

RPG
1D Diffusion

Modffusor



The First Modulated Optimized Diffusor
From The Acoustical Industry's Leading Innovator

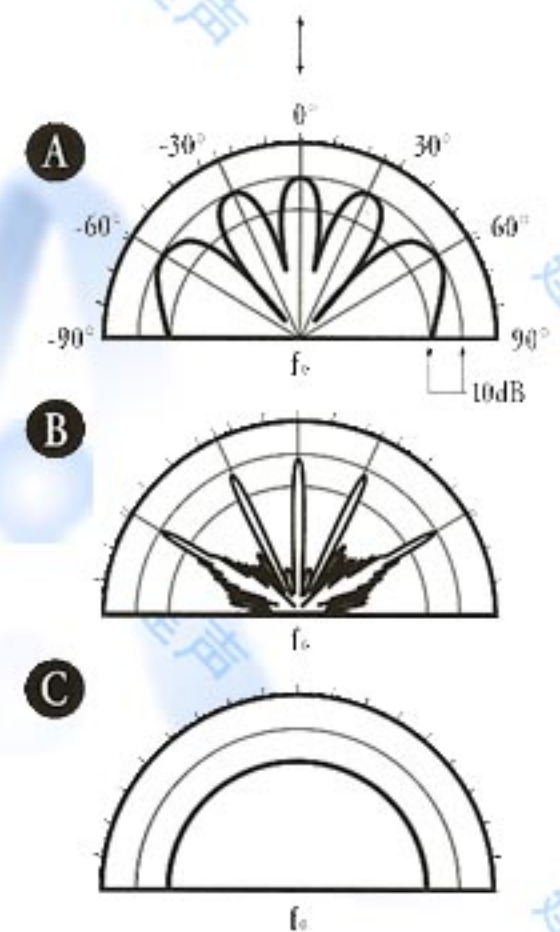


In 1983, RPG Diffusor systems, Inc. introduced the first commercial sound diffuser that offered uniform scattering over a designable bandwidth. The QRD[®] has now been used in thousands of project in a wide range of venues. As with any technology, research and experimentation lead to advance. The QRD[®] is a reflection phase grating formed from the periodic repetition of a base shape, consisting of a series of wells of depth based on the quadratic residue sequence, separated by dividers. While periodicity is the basis of the QRD[®], it is also one of its limitations, because periodicity causes lobing in specific diffraction directions. To minimize this lobing, which compromises the uniformity of the polar response, RPG developed the Modffusor[™]. By contrast to the QRD[®], the Modffusor[™] is formed from an aperiodic array of a single, asymmetric, optimized base shape. The optimization offers better performance than a low-prime, number theoretic diffuser and the aperiodic modulation minimizes lobing non-uniformity caused by periodicity. This, the Modffusor[™] offers the next generation of high performance reflection phase gratings.

Problem and Solution

Problem

Quadratic Residue Diffusers (QRD[®]) owe their diffusing ability to the phenomenon of diffraction from a periodic reflection phase grating. The product of the number and width of the wells defines the diffraction direction and the energy in these directions is equal due to the fact that the quadratic residue well depth sequence has a flat power spectrum. To cover wide areas, the QRD[®] is repeated. This periodicity decreases uniformity by focusing the energy in the diffraction directions (B), preventing uniform diffusion (C) from being achieved.



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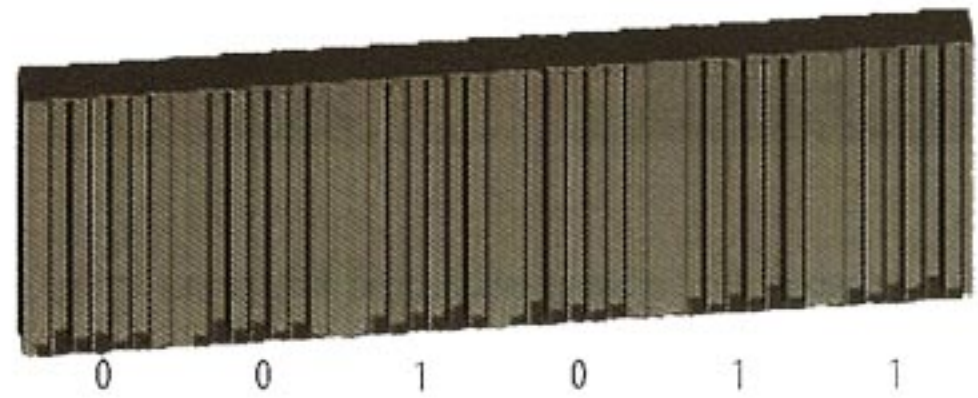
Modffusor
Problem and Solution



