



# Motion Amplification

User's Manual

Version 3.0

Revised 2/26/2020

**RDI Technologies**

10024 Investment Drive, Suite 150 • Knoxville, TN • 37932 • [www.rдитеchnologies.com](http://www.rдитеchnologies.com)

Copyright © 2016-2020 RDI Technologies Inc. All Rights Reserved

## Contents

1	Using the cameras .....	6
1.1	The Iris M and Iris CM Camera.....	6
1.2	The Iris MX Camera .....	6
1.3	Lenses .....	8
2	Software Overview.....	9
2.1	Installation.....	9
2.2	Managing your License.....	10
3	Iris M and MX Acquisition.....	12
3.1	Firewall Access for Iris MX.....	14
3.2	Recording Properties.....	15
3.2.1	Standard Recording.....	15
3.2.2	Shaft Inspection Recording.....	15
3.2.3	Calculate Speed.....	16
3.3	Recording Association .....	17
3.4	Iris M Camera Properties .....	17
3.5	Iris MX Camera Properties .....	18
3.6	Image Properties .....	19
3.7	Calculated Values .....	19
3.8	Recording/Playback Bar .....	20
3.9	Toolbar for Iris M Recordings .....	21
3.10	Toolbar for Iris MX Recordings .....	22
3.11	Image Viewer Window .....	23
3.11.1	Focus Brightening.....	24
3.11.2	Max Zoom.....	25
3.12	Settings.....	25
3.13	Information .....	26
4	Motion Amplification.....	27
4.1	Opening a File.....	27
4.2	Toolbar.....	28
4.2.1	Annotations .....	28
4.2.2	Motion Vectors .....	30
4.2.3	Amplification Regions .....	31

4.2.4	Threshold and Brightness.....	33
4.2.5	Motion Map .....	34
4.2.6	Save Snapshot to Current Collection .....	35
4.2.7	Trim Recording.....	35
4.2.8	Amplification Mode.....	35
4.3	Playback Bar .....	36
4.4	Adjusting Amplification .....	36
4.4.1	Extreme Amplification.....	37
4.5	Determining Amplification Period.....	37
4.6	Playback Speed .....	38
4.7	Exporting a Video .....	38
4.8	Settings.....	39
4.9	Information .....	41
4.10	Recording Information.....	41
4.11	Linked Recordings .....	43
4.12	Displacement and Frequency .....	43
4.12.1	Drawing a Region of Interest for Measurement.....	43
4.12.2	ROI Properties .....	47
4.12.3	Examples.....	48
4.12.4	General Plot Options.....	53
4.12.5	Time Waveform Plots .....	54
4.12.6	Frequency Spectrum Plots .....	62
4.12.7	Orbit Plots .....	66
4.12.8	Transient Path Plots .....	66
4.12.9	Measuring Multiple Locations Simultaneously .....	67
4.12.10	Advanced Plot Features .....	68
4.13	Filtering.....	71
4.13.1	How to Apply Filtering.....	71
4.13.2	Filtering Interface.....	71
4.13.3	Applying Specified Filters to a Recording.....	76
4.14	Stabilization .....	78
4.14.1	How to Stabilize.....	78
4.14.2	Stabilize Based on a Portion of the Frame .....	80
4.14.3	Completed Stabilization.....	81

5	Motion Explorer.....	83
5.1	Levels in the Hierarchy.....	83
5.1.1	Getting Started.....	84
5.2	Parts of the Application.....	84
5.2.1	Left Pane.....	84
5.2.2	Middle Pane.....	85
5.2.3	Right Pane.....	85
5.2.4	Ribbon Bar.....	87
5.2.5	Settings.....	96
5.2.6	Information.....	97
6	Motion Studio.....	98
6.1	Adding Content to a Movie Project.....	98
6.1.1	Adjusting View in the Available Content Pane.....	99
6.2	Previewing the Movie.....	100
6.3	Movie Workspace.....	100
6.3.1	Title Items.....	101
6.3.2	Video Items.....	101
6.3.3	Image Items.....	102
6.3.4	Composite Items.....	102
6.3.5	Reordering Items.....	103
6.3.6	Cut/Copy/Paste.....	104
6.3.7	Alter Time Scale Representation of Movie Project Items.....	104
6.3.8	Removing Project Items.....	104
6.3.9	Editing Project Items.....	104
6.4	File Menu.....	105
7	Motion Monitor.....	105
7.1	Configuration of the System.....	105
7.1.1	Connecting a Monitoring Device to the Client Computer.....	105
7.1.2	Hierarchy Tree.....	107
7.1.3	Device Hierarchy.....	108
7.1.4	Logical Hierarchy.....	110
7.1.5	Triggers.....	111
7.2	Monitoring.....	119
7.2.1	Live Motion Amplification.....	119

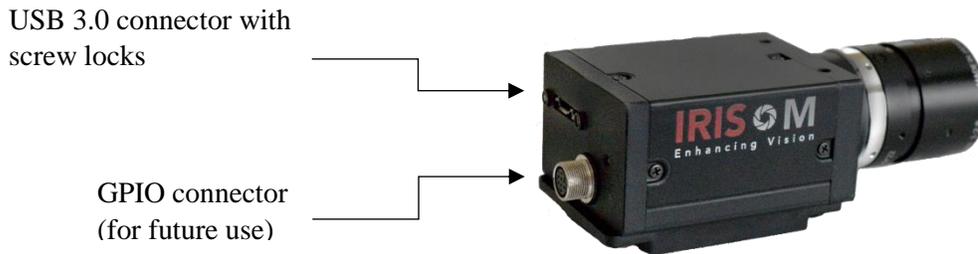
7.2.2	ROI Trigger Waveform.....	120
7.3	Review Collected Data.....	121
7.3.1	Motion Amplification .....	121
7.3.2	Manual Extraction.....	121
7.4	Managing Extractions .....	122
7.4.1	Extractions .....	123
7.4.2	Notifications.....	124
7.4.3	Storage .....	124
7.4.4	Import Extractions.....	125
7.5	User Preferences .....	126
7.6	Application Information.....	127
8	Specification .....	128
9	Troubleshooting .....	129
10	Revision History .....	129
11	Index.....	130

Motion Amplification™ is a registered trademark of RDI Technologies.

# 1 Using the cameras

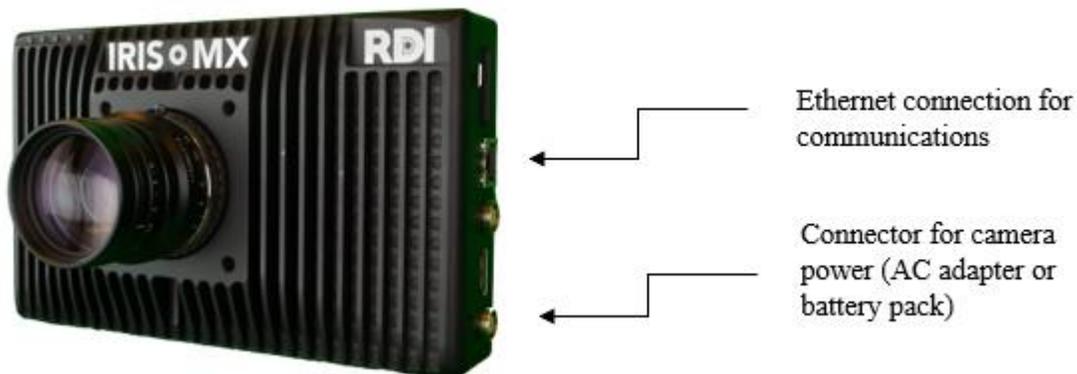
## 1.1 The Iris M and Iris CM Camera

The Iris M camera supported by the Motion Amplification software uses a USB3 streaming video camera capable of capturing high quality grayscale imagery. This is the same camera used by the Iris CM. The camera is connected to the acquisition computer by a USB3 cable. Power is supplied to the camera by the USB3 cable. The USB3 cable should be connected to the camera at all times by the screw lock connector and the cable should not exceed 3 meters in length (9.84 ft). It is possible the camera works with cables up to 5 meters in length but this is unsupported. The camera can lose data integrity at these lengths. If the camera is disconnected from the computer while the Iris M acquisition software is running, the software must be restarted once the camera is reconnected.

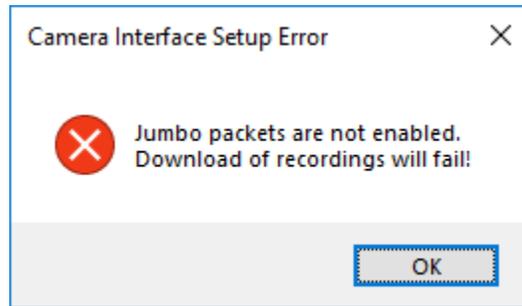


## 1.2 The Iris MX Camera

The Iris MX camera supported by the Motion Amplification software is a high speed camera capable of capturing high quality grayscale imagery at faster speeds than the Iris M camera and is available as an add-on to the Iris M. This high speed camera can capture up to 1,400 frames per second in HD resolution. The camera is connected to the acquisition computer by an ethernet cable, and a USB to ethernet adapter is typically required to connect the ethernet cable to the USB port on the acquisition computer. Power is supplied to the camera by either an external AC power adapter or a battery pack. If the camera is disconnected from the computer while the acquisition software is running, the software must be restarted once the camera is reconnected.

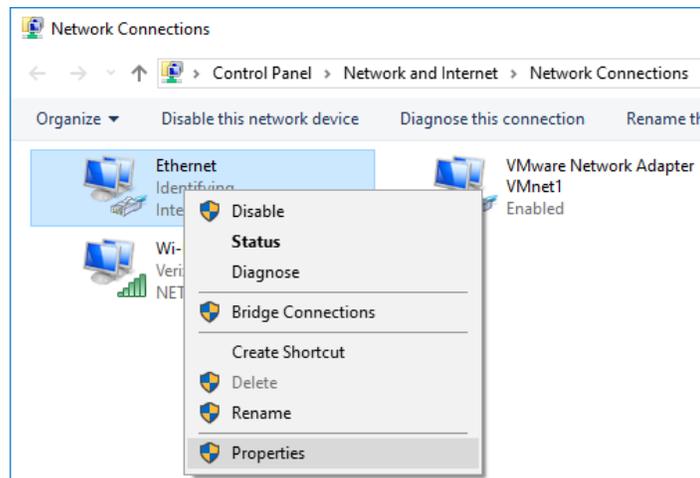


**Important:** In order to download recordings from the Iris MX camera, the network connection used to communicate with the camera must be configured correctly. If the connection is not configured correctly, the message below will be displayed when the acquisition application is launched.

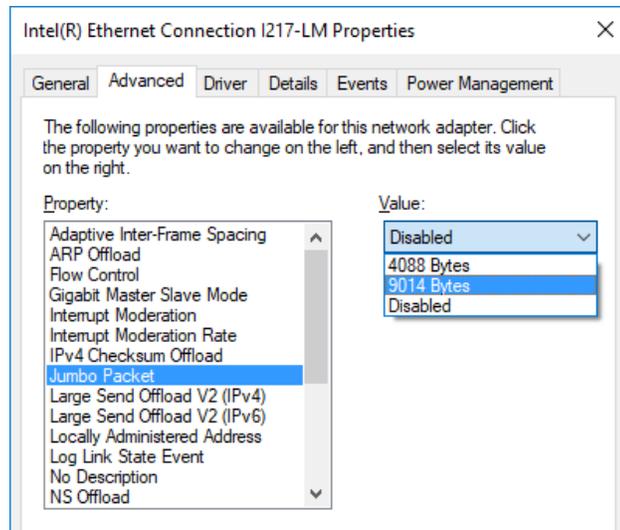


In order to configure the network connection properly, please follow the steps below:

- 1) Open the Windows Network and Sharing Center
- 2) Click “Change Adapter Settings”
- 3) Right click the network connection that will be used to communicate with the Iris MX camera and select “Properties”.

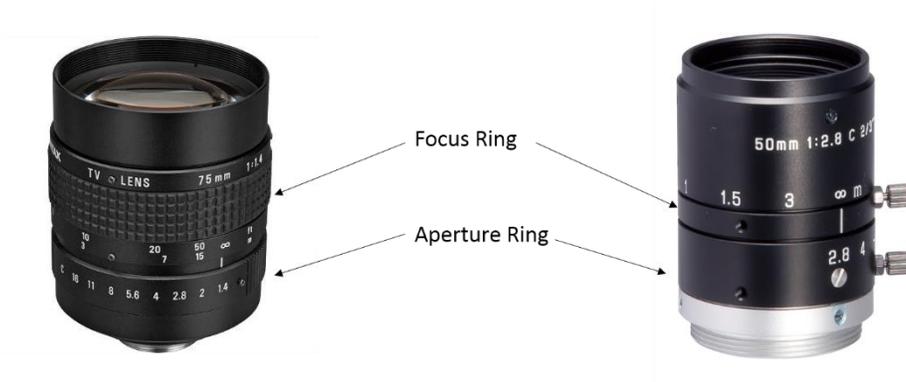


- 4) Under the Networking tab, click the Configure button for the network adapter.
- 5) Select the Advanced tab.
- 6) Select the “Jumbo Packet” item in the list and change it’s value to 9,104 bytes (or 9kB MTU). If the only options for Jumbo Packets is “On” or “Off”, choose “On”.



### 1.3 Lenses

The types of lenses used with both the Iris M and MX cameras are C-Mount lenses. The lenses mount to the front of the camera via a threaded interface. A standard kit may include several lenses. The focal length of the lens determines the field of view (fov) and magnification. By changing lenses to double the focal length, the magnification will double, while the fov will decrease by one half. By changing lenses to half the focal length, the magnification will decrease by one half and the fov will double.



**Aperture Ring** – The aperture ring is a collar on the camera that can be rotated to increase or decrease the aperture. The effect is letting more or less light in, respectively.

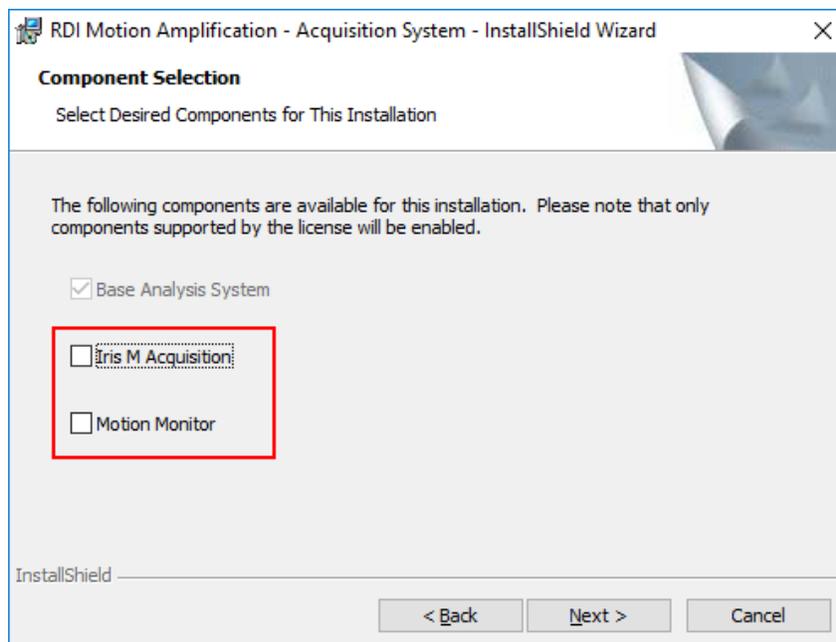
**Focus Ring** – The focus ring is a collar on the camera and changes the focus of the image.

## 2 Software Overview

The suite of Motion Amplification software consists of five software applications: Acquisition (for the Iris M and MX), Motion Amplification, Motion Explorer, Motion Studio, and Motion Monitor (for the Iris CM). On the Iris M acquisition device, all of the applications except Motion Monitor are installed. The Base Analysis System may be installed on another PC, and this installation will include Motion Amplification, Motion Explorer, and Motion Studio. The Acquisition software records the data from the Iris M and Iris MX cameras. The Motion Amplification software analyzes the data and amplifies the motion for all RDI recordings. Motion Explorer allows the user to create an organizational hierarchy under which collected recordings can be found. Motion Studio allows the user to create more complex MP4 videos. Motion Monitor configures the Iris CM (Continuous Monitoring) system and manages the transfer of recordings from the Iris CM device to the client computer.

### 2.1 Installation

During the installation sequence, if you are installing the software on a PC that is not the PC supplied with the Iris M/MX system and not the PC supplied with the Iris CM, then the license will only support the Base Analysis System. In this case, the Iris M Acquisition and Motion Monitor boxes should not be checked so that the applications are not installed. If they are installed, the license will not allow these applications to run.



If after installation and reboot an activation dialog is displayed, see [Managing Your License](#).

## 2.2 Managing your License

After installing the software, it can be activated three different ways. The simplest is if the computer is connected to the internet. If that is the case, simply enter the License ID and Password provided with your Motion Amplification purchase, click the “Next” button, and the software will be activated via the internet.

**License Status**

Name	Status
RDI Acquisition and Moti...	9200: License not found - activation is required.

**Actions**

I want to...

Activate a license or renewal.

Refresh my license.

Deactivate this workstation.

Using...

This computer's Internet connection.

Another computer's Internet connection.

**License Details:**

License ID:  ⚠

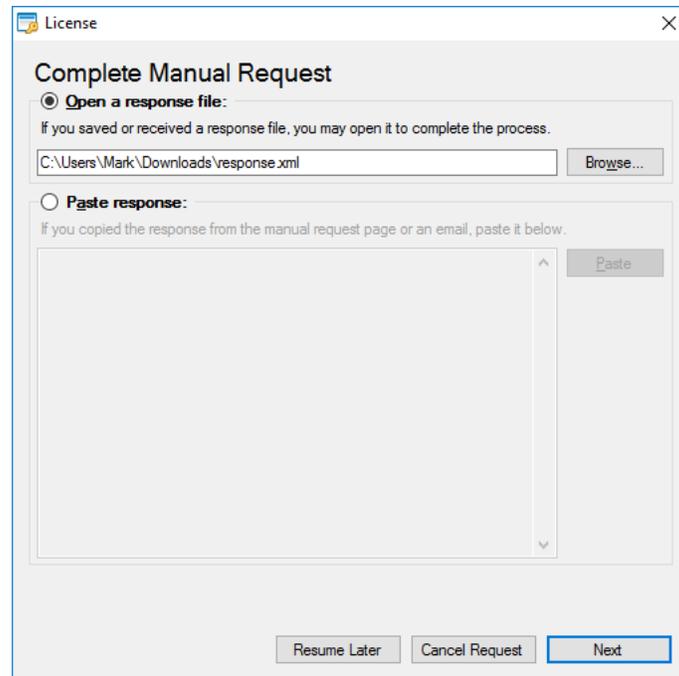
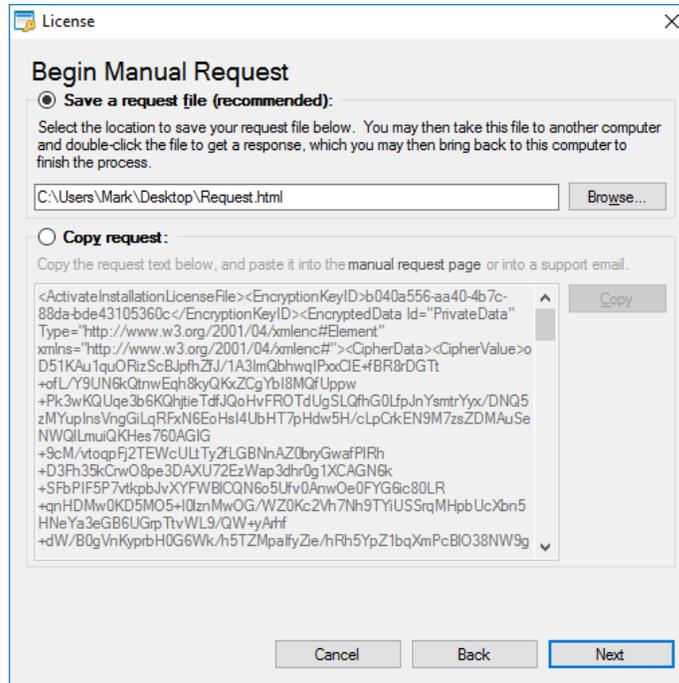
Password:  ⚠

Installation ID:

Installation Name:  (Optional)

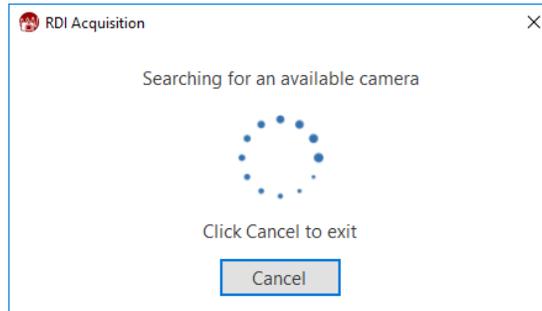
Cancel Back Next

If the computer is not connected to the Internet, you can use another computer’s internet connection. To use another computer’s Internet connection, enter the License ID and Password provided as a part of your purchase, select “Another computer’s internet connection” in the License Status dialog, and press the “Next” button. In the “Begin Manual Request” dialog, you will then be prompted to save an activation request file to your computer. You will then need to manually transfer that file to another computer and double click the file once transferred. This will produce an activation response file using the other computer’s Internet connection. That response file will need to be transferred back to the computer on which the software was installed. When you press “Next” from the “Begin Manual Request” dialog, you will be prompted to select the Activation response file. Selecting the proper response file and pressing the next button will complete the activation sequence.



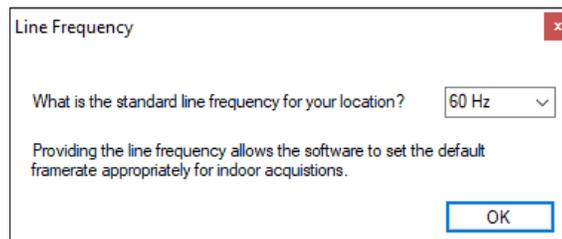
### 3 Iris M and MX Acquisition

The acquisition application allows the user to record data with either of the two Motion Amplification cameras. The Iris M or the Iris MX camera should be plugged into the computer prior to launching the software. The software will attempt to connect to one of these cameras, and while it is attempting to connect the following message will be displayed.



Selecting “Cancel” will close the Acquisition application.

The first time the software is opened the following dialog appears.



It is important to select the appropriate line frequency for your location when recording indoors. This sets the proper framerate to ensure your camera is timed to take images at the same frequency as your lights brighten and dim. See the

Troubleshooting section on issues with selecting the wrong framerate with AC lighting.

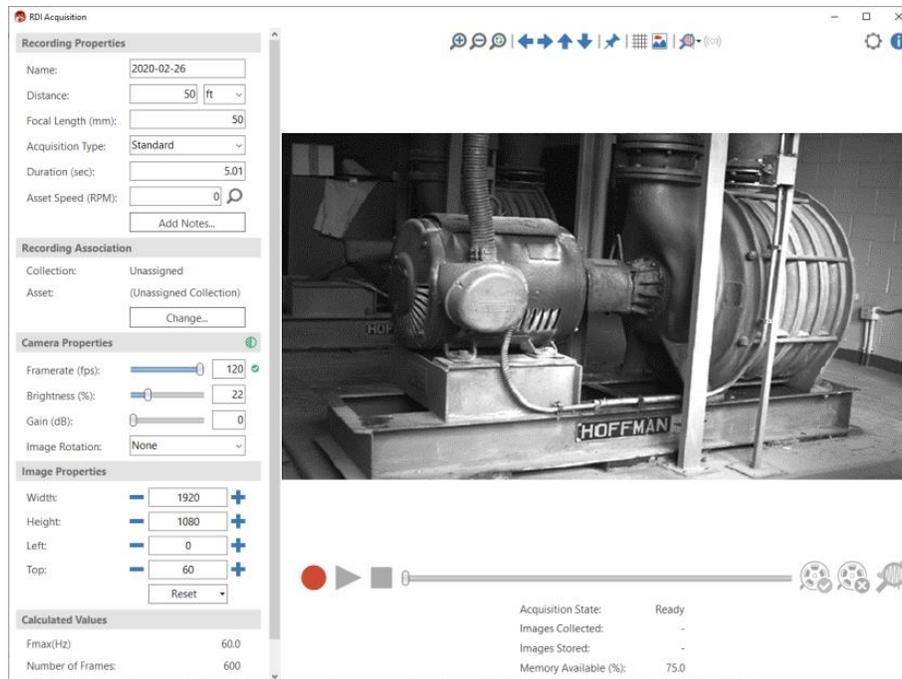
The default settings for the Iris M camera are as follows. Values are for 60 Hz line frequency unless noted.

Setting	Value
<b>Name</b>	“Current Date”
<b>Distance</b>	50 ft
<b>Focal Length (mm)</b>	50
<b>Time (seconds)</b>	3
<b>Framerate (fps)</b>	120 fps (100 for 50 Hz line frequency)
<b>Brightness (%)</b>	68.2 (57 for 50 Hz line frequency)
<b>Gain (dB)</b>	0.0
<b>Width</b>	1920
<b>Height</b>	1060 (1200 for 50 Hz line frequency)
<b>Left</b>	0
<b>Top</b>	0

The default settings for the Iris MX camera are as follows. Values are for 60 Hz line frequency unless noted.

Setting	Value
<b>Name</b>	“Current Date”
<b>Distance</b>	50 ft
<b>Focal Length (mm)</b>	50
<b>Time (seconds)</b>	3
<b>Framerate (fps)</b>	120 fps (100 for 50 Hz line frequency)
<b>Brightness (%)</b>	68.2 (57 for 50 Hz line frequency)
<b>Gain (dB)</b>	0.0
<b>Width</b>	1920
<b>Height</b>	1060 (1200 for 50 Hz line frequency)
<b>Left</b>	0
<b>Top</b>	0

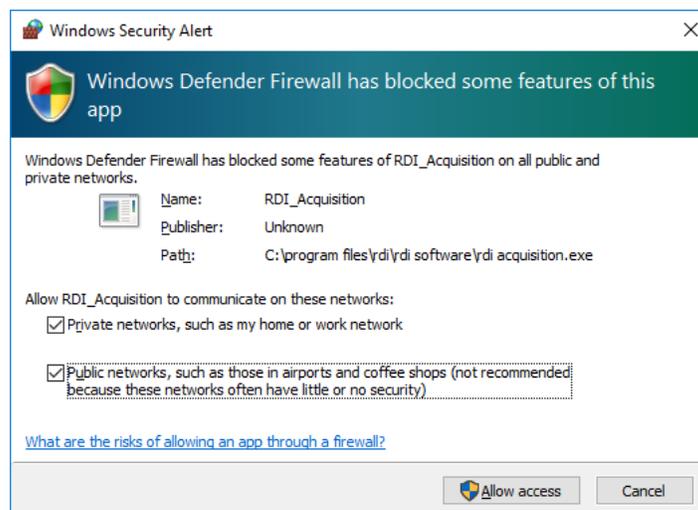
The Motion Amplification Software records video into a “.rdi” format. Each “.rdi” file has a corresponding folder of the same name that also stores data. It is necessary for the “.rdi” file and the corresponding folder to remain in the same directory.



### 3.1 Firewall Access for Iris MX

The first time the RDI Acquisition application is run, the user should see a message from the Windows Defender Firewall (or the currently installed firewall). The message is telling the user that Windows Defender Firewall has blocked some of the features of the RDI Acquisition application.

The RDI Acquisition application talks to the Iris MX camera using an ethernet connection, so the user needs to allow the camera to communicate with the acquisition application through the firewall. Simply check both boxes in the displayed message (shown below) and press the “Allow Access” button. This should allow the camera to properly communicate with the software.



## 3.2 Recording Properties

**Name** – Sets the filename of the recording. In the event a file with the same name already exists the software will append an auto advance number at the end of the filename. For example, if a recording with the filename “motor.rdi” exists the software will name the next file “motor\_01.rdi”.

**Distance** – Stores the distance from the lens to the object in the recording for retrieval later.

**Focal Length (mm)** - Stores the focal length of the lens in the recording for retrieval later.

**Acquisition Type** – Determines whether the recording is a Standard, Shaft Inspection, or High Density Recording.

### 3.2.1 Standard Recording

Standard recordings are used for typical Motion Amplification applications. Both the Iris M and MX support standard recordings. Below are the options present for Standard recordings.

Acquisition Type:	<input type="text" value="Standard"/>
Duration (sec):	<input type="text" value="3"/>
Asset Speed (RPM):	<input type="text" value="0"/> 

**Duration** – The entered value specifies the length of the recording in terms of the number of seconds to collect data at the specified framerate. The number of frames that will be collected based on the specified time appears in the “Calculated Values” section.

**Asset Speed (RPM)** – The entered value will be associated with the recording, and it can be used for order-based analysis in the Motion Amplification application. Providing an asset speed is not required for a standard recording.

### 3.2.2 Shaft Inspection Recording

Shaft Inspection recordings are used to capture a very detailed examination of a rotating shaft. The recording will capture approximately one revolution of the shaft with a high amount of detail. For these recordings it is desirable to maximize Gain and minimize Brightness (exposure time) during acquisition to prevent smearing of the images collected of the rotating shaft. Framerate will be automatically determined based on entered Asset speed, so accurate speed is critical. Shaft Inspection Recordings can only be collected with the Iris M.

Acquisition Type:	<input type="text" value="Shaft Inspection"/>
Asset Speed (RPM):	<input type="text" value=""/> 
	<input type="button" value="Add Notes..."/>

**Asset Speed (RPM)** – The entered value will be associated with the recording, and it can be used for order-based analysis in the Motion Amplification application. Providing an asset speed is required for a shaft inspection recording, and this is why the asset speed input box is highlighted.

### 3.2.2.1 High Density Recording

High Density recordings are used to capture a recording with a very dense representation of the motion of the subject. These recordings can be amplified. The framerate used for the recording will be determined based on frequency of interest. Asset speed is not required for this recording type. Shaft Inspection Recordings can only be collected with the Iris M.

Acquisition Type:	<input type="text" value="High Density"/>
Frequency (Hz):	<input type="text" value="0"/>
Number of Cycles:	<input type="text" value="1"/>
Asset Speed (RPM):	<input type="text"/> 

**Frequency (Hz/CPM)** – A frequency of interest must be provided for a High Density recording, and this is why the frequency input box is highlighted. The High Density recording is focused on this one frequency of interest. If motion at more than one frequency is needed, a Standard recording should be used instead.

**Number of Cycles** – This is the approximate number of cycles that will be captured by the High Density recording.

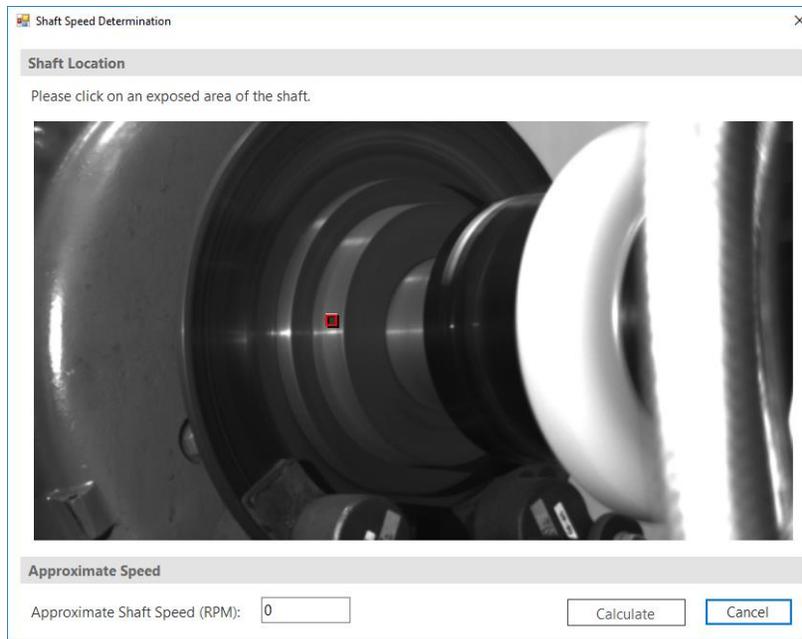
**Asset Speed (RPM)** – The entered value will be associated with the recording, and it can be used for order-based analysis in the Motion Amplification application. Providing an asset speed is not required for a High Density recording.

### 3.2.3 Calculate Speed

Pressing the magnifying glass icon adjacent to the Asset Speed input field will display a dialog that will help the user determine the rotational speed of the shaft. The calculate speed function is only available with the Iris M.

Asset Speed (RPM):	<input type="text" value="0"/> 
--------------------	--

A dialog is displayed that requires two pieces of information from the user. First, the user must click in the camera's field of view on an exposed area of the shaft. The second piece of information required is an approximate speed of the rotating shaft. This approximate speed needs to be within +/-15% of the shaft's actual speed. Once these two pieces of information are provided, the user can press the Calculate button to determine the speed of the specified shaft. If the user accepts the calculated speed, the dialog will close and the speed will be used to populate the asset speed field in the main acquisition window.



### 3.3 Recording Association

**Collection** – Specifies the name of the collection the recording will be associated with. A Collection can be chosen, and a new collection can be created with the acquisition software under the Collection Selection Window by pressing the “Change” button. By associating a recording with a collection and asset in the acquisition software, that recording is automatically associated similarly in Motion Explorer on the same computer.



**Asset** – Determines the asset under which the recording will be associated. Assets cannot be created in the acquisition software. See Section 5.2.4.1 for creating an asset in Motion Explorer.

### 3.4 Iris M Camera Properties

The following camera properties will be displayed if an Iris M camera is connected.

**Framerate (fps)** – Determines the number of images to be collected in one second. Equivalent to sampling rate.

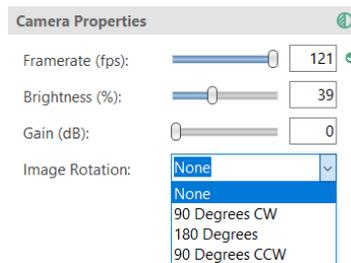
**Framerate Quality** - A  color  indicator is directly to the right of the framerate setting. This circle informs the user if the software is receiving the requested framerate. If the camera’s framerate drops below the requested value, the circle turns red . This indicates the camera cannot sustain the requested framerate. It is suggested the user reduce the vertical resolution of the camera to accommodate the requested

framerate or drop the framerate until the circle turns green. The user can hover the mouse over the circle to see what framerate the camera is achieving.

**Brightness (%)** – Adjusts the brightness of the image by changing the exposure time of the image. The larger the brightness level the longer the exposure time. This value is scaled from 0 to 100 percent.

**Gain** – Adjusts the sensitivity of the camera’s sensor. By increasing the gain, you will brighten your image, but you will introduce more noise and decrease the quality of the measurement. Sometimes this is necessary when the image is too dark.

**Image Rotation** – Rotates the image in the Image Viewer Window. The image is permanently rotated and appears the same when opened in Motion Amplification. The image can be rotated 90° Clockwise, 180°, and 90° Counter Clockwise.



### 3.5 Iris MX Camera Properties

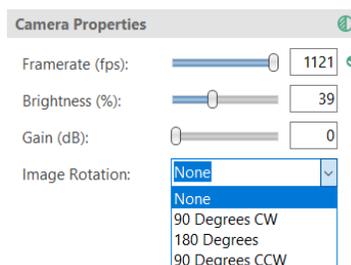
The following camera properties will be displayed if an Iris MX camera is connected.

**Framerate (fps)** – Determines the number of images to be collected in one second. Equivalent to sampling rate. Only Standard recordings allow the user to specify the framerate for the recording. For Shaft Inspection and High Density recordings, the application manages the framerate for the recording.

**Brightness (%)** – Adjusts the brightness of the image by changing the exposure time of the image. The larger the brightness level the longer the exposure time. This value is scaled from 0 to 100 percent.

**Gain** – Adjusts the sensitivity of the camera’s sensor. By increasing the gain, you will brighten your image, but you will introduce more noise and decrease the quality of the measurement. Sometimes this is necessary when the image is too dark. Available setting for gain are None, Low, and High.

**Image Rotation** – Rotates the image in the Image Viewer Window. The image is permanently rotated and appears the same when opened in Motion Amplification. The image can be rotated 90° Clockwise, 180°, and 90° Counter Clockwise.



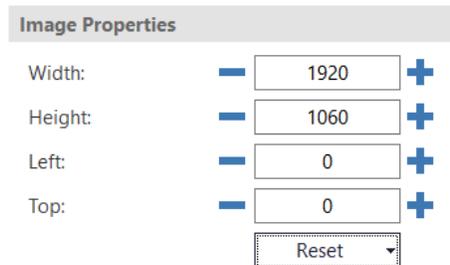
### 3.6 Image Properties

**Width** - Adjusts the width of the image in pixels.

**Height** - Adjusts the height of the image in pixels.

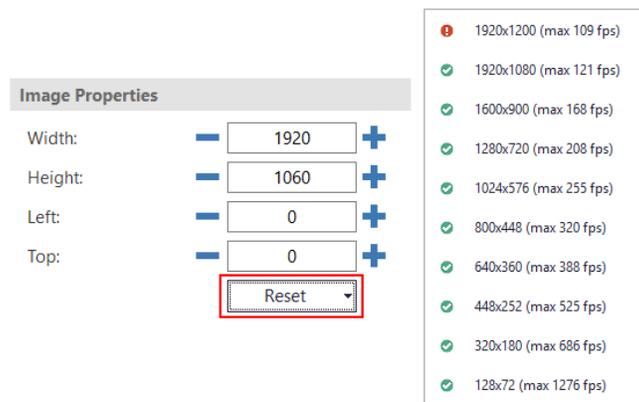
**Left** – Offset of the image from the left if the image is less than full width.

**Top** – Offset of the image from the top if the image is less than full height.



The image size and location can also be adjusted by drawing a Region of Interest (ROI) in the image. See Section 3.11.

Selecting the reset button displays a context menu with a list of recording sizes. The maximum framerate is displayed with each item in the list. Selecting one of these items will make the selected size the current frame size for the camera.



### 3.7 Calculated Values

**Fmax(Hz)** – The maximum frequency of any spectral plots generated from data collected with the current settings. This information is only displayed for Standard recordings.

**Number of Frames** –Number of images that will be collected based on the specified duration and framerate. Displayed if the Duration Type is set to “Time”.

**Recording Size (GB)** – Total size of the recording based on the number of images.

**Available Disk Space (GB)** -Available space on the disk drive selected to store recordings.

Calculated Values	
Fmax(Hz)	60
Number of Frames:	360
Recording Size (GB):	2.6
Available Disk Space (GB):	27.0

### 3.8 Recording/Playback Bar

The Recording/Playback bar is located below the Image Viewer Window. It serves to control and inform the user about recording and playback depending on which mode the user is in.

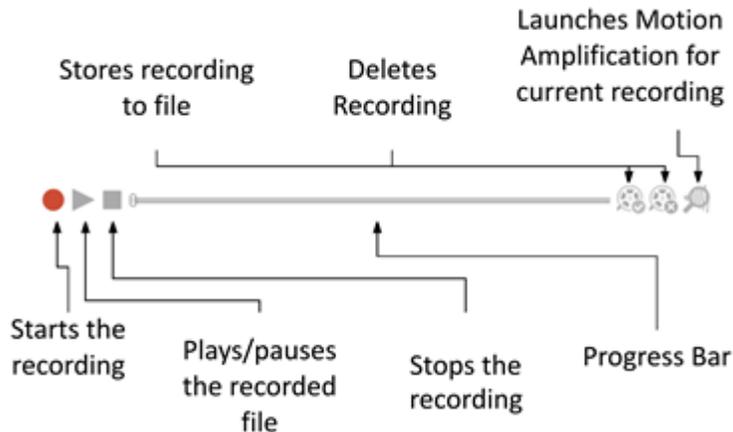
**Recording** – During live preview the Image Viewer Window will show a live stream of the camera. In the recording/playback bar the only option available will be the record button. Once recording begins the stop button will become active. Recording can be stopped at any time during acquisition without deleting data already collected.

