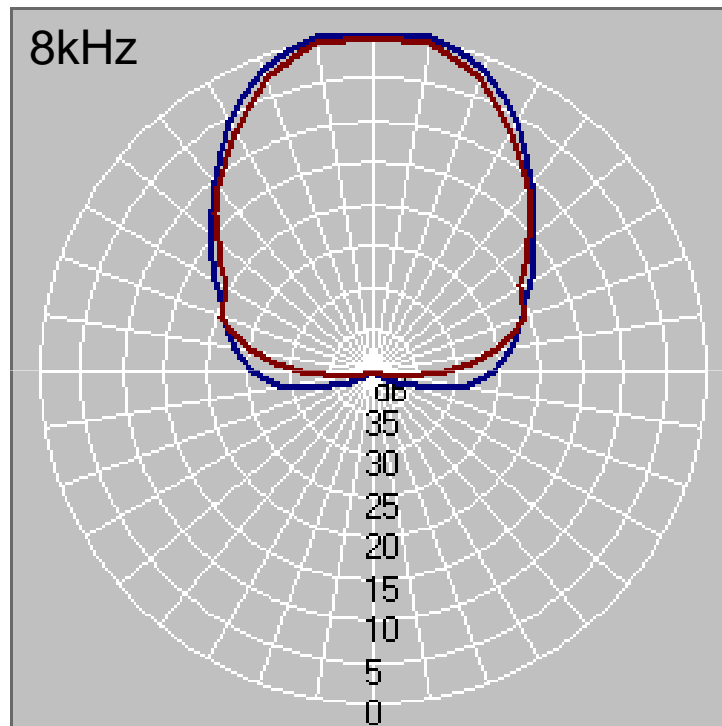
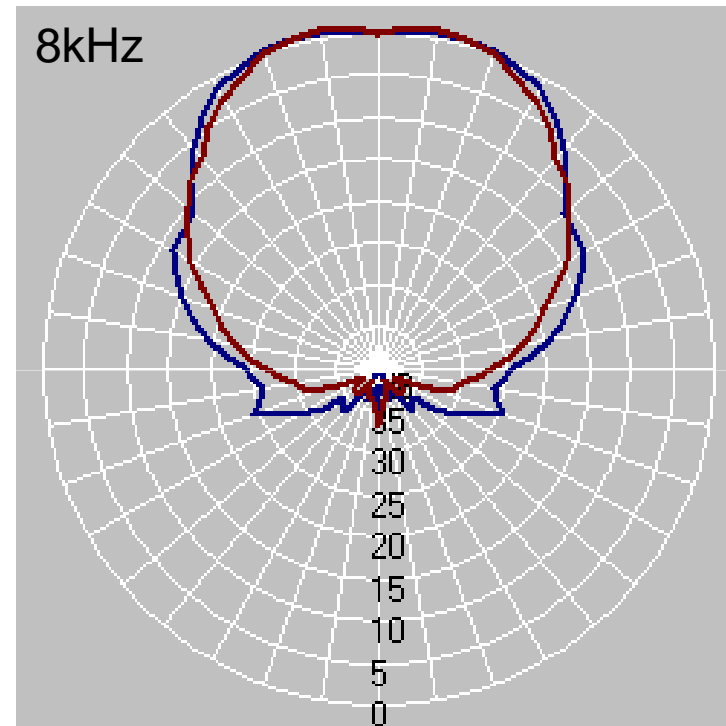


LA DIRECTIVITE DES ENCEINTES

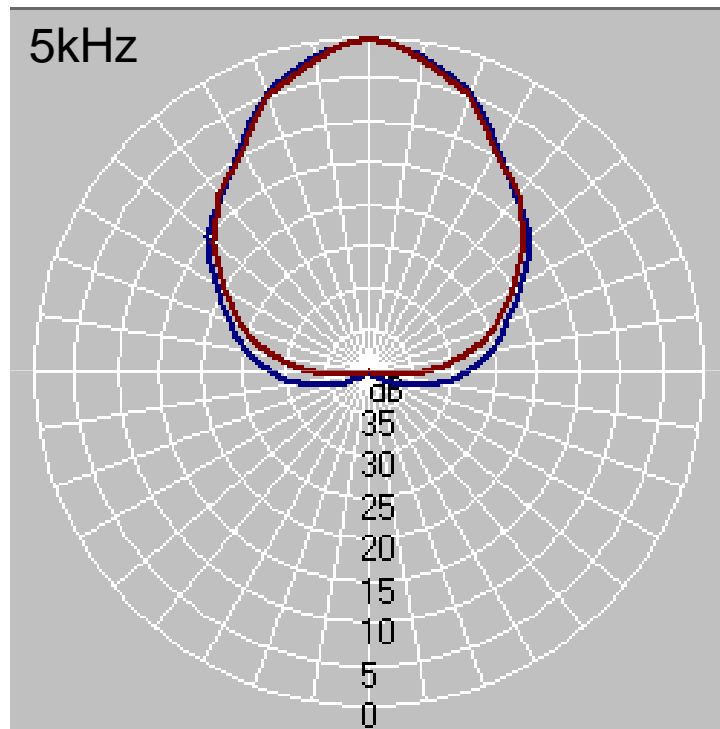
50° CONIQUE



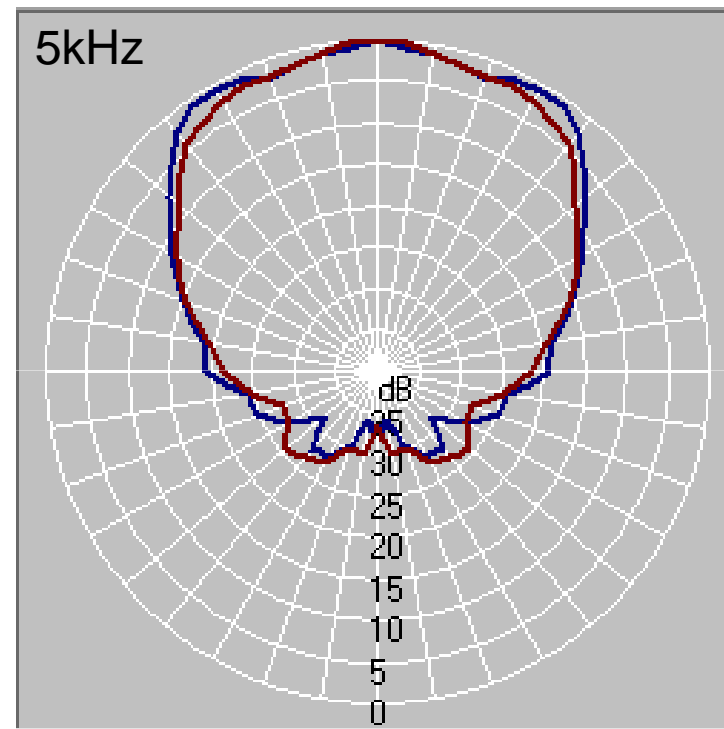
90° CONIQUE



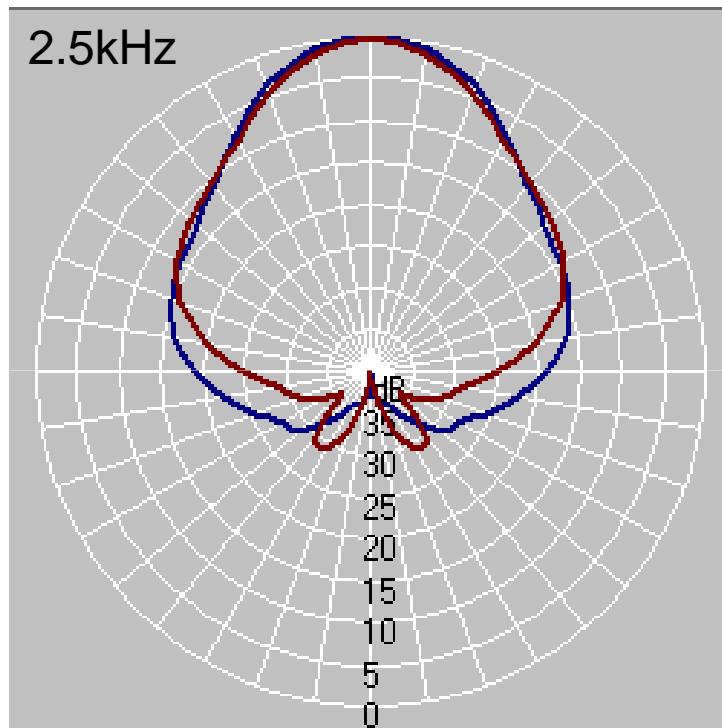
50° CONIQUE



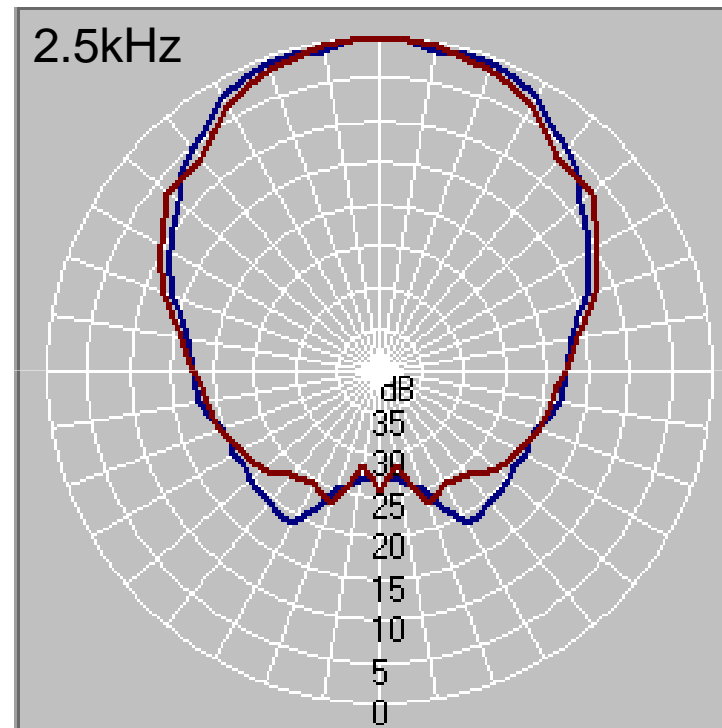
90° CONIQUE



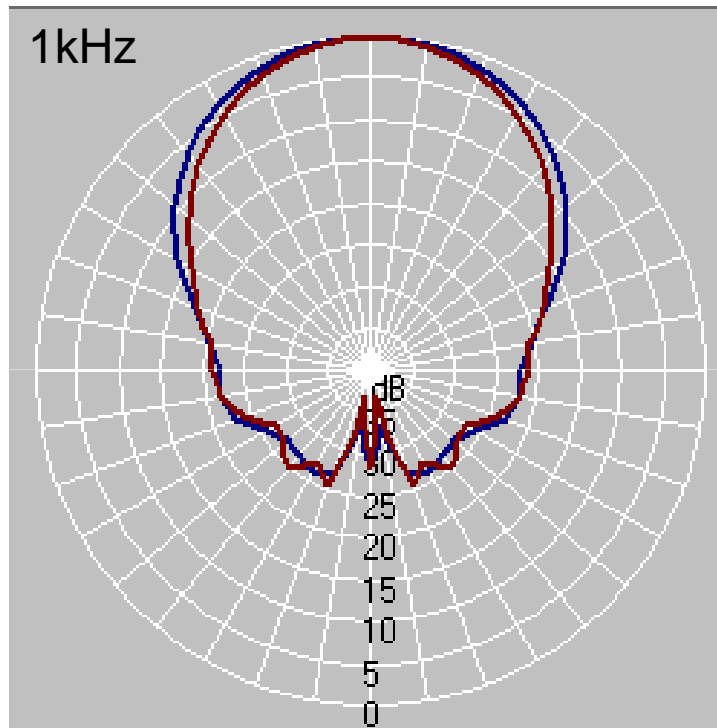
50° CONIQUE



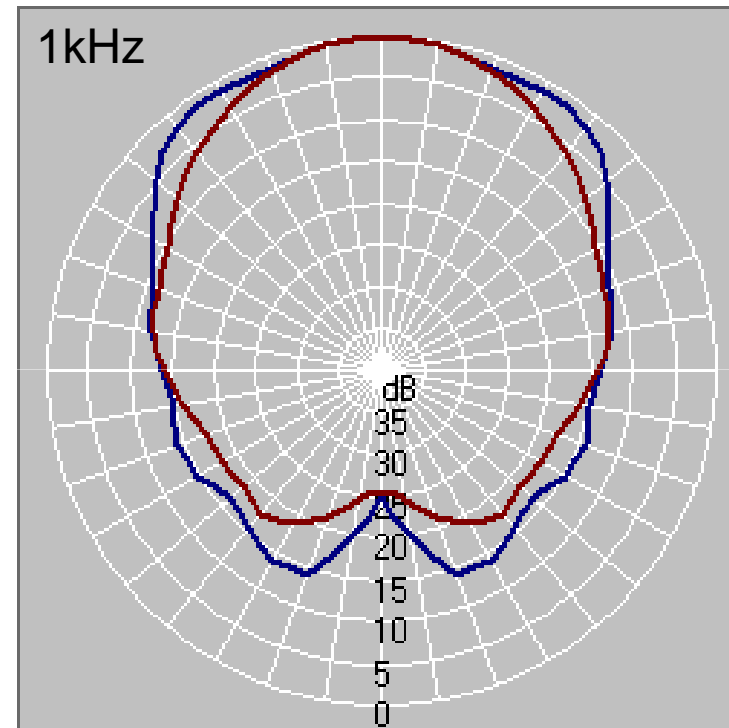
90° CONIQUE



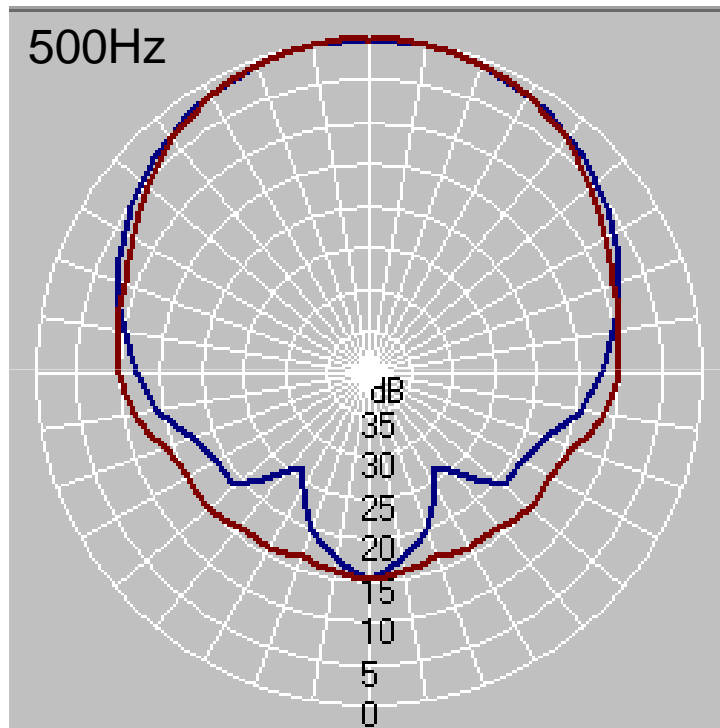
50° CONIQUE



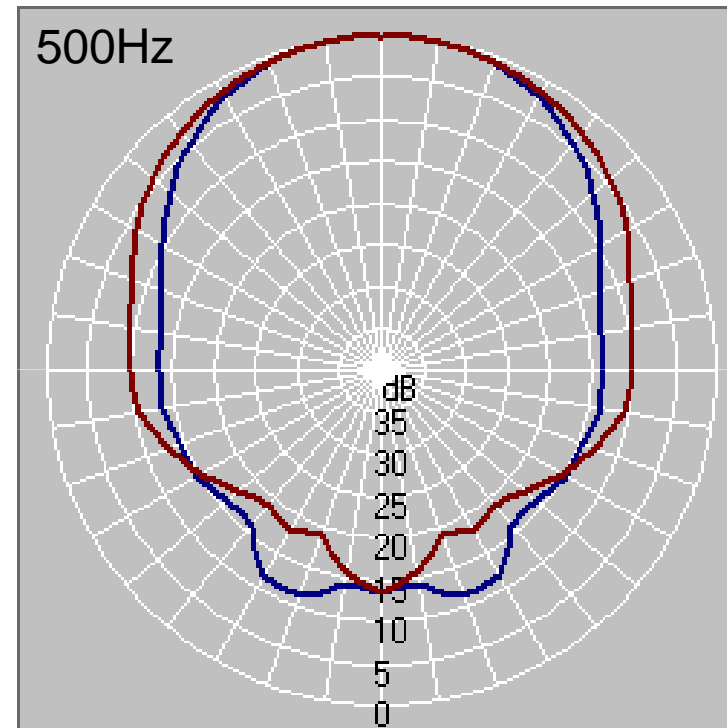
90° CONIQUE



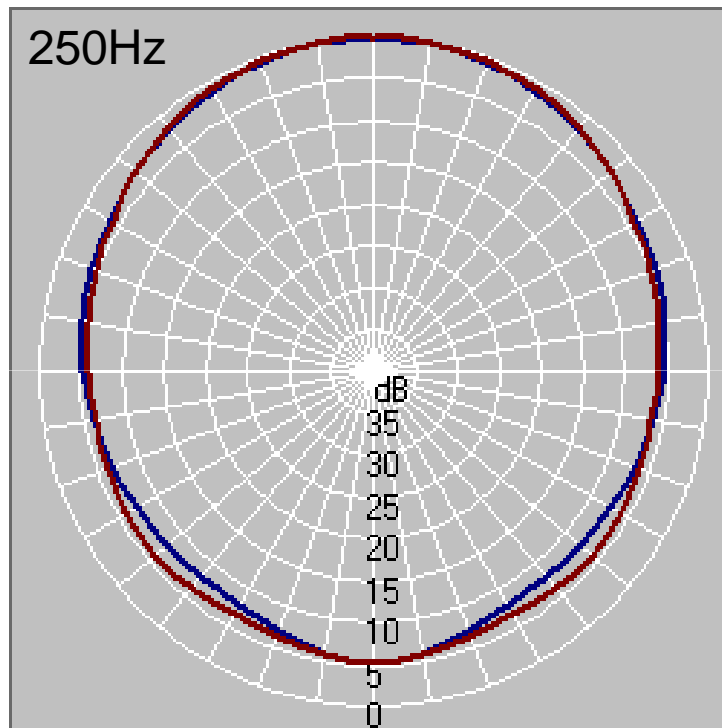
50° CONIQUE



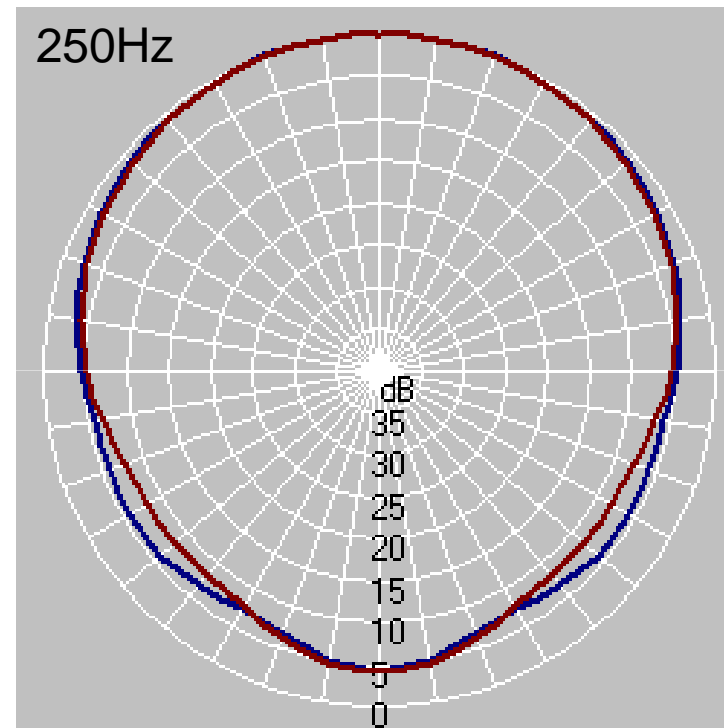
90° CONIQUE



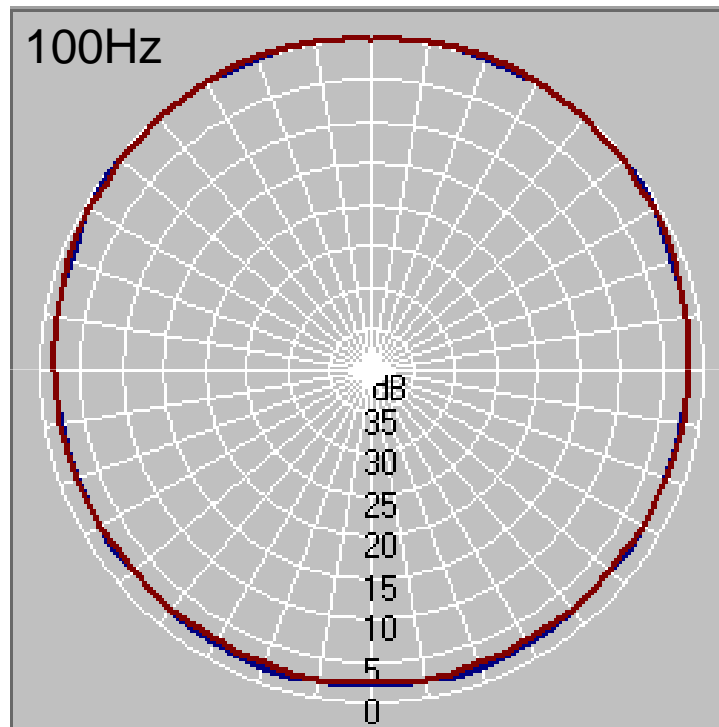
50° CONIQUE



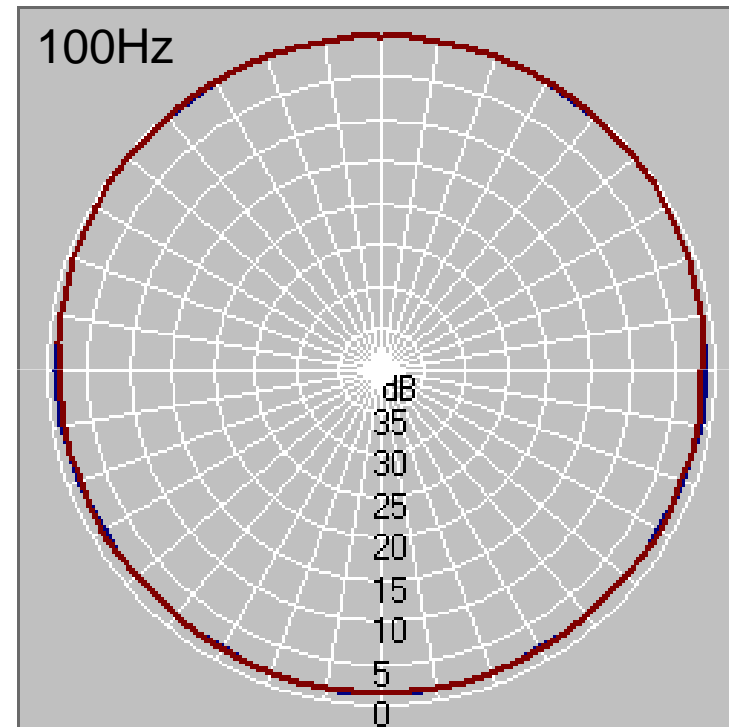
90° CONIQUE

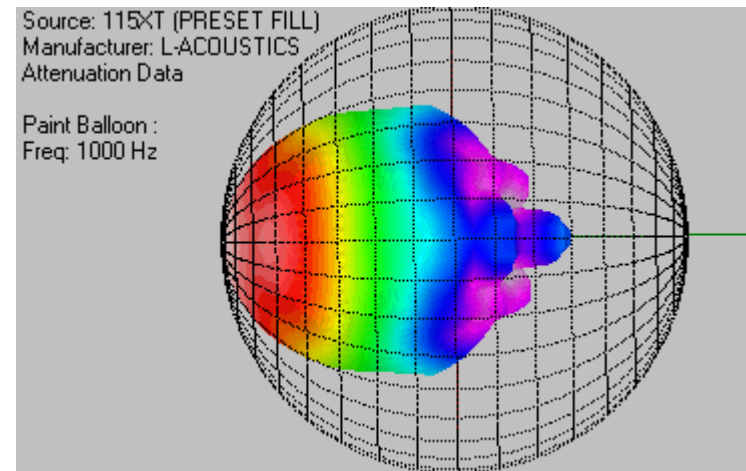
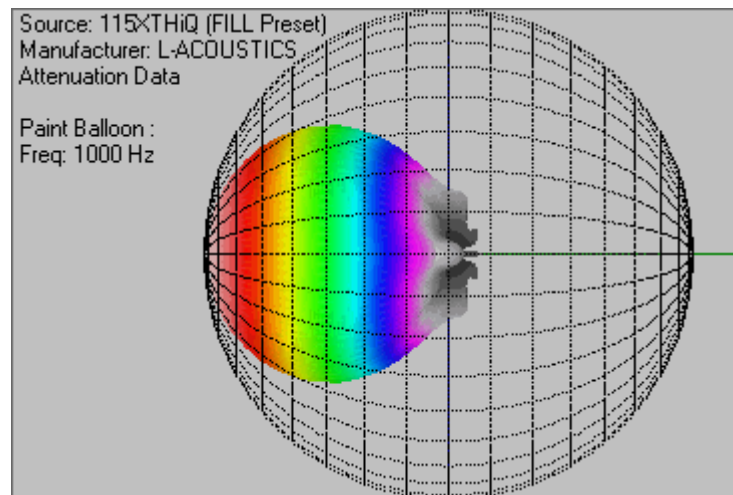
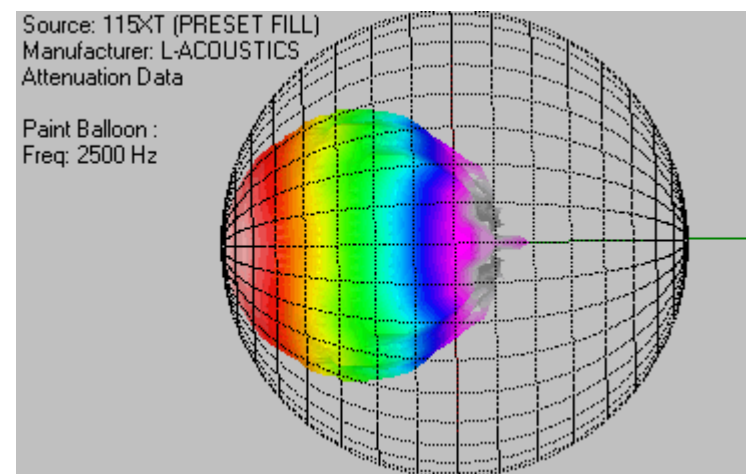
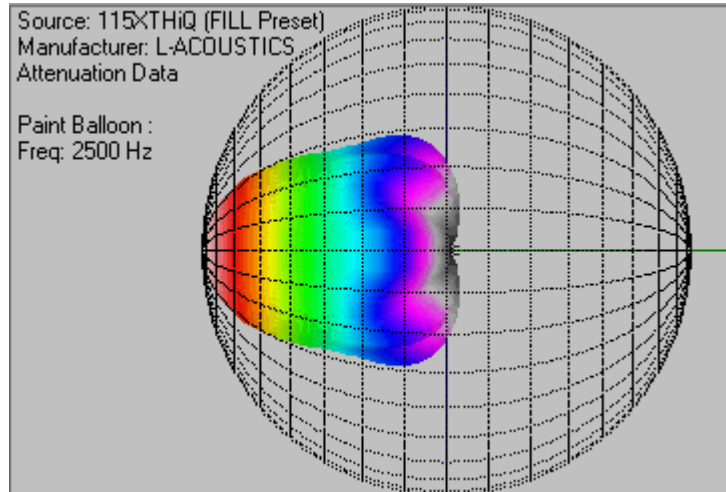


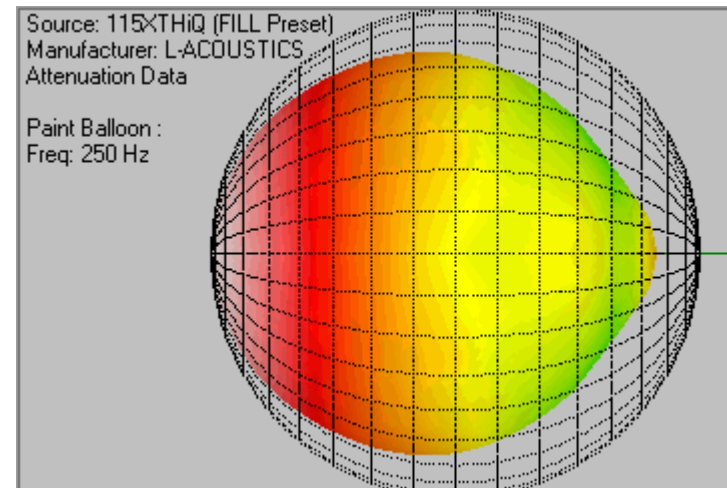
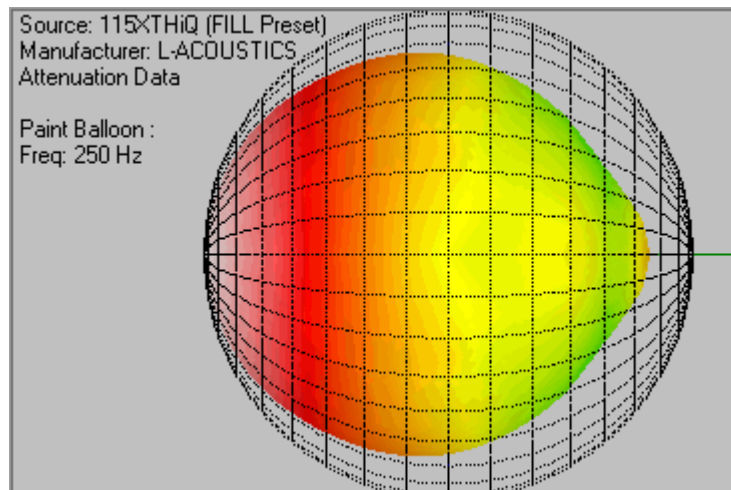
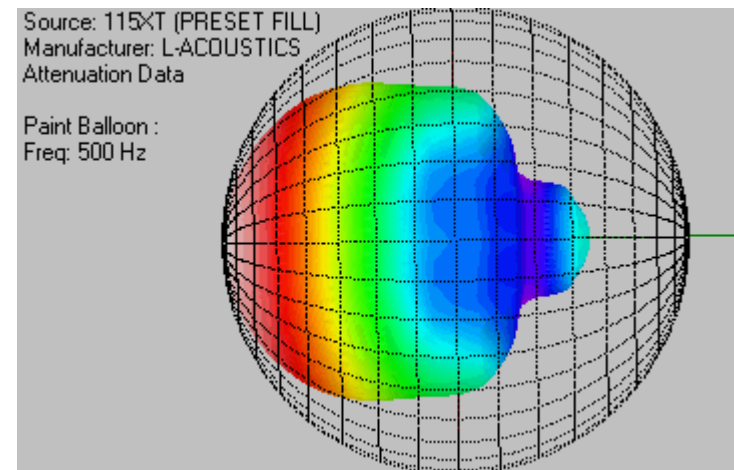
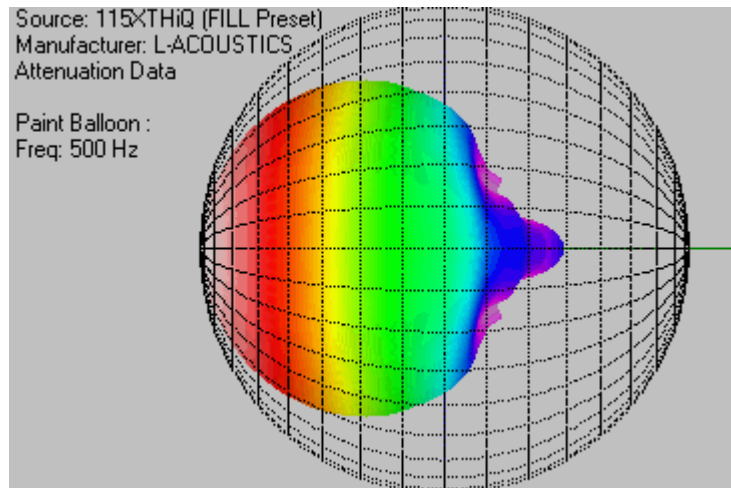
50° CONIQUE

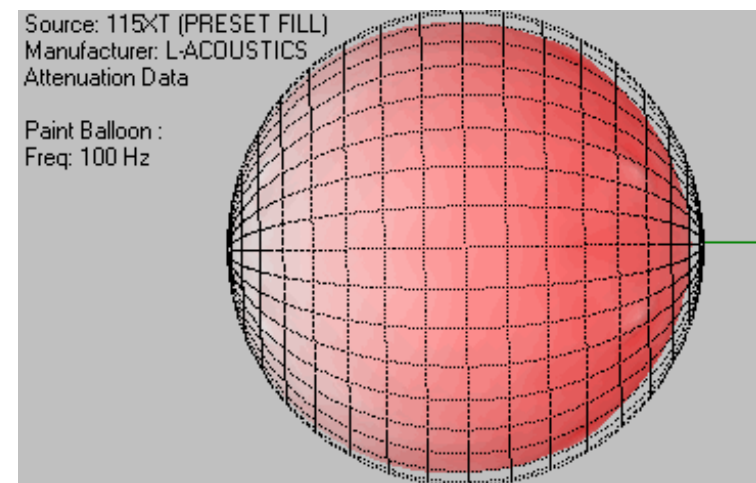
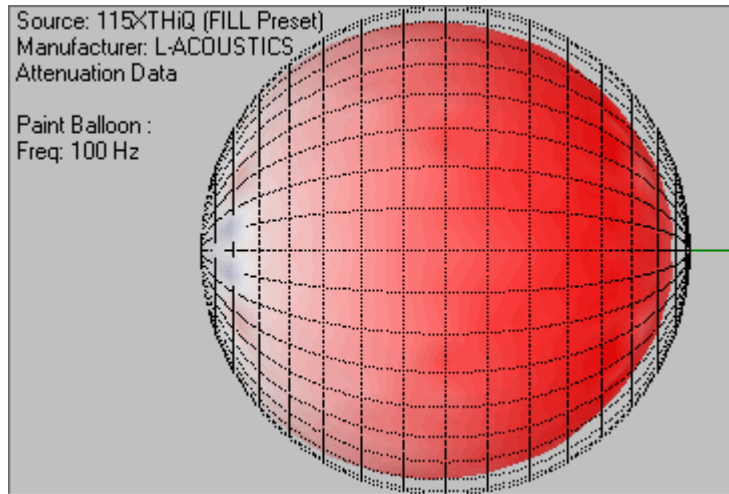


