# ELEMENTAL SCIENTIFIC LASERS

# ACTIVEVIEW2 SOFTWARE MANUAL

## 1) TABLE OF CONTENTS

# 1) TABLE OF FIGURES

## 2) SOFTWARE START-UP

Start ActiveView2 by double-clicking the desktop icon. [NB: wait two (2) minutes before starting the Laser Ablation Application for the computer boot process to complete].


Figure 2-1: Desktop shortcut to launch ActiveView2

The start-up screen provides status information of sub-systems relevant to the system configuration. The main program window will appear on completion of the self-tests.

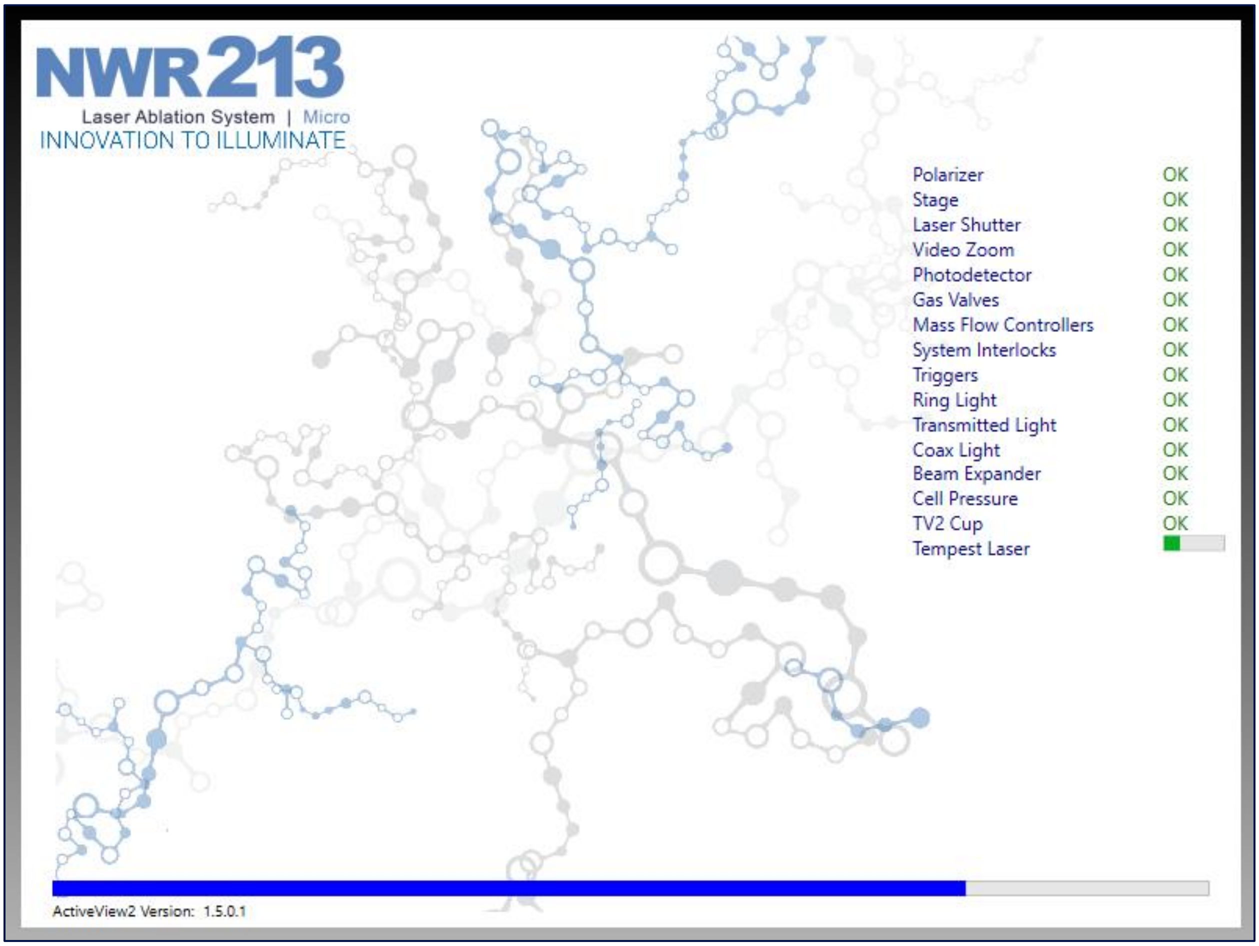



Figure 2-2: ActiveView2 Software Start Up Screen

If any of these sub-systems are not located, the system may require maintenance. Contact ESL Laser Support for assistance: lasersupport@icpms.com. The ActiveView2 version information is shown in the lower left corner. This number should be provided to ESL Laser Support with any support requests.

## 3) OVERVIEW OF THE NWR LASER ABLATION SOFTWARE

This section describes the main functions of the Laser Ablation Application. Figure 3-1 shows the location of the major application elements.

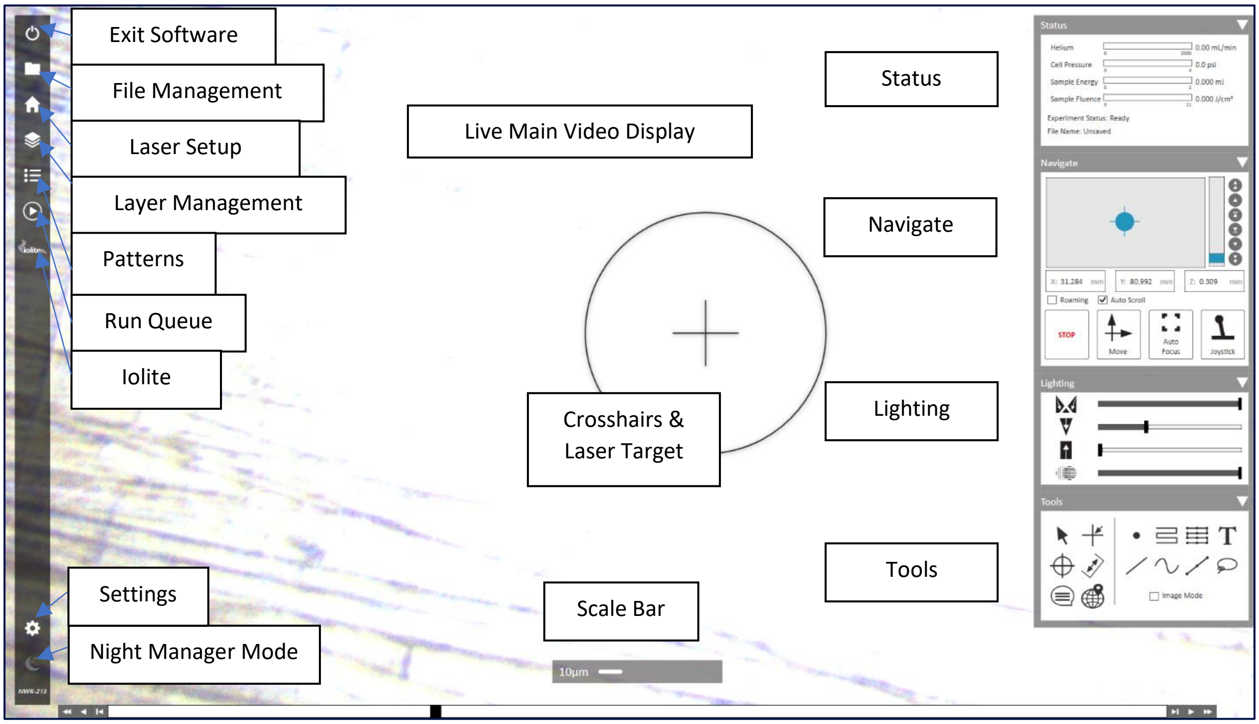



Figure 3-1: ActiveView2 Software Main Program Window Sections

### 1. Crosshairs

The crosshairs show the location that the laser will fire. The crosshair maintains its size at all zoom positions. The position can be modified in Settings: Crosshair position. It can also be modified with a floating menu selection when the mouse is right-clicked on the main video window. The appearance of the crosshairs can be modified in Settings: UI configuration

### 2. Laser Target

The circle or rectangle around the crosshairs shows the expected size and shape of the laser based on current live settings. The shape and size update according to the manual IVA or XYR settings and the zoom position.

### 3. Zoom Control

The zoom is driven by the scroll wheel of the mouse. The zoom range covers the maximum optical zoom to the entire working area of the sample chamber. All the layers (main camera, wide angle camera, patterns, imported images, sample maps, reference points, and annotations) scale with the zoom.

The zoom is centered on the crosshairs, except when Roaming Mode is active (see Section 5).


Figure 3-2: Minimum zoom position *i.e.,* full sample chamber view

## 4. Cup tracking

The cup of the TwoVolume sample chamber is manually operated using the magnetic push-arm and is not controlled by the software.

The TwoVol2 cup is controlled by internal motors and can be offset out of the way of the wide-angle camera to provide an unobstructed view. Right click the screen to choose between **Offset TV2 Cup** and **Center TV2 Cup**. The centered position is required for analysis. As part of the experiment process (pressing **Run** in the Run Queue) the TwoVol2 cup will automatically return itself to the Center position. See Settings:

Calibrate TwoVol2 Cup for information about recovering cup tracking.

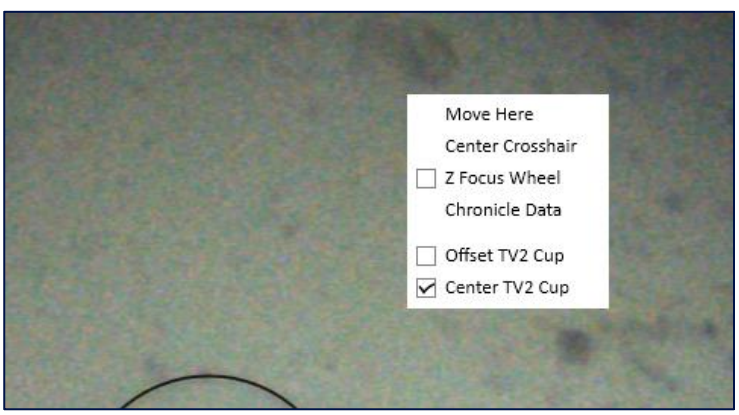



Figure 3-3: Cup position control

Sample chambers without moving cups (e.g., TwoVol3, single volume chambers, SelfSeal) do not require cup tracking.

## 5. Z Focus Wheel

The Z Focus Wheel allows the Z position to be changed with the mouse scroll wheel. Right click the screen and choose **Z Focus Wheel** to adjust Z position. While using the Z Focus Wheel the cursor will have a “Z” tailing it. Left click anywhere to return the mouse wheel to normal zoom control.

## 6. Scroll bar

The scroll bars allow straight X or Y movement and are accessed at the bottom and right edges of the main window. The step (⏭), jog (▶), and sprint (⏩) arrows determine the speed at which the stages will move in the specified direction. The black bar shows the relative position of the stages. Dragging the scroll bar will move the stages to that location.

The scroll bar settings can be accessed in Settings: Stage (see Section 15).


Figure 3-4: X axis scroll bar shown; Y axis scroll bar auto-hidden

## 7. Collapsible drop-down menus

The collapsible menus on the right contain functions that might be required at any point in the workflow. Each of the menus can be independently collapsed. Down arrows (▼) next to the header indicate an expanded menu, while Up arrows (▲) indicate a collapsed menu.

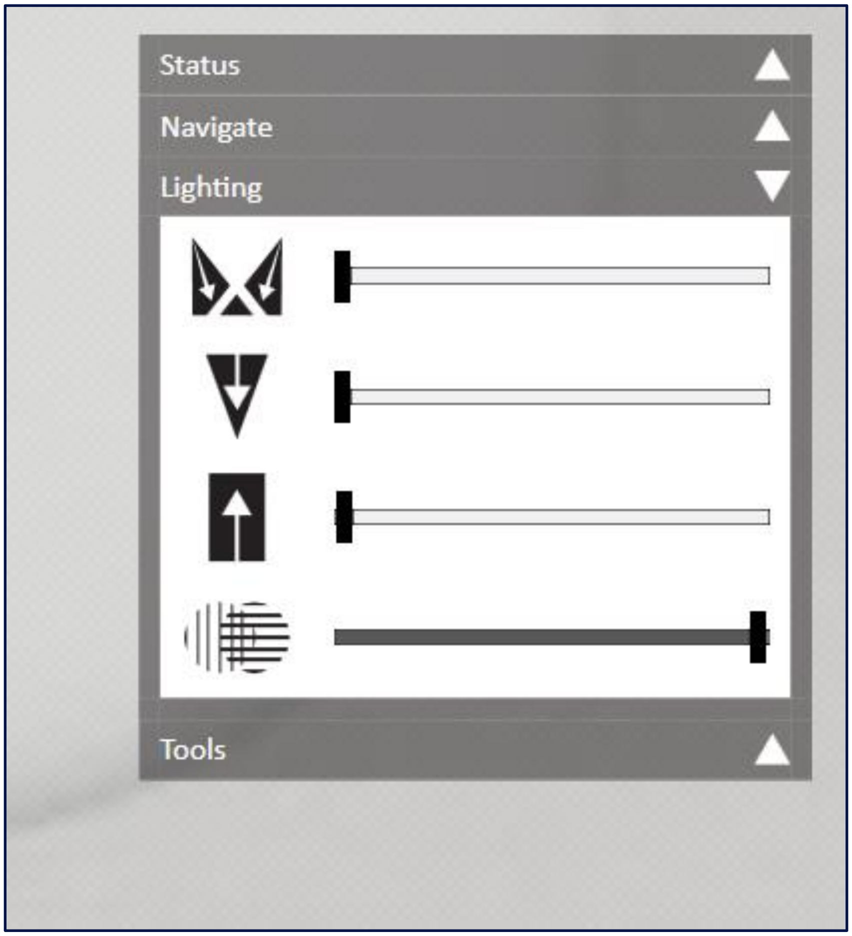



Figure 3-5: Collapsible menus: Status, Navigate, and Tools menus are collapsed (up arrow); Lighting has been expanded (down arrow).

## 4) STATUS MENU

The Status menu gives live readouts of key laser metrics. There are no buttons within the Status menu – it is purely informative, allowing users to monitor important information in a condensed area.

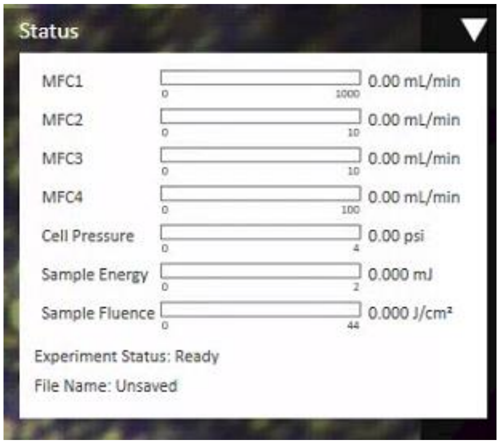



Figure 4-1: Status menu in Ready mode

1. Current Mass Flow mL/min

    The meters show the current flow as read by the mass flow controllers. The live reading is displayed to the right of the meter. See Mass Flow Control for more information (see Section 10.8).

2. Energy Display

    Displays the live energy at the sample surface in mJ.

3. Fluence Display

    Displays the live fluence at the sample surface in $J/cm^2$.

4. Cell Pressure Display

    Displays the live pressure measured in the sample chamber. The units can be toggled between PSI, kPa, and mbar in Settings: UI configuration (see Section 15).

5. Current High Voltage Display

    Displays the live laser electrode voltage (only for NWR193 and NWR193HE). The bar will turn yellow then red when a gas exchange is required.

6. File Name

    Displays the last saved file name. Before an experiment is saved, the File Name will show “Unsaved.” After saving, it will show the name followed by “.LAX” which is the ActiveView2 experiment file extension. See Save Experiment for more information (Section 9-3).

7. Experiment Status

“Ready” indicates that no experiment is running. “Running” indicates that the software is running an experiment from the

Run Queue. “Not Ready” may indicate that the stages require homing. See Home Stage (Section 5-2).

a. Experiment Pass

1. Appears if multiple experiment level passes have been set. The first number shows the current pass. The second number shows the total passes for the pattern (see Adjust Z Focus

Focal position adjustment of queued patterns can quickly be performed prior to commencing the experiment and starting analysis, by clicking on **Adjust Z Focus**. The **Adjust Z Focus** window will open and provide the user with the same options per accessing **Adjust Z Focus** via the pattern properties, except that only queued patterns are available. In this manner, the **Adjust Z Focus** acts as a way to profile and adjust the run queue prior to commencing the experiment.

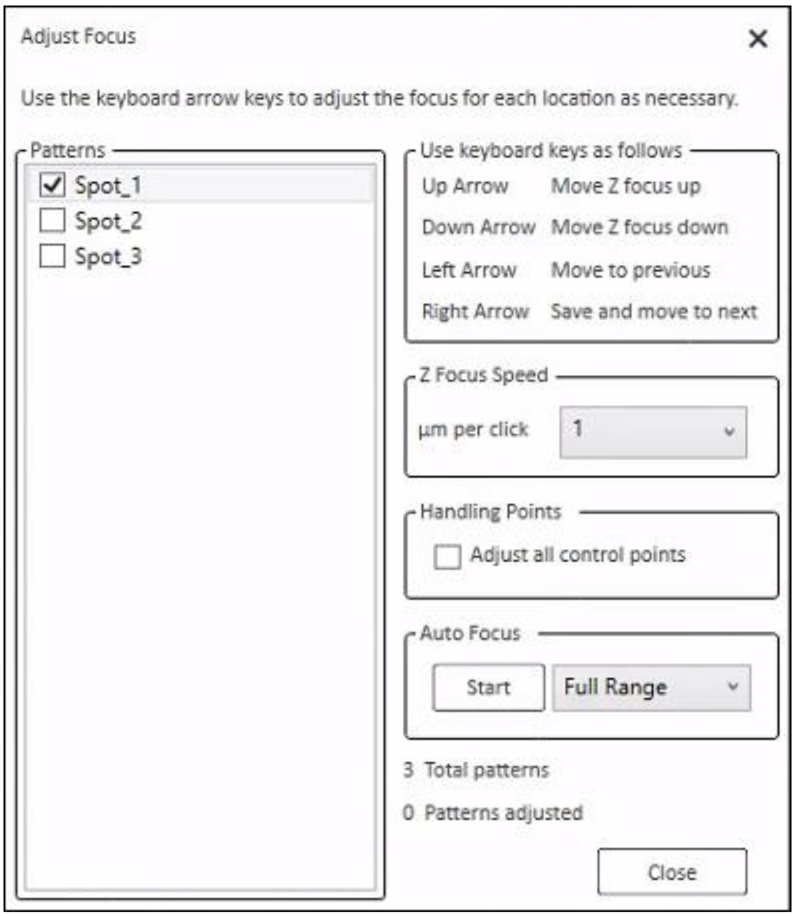



Figure 14-2: The Adjust Z Focus window specific for the run queue.

Total number of passes for more information on passes).

b. Pattern Name

Displays the name of the pattern currently running.

c. Current Pass

Displays either “Ablation” or “Pre-Ablation”.

### d. Pass Count

Appears if multiple pattern level passes have been set. The first number shows the current pass. The second number shows the total passes for the pattern (see Properties for more information on passes, Section 11-1).

### e. Status

The current action that the laser is performing. Examples include Dwell Time, Washout Delay, Moving IVA, Moving XYR and Laser Warmup.

## 5) NAVIGATE MENU

The Navigate drop down contains several mechanisms for changing the X, Y, and Z stage positions.

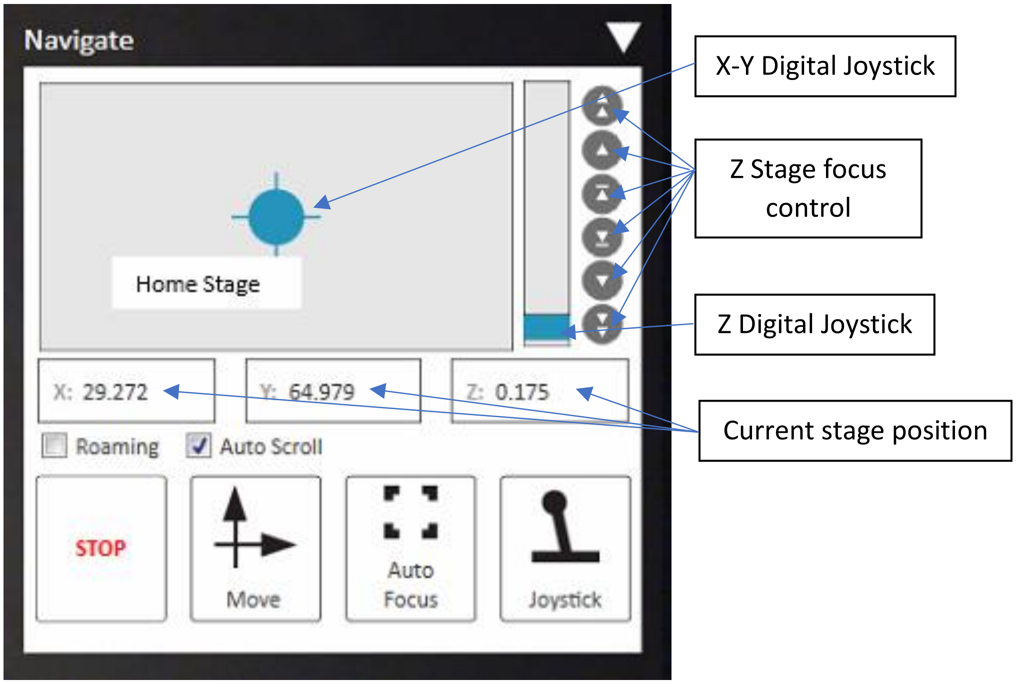



Figure 5-1: Navigate menu

### 1. Digital Joystick (X, Y)

When the blue dot is dragged away from the center, the X and Y stages move in that direction until the dot is released. The further the dot is dragged from the center the faster the stages will move.

### 2. Home Stage

Except for TV3 stages, the step position of the X, Y and Z stages are stored on software shutdown and the last stored position is used on startup. The stages do not need to be calibrated or homed each time the software is opened. Stages can be calibrated by right clicking the Digital Joystick area and choosing **Home Stage** (Figure 5-2). The calibration should be done any time the stages move outside of software control, particularly after maintenance to the chamber or Z axis, or if there is an abnormal shutdown of AV2 (power loss or software crash).

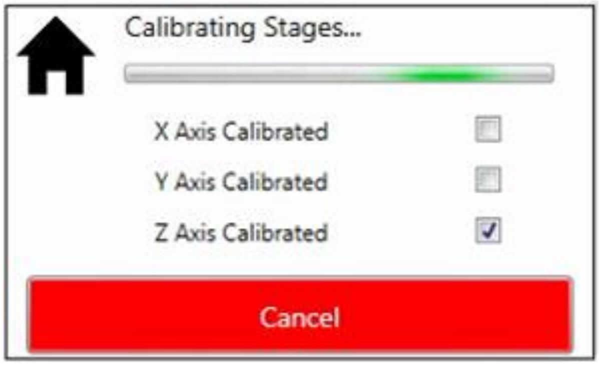



Figure 5-2: Stage calibration in progress

When each stage completes the process, a check box will appear next to its name. The stages will return to their previous position after all three stages have been homed. The window will close automatically.

In the event of an incomplete shutdown (e.g. power outage or software crash) the stages will request calibration with a pop-up window (Figure 5-3). Stages must be homed before performing any action that requires known stage positions such as creating ablation patterns or loading a saved experiment.

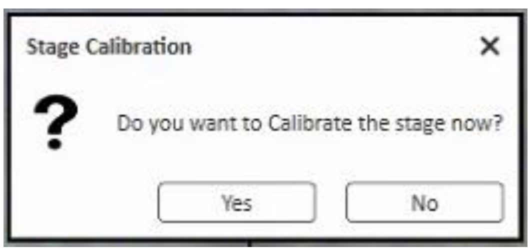



Figure 5-3: Stage calibration popup

### 3. Z stage focus control

Steps the Z stage up and down in step, jog, and sprint speeds. Stage speeds can be controlled in Settings: Stage. The blue bar can also be dragged to a desired Z position. The stages will move when the mouse is released.

### 4. X, Y, Z position display

Displays the current X, Y, and Z stage coordinates.

### 5. Roaming Mode

Roaming Mode is activated with check box (Figure 5-4)

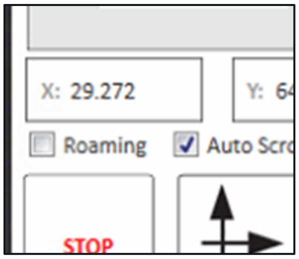



Figure 5-4: Roaming Mode check box

Everything in ActiveView2 is mapped into a single digital workspace. In normal mode the cross hair and main camera view are the focus for video, zoom, scan placement, etc. based on the current stage location. Roaming Mode can be used to place patterns in the digital workspace (e.g. on sample maps or imported images) away from the current stage location. During an experiment, when the laser, camera, and stages need to be over the pattern the user can employ Roaming Mode to work away from the stage location (e.g. to place patterns). This dramatically improves workflow and reduces experiment setup time by allowing the user to continue placing and editing patterns whilst an experiment is already running.

When Roaming Mode is active, zooming with the scroll wheel of the mouse will center on the *mouse* position (rather than on the stage location). The main and wide-angle cameras remain with the active stage position.

Patterns created while roaming are saved into the pattern list. It is strongly recommended that the user check the Z positions of the patterns placed while roaming before queuing them and adjust if necessary. See Layer Management: Adjust Focus for a quick Z position adjustment tool.

Figure 5-5 shows an active experiment with the main camera view at the left of the screen. Additional patterns are being placed on the sample map on the right of the screen while the experiment runs.

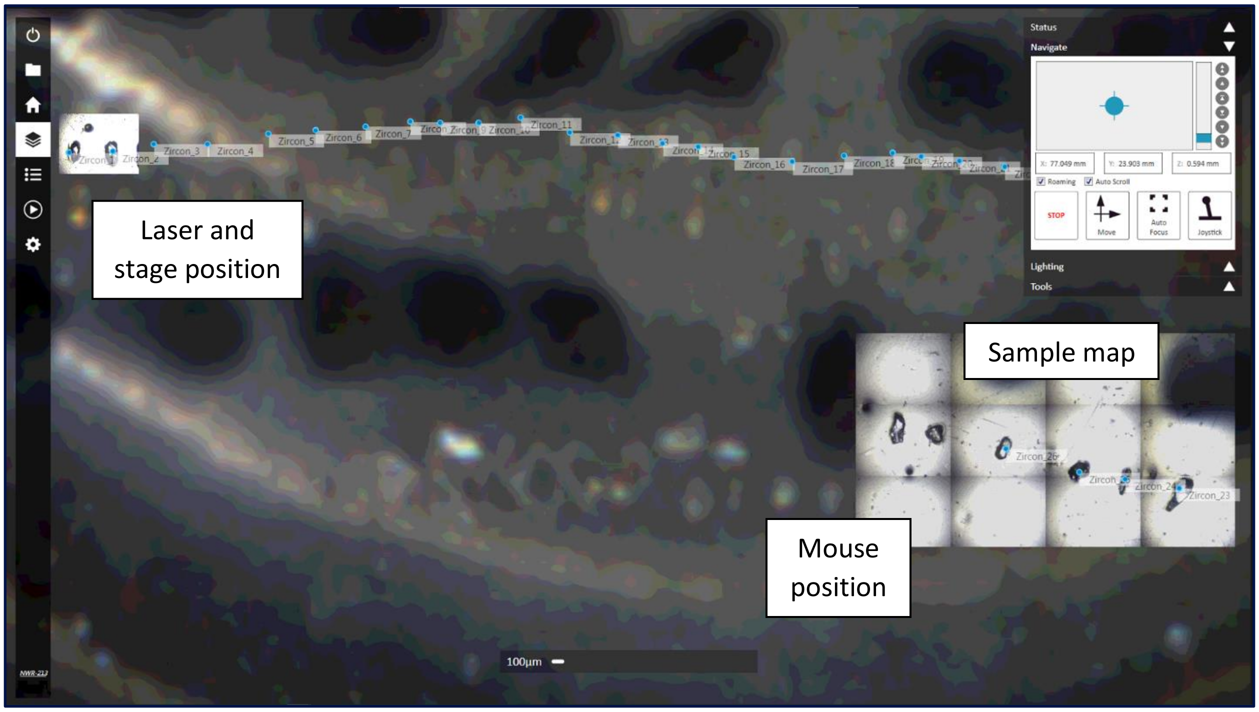



Figure 5-5: Roaming mode

## 6. Auto Scroll

When activated, the stages will continue to scroll when dragging a pattern or the distance measurement tool off the side of the current view.

## 7. Stop

Immediately stops stage movement and laser firing.

## 8. Move

Opens a window that allows users to move to or store/recall specific coordinates.

### a. Saved Positions

Users can **Add**, **Edit**, or **Delete** saved coordinate positions to and from the list in the box. The **Move** button will send the stages to that coordinate location. If the "**Don't Move Z"** box is checked, only the X and Y stages will move to the specified position. The **Stop** button will halt stage movement, canceling the movement.

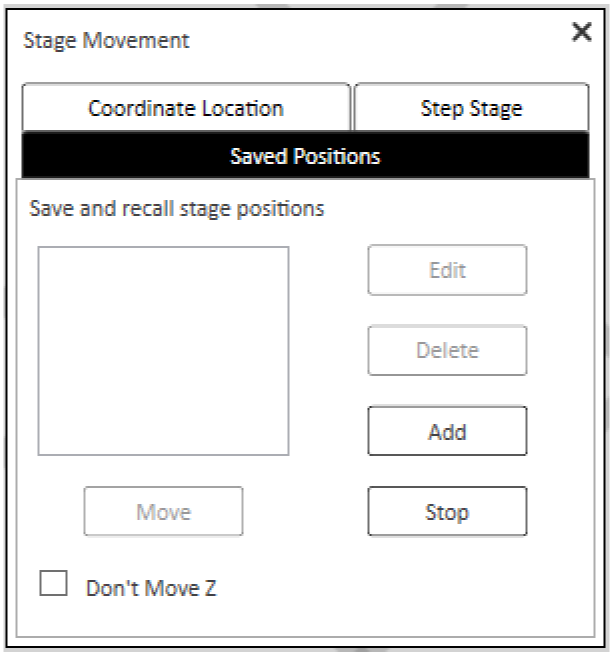



Figure 5-6: Move window

### b. Coordinate Location

Users can move directly to a specific coordinate without saving the position.

### c. Step Stage

Offset stages by a specified distance in mm or µm.

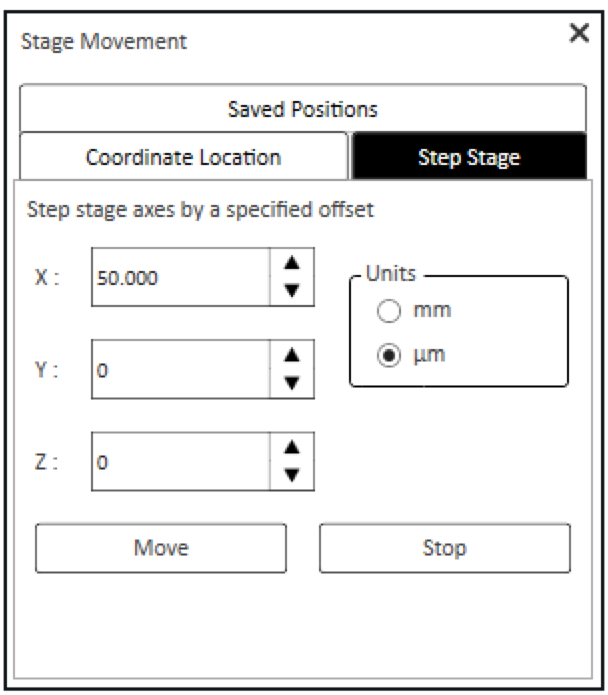



Figure 5-7: Step Stage tab

## 9. Auto Focus

Opens a window that locates the optimum Z stage position at the current X and Y coordinates. The Z stage is moved through several Z positions and stops at the stage position deemed to provide the optimum focal position based on a software algorithm. The window is shown below.

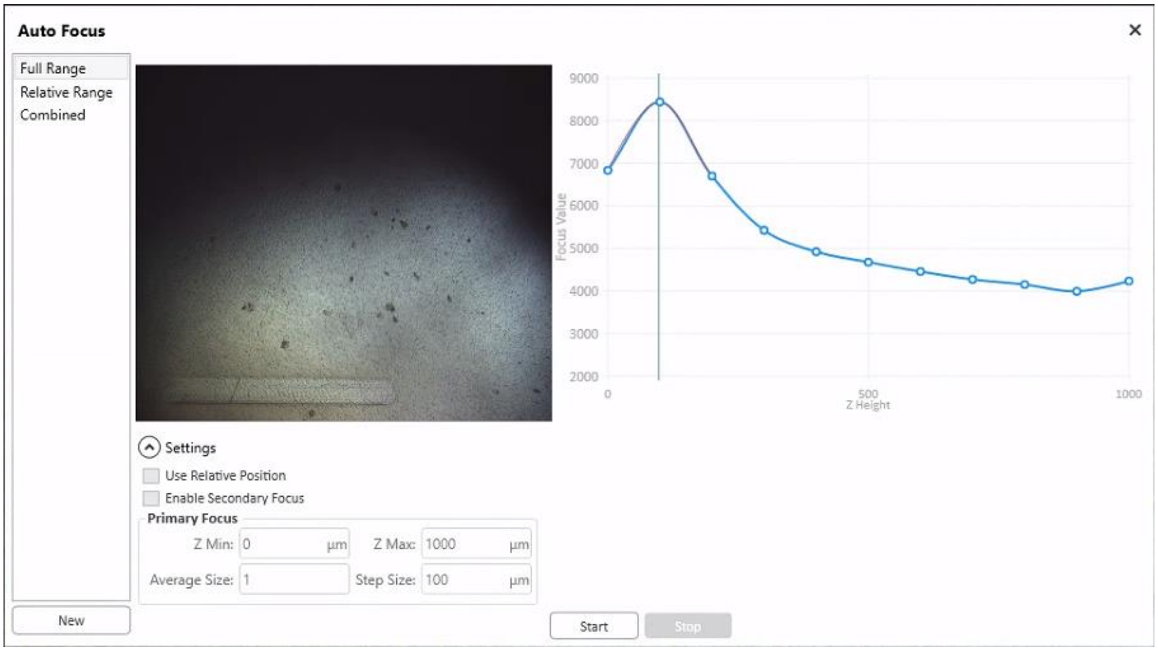



Figure 5-8: The Auto Focus window used to provide the optimum focal position for the current XY coordinates.

As a default, x3 **Auto Focus** schemes are provided: "**Full Range**", "**Relative Range**" and "**Combined**". Different schemes, start and end the **Auto Focus** process at different Z positions (Z Min and Z Max), and with different resolution in the Z axis (Step Size). This enables the user to utilize the quickest and most effective scheme for their given application. The **Full Range** Scheme provides a typically coarse determination of the focal position based on a large Z travel and large Z step sizes. The **Relative Range** provides a finer determination of the focal position based on small Z travel from the current Z position, and small Z step sizes. If the **Combined Scheme** is utilized then the system will perform the coarse **Full Range** scheme, immediately followed by the finer **Relative Range**. This **Combined Scheme** can be the faster and most effective scheme for determining accurately the correct focal position.

Further, the user can add new and custom schemes by clicking on the "New" button and following the prompts.

By right clicking on a given scheme the user can select this scheme to be used when the keyboard shortcut "CTRL A" is used.

It's also possible to Auto Focus a complete experiment prior to running by selecting "Adjust Focus" from the Run window.

## 10. Joystick

ActiveView2 supports the use of common USB joysticks.  See ESL Sales or Support for more information.  When activated, this button opens a window allowing the user to set the properties of a USB joystick.

## 6) LIGHTING MENU

The light controls are used to adjust illumination of the sample. Use the light source slider bars to set their respective light levels. Each slider can also be modified by hovering over the line and scrolling the mouse wheel. All three sources may be used simultaneously for the best possible sample illumination.

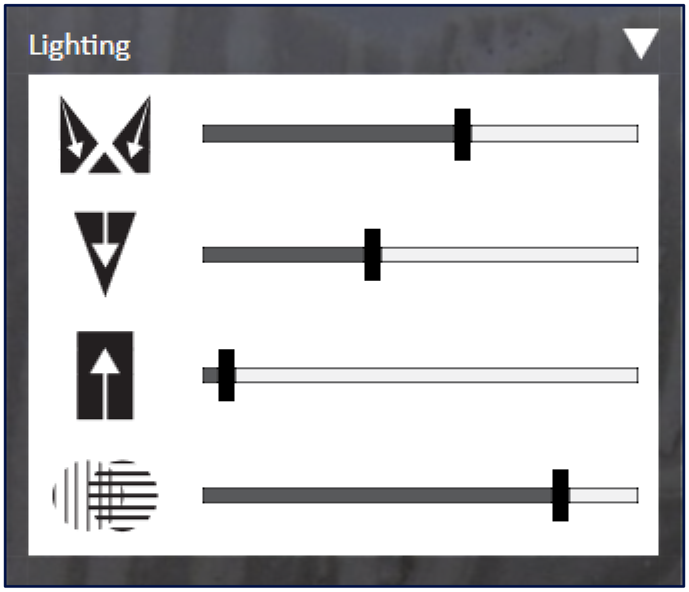


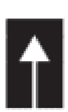

Figure 6-1: Lighting menu

### 1. Coax

This light source is coaxial with the viewing optics producing nearly shadow-less images. This provides high intensity illumination in the main camera field of view.

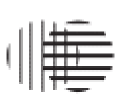
### 2. Ring

A series of lights surrounding the viewing objective that is well suited for uniformly illuminating the sample across a wide sample area and revealing surface structure and texture. Some product variations do not include the ring light.



### 3. Transmitted

This light source illuminates transparent or semi-transparent samples from underneath to enhance surface texture, reveal sub-surface structure and show refractory materials. This source can be used with the motorized polarizer.



### 4. Polarizer

The slider changes the orientation of polarized light from the transmitted source relative to the main video camera.

## 7) TOOLS MENU

The Tools menu is divided into pointer modifications on the left, and ablation pattern types on the right. Hovering over each tool provides a description. The active tool has an inverted color scheme (black background).

