

## Loudspeaker technologie van A tot Z

Erik Loots

Note: The concepts in this presentation have been described in the following books:



**Acoustical Engineering** (by Dr. Harry F. Olson)  
Published in 1947

explained in chapter 2 (Acoustical Radiating Systems)

- I) INTRODUCTION:  
2.3 Double Source (pag 32-35)
- II) STRAIGHT LINES  
2.5 Straight-Line Source (pag 36)

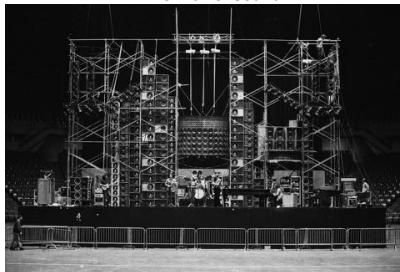


**Sound System Design and Optimisation**  
(by Bob McCarthy)

explained in chapter 2: Summation  
&  
Explained in chapter 7 Combination

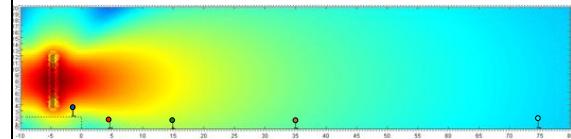


### A brief history: The Wall of Sound



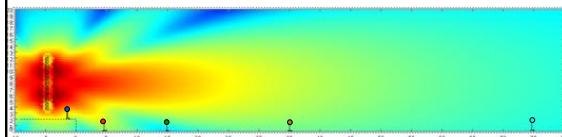
The Grateful Dead - 1974

### The Wall of Sound



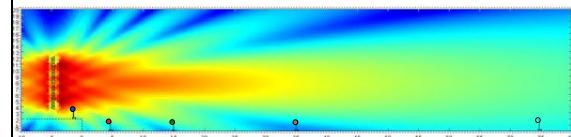
Column of 16 speakers, @ 50Hz

### The Wall of Sound

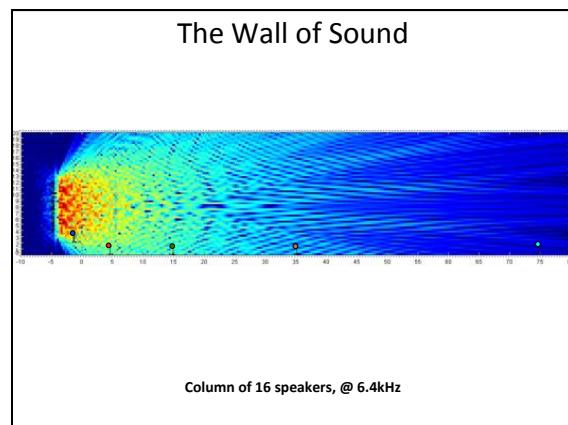
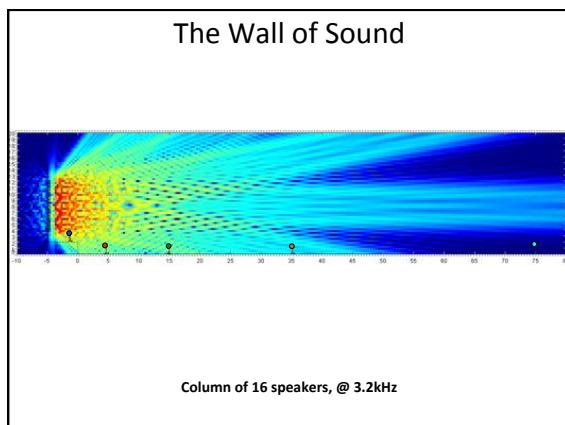
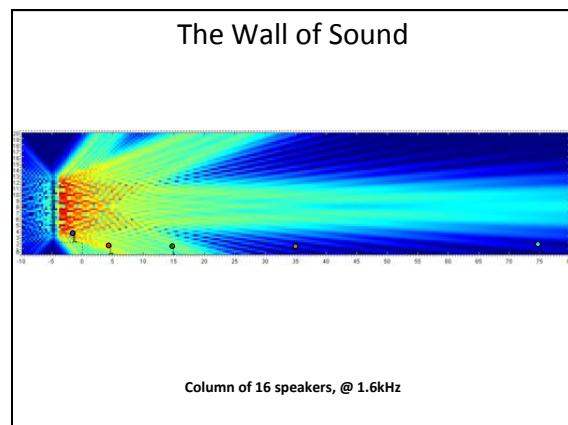
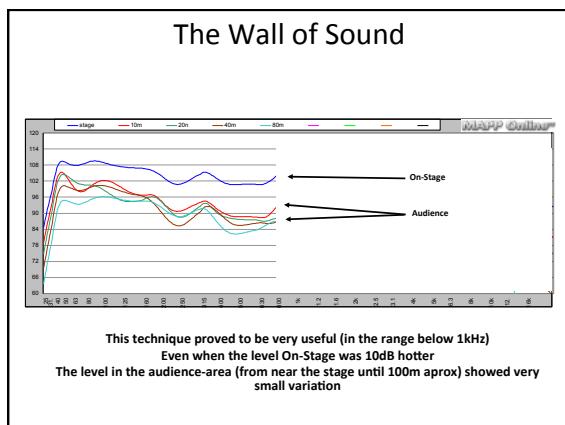
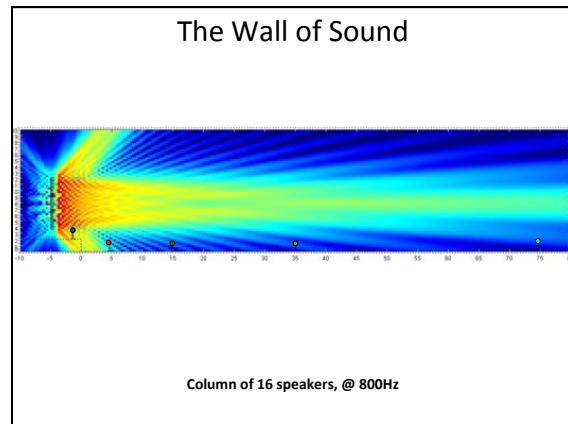
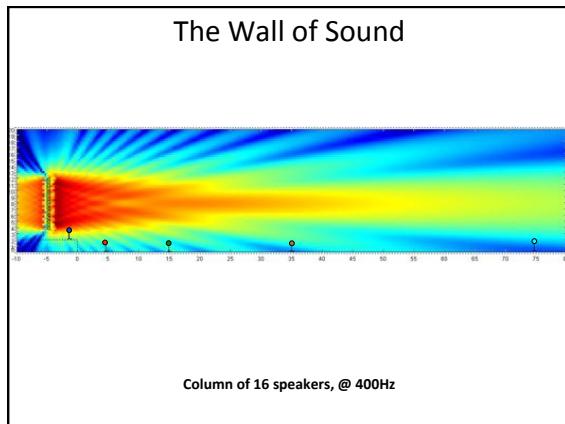


