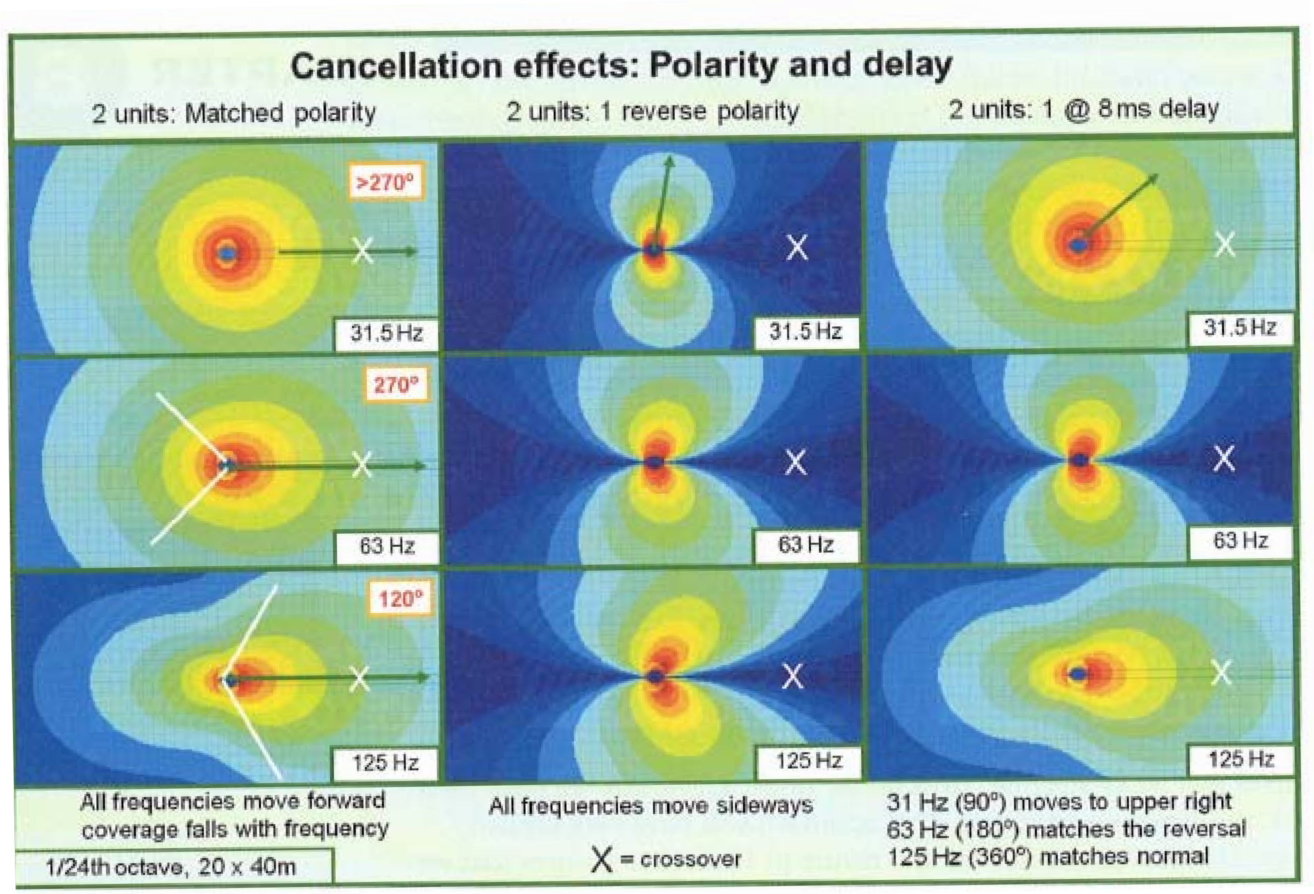
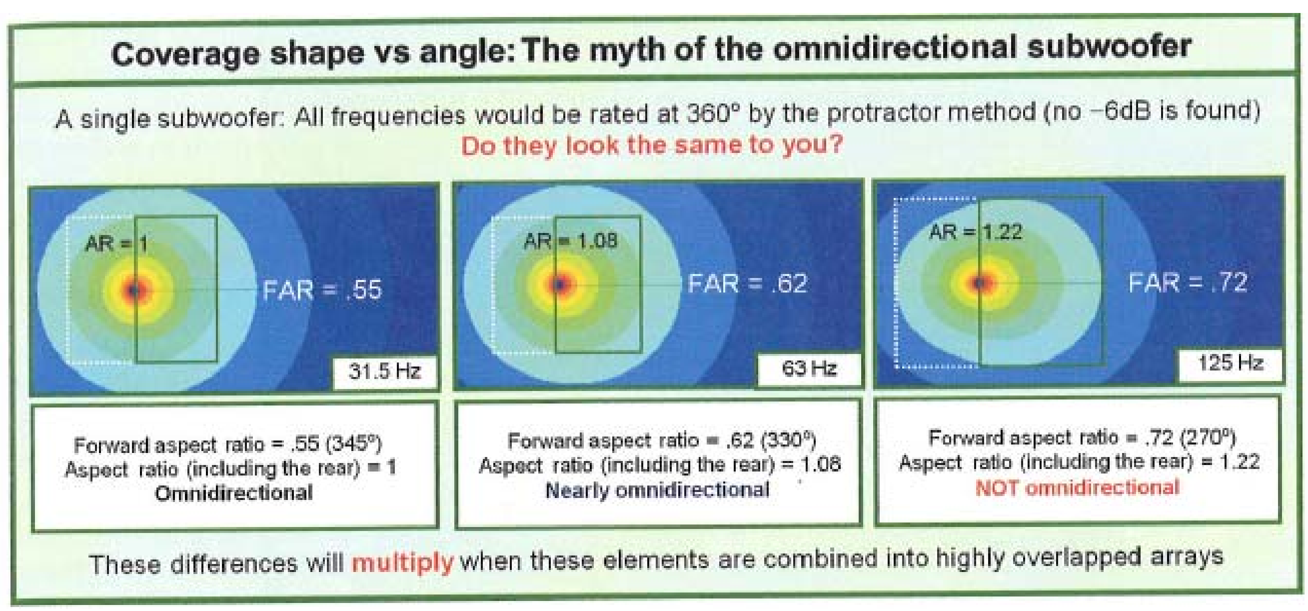
Lecture Summary – Cancellation (Steering)

