1. Overview

Figure 1: Soundskrit XYZ + Omni Demo Kit (Butterfly)

The XYZ + Omni Demo Kit (Butterfly) is an easy-to-use evaluation kit designed to demonstrate Soundskrit's Direction-of- Arrival (DoA) algorithm with a total thickness under 3.5mm. It includes the Butterfly PCB, which has three orthogonal Soundskrit dipole microphones and an omnidirectional microphone, connected to Soundskrit Demo Kit interface to demonstrate the sound localization performance in an intuitive way.

In Butterfly, the microphone signals are used to determine the direction of the dominant speech and automatically steer to sound source accordingly. The beamformer can also be manually steered along the horizontal plane and the vertical plane. Additionally, an immersive stereo mode outputs two directional beams in a stereo signal. Soundskrit Demo Kit Interface will be used as an all-in-one platform to demonstrate all these features.

What's In the Box	
Butterfly Board	The Butterfly development board with omni and 3 orthogonal dipole microphones.
Soundskrit PARDI audio interface	Multichannel audio interface to connect microphones over USB
Molex cable	To connect Butterfly microphone board with audio interface
USB-A to USB-C Cable	A cable to connect the board to your PC.

Table of Contents

2. Hardware Introduction

The Soundskrit Butterfly uses one omnidirectional microphone (W) and three Soundskrit dipole microphones which are oriented along three orthogonal axes (X, Y, and Z) to cover the 3D space. The omnidirectional microphone is the Knowles Everest, the dipoles labelled L and R are the Soundskrit SKR0710, and the Z dipole is a Soundskrit SKR0610. The corresponding directivity for voice pickup is labeled in the image below.

Figure 2: Butterfly Board

The PARDI audio interface has a USB-C connector to connect it to a PC and a Molex connector to connect the Butterfly board. The cable comes pre-connected and only needs to be reattached if it becomes disconnected.

Figure 3: Butterfly PARDI Board Interface

3. Software Introduction

The Soundskrit Demo Kit Interface is a platform used for evaluating performance of the Butterfly demo kit. It has a dedicated interface for Butterfly to show the DoA feature for ease of understanding, as well as the audio recording tracks, allowing users to configure the beam steering in different beamformer modes to compare the performance of voice capture.