90° CONIQUE

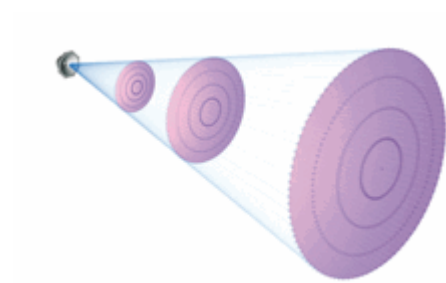
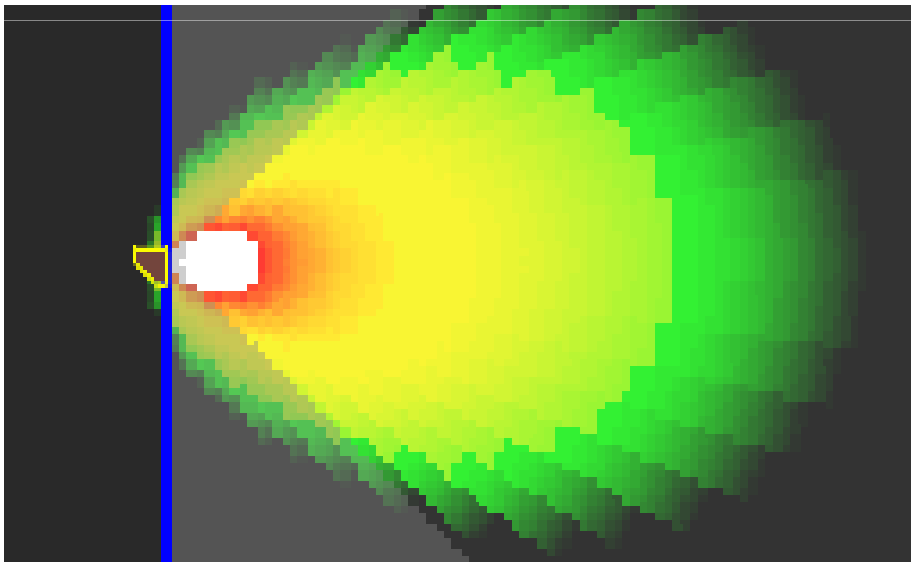
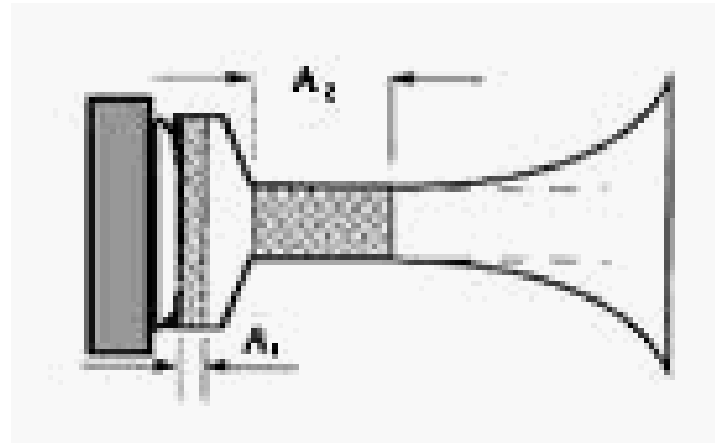
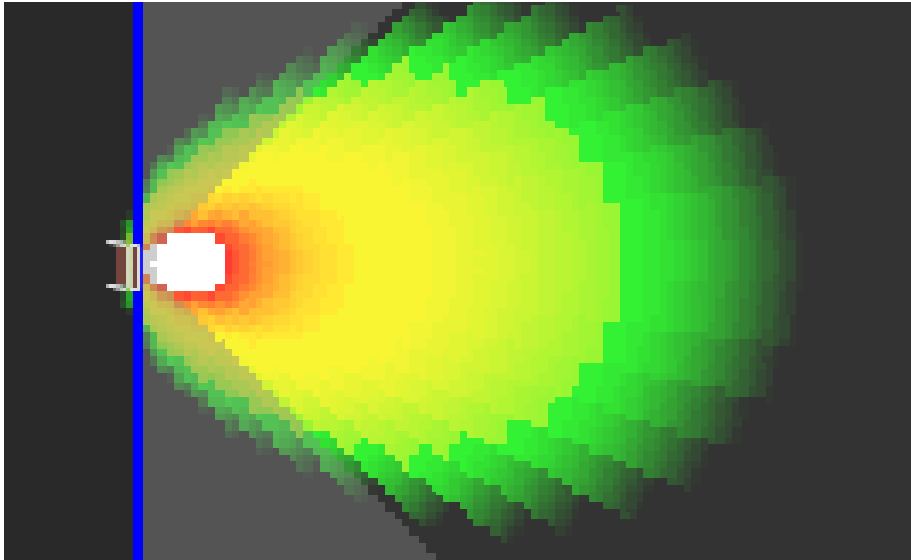


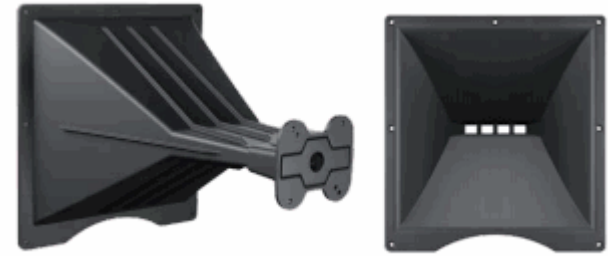
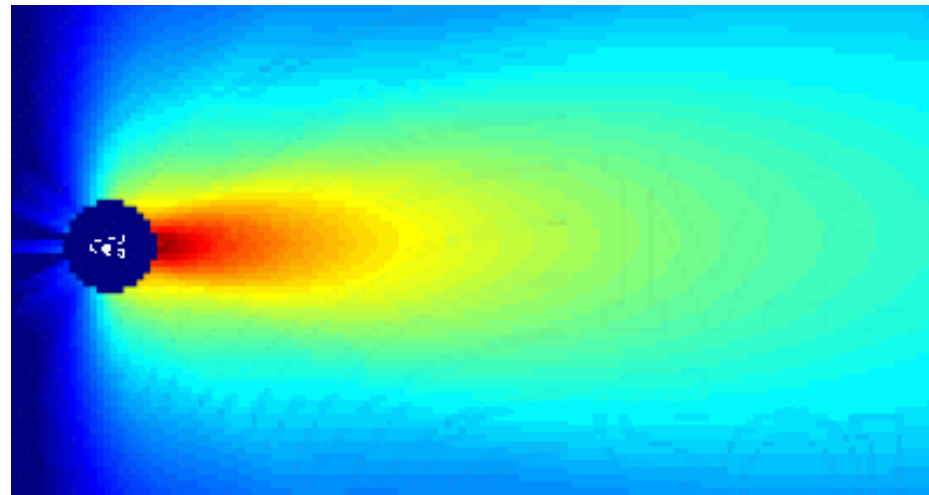
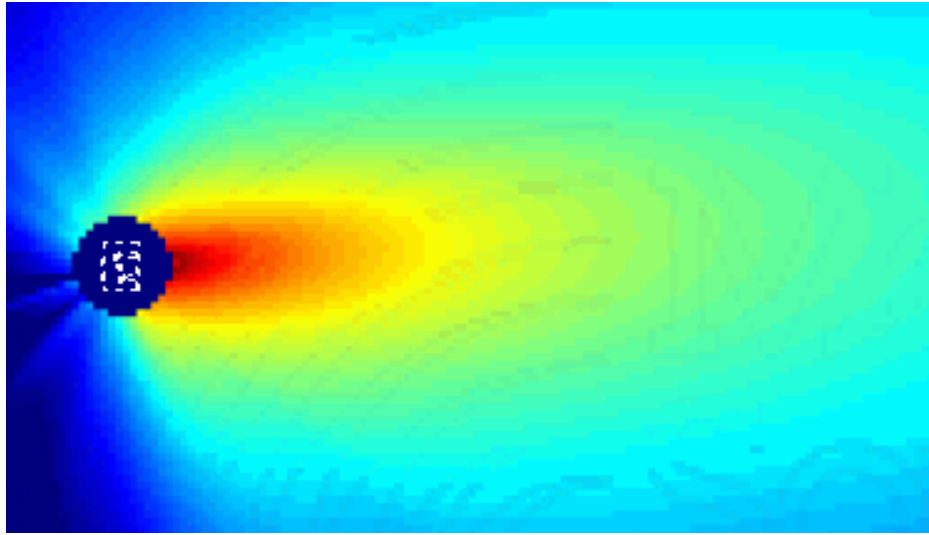






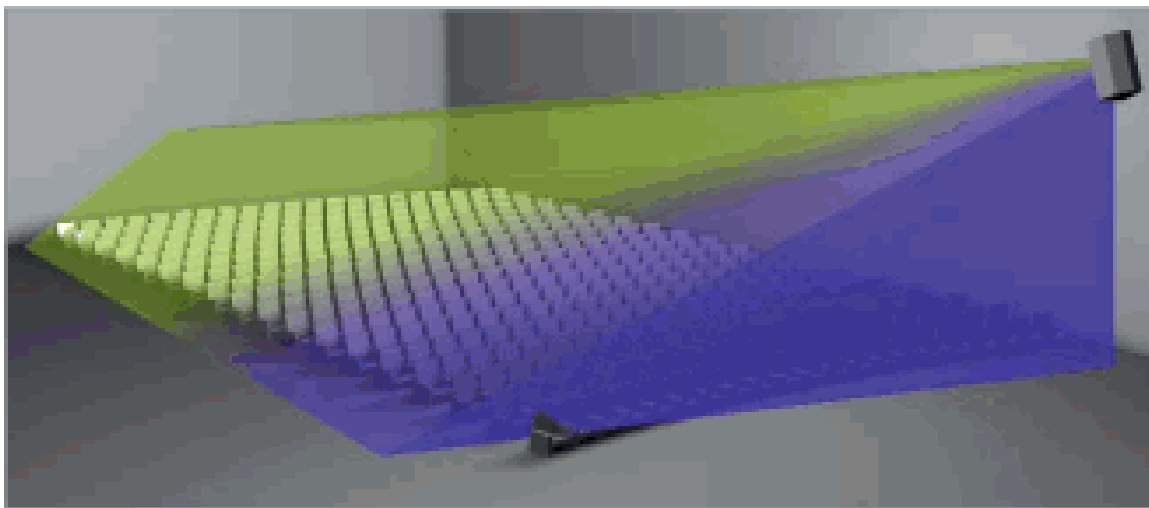
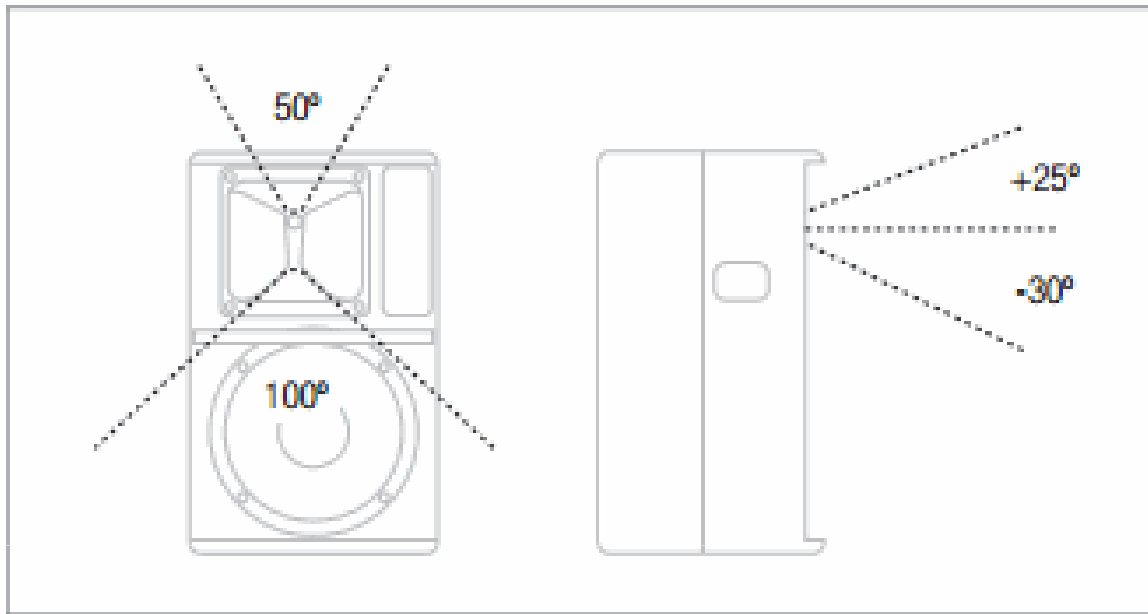
CONTROL DE LA DIRECTIVITE DANS LE HAUT DU SPECTRE



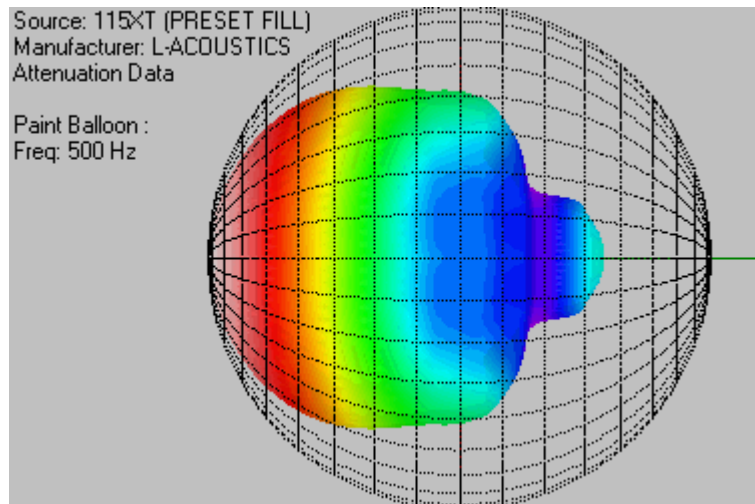
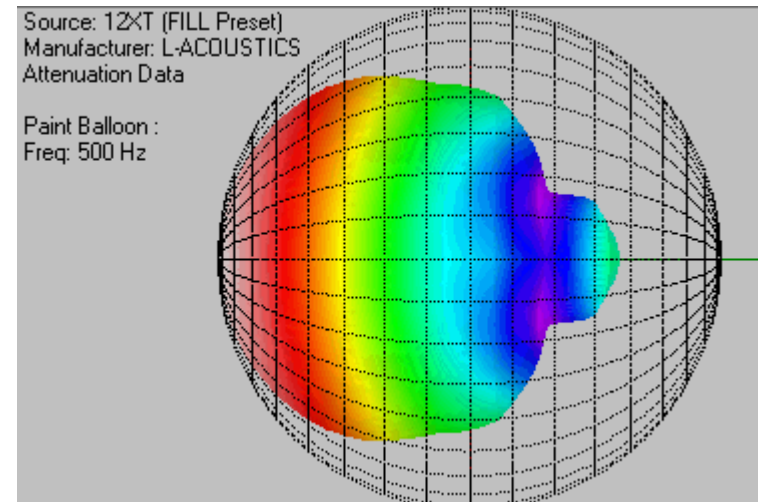
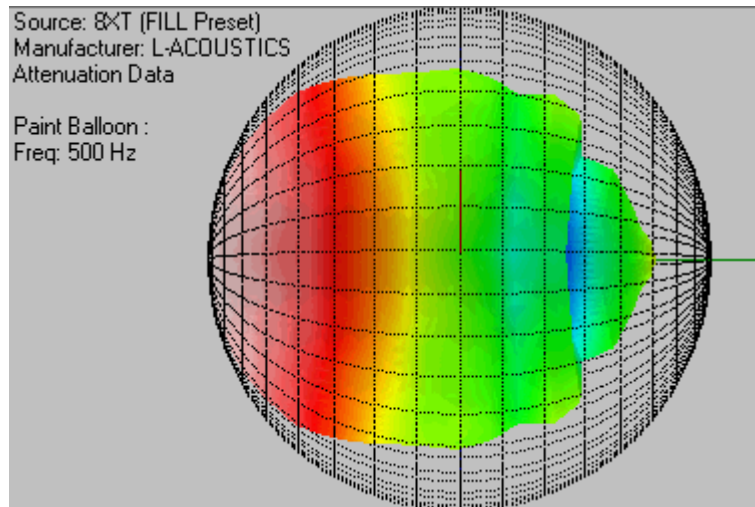


Constant-Q Horn

Pavillon asymétrique



CONTROL DE LA DIRECTIVITE DANS LE BAS DU SPECTRE



Lorsque la circonférence de la membrane est plus petite que la longueur d'onde, le HP n'est pratiquement pas directif

La directivité devient appréciable dès lors que la longueur d'onde est voisine de la demi circonférence du haut-parleur

Dès que la longueur est voisine du quart de la circonférence de la membrane, des lobes secondaires apparaissent.

Pour un HP de 8'(20cm)

Formule:

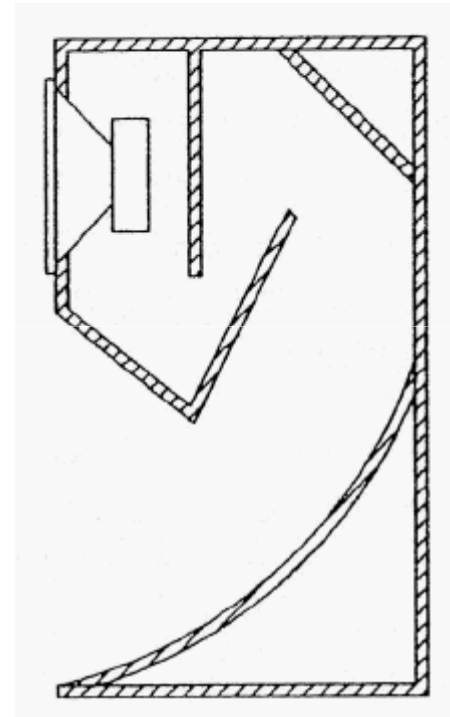
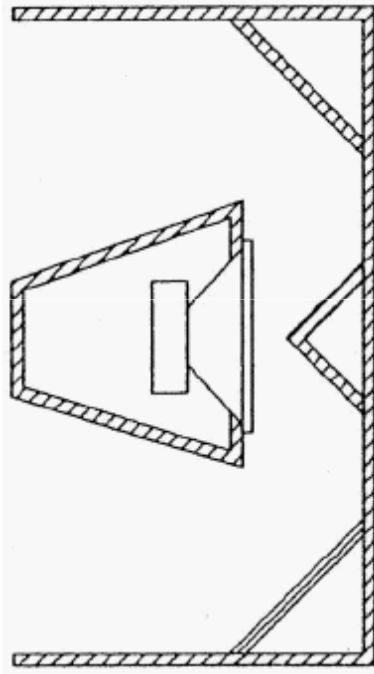
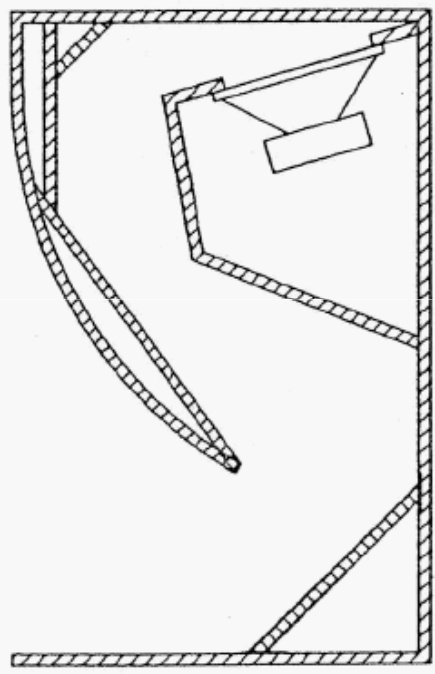
Circonférence d'un cercle = diamètre x π

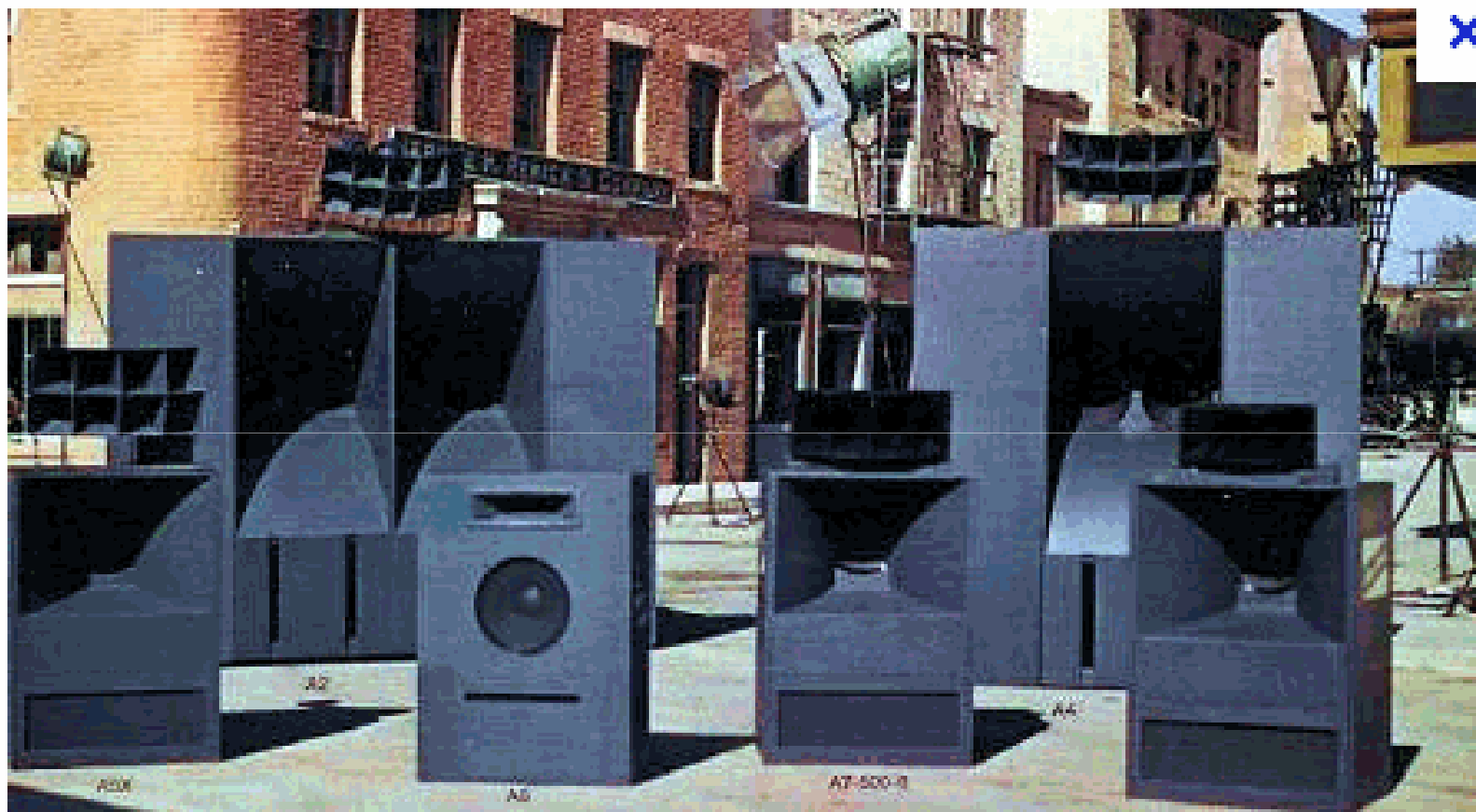
$$0.20 \times \pi = 0.6283$$

$$F = c/\lambda \qquad f = 340/0.6283 \qquad f = 541 \text{ Hz}$$

Les fréquences inférieure à 541Hz seront quasi omni

PAVILLON ET LABYRINTHE

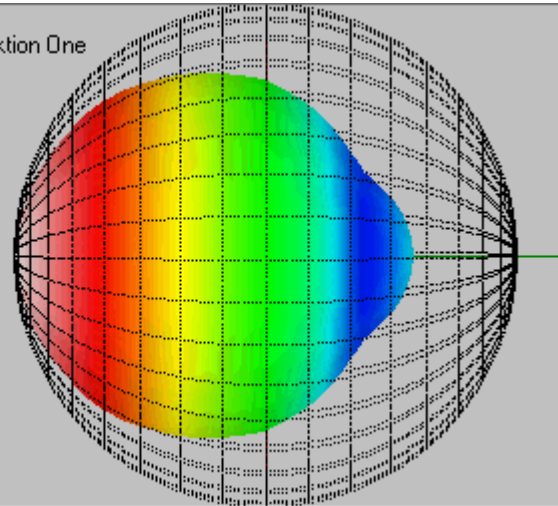






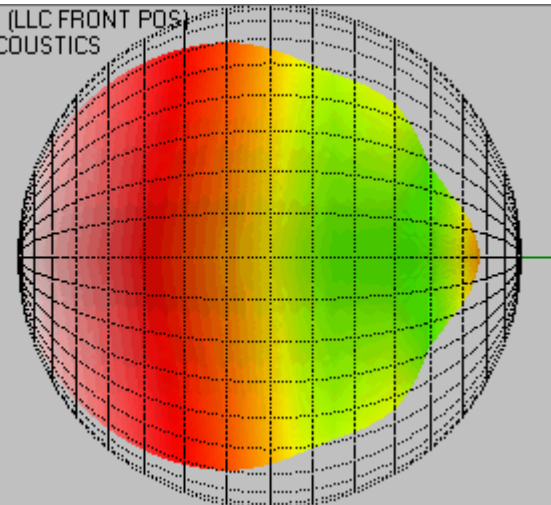
Source: RES 5
Manufacturer: Funktion One
Attenuation Data

Paint Balloon :
Freq: 250 Hz



Source: MTD112B (LLC FRONT POS)
Manufacturer: L-ACOUSTICS
Attenuation Data

Paint Balloon :
Freq: 250 Hz



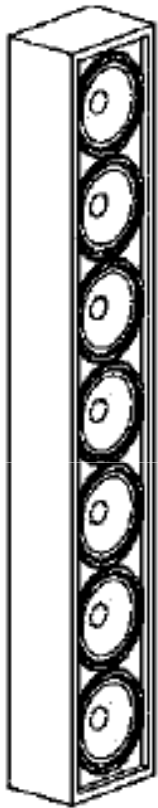


Fig. 1A Vertical speaker column

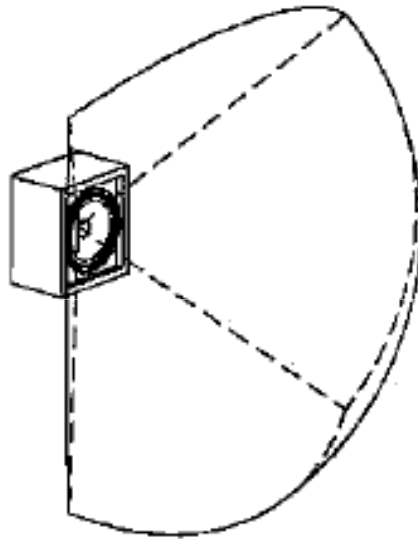


Fig. 1B Spherical wavefront diagram

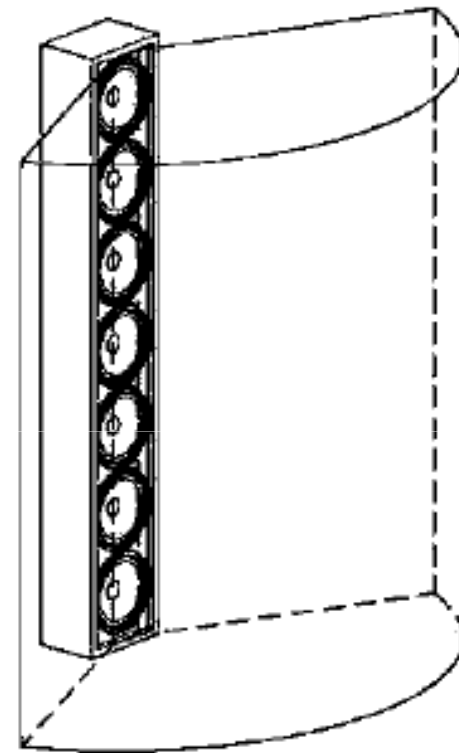
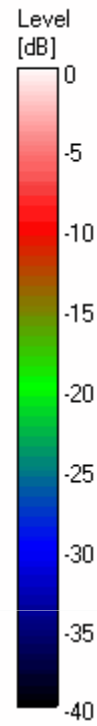
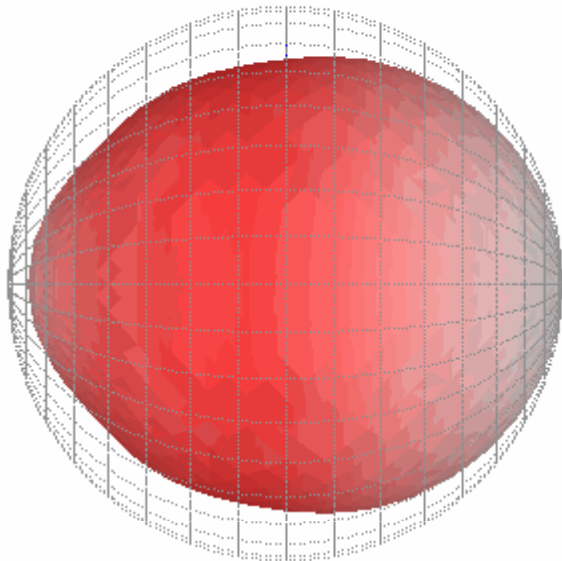


Fig. 1C Cylindrical wavefront diagram

Data Shown: KARA Line Source Array (L-Acoustics)
Display Parameters: Frequency: 250Hz (1/3rd Octave)

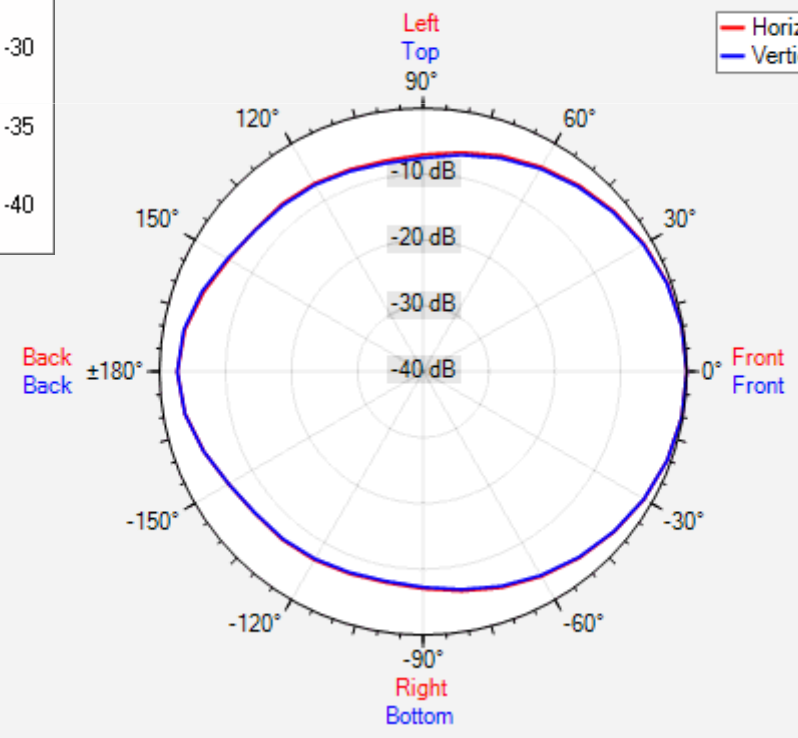


1/3rd Octa Frequency: 250 Hz

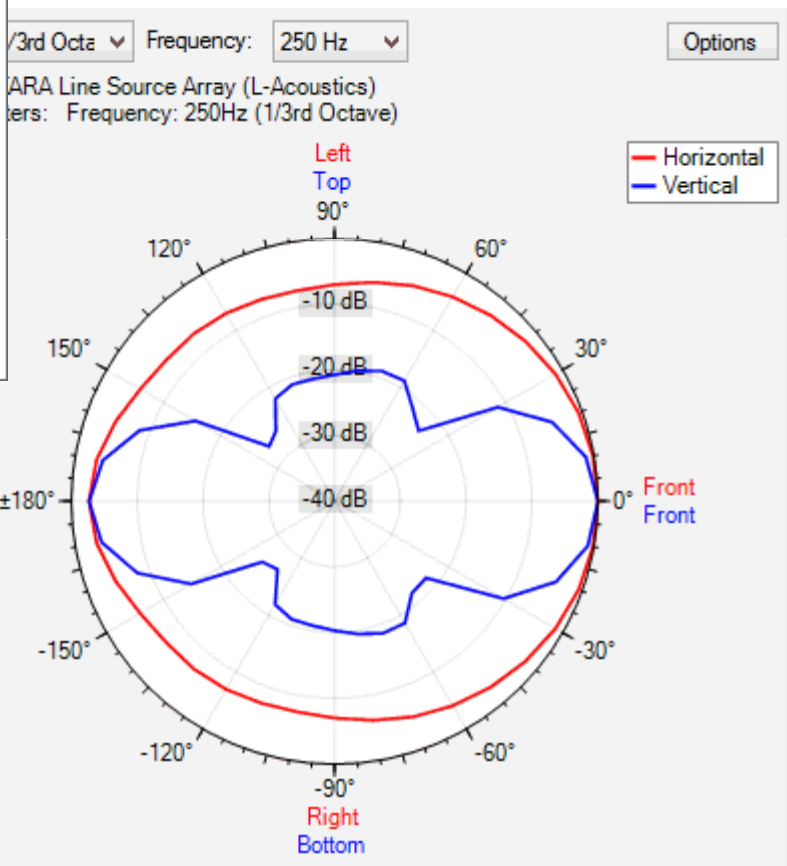
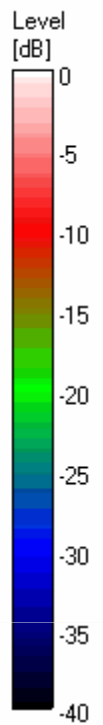
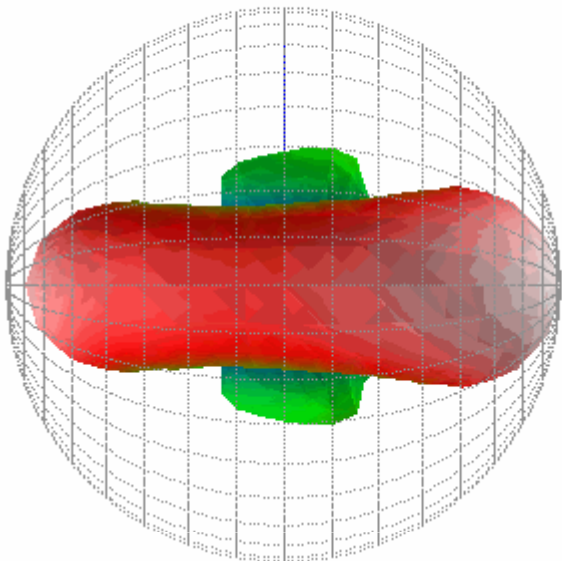
Options

KARA Line Source Array (L-Acoustics)
Parameters: Frequency: 250Hz (1/3rd Octave)

Horizontal
Vertical

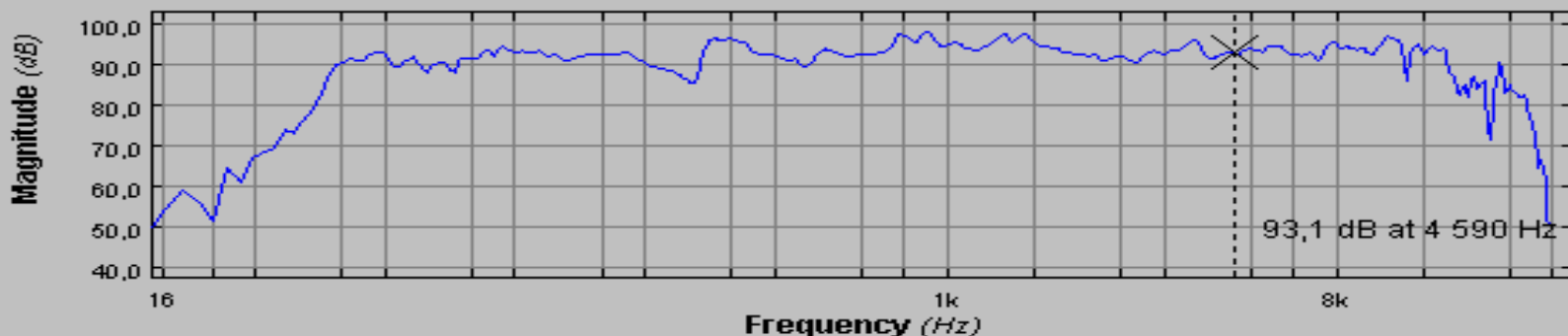


Data Shown: KARA Line Source Array (L-Acoustics)
Display Parameters: Frequency: 250Hz (1/3rd Octave)



Interférence et filtre en peigne

Band Spectrum Impulse Response **Frequency Response**



Result ■
Room ■
Processor ■
1/Processor ■

MAPP Online Pro - [1cq1.xml*]

