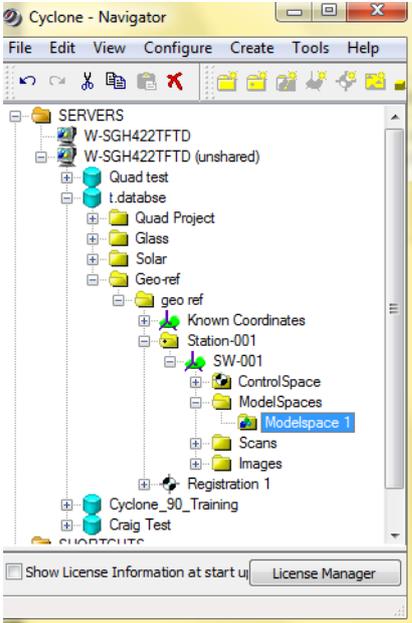
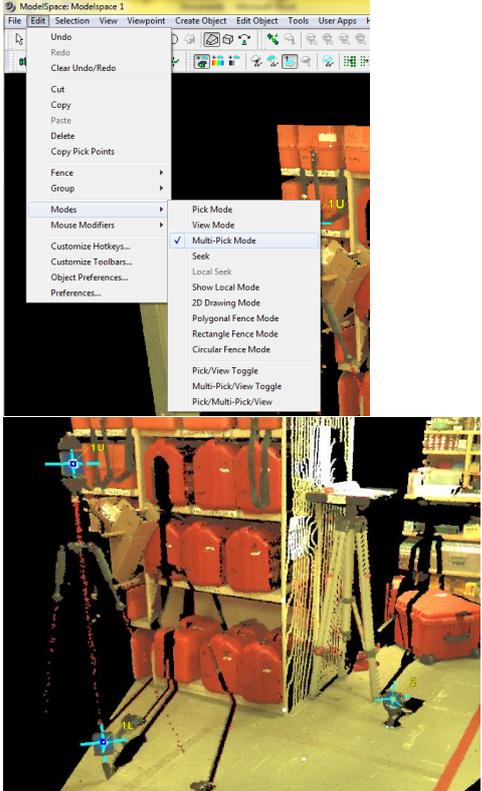


Geo-Referencing in ModelSpace

Step	Action	Detail	Picture
	Required data	Scan data GPS data (be sure to offset target height)	
1	Open ModelSpace	On Navigator, Open ModelSpace window	
2	Pick points	<p>From Menu bar, Edit > Mode > Multi-Pick Mode Pick Points</p> <ol style="list-style-type: none"> a. Reference Point For Position (X,Y,Z) Lower target, Benchmark (using GPS) b. Top & Bottom Points For Zenith direction (z) Upper & Lower target, Plumb nob c. Azimuth Point For Azimuth direction (x & y) Any point which has known Azimuth direction from Reference point d. Elevation Point (Optional) For Height redundant (Z) Benchmark, Ground Shot 	

3 Set Coordinate System

From Menu bar,
View > Coordinate System > Set from Point...
Point numbers will be run orderly from sequence of picked points.
Point numbers are also displayed on ModelSpace window in purple text

Assign all known data to points
OK

Set Coordinate System from Pick P...

Reference Point
1
X 0.000 m
Y 0.000 m
Z 0.000 m

Azimuth Point
3
Angle 0.000 deg

Top Point
2

Bottom Point
1

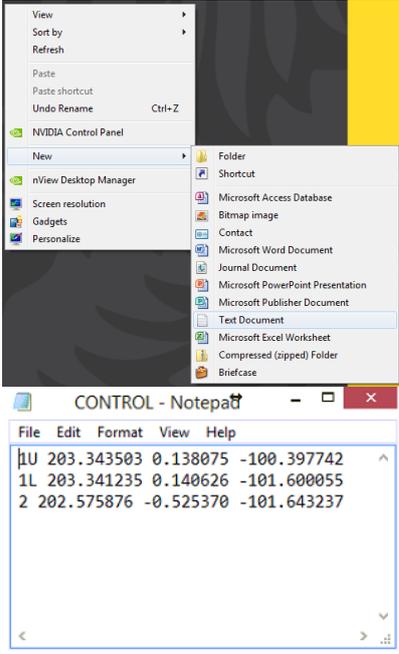
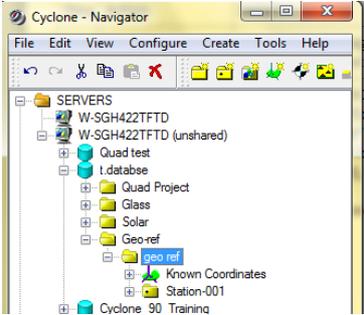
Elevation Point 1 (optional)
Elevation 0.000 m