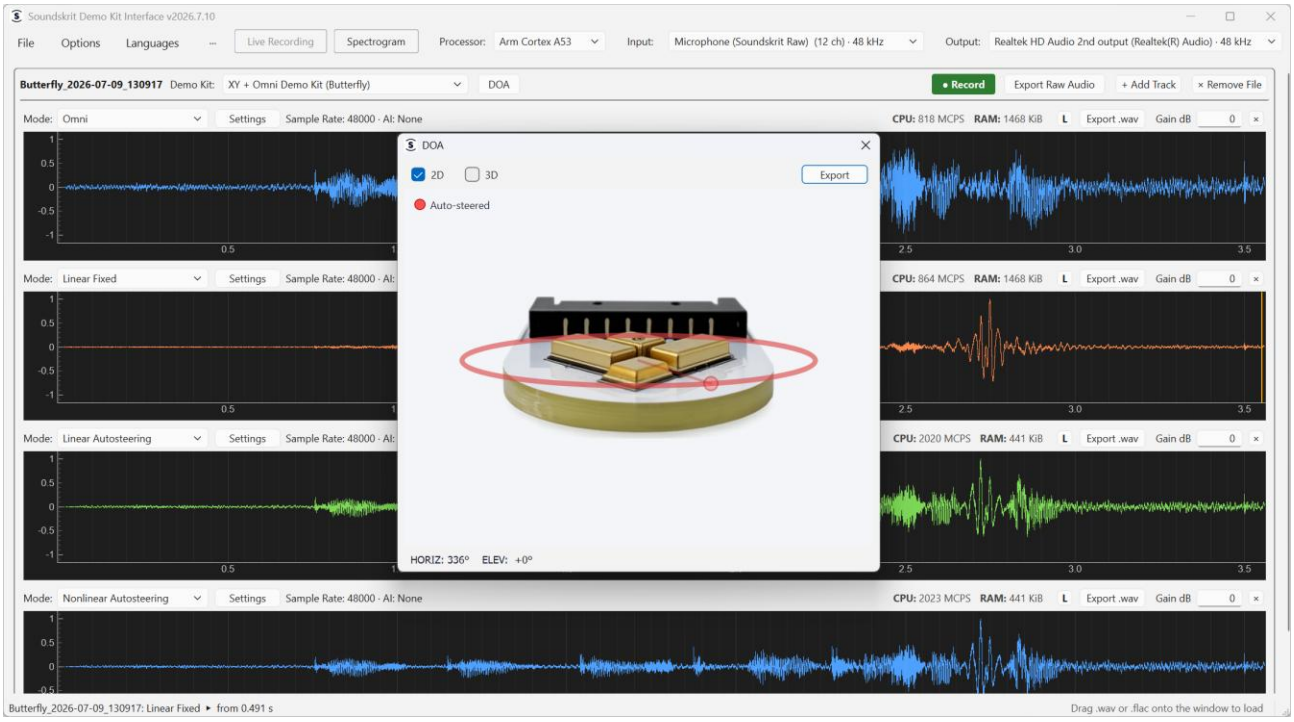


Figure 4: Soundskrit Demo Kit Interface

The software allows users to capture a recording via Live Recording mode, process the raw signals through various algorithms with different parameter configuration and compare algorithm performance side by side through playback. In addition, a dedicated DoA interface will allow users to understand the sound localization performance. To facilitate quick evaluations, sample audio files are also provided in the software, allowing users to test the algorithms even without connecting to the Butterfly demo kit.

The Demo Kit Interface also provides relevant computational metrics across all algorithm configurations, including CPU usage and RAM usage for various processor cores to help customers understand the algorithm requirements in embedded implementation.

For more detailed introduction of Soundskrit Demo Kit Interface, please refer to **Soundskrit Demo Kit Interface User Manual** from the Downloads page on Soundskrit's website.

4. Algorithm Introduction

To help customers understand the performance differences between algorithms and identify the most suitable solution for processing audio signals in their projects, Soundskrit provides various algorithm families, including beamformers and AI-based models. These algorithms are optimized for isolating voice pickup and suppressing background noise. Additionally, two specialized algorithms have been developed to support specific applications: speech transcription and stereo audio recording, respectively. Below is a detailed overview of these algorithms.

4.1. Beamformers

Soundskrit provides several beamforming algorithms for users to evaluate the performance in terms of voice capture and noise suppression and further decide which one works best for their application. The table below shows the beamformers that can be evaluated with the Butterfly.

Beamformer Descriptions*	
Omni	Outputs the equalized omnidirectional microphone signal, used as a reference for performance comparison.
Linear	A fixed, distortionless beamformer toward the speaker's mouth preserving natural voice quality.
Nonlinear	An enhanced beamformer, providing stronger background noise suppression, while introducing some distortion and artifacts.

** Please refer to the computational requirement shown in the GUI.*

4.2. AI Denoising

The GUI comes equipped with AI denoising models that are divided into three categories: Small, Medium, and X-Large. These models can be cascaded on top of a chosen beamformer. The table below shows the detailed description for each AI model.

AI Denoiser Description*	
Small	Small AI model for noticeable background noise suppression, with some distortion and artifacts.
Medium	Medium AI model for enhanced background noise suppression, with less distortion and artifacts
X-Large	Extra-large AI model for premium background noise suppression, with minimal distortion and artifacts

** Please refer to the computational requirements shown in the GUI.*

4.3. Beam Steering Mode

In the GUI, linear beamformer and nonlinear beamformer offer two modes respectively — *Fixed* and *Autosteering*. Comparing them shows the benefit of autosteering, which continuously tracks on the

target speaker to maximize speech quality while suppressing background noise. Additionally, a dedicated autosteering mode is provided specifically for far-field transcription applications.

Steering Mode	Description*
Fixed	The beam is steered to the pre-set direction to focus on the sound in corresponding direction while rejecting the rest.
Autosteering	The beam is autosteered to follow the loudest sound, ensuring the maximum pickup to it while suppressing the others.
Far Field 360 Degree Transcription	A far-field beam for speech-to-text: removes room reverberation, steers to the talker from any direction, and suppresses what remains.

*Note: The orthogonally arranged dipole microphones could generate a **Stereo Mode** which brings an immersive listening experience. You can also find this mode in **Mode** drop down menu in each audio track.*

5. Setup Guide

5.1 Installation

Download and launch the installer file from Downloads on Soundskrit website then follow the installation steps. A prompt may appear requiring approval for an unknown publisher.

Connect the Butterfly to your PC using the included USB-C to USB-A cable.

To start the software, search from the Windows start menu for ‘Soundskrit Demo Kit Interface’ or use the desktop shortcut generated by the installer.