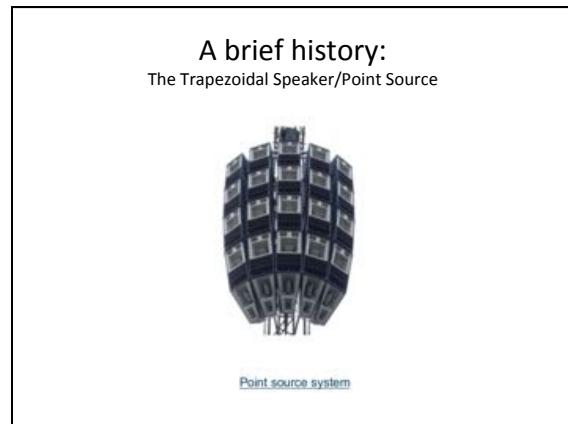
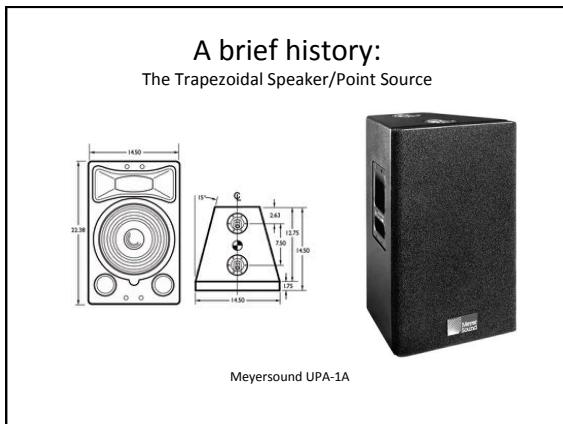
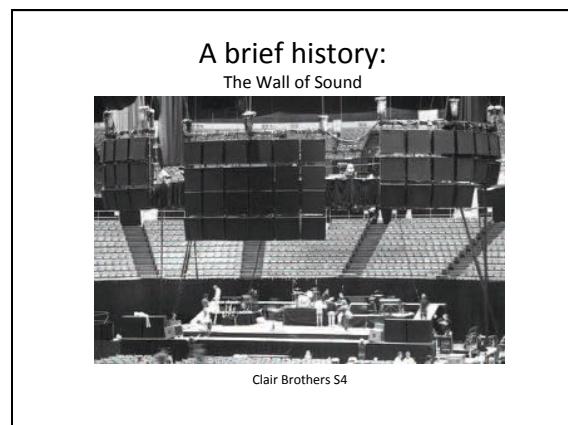
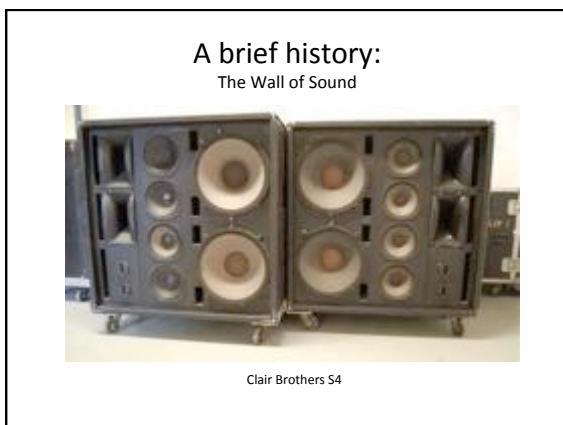
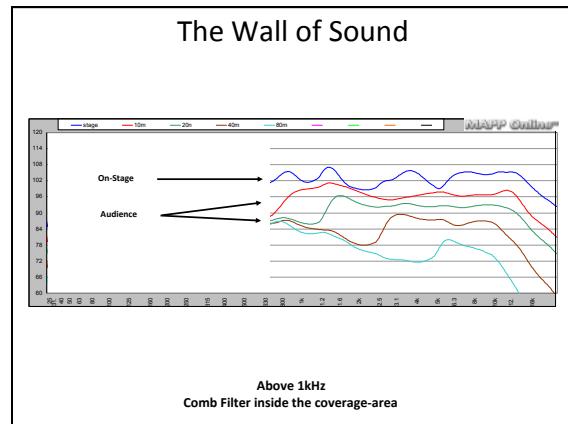
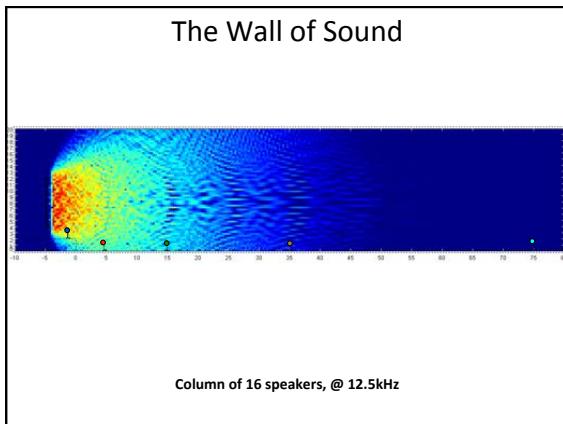
Column of 16 speakers, @ 100Hz

