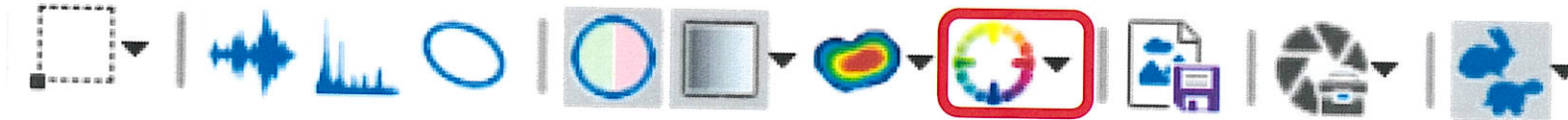


Phase Map

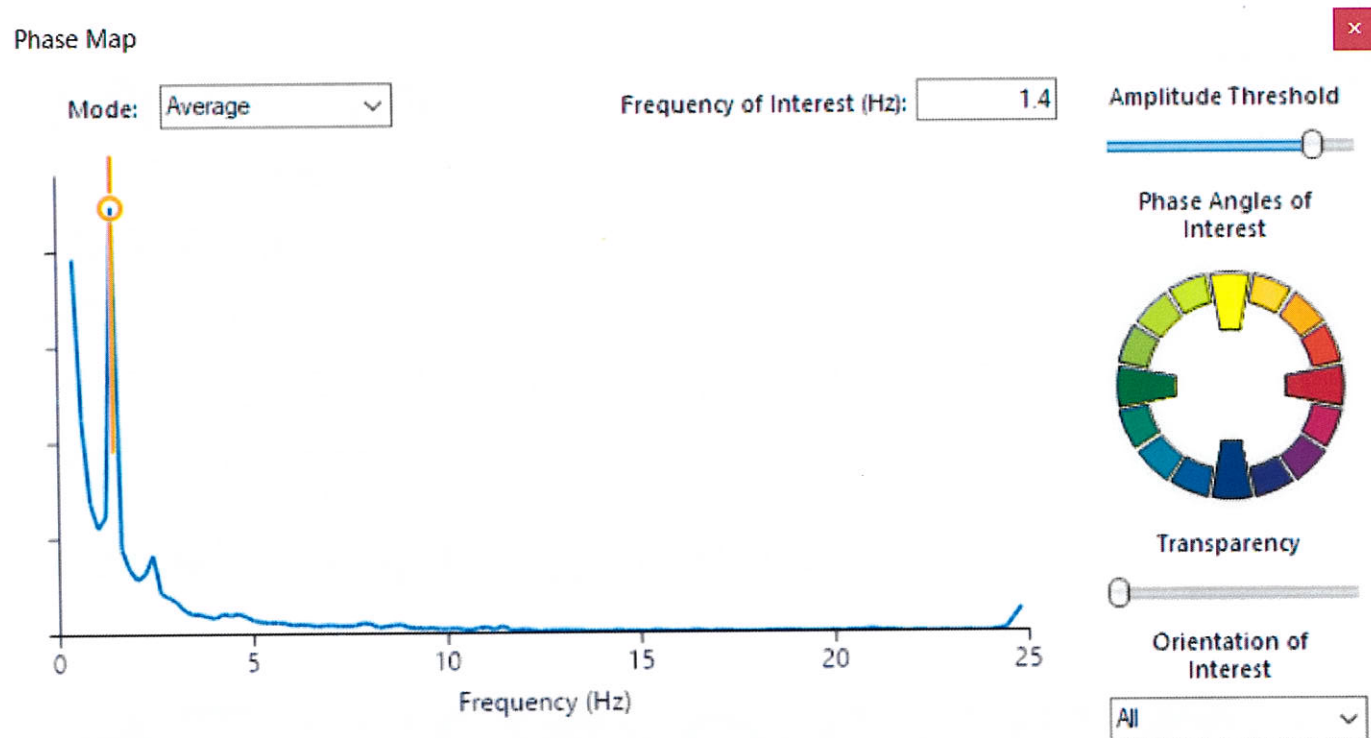
Phase Map - analysis tool, present areas vibrating in phase and out of phase. Especially useful to analyze looseness, deflection and



To enable, click Motion Map button.

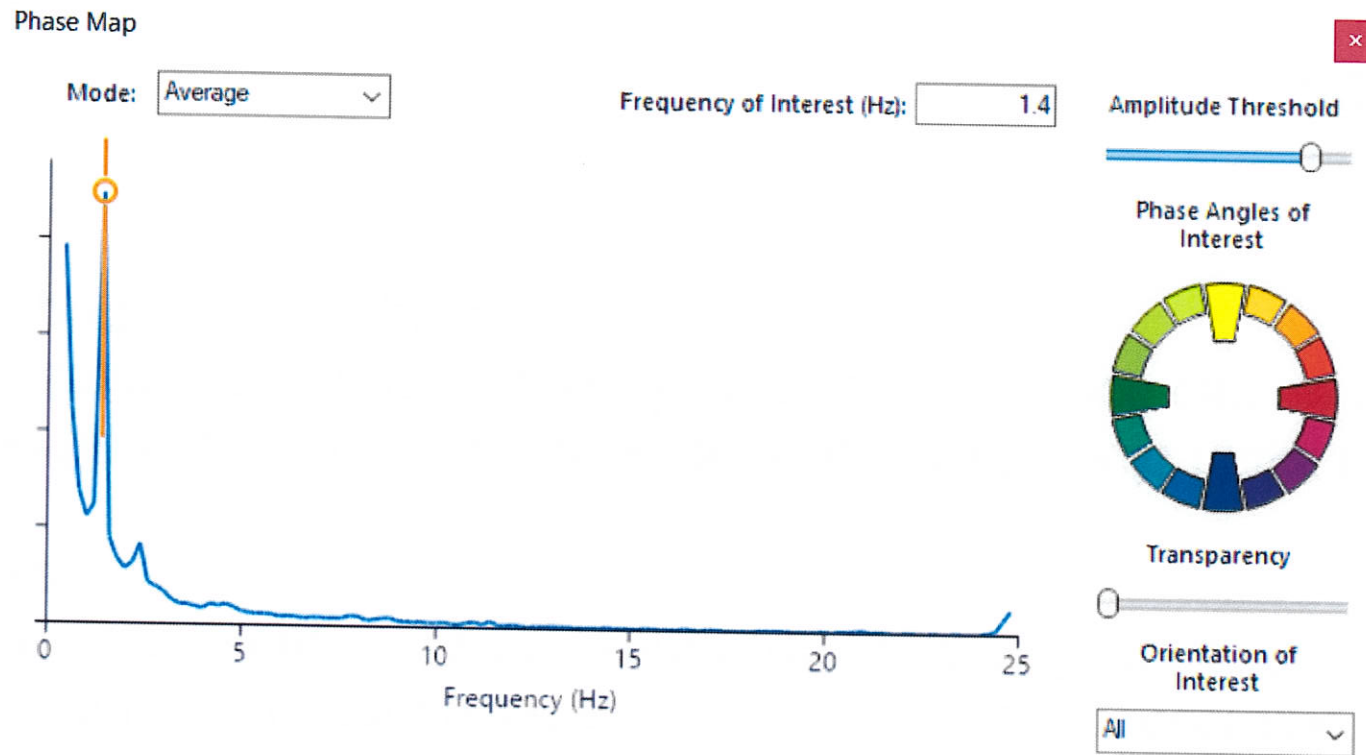
Settings include:

- Display Frequency Specific Motion Contours
- Autoscale
- Color scale
- Transparency scale
- Single Color/Multi color



Peaks in spectrum generated based on combination of two factors:

- Total number of pixels in image that are moving at any given frequency
- Amount of amplitude at any given frequency



Phase analysis of captured object :

- Select frequency of the interest
- Control circle to expose direction of the vibration

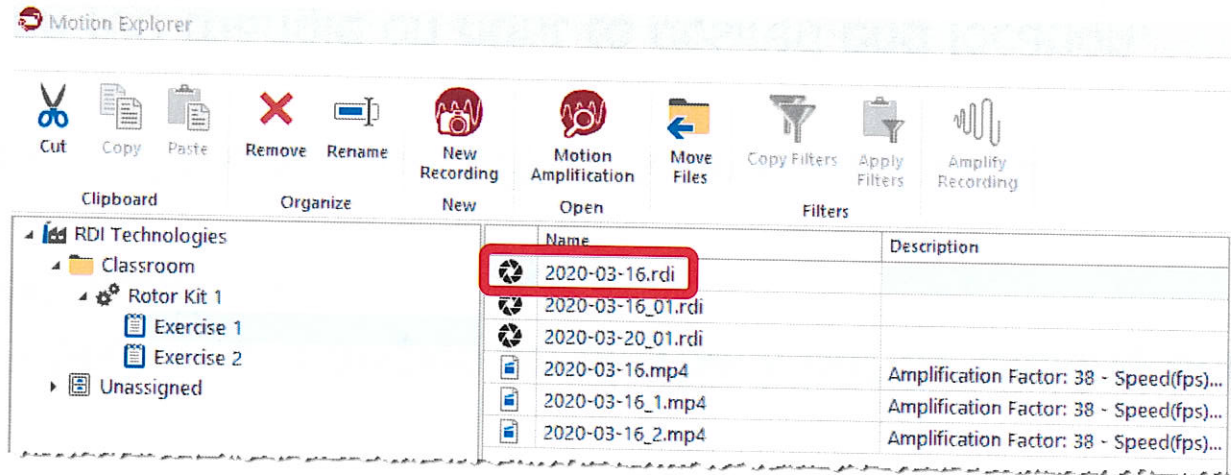
Exercise 13 – Trim/Rotate/Crop a Recording

Motion Amplification allows user to trim, rotate and crop a recording.

Especially helpful when users need to acquire a very long recording in order to capture a transient event and when some components is important to expose it on the picture

Undesired portions of recording can be deleted, which could make file size considerably smaller and easier to work with. Similar action can be done to delete some portion of the picture.

Exercise 13 – Trim/Rotate/Crop a Recording

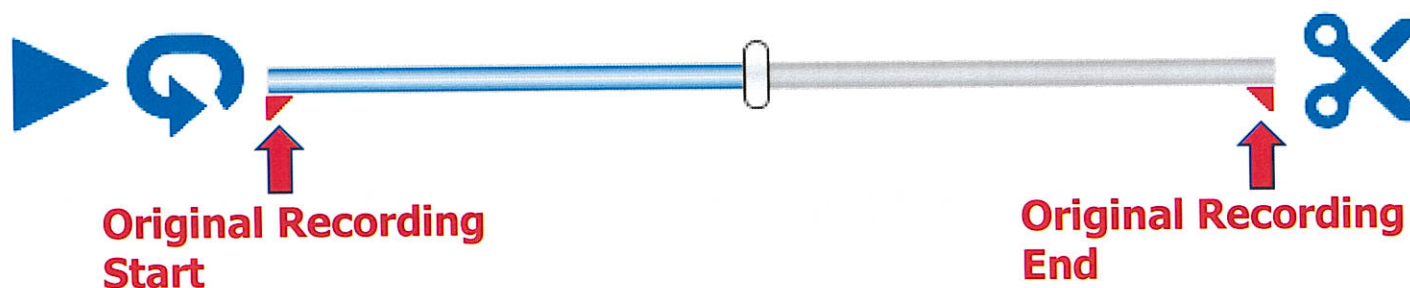


Step 1 – In Motion Explorer, highlight .rdi file and launch Motion Amplification.



Step 2 – Click *Trim Recording* button.

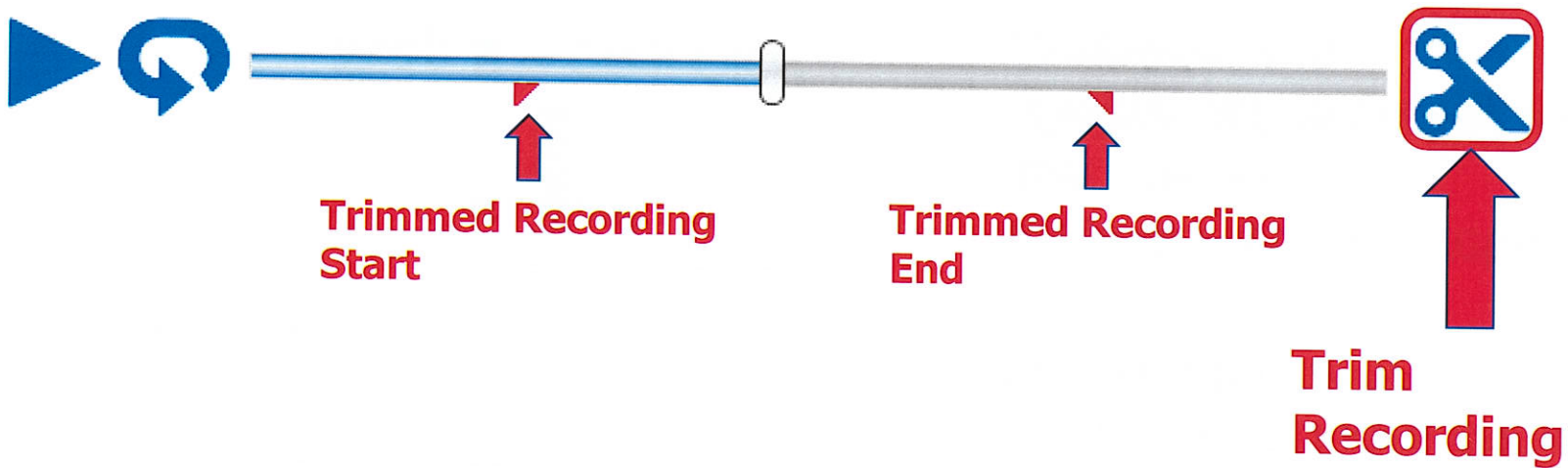
Exercise 13 – Trim/Rotate/Crop a Recording



Step 3 - Slide red triangles on playback bar by clicking and dragging to desired locations.

- Position red triangle on left to desired start location.
- Position red triangle on right to desired end location.

Exercise 13 – Trim/Rotate/Crop a Recording



Step 4 - With Trimmed Start and End markers in place, click ***Trim Recording*** button.

Exercise 13 – Trim/Rotate/Crop a Recording

Trim Recording

Name for trimmed recording:

2019-06-21_trim

Open new recording when complete

Delete old recording when complete

OK

Cancel

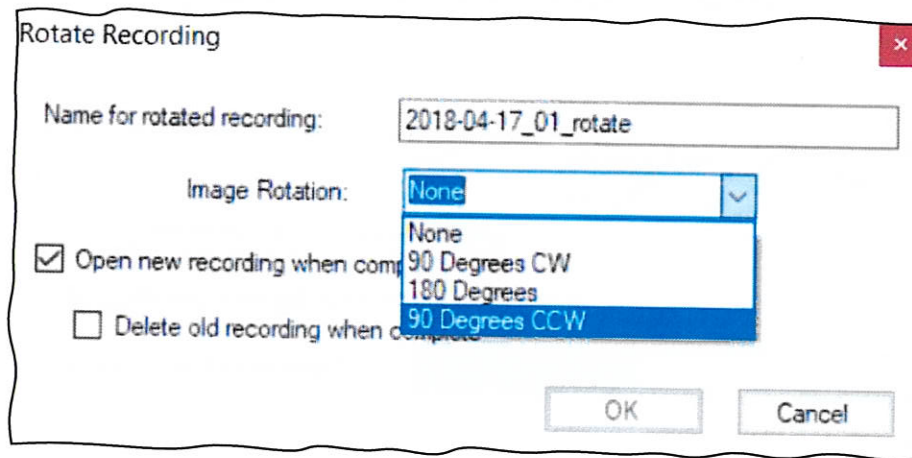
Step 5 – Click OK.

Trim Recording window opens.

File name includes original file name followed by "trim".

Original recording retained unless user checks *"Delete old recording when complete" box.*

Exercise 13 – Trim/Rotate/Crop a Recording



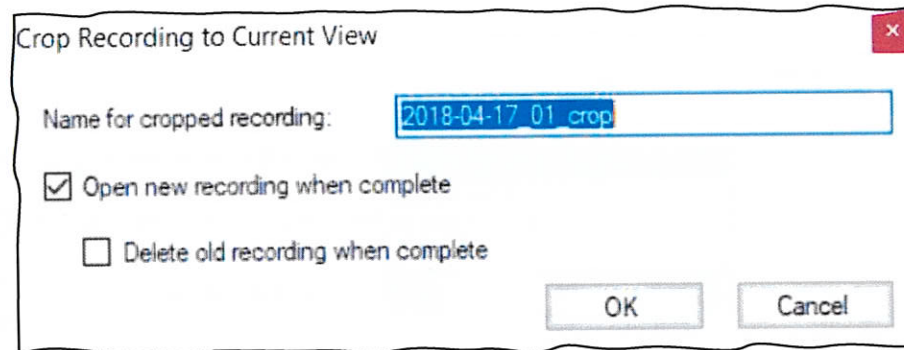
Select an option of rotation

Rotate Recording window opens.

File name includes original file name followed by "rotate".

Original recording retained unless user checks
"Delete old recording when complete" box.

Exercise 13 – Trim/Rotate/Crop a Recording



First zoom and set correct
portion of the screen to
activate this option

Crop Recording window opens.

File name includes original file name followed by "crop".

Original recording retained unless user checks *"Delete old recording when complete" box.*

Exercise 14 – Threshold Mapping

Step 1 – In Motion Explorer, highlight original .rdi file and launch Motion Amplification.

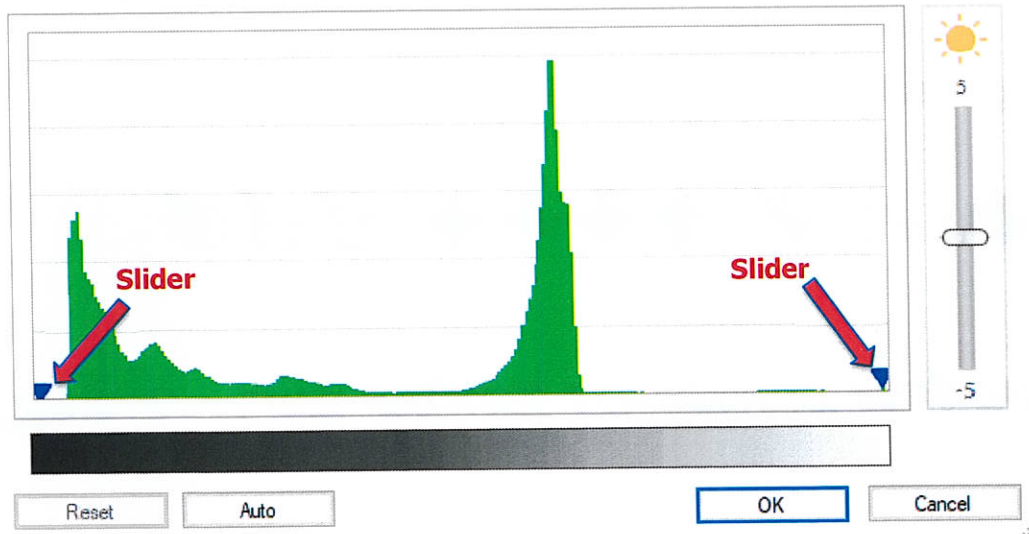
Step 2 – Click ***Adjust Threshold Mapping*** button.



Exercise 14 – Threshold Mapping

Threshold Editor

Drag upper and lower threshold values to adjust the portion of the available dynamic range that is mapped for display.



Threshold Editor opens.

Sliders at bottom can be moved so unused/little used portions of light intensities are ignored.

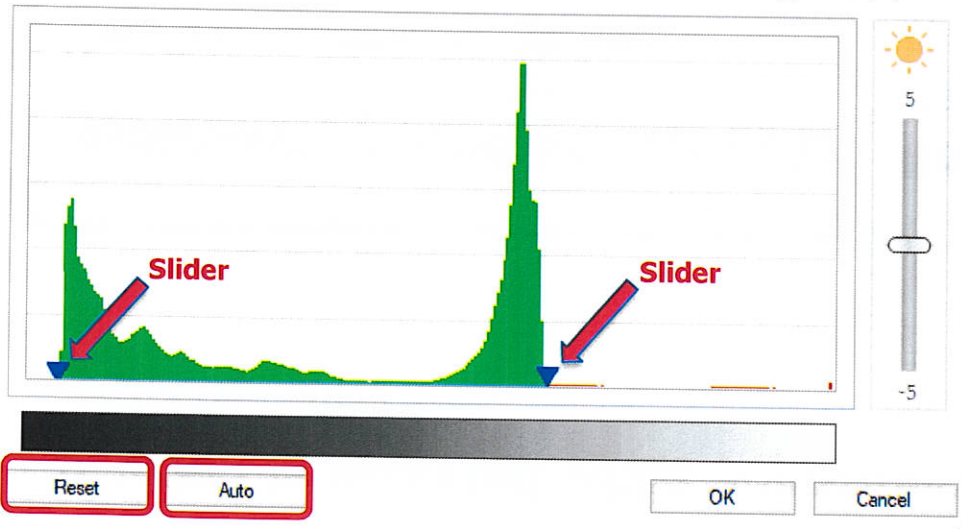
Can greatly increase contrast, enhancing ability to see detail in shaded areas.

Slider at right side allows user to adjust brightness of recording.

Exercise 14 – Threshold Mapping

Threshold Editor

Drag upper and lower threshold values to adjust the portion of the available dynamic range that is mapped for display.



Step 3 – Position sliders in histogram to just below and above portions of graph with highest intensities.

Step 4 – Click OK and view image.

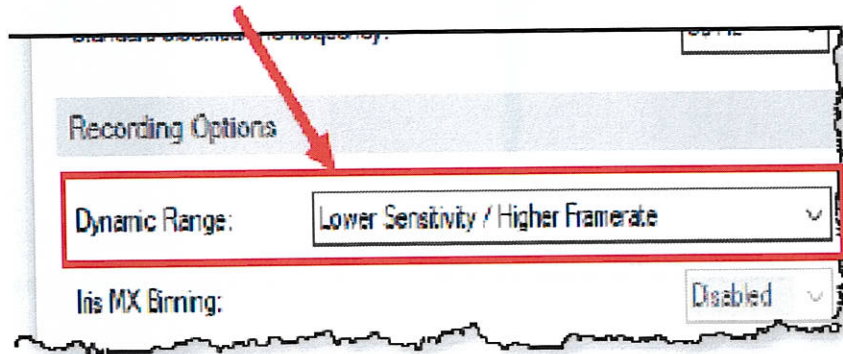
Reset: *Automatically resets sliders to original positions.*

Auto: *Sets sliders to automatically calculated "optimal" positions.*

Exercise 14 – Threshold Mapping

Adjustments to Threshold Mapping are retained to original .rdi file.

If video is exported while adjustment is in effect, adjustment will be visible in exported mp4 file.



Note: *Threshold Mapping **not** available if recording acquired with Dynamic Range set to:*

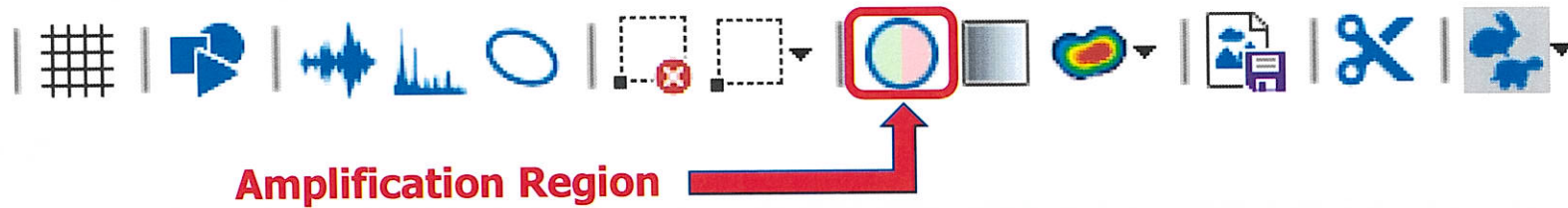
"Lower Sensitivity / Higher Framerate".

Exercise 15 – Applying an Amplification Region

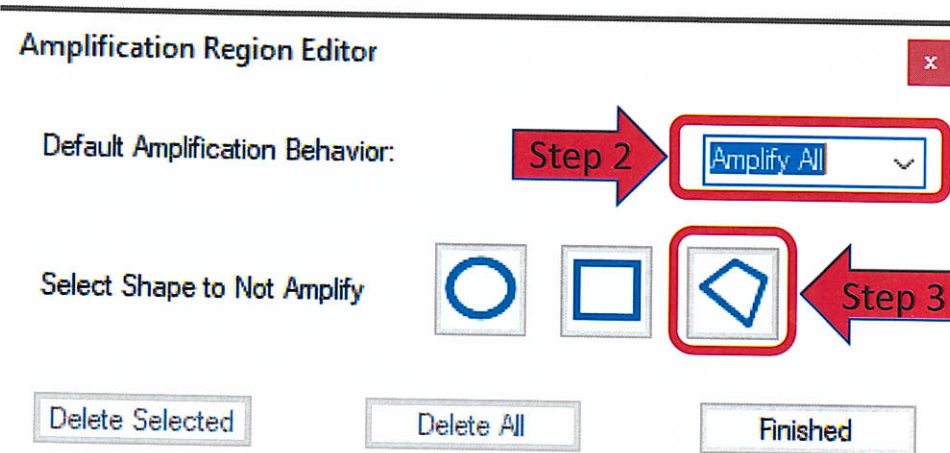
- Amplification Editor allows users to apply MA to selected portions of image, while excluding amplification of other portions.
- Useful if amplified movement of area/component detracts from usability of recording.
- Examples - handrails, piping, electrical conduit, clouds...
- Or, users may amplify only one component in image, focusing more attention on that component.

Exercise 15 – Applying an Amplification Region

Step 1 – Click **Amplification Region** button.



Exercise 15 – Applying an Amplification Region

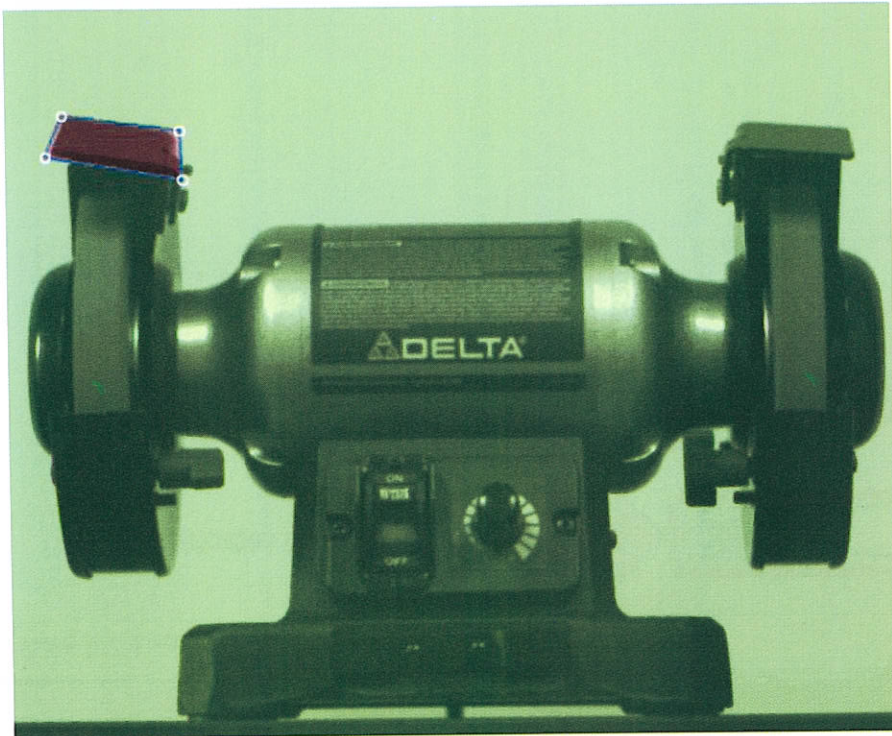


Step 2 – Click “Default Amplification Behavior” box, select **Amplify All**.

Shades entire image green, letting user know everything in image is amplified.

Step 3 – Select polygon shape for, ***“Select Shape to Not Amplify”***.

Exercise 15 – Applying an Amplification Region



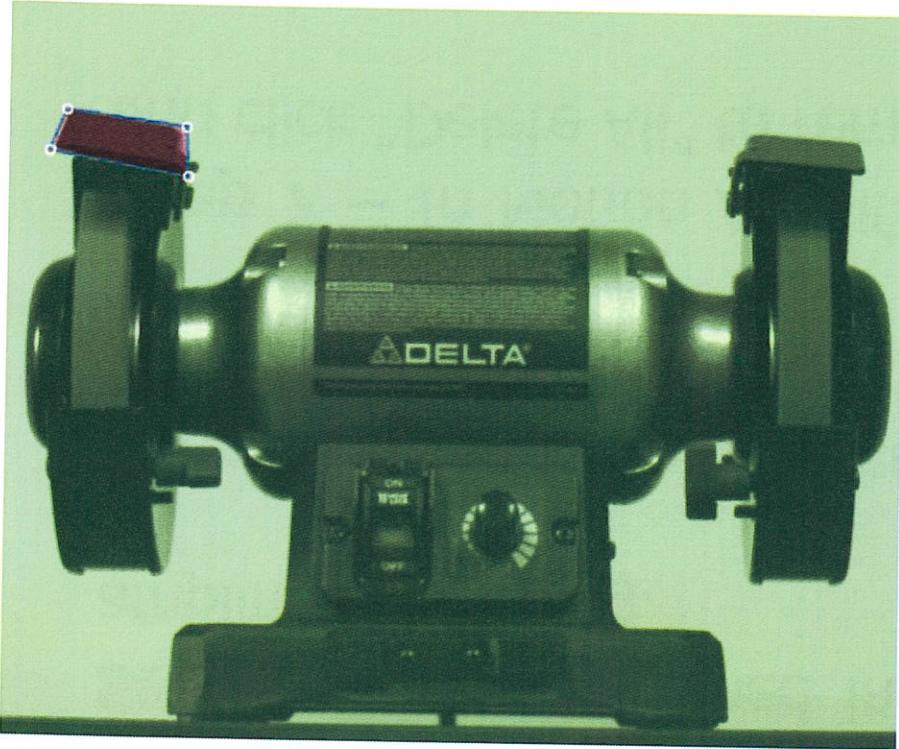
Step 4 – Left click and move cursor to draw first line of shape.

Left click again to end line and begin new one.

Continue process until you have desired shape.

Double left click will end drawing process.

Exercise 15 – Applying an Amplification Region



Shape may be repositioned by dragging/dropping.

Shape may be adjusted by left clicking on small circles at corners and dragging.

Exercise 15 – Applying an Amplification Region

Step 5 – Click Finished in “Amplification Region Editor” and play amplified recording.

Step 6 – In “Export Description” field type: Amplification Region Edited and export video.

Step 7 – In Motion Amplification, open Amplification Region Editor and click “Delete All” to remove excluded region, click “Finished”.

Applying a Grid

A grid can be superimposed over image to provide non-moving reference.

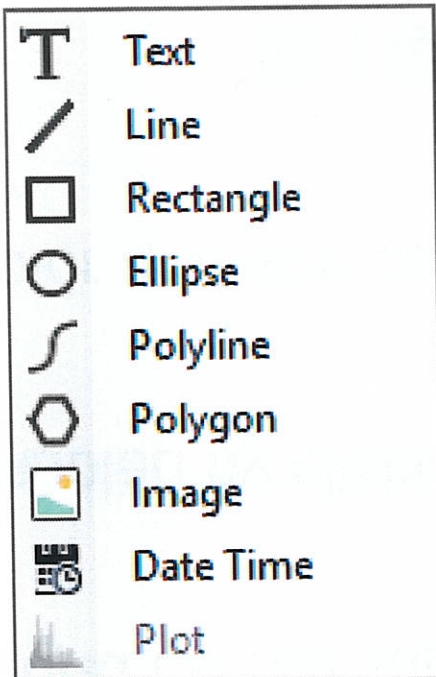
Enabled by clicking Show/Hide Grid button.

Color and size can be adjusted in Application Settings.



Show/Hide Grid

Image Annotation



Annotations can be added by using Annotation Editor.

