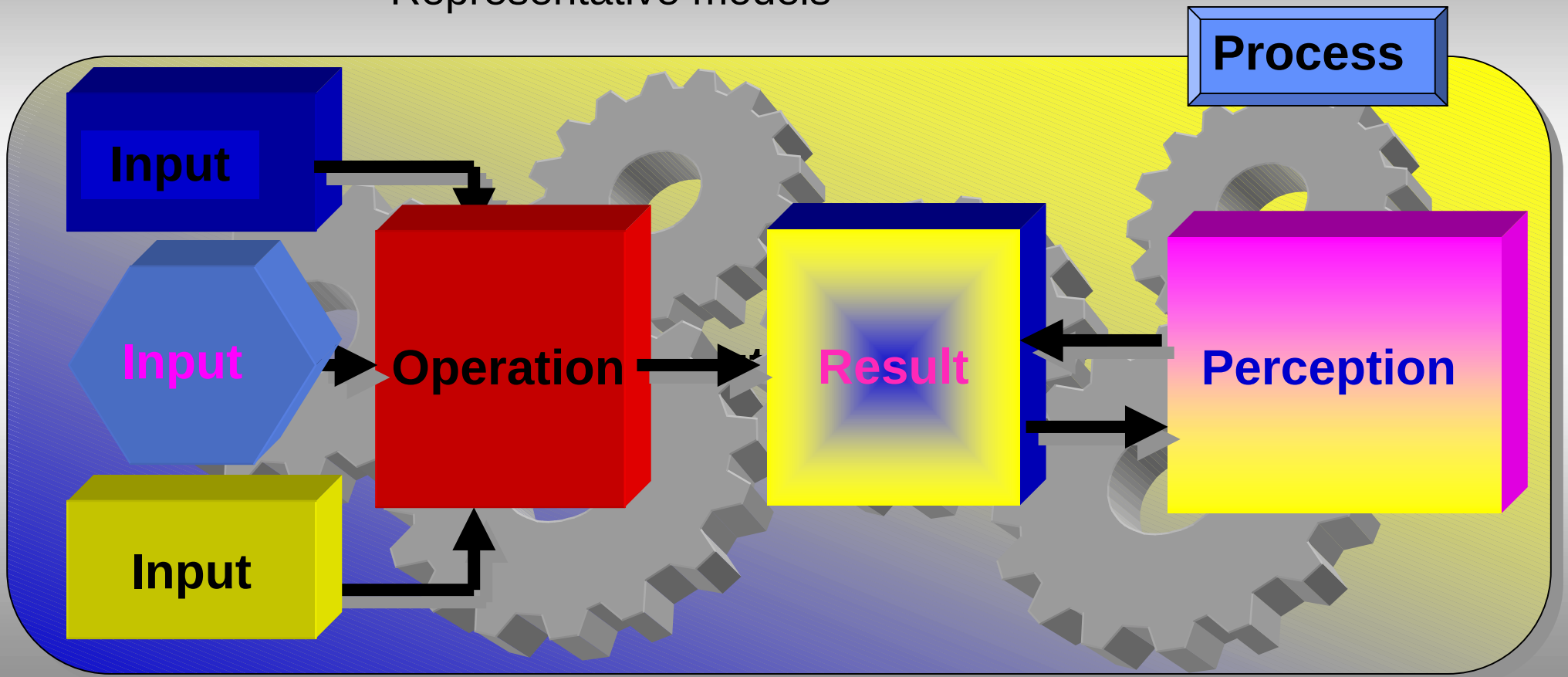
Fundamentals of Electroacoustics

Is it really possible to calculate acoustics ?
How does the acoustics of a room affect the sound of the loudspeakers ?

