3DSL NDT Software Suite
MT Eagle 2.2.2

MT Eagle is a motion tracking system that unlocks a feature in the 3DSL NDT software suite that streamlines the image capture and image stitching process. By automating the process, the 3DSL NDT software suite makes scanning large surface areas faster, easier, and more reliable.

Table of Contents

1. Getting Started with MT Eagle

All the functionality for the MT Eagle system is accessed through the Auto Align Window in Seikowave Portfolio. The button for Auto Stitching opens the Auto Align Window, as described in *Figure 2.1*.
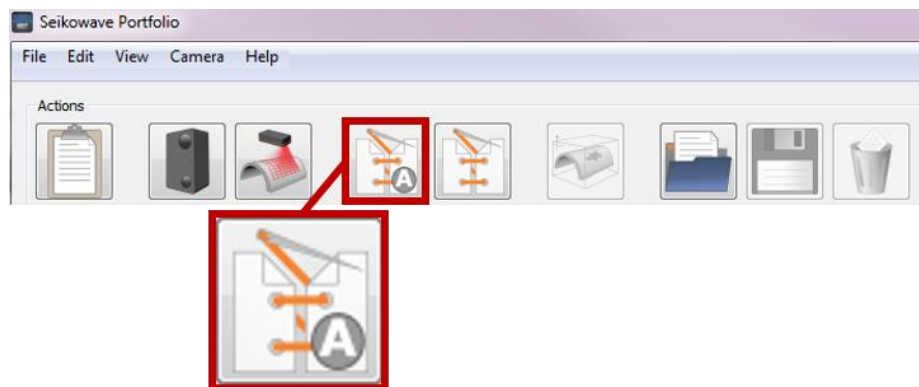
Figure 2.1: *Button for accessing the Auto Alignment Window and the features of the MT Eagle system.*

This section provides an introduction and overview of the MT Eagle system and its use for auto alignment. The process workflow for auto alignment has 4 steps as outlined in *Figure 2.2*. The following sections of this manual will guide the user through each step, while providing detailed information to assist in achieving the best performance possible.

How do we use an MT Eagle system?

Figure 2.2: *MT Eagle and Auto Alignment Process Outline*

2. The User Interface - Auto Align Window

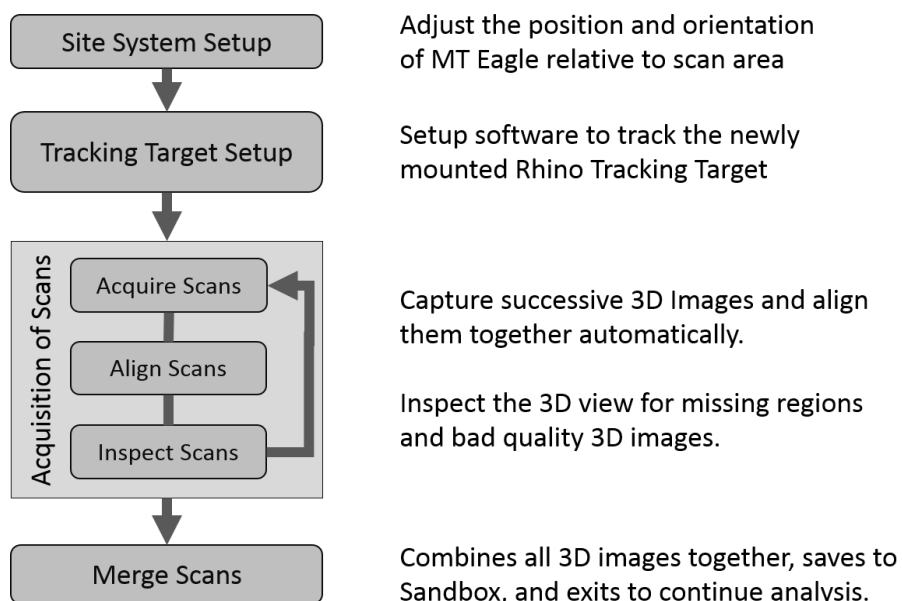All the functionality for MT Eagle is accessible from the Auto Align Window. This section presents the user interface of the Auto Align Window and all of its individual views and modes. The individual button functionality is also listed in various tables.

The default view for when the Auto Align Window is opened looks like this:
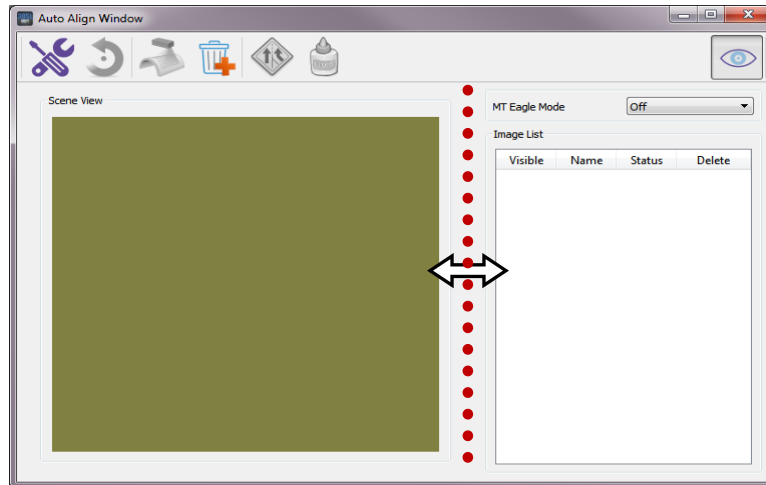
Figure 3.1: The Auto Align Window default view. The dashed red line can be moved to expand or collapse the regions on either side.

There are five main components to become familiar:

1	**Toolbar**		Holds all the buttons for performing the auto alignment process.
2	**Scene View**		This is the 3D View, where the 3D images will appear during acquisition.
3	**Image List**		This is the list of the 3D images in the Auto Align Window that contain image details discussed below.
4	**Auto Align Window Mode**		Toggles whether loading old scans or acquiring new scans. Acquiring is the Default.
5	**MT Eagle Mode**		Selects the current mode for MT Eagle. Default is Off.
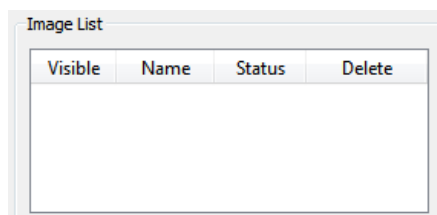
2.1 The Toolbar

The *Toolbar* is where the buttons used for setting up MT Eagle, acquiring and aligning scans, and stitching scans together are located. The *Toolbar* also helps to streamline the workflow, since when setting up the MT Eagle system and performing Auto Alignment, the buttons on the tool bar are designed to be used from left to right. Below is a picture of the toolbar in the default state.
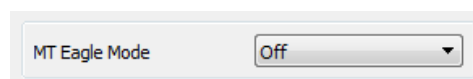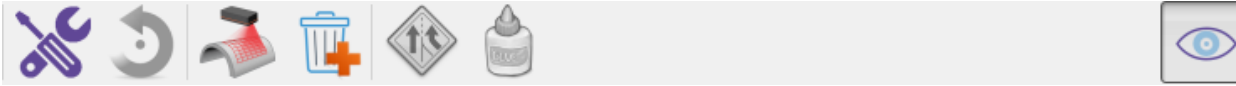

Figure 3.2 The Toolbar as it appears in the default state (Acquisition Mode).

The following table shows each button on the *Toolbar* and describes its function. Notice that the buttons are grayed out at varying stages. For example, *Process Setup Scan* is only enabled after a scan is taken in *Tracking Target Setup Mode*.

