



**LFM Gateway Mode
Data Preparation and
Registration Help Guide**

V 4.4.2.0

LFM Gateway Mode

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Contents	Page
1 Project Setup and Data Conversion.....	4
1.1 Workflow.....	5
1.2 Importing LAS (.las/.laz) Data.....	7
1.2.1 Earth Centred Earth Fixed (ECEF).....	8
1.2.2 Import Process.....	8
1.2.3 Metadata.....	9
1.2.4 Number of Points in the File.....	11
1.2.5 Classification of Data.....	11
1.2.6 Error Messages.....	11
1.3 Conversion Options.....	12
1.4 Importing Panoramic Photos.....	15
2 Registration Using a Full Survey.....	18
2.1 Adding the Survey.....	18
2.2 Identifying Targets.....	19
2.3 Target Accuracy.....	21
3 Registration Using a Partial/No Survey with Targets.....	24
3.1 Adding the Survey.....	24
3.2 Identifying Targets.....	25
3.3 Target Accuracy.....	27
4 Registration Using No Survey without Targets (Inter-Cloud Registration).....	30
4.1 Identifying Common Points.....	30
4.2 Visual Scan Manipulation.....	31
4.3 Completing the Registration.....	31
5 QA Reporting.....	34
5.1 Registration Status Tab.....	34
5.2 Network View.....	35
5.3 Merging Projects.....	36
6 Disclaimer.....	38
7 Trademarks.....	39
8 Copyright.....	40

1 Project Setup and Data Conversion

Data conversion is integrated in to the LFM Server Gateway Mode interface. After the scans have been added to the project the conversion seamlessly starts in the background. Scans are processed in parallel according to the amount of memory available on the machine (1 conversion per 4GB RAM). After a scan has finished converting it can be used instantly. There is no need to wait for the other scans to finish converting.

Scan formats that can be used in LFM Server Gateway Mode are listed in the following table:

Scan format
• .zfs
• .zfc
• .ptx
• .ptz
• .pts
• .fls
• .fws
• .3dd
• .rxp
• .tzf
• .rsp
• .prj
• .las (points only)
• .laz (points only)
• .dp (points only)
• .e57 (structured and unstructured)

LFM Server Gateway Mode supports the addition of colour to laser scan data in .jpg, .png or .nctri (iSTAR) formats. LFM Server Gateway Mode also supports the import of standalone panoramic pictures in .jpg and .png formats.

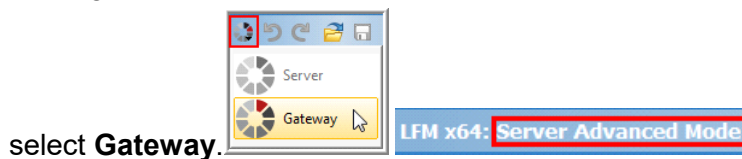
Note: For .prj files, the appropriate hardware license is required on the scanner in order to be able to import these files into third party software such as LFM Server Gateway Mode. Please contact your local Leica representative for further information.

1.1 Workflow

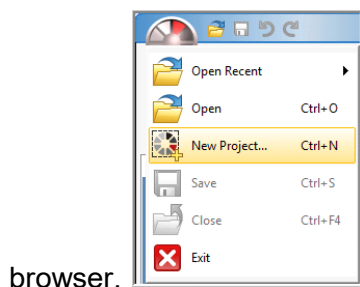
The workflow is described in the steps below:



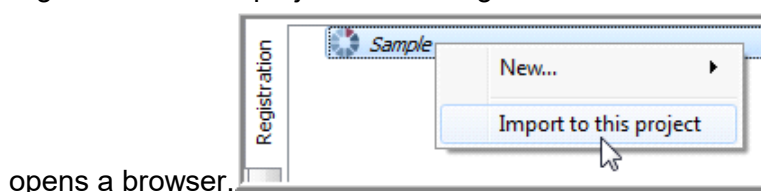
1. Start LFM Server by double clicking on the desktop shortcut.
2. After the interface has loaded, check you are in Gateway mode. The current mode will be shown at the top of the interface. If you are in Server mode, switch to Gateway mode by clicking the small LFM icon at the top left of the LFM Server interface as shown left and



3. Once in Gateway mode, click on the LFM Quick Access Menu (denoted by the large LFM logo) in the top left of the interface and select **New Project** as shown left. This will open a

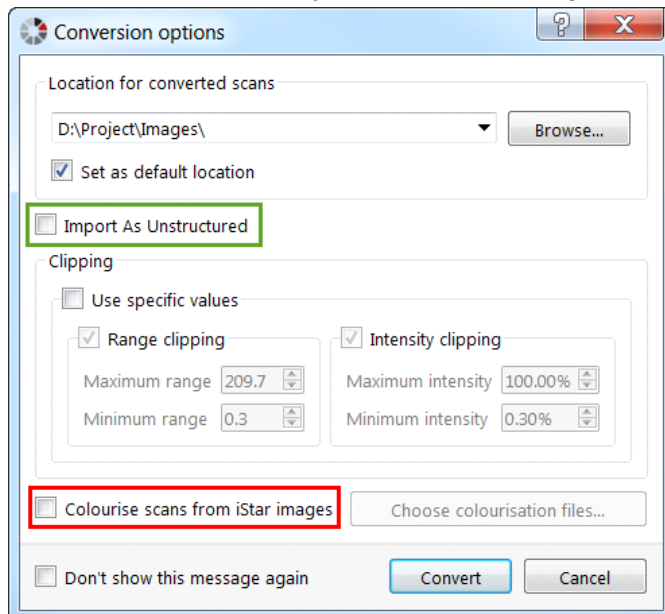


4. Specify the project location and name, then click **Save**. **Note:** For colour scans, please ensure the colour panoramic .jpg or .png files are in the same location as the source scans before proceeding with the steps below. The .jpg or .png must be named either the same as the scan itself or have “_color” at the end (e.g. Scan1.zfs and Scan1_color.jpg).
5. Right click on the project in the Registration tab and select **Import to this project**. This



6. Select the scans to be added and click **Open**.

7. Alternatively, select the scans to be added in a Windows Explorer window and drag and drop them on to the project node. This brings up the dialogue shown below:

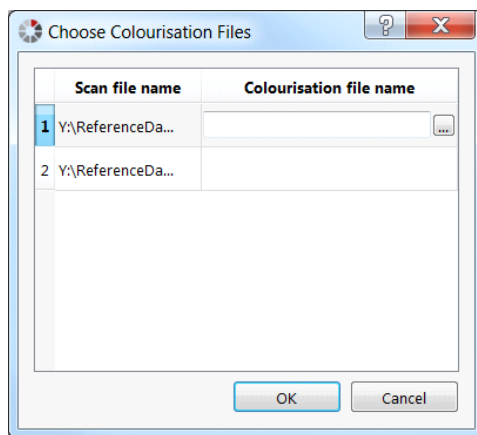


Note: If you are importing partial scans, select only the parent full scans. If the partial scans are in the same folder as the parent full scans, the partial scans are automatically imported by LFM Server.

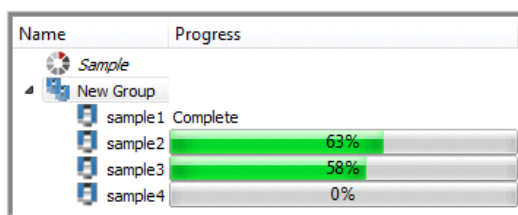
8. Select the desired destination folder for the converted scans. By default this will be the same folder as the .lfm file location.
9. If the data being imported is unstructured .ptx data, tick the **Import As Unstructured** box as highlighted left in green.

To add colour to scans from an iSTAR camera (through an .nctri file), follow the steps below:

1. Select **Colourise scans from iStar images** as highlighted in red in the image above.
2. Then click **Choose colourisation files**. The dialogue shown below appears.



3. Click on the three dots under the **Colourisation file name** field for each scan to select the corresponding .nctri file.
4. Click **OK** when done.
5. Click **Convert** on the Conversion Options dialogue after the appropriate options have been set. The scans automatically start to convert. After a scan has finished converting its status is shown as **Complete**.



Note: Ptx files should be formatted as shown below:

```
20222 X size
8623 Y size
785.884915 534.863432 43.552212 Position
-0.086158 -0.996281 0.000973 3x3 orientation
0.996280 -0.086159 -0.001912
0.001988 0.000805 0.999998
-0.086158 -0.996281 0.000973 0 Homogenous matrix of position and orientation
0.996280 -0.086159 -0.001912 0
0.001988 0.000805 0.999998 0
785.884915 534.863432 43.552212 1
0.000176 0.539844 -1.156689 0.056916 36 35 33 x,y,z, intensity(0.0 -> 1.0), r,g,b (8-bit)
0.000175 0.537848 -1.151469 0.056931 36 35 33
```

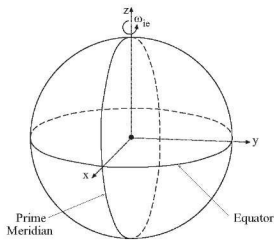
1.2 Importing LAS (.las/.laz) Data

LAS is a commonly used data format to deliver Lidar data captured using techniques such as airborne or mobile data capture systems. As these data capture mechanisms are used during the capture of large geographic areas, it is normal to capture the data in a geo-referenced form. As a result, LFM Server Gateway Mode only accepts LAS data that has been geo-referenced. This geo-referenced information can either be embedded within the LAS file as metadata or added during the import process within the LFM Server Gateway Mode interface.