Speaker: Volker Löwer, IFBconsulting

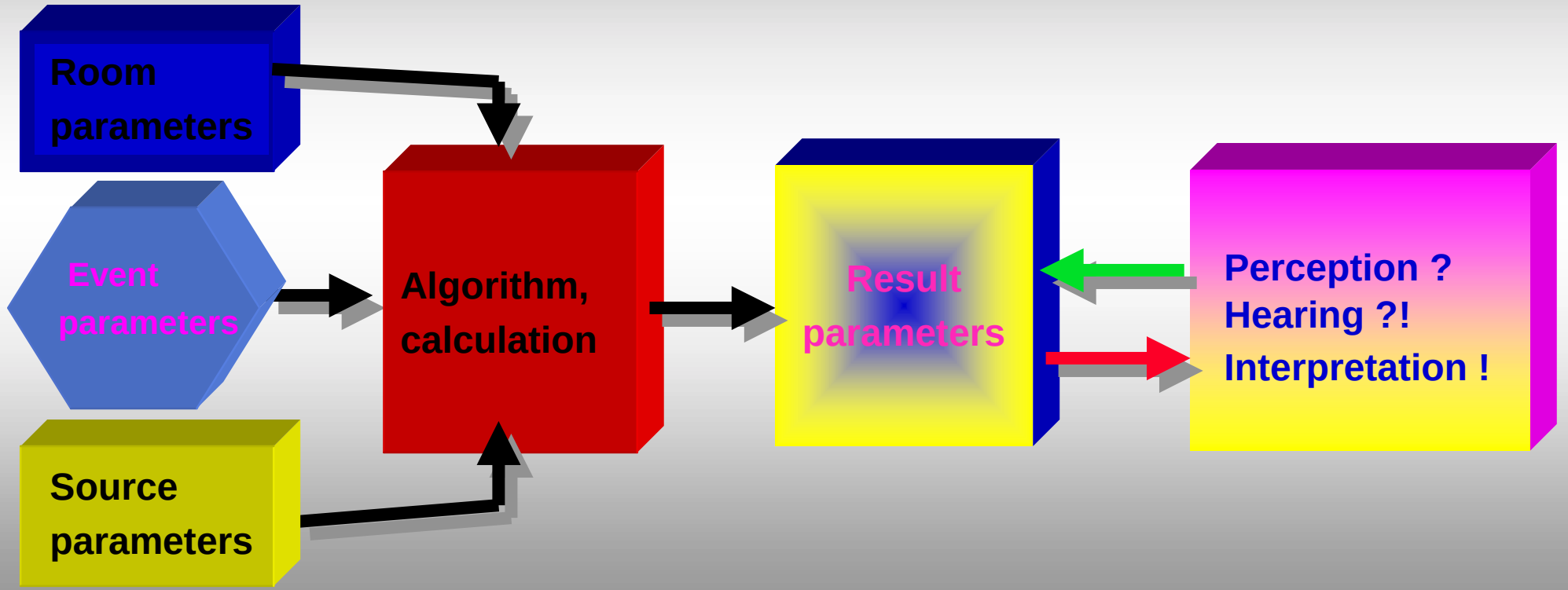
Preliminary remarks

- Processes of nature
- Subjective feeling
- Representative models

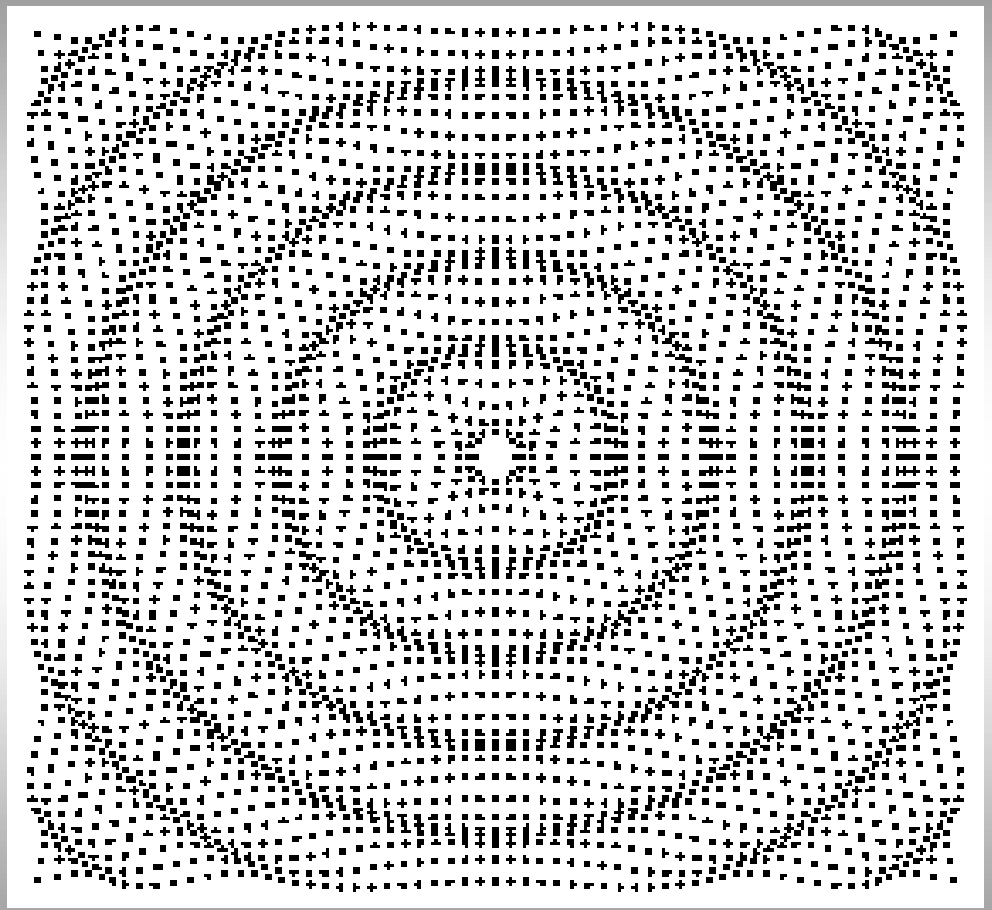


Models, algorithms

- Simplify the processes of the natural world
- Understand and recognise interrelations
- Calculate result parameters

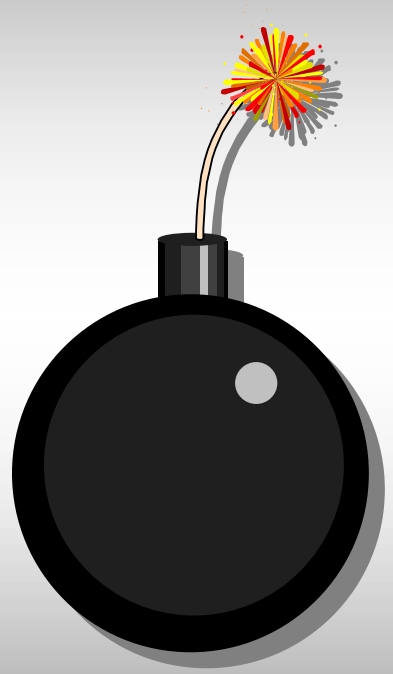


What is sound ?



- Sound pressure, p
- Sound velocity, v
- Sound propagation velocity, c

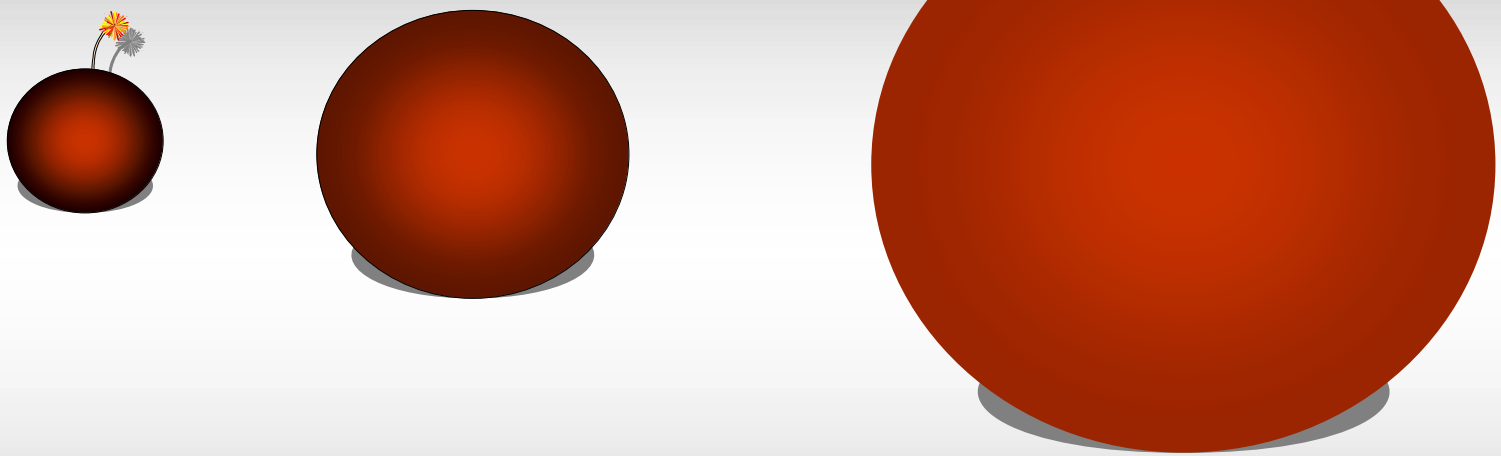
Distance law



Impulse-sound source, omni-directional ...

