Sound Reinforcement & Acoustics in Multi-Purpose Arenas

- Arena „AufSchalke“ Gelsenkirchen now „VeltinsArena“
- Gottlieb Daimler Stadion Stuttgart

by Volker Loewer, IFB Consulting

prolight+sound mediasystems

Fachmesse für Medientechnik und Systemintegration

Frankfurt am Main, 29.03.-01.04.2006

Multi-Purpose Arena

- Speech
- Music
- Voice-Alarm

- Live
- Recorded

- Ease of operation
- Flexibility
- ...

Multi-Purpose Arena

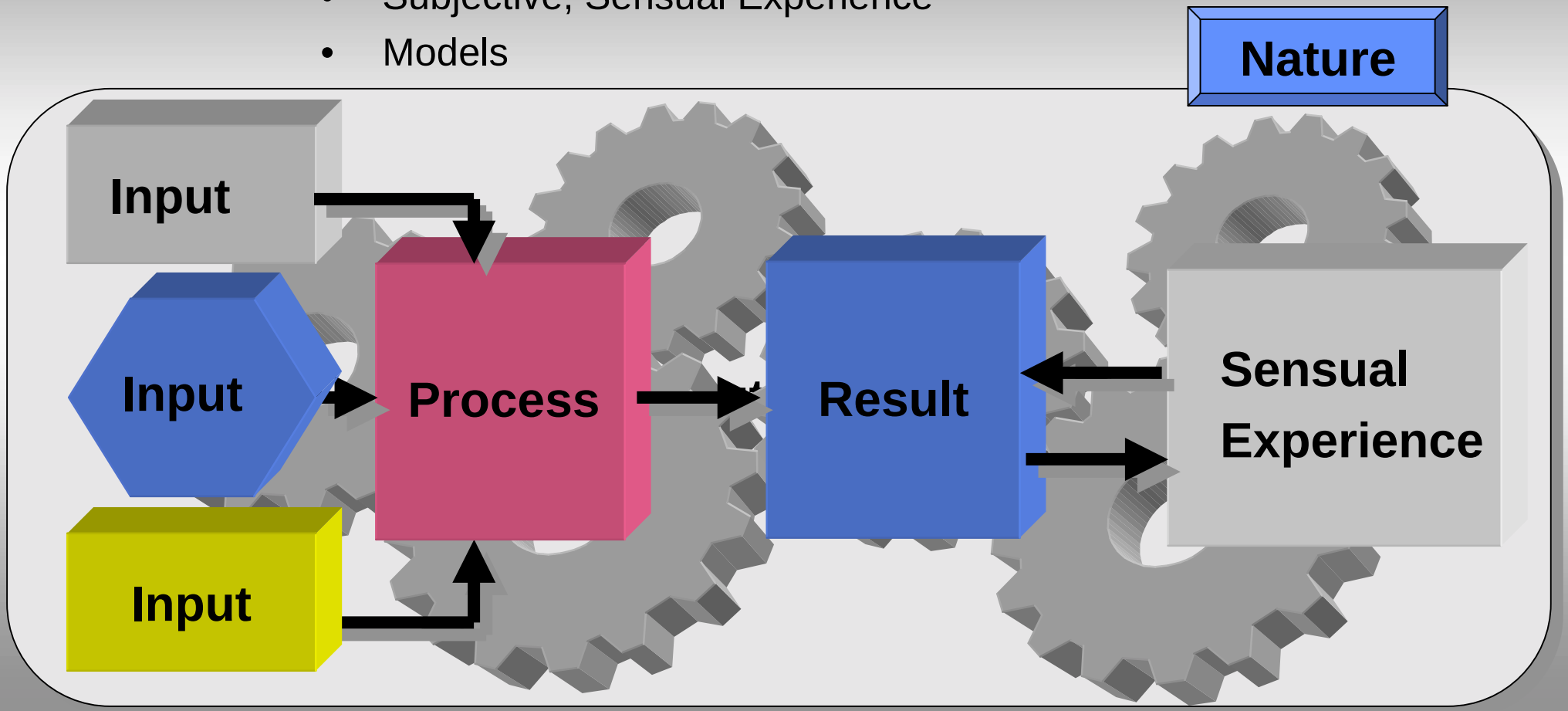
- SPLmax
- Frequency Response
- Phase Response
- STI
- Background Noise
- Reverberation
- Reflections
- Noise Pollution
- …

Multi-Purpose Arena

- Expectation of the Owners
- Tools for the Technicians
- **Entertainment for the Patrons**
- (that is where the money comes from)

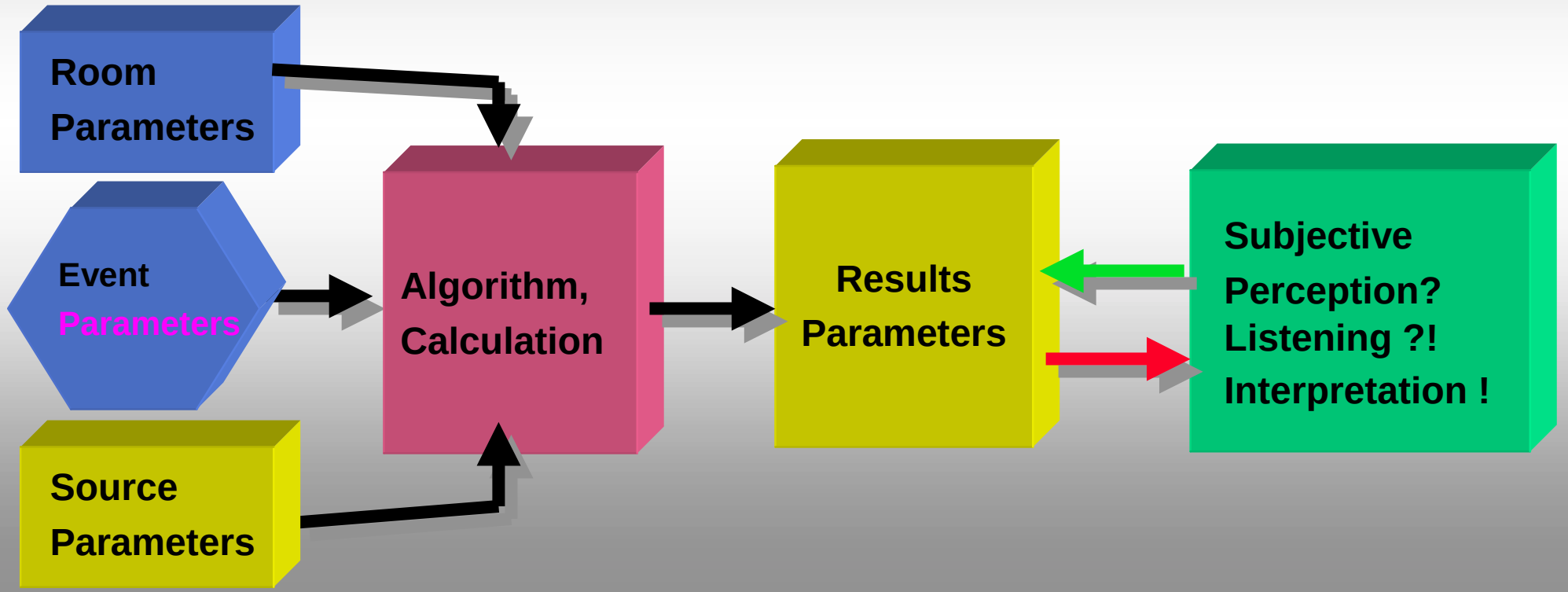
Introduction

- Process (it is all a matter of nature)
- Subjective, Sensual Experience
- Models



