

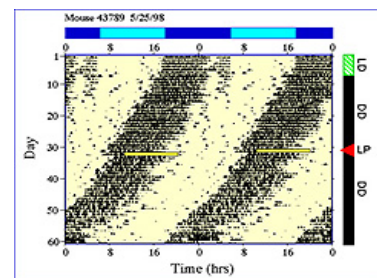


ClockLab

Data Analysis and Collection for Circadian Biology

Does it take you longer than 30 seconds to measure phase shifts? If so, ClockLab, the industry standard for the collection and analysis of circadian activity data, can help. It combines a point-and-click interface with state-of-the-art algorithms. Embedded controls turn each graph into a powerful interactive tool for data analysis. Our users enjoy ClockLab's speed and convenience. ClockLab's Analysis program has been applied to mice, hamsters, rats, drosophila, humans, bees, algae, Eurasian Lynx in the zoo, radio-tagged squirrels in the wilds of Alaska, and soil chemistry signals from the Mars Viking Lander.

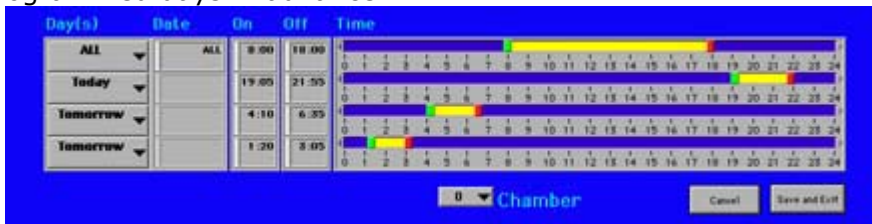
- ClockLab's data collection program incorporates a large array of features at reasonable cost:
 - Up to 448 channels on a desktop or laptop machine
 - USB interface for instant setup
 - Integrated light control and light recording
 - High-density switch connections
 - Remote data access via internet
 - Record switches, motion detectors, Minimitter ER-4000's
- Paste actograms and other plots into presentation graphics programs like PowerPoint, Illustrator or Photoshop. Every graph is completely editable.
- Automated detection of activity onsets and offsets makes it possible to
 - Measure phase shifts
 - Measure mean alpha
 - Predict future activity onsets... all with a few mouse clicks.
- Zoomable actograms for easy navigation through long records. Just drag on an interesting part of the actogram to zoom in. Then click to display the periodogram, FFT or activity profile for the chosen data segment.
- Chi-squared periodograms, activity profiles, FFT's and auto-correlograms.
- Bout analysis.
- Export all data and analyses to spreadsheet files.
- Access data in many formats, including...ClockLab format, Stanford Software's Chronobiology Kit, Actiwatch, Dataquest, Minimitter, Trikinetics and others.
- Extensive batch processing capabilities for printing and analysis.
- Windows and Macintosh compatible.



ClockLab Data Collection

CLOCKLAB's data collection application runs under the Windows 2000/XP operating system and performs many functions that are not usually incorporated in similar systems.