"0"Unit



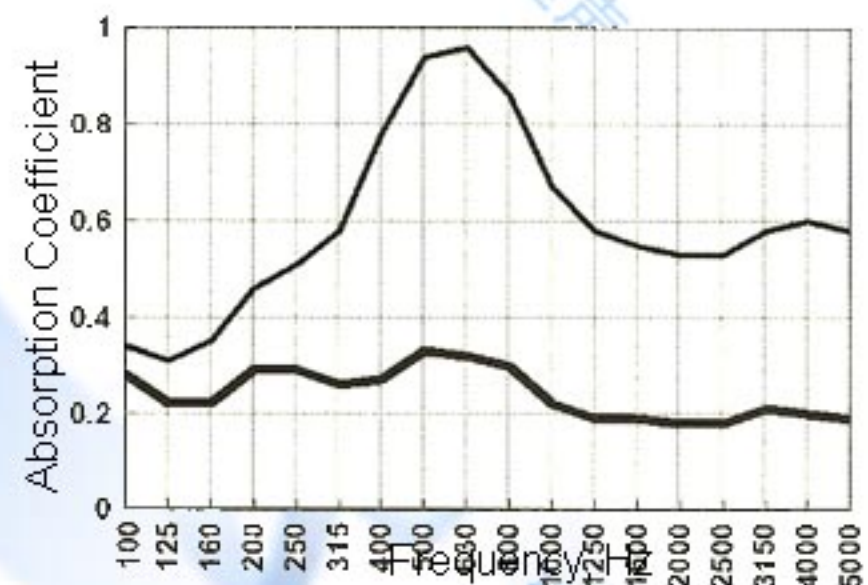
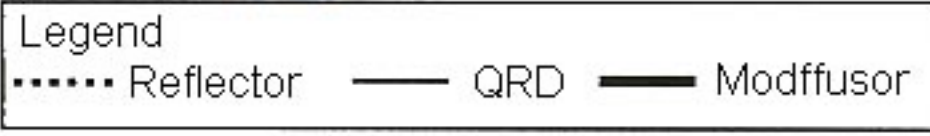
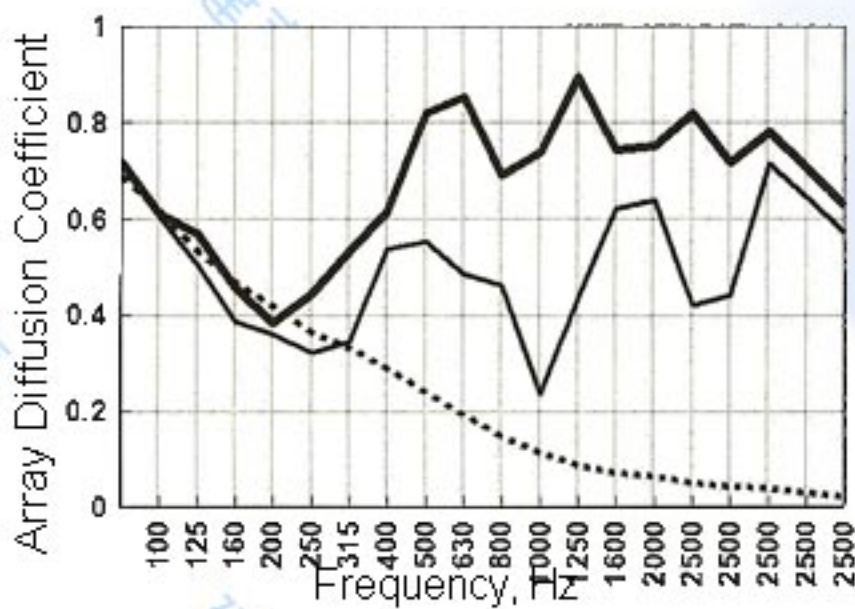
"1"Unit



Solution

To solve this problem, RPG patented a concept called Aperiodic Modulation of a Single Asymmetric Base Shape, in which a single, optimized, asymmetric, base shape ("0" unit) is modulated by simply flipping the base unit 180° (forming "1" Unit) according to the prescription of an optimal binary sequence with good aperiodic array below. The base shape, consisting of 7 full wells and two zero-depth half wells on either end, is optimized using RPG's proprietary Shape Optimizer software. Using aperiodic modulation, the performance of the single optimal base shape can be preserved, while covering an infinite area. The patented half wells provide seamless tiling and pseudo-symmetry which is aesthetically pleasing.