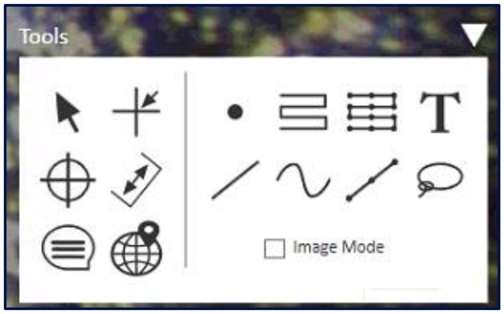
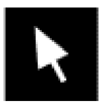



Figure 7-1: Tools Menu

### 1. Pointer



The pointer is used to manipulate existing patterns. One pattern at a time can be selected, or a group can be selected by dragging over an area. All selected patterns will be highlighted in the Layer Management Tab and can be edited together. Selecting and dragging the endpoint of one pattern will modify that endpoint's location. Patterns change color when selected.

The pointer tool can change the endpoint coordinates either one at a time by selecting the endpoint itself, or by selecting the outline (the mouse will become a pointing hand) to move the entire pattern.

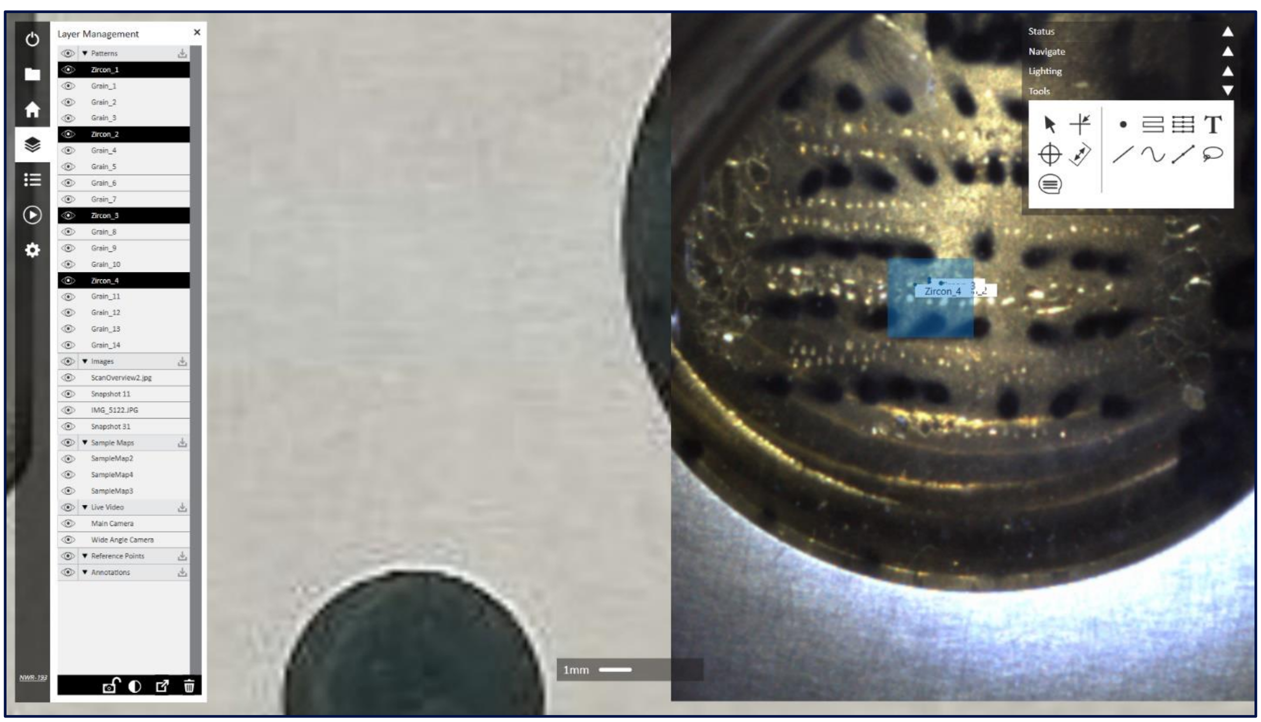
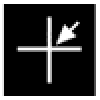


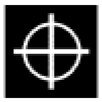

Figure 7-2: Selecting a group of patterns with the Pointer tool

## 2. Move To



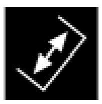
The Move To tool will move the stages to the point left clicked by the mouse. Holding the “Ctrl” key during a left mouse click will override any active tool (including pattern tools) to behave as the Move To tool. Right clicking the screen and selecting **Move To** will also bring the stages to the selected location.

## 3. Reference Point



Reference Points should be placed on clearly identifiable locations throughout the sample chamber and can be used to recoordinate the patterns if the sample has been moved (typically when the samples have been removed and replaced for further analysis). These points cannot be ablated but are essential for the Re-coordinate feature to work. A minimum of three reference points is required for Recoordination.

## 4. Distance Measurement



This tool displays the X, Y, distance, and angle between two points. Endpoints are shown as circles connected by the measurement line. When a second endpoint has been chosen, the text of the measurement can be selected, copied, and pasted into a different program by right clicking the text. The angle measurement increases counter-clockwise to 360 degrees (Figure 7-3).

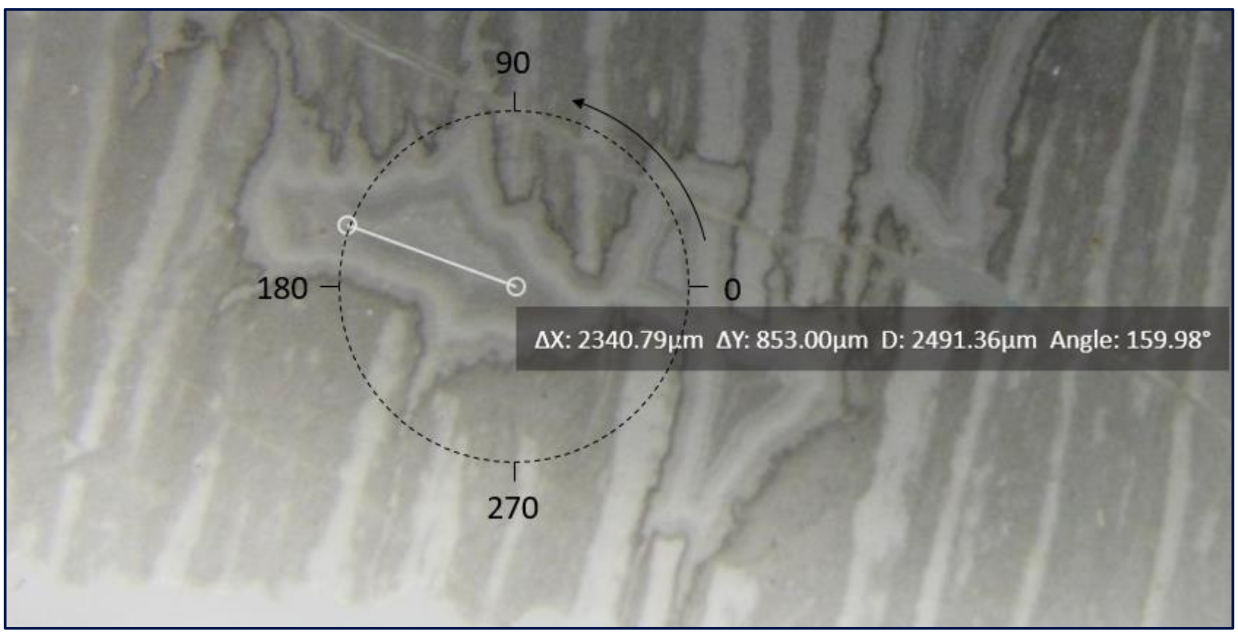
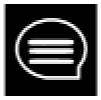



Figure 7-3: Distance Measurement with angle naming schematic overlaid

## 5. Annotations



This tool allows the user to place annotations or comments on the sample to label areas without ablation. The annotation is centered at the red dot in the upper left corner. To move the location of an annotation click and drag the text area with the Pointer tool. Clicking the **X** in the upper right corner of the annotation deletes it.


Figure 7-4: Example Annotation

## 6. Pattern placement tools

With any of the pattern type tools each left click places an endpoint for that pattern. The endpoint shows on the software as the X, Y position. The pattern appearance can be modified in Settings: UI configuration (Section 15). Right clicking an endpoint of the pattern can be used to access the Pattern Properties window. Pattern Properties are discussed greater detail in the Patterns section of Layer Management (Section 12-1).

## 7. Line

In line patterns, the stages travel along the designated path at a designated scan speed.

Line patterns must have at least two endpoints. Additional endpoints can be created to form segmented lines. When sufficient segments have been placed a right click ends the line. The Z position along each segment is interpolated between the Z positions of the endpoints.

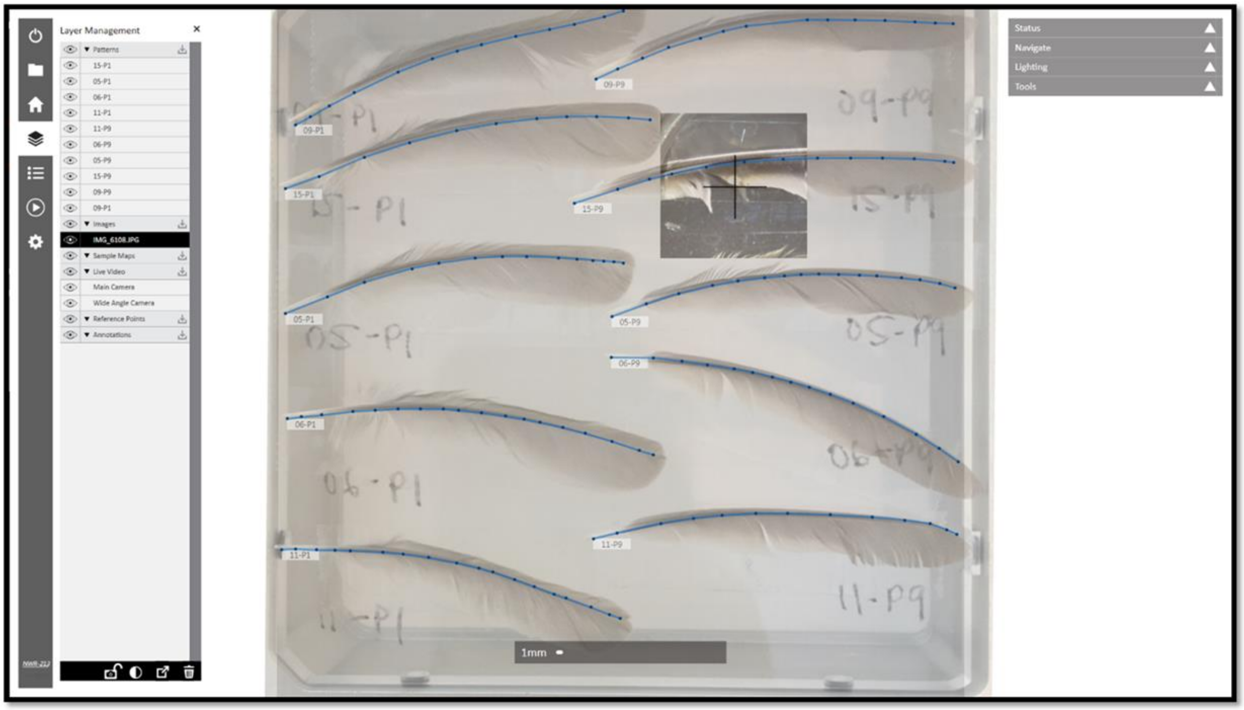



Figure 7-5: Example line patterns

A “Snap-Line” function is available to ensure completely horizonal or vertical lines can be easily created. This function can be found under *Settings>UI Configuration>Pattern Config.* as shown below. The feature can be toggled on/off by holding the shift key while placing the line.

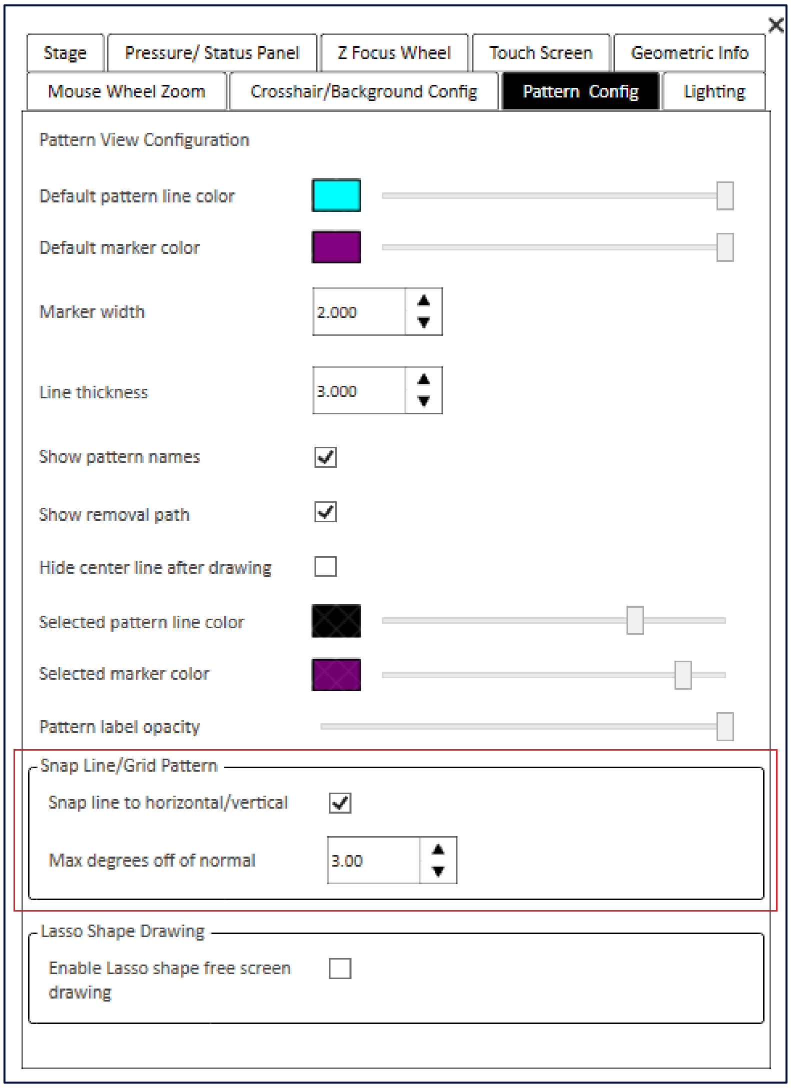



Figure 7-7-6: “Snap-Line” function

## 8. Curve

ActiveView2 creates Bézier curves. These curve patterns require at least two endpoints and can have many segments. As endpoints are placed, two co-linear control points are placed between each endpoint. After the initial curve is placed, the control points can be manipulated with the Pointer tool. Each segment starts and ends exactly at the endpoints, but the control points will adjust the curve.

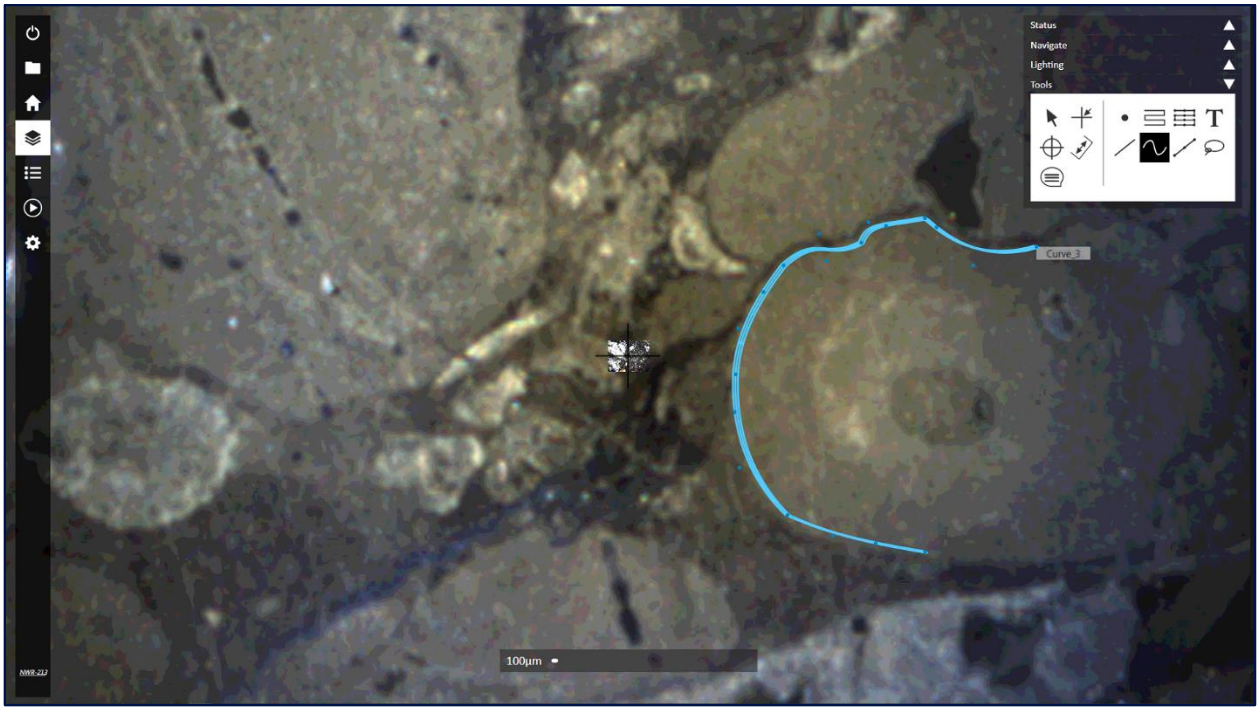



Figure 7-7: Example curve patterns

## 9. Raster

Raster patterns travel backwards and forwards to cover a rectangle or parallelogram. Rasters are created with two endpoints that define two corners of the raster and are initially rectangular (Figure 7-7). Once created, the raster will have three editable endpoints which can be moved with the Pointer tool to create parallelograms that are non-rectangular (Figure 7-9). The “Snap Line” tool can be used to restore perfectly rectangular shapes after a control point has been dragged.

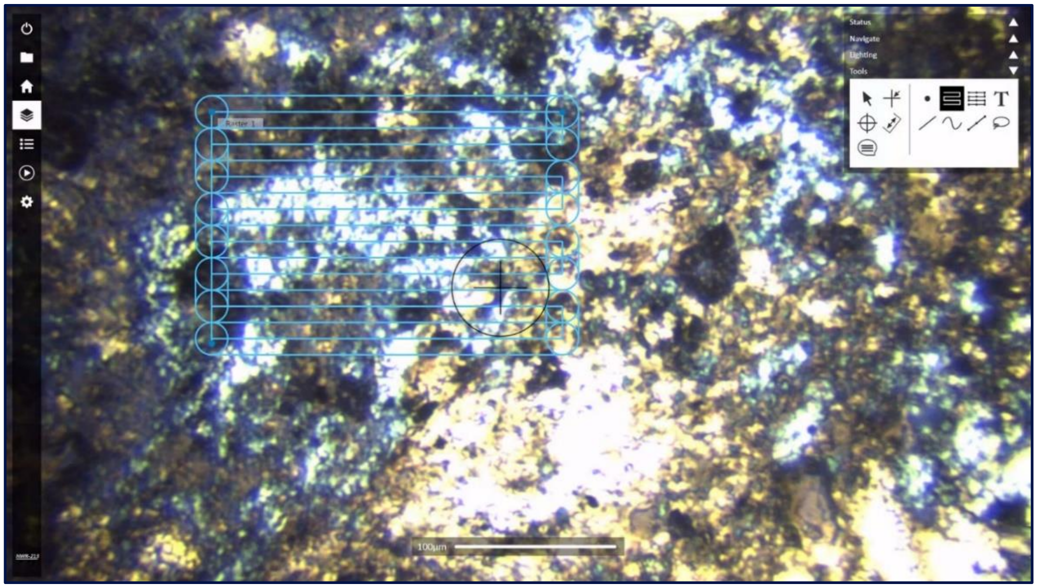



Figure 7-8: Example raster pattern

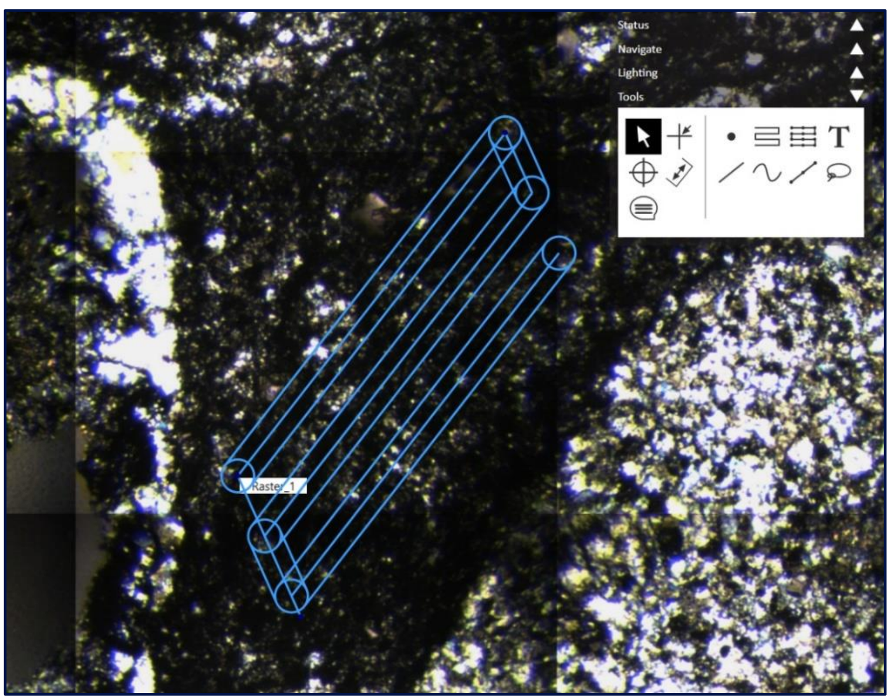



Figure 7-9: Example of an oblique raster pattern

## 10. Lasso

The lasso tool fills a user defined area with a horizontal or vertical raster type pattern, most typically employed for imaging of an irregular shaped area or sample. The orientation of the lines within the lasso can be set to horizontal or vertical in Pattern Properties. Right clicking finishes the lasso by connecting the current point to the start of the lasso by a straight line. There are two methods for creation of the lasso:

1. The default lasso creation method defines that each left mouse click creates a bounding point which the software will then connect with straight lines to create a boundary. There is no practical limit on the number of points that can be created enabling the creation of very irregular shaped imaging patterns.

   Importantly, the left click point creation follows the defined “snap” behavior in that when selected, points will be locked horizontally and vertically when they are near horizontal or vertical. For shallow angles, the “snap” feature should be disabled in Settings, or hold the shift key to toggle the current snap setting.

2. The freeform or freedraw method can be selected in the *Settings>UI Configuration>Pattern Config*. In this method the path of the cursor after the first endpoint creates the outer boundary of the lasso.

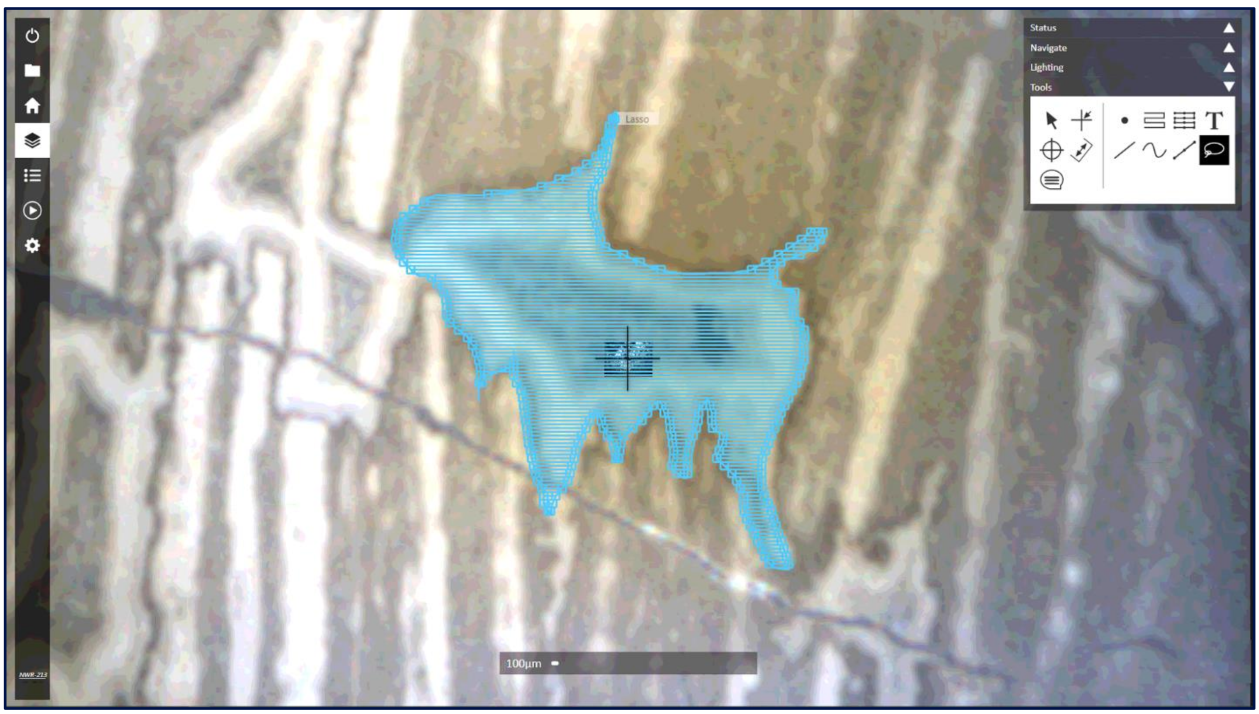



Figure 7-10: Example of a lasso pattern created using the freeform option

## 11.Spot

In spot patterns the stages stay over the designated spot for a specified number of seconds (dwell time) or laser shots (burst count).


Figure 7-11: Example of multiple spot patterns

## 12. Line of Spots

Identical spots can be placed along a line segment at a specified spacing using the line of spots tool. During ablation, the laser will move to each spot location and fire for a specified amount of time or burst count. The process for drawing a line of spots is the same for drawing a line pattern.

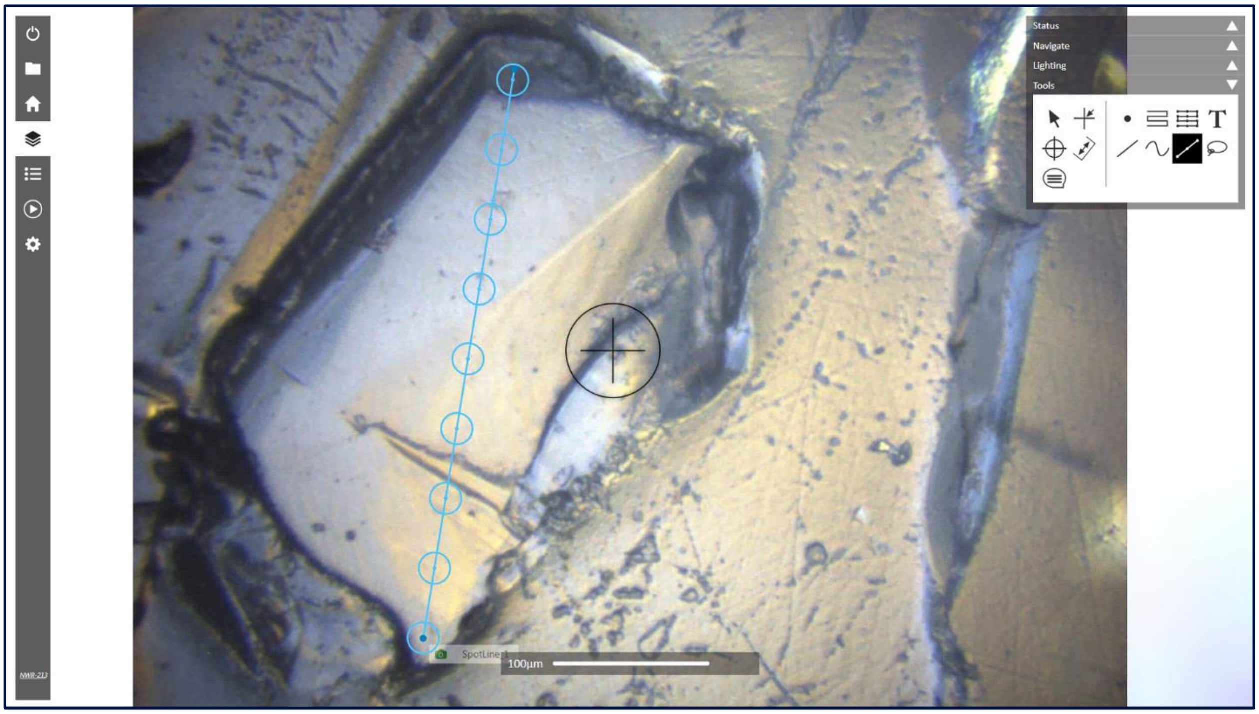



Figure 7-12: Example line of spot patterns

## 13. Grid of Spots

Grids are parallelogram areas with sets of spots arranged in rows and columns. The process for drawing a grid is the same as that of drawing a raster.

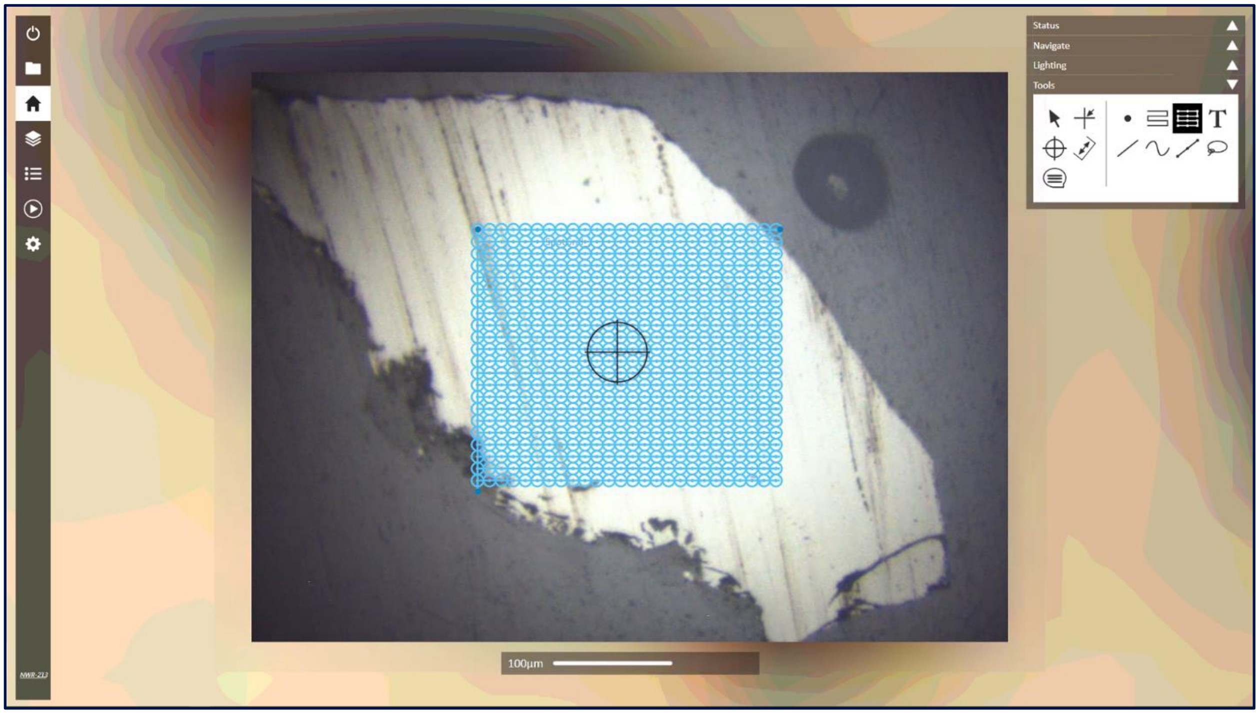



Figure 7-13: Example grid pattern

## 14. Text

To define a text pattern, select the Text tool and click on the desired upper left corner of the text. Select the font parameters, size, and enter the desired text. Press **OK** to set the pattern. Once text has been entered, the text, font, and size can be edited in the pattern properties window by pressing **Font**.

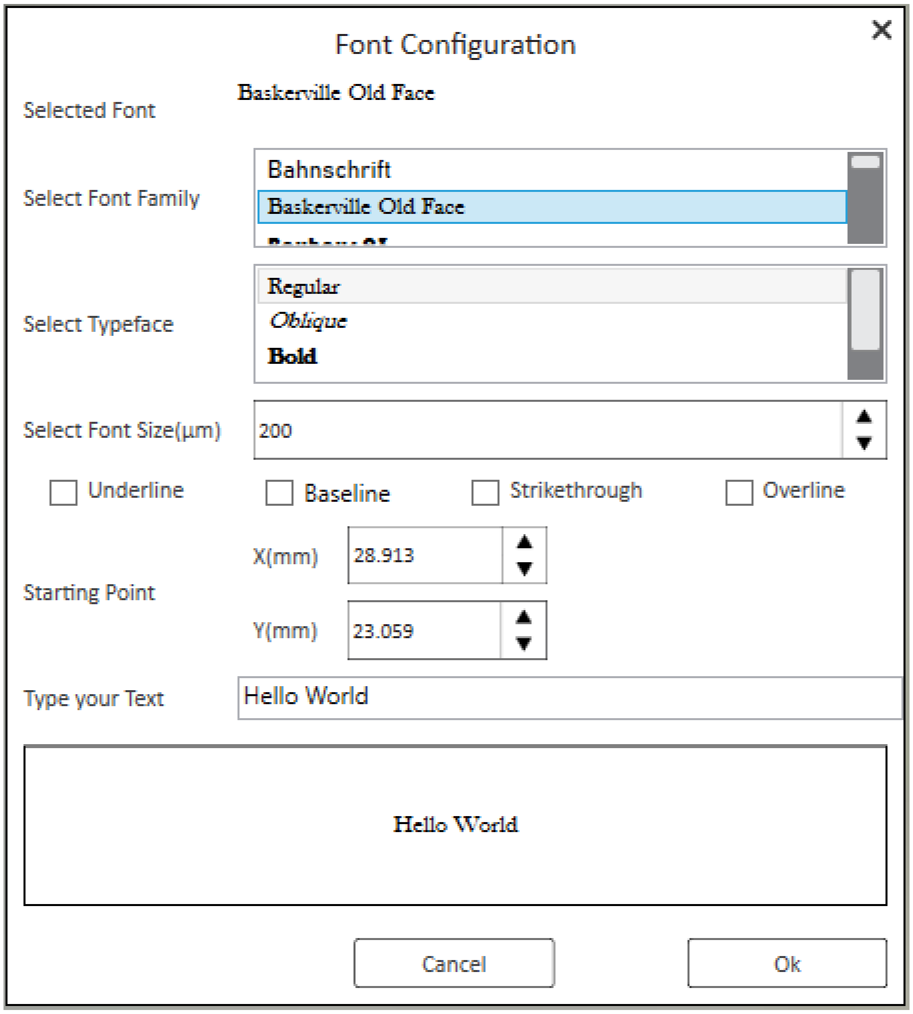



Figure 7-14: Font configuration

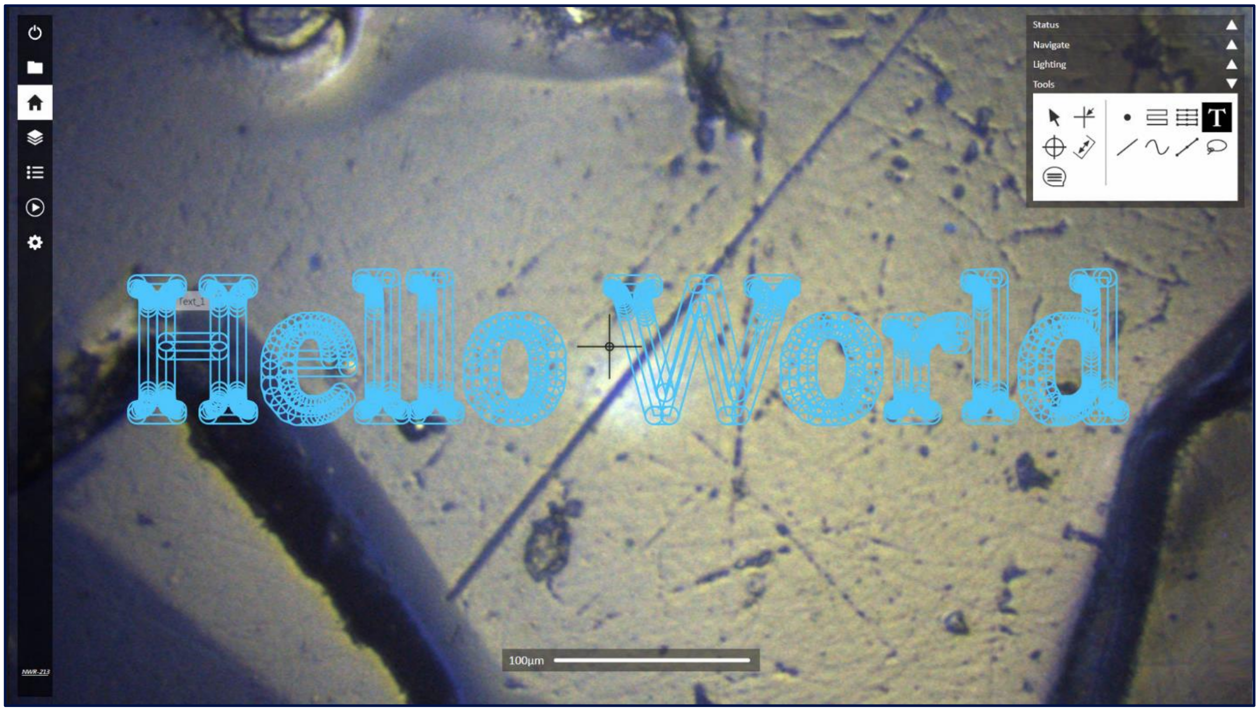



Figure 7-15: Example text pattern

## 15. Imaging Mode Patterns

When performing imaging experiments, it is important to control the exact laser shot position (XYZ) in order to generate an accurate elemental image, i.e. the pixel location is at the exact location of the laser shot. This is particularly important when performing high speed, high resolution imaging experiments using fast scanning ICP-MS instruments such as ICP-TOF-MS.

When “Image mode” is checked in the “Tools” window as shown below while creating a pattern, the laser shot itself is triggered by the XY stage position, i.e. the XY stage location tells the laser when to fire. In this scenario, the user can guarantee that the laser shot is at the exact desired XY location.

