

# Performing a Plane-Based Scan Registration

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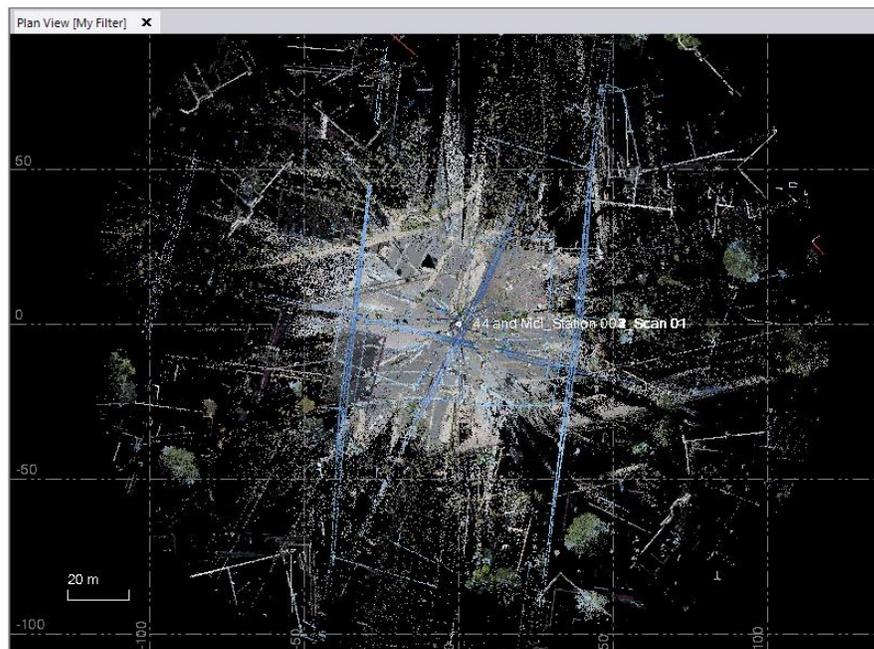
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## About this tutorial

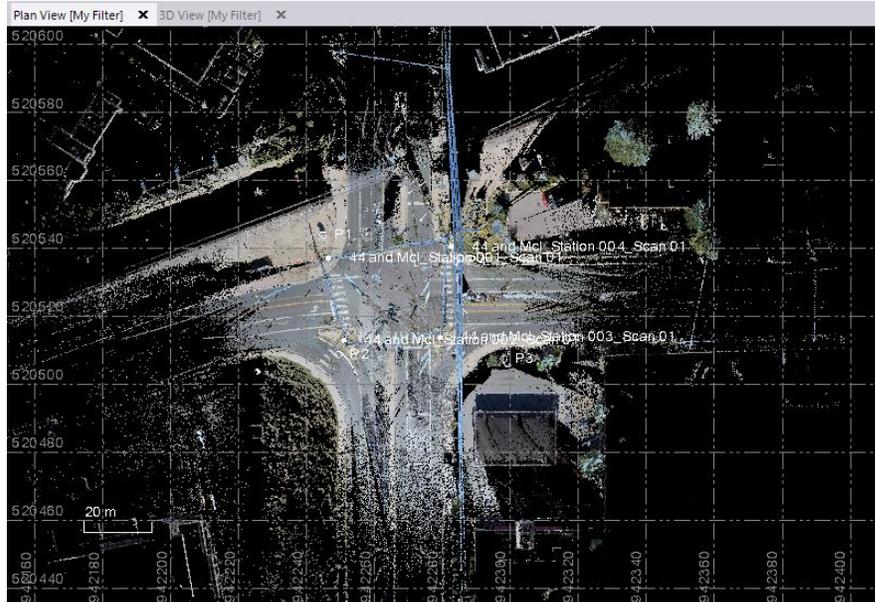
The **Scan Registration** command enables you to register overlapping scans imported from multiple scan stations to ensure they are correctly aligned. The command supports two major registration workflows:

- **Plane-based registration** - If your raw scan data was imported from a Trimble TZF (.tzf) or Faro FLS (.fls) file that does not include scan station position data, use this workflow to easily perform an automatic plane-based registration of the scan stations and their associated scans to each other, typically resulting in a single scan station group and a rigid point cloud. This is the workflow covered in this tutorial.
- **Pairwise registration** - This workflow is applicable if your raw scan data was imported in a format other than Trimble TZF (.tzf) or Faro FLS (.fls), or if it includes both unmovable scan stations (for example, scanning-capable total stations set up on known positions) and movable scan stations (for example free-standing scanners set up on unknown positions). It is also applicable if you do not obtain satisfactory results from a plane-based registration. See the tutorial *Processing Trimble SX10 Data* for an example of this workflow.

**Plan View** example of overlapping scan data before registration:



**Plan View** example of overlapping scan data after registration:



This tutorial project includes both survey and scan data that was collected at a street intersection. The survey data was collected with a Trimble SX10 total station. The scan data was collected at a later time with a Trimble TX8 scanner.

