OLYMPUS®

i-SPEED



USER GUIDE

PC Software

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End-user license agreement

NOTE

This license agreement applies to the software supplied on disk with the *i-SPEED* system and not the *i-SPEED* camera itself.

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1

Getting Started

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Getting Started

Overview of the i-SPEED PC Software

Welcome to the *i-SPEED* PC Software User Manual. *i-SPEED* PC Software is the accompanying software to the *i-SPEED* video camera from Olympus. The software is supplied on a single CD, which contains all the software necessary to install any of the versions or optional features. The installation procedure unlocks the version of the software that you have purchased.

The *i-SPEED* PC Software is a unique software system that provides the following core functionalities:

- Camera control
- Triggering of the cameras
- Synchronization of multiple cameras
- Download of images from the cameras to the PC
- Image processing to improve image quality
- Motion Analysis of the images
- Lens Calculator
- Acquisition of synchronized User Data
- Saving of images and data to a hard disk

In addition, the following functionalities can be added in the optional versions or module:

- Synchronization to GPS or IRIG time generators
- Automation of acquisition and download process
- Automatic correlation tracking of features within images
- Expansion of data acquisition using external hardware

Registration Numbers and License Numbers

Each version is supplied with a unique registration number. This number must be used to register the software and to request technical support. This number identifies the shipment and submission.

In addition, some versions are also supplied with a 16-digit License Key Code. This code is entered using the software License Manager to unlock certain features.

Basic, Advanced and Deluxe Versions

The *i-SPEED* PC Software comes in three versions:

- Basic Version
- Advanced Version
- Deluxe Version

The following table shows the delineation of features for the different versions:

Features	Basic	Advanced	Deluxe
Video Acquisition			
Multi-camera synchronization	✓	✓	✓
Remote camera control	✓	✓	✓
Remote file transfer/ download			✓
High-Speed Time Lapse Mode	✓	✓	✓
Pre/post Event triggering	✓	✓	✓
BROC/ROC	✓	✓	✓
Bayer/RGB decoding	✓	✓	✓
Hot Connect Mode	✓	✓	✓
User Data Acquisition			
Standard 2-channel data capture		✓	✓
Enhanced 16-channel data capture and waveform display			✓[1]
GPS/IRIG data synchronisation			✓[2]
Analysis and Measurements			
Real Time Velocity, distance, position	✓	✓	✓
On-screen graphing		✓	✓
Manual Feature Tracking	✓	✓	✓
Auto-feature tracking		✓	✓
Multi-Point manual/auto feature tracking			✓
Enhanced 2-D calibration		✓	✓
Image processing	✓	✓	✓
User Commentary			
Bookmarking of images	✓	✓	✓
User defined commentary	✓	✓	✓
Frame-by-Frame commentary		✓	✓
Data commentary			✓
Saving			
Microsoft AVI formats	✓	✓	✓
Sequences of still frames	✓	✓	✓
Image compression	✓	✓	✓
Partial image saving (clips)	✓	✓	✓

The Basic Version of the *i-SPEED* PC Software does not require that a software security device (often called a dongle, hardlock or keytag) be placed on the computer. Both the Advanced and Deluxe versions require such a security device be installed prior to launching the software. In the absence of the security device, the software will automatically revert to the Basic Version.

Optional data capture device[1]

This module allows users to connect upto 16 channels of synchronised data to the captured video files. It is an optional module that can be added at any time to the Deluxe version of the software, it requires the installation of supplied hardware and additional hardware drivers.

Optional GPS/IRIG Module[2]

This module allows users to connect your network of Olympus *i-SPEED* cameras to external time generators as commonly found on military ranges or outside test facilities. These time generators are used to exactly synchronize to thousandths of a second the various events that occur during a typical measurement.

This GPS/IRIG module is not included in any of the Basic, Advanced or Deluxe versions. It is an optional module that can be added at any time to the Deluxe version; it requires the installation of supplied hardware into the PC and additional hardware drivers.

Purchase Options

Users may purchase upgrades from the Basic to the Advanced or Deluxe versions of software, or add the optional data acquisition or GPS/IRIG Module at any time. All the software is installed at the same time from a single disk. Contact your Olympus sales agent for details on how to upgrade to a higher performance version of software.

2

Installation

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Installing the i-SPEED PC Software

The *i-SPEED* PC Software is supplied on a single CD. All three versions of the software – Basic, Advanced and Deluxe - are contained within this one disc. Only the features that you have purchased are unlocked for your installation.

The Advanced and Deluxe versions of the *i-SPEED* PC Software are protected by a software security key tag (also known as a keylock, Hardlock or dongle). The minimum recommended PC specification to run the *i-SPEED* PC Software is given below. However, due to the nature of video analysis being computational intensive, for more advance use, it is recommended that a higher specification PC is used.

- Windows 2000/XP operating systems
- 2GHz processor
- 512Mb RAM
- 20Gb hard disk drive
- High speed graphics card (AGP or equivalent, 64Mb preferred)
- 100 Base-T Ethernet
- Parallel port

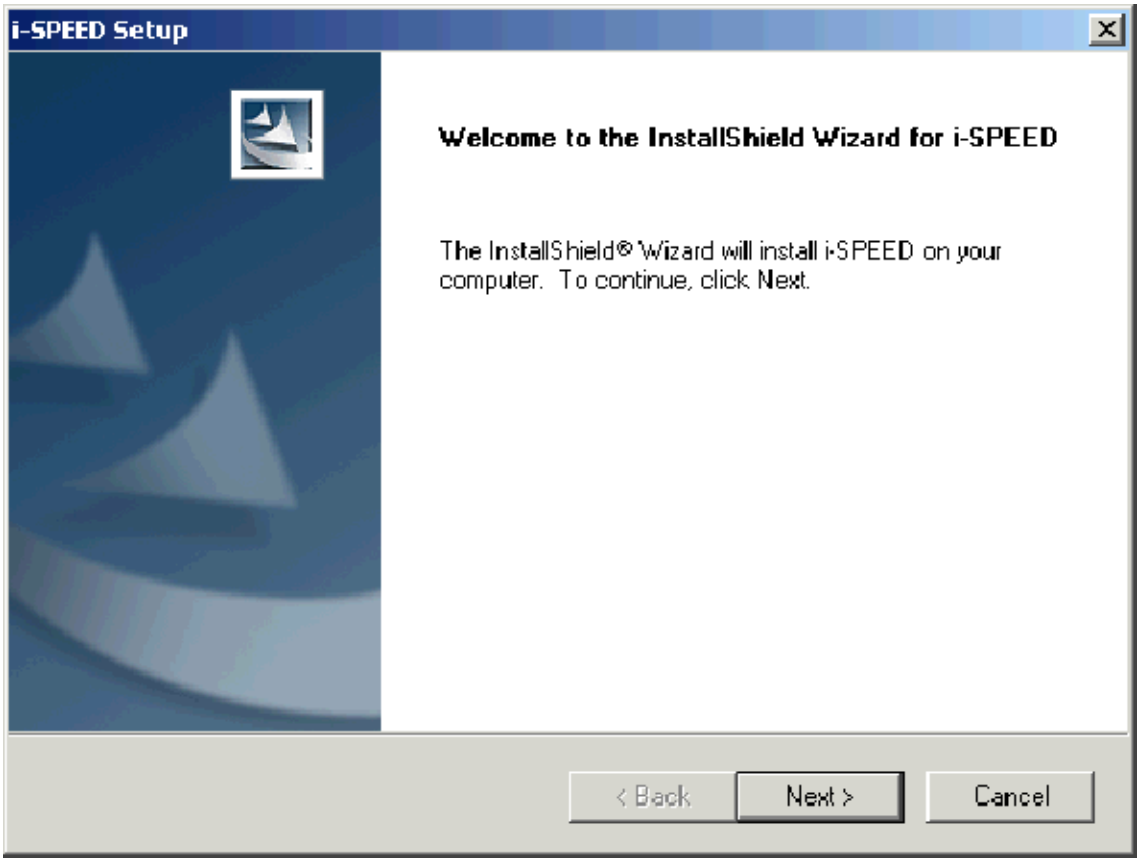
The installation procedure is the same for all operating systems.

Install the i-SPEED PC Software Application

1 Power on your personal computer.

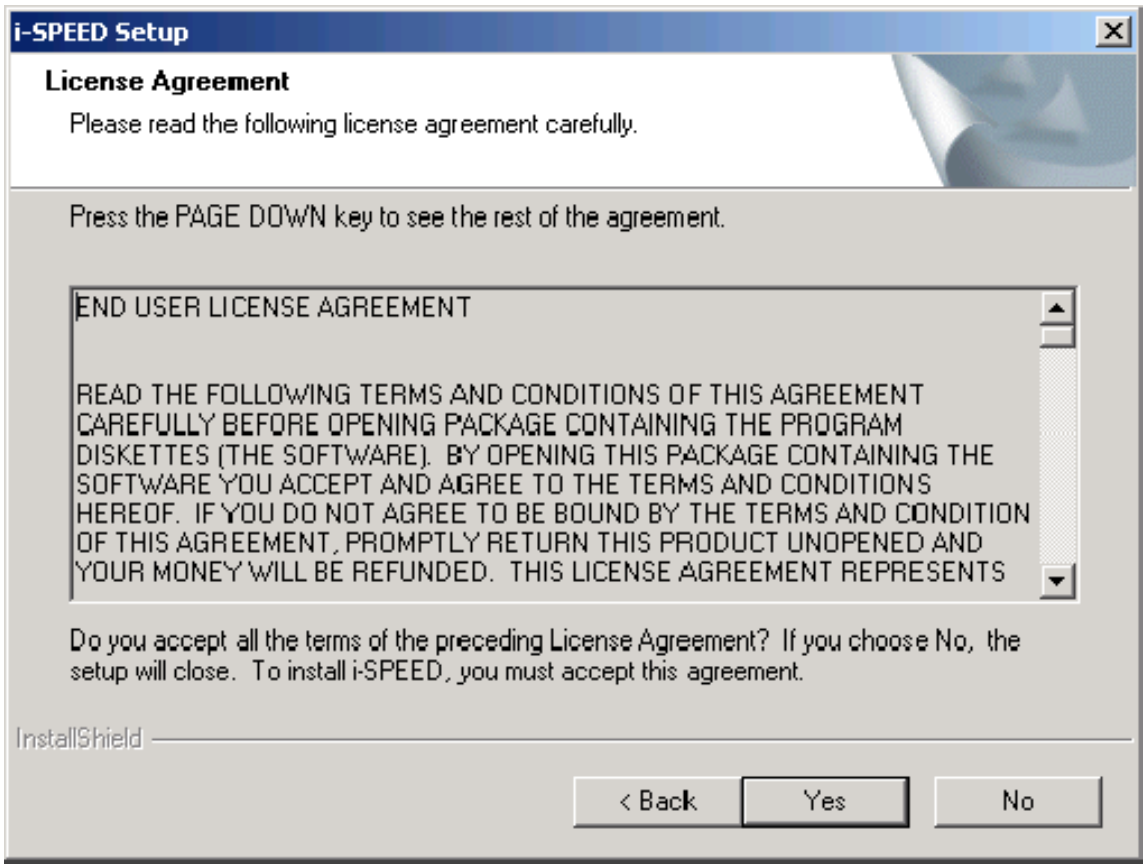
NOTE: Note: you must be logged in as Administrator on the personal computer to properly install *i-SPEED* PC software.

2 Insert the CD that contains the *i-SPEED* PC Software into your CD-ROM drive. The *i-SPEED* PC Software installer should automatically start. If it does not, from the **RUN** prompt, type **F:\SETUP**, where "**F**" is the letter of your CD drive. The following installer Welcome screen will appear:

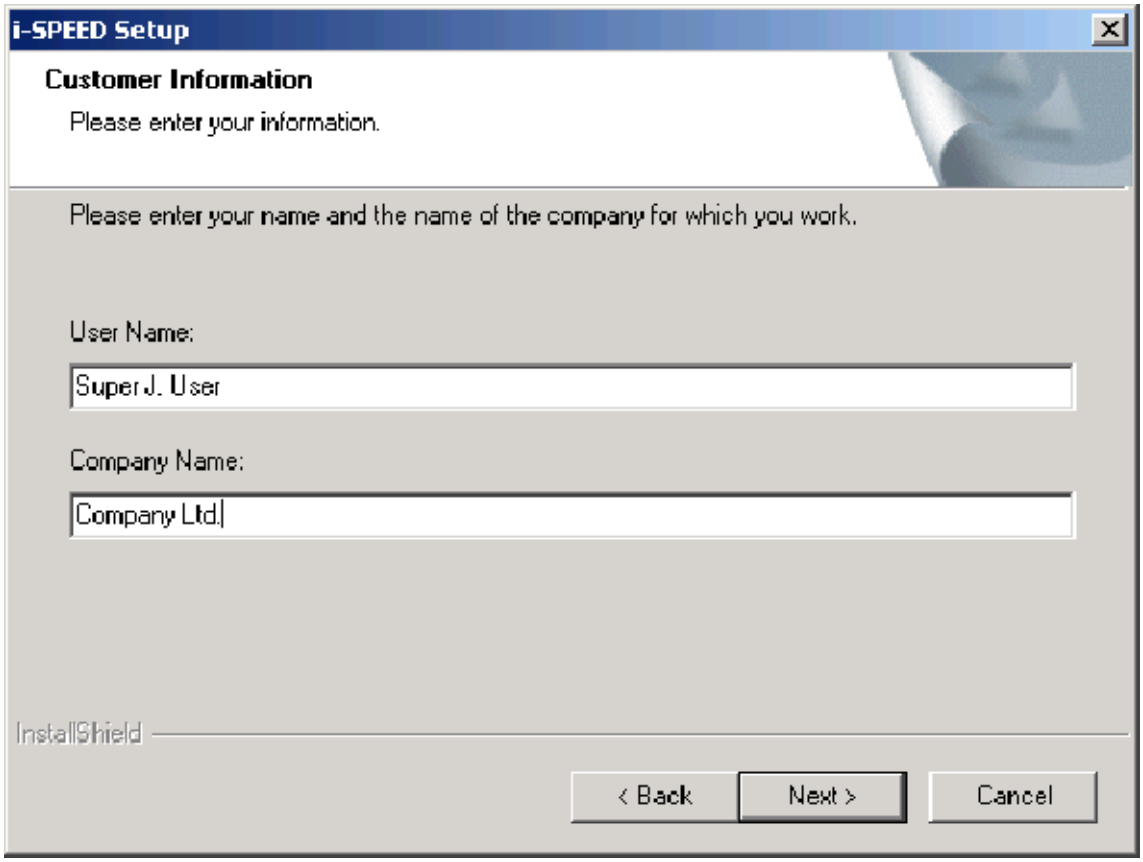


If the *i-SPEED* installer indicates that it has detected a previous version of the software, skip to the next chapter to upgrade your software without re-installing all the components.

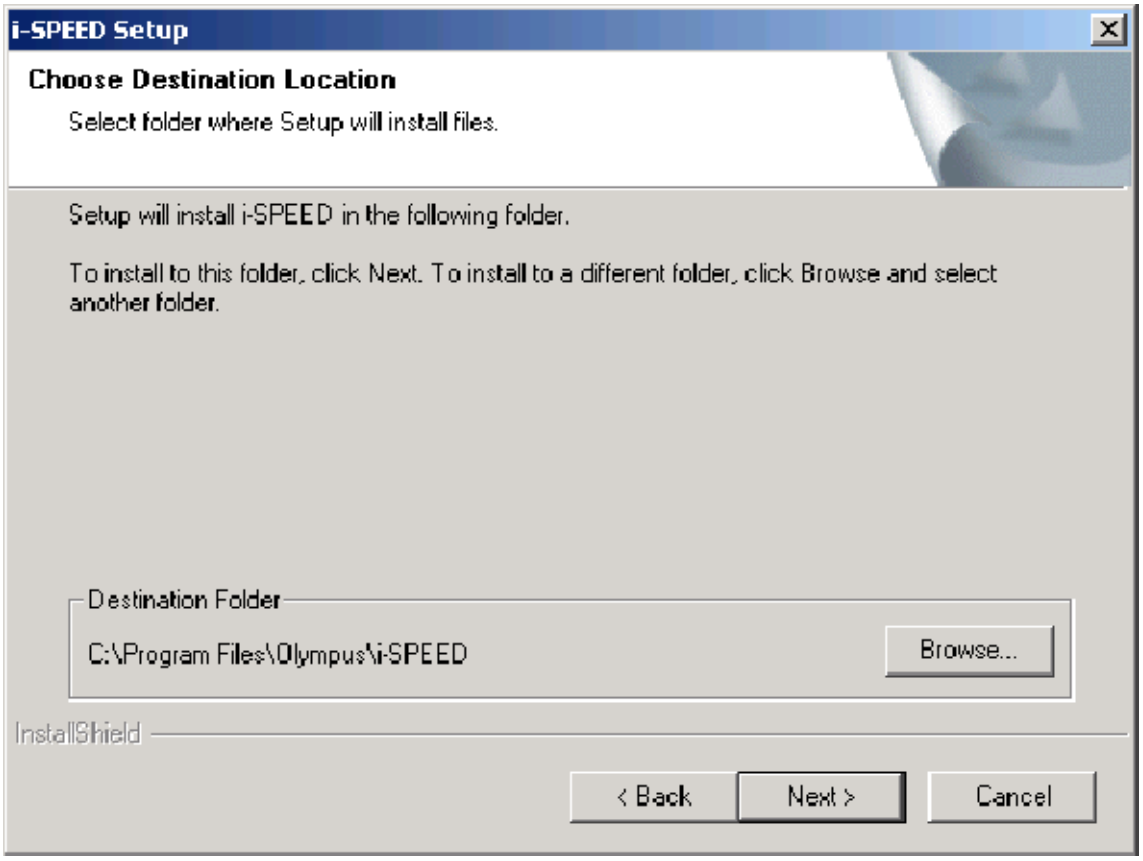
3 Click **NEXT**. The *i-SPEED* PC Software License Agreement will pop up. Read the agreement carefully.



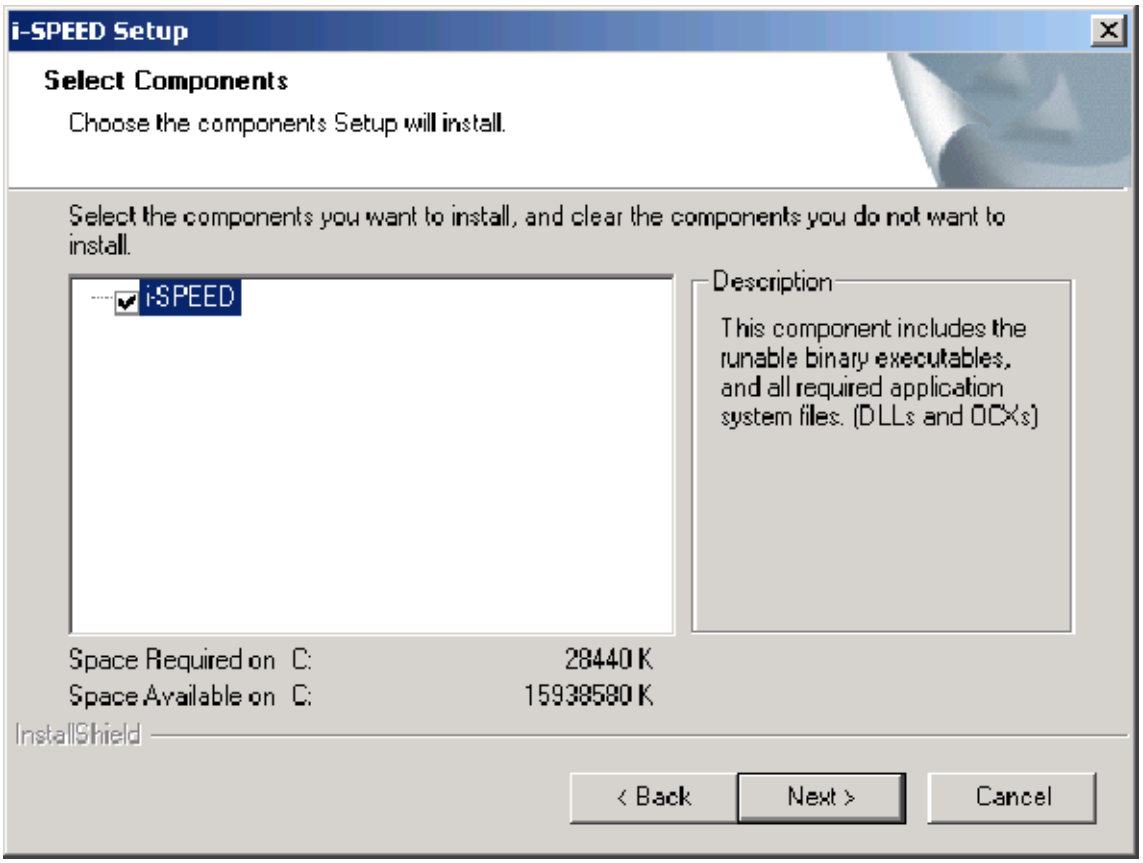
4 If you agree to the license terms, click **YES**. The installer will prompt you for your name and affiliation.



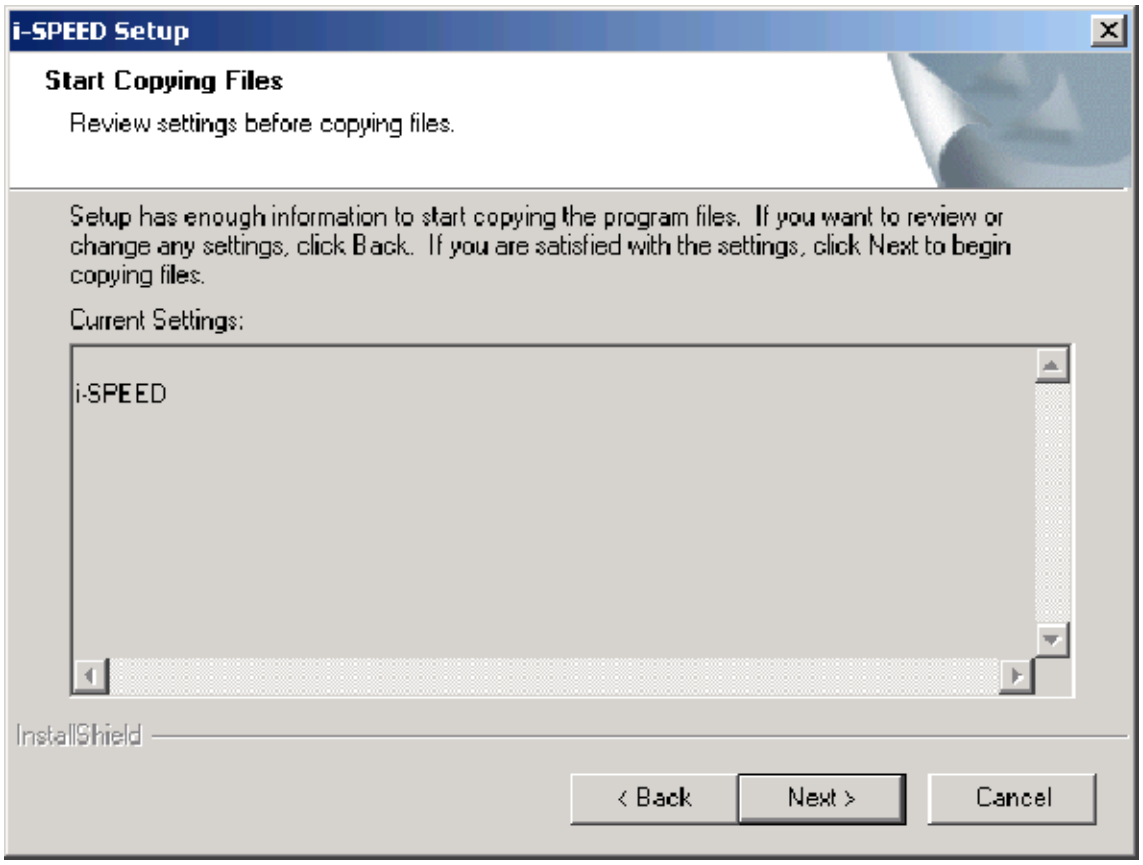
5 Click **NEXT** . The installer will prompt you to choose the destination folder. Unless you have a special configuration, select the default **C:\PROGRAM FILES\OLYMPUS\I-SPEED**.



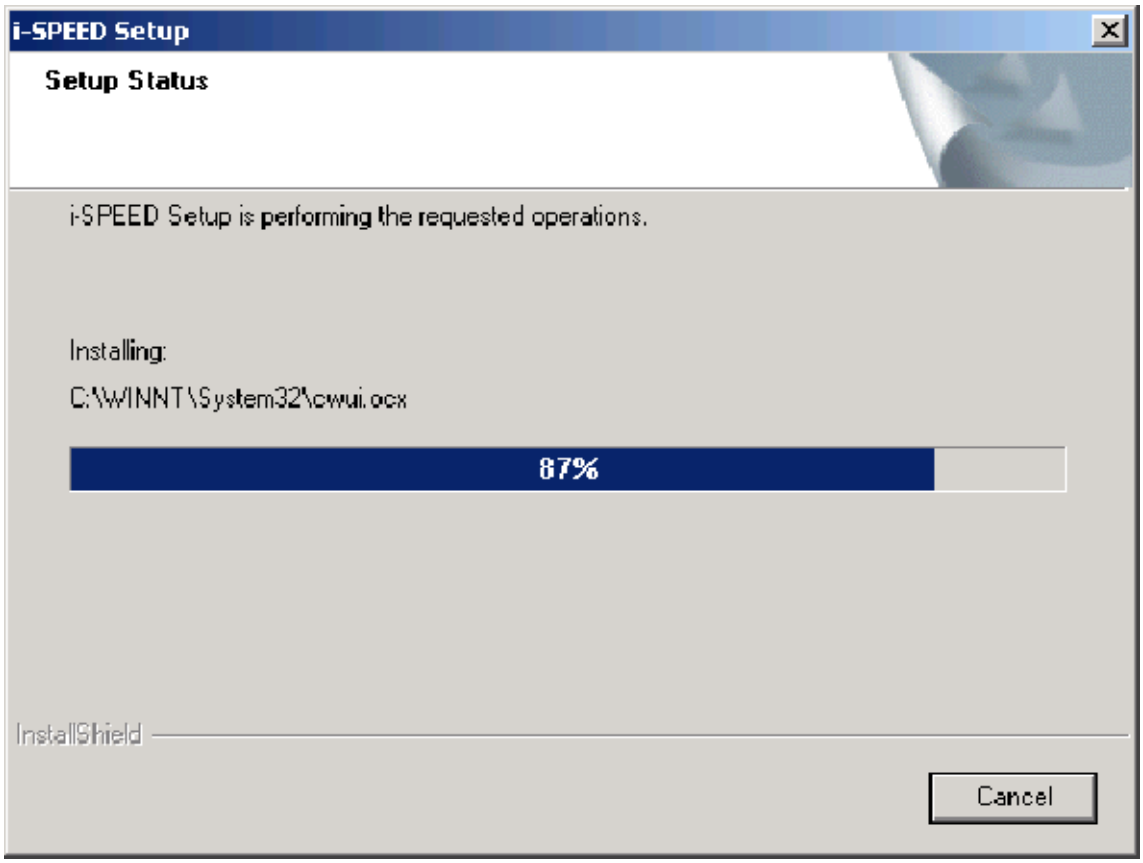
6 Click **NEXT**. The installer will prompt you to select the components of *i-SPEED* PC Software you desire to install. Select all the files available.



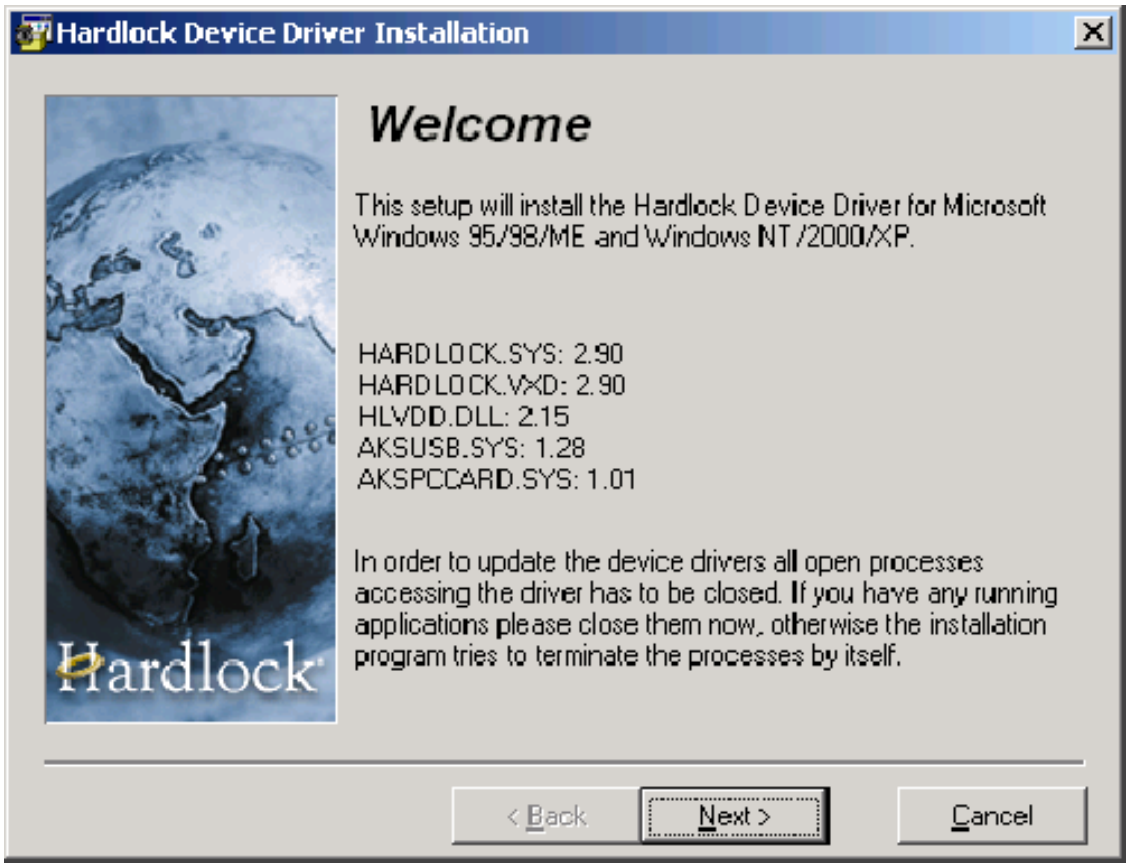
7 Click **NEXT.** At the Component Installation Summary screen, confirm that *i-SPEED* PC Software and the License Manager will be installed.



8 Click **NEXT.** The installer will then install the application and all the appropriate files. During the installation process, which could take many minutes – a status box will appear.



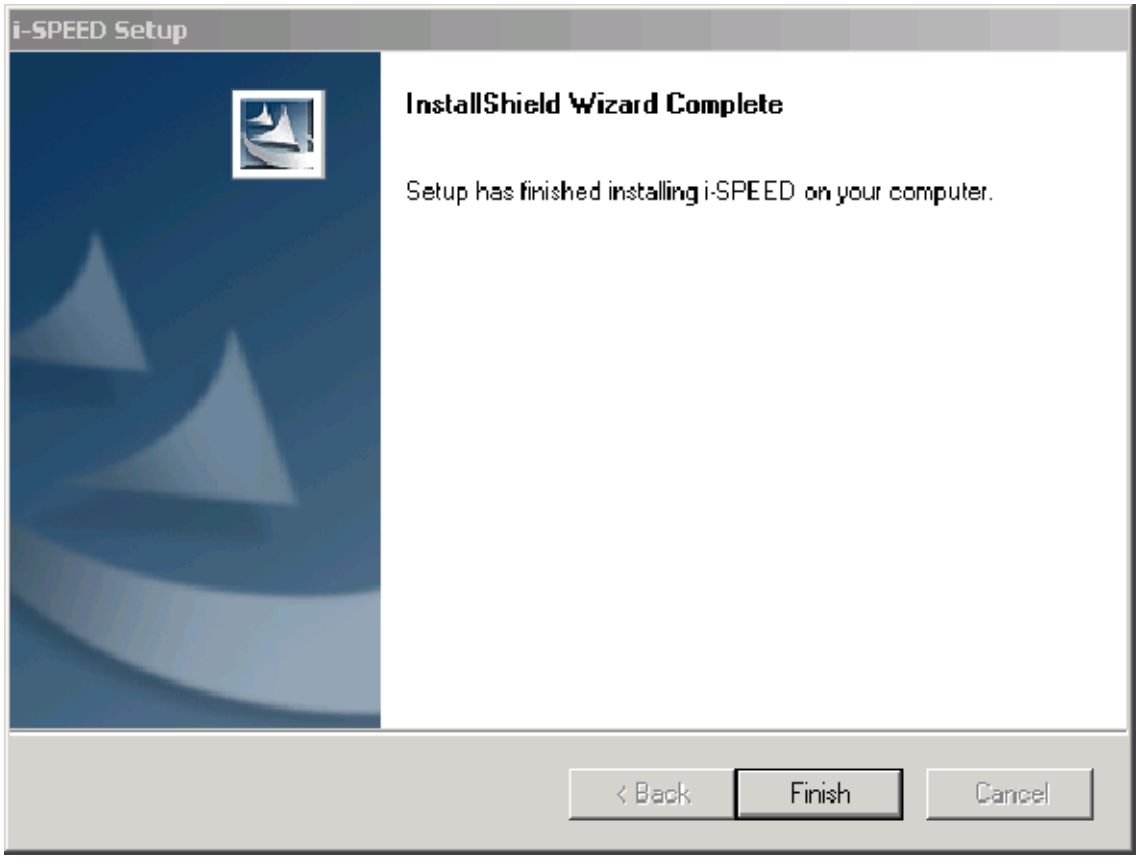
9 The installer will then start the security device driver installation subroutine.



10 Click **NEXT**. The software security drivers will be installed.



11 Click **FINISH**. The installer will then complete the installation.

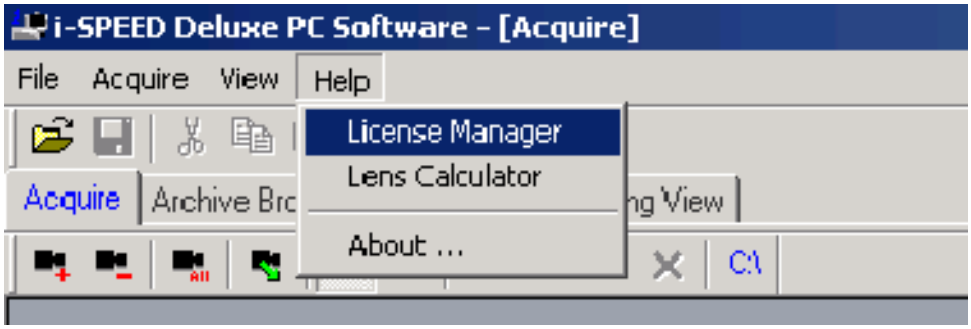


12 At the Setup complete screen, click **FINISH** and remove the CD-ROM from your CD drive.

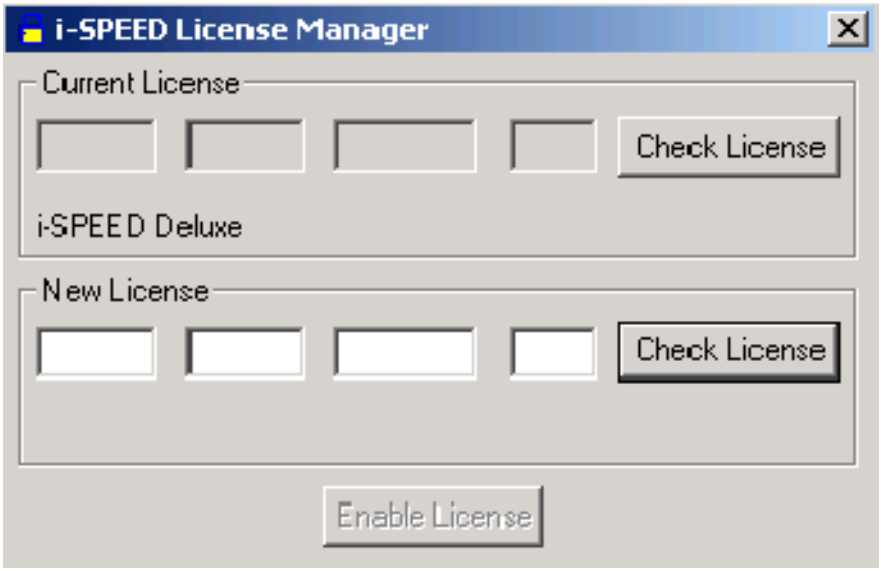
If you have purchased the Advanced or Deluxe PC Software package

To unlock the features of the Advanced and Deluxe PC Software, you must enter your 16-digit license code through the *i-SPEED* license Manager.

1 From the Windows Start Button, start the *i-SPEED* PC Software. After the *i-SPEED* PC software has started, click on Help ➧ License Manager.



The License Manager window appears.



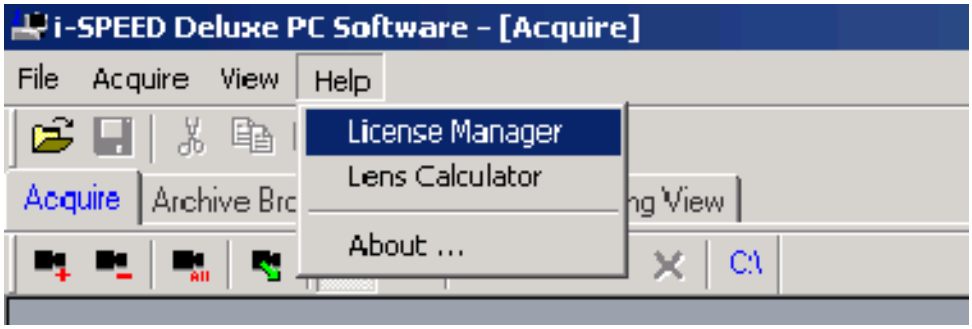
2 Type in the 16-digit Security License Code that was supplied with your software, then click on the Check License button. If a valid code has been entered, click on the Enable License button.

If you have purchased the optional GPS/IRIG or external data box packages

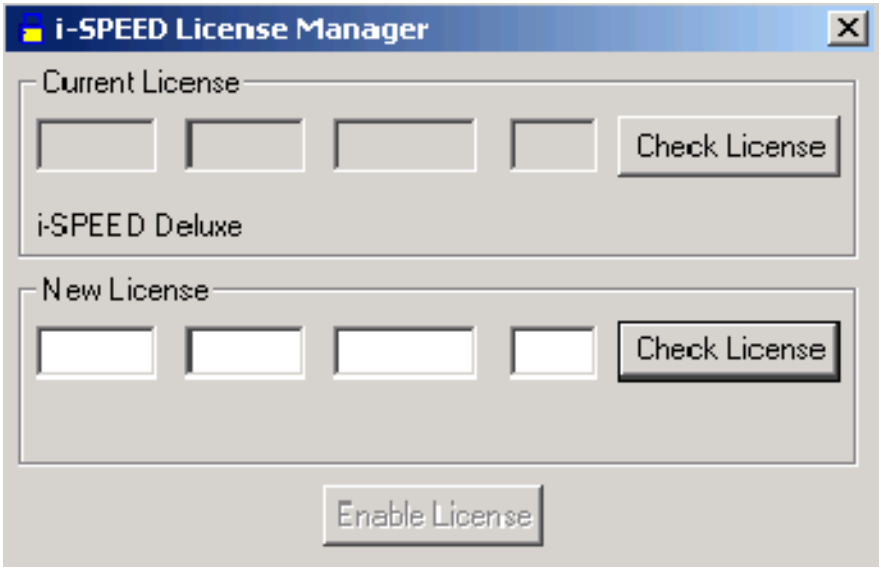
If you have purchased the optional GPS/IRIG or external data box packages, then you must (1) enter your unlock code and (2) install the external data acquisition drivers.

To unlock the optional features of the Deluxe PC Software, you must enter your new 16-digit license code through the *i-SPEED* license Manager.

1 From the Windows Start Button, start the *i-SPEED* PC Software. After the *i-SPEED* PC software has started, click on Help ➧ License Manager.



The License Manager window appears.



2 Type in the 16-digit Security License Code that was supplied with your upgrade package, then click on the Check License button. If a valid code has been entered, click on the Enable License button.

3 To install the external data acquisition hardware, remove the National Instruments NIDAQ disk from your packaging. Insert the disk.

4 Insert the "NIDAQ" driver CD from National Instruments (Disk 1). The driver installation program should start automatically. If it does not, from the **RUN** prompt, type **F:/SETUP**, where "**F**" is the letter of your CD-ROM drive.

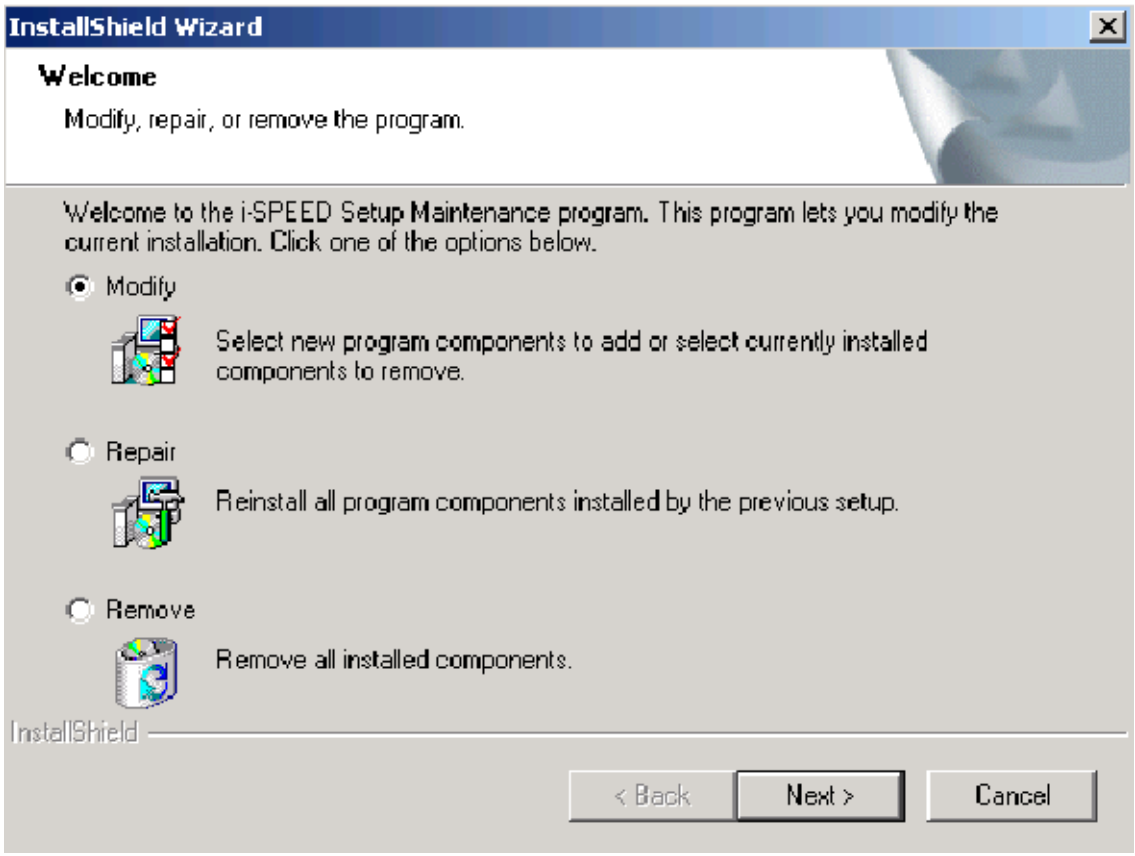
The NI-DAQ Installation screen appears, follow the on-screen instructions.

5 To install the GPS/IRIG hardware, insert the GPS/IRIG driver disk supplied. The driver installation program should start automatically. The GPS/IRIG installation screen appears, follow the on-screen instructions.

If you are upgrading from previous versions of i-SPEED PC Software

NOTE: Note: it is not necessary to uninstall previous versions of *i-SPEED* PC Software.

During the installation procedure, the installer will automatically detect that you are upgrading a previous version of *i-SPEED* PC Software software. You will see the following screen.



1 Select the Repair option.

2 Click **NEXT**. The installer will then install the new application and all the appropriately modified files.

The installer may prompt you that it has detected a READ ONLY file, and ask you if you wish to overwrite this file. In this event, click **YES**. If the security driver is required, the installer will automatically start the proper driver installer. When complete, click **FINISH** and remove the CD-ROM from your CD drive. Restart your computer.

3

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Quick Tutorial

This brief tutorial is designed to provide a quick summary of the features and benefits of the *i-SPEED* PC Software. This overview covers provides simple, step-by-step instructions for (1) recording an image, (2) downloading it to the computer, (3) manipulating it within the Strip View, and (4) then playing / processing / analyzing it within the Working View. These fundamental tasks within the *i-SPEED* PC Software encompass the key features of the software. Users that require a more comprehensive explanation of any feature are referred to the detailed User Manual.

For previously recorded sequences the process starts by (1) exploring your hard-drives with the Archive Browser, (2) viewing temporal relationships within Strip View, and (3) then playing / processing / analyzing it within the Working View

Making a Recording

1 Click on the Acquire tab.

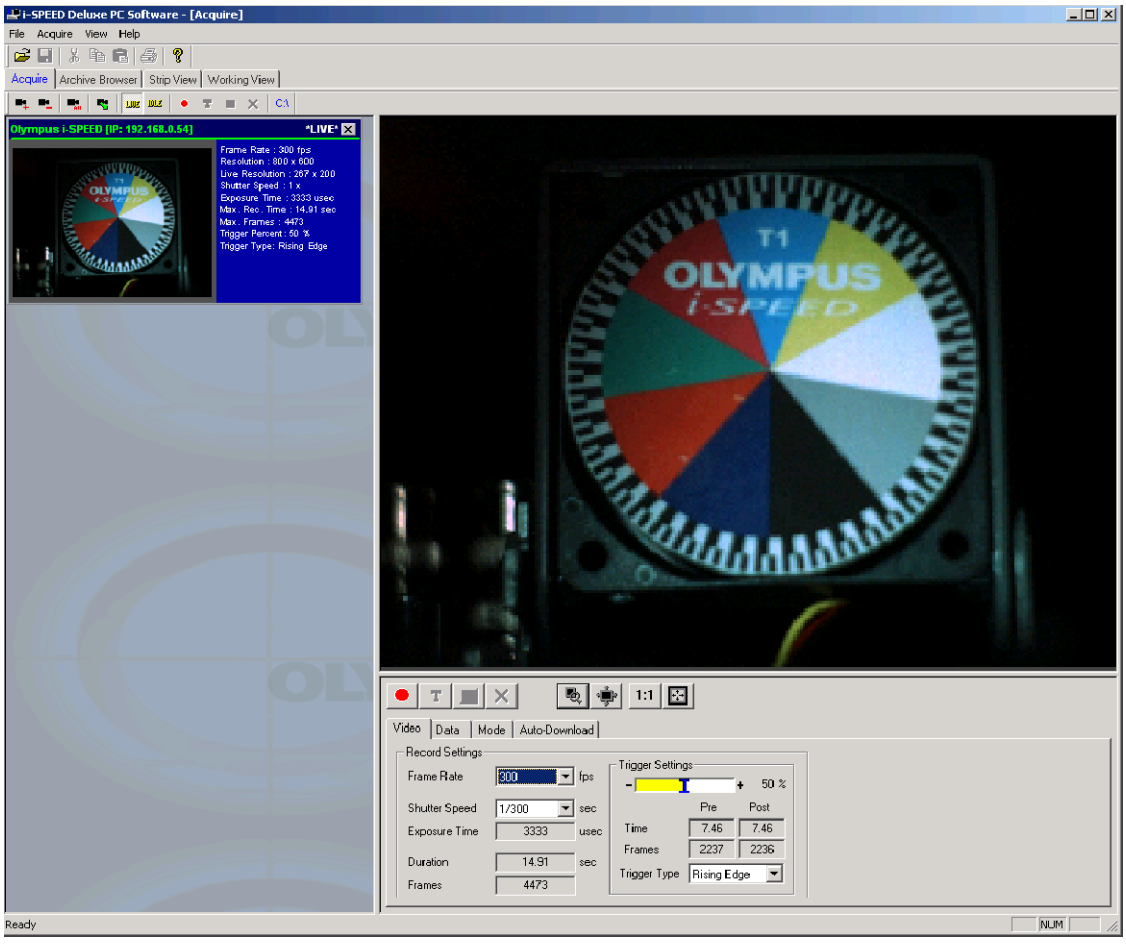


2 Either click on the Add a Camera button or Add All Cameras button. If you select the Add a Camera button, the following window will appear:



Type in the IP address of the camera you wish to add to the network. The IP address can be found in the Home/Config/Ethernet menu screen on the CDU or in the Feature setup menu on the RCP.

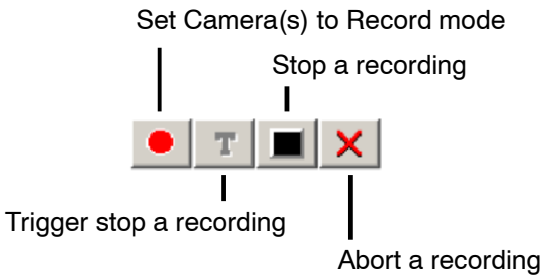
The list of open cameras will be listed in the left column of the Acquire window, as shown below:



3 Highlight each camera along the left side and enter the record parameters in the control panel on the lower right, as described in the User Manual. The parameters include:

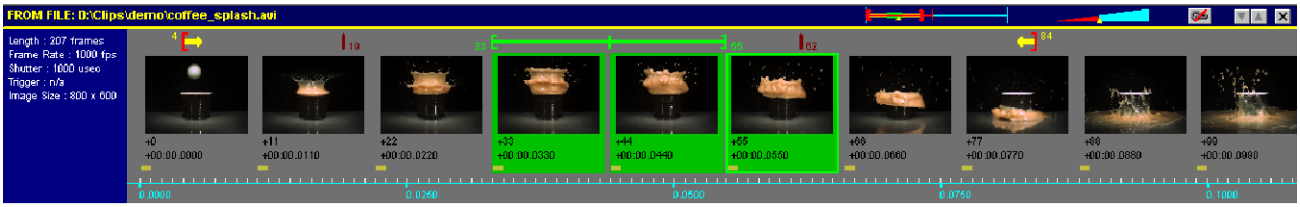
Video
Frame rate
Shutter speed
Trigger position
Trigger type
Mode
Burst Record on Command (BROC)
Record on Command (ROC)
Time lapse
Economy mode
Pan
Bayer mode
Data
Data source (camera or external box)
Sample rate
Sensor type (Deluxe only)
Gain (Deluxe only)
Offset (Deluxe only)
Labels (Deluxe only)
Auto Download
Destination folders
Frame range
Reset type
Internal clock reset delay
Filename

4 Click on the Set Camera(s) to Record button (tool tip shortened to “Record”).



5 When ready, click Trigger Stop a Recording button (if available), else use the hardware trigger button. The *i-SPEED* PC Software will trigger the camera per the trigger instructions in the video tab.

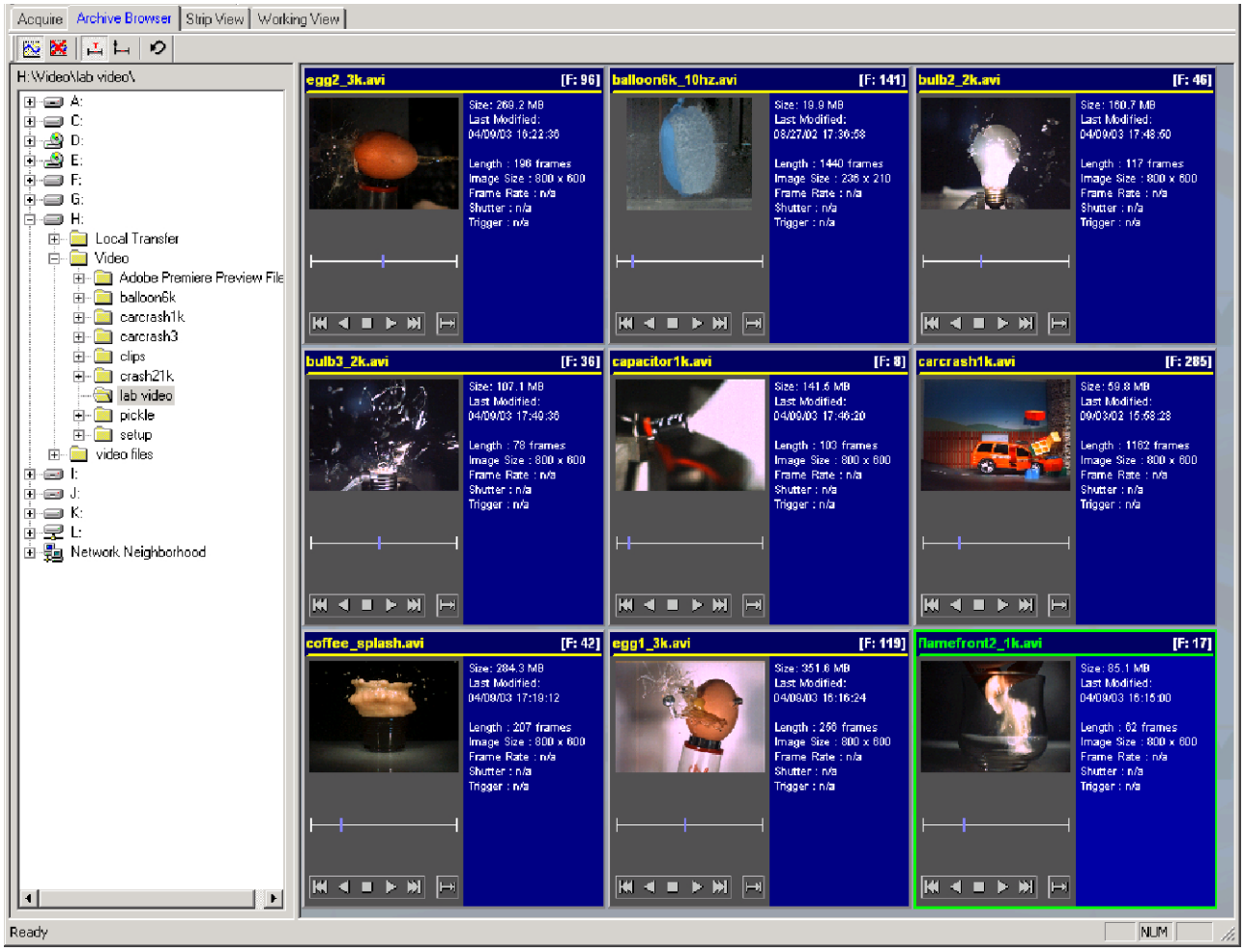
When the recording is complete, it will open in the Strip View.



Open Stored Images and Data

1 Select the Archive Browser tab.

2 Use the Navigator bar along the left side of the Archive Browser



3 Highlight the video of choice.

4 Right click within the window. Select “Open within Strip View”, or simply double click on the image.

Download and Navigate in Strip View

1 Select the region in which the event of interest occurred. Left click on the left side of the event and drag the mouse over the strip, highlighting the time of interest.

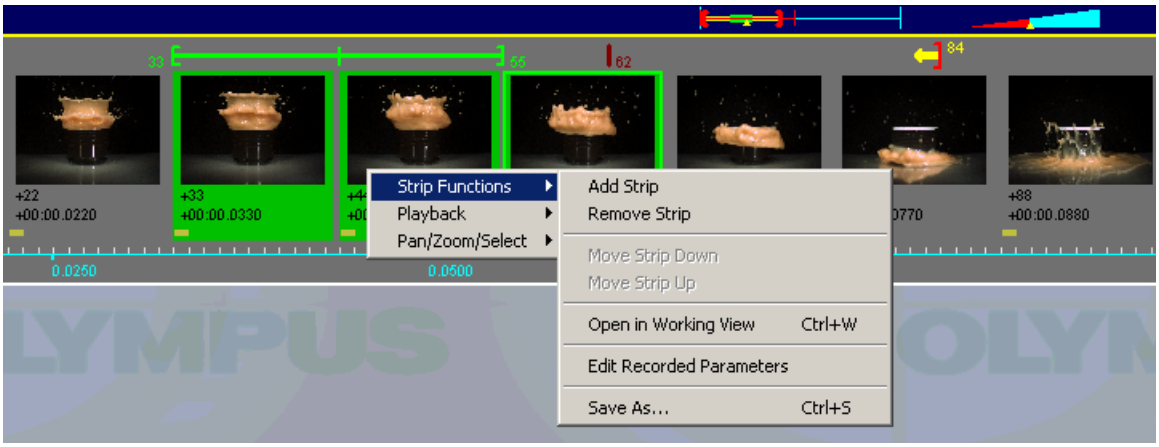
2 Right click within the highlighted area. Select “Transfer Selected Frames”, or simply hit the “Enter” key. The strip view will automatically zoom and center the strip on your selected region.

3 Use the zoom and pan features of the Strip View to fine-tune your region selection.



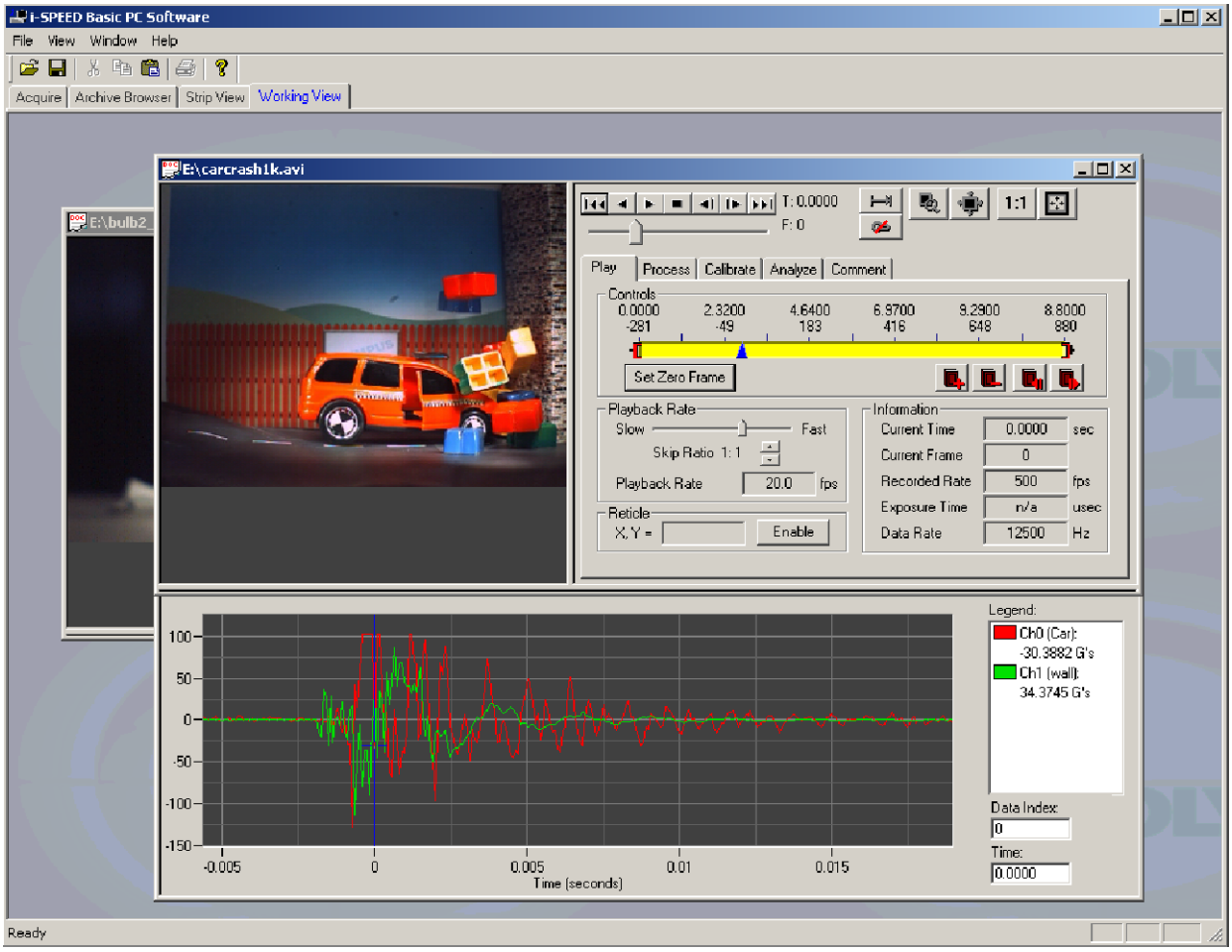
4 When you have bracketed the region of interest, set the Range. Right click within the video and select “Set Range as Selection”, or simply press ctrl-R.