As the geo-referenced data is in a specified map projection, to avoid any issues with multiple LAS scans in different projects, when the LAS data is loaded into LFM Server Gateway Mode, the data will be re-projected into an Earth Centred Earth Fixed (ECEF) Cartesian co-ordinate system.

1.2.1 Earth Centred Earth Fixed (ECEF)

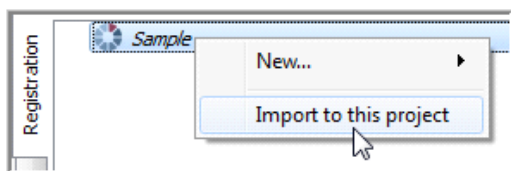
Rather than using a projection system where points in the scan data are projected onto a flat surface for the production of maps, using ECEF co-ordinates allows the data to be mapped on to a spherical body which is representative of the Earth's surface. This allows LFM Server users to seamlessly utilise multiple LAS scans within a single project or dataset.



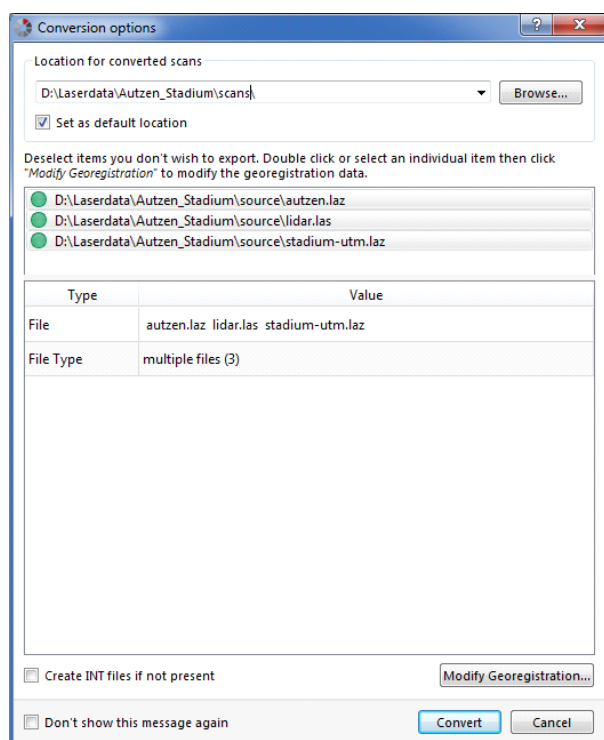
1.2.2 Import Process

The import process is as described below:

1. Right click on the project in the **Registration** tab and select **Import to this project**. This opens a browser.
2. Select the LAS files to be added and click **Open**.
3. Alternatively select the LAS files to be added in a Windows Explorer window and drag and drop them onto the project node.



Having selected the data to be imported, the Conversion Options dialog (shown below) is displayed. This allows the user to interrogate the metadata for each file and set the appropriate source projection system if needed.



Any source LAS data that is geo-referenced will have a green circle next to it. A red circle signifies that the data is not geo-referenced and it is necessary for the user to setup the geo-reference manually.

1.2.3 Metadata

Selecting one of the LAS files within the interface above will display the metadata stored within that file in the lower part of the dialog (if it is available). This metadata is optional and will be completed by the service provider that generated the data. When multiple files are selected the metadata interface will display the list of all files selected and the number of files selected. Displaying the number of files selected helps ensure the number of files in the interface is as expected, as when selecting thousands of source files it can be difficult to verify all files are selected.

Type	Value
File Name	stadium-utm
File Type	LAZ
LAS Version	1.2
Project GUID	1729464643-21321-17479-4394-1849DEF4CD7F
System Identifier	PDAL
Generat...oftware	PDAL 0.1.0
File Creation Date	198/2013
Total Points	The files reports 484781 points, contents estimate 693895
Extent Min	494367.91, 4878180.65, 126.64

One of the groups within this section of the dialog is the geo-registration information. This specifies the projection information within the metadata if specified. If the projection information is not set, then the field will be missing from the interface and it will be necessary to set this directly for the data using the Modify Georegistration button. The provider of the data will be able to supply details of the geo-registration codes to use.

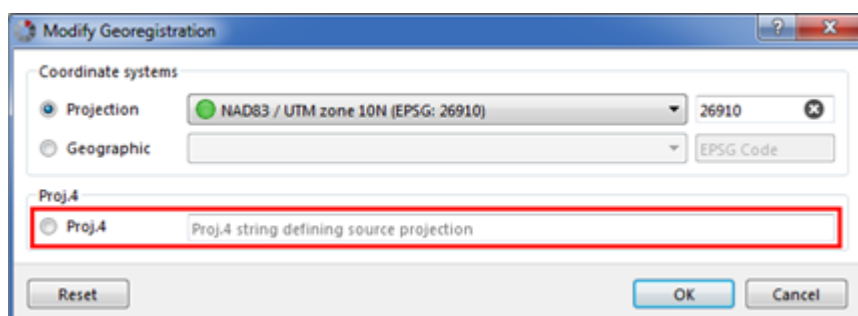
Type	Value
Georegistration	
Coordinate System	NAD_1983_HARN_Lambert_Conformal_Conic
Projection	user defined

☐ Create INT files if not present

[Modify Georegistration...](#)

Type	Value
Georegistration	
Coordinate System	NAD83 / UTM zone 10N
Projection	NAD83 / UTM zone 10N
Geographic Citation	NAD83
Horizontal Units	metre
Vertical Units	metre
Proj.4 code	+init=epsg:26910
Classification	sampled 242 points
Unclassified	71 %

The geo-registration code (to specify the projection of geographic coordinate system) is based on the IOGP's EPSG Geodetic Parameter Dataset. This is a collection of definitions of coordinate reference systems and coordinate transformations which may be global, regional, national or local in application (see <http://www.epsg.org/>). The list of EPSG codes is extensive, there are additional codes such as the ESRI spatial reference codes. Whilst these codes cannot be directly entered through the .las import interface, it is possible to enter the Proj.4 definitions for a spatial reference code. In this case select the Proj.4 toggle within the interface (highlighted below) and enter the code by hand. A good source of spatial reference codes is <http://spatialreference.org/>.



Modify Georegistration

Coordinate systems

☒ Projection NAD83 / UTM zone 10N (EPSG: 26910) 26910 ✕

☐ Geographic EPSG Code

Proj.4

☒ Proj.4 Proj.4 string defining source projection

1.2.4 Number of Points in the File

The metadata interface will display the number of points reported in the header block of the source data. It will cross reference this with an estimated calculation of the number of points in the file and any difference will be reported.

Type	Value
File Creation Date	Unable to retrieve file creation date
Total Points	20826
Extent Min	250004.36, 2762941.87, 17.64
Extent Max	250698.44, 2763581.92, 19.99

It should be noted with compressed LAZ files the estimating of the number of points can be imprecise and therefore may be different. The number of points in the file is needed to allow random access to the data for deriving data such as the classification of return points.

1.2.5 Classification of Data

LAS data points not only have a position, intensity and RGB value, they also have a classification value. When a single las file is selected in the interface and the metadata for the file is displayed, at the end of the metadata interface is a summary of the classification of the points. This table is derived by taking a random sample of points from within the file and reading classification values. There is small overhead in obtaining this information so the interface may take a second or two to update.

Classification	sampled 500 points
Unclassified	19%
Ground	43%
Transmission Tower	10%
Wire Structure Connector	27%

1.2.6 Error Messages

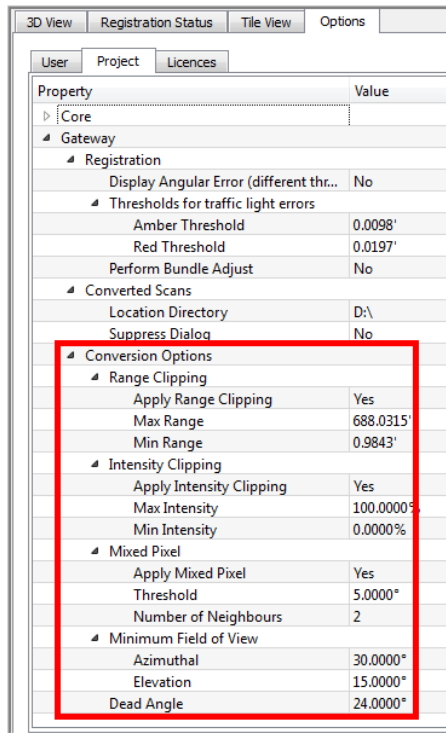
In the unlikely event there is an issue reading the LAS data, this will be reported in the metadata interface.

Type	Value
File Name	000057
Message	Invalid LAS format data, contact data provider.