	Toggle *Tracking Target Setup Mode*	The first step of using MT Eagle is to make sure that MT Eagle and the 3D Scanner are set up together. In the Tracking Target Setup Mode, only one 3D Image can be captured at a time, and it must be an image of the CS100/Verification Target.
	Process Setup Scan	This button is enabled after a single image is captured while in Tracking Target Setup Mode. The single 3D image captured is processed to perform calculations to allow MT Eagle and the 3D Scanner to be ready for auto aligning images.
	Capture 3D Image	Same as in Seikowave Portfolio, this acquires a 3D Image and loads it into the Image List.
	Delete All Images	Removes all 3D images from the 3D Image list.
	Auto Align 3D Images	Automatically aligns all acquired images. If images cannot be aligned, the 3D Image List will display the images that cannot be aligned. Enabled after there are two or more 3D images.
	Merge and Exit	Merges aligned images into a single image. This is the final step and will end the session in the Auto Align Window. Merging also saves the merged image, and exits the MT Eagle Window. Enabled after all the scans are successfully Aligned.

Figure 3.3 List of buttons on the toolbar, the names and a brief explanation of their action.

2.2 Scene View
The *Scene View* is where all the 3D images inside the Auto Align Window are displayed.
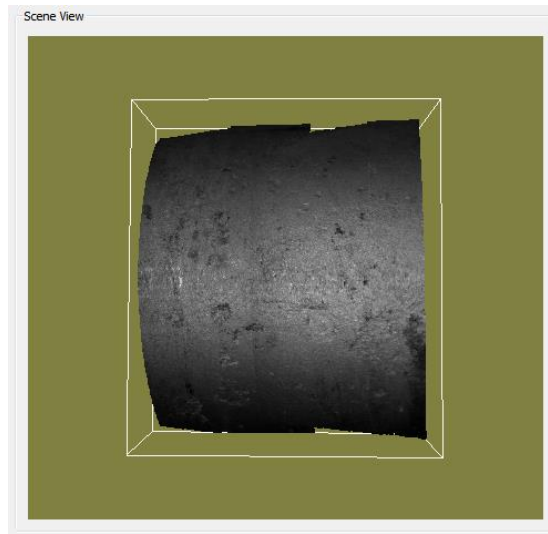

Figure 3.4 An image of the Scene View and the 3D data that it displays as scans are taken.

2.3 Image List
The *Image List* is a table that holds all of the images collected while the Auto Align Window is active with one scan per row, and displays the scan's information in the columns.

(a)   *(b)*

Figure 3.5 The Image List shows the current images that are inside the Auto Align Window. (a) shows the images prior to the Align process, and (b) shows post Align process.

The **Visible** column contains checkboxes for toggling between hiding/displaying the associated scan in the Scene View. The unique scan name is displayed in the **Name** column. The **Status** column shows whether or not scans could be aligned after clicking the *Align Button*. The ? indicates that the Align process hasn't been performed. After the Alignment is performed, a ✓ will indicate that the scan can be aligned, while a ✖ indicates that it could not be aligned to another scan. The **Delete** column contains a button for each scan to remove that specific scan from the Auto Align Window.

2.4 Auto Align Window Mode (Loading vs. Acquiring)

This mode, which is toggled by the corresponding button, selects between a live MT Eagle Acquisition mode, and a post processing mode where the scans to be aligned are loaded from Seikowave Portfolio's sandbox.

Loading Mode is used to take images from the Portfolio Sandbox (that were also previously acquired with MT Eagle) and place them in the Auto Align Window. This feature is for instances where one may want to acquire a bunch of images, but do the aligning and merging at a later date. In *Loading Mode,* the Auto Align Window changes to the view in *Figure 3.6.*
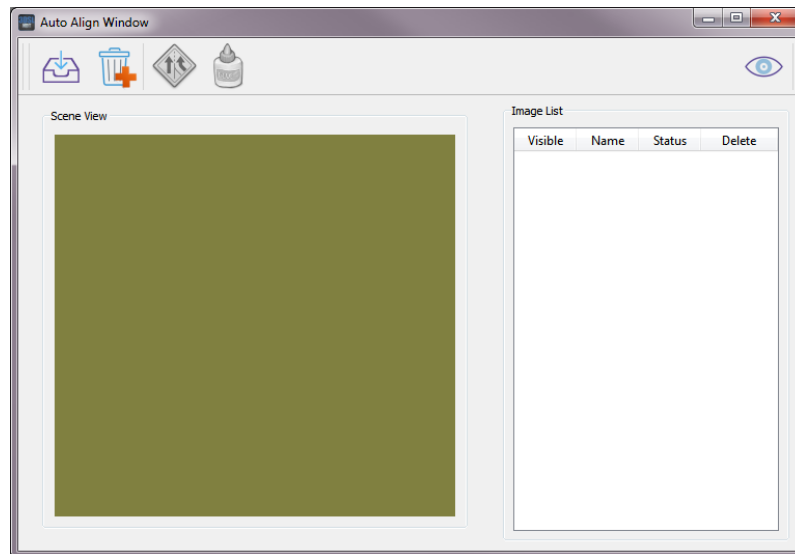
Figure 3.6 A view of the Auto Align Window in Loading Mode.

Notice that the toolbar has changed, and the MT Eagle Mode drop down list selector has been removed. In *Loading Mode,* the MT Eagle system is not functional since the scans were already acquired using the MT Eagle system.
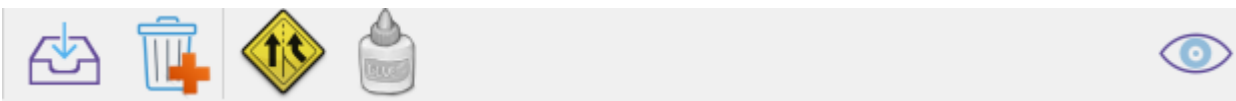
Figure 3.7 The Toolbar while in Loading Mode.

The majority of the buttons on the toolbar are the same, but the new items are:

Load Button		Takes every scan from the Portfolio Sandbox and loads them into the MT Eagle Window.
Loading/Acquisition Mode Toggle		When depressed, indicates Acquiring Mode.

2.5 MT Eagle Mode

There are several different modes that the MT Eagle system can operate in to facilitate setup, positioning, and tracking. The four modes are: Off Mode, Threshold Mode, Positioning Mode, and Tracking Mode. In the following sections, each mode will be presented with more details and an explanation of the specific User Interface Views.
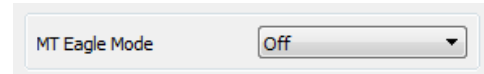

Figure 3.8 The MT Eagle Mode Selector

Mode	Description
Off	• The MT Eagle is Off.
Tracking	• The MT Eagle tracks the Targets that are selected in the corresponding Tracking View. • Live view from the 3D Scanner is displayed below the Image List with exposure control.
Positioning	• An MT Eagle setup mode that is used to "position" the system appropriately. • Live view from MT Eagle (grayscale image) • Controls for MT Eagle
Threshold	• An MT Eagle setup mode that is used to adjust the controls of the MT Eagle system for optimal tracking. • Live view from MT Eagle (with a binary black/white image) • Controls for MT Eagle

Tracking Section	
Target Tracking Indicators	The MT Eagle tracks the targets that have the reflective spheres, and depending on how many spheres are detected the tracking quality will be adjusted: • ✖ - Not Tracked • ⚠ - Partially Tracked • ✔ - Completely Tracked
High Visibility Mode Toggle	When checked, makes a color indicator appear around the Scene View. The color indicator is for tracking the Scanner Target or the Setup Target. • **Red** – Not Tracked • **Yellow** – Partially Tracked • **Green** – Completely Tracked
Tracking Error Indicators	The error indicator reports the average tracking error in millimeters over all the spheres. When the Tracking Targets are Completely Tracked, the error is reported, otherwise it indicates the tracking status.
Rhino View	Same View as in Seikowave Portfolio.
Exposure Setting	Same Control as in Seikowave Portfolio.
Use Colormap	Used for switching the Rhino View colormap from default to the colormap selected in the Portfolio Main Window.

Figure 3.9 Summary of Controls unique to Tracking Mode.

