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Adapt-A-Base vs. Custom Cage

We sell a custom mouse cage that uses our film sensor technology. We do not, however, sell a custom "rat cage"; we only sell an Adapt-A-Base solution, which will work together with the commercial rat cage type of your choice. We have an Adapt-A-Base solution for mice as well, that will work together with the commercial mouse cage type of your choice. So "custom cages" can be used with mice only. Our Custom Cage (for mice): uses our film sensor technology, has

dimensions 8" W x 13" L x 9" H. The inside dimensions of our film sensor cage are 6" x 6" (232 sq cm). The Adapt-A-Base platform itself is made of acrylic sheet, and the sensor components are mostly made of polylactic acid. Both solutions, custom mouse cage and Adapt-A-Base, offer the same monitoring and data recording capabilities, both use our film sensor technology, and the price is identical for both, but the Adapt-A-Base solution price includes the Adapt-A-Base platform only, so there is an additional cost for the commercial mouse cage of your choice if you do not have commercial cages in house already, and would like to purchase them from us.

Adapt-A-Base Care

The user should take care not to use excessive solvents/water/cleaner if/when cleaning the sensors. Excessive moisture could seep around the electronics enclosures and lead to corrosion, short-circuits, etc. If cleaning is necessary, we recommend wiping the surface of the device with a damp cloth and allowing it to dry completely before reconnecting. If debris falls into crevices on the device (e.g., around the sensors), we recommend compressed air to remove it. We also recommend using proper wire management and avoiding moving the sensors and acquisition unit after setup, as doing so can cause sensor cables to become slightly dislodged and interrupt signal acquisition.

Circadian Rhythm

SleepStats can estimate the circadian rhythm of rodents by tracking the proportion of time spent in sleep/wake over a discrete or sliding interval. Refer to our manuals for more information. You are able to export the sliding sleep/wake percentage generated to CSV for further processing/analysis, as well as a variety of other data summaries. SleepStats4 PRO's activity analysis routines include generating ActiGraphs, which can be exported to a format compatible with ActiMetrics' ClockLab software.

Commercial Cage Recommendations

Adapt-A-Base (for either rats or mice) is our solution for customers who would like to choose their own mouse or rat commercial cage type. So we offer Adapt-A-Base solutions for either mice or rats. The commercial cage type of your choice will sit on the appropriate Adapt-A-Base platform. The Adapt-a-Base utilizes the same technology as the film sensors used in our Custom Mouse Cages, with two sensors that are protected by spring-loaded housings that keep the sensors in good contact with the bottom of your cage. Because the sensors cover a smaller area, we use two sensors and combine the information into a single signal that is recorded similarly to the film sensor (that is, you still only record one signal per cage). One advantage of the Adapt-a-Base is its flexibility in cage fitment, as we can design a base that is tailor-made to fit your specific cage, and this allows customers to use cages already present in their housing facility if desired. Initial design for a new customer-specific cage requires that the customer ship us a cage base for design and fitting purposes, which adds additional time (4-6 weeks) to the lead time. For this reason, we keep bases for several 'recommended' commercial cage models in stock for customers who do not have the need for a specific cage: specifically, the Ancare N10 cage (for mice), and the Tecniplast 1291 cage (for rats). But we have bases designed for various other models as well.

Recommended Commercial Cage Types:

- Ancare N10 commercial cage for Mouse: According to the Ancare website, the dimensions of the N10 cage are 7.5 x 11.5", which would be roughly 550 sq cm: https://www.ancare.com/products/cages-and-caging-equipment/rodent-cage/mouse-cage
- Tecniplast 1291 commercial cage for Rat: According to the Tecniplast website, the dimensions for this cage are 425 x 266 x 185 mm, or 16.73 x 10.47 x 7.28 in. with a floor area of 800 cm2/124 in2: https://www.tecniplast.it/usermedia/en/2016/brochures/TP_HOUSING_CONVENTIONAL.pdf

Computer Recommendations

Typically, customers use two separate machines: one in the animal facility to do data collection, and another in the lab/office to do data analysis. The computing hardware recommendations for these cases are as follows:

Data Acquisition (PiezoSleep): A computer running Windows 10 or Windows 11 with 8GB of RAM and an ultra3/ultra5 Intel processor, and a minimum of 2GB of storage. When recording, the base PiezoSleep system generates data at a rate of 150MB per cage per week. Storing data in an internal storage device is strongly recommended for system reliability. A 1-2TB internal SSD is recommended. The use of USB- or Network-attached storage is not recommended.

