RBA-11-002-IP A presentation on www.akutek.info :

The Scattering from Reflector Panels with Convex Edges

Jonathan Rathsam and Dr. Lily M. Wang

September 7, 2007

19th International Conference on Acoustics

Madrid, Spain

University of Nebraska

Overhead Reflector Panel

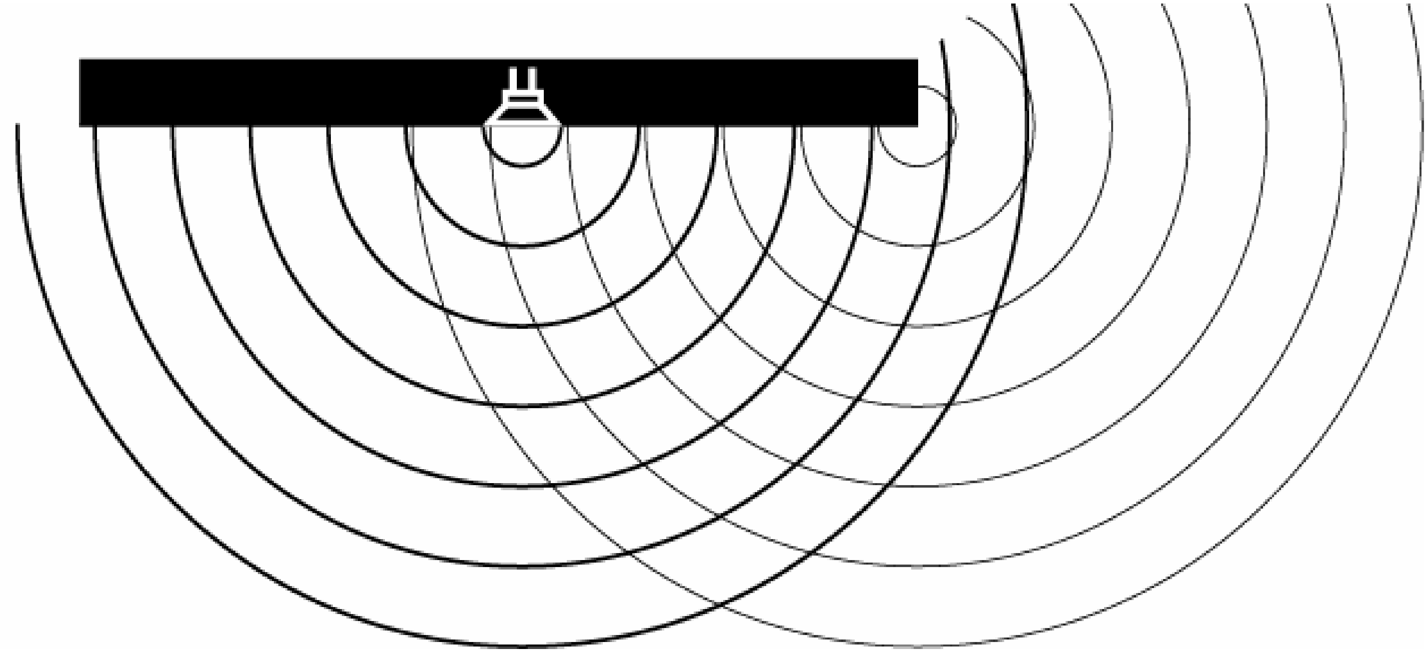
- Reinforces onstage sound sources
  - Provides early reflection to audience
  - Better communication on stage
  - Helps performer monitor own performance

Background: Boundary Wave

- A wave that emanates in all directions from the edge of a reflector
  - Maintain continuous sound field despite discontinuity in acoustical impedance

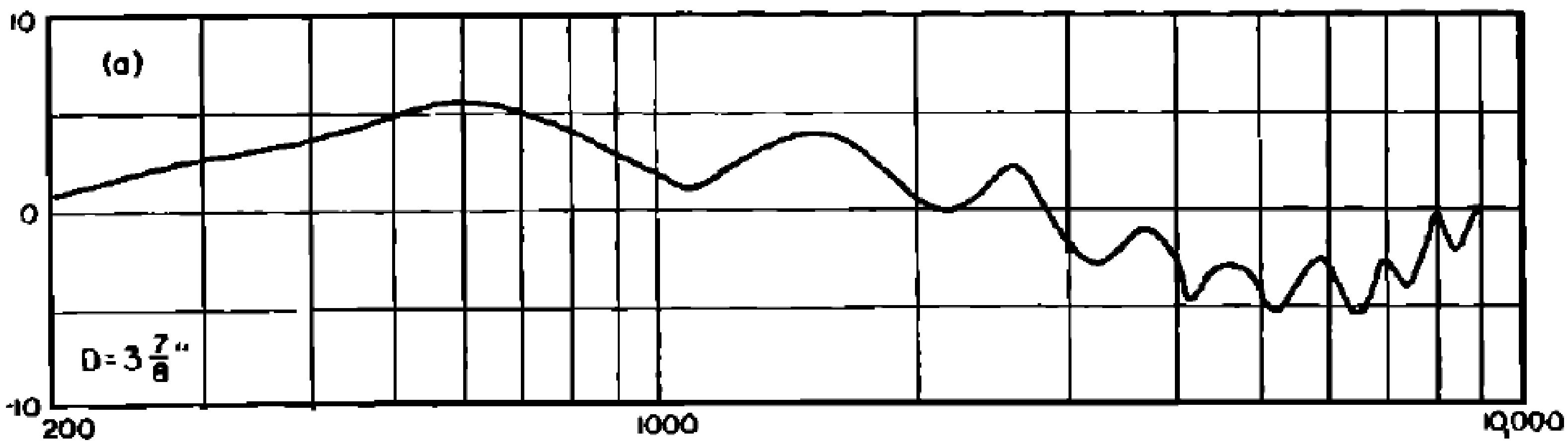
- Interferes with first order scattered (or radiated) energy to produce a comb filter