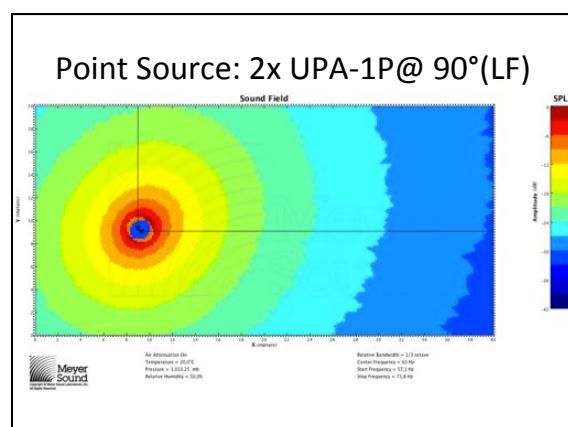
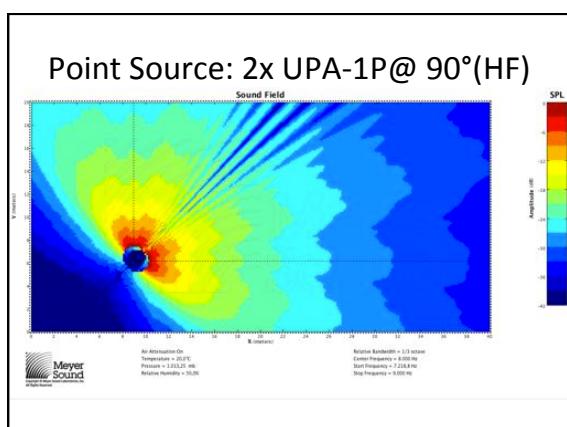
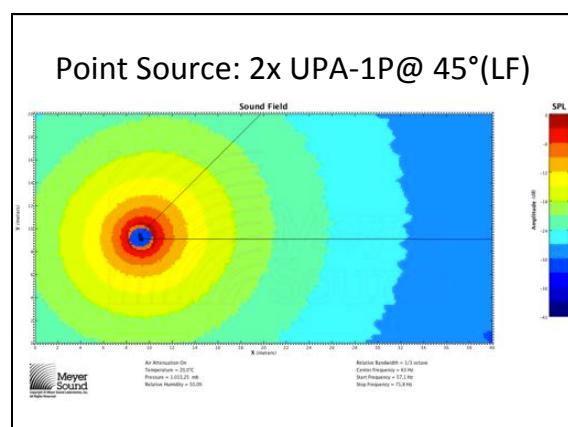
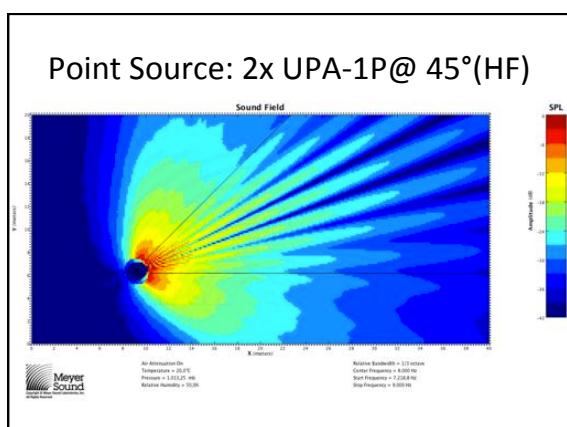
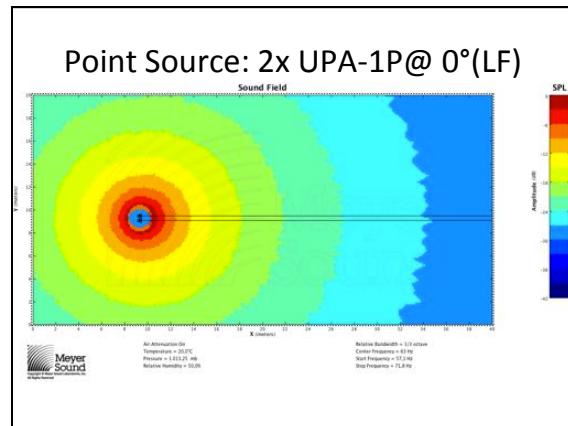
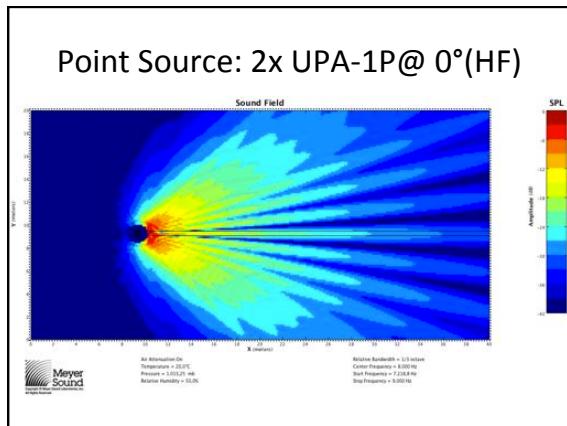
### The Wall of Sound