*Note: This feature is often referred to as “Stage Triggering Mode” and can be useful to control the laser dosage/or spot overlap in other applications such as depth profiling.*

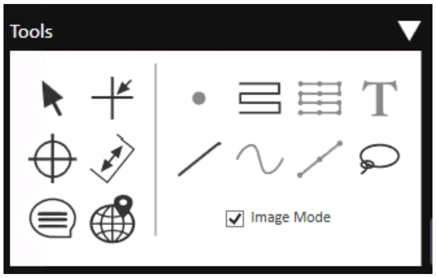



Figure 7-16: Tools window showing Imaging Mode selected and the available image pattern selections (line, raster, lasso)

Typically, imaging experiments are performed by covering the 2D area to be imaged with multiple line scans displaced from each other to achieve the desired image resolution. When using the **Raster** and **Lasso** tool in imaging mode the 2D area can be more easily defined by dragging the raster over the desired area, or with the lasso tool by defining the boundaries of the desired area.

Once the area is defined, the user can access the pattern property window to define the required imaging parameters (via a right click on the pattern itself or a right click or double-click on the pattern name in the Layer Management pane). The area to be imaged will be filled with line scans based on the spot size employed (IVA or XYR settings) and the raster spacing.

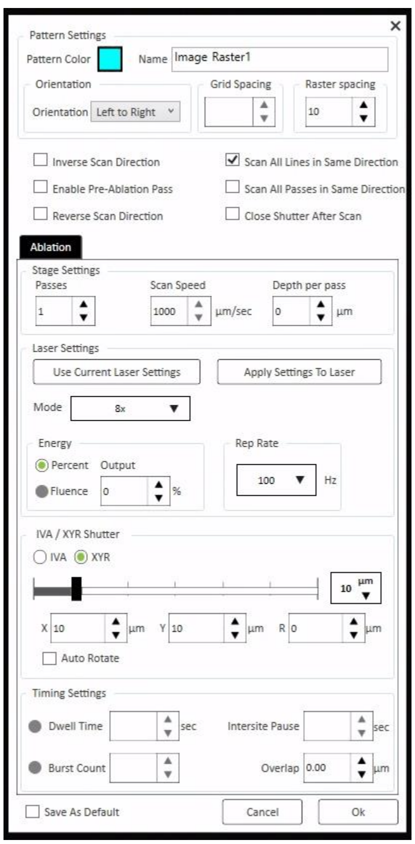



Figure 7-17: Image pattern property window

For patterns placed while in imaging mode, the pattern property window has some subtle differences related to the direction of the laser scan and the relationship between the stage speed, frequency, desired resolution and spot/pulse overlap.

### a. Orientation

By modifying the selection in the "Orientation" box between "Left-to-Right," "Right-to-Left," "Top-to-Bottom," and "Bottom-to-Top" the user can define the way the laser will scan across the sample surface, i.e., either horizontal lines or vertical lines will be placed. From an analytical perspective it does not matter which orientation is employed although horizontal line scans are more typical. When alternating line directions, the "Orientation" applies to the first, and odd-numbered lines, since every other line will move in the opposite direction.

### b. Scan All Lines in Same Direction

It is possible to define the scan direction such that all scans will scan in an identical scan direction.

When selected, this option ensures that all lines scans in a raster or lasso pattern are ablated in the same direction, e.g. from left to right. This is the normal mode of operation for TwoVol2 ablation chambers, although when the "Scan All Lines in Same Direction" is employed the imaging experiment will experience more dead time due to the time taken for the stages to travel to the start of the next line pattern.

Users can uncheck "Scan All Lines in Same Direction" so that line scans will now ablate in alternate directions. This will reduce dead time, since the stages have a small distance to travel to the start of the next line pattern, which will result in a significant reduction in total imaging time.

### c. Scan Speed, Rep Rate and Overlap

When imaging mode is employed, "Scan Speed" is **no longer an independent property**, since "Rep Rate," "Spot Size," and "Overlap" define the scan speed and the "laser dosage" or the number of laser shots (or partial laser shots) per location/pixel.

The "Scan Speed" box is grayed-out for image patterns since it is instead calculated based on the "Rep-Rate", "Spot Size" and "Overlap" input.

The "Overlap" variable units are in microns and describe how much space is inserted between subsequent shots (when "Overlap" value is negative) or by how far subsequent shots are overlapped upon each other (when the "Overlap" value is positive). In this way, overlap is used to vary the laser dosage of a given imaging pattern.

For harder materials, e.g., geological thin sections, a high laser dosage achieved via input of a high and positive overlap value is typically employed. In contrast, for softer materials e.g. biological thin sections, a low laser dosage achieved via input of "0" overlap value is employed – in this manner a dosage of 1 laser shot per pixel can be achieved e.g. edge-to-edge ablation.

## 16.Sample Maps

Sample maps are mosaics created by stitching together multiple camera images. They are useful to facilitate navigation of the sample surface.

The user simply defines the area that they wish to create a sample map from by simply dragging the mouse. Once the area is defined a window will show providing information about the new image, and also enables the user to toggle between employing the Main Camera or Wide Angle Camera. Once the options have been selected, clicking “Build” will commence generation of the sample map. It’s possible to stop the sample map at any point during the build and keep the image by clicking the “Stop and Keep” button.

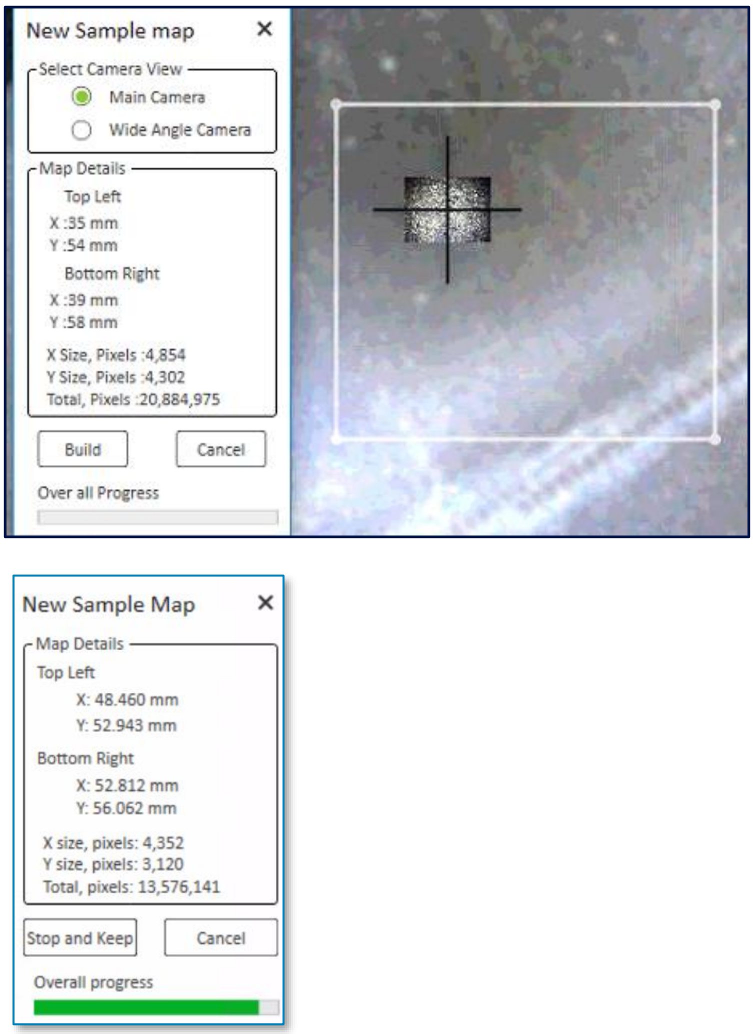



Figure 7-18 Creating a new Sample Map

Since the main camera has high resolution, sample maps can become very large in pixel count and file size. If the main camera is selected, the bounding rectangle showing the selected area while it is being dragged will turn yellow then red if the resulting image will be too large for ActiveView2 to efficiently manage. For systems configured with no wide-angle camera, sample maps covering larger areas can be constructed with reduced resolution by reducing the sample map resolution in Settings/Sample Map/Image resolution.

## 8) POWER BUTTON

Use the power button to close the software. If there are unsaved changes, this prompts a Save Changes window which can be used to bring up the Save Experiment wizard. Further, if devices such as Mass Flow Controllers (MFCs) are operational, then a prompt will appear asking for confirmation to turn them off.

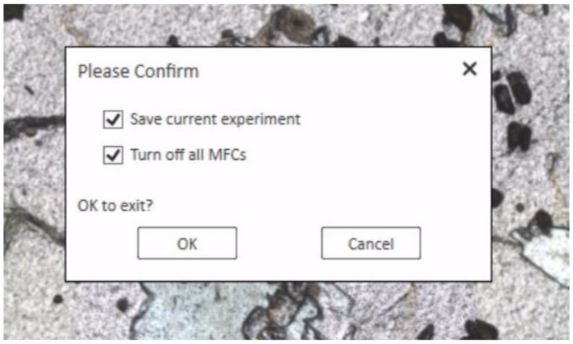



Figure 8-1: Save Changes and Device Confirmation Window

## 9) FILE MANAGEMENT TAB

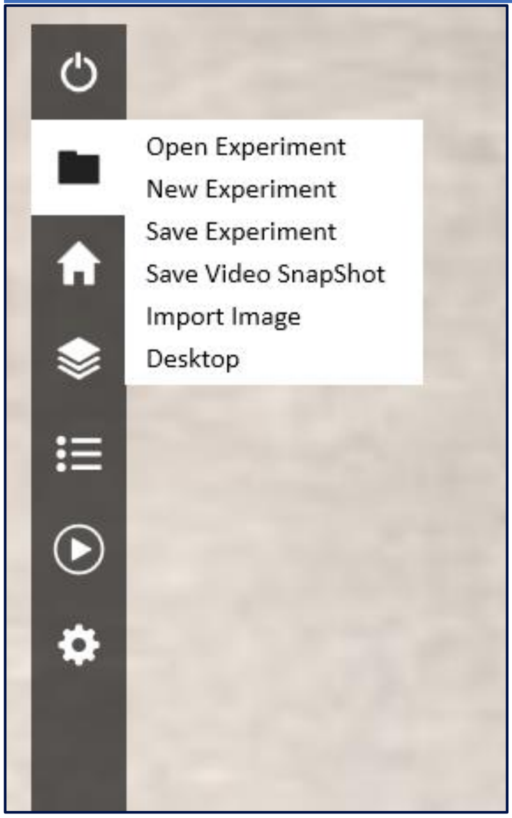



Figure 9-1: File Management tab

1. Open Experiment

   Open and load a previously saved experiment file.

2. New Experiment

   Clear the existing work and create a new experiment. Save any existing work before choosing this option otherwise it will be permanently lost.

3. Save Experiment

   Save the experiment. The experiment can be saved as an .LAX file (maintains images) or a .CSV file (stores only pattern and reference point information). The .CSV file content can be customized in the Settings: CSV Save Settings window.

4. Save Video SnapShot

   Save an image of the current main camera view.

5. Import Image

   Import an external image into the software. This button launches a wizard that is discussed further in the Layer Management: Images (Section 12-3).

6. Desktop

   Minimize ActiveView2 to the taskbar. This does not close ActiveView2 or alter the experiment. This can also be achieved by holding down the Windows (⊞) key and pressing "D"

## 10) LASER SETUP TAB

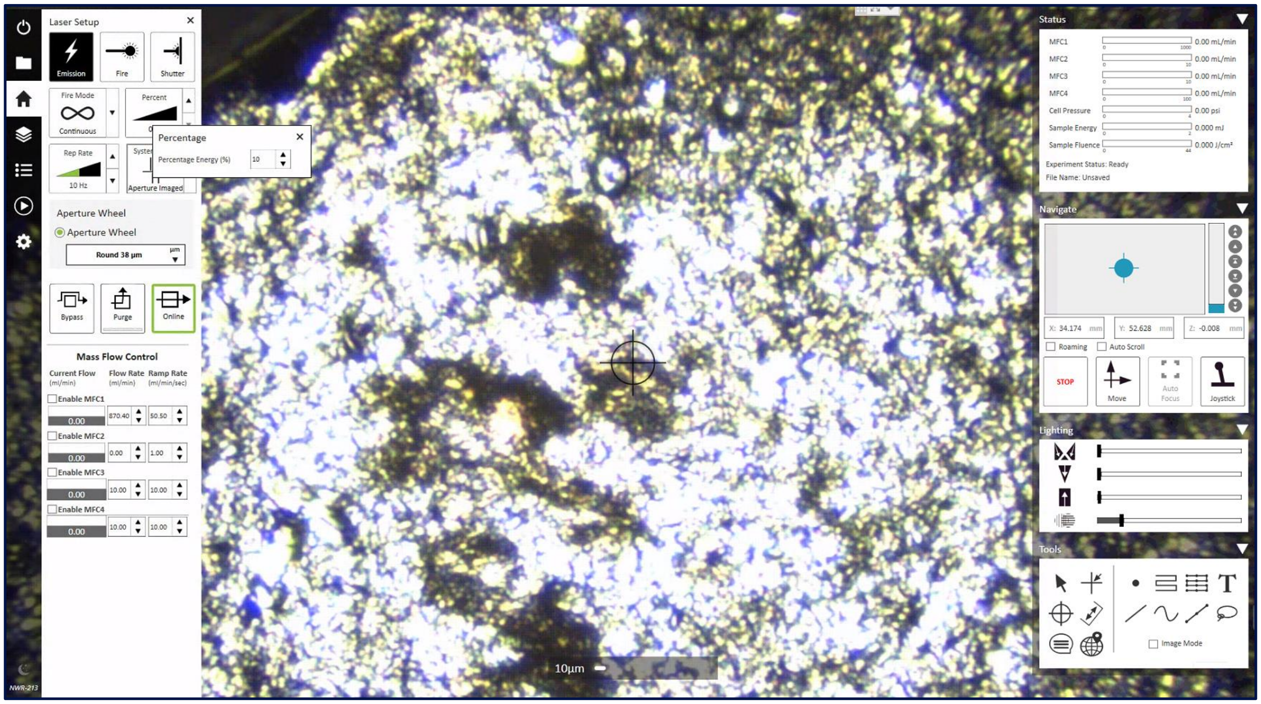



Figure 10-1: Laser Setup tab

The Laser Setup tab shows the currently active laser and gas control properties and allows them to be adjusted. Settings in this window do not influence properties of scan patterns.

### 1. Manual laser firing

The icon colors have a black background when they are “on”.

#### a. Emission

Sets the laser to a ready state.

#### b. Fire

Fires the laser through the beam delivery system.

#### c. Shutter

Allows the laser through the objective, into the sample chamber.

## 2. Fire Mode

The laser can be configured to fire different numbers of shots by choosing the desired option from the drop down at the right of the Fire Mode button.

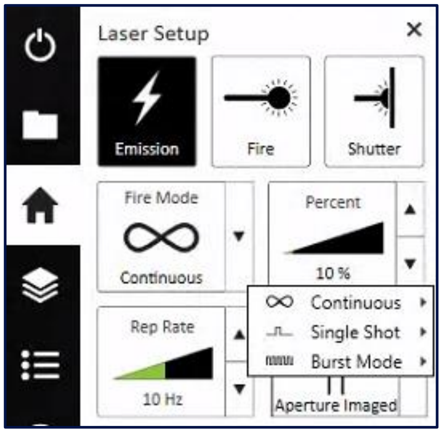



Figure 10-2 Available Fire Modes

### a. Continuous

The laser will start firing when "Fire" is pressed and continue firing until "Fire" is turned off.

### b. Burst

The laser will fire the specified number of shots and stop firing. To specify the burst count, put the laser in "Burst" mode, then right click on the button to bring up the Burst Count menu. Press Enter to set the burst count, see Figure 10-3.

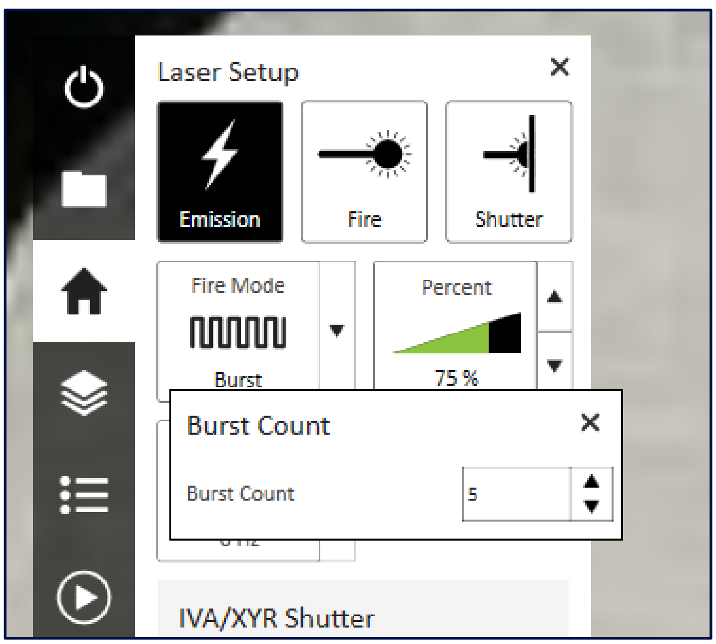



Figure 10-3: Set manual burst count

### c. Single shot

The laser will fire one shot every time the Fire button is pressed.

## 3. Percent/Fluence

There are two modes for setting energy output.

Percent energy mode runs a linear scale from 0-100%, where 0% delivers zero laser energy and 100% delivers the maximum available energy to the sample surface, adjustable in 0.01% increments. Percent energy mode works for circular (IVA) and rectangular (XYR) spot shapes. The percent energy can be selected by left-clicking on the icon and entering a value, or by left clicking on the up and down arrows on the right of the icon.

Fluence mode uses the internal calibration of the system to deliver the user-entered fluence value to the sample surface. The fluence can be selected by left-clicking on the icon and entering a value (Figure 10-5), or by left clicking on the up and down arrows on the right of the icon. Fluence mode works for circular (IVA) and rectangular (XYR) spot shapes.

To change between Fluence and Percent mode, right click and choose the desired metric (Figure 10-4). Changing the Laser Output Increment (accessed by right clicking) will change the step size of the arrows to the right of the button.

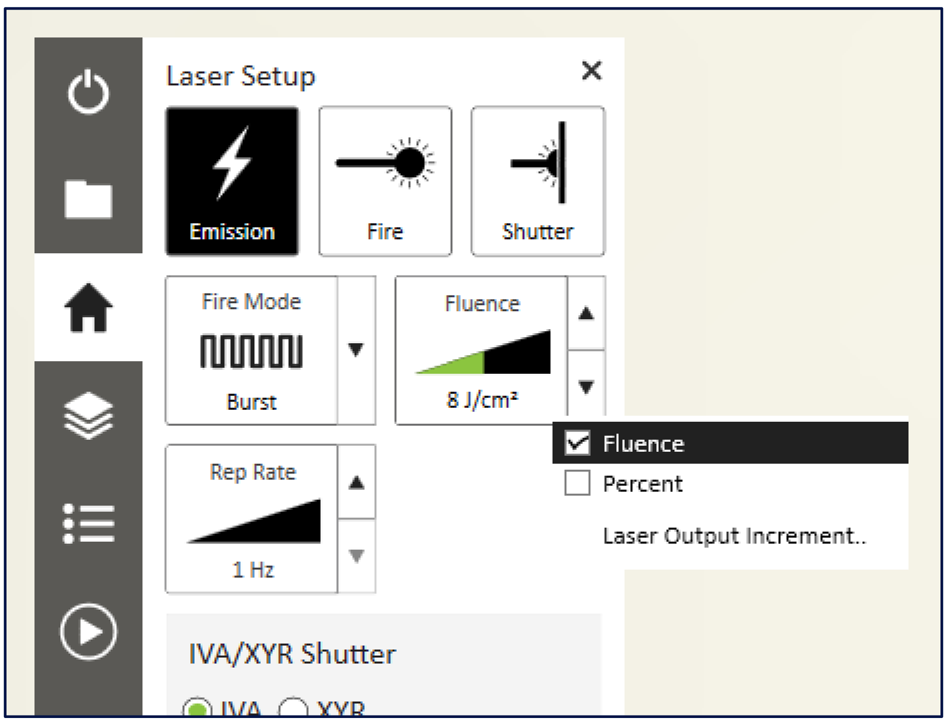



Figure 10-4: Change between Fluence and Percent

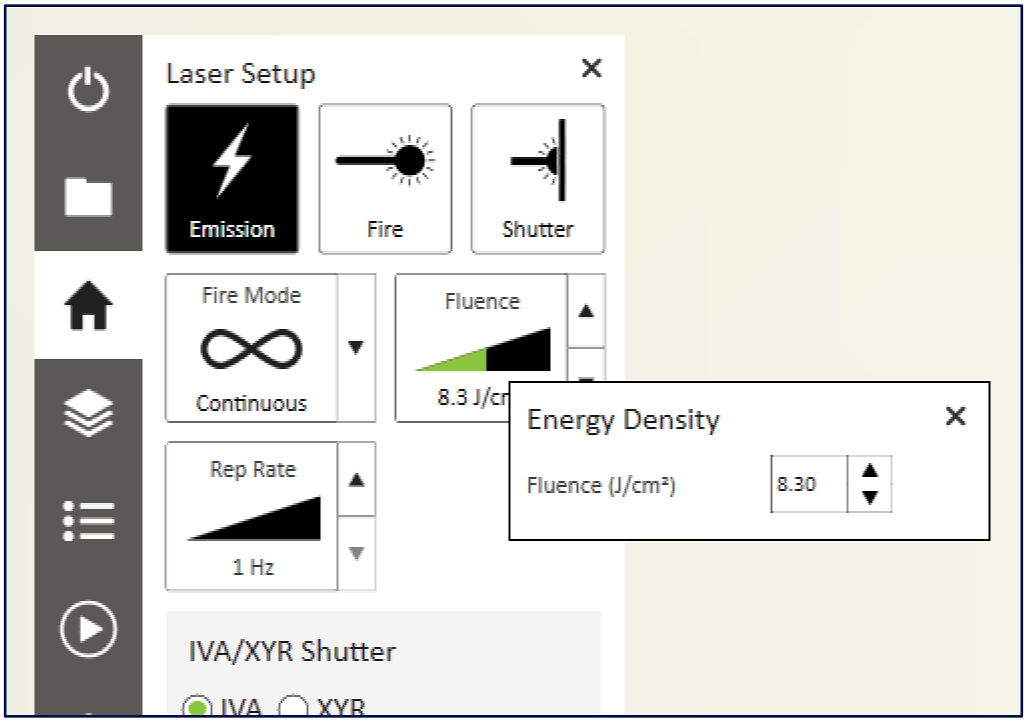


Figure 10-5: Edit fluence

## 4. Repetition Rate

The repetition rate defines the number of times the laser will fire per second (Hz) and is set using the Rep Rate control. The user can click on the button to type in the desired repetition rate or use the arrows on the right of the button.

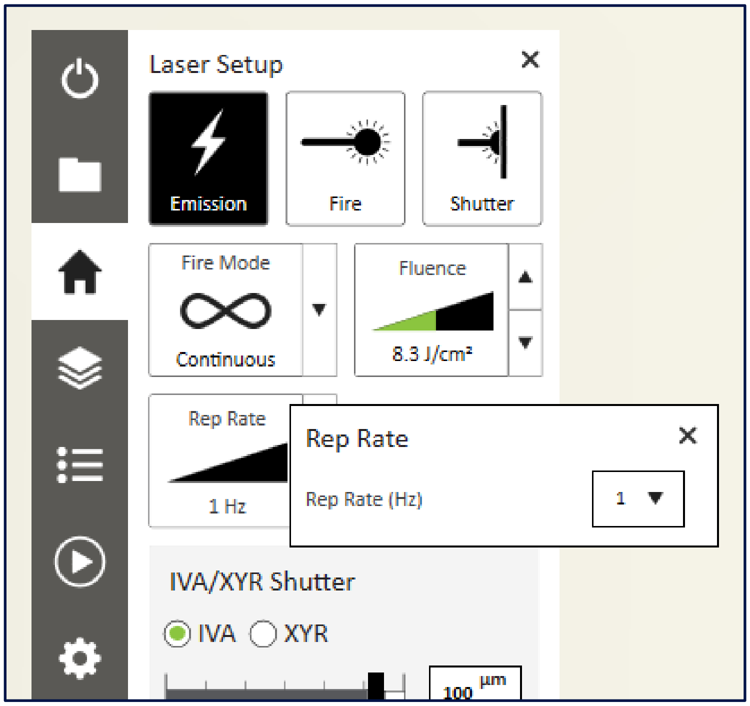



Figure 10-6: Set the laser repetition rate

## 5. Mode

Some laser systems have special modes, which are software-controlled and have mutually exclusive hardware settings. The configuration of the system determines the appearance of this button. Where available, a drop down appears and allows users to swap between modes.

For example, on the NWR213, "Imaged" mode provides aperture imaged spot sizes from 1-110 µm that change independently from fluence. "Focused Beam" mode in the NWR213 changes the available spot range to 110-250 µm (Figure 10-7). The fluence of Focused Beam mode changes with spot size and the crater edges will be less well-defined.

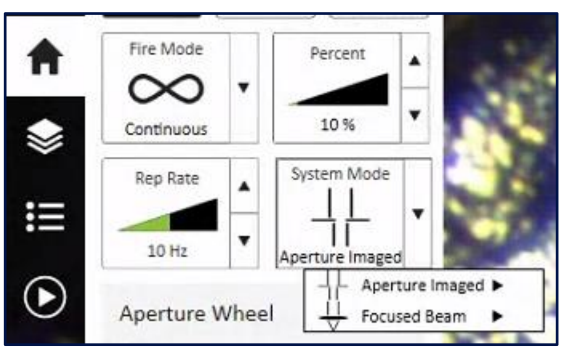



Figure 10-7: Toggling between NWR213 modes

## 6. Beam shaping (IVA/XYR Shutter/Aperture Wheel)

The available spot size and shape options depend on the configuration of the NWR platform. The default hardware configuration for NWR266macro contains an aperture wheel with 11 available aperture positions that range from the minimum to maximum available on the laser. The default hardware configuration for all other systems is the IVA which allows 1 µm increment circular spot sizes from minimum to maximum beam diameter.

### a. Aperture wheel

Controlled by selecting from the range of available spot sizes in the drop-down menu.

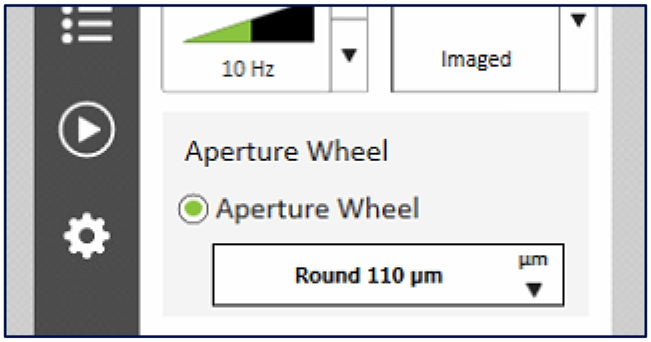



Figure 10-8: Aperture wheel device control

### b. Infinitely Variable Aperture (IVA) device

Allows 1 µm increment circular spot sizes from minimum to maximum beam diameter.

The IVA device can be adjusted with either the slider, the dropdown menu, or typing the desired spot size into the drop-down window. As the IVA changes the circle around the software crosshairs will adjust. The IVA radio button must be selected to make IVA adjustments (XYR controls will be greyed out).

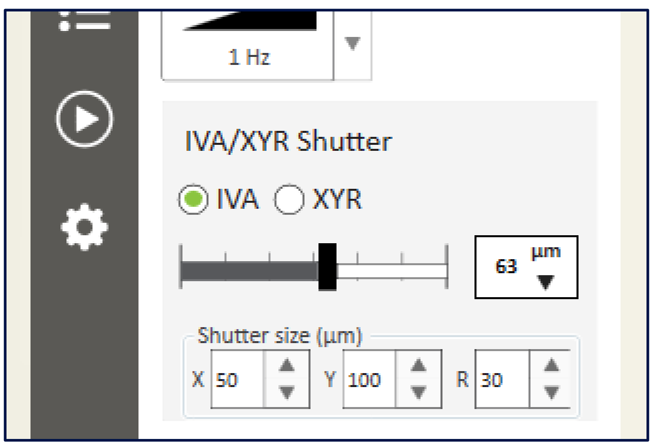



Figure 10-9: Manual IVA device control

### c. The X-Y-Rotational Shutter (XYR) device

When installed, the XYR device allows rectangular craters to be created. The XYR device can be adjusted with the arrows or by typing directly into the X, Y and R (rotation) windows. The shutter can form rectangles in 1 µm increments in X and Y whose diagonal is less than or equal to the maximum spot diameter, at whole number angles between -90° and +90°. For systems with both an IVA and an XYR, the XYR radio button must be selected to make XYR adjustments and IVA controls will be ignored.

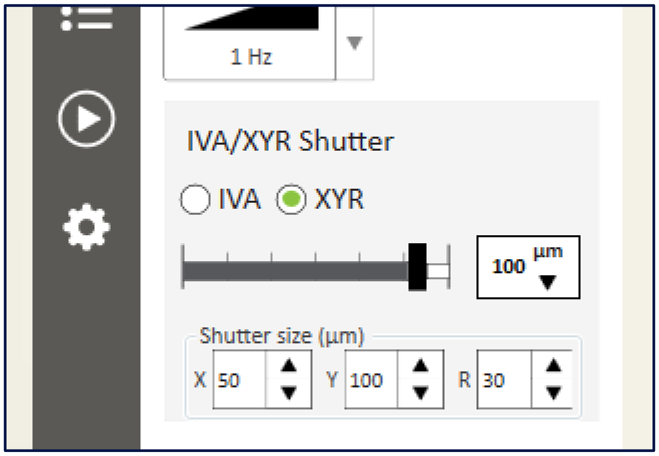
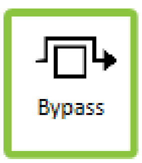


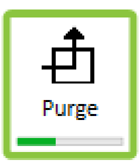

Figure 10-10: Manual XYR device control

## 7. Gas Control




### a. Bypass

Helium is diverted around the sample chamber while still being delivered to the ICP. Bypass mode can be used when opening the chamber to prevent atmospheric gases reaching the plasma.

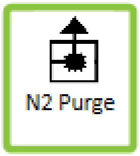



### b. Purge

Helium is swept into the sample chamber and directed out of the system via the purge fitting on the rear of the instrument. This is a required step between closing the sample chamber and starting analysis. Unlike the other modes, Purge has a time associated with it. Set the purge timeout by right clicking the **Purge** button (minimum 120 seconds recommended for TwoVol1, TwoVol2 and TwoVol3). The green bar across the bottom of the **Purge** button shows the purge progress. The Mass Flow Controller is bypassed during Typhoon purge (TwoVol2 and TwoVol3) and the ramp rate does not apply. After a purge is complete, the valves will automatically switch into Online mode, dropping the flow to 0 mL/min, and will begin to ramp up to the set “Flow Rate” according to the “Ramp Rate”.


### c. Online

Helium is swept through the sample chamber and towards the plasma. The helium flow rate can be modified during tuning but is typically around 800 mL/min for the TwoVol2 and TwoVol1 sample chambers.




### d. $N_2$ Purge

The NWR193 and NWR193HE require a beam delivery purge of nitrogen gas to prevent the laser from interacting with atmospheric gasses. The $N_2$ Purge is independent from the other gas modes and should be on any time the laser will be fired, as energy loss (and therefore energy at the sample) will vary with content. In some systems the $N_2$ Purge flow rate is controlled by the ball rotameter in the cabinet and is typically set to 1-2 L/min. In other systems the $N_2$ Purge is controlled by a designated MFC. Wavelengths above 193 nm do not require a beam delivery purge.

## 8. Mass Flow Control

### a. Enable

The checkbox above the MFC acts as an on/off switch.

### b. Current Flow Readout

The “Current Flow” is the measured value reported by the MFC. It is reported numerically at the bottom of the bar and graphically above. The current flow rate is also displayed in the Status window.

### c. Flow Rate

This is the desired flow rate. Type directly into the box to set the flow rate in Bypass or Online mode.

### d. Ramp Rate

To protect the plasma from dramatic gas flow changes, the “Ramp Rate” is employed. This value controls the rate at which the MFC will attempt to reach the “Flow Rate” value, and the optimum “Ramp Rate” depends on plasma robustness. Typical values run from 10 mL/min/sec to 50 mL/min/s.

### e. MFC<n>

If additional optional mass flow controllers are configured, they are controlled identically to the first MFC.

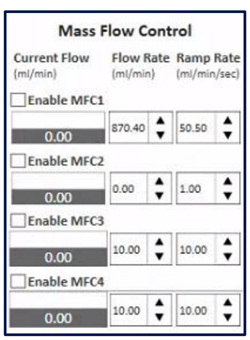



Figure 10-11: Mass flow controller control panel

## 11) LAYER MANAGEMENT TAB

The Layer Management tab controls and organizes the images, live video, pattern scans and notations displayed in the main viewing area of ActiveView2. As data is input into ActiveView2 it appears as a layer under the appropriate, e.g. Patterns, Images, Sample Maps, Live Video, Reference Points and Annotations. Headings cannot be added or removed.

### 1. Navigating Layer Management

#### a. Hide/Show

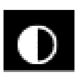
The eye icons next to each layer will hide or unhide that layer on the main screen. Hidden layers are invisible but maintain their spatial position and can be turned on at any time. The eye at the heading level will hide or show all layers under that heading. A crossed-out eye indicates that the item is hidden in the visible workspace.


Figure 11-1: Hide/Show icons

#### b. Collapse/Expand

Each category can be collapsed using the arrow next to the heading. Click the arrow again to expand the category.

#### c. Opacity



Each layer can have its own opacity setting. Adjust the opacity of specific layers by selecting them in the tab and clicking the **Opacity** button. 0% Opaque layers act like hidden layers. Moderate opacities can be employed to use information from multiple viewing sources at once.

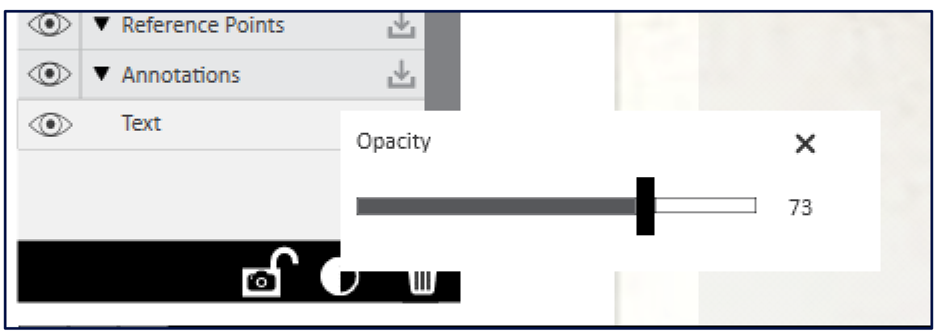



Figure 11-2: Opacity slider

#### d. Delete

Remove items from the experiment. This action cannot be undone.

## 2. ImageLock

ImageLock is a software-based tool that corrects for errors in stage position that occur during long series of multiple stage movements. When turned on, and during pattern placement, ImageLock stores an image from the main camera, as well as the zoom, lighting, polarizer and stage settings in the Experiment. When the scan is run ActiveView2 returns to these settings and compares the current live camera view with the saved image file. Any differences are corrected by incremental stage adjustments until the detected difference is < 1 µm (configurable) in under 2 seconds, at which point the scan runs as normal.

ImageLock can be turned on and off using the ImageLock icon at the bottom of the Layer Management Window which toggles the padlock icon open (for off) and closed when ImageLock is on. The only noticeable difference when placing scans with ImageLock turned on is that the crosshair and stage will now move automatically to the location where a new scan is placed in order to capture the image file. Scans placed using ImageLock feature a green padlock icon beside them. Scans with active ImageLock data can be moved using the pointer tool, and the stage will automatically move to the new location to collect a new image.

When running scans with ImageLock there may be a delay of up to 2 seconds while any corrections are applied. The corrections occur before laser warmup and do not affect timing relating to triggering or ICP-MS plugins.

In the event of ImageLock failure, the lock logo will appear red and open. This can occur if the sample has been moved, or if the sample has too little contrast on the surface. The user can configure error handling procedures in Settings:

ImageLock Settings. Patterns placed with ImageLock off can have ImageLock added later using the right click menu, or by dragging the pattern with the mouse on the main video.

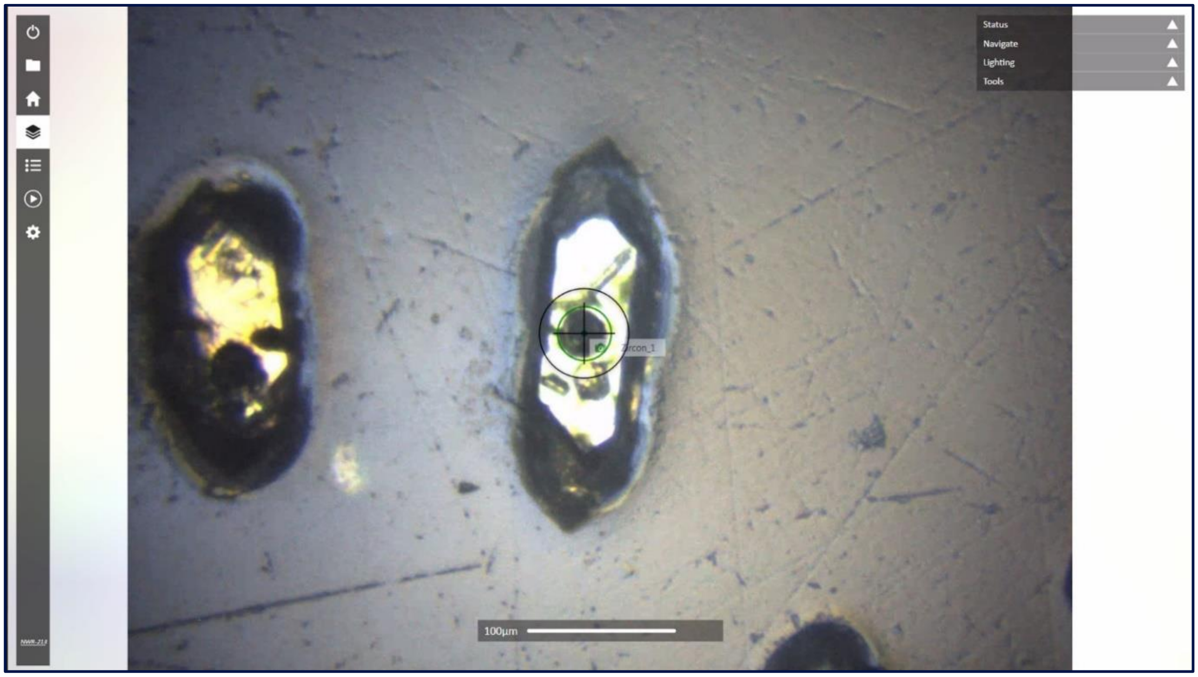



Figure 11-3: Example ImageLock pattern

## 3. Patterns

The first heading of layer management contains all the patterns placed in this experiment. Much of the control is run by selecting and right clicking the desired patterns to display a popup context menu.


