PLEXON
Neurotechnology Research Systems

User Guide

Version 3.7 - May 2017

CinePlex® Studio

Part of the CinePlex Behavioral Research System

CAUTION
Camera Damage
Never connect or disconnect the camera while the power is on. The camera can be permanently damaged.

This Guide is for use in conjunction with a CinePlex System integrated with an OmniPlex® System

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NOTE TO CINEPLEX V1 AND V2 USERS

The V3 version of CinePlex software is not compatible with hardware, software, or licensing for prior versions. **DO NOT ATTEMPT TO INSTALL V3 ON SYSTEMS RUNNING PRIOR VERSIONS**. It will not operate correctly, or possibly, not at all.

Caution

Electrostatic Discharge

Some devices can be damaged by improper handling. Use appropriate electrostatic discharge (ESD) procedures when handling these devices. See http://www.esda.org/ for additional information on ESD procedures.

CAUTION

Camera Damage

Never connect or disconnect the camera while the power is on. The camera can be permanently damaged.

Caution

USB Security Key Damage

Before installing SafeNet® Sentinel™ security key drivers remove *all* Sentinel USB keys from the PC. If a system driver is installed with a USB key in the port, the key may become unusable.

CinePlex® Studio

Part of the CinePlex Behavioral Research System

User Guide

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Publication History

This is the first release of the User Guide for Plexon® CinePlex® Studio. It is based on CinePlex Studio Version 3.7. Prior CinePlex User Guides contained information on both the Studio and Editor applications.

Starting with CinePlex System Version 3.6 and in later versions, the CinePlex Studio and CinePlex Editor software each have their own independent, dedicated installers. This was done so that the user can easily install one application without the other, depending on the expected usage of the target computer. Both can be installed on the same computer if required according to the following:

- Install the CinePlex Studio software on computers where cameras are connected, or where existing video files are to be retracked, or otherwise reprocessed.
- Install the CinePlex Editor software on computers where offline processing of pre-recorded video and neural data files will be done.

Plexon User Guides are periodically updated and reissued, typically in conjunction with new software releases. You can see a summary of changes that have been implemented in the software by accessing the Change Log for this product on the Plexon website, www.plexon.com.

CinePlex Studio User Guide publication history:

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- February 2010 — CinePlex v3.0 User Guide (Studio and Editor)
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Note: The CinePlex Editor v3.6 User Guide was released in December 2015.

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1.1 Scope of this User Guide

The scope of this user guide is Plexon® CinePlex® Studio software. This software is part of the CinePlex Behavioral Research System (CinePlex System).

CinePlex System Terminology

CinePlex Behavioral Research System (CinePlex System)—An integrated set of software and hardware components comprising the following items:

- Two software components, CinePlex Studio and CinePlex Editor, which can be installed separately (or together) on a PC:
  - — CinePlex Studio—Software that can run in an offline mode on a Windows 7 PC, or can be used in an online mode on a Plexon supplied Windows 7 PC with the CinePlex System hardware (including one to four cameras) to capture video, tracking and behavioral data.
  - — CinePlex Editor—Software that can run on a Windows 7 PC and can be used as an offline tool for analyzing video and/or neural data files.
- CinePlex System hardware—A PC, one to four cameras, associated cables and camera mounting kits, and (optionally) a digital output (DO) unit.

The CinePlex/OmniPlex System

This user guide applies to CinePlex Systems that are integrated and synchronized with a Plexon OmniPlex® Neural Data Acquisition System (OmniPlex System). This integrated configuration is referred to as the CinePlex/OmniPlex System in this user guide.

Summary of Additional CinePlex System Configuration Options

Other CinePlex System configurations are available from Plexon, but these configurations are not in the scope of this user guide:

- CinePlex System supplied with the Plexon Multichannel Acquisition Processor (MAP) System.
- CinePlex System supplied with a third-party neural data acquisition (NDAQ) system.
- CinePlex System supplied in the standalone configuration (without an NDAQ system).

Note: The OmniPlex System and the MAP System are both examples of NDAQ systems.

Note: The capabilities of the CinePlex System are the same, regardless of the specific integrated NDAQ system, but some details of installation, data flow, usage and file management vary with different NDAQ models.

1.2 Description and Capabilities of the CinePlex System

The CinePlex System is a video capture (recording), positional tracking and behavioral event research system. Using the CinePlex System and one or more cameras, you can capture and record video in Microsoft® standard Audio Video Interleaved (AVI) format. These files are compatible with Windows® Media Player® and many other media players.

In addition to capturing and recording video, you can also

- Track the location (2D or 3D coordinates) of the animal in each video frame
- Synchronize the captured video frames with simultaneously recorded neural data files
- Play the synchronized video and neural data recordings

1.3 System Hardware, Software and Cameras

This section provides an overview of the hardware and cameras supplied with the CinePlex System.

- Windows 7 computer and monitor(s)
- Associated cables
- Up to four cameras
- Digital output (DO) unit, supplied with the Basic Behavior license

Software

The CinePlex software is factory installed and tested on the computer supplied by Plexon. The flash drive with a copy of the software is also included in the shipment. The appropriate USB license key is also included.

Cables

For cabling connections, see Appendix A, Cabling Guide.

Cameras

The CinePlex System can be ordered with one to four camera assemblies of the models listed in Section 1.7, “CinePlex Studio Features” on page 6.

Digital Output Unit

The DO unit and digital output capability are included only with the Basic Behavior license. See Section 5.11, “Specifying Digital Outputs” on page 172.

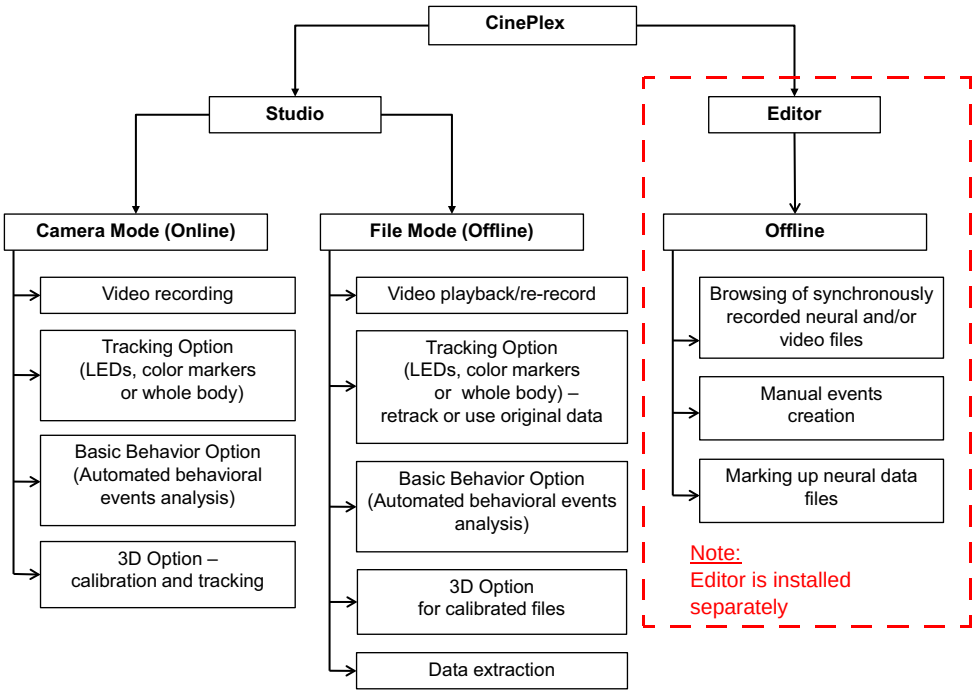
1.4 Camera Repositioning

The CinePlex System allows rapid repositioning of cameras to suit the specific needs of each experiment. After mounting the cameras, you can enter new

settings for the repositioned cameras, calibrate the new arenas (if necessary) and proceed with the experiment. In many cases, this repositioning process and resetting of parameters can be accomplished in a few minutes per camera.

1.5 Overview of CinePlex Studio Features and Functions

This section describes the video capture, recording and file processing features of the Studio core components and options (CinePlex Tracking, CinePlex Basic Behavior and CinePlex 3D). This information assists the experimenter in selecting the components and options to use for his or her experiments. The figure below provides an overview of the CinePlex System functions.



CinePlex Studio can be deployed in any of the combinations listed below. You can select and purchase the combination that meets the needs of the experiments to be performed. The Tracking Option is an extension built on top of the Studio core function (recording). The Basic Behavior Option and 3D Option are extensions built on top of the Tracking Option.

- Video recording—The basic Studio function
- Video recording and tracking—Studio + Tracking Option
- Video recording, tracking and behavior monitoring—
  Studio + Tracking Option + Basic Behavior Option
- Video recording and tracking in 3 dimensions—
  Studio + Tracking Option + 3D Option
- Video recording, tracking in 3 dimensions and behavior monitoring—
  Studio + Tracking Option + 3D Option + Basic Behavior Option

Note: The 3D Option is described in this chapter, but detailed procedures are not within the scope of this document. Information about the 3D Option is available directly from Plexon.

The CinePlex Studio features and options described in this chapter meet the requirements of a wide range of experiment designs. If assistance is needed in determining whether the system best suited to a particular experimental design, please contact Plexon at +1-214-369-4957 or support@plexon.com.

1.6 CinePlex Licensing Options

The table below shows the Studio licenses and how they can be combined. You can view the list of licenses installed on your system by selecting **About** from the **Help** dropdown list then clicking on the **Licensing** button. Note that the Studio and Editor licenses are both present on all CinePlex license keys.

CinePlex Applications Required	License(s) Required	Label on USB Key
Studio and Editor[a]	CPX V3	CPX v3
Studio and Editor + Tracking Option	CPX V3 CPT V3	CPX-T v3
Studio and Editor + Tracking Option + Basic Behavior Option	CPX V3 CPT V3 CPB V3	CPX-T-B v3
Studio and Editor + Tracking Option + 3D Option	CPX V3 CPT V3 3D	CPX-T-3D v3
Studio and Editor + Tracking Option + 3D Option + Basic Behavior Option	CPX V3 CPT V3 3D CPB V3	CPX-T-B-3D v3

a. The Studio and Editor applications are installed separately. They can both be installed and operating simultaneously on the PC.

It is acceptable to have some Studio options installed but not used in a particular experiment. The screen will display all of the optional functions, but they will not affect the performance of the other options.

Each Studio license can be configured (optionally) to handle up to four cameras.

1.7 CinePlex Studio Features

CinePlex Studio consists of hardware and software that support capturing, digital video recording (DVR) and playing back the video. CinePlex Studio software, along with the specified hardware and at least one FireWire camera and lens, provides the features and functions described in this section.

- General features and functions
  - CinePlex Studio is a Windows 7 application
  - CinePlex Studio runs in online mode on the computer supplied by Plexon as part of the CinePlex/OmniPlex System
  - CinePlex Studio can run on many standalone Windows computers in “Files” (offline) mode (i.e., analyzing files originally produced by the PC to which cameras are connected)

    Note: The standalone computer must have minimum memory, processor and instruction set to run CinePlex Studio efficiently. The requirements for the computer are summarized in Section 1.13.2, “Processing and Analyzing Data” on page 14.
  - In combination with the Plexon OmniPlex System, the CinePlex Studio functions can be synchronized with neural data recording
  - CinePlex Studio hardware, when supplied as part of a CinePlex/ OmniPlex System, consists of
    - A host PC, which runs the CinePlex Studio software and the associated Plexon OmniPlex System software
    - One or two monitors to display the CinePlex Studio and OmniPlex System user interfaces
    - A keyboard to allow user input such as file names
    - A mouse, to control the CinePlex Studio and OmniPlex System software
    - Associated cables and CinePlex System hardware itens
    - Up to four digital cameras
    - Associated cables and special CinePlex Studio hardware items
- Video
  - Provides a video capture capability, which can be synchronized with neural recordings from the OmniPlex System
  - Produces standard video AVI files in MPEG-4 format
  - Allows an essentially unlimited AVI file size (Microsoft extension to NTFS format eliminates the 4 GB file size limit)
  - Timestamps frames with the corresponding OmniPlex System times.

- Generates video file names that correspond to names given to synchronized neural data files
- Allows user-specified prefixes for filenames when recording non-synchronized files
- Enables you to select image quality and file sizes in recordings by changing the nominal bit rate
- Records directly to an internal hard drive
- Supports digital imaging with up to four AVT Stingray cameras (640 x 480 and 320 x 240 customer-selectable resolution) at up to 80 frames per second on each camera
- Supports digital imaging with up to four AVT Pike cameras (640 x 480 and 320 x 240 customer-selectable resolution) at up to 200 frames per second on each camera

  Note: Support for 200 fps on *more than two cameras* requires a Plexon prepared PC with a PLX-8 System Controller. Please contact your Plexon representative if you need this upgrade. (This upgrade is *not* required to run at 200 fps on one or two cameras.)
- Supports digital imaging with one AVT Pike high-resolution camera (960 x 960, 640 x 640 and 320 x 320 customer-selectable resolution) at up to 60 frames per second
- Supports near IR (infrared) recording and tracking (optionally available)

• Offline computation and/or extraction of selected static and dynamic data from CinePlex System video files

- Reads MPEG files created by CinePlex System Version 3
- Reads MJPEG files created by CinePlex System Version 1 or 2
- Reads certain MJPEG files that were originally created by tools not supplied by Plexon, for example, files with either “mjpg” or “ffds” signatures
- Reads MJPEG files of varying resolution if both the frame width and frame height are multiples of 16
- Allows re-recording of MJPEG and MPEG files in the more efficient MPEG-4 format resulting in file size reductions of up to 90%
- Allows selection of a time range or all of the file to be extracted
- Generates output files with user-selected content and format (for example, tab or comma delimited format or text)

1.8 CinePlex Tracking Option Features

CinePlex Tracking Option extends the capabilities of CinePlex Studio. It provides arena definition and automated tracking of an animal's movement and position over time. This option supports both real-time and offline tracking capability.

- Provides the option of calibrating the video and tracking data in inches or centimeters
- Features Smart Tracking that uses robust algorithms for LED tracking, object contour tracking, and reflective color tracking
- Allows tracking of up to 12 markers of different colors from up to four video streams
- Allows tracking of several markers of the same color, but differing in size, from up to four video streams
- Uses strobed word format to deliver tracking coordinates directly to the data buffer used by the OmniPlex System
- Analyzes each frame of video data to determine the positions of the objects being tracked, and timestamps and saves the data to files on the host PC. One or both of the following file types can be chosen:
  - — Video format (AVI)
  - — Digital video tracking (DVT) text format
- Analyzes contour motion across adjacent video frames, and generates data that experimenters can use to detect "freezing" in an animal's movements, as might be used in fear-conditioning experiments

Special Conditions

Some experiments might involve challenging conditions that make it difficult to track an animal, for example:

Multiple animals of the same color must be tracked

The experiment involves objects that move at very high speeds so that they cannot be reliably tracked at the maximum frame rate (200 frames per second).

Tracking multiple spots on an animal is desired, but there is no way to apply colors (as with a fish, for example)

The camera cannot be positioned to record the animal in the region of interest (in a tunnel maze, for example)

The ratio of the size of the trackable arena to the size of the animal is such that the animal's image is too small to be tracked or too large to be meaningful

Note: If the experiment requires tracking an animal in the dark (without LEDs), use the infrared (IR) capable camera (available from Plexon).

If your experiment involves any of the conditions listed above, please contact Plexon for assistance at +1 214-369-4957 or support@plexon.com.

1.9 CinePlex Basic Behavior Option Features

CinePlex Basic Behavior Option extends the capabilities of the Tracking Option and includes the following features for behavioral analysis and digital events:

- Allows you to define static and dynamic zones of interest within an experimental arena
- Allows you to define zone sequences
- Monitors objects traversing zones and sequences to generate logical and digital events
- Allows you to define behavioral events from one or multiple cameras to generate logical and digital events
- Provides real-time and offline information about behavioral events and tracked objects, including such attributes as speed, direction (vector), limb

angles, presence in particular zones in the arena, proximity to other objects, sequence of zones visited, and many similar metrics.

- Monitors vectors between objects to create behavioral events when within/outside of a customer-defined angle and tolerance
- Monitors animal head direction based on markers or LEDs on a headstage.
- Monitors animal speeds to create digital events when over/under a user-specified threshold
- Accumulates and displays behavioral event statistics
- Allows specification of up to 24 digital outputs to be generated when specific behavioral events occur in the arena

Note: Digital outputs are available for external devices when the digital output (DO) unit is attached to a USB port on the CinePlex System PC. The digital outputs can be pulsed, high, or low when the event occurs (that is, when the event becomes TRUE).

Note: Digital output hardware is included when the Basic Behavior license is purchased, and the digital output capability is included only when the Basic Behavior license is installed

1.10 CinePlex 3D Option Features

CinePlex 3D Option extends the capabilities of the Tracking Option and includes the following features for three-dimensional tracking and analysis:

- Allows tracking of up to 12 markers of different colors from up to four video streams in three dimensions
- Allows tracking of LEDs in three dimensions
- Permits three-dimensional reconstructions both online and from files
- Includes an embedded calibration function that does not require complex measuring between cameras and points in the experimental area
- Allows cameras to be moved and then recalibrated in a few minutes

Note: The 3D Option is described in this chapter, but detailed procedures are not within the scope of this document. Information about the 3D Option is available directly from Plexon.

1.11 CinePlex Combined Basic Behavior Option and 3D Option

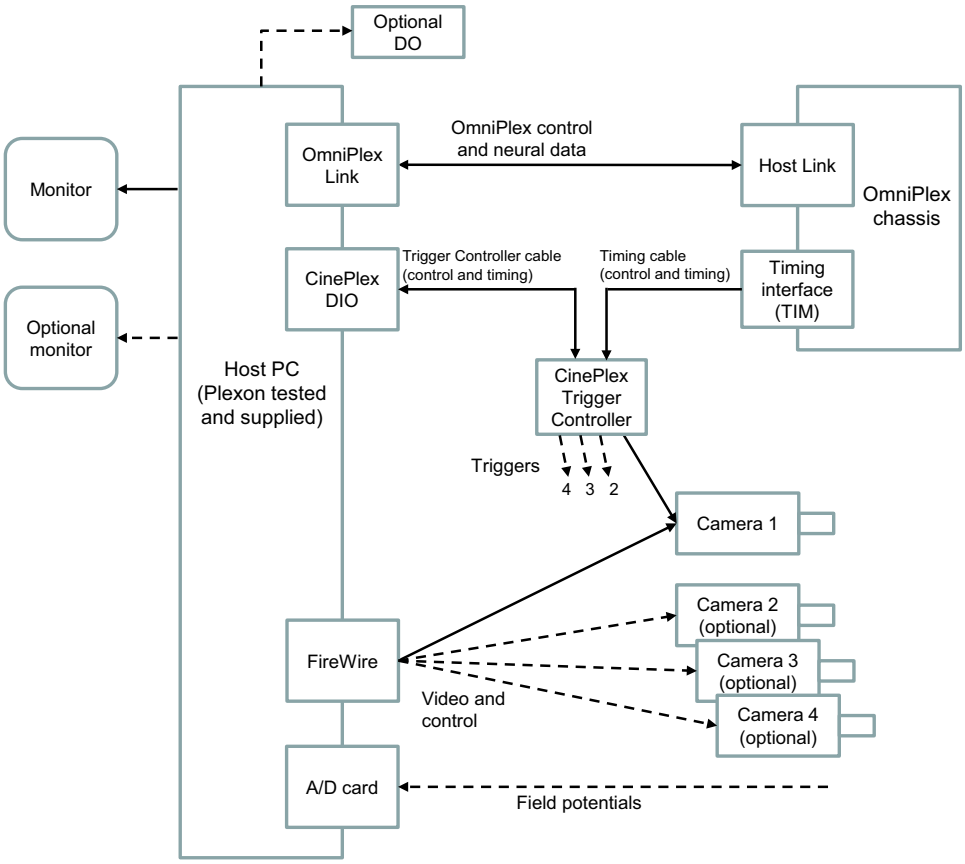
The CinePlex Basic Behavior Option and CinePlex 3D Option can both be installed and operating simultaneously along with the required CinePlex Tracking Option.

1.12 System Architecture and Components

This section describes the architecture and components of the CinePlex/ OmniPlex System.

1.12.1 CinePlex Studio in Synchronous Operation with OmniPlex System

The following illustration shows the basic system architecture. The OmniPlex System provides a 1 MHz clock signal that enables CinePlex Studio to timestamp each video frame with a synchronized time.



CinePlex Studio resides on the host PC. CinePlex Studio receives the raw video from the camera, compresses it, and stores it as an AVI file on an internal hard drive of the host PC.

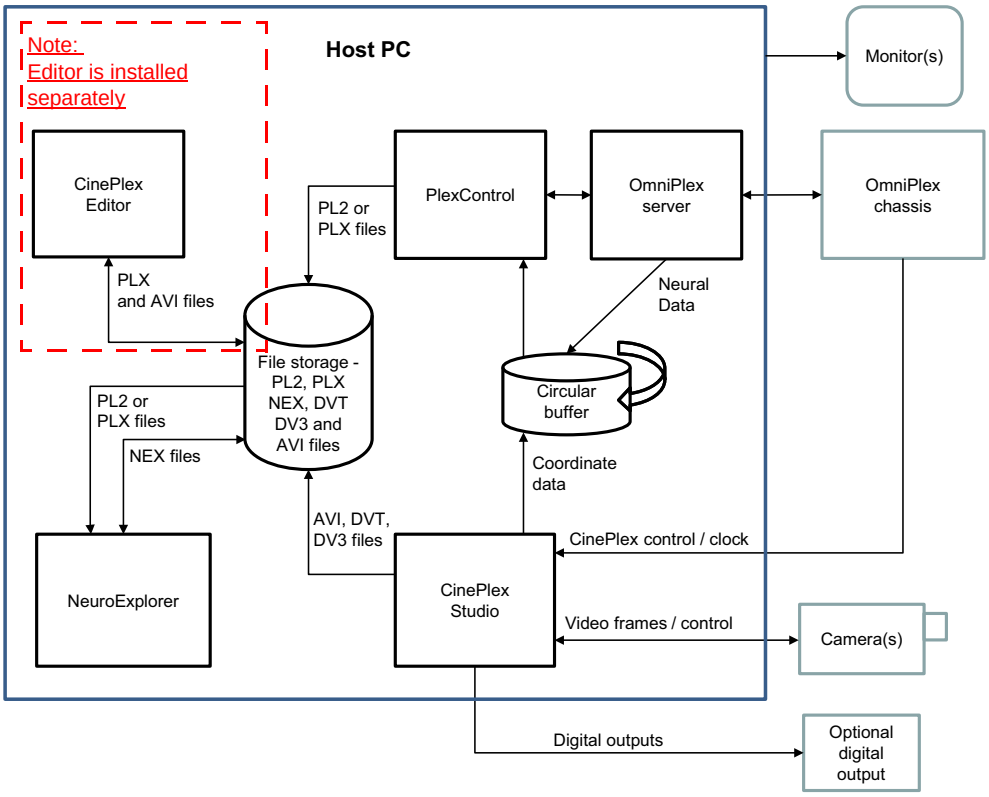
A timing cable connects the OmniPlex System timing interface with the CinePlex System digital input/output (DIO) interface. Through this cable, the OmniPlex System signals the CinePlex Studio computer to start, stop, pause, and resume recording video to AVI files.

The digital output (DO) unit, included with the Basic Behavior Option, connects to a USB port on the host PC and permits the Basic Behavior Option (if installed and licensed) to transmit digital outputs to external devices.

The optional analog/digital (A/D) card receives field potential inputs.

1.12.2 Hardware and Software Components

The following illustration shows the major hardware and software components of the CinePlex/OmniPlex System.



The components function as follows:

- OmniPlex System controls CinePlex Studio.
- CinePlex Studio controls the camera(s) and receives video from the camera(s).
- CinePlex Studio writes AVI files (and, optionally, DVT or DV3 files) to file storage and sends coordinate data to the circular buffer where the data are read by PlexControl (the OmniPlex System control application). The CinePlex System can also send coordinate data directly to the OmniPlex System via a software interface (controlled by an option in the Studio user interface).
- The circular buffer receives coordinate data from Studio and neural data from the OmniPlex System server.
- PlexControl writes PL2 (default) or PLX files, which contain both neural data and coordinate data, to file storage.
- CinePlex Editor reads/writes PLX and AVI files from/to file storage.
- NeuroExplorer reads PL2 or PLX files from file storage and writes NEX files.

Note: CinePlex Editor is installed separately. NeuroExplorer is sold separately.

Note: Coordinate data are generated and transmitted only if the Tracking Option is installed with CinePlex Studio.

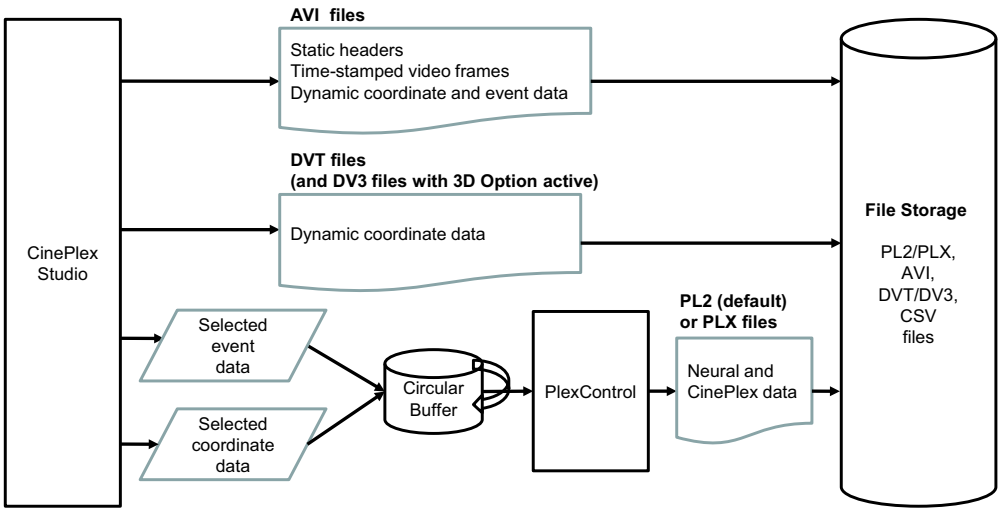
Note: Digital outputs (referred to in the above drawing) are associated with behavioral events, and are generated only if the Basic Behavior Option is installed and the Basic Behavior license is installed.

1.13 Data Flow, File Processing and Analysis

This section describes the flow of data in the system, and discusses methods that can be used for file processing and data analysis.

1.13.1 System Data Flow

The following illustration shows the data flow in a CinePlex/OmniPlex System.



The data flow proceeds as follows:

- If you have selected the AVI checkbox in the digital video recording (DVR) area of the Camera 1 Sources pane, CinePlex Studio writes AVI files directly to file storage. These AVI files have static headers, time-stamped video frames, and dynamic coordinate and event data.

Note: Coordinate and event data are generated and transmitted only if the Tracking Option and Basic Behavior Option, respectively, are installed on the CinePlex System.

- If you have selected the digital video tracking (DVT) checkbox in the DVR area of the Camera 1 Sources pane, CinePlex Studio writes DVT files containing dynamic coordinate data directly to file storage. If the CinePlex 3D Option is installed and active, DV3 coordinate data files are also written to file storage.

- CinePlex Studio sends selected event data and coordinate data to the circular buffer which, in turn, sends the data to PlexControl. PlexControl writes PL2 (default) or PLX files containing neural and CinePlex data to file storage.

1.13.2 Processing and Analyzing Data

After a recording session, you may perform data analysis on the host PC or transfer the files to a different computer (on which CinePlex Studio and/or CinePlexEditor are installed) for analysis.

Note: The standalone computer must have minimum memory, processor and instruction set to run CinePlex Studio efficiently. These requirements for offline operation are CinePlex System Version 3 software and a license key that enables the desired capability. However, it is important to determine that the computer on which the installation will be done meets the minimum system requirements. In general, this means a computer has a dual core Intel processor operating at better than 3 GHz with 3 GB of memory, and a NVIDIA® GeForce® 9600 GT or better video card. Requirements that are more current are available from Plexon support (support@plexon.com).

With all files and software accessible on a single computer, you can process and analyze the data as follows:

- Use CinePlex Studio in “Files” (offline) mode to rerecord and retrack the original video data.

  If the CinePlex Tracking Option, Basic Behavior Option and/or 3D Option are also installed, additional data manipulation can be performed, depending on the Option(s) installed. Examples of data manipulation include new or changed positional coordinate options, new or changed arenas, zones, and logical events.

- Use CinePlex Editor (installed separately) for simultaneously viewing, annotating, and processing the video, neural data, and position data.

  CinePlex Editor enables you to add and edit annotations and perform other operations on the data, such as artifact removal. When you complete the markup process, the results can be saved back into PLX files, or exported into text or CSV files. Text and CSV files can be opened in applications such as Excel or MATLAB for additional analysis. See the CinePlex Editor User Guide, available on the Plexon website.

- You can spike sort the data with Offline Sorter™, or analyze it with NeuroExplorer for place cell analysis, and save the results of this processing to another PLX file or to a NEX file. Offline Sorter software and NeuroExplorer software are sold separately; for more information on these applications, go to www.plexon.com.

Chapter 2
Installing, Starting and Testing CinePlex Studio

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2.3 Video Test Mode 23

2.1 Installing CinePlex Studio

If the CinePlex® Studio hardware has not yet been cabled, perform the necessary procedures. See Appendix A, Cabling Guide.

In most cases, the Studio software has already been installed by Plexon®.

If assistance is needed, contact Plexon support at +1-214-369-4957 or support@plexon.com.

CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

2.2 Startup and Operational Testing

The starting sequence for a synchronized CinePlex/OmniPlex® System is important for correct operation of CinePlex features. If the correct sequence is not followed, video might not be visible or it might not be possible to control and synchronize CinePlex Studio with the OmniPlex System.

Startup

The startup sequence is extremely important. The OmniPlex System must be started before Studio is started so that the client registration process works properly. Otherwise, when a recording is eventually started by the OmniPlex System, neither the file name string nor the recording time 0 messages are received.

If the OmniPlex System exits or is closed for any reason, it should be brought back up, then Studio should be closed and restarted, as well.

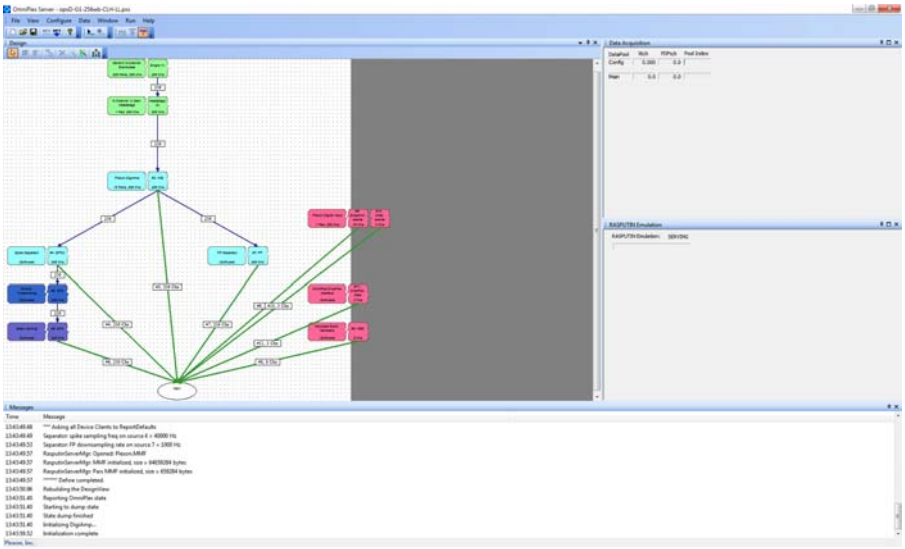
Follow these steps to start the system and perform an operational test.

1. Turn on power to the OmniPlex System chassis.

2. Power up the computer (Host PC) and log in.
3. Plug in the SafeNet® Sentinel™ license (USB key drive) into any USB port on the computer.

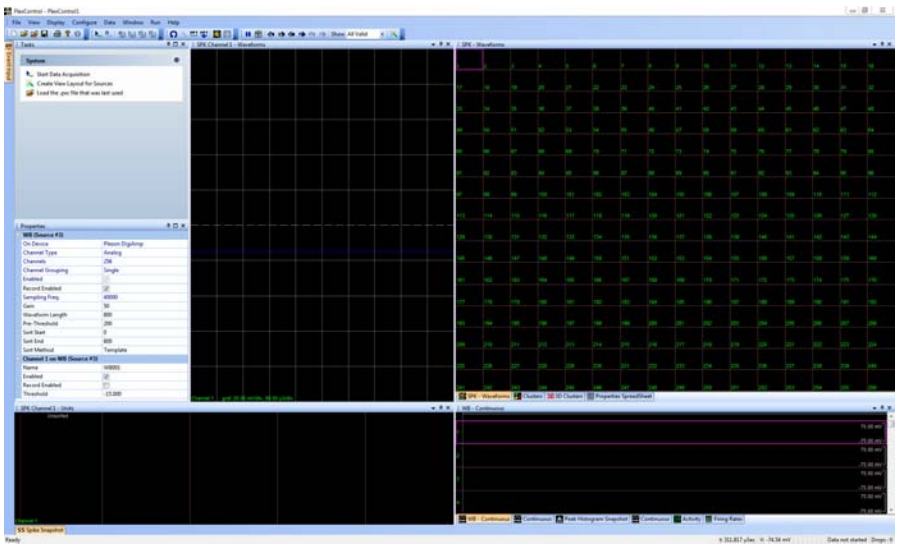
   Note: Both the OmniPlex and CinePlex licenses must be present.
4. Start the OmniPlex Server program and verify that there are no errors. The easiest way is to double-click the **OmniPlex Server** desktop icon.

   If there are no problems, the OmniPlex Server main window appears.

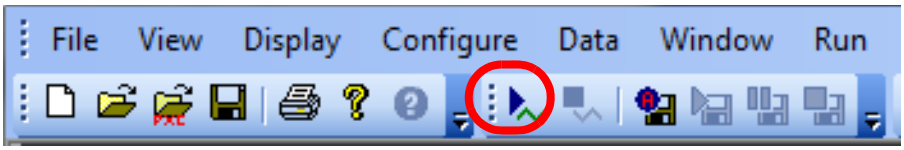


5 Start the PlexControl program and verify that there are no errors. The easiest way is to double-click the **PlexControl** desktop icon.

The PlexControl window displays.



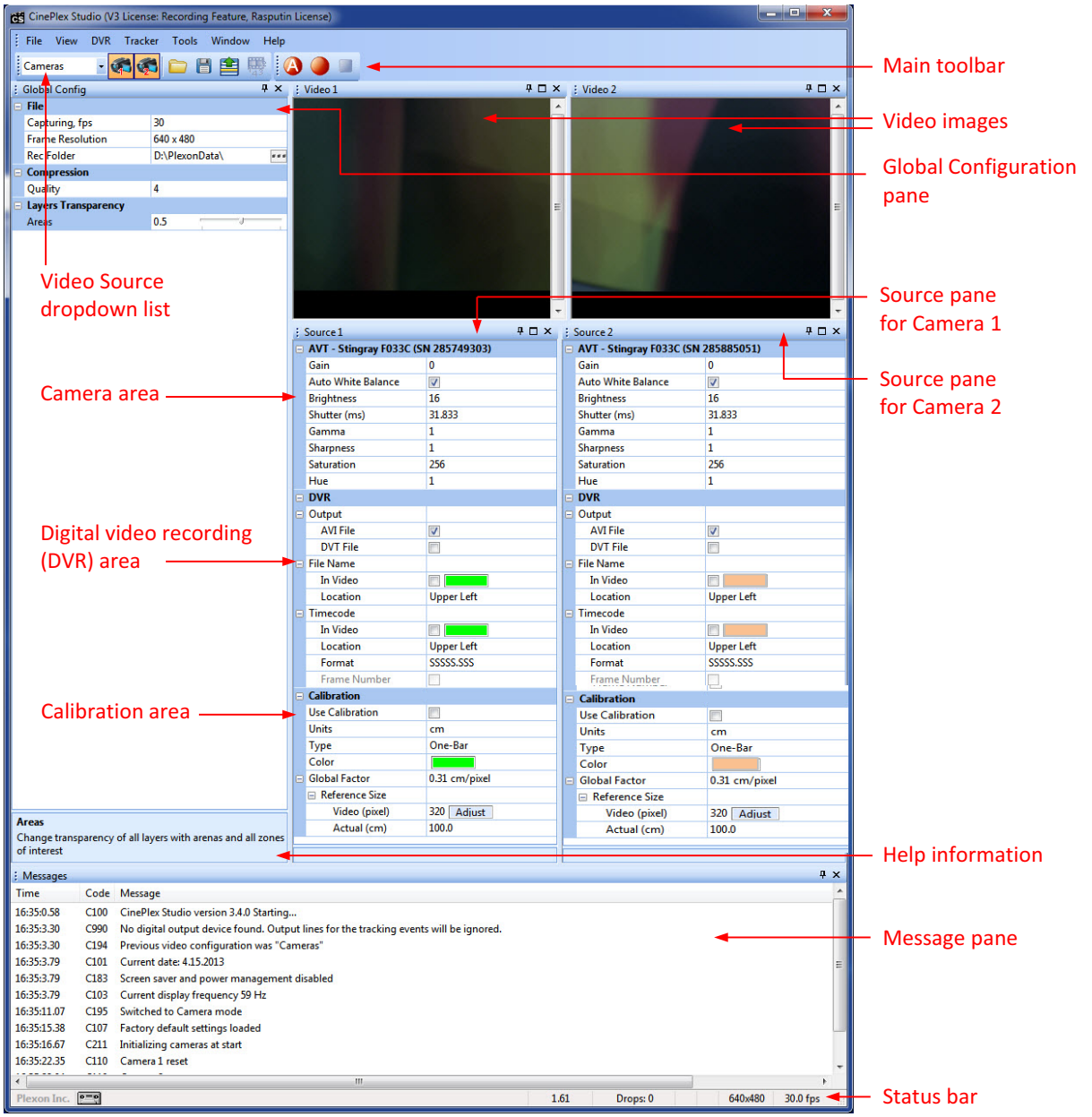
6 Press the **Start Data** button on PlexControl toolbar. (This starts the OmniPlex System 1 MHz clock.)



7 Wait to ensure that the system is attempting to collect neural data. (Typically, at this stage, there is no neural data input, but the system Messages pane should report that it is collecting data - “Data Starting.”) If the Message pane does *not* have the “Data Starting” message, refer to the OmniPlex System instructions.

8 Start the CinePlex Studio program. The easiest way is to double-click the **CinePlex Studio** desktop icon.

9 View the monitor to see if the CinePlex Studio main window displays. If Camera 1 is active, the video should be displayed in the Video 1 window. (It is acceptable if multiple cameras are active. For example, in the image below, Camera 1 and Camera 2 are both active.)

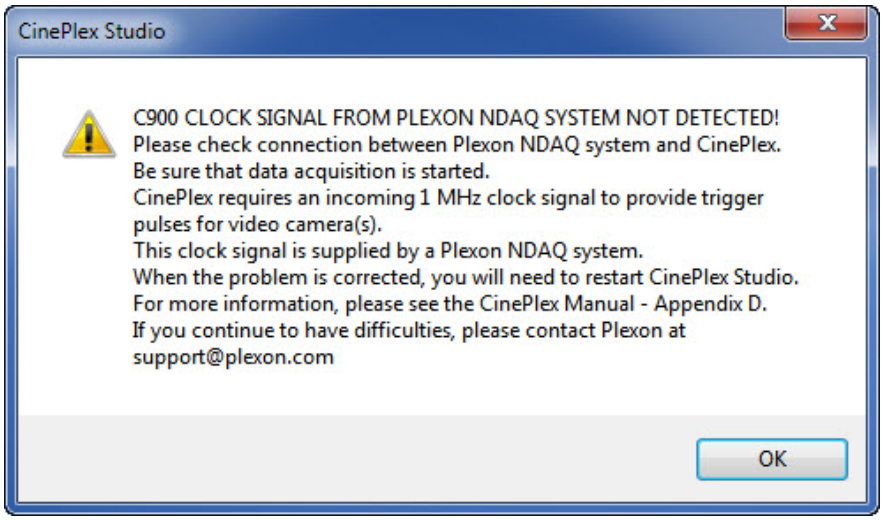


10 If the CinePlex Studio main window displays with video, as shown in the example in Step 9 (and Camera 1 is active), skip to Step 12. Otherwise, perform Step 11.

11 If the error window is displayed as shown below, it means that one of the following problems has occurred:

- The Timing cable is not connected correctly from the OmniPlex System to the Host PC.
- The **Start Data** button has not been pressed.
- The Trigger or FireWire cables are not connected between the host PC and the camera.

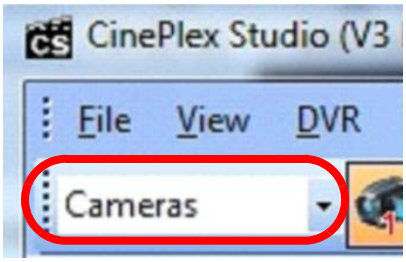
- The camera is in an error state.



Take the necessary action:

- Connect the Timing cable.
- If the **Start Data** button has not been pressed, press it now.
- If the Trigger or FireWire cables are not connected, shut down the computer and connect those cables now. Then restart the computer.
- If the camera is in an error state, cycle the power: Use the Windows® function to restart the host PC. Then perform Step 4 through Step 10 again.

12 Select **Cameras** mode (from the dropdown menu shown below), if not already selected. Video should now be displayed on the Video 1 window.



13 If proper video is observed at the monitor, it is reasonable to assume the camera, computer, and monitor are working correctly.

14 If there is no video, perform the following steps:

- If the **Camera 1** icon background (to the right of the **Cameras** dropdown) is *not* orange, it is not selected. Click on this icon now to select it. Ensure that the background changes to orange.
- Check the cabling, connections, AC power, on/off switches, lighting, and the iris, zoom, and focus of the camera.

  The cables might not be connected properly, one or more cables might be broken internally, a pin or pins on a cable could be bent or broken, the iris

on the camera could be shut, the zoom on the camera could be set improperly, or the focus could be set so that everything is a blur.

CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

TIP

Video Test Mode

Video Test Mode enables the experimenter to verify operation of the video portion of the experimental setup without having to activate and connect the OmniPlex System. The license keys normally required must be present on the computer. For the detailed procedure, see Section 2.3, “Video Test Mode” on page 23.

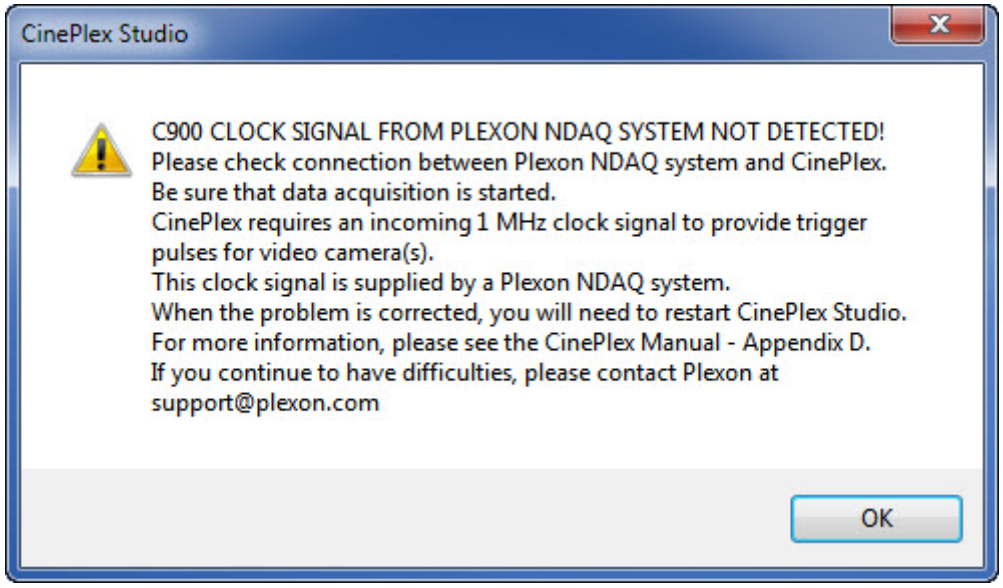
2.3 Video Test Mode

Video test mode is provided to enable the experimenter to verify operation of the video portion of their experimental setup without having to activate and connect the OmniPlex System, prepare animals for recording, connect preamplifiers, etc. The license keys normally required must be present on the computer.

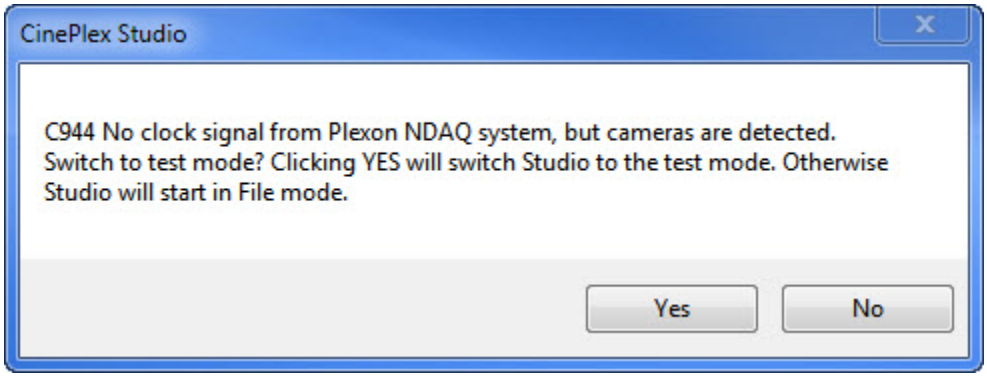
When CinePlex Studio starts, it checks for the presence of the Access IO board. If the AccessIO board is present, Studio checks for the clock signal from the OmniPlex System.

If the AccessIO board is not present or if there is no clock signal from the OmniPlex System, the following message displays if one or more cameras are detected. Otherwise Studio opens in File mode without showing the message.

Note: The dialog box text refers to the OmniPlex System as the Plexon Neural Data Acquisition (NDAQ) system.



After the **OK** button is pressed, the following window is displayed:



Click **Yes** to enter Test mode or **No** to enter File mode.

Test mode has several restrictions compared to the normal mode:

- CinePlex Studio switches cameras to free-running mode (using their internal trigger), since there is no external trigger available.
- The **Arm** button (the red circular button with the letter “A” in the main toolbar) is disabled, since it is impossible to sync with the OmniPlex System.
- Recording can be done only by pressing the **Record** button on the toolbar.
- The duration of each recording is restricted to 1 min.

Chapter 3
Recording Video with CinePlex Studio

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3.1 Setting Up Cameras and the User Interface

3.1.1 Positioning the Cameras and Verifying Video Quality

1 Ensure that **Cameras** is selected in the video source dropdown list on the main toolbar. Camera setting options do not display in the main window unless **Cameras** is set in the main toolbar. If only two cameras are installed, the toolbar would display two camera icons, as shown in the image below.

If it is not possible to select **Cameras**, Studio has not detected any attached cameras. See Appendix E, Troubleshooting for troubleshooting this problem.

Note: If there are two or more cameras, the system will automatically assign the camera with the lowest serial number to be Camera 1. If there is only one camera, it is Camera 1**.**

TIP

Consider calibration requirements

Plan the mounting of cameras with calibration in mind. Calibration of linear dimensions (in inches or centimeters) only works accurately when the camera is orthogonal to the arena.

Each of the arenas (that is, the arenas for Cameras 1, 2, 3 and/or 4) can be calibrated independently.

The calibration procedure is explained in Section 3.3, “Calibrating the Arena Dimensions” on page 30.

2 Select the icon(s) for the camera(s) to be used in the experiment (up to four cameras). A camera is active only if the corresponding icon is selected. The orange color in the icon indicates a camera is selected.

In the image in Step 1 above, the orange color on the **Camera 1** icon shows that Camera 1 is active, and it can also be seen that **Camera 2** is inactive. Clicking on the **Camera 2** icon will make it active also, as shown in the image below.

3 Read Appendix B, Optimizing Camera and Lens Usage for the Experiment, to understand the detailed requirements for camera mounting, cabling and

removal. This information is essential for positioning the camera(s) and obtaining the best results from the CinePlex® System.

CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

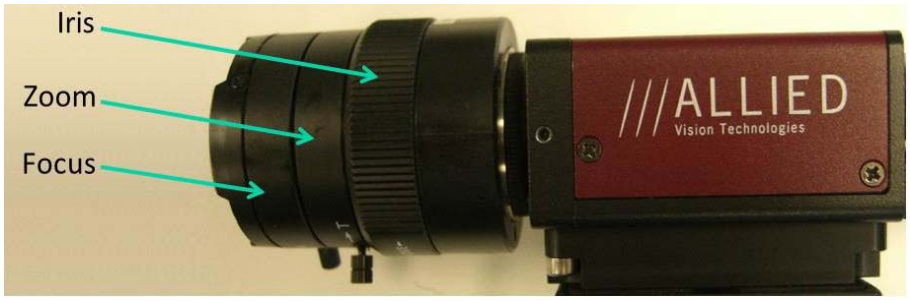
4 Set up one of the cameras as described in Appendix B. It is typical to set up Camera 1 first and mount it orthogonally to the arena.

TIP

Ensure that cameras are set up for optimum imaging

In general, it is best to position the camera as far from the experiment as possible, then zoom as much as possible in order to fill the field of view with the area of interest without distortion. Appendix B, explains how to compute the distance from the camera to the arena so that the whole arena is visible.

5 Obtain an initial video image from the camera using the default CinePlex Studio settings and changing only the physical adjustments (iris, focus and zoom) on the camera lens.

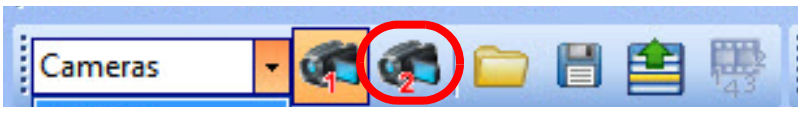


Note: The settings that are available on a particular lens depend on the lens make and model. Not all settings are available on all models.

6 If any attached camera experiences either of the following problems, take the action recommended here:

a If there is no Source window pane corresponding to the camera, go to the **Window/Layout** pulldown menu and select **Reset to Default Layout**.

b If there is a Source window pane corresponding to the camera, but no video is displayed there, select the camera icon in the toolbar to make the camera active. (For example, see the camera icons in the image below. In that image, the icon for **Camera 2** has not been selected, and therefore **Camera 2** is not yet active.)



TIP
Make the Video Image Larger
If the default video image is not large enough to make your desired adjustments, drag the video window out of its frame to another area on the monitor. Then adjust the window size in the normal way.

7 If the previous steps do not result in a good image on the camera, manually change camera settings in CinePlex Studio. The available settings depend on the camera model Typically, the settings should be adjusted in this order: **Contrast**, **Brightness**, **Sharpness**, and **Saturation**.

8 If the above steps do not cause the video to appear, refer to Appendix E-Troubleshooting.

9 Repeat Step 4 through Step 8 for each additional camera that will be used in the experiment.)

TIP
Video Test Mode
Video Test Mode enables the experimenter to verify operation of the video portion of the experimental setup without having to activate and connect the OmniPlex® System. The license keys normally required must be present on the computer. For the detailed procedure, see Section 2.3, “Video Test Mode” on page 23.

10 Calibrate the dimensions in the video field. (Calibration is accurate only when the camera is positioned orthogonally to the arena.)

Note: In many experiments, it is useful to calibrate the video image dimensions so that the ratio of centimeters to pixels (or inches to pixels) is known. The calibration ratio can be useful even if the Tracking Option is not currently installed, because the tracking data can be processed with the calibration data at a later time (if the Tracking Option is purchased). For the procedure, see Section 3.3, “Calibrating the Arena Dimensions” on page 30.

3.1.2 Arranging CinePlex Studio Windows

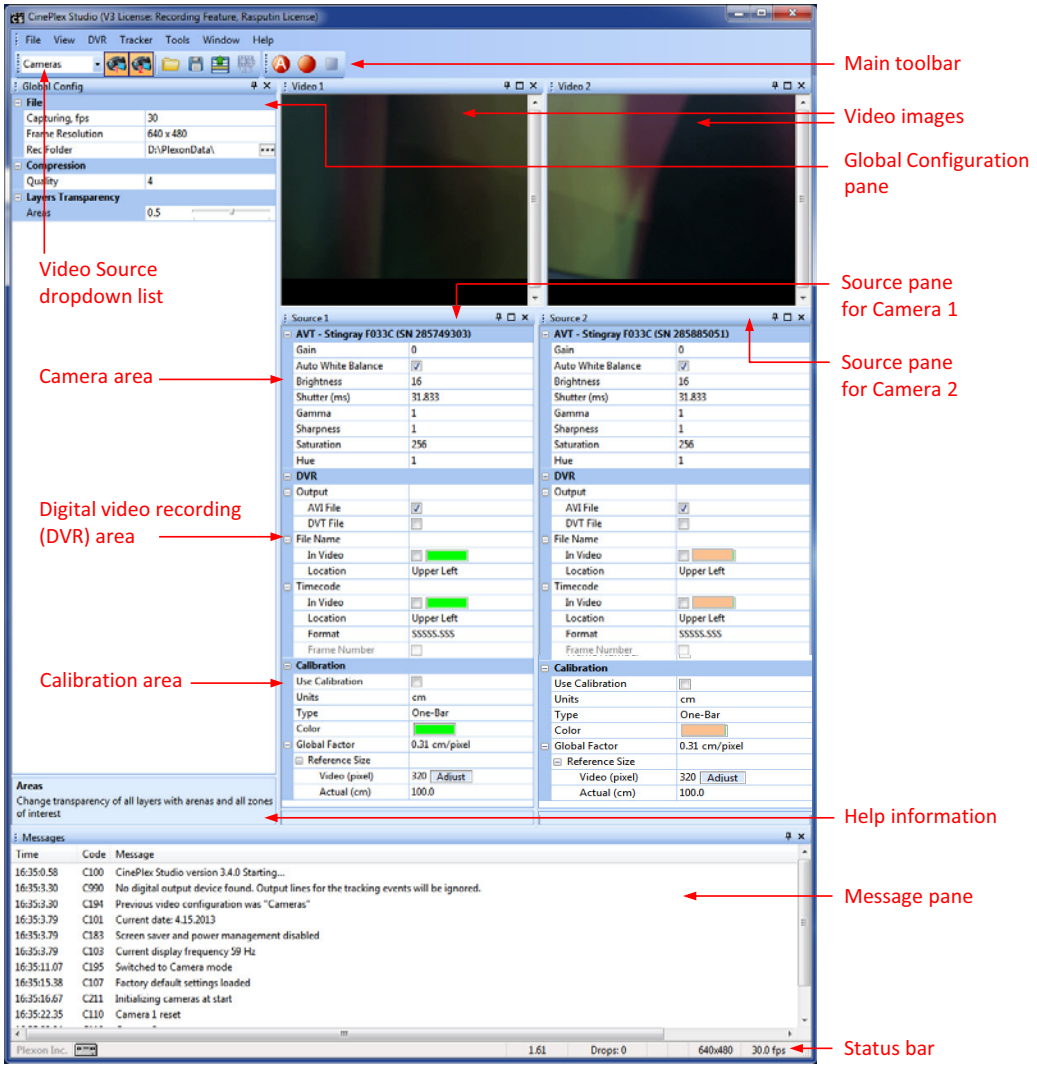
The default window layout will be sufficient for many experiments. However, to change the window layout, see Appendix D, Navigating the Plexon User Interface.

To load or save a layout configuration, see "Window Menu" in Appendix D.

3.2 Navigating the Studio Main Window

This section describes the CinePlex Studio main window, where you can view and modify Studio settings before starting the recording session.

This drawing shows the location of the panes in the CinePlex Studio main window. In this example, there are two cameras connected; up to four cameras can be licensed (optional).



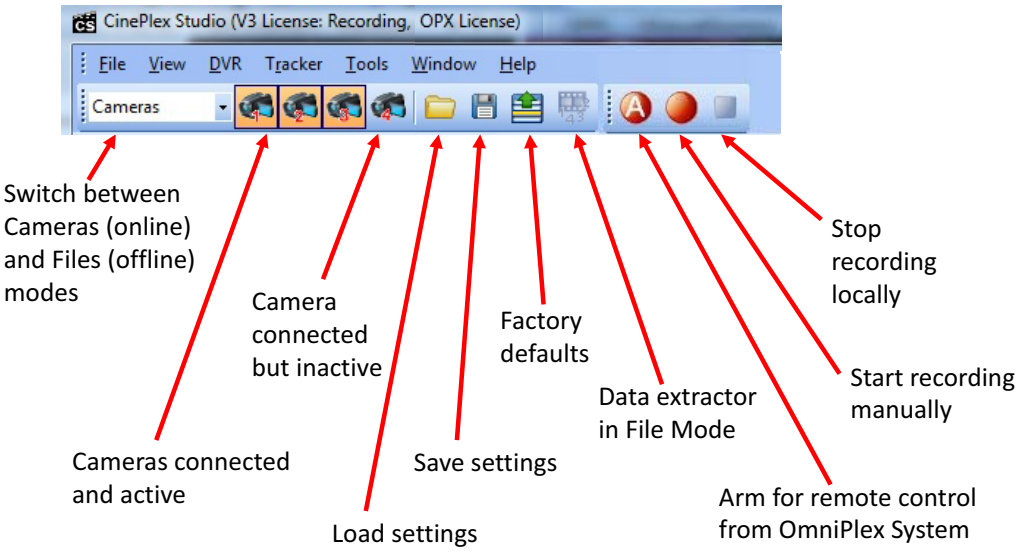
TIP

Verify "Cameras" Is Selected

Camera settings do not display in the main window unless **Cameras** is set in the main toolbar.

3.2.1 Main Toolbar Icons

The image below shows a close-up view of the CinePlex Studio main toolbar. In this example, there are four cameras connected and three of them are active.



3.2.2 Global Configuration Pane Settings

This pane (see the image above) is the first an experimenter will normally use when setting up CinePlex Studio, but perhaps not very often after that. It contains settings that pertain to the frame rate to use when recording, image resolution (quality of recordings to make), compression bit rate, and local file recording folder. For information about video formats and the video **Quality** setting, see Section 3.10.2, “MPEG-4 Quality and File Size” on page 69.

3.2.3 Source Pane Settings

This pane is the second an experimenter will normally use when setting up CinePlex Studio. There can be multiple Source panes if there are multiple cameras on the system. This pane contains parameters that relate to optical settings for each camera (contrast, brightness, sharpness, saturation, etc.), file output format (AVI or DVT), labeling/timestamping of frames and calibration. (For the calibration procedure, see Calibrating the Arena Dimensions, below.)

3.3 Calibrating the Arena Dimensions

In many experiments, it is useful to calibrate the video images from one or more cameras so that the ratio of centimeters to pixels (or inches to pixels) is known. The calibration ratio can be useful even if the Tracking Option is not currently installed, because the tracking data (such as the animal’s speed) can be processed with the calibration data at a later time (if the Tracking Option is purchased). This section describes how to perform the calibration procedure on an active camera. The calibration procedure can be repeated for any or all active cameras.

Note: Calibration only works accurately when the camera is orthogonal to the arena.

CinePlex Studio provides two methods of calibration - single axis (also called One-Bar) and dual axis (also called Two-Bar).

Calibration is the final section of the Source (Video) pane.

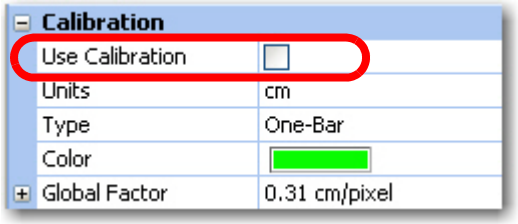
Setting Up the Camera

The camera should be set up according to the instructions in Section 3.1, “Setting Up Cameras and the User Interface” on page 26.

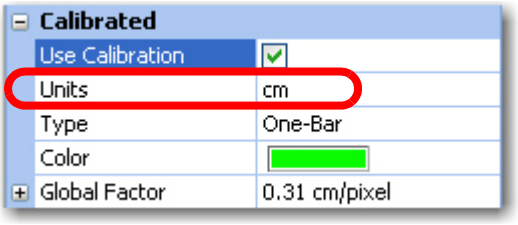
Selecting Calibration Units and Type

1. Open up the **Calibration** section (if it is not already open) by clicking on the “+” sign.

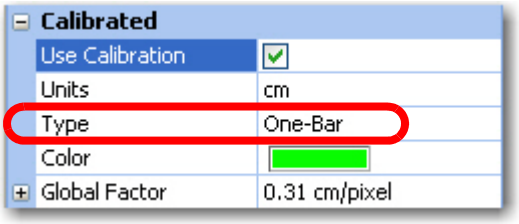
2. Check the box labeled **Use Calibration**. Note that the title of the section changes from **Calibration** to **Calibrated**. This is because the current calibration **Global Factor** is now being applied.



3. Select the unit of measure (**Units**) - either cm for centimeters or in. for inches.



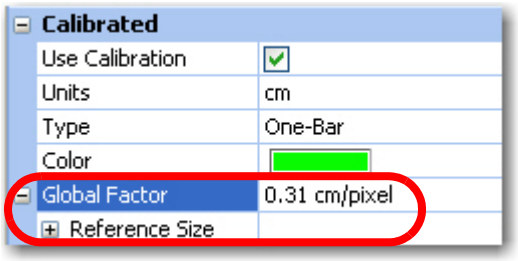
4. Select the method of calibration (**Type**) - either **One-Bar** or **Two-Bar**.

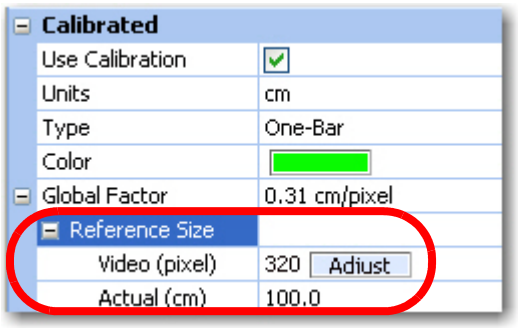


Setting Calibration Parameters with One-Bar Method

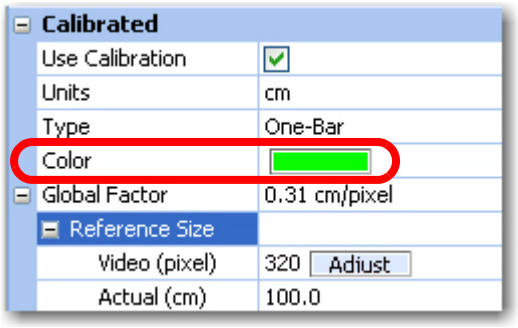
5 When **One-Bar** has been selected:

a Click the "**+**" sign next to **Global Factor** and then the "**+**" next to **Reference Size** to expand their subsections, if needed. If they are already shown as "**-**" signs, this is not needed.

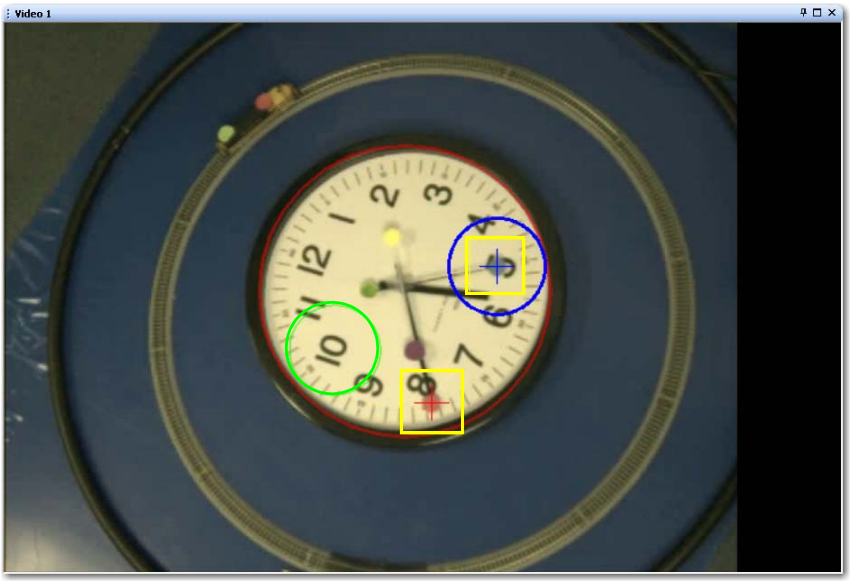




b If the current color in the box next to the **Color** item will not provide good contrast with the video image, click in the box and select a suitable color. The color selected is the color of the measurement bar used for calibration.

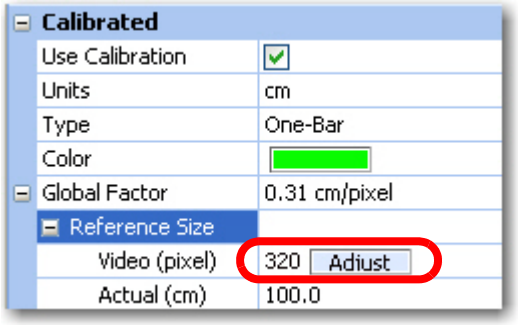


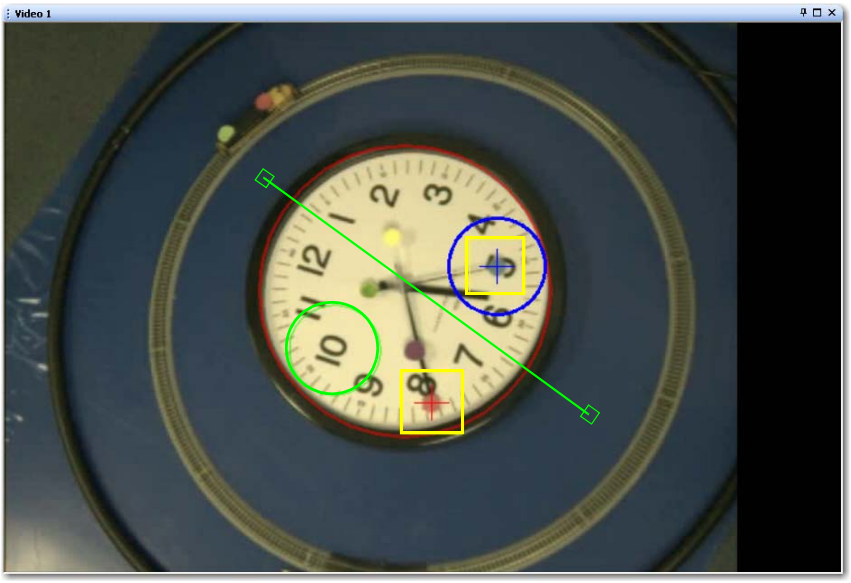
c Choose a feature in the experimental area whose video image extends over much of the field of view. As an illustration, the inside diameter of the clock frame in the image below will be used as the desired dimension.



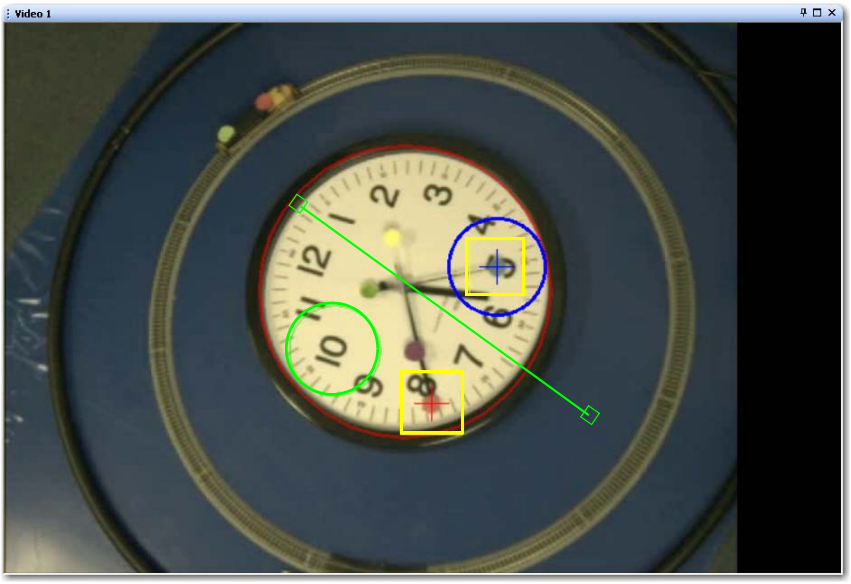
d Measure its longest dimension in the units desired, and record it for reference. The inside diameter of the clock frame measured 30.5 cm.

e Click the **Adjust** button. The cursor will go to the video image and a line will appear in the color selected. Select one end of the colored line and move it to one end of the feature just measured. Select the other end of the line and move it to the other end of the feature.

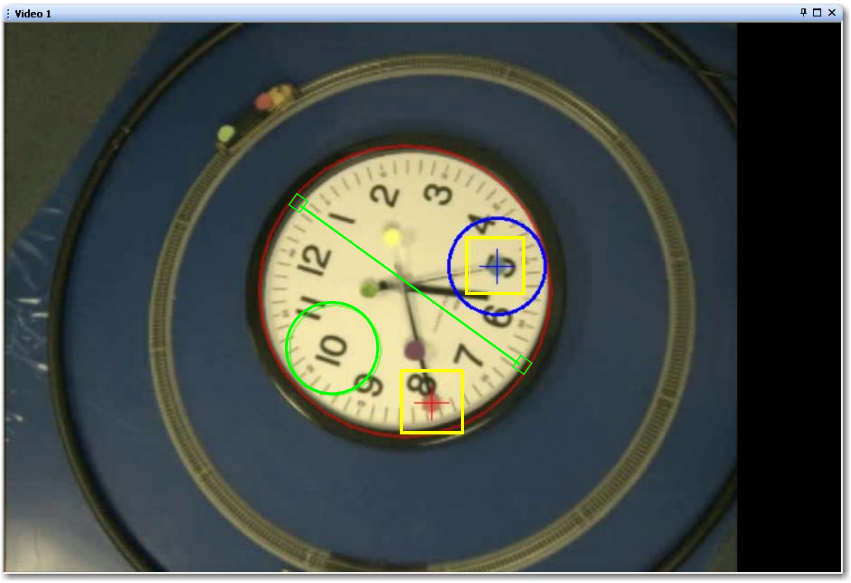




In the image above note the green line through the middle of the clock with the box on each end. This is the sizing bar.



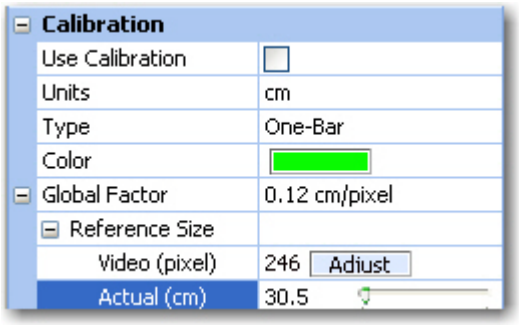
In the above image note that the left end of the sizing bar has been moved to the inside edge of the clock's frame. Select the other end of the sizing bar and move it to the opposite inside edge of the clock frame and ensure the sizing bar crosses the intersection of the clock hands.



In the above image note that the sizing bar now measures the inside diameter of the clock's frame.

f Right-click to record the length of the bar in pixels.

g Go to the slider next to the **Actual** item and move it so that it reads the dimension recorded above. Studio is now calibrated to the measured distance. The arrow keys may be used for fine adjustments to the slider positions.



In the image above note that the **Actual** setting has been changed to the measured inner diameter of the clock's frame (30.5 cm).

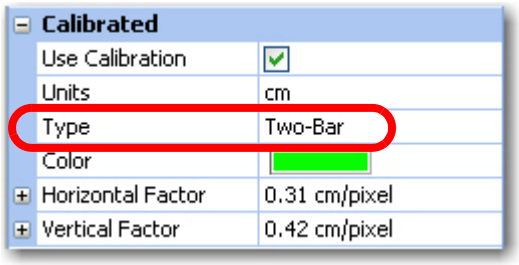
h Click all three "**-**" signs once the adjustment is satisfactory to hide the adjustments.

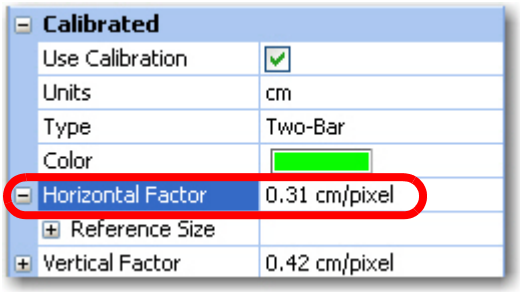
i After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

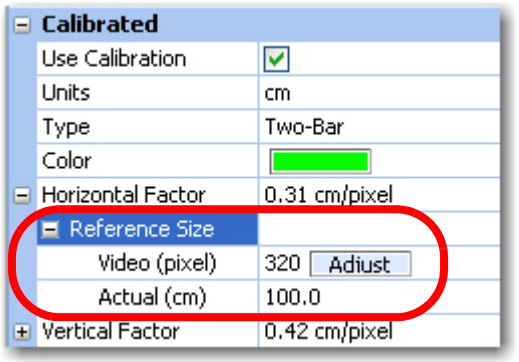
Setting Calibration Parameters with Two-Bar Method

6 When **Two-Bar** has been selected:

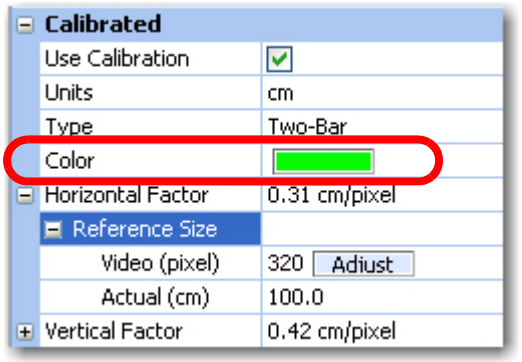
a Click the "**+**" sign next to **Horizontal Factor** and then the "**+**" next to **Reference Size** to expand their subsections, if needed. If they are already shown as "**-**" signs, this is not needed.







b If the current color in the box next to the **Color** item will not provide good contrast with the video image, click in the box and select a suitable color.



c Choose a horizontal feature (horizontal relative to the video image) in the experimental area whose video image extends over much of the field of view. Once again the inner diameter of the clock's frame will be used.

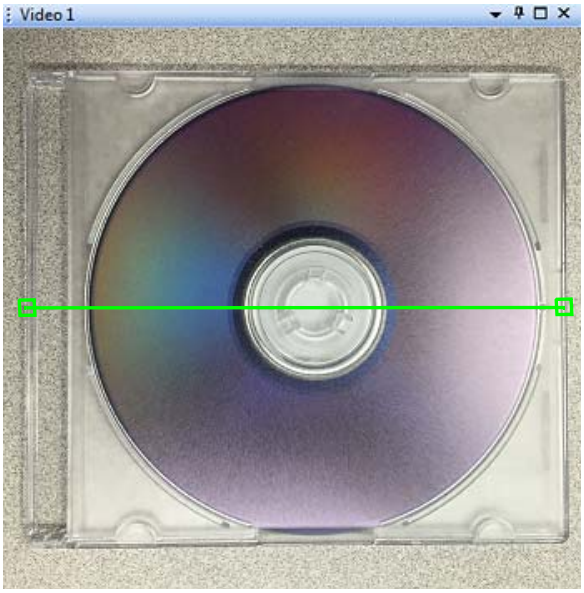
d Measure the feature's horizontal dimension in the units desired, and record it for reference. In this example, the width is 41.0 cm.

e Click the **Adjust** button in the **Horizontal** section. The cursor will go to the video image and a horizontal line will appear in the color selected.

In the image above note the green line with the box on each end. This is the sizing bar.

f Select the horizontal sizing bar and move it vertically so that it rests on the desired feature in the frame (in this example, it will be moved to the center of the disk). Select one end of the sizing bar and move it over the desired

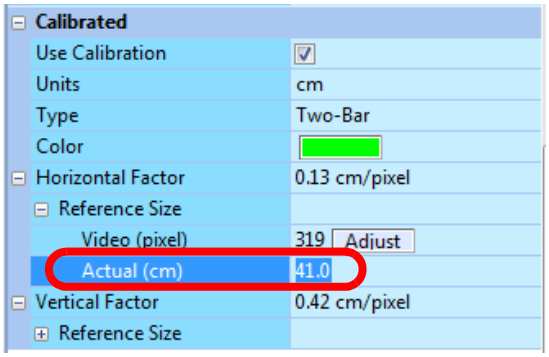
feature in the image. Repeat this process for the other end of the sizing bar. In this example, the ends of the sizing bar will be placed at the edges of the plastic case.



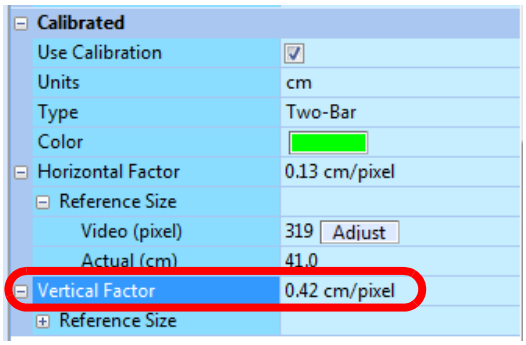
In the above image note that the sizing bar now measures the horizontal width of the plastic case.

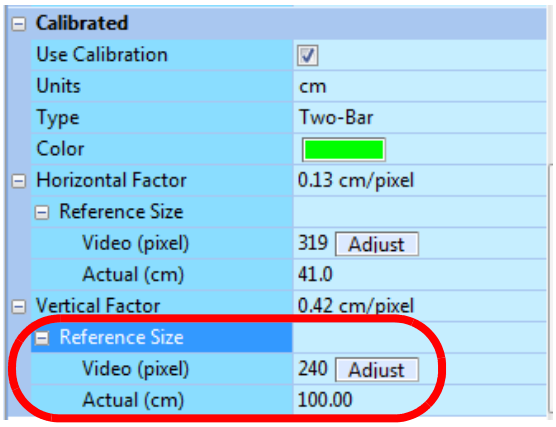
g **Right-click** to record the length of the bar in pixels.

h In the row labeled **Actual**, double click on the number and enter the actual dimension of the object under the sizing bar (41.0 cm in this example).

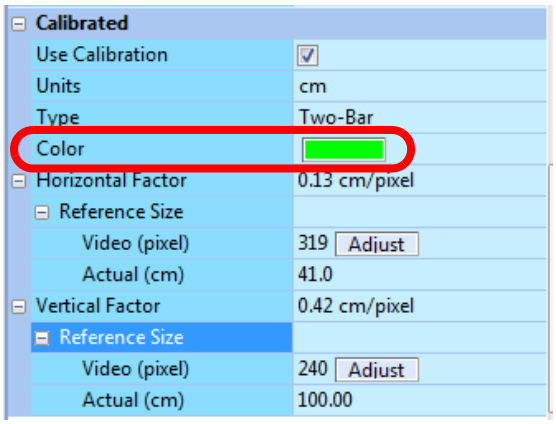


i Click the "**+**" sign next to the **Vertical Factor** and then the "**+**" next to **Reference Size** to expand their subsections, if needed. If they are already shown as "**-**" signs, this is not needed.





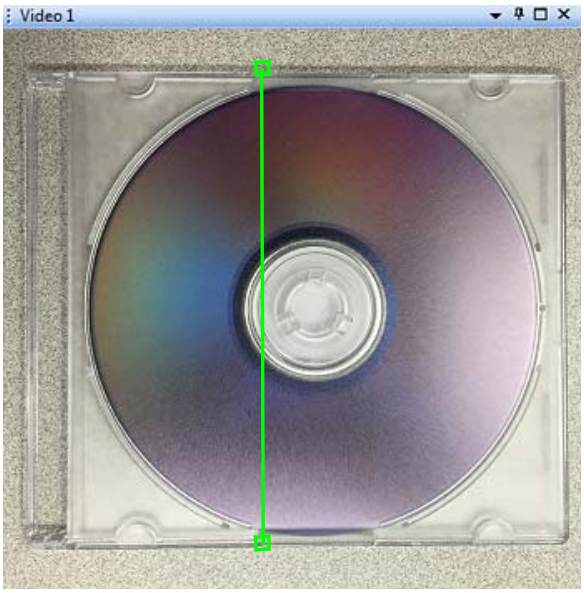
j If the current color in the box next to the **Color** item will not provide good contrast with the video image, click in the box and select a suitable color.



k Choose a vertical feature (vertical relative to the video image) in the experimental area whose video image extends over much of the field of view. In this example, the height of the plastic case will be measured.

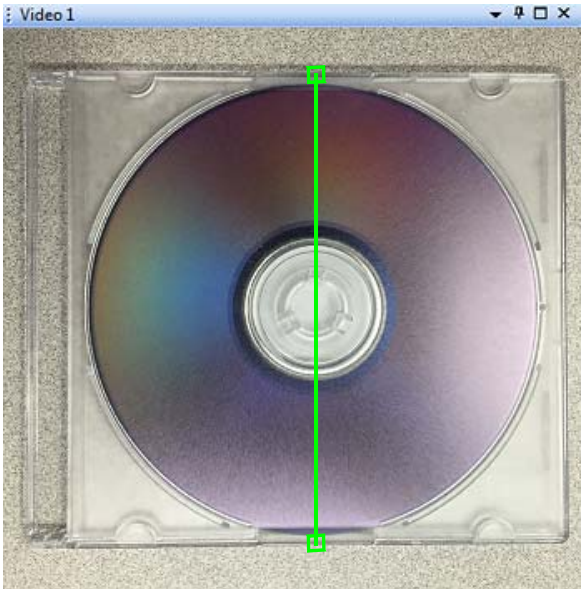
l Measure the feature's vertical dimension in the units desired, and record it for reference. In this example, the height of the plastic case is 31.9 cm.

m Click the **Adjust** button in the **Vertical** section. The cursor will go to the video image and a line will appear in the color selected.