Models, Algorithms

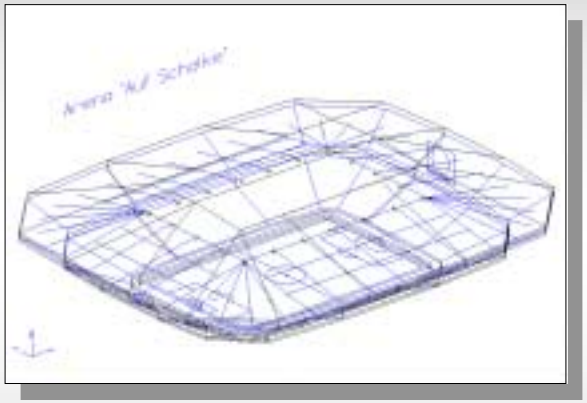
- Simplifying processes happening around us (nature)
- Discovering and understanding interaction and dependencies
- Calculate/Simulate paramaters and results



Evaluation Concept, Input

Acoustical Properties

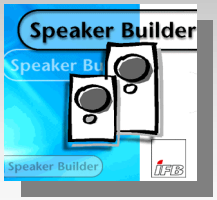
- Absorption
- Reflection
- Transmission



Geometry

Significant boundaries

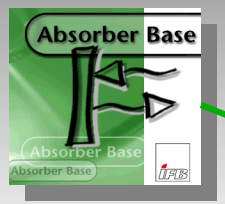