Figure 11-4: Layer Management tab

### a. Queue, Queue All, Auto Queue

In large experiments, it is not always the case that all the patterns in the software should be run at once. Patterns can be placed and manipulated in the Layer Management: Properties and the tabs, but will not run until a Run Queue Order is established. In the menu (accessed by right click) **Queue** will add the selected pattern(s) to the Run Queue List. **Queue All** will add all patterns to the list. Checking **Auto Queue** will add new patterns to the list as they are placed. The specific Run Queue Order is controlled in Pattern List View: Run Queue Order.

### b. Properties

Pattern properties are one way to define the parameters of specific patterns (the other being the Pattern List View Tab).

### c. Move to Pattern

Move the stages to center the crosshairs over the first vertex of the pattern.

### d. Duplicate Patterns

Make copies of the pattern. This brings up a window where the user determines the number of new copies and desired offset from the original in X, Y, and Z. The offset is cumulative and applies to each subsequent copy. In Figure 11-5, the user will end with 21 patterns on a diagonal line to the lower right. Negative values can be entered into the Offset boxes.

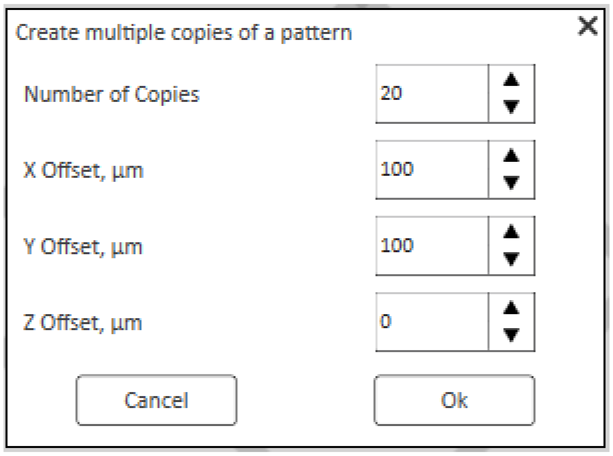



Figure 11-5: Duplicate Patterns

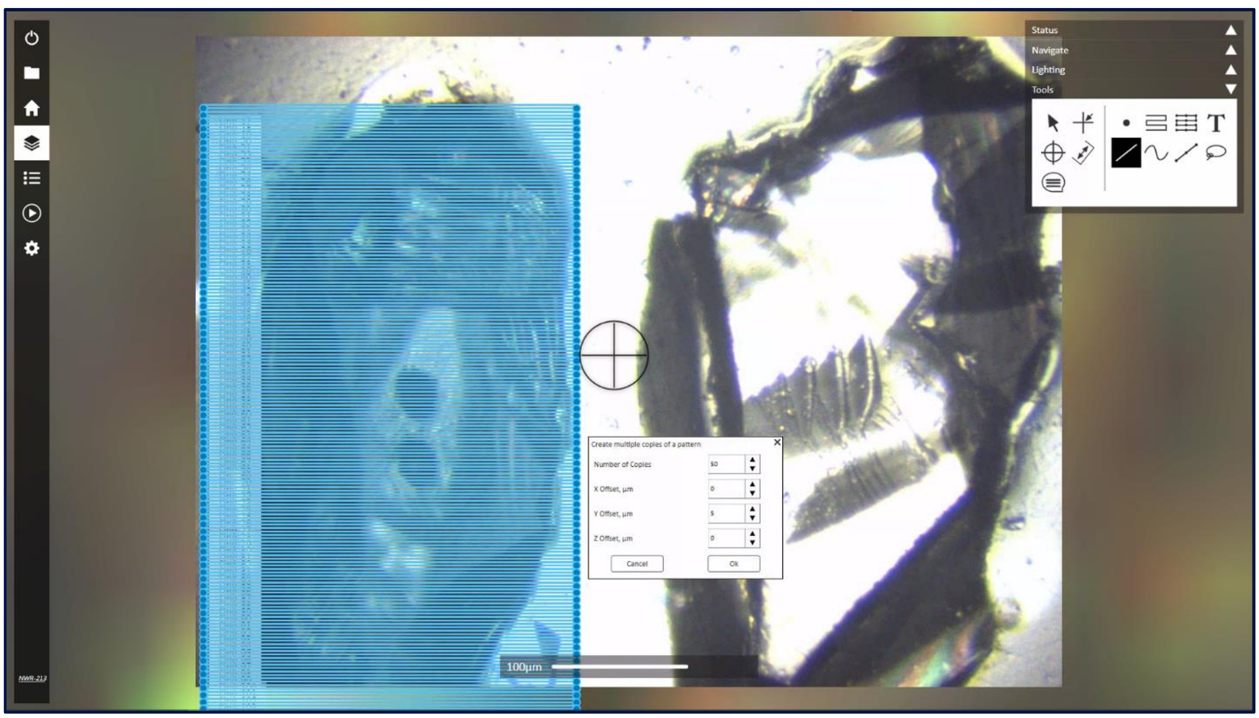



Figure 11-6: Example duplicated line patterns

### e. Translate/Rotate

A pattern or group of patterns can be translated, rotated or both using this window. The check boxes next to **Rotate** and **Translate** determine which transformation to apply to the selected patterns. The **Order** radio buttons determine which transformation occurs first.

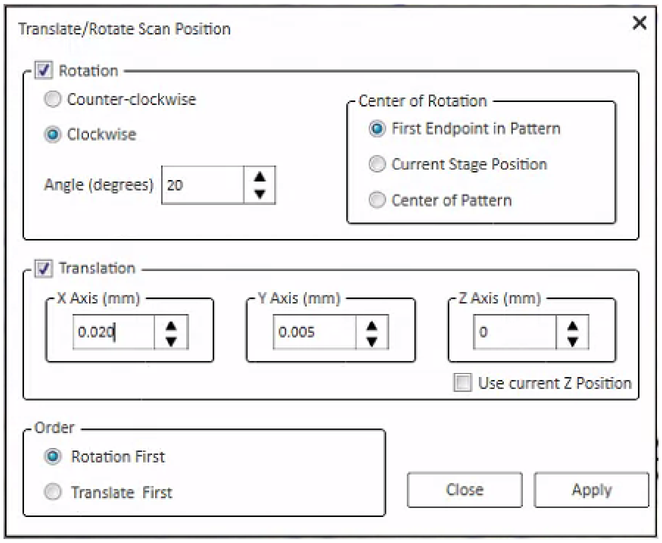



Figure 11-7: Translate/Rotate Pattern Position

### f. Edit Endpoints

Pattern placement is defined by endpoints. This window allows the user to see and edit the X, Y and Z coordinates for the endpoints of the selected pattern. This is particularly useful for modifying the Z position of patterns placed on samples with irregular topographies or those that do not remain normal to the objective. ActiveView2 will automatically interpolate the Z position between the closest two endpoints. Endpoints can also be edited in the Pattern List tab by selecting the pattern.

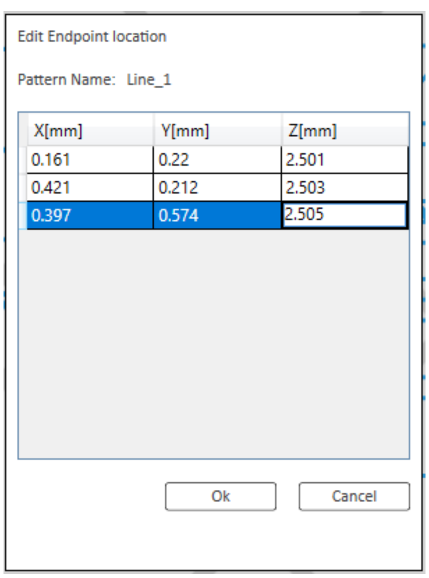



Figure 11-8: Edit Endpoints example for 2-segment line pattern

### g. Re-coordinate

Re-coordination allows the user to place saved or open patterns on samples that have since been removed and replaced from the chamber or on different samples requiring the same analysis pattern.

Reference Points should be placed on: a) easily identifiable features and b) features that won't change in orientation relative to the patterns; before removing the sample. Greater distance between reference points will decrease the impact of misplacement. For example, if the whole sample chamber insert is removed and replaced without changing the samples, three Reference Points will suffice for the entire insert. However, if the samples will change in orientation to each other, Reference Points should be placed for each sample, and each sample should be re-coordinated separately. Only three Reference Points are used for each re-coordination.

With three Reference Points, a pattern or group of patterns can be Re-coordinated. In the wizard, select what subset of patterns and additional layers should be re-coordinated, and which three Reference Points will be used (if there are more than three in the current experiment).

When prompted for each reference point, center the crosshair on the current location in the main camera view in X, Y and Z, and click **Set**. **Move to Ref Point** will drive the stages to the previous X, Y, and Z location which can be useful if the movement is large. The image of the original location is shown for each Reference point and can be opened in a separate resizable window with **Float Image**. Do NOT move the Reference Points during this process, move the stages so the crosshairs are at the original feature, then press the "Set" button. The "New Position Set" checkbox confirms that the new position is set for the current reference point. Press **Next >>**. When all three points have been set, click **Finish**. When complete, the selected items will be translated, rotated, and scaled to bring all the selected items' vertices to the new set locations.

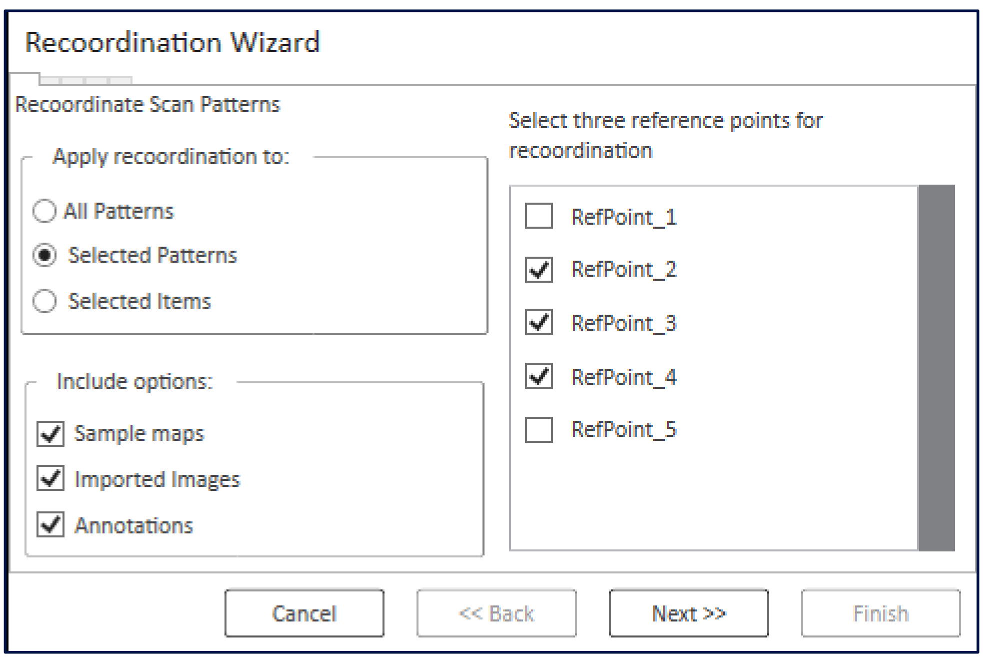



Figure 11-9: Re-coordination Wizard

### h. Adjust Focus

Within the Adjust Focus window, there are two options for adjusting the focal position of patterns and handling points. The first is a wizard in which the Z position of patterns or handling points can be accomplished efficiently using the keyboard arrows instead of the Edit Endpoints menu. With the desired patterns selected (can be a subset of the experiment), use the up and down arrows to change the Z focus, and the right arrow to accept the Z position for that endpoint. The wizard will automatically move to the next endpoint when an endpoint is accepted. The "Z Focus Speed" slider adjusts the speed that the up and down arrows move the Z motor. The checkbox shows the user the active pattern.

Secondly, an Auto Focus can be employed in which a software algorithm is used to automatically detect the optimum focal position. Again, desired patterns (can be a subset of the experiment), and all handling points can be selected for adjustment. Once the desired patterns and handling points have been selected, the user should click on the "Start/Stop" button to commence/cease the process accordingly.

When all the selected patterns have been modified, press the corner **X** to close.

It's also possible to adjust the focal position of the entire experiment prior to running by clicking on the "Adjust Focus" button from the Run window.

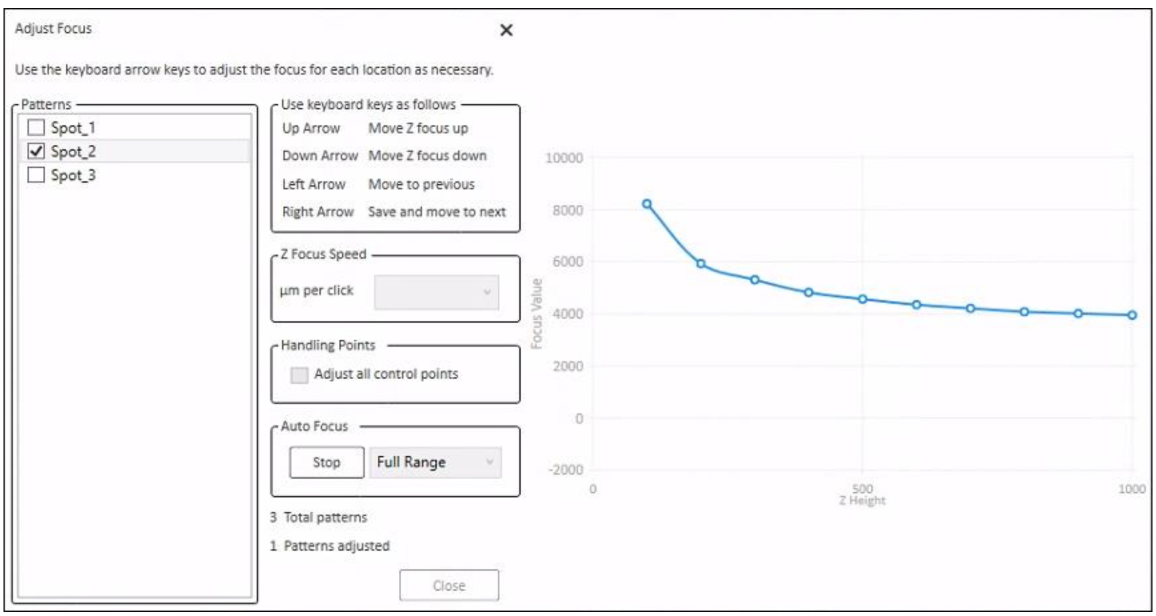



Figure 11-10: Adjust Z Positions

### i. Explode Pattern

Divides selected Raster, Lasso, Line of Spot, multi-segmented lines, and Grid patterns into their component parts. This can be used to modify sub-patterns independently.

### j. Group Patterns

This can be used to make a group of separate patterns act like one pattern. Note: a previously exploded pattern does not revert exactly, e.g. a Line of Spots that has been exploded and subsequently grouped will no longer have its Grid Spacing property.

### k. Merge Line Patterns

Like Group Patterns, Merge Line Patterns makes previously disparate line patterns act as one pattern, except a new segment will be created to connect each existing segment if necessary. This option is only available to selections that consist entirely of Line pattern types.

### l. Reverse Scan Direction

Changes the start and end of the line. Selecting this option will check the “Reverse Scan Direction” box in the Pattern Properties window.

### m. Move Patterns to Crosshairs

The first of the selected patterns will move to the current X, Y, and Z position of the crosshairs. Subsequent selected patterns will move to maintain their offset from the first pattern.

### n. Move Scan Focus

Changes the Z position of all selected patterns to the current crosshairs Z position (shown in the Navigate window). X and Y positions will be unchanged. The first vertex will be moved to the current Z location, all subsequent Z vertices will move a relative distance.

### o. Pattern Naming

After placement, patterns can be renamed in the Pattern List window. Patterns are named as they are placed according to the Pattern Naming. The Base Pattern Name is text or numbers that will stay the same. The Next Number will increment up as patterns are placed. Pattern Naming can be changed at any point. Each pattern type has its own Base Pattern Name. Return to the factory default names for the selected pattern by clicking **Default**.

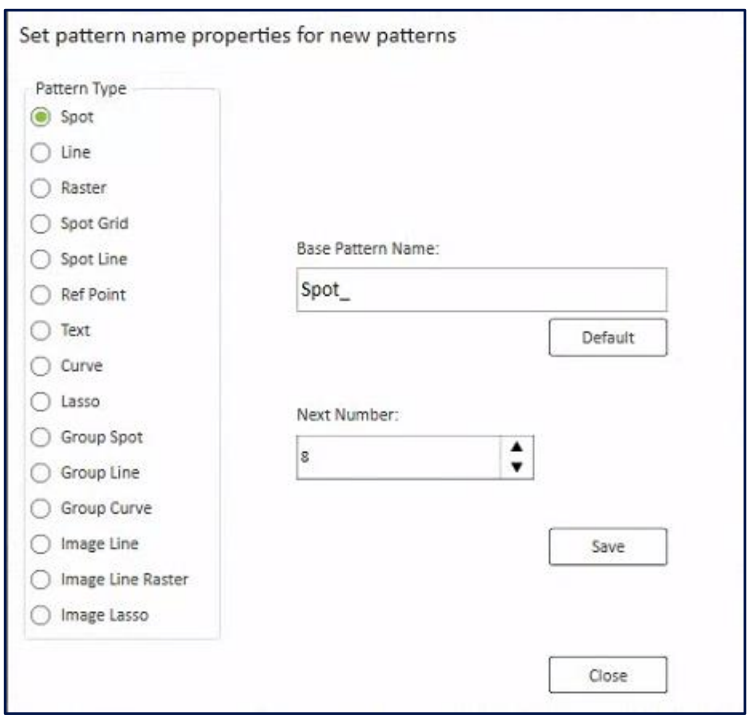



Figure 11-11: Pattern Naming

### p. Hide/Show Pattern

Reverses the current eye icon status. This acts like clicking the eye icon next to the selected pattern(s).

### q. Select All

Highlight currently placed patterns.

### r. Add ImageLock

Add ImageLock to a pattern that was placed with ImageLock turned off.

### s. Disable ImageLock

Remove ImageLock from a pattern that was placed with ImageLock turned on.

### t. Show Image

Show the reference image that ImageLock took when the pattern was placed in a popup window. Only applies to ImageLock patterns and Reference Points.

## 4. Images

Externally-generated images can be imported into ActiveView2 and aligned in the digital space. Some examples are cathode luminescence images, microscope captures, scanning electron microscope images, and overview images taken with a camera or scanner to show the relative orientation of samples in the chamber.

Select the  icon at the right side of the Images heading in Layer View to start the import process. Once the desired image has been selected, the curser will change to the Alignment Point tool for the next two clicks in the main window. Choose two features that are visible in both images and click them in the main ActiveView2 window, then click the features in the same order in the Image of the Import window. Spacebar + Click to pan the image without placing an alignment point. If necessary, zoom in on the Import image using the mouse wheel. Pressing **OK** will import the image into ActiveView2 and clear the Alignment points. Note that saved stage positions, such as fiducials on sample chamber inserts, can be readily accessed in this process to ease the importation of large images.

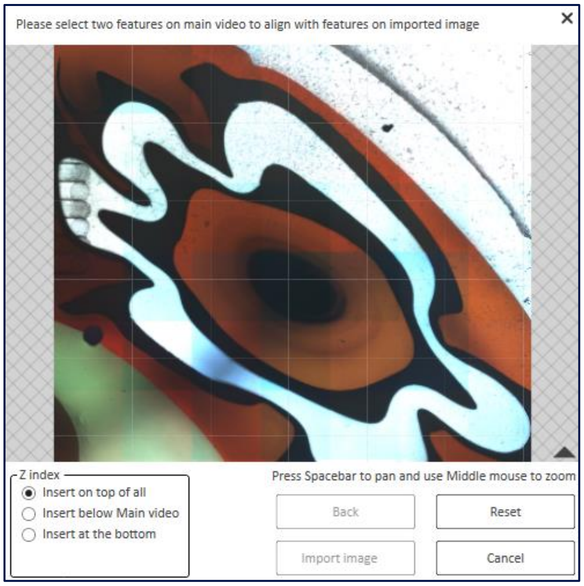



Figure 11-12: Import Image

Further, tools are available to specify the “z index” upon importation of the image relative to other imagery including the main video. The “z index” of any imported image can be adjusted at any point by accessing a menu via a right click on the image in the Layer Management window.

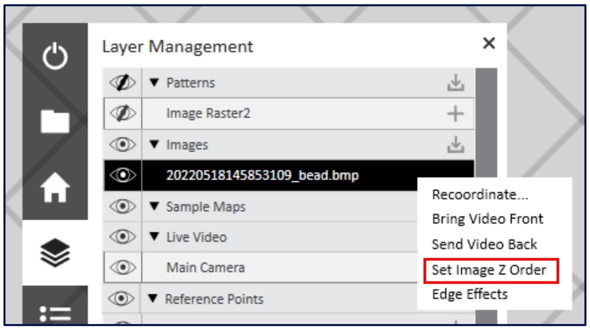



Figure 11-13: Open Image Z Order tool

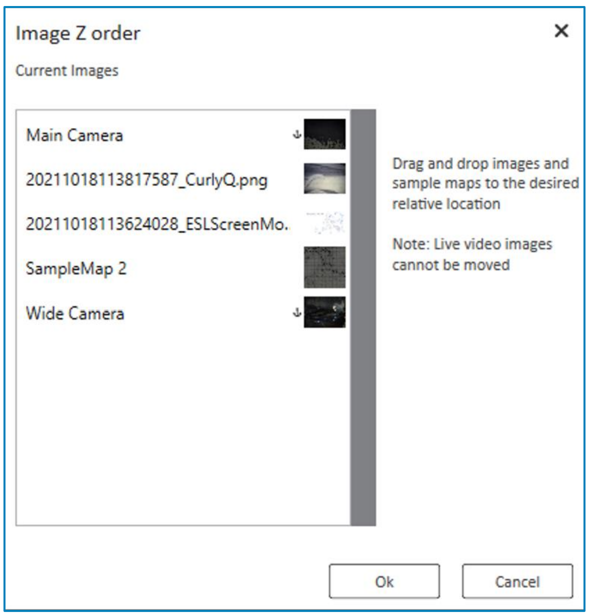



Figure 11-14: Adjusting the z index of experiment imagery

## 5. Sample Maps

Sample maps are mosaics, stitched together from still camera images. Create a new sample map by clicking the  icon in the Tools section.

## 6. Live Video

Shows the Main and Wide-angle camera layers. No new Live Video layers can be added, but this display allows the camera opacities to be changed. Right clicking each camera will offer a selection to take a "snapshot" – a single frame Sample Map that is placed under the Images heading. Live video imagery scales according to zoom position.

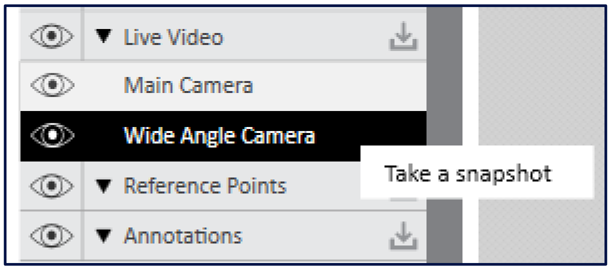



Figure 11-15: Snapshot

## 7. Reference Points

Any Reference Points created appear here. Reference points can be used for area of interest location reference or for recoordination. See Tools: Reference Point and Layer Management: Re-coordinate for more discussion.

## 8. Annotations

Any Annotations created appear here. See Tools: Annotations. Annotations scale according to zoom.

# 12) PATTERN PROPERTIES

The Pattern Properties window can be accessed from several places:

1. Right click the pattern in Layer Management and choose **Properties…**
2. Double click the pattern in Layer Management
3. Right click an endpoint in the main video display and choose **Pattern Properties**
4. Right click the pattern in the Run Queue and choose **Properties…**
5. Double click the pattern in the Run Queue

## 1. Ablation properties

The Pattern Properties determine the laser and stage parameters used when the pattern runs. Not all properties apply to all pattern types (e.g. line patterns will not have a dwell time) and these are grayed out as appropriate. The following properties are available and are described from top to bottom as they appear in the window (Figure 12-1).

a. Pattern color: The display color of the pattern in the software.
b. Name: The pattern name. The edited name appears in the Layer Management and Queue tabs.
c. Grid Spacing: Distance in X between sub-patterns in a Line of Spots and Grid/Raster pattern.
d. Raster spacing: Distance in Y between sub-patterns in a Grid, Raster or Lasso pattern. Also distance between lines in Image Raster and Image Lasso patterns.
e. Enable Ablation Pass: Selected by default to indicate that the ablation pass will run if the pattern is queued.
f. Enable Pre-Ablation Pass: Enables a Pre-Ablation pass.
g. Reverse Scan Direction: Patterns run by default in the direction they were placed. This box reverses that direction. The starting side of the line has the pattern label next to it – this will update on the display when the box is checked.
h. Scan All Lines in Same Direction: All lines in the pattern (e.g. Image Raster, Lasso and Image Lasso) will scan in the direction of the first line.
i. Scan All Passes in Same Direction: If multiple passes are set, all will be scanned in the same direction.
j. Passes: The number of times the pass type will run.
k. Depth per pass: The Z position can be adjusted for subsequent passes to account for anticipated depth of the crater. The depth of the crater left by one pass should be measured and entered as the "Depth per pass" value.
l. Use Current Laser Settings: Pulls the active laser settings shown in the Laser Setup tab into the Pattern Settings window (Energy/Fluence, Spot size, Spot shape, Rep Rate).
m. Apply Settings to Laser: Pushes current Pattern Settings properties to the Laser Setup tab. This can be used to test ablation properties on a sacrificial area before the experiment.
n. Fluence/Percent: The energy of the laser can be requested in either percentage, or by directly requesting the energy density (Fluence) with units of $J/cm^2$. The radio buttons determine the mode and change the units. The user types the numeric value of the specific mode into the Output box. See Laser Setup: Percent/Fluence.

o. Rep Rate: The frequency at which the laser delivers pulses (Hz). The available rep rates for each laser are shown in the drop-down arrow and can also be selected from that list. See Laser Setup: Repetition Rate
p. IVA/XYR Shutter or Aperture Wheel: The appearance of this option will be different depending on the beam shaping options configured. The beam shape can either be circular or rectangular. The radio button determines the shape (IVA or Aperture Wheel for circles, XYR for rectangles). The size is determined by the drop down (IVA) or the data boxes below (XYR). The Auto Rotate box will make the XYR pattern rotate perpendicularly to the line pattern. See Laser Setup: Beam shaping (IVA/XYR Shutter/Aperture Wheel).
q. Dwell Time/Burst Count: The duration of spot-based patterns can be defined in either number of seconds (Dwell Time) or number of laser shots (Burst Count). The radio buttons determine the mode that will be used.
r. Intersite Pause: Define the number of seconds to delay between sub-patterns (s) in Line of Spot, Grid, Raster, and Lasso patterns. This must be a whole number.
s. Save as Default: If checked the properties in the window when "OK" is pressed will be used as the default properties for all future patterns of that type. Each pattern type has its own default set of properties. Using the Default can reduce the editing work required if many similar patterns are required.

   It's possible to store multiple default pattern properties and build a "Library of Default Patterns" for future use. After clicking "Save as Default" the "Default Pattern Selector" window is opened in which the user can provide a name to the default properties e.g. U/Pb method or Eclogite_Image method.

   To select or recall a method simply right click over the desired pattern type in the "Tools" window and select "Default Patterns". Simple select the desired method from the list and once selected the properties will be employed as the default when placing patterns.

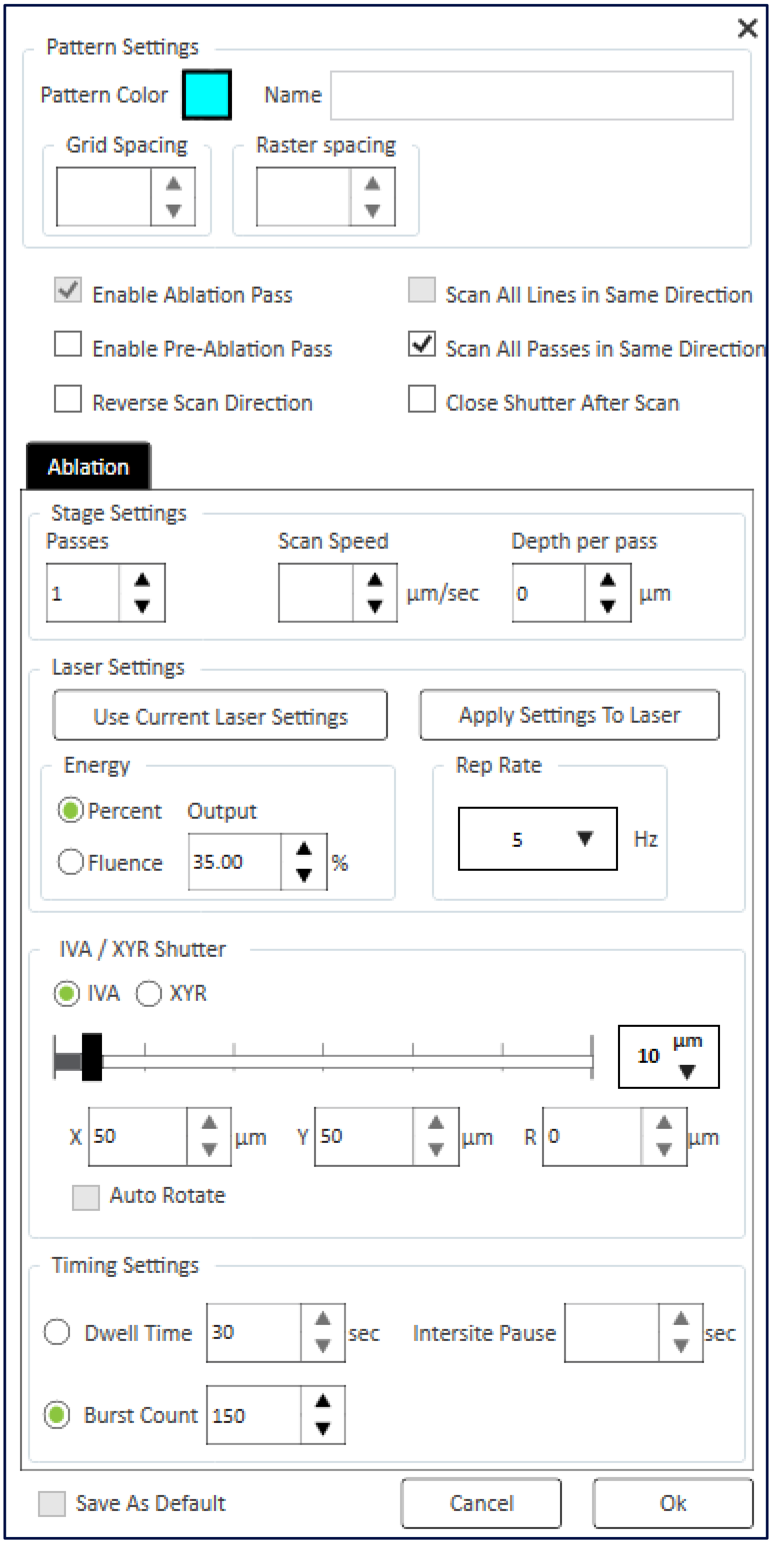


Figure 12-1: Example pattern properties window for a spot pattern

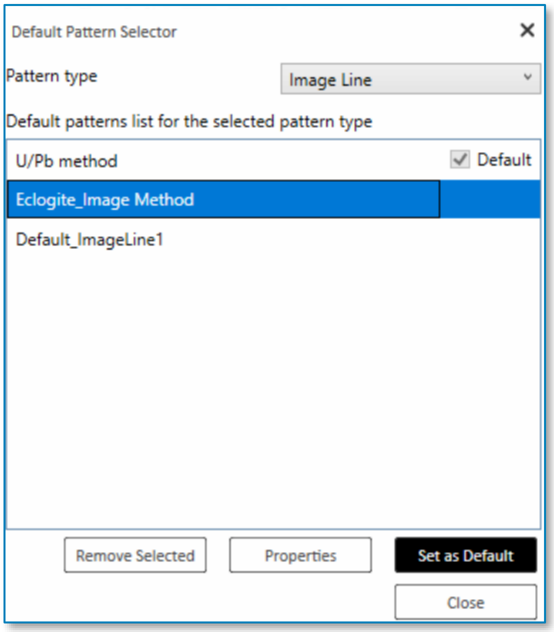



Figure 12-2 The Default Pattern Selector window.

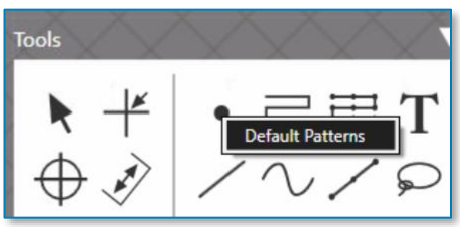



Figure 12-3 Right click on the desired pattern to open the “Default Patterns” for a given pattern type.

## 2. Pre-Ablation

Pre-ablation passes run before the Ablation pass and are usually used as a "cleaning" sweep to remove surface debris before the actual analysis. Typically, the parameters have a larger spot, faster scan speed or shorter dwell time, lower rep rate, and lower fluence than the Ablation pass. Pre-ablation is turned on by checking "Enable Pre-Ablation Pass" in the pattern window. Properties for pre-ablation follow the same options as for ablation, detailed above.

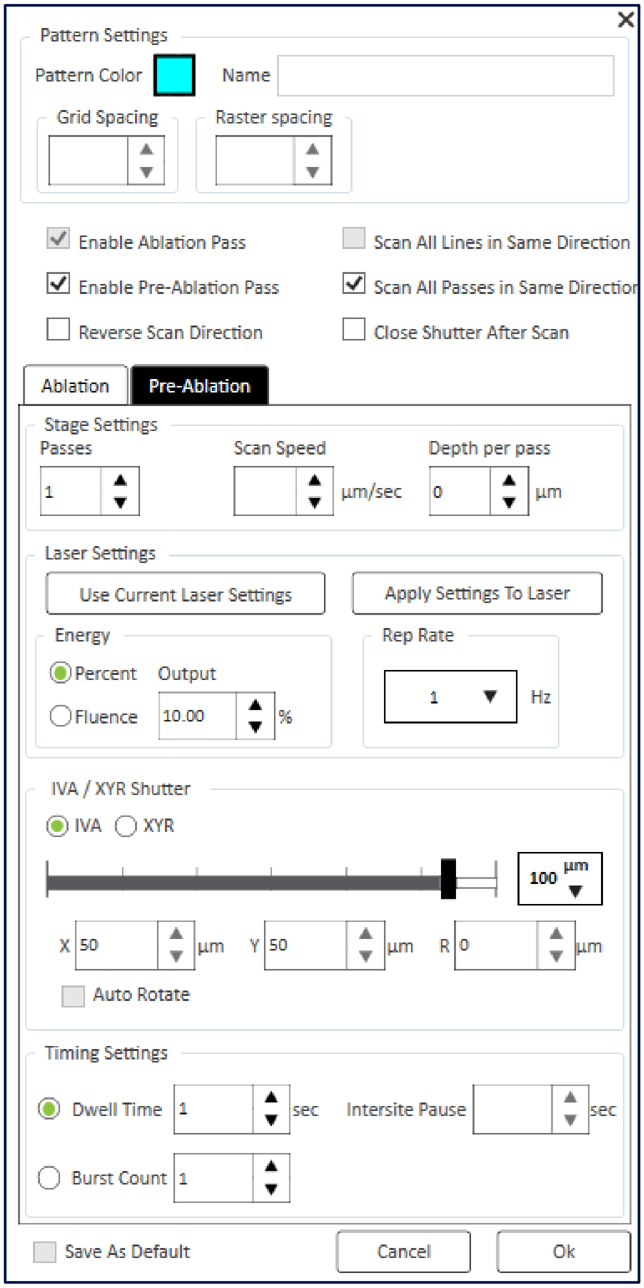



Figure 12-4: Example pattern properties window for a spot pattern with pre-ablation enabled

# 13) PATTERN LIST TAB

The Pattern List tab (Figure 13-1) offers an alternative way of viewing and modifying pattern properties and shows a spreadsheet-style summary view of all the patterns and their properties. Changing conditions in the Pattern List window will update the conditions in the Pattern Properties window (Section 12) and *vice versa*. Properties are represented in columns and each pattern is represented as a row.

## 1. White vs. gray properties

Properties in the Pattern List are white if they can be edited, and colored gray if they are irrelevant or locked. Properties can be edited by typing in the cell.

Some properties are irrelevant for specific pattern types (e.g. Grid Spacing for Line patterns). Others can be turned on an off. For example, Fluence (J/cm$^2$) and Energy (%) are mutually exclusive properties – you cannot define both. Therefore, when the box in "Fluence Enabled" is checked, Fluence (J/cm$^2$) is white and Energy (%) is gray. See Percent/Fluence for more information on laser energy control.

