

# **The B-Format – Recording, Auralization, and Absorption Measurements**

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## **Abstract**

B-format microphones are composed of four nearly coincident cardioid capsules arranged at the corners of a tetrahedron. They are capable of capturing the pressure signal as well as the particle velocity of the impinging sound field in all three Cartesian dimensions. This information can be used to auralize the captured sound field via headphones or loudspeaker arrays or to retrieve some of its physical properties. Commercial renderers for B-format sound files in 360° videos such as facebook360 and youtube are available but they do not disclose details about their methods. Consequently, they are inapplicable for research in auralization of 3D-sound. Moreover, B-format recordings are mainly used for entertainment by the Ambisonics community, while little attention has been paid to their potential in room acoustical analysis, especially for in-situ absorption measurements.

This thesis deals with three different issues regarding B-format microphones, namely the computation of the so-called B-format signals, the auralization of B-format recordings and the applicability of B-format microphones for in-situ absorption measurements. In all three areas the basis for further research is provided.

At first, filters to improve the B-format signals are compared by simulations and measurements. Then, a real-time binaural renderer including head tracking is built, whose methods are completely transparent. Finally, a new absorption measurement method, which extracts the sound field impedance from a B-format recording, is proposed and compared to the standard impedance tube method.

Results indicate that simple filters designed based on measurements can improve the B-format signals in the same way as theoretical filters proposed in literature, which are less practical. The binaural renderer works as basis for research related to auralization but needs further improvement and to be tested against its commercial counterparts. Finally, it was confirmed that the measurement of absorption with a B-format microphone works and suggestions to advance this methods are derived.

Keywords: B-format, Ambisonics, auralization, binaural renderer, digital signal processing, room acoustics, absorption measurement