t = 0 ms

Distance law

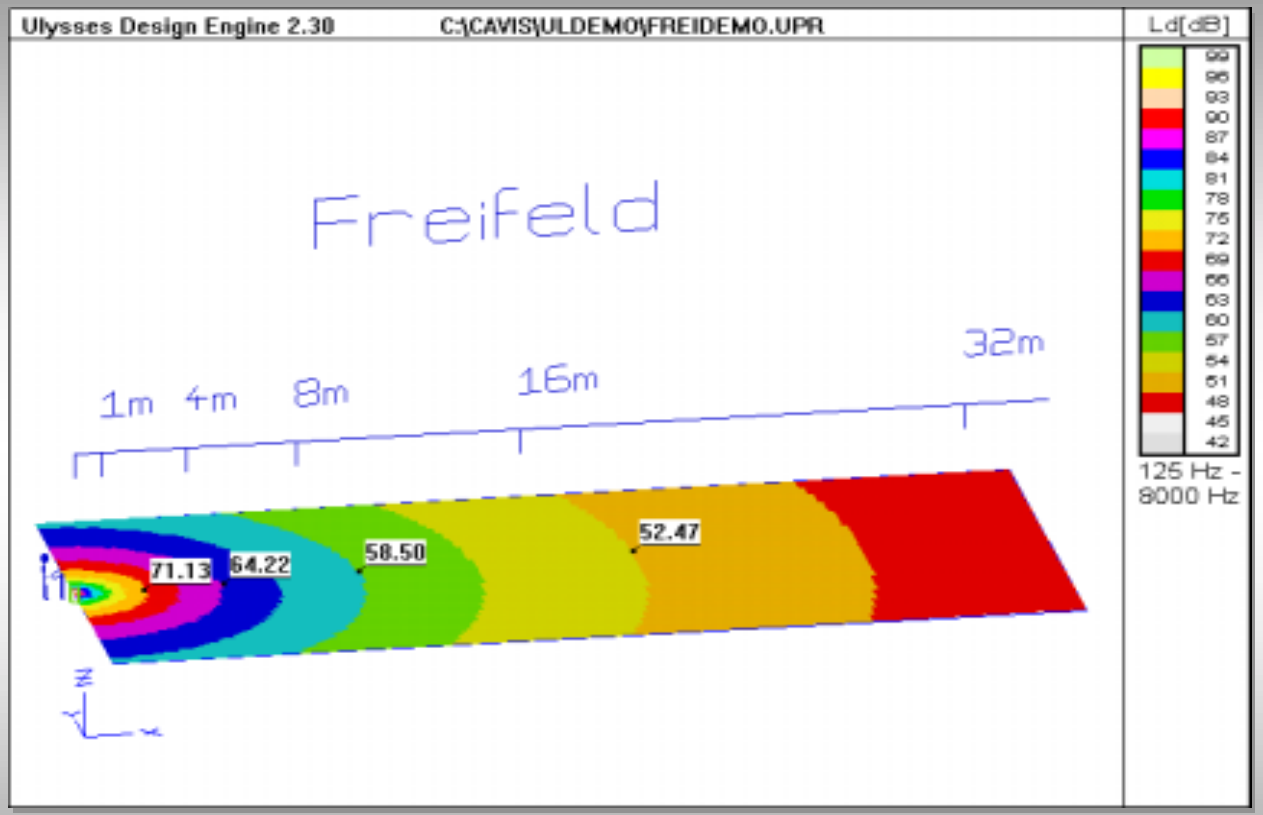


Ld = 0 dB
R = 1m

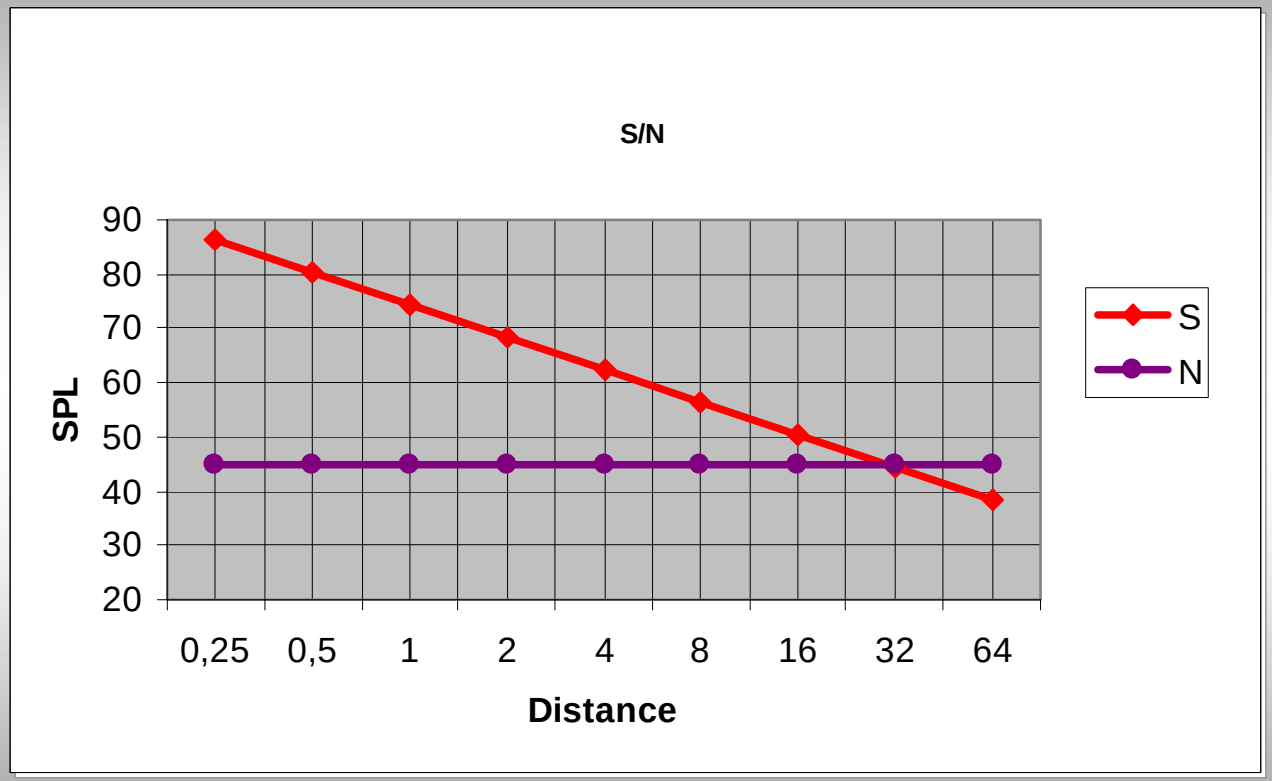
Ld = -6dB
R = 2m

Ld=-12dB
R = 4 m

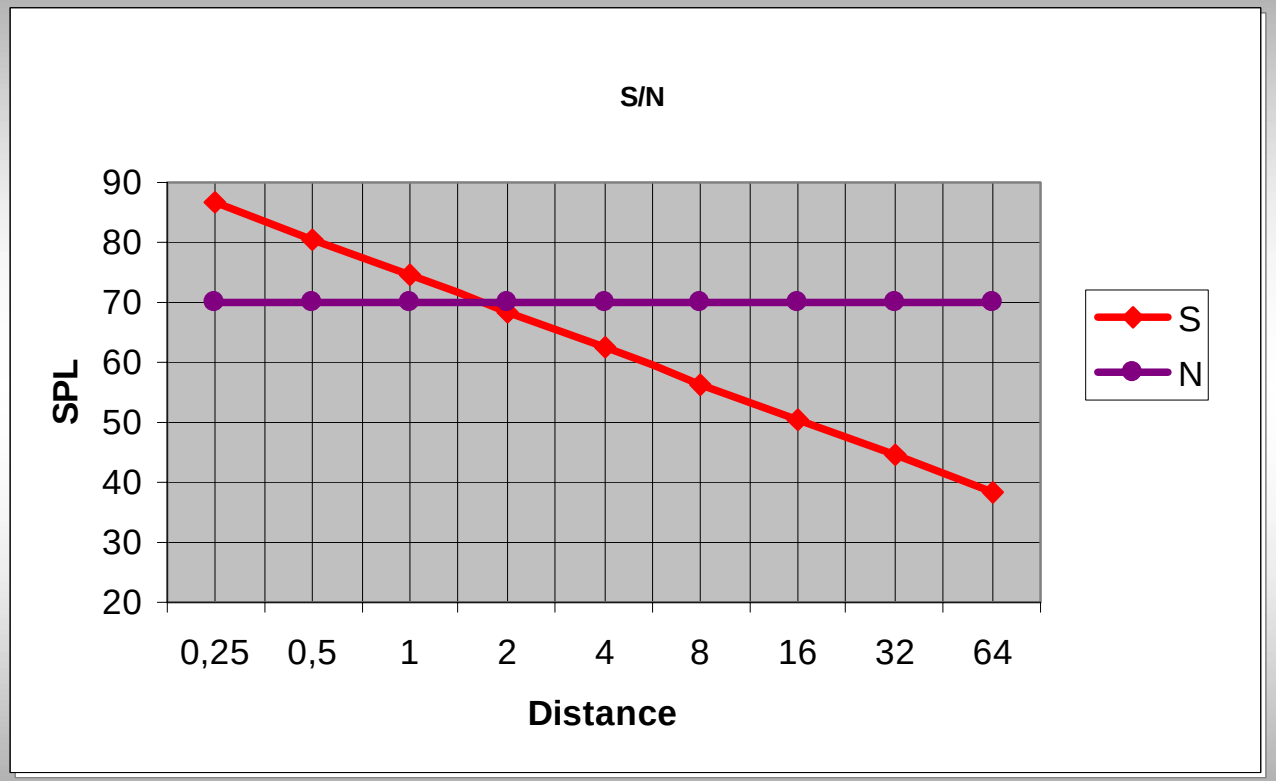
Freefield


Ulysses Design Engine 2.30
C:\CAVIS\ULDEMO\FREIDEMO.UPR
Ld[dB]
99
96
93
90
87
84
81
78
75
72
69
66
63
60
57
54
51
48
45
42
125 Hz - 8000 Hz
Freifeld
1m
4m
8m
16m
32m
71.13
64.22
58.50
52.47

