Sound optimisation of hi-fi racks using resonator technology

finite elemente

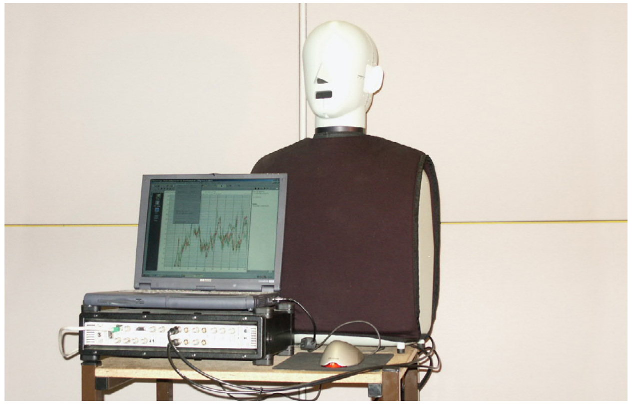
first class audio furniture

With kind assistance of
and in cooperation with

Fachhochschule Dortmund

University of Applied Sciences Dortmund

Reduction of oscillation and noise in technical systems with resonators



Acoustic dummy with PULSE system to measure airborne sound pressure

In research cooperation with the Dortmund University of Applied Sciences finite elemente developed a sound optimisation of the pagode° Master Reference rack by using resonators, relatively small, rod-shaped add-on components that are installed in the rack und handle triggered resonance oscillations instead of the large surface of the component shelves, inaudible due to their small noise radiation surface area.

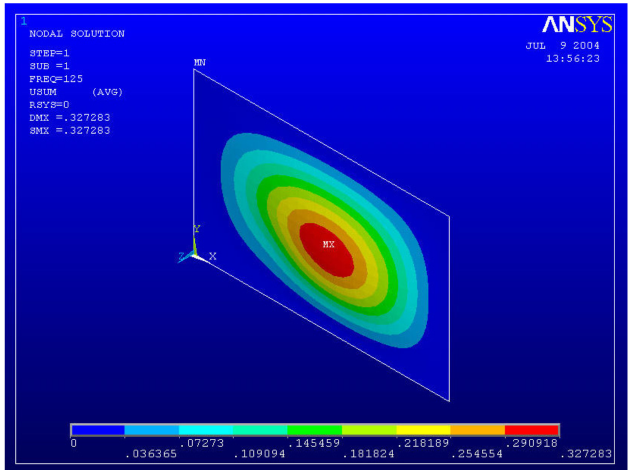
This patent pending process is based on mechanical energy principles for the mathematical determination of resonator geometry. Resonance oscillations of the rack are avoided in that the noise-neutral resonators, which are naturally easier to excite, dissipate the annoying oscillation energy, converting it into thermal energy.
If a component shelf of the rack is triggered by environmental or loudspeaker noise, then this will cause sound-distorting oscillations in this system component. Resonators installed in the component shelf level take over the incoming oscillation energy and are set in motion in place of the component shelf level.

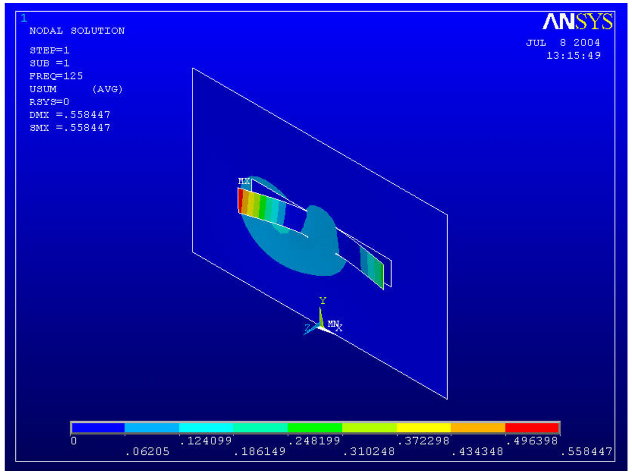
finite elemente
first class audio furniture