Source Properties



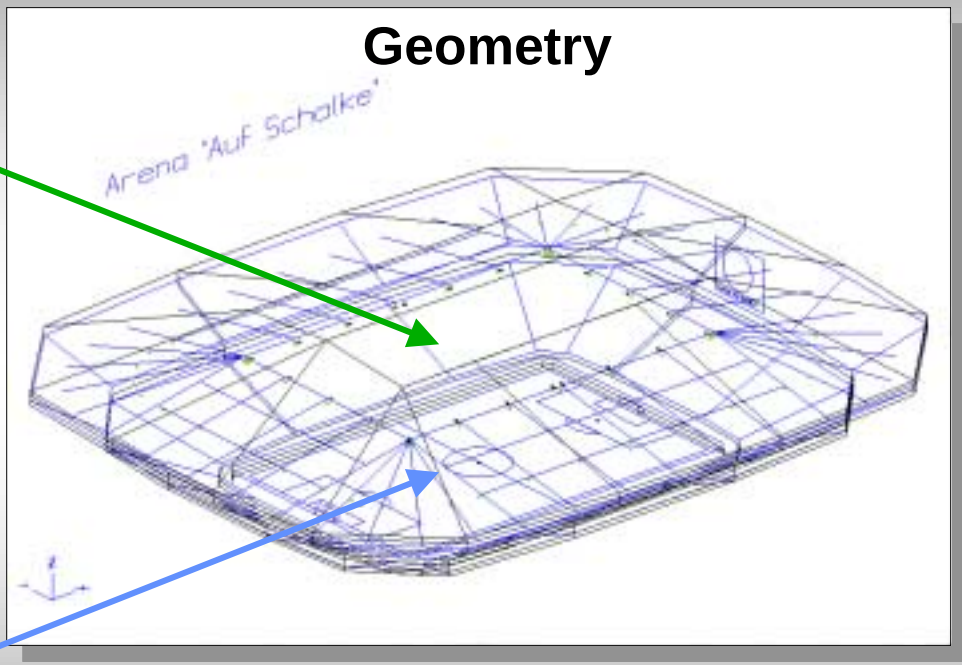
- Directivity
- Efficiency
- Quantity

Simulation Concept

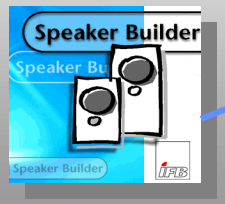
Acoustical Properties



Geometry



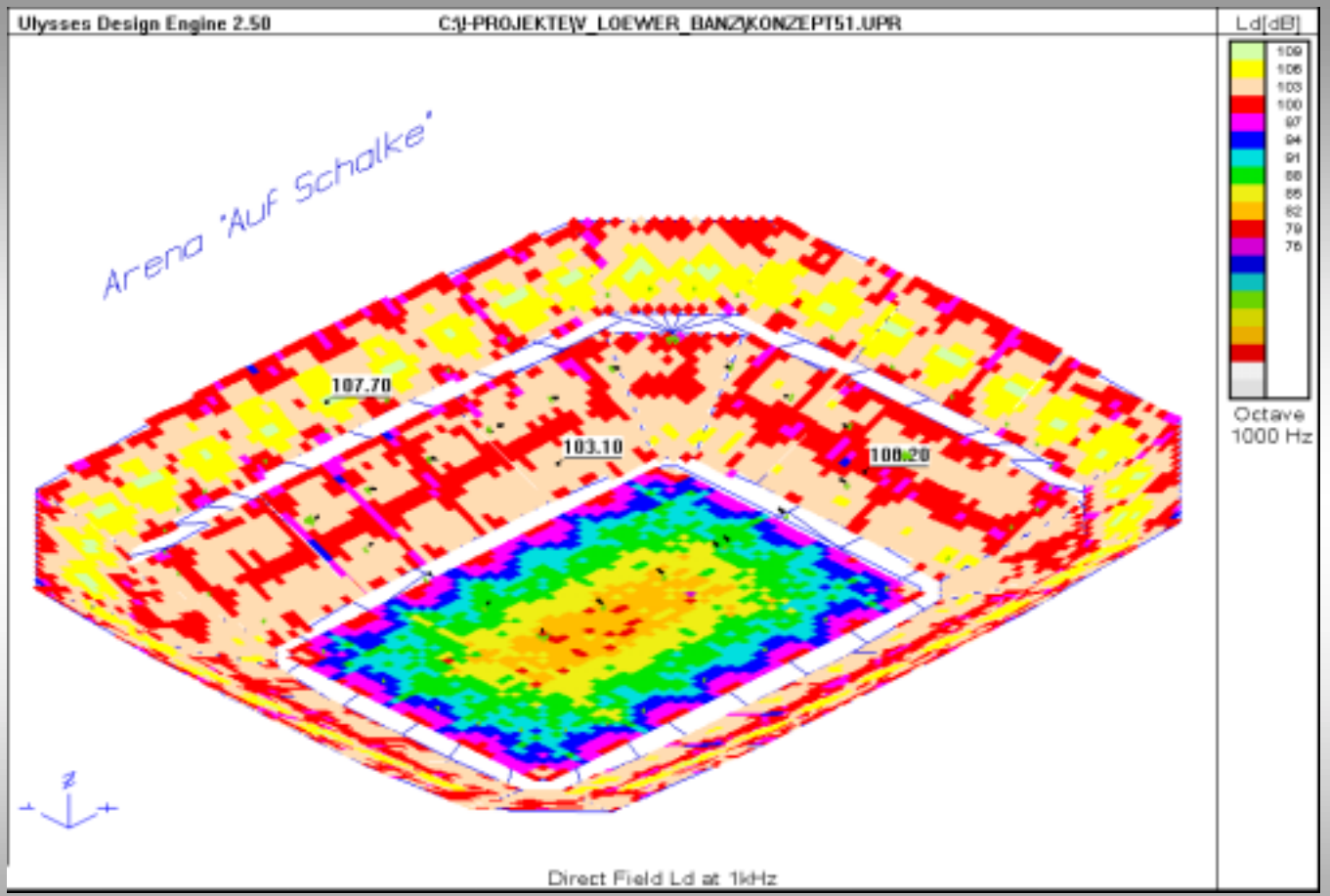
Source Properties



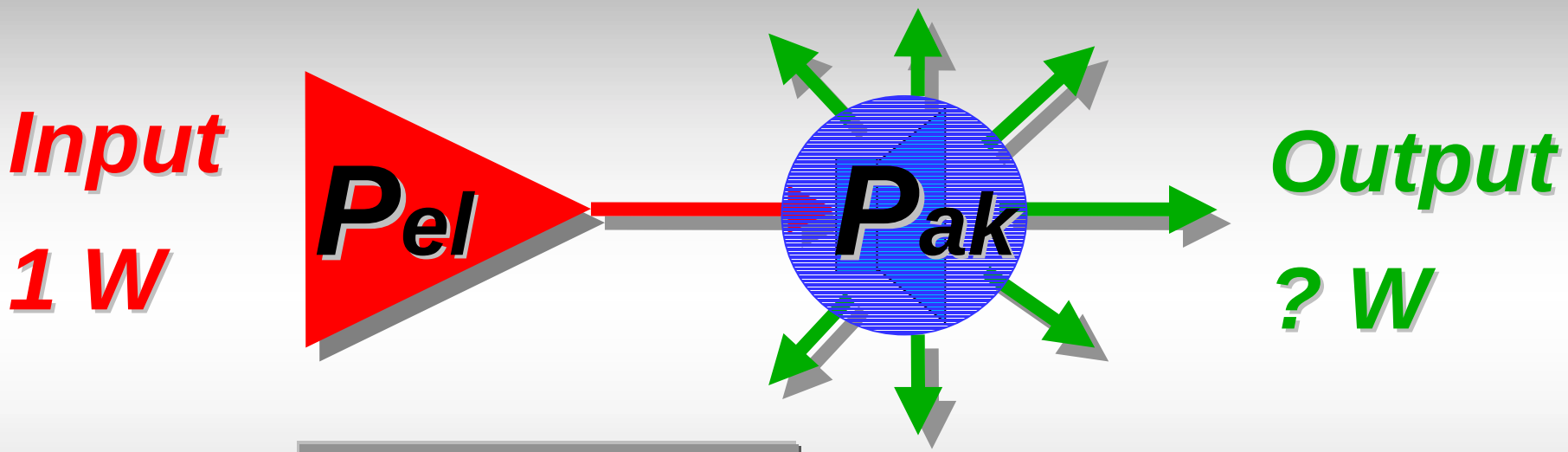
Direct Sound Ld

Direct Sound

- Speaker output
- Directivity
- Distance
- Number
- Aiming

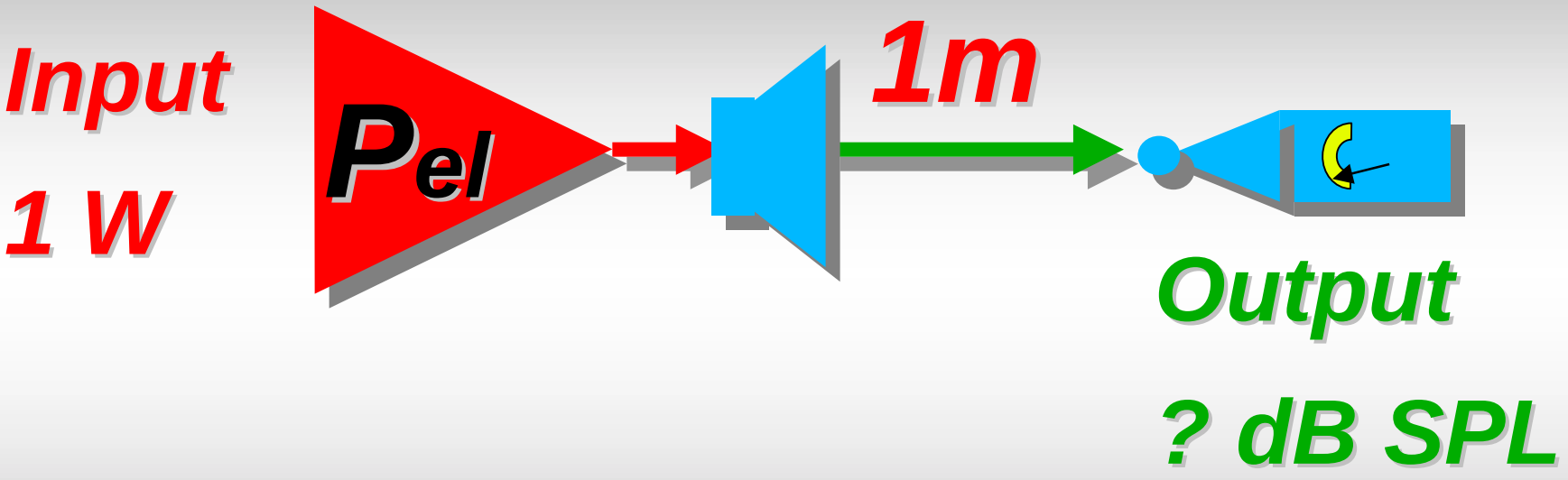