Column of 16 speakers, @ 200Hz



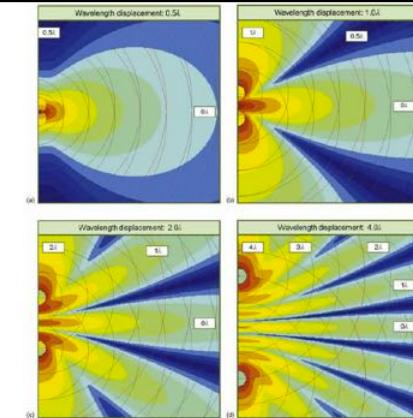
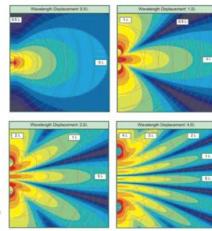
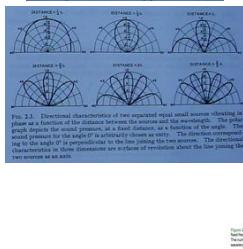




## Wavelength displacement

Fixed Frequency – Variable Displacement  
Variable Displacement – Fixed Frequency

### 2.3. Double Source (Doublet Source)



De afbeelding kan niet worden weergegeven. Mogelijk is er onvoldoende geheugen beschikbaar om de afbeelding te openen of is de afbeelding beschadigd. Start de computer opnieuw en open het bestand opnieuw. Als de afbeelding nog steeds wordt voorgesteld door een rode X, kunt u de afbeelding verwijderen en opnieuw invoegen.