2.5.1 Tracking Mode

Tracking Mode is the mode used to perform the automatic alignment of images using the MT Eagle system. In this mode, the MT Eagle system sends tracking information to the computer for use in aligning images. To the right in *Figure 3.10*, there is an example view of the tracking mode in the Auto Align Window. The Image List is the same as before, but there are two sections that are new. The sections are a Tracking indication section, and the Rhino View, used to control the 3D Scanner. Both sections are described in *Figure 3.9.*

2.5.2 Positioning Mode

Positioning Mode is a feature that assists the user to orient MT Eagle for scanning areas of interest. The grayscale video provided in the Eagle View shows users exactly what MT Eagle sees. While in Positioning Mode, the user will do all of the physical setup of the MT Eagle system before proceeding to the next step. Positioning and Thresholding Mode share the same view, with one slight difference explained in the second part of the Threshold Mode section.

2.5.3 Threshold Mode

Threshold Mode is for ensuring that nothing in the MT Eagle view interferes with the track-ability of the tracking targets. The threshold and LED intensity settings should be adjusted until only the spheres of the tracking targets are visible in the view.

The view for both Threshold and Positioning Modes are the same. The only difference is that the Eagle View image is displayed as black and white only in the Threshold Mode, as shown in *Figure 3.11*, and in Positioning Mode the image is grayscale. The individual components of the shared components of the Threshold Mode and Positioning Mode are shown in *Figure 3.12.*
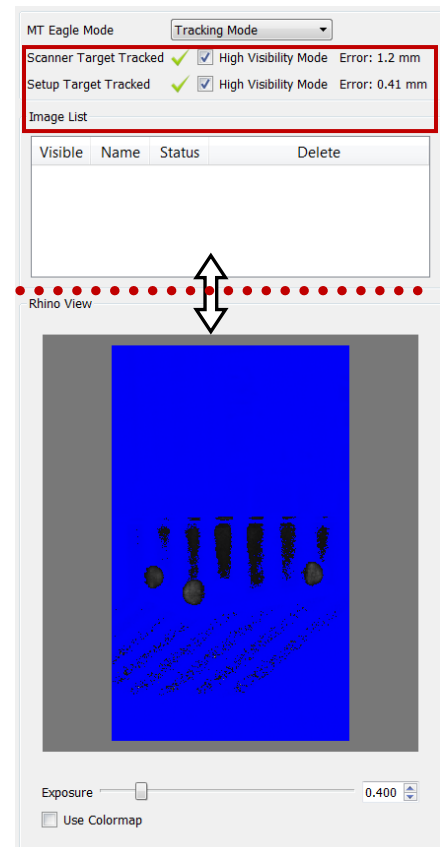
Figure 3.10 Tracking Mode View. The dashed red line can be moved, to expand the Rhino View area.

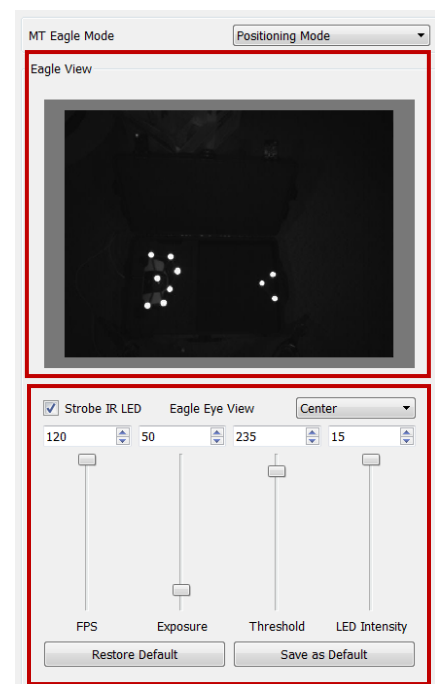(a)   (b)

Figure 3.11 Example of the difference between Positioning Mode and Threshold Mode. (a) Shows the grayscale image of Positioning Mode, while (b) shows the black and white only image (called binarized) that is used in Threshold Mode.

|	
Eagle View	Displays the grayscale video from MT Eagle cameras. Eagle Eye View selects which camera.
Strobe IR LED	This option enables the MT Eagle LEDs to be have a higher maximum brightness (enabled by default).
Eagle Eye View	Chooses which MT Eagle camera (Center, Right, or Left) to display in Eagle View
Eagle Settings	
FPS	Sets the framerate of the MT Eagle Cameras
Exposure	Sets the exposure values used by the MT Eagle Cameras
Threshold	Sets the threshold for binarizing the MT Eagle System. This is used for optimal detection of the reflective spheres on the Tracking Targets and should be set to make the Spheres the only areas of white in the image.
LED Intensity	Controls the brightness of the MT Eagle LEDs which are used to illuminate the tracking targets so that they can be accurately tracked.
Restore Default	Resets the four MT Eagle settings to their Factory Default values
Save as Default	Saves the current MT Eagle settings as the values used the next time the Auto Align Window is launched.

Figure 3.12 MT Eagle Settings - Explanation

3. Site System Setup

In order to perform automatic alignment of a selected scan area, the MT Eagle system needs to be oriented and positioned properly relative to this desired area. This section will first guide the user through the correct procedure to connect all of the MT Eagle components, and then the next section will present the recommended procedure to position and orient the MT Eagle system, with tips and tricks for optimizing the automatic performance.

A general procedure for arriving on site, would be:

1. Determine area to scan.

2. Roughly position Tripod relative to area.

3. Place Laptop next to Area

4. Mount MT Eagle on Tripod

5. Connect cable from I/O-X Box to MT Eagle system.

6. Connect USB Cable between I/O-X Box and Laptop

7. Connect Power to I/O-X Box.

8. Mount Rhino Tracking Target onto the Rhino with the provided thumb screws.

9. *Procedure Continues with Software for refinement of position.*
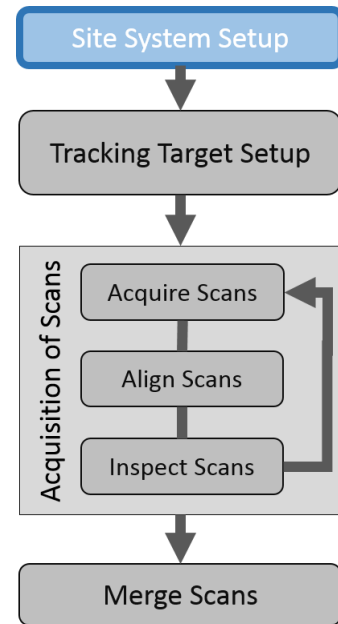
3.1 Physical Components and Making Connections

There are five (5) components that come with an MT Eagle system:

- MT Eagle System
- Power Adapter – 12V, 3A
- MT Eagle I/O-X
- USB Cable (Type-A to Type-B)
- Rhino Tracking Target

Figure 4.1 Connections for MT Eagle.

The physical setup of MT Eagle must be done prior to running any software. To start, mount MT Eagle to a tripod and make sure that it is stable. The MT Eagle I/O-X block must be connected to MT Eagle (see **Figure 4.1** for a fully connected MT Eagle).

WARNING: CONNECT POWER CABLE LAST, WHILE SETTING UP, AND DISCONNECT THE POWER CABLE FIRST WHILE PACKING THE SYSTEM UP OR THE MT EAGLE SYSTEM COULD BE DAMAGED.

3.2 MT Eagle Placement Procedure

Once MT Eagle is properly connected and secured to the tripod, the field of view (FOV) and the threshold settings can be adjusted. In *Figure 4.2,* the specific tracking region of MT Eagle is shown, which is the overlapping regions of the three separate cameras in the MT Eagle. This shows you the minimum and maximum distances that the MT Eagle system can be expected to track within.

Figure 4.2 MT Eagle Field of View for Tracking Region.

3.2.1 Mounting Tracking Target onto Rhino

To continue with the positioning of Eagle with respect to the tracking region, we will need the Rhino system and the attached Rhino Tracking Target. The Rhino Tracking Target must be securely attached to the Rhino. To do this, place the Rhino Tracking Target on top of the Rhino and use the provided thumb screws to fasten it to the plate. See *Figure 4.3* for an example of the proper orientation of the Rhino Tracking Target and where on the Rhino it is secured. Verify that the Rhino Tracking Target is securely fastened, and will not wobble around on top of Rhino before continuing.