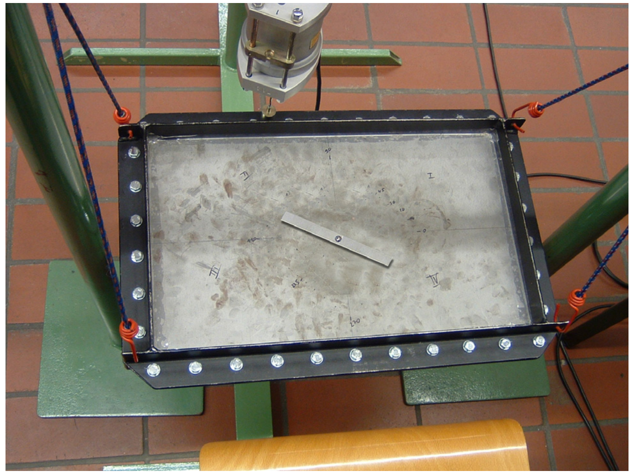
With kind assistance of
and in cooperation with
Fachhochschule
Dortmund
University of Applied Sciences
Dortmund

Reduction of oscillation and noise in technical systems with resonators

finite elemente
first class audio furniture







RED = maximal oscillation, BLUE = no oscillation

Modal analysis <u>without</u> resonator

- Natural resonance: 125 Hz
- Surface oscillates with strong amplitude
- 80% strong oscillation
  20% oscillation-free

Result: extreme sound loss caused by resonance disturbance

Modal analysis <u>with</u> resonator

- Twin resonator determined to 125 Hz, tensioned on one side
- Surface oscillates minimal
- Resonator oscillates in place of the surface
- 90% oscillation-free
  10% reduced oscillation

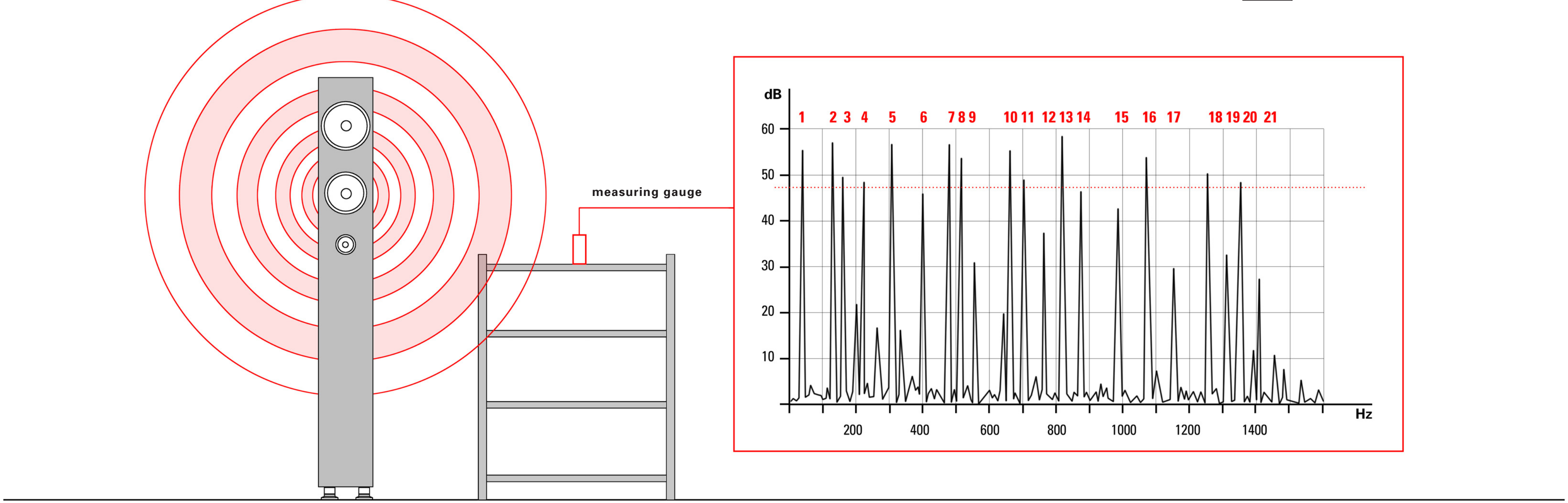
Result: considerable sound improvement through minimized natural resonances