Make sure the Butterfly is correctly connected to the PC and that the PARDI board is in raw mode. If the PARDI board is not in raw mode (this may apply to units shipped before June 2026), a window will appear, prompting you to change the PARDI board to raw mode.

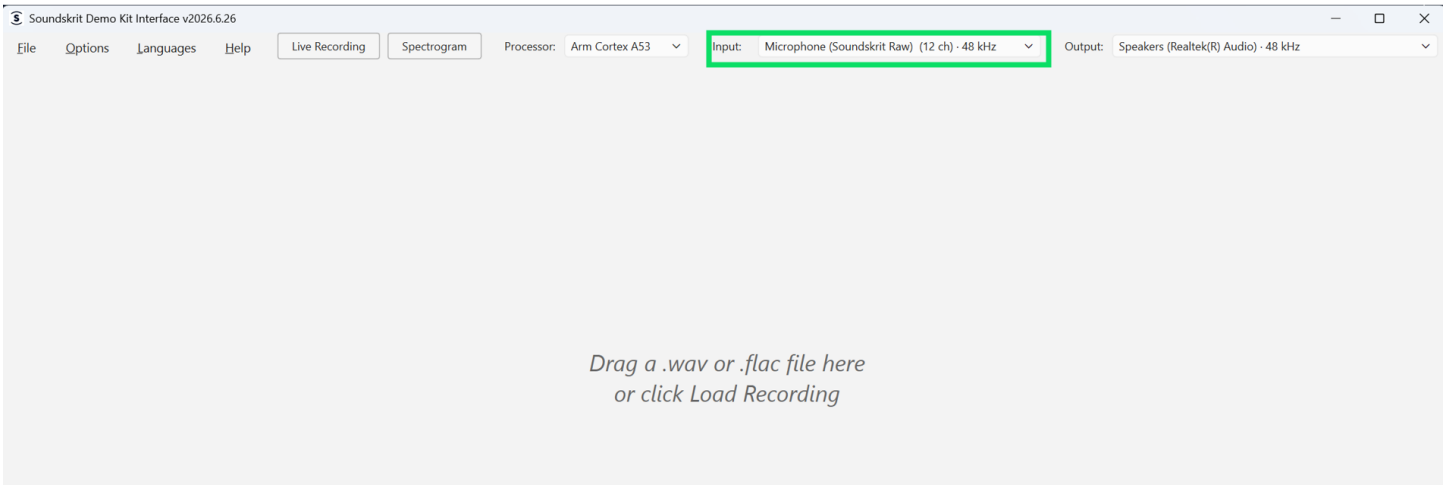


Figure 5: Raw Mode Detected

5.2 Audio Performance Evaluation

5.2.1 Sound Localization Evaluation

In the GUI, you can see a visualized DoA interface to evaluate the performance of sound source tracking. To open the interface, click **Live Recording**, then select the Butterfly in the **Demo Kit** drop-down menu. Click the **DoA** button next to the **Demo Kit** section to open the interface.