Figure 4.3 Rhino Tracking Target mounted on Rhino.

Start the software, connect to Rhino, and open the Auto Align Window. Once opened, switch MT Eagle Mode to **Positioning Mode**. Make sure the center camera is selected in **Eagle Eye View**. Now the MT Eagle can be adjusted so that the Rhino can be tracked over the region to be scanned. Orient the MT Eagle so that it is roughly positioned such that the scan area of interest is centered in the Center view and visible from both Left and Right **Eagle Eye View**s.

After MT Eagle is roughly positioned, the threshold settings may need to be adjusted from the defaults. Place the **Rhino** in view of MT Eagle oriented in a way such that the **Rhino Tracking Target** is facing MT Eagle as in *Figure 4.4a*.

Switch **MT Eagle Mode** to **Threshold Mode** and look at the video in the **Eagle View**. If there are clearly defined white circles corresponding to the reflective markers, then proceed with the instructions. If the white circles are not clear (as shown in *Figure 4.5b*), then the Exposure slide may need to be increased slightly so that the white blobs look acceptable. If there is too much whiteness (as shown in *Figure 4.5a*), then the threshold may need to be increased and exposure decreased until the view looks acceptable.
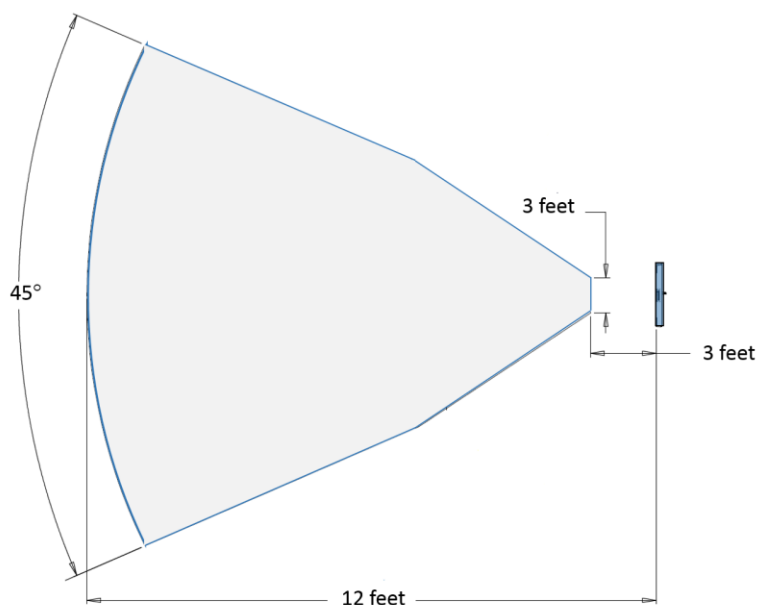
Minimum Working Distance of Eagle

(a)

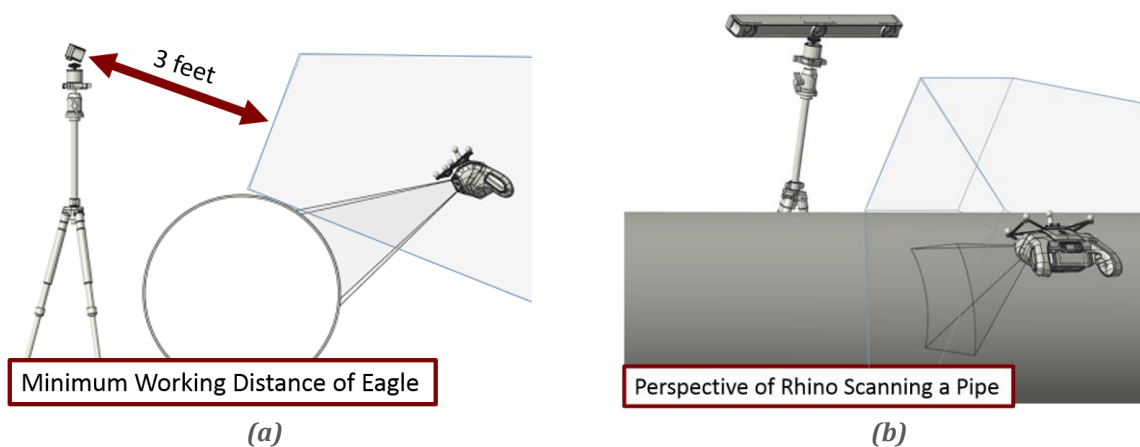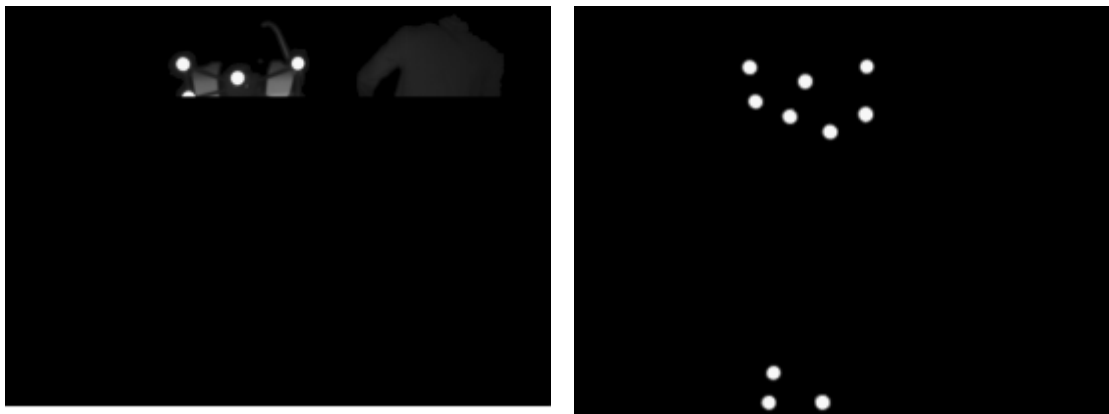Perspective of Rhino Scanning a Pipe

(b)

Figure 4.4 Common Arrangements of MT Eagle relative to a pipe, with Rhino in the tracking field of view. (a) Shows a side view with minimum tracking distance of MT Eagle. (b) Shows the perspective as a user would experience it while scanning an area of a pipe.

(a) Thresholding Mode with Improper Settings   *(b) Thresholding Mode with good settings.*

Figure 4.5 Thresholding Mode should show a black or white (binary) image, and if it looks like (a), then there is a problem with the settings. Decrease the Exposure or increase the Threshold to attempt at eliminating the regions that are not the reflective markers on the Tracking Target.

Good thresholding images show only the white circles corresponding to the locations of the reflective markers, and do not have any other white regions. The MT Eagle Settings are adjusted based upon the background of MT Eagle's view. In a pipeline ditch, the background could be sand, rock or metal brackets, and the Exposure, Threshold and LED Intensity need to be adjusted to minimize the appearance of white regions that are not the tracked spherical markers.

How does MT Eagle work?

- **LED Illumination** is infrared spectrum reflecting off spheres.
- Spheres are converted to blobs by **Threshold**ing binarization.
- Triangulation of blobs across multiple **camera images (Exposure)** form 3D points.
- Multiple 3D points form a **Tracking Target.**
- Real time identification and location of Tracking Targets yields Rhino's position.

4. Tracking Target Setup

The Tracking Target Setup is to perform calculations in the software to allow a newly mounted Rhino Tracking Target to be optimally tracked by an MT Eagle system. A newly mounted Rhino Tracking Target onto a 3DSL Rhino scanner must be setup by following the steps outlined in this section. Extra care should be taken during this setup, since it is a critical step and poor results will reduce the ease of automatic alignment in the Auto Alignment Window.