1.3 Conversion Options

Project conversion options can be set in **Options > Project** as shown below.

These are global preferences and will be applied to all scans added to the project.



Range Clipping

To aid the modelling and viewing process, data which is considered too near or too far away to be of interest can be clipped using the near and far range clipping. Points that have been clipped in this way are not displayed at all in the 3D window. The near and far clipping values can be adjusted directly by double clicking on the desired option and typing a new value into the appropriate text-fields or clicking on the up and down arrows.

The minimum and maximum range values will be set to the optimum values relative to the scanner type.

Intensity Clipping

To aid the modelling and viewing process, it is possible to clip intensity data which are considered too bright or too dull to be of interest. Points that have been clipped in this way are not displayed at all in the 3D window. The near and far clipping values can be adjusted directly by double clicking on the desired option and typing a new value into the appropriate text-fields or clicking on the up and down arrows.

The minimum and maximum intensity values will be set to the optimum values relative to the scanner type.

Mask Pixels

This function is designed to significantly reduce the splatter, or spray effect which arises when the laser scanner's beam switches from one object to another. It is able to locate lone pixels or pixels which have too few neighbours. All non-boundary pixels have eight surrounding neighbours and so, in normal circumstances, a pixel would expect to find its nearest neighbours at similar ranges. Those pixels at different ranges are flagged as being mixed pixels and are then masked out of the image.

The options are as follows; note that the defaults are generally optimal. To change, double click on the desired option and type the new value into the appropriate text-fields or click on the up and down arrows.

- Number of Neighbours (ranges from 1-8) - This value sets a threshold for required neighbouring points; if the threshold value is not reached, a pixel is deemed noisy and masked out.

Recommended Value = 2

- Threshold (degrees) - As an image is scanned by the algorithm, each pixel in turn becomes the centre pixel with eight neighbours. Eight lines are then formed from the centre pixel to its neighbours. Another line - the view line - is formed by drawing a line between the centre pixel and the origin. The Rejection Angle is the angle formed between the view line and each of the eight pixel lines.

Recommended value = 5°

Data masked out by this function will not be visible in 3D Modelling Windows, but will be coloured green in 2D Image Windows. The effect of the mask mixed pixels function is entirely reversible by modifying the conversion options and reconvert the scans. (In common with all these data points functions, the data is never actually deleted or modified, but is simply masked out and so easily restored.)

Minimum Field of View

The minimum azimuthal and elevation required for a scan to be processed. Scans not fitting this criteria will not be processed. This is often useful for bundled ptx scans which contain very small partials that are not of much value in isolation.

Dead Angle

This allows the user to change the dead region cut-off zone in the base of the scan. The default settings remove the points in the area directly underneath the scanner, where the scanner may see its own tripod etc. This may be adjusted if a slightly higher viewing angle is required. To change, double click on the desired option and type the new value into the appropriate text-fields or click on the up and down arrows.

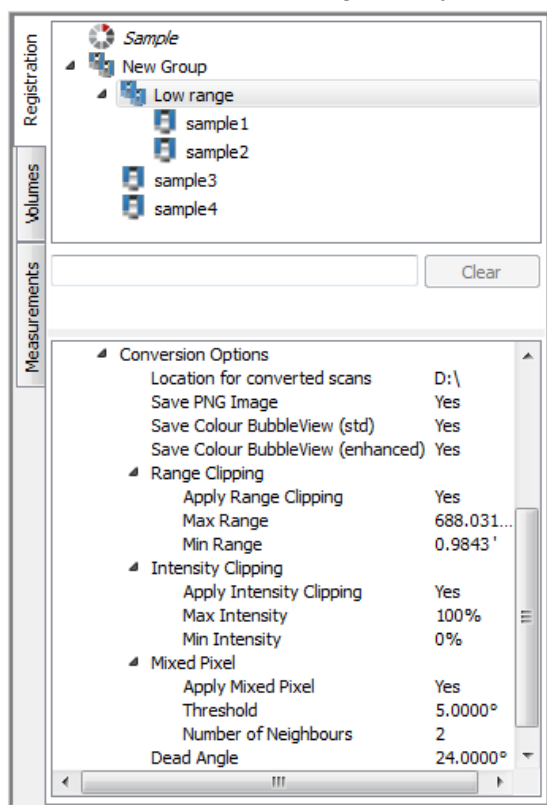
Individual Scan Settings

On review of the converted scans, several individual scans may require different conversion settings, for example a longer range setting.

To do this:

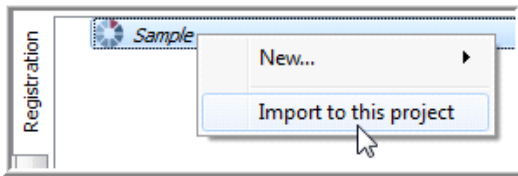
1. Create a new group by right clicking on the project within the **Registration** tab and select the **New > Register** Group.
2. Rename the group by right clicking on the group and selecting **Rename**.
3. Type in the desired name and press **Enter**.

The group conversion options can be edited at the bottom of the properties window as shown below. Scans can be added to a group by left mouse clicking and dragging the scans onto the group node.



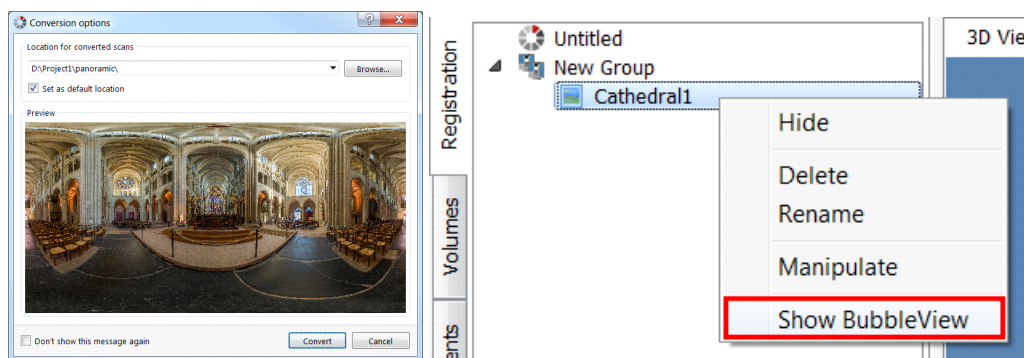
1.4 Importing Panoramic Photos

LFM Server Gateway Mode supports the import of panoramic photos in .jpg, .png or iSTAR (.nctri) formats.



To import panoramic photos:

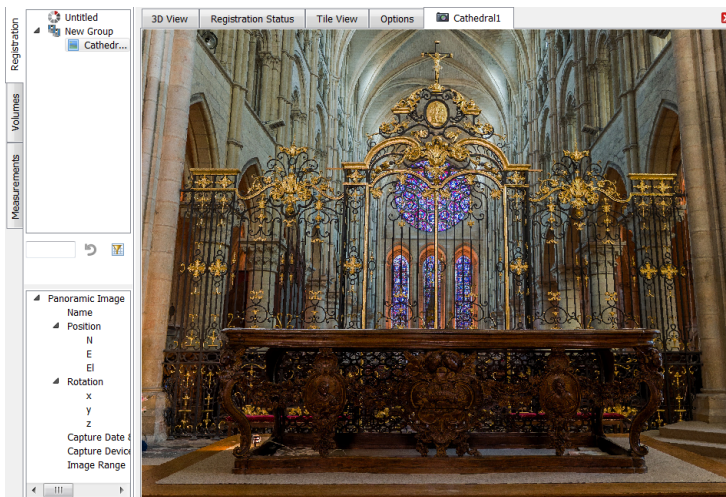
1. Right click on the project in the **Registration** tab and select **Import to this project**. This opens a browser.
2. Select the panoramic photos to be added and click **Open**.
3. Alternatively, select the panoramic photos to be added in a Windows Explorer window and drag and drop them on to the project node. The window shown left appears.
4. Click the **Browse** button and select the location for the output files then click **Select Folder**. A preview of the panoramic photo will be shown in the lower part of the dialog.
5. Click **Convert** to begin the import process.



Once the import process has completed the panoramic photo will be available in the Registration tab. It will also be represented in the 3D view by a 3D shape. The .jpg and .png files are represented by a sphere, .nctri files are represented by an iSTAR camera shaped object.

To view the panoramic photo follow the steps below:

1. Right click on the name and select **Show BubbleView**.
2. Alternatively, you can simply drag and drop the panoramic photo node from the Registration tab into the 3D view to load the panoramic photo OR You can right click on the panoramic photo representation in the 3D view and select **Show BubbleView**. The panoramic photo will be displayed as shown below.
3. Left click and drag to move the view around and use the mouse wheel to zoom in and out, just like a BubbleView. As there is no 3D scan data linked to a panoramic photo, functionality is limited to viewing only.



Panoramic photos are positioned at 0,0,0 by default. However, they can be repositioned by either entering coordinates or by visually positioning them in the 3D window.

Entering Coordinates

To change the position of a panoramic photo by entering coordinates, follow the steps below:

1. Select the panoramic photo to be positioned in the Registration tab.
2. In the bottom of the Registration tab you will see the Attributes Window which will display information about the panoramic photo, including the position.