Signal / Noise

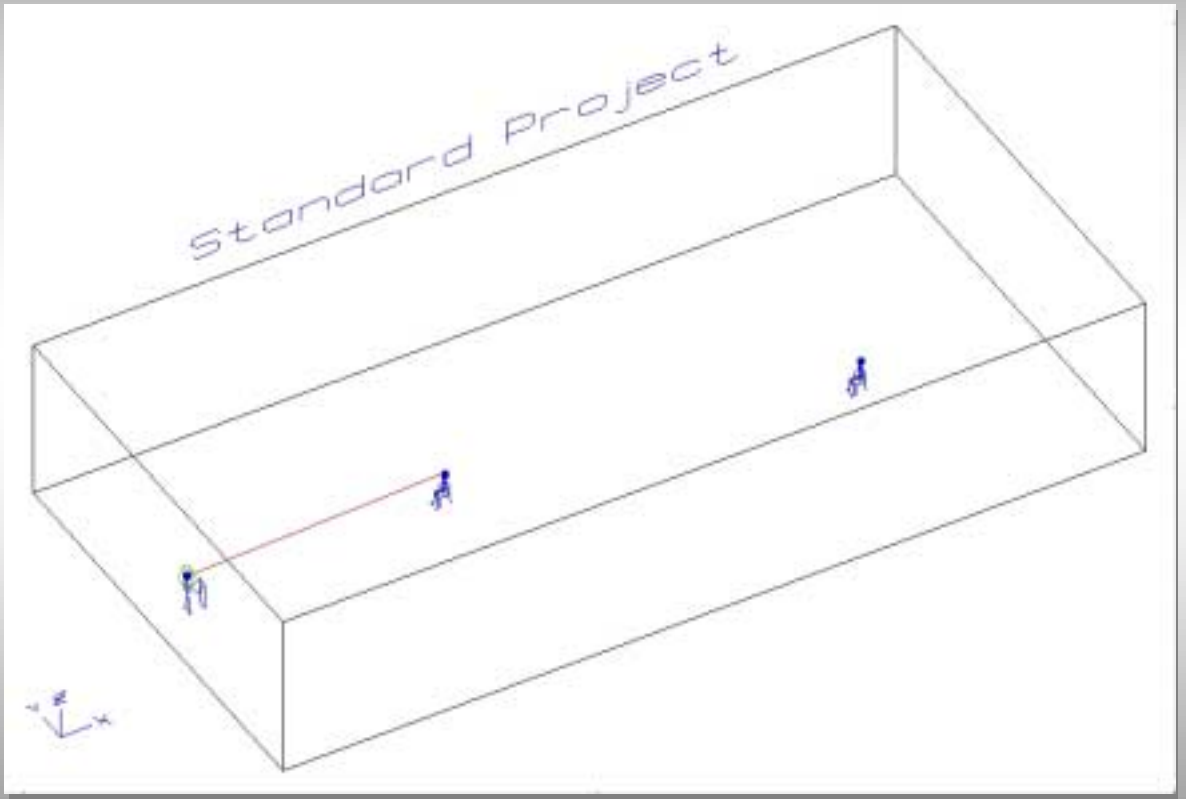


Signal / Noise

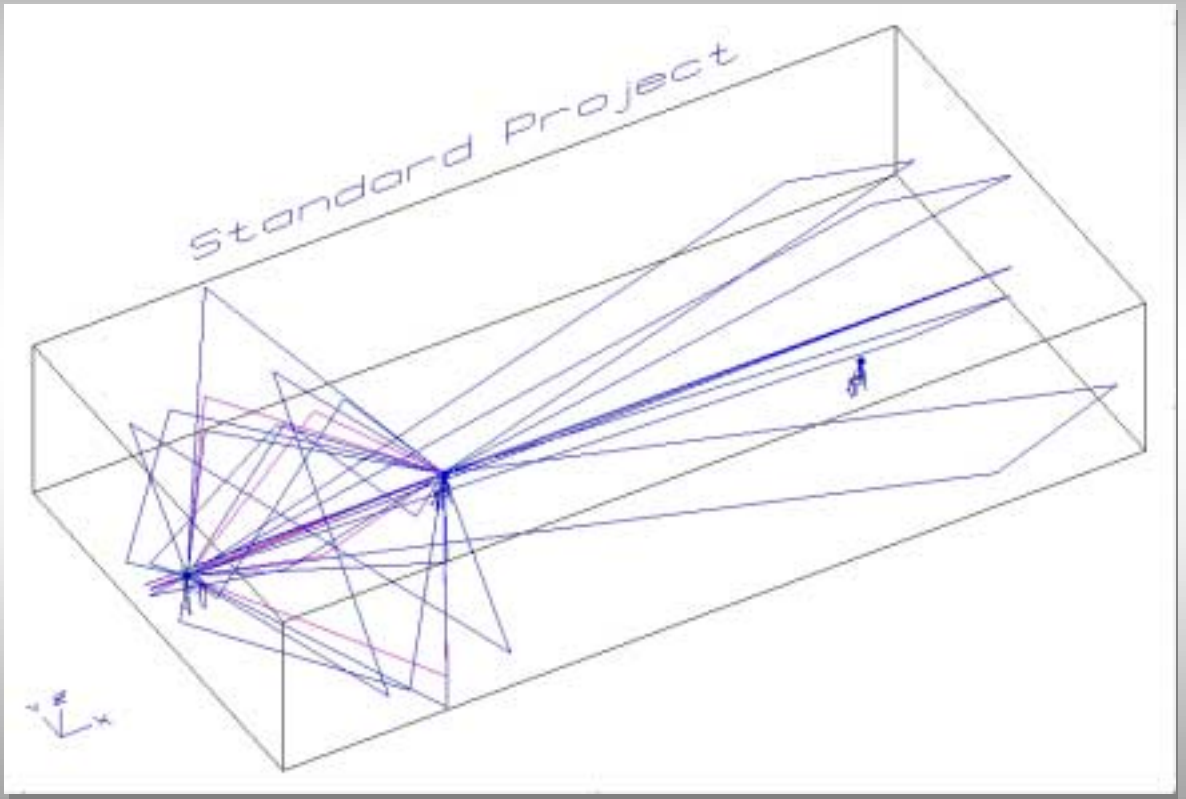


The room