File Edit View Insert Settings Tools Help

Predict

1 octave

500 Hz

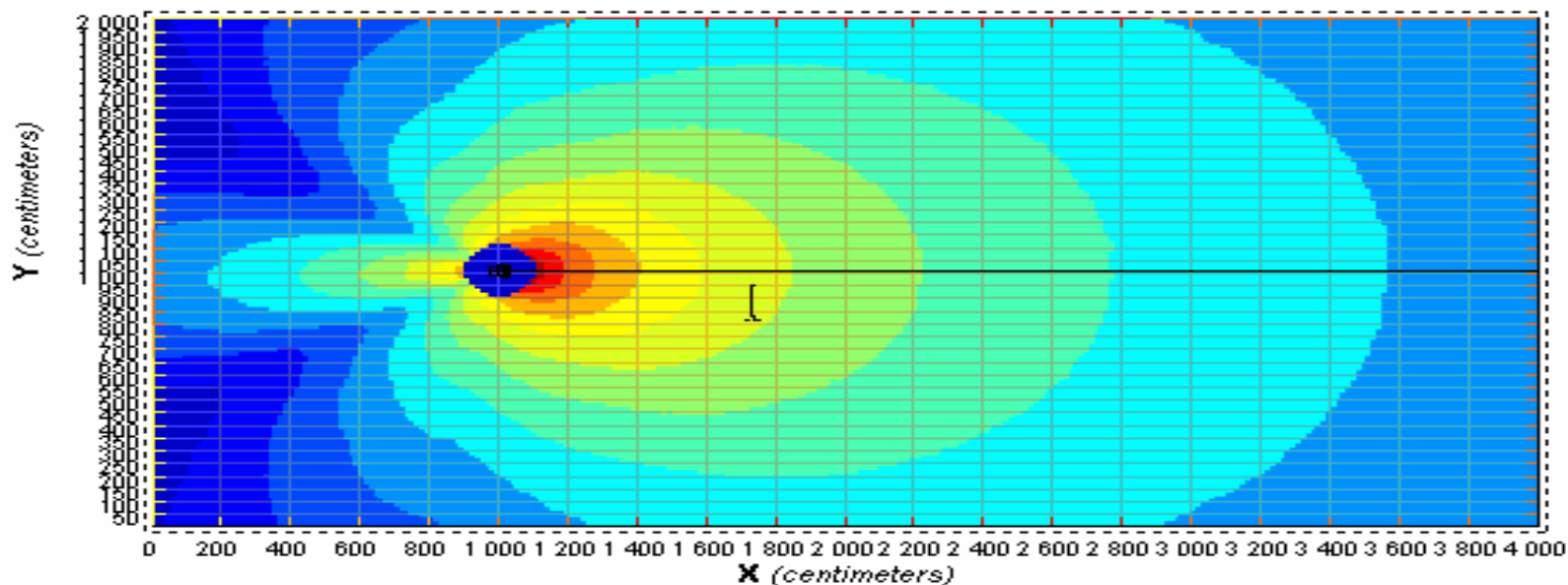
Select

Zoom

Rotate

Architecture

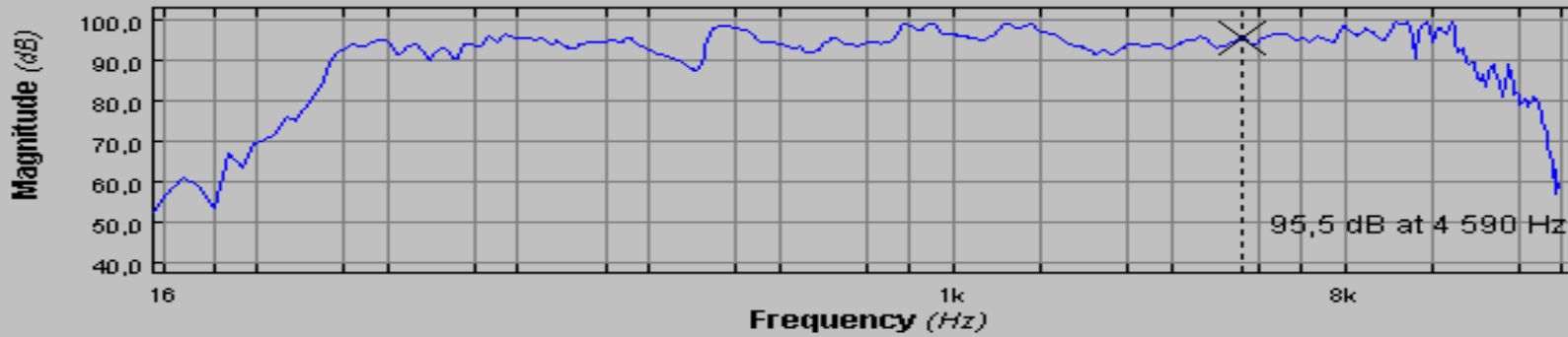
Sound Field



Band Spectrum

Impulse Response

Frequency Response



Result ■
Room ■
Processor ■
1/Processor ■

MAPP Online Pro - [1cq1.xml*]

File Edit View Insert Settings Tools Help

Predict

1 octave

500 Hz

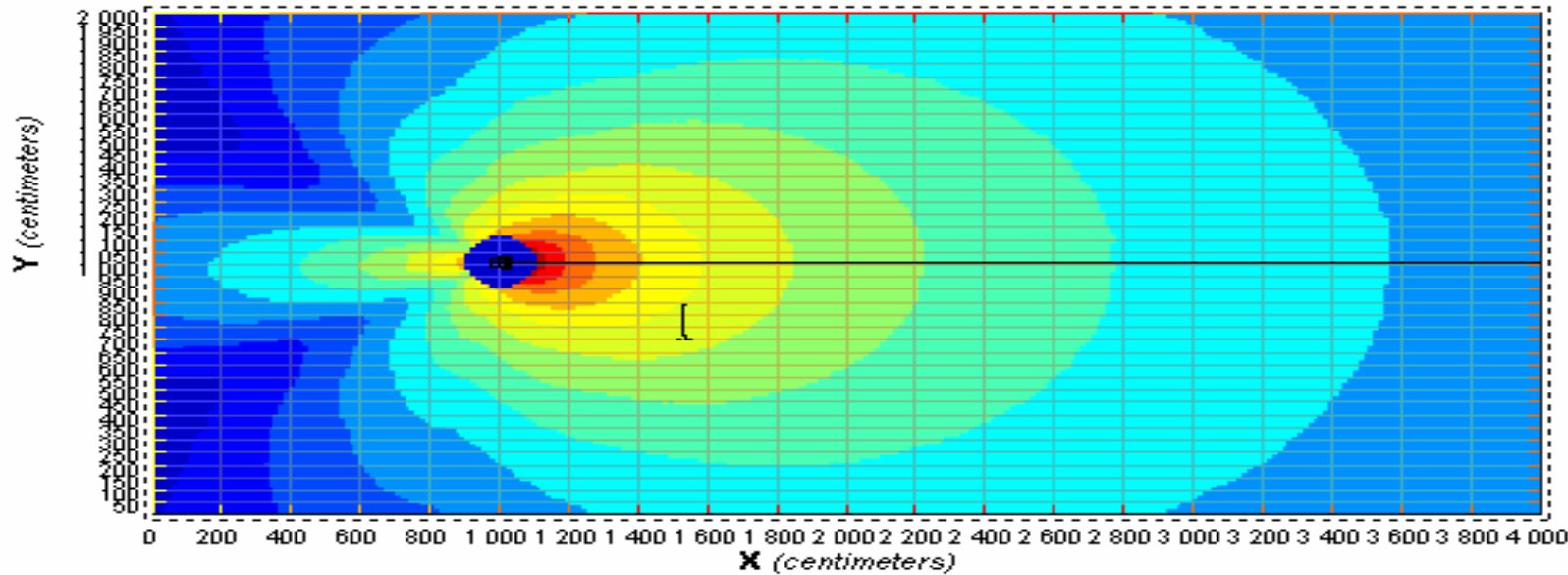
Select

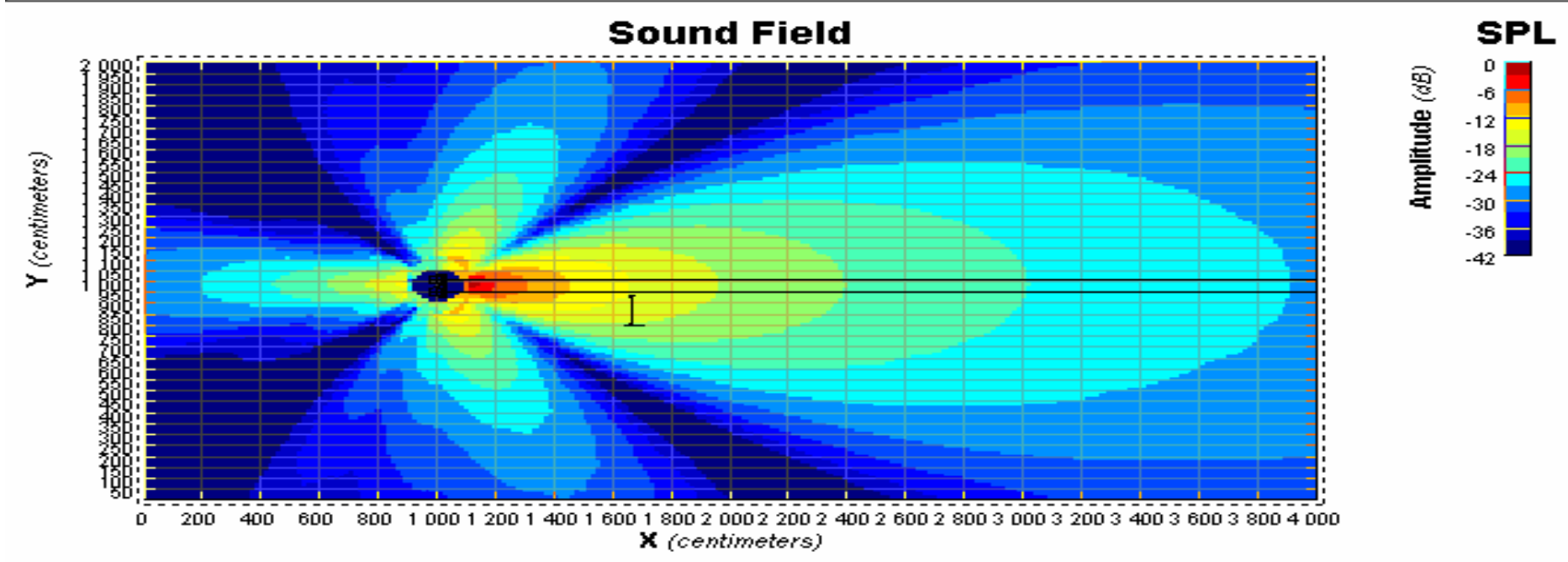
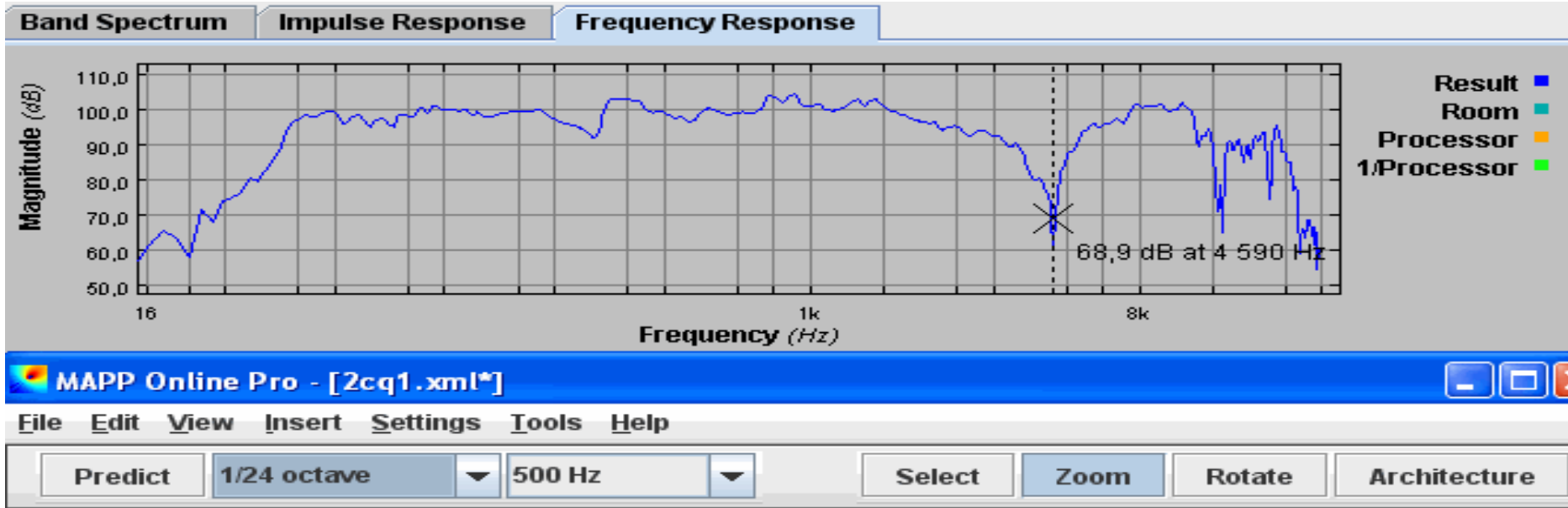
Zoom

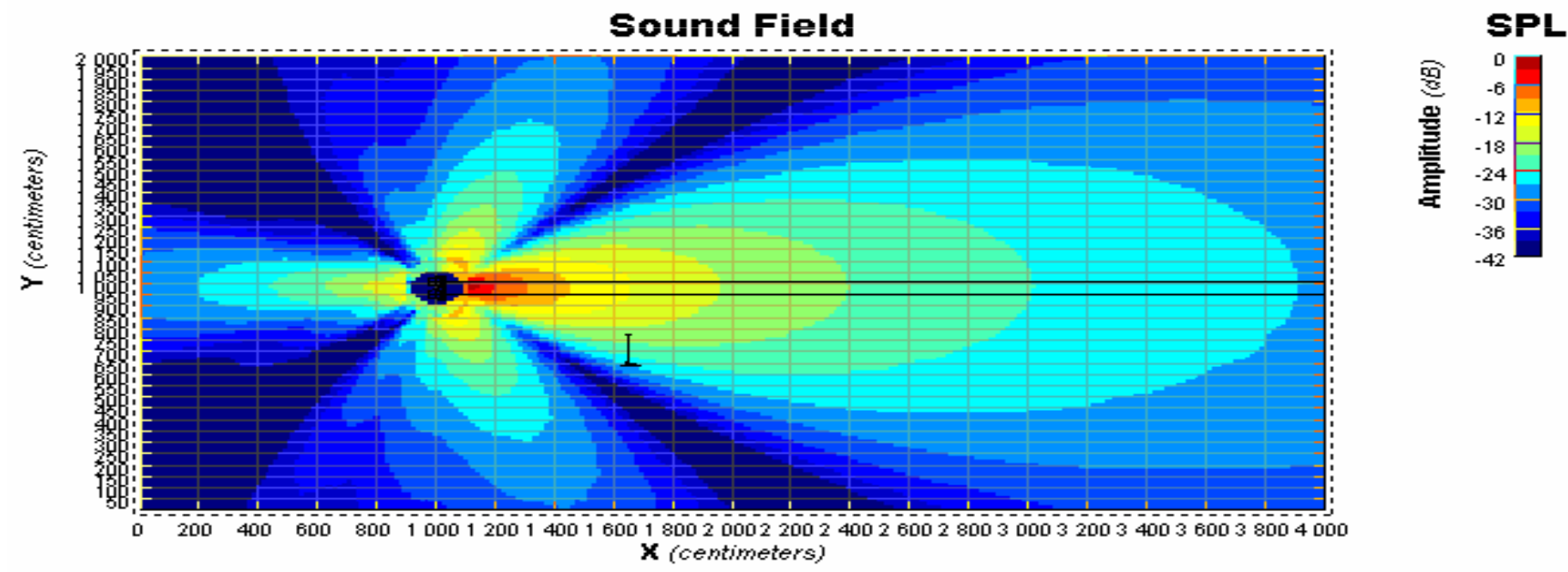
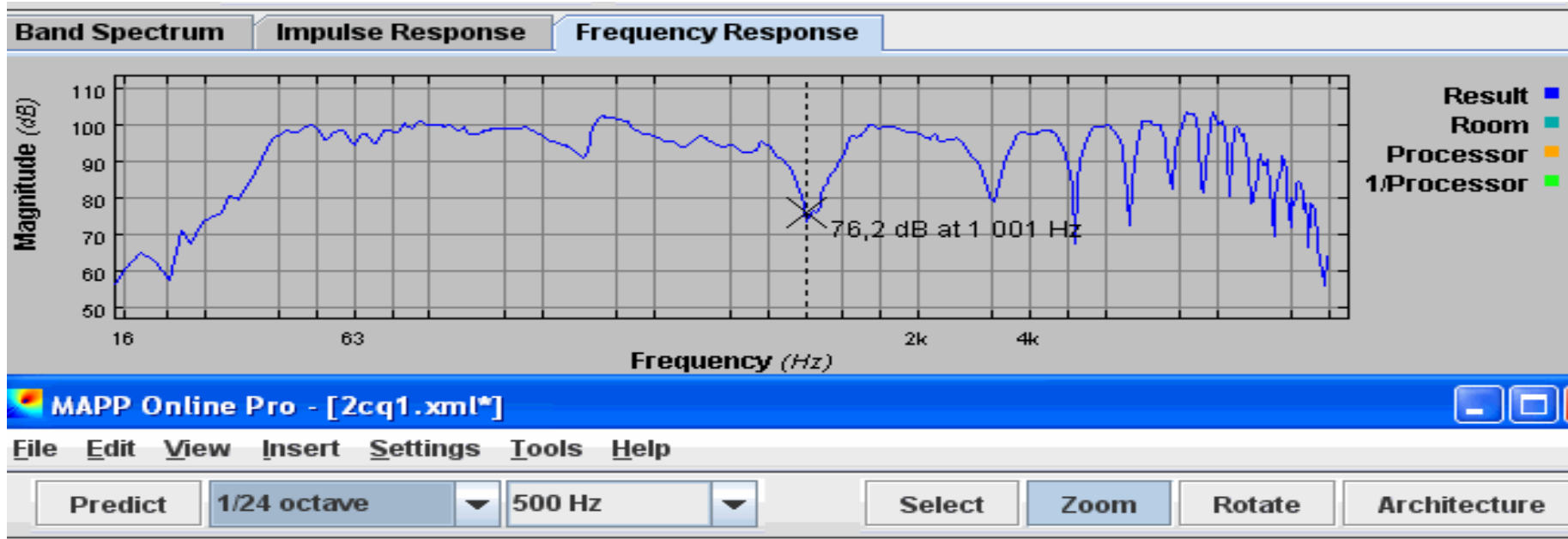
Rotate

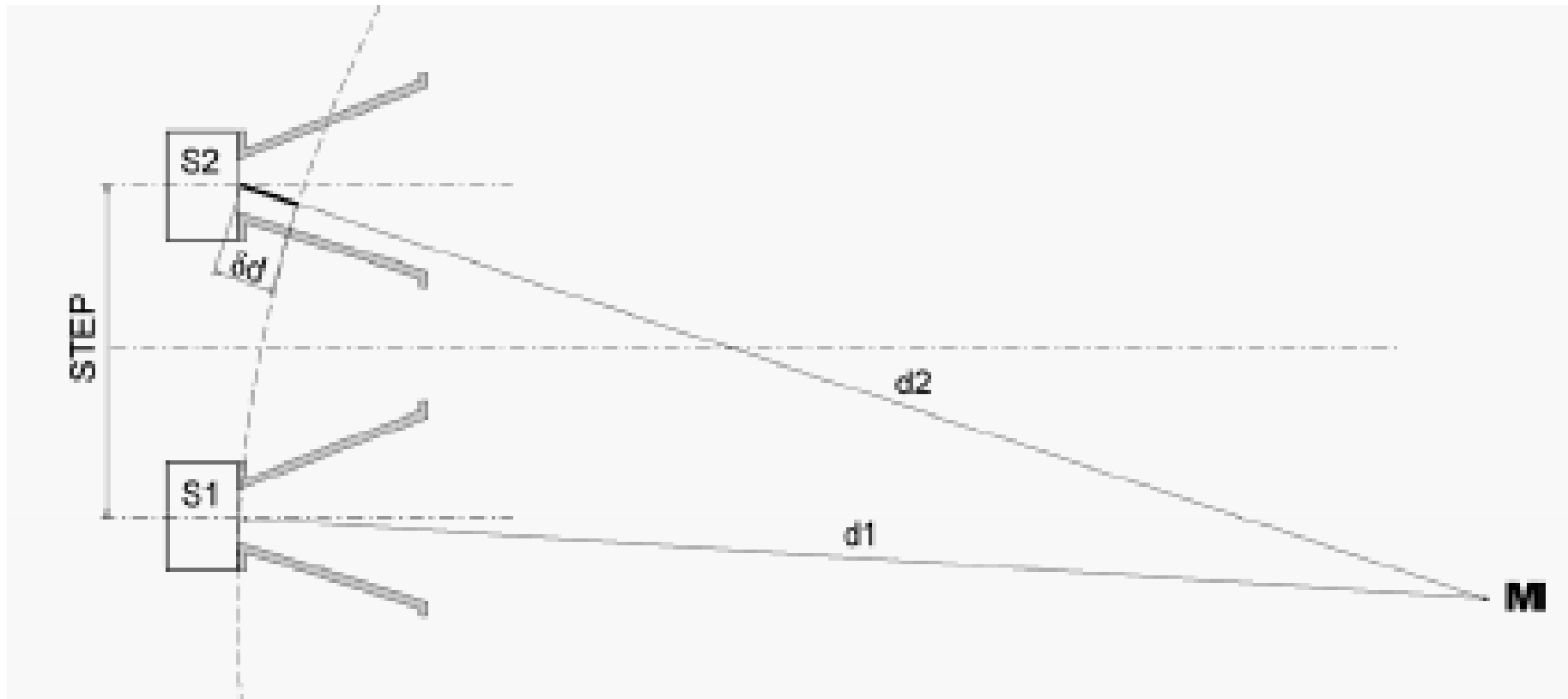
Architecture

Sound Field









$$\text{Retard} = \frac{d}{C}$$

Retard (seconde)

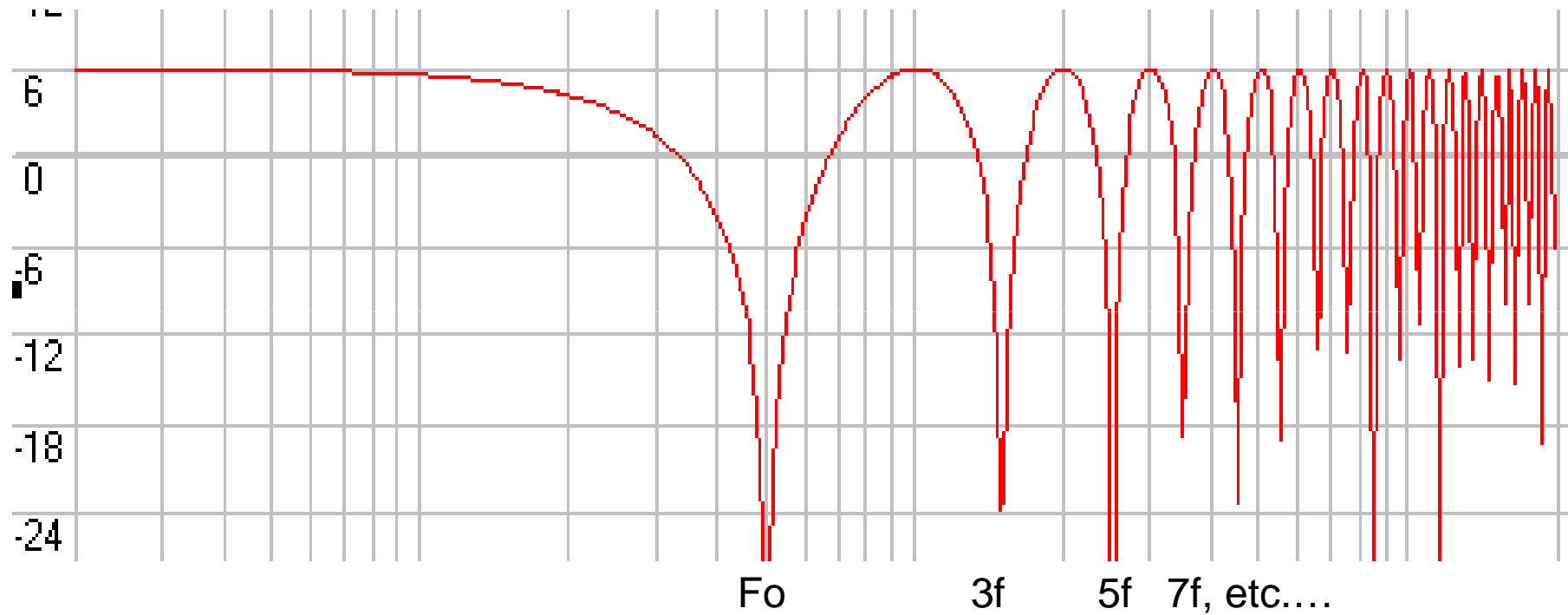
Distance (mètre)

Célérité (mètre/seconde)

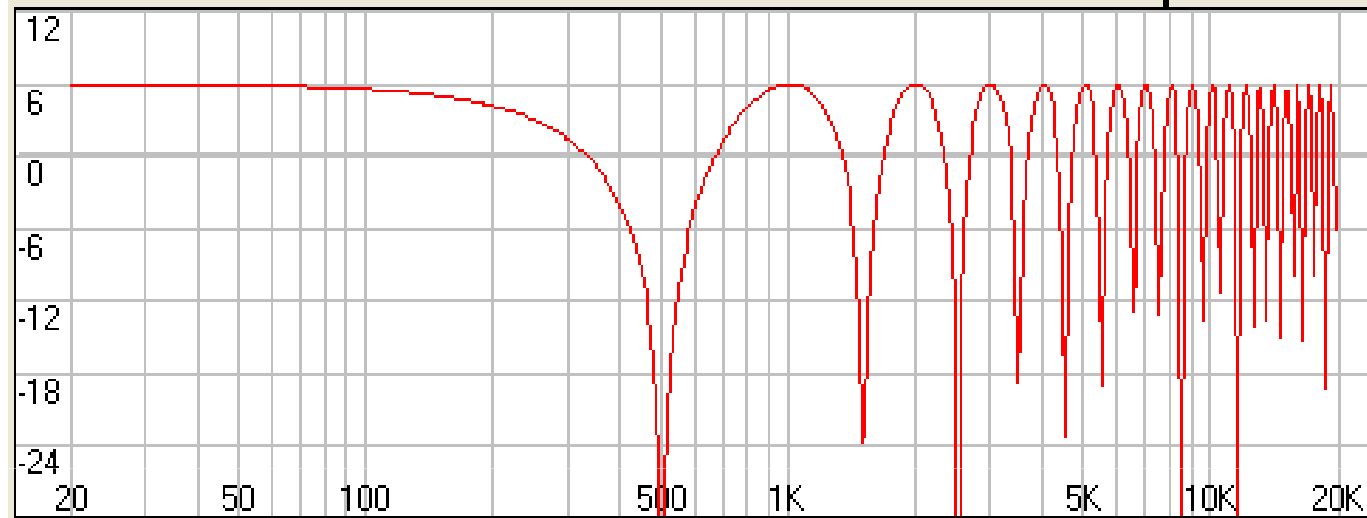
$$f_0 = \frac{1}{2\Delta t}$$

f_0 : fréquence d'origine (Hertz)

Δt : retard (seconde)



Ce décalage temporel génère le filtrage en peigne ci-dessous



$$f_0 = \frac{1}{2 \times 0.001s} = 500\text{Hz}$$

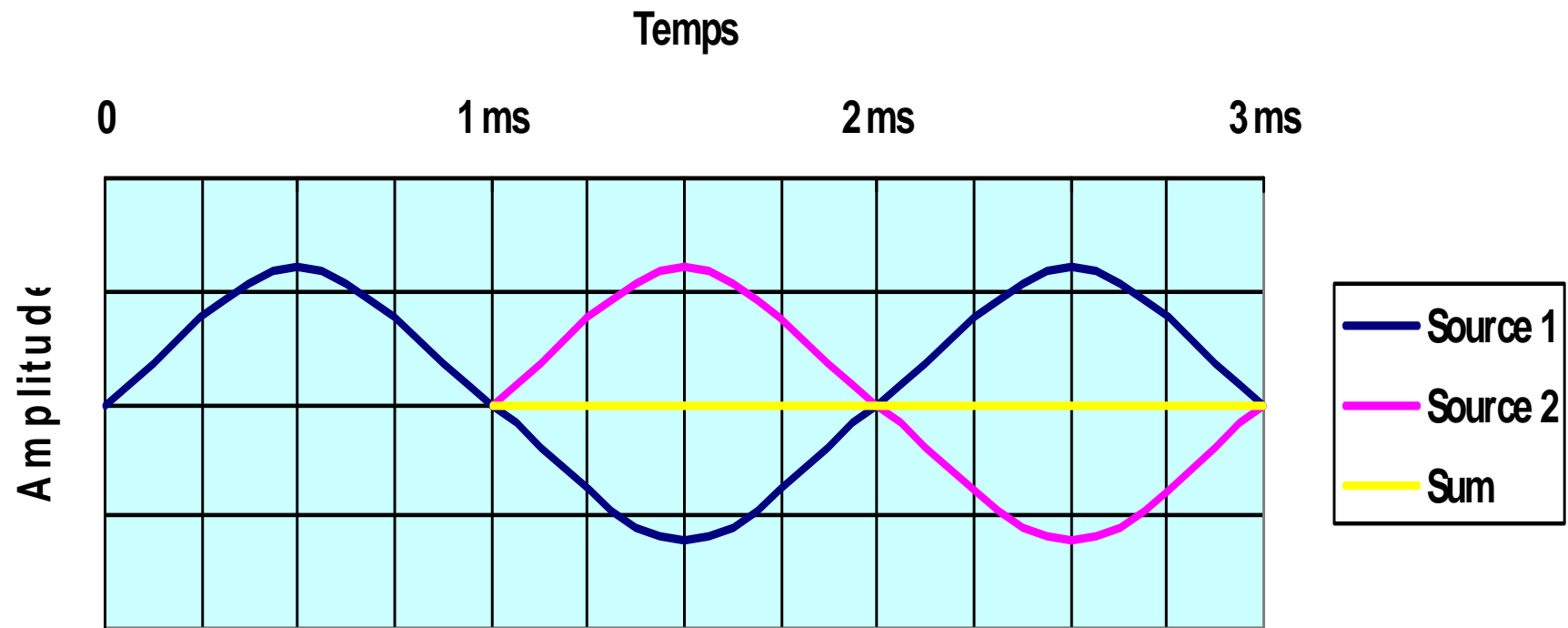
$$\Delta t = 1/(2f_0)$$

$$\Delta d = C \times \Delta t$$

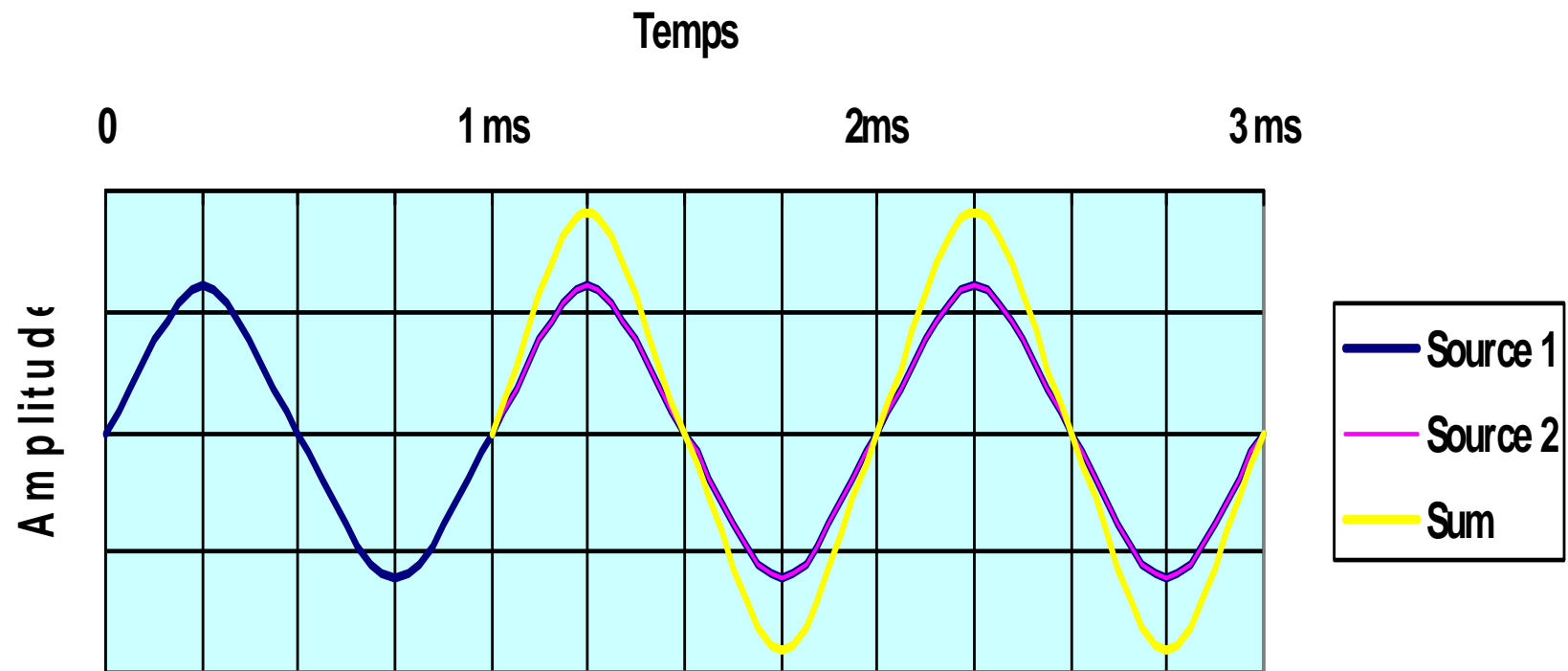
Interférences destructives

$$T = \frac{1}{f} \quad T = \frac{1}{500} \quad T = 0.002s = 2ms$$

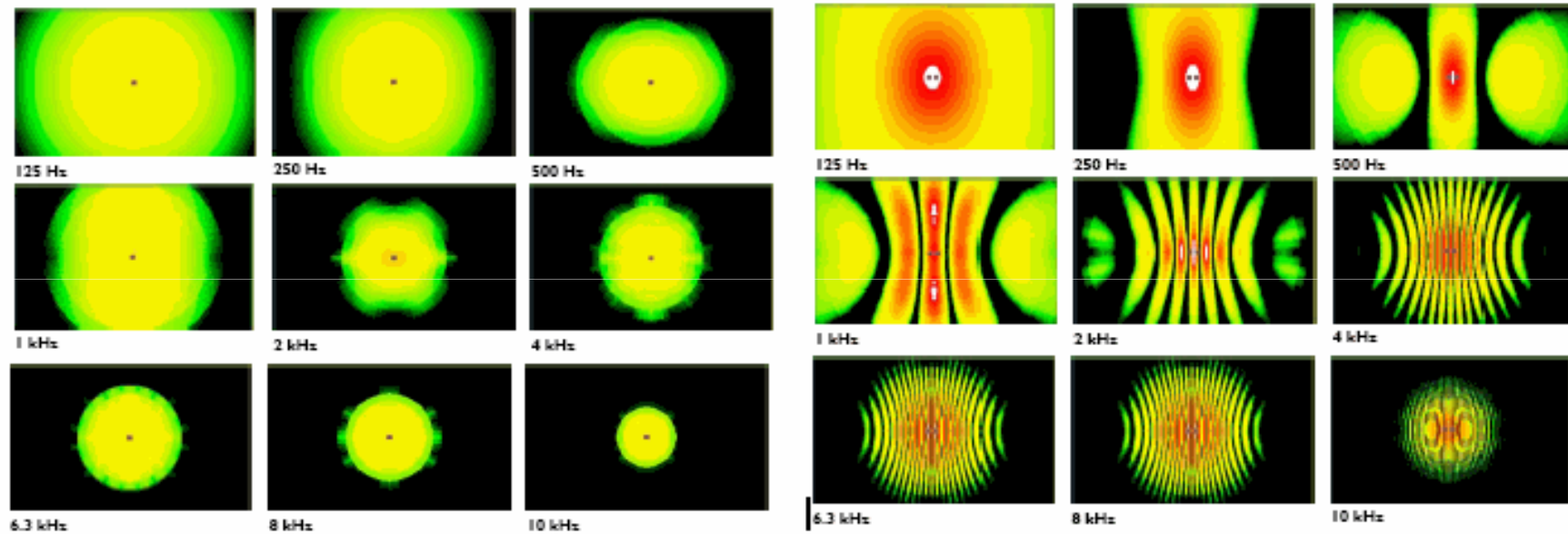
$$\lambda = \frac{c}{f} \quad \lambda = \frac{340}{500} \quad \lambda = 0.68m = 68cm$$