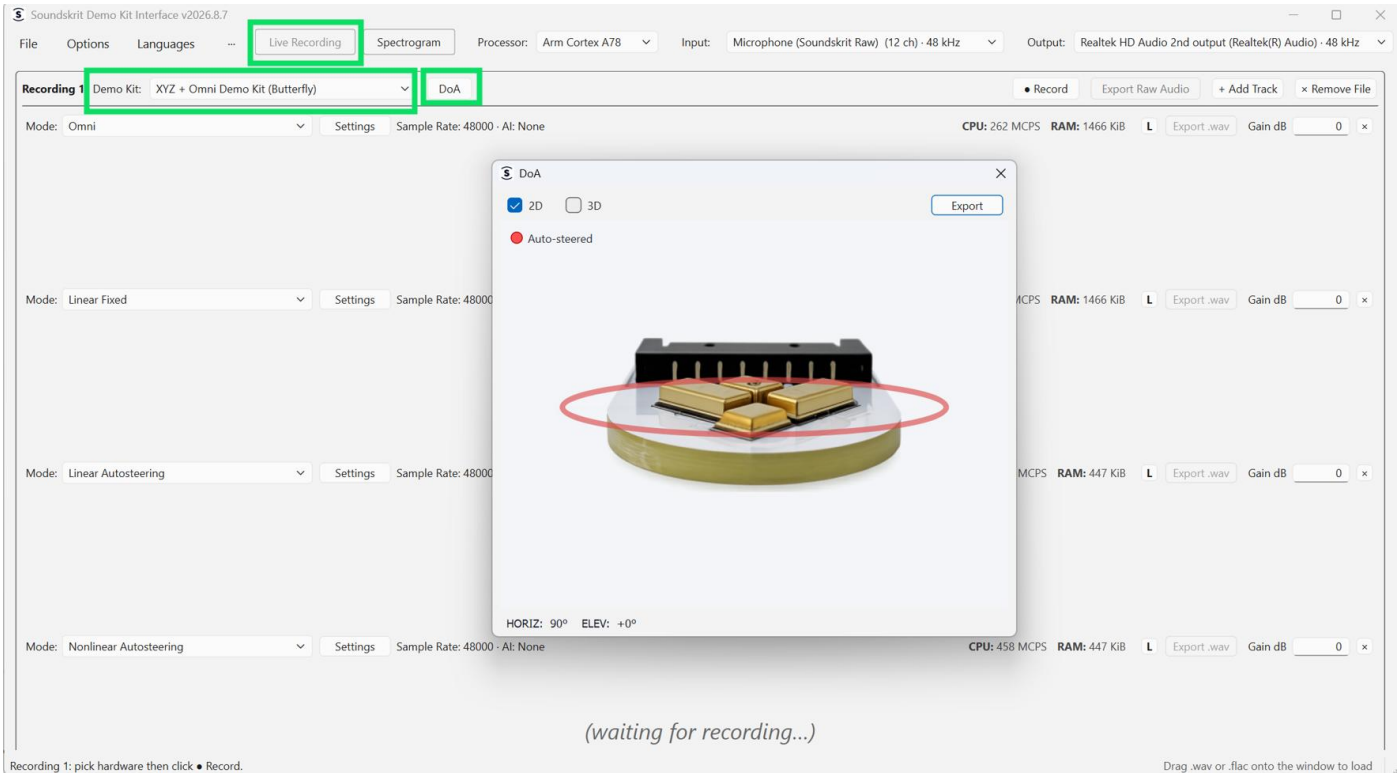


Figure 6: Butterfly DoA Interface

In the DoA Interface, you can select 2D or 3D to enable the 2D Planar DoA or 3D Spatial DoA. On the top-right corner, the **Export** button allows you to export the sound localization coordinates for further features, such as beam steering.

5.2.2 Listen to the Audio

In the DoA interface, auto-steering is used to indicate the direction of the sound source. In addition to the visual indication, you can evaluate the system's performance by listening to the audio output. There are three ways to obtain audio for performance evaluation in the GUI.

Option 1: Load built-in audio samples

You can find pre-recorded audio samples and load them in the Soundskrit Demo Kit Interface for quick performance comparison without the Butterfly kit connected. To find the audio samples, click **File** in the top-left corner, and choose **Samples**. In the new window displayed, you can choose the samples from the **Section** drop-down menu.