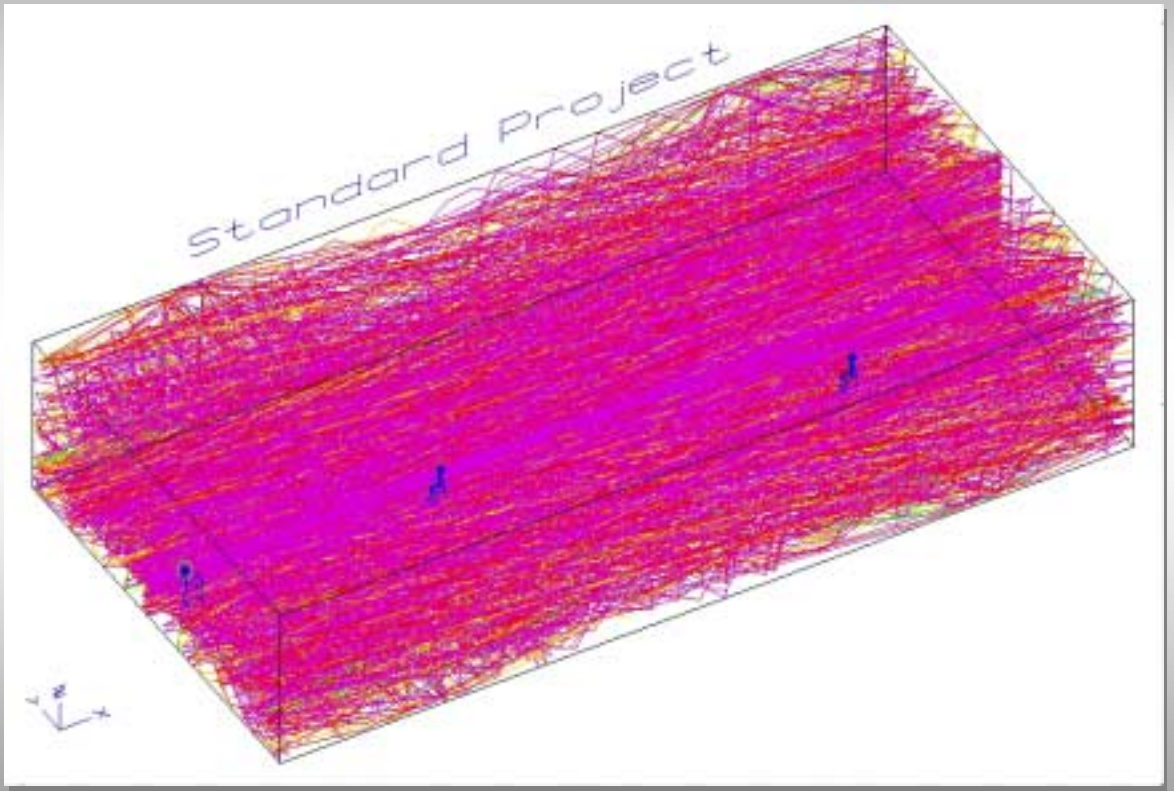
Direct sound Ld



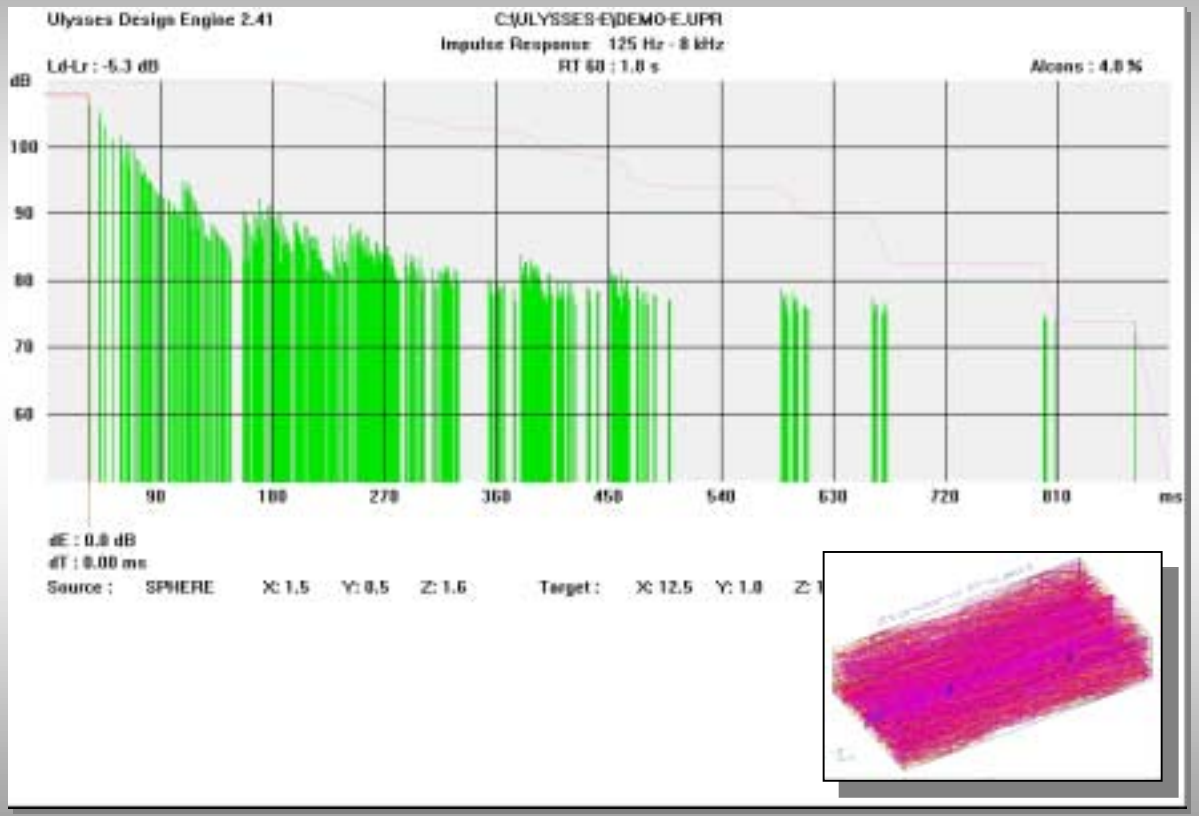
Reflections



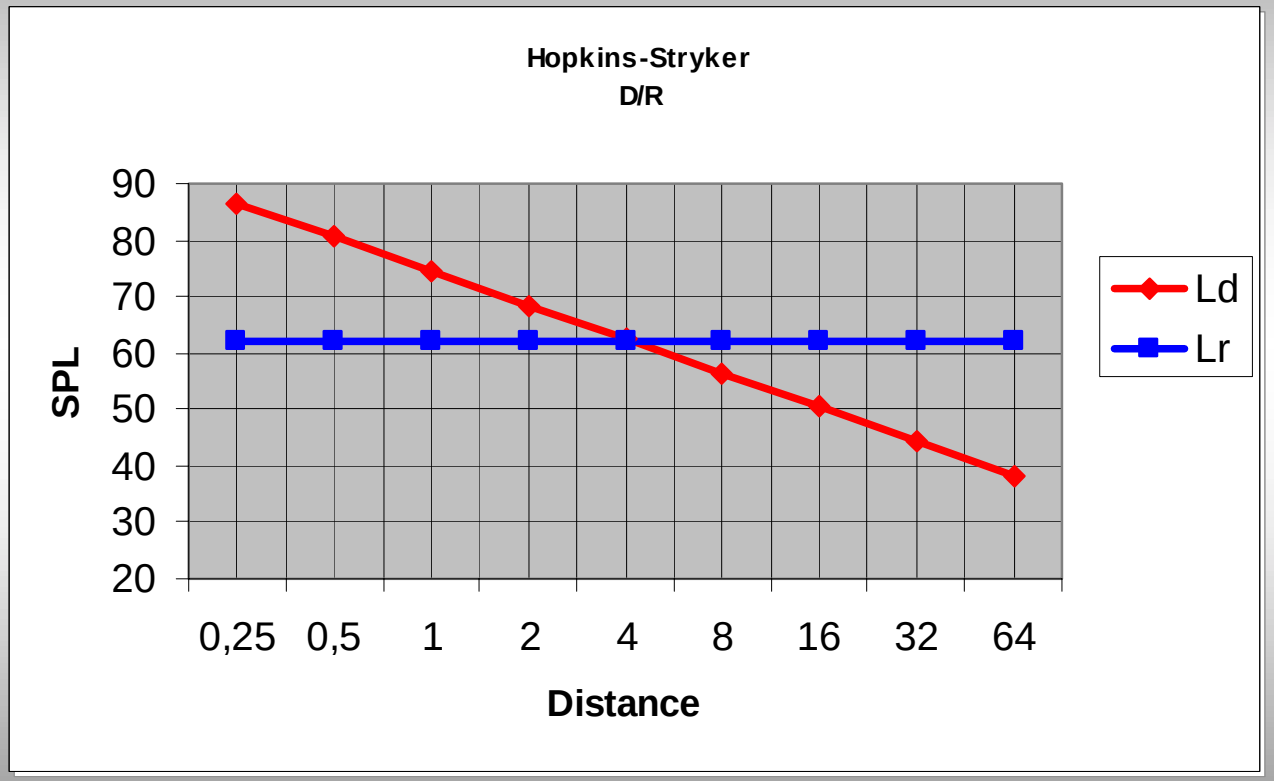