Chapter 10

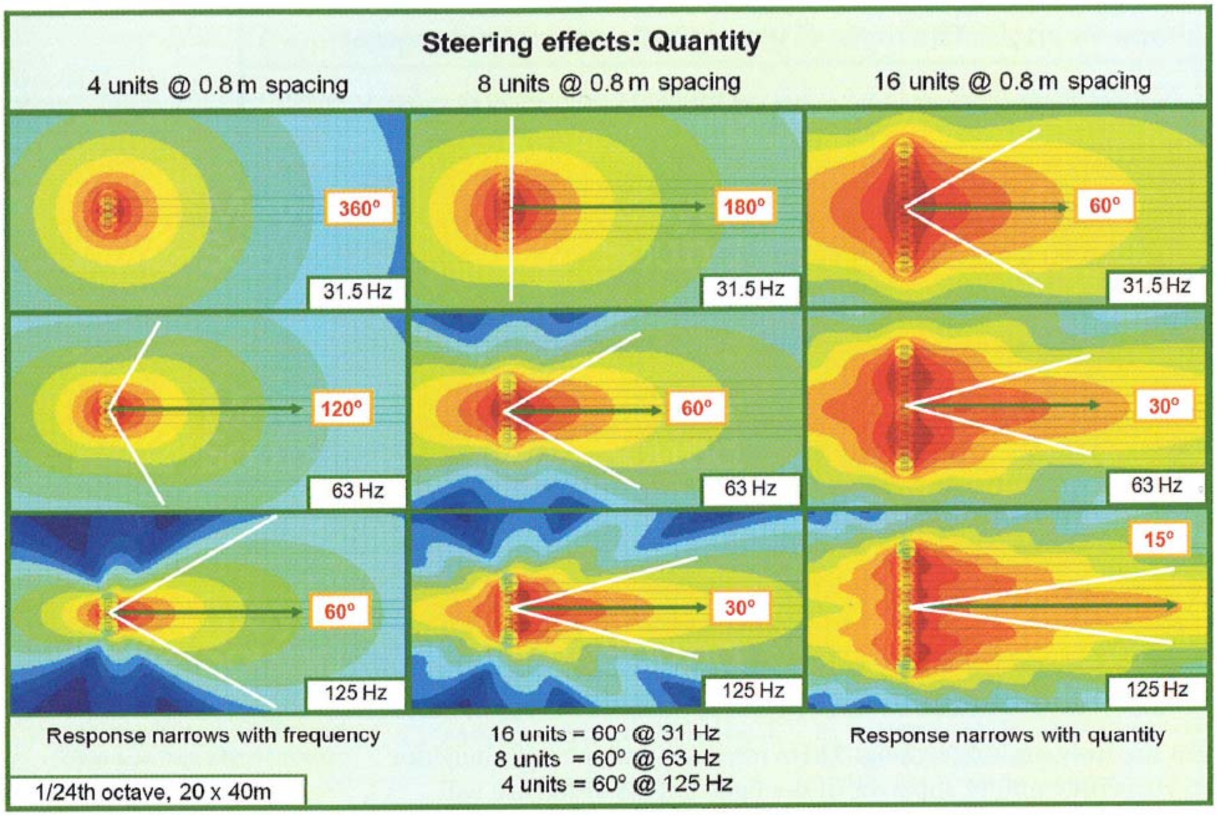
- **cancellation effects**



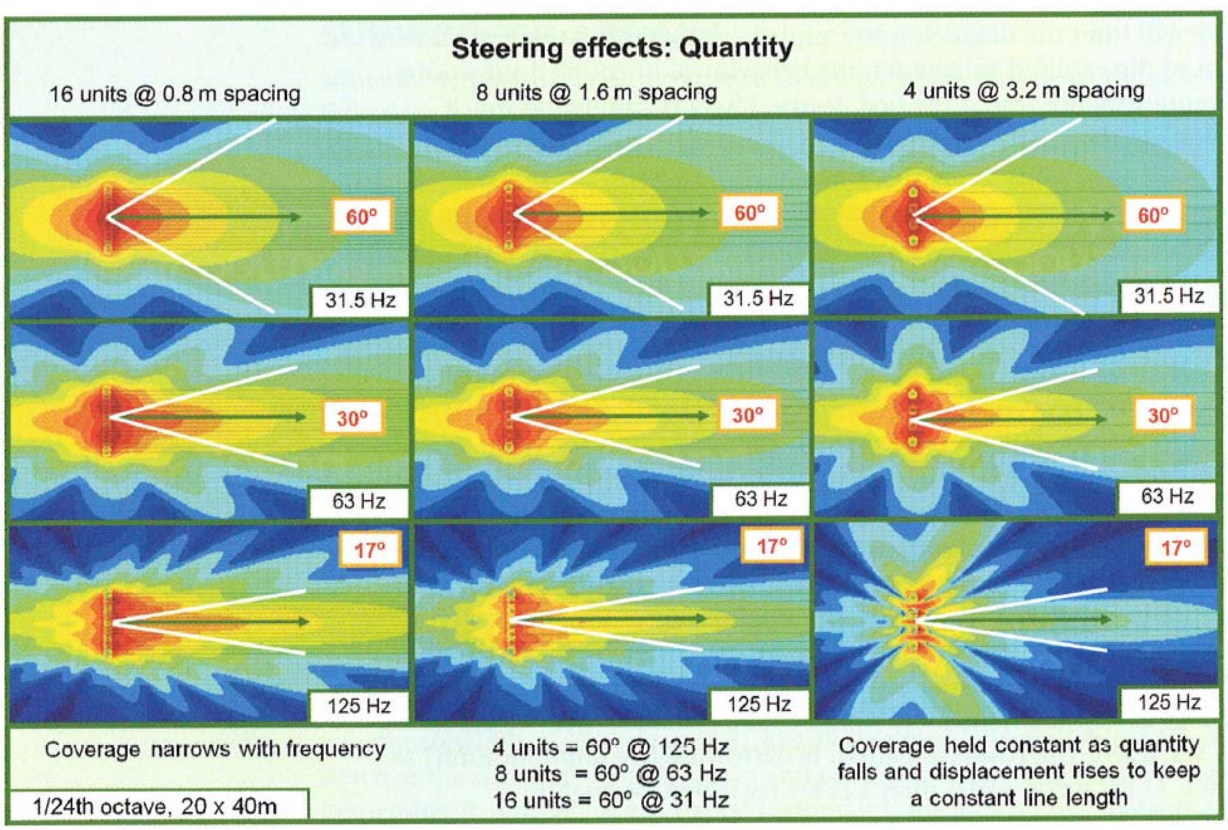
- **coverage shape and angle**



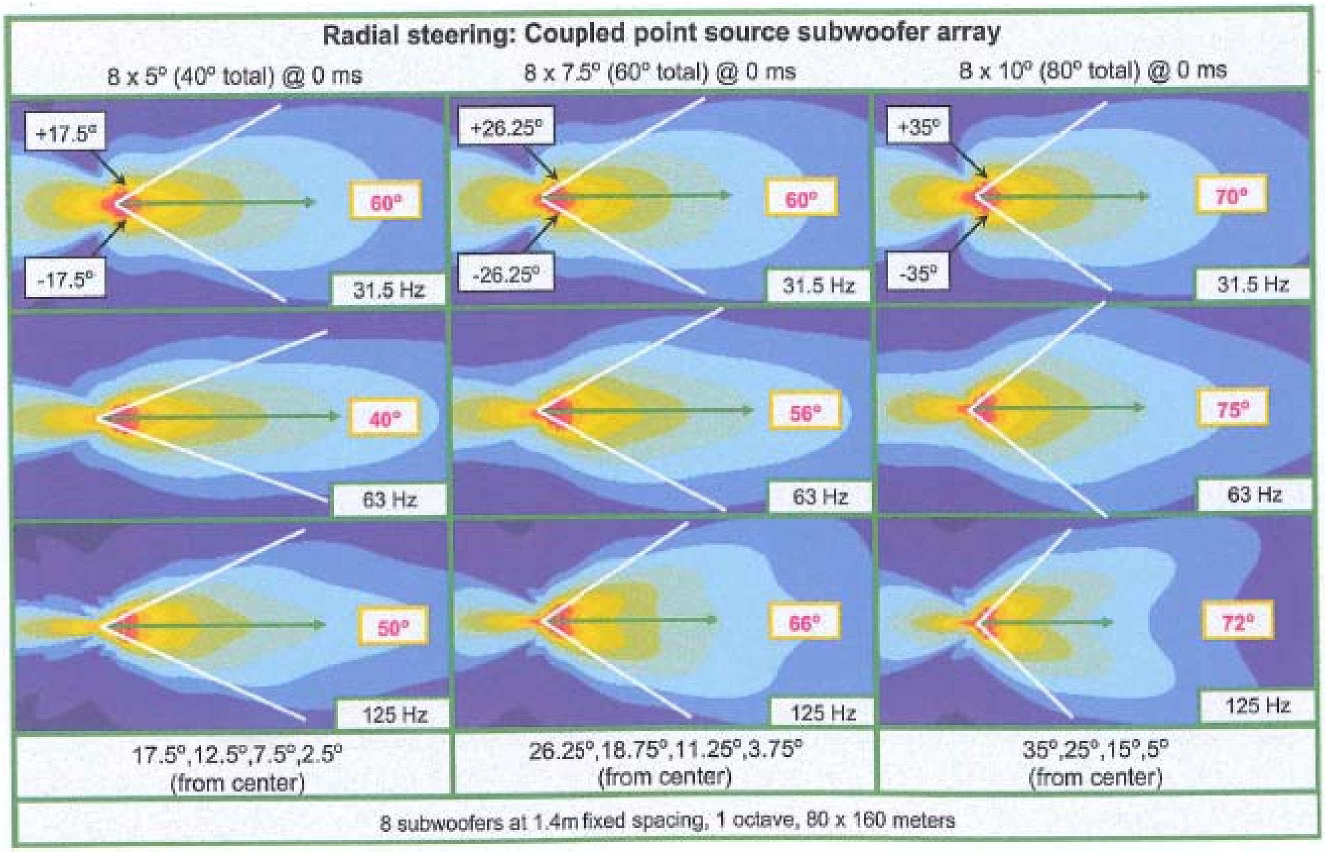
- **quantity effects – "steering" (more like *focusing*) a coupled line source arrays of subs**



- **spacing effects – "steering" (more like *focusing*) a coupled line source arrays of subs**

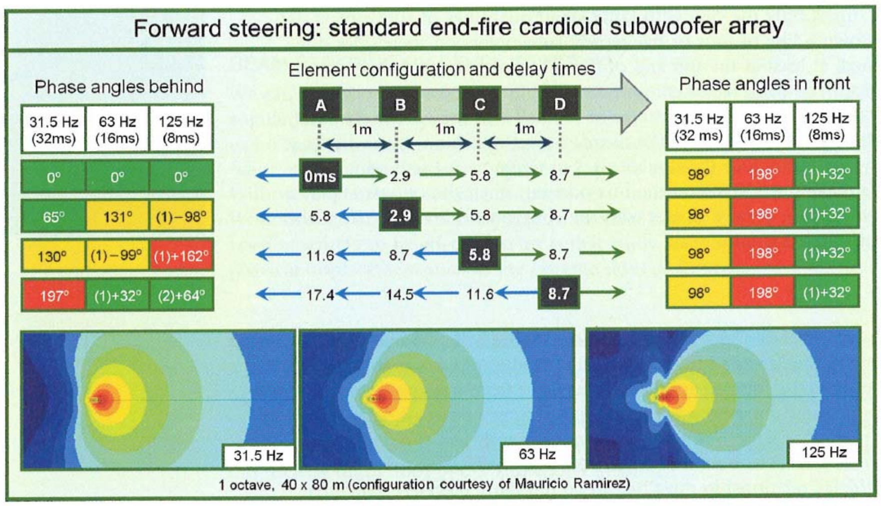


- **radial effects – "steering" a coupled point source sub array (but…the beamwidth of the subwoofer array rarely needs to be made wider!)**

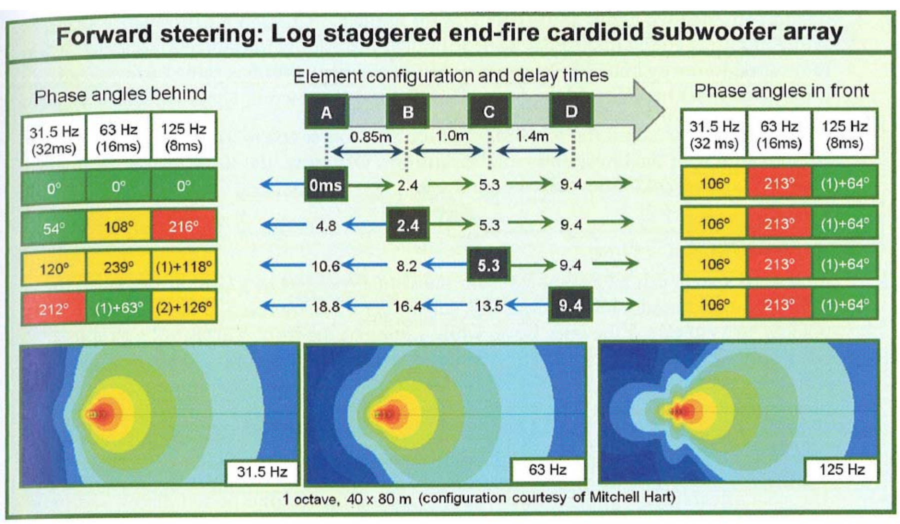


- **cardioid subwoofer arrays**
  - **reduce stage leakage (≥ 20 dB front/back ratio)**
  - **rear/side control reduces early house reflections**
  - **steering reduces horizontal coverage in addition to rear coverage**
  - **price is efficiency loss (reduced maximum SPL), compared with all subwoofers in phase acting as a block**
  - **extra space/special rigging required**
  - **not always applicable (no need to cancel rear if speakers are against a wall)**
  - **potential compromise in transient response ("tightness")**
  - **two cardioid configurations are in common use**
    - **end-fire (front-steered)**
    - **gradient (rear-steered)**

