PERMAS
FLUID/STRUCTURE ACOUSTICS

Acoustics with PERMAS:

➤ **acoustic vibration modes of fluids**
➤ **coupled fluid/structure vibration modes**
➤ **dynamic frequency response behavior**

INTERIOR ACOUSTICS
e.g. for active noise compensation
e.g. for partially filled tanks

SOUND RADIATION
e.g. for distribution of sound energy on the structure's surface
e.g. for sound pressure level in the surroundings

ACOUSTIC OPTIMISATION
e.g. for noise reduction by shape modifications
e.g. for stiffness dimensioning of filled tanks

DYNAMICS OF FLOATING STRUCTURES
e.g. for structural vibrations of ships

Experimental body-in-white

Frequency response analysis with PERMAS:

By using fluid elements, structural and interface elements, coupled vibration modes and frequency-dependent sound pressure fields are calculated in the interior.

structural elements

interior fluid elements

surrounding fluid elements
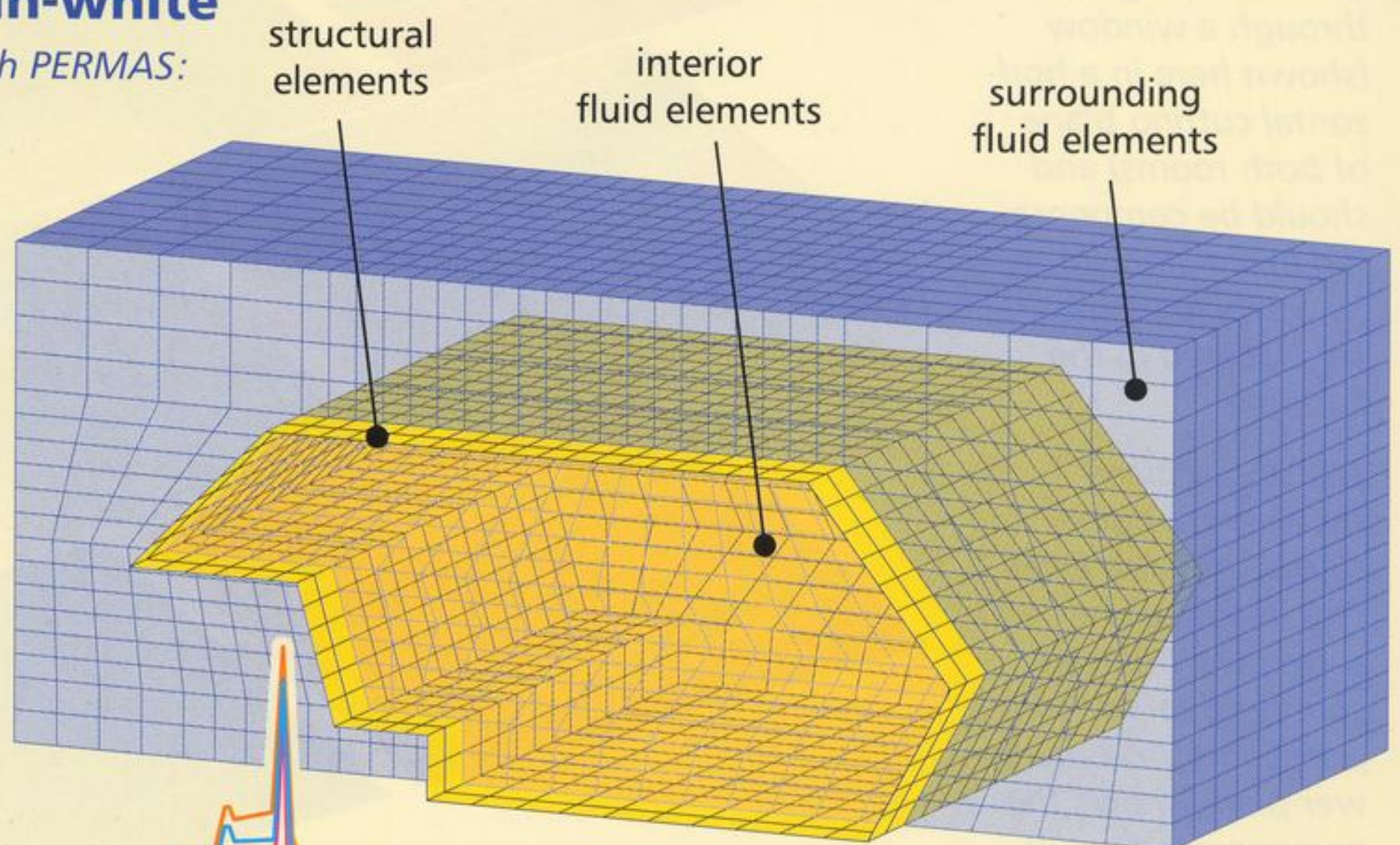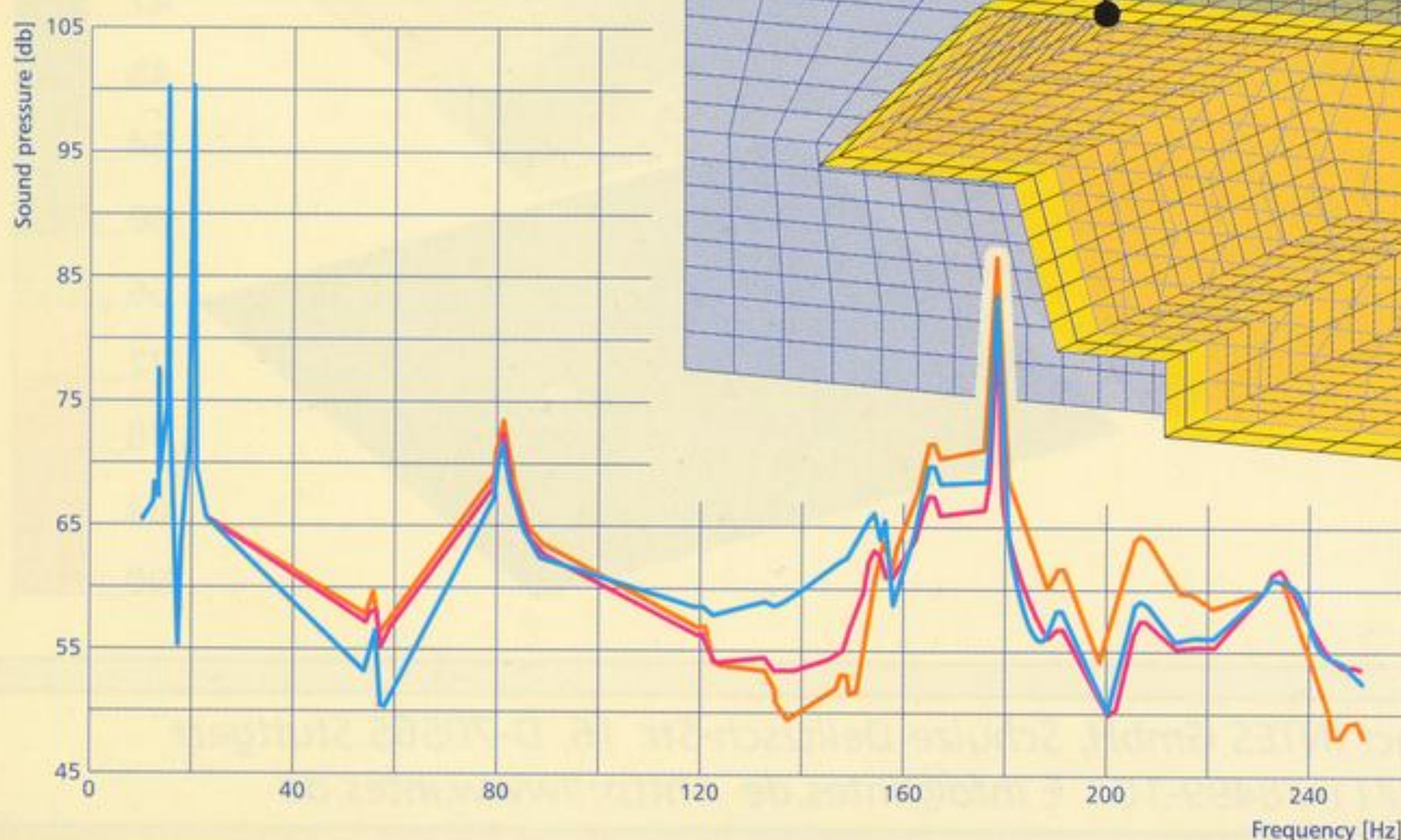
The diagram shows the sound pressure level at the position of the driver's head as a function of frequency.

VIBRATION MODES:

The directly coupled vibration modes are valuable results. The distribution of vibration energies allows to identify solid and fluid dominated modes. The exchanged energy serves as a measure of the degree of coupling.

Incompressible and compressible fluids can be taken into account.

DYNAMIC RESPONSE:

Dynamic loading is built-up by static loads combined with frequency-dependent functions.

Sound pressure and structural displacements, velocities, and accelerations are issued in the frequency and time domain.

ELEMENTS:

PERMAS provides special elements for acoustic calculations:

► Volumetric damping for acoustic absorption - e.g. for car seats.

► 2D surface wave elements for free surfaces.