## A brief history: The Line of Sound



L'Acoustics V-Dosc

## BACK TO THE FUTURE: MEET Dr. HARRY F. OLSON.:

The concepts in this presentation have been described in the book

Acoustical Engineering (by Dr. Harry F. Olson)

Published in 1947

explained in chapter 2  
(Acoustical Radiating Systems)

2

ACOUSTICAL RADIATING SYSTEMS

I) INTRODUCTION:  
2.3 Double Source (page 32-35)

II) STRAIGHT LINES  
2.5 Straight-Line Source (page 36)

## Straight-Line Source

### STRAIGHT LINES = Straight Line Array



ACOUSTICAL ENGINEERING  
HARRY F. OLSON  
McGraw-Hill Book Company  
New York  
1947

$R_s = \frac{\sin(\frac{\pi}{N} \sin \theta)}{\frac{\pi}{N} \sin \theta}$

The directional characteristics of a continuous line source are shown in Fig. 2.4. The directional characteristics are symmetrical about the line of the source. If this is carried out, equation 2.23 becomes

$\sin(\frac{\pi}{N} \sin \theta) = \frac{\pi}{N} \sin \theta$

If this is carried out, equation 2.23 becomes

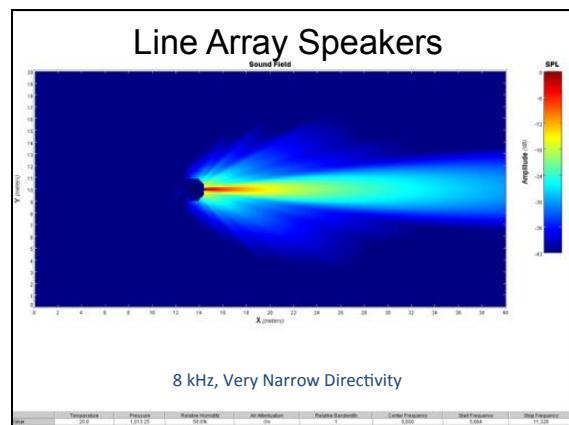
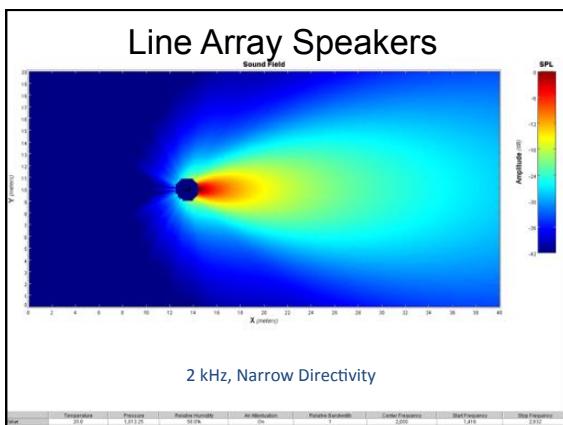
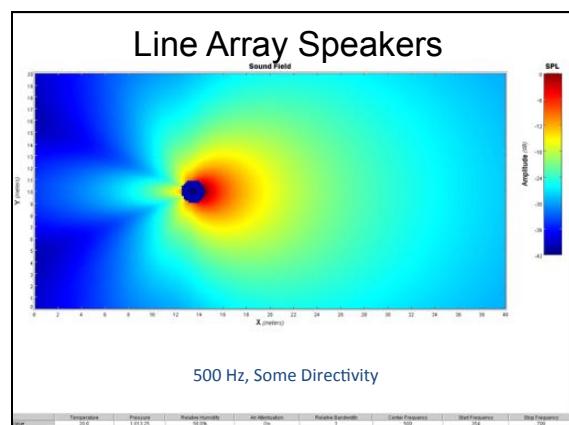
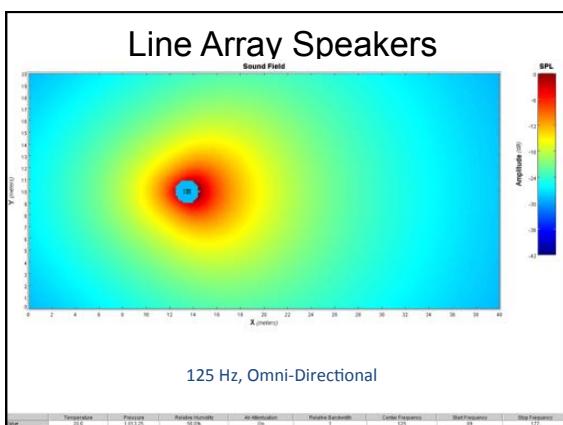
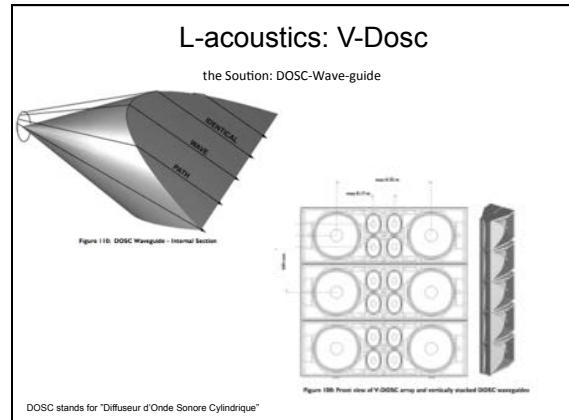
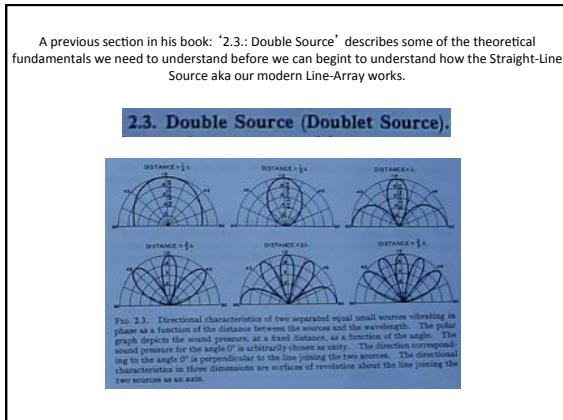
$R_s = \frac{\sin(\frac{\pi}{N} \sin \theta)}{\frac{\pi}{N} \sin \theta}$

