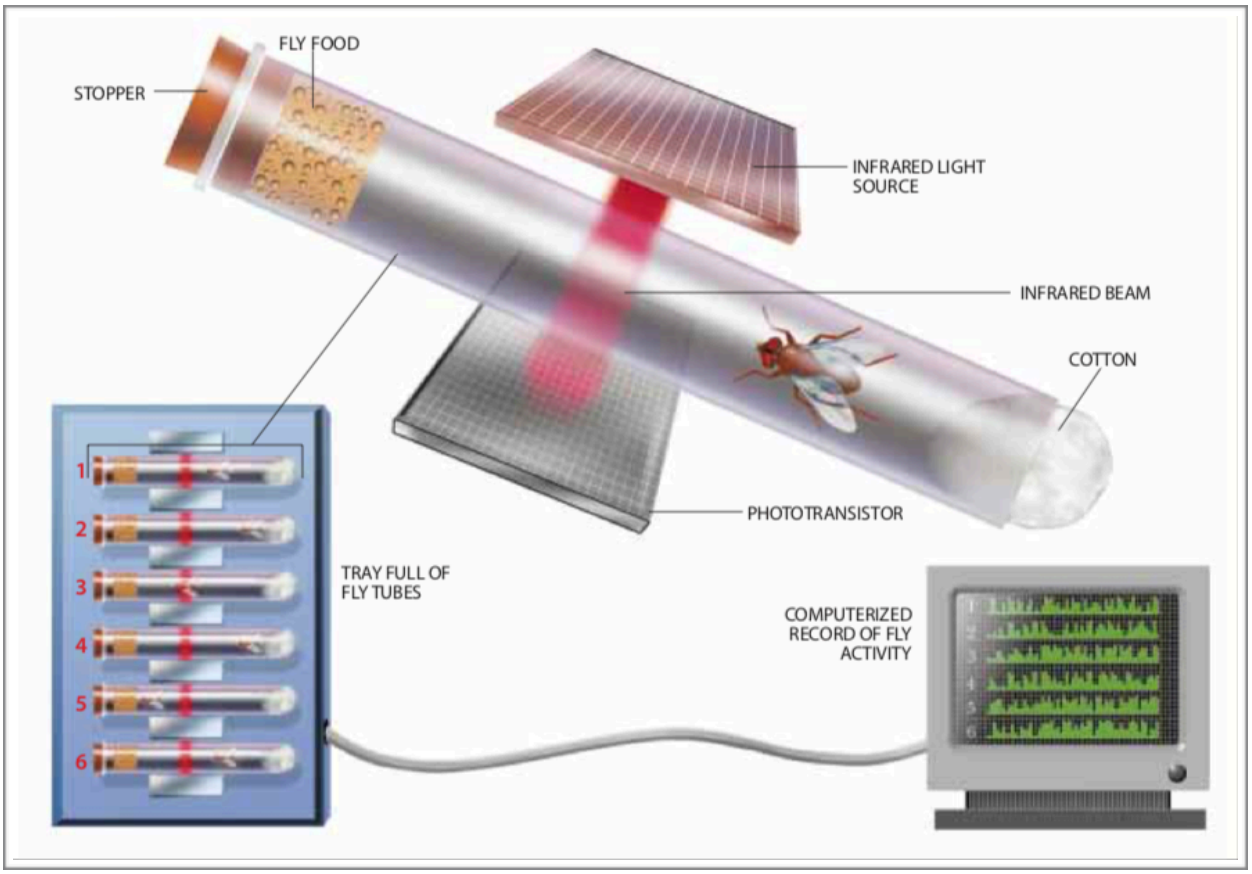
Drosophila Activity Monitoring System



©2000 Scientific American Vol. 282 No 3 THE TICK-TOCK OF THE BIOLOGICAL CLOCK, Michael W. Young

TriKinetics systems use infrared beams to detect and quantify animal movement over time. In a typical experiment, individuals are placed into transparent tubes with a supply of food, and as they move back and forth, their locomotor activity is recorded. Such daily activity records were first used to characterize the circadian rhythm of drosophila, and since then have been used to measure sleep, longevity, social interaction, geotaxis, phototaxis, learning, and drug response in various species of flies, mosquitoes, bees, spiders, ants, moths, cockroaches, wasps, beetles, zooplankton, and fish.