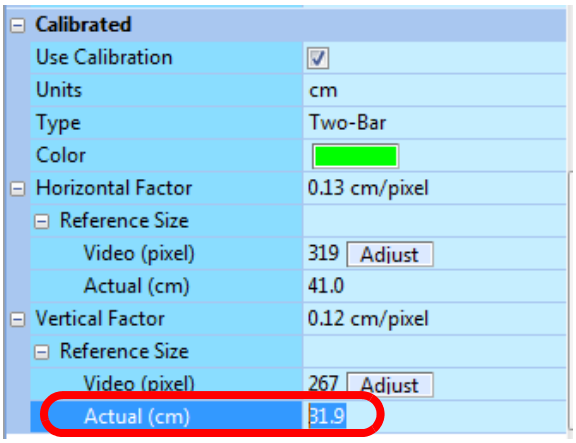
In the image above note the vertical green line with a box at each end. This line is the sizing bar.

n Select the vertical sizing bar and move it horizontally so that it rests on the desired feature in the frame (in this example, it will be moved to the center of the disk). Select one end of the sizing bar and move it over the desired feature in the image. Repeat this process for the other end of the sizing bar. In this example, the ends of the sizing bar will be placed at the edges of the plastic case.



o Right-click to record the length of the bar in pixels.

p In the row labeled **Actual**, double click on the number and enter the actual dimension of the object under the sizing bar (31.9 cm in this example).



Now the system has been calibrated in both horizontal and vertical directions. Note that the horizontal and vertical factors are slightly different in this example. This situation typically occurs if the camera is not orthogonal to the plane of the object that was measured during the calibration. The CineLAB System uses the horizontal and vertical factors to provide a more accurate calibration (versus a one-bar calibration).

q Click all five "**-**" signs once the adjustments are satisfactory if you want to hide the adjustments.

r After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

3.4 Recording Synchronized Video Tracking and Neural Data

This section explains how to record video and tracking data that is time-locked (synchronized) with neural data from the OmniPlex System. This procedure requires starting and stopping the CinePlex Studio video recording process remotely from the OmniPlex System. This method of triggering the recording ensures that:

- The timestamps in the CinePlex and OmniPlex files are derived from the same clock
- The CinePlex and OmniPlex file start times and stop times are synchronized
- The CinePlex frame numbers and timestamps are synchronized

Simultaneous starting, stopping, pausing, and resuming of the neural data and video files is essential in helping the researcher correlate the behaviors captured in the video with the observed neural activity.

Although you can manually start, stop, pause, and resume recording an AVI file at any time in CinePlex Studio by simply clicking the appropriate toolbar buttons, this method will *not* record synchronized files, because it produces video files that do not have the same start time as the corresponding neural data files.

Note: If the animal is being trained prior to the collection of neural data, the CinePlex System can record AVI and/or DVT files without the existence of neural data files. In that case, the OmniPlex System is used only as a clock source for the CinePlex System. The procedure for that case is provided in Section 3.8, “Recording Video without Neural Data (Used for Animal Training)” on page 3-54.

Procedure

Perform these steps to record synchronized video and neural data.

The steps must be followed in the sequence listed here. If they are not performed in order, it will not be possible to create a synchronized recording of video and neural data.

CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

CAUTION

Lighting Conditions

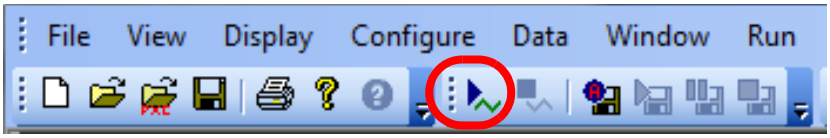
If lighting conditions change enough during recording that ‘objects too large’ or some other condition occurs, the position data may be meaningless.

1 Ensure that the system is connected as described in Chapter 2, Installing, Starting and Testing CinePlex Studio.

2 At the OmniPlex System chassis, turn the power on and start the OmniPlex Server and PlexControl.

3 If not already done, configure the OmniPlex System.

4 Click the **Start Data** button in the PlexControl toolbar so that neural data acquisition begins, and the neural data appears in PlexControl display. (This action also starts the OmniPlex System 1 MHz clock.)



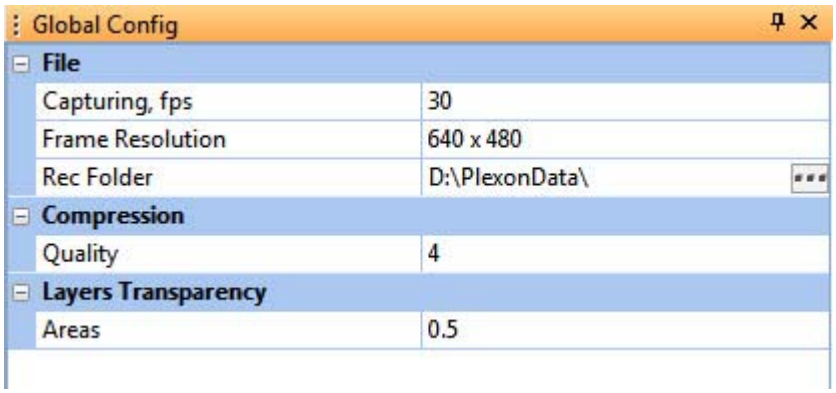
5 Double-click the **CinePlex Studio** icon ( ). Wait for the CinePlex Studio application main window to appear on the monitor.

Note: If Studio does not detect the OmniPlex clock, an error message will appear. If it does, see Appendix E-Troubleshooting.

6 Verify that **Cameras** is selected in the Studio dropdown list and that a camera image is displayed for each of the camera(s) that will be used in the experiment. The image is displayed for each camera icon that is selected. The image below shows that both Camera 1 and Camera 2 are selected (indicated by the orange color of the icons).

7 If there is an appropriate file containing all the desired CinePlex settings, load the file onto the CinePlex System using the **Load Settings** icon ( ) on the main toolbar or the **File/Load Settings** menu selection.

8 Click on the **Global Config** tab in the static configuration pane to display the Global Config pane.



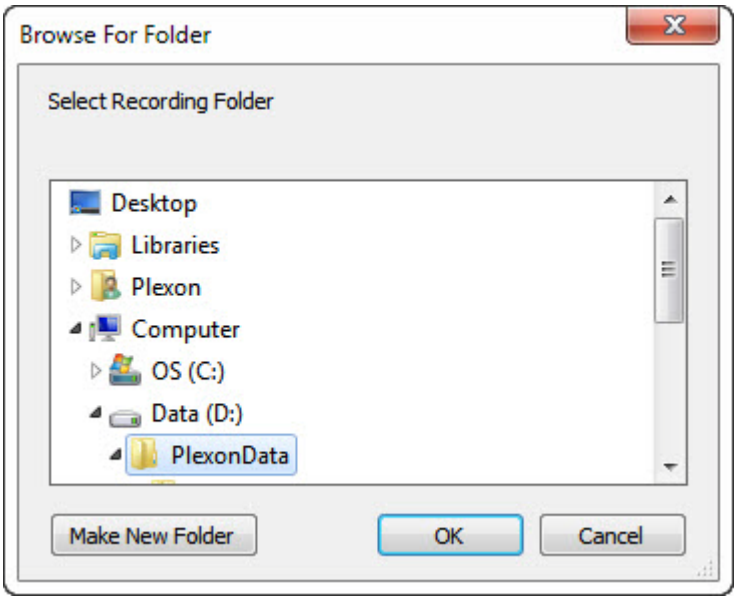
Note: This pane is the first an experimenter will normally use when setting up CinePlex Studio, but perhaps not very often after that. It contains settings that pertain to the frame rate to use when recording, image

resolution (quality of recordings to make), compression bit rate and local file recording folder. For information about video formats and the video **Quality** setting, see Section 3.10.2, “MPEG-4 Quality and File Size” on page 3-69.

9 View the settings in the Global Config pane and modify any that need to be changed prior to starting the next recording session.

10 To browse for the desired file location (where the recorded files will be saved), click on the browse icon, which is the rectangle with three dots on the **Rec Folder** row of the Global Config pane.

11 When the **Browse For Folder** dialog box appears, use standard Windows® methods to select or create the appropriate folder. The factory default location for the Recording folder is C:\PlexonData or D:\PlexonData (if disk D is available).

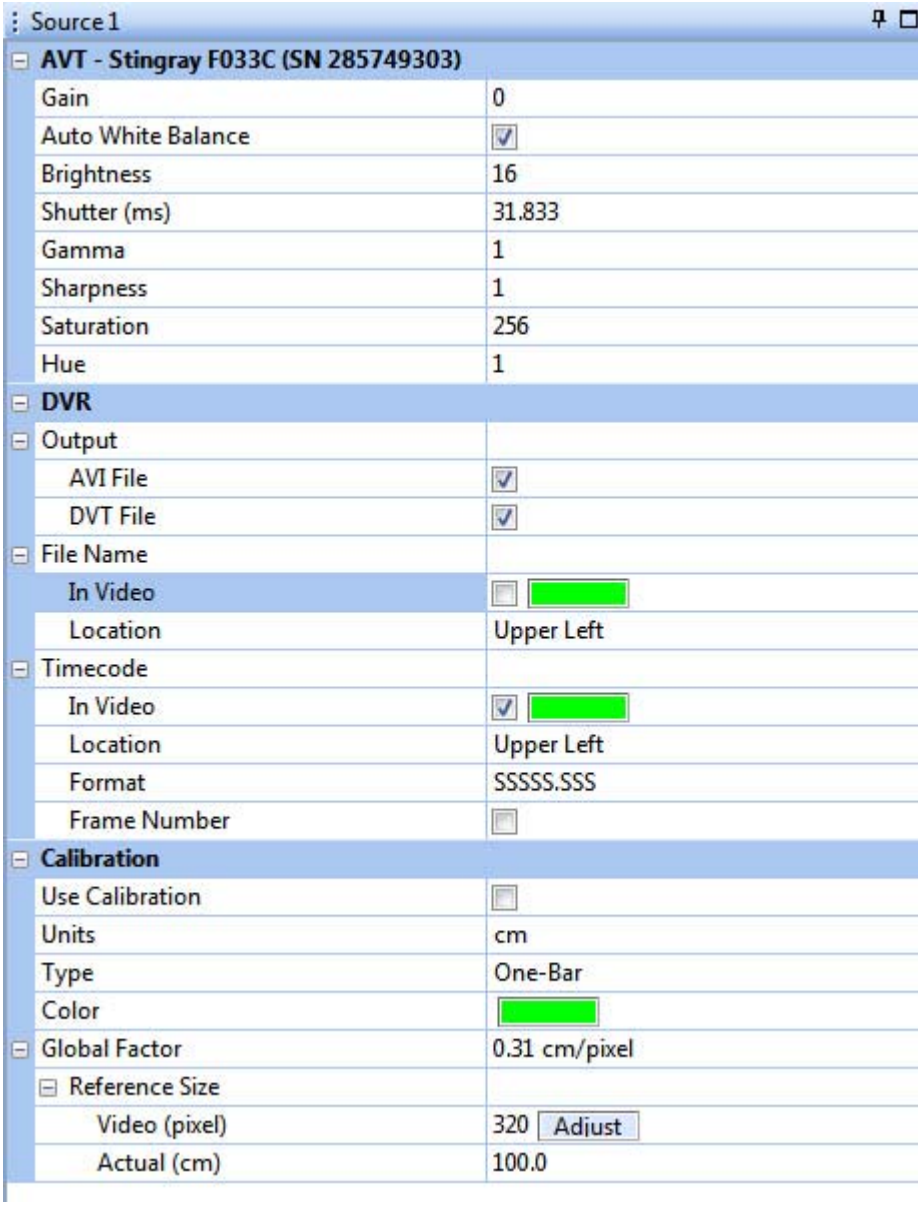


12 When finished choosing or creating a storage folder, click **OK**.

Note: The location of the Recording folder is included in the Settings file (if you save a Settings file), and is restored when the Settings file is loaded. To save settings, click **Save Settings** on the **File** menu, or click the **Save Settings** button ( ) on the toolbar.

Note: If the Recording drive is not NTFS compatible, a warning message displays.

13 To view the CinePlex Studio time display, see the Source pane under the Video window. The image below shows the Source 1 pane, which appears under the Video 1 window for Camera 1. Similar panes appear for each of the cameras you have activated in the previous steps.



14 In the **Camera** area of the Source pane (labeled with the camera model name), adjust the controls to obtain an acceptable image on the screen. The specific controls vary depending on the camera model. Typical adjustments include **Gain**, **Auto White Balance**, **Brightness**, **Sharpness** and **Saturation**.

Note: You can also use other image quality settings. To evaluate image quality settings, manually collect a set of AVI files at different settings and use the file mode to determine a minimum acceptable image quality setting for the experiment. (For information about video formats and the video **Quality** setting, see Section 3.10.2, “MPEG-4 Quality and File Size” on page 69.)

TIP

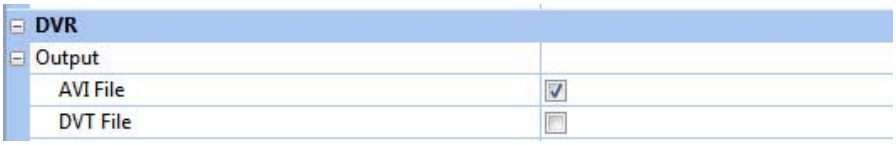
Reducing blurs and color streaks in the video

If the experimental subject moves quickly, blurs and color streaks can appear in the video. Reduce or eliminate these problems by increasing the shutter speed. See **Shutter (ms)** in the **Source** settings, as shown in the image above.

For additional tips, see "Sharpening the Image" on page B-7.

15 In the Sources pane, view the digital video recording (**DVR)** section.

16 In the digital video recording (**DVR)** area of the Source pane, select the type(s) of output to create - video file (**AVI File**), text file with frame numbers and timestamps (**DVT File**) or both.



CAUTION

Save the AVI File

It is *strongly* recommended that you save an **AVI File** for every experimental run, even if you are sending data directly from CinePlex to the OmniPlex System. (**AVI File** is the default output type.)

The AVI file is the originally recorded video of the experiment, and it can be retrieved and analyzed again. If you *deselect* the **AVI File** checkbox, the original video will *not* be saved.

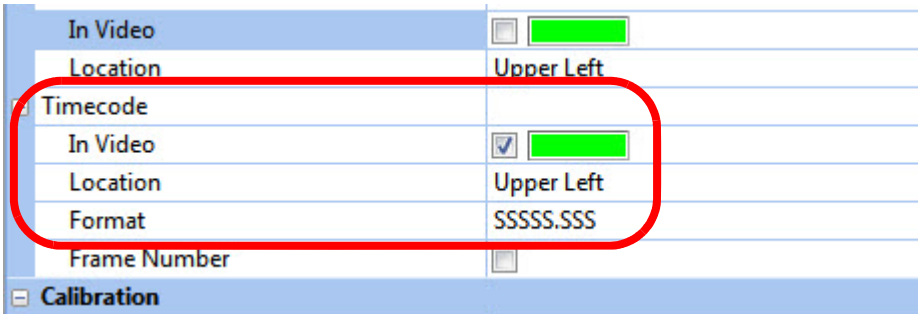
TIP

Generating timestamps and frame numbers—DVT FIle

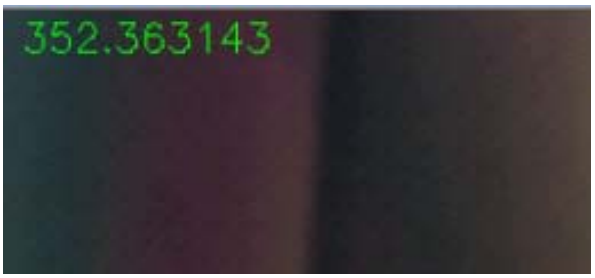
The system will generate a digital video tracking (DVT) file if you select the **DVT File** checkbox. However, if you have the basic Studio/Editor license only (without the Tracking license), the DVT file will display only frame numbers and timestamps (no coordinate data). Therefore, it is not typically needed in this case.

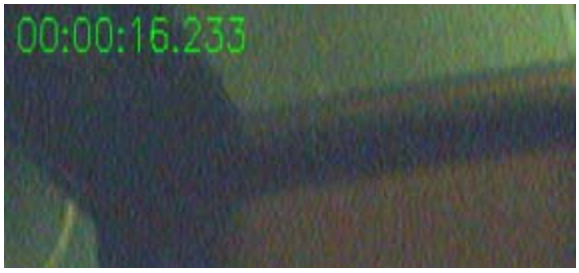
17 In the **Timecode** options, select the **In Video** checkbox to include the time. Choose a **Location** and a **Format** setting to configure the display. (CinePlex

Studio maintains a time code that tracks the time elapsed since the last time recording began.)



For example, the following images show the time code in the **Upper Left** location in **SSSSS.SSS** and **HH:MM:SS.SSS** format, respectively.





18 Repeat Step 13 through Step 17 for any other cameras connected to the system.

19 (Optional) If the arena dimensions have not yet been calibrated, the calibration can be done now. See Section 3.3, “Calibrating the Arena Dimensions” on page 30 for details.

20 From the CinePlex Studio toolbar, click the “**A**” arming button.

A yellow flashing cassette icon appears on the status bar at the bottom left of the CinePlex screen.

Note: At this point, CinePlex is in the armed condition and is waiting for a start signal to be sent from OmniPlex. The SPK - Activity pane in PlexControl shows no data on the CPX1 line.

21 From the PlexControl toolbar, click the **Start Recording** icon. If PlexControl prompts for a file name, enter it.

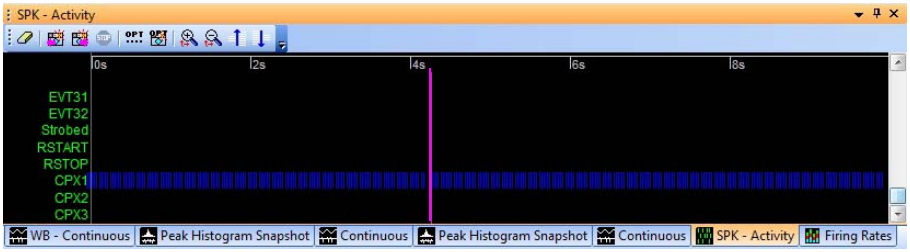
PlexControl starts recording and displays status information about the neural data file on the PlexControl status bar; for information on the PlexControl status, see the OmniPlex System instructions.

CinePlex Studio automatically starts recording and displays information about the video file in the CinePlex Studio status bar.

The Studio status bar will display the amount of free space remaining on the drive selected.

Note: The system automatically checks that there is at least 10 GB of free disk space on the PC before it starts recording a file. The file size can grow to fill the space available, except that the system automatically stops recording the current file when the available disk space has been reduced to 10 GB.

Studio starts sending the data to the OmniPlex System, and the SPK - Activity pane in PlexControl shows the synchronized data stream (see the blue data lines in this image):



Note: Plexon® recommends a short test recording to verify the data stream is being sent. The SPK - Activity pane in PlexControl should show the presence of the data stream, similar to that shown in the PlexControl image above.

22 To pause recording, click the PlexControl **Pause Recording** icon.

PlexControl pauses recording and displays status information about the neural data file on the PlexControl status bar.

CinePlex Studio pauses recording and displays information about the video file in the CinePlex Studio status bar. The status bar flashes green and gray to indicate that the recording is paused.

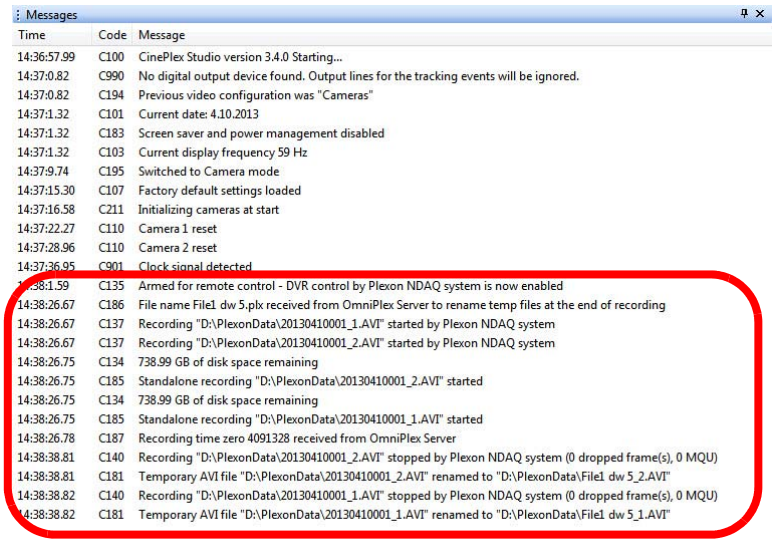
To resume recording, click **PlexControl Pause Recording** again.

23 To stop recording, press the **Stop Recording** button in PlexControl (Studio recording stops also.)

PlexControl stops recording to the neural data file, clears the recording information from the status bar, and saves the file as specified in Step 21.

CinePlex Studio stops recording and saves the video file(s) to the location that was specified as **Rec Folder** in the CinePlex Studio Global Configuration Pane. CinePlex Studio clears the recording information from the status bar and re-arms itself for the next recording session.

When Studio is armed, for efficiency it creates temporary files. When recording is started remotely (from the OmniPlex System), Studio writes to these temporary files. When recording is stopped, the temporary files are renamed, and new temporary files are opened in anticipation of a new recording session. The Studio Messages Pane displays information similar to the example below.


Messages

Time	Code	Message
14:36:57.99	C100	CinePlex Studio version 3.4.0 Starting...
14:37:0.82	C990	No digital output device found. Output lines for the tracking events will be ignored.
14:37:0.82	C194	Previous video configuration was "Cameras"
14:37:1.32	C101	Current date: 4.10.2013
14:37:1.32	C183	Screen saver and power management disabled
14:37:1.32	C103	Current display frequency 59 Hz
14:37:9.74	C195	Switched to Camera mode
14:37:15.30	C107	Factory default settings loaded
14:37:16.58	C211	Initializing cameras at start
14:37:22.27	C110	Camera 1 reset
14:37:28.96	C110	Camera 2 reset
14:37:36.95	C901	Clock signal detected
14:38:1.59	C135	Armed for remote control - DVR control by Plexon NDAQ system is now enabled
14:38:26.67	C186	File name File1 dw 5.plx received from OmniPlex Server to rename temp files at the end of recording
14:38:26.67	C137	Recording "D:\PlexonData\20130410001_1.AVI" started by Plexon NDAQ system
14:38:26.67	C137	Recording "D:\PlexonData\20130410001_2.AVI" started by Plexon NDAQ system
14:38:26.75	C134	738.99 GB of disk space remaining
14:38:26.75	C185	Standalone recording "D:\PlexonData\20130410001_2.AVI" started
14:38:26.75	C134	738.99 GB of disk space remaining
14:38:26.75	C185	Standalone recording "D:\PlexonData\20130410001_1.AVI" started
14:38:26.78	C187	Recording time zero 4091328 received from OmniPlex Server
14:38:38.81	C140	Recording "D:\PlexonData\20130410001_2.AVI" stopped by Plexon NDAQ system (0 dropped frame(s), 0 MQU)
14:38:38.81	C181	Temporary AVI file "D:\PlexonData\20130410001_2.AVI" renamed to "D:\PlexonData\File1 dw 5_2.AVI"
14:38:38.82	C140	Recording "D:\PlexonData\20130410001_1.AVI" stopped by Plexon NDAQ system (0 dropped frame(s), 0 MQU)
14:38:38.82	C181	Temporary AVI file "D:\PlexonData\20130410001_1.AVI" renamed to "D:\PlexonData\File1 dw 5_1.AVI"

Note: At this point, there is no tracking data being sent from CinePlex to the OmniPlex System, because CinePlex is once again in the armed condition. The SPK - Activity pane in PlexControl shows no data on the CPX1 line.

24 You can start and stop recording as many times as desired. When recording starts, data will flow from CinePlex to the OmniPlex System. When recording stops, data does not flow.

25 To disarm CinePlex Studio, from the **DVR** toolbar, click **Arm** to clear. The status bar returns to the disarmed state.

26 To view the captured video file, browse to the file location and double click to open the file.

27 To transfer files to an analysis computer (if different than the recording computer), follow standard Windows procedures.

3.5 File Naming Procedure During and After Recording

During the recording process, CinePlex Studio creates temporary names for the AVI files. When the recording is stopped, Studio renames the files.

If there is only one camera connected to the CinePlex System:

- The format of the temporary files is *yyyymmddnnn.avi*
- The format of the renamed files is *PLX_file_name.avi*

If there are multiple cameras connected to the CinePlex System:

- The format of the temporary files is *yyyymmddnnn_N.avi*
- The format of the renamed files is *PLX_file_name_N.avi*

where:

yyyymmdd is the year, month and day

nnn is a 3-digit number, 001, 002, ... 999 assigned automatically by the system

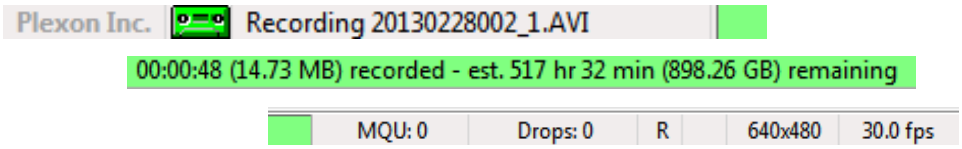
N is the camera number for which the file is created - 1, 2, ...

PLX_file_name is the file name specified by the user on the OmniPlex System in Step 21 of Section 3.4, “Recording Synchronized Video Tracking and Neural Data” on page 42.

Note: If Studio is armed on one day, but the start signal is not received until the next day, the temporary filename remains the one for the previous day.

3.6 Monitoring the Video During a Recording Session

The status bar in the CinePlex Studio main window displays information that allows the researcher to monitor the video recording process. This drawing shows the status bar during a typical recording session. (The image is split into three sections to fit the page.)



The contents of the status bar include

- A cassette icon that flashes yellow if recording is armed and is steady green when recording is in process.
- A display of the size of the recorded file in time and file size, and the remaining recording time and storage space available on the disk
- The maximum number of video frames queued for compression and waiting to be written to the AVI file at any time during the current recording session—maximum queued units (MQU)
- A count of the number of dropped frames during the current recording session
- A recording indicator; a letter R appears when recording is in process
- Numbers identifying the resolution of the current recording in pixels (horizontal x vertical)
- The instantaneous frame rate in frames per second (fps).

Note: During the recording process, the displayed value of the frame rate should match the value you specified in the Global Config pane. If the rate does not match, it is possible that the computer is experiencing partial congestion. Partial congestion is normally caused by non-Plexon applications. Partial congestion does not always result in dropped frames, but some processing might be slightly delayed. In the event that processing ever experiences problems, please contact Plexon support for help in identifying and resolving the issue.

3.7 Shutting Down the System after Recording

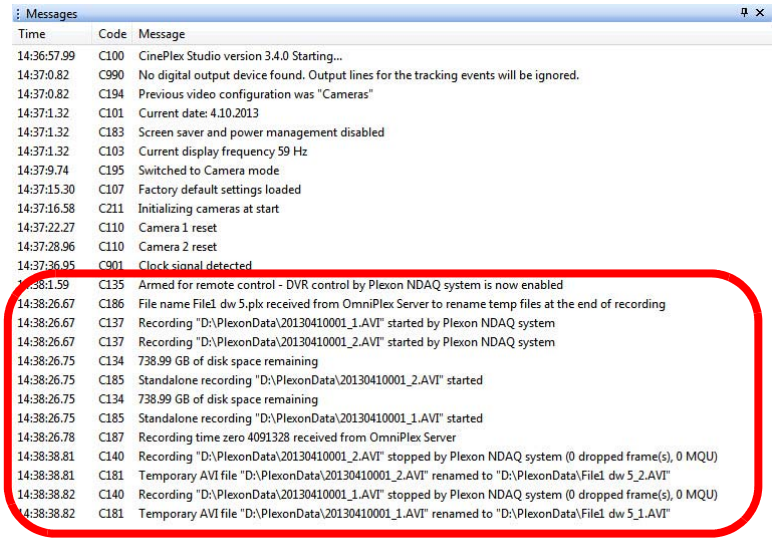
This section provides the steps for shutting down the system when you have finished your experiments. The system shutdown sequence is important for the integrity of the recorded data.

1 To stop recording, press the **Stop Recording** button in PlexControl (Studio recording stops also.)

2 PlexControl stops recording to the neural data file, clears the recording information from the status bar, and saves the current file.

CinePlex Studio stops recording and saves the video file(s) to the location that was specified as **Rec Folder** in the CinePlex Studio Global Configuration Pane. CinePlex Studio clears the recording information from the status bar and re-arms itself for the next recording session.

When Studio is armed, for efficiency it creates temporary files. When recording is started remotely (from OmniPlex), Studio writes to these temporary files. When recording is stopped, the temporary files are renamed, and new temporary files are opened in anticipation of a new recording session. The Studio Messages Pane displays information similar to the example below.


Messages

Time	Code	Message
14:36:57.99	C100	CinePlex Studio version 3.4.0 Starting...
14:37:0.82	C990	No digital output device found. Output lines for the tracking events will be ignored.
14:37:0.82	C194	Previous video configuration was "Cameras"
14:37:1.32	C101	Current date: 4.10.2013
14:37:1.32	C183	Screen saver and power management disabled
14:37:1.32	C103	Current display frequency 59 Hz
14:37:9.74	C195	Switched to Camera mode
14:37:15.30	C107	Factory default settings loaded
14:37:16.58	C211	Initializing cameras at start
14:37:22.27	C110	Camera 1 reset
14:37:28.96	C110	Camera 2 reset
14:37:36.95	C901	Clock signal detected
14:38:1.59	C135	Armed for remote control - DVR control by Plexon NDAQ system is now enabled
14:38:26.67	C186	File name File1 dw 5.plx received from OmniPlex Server to rename temp files at the end of recording
14:38:26.67	C137	Recording "D:\PlexonData\20130410001_1.AVI" started by Plexon NDAQ system
14:38:26.67	C137	Recording "D:\PlexonData\20130410001_2.AVI" started by Plexon NDAQ system
14:38:26.75	C134	738.99 GB of disk space remaining
14:38:26.75	C185	Standalone recording "D:\PlexonData\20130410001_2.AVI" started
14:38:26.75	C134	738.99 GB of disk space remaining
14:38:26.75	C185	Standalone recording "D:\PlexonData\20130410001_1.AVI" started
14:38:26.78	C187	Recording time zero 4091328 received from OmniPlex Server
14:38:38.81	C140	Recording "D:\PlexonData\20130410001_2.AVI" stopped by Plexon NDAQ system (0 dropped frame(s), 0 MQU)
14:38:38.81	C181	Temporary AVI file "D:\PlexonData\20130410001_2.AVI" renamed to "D:\PlexonData\File1 dw 5_2.AVI"
14:38:38.82	C140	Recording "D:\PlexonData\20130410001_1.AVI" stopped by Plexon NDAQ system (0 dropped frame(s), 0 MQU)
14:38:38.82	C181	Temporary AVI file "D:\PlexonData\20130410001_1.AVI" renamed to "D:\PlexonData\File1 dw 5_1.AVI"

Note: At this point, there is no tracking data being sent from CinePlex to OmniPlex, because CinePlex is once again in the armed condition. The SPK - Activity pane in PlexControl shows no data on the CPX1 line.

Note: You can start and stop recording as many times as desired. When recording starts, data will flow from CinePlex to OmniPlex. When recording stops, data does not flow.

3 To disarm CinePlex Studio, from the **DVR** toolbar, click **Arm** to clear. The status bar returns to the disarmed state.

4 To view the captured video files, browse to the file location and double click to open the file. Verify that the files for each camera are present and complete.

5 At this time, it is safe to exit the CinePlex application if you are finished.

Continue with these steps if you are shutting down OmniPlex also:

6 Click the **Stop Data** button in the PlexControl toolbar so that neural data acquisition stops.

7 Close the OmniPlex PlexControl and Server applications.

8 Turn the OmniPlex chassis power off.

3.8 Recording Video without Neural Data (Used for Animal Training)

This section explains how to record video and tracking data without neural data. In this case, the OmniPlex System is activated only for the purpose of providing the required clock for the CinePlex System. This procedure requires activation of the OmniPlex data stream (which starts the clock), and then starting and stopping the CinePlex Studio video recording process locally on the CinePlex System. This method of triggering the recording is typically used during animal training, when no neural data are being collected.

3.8.1 Recording Procedure

Perform these steps to record video data without neural data.

CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

CAUTION

Lighting Conditions

If lighting conditions change enough during recording that 'objects too large' or some other condition occurs, the position data may be meaningless.

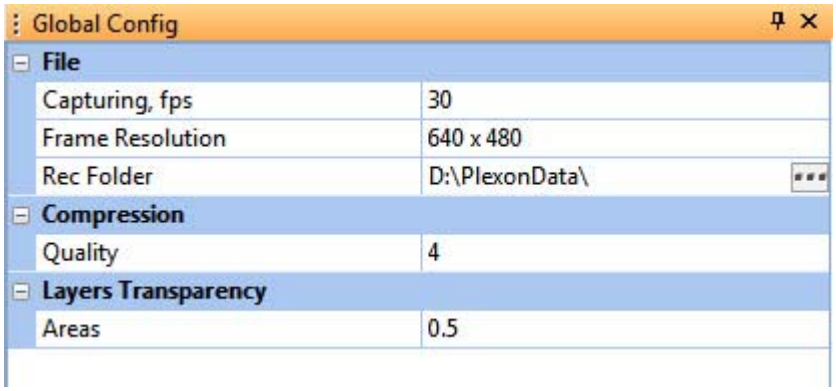
1. Ensure that the system is connected as described in Chapter 2, Installing, Starting and Testing CinePlex Studio.
2. At the OmniPlex System chassis, turn the power on and start the OmniPlex Server and PlexControl.
3. If not already done, configure the OmniPlex System.
4. Click the **Start Data** button in the PlexControl toolbar so that neural data acquisition begins, and the neural data appears in PlexControl display.
5. Double-click the **CinePlex Studio** icon. Wait for the CinePlex Studio application main window to appear on the monitor.

   Note: If Studio does not detect the OmniPlex clock, an error message will appear. If it does, see Appendix E-Troubleshooting.

6. Verify that **Cameras** is selected in the Studio dropdown list and that a camera image is displayed for each of the camera(s) that will be used in the experiment. The image is displayed for each camera icon that is selected. The image below shows that both Camera 1 and Camera 2 are selected (indicated by the orange color of the icons).

7 If there is an appropriate file containing all the desired CinePlex settings, load the file onto the CinePlex System using the **Load settings** icon ( ) on the main toolbar or the **File/Load Settings** menu selection.

8 Click on the **Global Config** tab in the static configuration pane to display the Global Config pane.

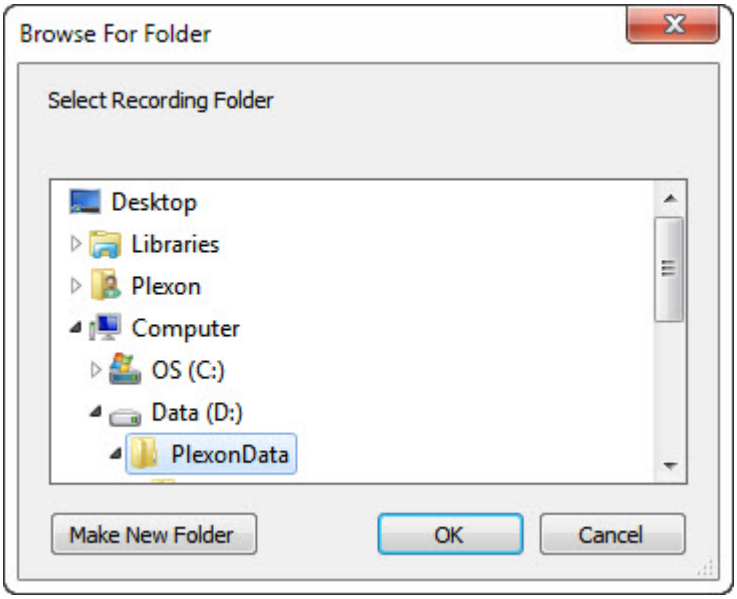


Note: This pane is the first an experimenter will normally use when setting up CinePlex Studio, but perhaps not very often after that. It contains settings that pertain to the frame rate to use when recording, image resolution (quality of recordings to make), compression bit rate and local file recording folder. For information about video formats and the video **Quality** setting, see Section 3.10.2, “MPEG-4 Quality and File Size” on page 69.

9 View the settings in the Global Config pane and modify any that need to be changed prior to starting the next recording session.

10 To browse for the desired file location (where the recorded files will be saved), click on the browse icon, which is the rectangle with three dots on the **Rec Folder** row of the Global Config pane.

11 When the **Browse for Folder** dialog box appears, use standard Windows methods to select or create the appropriate folder. The factory default location for the Recording folder is C:\PlexonData or D:\PlexonData (if disk D is available).

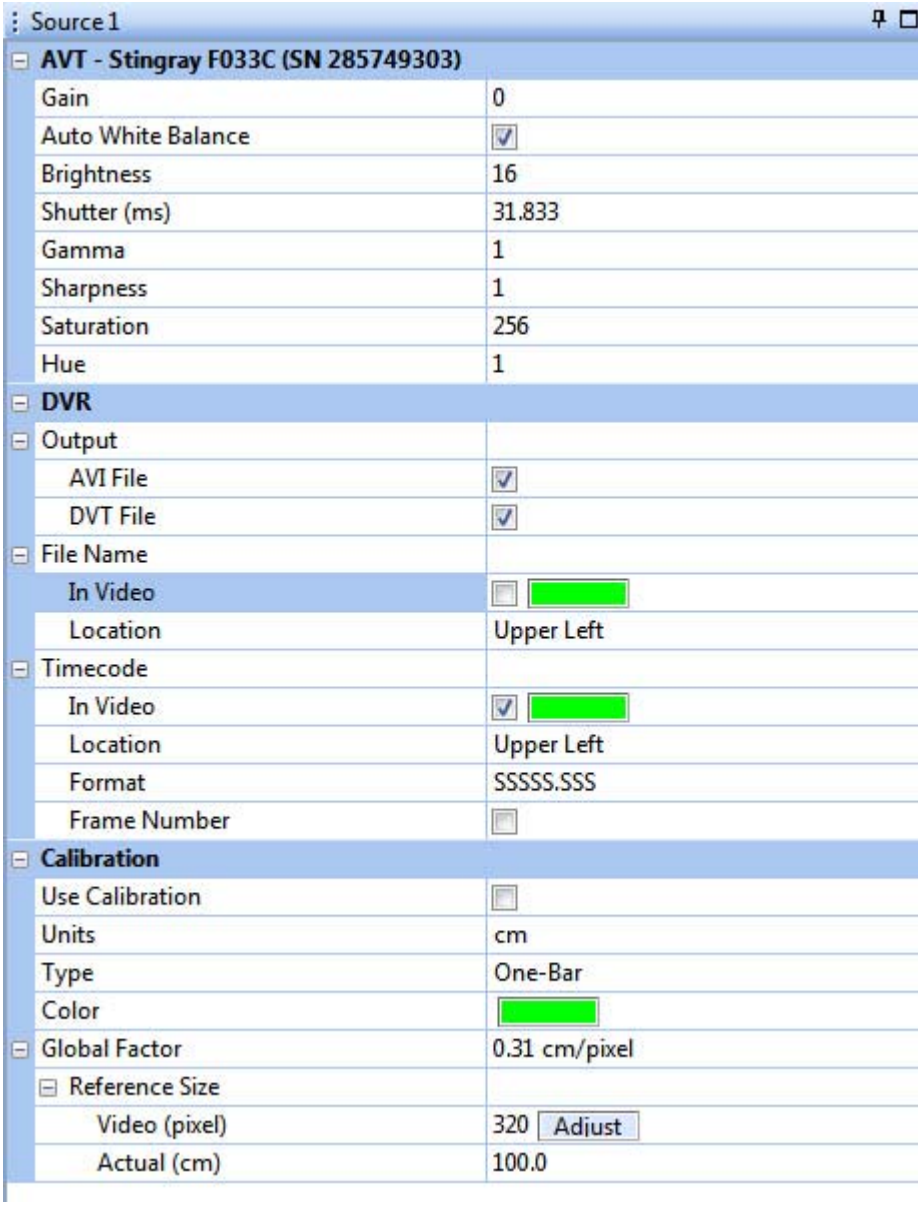


12 When finished choosing or creating a storage folder, click **OK**.

Note: The location of the Recording folder is included in the Settings file (if you save a Settings file), and is restored when the Settings file is loaded. To save settings, click **Save Settings** on the **File** menu, or click the **Save Settings** button ( ) on the toolbar.

Note: If the Recording drive is not NTFS compatible, a warning message displays.

13 To view the CinePlex Studio time display, see the Source pane under the Video window. The image below shows the Source 1 pane, which appears under the Video 1 window for Camera 1. Similar panes appear for each of the cameras you have activated in the previous steps. (Calibration is explained in a later step in this procedure.)



14 In the **Camera** area of the Source pane (labeled with the camera model name), adjust the controls to obtain an acceptable image on the screen. The specific controls vary depending on the camera model. Typical adjustments include **Gain**, **Auto White Balance**, **Brightness**, **Sharpness** and **Saturation**.

Note: You can also use other image quality settings. To evaluate image quality settings, manually collect a set of AVI files at different settings and use the file mode to determine a minimum acceptable image quality setting for the experiment. (For information about video formats and the video **Quality** setting, see Section 3.10.2, “MPEG-4 Quality and File Size” on page 69.)

TIP

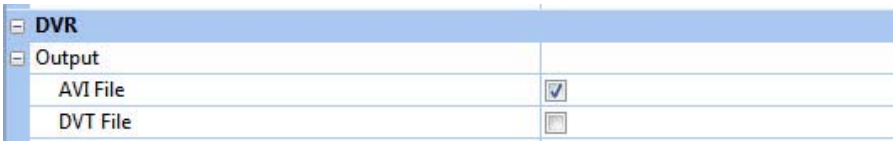
Reducing blurs and color streaks in the video

If the experimental subject moves quickly, blurs and color streaks can appear in the video. Reduce or eliminate these problems by increasing the shutter speed. See **Shutter (ms)** in the **Source** settings, as shown in the image above.

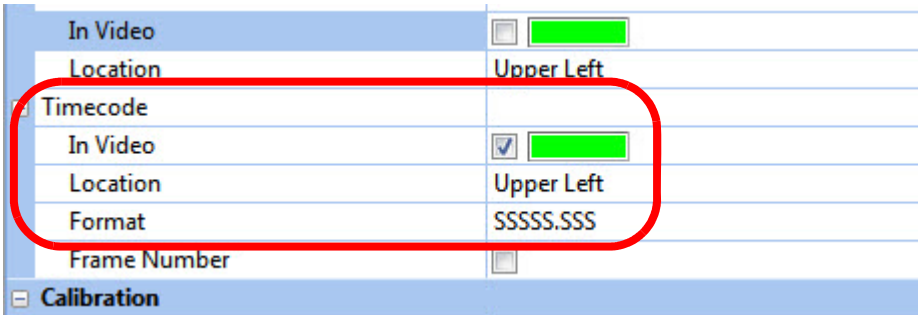
For additional tips, see "Sharpening the Image" on page B-7.

15 In the Sources pane, view the digital video recording (**DVR)** section.

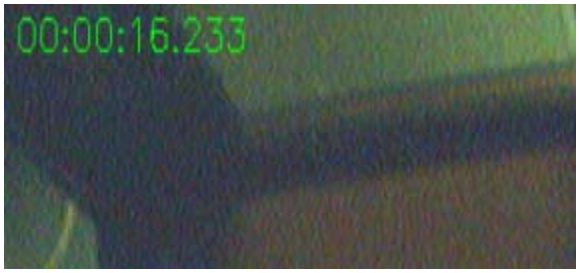
16 In the digital video recording (**DVR)** area of the Source pane, select the type(s) of output to create - video file (**AVI File)**, text file with frame numbers and timestamps (**DVT File**) or both.



17 In the **Timecode** options, select the **In Video** checkbox to include the time. Choose a **Location** and a **Format** setting to configure the display. (CinePlex Studio maintains a time code that tracks the time elapsed since the last time recording began.)



For example, the following images show the time code in the **Upper Left** location in **SSSSS.SSS** and **HH:MM:SS.SSS** format, respectively.



18 Repeat Step 13 through Step 17 for any other cameras connected to the system.

19 (Optional) If the arena dimensions have not yet been calibrated, the calibration can be done now. See Section 3.3, “Calibrating the Arena Dimensions” on page 30 for details.

20 To start recording video, click the **Start recording** button (the red circular icon) on the CinePlex Studio toolbar. A green cassette icon appears on the status bar to indicate that the recording is in process.

The **Pause or resume recording** and **Stop recording** buttons appear on the CinePlex toolbar.

Note: The system automatically checks that there is at least 10 GB of free disk space on the PC before it starts recording a file. The file size can grow to fill the space available, except that the system automatically stops recording the current file when the available disk space has been reduced to 10 GB.

21 To pause recording, click the **Pause or resume recording** icon.

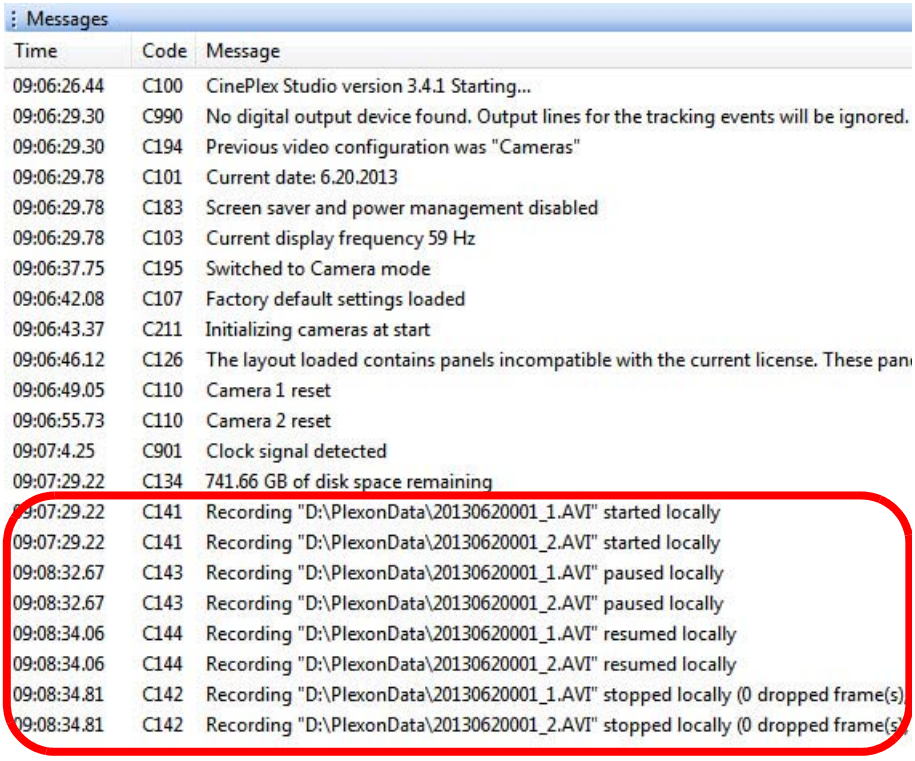
CinePlex Studio pauses recording and displays information about the video file in the CinePlex Studio status bar. The status bar flashes green and gray to indicate that the recording is paused.

To resume recording, click the **Pause or resume recording** icon again.

22 To stop recording, press the **Stop recording** icon.

CinePlex Studio stops recording and saves the video file(s) to the location that was specified as **Rec Folder** in the CinePlex Studio Global Configuration Pane. CinePlex Studio clears the recording information from the status bar and re-arms itself for the next recording session.

The Studio Messages Pane displays information similar to the example below.



Messages

Time	Code	Message
09:06:26.44	C100	CinePlex Studio version 3.4.1 Starting...
09:06:29.30	C990	No digital output device found. Output lines for the tracking events will be ignored.
09:06:29.30	C194	Previous video configuration was "Cameras"
09:06:29.78	C101	Current date: 6.20.2013
09:06:29.78	C183	Screen saver and power management disabled
09:06:29.78	C103	Current display frequency 59 Hz
09:06:37.75	C195	Switched to Camera mode
09:06:42.08	C107	Factory default settings loaded
09:06:43.37	C211	Initializing cameras at start
09:06:46.12	C126	The layout loaded contains panels incompatible with the current license. These pan
09:06:49.05	C110	Camera 1 reset
09:06:55.73	C110	Camera 2 reset
09:07:4.25	C901	Clock signal detected
09:07:29.22	C134	741.66 GB of disk space remaining
09:07:29.22	C141	Recording "D:\PlexonData\20130620001_1.AVI" started locally
09:07:29.22	C141	Recording "D:\PlexonData\20130620001_2.AVI" started locally
09:08:32.67	C143	Recording "D:\PlexonData\20130620001_1.AVI" paused locally
09:08:32.67	C143	Recording "D:\PlexonData\20130620001_2.AVI" paused locally
09:08:34.06	C144	Recording "D:\PlexonData\20130620001_1.AVI" resumed locally
09:08:34.06	C144	Recording "D:\PlexonData\20130620001_2.AVI" resumed locally
09:08:34.81	C142	Recording "D:\PlexonData\20130620001_1.AVI" stopped locally (0 dropped frame(s)
09:08:34.81	C142	Recording "D:\PlexonData\20130620001_2.AVI" stopped locally (0 dropped frame(s)

23 You can start and stop recording as many times as desired.

24 To view the captured video file, browse to the file location and double click to open the file.

25 To transfer files to an analysis computer (if different than the recording computer), follow standard Windows procedures.

26 If desired, to save the current settings, click **Save Settings** on the **File** menu, or click the **Save Settings** button ( ) on the toolbar.

3.9 Video Playback and Rerecording in Studio Files (Offline) Mode

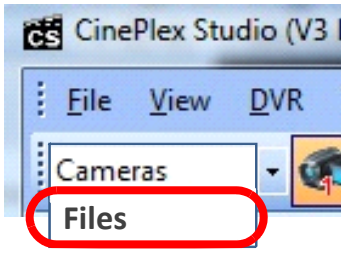
This section explains how to use CinePlex Studio in offline mode to play back and rerecord video from existing files. The existing AVI and/or DVT files are the ones recorded previously by means of the procedure in Section 3.4, “Recording Synchronized Video Tracking and Neural Data” on page 42.

Offline mode allows you to view existing CinePlex video file(s). The files can also be rerecorded with parameter settings that are different than those used for the original recording.

The offline functions of CinePlex Studio can be used on the OmniPlex/CinePlex host PC where the camera(s) are installed, or on a standalone computer. The CinePlex Studio license must be present on the computer.

3.9.1 Entering Offline Mode

CinePlex Studio has two modes of operation: **Cameras** (online) mode and **Files** (offline) mode. You can switch from **Cameras** mode to **Files** mode using the video source dropdown list on the CinePlex Studio main toolbar, as shown in this drawing.



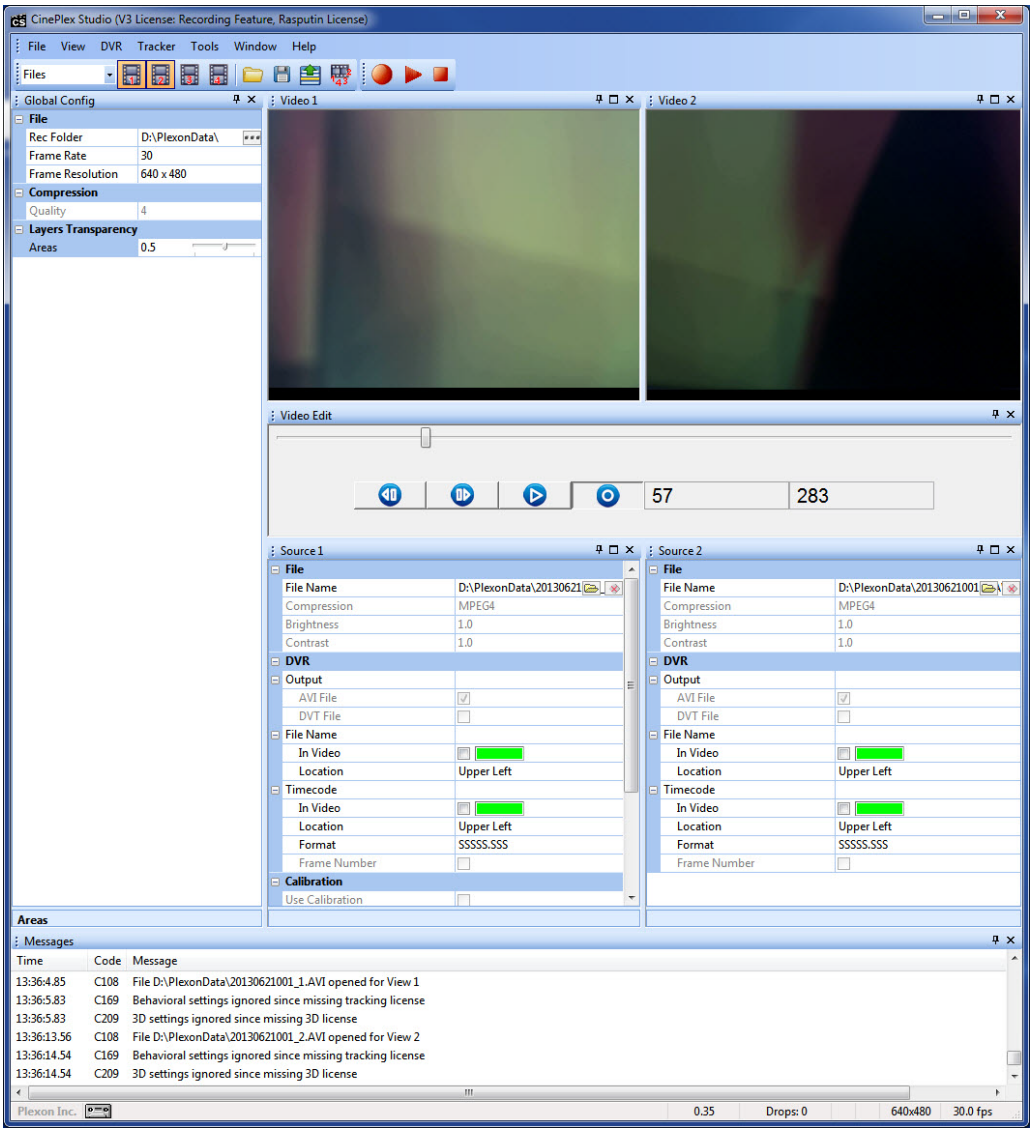
Note: CinePlex Studio comes up in **Files** (offline) mode automatically if no cameras are detected.

3.9.2 Selecting Files to Be Viewed and/or Rerecorded

Files are represented by icons in the toolbar. You can select from one to four files to process in offline mode, up to the number of cameras licensed for the system. The number in the file icon corresponds to the cameral number on which a file was originally recorded. In the following image, for example, **File 1** is selected, therefore the source file must be one that was recorded on Camera 1.

3.9.3 Managing the Offline Main Window Layout

The image below shows a typical layout with files from Camera 1 and Camera 2 enabled.



The Video Edit pane allows the opened file(s) to be viewed frame by frame.

The Global Config and Source panes allow you to change settings and rerecord the files. (The procedure is presented below.)

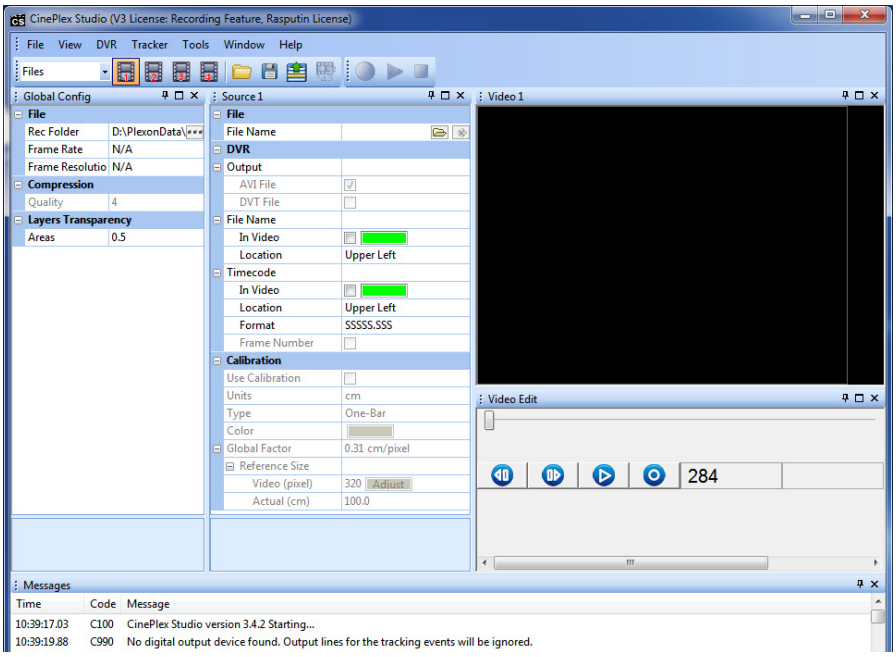
3.9.4 Procedure for Loading and Reviewing Video Files

The following procedure organizes the main window and loads the desired files. It also displays the Video Edit pane, which can be used to replay the video file frame by frame.

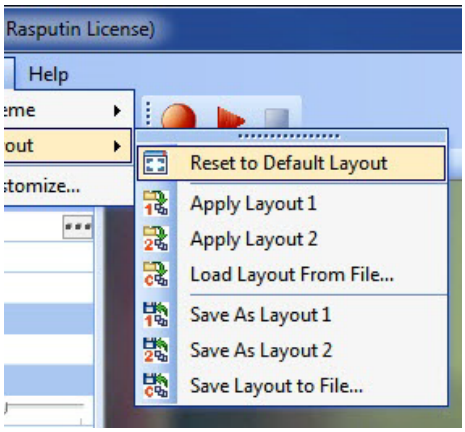
To view files from a single camera

1 To view files from a **single** camera, select the appropriate file icon. For example, in the image below, the file from Camera 1 (**File 1**) is selected.

2 Verify that you can see the video window and Source panel for the selected file (**File 1** and **Source 1** in this example).

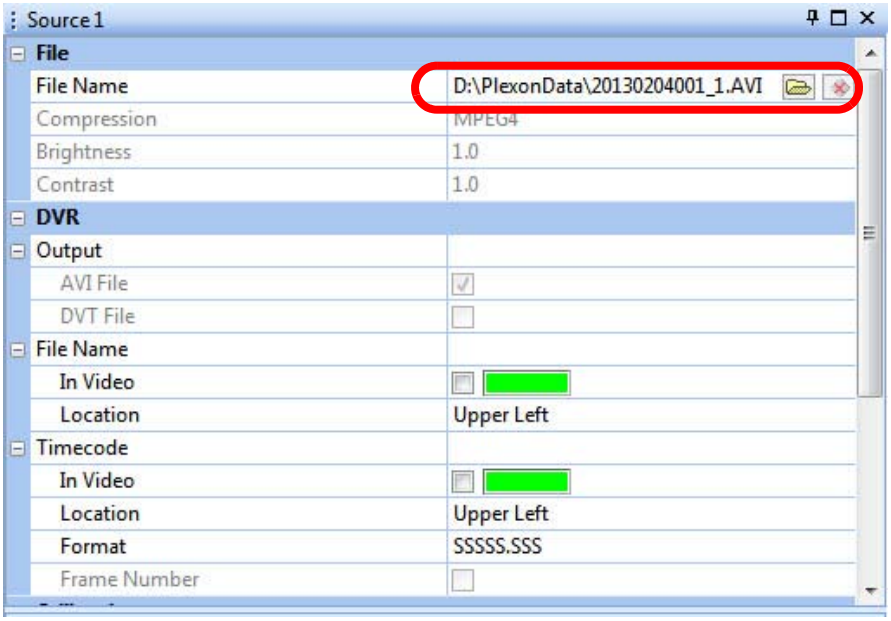


Note: If the video window is not displayed, from the **Window** dropdown menu, select **Layout** and then **Reset to Default Layout**.



3 In the Source pane, in the **File Name** row, click on the folder icon to navigate to the directory containing the desired AVI file and select the file.

Note: If you select a file that was created with any camera other than the camera associated with Source, the system will prompt you to select a different file (a file that was created with appropriate camera). The system can automatically detect which camera created the file, regardless of the file name. For example, in the image below, only files created with Camera 1 can be loaded in the Source 1 pane.



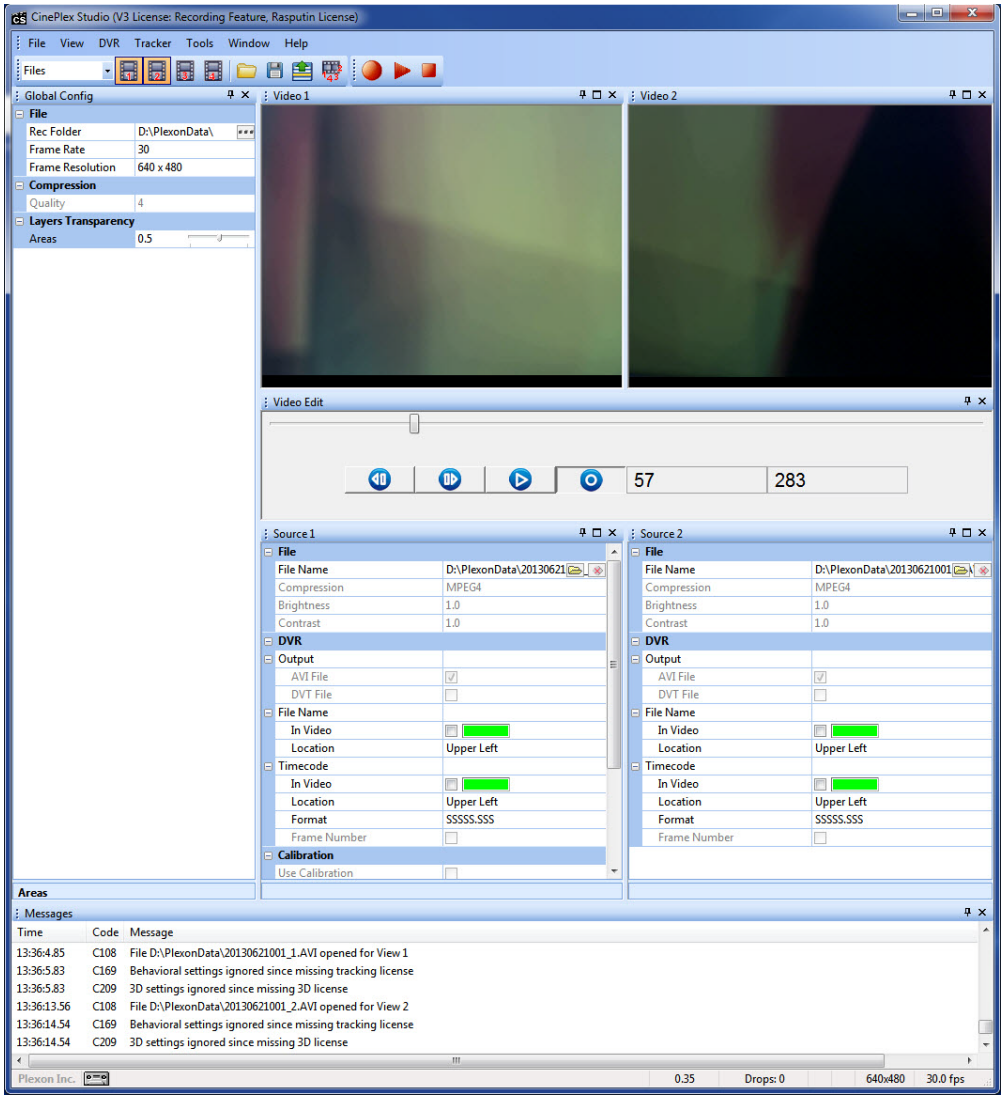
The buttons in the Video Edit pane can be used to replay the video file frame by frame.

4 To view files that were created with a different camera, repeat Step 1 through Step 3. (In Step 1, for example, disable all Files except the one file to be worked on next. For example, disable File 1 and enable File 2.)

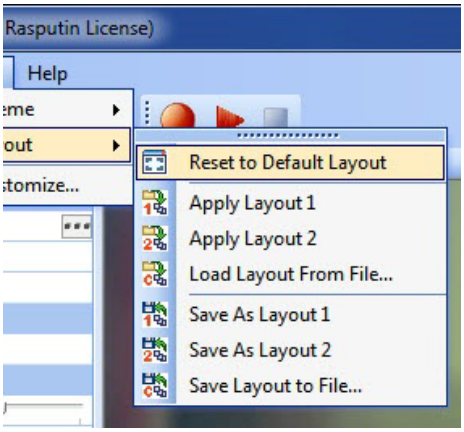
To view files from multiple cameras

1 To view files from **multiple** cameras, select the appropriate file icons. For example, in the image below, the files from Camera 1 (**File 1**) and Camera 2 (**File 2**) are selected.

2 Verify that you can see the video window and Source panel for the selected files. In the image below, **Source 1** and **Source 2** are displayed.



Note: If the correct video windows are not displayed, from the **Window** dropdown menu, select **Layout** and then **Reset to Default Layout**.



3 In each of the Source panes, in the **File Name** row, click on the folder icon to navigate to the directory containing the desired AVI file and select the file.

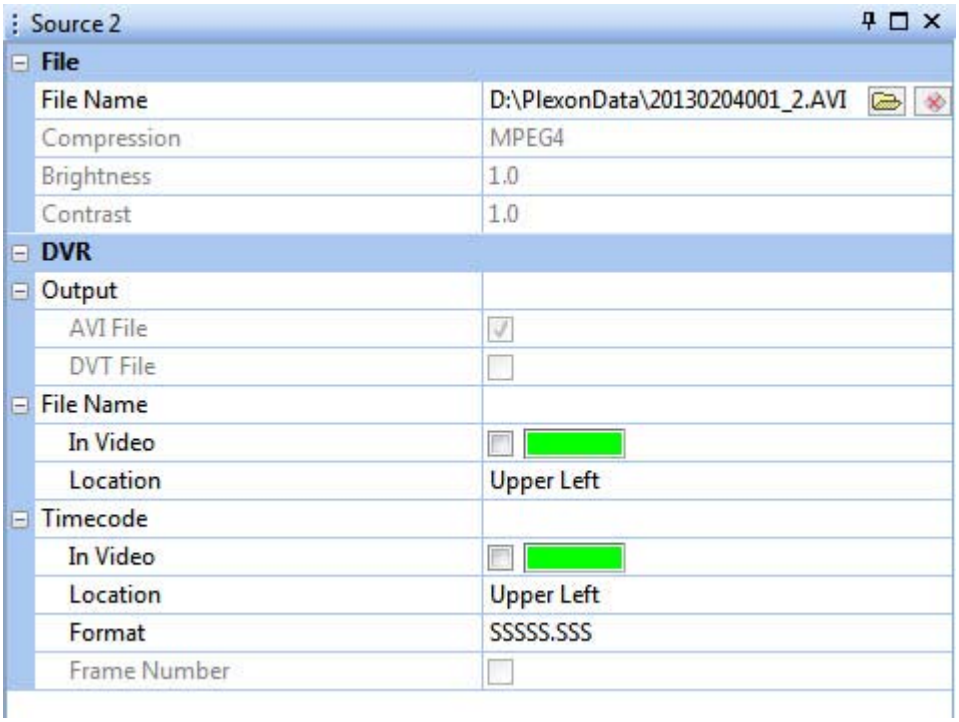
4 The options for file selection and video playback for multiple files are similar to those for a single file. (See To view files from a single camera on page 63.)

3.9.5 Rerecording AVI files in MPEG-4 Format

If you have AVI recordings that you wish to rerecord in the more efficient MPEG-4 format, follow the steps listed below.

The recording parameters are set in the Source pane. For example, the image below shows the Source frame for **File 2**, and the **File Name** is a file that was originally recorded with Camera 2.

Note: The **Compression** row in the Source pane displays the compression format of the existing file. When you create a new recording with the procedure below, the system will save the new recording in MPEG-4 format, which is highly efficient, thus minimizing storage space usage.



1 In the Source pane, you can set parameters that will cause the system to:

s Change brightness, contrast or other settings so that existing files are more usable

t Place the File Name and/or Timecode into the video frame that was not already done on the original run

2 In the Global Config pane, you can lower the **Quality** setting to further reduce file size and save storage space.

3 Start retracking of the existing video (with the new settings) by pressing the **Start recording from file** ( ) button in the main toolbar.

3.9.6 Summary of Offline Procedures

This section summarizes the use of the offline procedures.

1 Use CinePlex Studio to record one or more video files on an internal hard drive. If the Recording Folder has not been set, a notification message will display. See Section 3.4, “Recording Synchronized Video Tracking and Neural Data” on page 42.

2 The AVI and/or DVT files can be rerecorded on the host PC that is part of the CinePlex/OmniPlex System, or the files can be transferred to another computer for analysis computer. When finished copying the files to the analysis computer, rename the files, if desired.

The recommended system requirements for an offline analysis computer include a dual core Intel processor operating at better than 3 GHz with 3 GB of memory, and an NVIDIA® GeForce® 9600 GT or better video card. In addition, the appropriate Plexon license (see Section 1.6, “CinePlex Licensing Options” on page 5) must be plugged in to one of the USB ports. For a more detailed discussion of requirements, contact Plexon support at +1-214-369-4957 or support@plexon.com.

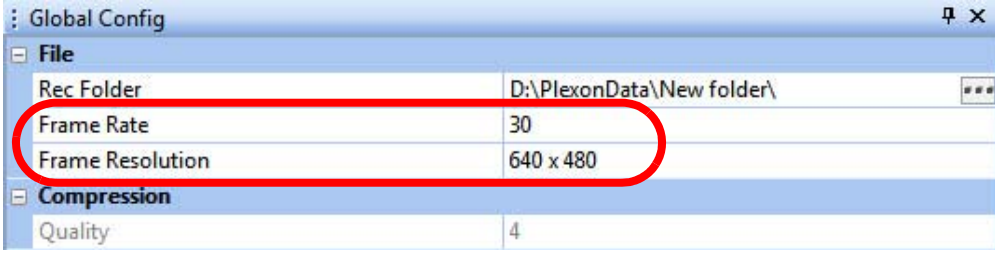
3 Extraction (see Chapter 7, Extractor Procedures).

3.9.7 Offline Functionality Compared to Online Functionality

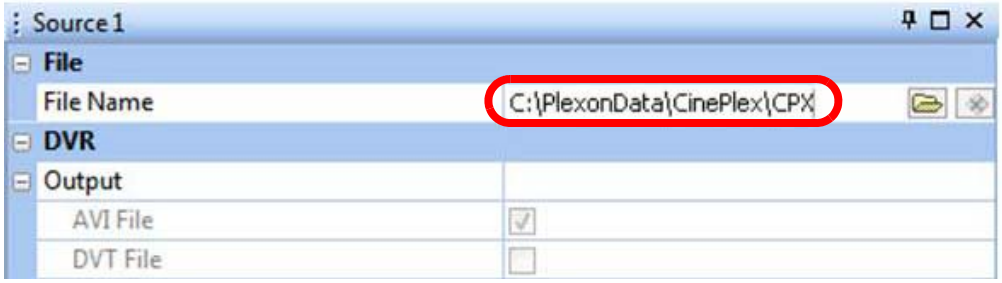
Most offline functionality is only marginally different from its online equivalent. The major exception is that the optional tracking and behavior functionality in a recorded file will be slightly different than the functionality for live video. This is because the compression techniques used to create AVI files of manageable size inherently discard some of the data that was present in the original, that is, there are losses that occur during compression. In particular, some color and brightness data might be slightly changed. Normally the differences are not visible to the naked eye, but they will cause slight differences in the sensitive algorithms used for tracking analysis (if the Tracking Option is installed).

Differences in the user interface are described below:

- Global Config pane - The frame rate and resolution shown are that of the source files selected. Other sections are unchanged.



- Source pane(s) - Most Camera adjustments are replaced with a file selection browsing tool. In their places are simple adjustments for brightness and contrast. Other sections are unchanged.



3.9.8 File Naming Procedure in Offline Mode

CinePlex Studio renames files during the retracking process. After you press the Start recording from file ( ) button, CinePlex Studio prompts for new file name(s), and you can accept the name as shown or enter a new name.

If there is only one file being retracked, the format of the prompted file name is filename-nn.avi,
where:

— filename is the original file name of the opened source file

— nn is a 2-digit number, 01, 02, ... 99 assigned automatically by the system for each new rerecorded file instance

for example:

filename-01.avi, filename-02.avi, filename-03.avi, ...

If there are multiple files being rerecorded, the format of the prompted file name is filenameN-nn.avi,
where:

— filenameN is the original file name for one of the opened source files

— nn is a 2-digit number, 01, 02, ... 99 assigned automatically by the system for each new rerecorded file instance

for example:

filename1-01.avi, filename1-02.avi, filename1-03.avi, ...
filename2-01.avi, filename2-02.avi, filename2-03.avi, ...

3.10 General Information on Video Formats, Synchronization and Timestamps

This section discusses technical aspects of video recording, including video file formats, synchronization and timestamps.

3.10.1 Reference Information - Digital Video Recorder AVI Files

The Digital Video Recording (DVR) feature of CinePlex Studio stores the video recording from one or more cameras on an internal hard drive. In most experiments, the user simultaneously collects a neural data file in an AVI file. With CinePlex Studio, you may start, stop, and timestamp these AVI files in a way that enables you to subsequently correlate them offline with the simultaneously-captured neural data.

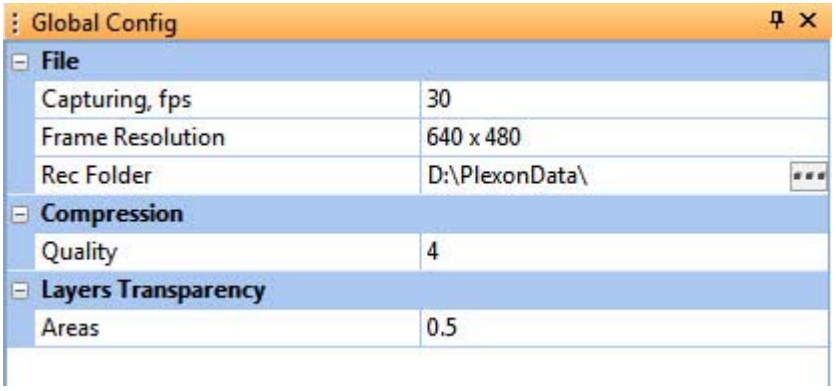
Note: If Studio is armed on one day, but the start signal is not received until the next day, the filename remains the one for the previous day.

CinePlex Studio records video into AVI files at a resolution of 640x480 pixels at up to 200 frames per second, which implies a raw data rate of over 700 GB/hour. To reduce disk usage, CinePlex Studio compresses the video using standard MPEG algorithms before it writes it to the AVI file. You can vary the file compression to find a suitable balance between AVI file size and image quality.

3.10.2 MPEG-4 Quality and File Size

MPEG-4 recording format is used because it produces files that are routinely 75 to 90% smaller than the equivalent MJPEG formatted files that were produced by earlier versions of CinePlex Studio.

The CinePlex System **Quality** settings for MPEG-4 range from 1 to 10. The values represent the nominal bit rate divided by 500,000. The default value of 4 is adequate for most experiments and Plexon recommends using that value unless there is a specific reason to modify it.



Note: If you increase the MPEG-4 **Quality** setting, for example, increasing it from 4 to 10, the size of the AVI file increases significantly (assuming the same recording duration), but it does not dramatically increase the quality of the image. Conversely, if you reduce the **Quality** setting, for example, from 4 to 2, the size of

the AVI file is reduced (for the same recording duration), however, the quality of the image degrades significantly.

3.10.3 MPEG Recording Processes

While it records, CinePlex Studio continually calculates and displays the amount of recording time left until the target hard drive would fill up. As the hard drive capacity is neared, CinePlex Studio stops recording.

The AVI files created by CinePlex Studio are industry-standard AVI-format files that you can play with many standard tools, including Microsoft Windows Media Player, which is pre-installed on most Windows computers. You can also use a variety of commercial software applications to edit and perform other operations on AVI files.

Note: Windows Media Player and other video players render files slower than real time if the files were recorded at 40 frames per second or greater. This can be confusing because the slider moves faster than the video plays such that the slider reaches the end of its travel before the video finishes playing.

The MPEG/AVI format allows the embedding of additional data segments within AVI files. Each embedded data segment has an identification tag. Typically, an AVI file reader that does not recognize a tag for an embedded data segment skips that data segment. CinePlex Studio always produces AVI files with a Plexon-specific additional tagged data segment that contains dynamic data, including the frame timestamp, for each video frame. CinePlex Editor can read this additional data segment in the AVI files generated by CinePlex Studio and thus recover the frame timestamp. Other AVI file readers like Windows Media Player ignore this data. This Plexon-specific nondestructive embedded data are not visible on the video frame. However, CinePlex Studio contains an optional feature that can overlay this timestamp in visible numerals on the video image itself; see Section 3.4, “Recording Synchronized Video Tracking and Neural Data” on page 42. CinePlex Editor software is installed separately from CinePlex Studio.

3.10.4 Synchronizing Files from Two Video Cameras

In some cases of synchronizing files from two video cameras, one file can be several frames longer than another due to minor software delays handling the Stop signal. The critical functionality is that the cameras start together and that triggers for corresponding frames occur at exactly the same time.

3.10.5 Synchronizing Video Files with Neural Data Files

To synchronize the video files with the neural data files, both systems must:

- derive all timestamps from the same clock
- start recording both files at the same time - use the same timestamp for relative time zero
- stop recordings at approximately the same time

The above conditions are met when CinePlex Studio is integrated with an OmniPlex System, because CinePlex Studio timing is locked onto and controlled from the main OmniPlex System clock. This ensures that the PLX and AVI files will have the same timing. Use of the same clock to generate the timestamps in each file avoids longer-term “drifting” of the time-base of one file relative to the other. For example, say the clock controlling the timestamp generation for video frames has a frequency difference of 1% from the clock controlling the timestamp generation of neural firing events in the neural data files; after 100 seconds, the occurrences that should appear as simultaneous in the neural data and AVI files appear instead as one second apart. Since CinePlex Studio is integrated with an OmniPlex System, synchronization occurs because CinePlex Studio is controlled with a clock signal derived from the main OmniPlex System clock. Thus, the PLX and AVI files are guaranteed to have the same time-base.

Note: The CinePlex Studio clock is 1 MHz. This means that the resolution of time-stamps generated by CinePlex Studio is 1 μsec.

When using CinePlex Studio with the OmniPlex System, the OmniPlex System generates control signals and routes the signals through the control cable to the appropriate inputs for CinePlex Studio. To use this mode of operation, *arm* CinePlex Studio to respond to the electrical control signals. When armed, CinePlex Studio starts recording the video file exactly one frametime after the start of the neural data file.

Note: CinePlex Studio resets the relative timestamp to zero when armed and recording is started by PlexControl or when clicking the Record button to manually start recording a video file. Otherwise the timestamps continue to increment until CinePlex Studio is shut down.

Chapter 4
Recording Positional Data with CinePlex Tracking Option

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4.1 Introduction to the CinePlex Tracking Option

This chapter describes the CinePlex® Studio Tracking Option, the experimental applications for which it can be used, and how to use it. The Tracking Option extends the capabilities of CinePlex Studio by enabling the computation and recording of positional data. The Tracking Option requires the CPT V3 license in addition to the CPX V3 (Studio/Editor) license.

The general procedure for using the Tracking Option is:

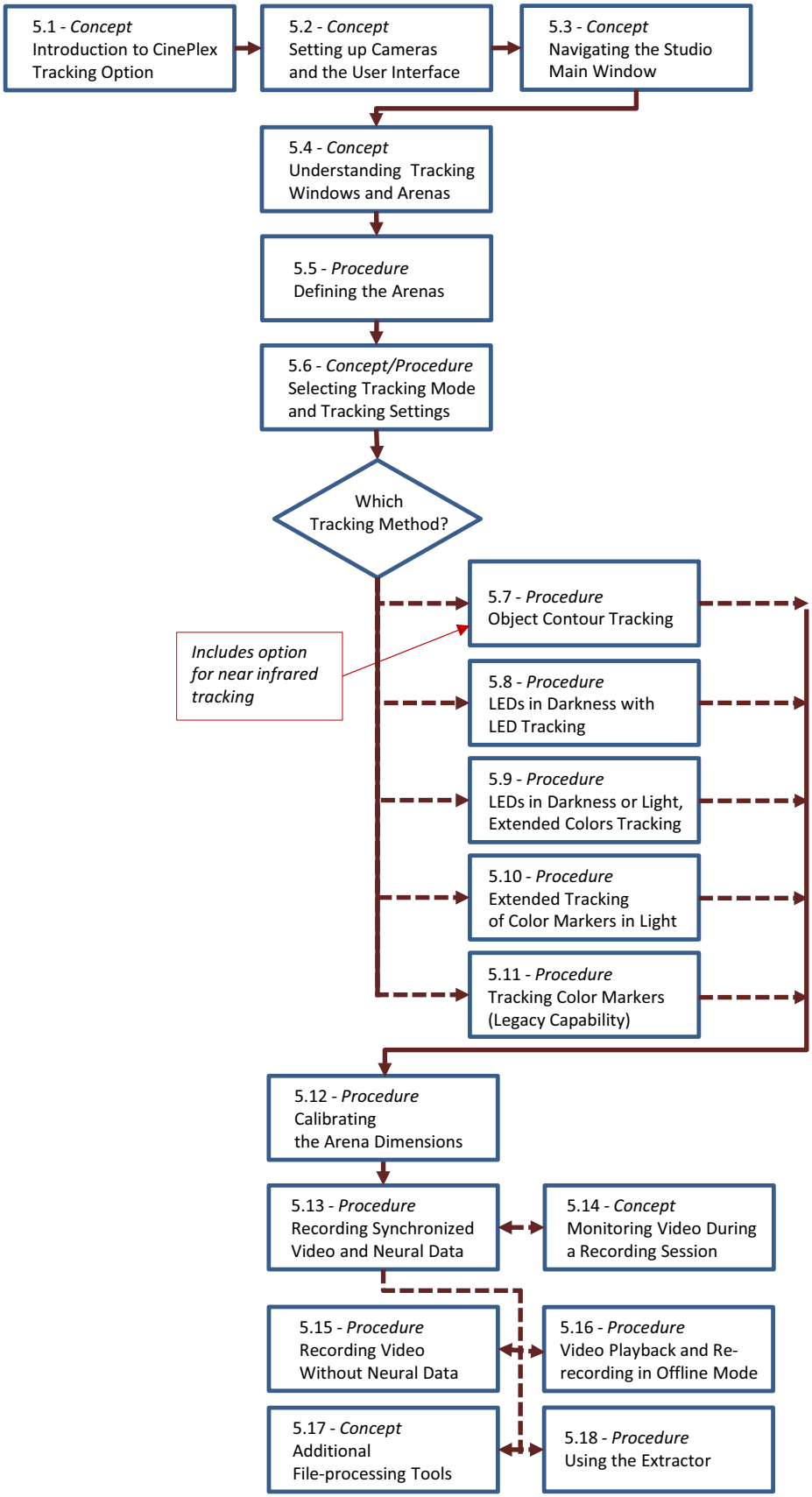
1. Position the camera(s) so that the desired physical experiment area is within the field of view of the camera
2. Define the shape of the arena for each camera
3. Select the tracking mode to be used - **Object Contour**, **LEDs**, **Color Markers**, or **Extended Tracking of Color Markers**
4. Set the parameters for the selected tracking mode
5. Perform a calibration of the dimensions in the arena
6. Set the location where the recorded files will be saved
7. Save the settings and layout
8. Synchronize the CinePlex and OmniPlex® Systems for recording
9. Start recording from the OmniPlex System
10. Stop recording at the OmniPlex System
11. If desired, retrack coordinate data in CinePlex Studio offline mode
12. If desired, rerecord synchronized files with CinePlex Editor (installed separately)

You can configure CinePlex Studio to capture video only (Audio Video Interleaved [AVI] files), track positions only (digital video tracking [DVT] files), capture video and track positions simultaneously, or create no files.