5 Now that you have isolated the event of interest and bracketed the event in time, move the image to the Working View. Right click within the strip and select “Strip Functions”, then “Open in Working View”, or simply double-click within the strip.

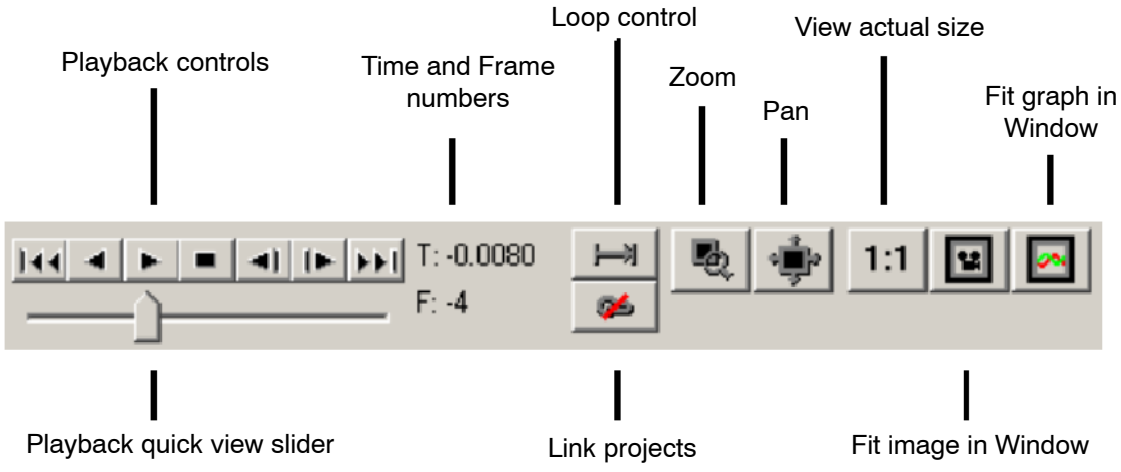


Playing Back in Working View

1 The images now appear in the Working View window.

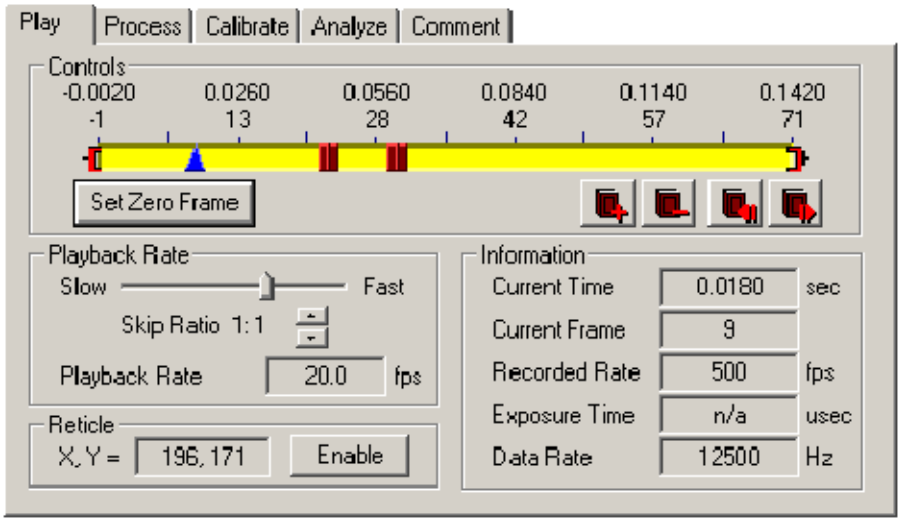


2 Review the data using the navigation tools on the top of the control panel.

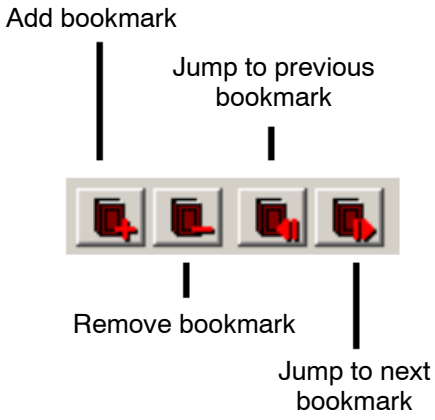


3 Zoom in and out to magnify the image.

4 Click on the Play tab:



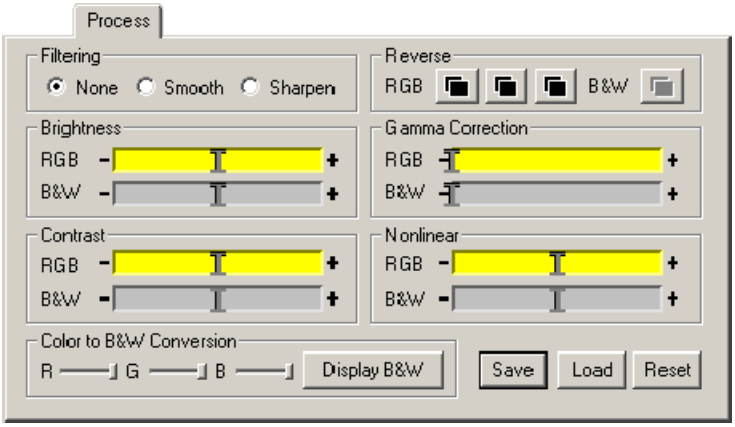
5 Set multiple bookmarks by clicking on the Add Bookmark icon.



6 Adjust the Range Brackets to modify the region of interest.

Image Processing to Enhance the Image

1 Click on the Process tab.



2 Use the Brightness, Contrast, Gamma and Nonlinear sliders to modify the appearance of the image until the features of interest are most pronounced (e.g. white on black background).

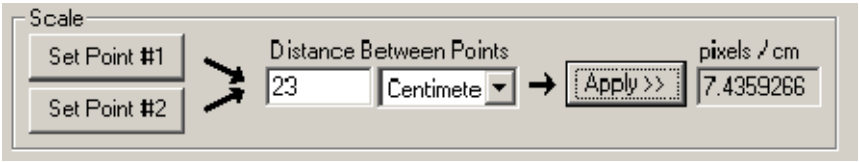
3 Try the Smooth and Sharpen features to improve the image appearance.

Calibrate the Video

1 Click on the Calibrate tab.

2 Find a feature within the video that has a known size.

3 Click the reticle on one side of the known feature.



4 Click on the Set Point #1 button.

5 Click the reticle on the other side of the known feature.

6 Click on the Set Point #2 button.

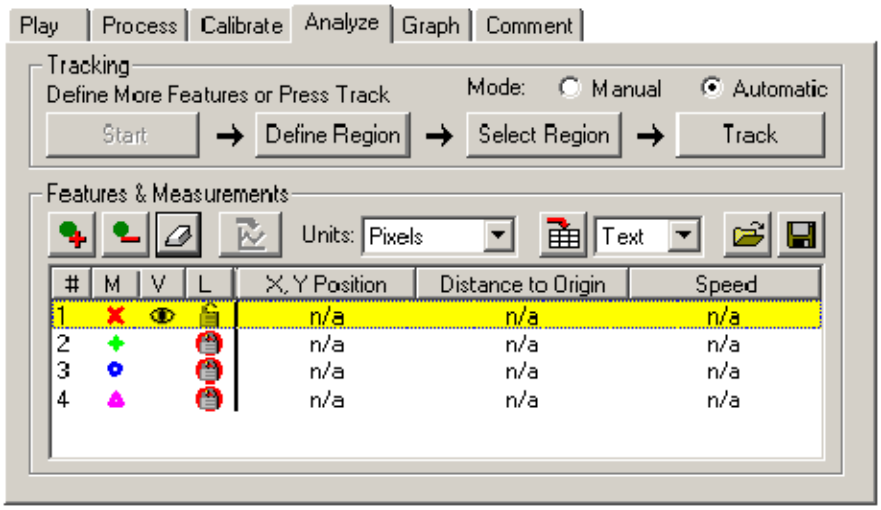
7 Enter the distance between the two points and the units of measure.

8 Click “Apply>>”.

Analyze the Motion

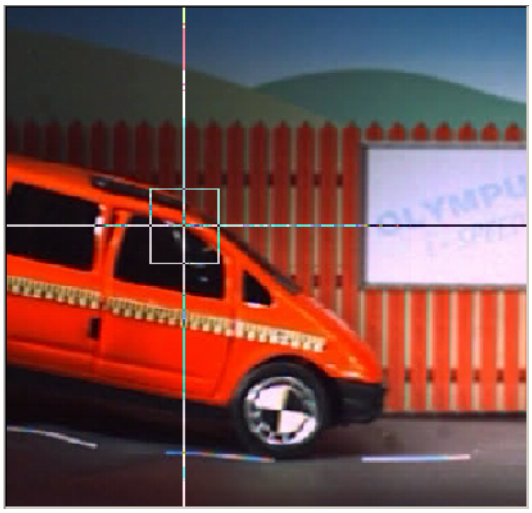
1 Click on the Analyze tab.

2 Click on the Start button to activate the analysis features. Highlight Feature 1 as the auto-track feature of interest.

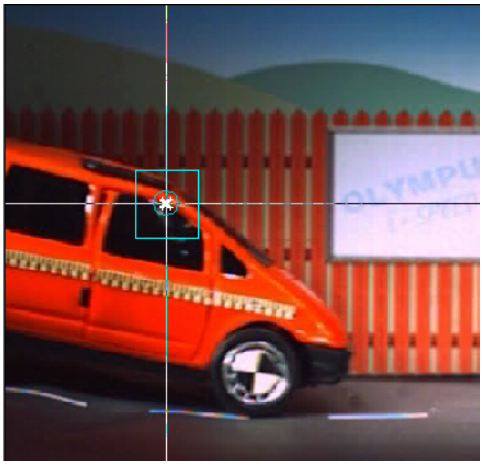


3 Click on the Define Region button.

4 Within the video, draw a box around the feature of interest.



5 Click on the Select Region button. The feature is marked with a white X. (The marker's color was changed from red to white. Access the color edit dialog by double clicking on the marker under the "M" column.)



6 Click on the Track button. The *i-SPEED* PC Software will track the feature of interest.



7 At the conclusion of the tracking, click on the Stop button.

8 Set the desired units.

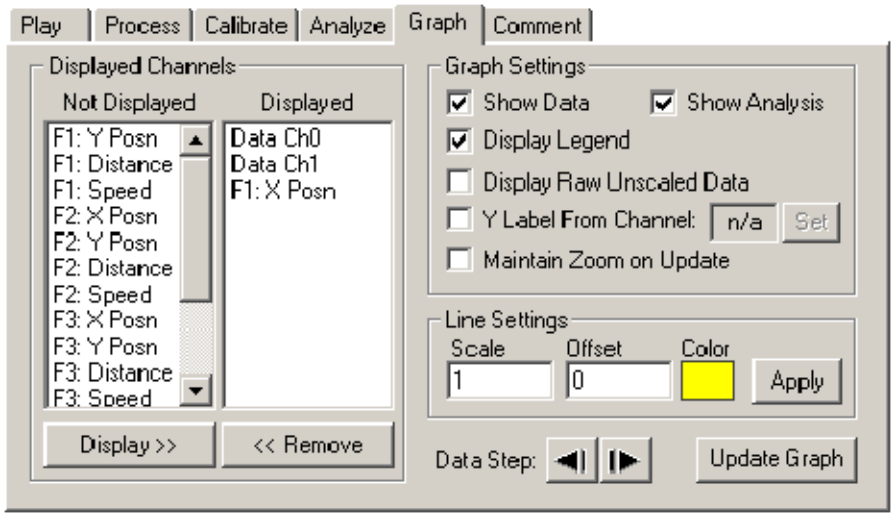
9 Click on the Export to Excel button if you would like to export the motion analysis to Excel.



Graph the Results in i-SPEED.

The Graph panel will appear if the Advanced or Deluxe versions of the *i-SPEED* PC Software are licensed. The Graph panel provides real-time feedback on the motion and user data.

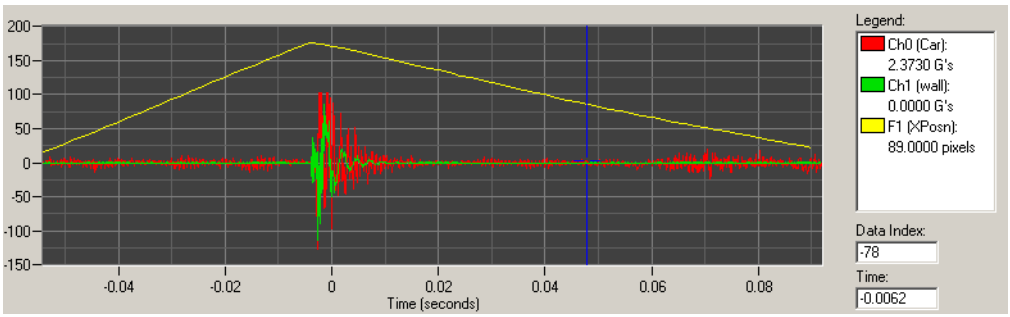
1 Click on the Graph tab.



2 Click on Show Analysis checkbox in the upper-right corner.

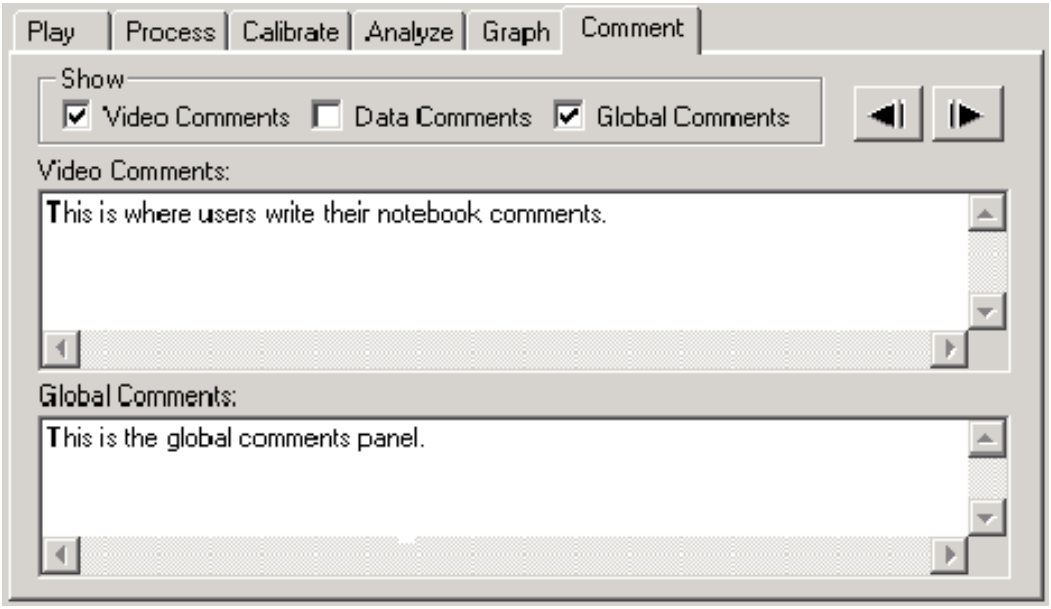
3 Select the Feature 1 channel characteristics for graphing. Move these characteristics from the left panel ("Not Displayed") to the right panel ("Displayed").

4 Click on the "Update Graph" button. The graph is now displayed with the resultant motion analysis.



Add User Comments

1 Click on the Comments tab.



2 Move to a frame in the video sequence.

3 Type in a video comment and a global comment.

4 Advance to another frame in the video sequence.

5 Type in a second video comment

6 Use the Comment step buttons to step through the commented frames.

4

Software Interface

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i-SPEED PC Software Interface

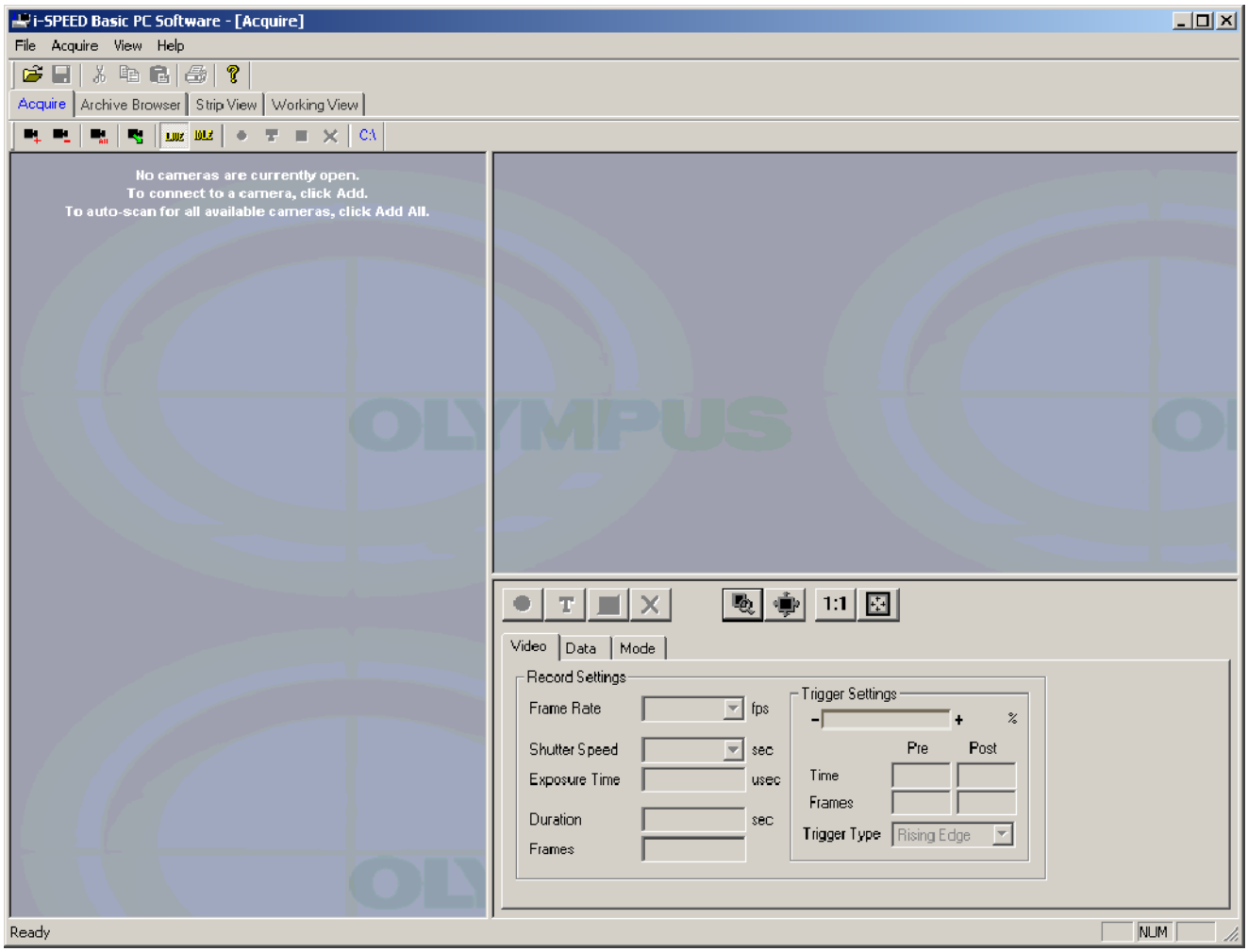
General Description

The *i-SPEED* PC Software is a standard Microsoft Windows application. The software has been divided into four separate “views” named the Acquire Window, the Archive Browser, the Strip View and the Working View. Each of these views provides certain functionality for acquiring video with your *i-SPEED* camera(s) or managing information that was previously acquired. The individual views can be selected with the tab view across the top of the desktop workspace.



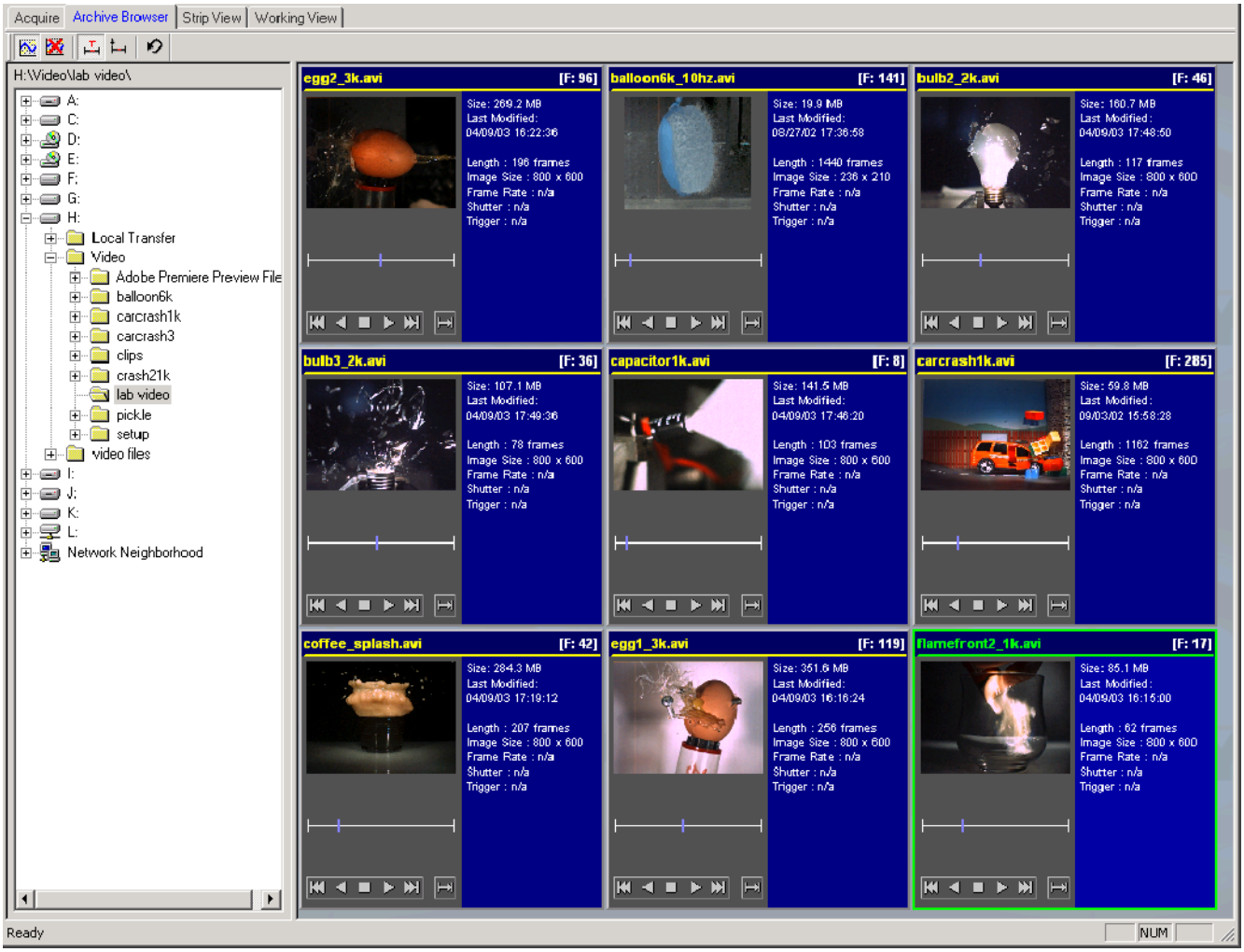
Acquire Window

The Acquire Window contains the tools for opening multiple cameras, setting the record parameters and recording both video and user data. The Acquire Window, shown below, contains multiple tab windows for setting record parameters.



Archive Browser

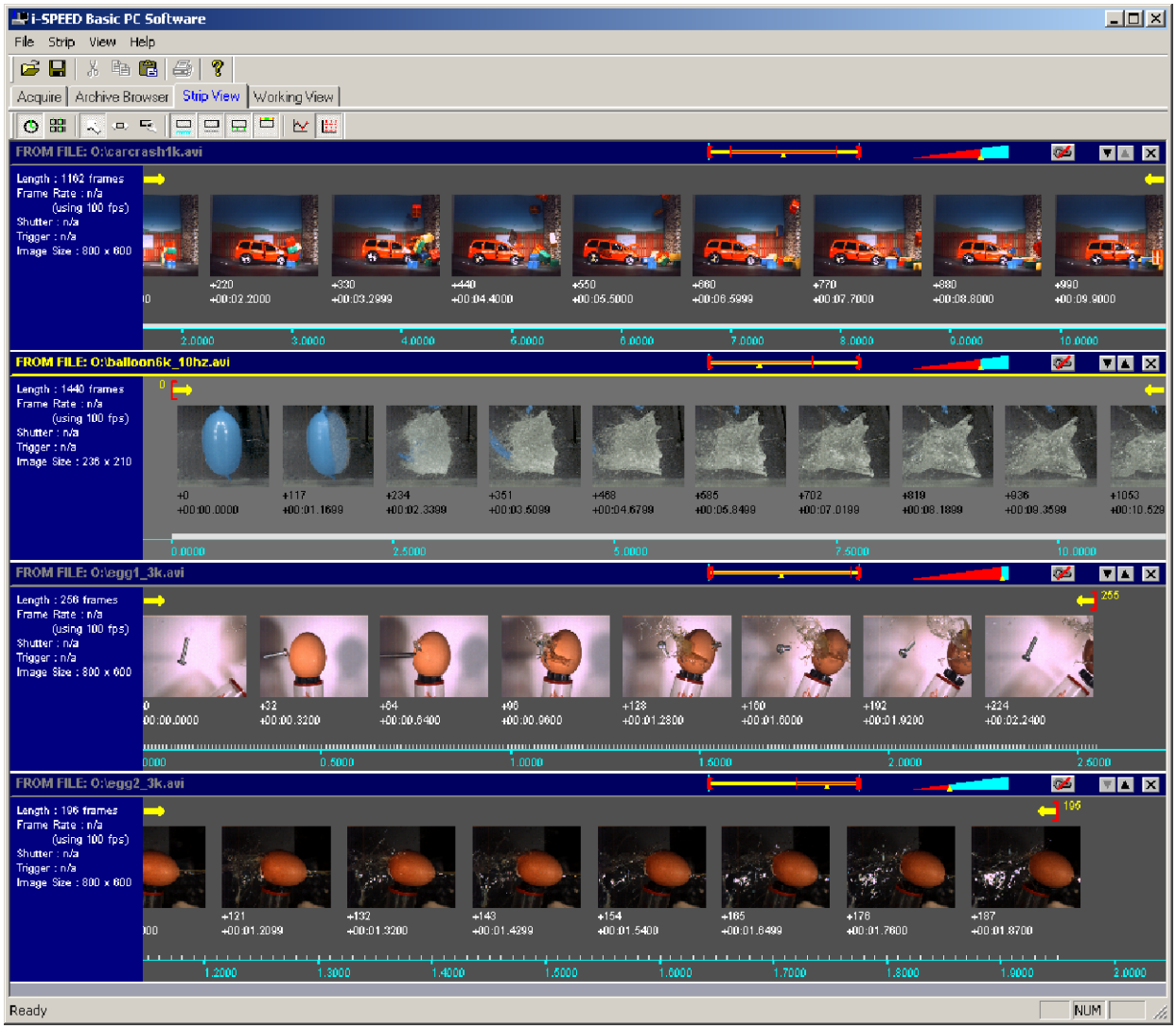
The Archive Browser view allows the user to open previously stored images and data. The Archive Browser contains playable thumbnails of images and a Windows explorer column along the left side.



Strip View

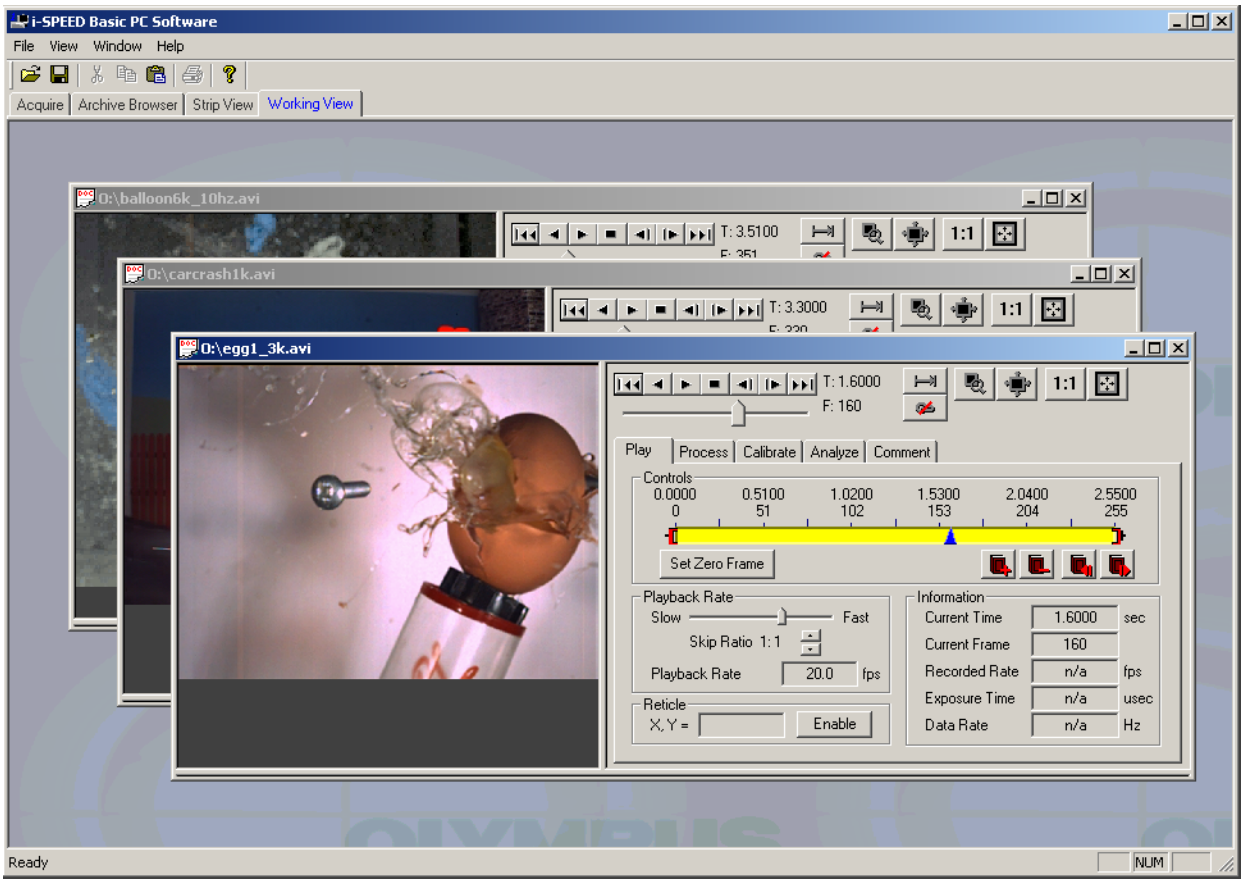
The Strip View shows all the open videos and recorded images in a filmstrip-type view, along a timeline. Thumbnail images are shown and the strips are synchronized in time for comparison. The advantage of the Strip View is best found when trying to visualize images as they are downloaded from the camera. The timeline can be expanded or contracted to zoom in or zoom out of certain events.

The Strip View is the ideal view for downloading images and data interactively.



Working View

The fourth view is named the Working View. In the Working View, each video is shown in conventional frame-by-frame basis. The Working View is used for analyzing motion, setting bookmarks, adding user notes and zooming in on certain important items.

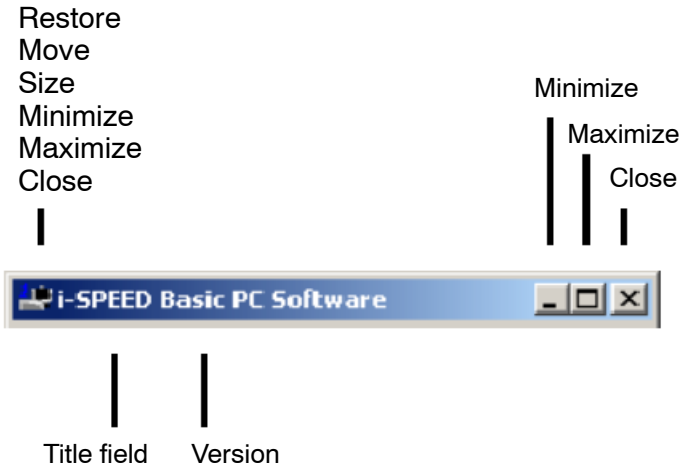


The Title, Menu, Tool and Status Bars

The desktop window is comprised of various elements and sections. *i-SPEED* PC Software is based on conventional Windows applications, with a menu bar across the top and a series of sizing icons across the bottom. Standard Windows messages appear across the bottom row as well.

In addition, there are certain layout features that are common to all windows. The title bar, the menu bar, the tool bar and the status bar all appear on the desktop in the same location on the desktop.

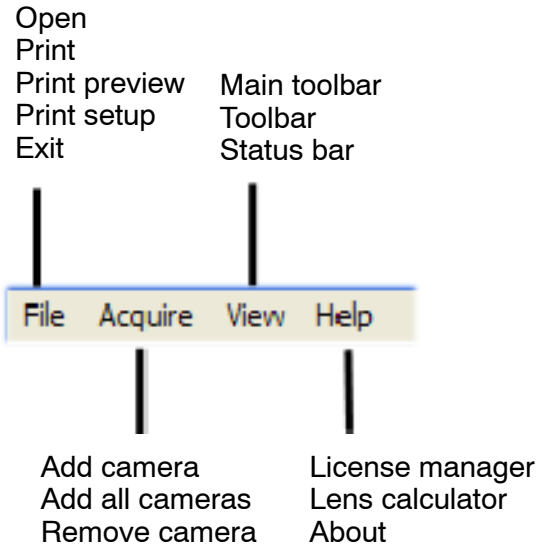
The *i-SPEED* PC Software title bar is always at the top of the screen. The components of the title bar are as shown below.



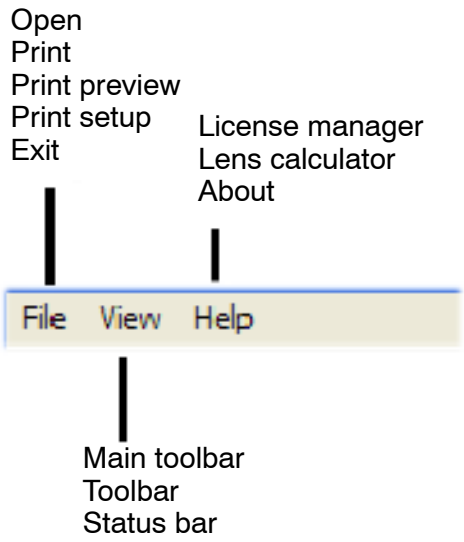
The version/subtitle field content depends on what windows are open. If no windows are open, the subtitle field shows the selected view (Archive, Strip, Acquire or Working) in addition to the version of software (Basic, Advanced or Deluxe).

Directly below the title bar is the menu bar. The *i-SPEED* PC Software menu bar spans the top of the desktop, and changes depending on which window is active. If the Acquire Window has been selected, the menu options are as follows:

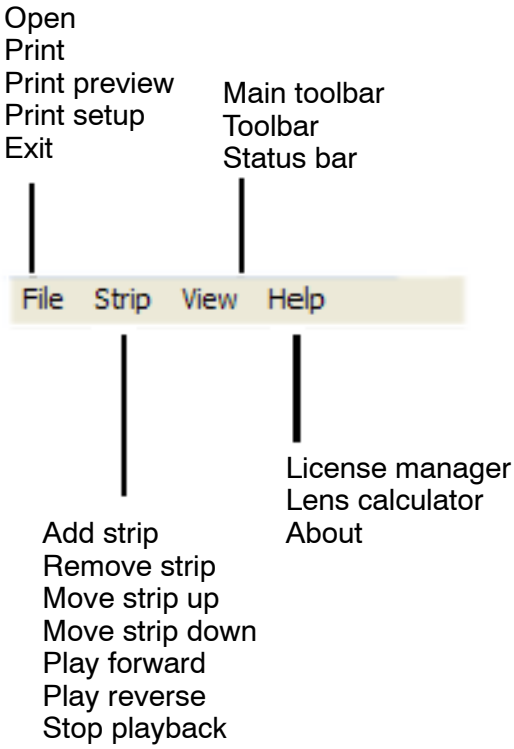
If the Acquire window is active, the menu options are as follows:



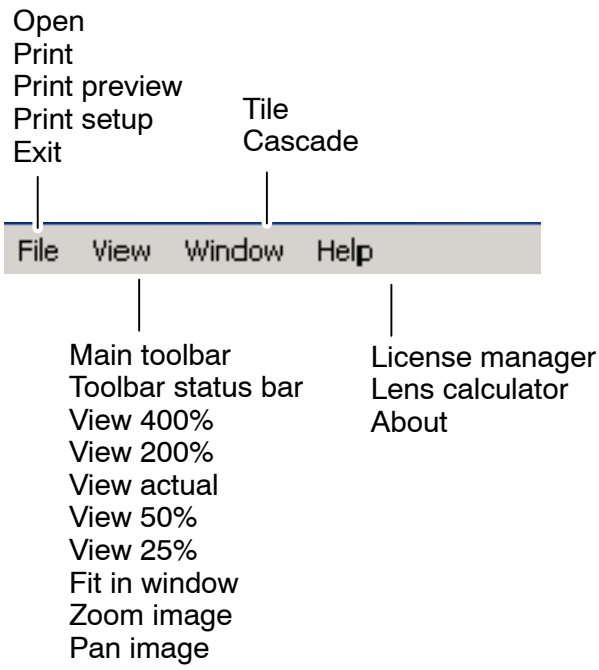
If the Archive Browser window is active, the menu options are as follows:



If the Strip View window is active, the menu options are as follows:

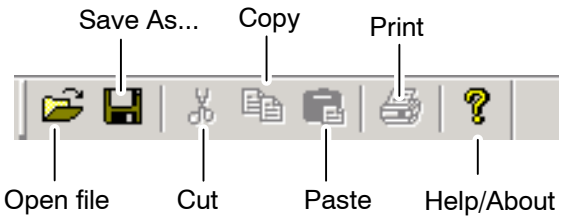


If the Working View window is active, the menu options are as follows:



The menu items contain standardized operations, as follows:

Below the menu bar is the icon tool bar. This icon bar does not change while the software is open. The features of the icon tool bar are as follows:



Below the icon bar is the tab selector. Tabs corresponding to the four views are shown:



At the bottom of the desktop is the “Status Bar”. The *i-SPEED* PC Software status bar contains information about the video file you are recording or viewing and about where you are pointing with your mouse cursor.

For optimum viewing area and to view images at their highest resolution, set your display to SXGA mode – 1280x1024 pixels - with a minimum of 24-bits of color. *i-SPEED* PC Software is designed to operate on displays as low as 800x600 pixels and will generate an error message if your color depth is not set to High Color (16-bits) or above.

The display resolution will actively update during resizing. To resize a display window, grab any corner of the window by clicking down on the mouse, and, while holding the mouse down, drag it - *i-SPEED* PC Software will maintain the correct aspect ratio.

Tool Tips

Throughout the *i-SPEED* PC Software desktop, you will also find Tool Tips. These helpful messages or phrases describe the various functions within *i-SPEED* PC Software. To view a Tool Tip, simply slide the mouse cursor over the function without clicking. For example, when the mouse cursor is placed over the **SET ZERO FRAME** button on the Play tab, the Screen Tip shown below appears.

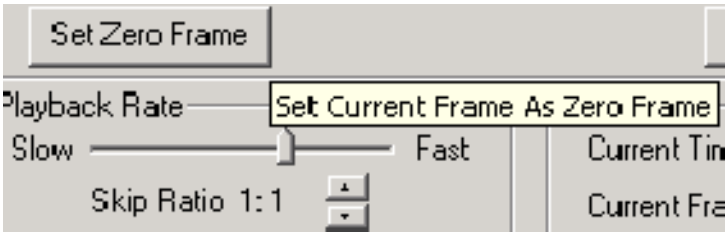


Image Size and Zooming

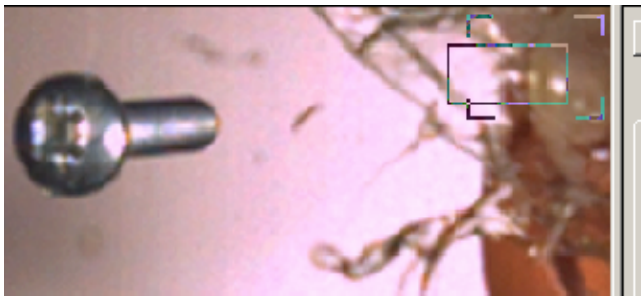
The image size is measured in pixels, horizontal by vertical. The actual image size is also expressed as 100% magnification. If selected, View 100% will present the image in the actual number of pixels as it was recorded (e.g. 800x 600, etc.).

You may change the image size (e.g. “zoom in” or “zoom out” by changing the View % or by zooming the image manually.

The following zoom commands are very useful:

View 100%	
	When selected, this command sets the zoom region and the window frame to be equal to the actual image size. That is, everything is displayed within a frame at 1:1.
View x %	
	When selected, this command sets the window frame to be a multiplier times the actual image size. For example, if 200% is selected for a video that was acquired at 800x600, the image will be displayed at 1600x1200. If the new frame size is larger than the desktop area permits, then the image is zoom magnified to the correct value and the window frame limited to the maximum size permitted by the window frame. For example, if 400% is selected in the above example, the image is magnified 4x to 3200x2400, but only the available number of pixels will be displayed, as limited by the frame.
Fit in Window	
	When selected, this command fits the entire image into the window frame. This command does not change the window frame size, just the image size.
Zoom Image	
	This command allows you to use your mouse or trackball to easily zoom the magnification up or down of the image. When selected, the mouse cursor turns to a 4-point star on the view window. Simply roll the mouse or trackball up the image to zoom up (magnify) or roll downward to zoom down (minimise).
Pan Image	
	This command allows you to use your mouse or trackball to easily pan the image – move the image in any direction to optimize its location.. When selected, the mouse cursor turns to a 4-point star on the view window. Simply roll the mouse or trackball in any direction to scroll the image in that direction. The location box appears in the upper right corner of the window showing you the relative size and location of the window on the actual image size.

If the visible resolution exceeds the view resolution (e.g. the image is magnified), a small zoom map will be displayed that illustrates the current visible size and position relative to the overall view size and location.



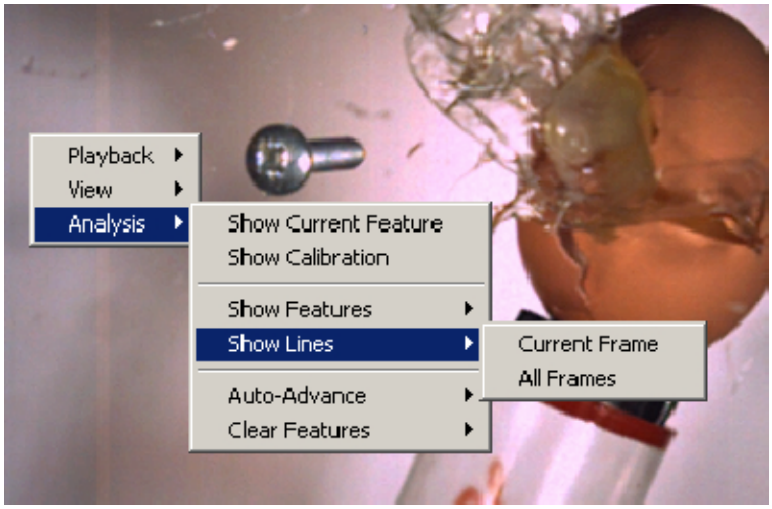
The zoom map position may be moved to any corner of the screen by right clicking within the window and selecting **ZOOM LEGEND**.

Context Menus

In addition to the controls in the menu bar, tool bar, control panel and playback shortcut bar, there are menus that can be accessed by right-clicking within the video display itself. These menus are called Context Menus.

The use of Context Menus provides very quick access to common commands. It also allows the maximization of workspace without compromise of features.

When you click the right mouse button inside of an open view window (e.g. a camera view windows, a strip or a working view window, a menu of options is shown. In the below window, the right-click command can be used to set the drawn lines during analysis in the working view.



Virtually all program features can be performed via contextual commands. It is a worthwhile habit to examine the contextual commands available for all windows.

The Reticle

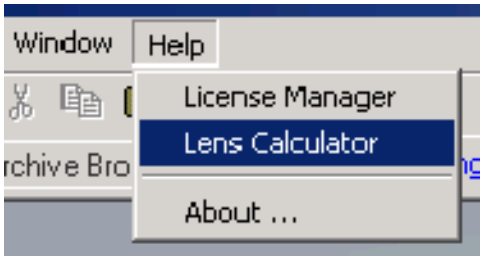
When enabled, the Reticle function displays a crosshair reticle on the view window (all types). The location of the reticle, in pixels from the upper left corner of the image (0,0) is displayed in the furthest left box on the status bar.

To enable and disable the reticle function, right click within any view window, then select/unselect Enable Reticle. The position of the reticle, in pixels from the upper right corner of the window is displayed in the Working View play tab.

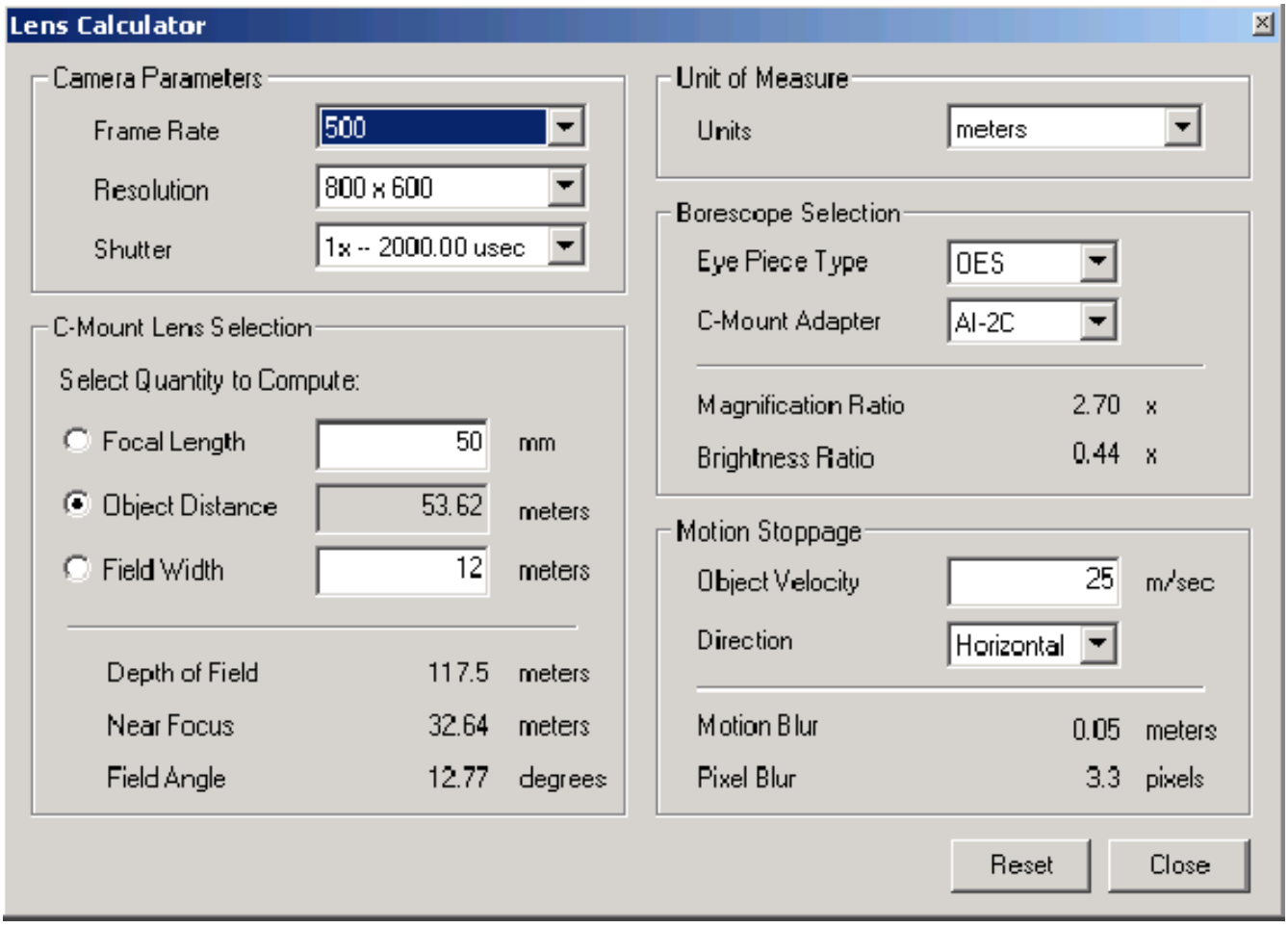
The Lens Calculator

The Lens Calculator is an important feature of the *i-SPEED* PC Software. The Lens Calculator is designed to help videographers select the appropriate optics for a measurement.

To view the Lens Calculator, select Lens Calculator from the Window menu.



The following window appears:



The Lens Calculator provides a collection of information on selecting depth of field, field angle, format size, hyperfocal distance, and other parameters. It also helps you determine how much blur your image will have when capturing high-speed events.

The *i-SPEED* Lens Calculator allows you to select either a C-mount camera lens or an Olympus borescope as your optical system.

C-Mount Lens Selection

If you are using a C-mount lens, you may use the calculator to determine one of the three most common optical parameters of your test, if you know the other two parameters. The three common parameters are:

- Focal Length
- Object Distance
- Field Width

To use the *i-SPEED* Lens Calculator with a C-mount lens:

1 Select the parameter for which you wish to compute a solution.
Depending on which of these options you select, various entry fields will become active or disabled. (white or gray). You are only allowed to change the active (white areas).

2 After you have selected the parameter you wish to compute, select the Frame Rate , Resolution and Shutter Speed using the drop down boxes.
The Frame Rate will affect the resolution, which in turn affects the sensor size used in computations. The Frame Rate will also affect the motion blur calculations. The Shutter Speed affects only the motion blur calculations.

3 Fill in the information about the scene that you know.
For example, if you are using a 50mm focal length lens and you desire a 12m field of view, enter this information in the appropriate boxes.

4 Select your units of measure.
Note that the focal length of a lens is always expressed in mm by convention.

5 Type in the expected rate of motion of your object.
Motion blur and pixel blur calculations are made using the various camera, lens, and scene information. The motion blur quantity depends only upon the Object Velocity, Frame Rate, and Shutter Speed. The result is given in terms of distance the object has traveled during the exposure time. The pixel blur depends on the same values as the motion blur, and in addition, also depends on the sensor size in pixels, the direction of motion (horizontal/vertical), and the magnification. The pixel blur is given as the number of pixels that the object has “blurred” through during the exposure time.

6 Select the direction of motion.
The direction of motion is given with respect to the axes of the camera sensor. A selection of **HORIZONTAL** implies that the object of interest will be oriented/moving along the horizontal axis of the camera. This selection is used to control the sensor size since the horizontal and vertical resolution for cameras are often different. The final input is the Object Velocity. This quantity is used for the motion blur calculations.

Olympus Borescopes

The *i-SPEED* Lens Calculator also assists in the selection of an Olympus borescope as an optical system. Olympus borescopes are specified by their eye-piece type and C-mount adapters. For more assistance in selecting the borescope that is best for your application, contact your local Olympus sales and support agent.

To use the *i-SPEED* Lens Calculator with your Olympus borescope:

1 Select the eyepiece type

2 Select the c-mount adapter type.

3 Select the Frame Rate , Resolution and Shutter Speed using the drop down boxes.
The Frame Rate will affect the resolution, which in turn affects the sensor size used in computations. The Frame Rate will also affect the motion blur calculations. The Shutter Speed affects only the motion blur calculations.

4 Fill in the information about the scene that you know.
For example, if you are using a 50 mm focal length lens and you desire a 12 m field of view, enter this information in the appropriate boxes.

5 Select your units of measure.
Note that the focal length of a lens is always expressed in mm by convention.

6 Type in the expected rate of motion of your object.
Motion blur and pixel blur calculations are made using the various camera, lens, and scene information. The motion blur quantity depends only upon the Object Velocity, Frame Rate, and Shutter Speed. The result is given in terms of distance the object has traveled during the exposure time. The pixel blur depends on the same values as the motion blur, and in addition, also depends on the sensor size in pixels, the direction of motion (horizontal/vertical), and the magnification. The pixel blur is given as the number of pixels that the object has “blurred” through during the exposure time.

7 Select the direction of motion.
The direction of motion is given with respect to the axes of the camera sensor. A selection of **HORIZONTAL** implies that the object of interest will be oriented/moving along the horizontal axis of the camera. This selection is used to control the sensor size since the horizontal and vertical resolution for cameras are often different. The final input is the Object Velocity. This quantity is used for the motion blur calculations and is described in the next section titled “Motion and Pixel Blur”.

After all the relevant parameters have been entered, the calculations region is updated automatically with the corresponding results.

The *i-SPEED* PC Software Lens Calculator calculates the following results:

Focal length	
	The distance from the rear principle plane to the focal point. A focal length equal to the diagonal of a sensor is generally considered to be “standard” - providing a perspective (viewpoint) consistent with the human eye. Focal lengths larger than the diagonal of the sensor are generally considered to be “telephoto”, providing narrow perspective. Focal lengths smaller than the diagonal of the sensor are generally considered to be “wide angle” or “retrofocus”. Focal lengths are always expressed in mm.
Magnification	
	The ratio of sensor size to field width. Magnifications less than unity have larger field widths. Magnifications are unitless.
Field width	
	The physical dimension, in chosen units, of the object field. If **HORIZONTAL** is chosen, the field width describes the long dimension of the field. If **VERTICAL** is chosen, the field width is the other dimension.
Object distance	
	The physical dimension, in chosen units, that will yield the sharpest image for a lens of specific focal length and field width. The object distance is theoretically computed from the front principle plane of the lens, not necessarily from the physical front of the lens, though this approximation is usually sufficient. The object distance is not dependent on the focus setting of the lens, though most lens designers will set the infinity (best) focus of the lens to be at the correct object distance.
Depth of field	
	The overall distance between near focus and far focus that an image will be perceptibly sharp to the average user.
Near focus	
	The distance from the lens to the closest point in object space that will be perceptibly sharp when the lens is focused at the optimum object distance.
Field angle	
	The full angle subtended by the field width to the lens, based on the object distance.
Motion blur	
	The amount of blur that will be evident in the image, in units of measure in object space.
Pixel blur	
	The number of pixels that will show blur of the motion.
Magnification ratio	
	The magnification ratio of the borescope when used at the chosen resolution. The magnification ratio shows the relative size of the object, as projected on the sensor and then on a standard video display.
Brightness ratio	
	The relative increase in brightness of the object. Numbers less than zero indicate a decrease in intensity. This number assists in the selection of lighting conditions.

5

Record Settings

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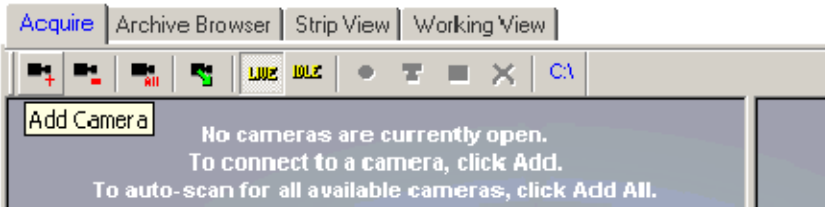
Record Settings

Connecting to a camera network

The *i-SPEED* PC Software allows users to connect up to 255 cameras onto a network. The software uses the internal Ethernet TCP/IP functionality. The computer which houses the *i-SPEED* PC software must be on the same network as the cameras.

To connect a camera to the network:

1 Click on the Acquire tab.



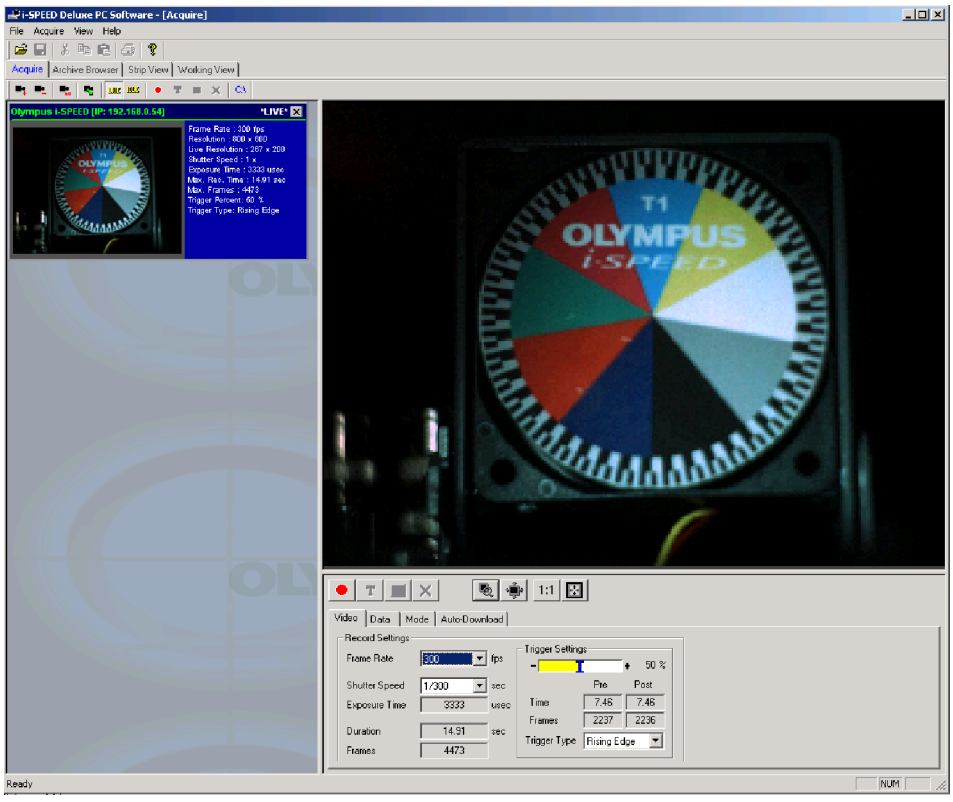
2 Either click on the Add a Camera button or Add All Cameras button.
If you select the Add a Camera button, the following window will appear:



3 Type in the IP address of the camera you wish to add to the network.
The IP address can be found on the camera serial number label. The typical default address is 192.168.0.54. The IP address for the camera can be also be changed via the CDU.