In this tutorial, you will perform two major steps:

1. Register the scans to each other, resulting in a single rigid point cloud.
2. Georeference the new point cloud to the control points to ensure the cloud is correctly positioned and oriented in the real world.

**Note:** If you need additional help at any time you are using the software, press **F1** to display the online Help.

## Step 1. Create the project

In this step, you will create a new project and import the tutorial data. The data consists of:

- Four TZF (.tzf) files, each of which was collected with a Trimble TX8 scanner and includes a scan station setup and scan points
- A JXL (.jxl) file that includes four control points that were measured using data collected with a Trimble SX10 total station at the same location where the scans were recorded.

**Note:** The downloaded *PerformingaPlaneBasedScanRegistration* folder contains this PDF file and a *Data* folder from which you will import data.

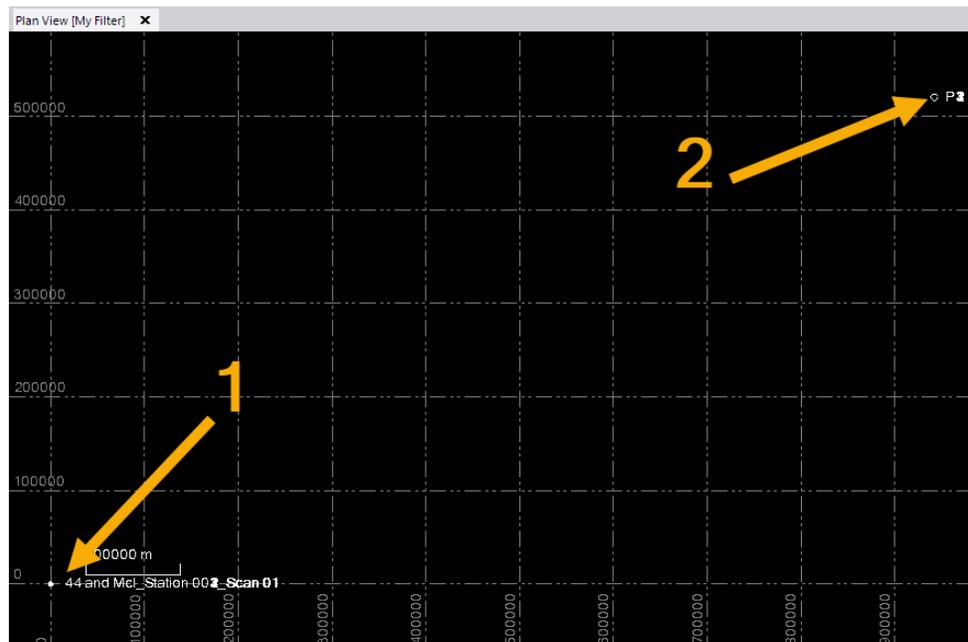
1. In the **Quick Access** toolbar (located at the top of the **SO** window), select **New Default Project**.

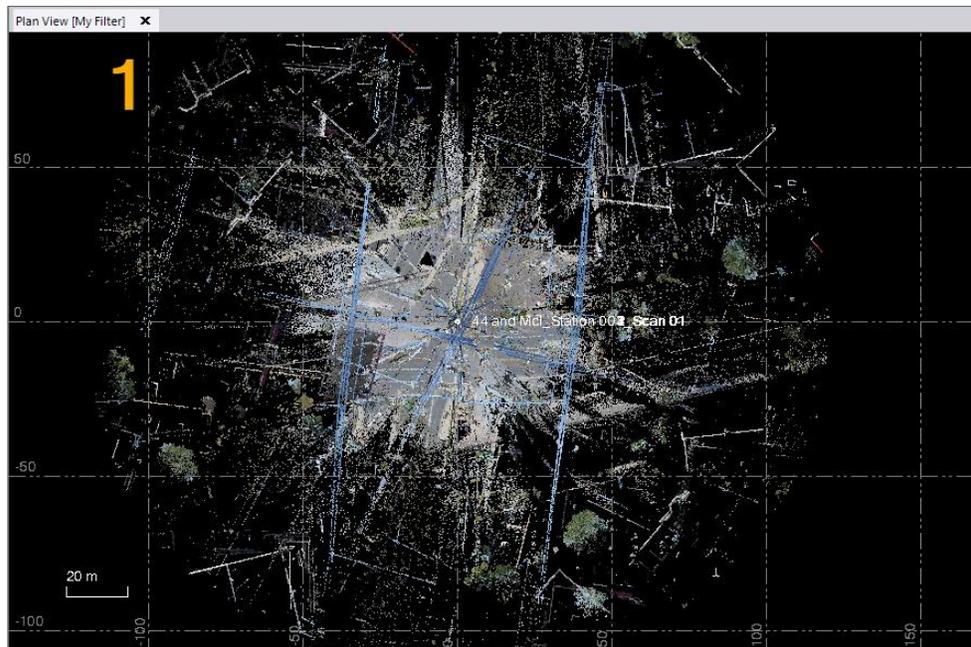
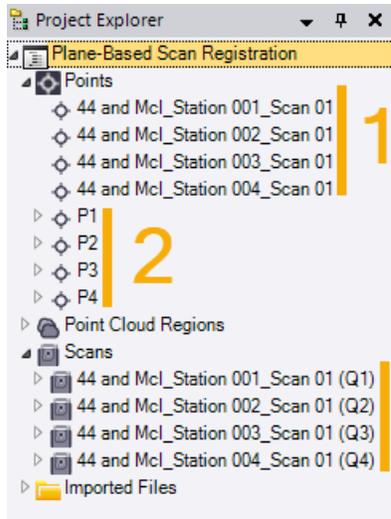
You can perform the tutorial steps without saving this project file. However, if you are interrupted while performing the tutorial, you can save it and then reopen it to continue at a later time.