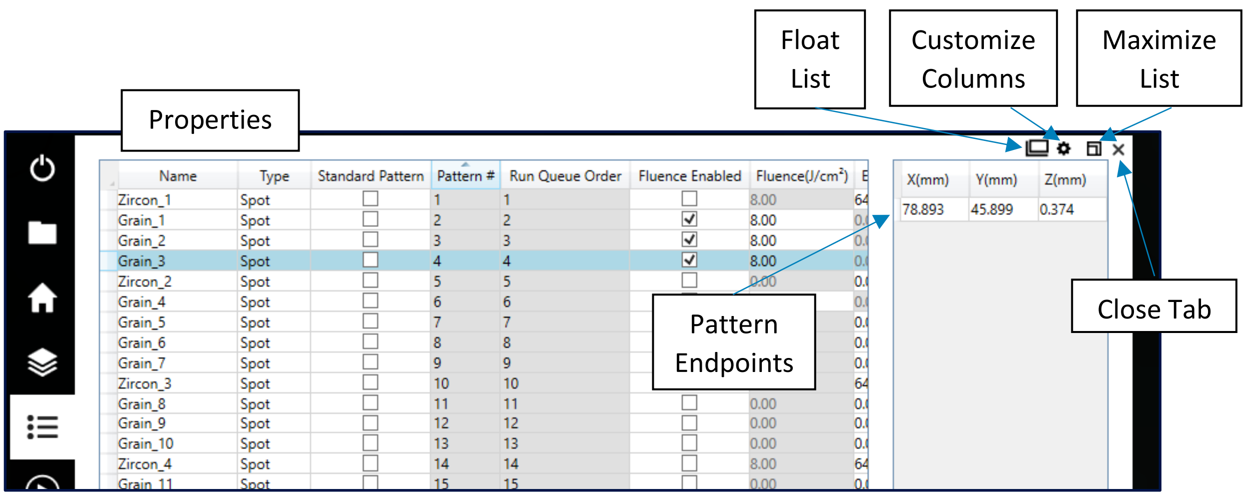



Figure 13-1: Pattern List controls

## 2. Maximize list

Expand the Pattern List Tab as wide as possible without covering the drop-down menus using the icon in the upper right of the tab.

## 3. Float list

Undock the list from the tab system. The float icon in the upper right of the tab can be used to bring the pattern list to an additional monitor if one has been added.

## 4. Customize columns

Users can define columns to display for easier editing and viewing of pattern conditions. For example, if a user prefers to only use line patterns, they may hide columns that don't relate to line patterns to make the chart easier to digest. Columns can be individually hidden by right clicking the column and selecting "Hide" or pressing the icon in the upper right of the tab.

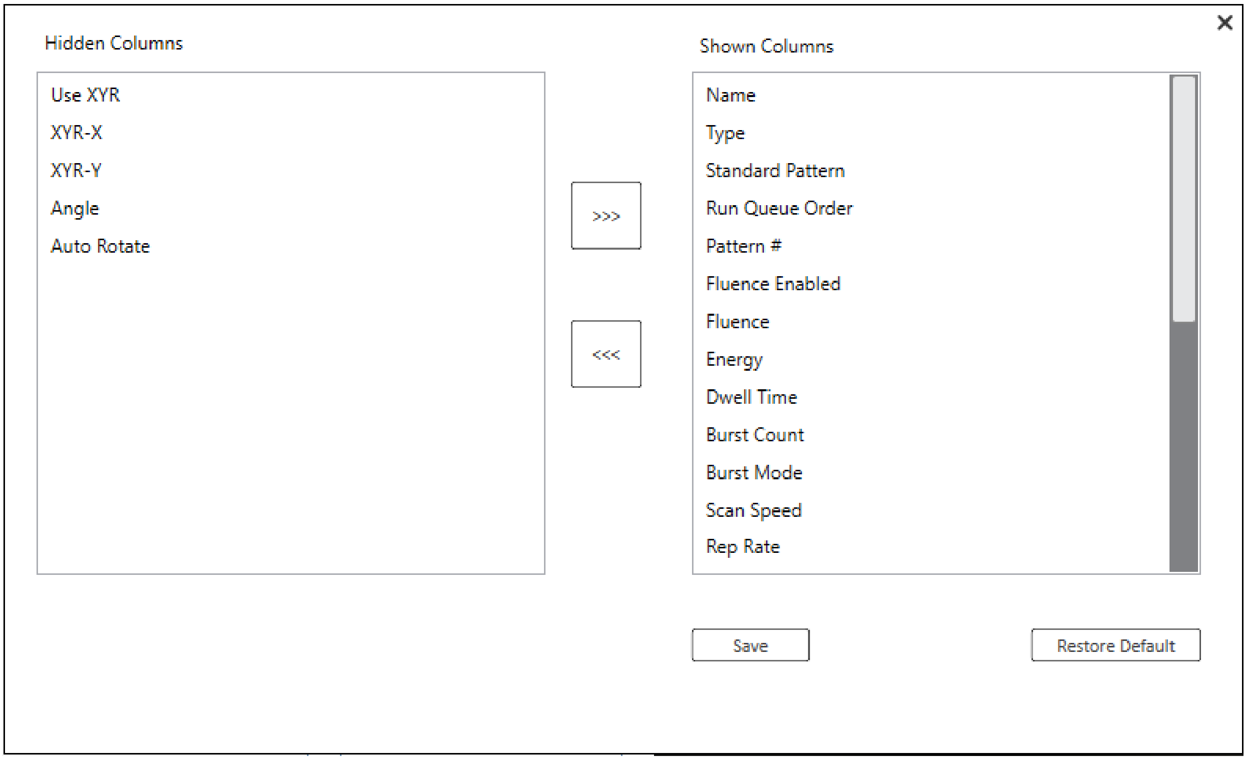



Figure 13-2: Customize columns

Columns can be clicked and dragged into their preferred order to change where they are displayed; a dark bar will show where the property will insert. Columns can be resized by dragging the edge to the correct size. Column size and order will be maintained on startup when the software closes.

## 5. Editing Endpoints

When a pattern is highlighted, the endpoints relating to that pattern appear as a pop out from the right end of the tab. They can be directly edited to change the endpoint locations to specific values. Changes to the endpoints update the Layer Management Edit Endpoints window and vice-versa.

## 6. Export to CSV

The pattern list tab can be saved to a csv file from the export to csv button at the bottom of the tab. This csv export differs from 'Save Experiment as CSV' from the file management menu in that the csv file content reflects what is currently displayed in the Pattern List View. Saving from the 'Save Experiment as CSV' File menu selection will save according to the Settings: CSV Save Settings.

## 7. Ablation and Pre-Ablation

Access the Pre-Ablation properties by switching from the **Ablation** to **Pre-Ablation** radio buttons at the bottom left of the tab. The columns will have “Pre-Ablation” added to the column name. Pre-Ablations will only be enabled if the **Pre-Ablation Pass Enabled** button is selected.

## 8. Auto Fill

Properties can be copied down a column by selecting the group and choosing **Auto Fill.** This will change all the values for that property in the selected group to match the value of the top pattern.

## 9. Auto Fill Special

Auto Fill Special allows the user to choose a base name and increment value. If the last digit is a number, the subsequent patterns will step up by the set increment. If the last digit is a letter or symbol, numbers will be added and incremented, starting from “1”. In the example below, subsequent patterns will be named Grain1, Grain2, Grain3, etc.

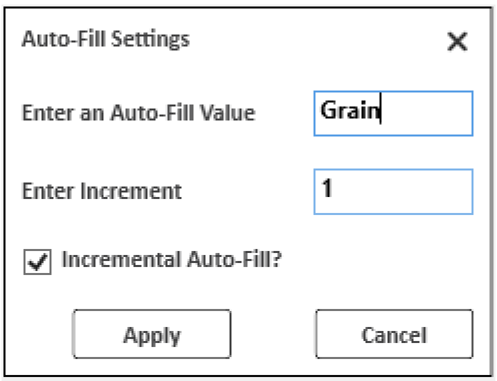
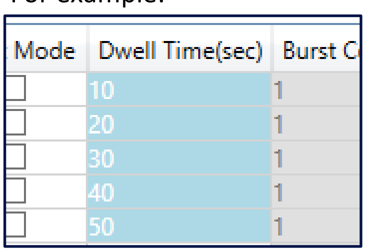


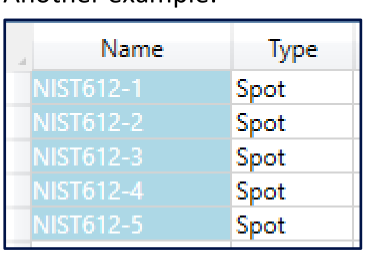

Figure 13-3: Auto-Fill Special example

For example:




Enter an Auto-Fill Value = 10
Enter Increment = 10
Result for 5 patterns: 10, 20, 30, 40, 50

Another example:




Enter an Auto-Fill Value = NIST612-1
Enter Increment = 1
Result for 5 patterns: NIST612-1, NIST612-2, NIST612-3, NIST612-4, NIST612-5

## 10.Run Queue Order

The Run Queue Order column shows the order that the patterns will run in the experiment, while the Pattern # shows the order of creation. By default, patterns will be added to the Run Queue in the order that they were placed (initially, Run Queue Order is the same as Pattern #). Since this is not always the desired run order, there is a button at the bottom of the tab, **Set as Run Queue Order**, which will order all the queued patterns according to their current order in the list. Unqueued patterns will be ignored by the **Set as Run Queue Order** button and maintain a value of "0".

Clicking the column header sorts the patterns in ascending/descending order. As long as the sheet is sorted according to that column, any changes the user makes to that column will result in the pattern moving up or down the list according to its value. To revert to the placement order, sort according to the "Pattern #" column.

Rows can be dragged for reordering by clicking on the small thumbnail at the far left end of the pattern row and dragging up or down.

## 11.Move up/Move down list

With pattern(s) selected, select **Move Up** or **Move Down** from the right click menu will move patterns up and down the list one space per click. Keyboard shortcuts CTRL+SHIFT+UP (Move Up) and CTRL+SHIFT+DOWN (Move Down) can also be employed.

Rows can be dragged for reordering.

## 12.Auto Add Patterns

The **Standard Pattern** check box can be used to identify a pattern on a reference material, calibrant or QC material. If the precise placement on the material is not important (e.g. glasses or alloy reference materials) then one pattern can be placed as a 'seed pattern' and the **Auto Add Patterns** button at the bottom can be used to create duplicates and spread them through the Pattern List. In the wizard, use the check box to identify which of the "Standard Patterns" should be copied, choose bracketing and frequency options, and decide how much space in X, Y, and Z should be between duplicates. When the wizard completes, the user will be given the option to accept the new order as the Run Queue Order.

Once generated, patterns can be adjusted to avoid undesirable locations such as cracks, edges, or previous ablations. The **Remove Auto Added Patterns** button will delete all the automatic patterns.

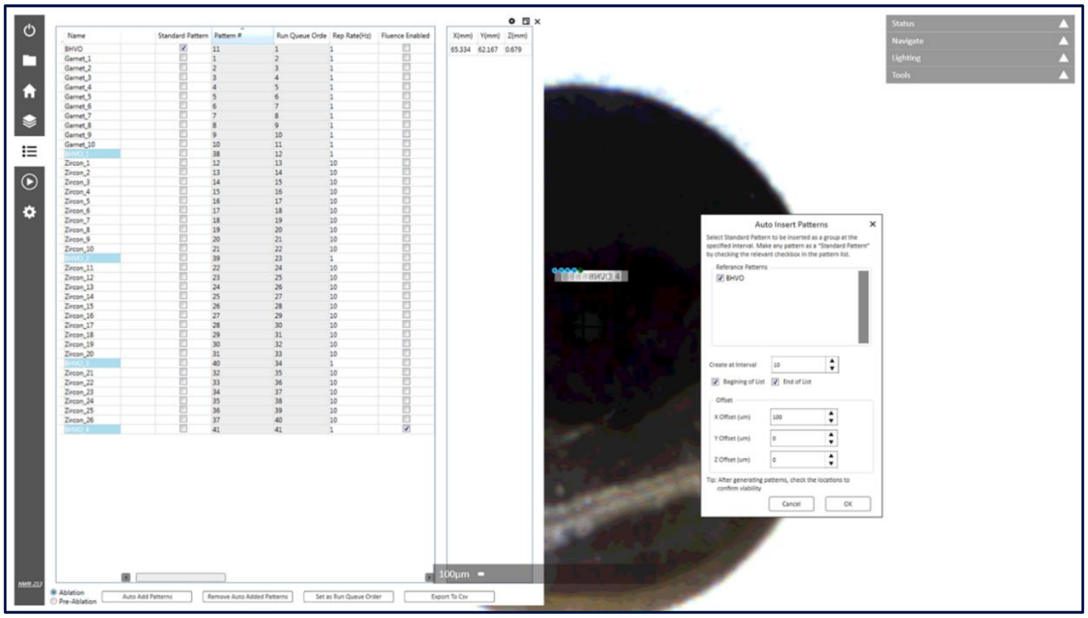



Figure 13-4: Auto add patterns

## 13. Distribute Throughout List

Patterns on reference standards, calibrants, or QC patterns can be placed in a batch (e.g. at the start or end of sample pattern placement). The **Distribute Throughout List** tool can then be used to spread them evenly though the list.

Right click the reference patterns and choose **Distribute Throughout List** to open the wizard (Figure 14-3) where the queue range, frequency and interval can be specified. When complete, the user will be given the option to accept the new order as the Run Queue Order.

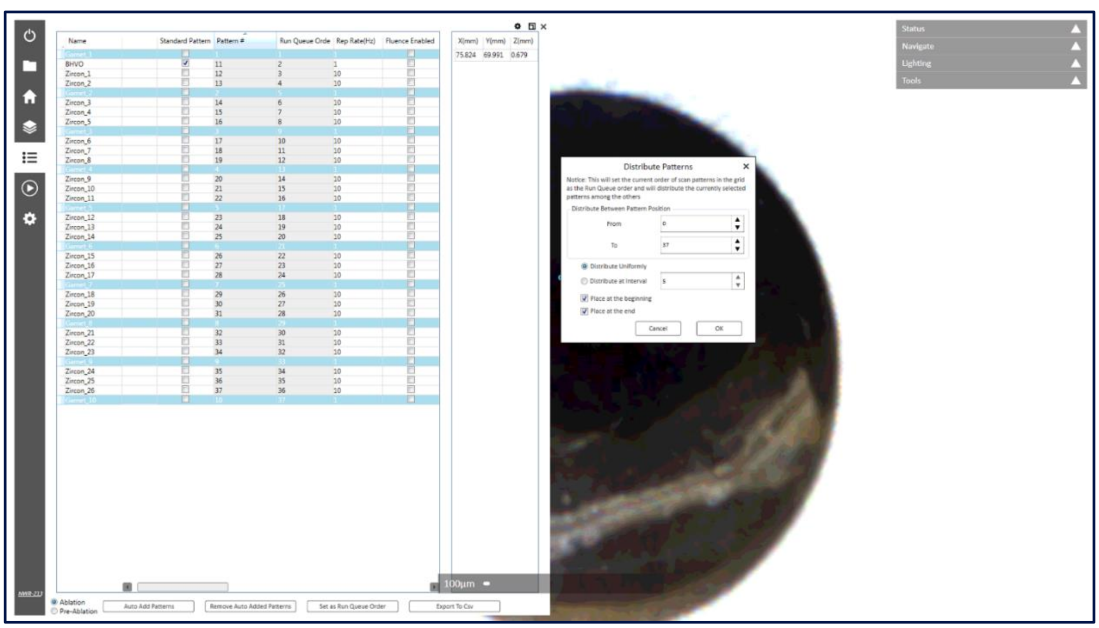



Figure 13-5: Distribute throughout list

## 14) RUN QUEUE TAB

The Run Queue tab displays the subset of patterns that have been queued. The order is set according to the Run Queue Order value. Selecting patterns and dragging up or down in the list will reorder the run queue.


Figure 14-1: Run Queue window

### 14.Adjust Z Focus

Focal position adjustment of queued patterns can quickly be performed prior to commencing the experiment and starting analysis, by clicking on **Adjust Z Focus**. The **Adjust Z Focus** window will open and provide the user with the same options per accessing **Adjust Z Focus** via the pattern properties, except that only queued patterns are available. In this manner, the **Adjust Z Focus** acts as a way to profile and adjust the run queue prior to commencing the experiment.

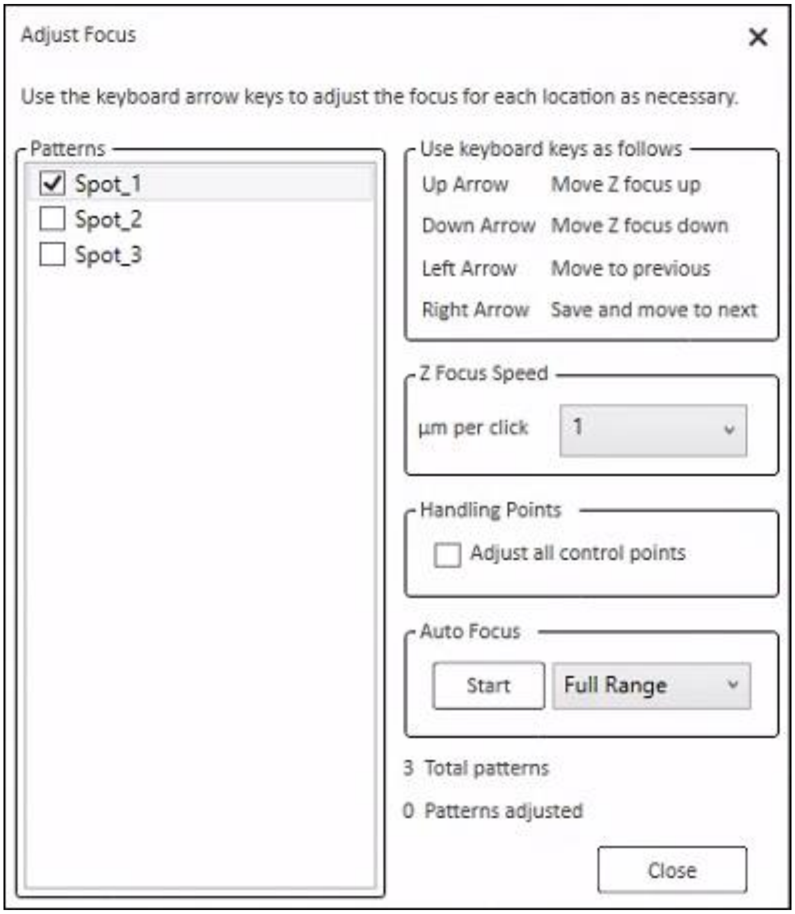



Figure 14-2: The Adjust Z Focus window specific for the run queue.

### 15. Total number of passes

The number of times that the Run Queue will repeat. This differs from the pattern pass-level pass count in that it applies to the entire experiment while the pattern pass-level applies only to that pass of that pattern. When this is set to "1", the Run Queue will run each pattern one time. When set to "2" or higher, the Run Queue will repeat after running each pattern once. See Experiment Hierarchy for more information about the order of events.

### 16. Enable Laser During Scan

This must be checked for the laser to fire during the experiment.

### 17. Generate Iolite logfile

Creates a log file of laser position, pattern properties and pattern timing as the experiment runs. This file can then be imported into Iolite data reduction software. Logs are created in C:\\ProgramData\ESI\ScanLogs\ by default. Each time the Run Queue starts, a new Log is created. Logs are automatically named with the time they were created in the format LaserLog_YY-MM-DD_hh-mm-ss.csv.

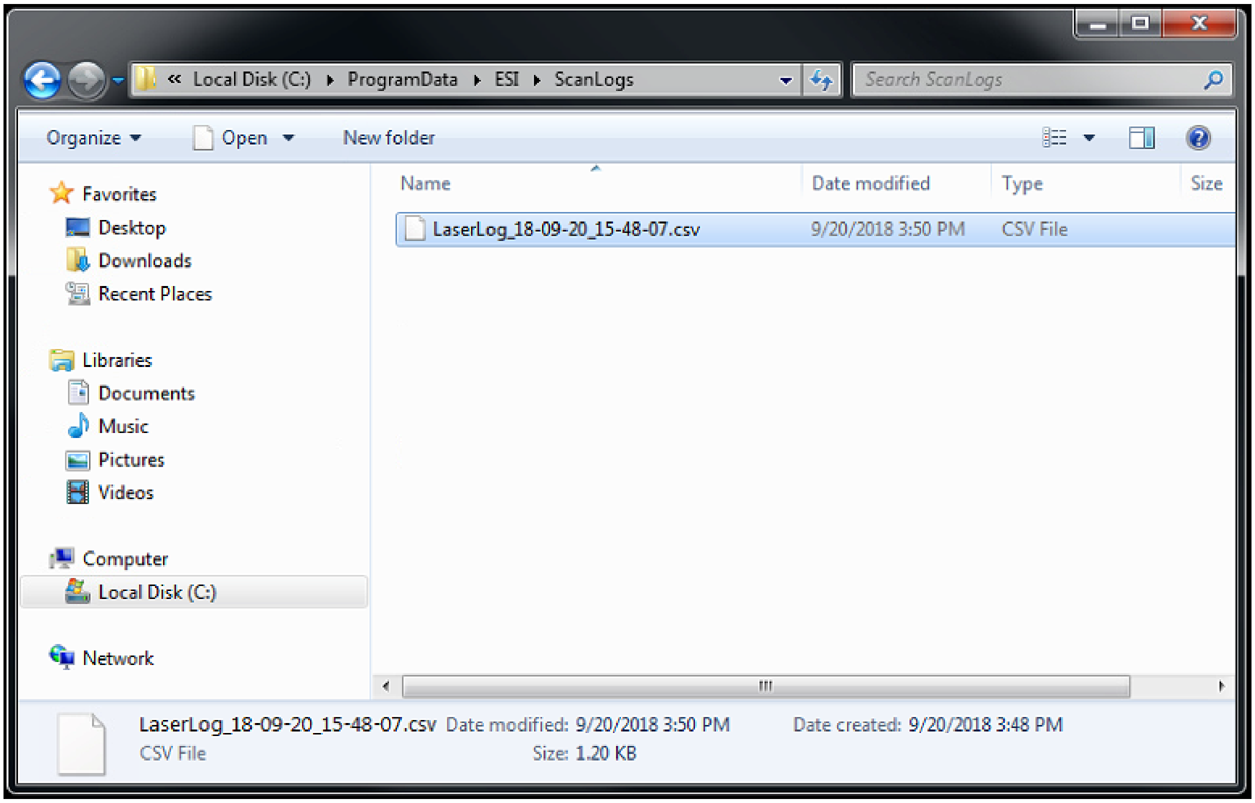



Figure 14-2: Laser Log File location

## 18.Stop Gas at Experiment End

When checked, all carrier gas mass flow controllers will have their flows disabled when the Run Queue is complete.

## 19.Stop N2 Purge at Experiment End (NWR193 and NWR193HE only)

When checked, N2 beam purge gas will be stopped when the Run Queue is complete.

## 20.Warmup Time

The laser will fire at the shutter (not hitting the sample) for the duration of the Warmup Time. This can be useful for some lasers to reach a steadier energy output and can also be used to collect a gas blank before each ablation, depending on the Trigger/Sync Properties settings.

## 21.Washout Delay

This will create a pause delay after the laser stops firing to allow signal washout. It can also be used to provide a gas blank after patterns and allow the ICP-MS time to download and process the data for the sample pattern.

## 22.Timing estimates

The number of patterns in the Run Queue is summed in the “Total” box. As the experiment continues, the “Completed” box registers the patterns that have finished and the “Remaining” box registers the patterns left. The “Estimated” time shows the estimated duration of the total Run Queue. The “Completion” shows an estimated time to complete the experiment, which counts down as the experiment runs.

## 23. Experiment Hierarchy

Warmup, Washout, and Experiment Passes are controlled in the Run Queue tab and apply to all patterns. Pattern Passes and Pre-Ablations are controlled in the Pattern List or Pattern Properties windows and can be different between each pattern.

In the order presented in the Run Queue, the first pattern will run the configured warmup, Pre-Ablation, Ablation, and washout. It will finish all Pattern Passes before moving on to the next pattern in the list. Experiment passes will cause the entire list to run again, including any configured Pattern Passes.

Only the Ablation Passes are required – all other components are optional.

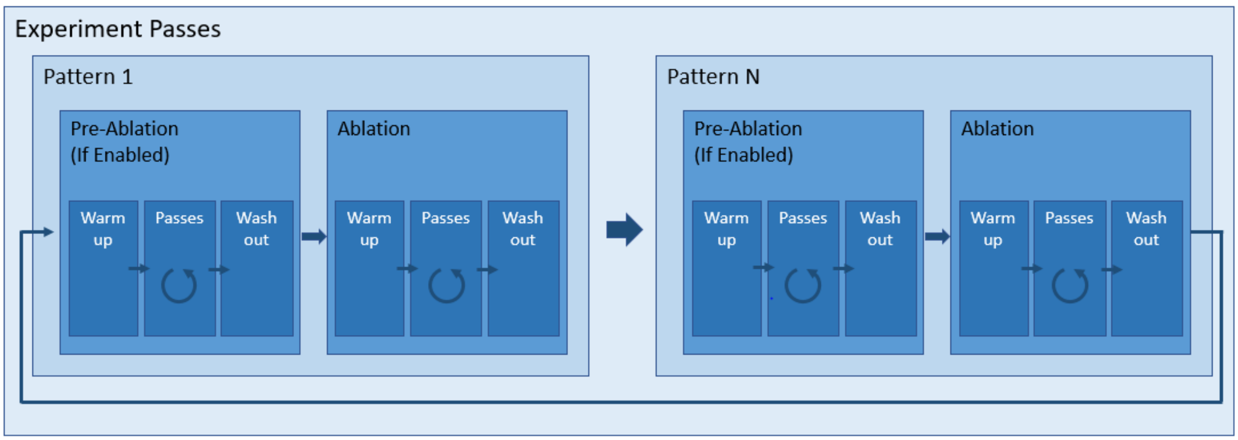



Figure 14-3: Experiment order hierarchy

## 24. Run

Start the experiment by pressing the **Run** button. This button is only enabled when no experiment is running. The other buttons will be pale.

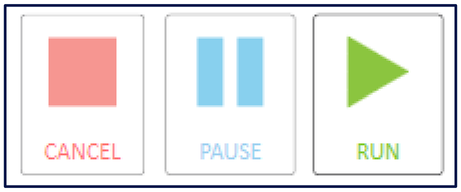



Figure 14-4: Start Run Queue

While running, the **Run** button is pale and the **Cancel** and **Pause** buttons are enabled. Pause will stop the experiment temporarily. Pause is not enabled for some pattern types. When the user presses Run again, the experiment restarts from the previous point. Pressing Cancel will stop the experiment and pressing Run again will restart the experiment from the top of the list.

Successfully completed patterns will have a green check mark next to their name in the Status column. Errors during an experiment (e.g. Cancelled patterns) will have a red X.

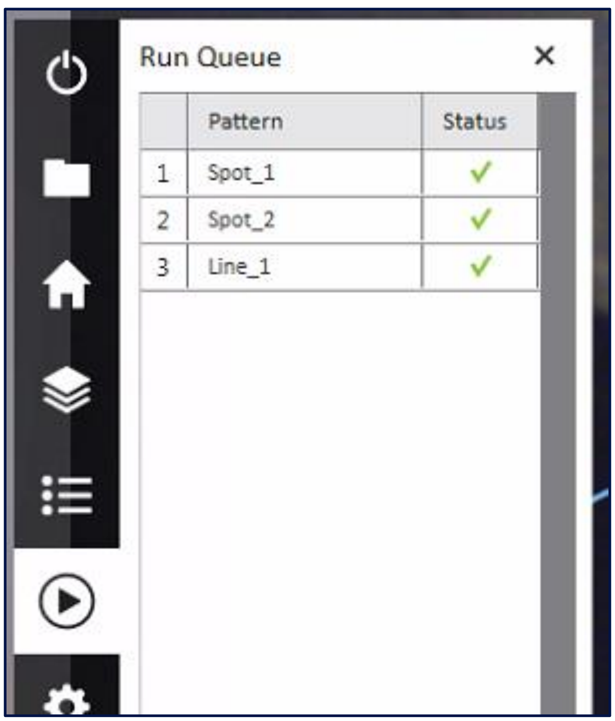



Figure 14-5: Successfully completed experiment

## 25. Remove from Queue

Choosing **Remove From Queue** from the right click menu will remove the selected patterns from the Run Queue. In the Pattern List, their Run Queue Order value will return to "0" until queued again. Pressing the Delete key will remove the patterns from the software entirely.

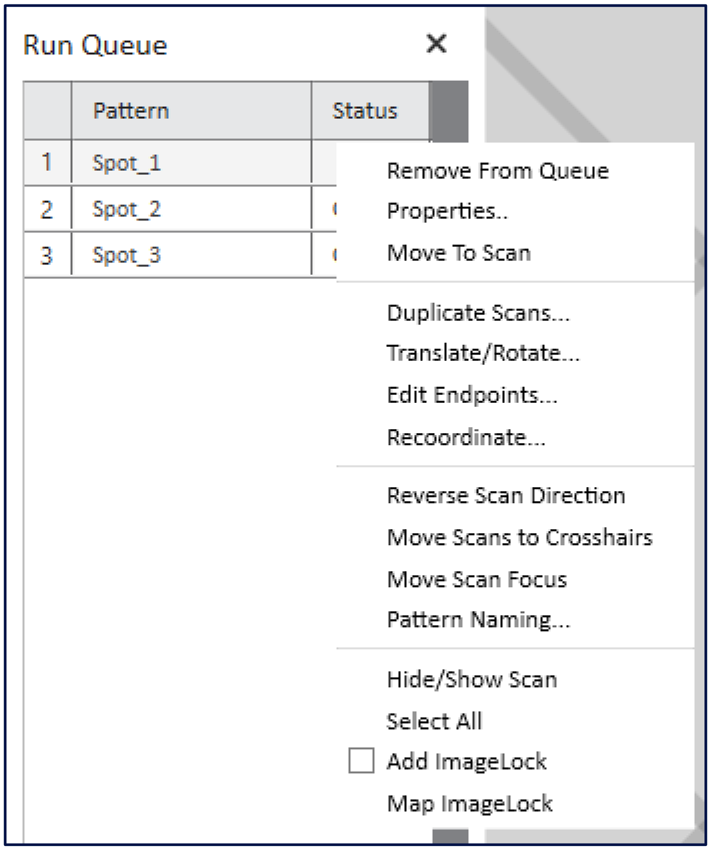



Figure 14-6: Right click menu of Run Queue

The remaining items in the right click menu have identical behavior to their corresponding names as discussed in Layer Management: Patterns.

## 26. Run Immediate

The **Run Immediate** is available in both the Run View and the Layer View. It runs selected patterns immediately, independent of the Run Queue and is a useful feature to enable the user to quickly run a “test” scan or “tuning” scan. The Run Immediate feature can work for an individually selected scan, or for a group of selected scans.

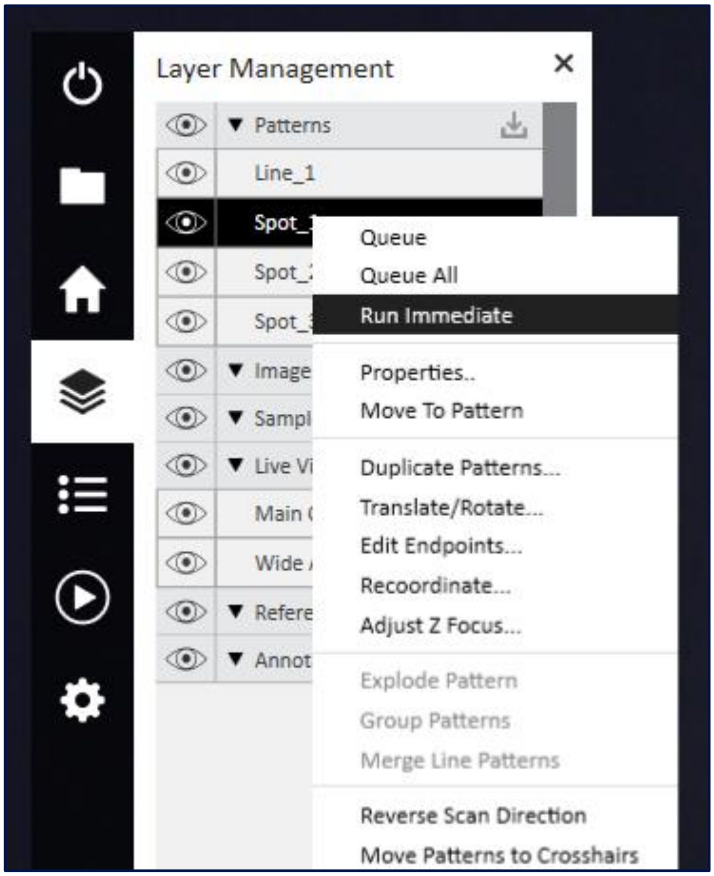



Figure 14-7: “Run Immediate” option selected to quickly run an individual or a group of selected scans independent of the Run Queue

## 15) SETTINGS

Settings outside the normal experiment workflow are found in the Settings Tab.

The installed version of ActiveView2 can be determined by selecting **"About"** in the Settings view.

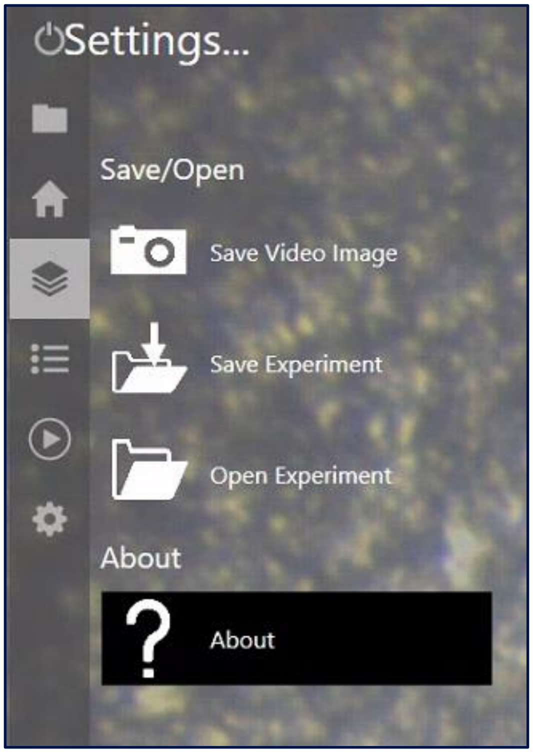



Figure 15-1: "About" selected to determine the version of ActiveView2 currently installed

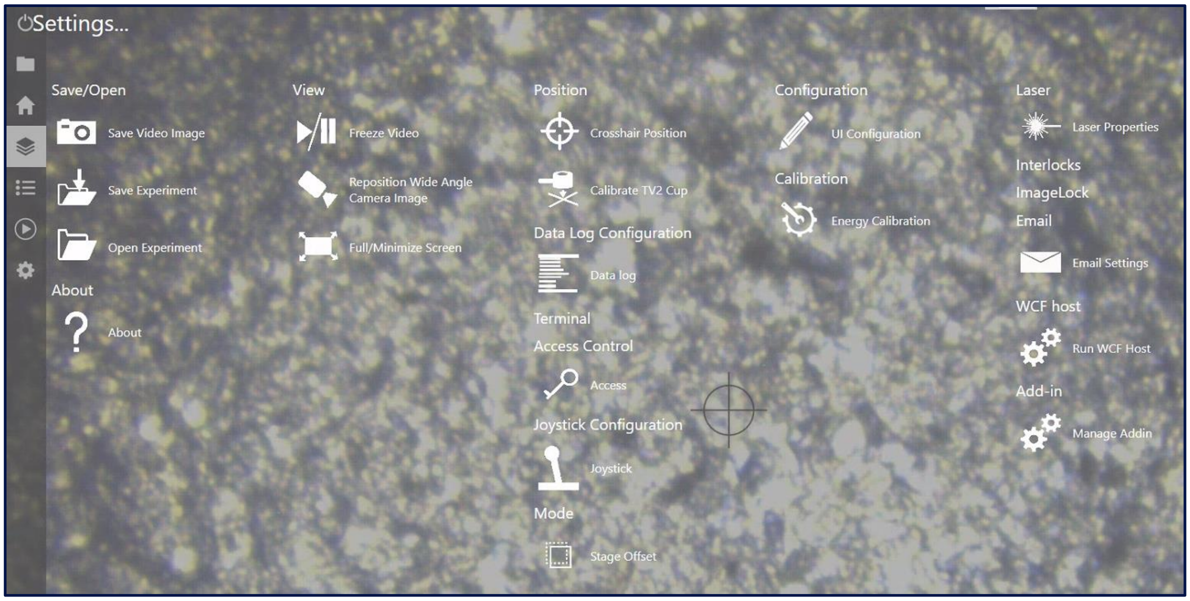



Figure 15-2: User access level Settings window

## 1. Access levels

The Settings tab has several appearances depending on the Access level currently logged in. On startup of the software, the Access level will be "User" by default, the most protected of the levels. Functions that require advanced familiarity with the system are hidden. Advanced users such as the primary operator can set a password which allows them to access the "Local Admin" Access level.

To enter the password, click **Access**. Choose the User Name from the drop down and enter the password, then press Login. Users can now be managed in this window. When finished click **Access** again and press **Logout** to return to the "User" level. Without logging out, AV2 will retain the access level for 24 hours, eliminating the need for subsequent logins. After 24 hours, the access level will revert to "User".

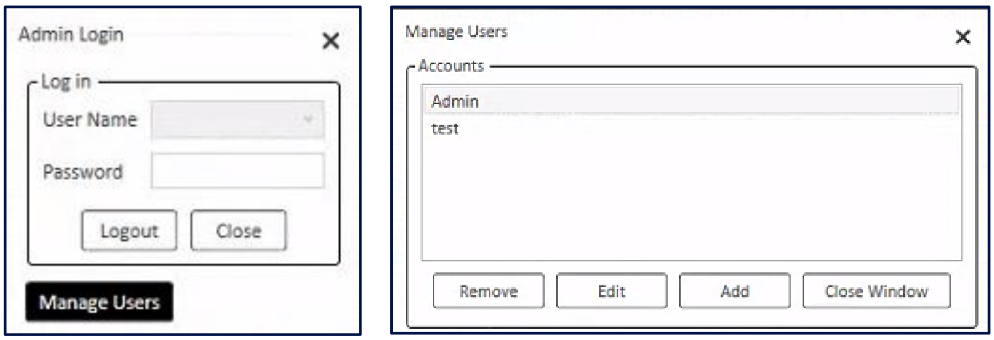



Figure 15-3: Access Control

# 16) USER ACCESS LEVEL CONTROLS

## 1. Save Video Image

Saves the current Main Camera image as a file on the PC, identical functionality to the Save Video SnapShot in File Management.

## 2. Save Experiment

Identical functionality to Save Experiment control in the File Management tab.

## 3. Open Experiment

Identical functionality to Open Experiment control in the File Management tab.

## 4. About

Shows ActiveView2 software version and other component version information.

## 5. Freeze Video

Stops the main camera video from updating.

## 6. Reposition Wide Angle Camera Angle (if installed)

Allows the user to change Main and Wide-angle camera relative alignment. This is configured at setup and should not require frequent calibration. With a feature in the sample chamber that can be viewed by both cameras, with the reposition window open, click and drag the Wide-angle camera image to the correct position. The feature must be in focus on the main camera for accurate repositioning. It is recommended that the user make the Main Camera semi-opaque before repositioning. To complete repositioning, press the X in the window and/or close the window.