If you selected the Add All Cameras command, the *i-SPEED* PC software will browse the network and automatically add all *i-SPEED* cameras it finds on the network with valid IP addresses. This process may take some time.

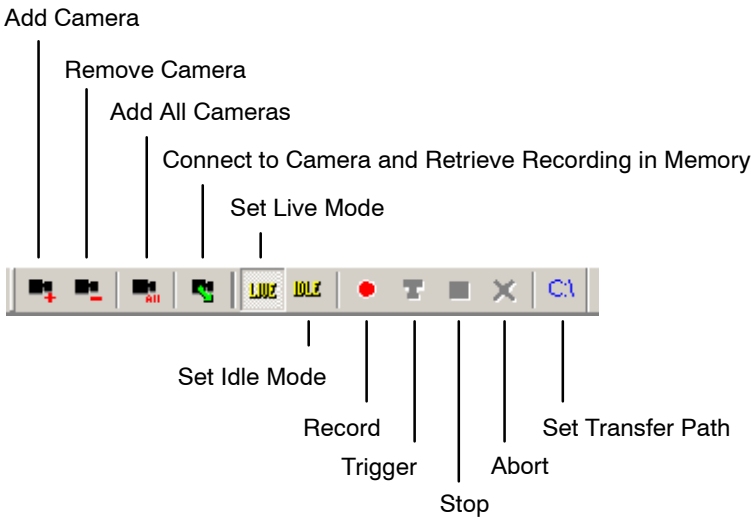
Once a camera has been added to the network, a thumbnail view of that camera appears in the left pane of the Acquire Window, as shown below:



The camera that is currently “active” is shown in the upper right pane of the Acquire Windows. You can select the active camera simply by clicking on a camera in the left column. The active camera information is shown in the lower right pane. When a camera is active, the record settings can be modified. The settings can only be changed for each camera individually.

The Acquire Tool Bar

The Acquire tool bar is found directly above the Acquire window. The Acquire tool bar provides the tools to connect cameras to the *i-SPEED* PC Software. The tool bar has the following components:



The functions of the Acquire Tool Bar are described as follows:

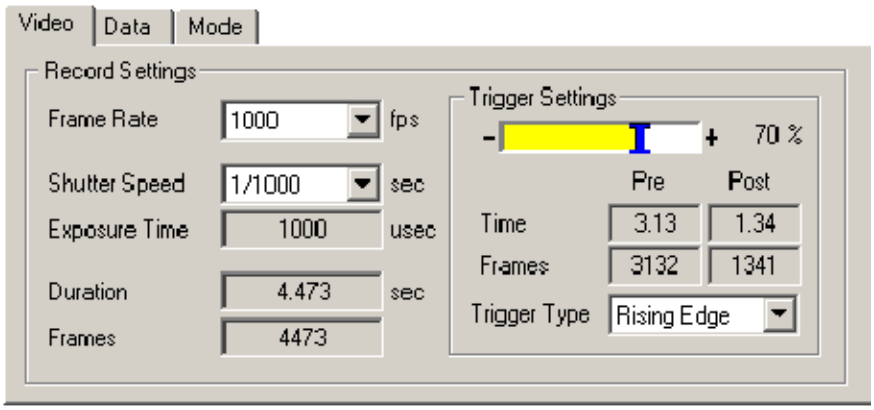
Add Camera	When this button is selected, the IP Select window appears. Type in the IP address of the camera you wish to add to the network. The list of cameras on the network are listed along the left side of the window.
Remove Camera	Click on this button to remove the highlighted (active) camera from the network.
Add All Cameras	Click on this button to instruct the *i-SPEED* PC software to browse a selected subset of the TCP/IP network and automatically add all available cameras to the list of cameras.
Connect to Camera and Retrieve Recording in Memory	Click on this button to connect to a camera and immediately download the recording currently in memory. If clip selection limits have been set with the CDU, then the selected range will be downloaded only. Use this feature to connect to a camera whose recording is complete (made with the CDU or with the *i-SPEED* PC Software, then disconnected from the network). This feature does not perform a camera memory reset unless a button is pressed on the CDU after completion.
Set Live Mode	Set all open cameras into live mode.
Set Idle Mode	Set all open cameras into idle mode.
Record	Start recording with all open cameras
Trigger	Trigger all cameras in accordance with the instructions in the Trigger tab (only available when using external data or GPS/IRIG)
Stop	Stop a recording immediately
Abort	Abort the current recording and reset the cameras
Set Transfer Path	Set the path for transferring thumbnail images and data.

Setting the record parameters

The record parameters for the currently active (highlighted and displayed camera) are set via the settings information in the lower right panel. The number of tab windows in this panel is dictated by the version of software you have licensed. The tab options are as follows:

	Basic	Advanced	Deluxe	GPS/IRIG	DATA
Video record	x	x	x	x	x
Data record via camera		x	x	x	x
Data record via external box					x
Mode	x	x	x	x	x
Auto-Download			x	x	x
GPS/IRIG Input				x	

The basic record parameters are found on the Video record tab:



The settings available in this window are as follows:

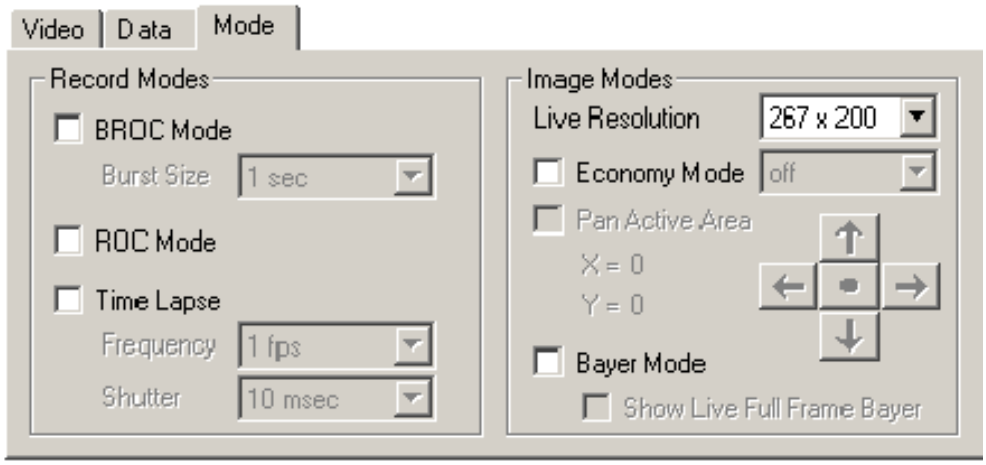
Frame Rate	The frame rate drag-down box displays the available video frame rates. The rates are determined by the camera hardware in the computer. The default is set to 60 fps.
Shutter Speed & Exposure Time	The shutter speed and the exposure time denote the amount of time that the electronic shutter of the shutter remains "open" during each frame. Shorter exposure times reduce blur within each frame, but at the expense of light collecting ability. The shutter speeds and exposure times are determined by the camera hardware in the computer. The default is set to the inverse frame rate (open shutter). Shutter speeds are displayed as a ratio of the inverse frame period (ie: 1x, 2x, 5x). Exposure times are displayed in microseconds (10^{-6} seconds). Select the shutter speed from the drag down box. The corresponding exposure time will be displayed in the gray box below the selected shutter speed.
Duration & Frames	The maximum amount of time that can be recorded during a video sequence, in seconds. The corresponding number of video frames that can be recorded during a video sequence. Note that few frames can be acquired by setting the trigger percent accordingly and using the stop button.
Trigger Percent	The percentage trigger puts the Reference Frame 0 at the desired position and dictates the amount of time prior to the trigger and after the trigger is received. The listed number is the pre-trigger percentage of the total acquisition. For example, a trigger percentage of "0%" instructs the *i-SPEED* PC Software to (1) continue to acquire one full buffer of images (acquire 0% before the trigger and 100% after the trigger) and (2) to put the Reference Frame 0 at the beginning of the sequence. Alternatively, a trigger percentage of "100%" instructs the *i-SPEED* PC Software to (1) stop acquisition immediately upon receipt of a trigger input (acquire 100% before the trigger and 0% after the trigger) and (2) to put the Reference Frame 0 at the end of the sequence. The Reference Frame 0 is placed at the exact frame when the trigger input is received. To see frames before and after the trigger input time, use trigger percentages in the range of 10% to 90%. In the resulting captured sequence, frames with negative numbers are BEFORE the trigger pulse was received and frames with positive numbers are AFTER the trigger pulse was received. Trigger percentages are selectable from 0% to 100% in 1% increments. The default is 100%. The trigger percent has no effect when the *i-SPEED* PC Software is set to Record on Command or Burst Record on Command modes (see below).
Trigger Type	The external trigger input is always enabled on the *i-SPEED* camera. The Trigger Type box is used to instruct the *i-SPEED* PC Software as to which type of external and internal (software button) triggers to accept. Select Rising Edge if your event trigger generates a positive going pulse. Select Falling Edge if your event trigger generates a negative going pulse.
Pre-Trigger Time	The amount of record time to be acquired prior to the trigger input.
Post –Trigger Time	The amount of record time to be acquired after the trigger input.
Pre-Trigger Frames	The number of frames to be acquired prior to the trigger input.
Post-Trigger Frames	The number of frames to be acquire after the trigger input.

Setting the Record Modes

The *i-SPEED* camera has three optional record modes that can be selected during the acquisition process:

- Burst Record on Command (BROC) Mode
- Record on Command (ROC) Mode
- Time Lapse Mode

The record modes are set in the Mode tab under the Acquire window.



Burst Record on Command (BROC) Mode

In this mode of operation, the *i-SPEED* PC software will record video in user-defined bursts every time a valid trigger is received. A valid trigger is either a software trigger (when available) or an external trigger input. Video is recorded after the trigger is received.

The *i-SPEED* PC Software will continue to concatenate (append) video every time a valid trigger input is received until either (a) the memory buffer fills or (b) the user presses the **STOP** button.

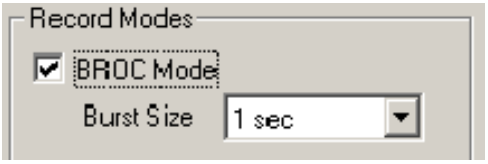
To set the *i-SPEED* PC Software into Burst Record on Command mode:

1 Select the Video tab.

2 Set the Trigger Type to either RISING EDGE, or FALLING EDGE.

3 Select the Mode tab.

4 Check the BROC Mode checkbox.



5 Set the duration of the burst in the drag-down menu box.

NOTE: It is important to note that, when the BROC mode has been selected, the Trigger button and an external trigger input have the same effect. Also, the trigger percent has no effect on the trigger – all triggers are 100% post trigger.

Record on Command (ROC) Mode

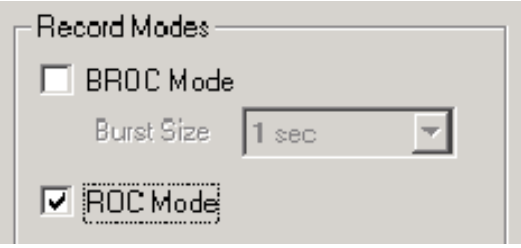
In this mode of operation, the *i-SPEED* PC software will record video only when a valid external trigger input is received. A valid trigger is defined as either (a) a voltage that exceeds a threshold determined by your camera hardware or (b) a voltage that falls below a threshold determined by your camera.

i-SPEED PC software will continue to concatenate (append) video every time a valid trigger input is received until either (a) the memory buffer fills or (b) the user presses the **STOP** button.

To set the *i-SPEED* PC Software into Record on Command mode:

1 Select the Mode tab.

2 Check the ROC Mode checkbox.



NOTE: It is important to note that, when the ROC mode has been selected, the trigger percent has no effect on the trigger.

Time Lapse Mode

In this mode of operation, the *i-SPEED* PC software will record a series of single snapshots to create the appearance of time lapse photography. The frequency of snapshot acquisition is determined by the user.

i-SPEED PC software will continue to acquire video every time until either (a) the memory buffer fills or (b) the user presses the **STOP** button.

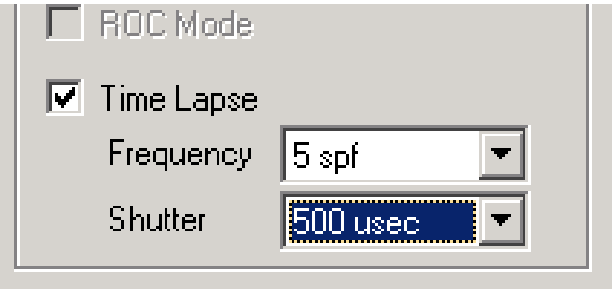
To set the *i-SPEED* PC Software into Time Lapse mode:

1 Select the Video tab.

2 Set the Trigger Type to either RISING EDGE, or FALLING EDGE.

3 Select the Mode tab.

4 Check the Time Lapse Mode checkbox.



5 Set the frequency of snapshots from the menu drop-down list.

6 Set the shutter speed.

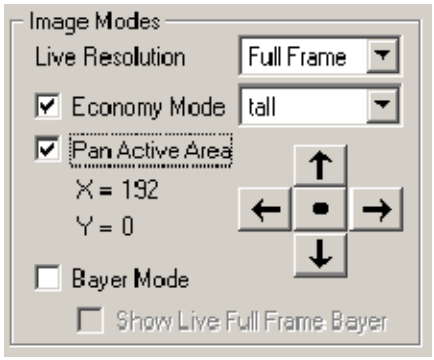
NOTE: It is important to note that, when the time lapse mode has been selected, the trigger percent has no effect on the trigger.

Setting the Camera Active Area

The *i-SPEED* camera has the ability to pan the active area within the sensor. To pan the area, the record resolution must be less than the full sensor resolution (800x600). The record resolution may be less than 800x600 if the camera is recording at a high frame rate (> 1000fps) or an economy mode has been enabled. To pan the active area:

1 Select the Mode tab.

2 If the record rate is less than 1000 fps, an economy mode must be enabled. Check the Economy Mode check box and select a desired economy mode from the drop-down list.



3 Check the Pan Active Area checkbox.

4 Adjust the location of the active area using the up-down-left-right arrows. Set the active area to the center of the sensor by clicking on the black dot in the center of the arrows.

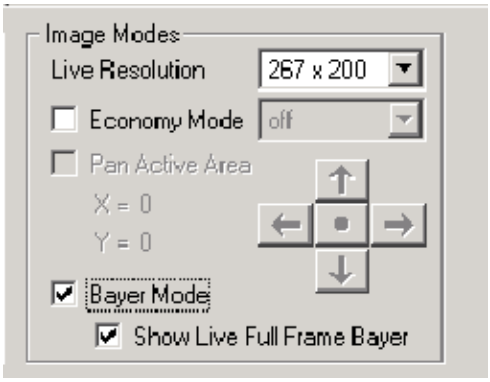
NOTE: While adjusting the active area, the camera image is automatically refreshed whenever the selection is changed. Because of the Ethernet link, the refresh may take many seconds.

Bayer Color Transfer Mode

The *i-SPEED* PC Software has built-in Bayer color decoders to expedite the transfer of color images from the camera to the PC computer. Typically, images from the sensor are immediately converted to color images at the camera. These full 24-bit color images are then transferred to the PC over the Ethernet connection. This transfer can take up to 3x longer than conventional 8-bit monochrome images.

Optionally, you can instruct the camera to acquire and transfer only the pixel data to the PC, and to build the color images using the preset proprietary coefficients at the computer. This process dramatically improves the transfer and refresh rates of the camera, but adds computational burden to the PC software.

Bayer images appear like patterned grayscale images. There are two checkboxes which impact Bayer vs. RGB color image transfer between the camera and the computer. The first is labeled Bayer Mode.



Select this checkbox if you wish for the camera to transfer images to the computer in Bayer decoded mode (raw pixel data) and for the RGB conversion to be at the computer.

The second selection is Show Live Full Frame Bayer. It is important to make sure that this check box is selected. Failure to do so could result in the loss of captured video.

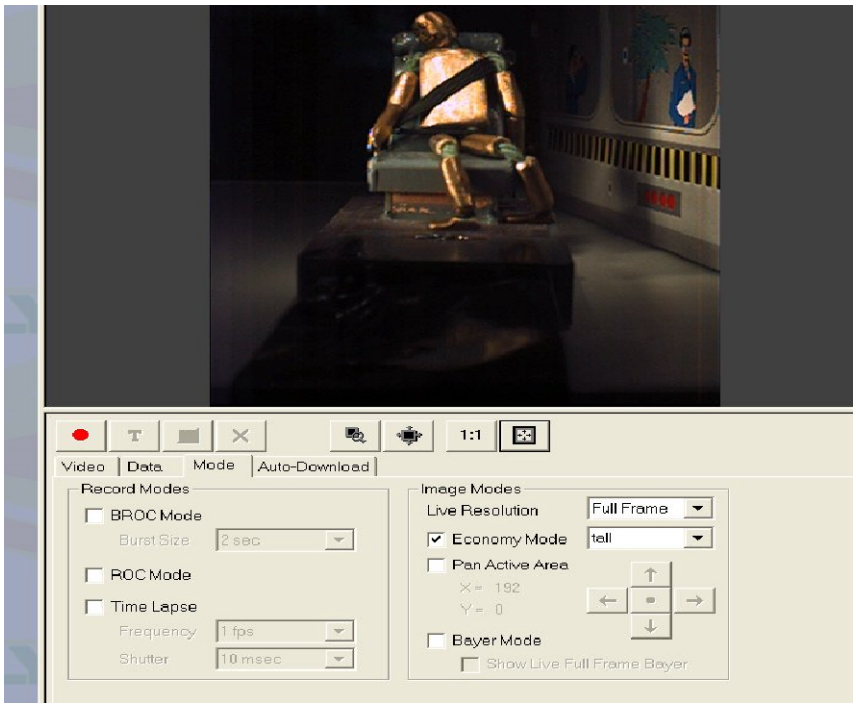
Economy Mode

Economy mode lowers the camera resolution to gain longer record times. As economy mode is an advanced feature of the camera software, please follow these instructions fully. Failure to do so could result in the loss of captured video or introduce frame errors.

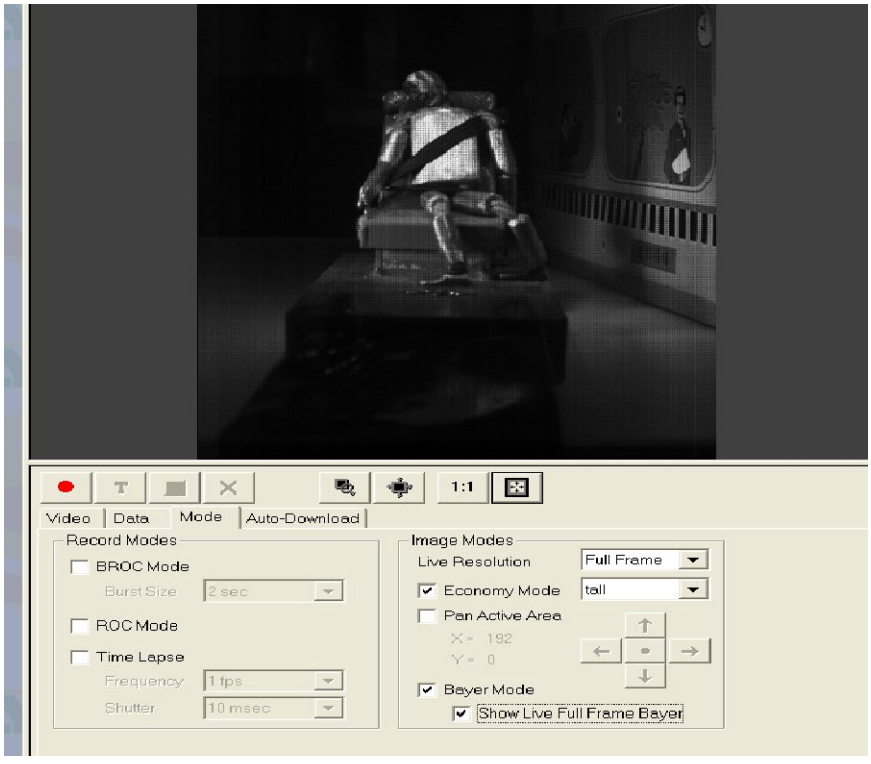
1 Select the Mode tab.

2 Check the Economy Mode box.

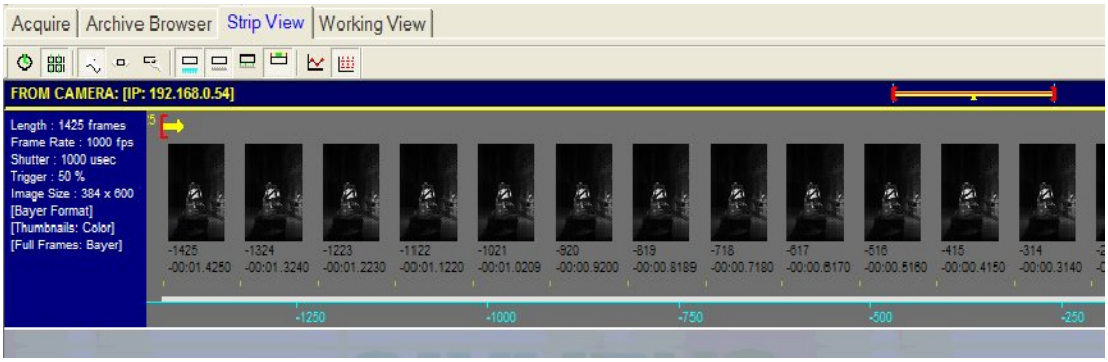
3 Select the desired economy mode from the drop-down list, in the following example, “Tall” is chosen.



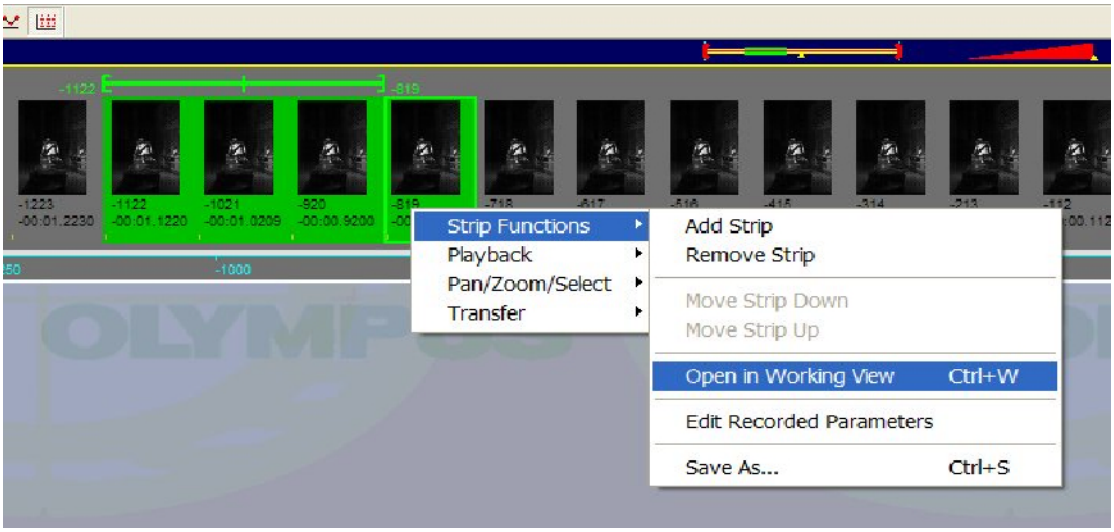
4 Next, Select the “Bayer mode” check box and make sure that the “Show live full fame Bayer” box is checked. Note the live video will change to monochrome and a Bayer check pattern will appear over the image. It is very important that a recording is not undertaken until this has been set.



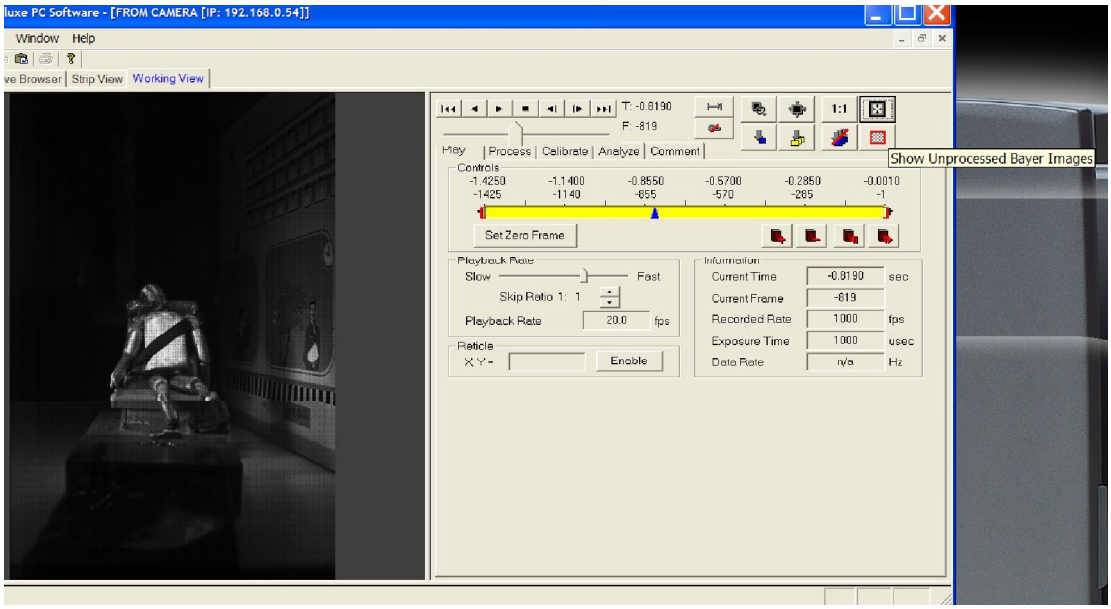
5 Now record as per normal, when the recording is complete, you will be passed through to the strip view. Again note that the thumbnail images are in Bayer and no colour information is present.



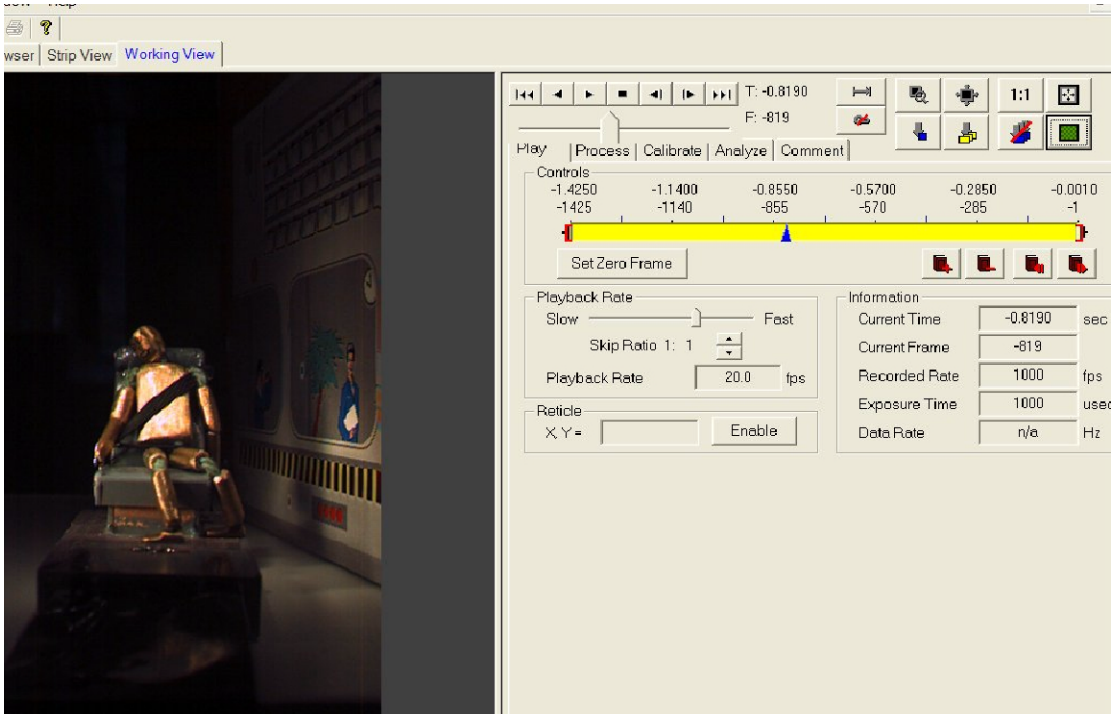
6 Select the area of interest and right click the mouse button to enable the working view workspace to be opened.



7 Once you are in the working view, the image will be shown in full resolution but without any colour information. It is possible to continue to work like this or the colour information can be applied by clicking the small button on the right of the screen (small checker square with the red border).



8 The image will now appear in full colour. Once the “show colour information” button is pressed its effects will be seen on every frame.



Acquiring User Data

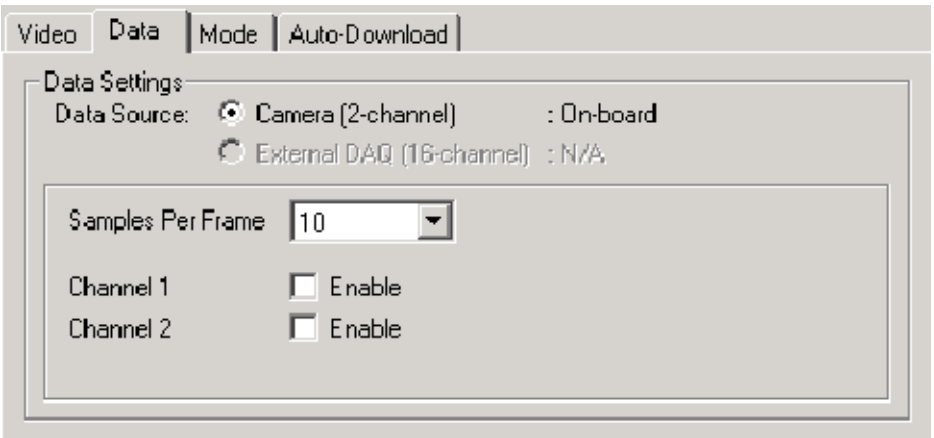
The *i-SPEED* camera has been designed to acquire user data through two hardware connections. User data is defined as any analog or digital voltage level from 0V to 5V. User data can come from sensors such as pressure transducers or accelerometers, or from gauges and other external devices.

User data is highly synchronized to the video using proprietary technologies. The comparison of the user data input via the camera versus the external box is as follows:

	Camera	External Box
# of Inputs	2	16
Rate	100 kHz	200 kHz
Inputs	0-5V	+/-10V
Settings	None	Diff, RSE, NRSE, Scale, Offset, Label, Gain

Acquiring User Data via the camera is enabled in the Basic, Advanced, and Deluxe versions of the *i-SPEED* PC Software. Acquiring User Data via the external box is enabled in the Deluxe version of the *i-SPEED* PC Software with the additional upgrade module.

The user data input parameters are set through the Data tab on the Acquire window:



User Data via Camera

To acquire 2 channels of User Data via the camera:

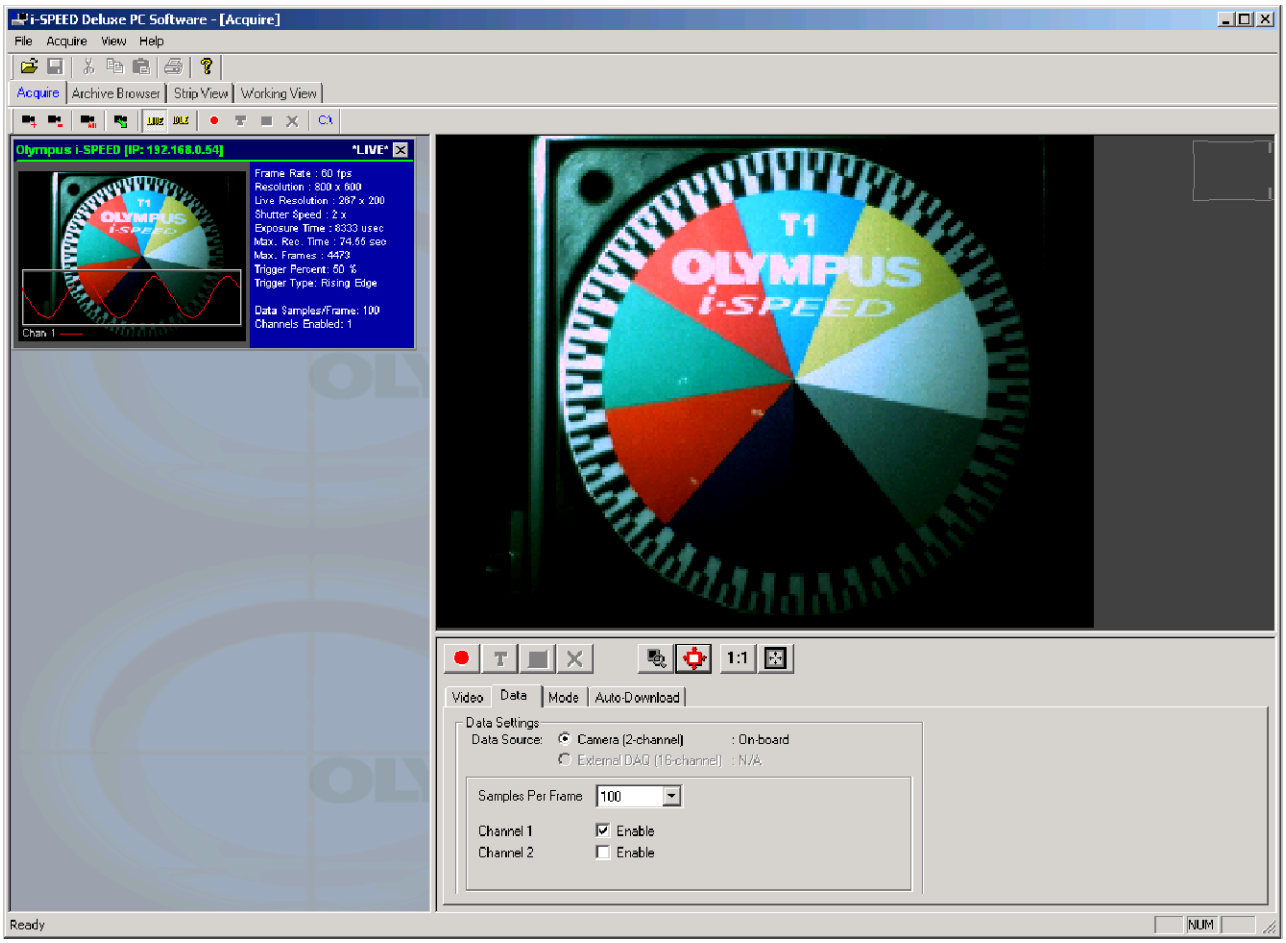
1 Connect your data sources to the camera inputs as directed in your *i-SPEED* camera hardware manual.

2 Select the Data tab.

3 Select the Camera data source to the on-board 2-channel source.

4 Enable either or both channels 1 and 2.

5 Select the Samples per Frame from the drop-down list.



NOTE: When using the on-board data source, a preview of the User Data will be drawn over the live thumbnail view on the left.

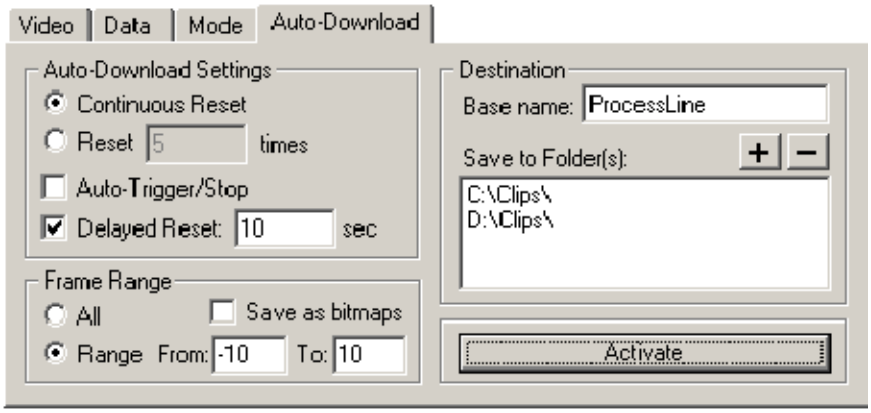
Automatic Download (Deluxe only)

Automatic Download allows you to set your system to record data, video, and IRIG/GPS timing automatically. Every time the system receives a trigger, the recording will complete, the results will be saved, and the system will restart the recording process automatically. This feature is very useful for applications that require capture of information at a remote site (e.g. a test range or hazardous environment) or when the event happens intermittently (e.g. a production line failure or explosion). This feature is available in the Deluxe version of the *i-SPEED* PC software.

To set the cameras to automatically download video and data to the PC, first configure the video and data settings normally as described above. However, instead of pressed the **RECORD** button, the Auto-Download parameters are configured and then activated.

1 Set the video and data settings for each camera.

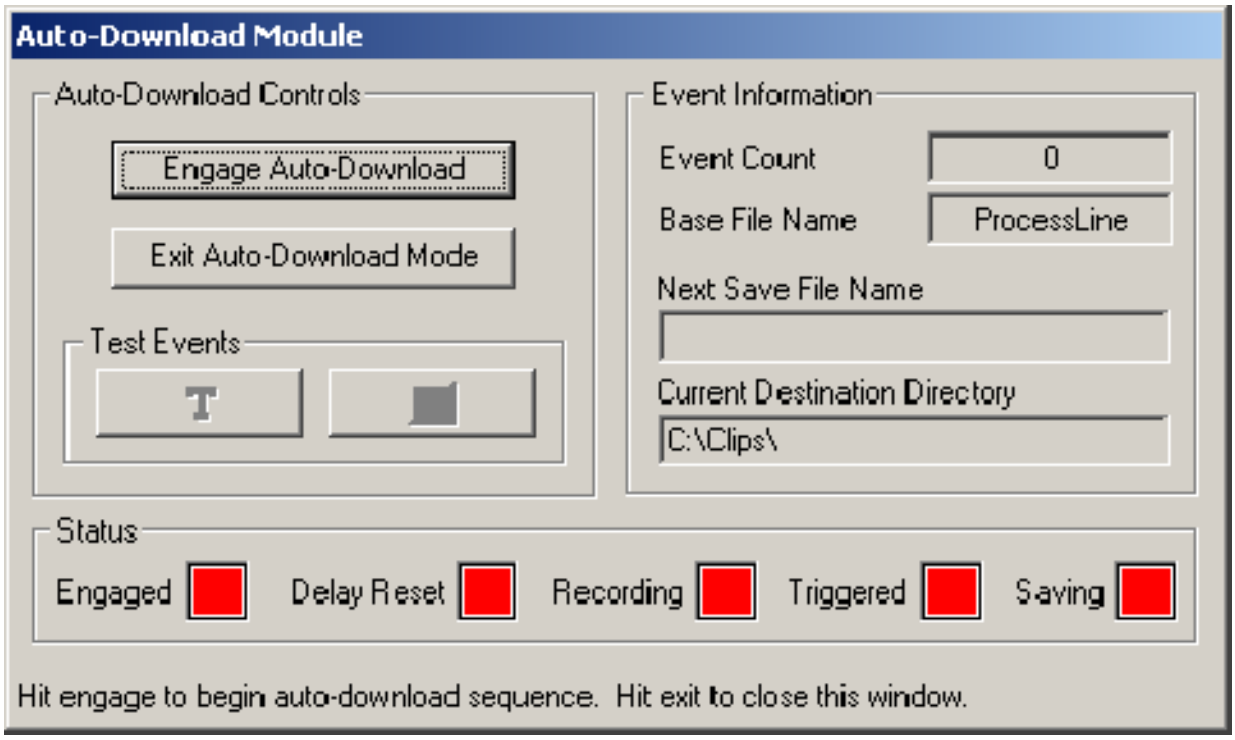
2 Select the Auto-Download tab.



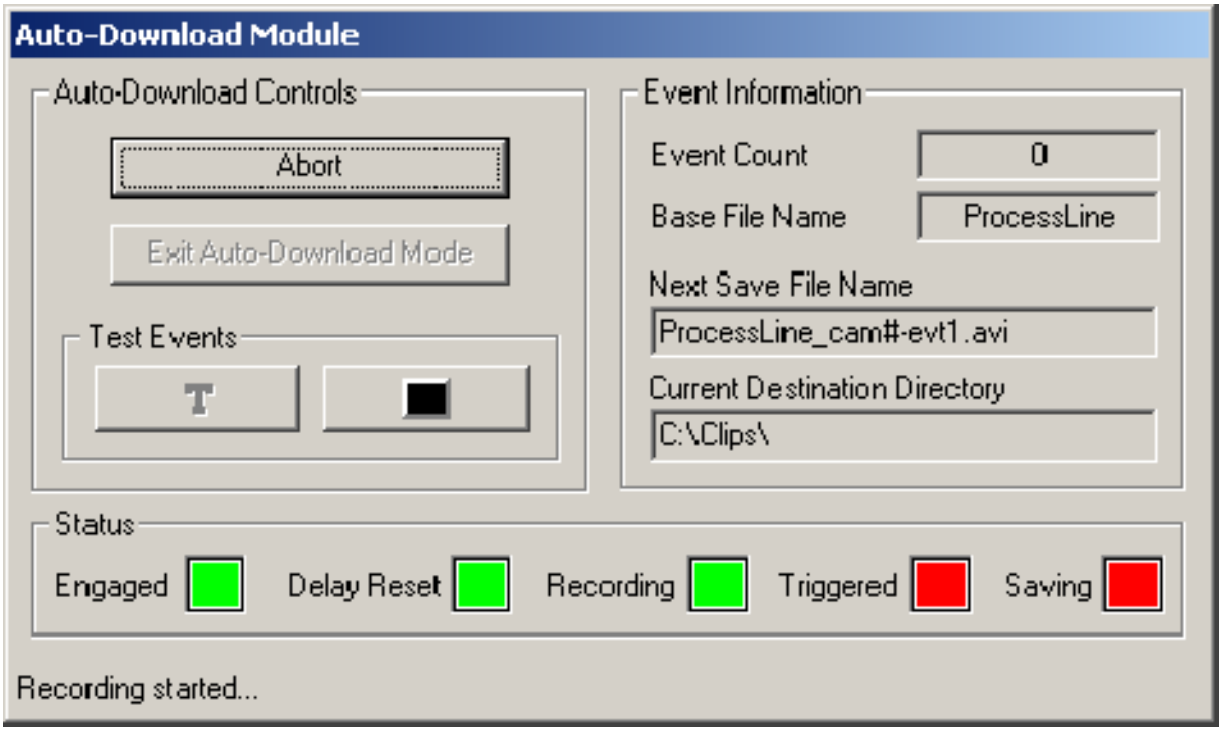
3 Configure the Auto-Download Settings. The possible settings are:

Continuous Reset	Will continuously save and re-arm until the operator disables Auto-Download mode.
Reset [n] times	Will download only a finite number of recordings, then disable Auto-Download and return to local recording mode. This feature helps prevent unintentional filling of hard drives.
Auto-Trigger/Stop	If this option is selected, every time that *i-SPEED* re-engages it will automatically (via software) re-trigger or re-stop. This means that it will wait the pre-trigger amount of time, and then automatically send a software trigger (if available) or a software stop command to the cameras. There is no need for an external trigger event to occur. (If an external trigger event occurs, then *i-SPEED* will not send the automatic trigger/stop command and will proceed as normal for that particular event only.) This feature is great if you would like to get as continuous a recording as possible. The only gap, being the amount of time that it takes to save to disk.
Delayed Reset [n] sec	If this option is selected, after *i-SPEED* finishes saving a recording, it will not re-engage itself until after the indicated number of seconds. If, for example, your line stays down for 30 minutes after it sends out the trigger signal to the cameras, you would enter 1800. After *i-SPEED* receives a trigger it saves to disk, and waits 1800 seconds (30 minutes) before it re-engages into record mode waiting for the next trigger.
Frame Range	The range of frames to be saved. In most cases, you will not want to save the whole range of frames recorded. This would potentially take a prolonged amount of time (during which you may miss other events). The frame range allows you to select a specific set of frames relative to the trigger frame to save for each event. This allows you to save on both disk space and save time.
Save as bitmaps	If this option is selected your image sequence is saved as a series of bitmaps named BaseName_cam#_evt#_####. BaseName is the name that you entered in the Auto-Download tab. ● cam# is the camera number, for example cam0 to indicate the first camera, or cam1 to indicate the next camera. ● evt# is the number of the received trigger. It starts at 1 and increments for every trigger. ● #### is the number of the frame in the sequence.

4 Press the **ACTIVATE** button.



5 The Auto-Download Module now has control over the *i-SPEED* program. At this moment, you can exit the module and reconfigure any settings or you can engage the module and begin the recording.



6 Once engaged, the current status of the Auto-Download Module is shown by the colored squares along the bottom.

7 Test Events allow you to simulate an external trigger event in software. If software triggering is available, the **TRIGGER** button will be enabled. If software stopping is available, the **STOP** button will be enabled. These test events allow you to make a test run of the record and save procedure to ensure that all pieces are functioning properly.

8 If "Reset [n] times" was set, after n events, the system will automatically end. If you wish to stop before n events, or if the system was set to continuous reset, you can abort Auto-Download by pressing the **ABORT** button.

6

Triggering

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Triggering your Recording

Overview of Triggering

When *i-SPEED* PC Software is in record mode, *i-SPEED* PC Software controls the acquisition process precisely, keeping track of time and location of frames and data from the external sensors. *i-SPEED* PC Software also keeps track of time from external phase lock devices such as GPS and IRIG generators.

i-SPEED PC Software will continue to infinitely record into the revolving memory buffers until a trigger event is received. A trigger event is either a software trigger (when using external data or GPS/IRIG) or a hardware trigger.

Triggering causes two events to happen:

Stop the recording at the desired time.

Isolate the exact point in time that the trigger impulse was received by *i-SPEED* PC Software hardware.

The user sets the Trigger Percent (on the Record tab) to tell *i-SPEED* PC Software when to stop the recording and where to put the Reference Frame 0 (video) and the Reference Datum 0 (data). The trigger percentage is the pre-trigger percentage of the total acquisition. For example, a trigger percentage of ”0%” instructs the *i-SPEED* PC Software software to (1) continue to acquire one full buffer of images (acquire 0% before the trigger and 100% after the trigger) and (2) to put the Reference Frame 0 at the beginning of the sequence. Alternatively, a trigger percentage of ”100%” instructs the *i-SPEED* PC Software software to (1) stop acquisition immediately upon receipt of a trigger input (acquire 100% before the trigger and 0% after the trigger) and (2) to put the Reference Frame 0 at the end of the sequence.

In the resulting captured sequence, frames with negative numbers are BEFORE the trigger pulse was received and frames with positive numbers are AFTER the trigger pulse was received.

There are three methods for stopping a recording:

- Sending a hardware pulse to the trigger in line of the camera or other *i-SPEED* PC Software hardware
- Clicking on the **TRIGGER** button (when available)
- Clicking on the **STOP** button.

Not all optional modules support both types of software triggers. Only those modes available to you are highlighted or displayed.

Trigger Command

i-SPEED PC Software treats pressing the **TRIGGER** button and an external hardware trigger the same. Upon receipt of a trigger stop (software or hardware) command, *i-SPEED* PC Software executes the stop record function per the trigger settings (pre-record time and post-record time). The **TRIGGER** button places the Reference Frame 0 at the trigger point of the video sequence and the Reference Datum 0 at the trigger point of the data.

STOP Command

Pressing the **STOP** button immediately stops the recording function and places the Reference Frame 0 at the end of the sequence. In other words, the **STOP** button behaves like the trigger percent is set for 100% regardless of its actual setting.

Defining the Reference Frame and Reference Datum

i-SPEED PC Software places the Reference Frame 0 and the Reference Datum 0 per the following rules. The term "buffer" refers to a single memory buffer, "Trigger Stop" refers to either clicking on the **TRIGGER** button or executing an external trigger, and "Stop" refers to clicking on the **STOP** button.

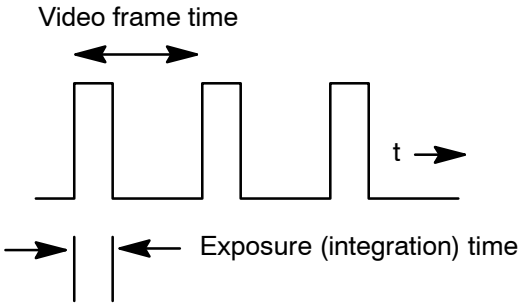
If…	What is returned…	Reference Frame is …
Buffer has been filled prior to Trigger Stop	A full buffer of video/data	On the frame corresponding to when the trigger was received.
Buffer has been filled prior to Stop	A full buffer of video/data	On the last frame and on the last data point.
Buffer has not been filled prior to Trigger Stop	All frames acquired prior to Trigger Stop and the desired number of post-trigger frames.	On the frame corresponding to when the trigger was received.
Buffer has not been filled prior to Stop	All frames acquired prior to Stop.	On the last frame and on the last data point.
Buffer has not been filled, Trigger Stop executed, then Stop	All frames acquired prior to the Stop	On the last frame and on the last data point.

NOTE: Some cameras do not add a frame after receiving an external trigger. That is, if the *i-SPEED* PC Software trigger percent is set to 100% and an external event trigger is received in the middle of a video frame, the camera immediately stops and only returns all the frames prior to the trigger frame. In this case, there is no Reference Frame 0 and the last frame is frame number –1. Most cameras continue recording for one or two frames after receipt of an external trigger to provide a trigger frame.

Defining a Frame, Exposure Time, and Buffer

Most often, the time that a video camera is actually acquiring images of the scene is only a small fraction of the total time. The actual acquisition time is termed the Exposure Time or integration time, and is most often measured in microseconds.

A video frame is defined to be the total time between exposures. A buffer is a sequential collection of video frames. The following time line drawing shows this relationship:



For example, if the video acquisition rate is 1000 fps, the video frame duration is 1 ms. The exposure time might only be 20 microseconds in duration. Therefore, the camera is only acquiring scene information (e.g. light) for 2% of its operation time.

In *i-SPEED* PC Software, frame counting is done at the leading edge of the frame. In this example, the exposure time (the time the camera shutter is open) is at the beginning of the frame. Some cameras integrate at the end of the frame. Consult your camera manual for information about your specific camera.

The Reference Frame is the frame in which the external event trigger is received. Whether a trigger is received during the exposure period or during the dark period has no impact on labeling the Reference Frame.

This subtle definition is very important. In the above example, if a trigger pulse is received after an exposure period is complete, then the first post-trigger image is on frame 1, not frame 0. Consequently, the image of frame 0 was acquired prior to the event trigger.

Camera Trigger Modes

i-SPEED PC Software has three camera trigger modes. Each mode acquires video (and data and time information) according to specific rules, as described in the following three sections.

To set the *i-SPEED* PC Software Camera Trigger mode, click on the Mode tab in the Acquire window.

In summary, the three record modes are:

- **Record on Trigger (ROT) mode.**
  In this mode, *i-SPEED* PC Software records video in accordance with the trigger percent setting on a one-time basis when a valid trigger is received.
- **Record on Command (ROC) mode.**
  In this mode, *i-SPEED* PC Software records video only during the periods when a valid external trigger input is received. When a valid external trigger input stops, *i-SPEED* PC Software stops recording. *i-SPEED* PC Software will continue in Record on Command mode until either the STOP button is pressed or the memory buffer fills.
- **Burst Record on Command (BROC) mode.**
  In this mode, *i-SPEED* PC Software records preset bursts of video frames every time a valid trigger is received. *i-SPEED* PC Software continues recording additional bursts on every input trigger until either the STOP button is pressed or the memory buffer fills.

After a recording is stopped, *i-SPEED* PC Software automatically returns the valid video frames and sets itself into Playback mode.

i-SPEED PC Software defaults to Record on Trigger (ROT) mode for all camera types.

Record on Trigger (ROT) Mode

In this mode of operation, when a trigger event occurs (either an external trigger pulse is received or the user presses the TRIGGER or STOP buttons), the desired number of pre-trigger and post-trigger frames are acquired and displayed.

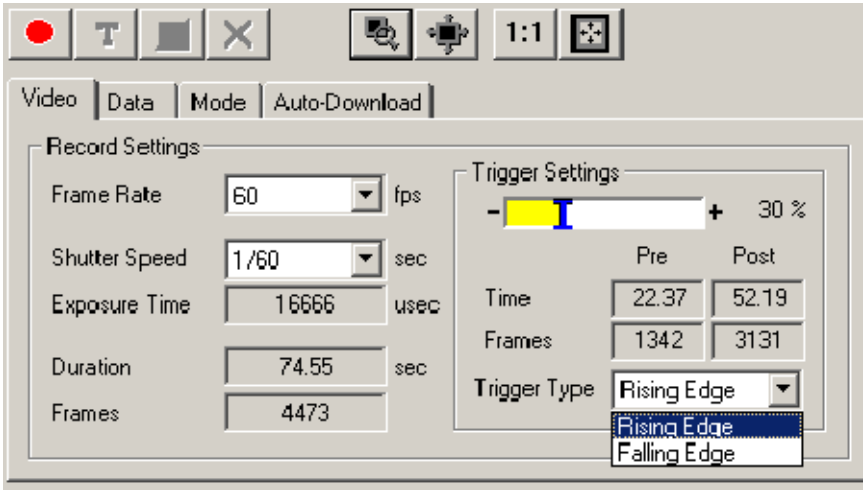
To set *i-SPEED* PC Software into Record on Trigger (ROT) mode:

1 Click on the Mode tab in the Acquire window.

2 Ensure that neither the ROC Mode nor the BROC Mode boxes are checked.

3 The camera should then default to Record on Trigger (ROT) mode.

4 Configure the trigger parameters in the Video tab.



In Record on Trigger mode, *i-SPEED* PC Software will return the following frames, depending on when the trigger event is received relative to the record buffer size

If the trigger % is…	and you have recorded…	and the event is…	then i-SPEED PC Software….
100%	a full buffer	Trigger Stop or Stop	stops and returns a full buffer, as recorded
100%	a partial buffer	Trigger Stop or Stop	stops and returns only those frames that were recorded
0%	a full or partial buffer	Trigger Stop	continues recording one full buffer more and stops
0%	a full buffer	Stop	stops and returns a full buffer, as recorded
0%	a partial buffer	Stop	stops and returns only those frames that were recorded
0% < t < 100%	a full buffer	Trigger Stop	continues recording the prescribed number of post-trigger frames, then stops and returns a full buffer
0% < t < 100%	a partial buffer	Trigger Stop	continues recording the prescribed number of post-trigger frames, then stops and returns all the post-trigger frames and the available pre-trigger frames.
0% < t < 100%	a full buffer	Stop	stops and returns a full buffer, as recorded
0% < t < 100%	a partial buffer	Stop	stops and returns only those frames that were recorded

Record on Command (ROC) Mode

In this mode of operation – also called Record on High/Low Level Mode, *i-SPEED* PC Software will record video only when a valid external trigger input is received. A valid trigger is defined as either (a) a voltage that exceeds a threshold determined by your camera hardware (Record on High) or (b) a voltage that falls below a threshold determined by your camera (Record on Low).

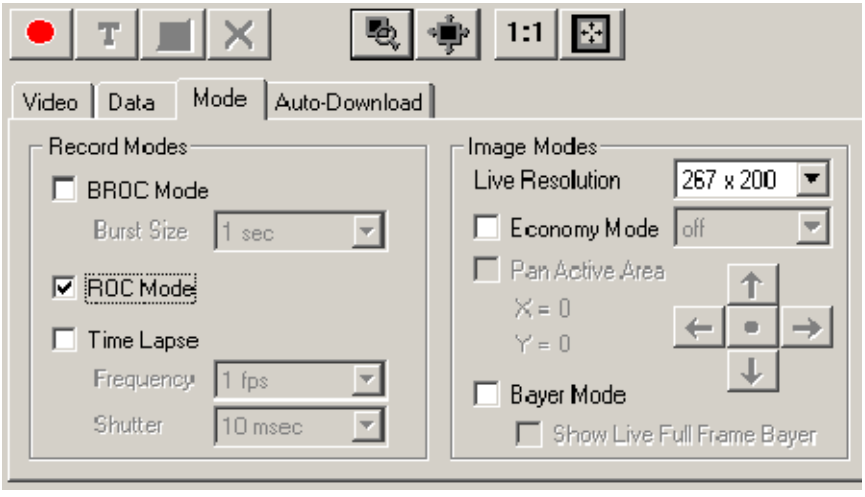
i-SPEED PC Software will continue to concatenate (append) video every time a valid trigger input is received until either (a) the memory buffer fills or (b) the user presses the STOP button.

While the cameras are in Record on Command mode, the TRIGGER button is always disabled. Also, Record on Command mode is disabled when multiple cameras are connected on the network.

To set *i-SPEED* PC Software into Record on Command mode:

1 Click on the Mode tab in the Acquire window.

2 Select the ROC Mode checkbox.



Burst Record on Command (BROC) Mode

In this mode of operation, *i-SPEED* PC Software will record video in user-defined bursts every time a valid trigger is received. A valid trigger is either a TRIGGER button or an external trigger input. Video is recorded after the trigger is received.

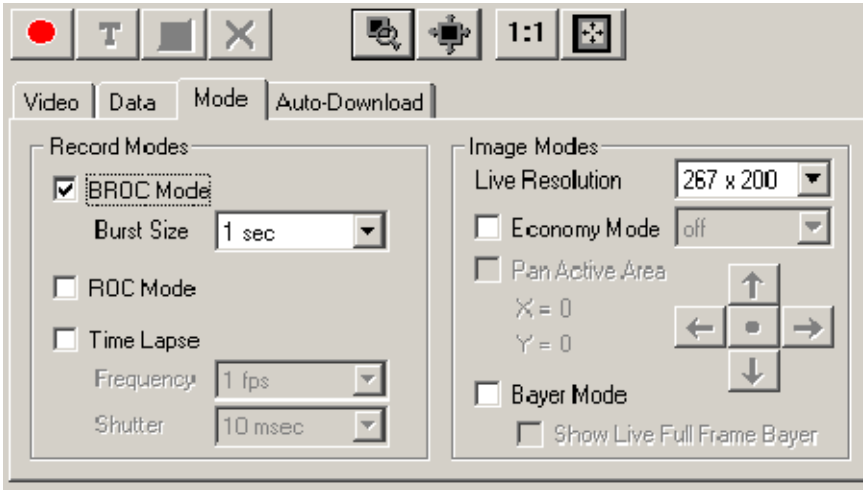
i-SPEED PC Software will continue to concatenate (append) video every time a valid trigger input is received until either (a) the memory buffer fills or (b) the user presses the STOP button.