Additional Notes on PiezoSleep4 Synchronized Video Module: If recording video with the PiezoSleep4 Synchronized Video Module, more performant computer specifications are required: a high-performance multi-core processor (Intel Ultra7 155H or similar), 16GB of RAM, and a dedicated, internal SSD. We recommend an auxiliary drive with a capacity of 2-4 TB, depending on the number and resolution of cameras being recorded (One 1080p camera recorded with H. 2. 64 compression will generate ~10 GB of video data per day). A gigabit Ethernet RJ45 network port is also required to connect the computer to the video network.

Data Analysis (SleepStats): A more powerful computer will have advantages when analyzing data, especially when processing data files with a high channel count or long duration (i.e., week-long). An ideal configuration would be 32 GB of RAM with a performance-oriented ultra7/ultra9 -H or -K series processor. The software will function with lower-performance hardware (less RAM, older, or slower processors).

Data Acquisition Devices

These devices are part of every system we sell. They manage the data collection from the cages, and they come in different sizes to accommodate the maximum number of cages you plan to have in your system: up to 8, 16, 32, 48, 64, or 80.

DIO

Allows you to:

1. Capture digital signals sent from third-party hardware
2. Send a digital output on the detection of sleep to activate third-party systems. It has an additional cost.

EEG Monitoring with Our Systems

If you are interested in doing EEG monitoring of your rodents, then we would need to know if the EEG monitors are wireless or tethered, and it would be important to know if your rodents are mice or rats. For tethered mice, we would direct you to our Custom Mouse Cage option, which comes with our EEG Cage Wall Extender (Dimensions: 6-in x 6-in x 7-in) that replaces the lid and is intended to keep the mice from escaping while allowing for the wires attached to the animal to move freely.

Solutions for tethered rats are dependent on the cage type you wish to use. Some customers route the tether through the wire feeder tops or cut a hole in the cage lids to route tethers. We have also seen where some customers remove the lid and wire-bar and place a cylinder inside the cage to restrict animal movement while tethered. To summarize, our system is perfectly compatible with tethered recordings, but how you want to accommodate the tether is up to you with commercial cages.

Environmental Sensor

Our environmental sensors are USB devices that record data for the following parameters from a cage environment every 2 seconds:

- Light Level (Lux) - The range of the sensor is between 3 Lux and 220,000 Lux.
- Temperature (Degrees Fahrenheit) – The sensor will navigate normal changes in ambient temperature with no problem.

- Relative Humidity (Percent) - The relative humidity accuracy rating is within + or - 2%.
- Pressure (Inches of Mercury) - The pressure accuracy rating is within + or - .1 millibar.

NOTE: The Environmental Sensor cannot be calibrated. If an environmental sensor is used during data collection, then a file with extension ".Env" will be created along with the other data files. This environmental sensor data and the decision statistics data can be overlaid and observed in the same zoom window.

SleepStats 4 (the base version of SleepStats that comes with every system) lets you view and export this data. Exporting the data will allow you to access the record of environmental information and do any analyses you might want (i.e., export the sleep bouts and correlate with temperature, light, etc.).

SleepStats 4 Pro (enhanced version of SleepStats 4, has an additional cost) will go one step further and use the light data (lux value) to automatically adjust the light/dark times used when computing sleep metrics in light vs dark.

The environmental sensors transfer data via a micro USB cable. The sensors can be attached to a surface with double-sided tape, cable ties, etc. We can also design a custom mounting solution if there's something specific that you require.

Expedited Shipping

If we have all the required parts and components in-house, then we can offer an expedited delivery option. Here are the expedited options we offer:

We will ship in no more than 2 weeks from the date of receiving the PO: 4% additional cost
We will ship in no more than 30 days from the date of receiving the PO: 2% additional cost

Otherwise, our standard lead time is 60 days from the time we receive your (purchase) order.

Lead Time (to Ship Orders)

Our standard lead time, from the time we receive your order to the time we ship your system to you, is 60 days.

Maintenance Costs

There are currently no maintenance costs for using our software once you purchase a system, nor are there maintenance costs for the hardware; you will own the hardware in your system. You will be able to use the software version that you purchase as long as you want to. There may be a small charge for upgrades to major new software releases in the future.

Mouse & Rat Systems Interchangeable?

No. We provide systems for both mice and rats; however, each system is built to work with one or the other only. The reason for this is that we have to apply amplification to the signal in mouse systems to account for the size differences between mice and rats. Other customization, unique to the data collection needs of either mice or rats, must also be accommodated, dictating that their hardware configurations are different. Separate systems would need to be purchased if you wish to monitor both mice and rats.