Figure 16-1: Reposition window

## 7. Full/Minimize Screen

Toggles the ActiveView2 window in and out of Full Screen mode.

## 8. Crosshair position

The crosshairs can be moved a small distance to keep them aligned with the laser. Fire a spot on a sacrificial sample. Without moving the stages, click on **Crosshair Position**. Click on the center of the ablation and press OK in the box. See Crosshairs for more information on crosshair use. (Major adjustments require service support.)

## 9. Calibrate TwoVol2 Cup (if installed)

For TwoVol2 sample chambers the cup position can be calibrated by clicking on this. The tool allows the user to adjust the stages in X and Y until the objective sits directly above the cup. Positional tolerance is fairly large, but data will be compromised if the cup blocks the laser beam. When the cup is in position, press Centered in X and Centered in Y, then click OK.

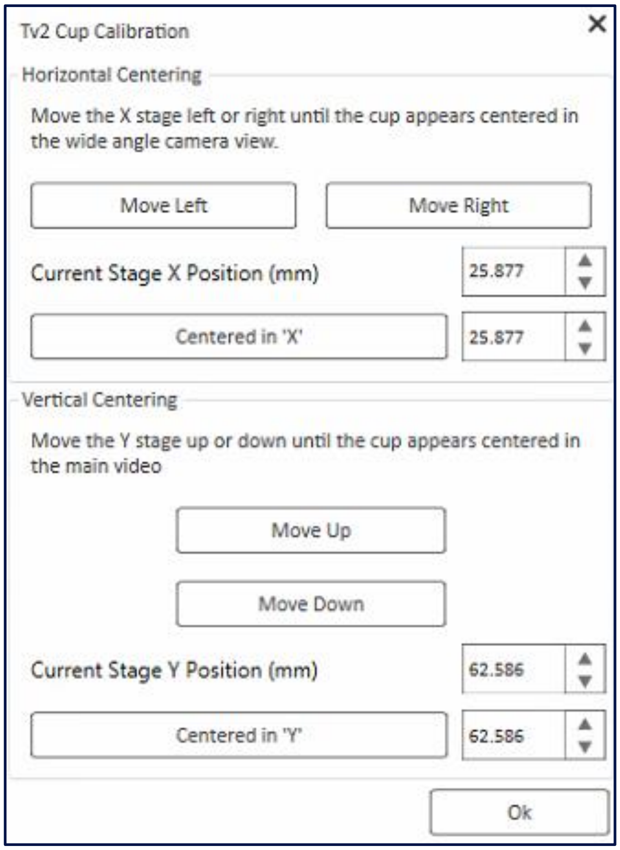



Figure 16-2: TwoVol2 Cup Calibration

## 10.Data log

Information about ActiveView2's activities is stored in the automatically generated software log (stored in C:\\ProgramData\ESI\Logs) used to diagnose problems with a service engineer. The current log is called softwareLog.log. To preserve drive space, the log is capped at 1 MB. Above 1 MB, the log will be transitioned to a backup file that contains the date in the file name. If there are more than 5 backups with automatic names in the Logs folder, ActiveView2 will delete the oldest log when it creates a new one. More logged items create more detail when an error is found, but also shortens the automatic record of the software log.

To prevent unnecessary load on AV2, as well as reducing drive writes, the only log items that should be selected under normal use are "Error" and Device_Error".

If an error flag is detected, a copy of the log file will automatically be saved in a C:\ProgramData\ESI\Logs\Errors. In this folder, 10 files will be saved before overwriting the oldest.

Individual log entries are timestamped, which can be formatted according to formatted system time or "ticks" (milliseconds) since AV2 started.

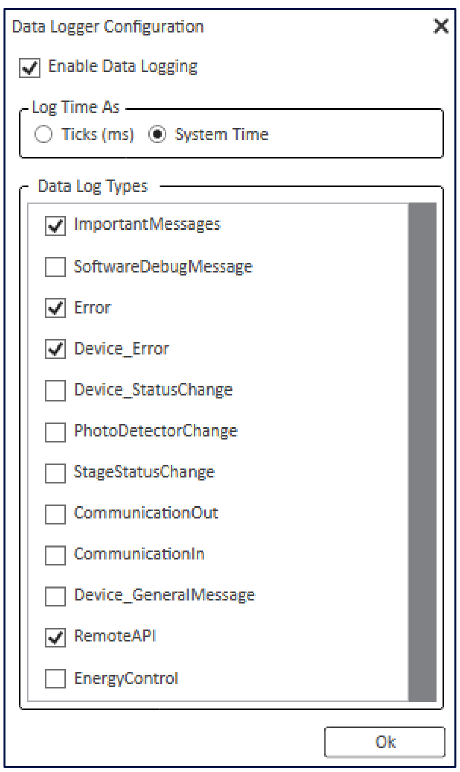



Figure 16-3: Data log

## 11.UI configuration

The User Interface Configuration allows users to customize the appearance and behavior of ActiveView2. Changes are made immediately and saved when the window is closed.

### a. Mouse Wheel Zoom

Mouse Wheel Zooming Speed: The slider adjusts how fast the zoom changes when the mouse wheel is moved. High slider positions mean faster zooming capabilities. See Zoom Control.

Inverse Zoom Direction: By default, the user scrolls the mouse wheel down to see a larger field of view. Checking this box reverses the scroll wheel direction – when checked, scrolling the mouse wheel down shows a narrower field of view.

Mouse Wheel Skip: The software can be set to "stick" a little at different points in the zoom scale. These sliders indicate how long the wheel should pause at each of the two positions: 1. The boundary between digital and mechanical zoom, 2. The point at which the main camera fills the screen vertically. The further right the slider position, the longer the pause.

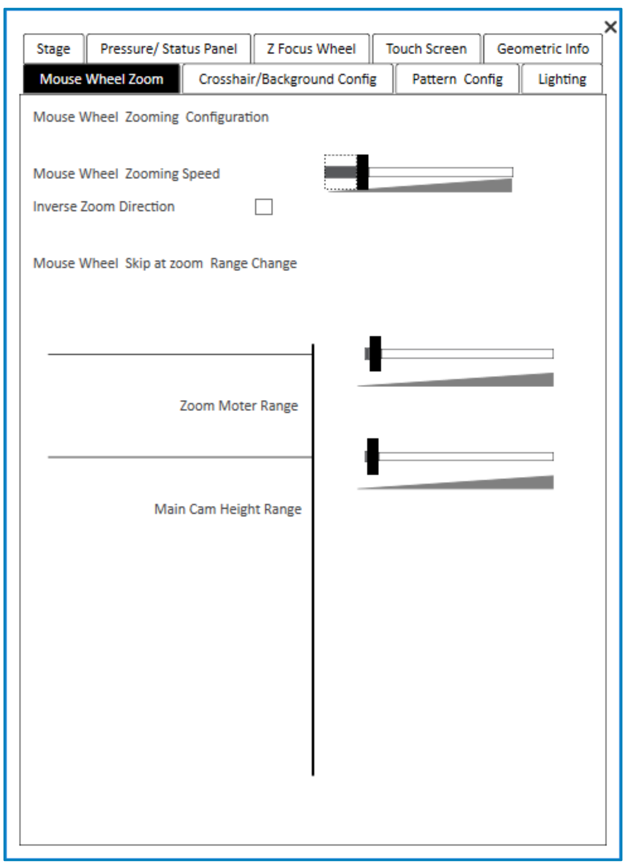



Figure 16-4: UI Configuration – Mouse Wheel Zoom

### b. Crosshair/Background Config

Crosshair Color: Adjust the color of the crosshair by clicking on the color box and selecting a color. See Crosshairs.

Crosshair Height: Make the apparent crosshair size larger or smaller by adjusting this number. Higher values make the crosshair larger.

Crosshair Thickness: Make the apparent crosshair thicker by adjusting this number. Higher numbers make the crosshair thicker.

Show Crosshair: Hide the crosshair icon by unchecking this box.

Cross Hatch Settings: The cross hatch is the pattern that indicates areas in ActiveView2 where the stage can reach but that doesn't have another image on it, the effective background. The colors of the crosshatch and background color can be adjusted by clicking on the color box and selecting a color. The opacity values of Stroke 1 and Stroke 2 are fixed.

Sample Chamber Background Image: The default gray box representing the sample chamber floor can be replaced with a static image specified by the user. There are no scaling or rotation controls for specifying this image, so rotation, aspect ratio, etc. need to be done in an image editor such as MS Paint before inserting into AV2.

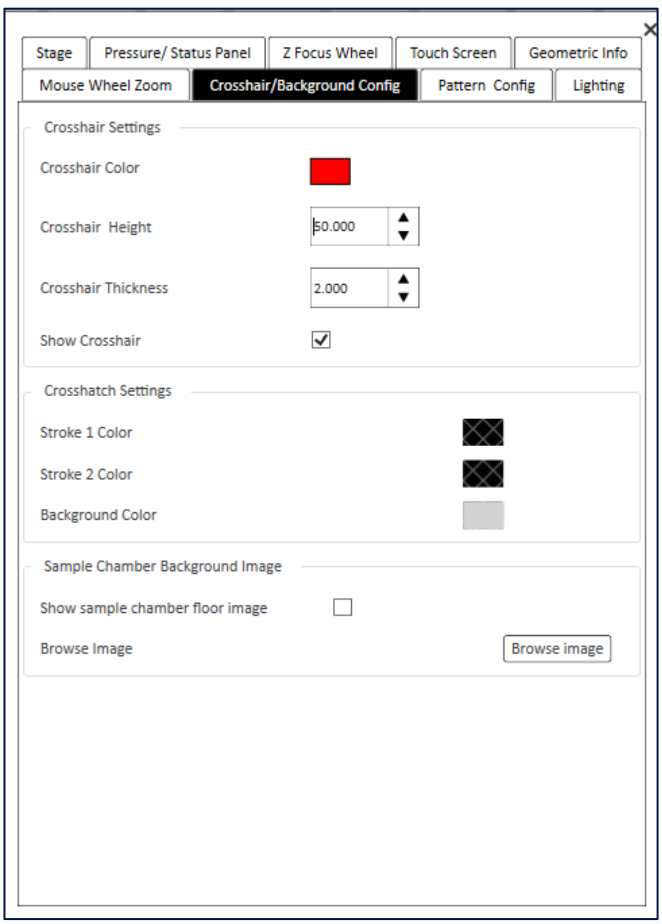



Figure 16-5: UI Configuration – Crosshair/Background Config

### c. Pattern Config

Default Pattern Line Color: Adjust the color of default pattern removal paths by clicking the color box and selecting a color. The slider bar adjusts the default pattern opacity. The pattern line color can be customized per pattern in the Pattern Properties window after the pattern is created.

Default Marker Color: Adjust the color and opacity of control points in a pattern.

Marker Width: Make the control points appear larger or smaller by adjusting this number. Higher numbers make the point larger.

Line Thickness: Make the pattern outline appear wider or narrower by adjusting this number. Larger numbers make the line wider.

Show Pattern Names: Check this box to show the pattern name on the main window at the start of the pattern. Note: for very large experiments, unchecking this will improve performance.

Show Removal Path: Check this box to show the anticipated removal path (pattern line). Note: for very large experiments, unchecking this will improve performance.

Hide Center Line After Drawing: Check this box to hide the line that connects control points after the pattern is created. The center line will still be shown while the pattern is being created.

Selected Pattern Line Color: Adjust the color and opacity of the removal paths of selected patterns, regardless of their pattern color.

Selected Marker Color: Adjust the color and opacity of the control points of selected patterns, regardless of the default marker color.

Pattern Label Opacity: The slider bar adjusts the default pattern label opacity. Positioning the slider further to the right results in an opaquer pattern label.

Snap Line/Grid Pattern: While creating new patterns with multiple endpoints, straight vertical or horizontal segments can be easily achieved with the “Snap” feature enabled. When snap is enabled, very shallow angles are interpreted as intended to be 0 degrees or 90 degrees. The snap behavior can be toggled to opposite of the setting while drawing a pattern by holding the shift key.

1. Snap line to horizontal/vertical: Turns the Snap feature on or off
2. Max degrees off normal: Defines the small angle threshold for when snap defines the line segment angle to be horizontal or vertical

Enable Lasso Free Screen Drawing:

1. When this box is checked, the mouse draws like the Windows Paint “Pencil” tool. This mode allows the most resolution for the lasso shape, but it is also difficult to control the positions and shapes of the resulting lines.

2. When unchecked, the user must click discrete points to control the shape of the lasso. This is beneficial for controlling the arrangement of ablation lines in the final lasso pattern.

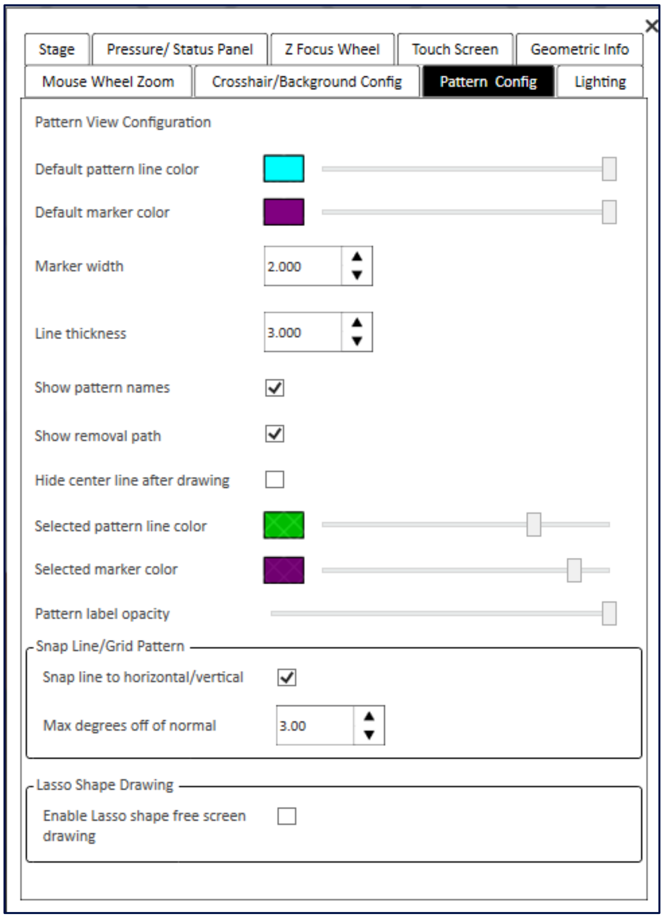



Figure 16-6: UI Configuration – Pattern Config

### d. Lighting

When hovering directly over a lighting control slider bar, the mouse wheel will change from zooming to adjusting the level of that light control. This value adjusts the sensitivity of the mouse wheel turns in controlling the brightness. Higher values result in a higher sensitivity and thus change the light more quickly. See Lighting.

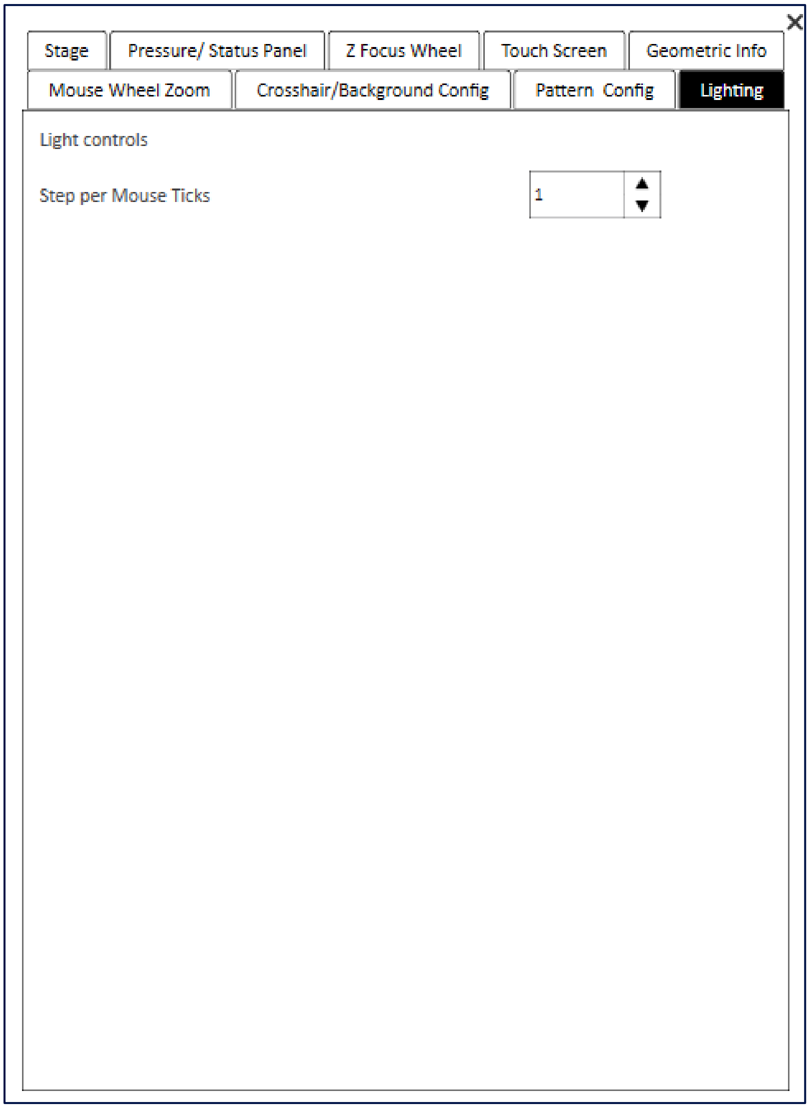



Figure 16-7: UI Configuration – Lighting

## e. Stage

Scrollbar Settings: Scroll bars for motion in one direction exist on the right (Y) and bottom (X) edges of the main screen. Z control is controlled by the Z stage . The box on the scroll bar indicates the relative position of the stages in that axis. On the edges of the scroll bar are controls for single steps ( ), medium scrolling ( ), and fast scrolling ( ) in each direction. The values in each box for the X, Y, and Z Track Bars determine the microns (single step) or microns per second (scrolling) that each button moves the stages.

Show Scrollbars: Checking this box shows the scroll bars in the main display

Auto Hide Scrollbars: Checking this box causes the scrollbars to hide when the mouse is not placed over them. They reappear when the mouse moves back.

Opacity of Scrollbars: This slider adjusts the opacity of the scrollbars. Values to the right are more opaque.

Stage Max Speed: This sets the maximum stage speed of the X, Y, and Z stages in the software by any mechanism. The suggested max speed for X and Y is 1 mm/s for the TwoVol2 sample chamber.


Figure 16-8: UI Configuration – Stage

### f. Pressure Unit / Component Visibility

The pressure in the cell is monitored and displayed in Status: Cell Pressure. This allows the user to change between PSI, kPa, and mbar. Status panel display of installed components can be shown/hidden.

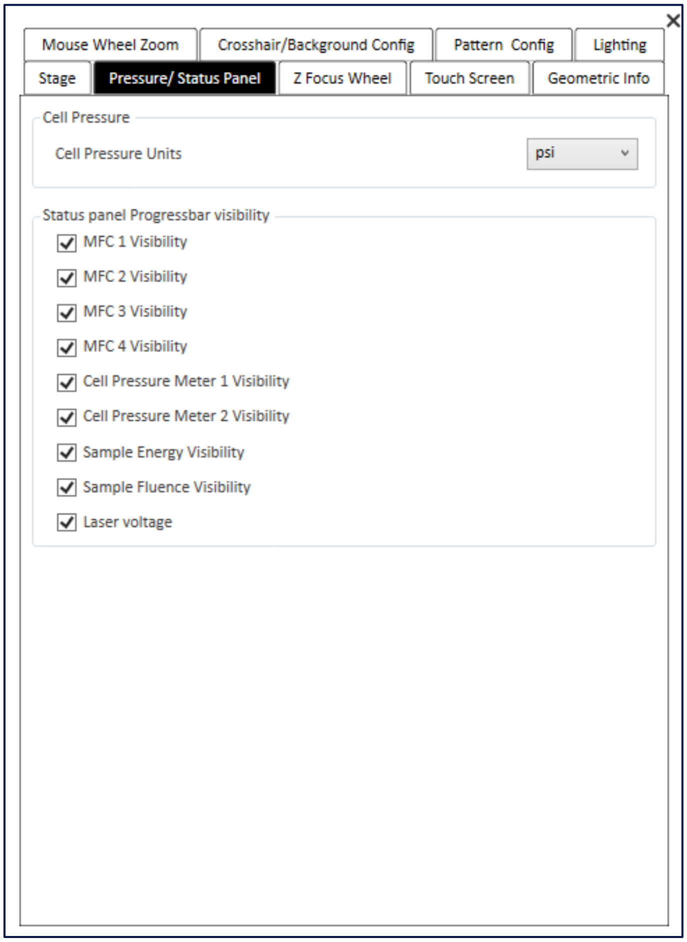



Figure 16-9: UI Configuration – Pressure / Status Panel

### g. Z Focus Wheel

When the user right clicks the main screen there is an option to turn the scroll wheel from a zoom control (wider and narrower field of view displayed) to a focus control (higher and lower Z stage position). While in the Z Focus Wheel mode, the mouse curser will change to a “Z”. Quick wheel turns will move the Z stage faster than slow turns. Left clicks anywhere in the software will close the tool. See Overview: Z Focus Wheel for more information.

Fast move steps: Set the step size for fast movements of the scroll wheel.

Slow move steps: Set the step size for slow movements of the scroll wheel.

Threshold for Slow/Fast: Determines the threshold in µs

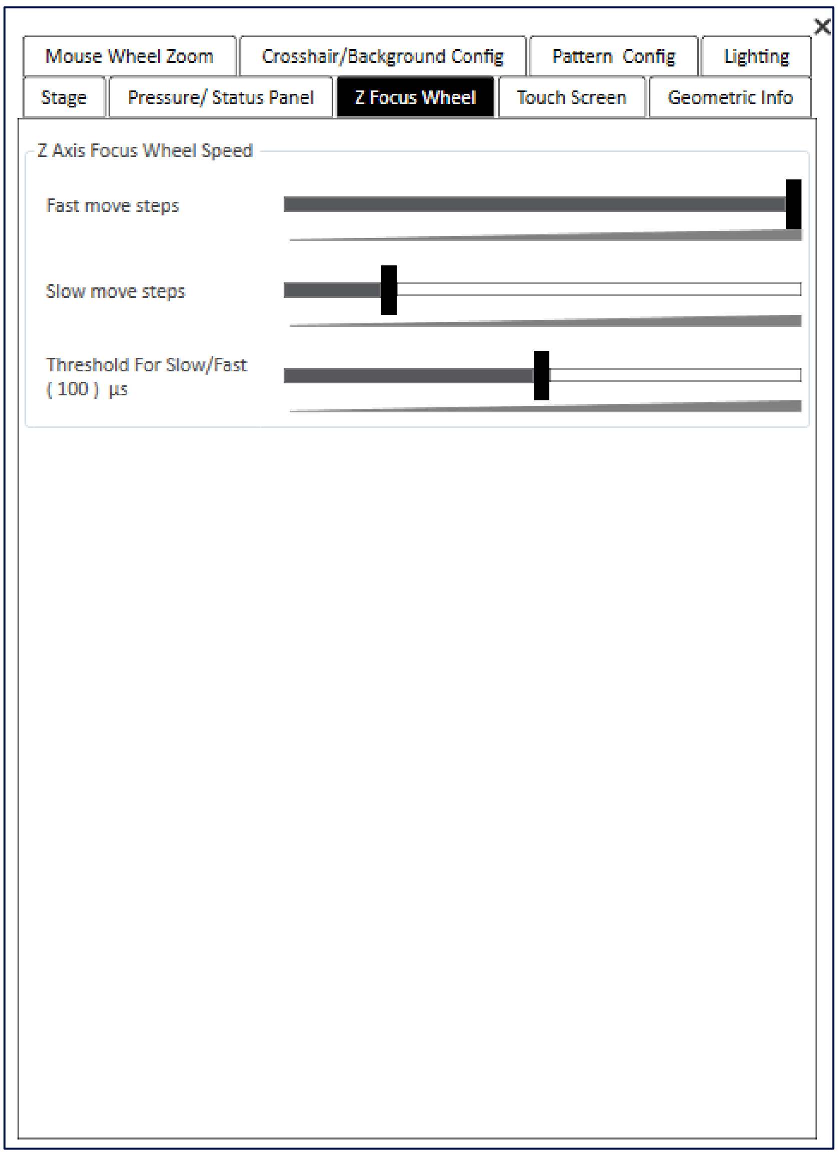



Figure 16-10: UI Configuration – Z Focus Wheel

## 12.Laser Properties

The Laser Properties window and the options vary by laser type, although there is one tab that is common to all products entitled “Energy Curve”. This tab contains a utility for a basic evaluation of laser performance.

Users can set the step size for incrementing the energy percent setting during a test. The “Start” button begins the test. The laser energy percent setting is changed, internal photodiode energy is collected, and plotted. The Y-axis is displayed in device units. These units have no direct association with Energy or Fluence.

Data collected can be exported to a CSV file for tracking performance history.

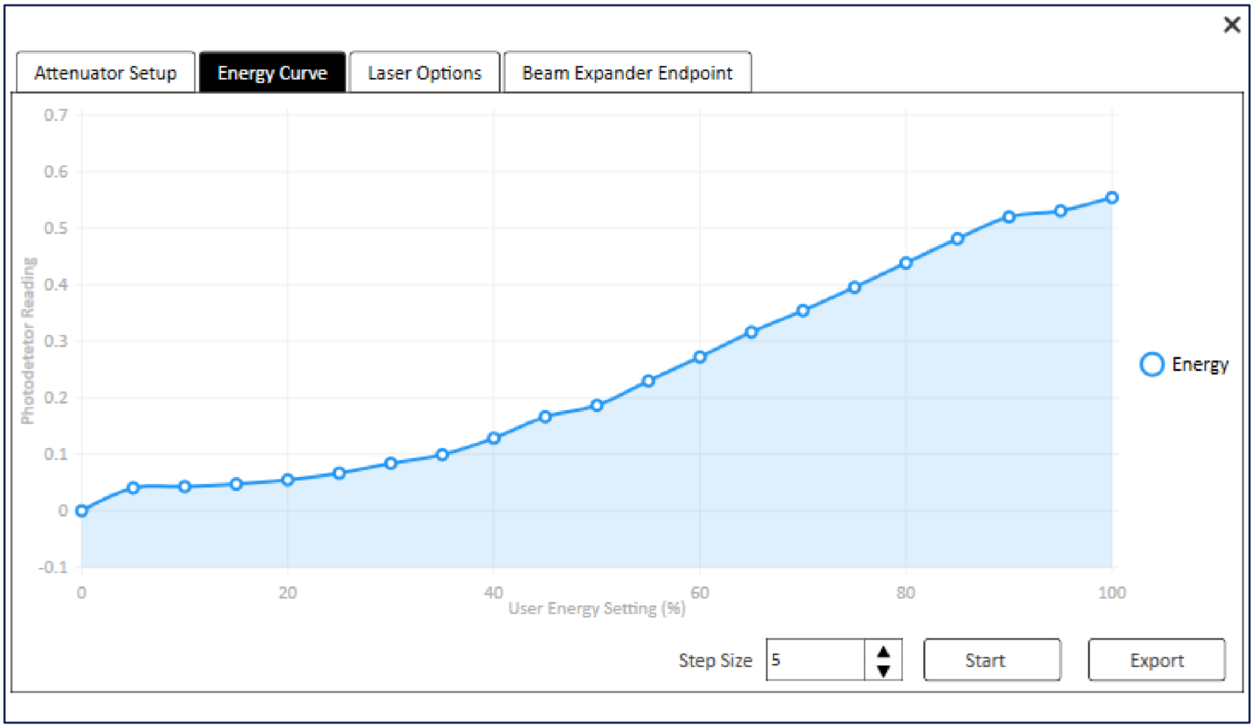



Figure 16-11: Laser Properties – Energy Curve

Auto-Gas Exchange is available for the NWR193UC with Coherent laser source only. The ArF gas exchange function is completely automated within ActiveView2 and is accessible from the "Gas Exchange" tab. Simply click "Auto Gas Exchange" and follow the guidelines.

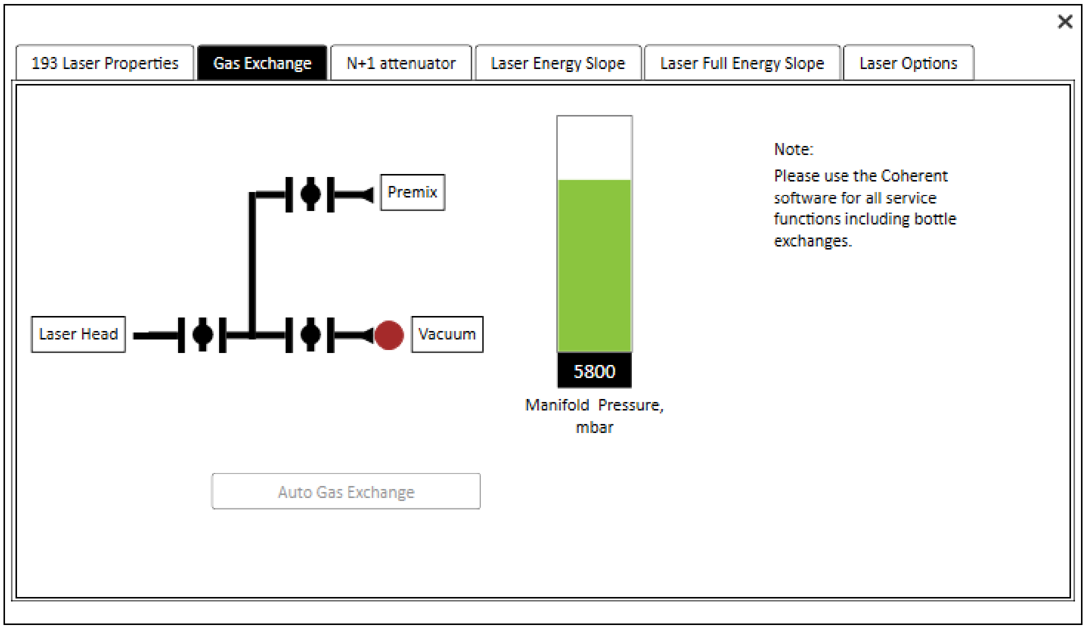



Figure 16-12: Integrated Gas Exchange for NWR193UC with Coherent laser source

# 17) LOCAL ADMINISTRATOR ACCESS LEVEL CONTROLS

The Local Administrator password allows access to the following controls in addition to all the User Access Level controls.

## 1. CSV Save Settings

Local Administrators can determine the configuration of the CSV file when a user saves a .CSV file from either Settings > Save Experiment or opens File Management > Save Experiment. Available properties are listed in alphabetical order in the Property Name column. Properties with "Pre" in the name refer to Pre-Ablation properties. Checkboxes in the Save column indicate which properties are written to the .CSV file. The column name in the output file can be customized by editing the CSV Column Name for each property. In addition to customizing the file output, the CSV Column Name can also be used to "translate" imported .CSV files into the software that may not have standard ActiveView2 property names.

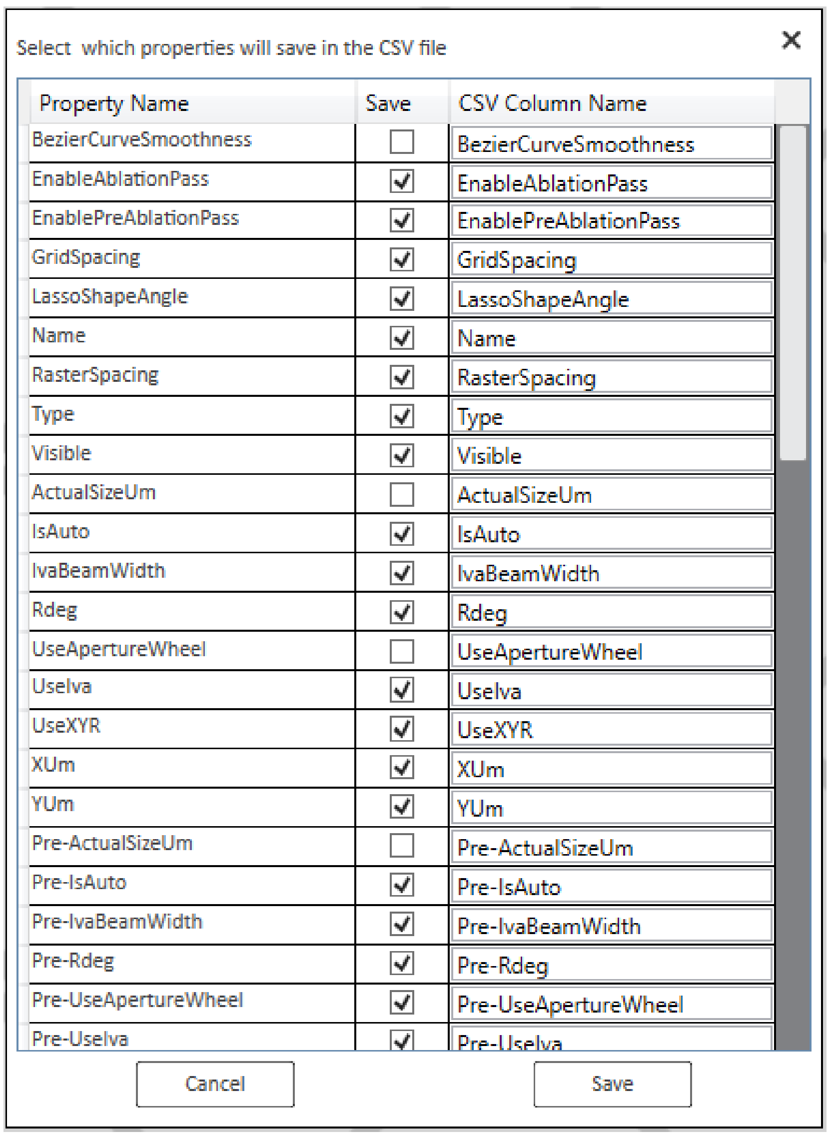
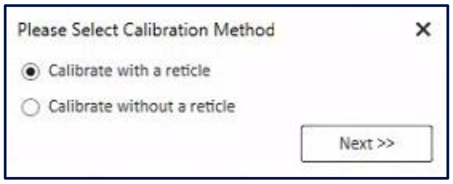



Figure 17-1: CSV Save Settings

## 2. Calibrate screen

ActiveView2 translates camera pixels into Experiment XY coordinates through data collected using a screen calibration process. This is done with a reticle for best results (provided in the accessory box) or without a reticle.




### a. With a reticle

Place the reticle in the sample chamber, focus on it, and identify known distances by following the steps in the wizard. Several mechanical zoom positions are required for accurate calibration. Click on two points a known distance apart (ticks on the reticle) and type in the distance. Click **Finish** to complete the process.

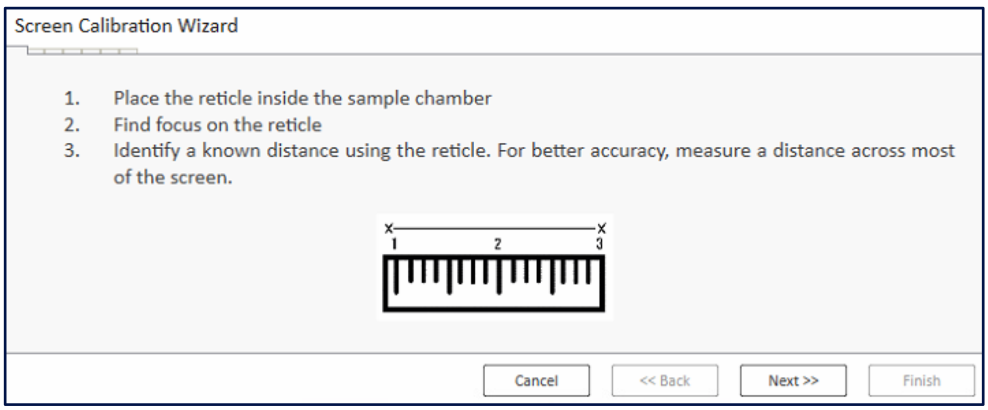



Figure 17-2: Screen calibration wizard

### b. Without a reticle

Select the “calibrate without reticle” option and simply follow the onscreen wizard.

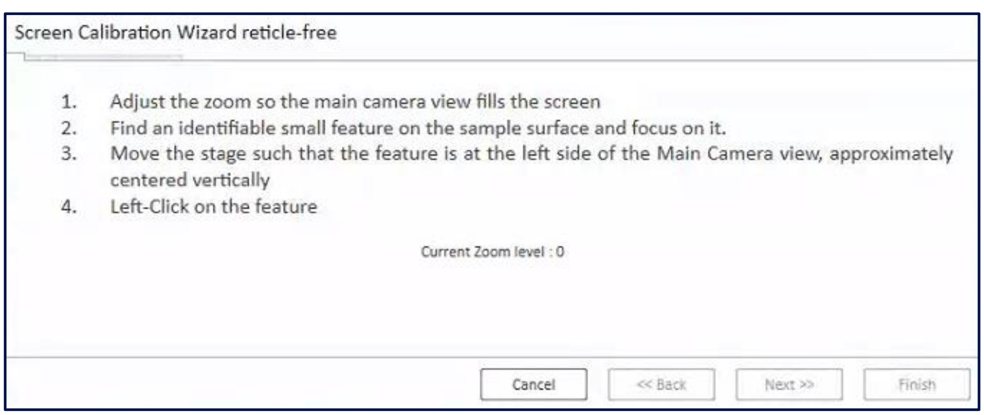



Figure 17-3: Reticle Free Calibration Wizard

## 3. Camera Settings

If the system has two cameras, a different settings panel opens displaying the tab items related to camera settings.

## 4. Main Camera

Adjust the digital camera settings for the Main camera using this window.

## 5. Wide Angle Camera

Adjust the digital camera settings for the Wide-angle camera using this window.

