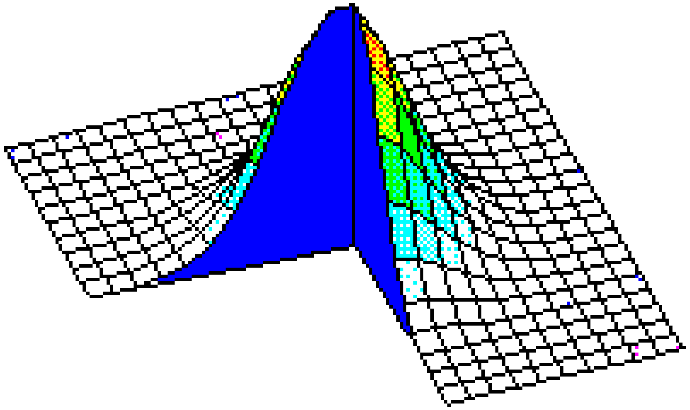
Theoretical Basis

- A comparative study of equal size antenna prototypes have been performed



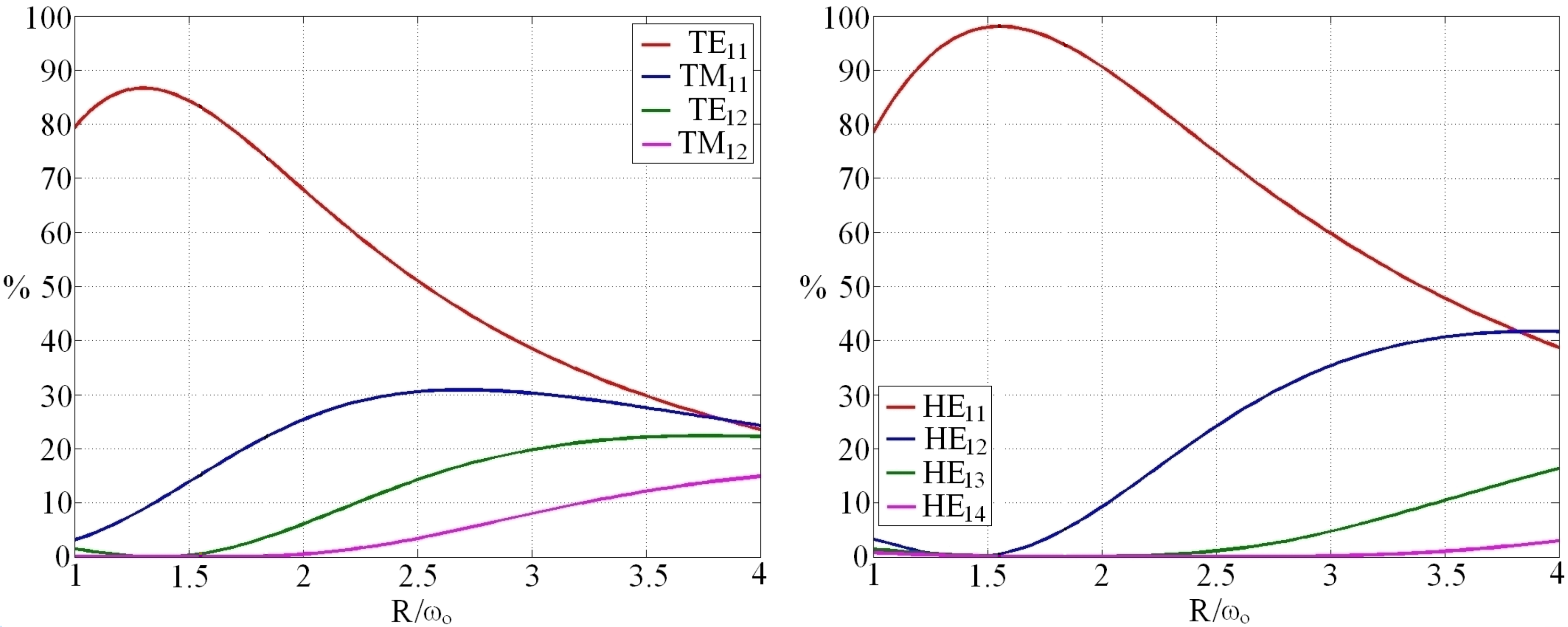
Theoretical Basis

- Relation between waveguide modes and space modes,
  - Waveguide modes
    - TE/TM
    - HE
  - Space modes
    - Gaussian beam modes
- Goal of GPHAs: to obtain the most pure Gaussian fundamental beam mode, Ψ_{00}



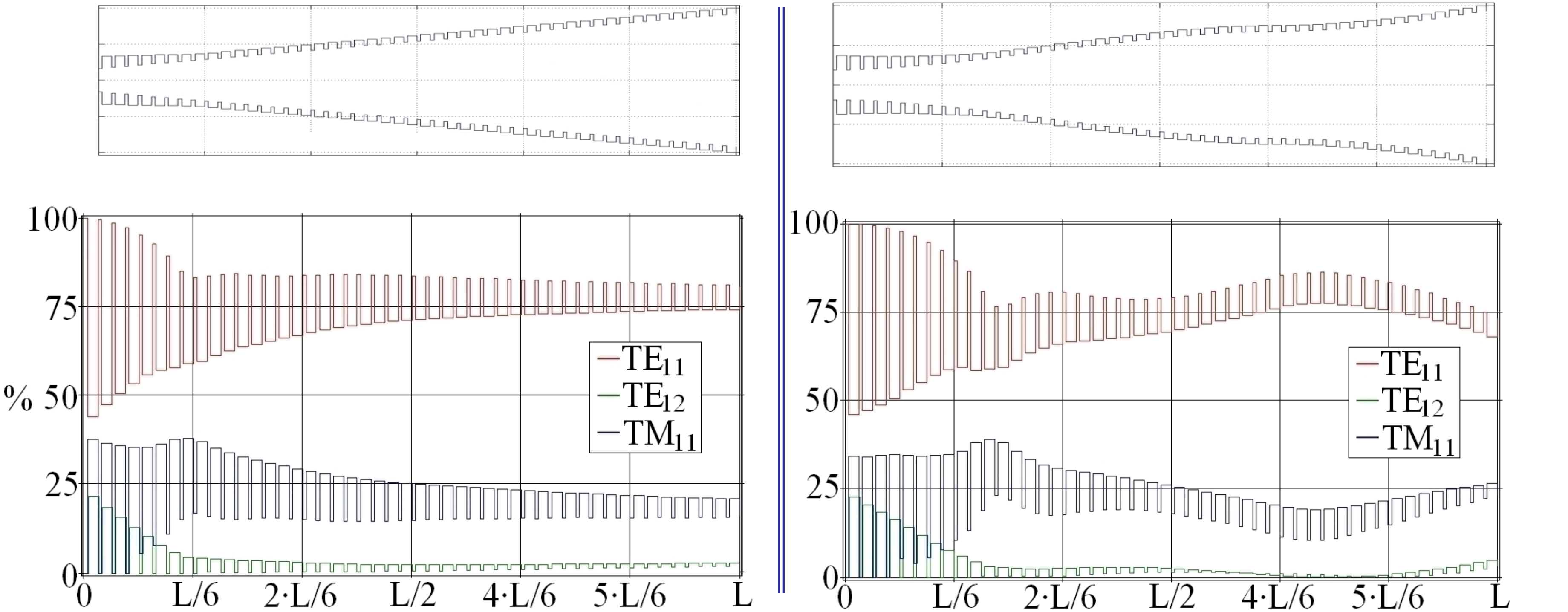
Theoretical Basis

- Expansion of Ψ_{00} in terms of TE/TM or HE modes, (correlation at aperture)



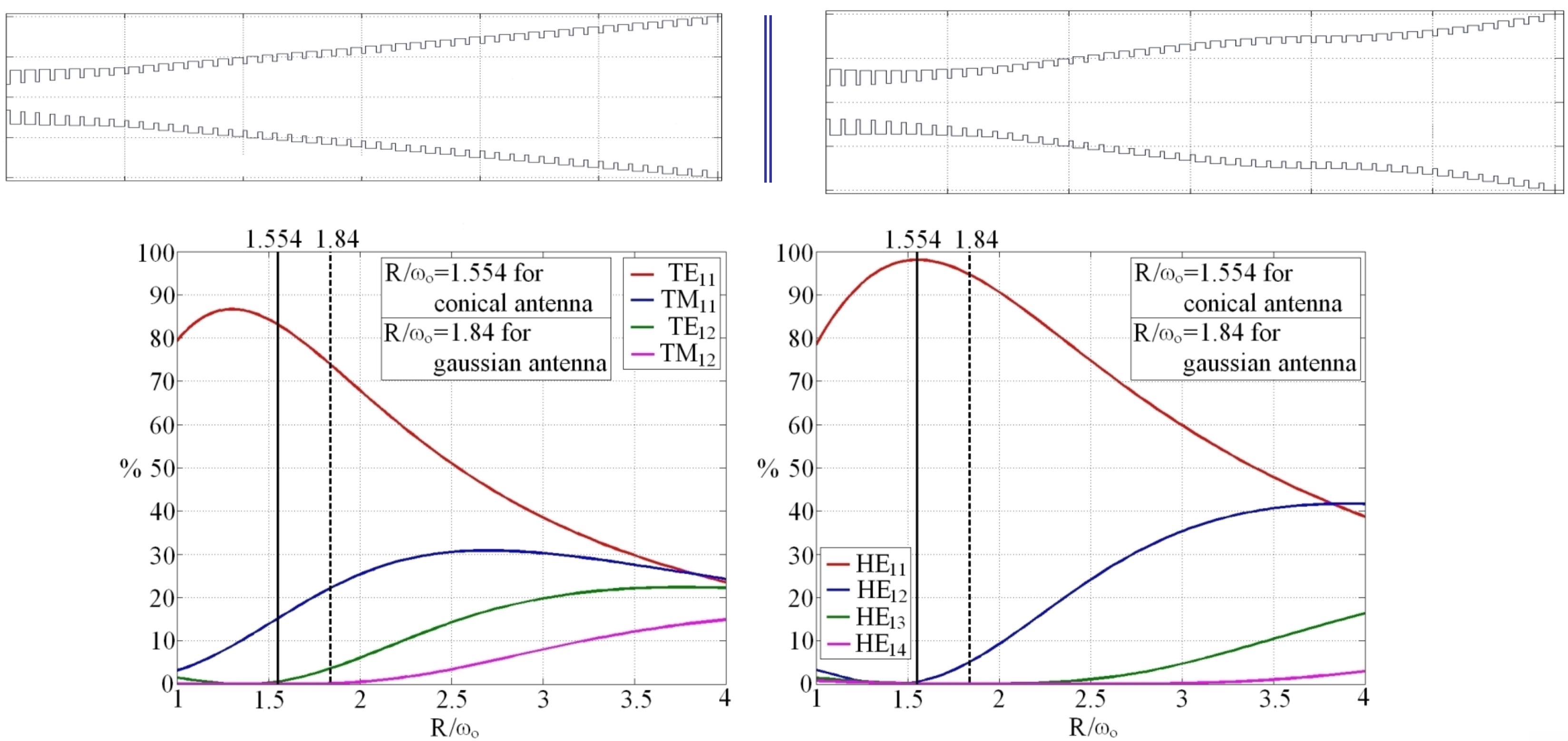
Comparison results

- Mode mixture along the antennas:



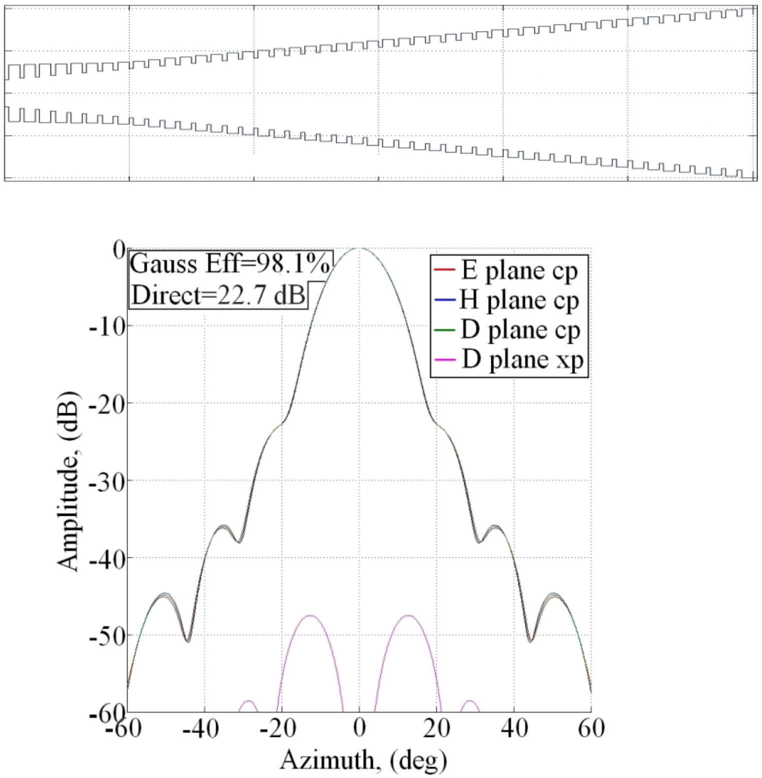
Comparison results

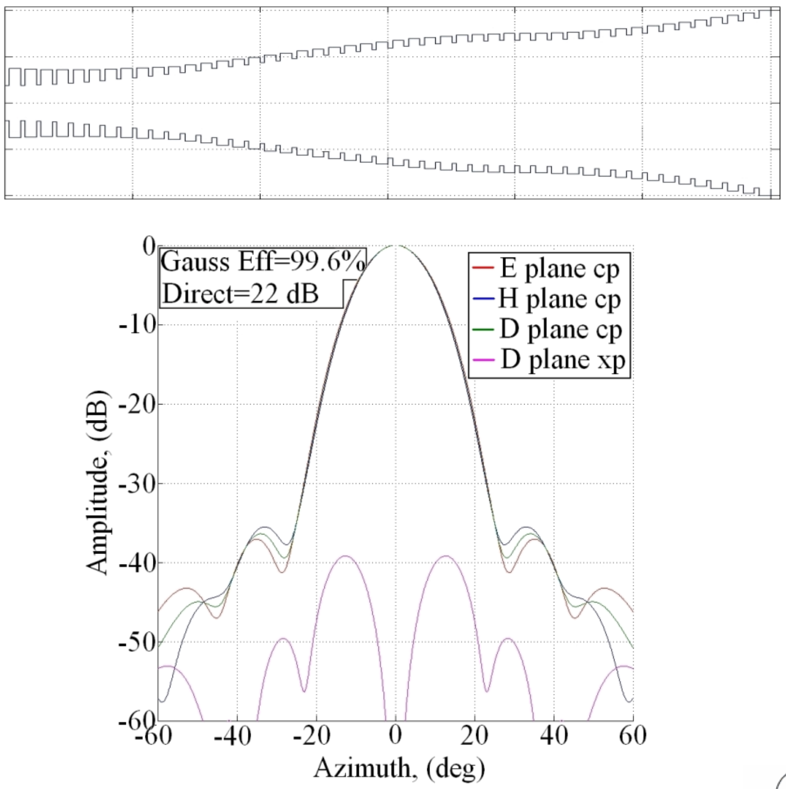
- Mode mixture at the aperture:



Comparison results

- The radiation pattern,





Comparison results

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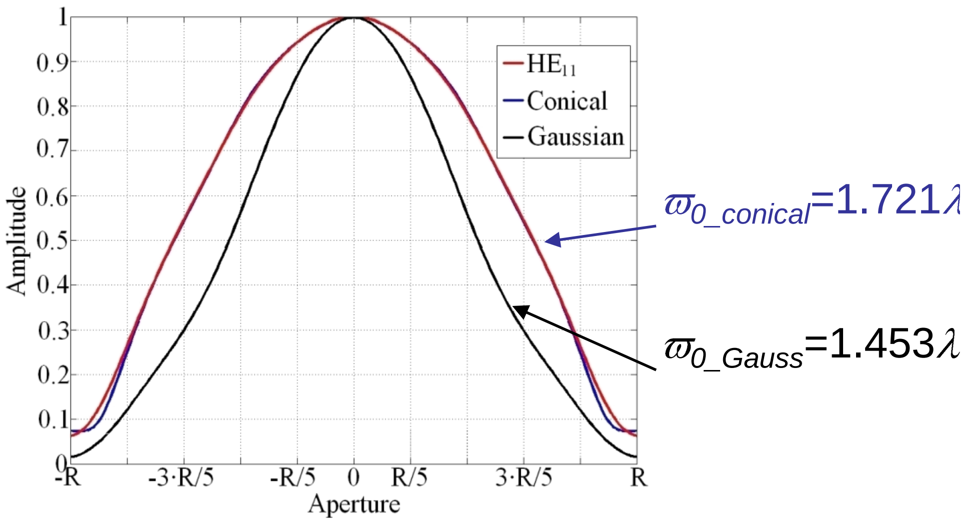
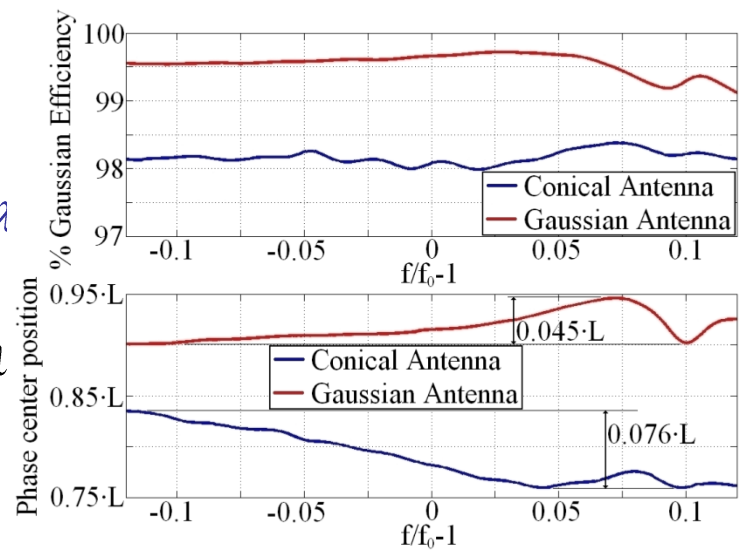
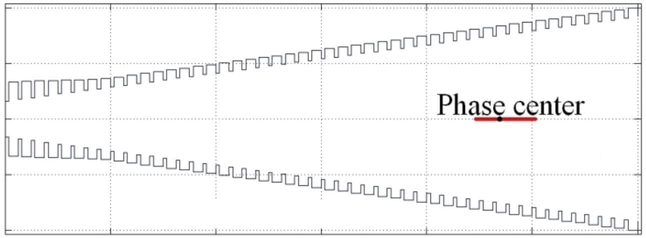
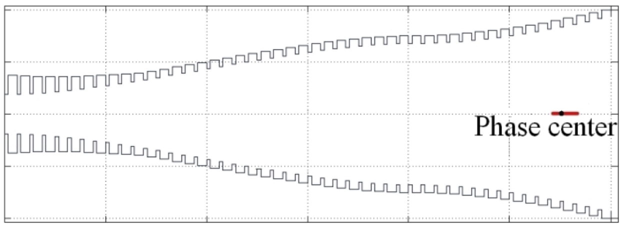
- The aperture field distribution,









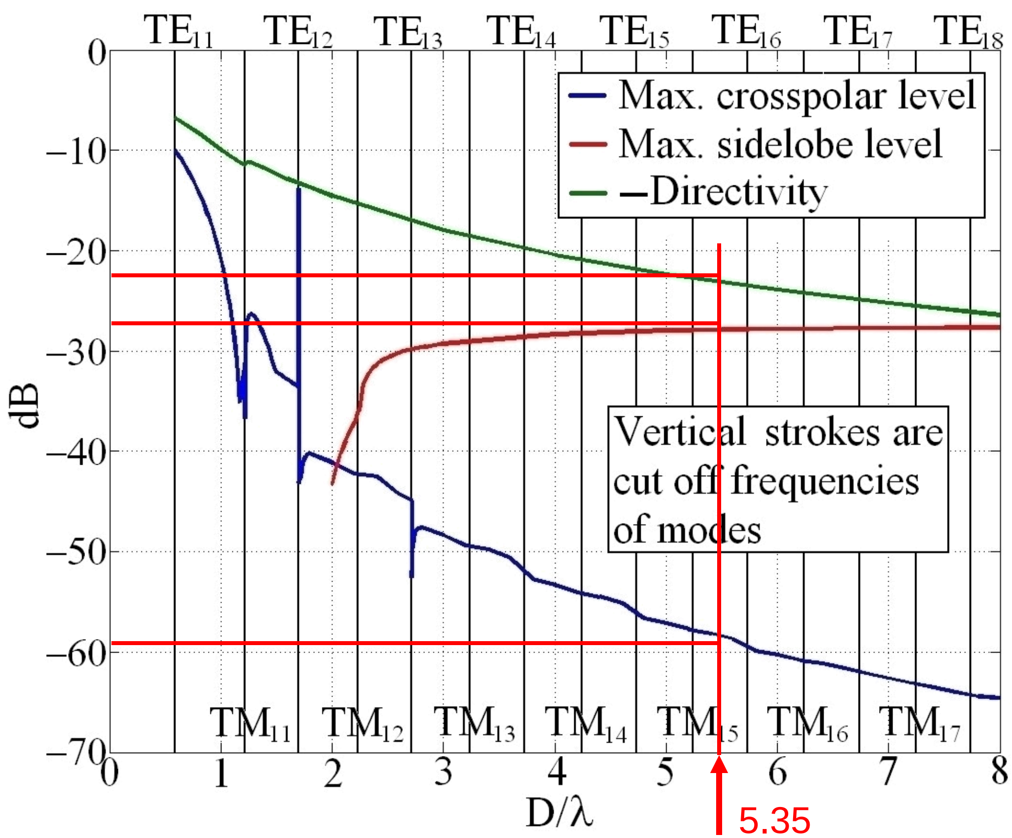
Comparison results

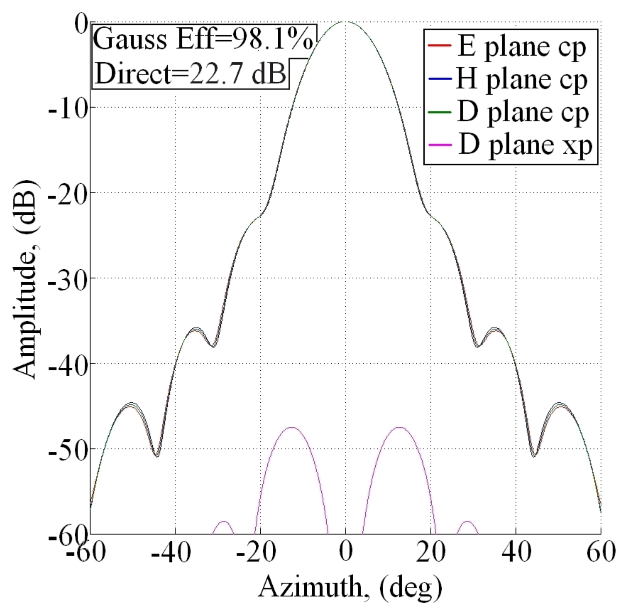
- Partial conclusions:

	Conical	GPHA
Gauss Efficiency	98.1%	99.6%
Directivity	22.7 dB	22.0 dB
Phase center	0.076L	0.045L
Output Mode	HE_{11}	Ψ_{00}