Efficiency η



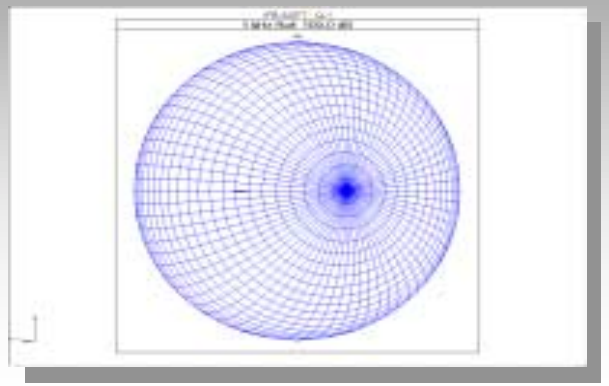
$$\eta = \frac{P_{ak}}{P_{el}}$$

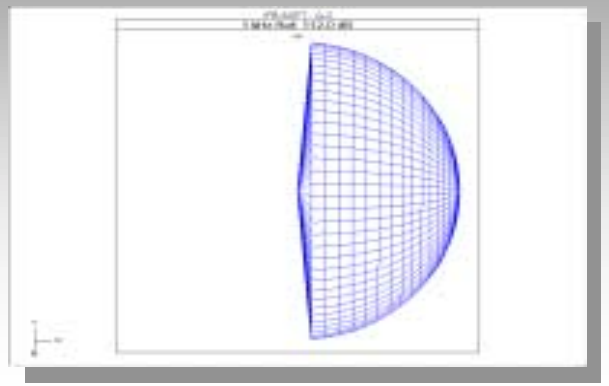
Speaker Sensitivity

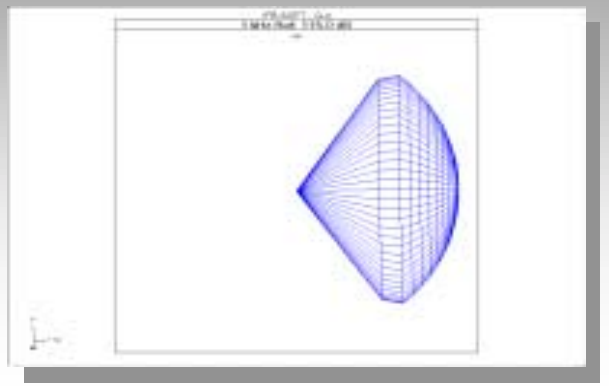


L_{sens} = ? dB SPL/1W/1m

Speaker Directivity, Q & Di







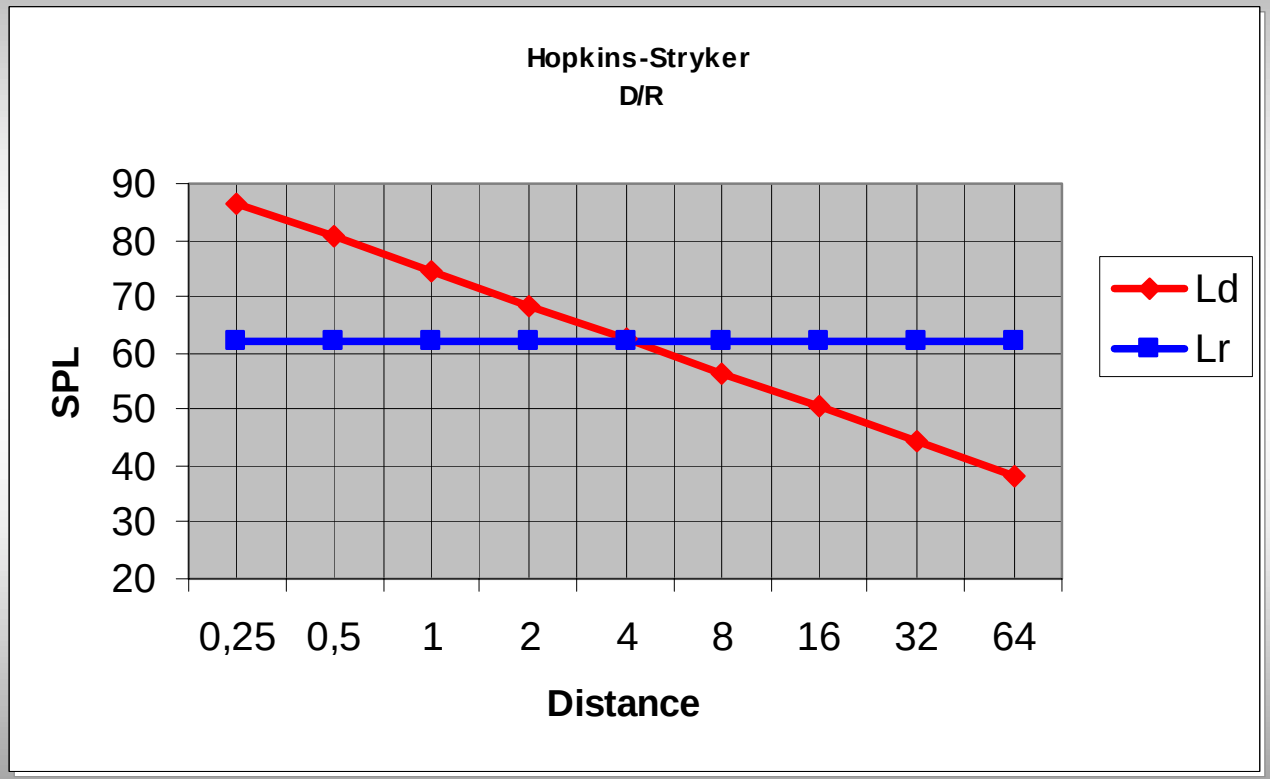
Q= 1
DI= 0 dB

Q= 2
DI= 3 dB

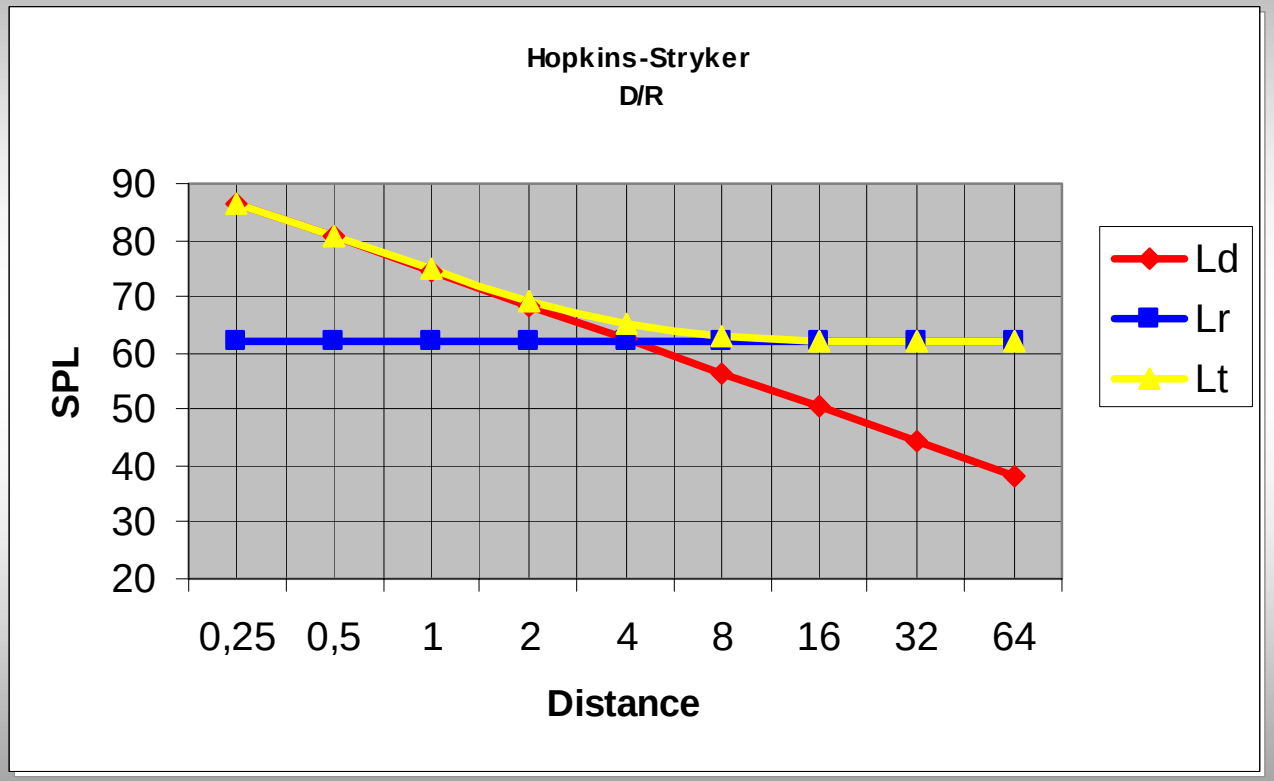
Q= 4
DI= 6dB

$$D_I = 10 \log Q$$