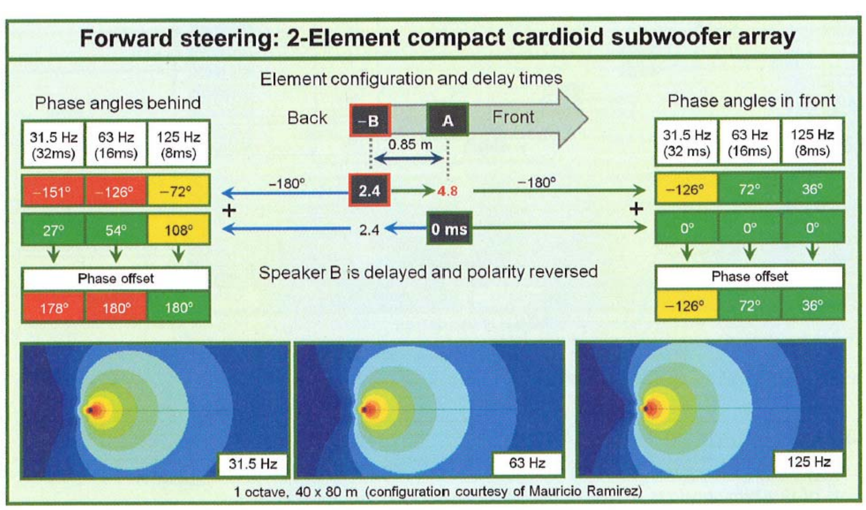
- **forward steering**
  - **end-fire cardioid subwoofer array**



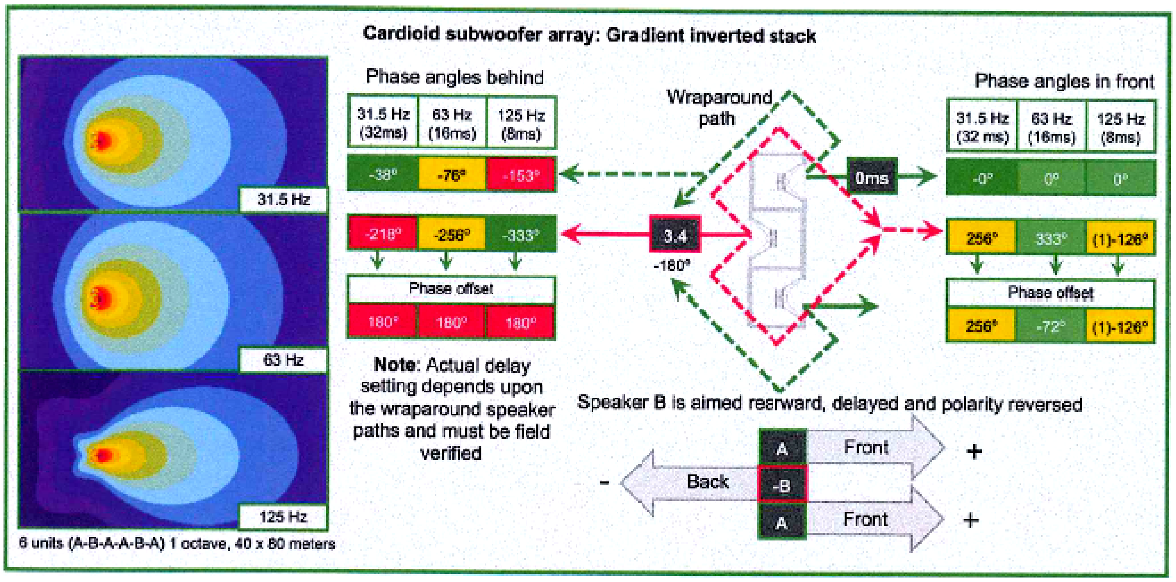
  - **log-staggered end-fire cardioid subwoofer array**



  - **(compact) gradient in-line cardioid subwoofer array**

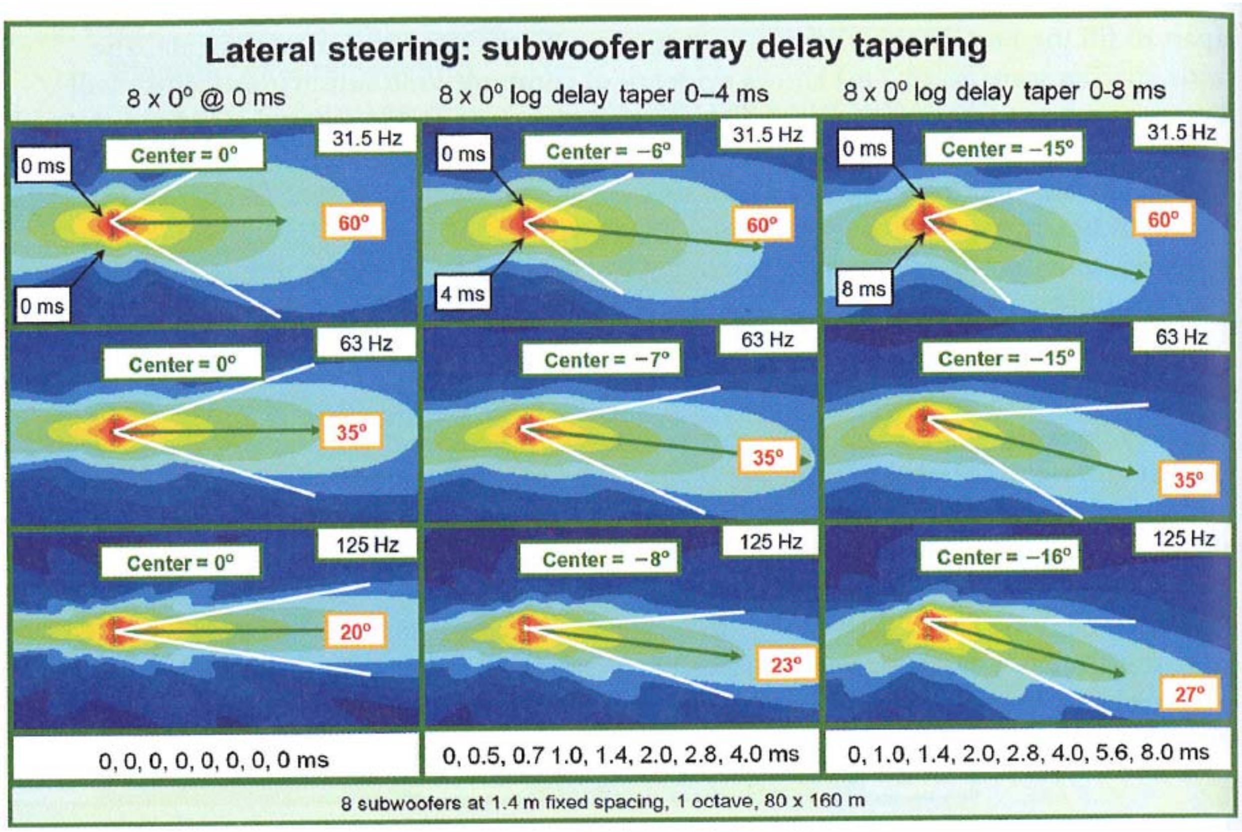


- **gradient inverted stack cardioid subwoofer array**



2 wide, 4 element end-fire array outdoors

- **lateral steering of line source sub array**



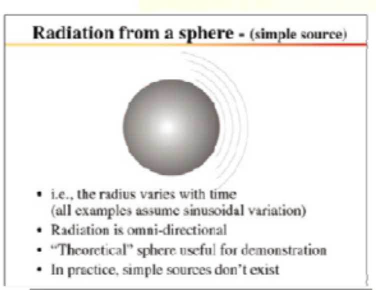
- **delay (beam) steering – not a "new idea"… (discussion in text limited to subwoofer arrays)**