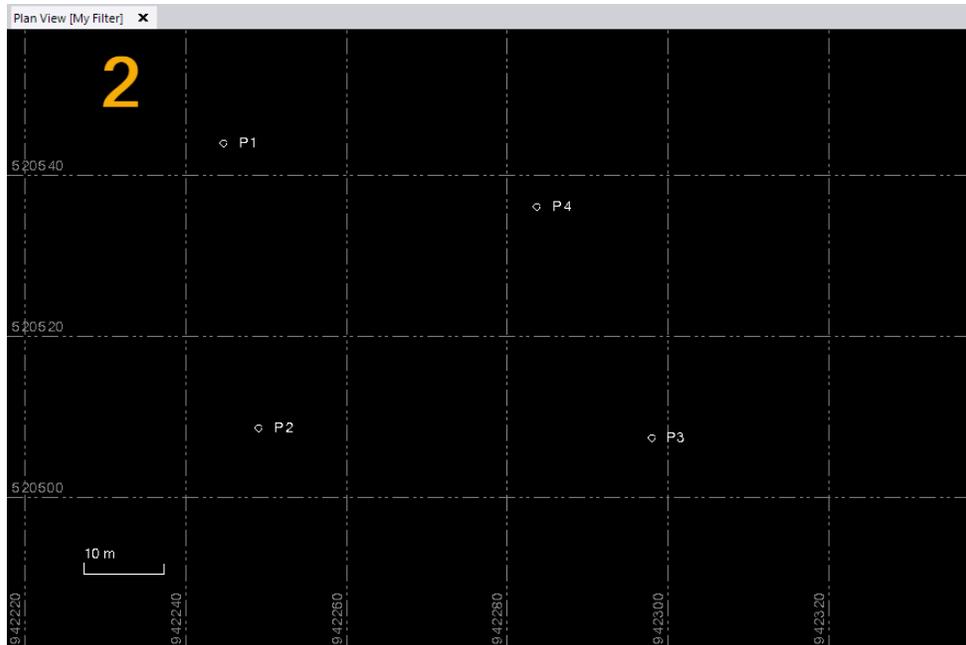
2. Open your downloaded *PerformingaPlaneBasedScanRegistration* folder and do the following:
  - a. Open the *Data* folder.
  - b. Select the four TZF (.tzf) files and the *Natural Targets.jxl* file.
  - c. Drag and drop all of the files on the **Plan View** in the **SO** window to import the data into your project.

The import will take several minutes to complete.

Because the TZF files do not include position information, after import the scan stations and their scans are all positioned at 0,0 (1 below) in the **Plan View**. As you can see, the scan stations are located a great distance from their real-world location as represented by the survey control points (2).



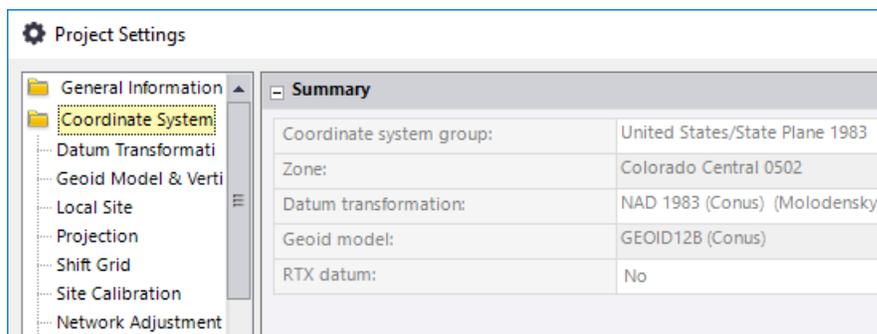




**Note:** Each of the imported scan stations originally included multiple scans, but the extra scans were removed from the tutorial data set to make the tutorial downloadable ZIP file as small as possible to ensure the fastest download time.

The imported JXL file specifies the coordinate system to be used for the project, which you will now verify.

3. In the **Quick Access** toolbar, select **Project Settings**.
4. In the left navigation pane of the **Project Settings** dialog, select **Coordinate System**.



