SIGNALSOLUTIONS

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# PiezoSleep™ System Overview

## Introduction

The *PiezoSleep*™ system utilizes our proprietary non-invasive sensing technology to simplify monitoring of sleep-wake behavior, breathing, and activity in rodent preclinical models. There are no restrictions on the use of food, water, bedding or nesting material, and the system is suitable for continuous, around-the-clock monitoring of up to eighty animals simultaneously. The automated sleep-wake classification has been well validated, boasting 92% agreement compared to manual EEG/EMG scoring of sleep‡, and has been applied to various research areas including: Sleep Phenotyping[1], Alzheimer's Disease[2], Respiratory Depression[3], and Traumatic Brain Injury[4].

The system works by converting animal movements within the cage into signals that reflect behavior. During data collection, *PiezoSleep*™ software reduces signals to a set of quantitative measures that are used to infer whether the animal is in sleep or wake in real time and stores data. Following data collection, *SleepStats*™ software allows for more in-depth analyses and visualization of various sleep parameters including sleep bout length statistics, daily sleep proportion, circadian rhythm, sleep related breathing signals, and activity.

Overall, the *PiezoSleep*™ system uniquely enables automated, high-throughput sleep monitoring while alleviating the cumbersome requirements and bottlenecks associated with traditional EEG-based sleep research. Signal Solutions strives to provide cutting edge technology and is continually innovating to provide the research community tools that overcome barriers surrounding preclinical sleep research.

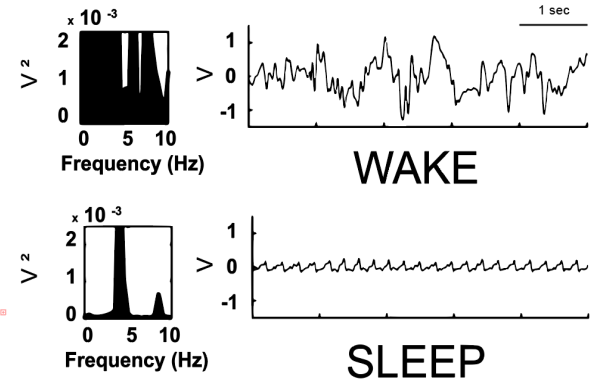
‡ 92% agreement compared to concordant scores assigned in 4 -second epochs by two independent manual raters in 42 C57BL\6 mice

**1**. Philip, V.M.,et al. *Genes, brain, and behav.* (2010); 9, 129-159. **2**. Barnett, A., et al. *Frontiers in pharmacol.* (2020); 13, 8841 70. **3**. Bubier, J. A., et al. *Scientific reports*, (2020); 10(1), 14970. **4**. Saber, M., et al. *European J. Neurosci.* (2019); 52(1), 2791–2814.

# System Details

## Non-Invasive Sensing Technology

The core of the *PiezoSleep*™ system is our patented sensing technology. Sensors are external to the animal environment (separated by a cage liner and/or cage floor), and generate signals that are representative of animal behavior. Wake behaviors (locomotion, rearing, grooming, etc.) generate highly variable, high-amplitude signals that are readily differentiable from those observed during sleep (primarily driven by the subtle movements associated with breathing).




## Precision Data Acquisition

Our data acquisition units are an all-in-one package that accomplishes signal amplification, conditioning, and sampling. Acquisition hardware can be configured to accommodate a variety inputs/outputs (either analog and digital), and are available to support as few as 1 to as many as 80 cages of simultaneous data collection. All data are simultaneously sampled and sent to the PC by a single USB 2.0 cable where they are processed and stored by *PiezoSleep*™ software.


Calamari (8 chan)

Squid Box (16, 32 chan)

Giant Squid Box (48, 64, 80 chan)

## Automated Sleep-Wake Analysis

The *SleepStats*™ data explorer software features functions that open and process multi-channel files created by the high-throughput *PiezoSleep*™ data recording and real-time monitoring system. *SleepStats*™ software provides a visual overview of the full recording from each channel, as well as plotting the sleep statistic overlaid with the sensor signal to confirm signal quality. Graphical representations of percent sleep, sleep bout information, and activity are automatically generated and provided. Data summaries can be exported to CSV files of within user specified time intervals and binning methods, providing additional flexibility in data analysis.