**Playback** – Once a recording is complete the Recording/Playback bar will enter playback mode. The recording can be played back for viewing. The pause and stop buttons can also be utilized. To advance the playback frame by frame, use the right and left arrows.

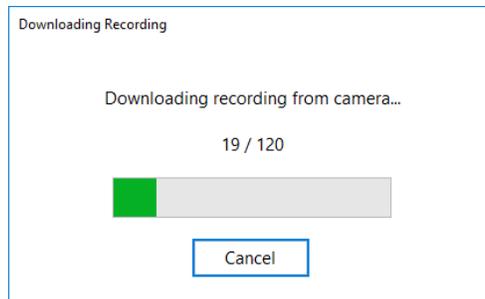
**Save Recording**  – Pressing this will save the recording after acquisition.

**Delete Recording**  – Pressing this will delete the recording.

**Amplify Recording**  – Pressing this will launch Motion Amplification and amplify the current recording.

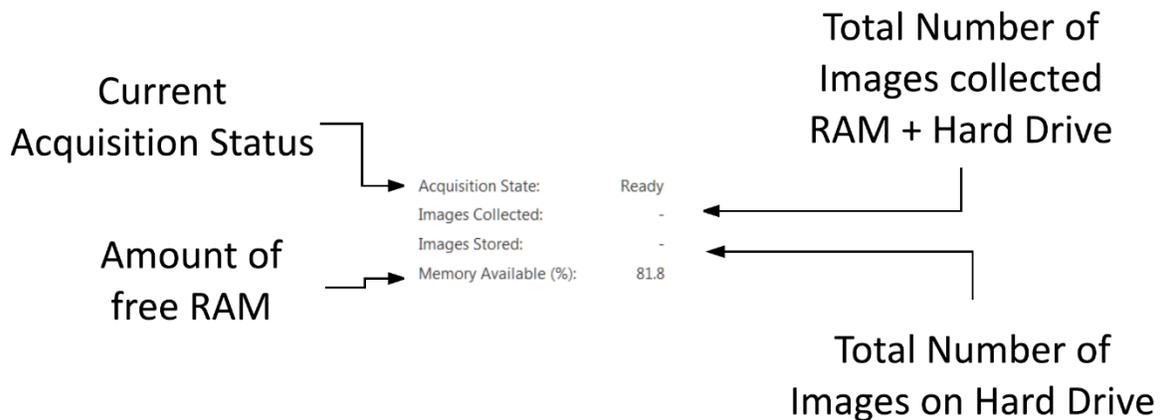


**Note:** The Iris M camera stores data on the acquisition computer as it is collected. The Iris MX camera initially stores the captured data on the camera, and it is transferred to the acquisition computer when the Save Recording button is pressed. This transfer process may take some time depending on the total size of the recording.



### 3.9 Toolbar for Iris M Recordings

The toolbar gives information about the Iris M acquisition during recording and playback. The software automatically streams the recording to your Solid State Drive (SSD). If the SSD cannot keep up with the recording software, then the application uses RAM as overflow for the images that are not written to the SSD fast enough. Once the recording is done and some images were recorded to RAM the recording will not be accessible to save or playback until the remaining images stored in RAM are transferred to the SSD.



**Acquisition State** – Displays information about the state of the system. Can be “Ready”, “Recording” or in “Review”.

**Images Collected** – Displays the total number of images collected. This is the number of images written to SSD and to RAM and accounts for all the images collected at the present time of display.

**Images Stored** – Displays the total number of images written to the SSD. This does not account for any images that are written to RAM because the SSD could not keep up with saving the files.

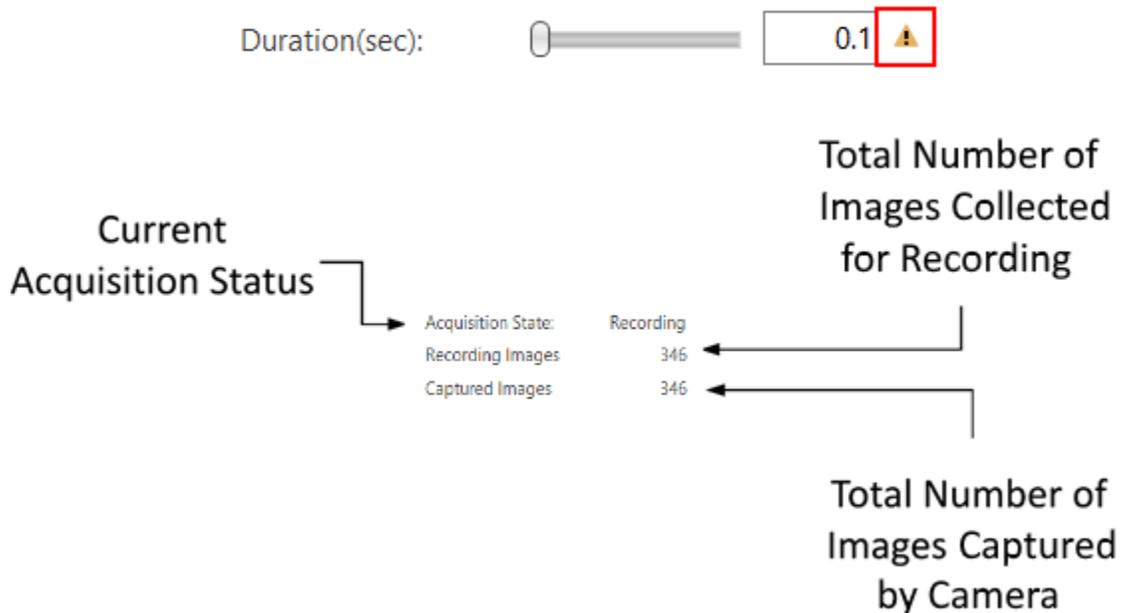
**Memory Available (%)** – Displays the current percentage of free RAM accessible to the application. If the SSD cannot keep up with storing image during acquisition this percentage will decrease as overflow images are written to RAM. If system RAM reaches a critical state of 5% available, the recording stops.



The Recording /Playback bar displays the position of the recording indicated by where the slider is relative to the bar. Green represents the number of images recorded to SSD and Yellow represents images recorded to RAM. Once acquisition is complete the bar will progressively turn solid green as images are moved from RAM to the SSD. The Save, Delete and Amplify buttons will also become active once recording completes.

### 3.10 Toolbar for Iris MX Recordings

The toolbar gives information about the Iris MX acquisition during recording and playback. The recording is initially stored in the camera. The Iris MX camera captures data in blocks of a certain size. For example, given a certain frame size the camera must capture data in blocks of N frames. So if N+1 frames are requested, then the camera must actually collect 2 \* N frames. The unneeded frames will be discarded. When you see the warning sign in the image below displayed next to the duration or time input field, hovering over the warning indicator will explain this behavior.



**Acquisition State** – Displays information about the state of the system. Can be “Ready”, “Recording”, “Review”, or “Downloading”.

**Recording Images** – Displays the total number of images collected that will be stored with the current recording.

**Captured Images** – As mentioned above, the camera may need to capture more images than were requested for the current recording. In this case, captured images will exceed recording images.



The Recording /Playback bar displays the position of the recording indicated by where the slider is relative to the bar. Green represents the number of images collected relative to the number requested for the current recording. Yellow represents any additional images that had to be captured by the camera due to the fact that it acquires data in blocks of a certain size. The Save, Delete and Amplify buttons will also become active once recording completes. Pressing Save or Amplify will initiate the transfer of the recording from the Iris MX camera to the acquisition computer.

### 3.11 Image Viewer Window



Image Viewer Window

**Image Information** –When the mouse is placed over the image, the percent of full brightness will be displayed in a tooltip.

**Image Toolbar** – The image toolbar above the Image Viewer Window allows the user to Zoom Out, Zoom In, Reset Zoom to full view and Move the image. The Move Image buttons are only accessible if the image is zoomed in. The Distance Pin icon allows the user to place a distance pin on the image and associate a distance with that location. Multiple pins can be placed on an image. The Grid Lines button will display a grid overlay in the Image Viewer Window. The Saturation button will display a red overlay on the images in the live display indicating any pixels that are saturated. The Motion Amplification button enables and disables live Motion Amplification. The Return to Live button is only active when Motion Amplification is enabled. Pressing this button will result in the amplified feed being reset to the current time. This is important because Motion Amplification is often shown at a reduced playback rate, so the displayed feed is getting farther behind relative to the current time when it is displayed at a slowed rate.

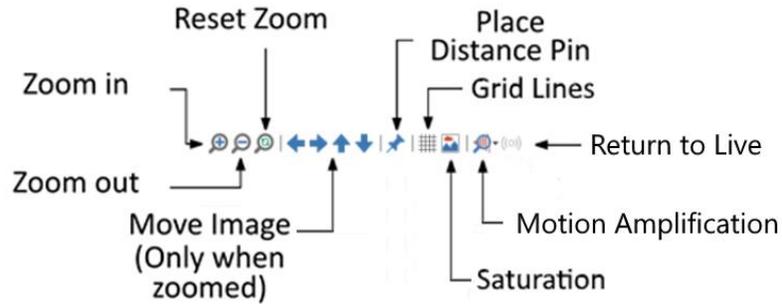


Image Toolbar

The user can draw a Region of Interest (ROI) to change the dimension and location of the image in the field of view. A Left Click + Drag will draw a red box on a portion of the image. When the user releases the mouse the acquisition window will only be the portion of the image containing the ROI.

**Note:** If the user records at this point only the information in the ROI will be recorded. The user can go back to the full field of view by pressing Reset under Image Properties.

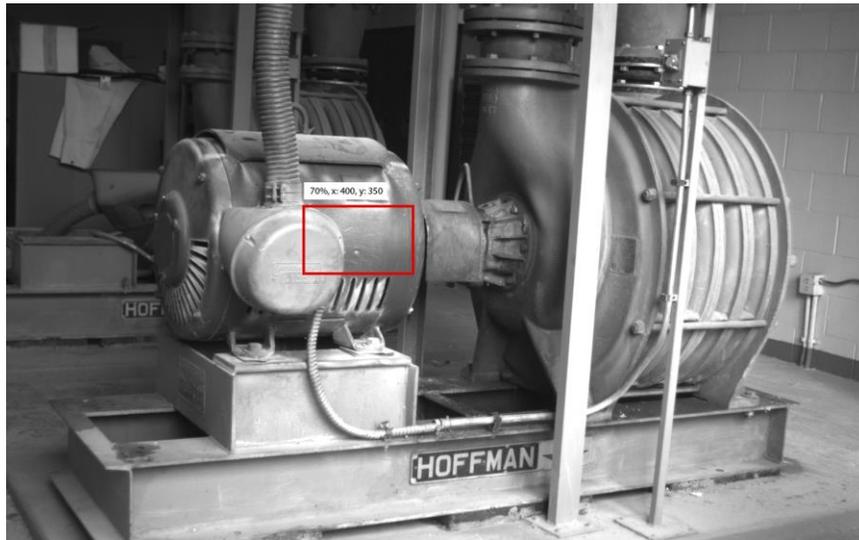
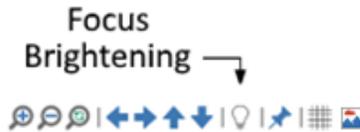


Image Viewer Window with ROI

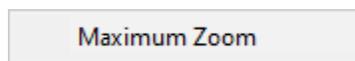
### 3.11.1 Focus Brightening

When connected to an Iris MX camera, a Focus Brightening item will be present in the toolbar. Selecting this item will put the software into a mode where the exposure is temporarily changed (brightened). The purpose of this mode is to make it easier to focus the camera properly. With very high framerates, it is often difficult to illuminate the subject with enough light. Focus brightening mode temporarily brightens the subject so that it is clearly visible in order to focus the camera lens correctly. When focusing is complete, the user should press the button again to exit focus brightening mode. Note: Focus Brightening only brightens the image prior to recording and not while recording.



### 3.11.2 Max Zoom

The main camera window has the ability to quickly zoom into a specific portion of the camera’s field of view. This can save the user from having to zoom in repeatedly to get to a desired location (possibly for focusing the lens). To access the function, right click in the camera window and select the maximum Zoom option. The cursor appearance will then change to a crosshair, and a left mouse click will specify the location where Maximum Zoom is applied.



### 3.12 Settings

The settings menu can be accessed by pressing the gear icon .

**Storage Folder:** The storage location of the acquisition application can be changed. This determines the location where recordings are stored.

**Default Recording Name:** The default file naming convention can be chosen from three different options.

**Line Frequency:** An option to specify the line frequency is also available. The Line Frequency setting only changes the default framerate to be 2x line frequency to reduce flicker from indoor lighting.

**Dynamic Range:** This option determines the dynamic range used by the camera to collect and store a recording. “Higher Sensitivity / Lower Framerate” is one option. This option uses the full dynamic range of the camera, but the available framerate is not as high as if the option “Lower Sensitivity / Higher Framerate” is chosen. This second option allows for higher framerates compared to the first option given the same field of view, but the camera is not quite as sensitive. The default is higher sensitivity, but if there are cases where higher framerate is needed for a given field of view the lower sensitivity option may be used. This option is applicable to both the Iris M and the Iris MX cameras. The selected option is indicated in the Camera Properties of the main acquisition window. The green icon reflects a choice of Higher Sensitivity, and the blue icon reflects a choice of Lower Sensitivity.



**Iris MX Binning:** The Iris MX camera supports a feature called binning. Binning is another way to achieve higher framerates for a given field of view. Without binning, every pixel on the camera is treated separately. In this case for every pixel of the camera sensor that has data collected, information for that individual pixel is stored. If binning is enabled, 2x2 groups of pixels on the camera’s sensor are aggregated into a single pixel in the stored image. So if the full field of view is used as an example, the full 2560x2048 sensor with binning enabled will result in images that are 1280x1024 without a reduction in the field of view. The

images collect without binning and those collected with binning will have the same field of view. This allows the camera to achieve higher framerates for a given field of view. Another way to achieve this effect is to change to a different lens and only collect a portion of that lens's field of view. An example would be changing from a 50mm lens to a 25mm lens and only collecting a 1280x1024 recording. Higher framerates would be possible with the 1280x1024 recording with the 25mm lens, but the field of view would be the same as that of the 2560x2048 recording with the 50mm lens.

**Frequency Units:** This option determines whether frequency units are expressed in Hz or CPM. When in displacement mode,  $F_{max}$  is expressed in these terms. The frequency axis of spectrum plots displayed in Motion Amplification is also expressed in these terms.

**Disk Space Warning:** This property can be set to display a warning when disk space falls below a certain amount.

**Grid Options:** The user can specify the color of the grid overlay and also the size (in pixels) of the grid overlay. The grid display is enabled and disabled by using the grid button available in the image toolbar.

RDI Acquisition Options

Recording Storage

Storage folder: C:\Users\Mark\Documents\RDI\Recording Browse...

Default Recording Name

Initial recording name based on today's date  
 Recording name based on previous recording name (even across sessions)  
 Recording name based on current Collection

Line Frequency

Standard electrical line frequency: 60 Hz

Recording Options

Dynamic Range: Higher Sensitivity / Lower Speed  
In-MX Binning: Disabled

Units

Frequency Units: Hz

Disk Space Warning

Free disk space in GB below which warning will be displayed: 5

Grid Options

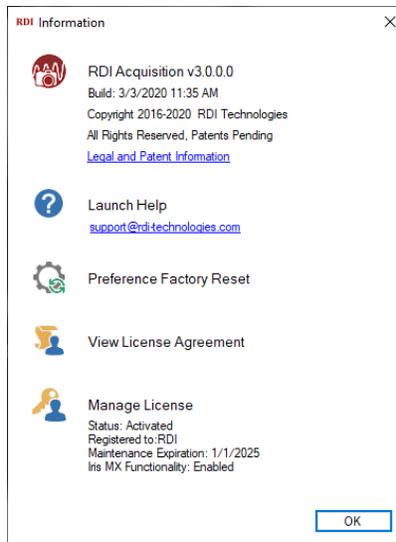
Grid Color: ■ Grid size (pixels): 200

OK Cancel

### 3.13 Information

Information about the software can be accessed by pressing the info icon .

The Information dialog provides access to information about the installed RDI Acquisition application. It also provides access to the help system and the email address for RDI support. The Preference Factory Reset option will return the application to the initial default values for all configurable items. The user may also display the License Agreement that was accepted during the installation process. The manage license button provides access to functionality such as activating and deactivating the license for the current installation and informing the user of maintenance expiration dates.

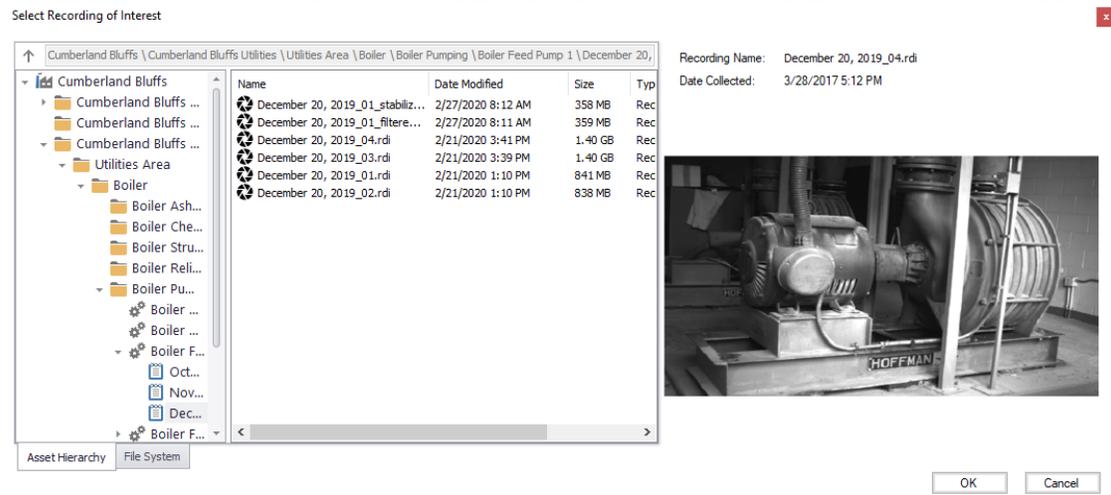


## 4 Motion Amplification



### 4.1 Opening a File

Click the "File..." button to select a recording file from the user's computer for amplification. The dialog that is displayed provides access to the hierarchy created in Motion Explorer. There is also a file system tab that provides direct access to recording stored on the computer.



## 4.2 Toolbar



The Zoom In button allows the user to zoom into an area of interest in the amplified recording. Once zoomed, the user can Zoom Out and Reset the Zoom position to full view. When the view has been zoomed, the user can also move the current view in any direction using the Pan buttons. 

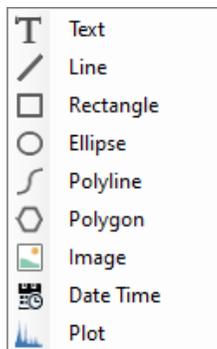
The distances button provides access to the distances stored with the current recording. Creating distances is discussed in section 2.2.11. 

A grid overlay is supported in Motion Amplification. If the Grid button is pressed, a grid will be shown in the Motion Amplification window. 

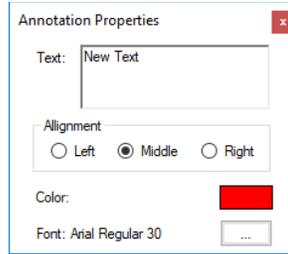
The spectrum, waveform, and orbit buttons control the display of those plot types. They are discussed in depth in section 2.5. 

### 4.2.1 Annotations

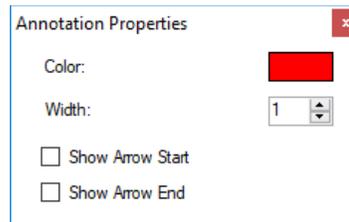
The Add Annotation button allows the user to add Text, Lines, Rectangles, Ellipses, Polylines, Polygons, Image Annotations, and Plot Annotations to the current recording.



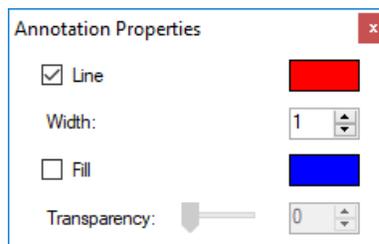
- Text Annotations: Drawn by clicking the left mouse button to define their location. The properties of the text annotation are then displayed, and these can be modified by the user.



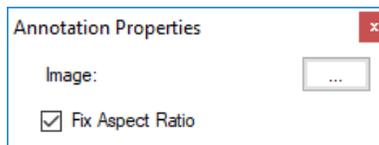
- **Line Annotations:** Drawn by pressing the left mouse button at the desired start of the line and then dragging the mouse (while still holding down the left mouse button) to release the mouse button at the desired end of the line. The properties of the text annotation are then displayed, and these can be modified by the user.



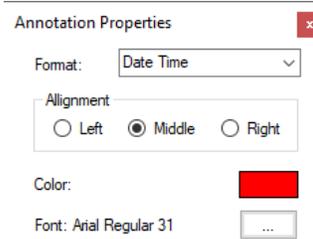
- **Rectangle and Ellipse Annotations:** Drawn by pressing the left mouse button at one corner and then dragging the mouse and releasing the button at the opposite corner. The properties of the text annotation are then displayed, and these can be modified by the user.



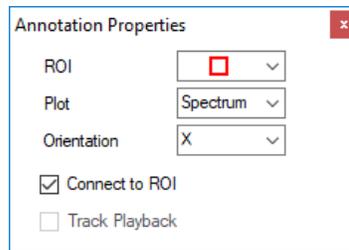
- **Image Annotations:** Drawn by pressing the left mouse button at one corner and then dragging the mouse and releasing the button at the opposite corner. The user then must select an image file that will be used to populate the space defined by the image annotation. BMP, JPEG, GIF, TIFF, and PNG image file types are supported.



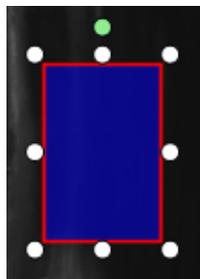
- **Date Time Annotations:** Drawn by pressing the left mouse button. This action defines the center of the space that will be occupied by the Date Time annotation. The content of the date time annotation is updated during playback so that it reflects the time of the current recording playback position. Several options are available for the Date Time annotation including format, alignment, color, and font.



- **Plot Annotations:** Drawn by pressing the left mouse button at one corner and then dragging the mouse and releasing the button at the opposite corner. The user then must select an ROI, plot type, and orientation to be used for the plot annotation. Checking the Connect to ROI box will draw a line between the ROI and the plot annotation. For waveform and orbit plot annotations, Track Playback is enabled. This will show a marker on the plot that represents the current playback location.



Annotations may be resized by dragging the white handles. The green handle may be used to rotate the annotation.



The Delete All button will remove all of the currently displayed annotations.

#### 4.2.2 Motion Vectors

When an ROI is present, the Show Motion Vectors option is available in the toolbar. Selecting this option will change the display of the ROIs such that a vector is displayed. The vector indicates the magnitude and direction of the motion for the current frame of the recording. As the recording position changes, the vectors will be updated for the current playback position.



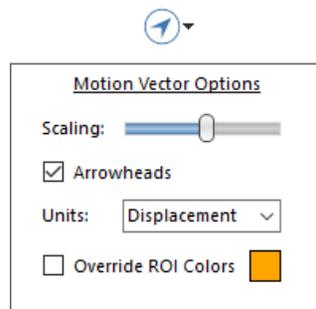
There are several options available to customize the displayed motion vectors. These options are accessed by pressing the down arrow next to the primary Motion Vector button in the toolbar.

**Scaling:** The motion vectors are scaled relative to each other. So if the displacement for ROI #1 is half that of ROI #2, the vector length for ROI #1 will be half that of the vector for ROI #2. The scaling slider determines the size of the motion vectors as a group. Moving the slider to the left will reduce the size of all of the displayed vectors.

**Arrowheads:** This option determines if arrowheads are displayed on the vectors.

**Units:** This option determines if the vectors are based on displacement calculations or velocity calculations.

**Override ROI Colors:** This option allows the user to override the default ROI colors with a single color. By default the displayed vectors inherit the color of the original ROI.



### 4.2.3 Amplification Regions

With amplification regions the user can choose to amplify only specific regions of the image. The Amplification Region Editor can be activated by pressing the Regions button on the toolbar.

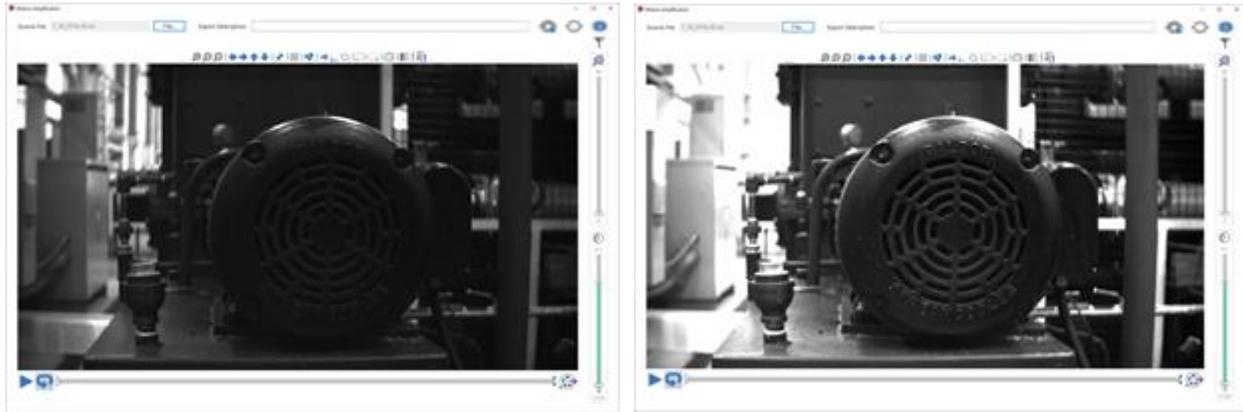
The Default Amplification Behavior determines if the entire image is amplified by default or not. If Amplify None is chosen, the shapes act to include amplification in regions they define. If Amplify All is chosen, the

shapes act to exclude regions they define. To help with this process, the image is color coded with red being regions where amplification will not occur and green being regions where amplification will occur.

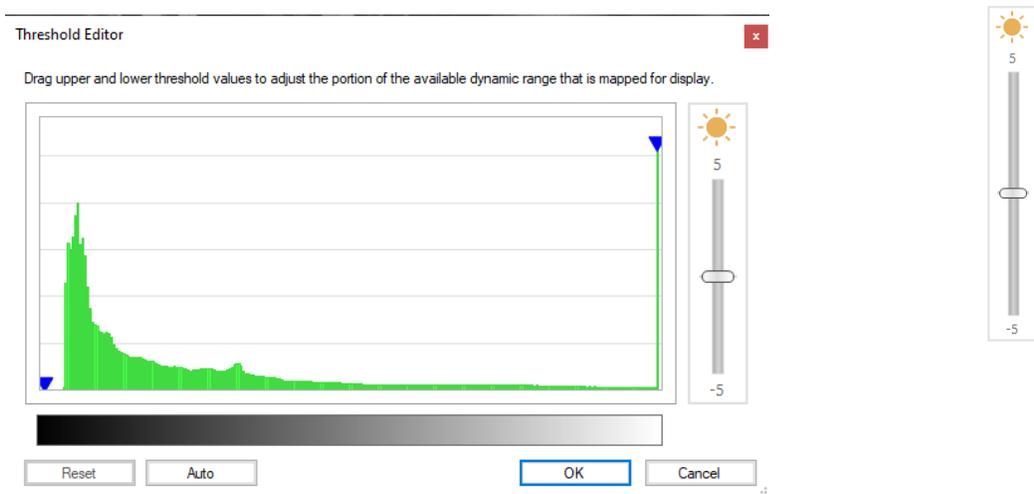
Three shapes can be chosen to define a region: a circle, a square and a polygon. The polygon can be created by using the left mouse button to click and define the points of the polygon. To end the creation of the polygon double click on the location of the last point, right click to define the last point, or press the escape key.



## 4.2.4 Threshold and Brightness



The camera can show more levels of grey than the computer screen is capable of displaying. Applying a Threshold to the image allows the user to choose which parts of the dynamic range of the camera will be shown on the screen. By default, the entire range of values are shown but in less detail. The benefit is making the shadows or highlights show better on the screen. The previous images shows the effect of applying a Threshold. The image to the left is the default image. The image to the right is after applying a threshold to highlight the dark areas of the image. The image below shows the Threshold Editor and the settings that were applied.



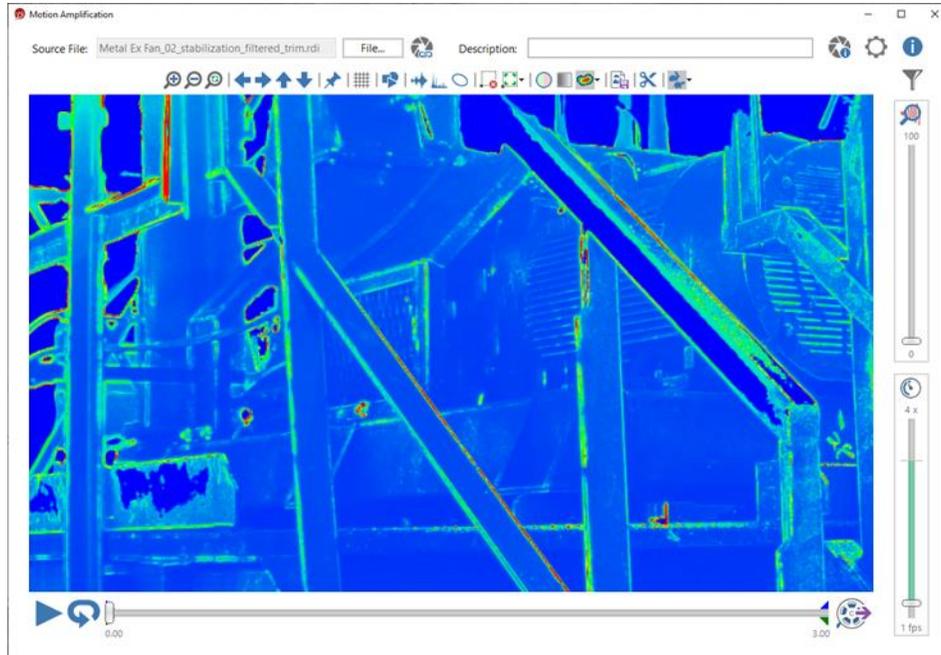
The Threshold Editor graph plots the number of pixels vs intensity value. A high peak on the left hand side as seen above indicates a large number of pixels have dark values. The green area indicates the range of intensities that will be shown on the screen. To adjust the range, the blue triangles can be moved to indicate the upper and lower intensity value for the image. In this case the user selected to show darker values to make them appear better on the screen.

The brightness of the recording is typically controlled during acquisition, but it can be fine-tuned during playback with the brightness slider to the right of the threshold window. The default, center position is no adjustment. Moving the slider above the center position will increase the brightness of the amplified playback. Moving the slider below the center position will decrease the brightness of the amplified playback.

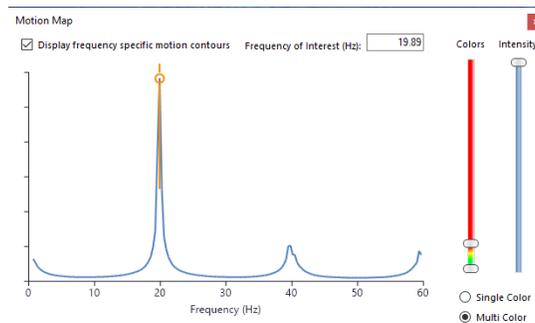
Pressing the Auto button will result in the software attempting to place the sliders at the locations that result in optimum brightness of the image.

#### 4.2.5 Motion Map

Clicking the motion map button will display a color overlay on the recording. This color overlay will be referred to as a “Motion Contour”. The motion contour indicates the amount of relative motion present at any given pixel. This is not a calibrated or absolute measure of motion, so ROIs should be used if accurate displacement values are desired. In multi-color mode, red indicates the most motion and blue indicates the least motion. In single color mode, pixels in red indicate the most motion.



The down arrow beside the motion map button provides access to the motion map options dialog. The default display is an overall motion contour, and it indicates the overall motion across the entire frequency range. Selecting the “Display frequency specific motion contours” changes the behavior so that the color overlay indicates motion for a specific frequency. Clicking on the spectrum displays the motion contour for a frequency of interest, and the Frequency of Interest input field can also be used to navigate the different frequencies present.



The sliders on the right side of the dialog are used to adjust the appearance of the color overlay. The left slider is used to determine how the range of motion is mapped to the color gradient that is shown. The right slider determines the intensity of the overlay. Intensity is referring to how transparent is the overlay. Full intensity will have zero transparency so the recording will not be visible through the color overlay.

#### 4.2.6 Save Snapshot to Current Collection

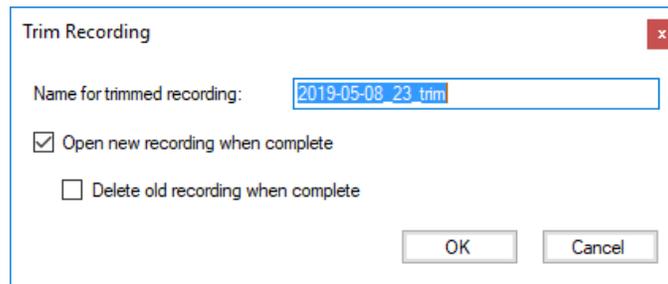
This option saves an image from the current state of the playback window. This image is then attached to the collection with which the current recording is associated. All overlays are saved with the image.

#### 4.2.7 Trim Recording

This option puts the application in a mode which is used to trim the recording. The playback bar, discussed in the following section, changes to a mode where it is used to specify the start time (left red triangle) and end time (right red triangle) for the trimmed recording. When the start and end times are correct, press the Execute Trim button to the right of the playback slider.

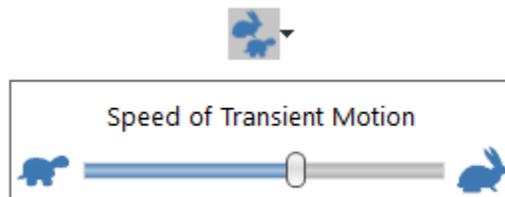


After pressing the Execute Trim button, a dialog will be displayed. It allows the user to specify the name of the trimmed file. Options are also present to open the trimmed recording when complete and delete the original recording when complete.

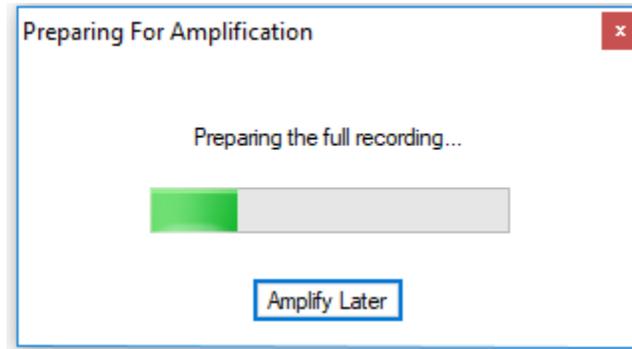


#### 4.2.8 Amplification Mode

The amplification mode button determines if Transient amplification or Standard amplification is applied. The Transient amplification algorithm allows the user to see amplified video instantly without waiting for lengthy calculations. It is also a good choice for viewing transient type motion since the standard amplification mode does not perform well on transient subject matter. “Transient” is intended to describe an object or objects that move (translate and/or rotate) through the scene. Standard amplification was the only amplification mode available prior to v3.0, and it is best suited to subjects that are vibrating about a fixed center (not moving through the scene).



Standard amplification mode requires potentially lengthy calculations to be performed before amplified playback is available. So if Transient amplification mode is disabled and the Standard calculations have not been performed, a calculation dialog will be displayed. Once the calculations are complete, amplified playback will be available using Standard amplification.

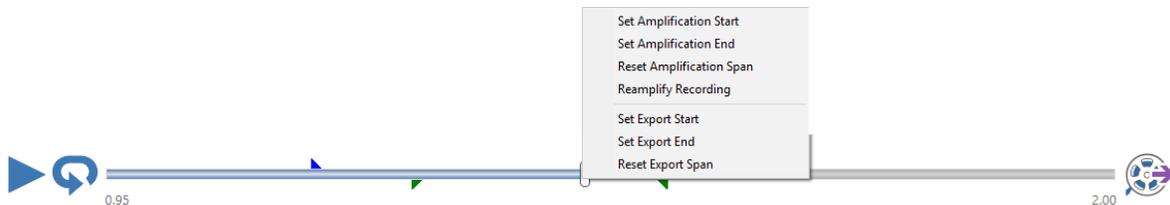


### 4.3 Playback Bar

The playback bar allows the user to Play and Pause the current recording. The Loop button can be enabled and disabled. If the loop button is enabled, when the recording is played and reaches the end, it will automatically be restarted.



When not in trim mode (described in 2.4.2.5), the portion of the recording to be exported is controlled by the green triangles shown on the playback bar. Right click on the playback position indicator to set the current recording position such that it is the Export Start or the Export End (see Section 4.7 Exporting a Video). The triangles can also be position by clicking them and dragging to the left or right.



Clicking on the current time label at the left edge of the playback bar will allow the user to enter the specified playback position. Once the enter key is pressed the current playback position will be updated.



### 4.4 Adjusting Amplification

The amplification slider located in the upper right of the amplification window controls the amount of amplification that is applied to the current recording as it is played. The lower position of the slider is 0,

which corresponds to no amplification being applied. The upper position of the slider is an amplification factor of 100. Increasing the amplification factor will increase the noise that is present in the amplified images.

#### 4.4.1 Extreme Amplification

The software has the ability to apply an amplification greater than the default maximum of 100. To access the functionality, right click on the amplification factor icon and select the option to Enable Extreme Amplification. This will change the maximum amplification factor from 100 to 500. When Extreme Amplification is enabled, the context menu item will change to Disable Extreme Amplification. Selecting this option will return the maximum amplification factor to 100.



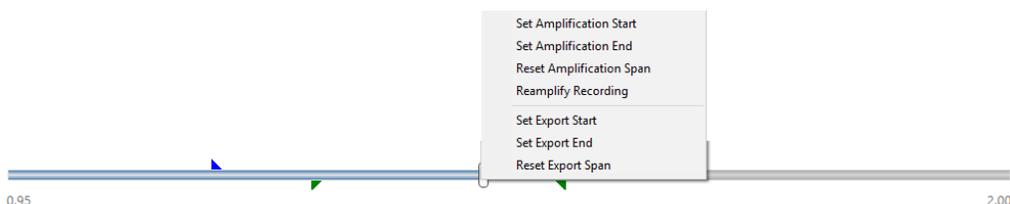
#### 4.5 Determining Amplification Period

Often motion is present in the video that the user may not want to amplify or the motion is so large that amplification has undesirable effect. For example, the motion of a press during impact may be interesting but the motion of the press lowering may not. To account for this the period of amplification can be changed. This will allow the user to set a start and end for amplification to occur. The software then only looks at this time period to determine motions and amplify those motions. This is beneficial when a motion that occurred at the beginning of the acquisition is large and may be adversely affecting a motion in the scene that occurs later and is more subtle.



