Goldmund White Paper

SPEAKERS

The materials, manufacturing techniques, and design concepts behind Goldmund speakers

Goldmund employs numerous advanced engineering and manufacturing techniques in the development and production of its speakers.

Heavy aluminum enclosures minimize extraneous resonances and vibrations. Mechanical grounding techniques route what little vibration is left into the floor, where it is immediately dissipated. Modular construction further decreases vibration and enhances mechanical grounding, while making future upgrades practical and simple. And active amplification options improve performance and system versatility.

When designing speakers, Goldmund engineers use computer-based modeling, which takes into account the characteristics of the speaker drivers and enclosure and allows them to perfect the speaker's acoustical performance. While we do listen to various prototypes during the design process to judge the efficacy of engineering changes, we design and build our speakers primarily to meet strict technical standards, not to suit the taste of a particular listener's ears.

Aluminum enclosures

Extraneous vibration is one of the most challenging problems in loudspeaker design. The intent of the speaker designer is that only the cones of a speaker's woofers and the domes of its tweeters produce sound waves. If a loudspeaker cabinet vibrates along with the woofers and tweeters, it contributes unwanted sounds of its own. The unwanted sound waves may partially cancel certain audio frequencies and reinforce others, creating an uneven frequency response and an unnatural sound.

A vibrating speaker cabinet also acts as an acoustical "spring," absorbing sound from the back of the woofers then re-radiating it into the cabinet and out through the ports to the listener.
The result is that sound "rings". In other words, the speaker continues to emit a musical note long after the note was supposed to end. This emission has two deleterious effects: It smears the musical note, spoken dialogue, or special effect being played; and it obscures the attack of the sound that follows.

Most speaker enclosures are built from medium-density fiberboard (MDF), a wood-based material that, while much less resonant than natural wood panels or plywood, still vibrates relatively easily.

Goldmund has chosen to build its speaker cabinets from a superior, although much more costly material: dense slabs of aluminum measuring at least one-half of an inch thick. Aluminum bracing inside the speaker cabinet further reduces what little vibration exists.

The use of aluminum results in a speaker that is heavier and denser than most speakers of comparable size. The result of this robust construction is a more natural, clean, and uncolored sound.

Internal amplification

Passive speakers are the best choice for those who prefer to select the power and quality of their amplifiers. These speakers also allow easy upgrading of a system to more powerful amplifiers when the need for greater output and sonic precision arises.

The Goldmund Metis 10 Acoustic Processor and Metis Active Speakers

Active speakers are best for those who prefer to leave all of the specification to Goldmund. The amplifiers in these speakers are designed expressly to meet the demand presented by the speaker drivers. Goldmund speakers' enclosures make comfortable homes for these amplifiers; the extraordinary thermal mass of the thick aluminum enclosures eliminates the need for amplifier ventilation and cooling fans.

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MODELING PROCEDURE

With the aim of ensuring the perfect functioning of our loudspeaker systems, we have implemented a modeling procedure enabling any component, as well as the whole systems themselves, to be under control.

This procedure allows us to be very efficient in case of driver and filter modification or replacement. On top of that, it allows any possible problems encounter by our dealers to be analyzed with the aim of correcting them. Finally, it will constitute a sound theoretical basis for any of our future loudspeaker system development.

The procedure comprises 5 steps, which are explained below with examples:

1. Thiele and Small parameter measurements (added-mass method)

2. Preliminary calculations:
    - Electrical, mechanical and acoustical lumped-constant parameters
    - Input impedance, volume velocity and membrane displacement (infinite baffle, closed-box, vented-box...)
    - First estimation of drivers and port radiating sound pressure

3. Crossover modeling and transfer function calculation

4. Modeling comprising crossover, driver and enclosure lumped-constant parameters:
    - Input impedance with and without cross-over
    - Volume velocities with and without cross-over

5. Final loudspeaker system calculations:
    - Introduction of the modeled filtered volume velocities into calculation code
    - Calculation of the loudspeaker system sound pressure in amplitude and phase, taking into account driver finite radiating surface and diffraction at the enclosure edges