This is the correct coordinate system for the project, so there is no need to make any changes.

5. Click **Cancel** to close the **Project Settings** dialog.

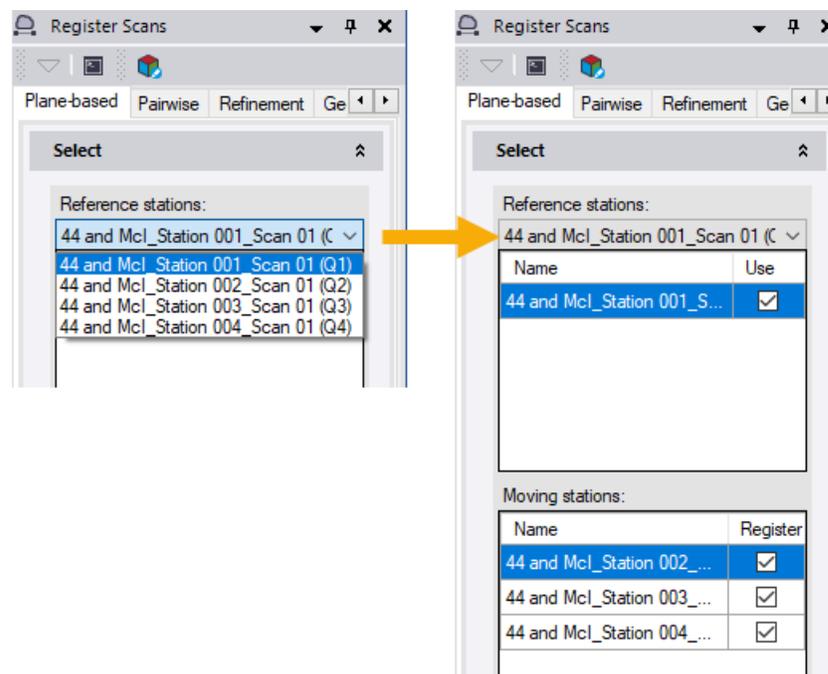
## Step 2. Perform the scan registration

In this step, you will first specify which scan station will remain stationary (referred to as the *reference station*) and which stations will move to align with the reference station during the automatic registration process (referred to as *moving stations*). Then you will start the automatic registration process.

1. In the **SO** ribbon, select **Point Clouds > Registration > Register Scans**.
2. In the **Register Scans** pane, select the **Plane-based** tab.

This tab is available for use only if your scan data was imported from a Trimble TZF (.tzf) or Faro FLS (.fls) file.

The **Reference stations** drop-down list includes all of the scan stations in the project, with the first one automatically selected and displayed in the list with the **Use** check box checked by default. The unselected stations are displayed in the **Moving stations** list with the **Register** check boxes checked by default.



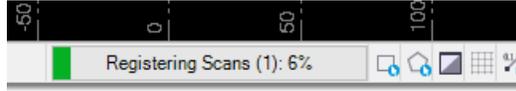
The scan from the selected scan station in the **Reference stations** list will not move during the automatic registration process. Instead, scans from all of the scan stations in the **Moving stations** list with a checked **Register** check box will move to align with the selected reference station's scan and with each other.

Because the imported stations do not have position data, the software simply defaults to the first station in the list as the "un-movable" reference station. Optionally, you could select a different station to be the reference station, but there is no need to do so for this tutorial.

Optionally, you could uncheck the **Register** check box for any stations in the **Moving stations** list that you do not want to include in the registration process.

3. Click the **Automatically Register** button.

The progress of the automatic registration process is displayed in the **Status** bar located at the bottom of the **SO** window. The process can take several minutes to complete.



When the process is complete, you are prompted to generate a registration report.

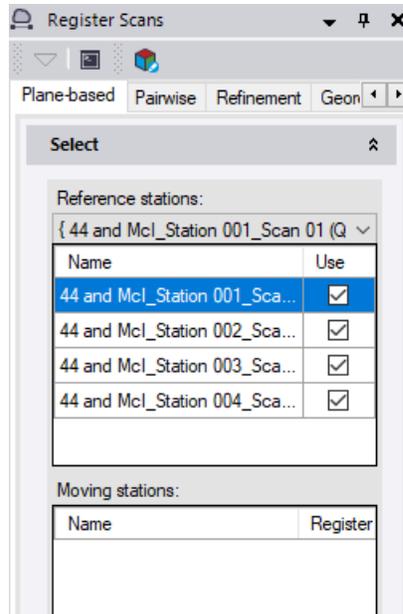
4. In the **Transformation Complete** message dialog, click **Yes**.

The **Scan Refinement Report** displays on a new tab in the **SO** window. The report lists each station included in the automatic plane-based registration process and the stations to which it is linked as a result. Each station link displays the associated error, overlap, and confidence values. (The values in your report may differ slightly from those shown in the example below.) If successful, the station link background color in the report is green, as shown below. Otherwise, the background color may be orange or red, indicating lessening degrees of confidence in the results. Before you make a final decision on the success of the registration process, you should view the resulting point cloud as described in the next step.

