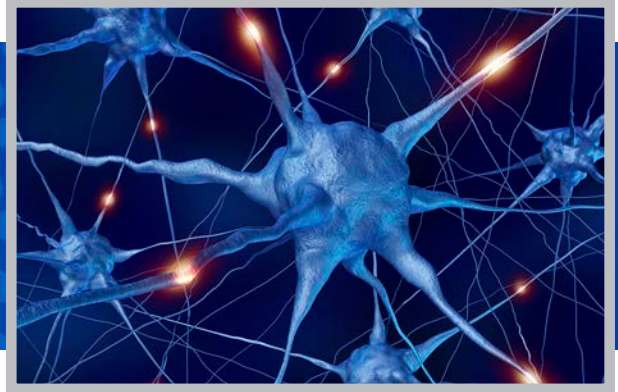




EEG/EMG SYSTEMS



Pinnacle offers **BIOPOTENTIAL RECORDING SYSTEMS** for sleep, seizure and general behavioral paradigms in freely moving mice and rats. Our EEG/EMG systems use head-mounted amplification to produce exceptionally clean waveforms, even during animal movement. We offer wireless & tethered preconfigured three- and four-channel systems. A flexible four-channel tethered system is available which adds the capability to incorporate simultaneous accelerometer or biosensor measurements, as well as optogenetic or electrical stimulation.



WIRELESS SYSTEM FOR MICE & RATS

Pinnacle's turn-key **WIRELESS EEG/EMG SYSTEMS** can record up to four biopotentials simultaneously and present data in real time for review. This lightweight, head-mounted Bluetooth® device enables animals to move freely. It is ideal for behavioral paradigms and group housed research. The same hardware can be used for mice and rats.

COMMON USES



SLEEP STUDIES



SEIZURE RESEARCH



DEPTH ELECTRODES



CORTICAL RECORDINGS



LOCAL FIELD POTENTIAL



COGNITIVE STUDIES

8274 WIRELESS SYSTEM SPECIFICATIONS

System Model	8274-HR	8474-HR
# Channels	3	4
System Configuration	2-EEG/1-EMG 3-EEG	4-EEG-REF (all channels share common)
High Pass Filter	EEG 0.5 Hz (Sleep) EEG 1.0 Hz (Seizure) EMG 10 Hz	
Total Gain	2600 V/V	
# bits	14	
Input Range	± 465 µV	
Resolution	57 nV / bit	
Sample Rate & Battery Life*	256Hz - 7 days 512Hz - 6 days 1024Hz - 3 days 2000Hz - 2 days	256Hz - 6 days 512Hz - 5 days 1024Hz - 3 days 2000Hz - 1 day

WIRELESS SYSTEM WEIGHT & SIZE**

Weight	Mice	3.8g (3.9g for 4-EEG)
	Rats	6.8g (6.9g for 4-EEG)
Size	Mice	17.1 x 16.2 x 11.0 mm
	Rats	32.1 x 21.2 x 18.3 mm

*Bluetooth interference may affect battery lifetime. For longer studies the removable battery can be easily replaced.

**Includes electronics, battery and enclosure.

TETHERED SYSTEM

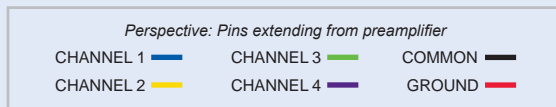
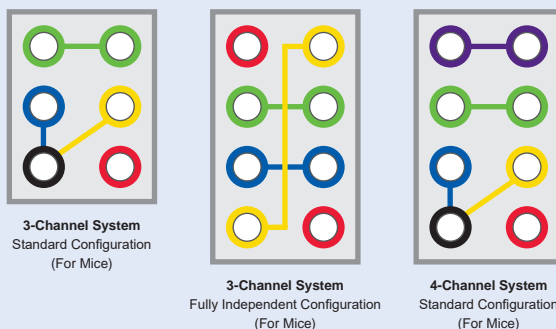
OUR TETHERED TURN-KEY SYSTEMS are engineered to deliver clean, artifact-free data. EEG and EMG waveforms are amplified and filtered at the head of the animal by the preamplifier. Signals are then passed through the low-torque swivel to the data conditioning and acquisition system for final-stage amplification and filtering.

TETHERED SYSTEM FEATURES	3-CHANNEL	4-CHANNEL
Available for both mice and rats	✓	✓
Optimized for sleep and seizure experiments	✓	✓
No cable artifact	✓	✓
Optional video recording	✓	✓
Digital input/output controls	✓	✓
Low-pass filters	✓	✓
Adjustable input range (gain)		✓
Optogenetics compatible		✓
Biosensor compatible		✓
Accelerometer compatible		✓
Sampling rate up to 20,000 Hz per channel		✓
TTL as analog inputs		✓
Change system configuration via preamplifier		✓
Electrical stimulation compatible		✓

HOW OUR PREAMPLIFIERS WORK

Pinnacle's preamplifiers provide differential amplification (x10 or x100) between electrodes. Our standard three- and four-channel preamplifiers have two referential channels and one or two differential channels. Fully referential and fully differential versions are also available. **Perspective:** Pins extending from preamplifier

Example: A 2 EEG/1 EMG preamplifier configured for seizure studies in mice has a gain of x100 on all channels, 1.0 Hz high-pass filters on the EEG channels, and 10 Hz high-pass filters on the EMG channel.