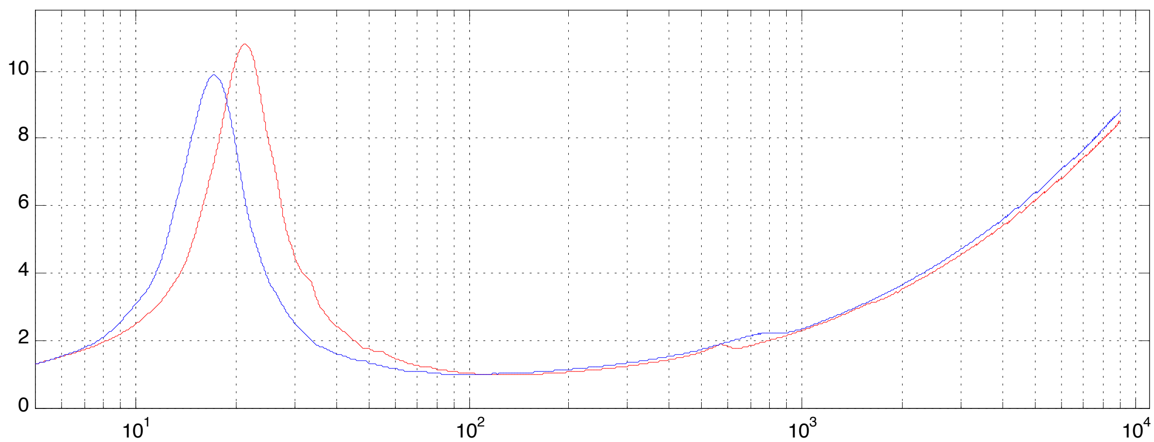
To sum up, this procedure offers various possible loudspeaker response calculations, allowing our systems to be studied and analyzed in different ways depending upon the application under consideration:

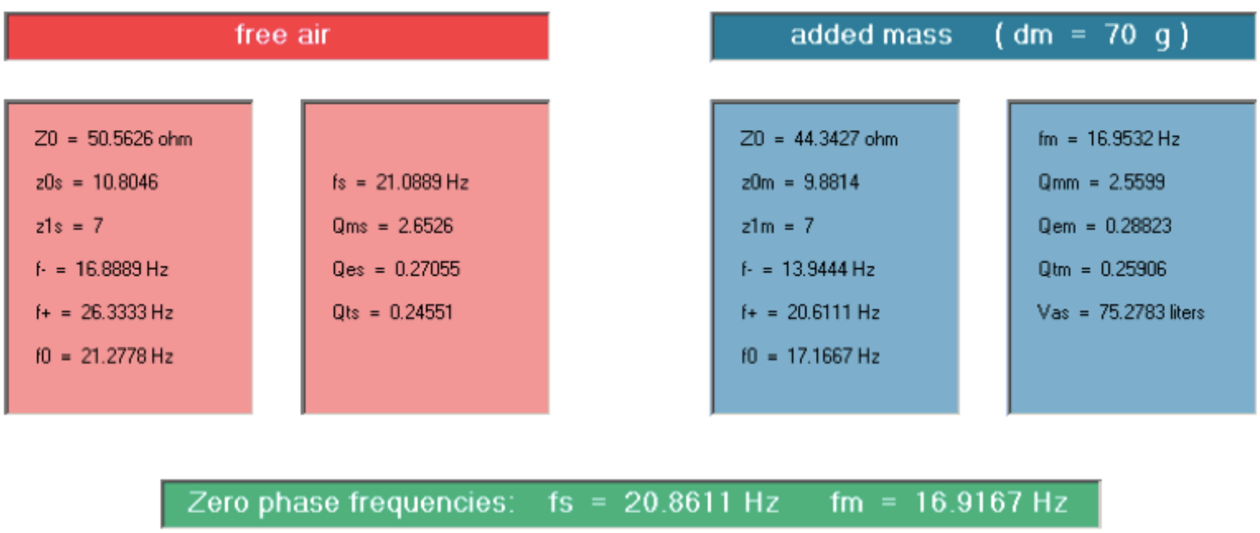
- Loudspeaker system input impedance (amplitude and phase)
- Electrical impedance at any location, like for example at the driver terminals
- Volume velocities in amplitude and phase (active and passive drivers, port…)
- X-over transfer functions
- Sound pressure level valid in the near field as well as in the far field, and taking into account the diffraction at the enclosure edges (GTD and UTD methods)
- Sound pressure phase and group delay (active and passive drivers, port, loudspeaker system)