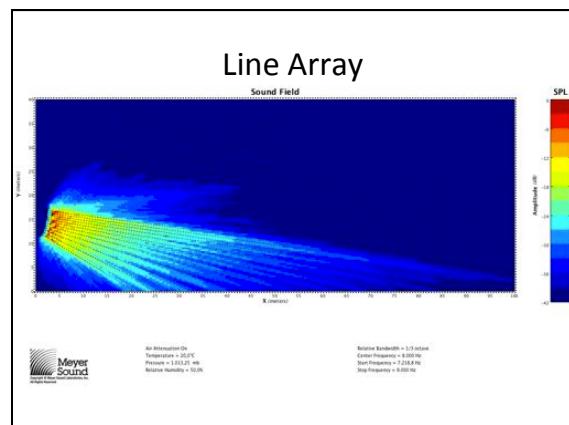
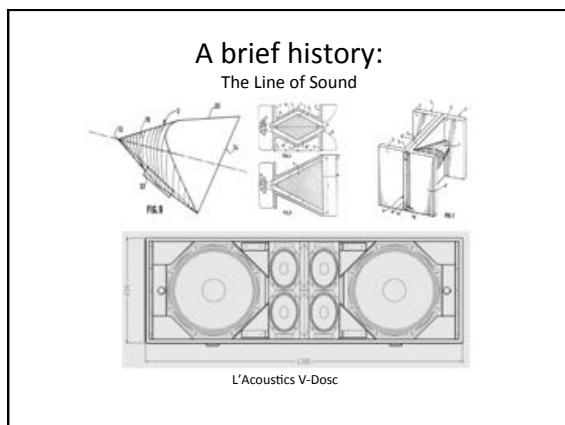
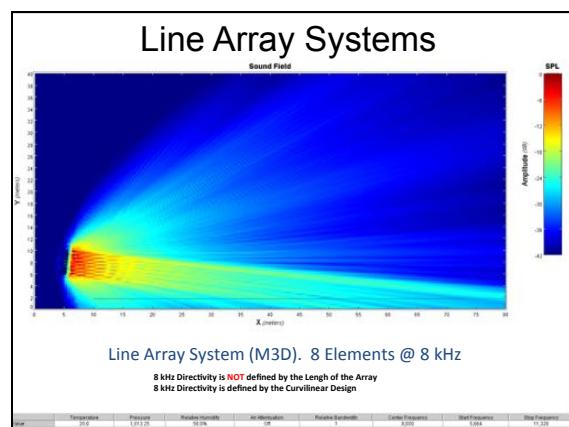
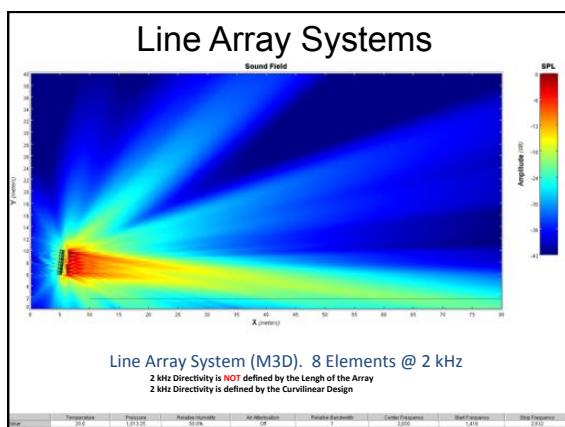
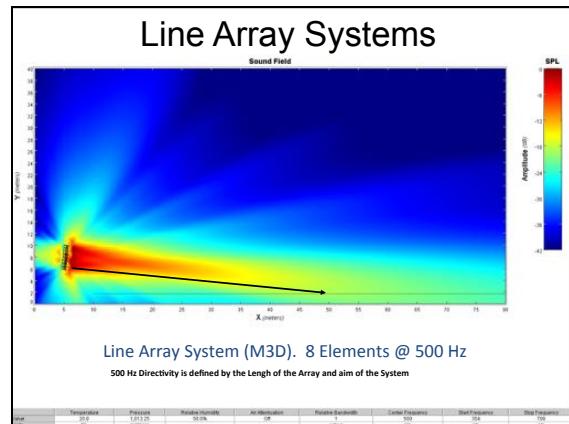
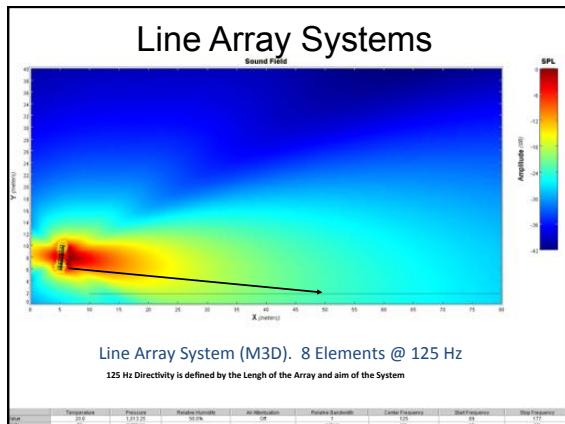
The directional characteristics of a line source as a function of the length and the number of sources are shown in Fig. 2.4. The sound pressure for the angle  $\theta = 0$  is arbitrarily chosen as unity.