► Semi-infinite elements for modeling the surrounding of the structure.

DAMPING/ABSORPTION:

► For the structure: Material and structural damping on elements, alternatively frequency-dependent.

► For the fluid: Volumetric and surface dampers.

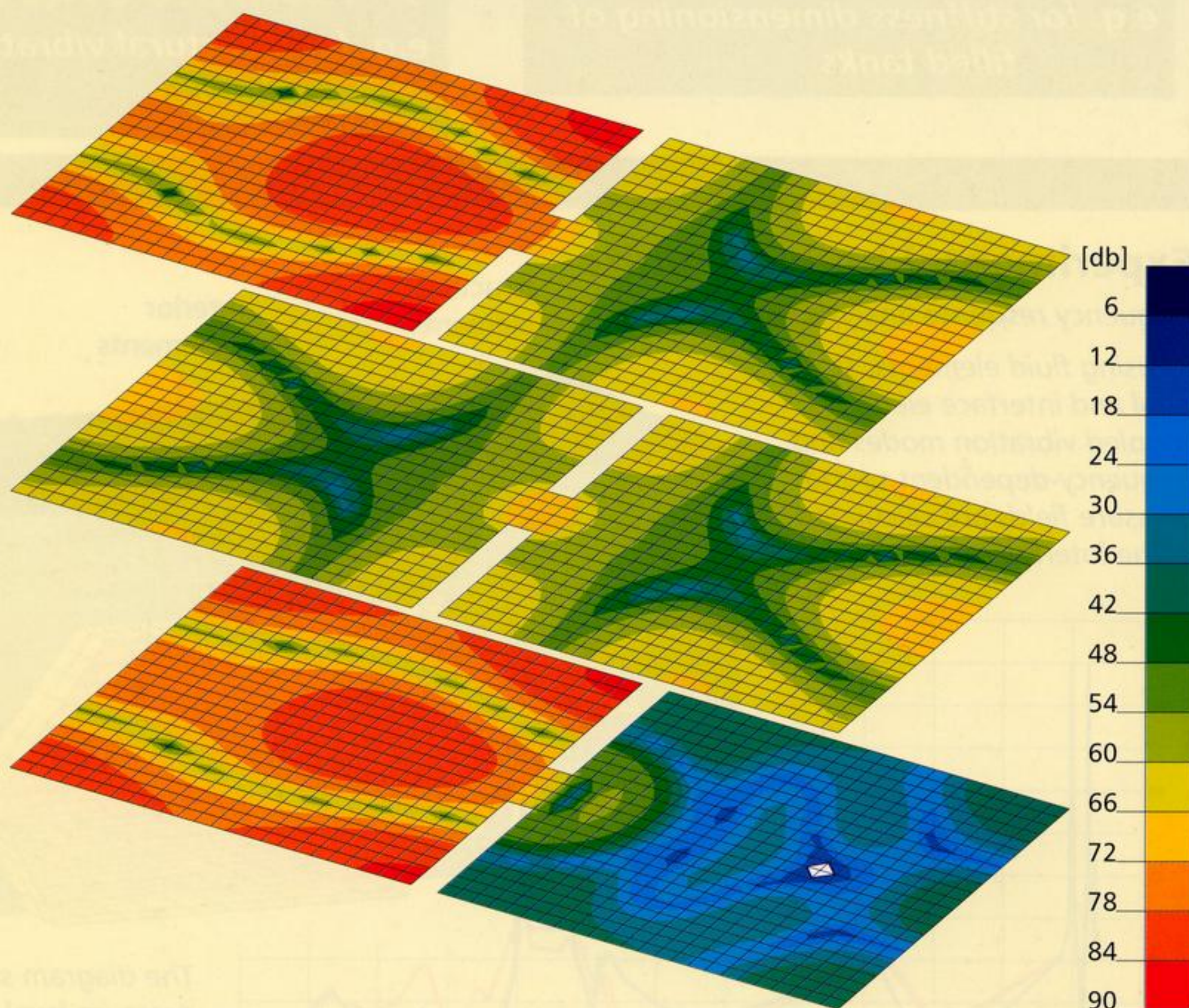► For the coupled system: Modal viscous damping.

RUN TIMES:

For coupled fluid/structure acoustics efficient algorithms are of utmost importance. PERMAS runs large models in short time, in particular when parallel processing is used.

Use of PERMAS for a layout of active noise compensation:

Noise is propagating from one room (left) to another (right) through a window (shown here in a horizontal cutting plane of both rooms) and should be compensated in the right room by active loud speakers located in the window.

The upper plane shows the original sound pressure level. The middle plane shows the induced sound signal for compensation. And the lower plane shows the compensated result (all in db and at 120 Hz).

[db]
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90