MouseQwake

MouseQwake is a sleep disruption/fragmentation system for mice. Its cages are designed specifically for MouseQwake systems, so if you wish to be able to use the MouseQwake's unique "shaking" capability, then you will need both the MouseQwake Data Acquisition Device (called Calamari MouseQwake) and the MouseQwake cages, which are essentially the same 'Custom Mouse Cages' that we provide as an option for our mouse systems. They are, however, equipped with a transducer beneath the cage floor, which gets activated to deliver vibro-tactile stimulation to affect sleep, which can be activated either in closed-loop (upon detection of

sleep or low activity) or open-loop (activation according to a fixed/randomized time interval). The basis of the MouseQwake system is the use of non-invasive vibrational stimulation that is adjustable in timing (when the stimulation is applied to the animal), amplitude (intensity of stimulation), and frequency (speed of vibration). Note: the Calamari MouseQwake can be used as a standard Calamari Data Acquisition Device if desired.
Dimensions of the equipment: DAQ: 8.25" L x 7.25" W x 2.25" H & 2 lbs, Cage Assembly: 13" L x 8" W x 11" H & 7.5 lbs.

The system can be set to operate within a range for each of these settings, or can be set to randomize them individually to avoid animal habituation to the stimulus.
The stimulation can be applied according to four protocols:

1. Sleep-Based: Applying stimulation upon PiezoSleep, estimating the animal to be in sleep
2. Activity-Based: Applying stimulation upon activity measure dropping below a set threshold, allowing the user to apply stimulation with more aggressive timing
3. Open-Loop: Applying the stimulation according to a fixed (or randomized) time interval
4. Manual (On Demand): Applying stimulus to all cages upon the user activating a software button.

Digital I/O Option: We also offer DIO for the MouseQwake system, which expands the functionality to:

1. Allow the user to trigger channels to stimulate individually using a TTL input
2. Generate a TTL output while a cage is being stimulated.

These functions of the systems are further described in our manuals and videos.

Nest Building

In general, nest building is not a problem in our cages, and in fact, we (and most of our customers) often supply nestlets to mice in every experiment. As with normal mouse bedding made of wood or paper, the movement of the mouse is still detected by the piezoelectric sensors through the bedding or through the nesting materials. Again, we expect that this should be no problem at all, and you can safely use our standard software to assess sleep vs. wake under these conditions.

RatQwake

RatQwake is a sleep disruption/fragmentation system for rats. If you wish to be able to use the RatQwake's unique "shaking" capability, then you will need both the RatQwake Data Acquisition Device (called Calamari RatQwake) and the RatQwake cage assembly that consists of our Adapt-A-Base technology, along with a Tecniplast 1291 commercial rat cage. The Adapt-A-Base is equipped with a transducer beneath the platform, which gets activated to deliver vibro-tactile stimulation to affect sleep, which can be activated either in closed-loop (upon detection of sleep or low activity) or open-loop (activation according to a fixed/randomized time interval). The basis of the RatQwake system is the use of non-invasive vibrational stimulation that is adjustable in timing (when the stimulation is applied to the animal), amplitude (intensity of stimulation), and frequency (speed of vibration). Note: the Calamari RatQwake can be used as a standard Calamari Data Acquisition Device if desired.

Dimensions of the equipment: DAQ: 8.25" L x 7.25" W x 2.25" H & 2 lbs, Cage Assembly: essentially the same as the Tecniplast 1291 commercial rat cage: 425 x 266 x 185 mm, or 16.73 x 10.47 x 7.28 in. with floor area: 800 cm2/124 in2.

The system can be set to operate within a range for each of these settings, or can be set to randomize them individually to avoid animal habituation to the stimulus.
The stimulation can be applied according to four protocols:

1. Sleep-Based: Applying stimulation upon PiezoSleep, estimating the animal to be in sleep
2. Activity-Based: Applying stimulation upon activity measure dropping below a set threshold, allowing the user to apply stimulation with more aggressive timing
3. Open-Loop: Applying the stimulation according to a fixed (or randomized) time interval
4. Manual (On Demand): Applying stimulus to all cages upon the user activating a software button.

Digital I/O Option: We also offer DIO for the RatQwake system, which expands the functionality to:

1. Allow the user to trigger channels to stimulate individually using a TTL input
2. Generate a TTL output while a cage is being stimulated.

These functions of the systems are further described in our manuals and videos.

REM/NREM

SleepStats4 PRO supports 3-state sleep-wake analysis, further classifying sleep into NREM and REM. The system works by tracking physiological changes in breathing during sleep to discriminate REM-like and NREM-like behavior. However, the physiological manifestations that occur in REM are not one-to-one with REM sleep, often trailing behind true REM onset and coming in and out within a REM bout. Due to this, the point-to-point accuracy with human scores may seem to show low agreement. However, when considering the estimates across longer intervals (e.g., % time spent in 12-hour periods), the system aligns well with those derived from human-assigned scores.