Results per station

Station Name	Linked Station Name	Error	Overlap (%)	Confidence (%)
44 and Mcl_Station 001_Scan 01 (Q1)	44 and Mcl_Station 002_Scan 01 (Q2)	0.002 m	70.15%	99.96%
	44 and Mcl_Station 003_Scan 01 (Q3)	0.006 m	51.65%	99.60%
	44 and Mcl_Station 004_Scan 01 (Q4)	0.005 m	44.13%	99.00%
44 and Mcl_Station 002_Scan 01 (Q2)	44 and Mcl_Station 001_Scan 01 (Q1)	0.002 m	70.15%	99.96%
	44 and Mcl_Station 003_Scan 01 (Q3)	0.003 m	64.37%	99.91%
	44 and Mcl_Station 004_Scan 01 (Q4)	0.006 m	52.88%	99.65%
44 and Mcl_Station 003_Scan 01 (Q3)	44 and Mcl_Station 001_Scan 01 (Q1)	0.006 m	51.65%	99.60%
	44 and Mcl_Station 002_Scan 01 (Q2)	0.003 m	64.37%	99.91%
	44 and Mcl_Station 004_Scan 01 (Q4)	0.002 m	58.47%	99.82%
44 and Mcl_Station 004_Scan 01 (Q4)	44 and Mcl_Station 001_Scan 01 (Q1)	0.005 m	44.13%	99.00%
	44 and Mcl_Station 002_Scan 01 (Q2)	0.006 m	52.88%	99.65%
	44 and Mcl_Station 003_Scan 01 (Q3)	0.002 m	58.47%	99.82%

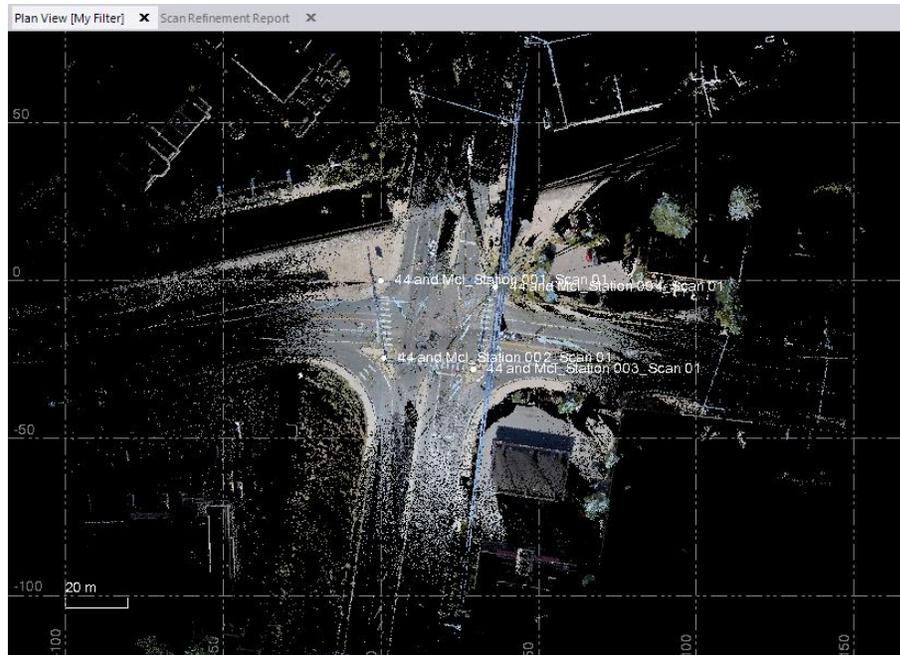
In the **Register Scans** command pane, the selected stations in the **Moving stations** list have moved to the **Reference stations** list. In addition, the selected reference scan station is now a scan station group and its name in the drop-down list has been appended with each of the added station names, separated by a semicolon: *{Selected reference station ; selected moving station 1 ; selected moving station 2 ; selected moving station 3}*. The scan station group represents a single, rigid point cloud.