Boundary Wave (from loudspeaker)



Identification of Boundary Wave

- Nichols [1946] identified the “baffle effect” in loudspeaker measurements



Investigations on Loudspeaker Enclosures

- Olson [1969] investigated loudspeaker enclosures with various edge profiles
- A spherical loudspeaker box produced a smooth frequency response (the “baffle effect” or boundary wave was removed)

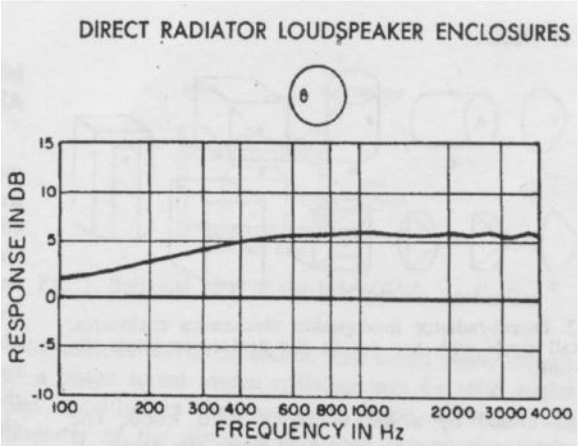


Fig. 6.

Research Question

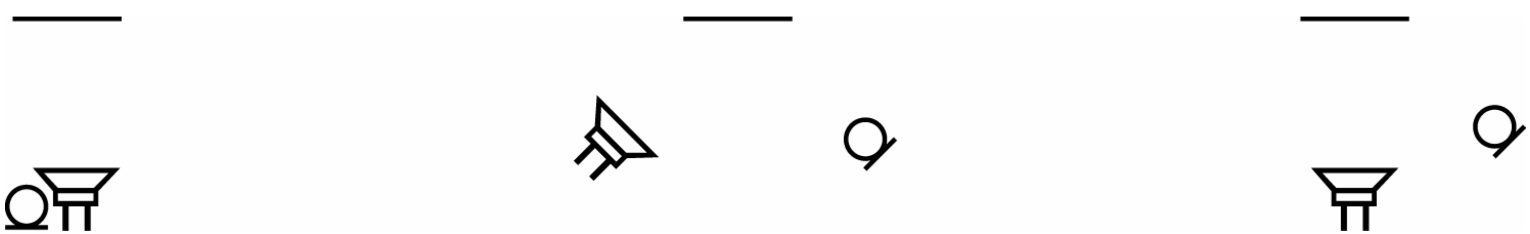
- What is the effect of adding convex edges to reflector panels?

Simulation Set-Up

- 2D / 3D Boundary Element Method (BEM)
- Sysnoise Rev.5.6
- 6 elements per wavelength
- Sources and receivers are located 15 m from reflector panel (typical distance in practice)

Results Divided into Two Sections:

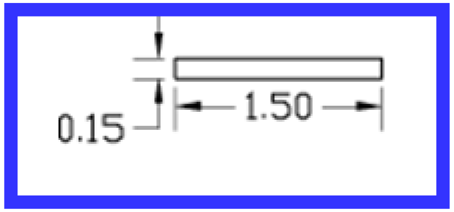
- Frequency response at a single receiver

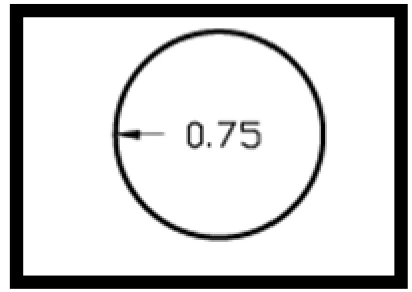


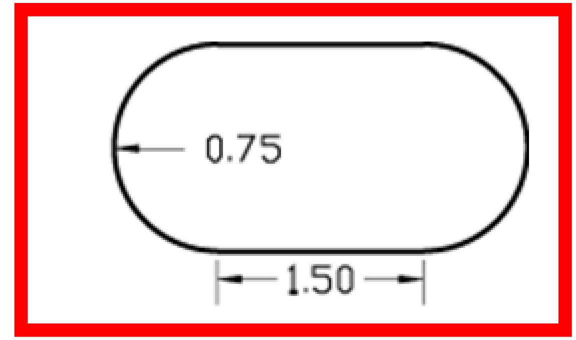
(*i*) (*ii*) (*iii*)

- Beam pattern (magnitude across a semicircular receiver array at a single frequency)