Currently, 3-state classification is only supported for mice using our custom (film sensor) cage system. REM classification is not supported for rats or for mouse Adapt-a-Base systems.

A more complete description of the performance of 3-state classification can be found on page 60 of the SleepStats4 Manual

Respiration Rate

In terms of comparing respiration rate data between the Adapt-a-Base and the Custom Mouse Cage, the respiration rate signal is estimated in the software from the signal acquired by the cage and amplifier. Because the Adapt-a-Base must measure through the plastic cage floor, mouse Adapt-a-Base systems are more prone to variability in capturing the breathing signal during sleep. Therefore, our recommendation, if respiration rate is of particular importance to your research, especially if you plan to track REM/NREM sleep, would be for you to choose our Custom Mouse Cage for your mouse system, as breathing-related measures are a key component in deciphering NREM from REM. We have seen that the algorithm for rat Adapt-a-Base systems is robust and reliably captures the breathing signal and reports the sleep-wake estimation accurately. This is due in part to the larger size of rats. Note: We do not offer REM/NREM detection for rat systems.

Seizure Detection

Our system provides a means of rapidly screening data to confirm seizures. To provide a means of verification, the seizure systems require the use of simultaneous video recording, which we have integrated into PiezoSleep. Once Piezo and video data have been collected, we process the raw signals from our data files to flag candidate seizure time points, which can be rapidly reviewed through our custom video annotation software. In its current state, the system is primarily built to flag and review potential seizure events, allowing researchers to more rapidly screen for seizures compared to exhaustive video review.

Set-Up Recommendations

We recommend allowing for 12" of vertical space on your shelves so that you can remove/refill the water bottle, move animals in and out of the cages, etc. We also recommend leaving 8-12" of space between sensors to limit cross-talk. While we recommend solid, heavy-gauge shelving, customers often use systems on wire-rack style or thin, stainless steel shelving. In some cases,

the shelving can have intrinsic vibrations/resonances, but these are only a concern if they are in our frequency range of interest. We have seen that anti-vibration foam/rubber matting has been helpful in these situations. Because the 'custom cage' system is able to receive a more direct measurement (i.e., it is not measuring through the plastic cage floor), it is usually less susceptible to these issues. We have seen that different recording environments (rooms) have different sources of noise (air flow, machinery in nearby rooms, air/water supply lines etc.), so we usually recommend customers take some test data collections (such as recording the cages without animals in the cages) so that we can assess the noise signature of the new environments and identify any potential sources of interference.

Sleep Fragmentation

Our MouseQwake and RatQwake systems provide sleep fragmentation solutions for mice and rats. MouseQwake and RatQwake are sleep fragmentation devices: the MouseQwake system is based on our film sensor cages, and the RatQwake system is based on our Adapt-a-Base systems. Both utilize non-invasive vibrational stimulus to interrupt sleep in either closed-loop (upon detection of sleep or low activity) or open-loop (activation according to a fixed/randomized time interval). See MouseQwake or RatQwake.

System Portability

The system is fairly robust. The sensor and data acquisition device are the most fragile components. So long as you take care to protect the electronics and the sensor, you should be able to relocate the system without any issues.

Warranty

We provide a 1-year warranty for the entire system, at no additional cost, that covers both hardware and software. If you were ever to have problems with your system, then please contact us, and we will try to determine what the problem is in order to potentially avoid your needing to send any components to us. If we determine that we need a device to be shipped to

us, then we will do everything possible to turn it around in less than 1 week. We have an excellent track record for systems sold without ever having any problems.

Warranty (Extended)

We offer an Extended Warranty for the entire system for an additional cost based on the total system cost: 5% for 1 additional year, 7.5% for 2 additional years, 10% for 3 additional years.

What We Measure

Our sensors generate a signal that is representative of the movement of the animal within the cage - high-intensity, random signals during wake and rhythmic signals representative of breathing during sleep. We process the signals in time and frequency domains to derive various signal parameters that we combine into a 'decision statistic' that represents the likelihood of sleep and wake. We have validated our system against manual scoring of EEG/EMG and report over 95% agreement with human scores. We save the breathing-related parameters to a specific data file, which can be visualized in our software. Our data analysis software (SleepStats) allows you to visualize various experimental variables, including daily percent sleep, sleep bout length information (mean, histograms, etc.), compare sleep in light/dark, and lets you export these numbers to CSV files that can be processed in common programs like EXCEL or GraphPad PRISM. We can also export 'activity' data to a format that is compatible with circadian analysis software ClockLabs.