The angle θ, the angle by which the wavefront is shifted by the delay system, is given by

$$\theta = \sin^{-1}\frac{x}{d} \qquad 2.26$$

where d = distance between the units, in centimeters.

Phase shifting can be used in many other ways besides beam tilting. For example, practically any wavefront shape can be obtained by introducing the appropriate phase shift in the sound sources.



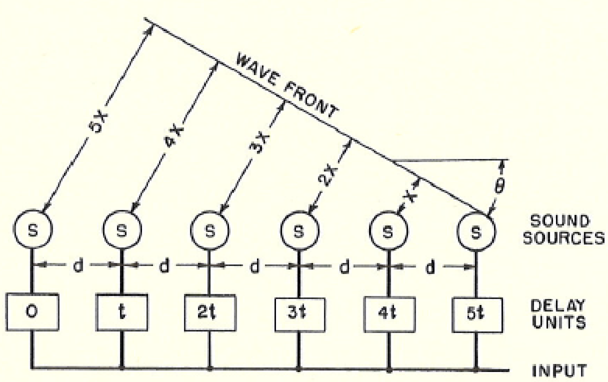
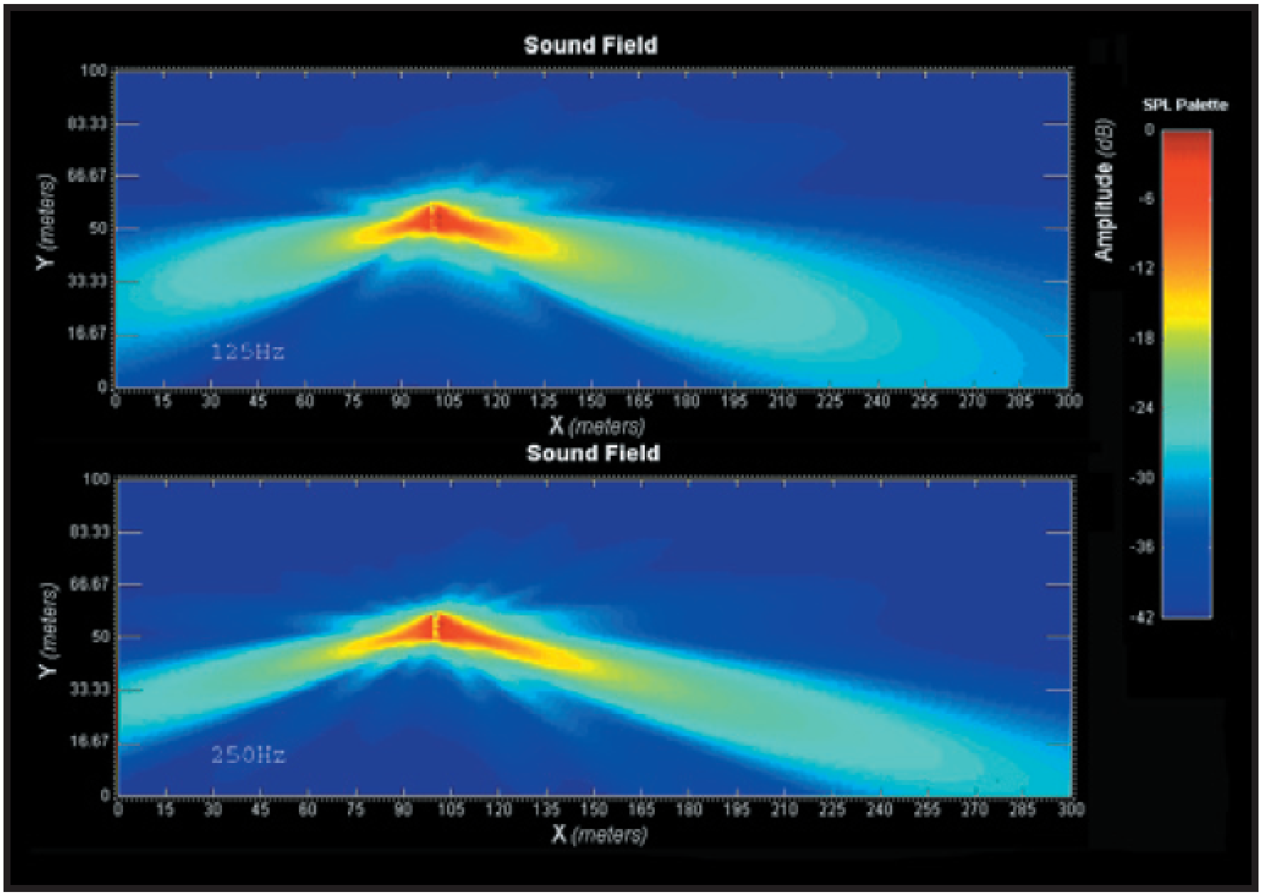
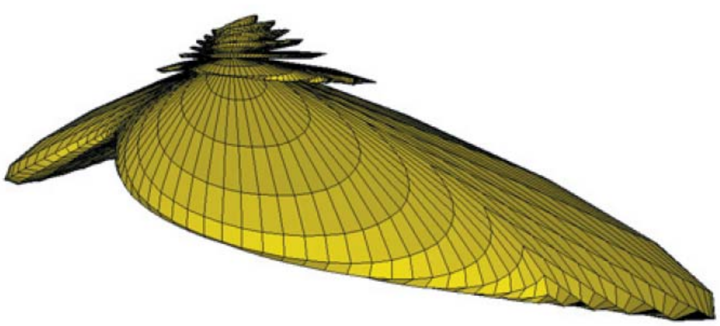


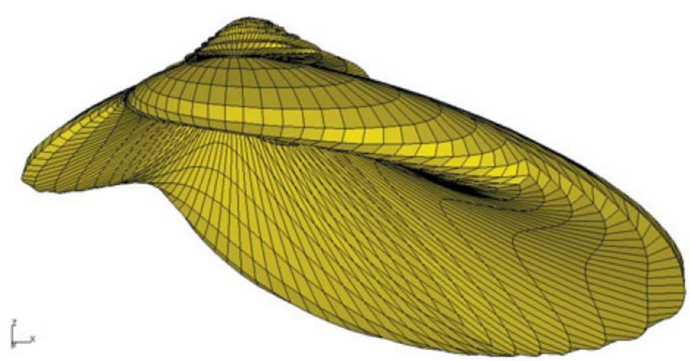
FIG. 2.5. A delay system for tilting the directional characteristic of a line of sound sources.