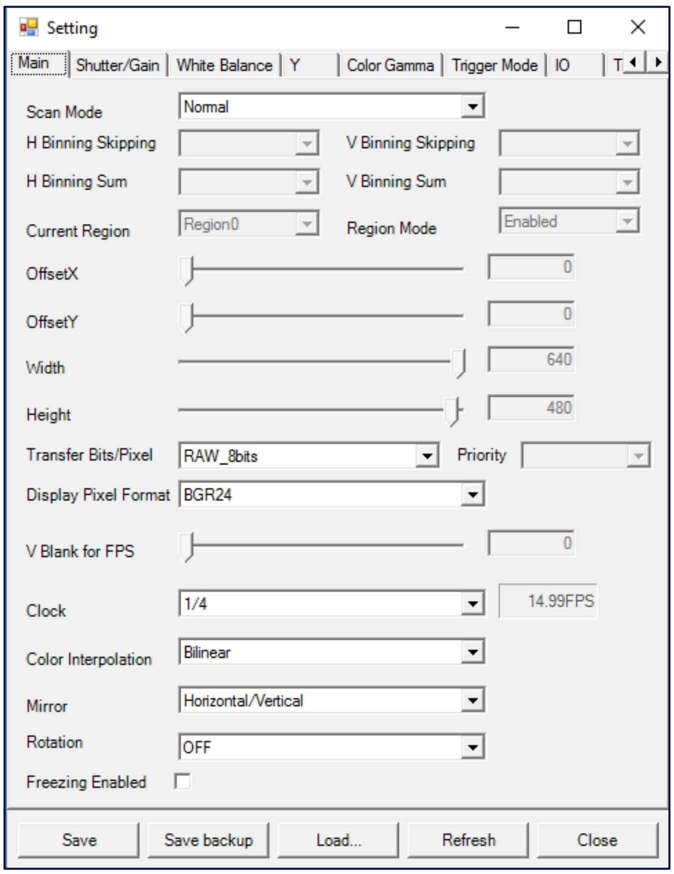



Figure 17-4: Camera settings

## 6. Calibrate Wide Angle Camera

This wizard uses an object in the wide-angle camera to correct the wide-angle camera image keystone and step/pixel ratio. It is best done with an easily identifiable object (e.g. the corner of a business card) that is placed roughly in the center of the ablation chamber, in focus in the main camera. After calibrating the wide-angle camera, positioning of the Wide Angle Camera (see Reposition Wide Angle Camera Angle) will need adjustment.

## 7. Sample Map

Opens the settings form for configuring sample maps. The “Sub Image Area” applies to the high-resolution camera and can be used to crop out darker areas in the image due to shadows. When sub image is used, more camera images will be collected to construct the final image.

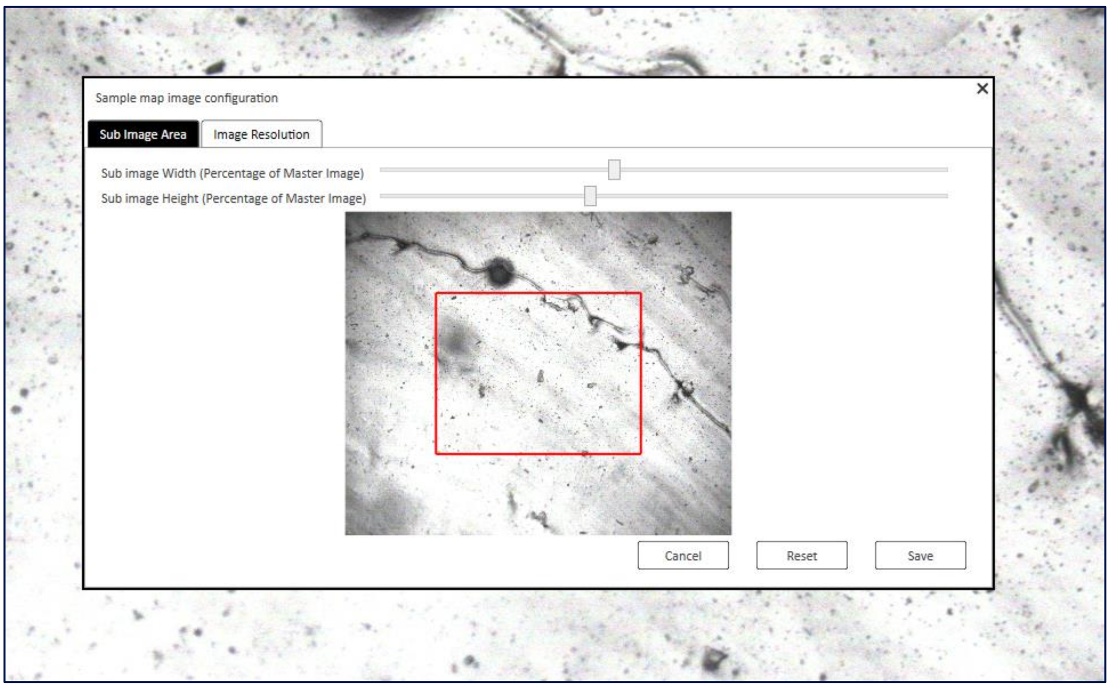



Figure 17-5: Sample Map Sub Image area definition

If the NWR system does not have a low-resolution Wide Angle camera, the image size limits result in a limited sample map size. To allow larger areas to be defined for a sample map on systems with only one (high resolution) camera, a second tab is available “Image Resolution”. On this tab, you can define reductions in resolution that will allow larger sample map areas, but with lower resolution.

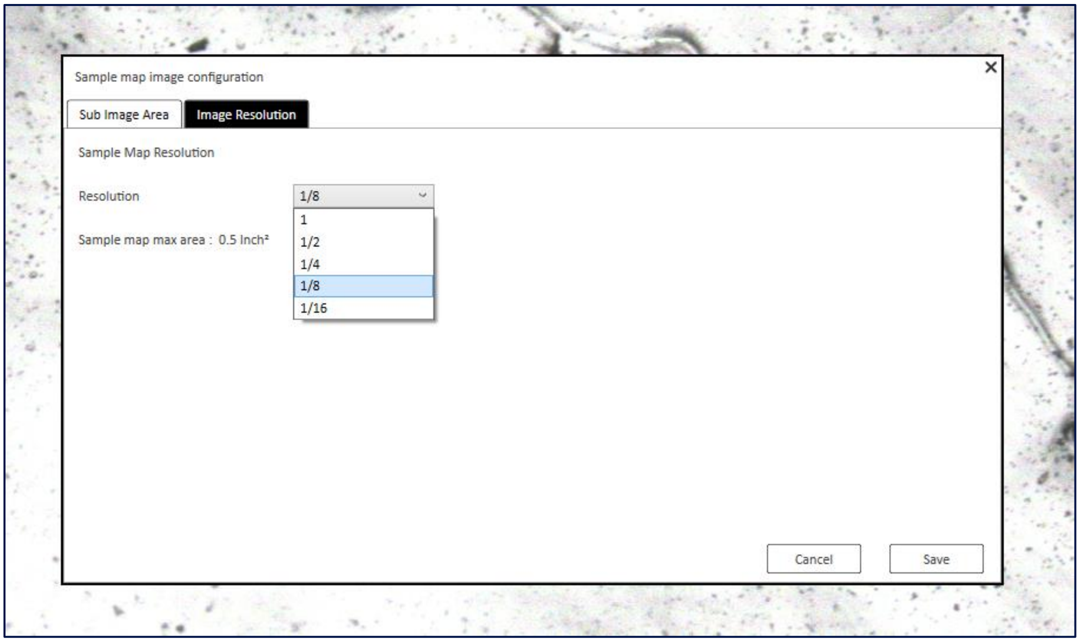



Figure 17-6: Image Resolution reduction for systems with only high-resolution camera

## 8. Joystick

USB Joystick support is possible with specific hardware. Contact ESL engineering for more information if this is required.

## 9. Trigger/Sync Properties

The NWR platform is capable of both sending and receiving either TTL/CMOS or Switch type triggers through the BNC ports on the rear of the instrument. Properly used, these connections can enable the laser to send or receive signals to start firing or begin an ICP-MS analysis. Different brands of ICP-MS require different software and hardware configurations.

### a. Sync Out

In Sync Out mode, the laser behaves as it normally would but sends signals out of the SYNC OUT port at the rear of the instrument. The type of signal is determined by the jumpers inside the laser (TTL by default) and the Polarity (Active Closed/Low or Open/High). The timing of the trigger relative to the laser and pattern operation configurable and can be set to begin at different points by selecting the radio buttons in the Sync out modes. If a delay is set, the laser will wait the specified number of seconds before sending the signals. This only applies to "Active when Laser Active".

Except for "Active when Laser Active" sync out becomes active after the first laser warmup.

Enable Sync Out during Pre-Ablation: When checked, a trigger is sent during Pre-Ablation.

Disabled: The sync out signal is not generated.

Active when Laser Active: The trigger signal is present only while the laser is active during a pattern. As an example; if a grid of spots is defined, the sync signal is only present while each of the spots is ablated and not present when the stages move to the next location. Note, the trigger will be sent at the beginning of any warm up period.

Active During Pattern Scan: The trigger signal is present when the pattern is initiated, remains present while the pattern is performed (including stage movements between ablations) and is not present after the completion of the pattern.

Active During Entire Experiment: The trigger signal is present when an experiment run is initiated, remains present during the entire experiment (including stage movements between ablations) and is not present after the experiment is complete. The signal remains active during the pause and movements between pattern locations.

Pulse at Start of Pattern Scan: A pulse is generated at the start of each pattern.

Sync Out Polarity-Switched Active Closed: The trigger will be a low impedance short while the sync signal is active and a high impedance open when not active.

Sync Out Polarity-Switched Active Open: The trigger signal will be a high impedance open while the signal is active and a low impedance short when not active.

Sync Out Polarity-TTL/CMOS Active Low: The trigger signal will either be a TTL/CMOS low level while the signal is active and will be a TTL/CMOS high level while the signal is not active. This is an alternate mode of operation from the switched mode. Both modes of operation cannot operate simultaneously.

Sync Out Polarity-TTL/CMOS Active High: The trigger signal will either be a TTL or CMOS high level while the signal is active and will be a TTL/ CMOS low level while the signal is not active. This is an alternate mode of operation from the switched mode.  Both modes of operation cannot operate simultaneously.

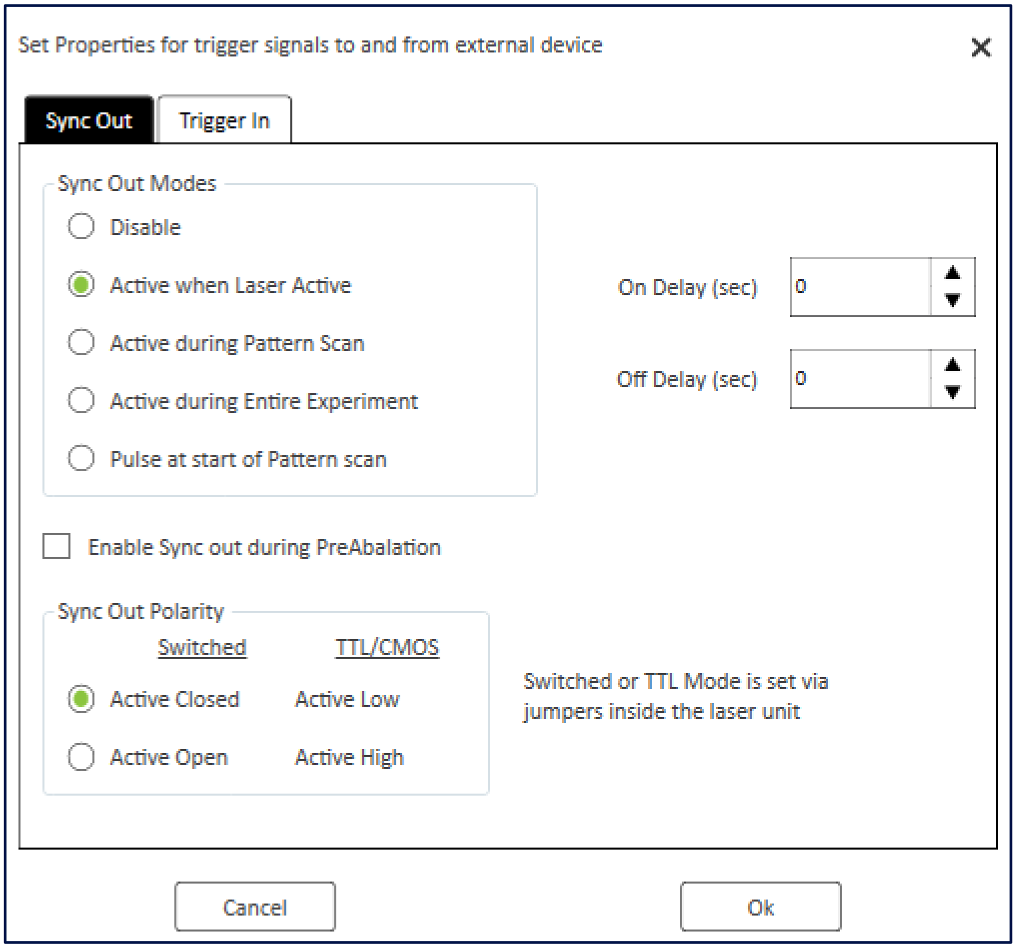



Figure 17-7: Sync Out properties

### b. Trigger In

The NWR platform can also wait for a trigger signal from the ICP-MS to start. If the software is set to anything other than “Don’t wait for Trigger”, the ablation will not begin until the trigger signal arrives. The Trigger In modes determine what action the laser will take when it receives the signal. If a delay is set, the laser will wait additional seconds before taking the action.

Don’t Wait for Trigger: The NWR Laser Ablation Platform ignores the trigger.

Start Next Pattern: After the **Run Experiment** button is selected, the NWR Laser Ablation Platform will wait for the trigger signal before performing the next pattern within an experiment.

Run Entire Experiment: After the **Run Experiment** button is selected, the NWR Laser Ablation Platform waits for a trigger before starting the experiment. Subsequent triggers during the experiment run are ignored.

Start Pattern Ablating: After the **Run Experiment** button is selected, the NWR Laser Ablation Platform runs the laser setup steps but waits for a trigger to start the ablation. Warmup will start AFTER the trigger is received. If "Enable Trigger In For Preablation" is selected the laser will wait for a trigger to start both preablation and ablation passes.

*Note that the shortcut CTRL+SHIFT+T will send a "software trigger in" signal which can be very useful to commence the experiment without impacting the ICP-MS settings.*

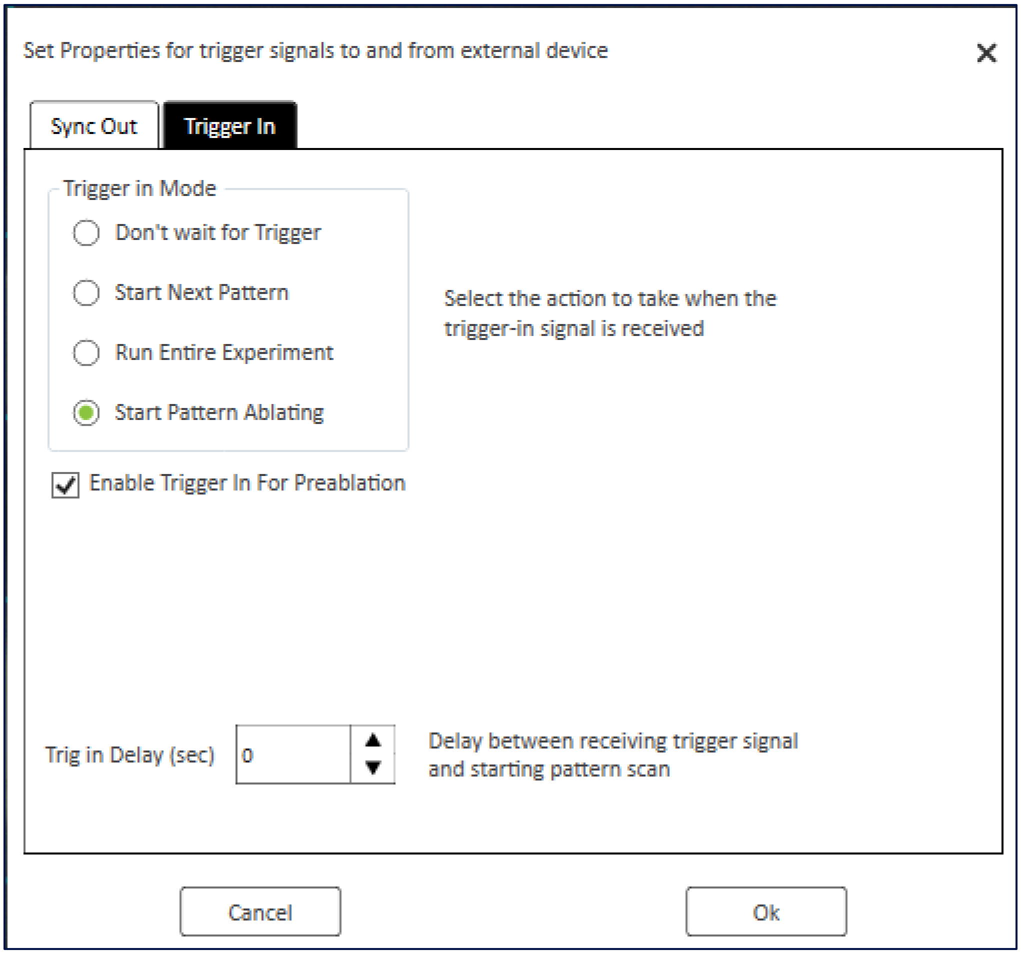



Figure 17-8: Triggering In properties

## 10.XYR Calibration

If XYR device loses its endpoints, the best way to home it is by restarting the system. If after a full hardware restart the craters do not match the intended dimensions, the Calibrate XYR Shutter utility can be used to home its position. Create an in-focus XYR spot on a sacrificial sample surface. Type in a size for X and Y in “Set Size” then press **Set Size**. Using the

Distance Measurement tool, enter the actual X and Y dimensions in the “Measured Size” boxes for each dimension. If the Z rotation needs adjustment, gradually change the rotational motor position in small increments (10 steps or so). Record the original Z step position for future reference. Press **Calibrate** for each axis when complete. Several iterations may be required.

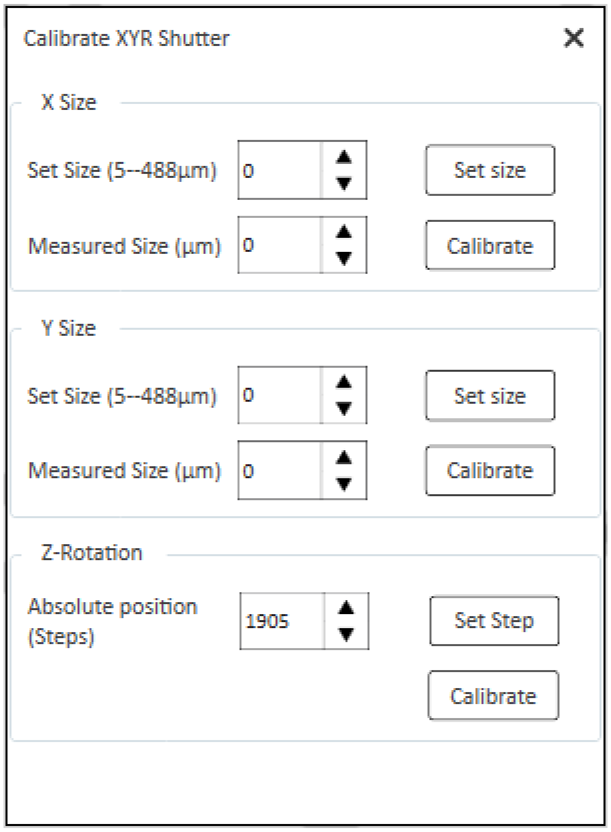
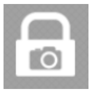



Figure 17-9: XYR calibration

## 11. ImageLock Settings



ImageLock is the software-assisted stage return accuracy improvement tool discussed in the Layer Management: ImageLock section. This window allows customization of ImageLock behaviors.

### a. Map Automatically

Turns ImageLock on or off by default.

### b. Error handling

In the case that an ImageLock pattern cannot be matched, ImageLock can be configured to take one of three options listed below. Ensure the action selected is consistent with the experiment plan/timings for the ICP-MS measurement to prevent desynchronization of analysis and ablation patterns.

Abort Experiment On ImageLock Error: The current Run Queue is cancelled.

Run Pattern but Skip ImageLock: The pattern will run in the X and Y coordinates as if it were not an ImageLock pattern.

Skip Pattern in ImageLock Error: The pattern will be skipped without firing.

### c. Max Offset X and Y

The maximum distance that ImageLock will hunt for a match before declaring an ImageLock error and taking the specified error action. This may need to be larger for older cantilevered stages, or smaller for samples that have similar-looking growth bands.

### d. Max Time for Process

The maximum number of milliseconds that ImageLock will hunt for a match before declaring an ImageLock error and taking the specified error action. Higher values will increase the chance of success, but the potential time may need to be accounted for on the ICP-MS side.

### e. Stage Settle Time

The time between ImageLock iterations may depend on the momentum of the stages. Inherently less accurate stages will need longer times.

### f. Do ImageLock on Move To

Uses ImageLock when the user selects a pattern and chooses **Move To** in addition to using ImageLock while a Run Queue is in action. This is useful for testing imagelock.

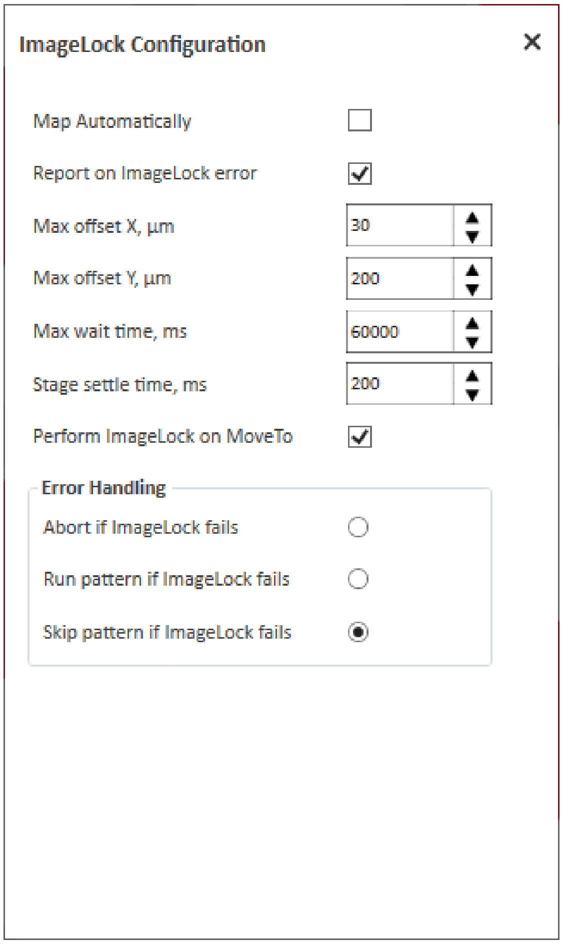



Figure 17-10: ImageLock options

## 12.Run WCF Host

Windows Communication Foundation (WCF) is used to present an Application Programming Interface (API), which can be used by collaborative tools on different computers. Refer to the Software Development Kit (SDK) documentation for more details.

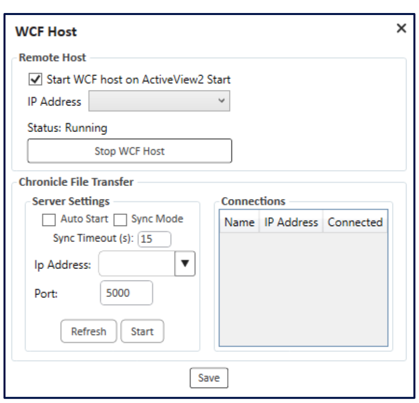



Figure 17-11: WCF host

## 13. Manage Add-in

Add-ins (sometimes called Plug-ins) are a way to extend the functionality of ActiveView2. Add-ins will come with an installer and their own documentation. Load and unload Add-ins from ActiveView2 with the “Activate” check box. When the add-in is successfully loaded, the box will be checked. “Activate at Startup” will cause add-ins to be loaded automatically when ActiveView2 starts. When add-ins are loaded, a new tab will appear on the left. Loaded add-ins are displayed in tabs across the top. Multiple Add-Ins can be loaded at the same time.

| Name | AddIn Full Name | Version | Publisher | Activate | Activate At StartUp |
|---|---|---|---|---|---|
| Email Notifier | EmailNotifierAddin.UserControlEmailGrid | 1.0.0.0 | ESL | ☐ | ☐ |
| Energy Test Addin | EnergyTestAddin.EnergyTestAddinUtility | 1.0.0.0 | ESL | ☐ | ☐ |
| SampleAddin | SampleAddin.SampleAddinUtility | 1.0.0.0 | ESL | ☐ | ☐ |
| Flunce Logger | FluenceAddin.FluenceLogAddin | 1.0.0.0 | ESL | ☐ | ☐ |
| Agilent Addin | AV2AgilentPlugin.AgilentAddin | 1.0.0.0 | ESL | ☐ | ☐ |

Figure 17-12: The Add-in selection box

## 18) NIGHTMANAGER MODE

Night Manager mode is separate application, based on a windows service that enables the user to schedule and automate the following:

- **He gas flow.** He gas can be programmed to flow through the transport lines and ablation chamber to enable a desired quantity of He to flow at a desired time. For instance, a small He flow (< 5 ml per min) could be programmed to continuously flow overnight to provide a small positive flow to avoid atmospheric gases from adsorbing onto internal surfaces of the sample chamber and tubing. Then, shortly prior to analysis the flow rate can be scheduled to increase to the desired analytical flow (typically ~800 ml per min).
- **$N_2$ purge gas.** In the NWR193 and NWRfemto products, the $N_2$ purge gas can be programmed to provide a small $N_2$ flow (< 5 ml per min) overnight to provide a small positive flow to prevent atmospheric gases from seeping into the system. Then, shortly prior to analysis the flow rate can be scheduled to increase to the desired analytical flow (typically ~1 L per min) such that the optical system is purged and stable prior to use.
- **Scheduled ArF gas exchange.** For the NWR193 products that utilize the Coherent Excistar laser source, an automated ArF gas exchange can be programmed to ensure that stagnated gas is not present within the laser source during periods of inactivity. This will ensure longevity of laser source performance.

To open the Night Manager application, double click on the icon located on the PC background.

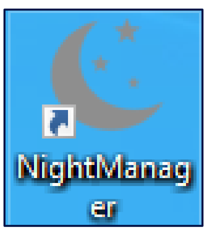



Figure 18-1: Night Manager icon located on the PC desktop

Night Manager will open as a separate application/window and a home screen will appear as shown below. The Night Manager application is split into 4 functional areas:

## 1. Schedule

The schedule page shows the user all events currently scheduled in an easy calendar (to select the date) and timeline (broken into hourly segments) format. The window includes gas schedules and ArF gas exchanges based on the selected profile.

### a. Night Manager Options

Options for Night Manager mode can be accessed from the schedule tab and are mostly related to when Night Manager mode opens in order to maintain desired conditions.

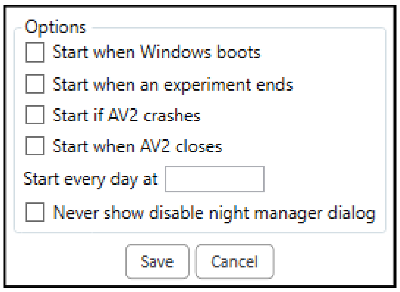



Figure 18-2: Night Manager mode options

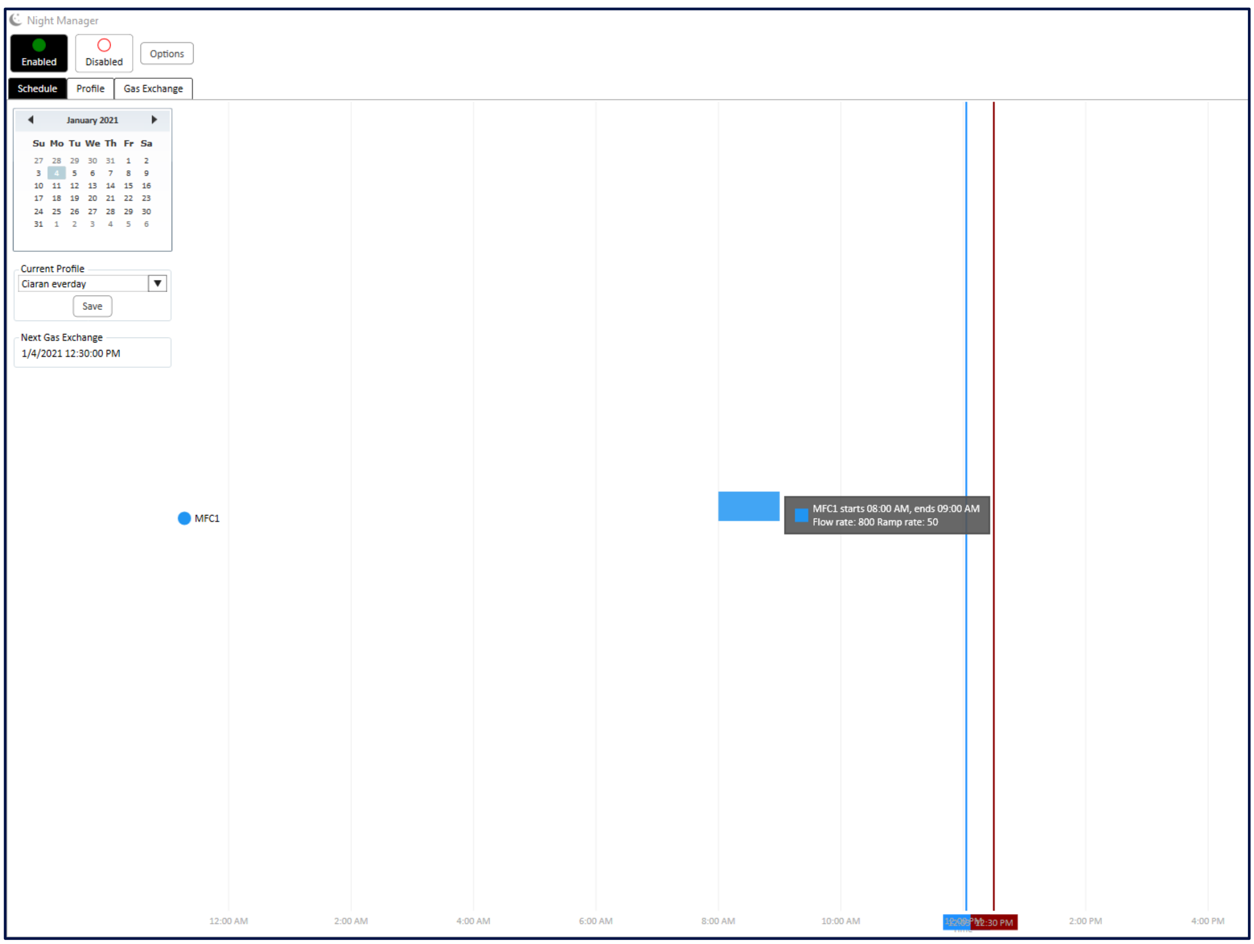



Figure 18-3: Night Manager Schedule page

## 2. Profile

Each user needs to create a **profile**. Different profiles enable different routines/schedules to be easily applied. For instance, a user could easily create a profile for normal usage, which would optimize the system (line/cell/optics purging) for analysis. Another profile could be created for when the system is dormant e.g. during a laboratory shut-down which would maintain the optics purge with a small $N_2$ flow and regular ArF exchanges.

To create a profile, select “New” and enter a profile name. To delete an existing profile select “Delete”. Once a profile is created and the required events are scheduled select “Save”.

Events are scheduled by selecting a day of the week (Figure 10-4). Right clicking on the day of the week gives the option to apply to other days or to all days. Then select a Mass Flow Controller (MFC) from the “Gas Option” drop-down menu, e.g. “MFC1” for He flow or “$N_2$ purge” to schedule an optics purge. The flow rate is entered along with the MFC ramp rate and the required start and end time. When complete, select “add” to add the event to the profile. Save the profile to transfer it to the Schedule page.

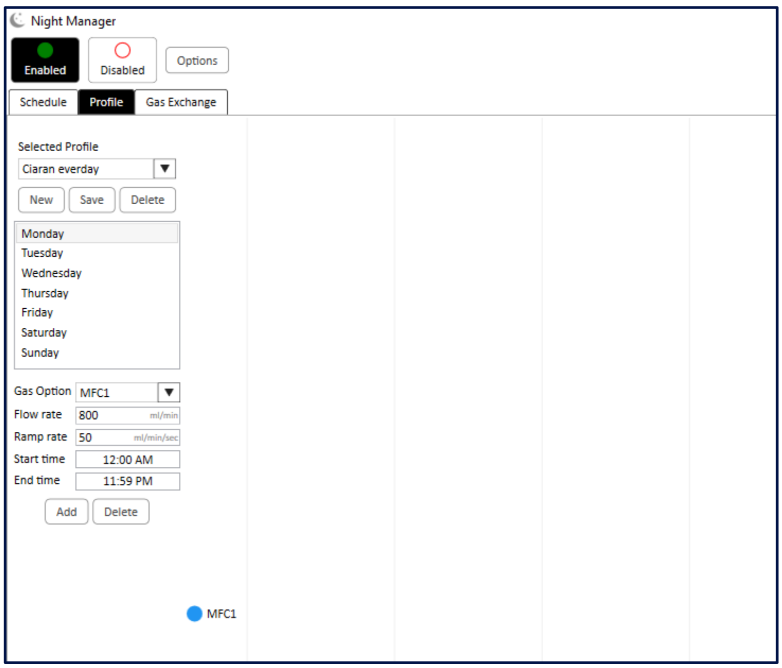



Figure 18-4: Night Manager Profile page

## 3. Gas Exchange

An automated ArF Gas Exchange for Coherent Excistar or MLase 193nm excimer lasers is scheduled by setting the date, time, and recurrence of the gas exchange, plus an appropriate name (Figure 18-5). Clicking the "Schedule" icon displays the event in the schedule box. Scheduled gas exchanges can be deleted via a right click in the scheduling box, followed by "delete".

*Note that in order for the automated ArF exchange to occur, the user must ensure that the ArF cylinder itself is left in the fully open position. This can be achieved by turning the cylinder head counterclockwise to the open position.*

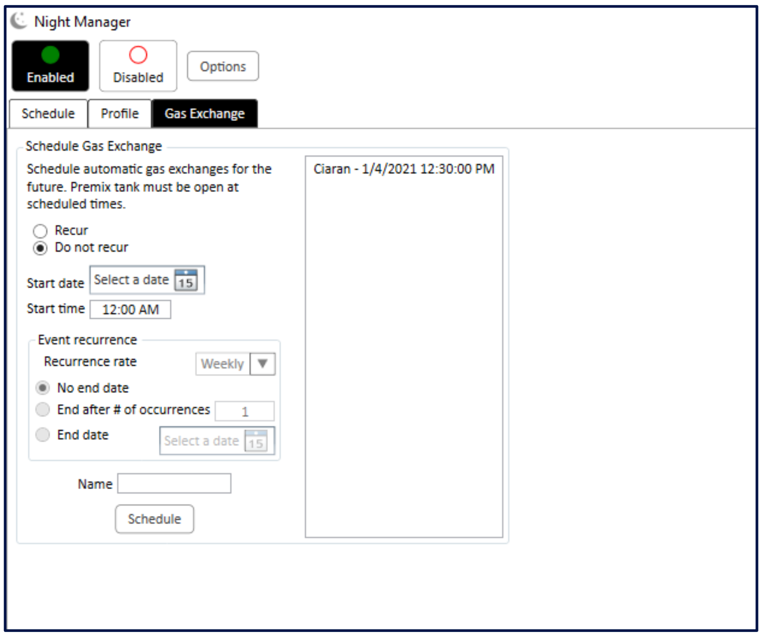



Figure 18-5: The Gas Exchange window of Night Manager mode

The user can revert to the "Schedule" page to view all scheduled events on the timeline.

## 4. Enabled/Disabled

At the top of the main window are two buttons marked "Enabled" and "Disabled". The active scheduled tasks will only be actioned if the Enabled button is active. The user should ensure the "Enable" button is enabled prior to shutting down the Night Manager mode application.

## 19) ENERGY CALIBRATION

Energy calibration is a procedure that must be performed periodically to display correct energy on the Status panel, as well as to allow energy control to function properly in Fluence mode. Energy calibration should be done after any beam alignment changes, and periodically as optics degrade due to normal wear.

There are two methods available to perform energy calibration. Manual and AutoCalibration (AutoCal). Manual calibration requires training and is restricted to service level permission in ActiveView2. AutoCal can be done with the correct equipment, and at local administrator access level.

Both methods of performing energy calibration can be accessed with the Energy Calibration icon in Settings.

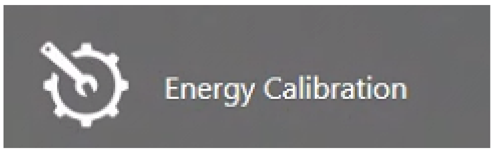



Figure 19-1: The Energy Calibration icon

The Energy Calibration form will open.

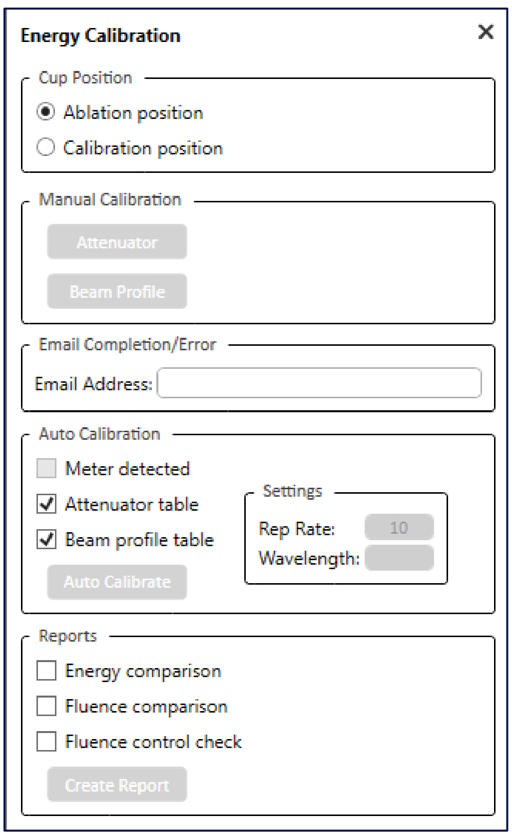



Figure 19-2: The Energy Calibration window

## 1. AutoCalibration

AutoCal is a component within ActiveView2 that enables simple, automated calibration of the energy output of the system using a certified and traceable USB energy meter (sold separately).

The energy meter is connected to the NWR platform via the USB connector on the front. The meter sensor/head is placed in a special ablation chamber drawer to locate it at the correct position for an accurate calibration procedure.