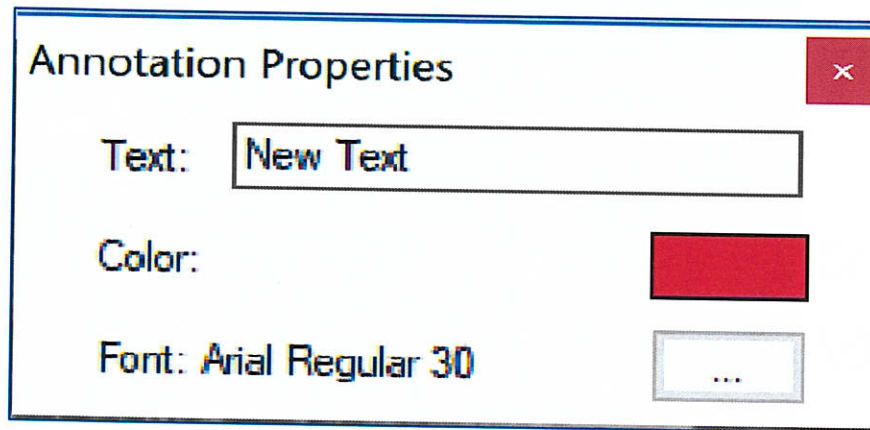
Opened by clicking Annotations button.

Type determined by selection in pop-up window.



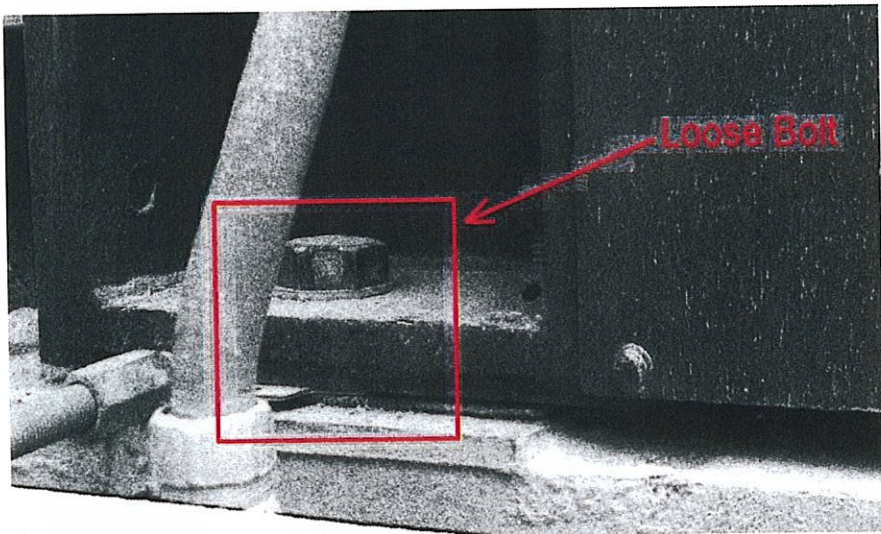
Image Annotation - Text

If **Text** selected, an "Annotation Properties" field appears.



- Desired text can be entered
- Color and font can be chosen

Image Annotation – Line or Shape



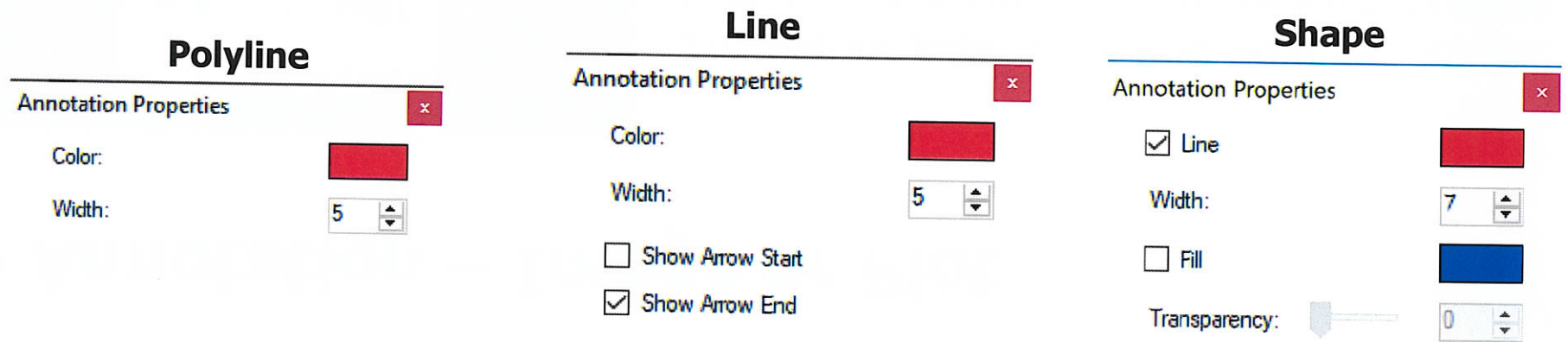
line or shape, click and hold left mouse button and draw on image.

Release left mouse button after completion.

Image Annotation – Line or Shape

Annotation Properties field appears.

- Color and width can be chosen.
- Arrows can be added to lines.
- Fill and transparency options for shapes.



The image displays three screenshots of the 'Annotation Properties' dialog boxes for different annotation types:

- Polyline:** Shows 'Color' set to red and 'Width' set to 5.
- Line:** Shows 'Color' set to red, 'Width' set to 5, and checkboxes for 'Show Arrow Start' (unchecked) and 'Show Arrow End' (checked).
- Shape:** Shows 'Line' checked, 'Fill' unchecked, 'Width' set to 7, and 'Transparency' set to 0.

Image Annotation – Image or Plot

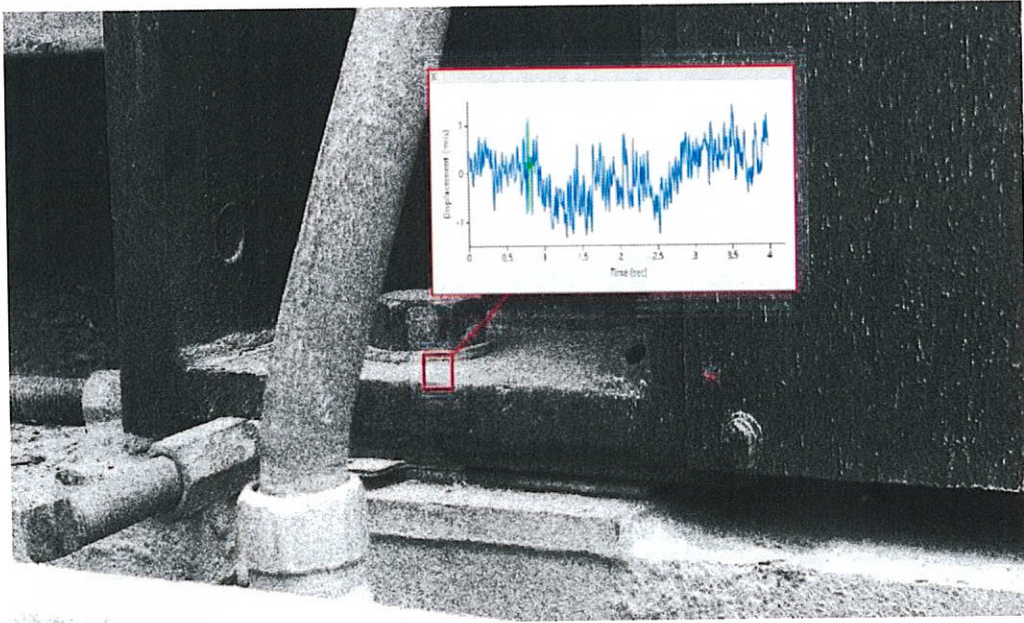


Image or plot, click and hold left mouse button and draw a box at desired location.

Release mouse button when finished.

Image Annotation – Image or Plot

Annotation Properties field appears.

- ROI, Plot type and orientation can be selected for plot.
- Browse function and Fixed Aspect Ratio for image

Plot		Image	
Annotation Properties x		Annotation Properties x	
ROI	<input type="text" value="□"/>	Image:	<input type="text" value="..."/>
Plot	Waveform	<input checked="" type="checkbox"/> Fix Aspect Ratio	
Orientation	X		
<input checked="" type="checkbox"/> Connect to ROI			
<input checked="" type="checkbox"/> Track Playback			

Image Annotation Adjustments

- Annotations may be moved by clicking and dragging.
- Can be resized by left clicking on annotation and dragging white “handles”.
- Properties can be edited by left clicking on or inside annotation.
- Can be deleted by right clicking and selecting ***delete annotation***. Deleting can also be done within annotation editor.

Exercise 16 – Annotation

Step 1 – Place red arrow in recorded image of class rotor kit and make it point at base of machine.

Step 2 – Create text annotation with the words, “Unsecured Base”, and position text annotation in line with arrow.

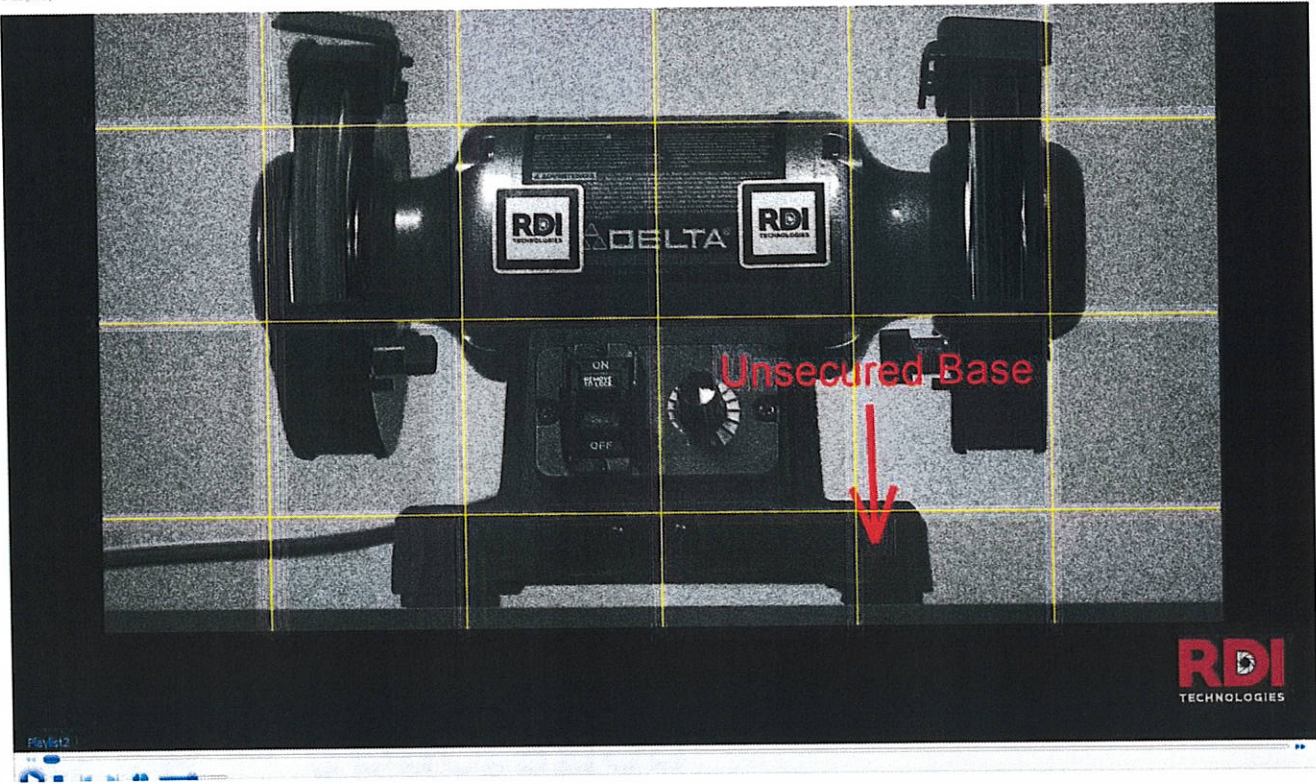
Step 3 – Overlay image with a yellow grid with a grid size of 200 pixels.

Step 4 – Amplify recording to 50x, export video, and play exported video.

Step 5 – Close mp4 player, close Motion Amplification, and rename stored video file in Motion Explorer, “Annotated with grid.mp4”.

Exercise 12 – Annotation

Annotated with grid.mp4
Description: Amplification Factor: 50 - Speed(fps): 10
Location: C:\Users\iris M\Documents\RDI\Videos
Create Date: 6/21/2019 10:48 AM
Size(MB): 39



Standard XY Vibration Measurement

Vibration measurements can be made from recordings in Motion Amplification.

Region of Interest (ROI) must be drawn on image.

To draw click and hold Left mouse button and drag mouse over region to be measured.

Software makes displacement measurement from this ROI.



Number of ROI's that may be drawn on image is unlimited.

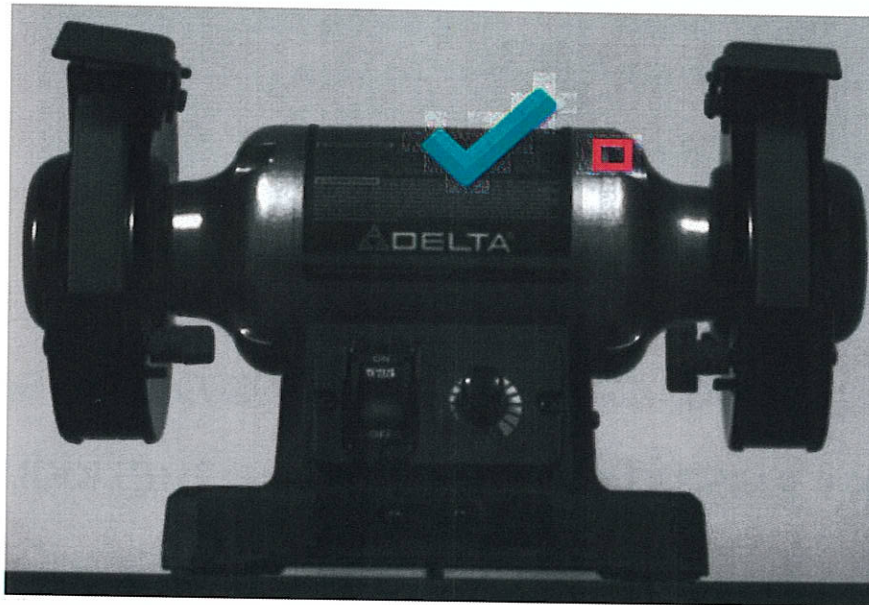
Standard XY Vibration Measurement

Important to understand basics of drawing an ROI to return accurate vibration data.

The following rules should be adhered to whenever an ROI is created.

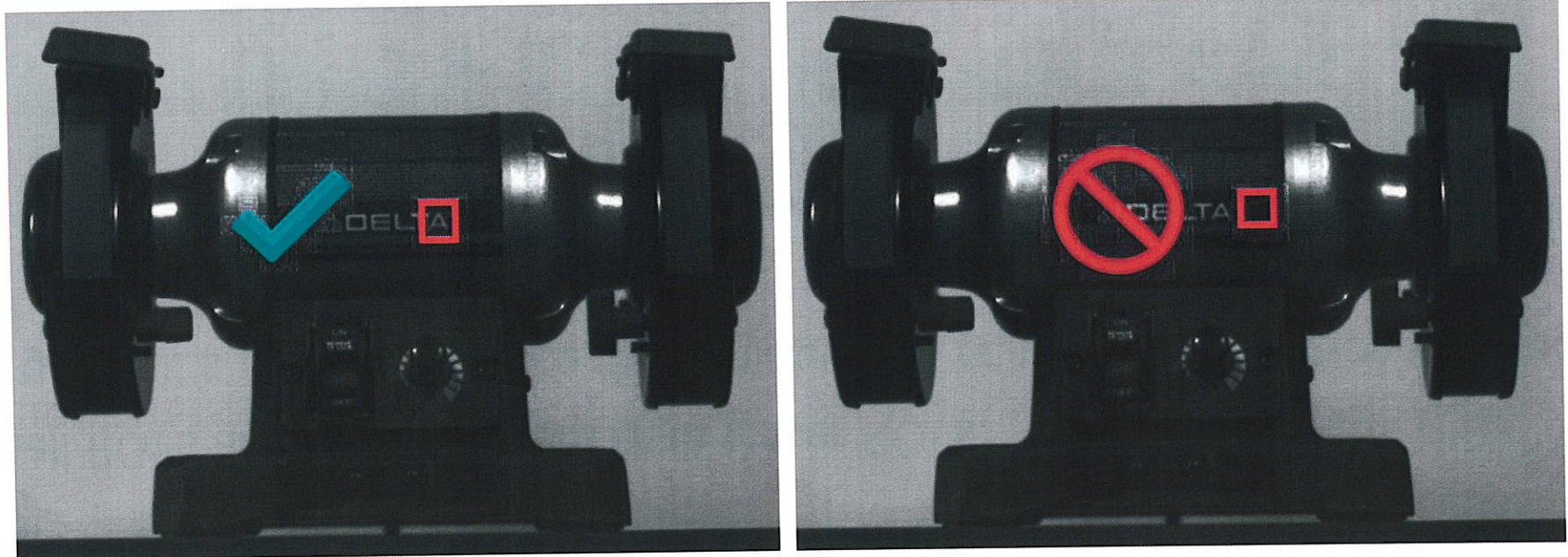
ROI Rule # 1 – Keep it small

- Small ROI's are more accurate than larger ROI's.
- Larger ROI's increase chance that unintended or undesired portion of image will be used for measurement.



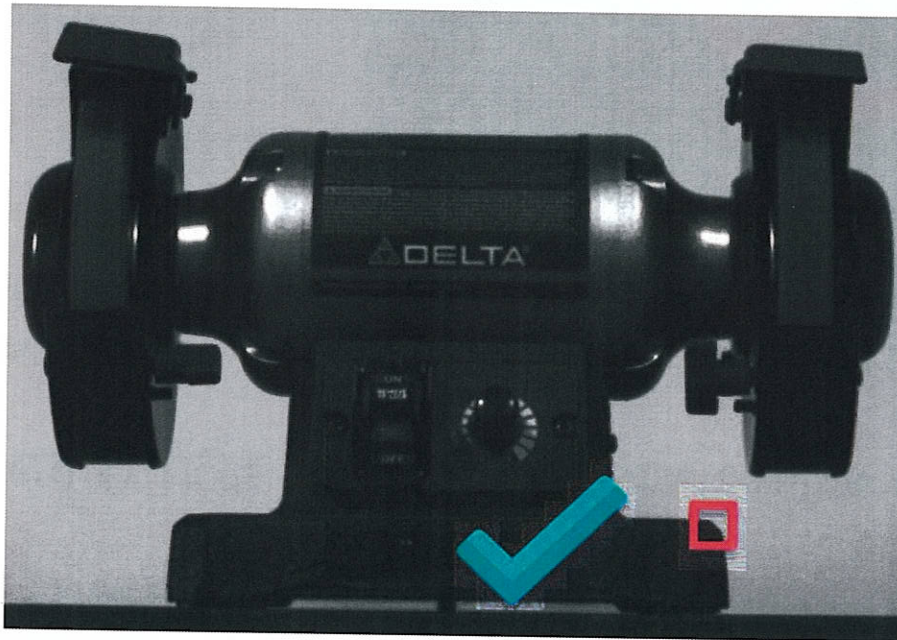
ROI Rule #2 – Capture Contrast

- Important that contrast be present within ROI.
- Iris M accessory kit includes contrast stickers and magnets.



ROI Rule #3 – Do Not Include Multiple Components

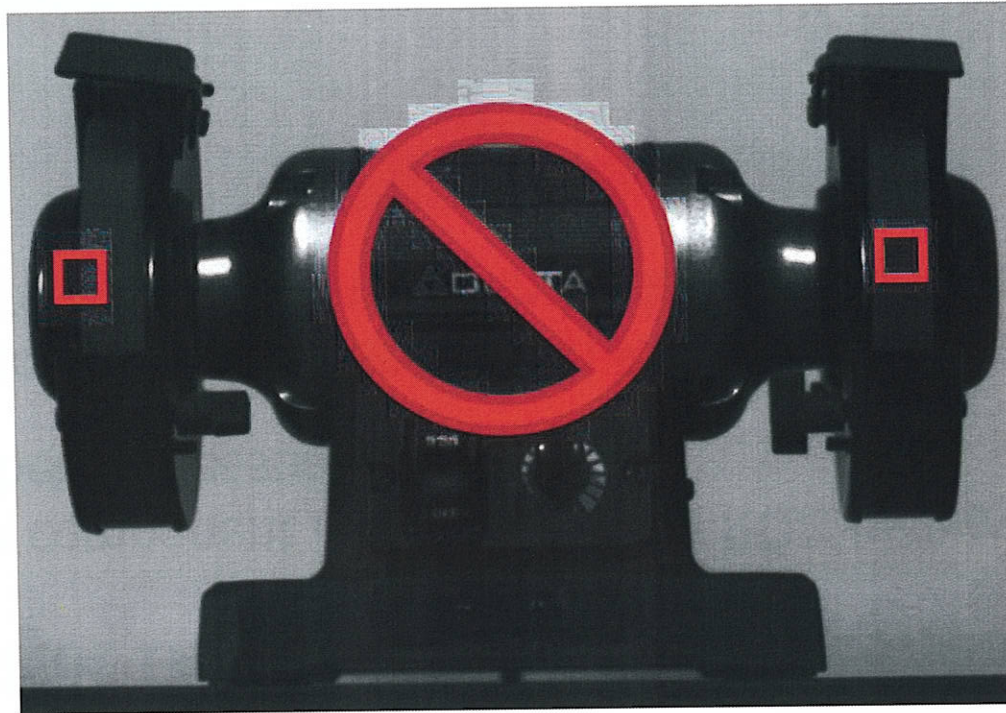
- When more than one component is included in an ROI, no way to determine which component is being measured.
- Often, an edge of a component is used for an ROI because there is contrast at the edge. Only acceptable if background behind selected edge has no contrast.



ROI Rule #4 – Do Not Capture Rotating Components

In Standard XY Mode, software is not capable of measuring displacement of rotating components.

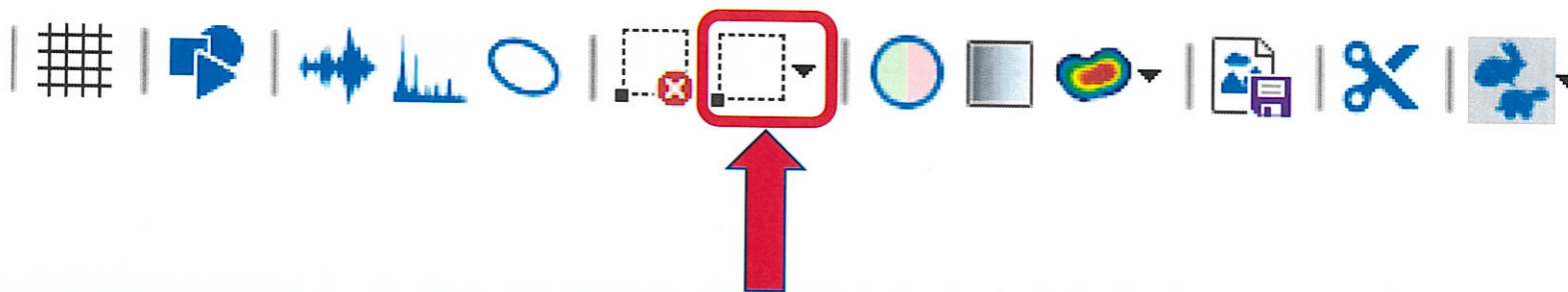
Vibration data generated from an ROI that captures any part of a rotating element is invalid and should be ignored.



Horizontal/Vertical Shaft Measurement

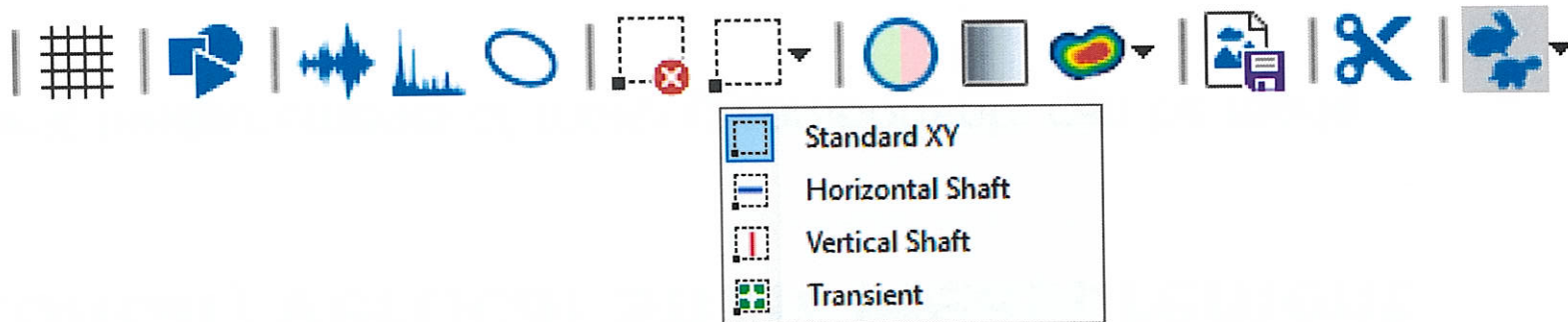
Displacement measurements of rotating components can be made.

Horizontal Shaft or Vertical Shaft option must be selected by clicking ROI Calculation Mode button.



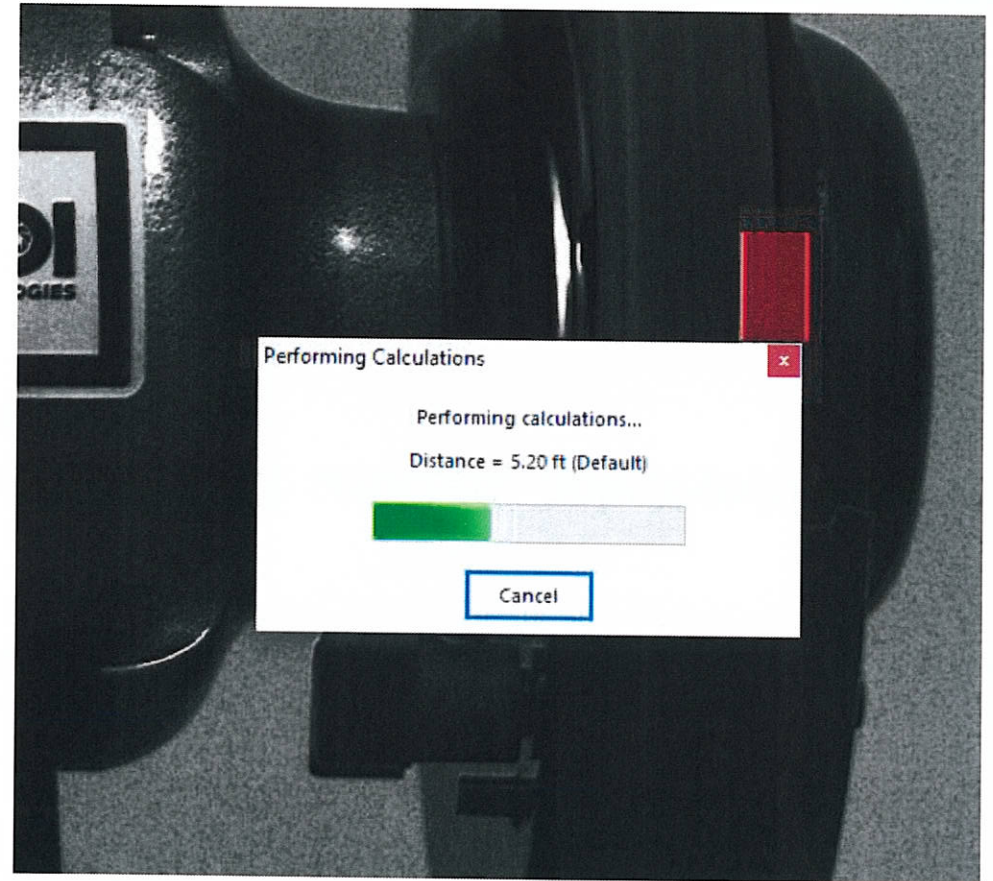
Horizontal/Vertical Shaft Measurement

- **Horizontal Shaft** – Measures vertical displacement of horizontal component or shaft.
- **Vertical Shaft** - Measures horizontal displacement of vertical component or shaft.

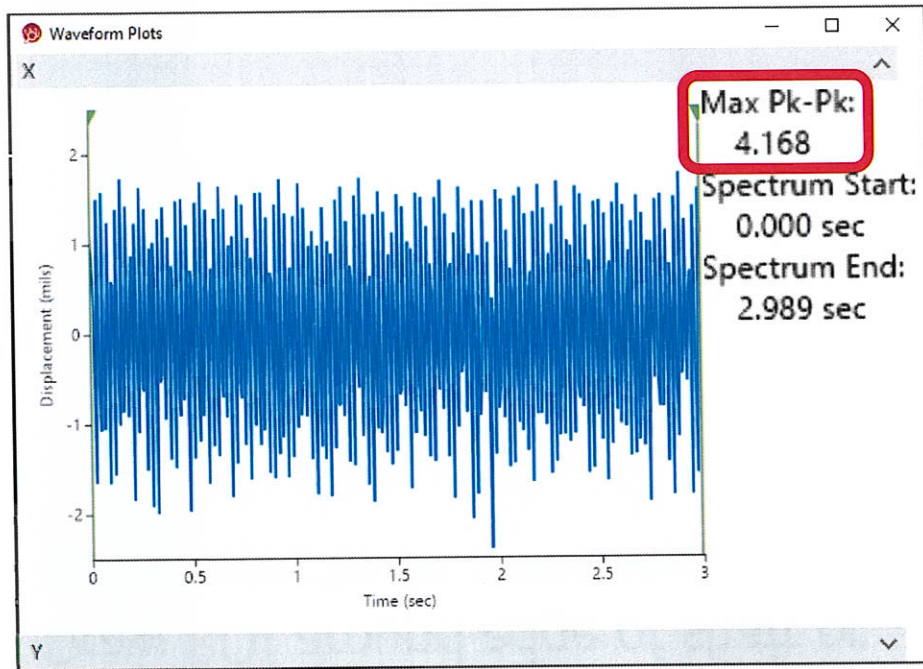


Horizontal/Vertical Shaft Measurement

Draw ROI around edge of shaft or component to be measured.



Horizontal/Vertical Shaft Measurement



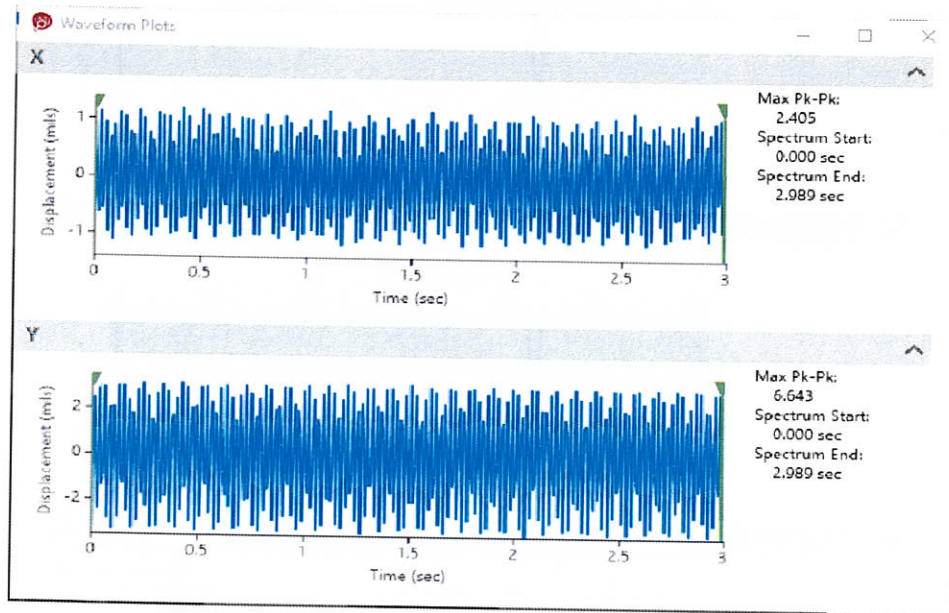
Waveform/spectrum generated for one axis only.

If vertical shaft selected, only X-axis plots are generated.

Recommended that waveform Max Pk-Pk value be used for this measurement.

Vibration Measurement - Waveforms

When an ROI is drawn software automatically generates X and Y waveform.