Direct and Reverberant Sound Field Ld & Lr

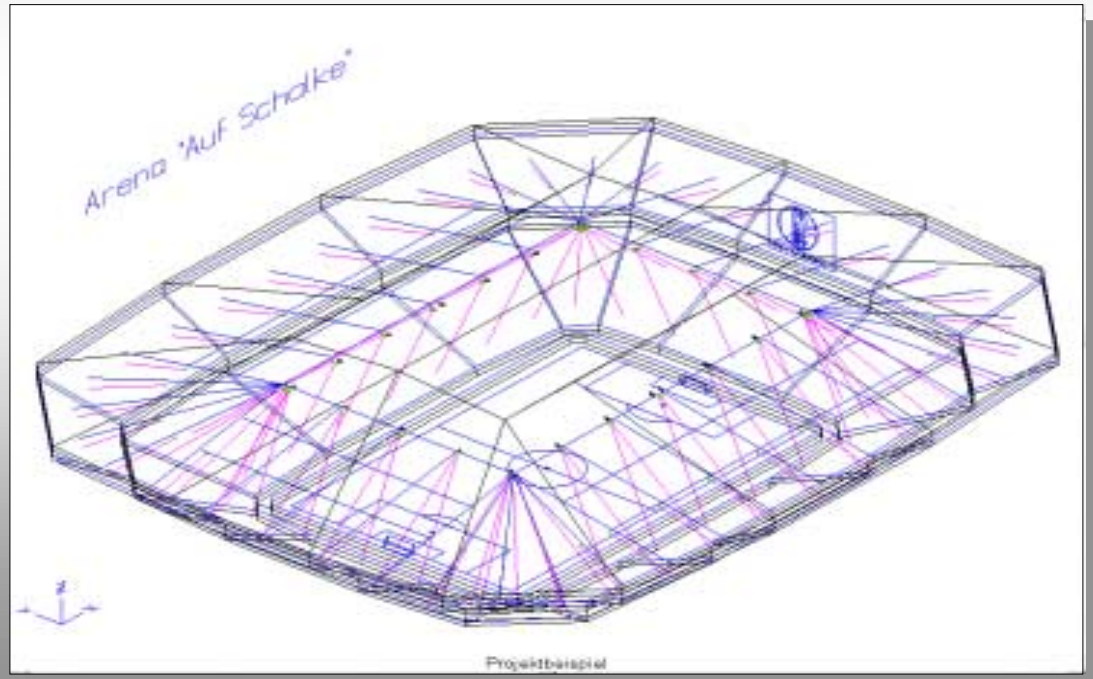


Total Sound Field Lt = Ld + Lr



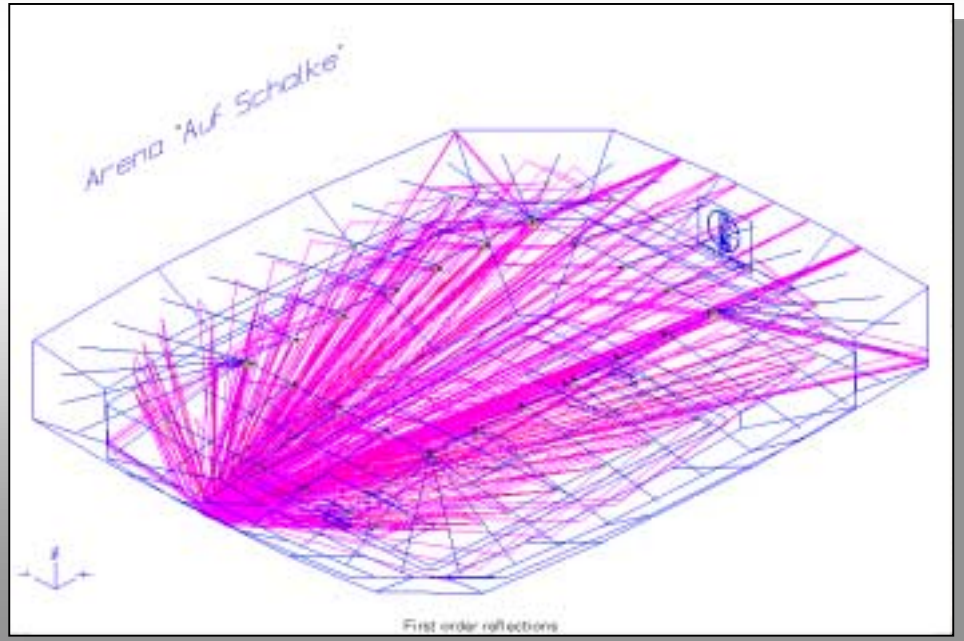
How is the desired Direct Sound Level generated ?

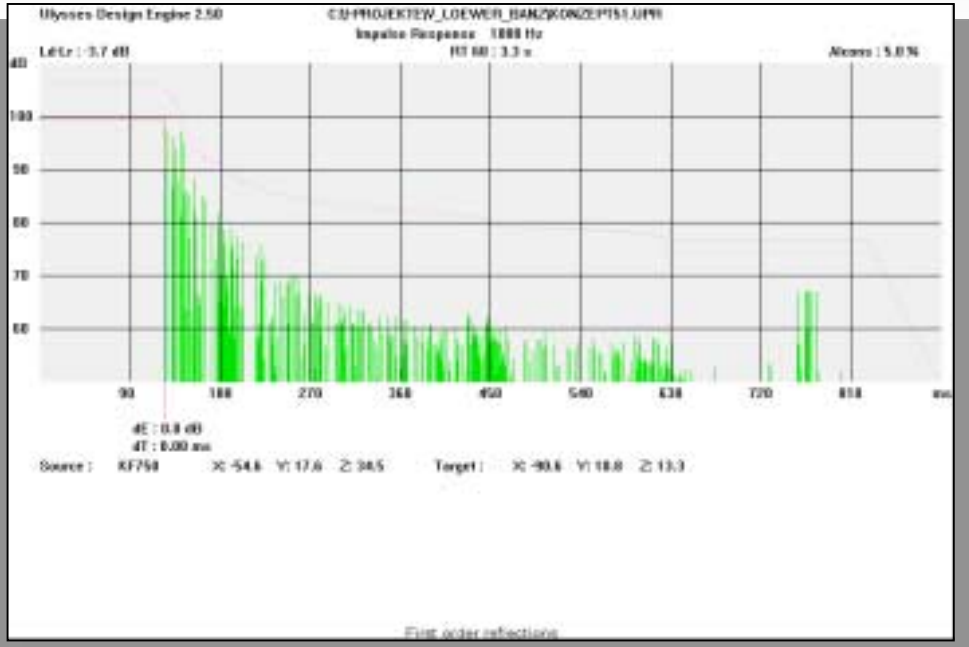
- More or less number of sources?
- Long Throws, short throws?
- Steep aiming angles?
- Low or high directivity devices?
- Coverage according to listening area or shotgun design?