Performance Specifications



Diffusion coefficient comparison between a traditional QRD and the Modffusor, reveals significant performance improvement, due to the reduction of periodic lobing. A flat panel response of comparable size also shown to indicate the Modffusor's better low frequency diffusion, as indicated by the onset of diffusion.

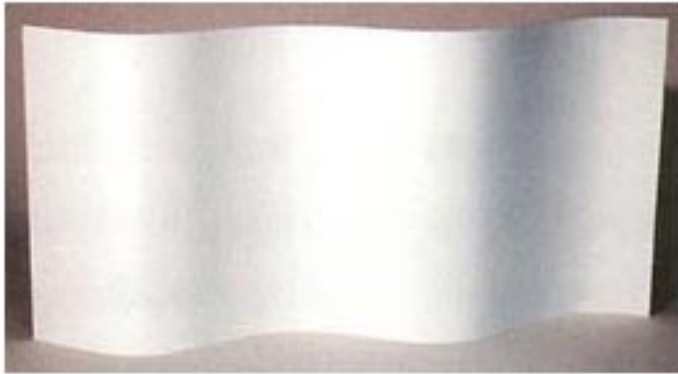
Installation

Installation of the array is accomplished by mounting the labeled Modffusors sequentially over supplied mounting cleats, which are attached to the wall or ceiling. The array consists of a beginning unit, a series of interior units and an end unit.

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Waveform Spline



Optimized One Dimensional Curved GRG Canopies
From The Acoustical Industry's Leading Innovator

Overhead canopy arrays are used in auditoriums to blend the direct and early reflected sound, increasing speech intelligibility and enhancing musical clarity and intimacy. Traditionally, non-optimized, periodic flat panels or arcs have been used and their placement has been either aesthetic or based on geometrical optics. If not properly designed, tilted, and arrayed, a canopy can provide uneven coverage, typically exemplified in minima and maxima in the sound pressure level. In addition, these simple shapes can be diaphragmatic, leading to a loss in low frequency sound. To solve this problem, RPG developed a powerful shape optimization software, which optimizes the shape, tilt, and arraying of the canopy array and eliminates all of the guesswork. The Waveform Spline is an optimized one dimensional way panel that provides uniform coverage over the entire stage or audience area. Novel, Class A, fire safe, honeycomb GRG composites also minimize diaphragmatic absorption.



Problem and Solution

Problem

Flat panel arrays provide uneven sound pressure across the audience area. Listeners experience sound level minima when the geometrical reflection point for a receiver is between panels. Coverage can be improved by curving or shaping the panels, but there is no guarantee that optimum results will be obtained, and consequently, uneven response is often still experienced.

Solution

To solve this problem, RPG developed the first Shape Optimization program, which automatically determine the best shape, tilt and arraying to insure uniform coverage. The Shape Optimize combines the power of the boundary element and multi-dimensional optimization techniques, incorporating the diffusion coefficient as the metric of optimal performance. The Waveform Spline provides optimal ensemble for musician on stage and uniform coverage in the audience. Each canopy element has the same optimal shape for aesthetic reasons. However, each panel's tilt is independent. This insures optimal coverage on stage and in the audience forestage seating area.

RPG

1D Diffusion

Waveform Spline

Performance Specifications

Shape Optimizer

In Fig. 1, we show the canopy section, sources/receivers on stage and receivers in the audience. In Fig. 2, we show the sound pressure level (SPL) at musicians' ear level over the entire stage from a source in the middle of the stage. The canopy is flat and extends across the entire width of the stage with gaps as shown in Fig. 1. Note the level is constant across the stage, but there are severe dips and peaks front to back. The Shape Optimizer examines thousands of potential canopy shapes in attempt to provide the most uniform coverage possible, based on the size and shape constraint imposed. Fig. 3 shows the dramatic improvement over the flat panel canopy. The standard deviation from uniformity (0 db is uniform coverage) is plotted in Fig. 4 for the flat panel, a 5' and 10' radius traditional arc, an angled panel, and the optimized Waveform Spline™. The improvement is dramatic.