The tracking function can also be used in offline mode with existing pre-recorded files. In offline mode the tracking parameters can be set to values that are different than those used during the original recording, if any, and the system will retrack the video based on the new settings (see Section 4.16, “Video Playback In Files (Offline) Mode” on page 137).

The CinePlex Studio default window layout will be sufficient for most instances. However, to load, change or save a window layout, see Appendix D-Navigating the Plexon User Interface.

Use the flowchart below to choose the concepts and procedures in this chapter that apply to your experiment.


5.1 - *Concept*
Introduction to CinePlex Tracking Option
5.2 - *Concept*
Setting up Cameras and the User Interface
5.3 - *Concept*
Navigating the Studio Main Window
5.4 - *Concept*
Understanding Tracking Windows and Arenas
5.5 - *Procedure*
Defining the Arenas
5.6 - *Concept/Procedure*
Selecting Tracking Mode and Tracking Settings
Which Tracking Method?
Includes option for near infrared tracking
5.7 - *Procedure*
Object Contour Tracking
5.8 - *Procedure*
LEDs in Darkness with LED Tracking
5.9 - *Procedure*
LEDs in Darkness or Light, Extended Colors Tracking
5.10 - *Procedure*
Extended Tracking of Color Markers in Light
5.11 - *Procedure*
Tracking Color Markers (Legacy Capability)
5.12 - *Procedure*
Calibrating the Arena Dimensions
5.13 - *Procedure*
Recording Synchronized Video and Neural Data
5.14 - *Concept*
Monitoring Video During a Recording Session
5.15 - *Procedure*
Recording Video Without Neural Data
5.16 - *Procedure*
Video Playback and Re-recording in Offline Mode
5.17 - *Concept*
Additional File-processing Tools
5.18 - *Procedure*
Using the Extractor

4.2 Setting Up Cameras and the User Interface

The procedures for setting up cameras and the user interface are the same as those used for the Tracking Option. See Chapter 3, Recording Video with CinePlex Studio.

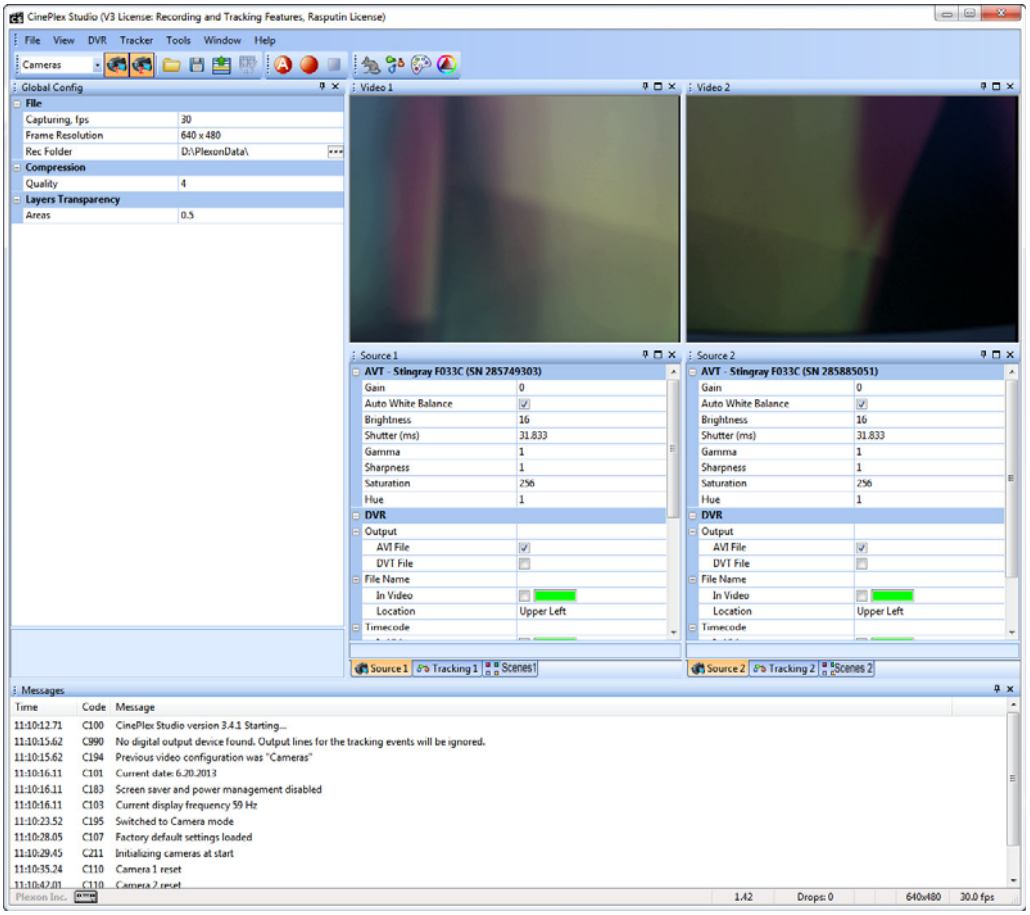
CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

4.3 Navigating the Studio Main Window

See the section Section 3.2, “Navigating the Studio Main Window” on page 29 for a basic description of the Studio main window, where you can view and modify CinePlex Studio settings before starting the recording session.

When the Tracking Option is present, there are additional toolbar options and panes, as shown in the image below.



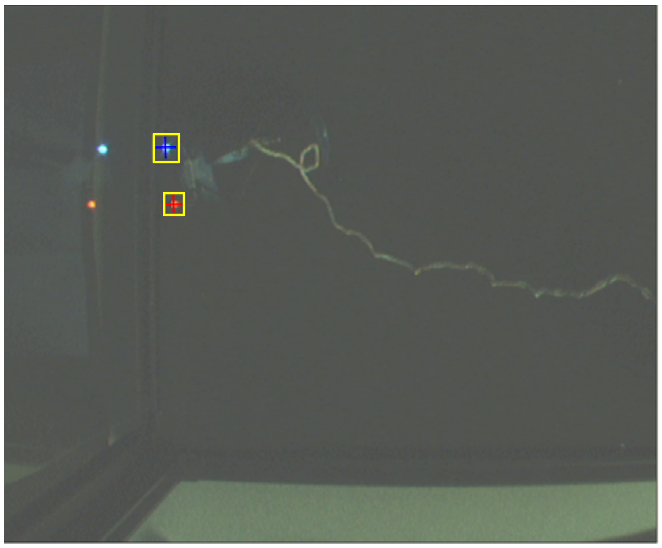
4.4 Understanding Tracking Windows and Arenas

This section explains how the CinePlex Studio software manages the video processing load by using system-generated **tracking windows** and user-defined **arenas**.

4.4.1 System-generated Tracking Windows

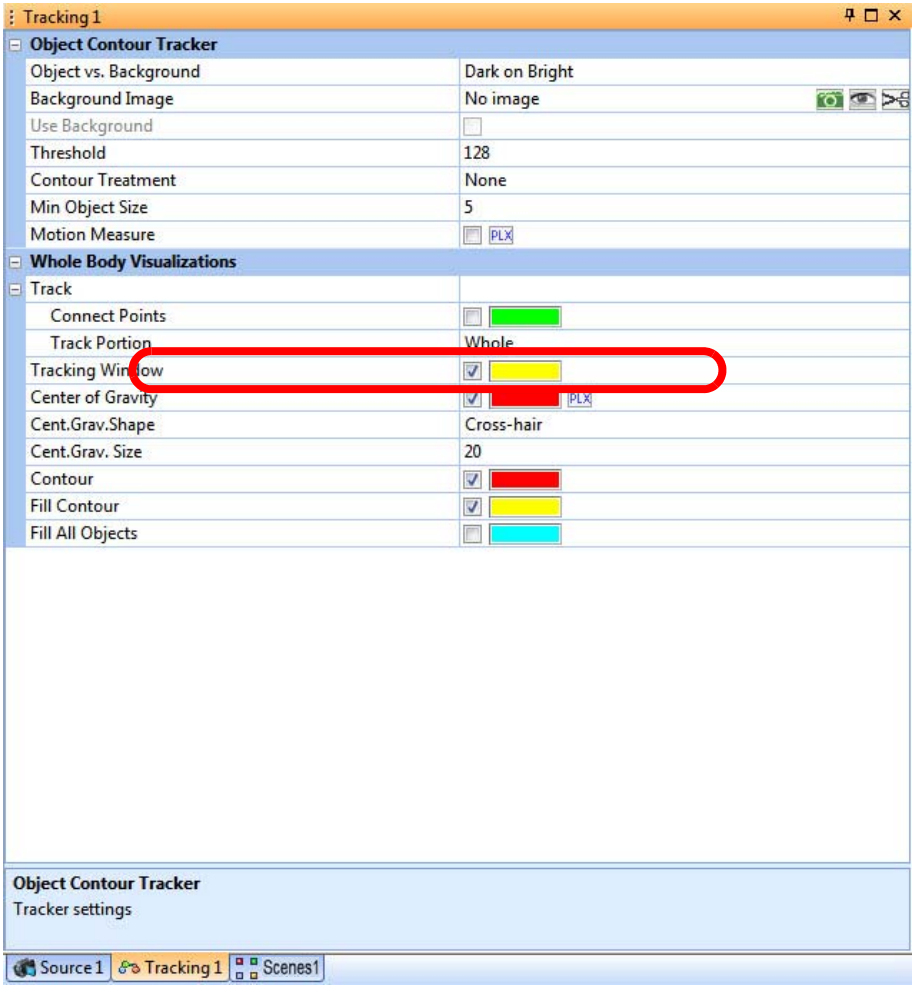
The system generates tracking windows to limit the processing and analysis of video data to a small portion of the video image, typically to the body contour of the animal or the color markers or LEDs mounted on the animal. This reduces the overall CPU load and allows tracking more colors. Tracking windows also reduce problems with unwanted parasite objects (for example, reflections).

Tracking windows are displayed as yellow rectangles in the video display, as shown in the image below



Tracking windows can be made to appear by selecting the Tracking Window checkbox in the Visualization area of the Tracking pane, as shown in the image below.

Note: In Object Contour mode, the area will be labeled Whole Body Visualization. In LED mode, it is labeled LED Visualization, and in Color Markers mode it is Marker Visualization.



The system automatically sets the size of the tracking window to cover the whole object. Each object (whole animal, LED, or marker) has its own tracking window. The tracking window is repositioned automatically. A history of an object's movement is used to predict its next position. If the object disappears because of occlusion by a cable or other means, its tracking window is moved according to the speed and movement direction in its most recently detected frames. If the system is tracking multiple LEDs or markers in single animal mode, the system will also use the positions of the found LEDs or markers to predict the position of the one that disappeared. If the object is not found after a certain number of frames, the size of the tracking window will be increased. If the object is not found within two seconds, the system switches to search in the whole frame (or within the arena, if an arena shape has been defined).

4.4.2 User-defined Arenas

You can define an arena for each camera image. Arenas reduce problems with unwanted reflections and parasite objects outside of the working area.

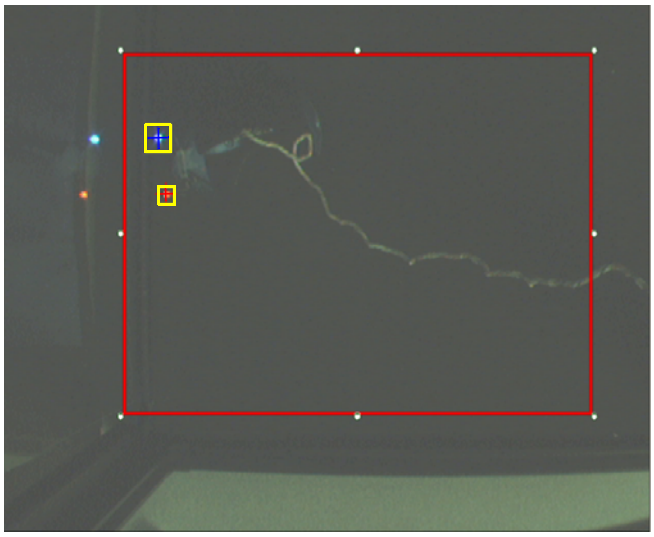
For accurate tracking, you should ensure that the ratio of the object size to the arena size is such that the system will be able to track the object. If the ratio is too

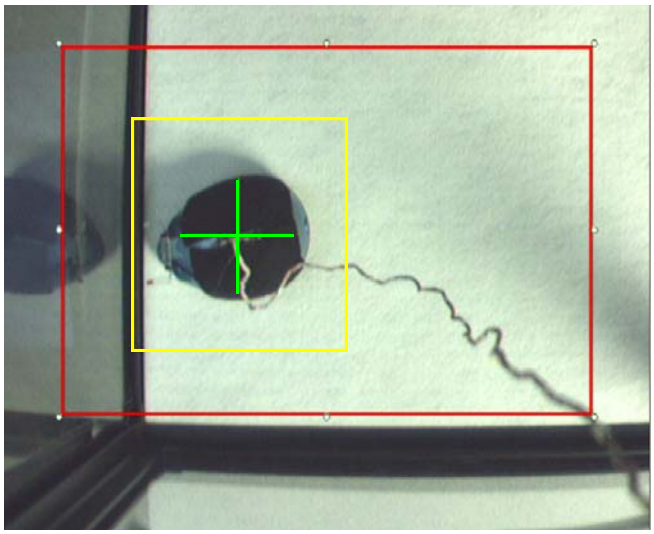
small (image size of the object less than a few pixels) the system will not be able to distinguish the object from noise. If the ratio is too large (more than 1/4 of the video image) the system will not track the object.

Using the tools provided by CinePlex Studio and the Tracking Option, you can draw an outline of the experimental arena over the video image. Once this outline is drawn, Studio ignores objects outside of the arena when processing the images. This results in lower CPU usage and reduces false object detections due to reflections and shadows. It also allows the experimenter to exclude areas of the image that have no relevance to the experiment. Arena tools allow drawing circles, ellipses, rectangles, and freehand objects. Arena logical operations (AND, OR, NOT, XOR) allow combining multiple arena shapes to produce a single complex arena shape.

Example - Using Arenas to Exclude Reflections

The following drawings show two examples of arenas (red rectangles) - one for LED tracking mode and one for Object Contour tracking mode. In each case, the reflections outside the arena are ignored by the CinePlex System.

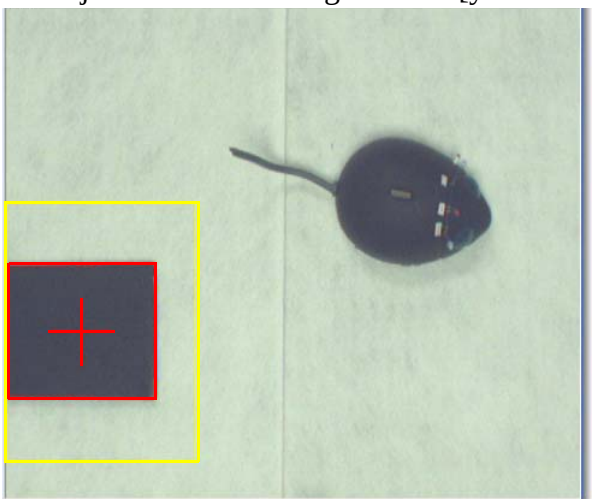




Example - Using Arenas to Exclude Background Objects or Colors

If a background object (or background color) might interfere with the tracking function, the object (or color) can be removed from the arena. This will allow the system to track the animal correctly.

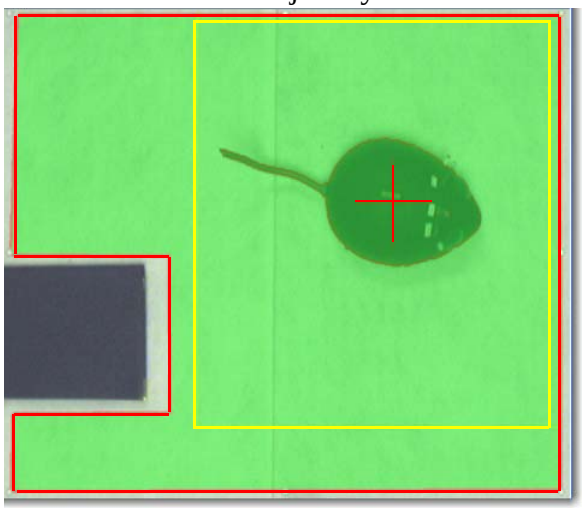
This image shows an animal to be tracked along with a background object of approximately the same color. The background object is larger than the animal and the system is tracking the background object (the red cross hair is centered on the object and the tracking window [yellow rectangle] is surrounding the object).



To avoid this situation, the experimenter can use one or both of the following tools:

- Define a specific arena shape in which to track
- Use background subtraction (discussed elsewhere in this chapter)

This image shows a defined arena (in green) that the system will use to track the animal. The arena excludes the background object, therefore the system will never lock onto the object by mistake.



Modifying Arenas In Offline Mode

If you transfer an AVI file to an offline analysis computer on which CinePlex Studio is installed, that file can be retracked with new or changed arenas.

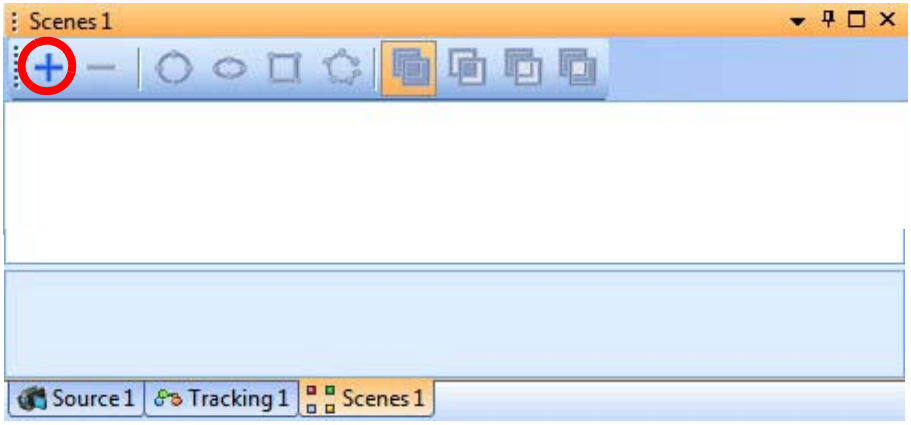
> **Note:** The standalone analysis computer must have minimum memory, processor and instruction set to run CinePlex Studio efficiently. The requirements for the computer are summarized in Section 1.13.2, “Processing and Analyzing Data” on page 14.

4.5 Defining the Arenas

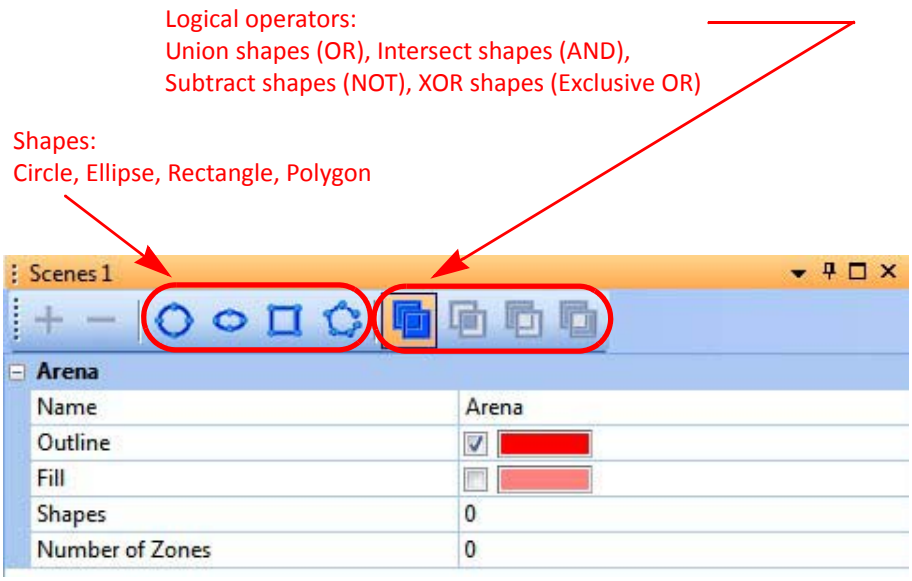
This section explains how to define an arena for each camera, beginning with Camera 1. One arena is allowed per camera.

Adding the Arena for Camera 1

1 In the Scenes tab for Camera 1, click the **Add arena (+)** button.



A Scenes settings pane is displayed, and the toolbar now displays active icons for shapes and logical operators.



Note: If additional CinePlex System options (for example, Basic Behavior Option and/or 3D Option) are installed, the window might contain additional tabs and toolbar icons. This chapter focuses only on the Tracking Option.

2 One or more shapes can be added to the arena. To draw a shape, click the desired shape on the toolbar (**Circle**, **Ellipse**, **Rectangle**, or **Polygon**). For a circle, ellipse or rectangle, left-click and hold the mouse on a desired point on the image and move the mouse to size the arena.

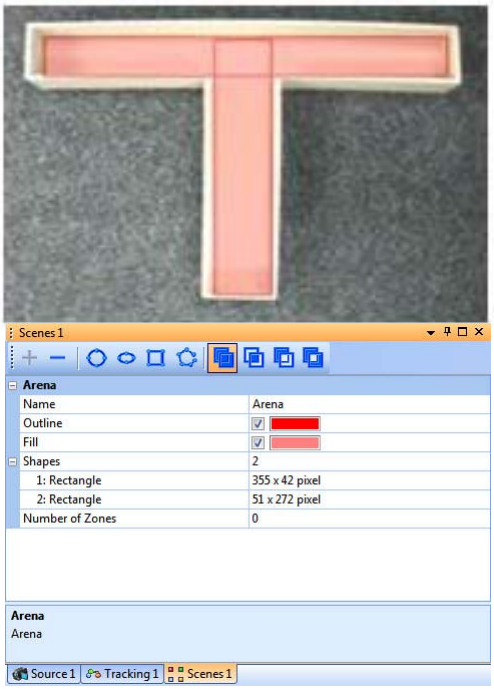
Note: For a freehand polygon, click the left mouse button over desired points that will be the nodes of the polygon, and use a right-click to close the polygon. The shape can be moved or resized by left-clicking and dragging.

3 Multiple shapes can be drawn and logically combined to create an arena with a complex shape. After the first shape is drawn, draw a second shape as follows:

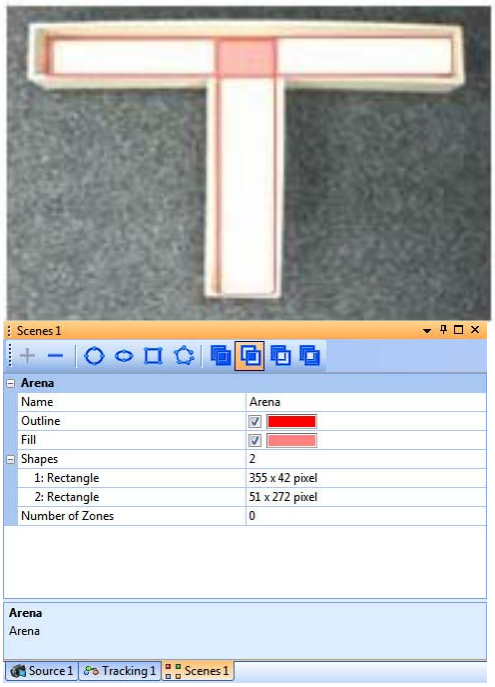
- Click on the **logical operator** that will combine the first and second shape.
- Then click on the icon for the second shape and draw the second shape.
- To view the combined shape more clearly, click on the **Fill** checkbox to select it.

The images below show examples of combined arena shapes. Tracking will only occur in the shaded regions.

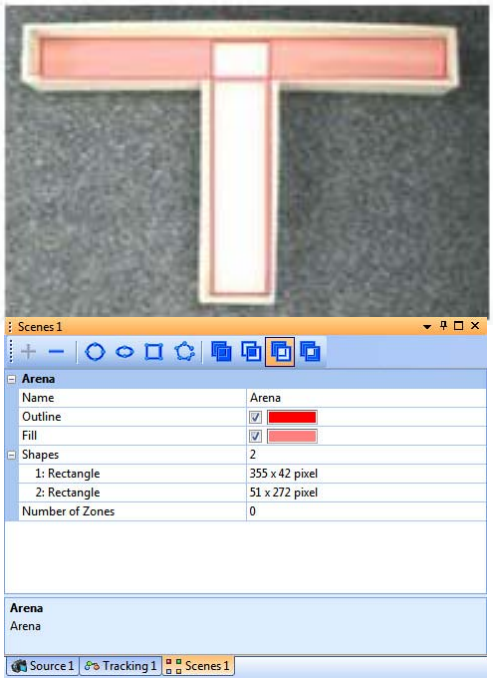
Union shapes



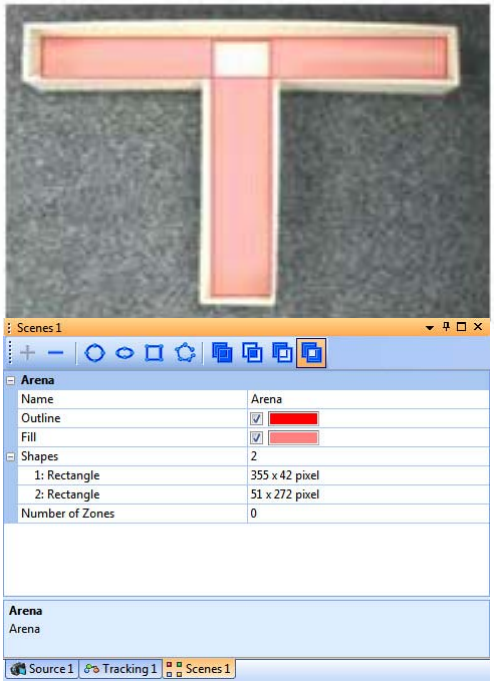
Intersect shapes



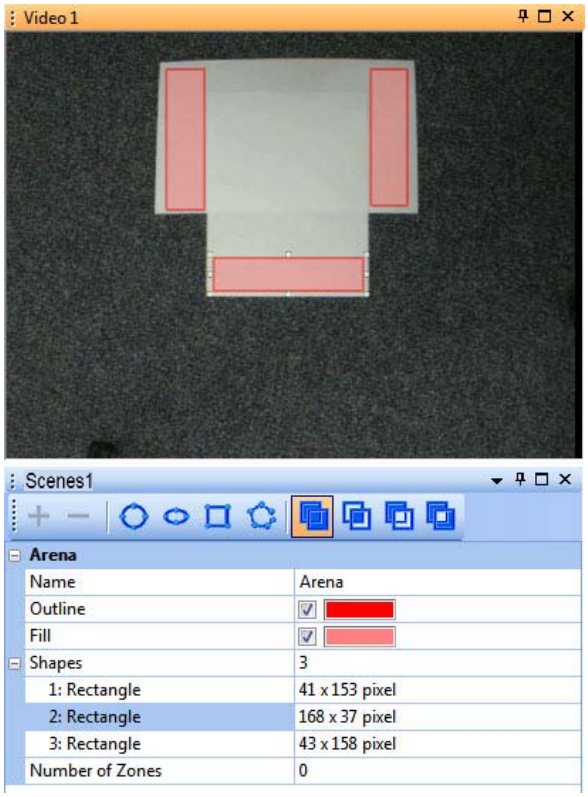
Subtract shapes



XOR shapes

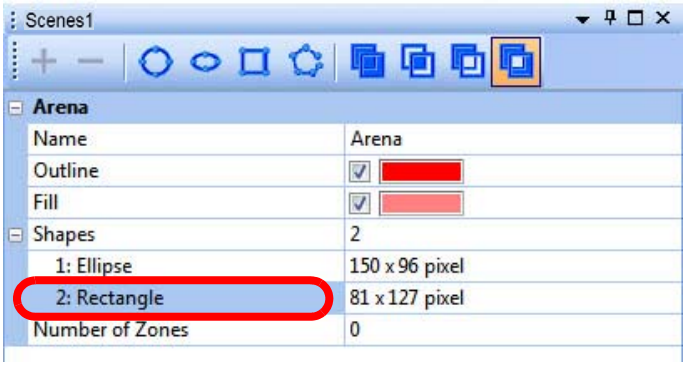


Arenas drawn from several shapes do not need to be contiguous (as was the case in the examples above). The image below shows an arena that contains noncontiguous shapes. Tracking will only occur in the shaded regions.



4 If desired, use the logical operator and shape icons multiple times to add and join several shapes to accurately define the arena.

5 To delete a shape, select the desired shape in the Arena pane (or in the Video pane) and press the **Delete** key on the computer keyboard. In the images below note that the rectangle is selected for deletion.



Adding Arenas for Additional Camera(s)

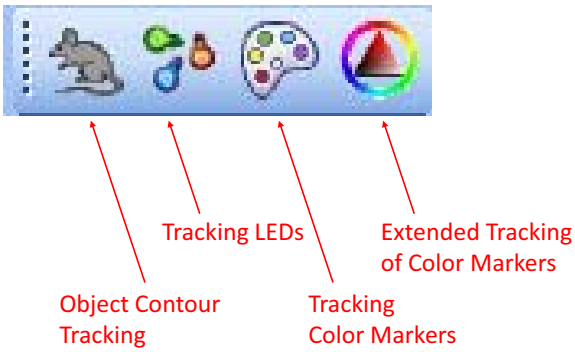
6 Repeat Step 1 through Step 5 for any additional camera(s) to be used in the experiment.

4.6 Selecting the Tracking Mode and Tracking Settings

This section assists you in selecting the tracking mode to use for the experiment. It also explains the purpose of two of the settings common to all tracking modes: **Threshold** and **PLX** buttons.

4.6.1 Tracker Toolbar

The Tracker toolbar (shown below) allows you to select the desired tracking mode.When one of the tracking modes is selected, the system tracks the position of subject(s) in the video images, in real time, and delivers the tracked position coordinates to the OmniPlex® System.



4.6.2 Understanding the Tracking Mode Options

The tracking modes are listed below.

Note: Only one tracking mode can be active at a time. Tracking modes cannot be combined.

- **Object Contour Tracking**: In this mode, CinePlex Studio analyzes the image to find a whole-body shape that corresponds to the desired object, and then computes (and tracks) the center of gravity of the shape.
- **Tracking LEDs**: In this mode, CinePlex Studio tracks up to three light emitting diodes (LEDs) on the subject or subjects being tracked.
- **Tracking Color Markers**: This mode of tracking is retained primarily for legacy purposes, for experimenters who have been using this mode and wish to continue doing so. It can be used in experiments requiring a small number of distinct reflective colors (typically up to five colors in a typical arena) with good lighting. It is possible to track more than 5 colors, but only if the arena lighting is sufficient.

TIP
Extended Tracking of Color Markers
For new experiments, Plexon strongly recommends using the **Extended Tracking of Color Markers** mode rather than the Color Markers tracking mode.

- **Extended Tracking of Color Markers**: This is the recommended mode of color markers tracking for most applications. In this mode, CinePlex Studio tracks up to 12 reflective colors (tape or paint, for example) on the subject or subjects being tracked. The actual number of trackable colors depends on the colors themselves, their relative sizes, and the lighting within the arena.

4.6.3 Guidelines for Selecting the Tracking Mode

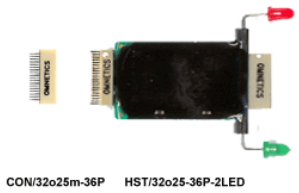
This section assists you in selecting the tracking mode to use for the experiment, and optimizing tracking parameters to suit the needs of the experiment.

The table below provides an overview of the recommended tracking mode to use under various conditions.

Tracking Device to be Used on the Animal	Are LEDs the Brightest Spots in Arena?	Recommended Tracking Mode to Use
No LEDs. No colored markers	Not Applicable	Object Contour
LEDs	Yes	LED or Extended Tracking of Color Markers
LEDs	No	Extended Tracking of Color Markers
Colored markers	Not Applicable	Extended Tracking of Color Markers

In general, for a given experimental setup, only one tracking mode is optimal. The following guidelines help to determine which tracking mode to use.

- In general, the best tracking results occur when light-emitting diodes (LEDs) are attached to the animal. This is due to:
  - The relatively small size of the objects being tracked
  - The high intensity of colors against a dark or partially lit background
- The easiest way to use LEDs is to mount them directly on the animal headstage. Plexon offers headstages with LEDs mounted on them, such as the headstage shown in this drawing.



CON/32o25m-36P HST/32o25-36P-2LED

- To track not only position but head direction, use two or three LEDs.
- For LED tracking, the system finds the brightest spots on the image, and determines their positions in the color space. LED tracking mode is

recommended when LEDs are to be tracked, and they are the brightest spots on the image and the rest of the image is dark. Check the Pure Colors option to cause the system to recognize Plexon standard red, green, and blue LED colors automatically. Otherwise, select the colors to track.

- Object Contour Mode can only track the “center of gravity” of one animal’s contour, therefore, Object Contour mode cannot be used with LEDs or multiple animals.
- If the experiment requires Motion Measure, which can be used for studies of freezing behavior, use Object Contour mode.
- If the animals are multicolored, especially with high-contrast colors (for example, Long Evans rats), Object Contour mode works best with a contrasting background color, such as red.
- Object Contour mode is more sensitive to changes in background and lighting conditions compared to the other tracking modes.
- In general, more effort is required to configure Object Contour mode to obtain optimal tracking results than is required for either LED or Extended Reflective Colors modes. This is because slight variations in background and lighting can cause the animal’s contour to vary slightly, even if the animal is not moving.

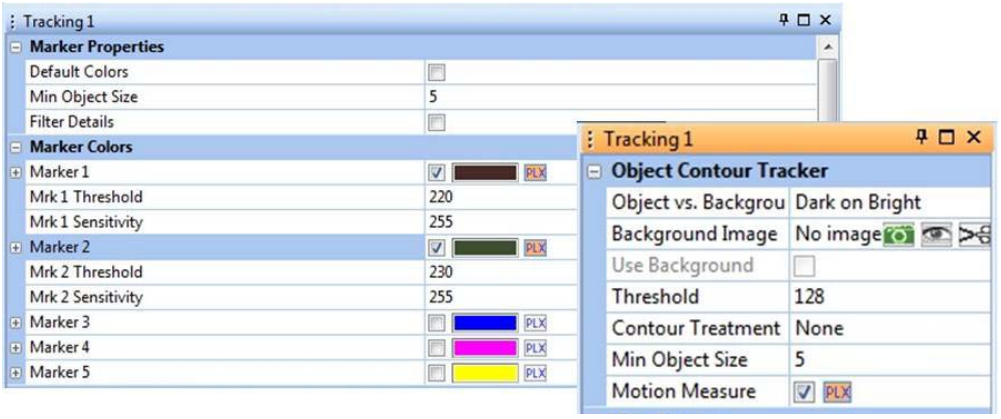
4.6.4 Understanding the Threshold Setting

All tracking modes have a user-configurable Threshold parameter that is used in the calculation the system performs to locate and track an object. The result of the calculation depends on [1] the contrast between the tracked object and the background, and [2] the Threshold value set by the user. For a general understanding of how the Threshold value affects tracking, see Section 4.7.2, “Setting the Threshold” on page 94. That section presents the Threshold concept from the point of view of Object Contour tracking mode, but the discussion applies to all tracking modes.

4.6.5 Sending Tracking Data to the OmniPlex System

The system stores tracking data on the host computer in AVI and/or DVT files, as specified by the user. In addition, you can specify that the tracking data (X, Y coordinates as a function of time) from Camera 1 be sent to the OmniPlex System. The OmniPlex System incorporates this tracking data into the PLX files, which also contain the neural data. The procedure for sending tracking data from CinePlex Studio to the OmniPlex System is included in the recording procedure, Section 4.13, “Recording Synchronized Video Tracking and Neural Data” on page 128.

To configure CinePlex Studio to send tracking data to the OmniPlex System, click the appropriate **PLX** button(s) for Camera 1 in the CinePlex Studio configuration pane. The diagram below shows an example of **PLX** buttons. When a **PLX** button is selected, it turns orange; when it is not selected, it is clear.



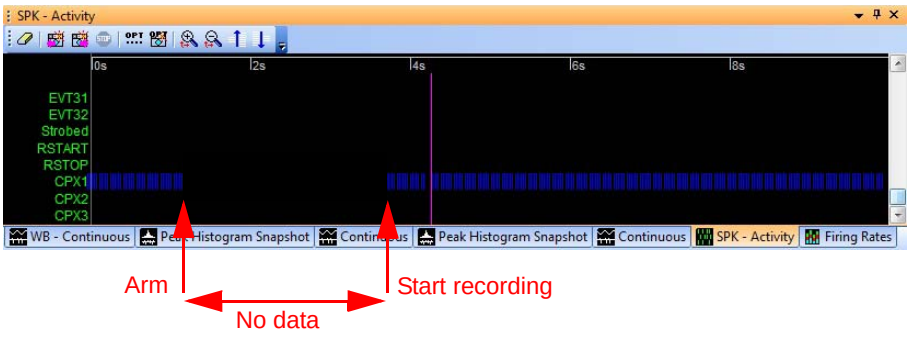
The following conditions apply to the process of sending tracking data from CinePlex Studio to the OmniPlex System:

- Data can be sent for Camera 1 only.
- Data can be sent in online (“Cameras”) mode only, not in offline (“Files”) mode.
- Data can be sent for up to three LEDs or colored markers. (Only three of the PLX buttons can be active simultaneously.)

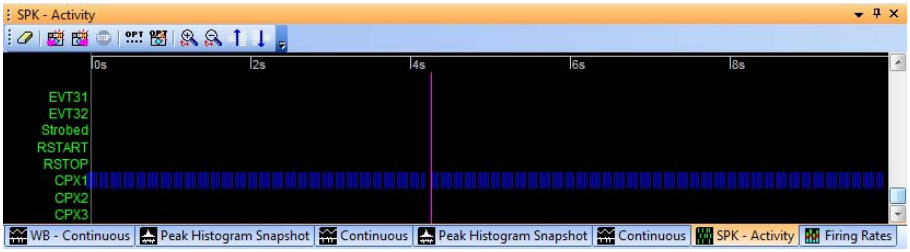
The procedure for sending data is as follows:

1. Start the OmniPlex Server and PlexControl.
2. Start data acquisition in the OmniPlex System by pressing the **Start Recording** button on the PlexControl toolbar. (This step also causes the OmniPlex System to begin sending timing signals to CinePlex Studio. Without this step, CinePlex Studio cannot send data to the OmniPlex System.)
3. Start CinePlex Studio.
4. Verify that “Cameras” is selected in the CinePlex Studio pulldown menu and that a camera image is displayed for Camera 1. (It is acceptable if other camera video images are also displayed, but Camera 1 is required.)
5. In CinePlex Studio, load a settings file that contains tracking, or configure tracking. Ensure that at least one **PLX** button is pressed.
6. Arm CinePlex Studio (press the “**A**” arming button in the Studio toolbar).

   Note: At this point, there is no tracking data being sent from CinePlex Studio to the OmniPlex System. In the armed condition, CinePlex Studio is waiting for a start signal to be sent from the OmniPlex System. The **SPK - Activity** pane in PlexControl shows no data on the CPX1 line.



7 Start recording by pressing the **Start Recording** button in PlexControl (Studio recording starts also). Studio starts sending the coordinate data to the OmniPlex System, and the **SPK - Activity** pane in PlexControl shows the synchronized data stream (see the blue data lines in the image below). Scroll to the bottom of the Activity window to show the CPX1 data row.



8 Stop recording by pressing the Stop Recording button in PlexControl (Studio recording stops also.)

Note: At this point, there is no tracking data being sent from CinePlex Studio to the OmniPlex System, because Studio is once again in the armed condition. The **SPK - Activity** pane in PlexControl shows no data on the CPX1 line.

9 You can start and stop recording as many times as desired. When recording starts, tracking data will flow from CinePlex Studio to the OmniPlex System. When recording stops, tracking data will not flow.

10 If you disarm CinePlex Studio (by clicking the "**A**" arming button), tracking data will flow again from CinePlex Studio to the OmniPlex System.

Note: Plexon recommends a short test recording to verify the data stream is being sent. The **SPK - Activity** pane in PlexControl should show the

presence of the data stream, similar to that shown in the PlexControl image above.

TIP

Tracking Data - Add it in real-time or add it later

If the **PLX** button for the desired tracking data is pressed before the start of recording, as explained in the procedure above, CinePlex Studio sends the tracking data to the OmniPlex System in real-time.

If you forget to press a particular **PLX** button before starting recording, or want to press different **PLX** button(s) later, CinePlex Editor can be used to replay the PLX and AVI files, and overlay the coordinate data. (CinePlex Editor is installed separately.)

4.6.6 Tracking Parameters - List of Configuration Procedures

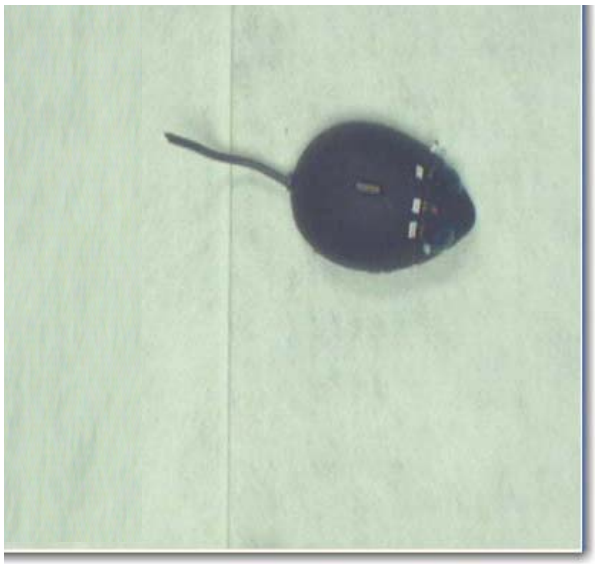
The following sections contain procedures that configure the tracking parameters for specific experimental applications. Select the appropriate procedure for your experiment:

- Section 4.7, “Object Contour Tracking” on page 91
- Section 4.8, “LEDs In Darkness with LED Tracking” on page 106
- Section 4.9, “LEDs In Darkness or Light with Extended Tracking of Color Markers Mode” on page 110
- Section 4.10, “Extended Tracking of Color Markers In Light” on page 112
- Section 4.11, “Tracking Color Markers (Legacy Capability)” on page 121

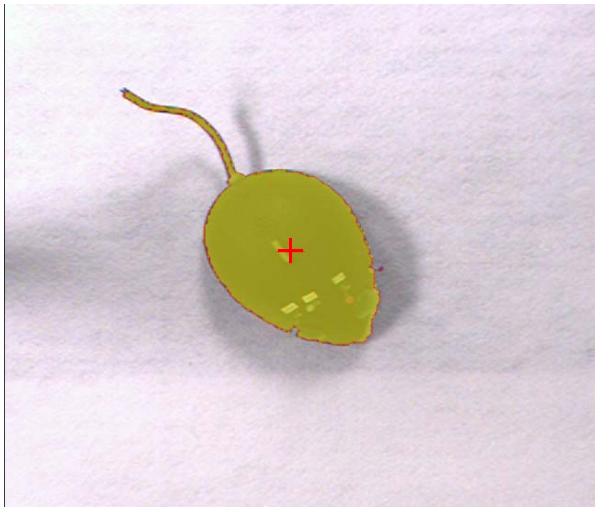
4.7 Object Contour Tracking

Object Contour tracking records coordinate data for the movement of an animal within an experimental arena without requiring LEDs or reflective color markers to be attached to the animal.

In Object Contour tracking mode, the system compares the color of the animal with the background color and any background objects. The image below shows a dark colored animal to be tracked on a light colored background and without any background object in the window. The background’s light color is uniform and provides a good contrast to the animal’s color.



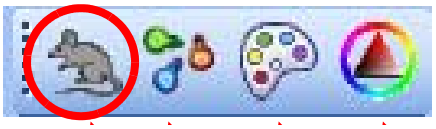
The image below shows an example of a well defined animal contour generated by CinePlex Studio.



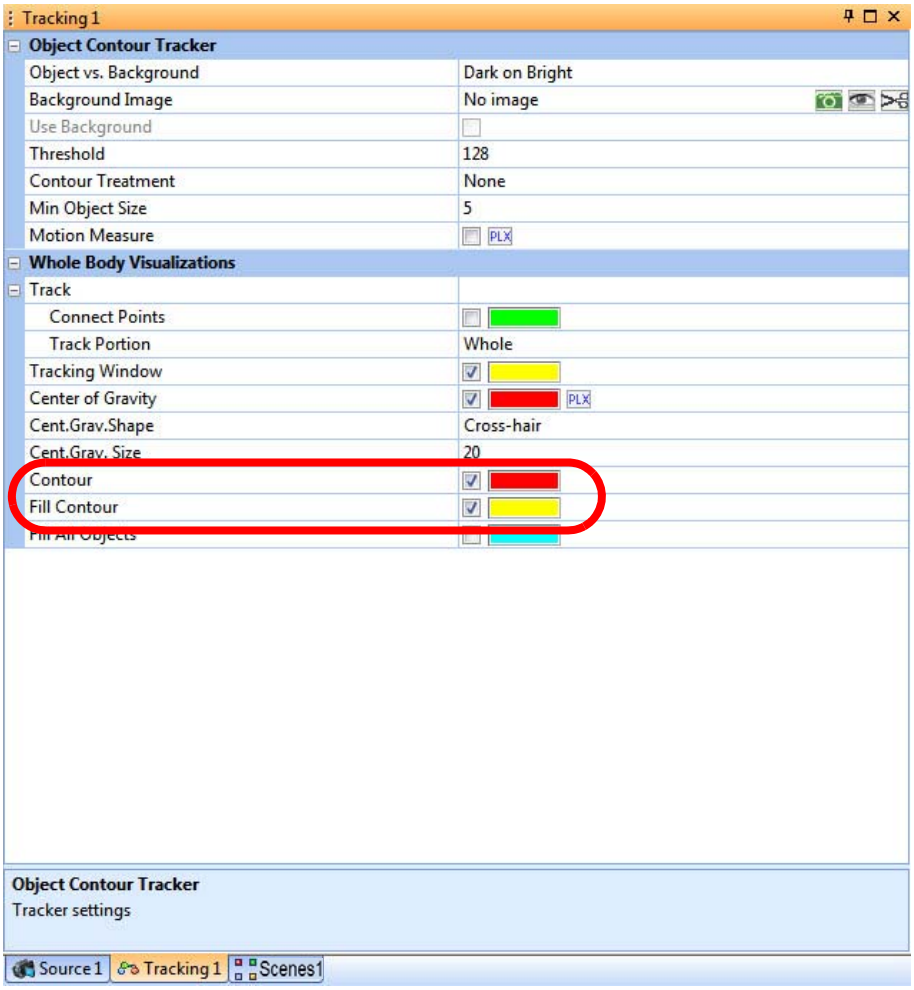
4.7.1 Configuring Parameters for Object Contour Tracking

Perform these steps to select and configure Object Contour tracking.

1. Place the animal in the camera field of view.
2. At the camera lens, adjust the zoom, focus, and iris settings for the best picture quality. For additional guidance on camera setup and video quality, see Section 3.1, “Setting Up Cameras and the User Interface” on page 26.
3. To select the Object Contour tracking mode, click the appropriate icon on the Tracker toolbar.



4. Click the Tracking tab to display the tracking parameters. In the **Whole Body Visualization** group check **Contour** and **Fill Contour** so that the objects found by the system are visible.

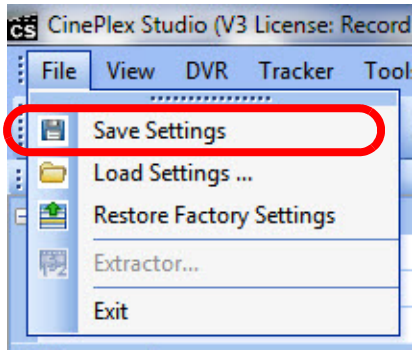


5. In the video image, view the contour(s) of the object(s) that the system is tracking. If the contour of the tracked object is not well defined, follow the

instructions in one or both of the following sections to obtain good tracking results:

- Section 4.7.2, “Setting the Threshold” on page 94
- Section 4.7.3, “Object Contour Mode Advanced Functions - Overview” on page 96

6 (Optional) After the Tracking parameters are set as desired, click the **Save Settings** button ( ) on the toolbar, or, on the **File** dropdown menu, click **Save Settings**:

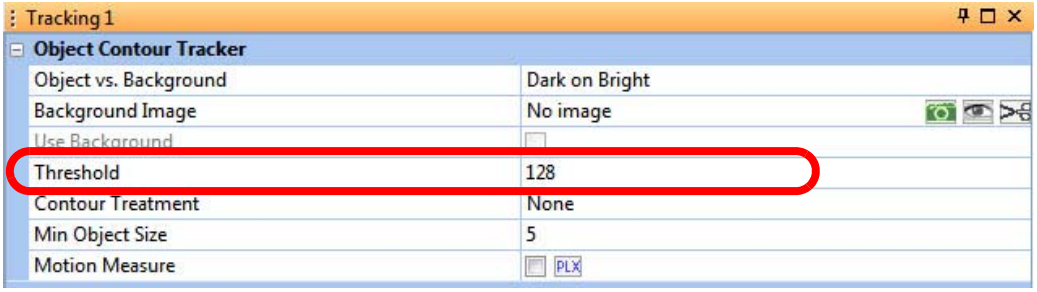


4.7.2 Setting the Threshold

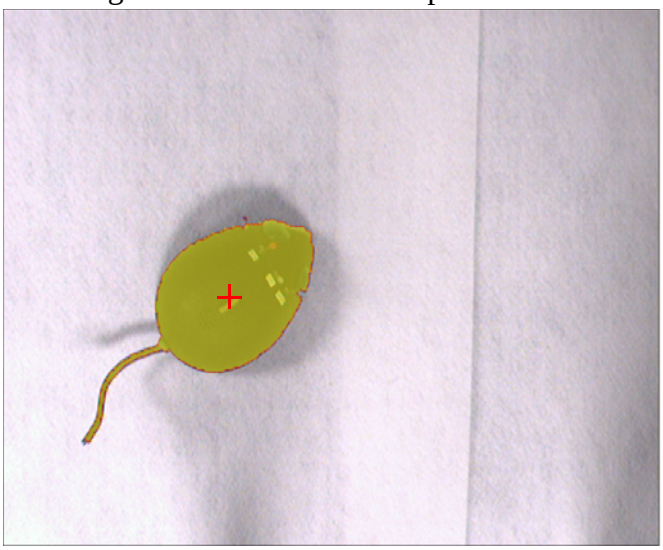
CinePlex Studio can locate an object of a specified color by the color contrast between the desired color and the threshold setting. If the animal has good contrast relative to the arena image, and the background is uniform (that is, there are no other objects with similar contrast), adjust the **Threshold** setting in the Object Contour Tracker area to fill the whole image of the animal.

Note: If the background is not uniform or does not have good contrast with the animal, setting the **Threshold** parameter might not be sufficient for tracking. If this condition exists, perform the procedure in Section 4.7.5, “Background Subtraction” on page 99 to remove the background from the video.

The Threshold is set in the **Object Contour Tracker** group.

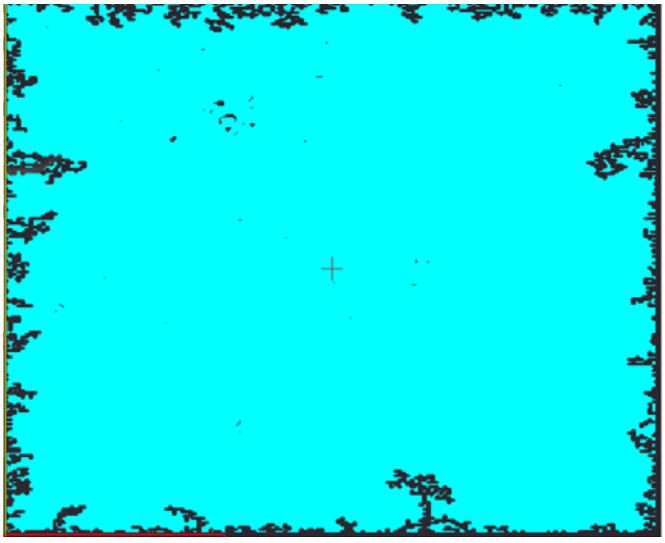


The image below shows an example of a well defined animal contour.



Use the guidelines below to adjust the **Threshold** setting.

If the threshold setting is too low, the image could be similar to the one shown below. It will probably be necessary to experiment with the setting to obtain the optimal value.



If the size of the found target object is larger than 1/4 of the frame area, there will be a red blinking message on the bottom of the screen notifying that the threshold is probably too low and both the Arm and Record buttons will be disabled.

(Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

4.7.3 Object Contour Mode Advanced Functions - Overview

For some experimental arrangements, adjusting the **Threshold** setting is not, by itself, sufficient to obtain the desired tracking results. Additional adjustments may be needed. Object Contour mode includes optional advanced functions to handle special circumstances in the experimental environment. These functions are accessed in the Tracking pane.

Use one or more of the following procedures to improve tracking:

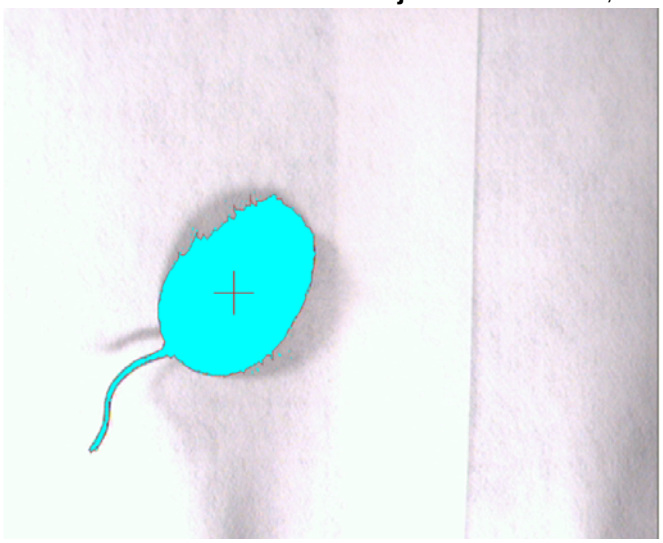
- Section 4.7.4, “Detail Filtering Adjustment” on page 97
- Section 4.7.5, “Background Subtraction” on page 99
- Section 4.7.6, “Close Contour Option” on page 103
- Section 4.7.7, “Motion Measure Option” on page 105

4.7.4 Detail Filtering Adjustment

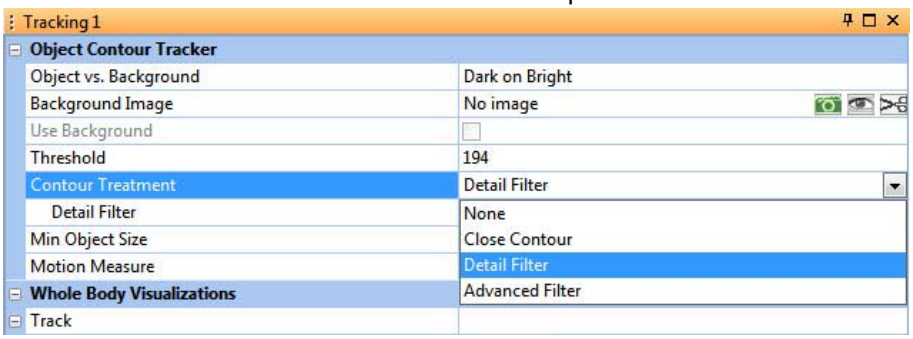
Use Detail Filtering to remove small features of the image that distort the tracking results. For example, a long tail on a target animal can skew the centroid calculation; cables attached to the target can also skew the results. The Detail Filtering adjustment parameter, which has a range of 1 - 10, can remove progressively larger features. Use the lowest setting that provides adequate results for the experiment.

To set the Detail Filtering Adjustment value

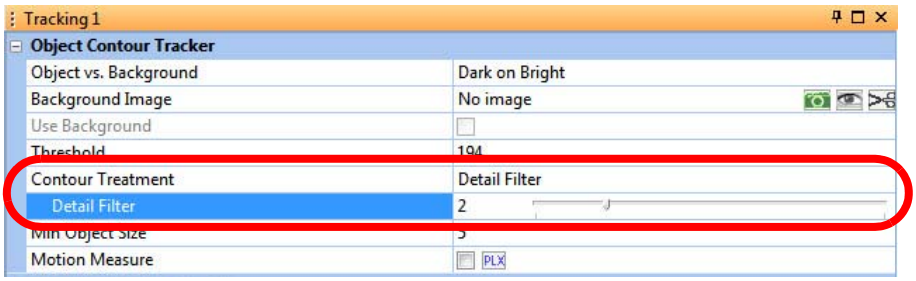
1 In the Properties window **Object Contour Tracker** area, click **Show Contour**, **Fill Contour** and/or **Find All Objects** checkboxes, and view the video image.



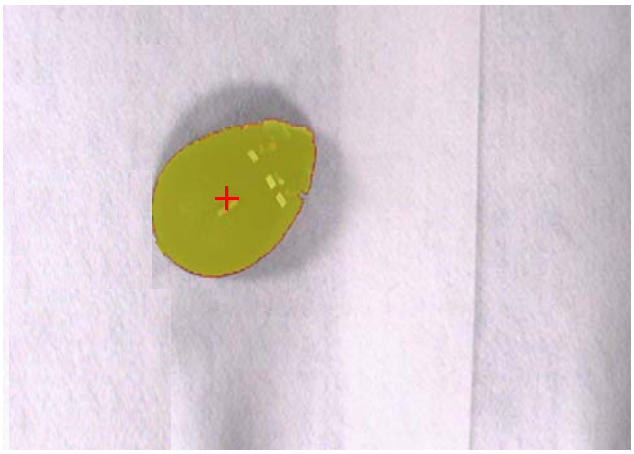
2 Select **Detail Filter** in the **Contour Treatment** pulldown menu.



3 Click **Detail Filter** and set the slider to **2**.



4 Observe the effect on the image. Set the **Detail Filter** slider to lowest setting that removes the undesirable features from the target image.

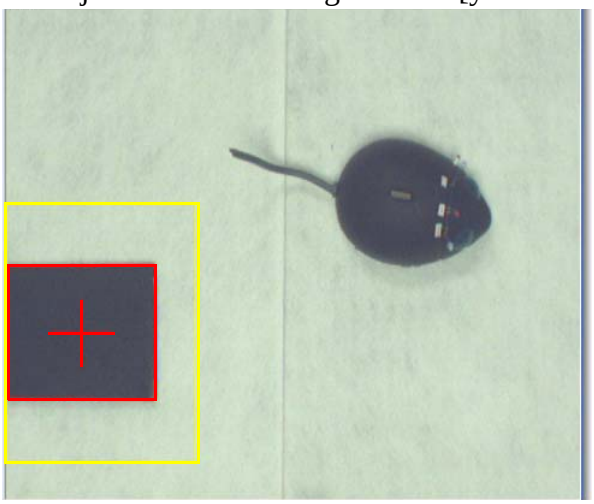


5 (Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

4.7.5 Background Subtraction

If a background object (or background color) might interfere with the tracking function, the system can be configured to ignore the object (or colored area). This will allow the system to track the animal correctly.

This image shows an animal to be tracked along with a background object of approximately the same color. The background object is larger than the animal and the system is tracking the background object (the red cross hair is centered on the object and the tracking window [yellow rectangle] is surrounding the object).

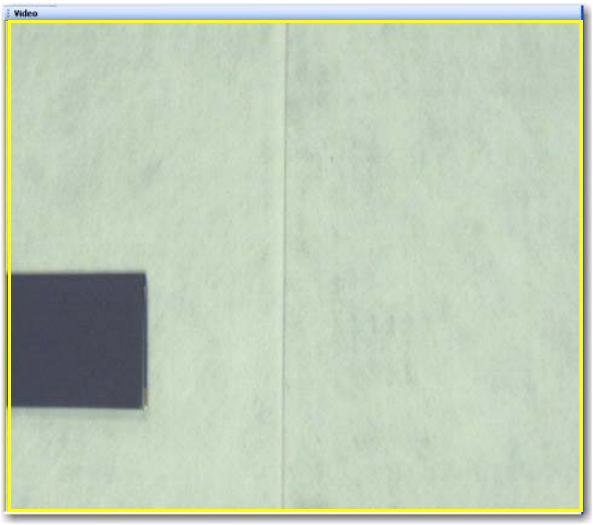


To avoid this situation, the experimenter can use one or both of the following tools:

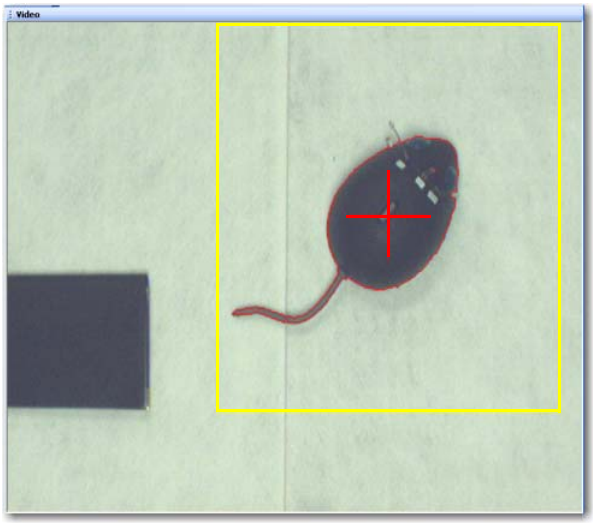
- Use background subtraction (discussed in this section)
- Define a specific arena shape in which to track (discussed elsewhere in this chapter)

Example - Using Background Subtraction to Exclude Background Objects

This image shows the background object with nothing else in the window. You can capture the image of this window to use for background subtraction.

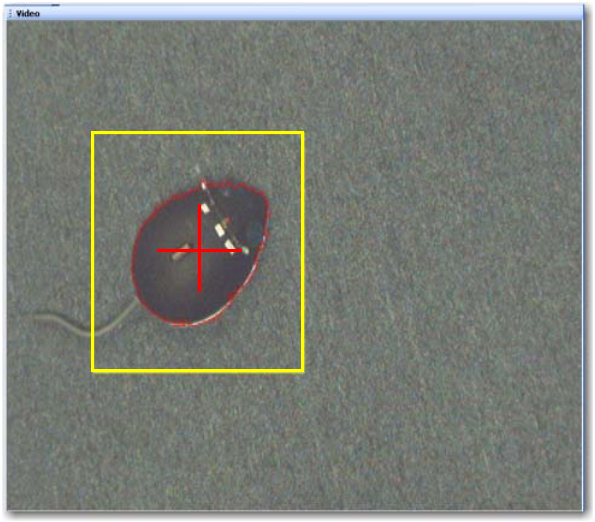


This image shows the background object and the animal together after the user has configured the background subtraction function. Note that the system is tracking the animal, as indicated by the positions of the red cross hair and yellow rectangle and the contour around the animal.



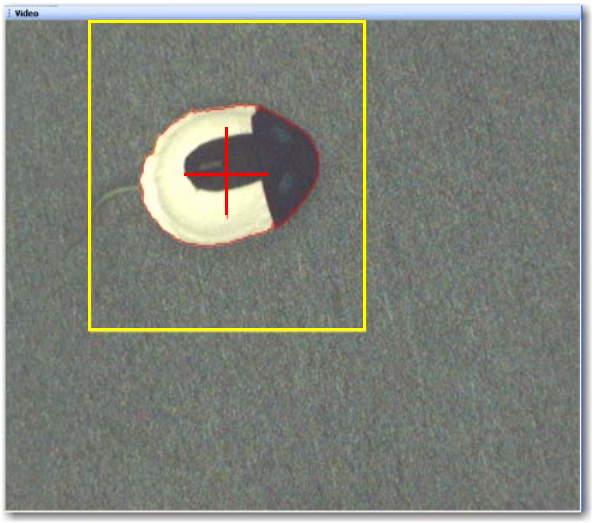
Example - Using Background Subtraction to Exclude a Low-Contrast Background Color

Background subtraction will allow you to do body tracking even when there is a low color contrast between the animal and background, a condition which is seen in the following image.



Example - Using Background Subtraction with a Multicolored Animal

You will be able to track multicolored animals using Plexon's special algorithm of background subtraction. In this case be sure that all colors contrast with the background color. You can use different background colors to try to improve the quality. For example, a brick red background works well for Long-Evans rats. Note that the contour encloses the complete animal



To apply the Background Subtraction option

1. In the Object Contour Tracker area, ensure that the **Contour** and **Fill Contour** checkboxes are selected (so the object contour can be viewed in the Video pane later in this procedure).
2. Remove the animal from the tracking area.
3. Capture background image by clicking the **Camera** icon. The **Use Background** control will activate so that it may be clicked.

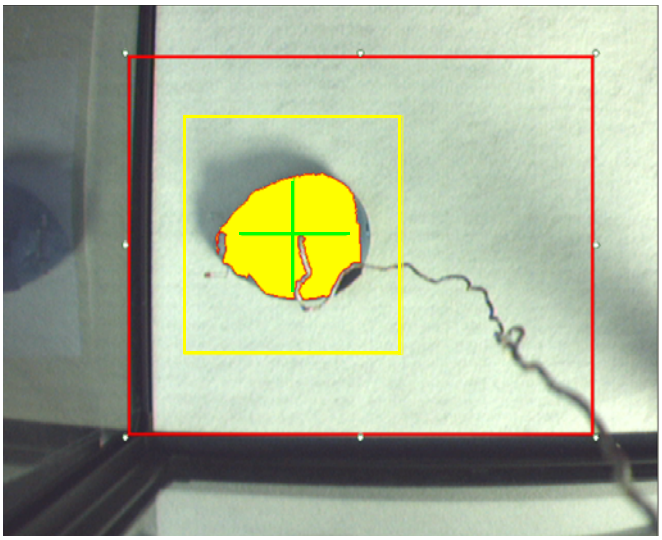
4. Check the **Use Background** checkbox (see diagram above). Checking this box configures the system to subtract the background image from the video.

   Note: Pressing the eye icon brings up a window containing the latest background image. Pressing the scissors icon deletes the latest background image.

5. Replace the animal in the tracking area.
6. Adjust the Threshold (see diagram above) so the animal is detected and the animal's outline is filled in the Video pane (see Section 4.7.2, "Setting the Threshold" on page 94).
7. (Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

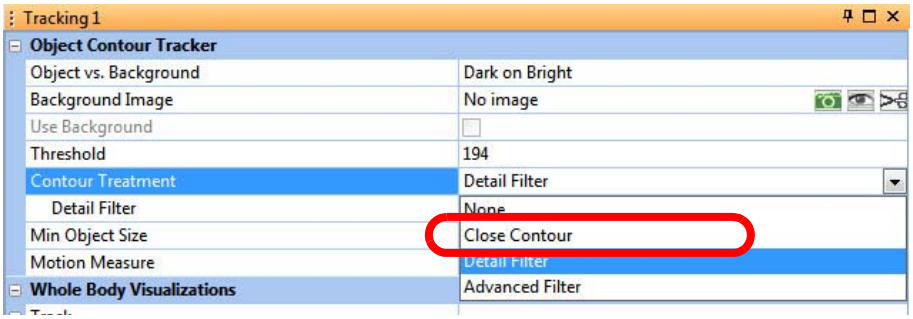
4.7.6 Close Contour Option

The Close Contour capability causes the tracker to merge multiple objects in near proximity to each other into a single object. This can occur, for example, when a cable passes between the animal and the camera. Adjust the setting so that a single object is displayed. The image below is taken before the Close Contour setting is applied.

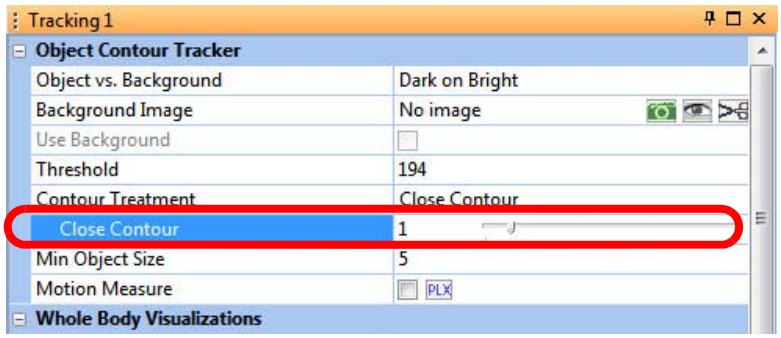


To apply the Close Contour option

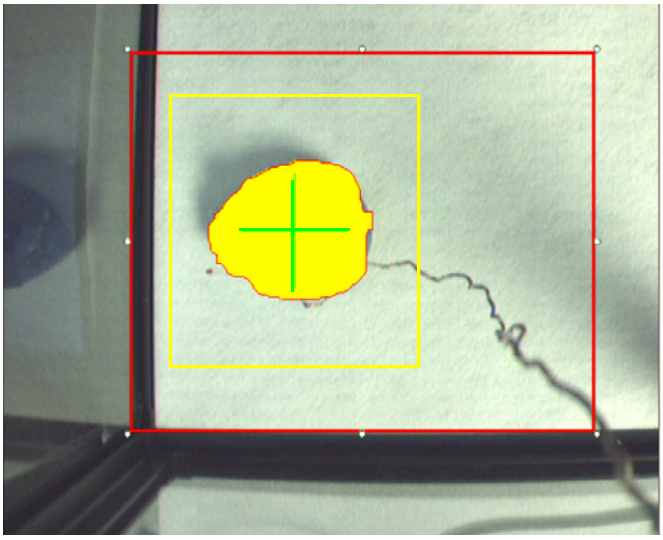
1 Select **Close Contour** in the **Contour Treatment** pulldown menu.



2 Adjust the **Close Contour** setting until the image contour is closed.



The image below is taken after the **Close Contour** setting is applied.



3 (Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

4.7.7 Motion Measure Option

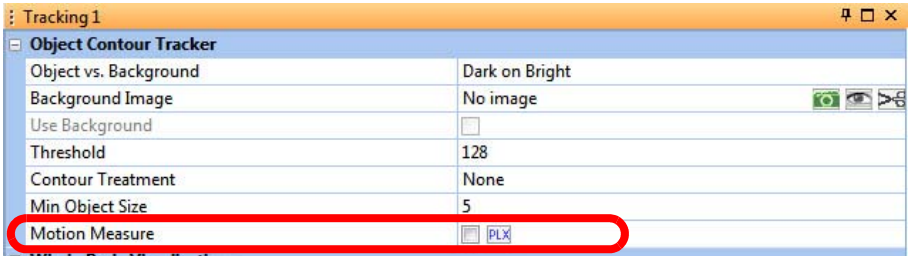
CinePlex Studio Motion Measure is an Object Contour mode option that can be used for studies of an animal's freezing behavior. Motion Measure is the normalized contour difference of the animal's body computed on a frame-by-frame basis.

Note: The Motion Measure option must be included during a CinePlex Studio recording or re-recording session if you plan to analyze the data with the CinePlex Editor Freezing Detector function. See the CinePlex Editor User Guide for information about the Freezing Detector.

If the Motion Measure checkbox is selected, CinePlex Studio writes the motion-measurement data for each video frame to the AVI and DVT files. If the **PLX** button beside the Motion Measure checkbox is selected, Studio also writes the data to the OmniPlex System.

To apply the Motion Measure option

1. On the **Object Contour Tracker** menu, double-click the **Motion Measure** checkbox to enable Motion Measure.

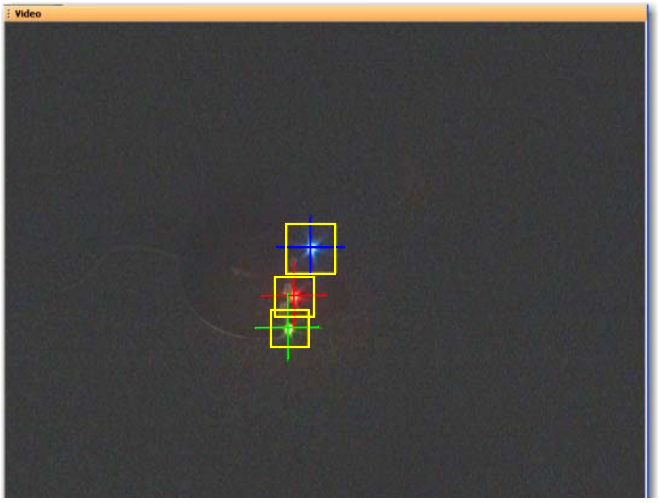


2. Click on the **PLX** button, if desired, to write Motion Measure data to the OmniPlex System. (The **PLX** button turns orange when selected.)
3. (Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

4.8 LEDs In Darkness with LED Tracking

This section configures CinePlex Studio to track colored LEDs in darkness with the LED tracking mode selected. Up to three different colored LEDs can be tracked.

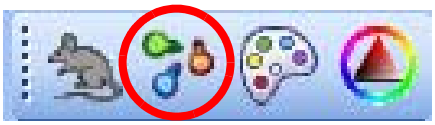
In darkness, the LEDs are the brightest spots in the window, therefore, the LED tracking mode is excellent for this condition. The image below shows three LEDs being tracked in darkness.



4.8.1 Configuring Parameters for LED Tracking

Perform these steps to select and configure LED tracking.

1. Place powered LEDs in the camera field of view.
2. At the camera lens, adjust the zoom, focus, and iris settings for the best picture quality. For additional guidance on camera setup and video quality, see Section 3.1, “Setting Up Cameras and the User Interface” on page 26.
3. To select the LED tracking mode, click the appropriate icon on the Tracker toolbar.

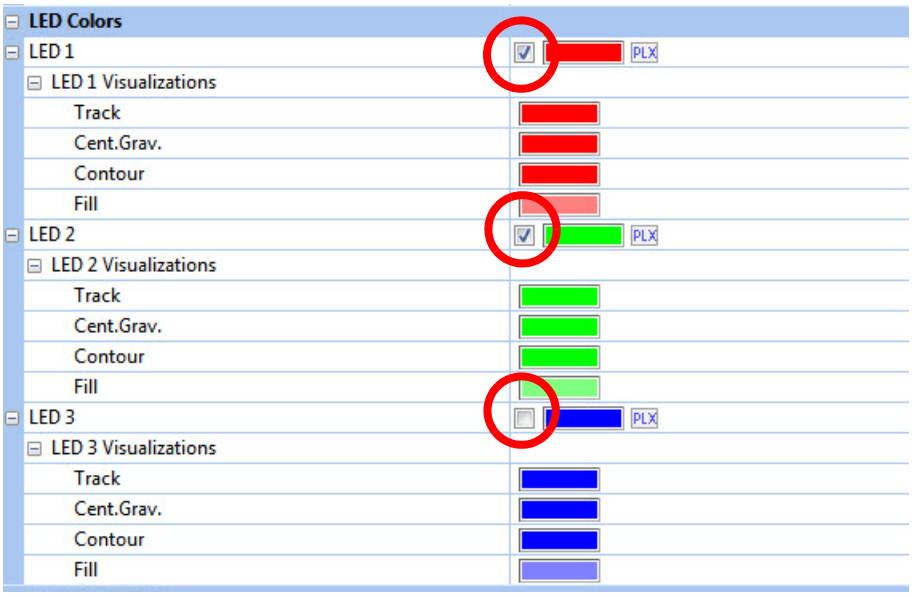


4. Click on the Tracking tab in the Dynamic Configuration pane to view the Tracking parameters.
5. In the **LED Visualization** group check **Contour** and **Fill Contour** so that the objects found by the system are visible. These selections are common to all LEDs used in the experiment.

6 Check the **Pure Colors** checkbox in the LED Tracker area. Checking this box causes the standard red, green and blue LED colors to appear in the **LED Colors** area in the Tracking configuration pane.

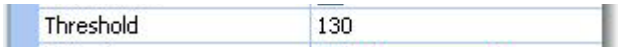
Note: In **Pure Colors** mode, software is optimized for the red, green and/or blue LEDs supplied by Plexon.

7 Check each color to track in the LED properties area (LED 1, LED 2 and/or LED 3).



8 For each color checked in Step 7, check the **PLX** button, if desired, to send a copy of the tracking coordinate data to the OmniPlex System. (The **PLX** button turns orange when selected and clear when deselected.)

9 Change the **Threshold** (common to all LEDs) so that the correct objects are filled and outlined on the Video window. Their color crosses (representing the centers of gravity) should be centered on the correct objects.



10 If pure colors do not give good results, use the pick-up tool to select the color from the video (see "Using the Color Pick-up Tool with LED Tracking" below). Adjust the **Threshold** as needed.

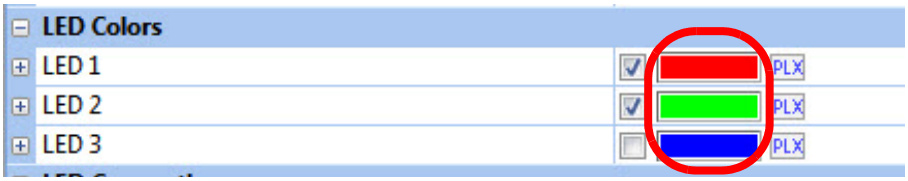
11 (Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

4.8.2 Using the Color Pick-up Tool with LED Tracking

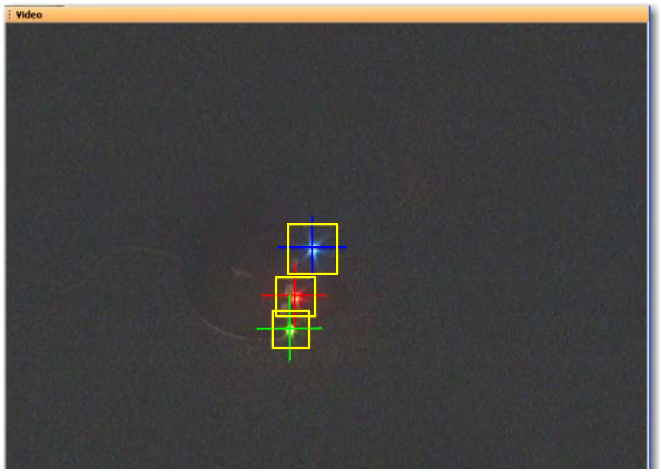
This procedure explains how to use the color pick-up tool to adjust Color 1, Color 2, or Color 3 to match an existing color of an LED on the animal.

LED color shade selection is possible, but requires precision in the pixel selection process. This is because an LED image is a hot white center surrounded by pixels of varying shades of color. You must click on one of the pixels of the desired color, but not white.

1 To use the color pick-up tool on a specific **LED**, click on the **Color Selection** box for the color that is to be adjusted.

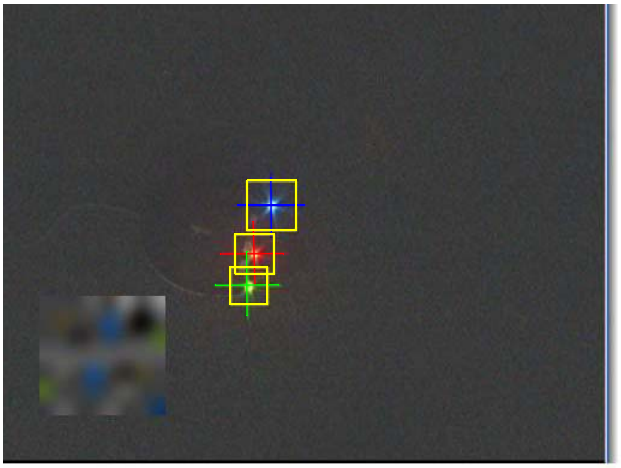


2 The image below shows a sample video window before clicking the **Color Selection** box.



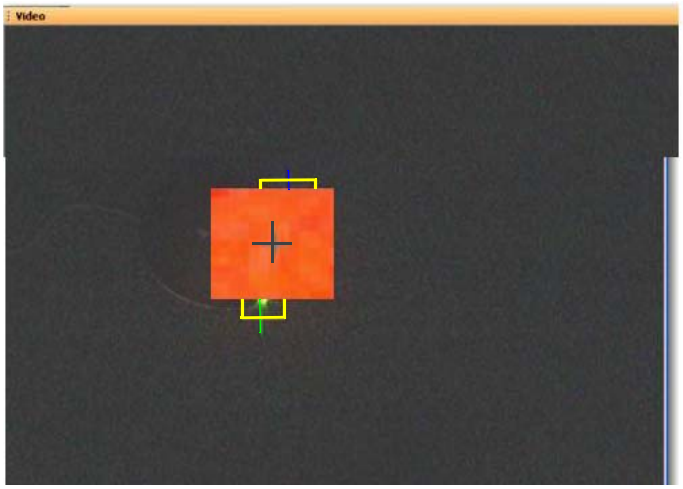
3 In the Video window a square area surrounding the cursor displays as a magnified window. Move the magnified window over the area to be shown in

the **Color Selection** box. The image below shows the magnified cursor window in the lower left of the diagram - note the digitization of the area.