STEPS DETAILED EXPLICATIONS WITH EXAMPLES

1. Thiele and Small parameter measurements (added-mass method)

This well-known method enables the TS parameters to be measured without test enclosure. The measurement is carried out manually and/or automatically to ensure a high level of accuracy. The figure below shows an example of automatic measurement (*Logos Sub* active driver).





Coming from the average of several driver measurements, the TS parameters (R_e, L_e, f_s, Q_{ms}, Q_{es}, Q_{ts}, V_{as}) are finally compared with the constructor ones before being introduced in calculation code.

2. Preliminary calculations

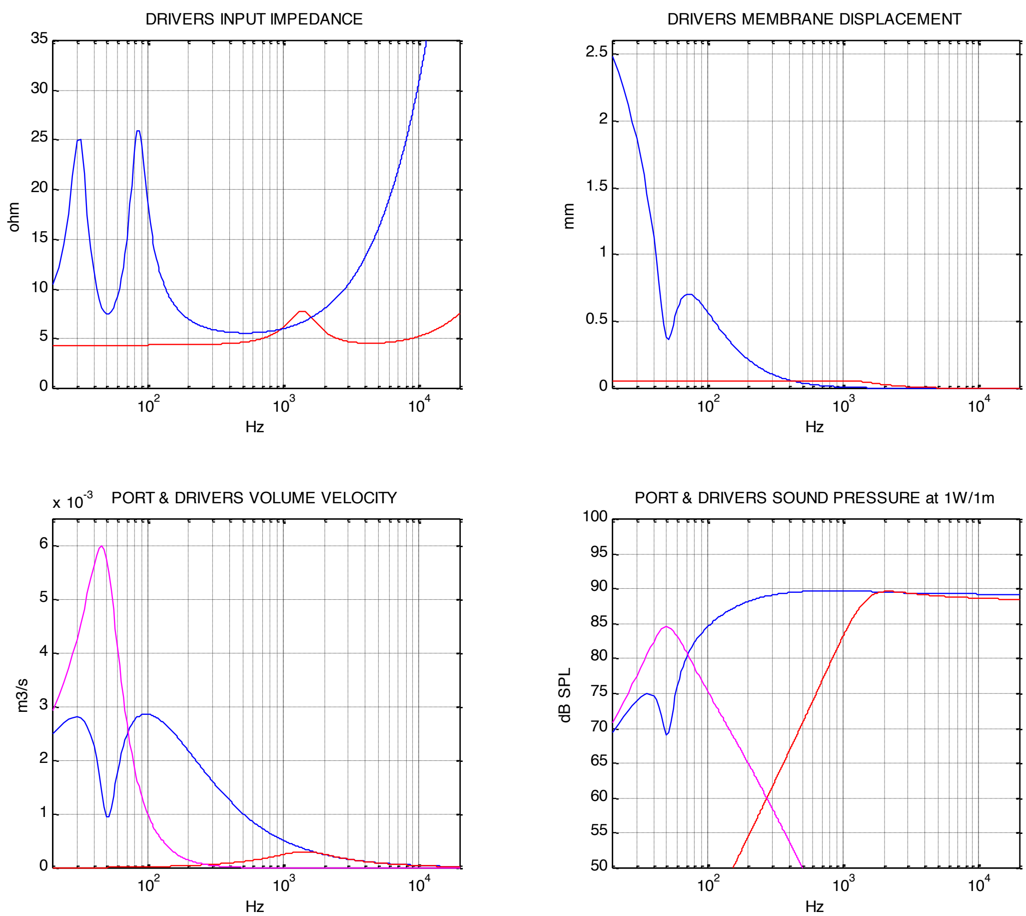
First we need to determine:

- The force factor Bl
- The mechanical parameters linked to the mobile system: mass m_s, resistance R_{ms} and compliance C_{ms}
- The acoustic equivalent parameters of enclosure, port and losses due to leakage: C_{ab}, m_{ap}, R_{leak}
- The acoustical radiation impedance m_{ar} and R_{ar}

These lumped-constant parameters enable input impedance, membrane displacement, as well as drivers and port volume velocities to be calculated. According to the hypotheses of membrane coincidence and monopole radiation, they lead to a first estimation of drivers and port radiating sound pressure.

The figure below shows the example of the *Minilogos* calculation results:

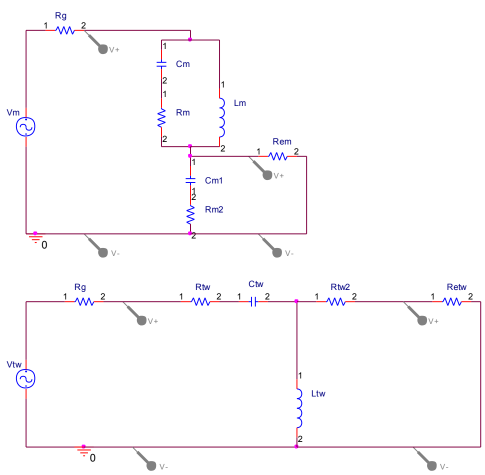
- Drivers input impedances
- Drivers membrane displacements
- Port and drivers volume velocities
- Port and drivers radiating sound pressure estimated at 1W/1m

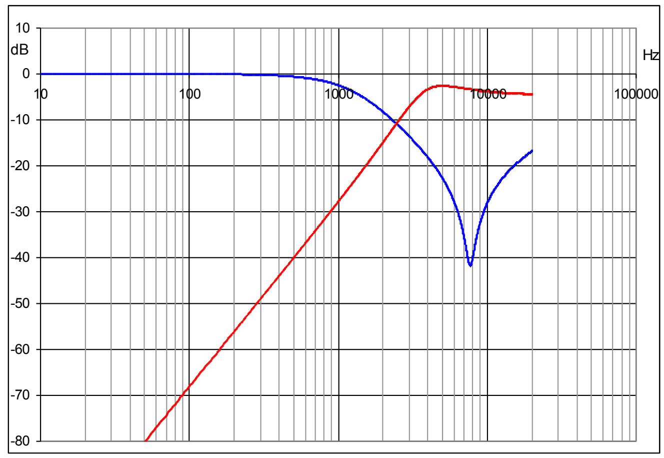


3. Crossover modeling and transfer function calculation

The above calculation of port and drivers sound pressure radiated at 1W/1m, enables the crossover cut-off frequencies and slopes to be estimated.

The figures below show the example of the *MiniLogos* crossover modeling and transfer function calculation.