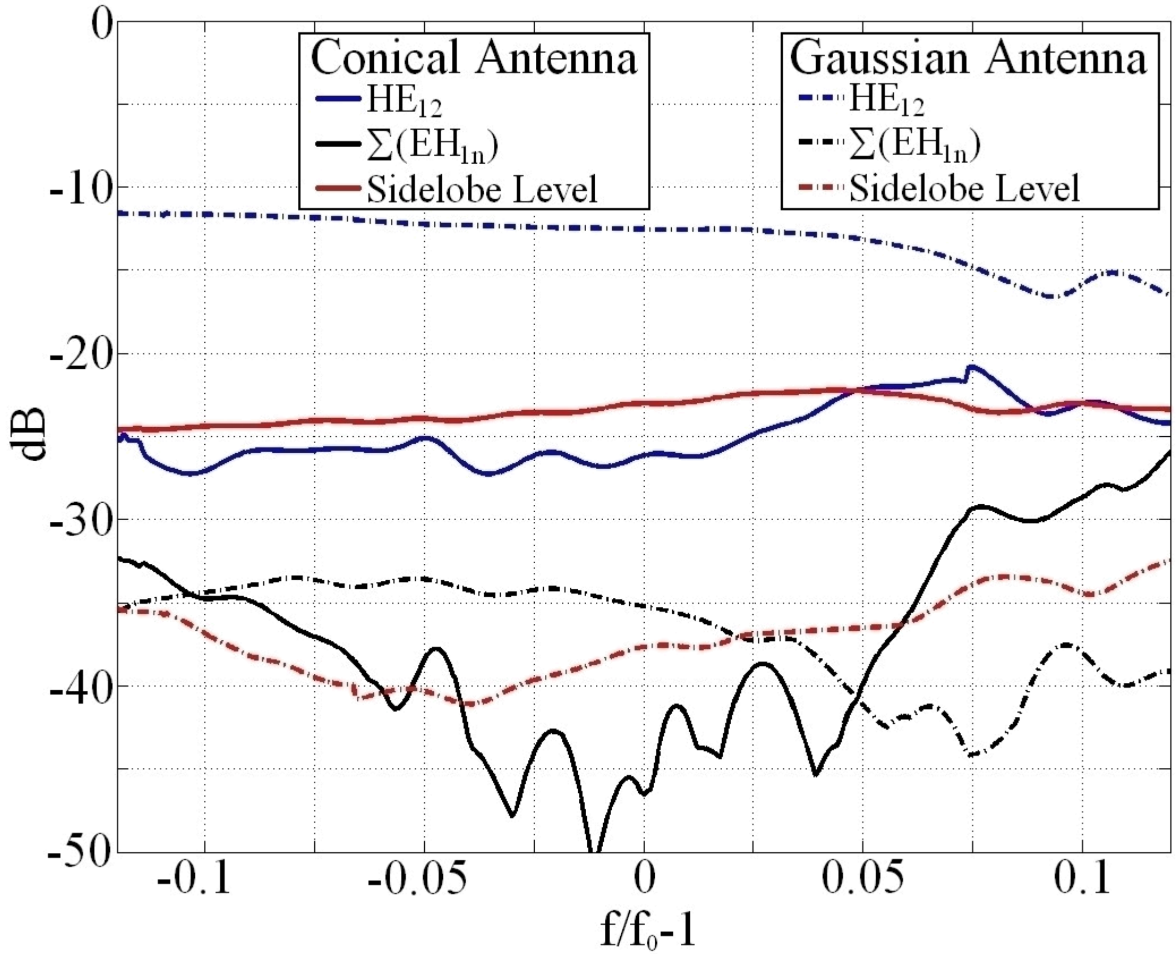
Comparison results

- Radiating features of HE_{11} mode





Comparison results

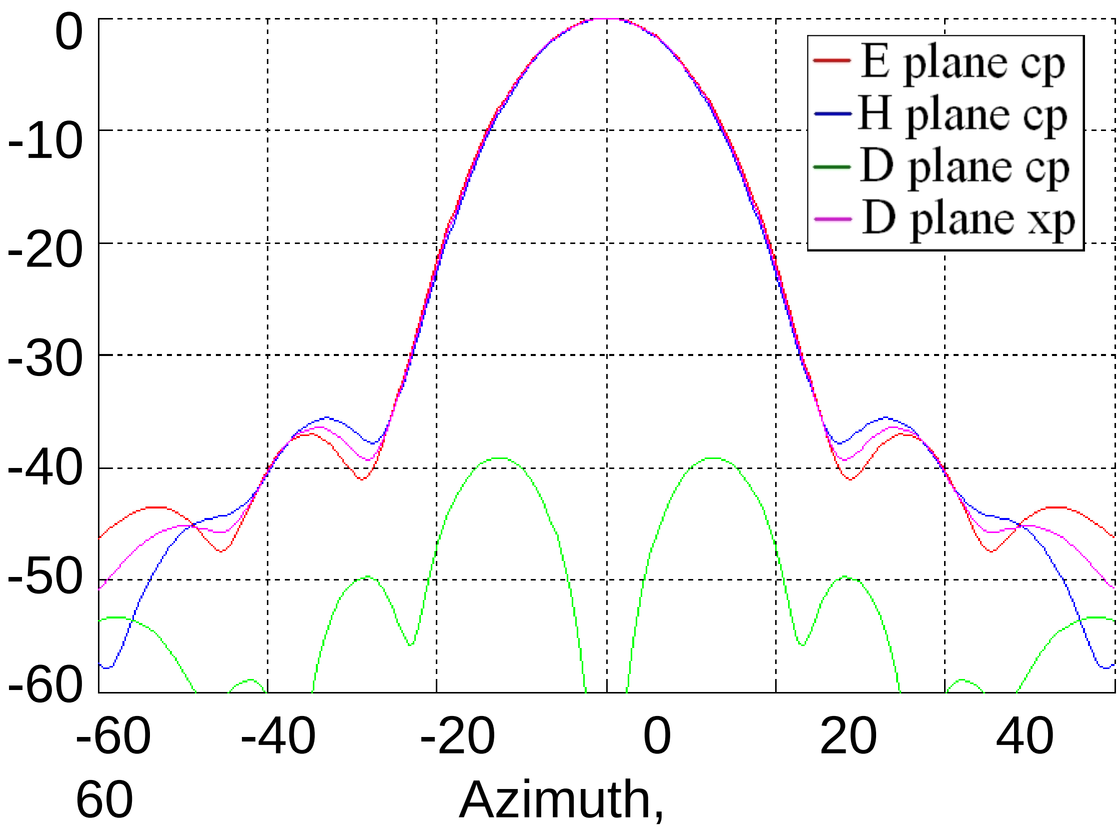


Comparison results

- Because of the four design parameters of the GPHAs, other possibilities:
  - Previous design parameters (GPHA)
    - L_{int}=11.025λ, r_{int}=1.893λ, ϖ_0=0.928λ, ϖ_0'=1.323λ
  - New design parameters (GPHA*)
    - L_{int}=11.249λ, r_{int}=1.905λ, ϖ_0=0.904λ, ϖ_0'=1.288λ
- Two equal-size GPHAs

Comparison results

Total length= 16.5 λ D/λ=5.35



dB

Azimuth, (deg)

Conical

D = 22.7 dB

Eff.= 98.1%

GPHA*

D = 22.6 dB

Eff.= 98.6%

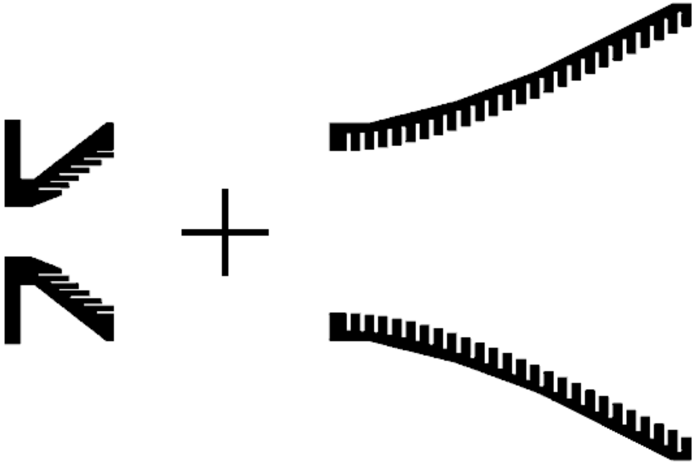
GPHA

D = 22 dB

Eff.= 99.6%

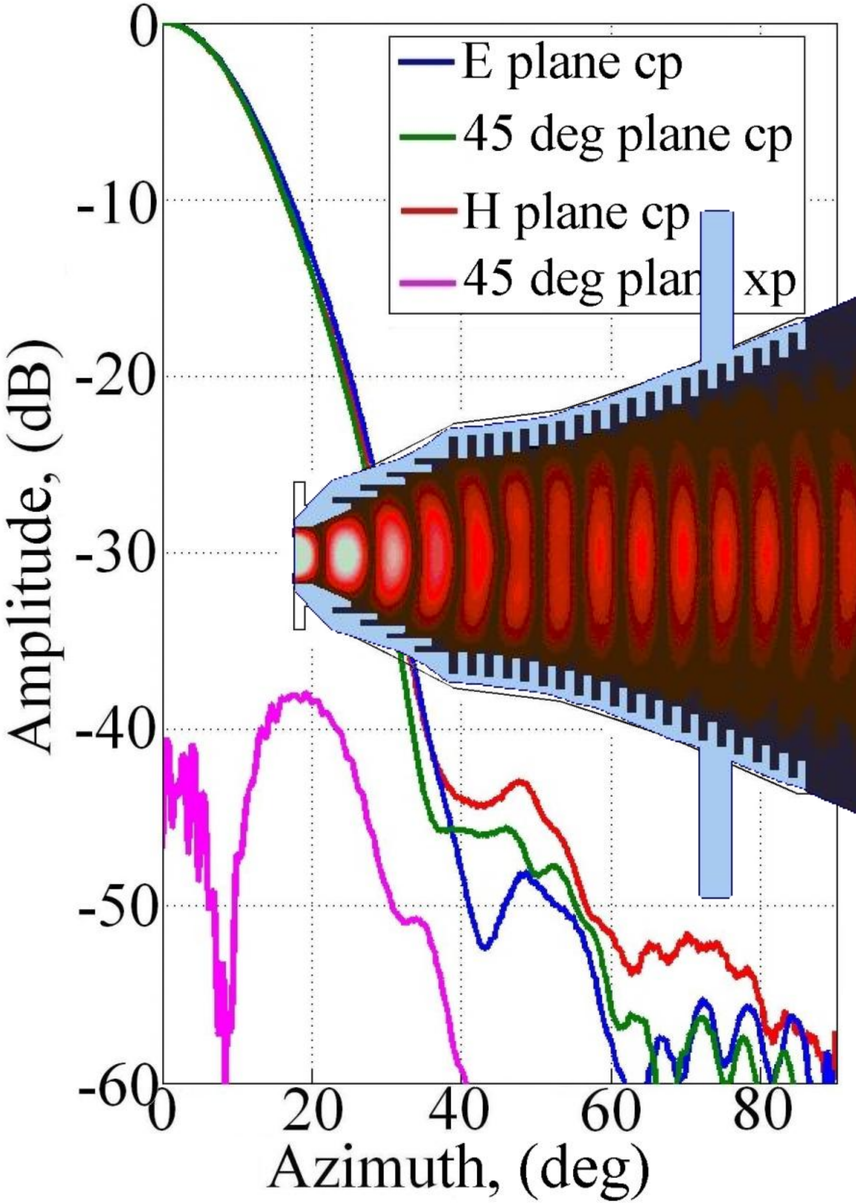
Profiled feed-horns

- In the last few years, a new type of profiled corrugated horn antenna has appeared.
- They consist in the combination of two technologies:
  - Horizontal corrugations for throat region
  - Vertical corrugations for flare region
- This profiles are very short for a reasonable nice bandwidth (25 to 30 %) and high performance.



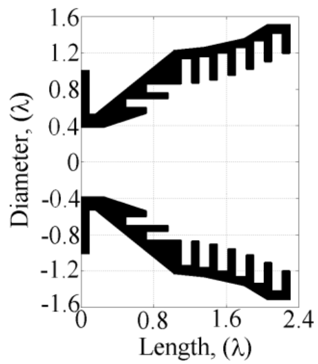
Profiled feed-horns

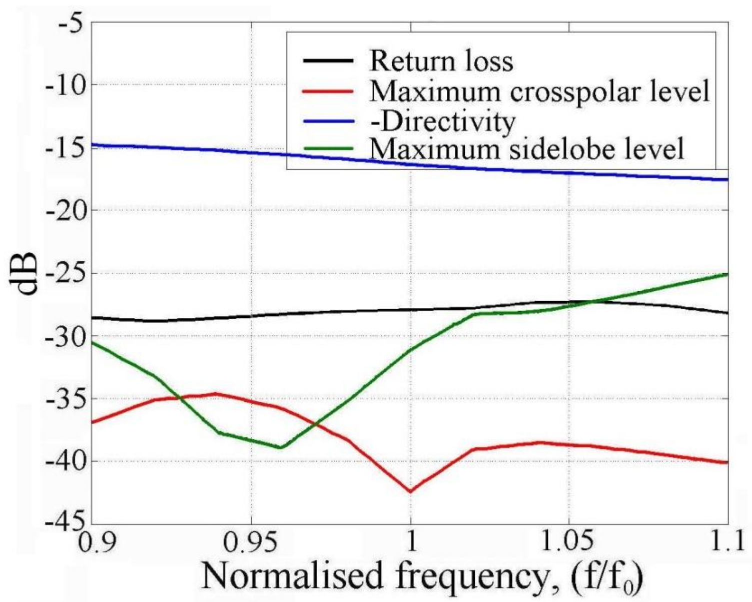
- First design of the combination of vertical and horizontal corrugations:

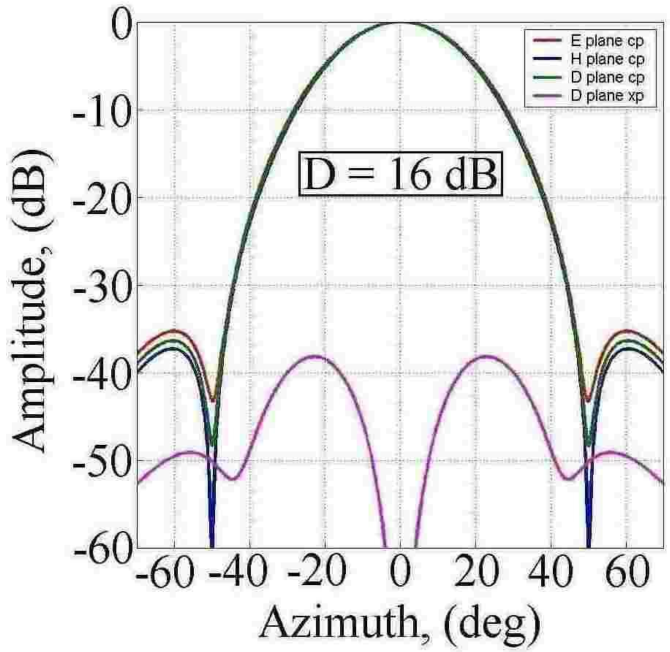


Profiled feed-horns

- 16 dB directivity horn antenna, 20% bandwidth in 2.3λ length, ensuring:
  - Return loss < -27 dB
  - X-pol < -35dB
  - Side-lobes < -25 dB