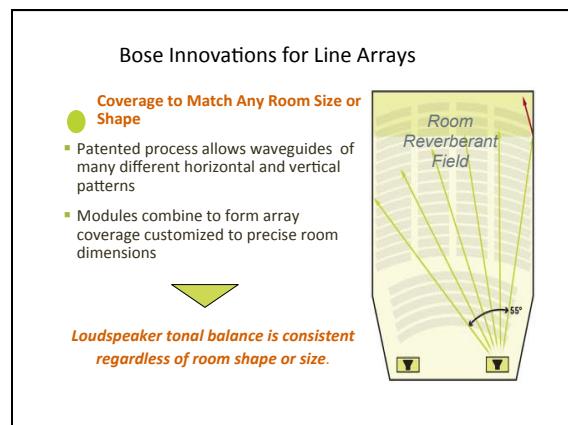
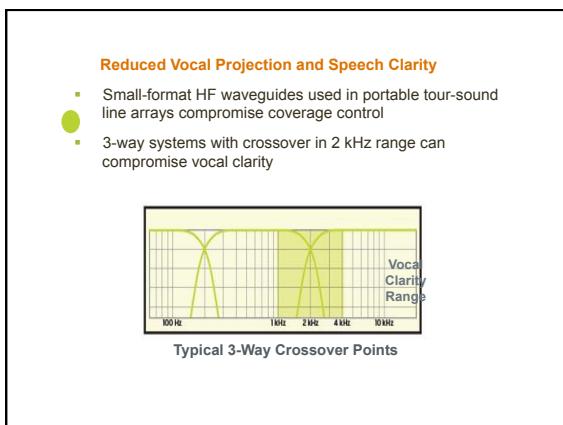
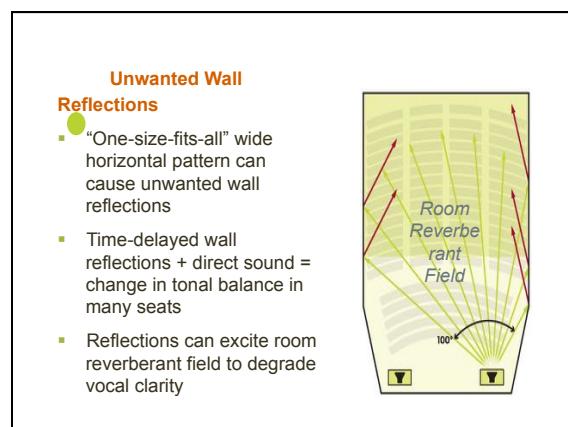
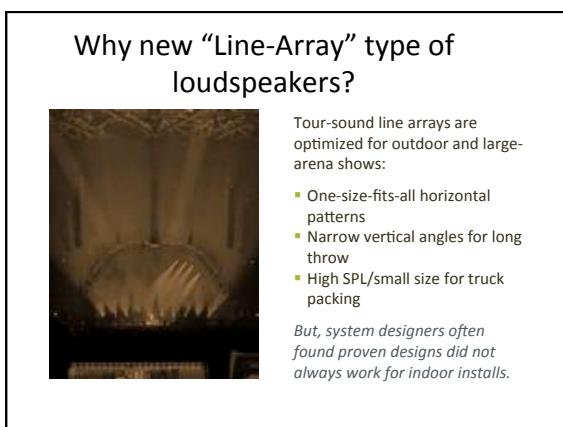
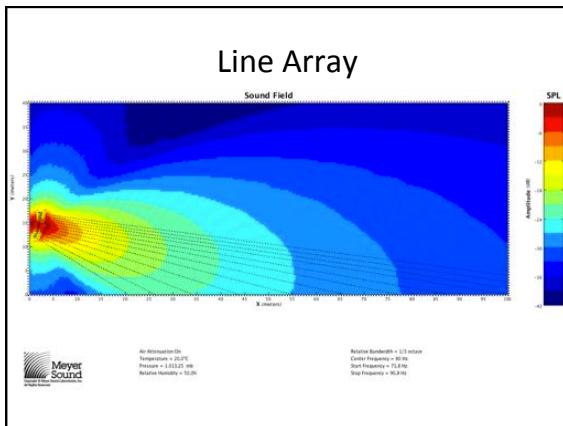
Comparing Fig. 2.4 with Fig. 2.3 it will be seen that there is practically no difference when the length of the source is small compared with its width.