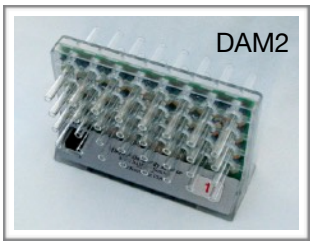
The system consists of a host Macintosh or Windows PC for data collection, a central power supply unit, and one or more activity monitors, all of which operate continuously over a period of days or weeks to capture the locomotor behavior of each individual. With 32 tubes per monitor, and up to 120 monitors per system, over 3000 activity records may be generated concurrently.

In addition to individual monitoring, units are available to monitor groups or populations in larger tubes, and these can also be used for larger animals. Tube diameters from 2mm to 150mm have been used, with 5mm the long-established standard for individual drosophila.

In all cases, the infrared beams allow unit operation in daylight or darkness, at any orientation and temperature, and are compatible with large-scale experiments across many individuals in multiple incubators and conditions. The units are easy to use, repeatable, robust, and time-tested.

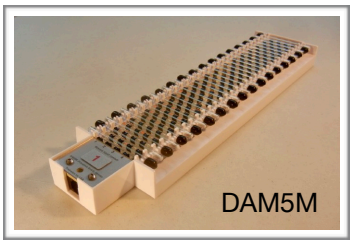
TRIKINETICS

DAMSystem Monitor Gallery



DAM2 *Drosophila Activity Monitor*

- 5 or 7mm tube
- 32 tubes
- 1 beam per tube

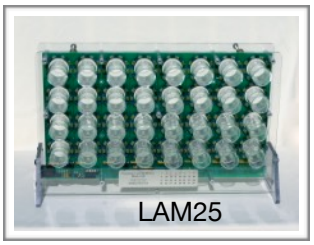


DAM5M *Drosophila Activity Monitor*

- 5mm tube diameter
- 32 tubes
- 4 beams per tube

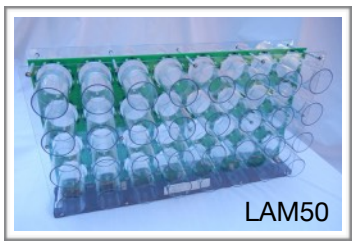
MB5 *Drosophila Activity Monitor*

- 5, 7, 10mm tubes
- 16 tubes
- 17 beams per tube



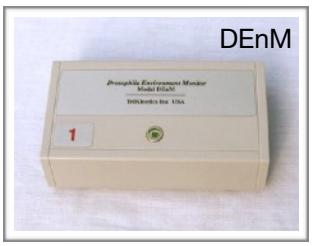
LAM25 *Locomotor Activity Monitor*

- 10, 16, 25mm tube
- 32 tubes
- 1 or 3 beam arrays per tube



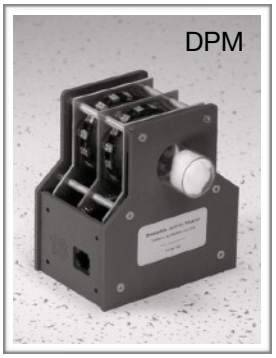
LAM50 *Locomotor Activity Monitor*

- 50mm tube size
- 32 tubes
- 1 beam array per tube



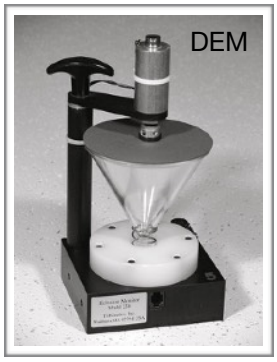
DEnM *Drosophila Environment Monitor*

- Records temperature, humidity, and ambient light inside a chamber.



DPM *Drosophila Population Monitor*

- 25mm diameter
- 1 tube or vial
- 3 beam arrays



DEM *Drosophila Eclosion Monitor*

- Measures time of eclosion as flies fall through the funnel

Monitor Selection

Tube diameter is the most important selection criteria, and is based on the size of the animal to be studied. The goal is to use the smallest tube which still allows the animal to move freely, and generally this is about twice the standing height. We recommend observing candidate animals in tubes of different sizes and selecting the smallest one which allows repeated movement from end to end.

All monitors may be operated with horizontal or vertical tubes.

Monitors for Drosophila Melanogaster

Individual flies

The 5mm tube diameter is the standard size for measuring the activity of individual flies. DAM2 uses a single beam at the tube midpoint, and counts any motion which breaks the beam. DAM5M uses 4 beams spaced at 9mm to record not only total counts, but also the position of each count and the fraction of time in each beam. MB5 uses 17 beams spaced at 3mm to capture all activity, no matter where in the tube it occurs.