SYSTEM FOR RATS

COMMUTATORS



A low-torque commutator mounts above the cage for free, unencumbered movement. A 1-inch cable extends from the commutator.

PREAMPLIFIERS



Preamplifiers amplify and filter signals at the head, ensuring clean, artifact-free data. An 18-inch cable, protected by a metal spring coil, connects the preamplifier to the commutator. A P1 Technologies screw connector secures the preamplifier to the animal's head.

High-Pass Filters: 0.5 Hz EEG, 10 Hz EMG for sleep; 1.0 Hz EEG, 10 Hz EMG for seizure

Gain: x100 for sleep; x10 for seizure

3-Channel Configurations	Sleep	Seizure
2 EEG/1 EMG	•	•
3 EEG		•
4-Channel Configurations	Sleep	Seizure
2 EEG/1 EMG/1 BIO	•	•
2 EEG/1 EMG/1 Accelerometer	•	•
3 EEG/1 EMG	•	•
3 EEG/1 BIO		•
3 EEG/1 Accelerometer		•
4 EEG		•
4 EEG Fully Referential		•

RAT HEADMOUNTS



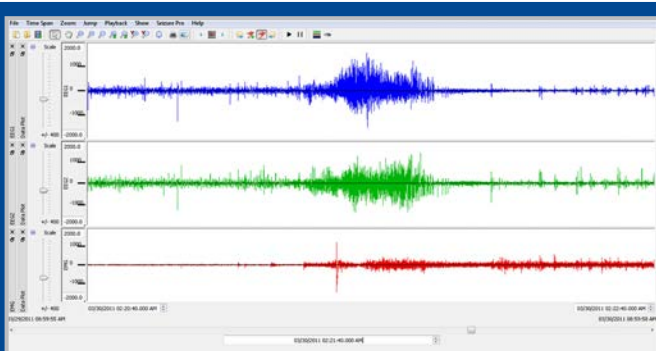
Prefabricated rat headmounts use fittings mounted on a 9 mm X 9 mm board with EEG or EMG electrode wires attached. An additional two-pin electrode is used for 4 EEG configurations.

CUSTOM CONFIGURATIONS AVAILABLE

DATA CONDITIONING AND ACQUISITION SYSTEM

A data conditioning and acquisition system (DCAS) performs secondary amplification and filtering before sending data to Pinnacle's Sirenia® Acquisition software for collection via a USB connection.

Specifications	3-Channel	4-Channel
Adjustable Sampling Rates	200 - 2,000 Hz	200 - 20,000 Hz
Software Configurable Low-Pass Filters	11 Hz - 1 kHz	21 Hz - 15 kHz
ADC Resolution	16 bits	18 bits
TTL Support	4 TTL Input/Outputs	4x TTL Configurable as Digital In/Out or 12-bit Analog



Seizure event from a C57 mouse model captured using Pinnacle's three-channel EEG/EMG system.

Data courtesy of Drs. Philip Haydon and Jerome Clasadonte, Tufts University School of Medicine, Department of Neuroscience

SYSTEM FOR MICE

COMMUTATORS

A low-torque commutator ($< 2 \times 10^{-4}$ N-m), mounted above the cage, allows for unencumbered freedom of movement. A seven-inch cable extends from the commutator.



PREAMPLIFIERS

Preamplifiers amplify and filter signals at the head for clean, artifact-free data. The commutator connects to the preamplifier's seven-inch cable, made of six insulated, lightweight wires. The mouse preamplifier attaches to the headmount via a friction fit.



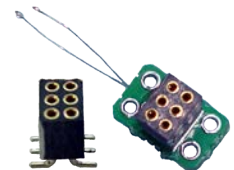
High-Pass Filters: 0.5 Hz EEG, 10 Hz EMG for sleep; 1.0 Hz EEG, 10 Hz EMG for seizure

Gain: x100 for sleep; x10 or x100 for seizure

3-Channel Configurations	Sleep	Seizure
2 EEG/1 EMG	•	•
2 EEG/1 EMG (Independent)	•	•
3 EEG		•
3 EEG (Independent)		•
4-Channel Configurations	Sleep	Seizure
1 EEG/1 EMG/2 BIO	•	•
2 EEG/1 EMG/1 BIO	•	•
2 EEG/1 EMG/2 BIO	•	•
2 EEG/1 EMG/1 Accelerometer	•	•
3 EEG/1 EMG	•	•
3 EEG/1 BIO		•
3 EEG/2 BIO		•
3 EEG/1 Accelerometer		•
4 EEG		•
4 EEG Fully Referential		•

MOUSE HEADMOUNTS

Prefabricated headmounts reduce surgery time, allow for reproducible electrode placement and provide ready-to-insert EMG leads. Six- or eight-pin headmounts support flexible electrode placement for customizable cortical or depth recordings.