FLAT CIRCLE CONVEX

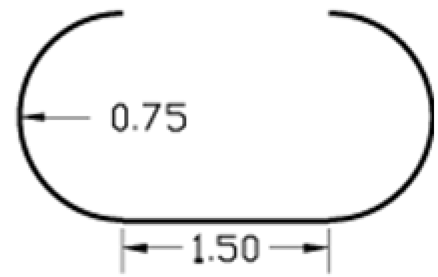


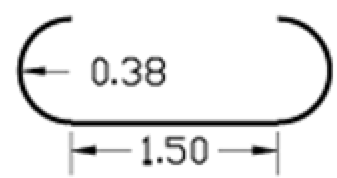




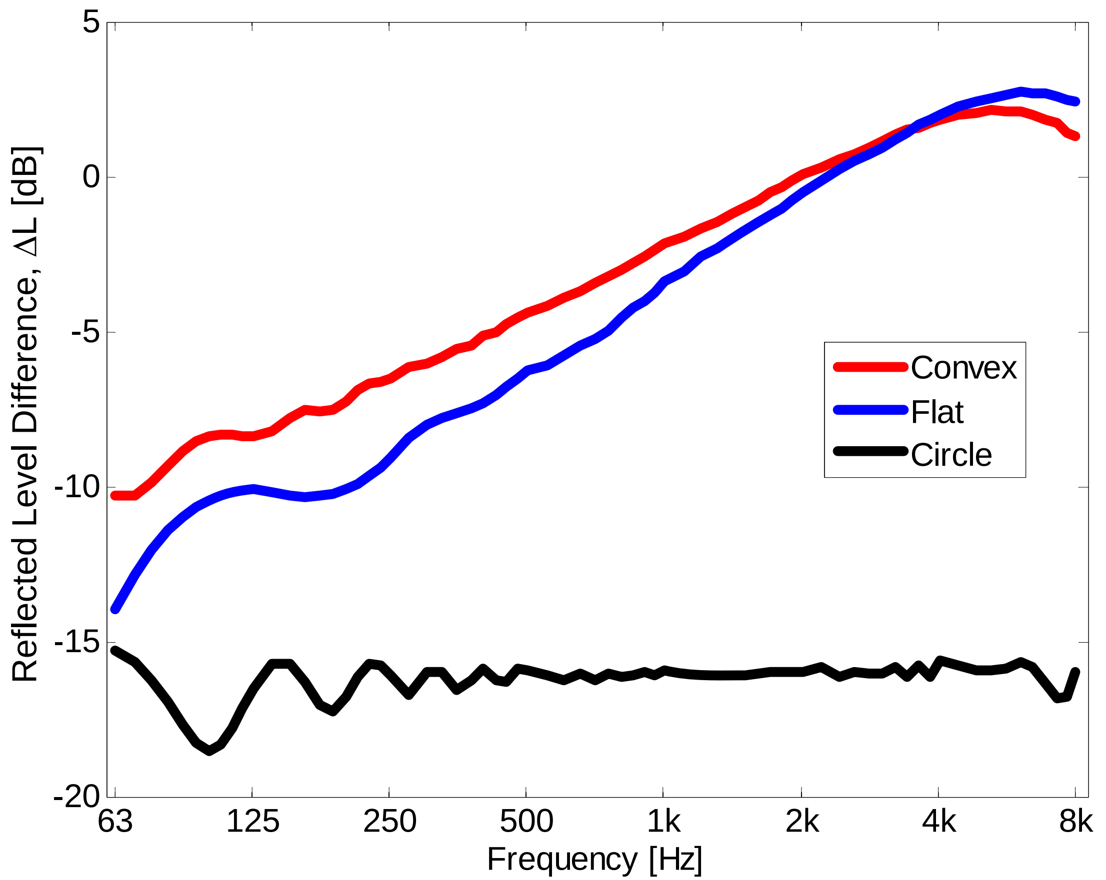
Panels Investigated

(all dimensions in meters)