To adjust the period over which the amplification occurs place the playback indicator at the starting position you would like amplification to occur and then right click the playback position indicator. From the drop down menu select Set Amplification Start. This will move a blue triangle above the bar to the current position indicating it is the start of amplification. You can also drag the left blue triangle to the desired position. Now move the playback position indicator to the point where you would like amplification to end. Right click and choose Set Amplification End. A second blue triangle will appear above the bar at the current position indicating the ending point of the amplification period. You can also drag the right blue triangle to the desired position.

**Important: To apply amplification for this period of time right click and select Reamplify Recording.**



**Note: When a period less than the total length of the recording is set as the Amplification region, only the portion of the recording that is amplified will appear amplified on playback. The remaining period outside of the amplification window will appear as normal video.**

## 4.6 Playback Speed

The Playback Speed button has multiple positions. The slowest position is at the bottom, and the fastest position is at the top.

For Standard recordings, the fastest position will result in playback being four times the speed as the data was collected. The slowest position will result in playback speed equal to  $1/N$  of the acquired speed where  $N$  is the framerate. For example, for a recording acquired at 120 fps playback at the slowest playback speed would be shown at  $1/120$  fps. The default position is 10% of the original recording speed.

For Shaft Inspection and High Density recordings, the lowest allowable playback speed is 1 fps and the highest is 400 fps.

## 4.7 Exporting a Video

The Export button is to the lower right of the Motion Amplification window. It will pause any playback in progress and initiate an export of the current recording. The exported recording will include any overlays (grid and/or annotations) that are currently displayed.

It should also be noted that only the currently displayed portion of the full frame will be exported, so if the user has zoomed into a certain portion of the window only that portion will be exported.

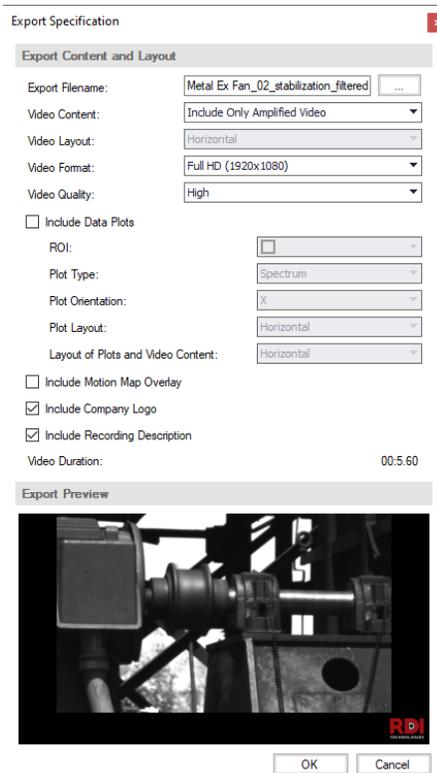
As discussed in 4.2.8, if the user doesn't want to export the entire duration of a recording, a portion of the recording can be identified for export by setting the Export Start and Export End.

Once the Export button has been pressed, the user is presented with a dialog containing several options (see image below):

- **Export Filename:** Specify the filename of the mp4 that is to be created.
- **Video Content:** Specify to include only amplified content or include both the original video and the amplified video.
- **Video Layout:** If both original and amplified video are selected, the orientation between this content may be specified.
- **Video Format:** The user may specify the format of the MP4 that is produced to be either Full HD (1920x1080), HD (1280x720), or SD (640x480). The larger the format, the larger the size of the produced file.
- **Video Quality:** The user can choose between high, medium, and low format options. High will produce the highest quality video and the largest file size. Low will result in the smallest file size and the lowest quality video. This selection determines the level of compression that is used when producing the video.
- **Include Data Plots:** The user may choose to include data plots. If no ROI is present, this option will not be enabled.
  - The ROI for the data plots to be included in the exported video must be specified.
  - The type of plot to be included must be specified. Available options include Spectrum, Waveform, Spectrum & Waveform, and Orbit.
  - The next available option is Plot Orientation. If Spectrum or Waveform were previously selected, the options available include X, Y, and X & Y. If Spectrum & Waveform was previously selected, the only two choices available are X and Y. If Orbit was selected previously, this option is not enabled.

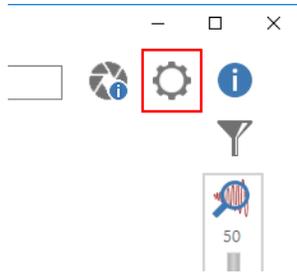
- Plot Layout is the next option available. If the previous selection result in more than one plot being included in the export, then this option determines the layout of those plots relative to each other.
- Layout of Plots and Video Content determines the layout between the video content and the plot content.
- **Include Motion Map:** Enabling this option will result in the display of the current motion map overlay in the exported video. This option is only enabled if a motion contour is displayed when the Export button is pressed.
- **Include Company Logo:** Enabling this option will result in the logo specified in the user preferences dialog being included in the generated plots.
- **Include Export Description:** Enabling this option will include the description available on the main Motion Amplification window in the exported video.

At the bottom of this dialog is a preview window. All of the options above will be reflected in the preview window as they are changed. Pressing the OK button will produce the requested MP4 video.



## 4.8 Settings

The settings button in Motion Amplification provides access to options related to the grid and producing an exported MP4 video.



**Display Options:** This section includes items that control the color for the grid lines and the grid size in pixels. There is also an option to show the saturation level in the playback window, and this is similar to the functionality available in the acquisition application.

**Export Options:** This section includes an option to specify the location for exported files to be written to the user's computer. An option to include a company logo is available. If selected, the company logo will be displayed in the lower right of every frame in the video. The last option is a browse button to select the user's own logo. The logo file needs to be either png, jpg, or bmp format. When displayed, the logo file will be resized proportionally such that it is 100 pixels high. For better appearances use a logo that has transparency set or a black background since the logo will be applied to the black bar region below the video.

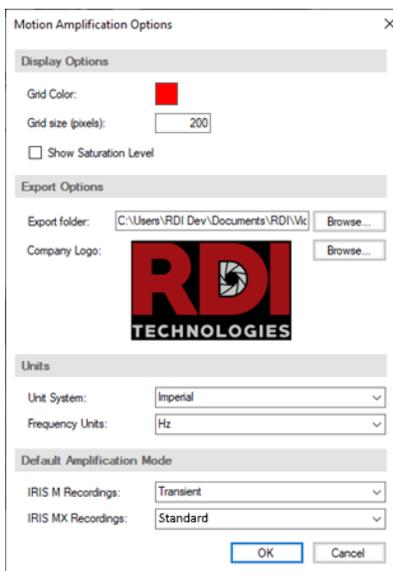
**Units:** This section allows you to change the unit system between Metric and Imperial with the respective units being:

Metric: Microns ( $\mu\text{m}$ ) and Millimeters per Second (mm/sec)

Imperial: Thousands of an Inch (mils) and Inches per Second (in/sec)

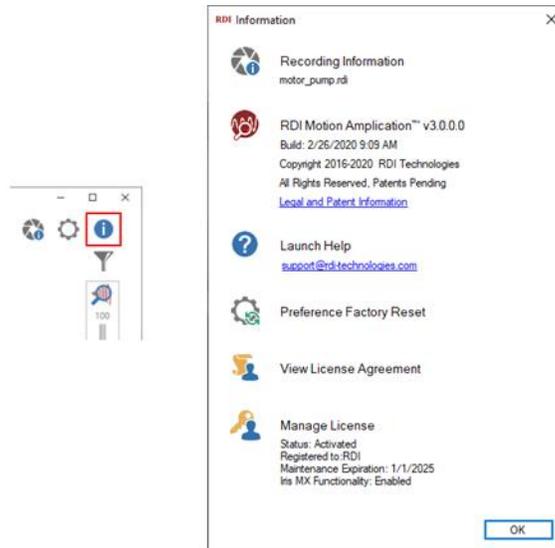
A preference for frequency units is also available: The choices for this are Hz and CPM.

**Default Amplification Mode:** The options in this group determine the default amplification mode for Iris M, CM, and MX recordings. The choices are Transient amplification and Standard amplification. These options are discussed above in section [2.4.2.7](#).



## 4.9 Information

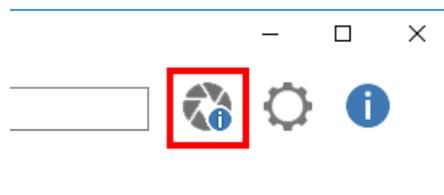
The information dialog provides access to further information about the current recording and the installed Motion Amplification application. It also provides access to the help system and the email address for RDI support. The user may also display the License Agreement that was accepted during the installation process. The manage license button provides access to functionality such as activating and deactivating the license for the current installation.



## 4.10 Recording Information

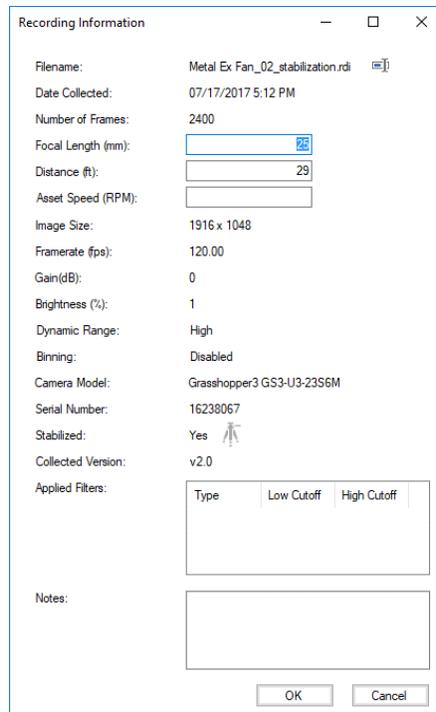
Pressing the recording information button will display information about the current recording. This includes information entered by the user at the time of collection and information about the hardware used to collect the data.

The Recording Information dialog may also be accessed from the main application window by pressing the Recording Information button shown below.

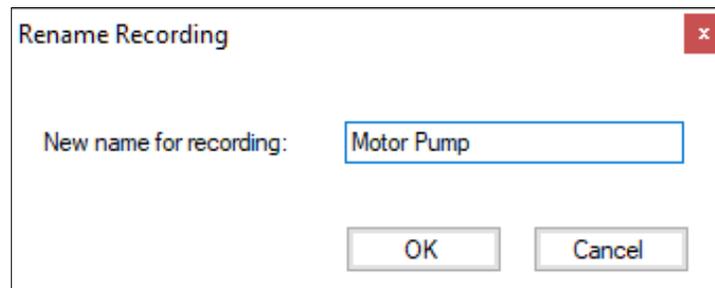
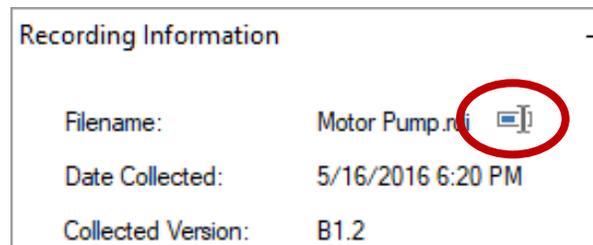


Three fields are editable: Focal Length, Distance, and Asset Speed. This allows the user to change these values if they were entered incorrectly at recording time or not entered at all.

This dialog also provides access to the stabilization functionality that is discussed in [Chapter 4](#).



Users can choose to rename recordings from the recording information window. To rename a recording click the cursor text button in the upper right-hand corner of the window in the Filename field as seen below. This will open a “Rename Recording” window, also shown below. Enter the new file name in the field and select OK to accept. The “.rdi” file and all files associated with it will be renamed.

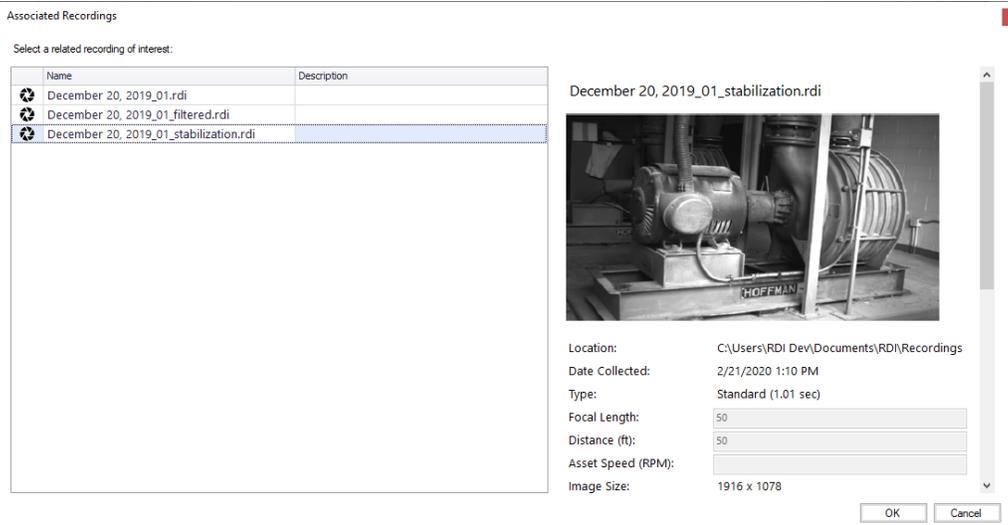


## 4.11 Linked Recordings

Selecting the linked recording button will display a collection of recordings that are all derived from the same original recording. This collection will include filtered, stabilized, and trimmed recordings, along with the original recording.



Select the recording of interest from the list and press the OK button to open it.

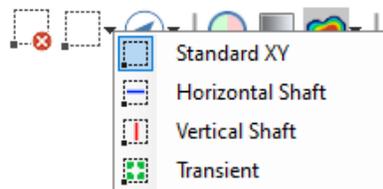


## 4.12 Displacement and Frequency

### 4.12.1 Drawing a Region of Interest for Measurement

Displacement measurements can be made directly from the recording in the Motion Amplification Software. A Region of Interest or ROI must be drawn on the image at the location where the measurement is desired. The following image shows the location of the Time Waveform, Spectrum, and Orbit buttons. These buttons will launch separate windows for the different types of plots.

There are 3 types of displacement measurements: Standard XY, Horizontal Shaft, and Vertical Shaft. Select the desired type of measurement from the drop down in the toolbar of the main application window.

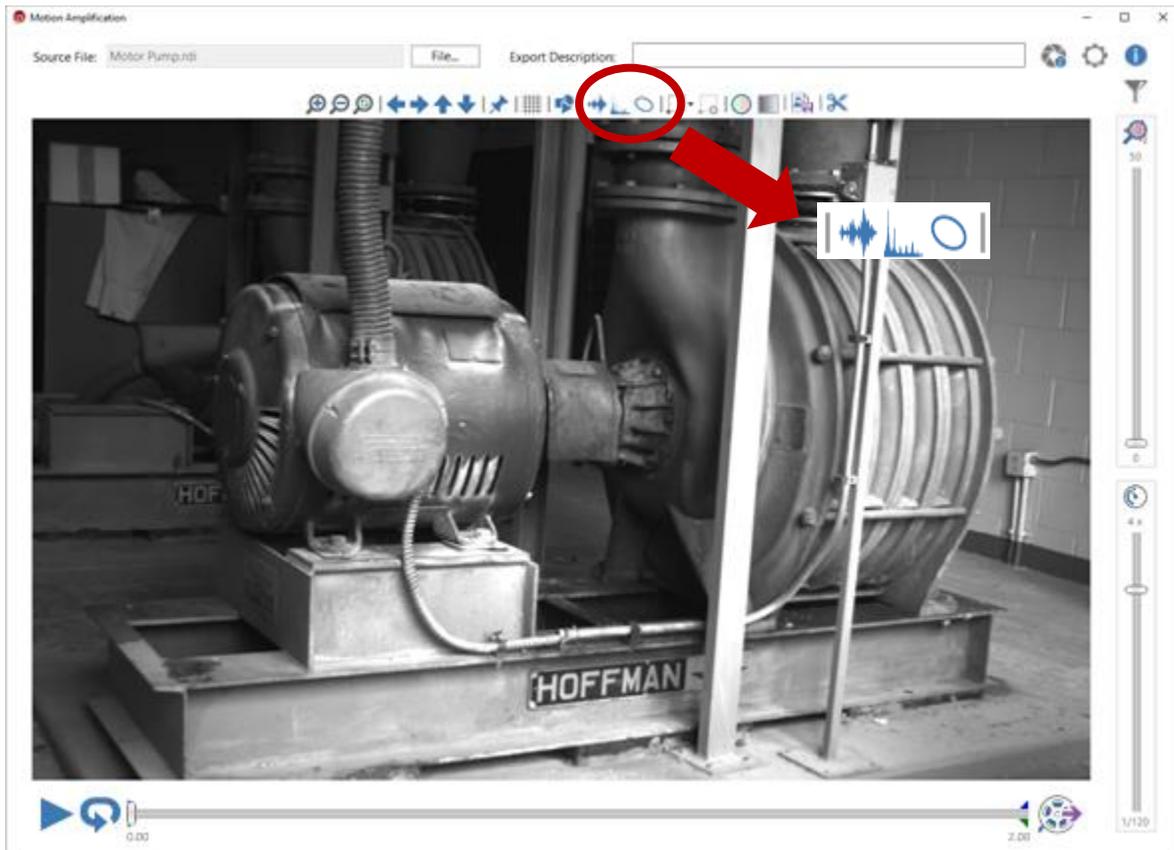


A Standard XY ROI is intended to calculate both X and Y motion. This type of measurement is not intended to be used for a rotating shaft. A Horizontal Shaft ROI is intended to be drawn on a rotating horizontal shaft, and it will calculate the vertical displacement of the shaft. A Vertical Shaft ROI is intended to be drawn on a rotating vertical shaft, and it will calculate the horizontal displacement of the shaft. A Transient ROI is designed to track an object or portion of an object as it moves through the camera's field of view.

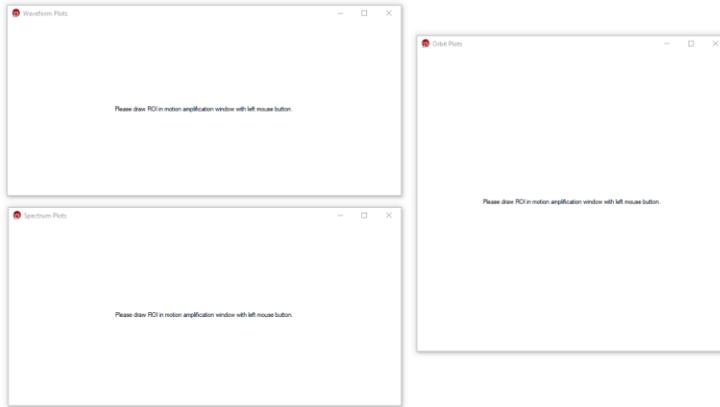
In the case of the transient ROI there may be two components to the motion: the translation of the object and the dynamic motion that occurs about a translating center of motion.

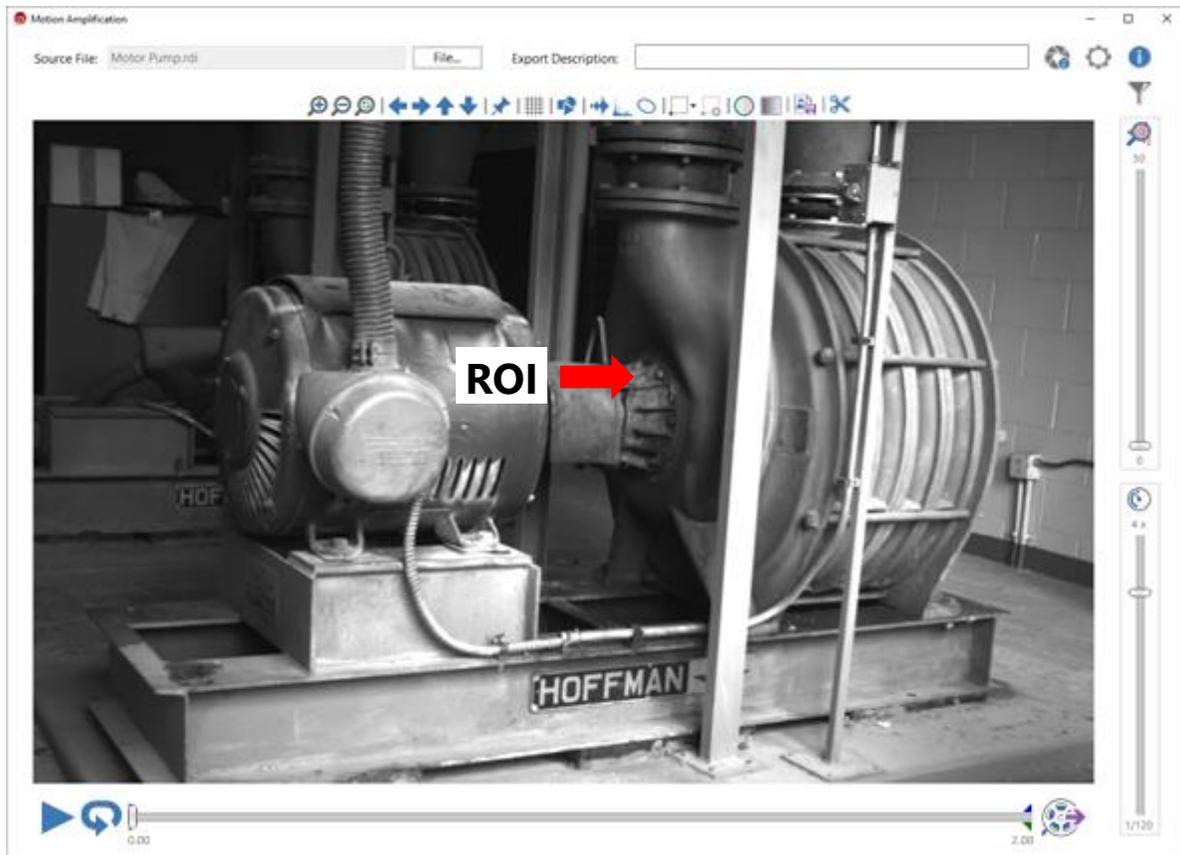
To draw an ROI for which displacement measurements are to be made, the user will Left Click and hold the left mouse button. Then drag the mouse over the region to measure. Once the ROI is in the suitable place, the user then releases the left mouse button. At this point the software determines the displacement measurement within the ROI.

**Note: The software can look at any location within the ROI to measure displacement. This is done to ensure the software is given adequate signal to make a quality measurement. It is important to only draw an ROI over an area in which you are OK with a measurement being made anywhere within the ROI.**

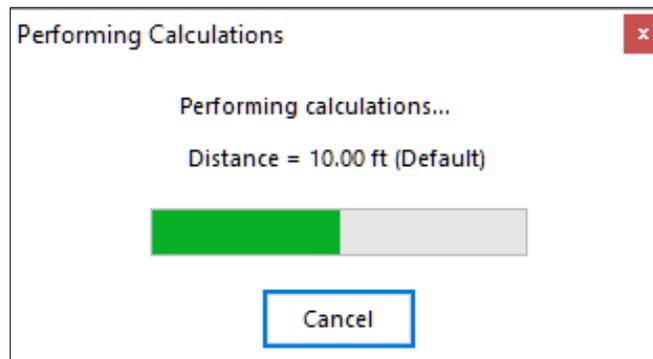


Below are the Time Waveform and Spectrum Windows when they are launched by clicking the respective button. They remain blank until an ROI is drawn. The Orbit Window behaves in the same manner.





Once an ROI is drawn as shown above, a progress window will pop up as seen below. The software will then calculate the displacement in the ROI. Once complete, the Time Waveform, Spectrum, and Orbit windows will populate with the displacement data calculated from the ROI.



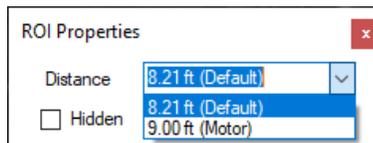
## 4.12.2 ROI Properties

### 4.12.2.1 Distance

Standard XY, Horizontal Shaft, and Vertical Shaft ROIs have an associated distance. The default distance for an ROI is the default distance for a recording. However, if multiple distances have been defined for the current recording these distances are available in the drop down selection. Selecting a different distance will result in that distance being used for displacement calculations performed for that ROI.

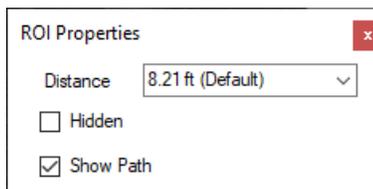
### 4.12.2.2 Hidden

These ROI types also have a property that determines if the ROI is visible. ROIs are visible by default, but checking the Hidden box will hide the ROI from view. Right clicking on the camera window will allow the user to show any hidden ROIs.



### 4.12.2.3 Show Path

Transient ROIs have the same properties as Standard XY ROIs, but they also have a property that determines if the Path is visible in the main playback window.



Below is an example of a Transient ROI tracking the corner of the car hood. The red line indicates the path that the portion of the hood identified by the ROI follows.



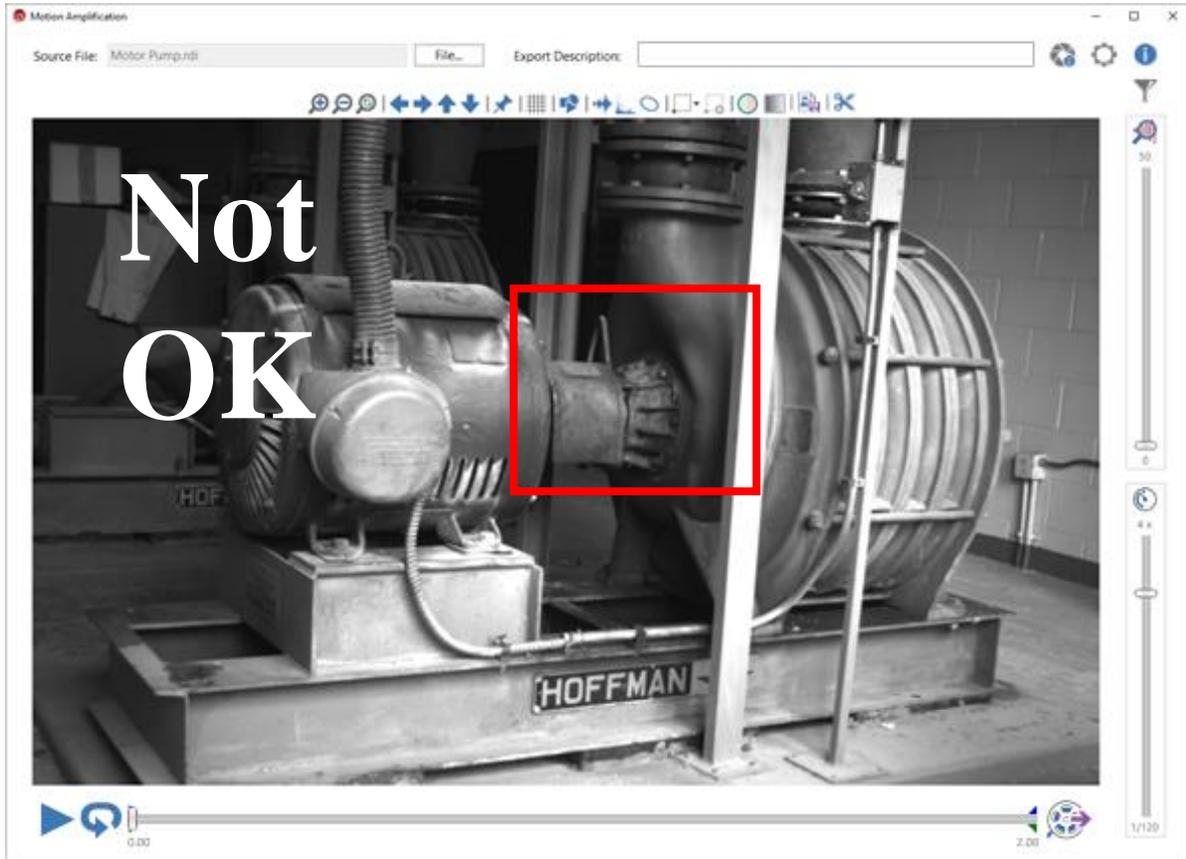
### 4.12.3 Examples

**IMPORTANT:** It is important to understand the basics of drawing an ROI to return an accurate time waveform. The ROI should only be drawn over a region for which you are interested in measuring. If the ROI shares an area with two different objects that are moving differently, there is no guarantee which object the time waveform represents. Therefore, care must be taken in drawing the ROI. The time waveform measurement cannot be made over a uniform surface. Some level of contrast must be present for the software to “see”. This means some level of contrast must be present in the ROI for proper measurements. Alternatively, this makes it possible to draw an ROI over an edge of an object that has a uniform background.

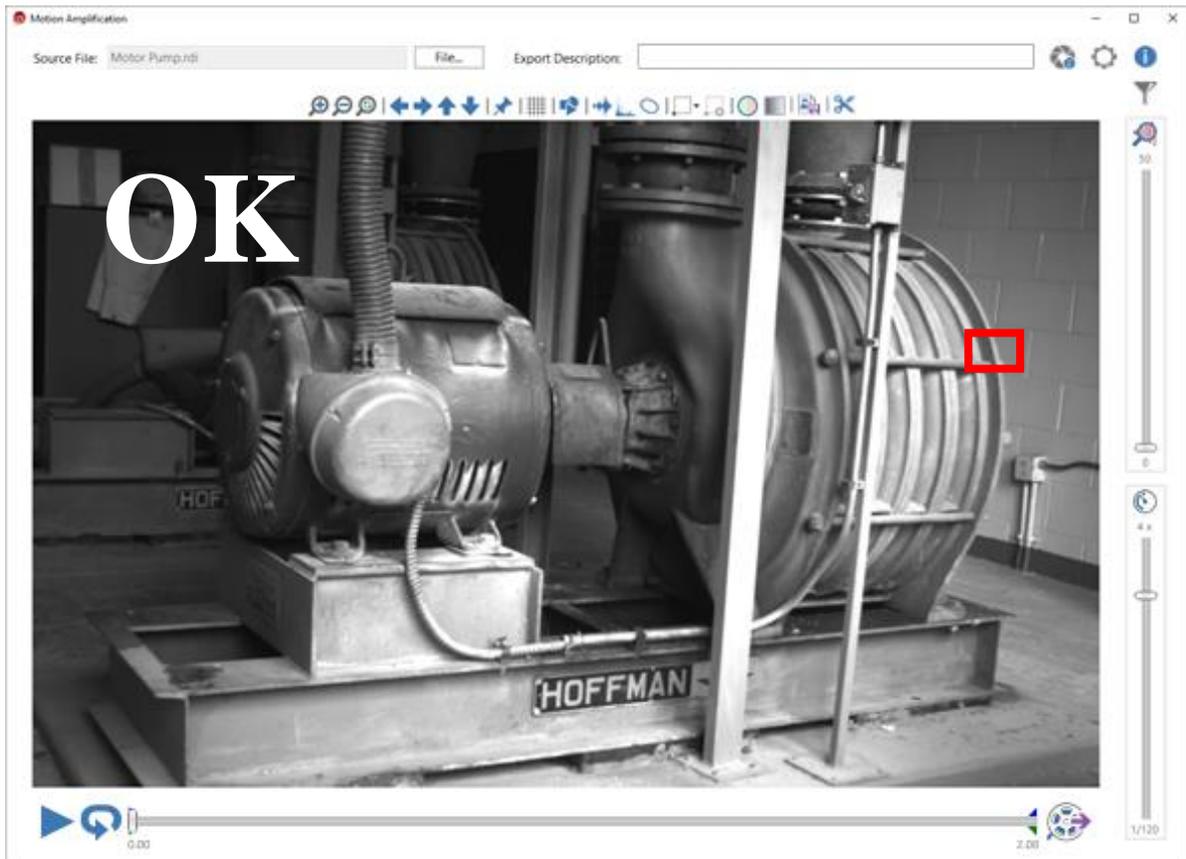
In the following image the ROI is drawn on a very small piece of machinery. It is suitable for the software to select any location in the box to measure from.



In the following image the ROI is much bigger. This is undesirable because the software may choose any location within the ROI from which to measure. There is uncertainty as to where the time waveform originates.



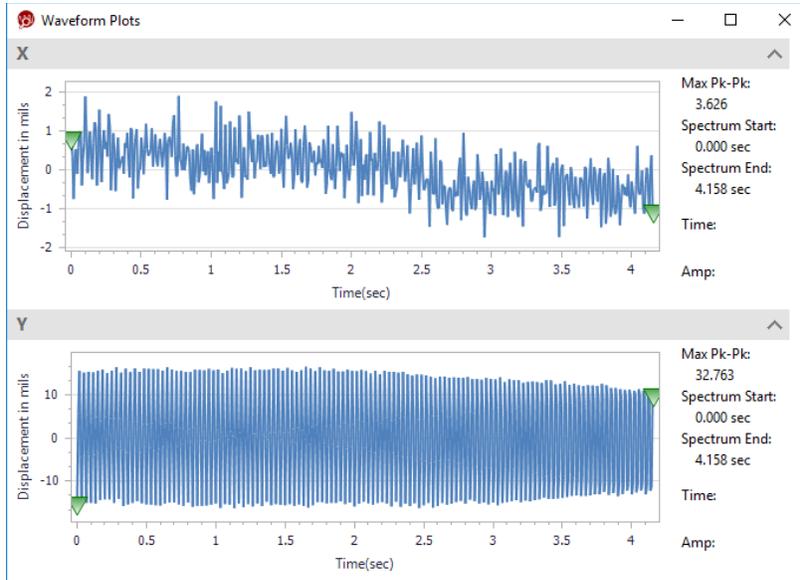
In the following image the ROI is drawn on the edge of the machine. However, the background is uniform while the machine has contrast. The user can be confident the software will measure on the machine.



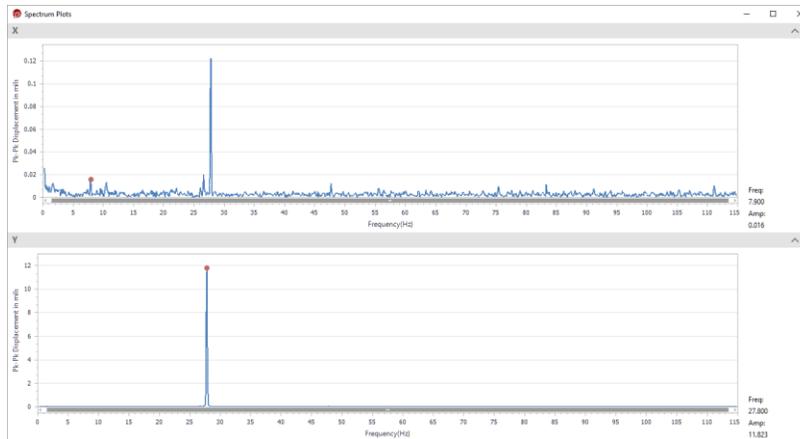
In the following image the ROI is drawn on the edge of the machine. In this case there is contrast in the background. This is undesirable as the software may measure the machine or background.



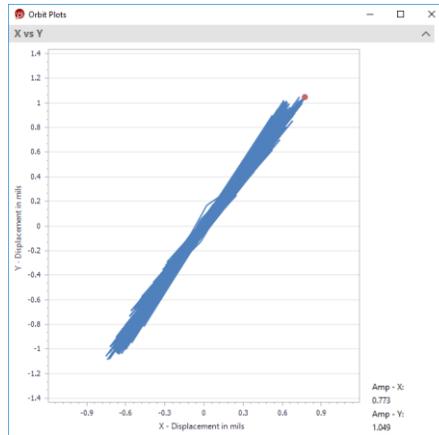
Below are examples of the Time Waveform, Spectrum, and Orbit plots. The software measures both the X and Y direction as seen from the camera. For the Time Waveform and Spectrum plots, the X direction is shown in the top plot of each image. The Y direction is shown in the bottom plot of each image. The Orbit plot includes measurements from both the X and Y directions.



Time Waveform Plots



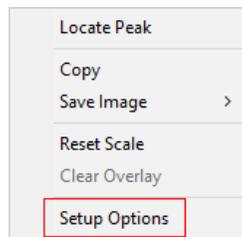
Frequency Spectrum Plots



Orbit Plot

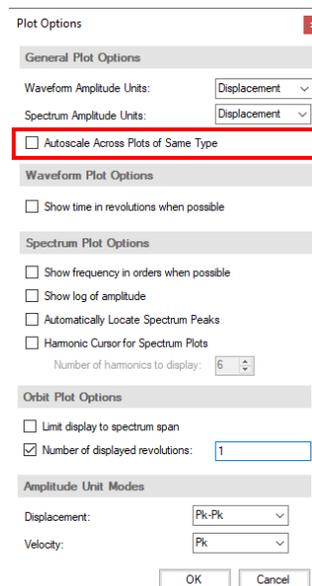
#### 4.12.4 General Plot Options

The waveform, spectrum, and orbit plots all provide access to plot-related preferences via the “Setup Options” context menu item.



##### 4.12.4.1 Autoscale Across Plots of Same Type

The default amplitude scaling behavior is for the amplitude axis for all plots to be scaled independently. This option allows the user to change that behavior such that all plots of the same type are scaled to the same maximum amplitude value.

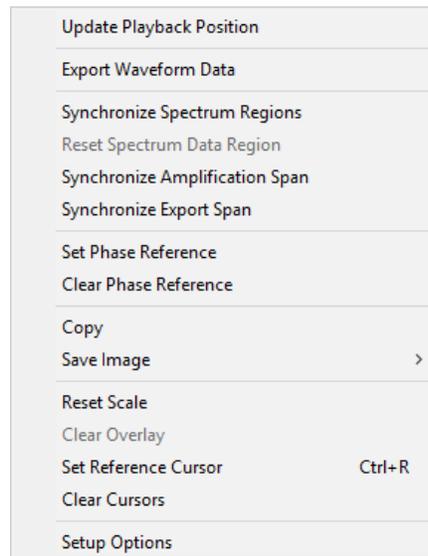


### 4.12.5 Time Waveform Plots

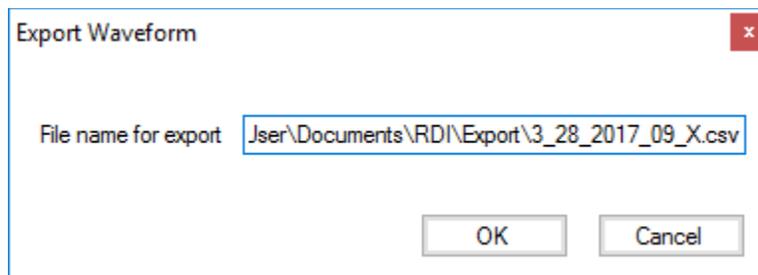
The Time Waveform plots the displacement (Y-axis) as a function of time (X-axis) over the time period the measurement was made. The available amplitude units are thousandths of an inch (mils) or microns ( $\mu m$ ) for displacement.

The Time Waveform Plot displays the maximum peak-to-peak values on each waveform on the upper right corner of the plot. The lower right corner displays the information at the cursor position. The cursors may be moved by moving the mouse over the waveform and left clicking. The values of time and amplitude for that location are then updated in the lower right corner of the plot. The cursor location can be fine adjusted by using the right and left arrows keys to move the cursor one increment at a time.

Clicking the right mouse button in the context of a time waveform plot exposes additional functionality.



The Export option will send the data samples of the selected waveform to a “.csv” file. This file format can be easily imported to Microsoft Excel or other software applications for further data manipulation. Once this option is selected, a dialog is displayed that allows the user to specify the file name for the exported data.