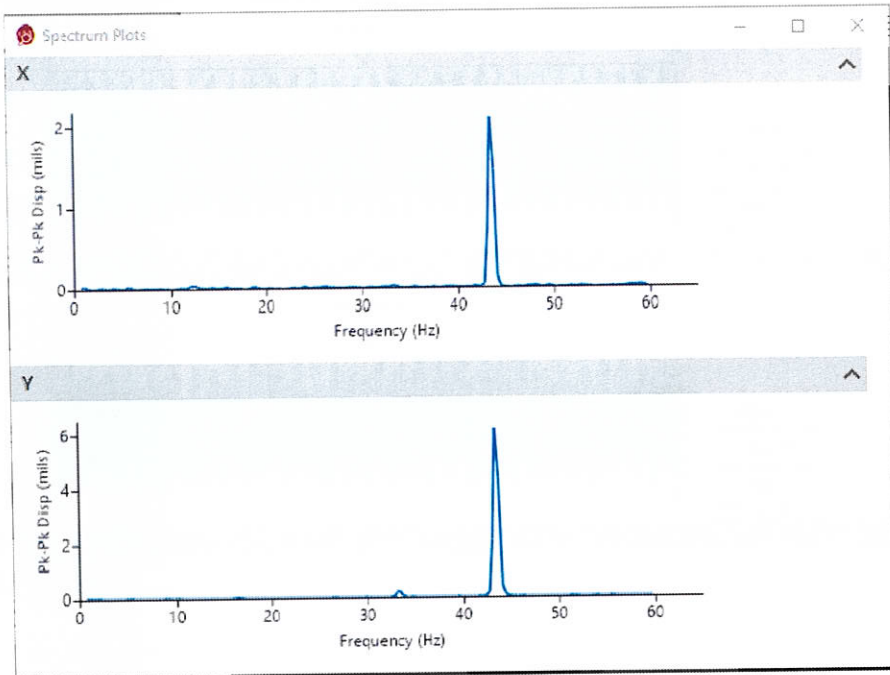
Waveforms graph amplitude vs. time.

- Amplitude in displacement (Mils or Microns).
- Time in seconds.

Length of waveform is time length of recording.

Vibration Measurement - Spectra

Software automatically generates vibration spectra.



Spectrum plots amplitude vs. frequency.

- Amplitude in displacement (Mils or Microns).
- Frequency in Hz, or CPM.

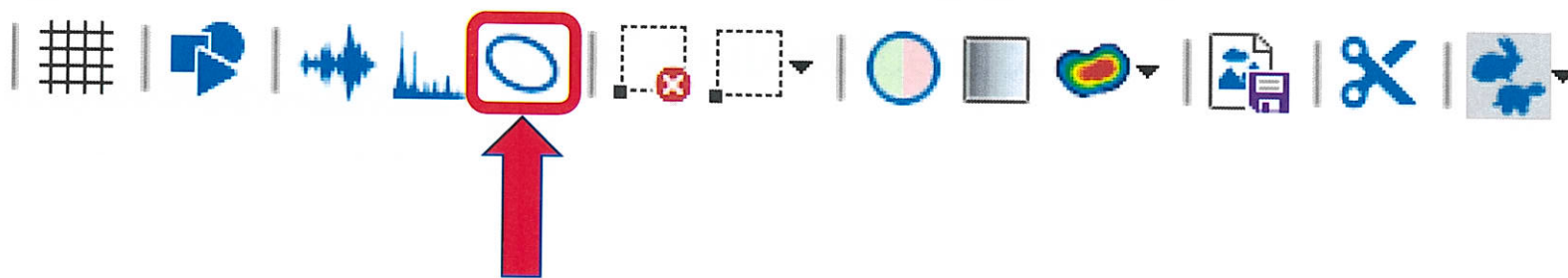
Fmax (Maximum frequency) of spectrum is exactly half the framerate used in acquisition.

Vibration Measurement – Orbit

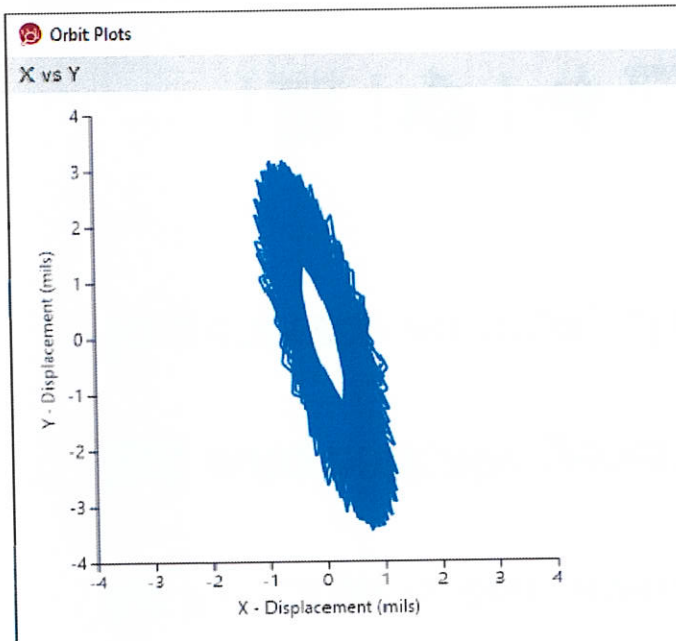
An X-Y orbit is also available.

Not automatically generated when an ROI is drawn.

To generate an orbit, click Orbit button after drawing an ROI.



Vibration Measurement - Orbit

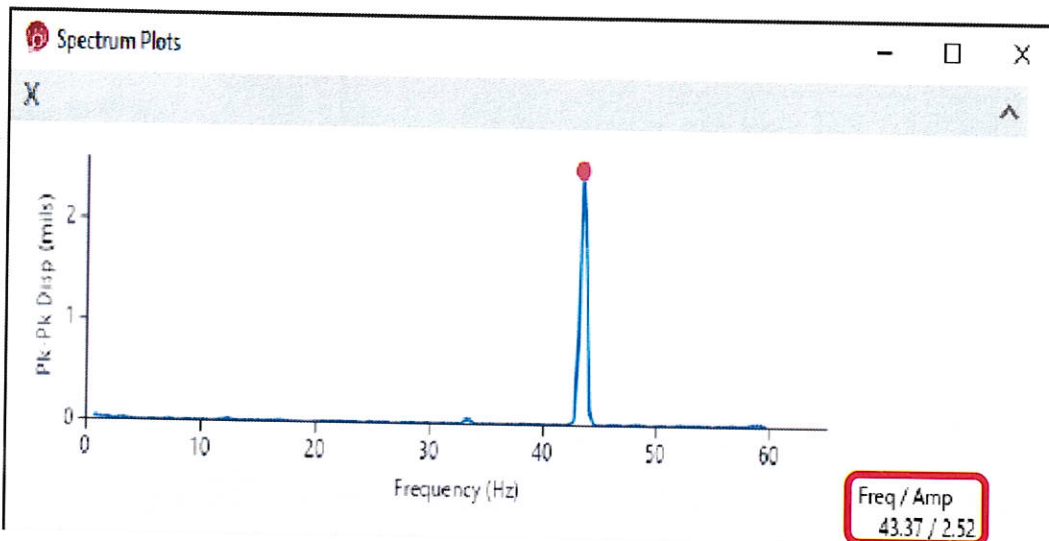


Orbit is amplitude plot of:
"X" waveform vs. "Y" waveform.

In most applications a filtered orbit is preferred.

Exercise 17 – Vibration Plotting

Step 1 – Draw ROI on image in Motion Amplification. Results in a waveform and spectrum window to appear.



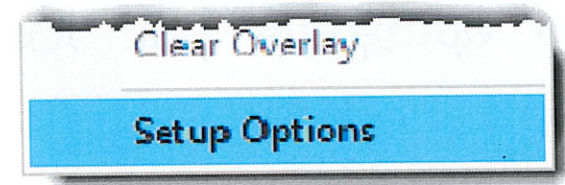
Step 2 – Left click inside X-axis spectrum to activate cursor.

Use arrow keys on keyboard to position cursor at center of dominant peak.

Frequency and amplitude of cursor's position are listed in lower right corner of plot.

Exercise 17 – Vibration Plotting

Step 3 – Right click inside spectrum and select “Setup Options” in drop-down menu.



Exercise 17 – Vibration Plotting

Plot Options

General Plot Options

Waveform Amplitude Units: Displacement

Spectrum Amplitude Units: Velocity

Autoscale Across Plots of Same Type

Waveform Plot Options

Show time in revolutions when possible

Spectrum Plot Options

Show frequency in orders when possible

Show log of amplitude

Automatically Locate Spectrum Peaks

Harmonic Cursor for Spectrum Plots

Number of harmonics to display: 6

Orbit Plot Options

Limit display to spectrum span

Number of displayed revolutions: 1

Amplitude Unit Modes

Displacement: Pk-Pk

Velocity: Pk

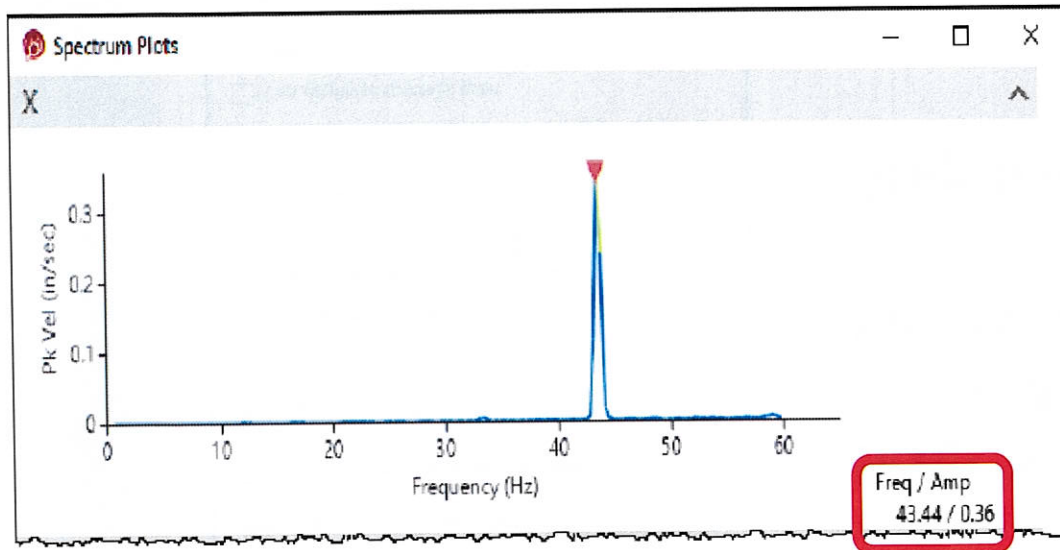
OK Cancel

Step 4 - Under "General Plot Options", select Velocity for Spectrum Amplitude Units.

Step 5 – Under "Spectrum Plot Options", Check **Automatically Locate Spectrum Peaks** box.

Step 6 – Click OK.

Exercise 17 – Vibration Plotting



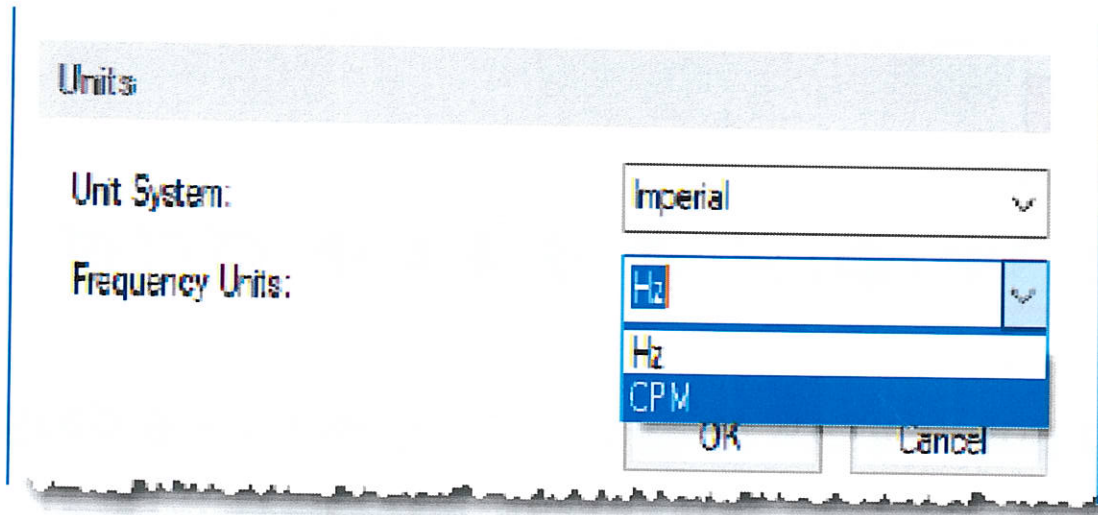
Now center of dominant peak is listed as a slightly different frequency than before Automatic Locate feature was enabled.

Peak Locate feature can also be applied manually by right-clicking in plot and selecting "Locate Peak" from drop-down menu.

Also amplitude values are now Pk Vel (In/sec) instead of Pk-Pk Disp (mils).

Exercise 17 – Vibration Plotting

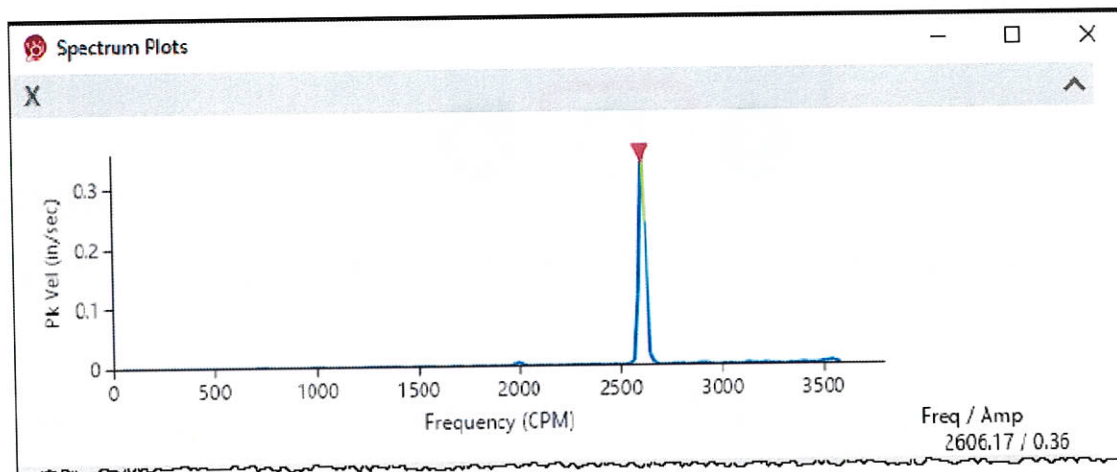
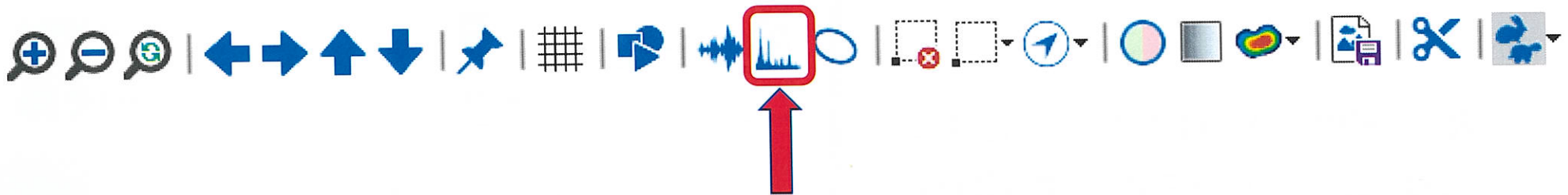
Step 7 – Click Application Settings button at upper right corner of Motion Amplification screen.



Step 8 – Select CPM for Frequency Units, click “OK.”

Exercise 17 – Vibration Plotting

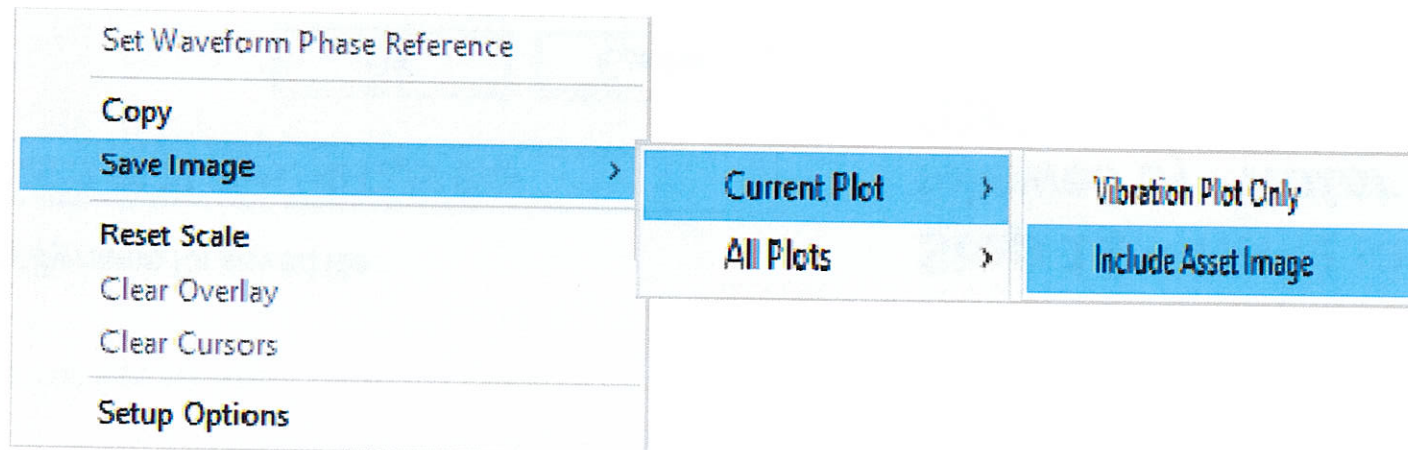
Step 9 – Close Spectrum Plots window and then reopen by clicking Spectrum button.



Frequency values are now CPM instead of Hz.

Exercise 17 – Vibration Plotting

Step 10 – Right click in spectrum and select Save Image > Current Plot> Include Asset Image.



Exercise 17 – Vibration Plotting

Name For Saved File



Specify name for saved file:

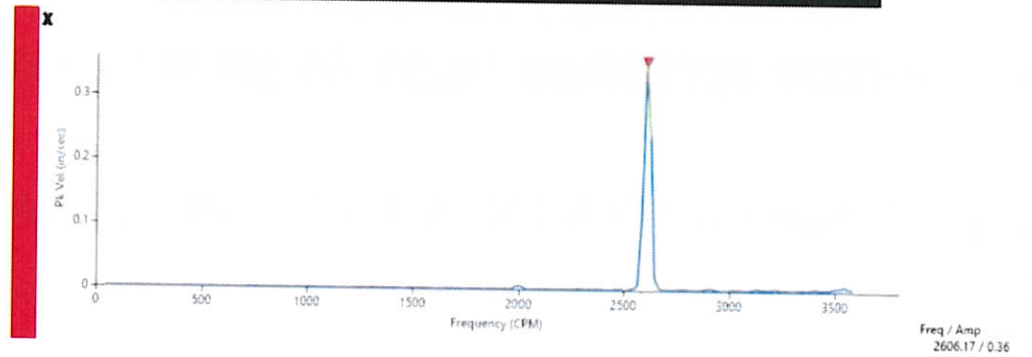
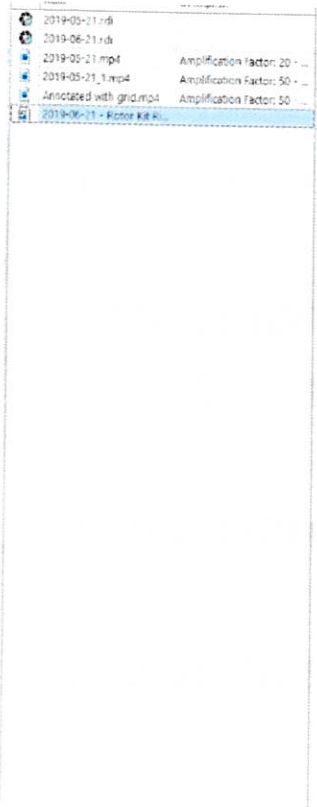
2019-06-21 -Rotor Kit Right Side

OK

Cancel

Step 11 – Name saved file with current date followed by "***Rotor Kit Right Side***", click "OK".

Exercise 17 – Vibration Plotting



Step 12 – Open Motion Explorer window.

Spectrum stored, along with still image of video, as a .png file.

Applying Multiple Distance Measurements

Vibration amplitude accuracy depends greatly on distance measurement accuracy.

If measurement is off by 10%, amplitude accuracy will also be off by 10%.

In many instances, especially when capturing recordings of large structures and machines, distances will vary significantly across different parts of image.

Users can load different distance measurements for different locations in image.


Exercise 18 – Multiple Distance Locations

Step 1 – In Motion Explorer, highlight .rdi file of rotor kit and launch Motion Amplification.


Step 2 – Click Locations button in Motion Amplification toolbar.



Exercise 18 – Multiple Distance Locations

Define Locations 

<u>Location Name</u>	<u>Distance (ft)</u>	<u>Color</u>	<u>Active</u>
Default	6.20		<input checked="" type="radio"/>



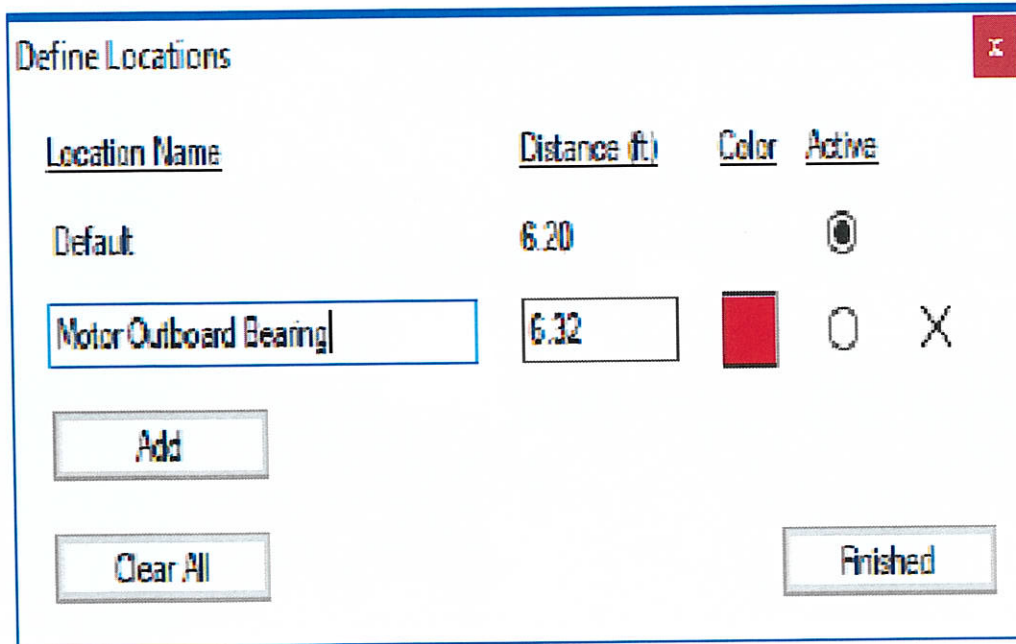
Step 3 – In Define Locations window, click **Add** button.

Exercise 18 – Multiple Distance Locations



Step 4 – Left click anywhere in image.
A red thumbtack will appear.

Exercise 18 – Multiple Distance Locations



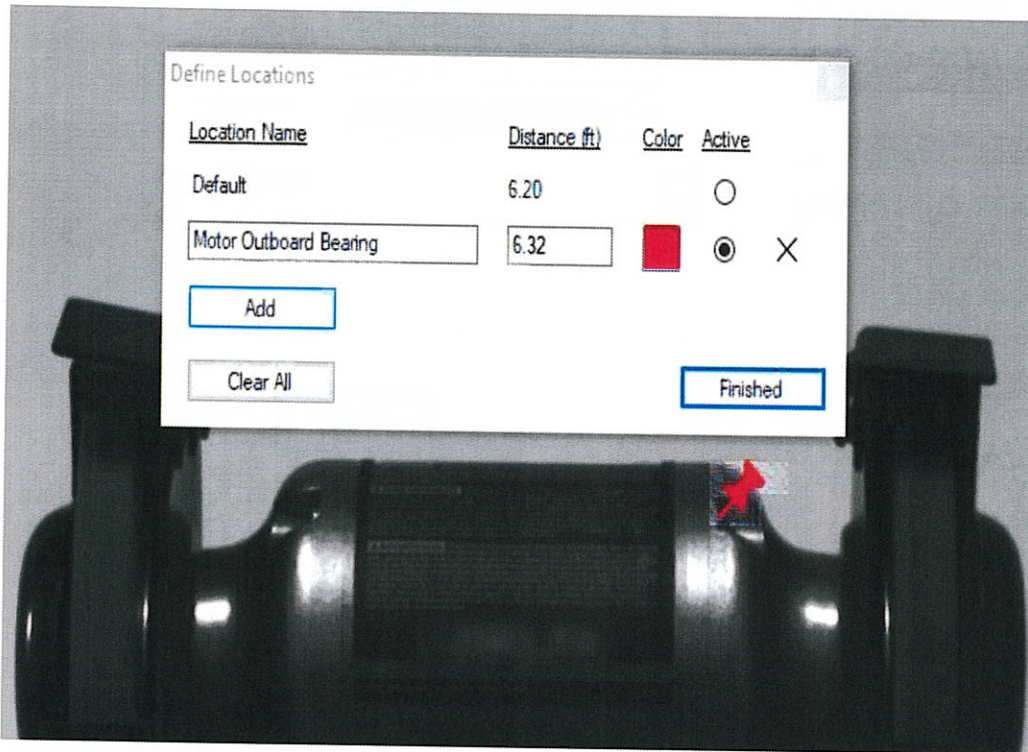
<u>Location Name</u>	<u>Distance (ft)</u>	<u>Color</u>	<u>Active</u>
Default	6.20		<input checked="" type="radio"/>
Motor Outboard Bearing	6.32	Red	<input type="radio"/> X

Buttons: Add, Clear All, Finished

Step 5 – Measure distance to another location on rotor kit and enter that distance into second distance field in Define Locations window.

Also, enter location name.

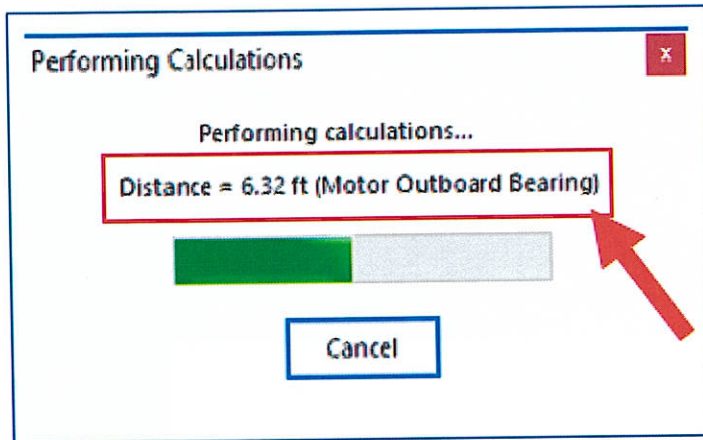
Exercise 18 – Multiple Distance Locations



Step 6 – Drag red thumbtack to measured position and drop it there.

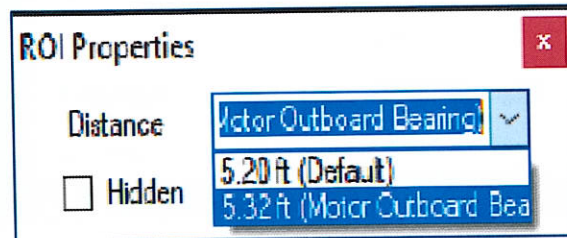
Step 7 – Click “Active” bubble to make new location active and click “Finished”.

Exercise 18 – Multiple Distance Locations



Step 8 – Draw an ROI on image at newly measured location.

New distance is now being used to calculate vibration displacement values.



Note: To apply a different location measurement to ROI, left-click on ROI.

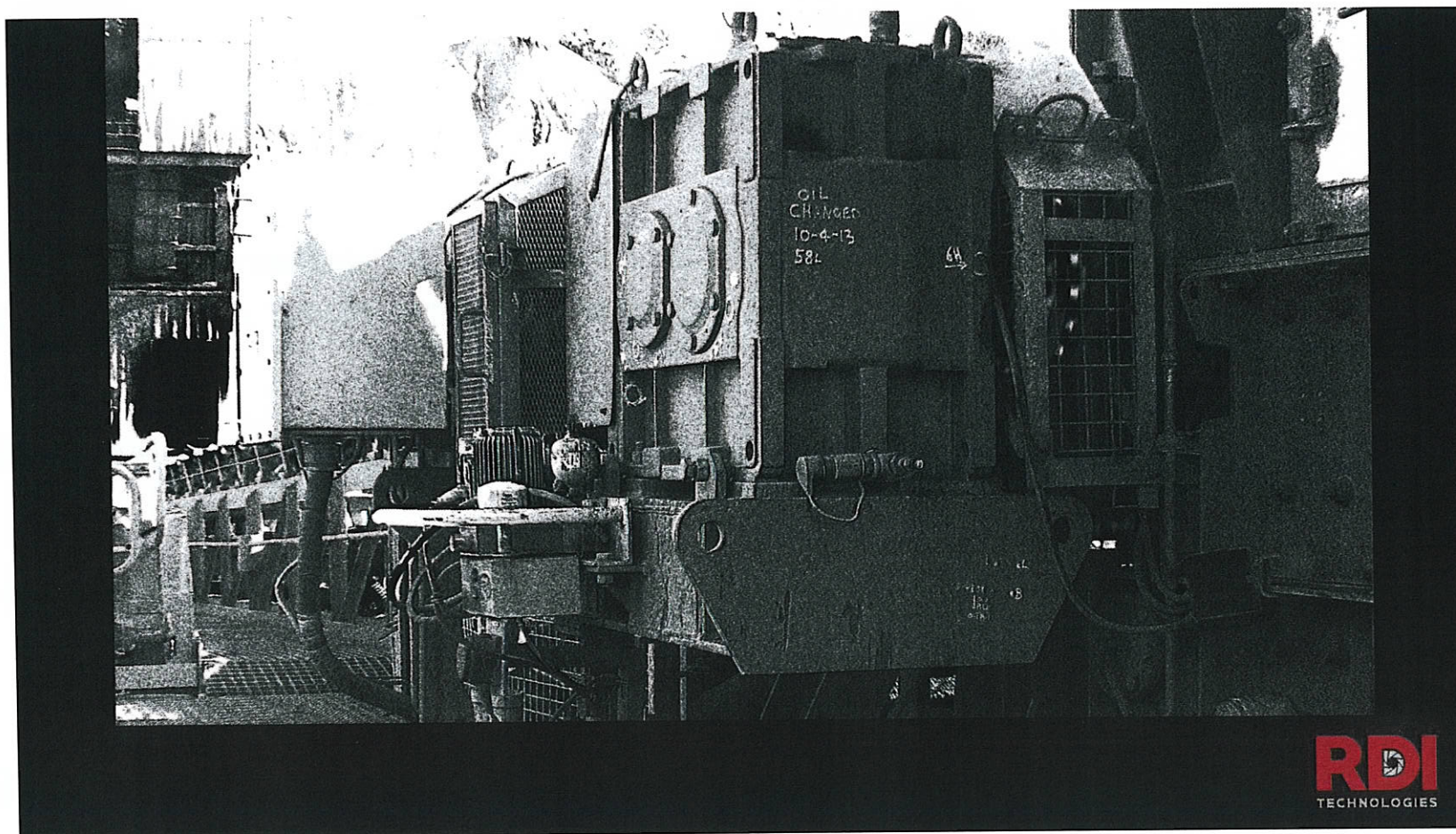
A drop-down menu will appear, user can choose one of the listed locations for that ROI.