Note: Only works "well" when elements approximate "point" sources ("non-point-source" behavior of elements leads to generation of *grating lobes*)

- **problem of back lobes (Ref: *DSP Beam Steering with Modern Line Arrays*, Meyer Sound White Paper) – the back lobes get "steered down" too (but that assumes a certain degree of "silliness" in wanting to "fly" an array like this!)**

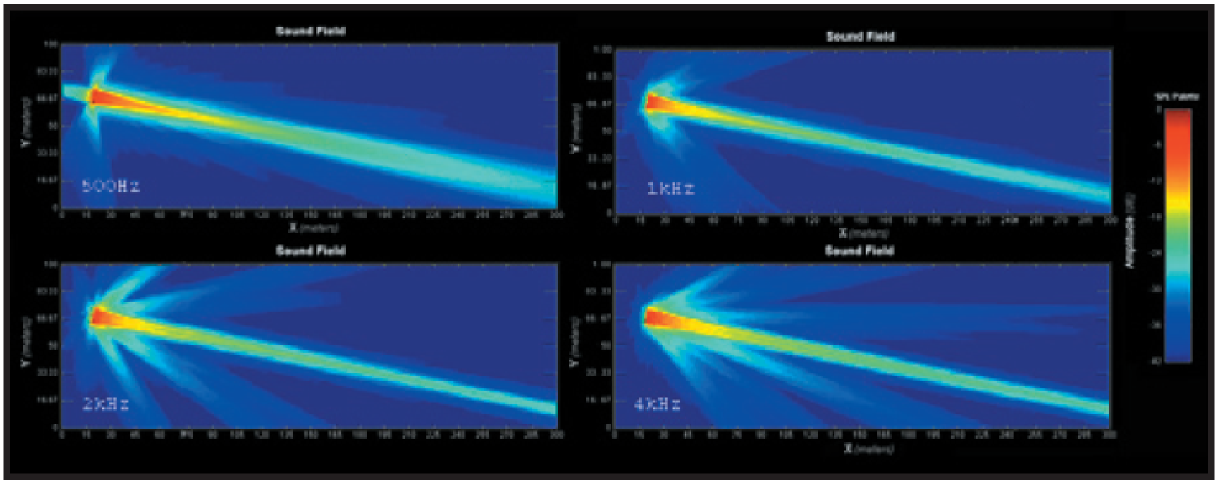


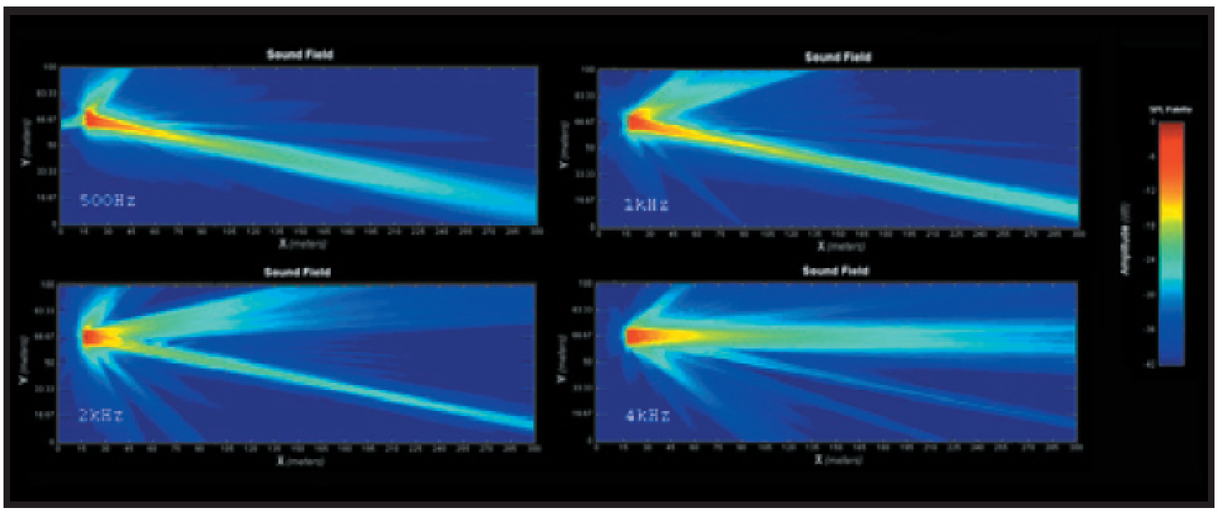


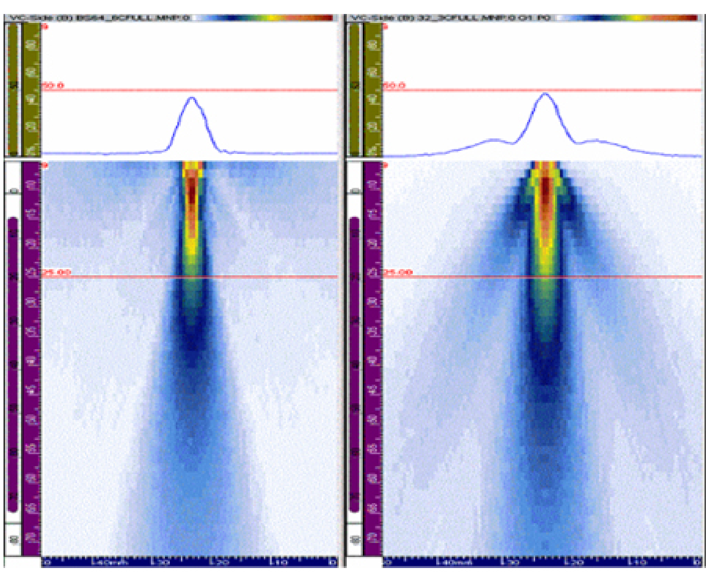


Tilting the cone up to look underneath…

- **problem of grating lobes**





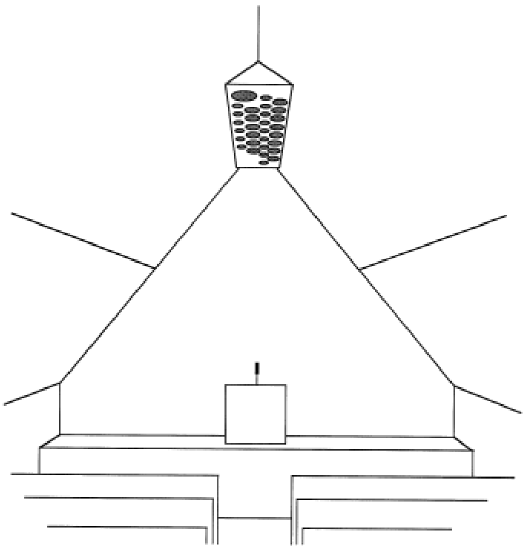


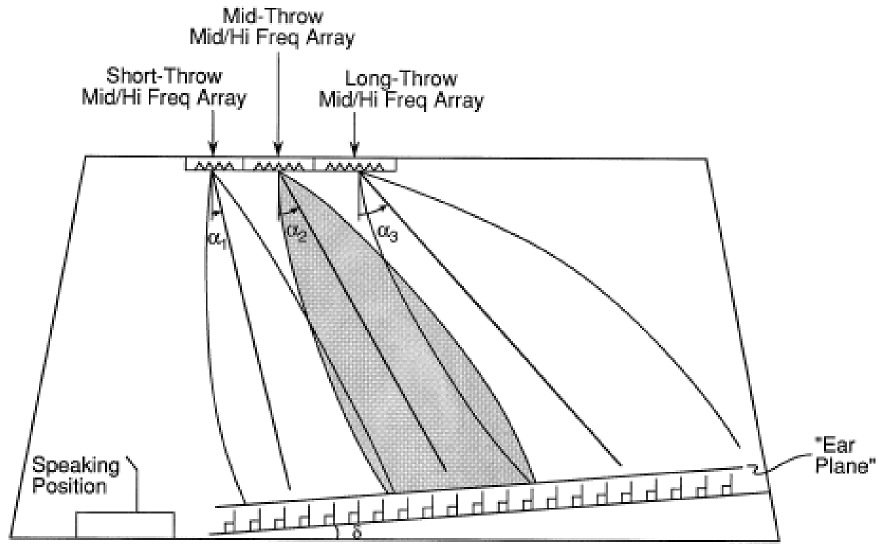