The Total Acoustic Power Output creates:

- Direct Sound Level Ld
- Reflection Potential
- Reverberation Level (Lr)
- Intelligibility (Ld vs. Lr)
- Total Sound Pressure Level (Lt = Ld+Lr)
- Noise Pollution Potential

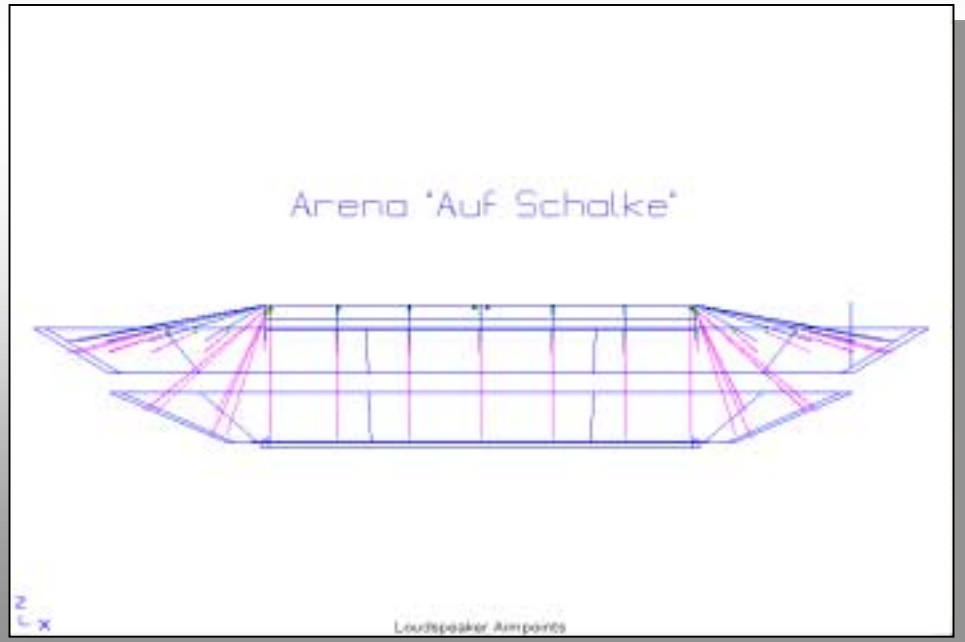




A lower Total Acoustic Power Output ...*:

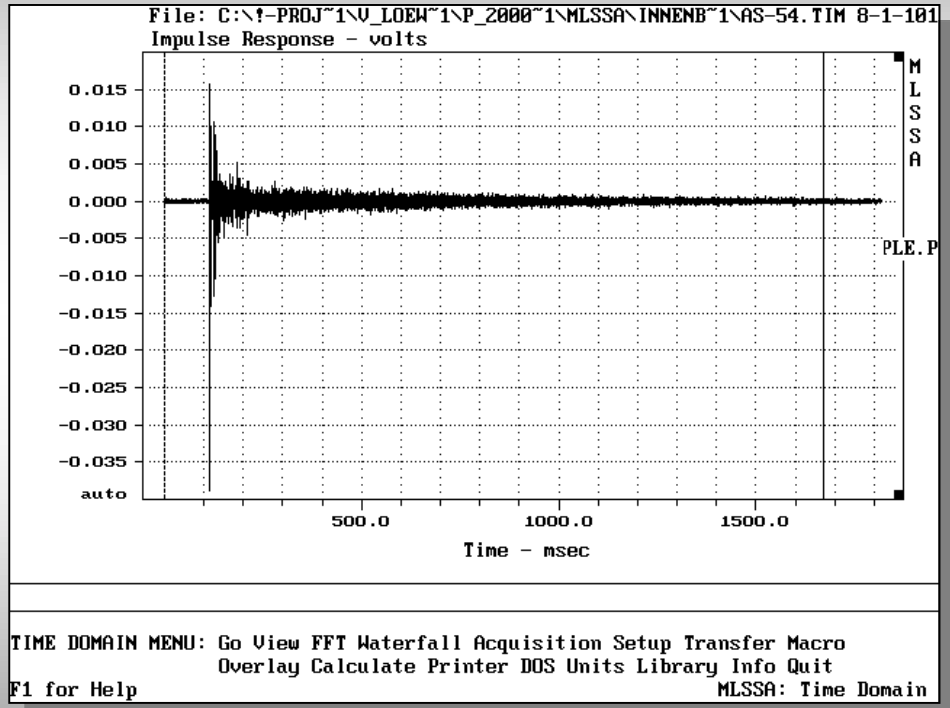
- reduces Potential Reflections
- reduces Reverberant Level (Lr)
- increases Intelligibility (Ld vs. Lr)
- reduces Total Sound Pressure Level (Lt = Ld+Lr)
- minimizes Potential Noise Pollution

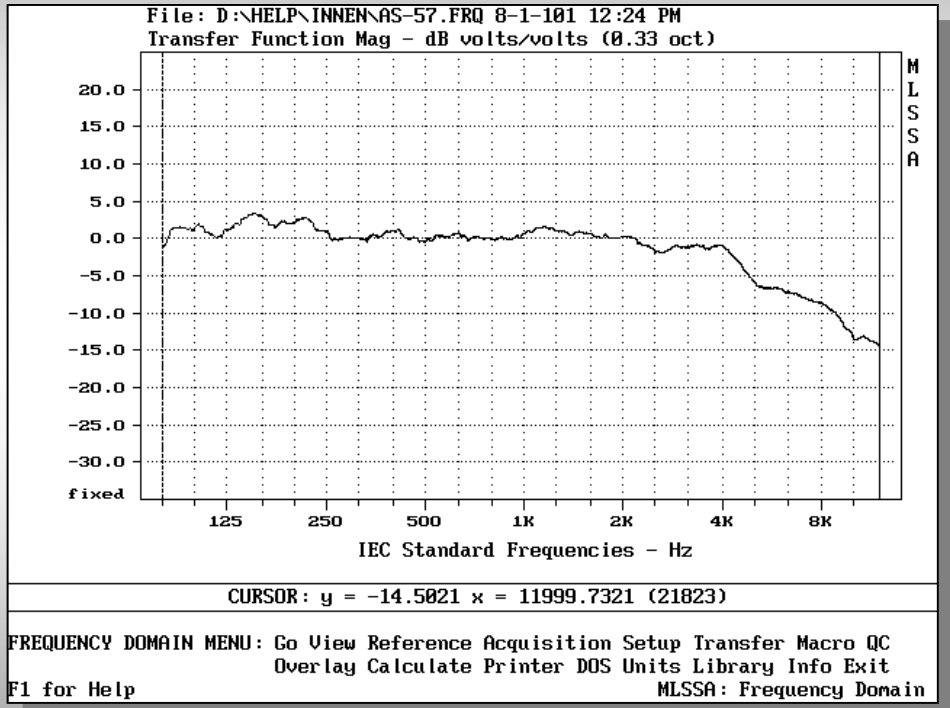
* for Equal Direct Sound Pressure Level



… and creates an excellent result:

Impulse and Frequency Response, typical





Speech Transmission Index, not occupied, typical

MTF Matrix (Uncalibrated)

