Understanding more

1 Impulse response

The impulse response measures how a transient such as a drum beat is reproduced in the room. Reflections, diffraction, resonances, misaligned drivers, etc., combine to smear out the transient.
As the name indicates, the impulse response shows how the system and room responds to an impulse input signal. An ideal speaker adds no ringing, coloring, or time smearing to the recording, so its impulse response should look just like the input impulse.
The similarity between the different loudspeakers' impulse responses at the listening position affects the perception of stage and image. The more similar the impulse responses, the more easy it is to trick the brain that the loudspeakers are not really there, and that the sound emanates from a virtual stage spanned by the physical speakers.

2 Magnitude response

The magnitude response (a commonly used but imprecise term is "frequency response") measures how much each frequency component, or tone, is attenuated. A good magnitude response should be as smooth as possible. Otherwise, different tones are reproduced with unequal strength, and the music is subjected to undesired coloration.

3 Mixed-phase filters

Infinitely many different filters can be designed to have the exact same magnitude response. They differ only in their impulse response. Therefore, it is useful to classify filters according to how their impulse responses behave.

Two commonly used filter classes in audio applications are minimum-phase filters and linear-phase filters. They are two special cases that are relatively easy to design, but that come with tightly constrained impulse response characteristics. A minimum-phase filter, by definition, is constrained to apply only the smallest possible delay to the signal given a desired magnitude response. A linear-phase filter, by definition, applies a delay which is constant across the whole frequency range. Therefore, neither of these two filter designs can make a desired change to the phase or impulse response, unless the desired change is exactly the particular change they make by definition. Minimum-phase and linear-phase filters may even worsen both the impulse response and the magnitude response of a system, simply by applying their magnitude response corrections at the wrong time.

A more difficult design task is to make a mixed-phase filter that matches a desired magnitude response while also having a customized impulse response. A properly designed mixed-phase filter can make significant improvements to the impulse response of a sound system at the listening position:

- Misaligned drivers in multi-way loudspeakers can be corrected by automatically applying different delays to different frequency ranges.
- Energy from direct wave and early reflections can be optimally combined to arrive as a single wave-front to the listener.

Dirac Live® uses mixed-phase filters to optimize the impulse response while applying a desired magnitude response and its performance is quite unique in that it is so successful in making the system response resemble that of an ideal speaker. This is thanks to robust design of so-called mixed-phase filters and its proprietary algorithm based on multiple measurements.