Research installation with resonator

- Twin resonator determined to 125 Hz on all-round tensioned metal plate

Conventional hi-fi rack

finite elemente
first class audio furniture



Design:

- conventional design
- tubular steel welded or bolted
- component shelves in solid MDF
- alternative in a different wood type filled with sand an/or lead pellets
- insufficient attenuation and dissipation

Measured results:

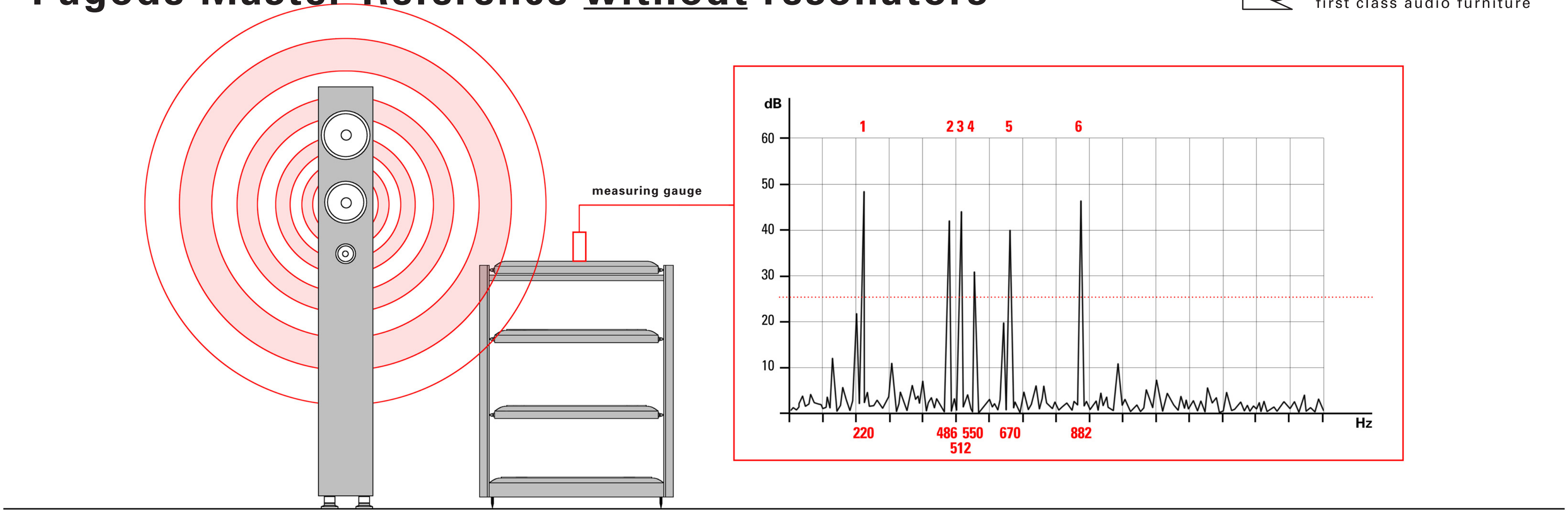
- uncontrolled oscillation behaviour
- high number of sound-distorting resonances
- too numerous high amplitudes
- high sound pressure values = clearly audible in music reproduction

Effect:

- compressed and contour-less sound
- lack of transparency
- limited three-dimensionality
- tonal displacements
- insufficient resolution of detail
- limited dynamic scope

Pagode Master-Reference <u>without</u> resonators

finite elemente
first class audio furniture



Design:

- sound-optimised lightweight design
- side pillars in solid aluminium
- component levels as wooden frame in solid Canadian maple wood
- high-absorption shelves with defined coupling
- horizontal tensioning of the component levels using stainless steel spikes
- balanced concept of attenuation and dissipation

Measured results:

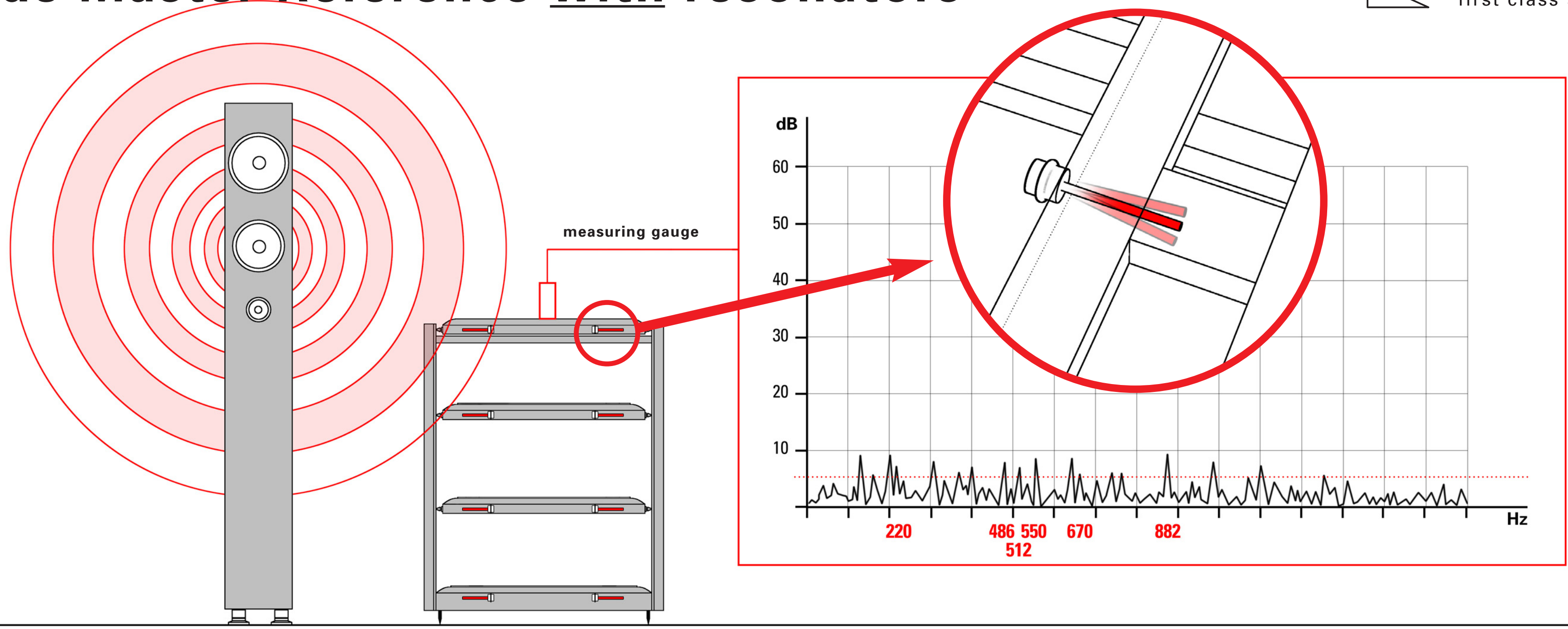
- optimised oscillation behaviour
- only six sound-influencing natural resonances: 220 Hz, 486 Hz, 512 Hz, 550 Hz, 670 Hz, 882 Hz
- reduction of the highest amplitudes
- clear reduction in sound pressure values = scarcely audible in music reproduction

Effect:

- open and contoured sound
- high transparency
- extended three-dimensionality
- correct tonality
- very good precision of detail
- large dynamic scope

Pagode Master Reference with resonators

finite elemente
first class audio furniture



Design:

- design as Pagode MR
- controlled resonance attenuation with resonators
- 4 resonators per level, exactly determined to the natural resonances of the test rack: 220 Hz, 486 Hz, 512 Hz, 550 Hz, 670 Hz, 882 Hz