6 elements, 0.4 mm pitch   3 elements, 1 mm pitch

Grating lobes are caused by the non-point source behavior of elements. *Grating lobes will occur whenever the size of individual elements in an array is equal to or greater than the wavelength, and there will be no grating lobes when element size is smaller than half a wavelength. (For element sizes between one-half and one wavelength, the generation of grating lobes will depend on the steering angle.)*

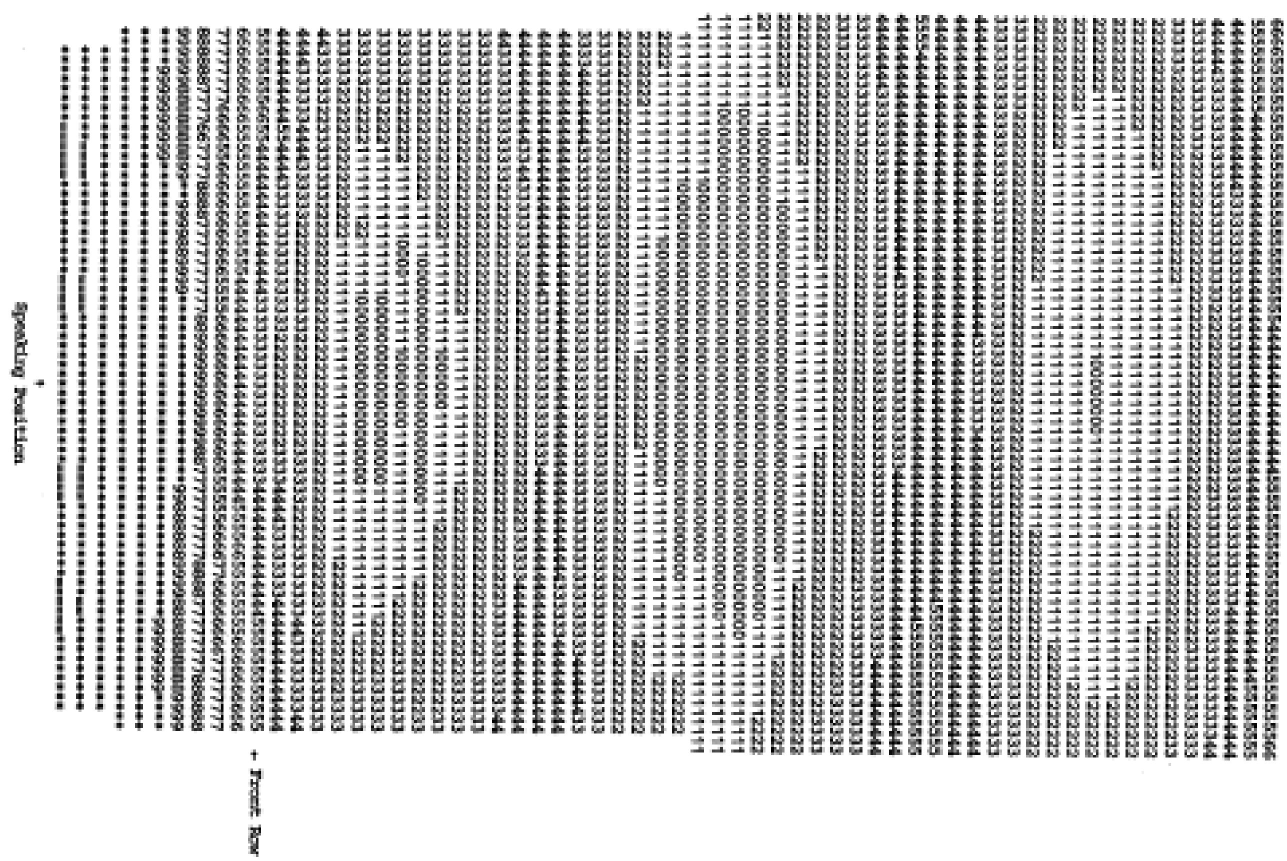
The amplitude of grating lobes is significantly affected by pitch size (element-to-element spacing), the number of elements, frequency, and bandwidth.