To set *i-SPEED* PC Software into Burst Record on Command mode:

1 Click on the Mode tab in the Acquire window.

2 Select the BROC Mode checkbox.

3 Select the desired duration for each burst.



NOTE: In Burst Record on Command mode, the Trigger Percent function is disabled. *i-SPEED* PC Software will only post-trigger in this mode (record frames AFTER receiving a trigger).

7

Making a Recording

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Making a Recording

The Record Sequence

To record a video (and synchronized data, if enabled), follow these steps:

1 Add your camera(s) to the network.

2 Set the video record parameters for each camera.

3 Set the record and image modes for each camera.

4 Set the data record parameters for each camera.

5 Adjust the field of view, optics and lighting for each camera.

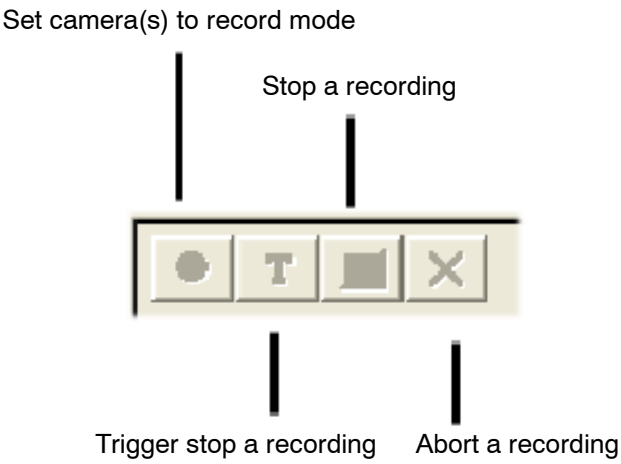
6 Press the Record button.

7 Trigger or stop your recording.

Making a Recording

Section 5 describes the process of adding, highlighting and setting the parameters of a video and user data recording.

After the cameras are set up, use the four functions found on the Acquire window top and lower right panel to record.



1 Press the Set Camera(s) to Record button (tool tip shortened to “Record”).

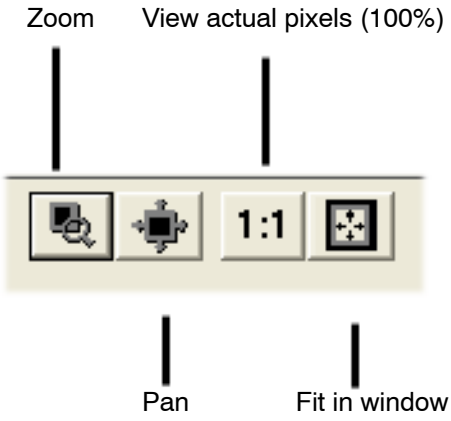
2 When the event of interest occurs, press the Trigger Stop button or send an external trigger pulse or press the Stop button. Note that the software trigger button may not be highlighted depending on which Record Mode (BROC, Time Lapse, etc.) has been selected.

Trigger	The **TRIGGER** button executes the stop record function per the trigger settings (pre-record time and post-record time). The **TRIGGER** button places the Reference Frame 0 at the trigger point of the sequence.
Stop	The **STOP** button immediately stops the recording function and places the Reference Frame 0 at the end of the sequence. Also called a “Panic Stop” button, the **STOP** button behaves like the trigger percent is set for 100%., regardless of its actual setting .
External Trigger Pulse	An external trigger pulse is treated like a **TRIGGER** event. For more information on how to connect an external trigger input, consult your *i-SPEED* camera hardware user manual.

3 In the event of a failed test, click on the Abort button. The camera is stopped and no frames of video or user data are recorded.

Zooming, Panning and Viewing Live Images

You can zoom, pan, magnify and maximize your live images using the shortcut buttons on the Acquire window panel.



View Actual Size	When selected, this command sets the zoom region and the window frame to be equal to the actual image size. That is, everything is displayed within a frame at 1:1.
Fit in Window	When selected, this command fits the entire image into the window frame. This command does not change the window frame size, just the image size.
Zoom Image	This command allows you to use your mouse or trackball to easily zoom the magnification up or down of the image. When selected, the mouse cursor turns to a triangle with an up-down arrow next to it on the view window. Click and drag the mouse upward to zoom in (magnify) or drag the mouse downward to zoom out (minify).
Pan Image	This command allows you to use your mouse or trackball to easily pan the image – move the image in any direction to optimize its location.. When selected, the mouse cursor turns to a 4-way arrow on the view window. Click and drag the mouse in any direction to scroll the image in that direction. The location box appears in the upper right corner of the window showing you the relative size and location of the current view relative to the actual image size.

Other zoom, pan, view and image functions are available through use of the context (right-click) menus.

8

Downloading Images and Data

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Downloading Images and Data

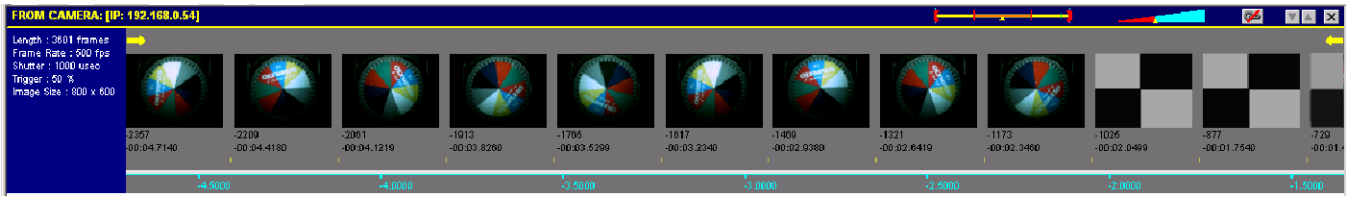
Thumbnails and Full Frames

For most recordings, the complete sequence of recorded frames from the camera is not required. Most often, a subset of the frames near some occurrence of a special event is particularly of interest. In order to speed the location and isolation of the particular frames of interest in a recorded video, low resolution thumbnails are transferred from the camera first whenever possible. Once the desired event is localized, the specific set of full resolution frames near the desired event may be downloaded. This selective downloading of frames greatly reduces the amount of time transferring memory from the camera to the PC.

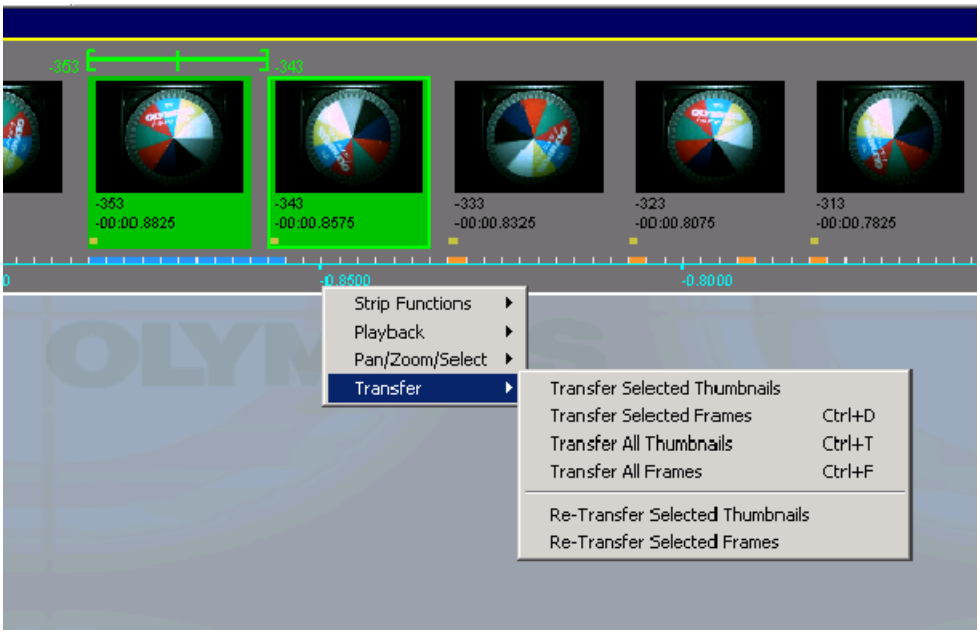
The Strip View was specifically designed to aid in localizing events of interest. Strips within the Strip View may be directly from a recording from a camera or may be a previously recorded video stored on your hard drive.

Strips that are directly from a camera recording are special instances of both the video and the data strips described in the previous section. These “playback strips” are specially programmed to interface with the camera and download frames as needed. Whenever possible, the strips will transfer low resolution thumbnails of each frame as needed. The strip maintains a cache of transferred thumbnails and frames in the directory set as the Transfer Path (see section 5).

Navigation inside of a camera playback strip is identical to a normal strip, however, there will be slight delays as the necessary thumbnails are being downloaded from the camera. Frames that are waiting to be transferred will be represented by a checkerboard pattern.



If the timeline is visible, within the frame markers, there will be color codes to denote whether the thumbnail or full frame has been transferred. If there is no color between the frame tick marks, then neither the thumbnail or the full frame have been transferred yet. An orange marker indicates that the thumbnail has been transferred. A blue marker indicates that the full frame has been transferred. For example, in the following image, we see that the full frames -353 to -343 have been transferred, and thumbnails have been transferred for -333, -323, -313 (recall that the drawn images can be thought of as flags, with the flag pole aligned to the left side of the drawn image region).

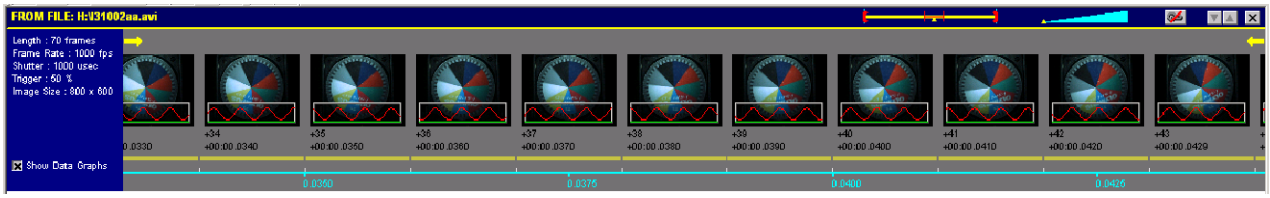


Users can transfer selected thumbnails or full frames by selecting a region and then using a keyboard shortcut or the context menu to access the desired command. All download operations in the strip view use the current selection (green) to determine which frames to operate upon. The software will not re-transfer any frames that have already transferred. If for some reason, a frame or range of frames needs to be re-transferred, the user can force a re-transfer of any thumbnail or full frame via the context menu.

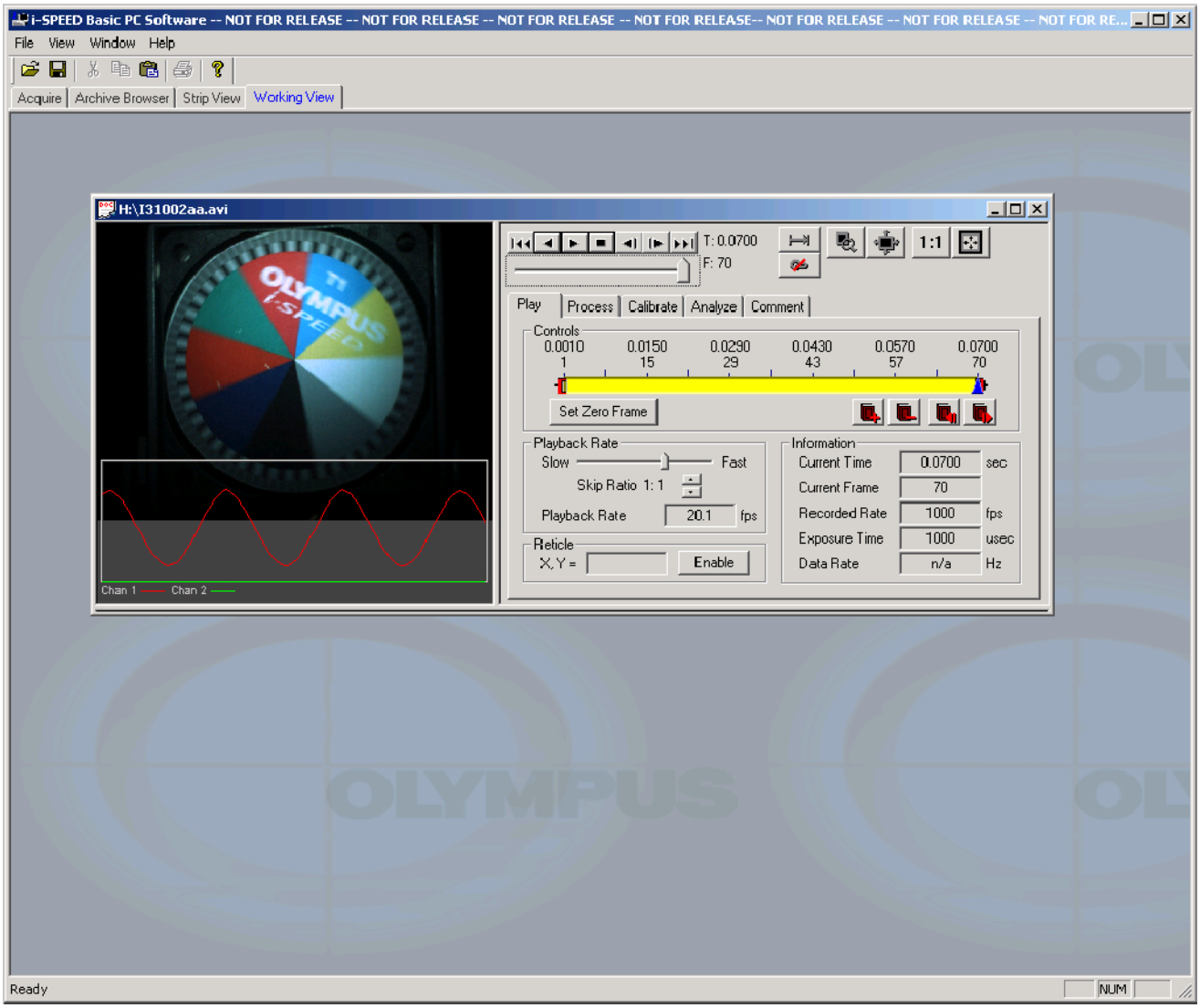
On-Board Camera Data

If a recording was done using the on-board camera data, as each thumbnail is transferred, the data corresponding to that thumbnail is simultaneously transferred. Therefore, in order to obtain a complete view of the data that was acquired, the corresponding set of thumbnails (or full frames) must be transferred.

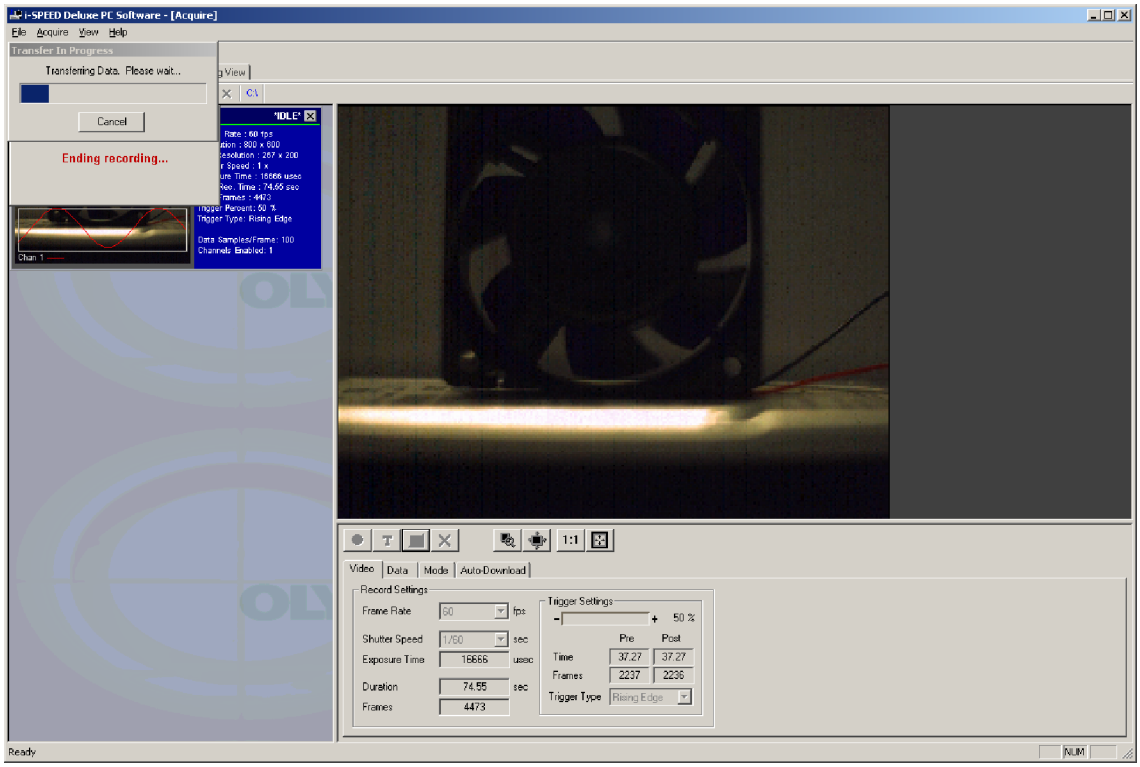
In the Basic version of the *i-SPEED* PC software, the data will be displayed in a manner similar to the CDU. The data channels will be drawn over the images in the camera strip.



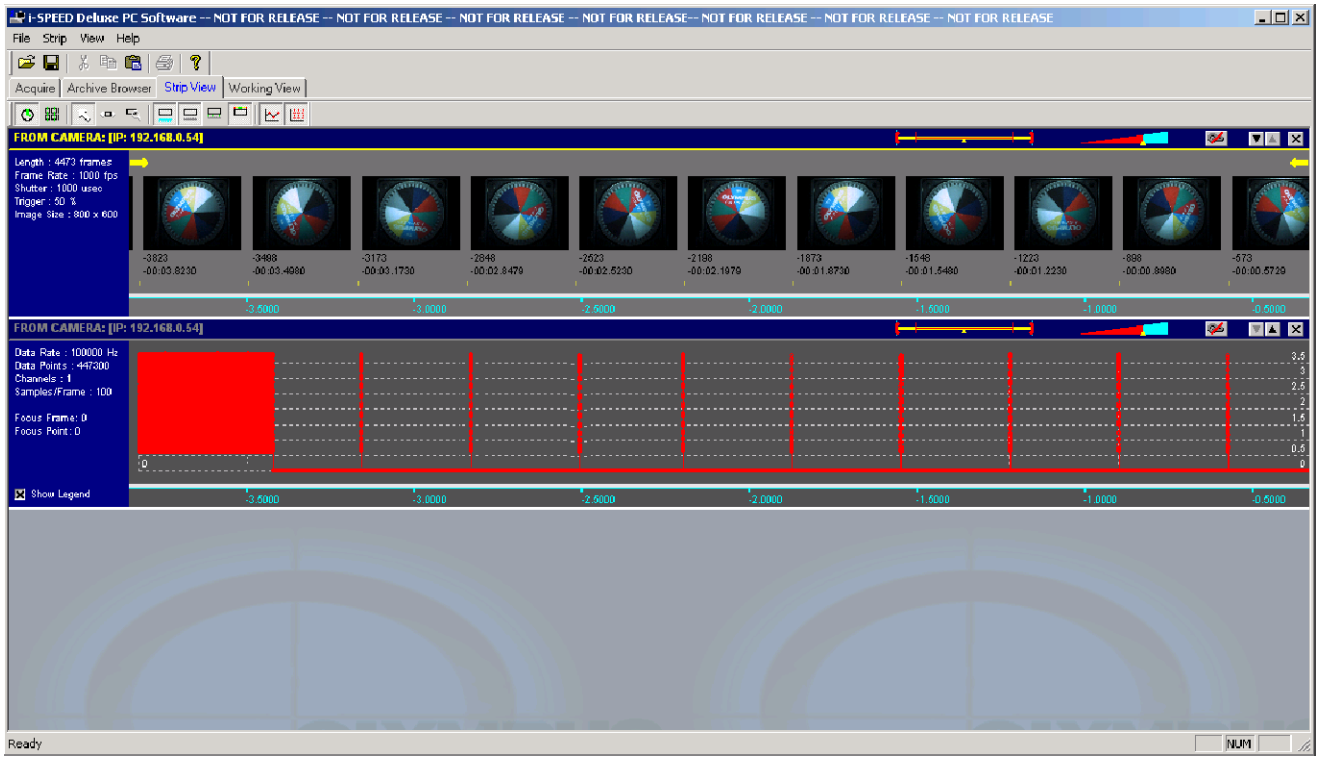
The data channels are also similarly drawn over the images in the Working View.



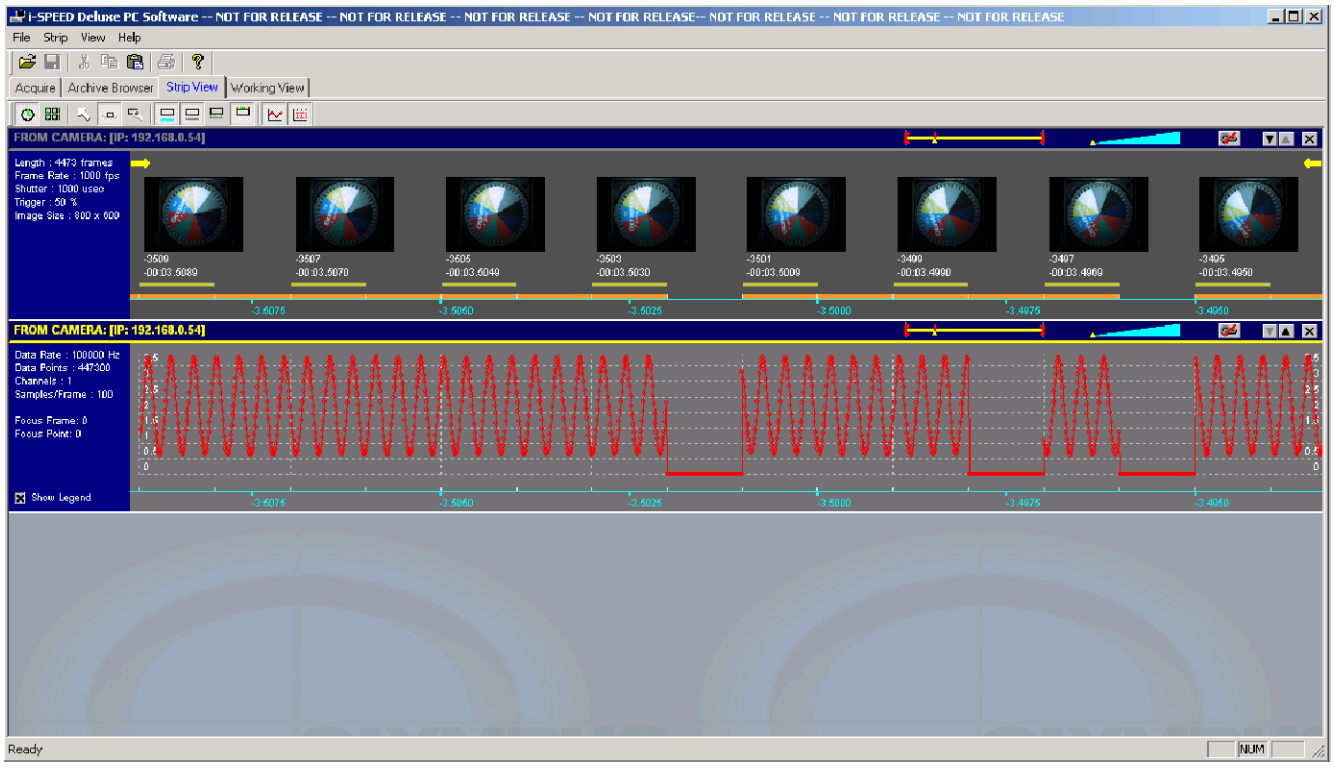
In the Advanced and Deluxe versions of the *i-SPEED* PC software, the on-board data will be displayed in a separate data strip. In order to have a coherent looking data strip, the camera data is transferred immediately after a recording, just before the strips are displayed.



This transfer may take an extended amount of time. If not all of the data is immediately required, the user may cancel this transfer operation without any major side effects. If cancelled, portions of the resulting data strip will contain zero values. As the thumbnails (or full frames) are transferred, these zero sections will fill in with the corresponding data.



For example, in the above image, approximately 20% of the data transfer was allowed to complete prior to hitting cancel. The additional sections of data that are spaced out at equal intervals correspond to each thumbnail that was transferred on-demand to fill the initial strip view. As more thumbnails are downloaded, more portions of the data strip will be filled in.

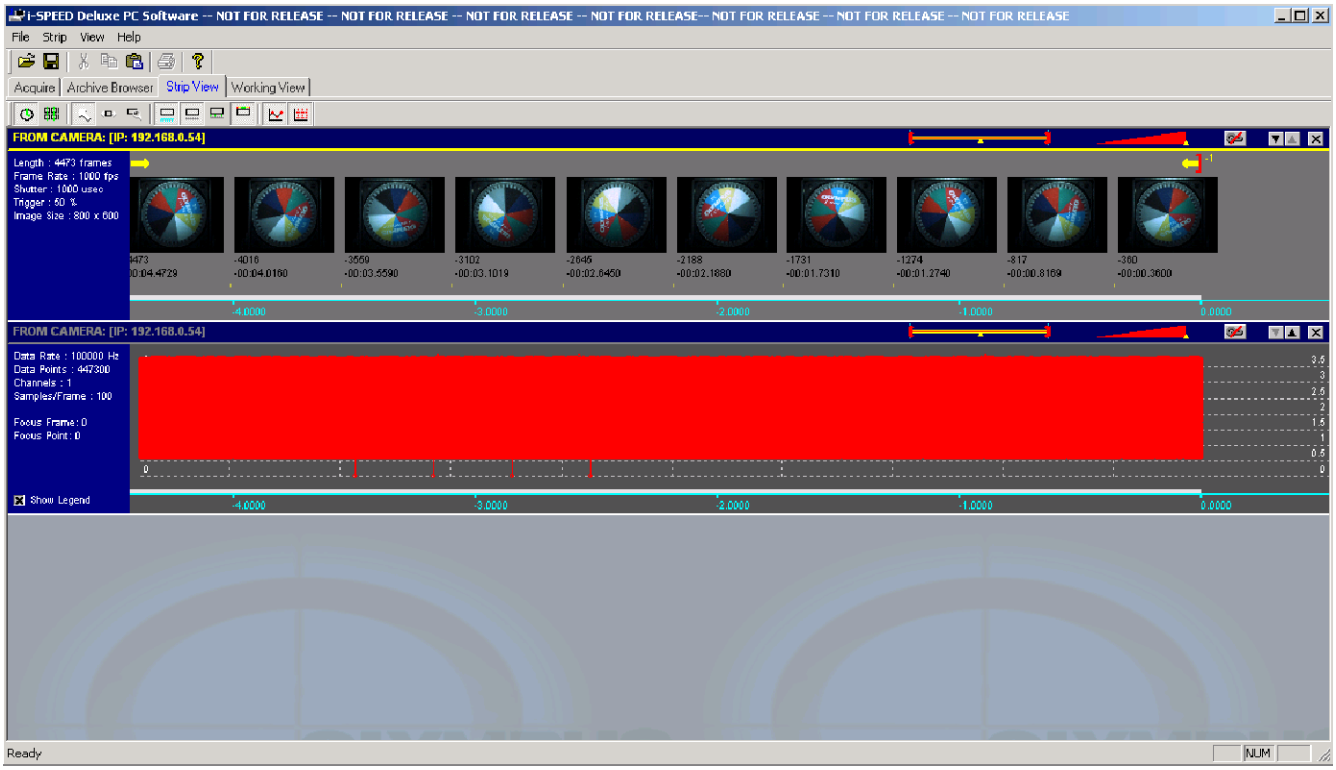


After zooming in on the region near the end of the initially transferred section, we see that there are portions of zero data that correspond to sections where the thumbnails have not yet been transferred (no color markers between the frame ticks).

External Data

If a recording was done using the external data acquisition source (Deluxe version only), the data has already been stored in the local PC memory. Therefore, a complete view of the data is immediately available, independent of whether the thumbnails (or full frames) have been transferred.

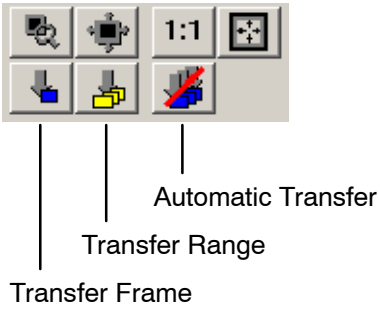
Data from the external source will display automatically in a data strip once the recording has been completed.



There are no gaps in the data and there is no additional transfer time required when using the external data source since the data is already stored in local PC memory.

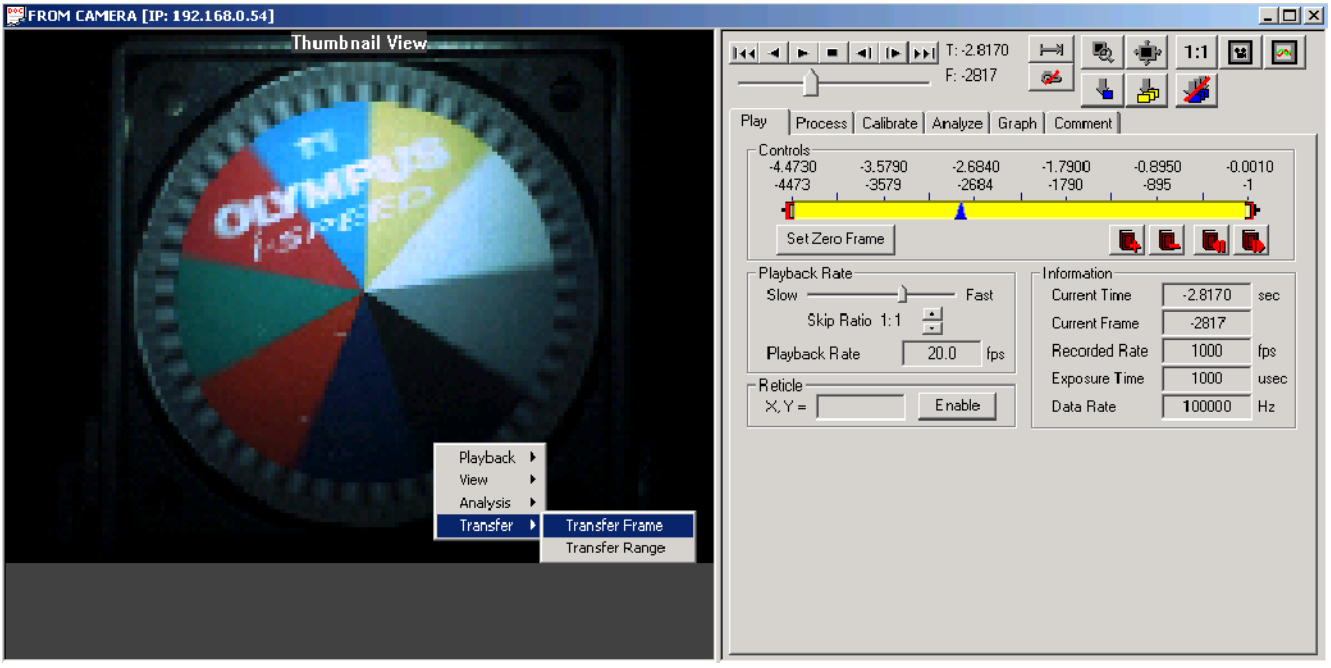
Downloading in the Working View

Thumbnails and full frames may also be transferred in the Working View (described in more detail in a later section). Thumbnails are automatically transferred on demand. Full frames may be transferred by using the additional controls underneath the pan/zoom buttons in the control panel.

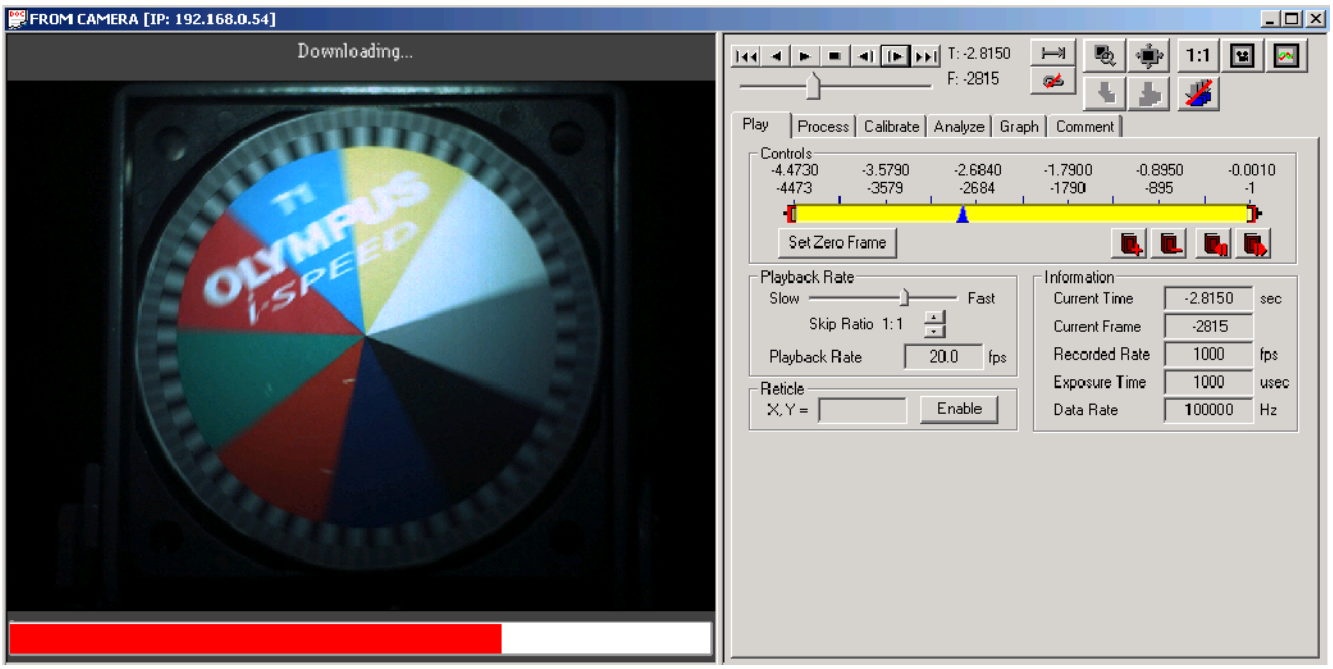


Transfer Frame	Transfers the current full frame from the camera.
Transfer Range	Transfers the current selected range from the camera. The range is set by dragging the red end sliders on the main slider control in the play tab.
Automatic Transfer	Enable automatic transfer of full frames on demand. As the video is playing or as the slider is moved around, if a full frame has not been transferred yet, it will be transferred as necessary. With this mode enabled, a thumbnail view will never be shown. Instead of transferring thumbnails on demand, full frames are always transferred.

Indicators on the top and bottom of the image viewing area in the working view show whether a given displayed frame is a thumbnail or a full frame and also show the transfer progress when transferring a full frame. If the top of the image window says “Thumbnail View”, then the currently displayed image is a thumbnail.



The full frame may be transferred by using the context menu as shown, or via the control panel buttons. When transferring a full frame, a red progress bar will be drawn across the bottom of the image.



Saving Prior to Downloading

It is not required to download full frames before saving a video to file. The save operation will automatically download any full frames that have not already been transferred. Thumbnails are never saved to a video file. They are only temporary images used to facilitate region selection for camera recordings.

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Strip View

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Strip View

Strip View Overview

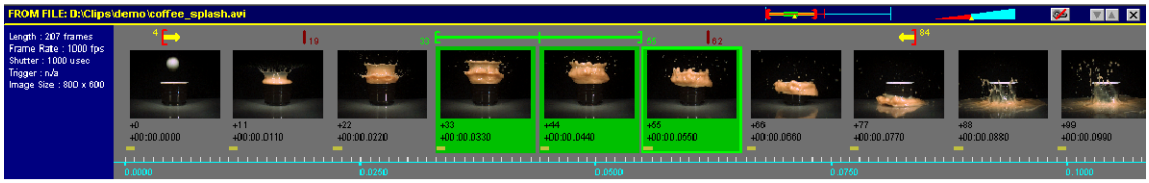
The strip view is a specially designed view that allows a user to see an overview of a complete event in a filmstrip format. This view enables a user to zoom in on specific moments in time while still maintaining a view of the context before and after the moment of interest. In addition, the strip view allows a user to view multiple events that may have been recorded at different frame rates to be displayed aligned to one another.

As one event is zoomed and panned, the other events will also zoom and pan simultaneously, maintaining perfect alignment with one another.

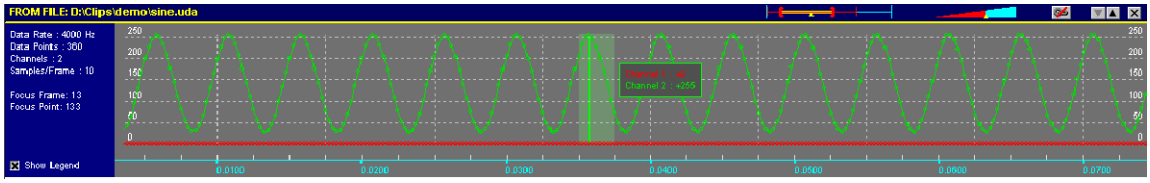
Strip View Layout

The strip view is comprised of a toolbar across the top that controls the strip view settings, and a main region that contains the strips. Each strip is comprised of three regions: a title bar, an information section, and a drawing area.

There are two possible types of strips that can be drawn: a video strip and a data strip. The video strip shows individual frames from the video and the data strip plots data or analysis.



The video strip draws as many frames as possible along a horizontal time line without overlapping any of the frames. The exact time corresponding to a drawn frame is the value on the time line corresponding to the left edge of the frame. (This can be visualized like a flag pole planted in the time line at the left edge of the drawn frame, and the frame is the flag extending to the right of the pole). Additional information is drawn beneath each frame, such as the frame number, time, and a bar indicating the exposure duration.



The data strip draws any associated data or analysis corresponding to a given video. The data strip is always permanently aligned to the corresponding video strip. If the video strip is panned or zoomed, the data strip will pan and zoom simultaneously, and vice versa.

Strip View Definitions

Alignment Mode

The alignment mode controls how linked strips are drawn relative to one another. Linked strips can be aligned so that frames correspond to one another in time (Time Alignment) or frame number (Frame Alignment).

Linking

One of the powerful features of the strip view is the ability to draw multiple events recorded at different frame rates in a time or frame synchronized fashion. When one event is panned or zoomed, all linked events are simultaneously panned or zoomed by the same amount. Linking is enabled by clicking on the chain link icon in the title bar of each strip.

Range

These are the frames that are within the yellow and red end markers. The range is used to control the playback in the Working View and the default save range when saving. The range may be modified in the Strip View by dragging the yellow and red end markers above the video frames or in the Working View by dragging the red end markers in the Play tab controls. The range may also be set to the current selection by using the context menu, or hitting “Space”.

Selection

These are the frames highlighted in green. The selection is used primarily for zooming in on a set of frames of interest. Most often, a user will select a set of frames by clicking and dragging the mouse over the frames and then hit “Enter” to expand and center these frames. The selection is not used for saving or setting the play range for the Working View.

Frame ticks

These marks show the number and location of actual image frames relative to the visible time line. These marks are equally spaced along the time line.

Timeline

The line drawn across the bottom of each strip that shows either the corresponding time value or frame value across the strip. The time line must be displayed in order to see the frame ticks and some of the comment markers.

Comment markers

Indicate where user comments have been added to the event. If the mouse is held in place above one of these green markers, a small window will appear that displays the associated comment.

Data markers

Circles at locations in the graph where there are data points. This helps to visualize exactly where data points were acquired relative to the shown video.

Bookmark markers

Brown lines that show the existence and location of user-defined bookmarks.

Strip View Settings

The following settings control how the strips are drawn and manipulated. These settings can be changed via the toolbar across the top of the window.



Alignment Mode

There are two possible alignment modes that control how linked videos are drawn relative to one another. These modes are: Time Alignment Mode and Frame Alignment Mode.

In time alignment mode, the videos are aligned such that a vertical line on the screen will intersect each linked strip at the exact same time value. For example, if you have one video that was recorded at 1000 fps and a second video recorded at 2000 fps, when they are linked, they will display such that the frames from the 2000 fps video that are aligned vertically with a frame from the 1000 fps video should have a frame number that is twice that of the 1000 fps frame number.

In frame alignment mode, the videos are aligned such that a vertical line on the screen will intersect each linked strip at the exact same frame number. Record rates are not used when videos are aligned in this mode. Only the frame number is used for alignment.

Mouse Mode

There are three possible mouse modes that control how clicking and dragging the mouse interacts with the drawn strips. These modes are: Selection, Pan, and Zoom.

Selection mode will allow you to highlight specific frames, set the focus point in the graph, and manipulate range bounds. This is the most general mode, and users will most likely remain in this mode. Panning and zooming can be accomplished in this mode either by using the pan and zoom controls in the title bar or by using keyboard or context menu controls.

For finer control of panning and zooming, the pan and zoom mouse modes are provided. When either of these modes are selected, clicking and dragging the mouse horizontally will increase or decrease the current pan or zoom setting.

Displayed Items

Many of the displayed items in the strips can be shown or hidden via the buttons in the toolbar. When objects are shown or hidden, the contents of the strip will resize to fill the available space. The configurable displayed items are: Time Line, Frame Ticks, Comment Markers, Range, Selection, and Bookmark Indicators, Data Markers, and Data Gridlines.



The time line draws a line across the bottom of each strip that shows either the corresponding time value or frame value across the strip. The time line must be displayed in order to see the frame ticks and some of the comment markers.

Frame ticks are drawn directly above the time line and indicate the presence of a video frame at that location. Depending on the current zoom level, not all video frames will be drawn. A single displayed frame may overlap many hidden frames. The Frame Ticks provide a means for knowing where and how many hidden frames are present.

Comment markers indicate where user comments have been added to the event. If the mouse is held in place above one of these green markers, a small window will appear that displays the associated comment.



Range, selection, and bookmark indicators are drawn across the top of the video strips just below the title bar. The range is shown with yellow and red indicators, the selection is shown with a green bar, and the bookmarks are shown in brown. As described above, the range controls what range is used for playback in the working view and what range is used for saving. The selection is a tool used to highlight specific frames for panning and zooming and downloading (when viewing a recording from a camera). The bookmarks are indicators that can be used to mark special frames. Bookmarks can be set or removed from the working view. Only the range markers are interactive, the selection and bookmarks are only indicators. The range markers may be clicked and dragged to modify the range. If a range marker moves outside of the displayed region, an indicator will appear on the edge of the strip. If this indicator is clicked, the strip will be panned to show the range marker.

Data markers will draw circles at locations in the graph where there are data points. This helps to visualize exactly where data points were acquired. Note however that the display of many data markers will result in slower interactivity due to the additional drawing requirements.

Data gridlines are the horizontal and vertical lines drawn behind the graph and the vertical scale values drawn on the left and right of the strip. The vertical lines correspond to the point where the corresponding video frame is drawn.

Title Bar Controls

The title bar contains the source of the displayed strip and a set of controls on the right side. These controls are: Pan, Zoom, Link, Move Down, Move Up, and Close.



The pan and zoom controls operate very similar to typical scrollbars. If you click and drag the red bar in the pan control, the strip will pan. If you click and drag the right edge of the red triangle in the zoom control, the strip will zoom. If you click outside of the red bar in the pan control or away from the right edge of the triangle in the zoom control, the pan or zoom setting will jump a fixed amount. These controls can be used in any mouse mode.

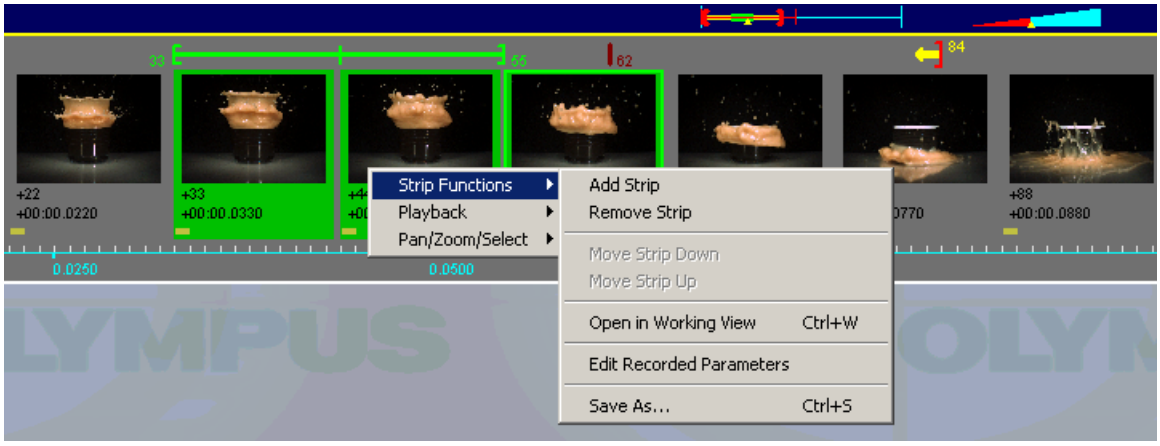
The link button indicates whether or not the strip is linked with other strips. Linking either a video or data strip for a given event will automatically link both. When linking, the strip pan and zoom settings may change in order to be in alignment with any other linked strips.

Move up and move down allow you to reorder the drawn strips. The order does not have any other effect upon the strip view other than to change the ordering of the strips.

The close button will close the strip. Closing a data strip for an event will not close the corresponding video strip, however, closing a video strip will automatically close any corresponding data strip.

Adding and Removing Strips

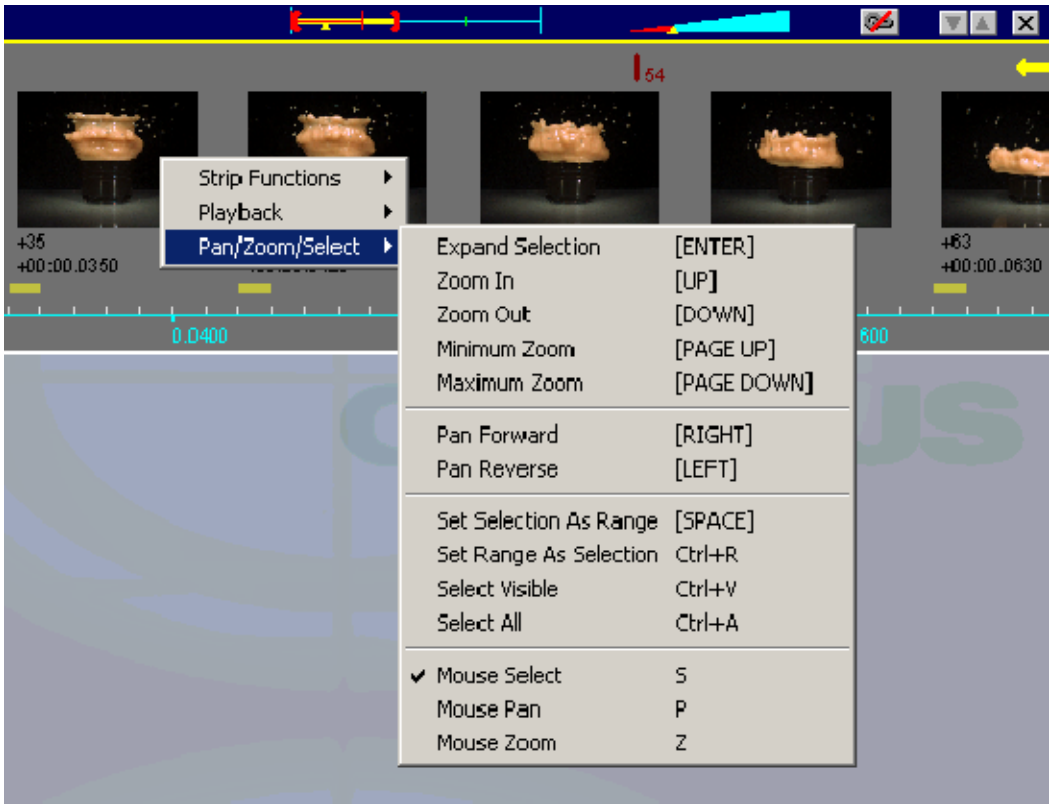
Strips may be added by using the File menu or Strip menu, using the context menu in the strip view, or by double clicking on a video in the Archive Browser.



Strips may be removed by clicking on the close button in the upper right corner of each strip or via the context menu.

Navigating in a Strip

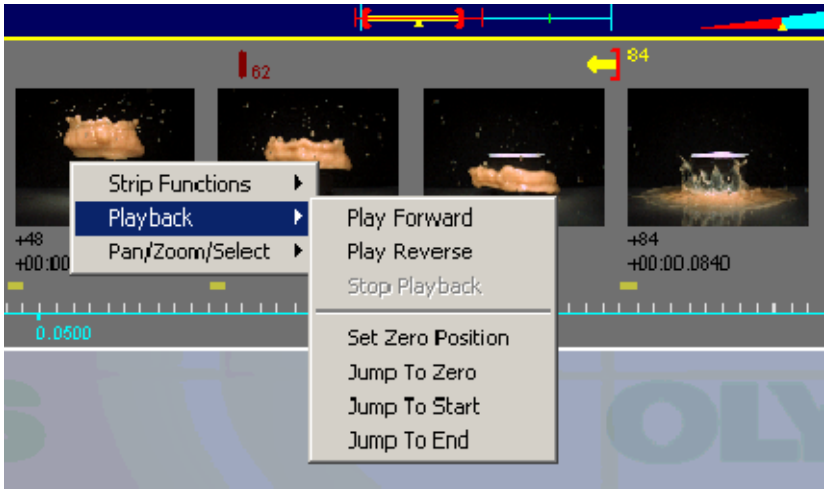
There are multiple ways to navigate around a strip. A strip may be panned or zoomed using the controls in the title bar of each strip, via context menu, using keyboard shortcuts, or by using the pan or zoom mouse mode and clicking and dragging in the strip.



A quick way to zoom in on a set of frames of interest would be to select a set of frames by clicking and dragging the mouse over these frames (in selection mouse mode), and then hit “Enter”. This will center and zoom in on the current selection that was just made (shown in green).

Playing Strips

Strips may be played in forward or reverse by using the commands in the context menu, or via the Strip menu.

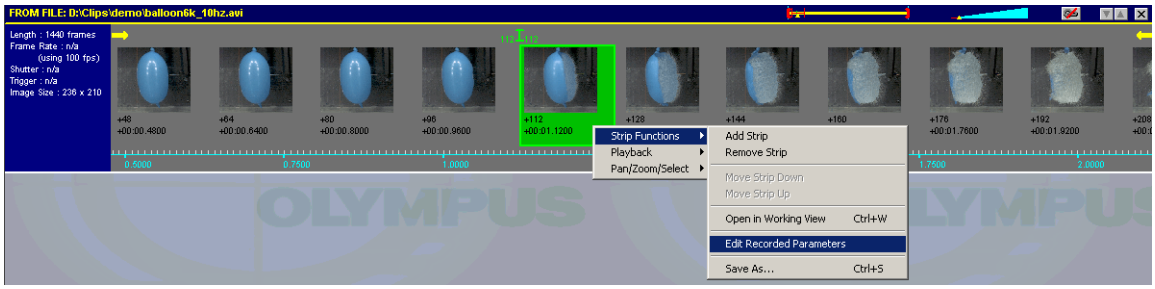


Bookmarks

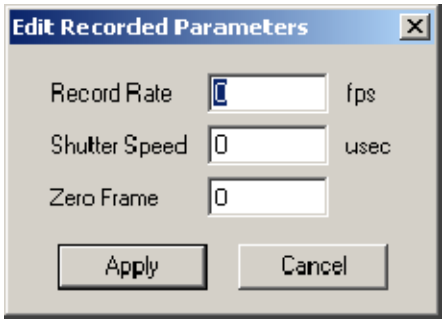
Bookmarks may be viewed in the strip view by ensuring that the “Range, Selection, and Bookmark Indicators” button is selected in the toolbar. Bookmarks will be shown as brown indicators drawn above the frames in the video strips. Bookmarks cannot be edited in the strip view, a working view must be opened for the strip and bookmarks can be edited within the working view.

Edit Recorded Parameters

Typically, video files are accompanied by a configuration file which contains information such as record rate, shutter speed, and trigger frame. If a video is opened without an associated configuration file, the software will assume a default record rate (100 fps) and leave the other fields empty. These values can be edited with correct values if they are known. Select the “Edit Recorded Parameters” option under “Strip Functions” in the context menu.



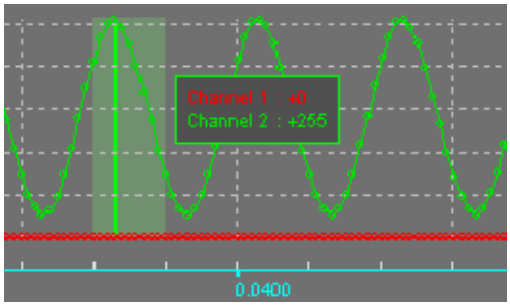
This allows you to set the record rate, shutter speed, and zero frame directly.



Data Strip Interaction

Data strips are automatically and permanently linked to the corresponding video. If the data strip is panned or zoomed, the corresponding video strip will also be similarly panned or zoomed.

When in selection mouse mode, clicking on a data strip will have a different effect than clicking on a video strip. Clicking on the data strip will not set the selection, but rather will set a location for a focus point and focus frame. The focus frame will be shown in a blended green color and the focus point by a solid green vertical line. If enabled, a legend will be drawn that displays the labels and values for each value plotted. As the strip is panned, the focus point remains at the same fixed point on the screen and will display the values of the points underneath it.



10

Working View

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Working View

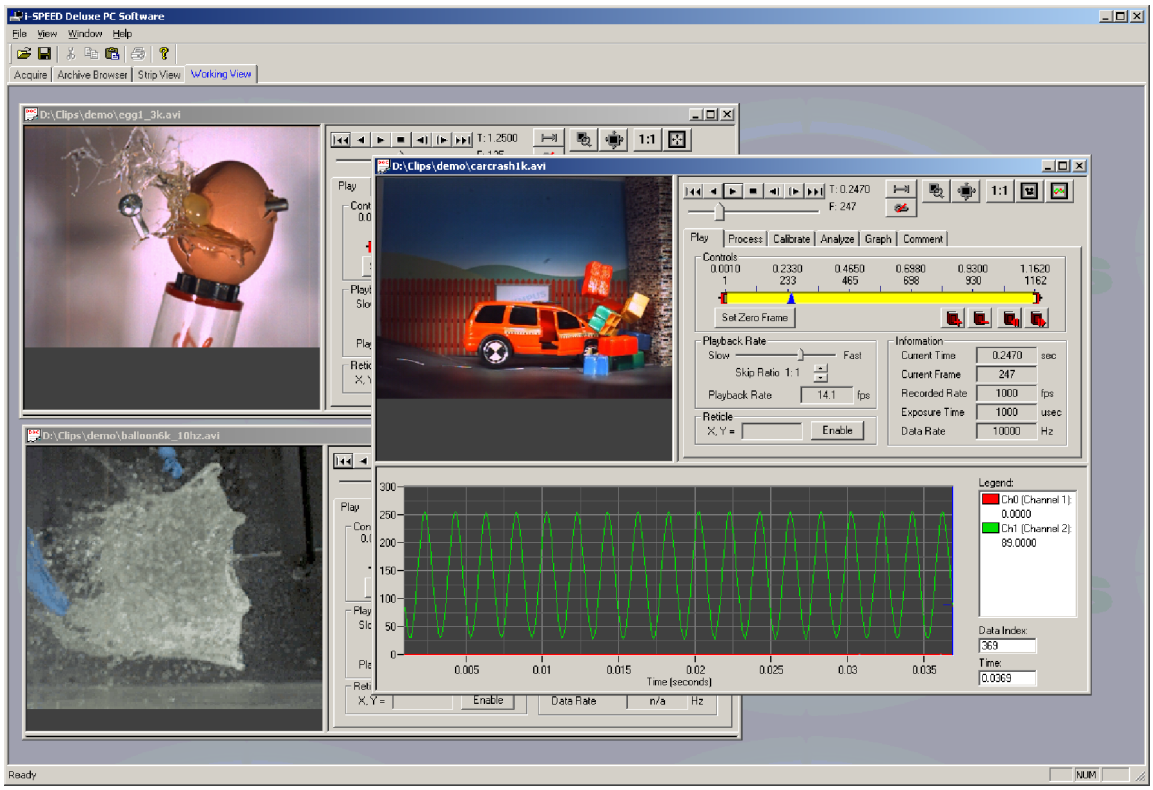
Working View Overview

The Working View is a multiple paned view that allows a user to interact with the video and data in a more traditional frame-by-frame format. This view enables a user to perform motion analysis, add user comments, show data and video in the same window and enhance the image quality using advanced image processing.

The Working View is where the majority of study of recorded events will occur. The Strip View is primarily used to view broad contexts of events, to be able to narrow down sections of interest, and to be able to view temporal relationships between events. In contrast, the Working View is the more conventional view, showing a single frame at a time, where the viewing window may be enlarged, the image may be panned and zoomed, and other types of analysis can be carried out.

Working View Layout

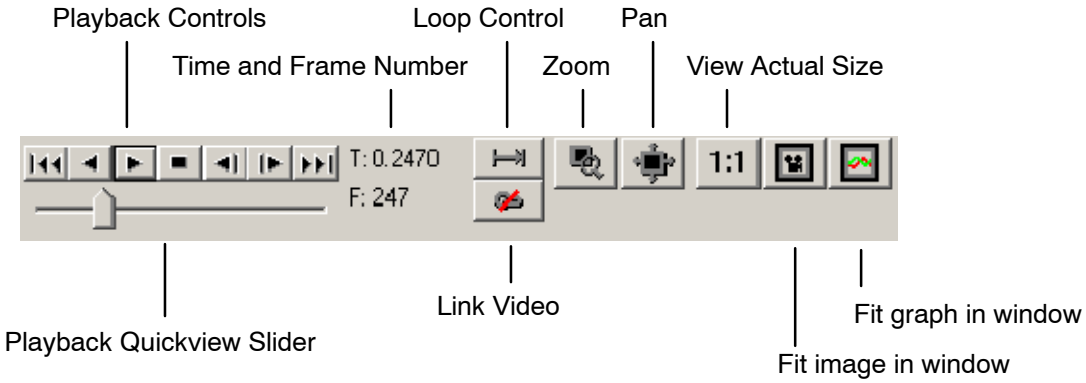
The Working View layout is comprised of a large workspace. Each individual video is contained in a working window. Multiple windows, corresponding to multiple video sequences, can be cascaded or tiled in the large workspace.