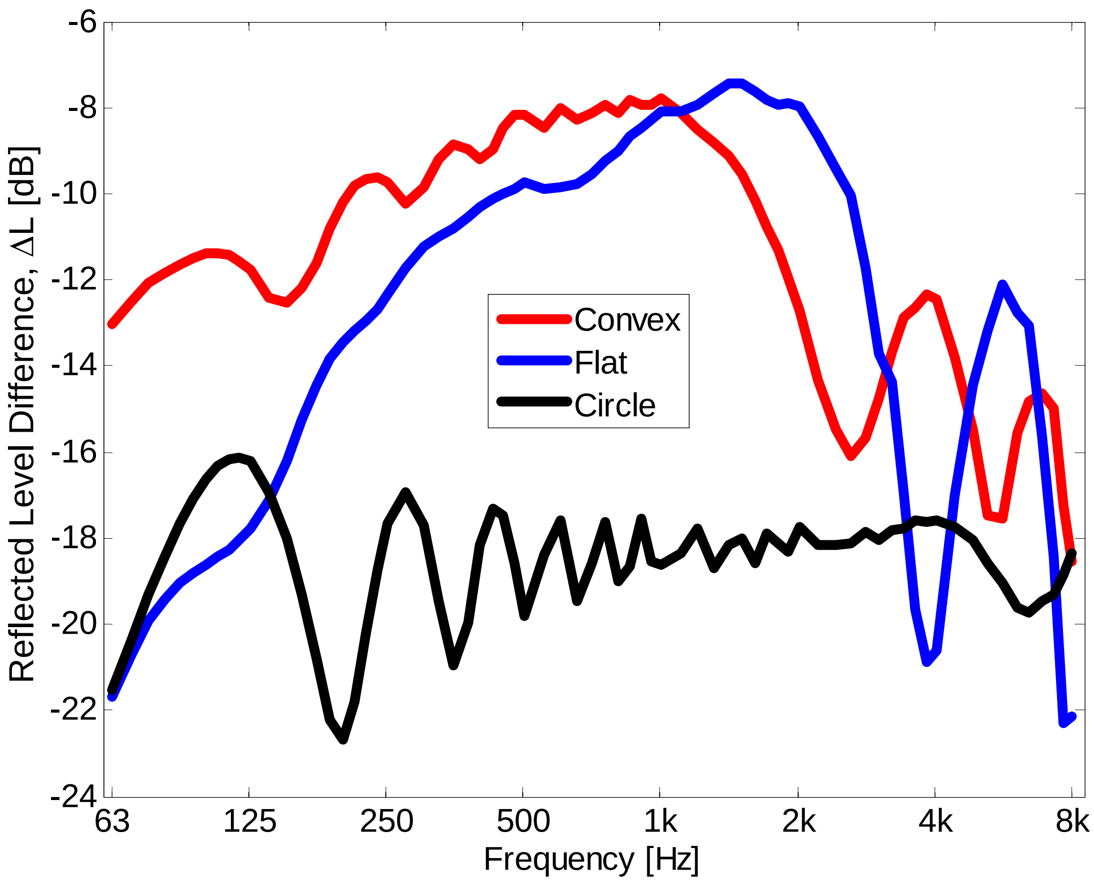


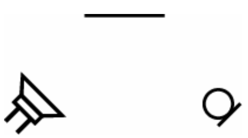


Results: Frequency Response *(i)*

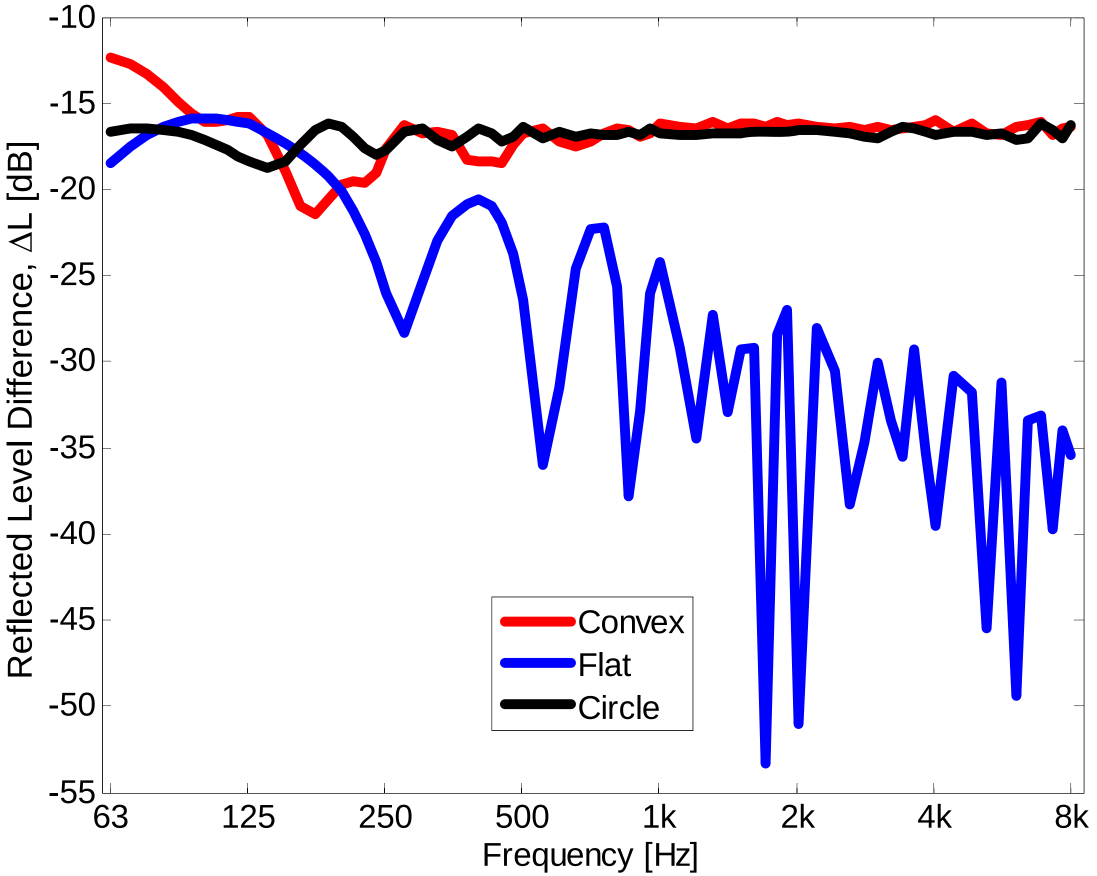


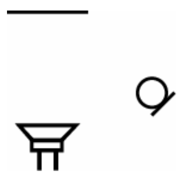
Results: Frequency Response *(ii)*





Results: Frequency Response *(iii)*

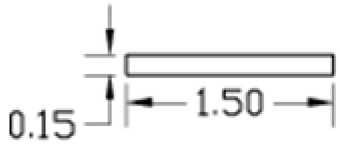


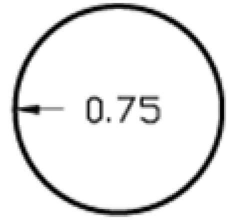


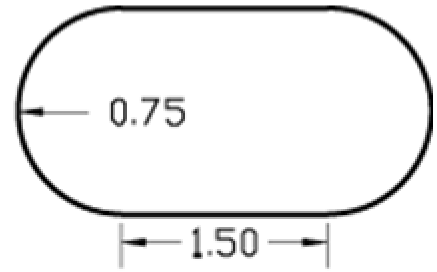