There are 4 steps in this part of the setup procedure:

1. **Positioning** - Temporarily orient the MT Eagle so that both the Rhino and the **CS100/Verification Target** are within field of view of the MT Eagle system.
2. **Track Both Targets -** Verify Tracking of both Targets (**CS100/Verification Target** and Rhino Tracking Target)
3. **Scan the Setup Tracking Target -** Take a scan of the CS100/Verification Target with good 3D imaging practices
4. **Process the scan**
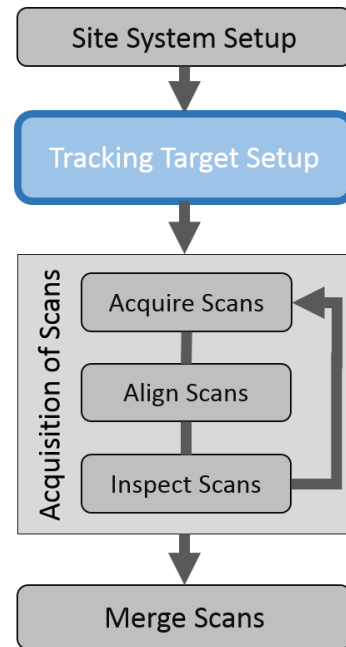
4.1 Step 1: Positioning

Once the physical setup of MT Eagle is finished and the **Rhino Tracking Target** is successfully mounted, the procedure for setting up the software can begin. It is suggested that for optimum results the Tracking Target Setup Procedure be performed by temporarily setting the system up for this setup procedure, and then repositioning everything to the area to be 3D imaged. The supplied pelican case should be used as a guide as described in *Figure 5.1.*

The Rhino with Rhino Tracking Target should be placed to the left side of the case, while the **CS100/Verification Target** be placed to the right of the case.

Both Tracking Targets should be in the field of view of MT Eagle. This can be verified by using the **Positioning** or **Threshold Modes** described in the previous section.
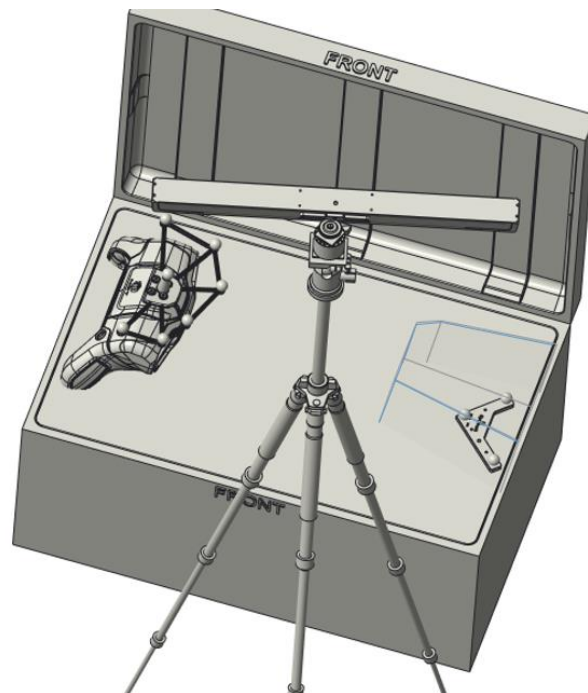
Figure 4.1 Suggested orientation to perform Setup, so that Rhino can be held still.

4.2 Step 2: Track Both Targets

Next, switch *MT Eagle Mode* to *Tracking Mode*. Click the *Setup* button as shown below in *Figure 4.2*.

Figure 4.2 Enter Setup Mode by clicking the Setup button.

Once the *Setup Mode* has been entered and providing the *CS100/Verification Target* was correctly placed and *MT Eagle* is in *Tracking Mode*, there should be a green check mark next to the *Setup Tracking Target* text and a green border should appear within the *Scene View* box around the *3D Scene* (see *Figure 4.3* below).
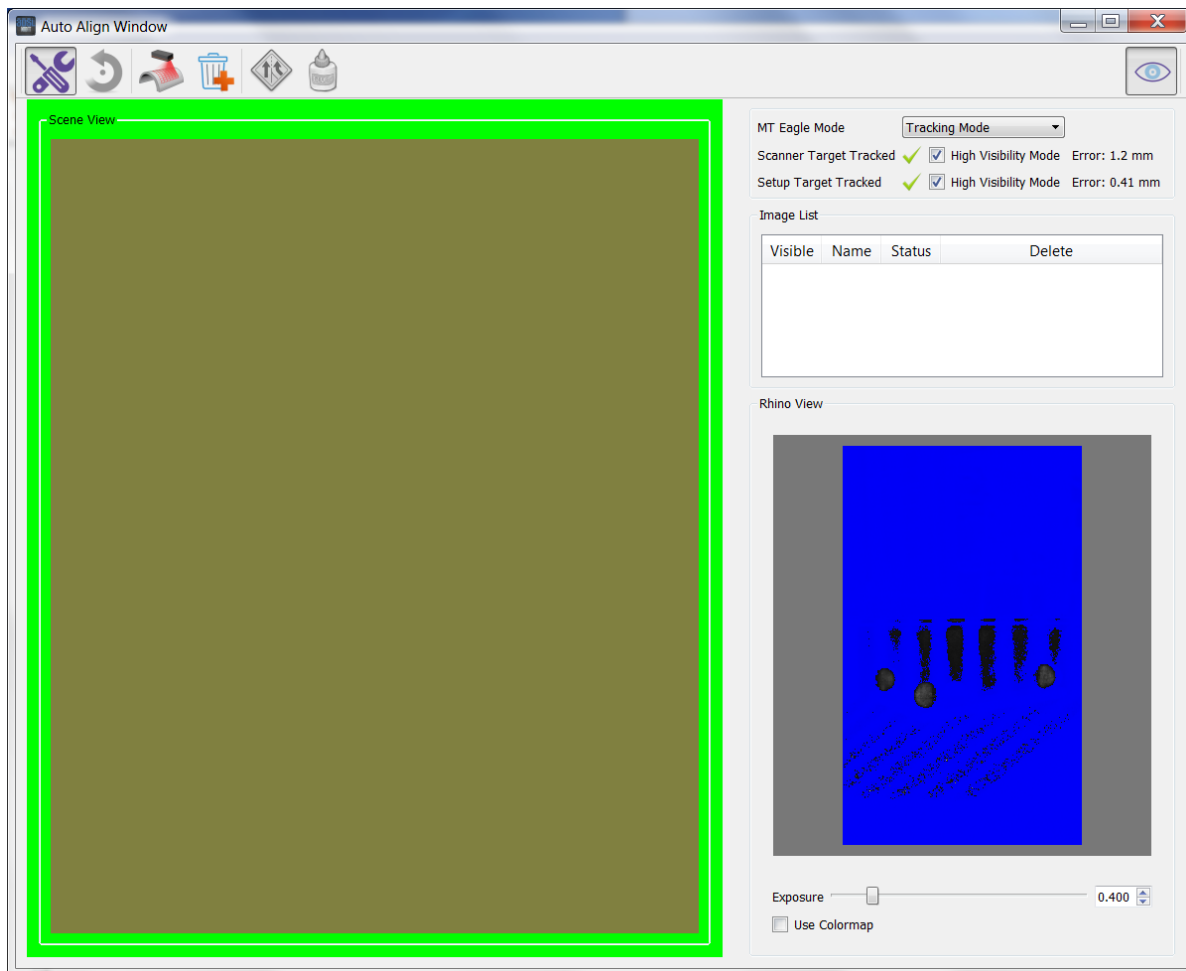

Figure 4.3 Setup Mode with Both Tracking Targets completely Tracked. As indicated by both the green checkmarks and the green high visibility border around the 3D Scene View. Also, the Rhino View shows the three reflective markers of the CS100/Verification Target.

If either Tracking Target is not tracked, switch **MT Eagle Mode** to **Positioning Mode** and verify that each camera can see each of the reflective markers. If some or all cameras can't see each reflective marker, then adjust the positions until they can and then switch back to **Tracking Mode**.