Each of the Working View windows has three sections:

- Video panel
- Graph panel
- Control panel

The following controls are available for the manipulating the image and graph within the video panel:

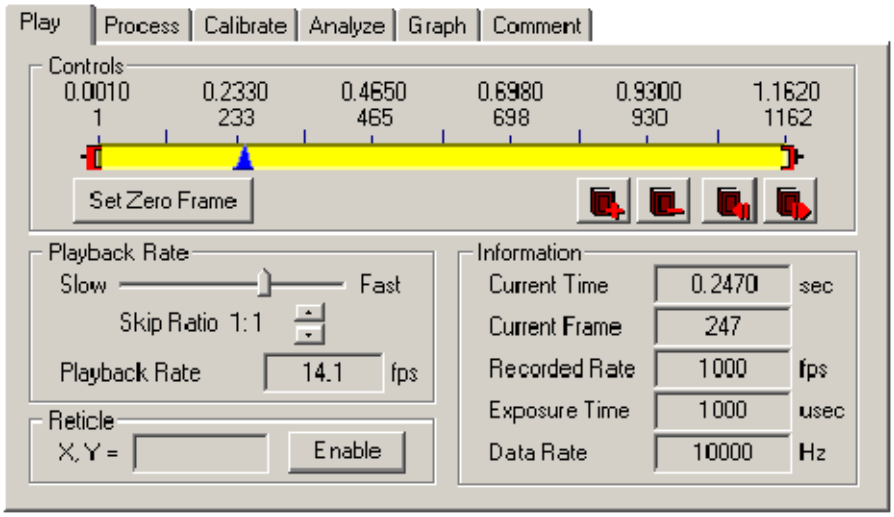


These functions are described as follows:

Playback Controls	The following controls are available by clicking on the playback control buttons (from left to right): ● Skip to the beginning of the entire recording ● Play backward ● Play forward ● Stop ● Step back one frame ● Step forward one frame ● Skip to the end of the entire recording
Playback Quickview Slider	Use this slider to quickly scan the video to find an event or location of specific feature.
Loop Control	By clicking on this button, the playback is continuously looped over the selected range. When this button is not selected, the playback stops at the end of the selected range.
Time and Frame Number	The time of the current image and the frame number within the video sequence
View Actual size	When selected, this command sets the zoom region and the window frame to be equal to the actual image size. That is, everything is displayed within a frame at a zoom ratio of 1:1.
Fit Image in Window	When selected, this command fits the entire image into the window frame. This command does not change the window frame size, just the image size in the window.
Fit Graph in Window	When selected, this command fits the entire graph into the window frame. This command does not change the window frame size, just the graph viewing size in the window.
Zoom Image	This command allows you to use your mouse or trackball to easily zoom the magnification up or down of the image. When selected, the mouse cursor turns to a triangle with an up-down arrow next to it on the view window. Click and drag the mouse upward to zoom in (magnify) or drag the mouse downward to zoom out (minify).
Pan Image	This command allows you to use your mouse or trackball to easily pan the image – move the image in any direction to optimize its location.. When selected, the mouse cursor turns to a 4-way arrow on the view window. Click and drag the mouse in any direction to scroll the image in that direction. The location box appears in the upper right corner of the window showing you the relative size and location of the current view relative to the actual image size.
Link Videos	Links and unlinks individual windows (videos) that are contained in the working view. When linked, the videos are synchronized and played back in unison. That is, when the play button is pressed, all videos that are linked play together.

The Working View control panel has six (6) tab windows:

- Play
- Process
- Calibrate
- Analyze
- Graph (Advanced and Deluxe only)
- Comment



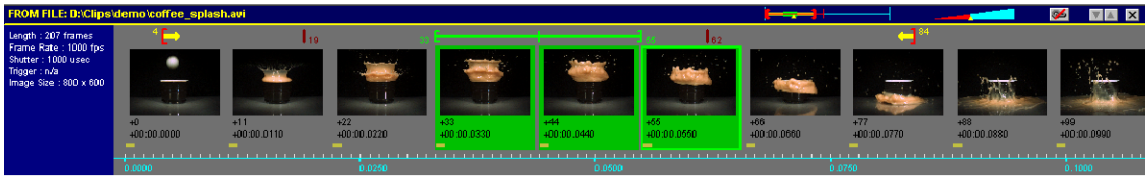
The functions of these control panels are described in sections 11 through 16.

Adding and Removing Working View Windows

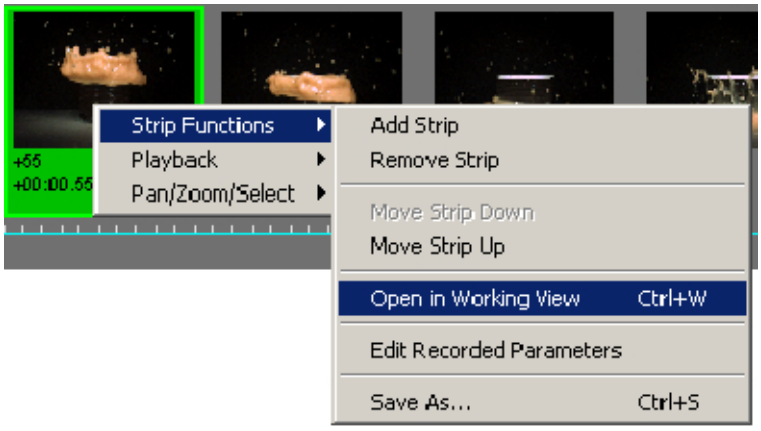
To bring an image into the Working View, perform one of the following steps:

From the Strip View:

1 Highlight the strip of interest.



2 Open the context menu by clicking the right mouse button on the strip. Select “Strip Functions” and select “Open in Working View”. (Keyboard shortcuts from the Strip View are (1) CTRL-W or (2) double click within an image).



From the Archive Browser:

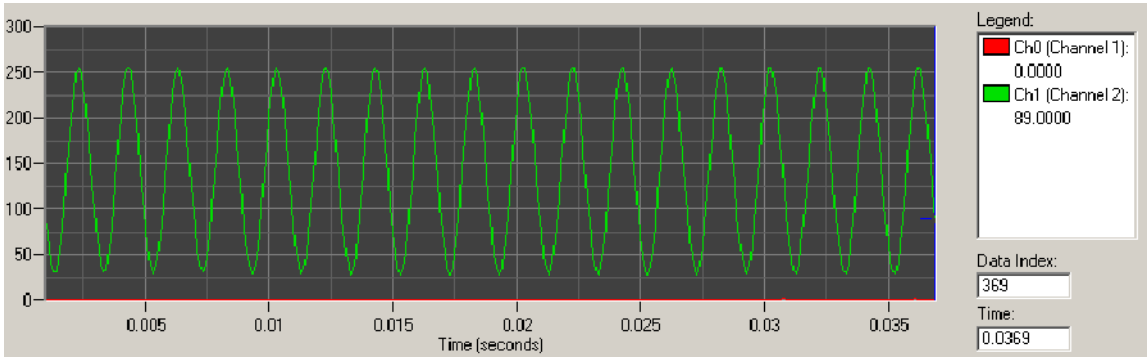
1 Highlight the video of choice.

2 Open the context menu by clicking the right mouse button on the video. Select “Open in Working View”.



The Graph Panel

The graph panel is available with the Advanced and Deluxe versions of the software only. The graph shows both user data from sensors and motion analysis data. The content of the graph panel is controlled by the Graph tab in the control panel.



On the right side of the graph panel are the following features:

Legend	Shows the various graph lines and color assignments
Data index	The number of the data point that is currently highlighted by the vertical blue line
Data time	The time of the data point that is currently highlighted by the vertical blue line.

The graph also supports panning and zooming. To pan the graph, set the mouse mode to Pan by clicking on the Pan button in the control panel. The cursor will change to a 4-way arrow. The panning works identically like in the image window. To zoom in on a region in the graph, set the mouse mode to Zoom by clicking on the Zoom button on the control panel. The cursor should change to a dotted box with a pointer next to it. Click the left mouse button on the graph and drag the mouse to define a zoom region. To zoom back out, double click in the graph window when in pan or zoom mode.

Synchronizing Multiple Windows

To synchronize multiple windows, simply click on the chain-link button in the control panel. When the chain-link button is in the unlinked position, this window is not linked to any other window within the Working View or Strip View. When the chain-link button is in the link position, the window is linked to all other linked windows and strips. If a video is linked in the Working View, it is also linked in the Strip View.

The type of synchronization that is in effect is dependent upon the alignment mode in the Strip View. If the strip view alignment mode is Time Alignment, then the working views will be aligned to the same time. If the alignment mode is Frame Alignment, then the working views will be aligned to the same frame number. See section 9 for information about alignment modes.

This powerful feature lets users view images, data and analyses relative to other views, camera angles or pre-recorded images. This feature allows recordings that were captured at different frame rates to be played back in true time synchronization. For example, if video 1 was recorded at 1000 fps and video 2 at 100 fps, when these are played back synchronized in Time Alignment mode, video 1 will display 10 frames for every 1 frame that is displayed for video 2.

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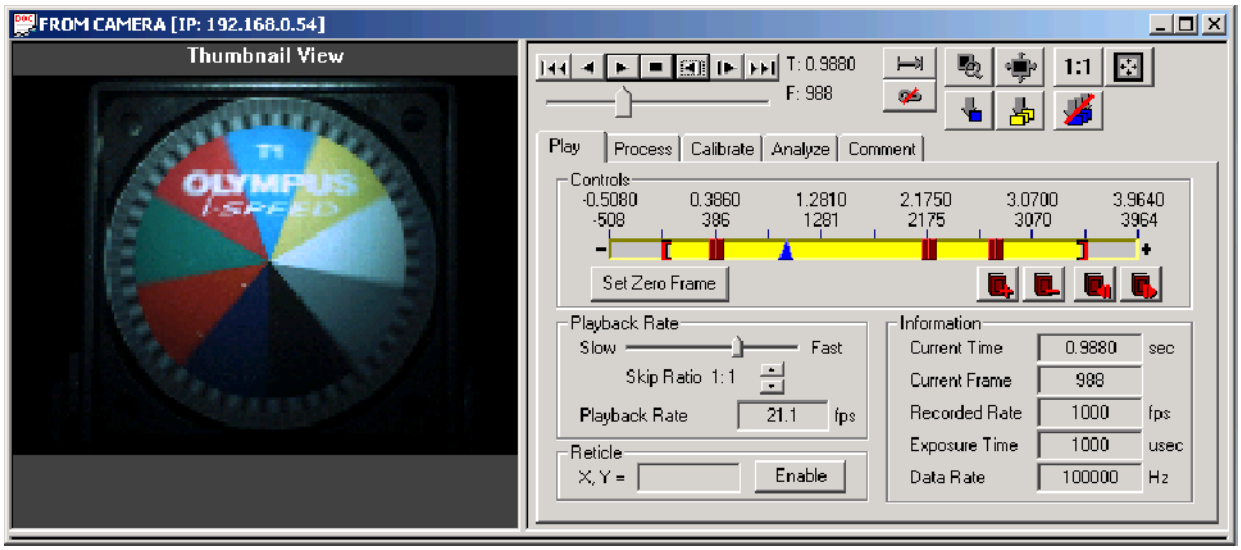
Playback in Working View

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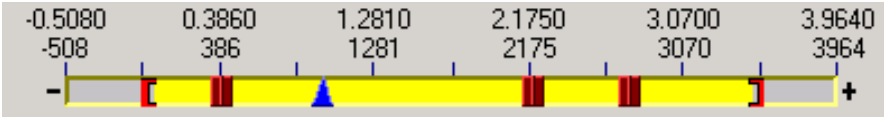
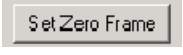
Playing Back in Working View

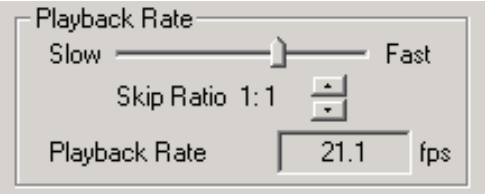
Components of the Play Tab

The Play tab within the working view contains many valuable functions for navigating the video sequence.



The components of the Play tab are described as follows:

Slide Bar	 The slide bar allows the operator to quickly move to a specific part of the playback cycle. Just click on the center blue triangle of the slider and, holding down the left mouse button, drag the slider to the desired position. The time and the frame numbers are displayed directly above the slide bar. The active area is displayed in yellow. The inactive area is displayed in gray.
Slide Bar Range Brackets	
	 The slide bar range brackets are used to establish the beginning and end of the playback range. To approximately select the beginning of the playback range, click on the left square and, holding down the left mouse button, drag the slider to the desired position. Note that the range bracket information is carried back to Strip View and to the Save window.
Set Current Frame to Zero	 By clicking the SET ZERO FRAME button, the current frame of the video playback is reset to become the Reference Frame 0 and the current datum is reset to become the Reference Datum 0. Set Frame to Zero cannot be undone from within the *i-SPEED* PC software.

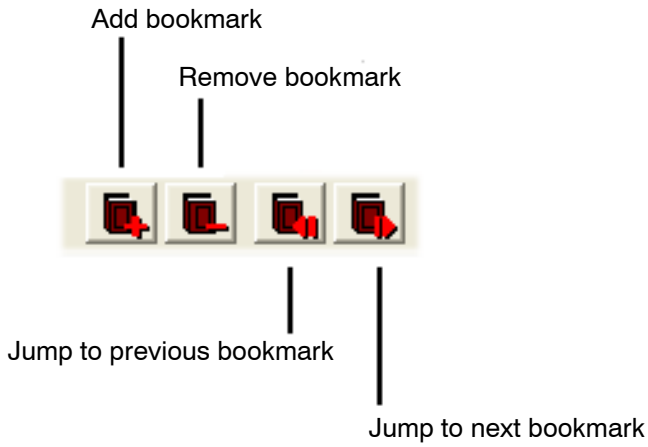
Set Playback Rate	 The actual playback rate on the computer screen is determined by many factors, including the number of synchronized images, the video RAM and the speed of the computer processor. Therefore, the *i-SPEED* PC Software provides a slider between "slow" and "fast". Set the relative speed of playback by clicking on the center post of the slider and, holding down the left mouse button, drag the slider to the desired position. Read the actual playback rate in the box below.
Skip Ratio	This feature allows users to speed up the display update rate by skipping frames. Use the up/down arrows to select the number of frames to skip. The default is 0 frames (all frames are shown).
Reticle	 The actual position of the reticle on the image is shown here, in pixels from the upper left corner (0,0).
Current Time	The time of the visible frame is displayed.
Current Frame	The frame number of the visible frame is displayed.
Recorded Rate	The rate at which the video was originally acquired, in frames/second, is displayed. If the image was not originally recorded with the *i-SPEED* PC Software, then N/A (not available) is displayed.
Recorded Data Rate	The rate at which the data was originally acquired, in Hz, is displayed. If the data was not originally recorded with the *i-SPEED* PC Software, then N/A (not available) is displayed.
Exposure Time	The exposure time, in microseconds, of the original recording is displayed. If the image was not originally recorded with the *i-SPEED* PC Software, then N/A (not available) is displayed.

Setting Bookmarks

The *i-SPEED* PC Software allows users to bookmark key events. Bookmarks are user-defined and editable markers for important events in the sequence, denoted by red rectangles on the yellow slider bar.



Bookmarks are set, removed and reviewed by using the bookmark icons on the play tab:



To set a bookmark:

1 Play or single step the video to the desired location.

2 Click on the Set Bookmark icon. A red rectangle is placed at that location on the slider bar.

To step through bookmarks, use the Jump to Previous Bookmark and Jump to Next Bookmark icons.

To remove a bookmark:

1 Use the Jump to … Bookmark feature to select the bookmark that you wish to remove.

2 Click on the Remove Bookmark icon. The red rectangle is removed from the slider bar.

Bookmarks are displayed in the Strip View and in the Archive Browser.

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Adding User Comments

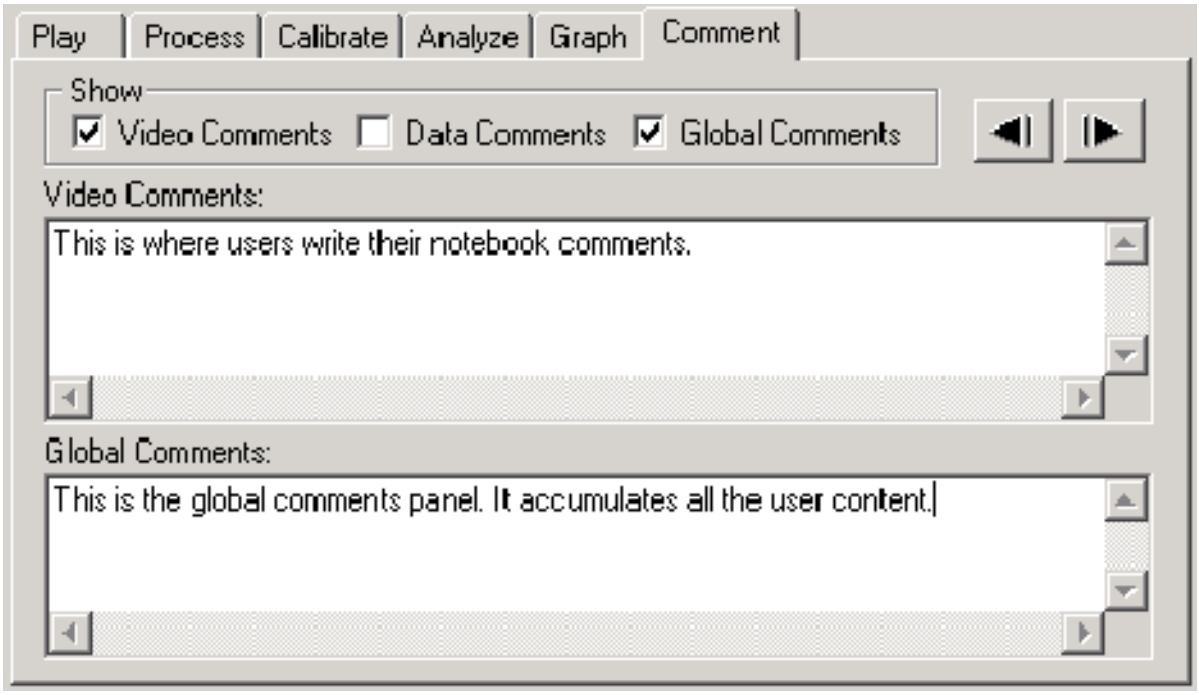
The Comments Tab 87

Adding User Comments

The Comments Tab

i-SPEED PC Software allows users to record comments in conjunction with analysis and other studies of the acquired video and data. These comments are categorized and indexed to specific locations (frames for video notes, data for data notes).

The comment tab in the Working View is shown below:



i-SPEED PC Software Notes are saved in the *i-SPEED* PC Software Binary File that is created along with your video sequence and your data file. Comments are saved any time that you save your video to a new file, in its entirety, or as a reduced number of frames. You can also force a save of modified comments by selecting File, then Save Comments/Bookmarks.

There are two forms of the *I-SPEED* PC Software Notes window. A two-tiered window appears when you have recorded with video alone, as shown above

A three-tiered window appears when you have recorded with video and data.

The features of the comments tab are as follows:

Video comments	These comments are saved alongside each frame of video.
Data comments	These comments are saved alongside each data point in the data sequence.
Global comments	These comments are free form – not assigned to any particular frame or data point.
Comment step	 Step to the previous or next comment in the sequence.
Show	 Checkboxes to selectively display video, data or global comment field locations.

To review *I-SPEED* PC Software comments saved with an image sequence or with a data sequence, simply click on **FORWARD STEP** button or **BACKWARD STEP** button. You will be automatically advanced to the next sequential comment (video or data).

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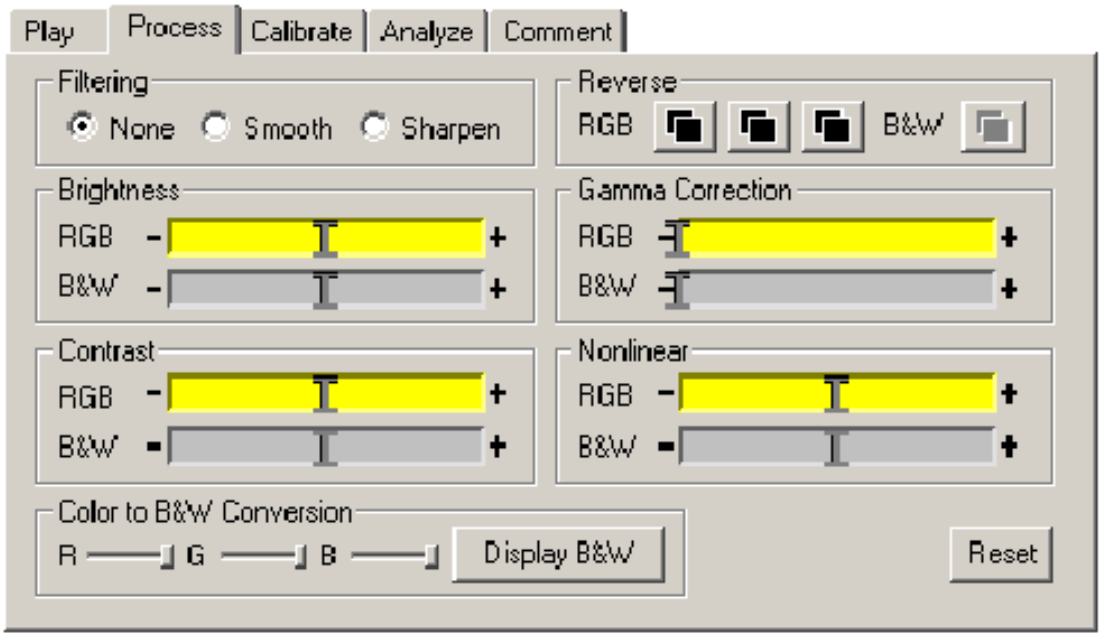
Image Processing

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Image Processing

The Image Processing Tab

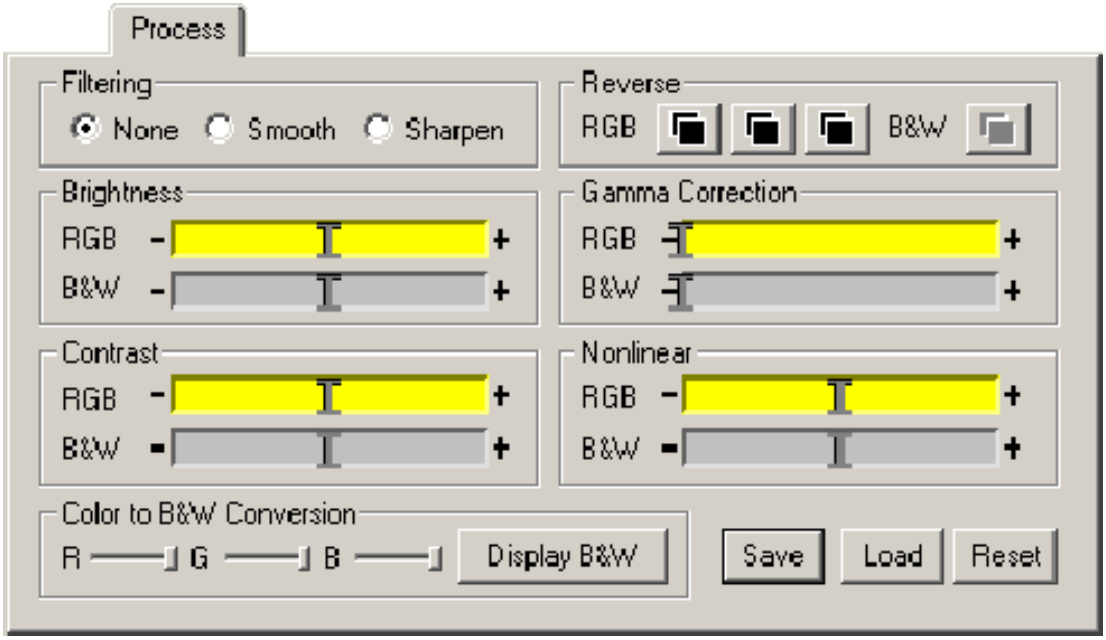
The image processing tab is the second tab found in the Working View, named “Process”, as shown below.



The various components of the Process tab are described in the following sections.

Image Filtering

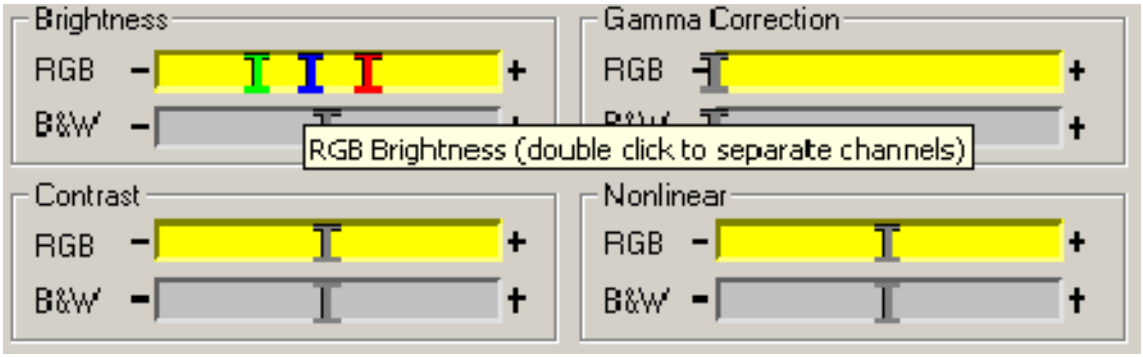
To improve the appearance of the video image, you can apply either a sharpening or smoothing filter.



Sharpen	When enabled, the video is passed through an image sharpening algorithm that enhances the edges and removes some of the pixelization effects that occur during low resolution recordings.
Smooth	When enabled, the video is passed through an image smoothing algorithm that reduces the edge contrast and improves appearance of the image
None	When selected, the image is displayed unprocessed.

Image Enhancement

This image processing windows allow you to set all the parameters about the image, save your settings and restore them for later use. Note that there are the same sets of sliders for color and monochrome (black and white) images. For the color settings, the red, green and blue channels are modified as a group when the slider is the default gray color. By double clicking on the slider control, the slider bars will separate into red, green, and blue sliders that can be adjusted independently.



The various image settings are:

Brightness
Adjusts the brightness of the image. Higher brightness values will cause the image pixels to move closer to white (255). Lower brightness values will cause the image pixels to move closer to black (0).

Contrast
Adjusts the contrast of the image. Higher contrast will try to move colors toward white or black and reduce the grays. Lower contrast will move all colors closer to gray.

Gamma Correction
Adjusts the gamma of the image. The gamma of the image affects the brightness of the displayed result on your monitor. Higher values will brighten the image more.

Nonlinear
Adjusts the nonlinear palette function. By adjusting this value, you can change the mapping of input to output colors to be either exponential (more blacks) or logarithmic (more whites). A more detailed explanation is provided below.

Reverse
Changes the color palette such that whites and blacks are reversed. Each channel can be inverted independently for color images.

Display B&W
Converts color images to monochrome images using the conversion factors indicated by the R, G, and B sliders.

R Scale
Amount of red channel to include when converting from color to monochrome.

G Scale
Amount of green channel to include when converting from color to monochrome

B Scale
Amount of blue channel to include when converting from color to monochrome.

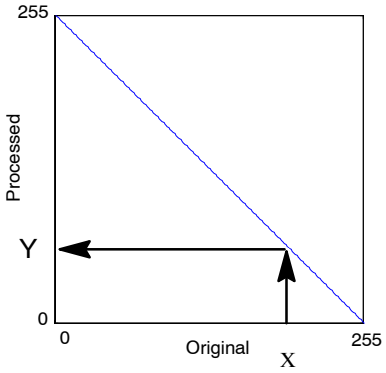
Save
Allows you to save certain image settings into an LUT (Look Up Table) format for later retrieval.

Load
Allows previously stored image settings to be loaded for this image.

Reset
Sets all the values to their default levels.

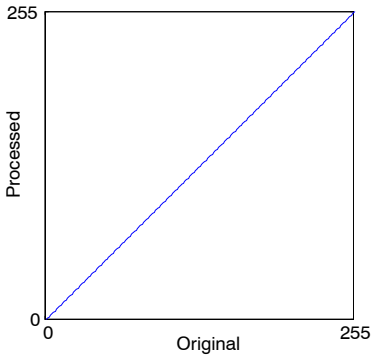
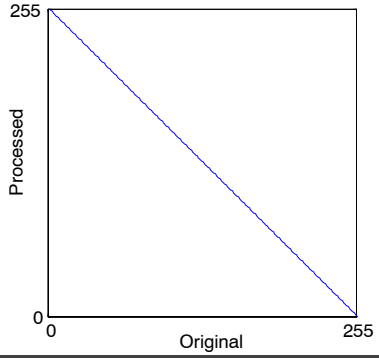
Detailed Input/Output Mappings

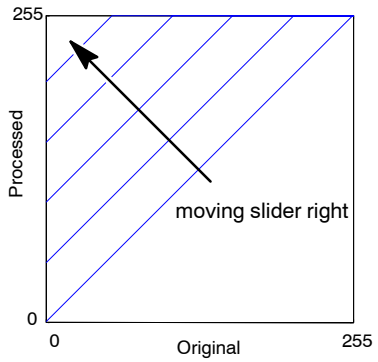
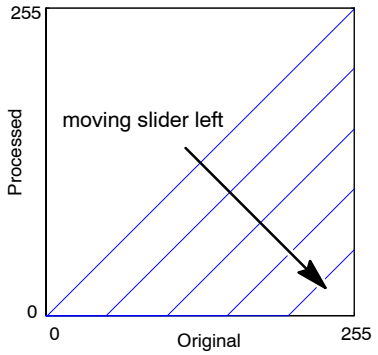
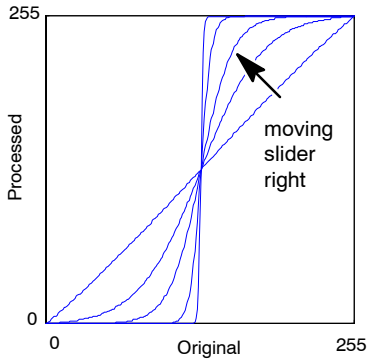
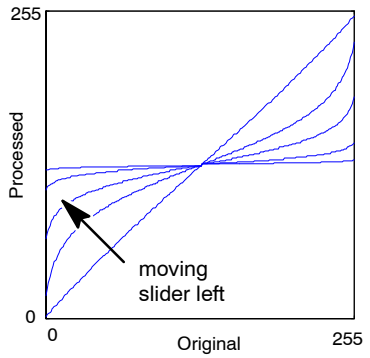
The Nonlinear and Reverse features allow you to improve the image contrast to enhance the tracking success. Understanding that *i-SPEED* PC Software looks for objects that have some “color” or, more specifically, a “level of greyscale”, changing these values adjusts the “palette” to improve the white-on-black image contrast. A level of greyscale is best described as the level between black (a value of ‘0’ on an 8-bit gray scale) and white (a value of ‘255’ on an 8-bit gray scale).

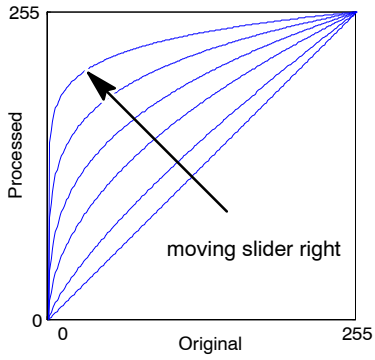
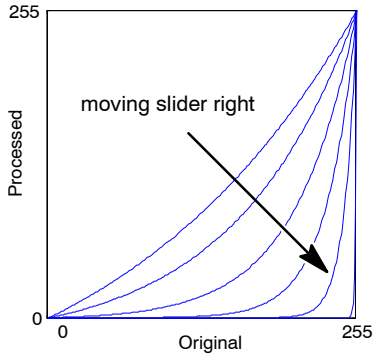
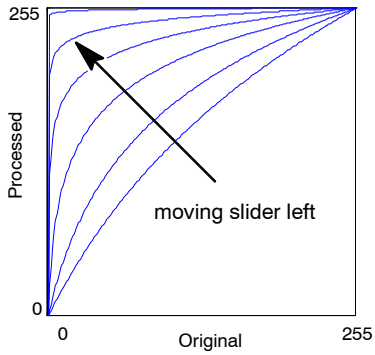


A description of these image processing palette options is given below. The images on the left are examples of the effects of each of the palette options. The plots on the right show the mapping of pixel intensity values from the original (horizontal axis) to the processed (vertical) image after applying the new palette.

To help in understanding the palette mapping plots, here is an example using the reverse palette. For a given pixel intensity of X in the original image, we move upward at coordinate X until we intersect with the blue line, then we move horizontally to find the new pixel value in the processed image, in this case it would be Y. This is done for every pixel in the image, producing the final processed image as shown in the figures on the left.

Normal	This is the default and standard palette with no processing occurring. In other words, the processed pixels are identical to the original pixels.	
Reverse	This option uses a reverse palette, where ‘255’ is black and ‘0’ is white. This will invert the image so that light regions are dark and dark regions are light. Contrast is not affected.	

Brightness	Adjusts the brightness of the image. Moving the slider to the right will increase the brightness of the image by uniformly increasing the pixel intensity values. Moving the slider to the left will decrease the brightness of the image by uniformly decreasing the pixel intensity values.	 
Contrast	Adjusts the contrast of the image. Moving the slider to the right will increase the contrast of the image. This has the effect of moving pixel intensity values towards white (255) or black (0). Moving the slider to the left will decrease the contrast of the image. This has the effect of moving pixel intensity values towards gray (128).	 

Gamma	Adjusts the gamma of the image. Gamma correction is typically used to adjust for differences in the way monitors display brightness and colors. Adjusting this slider is similar, although not identical, to adjusting the nonlinear slider. Moving the slider to the right will increase the brightness of the image in a nonlinear fashion as shown.	
Nonlinear	Adjusts the image using nonlinear input/output mappings. This slider is a combination of a logarithmic (moving slider to the right) and exponential (moving slider to the left) palette. The logarithmic palette increases the contrast in dark regions and decreases the contrast in light regions. This has the effect of bring out more detail in the dark regions and making light regions very light. The exponential palette increases the contrast in light regions and decreases the contrast in dark regions. This has the effect of making dark regions darker and bringing out more detail in lighter regions.	 

Saving and Loading Processing Settings

Image processing settings may be saved to a file and later reloaded (Advanced and Deluxe versions only). Different processing settings can be saved to different files and loaded as necessary. The Save button will prompt you for a destination. Image processing files have the “lut” file extension.

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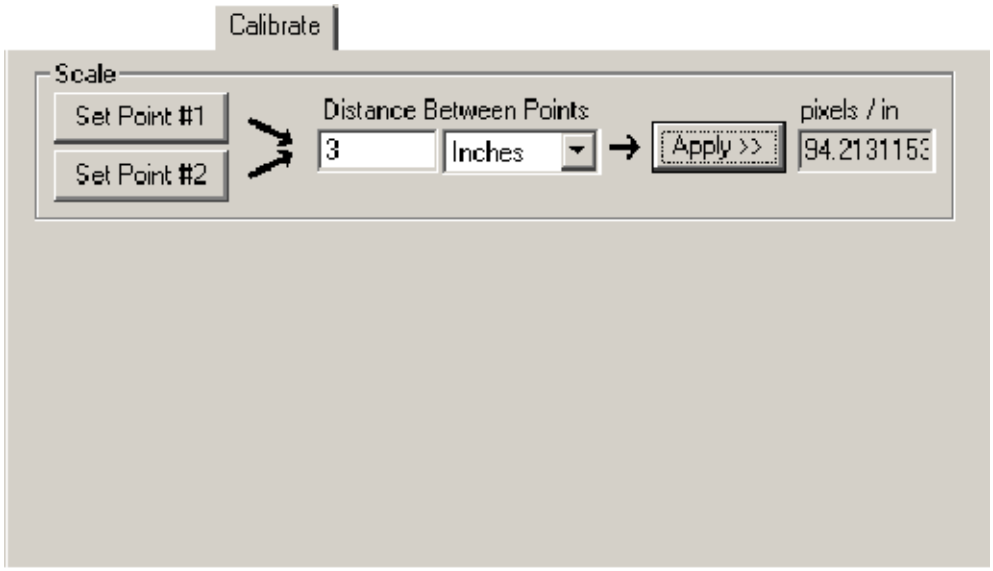
Image Calibration

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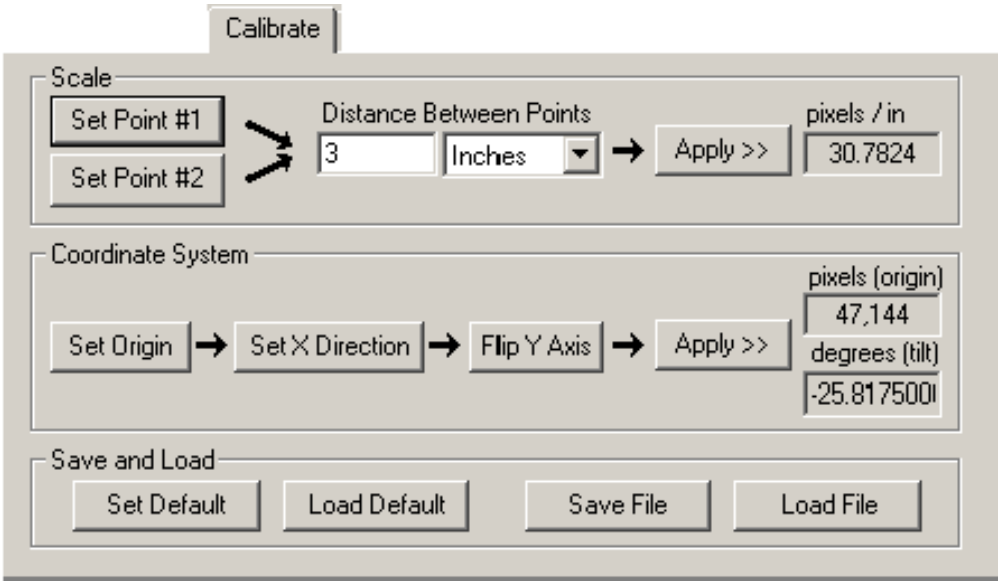
Image Calibration

The Image Calibration Tab

The image calibration tab is the second tab found in the Working View, named “Calibrate”. The version of the Calibrate tab for the Basic *i-SPEED* PC Software is shown below.



The Advanced and Deluxe versions of the *i-SPEED* PC Software include a more feature-laden version of the tab, as shown below:



The various components of the Calibrate tab are described in the following sections.

Overview of Calibration

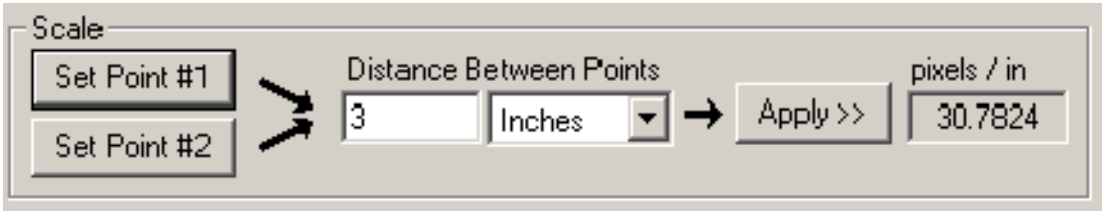
Calibrating an image serves the following functions:

- Converts and scales the recorded video image to real-world dimensions (e.g. inches, meters, etc.)
- Rotates the image to remove any unwanted tilt introduced during the recording process from the analysis process
- Establishes an origin (0,0) and X,Y coordinate plane for motion analysis (direction of motion).

Image calibration requires measurement information about some feature in the image. We suggest that you include a horizontal ruler in the picture or some equivalent frame of reference that has both a well-defined scale and known rotational orientation. After an image is calibrated, you can change the units of measure at any time in the Analyze tab.

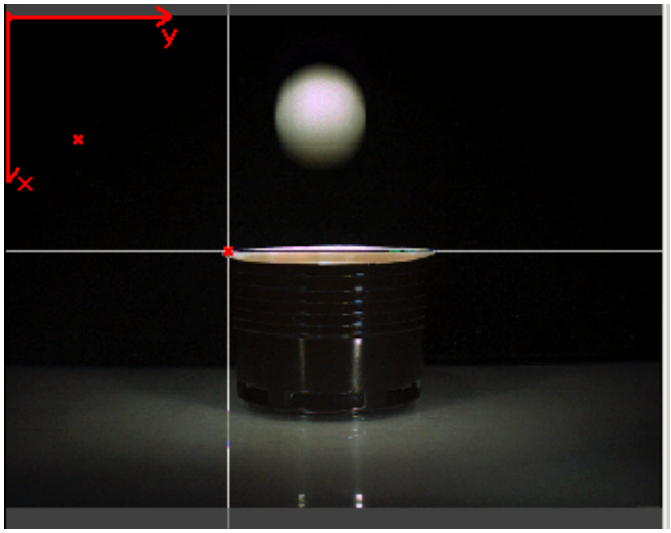
Calibrating the Scale

The process of calibrating the scale is outlined in the top box on the Basic, Advanced and Deluxe tabs.



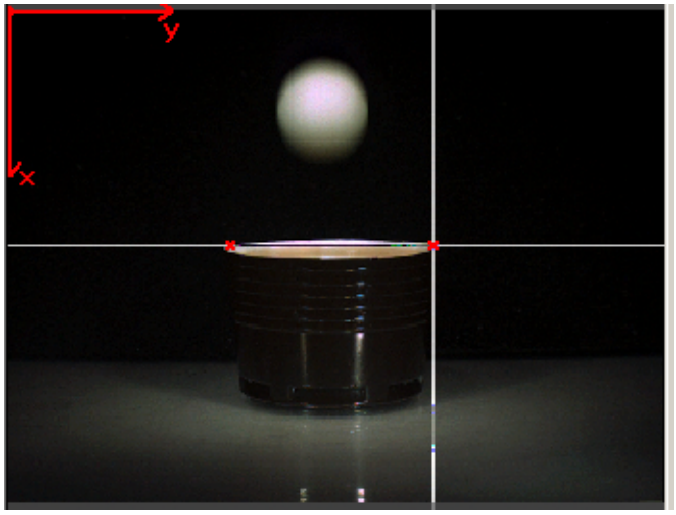
To set the calibration scale:

1 Within the video image, find a known frame-of-reference object. Left-click on one end of the object, using the reticle as a guide.



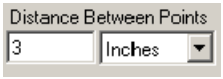
2 Click on **SET POINT #1**.

3 Within the video image, left-click on the other end of the known object.



4 In the Calibration dialog, click on **SET POINT #2**.

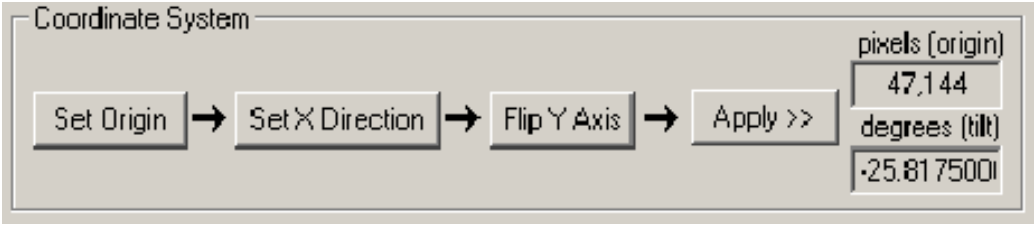
5 Type the distance between the points and choose the unit of measure from the drag-down list (e.g. inches, meters, etc.).



6 Click on **APPLY** button to set the scale factor.

7 The current values will now apply to the currently open recording, until either the recording is closed, or the calibration settings are saved or loaded.

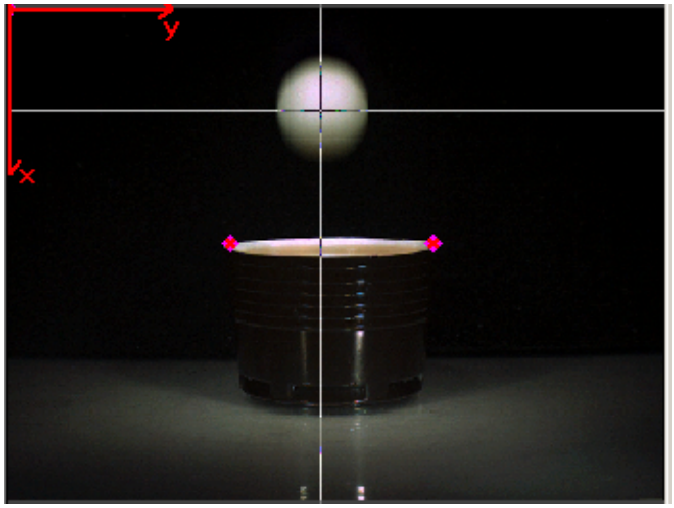
Calibrating the Coordinate System (Advanced and Deluxe versions only)



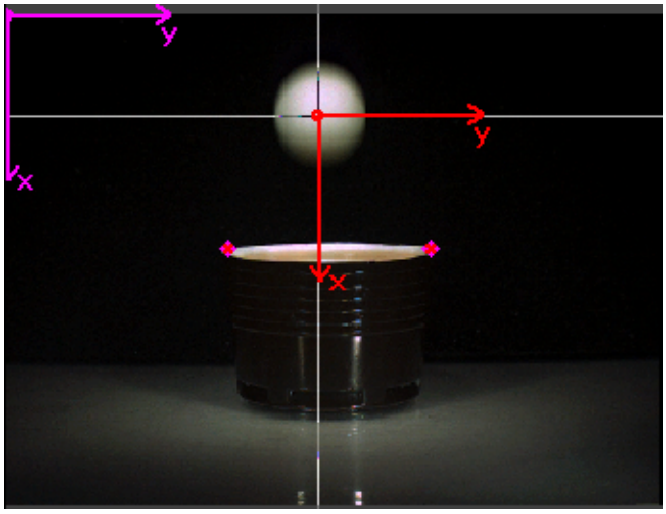
The coordinate system is defined to include the origin (0,0 point) and the X,Y axes. The coordinate system is used in the motion analysis of video.

To calibrate the origin and axes of the coordinate system:

1 Choose a point in the image that will serve as the origin of your coordinate system. Left-click on one end of the object, using the reticle as a guide.



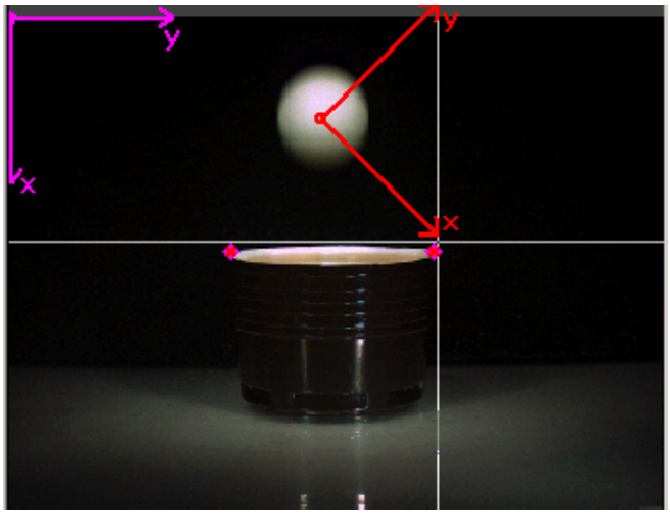
2 On the Calibrate tab, click on **SET ORIGIN**. The coordinate system marker moves such that its 0,0 position is on the selected point. Note that the moved marker is shown in red and the original marker position is shown in purple.



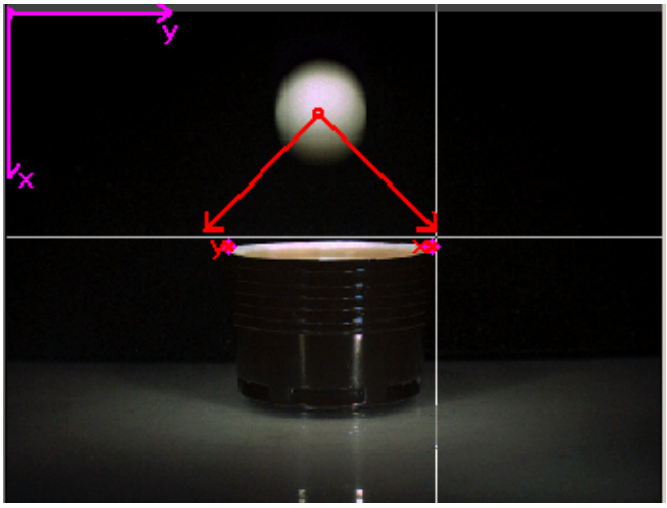
3 Determine the appropriate positive X-axis direction, and left-click anywhere in the image in that direction. The coordinate X,Y markers will rotate to align the X direction with the new reticle position.

4 On the Calibrate tab, click on **SET X-DIRECTION**. .

5 In the image, the coordinate markers will automatically rotate to align the X axis between the origin and the current point.



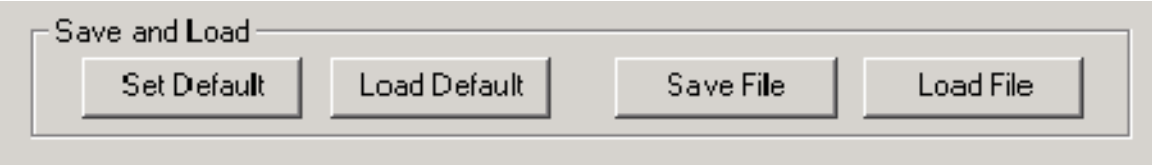
6 A default Y-axis will also be drawn at a right angle to the X-axis. To flip the Y axis (e.g. reverse the positive Y direction), click on the **FLIP Y AXIS** button in the Calibrate tab.



7 Click on **APPLY** to set the calibration. The origin location and the tilt degrees are shown in the text boxes on the right side of the Calibrate tab.

Saving and Loading Calibration Settings (Advanced and Deluxe versions only)

The calibration values that are set using the **CALIBRATE SCALE** or **CALIBRATE COORDINATE SYSTEM** buttons only apply to the current recording, and even then, only until the recording is closed. To keep the values as defaults for all future measurements, click on the **SET DEFAULT** button in the Calibrate tab .



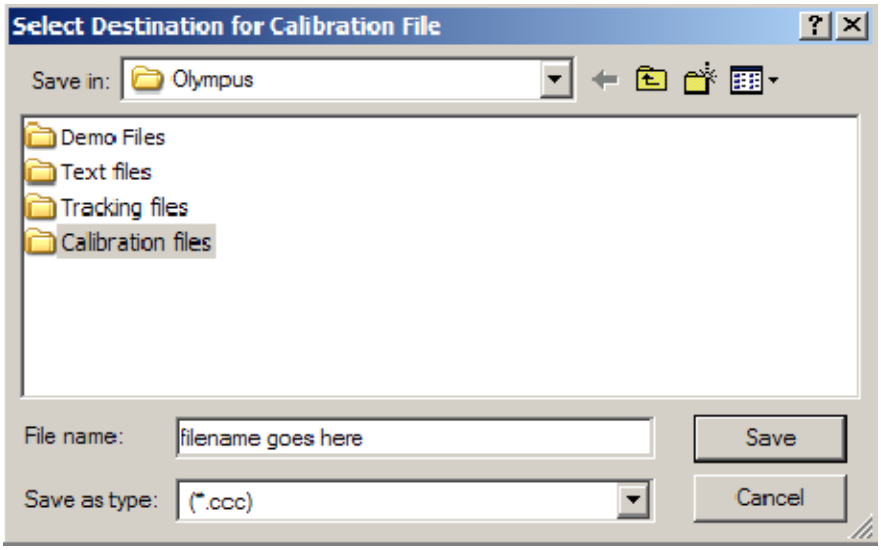
To re-load the default calibration settings (e.g. after experimenting or if you wish to change the analysis positions), click on the **LOAD DEFAULT** button . The default calibration settings will apply.

You may wish to have different calibration settings for different recordings, rather than only one default set.

To save the current calibration values to disk at any time, click on **SAVE FILE** button in the Calibrate tab..

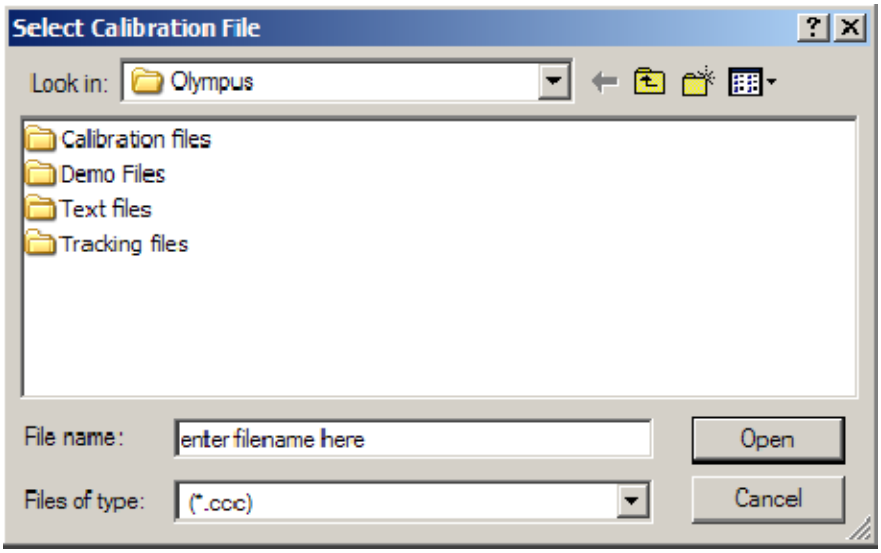
The Select Destination for Calibration File dialog box appears:

Enter the filename and click on the SAVE button. Calibration files are saved as *.CCC file.



Calibration files can be applied to any image at any time. Only one file can be applied to an image at any time. To load a previously stored calibration onto an image, click on the **LOAD FILE** button in the Calibrate tab. .

The Select Calibration File dialog window appears.

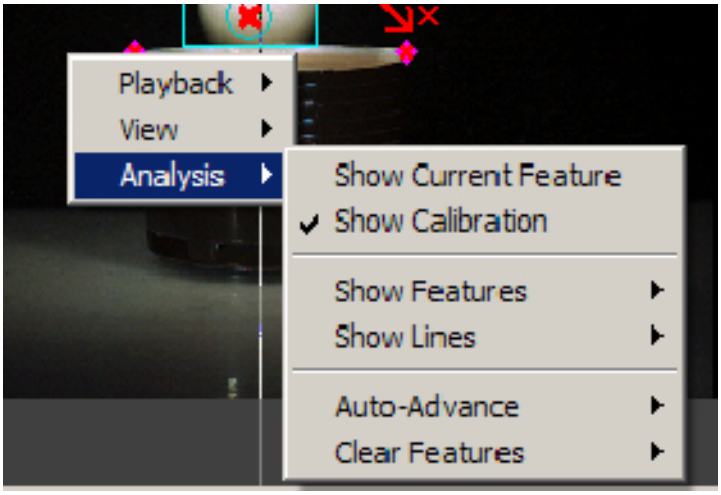


Select the calibration file you wish to apply to the image and click on **OPEN** button.

Displaying Calibration Marker (Advanced and Deluxe versions only)

The calibration marker can be toggled on and off the video in the Working View at any time -- for example, during image processing, during analysis or during normal viewing.

The visibility of the calibration marker is controlled via the right-click contextual menu. To enable or disable the visibility of the calibration marker, right click anywhere within the video, select Analysis, then Show/Hide Calibration.



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Analyzing Motion

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Analyzing Motion

Overview of Motion Analysis

Motion analysis is performed in the Working View. The process of analyzing motion contains the following steps:

- Image processing
- Point-by-point or automatic feature tracking
- Analysis and calculations
- Graphing

Manual vs. Automatic Tracking

"Tracking" is the ability to select a distinct feature and determine its frame-by-frame motion characteristics (e.g. position, velocity, etc.) over time, with respect to the plane of the image.

There are two general methods of tracking:

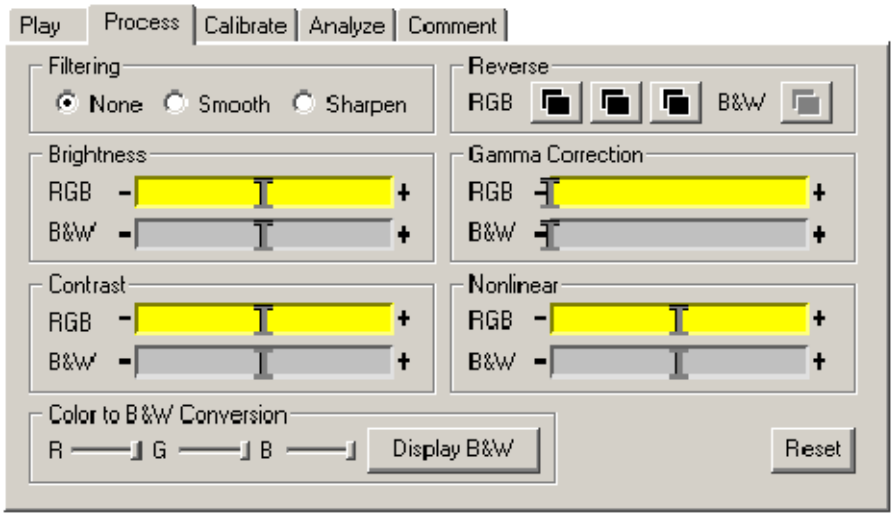
1 **"Automatic Tracking"** (often shortened to Auto-Tracking) requests that the user select the feature to be tracked in the initial frame only. The *i-SPEED* PC Software then steps through the video image, frame by frame, and automatically finds the selected feature. When it finds a match from the originally selected feature in subsequent frames, it highlights the location of the feature per frame and stores the positions in the database. Automatic tracking is the most effective and expeditious solution for most applications.

2 **"Manual Tracking"** requires the user to manually step through the video one frame at a time, using the mouse to select the location of the feature in each frame. The manual tracking method is preferable for low-quality images or very irregular feature paths not suitable for auto tracking.

Image Processing

To optimize the success of tracking an image, users must generally first perform some form of image processing.

To optimize the image via image processing, click on the Process tab in the working view.



The Process tab contains features and controls for modifying, enhancing, sharpening and processing an image. These functions help optimize images for tracking by highlighting the features to be tracked and suppressing the effects of the background. The goal for image processing is to improve the ability of the *i-SPEED* PC Software's auto-tracking algorithms to find the features on each frame.

It should be noted that the tracking algorithm looks for correlation of pixel patterns. So, features with high contrast-to-noise ratios are always desirable. By modifying the image using the functions of the Process tab, you are improving the likelihood of achieving a high correlation factor between a pattern of pixels and the desired initial feature. The image processing settings are used during the tracking process.

The Process tab provides the following features:

- Filtering (smoothing, sharpening)
- Brightness
- Contrast
- Gamma Correction
- Nonlinear palette
- Conversion from color to monochrome
- Individual RGB channel palette settings
- Reversal of color images
- Reversal of monochrome images

Calibration

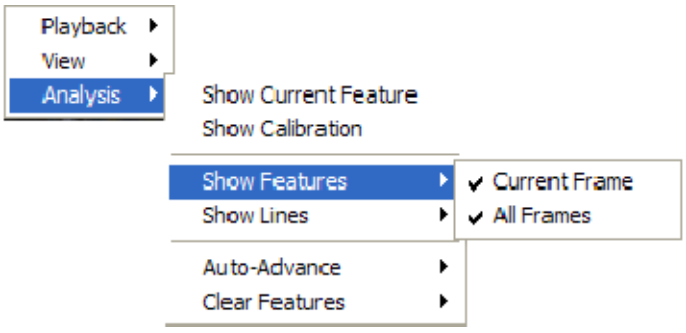
Images are expressed in pixels, as presented from the *i-SPEED* camera. In order to convert your images from pixels to units of inches, meters, millimeters, etc., you must calibrate the image. The *i-SPEED* PC Software provides calibration tools for the following functions:

- Linear scaling
- Coordinate system
- Origin location

The calibration functions are described in detail in Section 14 of this User Manual.