Frequency Based Filtering

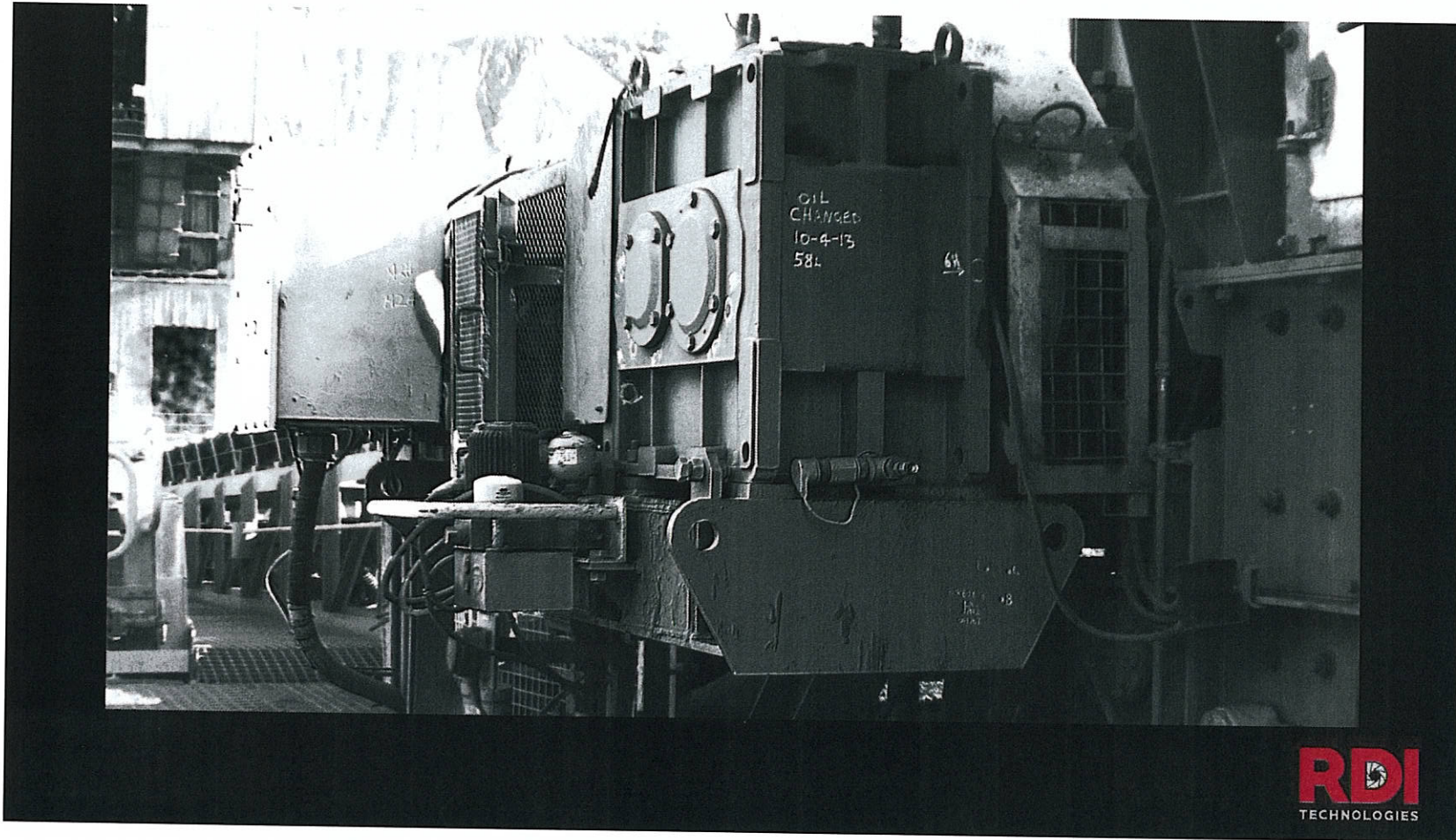
Frequency Based Filtering is useful in several ways.

- Analyze movements caused by different forcing functions separately.
- ***By passing only frequencies at which motion is occurring, most of the noise that causes the amplified recording to appear grainy can be removed.***

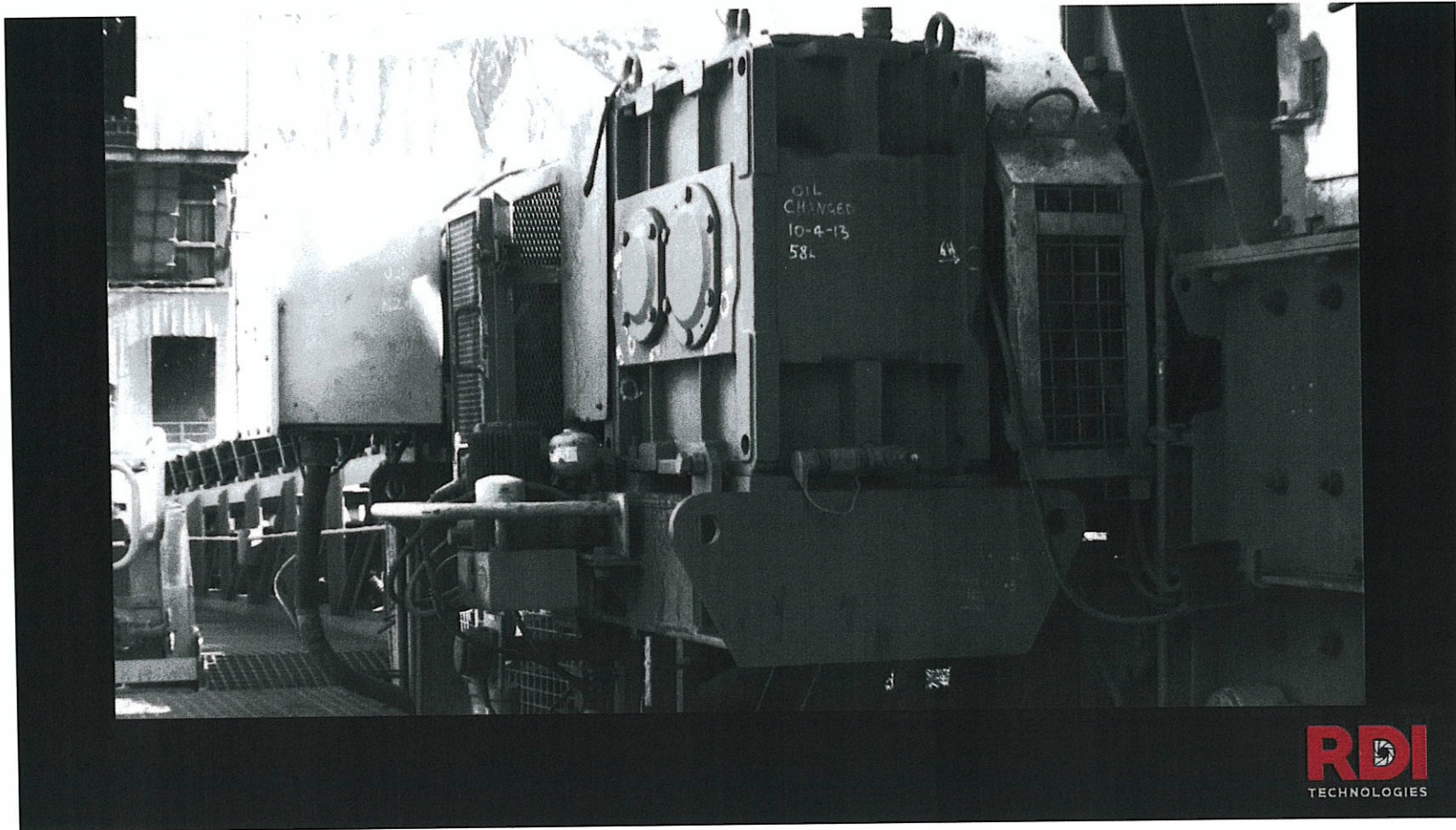
Frequency Based Filtering – No Filter



Frequency Based Filtering – 2 Hz Band Pass



Frequency Based Filtering – 25 Hz Band Pass

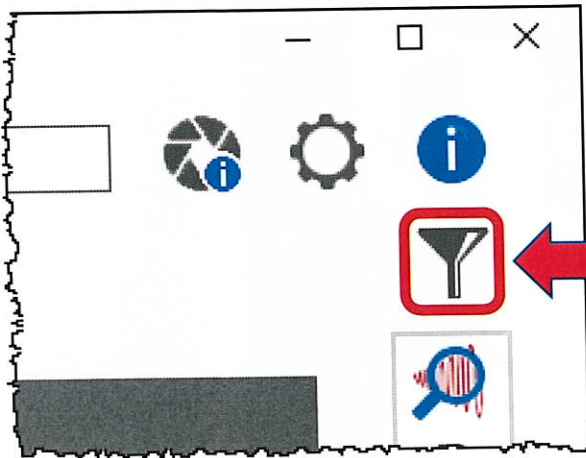


Frequency Based Filtering – 4 Hz Band Pass



Exercise 19 – Frequency Based Filtering

Step 1 – In Motion Explorer, launch Motion Amplification for the .rdi file from the previous exercise.

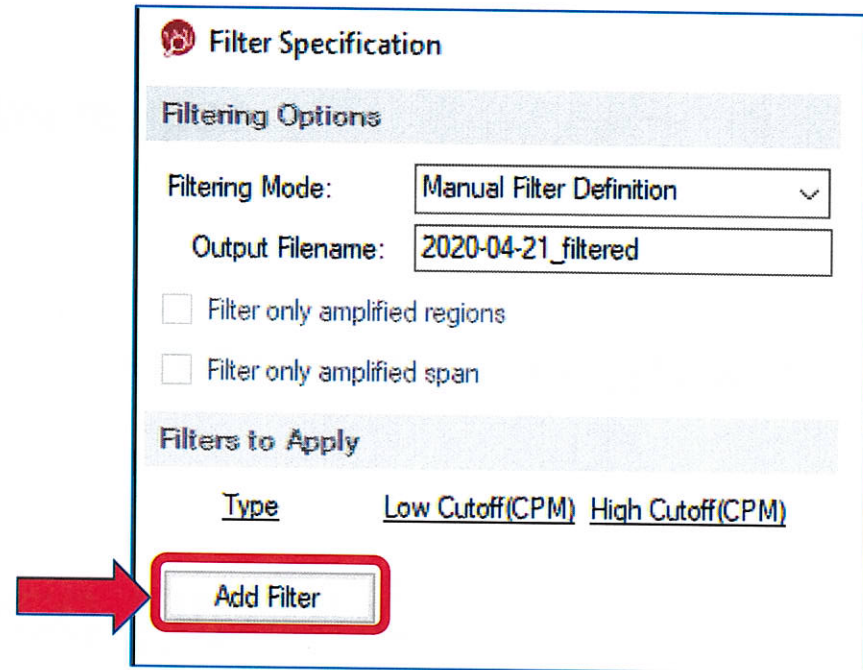


Step 2 – In Motion Amplification, click Filter Recording button.

Exercise 15 – Frequency Based Filtering

Step 3 – When Filter Specification window opens, draw an ROI on rotor kit in image. A spectrum now appears in bottom of window.

Step 4 – Click "**Add Filter**" button on left side of window under "Filters to Apply".



The screenshot shows the "Filter Specification" dialog box. It has a title bar with a red circular icon and the text "Filter Specification". Below the title bar is a section titled "Filtering Options" with a light blue background. This section contains a "Filtering Mode" dropdown menu set to "Manual Filter Definition", an "Output Filename" text box containing "2020-04-21_filtered", and two unchecked checkboxes: "Filter only amplified regions" and "Filter only amplified span". Below this is another section titled "Filters to Apply" with a light blue background. It contains a table with three columns: "Type", "Low Cutoff(CPM)", and "High Cutoff(CPM)". At the bottom of the dialog box, there is a button labeled "Add Filter" which is highlighted with a red rectangular border. A red arrow points from the left towards this button.

Exercise 15 – Frequency Based Filtering

Filter Specification

Filtering Options

Filtering Mode: Manual Filter Definition

Output Filename: 2020-04-21_filtered

Filter only amplified regions

Filter only amplified span

Filters to Apply

Type	Low Cutoff(CPM)	High Cutoff(CPM)
Bandpass	1678.8	1933.62 X
Bandpass		
Lowpass		
Highpass		
Bandstop		

Step 5 – Click selection arrow under “Type” to select type of filter.

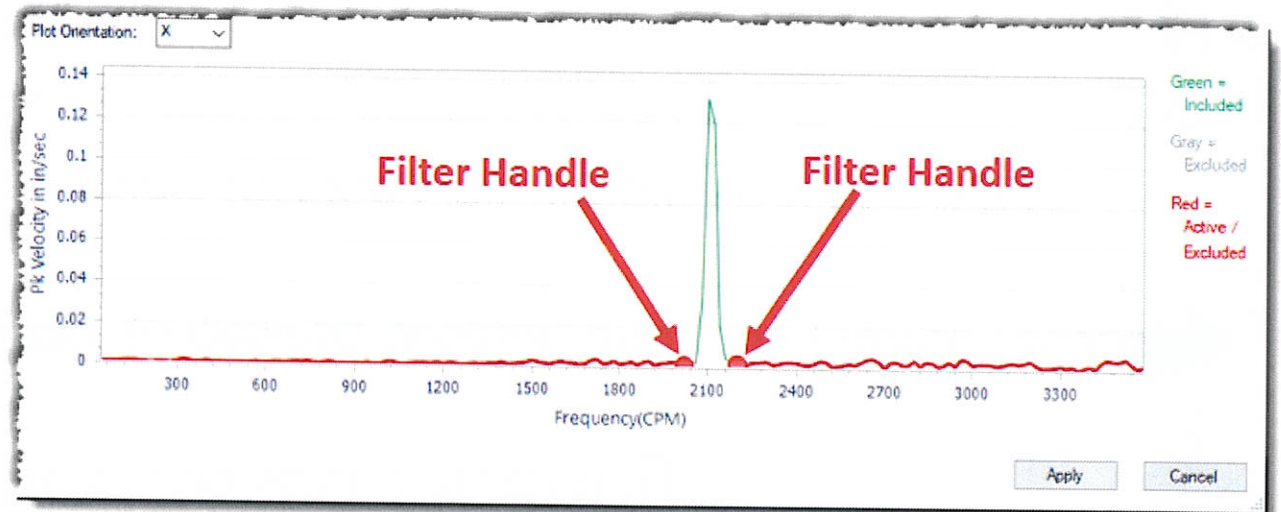
Select ***Bandpass*** filter.

Exercise 15 – Frequency Based Filtering

Step 6 – Using pointer, click and drag filter “handle” on left and position it just to left of dominant peak in spectrum.

Then position the other filter handle just to right of peak. This sets Low and High Cutoff values for the filter.

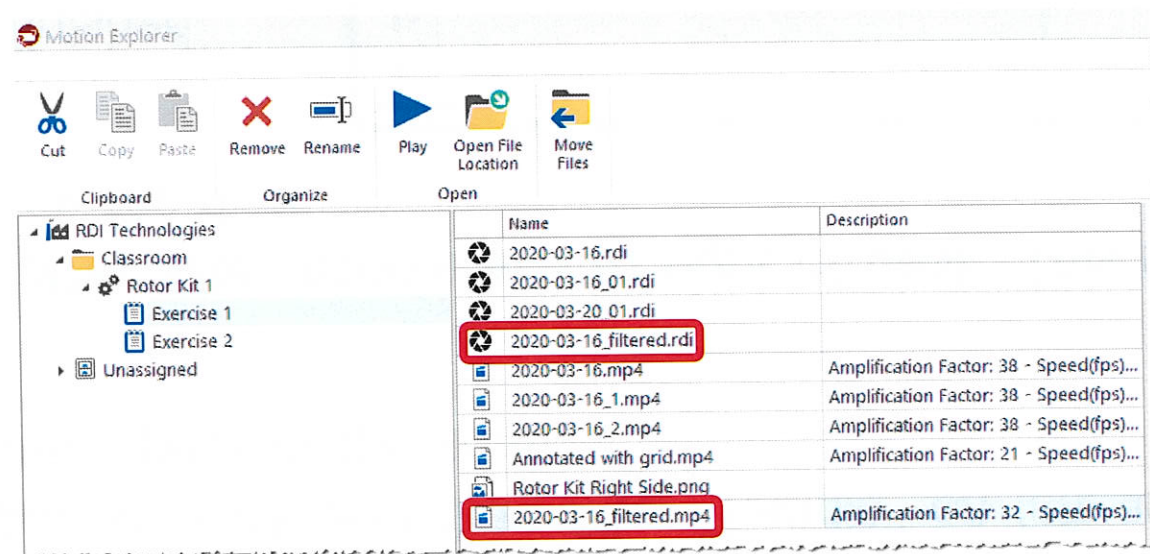
Click ***Apply*** when finished.



Exercise 15 – Frequency Based Filtering

Step 7 – Adjust Amplification slider to desired position and play filtered recording.

Step 8 – Export filtered recording using Include Only Amplified Video option.



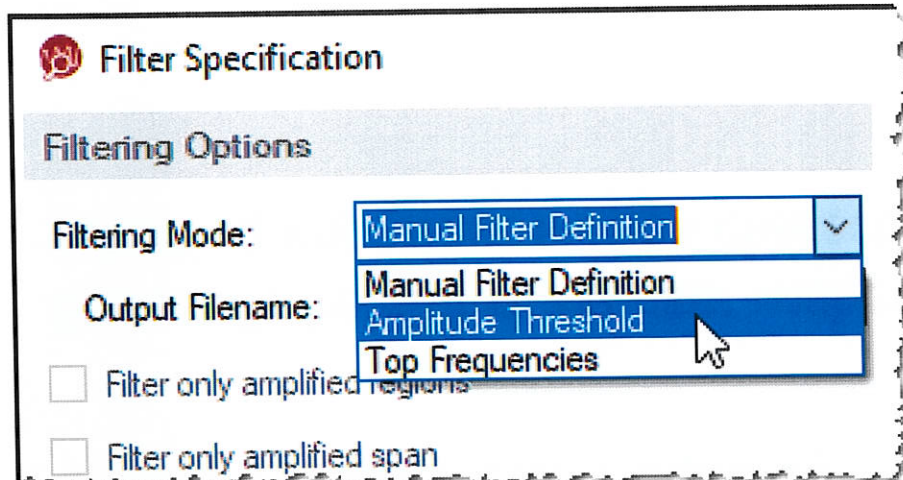
Step 9 – Exit Motion Amplification and look at Motion Explorer Window. Both filtered recording (.rdi) and filtered video (.mp4) now appear.

Amplitude Based Filtering

Another method of filtering allows users to set a band pass filter based on amplitude rather than frequency.

Especially helpful when user wishes to eliminate majority of image noise while retaining important motion characteristics of original recording.

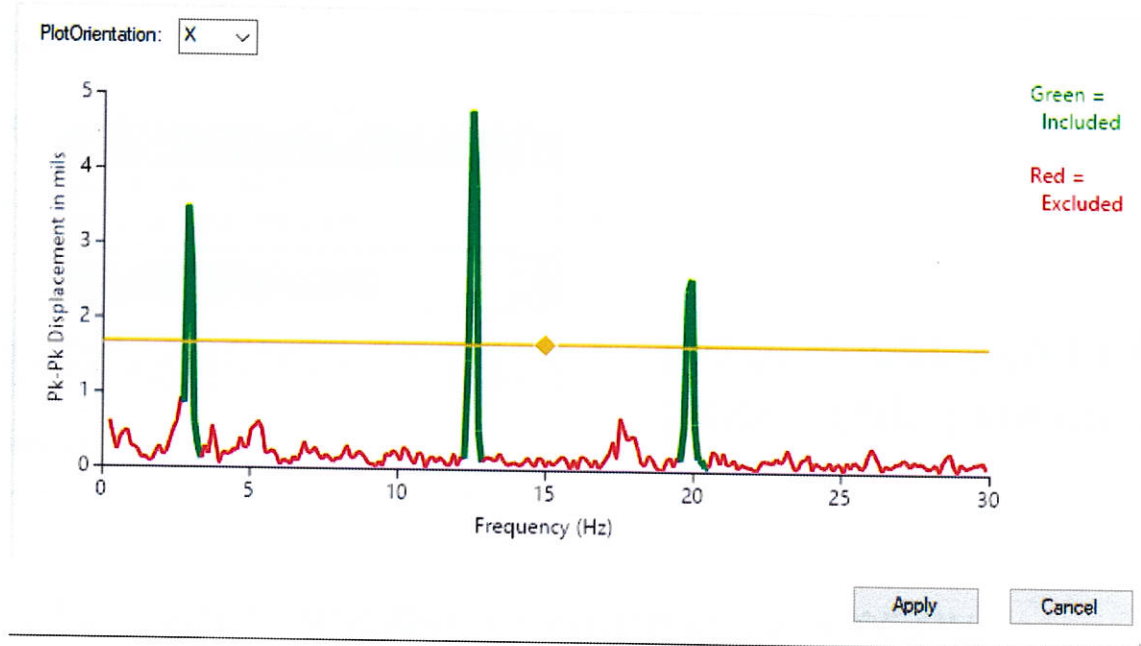
Amplitude Based Filtering



To use Amplitude Based Filtering:

Select ***Amplitude Threshold*** as Filtering Mode.

Amplitude Based Filtering



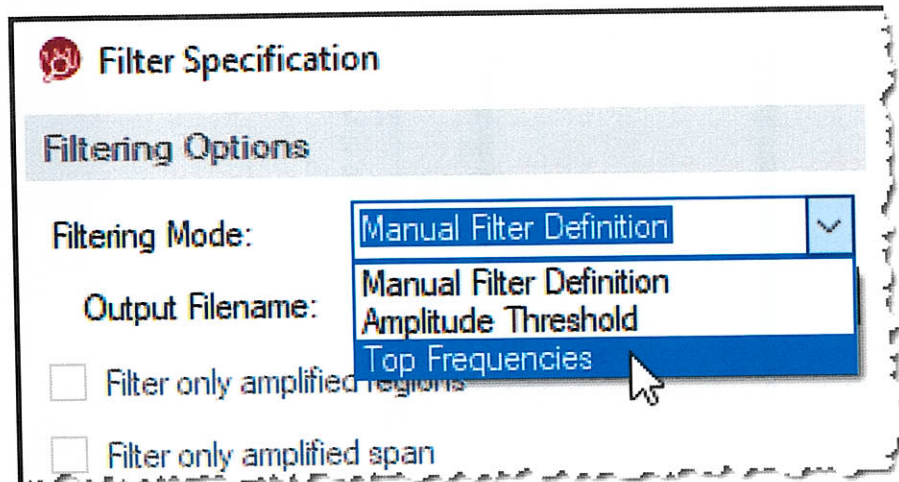
Using spectrum in Filter Specification window, drag yellow line to desired amplitude.

In this example, line has been positioned to allow only three significant peaks to pass.

Filtering Based on Top Frequencies

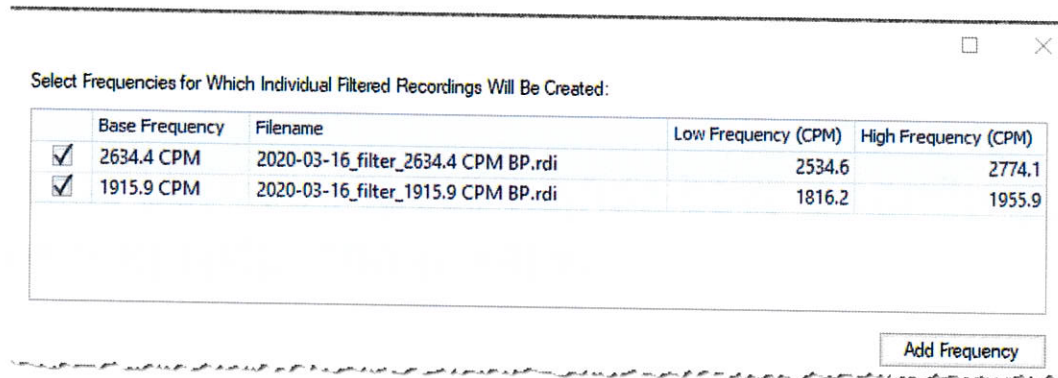
A third method of filtering allows user to set band pass filters around automatically selected peaks in spectrum.

Makes creation of multiple filtered recordings much faster and easier when multiple peaks appear in vibration spectrum.



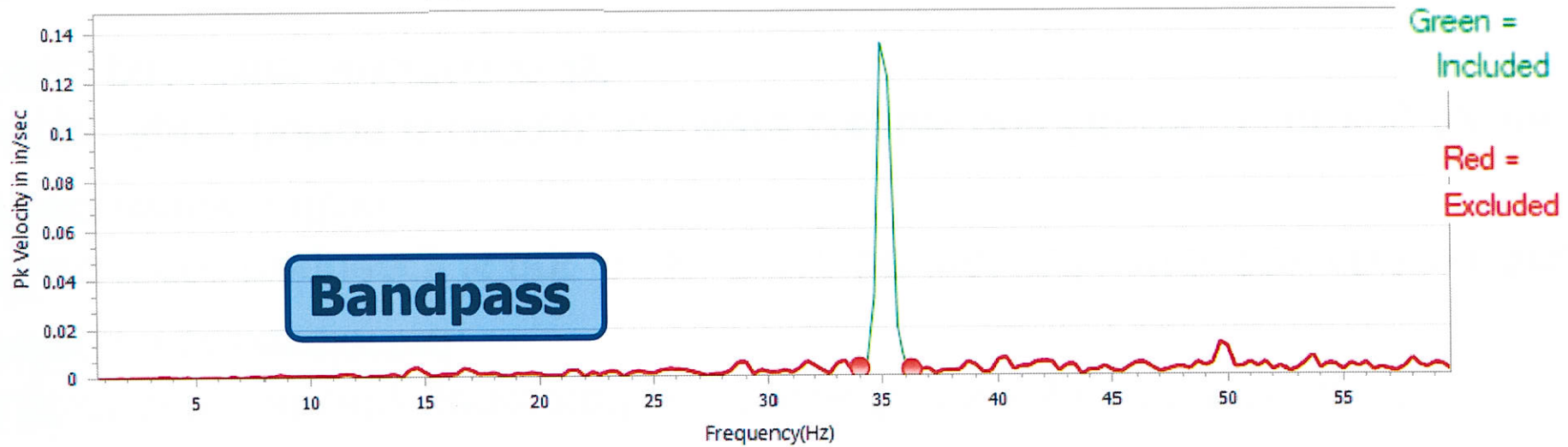
Select **Top Frequencies** as Filtering Mode under Filtering Options.

Filtering Based on Top Frequencies



- List of automatically generated band pass filters appears; each can be either selected or deselected.
- If a desired frequency is not in list, it can be manually added by clicking **Add Frequency** button.
- When Apply button is clicked, software creates one filtered recording for each band pass filter selected in list.

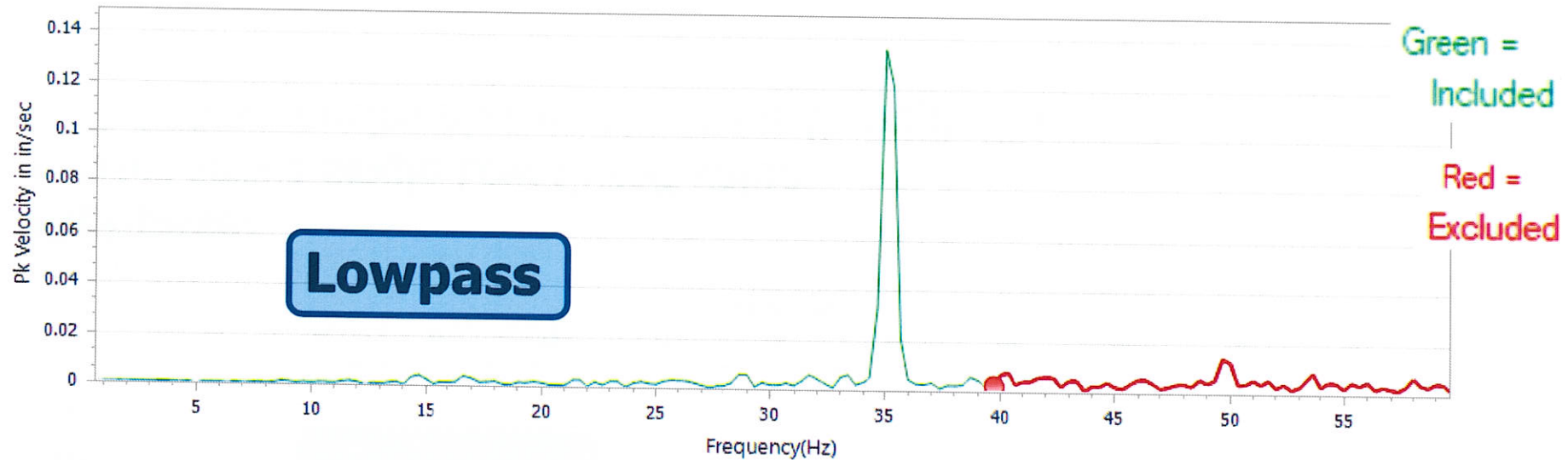
Explanation of Filter



Bandpass:

- User sets Low and High Cutoff value.
- Only frequencies between these values pass through filter.

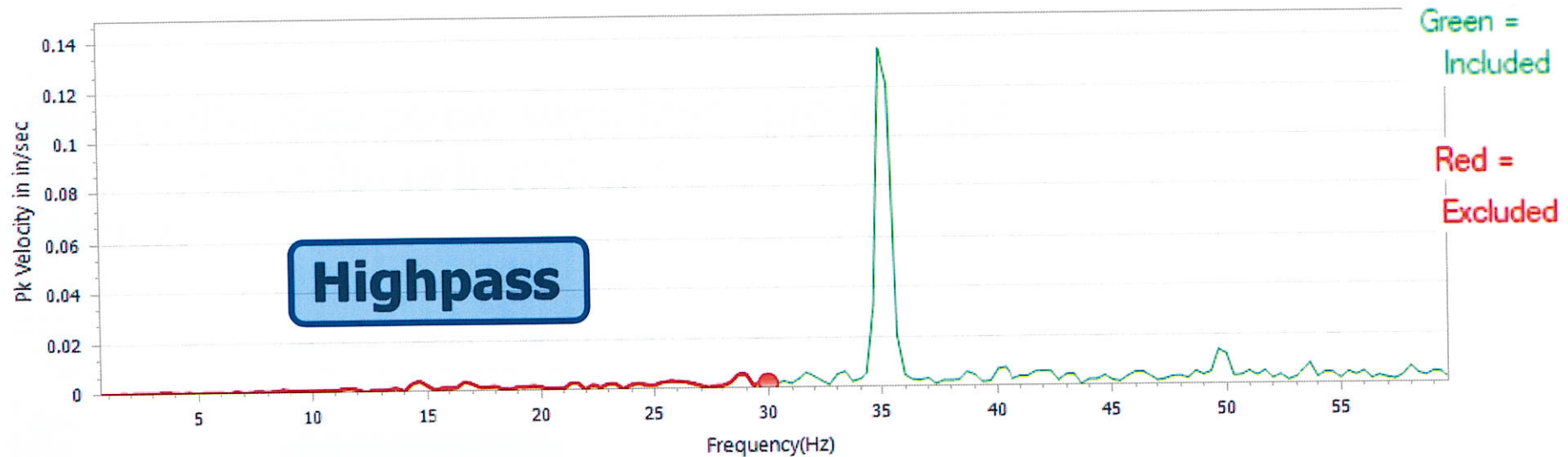
Explanation of Filter Types



Lowpass:

- User sets a single High Cutoff value.
- Only frequencies below value pass through filter.

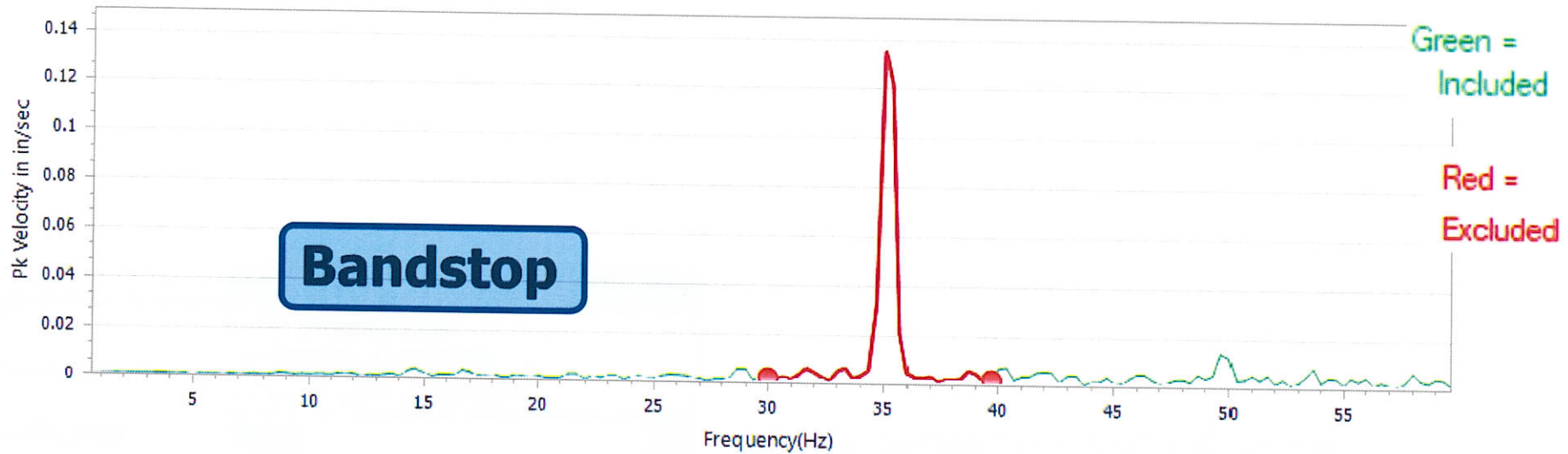
Explanation of Filter Types



Highpass:

- User sets a single Low Cutoff value.
- Only frequencies above value pass through filter.