4.3 Step 3: Scan the Setup Tracking Target

Once both targets are tracked, orient the **Rhino** so that the **Rhino View** shows the three reflective markers centered in the scan area, as demonstrated in *Figure 4.3.* Use good scanning practices for setting the proper exposure values, when utilizing the Pelican as Setup platform the exposure should be approximately 0.4 milliseconds.
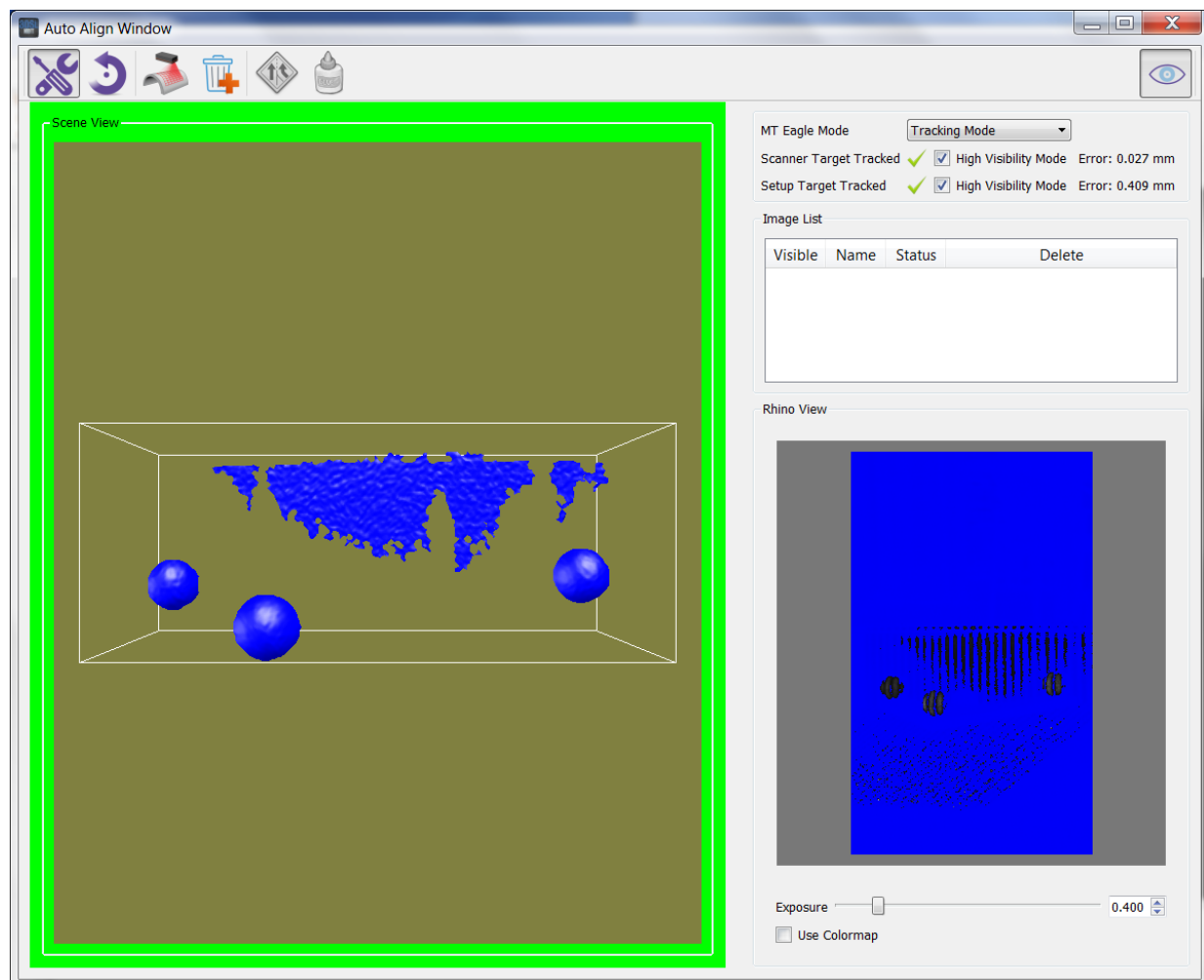
Figure 4.4 The acquired setup scan. Notice that the main features in field of view are the 3 spherical markers.

After orienting **Rhino** and setting the right exposure, take a scan. The image will appear and it should be inspected for quality. There should be three semi-spheres visible and they should look like *Figure 4.4* above if they are of a good quality. If they do not look round, then try to adjust the exposure or the position of Rhino and retake the scan. If they have holes.

4.4 Step 4: Process the Scan

Providing a good **Setup** scan was acquired, the scan can be processed. Click the **Process** button and wait for the software to finish processing the scan.

Figure 4.5 Process the Setup Scan to finalize the procedure.

If the **Setup** was successful, the software will display the message "*Updated MT Eagle System!*" in a message dialog as shown in *Figure 4.6*.
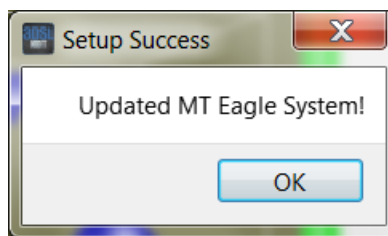

Figure 4.6 Setup completion Message Box

However, if **Setup** was unsuccessful, one of two messages will appear and the **Setup** scan will need to be retaken.

The first of these messages is *"Detected Too Few Spheres".* If this message is received, retake **Setup** scan and make sure the reflective markers are placed roughly in the center of the scan area and are completely illuminated by the projected light patterns.

The second of these messages is *"Detected Too Many Spheres".* If this message is received, retake **Setup** scan and adjust the exposure to improve the scan quality. The spherical markers are highly reflective, so the required exposure is smaller than would be expected.

If **Setup** went successfully, the **Auto Align Window** will automatically exit **Setup Mode**. It is now ready to use for auto-aligning 3D Images!
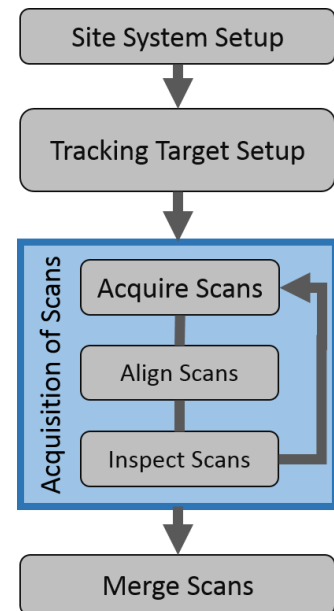
5. Acquisition of Scans

Once MT Eagle and the Auto Align Window are set up, scan acquisition may begin of the desired areas. There are some general requirements that must be followed for optimum results with automatic alignment, and there is a simple process that is easy to follow.

It is suggested that before beginning to scan an area, that a brief examination be performed to get a conceptual map of where to acquire data and to plot a course over the surface.

Rule #1: The MT Eagle system must be tracking the Rhino Tracking Target when acquiring scans, so pay close attention to the colored indicators of the UI.

Rule #2: Scans must always be overlapping with another scan for successful alignment.

As shown in Figure 6.1, it is suggested that the first scan acquired be roughly in the middle of the circumferential extent of the planned area.

The Acquisition of scans can be broken down in to the simple process:

- Acquire Scans
- Align Scans
- Inspect Scans
- Repeat

The following sections outline best practices and suggestions for each of the steps in the process.

It is important to note that this process is repeatable. The user can continuously alternate between scanning one or more images and aligning them until they are happy with the result.

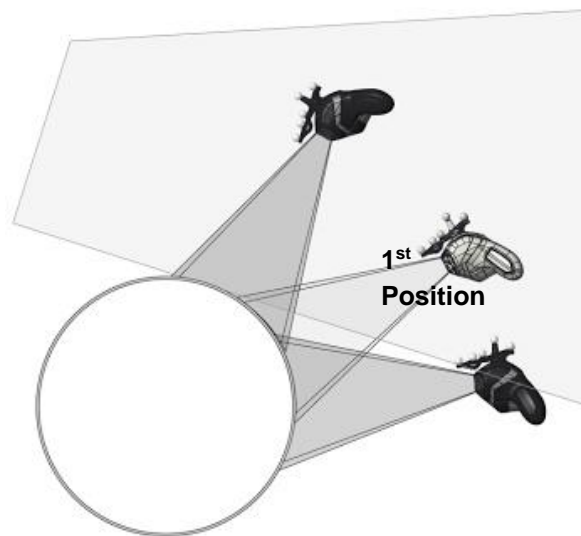**It only ends when the Merge process is performed.**

Figure 6.1 A suggestion is to take the first scan in the middle of the circumferential region that you want to scan.