Summary: Frequency Response Results

- Panel with convex edges behaves like a
  - flat panel for specular reflections
  - round panel for nonspecular reflections

FLAT CIRCLE CONVEX

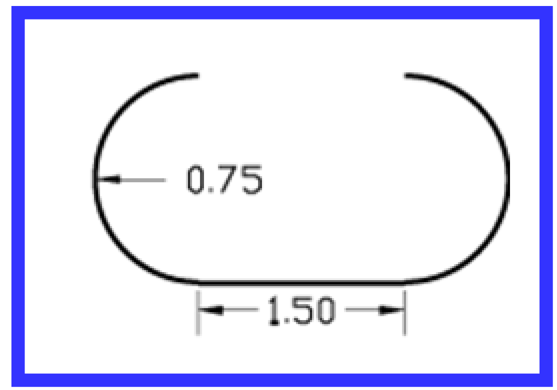


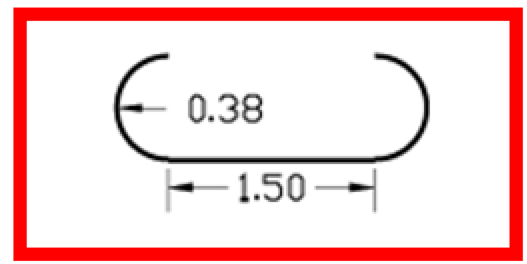


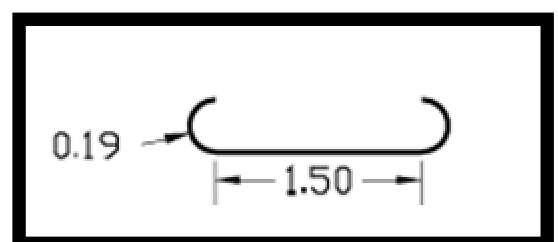


Panels investigated

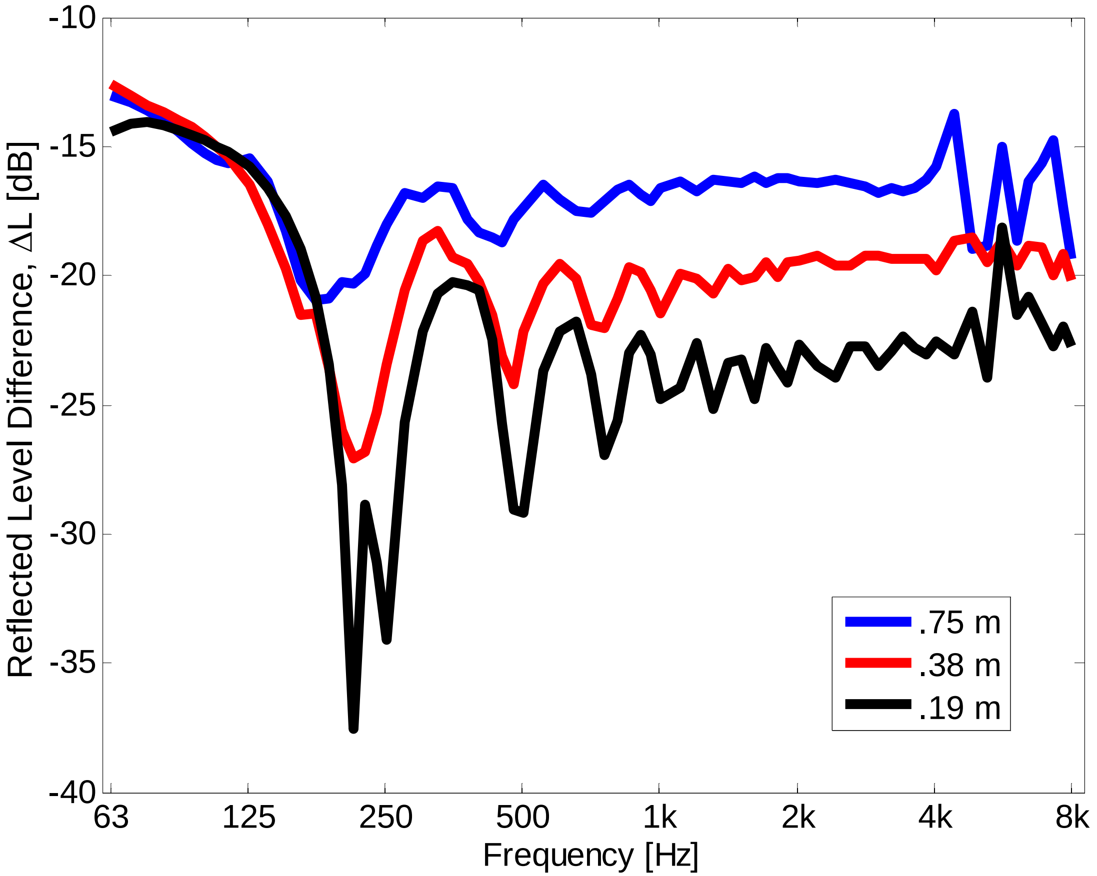
(all dimensions in meters)