Explanation of Filter Types



Bandstop:

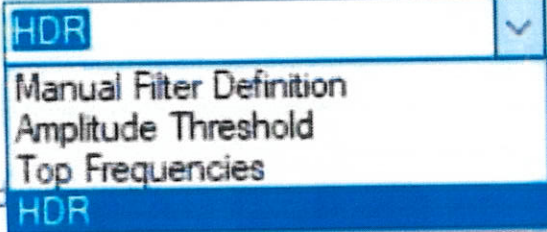
- User sets Low and High Cutoff value.
- Only frequencies below and above Low and High Cutoff values pass through filter.

HDR

Filter Specification

Filtering Options

Filtering Mode:



A dropdown menu with a blue border and a downward arrow on the right. The selected item is 'HDR' in a blue box. The menu is open, showing the following options: 'Manual Filter Definition', 'Amplitude Threshold', 'Top Frequencies', and 'HDR' (highlighted in blue).

Output Filename:

Manual Filter Definition
Amplitude Threshold
Top Frequencies

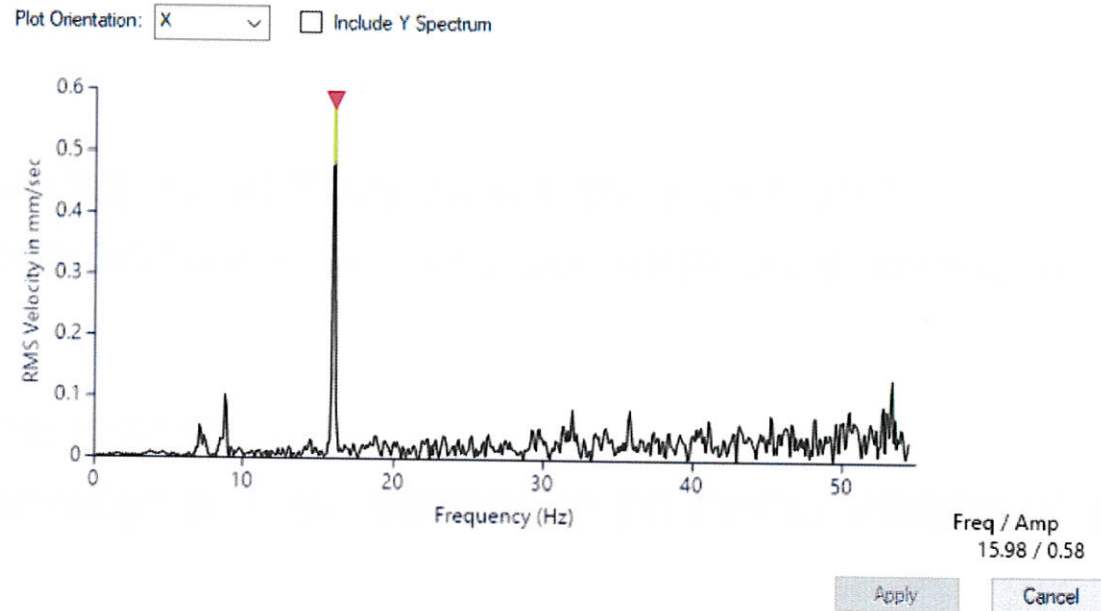
Filter only amplified

HDR

To use High Density Recording:

Select ***HDR*** as Filtering Mode.

HDR Filtering



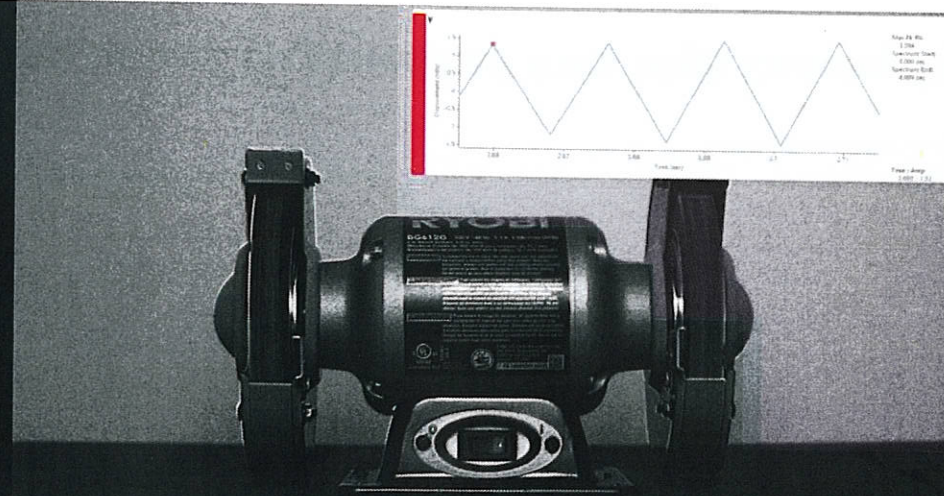
Select frequency at Filter Specification window, to which HDR will be applied.

In this example, the red arrow point is the chosen frequency.

High Density Recording

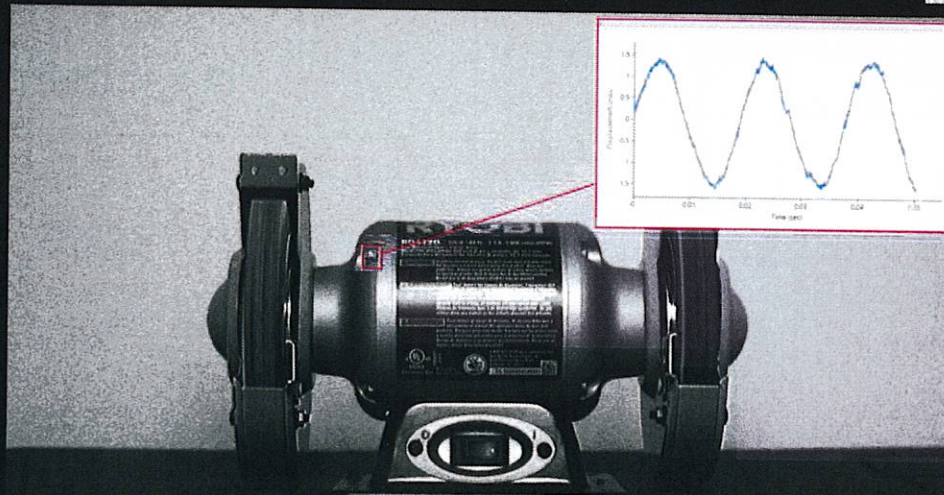
- Because framerate in most MA recordings is relatively low compared to movements being captured, video playback may seem a bit jerky at times.
- Also, vibration waveform may appear to be under-sampled, showing flat-topped or non-sinusoidal shapes.
- If smoother video playback or more accurate time waveform shape is desired, High Density Recording acquisition mode is available.

Standard
Recording
120 FPS



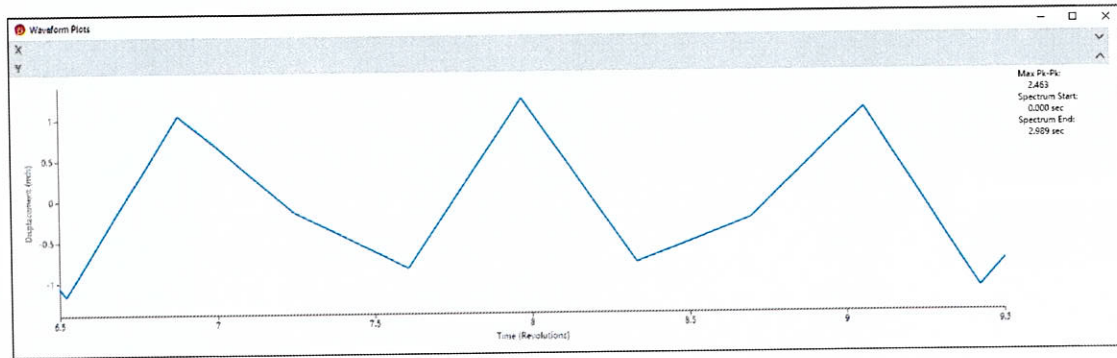
RDI
RESEARCH DESIGN INSTITUTE

High Density
Frequ of
Interest
3580 CPM

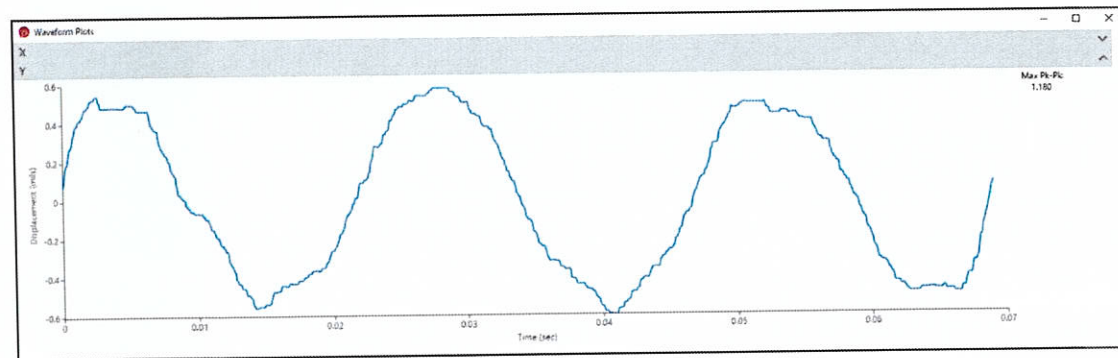
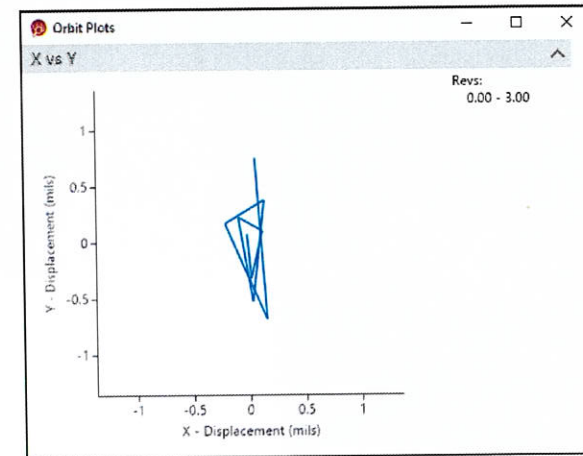


RDI
RESEARCH DESIGN INSTITUTE

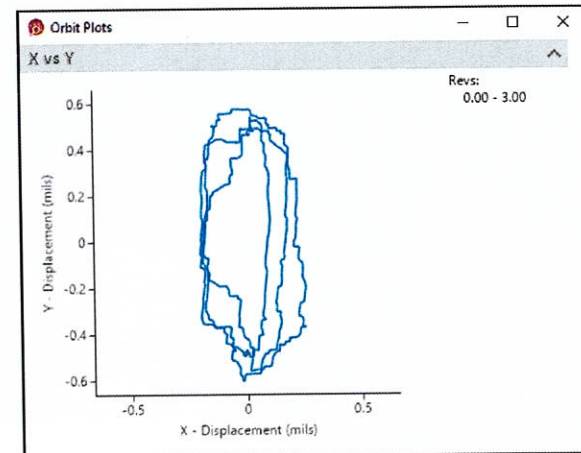
High Density Recordings render superior waveform/orbit data.



Standard (filtered) Recording.



High Density Recording.



Spectrums cannot be generated from High Density Recordings.

Exercise 20 – Phase Analysis

Traditionally two methods for acquiring phase data:

- ***Synchronous Phase***
- ***Relative or cross-channel phase***

Synchronous Phase - Vibration analyzer along with a once-per-rev pulse generator (Key sensor, or Photo-tach).

Once per rev pulse is superimposed over filtered (usually 1X Band Pass) waveform.

Difference in time between pulse and waveform high spot is converted to degrees of shaft rotation.

Exercise 20 – Phase Analysis

Relative or cross-channel phase - Overlaying two simultaneously measured, filtered (1X Band Pass) waveforms, and calculating amount of shaft rotation between high spots of the two waveforms.

Because 1x TS Band Pass Filter was applied to filtered recording in previous exercise, it can be used to assess phase relationships between virtually any two locations in recording.

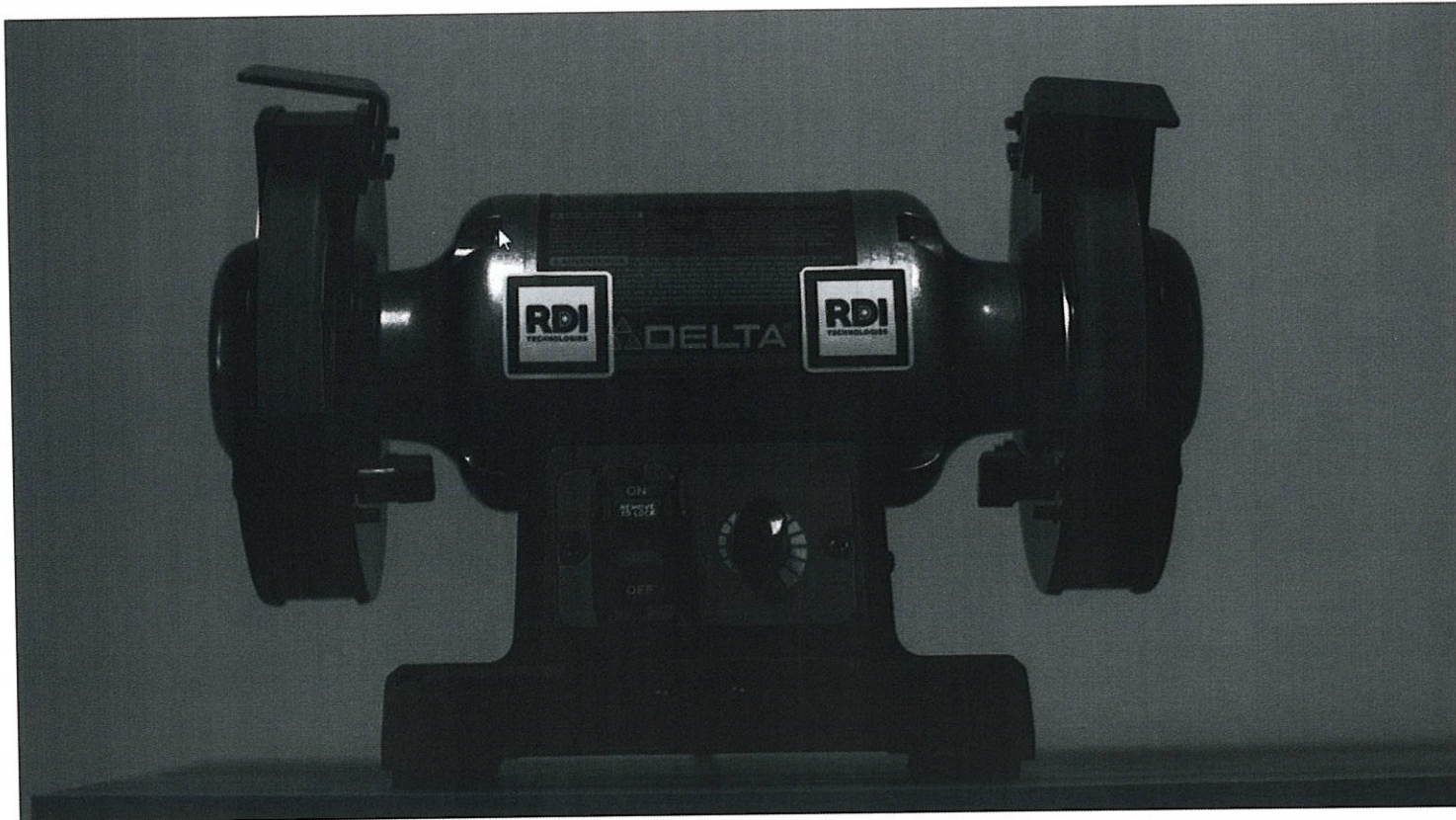
Exercise 20 – Phase Analysis

Step 1 – In Motion Explorer, highlight filtered .rdi file from previous exercise and launch Motion Amplification.

Step 2 – Draw an ROI on left side of rotor kit. ROI will be red.

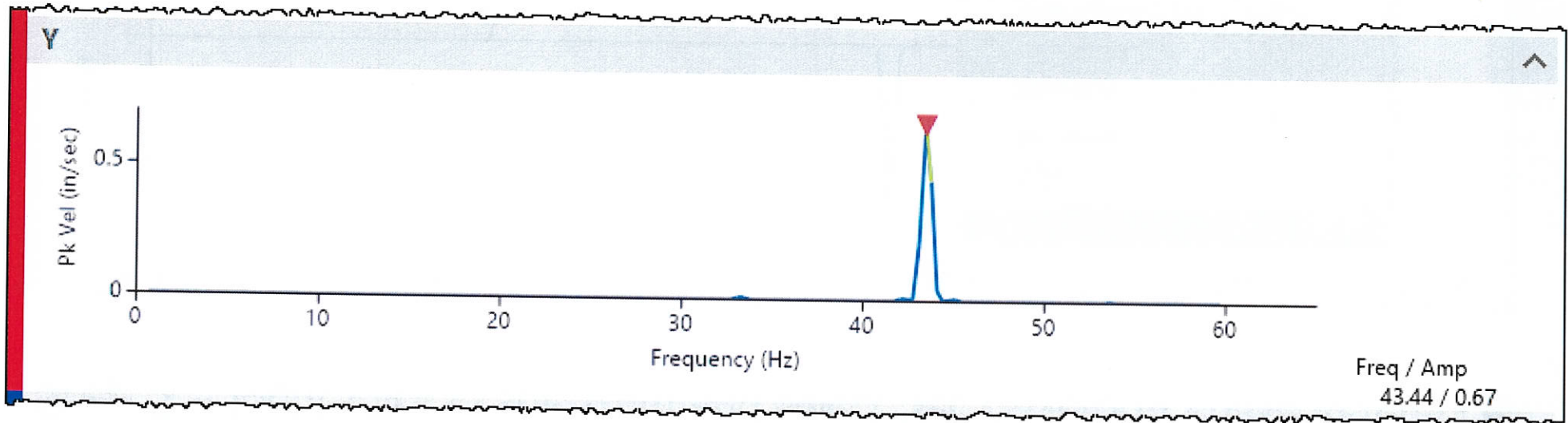
Step 3 – Draw an ROI on right side of rotor kit. ROI will be blue.

Exercise 20 – Phase Analysis



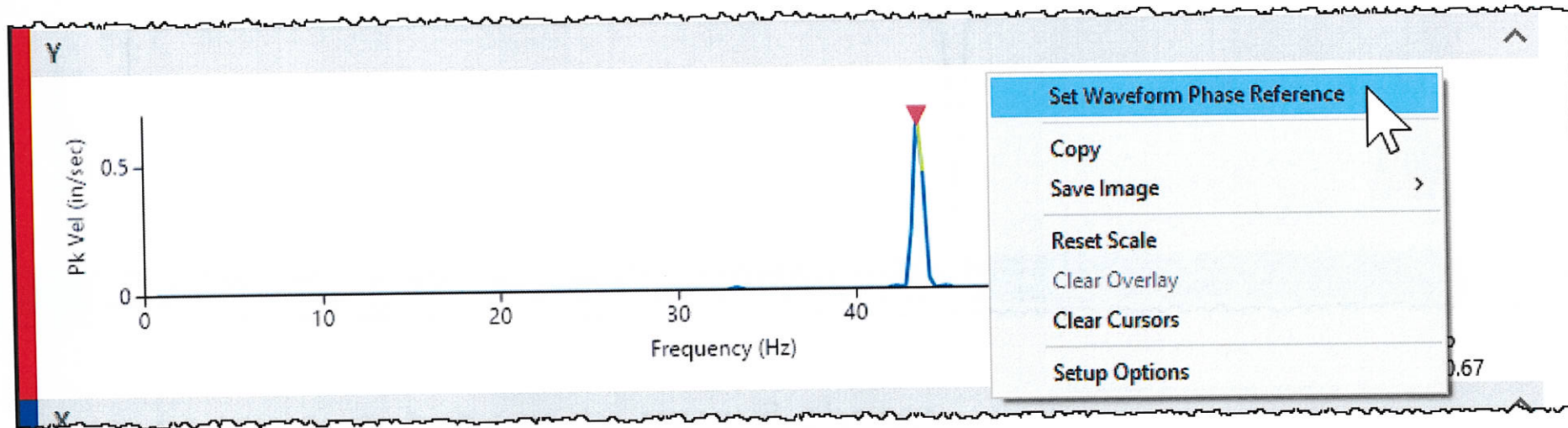
Exercise 20 – Phase Analysis

Step 4 – Left click on peak in Y-Axis Spectrum from red ROI to place a cursor at center of peak at 1x Turning Speed.



Exercise 20 – Phase Analysis

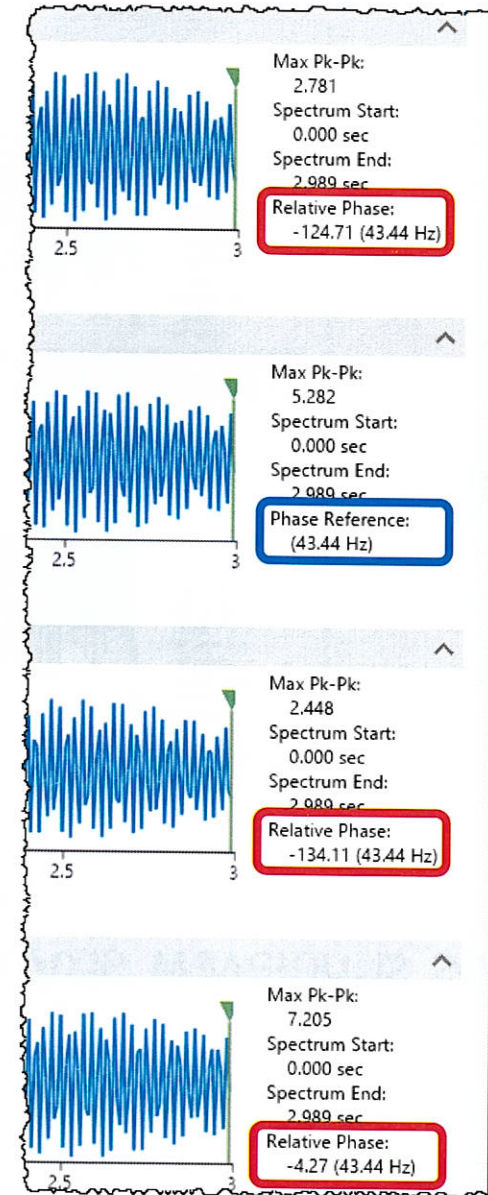
Step 5 – Right-Click in spectrum and select Set Waveform Phase Reference.



Exercise 20 – Phase Analysis

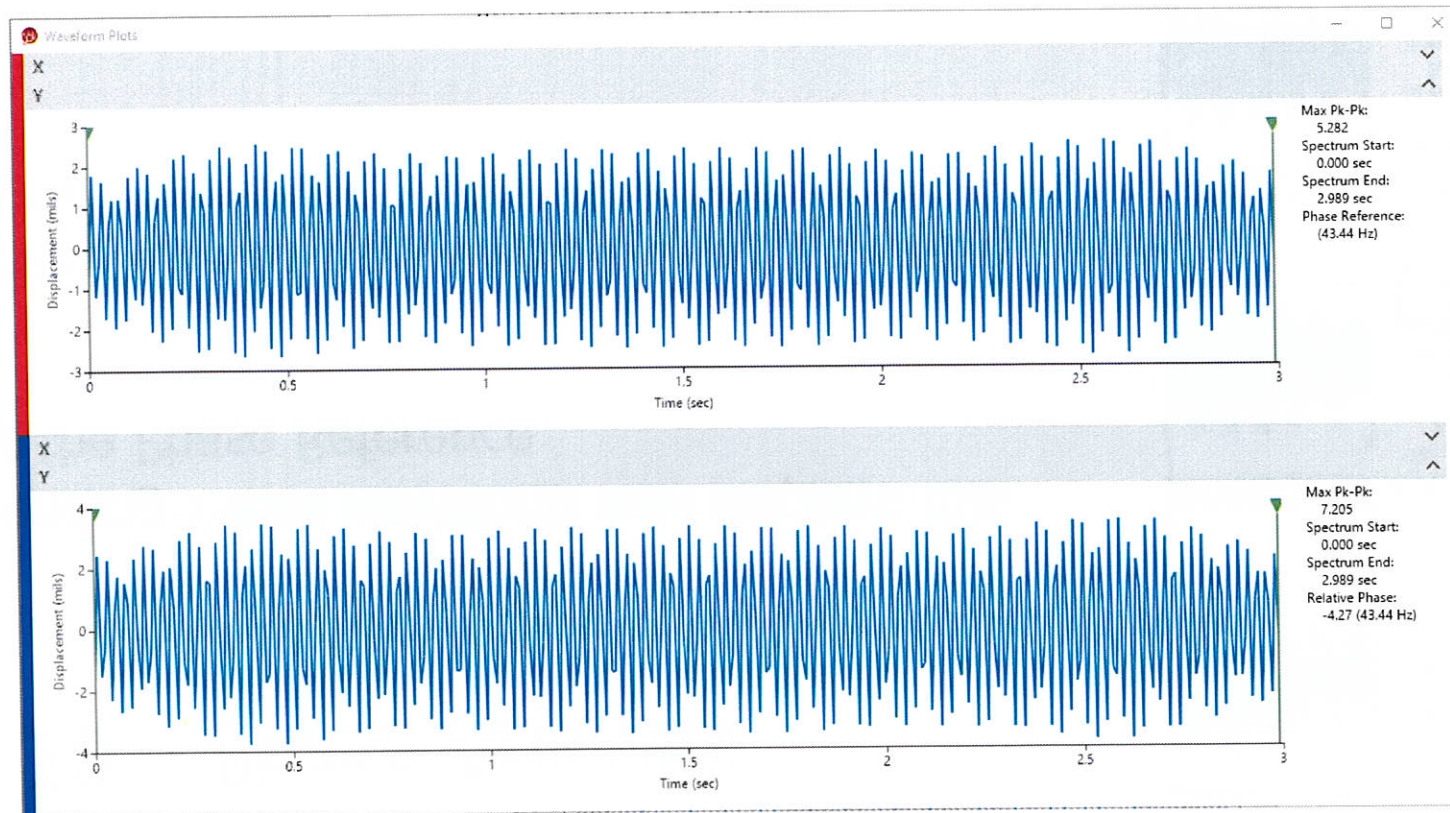
The corresponding Y-Axis waveform now displays this frequency as the Phase Reference.

Relative Phase value is now displayed in the three other waveforms based upon this Y-Axis Reference.



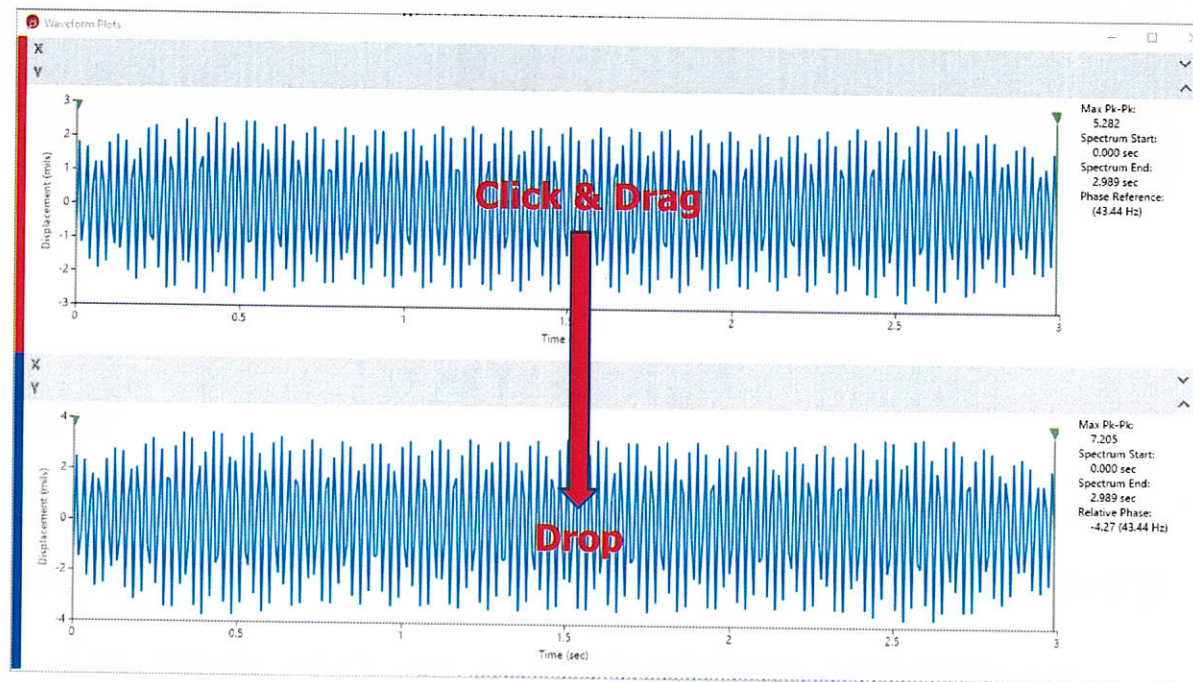
Exercise 20 – Phase Analysis

Step 6 – Click arrows at right side of window to hide X-Axis waveforms so only Y-axis waveforms appear on screen as in image below.



Exercise 20 – Phase Analysis

Step 7 – Using mouse or touchpad, drag and drop waveform at top of window onto waveform at bottom of window.

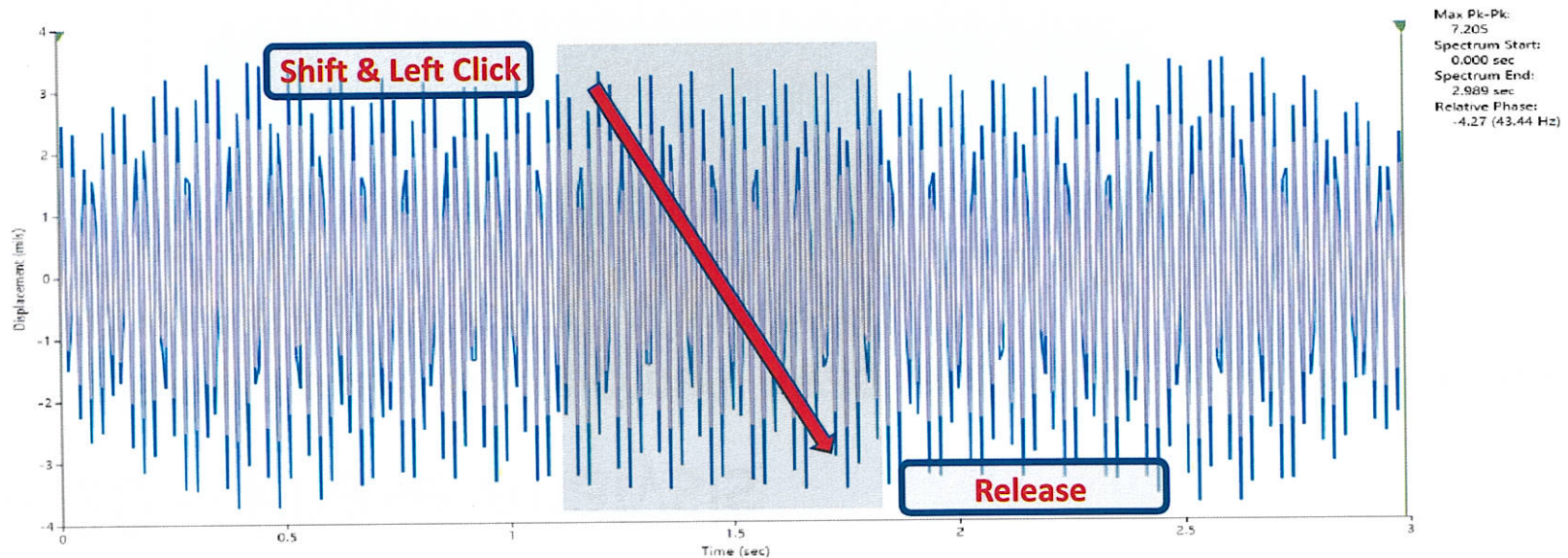


Exercise 20 – Phase Analysis

Step 8 – Zoom to a smaller section of overlapped waveforms.

Place cursor at start of zoom location, hold shift key along with left mouse button, drag downward and to right until shaded window captures desired part of waveform.