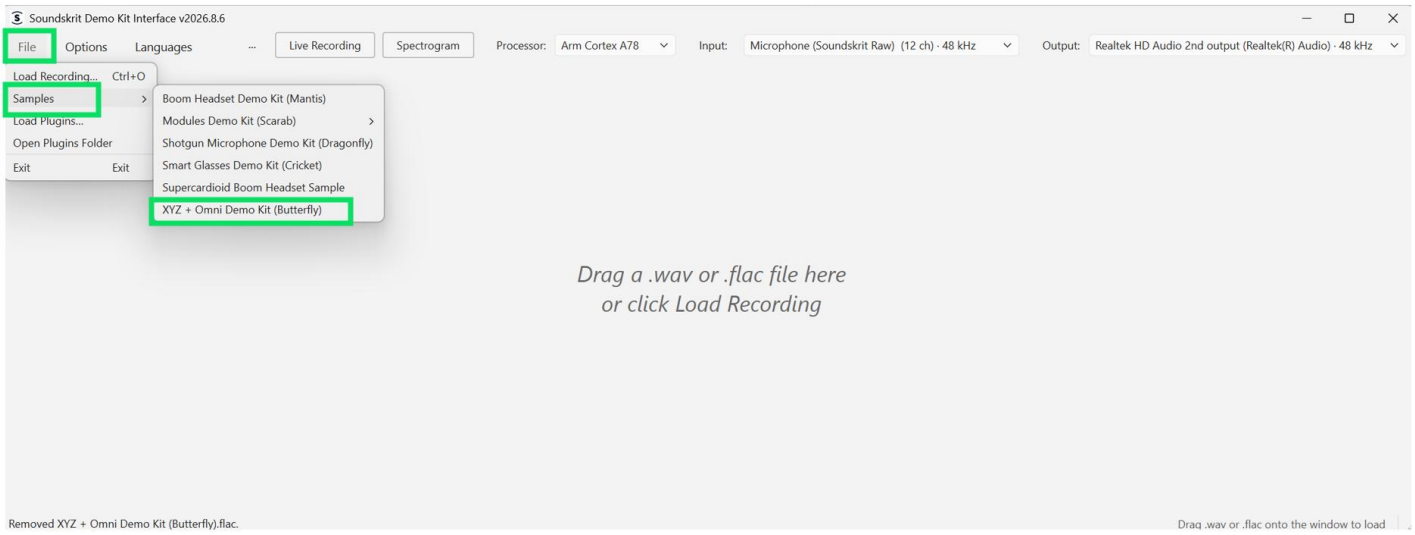


Figure 7: Audio Samples in Soundskrit Demo Kit Interface

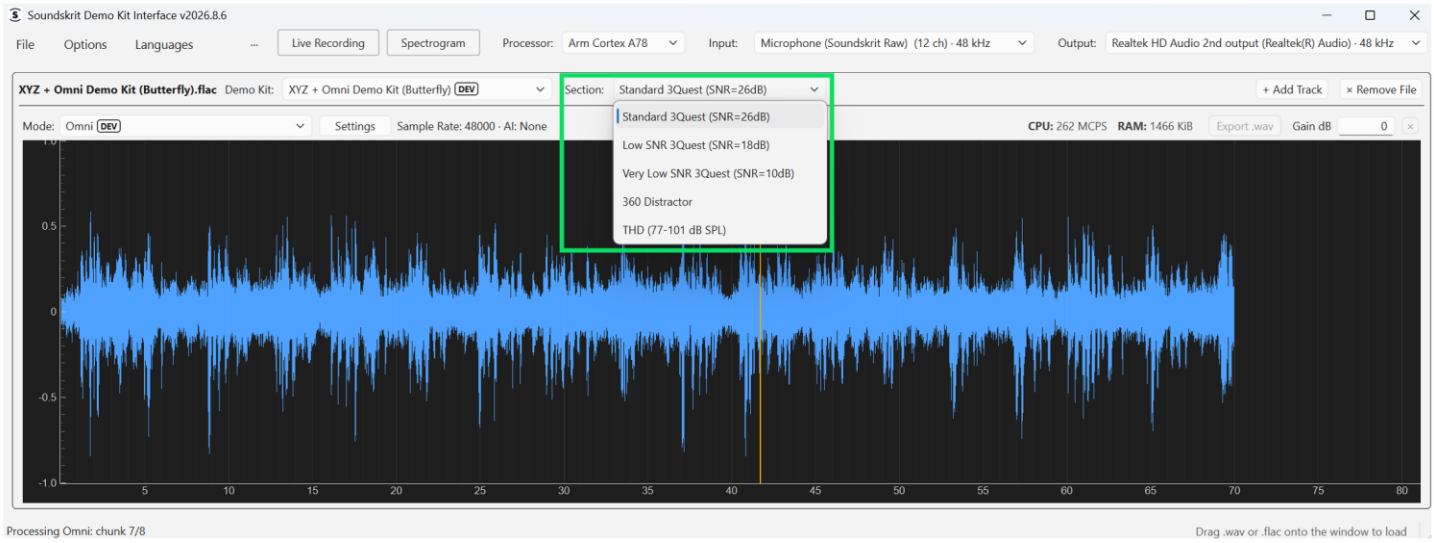


Figure 8: Different Audio Samples for Butterfly

Below is the introduction of the recording setup for each audio sample.

3QUEST samples assess speech quality and noise suppression in typical noise. In a 3QUEST test, a talker speaks a set of standard sentences while realistic background noise is played around the device. Three versions are provided at decreasing signal-to-noise ratios for speech level to background noise: 26dB (standard 3Quest setup), 18dB, and 10dB SNR. The SNR is computed at the HATS mouth reference point (25mm in front of the mouth).