Interférences constructives



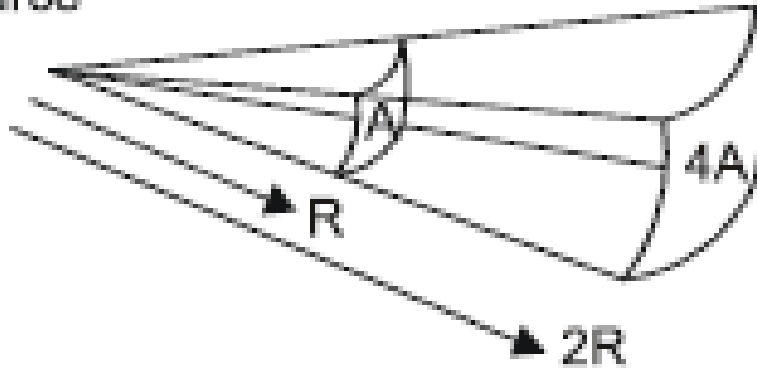
Couplage de haut parleur traditionnel



La diffusion sonore

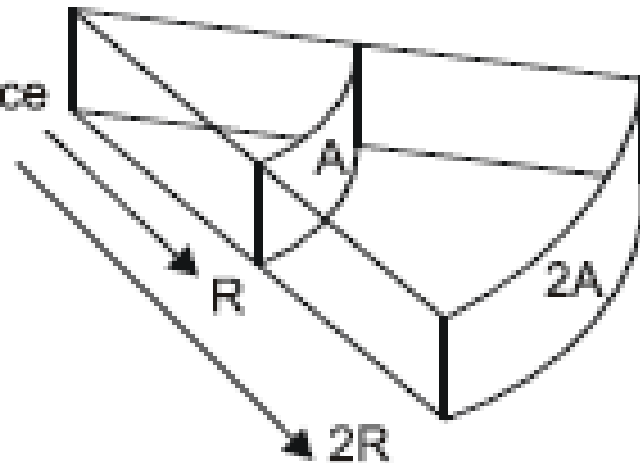
PROPAGATION SPHERIQUE ET CYLINDRIQUE

Point
source



6dB de perte par doublement
de la distance

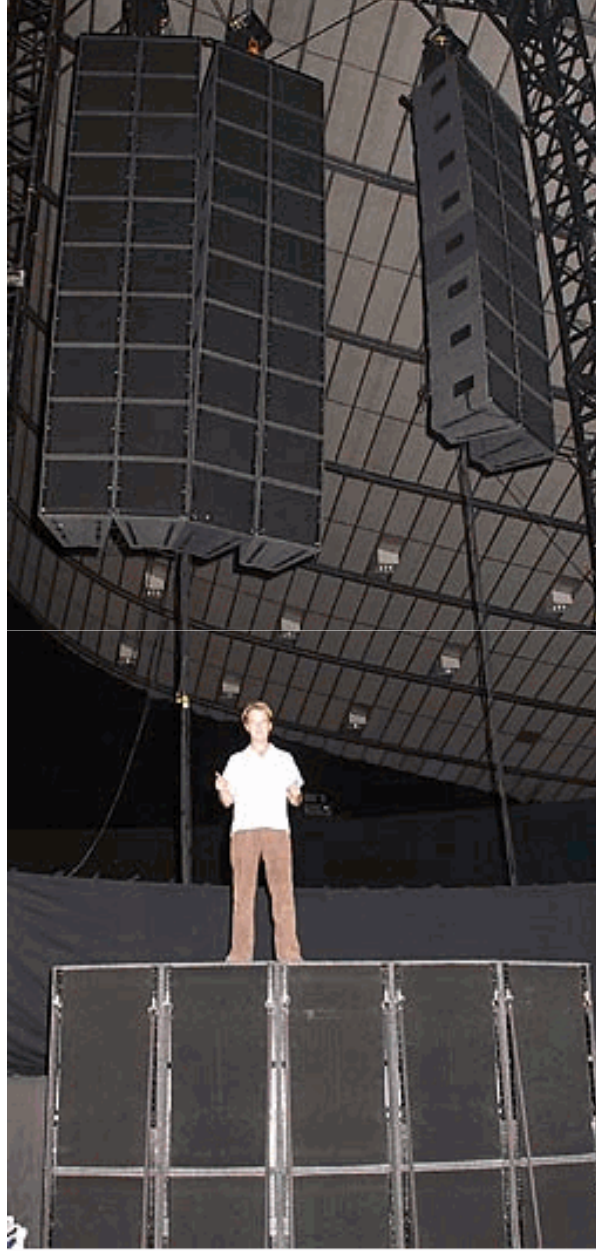
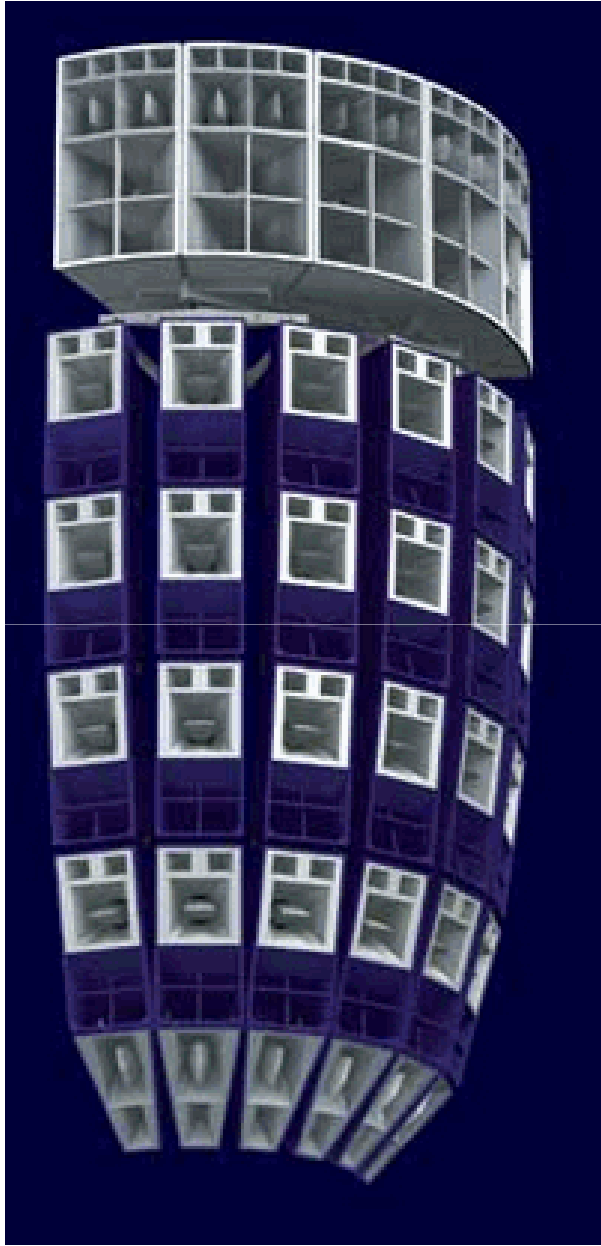
Line
source

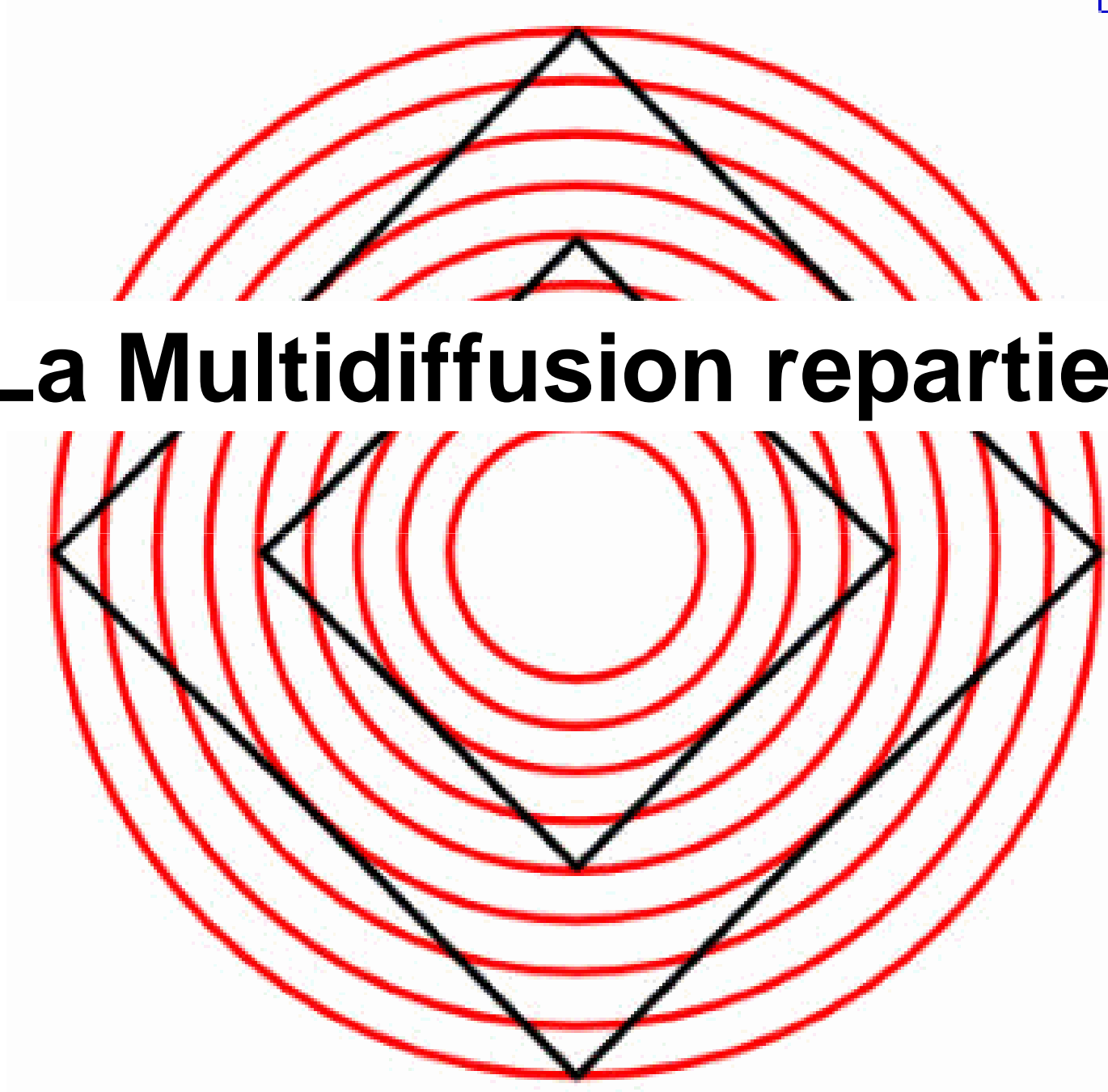


3dB de perte par doublement
de la distance

3dB de gain par doublement
des sources







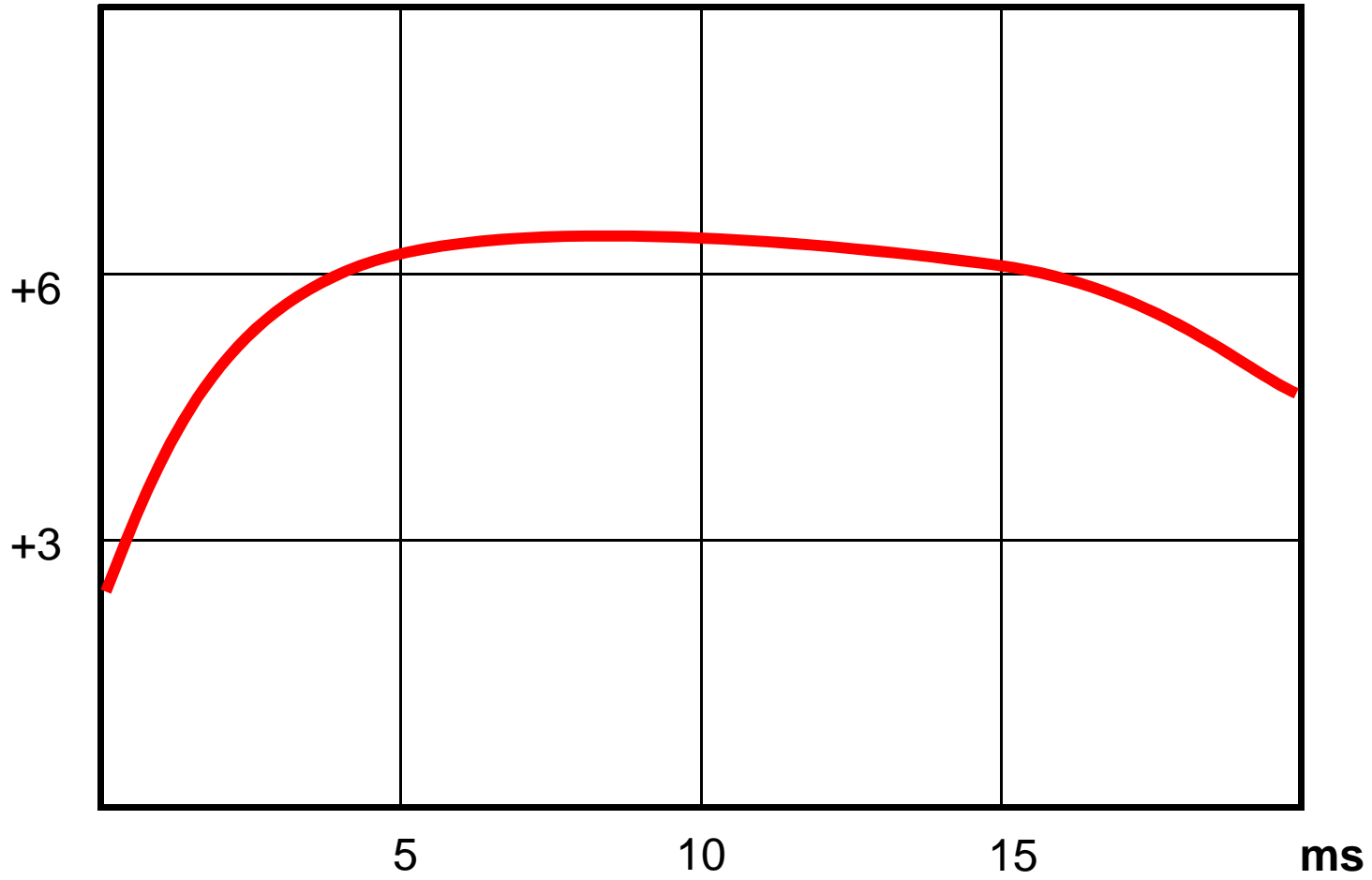
La Multidiffusion repartie

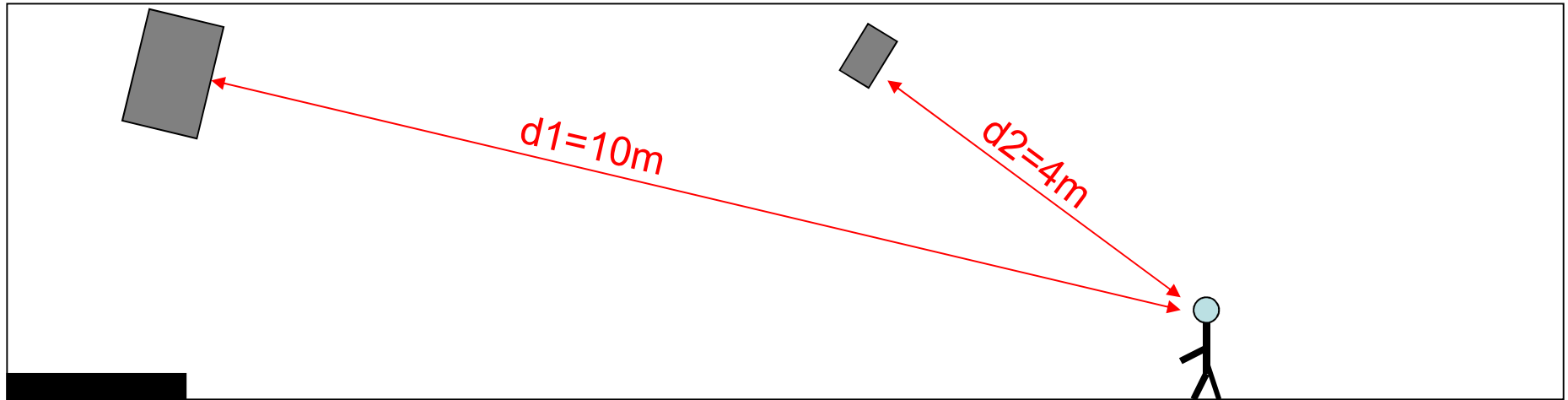
EFFET HAAS

A la fin des années 40, Helmut Haas définit la loi du premier front d'ondes :

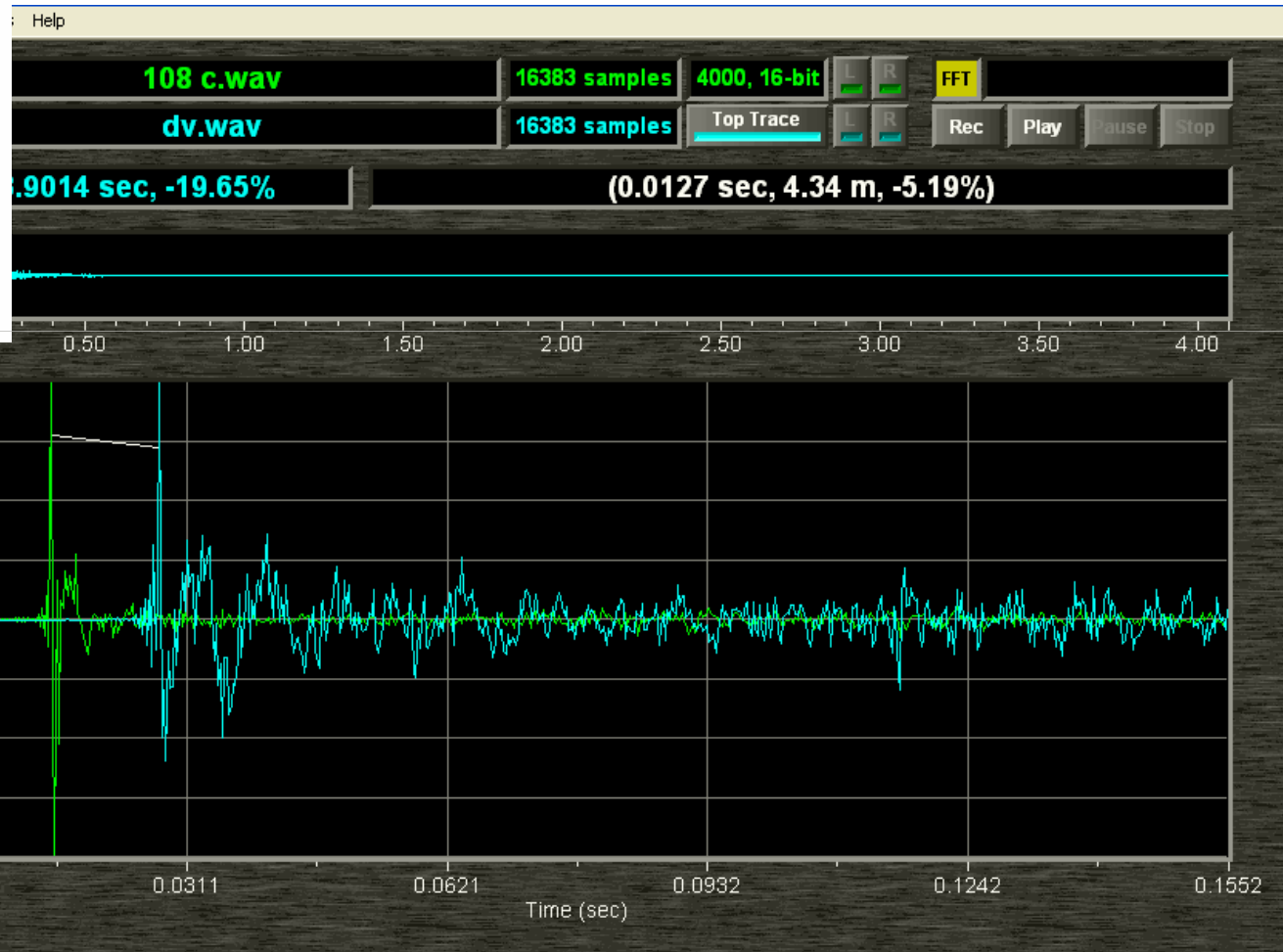
La localisation d'une source est donnée dans la direction d'où provient le son qui arrive en premier à l'oreille (son direct), même si le son retardé a une intensité supérieure au son direct de 6 à 10 dB

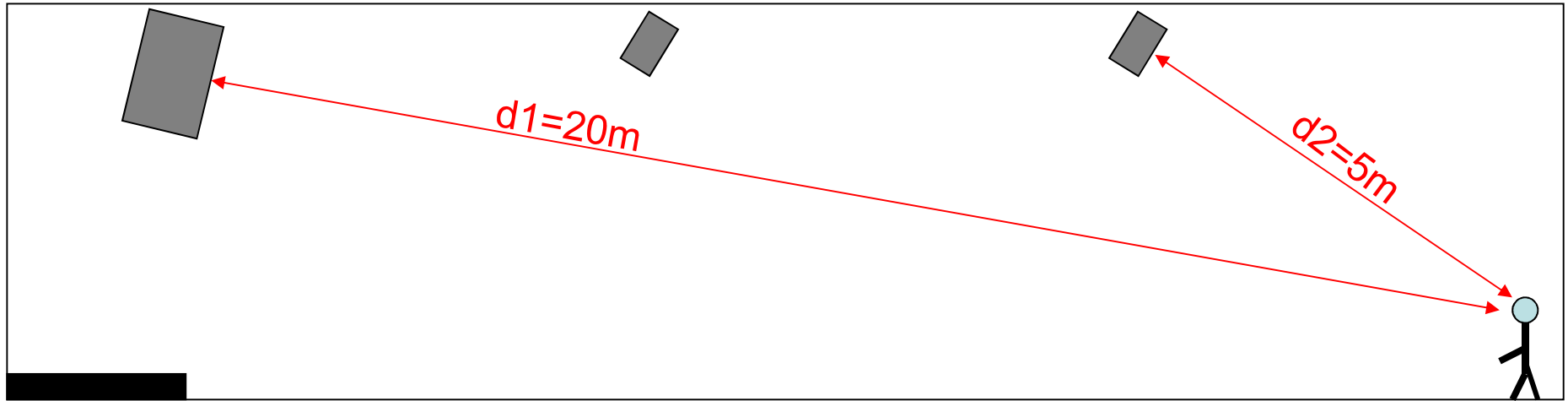
dB



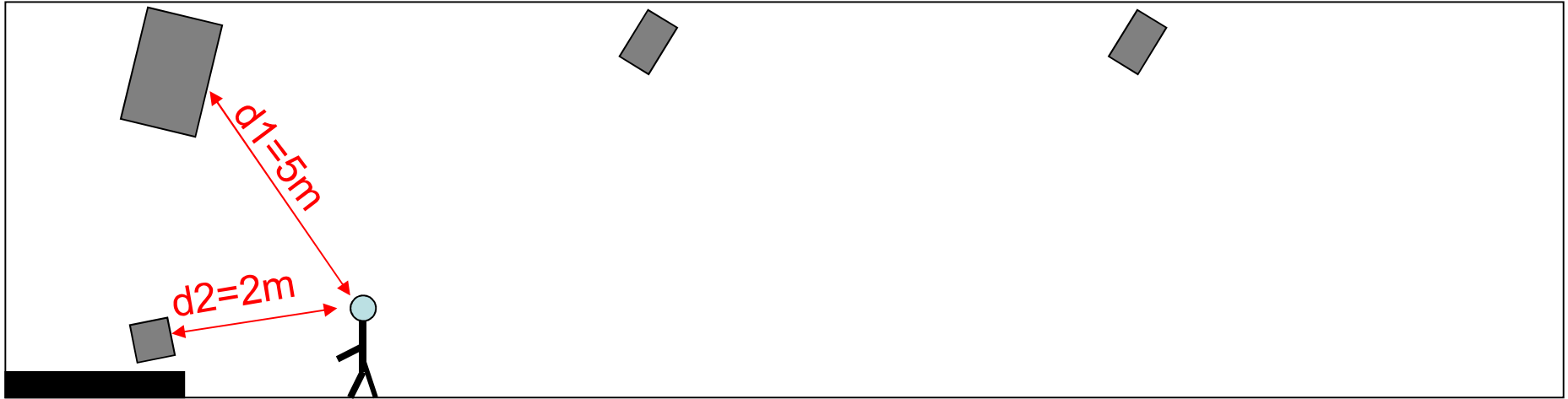


$$\text{Delay} = [(d1-d2)/C] + \text{Effet Haas}$$

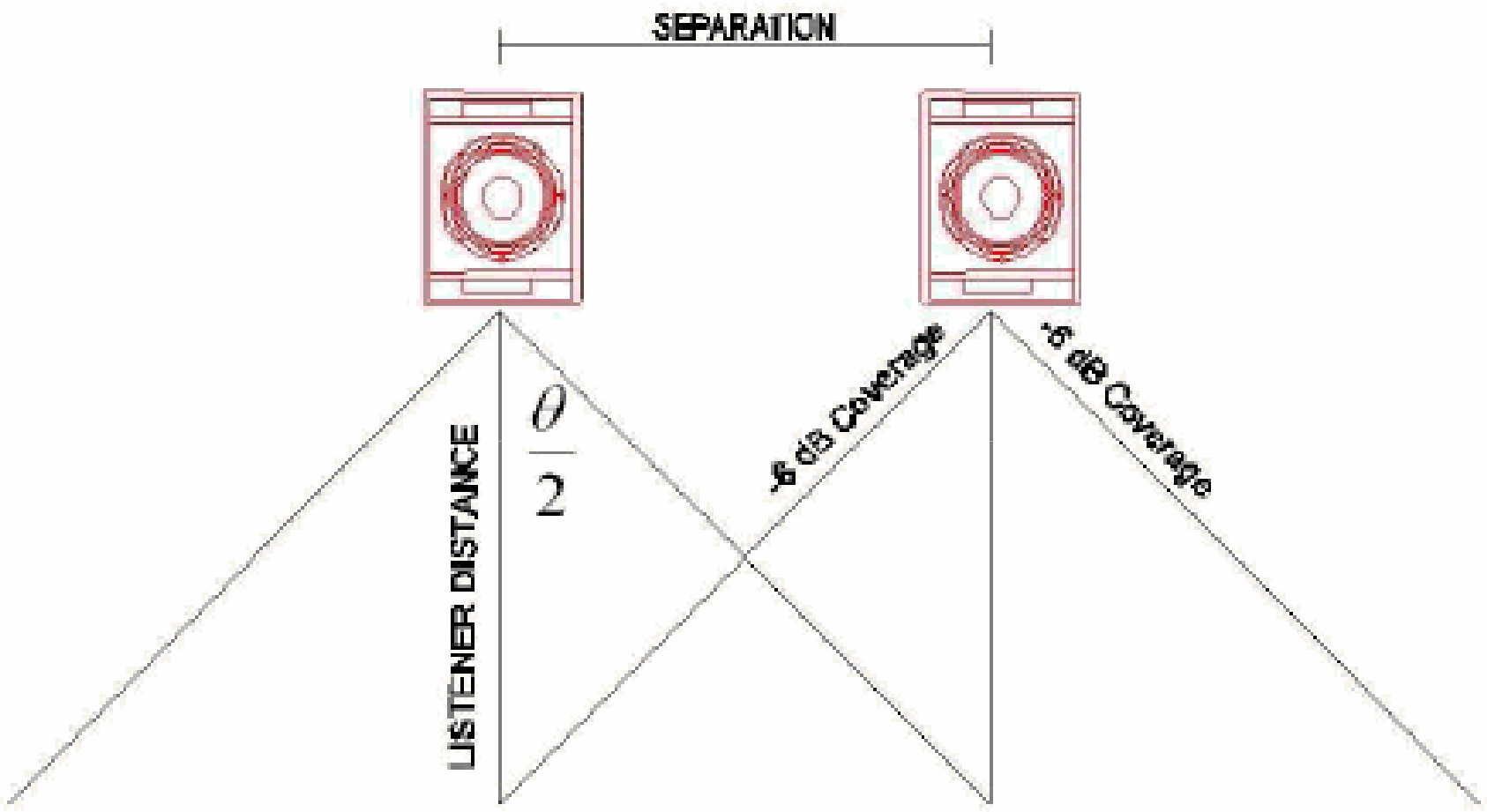




$$\text{Delay} = [(d1-d2)/C] + \text{Effet Haas}$$

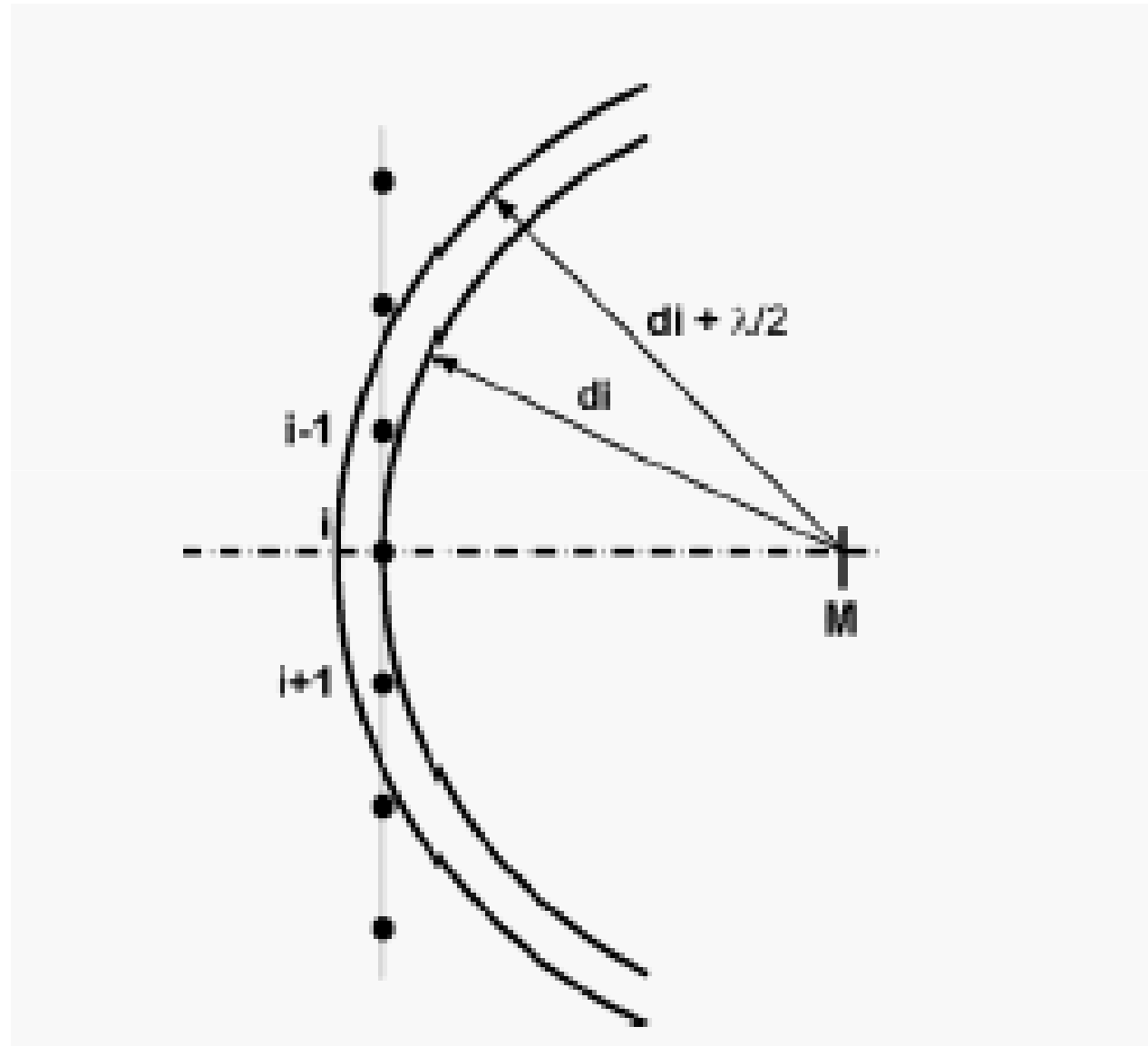


$$\text{Delay} = (d1-d2)/C$$



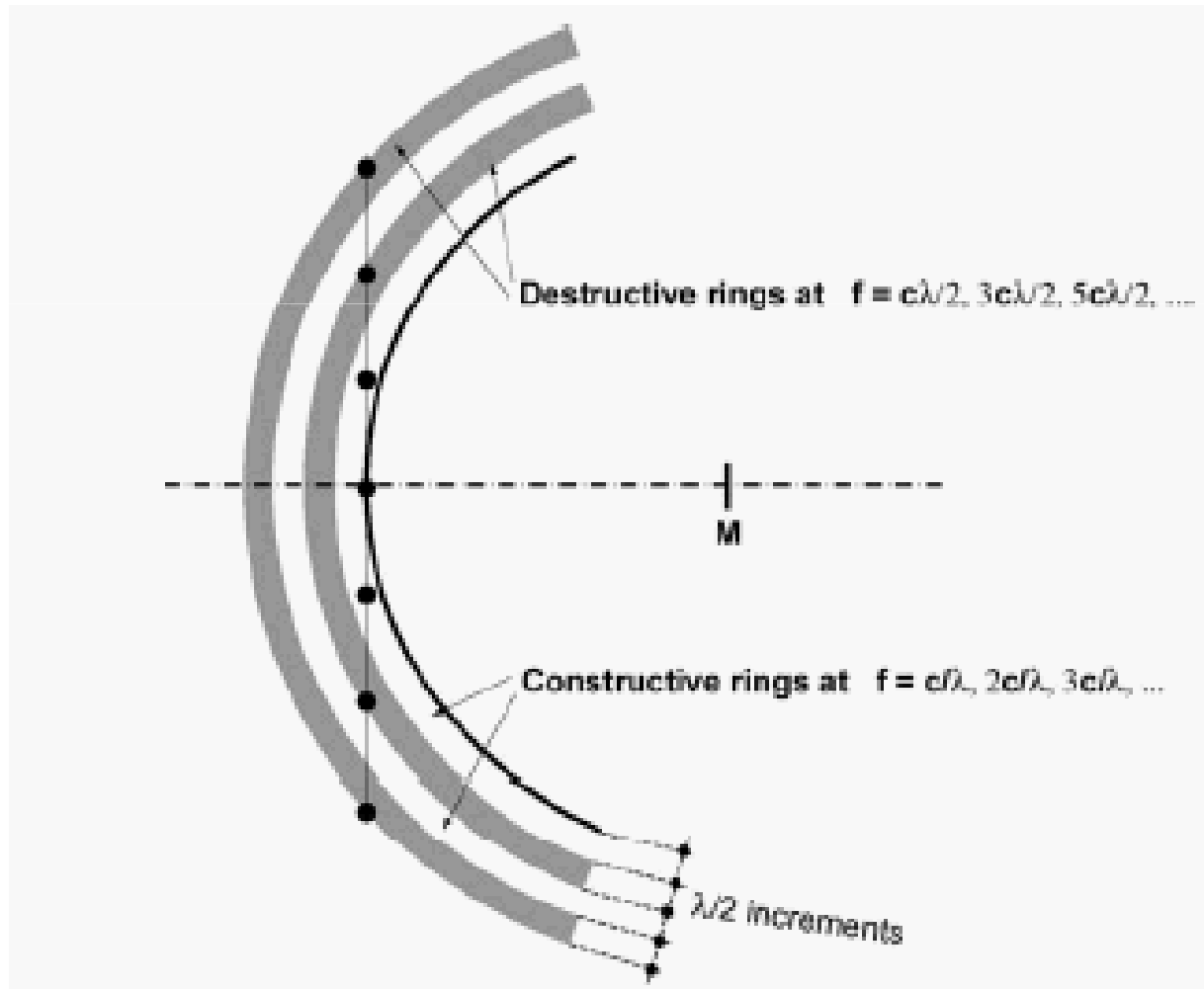
LES SYSTEMES LINE SOURCE

L'approche de Fresnel

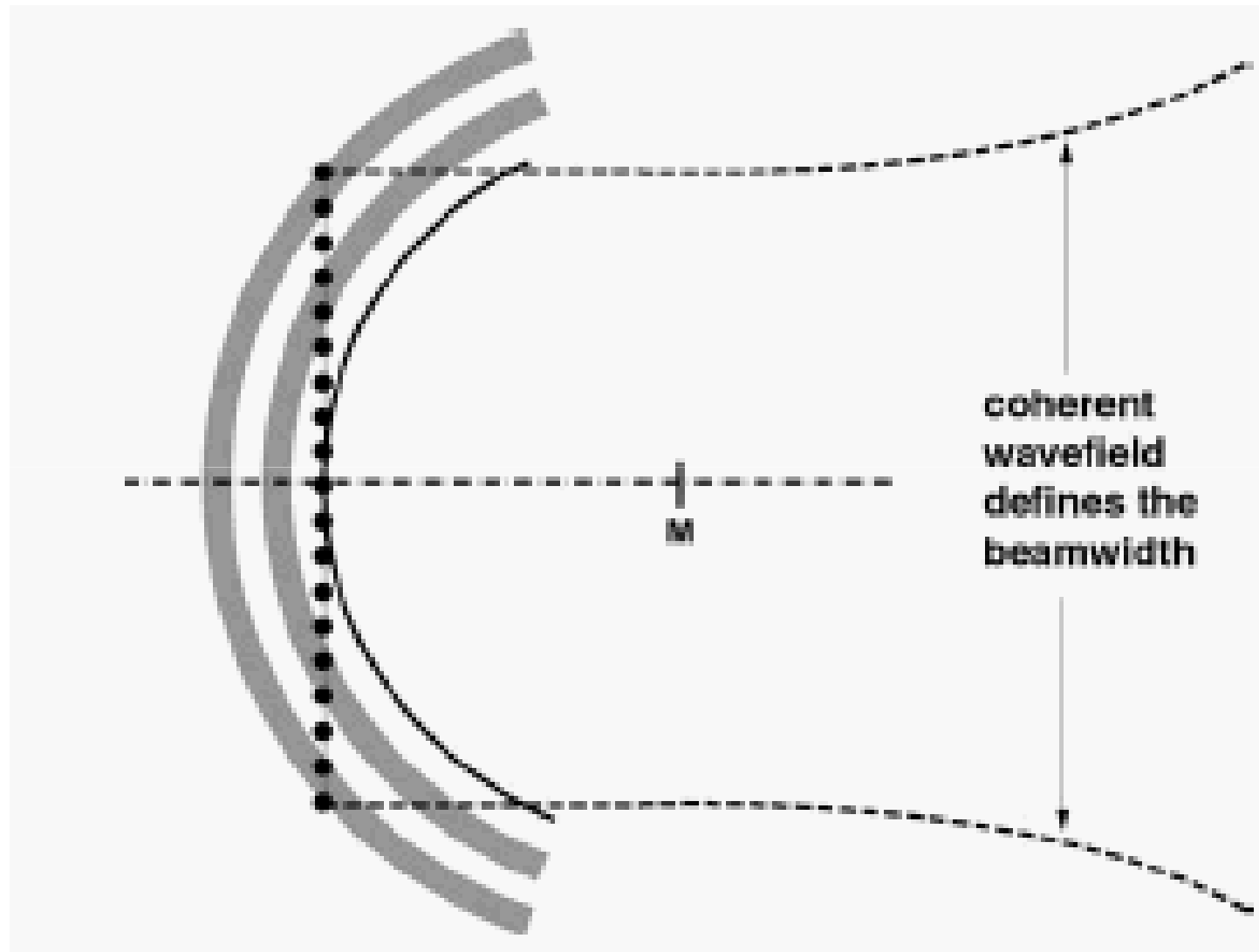


L'approche de Fresnel

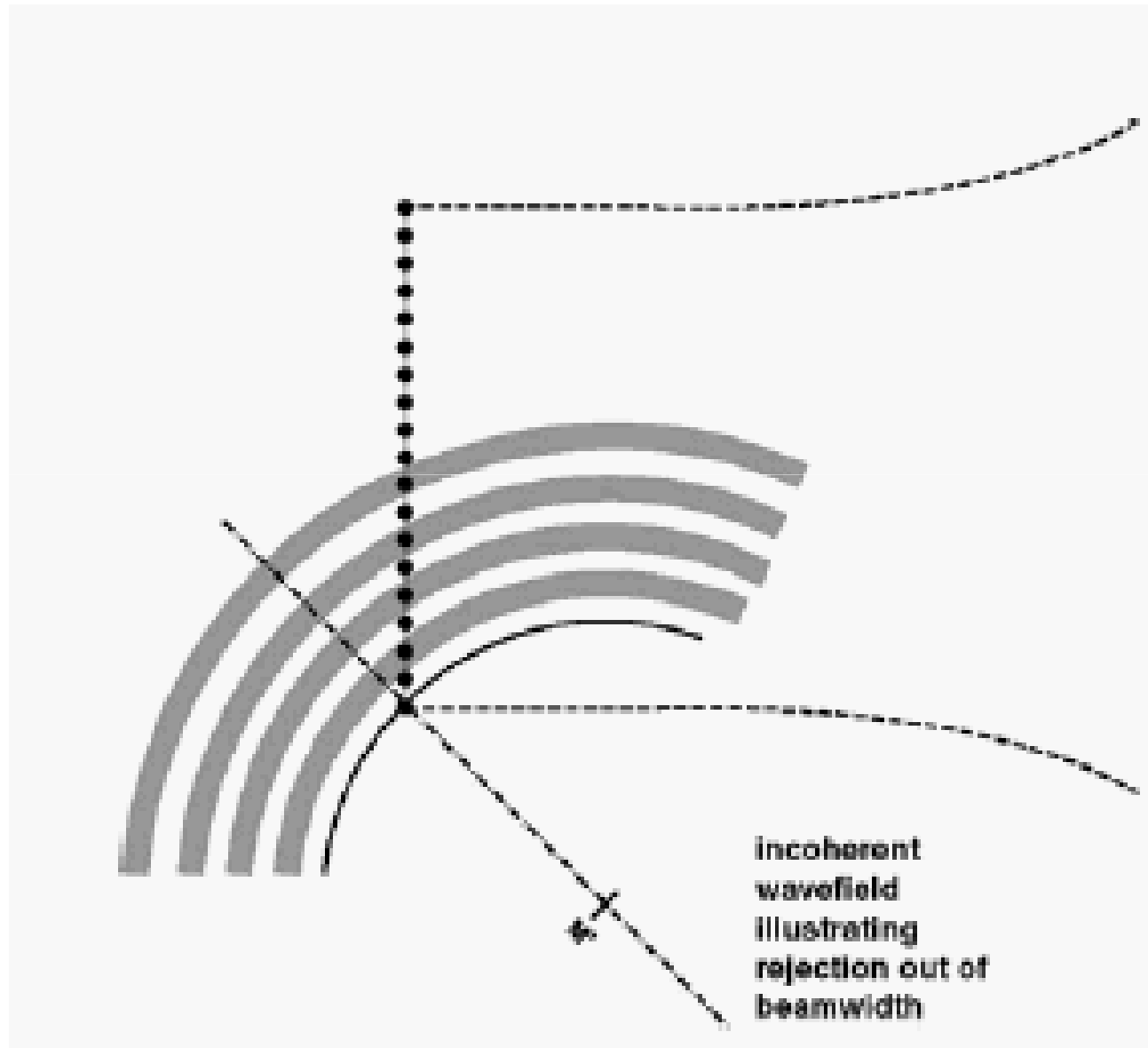
Traçons maintenant une série de cercle dont le rayon augmente par pas $d\theta/2$.