4 Position the crosshair over a representatively colored pixel. The **Color Selection** box displays the color of the pixel directly under the **crosshair**. The image below shows a red pixel under the magnified area.

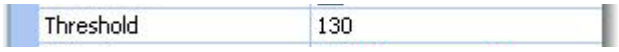
Note: Be sure that the pixel is the dominant color of the LED, and not the white center of the LED.



5 Click the pixel.

6 The color of the corresponding color box in the properties window will be changed to that of the clicked pixel.

7 Change the **Threshold** (common to all LEDs) so that the correct objects are filled and outlined on the Video window. Their color crosses (representing the centers of gravity) should be centered on the correct objects.



Note: For a general discussion of Threshold values, see Section 4.7.2, “Setting the Threshold” on page 94.

8 If the cursor does not track accurately with the threshold set to optimum, change the color or adjust the sharpness and saturation.

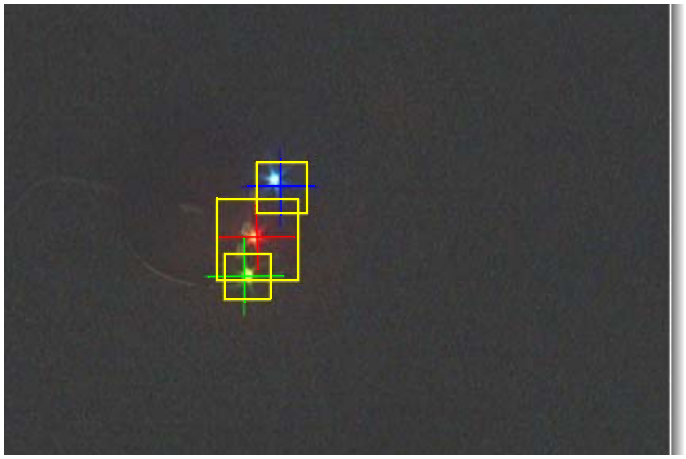
9 Repeat the steps in this section for any additional camera(s) to be used in the experiment.

10 (Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

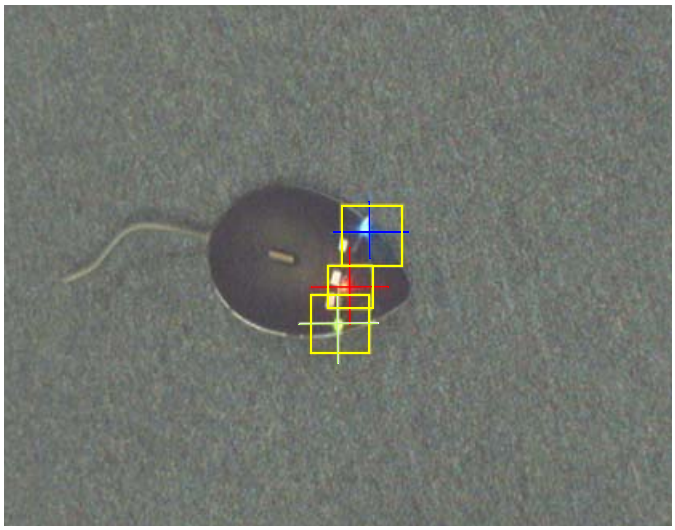
4.9 LEDs In Darkness or Light with Extended Tracking of Color Markers Mode

CinePlex Studio can track colored LEDs in darkness or light with the Extended Tracking of Color Markers mode selected.

In darkness, the LEDs are the brightest spots in the window, therefore, the Extended Tracking of Color Markers mode works well for this condition. The system treats the LEDs as if they were reflective colors. The image below shows three LEDs being tracked in darkness.



In light, the LEDs might (or might not) be the brightest spots in the window. If the LED colors have sufficient brightness and contrast with respect to the background, Extended Tracking of Color Markers works well for this condition. The image below shows three LEDs being tracked in light.



Note regarding use of the color pick-up tool with LEDs

With the color pick-up tool, LED color shade selection is possible, but requires precision in the pixel selection process. This is because an LED image is a hot white center surrounded by pixels of varying shades of color. You must click on one of the pixels of the desired color, but not white.

To configure tracking of LEDs with Extended Tracking of Colors mode

Follow the same procedure as with Section 4.10, “Extended Tracking of Color Markers In Light” on page 112.

4.10 Extended Tracking of Color Markers In Light

This section configures CinePlex Studio to track reflective colored markers in light with the Extended Tracking of Color Markers mode selected. Up to 12 different colored markers can be tracked.

The image below shows three reflective markers being tracked.

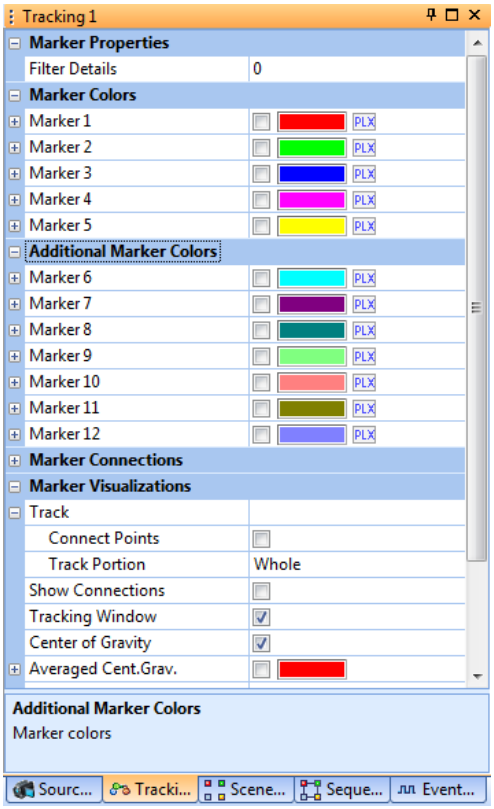
4.10.1 Enabling Extended Tracking of Color Markers In Light

Perform these steps to select and configure Extended Tracking.

1. Place the colored targets in the camera field of view.
2. At the camera lens, adjust the zoom, focus, and iris settings for the best picture quality. For additional guidance on camera setup and video quality, see Section 3.1, “Setting Up Cameras and the User Interface” on page 26.
3. To select the Extended Tracking of Colors mode, click the appropriate icon on the Tracker toolbar.

4. Click on the Tracking tab for Camera 1 in the Dynamic Configuration pane to view the Tracking parameters.
5. In the **Marker Visualizations** group check **Contour** and **Fill Contour** so that the objects found by the system are visible. These selections are common to all color markers used in the experiment.

6 In the **Marker Colors and Additional Marker Colors** areas, click the checkboxes to select the colors to be tracked.



Note: You can track markers of the same color with different sizes. See Section 4.10.2, “Examples of Tracking Markers of the Same Color but Different Sizes” on page 113, below.

7 For each color checked in Step 6, check the **PLX** button, if desired, to send a copy of the tracking coordinate data to the OmniPlex System. (The **PLX** button turns orange when selected and clear when deselected.)

8 Follow the procedure in "Examples of Tracking Markers of the Same Color but Different Sizes" (below) to select the specific colors to track.

9 (Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

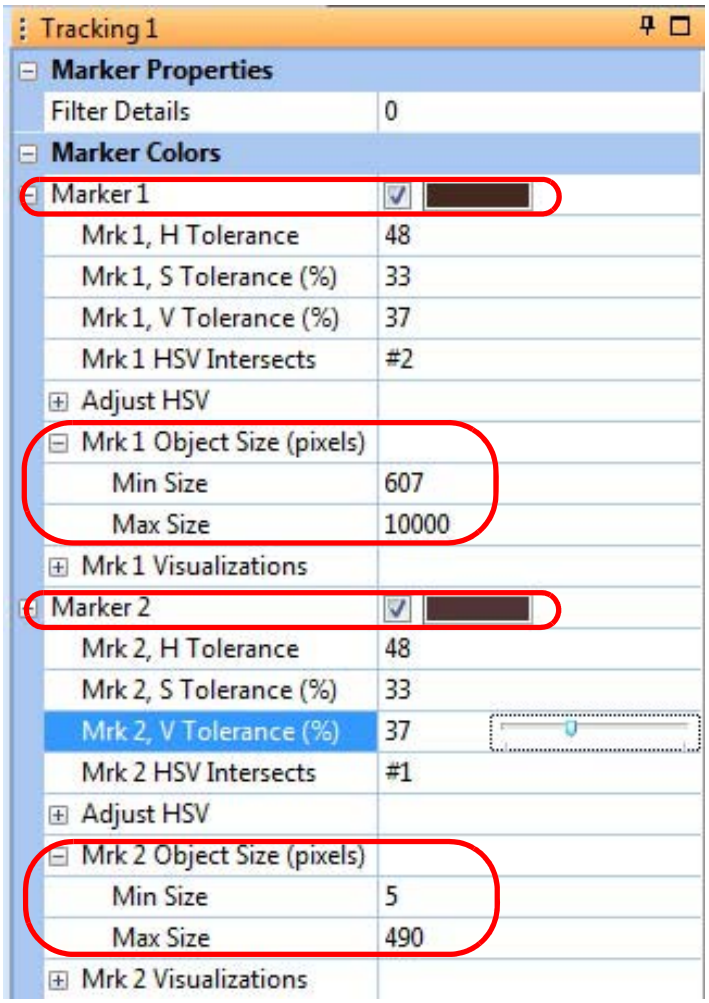
4.10.2 Examples of Tracking Markers of the Same Color but Different Sizes

You can use several markers of the same color, but differing in size, from up to four video streams; the system will track each of those markers.

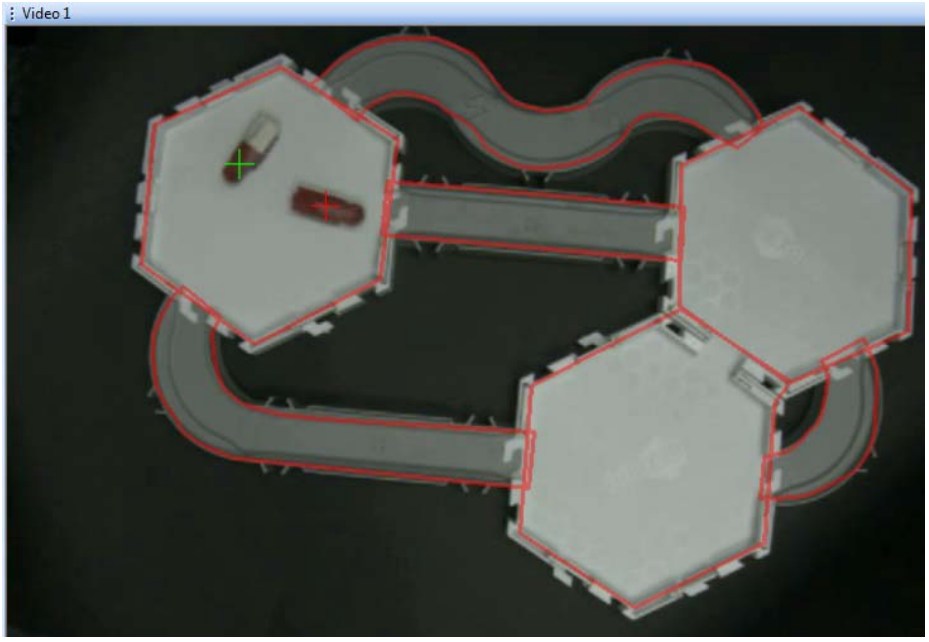
Example 1

In the example below, Markers 1 and 2 are configured for the same color, but the **Object Size** parameters have been set with mutually exclusive size ranges—see **Min Size** and **Max Size** for Markers 1 and 2.

Note: One typical use for this approach is the tracking of animals in the dark using infrared cameras. In this mode, you might be tracking two animals, one with all dark fur and one with half of its fur dark. By specifying different sizes for the two markers, you can track each animal independently.

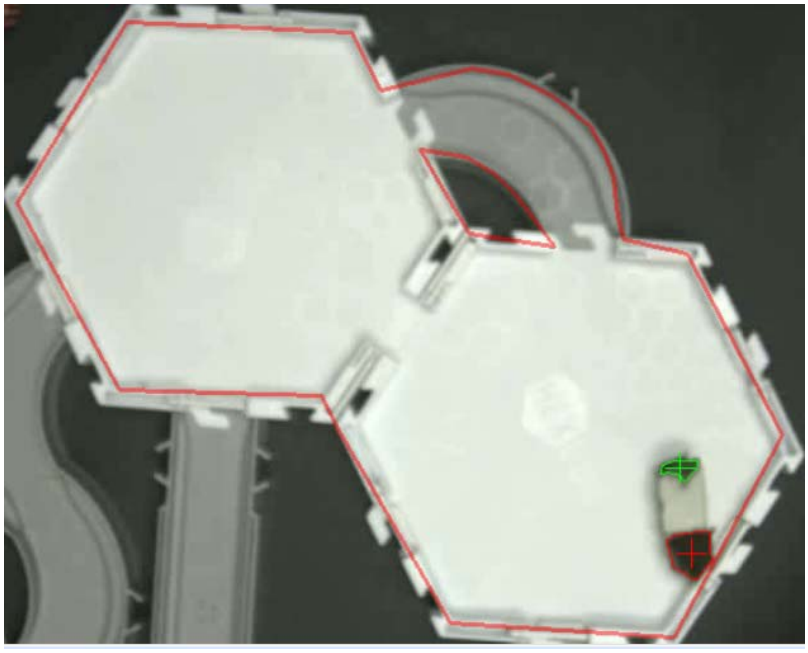


The image below shows how the two objects are tracked independently. (The colors of the crosshairs are selected in the **Mrk 1 Visualizations** and **Mrk 2 Visualizations**. You can select any convenient colors for the crosshairs.)



Example 2

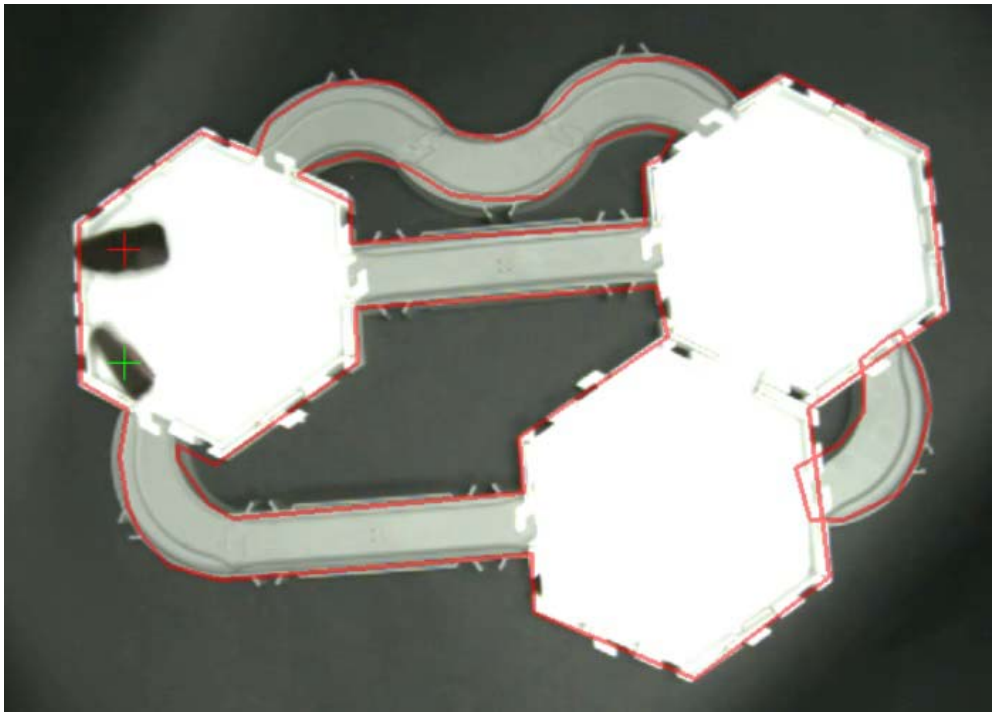
In the example below, there are two dark areas of different sizes on the animal. These two dark areas are being tracked independently.



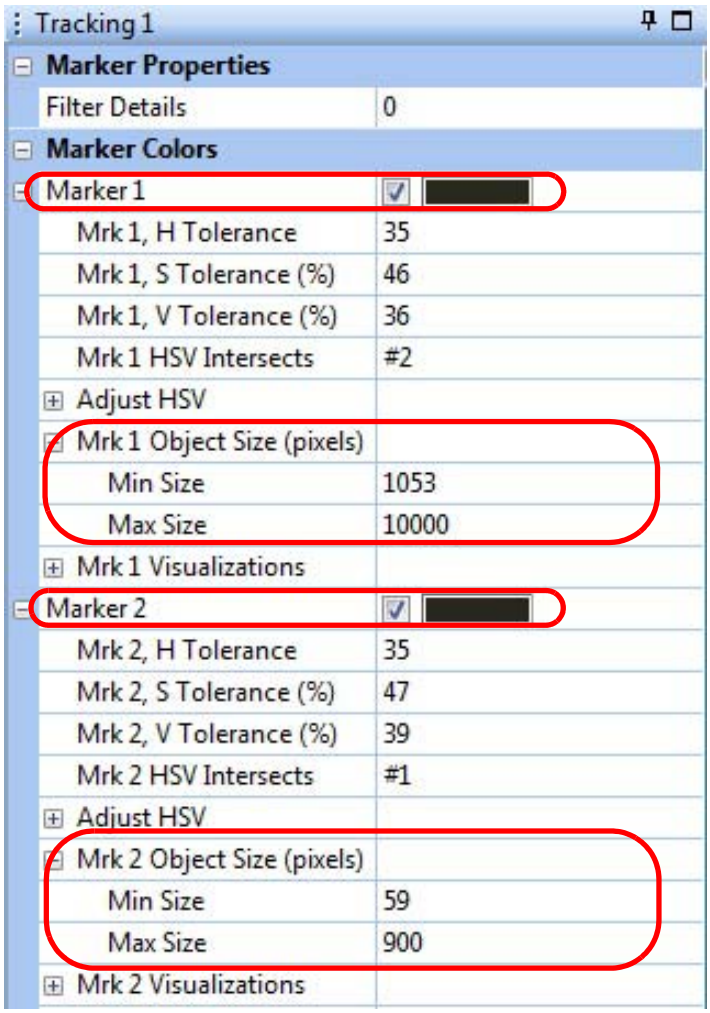
Note: The tracking of two same-colored markers of different size can also be applied to experiments involving infrared imaging. Colors are not visible in infrared, so two animals (or two parts of a single animal) can be marked by markers of the same color, but having different size. You need to make sure of course the markers exhibit significant infrared contrast to the animal, for example, white markers on a black animal.

Example 3

In the example below, there are two dark animals of different sizes. These two dark areas are being tracked independently.



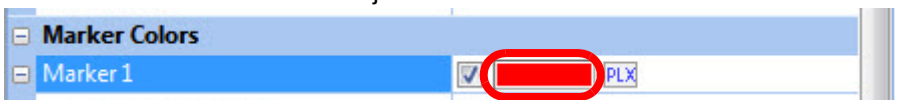
Here are the settings that specify the tracking seen in the above image:


Tracking 1
Marker Properties
Filter Details
0
Marker Colors
Marker 1
Mrk 1, H Tolerance
35
Mrk 1, S Tolerance (%)
46
Mrk 1, V Tolerance (%)
36
Mrk 1 HSV Intersects
#2
Adjust HSV
Mrk 1 Object Size (pixels)
Min Size
1053
Max Size
10000
Mrk 1 Visualizations
Marker 2
Mrk 2, H Tolerance
35
Mrk 2, S Tolerance (%)
47
Mrk 2, V Tolerance (%)
39
Mrk 2 HSV Intersects
#1
Adjust HSV
Mrk 2 Object Size (pixels)
Min Size
59
Max Size
900
Mrk 2 Visualizations

4.10.3 Using Color Pick-up Tool on Extended Tracking of Reflective Colors

This procedure explains how to use the color pick-up tool to adjust any of the tracked colors (Color 1 through Color 12) to match an existing color of a reflective color marker on the animal.

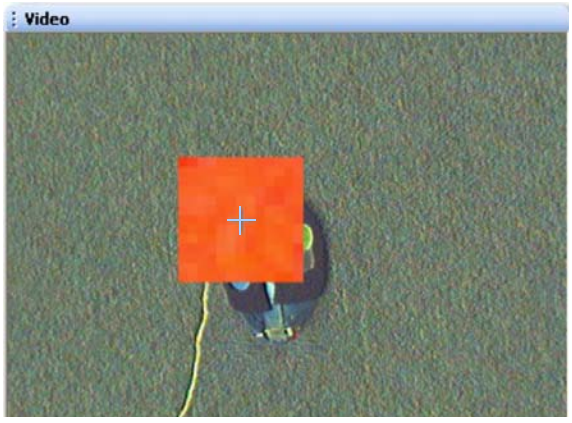
1 To use the color pick-up tool on a specific **color**, click on the **Color Selection** box for the color that is to be adjusted.



2 The image below shows a sample video window before clicking the **Color Selection** box.

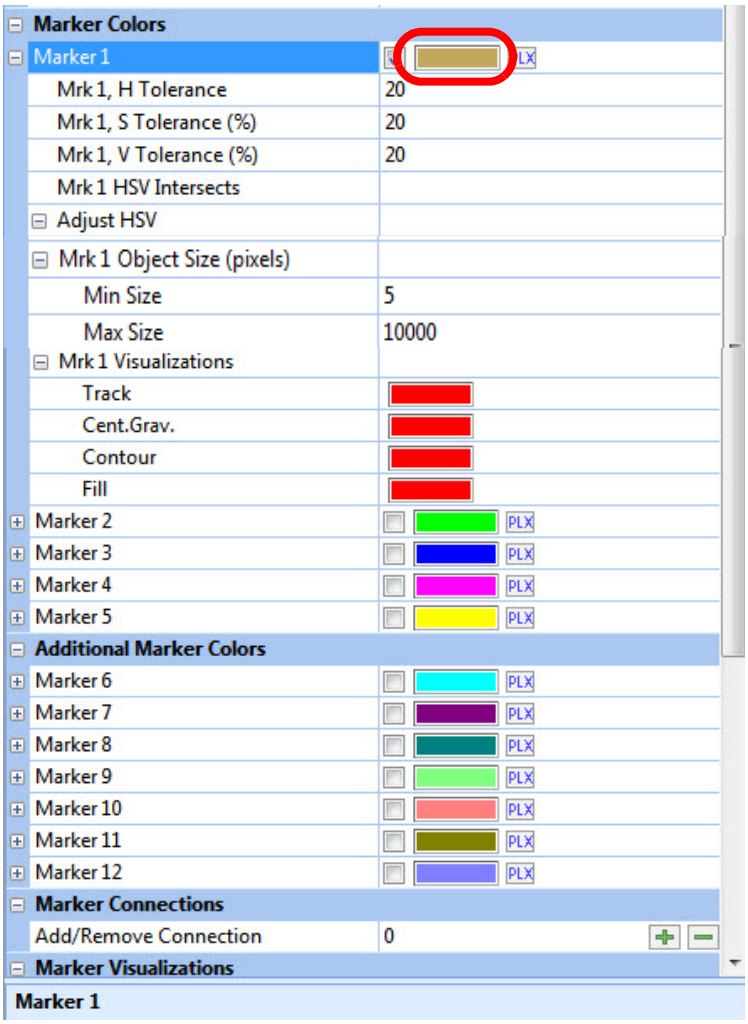
3 In the Video window a square area surrounding the cursor displays as a magnified window. Move the magnified window over the area to be shown in the **Color Selection** box. The image below shows the magnified cursor window in the lower left of the diagram - note the digitization of the area.

4 Position the crosshair over a representatively colored pixel. The **Color Selection** box displays the color of the pixel directly under the crosshair. The image below shows a red pixel under the magnified area.



5 Click the pixel.

6 The color of the corresponding color box in the properties window will be changed to that of the clicked pixel.



7 Click the checkbox for **Fill Contour** in the **Marker Visualizations** area (if not already selected) so that the image of the selected object is seen in the video image.

8 Repeat Step 1 through Step 7 for the other colors that will be tracked in the experiment.

9 Work with the Tolerance parameters (in the following section) to improve tracking efficiency.

10 (Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

4.10.4 Improve Tracking Efficiency with Tolerance Parameters

1 If necessary to improve tracking, adjust the **H**, **S** and **V** tolerances so there are no **Intersects** among the various colors.

2 Change the **H**, **S** and **V Tolerance** setting so that the correct object is filled and outlined on the Video window. The crosshair should be centered on the correct object.

Note: Do ***not*** change the **Adjust HSV** settings manually. These settings were adjusted automatically by the system when you clicked the colored pixel in the earlier step.

3 If the above steps do not provide accurate visualization of the objects that need to be tracked, or do not eliminate all the **Intersects**, consider making some or all of the following additional adjustments and changes:

- Use different marker colors, especially if two of the colors being used in the experiment are similar to each other.
- Increase the lighting level in the experimental area, if possible.
- Reduce the number of color markers being used in the experiment.
- Increase the gain on the camera (although this will also increase noise).

Note: The above list is intended as a general guide. If you need additional information on these adjustments, contact Plexon support.

4 After completing the previous steps, verify that the video display looks similar to the following image, in which the system is set up to track three colors.

5 Repeat the steps in this section for any additional camera(s) to be used in the experiment.

6 (Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

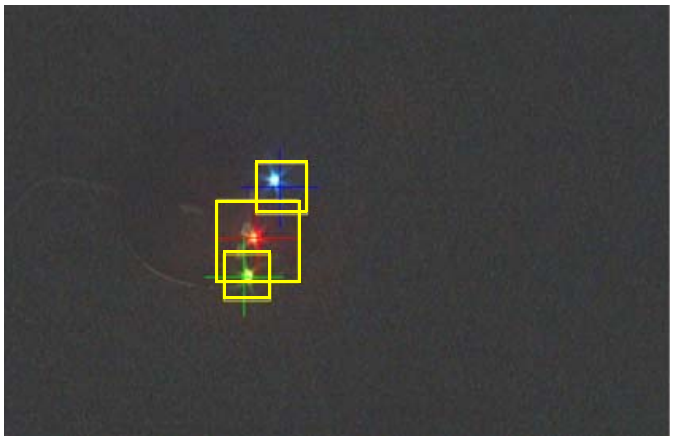
4.11 Tracking Color Markers (Legacy Capability)

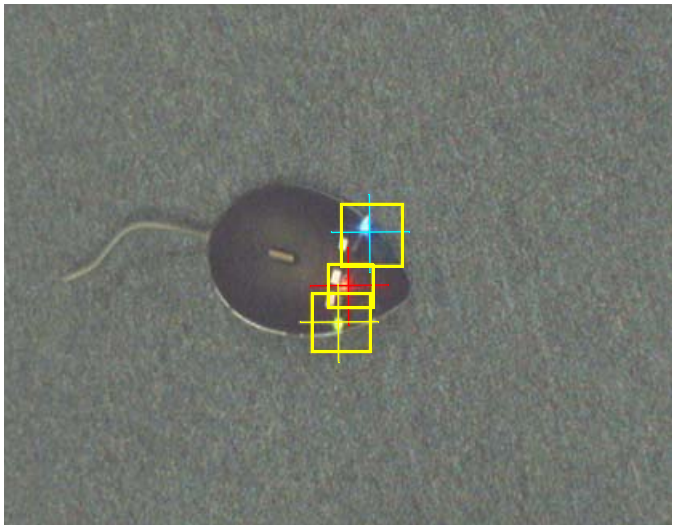
This section configures CinePlex Studio to track an animal with Color Markers tracking mode selected, and with any of the following experimental configurations:

- LEDs in darkness
- LEDs in light
- Reflective colored markers in light

Note: This mode of tracking is retained for legacy purposes only, for experimenters who have been using this mode and wish to continue doing so. In this mode, up to 5 colors can be tracked in the typical arena. It is possible to track more than 5 colors, but only if the arena lighting is sufficient. For new experiments, Plexon strongly recommends using the **Extended Tracking of Color Markers**, as described elsewhere in this chapter.

The images below show LEDs in darkness, LEDs in light, and reflective markers (respectively) being tracked.

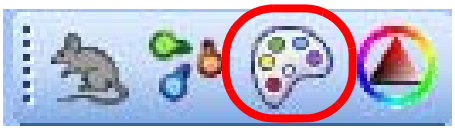




4.11.1 Enabling Color Markers Tracking Mode

Perform these steps to select and configure Color Markers tracking mode.

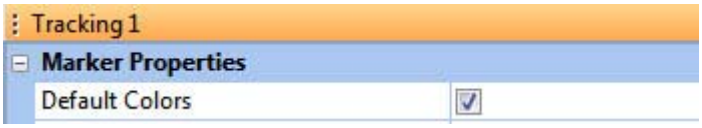
1. Place the colored targets in the camera field of view.
2. To select the Color Markers tracking mode, click the appropriate icon on the **Tracker** toolbar.



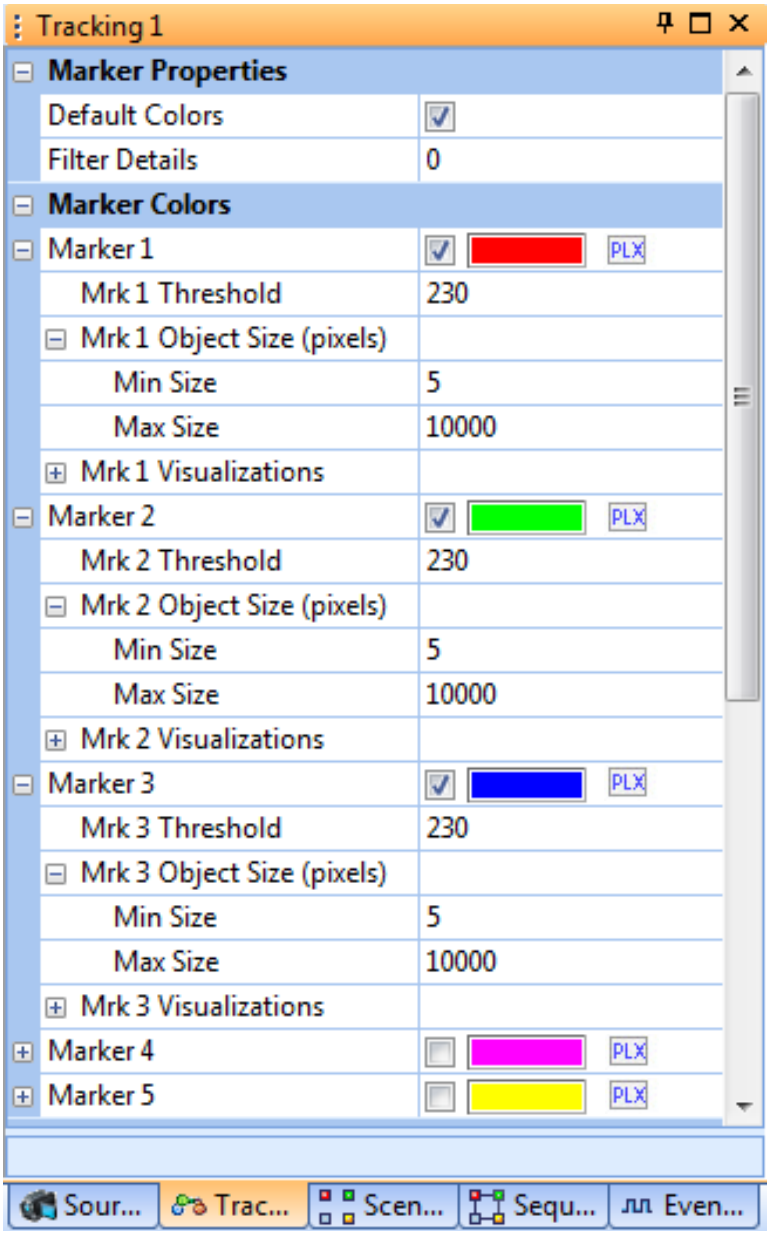
The **Tracking** pane for the selected tracking mode displays in the **Static Configuration** pane.

3. In the **Visualization** group check **Contour** and **Fill Contour** so that the objects found by the system are visible. These selections are common to all color markers used in the experiment.

4. Check the **Default Colors** checkbox in the **Marker Properties** area.



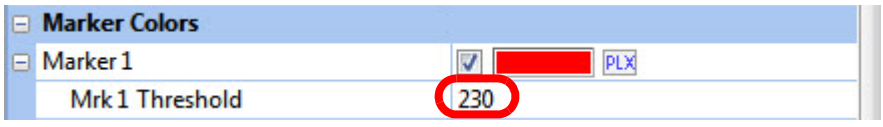
5 Check the color to track by clicking the corresponding checkbox.



6 If any settings need to be changed for a particular color, click on the '+' for that color.

7 Adjust the **Threshold** of the selected color (see diagram below) so that the correct object is filled and outlined on the **Video** window and its color cross is properly centered.

Note: If working with default colors, the **Threshold** should be moved to lower values to provide stable tracking.



Note: For a general discussion of Threshold values, see "Setting the Threshold" (below).

8 If the default colors do not give good results, select the color from the video. To do this, use the method described in Section 4.10.2, “Examples of Tracking Markers of the Same Color but Different Sizes” on page 113. Adjust the **Threshold** higher to find and track the object.

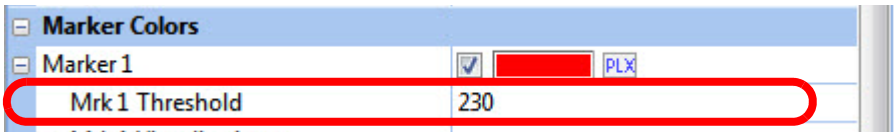
9 Repeat Step 6 through Step 8 for each color selected.

10 (Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

4.11.2 Setting the Threshold

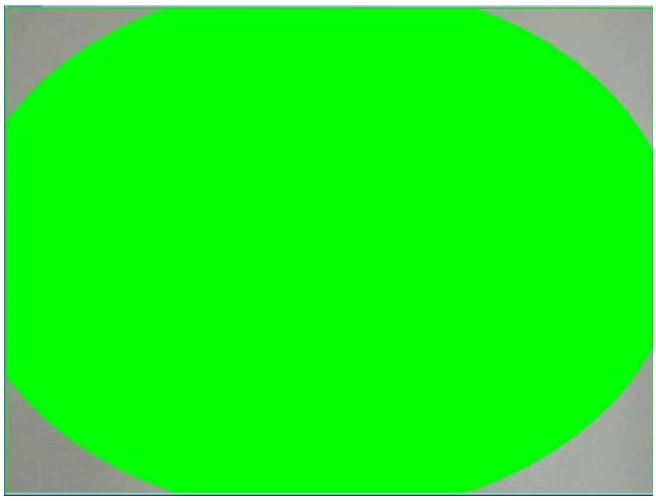
CinePlex Studio can locate an object of a specified color by the color contrast between the desired color and the threshold setting. If the marker has good contrast relative to the animal, adjust the **Threshold** setting in the **Marker Colors** area to fill the whole image of the animal.

The Threshold is set in the **Marker Colors** group.



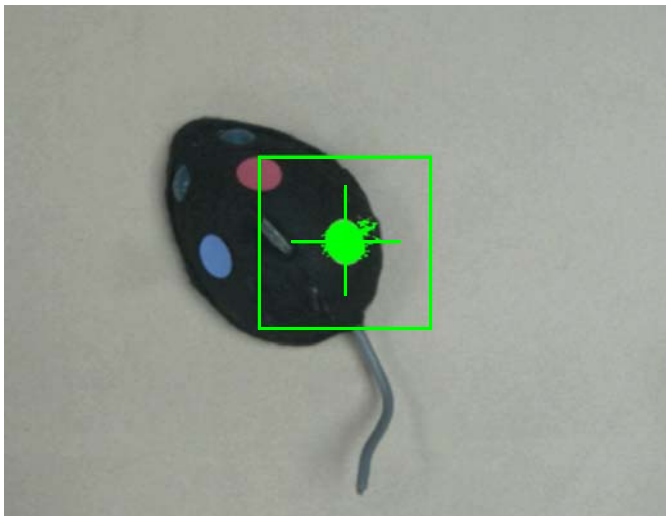
Use the guidelines below to adjust the **Threshold** setting.

If the threshold setting is very low, the image could be similar to the one shown below. It will be necessary to experiment with the setting to obtain the optimal value.



If the size of the found target object is larger than 1/4 of the frame area, there will be a red blinking message on the bottom of the screen notifying that the threshold is probably too low and both the Arm and Record buttons will be disabled.

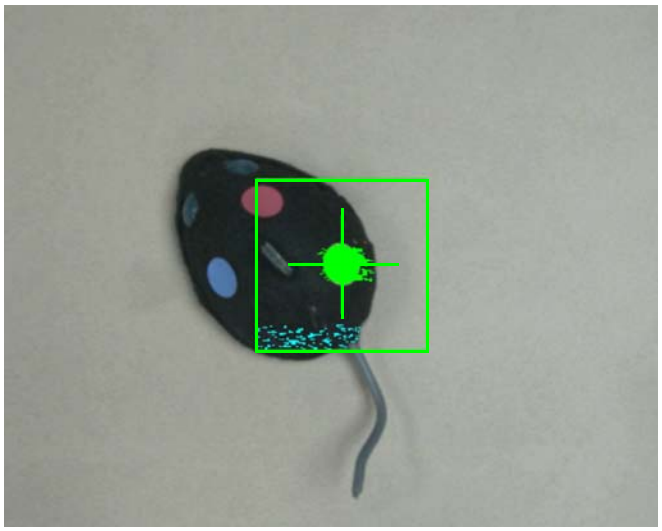
If the threshold is low, the center of gravity crosshair will exhibit jitter. Click the **Fill Contour** checkbox to view the contour that the system is tracking. The image below shows an example. There are several parasite objects that are being tracked in addition to the desired marker.



Try to set the threshold so that the number of parasite objects is as few as possible.

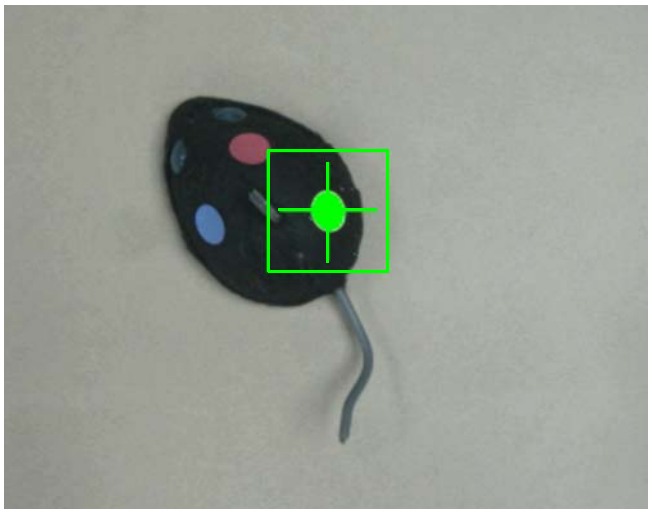
There is an additional tool to use to check whether the threshold is set too low. To see all objects, click the **Fill All Objects** checkbox. As shown in the image

below, the system is tracking the correct object, but it is also wasting bandwidth analyzing a large number of parasite objects.



Note: The **Fill All Objects** function (which displays the blue objects inside the green rectangle in the above image) is automatically disabled when the recording starts, and these objects are not displayed during recording.

Increase the threshold to reduce the number of parasite objects. The image above shows the tracked object (in green), but the image also contains a large number of parasite objects (in blue). After you increase the Threshold value, there should be fewer parasite objects. The image below shows very few parasite objects and effective tracking of the desired object.



Increasing the threshold does not work in all cases. If the threshold is too large, the target object will be smaller.

(Optional) After the Tracking parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

4.12 Calibrating the Arena Dimensions

In many experiments, it is useful to calibrate the video image so that sizes, positions and velocities are reported in the desired units of measure instead of pixels. See Section 3.3, “Calibrating the Arena Dimensions” on page 30 for the procedure.

4.13 Recording Synchronized Video Tracking and Neural Data

This section explains how to record video and tracking data that is synchronized with neural data from the OmniPlex System. This procedure requires starting and stopping the CinePlex Studio video recording process remotely from the OmniPlex System. This method of triggering the recording ensures that:

- The timestamps in the CinePlex and OmniPlex files are derived from the same clock
- The CinePlex and OmniPlex file start times and stop times are synchronized
- The CinePlex frame numbers, coordinate data and timestamps are synchronized

Simultaneous starting, stopping, pausing, and resuming of the neural data and video files is essential in helping the researcher correlate the behaviors captured in the video with the observed neural activity.

Although you may manually start, stop, pause, and resume recording an AVI file at any time in CinePlex Studio by simply clicking the appropriate toolbar buttons, this method will *not* record synchronized files, because it produces video files that do not have the same start time as the corresponding neural data files.

4.13.1 Recording Procedure

Perform these steps to record synchronized video and neural data.

CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

CAUTION

Lighting Conditions

If lighting conditions change enough during recording that ‘objects too large’ or some other condition occurs, the position data may be meaningless.

1 Ensure that the system is connected as described in Appendix A-Cabling Guide so that the clock and control signals can be sent from the OmniPlex System to the CinePlex Studio components.

Note: For more information on setting up and running the OmniPlex Server and PlexControl, refer to the OmniPlex instructions.

2 At the OmniPlex chassis, turn the power on and start the OmniPlex Server and PlexControl.

3 If not already done, configure the OmniPlex System.

4 Click the **Start Data** button in the PlexControl toolbar so that neural data acquisition begins, and the neural data appears in PlexControl display.

5 Double-click the CinePlex Studio icon. Wait for the CinePlex Studio application main window to appear on the monitor.

Note: If Studio does not detect the OmniPlex clock, an error message will appear. If it does, see Appendix E-Troubleshooting.

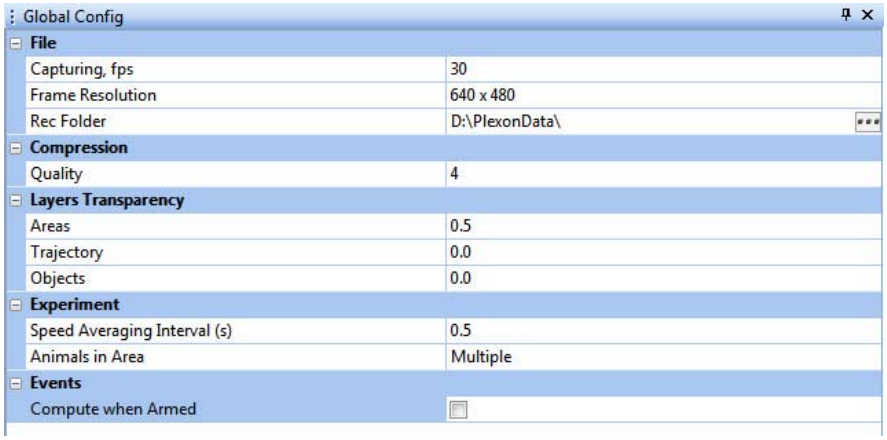
6 Verify that “Cameras” is selected in the Studio pulldown menu and that a camera image is displayed for Camera 1. (It is acceptable if other camera video images are also displayed, but Camera 1 is required.)

7 If there is an appropriate file containing all the desired CinePlex settings (with the tracking function configured), load the file onto CinePlex Studio using the Load settings icon ( ) on the main toolbar or the **File/Load Settings** menu selection.

8 Click on the Global Config tab in the static configuration pane to display the Global Config pane.

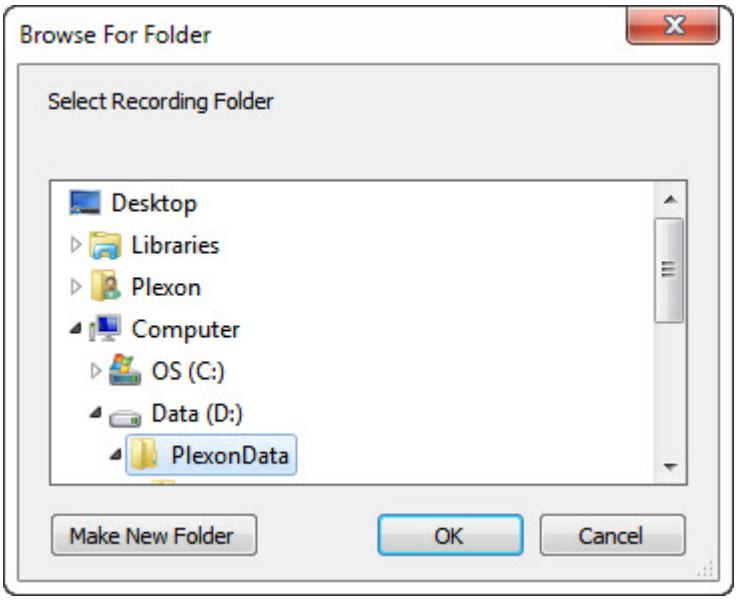
Note: This pane is the first an experimenter will normally use when setting up CinePlex Studio, but perhaps not very often after that. It contains settings that pertain to the frame rate to use when recording, image resolution (quality of recordings to make), compression bit rate, local file name, and whether the experiment involves one animal or many.

9 View the settings in the Global Config pane and modify any that need to be changed prior to starting the next recording session:



10 To browse for the desired file location (where the recorded files will be saved), click on the browse icon, which is the rectangle with three dots on the **Rec Folder** row of the Global Config tab.

11 When the **Browse for Folder** appears, use standard Windows® methods to select or create the appropriate folder. The factory default location for the Recording folder is C:\PlexonData or D:\PlexonData (if disk D is available).

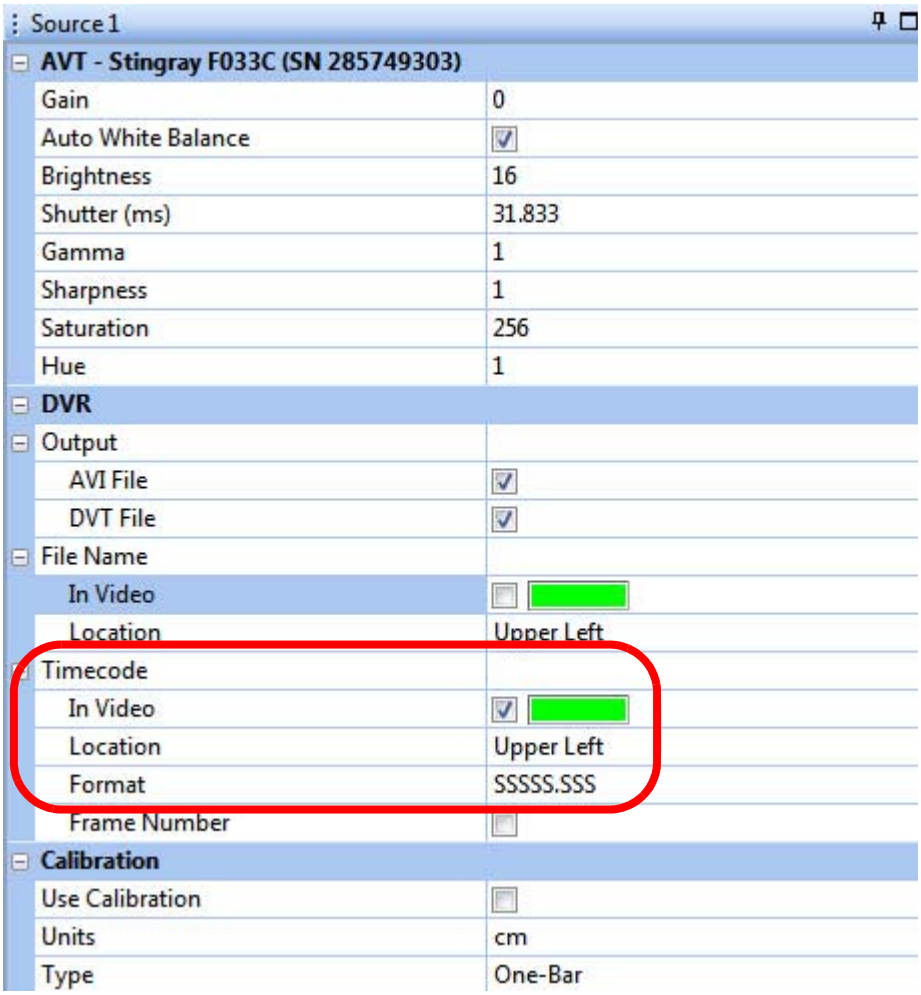


12 When finished choosing or creating a storage folder, click **OK**.

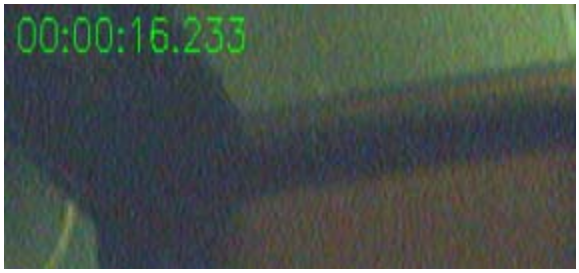
Note: The location of the **Recording** folder is included in the Settings file (if you save a Settings file), and is restored when the Settings file is loaded. To save settings, click **Save Settings** on the **File** menu, or click the **Save Settings** button ( ) on the toolbar.

13 To view the CinePlex Studio time display, select the Source 1 tab in the Video 1 window, and view the digital video recording (**DVR)** section. (CinePlex Studio maintains a time code that tracks the time elapsed since the last time recording began.)

14 In the **Timecode** options, select the **In Video** checkbox to include the time. Choose a **Location** and a **Format** setting to configure the display.



For example, the following images show the time code in the **Upper Left** location in **SSSSS.SSS** and **HH:MM:SS.SSS** format, respectively.



15 In the **Camera** area, adjust the controls to obtain an acceptable image on the screen. The specific controls vary depending on the camera model. Typical adjustments include **Gain**, **Auto White Balance**, **Brightness**, **Sharpness** and **Saturation**.

Note: You can also use other image quality settings. To evaluate image quality settings, manually collect a set of AVI files at different settings and use the file mode to determine a minimum acceptable image quality setting for the experiment.

TIP

Reducing blurs and color streaks in the video

If the experimental subject moves quickly, blurs and color streaks can appear in the video. Reduce or eliminate these problems by increasing the shutter speed. See **Shutter (ms)** in the **Source** settings, as shown in the image above.

For additional tips, see "Sharpening the Image" on page B-7.

16 In the digital video recording (**DVR)** area of the Sources pane, select the type(s) of output to create - video file (**AVI File**), text file with digital video tracking (**DVT File**) data, neither or both.

CAUTION

Save the AVI File

It is *strongly* recommended that you save an AVI File for every experimental run, even if you are sending data directly from CinePlex to OmniPlex. (The AVI File is the default output type.) The AVI file is the originally recorded video of the experiment, and it can be retrieved and analyzed again. If you deselect the AVI File checkbox, the original video will not be saved.

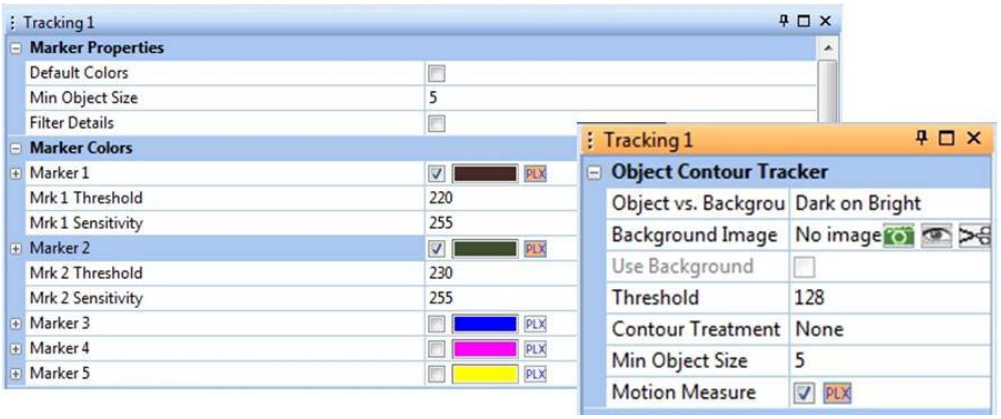
TIP

Timestamps, frame numbers and tracking data—DVT File

The system will generate a digital video tracking (DVT) file if you select the DVT File checkbox. The DVT file will have frame numbers and timestamps as data extracted from the AVI files with the Extractor Function. However there is an algebraic relationship between the tracking coordinates extracted from the AVI file versus the coordinates listed in the DVT file. See Chapter 7, Extractor Procedures.

17 You have the option to send tracking data from CinePlex Studio to the OmniPlex System. To send tracking data, click the **PLX** button(s) in the Camera 1 pane for the type(s) of data to be sent. (If no **PLX** button is checked, no data will be sent to the OmniPlex System during the recording session.)

Note: When a **PLX** button is selected, it turns orange; when it is not selected, it is clear.



The following conditions apply to the process of sending tracking data from CinePlex Studio to the OmniPlex System:

- Data can be sent for Camera 1 only.
- Data can be sent in online (“Cameras”) mode only, not in offline (“Files”) mode.
- Data can be sent for up to three LEDs or colored markers. (Only three of the PLX buttons can be active simultaneously.)

18 (Optional) If the arena dimensions have not yet been calibrated, the calibration can be done now. See Section 3.3, “Calibrating the Arena Dimensions” on page 3-30 for details.

19 Repeat Step 13 through Step 16 for any other cameras connected to the system.

20 From the CinePlex Studio toolbar, click the “**A**” arming button. A yellow flashing cassette icon appears on the status bar.

Note: At this point, there is no tracking data being sent from CinePlex Studio to the OmniPlex System. In the armed condition, Studio is waiting for a start signal to be sent from the OmniPlex System. The **SPK - Activity** pane in PlexControl shows no data on the CPX1 line.

21 From the PlexControl toolbar, click the **Start Recording** icon. If PlexControl prompts for a file name, enter it.

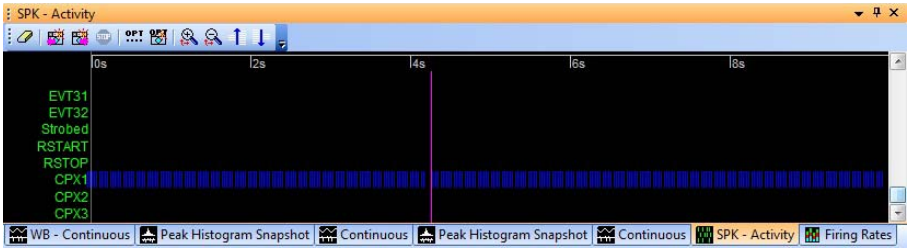
PlexControl starts recording and displays status information about the neural data file on the PlexControl status bar; for information on the PlexControl status, see the OmniPlex System instructions.

Studio automatically starts recording and displays information about the video file in the Studio main window status bar.

The Studio status bar will display the amount of free space remaining on the drive selected.

Note: The system automatically checks that there is at least 10 GB of free disk space on the PC before it starts recording a file. The file size can grow to fill the space available, except that the system automatically stops recording the current file when the available disk space has been reduced to 10 GB.

Studio starts sending the coordinate data to the OmniPlex System, and the **SPK - Activity** pane in PlexControl shows the synchronized data stream (see the blue data lines in this image):



Note: Plexon recommends a short test recording to verify the data stream is being sent. The **SPK - Activity** pane in PlexControl should show the presence of the data stream, similar to that shown in the PlexControl image above.

22 To pause recording, click the PlexControl **Pause Recording** icon.

PlexControl pauses recording and displays status information about the neural data file on the PlexControl status bar.

CinePlex Studio pauses recording and displays information about the video file in the CinePlex Studio status bar. The status bar flashes green and gray to indicate that the recording is paused.

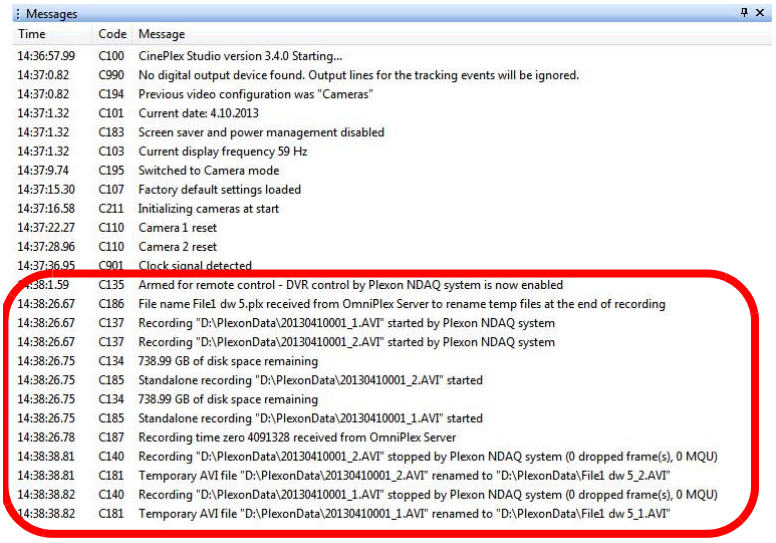
To resume recording, click PlexControl **Pause Recording** again.

23 To stop recording, press the **Stop Recording** button in PlexControl (Studio recording stops also.)

PlexControl stops recording to the neural data file, clears the recording information from the status bar, and saves the file as specified in Step 21.

Studio stops recording and saves the video file(s) to the location that was specified as **Rec Folder** in the CinePlex Studio Global Configuration Pane. Studio *clears the recording information from the status bar and re-arms itself for the next recording session.*

When Studio is armed, for efficiency it creates temporary files. When recording is started remotely (from the OmniPlex System), Studio writes to these temporary files. When recording is stopped, the temporary files are renamed, and new temporary files are opened in anticipation of a new recording session. The Studio Messages Pane displays information similar to the example below.



Note: At this point, there is no tracking data being sent from CinePlex Studio to the OmniPlex System, because Studio is once again in the armed condition. The **SPK - Activity** pane in PlexControl shows no data on the CPX1 line.

24 You can start and stop recording as many times as desired. When recording starts, tracking data will flow from CinePlex Studio to the OmniPlex System. When recording stops, tracking data does not flow.

25 To disarm CinePlex Studio, from the **DVR** toolbar, click **Arm** to clear. The status bar returns to the disarmed state.

TIP

Tracking Data - Add it in real-time or add it later

If the **PLX** button for the desired tracking data is pressed before the start of recording, as explained in the procedure above, CinePlex Studio sends the tracking data to OmniPlex in real-time.

If you forget to press a particular **PLX** button before starting recording, or want to press different **PLX** button(s) later, CinePlex Editor can be used to replay the PLX file and overlay the coordinate data. (CinePlex Editor is installed separately.)

26 To view the captured video file, browse to the file location and double click to open the file.

27 To transfer files to an analysis computer (if different than the recording computer), follow standard Windows procedures.

28 To view the neural and video files together, use CinePlex Editor. You can also view just the video files using CinePlex Editor, Windows Media Player® or

CinePlex Studio on the analysis computer. (CinePlex Editor is installed separately.)

29 (Optional) If you want to save the settings from this session, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

4.13.2 File Naming Procedure During and After Recording

During the recording process, CinePlex Studio creates temporary names for the AVI files. When the recording is stopped, Studio renames the files.

If there is only one camera connected to the CinePlex System:

- The format of the temporary files is **yyyymmddnnn.avi**
- The format of the renamed files is **PLX_file_name.avi**

If there are multiple cameras connected to the CinePlex System:

- The format of the temporary files is **yyyymmddnnn_N.avi**
- The format of the renamed files is **PLX_file_name_N.avi**

where:

yyyymmdd is the year, month and day

nnn is a 3-digit number, 001, 002, ... 999 assigned automatically by the system

N is the camera number for which the file is created - 1, 2, ...

PLX_file_name is the file name specified by the user on the OmniPlex System in *Step 21* of *Section 4.13.1, "Recording Procedure" on page 128*.

Note: If Studio is armed on one day, but the start signal is not received until the next day, the temporary filename remains the one for the previous day.

4.14 Monitoring the Video During a Recording Session

The status bar in the CinePlex Studio main window displays information that allows the researcher to monitor the video recording process. See the section Section 3.6, "Monitoring the Video During a Recording Session" on page 51 for a description of this feature.

TIP
Verify that the tracking window is displayed as expected
During the recording, you should see that the tracking window is successfully following the subject in the arena.

4.15 Recording Video without Neural Data (Used for Animal Training)

You can record video and tracking data without neural data. In this case, the OmniPlex System is activated only for the purpose of providing the required clock for the CinePlex System. This procedure requires activation of the OmniPlex data stream (which starts the clock), and then starting and stopping the CinePlex Studio video recording process locally (using the CinePlex controls). This method of triggering the recording is typically used during animal training, when no neural data are being collected.

See the section Section 3.8, “Recording Video without Neural Data (Used for Animal Training)” on page 54 for this procedure.

Note: In addition to the parameters configured in that procedure, you can also configure the Tracking Option parameters. If the Tracking Option is enabled and the DVT file format is selected, the DVT file will contain the tracking coordinates.

4.16 Video Playback In Files (Offline) Mode

CinePlex Studio can be used in offline mode to play back and rerecord video from existing files. The existing AVI and/or DVT files are the ones recorded previously by means of the procedure in Section 4.13, “Recording Synchronized Video Tracking and Neural Data” on page 128.

The procedure is the same as presented in Section 3.9, “Video Playback and Rerecording in Studio Files (Offline) Mode” on page 61.

4.17 Additional File-processing Tools

The following tools can also be used for processing of files:

- Use the Retrack AVI feature if you want to re-record an existing video file with modified arenas, or with different parameter settings than those used in the original recording. See Chapter 6, Retrack AVI Procedure.
- Use the CinePlex Studio Extractor to extract static and dynamic data from a Plexon AVI file for analysis with a database program such as Microsoft® SQL Server® or data processing tools such as Microsoft Excel®. See Chapter 7, Extractor Procedures.
- You can use CinePlex Editor (installed separately) to view the AVI file time-locked (synchronized) with its partner neural data file to see what the subject was doing at a time of interest in the neural data. The video and neural data are time-locked because both systems (the OmniPlex and CinePlex Systems) are running off the same clock signal. This ensures that the PLX and AVI files will have the same timing.

- You can import and analyze the X, Y position data in PLX files with NeuroExplorer®, Version 3.088 or later. For details about NeuroExplorer, see www.plexon.com.

Chapter 5
Generating Events with CinePlex Basic Behavior Option

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5.1 Introduction to the CinePlex Basic Behavior Option

This chapter describes the CinePlex® Studio Basic Behavior Option, the experimental applications for which it can be used, and how to use it. The Basic Behavior Option extends the capabilities of CinePlex Studio and CinePlex Tracking Option. The Basic Behavior Option requires the CPB V3 license in addition to the CPT V3 (Tracking) and CPX V3 (Studio/Editor) licenses.

5.1.1 General Procedure

The general procedure for using the Basic Behavior Option is the same as that for the Tracking Option (see Chapter 4, Recording Positional Data with CinePlex Tracking Option), with the additional procedures described in this chapter. The additional Basic Behavior procedures include:

- Defining static and dynamic zones of interest within an experimental arena
- Defining zone sequences
- Monitoring objects traversing zones and sequences and generating logical and digital events
- Defining behavioral events from one or multiple cameras to generate logical events and electrical signals
- Recording and viewing real-time and offline information about behavioral events and tracked objects, including such attributes as speed, direction (vector), limb angles, presence in particular zones in the arena, proximity to other objects, sequence of zones visited.
- Monitoring vectors between objects and creating behavioral events when the objects are within/outside of a customer-defined angle and tolerance
- Monitoring animal head direction based on markers or LEDs on a headstage.
- Monitoring animal speeds to create digital events when the speed is over/under a user-specified threshold
- Accumulating and displaying behavioral event statistics

5.1.2 Terminology

The following terminology is useful in discussing behavior recording and tracking:

- **Zones**: A zone is a defined portion of the arena that has significance in an experiment. Many zones can be defined simultaneously. CinePlex Studio provides tools that allow you to draw zone outlines on top of the video image. These tools operate in the same way as the arena tools, allowing complex shapes to be created by means of logical operations.

Note: Complex zones can be created for either static or dynamic zones; see the definitions of static zones and dynamic zones, below.

- **Static Zones**: Zones that do not move with respect to the image or the arena are referred to as static zones. In general, they are used in object recognition experiments. For example, a static zone could be an area the animal should avoid to receive a reward or it could be an area the animal must traverse to receive the reward. It could even be one of the zones in a sequence of zones the animal should traverse.
- **Dynamic Zones**: A dynamic zone is a circular area around a marker or LED. In general, it is used to detect social interactions among animals. Dynamic zones are available for LED tracking mode, Color Markers mode and Extended Tracking of Color Markers mode. They are not available in Object Contour tracking mode.
- **Sequences**: A sequence is an ordered list of zones. Many different sequences can be defined.
- **Events**: Logical events can be defined so that, when an animal enters or leaves a zone, or completes a sequence, the event becomes true. Many events can be specified. Their current states are dynamically displayed in the Event Statistics pane. The system can generate electrical pulses or levels (high or low) based on logical event states or state changes.
- **Combination Events:** A combination event is an event that becomes true when two or more other events are true. The events used in a combination event can be generated from one or multiple cameras. This allows events to be generated by simultaneous occurrences in several different images, if desired.

5.2 Setting Up Cameras and the User Interface

The procedures for setting up cameras and the user interface are the same as those used for the Tracking Option. See Chapter 3, Recording Video with CinePlex Studio.

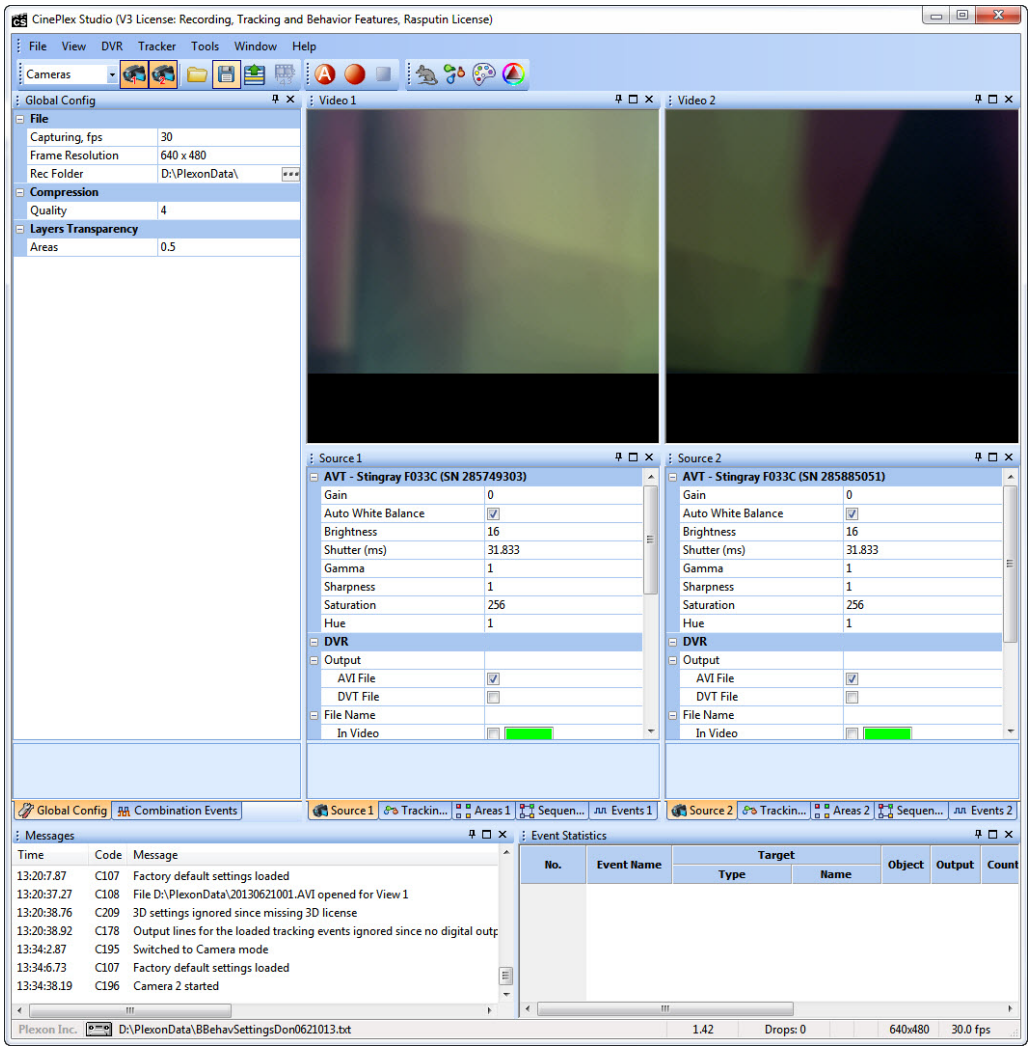
CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

5.3 Navigating the Studio Main Window

See the section Section 3.2, “Navigating the Studio Main Window” on page 29 for a basic description of the Studio main window, where you can view and modify CinePlex Studio settings before starting the recording session.

When the Tracking Option and Basic Behavior Option are present, there are additional toolbar options and panes, as shown in the image below.



5.4 Defining Arenas and Configuring Tracking Parameters

The procedures for defining the arenas and tracking parameters are the same as those used for the Tracking Option. See Chapter 4, Recording Positional Data with CinePlex Tracking Option.

5.5 Configuring Zones, Sequences and Events for Basic Behavior

This section explains how to create and configure zones, sequences of zones, events and combination events.

You can specify values for behavioral events for tracked objects, including such attributes as speed, direction (vector), limb angles, presence in particular zones in the arena, proximity to other objects or sequence of zones visited. For example, the system can create a digital event when the animal's speed is over/under a user-specified threshold, or the animal is within a user-specified distance of a certain point in the arena.

5.5.1 Before You Start

The procedures in Chapter 4, Recording Positional Data with CinePlex Tracking Option are required for configuring an arena for each camera. The arena must be configured and the Tracking Option must be configured before a zone can be created. The Basic Behavior Option is built on the Tracking Option.

5.5.2 Overview of Procedure

The procedure consists of the following tasks:

- Section 5.6, "Adding Zones (Static and Dynamic)" on page 143
- Section 5.7, "Defining Sequences of Zones" on page 149
- Section 5.8, "Defining Logical Events" on page 152
- Section 5.9, "Defining Combination Events" on page 166

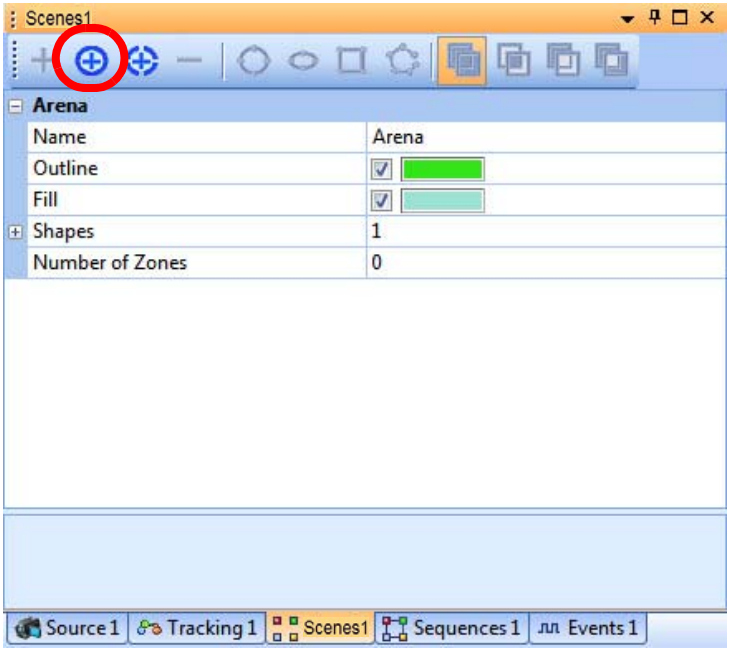
5.6 Adding Zones (Static and Dynamic)

There are two types of zones—static and dynamic. Static zones are created by clicking the **Static Zone** icon and defining the shape, size and location of the zone in the video image. Dynamic zones are created by clicking the **Dynamic Zone** icon and selecting the LED or color marker around which to draw it.

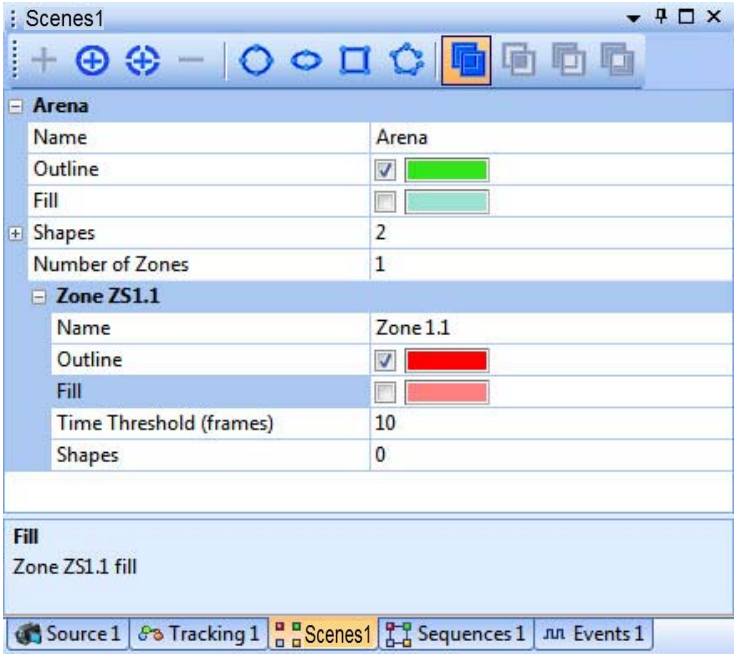
Note: See See "Terminology" on page 140 for definitions of static zone and dynamic zone. In general, static zones are associated with static objects in the arena and dynamic zones are associated with objects attached to the animal.

5.6.1 Adding a Static Zone

1 On the **Scenes** tab click the **Add static zone to current arena** icon.

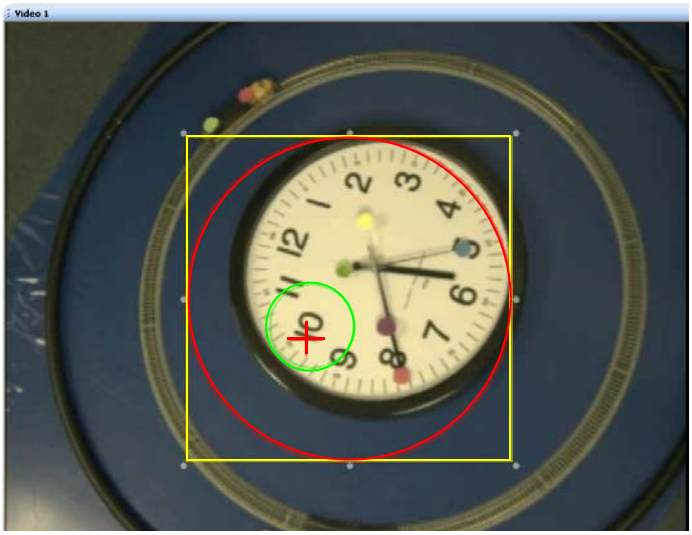


The parameters are displayed for the new Static Zone.

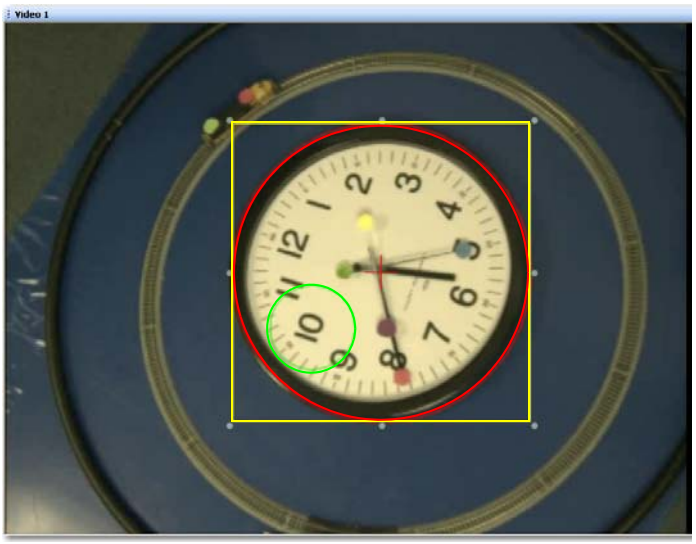


2 Select the drawing tool that makes the most sense for the zone that needs to be created.

3 Draw the zone outline over the image corresponding to the first physical zone of interest. For the image below a red circle was added.



4 Adjust size and shape so that the complete zone, and nothing else, is enclosed by the outline. For the image below, the circle was adjusted to fit around the clock by moving and adjusting the circle by the handles on the yellow square.



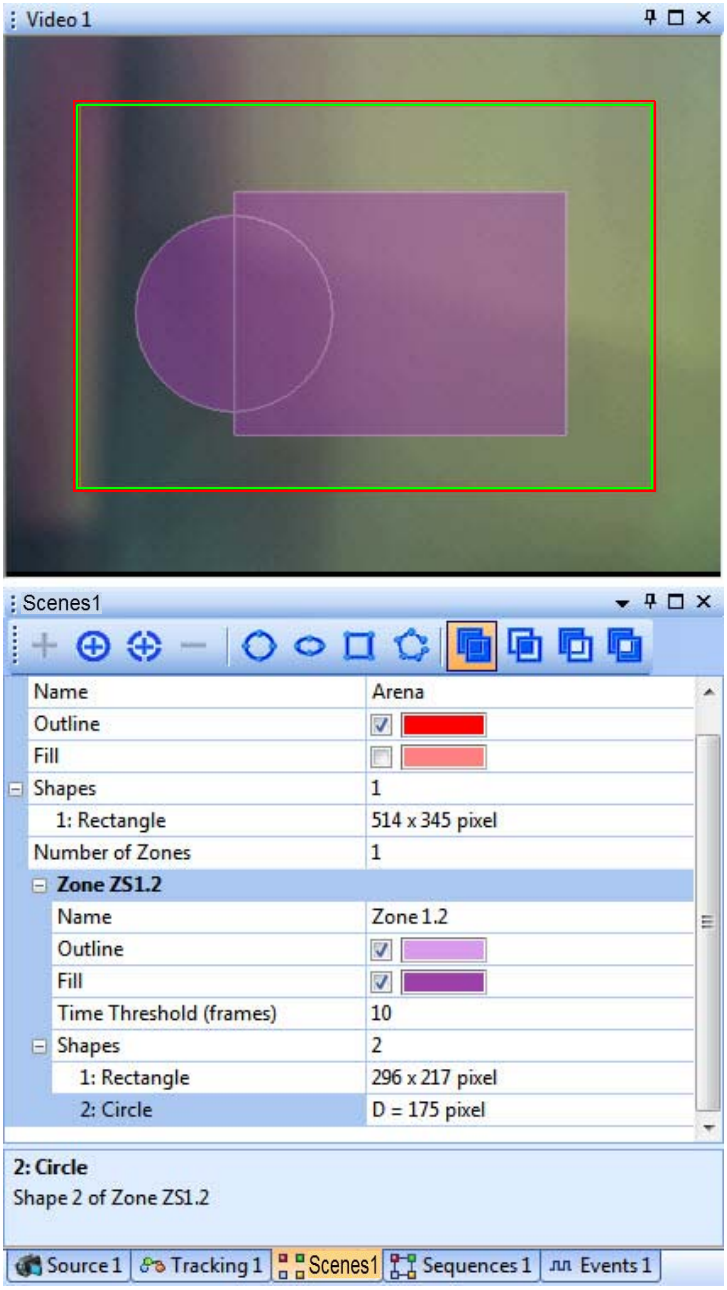
5 If a complex zone is desired, select a different drawing tool if needed, and the logical operator to be applied.

Note: Complex zones can be created by applying logical operations to additional shapes as they are added to the zone. These logical

operations are selected from the Scenes toolbar:

For a detailed description of the logical operators, see Section 4.5, “Defining the Arenas” on page 82.

The image below shows an example of a complex static zone.



6 If necessary, adjust the value for the **Time Threshold (frames)** parameter. This parameter specifies the number of frames that an object must be detected in the zone before it is considered “present.” Whether an object is “present” or not can be used to trigger a zone-related event. For a description

of the **Present in Zone** parameter, see Section 5.8.1, “Events Based on a Zone” on page 153.

Note: An object is considered “absent” from a zone in the first frame its coordinates are not in the zone.