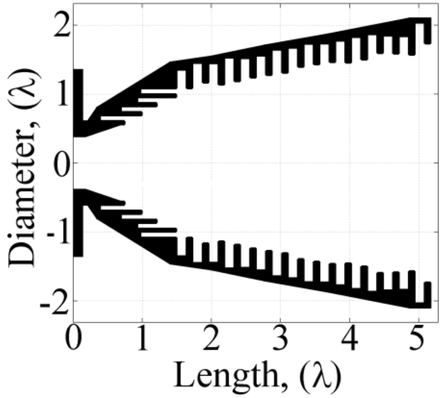


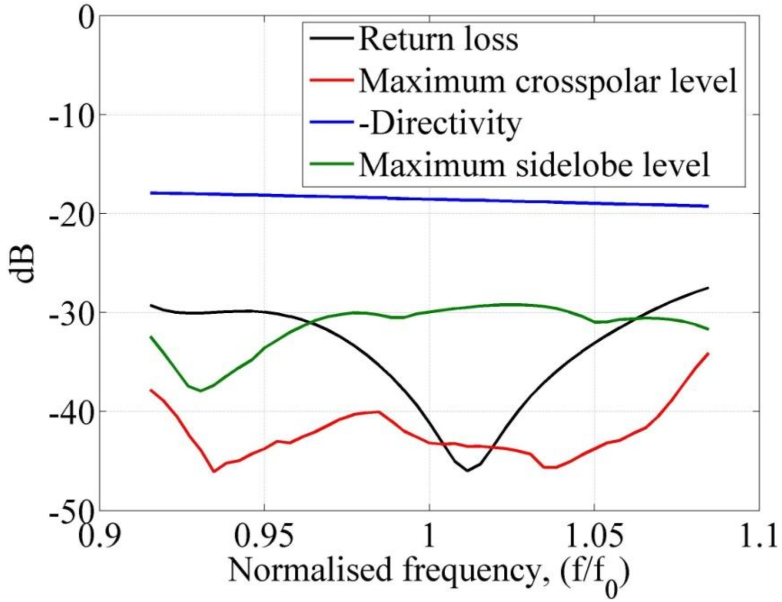


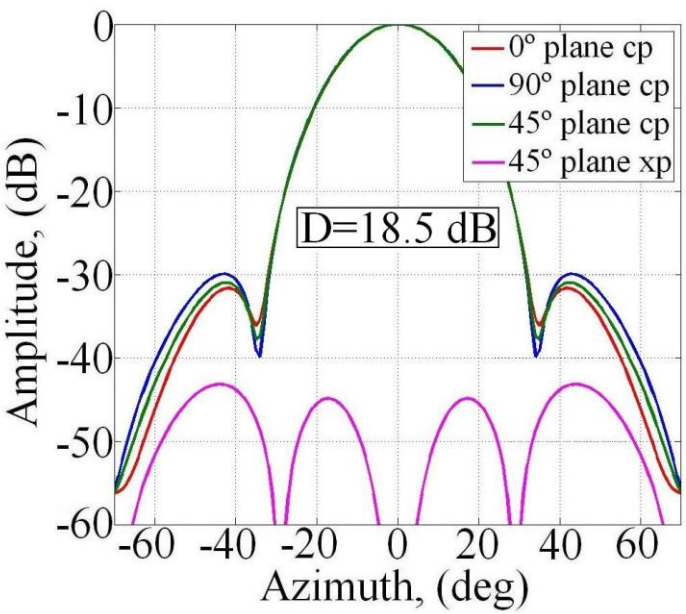


Profiled feed-horns

- 18.5 dB directivity horn antenna, 15% bandwidth in 5.2λ length, ensuring:
  - Return loss < -30 dB
  - X-pol < -40dB
  - Side-lobes < -30dB

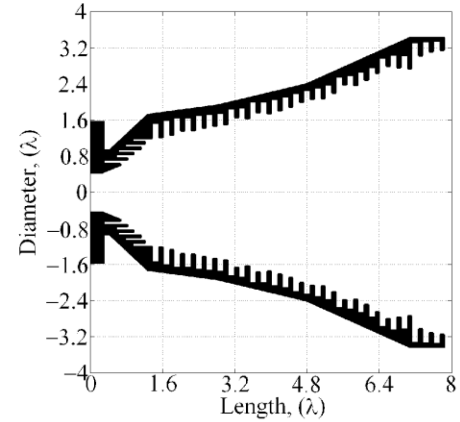


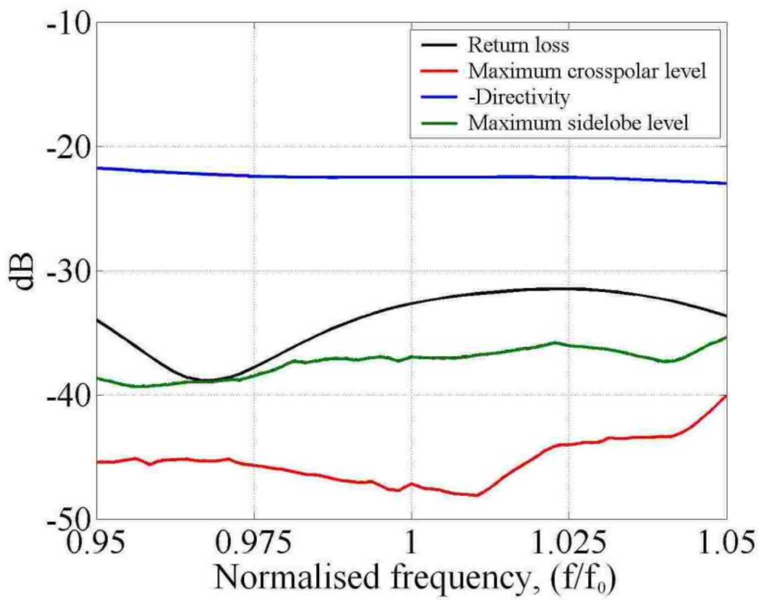


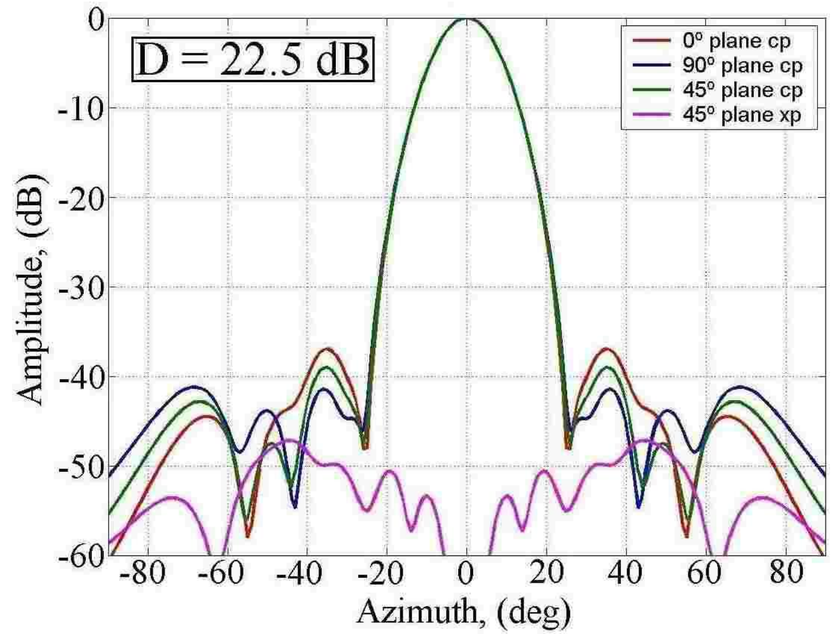


Profiled feed-horns

- 22.5 dB directivity horn antenna 10% bandwidth in 7.9λ length ensuring:
  - Return Loss < -31dB
  - X-pol < -40dB
  - Side-lobes < -35dB

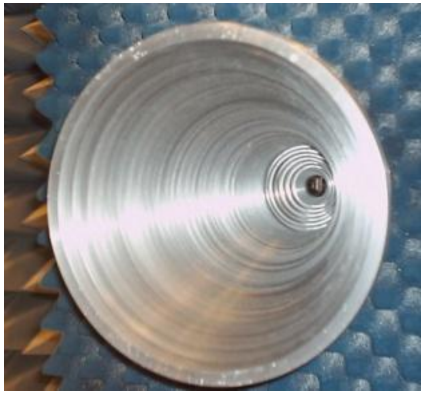


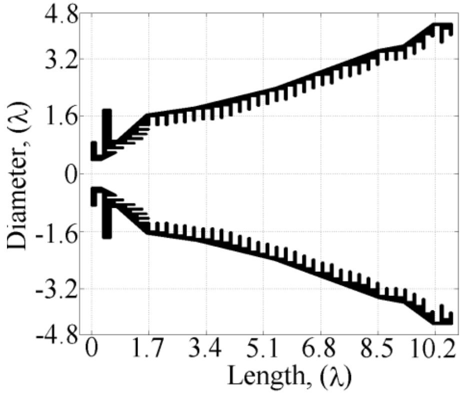


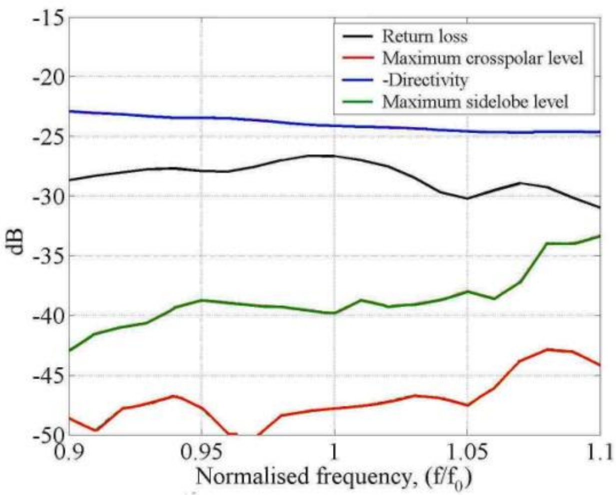


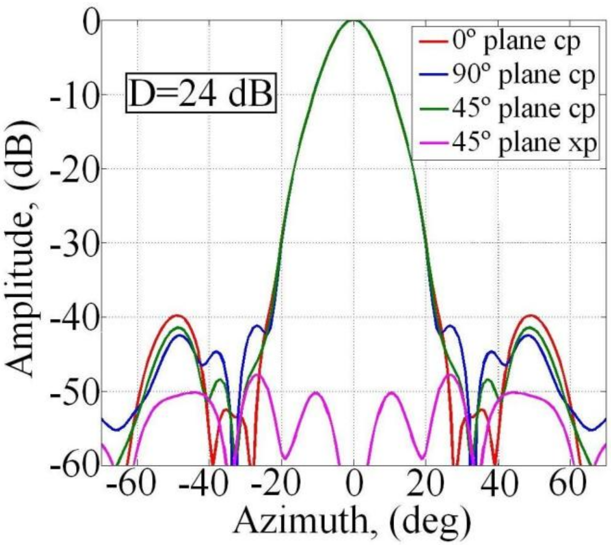
Profiled feed-horns

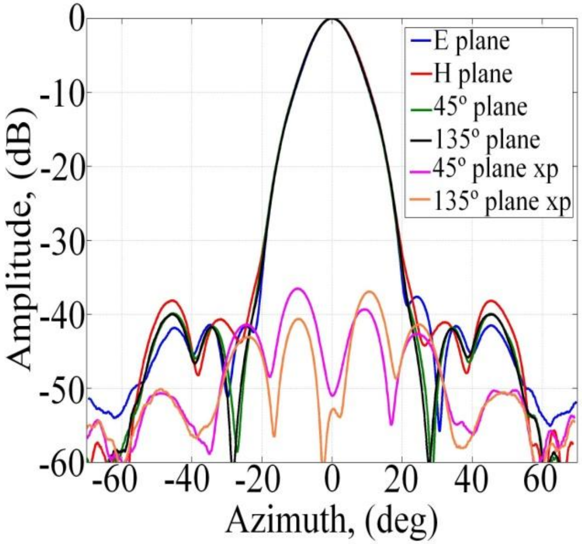
- 24 dB directivity horn antenna, 20% bandwidth in 10.5λ length ensuring (manufactured and Measured):
  - Return Loss < -27dB
  - X-pol < -43dB
  - Side-lobes < -34dB