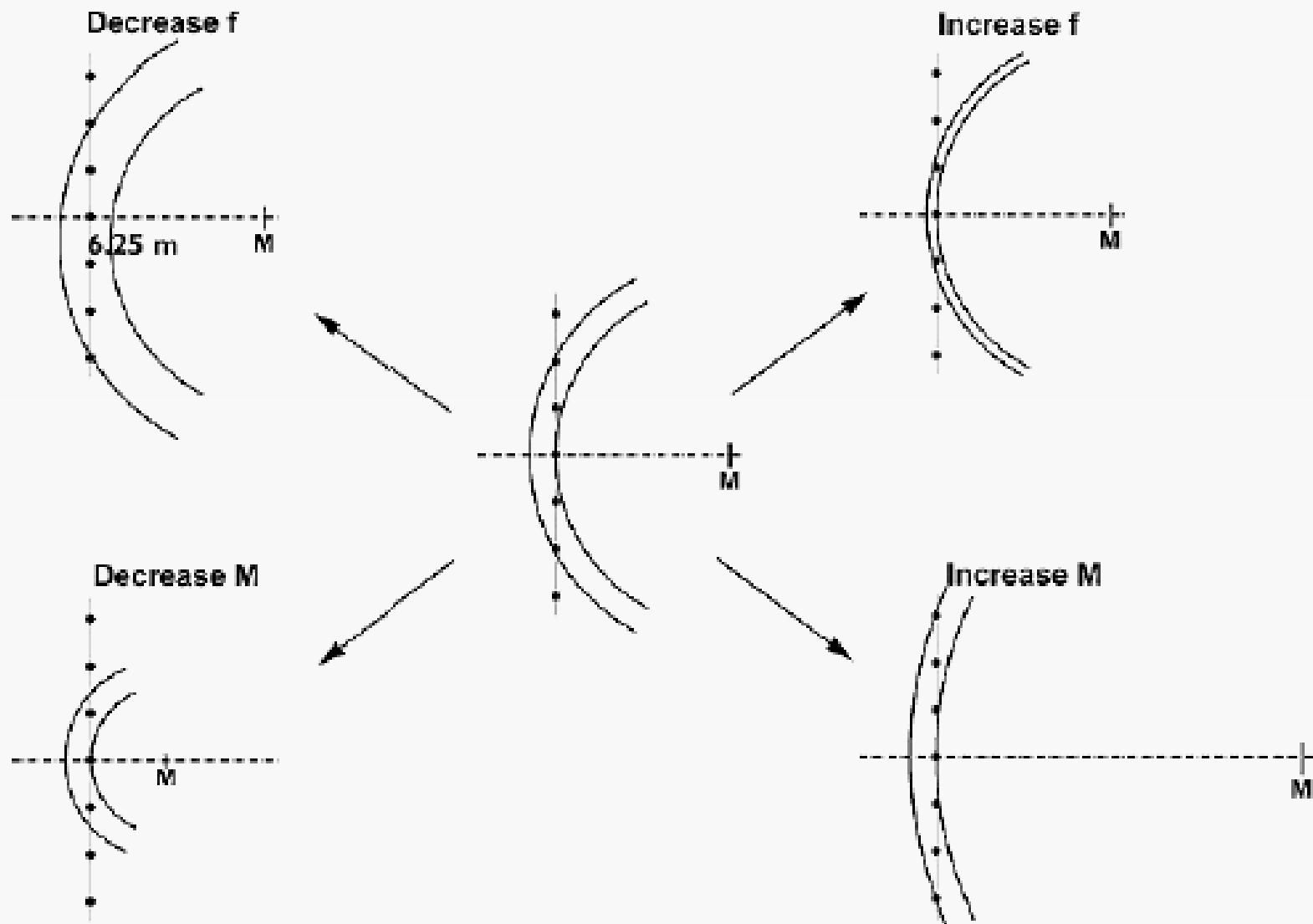
L'approche de Fresnel



L'approche de Fresnel

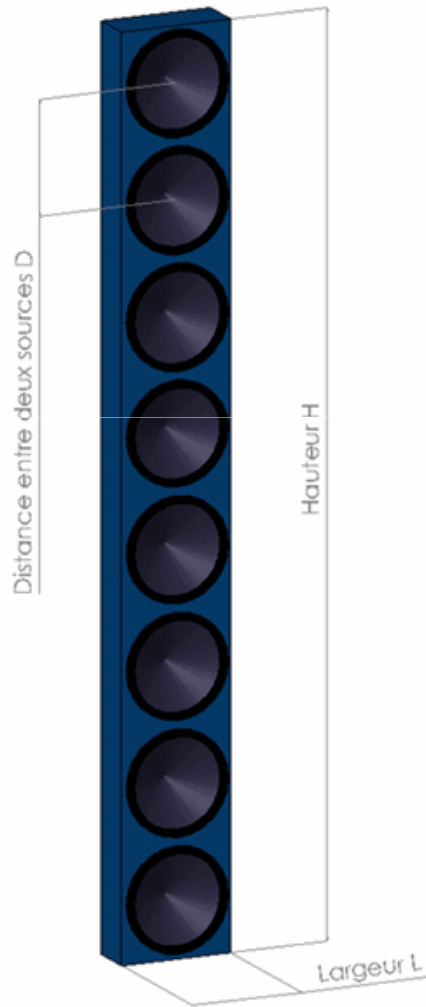


L'approche de Fresnel



WST

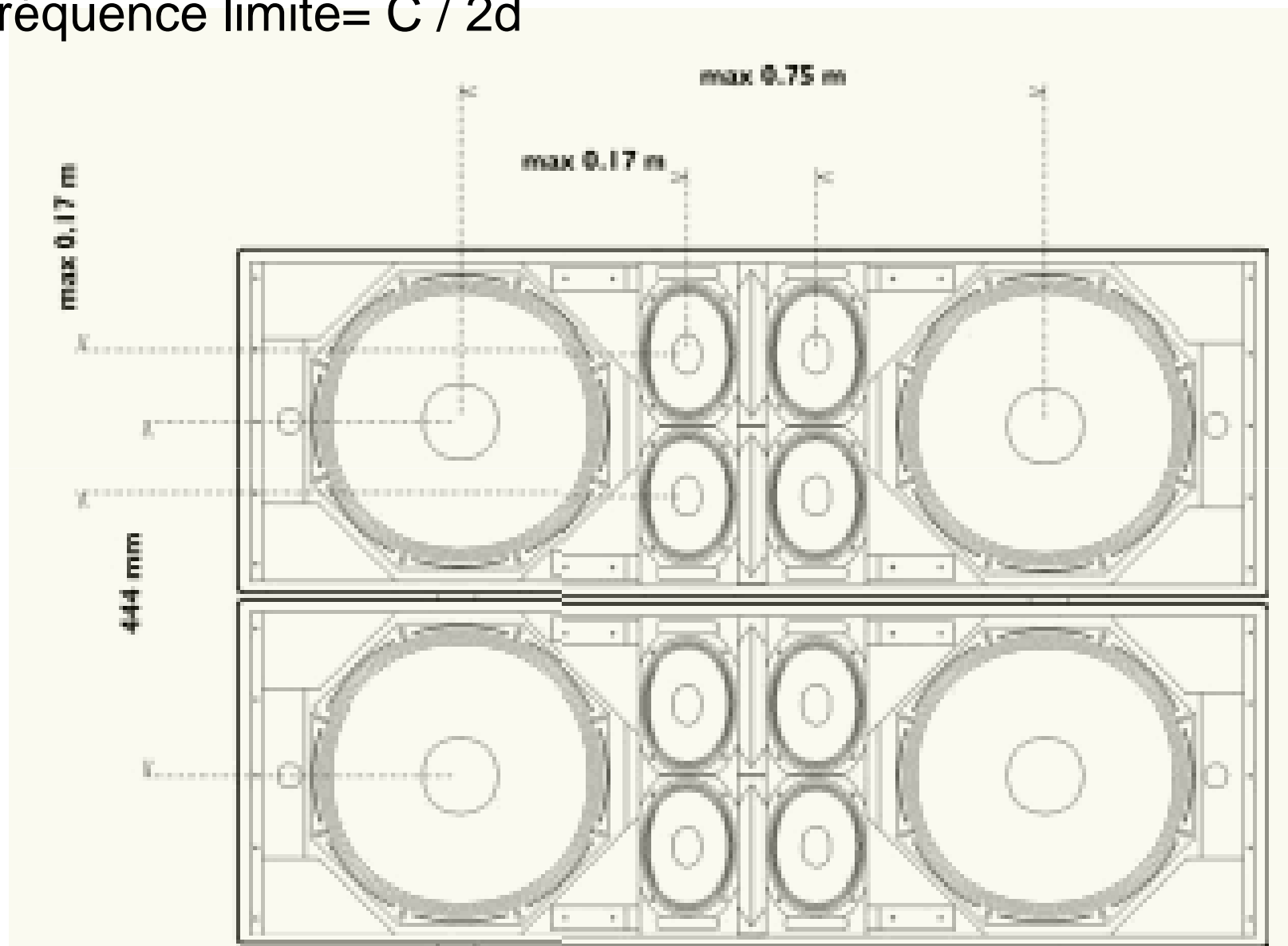
CRITERE N°1 La distance entre les centres d'émission s acoustiques des différentes sources doit être inférieure à la demi-longueur d'onde de la fréquence la plus élevée émise.



D est la distance entre les centres acoustiques

$$D \leq \frac{\lambda}{2}$$

Fréquence limite = $C / 2d$



Fréquence limite = $C / 2d$

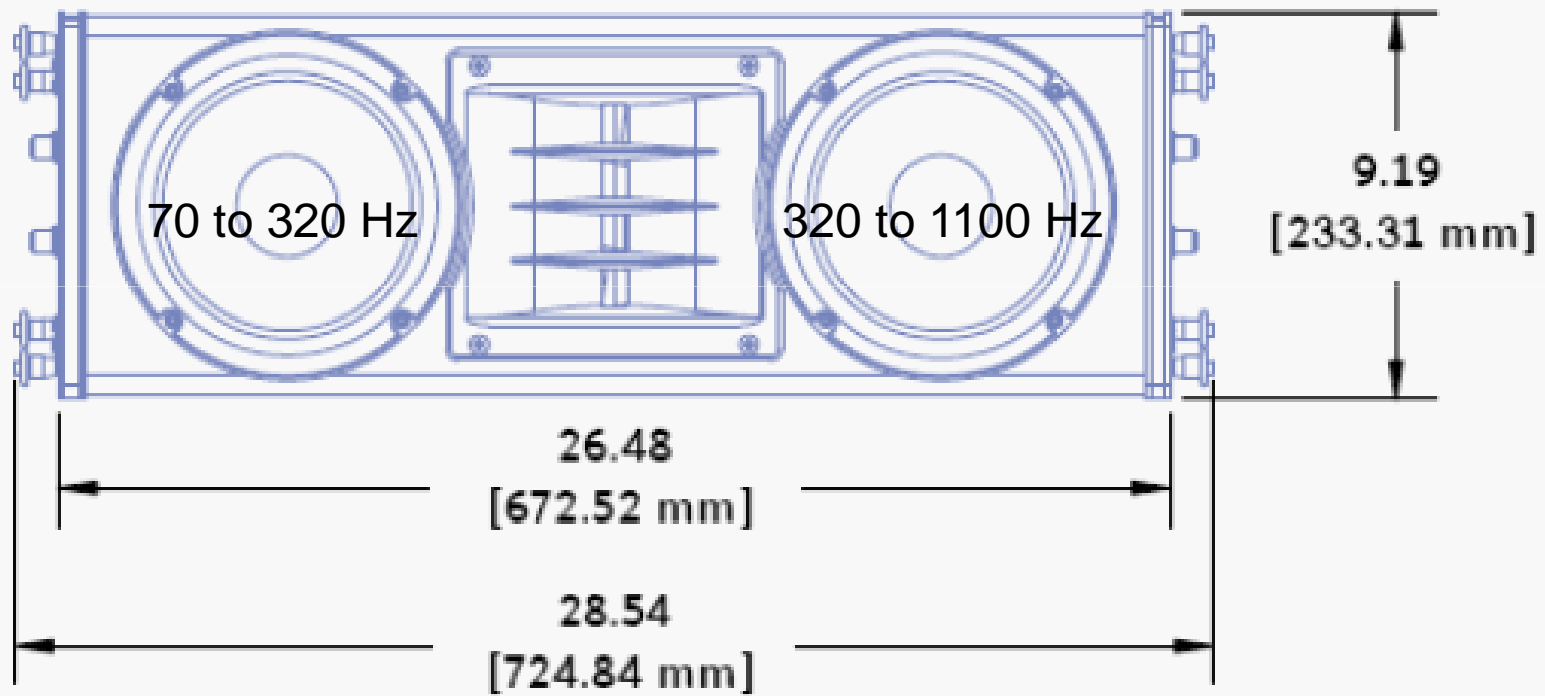
$$340 / (2 \times 0.75) = 226 \text{ Hz}$$

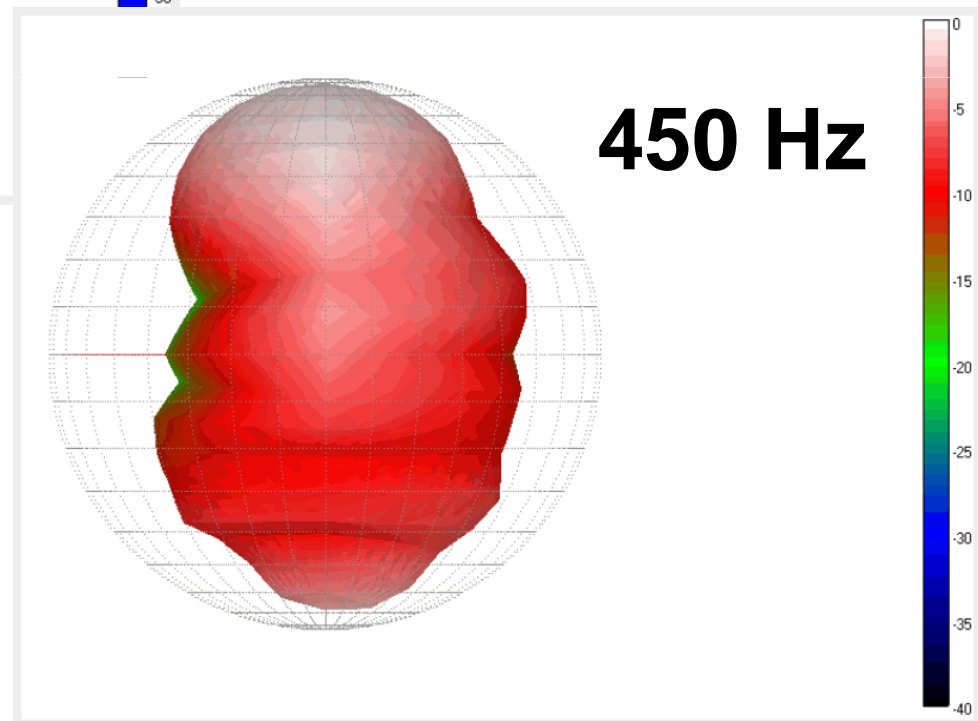
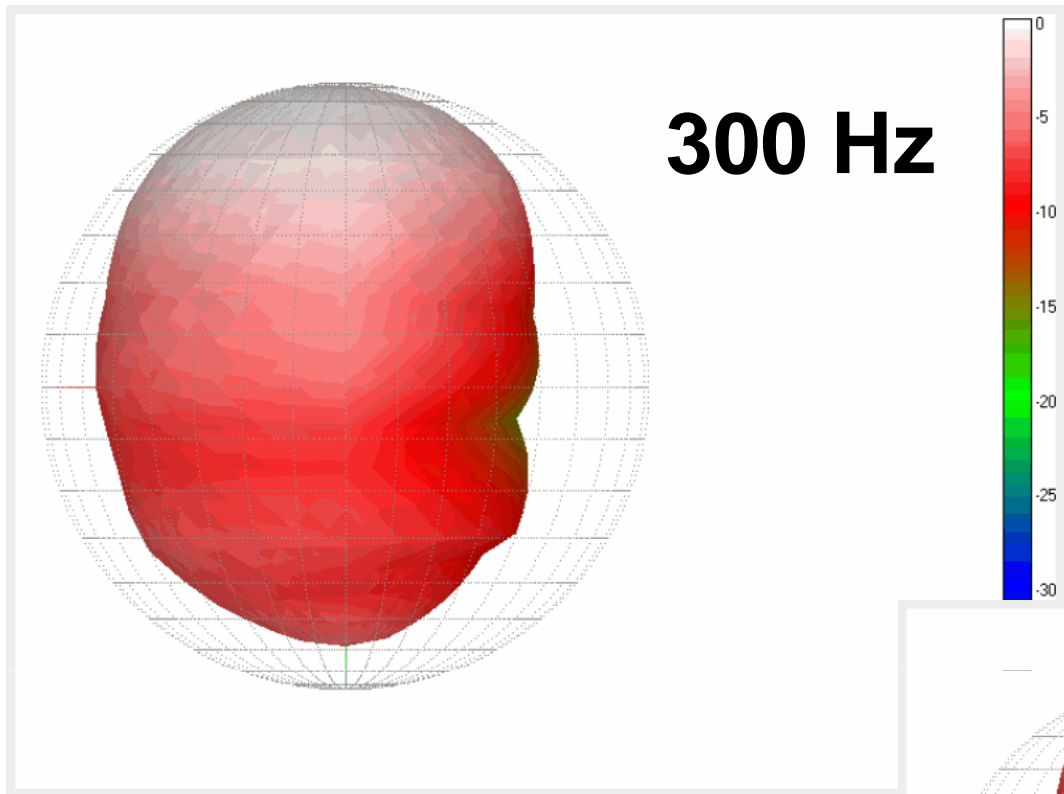
$$340 / (2 \times 0.17) = 1000 \text{ Hz}$$

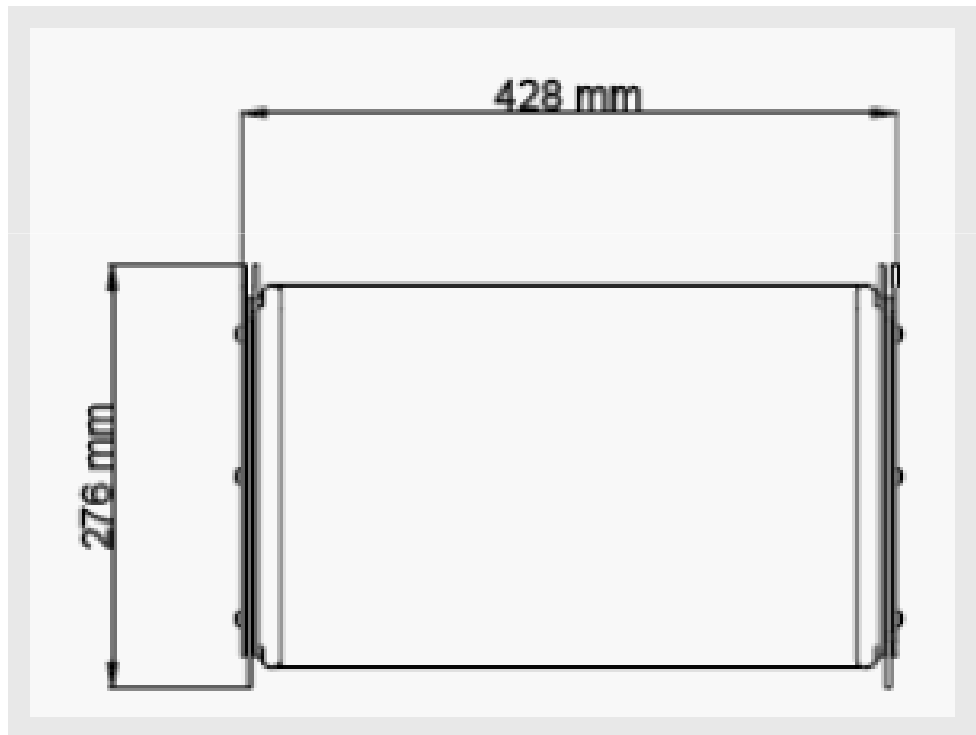
Ecart max. = $C / 2f$

$$340 / (2 \times 200) = 0.85 \text{ m}$$

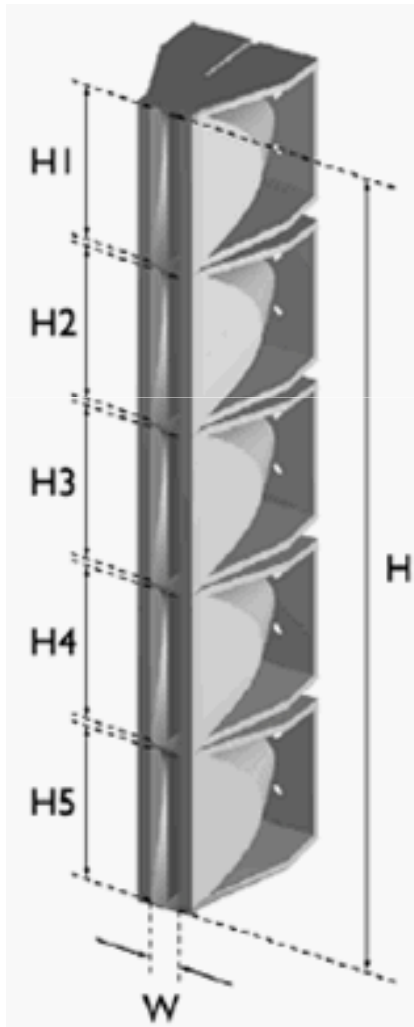
$$340 / (2 \times 1000) = 0.17 \text{ m}$$







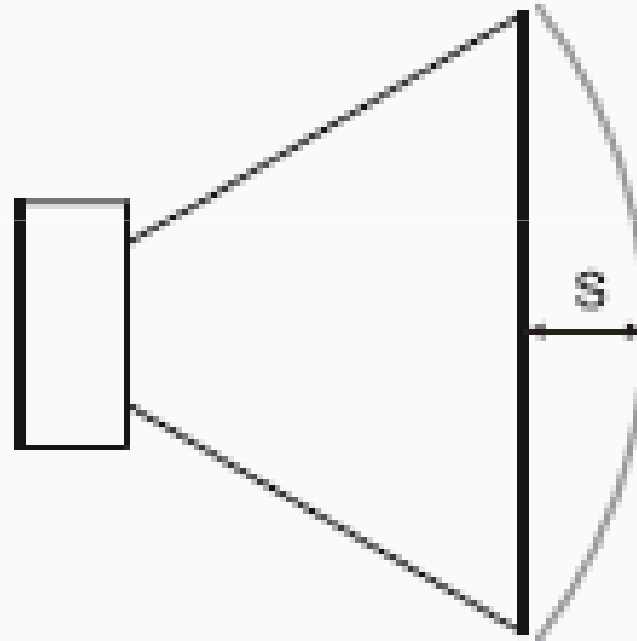
CRITERE N°2 La surface radiante doit représenter au moins 80% de la surface totale.



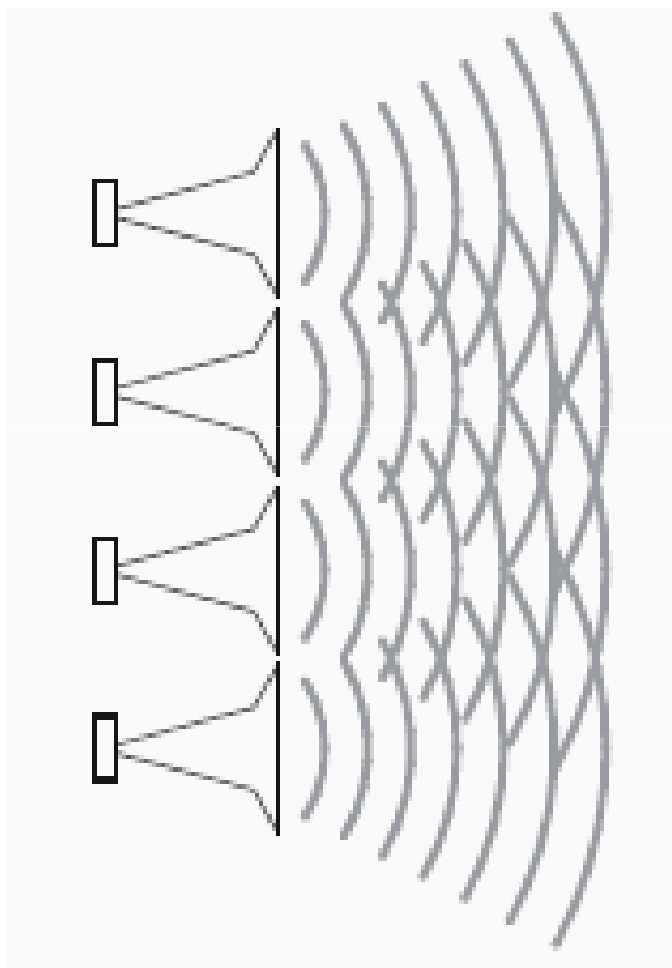
$$H1 + H2 + H3 + H4 + H5 \geq 0.8 \times H$$

CRITERE N°3 L'écart maximum entre le front d'onde rayonnée par chaque source et un front d'onde plan doit être inférieur au quart de la longueur d'onde de la fréquence la plus élevée ce qui implique l'utilisation d'un guide d'onde capable de générer une onde plane ou quasi plane.