If the objective is to record total activity over time, including circadian rhythm, and the flies are similar in behavior to wild-type, the DAM2 will suffice in most applications. The DAM5M will be better at characterizing sleep in slowly-moving flies, and can also report the location of their activity for preference assays. The MB5 provides the ultimate in data fidelity, comparable to video recording.

Groups of flies

The LAM25H is effective at measuring the consolidated activity of a group of flies (up to 25 individuals or so.) The 25mm tube diameter allows the flies to move freely and share social behavior. An enhanced version of the LAM25H, the LAM25H-3, provides even greater data fidelity in this application by measuring activity at 3 spaced points along the tube length.

The DPM is also effective at measuring groups of flies in a single 25mm vial.

Eclosion

The DEM Eclosion Monitor can measure the eclosion history of a population of fly pupae. Emerging flies are nudged down through the funnel by a tapping solenoid, and counted as they fall through the base unit.

Sleep Deprivation

The DAM2, LAM25, and MB5 may be mounted to a shaking platform for mechanical sleep deprivation. Short, repetitive vibration pulses are typically applied by the LC4 Light Controller at various times of the day under the direction of the DAMSystem3 software.

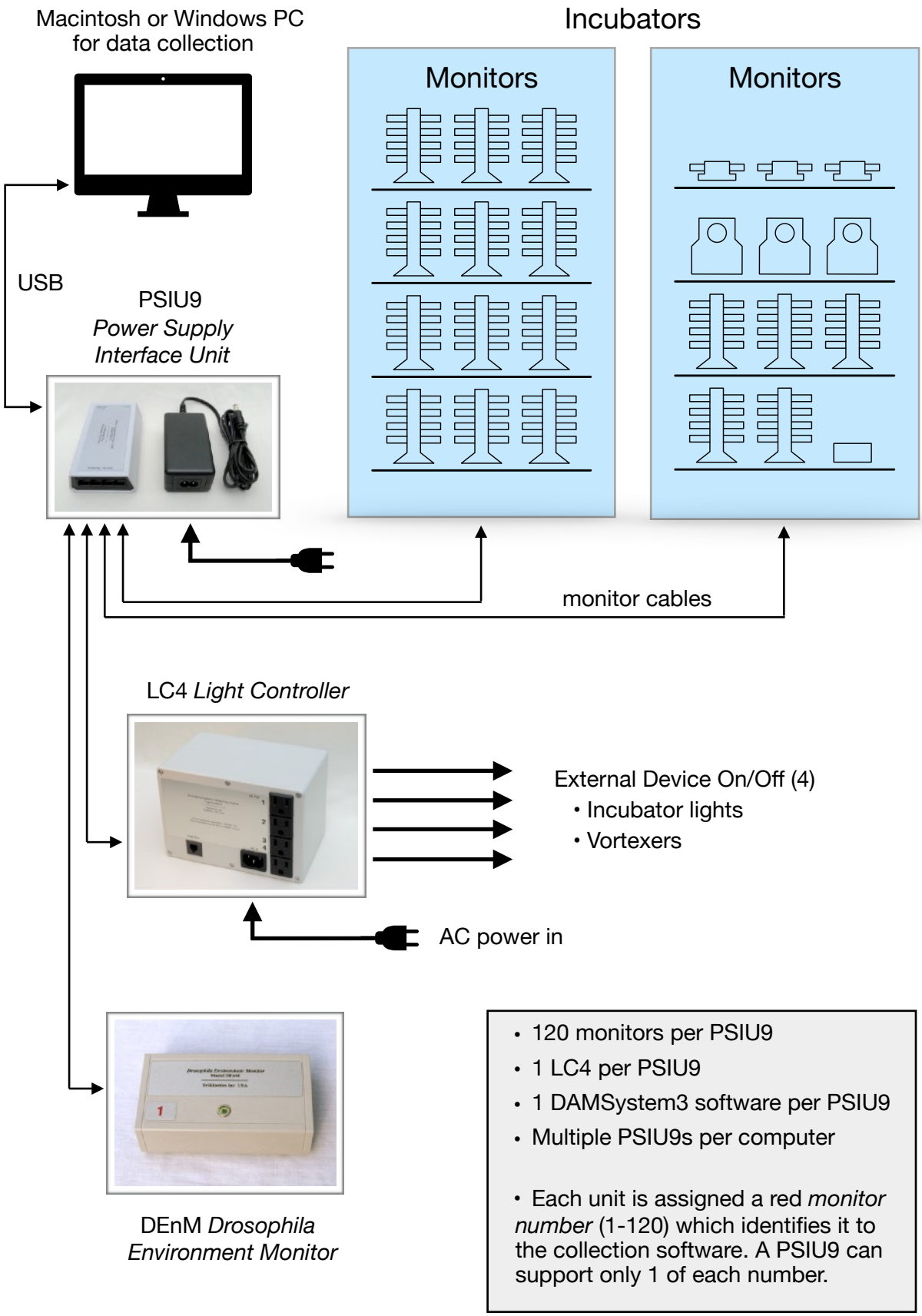
Gas Delivery

The MAN2 Gas Distribution Manifold allows controlled gas flow through the 5mm tubes of the DAM2, and has been used for studies of hypoxia and drug/alcohol effect.

Monitors for Larger Species

Tube sizes of 7, 10, 16, 25, and 50mm are available for studies of larger species. LAM10 has been effective for some zooplankton, LAM16 for bees, LAM25 for spiders, LAM25H for mosquitoes, and LAM50H for large beetles and cockroaches. If the animal stands to 1/2 of the inside tube height, the 3-beam version of LAM10/16/25 will provide reliable detection; otherwise the 9-beam -H version should be used.

DAMSystem Components



- 120 monitors per PSIU9
- 1 LC4 per PSIU9
- 1 DAMSystem3 software per PSIU9
- Multiple PSIU9s per computer

- Each unit is assigned a red *monitor number* (1-120) which identifies it to the collection software. A PSIU9 can support only 1 of each number.