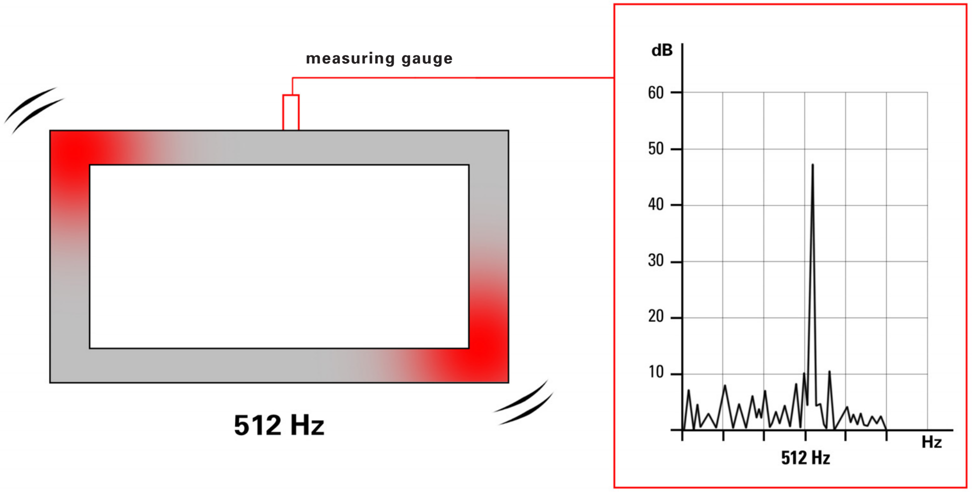
Measured results:

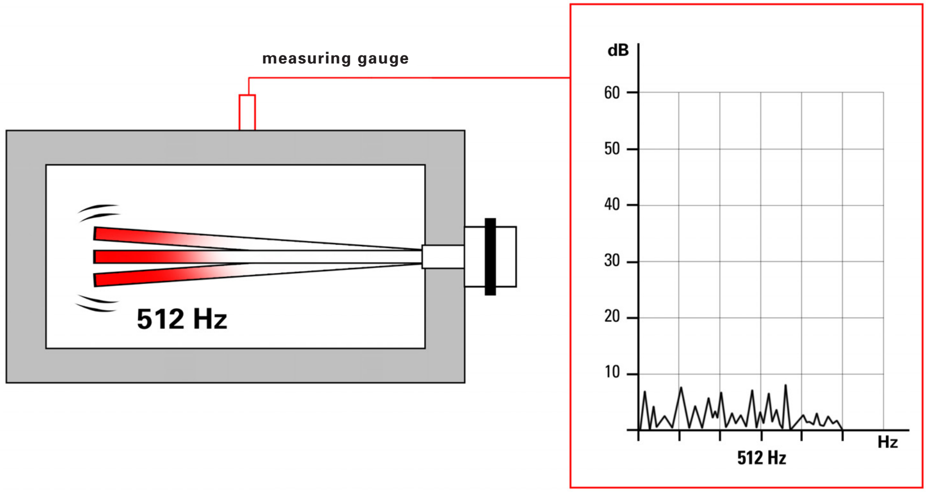
- perfectly controlled oscillation behaviour
- no sound-influencing natural resonances
- drastically minimised sound pressure values = no longer audible in music reproduction

Effect:

- outstanding open and contoured sound
- excellent transparency
- holographic three-dimensionality
- perfect tonality
- superior precision of detail
- exceptional dynamic scope
- extreme homogeneity in sound

Functional principle of the resonator





Oscillation amplitudes within technical systems that are excited by airborne or solid borne noise can be clearly reduced by integrating or adapting resonators. Resonators are rod-shaped metal components where their first natural frequency is matched to the excitation frequency or the system's natural frequency. Large amounts of the kinetic energy – with natural excitation up to 90%, with forced excitation up to 70% - are inaudibly converted by the resonators into heat. The example shows the amplitude behaviour with and without resonator at 512 Hz.

Design:

- metal rod tensioned on one side in stainless steel cylinder
- resonator geometry exactly determined to 512 Hz
- stainless steel cylinder bolted with surface contact to the system to be attenuated