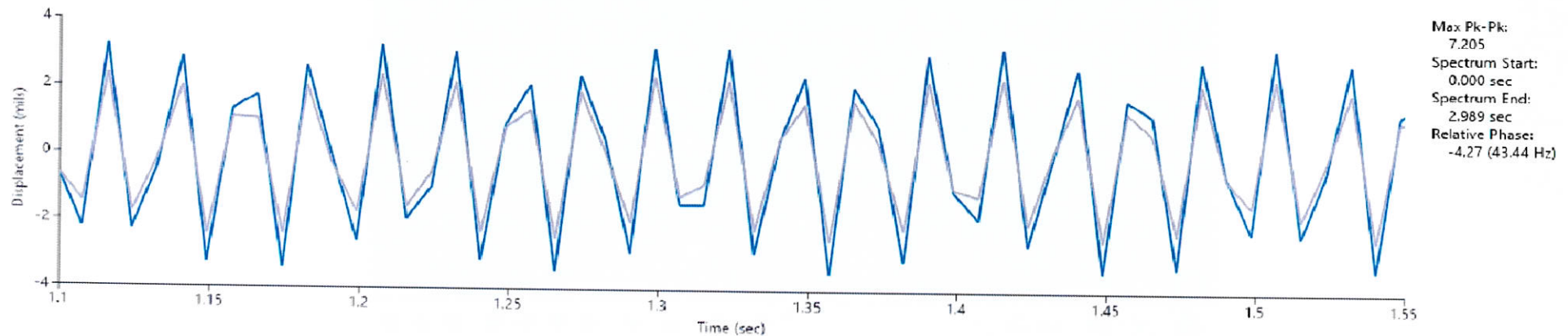
Then, release buttons.



Exercise 20 – Phase Analysis

Zoomed window appears with both waveforms overlapped.

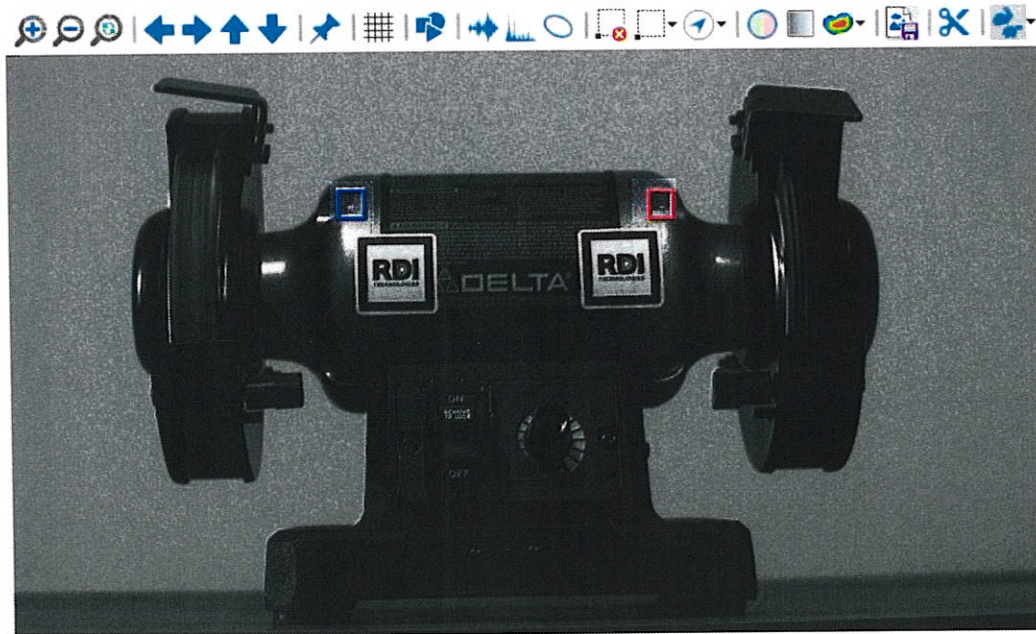
In example here, it appears two sides of rotor kit are moving vertically in phase.



Step 9 – Store image of overlapped waveform and name file “Y-Axis Phase Data”.

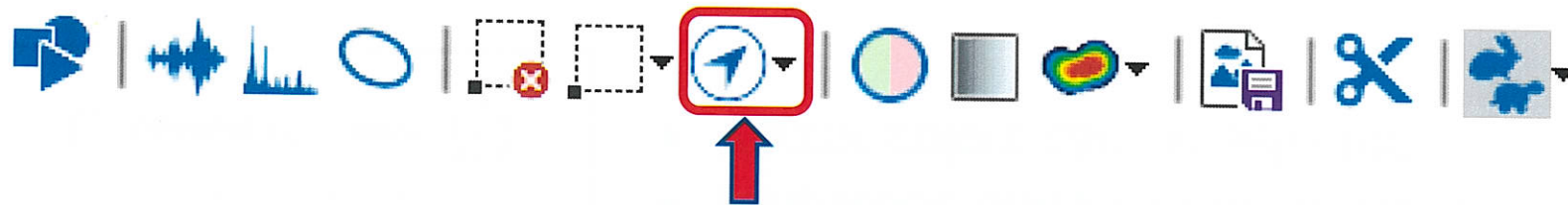
Exercise 21 – Motion Vectors

Motion Vectors provide another way to view or show phase relationships.

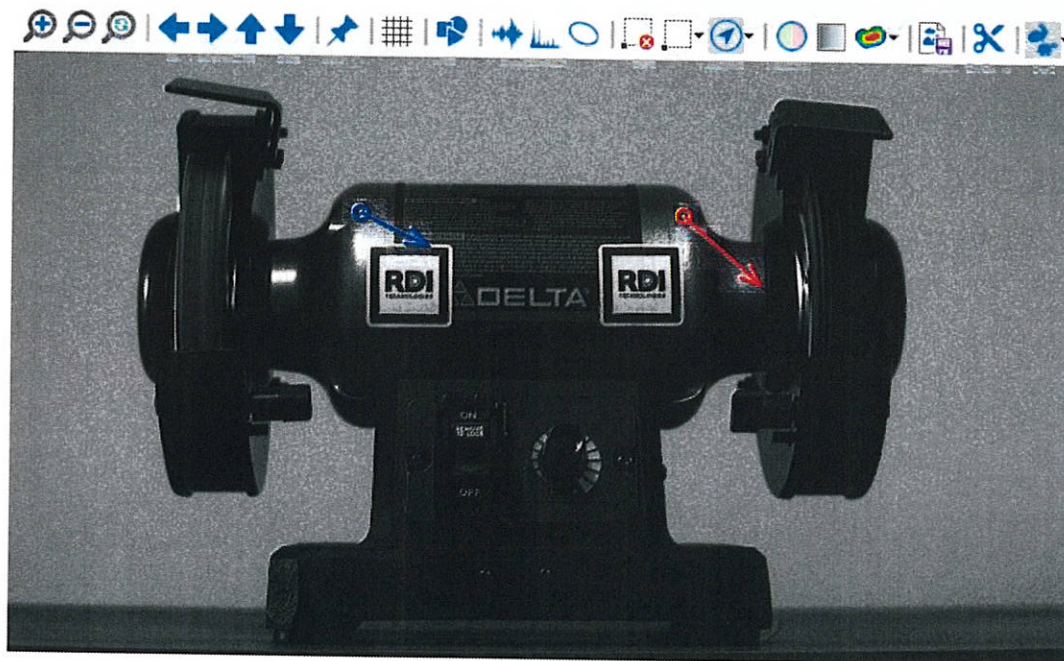


Step 1: In Motion Amplification, draw two ROI's, one on each side of rotor kit.

Exercise 21 – Motion Vectors



Step 2: Click **Show Motion Vectors** button in toolbar.

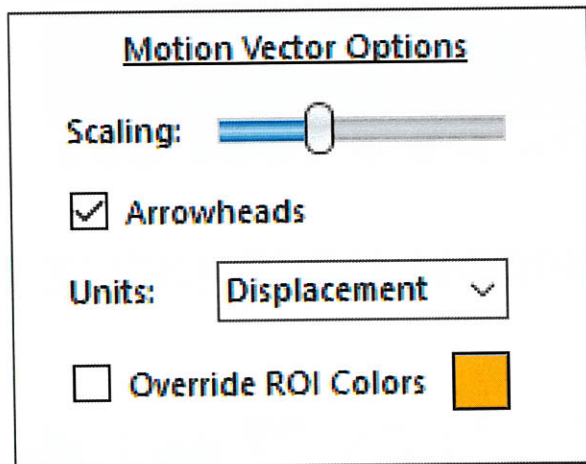


ROI's replaced with moving animated vectors

Exercise 21 – Motion Vectors



Step 3: Click arrow next to Show Motion Vectors button.



Motion Vector Options window:

- Length of vector lines can be adjusted
- Arrowheads can be added or remove
- Amplitude units can be selected
- Vector colors can be selected

Image Stabilization

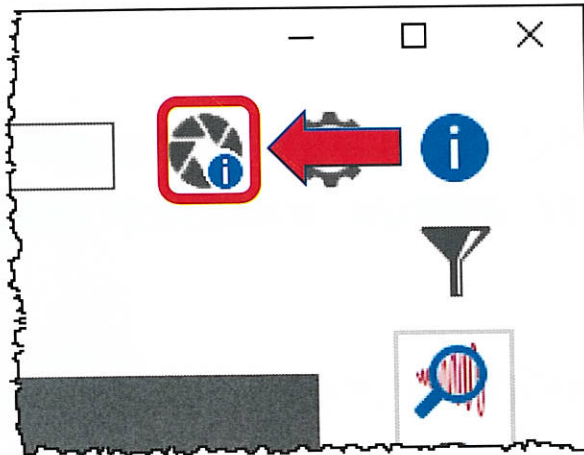
One of the most difficult environments to deal with is excessive ground or floor vibration, or wind, causes camera to shake.

When Amplification is applied, “camera shake” will be very apparent.

When camera shake is present, best course of action is to isolate camera tripod from vibration by using vibration isolation pads, or to relocate camera.

If this is impossible, stabilization may be the only course of action.

Image Stabilization





To stabilize a file, click Recording information button.

Image Stabilization

Erasing: Disabled

Camera Model: Grasshopper3 GS3-U3-23SSM

Serial Number: 18393712

Stabilized: No  

Collected Version: v2.5

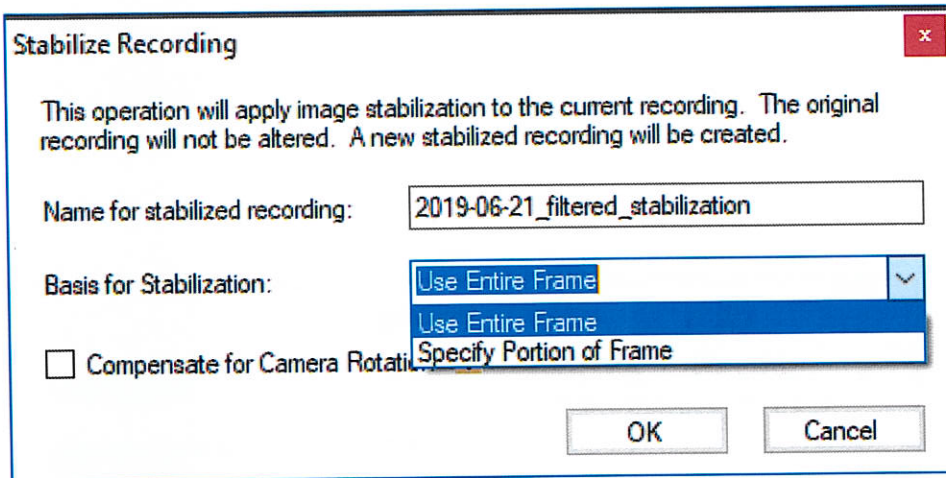
Applied Filters:

Type	Low Cutoff	High Cutoff
Bandpass	42.039	44.708

Opens "Recording Information" window.

To stabilize recording press tripod icon.

Image Stabilization

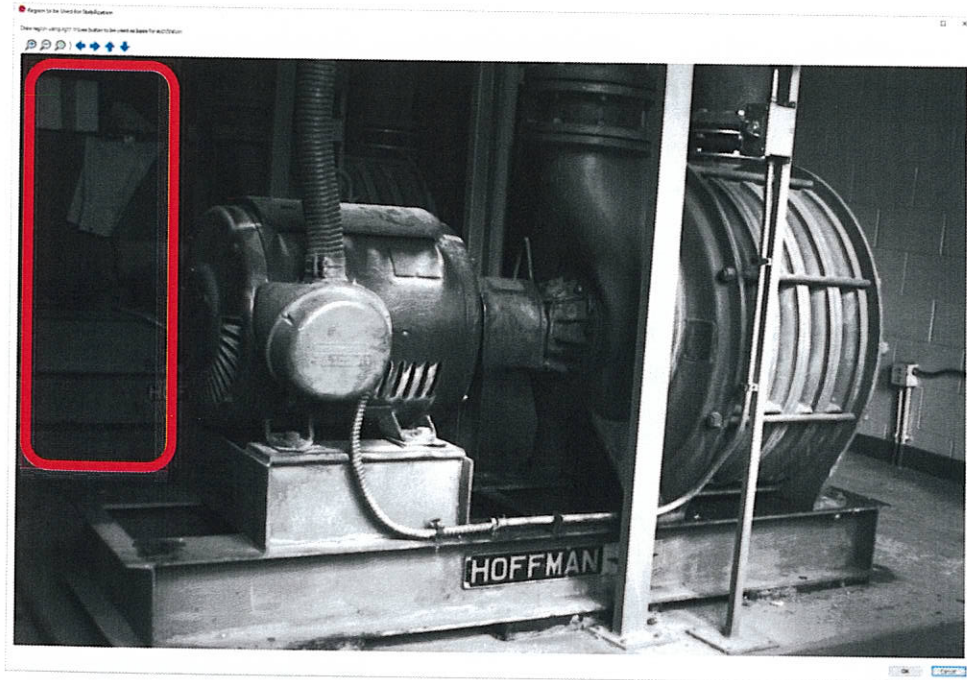


“Stabilize Recording” window will be displayed.

Users can choose between stabilizing file based on entire frame (default) or selecting a portion of frame for stabilization.

If “Use Entire Frame” is selected file will proceed to be stabilized.

Image Stabilization



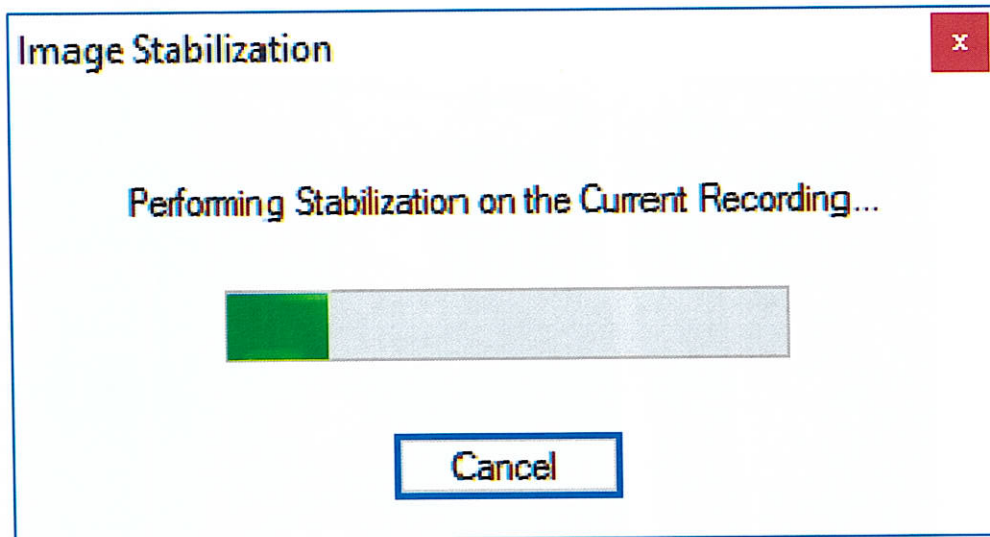
If "Specify Portion of Frame" is selected, a window showing image will be displayed.

ROI can be drawn on image telling software which portion to use for stabilization.

ROI needs to be drawn on portion of image that is not moving and works best if there is some degree of contrast.

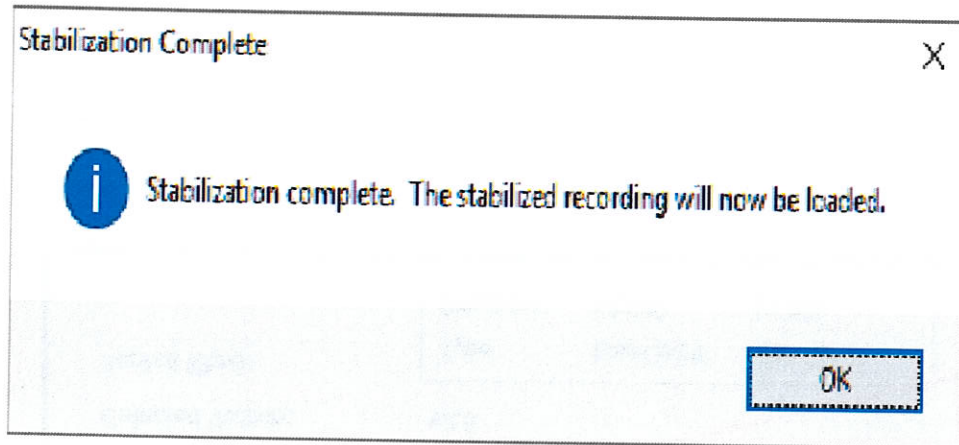
Once OK button is pressed software applies stabilization based on ROI drawn.

Image Stabilization



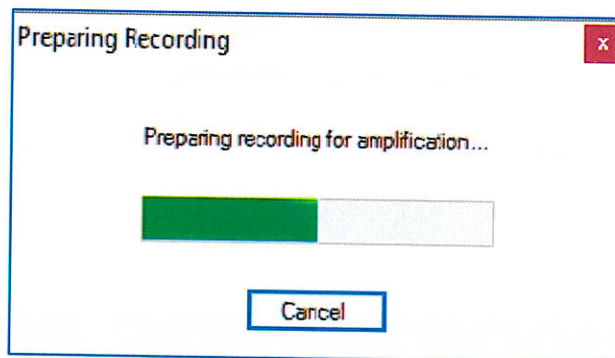
Progress window indicating stabilization occurring.

Image Stabilization



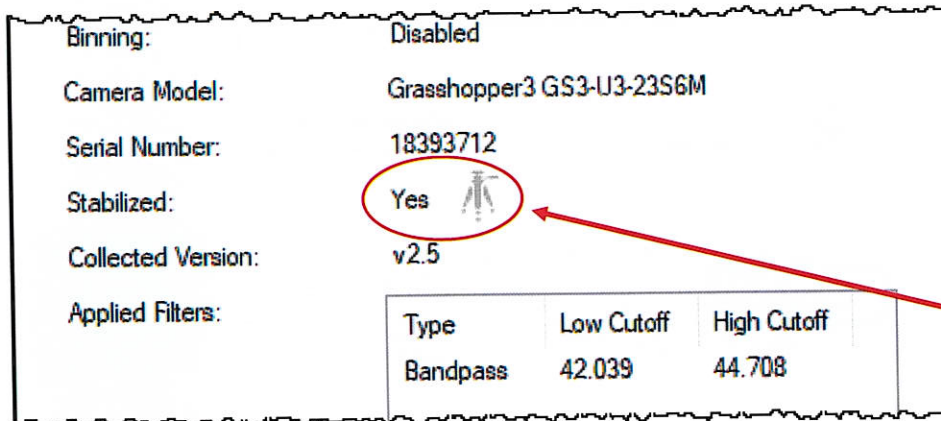
Once complete a window will appear informing user that stabilization is complete.

Original un-stabilized recording will be closed.



After closing "Stabilization Complete" window the new stabilized file will be amplified.

Image Stabilization



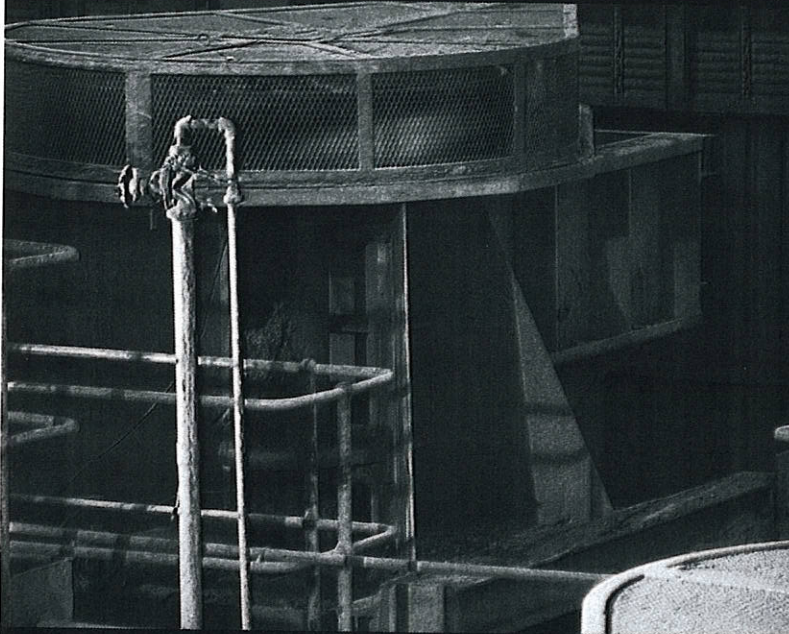
Once stabilized recording is amplified.

“Recording Information” window will still be open and must now be closed.

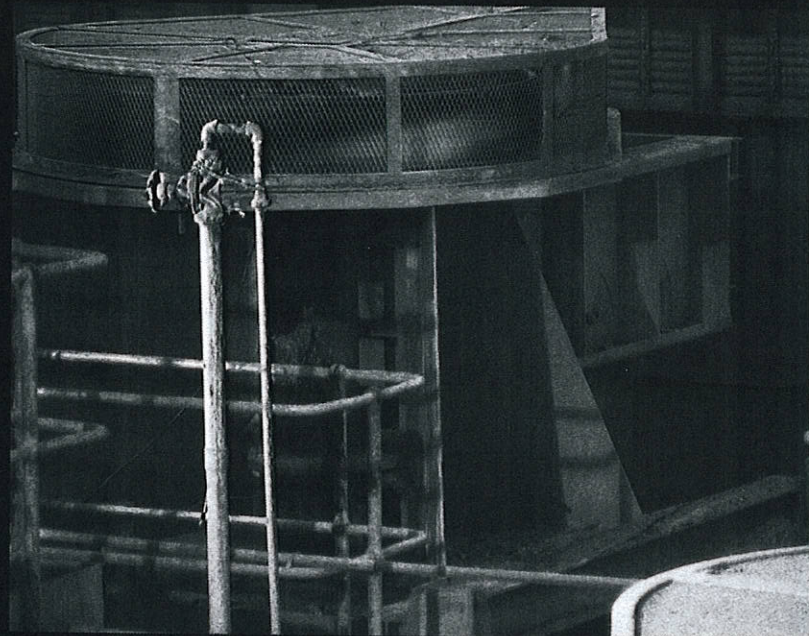
Once stabilized entry now reads “Yes”, and tripod icon appears grayed.

Digital Stabilization

Unstabilized



Stabilized



IRIS M
Enhancing Vision

Images Courtesy Visual Vibrations

RDI
TECHNOLOGIES

RDI
TECHNOLOGIES

Property RDI Technologies, Inc.

Image Stabilization – Best Practices

- Create Filtered Recording first, then Stabilized Recording.
- If camera shake is periodic and frequency is different than Analysis Frequency of Interest, a Band Pass Filter at Analysis Frequency of Interest will likely remove camera shake without need for Image Stabilization.

Image Stabilization – Best Practices

- Machine/Component = less than half of screen - “Use Entire Frame”
- Machine/Component = more than half of screen - “Specify Portion of Frame”.
- Try to stabilize first without compensating for camera rotation.
 - Need for less common
 - Takes longer

Section 5 Review

1. Are waveform displacement values affected by the Amplification Slider position in Motion Amplification?
2. How many ROI's can be drawn on a single Motion Amplification image?
3. Would motion that occurs at 30 Hz be visible in a Motion Amplification recording in which a 60 Hz Low Pass Filter was applied?
4. Does the application of a Filter permanently change the original .rdi file to which it is applied?

Section 5 Review

5. Can Acceleration in G's be selected for Waveform Amplitude Units in the General Plot Options window?
6. What is the format of the file created when a Motion Amplified video is exported?
7. Can the displacement of a rotating component be calculated in Motion Amplification by drawing an ROI on it?
8. Images acquired using gain often appear very grainy after Motion Amplification is applied. How can the Motion Amplified recording be made to appear less grainy?



Section 6

Introduction to Motion Studio

Objectives:

1. Identify Basic Functions of Motion Studio
2. Create Motion Studio Project as Class Exercise

Launching Motion Studio

RDI Motion Studio brings video editing capabilities into RDI software suite.

Build movies with:

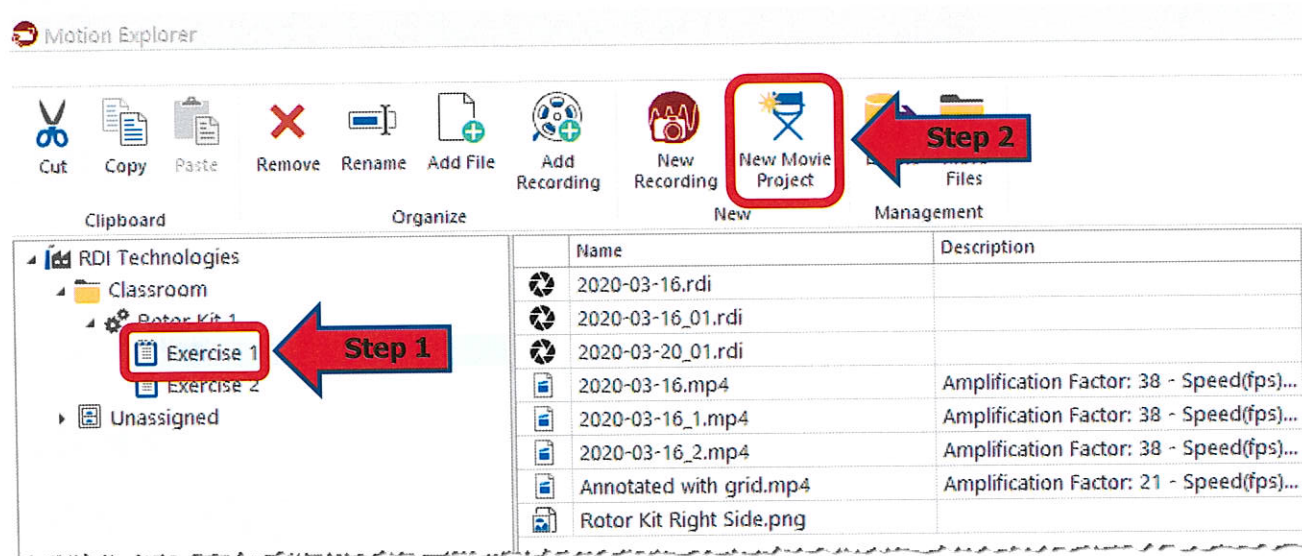
- MA MP4's.
- Still images.
- Titles.
- Annotations.

Helps tell a complete story.

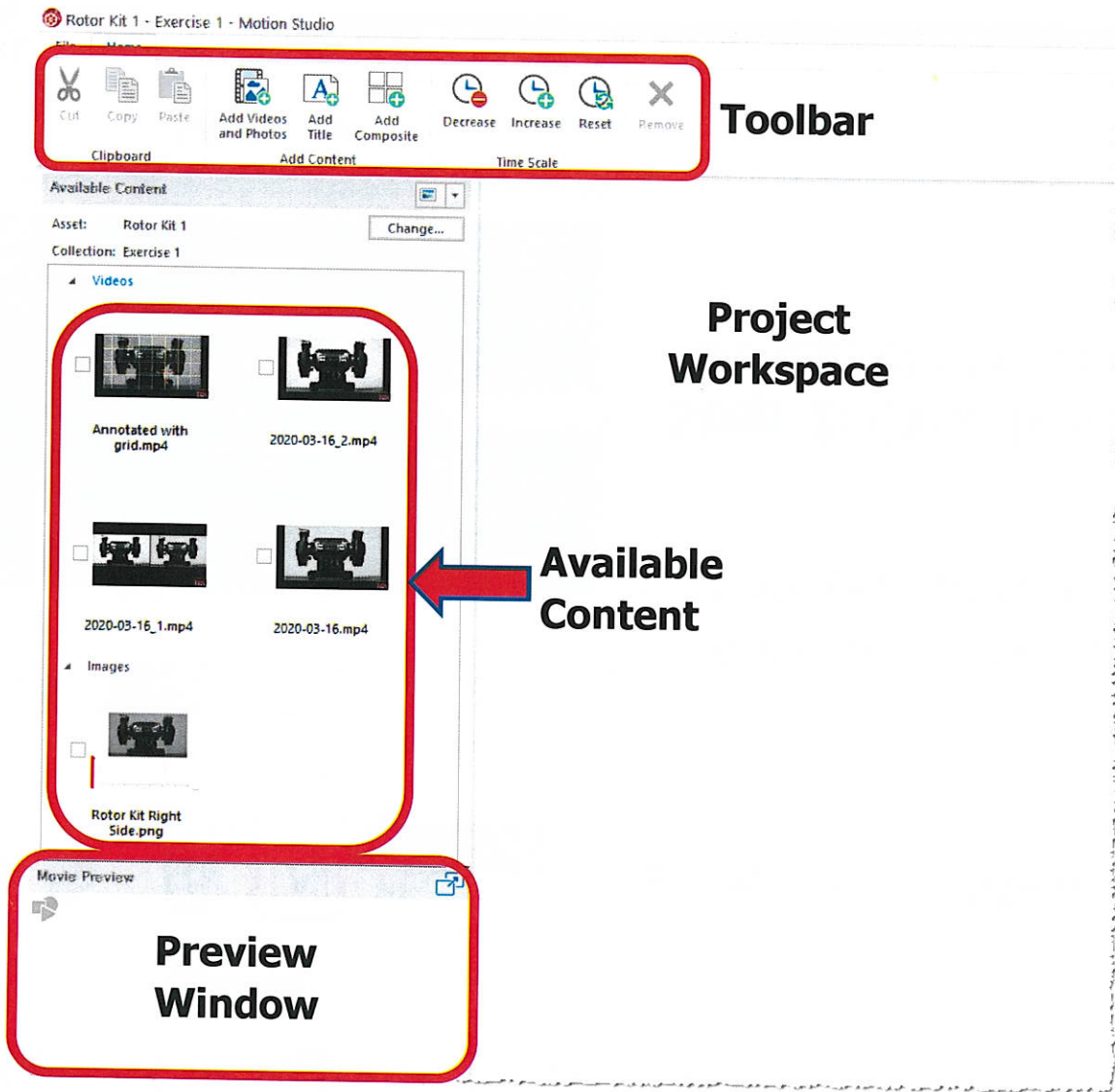
Can be launched from within Motion Explorer or from desktop.

Exercise 22 – Launch Motion Studio

Step 1 – Open Motion Explorer and Highlight collection named Exercise 1, under Rotor Kit 1 Asset in Classroom folder



Step 2 – Click New Movie Project button in Ribbon Bar. This will launch the Motion Studio application

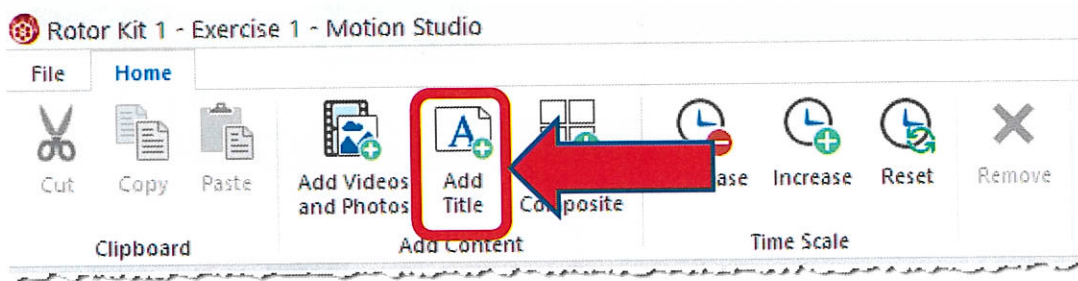


Motion Studio launches in a new window.