Context Menu Shortcuts

The *i-SPEED* PC Software contains contextual menu shortcuts to common operations. To access the contextual menus for motion analysis, right-click within the working view image. The following menu appears:



The ability to toggle features on/off, view lines, and clear the image of tracking point indicators are available via the context menu.

Basic, Advanced and Deluxe Versions

The Basic version *i-SPEED* PC Software module allows you to calibrate, process and manually click on features with your mouse within each video frame. The X,Y position of each click is recorded. The database can then be exported to Excel or a text file with the frame number and time position.

The Advanced and Deluxe versions *i-SPEED* PC Software add improved calibration, image processing and graphing features and allow automatic tracking of user-defined features. These versions also export tracked data to an Excel spreadsheet or text file in the same fashion as with the manual tracking.

The following matrix shows the features included in the three versions.

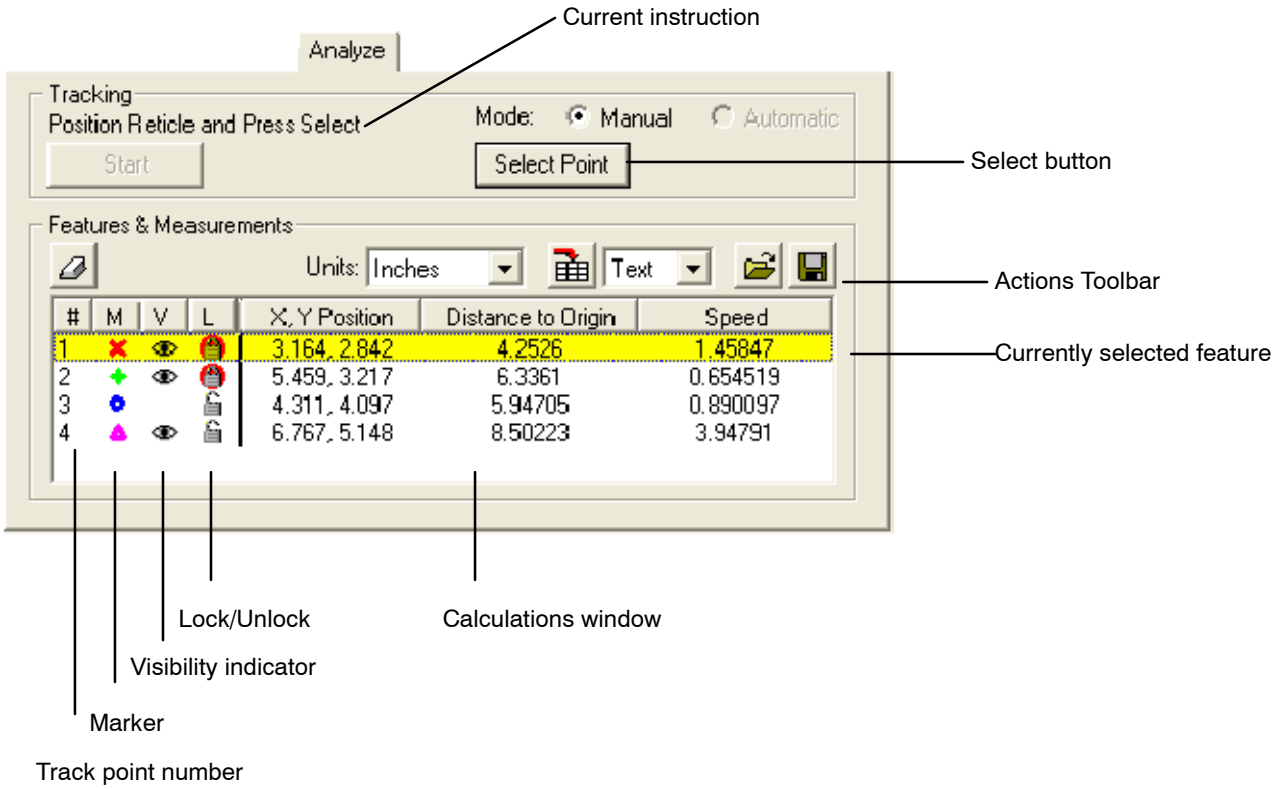
		Basic	Advanced	Deluxe
Tracking	4-point Manual Tracking	✓	✓	✓
	1-feature Automatic Tracking		✓	
	4-feature Automatic Tracking			✓
	Ability to add/remove number of features			✓
Image Processing	Brightness, Contrast, Gamma Controls	✓	✓	✓
	Non-linear image scaling	✓	✓	✓
	Color to monochrome conversion, reversal	✓	✓	✓
	Saving/Loading configurable settings		✓	✓
Calibration	Standard 2-D calibration	✓	✓	✓
	Enhanced/configurable 2-D calibration		✓	✓
Display and Graphing	Real Time velocity, distance, position	✓	✓	✓
	On-screen graphing		✓	✓
	Melding of user data and analysis graphs		✓	✓
Exporting	Export to Excel directly	✓	✓	✓
	Export to other programs (via file)	✓	✓	✓

Manually tracking features

Manual tracking requires the user to manually step through an image sequence (avi movie or sequentially numbered series of tiff, bitmap or jpeg images) one frame at a time, using the mouse to select the location of the feature in each frame. The manual tracking method is preferable for low-quality images or very irregular feature paths not suitable for auto tracking.

The Manual Tracking Tab

The manual tracking tab has the following components:



Current instruction

The text in this location changes to instruct the user as to the next procedural action. This guide facilitates the process.

Select Point button

Pressing this button registers the X,Y position of the reticle into the database for the currently selected feature.

Currently selected feature

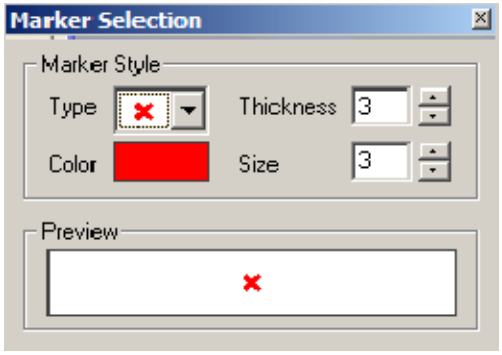
The currently selected feature (point) is highlighted in yellow. If you are using the Deluxe version of the *i-SPEED* PC Software, you can old down the CTRL or Shift buttons to select and deselect multiple features at the same time for editing (adding or removing) this window.

Track point number (#)

The feature number. Hold down the CTRL or Shift buttons to select and deselect multiple features at the same time.

Marker (M)

The marker assigned to each feature. Double clicking on the marker will bring up the feature editor window



In the feature editor window, users can select the type and color of each marker, the thickness of the lines and the size of the marker. Use this tool to combine similar features (e.g. elbow, wrist and shoulder) of an object or to improve visibility of the marker against the background.

Visibility Indicator (V)

Click on this icon to show/hide the denoted marker on the image. This tool is valuable when tracking multiple points or objects that cross each other. Hiding markers helps understand motion.

Lock/Unlock (L)

Click on this icon to lock or unlock the selected feature. When a feature is locked, any of the tracked points for this feature cannot be modified. The feature will also be skipped in any auto-advance cycle.

The Calculations Window

The position, distance moved and speed (magnitude of the velocity) of the object are displayed in this window. These items are not editable by the user.

Actions Toolbar

This toolbar contains icons for common user actions during manual tracking.



The functions include:

- Clear Tracked Points for Selected Features

Clicking on this button erases all the tracked points for the currently selected feature (highlighted in yellow).

Units

The units of measure for displaying the calculations in the calculations window. Units include pixels, inches, feet, meters, millimeters, centimeters. Units do not need to be the units of calibration – for example, calibrate the image in inches, display calculations in feet or meters.

Export to 

:

Clicking on this button causes the current database of tracked points to be exported to either Microsoft Excel or a text file, as selected in the drag-down box. Microsoft Excel must be loaded on the computer. Each row of the export file corresponds to a frame of video, with the time and frame number in the first two fields followed by a series of X,Y coordinates for each feature.

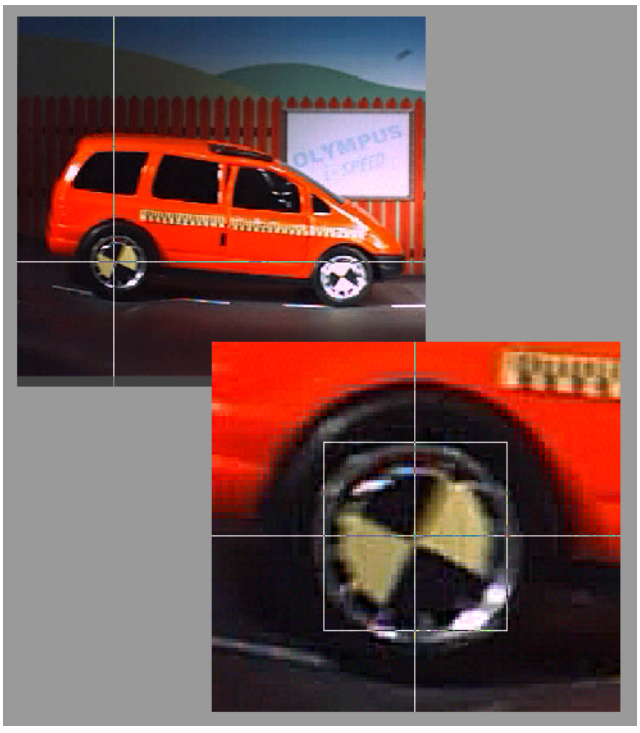
Load Track Results from File, Save Track Results to File  :

Clicking on these buttons causes the *i-SPEED* PC Software to store the tracked points with the video. When the video is opened again, the tracked points will automatically appear overlaid on the video. You can also save tracked points and open the file on another video for comparison of motion between files. This is an ideal technique for comparing current motion with a pre-defined master motion.

Manual Tracking Procedure

The process for manually tracking a feature through an image sequence is as follows:

1. Click on the Start button .
2. Select **MANUAL** mode
3. If you are using the Deluxe version of the *i-SPEED* PC software, click on the Add or Remove features buttons in the toolbar until you have the desired number of feature trackers. If you are using the Basic or Advance version of the *i-SPEED* PC software, click on the Lock/Unlock icon for each feature you wish to use.
4. Navigate through the recording video to the desired frame, using either the playback controls.
5. Highlight the feature of interest.
6. In the image, place the crosshairs (reticle) on the feature of interest. Use the zoom feature to zoom in on the feature for greater accuracy.



7 Click on the **SELECT POINT** button. or hold down the CTRL-SHIFT keys and click with the mouse.

8 *i-SPEED* PC Software places the active feature marker on the selected location for this frame. The blue circle ⊕ denotes the marker(s) associated with the current frame.

9 Repeat steps 5,6, and 7 for the each unlocked feature in the list. The *i-SPEED* PC Software will automatically advance to the subsequent feature if the auto-advance feature is enabled. To enable/disable this feature, right-click within the image, select Analysis, then Auto-Advance Feature on/off.

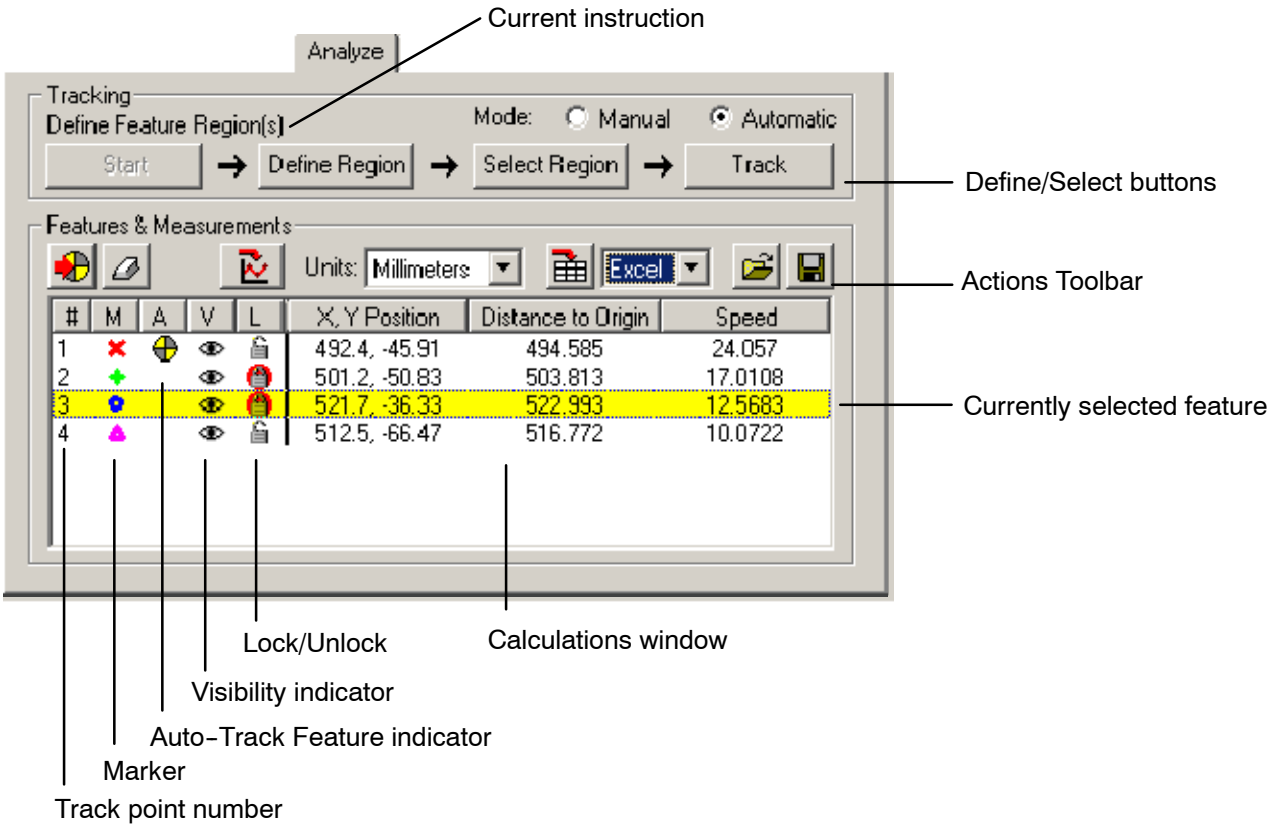
10 Advance to the next frame and repeat steps 5,6 and 7. The *i-SPEED* PC Software will automatically advance to the next video frame if the auto-advance feature is enabled. To enable/disable this feature, right-click within the image, select Analysis, then Auto-Advance Frame on/off.

Automatically tracking features (Advanced/Deluxe Versions)

Automatic Tracking uses a modified template tracking algorithm to track patterns through a video sequence. A tracking template is a group of pixels within the image. Tracking templates are also referred to as “features” or “regions” of an image. The *i-SPEED* PC Software automatically steps through the video image, frame by frame, to find a pattern to the user-selected tracking template. When the correlation tracking algorithm finds a match, it highlights the location of the feature and continues to the next frame. If no adequate match is found or the video reaches the end, the *i-SPEED* PC Software discontinues automatic tracking. In such a situation, the user can set a new tracking template in the frame in which the previous template was lost and resume tracking. Automatic tracking is the most effective and accurate tracking technique for most applications.

The Automatic Tracking Tab

The automatic tracking tab has the following components:



Current instruction

The text in this location changes to instruct the user as to the next procedural action. This guide facilitates the process.

Define/Select buttons

This sequence of buttons, separated by arrows, is used to define a region around the feature, select the region and then track the selected regions.

Currently selected feature

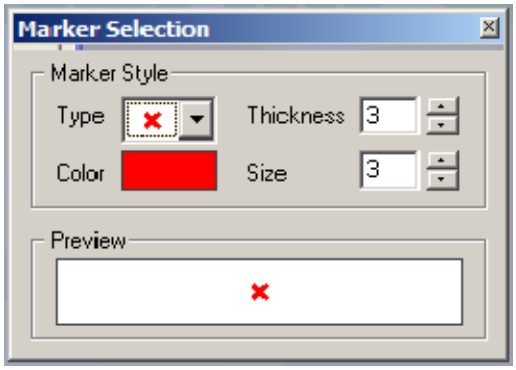
The currently selected feature is highlighted in yellow. If you are using the Deluxe version of the *i-SPEED* PC Software, you can old down the CTRL or Shift buttons to select and deselect multiple features at the same time for editing (adding or removing) this window.

Track point number (#)

The feature number. Hold down the CTRL or Shift buttons to select and deselect multiple features at the same time.

Marker (M)

The marker assigned to each feature. Double clicking on the marker will bring up the feature editor window



In the feature editor window, users can select the type and color of each marker, the thickness of the lines and the size of the marker. Use this tool to combine similar features (e.g. elbow, wrist and shoulder) of an object or to improve visibility of the marker against the background.

Auto-Track Feature Indicator

This icon shows you which features are set to auto-track and which are set to manually track. If the bow-tie target is visible for the feature, then this feature will be automatically tracked when the user presses the Track button. If the bow-tie target it is not visible, then this feature will not be automatically tracked.

To select or features to include in the auto-tracking process, click on the Set Feature to Auto Track button in the Actions Toolbar.

Visibility Indicator (V)

Click on this icon to show/hide the denoted marker on the image. This tool is valuable when tracking multiple points or objects that cross each other. Hiding markers helps understand motion.

Lock/Unlock (L)

Click on this icon to lock or unlock the selected feature. When a feature is locked, any of the tracked points for this feature cannot be modified. The feature will also be skipped in any auto-advance cycle.

The Calculations Window

The position, distance moved and speed (magnitude of the velocity) of the object are displayed in this window. These items are not editable by the user.

Actions Toolbar

This toolbar contains icons for common user actions during manual tracking.



The functions include:

Set Feature to Auto Track

Clicking on the button causes the currently selected feature (highlighted in yellow) to become an auto-track feature. All features that are designated as auto-track features will be included in the auto-track routine when the user presses the Track button. In the Deluxe version of the *i-SPEED* PC Software, clicking on this button toggles the auto-track selection on/off. In the Advanced version, one feature is always designated as auto-track. There is no auto-track capabilities in the Basic version.

Clear Tracked Points for Selected Features

Clicking on this button erases all the tracked points for the currently selected feature (highlighted in yellow).

Update Graph 

Clicking on this button updates the graph with the most current track points.

Units

The units of measure for displaying the calculations in the calculations window. Units include pixels, inches, feet, meters, millimeters, centimeters. Units do not need to be the units of calibration – for example, calibrate the image in inches, display calculations in feet or meters.

Export to  :

Clicking on this button causes the current database of tracked points to be exported to either Microsoft Excel or a text file, as selected in the drag-down box. Microsoft Excel must be loaded on the computer. Each row of the export file corresponds to a frame of video, with the time and frame number in the first two fields followed by a series of X,Y coordinates for each feature.

Load Track Results from File, Save Track Results to File  :

Clicking on these buttons causes the *i-SPEED* PC Software to store the tracked points with the video. When the video is opened again, the tracked points will automatically appear overlaid on the video. You can also save tracked points and open the file on another video for comparison of motion between files. This is an ideal technique for comparing current motion with a pre-defined master motion.

Automatic Tracking Procedure

The process for manually tracking a feature through an image sequence is as follows:

1 Click on the Start button 

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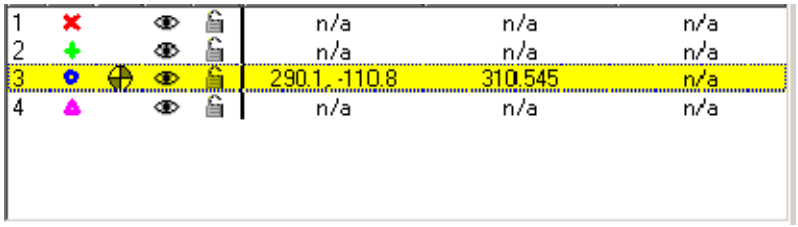
2 Select **Automatic** mode 

3 If you are using the Deluxe version of the *i-SPEED* PC software, click on the Add or Remove features buttons in the toolbar until you have the desired number of feature trackers. If you are using the Basic or Advance version of the *i-SPEED* PC software, click on the Lock/Unlock icon for each feature you wish to use.

4 Highlight each feature that you wish to auto-track and click on the Set Feature to Auto Track  button.

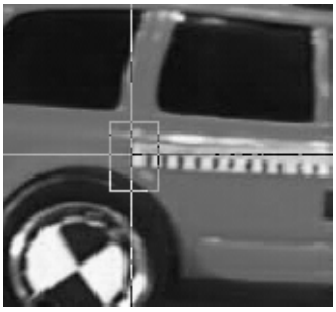
5 Navigate through the recording video to the desired frame, using either the playback controls or the contextual menu shortcuts.

6 Highlight the feature of interest (highlighted features have a yellow background)



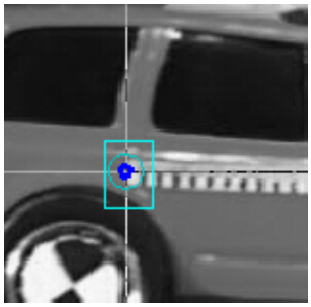
7 Click on the Define Region button. 

8 Using the mouse, draw a box around the feature to auto-track. This is the “tracking template”.



9 Click on the **SELECT REGION** button Select Region or hold down the CTRL-SHIFT keys and click with the mouse.

10 *i-SPEED* PC Software places the active feature marker on the selected location for this frame. The blue circle ⊕ denotes the marker(s) associated with the current frame. The blue box denotes that the initial template location.



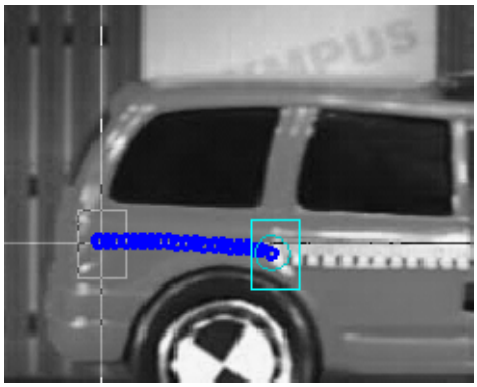
11 Repeat steps 6-9 for the each unlocked, auto-track designated feature in the list. The *i-SPEED* PC Software will automatically advance to the subsequent feature if the auto-advance feature is enabled. To enable/disable this feature, right-click within the image, select Analysis, then Auto-Advance Feature on/off.

12 Click on the Track button Track. The *i-SPEED* PC Software will track all auto-track designated objects.

13 While tracking, the Track button will change to a Stop button

14 Stop. Clicking on this Stop button will stop the tracking at its current location. Otherwise, *i-SPEED* PC Software will continue to track until it can no longer find a good template match or it reaches the end of the video sequence.

15 When complete, the image will show all the tracked points.



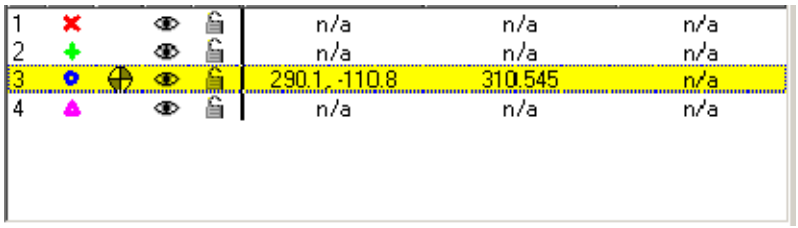
Restarting auto-tracking after stop

If the automatic tracking process stops due to a natural template loss, you may continue to track a point manually or automatically. To continue tracking this object manually, select **MANUAL** mode Mode: Manual and follow the instructions for manual tracking of objects.

To continue tracking this feature automatically, you must reset your tracking template at the frame where the feature was lost.

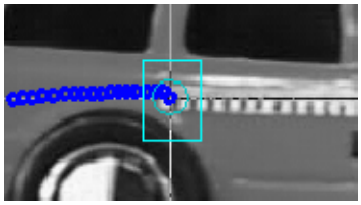
1 Using the playback controls, navigate through the recording video to the last frame containing a successful track (e.g. the frame just prior to the stoppage).

2 Highlight the feature of interest (highlighted features have a yellow background)



3 Click on the Define Region button. 

4 Using the mouse, draw a box around the feature to auto-track. This is the new"tracking template".



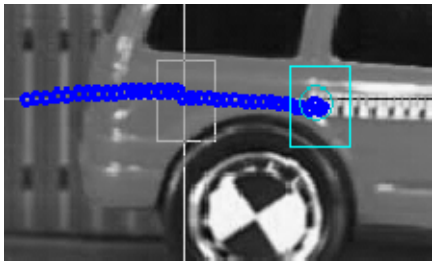
5 Click on the **SELECT REGION** button 

or hold down the CTRL-SHIFT keys and click with the mouse.

6 Click on the Track Button 

.

7 The displayed data will appear as though it was one continuous feature track sequence instead of a restarted series of auto-track.

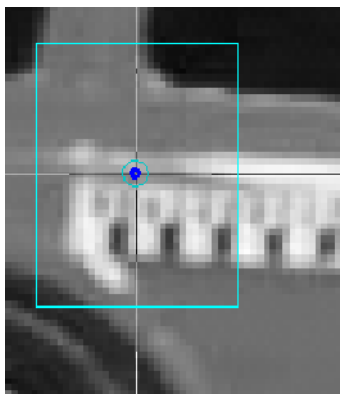


Creating optimum tracking templates

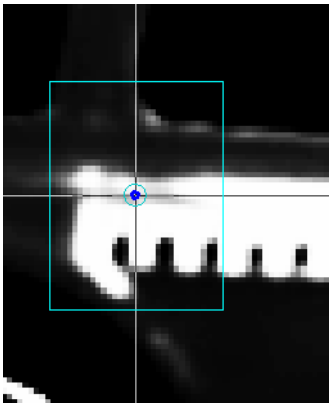
The *i-SPEED* PC Software tracking algorithms use all image processing settings in the calculation of the correlation ratio between the current frame the original tracking template. Therefore, the potential success at tracking objects (features) is based heavily on the quality of processed image presented to the algorithm.

The following are suggestions for optimizing the tracking template:

- Display color images as Black/White images unless the feature to be tracked is color dependent. The algorithms convert images to 8-bit monochrome automatically.
- Make tracking templates asymmetric in both X and Y directions. This will increase the probability of only one solution to the pattern match.



- Use the image processing brightness, contrast and nonlinear controls to strengthen the white portions of the tracking template while darkening the background.



- Find features that are not changing drastically from frame to frame. The *i-SPEED* PC Software looks for high correlation from frame to frame. Features that are rotating quickly or changing from frame to frame (e.g. going in/out of shadows) are more likely to fail.

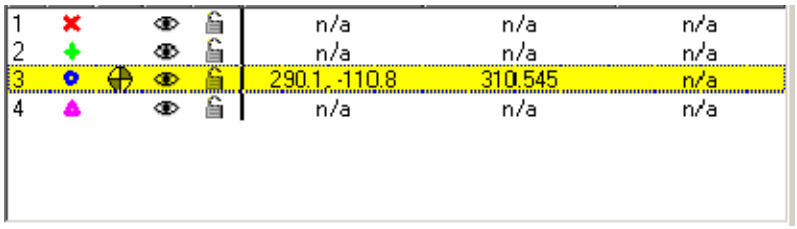
Manually repairing automatically tracked data

At any time, you can repair or replace tracked data points. Since only one tracked point per feature can exist per frame, all changes to the tracking data automatically replaces previous data.

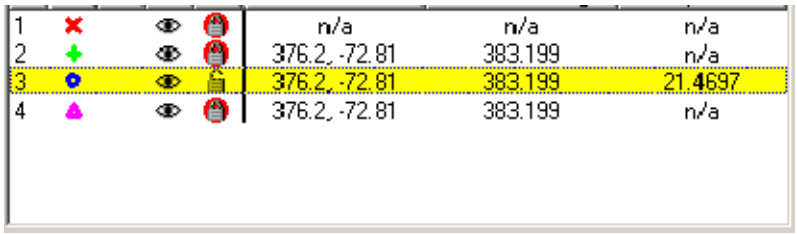
Therefore, you can use a modified manual tracking routine to repair incorrect data, as follows:

1 Select **MANUAL** mode 

2 Highlight the feature of interest.

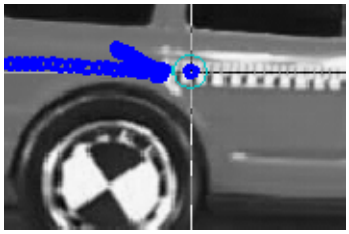


3 Using the Lock/Unlock feature unlock the feature of interest and lock all other features.



4 Navigate through the recording video to the desired frame, using either the playback controls.

5 In the image, place the crosshairs (reticle) on the feature of interest. Use the zoom feature to zoom in on the feature for greater accuracy, if necessary.

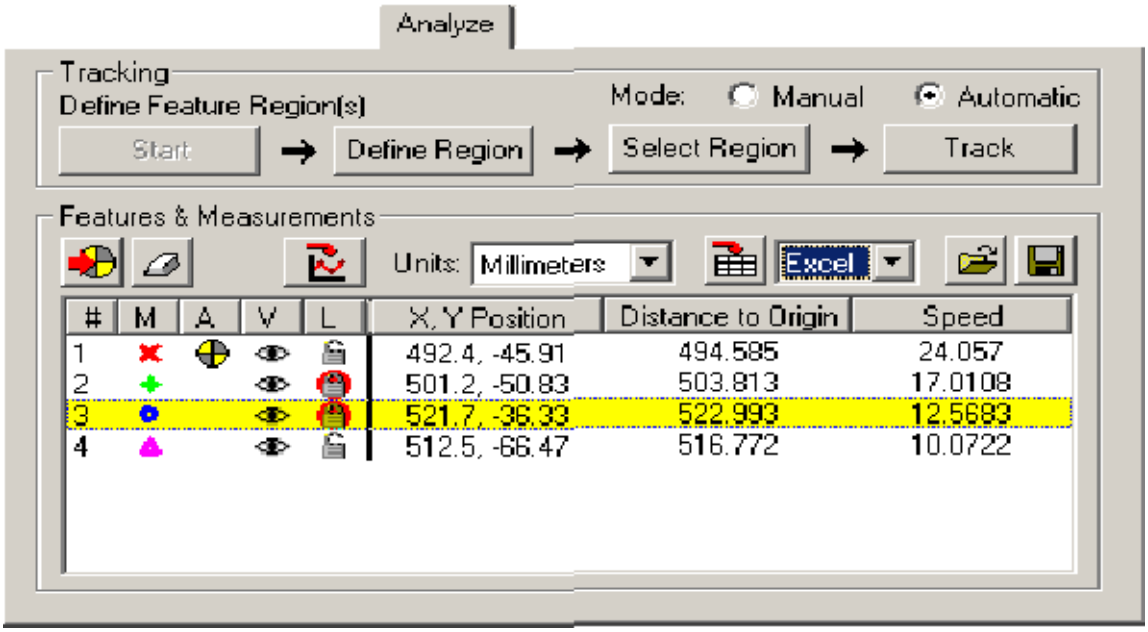


6 Click on the Select Point button. 

7 Repeat this process for each track point that you wish to repair. At any time, you may switch to automatic tracking.

Displaying position, distance and velocity

Location, distance and velocity are displayed in real time in the calculations window of the Analysis tab.



X,Y Position

Location is presented from the user-defined origin, as set in the Calibrate tab. In the absence of user calibration, the location is presented from the 0,0 point – the upper left corner – of the sensor.

Distance to Origin

The distance from the current point to the user-defined origin, in user-selected units. In the absence of user calibration, the location is presented from the 0,0 point – the upper left corner – of the sensor.

Speed

The distance that the point has moved from the previous frame to the current frame, in user-selected units, divided by the time between frames. The distance moved is always a positive number.

Exporting Motion Analysis

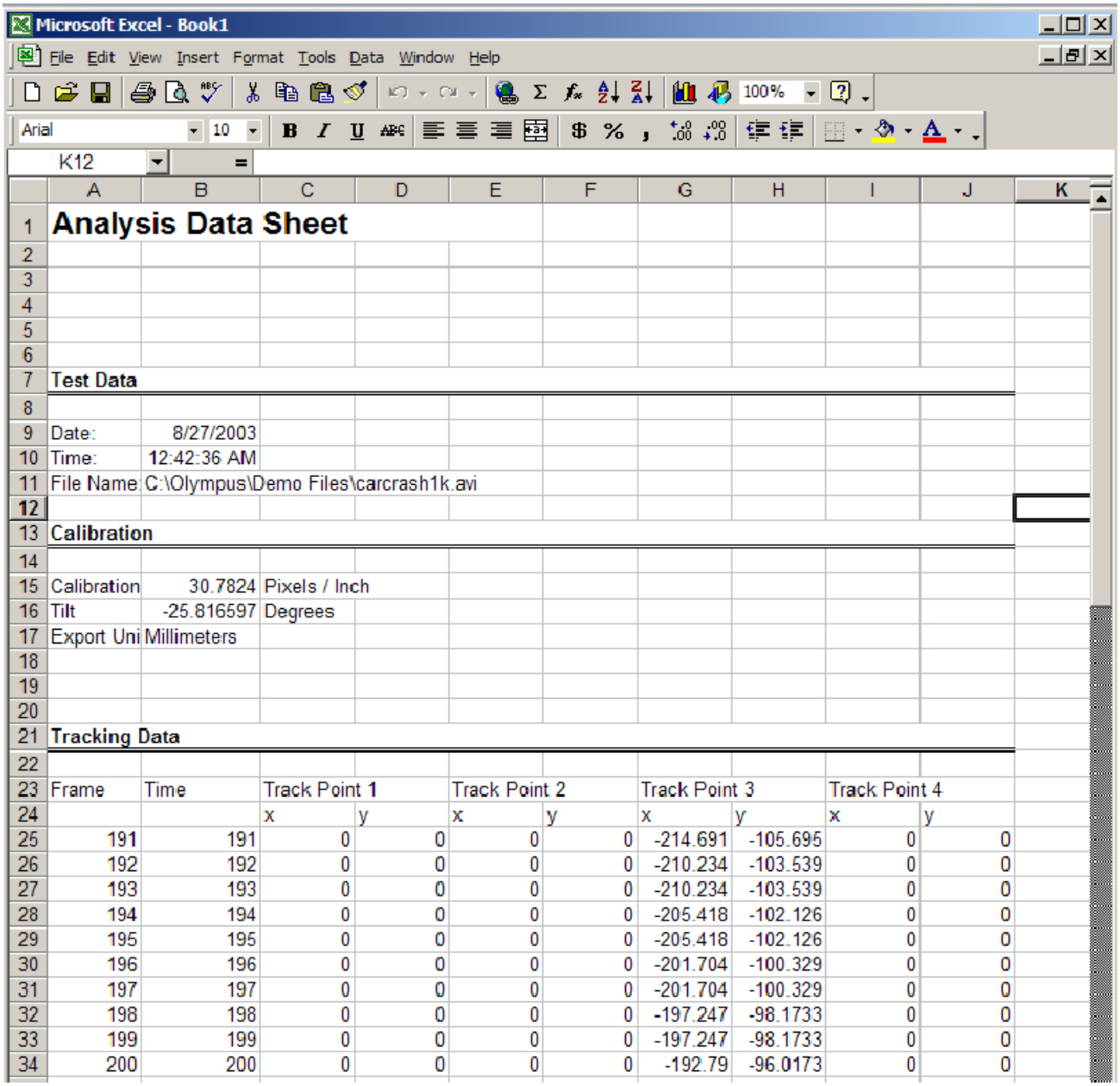
Tracked point data may be exported for more detailed motion analysis and calculations with other scientific programs. There are two options for exporting within *i-SPEED* PC Software – Export to Excel and Export to Text.

Export to Excel

To export data to an Excel spreadsheet, set the export destination to Excel from the drag down menu box on the Action Toolbar, and click the Export button. 

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Microsoft Excel will be launched automatically and a new workgroup created. In the first worksheet of the workgroup, the tracked points will be exported. The worksheet looks like the following:



Microsoft Excel - Book1

File Edit View Insert Format Tools Data Window Help

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	A	B	C	D	E	F	G	H	I	J	K
1	**Analysis Data Sheet**										
2											
3											
4											
5											
6											
7	**Test Data**										
8											
9	Date:	8/27/2003									
10	Time:	12:42:36 AM									
11	File Name:	C:\Olympus\Demo Files\carcrash1k.avi									
12											
13	**Calibration**										
14											
15	Calibration	30.7824	Pixels / Inch								
16	Tilt	-25.816597	Degrees								
17	Export Uni	Millimeters									
18											
19											
20											
21	**Tracking Data**										
22											
23	Frame	Time	Track Point 1		Track Point 2		Track Point 3		Track Point 4		
24			x	y	x	y	x	y	x	y	
25	191	191	0	0	0	0	-214.691	-105.695	0	0	
26	192	192	0	0	0	0	-210.234	-103.539	0	0	
27	193	193	0	0	0	0	-210.234	-103.539	0	0	
28	194	194	0	0	0	0	-205.418	-102.126	0	0	
29	195	195	0	0	0	0	-205.418	-102.126	0	0	
30	196	196	0	0	0	0	-201.704	-100.329	0	0	
31	197	197	0	0	0	0	-201.704	-100.329	0	0	
32	198	198	0	0	0	0	-197.247	-98.1733	0	0	
33	199	199	0	0	0	0	-197.247	-98.1733	0	0	
34	200	200	0	0	0	0	-192.79	-96.0173	0	0	

The following is the organization of the worksheet:

Row 1: Title
Row 7: Sub-title “Test Data”
Row 9: Date of worksheet creation
Row 10: Time of worksheet creation
Row 11: Filename of video image
Row 13: Sub-title “Calibration”
Row 15: Scale calibration
Row 16: Tilt calibration
Row 17: Export units
Row 21: Sub-title “Tracking Data”
Row 23: Column headings
Row 25 start of tracking data

Tracking data is presented such that each row of the worksheet corresponds to a frame of video.

Column A: Frame number
Column B: Frame time
Columns C, D: X,Y position of Feature 1
Columns E, F: X,Y position of Feature 2
Columns G, H: X,Y position of Feature 3
Columns I, J: X,Y position of Feature 4

More columns are automatically added for more features.

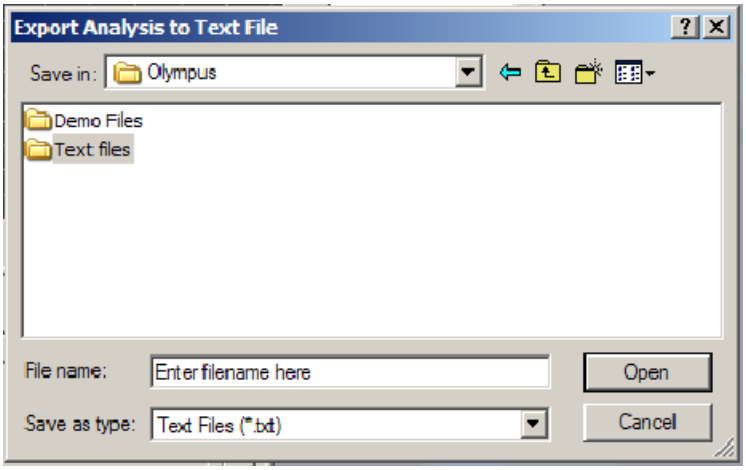
Note that the maximum number of rows allowed by Microsoft Excel is 65,560. If your video sequence has more than 65,550 frames, you cannot export to Excel (an error message will be generated). In this case, you must export to text and parse the length of the file.

Exporting to a text file

To export data to a comma-delimited text file that can be used by all known scientific analysis software packages (Matlab, Mathcad, etc.), set the export destination to Text from the drag down menu box on the Action Toolbar, and click the Export button. 

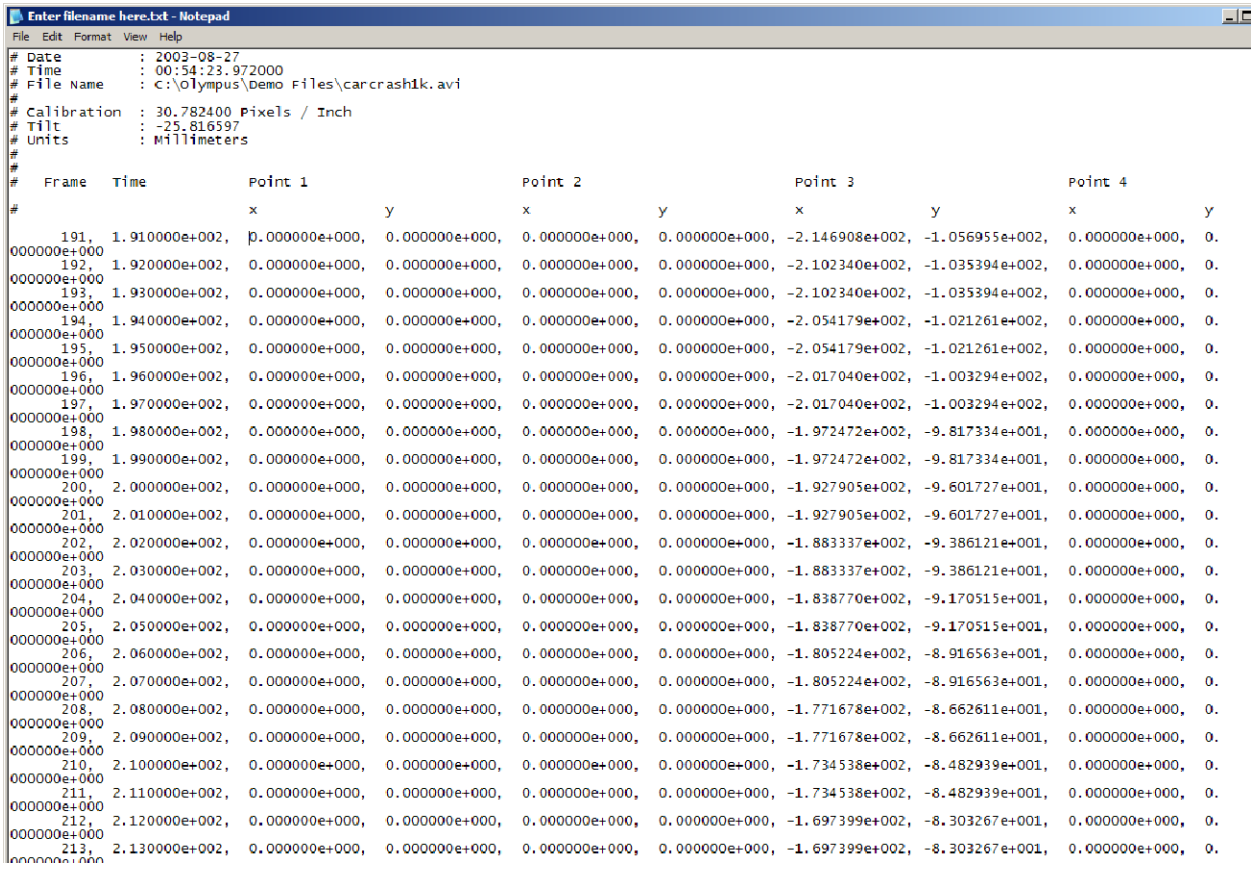
.

You will be prompted for a save destination for the text file:



Type in the filename and location. The file will be created at the prescribed destination.

The format of the text file is as follows:


Enter filename here.txt - Notepad

File Edit Format View Help

```
# Date          : 2003-08-27
# Time          : 00:54:23.972000
# File Name     : C:\Olympus\Demo Files\carcrash1k.avi
#
# Calibration   : 30.782400 Pixels / Inch
# Tilt          : -25.816597
# Units         : Millimeters
#
#
#   Frame   Time            Point 1                         Point 2                         Point 3                         Point 4
#                           x               y               x               y               x               y               x               y
      191,  1.910000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -2.146908e+002, -1.056955e+002,  0.000000e+000,  0.
000000e+000
      192,  1.920000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -2.102340e+002, -1.035394e+002,  0.000000e+000,  0.
000000e+000
      193,  1.930000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -2.102340e+002, -1.035394e+002,  0.000000e+000,  0.
000000e+000
      194,  1.940000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -2.054179e+002, -1.021261e+002,  0.000000e+000,  0.
000000e+000
      195,  1.950000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -2.054179e+002, -1.021261e+002,  0.000000e+000,  0.
000000e+000
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000000e+000
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000000e+000
      198,  1.980000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -1.972472e+002, -9.817334e+001,  0.000000e+000,  0.
000000e+000
      199,  1.990000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -1.972472e+002, -9.817334e+001,  0.000000e+000,  0.
000000e+000
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000000e+000
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000000e+000
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000000e+000
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000000e+000
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000000e+000
      205,  2.050000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -1.838770e+002, -9.170515e+001,  0.000000e+000,  0.
000000e+000
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000000e+000
      207,  2.070000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -1.805224e+002, -8.916563e+001,  0.000000e+000,  0.
000000e+000
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000000e+000
      209,  2.090000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -1.771678e+002, -8.662611e+001,  0.000000e+000,  0.
000000e+000
      210,  2.100000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -1.734538e+002, -8.482939e+001,  0.000000e+000,  0.
000000e+000
      211,  2.110000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -1.734538e+002, -8.482939e+001,  0.000000e+000,  0.
000000e+000
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000000e+000
      213,  2.130000e+002,  0.000000e+000,  0.000000e+000,  0.000000e+000,  0.000000e+000, -1.697399e+002, -8.303267e+001,  0.000000e+000,  0.
```

Line 1: Creation data
Line 2: Creation time
Line 3: Origin filename
Line 5: Scale calibration
Line 6: Tilt calibration
Line 7: Export units
Line 10: Sub-title row
Line 11: Sub-title row
Line 12: Tracking data.

Like the Excel output, the text file includes (from left to right) frame number, frame time, X,Y position for each tracked point (4 minimum).

Saving and Loading Tracked Points (Advanced and Deluxe only)

Tracked points are automatically saved in a special binary file named filename.ist, where 'filename' is the name provided by the user during saving.

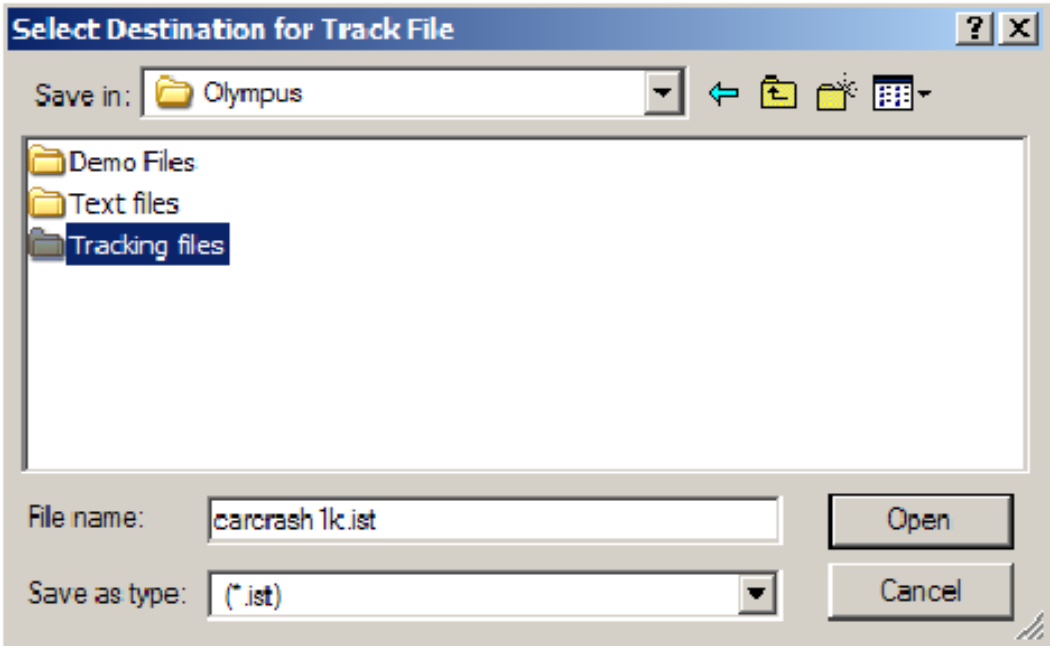
However, as an additional feature of *i-SPEED* PC software Advanced and Deluxe versions, users can save and load tracked points in separate IST files. By using the Save/Load feature, tracked points from one analysis can be overlaid onto another image for comparison and for computation of deviations or errors. This very powerful feature helps understand part motion beyond what is available with standard analysis and exporting.

To save tracked points:

1 Complete the analysis per the above-described procedures.

2 Click on the Save Track Results to File button in the Action Toolbar (Advanced and Deluxe only) 

3 You will be prompted for a destination and file name for the new IST file.



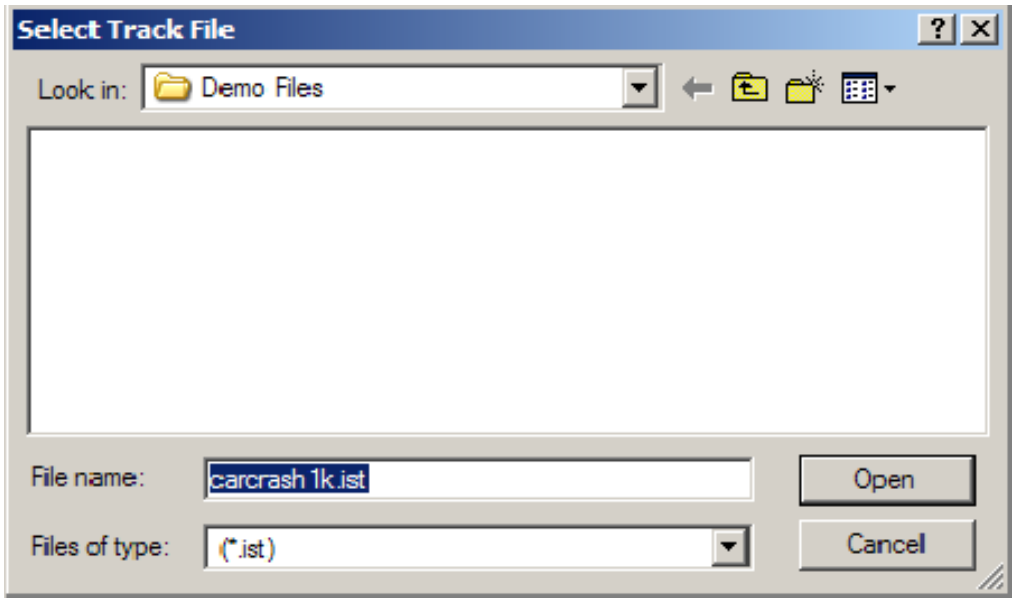
4 Type in the file name and destination.

To load previously saved tracked points:

1 Open a video sequence

2 Click on the Load Track Results from File button 

3 Select the file to load



4 Click on the Open button.

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Graphing User Data and Analysis

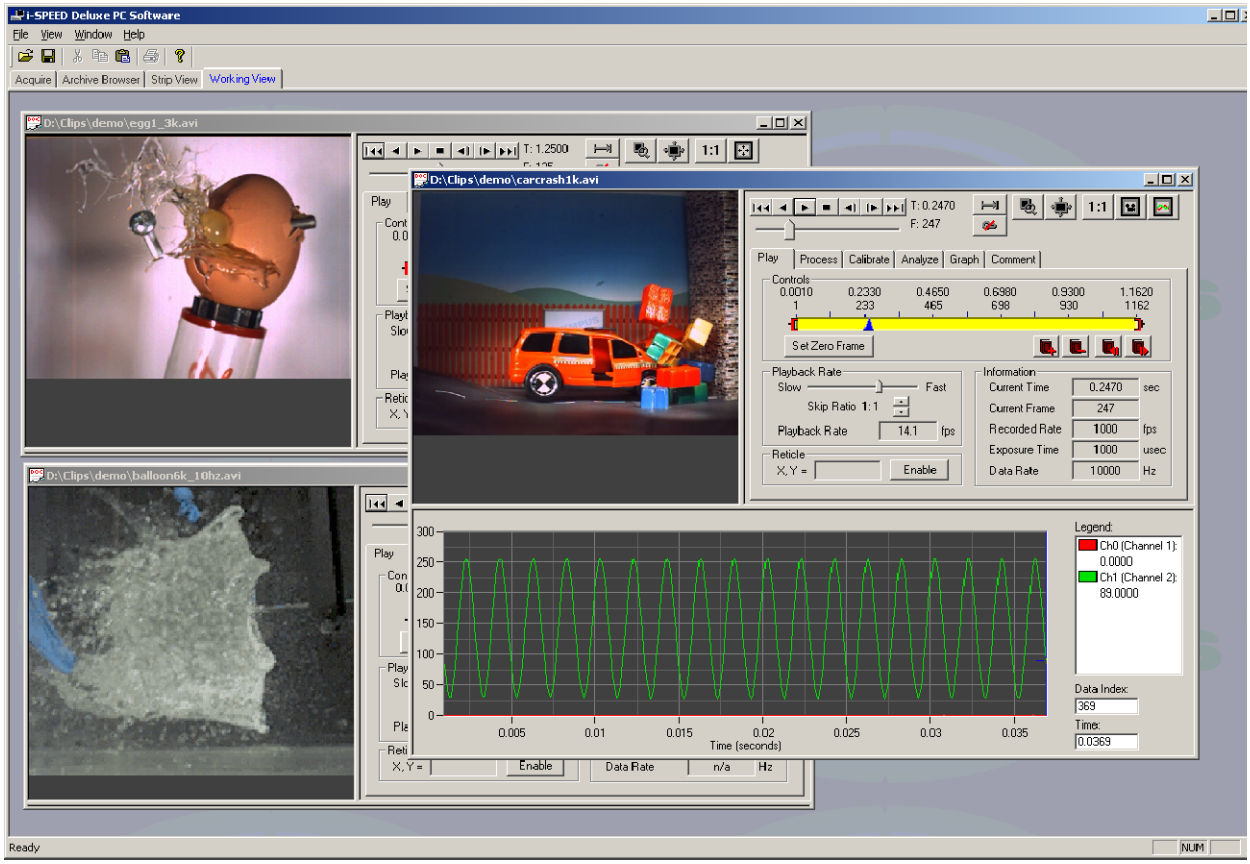
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Scaling the Visible Data 125
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Graphing User Data and Analysis (Advanced and Deluxe Versions only)

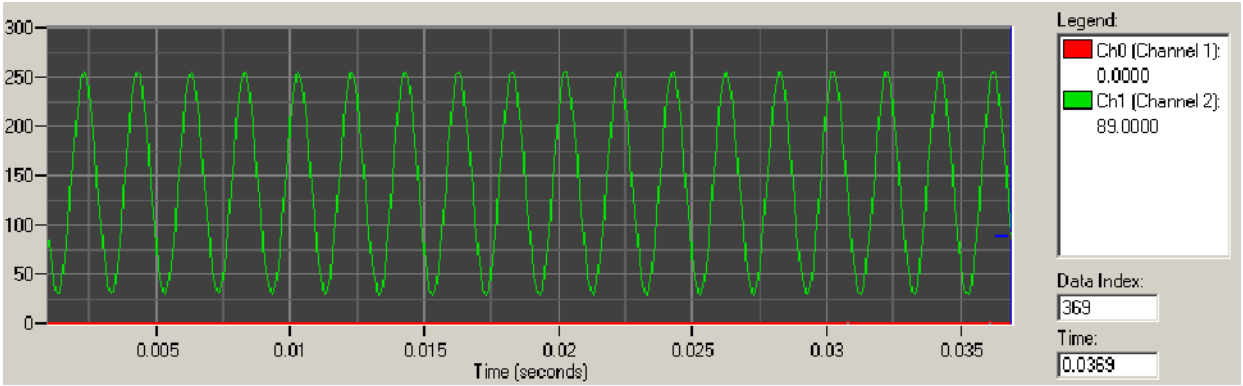
The Graph Panel

The graph panel is available with the Advanced and Deluxe versions of the software only. The graph shows both user data from sensors and motion analysis data.

The graph panel is part of the Working View. It is located below the video panel and the control panel. It is only visible when either user data is present or if motion analysis has been performed on the image from within the Analyze tab.



The graph panel is available with the Advanced and Deluxe versions of the software only. The graph shows both user data from sensors and motion analysis data.



On the right side of the graph panel are the following features:

Legend	Shows the various graph lines and color assignments
Data index	The number of the data point that is currently highlighted by the vertical blue line
Data time	The time of the data point that is currently highlighted by the vertical blue line.

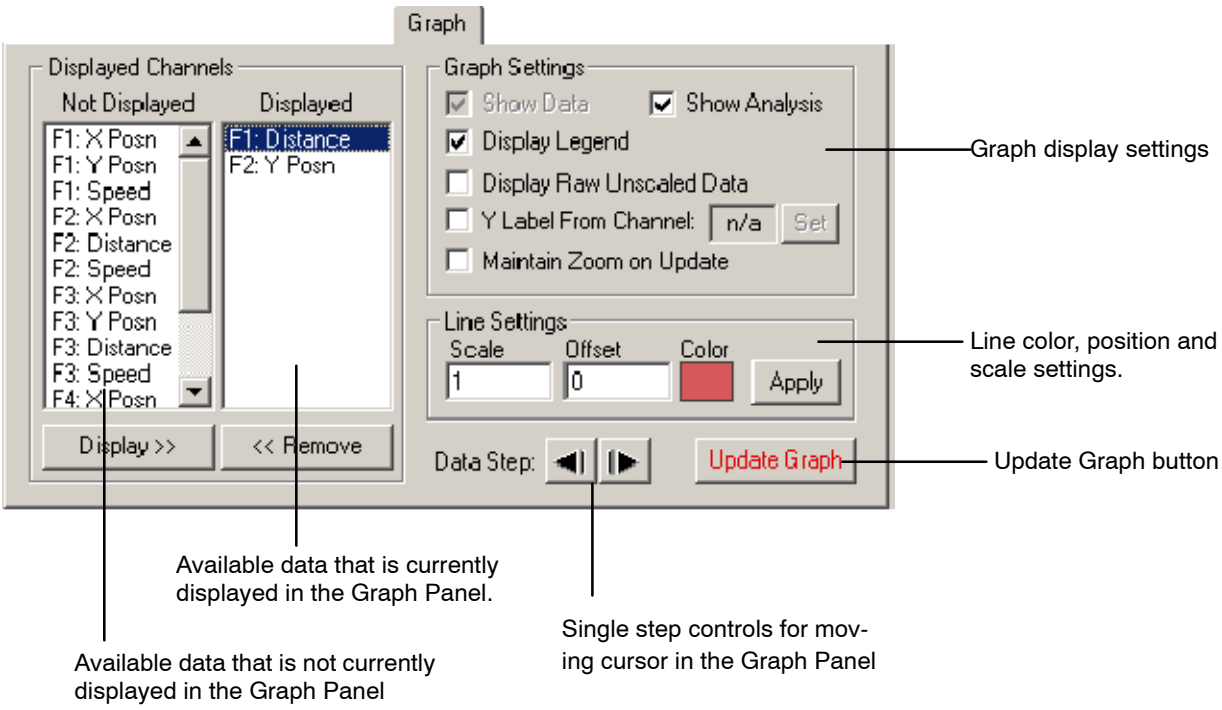
The Graphing Tab

The graphing tab is the fifth tab (left to right) in the Working View. It is only visible in the Advanced and Deluxe versions of the *i-SPEED* PC software.

In order to use the graphing tab, either (1) User Data acquired from external sensors at the same time as the video must be present or (2) you must have analyzed motion within your image using the Analyze tab. Until either of these conditions exist, the graph panel of the Working View will be hidden.