Diffuse field or reverberation field, Lr



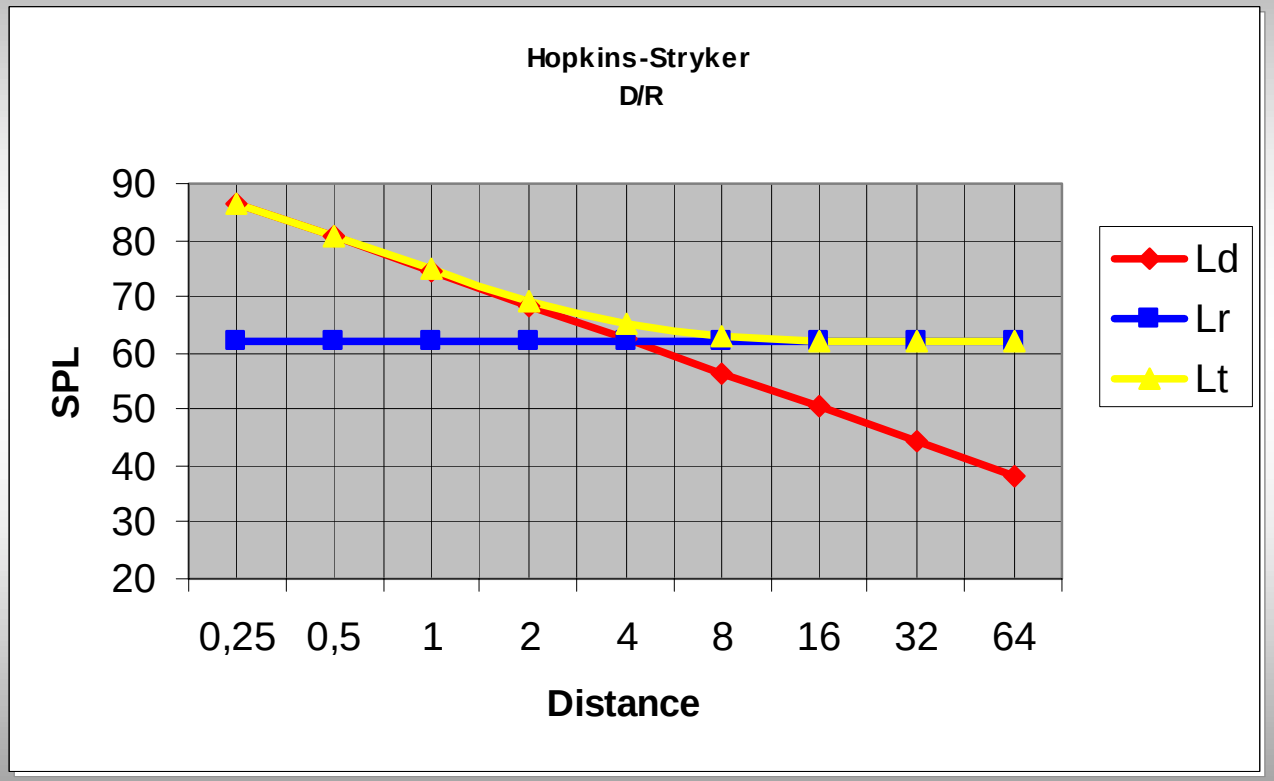
Energy vs. time, reflectogram, reverberation