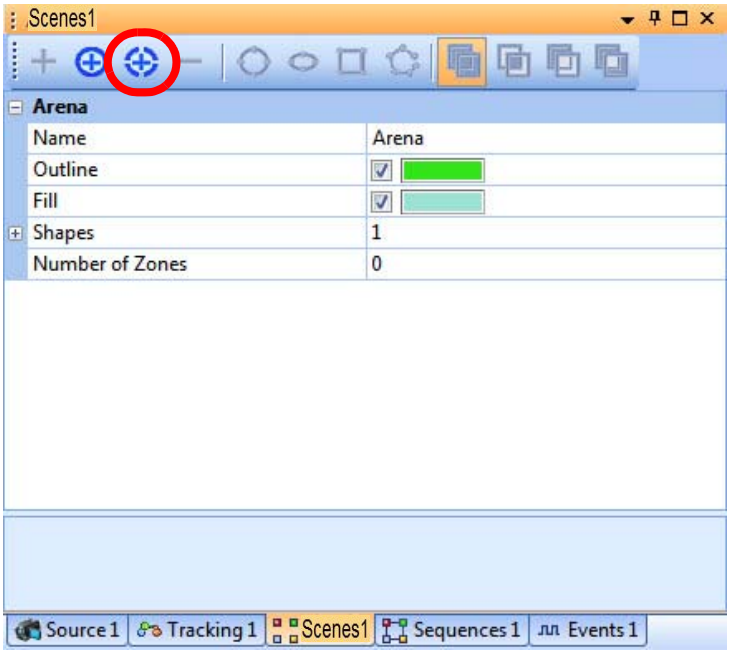
7 Repeat Step 1 through Step 6 for each additional zone to be defined.

8 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

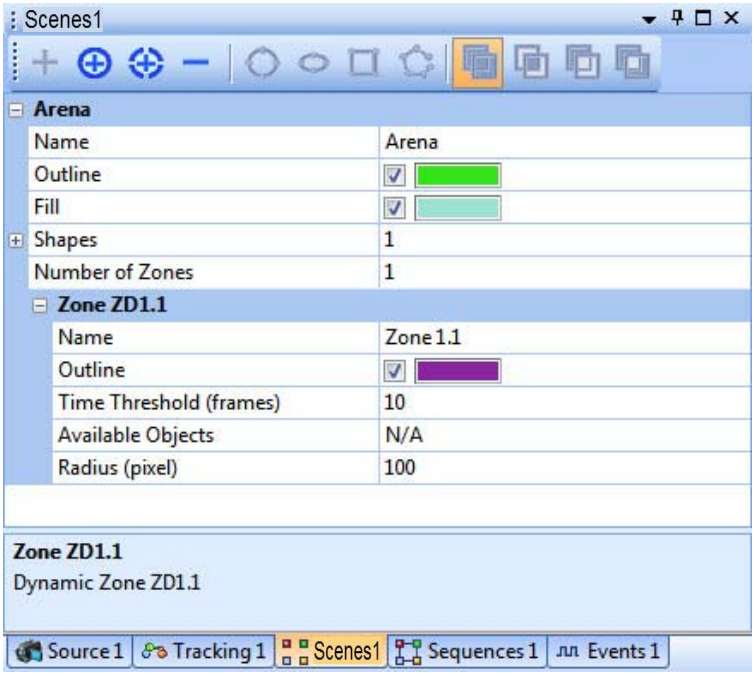
5.6.2 Adding a Dynamic Zone

Note: Dynamic Zones are not available for the Object Contour Tracking option.

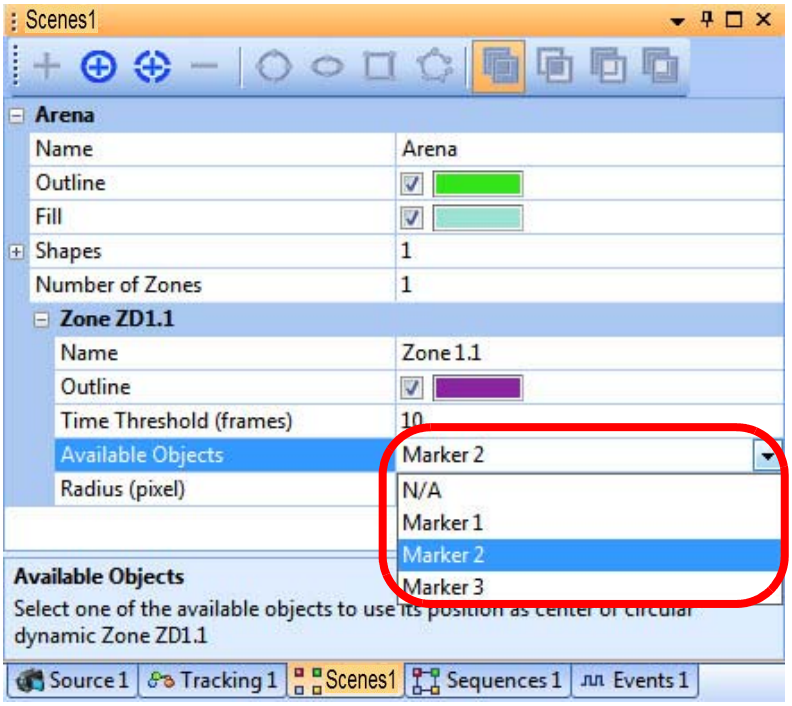
1 On the Scenes tab click the **Add dynamic zone to current arena** icon.



The parameters are displayed for the new Dynamic Zone.



2 In the **Available Objects** row, select the specific marker or LED on which the dynamic zone will be centered.



3 If necessary, adjust the values for the **Time Threshold (frames)** and **Radius** parameters.

The **Time Threshold (frames)** parameter specifies the number of frames that an object must be detected in the zone before it is considered “present” (and a zone-related event is triggered). For a description of the **Present in Zone** parameter, see Section 5.8.1, “Events Based on a Zone” on page 153.

Note: An object is considered “absent” from a zone in the first frame its coordinates are not in the zone.

The **Radius** parameter specifies the radius of the dynamic zone from the center of the LED or color marker.

4 Repeat Step 1 through Step 3 for each additional zone to be defined.

5 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

5.7 Defining Sequences of Zones

Note: Before defining sequences of zones, two or more zones must be defined.

TIP

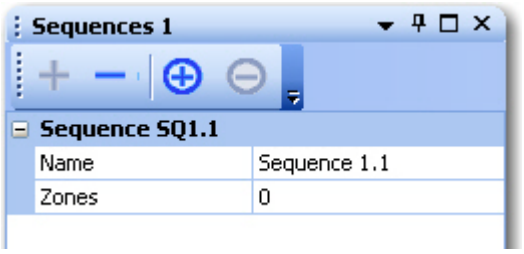
To view all panes in the main window, reset to default layout

If some of the panes are not visible in the main window, it may be helpful to restore the default screen layout. From the **Window** dropdown list, select **Layout**, then **Reset to Default Layout**.

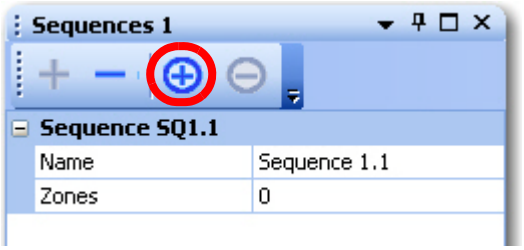
1 After two or more zones have been added, use the Sequences tab.

2 Click the **Add new sequence** icon to add a sequence.

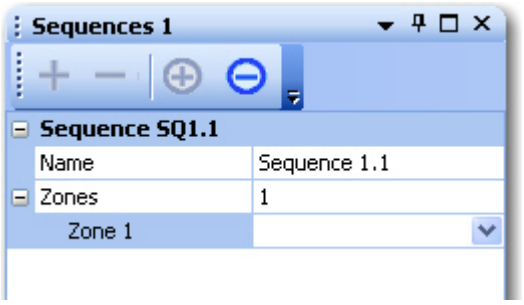
A new sequence is added to the pane.



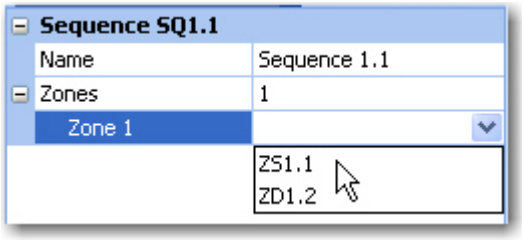
3 Click the **Add zone to selected sequence** icon to add a zone to the sequence.



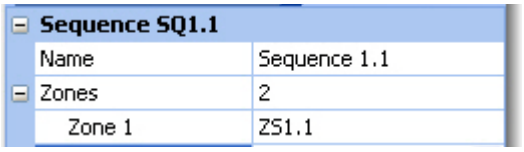
A zone is added to the sequence.



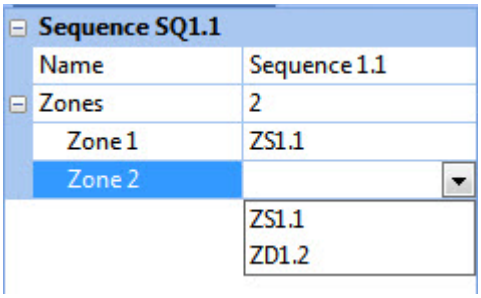
4 Select available zones from the drop down list for the new sequence.



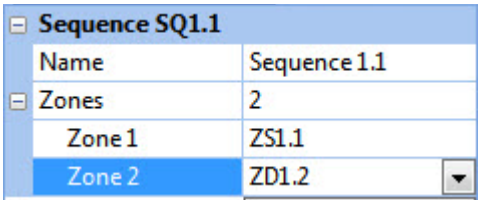
The selected zone is displayed in the **Zone 1** setting.



5 To add a second zone, repeat Step 3 and Step 4.



The selected zone is displayed in the **Zone 1** setting.



6 Repeat these steps for each additional sequence to be defined.

7 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

TIP

Understanding how sequences of zones are used

The purpose of defining a sequence of zones is to use this sequence to define a behavioral event. For example, you might configure an event in which the animal enters Zone 1 and receives a stimulus, then moves to Zone 2 to obtain a reward, then moves to Zone 3.

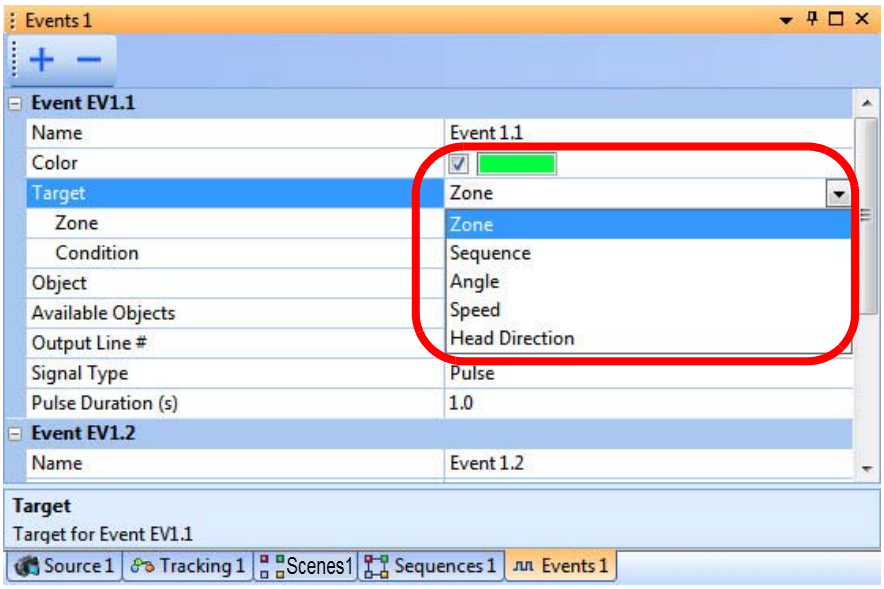
When you are configuring a sequence on zones, keep in mind how the system detects events based on these sequences, as described in Section 5.8.2, “Events Based on a Sequence of Zones” on page 155.

5.8 Defining Logical Events

Logical events can be defined as TRUE when an animal enters or leaves a zone or completes a sequence, or when a specified parameter (the angle between two vectors, the animal's speed or the animal's head direction) is within a specified range.

1 In the **Events** tab, select the **Add new tracking event** icon to create an Event.

2 In the Target row, select the type of Target behavior to be associated with the event.



The available parameters vary according to the type of Target selected. The available Targets depend on the type of tracking:

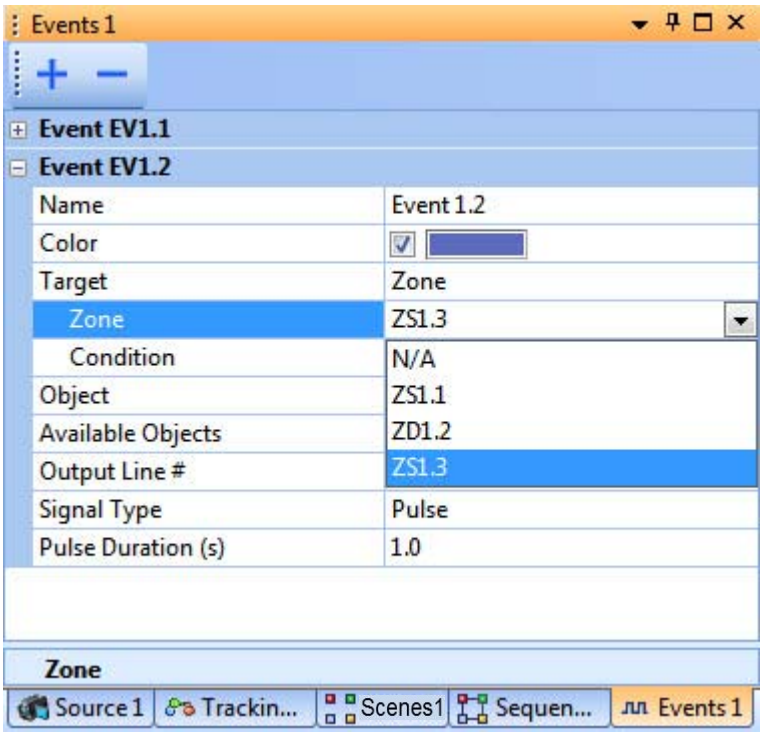
- For Object Contour Tracking, the Targets listed in the dropdown are **Zone**, **Sequence** and **Speed**.
- For LEDs, Markers, and Extended Markers, the Targets listed in the dropdown are **Zone**, **Sequence**, **Speed**, **Angle** and **Head Direction**.

See the specific procedure for each type of **Target**:

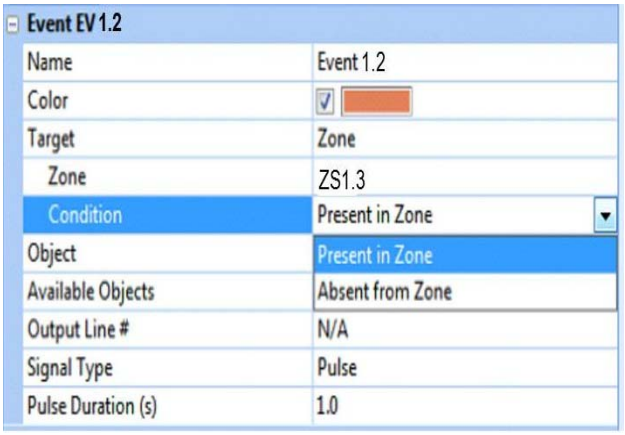
- Section 5.8.1, "Events Based on a Zone" on page 153
- Section 5.8.2, "Events Based on a Sequence of Zones" on page 155
- Section 5.8.3, "Events Based on an Angle" on page 157
- Section 5.8.4, "Events Based on Speed" on page 160
- Section 5.8.5, "Events Based on Head Direction" on page 164

5.8.1 Events Based on a Zone

1 Select a **Zone**.



2 Define the **Condition**.



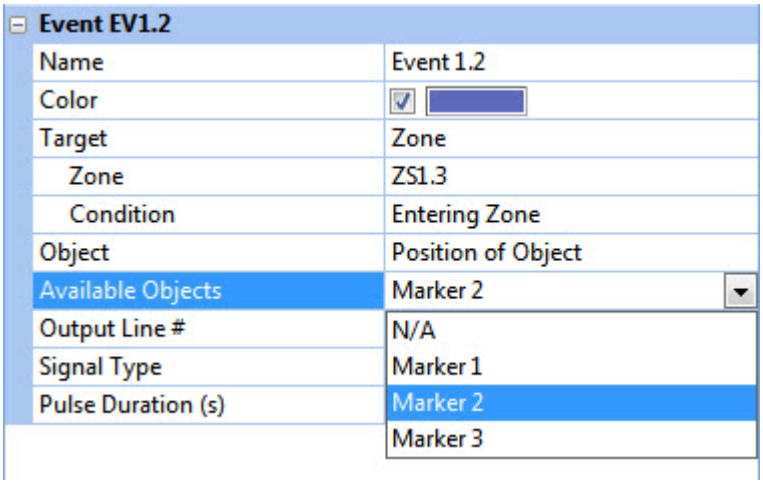
The **Present in Zone** event is dependent on the **Time Threshold (frames)** parameter that was set in the Scenes panel (see Section 5.6.1, “Adding a Static Zone” on page 144 or Section 5.6.2, “Adding a Dynamic Zone” on page 147 as applicable). Specifically:

- The **Present in Zone** event is triggered only when the coordinates of the object are inside the specified zone for the number of consecutive frames specified by the value of the **Time Threshold (frames)** parameter in the Scenes panel.

- An object is considered absent from a zone in the first frame its coordinates are not in the zone.

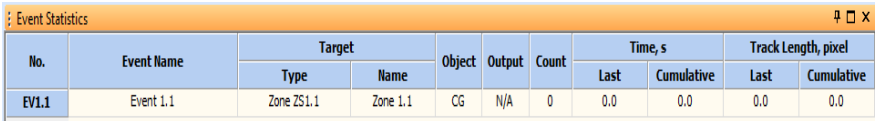
Note: (The meaning of "object" is explained in the **Available Objects** discussion in the next step.)

3 In the **Available Objects** row, select a tracked object to traverse the specified zone.



The event will become TRUE when the conditions are satisfied. At that point, the event count will be incremented and times and track lengths in the Event Statistics will be extended.

4 Event statistics can be viewed in the Event Statistics pane of the main window.

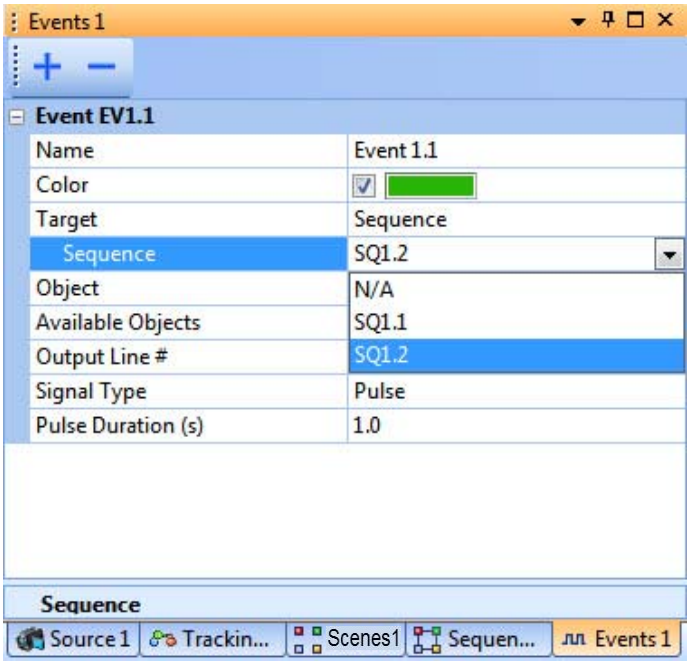


5 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

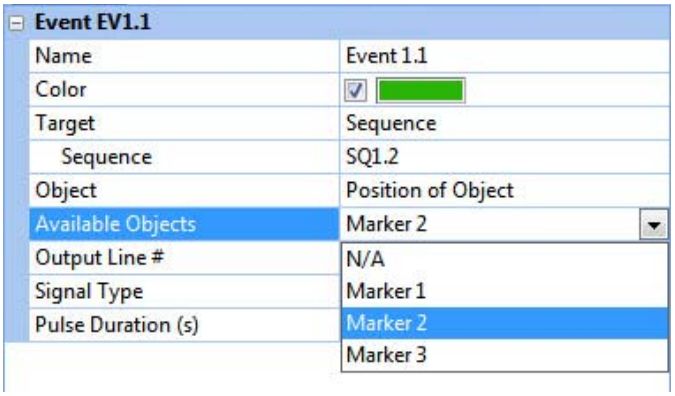
5.8.2 Events Based on a Sequence of Zones

This section explains how to configure events based on a sequence of zones and how the system detects and reports these events. It is recommended that you have a thorough understanding of the information in this section when you are defining sequences (as described in Section 5.7, “Defining Sequences of Zones” on page 149) and when you are creating events based on those sequences (as discussed below).

1 Select a **Sequence**.

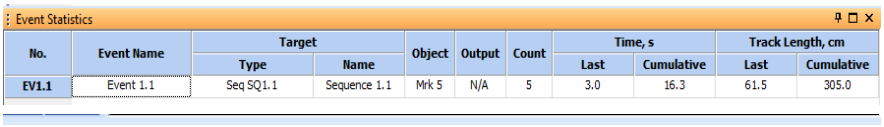


2 In the **Available Objects** row, select a tracked object to traverse the specified sequence of zones.



The event will become TRUE when the conditions are satisfied. At that point, the event count will be incremented and times and track lengths in the Event Statistics will be extended.

3 Event statistics can be viewed in the Event Statistics pane of the main window.



No.	Event Name	Target		Object	Output	Count	Time, s		Track Length, cm	
		Type	Name				Last	Cumulative	Last	Cumulative
EV1.1	Event 1.1	Seq SQ1.1	Sequence 1.1	Mrk 5	N/A	5	3.0	16.3	61.5	305.0

4 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

Understanding how the system interprets events based on sequences

The system treats sequence-based events “strictly.” Any interruption in the traversing of a sequence results in the system restarting the entire sequence from the beginning. The following conditions can cause a sequence to restart:

- Loss of tracking of the object fulfilling the sequence for even one frame.
- Exit from the arena by the object fulfilling the sequence for even one frame.
- Entry into any zone not in the sequence.
- Entry into a zone that is not the next zone specified in the sequence (for example, a sequence is configured as Zone1 > Zone2 > Zone3, and the object enters and exits Zone1 then enters Zone3).
- Exit from any zone in the sequence followed by re-entry into that zone before the sequence is completed. However, if it is the first zone, the sequence will be restarted.

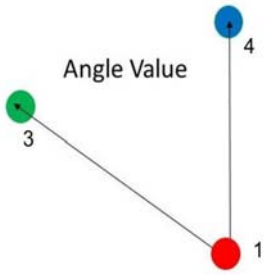
If a sequence restarts, it means that the event has not occurred. In that case, the system does not increment any counters and it resets the timer.

The system computes the track length and time for a sequence event as follows. Consider a sequence that consists of an object entering Zone1, then exiting Zone1, and some time later entering Zone2 and then exiting Zone2. The system starts measuring track length and time when the object enters Zone1 and it stops measuring track length and time when the object exits Zone2. The track length and time that the object spends between Zone1 and Zone2 are included in the total measurements.

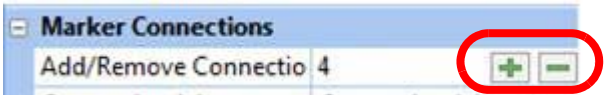
5.8.3 Events Based on an Angle

This section explains how to define and specify values for behavioral events based on the angle between two vectors. For example, an event could be generated when the animal's front leg is bent more than a certain angle.

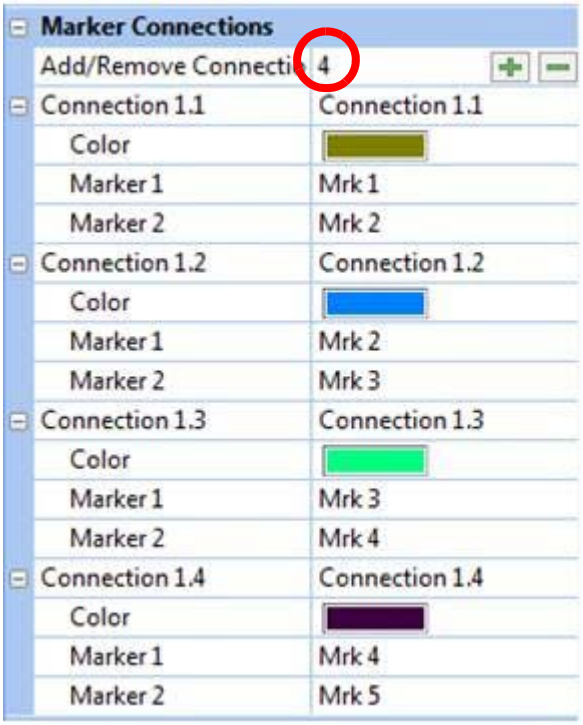
The procedure for creating an angle-based event involves defining *connections* between pairs of markers (or LEDs) and then defining an *angle* between a pair of connections. In the example shown below, one connection is defined from the red marker to the green marker, and a second connection is defined from the red marker to the blue marker. Then the angle of interest (Angle Value) is specified as the angle those two connections, in degrees.



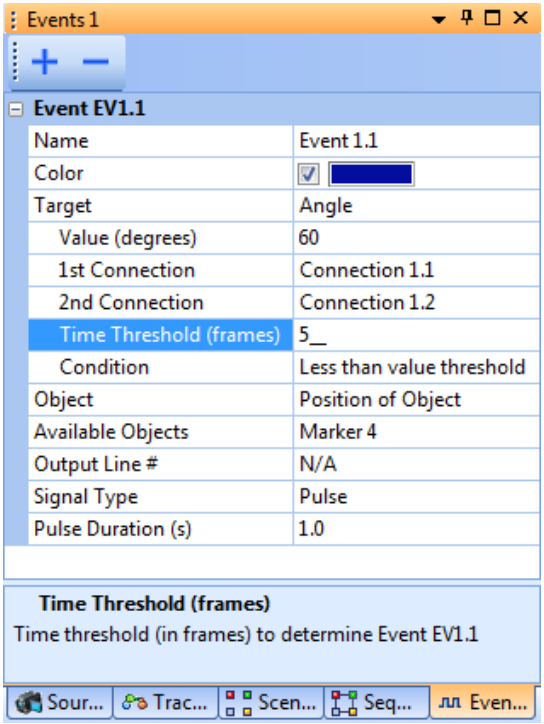
1 Add connections by clicking on the **+** icon in the **Add/Remove Connections** row.



2 Define two or more connections. In the example below, the user is defining four connections.



3 Define the event parameters.



The **Angle** event is considered TRUE only when the angle between the two vectors (**1st Connection and 2nd Connection**) meets the specified

Condition for the number of consecutive frames specified by the value of the **Time Threshold (frames)** parameter. The **Angle** event is considered FALSE in the first frame the specified condition is not met.

For example, in the image above, Event 1.1 (the Angle event) will be triggered when the observed angle between Connection 1.1 and Connection 1.2 is less than 60 degrees for five consecutive frames.

The **Available Objects** selection (optional) instructs the Event Statistics to display the track length of the selected object during the time that the event is TRUE.

When the event becomes TRUE, the event count will be incremented and times and track lengths in the Event Statistics will be recomputed and updated.

4 Event statistics can be viewed in the Event Statistics pane of the main window.

5 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

5.8.4 Events Based on Speed

This section explains the settings for the calculation of the animal's speed. It is not necessary to adjust any of these settings if you do not need data on the animal's speed (or if you are satisfied with the default values). There are two topics in this section:

- Procedure for configuring the Speed event
- How to decrease jitter in the speed calculation

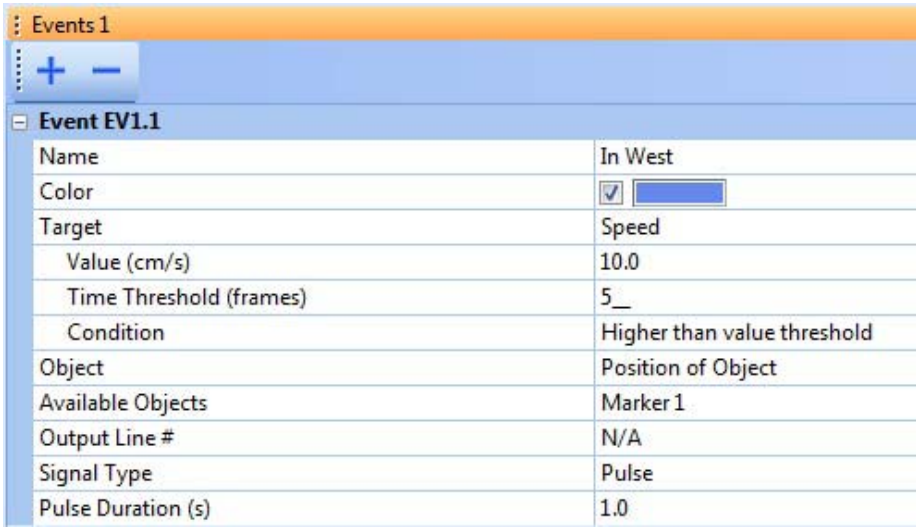
Procedure for configuring the Speed event

1. In the Events pane, specify the **Target** as **Speed**.
2. Specify the speed (**Value**), **Time Threshold** and **Condition**, **Object** (**Averaged Cent.Grav.** or **Position of Object**) and **Available Object**, plus any additional parameters as needed in the **Event** group. Speed is recorded in pixels/second unless the camera is calibrated, in which case it is recorded in cm/second or inches/second.

   The **Available Object** selection specifies the object to be tracked.

   The **Speed** event will become TRUE only when the tracked **Available Object** has been moving at a speed (**Value**) that meets the specified **Condition** for the specified **Time Threshold**.
3. (Optional) Set the **Color** parameter. The **Color** selection defines the color the system will use to highlight the event in the Event Statistics frame, provided that the event becomes TRUE.

   In the example below, if Marker 1 moves faster than 10.0 cm/s for five consecutive frames the event becomes TRUE.



When the event becomes TRUE, the event count will be incremented and times and track lengths in the **Event Statistics** pane will be recomputed and updated.

4 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

How to decrease jitter in the speed calculation

The **Speed Averaging Interval (s)** specifies the time period or window (in seconds) over which the average speed is calculated. This setting is used to decrease jitter in the calculation of the speed of a tracked object. When this parameter is set to 0 (the default value), the speed is computed for two sequential frames, and no averaging is performed.

If you see that the jitter or rapid variation in the speed is causing false triggering of speed events, consider setting the **Speed Averaging Interval (s)** to a non-zero value. You can set it to any value from 0 to 1.0 in increments of 0.1s (0.0, 0.1, 0.2, ... 0.9, 1.0). The larger the averaging window, the less the jitter. However, larger averaging intervals decrease the average speed. Therefore, be cautious about setting a non-zero value.

Calculation Example

- Assuming the frame rate of the camera is 30 frames per second (fps), a **Speed Averaging Interval (s)** setting of 0 means that the animal's speed would be calculated between sequential frames (30 times per second). Therefore, the speed will jitter.
- Assuming a camera frame rate of 30 fps and a **Speed Averaging Interval (s)** setting of 0.5 (0.5 second), the average speed would be calculated as follows:

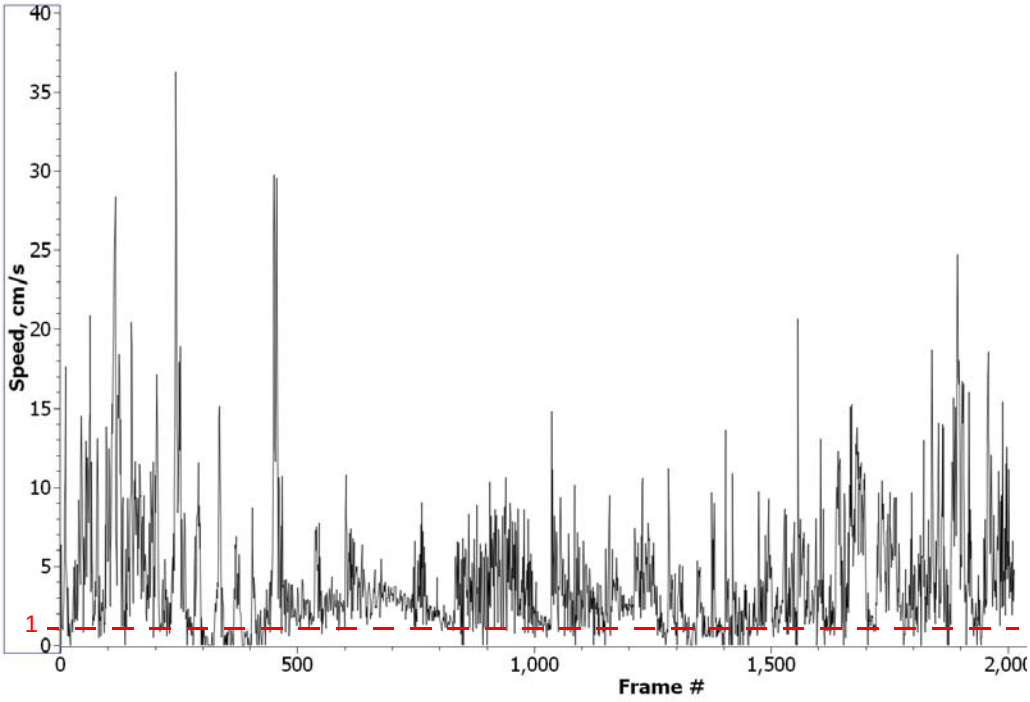
  Average speed for the 16th frame =
  { (animal's location in the 16th frame) –
  (animal's location in the 1st frame) } ***/*** (0.5 second)

  Average speed for the 17th frame =
  { (animal's location in the 17th frame) –
  (animal's location in the 2nd frame) } ***/*** (0.5 second)

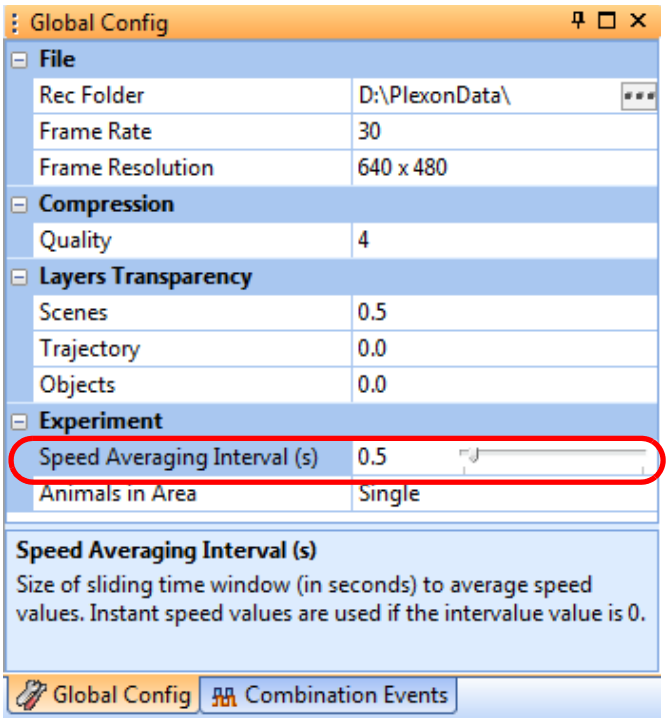
Usage Example

In the example below, the goal is to determine when the animal is immobile (not moving). In this example, there is a great deal of jitter in the unaveraged speed data, so that it appears as if the animal is never immobile even though the AVI video file clearly shows periods of immobility.

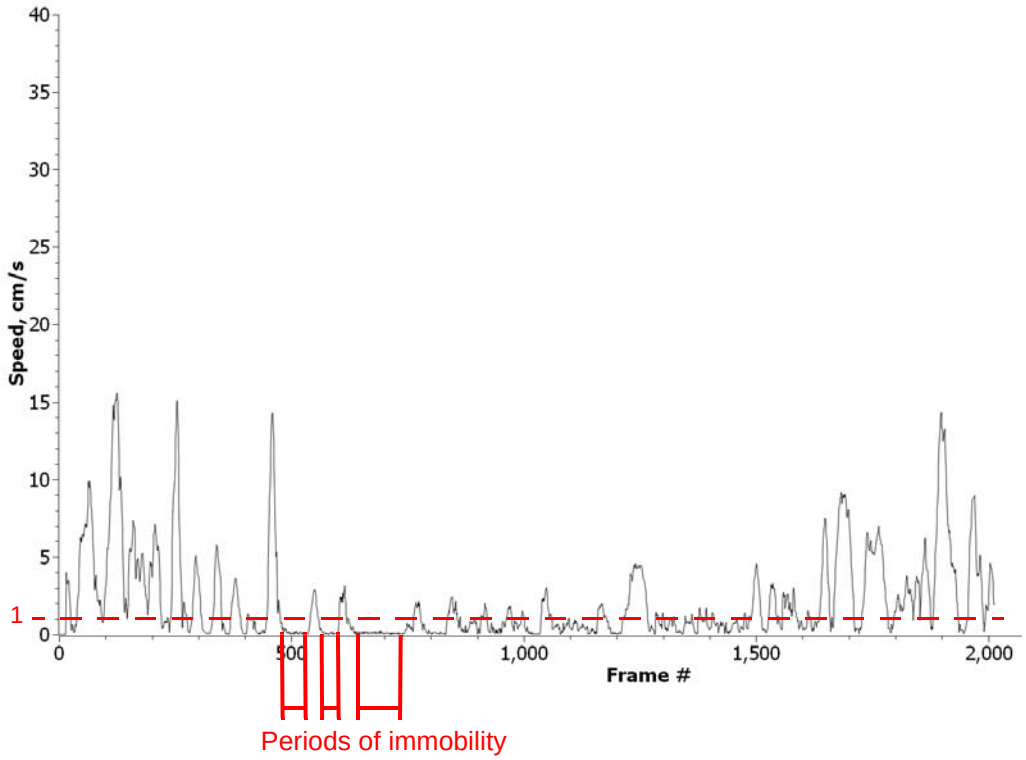
Let's define immobility as periods with speed less than 1cm/s for a duration of at least 60 frames. This means the speed should stay below 1cm/s for at least 2s at 30 fps. In this graph of the data, it appears that the speed never meets our definition of immobility.



In this situation you can use the **Speed Averaging Interval (s)** parameter to remove some of the jitter from the speed calculation. We will set this parameter to 0.5s and see how it affects the calculated speed.



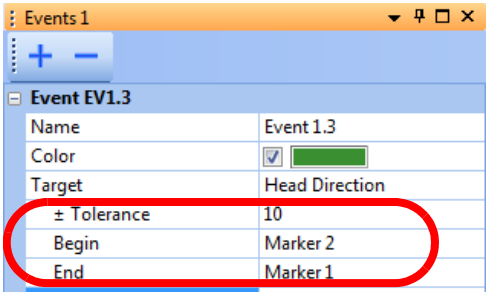
The results are shown in the graph below. Much of the jitter has been removed, and the calculated speed is noticeably lower than before. There are clearly some periods of what appears to be immobility as defined above.



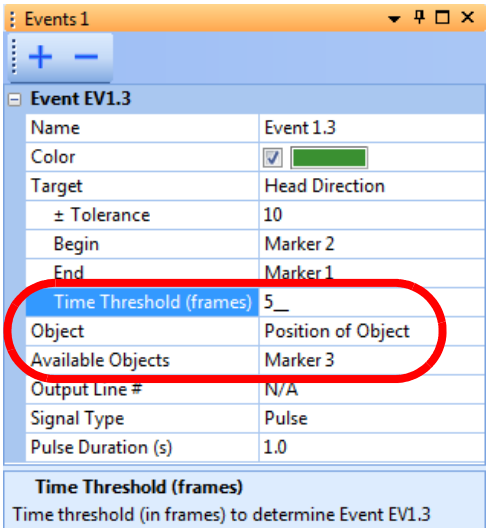
5.8.5 Events Based on Head Direction

This section explains how to define and specify values for behavioral events based on the animal's head direction as determined with markers or LEDs on the headstage. For example, an event could be generated when the animal's head faces toward the feeding station (within a certain number of degrees).

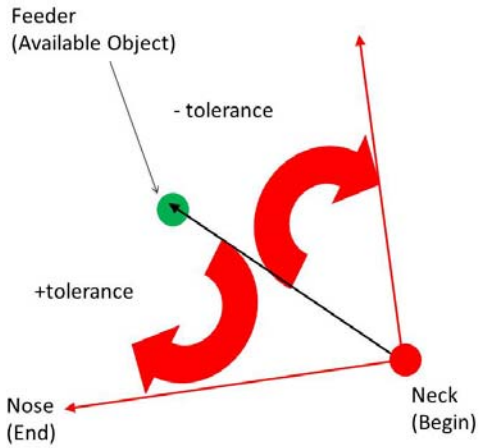
1 In the Events tab, specify the **Tolerance** (in degrees) and specify the markers or LEDs that identify the beginning and end of the head.



2 Specify the **Time Threshold** in seconds, **Object** (**Averaged Cent.Grav.** or **Position of Object**) and the target object (**Available Objects**). In the image below, the feeder location (for example) is identified as Marker 3. The event will be triggered when the head direction is within + or - 10 degrees of Marker 3 for the specified **Time Threshold** (five consecutive frames).



The meaning of these parameters is illustrated in the following diagram:

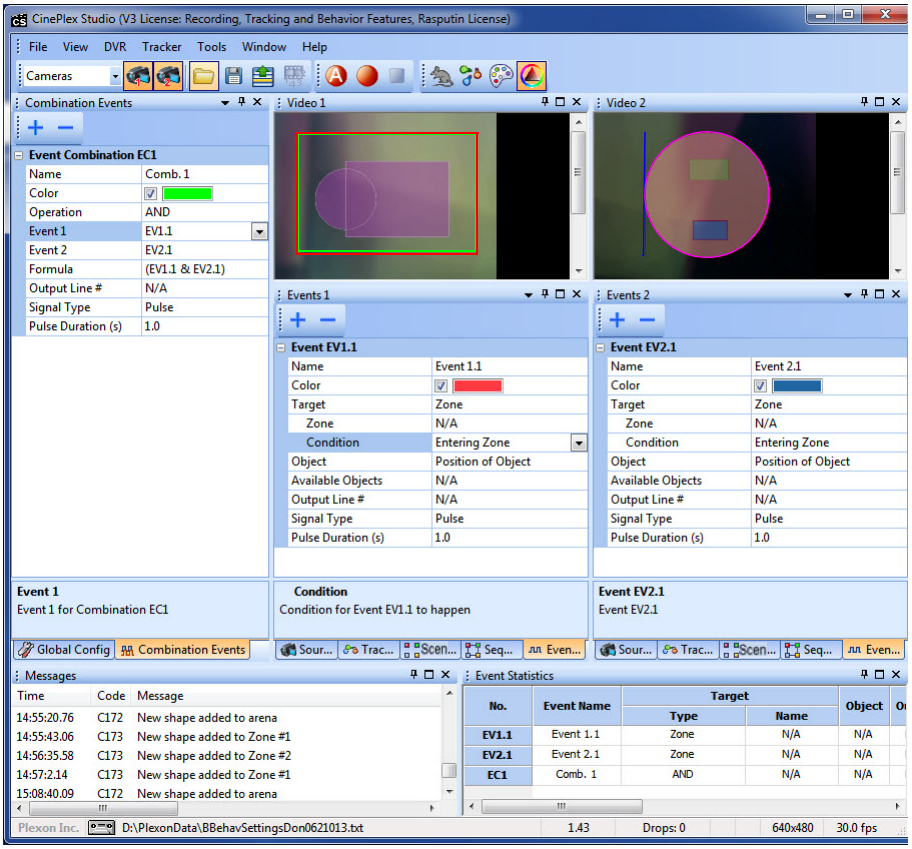


3 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

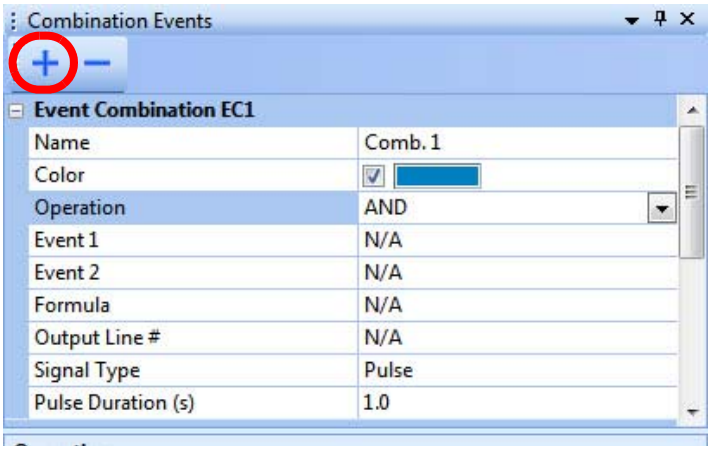
5.9 Defining Combination Events

1 Use the **Combination Events** tab.

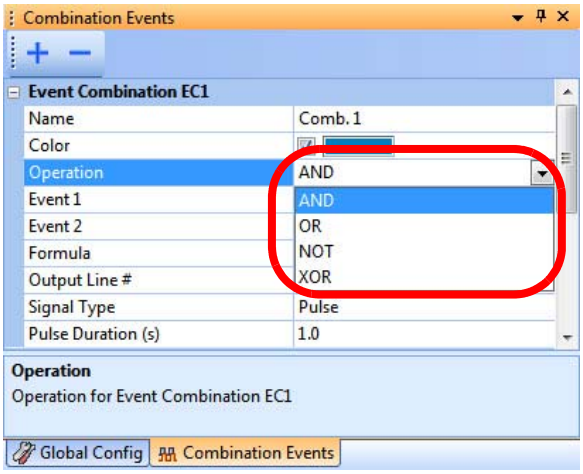
Note: When two or more video sources are available, combination events can be created using events from multiple cameras. This is helpful, for example, for triggering an event when an animal is occupying a volume that has a different projection in each source. In the example below, the **Combination Events** tag is located in the Global Configuration pane; however, if desired, it can be repositioned in other panes, for example, the Video1 pane.



2 Click the **Add new combination of tracking events** icon.



3 Select the logical operation to use.



Operation (see the image above)—Used to specify events that are combinations of one or more existing events on which logical operations are performed. The existing events can be any single or combination event. The four logical operators are **NOT**, **AND**, **OR** and **XOR**:

NOT—For single events, an event can be defined which is the opposite of it by using the **NOT** operator. The new event is true when the original event is not true and vice versa (the new event is not true when the original event is true). For example, **NOT**[animal is inside feeding zone] means the animal is not inside the feeding zone.

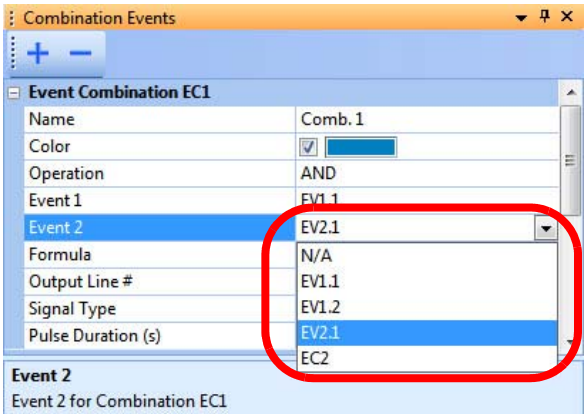
For the combination of two events, the **AND**, **OR** and **XOR** operators are available. The resulting combination event is considered true under the following conditions:

AND—Both of the individual events are true

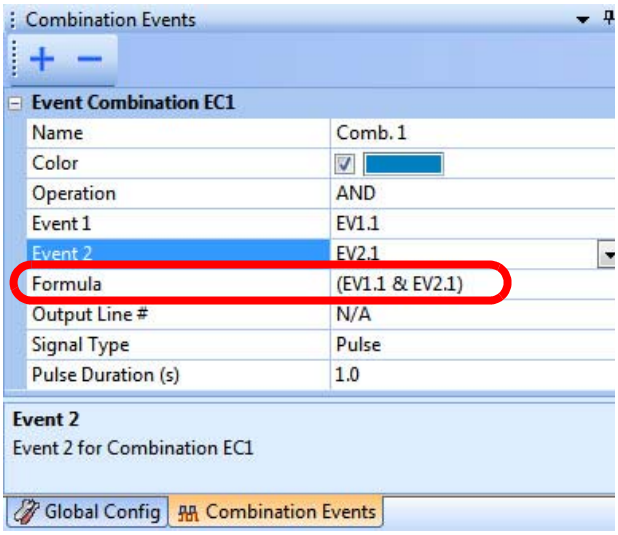
OR—Either one of the individual events is true, or both of the individual events are true

XOR—Either one of the individual events is true, but not both of them

4 Select each event in the sequence from the drop down list of available events.

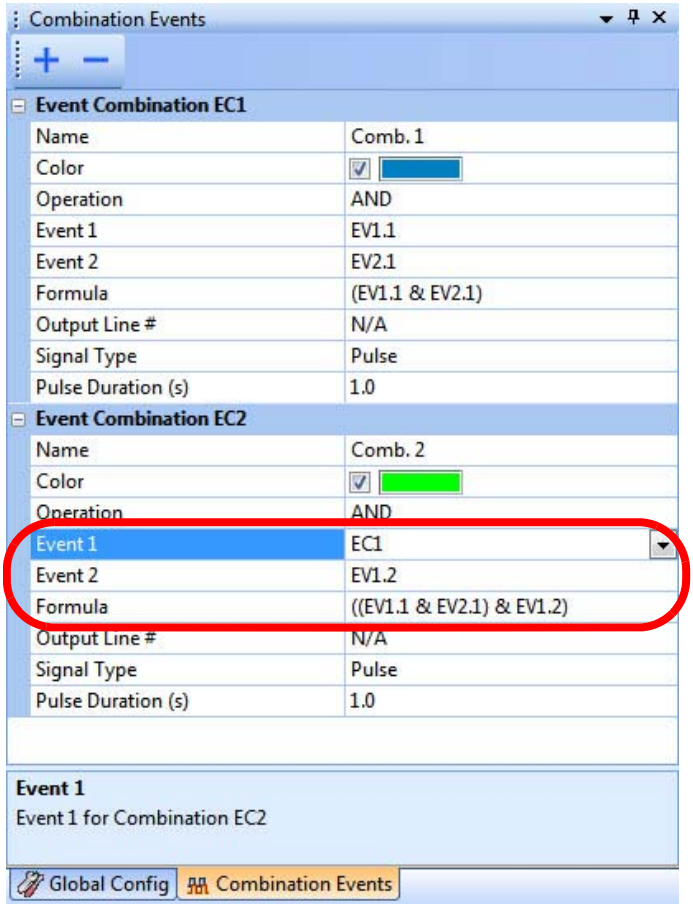


The system generates an entry in the Formula line based on the Operation and Event(s) that the user selected in the above steps.



5 If desired, an Event Combination can contain other Event Combinations, as shown in the following example. Events of arbitrary complexity can be created

by combining already combined events with combined or non-combined (single) events.



6 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

5.10 Using Dynamic Zones to Detect Social Interactions

If you are tracking an animal by means of LEDs or color markers, you can use the dynamic zones capability to detect when a tracked LED or marker moves within a certain distance of another animal.

Example—Social interaction—Proximity of animal to another animal

This example defines a behavioral event for an animal's proximity to another animal. For one of the animals, you can define a dynamic zone of a certain radius around a marker on the animal's head. Then you can cause an event to be triggered when a marker on the head of a second animal touches or crosses the boundary of the dynamic zone around the first animal. In this example, we will set the radius of the zone to 3cm, so if the animals approach within 3cm, the event will be triggered.

In the Tracking toolbar:

1. Select **LED** or **Extended tracking of color markers** tracking mode. In this example, we will select markers.

In the Tracking pane:

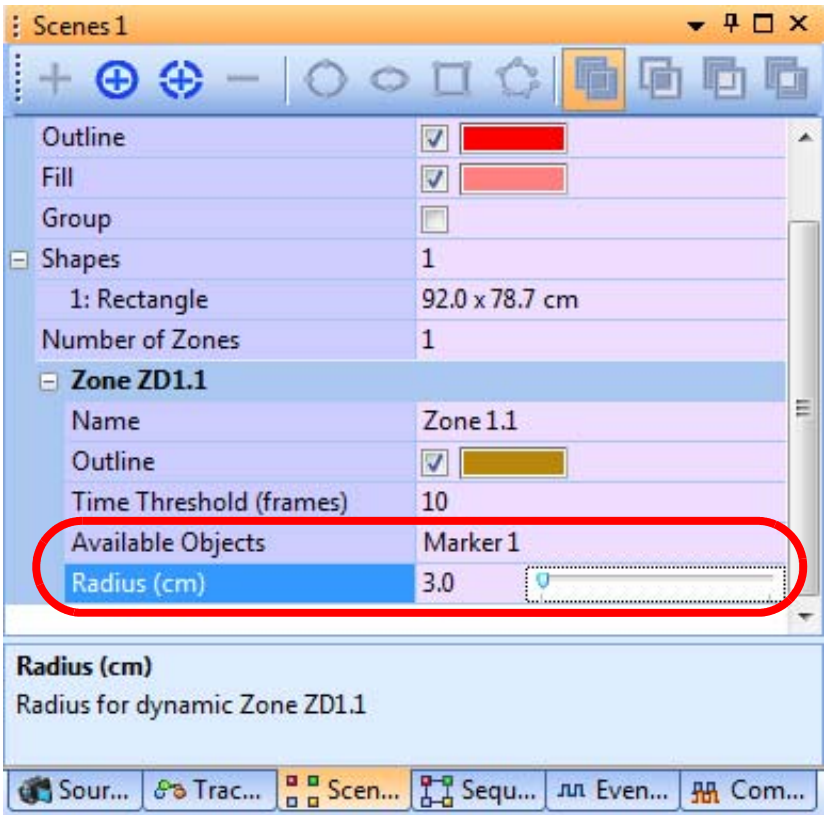
2. Select the checkboxes for Marker 1 (the marker on the head of the first animal) and Marker 2 (the marker on the head of the second animal).

In the Sources pane:

3. Calibrate the arena in cm.
4. Select the **Use Calibration** checkbox.

In the Scenes pane:

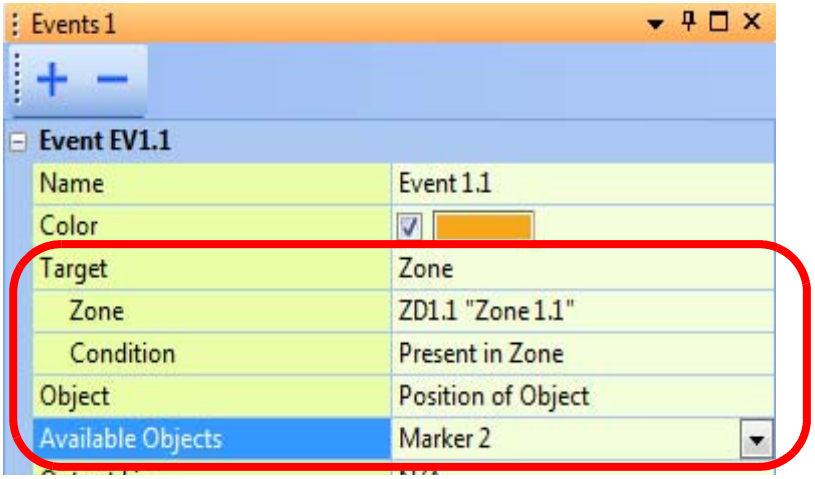
5. Draw the arena.
6. Define a dynamic zone around Marker 1.
7. Set **Available Objects** to Marker 1 and **Radius (cm)** to 3.0cm.



In the Events pane:

8 Set the **Target** to the dynamic zone that was established previously for the 3cm radius around Marker 1 on the head of the first animal.

9 Set the **Condition** as Present in Zone and **Available Objects** as Marker 2 (the marker on the second animal's head).



In the above example, when Marker 2 comes to within 3cm of Marker 1, regardless of which animal is moving, the event (EV1.1 in this example) is triggered.

Save settings if desired:

10 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

5.11 Specifying Digital Outputs

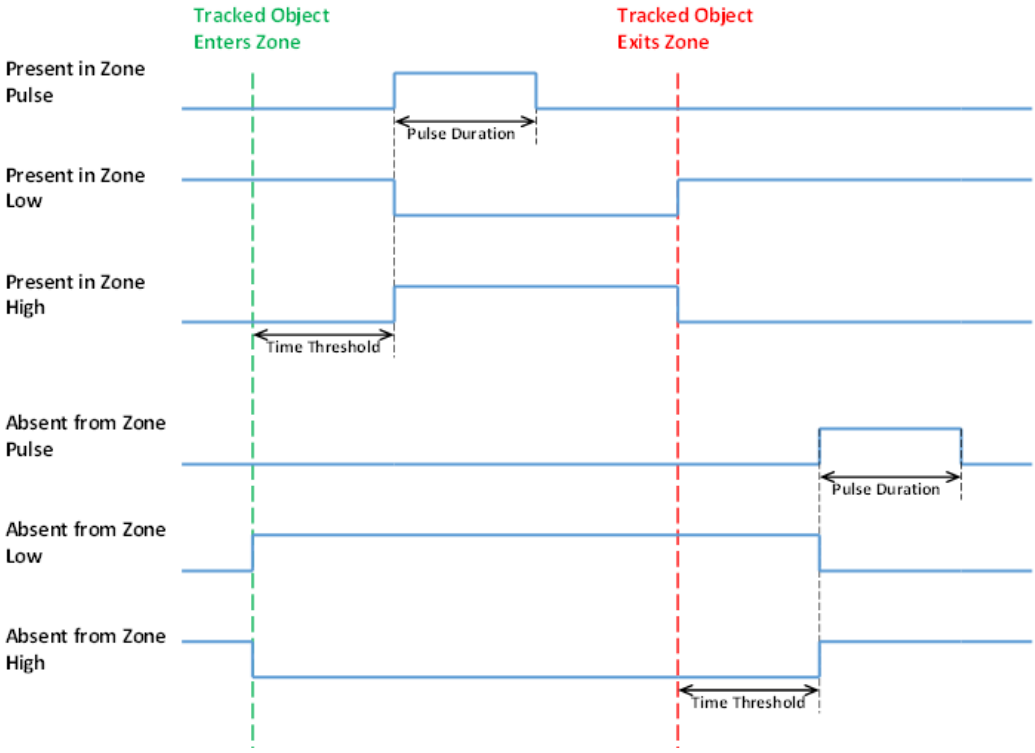
The CinePlex System can be configured to generate zone events when a specified tracked object enters or exits from a specified zone. These events can be mapped to digital outputs in order to pass the information to external devices.

The exact nature of the resulting digital output depends on several settings in the CinePlex user interface:

- The **Time Threshold (frames)** parameter associated with the zone
- The **Condition** associated with the zone event—**Present in Zone** or **Absent from Zone**
- The **Signal Type** associated with the zone event—**Pulse**, **Low** or **High**

Note: If the **Signal Type** is **Pulse**, the **Pulse Duration (s)** parameter needs to be set to a value between 0.1 to 5.0 (default value is 1.0)

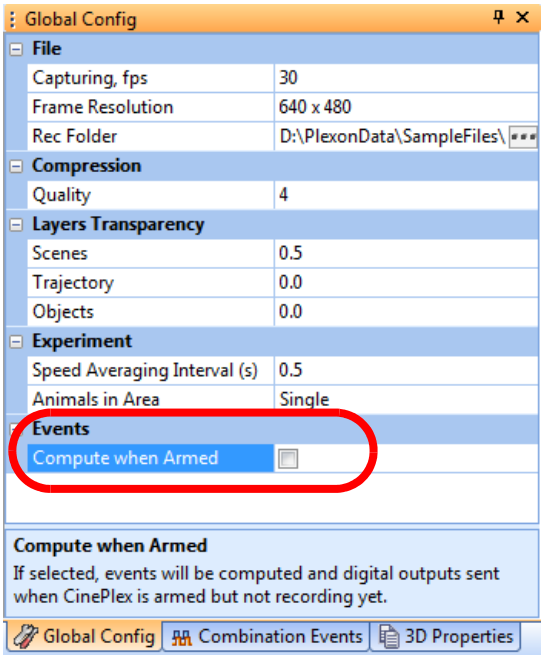
The meaning of these parameters is illustrated in the diagram below. The figure assumes that the tracked object starts outside the zone and enters and exits the zone at the times indicated. Note that the system applies **Time Threshold** parameter for the TRUE condition but not for the FALSE condition.



Note: By default, the system does not evaluate event conditions while it is in Armed mode ( ). This ensures that the CinePlex System does not send signals to the OmniPlex System or user systems attached to the DO Unit before recording actually starts. Evaluation of event conditions only begins when recording starts.

If you want the CinePlex System to send event data to the OmniPlex System while the CinePlex System is in the Armed state, you can select the **Compute when Armed** checkbox. However, this can cause events to be present in the OmniPlex System PL2 file that are not present in the CinePlex AVI file.

The default setting, which is recommended for typical applications, is unchecked, as shown in the image below.



Digital Output Unit

In order to transmit digital outputs to external devices, the digital output (DO) unit must be installed. (It is included with the Basic Behavior Option and the Basic Behavior license must be installed to use this feature.) The DO unit connects to a USB port on the host PC. (Be sure to restart the CinePlex Studio application after connecting the USB cable.) The DO unit is shown below.

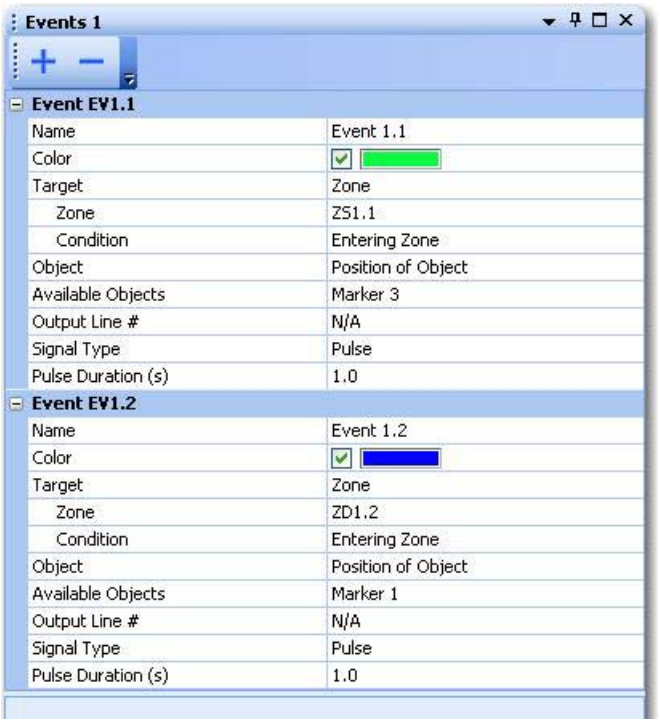
You can specify creation of digital outputs for single events and for combination events. Up to 24 different digital outputs can be specified, any of which can be pulsed, high, or low when the event occurs (i.e., when the event becomes TRUE).

Procedure

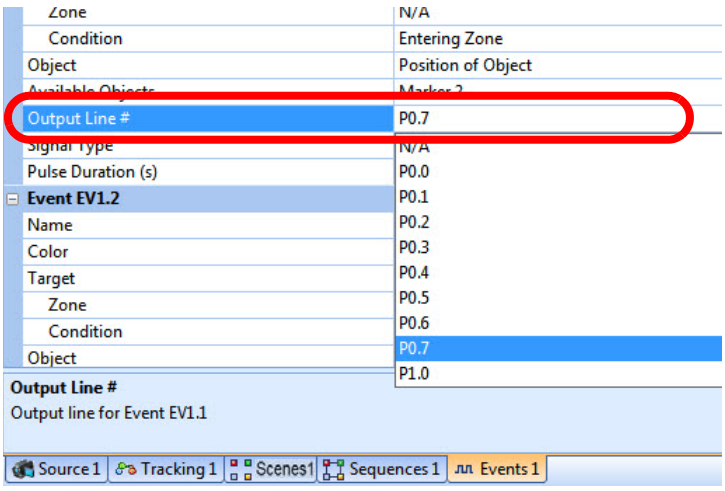
1 Ensure that the CinePlex DO unit is connected to a USB port on the host PC.

2 Restart the CinePlex Studio application after connecting the USB cable.

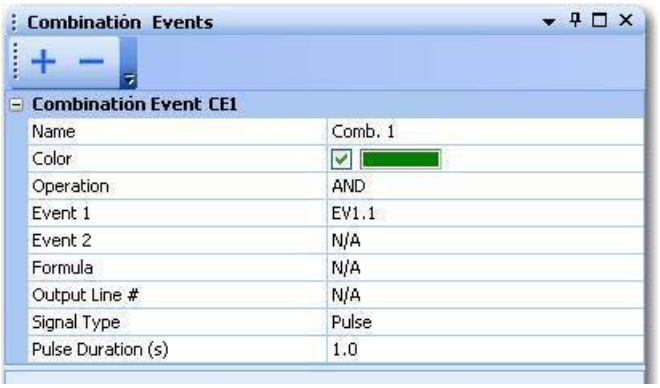
3 Open the Events tab.



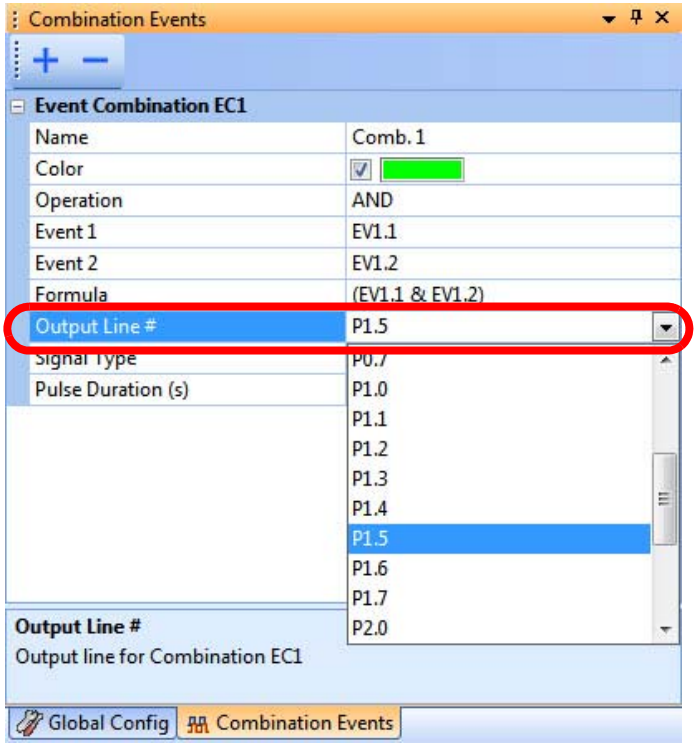
4 To specify that a digital output is sent when an event occurs (becomes TRUE), select the desired output line from the drop down list associated with the event. The output line numbers correspond to the line numbers shown in the side view of the DO unit (see the photograph of the DO unit, above).



5 For event combinations, open the Combinations Event tab.



6 To specify that a digital output is sent when a combination event occurs (becomes TRUE), select the desired output line from the drop down list associated with the combination event.

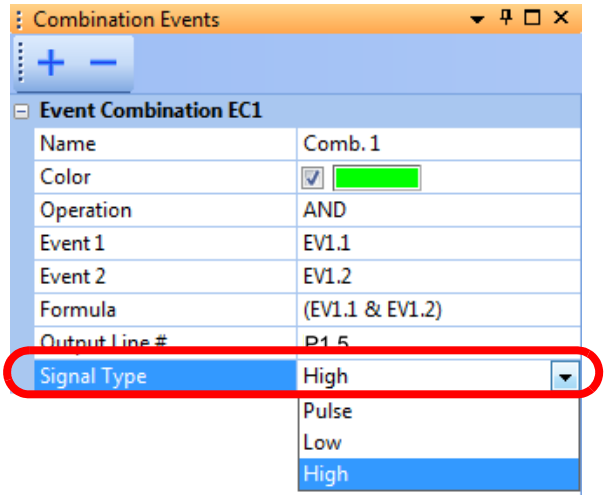


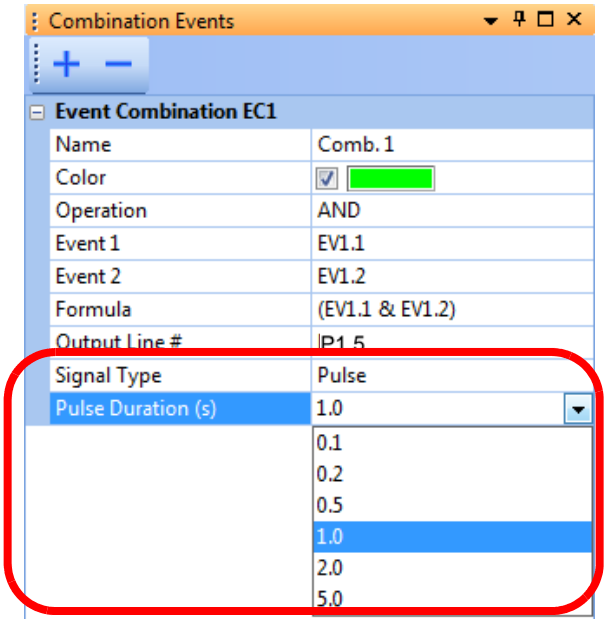
7 (This step refers to the DO signals illustrated in the diagram at the beginning of this section, Section 5.11, “Specifying Digital Outputs” on page 172.)

Select the **Signal Type**, which can be a **Low** or **High** level signal or a **Pulse**. If you select **Pulse**, the **Pulse Duration (s)** row will appear and you can enter the length of the pulse (0.1 to 5.0 seconds). These options are shown in the images below.

- An output signal specified as a **Pulse** indicates that a transition has occurred, for example, an animal has entered a specific zone. The pulse signal transitions from 0V to 5V.

- An output signal specified as a level indicates that a condition is true for some period of time, for example, an animal is inside a particular zone:
    - **High** true output voltage transitions from 0V (not asserted) to 5V (asserted).
    - **Low** true output voltage transitions from 5V (not asserted) to 0V (asserted).





8 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

Timing of Event Digital Output Signals Relative to Frame Timestamp

It is important to understand the timing of event digital output signals relative to the frame in which an event actually occurs.

The timestamp associated with a video frame is the time when its shutter opens relative to time zero in the recording. The time when a digital output signal is generated to reflect the change in the state of an event will always lag the video frame time. These are the components of the lag:

a Shutter open time

b Image processing time in the camera

c Image transmission time from the camera to the CinePlex Studio computer

d CinePlex Studio image processing time

e CinePlex Studio logical processing to determine need for new True or False event

f CinePlex Studio I/O processing sending the digital output signal

The sum of all of these times varies with image size, computer speed, image complexity, tracking type, event count, and a few more minor factors. But the biggest factor by far (of those listed above) is [a] the shutter open time, since by default it is set to the maximum possible, which is slightly less than the interframe interval.

For example, at 30 frames per second, the shutter open time defaults to 0.0322 milliseconds for many cameras. The typical total for lag factors [b] through [f] (in the above list) is normally 0.020 seconds or less. However, it could be more than 0.020 seconds in some circumstances. So in the case where CinePlex Studio is running in a mode controlled by the OmniPlex System, and CinePlex digital outputs are connected to OmniPlex digital inputs, the events arriving at the OmniPlex System will be timestamped 0.0522 seconds, usually less, after the timestamp for the frame in which they are detected.

5.12 Calibrating the Arena Dimensions

In many experiments, it is useful to calibrate the video image for each camera so that sizes, positions and velocities are reported in the desired units of measure instead of pixels. See Section 3.3, “Calibrating the Arena Dimensions” on page 30 for the procedure.

5.13 Recording Synchronized Video Tracking and Neural Data

The procedure for recording video and neural data is the same as that used for the Tracking Option. See Chapter 4, Recording Positional Data with CinePlex Tracking Option.

5.14 Monitoring the Video During a Recording Session

The status bar in the CinePlex Studio main window displays information that allows the researcher to monitor the video recording process. See the section Section 3.6, “Monitoring the Video During a Recording Session” on page 51 for a description of this feature.

TIP

Verify that tracking and events are displaying as expected

During the recording, you should see that the tracking window is successfully following the subject in the arena. If you have configured events, verify that the Events Statistics are updating as expected.

5.15 Recording Video without Neural Data (Used for Animal Training)

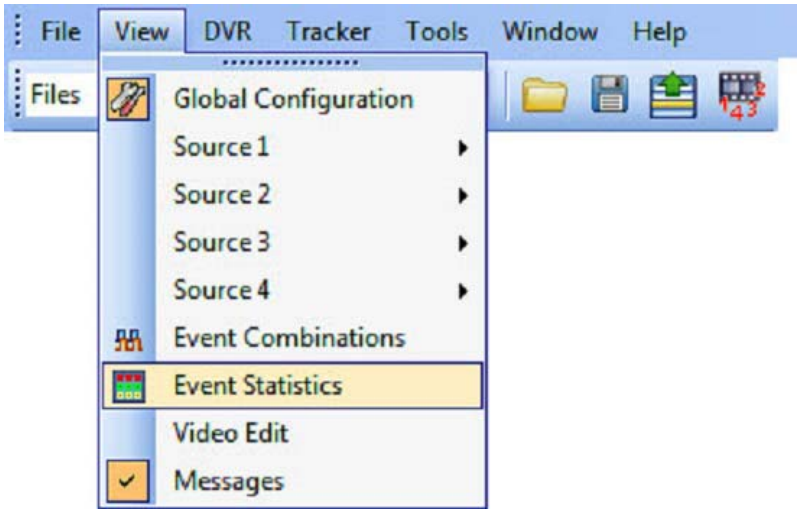
You can record video, tracking and basic behavior data without neural data. In this case, the OmniPlex® System is activated only for the purpose of providing the required clock for CinePlex. This procedure requires activation of the OmniPlex data stream (which starts the clock), and then starting and stopping the CinePlex Studio video recording process locally (with the CinePlex controls). This method of triggering the recording is typically used during animal training, when no neural data are being collected.

See the section Section 3.8, “Recording Video without Neural Data (Used for Animal Training)” on page 54 for this procedure.

Note: In addition to the parameters configured in that procedure, you can also configure the Tracking Option and Basic Behavior Option parameters.

5.16 Displaying Behavioral Event Statistics

To open the event statistics pane, select **Event Statistics** from the **View** pulldown menu.



The images below are examples of event statistics displays for sequence-based and angle-based events.

Event Statistics

No.	Event Name	Target		Object	Output	Count	Time, s		Track Length, cm	
		Type	Name				Last	Cumulative	Last	Cumulative
EV1.1	Event 1.1	Seq SQ1.1	Sequence 1.1	Mrk 5	N/A	5	3.0	16.3	61.5	305.0

Event Statistics

No.	Event Name	Target		Object	Output	Count	Time, s		Track Length, cm	
		Type	Name				Last	Cumulative	Last	Cumulative
EV1.1	Event 1.1	60.0 degrees	88.4	N/A	N/A	18	0.1	1.3	0.0	0.0

5.17 Video Playback and Rerecording In Studio Files (Offline) Mode

CinePlex Studio can be used in offline mode to play back and rerecord video from existing files. The existing AVI and/or DVT files are the ones recorded previously by means of the procedure in Section 5.13, “Recording Synchronized Video Tracking and Neural Data” on page 179.

The procedure is the same as presented in Section 3.9, “Video Playback and Rerecording in Studio Files (Offline) Mode” on page 61.

5.18 Additional File-processing Tools

Additional tools can be used for processing of files. See Section 4.17, “Additional File-processing Tools” on page 137.

Chapter 6
Retrack AVI Procedure

6.1 Retracking AVI In Studio Files Mode 182
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6.3 Selecting the Correct Procedure 183
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6.5 Retracking Video in Systems Licensed for Multiple Cameras 187
6.6 Retracking Single Video when Licensed for Multiple Cameras 189
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6.8 Modifying Parameters for Retracking 195
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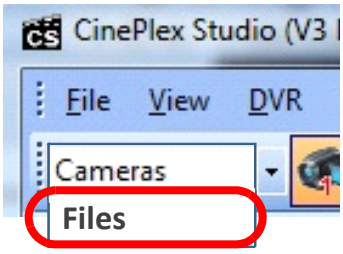
6.1 Retracking AVI In Studio Files Mode

This chapter explains how to retrack video streams using settings that are different from those used in the original AVI recording. This procedure is useful if you did not specify tracking during the original recording, or if you are not satisfied with your tracking results and want to apply new calibration, tracking parameters, arena shapes, behavioral events and/or recording settings.

6.2 Getting Started—Entering Offline Mode

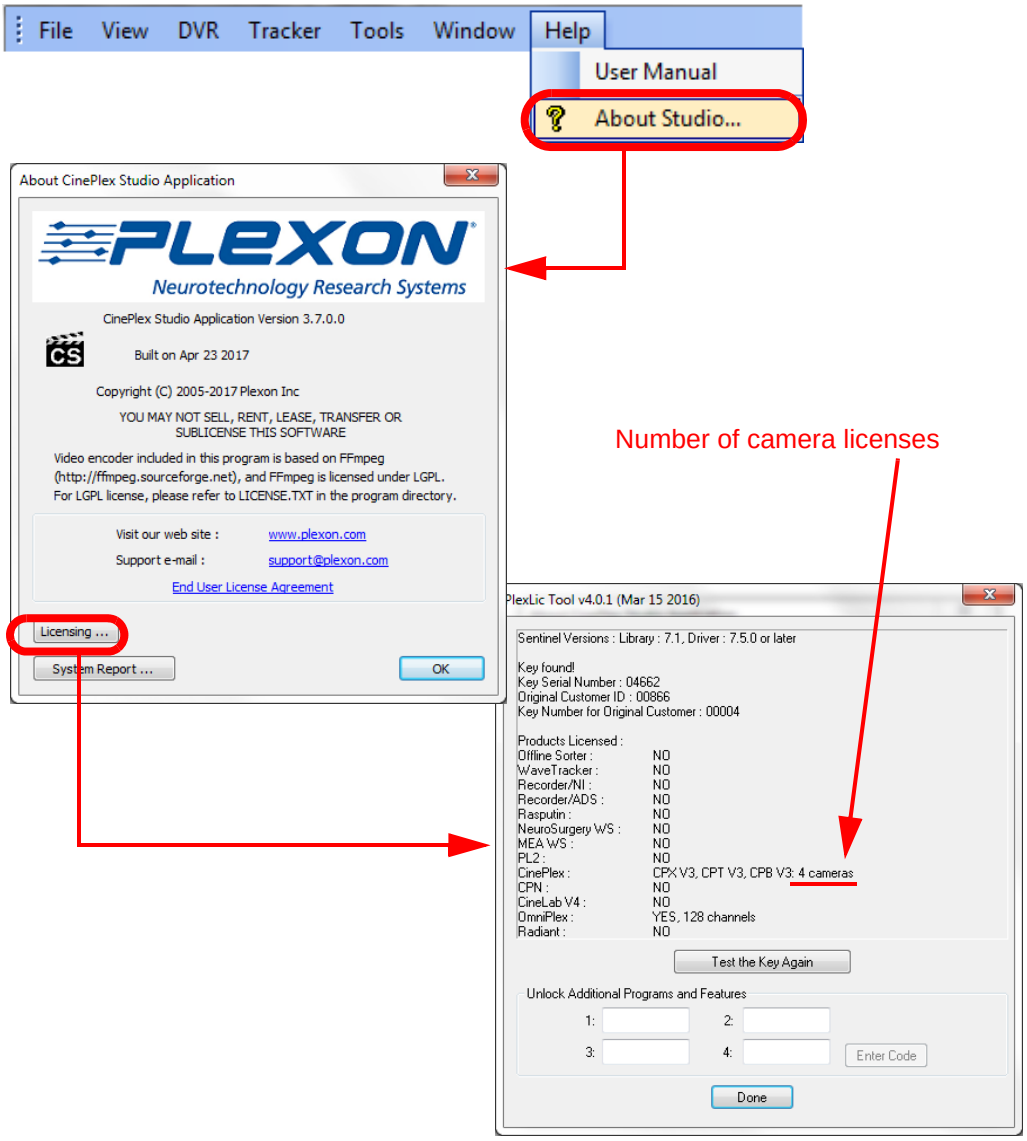
If your system is in **Cameras** mode, switch to **Files** mode using the video source dropdown list on the CinePlex Studio main toolbar, as shown in this image.



Note: CinePlex Studio comes up in **Files** mode (offline) automatically if no cameras are detected.

6.3 Selecting the Correct Procedure

Find out how many cameras your system is licensed for. In the example below, the system is licensed for four cameras, Your system might have from one to four camera licenses.