To edit the position, follow the steps below:

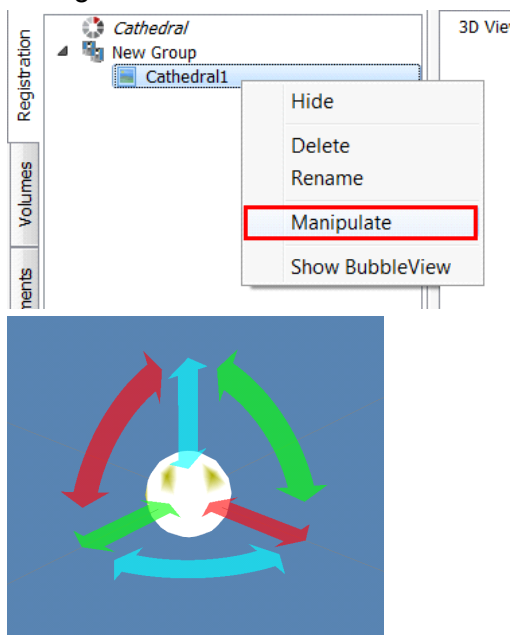
1. First select the relevant x/y/z field with a left mouse click, and then double click to make the field editable.
2. Enter the desired coordinate and press **Enter**.
3. Repeat this for the other positional fields.

Visually Positioning

To change the position of a panoramic photo by visually positioning it, follow the steps below:

1. Right click on the panoramic photo in the Registration tab and select **Manipulate**.
2. In the 3D window the panoramic photo 3D representation will be shown with a red/green/blue coordinate frame around it.
3. Left click and drag the relevant arrows to move the panoramic photo to the appropriate position.
4. Right click on one of the arrows to accept the new position or press **Escape** to cancel the manipulation and return the item to its original position.

Any panoramic photos present in the project at the point of dataset (.lfd) generation will be carried through to the LFM Server dataset for viewing by engineering users.

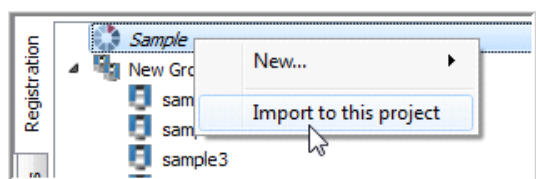


2 Registration Using a Full Survey

2.1 Adding the Survey

To add the survey, follow the step below:

1. Right clicking on the project node in the Registration tab and select **Import to this project**. This will bring up a browser.
2. Select the survey file to be added and click **Open**.



The supported survey formats are .crd and .k.

These are effectively composite files, comprising consolidated data from all field survey stations. Users may adapt unsupported formats to comply with the standard LFM files, please review the examples listed below.

Sample format of a .crd (coordinate) file.

T001	0.000	0.000	0.000
T002	13.000	11.000	16.000
T003	11.250	10.019	32.233
T004	19.845	96.100	34.892
T005	67.228	56.872	34.766

Target name, X, Y & Z stored in metres.

Note: File can be space or tab delimited

Sample format of a K (Kramer) file.

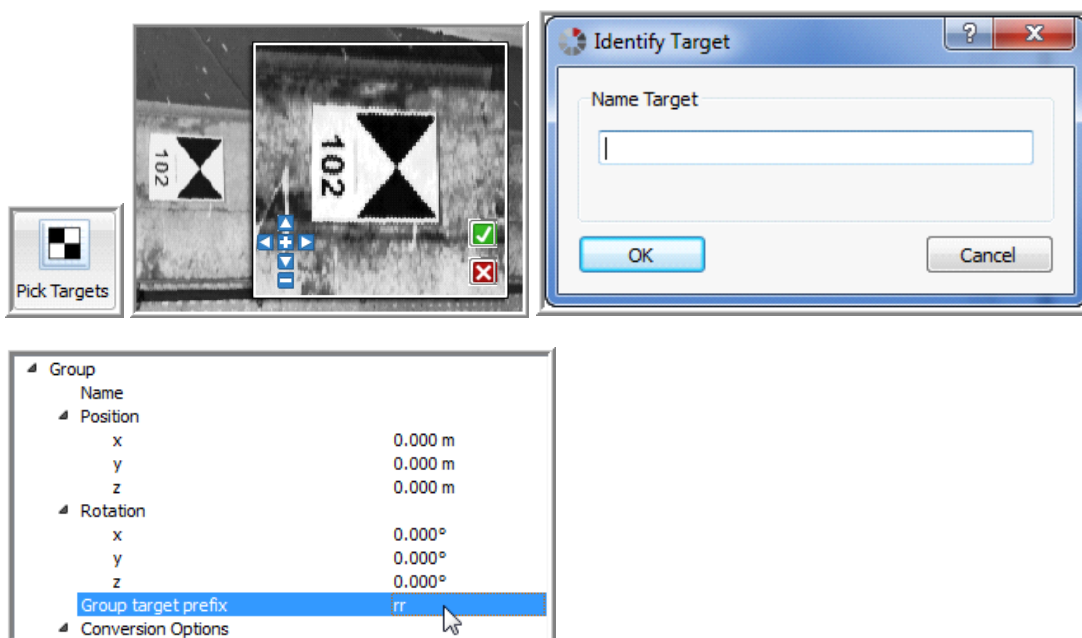
T001	7	0.000	0.000	0.000
T002	7	13.000	11.000	16.000
T003	7	11.250	10.019	32.233
T004	7	19.845	96.100	34.892
T005	7	67.228	56.872	34.766

Note: There should be six blank lines at the top of the file. The first figures should be the target identifier, the second column should contain a figure seven (LFM will ignore), with the remaining X – Y – Z readings. (Easting, Northing & Elevation) All numbers recorded will be interpreted as metres. This is to copy the format of the Kramer survey adjustment package.

2.2 Identifying Targets

To identify targets, follow the steps described below:

1. After the survey has been added, right click on the scan to be registered and select **Show** OR alternatively drag and drop the scan node into the 3D window. The BubbleView will load for the selected scan and the Tools toolbar will become available at the top of the interface.
2. Navigate round the BubbleView to the first target to be picked. Click the **Pick Targets** button from the Tools toolbar and select the target centre with a left mouse click. This will bring up a small magnified target identification area where the target centre can be picked by a left mouse click.
3. Toggle between checkerboard, spherical or free pick target types by rolling the mouse wheel.
4. Alternatively, targets can also be picked in the 3D window. This is useful for registering mobile scan data (such as .pts or .dp) which will not produce a BubbleView.
5. Load the 3D points belonging to a scan by right clicking on the scan and selecting **Load Points**.
6. Navigate to the target to be picked and click the **Pick Targets** button from the Tools toolbar (shown above) and select the target centre with a left mouse click.
7. After picking the target centre the Identify Target window will appear. Type in the name of the target and click **OK**.



Note: The target name should exactly match the survey, for example if the target in the survey is referred to as *rr127, the name entered must be *rr127. Note also that this is case sensitive.

The user may apply a group target prefix if all targets have the same prefix.

To do this, follow the steps below:

1. Select the appropriate group and fill in the Group Target Prefix option in the attributes window as shown left. This automatically enters the specified prefix in the Identify Target window when selecting targets. Identified targets appear as yellow crosses in the BubbleView and as black target icons under the scan node in the Registration tab. If the target number entered cannot be found in the survey, a red exclamation mark is shown over the black target icon in the Registration tab.
2. Repeat this process for other targets visible in the scan.

Target Predication

Once two targets have been identified, other targets in the scan will begin to appear via the target prediction system. These will appear as green crosses in the BubbleView window and green target icons under the scan node in the Registration tab.

Select a predicted target by double clicking on it under the scan node in the Registration tab. This will centre the BubbleView window and target identification zoom window on the predicted target.

Note: Targets are sorted by ascending range so it is often best to start with the target at the top of the list.

There are four options at this stage:

- Left mouse click on the centre of the target to change the position and name of the predicted target and move on to the next prediction.
- Right mouse click on the centre of the target to change the position only. This will accept the predicted target name and move on to the next prediction.
- Click the tick button (shown below) in the target identification zoom window. This will accept both the position and name of the predicted target and move on to the next prediction. The “Y” button on the keyboard will also perform the same function.
- Click the cross button (shown below) in the target identification zoom window. This will not accept the predicted target and move on to the next prediction. This is used when the target cannot actually be seen (e.g. if it is on the other side of a wall or if it is too far away). The “N” button on the keyboard will also perform the same function.



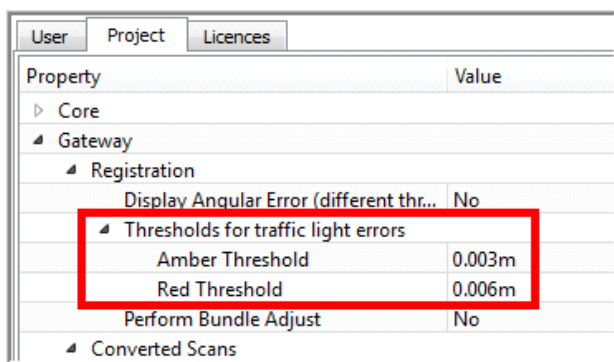
Note: If a picked target has a negative effect on the scan registration (i.e. by causing a traffic light to turn red) then the target zoom window will remain on that target and will not proceed to the next prediction. This is an alert to the user that the accuracy of the registration has been compromised and the user should look to address the error before moving on.