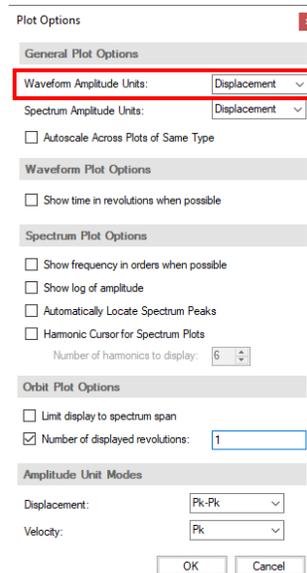


An option to Copy the current plot to the clipboard is also available in the plot's context menu. When this option is selected, a bitmap representing the current plot is placed in the Windows clipboard. Once the

plot is in the clipboard, the image can be pasted into many other applications such as Microsoft Paint or Microsoft Word.

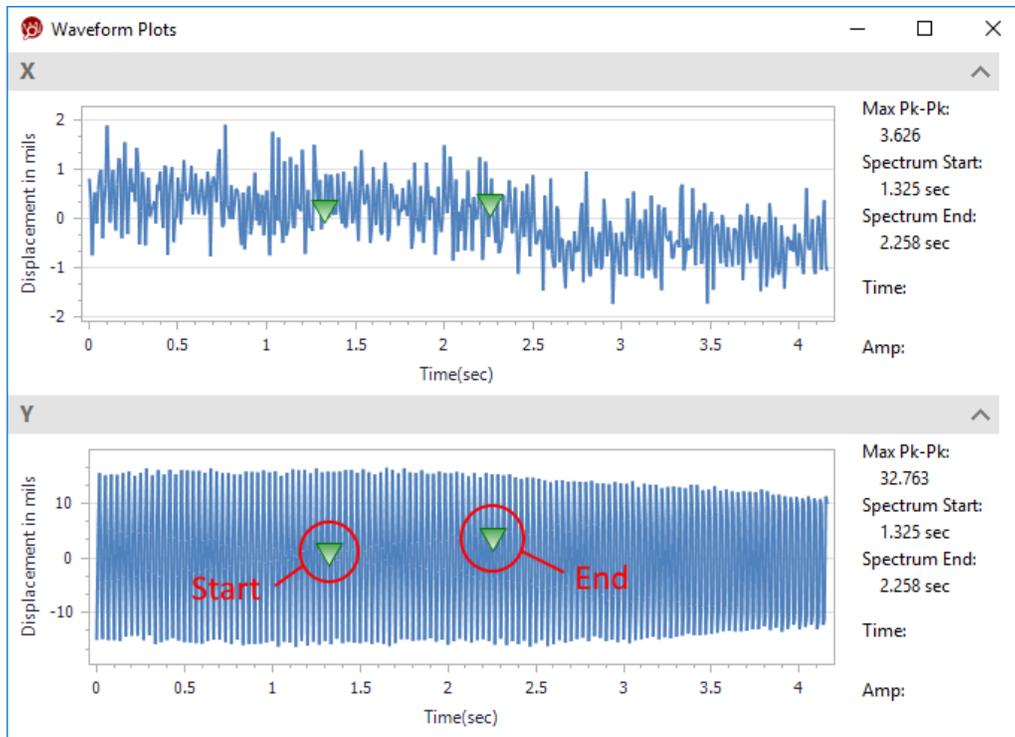
#### 4.12.5.1 Waveform Amplitude Units

The Time Waveform plot can be shown in units of velocity by right clicking the graph. From the menu select “*Setup Options*”. Shown below, the configuration dialog allows a choice between displacement or velocity for both the Time Waveform and Spectrum. If velocity is selected, the Time Waveform is differentiated to determine velocity. Available units are inches per second (in/s) or millimeters per second (mm/s). Imperial or metric units can be changed under the Settings menu in the upper right corner of the Motion Amplification Software.



#### 4.12.5.2 Time Span for Spectrum Plots

The waveform plots allow the user to specify the start and end position of the time span that is to be used to construct the spectral plots. The start and end indicators are represented by the inverted green triangles shown in the image below. These indicators can be dragged with the left mouse button to change the span from which spectral data is calculated. The spectrum plots will be updated dynamically as the span is changed. The start and end times are displayed in the upper right corner of each waveform plot.

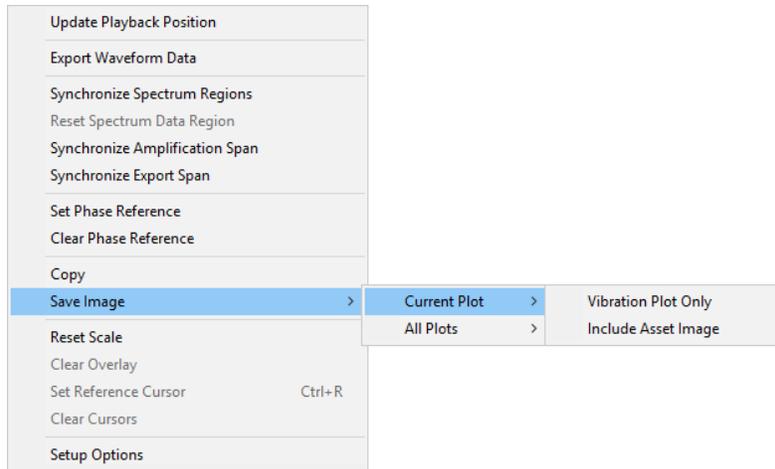


#### 4.12.5.3 Update Playback Position

The video playback can be adjusted so the video shows the exact moment that corresponds to a specific sample in the time waveform. The user can right click at a point in the time waveform and click Update Playback Position. The video will then adjust to that specific time as well. This is helpful to easily observe what is happening in the video for a specific event in the time waveform.

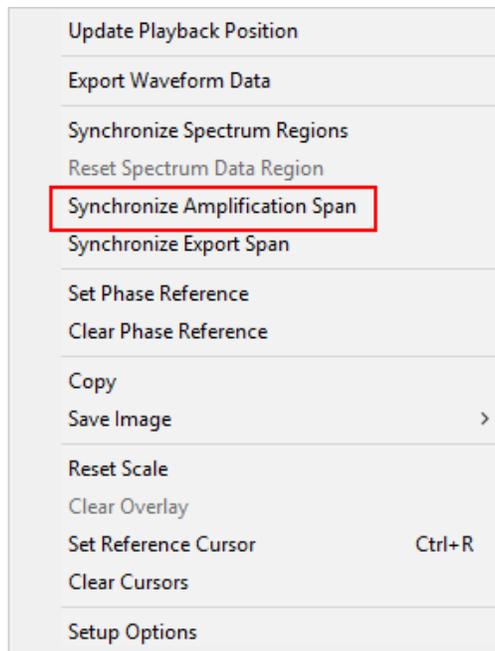
#### 4.12.5.4 Save Image

The user can save an image from the video along with the corresponding plots. The user can right click on a plot and choose Save Image. From there the user has the option for either Current Plot or All Plots. For both of these selections the user can choose whether the resulting image should only include the vibration plot(s) or if the asset image (with the measurement locations indicated) should also be included. If one of the two options under Current Plot are chosen, only the selected plot is displayed. If the user selects one of the options under All Plots, all displayed plots are saved in the resulting image. All data is saved as an image file and automatically imported into Motion Explorer if the recording is associated with a Collection and Asset.



#### 4.12.5.5 Synchronize Amplification Span

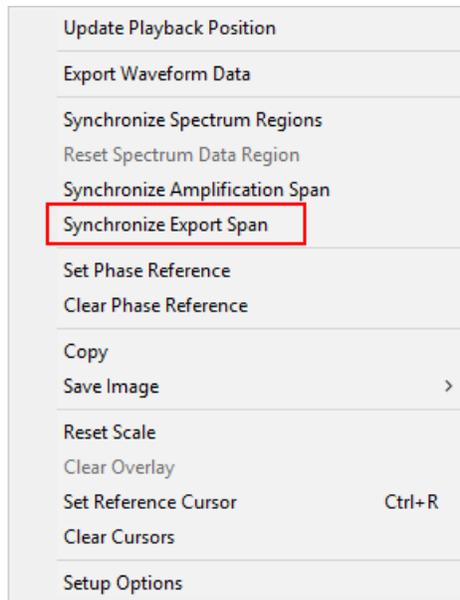
There is an option in the waveform context menu to “Synchronize Amplification Span”. The span defined by the green start/end indicators on the waveform or spectral data will be applied to the span used for amplification in the main Motion Amplification playback window. The consequence of this is that the amplification span can be set graphically using the content in the waveform plot.

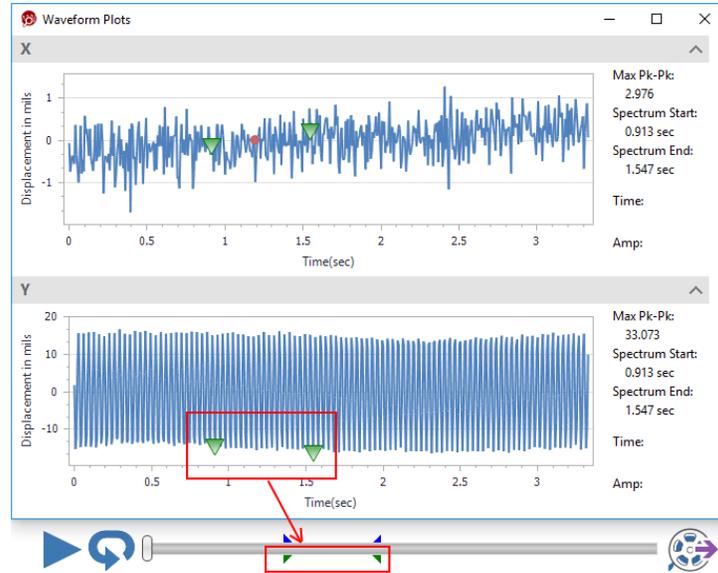




#### 4.12.5.6 Synchronize Export Span

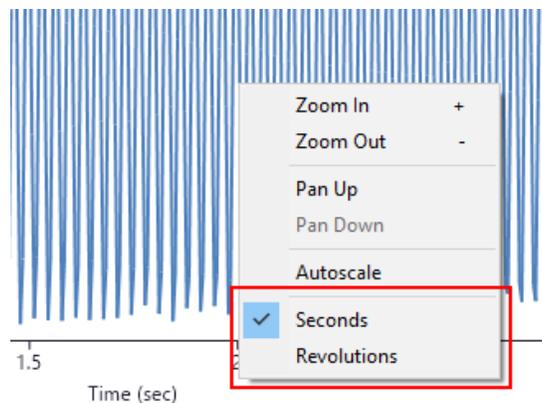
There is an option in the waveform context menu to “Synchronize Export Span”. This will take the span defined by the green start/end indicators on the waveform (also used to determine the span used for calculating spectral data) and set the span that is to be exported in the main Motion Amplification playback window to this same time frame. The consequence of this is that the export span can be set graphically using the content in the waveform plot.





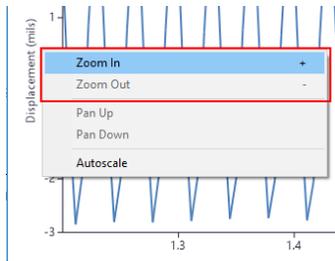
#### 4.12.5.7 Waveform X Axis Units

The X axis of time waveform plots can be expressed in seconds. If the current recording has an asset speed defined, then the x axis can also be expressed in revolutions. This can be specified via the context menu available in the x axis. If the x axis is displayed in time, the cursor information is displayed in seconds. If revolutions is specified, the cursor information is specified in revolutions.



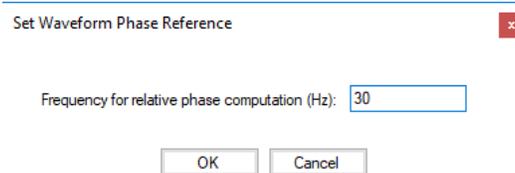
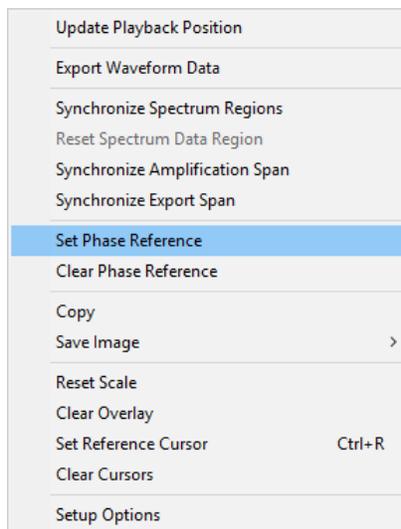
#### 4.12.5.8 Amplitude Axis Zoom In/Out

The amplitude axis of waveform plots can be zoomed in and out via context menu options available on the amplitude axis. The shortcut keys “+” and “-” also serve as a request to zoom in and out, respectively.

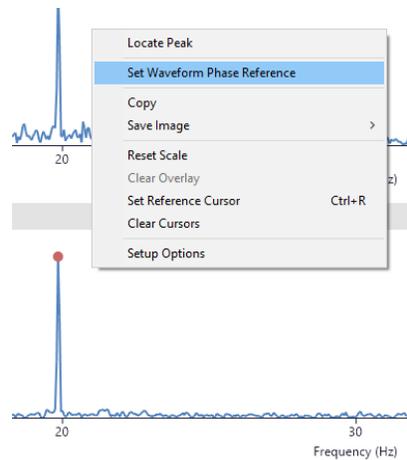


#### 4.12.5.9 Relative Phase

Waveform displays support relative phase measurements. There are two ways to define the reference for the relative phase measurements. The first way is from a waveform plot. The user can select the Set Phase Reference option from the waveform plot context menu. This will result in the display of a dialog that allows the user to enter a frequency of interest for the relative phase calculations.



The second way to specify the reference for the relative phase calculations is from a spectrum plot. The Set Waveform Phase Reference context option will set the frequency associated with the primary cursor location to be the frequency of interest. The waveform associated with the spectrum will also be considered to be the phase reference.



Once a phase reference has been designated, the waveform designated as the phase reference will have the phase reference frequency displayed in the upper right of the plot as shown below.

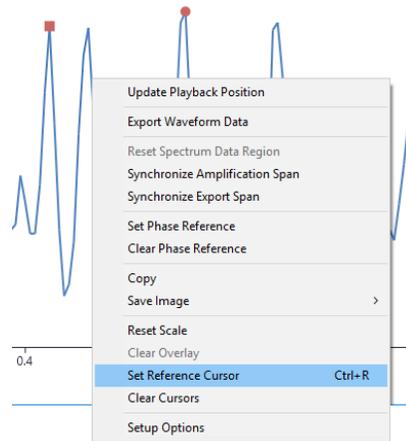
Max Pk-Pk:  
17.845  
Spectrum Start:  
0.000 sec  
Spectrum End:  
19.992 sec  
**Phase Reference:  
(19.86 Hz)**

All of the other displayed waveforms will have the relative phase information displayed in the upper right corner.

Max Pk-Pk:  
23.488  
Spectrum Start:  
0.000 sec  
Spectrum End:  
19.992 sec  
**Relative Phase:  
-86.42 (19.86 Hz)**

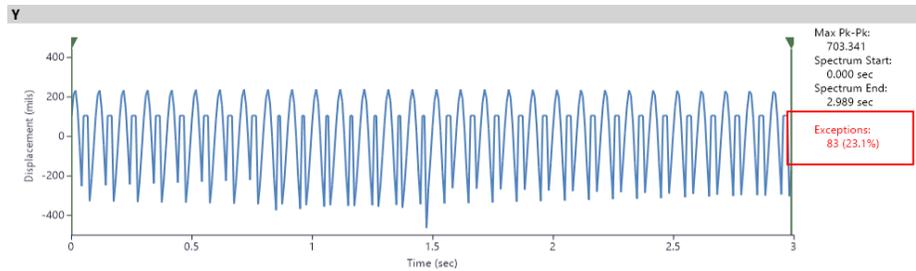
#### 4.12.5.10 Waveform Reference Cursor

Waveform plots support a reference cursor. The user can specify the reference cursor by using the Set Reference Cursor context menu item, the Control+R key sequence, or the Alt + Left Mouse Click sequence. When a reference cursor has been designated, the cursor information in the lower right of the plot includes the primary cursor information, the reference cursor information, and the difference information between the two cursors.



#### 4.12.5.11 Exceptions in Calculated Waveform

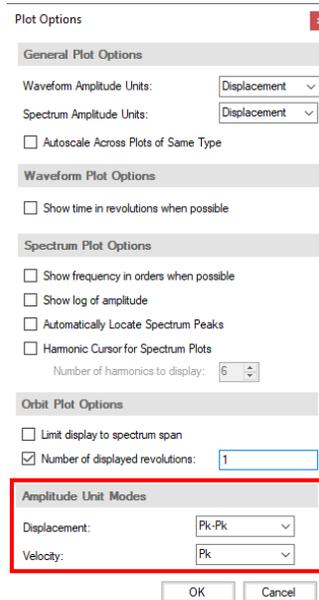
If the user draws an ROI such that the feature of interest moves outside the defined ROI, exceptions in the calculations may occur. This can be visually identified as discontinuities or asymmetries in the waveform. These exceptions are also conveyed to the user in the information displayed on the right side of the plot. Exceptions typically don't occur, but if they do the user might want to try a different ROI placement to try to prevent the exceptions this resulting in a more accurate waveform.



#### 4.12.6 Frequency Spectrum Plots

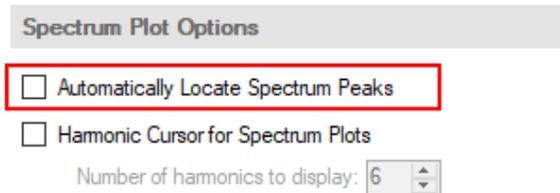
The frequency spectrum is determined from the time waveform by process of the Fast Fourier Transform (FFT). All spectra have a Hanning Window applied to them by default. This window gives a good representation of both amplitude and frequency. The lower right hand corner displays the information at the cursor position. The cursors may be moved by moving the mouse over the spectrum and left clicking. The values of frequency and amplitude for that location are then updated. The cursor location can be fine adjusted by using the right and left arrows keys to move the cursor one increment at a time. A peak locate feature is available to determine peak locations and amplitudes more accurately. This feature can be enabled to automatically locate peaks by left clicking the spectrum and selecting “Setup Options”, then check the box to automatically locate peaks. The software will automatically locate a peak if it is near a peak. The information indicated in the lower right hand corner of the spectrum window will be updated with the located peak information. When a peak has been located, a triangle will be shown in the spectrum at the extrapolated peak location, indicating peak locate is active. Alternatively, the user can choose to manually locate peaks without it being automatically activated by selecting a location close to a peak and right clicking and selecting “Locate Peak”. Again, a triangle will be shown when peak locate is active.

From the Plot Options screen, the user can specify the amplitude unit mode for the displayed spectral data. The available options are RMS, Pk, and Pk-Pk, and the unit mode can be set independently for displacement and velocity.



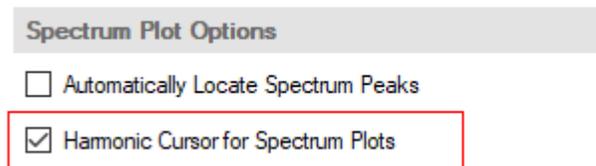
#### 4.12.6.1 Automatically Located Spectrum Peaks

The spectrum plot options include an item that when selected tells the software to try to perform a spectrum peak locate whenever the cursor is moved. If a peak is located at the current cursor location, the cursor is placed at the calculated value of peak. If a peak is not located, then the cursor remains in its unlocated position.



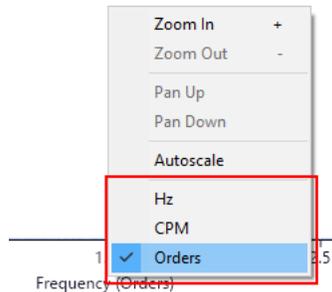
#### 4.12.6.2 Harmonic Cursor

The default cursor for spectrum plots is a single cursor. The “Harmonic Cursor” option allows the user to change the cursor type to a harmonic cursor. This cursor type shows additional cursors at integer multiples of the primary cursor’s frequency.



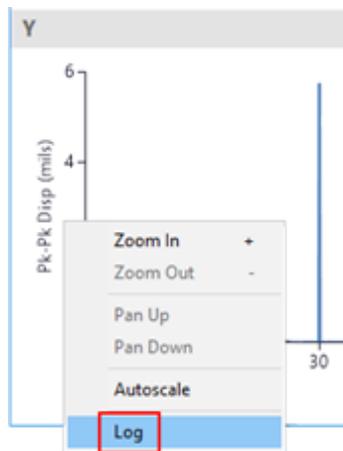
#### 4.12.6.3 X Axis Units

The x axis of a spectrum plot is expressed in Hz (or CPM) by default. However, if an asset speed is associated with the recording the user can choose to express the x axis in orders by selecting a context menu option available on the plot's x axis.



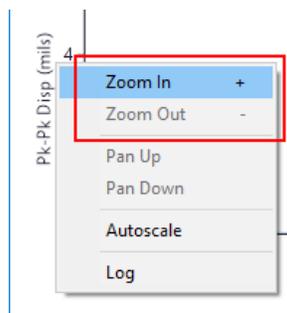
#### 4.12.6.4 Log Amplitude Axis Display

The amplitude axis of spectrum plots is displayed in linear units by default. The user may also choose to express the amplitude axis of an individual plot in log units by selecting the Log option in the amplitude axis context menu.



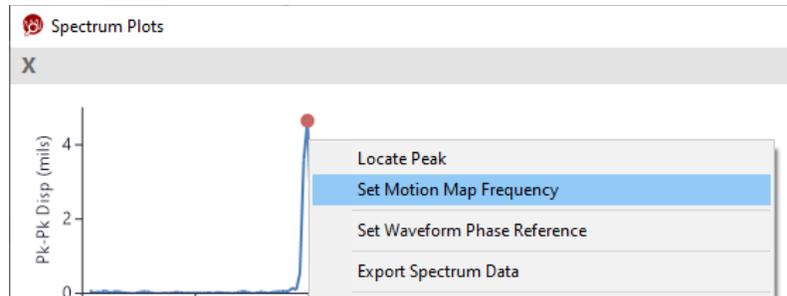
#### 4.12.6.5 Amplitude Axis Zoom In/Out

The amplitude axis of spectrum plots can be zoomed in and out via context menu options available on the amplitude axis. The shortcut keys “+” and “-” also serve as a request to zoom in and out, respectively.



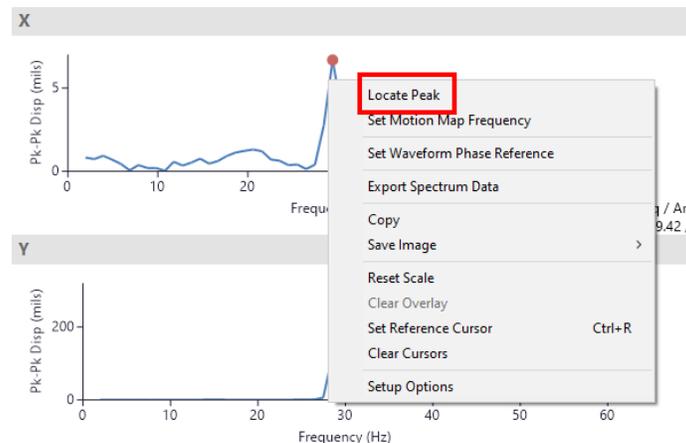
#### 4.12.6.6 Set Motion Map Frequency

If a motion map overlay is displayed, the Set Motion Map Frequency option is available in the spectrum plot context menu. Selecting this option will update the motion contour that is displayed so that it reflects the frequency associated with the spectrum cursor.



#### 4.12.6.7 Locate Spectrum Peak

The spectrum context menu includes an item that is used to tell the software to attempt to locate a peak in the spectral data for the current cursor position. If a peak is located, the cursor is moved to the located frequency and amplitude values. If a peak is not located, the cursor position is unchanged.



#### 4.12.6.8 Set Motion Map Frequency

Selecting this option will update the motion display by displaying the motion contour for the frequency of interest.

#### 4.12.6.9 Set Waveform Phase Reference

This option will set the phase reference for relative phase calculations displayed on waveform plots.

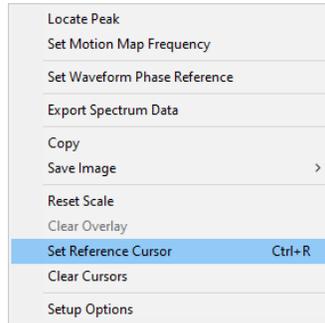
#### 4.12.6.10 Export Spectrum Data

Selecting the Export Spectrum Data option will send the data samples of the selected spectrum to a “.csv” file. This file format can be easily imported to Microsoft Excel or other software applications for further data manipulation. Once this option is selected, a dialog is displayed that allows the user to specify the file name for the exported data.

#### 4.12.6.11 Spectrum Reference Cursor

Spectrum plots support a reference cursor. The user can specify the reference cursor by using the Set Reference Cursor context menu item, the Control+R key sequence, or the Alt + Left Mouse Click

sequence. When a reference cursor has been designated, the cursor information in the lower right of the plot includes the primary cursor information, the reference cursor information, and the difference information between the two cursors.

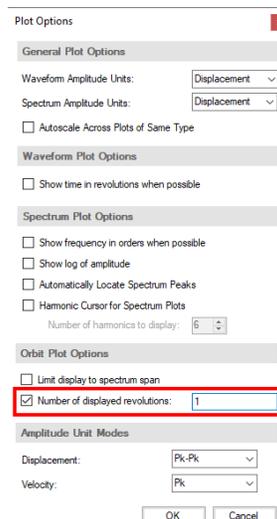


### 4.12.7 Orbit Plots

An orbit plot combines the vibration in both the X and Y directions into a single plot. The X and Y waveforms consist of a sequence of data samples, and for each data sample the X and Y measurements are collected at the same time. The orbit plot takes each of these data samples and plots the value from the X waveform on the X axis and the value from the Y waveform on the Y axis. So the resulting data trace follows the X-Y motion over time. The available units are thousandths of an inch (mils) or microns ( $\mu m$ ) for displacement.

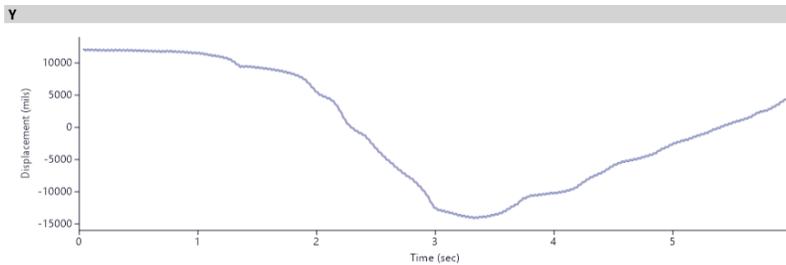
#### 4.12.7.1 Limit Duration of Orbit Plot

If an asset speed is associated with the current recording, the number of revolutions displayed in orbit plots can be controlled via an item in the Orbit Plot Options section of the Plots Options menu available from all plots. The Limit Displayed Revolutions may be enabled and a number of revolutions may then be specified. This number of revolutions will be used to determine the range of data displayed in orbit plots associated with recordings where an asset speed is defined.



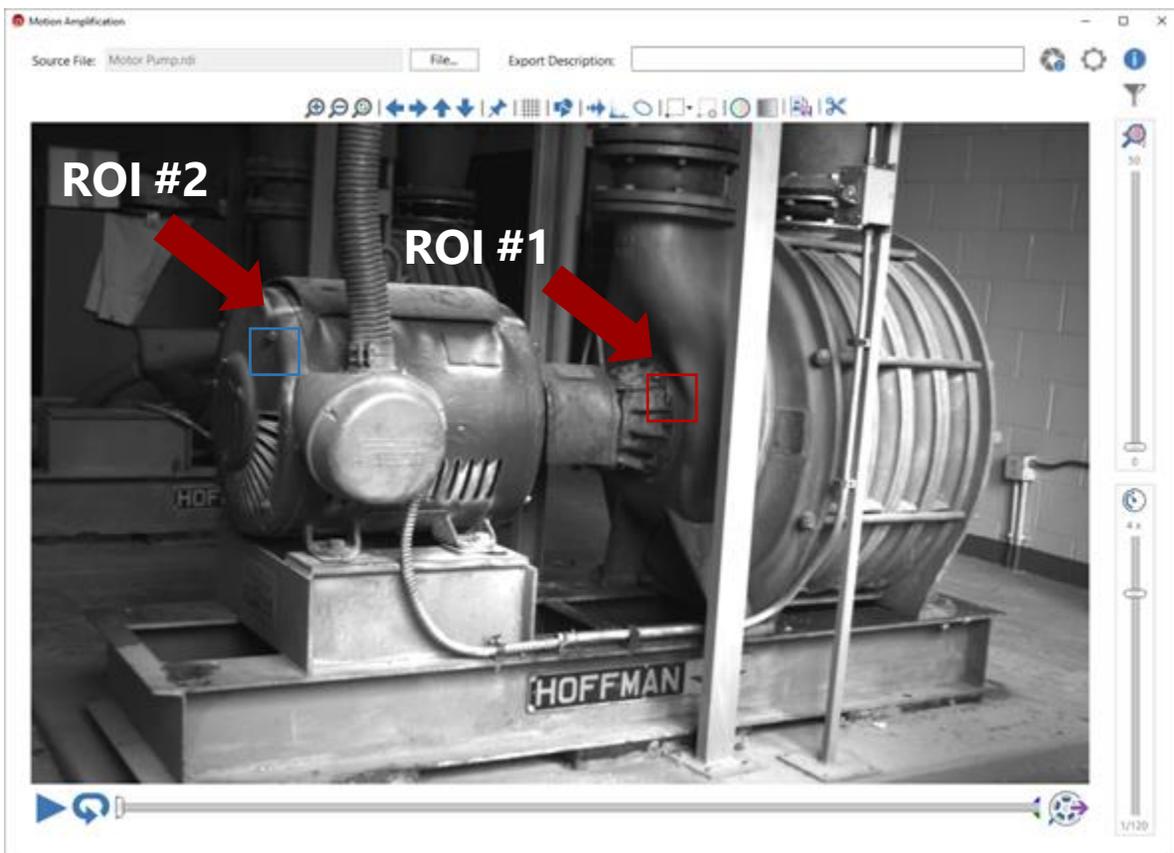
### 4.12.8 Transient Path Plots

A transient path plot shows the gross motion of the content identified by the ROI. This plot tracks the motion of the identified region or object through the camera’s field of view. The available units are thousandths of an inch (mils) or microns ( $\mu m$ ) for displacement. The plot below shows the Y movement of the portion of the asset identified by the ROI.



#### 4.12.9 Measuring Multiple Locations Simultaneously

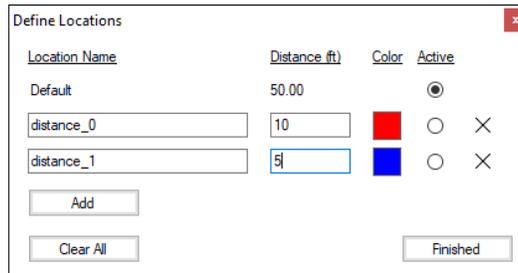
Multiple locations can be measured for displacements within the video. To do this, simply draw a second ROI. This process can be continued for multiple ROIs. The image below shows the interface when two ROIs are drawn.



##### 4.12.9.1 Using Different Distances for Multiple Measurements

At times the user may want to make displacement readings for locations in the image that are at different distances from the camera. It is important to know the distance from the camera to the object being

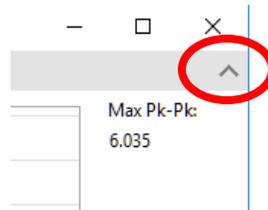
measured to ensure an accurate displacement. The user can load different distance measurements for different locations in the image. To do so, the user can click the Distance Pin in Motion Amplification. This will launch a Define Locations Window as shown below that will allow the user to select different active distances. Once a distance is selected, all measurements will be made with that distance until it is changed. All previous measurements are unaffected if a new distance is selected. This allows multiple displacement measurements to be made at different distances. Distance pins can also be added in Motion Amplification.



#### 4.12.10 Advanced Plot Features

##### 4.12.10.1 Collapsing Plots

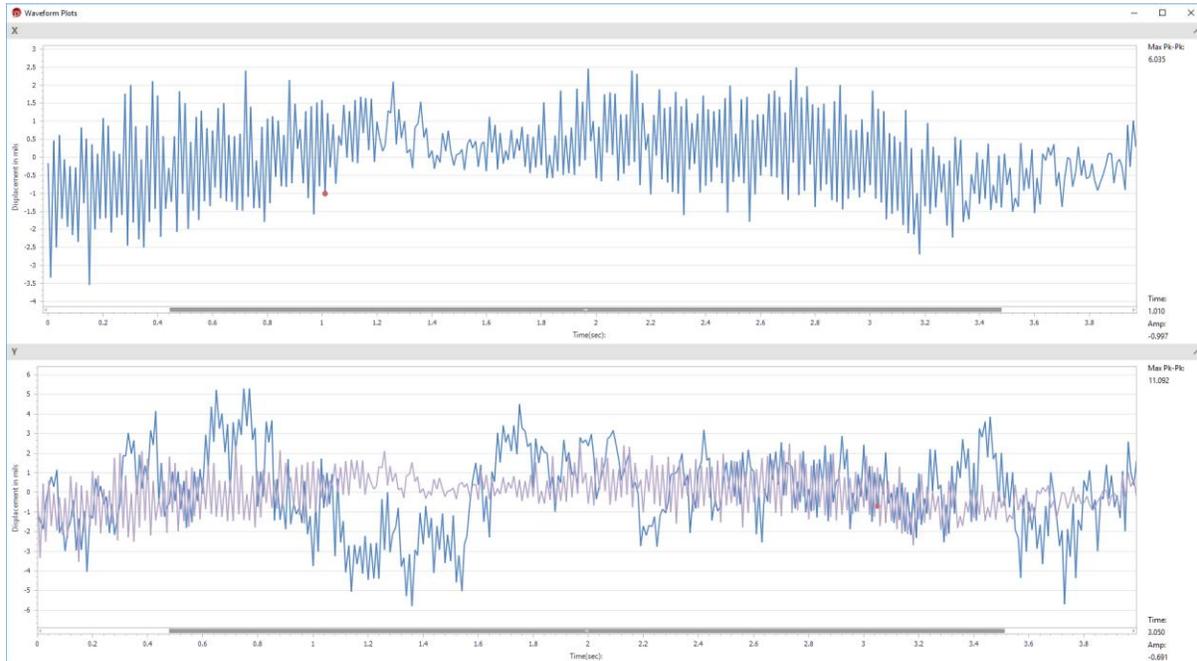
When multiple ROIs are drawn, each ROI has both an X and Y component. This can quickly fill the screen with Time Waveform and Spectrum plots. Each plot is collapsible making it easy to keep plots from taking up space on the screen. To collapse a plot, simply click on the caret symbol “^” in upper right hand corner of the plot.



To expand the plot click the carrot symbol a second time.

### 4.12.10.2 Plot Overlays

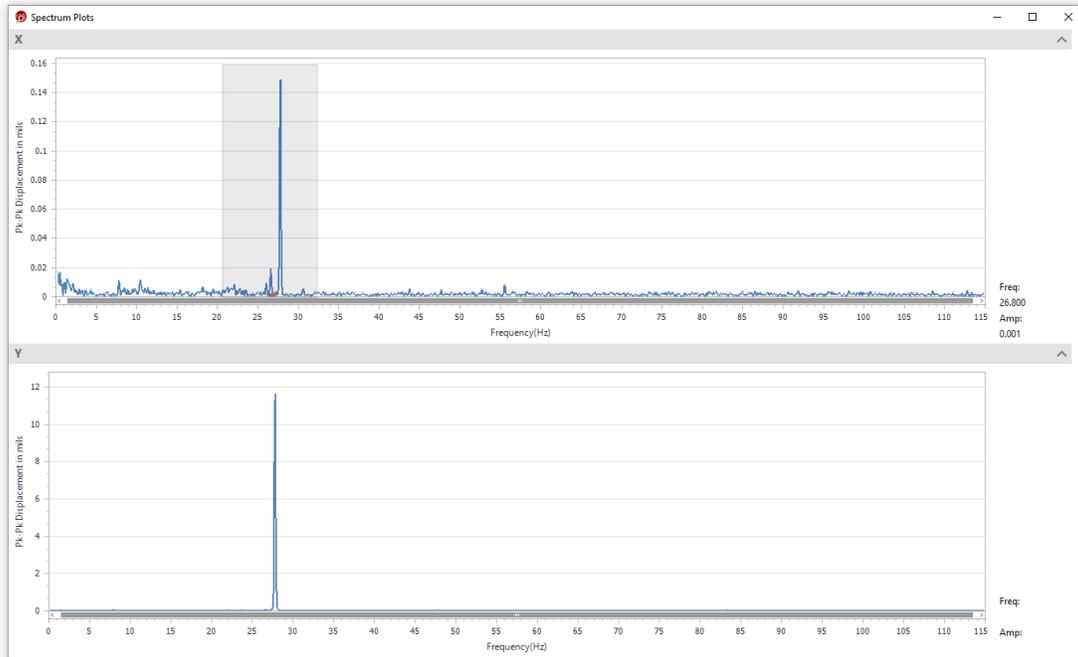
Plots can be overlaid onto one another for comparison. This is done by right clicking and holding on a plot. Drag the mouse until it is over the plot that you would like to overlay onto. Release the mouse and the initial plot is now overlaid onto the target plot. To remove the plot simply right click and click “*Clear Overlay*” from the menu. Below are examples of the Time waveform and Spectrum showing overlaid plots. This feature is available for Time Waveform, Spectrum, and Orbit plots.



### 4.12.10.3 Plot Zooming

Zooming in and out of a plot can be achieved by scrolling forward and backward respectively with the center mouse wheel to zoom in and out. The plot scaling can be reset at any time by right clicking and choosing “Reset Scale” from the menu.

Sections of the plot can be zoomed to fill the entire plot region. This is accomplished by holding the shift key while the mouse is on a plot. With the shift key held, click and drag the mouse over the region to zoom and fill the plot. Release the mouse button to zoom in on the plot. The image below shows the plot appearance as the user drags over a region to zoom. The shaded area shows the area in which the plot will be zoomed.

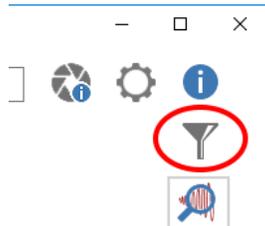


## 4.13 Filtering

The Filtering functionality in the Motion Amplification software allows users to amplify certain frequencies that are present in the vibration data extracted from a recording. If filtering is not applied to a recording during the amplification process, all of the motion that is present is amplified. Assuming multiple frequency components are present, the user may choose to amplify the motion of any specific frequency that is present, or the motion associated with multiple frequencies may be amplified. When filtering is applied to a recording, the original recording is not altered. At this point a new recording is created.

### 4.13.1 How to Apply Filtering

Filtering functionality can be accessed from the Motion Amplification main window via the filtering button shown below.



### 4.13.2 Filtering Interface

Once this button is pressed, a filtering-specific dialog is displayed. It includes the name for the filtered recording that will be created when the Apply button is pressed. A section of the dialog is present for the filters that will be applied to the recording. In the upper right corner, an image viewer window is also included. It shows an image from the original recording and allows the user to step through the recording. The user can draw an ROI on the image to calculate displacement for that region. In the lower right corner, a spectrum plot will display the frequency data from the displacement calculations.



#### 4.13.2.1 Filter Only Amplified Regions

An option is available to “Filter only amplified regions”. It is only available when amplification regions have been defined. If this option is NOT selected, filtering will be applied to the entire field of view, not just the pixels “included” by the amplification regions. If this option is selected, only pixels “included” by the amplification regions will have filtering applied. Only pixels included by filtering can increase the processing time required for filtering. It can also prevent filtering effects (such as “smearing”) from showing up in regions that are not intended to be the focus of the video.