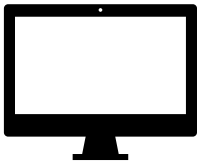
A Basic System

A basic system will include the following components, and may be expanded at any time with additional monitors:

- Data Collection Computer (Macintosh or Windows PC)
- PSIU9 Power Supply Interface Unit
- Activity Monitors (1 or more of DAM2 / DAM5M / DPM / LAM25, etc)
- Tubes and caps (5mm, 7mm, 10mm, 16mm, 25mm, etc)
- Enclosure to provide temperature/light stability (incubator or insulated box)

All necessary cables are included.

Data Collection Computer



Any desktop or laptop Macintosh or Windows PC with an available USB port will suffice for data collection as long as the software meets the following minimum requirements:

Windows 7,8,10 (32 or 64 bit) updated to the latest Microsoft release

MacOS Lion 10.7 or later, updated to the latest Apple release

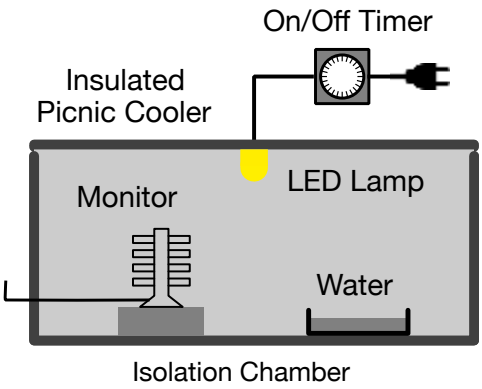
A high-performance computer is not required for data collection, so an older machine or an entry-level new machine will normally serve. A UPS backup power system is recommended to prevent data loss in the event of a power outage.

Experimental Chamber

Measurements of circadian rhythm, sleep, and overall activity generally require stable temperature and light conditions. Temperature-controlled incubators are often used for this purpose, but sometimes a simple insulated box will suffice.

The following setup can be built with components from any Walmart or hardware store for less than $50., and is a good way to get started on a limited budget.

Drill a hole in the top of an insulated picnic cooler and mount an LED night light (0.5 watt max.) Connect the lamp to a 24-hour security timer with an extension cord. (Use UL-approved components only.)



Isolation Chamber

Drill another hole for a monitor cable, and pass the cable through. Use putty or RTV to seal both holes.

Locate the cooler in a room with stable temperature, and place a small dish of water in the chamber to humidify the air. Plug the timer into a wall outlet and set the on/off schedule to 12 hours on and 12 hours off (or otherwise as desired.) Place the activity monitor(s) on a block above the chamber floor, and connect them to the PSIU9 network. Use a splitter inside the chamber if more than one monitor is used.