5.1 Acquire Scans

This step is conceptually pretty simple; 1) make sure that the Rhino is tracked, and 2) press the scan button! But in order to achieve good results there are a few other things to keep in practice.

Good Scan Quality

As with any 3D imaging task, good scan quality is highly desired and it is important, when utilizing the Auto Align Window, to use good 3D scanning techniques with the 3DSL Rhino system.
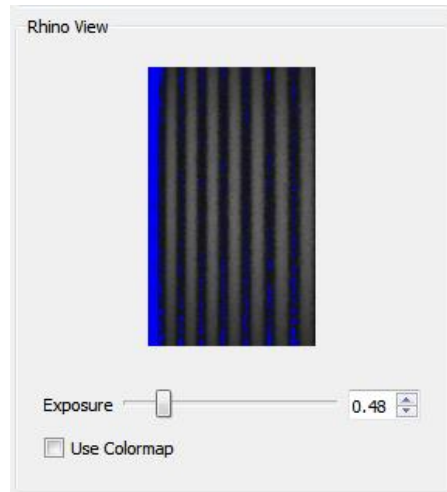
The Rhino exposure settings need to be adjusted for the scan surface. The **Rhino View** of the Auto Align Window will assist by indicating if the area is overexposed (red areas) or underexposed (blue areas). Overexposed and underexposed areas may not generate 3D data.

If a user is more comfortable or practiced with visualizing the live video to achieve good scan results by using a specific colormap, then that colormap can be used. The checkbox that says **"Use Colormap"** will change the **Rhino View** to the colormap that is set in Seikowave Portfolio preferences.

Figure 6.1 Rhino View and the difference controls that are available. Exposure Slider, and Colormap toggle.
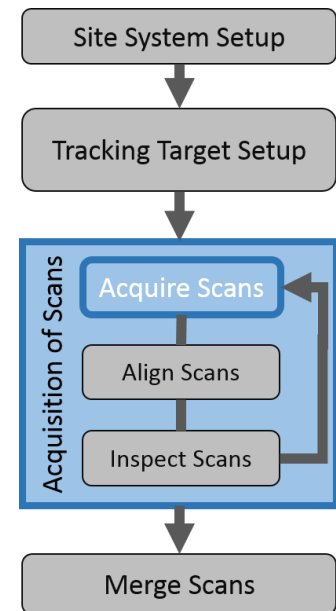
Overlap Adjacent Scans

In order to align scans, there is a certain amount of similarity between the scans that is required. The similarity is achieved by having overlap between the scan regions. The guidelines for overlapping scans are as follows:

1. Overlapping regions MUST contain the same features/defects or geometry in both scans.
2. Less geometry (ie corrosion, corners, welds, magnets) for alignment requires more overlap
3. More geometry requires less overlap.
4. Ideally 50% overlap (20% overlap minimum)
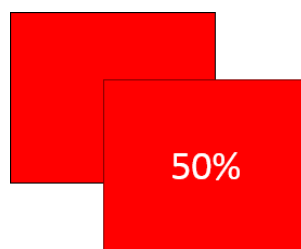
Example of 50% overlap   *Example of 20% overlap*
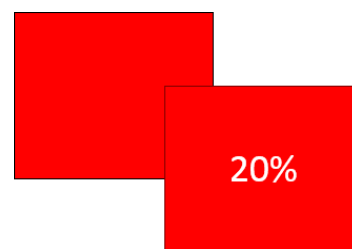
Figure 6.2 Representation of what the % overlaps would look like when placing scans on the area.

Rhino is Tracked

In order to perform automatic alignment, the 3D Scanner must be tracked by the MT Eagle system. The easiest way to determine if the Rhino scanner is tracked by MT Eagle is by enabled the high visibility mode and looking for the green border around the 3D Scene View, as shown in *Figure 6.3*.
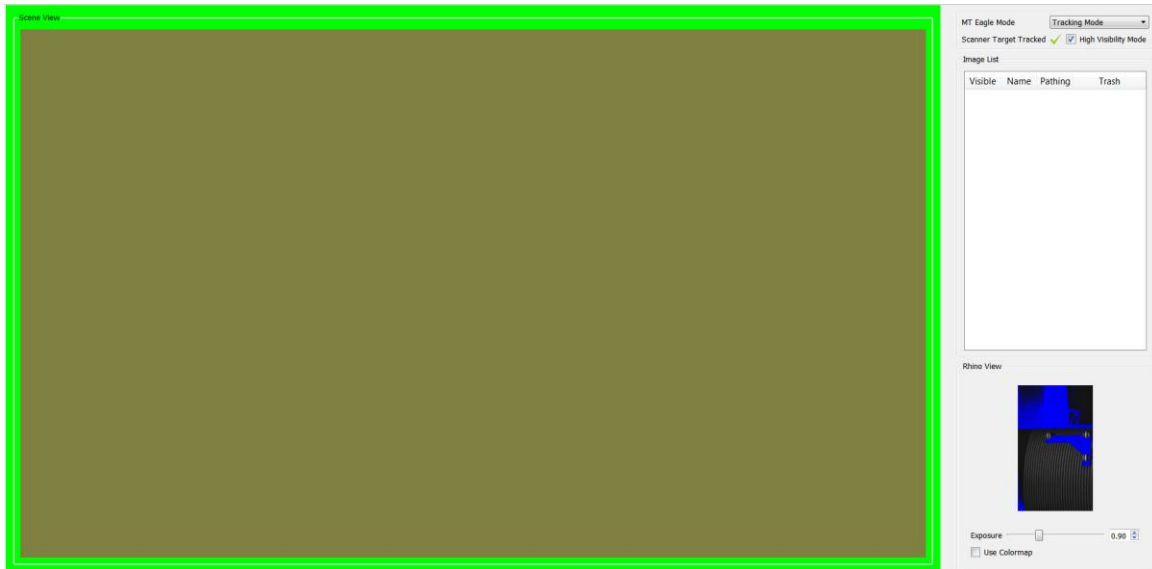

Figure 6.3 Demonstration of the green border that indicates a tracked scanner.

Scanning techniques for best results:

- Begin acquiring scans in the center of the scan area and move out from there
- Make sure that the tracking status (either the small indicator or large high visibility box) is green while acquiring each scan
- Avoid any Rhino motion while a scan is being acquired
- Avoid holding Rhino at extreme angles to the MT Eagle system

Acquired Images and Where to View them.

In addition to showing up in the *3D Scene,* each scan will appear in the *Images List* on the right side of the Auto Align Window. This list allows for toggling the visibility of each individual scan in order to check for sufficient overlap and general quality of a scan. It will also allow for the deletion of scans that are undesirable. **Warning: Scans that are still in the list but hidden will still be aligned and subsequently merged.**
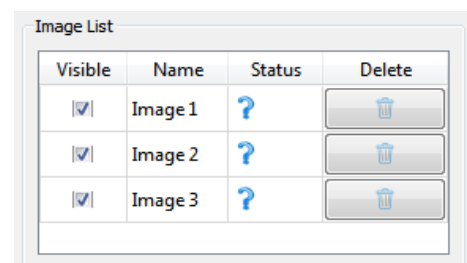

Figure 6.4 The status indicates where in the alignment process: these scans have not been aligned.

5.2 Align Scans

When ready to align two or more 3D images simply click the Align Button, and wait for the process to complete. The length of time will depend on the number of images, but the progress bar will give an indication of the progress. This step is largely just clicking the button and proceeding to the Inspection step to determine whether the auto alignment was satisfactory.