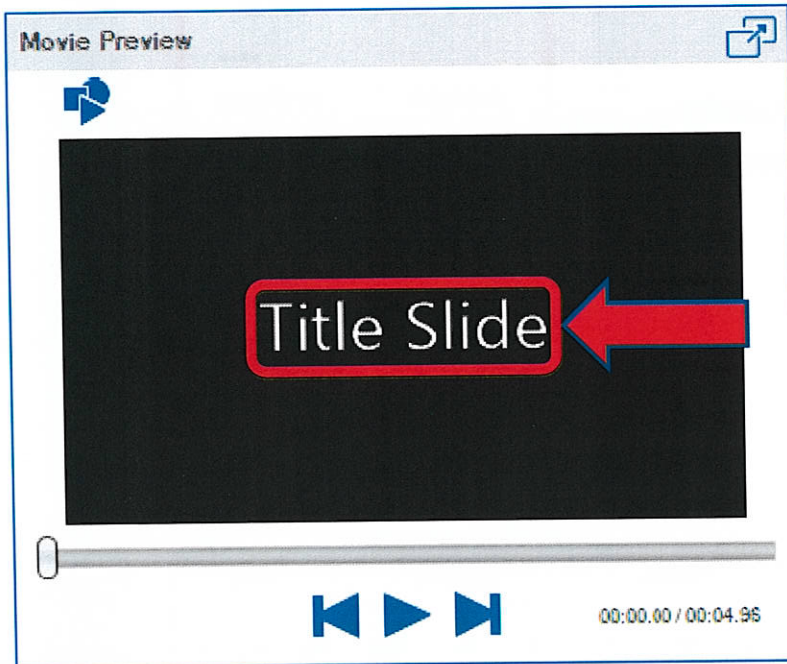
.mp4 video files and .png images associated with this collection appear in Available Content window.

These videos and images can be used to build a Motion Studio Project.

Exercise 23 – Add a Title Slide



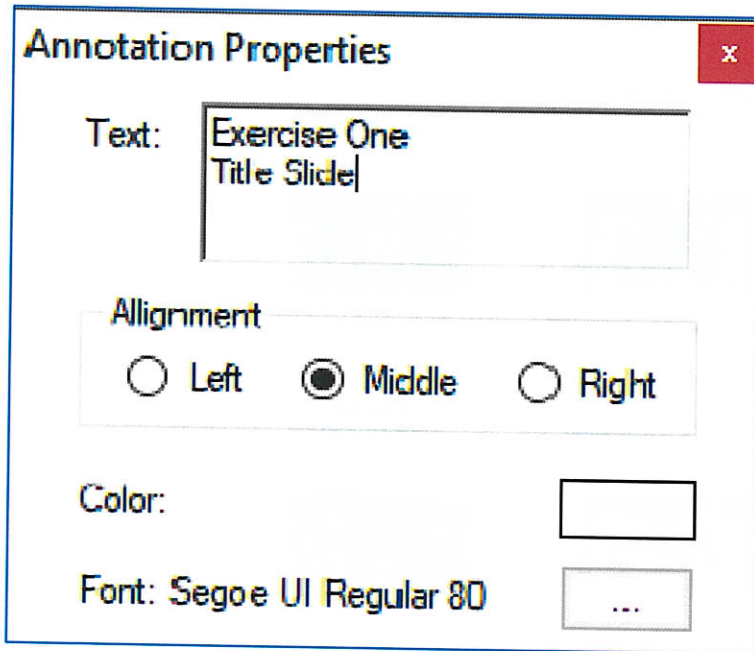
Step 1: In toolbar click, **Add Title**



A generic Title Slide now appears in Movie Preview window at lower left corner of screen.

Step 2: Click directly on words, "Title Slide" to edit text of title slide.

Exercise 23 – Add a Title Slide



Annotation Properties

Text: Exercise One
Title Slide

Alignment

Left Middle Right

Color:

Font: Segoe UI Regular 80

Annotation Properties window appears where Title Slide can be edited

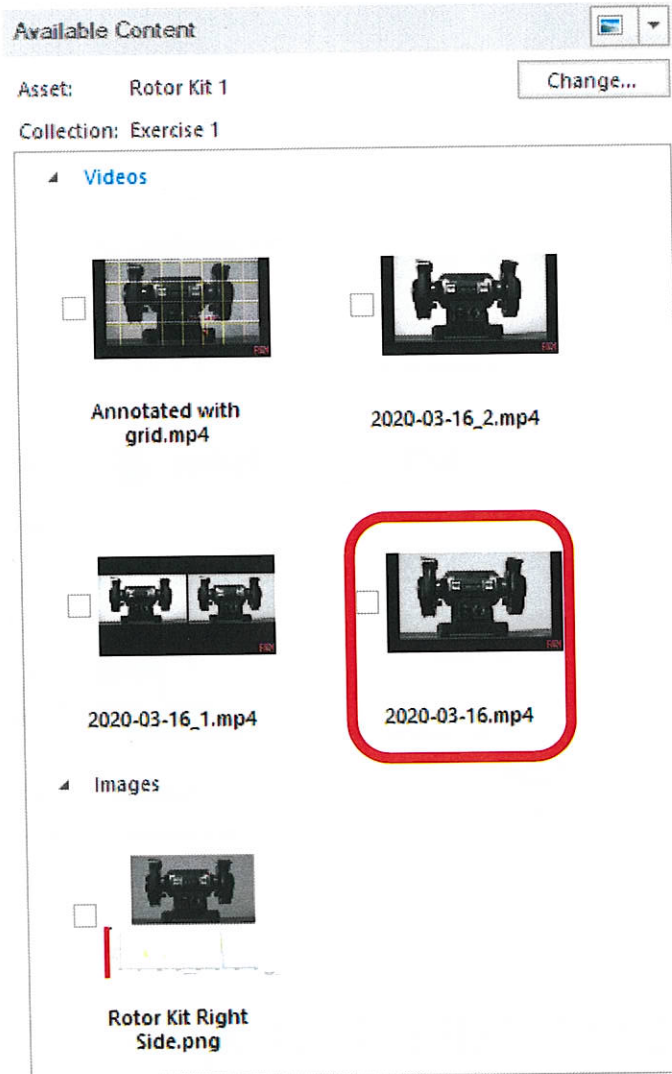
Step 3: In text field type the following:

Exercise One

Title Slide

Step 4: Close Annotation Properties window by clicking red Close button. 

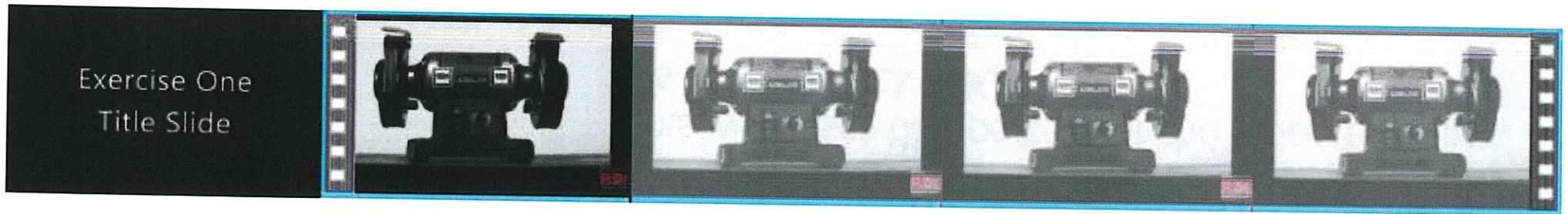
Exercise 24 – Add and Edit a Video Segment



Step 1 – Click Check box next to first video that was created in the class.

Checking box next to listed file will add that video to the project workspace.

Exercise 24 – Add and Edit a Video Segment

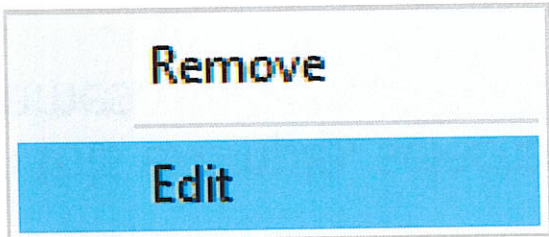


Note this single video now appears in project workspace as four identical frames.

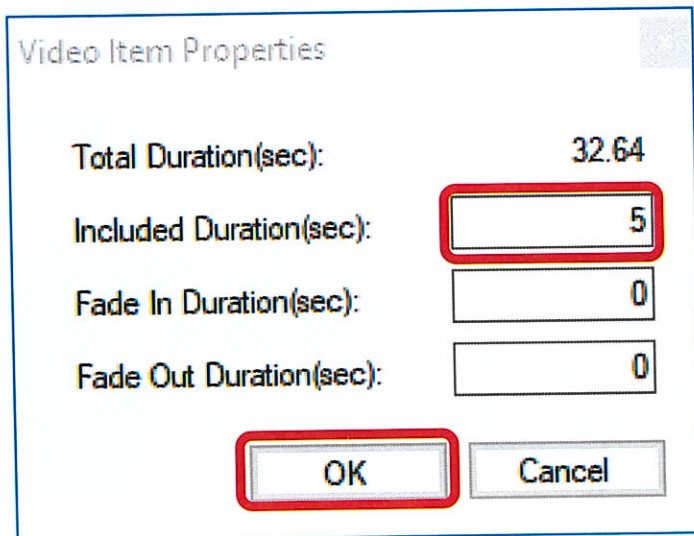
By default, each frame of video in project cannot be larger than 10 seconds.

In this example, selected video is just over 32 seconds, therefore it appears as four frames.

Exercise 24 – Add and Edit a Video Segment



Step 2 – Right click anywhere in the four frames and select **Edit**.

A dialog box titled 'Video Item Properties' with the following fields and values:

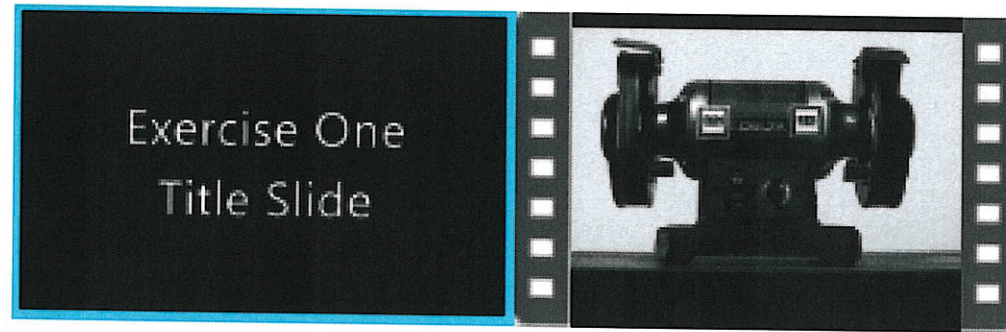
- Total Duration(sec): 32.64
- Included Duration(sec): 5 (highlighted with a red box)
- Fade In Duration(sec): 0
- Fade Out Duration(sec): 0

At the bottom, there are two buttons: 'OK' (highlighted with a red box) and 'Cancel'.

Step 3: Enter 5 in Included Duration field.

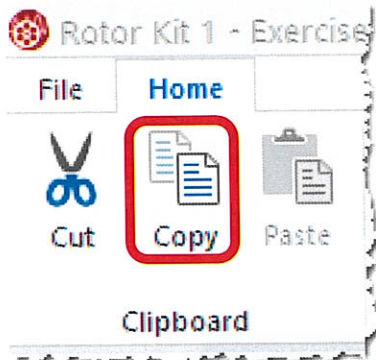
This will reset this portion of the video to only 5 seconds. Click **OK**.

Exercise 24 – Add and Edit a Video Segment

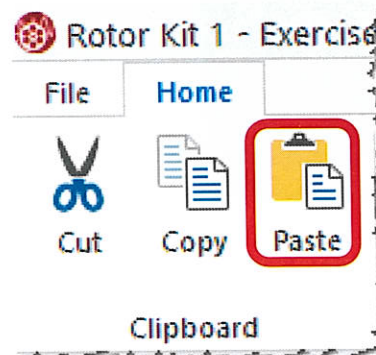


The first video segment now appears as a single frame in the project workspace because it is only 5 seconds long.

Exercise 25 – Copy, Paste, and Annotate a Video Segment



Step 1: With the first video segment selected in the project workspace, go to the toolbar and click **Copy**.



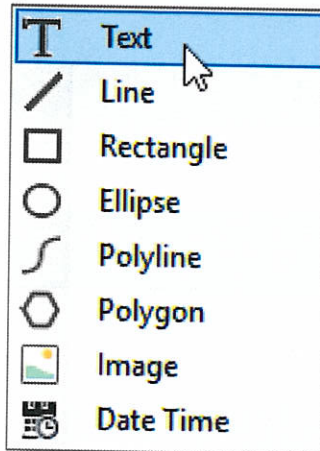
Step 2: Next, click **Paste**

Step 3: Edit new segment so that it plays for 5 seconds.

Exercise 25 – Copy, Paste, and Annotate a Video Segment

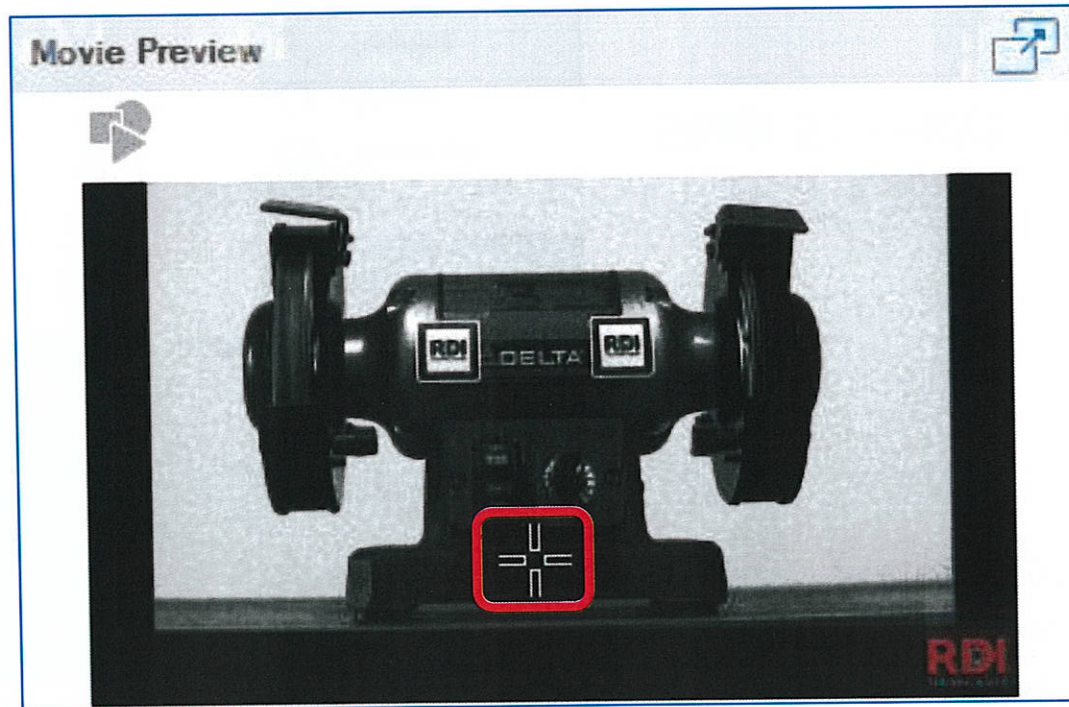


Step 4: Click on third video segment in Project Workspace and click **Annotate** Button in Movie Preview window.



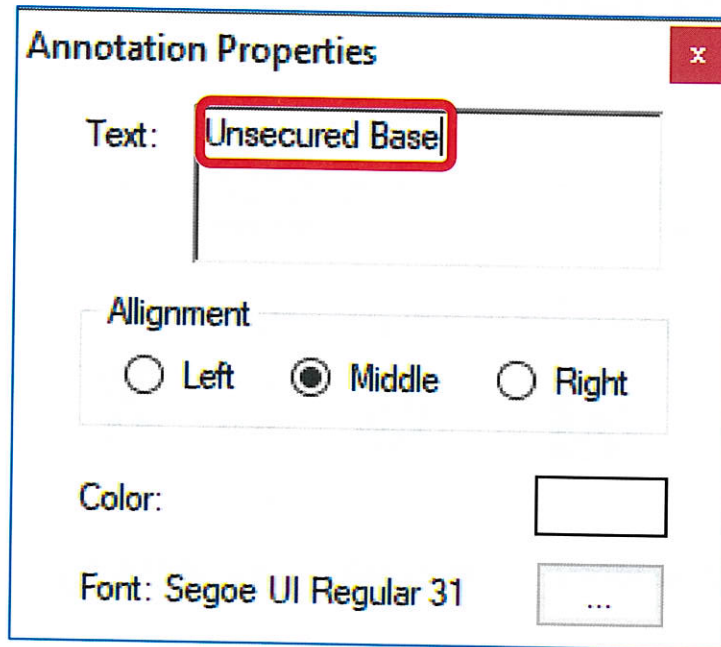
Step 5: Select **Text**.

Exercise 25 – Copy, Paste, and Annotate a Video Segment



Step 6: Move Crosshair Cursor to desired text location in Movie Preview Window and Left Click.

Exercise 25 – Copy, Paste, and Annotate a Video Segment



Annotation Properties

Text:

Alignment

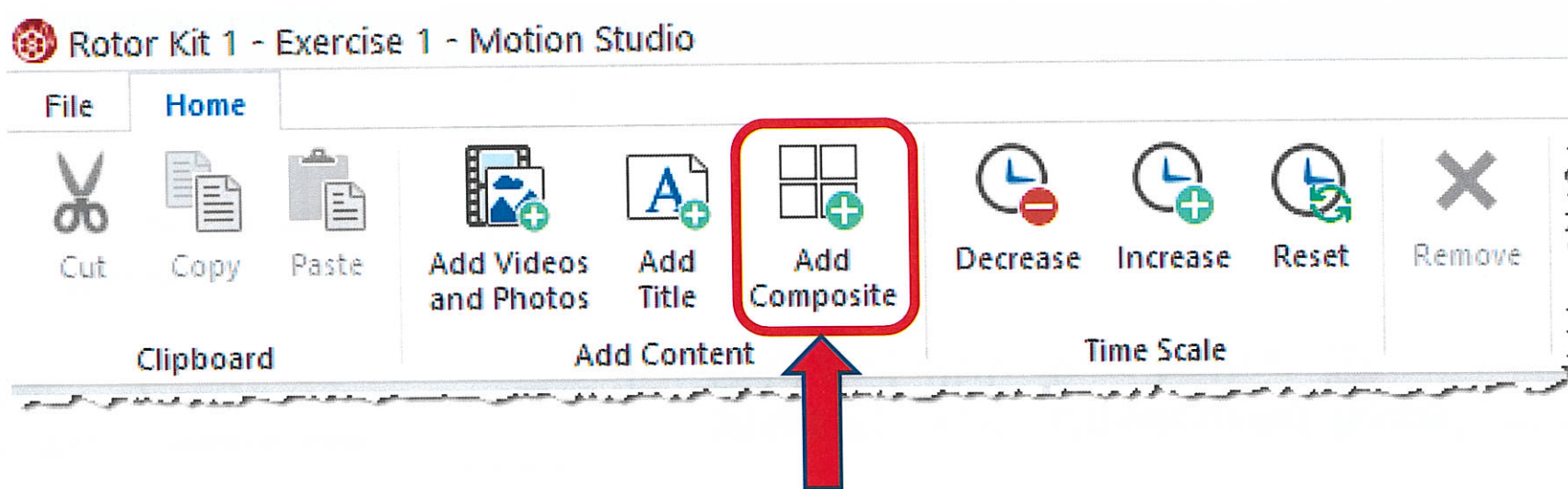
Left Middle Right

Color:

Font: Segoe UI Regular 31

Step 7: Type “**Unsecured Base**” into Text field and click close button. 

Exercise 26 – Add a Composite



Step 1: In toolbar click, **Add Composite**.

Exercise 26 – Add a Composite

Composite Tile Creation

Type of Composite Tile:

Click Inside This Box

Tile Duration(sec):

Tile Duration(sec):

Overall Duration(sec):

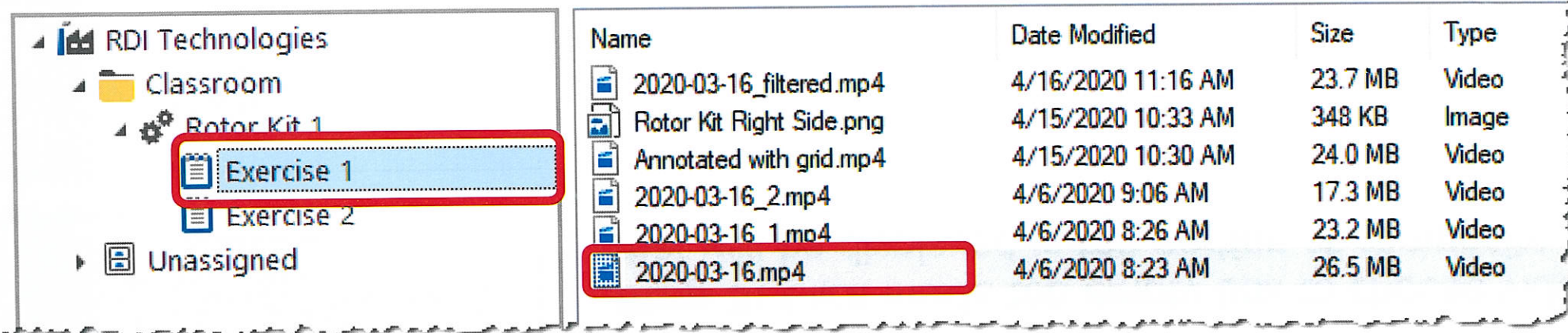
Step 2: Select Top/Bottom for Type of Composite Tile.

Step 3: Click inside top empty box to choose video that will be displayed in top portion of composite.

Exercise 26 – Add a Composite

Select File of Interest

Please select a file which you would like to add to the current project:



The screenshot shows a file selection window with a folder tree on the left and a file list on the right. The folder tree shows the following structure:

- RDI Technologies
 - Classroom
 - Rotor Kit 1
 - Exercise 1** (selected)
 - Exercise 2
 - Unassigned

The file list on the right contains the following files:

Name	Date Modified	Size	Type
2020-03-16_filtered.mp4	4/16/2020 11:16 AM	23.7 MB	Video
Rotor Kit Right Side.png	4/15/2020 10:33 AM	348 KB	Image
Annotated with grid.mp4	4/15/2020 10:30 AM	24.0 MB	Video
2020-03-16_2.mp4	4/6/2020 9:06 AM	17.3 MB	Video
2020-03-16_1.mp4	4/6/2020 8:26 AM	23.2 MB	Video
2020-03-16.mp4 (selected)	4/6/2020 8:23 AM	26.5 MB	Video

Step 4: On left side of selection window, browse to Exercise 1 collection within Motion Explorer. Next, select the original unfiltered video, click **OK**.

Exercise 26 – Add a Composite

Composite Tile Creation

Type of Composite Tile:



Tile Duration(sec): 32.64

Click Inside This Box

Tile Duration(sec):

Overall Duration(sec):

Step 5: Click inside second box to choose video that will be displayed in bottom portion of composite.

Exercise 26 – Add a Composite

Name	Date Modified	Size	Type
2020-03-16_filtered.mp4	4/16/2020 11:16 AM	23.7 MB	Video
Rotor Kit Right side.png	4/15/2020 10:33 AM	348 KB	Image
Annotated with grid.mp4	4/15/2020 10:30 AM	24.0 MB	Video
2020-03-16_2.mp4	4/6/2020 9:06 AM	17.3 MB	Video

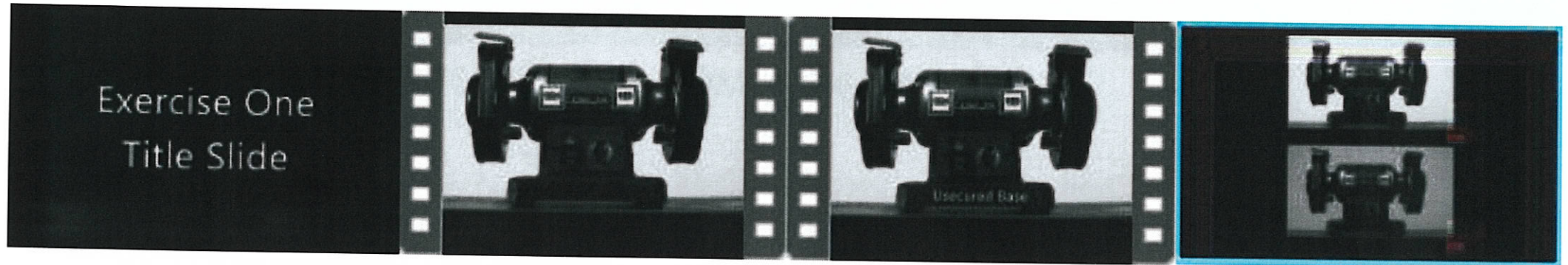
Step 6: Select Filtered Video, click **OK**.

Tile Duration(sec): 32.64

Overall Duration(sec):

Step 7: Set Overall Duration to 5 seconds, click **OK**.

Exercise 26 – Add a Composite



The Composite segment should now appear in the workspace.

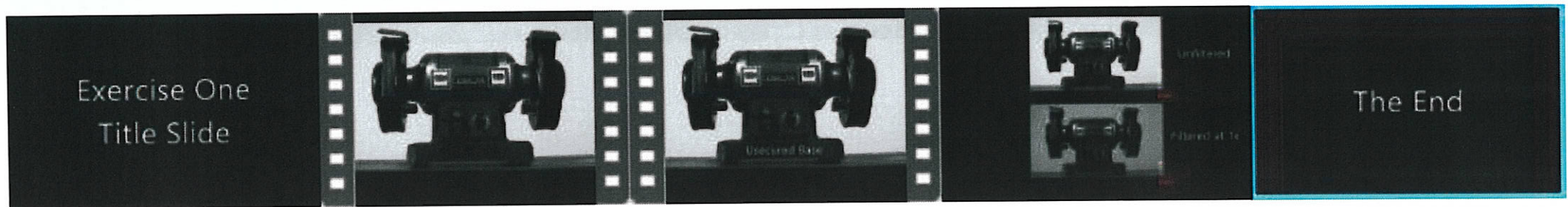
Exercise 26 – Add a Composite

Step 8: Create annotation that reads “**Unfiltered**”, position it to right of unfiltered video in composite.

Step 9: Create annotation that reads “**Filtered at 1x**”, position it to right of filtered video in composite.

Step 11: Create title slide that reads “**The End**”, place it at end of project.

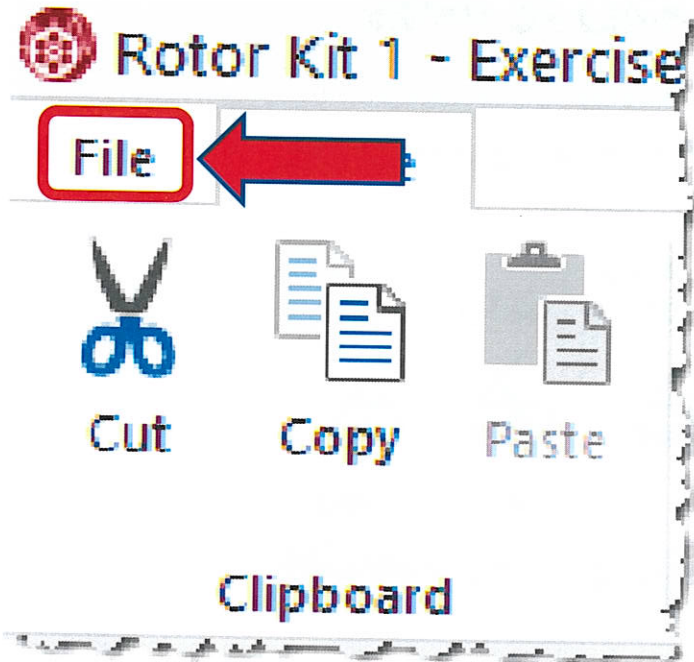
The workspace should now look like this:



Exercise 27 – Save a Project and a Movie

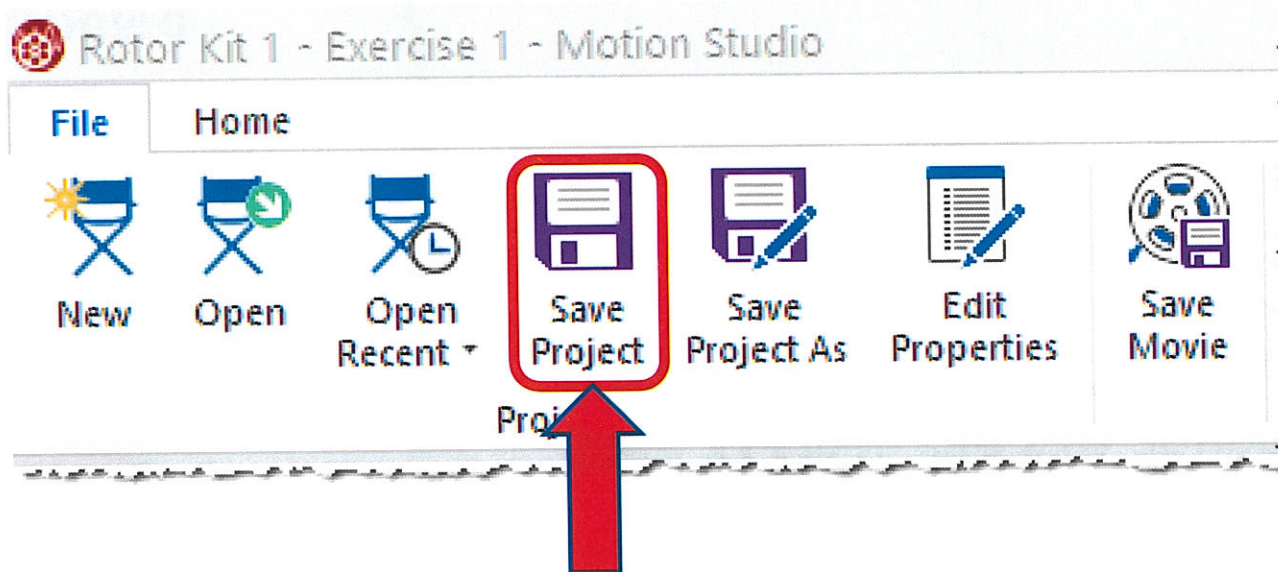
The Motion Studio Project can be saved.

To create mp4 file, use Save Movie command.



Step 1: Open **file tab** at upper right corner of toolbar

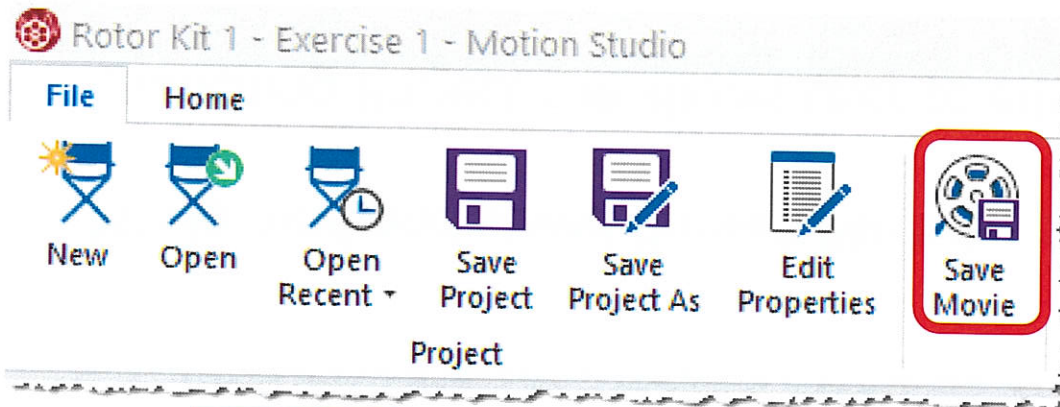
Exercise 27 – Save a Project and a Movie



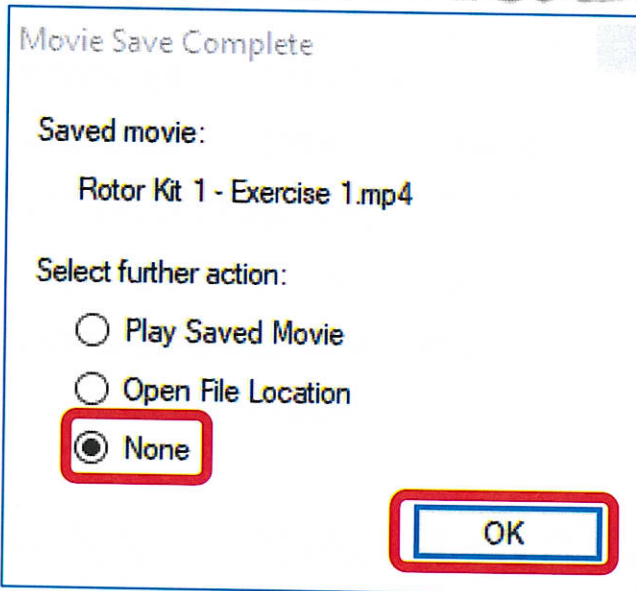
Step 2: Click Save Project.

Project has been saved and link a has been created in Motion Explorer.

Exercise 27 – Save a Project and a Movie









Step 3: Click Save Movie.