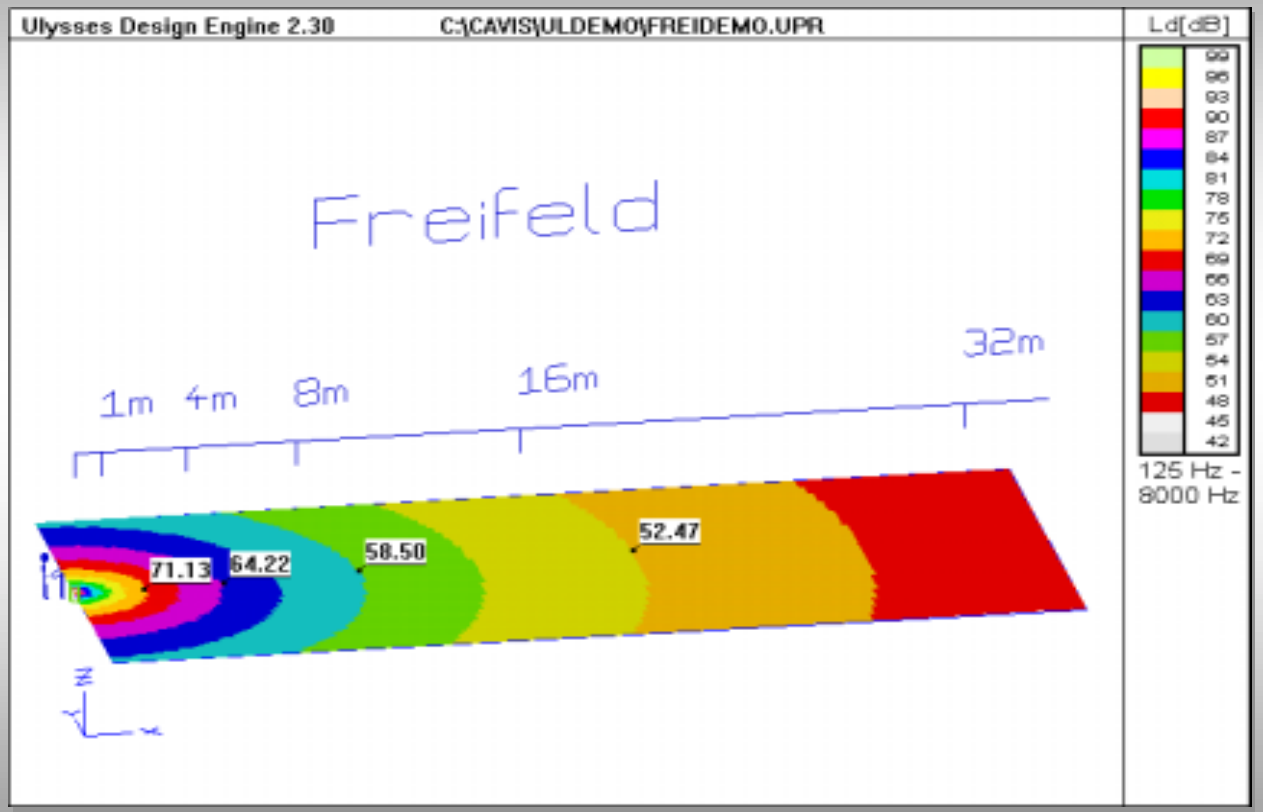
Direct sound and reverberation, Ld & Lr



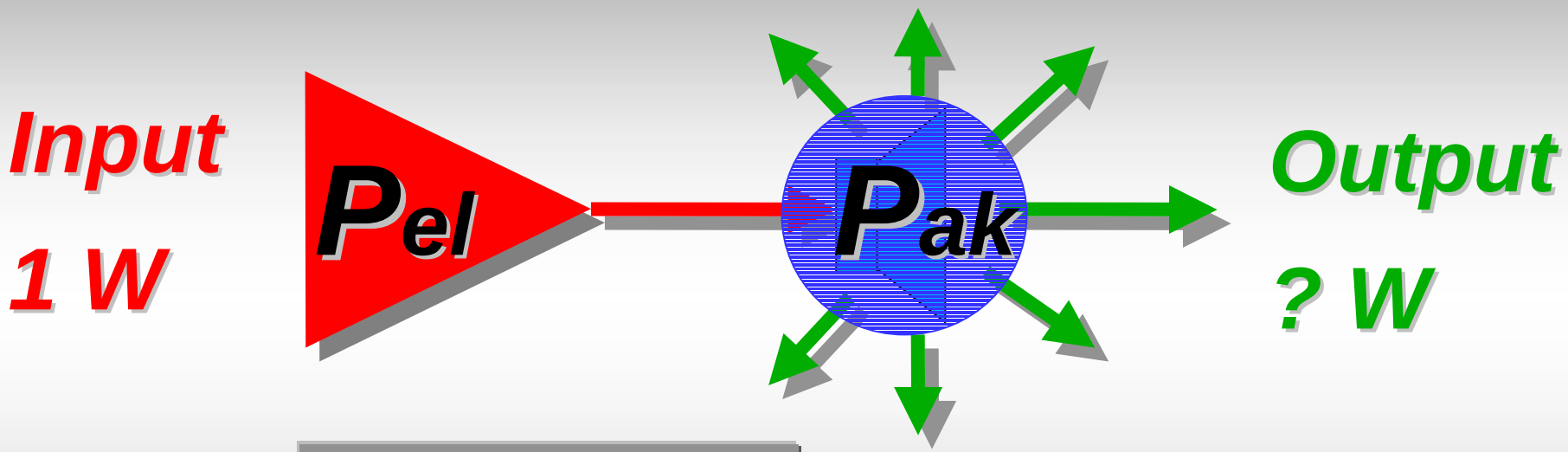
Total sound field Lt = Ld + Lr



Direct sound distribution, Speaker Direct Field

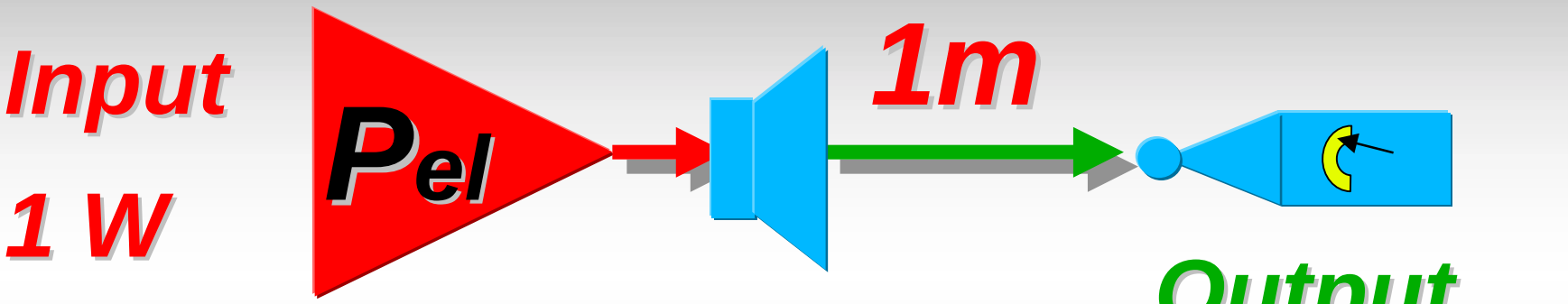


Efficiency η



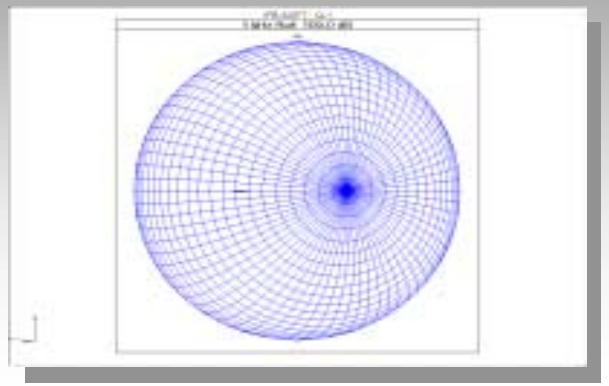
$$\eta = \frac{P_{ak}}{P_{el}}$$

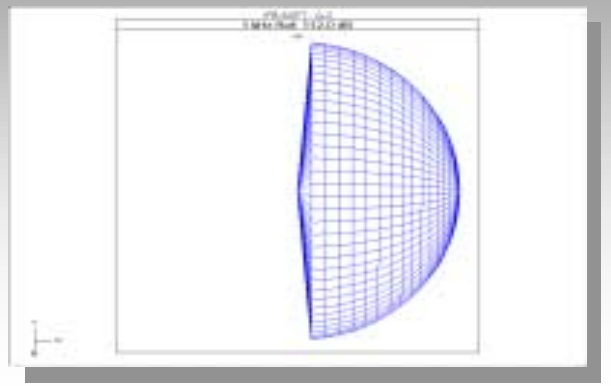
Sensitivity

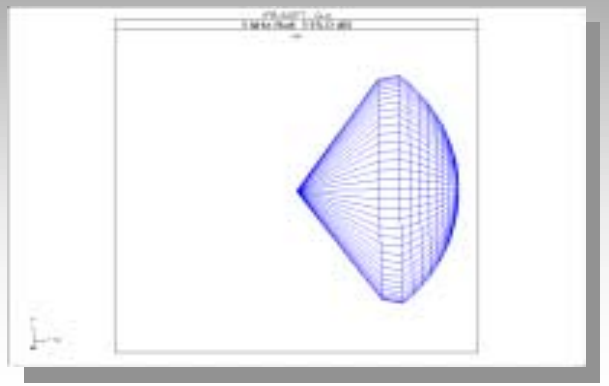


L_{sens} = ? dB SPL/1W/1m

Directivity Q & D_I







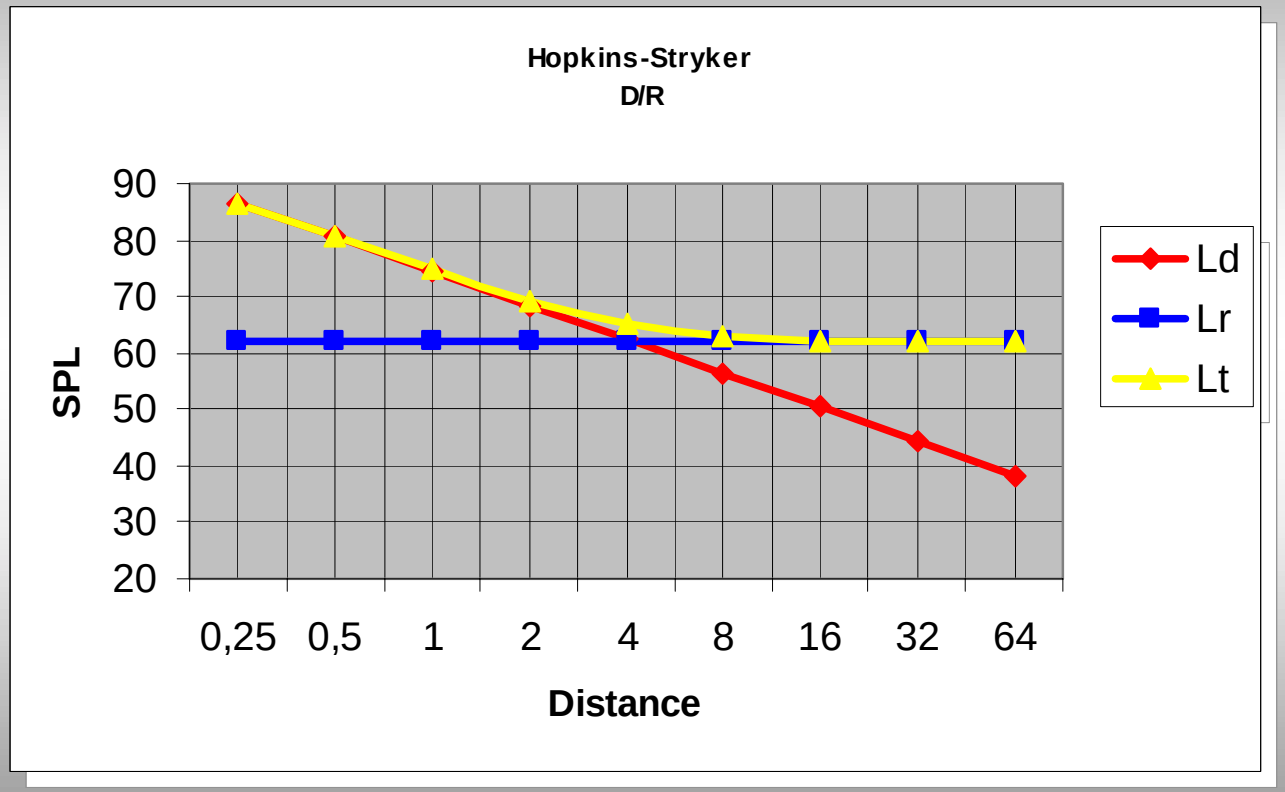