On the other hand, the directional characteristics are sharp when the length of the line is several wavelengths.









### Bose Innovations for Line Arrays

**Coverage to Match Any Room Size or Shape**

The first plot shows a room with a blue-to-red color scale indicating sound pressure level. The second plot shows a similar room with a more uniform green-to-yellow color scale, indicating improved coverage matching.

### Bose Innovations for Line Arrays

**High-Frequency Summation for Large Vertical Angles Without Array "Seams"**

- New acoustic design provides coherent wave front summation of all modules for all arrays
- Design maintains equal spacing for HF sources in arrays without need for splay angles

*Sound quality is consistent seat to seat, even with large vertical coverage angles.*

### Bose Innovations for Line Arrays

**Large-Format Waveguides with 500-Hz Crossover**

- Large-format waveguides for horizontal control in vocal clarity range
- 500 Hz and above from waveguide – no polar lobing in vocal range
- *Improved vocal projection and speech clarity*

The graph shows a sharp peak in the vocal clarity range between 1000 Hz and 4000 Hz, with a grid below it labeled 'Vocal Clarity Range'.

**Large-Format HF Waveguide**

### Shape the sound to the room

- Can vary both H and V patterns per module
- Narrow patterns at top of array for long throw
- Wide patterns at bottom of array for short throw
- Customized Coverage
- Directivity Index (DI) set far/near distance levels

### Progressive Directivity Array

**Choose horizontal AND vertical pattern for EACH module**

- Narrow horizontal and vertical patterns for top modules
- **Progressively** wider patterns for bottom modules
- Better match array coverage to room dimensions
- Directivity (Q) differences equalize front-to-back levels

**High efficiency**  
**All AMP channels run @ 100%**

### Scalable Coverage and SPL

Array Configuration (Total Vertical Angle)	(0) Degrees	(10) Degrees	(20) Degrees	(30) Degrees	(40) Degrees
SPL @ 25M (RMS) (Calculated)	98 dB	100 dB	110 dB	120 dB	125 dB
Pattern Control Frequency	500 Hz	300 Hz	250 Hz	200 Hz	180 Hz
Performance					
Horizontal Coverage Quality	Good	Excellent	Excellent	Excellent	Excellent
Vertical Seam Quality	Good	Good	Excellent	Excellent	Excellent
Evenness of SPL	Good	Excellent	Excellent	Excellent	Excellent
Acoustic Efficiency	Good	Good	Excellent	Excellent	Good
Cost	1	X 1.5	X 2	X 2.5	X 3

### RoomMatch™ Waveguide System

- 42 coverage patterns for precise coverage of almost any room
- Typical line arrays offer only 1 horizontal coverage pattern!
- Competitive Point and shoot devices typically have 3-4 patterns
- Only loudspeaker series that spans 55x5 to 120x60 coverage

### RoomMatch Asymmetrical Array Modules

- Horizontal differs left vs. right of center
- All other specs same as current modules

*For many rooms, especially long, narrow:*

- Better coverage for L+R arrays
- Enhanced stereo soundstage effects
- Reduced need to "yaw in" arrays for better aesthetics and ease of installation

Bose Professional Systems Division

### Total of 42 different RoomMatch Modules

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### System Design Concept Capitole/Gent

#### FLEXIBILITY

1 installation for different configurations and applications:

- Standard L/R
- Standard L/R with Separate Sub Send (Mono)
- Standard L/R with Separate L/R Subb
- Left – Center – Right (center as mono mix from L/R)
- Left – Center – Right (Center as a separate mix)
- Left – Center – Right – Subb (Mono)
- Left – Center – Right – Subb L/R
- Complex Band/Vocal system drive for Musical Theatre

### System Design Concept Capitole/Gent

#### FLEXIBILITY

- Speaker settings (X-over, internal delay & level between drivers and limiters) are stored in the BOSE-amplifiers
- System settings (Level, delay, Eq for the system sub-systems) are stored in a separate system controller: Galileo Calisto 616

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### System Design Concept Capitole/Gent

#### FLEXIBILITY

- Visiting productions can connect via AES-3 and Analog through 6 different inputs
- Visiting productions can make their own system drive configurations from input to output
- Visiting productions have full access and control over all system related settings