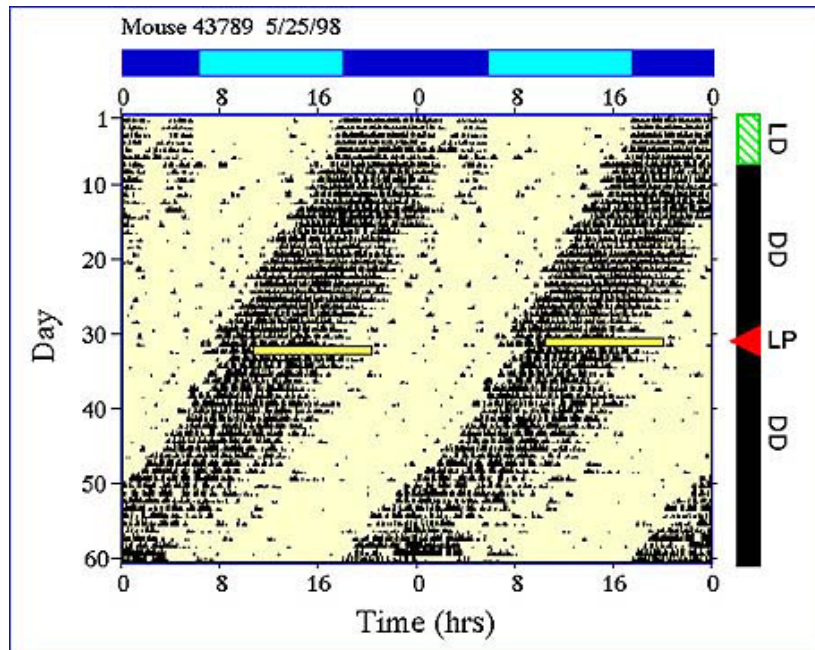
- **Up to 448 channels.** Multiple 56-channel USB interfaces (**NEW**) for laptop or desktop computers. Easy setup and small footprint.
- **Low cost per channel.** High channel counts save computer costs and space.
- **Reliable.** Our systems have logged over 500,000 hours of trouble-free operation.
- **Start and Stop each channel independently.** Recording on any channel can be started (or stopped) at any time with a user-selectable file name. Different files can be located in different directories for convenient segregation of multiple, concurrent experiments.
- **Simple, high-density connections.** RJ-45 (ethernet-style) connectors for compact wiring.
- **Monitor almost any sensor,** including running wheels and infrared motion detectors.
- **Light detection.** CLOCKLAB can easily be configured with light detectors (provided). Light levels are recorded with 1-minute precision in each data file. No need to guess about blown bulbs, accidental chamber openings or faulty, misprogrammed or inaccurate light timers.
- **Integrated light control.** Control the lights or other devices in up to 96 different animal chambers independently using the simple menu-and-slider control panel shown below. Multiple daily 24-hour or T-cycles, or one-time pulse protocols. One-time pulses can be programmed days in advance.



- **Support for Minimitter E-Mitter Temperature and Activity monitors.** In addition to running wheels connected directly to the ClockLab switch interface boxes, ClockLab can record temperature and activity from animals fitted with Minimitter's E-Mitter transmitters.
- **Remote data access.** Download data files over the internet at any time using FTP or Windows' network capabilities.
- **View actograms in real-time.** Scaled and Percentile actograms are available. Buttons allow the user to scan quickly through the actograms of each channel in sequence.
- **Automatic detection of low activity levels.** Low-activity warning for all channels can be viewed in a single window.
- **Clock synchronization.** CLOCKLAB synchronizes itself to the computer's internal clock, which can be automatically kept up to date with the National Bureau of Standards time standard using the network-based program AtomTime.
- **Comes with the Clocklab Analysis package.** Multicomputer site license provided for the most sophisticated and easy-to-use circadian analysis package currently available.

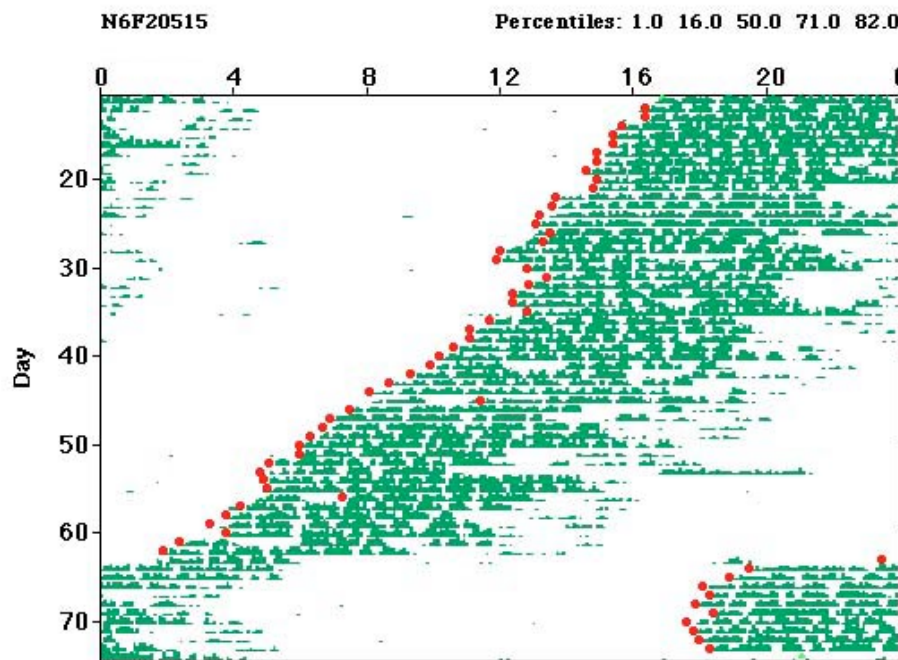
Editing ClockLab Plots in Drawing Programs

This example shows what kind of figures can be made from ClockLab graphs by cutting and pasting them into a standard Windows or Mac drawing program, such as Illustrator or Corel Draw or PowerPoint. ClockLab generates a black-and-white actogram with an optional light/dark bar above. The actogram background color, the yellow light-pulse indicators and the vertical bar and labels were added in the drawing program. All of the elements of the actogram are editable.



