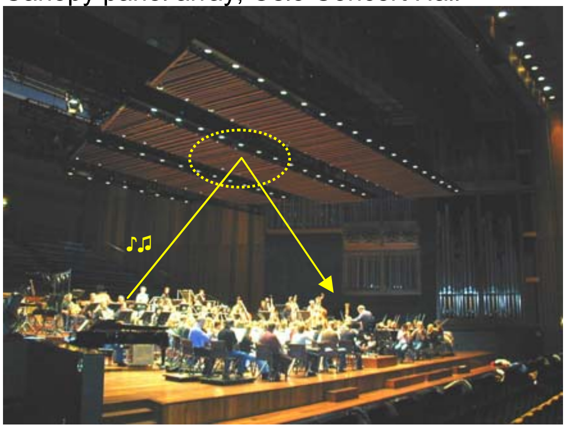
M Skålevik:

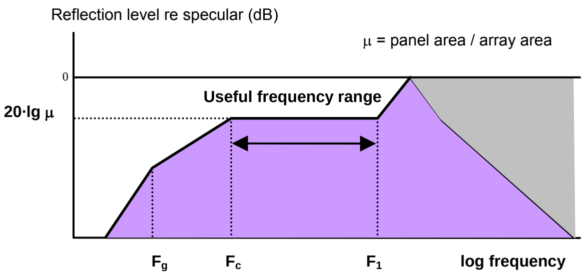
Frequency limits of flat panel reflector arrays status report

Canopy panel array, Oslo Concert Hall



Impulse response

Frequency response

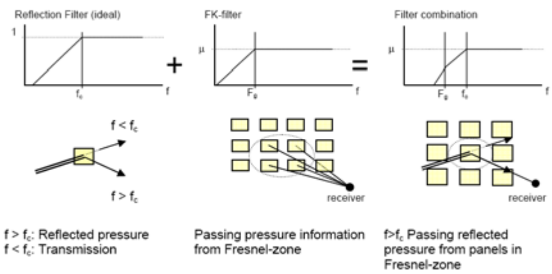


F_g determined by total size of array, relative to Fresnel-Zone (formula: Rindel 1991)

F_1 determined by size of panel, relative to Fresnel-Zone (formula: Rindel 1986)

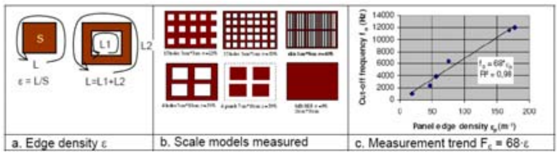
F_c determined by element size, F_c= 3/(8*a*)~64·ε analytical with disc of radius *a* (Skålevik 2006)

Low frequency theory, two-filter model

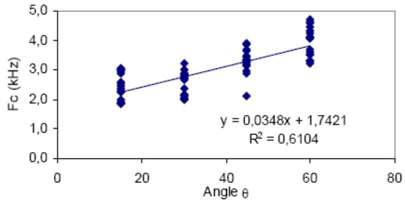


Pressure on panel surface depends on distance to panel edge, thus limited by panel edge density ε_p= perimeter/surface = 2/*a* (disc)

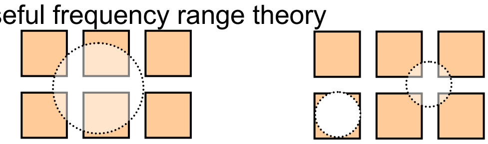
Predicting F_c from Edge Density, trend from scale model measurements F_c=68·ε



Angle dependency, rectangular elements



Useful frequency range theory



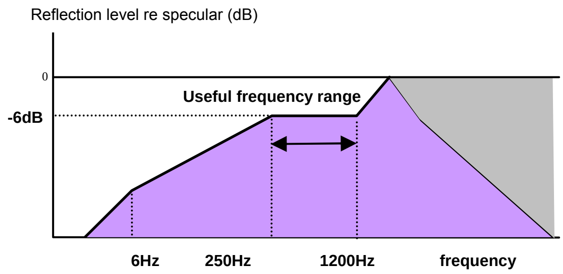
$F_c < f < F_1$
Element large compared to wavelength, and Fresnel-zone larger than element.

$F > F_1$
Fresnel-zone smaller than element. Reflection level depends on position

Narrow range problem of flat array, example

Array size:	14m x 14m
Panel size:	1.0m x 1.0m (square)
Edge density:	ε_p=0.25m^{-1}
Panel density:	50% (μ=0.5)
Array height:	7m above source/receiver

Normal reflection, assuming F_c=64·ε_p
F_g = 6Hz, F_c = 250Hz, F_1 = 1200Hz



Some solutions to narrow range problem:

- Curved panel, extending high limit
- Double-layer (two-way system like in Oslo Concert Hall), small panel array below larger panel array

Some remarks:

- Smooth response in 500-4000Hz octaves important in orchestra canopy
- The old rule of thumb: 50% panel density stands firm
- Flat-panel single-plane arrays being simple, low cost, and important theoretically, however difficult to achieve smooth wide-band response

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