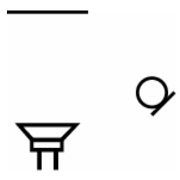




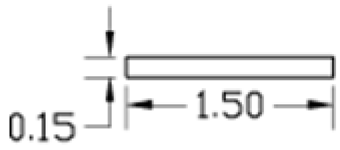


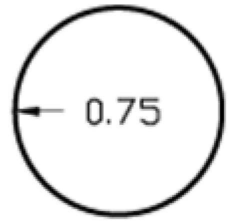
Frequency Response at various curvature radii

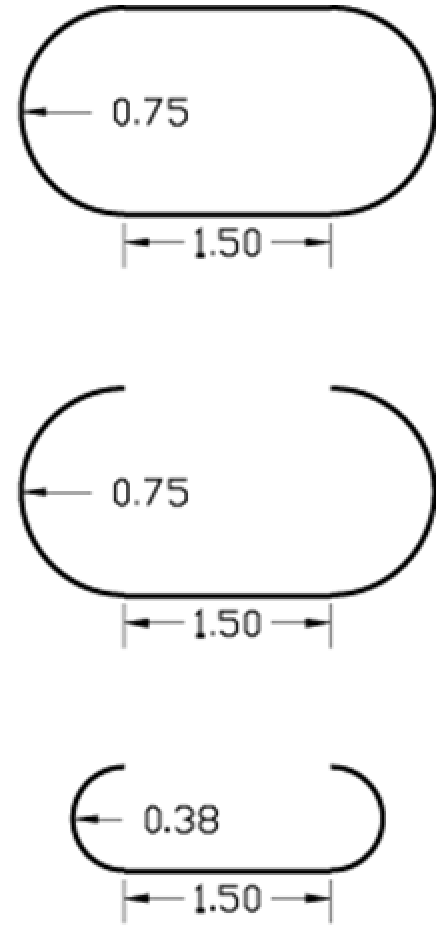




FLAT CIRCLE CONVEX

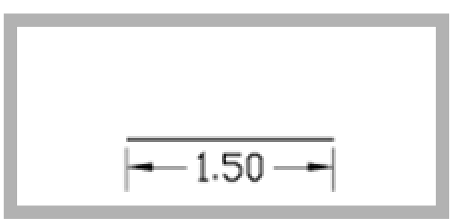


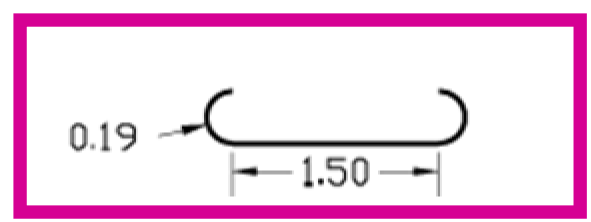




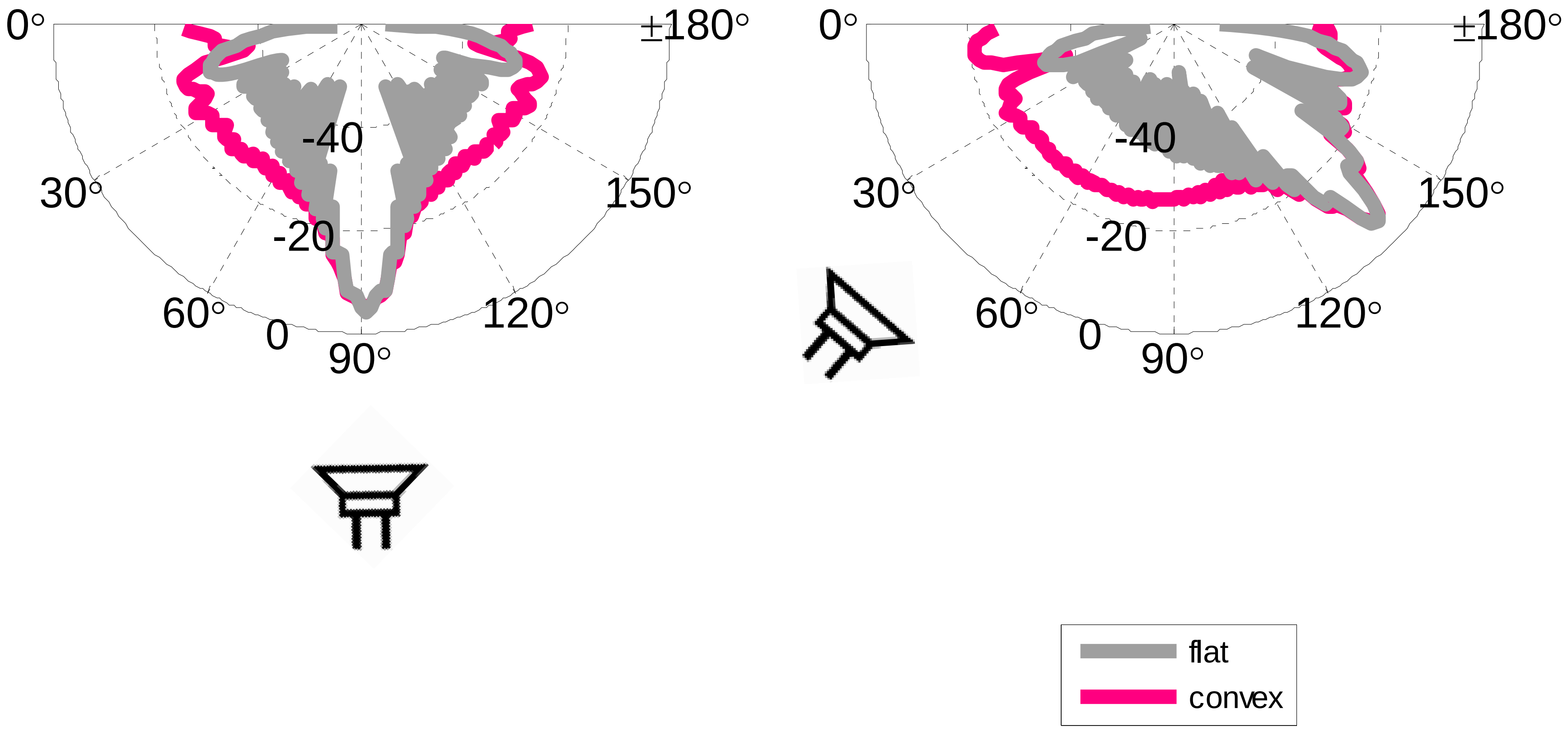
Panels Investigated

(all dimensions in meters)