Q= 1
DI= 0 dB

Q= 2
DI= 3 dB

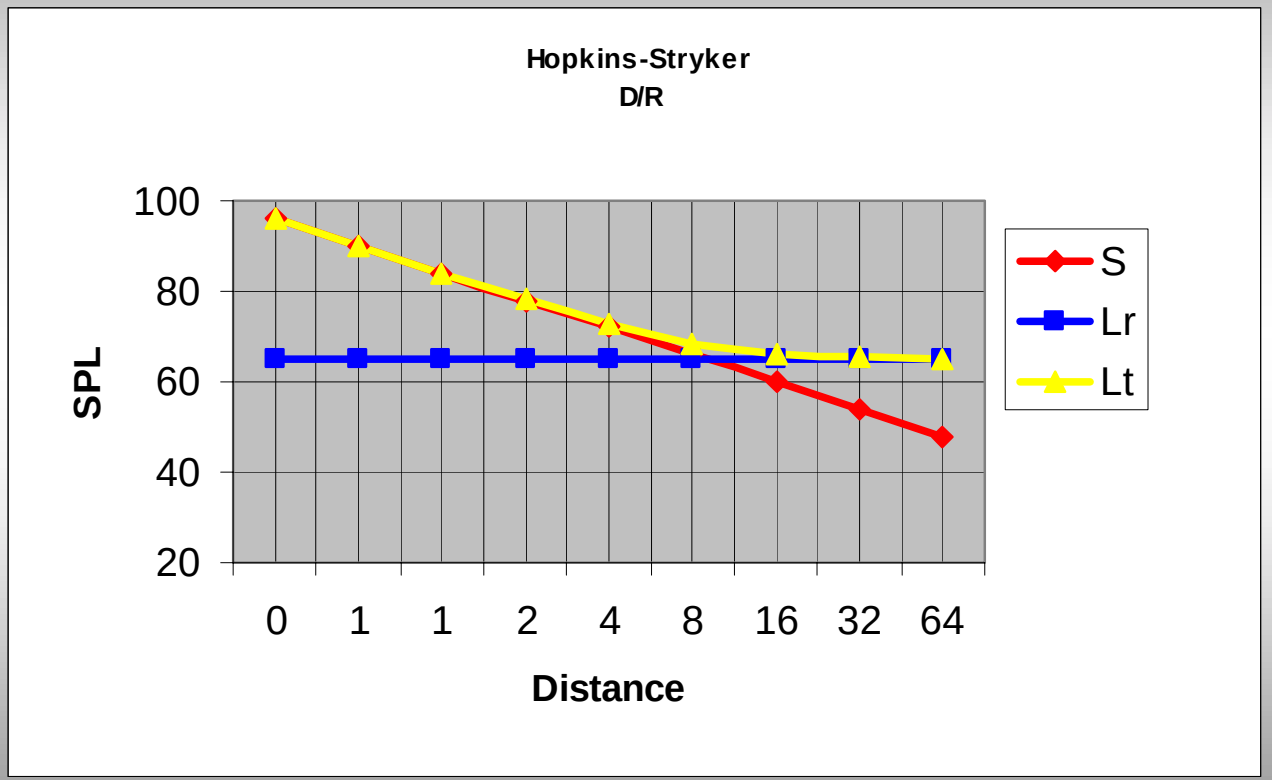
Q= 4
DI= 6dB

$$D_I = 10 \log Q$$

Total sound field Lt = Ld + Lr , Q= 1, D_I= 0dB



Total sound field Lt = Ld + Lr , Q= 8, D_I= 9 dB



Hopkins Stryker Equation

$$\Delta L_D = 10 \log \frac{Q}{4 \pi r^2}$$

$$\Delta L_R = 10 \log \frac{4}{S \alpha}$$

$$\Delta L_T = 10 \log \left(\frac{Q}{4 \pi r^2} + \frac{4}{S \alpha} \right)$$

Discussion

- Any question is welcome ...

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Thank you for your attention!