2.3 Target Accuracy

Once a target is registered, feedback on the accuracy will be displayed at the side of the target in the Registration tab. This feedback takes the form of two traffic light icons. This is a rapid way of interpreting registration accuracy. The coloured icons allow the user to visually 'skim' through the results, focusing quickly on the targets causing concern. These will appear as amber or red in the components browser.

The left icon (diamond shape) refers to the inter distance between the selected target and its neighbours within the scan. These inter distances are compared against the corresponding inter distances in the survey.

The right icon (circle shape) refers to the distance between the picked target in the scan and the corresponding target position in the survey post registration. Generally there should be more than 5 target correspondences in every scan to ensure accurate registration.



The traffic lights will be red, amber or green. The thresholds for these colours can be changed in the **Options > Project** tab.

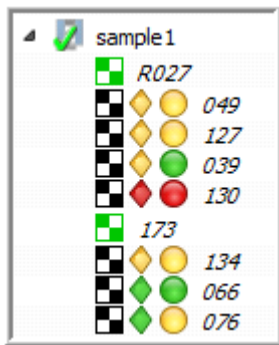
Anything between 0 and the amber threshold will be green. Anything between the amber threshold and the red threshold will be amber. Anything above the red, threshold will be red.

The recommended values are amber = 0.003m and red = 0.006m. If the threshold is altered during registration, an automatic update of target accuracy is carried out respective to the new settings.

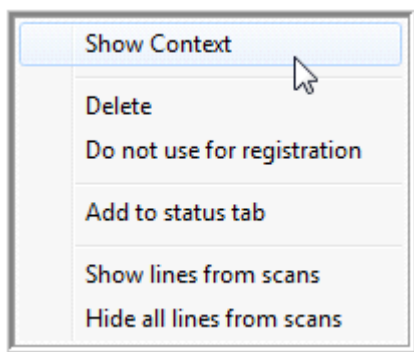
As soon as two targets have been selected within a scan, provided a survey is attached to model, the system will show the accuracy of the target fitting. As this process is on-going as targets are selected, poorly fitted targets will be highlighted instantly, allowing an immediate refit. This saves a great deal of time later on identifying rouge targets. Numerical error readings are provided in the Attributes window for confirmation.

Improving the Accuracy of Poorly Fitting Targets

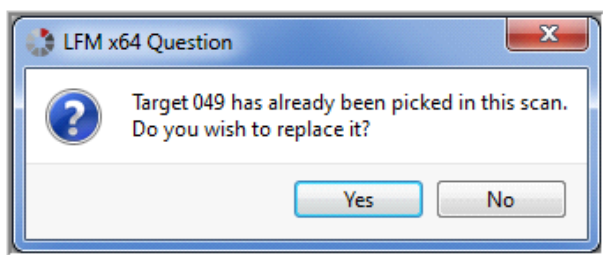
The example shown below demonstrates poor accuracy on target 130:



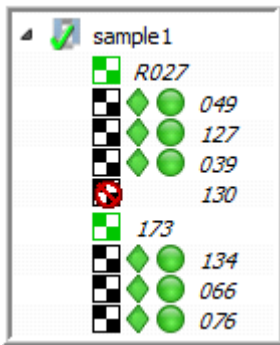
Inaccurately fitted targets such as this can be reviewed by right clicking on the target in the Registration tab and selecting **Show Context**. This will show the graphical representation of the pick against the 3D point cloud.



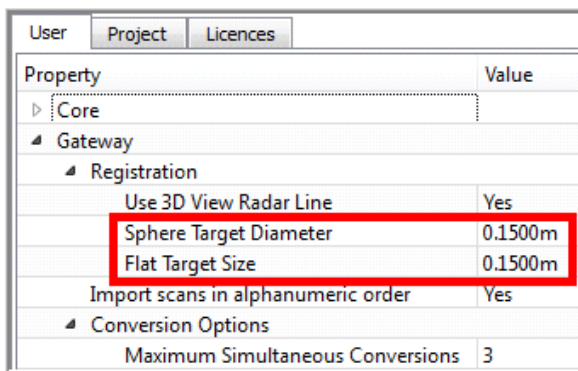
Targets can be re-picked by clicking on the centre of the target in the target identification window within the BubbleView, entering the target name and clicking **OK**. This will present a warning as shown left that the target has already been picked. Click **Yes** to accept or **No** to cancel.



The image shown below demonstrates the scan registration after the Do not use for Registration feature has been applied to target 130. The registration of the scan is now good. This feature can be removed if necessary by right click again on the target and selecting **Use for Registration**.



Once the registration is complete you can then move on to the next scan. This should be repeated for all scans in the project.



Note: Target sizes can be changed in the **Options > User** tab as shown left.

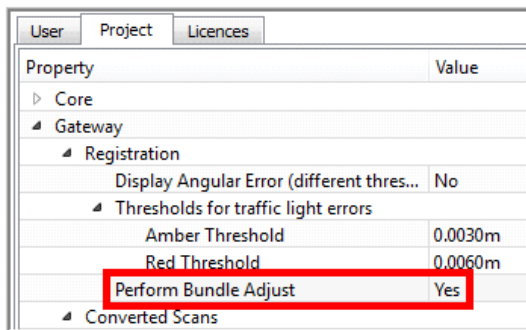
Once the Registration is complete it is good practice to update the scan headers. This will store the position, rotation and targets in the .zfc file itself rather than just the project file. This means that registered scans can be added to another project still in the correct position. This is also useful for service providers delivering to users using LFM Modeller or AVEVA Laser Modeller.

To update the scan headers, right click on the group and select **Scan Headers > Update Scan Headers**.

3 Registration Using a Partial/No Survey with Targets

If site access is limited there may only be a partial survey or no survey at all. If targets have been placed in the scanned scene, these can be registered using a process called Bundle Adjustment. If a partial survey is used, the scans will be registered to the site coordinates as specified in the partial survey. If no survey is used, the scans will be registered locally.

Bundle adjustment is an iterative process which calculates the mean position of a target from each target pick over multiple scans.

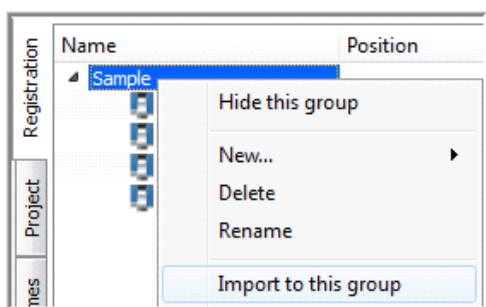


Before starting registration using Bundle Adjustment, please ensure the **Perform Bundle Adjust** option in the **Options > Project** tab is set to **Yes** as shown left.

3.1 Adding the Survey

If a partial survey is available, add the survey by following the steps below:

1. Right click the project node in the Registration tab and select Import to this group. This will bring up a browser.
2. Select the survey file to be added and click Open.



Supported survey formats are .crd and .k.

These are effectively composite files, comprising consolidated data from all field survey stations.

Users may adapt unsupported formats to comply with the standard LFM files, please review the examples listed below.

Sample format of a .crd (coordinate) file.

T001	0.000	0.000	0.000
T002	13.000	11.000	16.000
T003	11.250	10.019	32.233
T004	19.845	96.100	34.892
T005	67.228	56.872	34.766

Target name, X, Y & Z stored in metres.

Note: File can be space or tab delimited.

Sample format of a K (Kramer) file.

T001	7	0.000	0.000	0.000
T002	7	13.000	11.000	16.000
T003	7	11.250	10.019	32.233
T004	7	19.845	96.100	34.892
T005	7	67.228	56.872	34.766

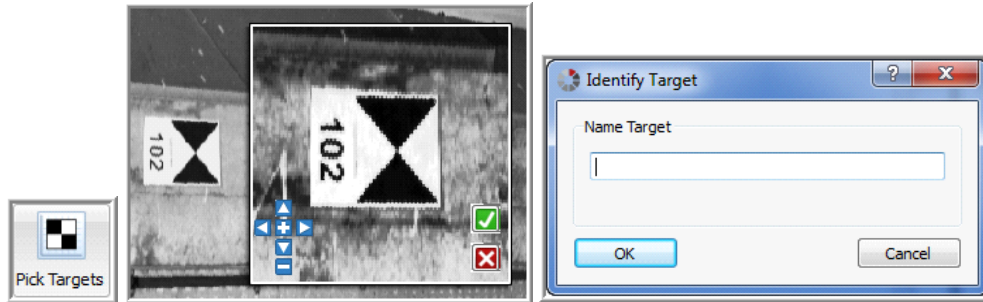
Note: There should be six blank lines at the top of the file. The first figures should be the target identifier, the second column should contain a figure seven (LFM will ignore), with the remaining X – Y – Z readings. (Easting, Northing & Elevation) All numbers recorded will be interpreted as metres. This is to copy the format of the Kramer survey adjustment package.