- **application: electronically steered arrays**

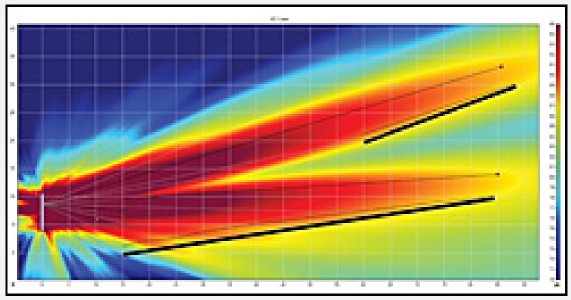




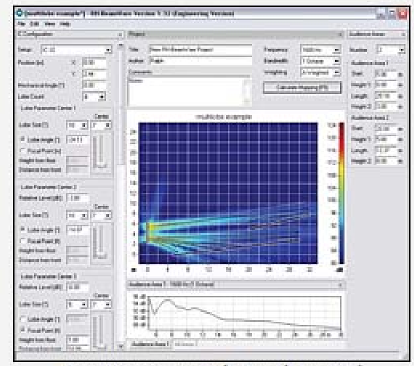
- **virtual loudspeaker aiming**



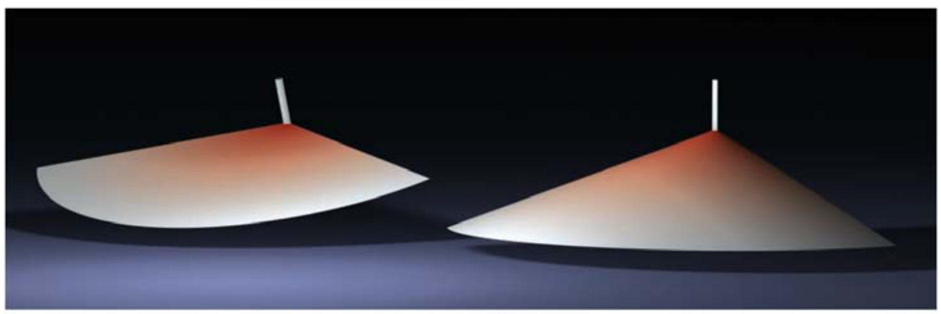
- **Renkus-Heinz ICONYX**



BeamWare lets you program array coverage and shape it to the audience before you load the truck



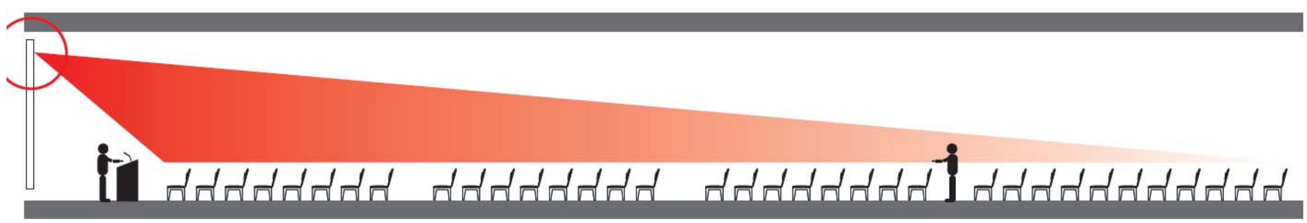
BeamWare 2 - Complex mathematical calculations behind an intuitive GUI



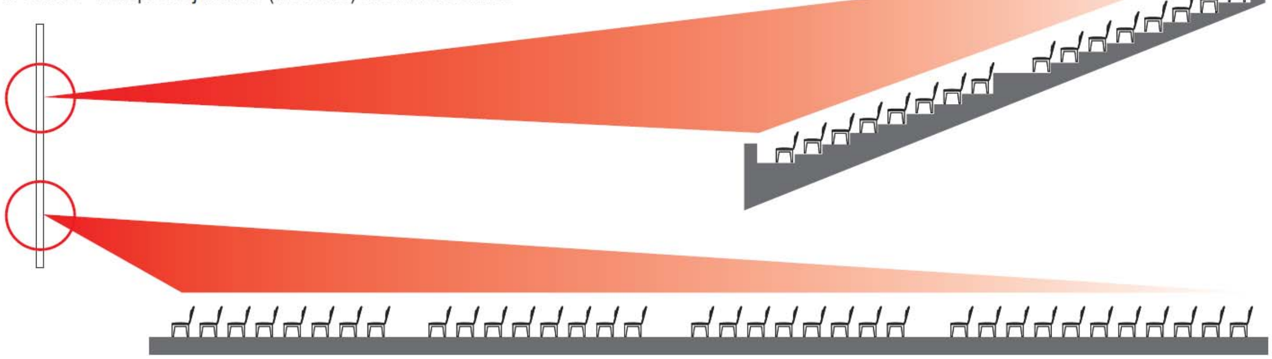
Passive Column tilted down

Iconyx Column steered down

ICONYX - Adjustable (Movable) Acoustic Center



ICONYX - Multiple Adjustable (Movable) Acoustic Centers



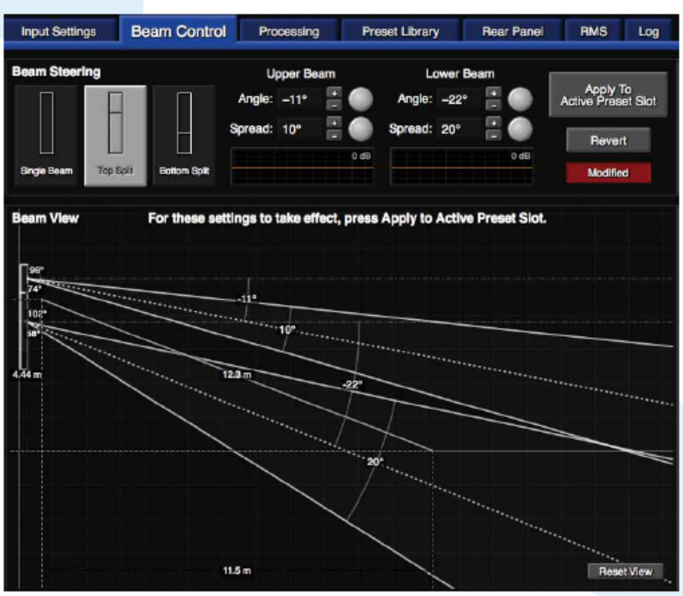
- **Meyer (no relation) Sound Steerable CAL Column Array Loudspeaker**
- *"CAL is a digitally steerable column array product in which all high-frequency and low-frequency drivers are tight-packed in a bi-amped configuration and are individually amplified and processed."*

CAL's adjustable beam height and steering allow flexible installation options without compromising speech intelligibility. Cabinets may be placed higher up, as normally preferred for aesthetics, security, and free pedestrian transit. At the same time, the sound can be precisely steered to target pedestrian level while avoiding hard surfaces, thus minimizing destructive reflections.

The close spacing of independently controlled drivers combined with proprietary signal processing enables accurate beam forming.

Features & Benefits

- Variable vertical coverage from 5° to 30°
- 60° of vertical beam steering, ±30° *
- Custom-built drivers and tweeters designed and optimized for beam steering
- Every driver and tweeter has dedicated amplifier channel and processing
- The best algorithms utilized based on years of research into sound field synthesis
- Low profile, discreet aesthetics, custom colors and weather protection
- AVnu Alliance certification ensures seamless interoperability with other certified AVB devices



The Beam Control tab displays CAL's vertical beam coverage (spread) and vertical steering, both of which can be altered by entering angle values or by dragging in the beam view area. Split beams can also be configured on the Beam Control tab (CAL 64 and CAL 96 only).