Step 4: Select None, click OK.

Step 5: Close Motion Studio.

Exercise 27 – Save a Project and a Movie

	2020-03-16_2.mp4	Amplification Factor: 38 - Speed(fps)...
	Annotated with grid.mp4	Amplification Factor: 21 - Speed(fps)...
	Rotor Kit Right Side.png	
	2020-03-16 filtered.mp4	Amplification Factor: 32 - Speed(fps)...
	Rotor Kit 1 - Exercise 1.mp4	
	Rotor Kit 1 - Exercise 1	

Movie mp4 and saved Project File now appear in Motion Explorer hierarchy.

Launching Project File allows user to edit project.

Class Project

Create a presentation using Motion Studio. You will share your project with the rest of the class when completed.

Instructions:

Using data collected in classroom and in field, **create two Motion Studio movies**. Each must include the following criteria:

- 1) Begin with a title screen using "Motion Studio Class Project Video (1 or 2)" as title. Include a second line with your name.
- 2) Include at least 6 different video segments in each presentation:
 - At least one of the segments in one of the videos needs to use Shaft Inspection or HDR.
 - All video segments using Standard Acquisition must be filtered in some way.
 - Include at least one composite segment in each video.
 - Use some kind of annotation in at least one segment.
 - Use an amplified or de-amplified area in at least one segment.
 - Include a vibration spectrum (either as a separate .png image, or as an annotation) in at least one video segment.
- 3) End each video with a title slide that reads, "The End".

Before Acquiring a Recording

The “Nower Never” 5 things to remember before pressing the **red** button:

1. **Lens** - Accurately record Lens focal length
2. **Distance** – Accurately measure and enter distance to asset
3. **Lighting** - Set correctly for environment and subject
4. **Focus** – Zoom in, focus, then zoom out
5. **Stability** – to avoid camera shake use vibration isolation pads under tripod legs and ensure that the tripod is tightened at all joints.



Section 7

Maintaining the Motion Explorer Database and Basic Troubleshooting Tips

Objectives:

1. Import, Export and Move Files using Motion Explorer
2. Discuss Basic Troubleshooting Tips

Maintaining the Motion Explorer Database

MA files are large.

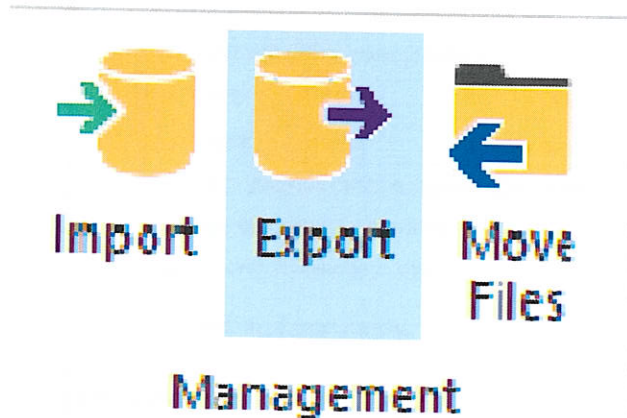
Acquisition unit has 500 GB hard drive, 80 GB used by applications. Leaving about 420 GB.

Recommended - after MA data has been analyzed and processed, it be permanently stored on either a server or a portable hard drive device.

Import, Export, and Move functions within Motion Explorer.

Exercise 28 – Data Export

Export function allows users to move a group of recordings (and collections, assets, and folders) from acquisition unit to another computer or external hard drive.



Step 1 – In Motion Explorer, highlight Classroom folder in hierarchy and click Export at top of window.

Exercise 28 – Data Export

Export Specification (Page 1 of 2)

Specify export parameters...

1) What would you like to export:

- All Collections not previously exported
- All Collections created within a date range
 - Start: Tuesday, April 24, 2018
 - End: Tuesday, April 24, 2018
- Manually select items to export

2) Type of Collection files to include:

- RDI Recordings
- Exported MP4 Videos
- All Other Files

3) Specify target location for export operation:

Export Name: RDI Technologies_export

Directory: C:\Export Example

The screenshot shows a dialog box titled 'Export Specification (Page 1 of 2)'. It contains three main sections. Section 1, 'What would you like to export:', has three radio button options. The first, 'All Collections not previously exported', is selected. Section 2, 'Type of Collection files to include:', has three checked checkboxes: 'RDI Recordings', 'Exported MP4 Videos', and 'All Other Files'. Section 3, 'Specify target location for export operation:', has an 'Export Name' field with 'RDI Technologies_export' and a 'Directory' field with 'C:\Export Example'. A blue selection box is visible at the end of the directory field. Red arrows point from the instructions on the right to these specific elements: the first arrow points to the selected radio button, the second to the checked checkboxes, and the third to the blue selection box.

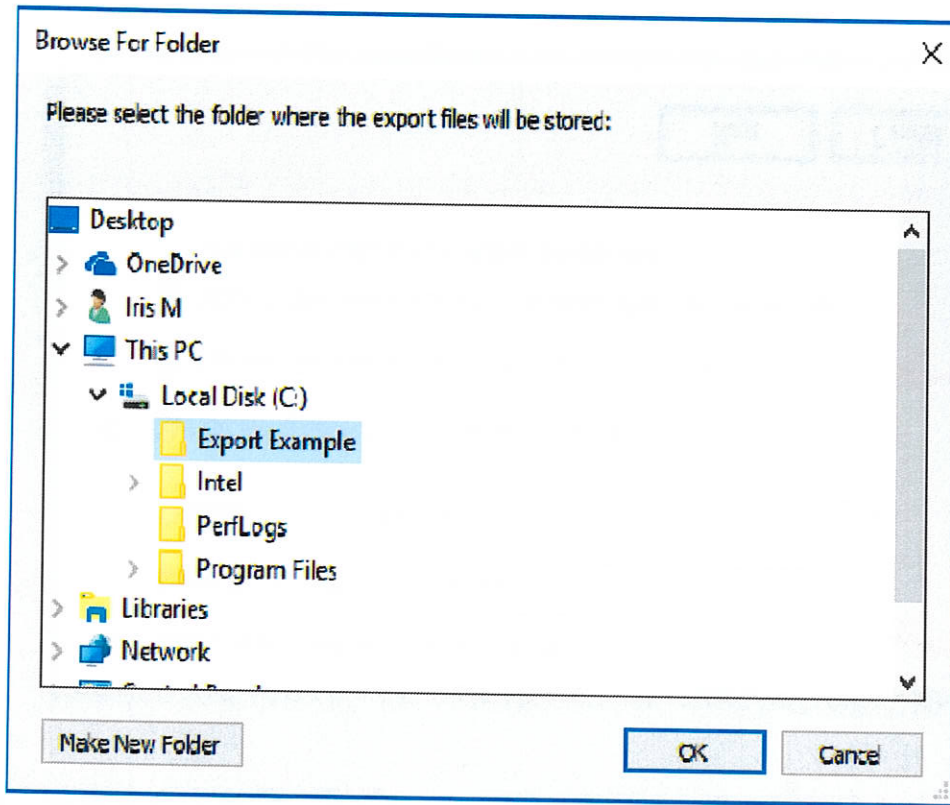
Step 2 – Make following selections:

1) Select "All Collections not previously exported".

2) Check all three boxes.

3) Leave default export name, and then click selection box...

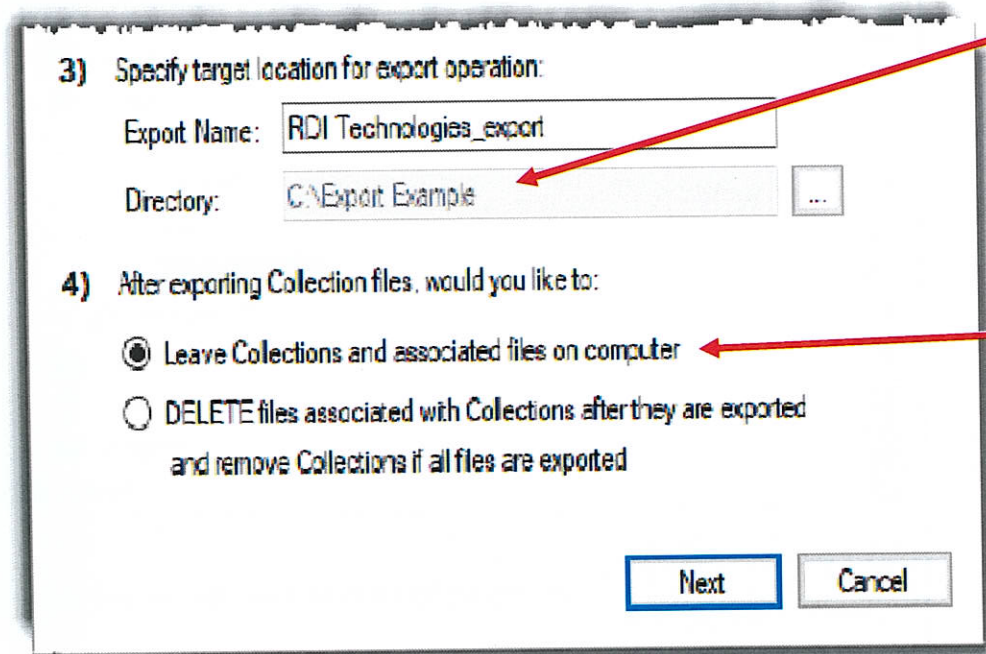
Exercise 28 – Data Export



Step 3 – In Browse for Folder window, click “Make New Folder”, and type “Export Example” for name of new folder.

Then click, “OK”.

Exercise 28 – Data Export



The screenshot shows a dialog box with the following content:

3) Specify target location for export operation:

Export Name:

Directory: ...

4) After exporting Collection files, would you like to:

Leave Collections and associated files on computer

DELETE files associated with Collections after they are exported and remove Collections if all files are exported

Next Cancel

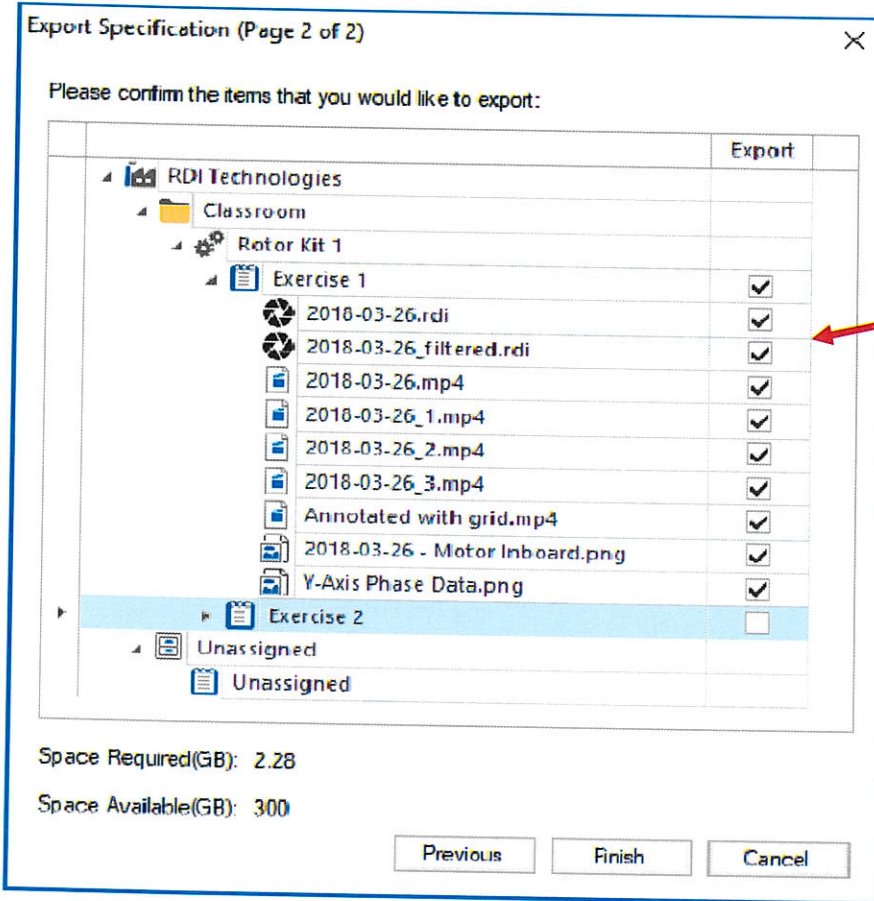
Two red arrows point from the text on the right to the 'Directory' field and the selected radio button.

3) Target Directory has now been set to newly created "Export Example" folder.

4) Select "Leave Collections and associated files on computer".

click "Next".

Exercise 28 – Data Export




Step 4 – Export Specification page 2 opens.

Make sure desired files are selected.

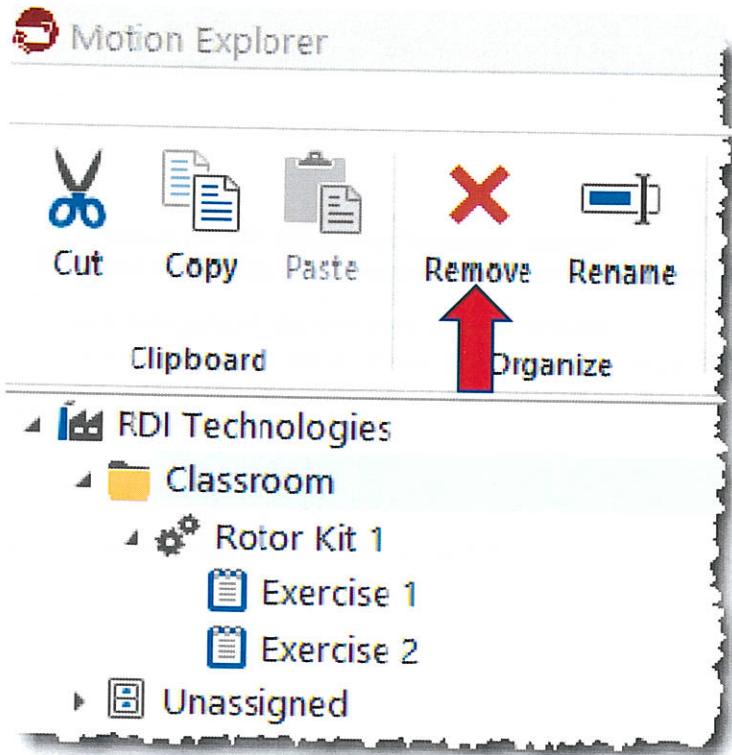
Click Finish to proceed with export.

Exercise 28 – Data Export

<input type="checkbox"/> Name	Date modified	Type
 RDI Technologies_export.exp	4/24/2018 2:15 PM	EXP File

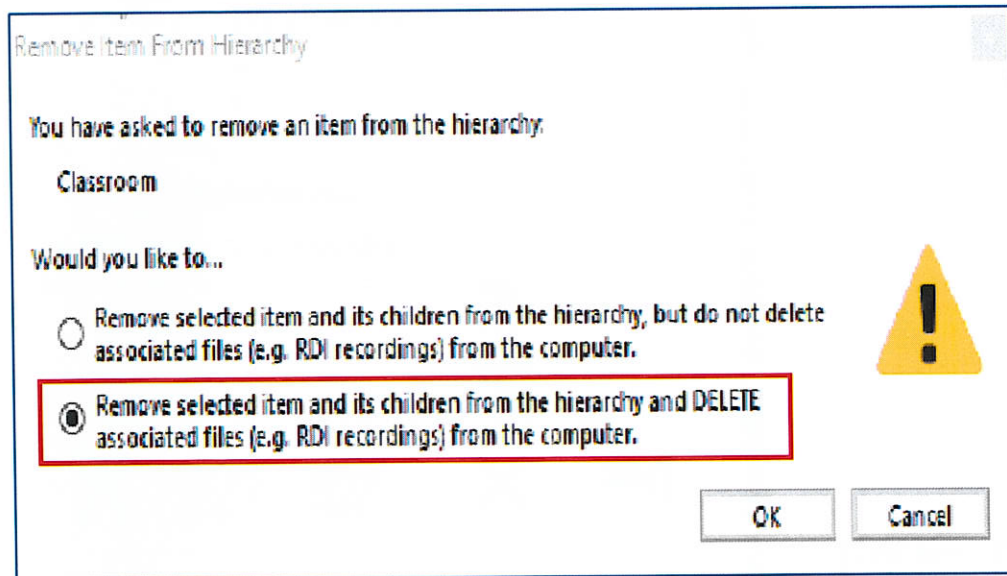
Step 5 - In Windows Explorer, verify that export files are inside folder on hard drive named, "Export Example".

Exercise 28 – Data Export



Step 6 – In Motion Explorer, Highlight Classroom folder in hierarchy and click “Remove”.

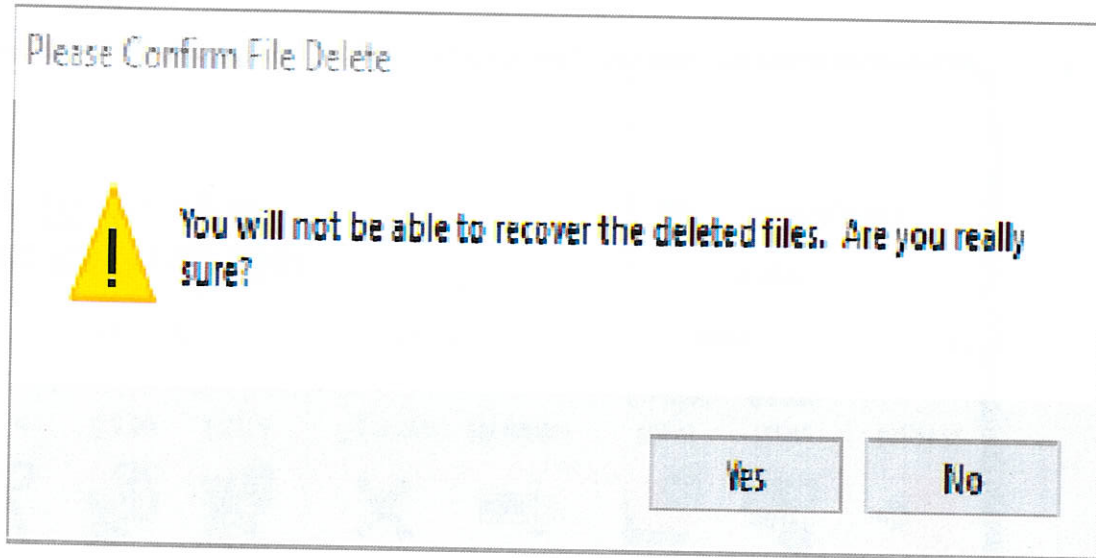
Exercise 28 – Data Export



Step 7 – Select “Remove selected item and its children from the hierarchy and DELETE associated files from the computer.”

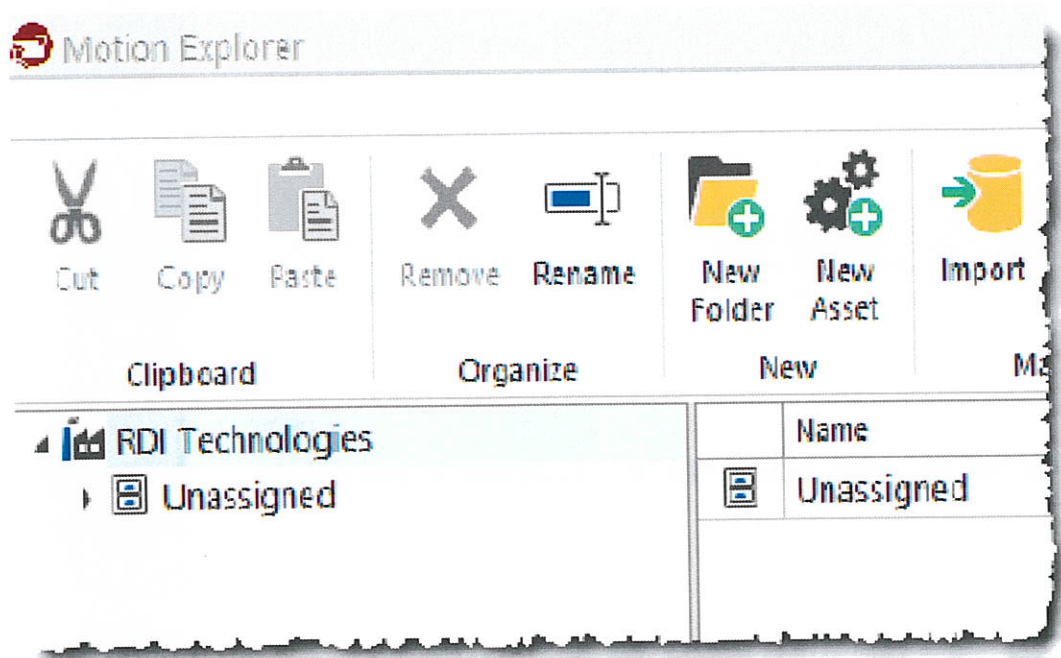
Click “OK”.

Exercise 28 – Data Export



Step 8 – Click “Yes”.

Exercise 28 – Data Export

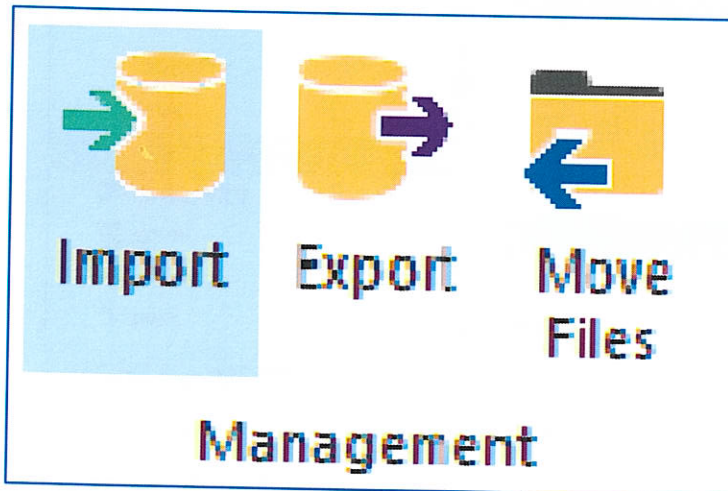


Result – Classroom folder and its contents have been removed from Motion Explorer.

All data files that were linked to this hierarchy have also been deleted from hard drive.

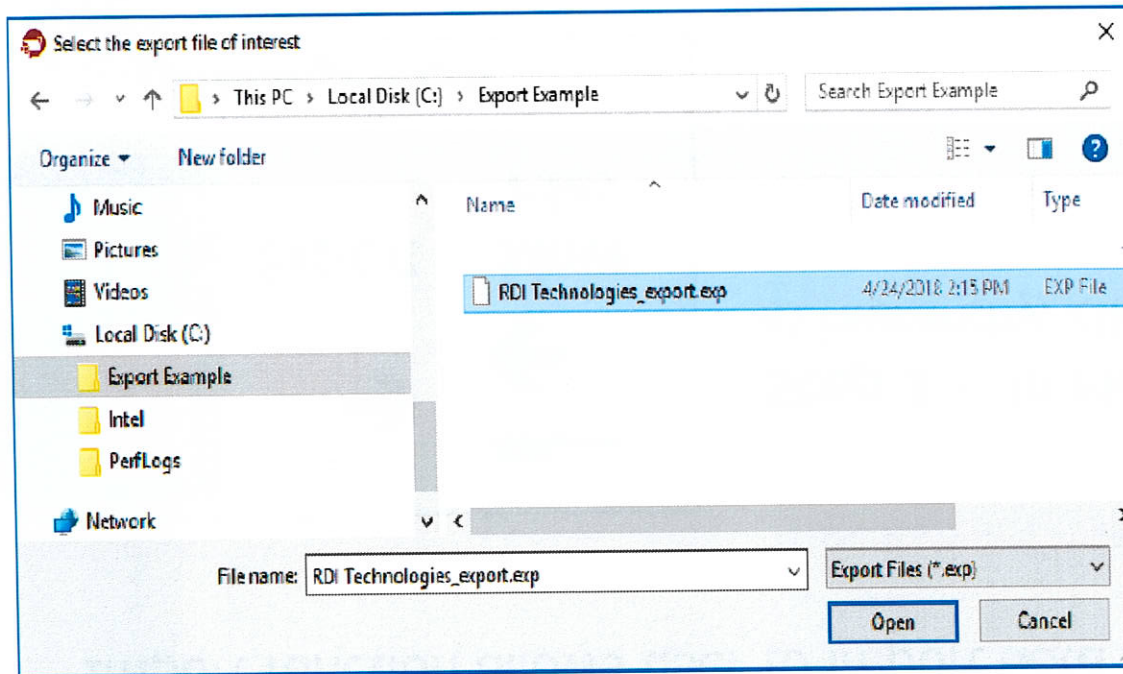
Exercise 29 – Data Import

Import function allows user to import data files.



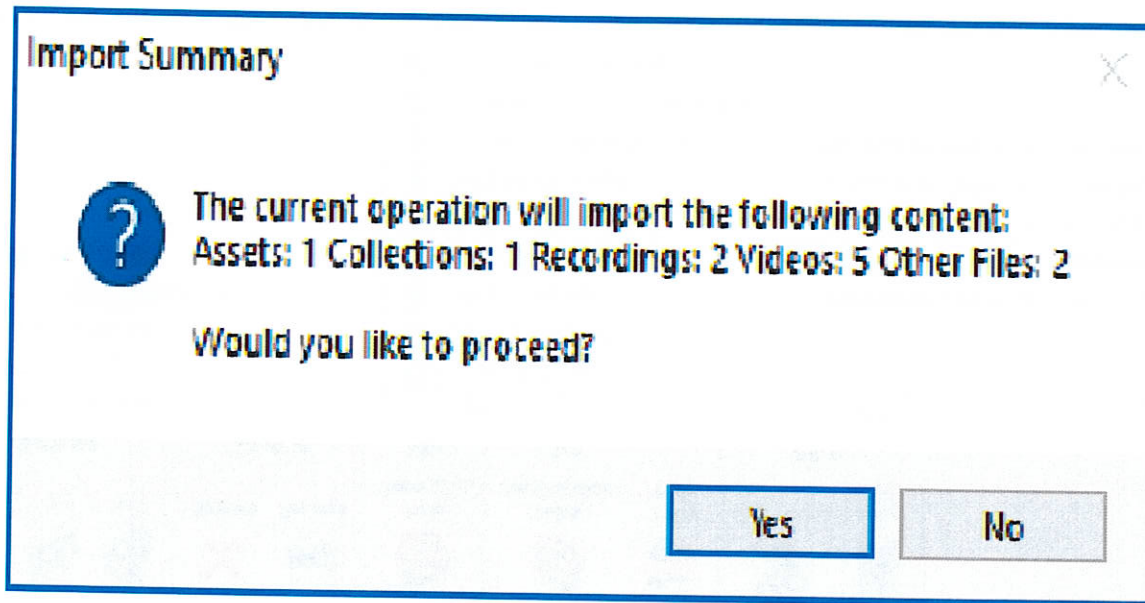
Step 1 – In Motion Explorer, highlight company name in hierarchy, click Import.

Exercise 29 – Data Import



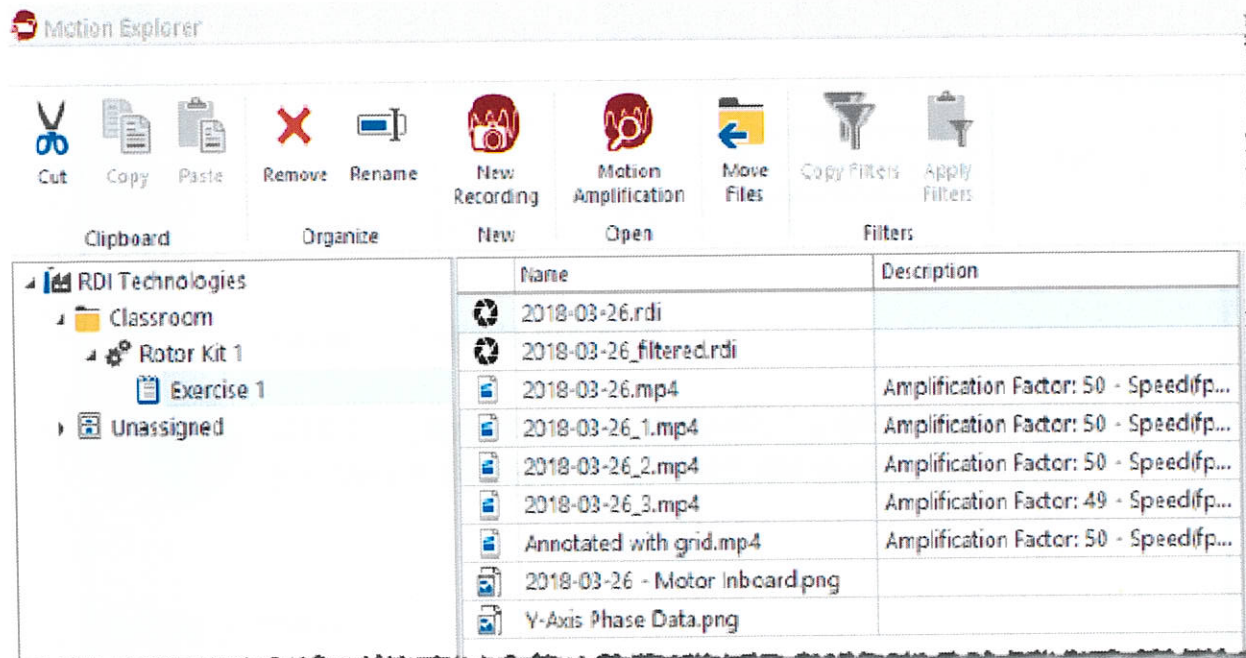
Step 2 – Select the .exp file that was created in previous exercise, click "Open".

Exercise 29 – Data Import



Step 3 – Click “Yes”.

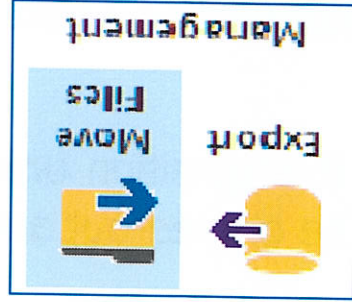
Exercise 29 – Data Import



Result – Classroom folder has been restored to Motion Explorer hierarchy along with its contents.

Also, data files have been restored to acquisition unit hard drive original location.

Move Files

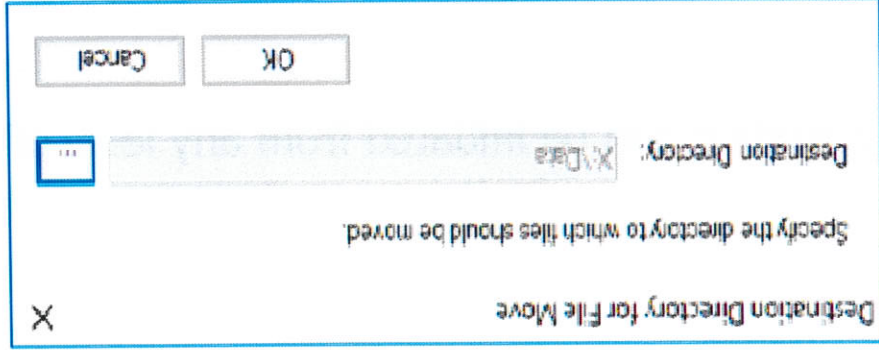


Allows data files to be moved from one storage location to another.

Difference between move and export is hierarchy for moved files will still be shown in Motion Explorer.

Operation can be initiated from any level of hierarchy.

Move Files



Select destination, click "OK";

After move is complete, hierarchy within Motion Explorer remains unchanged, as long as connection exists between acquisition unit and where files were moved.

If acquisition unit becomes disconnected from where files reside, affected levels of hierarchy will be grayed-out and not be functional.

Troubleshooting

Lighting brightens and dims during playback/Motion Amplification.

- If indoor check framerate.
- If other than 120 FPS flicker may occur.
- May be possible to use Frequency Based Filtering to remove flicker.

Motion Appears across entire image.

- Possible camera was shaking during acquisition.
- Ensure vibration reduction pads were used during acquisition.

Troubleshooting

- ***Motion too slow or stops when adjust playback speed of amplified recording.***
- It's possible to select a playback speed that affects the way motion appears in recording - classic "Wagon Wheel Effect".
- Example, if a motion is at 30 Hz and 30 fps playback is selected it may appear stopped or without motion.

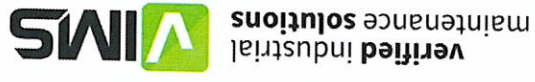
- Try multiple playback speeds.

- Recommended to start from slowest playback speed and work up.

Troubleshooting

For more troubleshooting and general support go to RDI Technology Support page.

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



TECHNOLOGIES

RDI