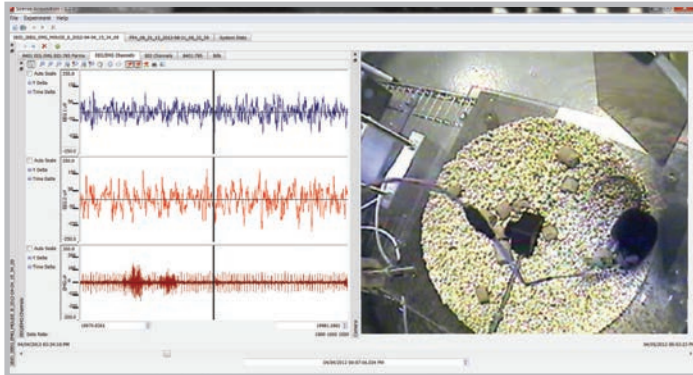
SUPPORTING PRODUCTS

SLEEP DEPRIVATION

Gently restrict sleep in rodents based on real-time EEG/EMG thresholds or programmed schedules without human intervention.

SYNCHRONIZED VIDEO

Integrated video recording provides a platform for synchronizing EEG and EMG changes with observable behavioral states. Video can be added to any new or existing hardware system. Captured video is displayed live on screen as it is streamed from the animal and is synchronized with other recorded data in playback mode.



EEG and EMG data recorded simultaneously with full-color video.

SENSORS *

The addition of sensors enables the correlation of EEG/EMG activity with neurophysiological changes in freely moving mice and rats.

OPTOGENETICS* / ELECTRICAL STIMULATION*

A stimulus controller can be added for optical stimulation using LED fiber probes or electrical stimulation using traditional electrodes.

USE WITH YOUR EXISTING AMPLIFIER *

Analog adapters allow researchers to use their existing amplification/acquisition systems with Pinnacle's preamplifiers and headmounts.

***Tethered Systems Only**

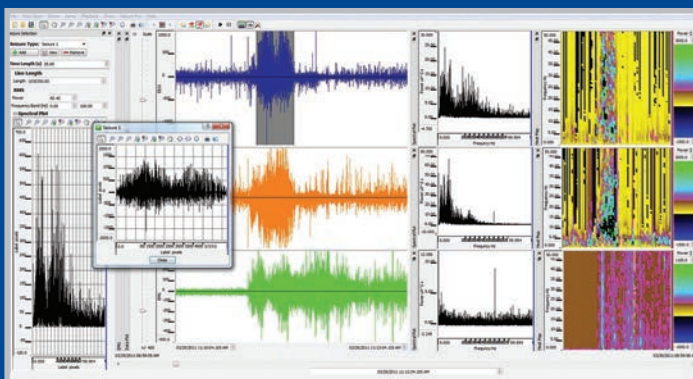
"The clarity of the data rivals anything I have ever seen. Quite simply, this is the best system for EEG and sleep recording on the market today."

— Dr. Fred Turek
CEO, NuNetix, Inc.

ADVANCED ANALYSIS SOFTWARE

SIRENIA® SEIZURE PRO

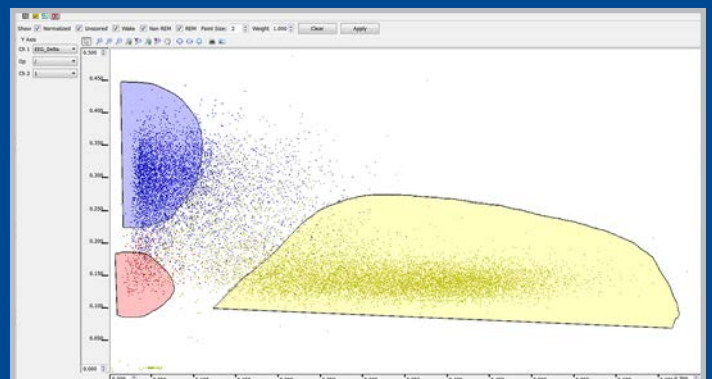
Quickly identify, analyze and log user-defined seizure events in a given time period. Tools include spectral power, heat maps, line length, amplitude and seizure duration. Custom reports and graphs can be generated.



A seizure event in a C57 mouse identified and selected for automated analysis using Sirenia® Seizure Pro.

SIRENIA® SLEEP PRO

Reduce scoring and analysis time with semiautomated tools such as cluster scoring, threshold scoring, hypnograms and spectral plots. Quickly compare scores, perform bout and sleep analyses and customize high-quality charts and graphs.



Data from a C57 mouse are quickly scored using Sirenia® Sleep Pro's semi-automated cluster scoring tool.

SIRENIA® FEEDBACK PRO

Create rule sets using baseline data, thresholds and power analysis to initiate stimuli in real-time for a variety of sleep, seizure, optogenetics and other studies.

SIRENIA® X-Y TRACKING

Track real-time or pre-recorded locomotor behavior. Includes quadrant and user-defined zone analysis, speed plots, movement trajectories, heat maps and overlay capabilities.