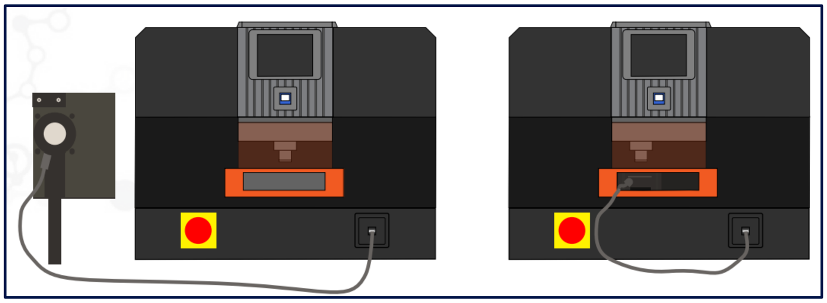


Figure 19-3: USB energy meter in the TwoVol2 drawer (left), ensuring Class 1 operation during the AutoCal procedure (right)

Once the meter is in the ablation chamber, open the Settings menu and load the AutoCal application from the Energy Calibration icon on the left-hand side of the ActiveView2 main screen. In most cases, an auto calibration of both the attenuator table and beam profile table is required. Select “Calibration Position”, check both the “Attenuator Table” and “Beam Profile Table”, then select the “Auto Calibrate” option. The process takes about 10 minutes and the user will be notified when it is complete.

## 2. Manual Calibration

With Service level access, the Manual Calibration buttons on the Energy Calibration form will be enabled.

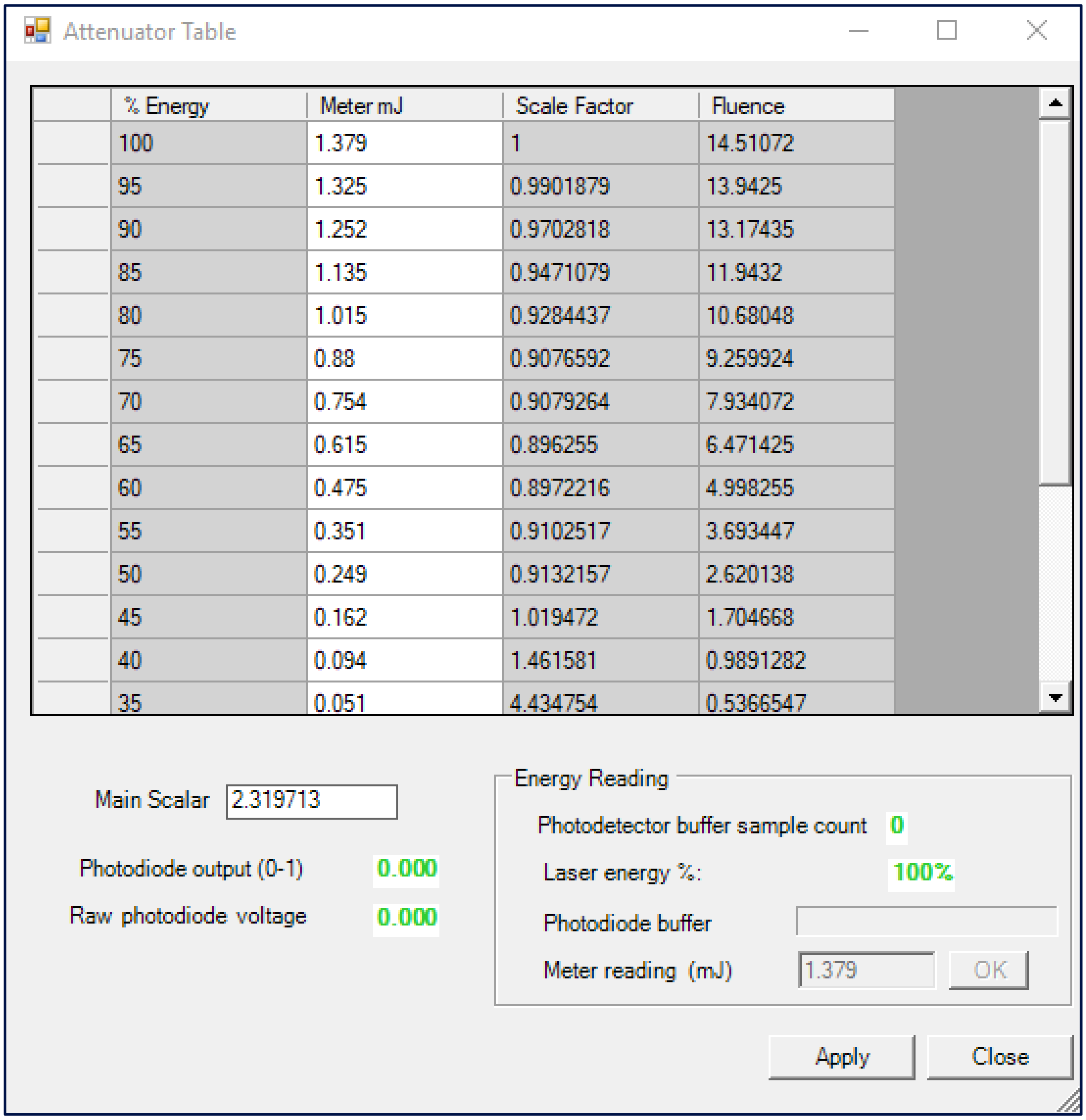
The live Energy and Fluence outputs in the Status window are calculated from calibrated photodiode readings. Photodiode calibration is a two-step process. First the energy at the largest aperture imaged spot is measured at different attenuator positions to account for non-linearities in the photodiode response. The second step (Beam Profile Table, below) accounts for beam heterogeneities. Each of these manual calibration steps can be performed by clicking the button in the Energy Calibration window to open the respective form.

### a. Attenuator Table

Before opening the Attenuator Table, place an external energy meter in the ablation chamber under the laser. The laser should be fully warm and beam delivery path fully purged before calibrating. The Sample Drawer Interlock may need to be defeated.

**Important! By defeating the drawer interlock and running the laser without the drawer in place, the system becomes Class IV. Ensure the calibration is carried out in a controlled environment and all personnel have appropriate Personal Protective Equipment (PPE) such as appropriate wavelength laser safety glasses. Please reference the system manuals for more information.**

When the Attenuator Table wizard is opened, the laser will begin to fire at the largest available spot size. The Photodiode Buffer will create a pause to make sure there are enough measurements for an accurate value. When the buffer is complete, type the output of the external energy meter into the "Meter Reading (mJ)" box and press **OK** to move down the table.



| % Energy | Meter mJ | Scale Factor | Fluence |
|---|---|---|---|
| 100 | 1.379 | 1 | 14.51072 |
| 95 | 1.325 | 0.9901879 | 13.9425 |
| 90 | 1.252 | 0.9702818 | 13.17435 |
| 85 | 1.135 | 0.9471079 | 11.9432 |
| 80 | 1.015 | 0.9284437 | 10.68048 |
| 75 | 0.88 | 0.9076592 | 9.259924 |
| 70 | 0.754 | 0.9079264 | 7.934072 |
| 65 | 0.615 | 0.896255 | 6.471425 |
| 60 | 0.475 | 0.8972216 | 4.998255 |
| 55 | 0.351 | 0.9102517 | 3.693447 |
| 50 | 0.249 | 0.9132157 | 2.620138 |
| 45 | 0.162 | 1.019472 | 1.704668 |
| 40 | 0.094 | 1.461581 | 0.9891282 |
| 35 | 0.051 | 4.434754 | 0.5366547 |



Figure 19-4: Attenuator Table

## b. Beam Profile Table

**Important! The Attenuator Table calibration must be completed before the Beam Profile Table calibration.**

This table is the second part of photodiode calibration. With the external energy meter still in the ablation chamber, open the Beam Profile form.

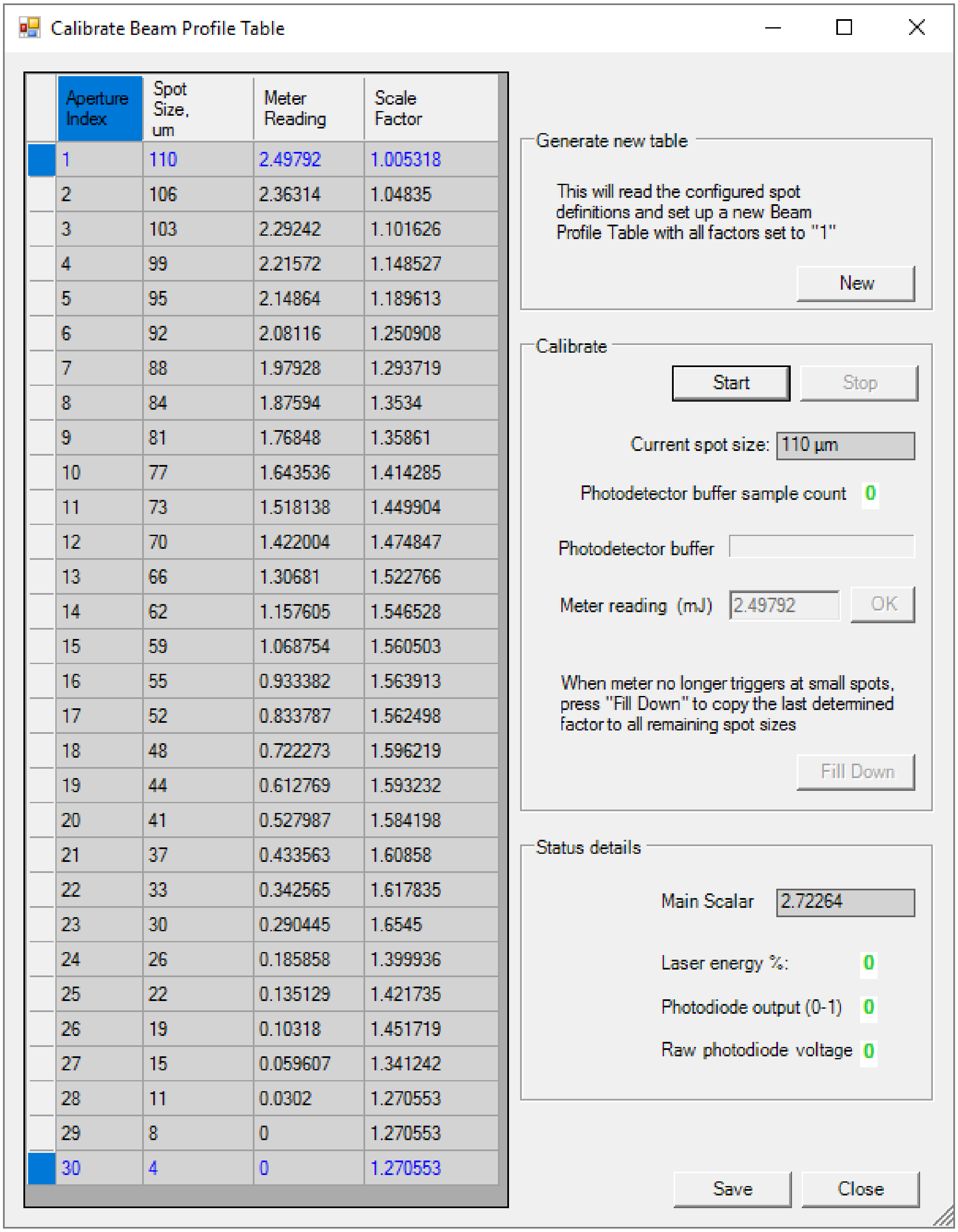



Figure 19-5: Beam Profile Table

Use the “New” button if the aperture device has been changed, or there has been aperture configuration work, or simply to start with a new table based on configured aperture device data. The “New” button will erase all current scale factors, setting them to “1”, and rebuild a new table.

To begin beam profile calibration process, click the “Start” button. The form will automatically step through the required calibration points and collect photodetector data after the aperture device finishes its move. When it has collected sufficient samples in its buffer, the progress bar will turn green. At this point, the current energy reading from the detector in the sample chamber should be entered in the “Meter Reading (mJ)” box. Pressing the enter key will cause the scalar for that spot size to be calculated, and the form will automatically move to the next spot size.

As spot sizes decrease, the meter’s trigger level should be adjusted to be able to trigger reliably. When the energy is too low to trigger the meter at all, the “Fill Down” button should be used to copy the last successfully determined scalar value for all the remaining spot sizes.

When calibration is complete, review the resulting energy values entered for errors, as well as the resulting scalar values. If anything doesn’t look right, the errors must be corrected.

After reviewing results, press “Save” to apply the new energy calibration values.

# 20) CHRONICLE DATA MANAGEMENT

## 1. What is the Chronicle Data Management Feature?

“Chronicle” is a new feature set introduced in version 1.5 which perhaps represents the largest set of features added to the software to-date. Chronicle is an array of Data Management features in which all data associated with an experiment e.g. microscopy, parameters, ICPMS data and reduced data is transferred and stored for easy access in ActiveView2. ActiveView2 becomes the hub for all your data.

## 2. What do I need to utilize Chronicle?

- Version 1.5+ of ActiveView2
- Chronicle File Watcher installed on the ICPMS (or other) instrument
- A local network connection between the embedded PC on the above instrument
- Ethernet cables and a suitable network switch
- Set up network communication according to (for example):
    - GD100100_A Procedure, set up an isolated LAN.pdf

## 3. How to Setup Chronicle

### a. Within ActiveView2

Go to the Settings menu within ActiveView2 and select the WCF Host option (Settings >>WCF Host) and the below window will be displayed:

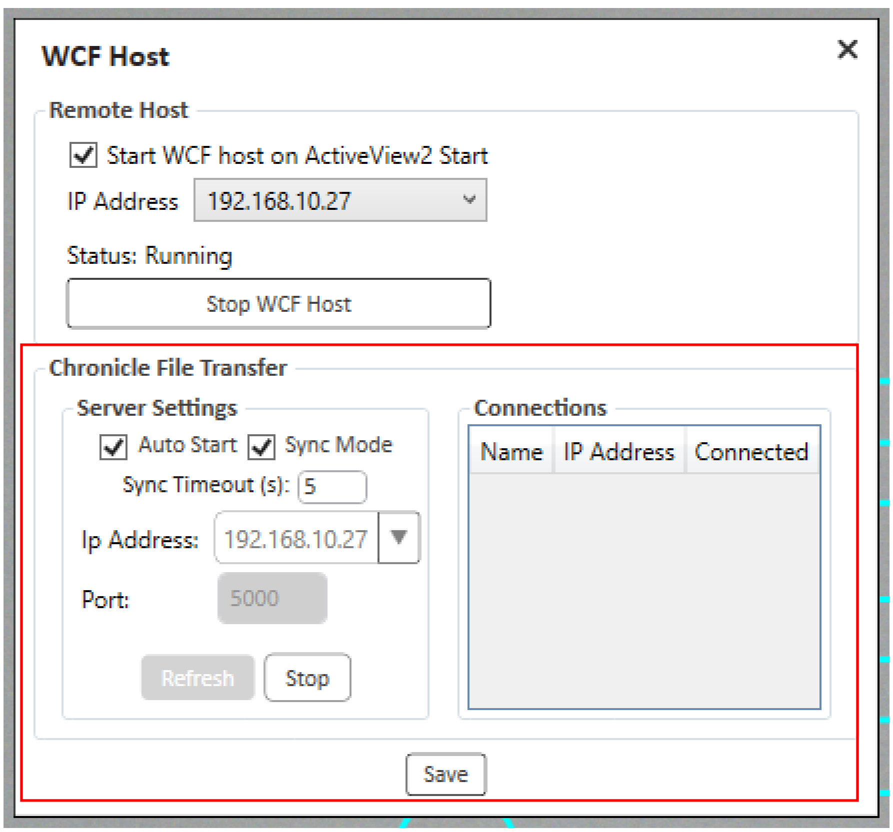



Figure 20-1: WCF Host tools showing Chronicle Synchronization section

The correct IP address is required to be selected from the IP address in the Chronicle File Transfer options.

If “Auto Start” is selected, then the Chronicle WCF Host will be active automatically upon startup of ActiveView2. Select this option if you wish to employ Chronicle every time.

“Sync Mode” is a feature in which the operation of the ESL LA instrument and ICPMS instrument can be further synchronized. In this mode, the ESL LA instrument will only move to the next pattern/scan following creation and transfer of the ICPMS data file via the WCF Host. Sync Mode is a great way to ensure the LA and ICPMS acquisition processes are synchronized and the correct data file is associated to the correct pattern/scan.

Hit “Save” once the desired entries have been made.

### b. On the ICPMS Instrument

Chronicle relies on a File Watcher which is installed on the ICPMS computer. This File Watcher watches for the creation of a new data file within the target folder (typically the folder in which new ICPMS data files are written to). Once the file is identified it’s transfer to ActiveView2 is facilitated using WCF.

To install the File Watcher utility on the ICPMS computer, follow these steps:

- There is a “FileWatcherInstaller.exe” located in AV2’s folder paths at:
  - C:\ProgramData\ESI\Utility\Chronicle Tools
- Copy that installer executable (to a thumb drive for example) and paste it onto the desktop of the ICPMS computer.
- Run the FileWatcherInstaller.exe installer on the ICPMS computer.
- Follow the prompts during installation.

Following installation of the File Watcher the user should double click on the File Watcher icon which will load the below window:

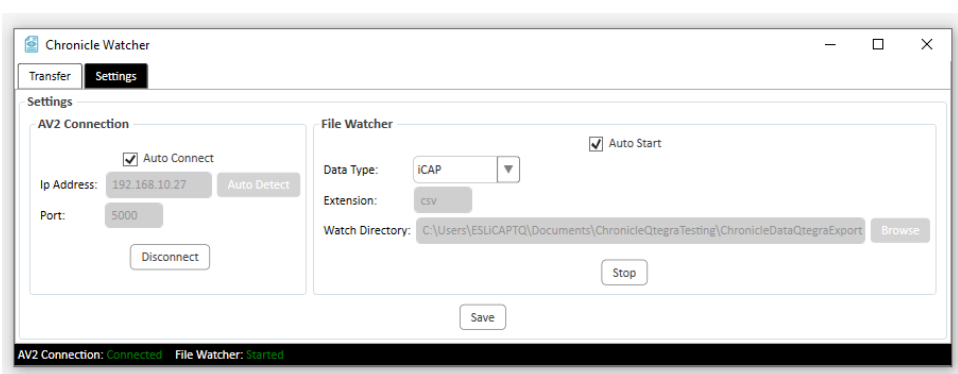



Figure 20-2: Chronicle File Watcher on ICPMS Computer

The “Auto Connect” option can be selected to ensure the correct connection is made.

Further, the “Auto Detect” option can locate all the available IP addresses.

The next step is to define the type of ICPMS (or other) data type. This step is important to enable the correct display of Time Resolved (TR) data within ActiveView2.

It is important to select the correct directory for the File Watcher and this is achieved by selecting the directory of choice using the “Browse” option.

“Auto Start” can be utilized to automatically start the AV2 connection, and the File Watcher.

The status of the AV2 Connection and File Watcher is shown at the bottom of the window.

Hit “Save” once the desired entries have been made.

It is recommended to switch to the “Transfer” tab which can remain open on the ICPMS and will provide a log of each file transferred from the ICPMS to the ActiveView2 software.

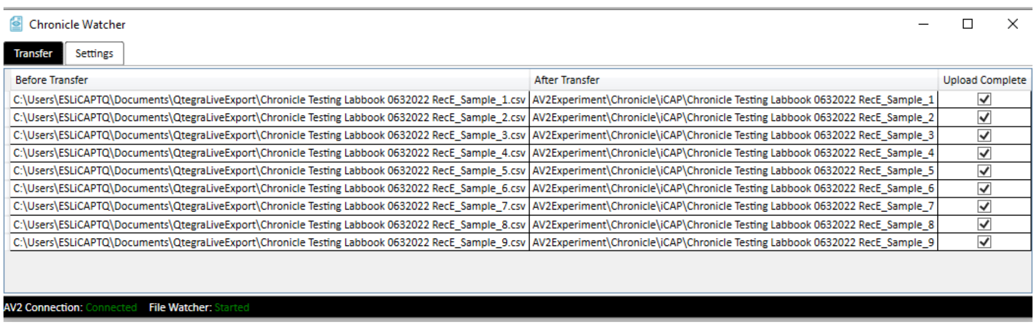



Figure 20-3: Chronicle File Watcher view after several data file transfers

## 4. Chronicle Data Management Connection

Chronicle Data Management is now operational and ready to be used as indicated by the “Connected” status in the status window below:

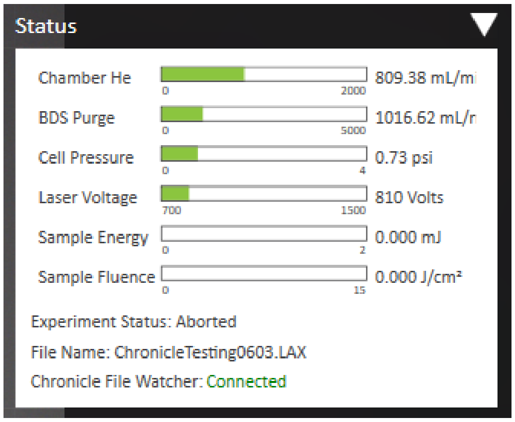



Figure 20-4: AV2 Status view showing Chronicle File Watcher status

The WCF Host will also indicate in “Connections” when the File Transfer is successfully setup.

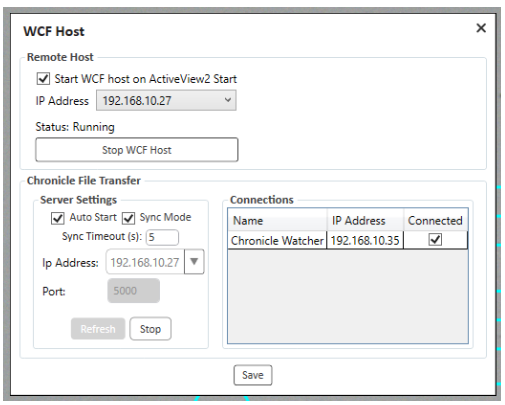



Figure 20-5: AV2's WCF Host settings showing active Chronicle connection

Now that the Chronicle Data Management is ready, data from the ICPMS will be transferred into ActiveView2 on a per pattern/scan basis.

The management of sample imagery e.g. sample maps/mosaics, screenshots, imported imagery is an important feature of Chronicle Data Management and such imagery will also be available for the user to view and associated with a particular pattern/scan.

- Importantly this now includes the ability of ActiveView2 to take a "Pre-ablation" and "Post-ablation" image of the pattern/scan location.
    - These options are essentially a pattern property and as such can be selected from the Pattern Properties window as per any other pattern property per the window below:

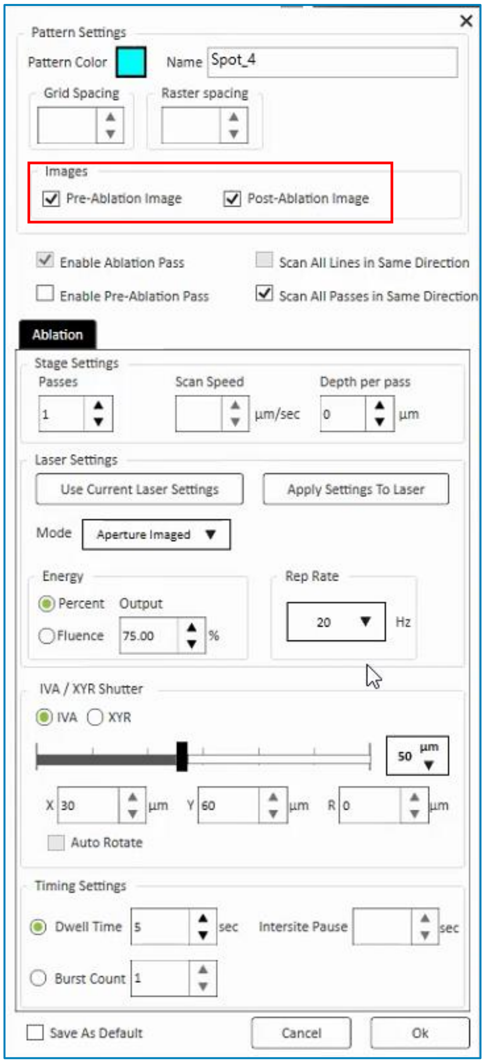



Figure 20-6: Spot pattern property window showing options to capture pre and post ablation images

As the LA-ICP-MS experiment proceeds, all the intended data will transfer into ActiveView2 on a per pattern/scan basis including ICPMS data and any imagery including Pre and Post ablation images if desired. The data can be readily viewed via a number of different locations in ActiveView2:

- If data is available, a "▶" icon will be shown to the left of the Pattern in Layer Management per the window below:

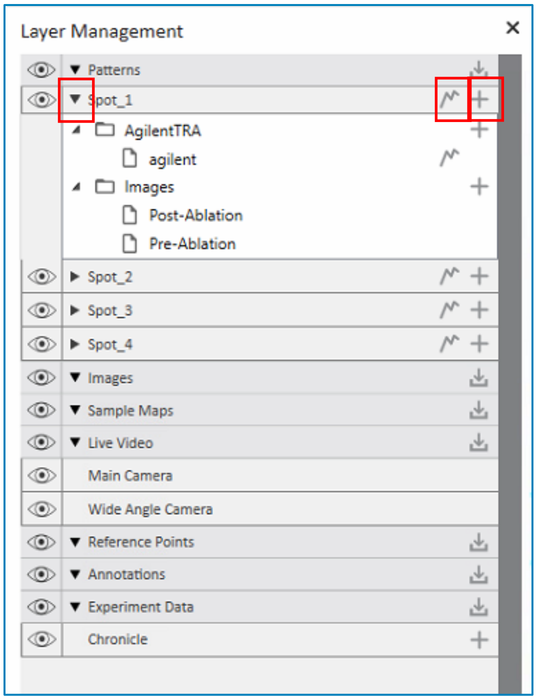



Figure 20-7: Layer view showing Chronicle data for a spot pattern

- Clicking on the "▶" icon will expand the node such that all the associated data is available for selection and display.

- If ICPMS data is available in a compatible format, then the Time Resolved (TR) profile can be directly viewed within ActiveView2 per below, by clicking on the “Chart” icon.
    - Various isotopes can be selected and displayed simultaneously, and the y-axis can be changed to a log scale by checking the “Log” box. The user can rapidly switch from one TR profile to the TR profile of the neighboring pattern/scan using the “<” or “>” icon.

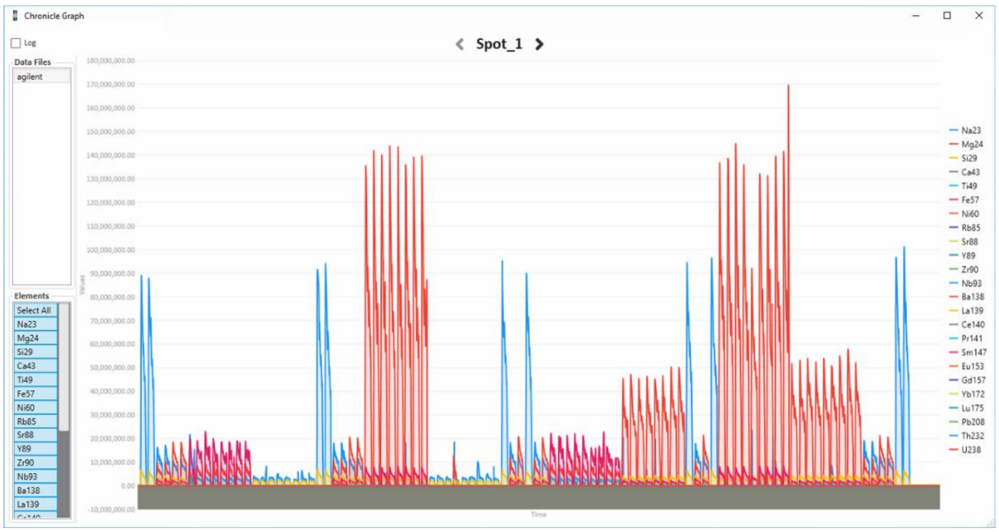



Figure 20-8: Chronicle data chart window

- The user can choose to manually import any type of file, create a folder or even use hyperlinks, and associate this to a particular pattern/scan by selecting the “+” icon next pattern/scan. Doing so opens the below widow from which the user can readily import and associate the data.

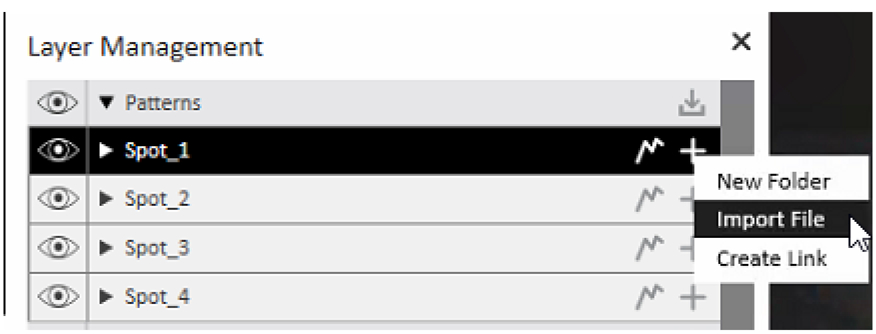



Figure 20-9: Floating tool window for Chronicle data management

It is also possible to access all the associated data from the Digital Workspace that includes the main camera images and all overlaid patterns and scans. This is an incredibly useful feature since associating the data to a pattern/scan and the overlaid pattern with its XYZ coordinates enables the user to browse the sample surface and view data in a “google earth” type manner.

- Simply right click on the overlaid pattern to bring up the below menu and select “Chronicle Data” per below.

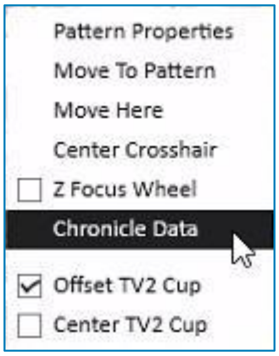



Figure 20-10: Floating tool window for a pattern in AV2's workspace

- This will allow the user to access all the data associated with this pattern/scan and others per below:


Figure 20-11: Icon indicating data has been added to a pattern

- Data can be accessed as already described per Layer Management

Finally, Chronicle can manage data that is not associated with an individual Pattern/scan, but with the entirety of the experiment. A good example of this would be the iolite logfile that is generated by ActiveView2. If this logfile is generated it can be found in the Experiment Data section in the Layer Management window per the window below:

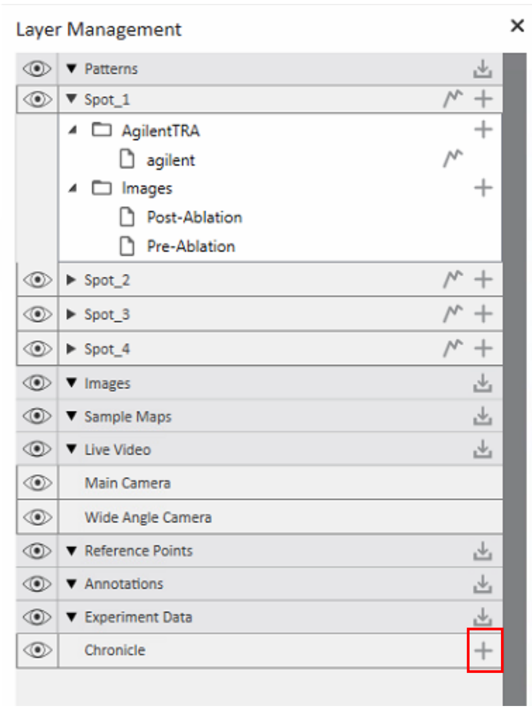



Figure 20-12: Experiment-level Chronicle data

- Further, this feature enables the user to import and store other relevant data to the experiment by utilizing the import feature available by clicking the "+" icon.

Finally, it should be noted that once the experiment has ended and all data is successfully transferred, the ActiveView2 experiment should be saved. This process ensures all the relevant data is successfully stored in the .lax file, and available for future use and perusal.

## 21) NWR193HE ACTIVEVIEW2 USER INTERFACE

Overall, the NWR193HE user interface is very similar to other ESL laser ablation instruments such as the NWR193. In may respects the user interface is simpler due to a less complex integration of the Compex laser source for energy attenuation and gas exchange.

However, there are some unique aspects of the NWR193HE ActiveView2 User Interface that are worthy of description and these are mostly related to the unique “mode switching” capability of the system. The mode of the NWR193HE can be switched using the icon indicated below in red. Modes can be selected via a drop down menu accessed by clicking on the triangle.


Figure 21-1: A screenshot of the main User Interface showing the location of the Mode Switching Icon.

### NWR193HE Mode Switching

The NWR193HE is a very high energy laser ablation system since it employs a Coherent Compex laser with an output in excess of 100 mJ. This high energy can be utilized in one of two ways:

1) To generate ablations with very high fluences e.g. 50 J cm-2
2) To generate ablations with a large spot size e.g. 300 microns in diameter

Extremely high fluences can be useful for applications such as the ablation of extremely difficult and transparent samples such as high purity and natural quartzes. In such an application the high fluence has been demonstrated to improve the ablation efficiency and avoid a “catastrophic” or “explosive” ablation event greatly improving the stability of the ICPMS signal.

Large spot sizes can be very useful to maximize the surface area sampled, and thus achieving a result that is more likely to be representative particularly for heterogeneous samples. Further, when combined with ESL’s XYR assembly a rectangular slit ablation which is long (up-to 300 microns) in one axis can be utilized.

This enables the highest sensitivity based on the long axis, but importantly, a high resolution based on the short axis.

In total there are actually four selectable modes based on the above considerations but also based on economical considerations such as gas and optic lifetime which will be reduced if always operating in a "high energy" mode. Thus, "low energy" modes are made available in which the energy output of the Coherent Compex is greatly reduced to conserve gas and longevity of optics. In principle, if the desired fluence for the application can be achieved in a low energy mode then this is much preferred for the aforementioned reasons.

The screenshot below shows the four selectable modes.

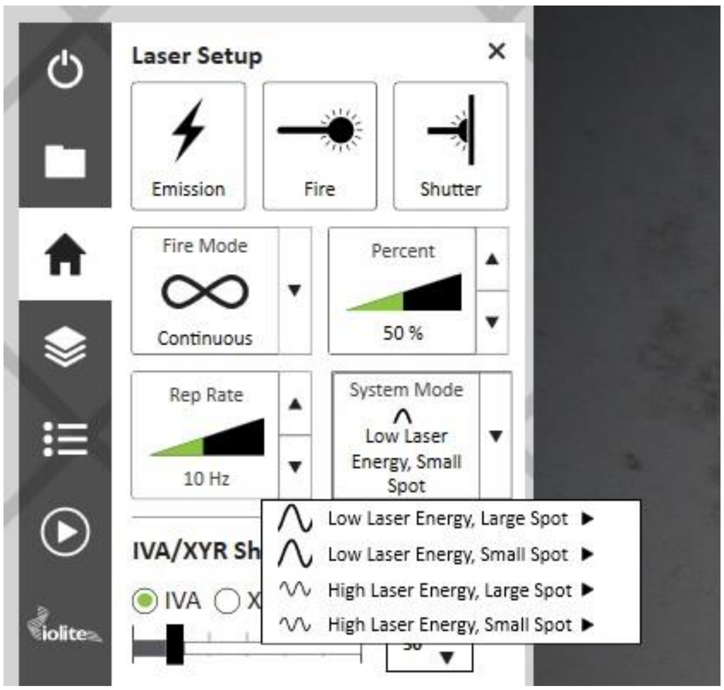



Figure 21-2 A screenshot showing the four selectable modes of the NWR193HE.

1) **Low Laser Energy, Large Spot**
In this mode, the energy output of the Coherent Compex laser source is reduced to conserve gas lifetime and improve optic longevity. However, the magnification factor of the beam delivery system (BDS) is optimized via the location of optics (motorized and under software control) to yield the largest possible spot sizes of up to 300 microns.

Note, that whilst this mode generates the large spot sizes it will also generate the lowest fluence of around 8 J cm-2 and thus should be only used for materials with a relatively low ablation threshold.

2) **Low Laser Energy, Small Spot**
In this mode, the energy output of the Coherent Compex laser source is also reduced to conserve gas lifetime and improve optic longevity. However, the magnification factor of the BDS is optimized to yield smaller spot sizes, down to 1 micron. This mode should be employed for

applications in which large spot sizes are not required and for samples that do not have a particularly high ablation threshold and thus do not require high fluence.

**3) High Laser Energy, Large Spot**

In this mode, the energy output of the Coherent Compex laser source is maximized. The magnification factor of the BDS is optimized to yield large spot sizes up to 300 microns. Since the energy output of the laser is maximized the achievable fluence is high enough e.g. 13 J cm-2 to ablate all but the most difficult and/or transparent samples.

**4) High Laser Energy, Small Spot**

In this mode, the energy output of the Coherent Compex is maximized and since the magnification factor of the BDS is optimized to yield small spot sizes, this mode provides the highest possible fluence of up to 50 J cm-2. This mode should be employed for extremely difficult and transparent samples with a high ablation threshold and especially when large spot sizes are not required since the largest achievable spot in this mode is 160 microns.

## Laser Properties Window

The "Laser Properties Window" accessible by *Settings => Laser Properties* is subtly different to other systems. Actually, the NWR193HE Laser Properties Window is very simple and simply displays: the "Laser Status", the "High Voltage" value and the "Sample Energy". Information about the Compex laser source such as version and shot counts are also accessible. Below is a screenshot of the NWR193HE Laser Properties Window.

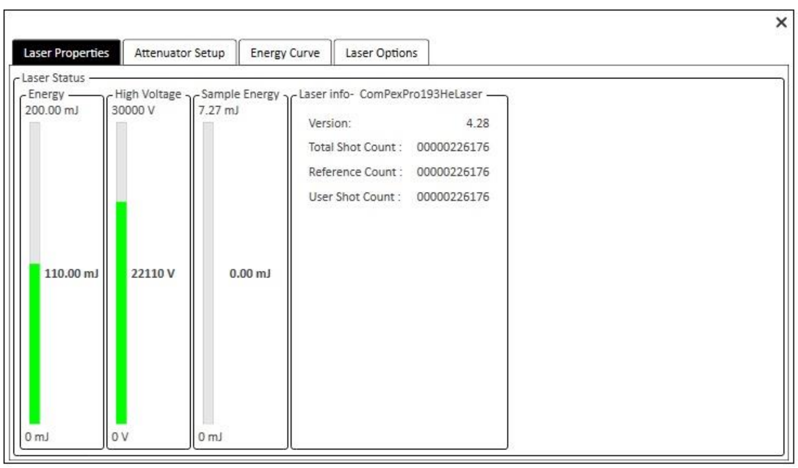



Figure 21-3 A screenshot of the NWR193HE Laser Properties Window