The screenshot shows the 'Filter Specification' dialog box. Under the 'Filtering Options' section, the 'Output Filename' is 'piping\_filtered\_01'. The checkbox for 'Filter only amplified regions' is checked and highlighted with a red box. The checkbox for 'Filter only amplified span' is unchecked. The 'Filtering Mode' is set to 'Manual Filter Definition'.

#### 4.13.2.2 Filter Only Amplified Span

An option is available to only perform filtering on the time frame identified by the amplification span. One effect of choosing this option is that the duration of the filtered recording will be trimmed such that it starts at the time specified by the amplification span start and ends at the time specified by the amplification end.

The screenshot shows the 'Filter Specification' dialog box. Under the 'Filtering Options' section, the 'Output Filename' is 'piping\_filtered\_01'. The checkbox for 'Filter only amplified span' is checked and highlighted with a red box. The checkbox for 'Filter only amplified regions' is unchecked. The 'Filtering Mode' is set to 'Manual Filter Definition'.

#### 4.13.2.3 Filtering Mode

Filtering Mode is an important decision that the user must make. It determines which type of filter specification will be used. The two options are Manual Filter Definition and Amplitude Threshold. These two options are discussed below.

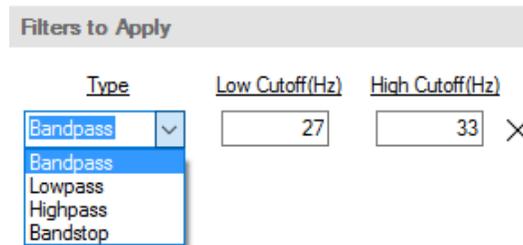
The screenshot shows the 'Filter Specification' dialog box. Under the 'Filtering Options' section, the 'Output Filename' is 'piping\_filtered\_01'. The checkboxes for 'Filter only amplified regions' and 'Filter only amplified span' are unchecked. The 'Filtering Mode' dropdown menu is open, showing 'Manual Filter Definition' (highlighted in blue) and 'Amplitude Threshold' as options. The entire 'Filtering Mode' section is highlighted with a red box.

#### 4.13.2.4 Manual Filter Definition

##### 4.13.2.4.1 Filters to Apply

Once the Add Filter button is pressed, a filter will be displayed. It will default to a bandpass filter, and it will have a default low and high cutoff. The options for filter type include Bandpass, Lowpass, Highpass, and Bandstop. A bandpass filter will only allow frequency content between the low and the high cutoff to be amplified. All other frequency content will be excluded from amplification. A lowpass filter will only allow frequency content below the high cutoff to be amplified. A highpass filter will only allow frequency content above the low cutoff to be amplified. A bandstop filter will exclude frequency content between the low and the high cutoff limits, and all other frequency content will be amplified. Multiple filters may be added to ensure that only the desired frequency content is amplified.

**Note:** In order for a frequency to be amplified, it must be allowed by ALL of the defined filters. If any of the defined filters exclude a frequency, it will not be amplified. This is the reason that the user interface only allows one bandpass filter, one lowpass filter, and one highpass filter.



Type	Low Cutoff(Hz)	High Cutoff(Hz)
Bandpass	27	33 X

##### 4.13.2.4.2 Image Viewer Window

The image viewer window in the filter specification interface allows the user to draw an ROI for which displacement calculations are performed. Once an ROI is drawn and the calculations are complete, the spectrum plot is populated. Different ROIs can be drawn to understand the different frequencies that are present at different locations in the image. The slider below the image viewer represents the entire duration of the recording, and moving the slider's position will update the image appropriately.

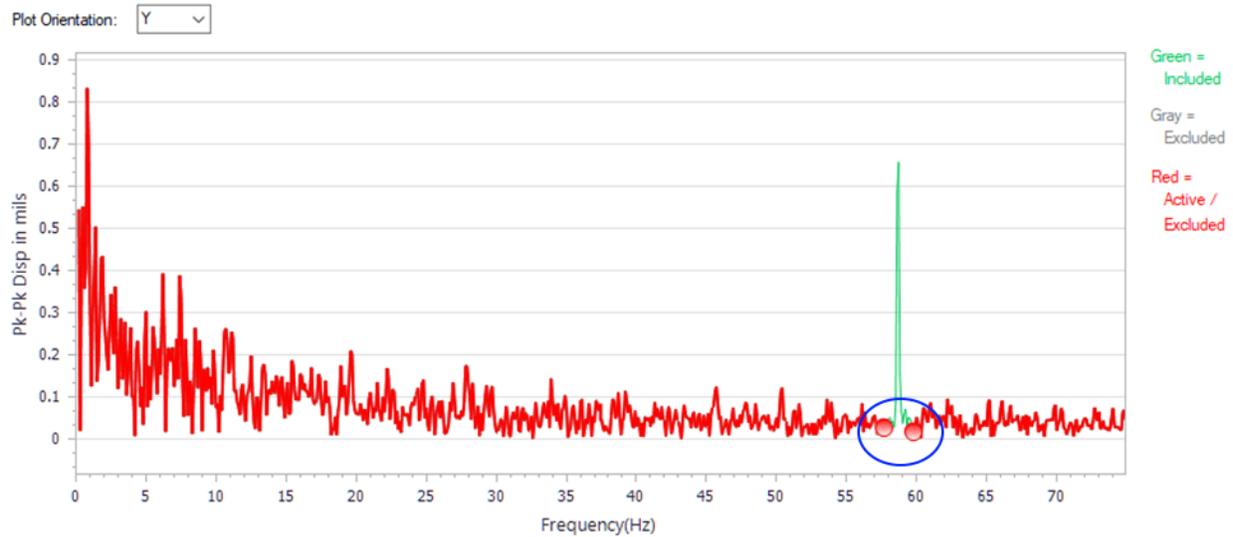


##### 4.13.2.4.3 Spectrum Plot

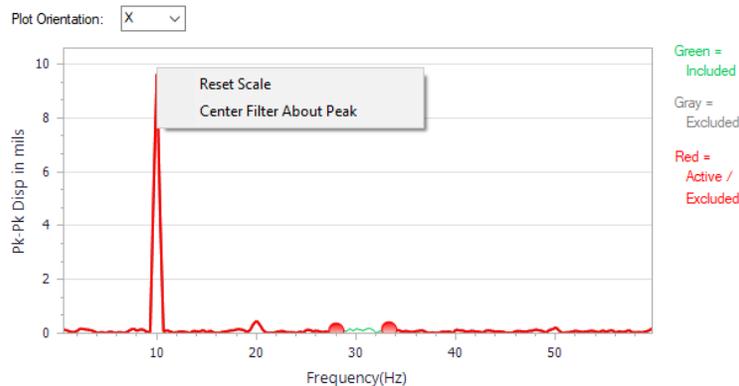
Once an ROI is drawn in the image viewer window, the spectrum plot will be populated. In the upper left corner of the spectrum plot, the user can choose whether to display the spectrum from the X direction or

the Y direction for the current ROI. The spectrum plot provides a graphical means to specify filters appropriately relative to the frequency content that is present and what is desired to be included in amplification. The frequency content associated with the green portion of the spectrum will be included in amplification. The red portion of the spectrum indicates that it is associated with the current or active filter and will be excluded from amplification. To change the active filter, select a different filter in the list of filters to apply. Gray portions of the spectrum are also excluded, but they are excluded because of a filter other than the one currently active. Please see the next section for an example.

Cutoff frequencies for the active filter can be adjusted graphically by using a left mouse click and dragging the cutoff frequency handle (shown circled in blue below) to the left or right. The cutoff frequency value in the table of filters to apply will be updated when frequencies are adjusted graphically. To change the active filter, select a different filter in the list of filters to apply.

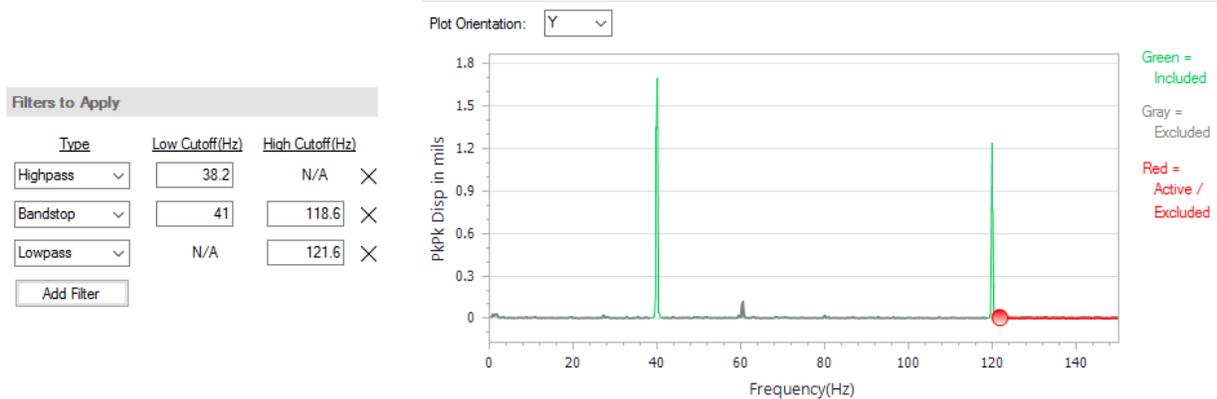


If the current filter is a bandpass or a bandstop filter, a context menu option is available to center the current filter about the peak of interest. If this option is selected, the bandpass or bandstop will be moved so that it is centered about the peak that is located where the user accessed the context menu. In the image below, the right mouse button was clicked near the large peak at 10 Hz.



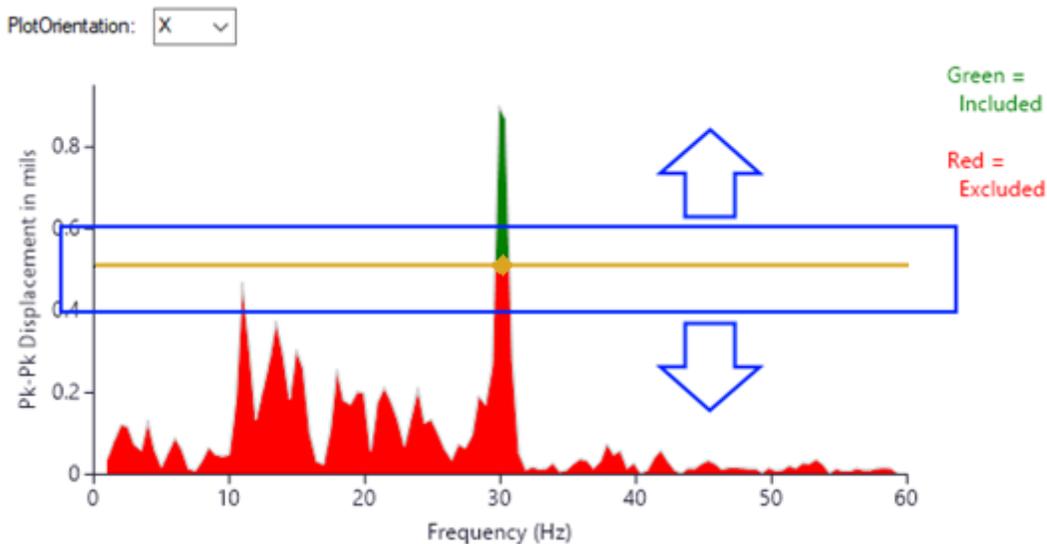
#### 4.13.2.4.4 Example with Multiple Filters

Below is an example where the intention is to include the 40 Hz and the 120 Hz frequency content in the amplification process. Three filters are required. First, a highpass with a cutoff just below the lower frequency of interest. Second, a bandstop between the two frequencies of interest. Finally, a lowpass with a cutoff just above the higher frequency of interest. The green portions of the spectrum are the only frequencies that will be included in the amplification process.



#### 4.13.2.5 Amplitude Threshold Filter Definition

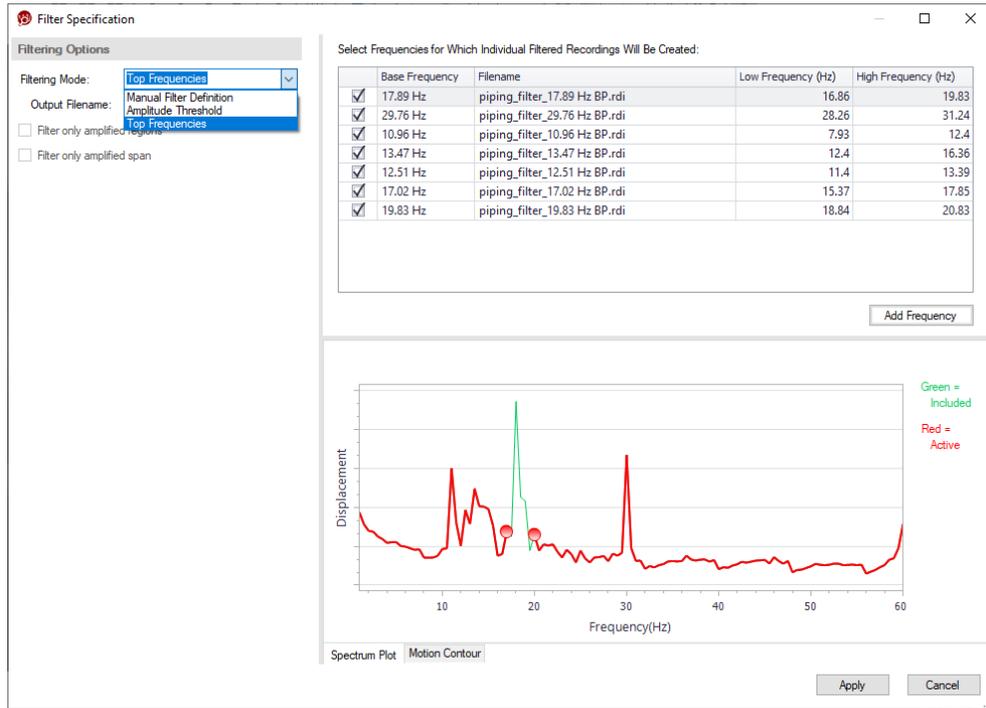
Amplitude threshold filter definition does not require the user to specify individual filters. Instead, it allows the user to specify an amplitude threshold which is used to determine which peaks are included. The peaks colored in green are included, and the frequency content shown in red is excluded. The filtering process tries to include all of the frequency content of a peak even if only the top part of the peak is colored in green. To move the amplitude threshold, click the horizontal line with the mouse and drag it up or down.



#### 4.13.2.6 Top Frequency Filtering

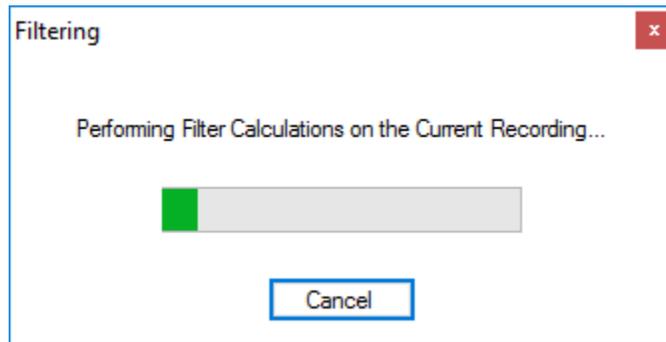
Top frequency filtering searches the recording for frequencies that may be of interest to the user. These frequencies are displayed in a list with a check box beside each frequency. The low and high cutoff limits for the bandpass filters can be edited graphically or by editing the cells in the table. When the Apply button

is pressed, each frequency that is checked will have a separate filtered recording created by applying a bandpass filter about that frequency.



#### 4.13.3 Applying Specified Filters to a Recording

Once the filters have been defined, press the Apply button. This will initiate the filtering process which results in a new recording. During the filtering process, the dialog below will be displayed.



Once the filtering process is complete, the new recording will be loaded. If the user looks at the recording information, the filters that have been applied are listed. See the image below for an example.

Recording Information

Filename: Metal Ex Fan\_02.rdi

Date Collected: 2/21/2020 1:10 PM

Type: Standard (1.0 sec)

Focal Length (mm): 50

Distance (ft): 50

Asset Speed (RPM):

Image Size: 1920 x 1080

Framerate (fps): 120.00

Gain(dB): 0

Brightness (%): 39.5

Dynamic Range: High

Binning: Disabled

Camera Model: Iris M

Serial Number: 15190592

Stabilized: No

Collected Version: v3.0

Type	Low Cutoff	High Cutoff
Bandpass	26.99 Hz	32.99 Hz

Notes:

OK Cancel

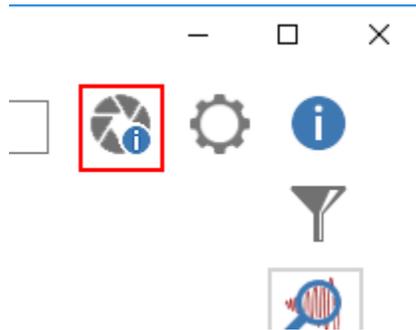
## 4.14 Stabilization

Stabilization offers the ability to digitally stabilize rdi recordings if camera vibration has been introduced into the video. Sometimes vibration makes it to the camera despite best attempts to eliminate it at the source.

**Note: Passive methods of stabilization are preferred. Always use the vibration pads and avoid vibrating surfaces as the first method of eliminating camera vibration. Digital stabilization is designed to be used only in cases where other vibration methods are not possible.**

### 4.14.1 How to Stabilize

To stabilize a file, press the recording info button at the top right of the Motion Amplification Analysis window.



This will bring up the “Recording Information” window giving details about the file. One of the properties is “Stabilized”. This line indicates whether the recording has been stabilized.

**Note: A recording can only be stabilized once.**

If the recording has not been stabilized this line will read “No” and the tripod icon will be blue, indicating the button is clickable. To stabilize the recording, press the tripod icon.

Recording Information

Filename: Scroll1.rdi

Date Collected: 12/15/2016 7:05 AM

Number of Frames: 120

Focal Length (mm): 25

Distance (m): 3.1

Asset Speed (RPM):

Image Size: 1920 x 1200

Framerate (fps): 100.00

Gain(dB): 6

Brightness (%): 0

Dynamic Range: High

Binning: Disabled

Camera Model: Grasshopper3 GS3-U3-23S6M

Serial Number: 16400471

Stabilized: No 

Collected Version: v1.1

Applied Filters:

Type	Low Cutoff	High Cutoff

Notes:

OK Cancel

After clicking the tripod icon, the “Stabilize Recording” window will be displayed.

When a file is stabilized, it creates a new stabilized .rdi file. The original file is not altered. The first entry box is where the new filename is entered. The second dialog box allows a choice of stabilization types. The user can choose between stabilizing the file based on the entire frame (default) or selecting a portion of the frame for stabilization



If “Use Entire Frame” is selected as the basis for stabilization, the file will proceed to be stabilized. Now see Section 4.14.3 Completed Stabilization.

If “Specify Portion of Frame” is selected as the basis for stabilization, see Section 4.14.2 Stabilize Based on a Portion of the Frame.

**Compensate for Camera Rotation:** If this option is not selected, the stabilization process will only compensate for X/Y motion of the camera. If this option is selected, additional stabilization is performed by compensating for the rotation of the camera relative to the subject. This option approximately doubles the time required to stabilize a recording, so it should only be used when standard X/Y stabilization does not fully compensate for the motion of the camera.

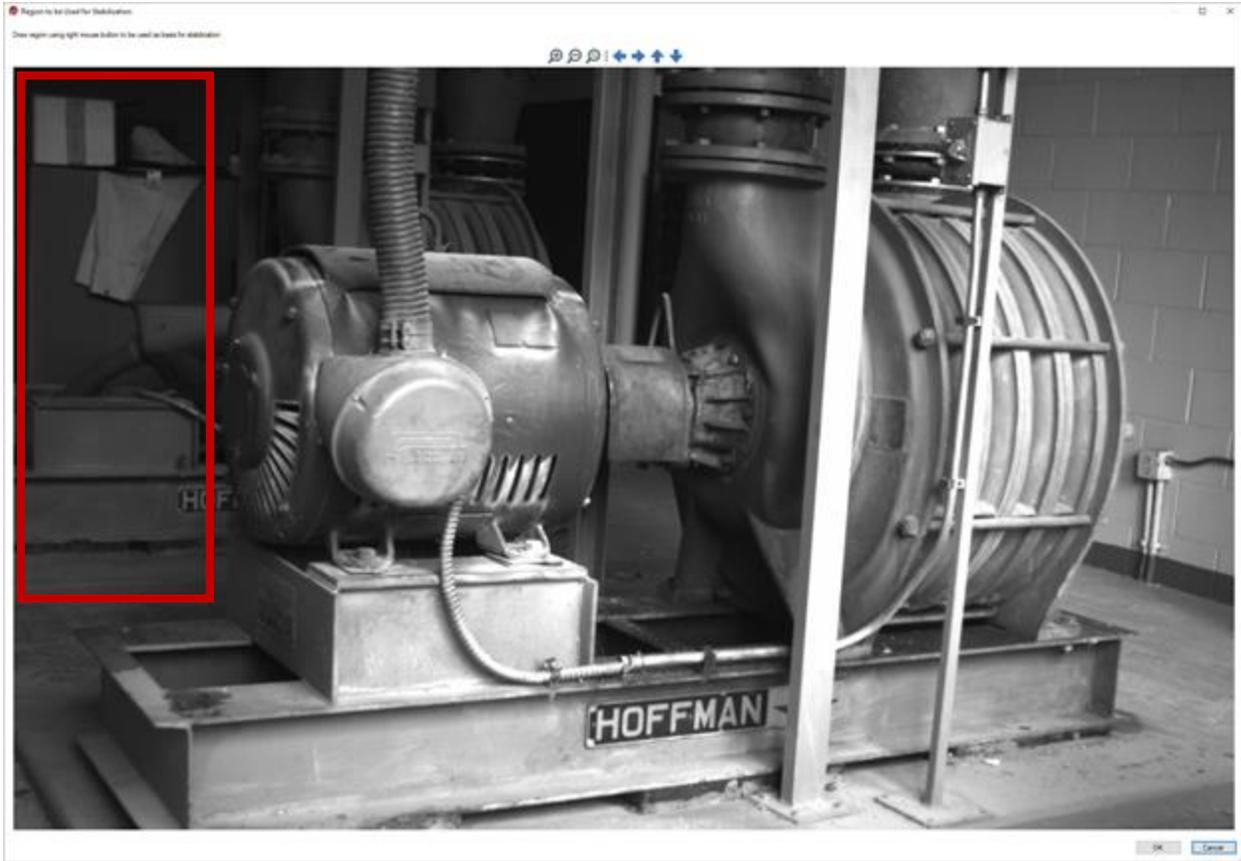
#### 4.14.2 Stabilize Based on a Portion of the Frame

In some instances, the motion of the object of interest may dominate the frame and make it difficult to decide what is of interest and should be moving, and what is the background and should not be moving. In these instances, it may be useful to manually select an ROI in the frame in a region that should not be moving. The stabilization software can then better determine how to stabilize the motion of the camera.

**Note: Do not select regions containing objects that are moving.**

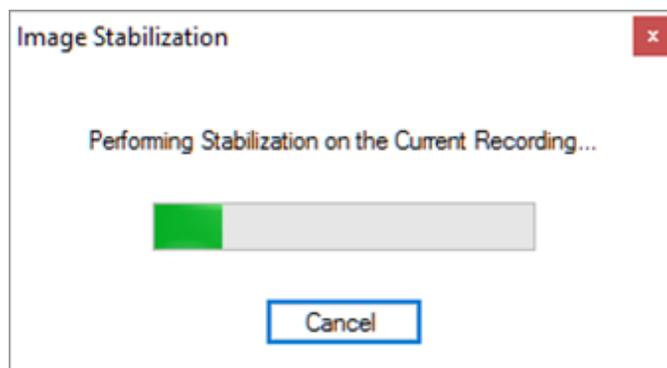
To do this, select “Specify Portion of Frame” from the “Stabilize Recording” window and select “OK”. A new window showing an image of the recording will be displayed. Now an ROI can be drawn on the image by right clicking and dragging the mouse. Once the appropriate ROI is drawn, release the mouse button. If satisfied with the ROI click “OK”. If not redraw the ROI.

Once the OK button is pressed the software will now stabilize based on the ROI drawn. With this method, select regions of the image that are known to be stationary.

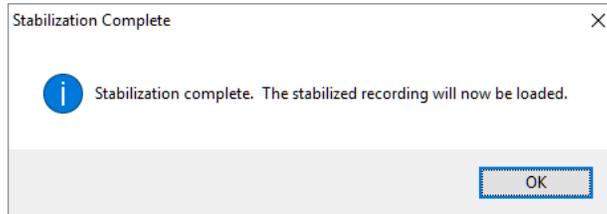


#### 4.14.3 Completed Stabilization

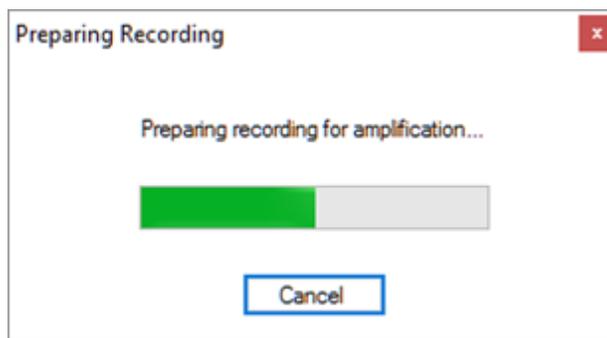
After either stabilizing from the entire frame or a portion of the frame, a progress window will appear indicating stabilization is occurring.



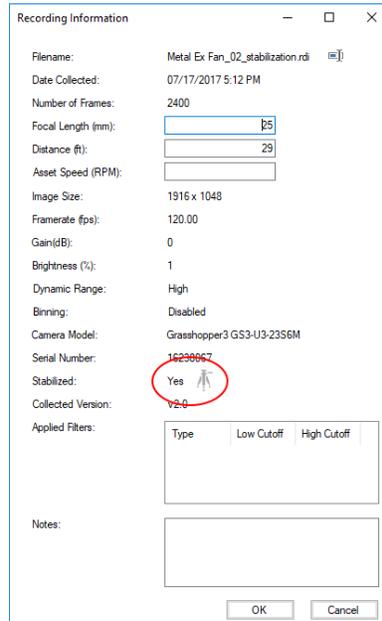
Once stabilization is complete, a window will appear informing the user that stabilization is complete and the new stabilized recording will be loaded in the software. The original un-stabilized recording will be closed.



After closing the “Stabilization Complete” window, the new stabilized file will be amplified.



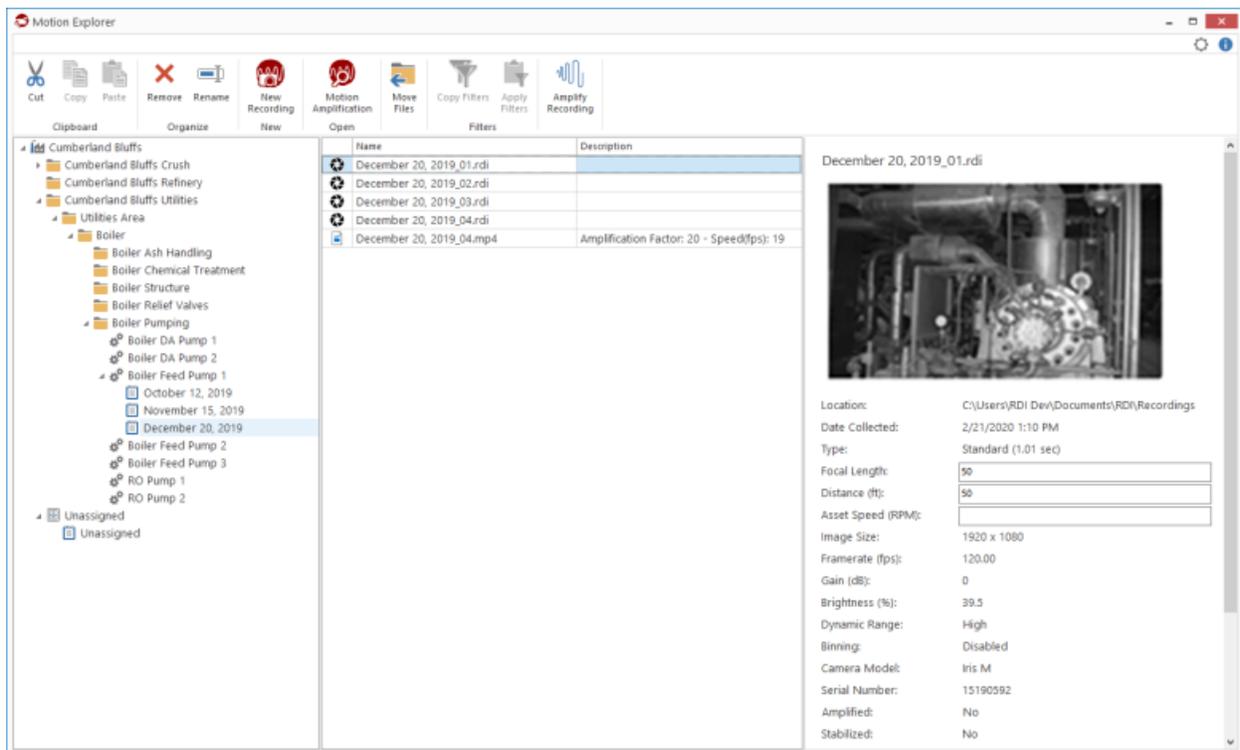
Once the stabilized recording is amplified, it is now ready to be viewed. The “Recording Information” window will still be open and must now be closed. Note: The Stabilized entry now reads “Yes” and the stabilization tripod icon now appears grayed and inactive, indicating the file can no longer be stabilized.



## 5 Motion Explorer

Motion Explorer allows you to create a hierarchy of folders and assets and organize your recordings, exported MP4 videos, and other files under the appropriate asset. Assets have one or more collections associated, and these collections are where recordings and exported MP4 videos reside.

When the RDI Acquisition application collects a recording, it will automatically be associated with the selected collection from the asset hierarchy. When Motion Amplification creates recordings as a result of filtering or stabilization, these recordings will automatically be associated with the same collection as the original recording. MP4 videos exported from Motion Amplification will also be associated with the same collection as the source recording.



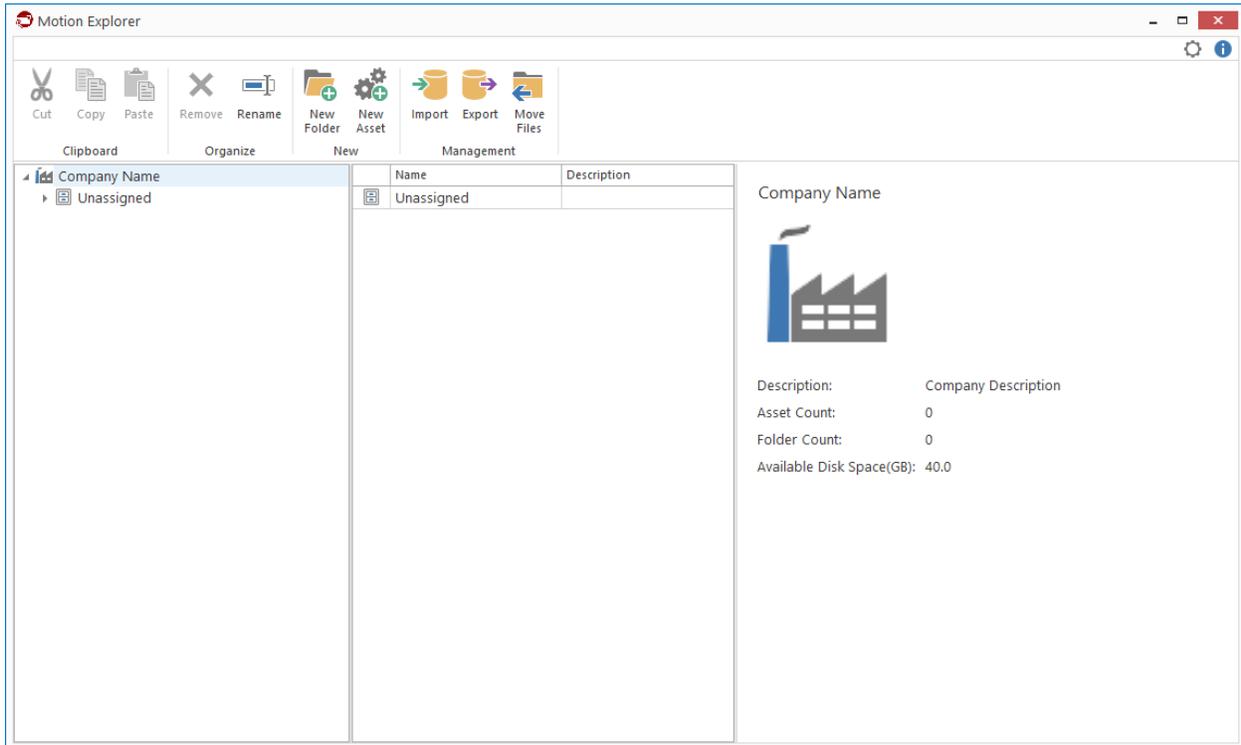
### 5.1 Levels in the Hierarchy

The highest level of the hierarchy is the company. You can rename this item to something appropriate for your organization. Under this highest item in the hierarchy, folders and assets can be added. Folders can contain other child folders or assets. Assets can only contain Collections. Collections contain recordings, exported MP4 videos, and other files. So one approach is to use collections to organize the data associated with a given survey of an asset. The collection name can be anything, and naming them with the data of the survey is one approach. So a given asset can have a collection for each survey that you perform.

There is also an Unassigned folder in the hierarchy. This may be used to hold collections that are not associated with a particular asset. Until a collection under an asset is selected in RDI Acquisition, all collected recordings will be associated with the default collection in the Unassigned folder.

## 5.1.1 Getting Started

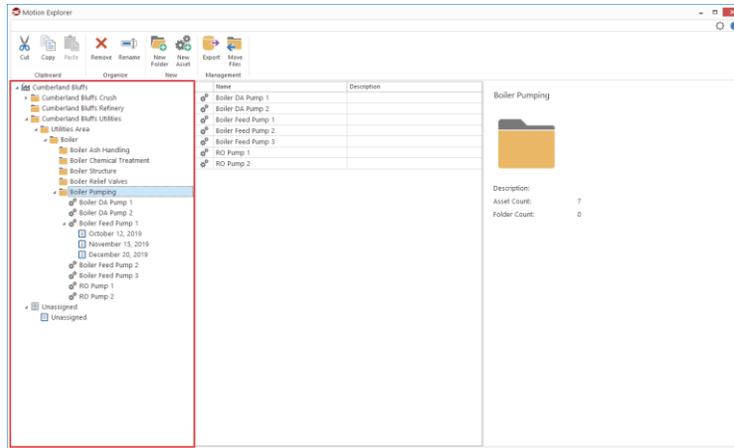
When you first install the RDI Software, you will have a hierarchy that only contains an item representing your company and an Unassigned folder. You can rename the company item to something appropriate for your organization. You can also add Folders and Assets to represent the logical organization of your facility or facilities. The recordings you collect and the MP4 videos that you export will be associated with the assets that you define.



## 5.2 Parts of the Application

### 5.2.1 Left Pane

The left pane of Motion Explorer represents the asset hierarchy by using a tree control. You can expand any given item to see its child items. Individual recordings, exported MP4s, and other files are not shown in the left pane. The item in the tree shows the item's name. When an item in the left pane is selected, the applicable options for the selected item are shown in the ribbon control.



### 5.2.1.1 Drag/Drop to Reorganize Hierarchy

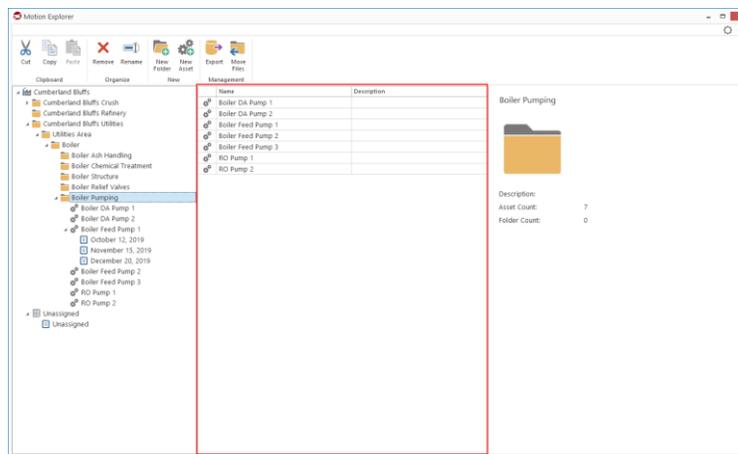
You can reorganize the items in the left pane by using the drag/drop mechanism also found in Windows File Explorer.

### 5.2.2 Middle Pane

The middle pane displays a list of items associated with the item selected in the tree. When an item is selected, the applicable options for the selected item are shown in the ribbon control.

Multi-select is supported in the middle pane. For example, you can select several items and choose to delete them all at once. Items can be dragged from the middle pane and dropped onto the left pane in order to move the items from one location to another.

To rename an item in the middle pane, once the item of interest is selected click on the Name or Description that you would like to change. An edit cursor will be displayed in the text field and you are then free to change the text. Pressing the enter button or clicking anywhere other than the field being edited commits the changes. Pressing the Escape key will cancel the changes.

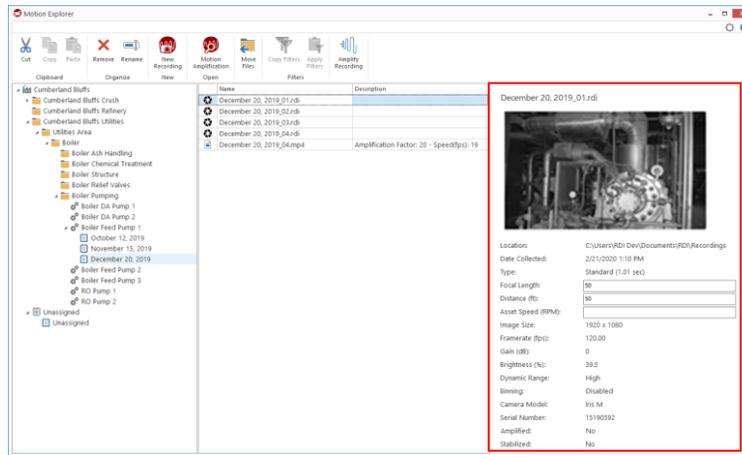


### 5.2.3 Right Pane

The right pane shows additional information about the selected item. The right pane is customized for the different types of hierarchy items.

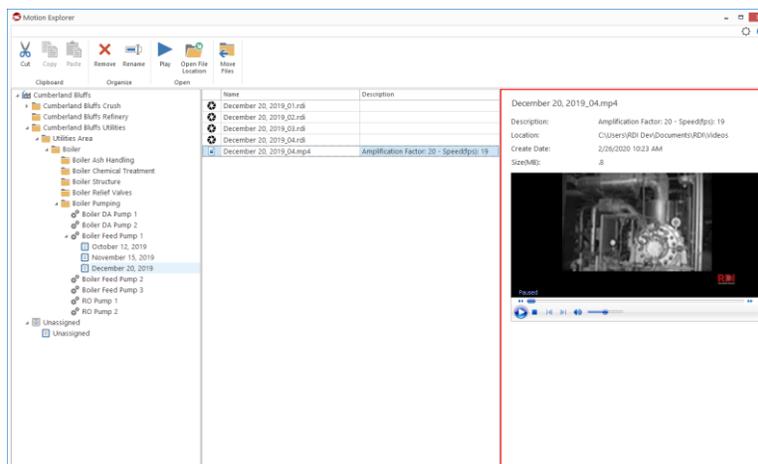
### 5.2.3.1 Recording Preview

When a recording is selected, a preview of the recording content is shown. The properties associated with the recording are also displayed. The focal length, distance, and notes may be edited in the right pane.