Frequency-Hz	125	250	500	1000	2000	4000	8000
level dB-SPL	63.2	64.7	66.7	69.7	71.5	72.7	68.9
m-correction	1.000	1.000	1.000	1.000	1.000	1.000	0.999
0.63	0.671	0.622	0.559	0.575	0.674	0.830	0.943
0.80	0.637	0.584	0.513	0.525	0.642	0.800	0.925
1.00	0.585	0.536	0.454	0.461	0.601	0.761	0.901
1.25	0.514	0.496	0.406	0.413	0.568	0.731	0.877
1.60	0.429	0.481	0.380	0.405	0.557	0.720	0.859
2.00	0.377	0.486	0.340	0.408	0.546	0.711	0.842
2.50	0.344	0.464	0.354	0.375	0.520	0.690	0.821
3.15	0.307	0.430	0.362	0.332	0.501	0.672	0.802
4.00	0.285	0.386	0.317	0.347	0.480	0.668	0.795
5.00	0.184	0.345	0.267	0.343	0.467	0.649	0.788
6.30	0.115	0.318	0.285	0.258	0.441	0.625	0.767
8.00	0.176	0.304	0.176	0.208	0.400	0.602	0.738
10.00	0.046	0.361	0.156	0.249	0.395	0.597	0.729
12.50	0.274	0.338	0.231	0.244	0.374	0.587	0.717
octave MTI	0.390	0.463	0.399	0.417	0.507	0.619	0.735

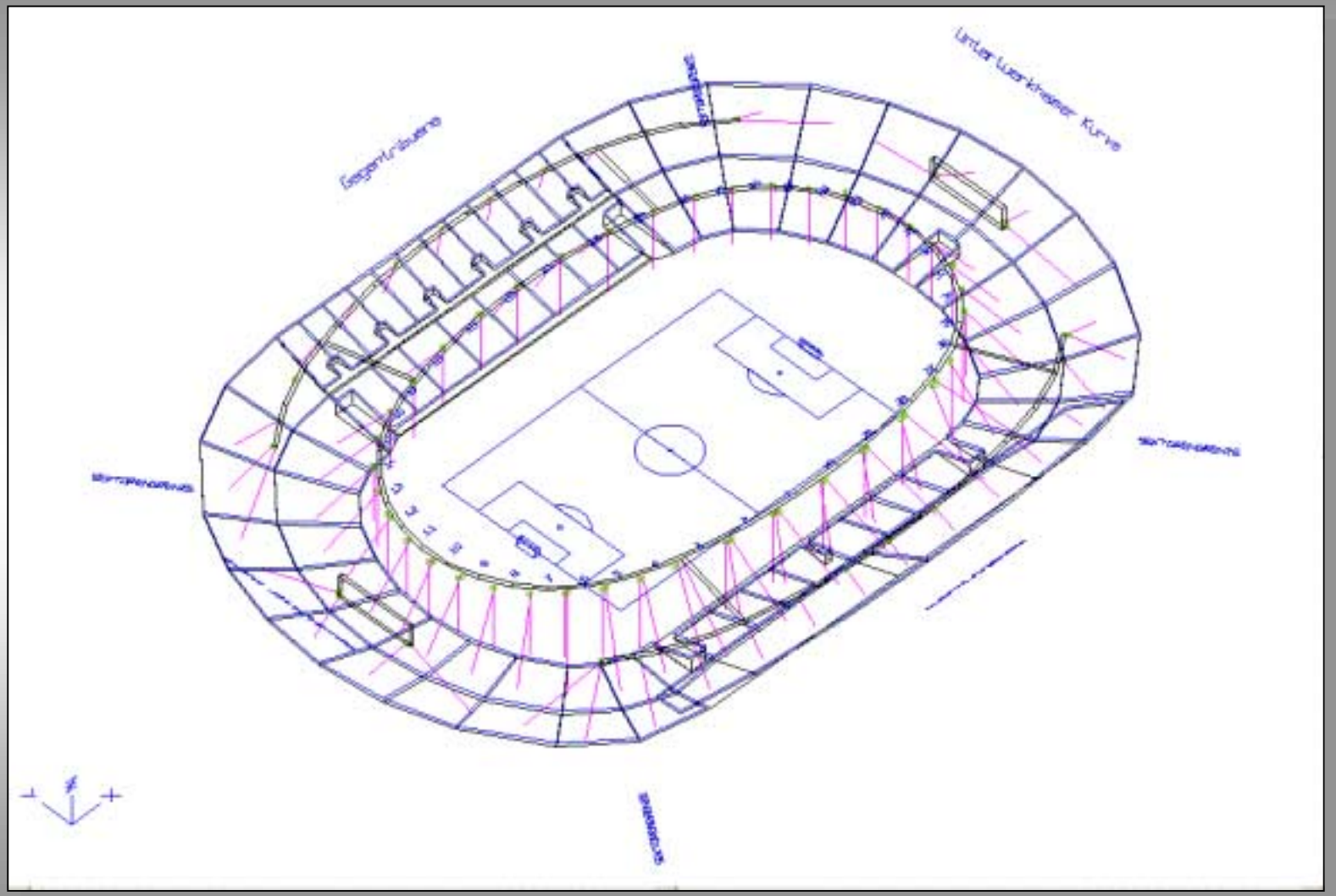
PLE.P

STI value= 0.514 (0.497 modified) ALcons= 10.5% Rating= FAIR

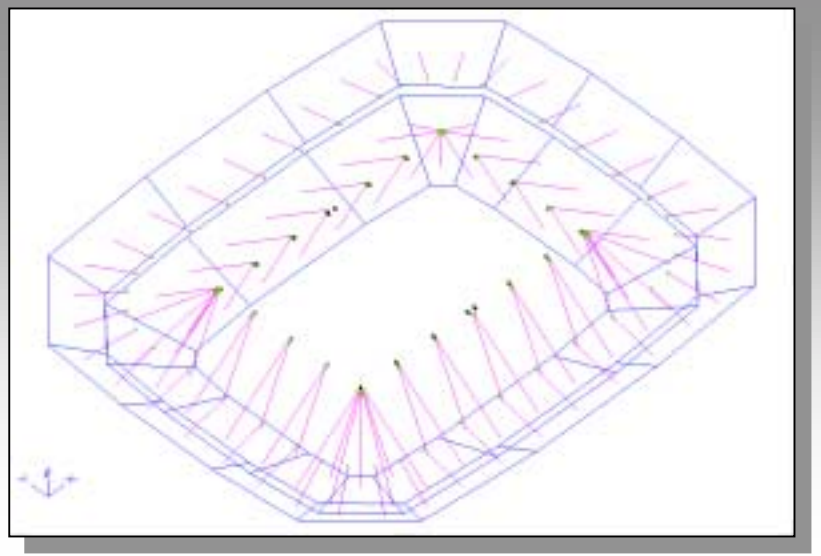
ESC to exit, F1 to print, Shift-F1 to dump. MLSSA: STI