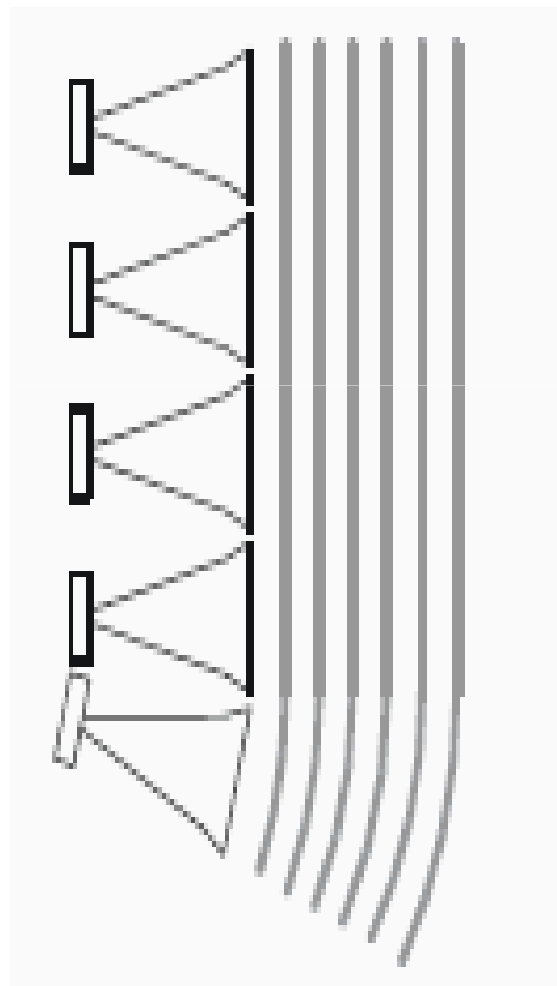
$$s \leq \lambda/4 \text{ (iii)}$$

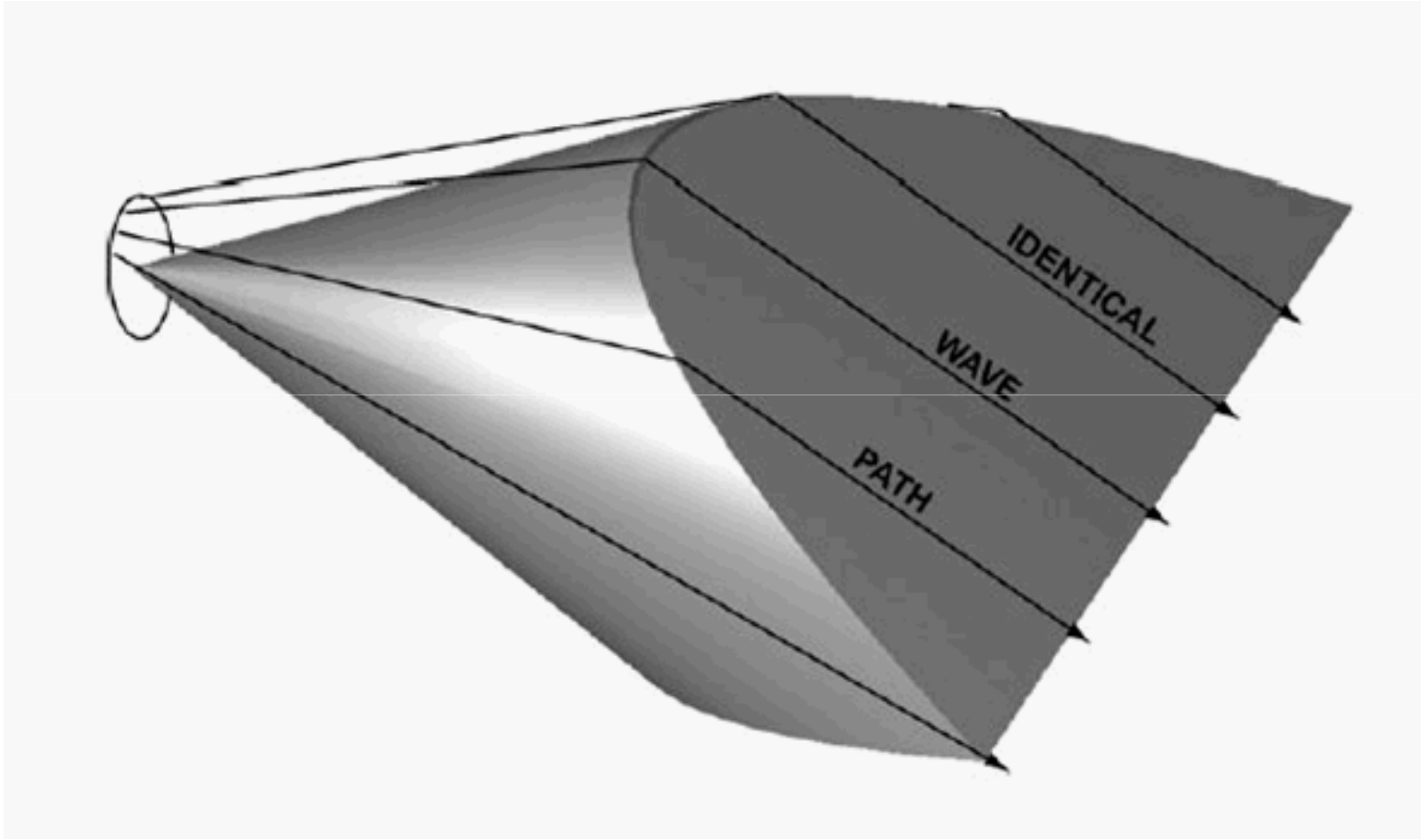


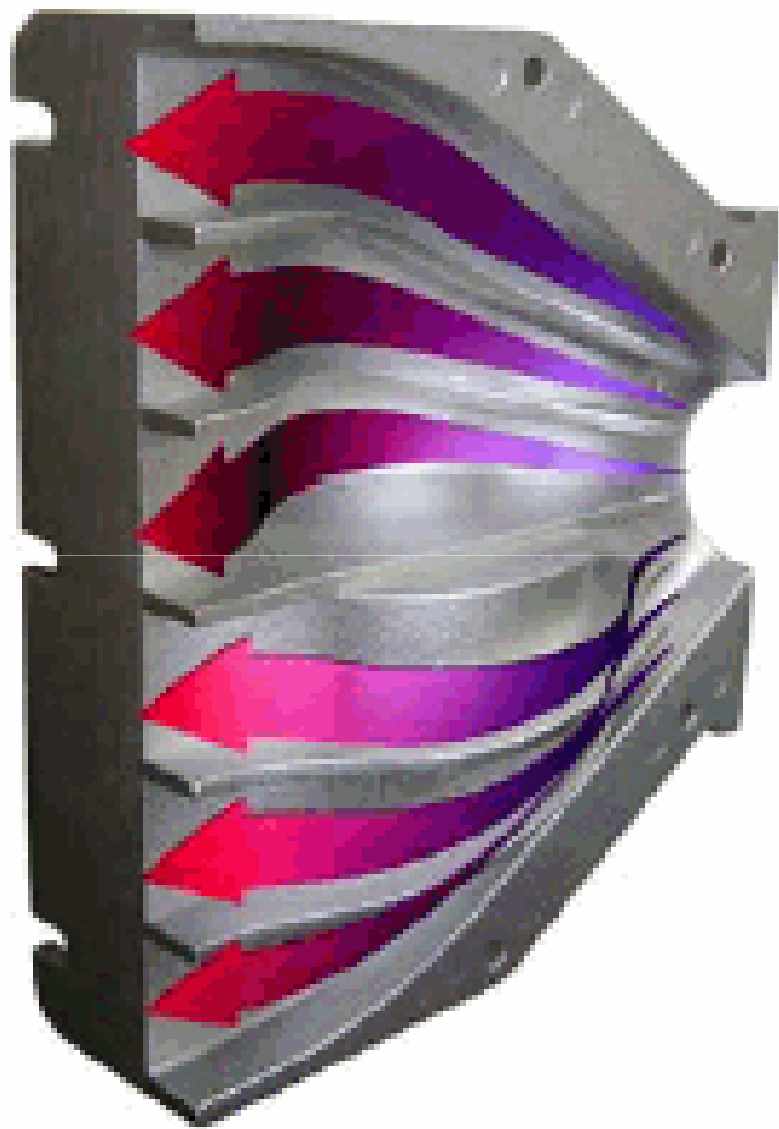
Couplage traditionnel

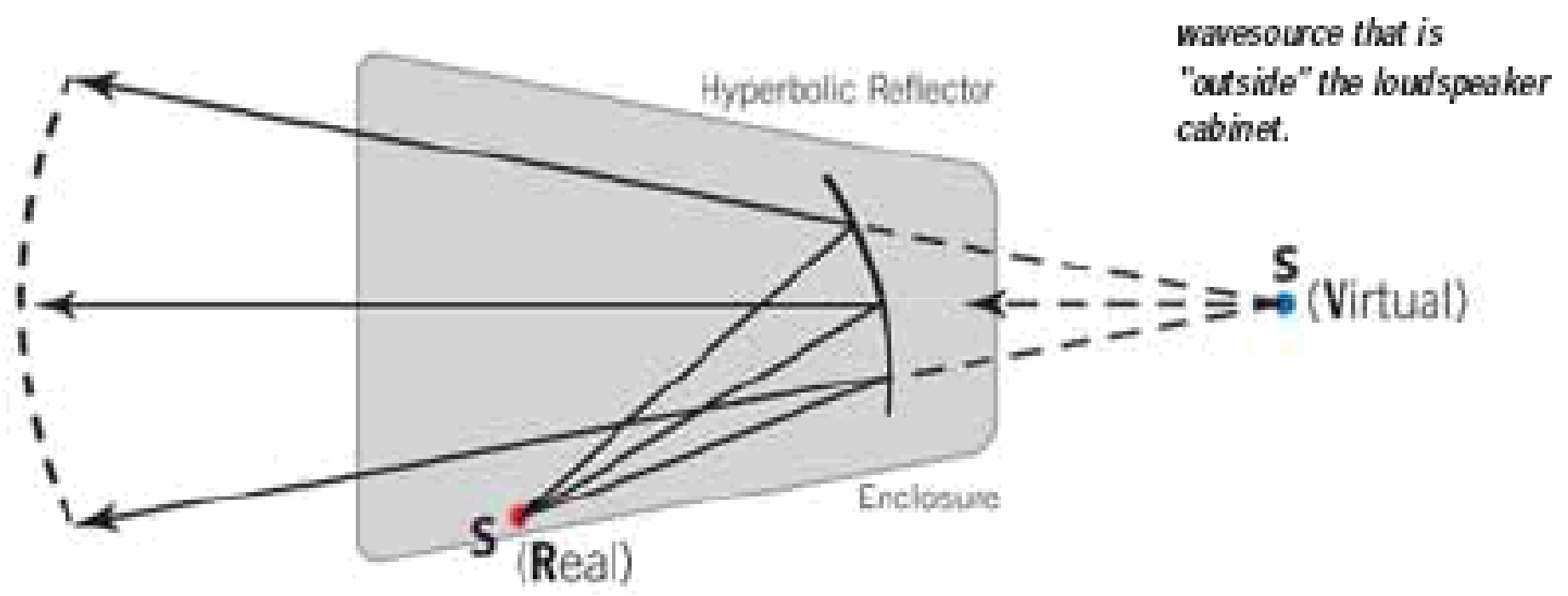


Le critère 3 est respecté





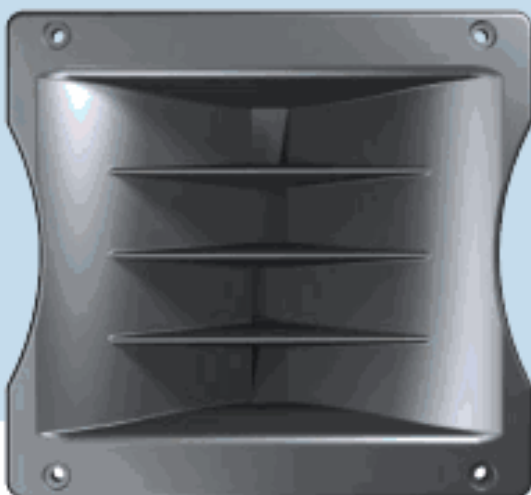






*Fig 1: Computer
Rendered, GEO S805
Wavesource*

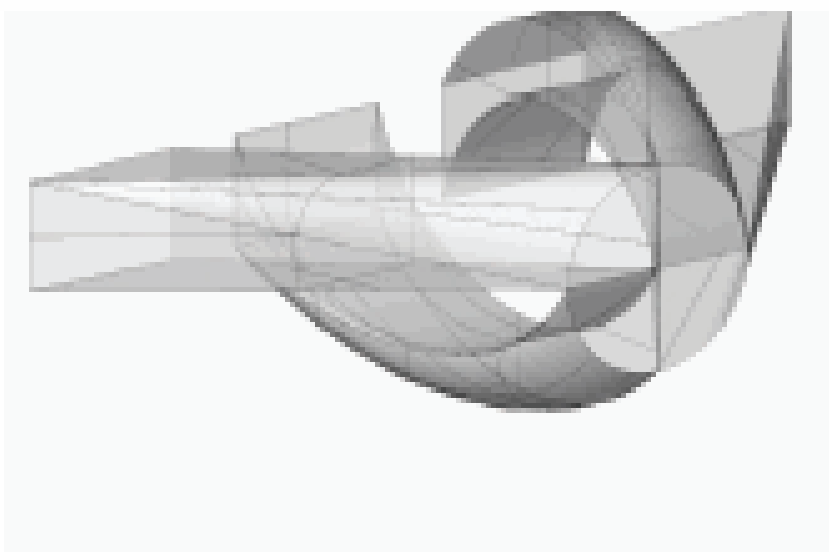


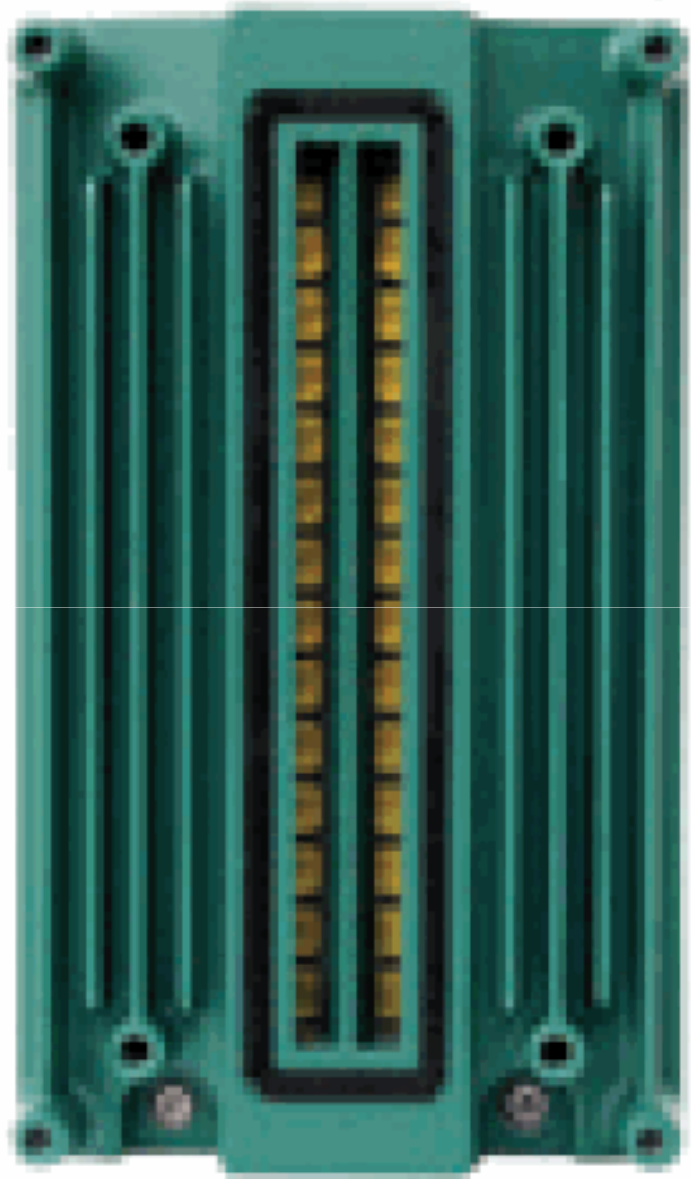


A low-distortion horn provides wide, 100-degree constant directivity horizontal coverage.

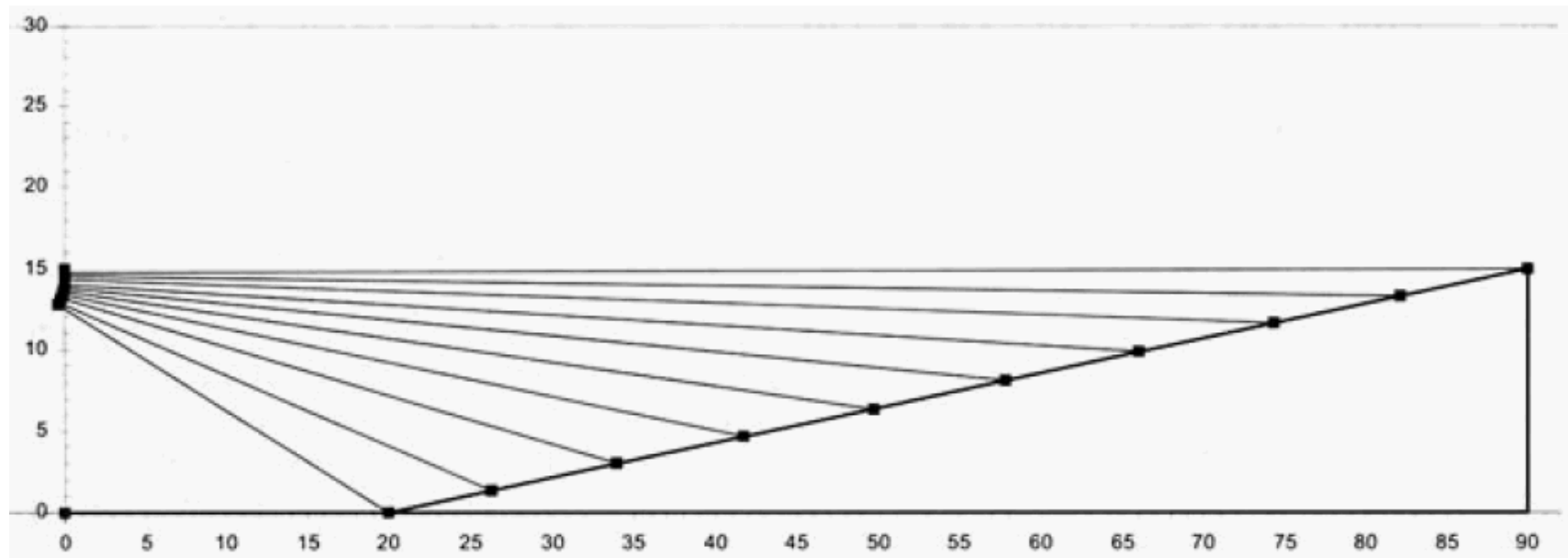


A single 3-inch diaphragm, 1.2-inch exit, neodymium magnet compression driver is mounted on Meyer Sound's patented REM manifold.





CRITERE N°4 Pour obtenir une atténuation de 3 dB par doublement de la distance le long de l'audience, L'angle d'inclinaison entre les boites doit être inversement proportionnel à la distance de l'auditeur (espacement constant entre les points de visée de chaque boite sur l'audience).



CRITERE N°5 L'angle maximum entre chaque élément du réseau est défini par la formule suivante

$$\alpha_{\max} = \left\{ \frac{1}{24 \text{ARF} \times \text{STEP}} - \frac{\text{STEP}}{d_{\min}} \right\} \frac{180}{\pi}$$

- α_{\max} Est l'angle maximum admissible entre deux éléments.
- ARF (Active Radiating Factor) : 80% pour répondre au critère n°1
- STEP distance entre les centres acoustiques des hauts parleurs (diamètre du HP + boiserie au dessus et en dessous)
- d_{\min} Distance de l'auditeur le plus proche

COMPONENT	Nominal Diameter (mm)	Enclosure Height (m)	Max Interelement Angle (degrees)	Max Interelement Angle (degrees)
18"	460	0,496	3,2	4,6
15"	380	0,416	4,8	6,0
12"	300	0,336	7,0	7,9
8"	205	0,241	11,0	11,7
			$d_{\min} = 10 \text{ m}$	$d_{\min} = 20 \text{ m}$

$$\left\{ \frac{1}{24 \times 0.8 \times 0.416} - \frac{0.416}{10} \right\} \frac{180}{\pi} = 4.8$$

La zone de Fresnel et de Fraunhofer

la propagation d'un assemblage linéaire est cylindrique (-3dB) en champ proche (zone de Fresnel) et sphérique (-6dB) en champs lointain (zone de Fraunhofer).

La limite entre ces deux zones (*d border*) est proportionnelle à la fréquence et au carré de la longueur de la ligne.

$$d_{border} = \frac{3}{2} H^2 F \sqrt{1 - \left(\frac{1}{3HF} \right)^2}$$

H est la hauteur de l'array (en mètre)

F est la fréquence (en kHz)

Freq (Hz)	H=0.9 m d _{border} (m)	H=1.8 m d _{border} (m)	H=3.6 m d _{border} (m)	H=5.4m d _{border} (m)
63	No cylindrical	No cylindrical	No cylindrical	1
125	No cylindrical	No cylindrical	2	5
250	No cylindrical	1	5	11
500	0	2	10	22
1k	1	5	19	44
2k	2	10	39	87
4k	5	19	78	175
8k	10	39	156	350
16k	19	78	311	700

La zone de Fresnel et de Fraunhofer

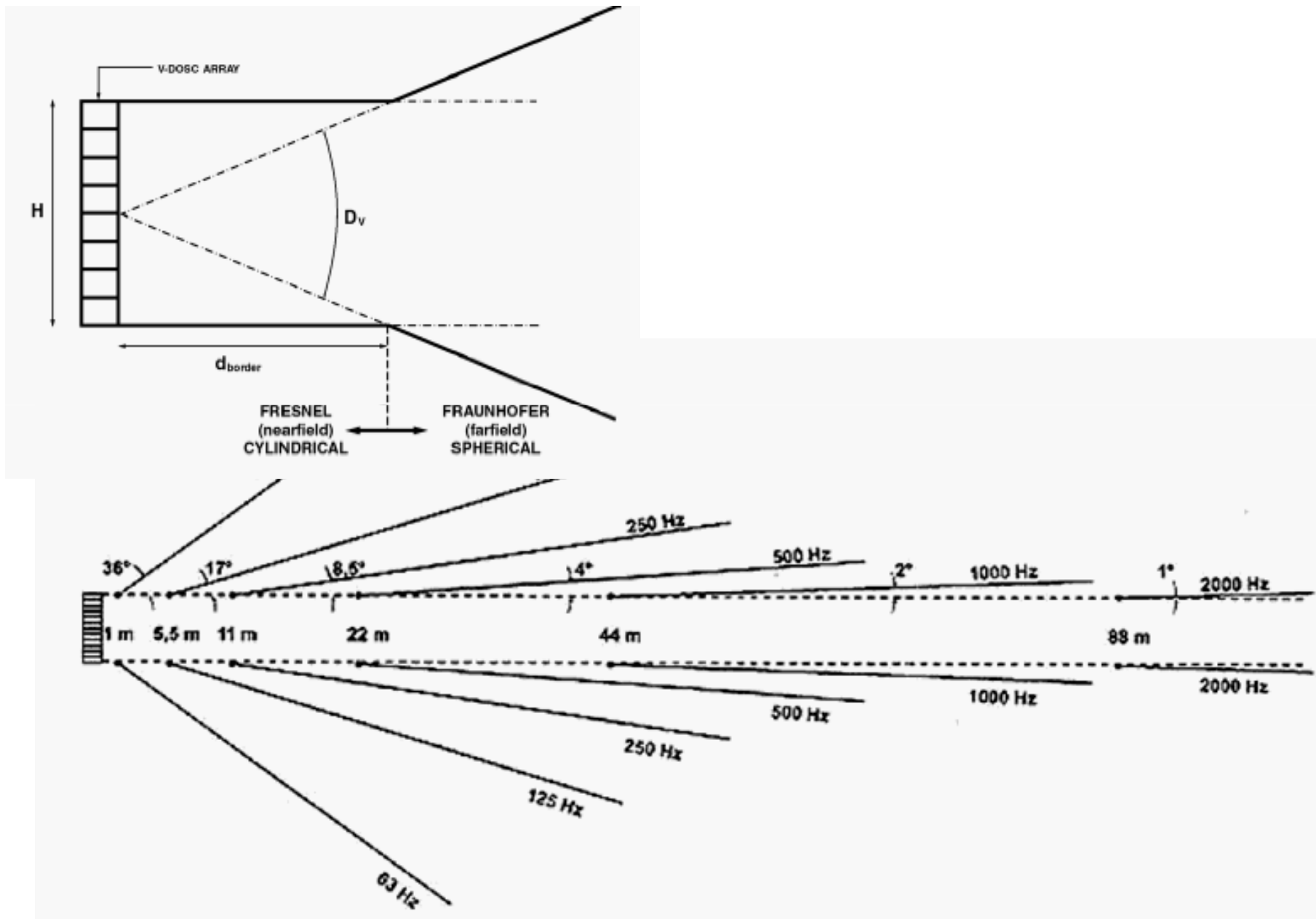
Dans la zone de Fresnel, le front d'onde est cylindrique La hauteur du front d'onde est égale à la hauteur de l'array.

Dans la zone de Fraunhofer, le front d'onde est sphérique et il se propage horizontalement (couverture nominale annoncée par le constructeur) et verticalement selon la formule suivante, où **D_v** est l'angle de couverture vertical en degrés:

$$D_v = 2 \sin^{-1} \left(\frac{0.6}{3HF} \right)$$

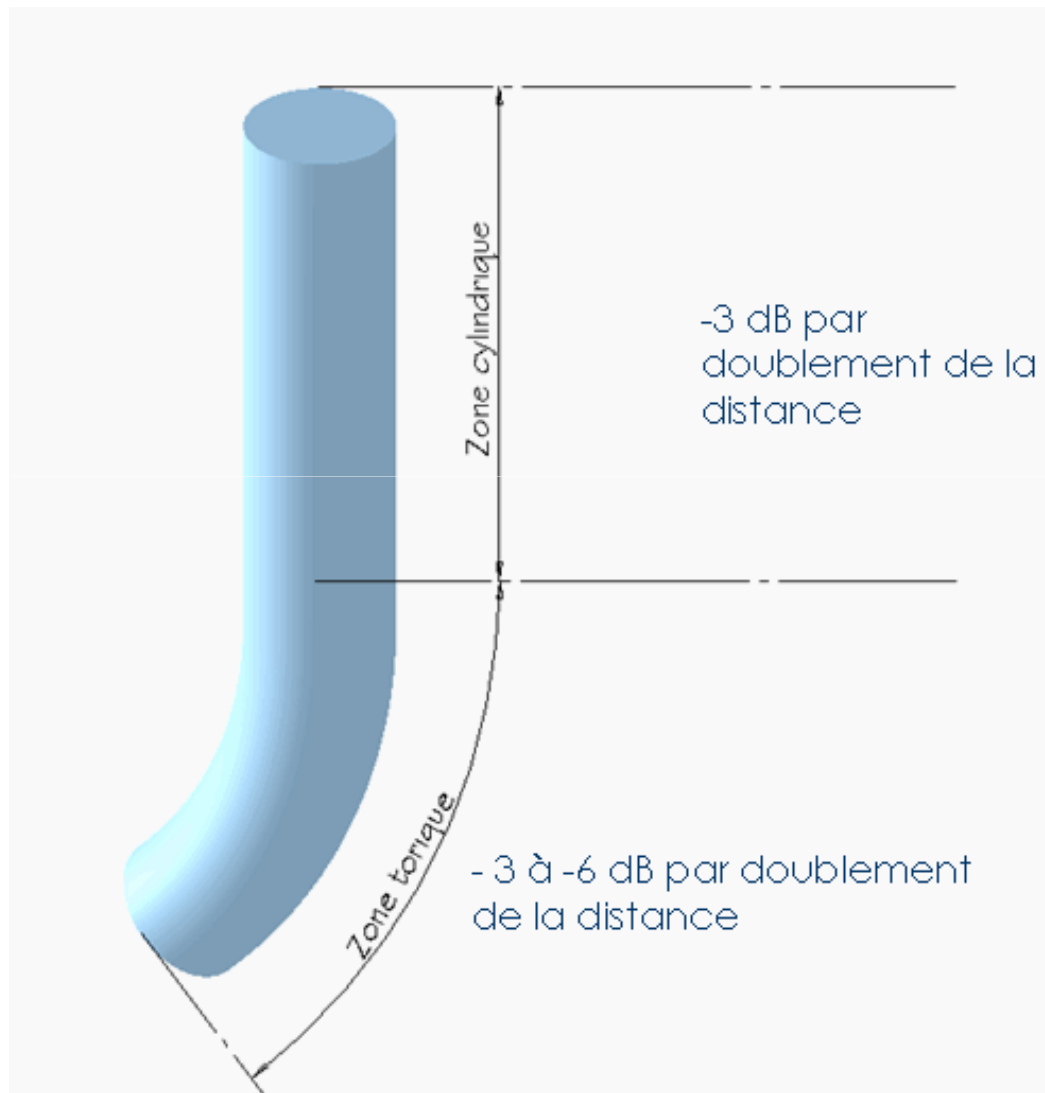
Freq (Hz)	H=0.9 m D _v (deg)	H=1.8 m D _v (deg)	H=3.6 m D _v (deg)	H=5.4m D _v (deg)
63	-	-	124	72
125	-	125	53	34
250	125	53	26	17
500	53	26	13	8.5
1k	26	13	6.4	4.2
2k	13	6.4	3.2	2.1
4k	6.4	3.2	1.6	1.1
8k	3.2	1.6	0.8	0.5
16k	1.6	0.8	0.4	0.3

La zone de Fresnel et de Fraunhofer



Le parfait couplage entre les sources permet d'obtenir des niveaux sonores plus importants à puissance électrique égale.

Les systèmes ligne source passe d'une propagation cylindrique à une propagation sphérique en fonction de la fréquence et de la distance (comme nous l'avons vu précédemment) mais aussi en fonction de l'angle entre les boîtes.

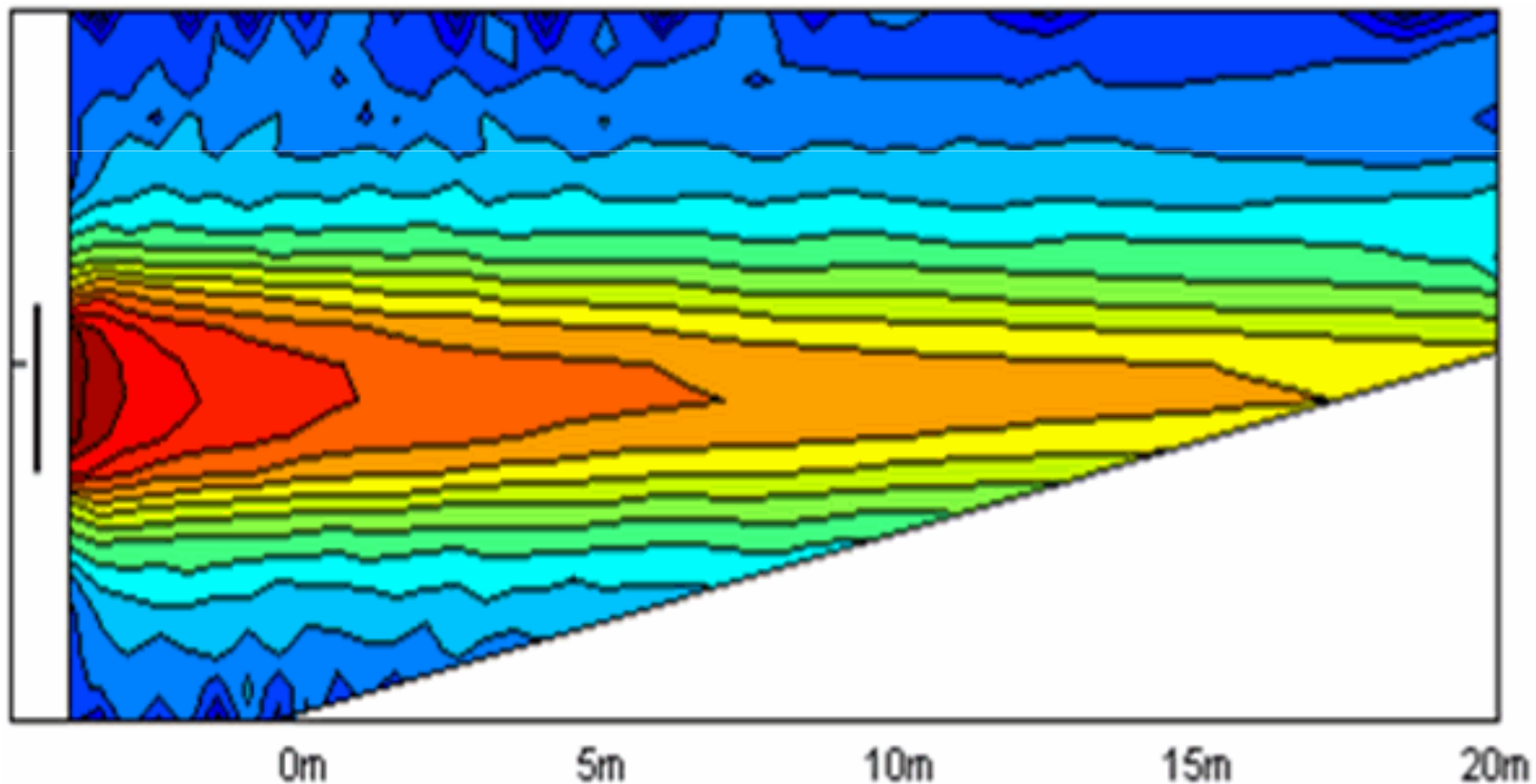


Assemblage linéaire

L'assemblage linéaire optimise la pression acoustique et l'intelligibilité par contre la pression acoustique n'est pas du tout homogène (antenne).

Idéal pour la longue portée, une section linéaire est utilisée au sommet de la ligne.

On observe que le niveau sonore sous la ligne est minimale.

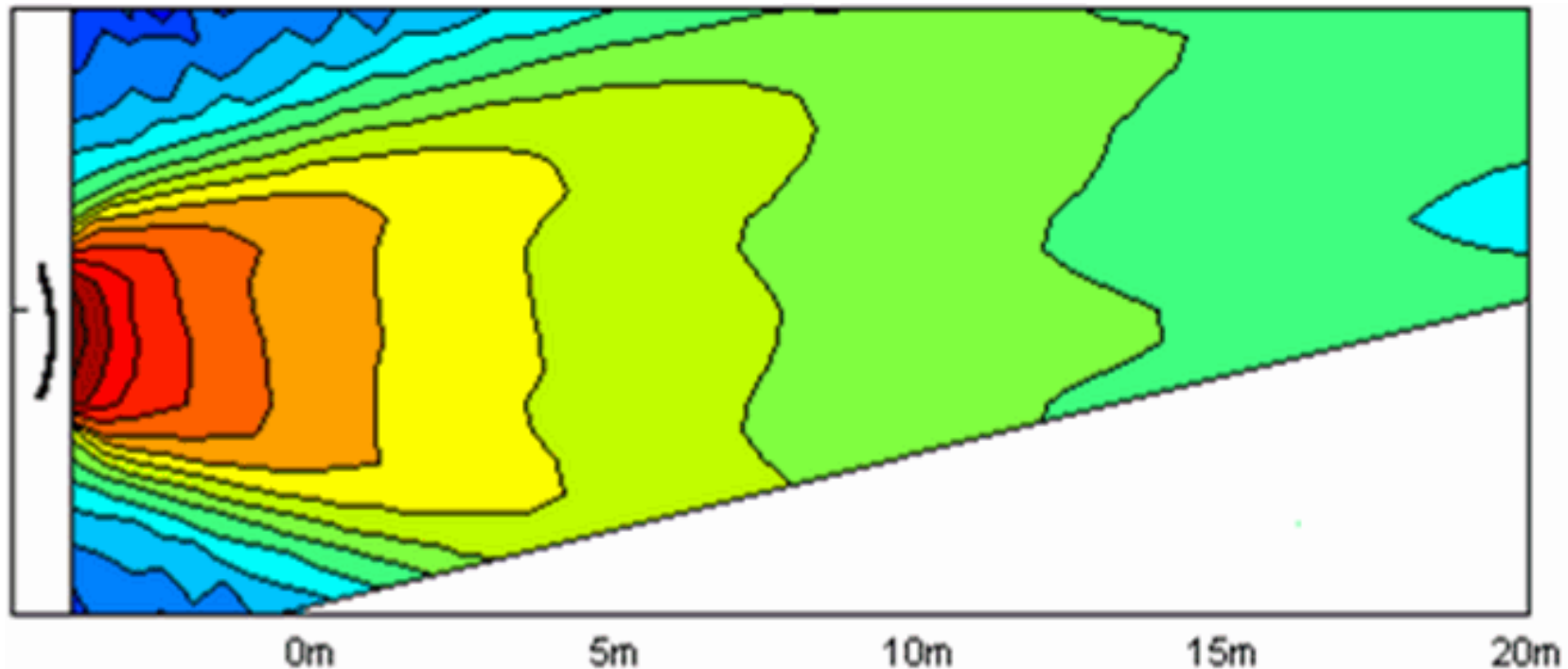


Assemblage à courbure constante

Si tous les angles entre les enceintes sont identiques, la pression acoustique est mieux répartie qu'un assemblage linéaire pas homogène.

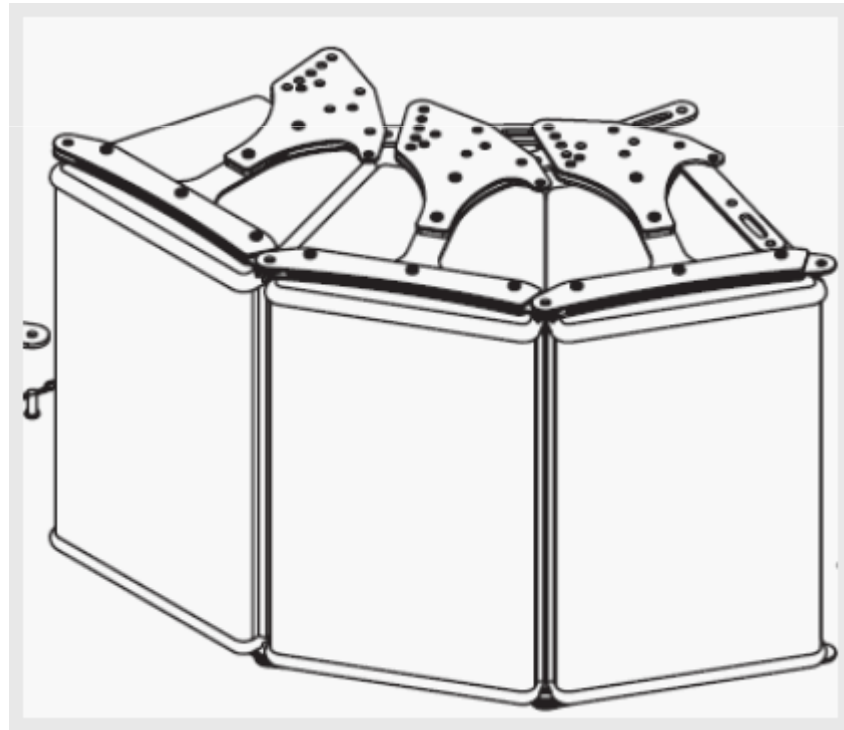
Le niveau sonore hors de l'axe reste très faible

Si les enceintes sont toutes anglés au maximum, l'assemblage génère un front d'onde sphérique et donc, la pression acoustique décroît de 6 dB par doublement de la distance.