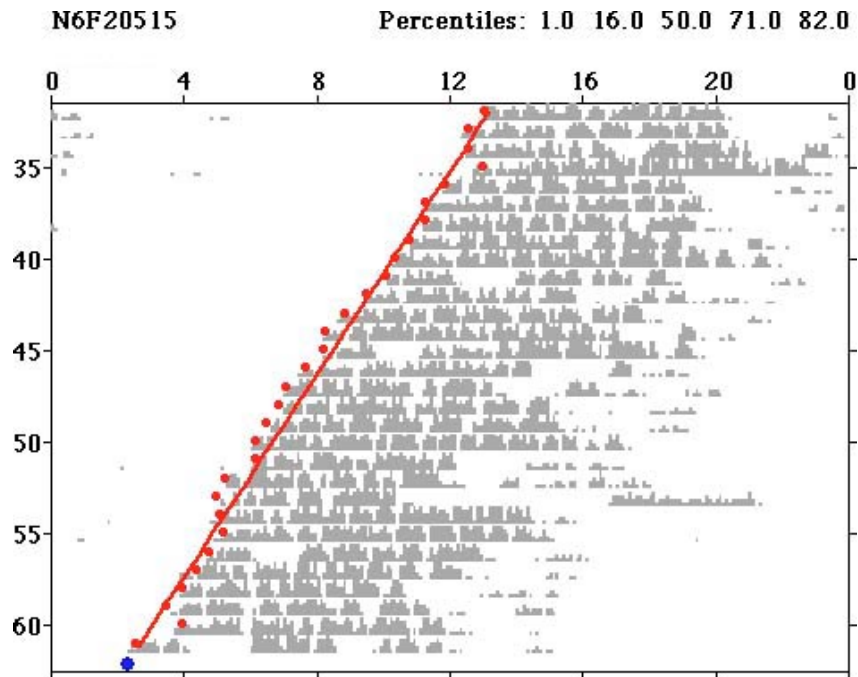
Automated Identification of Activity Onset Times

The red dots show the results of the automated onset-time calculation, available instantly at the touch of a button. The calculations are 95% correct for most data. In this example, two or three of the times need to be edited, which is done simply by clicking on the appropriate point within the line for a given day. The underlying actogram is automatically dimmed to increase the visibility of the dots. With the onset times identified, several useful calculations are now possible, such as prediction of onsets on subsequent days, calculating TAU and calculating phase shifts.