The graphing tab sets what is displayed in the graph panel and how it is displayed (colors, line width, etc.). The step controls for the graph are also located in the graphing tab.

The key components of the graphing tab are as follows:



The features of the Graphing tab are as follows:

Not Displayed Channels

Listed in this box are the data channels (either user data or analysis data) that are available for display, but are not currently displayed.

Displayed Channels

Listed in this box are the data channels (either user data or analysis data) that are currently displayed.

Display>> and <<Remove buttons

Use these buttons to select and remove channels of data to be displayed in the Graph Panel of the Working View window.

Show Data checkbox

If highlighted, then user data acquired with the video is displayed in the Channels window at left, and is available for display on the Graph Panel.

Show Analysis checkbox

If highlighted, then motion analysis data is displayed in the Channels window at left, and is available for display on the Graph Panel.

Display Legend checkbox

If selected, displays the legend in the Graph Panel. If not selected, then the legend is hidden and the graph is extended to the full length of the window.

Display Raw Unscaled Data checkbox

If selected, displays the data without any scaling factors (e.g. raw volts) or offsets.

Y Label from Channel checkbox

The Y axis of the Graph Panel is automatically set to the maximum of all selected channels. This auto-scaling allows the full visibility of graphs, but also causes some graphing to be lower resolution. If this feature is selected, the user has the opportunity to override the autoscaling and set the Y axis scale and Y axis label to any of the displayed channels.

Maintain Zoom on Update checkbox

If selected, the current zoom region is preserved even during graph updates. If not selected, the action of updating the graph results in the reset of zoom window to full size.

Line Settings

Set the visibility, offset and scale of the lines in the graph.

Data Step buttons

Single step forward and backward to see actual data values in the legend. The Display Legend checkbox must be selected for this feature to be of value.

Update Graph button

The graph is NOT redrawn every time a user input is registered. To apply your changes to the graph, click on the Update Graph button.

Zooming and Panning a Graph

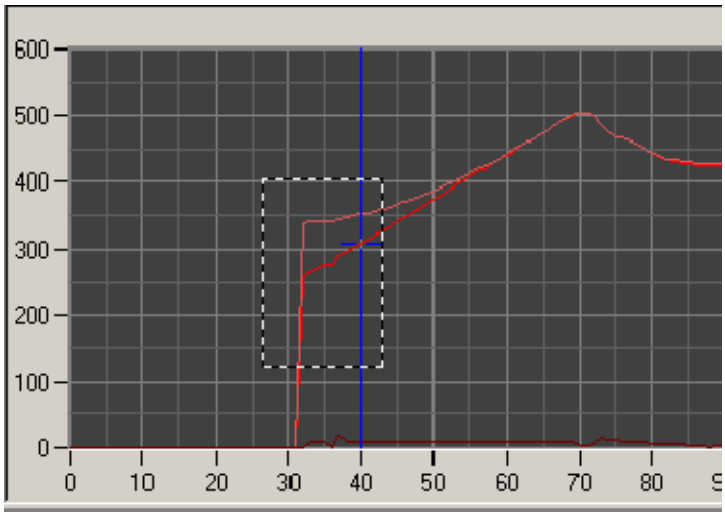
The graph also supports panning and zooming.

Panning

To pan the graph, set the mouse mode to Pan by clicking on the Pan button () in the control panel. The cursor will change to a 4-way arrow. The panning works identically like in the image window.

Zooming

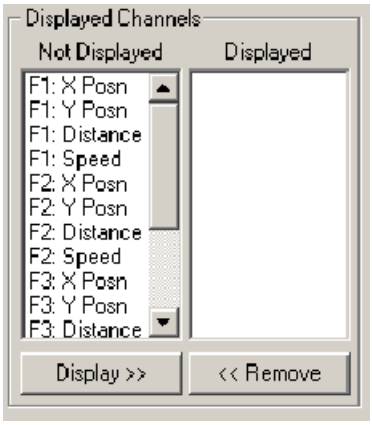
To zoom in on a region in the graph, set the mouse mode to Zoom by clicking on the Zoom button () on the control panel. The cursor should change to a dotted box with a pointer next to it. Click the left mouse button on the graph and drag the mouse to define a zoom region.



To zoom back out, double click in the graph window when in pan or zoom mode.

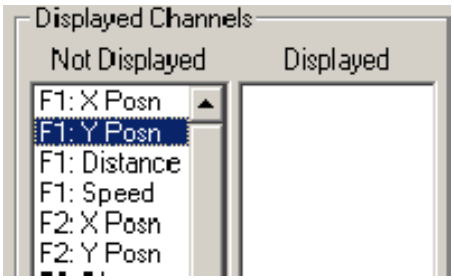
Changing the Displayed Channels

All the available channels for display are initially listed in the Not Displayed box.



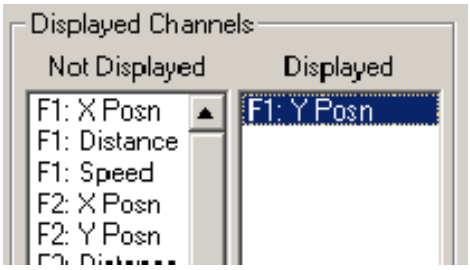
To display a channel:

1 Select the channel for display



2 Click on the Display >> button 

The channel will be displayed on the Graph Panel.



To remove a channel from the Displayed list:

1 Select that channel.

2 Click on the << Remove button 

The channels are listed by feature number or data input number. The code for determining the features is as follows:

F = “Feature”
D = “Data Input”
1,2,3, = numerical value of that feature or input channel.
X Posn = X axis position
Y Posn = Y axis position
Speed = Relative Speed
Distance = Distance moved since first tracked frame

So, the code for “Feature 1 Speed” is “F1: Speed”, for Feature 2 Speed is F2: Speed, for Data input channel 3 is D3.

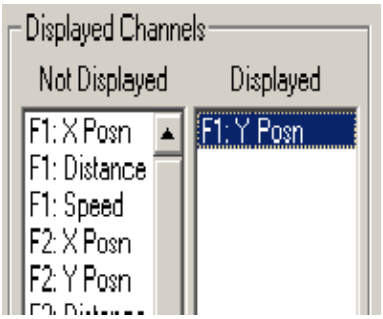
Changing the Y Axis

The Y axis of the Graph Panel is automatically set to the maximum of all selected channels. This auto-scaling allows the full visibility of graphs, but also causes some graphing to be lower resolution. If this feature is selected, the user has the opportunity to override the auto-scaling and set the Y axis scale and Y axis label to any of the displayed channels.

To change the Y-axis scale and label:

1 In the Graphing Tab, select the feature from the Displayed Channels box.

2 Check the checkbox next to Y Label from Channel

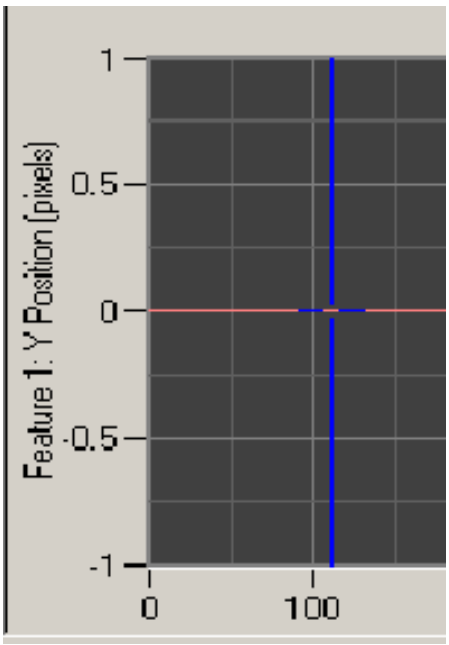


3 The channel name will appear in the box on the right 

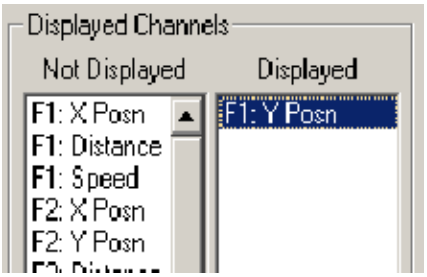
4 Click on the Set button.

5 Click on the Update Graph button. 

The graph in the Graph Panel will rescale using the Y axis values from that channel. In addition, a label will be added that indicates the Y-axis description. The X-axis is automatically determined by the *i-SPEED* PC Software as either frame number or data index.



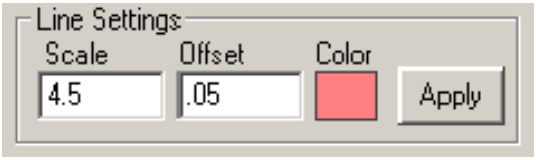
Scaling the Visible Data



Data can also be scaled using a standard y=mx+b linear representation, where m is the scale factor and b is the offset. Each channel can be scaled independently of the other channels. Note that this is a scaling of the visibility of data; the actual data is not changed when saved.

To scale a channel of data:

1 In the Graphing Tab, select the feature from the Displayed Channels box.



2 Change the Scale and Offset from within the Line Settings group.

3 Click on the Apply button.

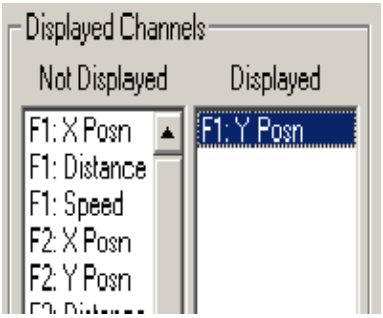
4 Click on the Update Graph button. 

Changing the Line Colors

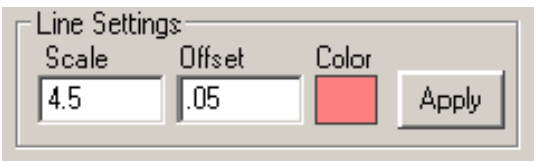
You may also change the colors of the graph from within the Graphing tab.

To change the color of the line:

1 In the Graphing Tab, select the feature from the Displayed Channels box.



2 Click on the color swatch (rectangle). The standard Windows color selector dialog window appears.



3 Select the new color for the line.

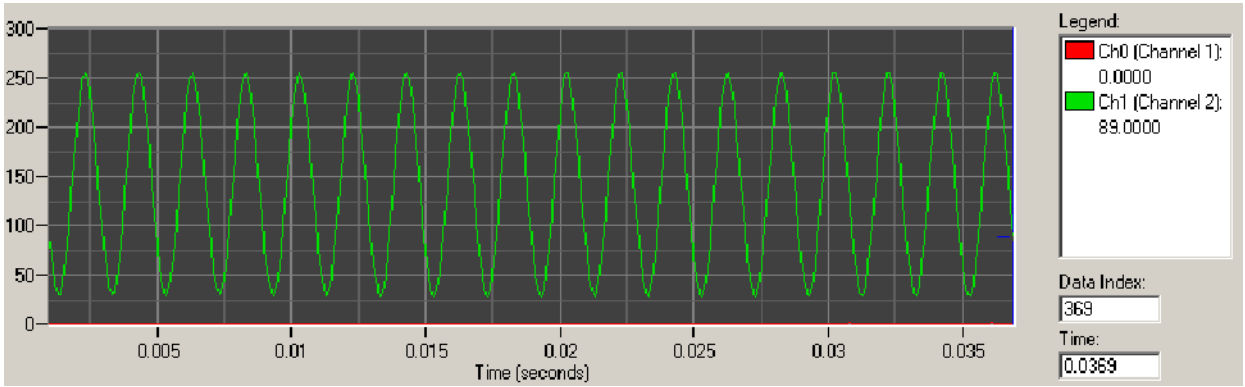


4 Click on the OK button to register that Click on the Apply button.

5 Click on the Update Graph button 

Single Stepping through a Graph

The single step forward and single step backwards buttons allow you to step through the data one data point at a time. The data index shows the current position.



Note that, most often, external input data is acquired at a different rate than video. Therefore, one video frame may include many of data points within its time period. The data index is a multiple of the frame rate. For example, data might be acquired at 100kHz and video acquired at 1000 fps, so there are 100 data points per video frame.

To step through the data, use the Data Step buttons. 

. The on-screen cursor (blue) will track the progress trough the graph.

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Saving and Reloading your Work

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Saving and Reloading your Work

Overview

One of the most important aspects of the *i-SPEED* PC Software is the ability to save and load all the components of your work. The following information may be saved (and later reloaded):

- Video
- User Data
- Motion Analysis
- Image Processing Settings (Advanced and Deluxe versions only)
- User Comments (Advanced and Deluxe versions only)
- Calibration information (Advanced and Deluxe versions only)
- Test configuration information
- GPS/IRIG timing data

The *i-SPEED* PC Software uses a video-centric file naming convention. That is, you name the video file during the save procedure and all the other files are saved with the same filename, but different suffix. During the Save As… process, you are asked for one filename. All the various pieces of your test are named this filename with a different 3-letter suffix (e.g. filename.avi, filename.isz, filename.uda, etc.)

Image processing settings, calibration information and analyses can be saved and reloaded independently through their respective tabs. For more information on saving and reloading saved settings, consult the image processing, image calibration and motion analysis sections of this user guide.

When copying or moving files, it is very important to move all files of the same name. Critical information or user-added content may not appear if all files are not moved together.

The *i-SPEED* PC Software will automatically load all files with the same filename in the same directory. You can also load image processing, image calibration and analysis files separately.

i-SPEED PC Software File Formats

The *i-SPEED* PC Software creates the following file formats, based on what you have used in your measurement.

AVI	Standard Microsoft Windows Video format. *i-SPEED* PC Software can save video into AVI file format.
BMP	Standard bitmap file format. *i-SPEED* PC Software can save video as a series of sequential BMP images.
TIF	Standard tag image file format. *i-SPEED* PC Software can save video as a series of sequential TIFF images.
JPG	Standard jpeg compressed file format. *i-SPEED* PC Software can save video as a series of sequential JPG images.
ISC	*i-SPEED* PC Software configuration file. Contains all the configuration information about your measurement so that when you load a video file back up, *i-SPEED* PC Software knows the frame rate, shutter speed, trigger frame and other aspects of the original recording
ISD	*i-SPEED* PC Software data file. The software creates tab-delimited text files that contain all the user data and associated settings from a measurement.
ISZ	*i-SPEED* PC Software Comments and GPS/IRG data file. This binary file (uneditable) contains the user comments and GPS/IRIG data. User comments can be updated by using the Save Comments… menu command.
XLS	Standard Microsoft Excel file. *i-SPEED* PC Software analysis can be exported to Excel and saved in this format.

LUT	*i-SPEED* PC Software image processing look-up table settings. Contains settings for modifying an image using *i-SPEED* PC Software image processing tools. Look-up table settings are stored separately from other files and can be applied at any time to an image through the Process tab.
CCC	*i-SPEED* PC Software calibration file. Contains the calibration settings (e.g. origin location, X,Y coordinate system, tilt angle, etc.) about an image. Calibration files are stored separately from other files and can be applied at any time to an image through the Calibrate tab.
IST	*i-SPEED* PC Software analysis file. Contains the tracked points (location, color, etc.) from a motion analysis tracking procedure. Analysis files are stored separately from other files and can be applied at any time to an image through the Analyze tab.
TXT	Standard Windows text file. Created when analysis is exported to Text.
IBD	*i-SPEED* PC Software basic data file. Created when user data is captured and saved in the Basic version of *i-SPEED* PC Software. Data in this file will be loaded and displayed over the video frames in the Basic version and displayed in a separate data strip in the Advanced and Deluxe versions.
UDA	*i-SPEED* camera native configuration and data file. This file is generated by the *i-SPEED* Camera when storing captured events onto a PCMCIA card. It contains record settings and user data. These files will automatically be read and displayed by *i-SPEED* PC Software.

Video file types

Video may be saved as either one continuous movie in the standard Microsoft Windows video (.AVI) format or as a sequence of individual image files. The *i-SPEED* PC Software allows you to save individual frames as bitmap (BMP), TIFF (TIF) or JPEG (JPG) formats. For example, you can save one 2000 frame video sequence to disk as one AVI movie or as 2000 sequential, individual BMP images.

You can also load files in one format and resave them in another format.

If you elect to save a video as a sequence of image files, *i-SPEED* PC Software will append an underscore and a frame number to the file name you select. Therefore, you should avoid using filenames that end in numbers or contain underscores and numbers. To avoid confusion, *i-SPEED* PC Software will display a confirmation dialog containing the pattern of image filenames that will be saved. Please check the resulting pattern to see if it matches your desired naming/numbering scheme.

If, during the save process, you select an image file that is already a part of a sequence, *i-SPEED* PC Software will prompt you asking if you wish to overwrite the existing sequence. If you select **OK**, *i-SPEED* PC Software will delete the entire selected sequence of image files, and then save the new sequence of images. Use caution when over-writing a sequence of image files, ALL image files matching the pattern selected will be deleted. Pay close attention to the pattern displayed in the confirmation dialog when over-writing an existing sequence.

Data file types

User data is saved in a universal ASCII text format for easy loading by third-party software packages for data analysis.

Saving vs. Exporting

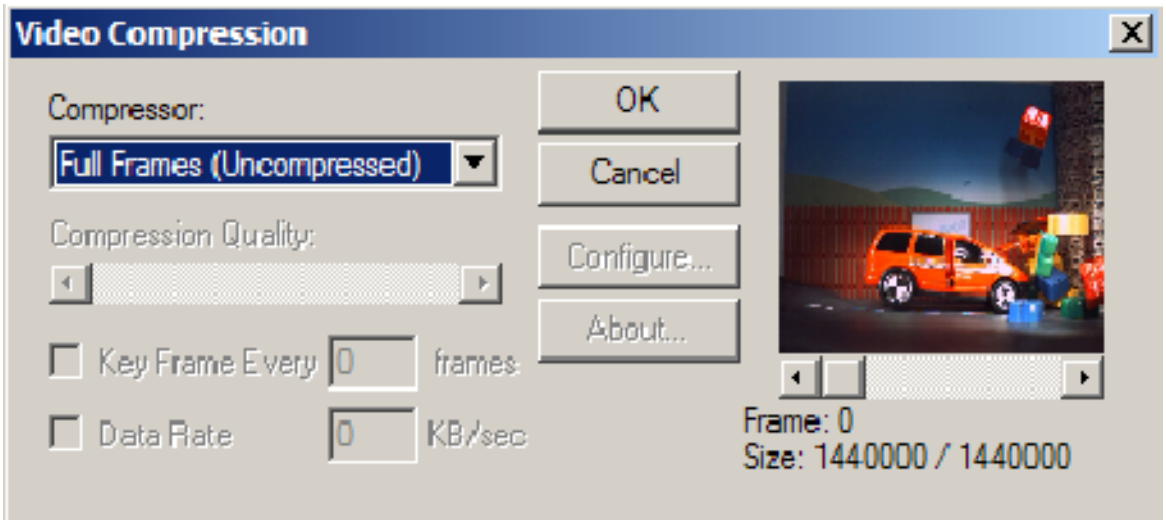
The *i-SPEED* PC Software provides the ability to export motion analysis results to either Excel or a text file (see the section on Motion Analysis). The process of Exporting is different than saving – it opens a separate software package (in this case Excel or WordPad) and populates that software with data. In Excel, the data is not saved until the software is closed or the user clicks on the Save As… menu item.

To export motion analysis data, set the export destination to Excel or to Text from the drag down menu box on the Action Toolbar in the Analyze tab (Working View), and click the Export button. 

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Applying Compression Codecs to AVI Video Files

If you have elected to save a video to an AVI file, *i-SPEED* PC Software will automatically present you with the video compression dialog window shown at right. This window provides you with the opportunity to apply a compression codec to the AVI movie. Compression codecs are used to compress the file (make it smaller in size). Most codecs are lossy, and will degrade the image quality. You will not be able to recover the original quality images from a compressed AVI.



The settings for the Video Compression window are as follows:

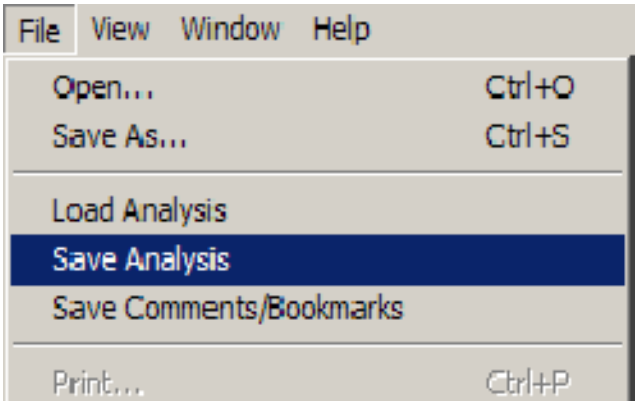
Compressor	The compression codec that you wish to apply. The various codecs listed in this dialog are provided by your operating system. *i-SPEED* PC Software searches your operating system for the loaded codecs and displays them in a single list box. The default value is Full Frames (uncompressed). It is highly recommended that you save using the “Full Frames (Uncompressed)” option.
Compression Quality	Some codecs allow you to balance the quality vs. size. If the selected codec allows this feature, adjust the quality value.
Key Frame	Some codecs allow you to set the key frame increment. If the selected codec uses key frames in its algorithm, set the increment between key frames.
Data Rate	Some codecs allow you to set the data sample rate. If the selected codec uses data rates in its algorithm, set the rate here.
Configure	If the selected codec requires additional configuration settings, click on this button to adjust them.

Saving Analyses, Calibrations, Comments and Bookmarks

One of the features of *i-SPEED* PC Software is the ability to save and load important information about your measurement and motion analysis. This information is invaluable for a later understanding of the measurement. It is also invaluable for apply the results of one test to another for comparison.

Saving and Loading .IST Analysis Files (Advanced and Deluxe versions only)

You can save your analysis files separately. Analysis files are saved using the File ➧ Save Analysis menu item. Analysis files can be loaded using the File ➧ Load Analysis menu item.

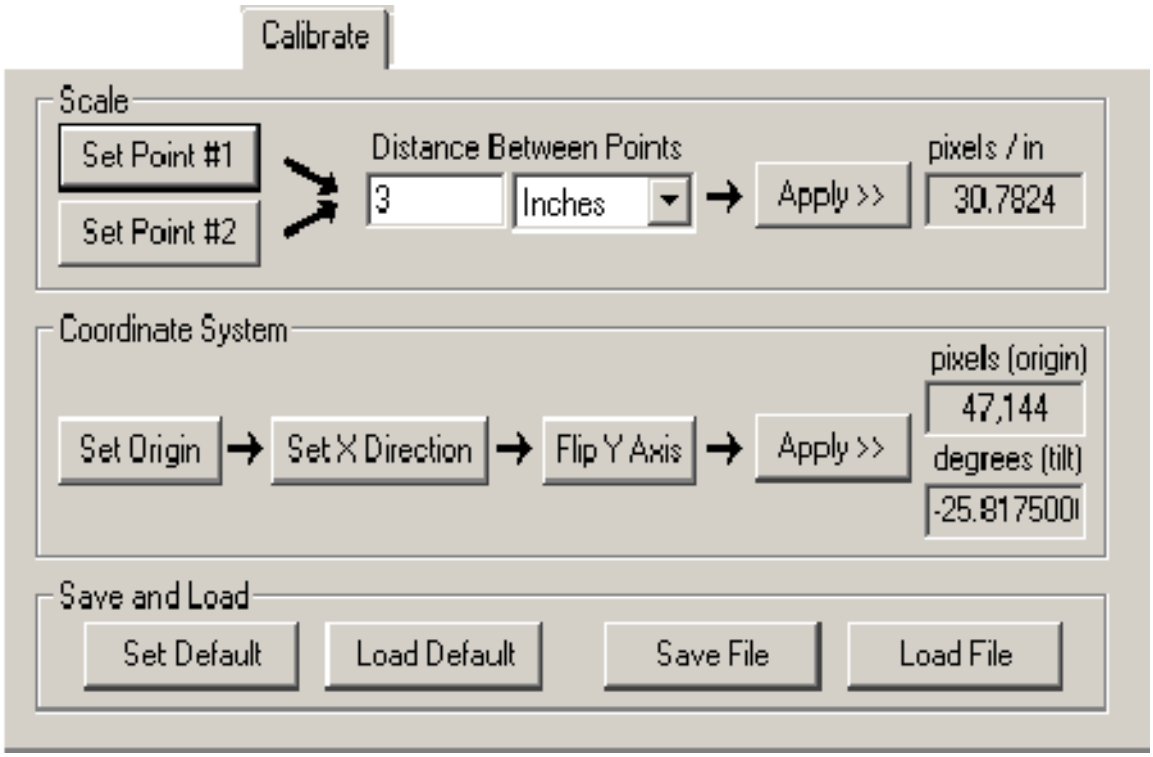


Analysis files contain tracked point information. The ability to save tracked point information for later overlay on another image is valuable for comparing current results with previous results. This ability to compare results is invaluable for applications where current measurements are used to determine a deviation from a perfect motion.

Analysis files are saved in an *i-SPEED* PC Software .IST format. This file format is compressed and readable only by *i-SPEED* PC Software. .IST files cannot be edited.

Saving and Loading .CCC Calibration Files (Advanced and Deluxe versions only)

You can save your image calibration files separately. Calibration files are saved using the Save File button on the Calibrate tab in the Working View. Likewise, Calibration files can be loaded by using the adjacent Load File button.

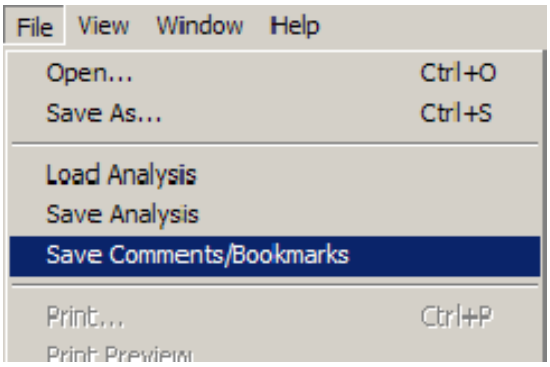


Calibration files contain information relating to the origin (0,0) and orientation of the X,Y calibration system. The ability to save calibration information for later overlay on another image is valuable for simplifying repetitive tests. For example, if you have the camera placed in the same location for a test that you are performing repetitively, you can very quickly apply the same calibration file to the image for analysis. This step saves the time and effort associated with manually setting the origin and X,Y axes.

Calibration files are saved in an *i-SPEED* PC Software .CCC format. This file format is compressed and readable only by *i-SPEED* PC Software. .CCC files cannot be edited.

Saving Comments/Bookmarks

You can save your comments and bookmarks into the .ISZ file at any time by clicking on the File ⏵ Save Comments/Bookmarks menu item.

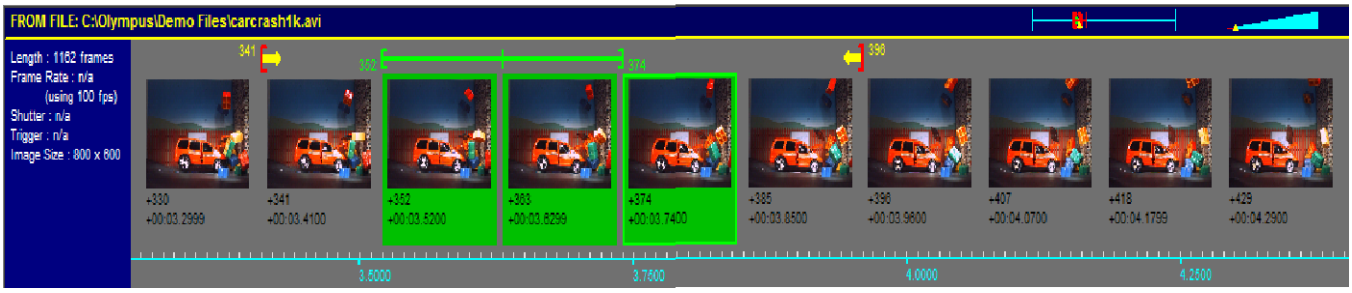


Comments and Bookmarks are saved in the .ISZ binary file. This file format is compressed and readable only by *i-SPEED* PC Software. .ISZ files cannot be edited.

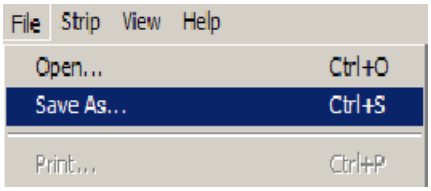
Saving from the Strip View

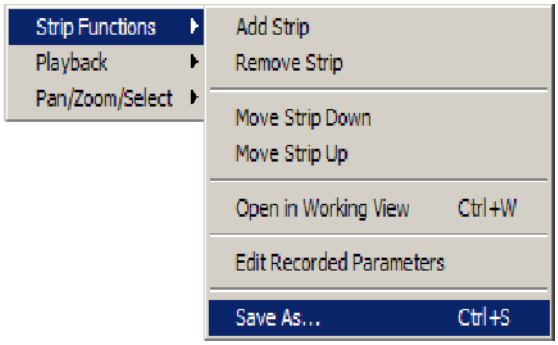
You can save directly from within Strip view.

1 Set the range you wish to save. The range is the set of frames that are within the yellow and red end markers. The range may be modified in the Strip View by dragging the yellow and red end markers above the video frames or in the Working View by dragging the red end markers in the Play tab controls. The range may also be set to the current selection (shown in green) by using the context menu, or hitting the “Space” bar.

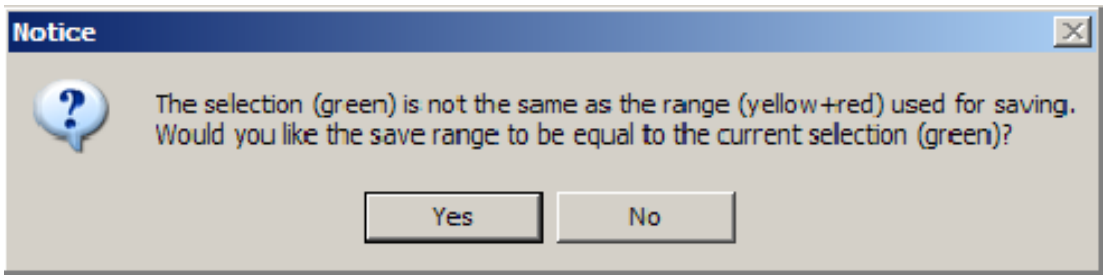


2 From the menu bar, select File ⏵ Save As…(as shown below left). Alternatively, you can select this function through the right-click contextual menu using the Strip Functions ⏵ Save As… shortcut.



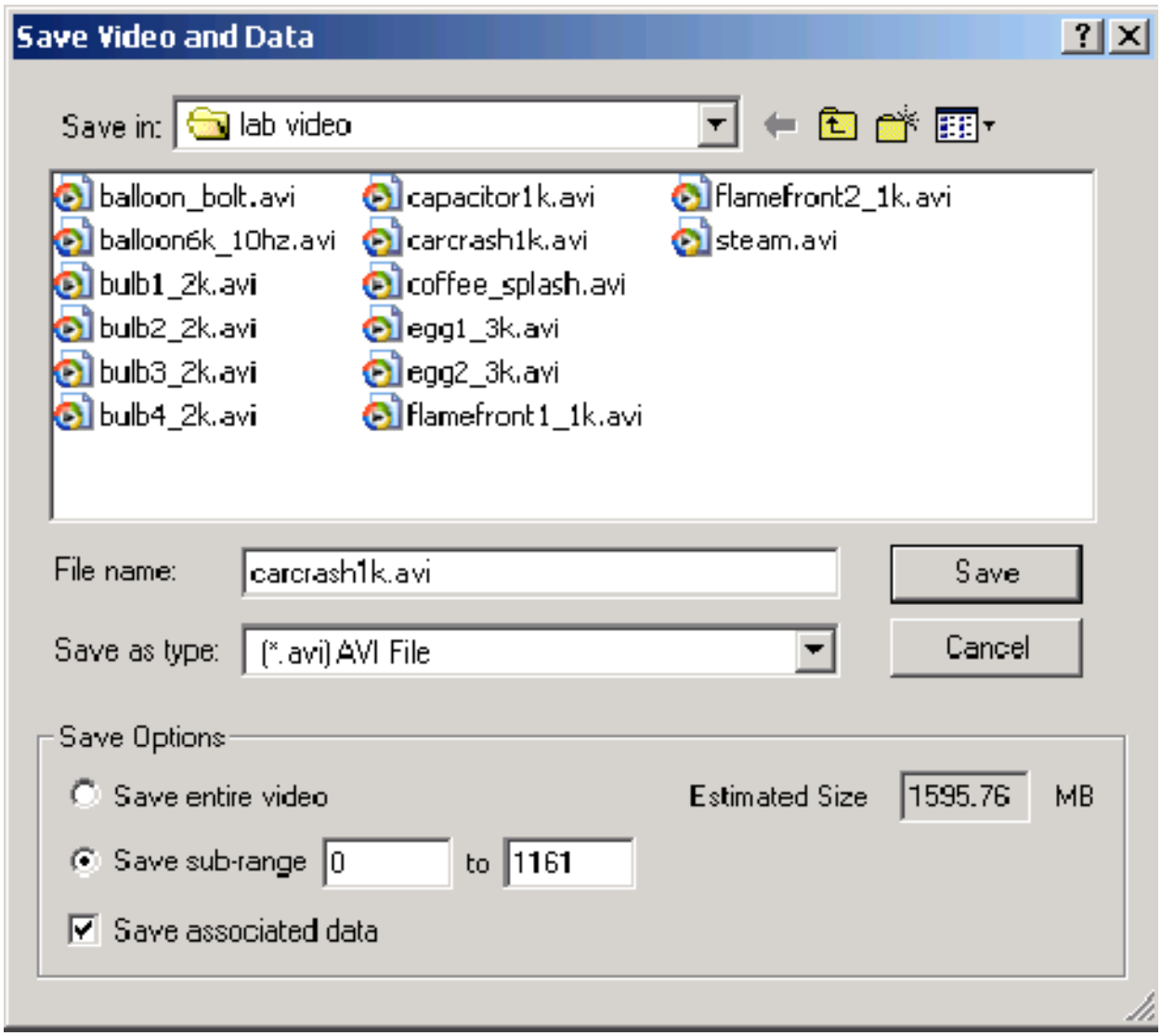


3 If the green highlighted current frame selection is not the same as the range set in step 1, *i-SPEED* PC Software will ask you whether you wish to override the range that had been previously set with the green highlighted selection. The notice that appears is as follows:



By clicking the Yes button, the Range is set to the current selection (as if the Space bar had been hit). By clicking the No button, the original Range is preserved.

4 The following Save Video and Data dialog will appear:

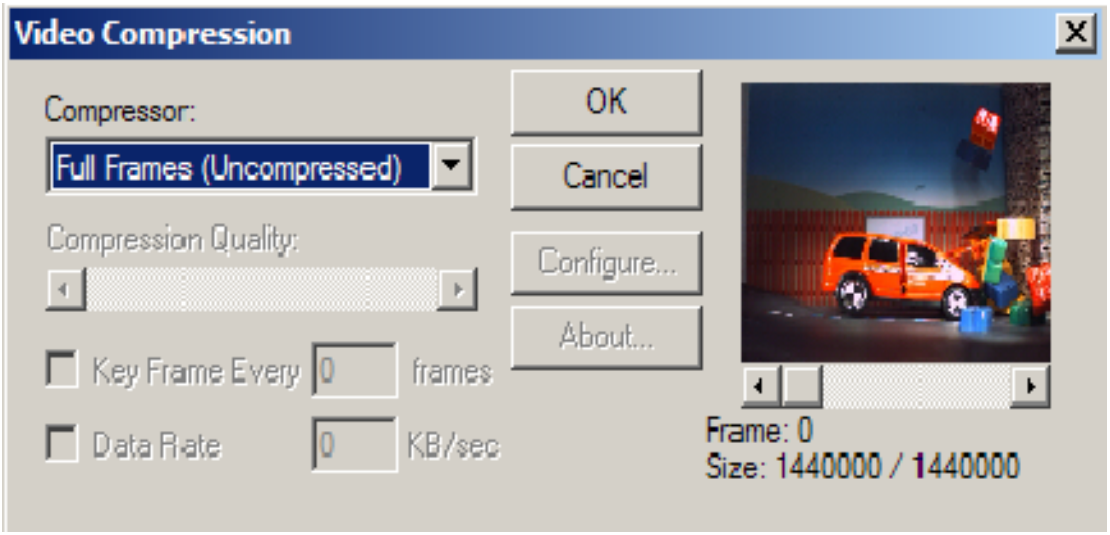


The settings for this Save As… window are as follows:

File Name	The Microsoft Windows compatible file name and associated folder location on the hard drive or network.
File Type	Select the desired file type from the drag down list. The options are AVI (Microsoft video) or a sequence of individual frames, each frame being saved in the BMP (bitmap), TIF (tag image file format) or JPG (JPEG) format.
Save entire video	Save the entire collection of frames from the current video clip.
Save sub-range M to N	Save a range of the frames, designated by frame numbers. The range can be set using the Range selection in Strip View or the end markers in Working View. You may also type in the range in the white boxes.
Estimated Size	Shows the estimated file size based on *i-SPEED* saving conventions.
Save associated data	Saves the associated data as filename.ISD. To save associated data with the video, select the **SAVE ASSOCIATED DATA** checkbox on the bottom of the Save As screen prior to saving. If the box is grayed, then *i-SPEED* PC Software has determined that there is no data available to save.

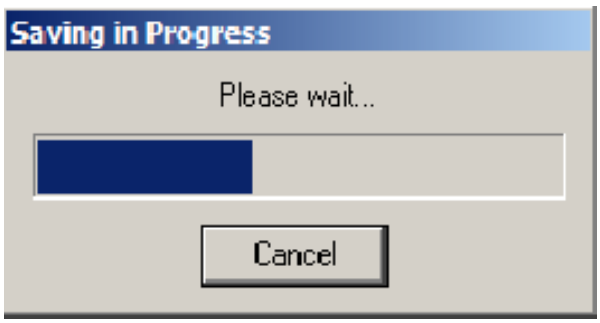
5 Click on the Save button.

6 If you have selected to save in the AVI movie format, the *i-SPEED* PC Software will ask if you desire to apply a compression codec as it saves your file.



7 Apply a codec per the above described guidelines and click OK.

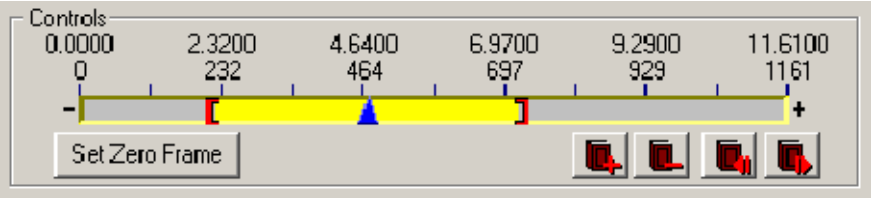
8 The save process begins. The progress indicator appears .



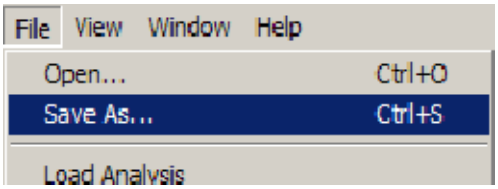
Saving from the Working View

You can save directly from within Strip view.

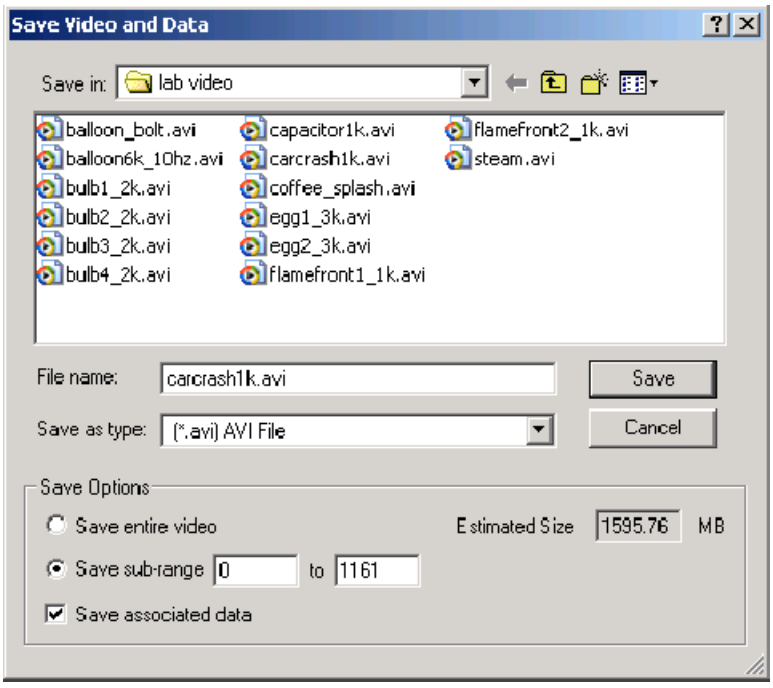
1 Set the range you wish to save. The range is the set of frames that are within the yellow and red end markers. The range may be modified by dragging the red end markers in the Play tab controls.



2 From the menu bar, select File ➧ Save As…(as shown below).



3 The following Save Video and Data dialog will appear:

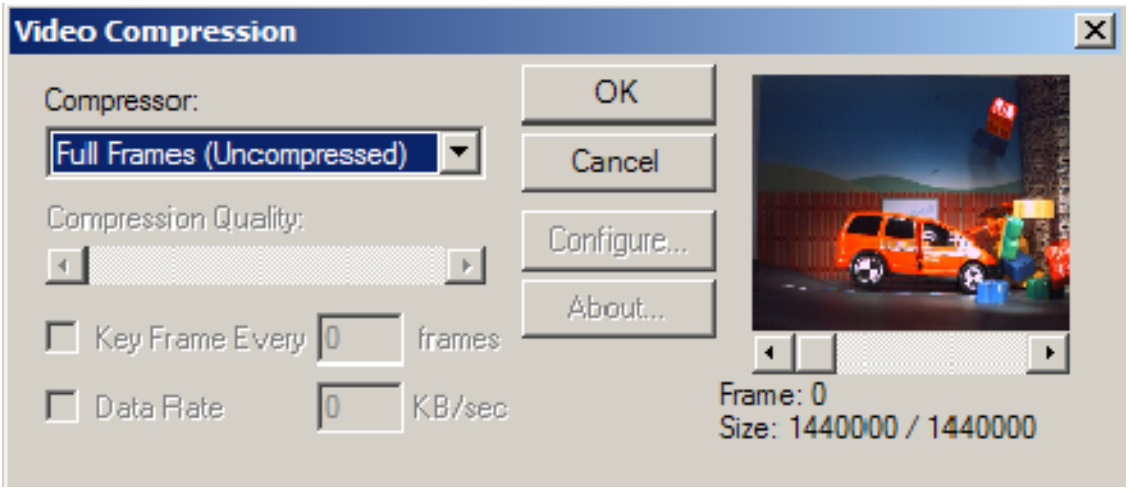


The settings for this Save As… window are as follows:

File Name	The Microsoft Windows compatible file name and associated folder location on the hard drive or network.
File Type	Select the desired file type from the drag down list. The options are AVI (Microsoft video) or a sequence of individual frames, each frame being saved in the BMP (bitmap), TIF (tag image file format) or JPG (JPEG) format.
Save entire video	Save the entire collection of frames from the current video clip.
Save sub-range M to N	Save a range of the frames, designated by frame numbers. The range can be set using the Range selection in Strip View or the end markers in Working View. You may also type in the range in the white boxes.
Estimated Size	Shows the estimated file size based on *i-SPEED* saving conventions.
Save associated data	Saves the associated data as filename.ISD. To save associated data with the video, select the **SAVE ASSOCIATED DATA** checkbox on the bottom of the Save As screen prior to saving. If the box is grayed, then *i-SPEED* PC Software has determined that there is no data available to save.

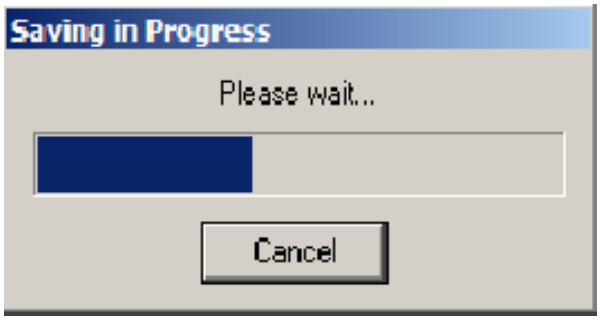
4 Click on the Save button.

5 If you have selected to save in the AVI movie format, the *i-SPEED* PC Software will ask if you desire to apply a compression codec as it saves your file.



6 Apply a codec per the above described guidelines and click OK.

7 The save process begins. The progress indicator appears .



Loading Video and User Data into i-SPEED PC Software

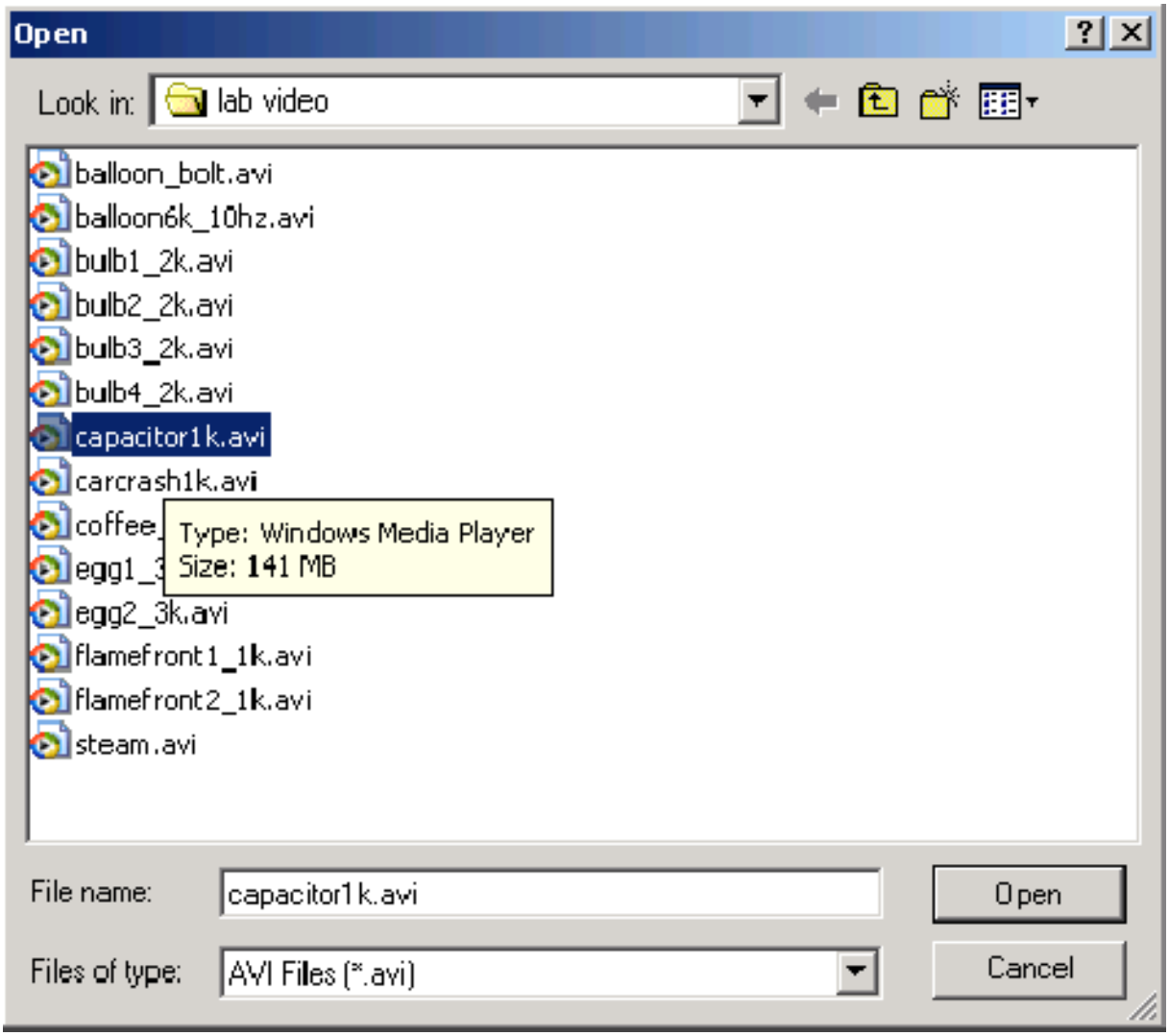
There are two methods of reloading previously saved work files – the standard Open window and the Archive Browser window.

Loading through the Open File menu

To load a previously saved video:

1 Select File ➧ Open from the menu.

2 The Open dialog appears:



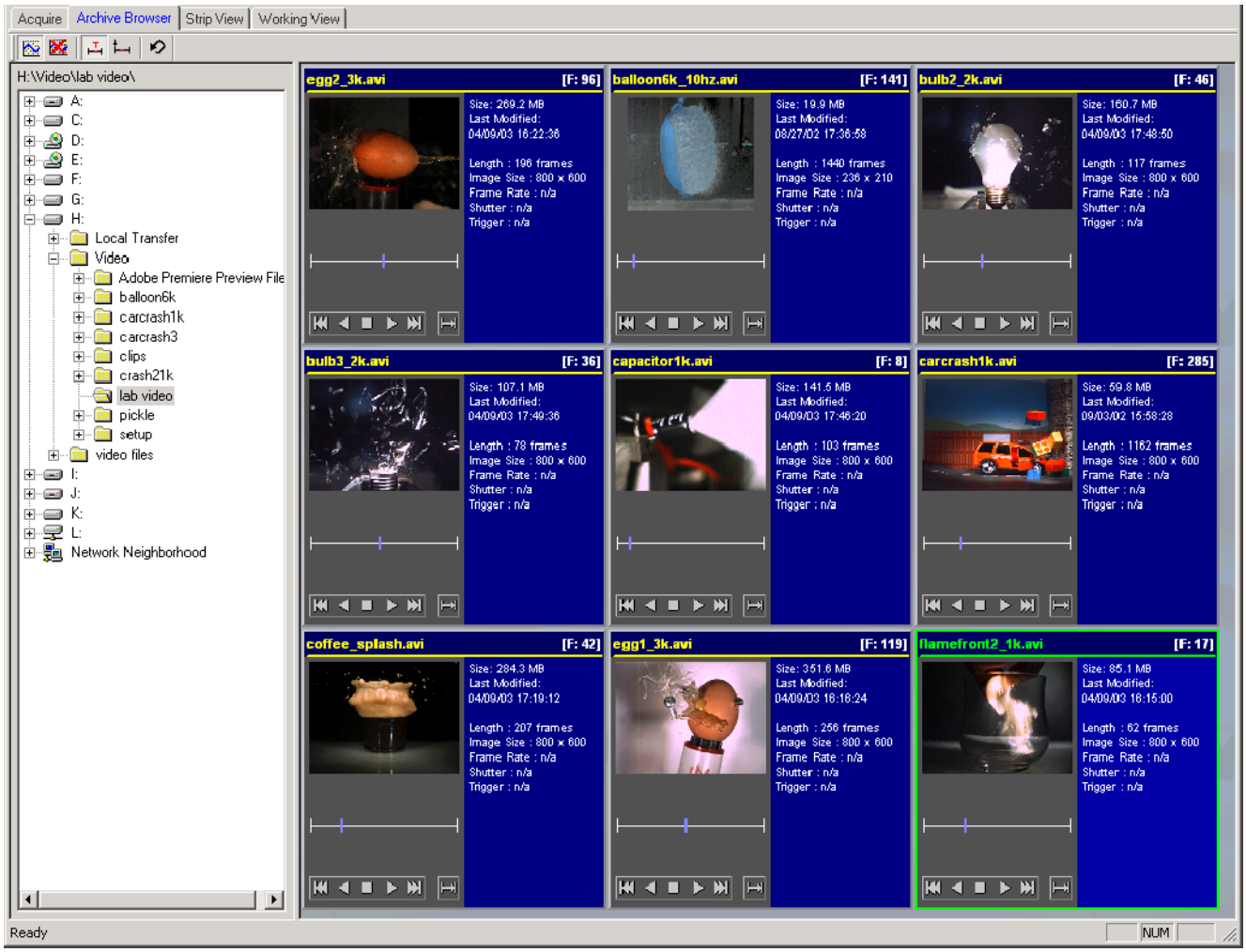
3 Either type in or select the filename of the file to load. For loading a sequence of image files, you can click on any image in the sequence and *i-SPEED* PC Software will load the complete sequence of image files that match the same pattern

4 Click on the Open button.

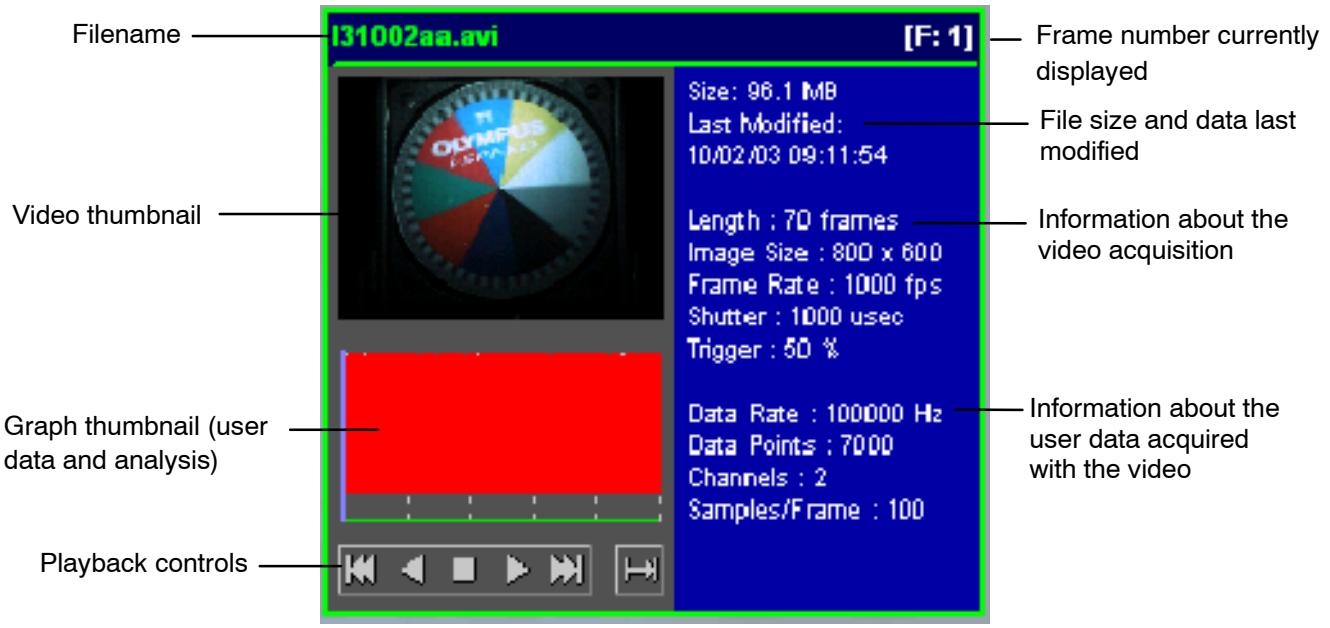
If video (in an AVI or an image sequence) and associated data were originally saved together, then they will share the same filename. Only the video filenames are shown in the Open dialog. The *i-SPEED* PC software will always look for associated data files; if found, data files are automatically opened with the video file.

Opening through the Archive Browser Window

The Archive Browser provides a very convenient mode of reviewing all your work before opening it. The Archive Browser presents a complete Windows Explorer panel along the left side of the screen and a thumbnail mosaic of the video acquisitions in the main desktop window.



The Archive Browser displays all the files within the currently selected folder, based on video name. Each pane of the Archive Browser contains the following information:



To select a file to open with the Archive Browser:

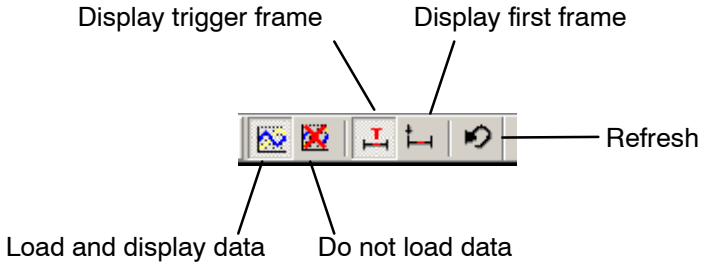
1 Explore your hard drive to the folder of interest.

2 Use the playback controls to browse the thumbnail view of the file or alternatively use the contextual (right click) menu to control playback of the video and data.



3 Double click within the image to move the video and data directly to the Strip view or right click within the image to access the contextual menu. Select Open in Strip View or Open in Working View.

The appearance of and the speed at which the Archive Browser downloads refreshes information can be adjusted by using the icon bar at the top of the Archive Browser window:



Saving and Loading in Bayer Format

What is Bayer

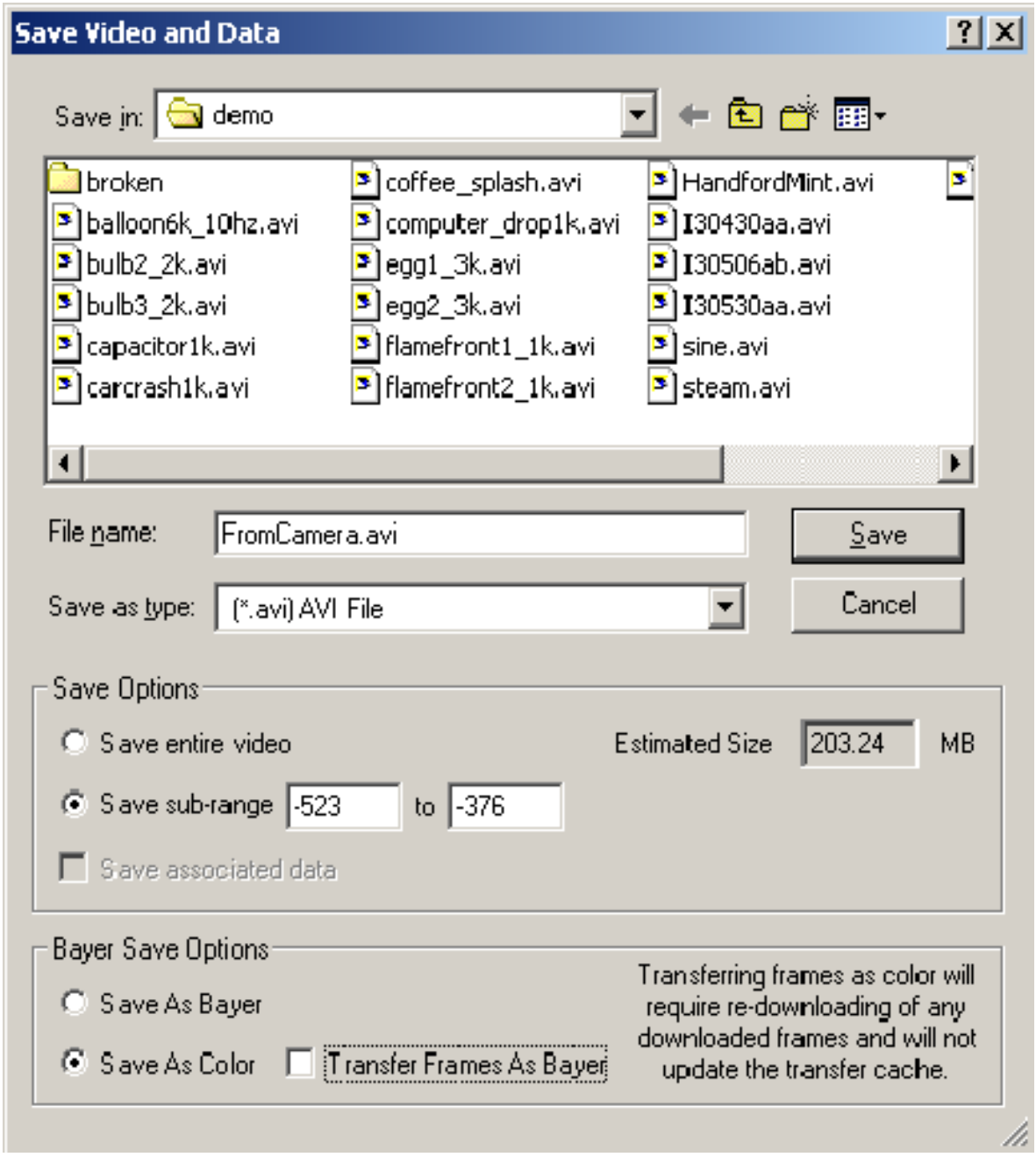
When using the *i-SPEED* Color Camera, the *i-SPEED* PC software is capable of saving and loading videos in raw Bayer format.