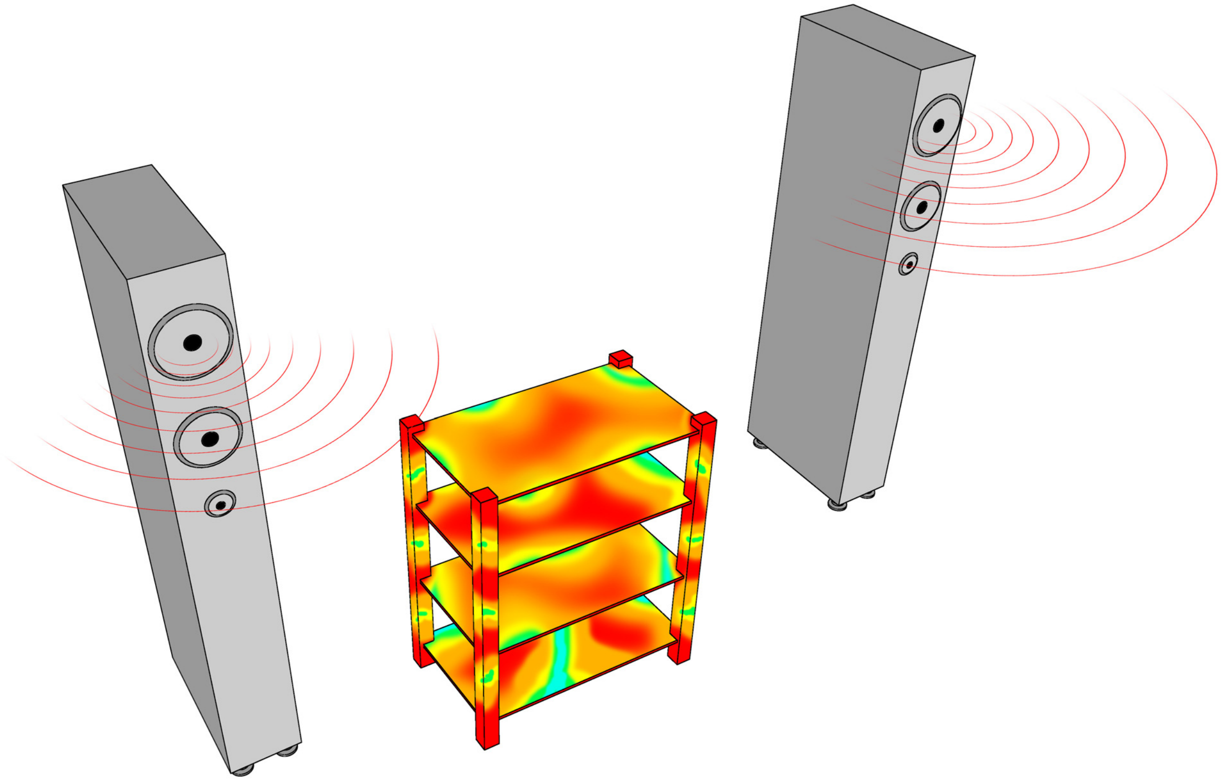
Measured results <u>without</u> resonator:

- very high amplitude at 512 Hz
- adjacent areas above and below 512 Hz with increased amplitudes

Measured results <u>with</u> resonator:

- amplitude at 512 Hz reduced by a factor of 6
- bandwidth effect of the resonator (±10%) reduces also amplitudes above and below 512 Hz