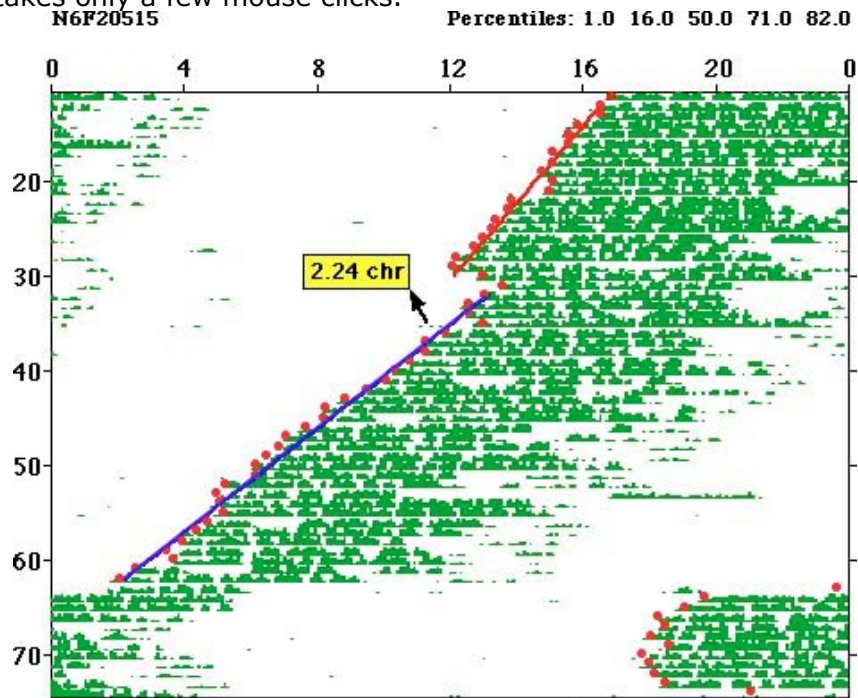
Predicting Activity Onset

Identification of onset times permits a simple least-squares prediction of the onset time for the following day. This feature aids in determining the appropriate timing of stimuli during an ongoing experiment. The predicted onset time is displayed graphically (blue symbol) and numerically in a text display (not shown). In this example, a least-squares fit was set up for the last 30 days of activity. The PREDICT function then identifies the probable onset time for the following day at 2:16 AM.



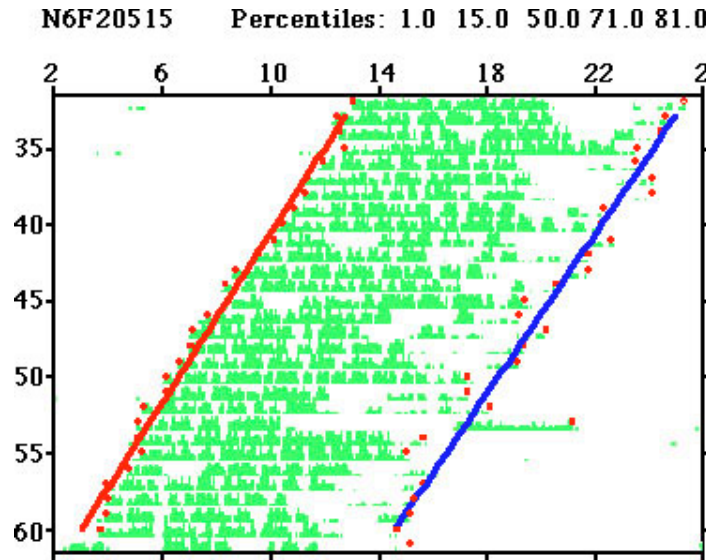
Calculating Phase Shifts

With the onset times identified, least-squares fits to the onsets have been calculated for two different time periods. Shift-clicking on the actogram within the raster for a given day will now display the time delay between the two fitted lines extrapolated to that day. Here, for example, the phase shift of 2.24 hours is being displayed for line 30. The TAU's for the two fits, here 23.6 and 23.75 hours, are also displayed for the user (not shown). Setting up the fits and displaying the phase difference takes only a few mouse clicks.



Mean alpha

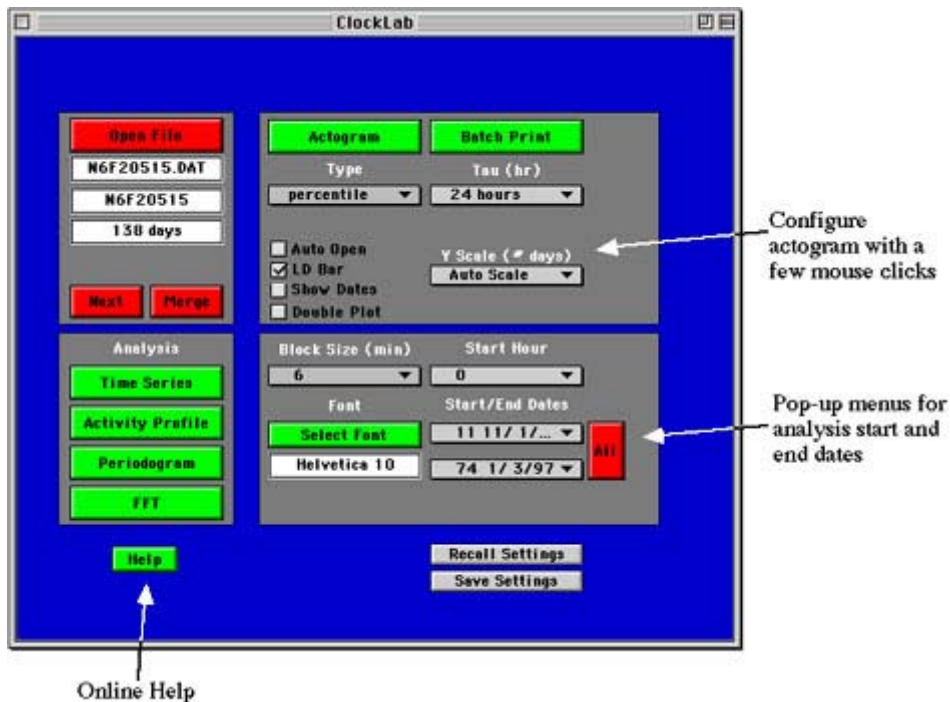
Here least-squares fits to both the onsets and offsets are displayed. ClockLab reports the mean horizontal distance between the two fitted lines as 11.54 hours. The standard deviation of the onset times is 0.38 hours. Standard deviation of the offset times is 0.99 hours.