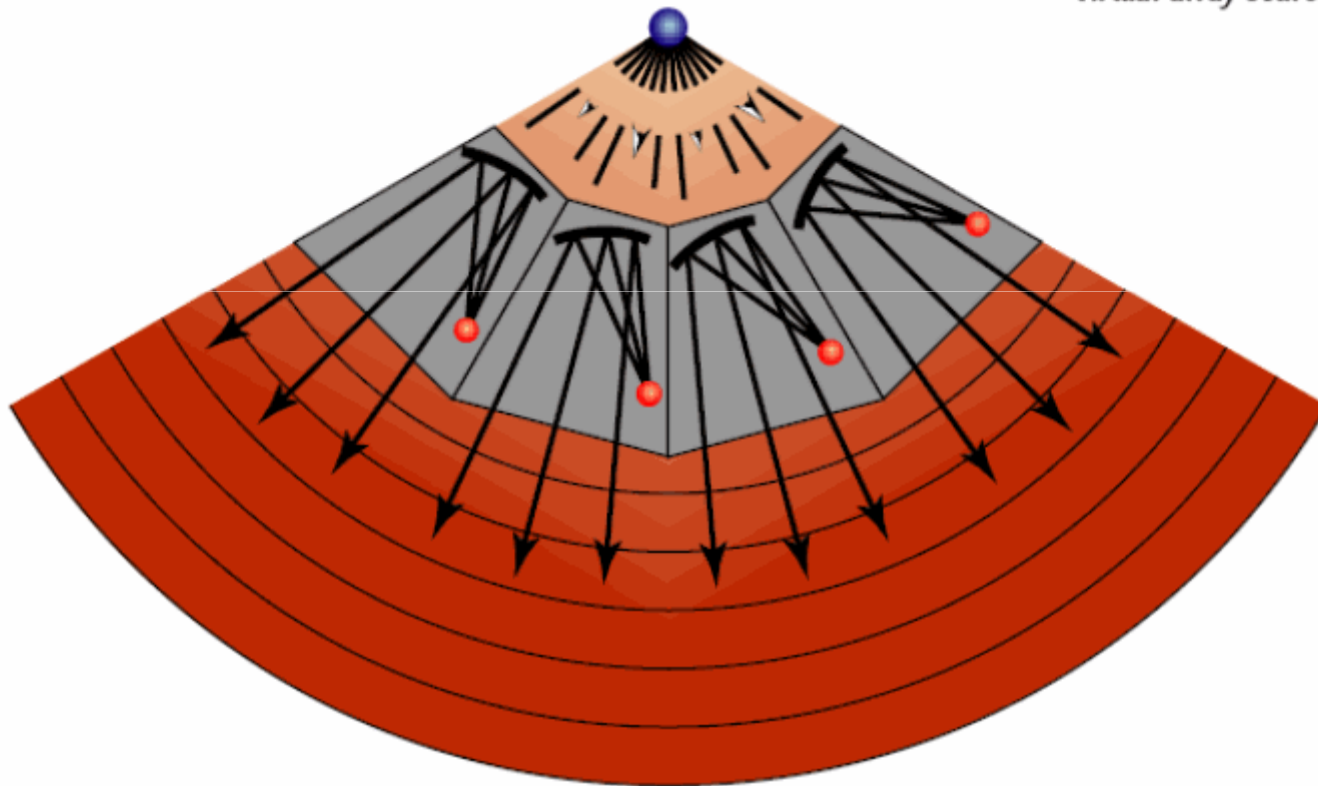


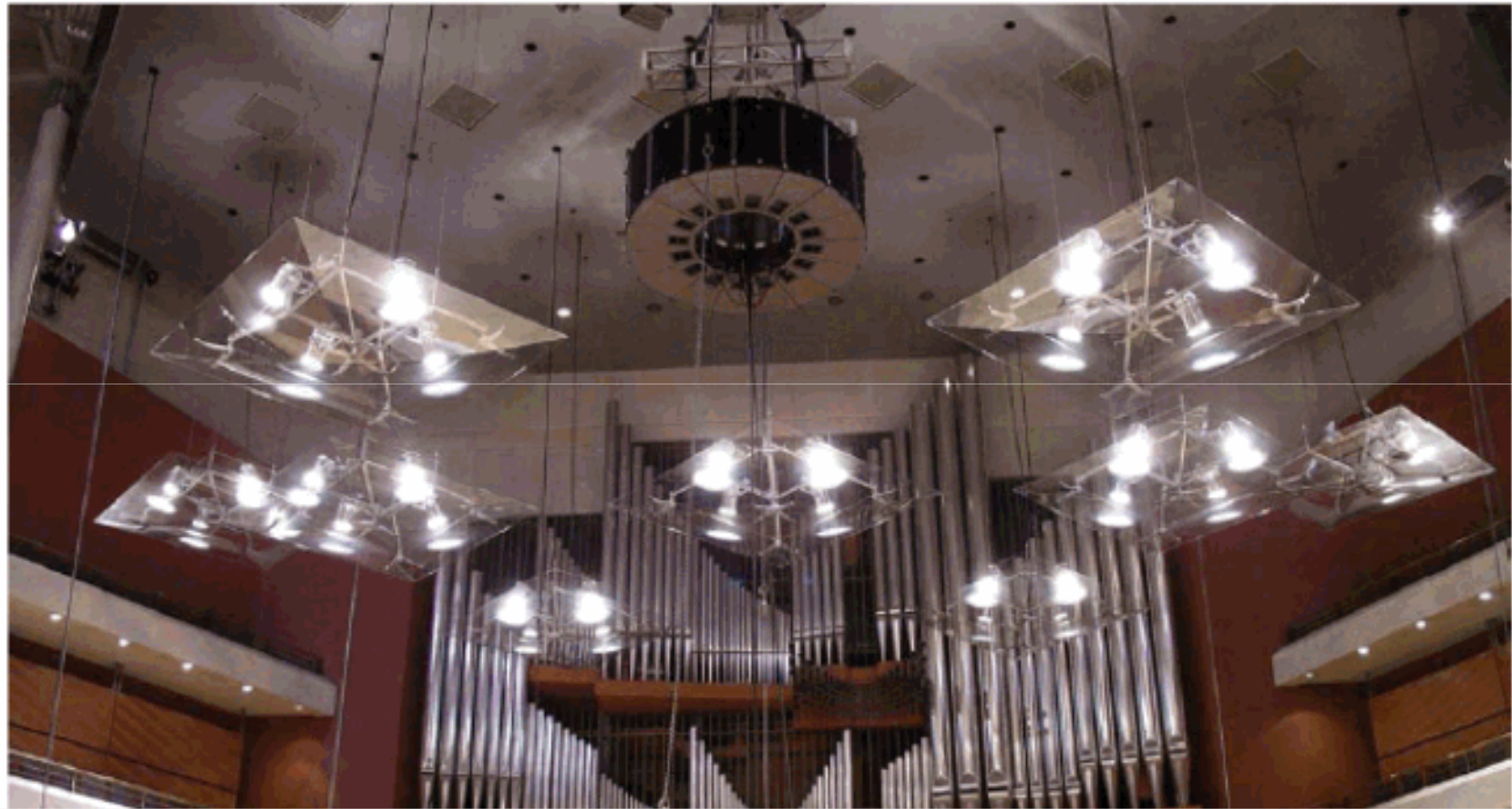


S830 Front view with grill



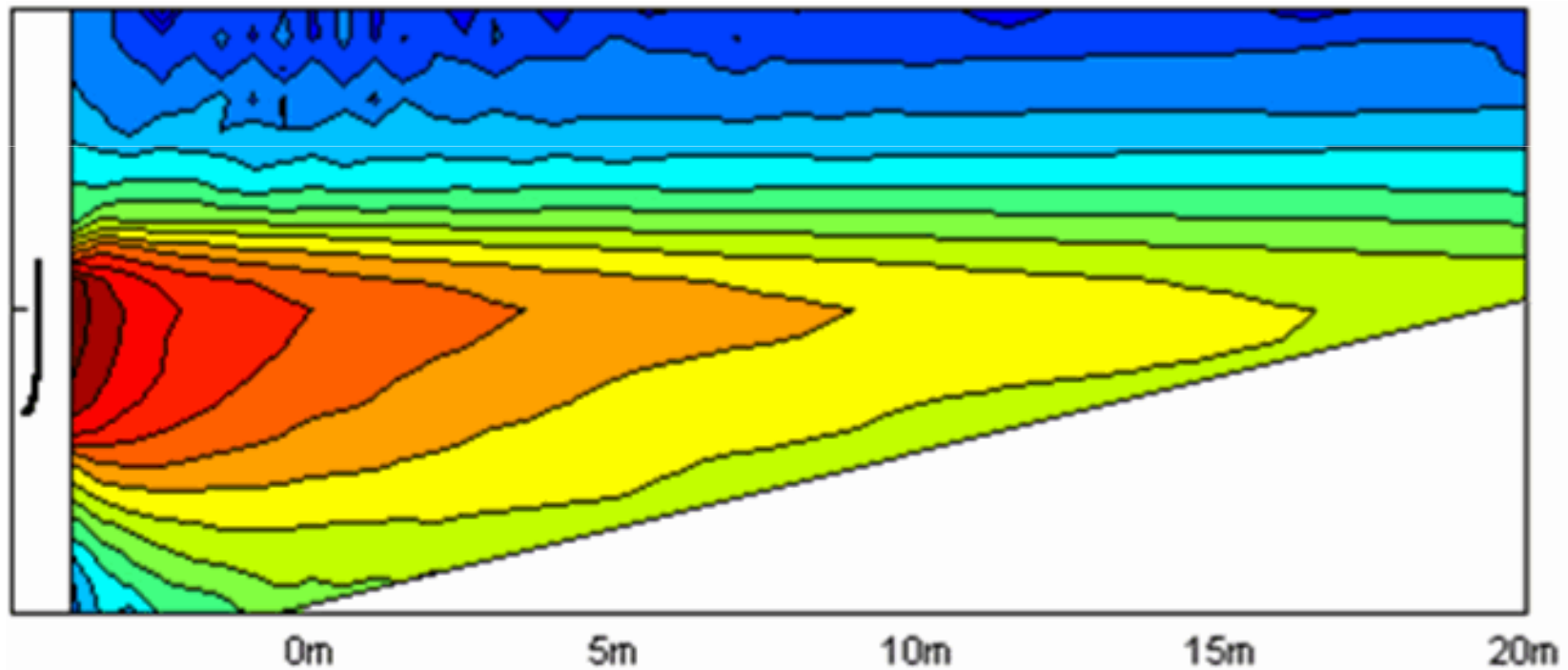
*Fig 2: Coherency through
GEO Wave Propogration.
Tangent wavefronts
radiate from common
virtual array source.*



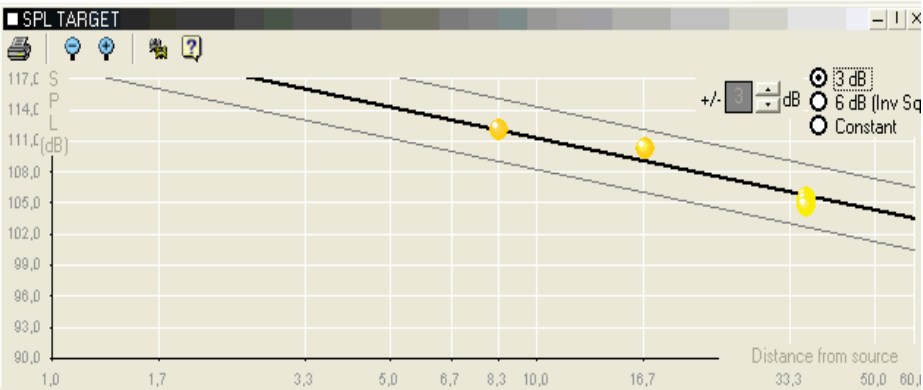
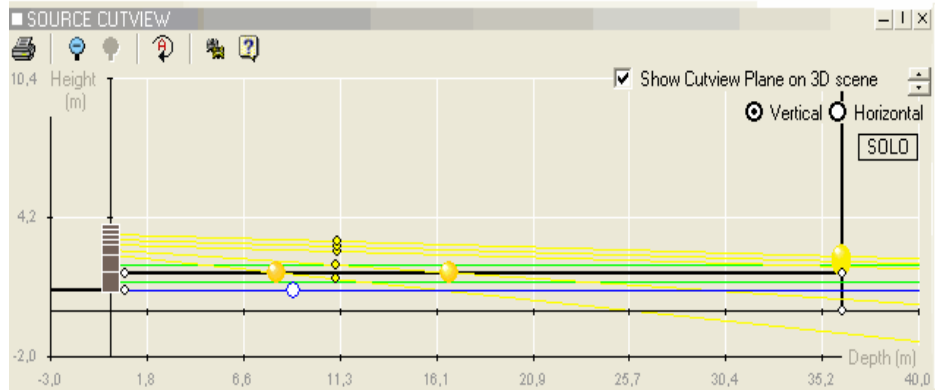
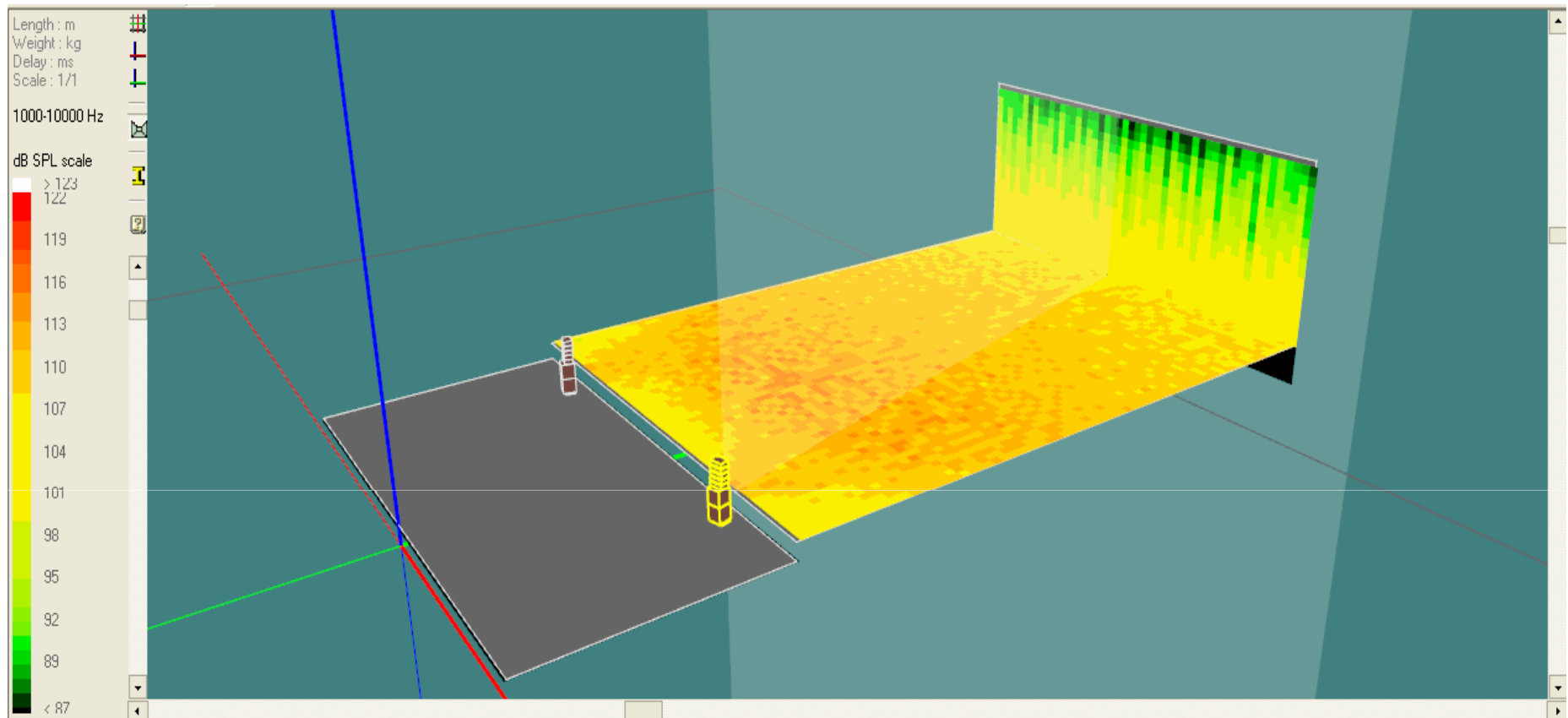


Assemblage à courbure variable adaptée à l'audience

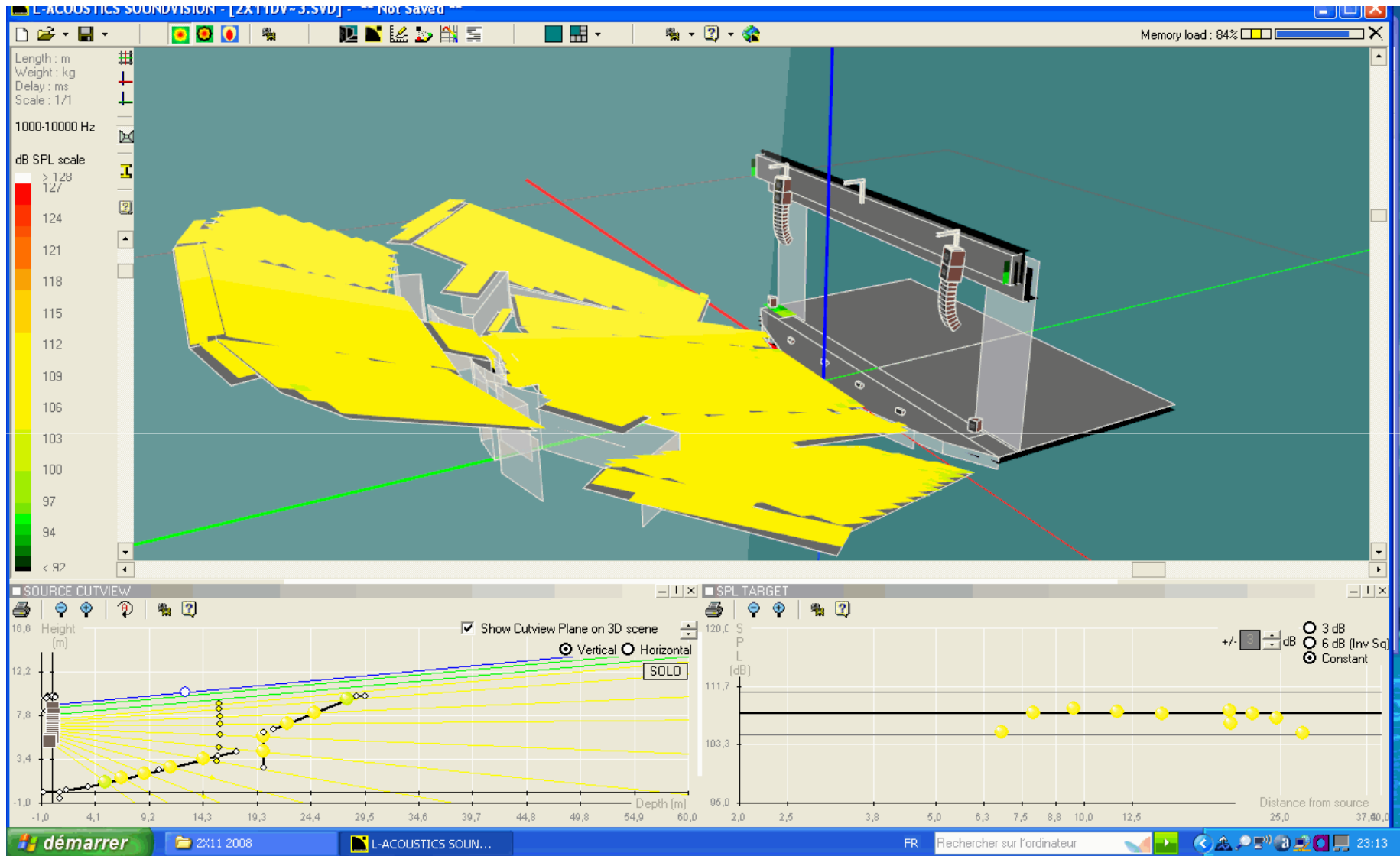
C'est dans cette configuration qu'un système line source prend toute sa valeur, puisqu'il permet d'obtenir une répartition homogène de la pression acoustique sur la totalité de l'audience.



Systeme stacké

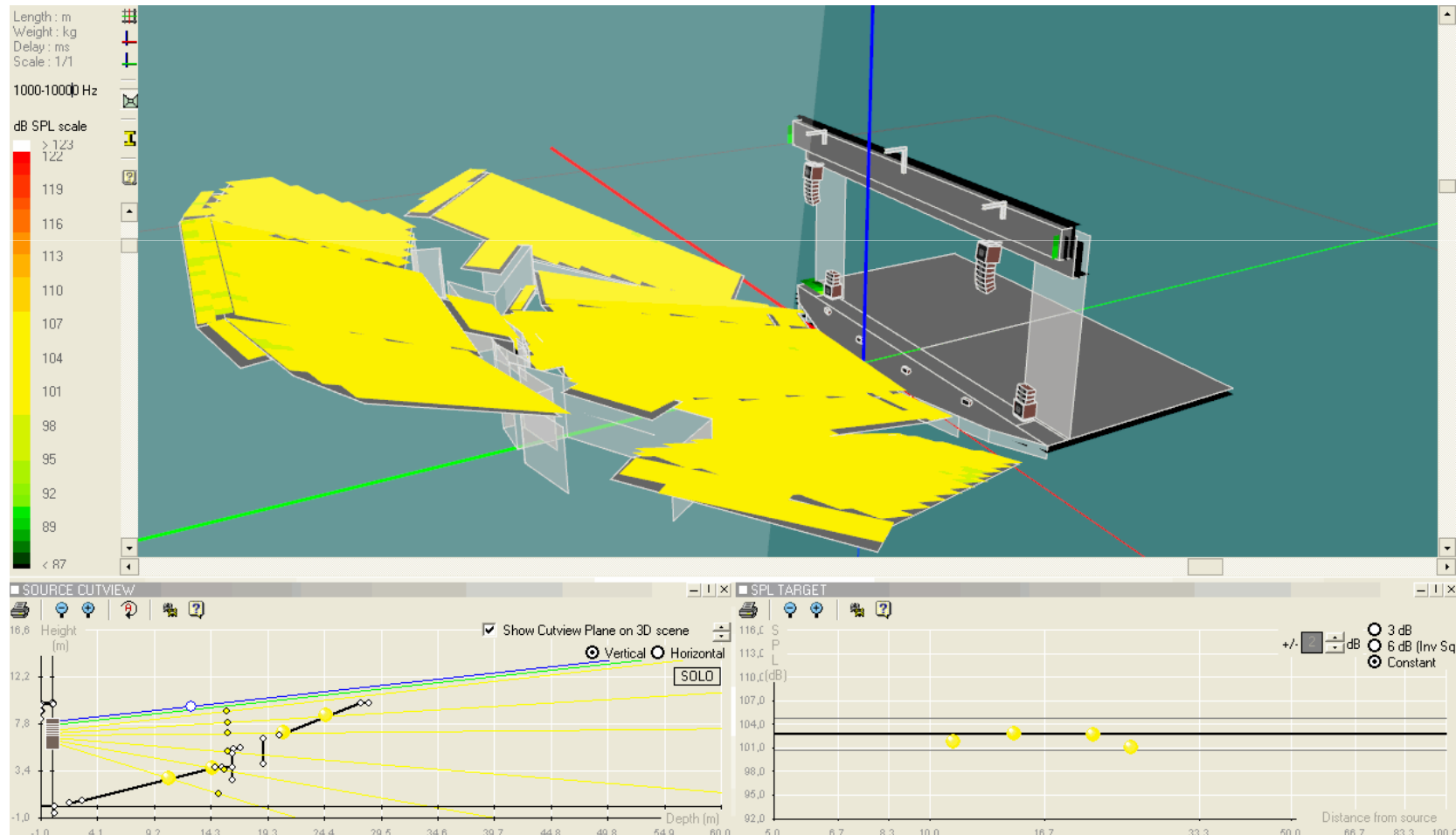


Systeme accroché

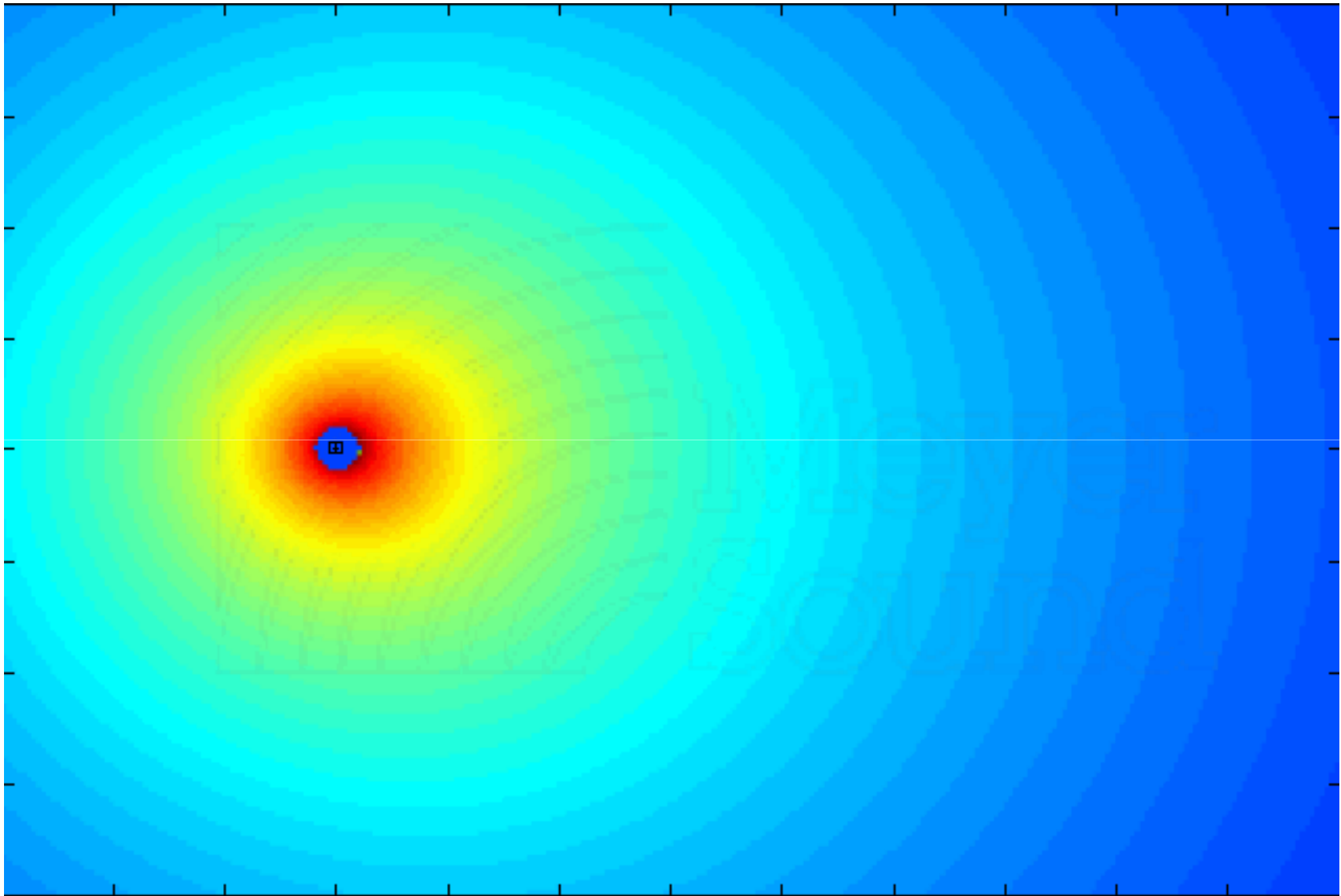


Systeme hybride (un systeme stacke + un systeme accroche)

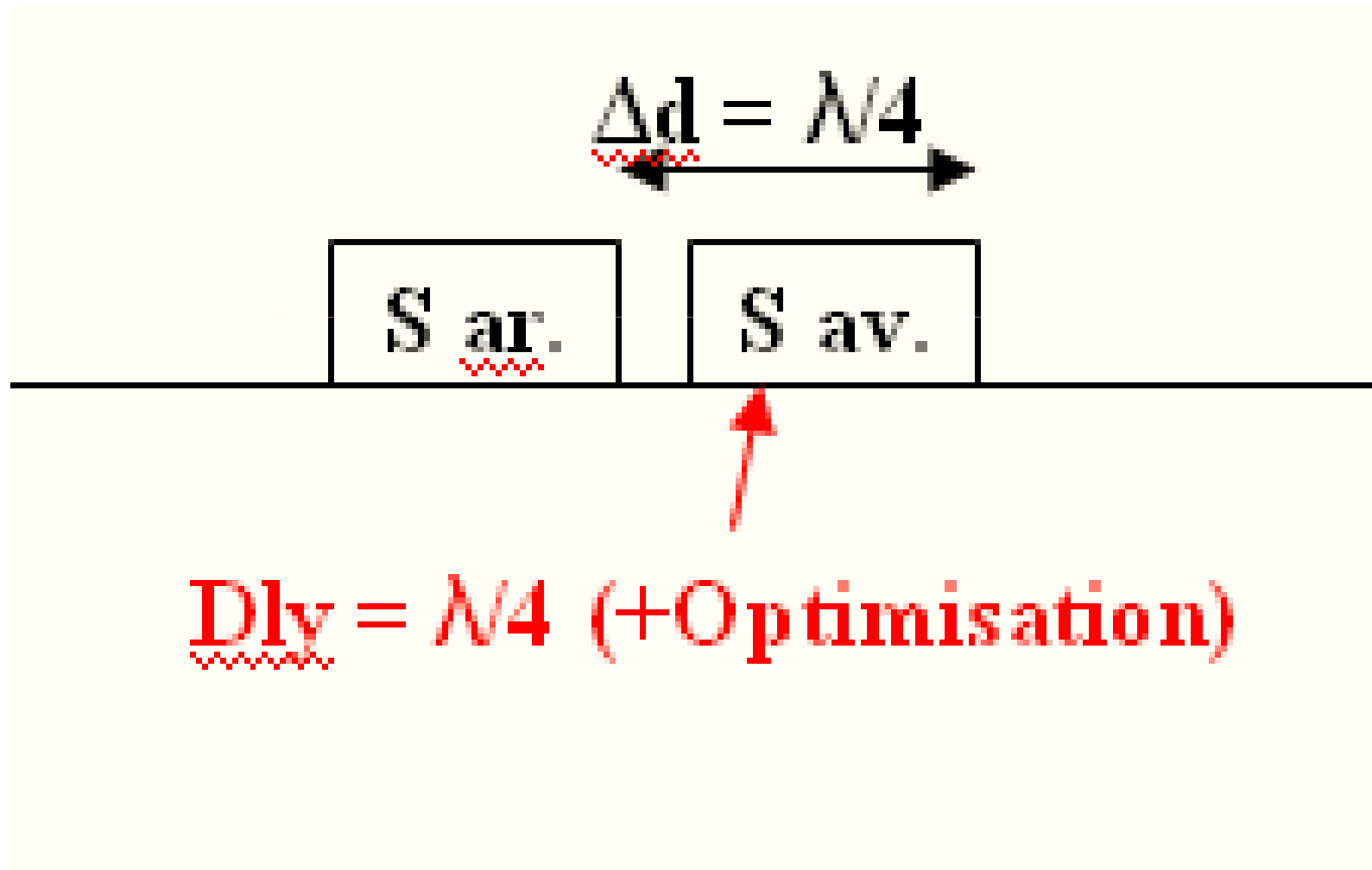
Cela peut être une bonne solution pour un théâtre à l'italienne par exemple. Le systeme au sol pour le parterre et le systeme accroché pour les balcons en évitant les surfaces (souvent réfléchissantes) où il n'y a pas d'auditeurs.



Sub



Arrangement Cardioïde



Pour un cardio à 80Hz

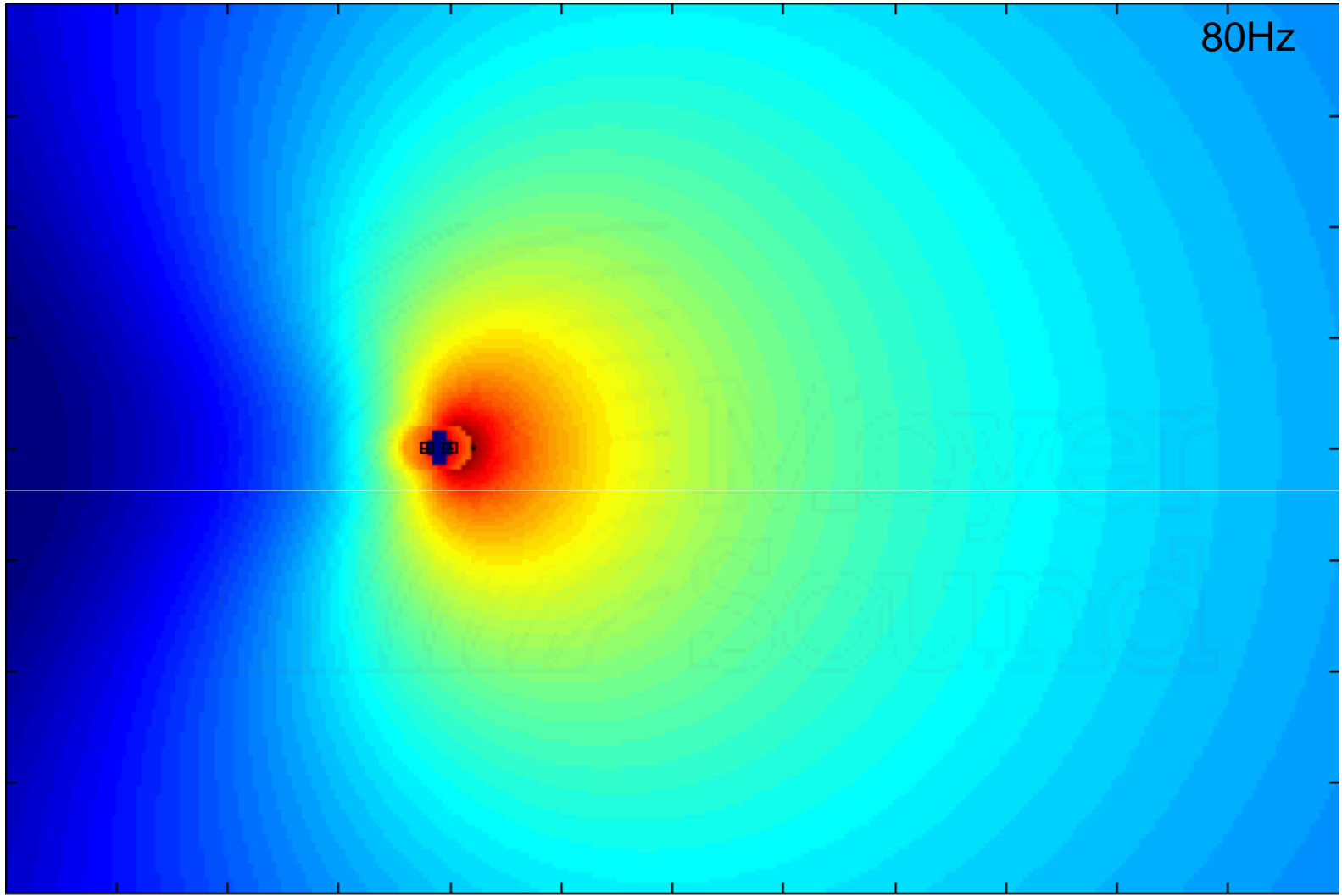
$$\lambda = C/F$$

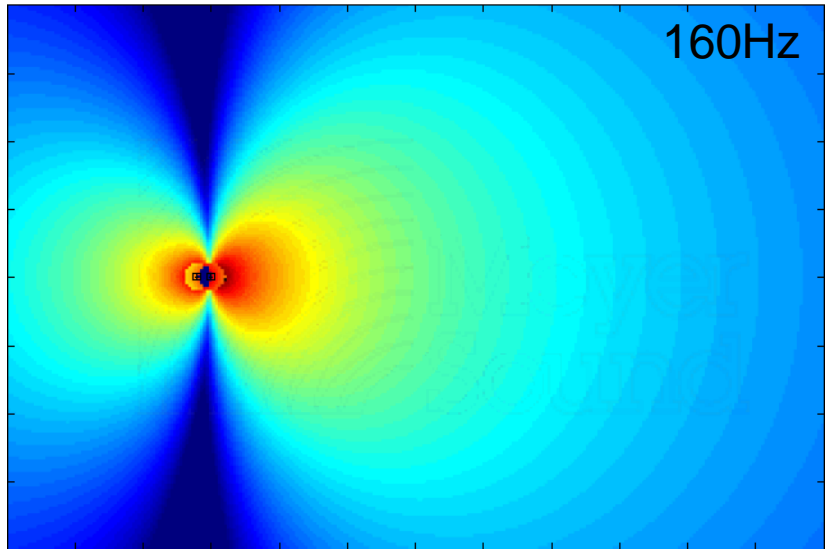
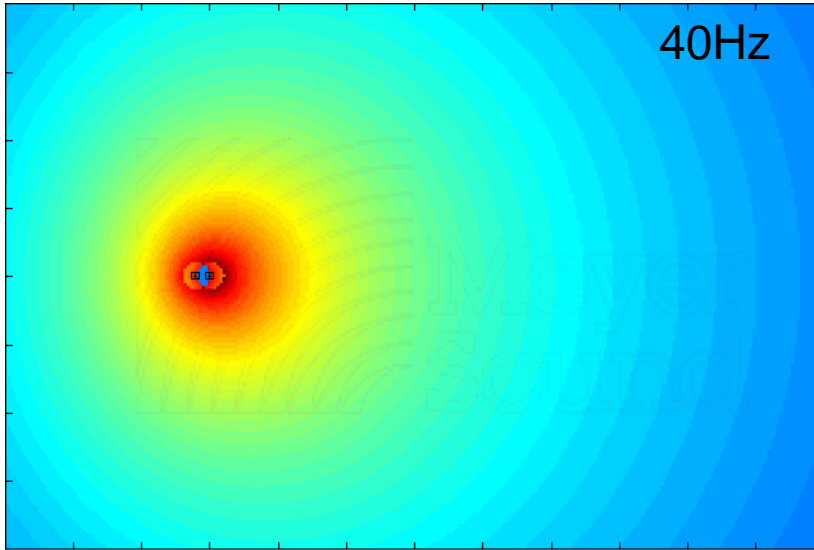
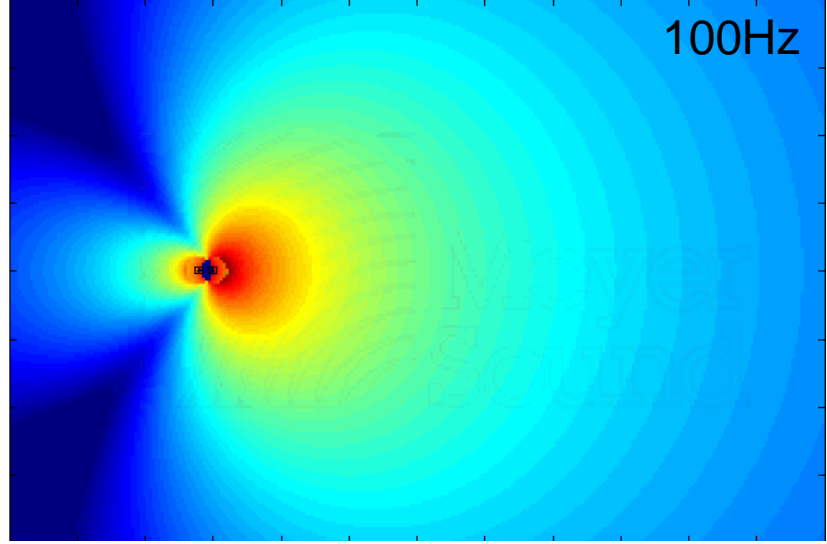
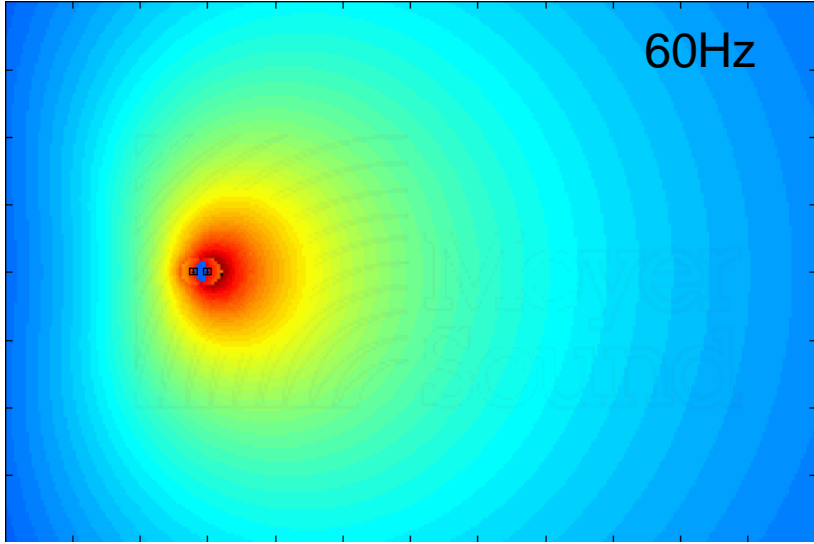