Go to the appropriate section for your system:

- Section 6.4, “Retracking Video in Systems Licensed for a Single Camera” on page 184
- Section 6.5, “Retracking Video in Systems Licensed for Multiple Cameras” on page 187
- Section 6.6, “Retracking Single Video when Licensed for Multiple Cameras” on page 189

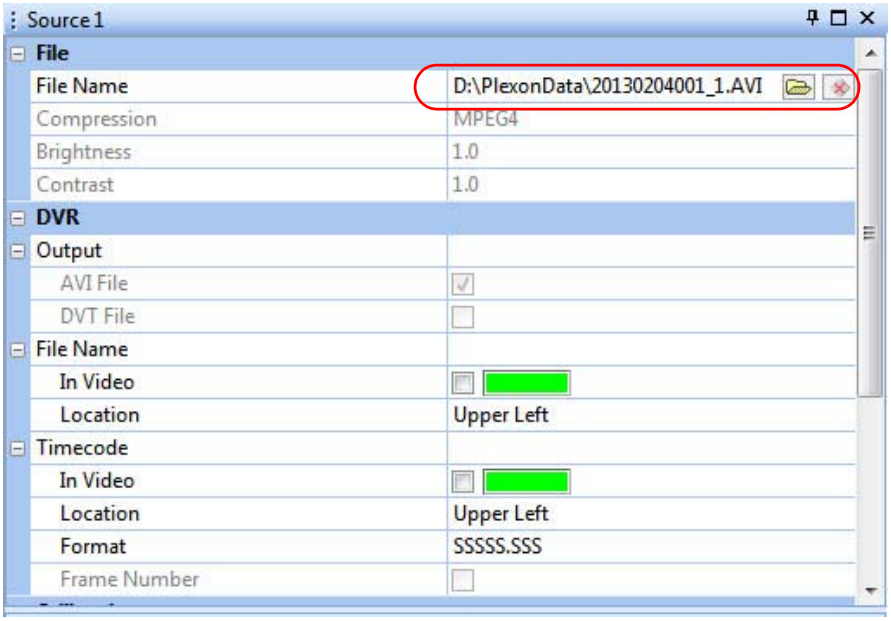
6.4 Retracking Video in Systems Licensed for a Single Camera

Selecting a File to Be Retracked

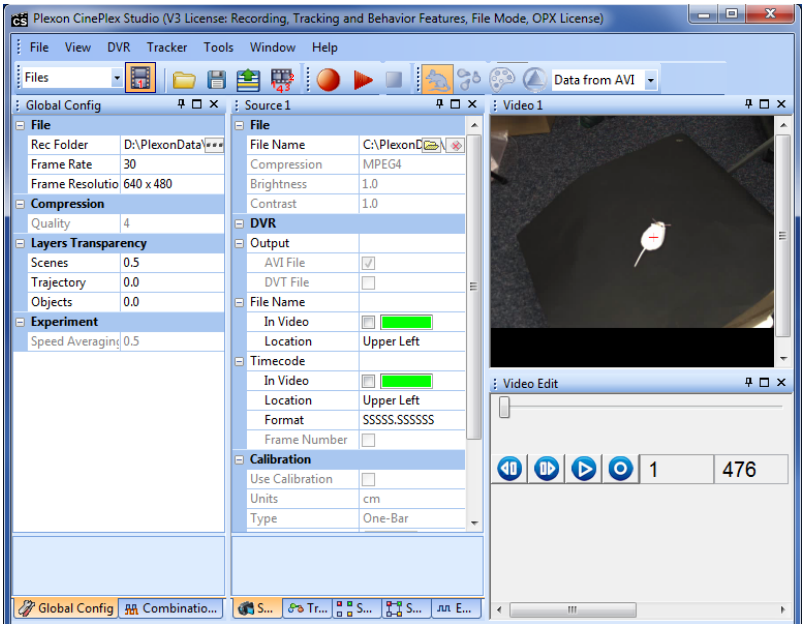
1 The main toolbar displays the icon for File 1. If it is not already selected, click on the icon to select it. It has an orange background when selected.

2 In the Source pane, in the **File Name** row, click on the folder icon to navigate to the directory containing the desired AVI file and select the file.

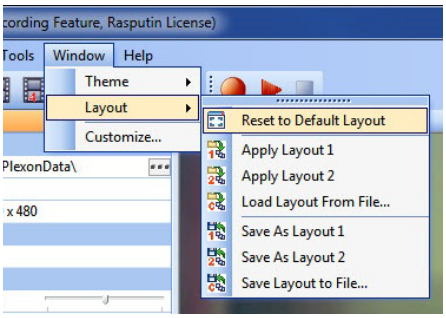
Note: If you select a file that was created with any camera other than the camera associated with Source, the system will prompt you to select a different file (a file that was created with appropriate camera). The system can automatically detect which camera created the file, regardless of the file name. For example, in the image below, only files created with Camera 1 can be loaded in the Source 1 pane.



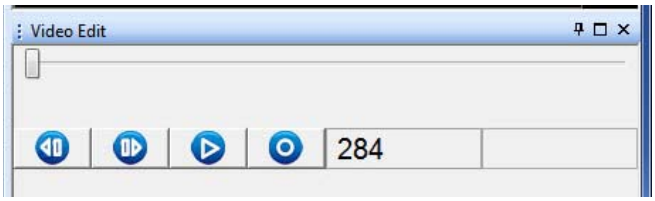
3 Verify that you see the video stream in the Video window.



Note: If the Video 1 window does *not* appear, restore the default layout. (In most cases, the Video 1 window appears, therefore this step is not necessary.)

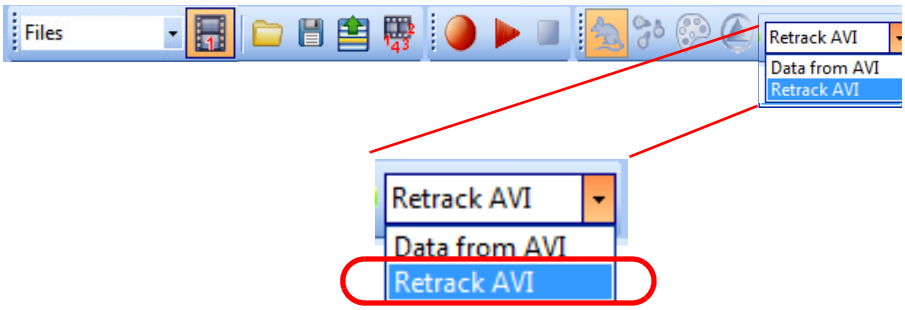


4 You can use the buttons in the Video Edit pane to replay the video file frame by frame if desired.



Select the Retracking Option

5 Select **Retrack AVI**.



Modify Parameters for Retracking

6 You can adjust a wide range of parameters prior to retracking the video. For examples of these parameter settings, see Section 6.8, “Modifying Parameters for Retracking” on page 195.

Retrack the File

7 Start retracking of the existing video (with the new settings) by pressing the **Start recording from file** ( ) button in the main toolbar.

Save Settings

8 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

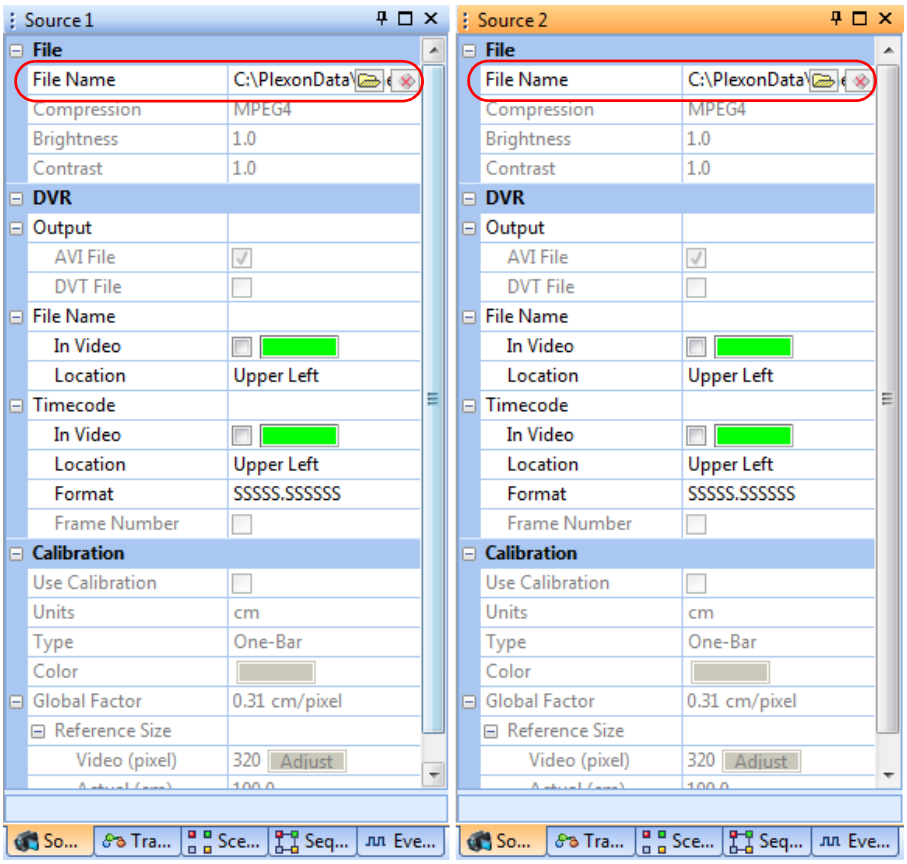
6.5 Retracking Video in Systems Licensed for Multiple Cameras

The procedures in this section assume a system with two camera licenses. These procedures are easily extended to systems with three or four licenses.

Selecting Files to Be Retracked

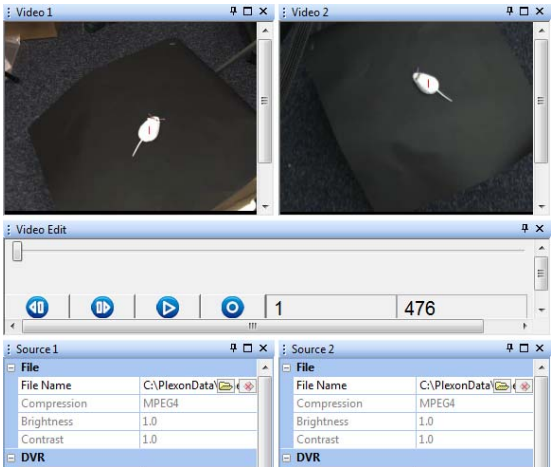
1 The main toolbar displays the icons for Files 1 and 2. If both files are not already selected, click on the icons to select them. They have an orange background when selected.

2 In the Source 1 and 2 panes, in the **File Name** row, click on the folder icon to navigate to the directory containing the desired AVI file and select the file.

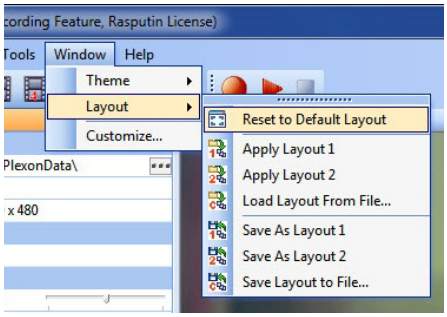


Note: If you select a file that was created with any camera other than the camera associated with that Source, the system will prompt you to select a different file (a file that was created with appropriate camera). The system can automatically detect which camera created the file, regardless of the file name. For example, only files created with Camera 2 can be loaded in the Source 2 pane.

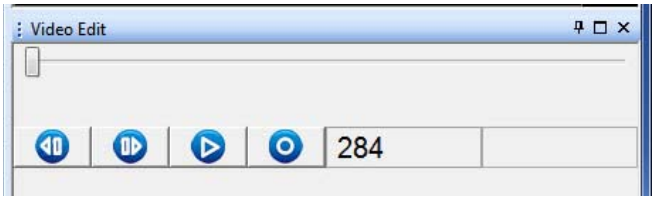
3 Verify that you see the video streams in the Video 1 and 2 windows.



Note: If the Video 1 and 2 windows do *not* both appear, restore the default layout. (In most cases, the Video windows appear, therefore this step is not necessary.)

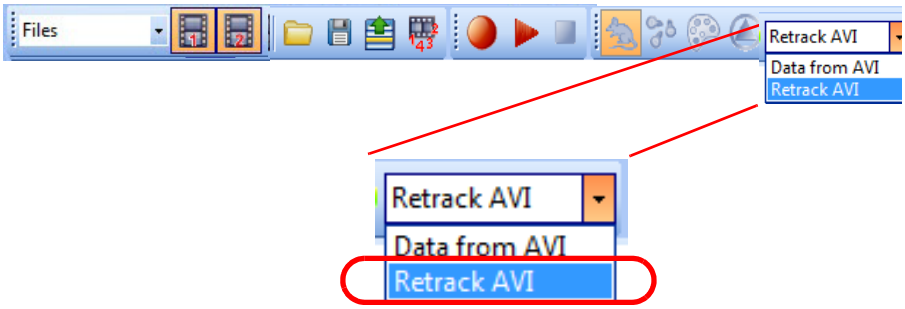


4 You can use the buttons in the Video Edit pane to replay the video file frame by frame if desired.



Select the Retracking Option

5 Select **Retrack AVI**.



Modify Parameters for Retracking

6 You can adjust a wide range of parameters prior to retracking the video. For examples of these parameter settings, see Section 6.8, “Modifying Parameters for Retracking” on page 195.

Retrack the File

7 Start retracking of the existing video (with the new settings) by pressing the **Start recording from file** ( ) button in the main toolbar.

Save Settings

8 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

6.6 Retracking Single Video when Licensed for Multiple Cameras

This section explains how to retrack a single video stream if your system is licensed for multiple cameras.

The procedures in this section assume a system with two camera licenses. These procedures are easily extended to systems with three or four licenses.

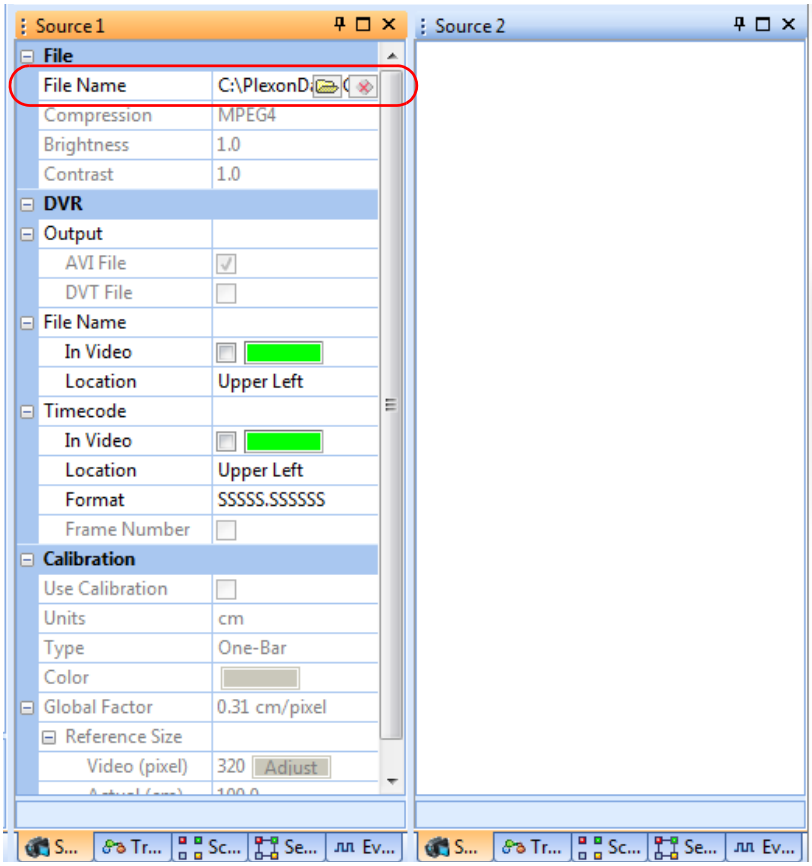
Selecting Files to Be Retracked
Example—Retracking File 1 Only

1 The main toolbar displays the icons for Files 1 and 2 (because the system in this example is licensed for two cameras). Select the icon for the file you want to retrack, and deselect the icon for the other file. An icon has an orange background when selected.

In this example, we are selecting File 1 to be retracked, and deselecting the icon for File 2.

2 In the Source 1 pane, in the **File Name** row, click on the folder icon to navigate to the directory containing the desired AVI file and select the file.

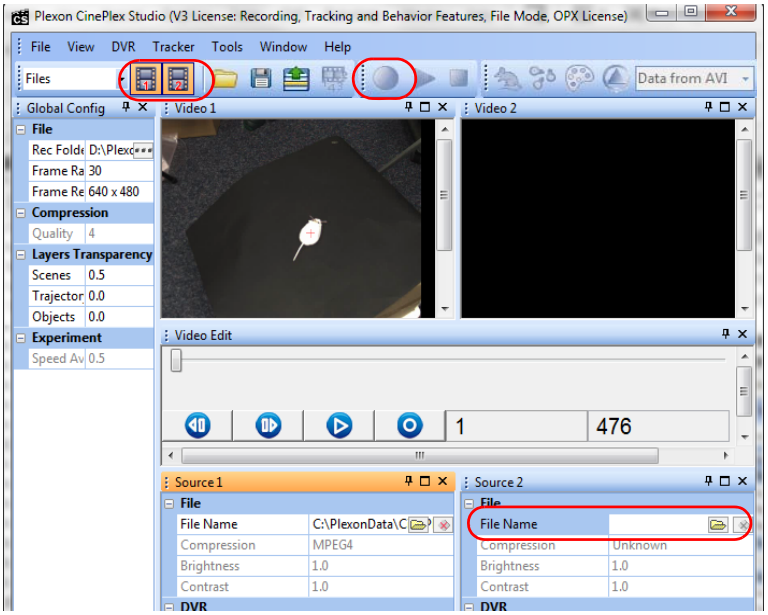
Notice that the Source 2 pane is blank because the File 2 icon was deselected in the previous step.



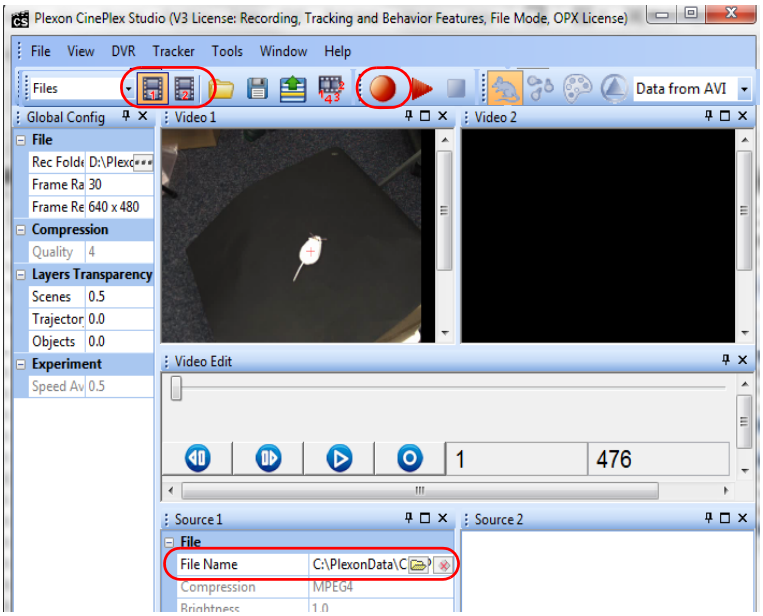
Note: If you select a file that was created with any camera other than the camera associated with that Source, the system will prompt you to select a different file (a file that was created with appropriate camera). The system can automatically detect which camera created the file, regardless of the file name. For example, only files created with Camera 1 can be loaded in the Source 1 pane.

Notice that the **Start recording from file** icon is active when there is a match between the File icon(s) selected and the actual file(s) loaded in the Source window(s). If there is a mismatch, the **Start recording from file** icon is disabled.

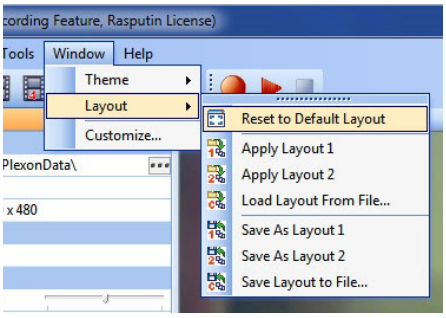
Example: File 1 and 2 icons selected, but Source 2 file not loaded. Mismatch—Start icon is disabled:



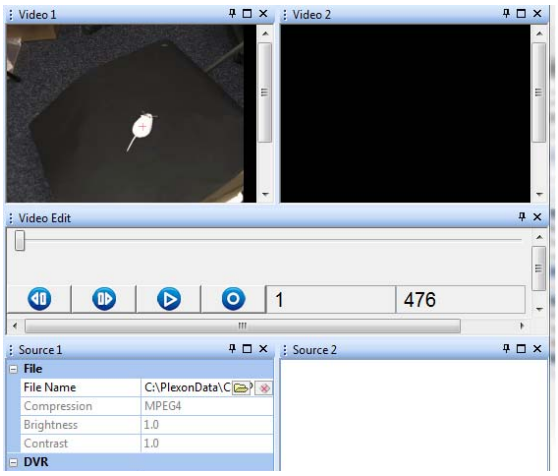
Example: File 1 icon selected and Source 1 file loaded. Match—Start icon is enabled:



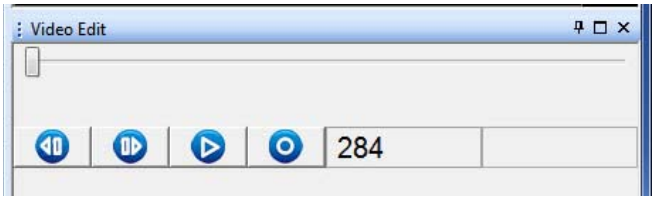
Note: If the Video 1 and 2 windows do *not* both appear, restore the default layout. (In most cases, the Video windows appear, therefore this step is not necessary.)



3 In this example, we are retracking the video for File 1 only.
Verify that you see the video stream in the Video 1 window only.

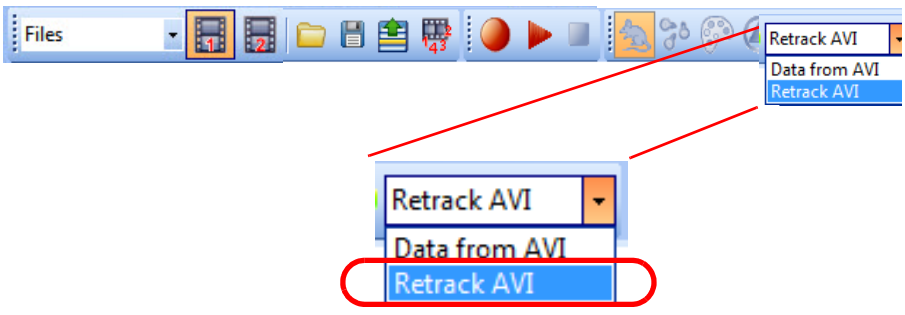


4 You can use the buttons in the Video Edit pane to replay the video file frame by frame if desired.



Select the Retracking Option

5 Select **Retrack AVI**.



Modify Parameters for Retracking

6 You can adjust a wide range of parameters prior to retracking the video. For examples of these parameter settings, see Section 6.8, “Modifying Parameters for Retracking” on page 195.

Retrack the File

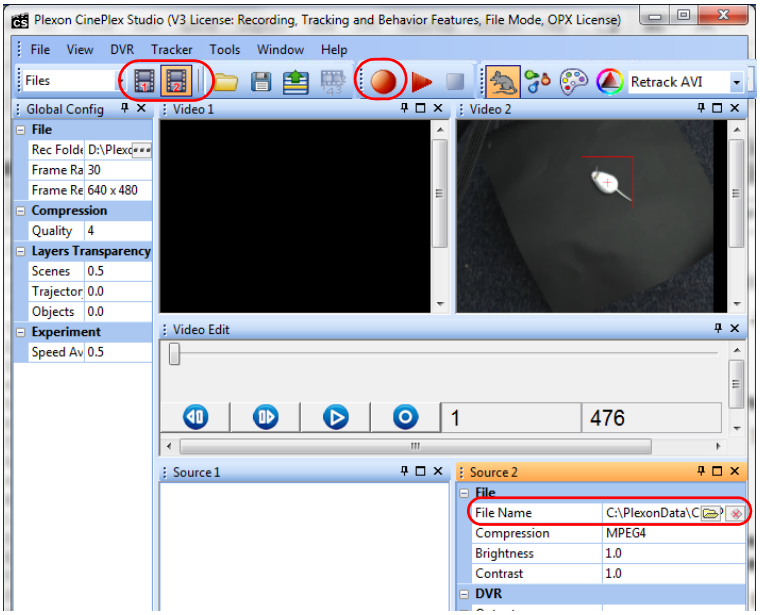
7 Start retracking of the existing video (with the new settings) by pressing the **Start recording from file** ( ) button in the main toolbar.

Selecting Different File(s) to Be Retracked Example—Retracking File 2 Only

8 In the previous example, we selected File 1 to be retracked, and deselected the icon for File 2.

Now deselect the icon for File 1 and select the icon for File 2.

9 Load a file for Source 2.



10 Proceed with the retracking steps in a manner similar to the previous example.

Save Settings

11 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

6.7 Requirements for Computer and License

The offline functions of CinePlex Studio can be used on the original OmniPlex/ CinePlex host PC where the camera(s) are installed, or on a standalone computer. The appropriate CinePlex Studio license must be plugged into a USB port on the computer.

The recommended system requirements for an offline analysis computer include a dual core Intel processor operating at better than 3 GHz with 3 GB of memory, and an NVIDIA® GeForce® 9600 GT or better video card. In addition, the appropriate Plexon license (see Section 1.6, “CinePlex Licensing Options” on page 5) must be plugged in to one of the USB ports. For a more detailed discussion of requirements, contact Plexon support at +1-214-369-4957 or support@plexon.com.

6.8 Modifying Parameters for Retracking

The examples in this section show how to adjust parameters prior to retracking the video.

Source Files

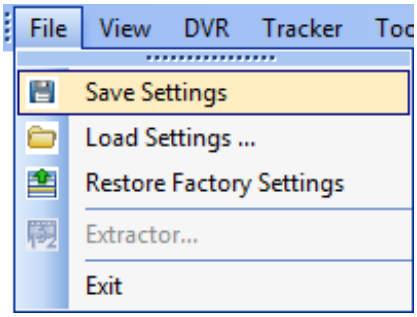
The AVI files to be retracked are typically the ones recorded by means of the procedure in either of the following sections. These sections provide additional guidance on setting the values for the parameters you want to modify:

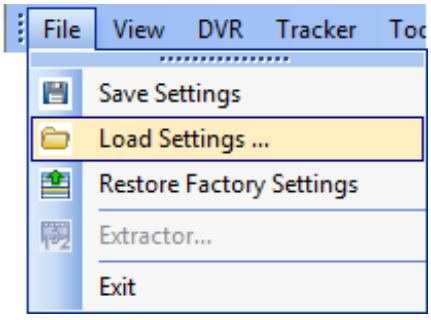
- Section 4.13, “Recording Synchronized Video Tracking and Neural Data” on page 128(with Tracking license)
- Section 5.13, “Recording Synchronized Video Tracking and Neural Data” on page 179 (with Tracking and Basic Behavior licenses)

Loading and Saving Parameter Settings

When you load the AVI file, the system automatically loads all the parameter settings that you used in making that original recording. You can then modify some of those settings as needed before you retrack the video. You can also save the new (modified) settings, if desired, for future experiments.

1 If you have a Settings file that you created in a previous recording session, either in Cameras mode or Files mode, you can load that Settings file and use those settings as a starting point for retracking the video. The images below illustrate the **Save Settings** and **Load Settings** menu options.

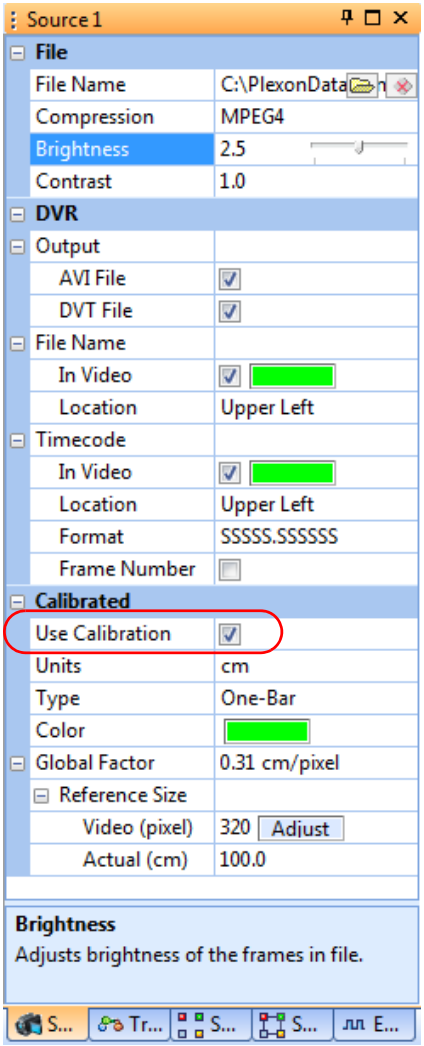




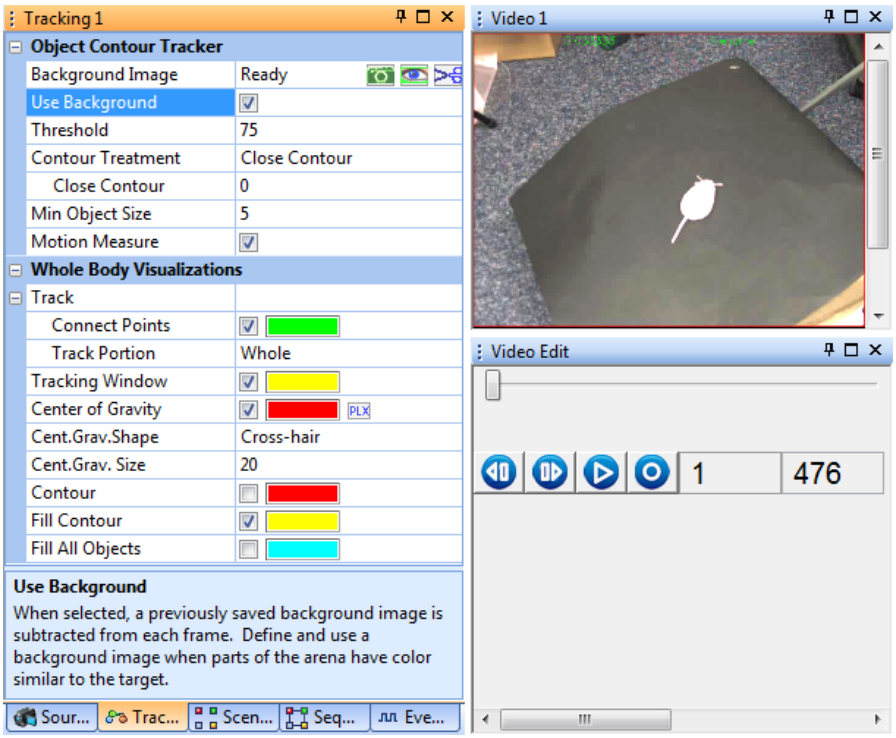
Modify the Retracking Parameters as Needed

2 In the Source pane, you can set parameters that will cause the system to:

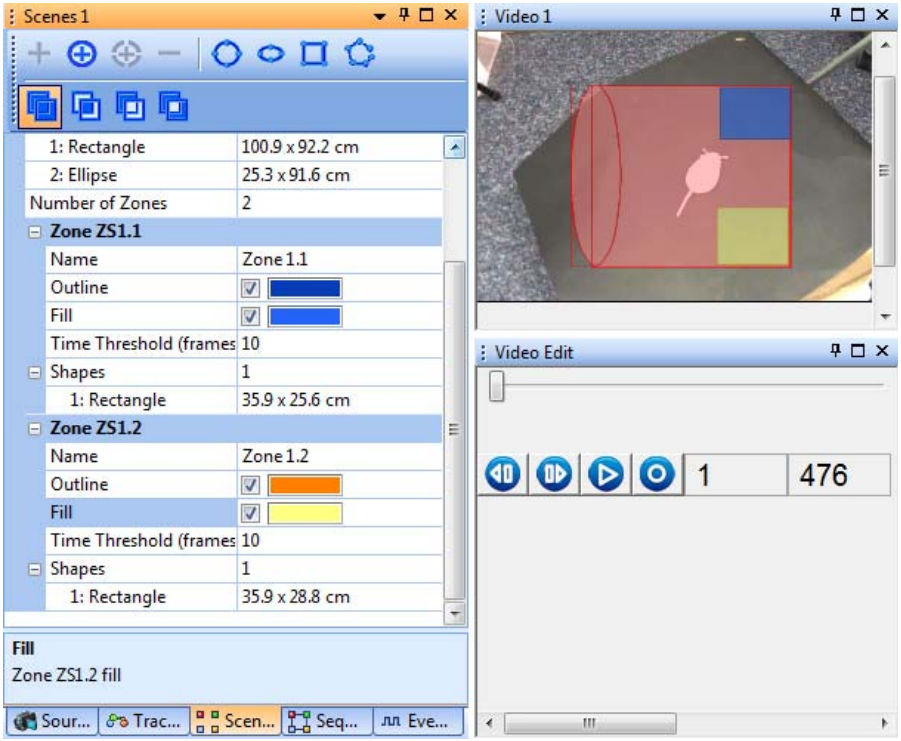
- Change brightness, contrast or other settings so that existing files are more usable
- Place the File Name and/or Timecode into the video frame if that was not already done on the original run
- Specify and modify calibration settings (be sure the **Use Calibration** checkbox is checked if you want to use the calibration)



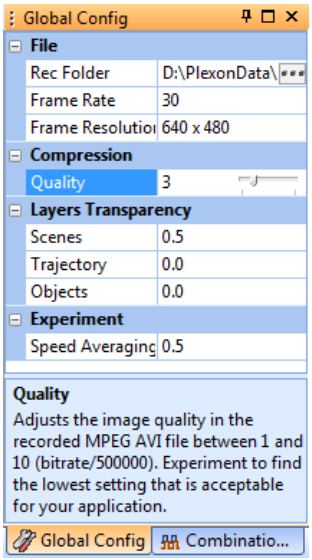
3 In the Tracking pane, you can adjust a number of parameters to more effectively track your subject. For details about each of these parameters, see Chapter 5, Recording Positional Data with CinePlex Tracking Option.



4 In the Scenes pane, you can adjust the arena geometry. For details about each of these parameters, see Chapter 5, Recording Positional Data with CinePlex Tracking Option. If you have the Basic Behavior license, you can also adjust the shapes and positions of zones, sequences of zones, events and combination events. For details about these parameters, see Chapter 6, Generating Events with CinePlex Basic Behavior Option.



5 In the Global Config pane, you can lower the **Quality** setting to reduce file size and save storage space.



6 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

6.9 Offline Functionality Compared to Online Functionality

Most offline functionality is only marginally different from its online equivalent. For details, see Section 3.9.7, “Offline Functionality Compared to Online Functionality” on page 67.

6.10 File Naming Procedure in Offline Mode

CinePlex Studio renames files during the retracking process. For details, see Section 3.9.8, “File Naming Procedure in Offline Mode” on page 68.

6.11 Additional File-processing Tools

The following tools can also be used for processing of files:

- Use the CinePlex Studio Extractor to extract static and dynamic data from a Plexon AVI file for analysis with a database program such as MATLAB® or data processing tools such as Microsoft Excel®. See Section 8.1, “Introduction—Extracting Data with CinePlex Extractor Function” on page 272.
- You can use CinePlex Editor to view the AVI file time-locked (synchronized) with its partner neural data file to see what the subject was doing at a time of interest in the neural data. See Chapter 4, Processing Video Files with CinePlex Editor. The video and neural data are time-locked because both systems (the OmniPlex and CinePlex Systems) are running off the same clock signal. This ensures that the PLX and AVI files will have the same timing. (Editor is installed separately.)

Chapter 7
Extractor Procedures

7.1 Introduction—Extracting Data with CinePlex Extractor Function..... 202
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7.3 Selecting the Correct Procedure 203
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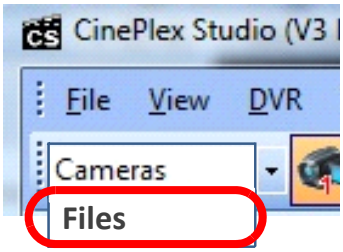
7.1 Introduction—Extracting Data with CinePlex Extractor Function

This chapter explains how to extract static and dynamic data from an Audio Video Interleaved (AVI) file. The CinePlex Extractor function places the data into files that are readable with standard text applications. These files are suitable for use by database programs such as MATLAB® or data processing tools such as Microsoft® Excel®.

Note: Static data in an AVI file includes system information and settings data. Dynamic data includes frame numbers, timestamps, positional coordinates and status of behavioral events.

7.2 Getting Started—Entering Offline Mode

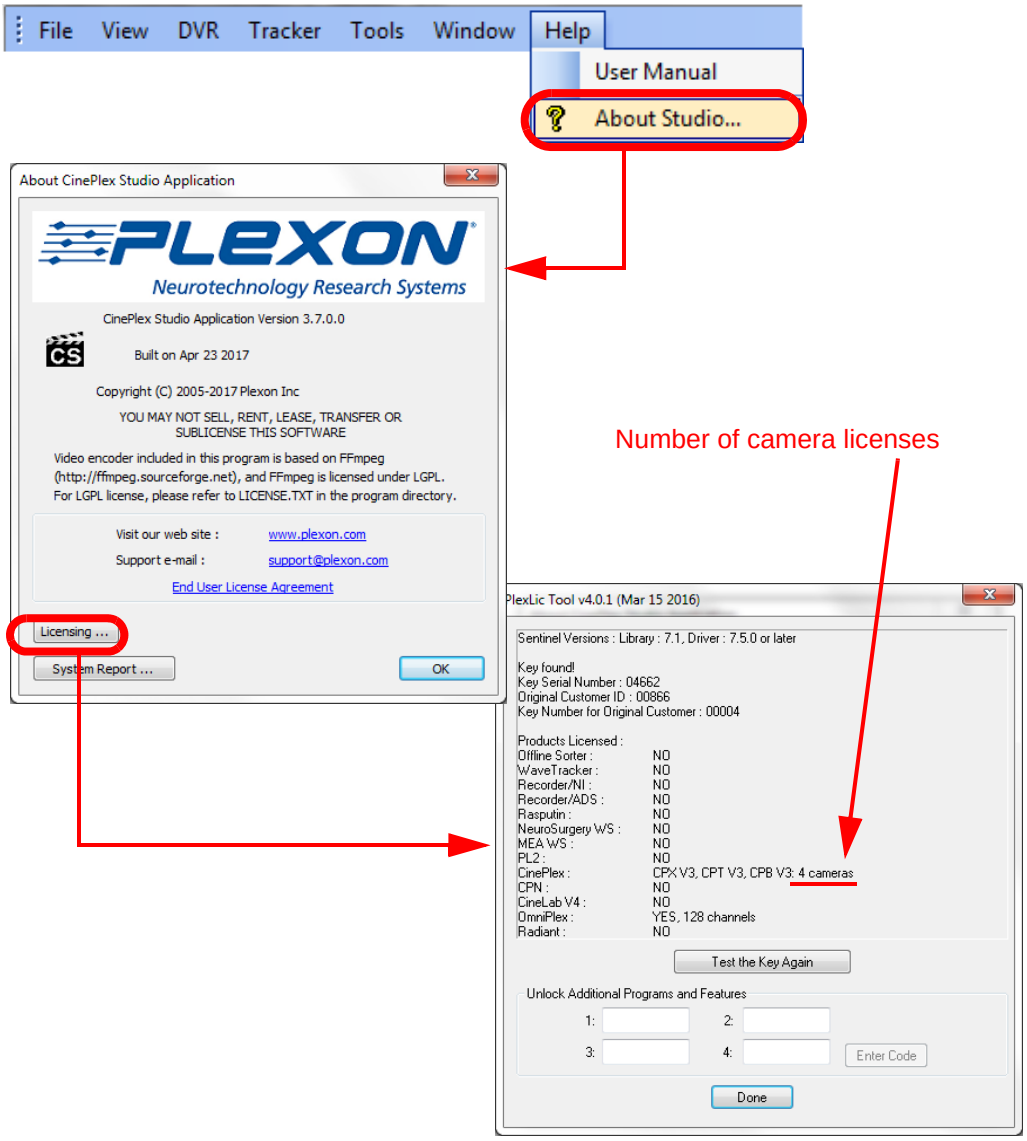
If your system is in **Cameras** mode, switch to **Files** mode using the video source dropdown list on the CinePlex Studio main toolbar, as shown in this image.



Note: CinePlex Studio comes up in **Files** mode (offline) automatically if no cameras are detected.

7.3 Selecting the Correct Procedure

Find out how many cameras your system is licensed for. In the example below, the system is licensed for four cameras, Your system might have from one to four cameras.



Go to the appropriate section for your system:

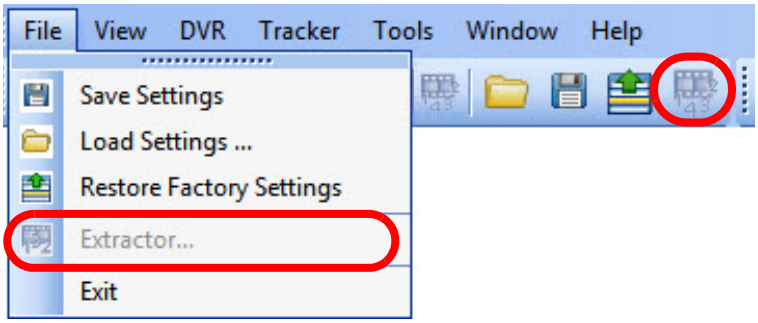
- Section 7.4, “Extracting Data in Systems Licensed for a Single Camera” on page 204
- Section 7.5, “Extracting Data in Systems Licensed for Multiple Cameras” on page 216

7.4 Extracting Data in Systems Licensed for a Single Camera

Selecting a File

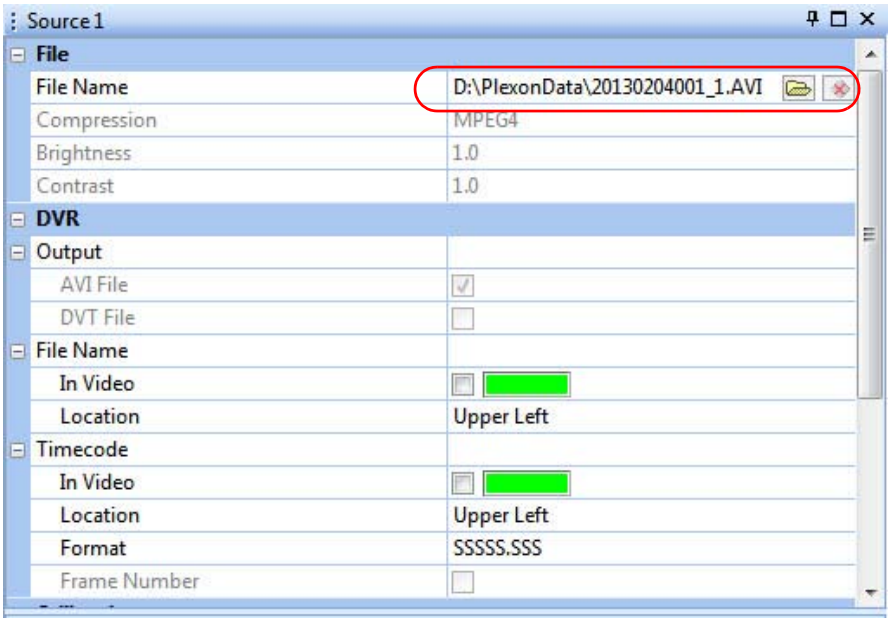
1 The main toolbar displays the icon for File 1. If it is not already selected, click on the icon to select it. It has an orange background when selected.

Notice that the Extractor icon and menu option are inactive, because no file has been loaded yet.

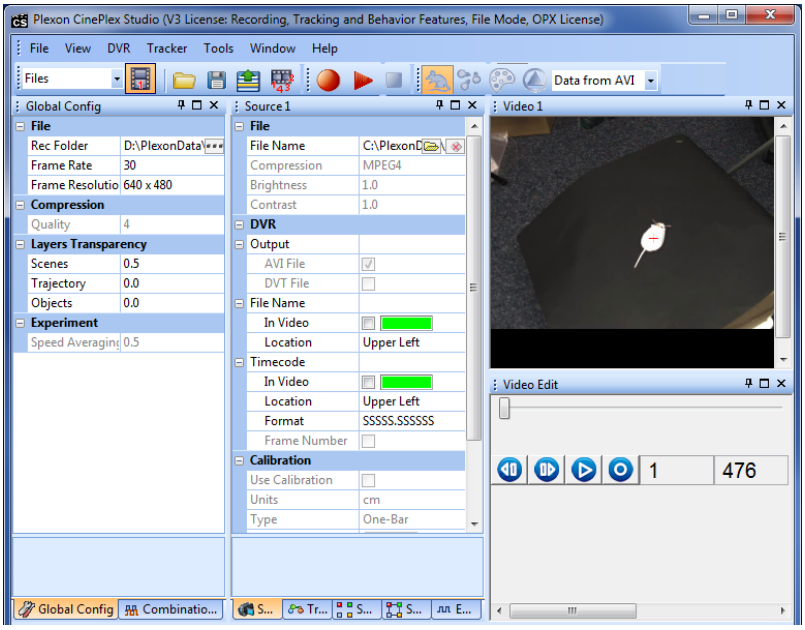


2 In the Source pane, in the **File Name** row, click on the folder icon to navigate to the directory containing the desired AVI file and select the file.

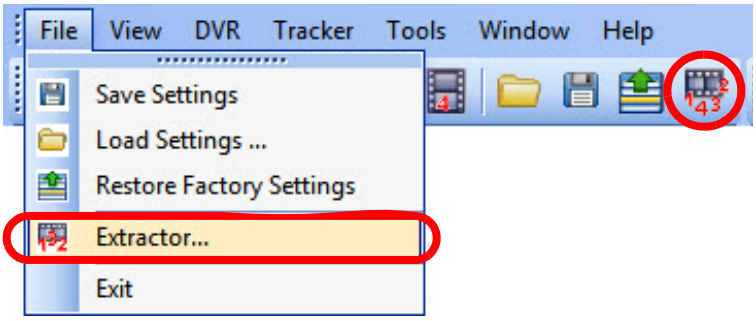
Note: If you select a file that was created with any camera other than the camera associated with Source, the system will prompt you to select a different file (a file that was created with appropriate camera). The system can automatically detect which camera created the file, regardless of the file name. For example, in the image below, only files created with Camera 1 can be loaded in the Source 1 pane.



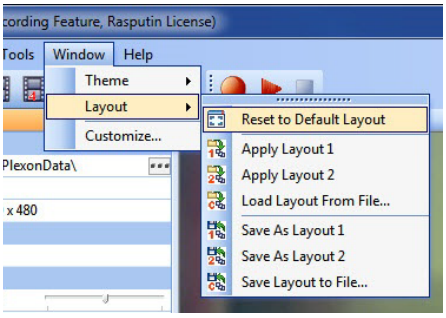
3 Verify that you see the video stream in the Video window.



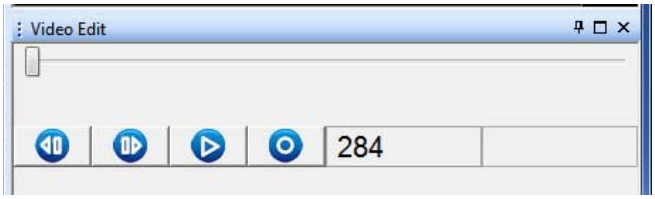
Notice that the Extractor icon and menu option are now active (enabled).



Note: If the Video 1 window does *not* appear, restore the default layout. (In most cases, the Video 1 window appears, therefore this step is not necessary.)

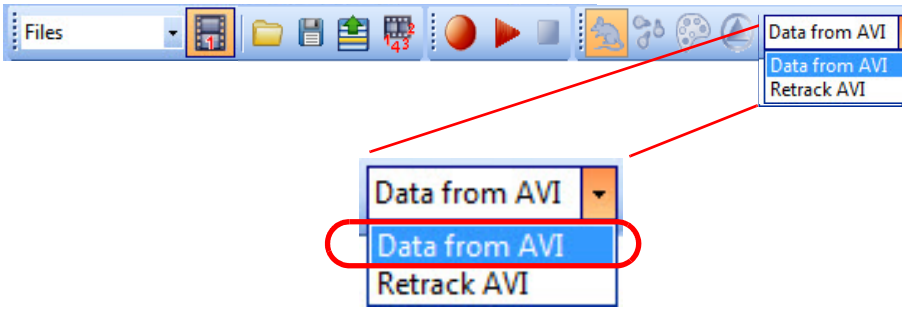


4 You can use the buttons in the Video Edit pane to replay the video file frame by frame if desired.



Selecting the Data from AVI Option

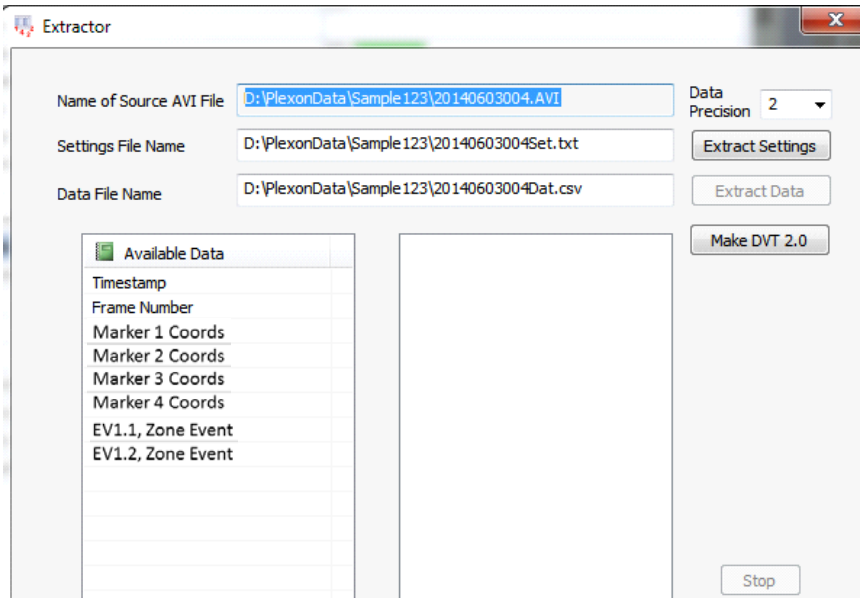
5 Ensure that the dropdown menu in the main toolbar is set to **Data from AVI**.



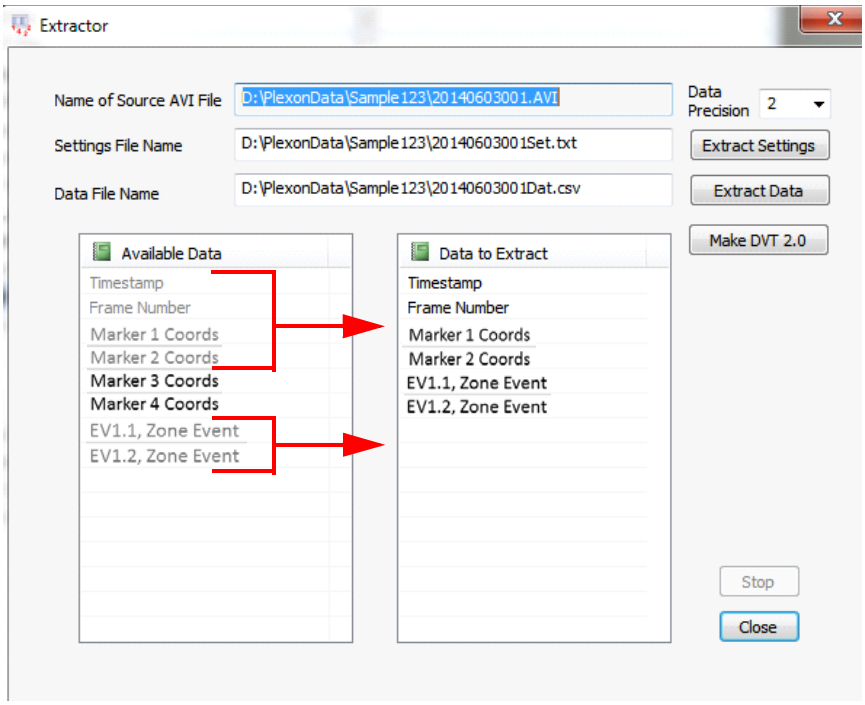
Configuring the Extractor

6 From the **File** menu select **Extractor**, or click the **Extractor** icon ( ) in the toolbar (see the image above to locate these features).

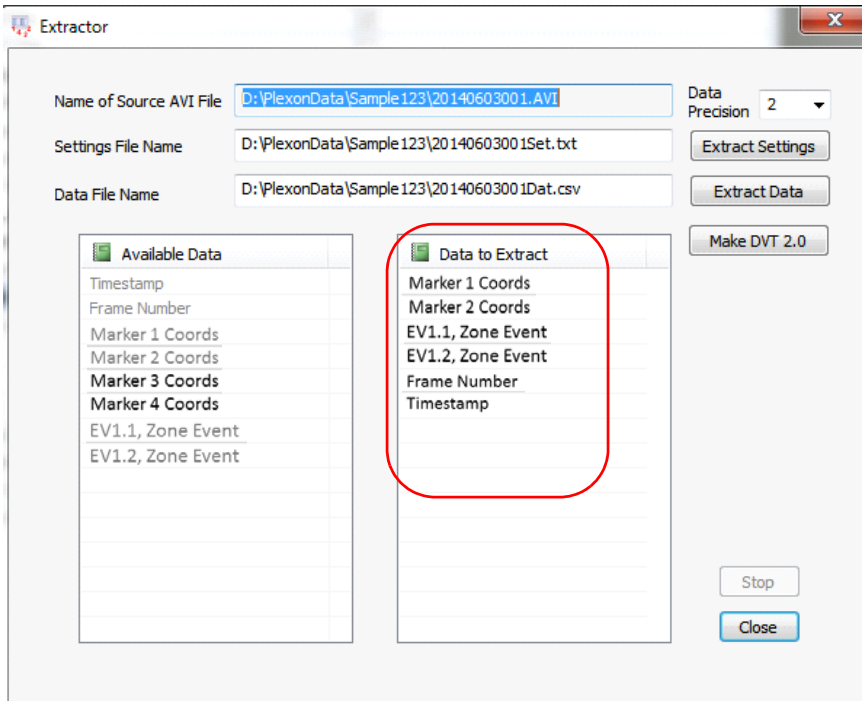
The **Extractor** dialog box opens. Examples of these dialog boxes are shown below.



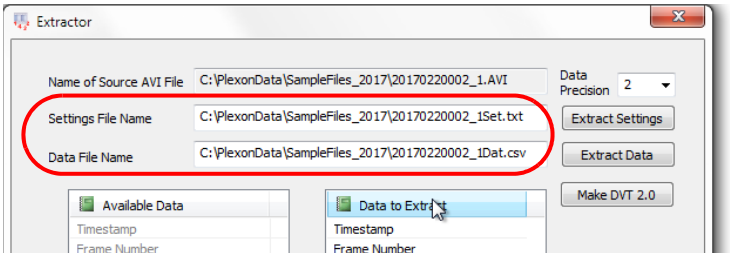
7 To select the data to be extracted, drag and drop the desired entries in the **Available Data** panel to the panel on the right. When the panel on the right is populated with one or more entries, the **Data to Extract** banner appears.



8 If desired, you can rearrange the order of the entries in the **Data to Extract** section by dragging and dropping them into the desired position in the list.

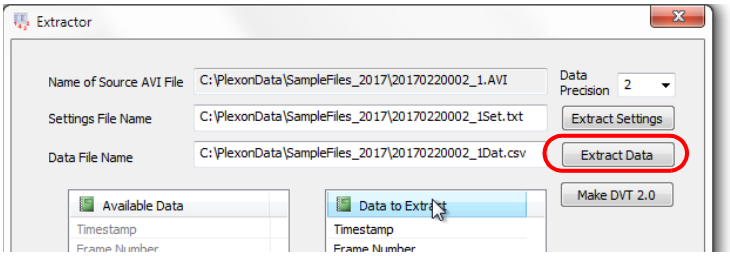


The default locations for the extracted Settings File and Data File are the same folder from which the original AVI file was opened. You can modify the locations and names of these files if you wish by typing in the preferred locations and names.

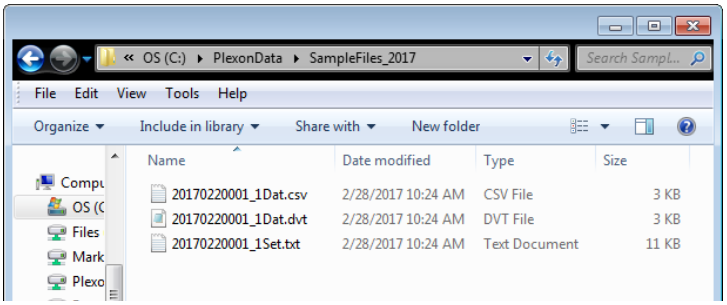


Extracting the Data

9 When ready to extract the data, click the **Extract Data** button.



The system will create the requested file and store it in the specified location.



10 If you want to stop the data extraction before the end of the file is reached, click the **Stop** button.

The data are extracted to a comma-separated-values (CSV) file and can be opened in a spreadsheet application such as Microsoft Excel. The column

headings are presented in the order that was specified in the **Data to Extract** section of the dialog box.

The image below shows an example of the data file opened in Excel®. In this example, the x and y coordinates are in pixels, because the arena was not calibrated prior to recording.

C21

	A	B	C	D	E	F	G
1	#	Timestamp	Frame_Numl	x	y	EV1.1	EV1.1_Track_Length
2	1	0.033333	1	352.00	324.35	0	0.00
3	2	0.066666	2	351.99	320.03	0	4.32
4	3	0.099999	3	360.37	311.68	1	11.83
5	4	0.133332	4	366.25	302.19	1	11.16
6	5	0.166665	5	380.03	290.33	1	18.18
7	6	0.199998	6	386.21	289.44	0	6.24

The image below shows an example of the same data file opened as text.

Untitled - Notepad

File Edit Format View Help

```
#,Timestamp,Frame_Number,x,y,EV1.1,EV1.1_Track_Length
1,0.033333,1,352.00,324.35,0,0.00
2,0.066666,2,351.99,320.03,0,4.32
3,0.099999,3,360.37,311.68,1,11.83
4,0.133332,4,366.25,302.19,1,11.16
5,0.166665,5,380.03,290.33,1,18.18
6,0.199998,6,386.21,289.44,0,6.24
```

If the arena is calibrated, the heading displays x_cm and y_cm (or x_in and y_in) as shown in the images below.

TIP

If you forgot to calibrate the arena prior to recording...

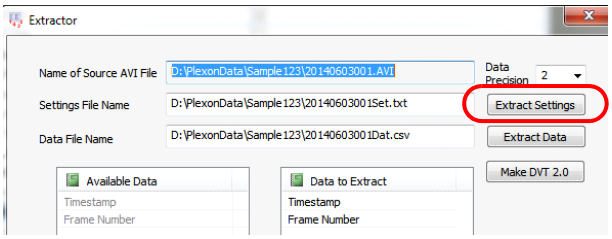
If you did not calibrate the area prior to recording and you want to obtain calibrated coordinate data now, you can do so by following the procedure in Section 7.6, “Calibrating the Arena and Extracting Calibrated Coordinate Data” on page 222.

	A	B	C	D
1	#	Timestamp	X_cm	Y_cm
20	19	0.95	35.17	21.49
21	20	1	34.87	21.38
22	21	1.05	34.76	21.29
23	22	1.1	34.79	21.15
24	23	1.15	34.91	20.99
25	24	1.2	35	20.83
26	25	1.25	35.43	20.79
27	26	1.3	35.4	20.62
28	27	1.35	35.48	20.54
29	28	1.4	35.53	20.55
30	29	1.45	35.6	20.66
31	30	1.5	35.71	20.74

	A	B	C	D	E	F
1	#	Timestamp	X_cm	Y_cm	EV1.2	EV1.2_Track_Length_cm
967	966	48.3	46.21	38.4	1	5.5
968	967	48.35	46.18	38.37	1	5.54
969	968	48.4	46.15	38.34	1	5.59
970	969	48.45	46.18	38.34	1	5.62
971	970	48.5	46.23	38.34	1	5.66
972	971	48.55	46.27	38.37	1	5.71
973	972	48.6	46.25	38.37	1	5.74
974	973	48.65	46.31	38.31	1	5.82
975	974	48.7	46.25	38.29	1	5.89
976	975	48.75	46.03	38.28	1	6.1
977	976	48.8	46.19	38.29	1	6.25
978	977	48.85	46.23	38.29	1	6.3
979	978	48.9	46.16	38.28	1	6.37
980	979	48.95	46.36	38.29	1	6.57
981	980	49	46.39	38.3	1	6.61

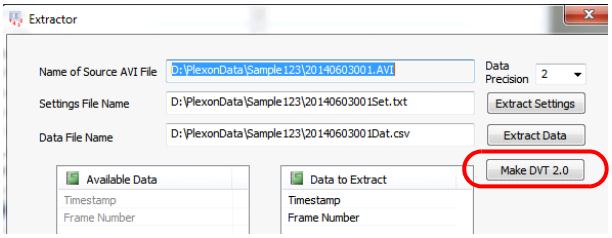
Extracting Settings

11 The settings from the AVI file may be extracted by clicking the **Extract Settings** button. This is useful if you have lost a Settings file but you know which AVI file was created with the desired settings.



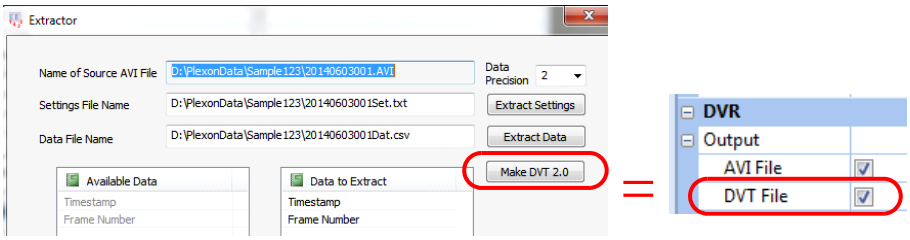
Creating a DVT File

12 A DVT file may be created by clicking the **Make DVT 2.0** button. This is useful if you did not check the DVT checkbox when you made the original recording.



An example of a text file with the extracted DVT data is shown below.

Note that the frame numbers and timestamps created with the Extractor **Make DVT 2.0** button are identical to the frame numbers and timestamps generated if you have selected the **DVT File** checkbox in the **Sources** pane.



Saving Settings

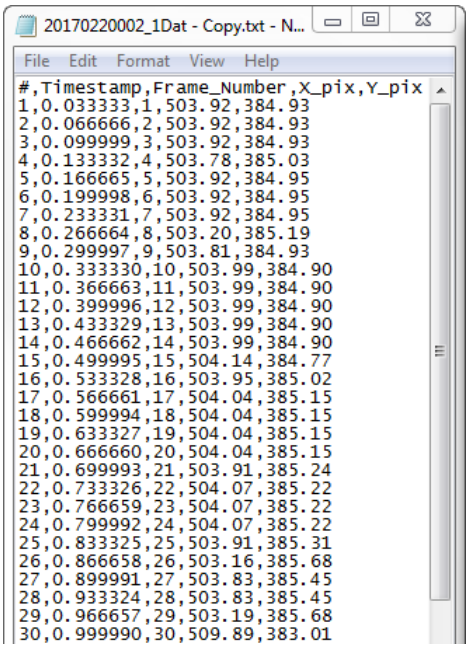
13 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

Viewing the AVI and DVT Files

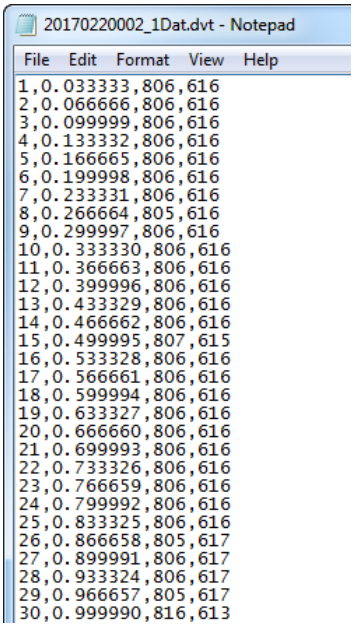
The frame numbers and timestamps in the DVT file are identical to the frame numbers and timestamps embedded in the AVI file, although the DVT file does not have a header row (see the image below). However, there is an *algebraic ratio* between the coordinate data in the DVT file with respect to the coordinate data in pixels obtained from the AVI file with the Extract Data function. In the image below, notice that the coordinate data in the DVT file is different (by an algebraic ratio) from the data in the AVI file.

Note: If the arena is *not* calibrated, the AVI data will appear in pixels and the columns will be named X_pix,Y_pix.
If the arena *is* calibrated, the AVI data will appear as X_cm,Y_cm (or X_in,Y_in), and the AVI coordinate data will be in cm (or inches).

AVI



DVT



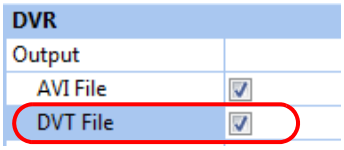
CAUTION

See Section 7.7.5, “Conversion of DVT Coordinates to Pixels” on page 227 for an understanding of the algebraic relationship between the positional data extracted from the AVI file (the Extract Data button in the Extractor dialog box) vs. data extracted in a DVT file (the Make DVT 2.0 button). They are not identical.

TIP

Create DVT files automatically in Sources or with the Extractor

If you know that you will want files with all your timestamps, frame numbers and coordinate data. you might find that it is convenient to preselect the **DVT File** checkbox in the **Sources** pane prior to recording, rather than opening the Extractor for each individual experimental run.



14 Close the Extractor dialog box (click on the **Close** button) when you have finished using the Extractor function.

15 Repeat Step 3 through Step 14 to extract data or settings from any additional files from this same camera.

16 Repeat the entire procedure to extract data or settings from the recordings made by other cameras.

Interpreting Events in Extracted Data

In the example below, the extracted data for each frame includes the condition (TRUE or FALSE) for events EV1.1 and EV1.2, and the track length for each event. Notice that track length is measured only if the event is happening. In this example, EV1.1 is FALSE (not happening) for the times shown, so the Track_Length is 0. For EV1.2, the event is TRUE (happening) for the times shown, so the Track_Length is measured and reported in the extracted data.

	A	B	C	D	E	F
1	#	Timestamp	EV1.1	EV1.1_Track_Length_cm	EV1.2	EV1.2_Track_Length_cm
956	955	47.75	0	0	1	4.53
957	956	47.8	0	0	1	4.58
958	957	47.85	0	0	1	4.78
959	958	47.9	0	0	1	5.05
960	959	47.95	0	0	1	5.17
961	960	48	0	0	1	5.17
962	961	48.05	0	0	1	5.25
963	962	48.1	0	0	1	5.25
964	963	48.15	0	0	1	5.33
965	964	48.2	0	0	1	5.38
966	965	48.25	0	0	1	5.46
967	966	48.3	0	0	1	5.5
968	967	48.35	0	0	1	5.54
969	968	48.4	0	0	1	5.59
970	969	48.45	0	0	1	5.62
971	970	48.5	0	0	1	5.66
972	971	48.55	0	0	1	5.71
973	972	48.6	0	0	1	5.74
974	973	48.65	0	0	1	5.82
975	974	48.7	0	0	1	5.89
976	975	48.75	0	0	1	6.1
977	976	48.8	0	0	1	6.25

Interpreting Speed and Speed Events in Extracted Data

If you configured a speed event in a recording, you can extract and view the speed event information. (To review the method of configuring speed events, see Section 5.8.4, “Events Based on Speed” on page 160.)

In the example below, EV1.1 is FALSE (not happening) during the times shown, as indicated by the 0 value in that column. When the speed event is FALSE, the system does not measure the track length of the object, so all of the values in the EV1.1_Track_Length_cm column are 0. Notice, however, that the system always measures the object’s speed for each frame, so these values are reported.

	A	B	C	D
1	#	EV1.1	EV1.1_Track_Length_cm	EV1.1_Speed_cm/s
23	22	0	0	2.91
24	23	0	0	2.41
25	24	0	0	1.76
26	25	0	0	0.61
27	26	0	0	0.29
28	27	0	0	0.29
29	28	0	0	0.3
30	29	0	0	0.62
31	30	0	0	0.6
32	31	0	0	0.35
33	32	0	0	0.11
34	33	0	0	0.11
35	34	0	0	0.26
36	35	0	0	0.62
37	36	0	0	0.53

In the example below, EV1.1 is TRUE (happening) during the times shown, as indicated by the 1 value in that column. When the speed event is TRUE, the system measures and reports the track length of the object as well as the object’s speed for each frame.

	A	B	C	D
1	#	EV1.1	EV1.1_Track_Length_cm	EV1.1_Speed_cm/s
516	515	1	0.79	0.02
517	516	1	0.88	0.08
518	517	1	0.97	0.13
519	518	1	1.03	0.12
520	519	1	1.12	0.17
521	520	1	1.21	0.09
522	521	1	1.3	0.11
523	522	1	1.4	0.04
524	523	1	1.48	0.02
525	524	1	1.55	0.11
526	525	1	1.59	0.12
527	526	1	1.67	0.02

7.5 Extracting Data in Systems Licensed for Multiple Cameras

The Extractor function can extract either data from one video file at a time. Use the procedure in this section when you have a CinePlex System licensed for multiple cameras.

It is suggested that you read through the previous procedure (Section 7.4, “Extracting Data in Systems Licensed for a Single Camera” on page 204) for detailed information about the options in the **Extractor** dialog box.

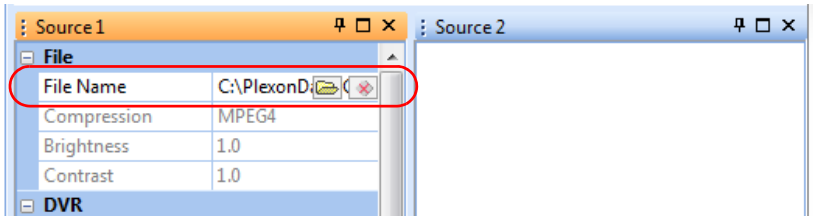
The procedures in this section assume a system with two camera licenses. These procedures are easily extended to systems with three or four licenses.

Selecting Files
Example—Extracting Data from File 1

1 The main toolbar displays the icons for Files 1 and 2 (because the system in this example is licensed for two cameras). In this example, we are extracting data from File 1, so we select the icon for File 1 and deselect the icon for File 2. An icon has an orange background when selected.

2 In the Source 1 pane, in the **File Name** row, click on the folder icon to navigate to the directory containing the desired AVI file and select the file.

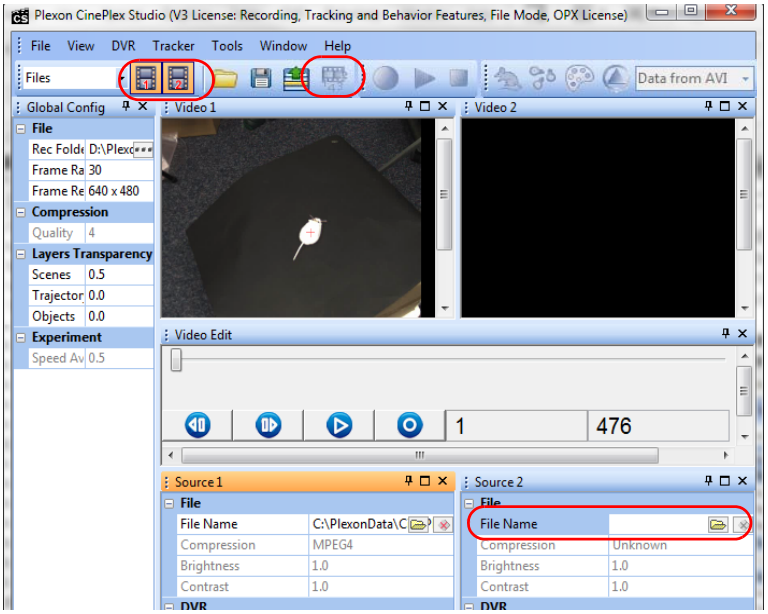
Notice that the Source 2 pane is blank because the File 2 icon was deselected in the previous step.



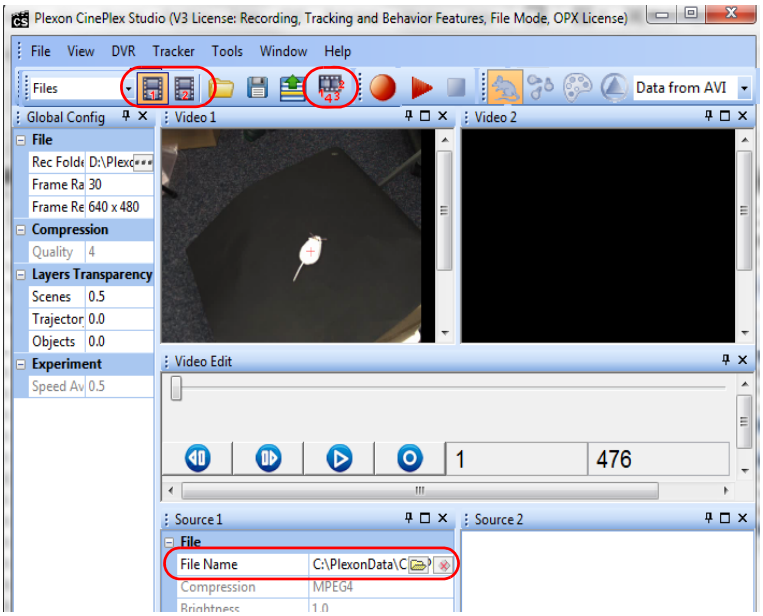
Note: If you select a file that was created with any camera other than the camera associated with that Source, the system will prompt you to select a different file (a file that was created with appropriate camera). The system can automatically detect which camera created the file, regardless of the file name. For example, only files created with Camera 1 can be loaded in the Source 1 pane.

Notice that the Extractor icon is active when there is a match between the File icon(s) selected and the actual file(s) loaded in the Source window(s). If there is a mismatch, the Extractor icon is disabled.

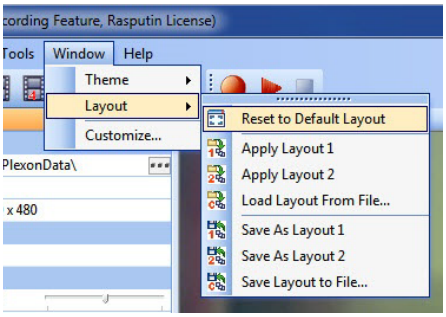
Example: File 1 and 2 icons selected, but Source 2 file not loaded. Mismatch—Extractor icon is disabled:



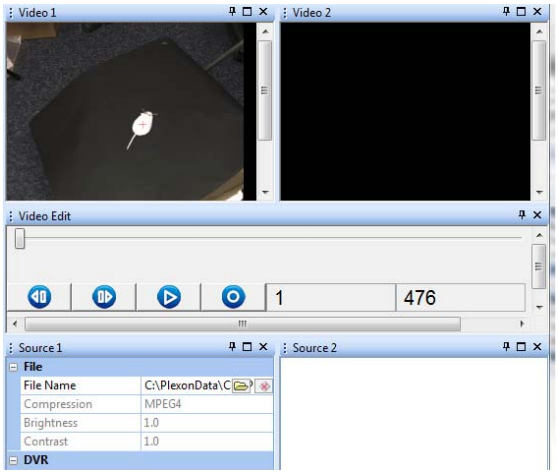
Example: File 1 icon selected and Source 1 file loaded. Match—Extractor icon is enabled:



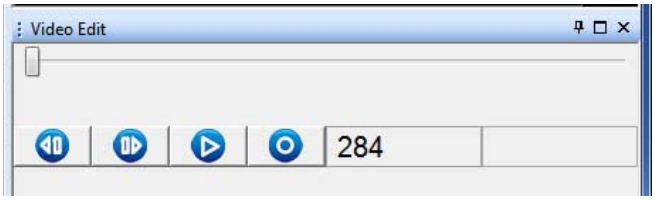
Note: If the Video 1 and 2 windows do *not* both appear, restore the default layout. (In most cases, the Video windows appear, therefore this step is not necessary.)



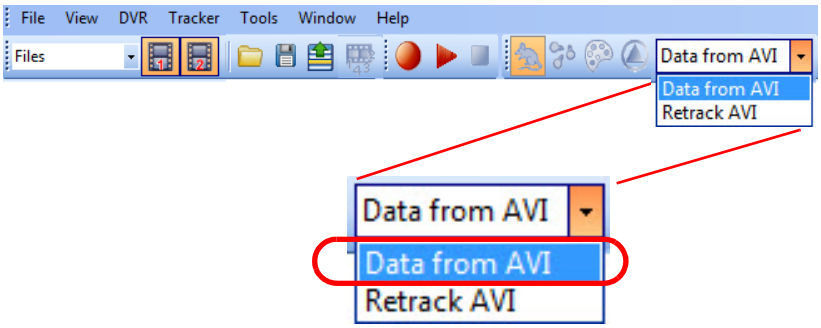
3 In this example, we are extracting data from the File 1 AVI file only. Verify that you see the video stream in the Video 1 window only.



4 You can use the buttons in the Video Edit pane to replay the video file frame by frame if desired.



5 Ensure that the **Data from AVI** option is selected.



6 Extract the desired File 1 settings, data or DVT file.
See the details for these steps in Section 7.4, “Extracting Data in Systems Licensed for a Single Camera” on page 204.

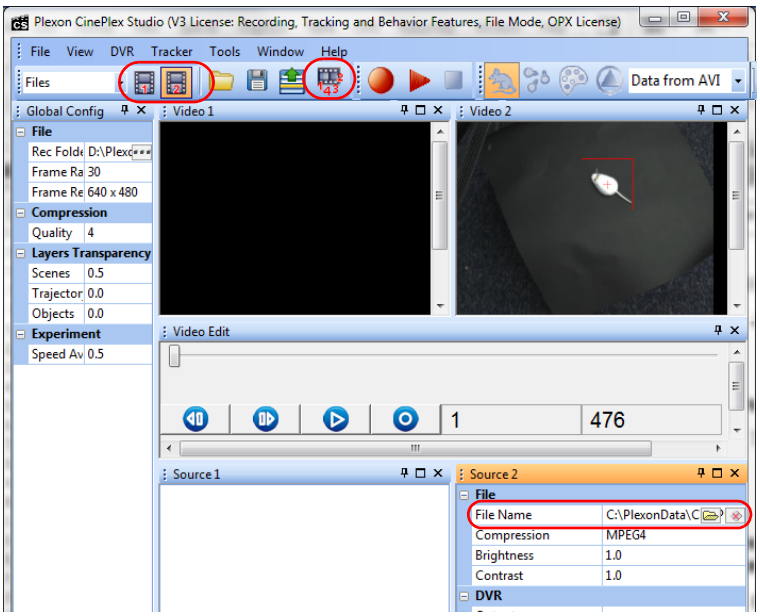
7 Close the Extractor dialog box (click on the **Close** button) when you have finished using the Extractor function.

Selecting a Different File
Example—Extracting Data from File 2

8 In the previous example, we selected File 1, and deselected the icon for File 2.

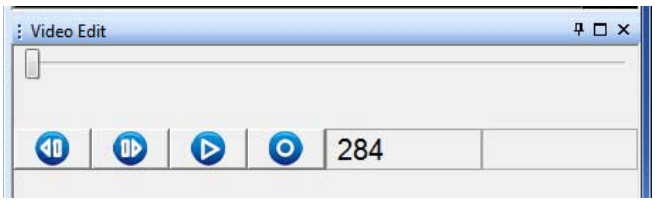
Now deselect the icon for File 1 and select the icon for File 2.

9 Load a file for Source 2.
Notice that the Extractor icon becomes active.

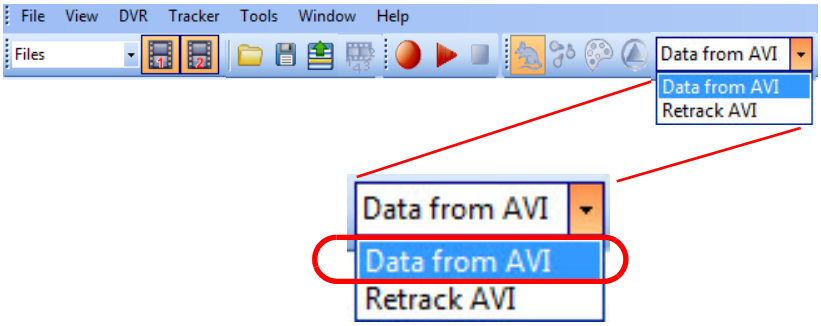


10 Verify that you see the video stream in the Video 2 window only, as shown in Step 9, above.

11 You can use the buttons in the Video Edit pane to replay the video file frame by frame if desired.



12 Ensure that the **Data from AVI** option is selected.



13 Extract the desired File 2 settings, data or DVT file.
See the details for these steps in Section 7.4, “Extracting Data in Systems Licensed for a Single Camera” on page 204

14 Close the Extractor dialog box (click on the **Close** button) when you have finished using the Extractor function.

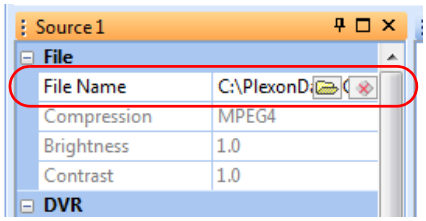
15 (Optional) After the parameters are set as desired, on the **File** menu, click **Save Settings**, or click the **Save Settings** button ( ) on the toolbar.

7.6 Calibrating the Arena and Extracting Calibrated Coordinate Data

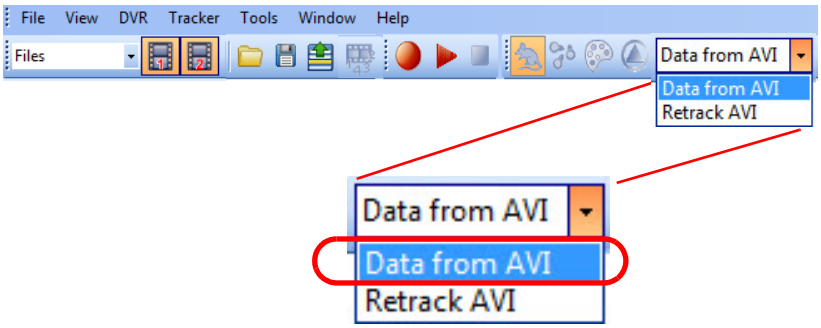
If you did not calibrate the arena prior to recording the AVI file, you can still obtain calibrated coordinate data by using the Extractor function.

Follow this procedure to extract calibrated coordinate data.

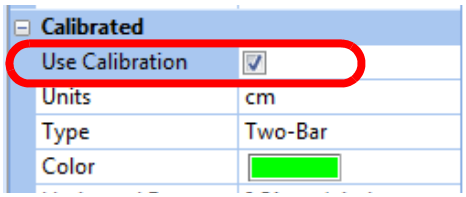
1 In Files mode, load the file.