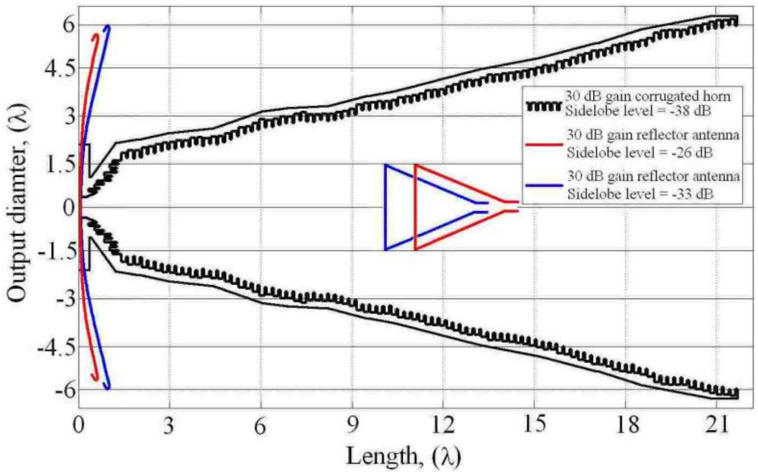




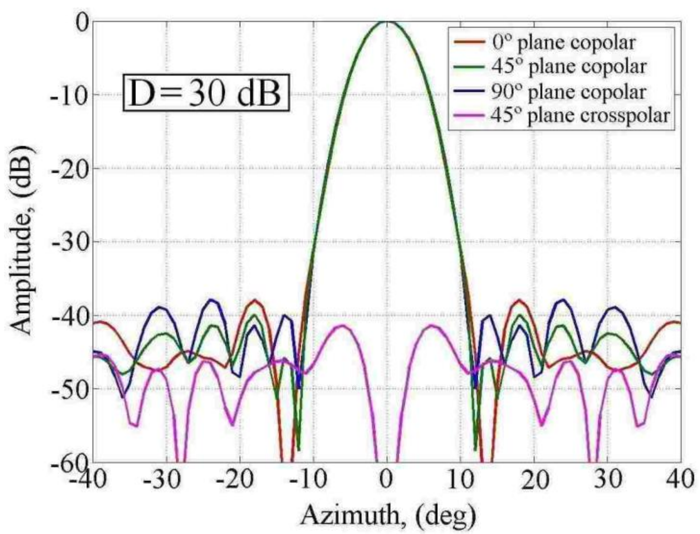


Profiled feed-horns

- The size reduction for new corrugated horns may drive to be considered as substitutes of reflector antennas in the range between 24 to 30 dB Gain



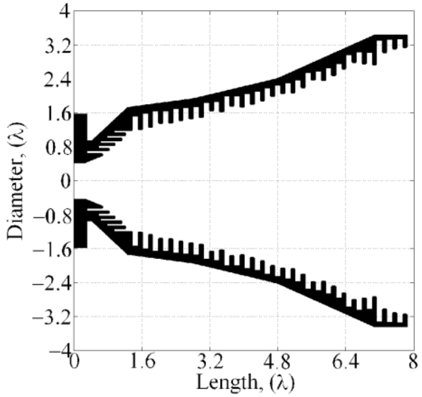
$$G = 10 \cdot \log_{10}\left(\eta \cdot \left(\frac{\pi \cdot D}{\lambda}\right)^2\right)$$



	Reflector antenna 1	Reflector antenna 2	Corrug. horn
Directivity	30 dB	30 dB	30 dB
Diameter	11.2·λ	12·λ	13·λ
Focal length	11.1·λ	10.2·λ	------
Total length	14.1·λ	13.2·λ	22·λ
Illum. taper	-11 dB	-16 dB	------
η	0.808	0.704	------
Sidelobe level	-26 dB	-33 dB	-38 dB

Profiled feed-horns

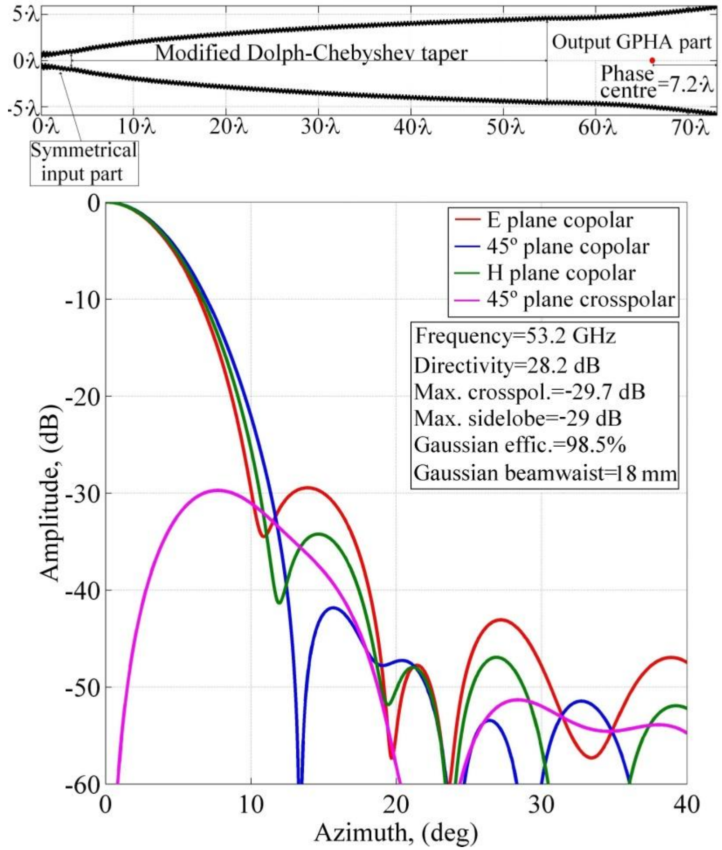
- In the table an study of the spillover significance has been made as an example for the 22.5 dB gain antenna increasing artificially its side-lobe level from -40 dB to -20 dB
- In the table can be seen the dramatic reduction in total efficiency that happens when side-lobe level is below -30 dB

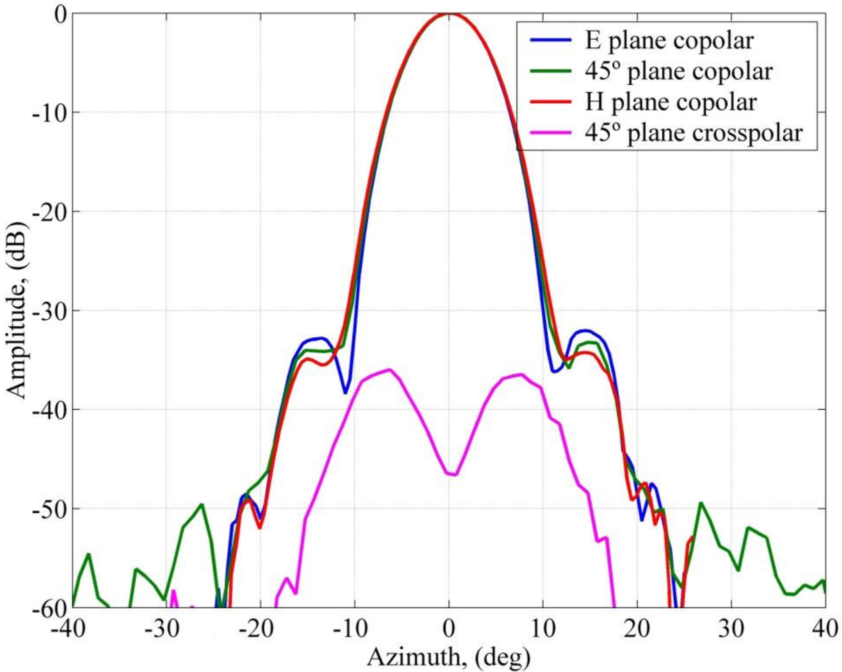


	η_i	η_s	$\eta_i \cdot \eta_s$
-20 dB	0.885	0.720	0.637
-25 dB	0.885	0.846	0.749
-30 dB	0.885	0.896	0.793
-40 dB	0.885	0.919	0.813

Examples

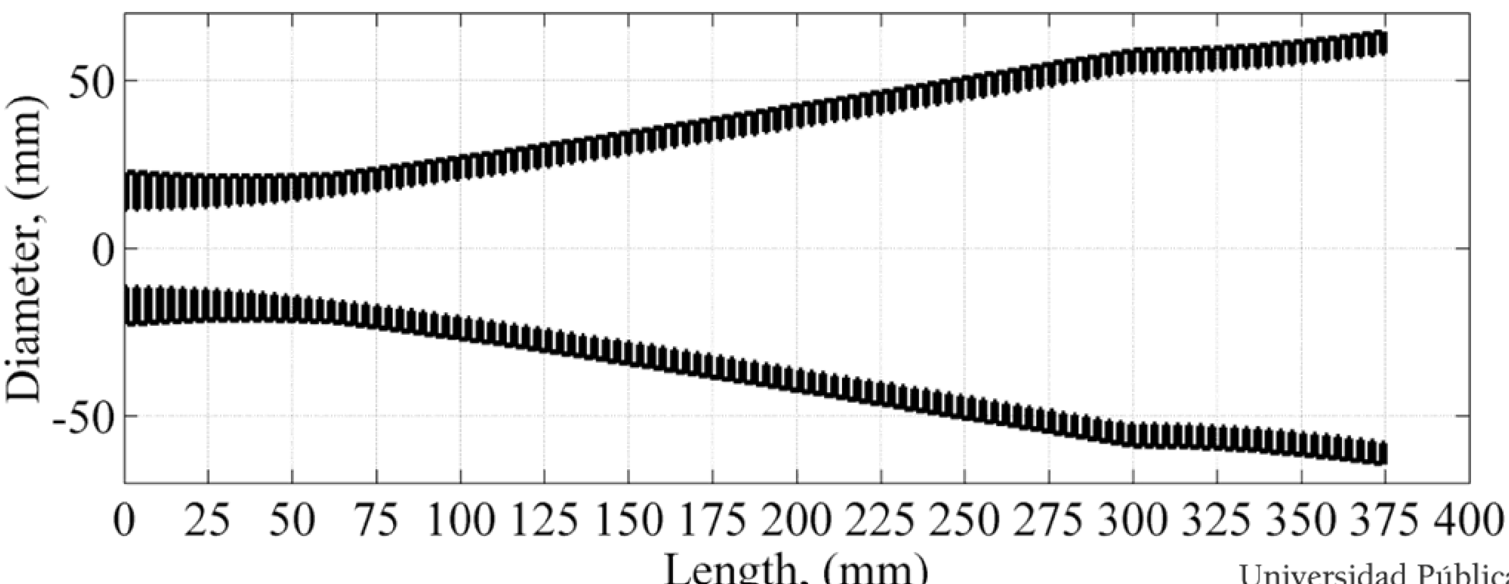
- Corrugated GPHA design for low power testing of the quasioptical transmission lines at TJ-II stellerator:





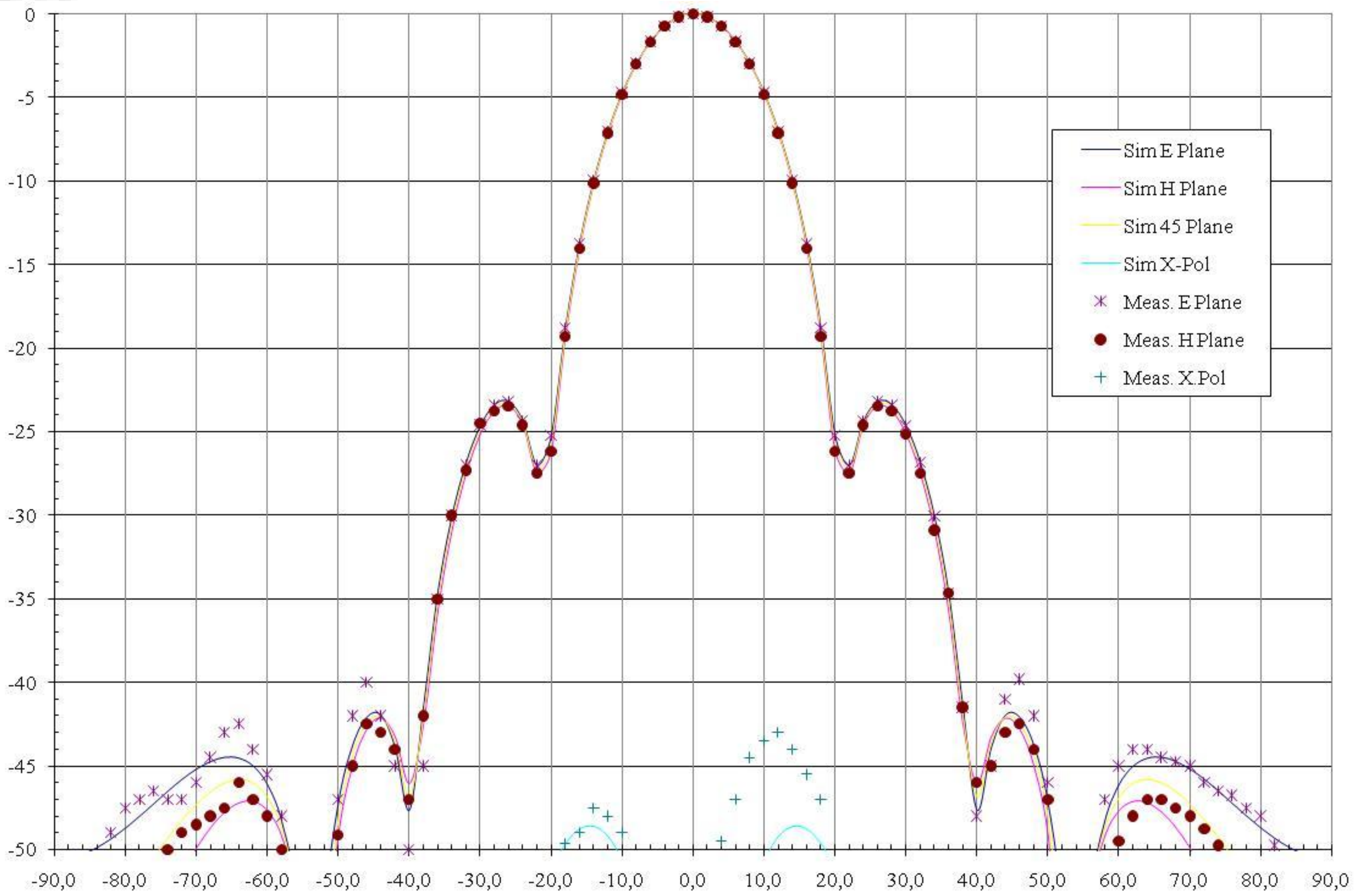
Examples

- Corrugated GPHA design for Hispasat 1C satellite:
  - Frequency range: 11.7 to 12.2 GHz
  - Illumination: 19 deg below -22 dB
  - Maximum cross-polar: below -45 dB
  - RL below -28 dB
  - Input dia.: 23.4 mm