3.2 Identifying Targets

To identify targets, follow the steps below:

1. Once the survey has been added, right click on the scan to be registered and select **Show** or alternatively drag and drop the scan node into the 3D window. The BubbleView will load for the selected scan and the Tools toolbar will become available at the top of the interface.
2. Navigate round the BubbleView to the first target to be picked. Click the **Pick Targets** button from the Tools toolbar and select the target centre with a left mouse click. This will bring up a small magnified target identification area where the target centre can be picked by a left mouse click.
3. Toggle between checkerboard, spherical or free pick target types by rolling the mouse wheel.
4. Alternatively, targets can also be picked in the 3D window. This is useful for registering mobile scan data (such as .pts or .dp) which will not produce a BubbleView.
5. Load the 3D points belonging to a scan by right clicking on the scan and selecting **Load Points**.

6. Navigate to the target to be picked and click the **Pick Targets** button from the Tools toolbar (shown above) and select the target centre with a left mouse click.
7. After picking the target centre the Identify Target window will appear. Type in the name of the target and click **OK**. Identified targets will appear as yellow crosses in the BubbleView and as black target icons under the scan node in the Registration tab.
8. Repeat this process for other targets visible in the scan.



In order to register the scans using the currently identified targets, right click on the group node and select **Register All** and **Bundle Adjust**.

Note: This function only applies to the parent group, it does not apply to any child groups.

Target Prediction

Any targets identified that do not have a corresponding survey point will be added to the bundle node. The bundle acts as an artificial survey which is made up by the targets picked in previous scans. When the bundle is built up enough to be used, LFM's target prediction system will become available as detailed below.

Once two targets have been identified other targets in the scan will begin to appear via the target prediction system. These will appear as green crosses in the BubbleView window and green target icons under the scan node in the Registration tab.

Select a predicted target by double clicking on it under the scan node in the Registration tab. This will centre the BubbleView window and target identification zoom window on the predicted target.

Note: Targets are sorted by ascending range so it is often best to start with the target at the top of the list.

There are four options at this stage:

- Left mouse click on the centre of the target to change the position and name of the predicted target and move on to the next prediction.
- Right mouse click on the centre of the target to change the position only. This will accept the predicted target name and move on to the next prediction.
- Click the tick button (shown below) in the target identification zoom window. This will accept both the position and name of the predicted target and move on to the next prediction. The “Y” button on the keyboard will also perform the same function.
- Click the cross button (shown below) in the target identification zoom window. This will not accept the predicted target and move on to the next prediction. This is used when the target cannot actually be seen (e.g. if it is on the other side of a wall or if it is too far away). The “N” button on the keyboard will also perform the same function.



Note: If a picked target has a negative effect on the scan registration (i.e. by causing one or more traffic lights to turn red) then the target zoom window will remain on that target and will not proceed to the next prediction. This is an alert to the user that the accuracy of the scan has been compromised and the user should investigate further before moving on.

If scans are registered locally to each other, it is possible that the “master” scan (which the others are registered to) will be classed as unregistered. As unregistered scans are not included in the LFM Server dataset generation, you may wish to class the master scan as registered. To do so, right click on the master scan and select **Force to Registered**.

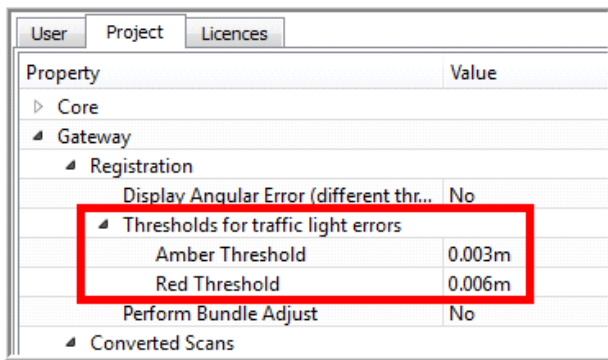
3.3 Target Accuracy

Once a target is registered, feedback on the accuracy will be displayed at the side of the target in the Registration tab. This feedback takes the form of two traffic light icons. This is a rapid way of interpreting registration accuracy. The coloured icons allow the user to visually 'skim' through the results, focusing quickly on the targets causing concern. These will appear as amber or red in the components browser.

The left icon (diamond shape) refers to the inter distance between the selected target and its neighbours within the scan. These inter distances are compared against the corresponding inter distances in the survey or bundle as appropriate.

The right icon (circle shape) refers to the distance between the picked target in the scan and the corresponding target position in the survey or bundle, post registration. Generally there should be more than 5 target correspondences in every scan to ensure accurate registration.

The traffic lights will be red, amber or green. The thresholds for these colours can be changed in the Options > Project tab.



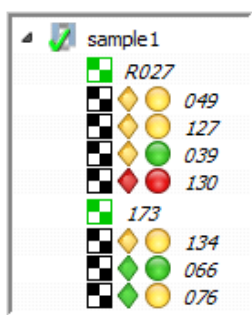
Anything between 0 and the amber threshold will be green. Anything between the amber threshold and the red threshold will be amber. Anything above the red, threshold will be red.

The recommended values are amber = 0.003m and red = 0.006m.

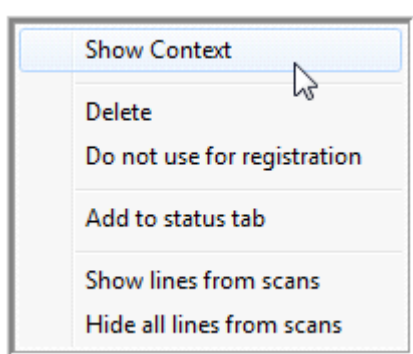
If the threshold is altered during registration, an automatic update of target accuracy is carried out respective to the new settings.

Improving the Accuracy of Poorly Fitting Targets

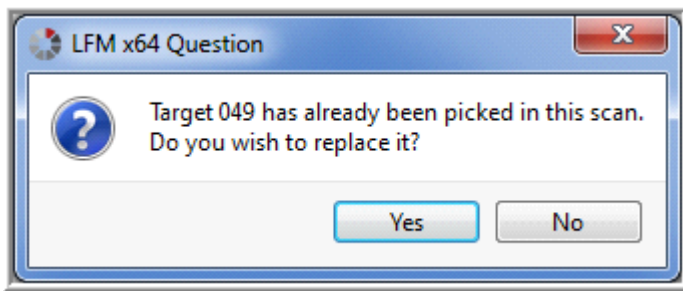
The example shown below demonstrates poor accuracy on target 130.



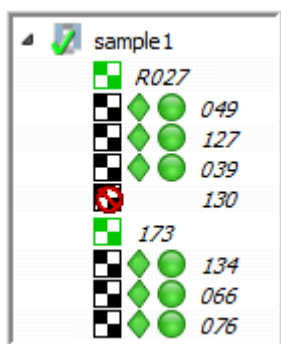
Inaccurately fitted targets such as this can be reviewed by right clicking on the target in the Registration tab and selecting **Show Context**. This will show the graphical representation of the pick against the 3D point cloud.



Targets can be re-picked by clicking on the centre of the target in the target identification window within the BubbleView, entering the target name and clicking **OK**. This will present a warning as shown left that the target has already been picked. Click **Yes** to accept or **No** to cancel.

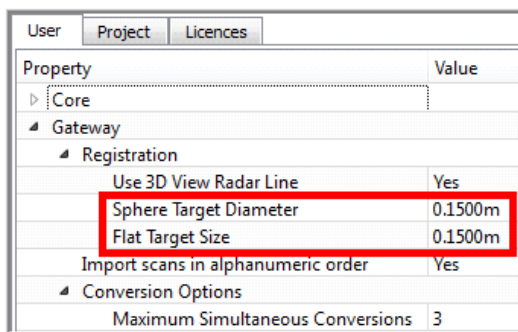


Targets can also be temporarily disregarded by right clicking on the target in the Registration tab and selecting **Do not use for Registration**. Targets that have the Do not use for Registration feature applied are shown with a red strikethrough as shown below.



The image shown left demonstrates the scan registration after the Do not use for Registration feature has been applied to target 130. The registration of the scan is now good. This feature can be removed if necessary by right click again on the target and selecting **Use for Registration**.

Once the registration is complete right click on the scan and select **Register All and Bundle Adjust**. You can then move on to the next scan. This should be repeated for all scans in the project.



Note: Target sizes can be changed in the **Options > User** tab as shown left.

Once the Registration is complete it is good practise to update the scan headers. This will store the position, rotation and targets in the .zfc file itself rather than just the project file. This means that registered scans can be added to another project still in the correct position. This is also useful for providers delivering to users using LFM Modeller or AVEVA Laser Modeller.

To update the scan headers right click on the group and select **Scan Headers > Update Scan Headers**.