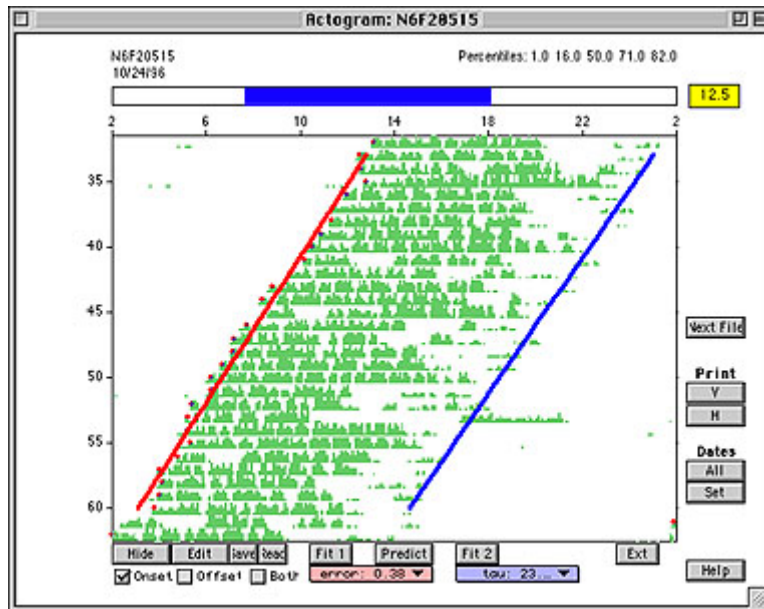
Note that the image compression used on the figure here makes it look a little fuzzy. The actual figures in the ClockLab program are limited only by the screen resolution.

Easy Point-and-Click Interface

The ClockLab interface and feature list is continually being upgraded and improved following suggestions from our users. No hidden menus or arcane command-keys. All features are accessible in the main control panel shown here, or from buttons contained within the actogram and periodogram windows. Each window features many convenient shortcuts. And each window features an online help button.

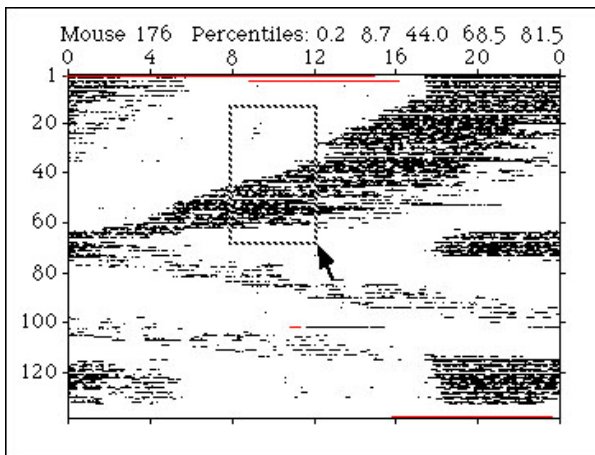


Here is the actogram window with its controls visible. The bottom row controls the display of activity onsets and offset, linear fits to onsets and offsets, and display and export of fit parameters. The right-hand column of controls are for printing and altering the START and END DATES for analysis. Above the actogram is the light-dark cycle display. The blue bars are created (or deleted) by dragging (or double-clicking) within the box.