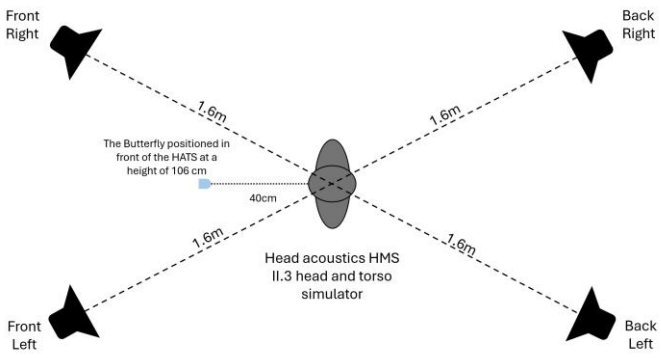


Figure 9: 3Quest Testing Setup

THD samples test for distortion at high speech levels. In this test, a talker's voice is played at progressively increasing levels, from 77 to 101 dB SPL, to simulate a person speaking louder and louder. The recording contains speech rising in level with no added background noise, letting you check whether the algorithms introduce any distortion as the voice gets louder.

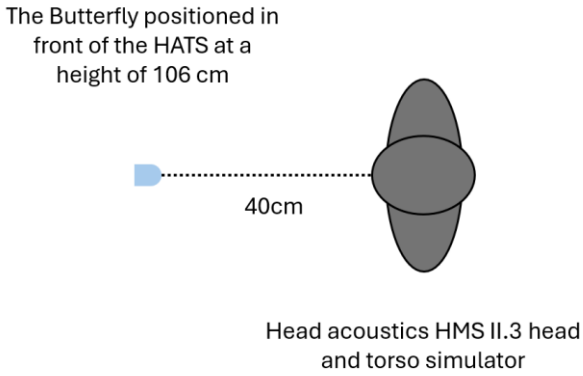


Figure 10: THD Samples Testing Setup

The **360 Distractor** sample evaluates how well competing talkers in the environment are removed. Throughout the test, a constant background noise at 26dB SNR is present while an interfering speaker (the distractor) is played through loudspeakers placed at five positions around the listener. The distractor speech is played in the following order: front center, front left, front right, back left, and back right. For each position, the sample contains three segments back-to-back: the target speaker alone, the distractor alone, and then the two together.

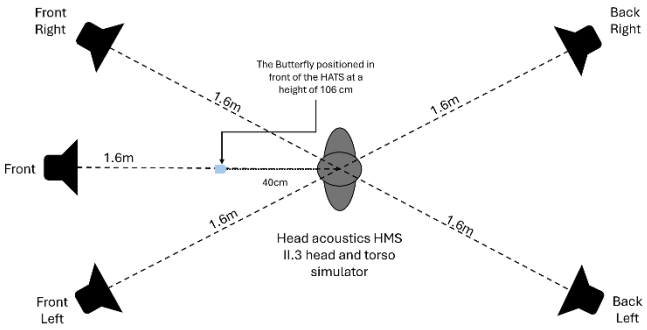


Figure 11: 360 Distractor Testing Setup

Select an audio sample, then choose an algorithm from the **Mode** drop-down menu to evaluate its performance on the selected sample.

Option 2: Load an External .wav File

Users can upload external .wav file for audio processing. The .wav file must be a raw signal recording captured from the Butterfly demo kit.

Please note, if the external audio file is not recorded by Butterfly demo kit, the audio file will only be marked as ‘External’, and no demo kit can be chosen for it. Under this circumstance, external audio file could be set as benchmark reference to compare the audio performance between Soundskrit Butterfly Kit and other audio solutions.

Option 3: Record Live with the Butterfly

Use Live Recording (see image below) to capture audio with the Butterfly and process it in real-time. Please make sure the Butterfly is positioned with the microphone side facing up when taking a live recording.

1. Click **Live Recording** to open the recording window. By default, six tracks are configured to compare performance across beamformers and voice pickup settings, in parallel (see Tracks Map below).

2. Click **Record** to start and **Stop** to end. The audio is distributed across the tracks with preset algorithms applied. All audio tracks are normalized to facilitate easy comparisons. Recording again replaces the previous take.

3. To compare more algorithms, click **Add Track** and set the algorithm **Mode** and other parameters in **Settings**, such as AI models for each track, or the angle for the fixed voice capture.

   Note: Please refer to *Figure 2* to understand the angle definition;

4. Click **Save Raw Audio** to keep all six raw channels (re-loadable later for processing), or **Export .wav** to save a single processed track.