$$343/80 = 4.28 \text{ m}$$

$$\lambda/4 = 1.07 \text{ m}$$

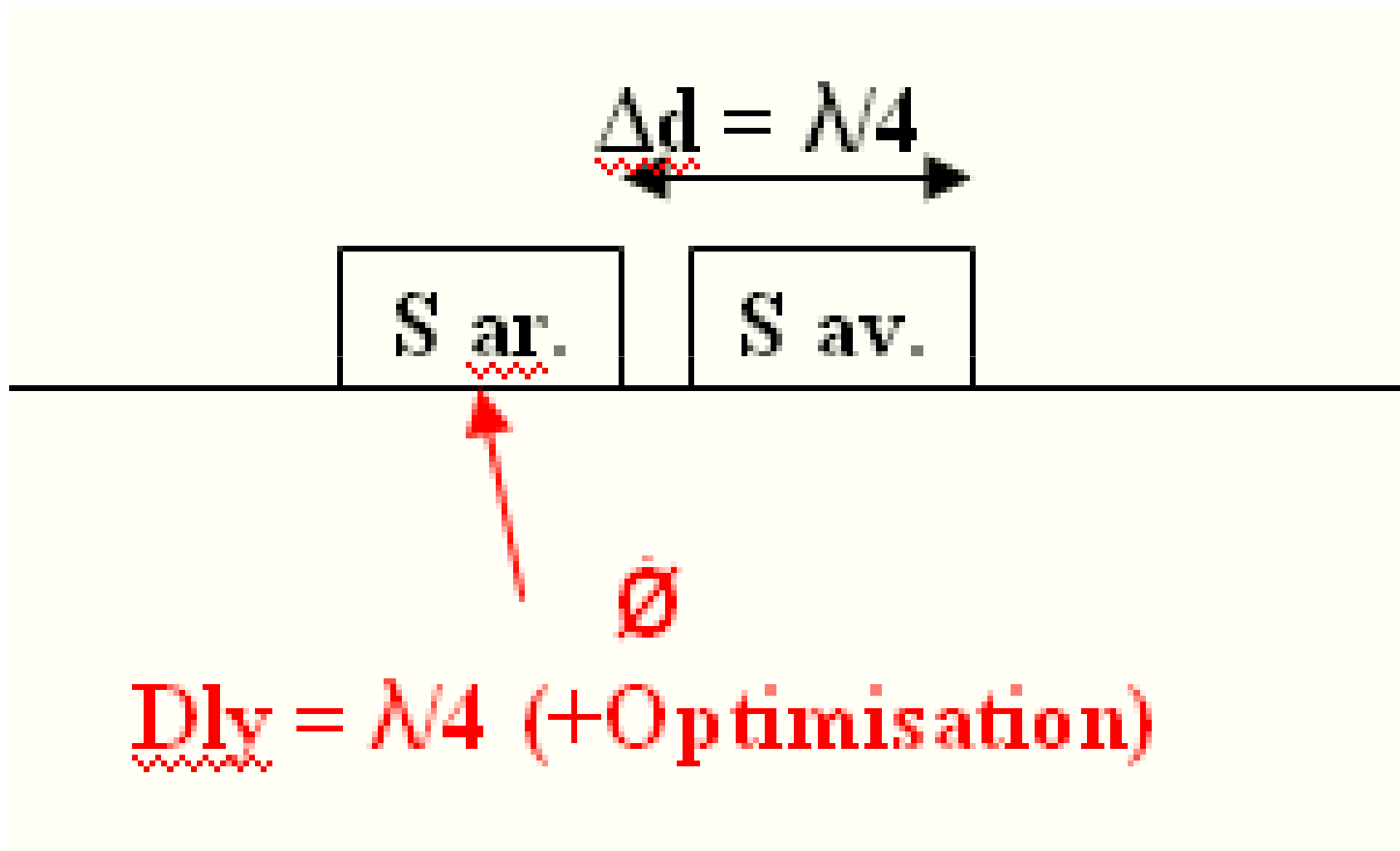
$$\text{Delay} = (\lambda/4)/343$$

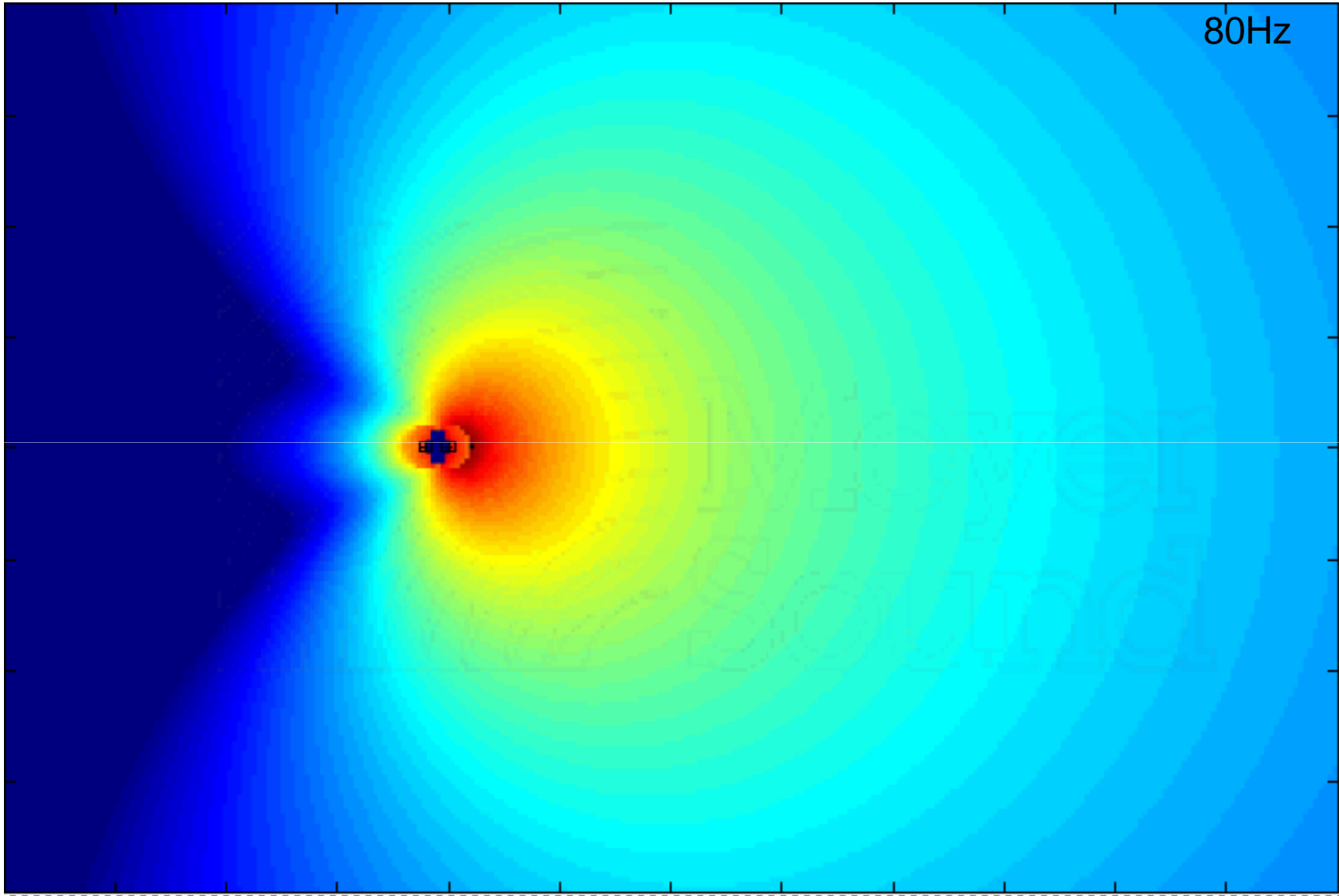
$$1.07/343 = 3.12 \text{ ms}$$

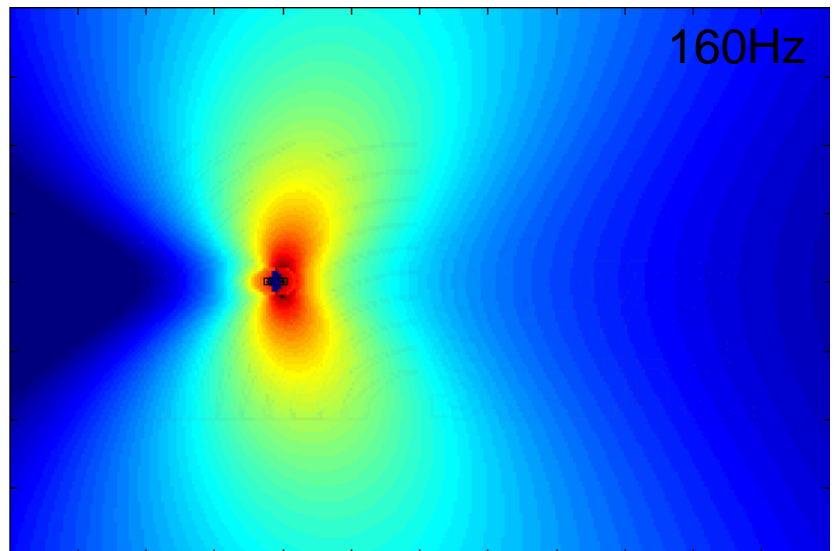
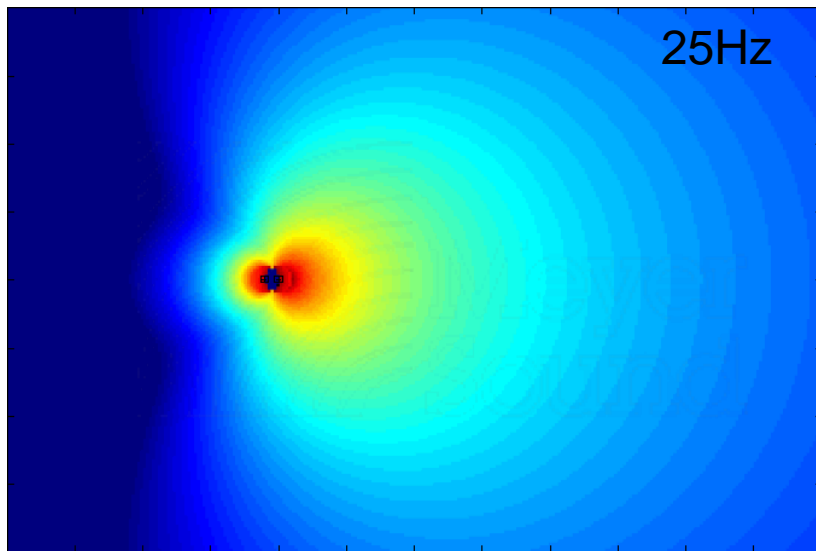
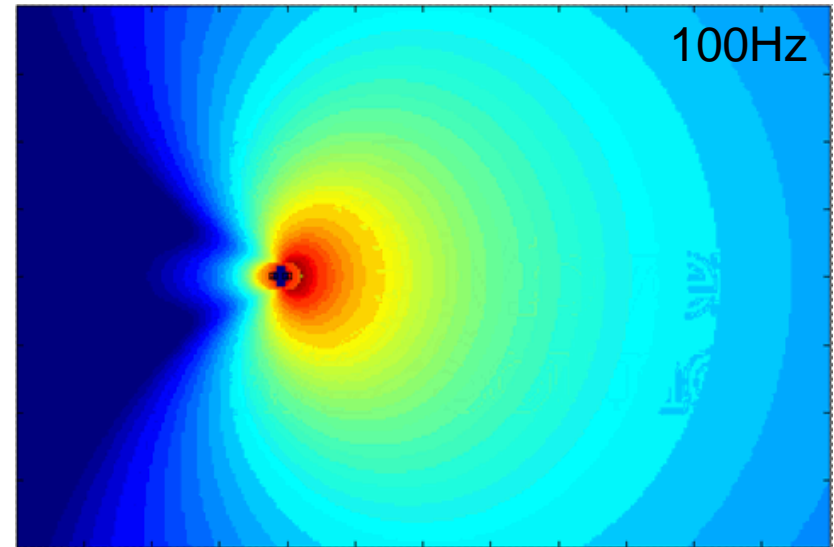
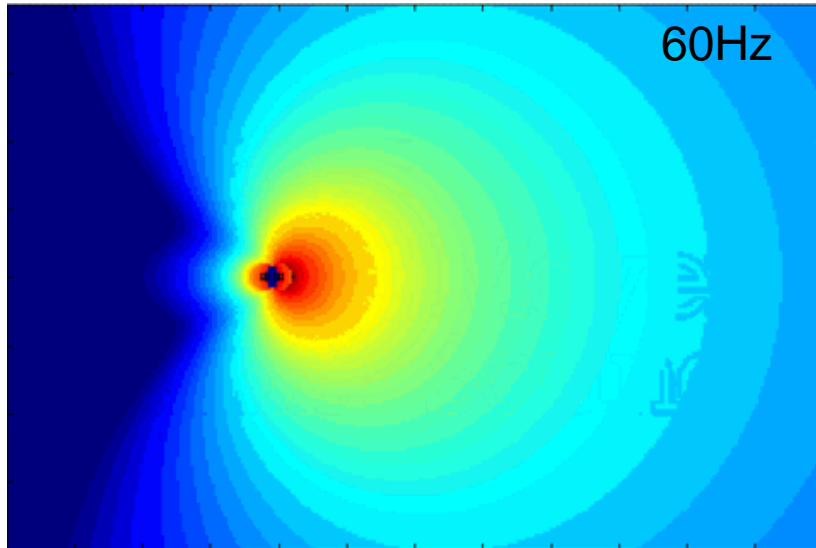




Arrangement cardioïde optimisant la rejection arrière



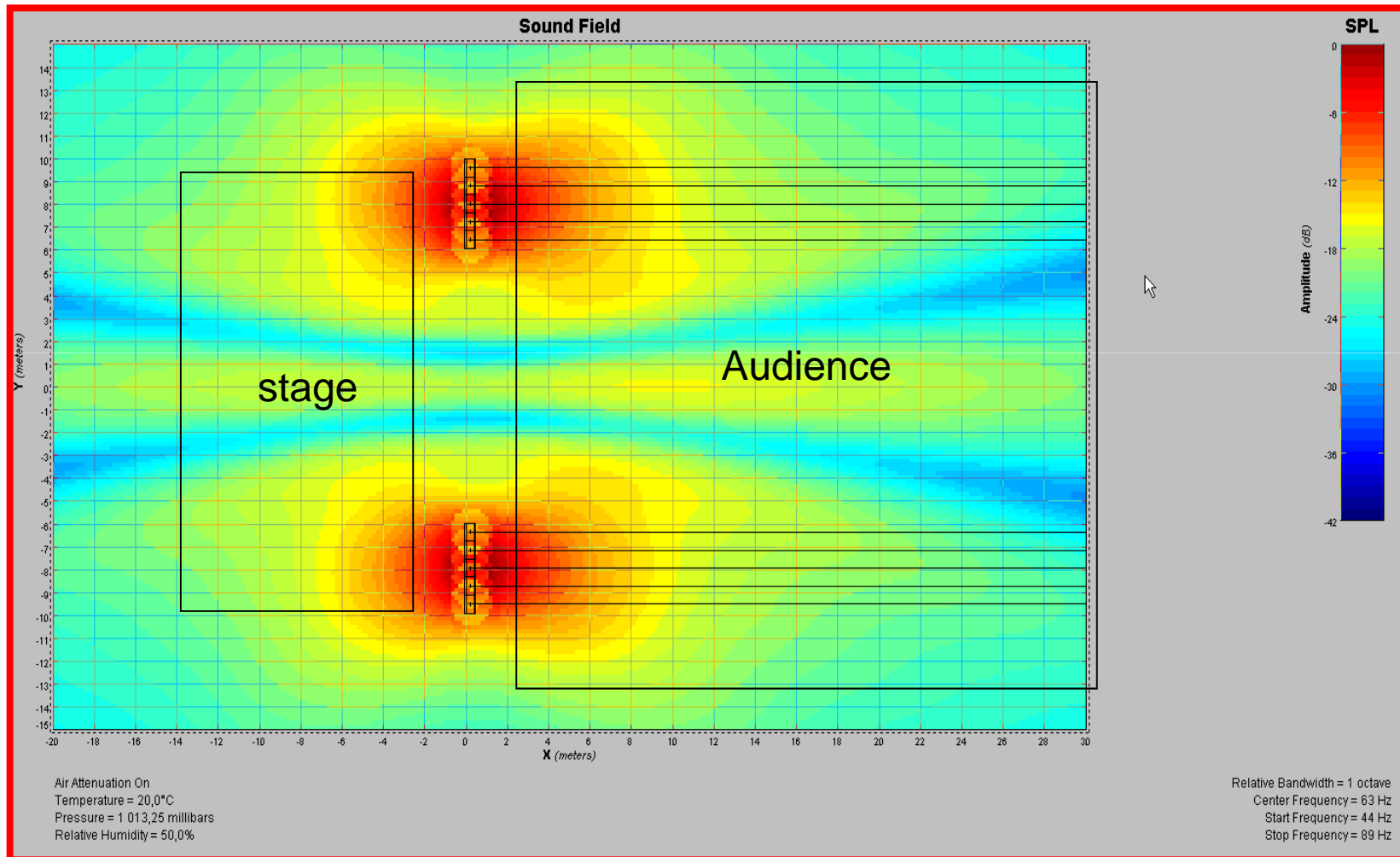




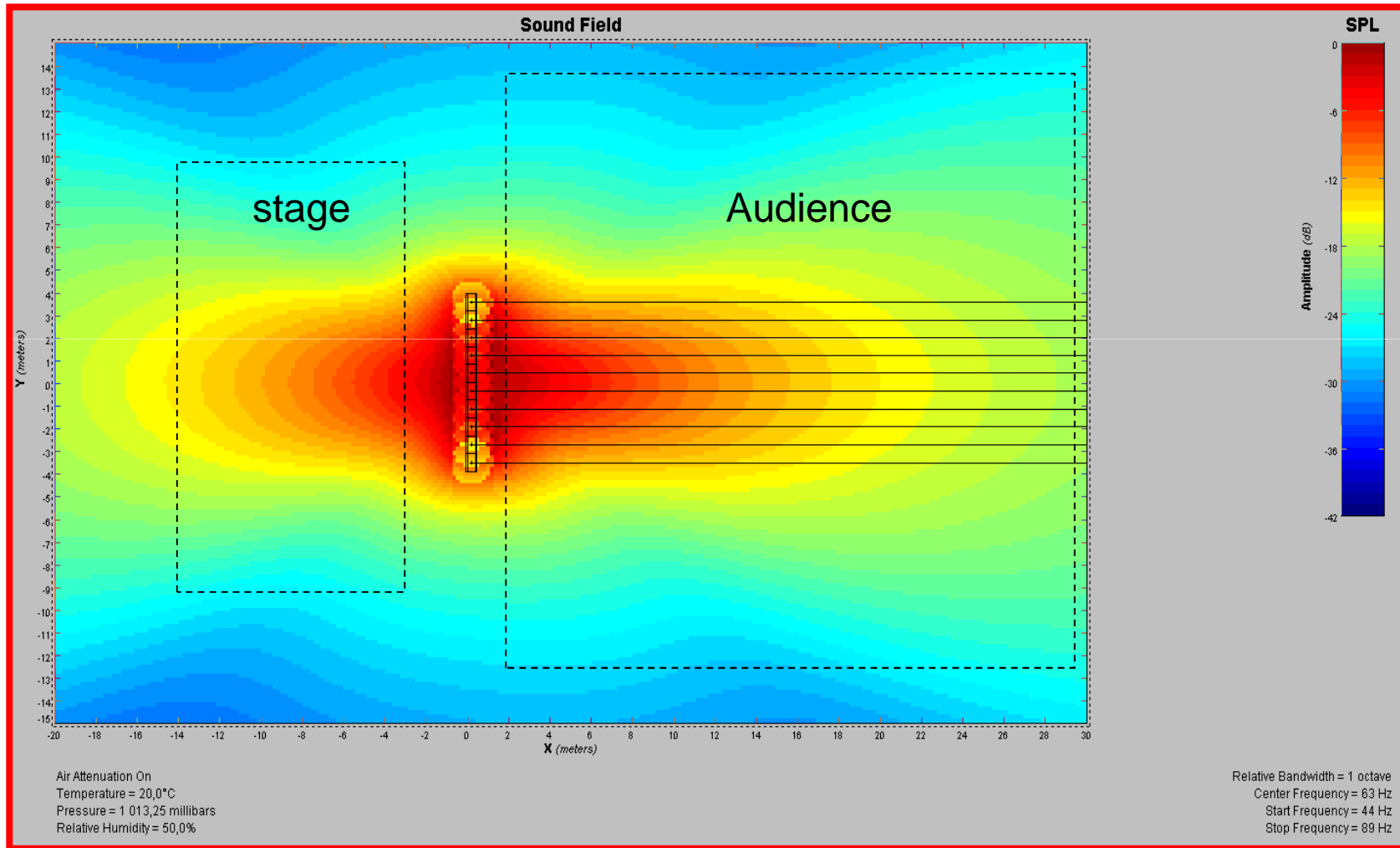
Sub sub sub...

PMarguerie

Sub jardin – cour



1 seule ligne de subs, couplage serré

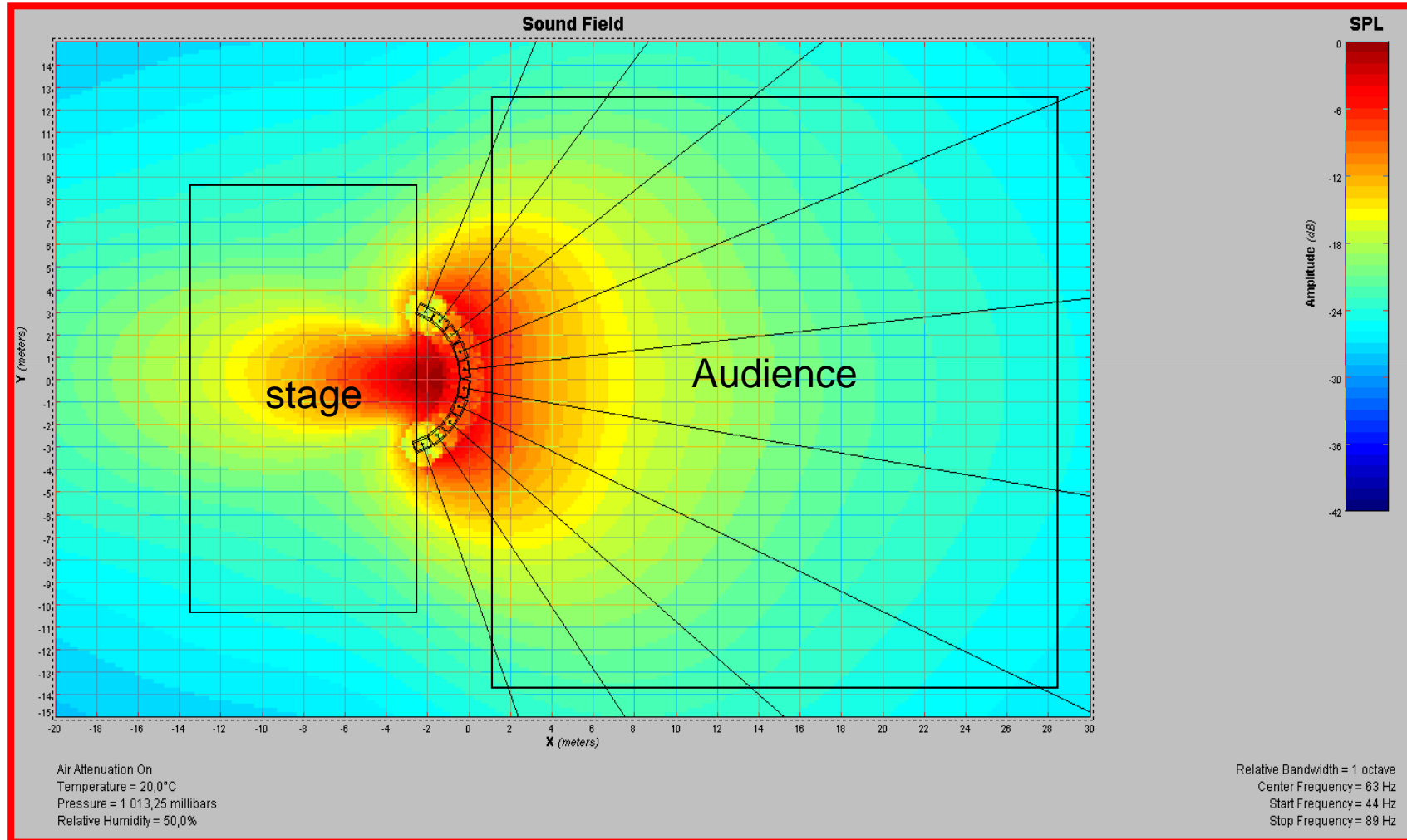


Arc réel de 10 subs

10 sub angles de 15°

Largeur de l'arc: 6,7m

Profondeur de l'arc: 2,8m!



ARRAY 2004

ELECTRONIC ARC CALCULATION FOR	8,00 m RADIUS (90 degree coverage)
EXPECTED COVERAGE:	84 °
BACKLINE OFFSET DELAY	0,00 m (for time aligning T1 to backline)
STACK SEPARATION	0,00 m metres

		ARRAY COORDINATES				
ARRAY LOCATION	DELAY TAP	X-AXIS Range Distance (m)	Y-AXIS Off Center Distance (m)	X-AXIS DELAY (msec)	ARC DELAY (msec)	TOTAL DELAY (msec)
centre	T1	0,00	0,00	0,0	0,00	0,00
	T2	0,00	1,72	0,0	0,53	0,53
	T3	0,00	2,87	0,0	1,46	1,46
	T4	0,00	4,02	0,0	2,78	2,78
outside	T5	0,00	5,17	0,0	4,45	4,45
	T6	0,00	7,15	0,0	7,96	7,96

SB218 DIMENSIONS				
W	130	cm	35,5	in
H	55	cm	35,5	in
D	70	cm	32	in

METRIC CONVERSION			
60,00	feet	18,29	metres

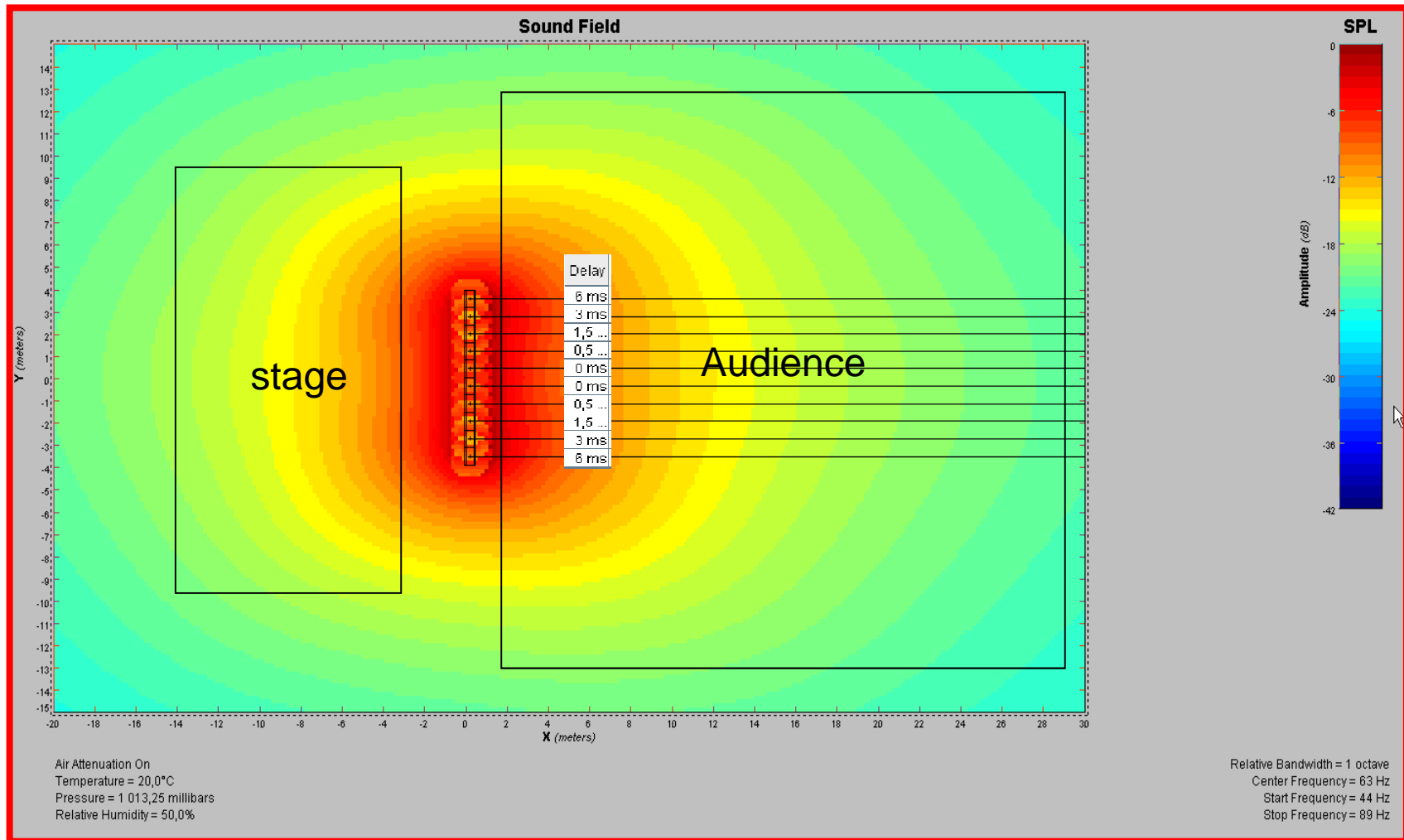
TOTAL DELAY = BACKLINE OFFSET + X-AXIS ALIGNMENT + ARC DELAYS



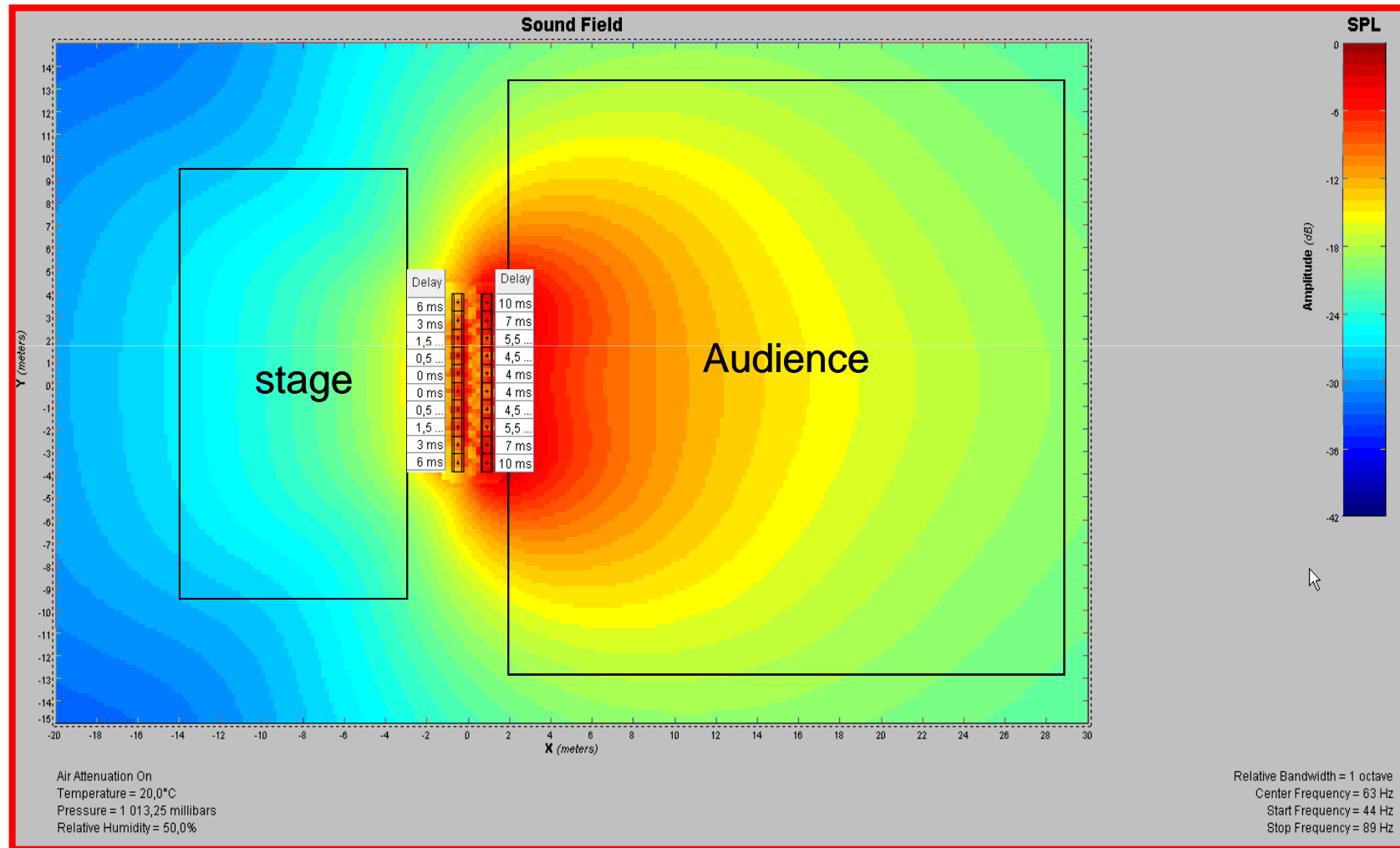
Arc sub v

10 subs en ligne, couplage jointif

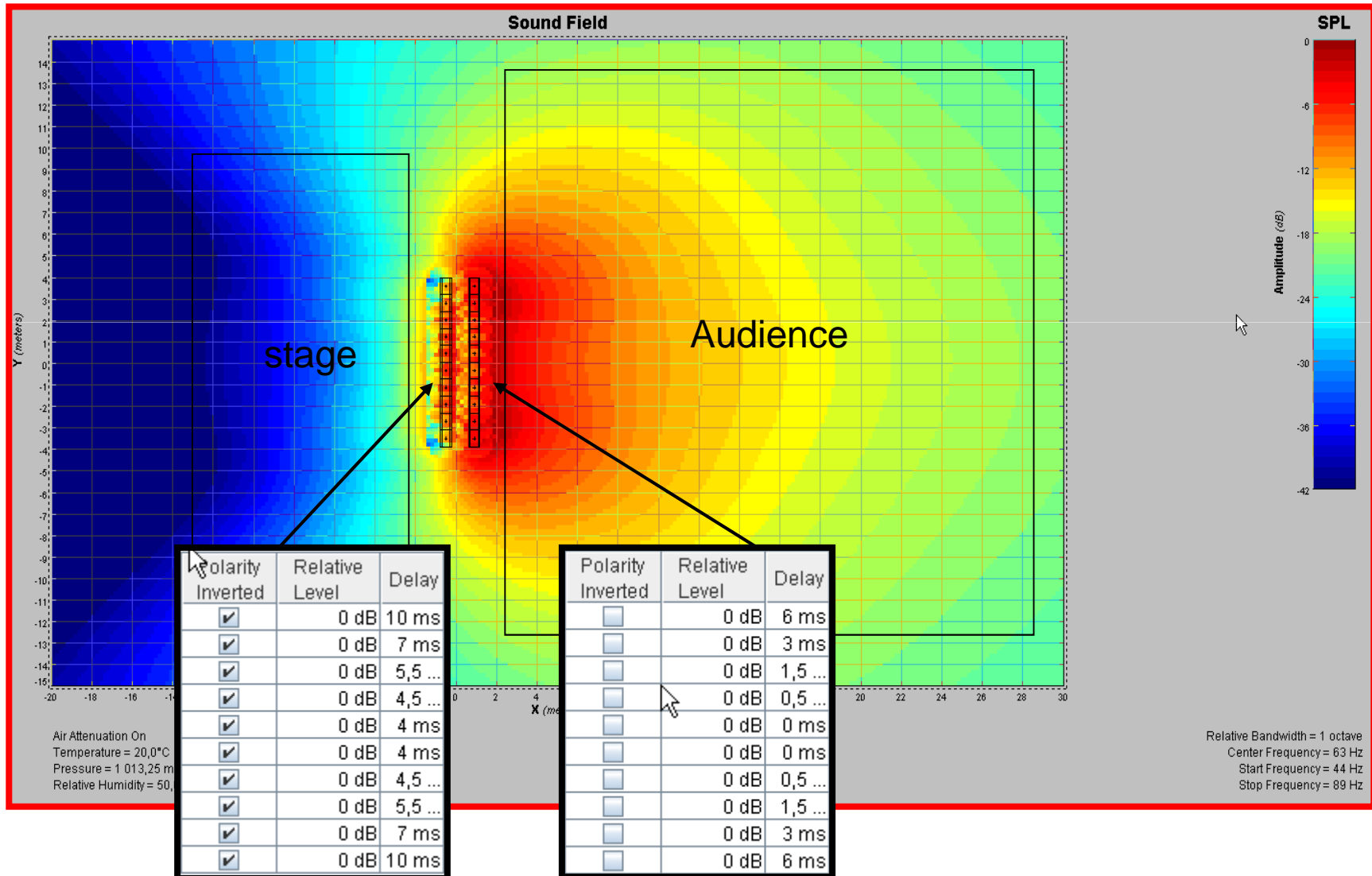
Longueur : 8m



Arrangement directif optimisé pour l'audience



Arrangement directif optimisé pour la réjection sur scène



Et en salle ça ressemble à quoi?