Zooming on the Actogram

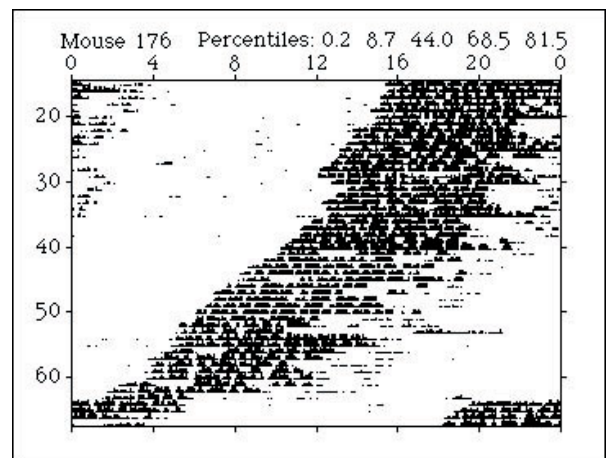
Zoom in on the actogram simply by dragging across the desired date range. Double Click to zoom out again.



Once the Actogram is zoomed in, a button-click sets the date range for all subsequent analyses (for example, periodograms) to the displayed limits of the actogram.

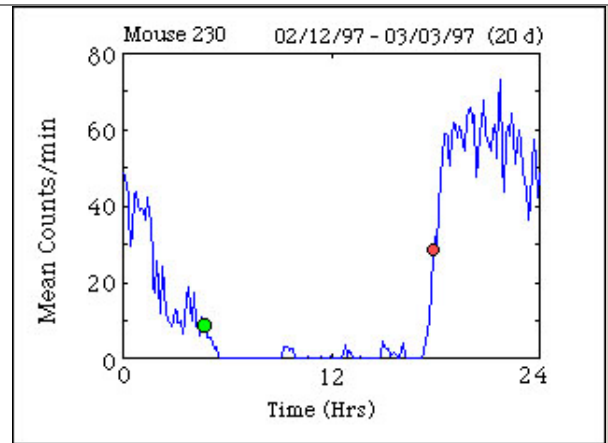
Another example of ClockLab's convenient features is the configuration of the light/dark bar above the actogram. The dark regions are placed in the bar simply by clicking and dragging over the desired time-range. Bars are removed by double clicking inside them. So setting up a complete light/dark bar takes only a few seconds.

Note: Image compression makes the images appear fuzzier here than they are in the program.



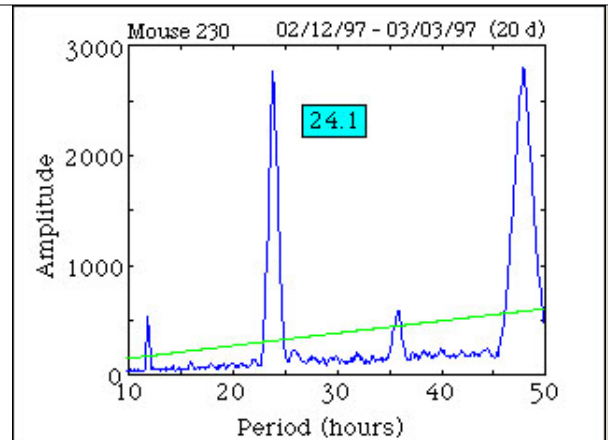
Activity Profiles

Dragable cursors control the alpha and rho periods and a display of counts that occurred within these periods (not shown). Counts for alpha and rho in each day can be exported to a spreadsheet file. X-axis units can be set to Hrs, C-Hrs, Degrees, or %Tau. SEM can be displayed for each point as a shaded areas around the plot line. Mean and median activity levels can be displayed as a horizontal line.



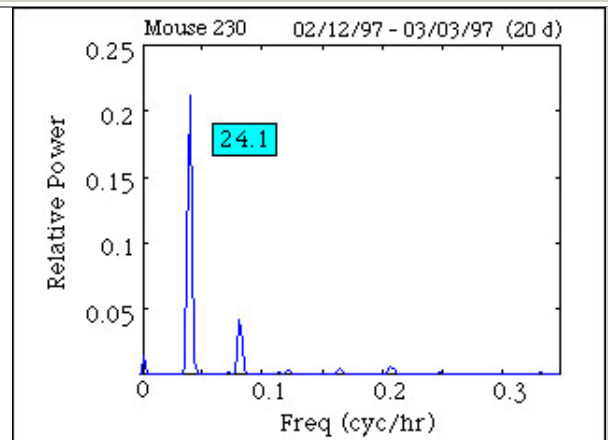
Periodograms

ClockLab can make Chi-square, F or Lomb-Scargle periodograms. Peaks are detected and labeled as shown (blue rectangle). A button in the window applies this TAU to subsequent actograms and activity profiles. Significance level (green) can be adjusted. The periodogram can be zoomed in to view the peak in detail by clicking and dragging across the image.