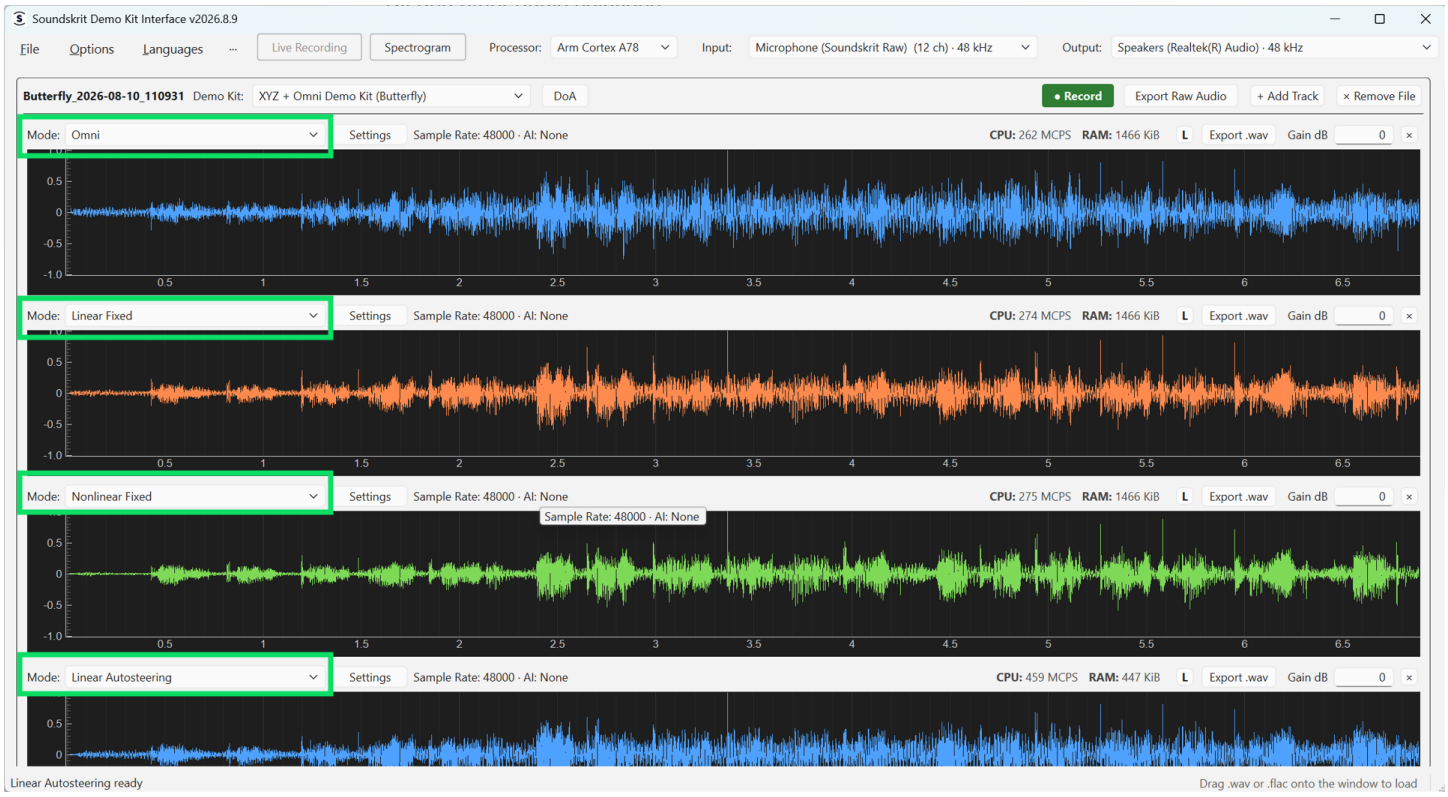


Figure 12: Automatic Tracks Setup in Live Recording

Tracks Map	
Track 1	Omni (reference audio)
Track 2	Linear Fixed
Track 3	Nonlinear Fixed
Track 4	Linear Autosteering
Track 5	Nonlinear Autosteering
Track 6	Far Field 360 Degree Transcription

6. Troubleshooting

This section provides solutions to common issues encountered during installation and operation of the demo kit.

Problem	Possible Cause	Solution
Soundskrit Demo Kit Interface keeps showing **Soundskrit Raw not detected**	Butterfly is not correctly connected to PC	Verify the connection between PARDI board and Butterfly, as well as between PARDI board and PC. A green LED indicator on PARDI board should be flashing if the connection is correct.
Cannot locate select **Mode** in track after loading external audio file recorded by Butterfly	'Demo Kit' is not chosen as Butterfly	Set Butterfly as the demo kit.