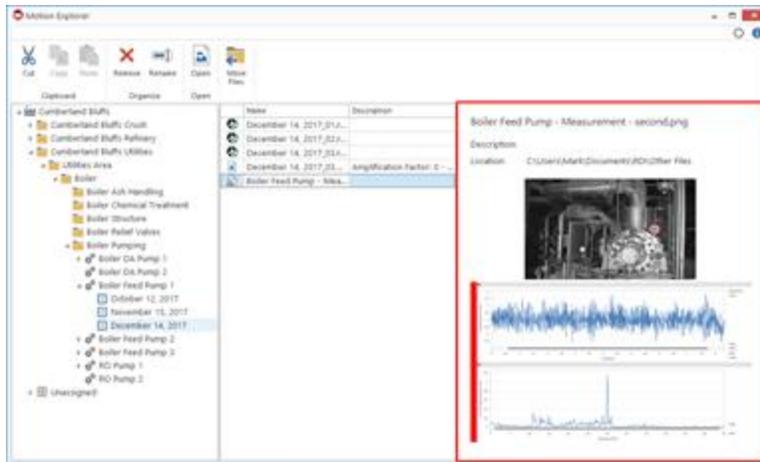
### 5.2.3.2 Exported MP4 Preview

When an exported MP4 is selected, the content of the MP4 is shown. It can also be played by pressing the play button.



### 5.2.3.3 Other Content

The content of PDFs and images is also displayed in the right pane of Motion Explorer.

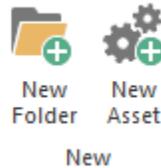


## 5.2.4 Ribbon Bar

The Ribbon Bar is context sensitive so it shows only the functions that can be performed on the currently selected item.

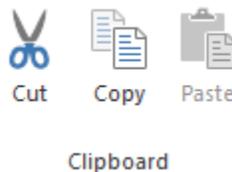
### 5.2.4.1 Add Items to the Hierarchy

When the Company item is selected, Folders and Assets can be added as children. When a Folder is selected, Folders and Assets can be added as children. When an Asset is selected, Collections may be added as children.



### 5.2.4.2 Cut/Copy/Paste

Items can be Cut and then Pasted to perform a move operation. Items can also be Copied and then Pasted to perform a copy operation. Recordings, exported MP4s, and other file type items cannot be copied from within Motion Explorer.

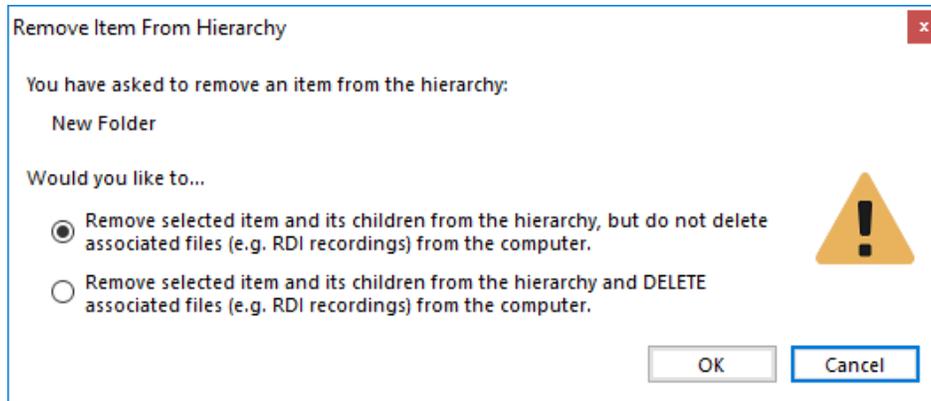
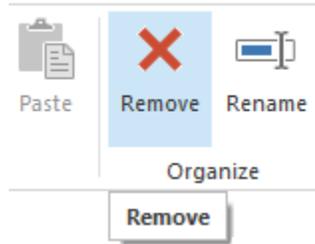


### 5.2.4.3 Remove

Any item except the Company can be removed from the hierarchy.

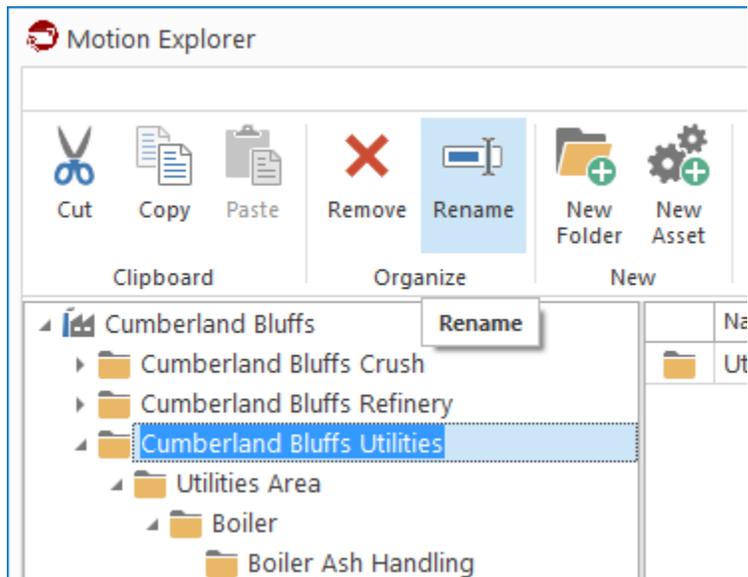
**Important:** When an item is selected to be removed, a dialog will be displayed asking a question about whether to A) remove the item and its children from the hierarchy OR B) remove the item and its children from the hierarchy and DELETE any associated files. The recordings, exported MP4s, and other files associated with a collection are not actually stored in the RDI Hierarchy Database. They are stored separately in the Windows File System and a link to their storage location is stored in the RDI Hierarchy

Database. You may choose to remove just the link to the file OR remove the link and delete the associated files. If the files are deleted, they cannot be recovered.



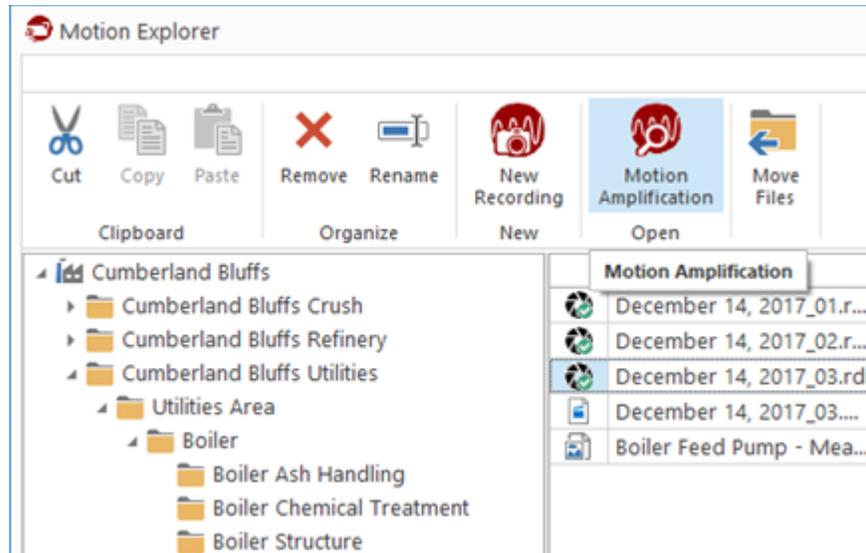
#### 5.2.4.4 Rename

Any item can be renamed with the Rename function available in the ribbon. When this option is selected, the selected item in the left or middle pane will be shown in edit mode as seen in the following image. Use the keyboard to rename the current item. Pressing the enter key or selecting another items commits the change. Pressing the Escape key will cancel the change.



#### 5.2.4.5 Launch Motion Amplification in Context

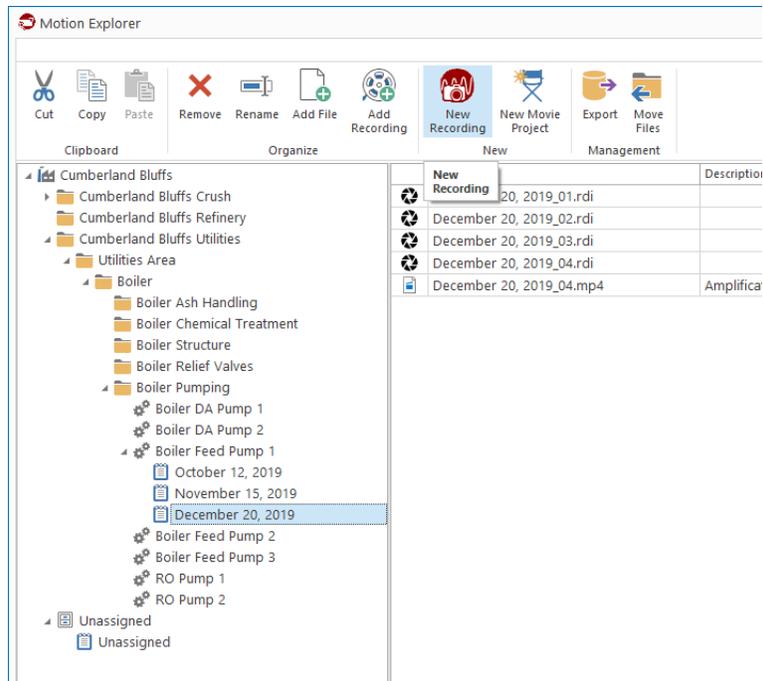
When a recording is selected in the middle pane, a Motion Amplification option will be available in the Ribbon Bar. When this button is pressed, the selected recording will be opened in Motion Amplification. If Motion Amplification isn't currently running, the program will be started.



#### 5.2.4.6 Launch RDI Acquisition in Context

When a collection item is selected in the left pane or middle pane, a RDI Acquisition option will be available in the Ribbon Bar. When this button is pressed, RDI Acquisition will be launched in the context of the selected collection. This means that any recordings collected will be stored as a member of that collection. However, you can always change the active collection from the Acquisition application.

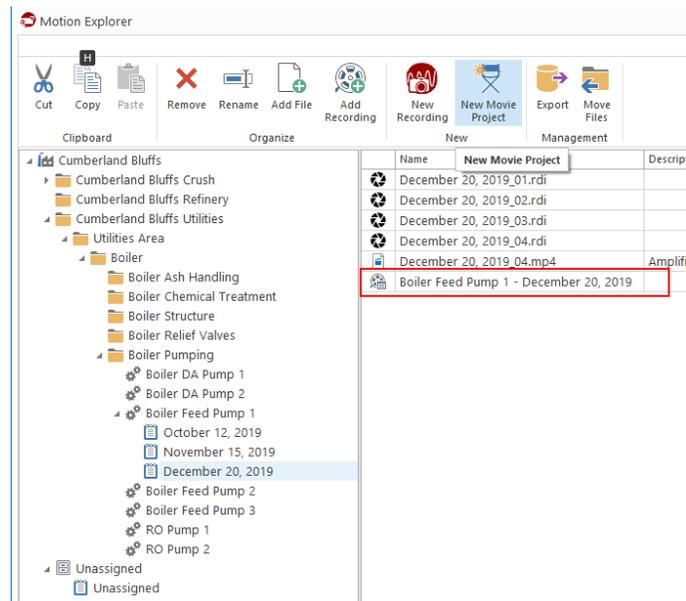
Another way to launch RDI Acquisition in context is to select a recording and press the New Recording button available in the ribbon bar. This will launch RDI Acquisition and set the current recording properties such that they match those of the selected recording. The purpose of this function is to quickly collect another recording whose properties match those of an existing recording.



#### 5.2.4.7 Launch Motion Studio In Context

When a collection item is selected in the left pane or middle pane, a Motion Studio option will be available in the Ribbon Bar. When this button is pressed, Motion Studio will be launched in the context of the selected collection.

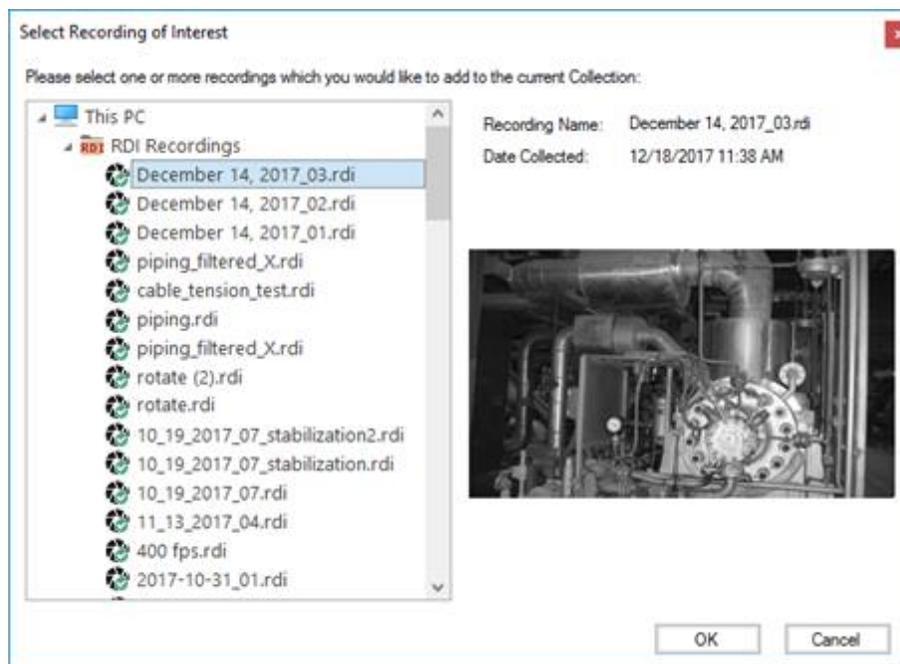
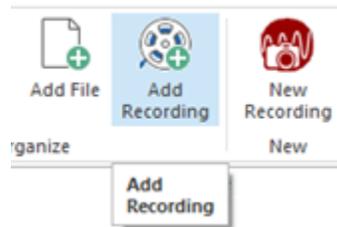
Motion Studio can also be launched in context by double clicking a movie project in the middle pane or selecting a movie project and then selecting the Open option in the ribbon bar.



#### 5.2.4.8 Add Existing Recordings to a Collection

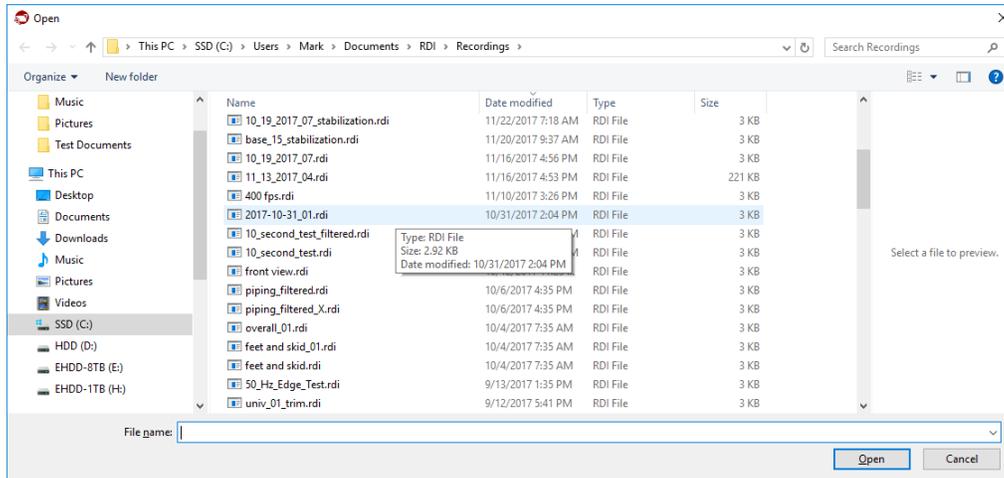
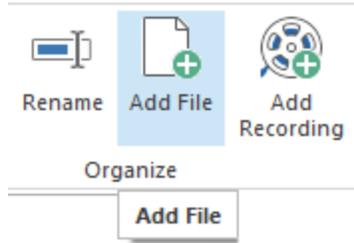
If you would like to add previously collected recordings to a collection, select a collection in either the left pane or center pane and choose the Add Recording option in the ribbon bar. This will display a dialog that lets you browse the recordings on your computer. A preview of the recording is shown when one is selected. This dialog supports multiple selection, so if you would like to add more than one recording use the standard Windows functionality: control+click / click or shift+click. A given recording may only be added to the hierarchy once. Attempting to add a recording already present in a collection will result in an error.

When a recording is added to a recording, only a link is added to the RDI Hierarchy Database. The file itself remains in its original location. So if the file is moved, the link from the RDI Hierarchy Database to the recording will be broken.



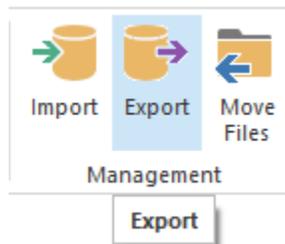
#### 5.2.4.9 Add Existing Files to a Collection

If you would like to add previously exported MP4 video or another previously saved file to a collection, select a collection in either the left pane or center pane and choose the Add File option in the ribbon bar. This will display a dialog that lets you browse the files on your computer. The displayed dialog is a standard Windows File Open Dialog and it supports multiple selection. So if you would like to add more than one file, use the standard Windows functionality: click, control+click or click, shift+click. A given file may only be added to the hierarchy once. Attempting to add a file already present in a collection will result in an error.



#### 5.2.4.10 Export

The purpose for the Export functionality available within Motion Explorer is to allow you to move a group of recordings (and their parent collections, assets, and folders) from one computer to another. For example, every Iris M system comes with an Acquisition System license and an Analysis Only license. Export provides an easy way to get a group of recordings from the Acquisition system computer to the Analysis Only computer.



You need to answer four questions before an export operation can begin:

- 1) What would you like to export?

There are several options that attempt to help you export only the items that need to be moved (since moving recordings is typically not an overly quick operation). The first option allows you to export any collection that has not been previously exported. A collection is considered to have been exported if all of its contents are exported. If an item is added to a collection, it is marked as not having been exported. The second option allows you to specify a date range such that only recordings created within that date range are exported. The third option simply allows you to manually specify what you want exported.

2) Types of Collection files to include?

You can also choose to export the following types of files: Recordings, Exported MP4s, other files associated with collections.

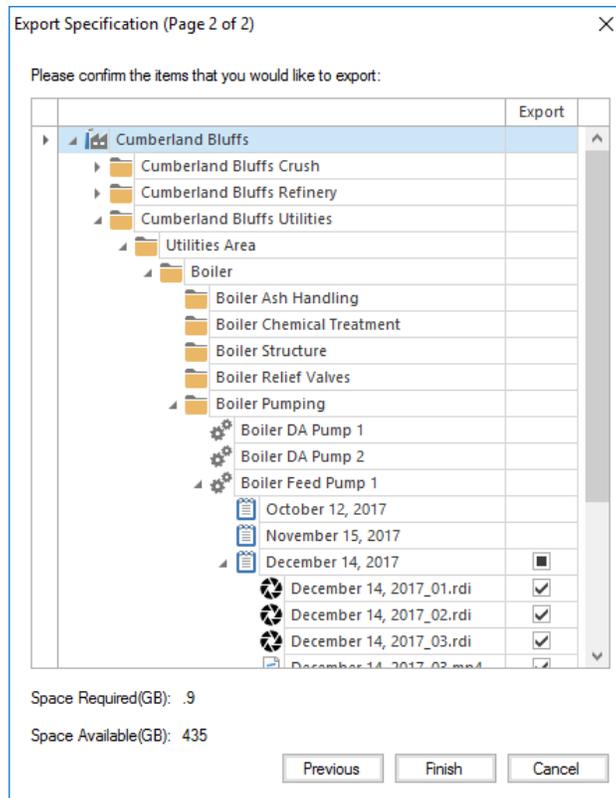
2) Target location for export operation?

You also need to specify a name for the export and select a directory where to store it. This is typically going to be an external drive that can be moved or a network drive that can be accessed by the destination computer where the files will be imported.

3) After exporting collection files, what would you like to do with the files on the current computer?

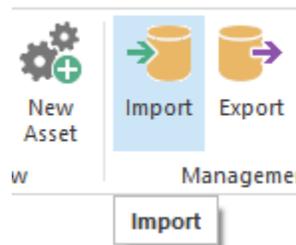
The last choice that needs to be made is to delete the files that are exported or leave them on the current computer. Deleting when exported will create free space on the computer.

Once you make selections for these four options a confirmation screen will be displayed. This allows you to change the items that are marked as to be exported. Once you click finish on this screen, the export operation will begin and a progress bar will be displayed. Once the export has completed, a file will be created with the specified name and the extension “.exp”. There will also be a folder with the same name as the export. This file and folder comprise the export package. Both must be available to perform an import operation of the contents.



### 5.2.4.11 Import

Importing is the process of moving previously exported collections and files onto a different computer from which they were exported. Importing involves selecting the “.exp” file created during the export process. Once you select this file, a confirmation message will be displayed telling you how many assets, recordings, and collection are contained in the export file. If you choose to continue the import, a progress bar will be displayed.



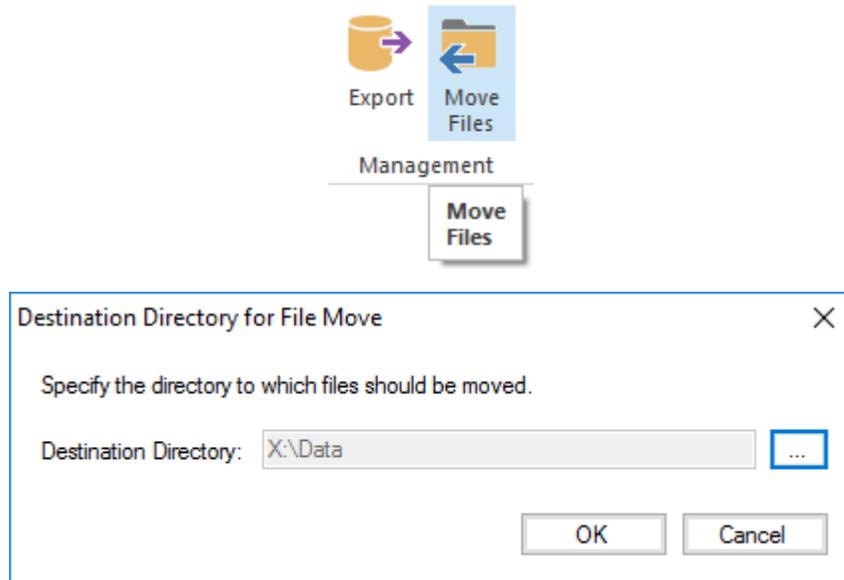
Part of this process is to create the necessary folders and assets with which the collections and recordings in the export file are associated. If a recording is imported that appears to be a duplicate, it is still imported but with a new, incremented name. For example, if “recording.rdi” was imported but already exists, it would still be imported but with the name “recording (2).rdi”.

### 5.2.4.12 Move Files

The move file function is intended to move one or more files from one storage location to another. For example, from the Acquisition computer’s internal SSD to an external SSD. An important difference

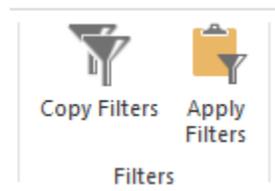
between move and export is that moved files will still be shown under their parent collection in Motion Explorer. Their place in the hierarchy is not altered. They are just moved from one storage location to another, most likely to increase available disk space.

This operation can be initiated from any level of the hierarchy. If it is initiated at a level in the hierarchy above an individual file, all of the files below the selected item will be moved. Once a destination directory is specified and you press “OK”, a progress bar will be displayed.

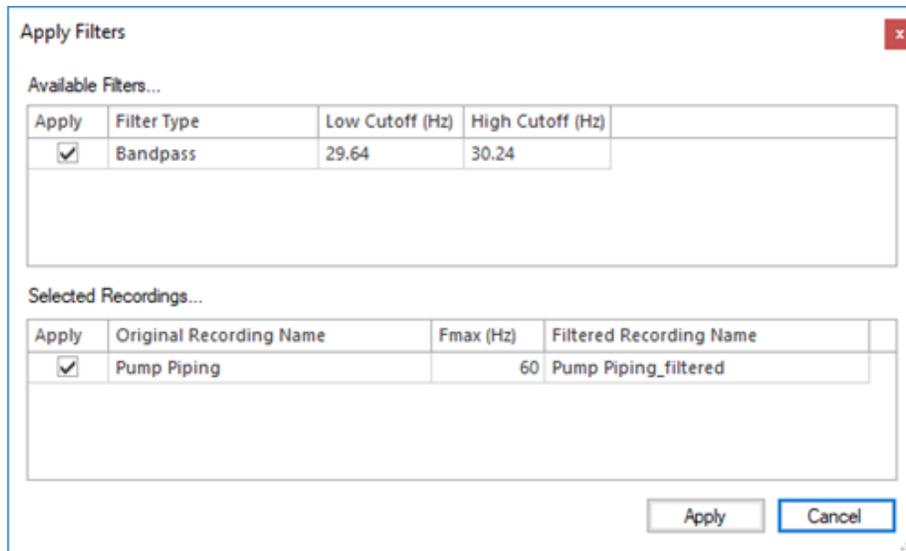


#### 5.2.4.13 Bulk Filtering

Motion Explorer allows the user to copy the filters that have been applied to one recording and apply those filters to one or more different recordings. This functionality would be useful in the case where the user collects multiple recordings on a given asset, but they would like to apply the same filters to all of the recordings. Thus, the user only has to set up the desired filters once. This functionality is accessed in the “Filters” section of the ribbon. The “Copy Filters” option will be enabled if a recording with one or more filters having been applied is selected. Once filters are copied, the user needs to select one or more different recordings, and then the “Apply Filters” button will be enabled.



When the Apply Filters options is selected, a confirmation dialog is shown (image included below). This presents the filters that will be applied, and also the recordings to which they will be applied. The filters to be applied may be disabled as well as the recordings to which they will be applied. At least one filter and one recording must be enabled in order to perform the filtering operation.



#### 5.2.4.14 Amplify Recording

If the user has one or more recordings selected that have not been amplified, the Amplify Recording Option will be enabled. Selecting this option will perform the amplification process on the selected recordings. The advantage of this function is most easily recognized when the user has a group of recordings that all need to be amplified. With this function they can all be amplified as a group, possibly while the user works on another task while the amplification is occurring.

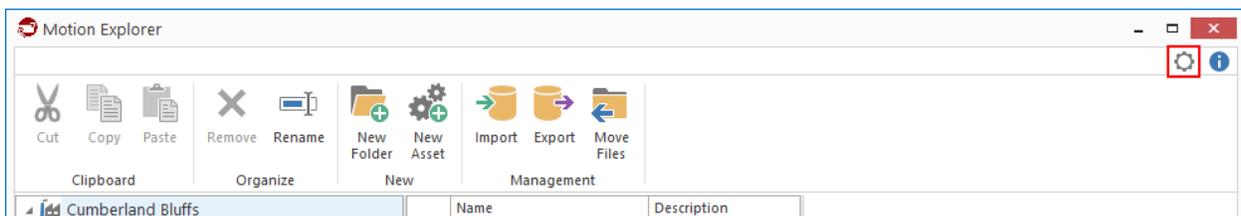


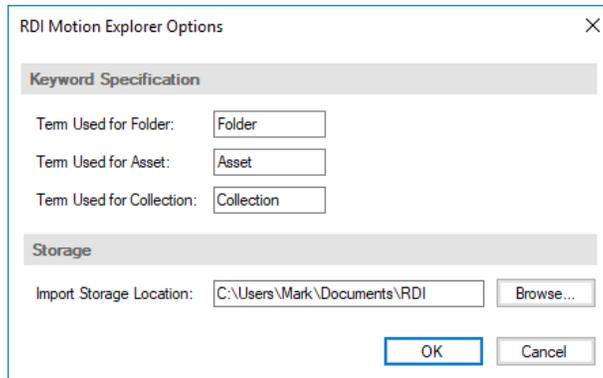
#### 5.2.5 Settings

The Settings button is found in the upper right corner of the Motion Explorer application. It provides access to several settings that are configurable.

The default terms that are used in the asset hierarchy are Folder, Asset, and Collection. You may specify different terms for these items in the hierarchy.

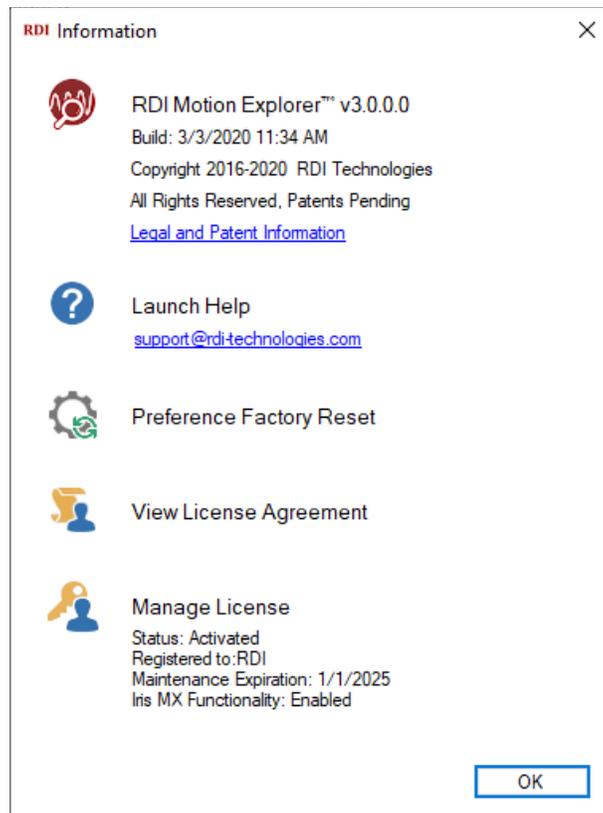
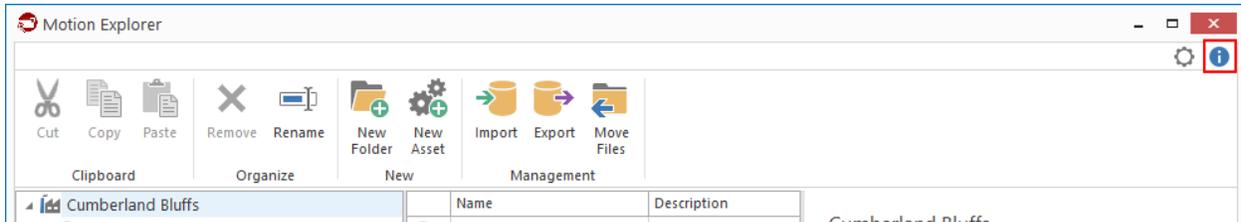
The settings menu also allows the user to specify the storage location for imported files.





### 5.2.6 Information

In the upper right corner of the Motion Explorer application is an Information button. Press this button to access information about the application, help, view the license agreement, and access license information.



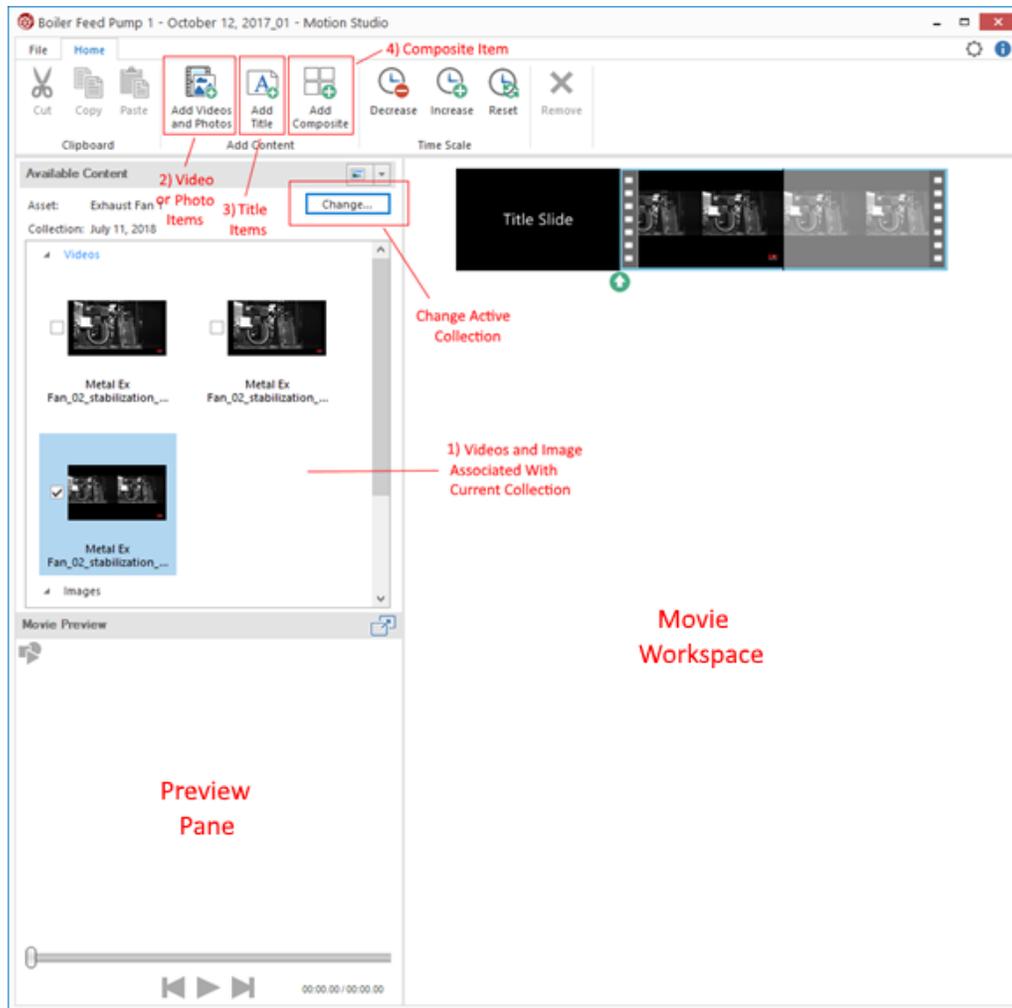
## 6 Motion Studio

Motion Studio brings video editing capability into the RDI suite of software. It supports the building of a movie project, where the movie project is composed of one or more various items. Title slides are one of the item types that can be added to a movie. They can contain text, images, and other various annotations. Previously created videos and images can also be added to a movie project. Annotations can be added to any file type. Motion Studio supports trimming and fade effects. Once the movie project has been completed, the user simply saves the movie and an MP4 is created that includes all the items associated with the movie project.

### 6.1 Adding Content to a Movie Project

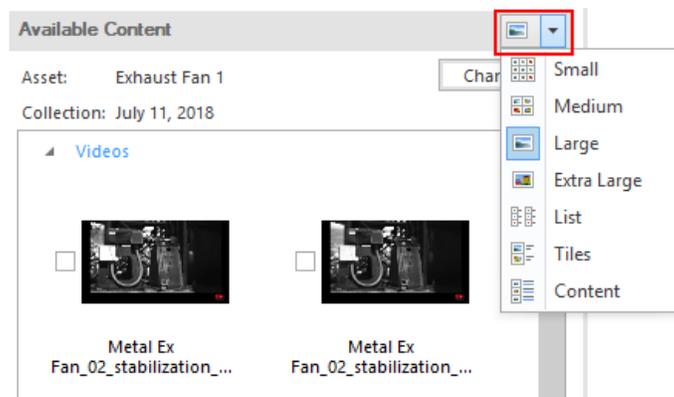
The first step in building a movie using Motion Studio is to add content to the movie project. This may be done one of several ways:

- 1) Check the boxes next to the items in the Available Content window in the upper left of the main workspace. When you check an item in the content pane it will be included in the project workspace. The Change button will allow the user to select a different Collection whose Video and Photo content is to be displayed in the upper left window.
- 2) Click the Add Videos and Photos button in the Ribbon Bar. Selecting this button will allow the user to browse the RDI hierarchy and the files on the computer's file system. Selecting an MP4 or photo/image will add that item to the movie project.
- 3) The Add Title button in the Ribbon Bar will add a title slide to the movie project. The default text of a title slide can be changed.
- 4) Composite Items can also be added to a movie project. This tile type allows the user to combine multiple videos, photos, and other images into a single item in the movie. Composite items will be covered more thoroughly in the following sections.



### 6.1.1 Adjusting View in the Available Content Pane

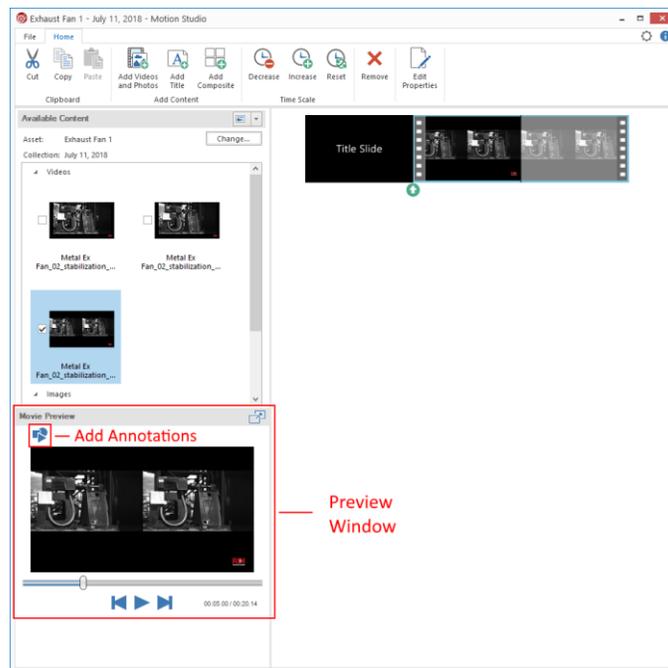
There are six different views available for the Available Content Pane. They range from Small to Extra Large with the addition of Tiles and Content options. The user can change this to see more or less information about the items, and this selection also affects the size of the thumbnail displayed for each item.



## 6.2 Previewing the Movie

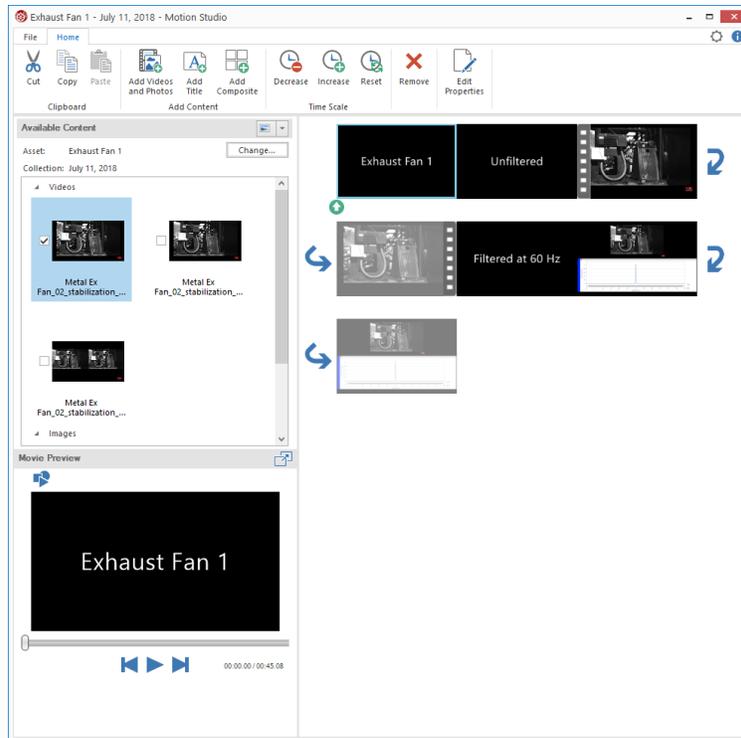
The Preview Window will show the current playback position of the movie. At the bottom of the window are Play, Pause, Previous Frame, and Next Frame buttons. In the upper right corner of the Preview Pane is a Maximize button. Pressing this button will maximize the preview window so that it fills the entire application main window.