2 Select **Data from AVI**.



3 In the Source pane, select the Use Calibration checkbox.



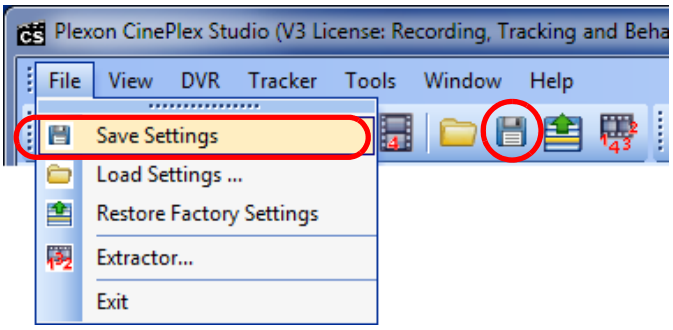
4 Perform a calibration according to the procedure in Section 3.3, “Calibrating the Arena Dimensions” on page 30.

5 Open the Extractor dialog and follow the procedure in Section 7.4, “Extracting Data in Systems Licensed for a Single Camera” on page 204 or Section 7.5, “Extracting Data in Systems Licensed for Multiple Cameras” on page 216 as applicable.

6 The data extracted from your AVI files will now be calibrated in cm (or inches).

	A	B	C	D	E	F
1	#	Timestamp	X_cm	Y_cm	EV1.2	EV1.2_Track_Length_cm
967	966	48.3	46.21	38.4	1	5.5
968	967	48.35	46.18	38.37	1	5.54
969	968	48.4	46.15	38.34	1	5.59
970	969	48.45	46.18	38.34	1	5.62
971	970	48.5	46.23	38.34	1	5.66
972	971	48.55	46.27	38.37	1	5.71
973	972	48.6	46.25	38.37	1	5.74
974	973	48.65	46.31	38.31	1	5.82
975	974	48.7	46.25	38.29	1	5.89
976	975	48.75	46.03	38.28	1	6.1
977	976	48.8	46.19	38.29	1	6.25
978	977	48.85	46.23	38.29	1	6.3
979	978	48.9	46.16	38.28	1	6.37
980	979	48.95	46.36	38.29	1	6.57
981	980	49	46.39	38.3	1	6.61

7 If desired, save the new settings. You can select the **Save Settings** option from the **File** dropdown menu or click the **Save settings to file** icon.



7.7 Digital VideoTracker (DVT) Files—Interpreting DVT Data

A Digital VideoTracker (DVT) file contains timestamp and tracking information for an audio video interleave (AVI) format recording.

The DVT file is a text file where each row contains positional data for a video frame.

Example of DVT file for LED mode

In this example, three LEDs were used during the original recording:

- The x,y coordinates for all three LEDs are displayed in each row—x1,y1 for LED1, x2,y2 for LED2 and x3,y3 for LED3.
- The coordinate data are in 0–1023 format.

The data for each row is in this form:
Frame Number, Timestamp, x1, y1, x2, y2, x3, y3

1,0.033000,910,35,110,366,19,247

2,0.066000,915,37,112,366,19,247

3,0.099000,927,38,112,366,19,247

4,0.133332,934,40,112,369,20,251

...

The above example was for LED mode. The format of each line depends on the selected tracker mode, as described below.

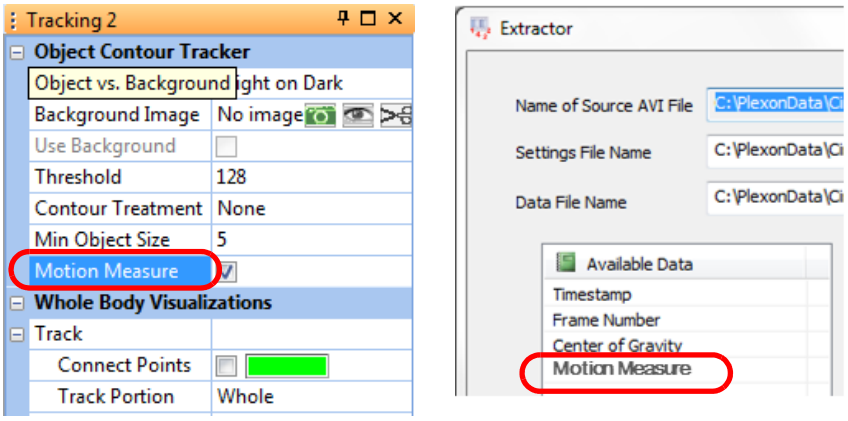
7.7.1 Object Contour Mode

For Object Contour mode, the format of each line is:

row,time,x,y,m

where:

- *row* is the row number
- *time* is the time of the frame in seconds
- *x* and *y* is the track position of the target centroid
- *m* indicates the motion measure value; see Section 5.7.7, “Motion Measure Option” on page 169. This field is present if the Motion Measure checkbox was selected in the original recording and Motion Measure was also selected in the Extractor dialog box (see the image below).



7.7.2 LED Mode

For LED mode, the format of each line is:

row,time,x1,y1,x2,y2,x3,y3

where:

- *row* is the row number
- *time* is the time of the frame in seconds
- *x1* and *y1* is the track position of color #1 (if selected)
- *x2* and *y2* is the track position of color #2 (if selected)
- *x3* and *y3* is the track position of color #3 (if selected)

7.7.3 Reflective Colors Mode

For Reflective Colors mode, the format of each line is:

```
row,time,x1,y1,x2,y2,x3,y3,x4,y4,x5,y5
```

where:

- *row* is the row number
- *time* is the time of the frame in seconds
- *x1* and *y1* is the track position of color #1 (if selected)
- *x2* and *y2* is the track position of color #2 (if selected)
- *x3* and *y3* is the track position of color #3 (if selected)
- *x4* and *y4* is the track position of color #4 (if selected)
- *x5* and *y5* is the track position of color #5 (if selected)

7.7.4 Extended Tracking of Color Markers Mode

For **Extended Tracking of Color Markers** mode, the format is similar to that for the **Reflective Colors** mode (above), but there can be up to 12 different colors selected, with rows up through x12 and y12 to track color #12.

7.7.5 Conversion of DVT Coordinates to Pixels

The data in the DVT and in PLX or PL2 files is always in the 0–1023 format, but in the CSV files extracted directly from the AVI file, the data are in unadjusted pixels, inches, or centimeters as the user has specified in the experiment calibration.

To convert DVT coordinates to pixels, multiply each coordinate by 639/1023.
:

$$xpixels = \frac{xcoordinate \times 639}{1023}$$

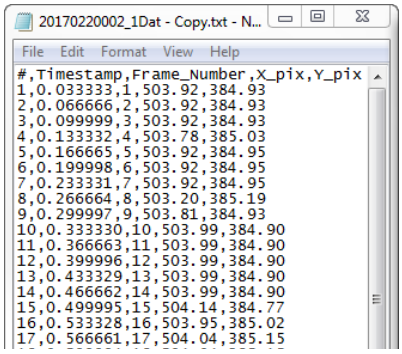
:

$$ypixels = \frac{ycoordinate \times 639}{1023}$$

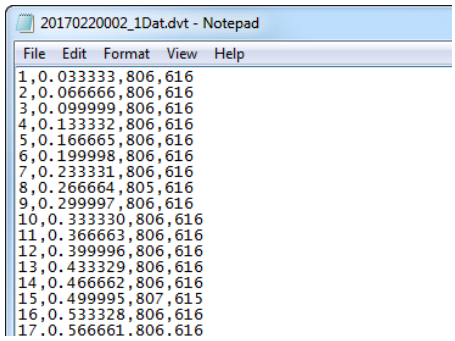
Consider the AVI and DVT files shown in the previous procedure.

Note: If the arena is *not* calibrated, the AVI data will appear as X_pix,Y_pix. If the arena *is* calibrated, the AVI data will appear as X_cm,Y_cm (or X_in,Y_in), and the AVI coordinate data will be in cm (or inches).

AVI



DVT

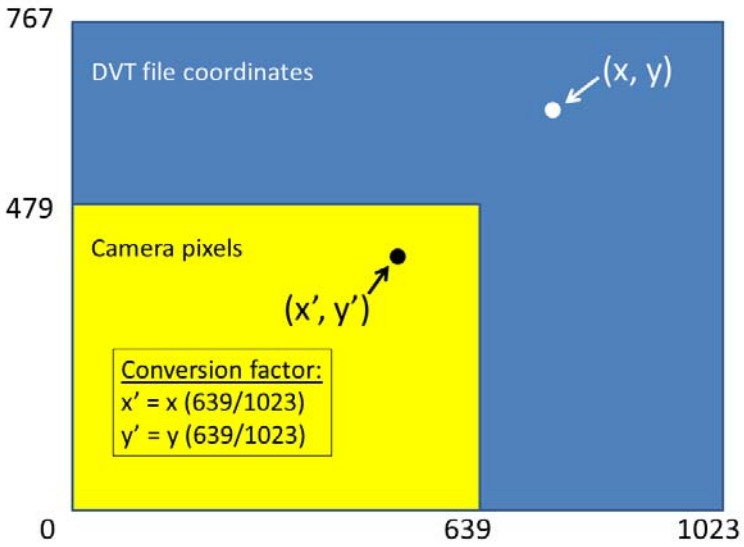


In Frame Number 6, for example:

xpixels = 806 x 639 / 1023 = 503.45 (and actual xpixels from AVI file = 503.92)

ypixels = 616 x 639 / 1023 = 384.77 (and actual ypixels from AVI file = 384.95)

The diagram below illustrates the relationship between the DVT coordinates (x,y) and camera pixels (x',y').



For any recording session, if you compare the calculated pixel coordinates (based on the above calculation from the DVT coordinates) with the actual camera pixel coordinates you will see that there can be differences of up to half of a pixel due to rounding errors.

Appendix A
Cabling Guide

A.1 Overview A-2
A.2 Required Cables A-2
A.3 Cabling Procedure A-3
A.4 Cabling Diagrams and Connection Details A-4
A.5 CinePlex/OmniPlex System Cable Images A-9
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A.7 Close-up Images of CinePlex/OmniPlex System Cables Installed A-11

CAUTION

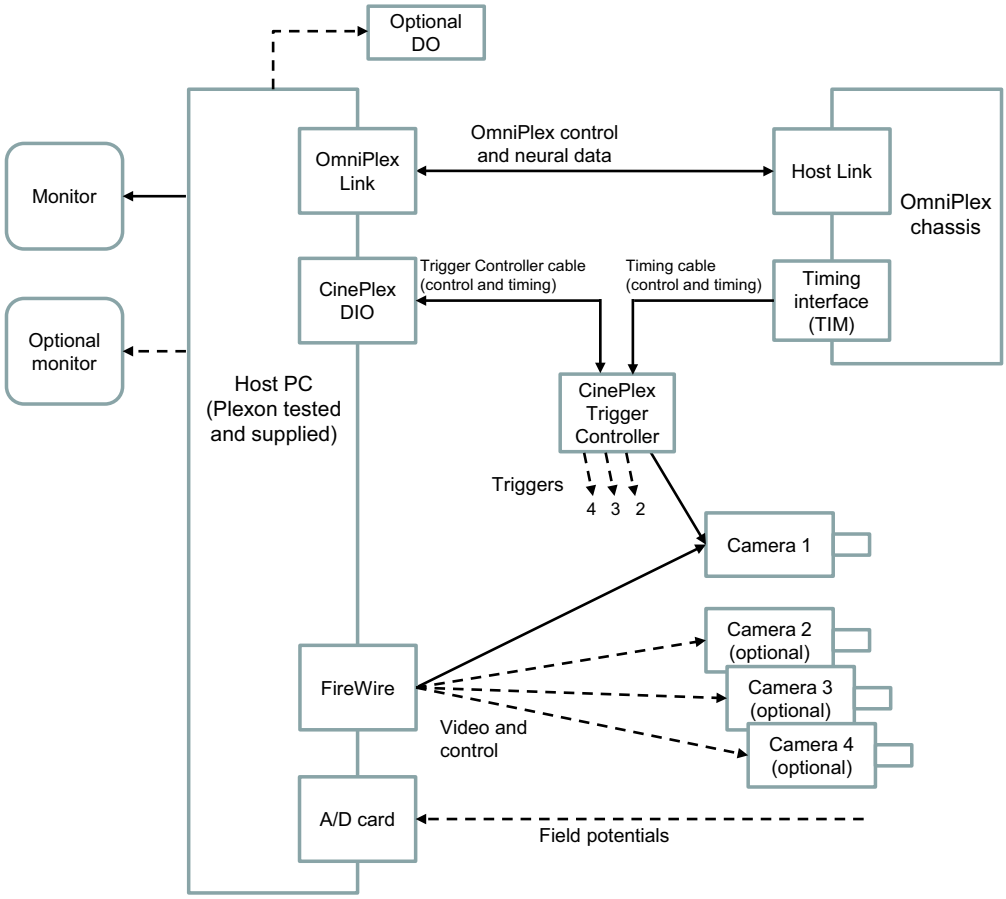
Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

A.1 Overview

This appendix is explains how to cable the Plexon CinePlex®/OmniPlex® System.

Plexon® hopes that this procedure solves cabling issues for most installations. Plexon welcomes feedback as to how to improve the experience. Please contact Plexon support (support@plexon.com or +1-214-369-4957) with comments.

The diagram below provides an overview of the required connections.



A.2 Required Cables

This section lists the cables required for connections between the CinePlex System and the OmniPlex System, and connections between the CinePlex System

and the cameras. (The cables listed here are in addition to those needed for normal OmniPlex System operation, such as the cable that carries OmniPlex control and neural data.)

For installations that use one or two cameras without a CinePlex Trigger Controller unit

The following cables are used if one or two cameras are installed and there is no CinePlex Trigger Controller unit in the system.

- Universal timing cable between the TIM Cable Adaptor and the Access IO Adaptor (CinePlex DIO).
- Trigger cable(s) from the CinePlex Access IO Adaptor to the video camera(s).
- FireWire cable(s) from the FireWire card in the host PC to the video camera(s).

Note: Plexon supplies the Trigger and FireWire cables bundled together with plastic tie wraps. This combination is referred to as a Combination Cable on the following pages.

- Optional cable from a USB port on the computer to the Digital Output unit (for customers purchasing the Basic Behavior option).

For installations that use up to four cameras with a CinePlex Trigger Controller unit

The following cables are used if one or more (up to four) cameras are installed and there is a CinePlex Trigger Controller unit in the system.

- Universal timing cable between the TIM Cable Adaptor and the CinePlex Trigger Controller.
- Trigger Controller cable between the CinePlex Trigger Controller and the Access IO Adaptor (CinePlex DIO).
- Trigger cable(s) from the CinePlex Trigger Controller to the video camera(s).
- FireWire cable(s) from the FireWire card in the computer to the video camera(s).

Note: Plexon supplies the Trigger and FireWire cables bundled together with plastic tie wraps. This combination is referred to as a Combination Cable on the following pages.

- Optional cable from a USB port on the computer to the Digital Output unit (for customers purchasing the Basic Behavior option).

A.3 Cabling Procedure

This procedure explains how to connect the CinePlex/OmniPlex System cables.

1. Make sure that there is no power present at the connectors on the back of the host PC before connecting the combination Trigger and FireWire camera

cable(s). Otherwise, the camera(s) could be damaged. To remove power from the connectors on the host PC, simply shut down the host PC from the Windows® Start menu.

CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

The following steps refer to diagrams that appear later in this appendix. Please refer to the applicable diagram(s) when performing these steps. Use either Step 2 or Step 3, as applicable to the configuration of the system.

2. For installations that use one or two cameras without a CinePlex Trigger Controller unit: Connect the Plexon supplied Universal Timing Cable and the Sync Start Wire between the OmniPlex System and the Host PC.
3. For installations that use up to four cameras with a CinePlex Trigger Controller unit: Connect the Plexon supplied Universal Timing Cable and the Sync Start Wire between the OmniPlex System and the Host PC.
4. Attach the combination Trigger and FireWire camera cable(s).
5. Connect all of the other cables for the system as shown in the diagrams.

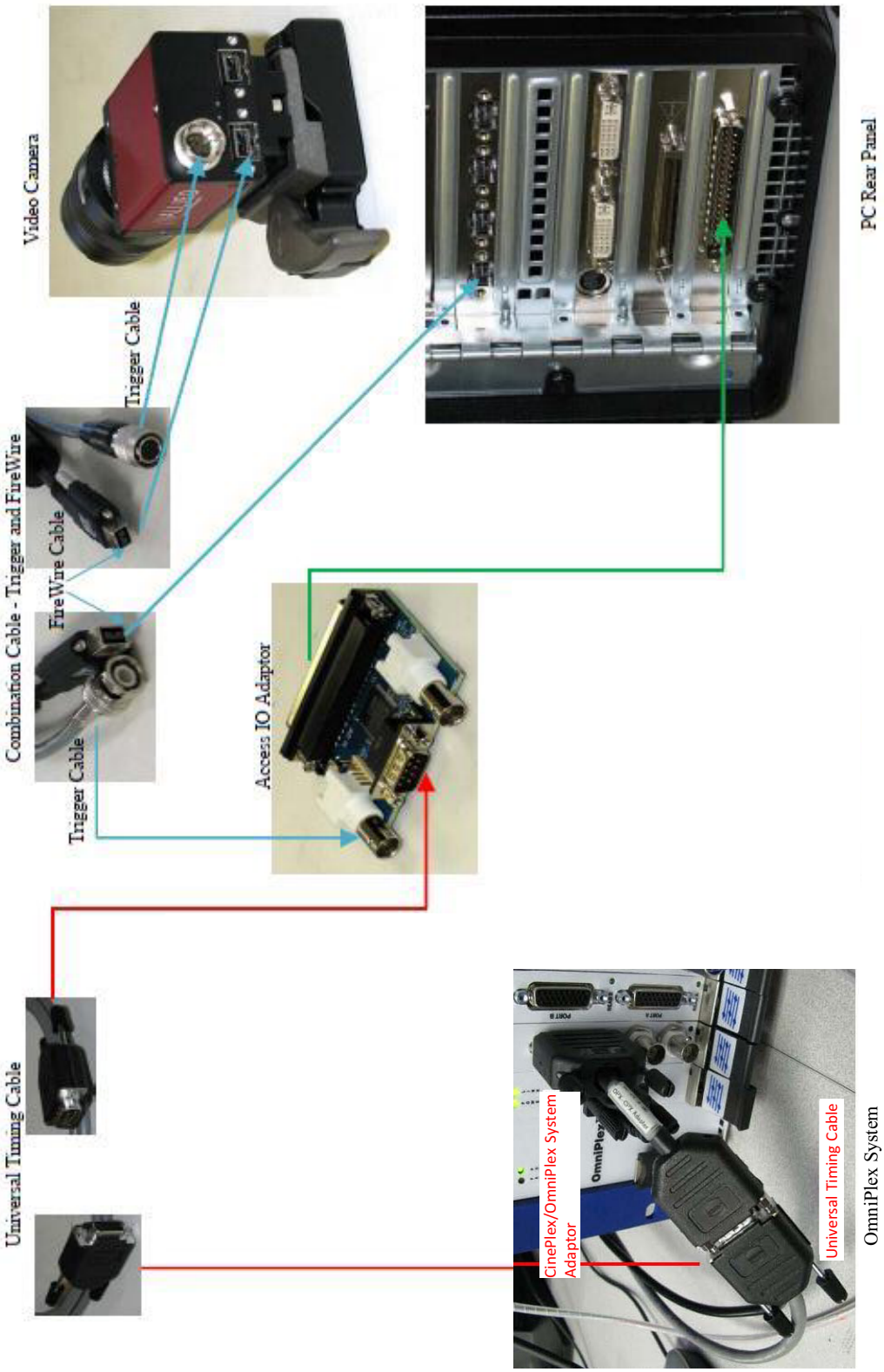
A.4 Cabling Diagrams and Connection Details

This section contains pictorial representations of the cabling for several typical CinePlex/OmniPlex System setups:

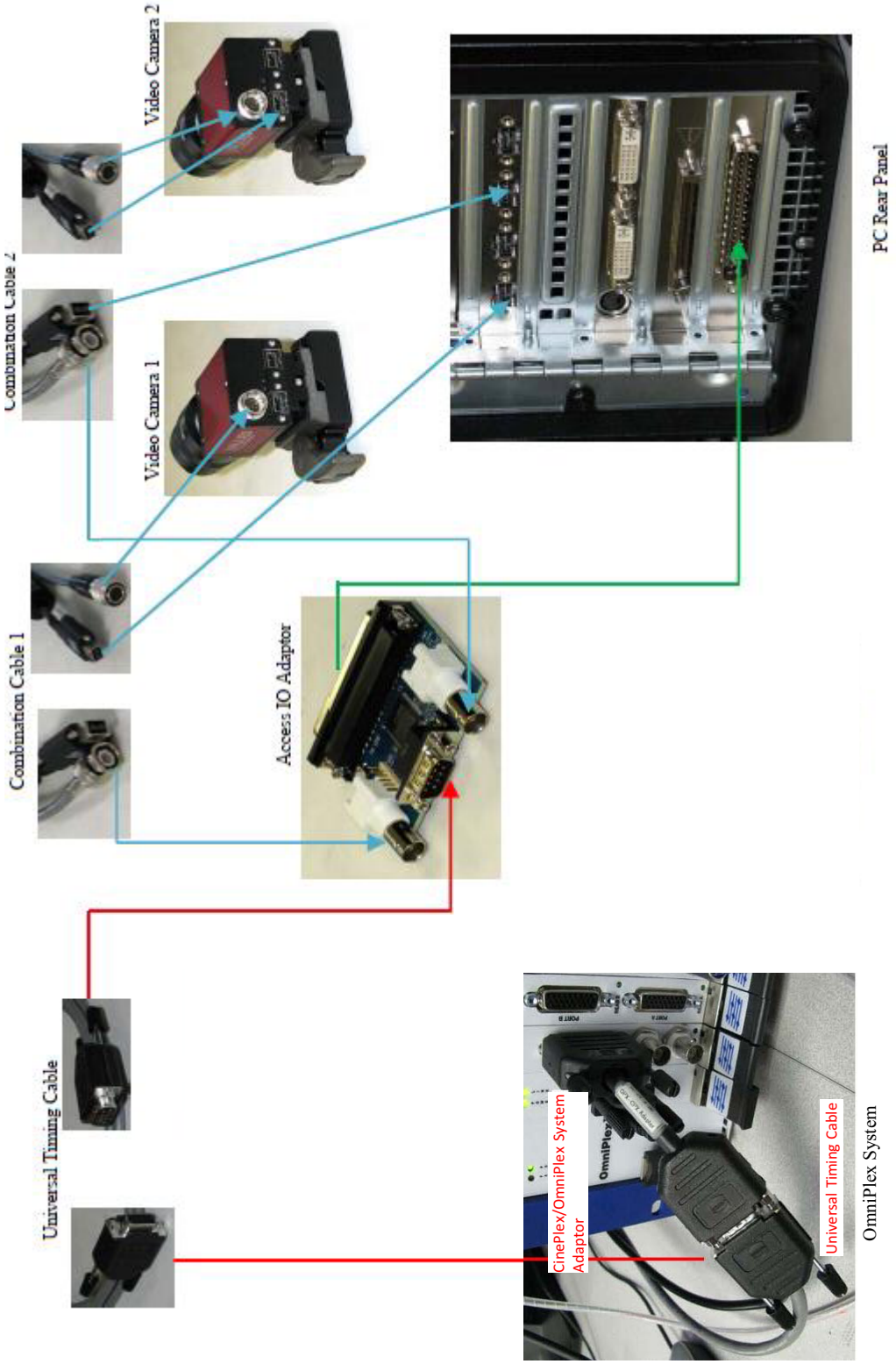
- CinePlex/OmniPlex System with One Video Camera on page A-5
- CinePlex/OmniPlex System with Two Video Cameras on page A-6
- CinePlex/OmniPlex System with Three Video Cameras on page A-7
- CinePlex/OmniPlex System with Four Video Cameras on page A-8

Please contact Plexon with questions about the setup if it differs substantially from those represented.

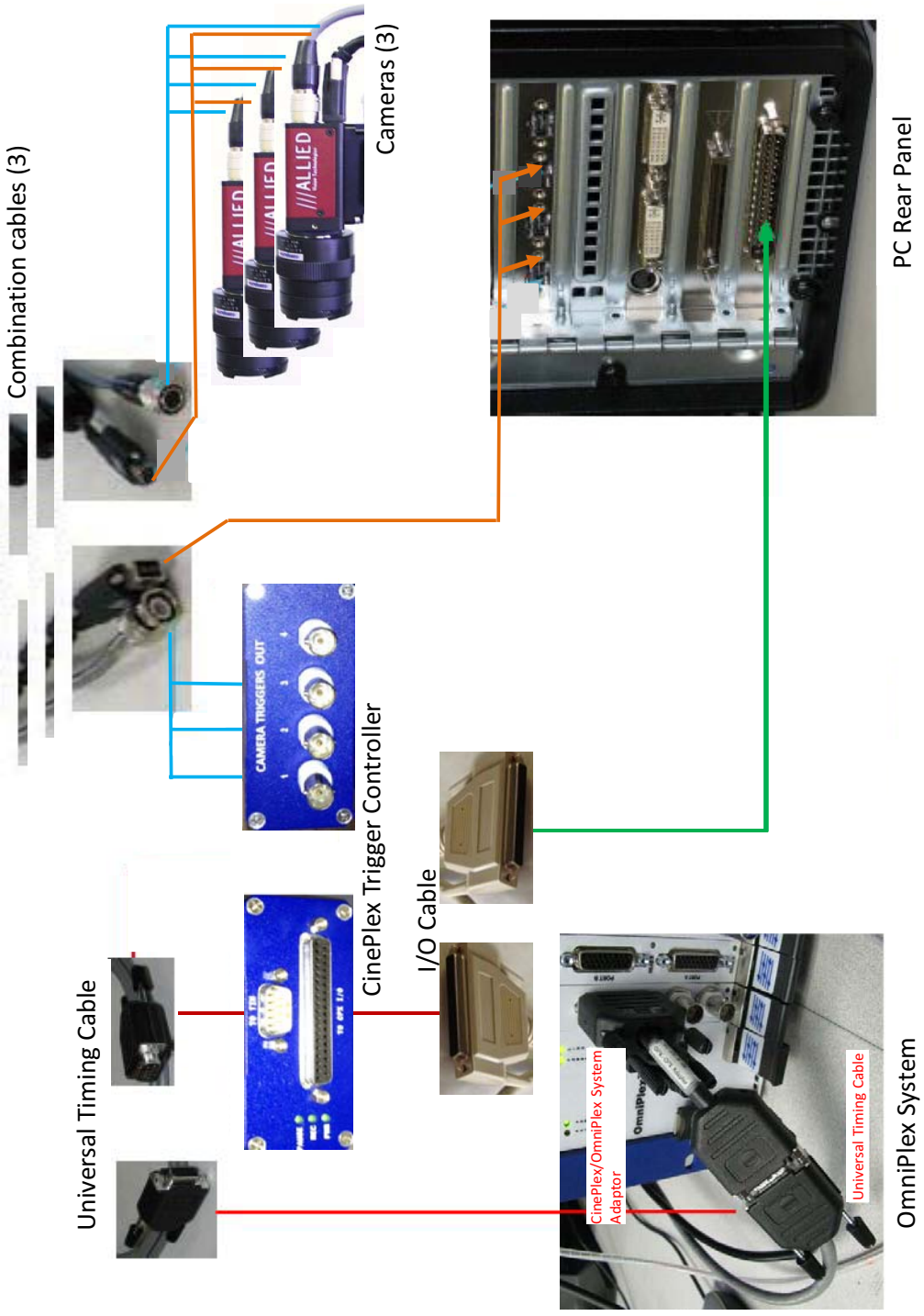
A.4.1 CinePlex/OmniPlex System with One Video Camera



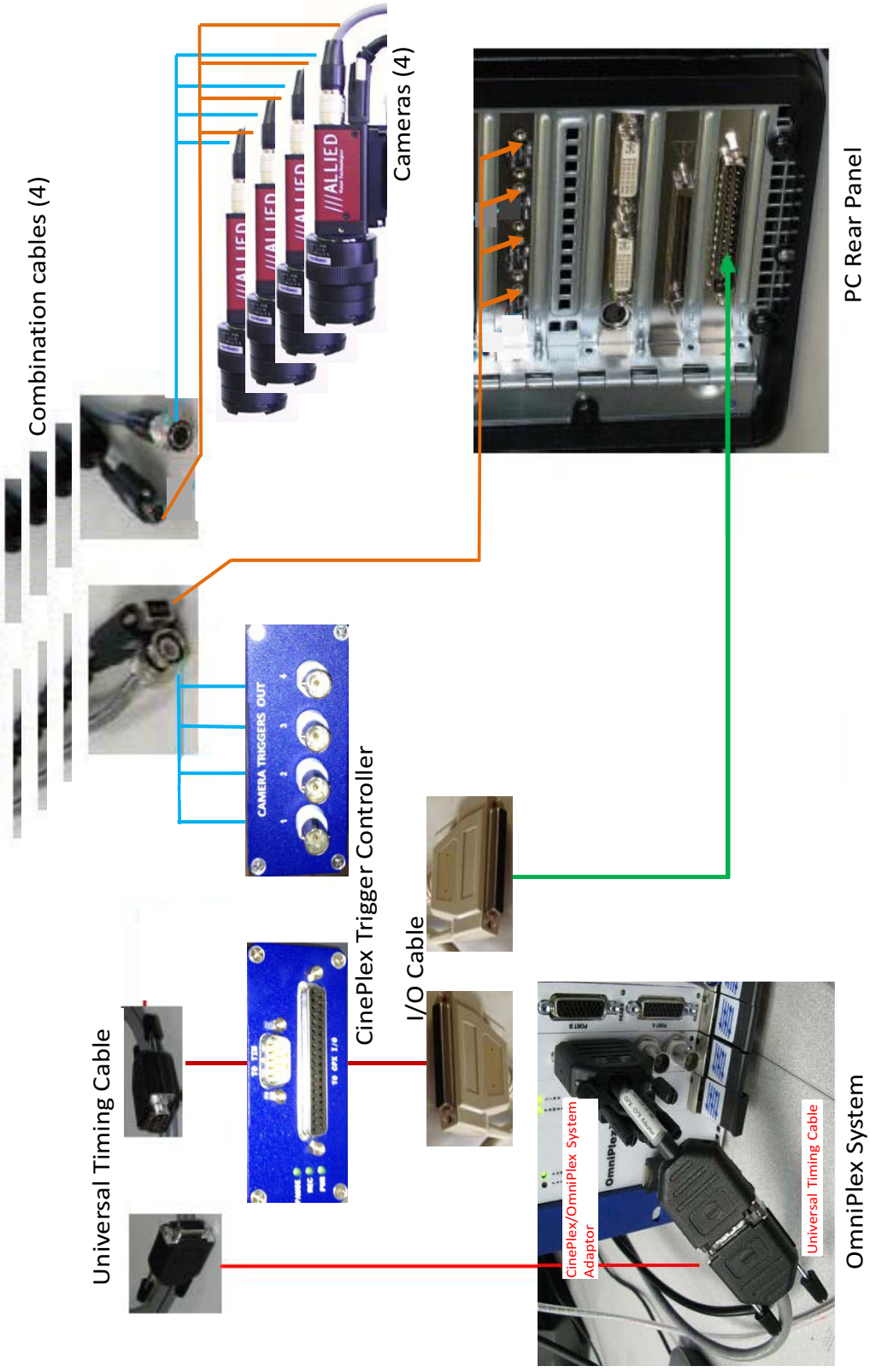
A.4.2 CinePlex/OmniPlex System with Two Video Cameras



A.4.3 CinePlex/OmniPlex System with Three Video Cameras



A.4.4 CinePlex/OmniPlex System with Four Video Cameras



A.5 CinePlex/OmniPlex System Cable Images

1. Universal Timing Cable

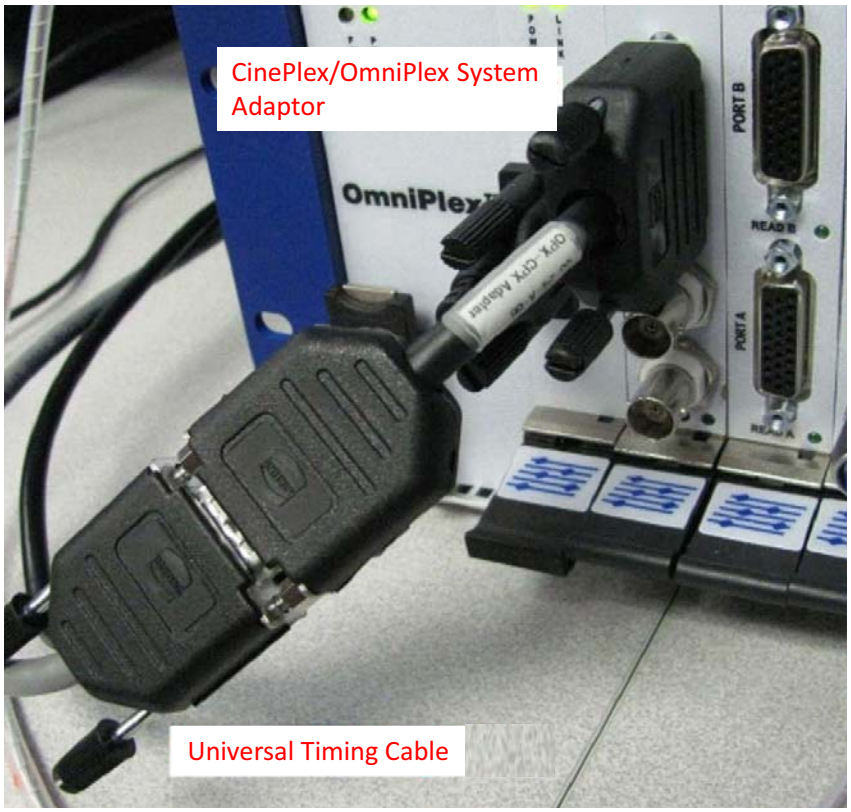
2. Combination Cable – Trigger and FireWire

IO Wire for CinePlex Trigger Controller

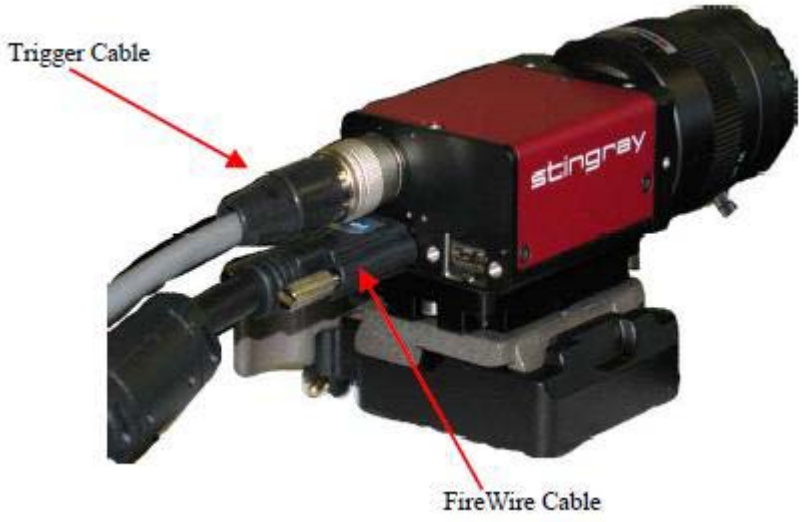
A.6 CinePlex Trigger Controller - Required for Three Or Four Cameras

A.7 Close-up Images of CinePlex/OmniPlex System Cables Installed

A.7.1 Connections to OmniPlex System

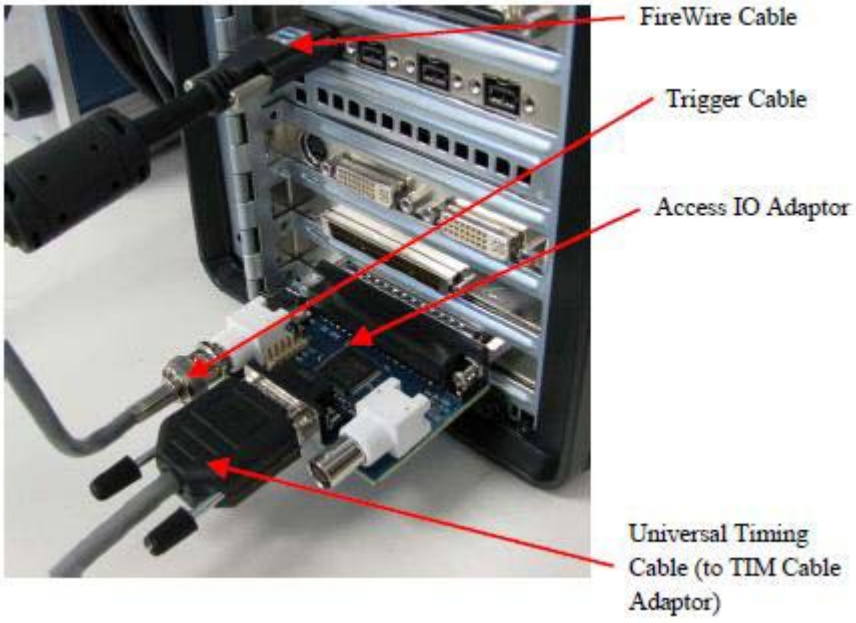


A.7.2 Connections to Video Camera

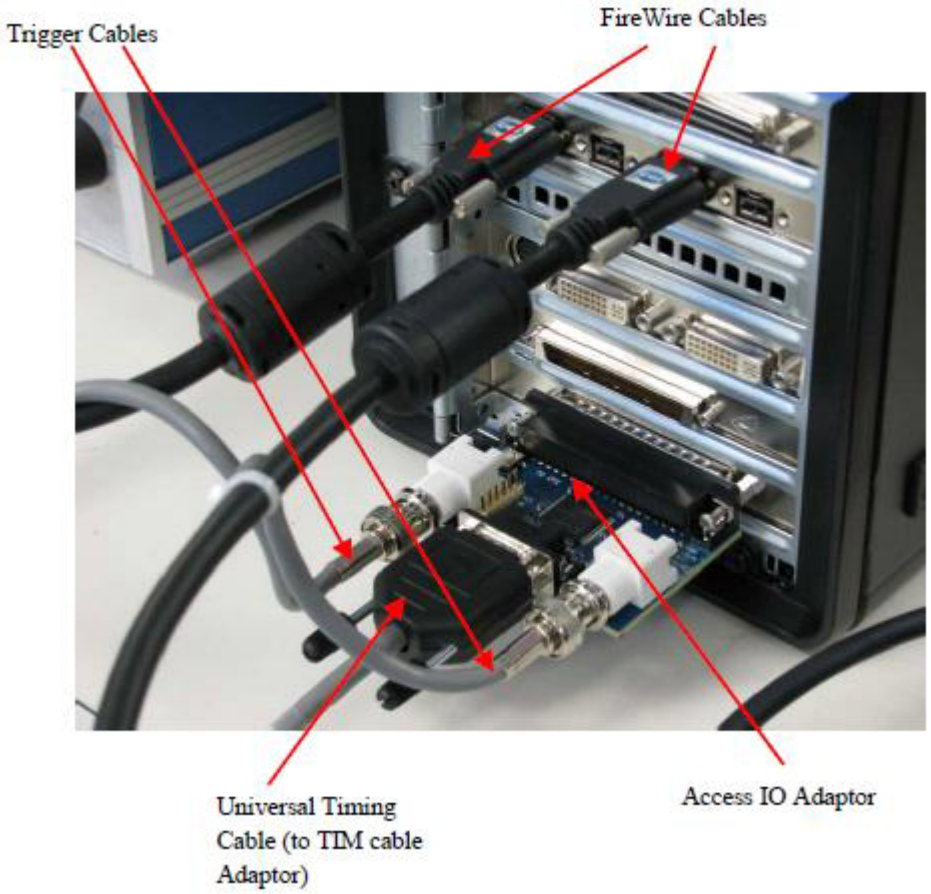


A.7.3 Connections to Computer

One Video Camera

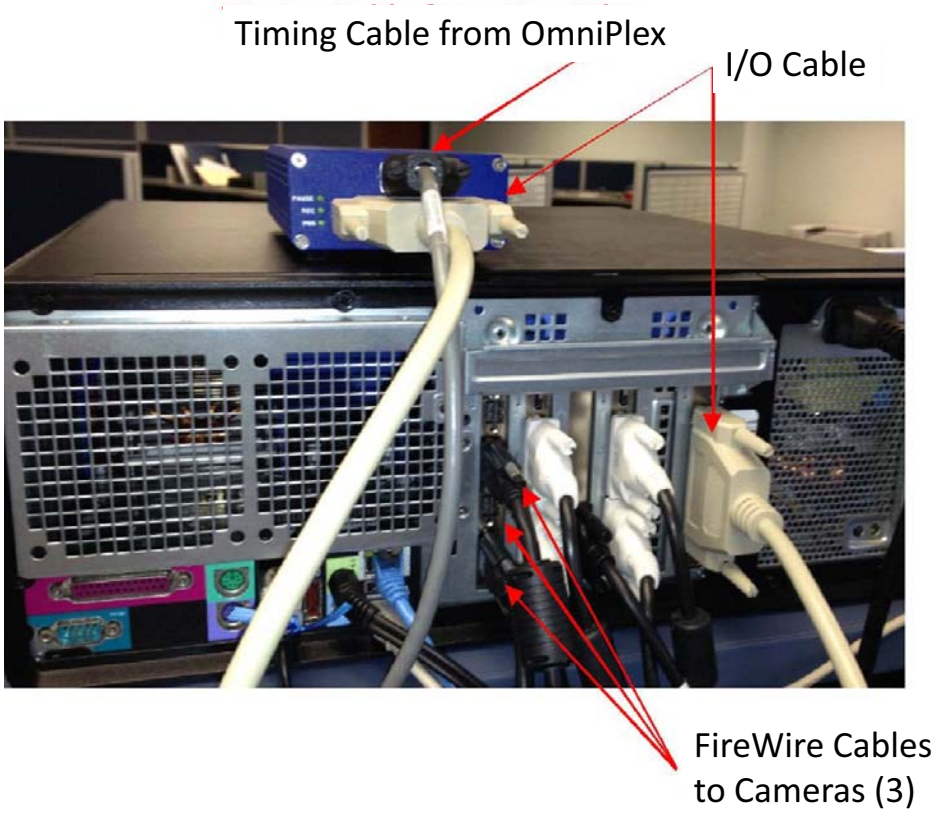


Two Video Cameras

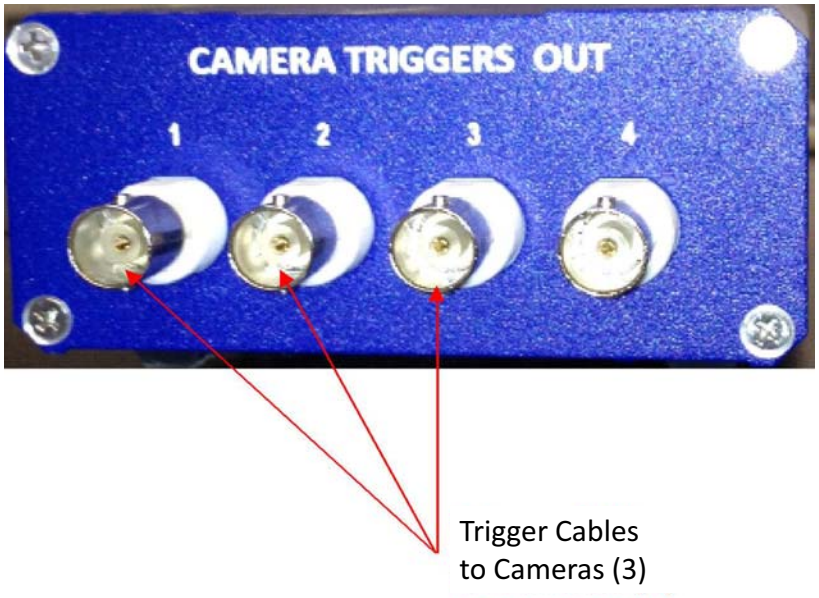


Three Video Cameras

Rear view of host PC:

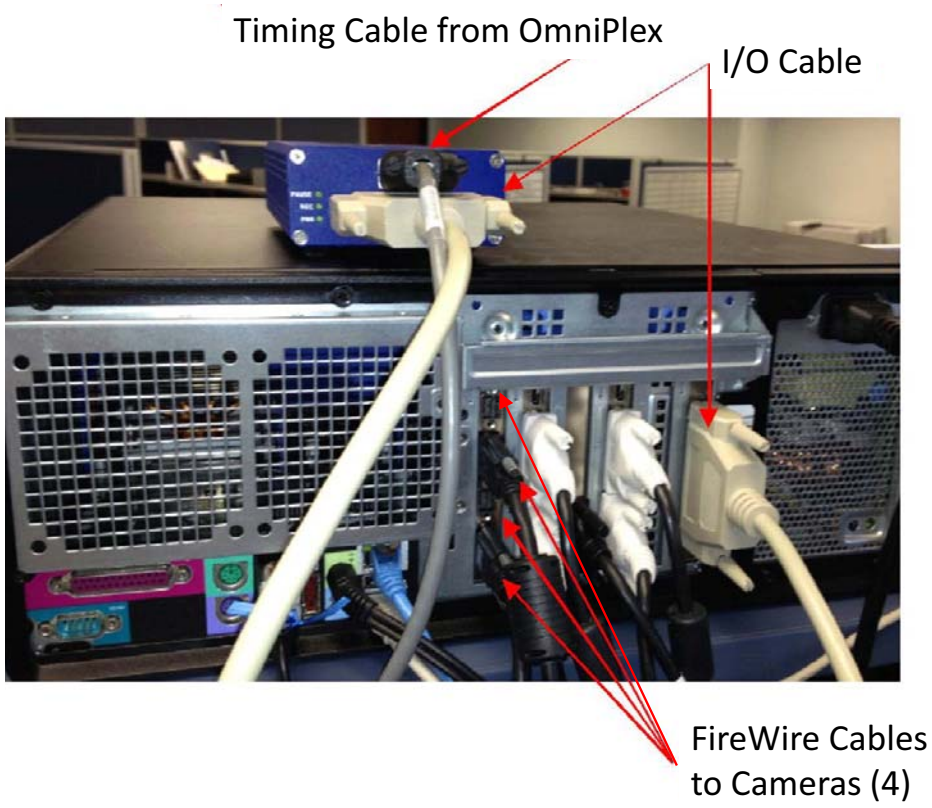


Front of CinePlex Trigger Controller with Connections for Three Cameras :

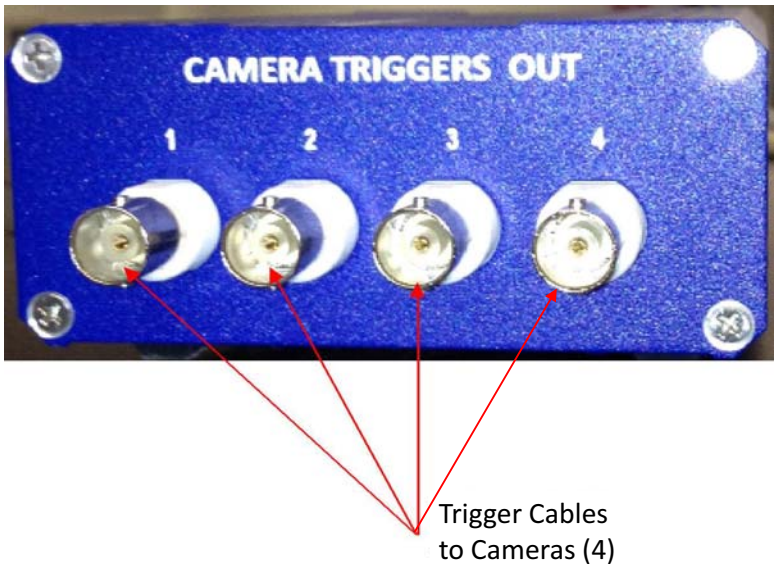


Four Video Cameras

Rear view of host PC:



Front of CinePlex Trigger Controller with Connections for Four Cameras :



Appendix B
Optimizing Camera and Lens Usage for the Experiment

B.1 Overview B-2
B.2 Available Cameras B-2
B.3 Camera Positioning and Lens Selection B-2
B.4 Experiment Design B-4
B.5 Camera Installation B-8

CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

B.1 Overview

This appendix provides details of camera and lens setup and usage. It is intended to assist the scientist in preparing the cameras and lenses for his or her experiment.

In any experiment where video is required, there is a physical area of interest in which it would be meaningful to record video. This area of interest can be a simple enclosure, a maze, a geometrical track, or any other area needed for the experiment. For video recording of behaving animals, this area of interest is known as the arena. The arena shape and size are critical in determining the lens used and the distance from the camera to the arena. Colors used and target visibility are also extremely important.

The sections that follow this introduction provide information about camera and lens selection, arena layout, and camera installation.

Plexon® hopes that this procedure solves these issues for most installations. Plexon welcomes feedback as to how to improve the experience. Please contact Plexon support at support@plexon.com or +1-214-369-4957 with comments.

B.2 Available Cameras

For CinePlex® Version 3, Plexon currently offers several AVT cameras and several lenses, both varifocal and zoom. The camera types are as follows:

- AVT Stingray (Type 1/2 CCD)
- AVT Guppy (Type 1/3 CCD)
- Pike (Type 1/3 CCD)

The setup of the camera, lens selection and distance from the experimental arena are discussed in the following section.

B.3 Camera Positioning and Lens Selection

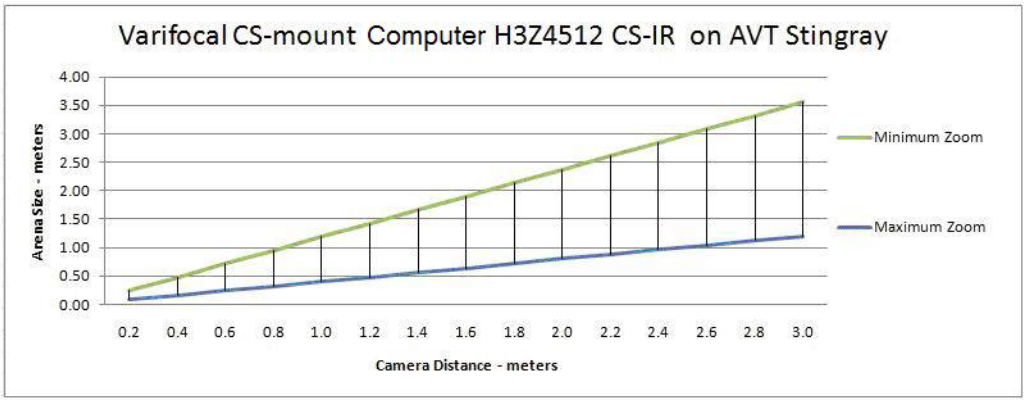
This section provides a systematic procedure for determining the position of the camera and selecting the lens to use in an experimental arena.

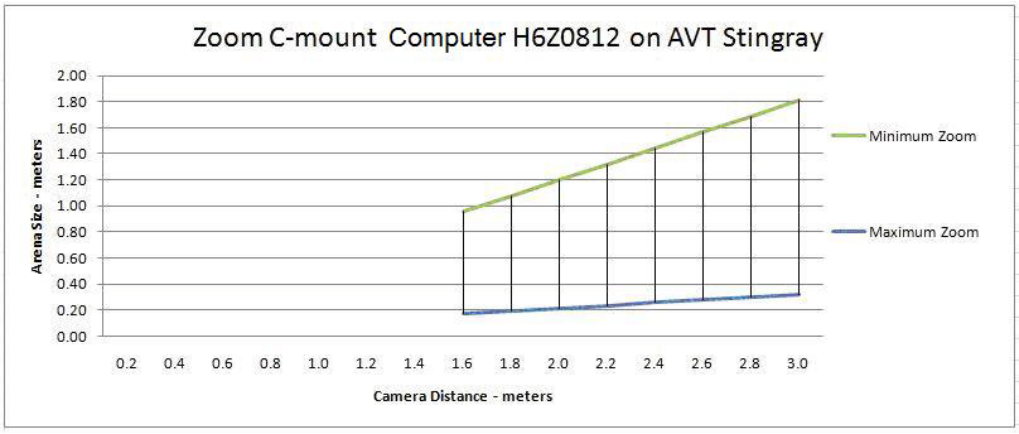
Investigators may find that they need to compromise arena size and/or camera distance to accommodate the physical limitations of the camera/lens combinations. The limiting factors are that the lens must be able to focus the arena image and that the arena image should fill the screen. If the camera's distance to the arena is fixed, the arena size must be kept within certain limits for

best results. Alternatively, if the arena size is fixed, the distance between the camera and arena must be kept within limits for best results.

1 Determine Optimal Arena Setups

Use the charts below to determine if a particular lens can be used with the current experimental setup. The area between the green and blue lines in the charts represents arena size and camera distance combinations that are acceptable for best results.





2 Determine the distance from the camera to the arena in meters

This distance should be as far as possible from the arena, while still close enough to allow the zoom function to fill the sensor with the arena image. Be sure to allow space for camera mounting. Find that distance on the X-axis (Camera Distance) of the Standard Varifocal chart.

3 Determine the size of the arena in meters

Imagine a circle, square or 4:3 rectangle drawn around the arena, completely enclosing it. The Arena Size in the charts above is the diameter of the circle, the side of the square, or the longer side of the 4:3 rectangle. Find that size on the Y-axis (Arena Size) of the Standard Varifocal chart.

4 Determine if the arena size and camera distance are optimal

If the (X,Y) position specified by the Camera Distance and Arena Size is in the area between the Green and Blue lines, the setup should yield optimal results

when the camera is zoomed appropriately. It is not necessary to proceed. The Standard Varifocal lens will work.

If the (X,Y) position specified by the Arena Size and Camera Distance is NOT in the area between the Green and Blue lines, the setup is sub-optimal. The image will be smaller than desirable, larger than desirable, or out of focus.

5 If the position is not optimal, try the steps above on the chart for the Zoom lens

If this lens yields an optimal result, contact Plexon to obtain the lens. If not, try adjusting Arena Size and Camera Distance to find an optimal combination with one of the lenses.

6 If an optimal result cannot be obtained using this procedure, contact Plexon for other lens possibilities

Note: The charts are derived from calculated numbers. Small variations in lens and camera manufacturing can result in as much as 10% variation.

B.4 Experiment Design

B.4.1 Field of View

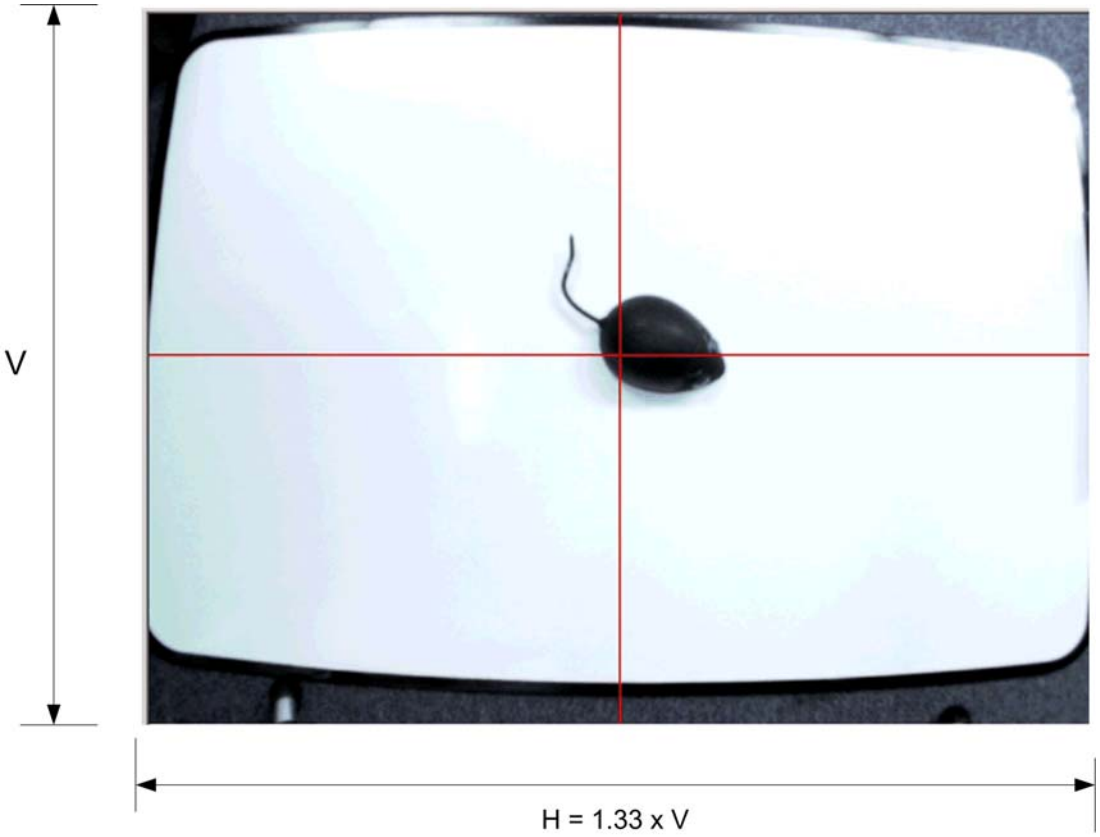
The field of view (what the sensor of the camera sees) depends on the distance between the camera and the surface and the angles of view of the lens that is used with the camera. The cameras supplied by Plexon generate screen images with the following geometries, depending on the camera model:

- images that are rectangular, 4 units wide by 3 units high, as shown by the diagram below. This aspect ratio corresponds to the sensor image size of 640 by 480 pixels or 320 by 240 pixels.
- images that are square, with sensor image size of 320 by 320, 640 by 640 or 960 by 960 pixels.

The example that follows in this section is based on a 4 by 3 rectangular geometry.

Orient the camera to the experimental area to take maximum advantage of the rectangular field of view. As shown in the following illustration, the 4:3 ratio

corresponds to a horizontal dimension (H) that is 1.33 times the vertical dimension (V).



When the camera is placed so that it is directed towards the experimental area, it has a horizontal angle of view and a different vertical angle of view because of the aspect ratio described above. The image producing sensor in the camera is also rectangular in the same proportion. So the ideal experimental layout will have a rectangular 4:3 arena with the camera aligned so that its longer (horizontal) sensor dimension is parallel to the arena's long side. Actual arenas may not be 4:3 rectangles, but in all cases, best results will be obtained when the

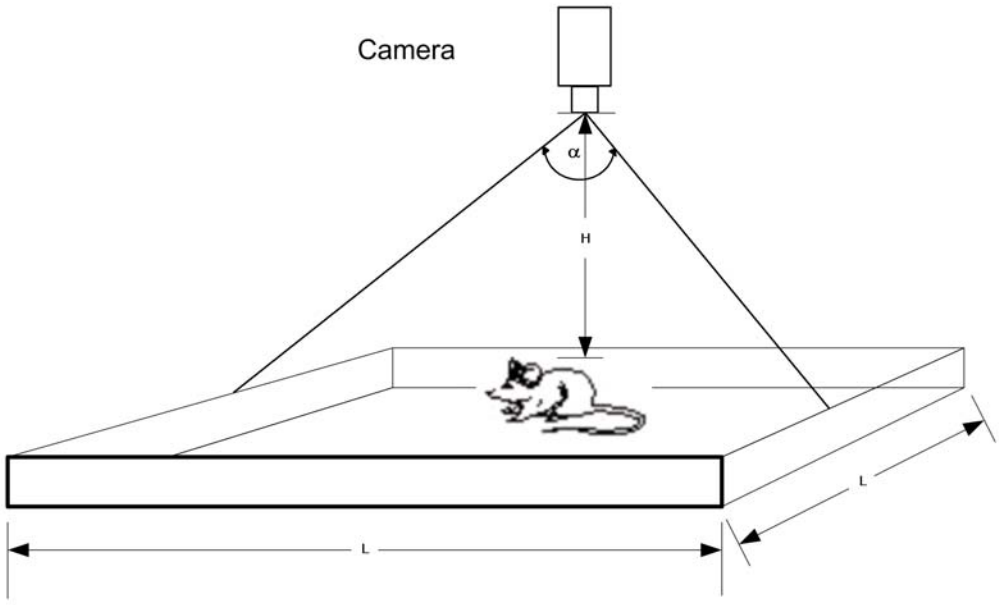
longest dimension of the arena is parallel to the longer sensor dimension of the camera.

When the camera and lens are viewed as shown in the image below, the long axis of the sensor is in the horizontal plane. This axis should be parallel to the longest dimension of the experimental area.

The table below shows the horizontal and vertical angles of view that correspond with maximum and minimum zoom of the camera, using the standard lens as an example. Other lenses will differ.

	α (normal lens)	
	Maximum zoom (minimum angle and area covered)	**Minimum zoom (maximum angle and area covered)**
Horizontal	30 degrees	83 degrees
Vertical	22 degrees	61 degrees

The best way to avoid optical distortions is to set the lens at Maximum Zoom and move the camera far enough away from the experiment that the maze, cage, track or other setup is completely imaged This is the optimum height. The figure below illustrates the parameters for a field of view estimate (maze size).



The formula to calculate the optimum height (**H**) of a camera over a square maze of side **L** (or a circular maze of diameter **L**) is:

$$H = \frac{L}{2\tan\left(\frac{\alpha}{2}\right)}$$

If the maze is round or square, use the Vertical Maximum zoom angle (or 22 degrees for the normal lens). If the maze is rectangular, use the Horizontal Maximum Zoom angle (30 degrees for the normal lens).

B.4.2 Colors

In contour tracking, to achieve the best tracking accuracy, choose colors with maximum contrast. For example, if the target animal is white, choose black or another dark color for the arena floor. Likewise, if the target is dark-colored, choose a bright white or other light color for the floor. For multi-colored animals like Long-Evans rats, red has been shown to have good contrast to the animal's fur colors. It may be necessary to experiment to determine the best background color in individual situations.

In all tracking modes, use materials with solid colors as floors, if at all possible. Avoid floor materials with patterns or textures.

B.4.3 Visibility

Unless otherwise required, the design of the arena should ensure that the target is completely visible to the camera in all areas. If the target is partially obscured by overhangs or other obstacles during its travel around the arena, the centroid calculations that determine target position and orientation can be affected.

B.4.4 Sharpening the Image

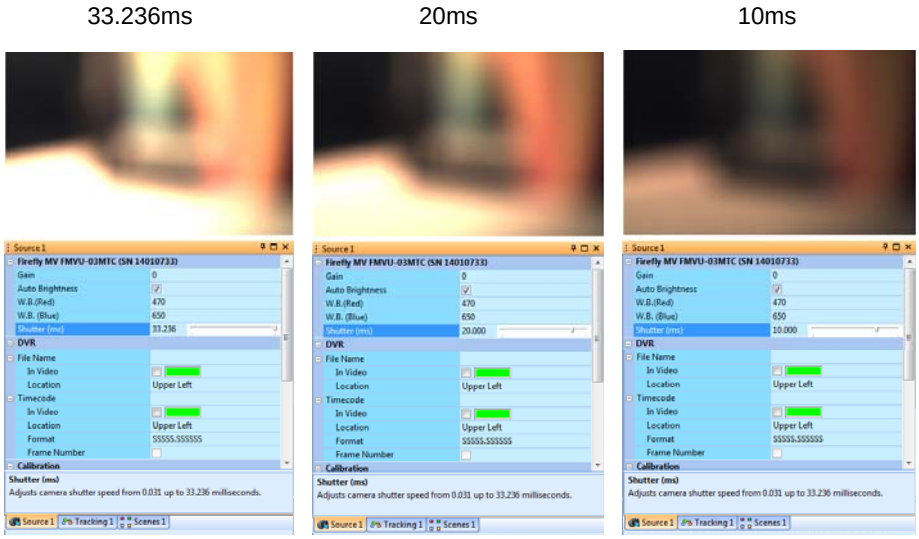
Reducing Blurs and Color Streaks in the Video

If the experimental subject moves quickly, blurs and color streaks can appear in the video. Reduce or eliminate these problems by increasing the shutter speed. See the shutter speed adjustment—**Shutter (ms)**—as shown in the images below.

Notes regarding shutter speed

Note: Although it may seem confusing, for historical reasons the terms "increasing shutter speed" and "reducing shutter open time" are synonymous.

If an image is too bright, you can make the image darker by reducing the amount of time that the shutter is open. In all the images shown in the example below, the frame rate is 30 frames per second (one frame per 33.236ms). By default, the shutter will stay open the entire 33.236ms per frame. You can reduce this opening time, **Shutter (ms)**, using the slider to set a new value. The images below show the effects on brightness for shutter speeds of 33.236ms, 20ms and 10ms.



It might be useful, for example, to adjust the **Shutter (ms)** value in the following situations:

- The image is too bright, so the video gets oversaturated:
  You might need to reduce the shutter open time (reduce the **Shutter (ms)** value) to make the image darker. You can reach a similar effect by closing the lens iris, but that means touching the cameras, and you will not be able to have the iris set exactly the same on all cameras.
- You will be recording animals in subdued lighting, but prefer to perform dimensional calibration in full lighting:
  In this case, It is useful to have the iris opened all the time when you set up cameras, and then reduce the shutter open time (reduce the **Shutter (ms)** value) slightly when you do the calibration. Then, increase the shutter open time to the maximum prior to performing experiments.
- You are tracking an animal at a certain frame rate, for example 30 fps, but your animal moves very quickly; so you might get a blurry image:
  You can improve the image by keeping the shutter closed most time within each frame. Alternatively, you might simply prefer to use a faster frame rate, which has the effect of reducing the maximum time the shutter can be open.

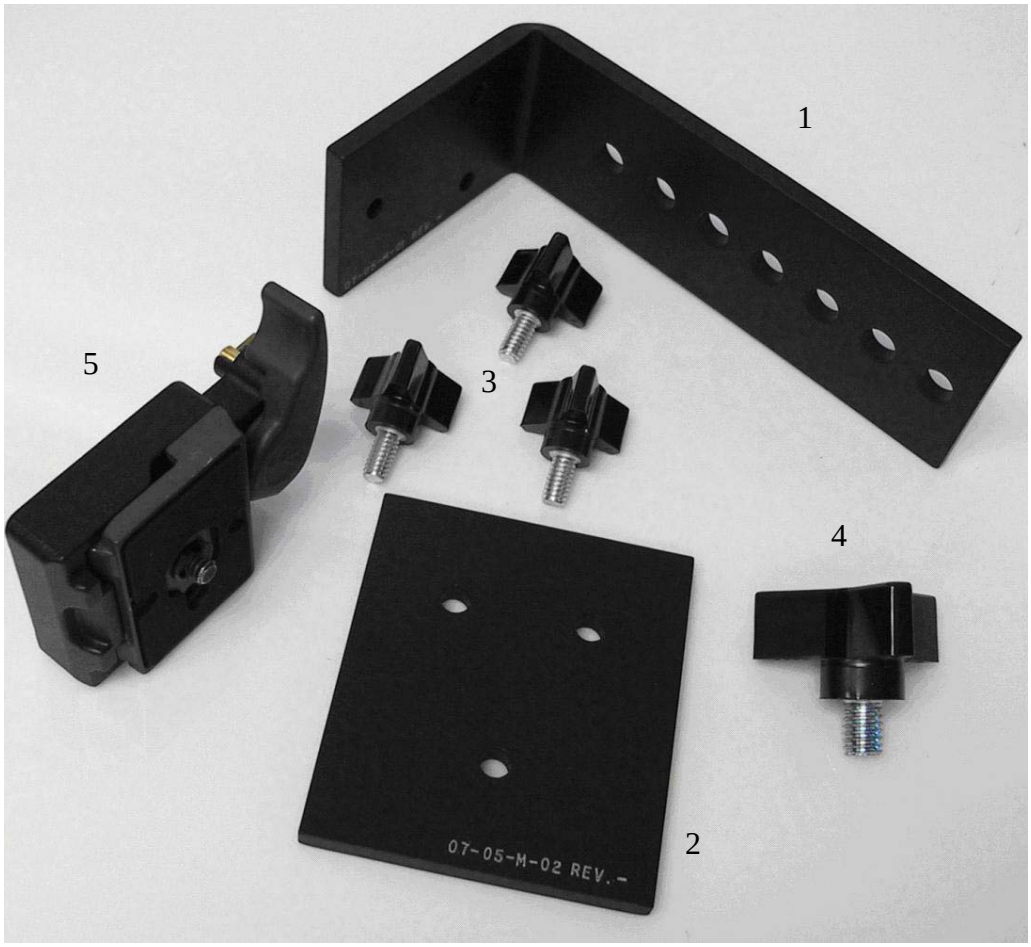
B.5 Camera Installation

B.5.1 The Plexon Camera Mounting Kit and Accessories

For repeatable, reliable video recording, the video camera(s) must be mounted stably and securely with respect to the experimental area. Cameras that vibrate or move can result in not just partial recordings or blurred images, but also in inaccurate position metrics, event triggers at undesired times, and, worst of all, non-repeatable experimental trials.

B.5.1.1 Plexon Mounting Kit

The Plexon mounting kit consists of both purchased and Plexon manufactured parts. It is included with CinePlex Version 3 and later cameras. The parts have been selected to apply in most of the situations encountered while doing CinePlex installations. Note that because of the general nature of the kit, not all parts will be used in all cases. In addition, there will be some cases where a particular installation will require that the customer purchase some additional parts locally.



1 Mounting Bracket (Plexon 07-05-M-01)

2 Sandwich Plate (Plexon 07-05-M-02)

3 Three Arm Phenolic Knob (small) - 1/4”-20 (3 ea.)(McMaster Carr 57715K16)

4 Three Arm Phenolic Knob (large) - 3/8”-16 (McMaster Carr 57715K83)

5 Quick Change Mounting Assembly (Bogen-Manfrotto)

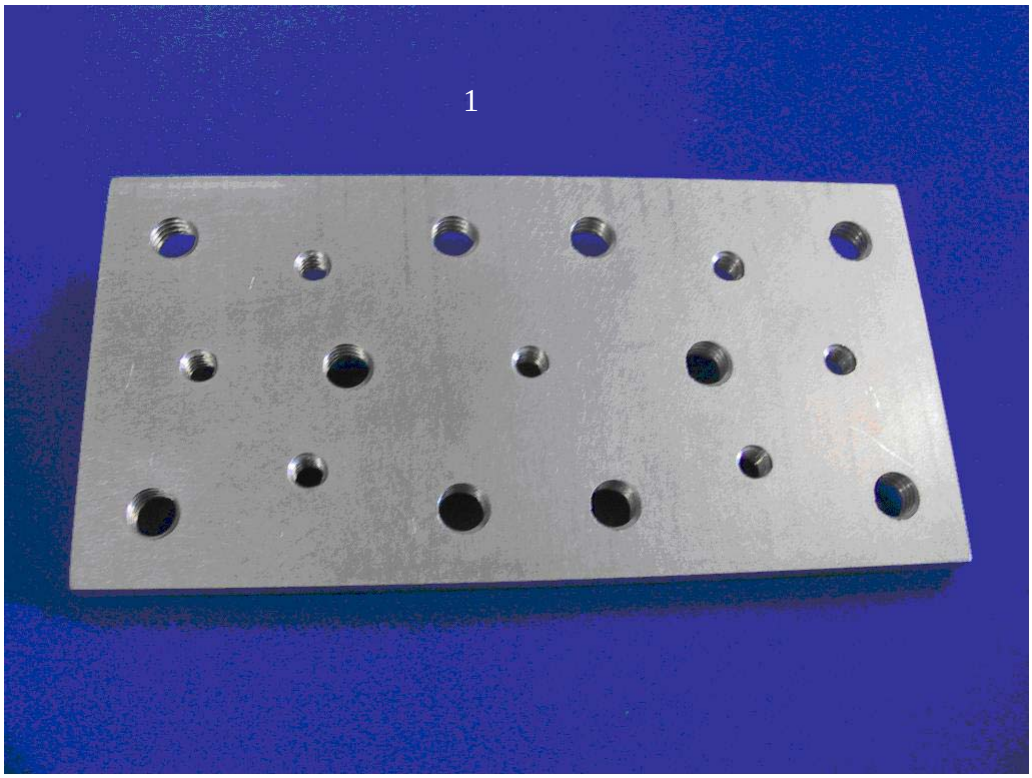
- **a** Rectangular Plate Adaptor (323)
- **b** Rectangular Plate (200PL)

B.5.1.2 Customer Supplied Parts as needed

The mounting kit does not include the small parts required for securing the mounting bracket to the desired surface. In those cases the customer will need to acquire the needed parts locally. Depending on the nature of the surface; screws, bolts, wall anchors, adhesive, or other items may be needed for a particular experimental setup. The customer should acquire these as needed.

B.5.1.3 Optional Mounting Accessories

Some experimental setups may require hard-to-find parts over and above those supplied in the Plexon Mounting Kit. Plexon has some optional parts available that can help provide secure mounting in many non-typical situations. See pages X and Y for some examples using these optional accessories.



1 Camera Mounting Plate 3x6” (Plexon 07-03-M-01)

2 Stud 036-014 (1/4”-20 m x 1/4” 20 f)(Bogen Manfrotto 036-014)*

3 Stud 036-038 (3/8” m x 3/8” f)(Bogen Manfrotto 036-038)*

4 Stud 037 (1/4”-20 m x 3/8” m)(Bogen Manfrotto 037)*

5 Stud 066 (1/4”-20 f x 2/8” f)(Bogen Manfrotto 066)*

6 Ball Head - Micro (Bogen Manfrotto 482)*

7 Ball Head - Mini w/ RC2 (Bogen Manfrotto 484RC2)*

8 Ball Head - Compact w/ RC2 (Bogen Manfrotto 486RC2)*

* Starred optional items are available from:

- Plexon - please contact the Plexon salesperson
- Online - search for “Manfrotto” and the item number from many sources such as:
  - — http://www.amazon.com/
  - — http://www.ritzcamera.com/
  - — http://www.bhphotovideo.com/

- A local professional camera or video store

CAUTION ABOUT TRIPODS

Note specifically that tripod mounting of the camera is NOT RECOMMENDED. This is because tripod adjustments, particularly leg locking mechanisms, can loosen and become unstable. Tripods can also be jostled or moved easily since they are generally not secured to a surface.

B.5.2 Bracket Mounting Choices to Make

First, choose where the camera should be mounted. Common choices are shown below:

B.5.2.1 Above the Experiment

1. Ceiling mount
2. Top of enclosure
   - **a** Inside of enclosure with room for cables
   - **b** Above the enclosure through an opening
   - **c** Inside of cage with room for cables

B.5.2.2 From the side of the Experiment

1. Wall mount
2. Side of enclosure
   - **a** Inside of enclosure with room for cables
   - **b** Outside of enclosure through an opening
   - **c** Inside of cage with room for cables

B.5.2.3 Below the Experiment

1. Up through a glass or cage floor to view the undersides of animals or for birds in perches
2. Floor mount aimed up an animals in the air or above the floor
3. Below enclosure
   - **a** Inside of enclosure with room for cables
   - **b** Below the enclosure through an opening
   - **c** Inside of cage with room for cables

B.5.2.4 Bracket Attachment Methods

Then, choose the most appropriate method of attaching the camera mounting bracket to the desired location.

1 On a surface of a wall or ceiling over 0.4 in (1 cm) thick, use one of the following methods or devise a custom method.

a Customer provided screws through the three threaded holes in the bracket into the wall. Wall anchors should be used as necessary.

b Customer provided bolts through the three threaded holes in the bracket into a wooden surface. Pilot holes can be drilled, if needed, using the sandwich plate as a template.

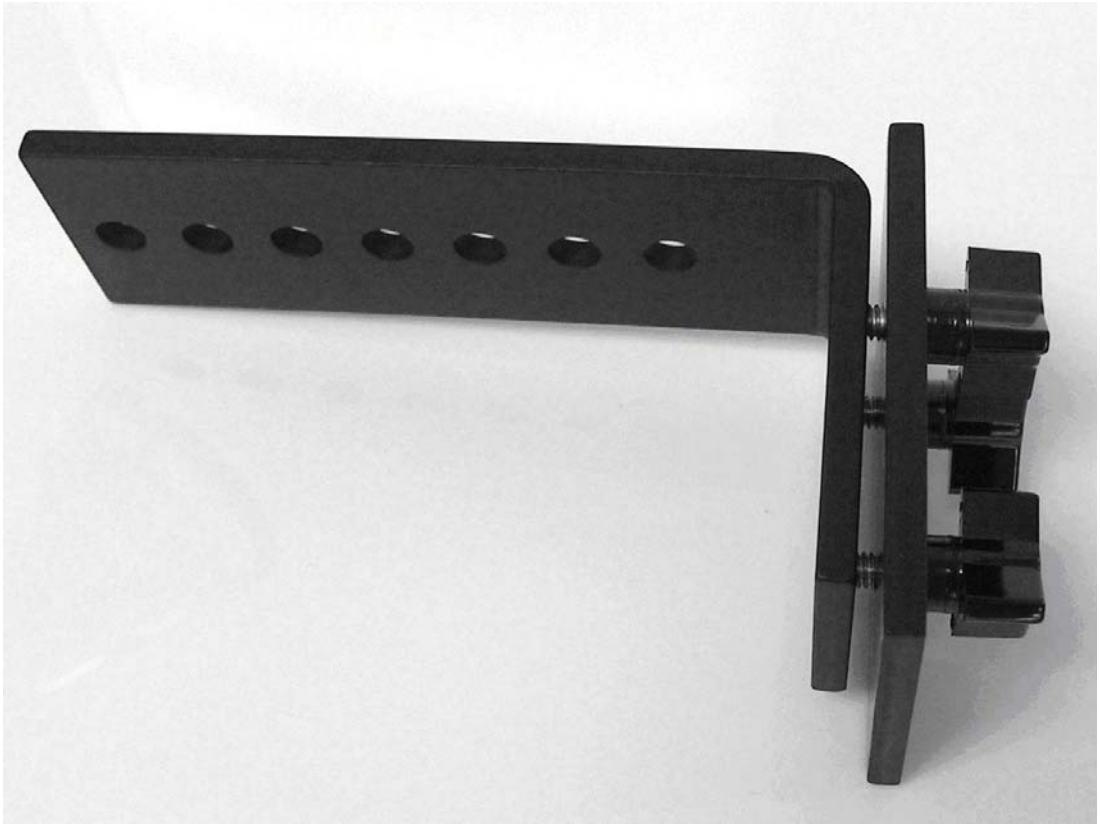
c Customer provided adhesive or epoxy to glue the surface of the mounting bracket containing the three threaded holes to the surface.

2 On a cage:

a Place the sandwich plate on the outside of the cage, then

b Insert the three small knobs through the sandwich plate holes and through openings in the cage, then

c Thread the three small knobs into the threaded holes in the mounting plate.



3 On a wall or surface under 0.4 inches (1 cm) thick:

a Drill three 9/32” (7 mm) holes using the sandwich plate as a template, then

b Insert the three small knobs through the wall into the threaded holes in the mounting plate.

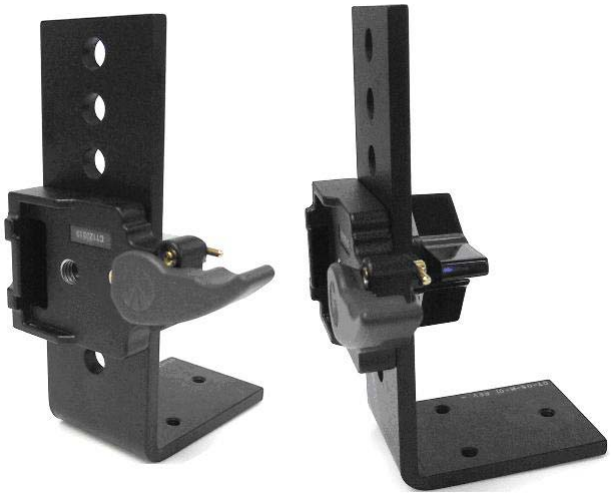
B.5.3 Installing the Camera

Procedure for Camera Installation

1 Power down all system components - computer, OmniPlex System, etc.

2 Select the bracket attachment method suitable for the experiment and install the mounting bracket. Make sure that the mounting bracket is firmly attached and stable.

3 Install the rectangular plate adaptor on the mounting bracket using the large phenolic knob. For most applications, the point of large lever should be pointing away from the experiment when secured. Tighten finger-tight.



4 Make sure that the large lever on the plate adaptor is in the open position and ready to accept the plate. If the large lever cannot be moved easily, move the small brass level to the unlock position, and try again.

5 Remove any cables from the camera, if present.

6 Attach lens to camera by screwing it on finger-tight.

7 The tripod adaptor should already be attached to the camera - if not, do so at this time.

8 Attach the rectangular plate to the camera tripod adaptor. For most applications, the lens should be oriented in the position labeled “2 LENS”. use the attached wire loop to finger-tighten the camera and then fold the loop down.

a Position “1 LENS” shown below

b Position “2 LENS” shown below

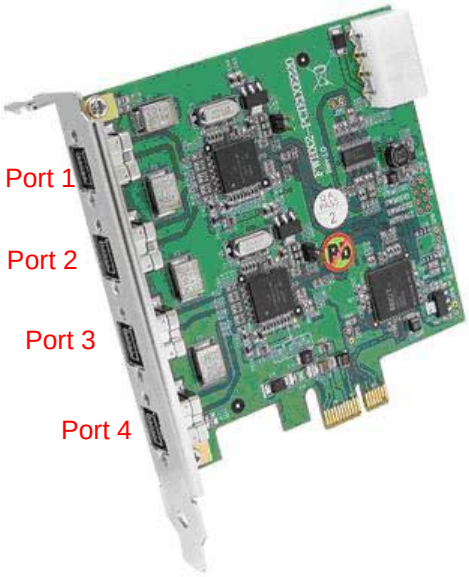
9 Snap the camera/plate combination into the plate adaptor that is already attached to the mounting bracket. Note that there is only one possible orientation. The large lever will snap closed. Move the small brass lever to the lock position. Make sure that the large lever cannot be unlocked.