The Alignment process first performs an alignment check to determine if the images can be aligned, and if the tests pass, all the scans are aligned. The results of these tests are shown in the Status column of the Image List. An example is shown in *Figure 6.5.*
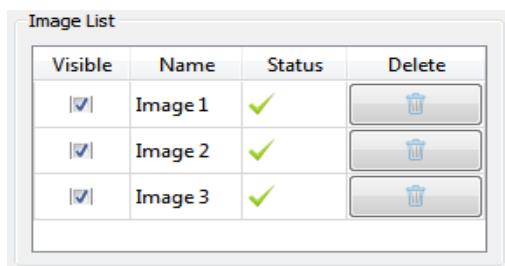
5.3 Inspect Scans

The goal of this step is to determine whether we can continue to merge the 3D data into a single scan. There are three things that must be done to verify that the Alignment and 3D data is good:

(a) Check alignment Status of individual scans
(b) Check for gaps or missed regions of the scan area.
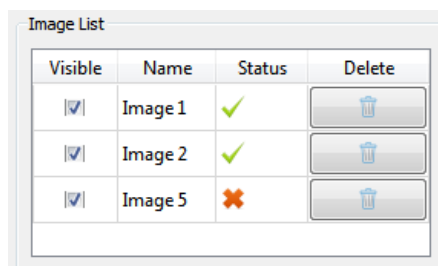(c) Confirm 3D image quality

The result of the Alignment process is shown in the Status column of the Image List. If there are all green checkmarks, then all of the individual image alignments were successful, as shown in *Figure 6.5a*. If there is an issue with the alignment check, the scans relating to the issue will have a red X in the status column of the Images List, as shown in *Figure 6.5b.* This is an indication of one or more of the following:

1) The scan was isolated, or too far from another scan. **Solution:** Take scans between the isolated scan and the others to "connect them".
2) The scan did not have sufficient overlap to its adjacent scan. **Solution**: Delete the failed scan, and retake the image, but with more overlap.

(a) All scans have been aligned   *(b) Image5 failed to find a path to an other scan*
Figure 6.5 The Status column of the Image List shows the result of the alignment operation.

Confirm that each of the images is of good quality. If an image is identified as bad, whether from overexposure, motion banding, or anything else, then simply Delete it from the Image List, and retake the image. The Align Scans step will then be repeated and the scans can be reassessed.

Advanced Problem Solving Technique: If the un-aligned 3D images look poorly aligned, then this could indicate a poorly setup Rhino Tracking Target.

6. Merge, Save, and Exit

This is the final step of the auto-align process. This involves merging all the 3D images into a single image, saving the file to disk, and exiting the *Auto Align Window*.

After the Alignment of the scans is acceptable, simply click the Merge button.

 Merge Button

Type in a File Name when prompted to do so. Clicking *Save* in the dialog will begin the Merge process and it cannot be stopped or cancelled after this point. The process can take a minute or two for large scans, a progress bar will show, and the scans in the Auto Align Window will then be combined.

The Auto Align Window will close automatically when finished merging and the merged scan with the given name will appear back in Seikowave Portfolio's sandbox to export for analysis. The merged scan with the entered filename will also be saved to the hard disk drive of the computer in the corresponding sandbox directory.

Warning: Performing the Merge operation will exit the Auto Align Window and save the combined scan into the sandbox.
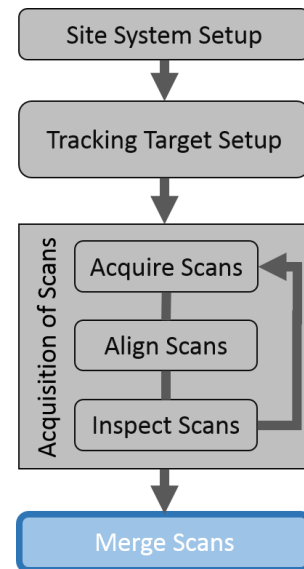
7. Glossary - MT Eagle and Auto Align Window Terms

Term	Definition
Align, Alignment, Aligning	The act of taking two or more 3D Images and moving them so that they overlap where key features, like corrosion and dents, line up
Binary Image	An image where each pixel is either solid black or solid white
Colormap	A definition of how to color an image based upon pixel value
Completely Tracked	For the given Tracking Target, every marker is tracked
CS100/Verification Target	The tracking target (see Tracking Targets) used for setting up the Auto-Align Software
Eagle Eye View	The camera from MT Eagle that has its image displayed in Eagle View
Eagle View	View where the live video from MT Eagle goes
Exposure	The duration that a digital camera's shutter is open, or more precisely how long the image sensor allows light to accumulate.
FOV	Field-of-view; what a camera can see
FPS	Frames per second
I/O-X Box	Input and Output Box used to power MT Eagle and provide Real-Time Tracking Information to connected Laptop
Image List	The detailed list of the 3D images in the Auto Align Window
Infrared (IR) LED Ring	Several infrared LEDs arranged in a circle around each MT Eagle camera
Marker	Reflective sphere used by MT Eagle for tracking the Tracking Targets
Merge	See stitching
MT Eagle Mode	Positioning, Threshold, Tracking, or Off
MT Eagle System	Motion Tracking System used for Automatically Aligning 3D Images
Not Tracked	For the given Tracking Target, less than 3 markers are tracked
Overlap	A region common to two or more 3D Images
Partially Tracked	For the given Tracking Target, more than three, but less than every marker is tracked
pixel saturation	When pixel values are maximum; usually indicates over-exposure
Positioning Mode	Mode for viewing the grayscale camera view from MT Eagle
Reflective Sphere	See Marker
Rhino	Handheld, Rugged, 3D Digital Pit Gauge

Rhino Tracking Target	The tracking target (see Tracking Targets) used for tracking a Rhino
Rigid Body	See Tracking Targets
Scene View	This is the 3D View, where the 3D images will appear during acquisition.
Stitching	The act of taking two or more 3D Images and combing them into a single image
Threshold Mode	Mode for viewing the binarized camera view from MT Eagle
Toolbar	Holds all the buttons for performing the process
Tracking	The action of MT Eagle knowing the position (in world coordinates) of a specific tracking target
Tracking Mode	Mode for providing real time position information from MT Eagle
Tracking Targets	Reflective markers rigidly fixed in a specific orientation used for MT Eagle tracking

Appendix A: Contact Information and Additional Resources

Please refer to these manufacturers for additional assistance with software products.

AVT (GigE Viewer) Support:
Refer to the manufacturer at http://www.alliedvisiontec.com/us/support.html

CloudCompare Support:
Refer to the manufacturer at http://cloudcompare.org/forum/

Webroot Support:
Refer to the manufacturer at https://www.webroot.com/us/en/business/support

3D NDT Software Suite Support:
Email: support@seikowave.com
Phone: 859-523-2491

About Us

Seikowave, Inc.

Seikowave, Inc. was founded to commercialize new technologies that can make high speed 3D measurements at reasonable costs suitable for diverse markets. Seikowave systems can acquire 3D point clouds with 350,000 points per point cloud at rates up to 1,000 point clouds per second. The key technologies are in the areas of digital signal processing, image processing, optical systems, and the interactions among these technologies.

We live in a three-dimensional world of length, width, and height. Our ability to make accurate measurements of these dimensions is critical to a wide variety of applications as diverse as measuring parts for automobiles, inspecting pipelines, inspecting coatings, inspecting welds, inspecting composite materials on aircraft, examining teeth for dental restoration, and many others.

Seikowave provides portable, ruggedized 3D imaging systems that even go 100 meters deep under water. The 3D imaging techniques pioneered by Seikowave are also used in the motion control of the robots – we give "eyes" to robots. This allows our robots to be used in applications other than inspection (for example, welding, coating application).

Seikowave uses 3D measurements to solve common problems encountered in general NDT applications. Our solutions acquire 3D data, analyze the data for defects and anomalies, and generate reports that determine the fitness for service and can help guide repair procedures if necessary. Our software tools enable characterization of infrastructure damage and determination of fitness-for-service using methods defined in API-579, ASME B31G, RSTRENG, ASME B31.8, ASME B31.4, and other guiding regulatory documents. Seikowave develops and manufactures all of the 3DSL hardware and software for these solutions.

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Seikowave has a global distribution network. Contact Seikowave to find out the distributor in your area.