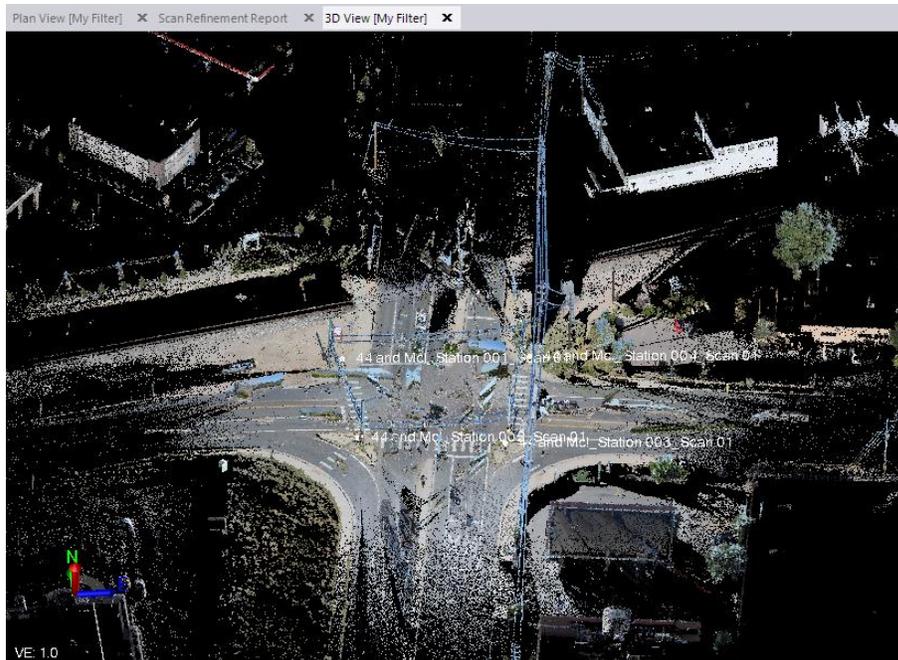
Note that the red **Compute Project Needed** icon displays in the **Status** bar.

5. Press **F4** to re-compute the project.

**Note:** Unlike the **Pairwise** method for registering scans, the **Plane-based** method does not benefit from a separate **Refinement** process because refinement is included in the plane-based registration algorithm.



6. In the **Quick Access** toolbar, select **3D View** to open the **3D View** tab. Then use your mouse and mouse wheel to navigate the 3D scene.



The four scans are now correctly registered into a single rigid point cloud. However, the cloud needs to be georeferenced to the survey control points to correctly position it in the real world.

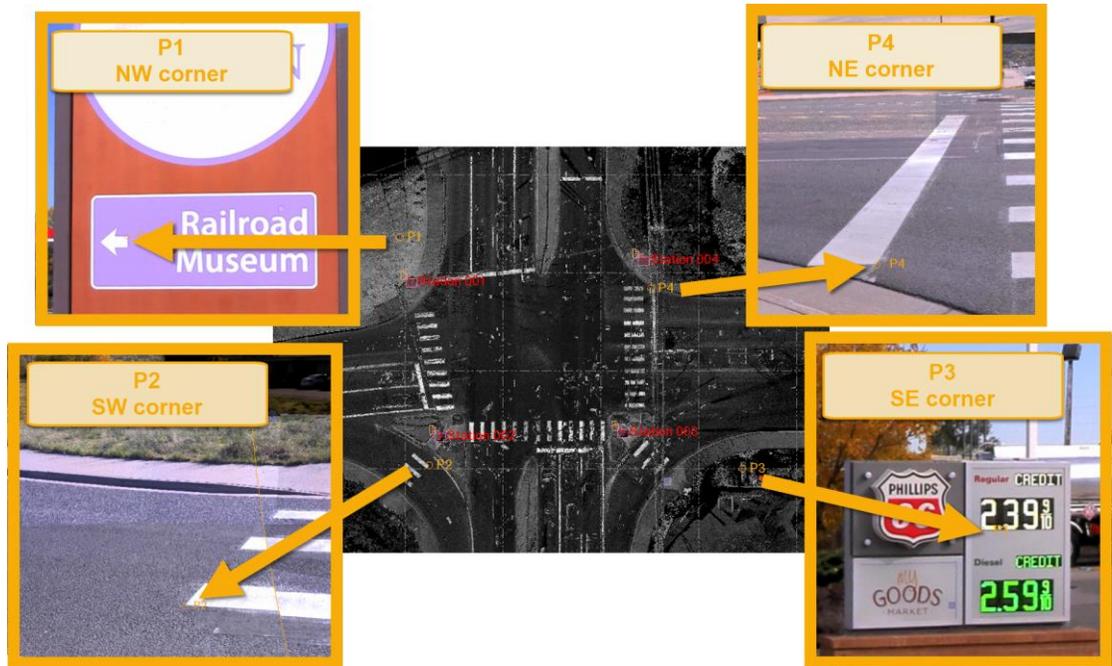
### Step 3. Georeference the point cloud

In this step, you will georeference the new point cloud to three of four control points (*P1* through *P3*) that were measured using Trimble SX10 survey data collected at the same street intersection at which the scans were captured. This will cause the point cloud to move, scale, and rotate as necessary to achieve the correct position and orientation in the real world. You will do this by mapping a corresponding scan point to each of the three control points.

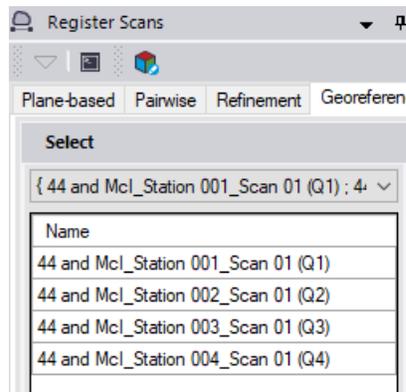
Note that one or more georeference point pairs can be selected to perform a point cloud transformation:

- One point pair - The point cloud will be translated (moved) only.
- Two point pairs - The best transformation that keeps the Z axis unchanged will be used.
- Three or more point pairs - The best transformation based on all point pairs will be used. If the point cloud was leveled, the resulting transformation will be constrained in the Z axis. (You will use this option.)