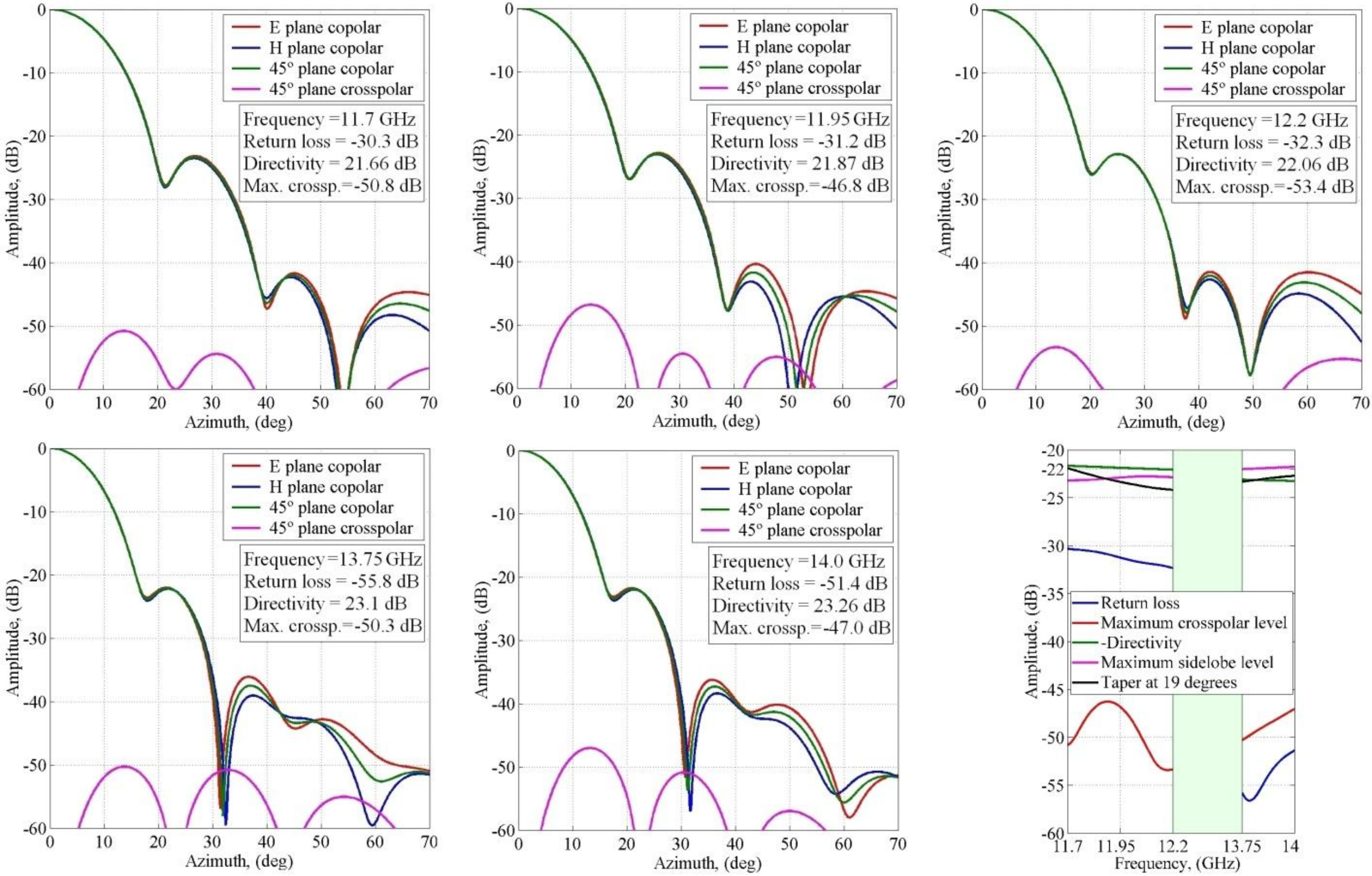


Examples

- Comparison between simulation and measurements…

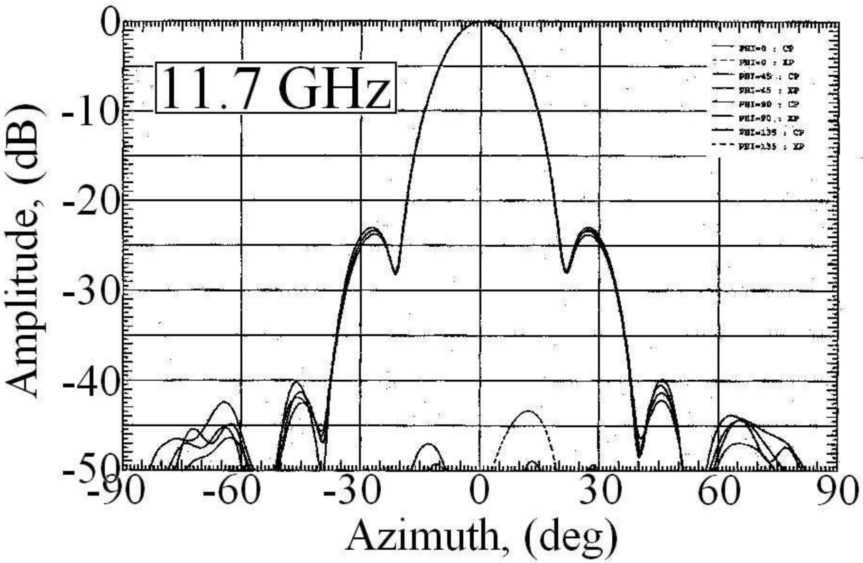


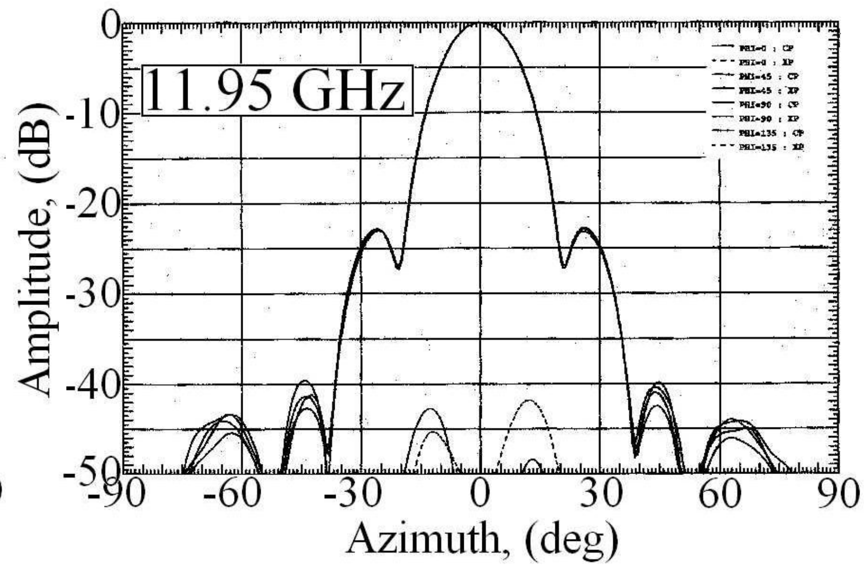
Examples

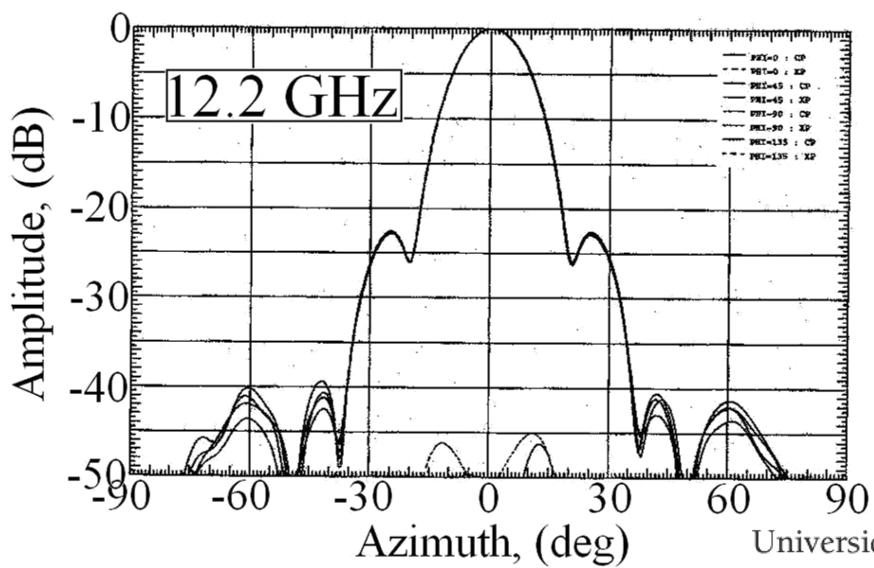


E plane copolar
H plane copolar
45° plane copolar
45° plane crosspolar
Frequency =11.7 GHz
Return loss = -30.3 dB
Directivity = 21.66 dB
Max. crossp.=-50.8 dB
Frequency =11.95 GHz
Return loss = -31.2 dB
Directivity = 21.87 dB
Max. crossp.=-46.8 dB
Frequency =12.2 GHz
Return loss = -32.3 dB
Directivity = 22.06 dB
Max. crossp.=-53.4 dB
Frequency =13.75 GHz
Return loss = -55.8 dB
Directivity = 23.1 dB
Max. crossp.=-50.3 dB
Frequency =14.0 GHz
Return loss = -51.4 dB
Directivity = 23.26 dB
Max. crossp.=-47.0 dB
Amplitude, (dB)
Azimuth, (deg)
Return loss
Maximum crosspolar level
-Directivity
Maximum sidelobe level
Taper at 19 degrees
Frequency, (GHz)