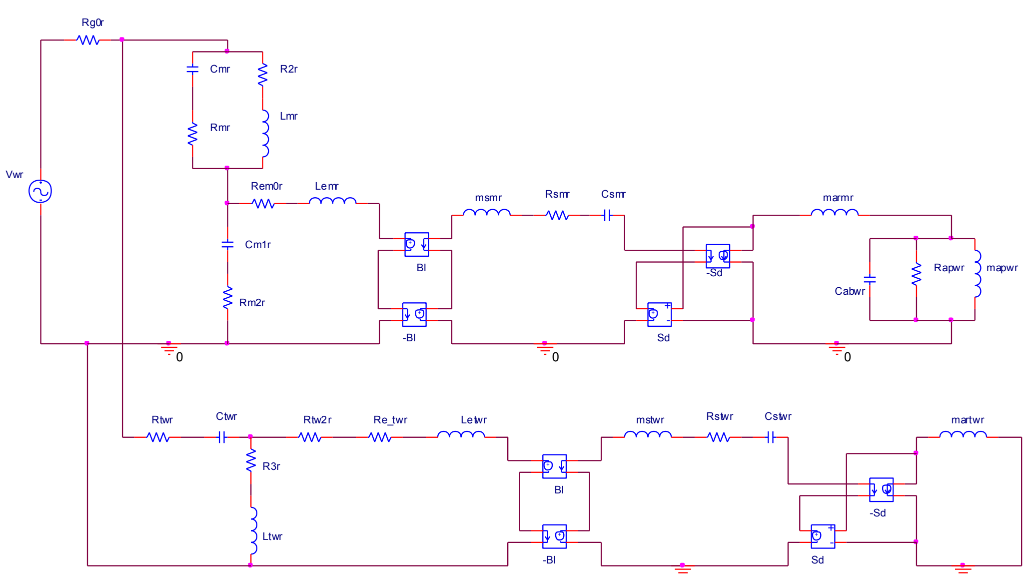


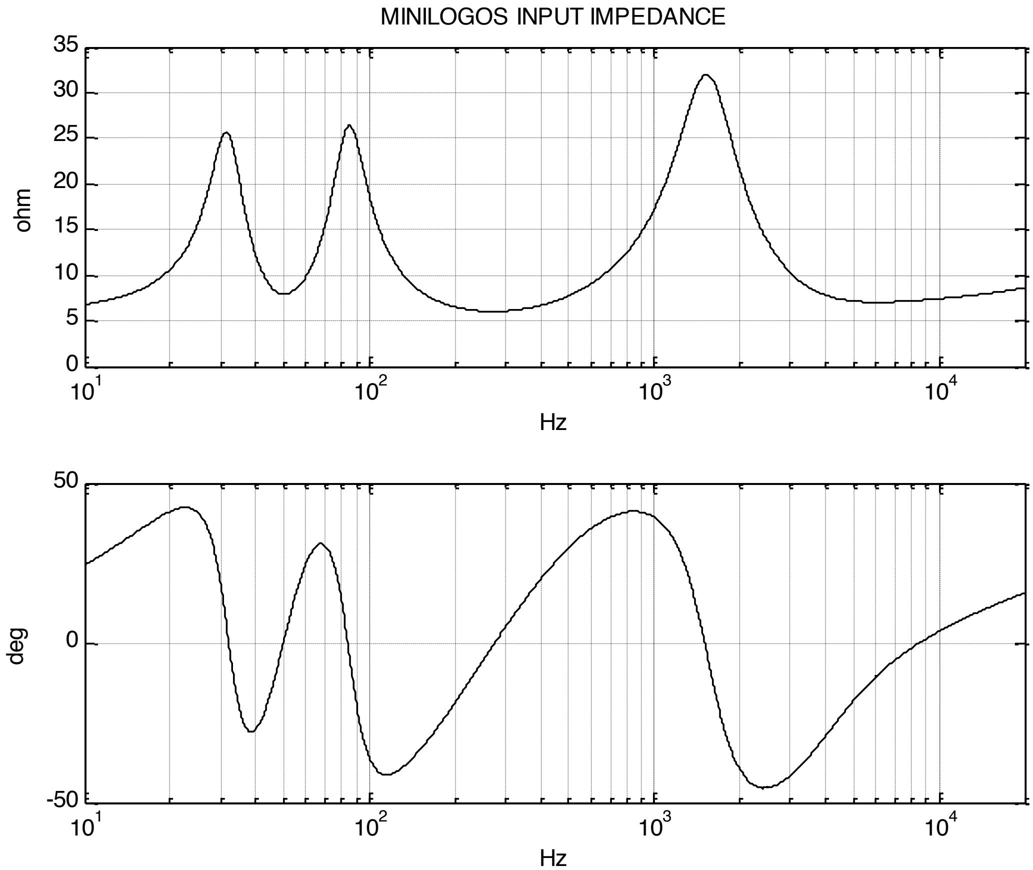


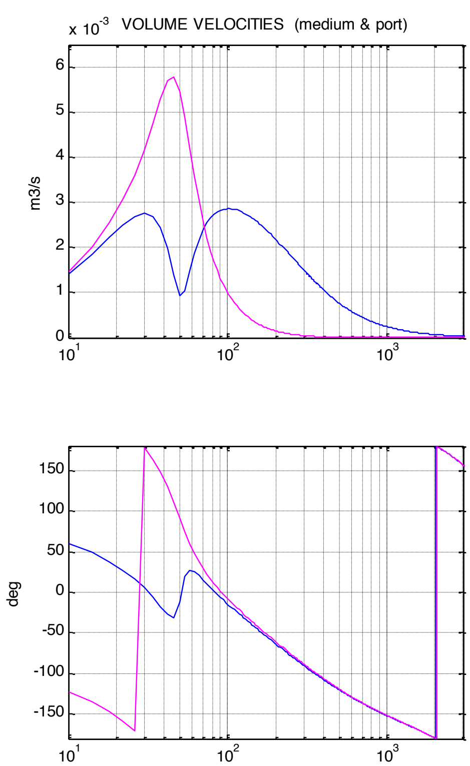
4. Modeling comprising crossover, driver and enclosure lumped-constant parameters

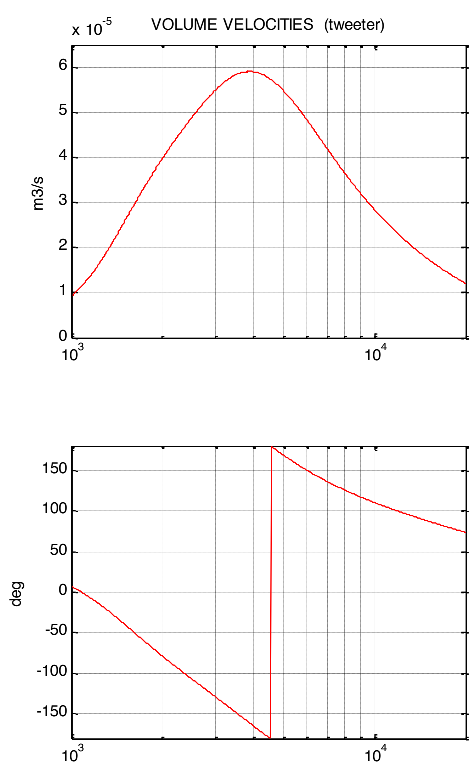
The points 2 and 3 lead to the final system modeling. The latter enable the filtered input impedance and volume velocities to be calculated.

The figures below show the *MiniLogos* final modeling and the resulting calculated filtered input impedance and volume velocities:




MINILOGOS INPUT IMPEDANCE
ohm
Hz
deg
Hz

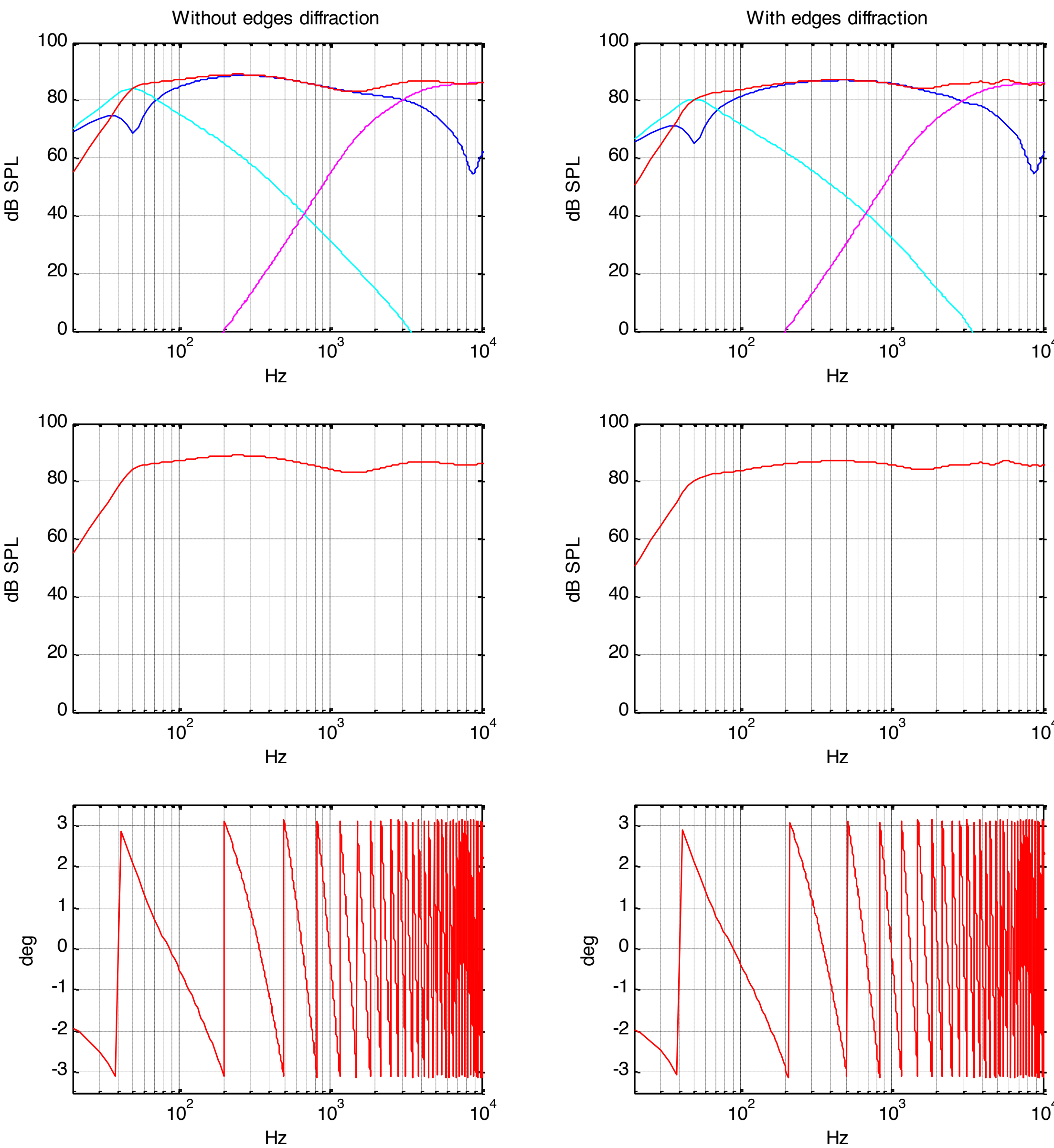

x 10^-3 VOLUME VELOCITIES (medium & port)
m3/s
deg


x 10^-5 VOLUME VELOCITIES (tweeter)
m3/s
deg

5. Final loudspeaker system calculations

The modeled volume velocities of drivers and port are introduced in the calculation with the aim of calculating the sound pressure radiated by the loudspeaker system.

The sound pressure is then calculated in amplitude and phase taking into account the driver finite radiating surface, the drivers and port locations in the enclosure and the diffraction at the enclosure edges (GTD / UTD methods). The figure below shows the *MiniLogos* sound pressure level at 1W/1m with and without box edges diffraction calculation:



The irregularities are calculated in order to compensate those of the driver. Thus, in case of a new loudspeaker system development, it is necessary to measure the driver frequency responses (baffle assembly). It is also necessary of course to measure the final product in an anechoic chamber in order to validate the calculation procedure.

Finally, it should be noted that the sound pressure phase derivative enables the group delay to be calculated with a great accuracy. This last loudspeaker response is very important for the development of in-phase drivers and analysis of fast response systems.