The following image, which was captured after georeferencing was completed, shows each of the three control points (*P1* through *P3*) to which you will georeference the point cloud and their location around the intersection. It also shows a fourth control point (*P4*), which you will not use to georeference the point cloud but will use to help verify a successful result.



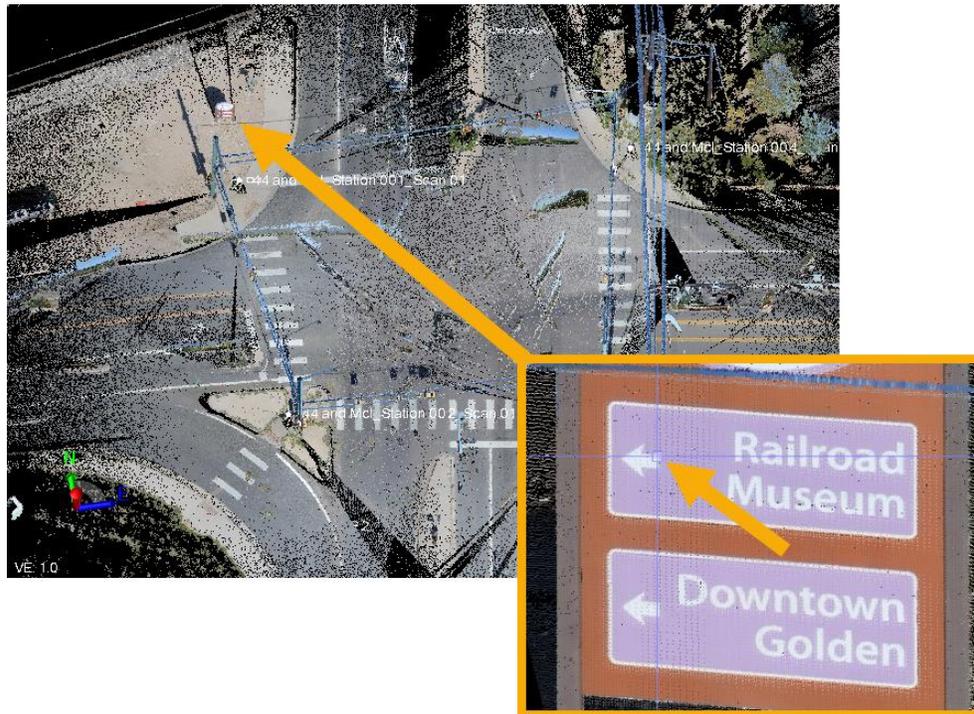
1. In the **Register Scans** command pane, select the **Georeferencing** tab.  
The new scan station group is selected in the **Select** drop-down list.



2. In the **Point ID** file, enter *P1*.  
The following photo, which is not included in the project, shows the specific location of control point *P1*.



3. In the **3D View**, zoom in on the sign shown in the photo above, which is located on the northwest corner of the intersection. Then, click in the **Scan point** field and click a scan point on the upper arrow on the sign post as shown in the photo.



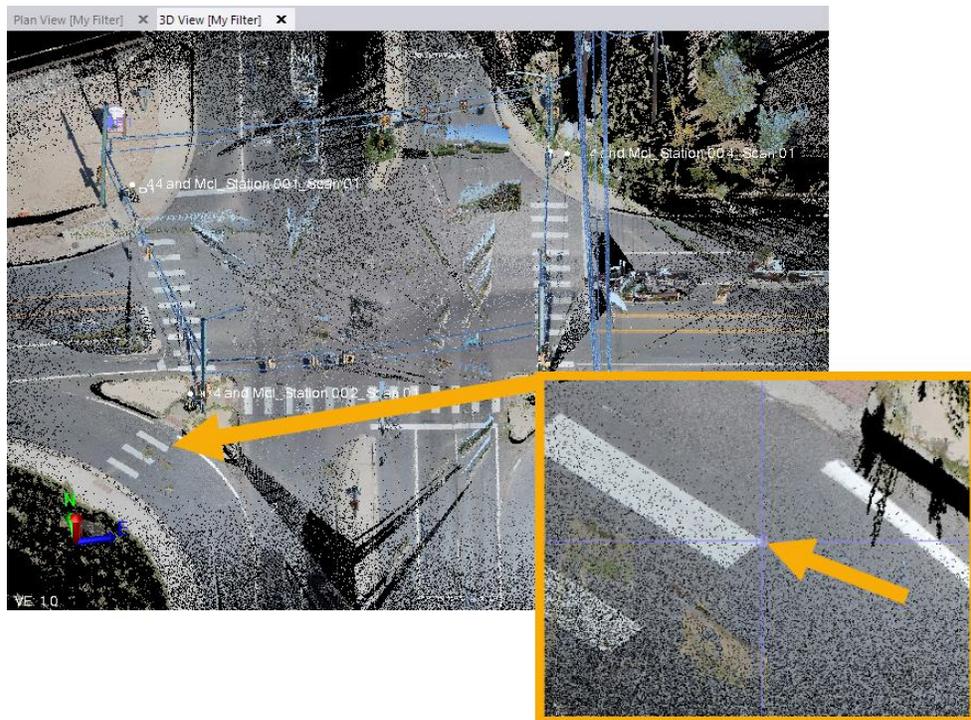
The coordinate for the selected scan point is displayed in the **Scan point** field.