7. Additional Support

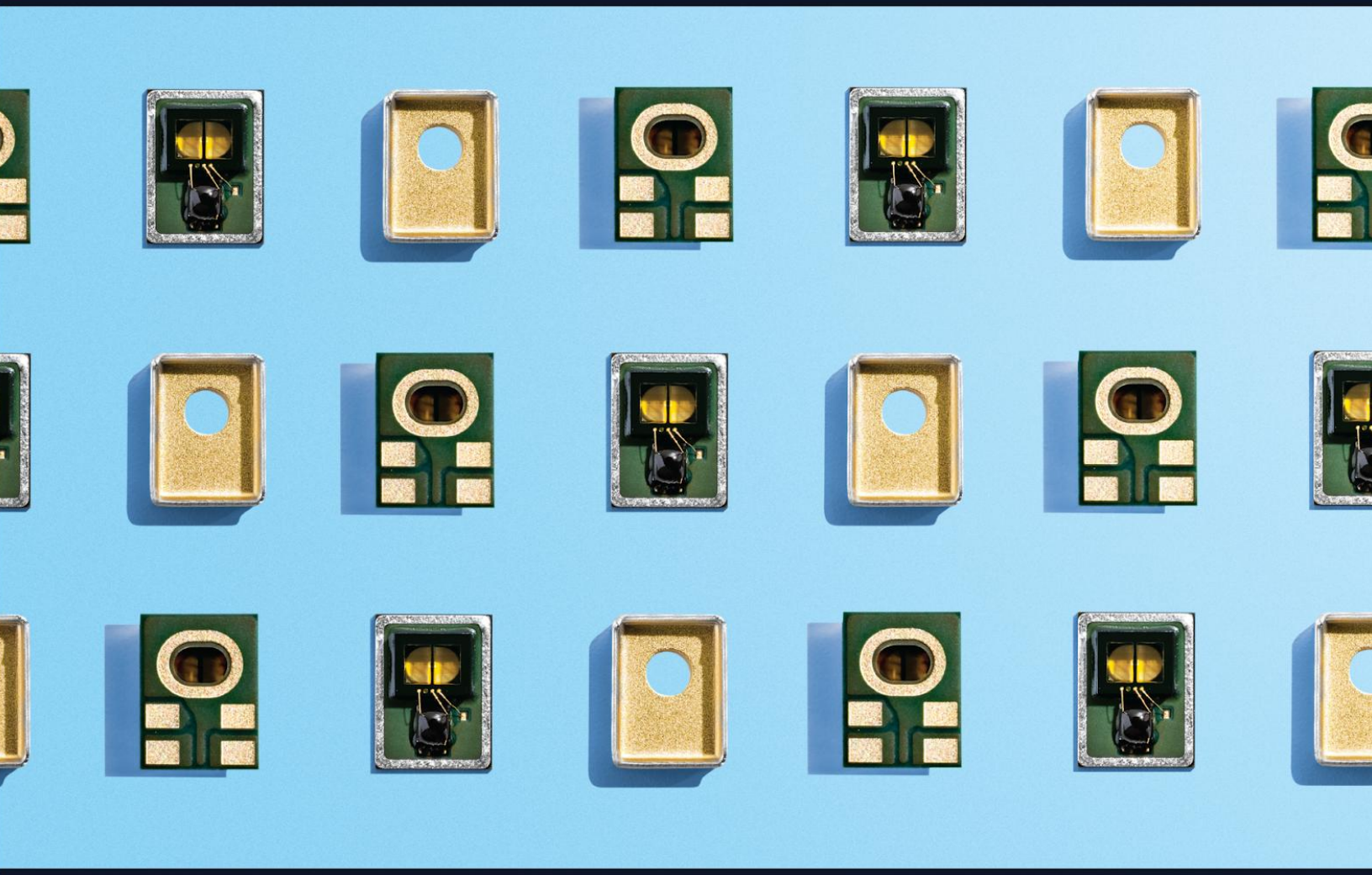
For further information on Soundskrit's products, visit our website at http://www.soundskrit.ca where you can find more application notes, datasheets, and purchasing information. If you have any questions or need technical support, please reach out to applications@soundskrit.ca.

8. Revision History

Revision Label	Revision Date	Sections Revised
-	Aug 2026	Initial release

Soundskrit developed the first high-performance directional MEMS microphone on the market, leveraging years of research in bio-inspired MEMS based on how spiders and other insects in nature hear. In combination with Soundskrit's in-house audio processing algorithms, directional microphones can be used to capture and isolate any sound in an environment with a fraction of the size, power, and computation of traditional omnidirectional-based microphone arrays.

Soundskrit was founded in 2019 and is headquartered in Montreal, Quebec with an R&D facility in Ann Arbor, Michigan.



soundskrit
Hear the impossible.