**Important:** The Preview Pane is also where you change the text of Title Items and add annotations to all the different item types. To edit an existing annotation (including text), click on the annotation of interest and the properties of that annotation will be displayed in a dialog box. The mechanism for editing annotations is identical to that used in Motion Amplification (See [Editing Annotations](#)).



## 6.3 Movie Workspace

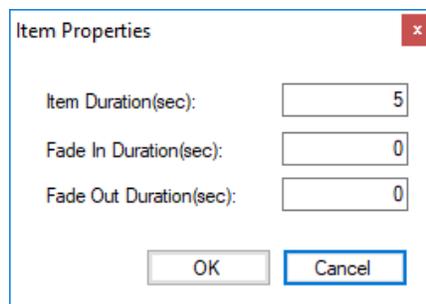
The right side of the application displays the contents of the current movie project. The movie will begin with the item in the upper left and play from right to left. When the end of a row is reached, the movie will wrap to the left side of the next row. The blue arrows indicate this order. The number of blocks representing an item is proportional to the item's duration. The default time scale is that 1 block represents 10 seconds. Anything items less than 10 seconds will appear as 1 block. Hovering over each item with the mouse will display a tooltip with the duration of the item.



### 6.3.1 Title Items

Title Items contain mainly text, but any annotation (including additional text) can be added to a Title Item. Additional annotations are added via the Add Annotation button available in the preview window.

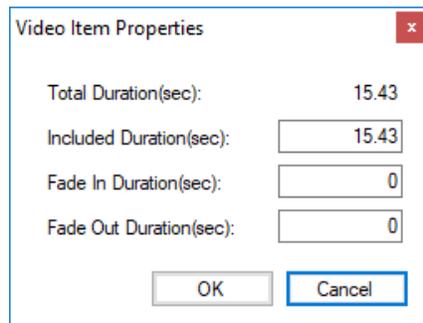
With a Title Item selected in the Movie Workspace, selecting the Edit Properties button in the ribbon will display its properties in a dialog. The available properties include the duration that the item should be displayed in the movie and the fade in and fade out durations.



### 6.3.2 Video Items

Video Items contain previously created MP4 videos. Annotations can be added to Video Items. Annotations are added via the Add Annotation button available in the preview window.

With a Video Item selected in the Movie Workspace, selecting the Edit Properties button in the ribbon will display its properties in a dialog. The available properties include the original duration of the MP4. The Included Duration property is the amount of the original video that is to be included in the movie. Fade in and fade out durations are also available.

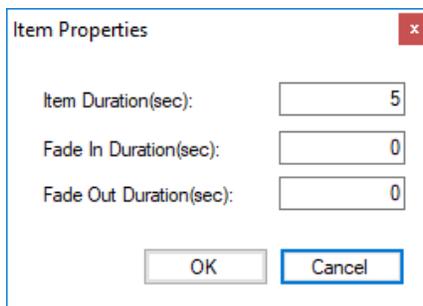


The screenshot shows a dialog box titled "Video Item Properties" with a close button (X) in the top right corner. It contains four rows of labels and values: "Total Duration(sec):" with the value "15.43"; "Included Duration(sec):" with a text input field containing "15.43"; "Fade In Duration(sec):" with a text input field containing "0"; and "Fade Out Duration(sec):" with a text input field containing "0". At the bottom, there are two buttons: "OK" and "Cancel".

### 6.3.3 Image Items

Image Items contain previously created photos and images. Annotations can be added to Image Items. Annotations are added via the Add Annotation button available in the preview window.

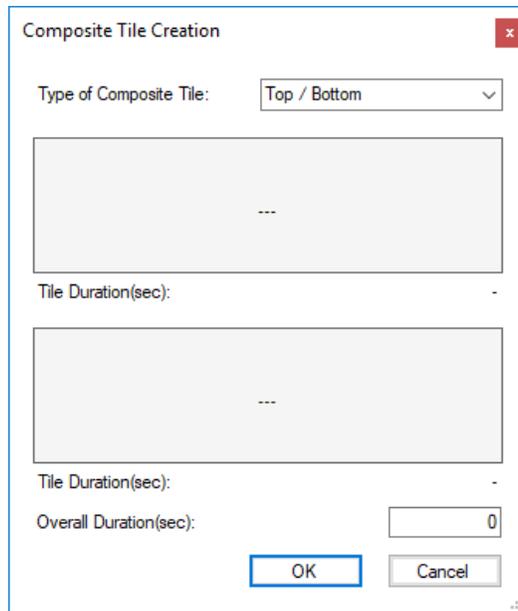
With an Image Item selected in the Movie Workspace, selecting the Edit Properties button in the ribbon will display its properties in a dialog. The available properties include the duration that the item should be displayed in the movie and the fade in and fade out durations.



The screenshot shows a dialog box titled "Item Properties" with a close button (X) in the top right corner. It contains three rows of labels and values: "Item Duration(sec):" with a text input field containing "5"; "Fade In Duration(sec):" with a text input field containing "0"; and "Fade Out Duration(sec):" with a text input field containing "0". At the bottom, there are two buttons: "OK" and "Cancel".

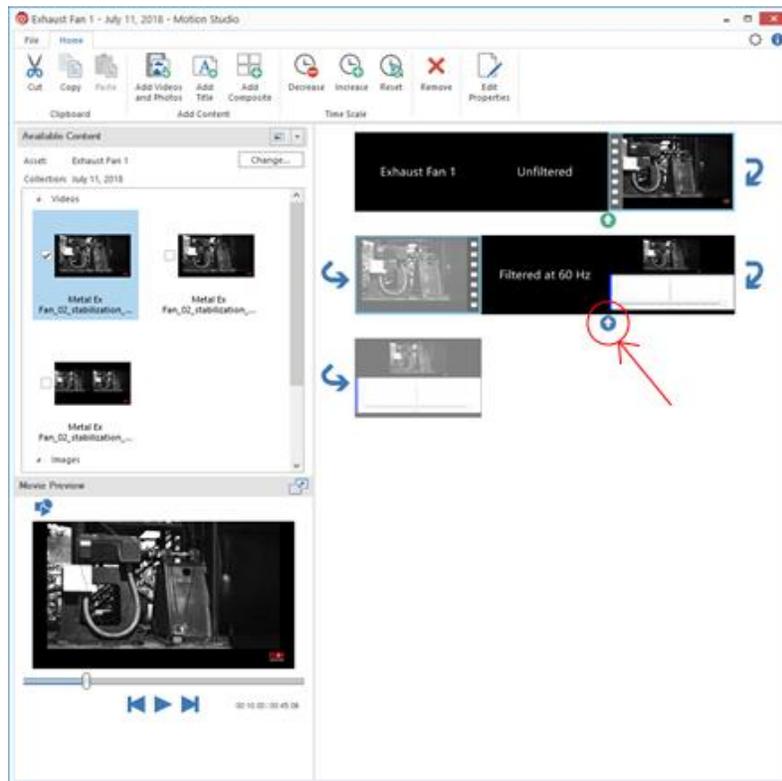
### 6.3.4 Composite Items

Composite Items can contain MP4 videos, photos, and other images. The Composite item can be either left-right, top-bottom, or window pane. Left/right and top/bottom allow the user to choose two different items to be displayed simultaneously. Window pane allows the user to choose up to four items to display. To add content to a Composite Item, click on the "..." shown in the dialog. This will bring up another dialog to let the user browse the RDI asset hierarchy or the computer's file system. The overall duration may be specified, and this can be used to trim the duration of any MP4 videos included in the Composite Item.



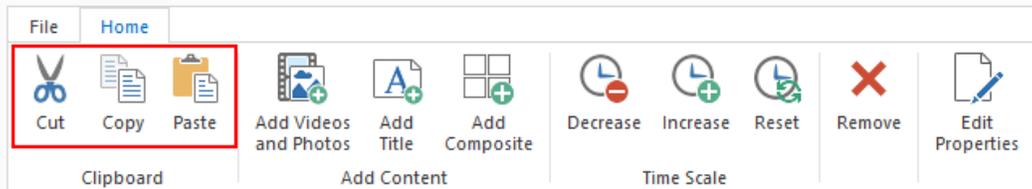
### 6.3.5 Reordering Items

To reorder an item, click the item in the Movie Workspace with the left mouse button. Hold the mouse button down and drag it to the desired location. The blue drop indicator with the white arrow is indicated in the image below, and it indicates where in the sequence the item will be placed.



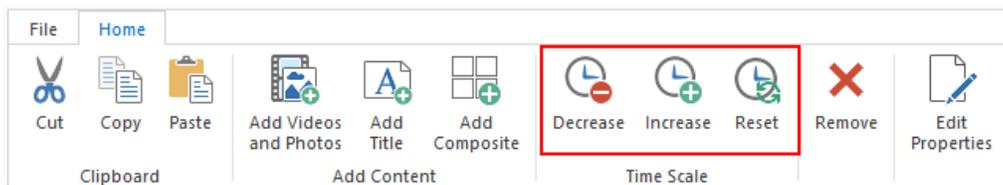
### 6.3.6 Cut/Copy/Paste

The Cut, Copy, and Paste items in the Ribbon Bar may be used to copy any item in the Movie Project. Pasted items will be placed before the item currently selected when the Paste button is pressed.



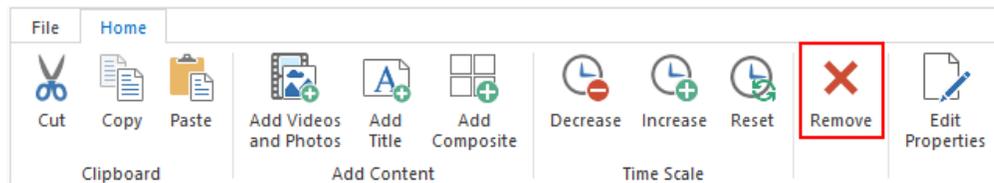
### 6.3.7 Alter Time Scale Representation of Movie Project Items

The time scale items in the Ribbon Bar may be used to alter the amount of time represented by each block shown in the Movie Workspace. As mentioned previously, each block represents 10 seconds by default. Pressing the Decrease button will reduce the current amount of time represented by each block by one half. Pressing the Increase button will double the amount of time represented by each block.



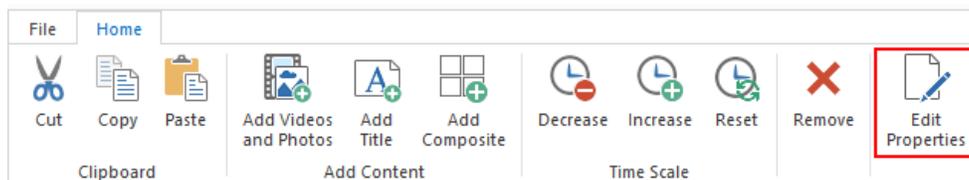
### 6.3.8 Removing Project Items

Pressing the Remove button in the ribbon bar will remove the item currently selected in the Movie Workspace.



### 6.3.9 Editing Project Items

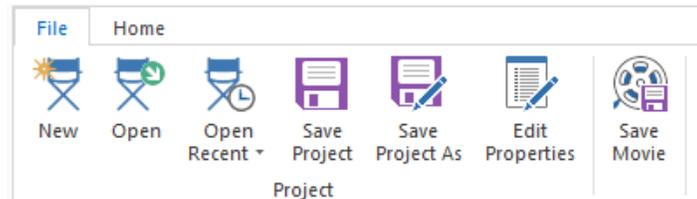
Pressing the Edit Properties button in the Ribbon Bar will display the properties dialog for the currently selected item.



## 6.4 File Menu

The File Menu in Motion Explorer is used to perform project-level operations. These include the following:

- Creating a New Project
- Open an Existing Project
- Open Recent Project
- Save Project
- Save Project As
- Edit Properties (of the Movie Project)



Save  
Movie

**Important:** Pressing the Save Movie button will construct an MP4 movie based on the current content of the Movie Project. This operation may take several minutes, and a progress bar will be displayed to help estimate the amount of time remaining. Once the movie creation is complete, the user is presented with a choice to play the movie, open Windows File Explorer to the location where it was stored, or continue working in Motion Studio. Once the movie is saved, it can also be found in Motion Explorer under the Collection with which the Movie Project is associated.

## 7 Motion Monitor

Motion Monitor is used to configure the Iris CM continuous monitoring system. The Iris CM consists of a data collection device and a client computer. Configuring the system involves connecting the monitoring device(s) to the client computer, setting up one or more monitoring cameras, associating these cameras with assets in the hierarchy, and defining triggers that are used to automatically save data of interest that is collected by the device. Once the system has been configured, the application may be used to monitor the assets associated with the monitoring device. The application can also be used to review data that the device has collected and manage the transfer of data from the monitoring device to the client computer.

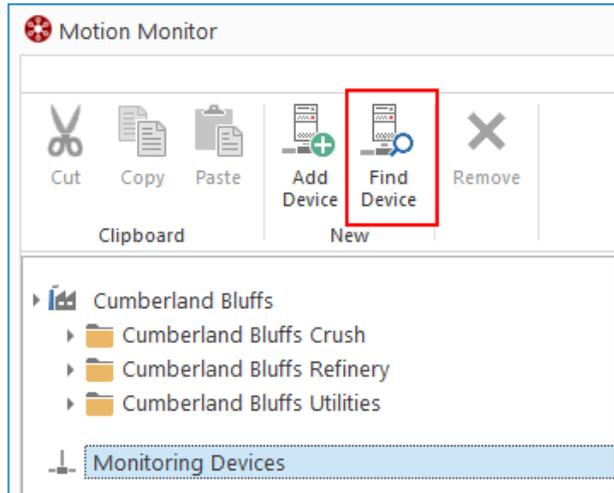
### 7.1 Configuration of the System

#### 7.1.1 Connecting a Monitoring Device to the Client Computer

Out of the box, the Iris CM client computer will be connected to the continuous monitoring acquisition device. However, if another acquisition device needs to be connected the user will need to either add the device manually or find the device by scanning the network for available units.

##### 7.1.1.1 Finding a Device

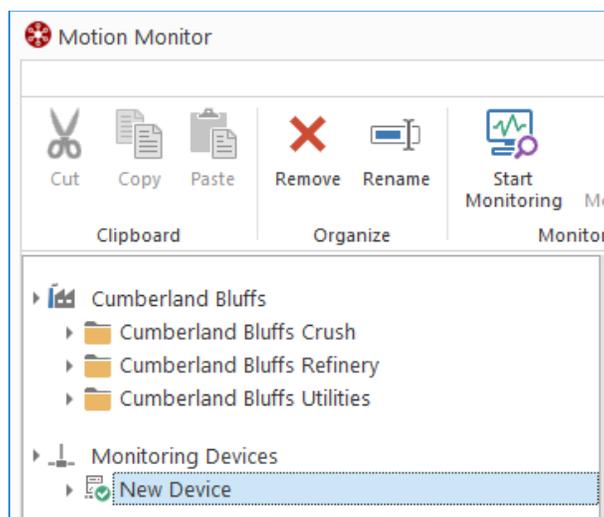
With the Monitoring Devices node selected in the tree, the “Find Device” can be used to search the network for available devices.



A list of available devices will be displayed, and device is represented by its IP address.

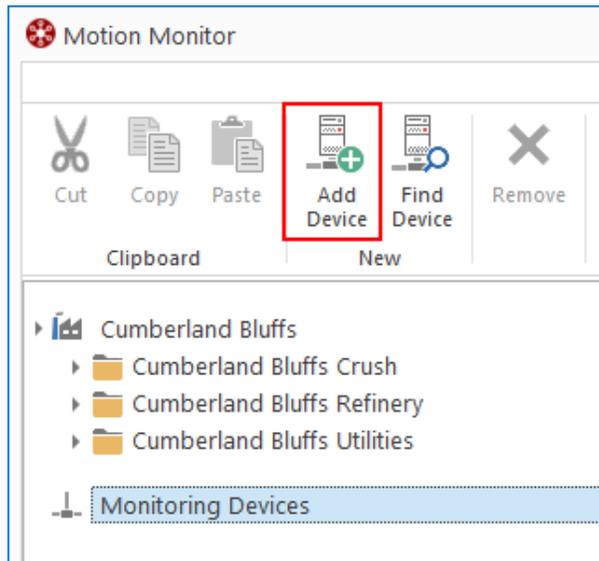


After a device is selected, it will appear under the Monitoring Devices in Motion Monitor as “New Device”. At that point a meaningful name can be provided using the “Rename” button in the ribbon.

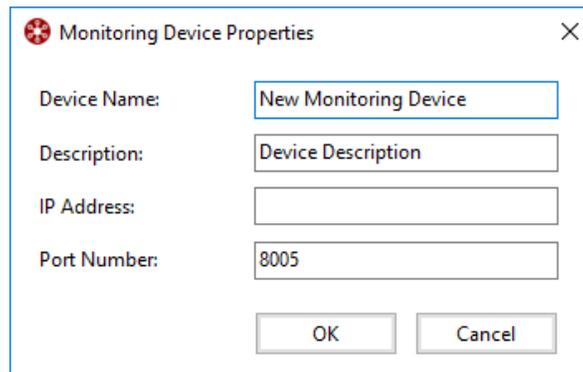


### 7.1.1.2 Manually Adding a Device

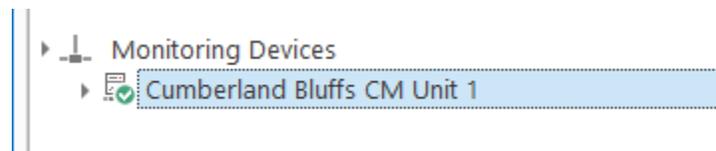
If the IP address of the monitoring device is known, the Add Device button in the ribbon can be used.



A dialog will be displayed that allows the user to enter a name that will be displayed in the hierarchy tree, a description, the IP address, and the port number.

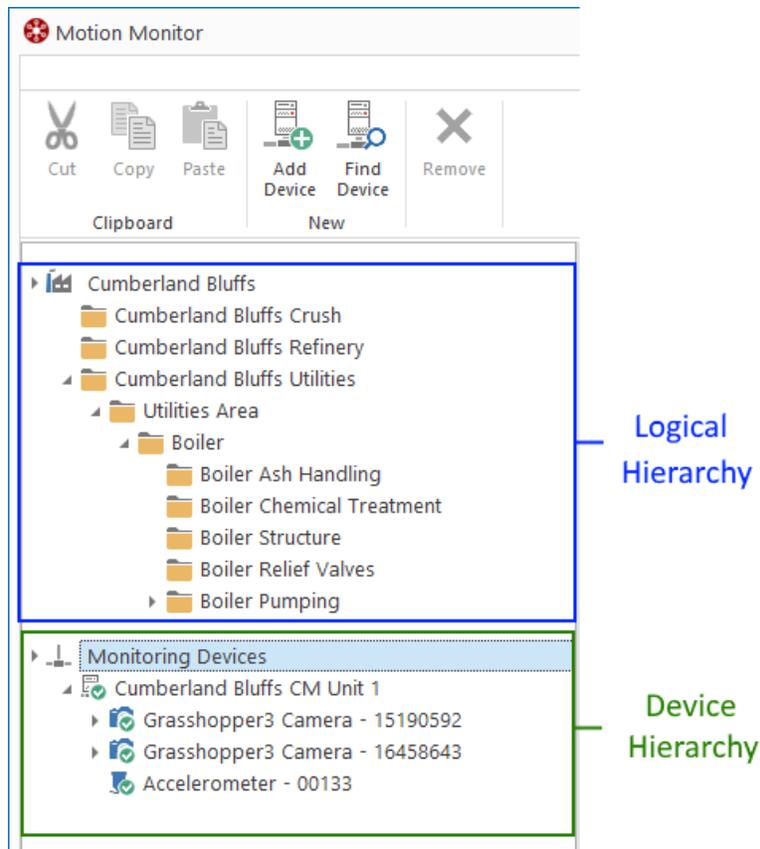


Once the information is provided, the device will be shown in the list of Monitoring Devices in the hierarchy tree.



### 7.1.2 Hierarchy Tree

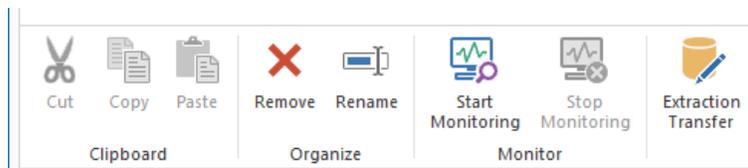
The hierarchy tree is divided into two sections: device and logical. The device hierarchy contains monitoring devices and their connected cameras and accelerometers. The logical hierarchy contains the folders and assets representing the organization of the facility. The logical hierarchy is the same as what is seen in Motion Explorer. Cameras can be associated with assets, and the purpose of this association is so that data collected is organized under the appropriate asset during analysis.



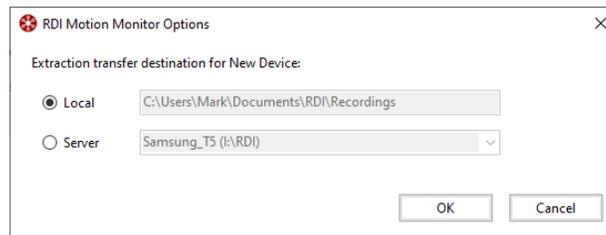
### 7.1.3 Device Hierarchy

#### 7.1.3.1 Monitoring Devices

One or more monitoring devices may be added to the device hierarchy. When a monitoring device is selected in the hierarchy, the ribbon allows the user to perform the following options:



- Remove: This option removes the device from the hierarchy.
- Rename: This option allows the user to change the name of the current device as seen in Motion Monitor.
- Start Monitoring: This option is discussed in Section 7.2.
- Stop Monitoring: After monitoring has been started, this option may be used to stop monitoring.
- Extraction Transfer: This option allows the user to specify if extractions will be transferred to the client computer or to an external drive connected to the monitoring device. If the network connection between the client computer and the monitoring device is slow, it may be faster to transfer extractions to an external drive connected to the server and then import them into the client computer. The import option is available via the ribbon when the company node in the logical hierarchy is selected.

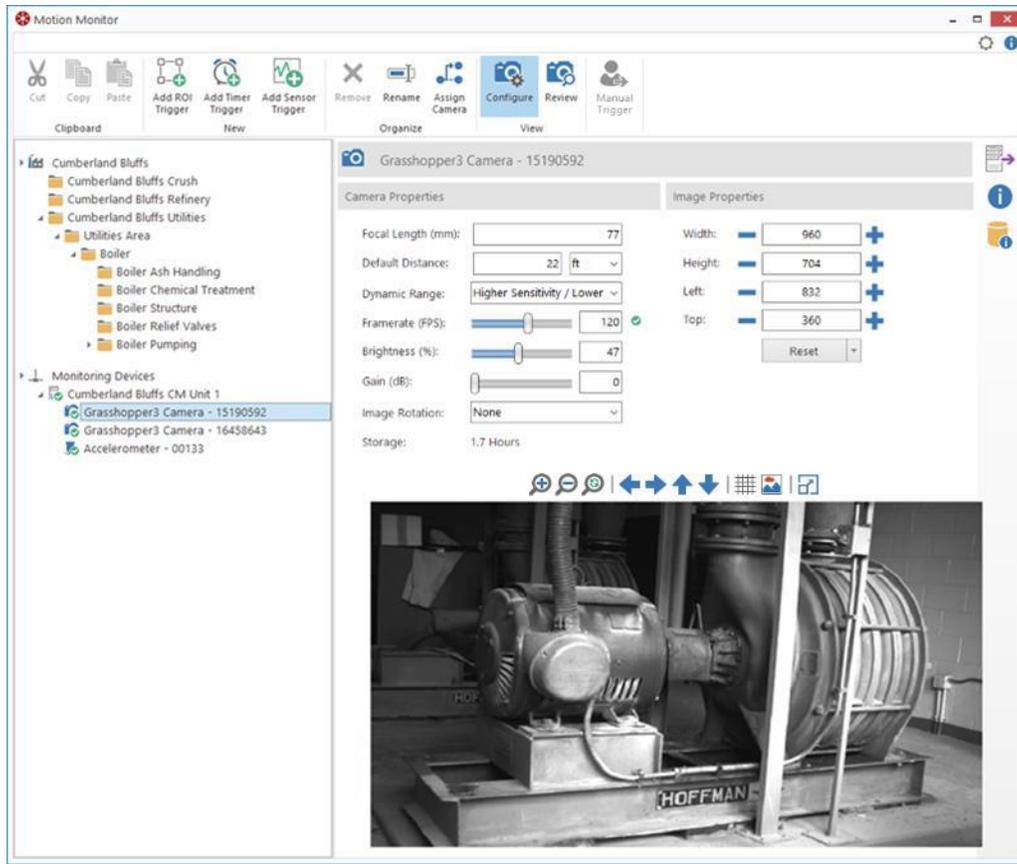


### 7.1.3.2 Cameras

Each monitoring device may support up to 3 monitoring cameras. When a camera is selected in the hierarchy tree, its current configuration properties are displayed in the right pane of the application.

The following properties are available for configuration:

- Focal length
- Default distance
- Dynamic range
  - The available options here are “Higher Sensitivity / Lower Framerate” and “Lower Sensitivity / Higher Framerate”. The higher sensitivity option will result in slightly higher quality motion amplification in some cases.
- Framerate
- Brightness
- Gain
- Image Rotation
- Storage
  - Important: This is the amount of time that the system can collect data for the current camera before it starts being overwritten. For example, by default the system can store 90 minutes of data per camera.
- Width/Height/Left/Top
  - This is the portion of the camera’s full frame view that will be recorded when the system is monitoring.
  - These values may also be specified graphically by drawing a box with the left mouse button in the camera’s field of view. The coordinates of the drawn box are used to populate these fields.



### 7.1.3.3 Accelerometers

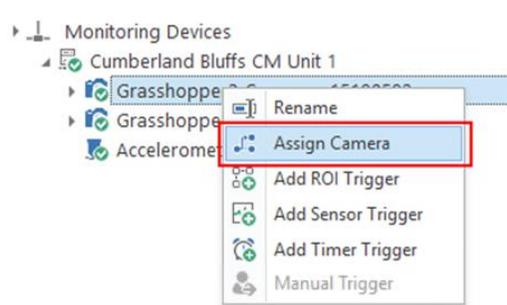
The Iris CM system also includes multiple USB accelerometers. When connected to the monitoring device, the accelerometers are displayed under the monitoring device to which they are connected.

## 7.1.4 Logical Hierarchy

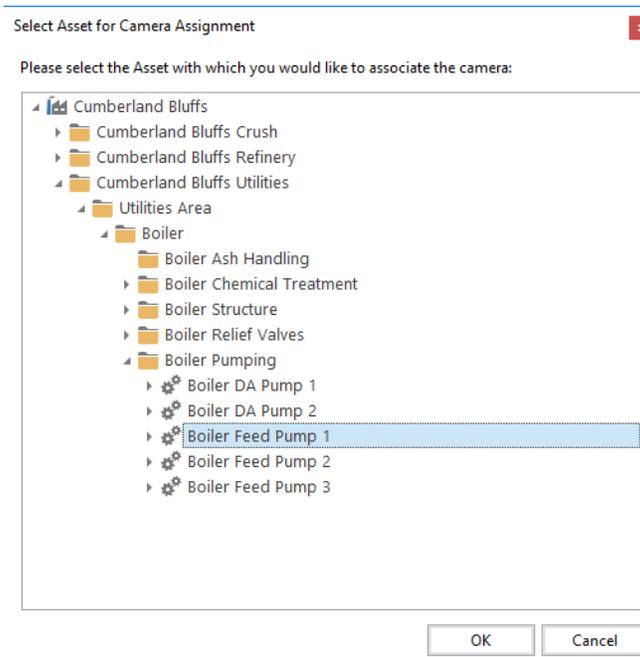
The logical hierarchy generally matches what is shown in Motion Explorer. Motion Monitor shows the same folders and assets that are displayed in Motion Explorer. Motion Monitor does not display the Collections in the hierarchy. The purpose of Motion Monitor's logical hierarchy is to allow the user to associate cameras with assets. When data is collected by the monitoring system and transferred to the client computer, the data is organized under the appropriate asset. Collections are created as necessary to store the collected data under the appropriate asset, and these collections are named using the current date.

### 7.1.4.1 Assigning a Camera

When a camera is selected in the device hierarchy, the user has an option in the ribbon and the context menu to assign that camera to an asset.



Selecting the asset of interest in the logical hierarchy will associate the camera of interest with that asset.

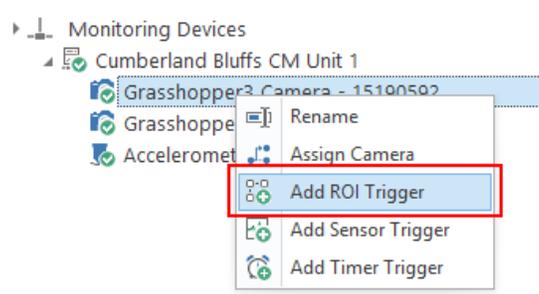


## 7.1.5 Triggers

Triggers are an important part of the Iris CM system. They allow the user to specify conditions when data will automatically be saved for permanent storage. When data is saved for permanent storage, it is first copied to temporary storage on the monitoring device. This copy of the data is referred to as an extraction. At this point the extraction is waiting to be transferred to the client computer. When the motion monitor application is connected to the monitoring device, the extractions can be transferred to the client computer. If no triggers are specified, data must be manually extracted before it is overwritten in the monitoring device. Once an extraction is transferred to the client computer, it is automatically deleted from the server.

### 7.1.5.1 ROI Triggers

ROI triggers allow the user to set a trigger level for displacement values calculated from an ROI defined within the camera's field of view. Select Add ROI Trigger from the ribbon or context menu to add a new trigger. A maximum of 6 ROI triggers per monitoring device are supported.



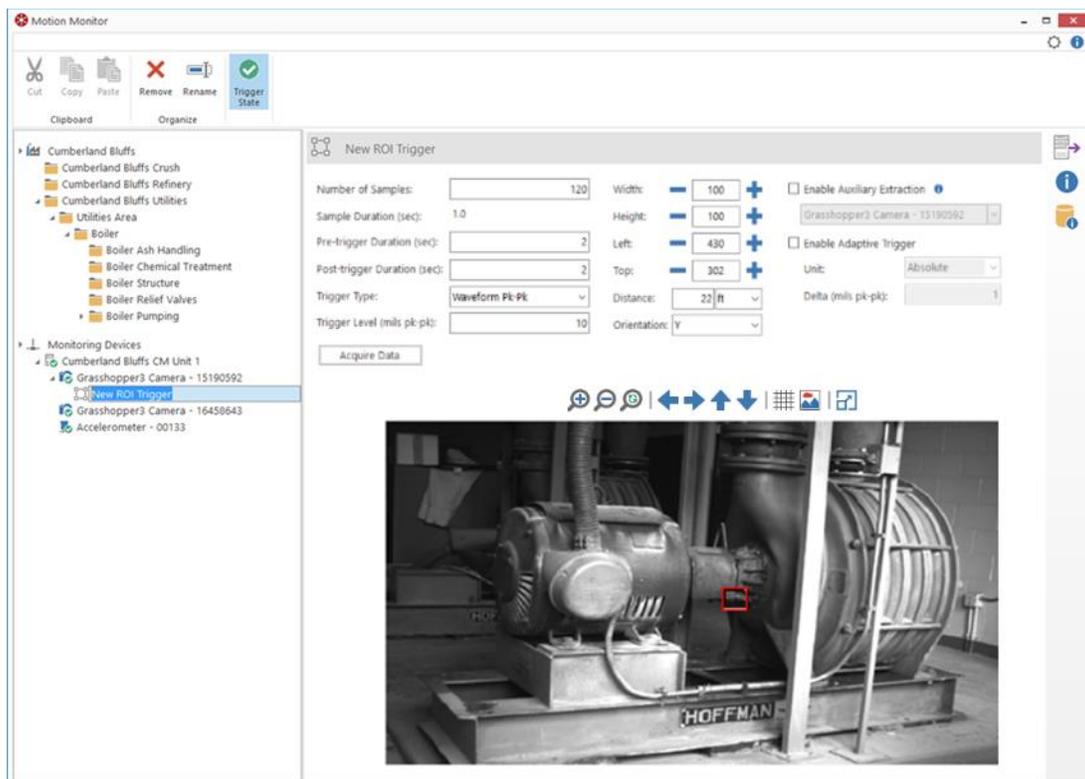
After adding an ROI trigger, a new item will be displayed under the current camera, and this trigger will be selected. Renaming the trigger's default name can help with organization. The trigger's properties will be displayed in the right pane. The following properties are available:

- Number of Samples: Number of samples to be collected
- Sample Duration (sec): Read only field showing the duration of the waveform when the specified number of samples is collected at the current framerate of the camera
- Pre-trigger Duration (sec): When the trigger event is evaluated to be true, the pre-trigger duration will be included in the resulting recording.
- Post-Trigger Duration (sec): When the trigger event is evaluated to be true, the post-trigger duration will be included in the resulting recording.
- Trigger Type
  - Waveform Pk-Pk: When this option is chosen, the trigger will be evaluated as true when the waveform pk-pk level meets or exceeds the specified trigger level.
  - Spectrum Digital Overall: When this option is chosen, the collected displacement waveform data will be used to construct velocity spectra. The trigger will be evaluated as true when the digital overall value calculated from the spectrum meets or exceeds the specified trigger level.
  - Spectrum Frequency Band: When this option is chosen, the collected displacement waveform data will be used to construct velocity spectra. The trigger will be evaluated as true when the amplitude calculated for the specified frequency band meets or exceeds the specified trigger level.
- Trigger Level: This is pk-pk level of the displacement waveform that will cause the trigger to be evaluated as true.
- Low(Hz): When Spectrum Frequency Band is specified, this property is displayed, and it allows the user to specify the minimum frequency used to calculate the amplitude in a frequency band.
- High(Hz): When Spectrum Frequency Band is specified, this property is displayed, and it allows the user to specify the maximum frequency used to calculate the amplitude in a frequency band.
- Width/Height/Left/Top: The location and size of the ROI trigger. The user may also graphically define the ROI location by drawing a box with the mouse.
- Distance: This is the distance that will be applied to the calculations for this ROI trigger.
- Orientation: The trigger can evaluate the displacement in the X direction or the Y direction. The user must specify the orientation of the displacement to be evaluated.

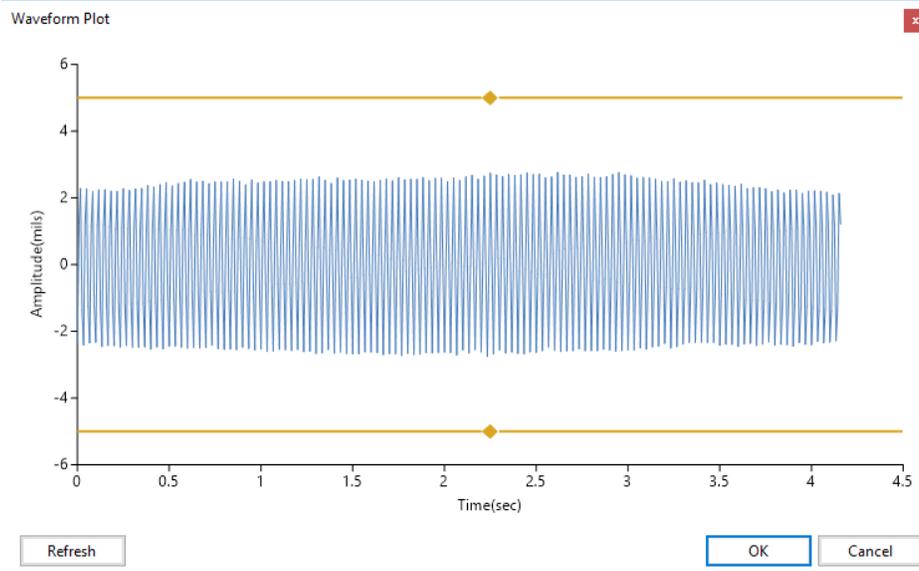
- **Enable Auxiliary Extraction:** If this option is enabled, when the trigger is evaluated as true data will not only be extracted for the current camera but also for any cameras selected in the list. The same time span will be extracted for all cameras.



- **Enable Adaptive Trigger:** This check box determines if the trigger will enable “Adaptive” logic. This logic allows the trigger to raise its trigger level by a delta value when the trigger level is evaluated as true. This helps prevent repeated true evaluations of the trigger when the displacement remains above the specified trigger level. If an elevated trigger level is evaluated as true, the level is again increased by the adaptive delta. This process continues.
  - **Unit:** This allows the user to specify the adaptive delta value in either absolute terms or in percentage terms. Percentage terms are applied to the originally specified trigger level.
  - **Adaptive Delta:** The delta value is the step change that is applied as the trigger level in change adaptively.
- **Trigger State:** This read only field indicates the current state of the trigger. The trigger state (enabled/disabled) can be changed via the ribbon or context menu.

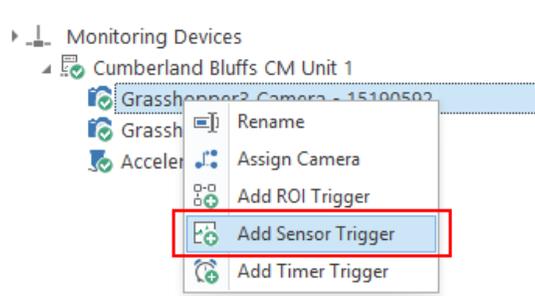


When the user presses the Display Waveform button, a waveform will be collected with the specified parameters. The trigger level is indicated on the plot. The level indicator can be dragged with the mouse to adjust the level in this dialog.



### 7.1.5.2 Sensor Triggers

Sensor triggers allow the user to set a trigger level for either waveform pk-pk values collected with the USB accelerometer (units of g's) or for the spectrum digital overall calculated from the collected waveform (units of in/sec pk or mm/sec rms). Select Add Sensor Trigger from the ribbon or context menu to add a new trigger. A maximum of 6 sensor triggers per monitoring device are supported.