Define Transformation		
Transform Calculator - 1 pairs		
Point ID/Scan point		
<input checked="" type="checkbox"/>	P1	-0.746, 7.119, 0.0
	Easting residua	0.000 m
	Northing residua	0.000 m
	Elevation residua	0.000 m
Point ID/Scan point		

The following photo shows the specific location of control point *P2* on the street in the southwest corner of the intersection. This is the next control point to which you will georeference the point cloud.



4. Click in the second **Point ID** field and enter *P2*. Then click in the **Scan point** field and click in the **3D View** to select a scan point on the street striping on the southwest corner of the intersection as shown here.



The following photo shows the specific location of control point *P3* on the filling station sign on the southeast corner of the intersection.



5. Click in the third **Point ID** field and enter *P3*. Then click in the **Scan point** field and click in the **3D View** to select a scan point on the following sign feature, which is located on the southeast corner of the intersection.

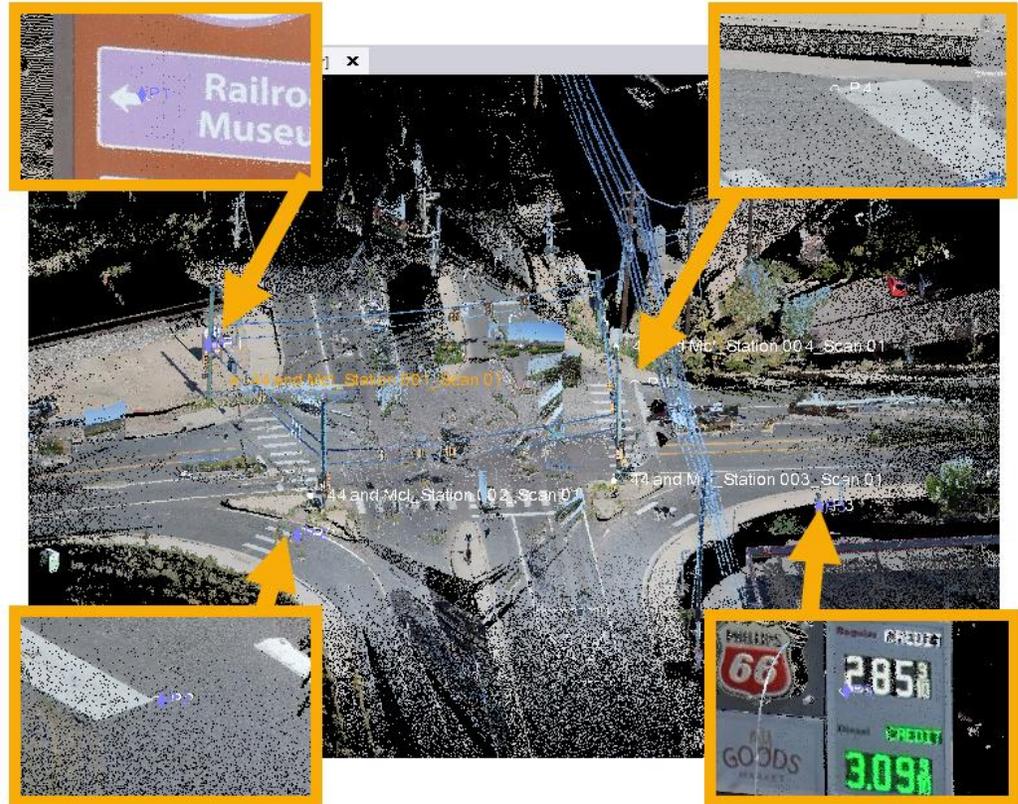


Although there is an additional control point that we could use for georeferencing the point cloud, three points are adequate to compute the transformation (as described at the beginning of this step).

6. Click the **Georeference** button.
7. Click the **Close** button to close the **Register Scans** pane.

8. With the **3D View** displayed, in the **SO** ribbon select **Home > View > Zoom Extents**. Then zoom in as shown here.

You can see that the control points now align with the selected scan points (even *P4*, which you did not georeference) and the point cloud is now correctly positioned.



This completes the tutorial. You can now make measurements, create deliverables, and perform other point-cloud related tasks in the project.