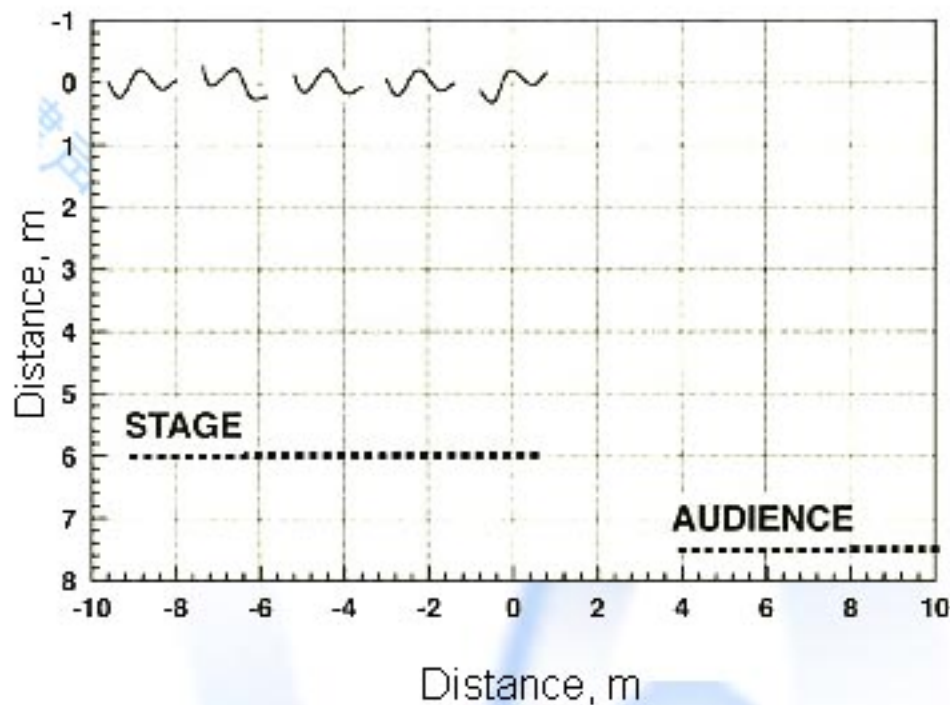


Figure 1. Canopy section

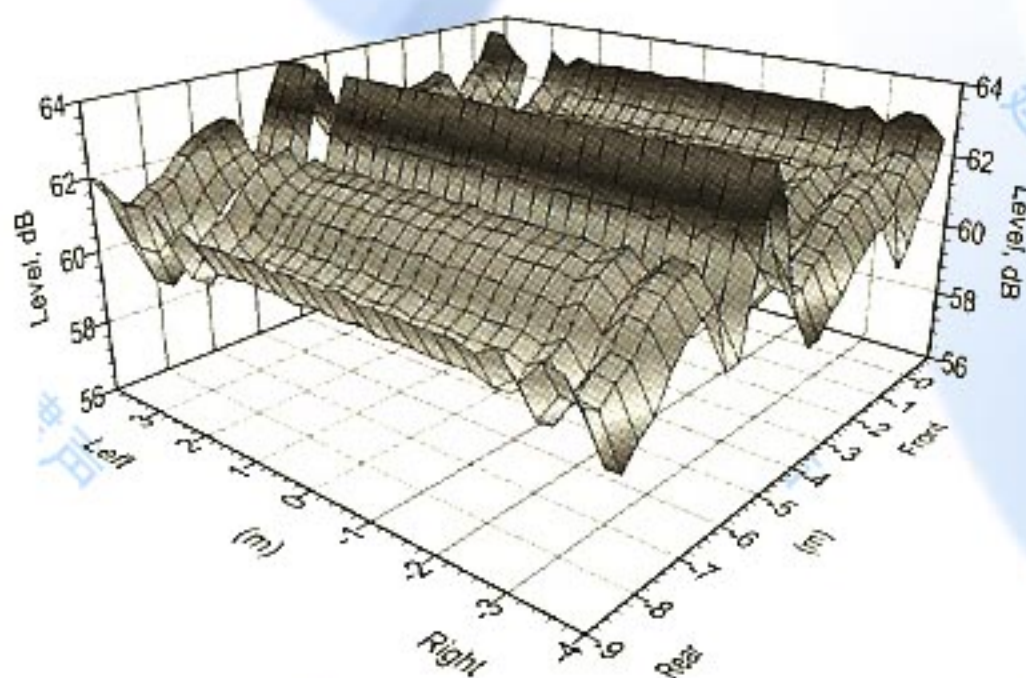


Figure 2. Sound level from flat canopy

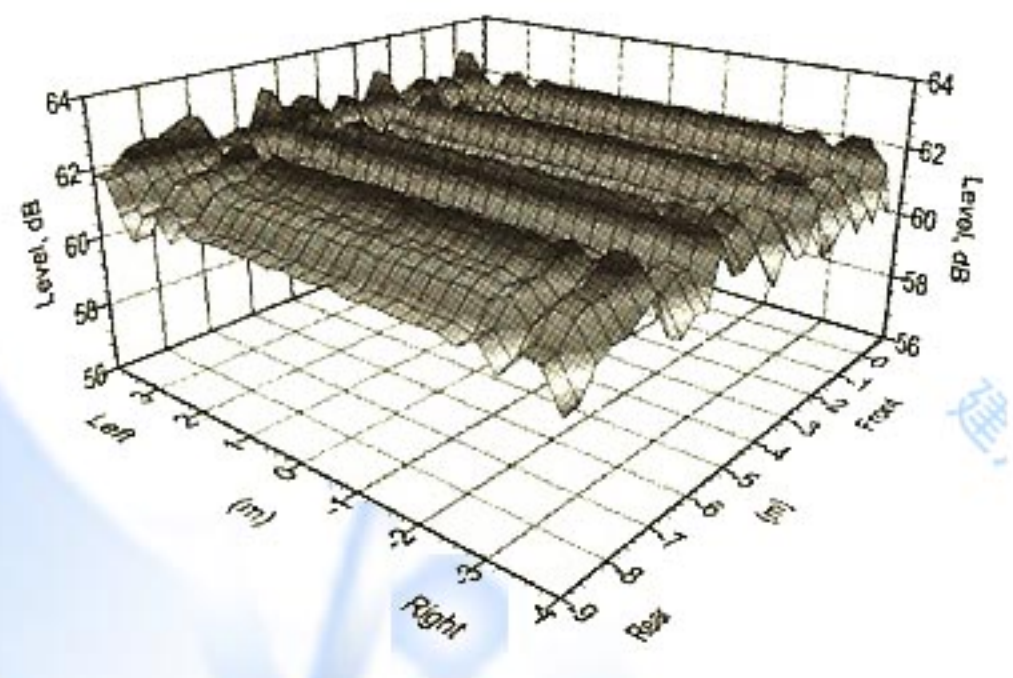
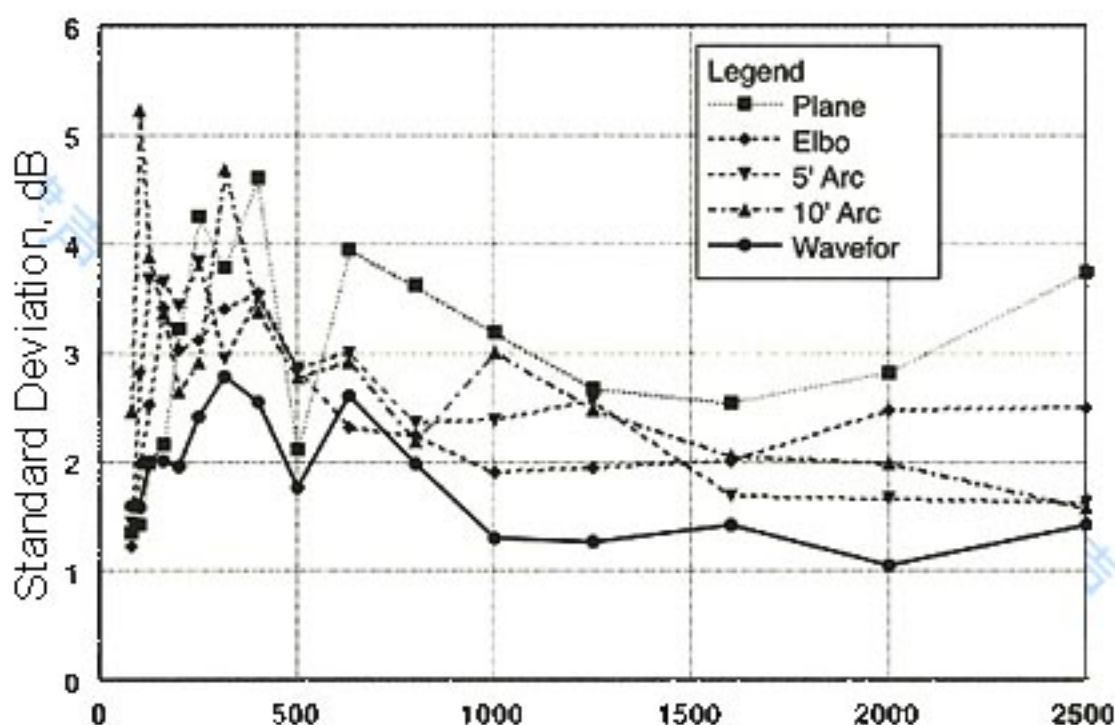


Figure 3. Sound level from optimized spline canopy



Installation

Installation is simple using integral metal hair pin connectors. Simply attach suitable supplied engineered cables for dead hung installation. The image to the far right illustrates how the Spline panels can be seamlessly joined end to end forming an arc.