4 Registration Using No Survey without Targets (Inter-Cloud Registration)

If site access is limited, there may be no survey and no targets placed throughout the scanned scene. In these circumstance scans can still be registered by identifying common points between each of the scan locations. If used in conjunction with scans registered to a survey, these scans can be registered to site coordinates. If there are no scans that have been registered to a survey the scans will be registered locally.

Scans that will be registered via Inter-cloud registration should be placed in their own subgroup.

To do this:

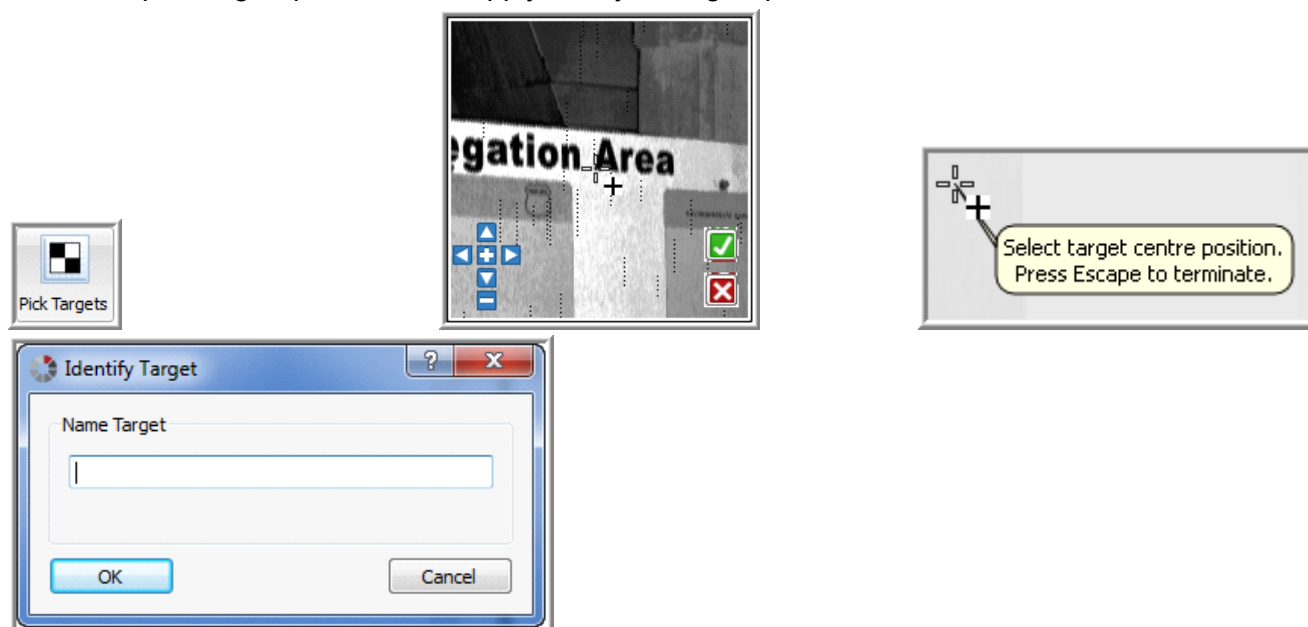
1. Right click on the project or parent group and select New > Register Group.
2. Then left click and drag the scans in to the new group.

4.1 Identifying Common Points

To identify common points, follow the steps below:

1. Right click on the scan to be registered and select **Show** or alternatively drag and drop the scan node into the 3D window. The BubbleView will load for the selected scan and the Tools toolbar will become available at the top of the interface. Anything on a flat surface can be used as a target as long as it can be seen in both scans being registered together. Corners of signs or small marks on walls traditionally make good targets.
2. Navigate round the BubbleView to the first point to be picked.
3. Click the **Pick Targets** button from the BubbleView toolbar and select the point with a left mouse click. This will bring up a small magnified target identification area.
4. Roll the mouse wheel until the mouse cursor changes to the crosshair icon as shown below right, and then pick the target with a left mouse click.
5. Alternatively, targets can also be picked in the 3D window. This is useful for registering mobile scan data (such as .pts or .dp) which will not produce a BubbleView.
6. Load the 3D points belonging to a scan by right clicking on the scan and selecting **Load Points**.
7. Navigate to the target to be picked and click the **Pick Targets** button from the Tools toolbar (shown above).
8. Again, roll the mouse wheel until the mouse cursor changes to the crosshair icon as shown above, then pick the target with a left mouse click.
9. After picking the target the Identify Target window will appear. Type in the name of the target (e.g. T1) and click **OK**. Identified targets will appear as yellow crosses in the BubbleView and as black target icons under the scan node in the Registration tab.

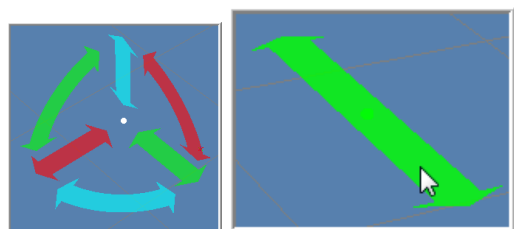
10. Repeat this process for other targets in the scan and also the same targets in the other scan to be registered.
11. Once the targets have been identified in both scans, right click on the group node and select **Register All**. Depending on the quality and accuracy of the picked targets this will place the scans in roughly the correct position. **Note:** This function only applies to the parent group, it does not apply to any child groups.



4.2 Visual Scan Manipulation

1. Alternatively the user may drag the scans close to the correct position via scan manipulation. To do this right click on the scan to be moved and select **Manipulate**. This will bring up an rgb modification frame positioned around the scan centre as shown left.
2. Hover the mouse cursor over the axis you wish to move or rotate the scan around.
3. Left click and drag the scan in to the desired position.

To escape this function and return the scan back to its original position press **Escape**. To accept the new scan position press **Enter**.

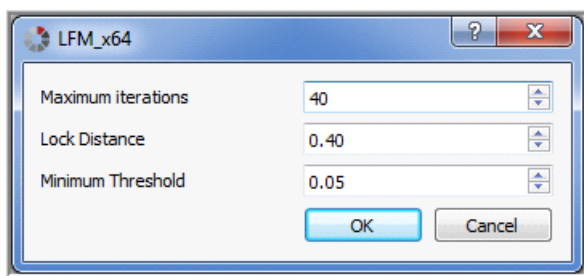


4.3 Completing the Registration

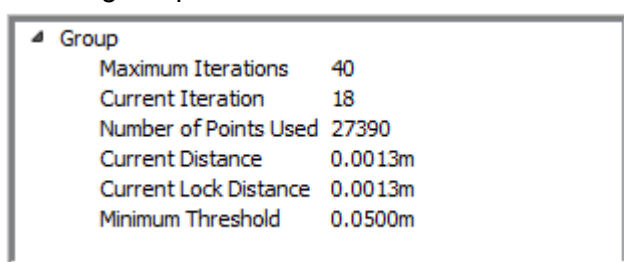
Once the scans are in roughly the correct position, LFM can further improve the registration using its in-built Inter-cloud registration function.

To do this:

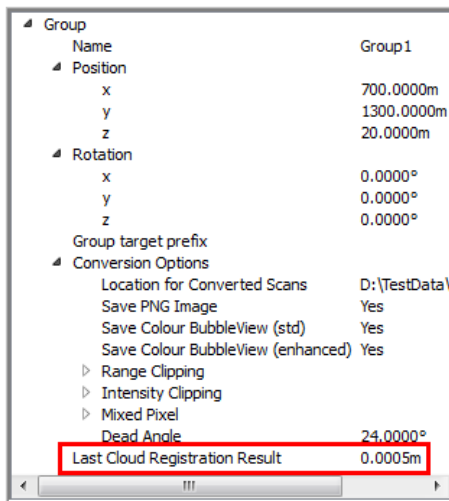
1. Right click on the group containing the scans to be registered and select Cloud All. Note: All the scans to be registered in this way must be loaded in both the 3D and BubbleView first. This will bring up the Inter-cloud registration options window as shown left.
2. Set the following options:
 - Maximum Iterations: The number of times the Inter-cloud process will run before completing unless it reaches the minimum threshold option as described below. Increasing this value will lead to better registration but will also take longer for the function to complete.
 - Lock Distance: The distance LFM looks for neighbouring points within when calculating the registration. The value entered here is the starting value. This value will decrease as the processing progresses.
 - Minimum Threshold: The error per point used that the Inter-cloud process aims for. When the value is reached, the process will complete unless the process reaches the maximum iterations value as described above.
3. Press OK to start the Inter-cloud registration procedure. This may take some time depending on the number of scans to be registered and the initial placement of the scans.



During the Inter-cloud process, if the group node is selected in the Registration tab, the attributes window will display information about the process as shown below. This can be used to gauge how far along the process is.



Once the Inter-cloud process is complete, the attributes window will return to showing information about the group. There will be an additional entry at the bottom of the attributes window called **Last Cloud Registration Result**.



Once the Registration is complete it is good practice to update the scan headers. This will store the position, rotation and targets in the .zfc file itself rather than just the project file. This means that registered scans can be added to another project still in the correct position. This is also useful for providers delivering to users using LFM Modeller or AVEVA Laser Modeller.