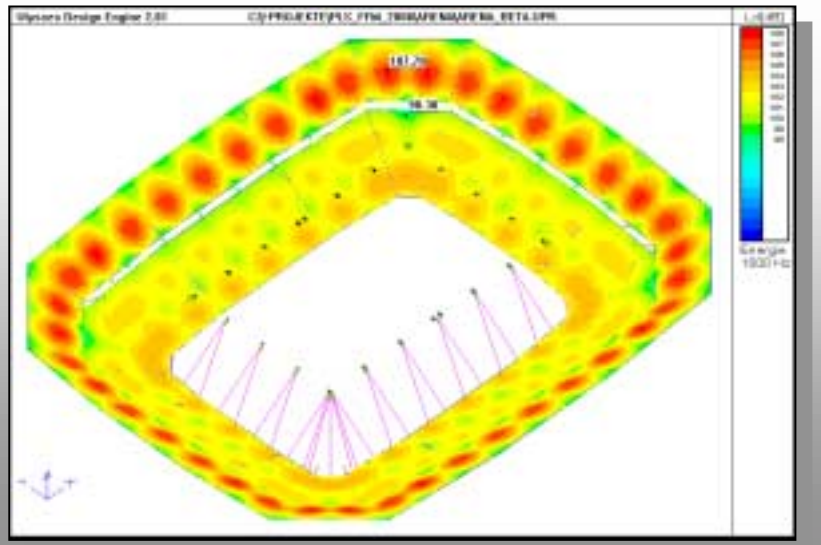
Gottlieb Daimler Stadion, Stuttgart

Gottlieb Daimler Stadion, Stuttgart, Simulation Model

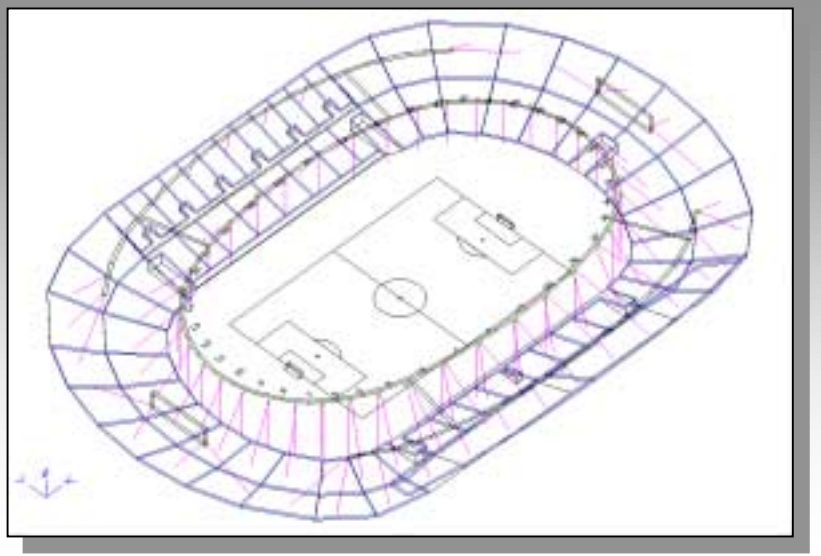


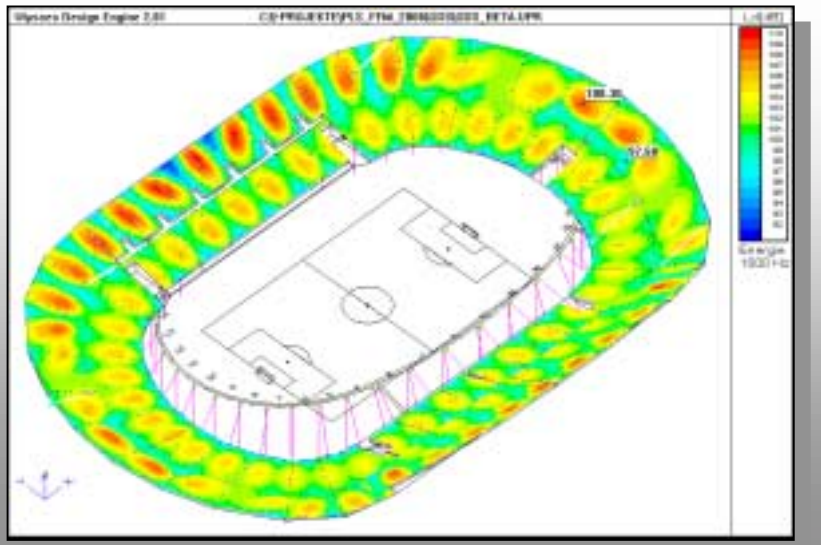
Schalke, Concept





Stuttgart, Concept





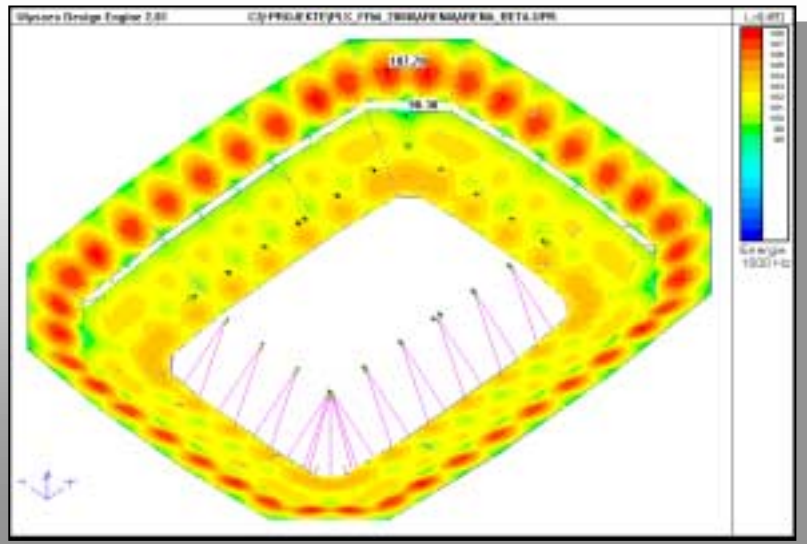
Schalke

+60.000 seats

Direct SoundPressure Level

Ld = 98-107 dB SPL @ 1 kHz

Pacoustic = 1400 Watt



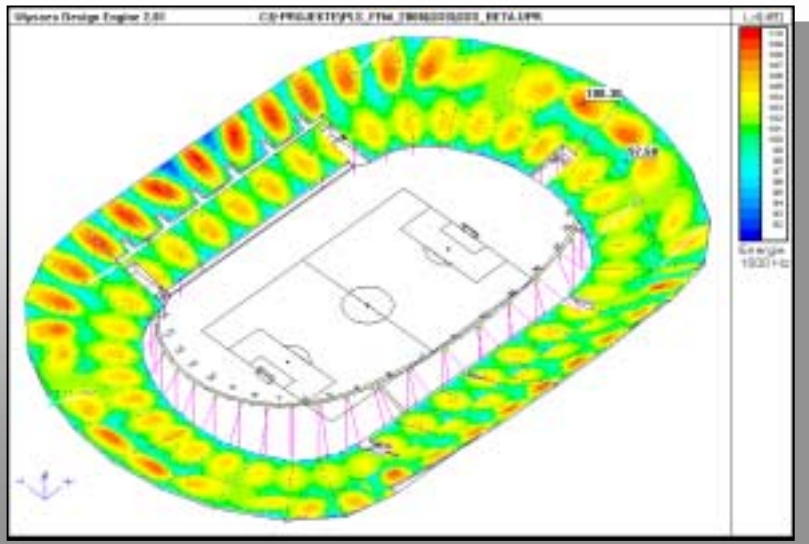
Stuttgart

+50.000 seats

Direct SoundPressure Level

Ld = 96-107 dB SPL @ 1 kHz

Pacoustic = 800 Watt



All data from simulation

Credits

- *Arena AufSchalke, now Veltins Arena*
- *FC Gelsenkirchen - Schalke 04 e. V.*
- *media systems, Gelsenkirchen*
- *Gottlieb Daimler Stadion, now …*
- *VfB Stuttgart*
- *EnBW*
- *Hochbauamt Stuttgart*
- *Siemens Stuttgart*
- *…*

Discussion

- Any Questions appreciated

Thank You for Your Attention!