Bayer format is an 8-bit per pixel image format that stores an array of red, green, and blue pixels in a special arrangement. Bayer formatted images can be converted back to 24-bit color images using special Bayer conversion functions. The advantage of storing in Bayer format is the reduced size of the resulting files (1/3 the size of color). The disadvantage is the increased processing time required for converting and displaying the Bayer images in color during playback.

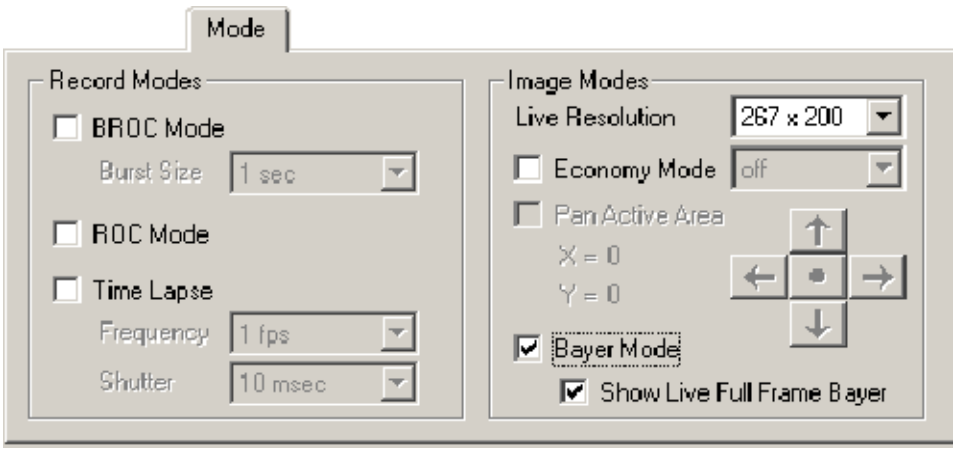
Due to the specialized nature of the Bayer format, ***do not*** save the images to a compressed format (JPEG or AVI with a codec). The resulting images will not be rendered correctly in color if compression has been applied.

Saving in Bayer Format

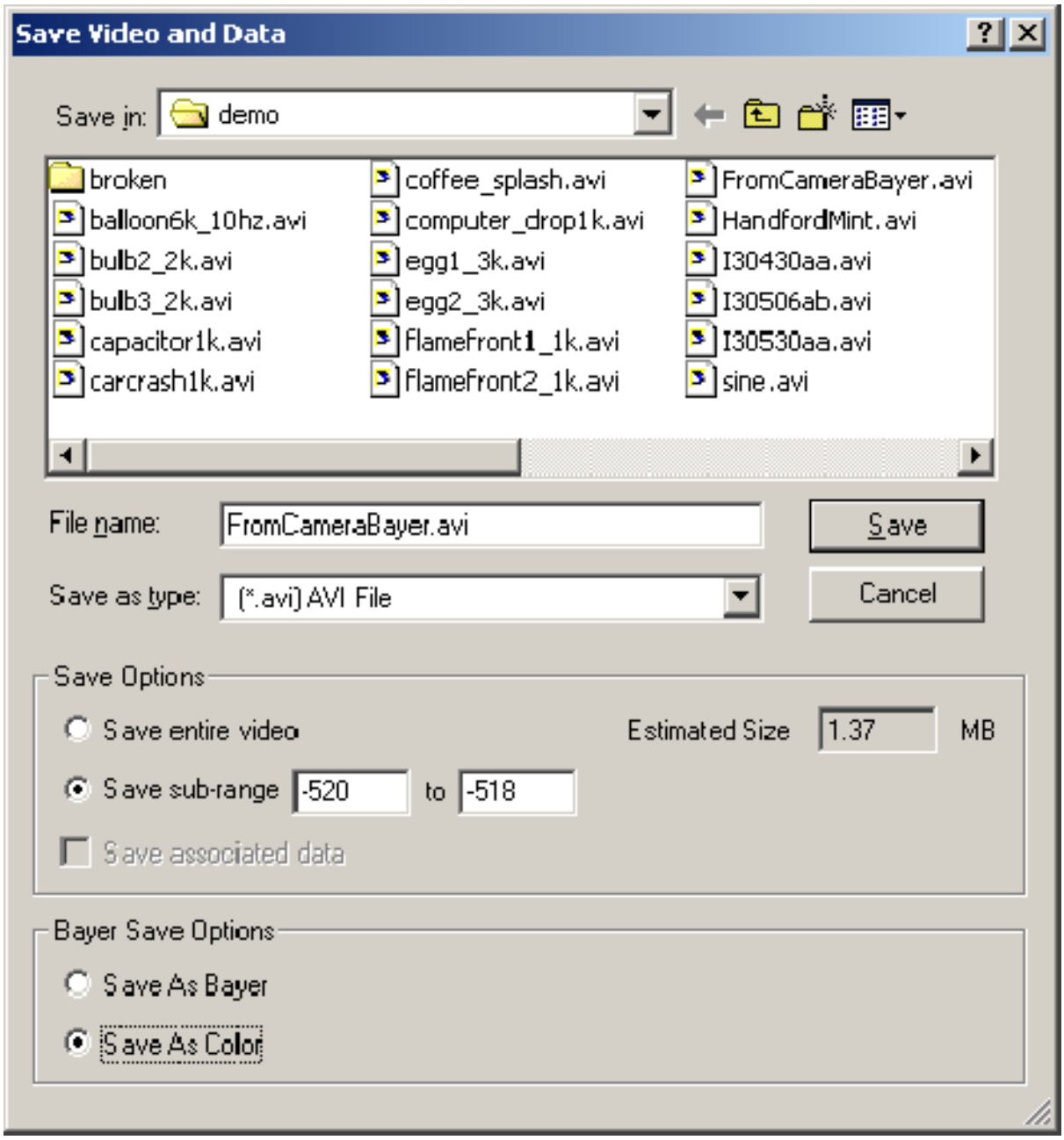
When saving a recording from a color *i-SPEED* camera, the Save As… dialog will have additional options at the bottom for saving in Bayer. If the recording was completed with Bayer mode enabled, the default will be to save the result in Bayer mode. If the recording was completed without Bayer mode enabled, the default will be to save the result in color.



Bayer mode is set in the Mode tab of the Acquire window, shown below.



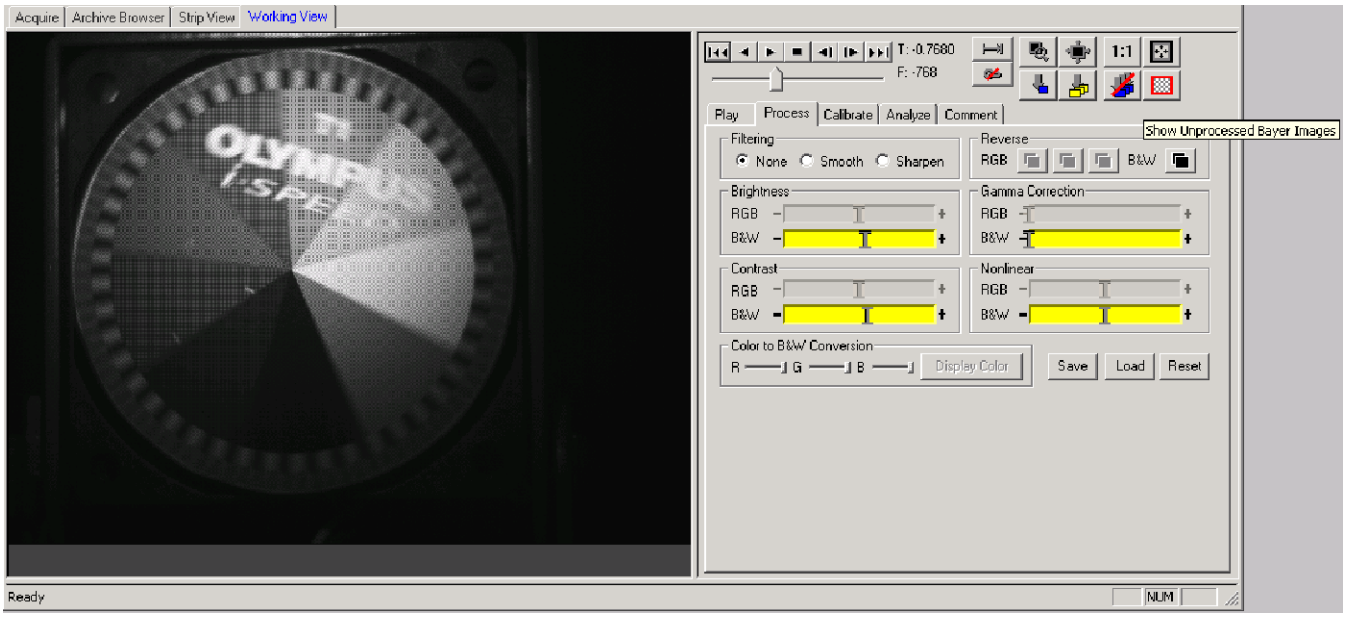
The user may override the default Bayer mode setting when saving, however, this will require a re-transfer of any frames already transferred, and the subsequent frames transferred during the save operation will not be stored in the transfer cache for later use. The re-transfer of frames is usually not significant in most cases.



When saving in color, typically the camera will perform the Bayer to color conversion in hardware and transfer the frame in color. If the user would prefer the Bayer to color conversion to occur in software (transferring the frame over Ethernet in the smaller Bayer format), select the Save As Color option, with transfers occurring in Bayer.

Reloading a File Saved in Bayer

Once a file has been saved in Bayer format, when it is reloaded, the configuration file (.ISC) will inform the *i-SPEED* PC Software that the video is in Bayer format. All thumbnails in the Strip View will be shown in Bayer format (to reduce processor load). Images in the Working View may be viewed in Bayer or in color format by clicking on the "Show Unprocessed Bayer Images" button in the control panel section, as shown below:

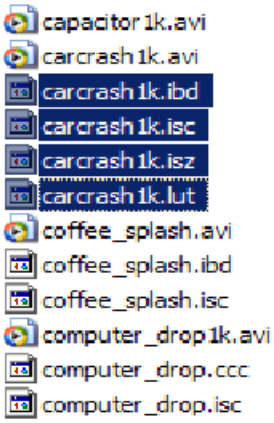


When displaying processed Bayer images in the Working View, the title bar will display the message: "Please Wait: Converting Bayer…" for every frame. The speed of the conversion will depend on the speed of your processor. Each frame of the video is converted from Bayer format on-the-fly as needed.

A file that has been loaded in Bayer may be re-saved in Bayer or in color. The save dialog will have a reduced set of the Bayer Save Options displayed at the bottom. Once a video is saved in color, it may not be saved in Bayer. The Bayer to color transformation is an irreversible operation.

Moving and Deleting i-SPEED Files on your Computer

When moving files created with the *i-SPEED* PC software, you must move all files of the same filename to preserve the full measurement. Depending on how the measurement was saved, there may be many files. All the files must be selected and moved together.



Likewise, if deleting files off a hard drive to save space, it is recommended to remove all files with the same filename. Files that are orphaned from an AVI (e.g. they do not have the same filename as an AVI file) are not useable in the *i-SPEED* PC Software.

Critical information or user-added content may not appear if the associated support files are not in the same folder as the video file(s).

18

GPS/IRIG Add-on Module

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GPS/IRIG Add-on module

Introduction

The *i-SPEED* GPS/IRIG Add-on module provides the ability to accurately synchronize your *i-SPEED* camera systems to an external time generator. Typically, time generators are centrally located to all the instruments participating in the measurement. IRIG (an abbreviation for Inter-Range Instrumentation Group) time generators are ground-based generators that use cables to transfer codes. The GPS/IRIG module will also allow you to synchronize to the network of Global Positioning Satellites (GPS), which broadcast master time as well as signals that enable *i-SPEED* to calculate its exact position on earth.

The *i-SPEED* GPS/IRIG Add-on module phase locks all the cameras within the *i-SPEED* system to the external source and, in addition to the local frame time, display the universal time.

Active Phase Lock Technology

The *i-SPEED* GPS/IRIG module uses a sophisticated 'Active Phase Lock' technology to attain the highest possible synchronization. A high-speed local oscillator – on the GPS/IRIG computer board – is phase-locked to the external time generator. In turn, the *i-SPEED* PC software then slaves the internal clocks for the hardware devices that are connected to the GPS/IRIG board, including video cameras, data acquisition hardware, and the time code generator output circuitry on the GPS/IRIG board.

Therefore, all the *i-SPEED* cameras are directly phase locked to the external generator. If connection to the external time code generator is lost, the internal clock will continue to maintain time and frequency stability.

Active Phase Lock assures that there is no drift between the acquisition clock and the external source clock.

The GPS Network

The worldwide GPS network consists of 21 satellites, 5 monitor stations, 3 uplink stations and 1 master control station that continuously broadcast radio navigation signals, named L1 and L2. The signals transmitted from the satellites consist of two modulated carriers. GPS receivers decode the radio navigation signals and compute user position and time.

The L1 signal is modulated with both a C/A code and a P code. The L2 signal is modulated with a P code only. Civilian access to the system is provided through the C/A code. The P code is intended for authorized military users only. The *i-SPEED* system operates on the C/A code.

The *i-SPEED* GPS/IRIG board determines time and position by measuring the time of arrival of the satellite signals. If the user has no knowledge of time nor position, then four satellites are required to determine a solution for the four unknown quantities X, Y, Z and time. If position is known and static, then time can be determined by measuring the time of arrival of a single satellite signal. Each satellite broadcasts information that allows the user to calculate the position of the satellite. Knowledge of this position, the user position, and a model of the transmission path characteristics allow accurate time determination.

IRIG and NASA Time Codes

IRIG time is encoded using binary code decimal (BCD) formats. The various formats in use throughout military and industrial test ranges are denoted using letters; the formats vary by both frequency and amplitude, as follows:

- IRIG B DC – a level shift format broadcast at 1 second intervals
- IRIG B AM – an amplitude modulated format broadcast at 1 second intervals
- IRIG A DC – level shift high frequency
- IRIG A AM – amplitude modulated high frequency

Other IRIG formats (D, G, H, etc.) are less commonly found. NASA 36 is a specialized time code format unique to NASA test ranges.

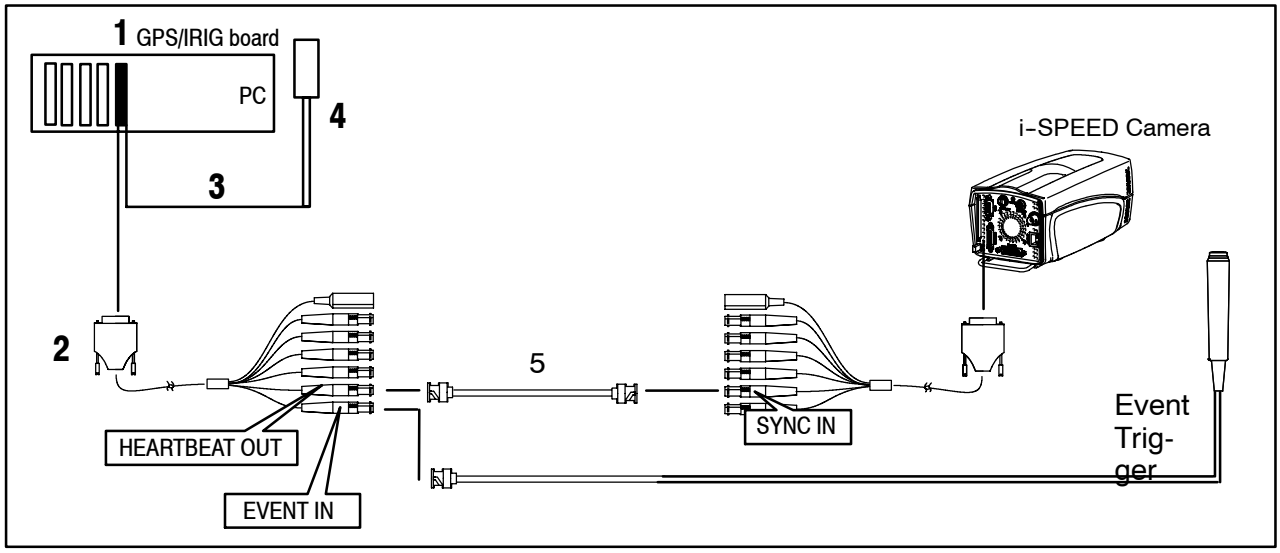
Connecting your GPS/IRIG Hardware

Hardware installation

1 Referring to your PC user manual, remove the cover and install the GPS/IRIG board (1) into a vacant PCI slot in the PC and replace the cover.

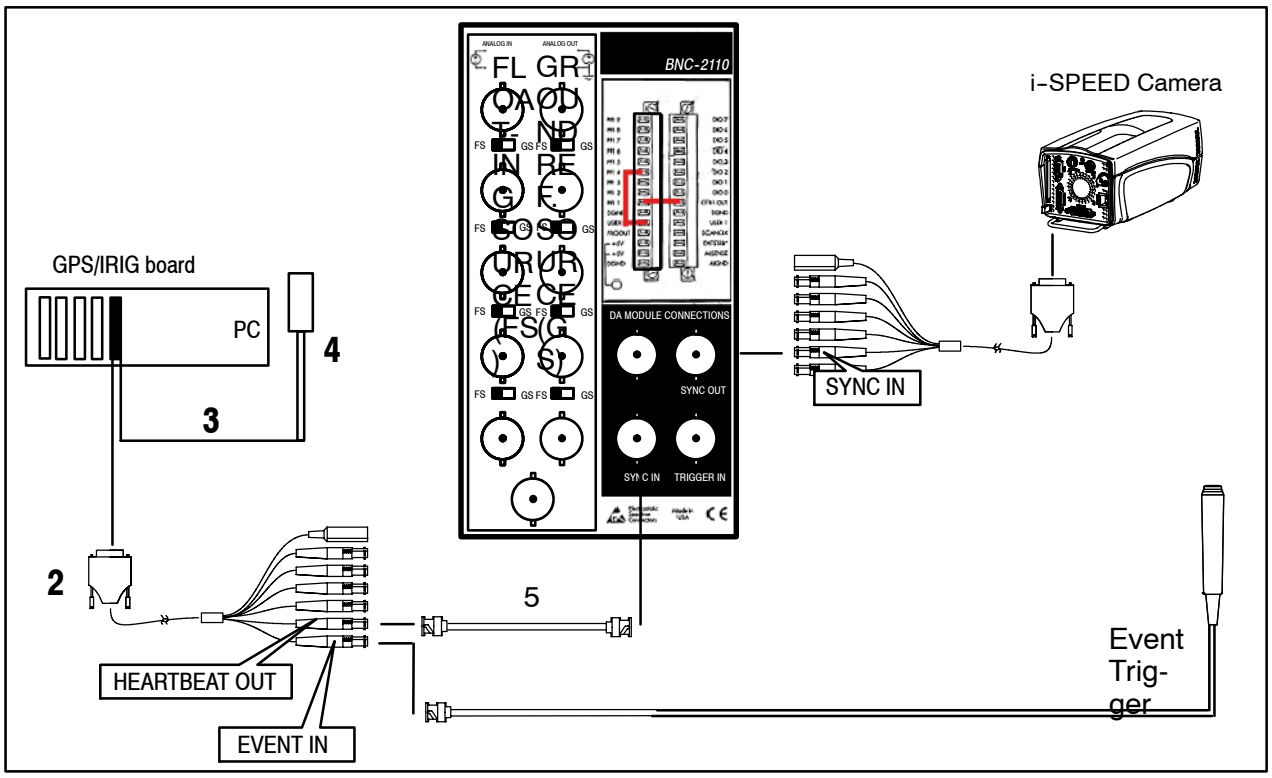
2 Site the antenna pole (4), then connect the breakout cable (2) and antenna cable (3) to the GPS/IRIG board.

3 Connect the one end of the BNC cable to the connector labelled 'HEARTBEAT OUT' on the GPS/IRIG board and the other end of the BNC cable to the connector labelled 'SYNC IN' on the i-SPEED camera.



NOTE: If connecting multiple cameras, the BNC connector must be connected to each camera 'SYNC IN' connector. There is no need to connect the event trigger to the camera(s) in addition to the GPS/IRIG board.

4 If installing both data acquisition and GPS/IRIG modules, connect as shown below.



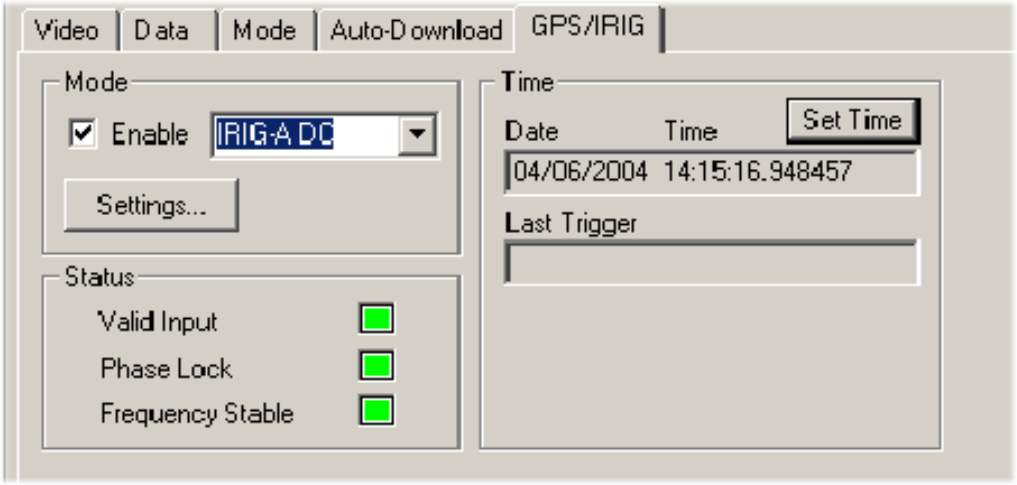
Device driver installation

1 When the computer detects new hardware, locate the drivers in the Drivers folder on the CD supplied or re-install the i-SPEED PC Software and be sure to check the box to load the GPS/IRIG drivers.

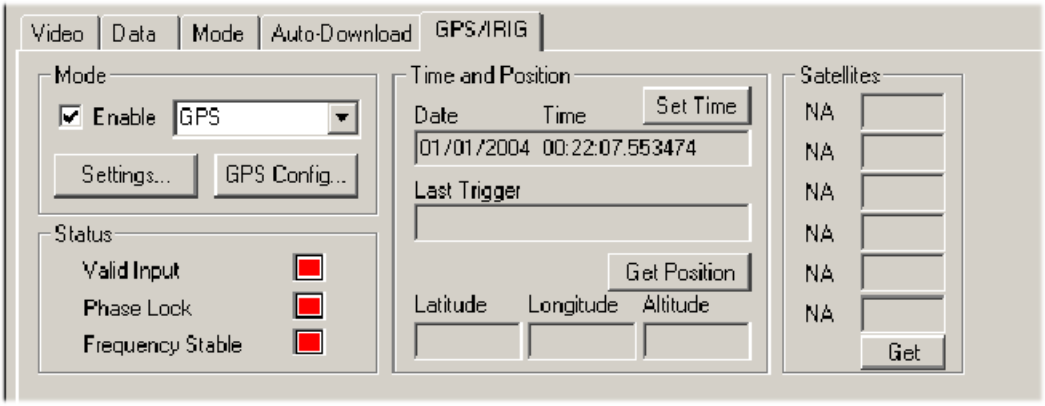
2 Reboot the system when driver installation is complete.

The GPS/IRIG Tab

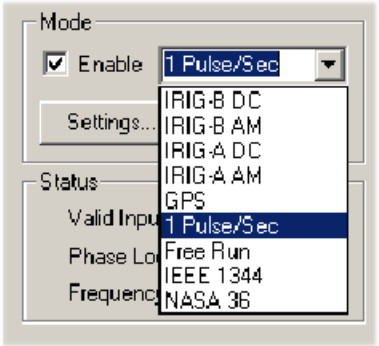
The GPS/IRIG tab is the fifth tab in the Video panel. If a ground-based time synchronization mode is selected, the tab appears as follows:



For the GPS mode, the tab appears as follows:



To enable time synchronization to an external source, click the Enable box. Then select the time synchronization mode from the drag down box. The options within this box are:



Select 1 Pulse/second when connecting to a 1 Hz TTL square wave. Select

Free Run to perform measurements when the external input is not present.

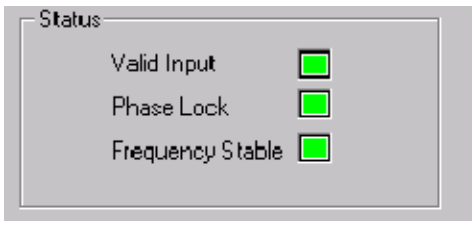
Status Indicators

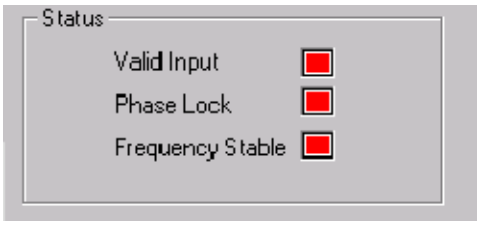
The 3 status indicators in the “Status” group box indicate the state of the GPS/IRIG board.

The “Valid Input” indicator is green when the GPS/IRIG board is tracking the indicated reference time source. If the light is red, it indicates that the GPS/IRIG board is not tracking the time source, usually because the time source has been lost of has become unstable. When this is the case, the board is freewheeling, and will keep time at the last known rate. When a timing Mode changes this light will turn to red until the GPS/IRIG board locks to the new timing source.

The “Phase Lock” indicator is green if the GPS/IRIG board oscillator is synchronized to better than 5 microseconds in IRIG, NASA, and IEEE modes; or to better than 2 microseconds in all other modes.

The “Frequency Stable” indicator is green if the on-board oscillator frequency offset relative to the timing source is better than 5×10^{-8}.



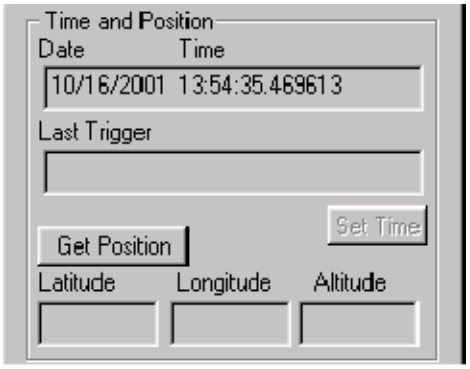


NOTE: It is not necessary to wait for all of the lights to turn green before recording with a GPS/IRIG Add-on module. However, the highest accuracy and stability is achieved when all lights are green. Equipment associated with timing and frequency generation must be at a steady state temperature to output stable signals. It is not uncommon to wait 20 minutes or longer to achieve thermal stability, (depending on your generator).

Time and Position

The following text fields and controls are located within the group box labeled “Time” (or “Time and Position” if running in GPS mode)

The GPS/IRIG Add-on module’s current date and time is displayed in the top text field. This information is automatically obtained from the external time source when possible. In the various IRIG modes, IEEE 1344, and NASA 36 modes the user must set the year manually.



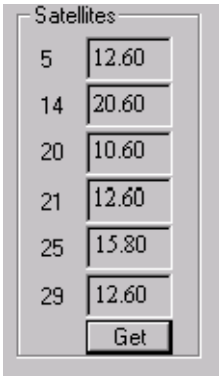
The “Last Trigger” text field is populated with the date and time of the last trigger event that the GPS/IRIG board received. This field is not displayed until you have performed at least one recording.

In GPS mode only, the “Latitude”, “Longitude”, and “Altitude” text fields display their information as labeled. The button “Get Position” will read this information from the GPS/IRIG board.

Satellite Strength Indicators (GPS mode only)

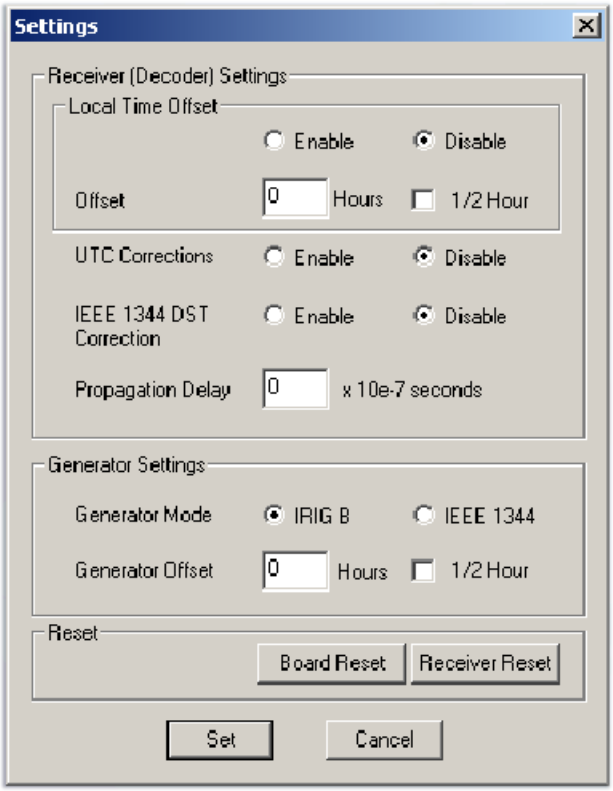
The “Satellites” group box contains information regarding the satellites that the GPS antenna currently sees. The text fields to the left of the edit boxes indicate the unique satellite identifier number. The number in the edit box indicates the received signal strength for the labeled satellite.

The “Get” button will read this information from the GPS/IRIG board. You can also tell the *i-SPEED* PC Software to automatically update the satellite information by enabling the check box in the Options menu. A slight latency may be detected when automatically updating these fields.



If the *i-SPEED* PC Software is unable to read the satellite signals, it will display an “NA”.

Time Code Settings



Clicking on the “Settings” button on the GPS or IRIG/NASA tab opens the settings dialog box shown at right.

In general you will not need to adjust the parameters that are accessed from this dialog box. They are typically set once (factory) and not touched.

The Settings box allows you to override certain time signals, to reset local time, or to add an offset to time to compensate for time zone changes. It also allows you to set your GPS/IRIG board as a “Generator”, where it sends pulses out instead of reading them in. This allows you to daisy chain many instruments off the GPS/IRIG hardware. The following are the setting options you can change:

Receiver (Decoder) Settings

Local Time Offset

Enable / disable the local time offset.

Offset

You can offset local time up to 16 hours from the receiver time in ½ hour increments.

UTC Corrections

The UTC Corrections may be enabled or disabled. Enabling UTC Corrections commands the device to include any leap second corrections provided by the reference source and act on any leap event data that is present.

IEEE 1344 DST Correction

The IEEE 1344 Daylight Savings Time Corrections may be enabled or disabled. Enabling IEEE 1344 DST Corrections commands the device to include the daylight savings time corrections provided by the reference.

Propagation Delay

It is sometimes desirable to program an offset into the basic time keeping functions relative to the reference input. For example, if the reference input is an IRIG-B time code, there may be significant cable delay between the IRIG-B generator and the GPS/IRIG board. The delay setting allows this time difference to be removed by inserting the known amount of offset between the IRIG B reference and the GPS/IRIG board location; in this scenario, a positive offset would be used.

Generator Settings

Generator Mode

An IRIG B or IEEE 1344 time code output signal is available in both modulated and DCLS (DC Level Shift) forms. This signal will be present at the GPS/IRIG board pigtail connector labeled “Time Code Output”.

Generator Offset

The generator can output a signal that is offset by up to 16 hours in ½ hour increments from its current time.

Reset Settings

Board Reset

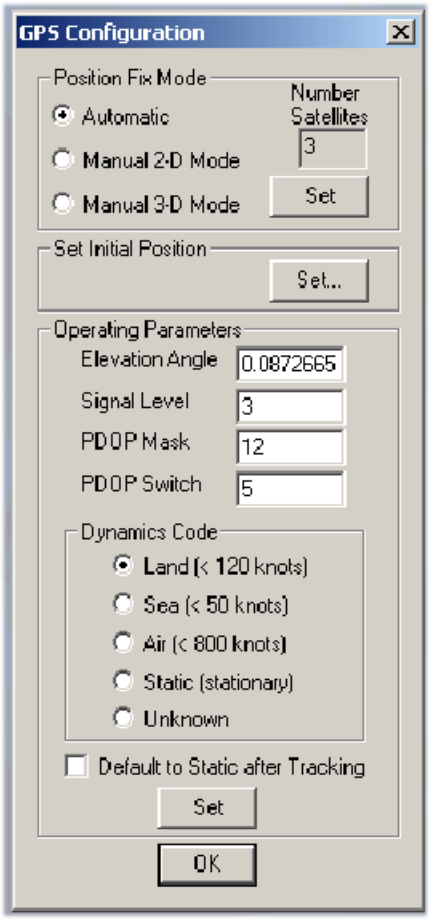
This button performs a board level reset. Contact Olympus technical support before selecting this button.

Receiver Reset

This performs a time code (and GPS) receiver reset of the GPS/IRIG board. Contact Olympus technical support before selecting this button.

Configuring the GPS Connection

Click on the **GPS CONFIG**... button on the GPS/IRIG tab to open the GPS configuration dialog box shown below.



In general, you should not need to adjust the parameters in this dialog window. The default parameters should work for the majority of applications.

Position Fix Mode

The options for this are Automatic, Manual 2D, and Manual 3D.

The preferable fix mode is 3D, where altitude is calculated along with the latitude, longitude and time. However, this requires four satellites with a PDOP (Position Dilution Of Precision) below the PDOP mask set in order to obtain position. Normally, this would provide the most accurate solution. Thus, if only 3-D solutions are desired, then you should select 3D manual mode. Depending on how the PDOP mask is set, this may be restrictive when the receiver is subjected to frequent obscuration, or when the geometry is poor due to an incomplete constellation.

Alternatively, if you only want a 2D solution, then 2D manual should be requested. In this case, the sensor uses either the last altitude obtained in a 3D fix, or the altitude supplied by the user. However, any error in the assumed altitude will affect the accuracy of the latitude and longitude solutions. High accuracy users should avoid this mode and should expect fixes with accuracy's that are at best as accurate as the supplied altitude. If a marine user enters sea-level as the altitude, then small errors in the horizontal solution will occur when the sea is rough or there are high tidal variations. However, these errors may be smaller than the altitude errors induced by the supplied altitude, so 2D may be preferable for a marine user who does not want to observe "unusual" altitudes.

The default mode is Auto 2D/3D, where the receiver first attempts to obtain a 3D solution with a PDOP below the PDOP mask and PDOP switch. If this is not possible, then the receiver attempts to obtain a 2D solution with a PDOP less than the PDOP mask. This mode supplies fairly continuous position fixes even when there is frequent obscuration. This mode is preferable for most land or air applications, where altitude changes are occurring and there is occasional obscuration.

Initial Position

By clicking on the "Set…" button in the Initial Position group box, the user can set the initial "guess" for the position of the receiver. This is also the location where you set the altitude, if in 2D mode.

Operating Parameters

To understand the operation of the GPS/IRIG hardware, one should first understand both "PDOP" and how it affects the quality of GPS data.

Dilution of precision (DOP) is the mathematical representation of the quality of GPS data being received from satellites. The number of visible satellites and their relative positions in the sky control DOP. The most commonly used dilution of precision is position dilution of precision (PDOP), which is the combination of horizontal dilution of precision (HDOP) and vertical dilution of precision (VDOP). A PDOP value of 1 indicates an optimum satellite constellation and high-quality data. The quality of the data decreases as the PDOP value increases.

Elevation Angle

This is the minimum elevation angle for satellites to be used in a solution output by the receiver. Satellites that are near the horizon are typically more difficult to track due to signal attenuation and are also generally less accurate due to higher variability in the ionospheric and tropospheric corruption of the signal. When there are no obstructions, the receiver can generally track a satellite down to near the horizon.

However, when this mask is set to low, the receiver may experience frequent constellation switching due to low elevation satellites being obscured. Frequent constellation switching is undesirable because small position jumps may be experienced when selective availability (SA) is present.

The benefit of a low elevation mask is that more satellites are available for use in a solution and a better PDOP may be yielded. The current mask is set to five degrees and provides a reasonable tradeoff of the benefits and drawbacks. High accuracy users may prefer a mask angle around ten degrees, where the ionosphere and troposphere begin to be more predictable.

Signal Level

This mask defines the minimum signal strength for a satellite to be used in a solution. There is some internal hysteresis on this threshold that allows brief excursions below the threshold if lock is maintained and the signal was previously above the mask. The default setting is 4.0.The mask should only be lowered cautiously since this mask is also used to minimize the effects of jammers on the receiver. High accuracy users may use a slightly higher mask of 5.0-6.0 since weaker measurements may be slightly noisier.

PDOP Mask and Switch

The PDOP mask is the maximum PDOP for which any 2-D or 3-D solution will be made. The switch is the level at which the receiver stops attempting a 3-D solution, and tries for a 2-D solution when in automatic 2-D, 3-D mode. The switch level has no affect on either manual mode. Raising the PDOP mask will generally increase the fix density during obscuration, but the fixes with the higher PDOP will be less accurate (especially with SA present). Lowering the mask will improve the average accuracy at the risk of lowering the fix density.

Dynamics Code

In AIR mode the receiver assumes a high dynamic environment. In this case, the satellite search and reacquisition routines are optimized to tolerate high accelerations. A user, which is subject to only benign accelerations (less than 1g) may benefit by selection of LAND or SEA mode where the search and reacquisition routines assume a low acceleration environment. In this case, satellite loss-of-lock is due more often to obscuration rather than extreme dynamics.

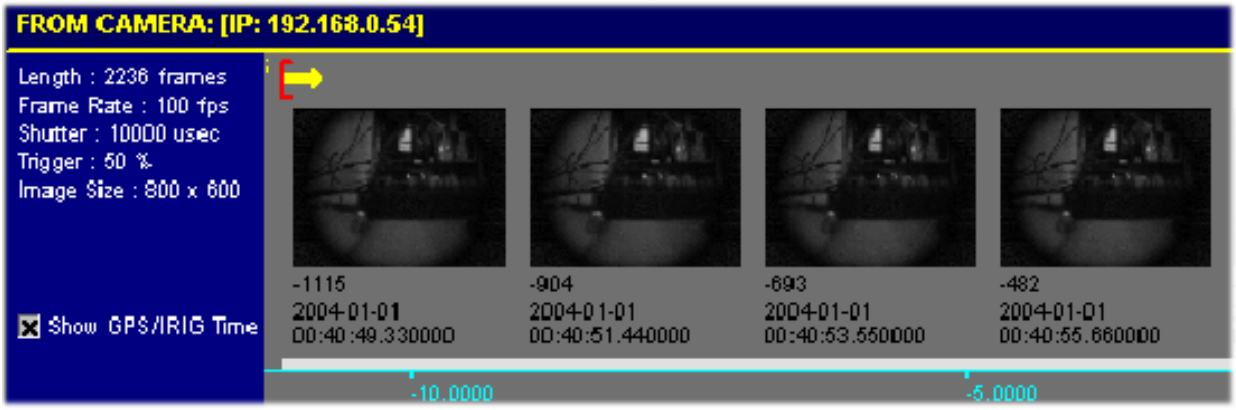
Default to Static

If the checkbox “Default to Static After Tracking” is set, the receiver will switch to Static Mode after satellite acquisition and lock.

Displaying External Time during Playback

The external time can be displayed in both Strip View and Working View windows.

In Strip View, the time is displayed under the individual frames.



Select the “Show GPS/IRIG Time” box to display this information.

In the Working View, more information is overlaid on the video image(s).



The following information is displayed:

Position

Position of the GPS antenna, in the following format:

“Lat ###.####, Long ###.####, Alt ###.####”

Trigger Time

Time that the external trigger was received, in the following format:

“Year-Month-Day-Hour-Minute-Second-Fraction of Second” Trigger Time

Frame Time

The accurate time of the shown frame, in the following format:

“Year-Month-Day-Hour-Minute-Second-Fraction of Second “

Source

The source of the displayed time (frame and trigger) is displayed here. The following are possible sources for time information:

Synch from External Source

The time was recorded from the phase locked external time source (GPS IRIG-B, etc.).

Source: OS System Clock at Acquisition

The time was derived from the system clock time at the end of the recording.

Source: Derived from Master

The time information was fundamentally obtained, as described above, from the external time source or the OS system clock. This is displayed for cameras that are not the first camera in a multi-camera recording.

Source: OS File Create Time

The time displayed was generated by a non-*i-SPEED* camera system. The time displayed is derived from the time of file creation.

19

Data Acquisition Add-on Module

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Single-Ended Grounded Sensors (Non-Referenced or NRSE) 157
Single-Ended Floating Sensors (Referenced or RSE) 157
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Data acquisition add-on module

Introduction

The data acquisition module provides more flexibility as to configuring the input channels. Channels are configured based on the type of sensor that is hooked up the input channel and to the calibration information provided with that sensor. This professional data acquisition system provides a complete flexibility to the user for acquiring professional data with video.

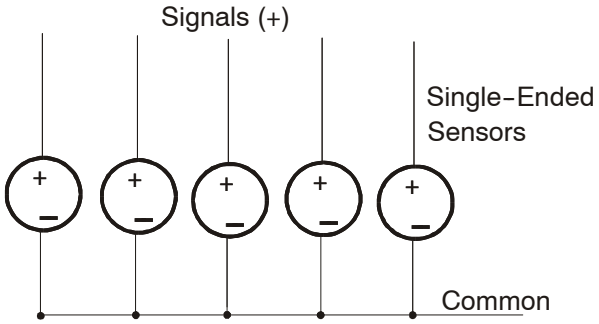
There is no live display of data when using the external data source.

Sensor Types

First, it is important to understand the different types of sensors and gauges that can be connected to the external data box.

Sensors have different characteristics that must be considered when connecting to the *i-SPEED* PC Software or any data acquisition system.

Some sensors have two output wires and produce a signal that is the difference between the positive (+, or signal) lead and the negative (-) lead. These are named “Differential” sensors.



Some sensors have one signal wire and one common wire. These sensors are generally named “Single Ended” sensors. Typically, the common wires for an entire group of Single Ended sensors are all tied together. These are very common in larger test facilities that use many sensors (crash testing, structural testing, etc.)

If the common wire from a sensor is physically connected to the data acquisition hardware, the system is considered to be “Referenced” – that is, the sensor common is considered referenced or tied to the data acquisition board common. Contrarily, if the common wire from a sensor is connected to a common building or earth ground (and perhaps not physically connected to the data acquisition hardware), the system is considered to be “Non-Referenced”.

Combining these, sensor types can be Referenced Single Ended, Non-Referenced Single Ended, or Differential.

i-SPEED PC Software is designed to work with all these sensor types. The operator must simply instruct the software as to which sensor type is being connected and the software automatically makes all the proper adjustments and switch settings. For example, if you are using a Referenced Single Ended sensor, the *i-SPEED* PC Software knows to reference the signal to the common ground of the system (e.g. computer or building) and makes the appropriate internal switch changes. Likewise, if you are using Differential sensors, *i-SPEED* PC Software knows which terminals to assign to the sensor and makes the appropriate switch changes to measure the difference between + and – leads.

Differential sensors are always recommended for better signal integrity. Single ended sensors are recommended only under controlled conditions, the most important of which is that you need more channels than are currently available. If your signal environment is the least bit noisy, your cable lengths exceed 3 meters (10 ft), or your signal level is less than 1V P-P, then it is highly recommended that you use Differential sensor types with two leads.

In the following sections, each type of sensor is summarized.

Differential Sensors

In this configuration, the Differential sensor has two leads – one positive (+) and one negative (–).Most commercial data acquisition systems are designed in a Differential configuration, especially if significant signal conditioning is required.

The negative lead of the sensor may be tied to earth or building ground and is therefore already connected to a common ground point with respect to the board (assuming that the computer is plugged into the same power system). This is termed “Grounded” or “Ground Sourced”. In this configuration, the little rocker switch under the BNC jack on your external data box should be placed in the “GS” position.

The negative lead of the sensor may not be tied to earth or building ground and is therefore “floating” with respect to the amplifier. Therefore, to reduce the effects of signal drift relative to the board ground, you must tie the ground reference of the floating signal to your board’s analog input ground through a bias resistor. In essence, you are “biasing” the drift toward ground. Technically, you should bias both the signal lead and the negative lead, but little improvement is gained by adding a bias resistor to the positive lead. You can add this bias automatically by sliding the little rocker switch under the BNC jack on your external data box to the “FS” position.

Single-Ended Grounded Sensors (Non-Referenced or NRSE)

Single–Ended sensors have one wire that carries the signal (+) and one common wire. Typically, single ended sensors are used in specialized applications such as crash testing where many additional sensors are required and the test environment is very well controlled. If you are using single ended sensors, you may tie the common wires of the sensors together.

On a Grounded Single–Ended sensor, the common lead of the sensor is also tied to earth or building ground and is therefore already connected to a common ground point with respect to the board (assuming that the computer is plugged into the same power system). However, since the differential amplifier needs both a positive (+) and negative (–) input, the common lead must be tied to a point on the External Box called the “AISENSE” – an internal ground sensing point.

When using Single–Ended Grounded sensors, the common lead gets tied to AISENSE at the BNC Breakout Box. All other connections and switches are handled automatically by the *i–SPEED* PC Software.

Single-Ended Floating Sensors (Referenced or RSE)

Single–Ended sensors have one wire that carries the signal (+) and one common wire. Typically, single ended sensors are used in specialized applications such as crash testing where many additional sensors are required and the test environment is very well controlled. If you are using single ended sensors, you may tie the common wires of the sensors together.

On a Floating Single–Ended sensor, the common lead of the sensor is not tied to earth or building ground and is therefore floating relative to the ground of the amplifier. Therefore, to reduce the effects of signal drift relative to the board ground, you must “reference” the floating signal to the amplifier analog input ground through a bias resistor. In essence, you are “biasing” the drift toward ground. Technically, you should bias both the signal lead and the negative lead, but little improvement is gained by adding a bias resistor to the positive lead.

You must add the bias resistor yourself, even if you are using the BNC Breakout Box (Single–Ended sensors do not use the negative lead of the BNC jack). For sources with low impedance, no bias resistor is needed and you may simply connect the common lead(s) to the AIGND terminal on your External data box directly.

For sources with large impedance, however, you must put a bias resistor in–line to de–couple the noise from the amplifier. Place a bias resistor of minimum 100x the equivalent source impedance between the negative terminal (common) of the sensor and the AIGND terminal on your External data box.

Installing the Data Acquisition module

Hardware installation

1 Connect the 1m data cable (2) to the breakout box (3) – Figure 1.

2 Connect the other end of the 1m data cable (2) to the DAQ card and secure – Figure 2.

3 Insert the data cable with DAQ card into the PCMCIA port in the PC or laptop – Figure 3.

Figure 1

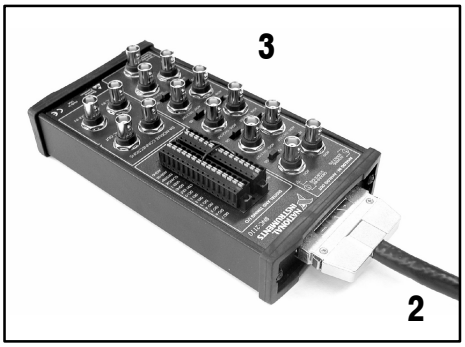


Figure 2

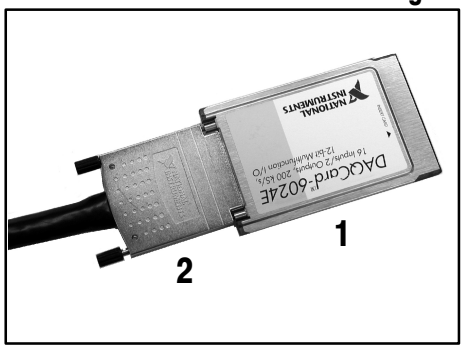
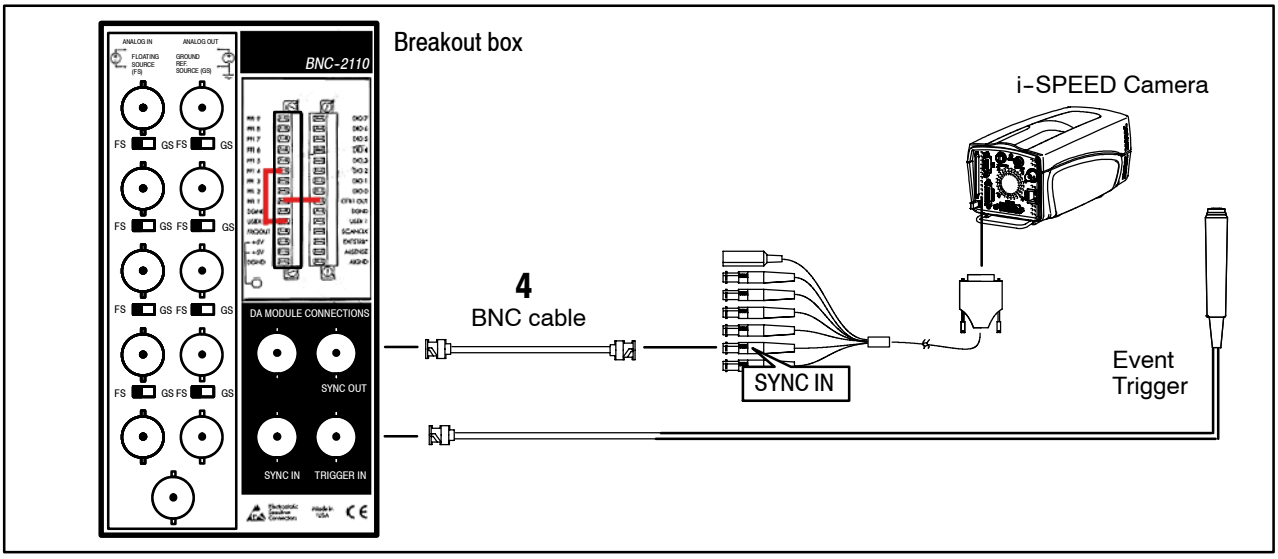


Figure 3



4 Connect the BNC cable (4) to the breakout box input labelled 'SYNC OUT' and to the i-SPEED camera connector labelled 'SYNC IN'. Connect the event trigger to the breakout box input labelled 'TRIGGER IN'.

NOTE: If connecting multiple cameras, the BNC connector must be connected to each camera 'SYNC IN' connector. There is no need to connect the event trigger to the camera(s) in addition to the breakout box.



Device driver installation

5 Insert the “NIDAQ” driver CD from National Instruments (**5**). The driver installation program should start automatically. If it does not, from the **RUN** prompt, type F:/SETUP, where ‘F’ is the letter of your CD-ROM drive.The NI-DAQ Installation screen appears, follow the on-screen instructions.

6 Reboot the system when driver installation is complete.

Configuring the Data Acquisition Software

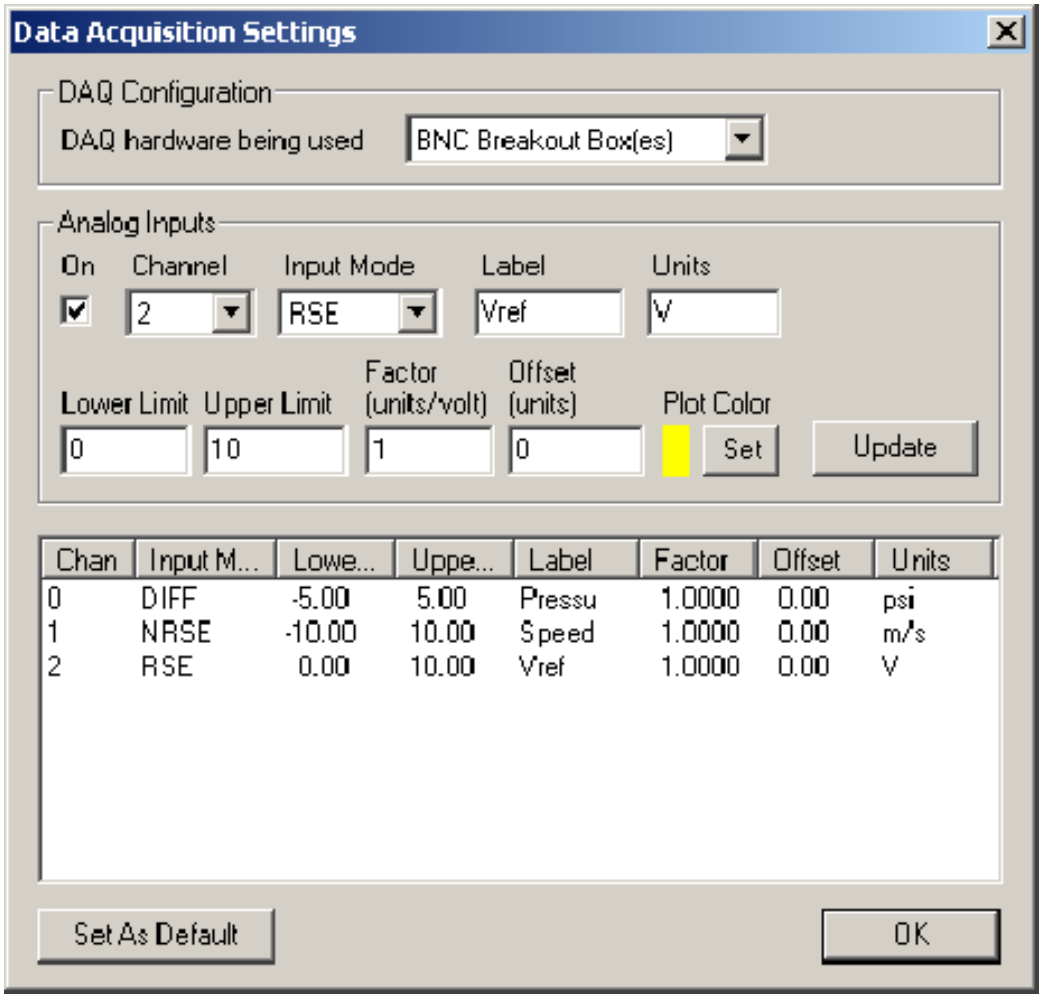
To set up your external data acquisition software:

1 Connect your external data box to the computer.

2 Select the Data tab.

3 Select the External DAQ source.

For each channel of data, perform the following steps:



4 Select the channel number that you will be connecting your sensor. Start with Channel 0 and proceed incrementally upward. If a channel is not available (e.g. in use), the software will not allow you to input any input parameters. Skip all unusable channels.

5 Connect your sensor to the data box.

6 Select the type of sensor input from the software.

7 Select the sensor parameters (gain, offset, label, etc.)

8 Click on update button.

The input parameters are defined as follows:

Channel	*i-SPEED* automatically determines and displays which channels are available based on which type of sensors you have already configured. Always start with Channel 0 and check the box to enable that channel.
Input Mode	The type of sensor you are connecting to that channel. The three options here are DIFF, RSE and NRSE.
Label	A short label for the analog input channel.
Units	A short field for placing units in the graphs.
Lower Limit	The lower limit, in volts, that you expect to see from your sensor. *i-SPEED* adjusts the dynamic range of the input from Lower Limit to Upper Limit based on the user inputs.
Upper Limit	The upper limit, in volts, that you expect to see from your sensor. *i-SPEED* adjusts the dynamic range of the input from Lower Limit to Upper Limit based on the user inputs.
Factor	The scale factor to be applied by the graphing and saving routine to convert the input volts to a meaningful number, in units/volt. This number is applied immediately after the input voltage is registered.
Offset	The offset to be applied to account for drifts or offsets in the input, in units. This offset is applied after the scale factor
Plot color button	The color of the line to be used in multiple-line graphs. Select this button to bring up the color palette.

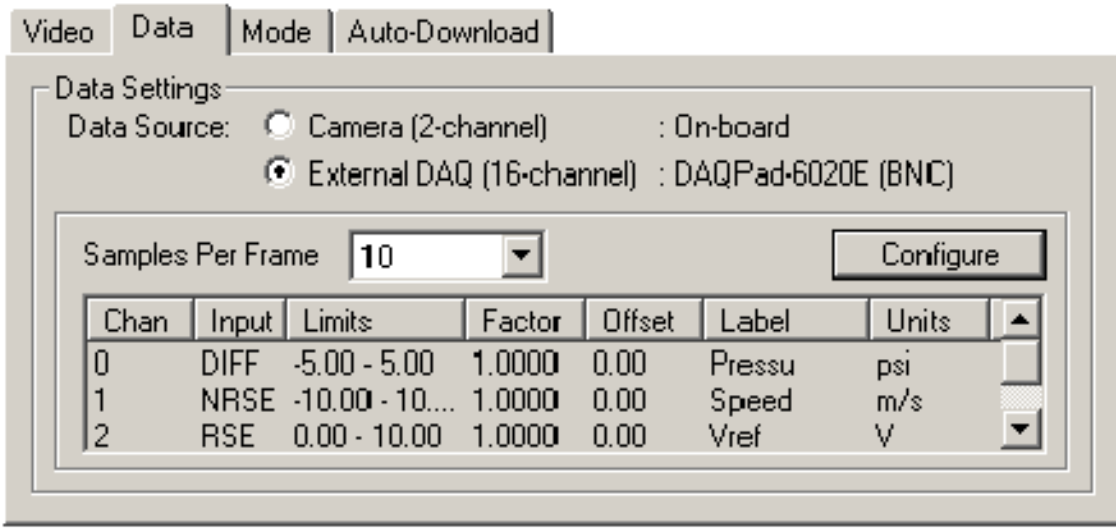
Choosing the Data Sample Rate

The maximum data sample rate is 200,000 data points/second. You can acquire data at a much faster rate than you can acquire video. To set the data sample rate:

1 Select the Data tab.

2 Select the samples per frame rate from the drop-down list.

The total data sample rate is the product of the number of channels times the sample rate per channel. For example, if you have 4 channels active and wish to acquire 10,000 samples per second per channel, the total sample rate is 4 x 10,000 = 40,000 samples/second. Likewise, if you have 8 channels active, the maximum rate per channel is 50,000/8 = 6,250 samples/second.



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