To update the scan headers right click on the group and select **Scan Headers > Update Scan Headers**.

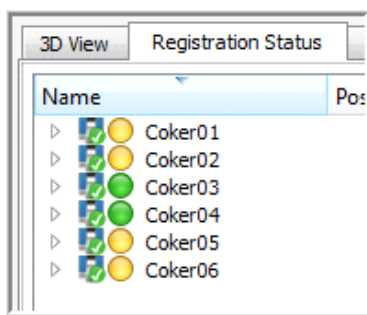
5 QA Reporting

5.1 Registration Status Tab

The Registration Status tab allows rapid interpretation of registration quality for quick and easy QA checks. Registration can be checked at both a scan and target level.

To add scans or targets to the Registration Status tab, follow the steps below:












1. Select the desired scans/targets in the Registration Management Panel.
2. After the desired scans/targets have been selected right click and select Add to Registration Status Tab OR drag and drop the scans/targets on to the Registration Status tab.
3. Click on the Registration Status tab to see the selected scans as shown below.












Each scan will have an overall traffic light to indicate any problem targets.

- If a scan has one or more red traffic lights, the overall traffic light will be red.
- If a scan has no red traffic lights but one or more amber traffic lights, the overall traffic light will be amber.
- If the scan has no red or amber traffic lights the overall traffic light will be green.

To see the targets identified in each scan, click on the arrow on the left of the desired scan name. This will show details of all the targets: their position, the error of the overall target from the survey and the correspondence (bundle or survey).

Name	Position	Error	Error Vector	Correspondence
<div>   Coker01 </div>				
▶  102	720.619, 1296.661, 32.238	0.002 m		Survey
▶  110	719.651, 1301.488, 32.563	0.001 m		Survey
▶  101	717.574, 1291.357, 32.046	0.001 m		Survey
▶  100	711.482, 1291.697, 32.359	0.002 m		Survey
▶  105	716.966, 1286.601, 32.135	0.004 m		Survey
▶  103	705.915, 1302.785, 31.321	0.003 m		Survey
▶  112	706.811, 1290.280, 32.361	0.002 m		Survey
▶  120	728.937, 1286.803, 32.474	0.002 m		Survey
▶  107	695.408, 1301.360, 32.447	0.002 m		Survey

To see the details of each individual pick for a target click on the arrow on the left of the desired target. This will show details of all the individual picks that contribute to that target: the scan name, the position, the error of the individual pick from the survey and the error vectors of the individual pick from the survey.

Name	Position	Error	Error Vector	Correspondence
 Coker01				
 102	720.619, 1296.661, 32.238	0.002 m		Survey
 110	719.651, 1301.488, 32.563	0.001 m		Survey
 101	717.574, 1291.357, 32.046	0.001 m		Survey
 100	711.482, 1291.697, 32.359	0.002 m		Survey
 105	716.966, 1286.601, 32.135	0.004 m		Survey
 Coker01 (105)	716.968, 1286.601, 32.139	0.005 m	0.002, -0.000, 0.004	
 Coker02 (105)	716.968, 1286.600, 32.136	0.002 m	0.002, -0.001, 0.001	
 Coker05 (105)	716.967, 1286.601, 32.137	0.002 m	0.001, -0.000, 0.002	

If an individual pick is found to be bad (usually indicated by red traffic lights) the user can do the following:

1. Right click on that pick and select Do Not Use For Registration. This will remove that pick from the calculation of the target and scan and re-register the scan accordingly.
2. After a pick has been confirmed as not being required, the user can right click on that target and select Delete.
3. To further refine the information available, the user can right click anywhere in the Registration Status tab and apply one of the following filter options:
 - Nothing
 - Red and amber traffic lights
 - Red traffic lights

Column Header	Purpose
Name	Name/identifier of the object plus an indication of quality (traffic lights)
Position	The x, y, z position of the object
Error	The distance between the surveyed point and the average of all related target picks
Error Vector	The x, y, z error
Correspondence	An indication to show if the target relates to the Survey or the Bundle

Exporting the Registration Information

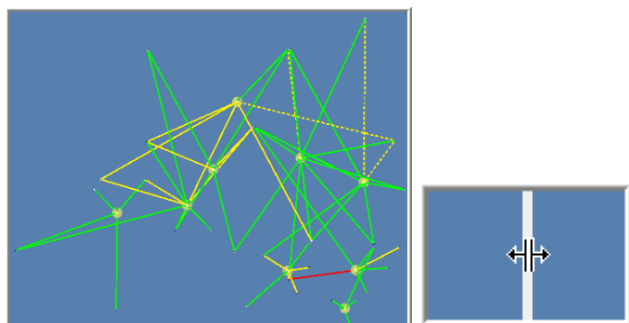
The registration information can be exported to a .csv file which can become the basis of a QA report for delivery to the client.

To do this, perform the following steps:

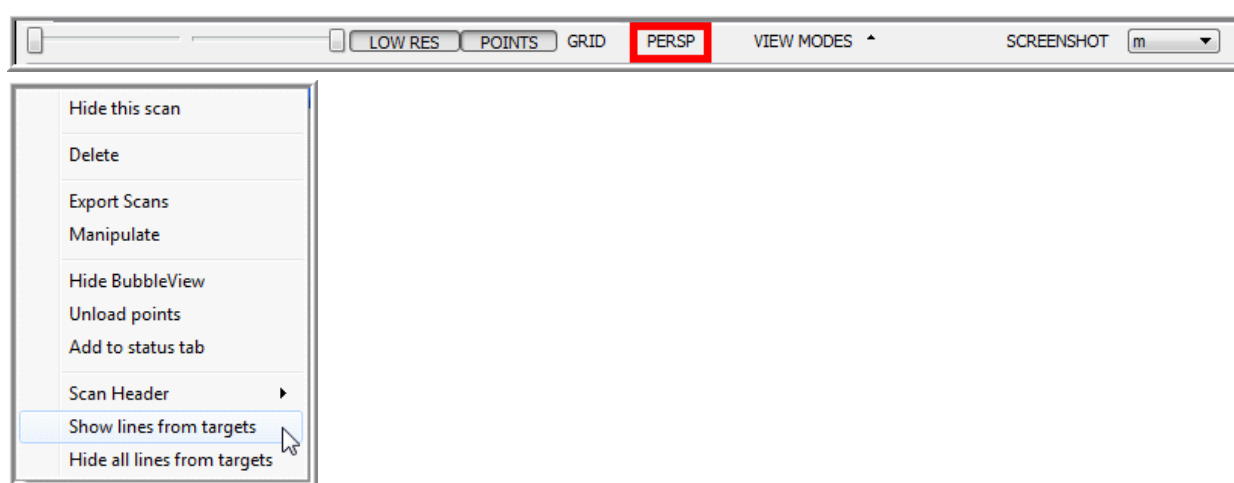
1. Right click anywhere in the Registration Status tab and select Export Report.
2. Select the appropriate destination, name the file and click Save.

5.2 Network View

The Network View allows the user to see a visual representation of the spread, location and quality of the scans and targets.



The best way to visualise this is to switch to the ortho view. To do this click on the perspective/ortho view switch button as highlighted below. This will split the screen into a side on and top down view. The user may alter the proportions of this view by clicking and dragging (left/right) the dividing line as shown left. The user may turn off the 3D points by clicking the Points button on the 3D workspace control bar shown below.



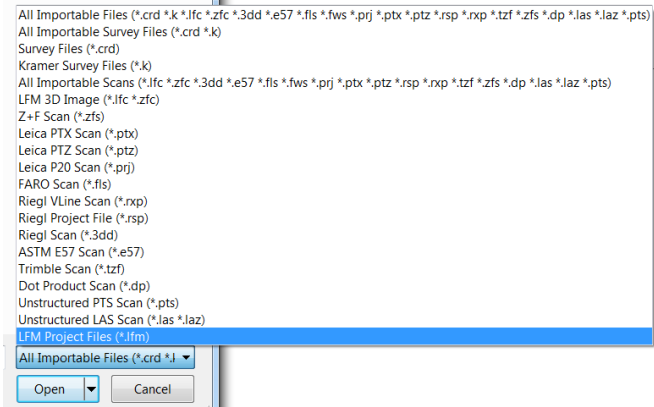
Any scan/group/target that is loaded will have its network lines shown in the 3D. Scans that have been marked as **Do not use for Registration** will be shown as dotted lines. The colour of the lines will match the colour of the traffic lights for that target.

To keep the network lines for a particular scan on, right click on the scan in the Registration tab and select **Show lines from targets** as shown left. This will keep the network lines on even if the scan is not selected in the Registration tab.

To hide the lines again, right click on the scan and select **Hide lines from targets**.

5.3 Merging Projects

It is sometimes desirable to split the registration of a large project across multiple users. Each user should have their own project file containing their scans to be registered. Once each user has registered their own sub-project a new master project should be created. The sub projects can then be imported to the master project by right clicking on the project node in the master project and selecting Import to this Project. In the browser that appears change the file type filter to LFM Project Files (*.lfm). Navigate to and select the first sub-project file in the file browser and click Open. Repeat for all other sub-project files.



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