Examples

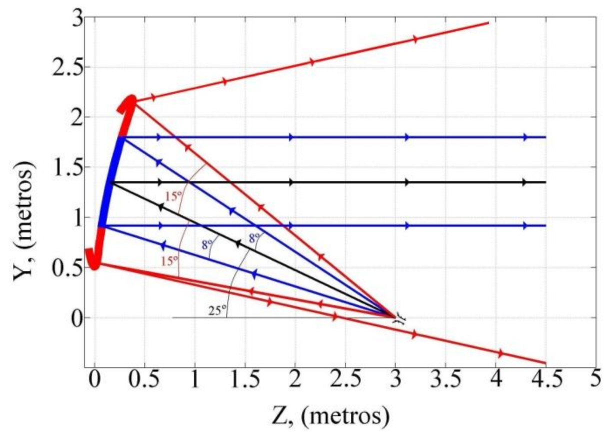

11.7 GHz
Amplitude, (dB)
Azimuth, (deg)
0
-10
-20
-30
-40
-50
-90
-60
-30
0
30
60
90

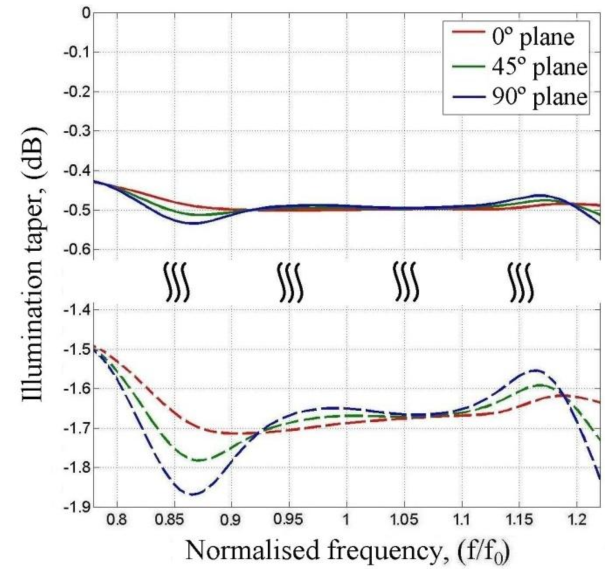

11.95 GHz
Amplitude, (dB)
Azimuth, (deg)
0
-10
-20
-30
-40
-50
-90
-60
-30
0
30
60
90

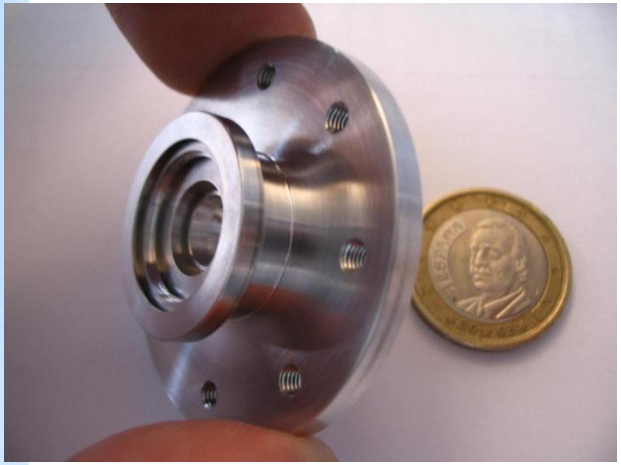

12.2 GHz
Amplitude, (dB)
Azimuth, (deg)
0
-10
-20
-30
-40
-50
-90
-60
-30
0
30
60
90

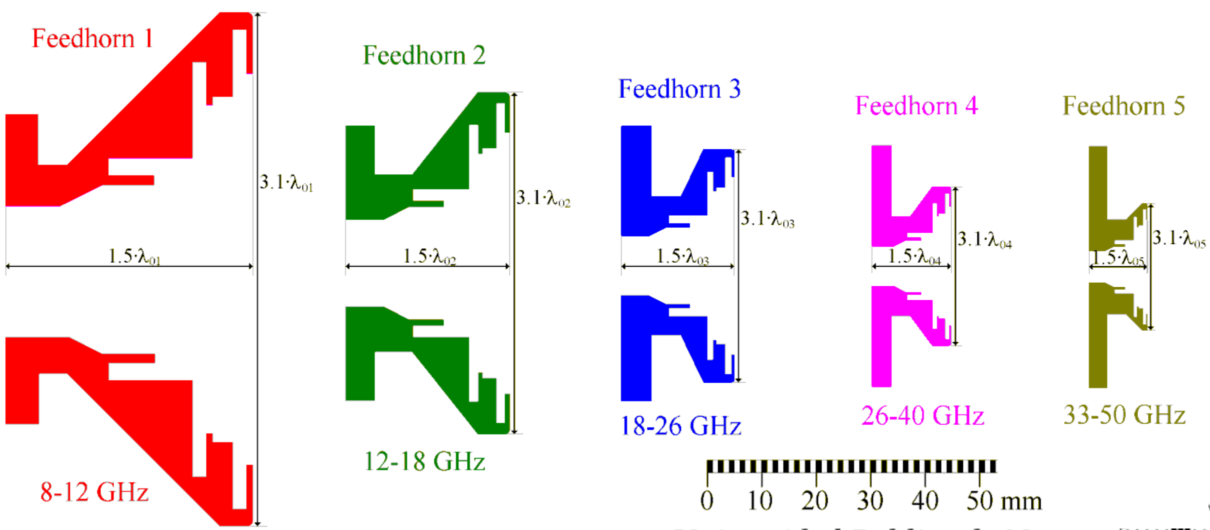
Examples

- Corrugated profiled feed-horns design for Limoges' University CATR



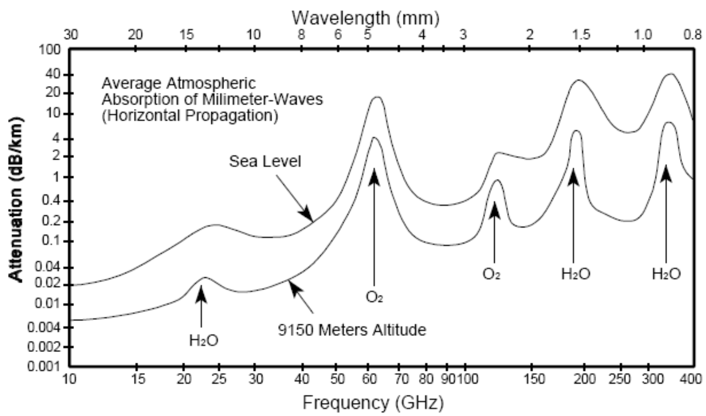


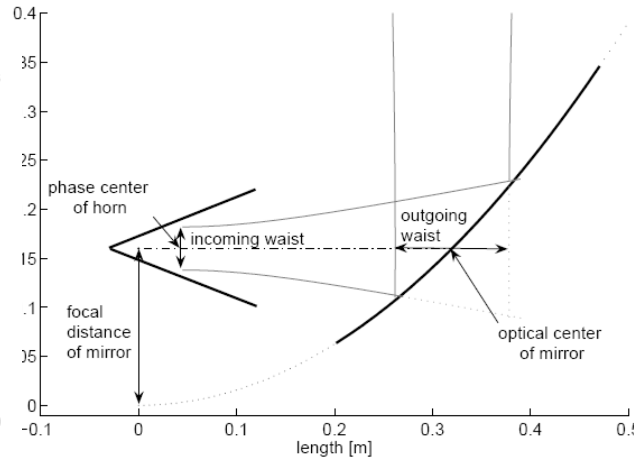


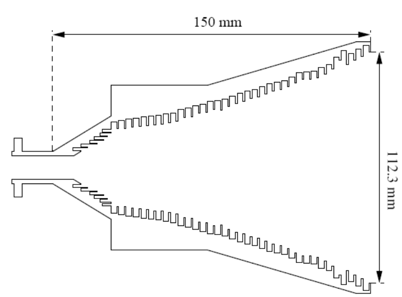


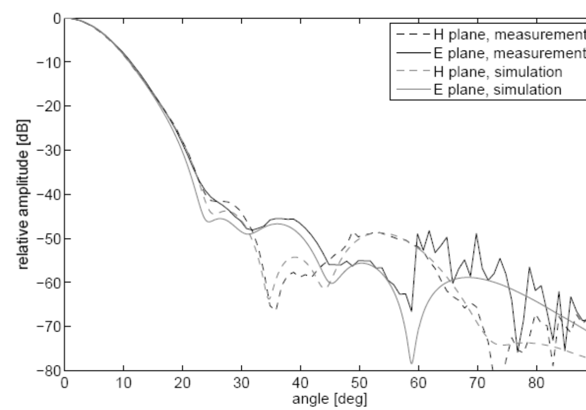
Examples

- Corrugated profiled feed-horn design for MIAWARA-C radiometer at 22 GHz in Bern University



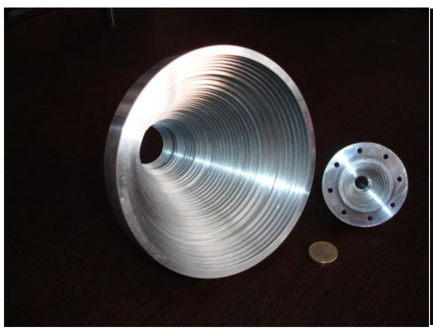


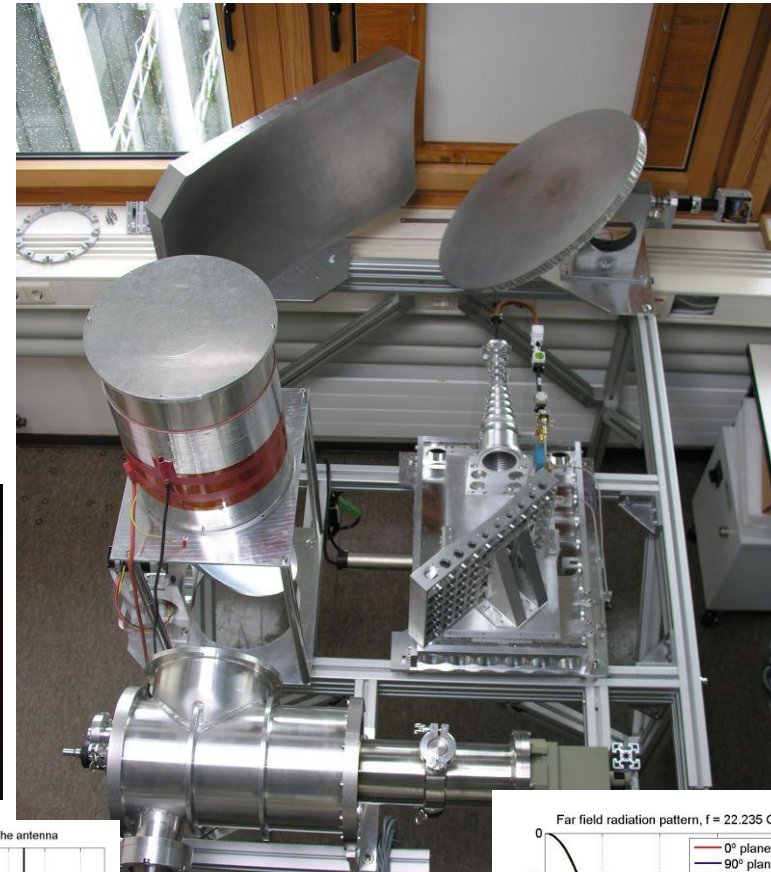


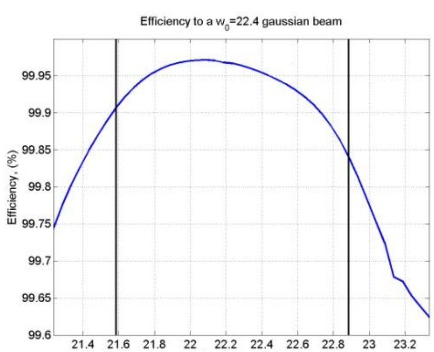


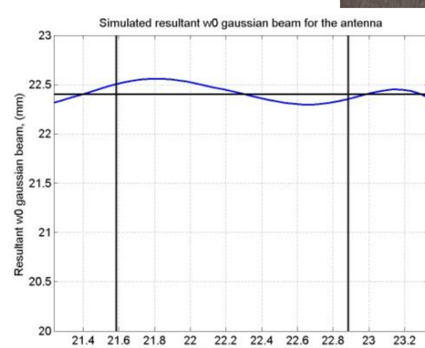
Examples

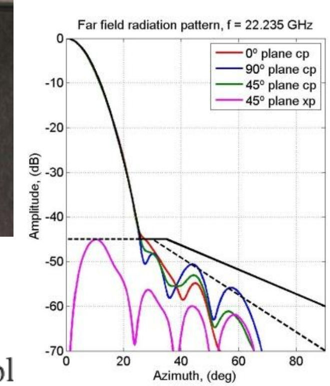
- Corrugated profiled feed-horn design for MIRA-5 radiometer at 22 GHz in Forschungszentrum Karlsruhe (Institute for Meteorology and Climate Research)





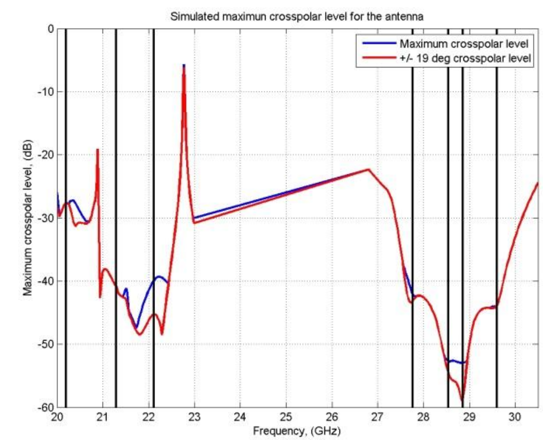


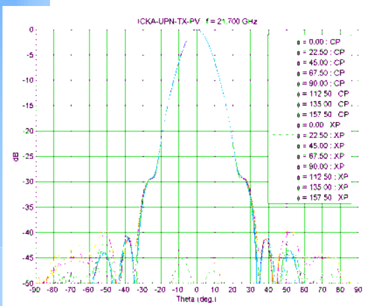


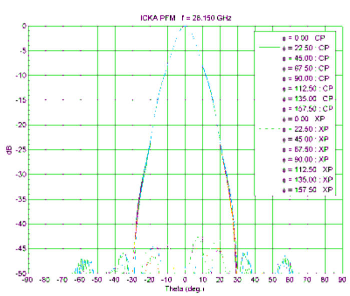


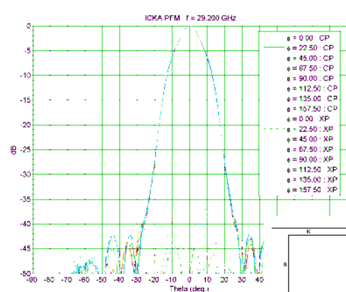
Examples

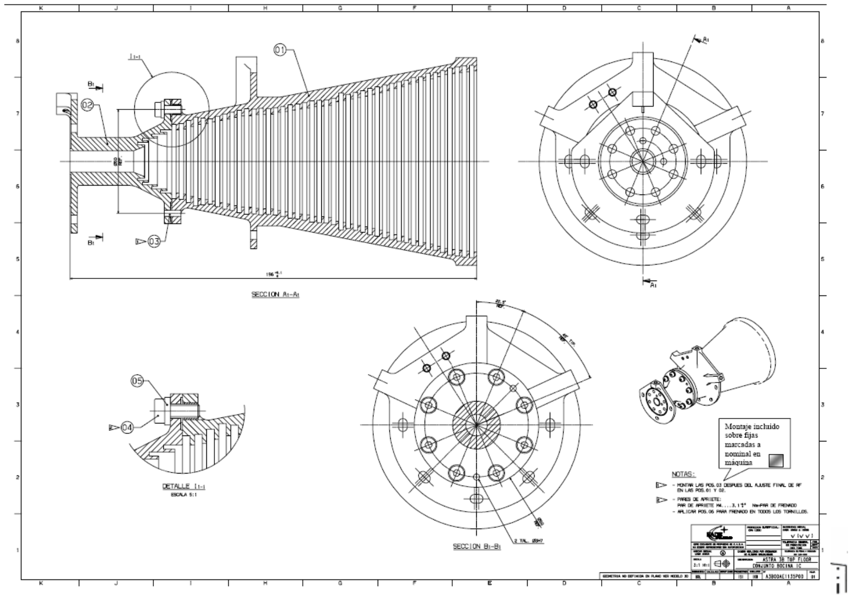
- Corrugated profiled feed-horn design for EADS/CASA to be onboard ASTRA 3B satellite IC horn:
  - Tx: 21.29–22.11 GHz,
  - Rx: 27.76–28.54 GHz + 28.81–29.60 GHz