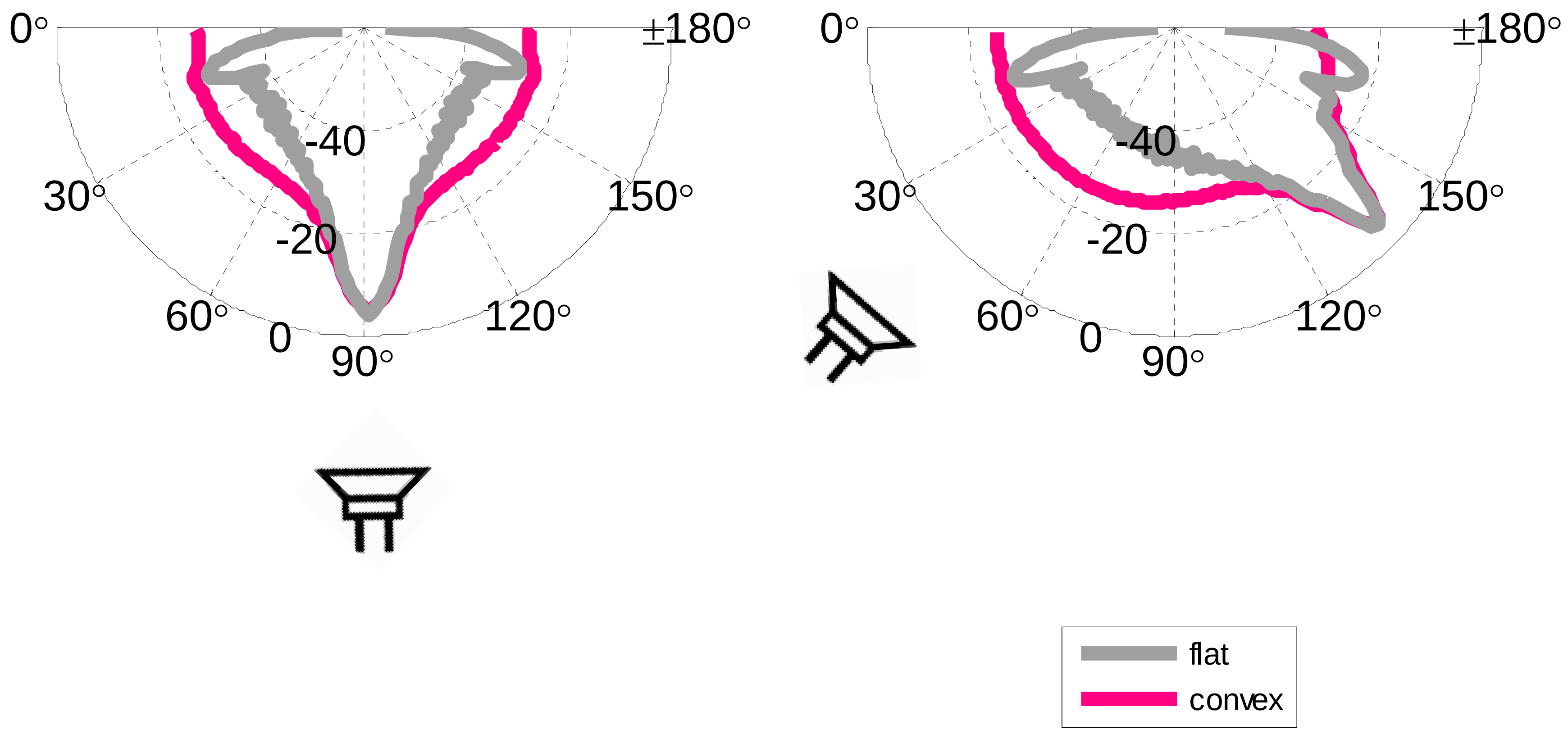


4000 Hz Beam Pattern (2D)

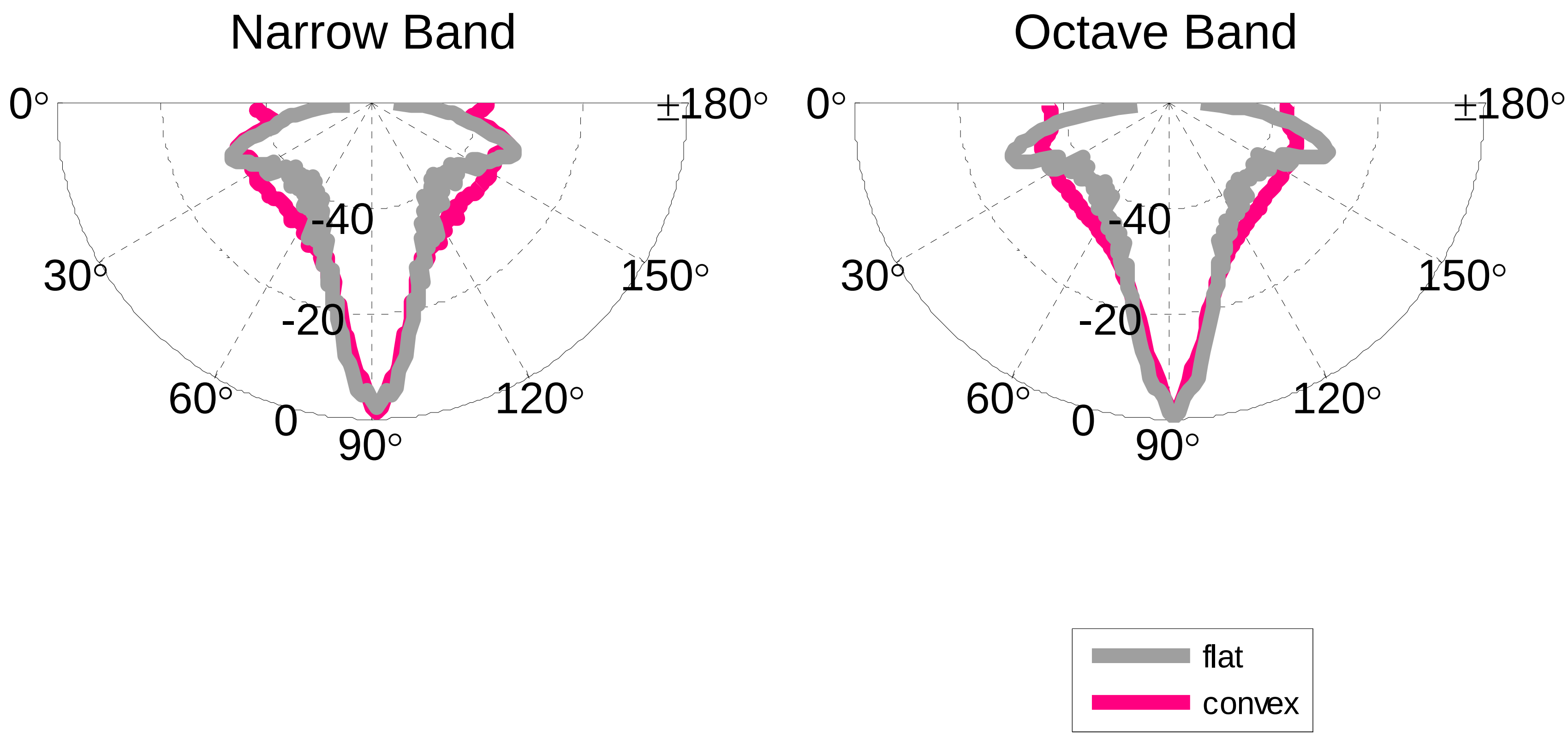


4000 Hz Beam Pattern (2D)

octave band filtered



4000 Hz Beam Pattern (3D)



Summary: Beam Pattern Results

- In octave-band filtered 2D simulations, convex edge increases reflected response 10 – 15 dB outside of specular reflection zone
- In 3D simulations, nonspecular scattering is reduced considerably

Conclusions

- Convex panels increase scattered amplitude outside specular reflection zone
- Long convex reflectors perform better than jelly-filled donut shaped reflectors
- Sample application for long convex reflectors: above a stage for reflecting sound energy to musicians

RBA-11-002-IP A presentation on www.akutek.info :

The Scattering from Reflector Panels with Convex Edges

Jonathan Rathsam and Dr. Lily M. Wang

September 7, 2007

19th International Conference on Acoustics

Madrid, Spain

UNIVERSITY OF Nebraska