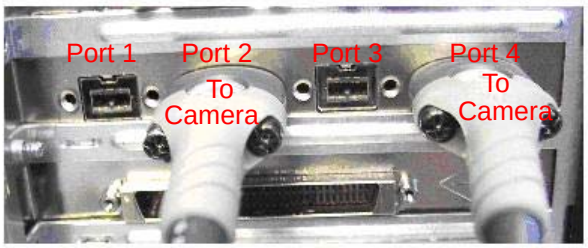
1 Attach the FireWire cable(s) to the camera(s). Use the FireWire socket labeled “1” in the photo.

2 Connect the other end(s) of the camera FireWire cable(s) to the FireWire board in the computer. The cable for Camera 1 should be connected to Port1 or Port2 on the FireWire board. If there is a second camera, it should be connected to Port3 or Port4. Tighten the screws so that each plug is secure in its socket.

CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.





3 Now connect the trigger cable(s) to the BNC connector on the AccesIO adaptor on the computer. If there are two cameras, a BNC T-adaptor will also be required.

4 Make sure all other system cables are attached as required. Apply power to all components, bring up the MAP Server and Sort Client and press the Start button on Sort Client. Bring up CinePlex and ensure that video is present. If not, go to the Troubleshooting section of the CinePlex manual and work through those procedures until a picture is present. If unable to get a picture, please contact Plexon support.

5 Loosen the large phenolic knob holding the camera/plate assembly to the mounting bracket and adjust the camera orientation until the experimental area is centered. Then tighten the large phenolic knob. It may also be necessary to repeat Step 8 with the camera in the “1 Lens” position of more adjustment latitude is needed.

6 Adjust the camera zoom until the experimental area fills the viewable image. If this is not possible the camera may need to be moved closer to or further away from the experiment. This can be done by selecting a different hole in the mounting bracket for the adaptor plate attachment. If there is space available, the mounting bracket may even be moved to the other side of its mounting surface. If a satisfactory view is still not possible, contact Plexon support for additional lens options.

7 Adjust focus, and iris as needed for a good image.

B.5.3.1 Mounting Options for Multi-camera Systems

Place each camera as needed to record its area of interest. Make the choices required for each position. Install each camera using the procedure.

B.5.4 Examples Using Optional Accessories

Some difficult mounting situations require the use of some of the optional mounting accessories mounted shown earlier. Here are some examples.

1. Using the optional Mini Ball Head between the camera and the mounting plate.

2. Using multiple ball heads to achieve difficult angles.

3 Using the Plexon camera mounting plate together with a ball head and stud 037 to achieve an offset camera mount at a difficult angle.

B.5.5 Camera Removal

Procedure for Camera Removal

1. Power down all systems.
2. Remove all cables from the camera.
3. Move the small brass level to the unlock position if not already there.
4. Place a hand on the camera to catch it as it releases.
5. Move the large lever to the unlock position.
6. Catch the camera and place it in a safe location.

Appendix C
CinePlex Studio Messages

C.1 Types of Messages C-2
C.2 How to Use Messages C-2
C.3 CinePlex Studio Simple Messages C-2
C.4 CinePlex Studio Critical Messages C-7

CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

C.1 Types of Messages

This appendix lists the system messages that the CinePlex® Studio software displays in reaction to current conditions and certain user actions. Messages are displayed in the Messages pane of the CinePlex Studio main window.

Informational messages are called *simple messages*, and the more urgent messages are called *critical messages*.

C.2 How to Use Messages

Messages provide a convenient flow of information to the user, and alert you to problems detected by CinePlex Studio. Therefore, messages can be useful for monitoring and troubleshooting the system. For information on correcting specific problems, see Appendix E-Troubleshooting.

C.3 CinePlex Studio Simple Messages

The table below lists the CinePlex Studio simple messages. In most cases, it is not necessary for you to take action when a simple message is displayed.

Note: In this table, [...] and <N> refer to text and numeric strings, respectively. These strings can differ for each instance of the message.

Table 1: CinePlex Studio Simple Messages

Message #	Message Text
C100	CinePlex Studio version [...] Starting...
C101	Current date:
C102	Date changed. Current date: [...]
C103	Current display frequency
C104	Display frequency successfully changed to <N> Hz
C107	Factory default settings loaded
C108	File opened for View
C109	File closed for View
C110	Cameras reset
C111	Frame resolution changed

Table 1: CinePlex Studio Simple Messages (Continued)

Message #	Message Text
C112	Loaded settings were created for a different resolution. Arena, zones and calibration (if present) are properly resized.
C113	Startup settings loaded from [...]
C114	Settings loaded from [...]
C115	Background image loaded from [...]
C116	Settings stored in the file [...]
C117	Background image stored in the file [...]
C118	Play file started
C119	Event Combinations view presented
C120	Video view presented
C121	Recorder Properties view presented
C122	Area Properties view presented
C123	Messages view presented
C124	Previous video configuration is not applicable due to hardware changes or absence of Rasputin or OmniPlex key
C125	Video configuration has been automatically reset to One File
C126	The layout loaded contains panels incompatible with the current license. These panels are removed.
C127	Remote start received and discarded
C128	Remote stop received and discarded
C129	Remote pause received and discarded
C130	Video configuration has been automatically set to connect all available cameras according to the license
C132	Video configuration has been automatically set to One File
C133	Video configuration has been automatically reset to Camera 1
C135	Armed for remote control - DVR control by Plexon NDAQ is now enabled
C136	Remote control disabled - DVR control by Plexon NDAQ is now disabled
C137	Recording [...] started by Plexon NDAQ
C138	Recording [...] paused by Plexon NDAQ
C139	Recording [...] resumed by Plexon NDAQ

Table 1: CinePlex Studio Simple Messages (Continued)

Message #	Message Text
C140	Recording [...] stopped by Plexon NDAQ (<N> dropped frame(s), <N> MQU) **Note:** MQU = maximum queued units. For a description of MQU, see "Monitoring the Video During a Recording Session" on page 3-51.
C141	Recording [...] started locally
C142	Recording [...] stopped locally (<N> dropped frame(s), <N> MQU)
C143	Recording [...] paused locally
C144	Recording [...] resumed locally
C145	Tracking switched to Object Contour mode
C146	Object Contour tracking stopped
C147	No LEDs are active. The objects for dynamic zones will be switched to N/A.
C148	Tracking switched to LED mode
C149	LED tracking stopped
C150	Can not switch to LED mode, since tracking license is not detected
C151	Tracking switched to Reflective Colors mode
C152	Reflective Colors tracking stopped
C153	Can not switch to Reflective Colors mode, since tracking license is not detected
C154	Recording [...] stopped due to missing license key
C155	Tracking stopped due to missing license
C156	No markers are active. The objects used in dynamic zones will be switched to N/A.
C157	Recording folder changed to [...]
C158	Recording [...] stopped since file size on FAT32 drive cannot exceed 4GB (<N> dropped frame(s), <N> MQU)
C159	Recording [...] stopped due to low disk space (<N> dropped frame(s), <N> MQU)
C160	End of File. Can not start recording
C161	End of File. Can not start playing
C162	Camera framerate changed to <N>
C163	Wizard opened
C164	Wizard finished
C165	CPX Studio window size reduced by Shrink button
C166	CPX Studio window size restored by Expand button

Table 1: CinePlex Studio Simple Messages (Continued)

Message #	Message Text
C167	Date has changed since the last file was recorded. The file number reset to 001
C168	Can not add sequence due to missing license key
C169	Tracking settings ignored since missing license
C171	Tracker Properties view presented
C172	New shape added to Arena
C173	New shape added to Zone
C174	Shape #<N> deleted from Arena
C175	Shape #<N> deleted from Zone
C176	Tracking Events view presented
C177	Event Statistics view presented
C178	Output lines for the loaded tracking events ignored since no digital output device found
C179	All shapes deleted from Arena
C180	All shapes deleted from Zone
C181	Temporary AVI file [...] renamed to [...]
C182	Renaming temporary AVI file [...] failed
C183	Temporary DVT file [...] renamed to [...]
C184	Renaming temporary DVT file [...] failed
C185	Standalone recording [...] started
C186	Standalone recording [...] stopped (<N> dropped frame(s), <N> MQU)
C187	Recording time zero [...] received from OmniPlex Server
C188	File N activated
C189	File N closed
C190	Zone Sequences view presented
C191	Standalone recording [...] paused
C192	Standalone recording [...] resumed
C193	Video Properties view presented
C194	Previous video configuration was [...]
C195	Switched to Camera mode
C196	Camera N started

Table 1: CinePlex Studio Simple Messages (Continued)

Message #	Message Text
C197	Camera N stopped
C198	Switched to File mode
C199	Camera settings for camera <N> have been applied to all available cameras
C200	View with 3D calibration settings presented
C201	3D data view presented
C202	3D calibration started
C203	3D calibration finished successfully
C204	3D calibration failed
C205	3D calibration interrupted and not ready
C207	Video Edit view presented
C209	3D settings ignored since missing 3D license
C211	Initializing CinePlex
C212	Initializing cameras at start
C213	Disconnected from IP address
C214	Connected to IP address
C215	View with 3D settings presented
C216	Extended Color Markers tracking stopped
C217	Tracking switched to Extended Color Markers mode
C218	3D calibration failed: there are cameras without reference frame
C219	Temporary DV3 file [...] renamed to [...]
C220	Renaming temporary DV3 file [...] failed
C221	3D settings ignored due to mismatch between number of cameras used for this calibration and number of available sources
C222	No calibration data present
C223	Tracking settings ignored since they are incompatible with the current license
C224	Screen saver and power management disabled
C225	Screen saver and power management enabled

C.4 CinePlex Studio Critical Messages

The table below lists the CinePlex Studio critical messages. In most cases, it is important for you to take action (or revise your previous action) when a critical message is displayed.

Note: In this table, [...] and <N> refer to text and numeric strings, respectively. These strings can differ for each instance of the message.

Table 2: CinePlex Studio Critical Messages

Message #	Message Text
C898	MAP and CinePlex Studio out of synch.
C900	Clock signal not detected
C901	Clock signal detected
C902	Recording [...] stopped due to loss of clock OR RECORDING STOPPED AND/OR DISABLED! CLOCK or TRIGGER SIGNAL NOT DETECTED!
C904	Current CinePlex Studio does not support this version of settings file. Try to read another file.
C905	Can not be armed for remote recording before arena definition is finished
C906	Apparently Adobe Acrobat Reader is not installed on this system
C907	Cannot find the manual at: [...]
C908	Error code <N> has occurred while trying to open [...].
C999	Polygon can not have less than 3 points.
C910	Can not create self-intersecting polygons.
C911	Recording folder doesn’t exist. Please choose another one.
C912	Saved layout does not exist
C913	Unable to load the requested layout! The default layout applied
C914	Can not be armed for remote recording until Wizard is exited.
C915	Can not start recording until Wizard is exited.
C916	Can not add new zone: number of zones of interest can not exceed 100.
C917	Can not add new zone: the boundary of the last existing zone is not defined.
C918	The number of shapes in arena can not exceed 100.
C919	The number of shapes in zone can not exceed 100.
C920	Overlapped zones are not allowed in sequence
C921	Can't delete selected zone since it is used for generation of tracking event(s). Modify the event(s) first.
C922	Can't delete selected zone since it is used in sequence(s). Modify sequence(s) first.

Table 2: CinePlex Studio Critical Messages (Continued)

Message #	Message Text
C923	The number of events can not exceed 100.
C924	Can't delete the last remaining shape from the selected zone since it is used for generation of tracking event(s). Modify the event(s) first.
C925	Can not be armed for remote recording due to missing license key
C926	Can not add event since LED or Marker tracking mode is not selected.
C927	Can not add event since no LEDs selected.
C928	Can not add event since no markers selected.
C929	Can't delete selected sequence since it is used for generation of tracking event(s). Modify the event(s) first
C930	Unable to save current layout
C931	Can not add event combination since tracking mode is not selected.
C932	Can not add event combination since no single events are defined.
C933	Can not add new event combination since not all events for the last combination are defined.
C935	Can't uncheck selected LED since it is used for generation of tracking event(s). Modify the event(s) first.
C936	Can't uncheck selected marker since it is used for generation of tracking event(s). Modify the event(s) first.
C937	Can not add event since tracking mode is not selected.
C938	Can not add event since no LEDs selected
C939	Can not add event since no markers selected.
C940	No Rasputin or OmniPlex key found. Switching to offline mode
C941	Access I//O board is not found, but cameras are detected. Switch to test mode? Clicking YES will switch Studio to the test mode. Otherwise Studio will start in offline mode.
C942	Access I//O board is not found. Switching to test mode
C943	Access I//O board is not found. Switching to offline mode
C944	No clock signal from Plexon NDAQ, but cameras are detected. Switch to test mode? Clicking YES will switch Studio to the test mode. Otherwise Studio will start in offline mode.
C945	No clock signal from Plexon NDAQ. Switching to test mode
C946	No clock signal from Plexon NDAQ. Switching to offline mode
C947	Recording is stopped, since recordings longer than 1 min are not allowed in test mode

Table 2: CinePlex Studio Critical Messages (Continued)

Message #	Message Text
C948	Can not add new sequence since the previously added sequence contains no zones.
C949	Can not add new sequence since the last zone in the previously added sequence is undefined.
C950	The number of sequences can not exceed 100.
C951	Can't delete selected sequence since it is used for generation of tracking event(s). Modify the event(s) first.
C952	Can not add new zone to the current sequence since the last zone in the sequence is undefined.
C953	Sequence can not contain more than 100 zones.
C954	Can not add new zone to the current sequence since no zones is defined.
C955	Files opened have different compression. Record, Play, Pause and Stop will be disabled.
C956	Files opened have different frame rate. Record, Play, Pause and Stop will be disabled.
C957	Can not open the same file twice.
C958	Start and end point of head direction vector should be different.
C959	Start point of head direction vector and end point of reference vector should be different.
C960	Can't associate selected LED with event since this LED is associated with dynamic zone used for generation of this event. Select another LED.
C961	Loading startup settings from [] failed because this version of settings file is not supported by Current version of CinePlex Studio
C962	Current Cineplex Studio does not support this version of settings file. Try to read another file.
C963	Loading last saved settings file [...] failed because the file is missing. Factory default settings have been applied
C964	Settings loading failed because file [...] is missing. Factory default settings have been applied
C965	No settings file to load. Factory default settings have been applied
C966	Can not start recording due to missing license key
C967	Can not start recording since disk information can not be retrieved
C968	Can not start recording. File number can not exceed 999. Delete or rename video (*.AVI and *.DVT) files in the recording folder and try again
C969	Can not start recording due to low disk space.
C970	Can not add arena due combination to missing license key

Table 2: CinePlex Studio Critical Messages (Continued)

Message #	Message Text
C971	Can't associate dynamic zone with selected LED since this LED is used for generation of event associated with this zone. Select another LED.
C972	Can't associate dynamic zone with selected Marker since this Marker is used for generation of event associated with this zone. Select another Marker.
C973	Only Motion JPEG RGB files are accepted. Record, Play, Pause and Stop will be disabled.
C974	Files opened have different frame resolution. Record, Play, Pause and Stop will be disabled.
C975	Only resolution 640x480 or 320x240 is supported. Record, Play, Pause and Stop will be disabled.
C976	CinePlex only supports MJPEG or Plexon MPEG4 AVI files. Try another file.
C977	Video frame width must be a multiple of 16. Record, Play, Pause and Stop will be disabled.
C978	Video frame height must be a multiple of 8. Record, Play, Pause and Stop will be disabled.
C979	CinePlex Studio has not been connected as a Client since SortClient is not running. No coordinate data will be recorded in .PLX file
C980	CinePlex Studio has not been connected as an OmniPlex Client since PlexControl is not running. No coordinate data will be recorded in .PLX file
C981	CinePlex Studio has not been connected as an OmniPlex Client since CinePlex.dll is absent or damaged
C982	Display resolution is not enough to run all available cameras even in 320x240 resolution. Number of cameras to use is reduced to fit the display resolution.
C983	Connections should be different.
C984	Connection points must be different.
C985	Open socket failed
C986	No network connection found
C987	Cannot connect to selected node.
C988	Cannot apply calibration: Number of cameras in the calibration file less than number of active cameras. Please try different calibration file or deactivate cameras.
C990	Camera switched to 320x320 resolution because of multi-camera license. One-camera license required to run 960x960 resolution for this camera.
C991	Cannot have resolution exceeding 320x320 because of multi-camera license. One-camera license required to run 960x960 or 640x640 resolution for this camera.
C992	Video signal detected

Table 2: CinePlex Studio Critical Messages (Continued)

Message #	Message Text
C993	Video signal not detected
C994	This CinePlex Studio (N camera license) requires minimum w x h screen resolution or higher
C995	Cannot write to the file. The file might be opened by other application. Please close the file first
C996	This CinePlex Studio (N camera license) cannot accept W x H frame resolution

Appendix D
Navigating the Plexon User Interface

D.1 Plexon User Interface D-2
D.2 Screen Elements D-2
D.3 Standard Menu Items and Dialogs D-10
D.4 Customization D-17

D.1 Plexon User Interface

The Plexon® User Interface embodies a standard look-and-feel for Plexon software products. To illustrate the underlying concepts behind the look-and-feel, this appendix uses screenshots from Plexon's CinePlex® Studio and Editor applications. Although there will be differences in menus and toolbars between different applications, how to use, handle, and operate the user interface components will be fundamentally the same across future generations of Plexon's software products including:

- CinePlex Studio
- CinePlex Editor
- Offline Sorter™

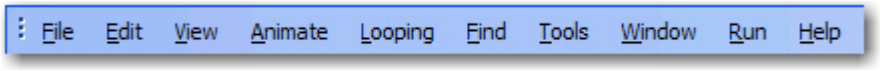
This appendix covers common functionality of the look-and-feel between different Plexon software applications. The discussion includes the following sections:

- Screen Elements
- Standard Menu Items and Dialogs
- Customization

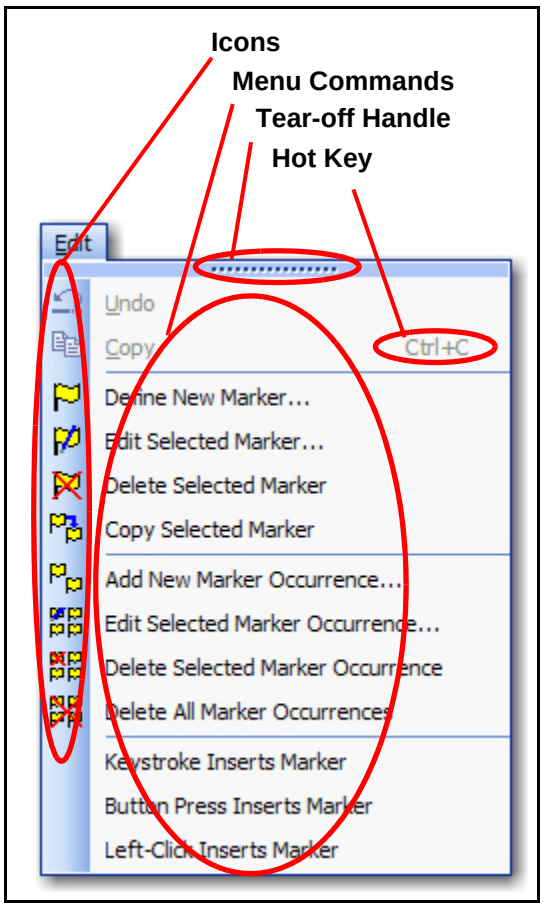
D.2 Screen Elements

D.2.1 Menus

The menu bar of the application contains the names of all of the menus for the application. Each menu name has a letter underlined which indicates the hot-key combination for that menu. To activate a particular menu, click the left mouse button on the name or press and hold the **ALT** key while pressing the underlined letter. The image below is the main menu of CinePlex Editor.



Each menu of the Plexon User Interface contain menu commands and may also contain Icons, Hot Keys and a Tear-off Menu Handle as shown by the illustration below of the Edit menu of CinePlex Editor.

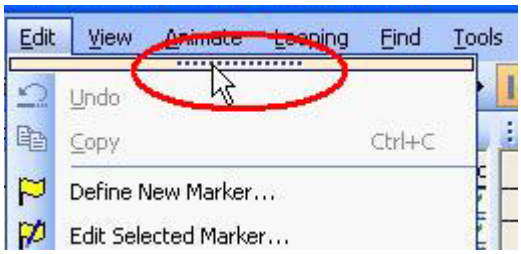


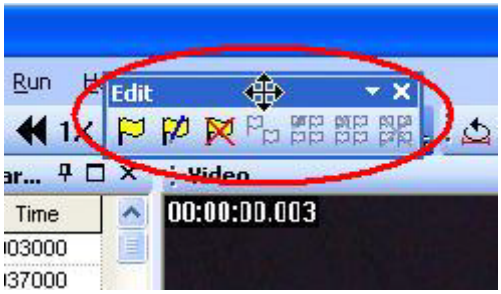
While all Plexon applications are shipped with their available menu commands organized into a set of menus, the contents of the menus can be customized and new menus can be created.

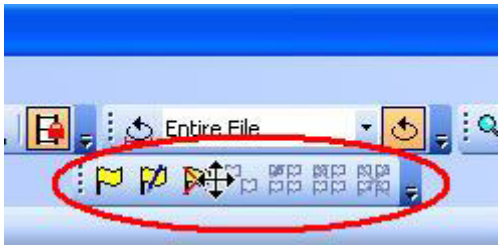
- **Icons** - Icons may be located immediately to the left of the menu commands. These icons will be displayed on the toolbar associated with the menu. In the example menu, there are icons associated with all but the last three of the menu commands. The presence of an icon next to a menu command means that the icon is also a label on a toolbar button and will execute the same command when clicked as the menu command on the menu.
- **Hot Keys** - Hot Keys are key combinations that will cause a menu command to execute without having to click the command on the menu. Typically, hot keys will contain two keys that must be pressed simultaneously for the combination to execute. The area at the far right of the menu commands may display the hot key combinations for the menu commands. In the example

menu, there is a hot key combination (CTRL + C) for the Copy command. Hot keys may be added or customized via the **Tools-Customize** dialog.

- **Tear-off Menu Handle** - The Tear-off Menu Handle is an area (the one containing the dots) at the top of the menu, present on many menus. The tear-off feature allows the quick creation of a toolbar that contains all of the commands in the menu that have command icons. You can hover the mouse over the tool to highlight it, drag the mouse to the toolbar area and place the menu as a toolbar there. The illustrations below show highlighting the Tear-off Menu Handle to begin dragging the toolbar, dragging the toolbar across the screen, and finally docking the toolbar in place.

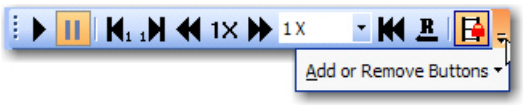




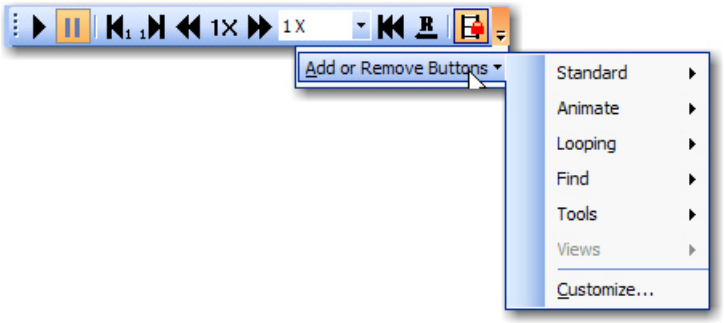


D.2.2 Toolbars

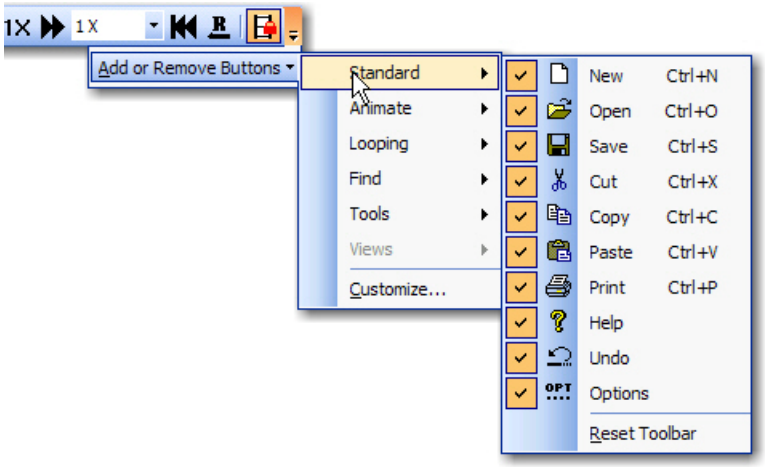
Each toolbar has a dropdown button at the right that will allow you to add or remove buttons from toolbars and will also allow you to access the **Customize** dialog box. When you click the dropdown button the **Add or Remove Buttons** dropdown menu will appear as shown below.



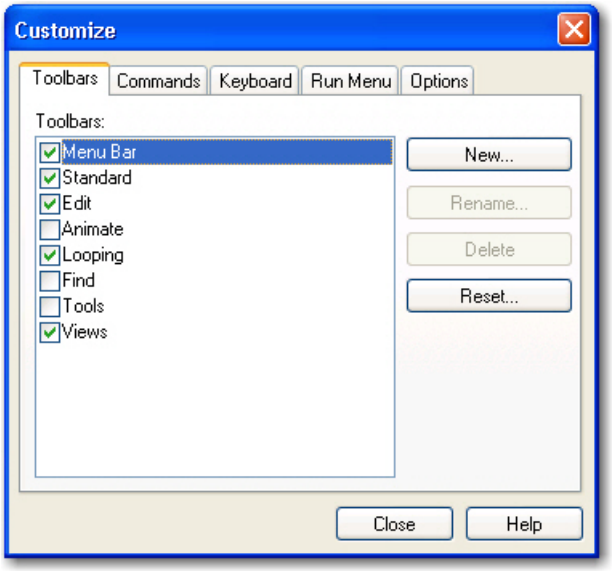
The dropdown menu also has a dropdown button. Clicking that button displays a menu list of the available toolbars and a menu command to allow access to the **Customize** dialog box.



Expanding one of the toolbar menus will display all of the available toolbar buttons for that particular toolbar and a checkbox beside each one that will indicate whether or not the button is visible on the toolbar. There is also an option to reset the toolbar back to its factory default setting.



Clicking the **Customize** menu command will open the **Customize** dialog box. This dialog box is common to Plexon software applications but may have different content on the tabs according to the software application.



For details on using the **Customize** dialog box, see "Customization" on page D-17

D.2.3 Windows

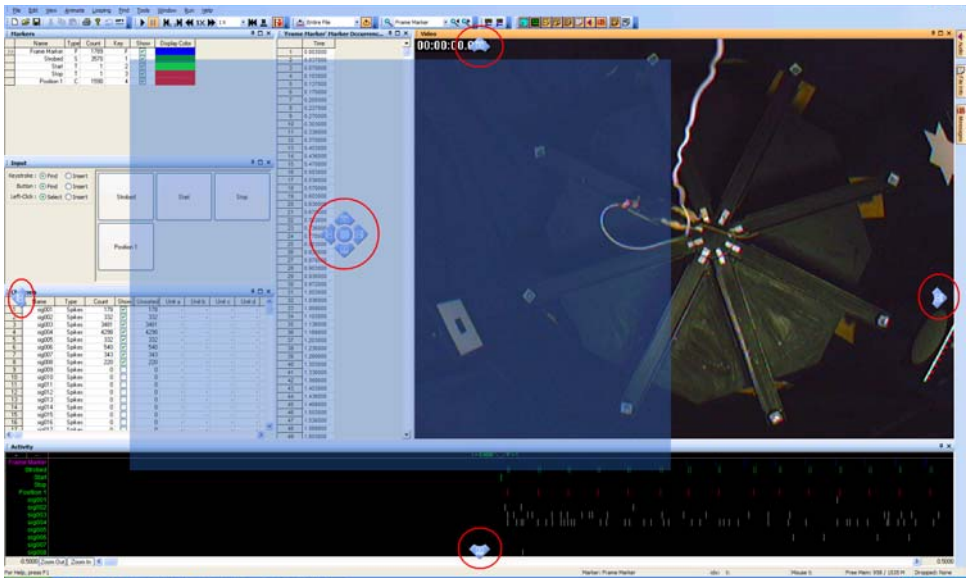
The image below shows a typical window title bar. It contains (from left to right) a **Title**, a **Auto Hide** button, a **Maximize** button, and a **Close** button.

- **Auto Hide Button** - The **Auto Hide** button "pins" a window to the screen to keep it visible or "rolls up" a visible window into a tab. When the window is pinned, the **Auto Hide** button points in a vertical direction. If the window is rolled up, the **Auto Hide** button points in a horizontal direction.

- **Maximize Button** - The **Maximize** button may not appear on all windows. It is the standard Windows® maximize button. Clicking the **Maximize** button on a window will maximize the original window and hide other windows occupying the same horizontal or vertical space. Clicking the **Maximize** button again will restore the previous layout. When clicked the image on the button toggles between one window and overlapping windows.

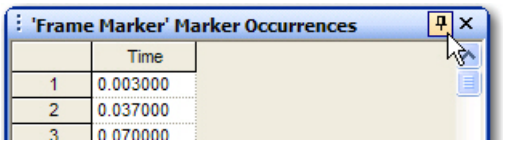
- **Close Button** - The **Close** button closes the window.

Plexon software applications often display several windows simultaneously. These windows may be resized by using standard resizing methods and may also be repositioned by dragging and dropping and by using **Docking Stickers**. The image below shows the repositioning of a window (denoted by the blue transparent rectangle) and various **Docking Stickers** (with red circles around them). These **Docking Stickers** allow you to dock the window being moved in one of several ways described below.



You can position a window by floating it, docking it at the desired docking sticker at a window edge or in a tab.

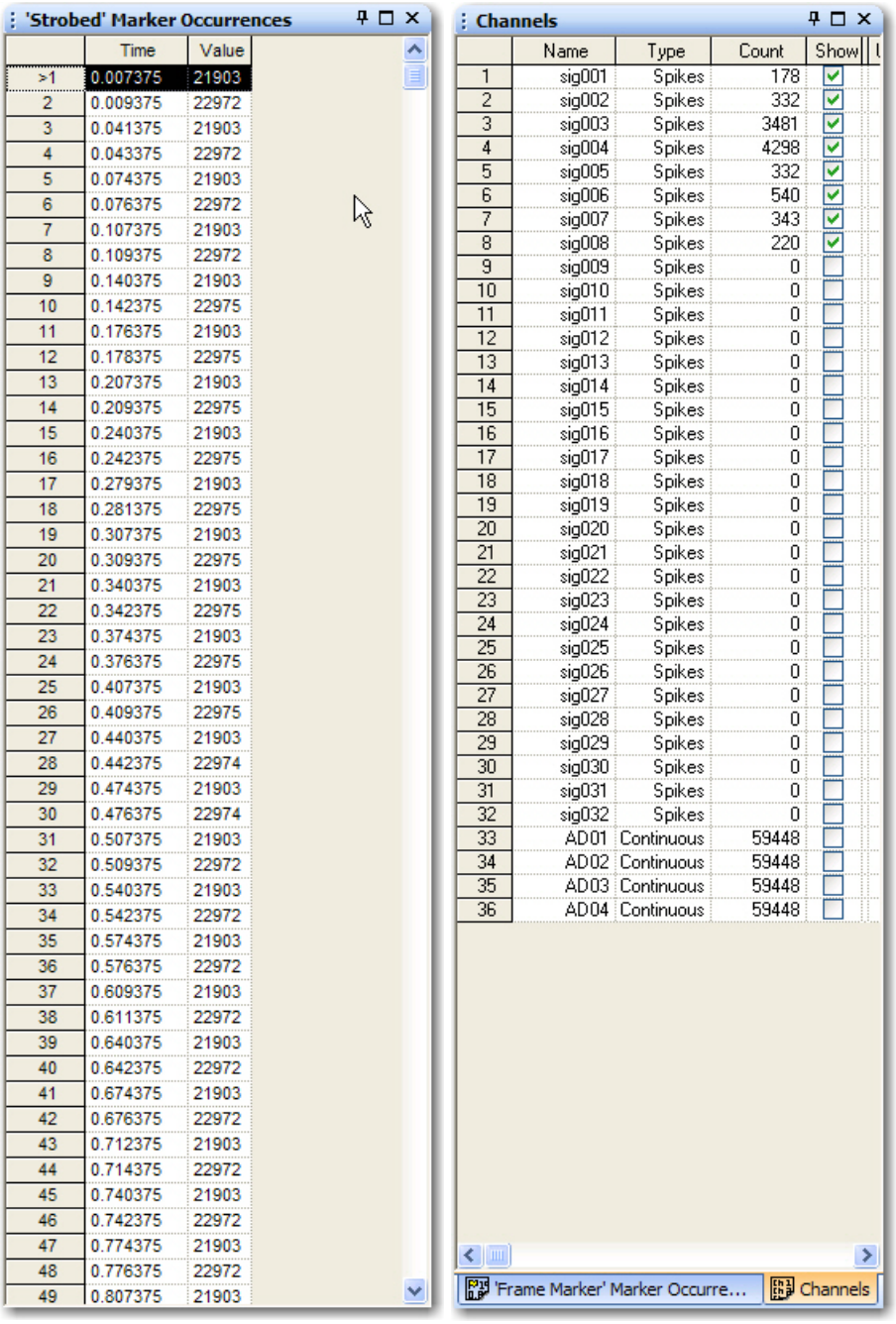
- **Floating a Window** - You can drag a window by the Caption Bar near the center of the screen and release it causing the window to float. Holding down the CTRL key while dragging will always float the window. Double-clicking on the Caption Bar will also float a window. Note that the size and position of the floating window is remembered.
    - **Rolled-up Windows** - Floating windows may be enabled for roll up up by pressing the **Auto Hide** button. The window will roll up when the focus is changed to a different window. The first image below shows a floating window before rolling it up. The second image below shows the rolled-up window after the focus has changed.



- **Docking a Window at the Application Frame** - When you begin to drag a window, a transparent blue rectangle appears to indicate the position of the window and the four **Docking Stickers** appear individually at each edge of the application frame to allow you to dock the window to the respective edge. To dock just move the mouse to the desired **Docking Sticker** and release the mouse button. The docked window will extend along the entire length of the edge to which it is docked. The image below shows all four screen **Docking Stickers**.

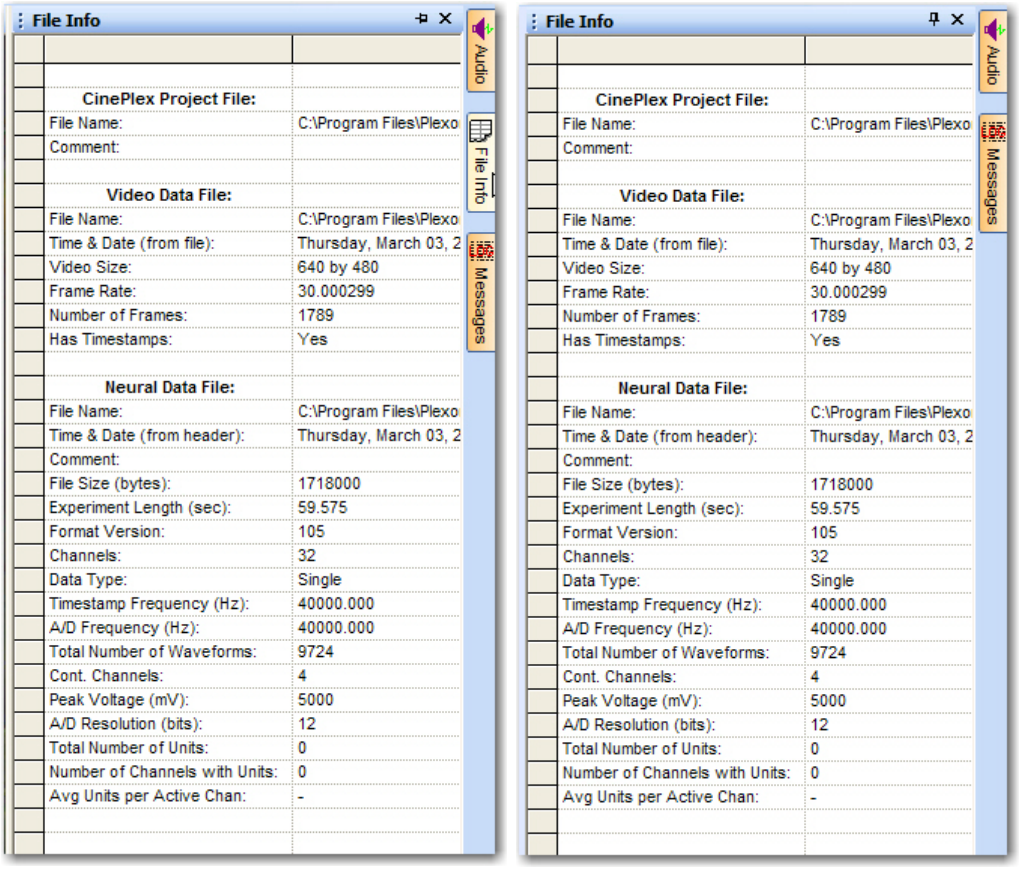
- **Docking a Window at a Window Edge** - When you move the window inside another window, the window **Docking Stickers** appear inside the window grouped together near the center of the window. Releasing the mouse button while it is over one of these stickers (except the center one) will dock the moving window to the respective edge of the window associated with the window **Docking Stickers**. The image below shows the window **Docking Stickers**. Note that the shading of these **Docking Stickers** is different that the shading of the **Docking Stickers** in the previous image.

- **Placing Windows into Tabs** - Releasing the mouse button over the center **Docking Sticker** will allow the moving window to occupy the same space as the window beneath and will create tabs along the bottom for switching the view between the two windows. The image below shows the Marker Occurrences window without sidebar tabs on the left. On the right, a Channels window has been placed into the same space by using the center docking sticker. Note that there are two sidebar tabs at the bottom of the window.



— **Hidden Windows** - Docked windows whose access is not needed often can be hidden or “rolled up” by pressing the **Auto Hide** button. When hidden, the window is represented by a sidebar tab. Sidebar tabs may be located at the left, right, or bottom of the screen and indicate hidden windows. To show one of these windows, just hover the mouse over one of the tabs and the window will appear. The **File Info** window of **CinePlex Editor** opened by the sidebar tab is shown below on the left. If you click the **Auto Hide** control, the window will be pinned and

remain open after you move the mouse away from the sidebar tab as shown on the right. The **Auto Hide** button will also have changed direction and be pointed downward. Note also that the **File Info** sidebar tab is gone on the right image.

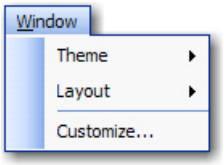


D.3 Standard Menu Items and Dialogs

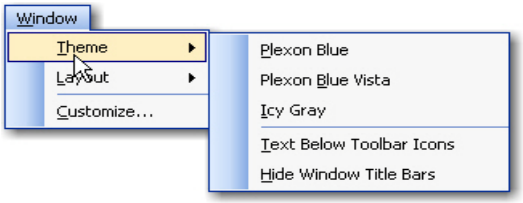
In Plexon software applications, some menu items may have the same functionality across several applications. These items are standard menu items and consist of the **Window** menu, the **Run** menu, and the **Help** menu.

D.3.1 Window Menu

The **Window** menu contains three items: **Theme**, **Layout**, and **Customize**.

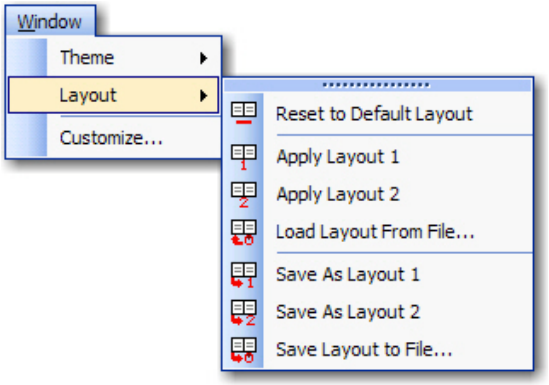


- **Theme** - Clicking on **Theme** displays a menu as shown below. A theme is a color scheme that is part of the look-and-feel of the user interface.



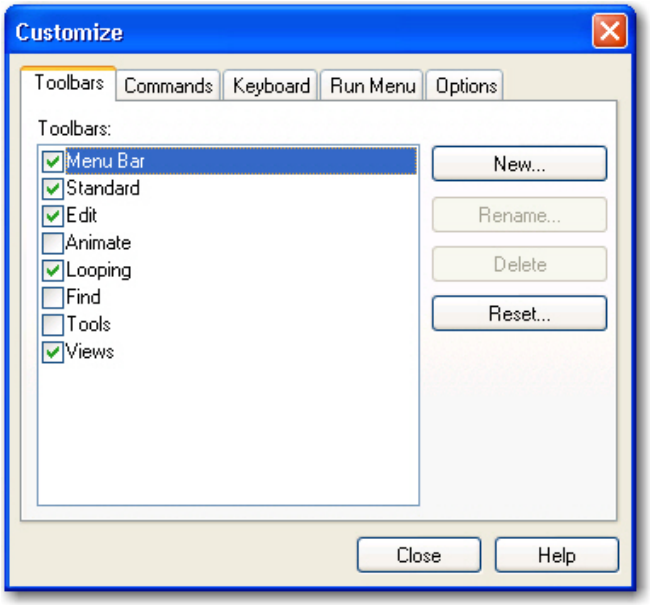
  - **Theme Group** - The top group of items are theme toggle items that may be selected to apply to the user interface look-and-feel. Only one of the themes may be selected at a time.
  - **Text Below Toolbar Icons** - This item is a toggle item to show or not show text below the toolbar icons.
  - **Hide Window Title Bars** - This item is a toggle item to hide or show window title bars.

- **Layout** - Clicking on **Layout** displays a menu as shown below. A layout is the size and placement of the windows on the screen. It also remembers the number and placement of toolbars.



  - **Reset to Default Layout** - Clicking on this item resets the layout to the factory default.
  - **Load Layout Group** - Clicking on **Apply Layout 1** or **Apply Layout 2** applies one of the standard layouts to the user interface. Clicking on **Load Layout From File** will allow you to select a layout file to apply to the user interface.
  - **Save Layout Group** - Clicking on **Save As Layout 1** or **Save As Layout 2** saves the current screen layout as one of the two standard layouts. You can also click **Save Layout to File** to save the current screen layout to a file that can be loaded by the **Load Layout From File** item.

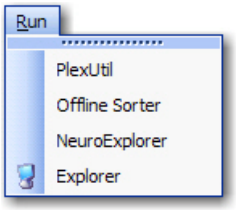
- **Customize** - Clicking **Customize** displays the **Customize** dialog box as shown below



For details on using the **Customize** dialog box, see "Customization" on page D-17.

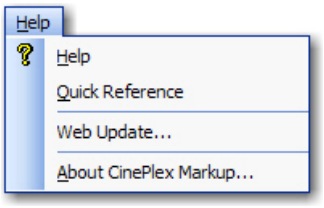
D.3.2 Run Menu

The purpose of the **Run** menu is to launch other applications quickly. The **Run** menu will be populated by default with some common Plexon applications. To launch other applications from within the current application, you can add new entries to the **Run** menu. A sample **Run** menu is shown below. For additional information about customizing the **Run** menu, see "Run Menu Customization" on page D-21.

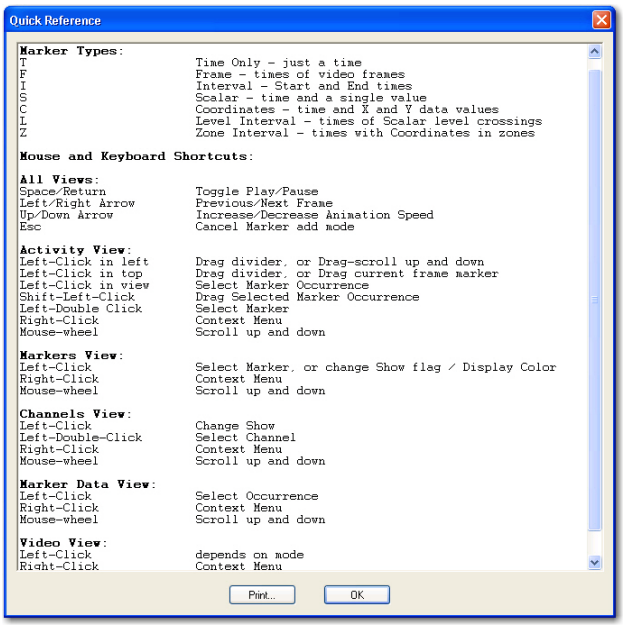


D.3.3 Help Menu

The **Help** menu contains four items: **Help**, **Quick Reference**, **Web Update**, and **About XXXXX** where **XXXXX** is the name of the application.

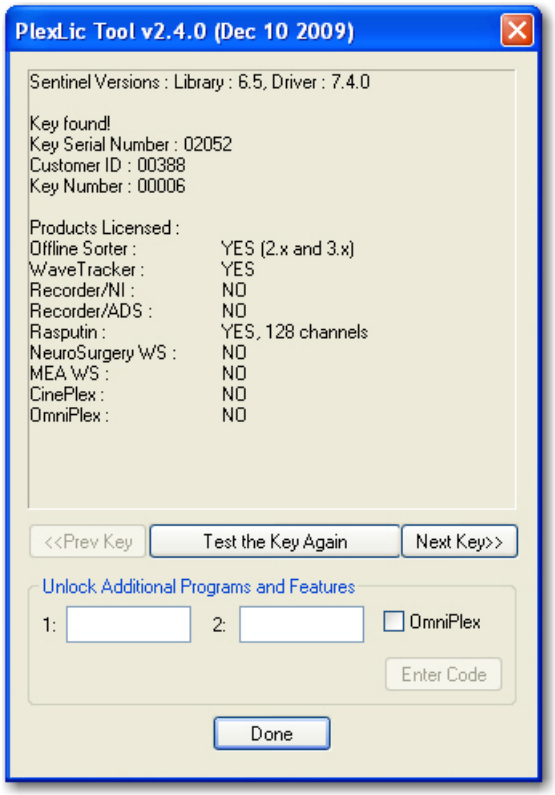


- **Help** - Clicking **Help** displays the User's Guide for the application.
- **Quick Reference** - Quick Reference may be missing in some applications. When present, clicking **Quick Reference** displays a dialog box similar to the one shown below. The purpose of the **Quick Reference** dialog box is to show keys and mouse buttons that control some of the commonly used functions in various views. You can print it by clicking **Print** or close it by clicking **OK**.



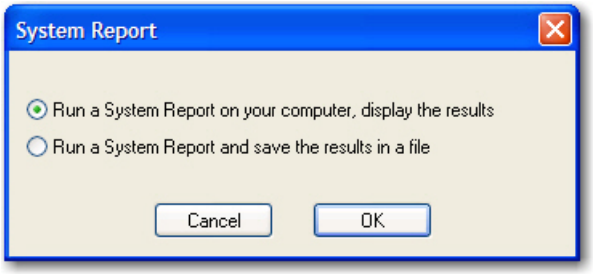
  - — **Print** – Click **Print** to print a copy of the Quick Reference.
- **Web Update** - This item allows you to update software via the internet. Clicking **Web Update** will first check to see if an update is available. If an update is available, it will be downloaded and installed.
- **About** - Clicking the **About** item displays the **About** dialog box. The text of the **About** item varies according to the application. The **About** dialog contains the version number and build data of the application, links to the Plexon website and support e-mail, and buttons for **Licensing**, **System Report**, and **Manage File Extensions**.

— **Licensing -** Clicking the **Licensing** button displays the **Plexon License Management** dialog box. The **Plexon License Management** window includes the complete licensing information for Plexon products. The window includes the following three areas: information, key testing, and code entry.

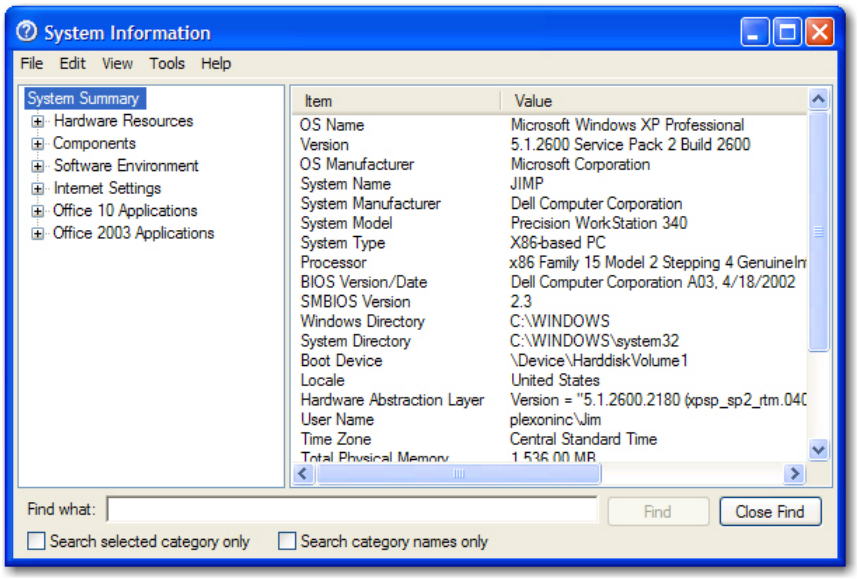


- The information area includes information on license keys and a list of all the Plexon products and their licensed status on this computer.
- If you have moved or added a key, the **Test the Key Again** button provides a convenient tool to test license keys to ensure they function correctly.
- If you have more than one key installed, the **Next Key>>** and **<<Prev Key** buttons appear. You may use these buttons to cycle through and test all keys.
- The code entry area is used to enter the unlock codes for optional programs and features. If you have licensed optional items, instructions for entering codes and testing keys are included with Plexon installation programs.

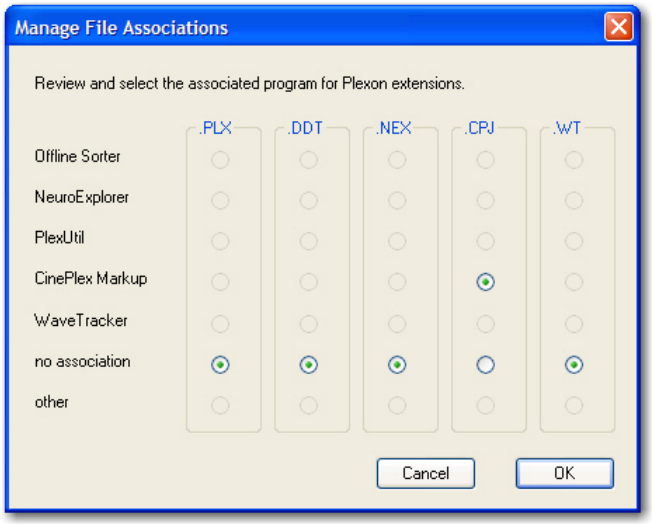
— **System Report** - The purpose of the **System Report** button is to help Plexon Support diagnose problems by listing system information. Clicking the **System Report** button will first display a dialog box to allow you to display the system report on the monitor or save the report to a file that can be sent via E-mail to Plexon Support.



- After selecting a choice, clicking **OK** will launch the standard Microsoft® System Information tool. The image below shows the System Information report displayed on the monitor.



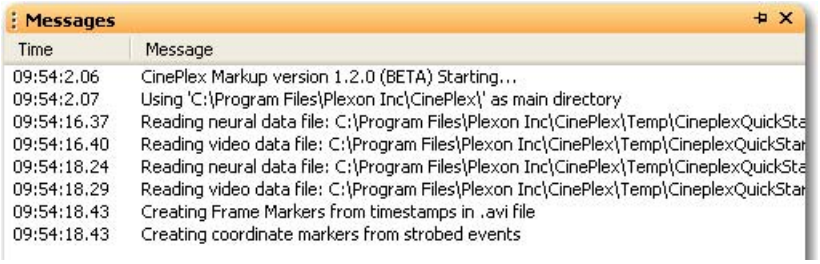
— **Manage File Extensions** - Clicking the **Manage File Extensions** button opens the **Manage File Associations** dialog box. The **Manage File Associations** dialog box allows you to review and select which file types are associated with Plexon software applications. For example, when the PLX file type is associated with **Offline Sorter**, double-clicking on a PLX file will open **Offline Sorter** and load that PLX file. If you have not installed some of the applications, their file extension radio buttons will be disabled.



D.3.4 Messages Window

The **Messages** window displays a log of timestamps and associated application events that Plexon Support can use for troubleshooting purposes.

Note: The Messages window is not available for all applications.



Right-clicking the mouse in the Messages window will display a right-click menu with the following items:

- **Erase** - This item clears the window of all messages
- **Pause** - This item stops the logging of messages
- **Show Debug Messages** - This item is a toggle to show or hide debug messages
- **Select and Copy All** - This item allows you to copy all of the messages to another application - such as a word processor
- **Save Log to File** - This item allows you to save the messages to a log file.
- **Mail Log to Plexon** - This item allows you to send the message log to Plexon for troubleshooting purposes

D.3.5 Right-click Menus

Most windows have right-click menus that control their behavior and options. To open a right-click menu, place the cursor inside a window and click and release the right mouse button. The right-click menu appears where the mouse is clicked. To select a menu item, move the cursor over it and click the left mouse button.

D.3.6 Current Selections

In grid-based windows, the currently selected item always appears with a >> or > in the left column of the appropriate grid-based window.

D.3.7 Undo

Plexon applications provide multiple *undo* levels. To undo an operation, on the **Edit** menu, click **Undo** or click the **Undo** button on the toolbar. You can undo operations that change the contents of the project file but may not undo operations that change the user interface options or colors.

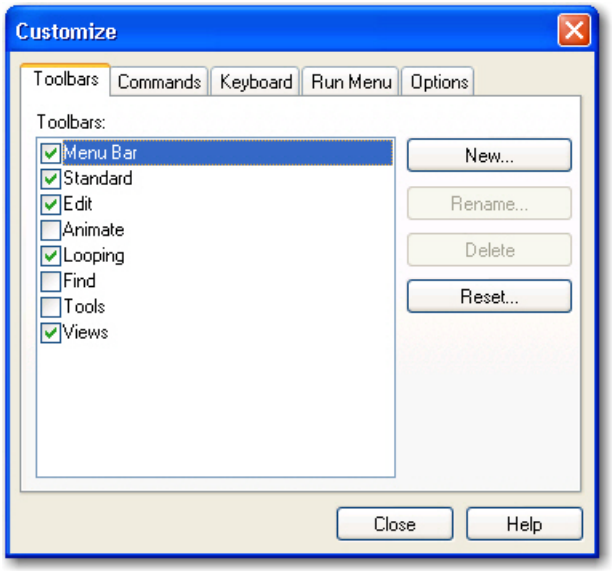
D.4 Customization

Although the menus and toolbars offer a rich set of commands and functions that should meet the needs of most Plexon customers, the **Customize** dialog box also allows you to customize several areas of the interface should the need ever arise. This section describes the uses of the **Customize** dialog box.

To open the **Customize** dialog box, from the **Tools** menu, select **Customize**. The **Customize** dialog box contains several tabs. The images below show the **Customize** dialog box from CinePlex Editor and displays five tabs - **Toolbars**, **Commands**, **Keyboard**, **Run Menu**, and **Options**. Although the content of the tabs will vary according to the application, the functional operation of each tab is respectively the same across all Plexon software applications.

D.4.1 Toolbars Customization

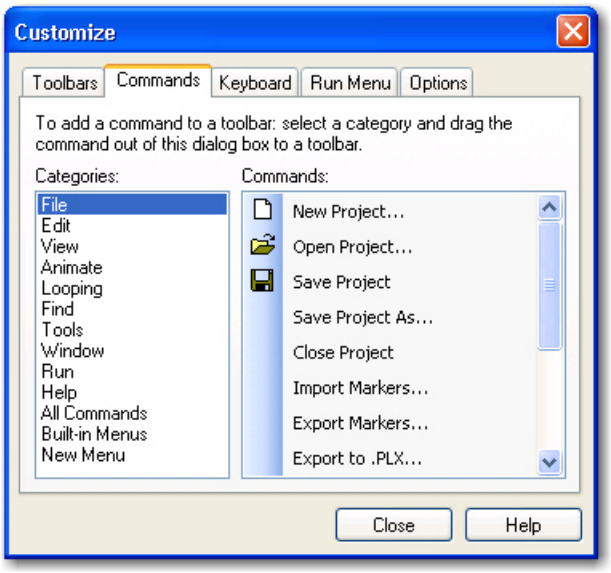
An image of the **Toolbars** tab follows:



- **Toolbars** - This box contains a list of the toolbars for the application. Click a toolbar checkbox to have it appear in the main application window.
- **New** - This button opens the **New Toolbar** dialog box. You can use this feature to create a custom toolbar for commands frequently used. Enter a toolbar name in the **Toolbar name** box.
- **Rename** - If you have selected a toolbar that was previously defined, click **Rename** to change the name of the toolbar. The **Rename Toolbar** dialog box displays.
- **Delete** - If you have defined a new toolbar and selected it, click **Delete** to remove that toolbar. There are no default values for newly defined toolbars. Standard toolbars may not be deleted. A confirmation dialog box displays.
- **Reset** - If you have selected a standard toolbar, click **Reset** to restore the toolbar to its default contents. If new buttons have been dragged to a toolbar, click **Reset** to restore the default version of the toolbar. A confirmation dialog box displays.

D.4.2 Commands Customization

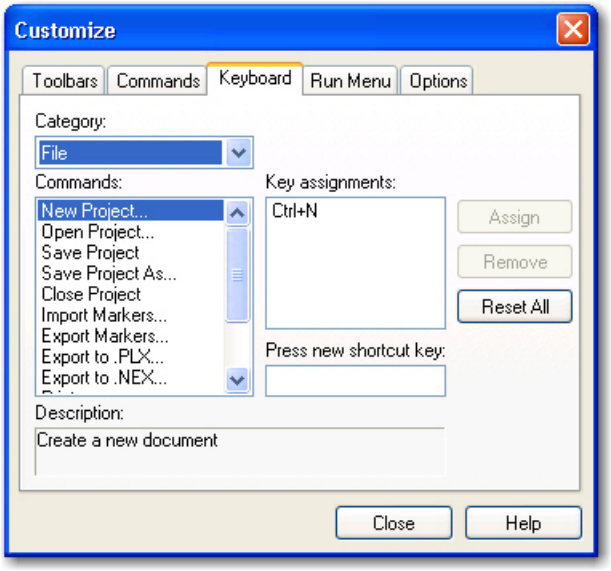
The **Commands** tab is used to customize which commands are available in toolbars. An image of the **Commands** tab follows:



- **Categories** - This is a list of all the toolbar categories. Select a toolbar category to see the buttons in the **Commands** area.
- **Commands** - This area shows all the buttons and the associated menu commands that belong to the selected category. You can select the desired command and drag it to the toolbar.

D.4.3 Keyboard Customization

The **Keyboard** tab allows you to bind keystrokes to commands. An image of the **Keyboard** tab follows:



- **Category** - This is a list of all the main menu headings. Select a menu heading to category to see the associated commands in the **Commands** area.
- **Commands** - This is a list of all the commands associated with the selected main menu heading in the **Category** area.
- **Key assignments** - This displays the current key assignment for the command selected in the **Commands** area.
- **Press new shortcut key** - This allows you to enter a shortcut key combination for the command selected in the **Commands** area.
- **Description** - This area displays a description of the currently selected command in the **Commands** area.
- **Assign** - This button assigns the shortcut in the **Press New Shortcut Ke**y area to the selected command in the **Commands** area. If the shortcut key is already assigned to another command, a confirmation dialog box displays to allow or cancel the reassignment.
- **Remove** - This button removes the selected shortcut key in the **Key Assignments** area from the selected command in the **Commands** area.
- **Reset All** - This button removes all custom key assignments. A confirmation dialog box displays to allow or cancel the operation.

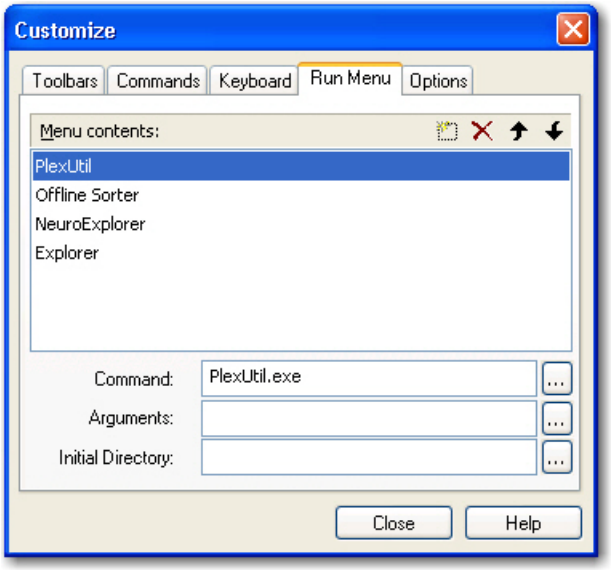
Procedure for Customizing Keystroke Shortcuts

1. From the **Window** menu, select **Customize,** and then click the **Keyboard** tab of the **Customize** dialog box.
2. Choose a category from the **Category** dropdown and from the **Commands** list, select the desired command to bind to a keystroke shortcut.
3. If there is already a key assignment listed in the **Key assignments** area, remove it by clicking the **Remove** button if so desired. You can also just reassign a new key combination to the selected command. (See Step 5)
4. Click the mouse in the **Press new shortcut key** area.
5. Click the **CTRL** or **ALT** key and hold it down while clicking another key. The dual key combination will be displayed in the **Press new shortcut key** area. This combination will be the key assignment for the selected command.
6. Click the **Assign** button to assign the key combination to the selected command. If there already is a key assignment for the command, a confirmation box will display to confirm or cancel the reassignment.

   Note: In CinePlex Editor do not bind menu operations to keystrokes that are associated with markers. Use only CTRL- or ALT- key combinations to bind to menu items, as these key combinations cannot be associated with markers.

D.4.4 Run Menu Customization

The **Run Menu** tab allows you to manage menu items on the **Run Menu**. An image of the **Run Menu** tab follows:



- **Menu contents** - This is a list of all the menu items in the **Run Menu**. Select an item to see its characteristics in the **Command**, **Arguments**, and **Initial Directory** areas.

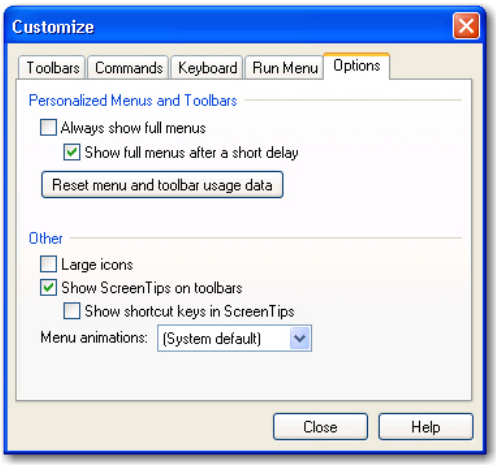
- **Buttons** - The toolbar buttons allow you to add a new menu item, delete a selected menu item, move the selected menu item upward in the list, and move the selected menu item downward in the list.
- **Command** - This area contains the name of the file that runs when the menu item is selected from the **Run Menu**. The browse button opens the standard **Open** dialog box filtered for executable files.
- **Arguments** - This is a list of all the arguments to be passed to the file in the **Command** area, if any. The browse button opens the standard **Open** dialog box filtered for all files. When applicable, the symbol "%1" can be used to denote the current document.
- **Initial Directory** - This contains the path of the file in the **Command** area. The path allows the system to find the file and execute it. The Browse button opens the standard **Browse For Folder** dialog box.

Procedure for Customizing the Run Menu

1. From the **Window** menu, select **Customize**, and click the **Run Menu** tab.
2. To add a menu item, click the **New** icon, enter the command in the **Command** text box, enter any arguments in the **Arguments** text box, and set the applications directory in the **Initial Directory** text box. In each case use the appropriate **Browse** button at the right of the text box. The **Browse** button for the command opens the standard **File Open** dialog box filtered for executable files. The **Browse** button for the arguments opens the standard **File Open** dialog box filtered for all files. Then **Browse** button for the initial directory opens the **Browse for Folder** dialog box.
3. To delete a menu item, select it and click the **Delete** button.
4. To reorder the menu items, select a menu item and use the **Up** and/or **Down** arrow buttons to reorder.

D.4.5 Options Customization

An image of the **Options** tab follows:



- **Personalized Menus and Toolbars** - This area contains two check boxes and a button. The application will hide infrequently used menu items, but you may customize the display of menu items using these two checkboxes. If you check the **Always show full menus** checkbox, the application will always show full menus and the **Show full menus after a short delay** checkbox will be disabled. If you do not check the **Always show full menus** checkbox, there will be the option of checking or clearing the **Show full menus after a short delay** checkbox. The **Reset menu and toolbar usage data** button will allow you to delete the record of commands used in the application and restore the default set of visible commands to the menus and toolbars. A confirmation dialog displays.
- **Other** - This area contains three checkboxes and a dropdown list. If you check the **Large icons** checkbox, the application will use large icons on the toolbar. If you check the **Show Screentips on toolbars** checkbox there will be the option of checking the **Show shortcut keys in Screen Tips** checkbox. The **Menu animations** dropdown list allows you to select the type of animation to be used on menus that have animation.

Appendix E
Troubleshooting

E.1 Physical Installation Issues E-2
E.2 Other Issues E-3

CAUTION

Never plug or unplug a camera FireWire cable with the PC Power ON. Permanent damage to the camera may result.

CinePlex® Version 3 is a powerful, complex product that gives its users extensive control over the video portions of their neural data collection process. This complexity gives rise to possible interactions and issues that were not present in earlier versions. For that reason Plexon® has compiled this list of common problems reported from the field, together with their normal solutions. If the steps here do not solve the problem, or if the problem is not listed, please contact Plexon Support at support@plexon.com or +1-214-369-4957.

E.1 Physical Installation Issues

In general, all of the following should be checked when unexplained problems are occurring. For more detailed installation instructions of CinePlex V3 hardware, please refer to the relevant documents.

Missing/Improper Wire and Cable Connections - Single Systems

Be sure that all required cable connections are in place and tight. Unpredictable results may occur if they are not. See Appendix A, Cabling Guide for complete detailed instructions for cabling the CinePlex System.
The most likely items to check are:

1. Short purple wire from TIM card nose board to the XS2 BNC connector on the TIM card.
2. Trigger cable(s) from the AccesIO tail board to the camera(s).
3. FireWire cable(s) from the FireWire card in the computer to the camera(s). If there are two cameras, there must be an empty FireWire socket between the two connections to the FireWire board or maximum frame rates will not be achievable.
4. Control cable from the TIM card nose board to the AccesIO tail board. If this cable is not in place, video frames may not be clocked and/or Studio may not start recording correctly.

Missing/Improper Wire and Cable Connections - Synchronized Systems

Cabling is slightly different when CinePlex Systems and MAPs are deployed as multiple synchronized systems using a Quad MAP Controller (QMC). Again, be sure that all required cable connections are in place and tight. This includes:

1. BNC cable and start button to the “BUTTON” input on the QMC OR BNC cable from the “PULSE” input on the QMC to an external experiment control system.
2. Control cable from the Master MAP TIM nose board to the QMC “CPX CTRL IN” socket.
3. Control cables from the QMC “CPX CONTROL OUT” for each system to their respective AccesIO tail boards. If this cable is not in place, video frames may not be clocked and/or Studio may not start recording correctly.
4. BNC Start cable from the QMC “START” socket to the “XS2” BNC connector on the TIM card on each synchronized MAP system.
5. BNC clock cable from the Quad MAP controller “CLK OUT” connector to the “Remote CLK” on each of the respective TIM boards. Also make sure that the toggle switch above these connectors is in the down position to select the remote clock.
6. Optionally, digital input signals from an external system can be input to the “DIGITAL INPUT” socket on the QMC where they are made available on the “DIGITAL OUTPUT” sockets to all MAP boxes.
7. Trigger cable(s) from the AccesIO tail board to the camera(s).
8. FireWire cable(s) from the FireWire card in the computer to the camera(s). If there are two cameras, there must be an empty FireWire socket between the two connections to the FireWire board or maximum frame rates will not be achievable.

Cables Too Short between Camera(s) and MAP/CinePlex Computer

Plexon supplies several lengths of these cables from 7 feet (2 meters) to 26 feet (8 meters). Please contact Plexon if one of these standard lengths will work in the installation. Note that cable lengths over 26 feet result in intermittent video signals at higher frame rates and are NOT RECOMMENDED.

Unstable Camera Mounting

Camera mounts must be stable or the resulting video data will shake and not be repeatable. This can be the case, for example, when a tripod is used to mount a camera, instead of the preferred wall or ceiling mount. Please refer to Appendix B, Optimizing Camera and Lens Usage for the Experiment.

E.2 Other Issues

General Problem Solution - No Video from Camera and Other Problems

The correct starting sequence must be applied to the MAP box, Sort Client, and CinePlex Studio. Not following the sequence completely is the cause of many types of errors, including no video being shown from the cameras. The startup sequence is as follows:

1. Power up the MAP.
2. Power up the computer, log in as Administrator, bring up the Server program, and then bring up the Sort Client program. Select the desired Parameters file.
3. In Sort Client, press **START** button and then the start recording triangular icon. Then press the stop recording rectangular icon.
4. Bring up CinePlex Studio. Verify that video is showing and select a tracking mode. Adjust parameters so that objects are being tracked successfully.
5. Contact Plexon support if problem is not resolved.

Error Messages While Running the Software Installation Package

The installation package adds programs and DLLs to the system. Therefore, the installation software:

1. Must be run from a computer account with administrator privileges.
2. Cannot be installed on a Vista computer.
3. Cannot be installed on a 64 bit computer.
4. Must be downloaded to and run from a local hard drive. Removable drives, including USB flash drives and USB hard drives, are not acceptable. Neither are networked drives.
5. Contact Plexon support if problem is not resolved.

Antivirus Software

Some MAP/CinePlex Systems come from Plexon with antivirus software pre-installed. The system has been tested with this antivirus software in place and should operated without problem as long as software and update settings are not changed. If problems occur that can be traced to the pre-installed antivirus software, please contact Plexon Support. It could be that a new set of virus signature files has caused some CinePlex components to be flagged as untrustworthy.

Please do not install any other antivirus software on the MAP/CinePlex System computer without consulting Plexon Support first. There are two reasons for this:

1. First, some antivirus tools have been know to quarantine or remove key components of the CinePlex System, rendering it unusable. A reinstallation of the CinePlex software will be required after the antivirus tool is removed from the computer.
2. Second, periodic downloads of updates or periodic scans for infections can disrupt video streams and processing, causing lost frames and delayed events.
3. Contact Plexon support if problem is not resolved.

Studio Will Not Start At All

There can be many causes for Studio failing to start when its icon is clicked or displaying an error and failing to start when OK is clicked. The most common causes and their solutions are shown below.

1. Missing CinePlex license key. Obtain or find the correct license key and restart CinePlex.
2. If CinePlex still will not start and reports a missing license key, install the Sentinel drivers (this is done by the CinePlex installation software or by running the file C:\Program Files\Plexon Inc\CinePlex\Common Files\Sentinel System Driver Installer 7.4.0.exe).
3. If CinePlex reports missing DLLs, reinstall CinePlex. All the required DLLs are in the installation package.
4. Contact Plexon support if problem is not resolved.

Studio Will Not Start In or Switch to Camera Mode

There can be many causes for Studio failing to go into camera mode. The most common causes and their solutions are shown below.

1. Missing MAP and/or CinePlex license key. Obtain or find the correct license key, install the Sentinel drivers (this is done by the CinePlex installation software), and restart CinePlex.
2. Missing or inoperative IO card or drivers.
3. Camera cables are loose or unplugged. Power all components of the system down, then check and reseat both ends of the two cables to the camera. Power the system back up, and follow the normal startup steps.
4. Contact Plexon support if problem is not resolved.

Studio Cannot Find AccesIO Drivers

1. Check for and disable any antivirus software. If the AccessIO drivers are in quarantine, restore them.
2. Try running Studio again. If the system still cannot find the AccesIO drivers go o the next step.
3. Reinstall the CinePlex software.
4. Contact Plexon support if problem is not resolved.

No Video in Studio

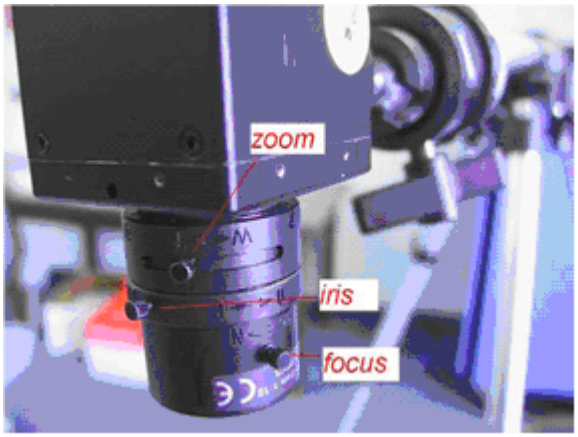
1. Sort Client must have a valid configuration file and the button labeled “START” must have been pushed. Until this has been done, no CinePlex

clock (or MAP clock from which it is derived) is being generated, so there is not video frame trigger.

2 After powering the system down, check the camera cables, especially the CinePlex System control cables.

3 Power the system back up and follow the normal startup steps.

4 If there is still a problem ensure that the manual iris control on the lens is fully open.



5 If the problem is still not resolved, there is a standalone un-triggered tool that will display video from the camera(s) if it is connected correctly and operational. Open the file below:

C:\Program Files\Plexon Inc\CinePlex\Common Files\AVT_SmartView_1_8.exe

6 If there is video for a particular camera using this tool, the camera and its FireWire cables are OK, and something is wrong with MAP cabling or operation. If no video, contact Plexon Support.

Cannot Focus the Video Image

The video is present, but blurry and cannot be focused at any zoom or focus setting. Note that the nearest focus for Plexon supplied lenses is from 0.2 to 1.6 meters depending on the lens.

1 Check for the presence of an annular spacer between the lens and the camera. The spacer should be present if the lens is a C-mount lens like Plexon's H6Z0812. The spacer should be absent for CS-mount lenses like the H32Z4512.

2 Adjust the zoom and focus rings on the lens until a clear picture is obtained. See figure above.

3 Contact Plexon support if problem is not resolved.

Slow Video in Studio

The video is present, but is updating very, very slowly - perhaps once every several minutes.

1. Remove the TIM card and check that the DIVCLK jumper is on the 1 MHz position instead of the 1 kHz setting. If not, move it to the 1 MHz setting.
2. Contact Plexon support if problem not resolved.

Filtering Video

Video is present, but the image is flickering.

1. Turn off any fluorescent lights illuminating the arena and use incandescent lights instead. If the flickering goes away, there may be problems with the fluorescent bulbs themselves, the starters, or the ballast. If fluorescent fixtures must be used, these problems must be fixed. Otherwise, look for alternative lighting sources
2. Contact Plexon support if problem is not resolved.

Arena is Too Small or Too Large within the Video Image

Once video has been obtained, the camera and lens must be adjusted so that the maximum dimension of the arena nearly fills the long dimension of the video image while ensuring that all other parts of the arena are within the video image as well.

1. If the arena image is too small, move the camera closer to the arena (outside of the near limit) or adjust the zoom ring towards the T (telephoto). Then adjust the lens focus ring until the video image is clear, if possible.
2. If the arena image is too large, move the camera away from the arena (within the physical limits of the environment) or adjust zoom ring towards the W (Wide Angle). Then adjust the lens focus ring until the image is clear, if possible.
3. Contact Plexon support if the arena cannot be adjusted to fill the video window.

Studio Will Not Start Recording When the Sort Client Start Icon is Pushed

1. Check that the Rasputin Datafile Options are set up for CinePlex System operation If Sort Client does not have these options available, contact Plexon Support to obtain the latest version.
2. Check that Studio is in the armed mode, waiting for Sort Client to start recording.
3. Check cables, especially the control cables - see the Physical Installation section of this document.
4. Check that the disk selected for recording video files is not full.
5. Contact Plexon support if problem is not resolved.

No Strobed Data Showing in Sort Client after Initial Startup

Usually, this occurs because the correct starting sequence has not been applied to the MAP box, Sort Client, and CinePlex Studio. The startup sequence is detailed in the section above General Problem Solution - Startup Sequence Not Followed.

1. Follow the start sequence. Go to LED or Markers mode. Press the PLX button next to up to three colors.
2. In Sort Client, ensure that the Strobed Data box is checked on the Settings/ Events tab. Press the Activity tab icon so that tab appears.
3. Scroll down to the bottom of the Activity tab window and verify that strobed data hash marks are being displayed.
4. Earlier version of Sort Client may not always display strobed data even though it is being received and written to the PLX data file successfully. Use the section below to verify strobed data in earlier versions of Sort Client.
5. Contact Plexon support if problem is not resolved.

No Strobed Data Showing in Earlier Versions of Sort Client - Use VTViewer

Sometimes, strobed data may not appear on the Activity tab after recording has been started. This is due to a display fault in earlier versions of Sort Client. The simple VTViewer client may be used to verify the generation of strobed data in this case.

1. Use the VTViewer icon or open the file below (on the MAP/CinePlex System computer) to bring up the VTViewer program

   C:\Program Files\Plexon Inc\CinePlex\Common Files\VTViewer.exe
2. Drop down the File menu and select the Connect option.
3. If the connection to Sort Client has been successful, colored spots representing current reported positions of the tracked objects will appear on the VTViewer grid.
4. If no colored spots are shown, please contact Plexon support.

Live Video Being Corrupted or Neural Data Being Dropped

Sometimes the live data will be corrupted or neural data will be dropped.

1. Try reducing monitor count, monitor resolution, or both.
2. If cards have recently been added to the PC bus, remove them to see if the problem is solved.
3. Contact Plexon Support for help in rearranging the order that existing cards are plugged into the PC bus.

Dropped Frame Count Non-zero While Recording

When the MAP/CinePlex System computer is heavily loaded causing available video buffering to fill, video frames may be dropped. The count of dropped frames is incremented each time this happens. This is not a normal condition and probably indicates that the computer is being asked to perform more than MAP/CinePlex System processing.

1. Stop running all unnecessary applications on the computer while recording. This includes CinePlex Editor, which can initiate intensive hard drive activity. Use the Task Manager to display and end unneeded tasks.

2. Disable scheduled tasks such as backup and Windows® Update. These can cause dropped frames when they run. Use the Task Scheduler to view all tasks. Contact the system administrator to disable unwanted tasks.

3. Internet activity, especially that involving heavy downloads such as from YouTube or similar sites should be prohibited on the MAP/CinePlex System computer. To avoid this possibility Plexon recommends placing the computer on a subnet isolated from intensive internet traffic.

4. If dropped frames still persist after these steps, please contact Plexon Support.

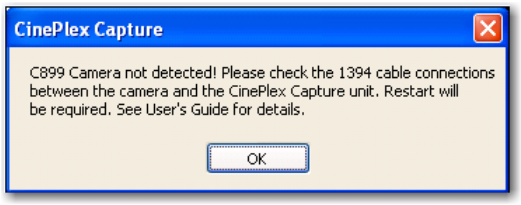
E.3.16 Other Typical Problems and Solutions

This section includes a list of some of the other typical problems with remedies for each one.

Note: The following problem refers to **CinePlex Capture** (earlier version of CinePlex Studio).

The following dialog appears when trying to run CinePlex Capture:

1. If the following **CinePlex Capture** dialog box appears after starting CinePlex Capture, read the instructions in the box. Verify the camera connections as detailed in the steps that follow.

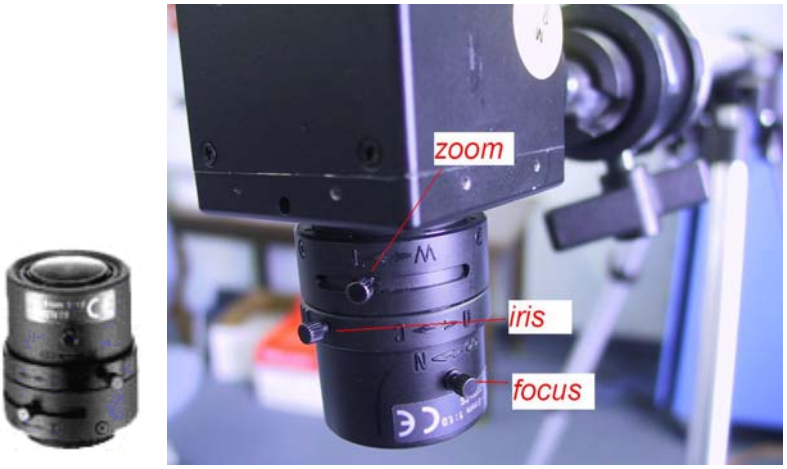


2. Check the 1394 cable between the camera and the CinePlex Capture computer. Make sure the cable is undamaged. Make sure to connect the cable to the "**In**" port on the camera. Do not connect the cable to the "**DaisyChain**" port on the camera.

3. Make sure the camera is the same camera that Plexon shipped with the CinePlex Capture computer. CinePlex cameras and computers are uniquely calibrated to each another and they are *not* interchangeable.

The video preview display is black

1. Set the manual iris control on the camera by twisting middle ring (iris) on the camera lens from closed to open.



2. From the **File** menu, click **Set Defaults**.

The video preview display is out of focus

1. Set the zoom and the focus controls on the camera by twisting the outer and inner rings on the camera lens until a clear picture displays in the Video window.
2. On CS mount cameras, ensure that the C to CS adaptor ring is not installed between the lens and the camera.

Dropped Frame Counts

1. Stop running all unnecessary applications on the computer while recording. This includes CinePlex Editor, which has file intensive activity. Use the Task Manager to display and end unneeded tasks.
2. Disable tasks such as backup and Windows Update. These can cause DFC increments when they run. Use the Task Scheduler to vie all scheduled tasks.
3. Place the CinePlex System computer on a subnet isolated from intensive internet traffic.
4. If the problem persists, please contact Plexon Support.

For details on DFC counts, see “Monitoring the Video During a Recording Session” on page 51.

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CinePlex® Studio

Part of the CinePlex Behavioral Research System

User Guide

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