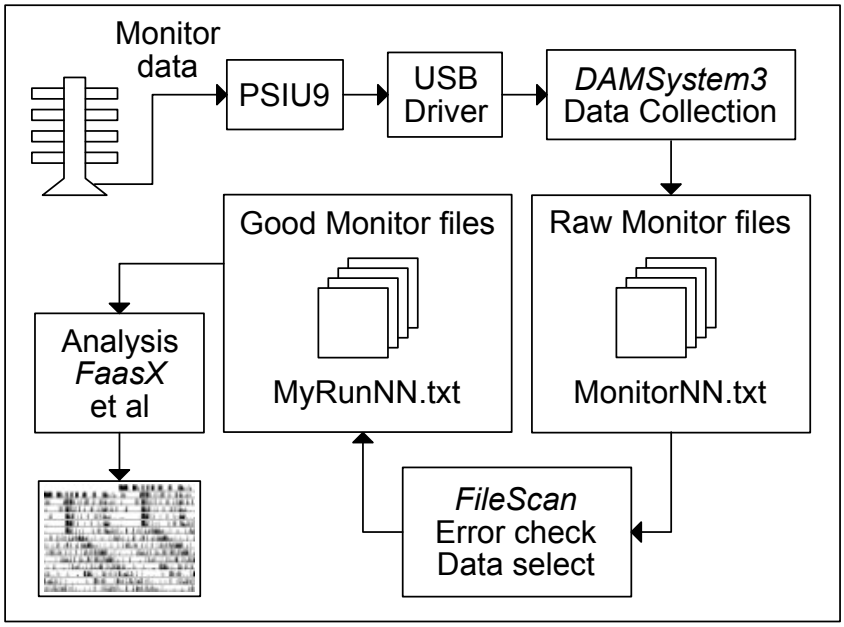
Finally, use duct tape to insure a light-tight seal between the top and sides of the chamber. Be aware that the LED lamp must be of very low power to prevent warmup of the chamber interior.

Software

The *DAMSystem3* data collection program uploads periodically from each activity monitor and saves its data in the respective raw monitor file on the hard drive.

These simple files will each contain all of the raw experiment data for a single monitor, and may include multiple data types, errors, collection gaps, etc.

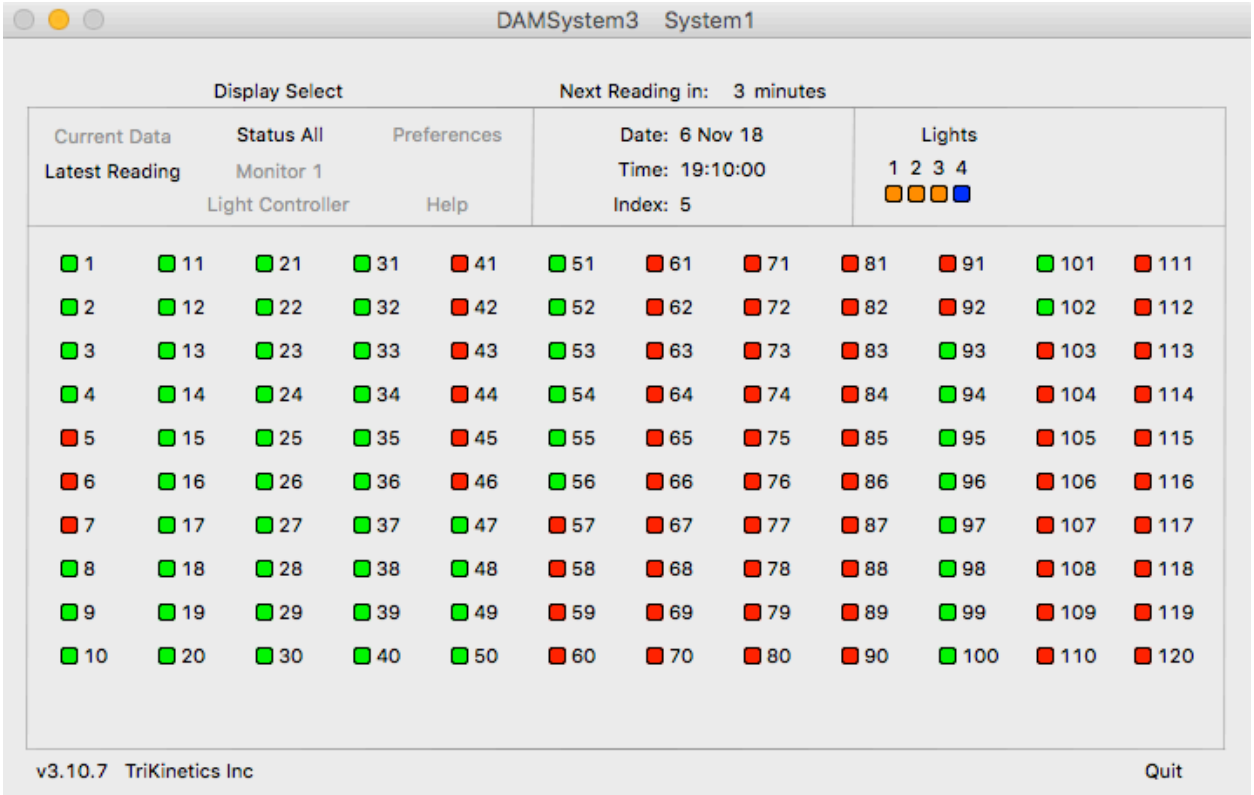
The *FileScan* program can then scan and correct errors, and select particular data types and date/time ranges to produce processed or 'good' data files. Both raw and good files are 42-column tab-delimited text files.