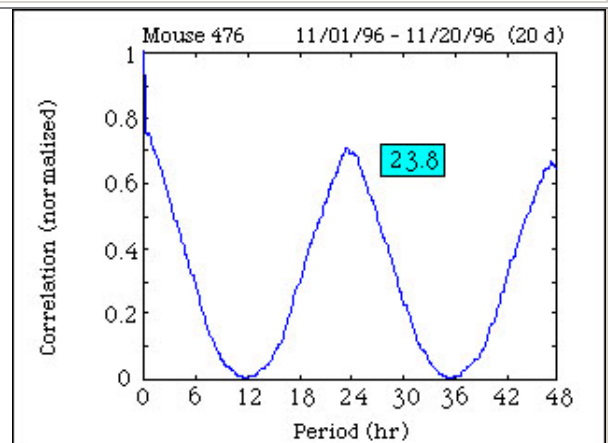
FFTs

Both power spectra and amplitude spectra can be plotted, with or without prior filtering (Blackman-Harris Window) to reduce artifacts. The FFT can be zoomed in to view the peaks in detail. Shift-clicking on a peak displays its amplitude, frequency and period. The period of the largest peak is identified automatically (blue rectangle).



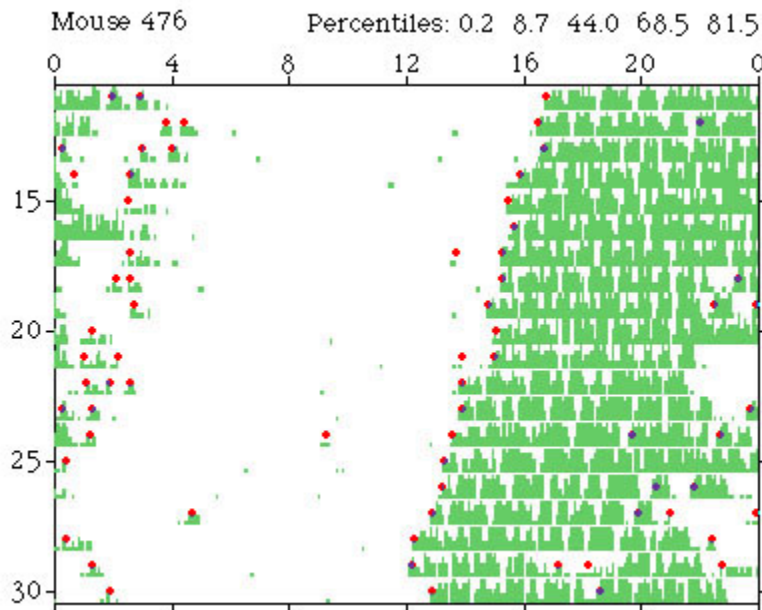
Autocorrelogram

An autocorrelogram of the data can be plotted. The peak period can be identified by shift-clicking on the peak. The graph can be zoomed.



Bout analysis

The program has identified and displayed the start of activity bouts that exceed a user-defined threshold (here, 5 counts/minute) for a user-defined period (here, 10 minutes). The day, start time, circadian day, circadian start time, number of counts per bout, and bout duration can be exported to a spreadsheet file.



Batch analysis and printing

With a simple interface, the user can select multiple files from a single directory. At the press of a button, Actograms, Periodograms or Activity Profiles are then printed for all selected files either 1, 4 or 9 to a page.

Alternatively the user can select any number of analyses. A spreadsheet containing the analysis parameters for each selected file is created. Analyses include

- Periodogram peak value, frequency and significance
- Secondary periodogram peak value, frequency and significance
- Counts per day
- Phase shift angles
- FFT peak frequency and value
- Tau and Alpha (from automated onset identification)

Finally, the median or mean count value can be calculated for each minute from any number of animals. The mean or median output can then be treated as a single animal, using any of the analysis features and plots available for single animal data. This feature is particularly useful for looking at records from many genetically identical drosophila.