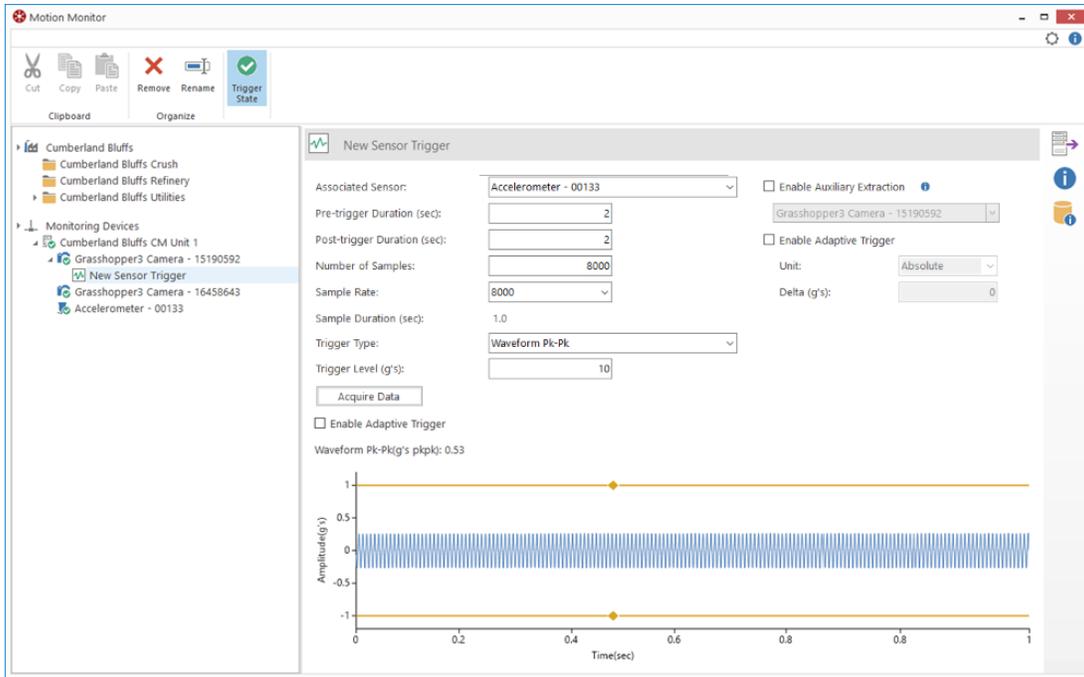


After adding a sensor trigger, a new item will be displayed under the current camera, and this trigger will be selected. Renaming the default trigger name to something relating to the monitoring asset or asset component would help associate the triggers with the related recordings. The trigger's properties will be displayed in the right pane. The following properties are available:

- Associate Sensor: Select the connected sensor that is to be used for this trigger. **A given sensor can only be used for one sensor trigger.**
- Pre-trigger Duration (sec): When the trigger event is evaluated to be true, the pre-trigger duration will be included in the resulting recording.
- Post-Trigger Duration (sec): When the trigger event is evaluated to be true, the post-trigger duration will be included in the resulting recording.
- Trigger Type: Specify either Waveform Pk-Pk, Spectrum Digital Overall, or Spectrum Frequency Band.
- Trigger Level

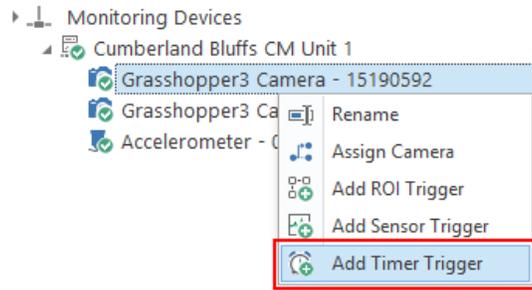
- Waveform Pk-Pk: This is pk-pk level of the acceleration waveform that will cause the trigger to be evaluated as true.
- Spectrum Digital Overall: The collected acceleration waveform data will be used to construct velocity spectra. The digital overall will be calculated for the velocity spectra. Units for the digital overall are in/sec Pk for the Imperial unit system and mm/sec rms for the metric unit system.
- Spectrum Frequency Band: The collected acceleration waveform data will be used to construct velocity spectra. The trigger will be evaluated as true when the amplitude calculated for the specified frequency band meets or exceeds the specified trigger level.
- Low(Hz): When Spectrum Frequency Band is specified, this property is displayed, and it allows the user to specify the minimum frequency used to calculate the amplitude in a frequency band.
- High(Hz): When Spectrum Frequency Band is specified, this property is displayed, and it allows the user to specify the maximum frequency used to calculate the amplitude in a frequency band.
- Number of Samples: Number of samples to be collected
- Sample Rate: The rate at which the accelerometer will perform its sampling.
- Sample Duration (sec): Read only field showing the duration of the waveform when the specified number of samples is collected at the current framerate of the camera
- Trigger State: This read only field indicates the current state of the trigger. The trigger state (enabled/disabled) can be changed via the ribbon or context menu.
- Enable Adaptive Trigger: This check box determines if the trigger will enable “Adaptive” logic. This logic allows the trigger to raise its trigger level by a delta value when the trigger level is evaluated as true. This helps prevent repeated true evaluations of the trigger when the displacement remains above the specified trigger level. If an elevated trigger level is evaluated as true, the level is again increased by the adaptive delta. This process continues.
  - Unit: This allows the user to specify the adaptive delta value in either absolute terms or in percentage terms. Percentage terms are applied to the originally specified trigger level.
  - Adaptive Delta: The delta value applied to the original trigger level.
- Enable Auxiliary Extraction: If this option is enabled, when the trigger is evaluated as true, data will not only be extracted for the current camera but also for any cameras selected in the list. The same time span will be extracted for all cameras.



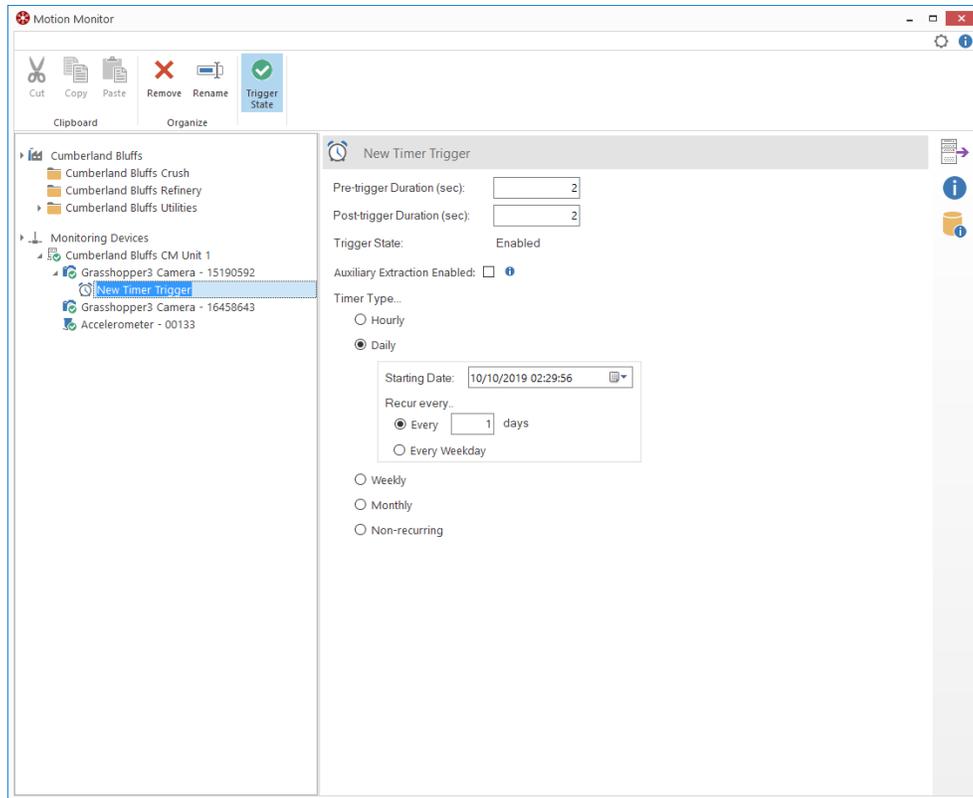


### 7.1.5.3 Timer Triggers

Timer triggers allow the user to schedule when extractions occur. Select Add Timer Trigger from the ribbon or context menu to add a new trigger.



After adding a timer trigger a new item will be displayed under the current camera, and this trigger will be selected. Renaming the default trigger name to something relating to the monitoring asset or asset component would help associate the triggers with the related recordings. The trigger's properties will be displayed in the right pane.



The following properties are available:

- Pre-trigger Duration (sec): When the trigger event is evaluated to be true, the pre-trigger duration will be included in the resulting recording.
- Post-Trigger Duration (sec): When the trigger event is evaluated to be true, the post-trigger duration will be included in the resulting recording.
- Trigger State: This read only field indicates the current state of the trigger. The trigger state (enabled/disabled) can be changed via the ribbon or context menu.
- Enable Auxiliary Extraction: If this option is enabled, when the trigger is evaluated as true data will not only be extracted for the current camera but also for any cameras selected in the list. The same time span will be extracted for all cameras.



- Timer Type
  - Hourly: Allows the user to specify the duration at which the timer will be evaluated as true. The timer begins when monitoring is started. In the instance below, it would extract a recording 1 hour after monitoring begins, 2 hours after monitoring begins, etc.

Recur every..

Number of Hours:

Number of Minutes:

Number of Seconds:

- Daily: The user may specify a starting date/time and the interval at which the trigger will be evaluated as true.

Starting Date:

Recur every..

Every  days

Every Weekday

- Weekly: The user may specify a starting date/time, the number of weeks between trigger evaluation, and the days of the week that the trigger will be evaluated.

Starting Date:

Recur every  weeks

Sunday

Monday

Tuesday

Wednesday

Thursday

Friday

Saturday

- Monthly: The user may specify a starting date/time. The day of the month that the trigger should be evaluated to true is also specified. The repeat duration is also available.

Starting Date:

Recur every..

Day of Month:

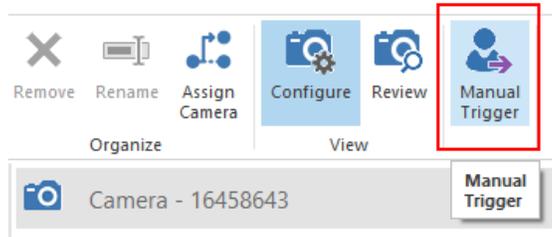
Every  month(s)

- Non-recurring: This is a one-time use trigger where it will evaluate to as true at the specified date/time and will not repeat.

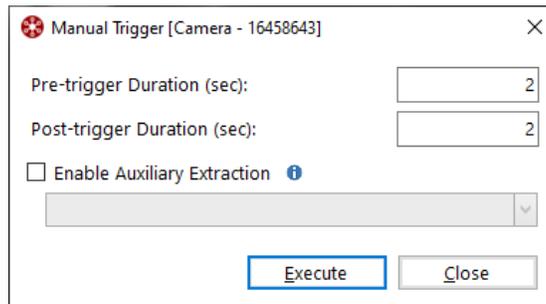
Trigger Date:

#### 7.1.5.4 Manual Triggers

During a monitoring session, the user can request an immediate extraction at any time. With a camera selected in the hierarchy, select the Manual Trigger item in the ribbon.

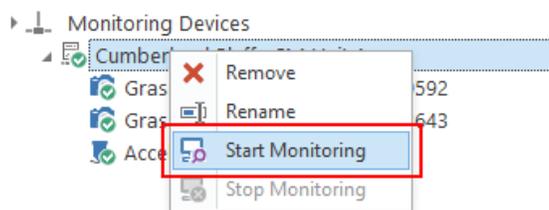


After the Manual Trigger item is selected, the dialog shown below is displayed. The user can specify a pre and a post trigger duration. If more than one camera is connected to the system, an auxiliary extraction can also be configured such that the data from multiple cameras is extracted for the specified duration.



## 7.2 Monitoring

Once the cameras and triggers are configured, the user can start monitoring via a ribbon or context menu option. Once monitoring is started for a given monitoring device, no configuration changes can be made. Monitoring must be stopped in order to reconfigure the monitoring device of interest.



Once monitoring is started, the green check marks next to the monitoring device and cameras will change to a purple magnifying glass.

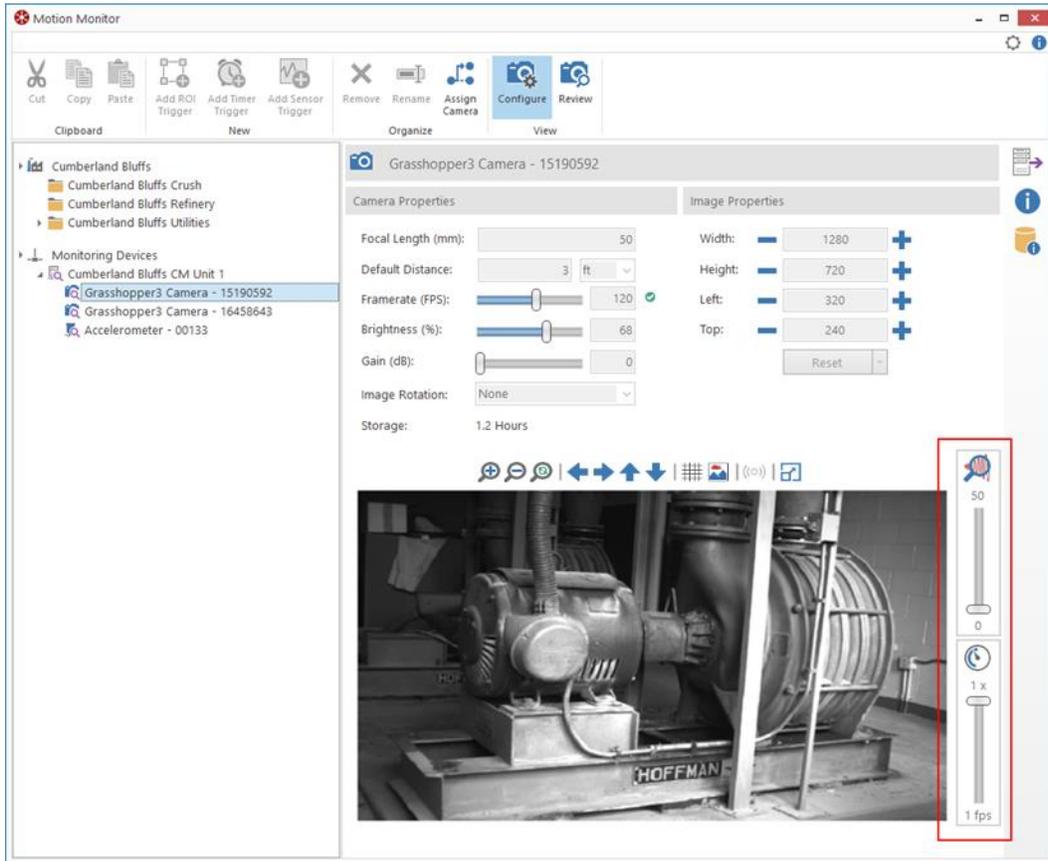


**Important:** When monitoring is started, data stored on the acquisition device from the previous monitoring session will be deleted, but extractions that have not yet been transferred will not be deleted.

### 7.2.1 Live Motion Amplification

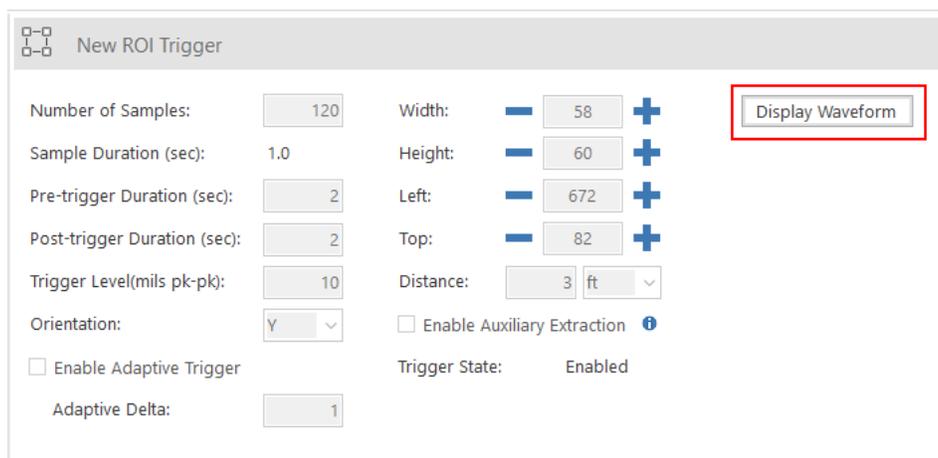
Once monitoring is started, two additional input controls are available on the Configure display. One is for Amplification Factor and one is for Playback speed. Increasing the amplification factor will perform live

motion amplification on the displayed camera feed. Decreasing the playback speed slider will slow down the amplified feed, which is often necessary to see the motion of interest.



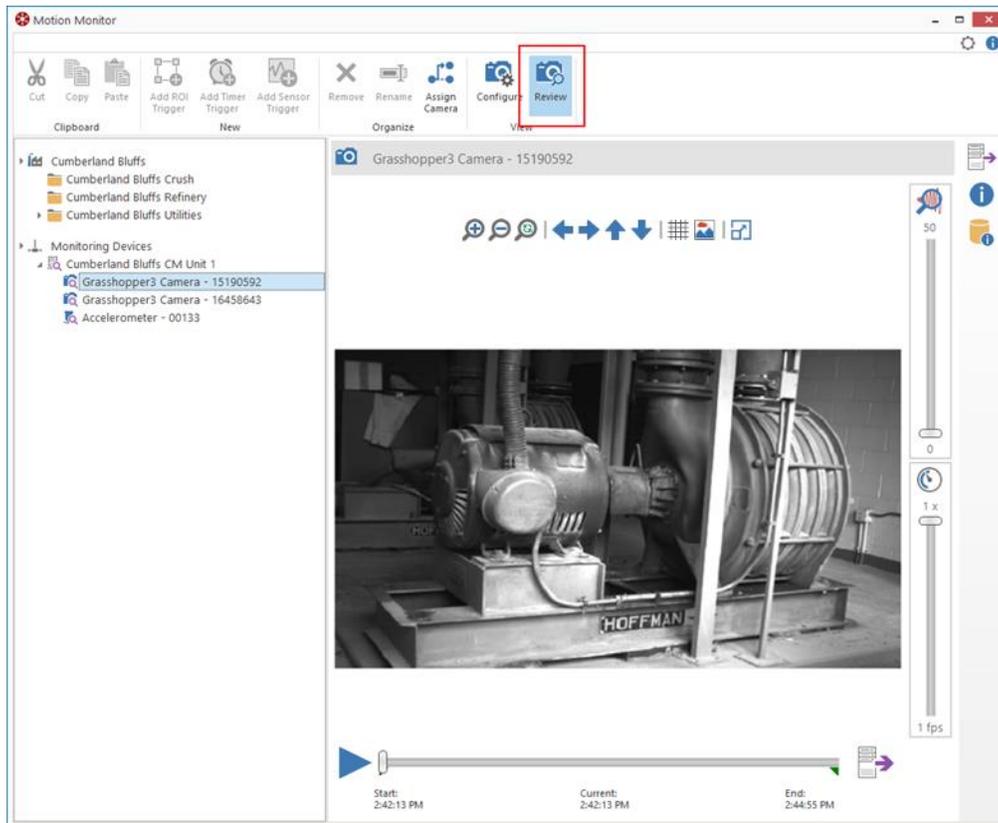
### 7.2.2 ROI Trigger Waveform

Once monitoring is active, the user can still collect and display waveform data for defined ROI triggers.



## 7.3 Review Collected Data

After monitoring has started, the Review tab available in the ribbon will allow the user to review the data that has been stored for the current camera. After monitoring is stopped, this data will be available until monitoring is restarted. The playback indicator at the bottom of the screen will show the available range of data. The user can play or move to a certain position of interest by clicking on the playback span.

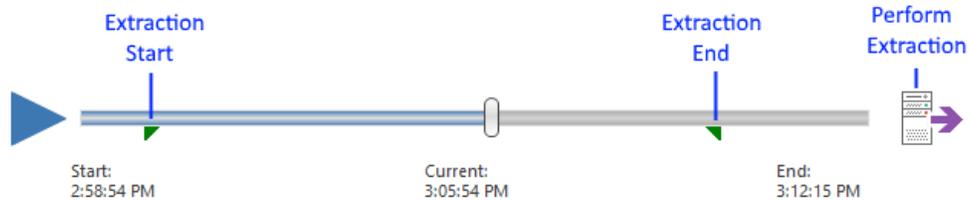


### 7.3.1 Motion Amplification

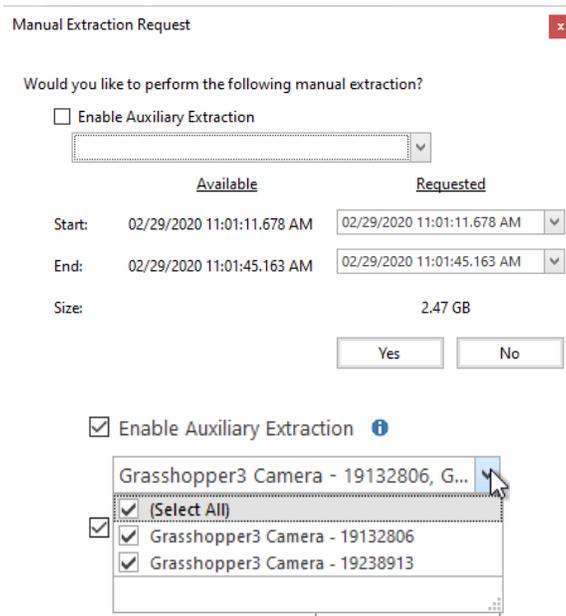
While reviewing the data on the device, the user may perform motion amplification on the data that is being reviewed. The amplification factor and playback speed may be adjusted with the sliders on the right side of the window.

### 7.3.2 Manual Extraction

Manual extraction is another way (in addition to triggers) that may be used to extract data from the acquisition device to the client computer. The user may either drag the green triangles to the desired locations or right click on the playback position indicator and set that location as either the start or end location for the extraction. Once the start and end times are appropriately set, the Perform Extraction button will display a confirmation dialog before the extraction is initiated. The length of the specified span is proportional to the time that it takes to transfer the extraction from the monitoring device to the client computer.

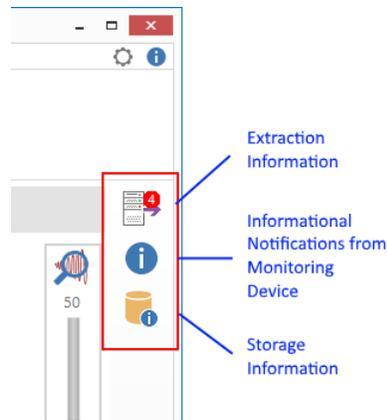


The Manual Extraction Request dialog displays the start and end times for the extraction request, and these times can be modified. If multiple cameras are connected to the system, the user can request that data from all of the cameras be extracted for the same time range by selecting Enable Auxiliary Extraction. The extraction is initiated via the “Yes” button.



## 7.4 Managing Extractions

The collapsible pane on the right side of the Motion Monitor application provides access to important information related to extracting data from the monitoring device. It includes information about extractions available, transfers in progress, and completed extractions. There is also an information area where notifications are passed from the monitoring device to the client computer. Storage information for the connected monitoring devices and the client computer is also available.



### 7.4.1 Extractions

The extraction information contains entries for pending, available, transferring, and completed extractions.

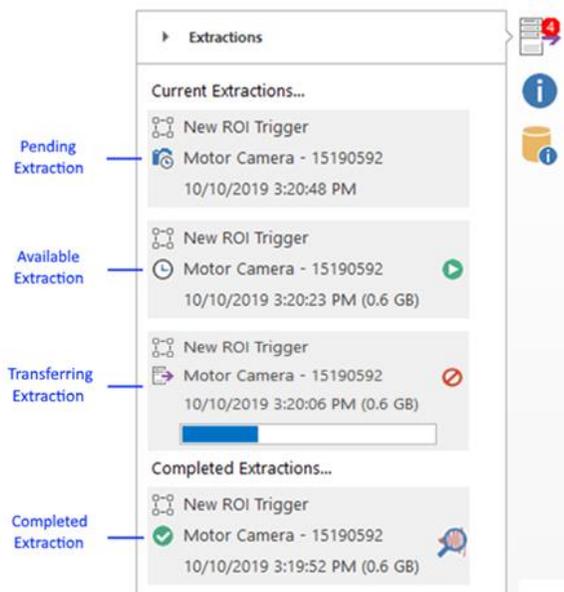
Pending extractions have been triggered, but their post duration condition has not been met. So they are not yet available for transfer.

Available extractions are on the monitoring device and available to be transferred to the client computer. The green button will start the transfer of an available extraction

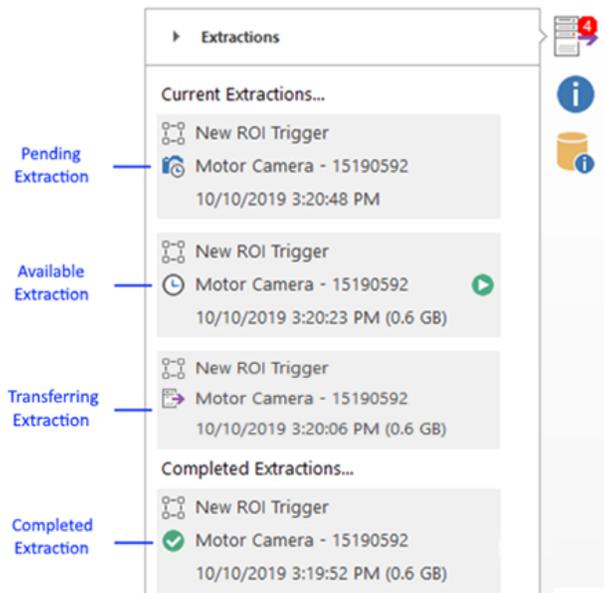
Only one extraction can be transferred at a time. It has a progress bar to estimate how long the transfer will take to complete. There is also a cancel button to stop the transfer. Additional extractions will be queued for transfer.

Once an extraction has been transferred it is moved to the completed group. The Motion Amplification button will result in the transferred recording being launched in the Motion Amplification application.

If the application is closed during the transfer of an extraction, the partially transferred file will be deleted from the client and the next time the client is run this extraction will again appear as available for transfer.

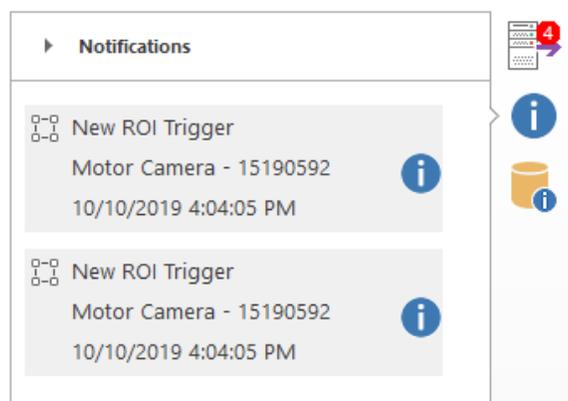


When the extraction destination is external drive connected to the monitoring device, the extraction workflow is slightly different. When an extraction is being transferred, there is a progress indicator shown as the server performs the file transfer. In addition, after the transfer is complete the button to launch the recording in Motion Amplification is not available.



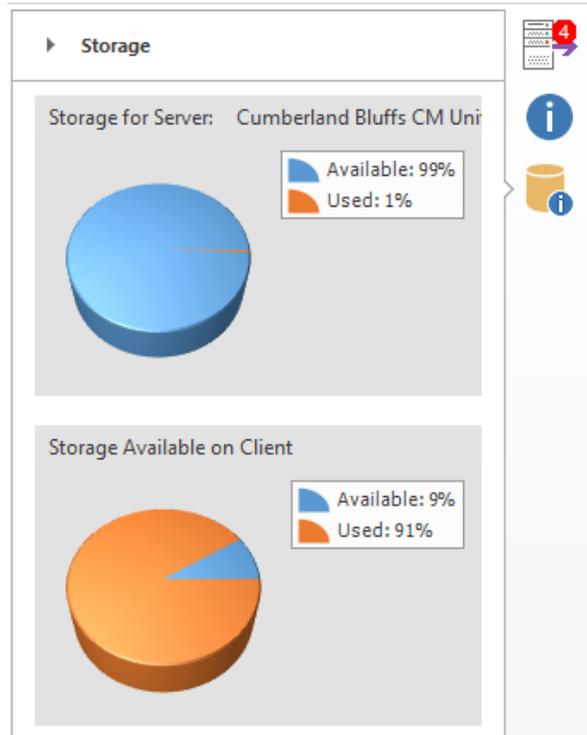
### 7.4.2 Notifications

There are various notifications that the monitoring device may send to the client computer. These include messages indicating that the monitoring device is out of storage. Notifications indicating that there is a problem with a certain ROI trigger can also be sent. Pressing the “i” button next to the entry will display the message to the user.



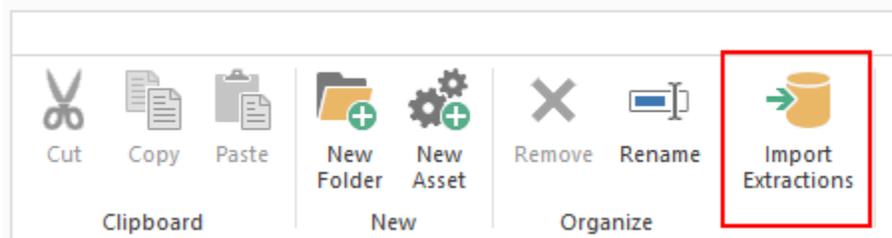
### 7.4.3 Storage

The storage information section will give storage information for the connected monitoring device(s) and the client computer. When a monitoring device’s storage is full, there is no space to store additional extractions before they are transferred to the client computer. If the client computer’s storage is full, there will be no more space to transfer extractions from the monitoring device to the client computer.

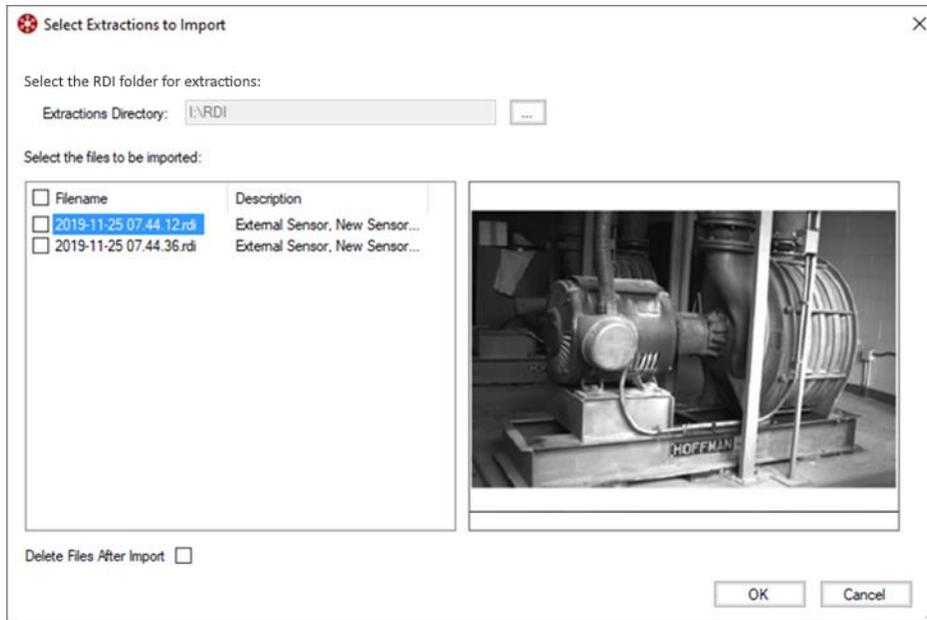


#### 7.4.4 Import Extractions

When extractions have been exported to an external drive attached to the monitoring device, they may be imported to the client computer. To import extractions, the external drive must first be detached from the monitoring device. Then, the external drive must be connected to the client computer. Then, **with the company level of the hierarchy selected** the Import Extractions item in the ribbon should be selected.

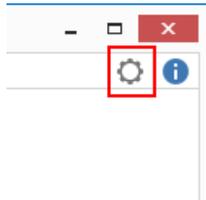


Once the Import Extractions option has been selected, a dialog will be displayed that allows the user to specify the directory from which extractions are to be imported. This will likely be the external drive that has been disconnected from the acquisition device and connected to the client computer. In addition, the user must select the files in the list which are to be imported. There is also an option to delete files after they are imported. Once the OK button is pressed, the selected files will be imported into the RDI hierarchy database on the client computer. They will then be available for analysis.



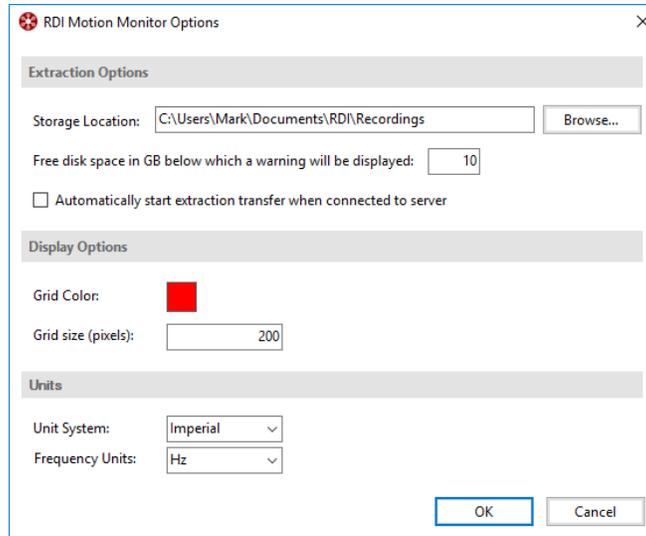
## 7.5 User Preferences

Motion Monitor's user preferences can be accessed from the gear icon in the upper right of the main window.



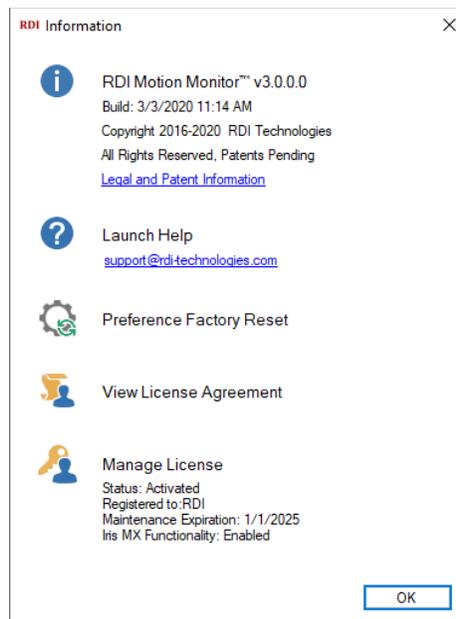
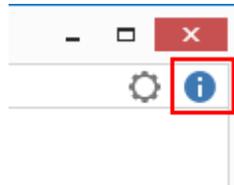
The options in the user preferences dialog include the following:

- Extraction Options
  - Storage Location: This option controls where the data transferred from the monitoring device to the client computer are stored.
  - Free disk warning limit: When the available client computer storage is below this limit a warning will be displayed.
  - Automatically transfer extractions: This option determines whether the software will automatically start transferring available extractions when the application is started or when one becomes available.
- Display Options
  - Grid Color: Specifies the color of the grid lines
  - Grid Size: Specifies the size of the grid squares in pixels
- Units
  - Unit System: Choose Imperial or Metric
  - Frequency Units: Choose Hz or CPM



## 7.6 Application Information

In the upper right corner of the Motion Monitor application is an Information button. Press this button to access information about the application, help, view the license agreement, and access license information.



## 8 Specification

<b>Specification</b>	
<b>Motion Amplification™</b>	
Available Lens	6mm, 12mm, 25mm, 50mm, 100mm
Acquisition System	i7 processor, 16GB RAM, 500GB SSD, dual batteries, lightweight, MIL-STD-810G standard drop protection, 3 yr accidental damage protection
Iris M Sample Rate	120/100 fps default, up to 1,300 fps at reduced resolution
Iris M Frequency Range	US: Up to 3,600 cpm @ 120 fps default Int: Up to 3,000 cpm @ 100 fps default Maximum: 39,000 cpm @ 1,300 fps with reduced resolution
Iris MX Sample Rate	1,400 fps default, up to 29,000 fps at reduced resolution
Iris MX Frequency Range	Up to 42,000 cpm @ 1,400 fps default Maximum: 870,000 cpm @ 29,000 fps with reduced resolution
Iris CM Sample Rate	120 fps default, up to 1,300 fps at reduced resolution
Iris CM Frequency Range	US: Up to 3,600 cpm @ 120 fps default Int: Up to 3,000 cpm @ 100 fps default Maximum: 39,000 cpm @ 1,300 fps with reduced resolution
Minimum Displacement	< 0.01 mil (2.5 µm) at 3.3 ft (1m) with 50mm lens at max brightness
Motion Amplification Factor	1-500x
Vibration Pads	95% impulse absorption
Tripod	Professional Grade with pistol grip
Case	Watertight, dustproof, crushproof
USB3 Cable Length	16.4 ft. (3 m)
<b>Features</b>	
<b>Motion Amplification™</b>	
Export Format	HD MP4 at 1920x1080 resolution
Video Annotations	Text, shape and annotations overlays with export to video
Playback/ Export Video Speeds	4x speed to 1/framerate
Grid Overlay	Configurable grid overlay (size, color)
Export Options	Side-by-side playback of original and amplified video or amplified video Only
Logo Export	Ability to overlay custom logo onto exported videos
Image Zoom	Exported video shows only zoomed region

## 9 Troubleshooting

### Lighting brightens and dims during playback/Motion Amplification.

For indoor recording, check the framerate (fps) during acquisition. If the framerate is set at a frequency other than 2x the line frequency, a beating (beat frequency) between the framerate and lighting may occur.

### Motion Appears across the entire image.

It is possible the camera was shaking during acquisition. Ensure vibration reduction pads were used during acquisition.

### Motions seem too slow or stops when I adjust playback speed of the amplified video.

It is possible to select a playback speed that affects the way the motion appears in the video. This is the classic “Wagon Wheel Effect”. For example, if a motion is at 30 Hz and you select a 30 fps playback, it may appear stopped or without motion. To accommodate this, it is recommended to try multiple playback speeds to see what works best for the specific motion you are trying to illustrate.

For more troubleshooting and general support see the RDI Technology Support page.

<http://www.rdi-technologies.com/support>

## 10 Revision History

Revision	Date	Notes
1.0	September 03, 2016	Initial Release
1.1	December 31, 2016	Displacement and Frequency Added
1.2	January 23, 2017	Displacement and Frequency Updates
1.3	February 27, 2017	Stabilization Added
1.4	April 18, 2017	Orbits Added
1.5	June 9, 2017	Filtering Added
2.1	December 20, 2017	Motion Explorer Added
2.2	April 9, 2018	v2.2 Updates
2.3	August 31, 2018	v2.3 Updates, Motion Studio Added
2.4	December 8, 2018	v2.4 Updates, Iris MX Added
2.5	June 21, 2019	v2.5 Updates
2.6	October 10, 2018	v2.6 Updates, Motion Monitor / Iris CM
2.6.1	November 27, 2019	v2.6.1 Updates
3.0	February 26, 2020	v3.0 Updates

## 11 Index

- Acquisition Mode**, 7, 9
- Annotations, 20, 21, 72, 75, 77, 81
- Aperture Ring**, 5
  - asset, 8
  - bandpass, 48
  - bandstop, 48, 49
- Brightness**, 7, 9, 13
- Calculated Values, 10
- camera, 5, 6, 7, 11
- Camera Properties, 9
- collection, 8, 24, 28, 57, 58, 62, 63, 64, 65, 66, 67, 68, 69, 70
- Collection, 8
  - default setting, 7
- Displacement, 9, 14
- Exporting a Video, 2, 24
- field of view, 5, 14
- Filtering, 3, 70
- $F_{\max}$ , 9, 14, 15
- Focal Length**, 7, 8
- Focus Ring**, 5
- fov. *See* field of view
- Framerate**, 9
- Gain**, 7, 9
  - highpass, 48, 49
  - Image Properties, 10, 14
- Image Toolbar**, 13, 14
- Installation, 6
- Lenses, 5
- License, 17
- line frequency, 6, 15
- lowpass, 48, 49
- Motion Explorer**, 8, 72
- Motion Studio, 3, 6, 64, 72, 73, 80, 82
- Orbit plot, 36
- Recording/Playback Bar, 11
- Region of Interest. *See* ROI
- Ribbon Bar, 64
- ROI, 10, 14
- Settings, 15
- spectrum, 9, 15, 37, 39, 42, 43, 47, 48, 49
- Stabilization, 3, 54
- Toolbar, 11, 20