Monitor Data Flow

These files are then ready for input into a text editor, spreadsheet, or any number of available analysis programs (*FaasX*, et al.)

Note that once collected, the raw monitor files may be moved to another computer for storage, processing, and analysis.

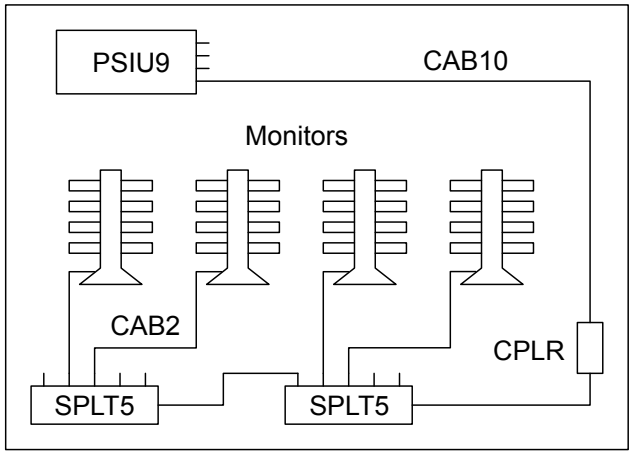


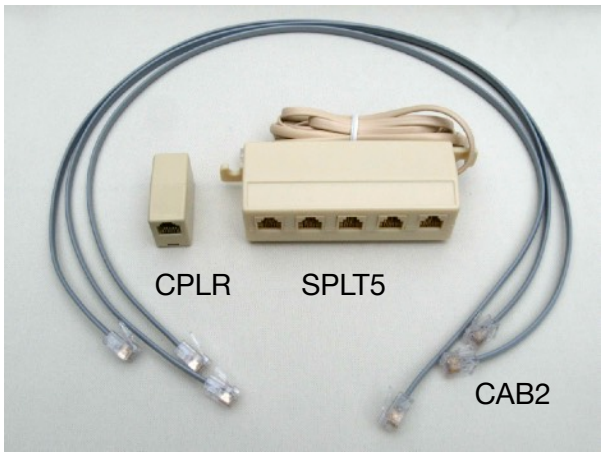
External Device Control

The LC4 *Light Controller* allows the *DAMSystem3* data collection program to turn on/off up to 4 external devices on a programmed schedule. These may be incubator lights on a 12/12 on/off cycle each day for circadian rhythm entrainment, heaters on a short pulse cycle to test arousal thresholds, or shaker platforms for sleep deprivation. Pulses may range from 0.1 seconds to 99 hours in length, and may be repeated in complex and random patterns if necessary, all synchronized to the monitor data collection cycle.

LC4 *Light Controller*

Monitor Cables





All monitors except the MB5 connect to the PSIU9 with 4-wire telephone cables, couplers, and splitters as shown. Each monitor is supplied with a CAB2 cable (60cm) which connects it to an SPLT5 5-way splitter. The splitters connect to each other in series, and finally through a CPLR coupler and CAB10 cable (305 cm) to the PSIU9.

Each incubator should be connected to the PSIU9 with a separate CAB10 cable so that the total distance from the PSIU9 to each monitor is minimized. This separation also helps with troubleshooting in the event of cable faults.

Product Pricing and Orders

Current prices for all products, along with notes and procedures for order placement, are listed on the Product Price List.

Additional information is available from:

TriKinetics Inc USA

www.trikinetics.com

sales@trikinetics.com