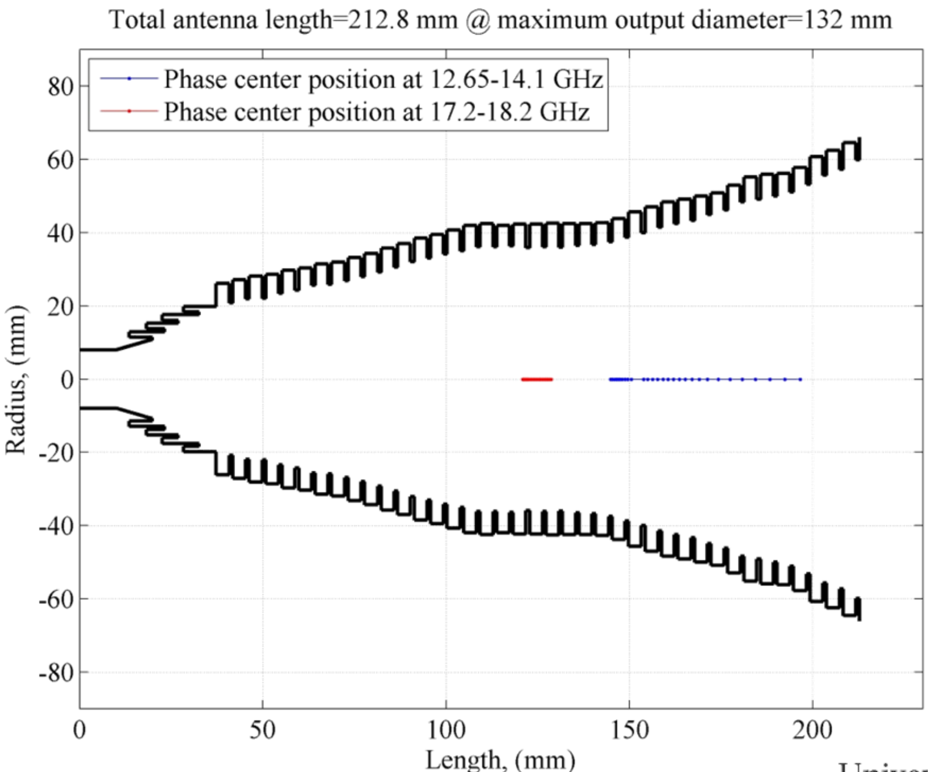






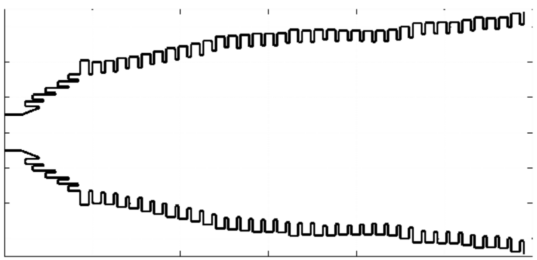
Examples

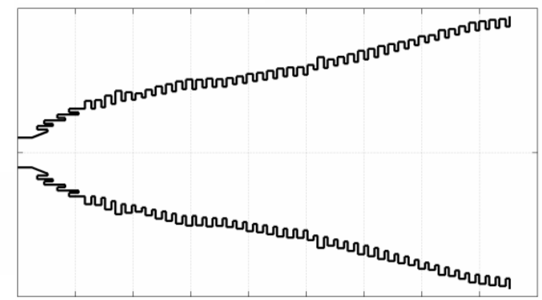
- Corrugated profiled feed-horn design for EADS/CASA to be onboard Hispasat 1E satellite
  - Europe Rx Horn: 12.65-14.10 GHz + 17.20-18.20 GHz
  - Principal requirement: phase center stability ± 15 mm

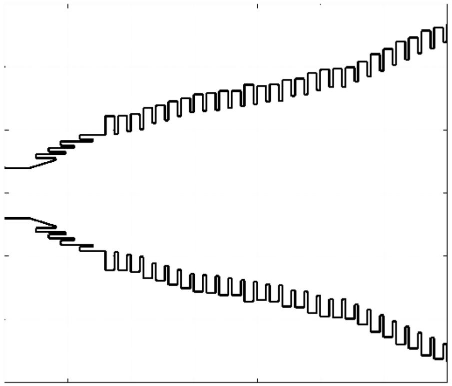


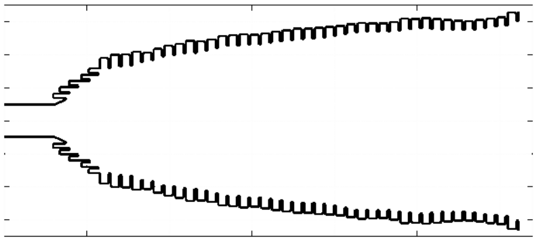
Examples

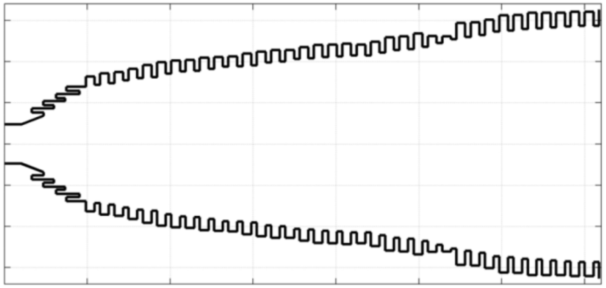
- Corrugated feed-horns profiles for different satellite and terrestrial applications

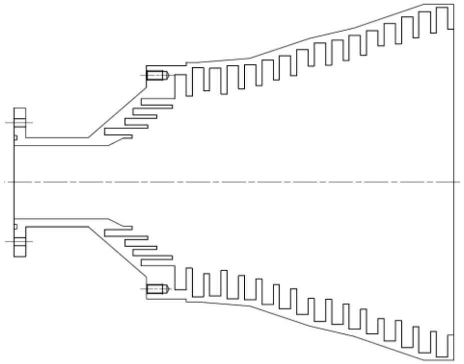








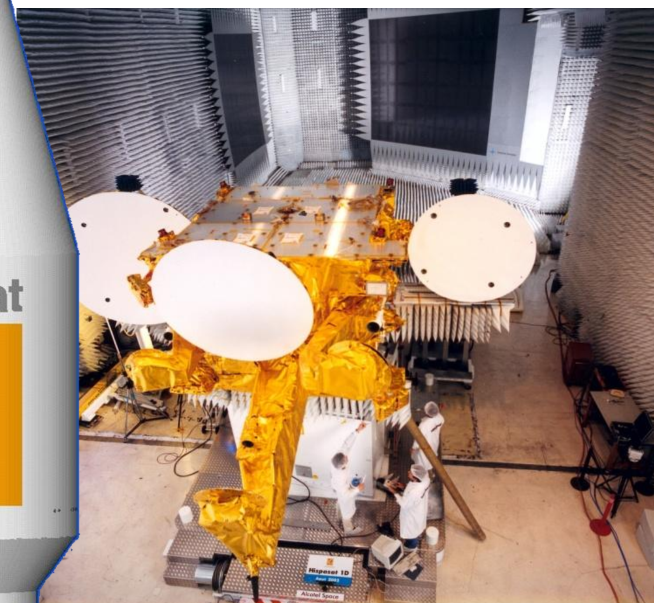


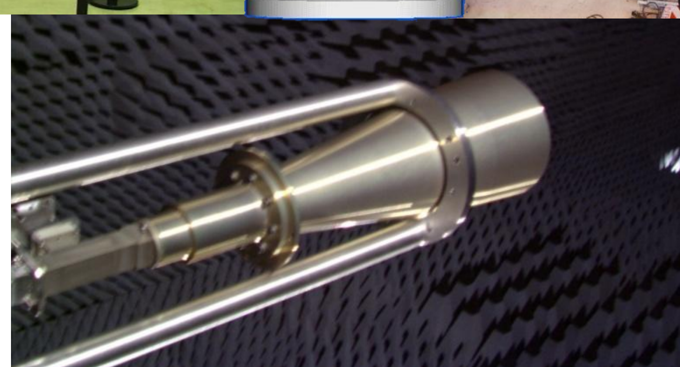


Some pictures… the Group

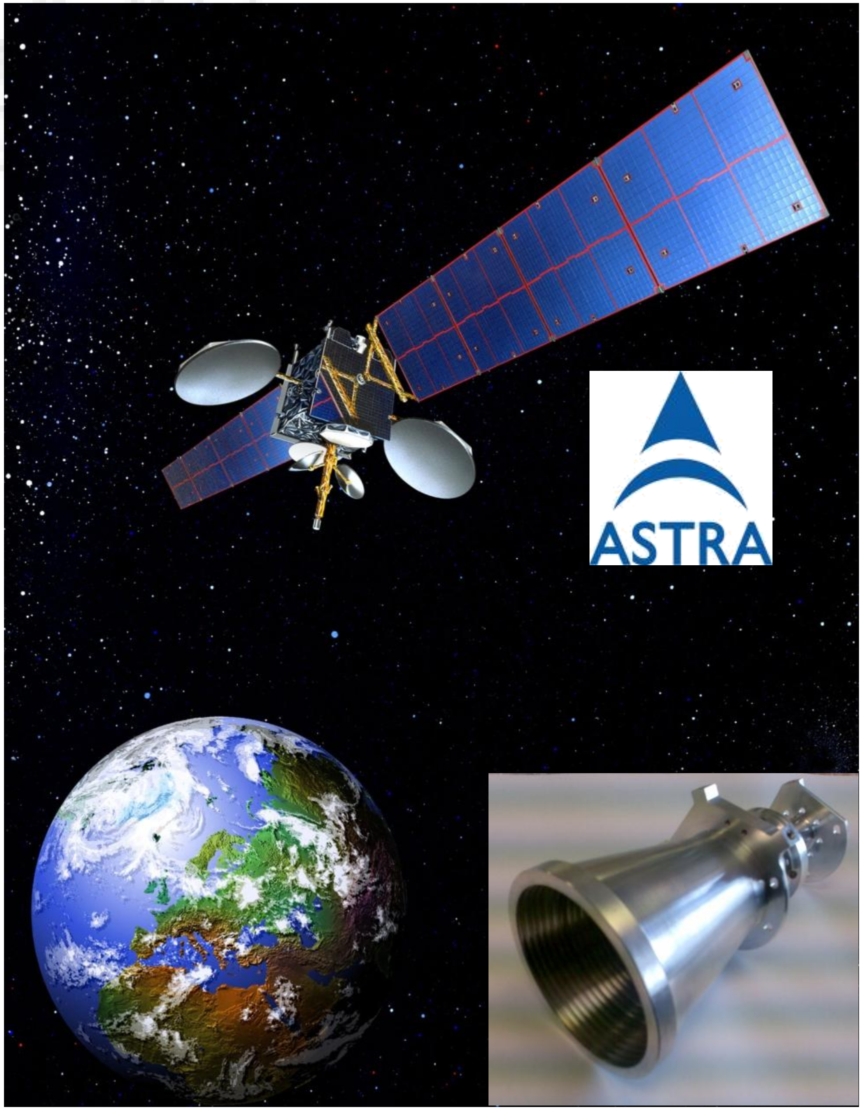
Some Pictures…

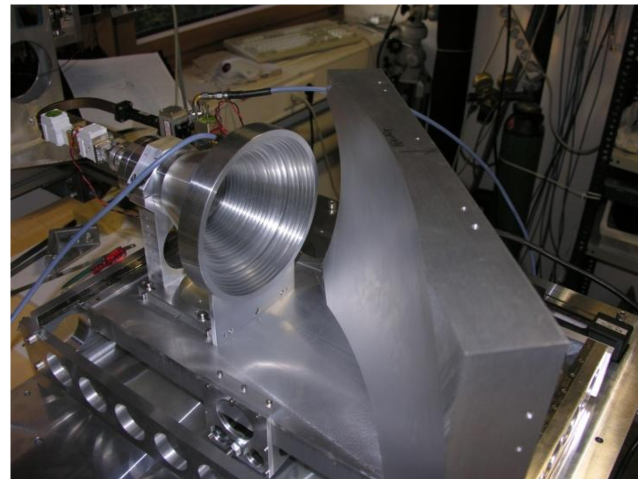
Grupo de Antenas
Universidad Pública de Navarra





Some pictures…





Some pictures…