Modal analysis of a conventional hi-fi rack



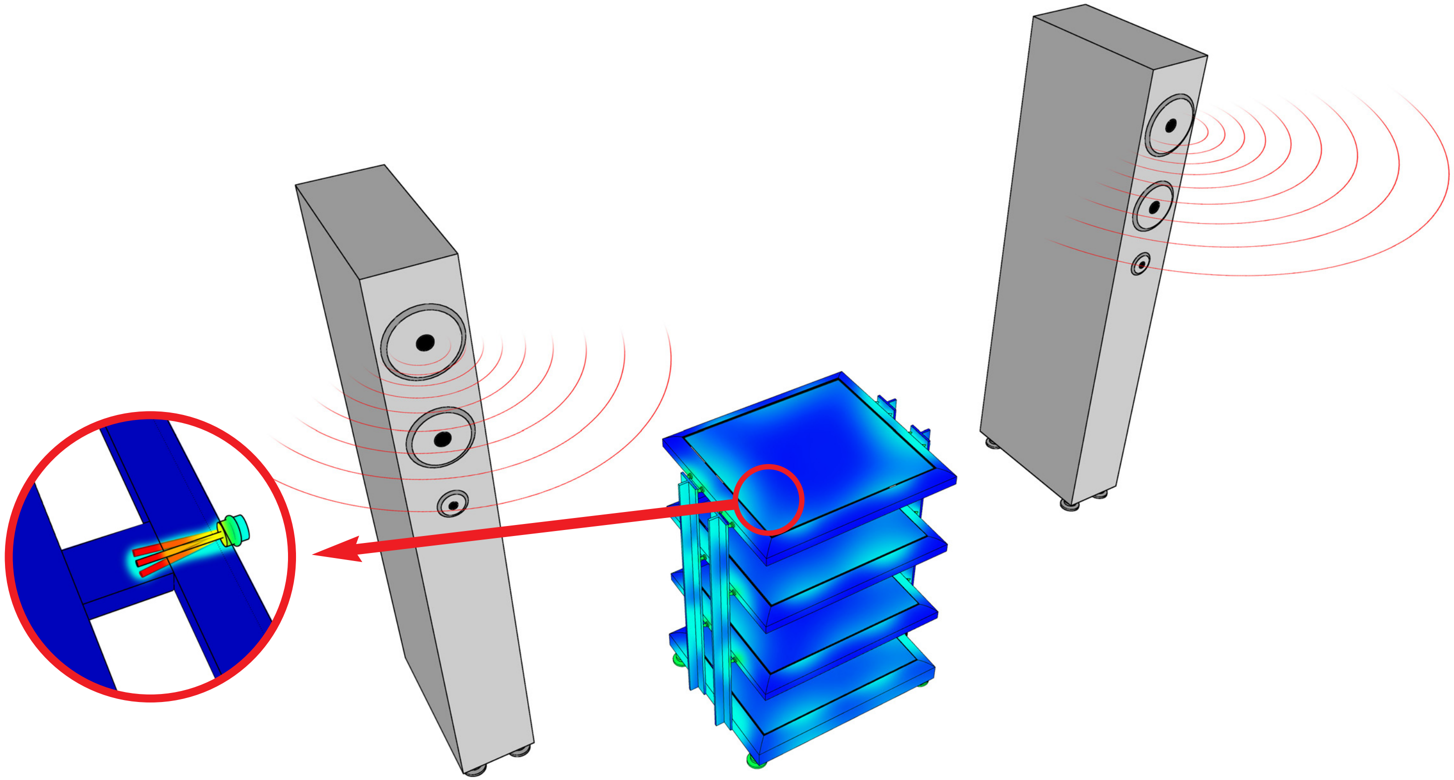
Legend:
- no oscillation
- minimal oscillation
- low oscillation
- medium oscillation
- strong oscillation
- maximal oscillation

Measured results:
- uncontrolled oscillation behaviour
- high number of sound-distorting resonances
- too numerous high amplitudes
- high sound pressure values = clearly audible in music reproduction

Effect:
- compressed and contour-less sound
- lack of transparency
- limited three-dimensionality
- tonal displacements
- insufficient resolution of detail
- limited dynamic scope

Modal analysis of a Pagode Master Reference

finite elemente
first class audio furniture



Legend:

- no oscillation
- minimal oscillation
- low oscillation
- medium oscillation
- strong oscillation
- maximal oscillation

Measured results:

- perfectly controlled oscillation behaviour
- no sound-influencing natural resonances
- drastically minimised sound pressure values
  = no longer audible in music reproduction

Effect:

- outstanding open and contoured sound
- excellent transparency
- holographic three-dimensionality
- perfect tonality
- superior precision of detail
- exceptional dynamic scope
- extreme homogeneity in sound

finite elemente

first class audio furniture

Kirchplatz 16 A
D-59909 Bestwig
Tel. ++49-(0) 2904-4192
Fax ++49-(0) 2904-3580

info@finite-elemente.de
www.finite-elemente.de

Fachhochschule
Dortmund

University of Applied Sciences
Dortmund

Labor für Schwingungstechnik und Akustik
Prof. Dr.-Ing. Thomas Borchert
Sonnenstraße 96 - 100
D-44139 Dortmund

Tel. ++49-(0) 231-9112-292
Fax ++49-(0) 231-9112-334

thomas.borchert@fh-dortmund.de
www.fh-dortmund.de