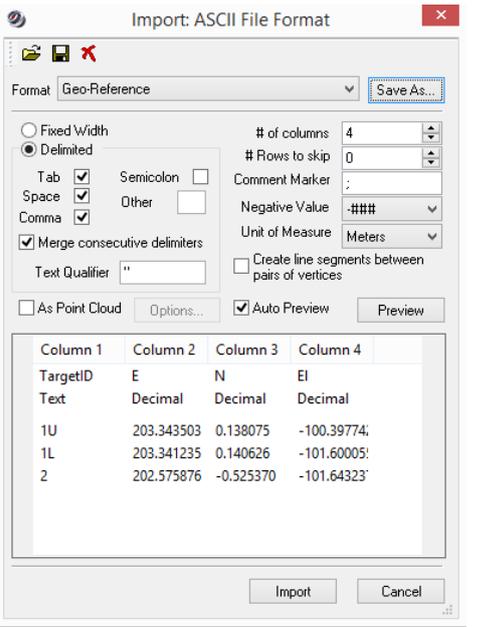
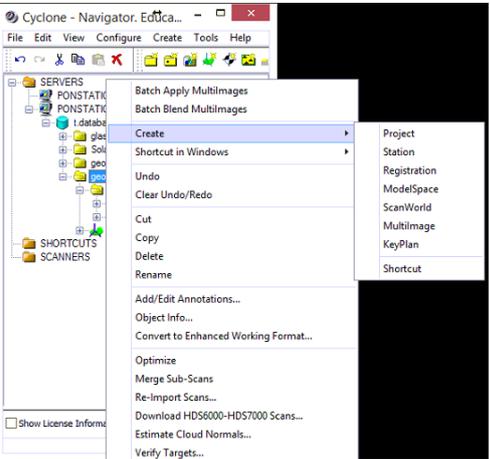
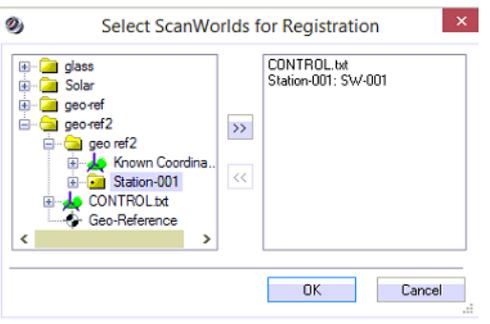
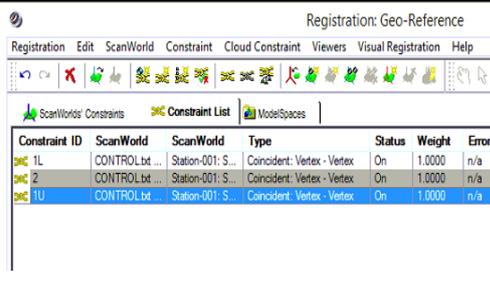
Elevation Point 2 (optional)
Elevation 0.000 m

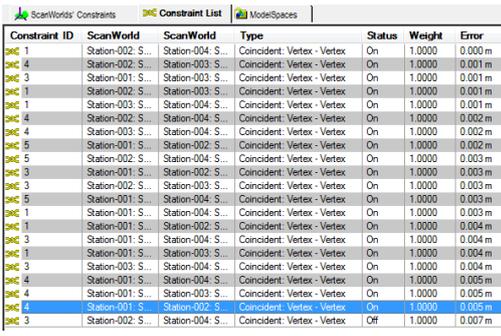
OK Cancel



Geo-Referencing by import text file

Step	Action	Detail	Picture
	Required data	1. Laser Scan data including scans of targets 2. Coordinates (e.g. MGA EN & AHD heights or local datum ENH) of targets (be sure to measure target heights above ground marks if applicable)	See notes at end of this document for more details.
1	Create Control file	On desktop, Right Click > New > Text Document Rename the file "Control" Open "Control.txt" Input GPS data in following format [Target Name],[Easting], [Northing], [Elevation] File > Save Close Notepad window	
2	Import Control data	On Navigator, Left Click on Project File > Import... Choose Control.txt from Desktop Import window will pop up Set Column 1 as Target ID Set Column 2 as E (Easting) Set Column 3 as N (Northing) Set Column 4 as Ele (Elevation) Import	

																															
3	Create new Registration	<p>Left Click on project</p> <p>On the main menu bar, Create > Registration</p> <p>Rename Registration as "Geo-Reference"</p> <p>Double click on Registration (just created)</p>																													
4	Import ScanWorld	<p>On registration window, ScanWorld > Add Scan world > ...Select data from pointcloud ScanWorld and Control ScanWorld...</p> <p>OK</p> <p>Note: Ctrl+Click for multiple selects</p> <p>Press ">>" to select</p>																													
5	Target Registration	<p>Right click on Control and "Set Home ScanWorld"</p> <p>Select ungrouped</p> <p>Open Constraints tab</p> <p>Highlight all stations (use Ctrl+Click)</p> <p>On main menu bar, Constraint > Auto-Add Constraints (Target ID Only)</p> <p>(Note there are no error vectors yet. First you need to register the targets together. Step 8)</p>	 <table border="1" data-bbox="1023 1843 1513 2007"> <thead> <tr> <th>Constraint ID</th> <th>ScanWorld</th> <th>ScanWorld</th> <th>Type</th> <th>Status</th> <th>Weight</th> <th>Error</th> </tr> </thead> <tbody> <tr> <td>1L</td> <td>CONTROL.txt...</td> <td>Station-001: S...</td> <td>Coincident: Vertex - Vertex</td> <td>On</td> <td>1.0000</td> <td>n/a</td> </tr> <tr> <td>2</td> <td>CONTROL.txt...</td> <td>Station-001: S...</td> <td>Coincident: Vertex - Vertex</td> <td>On</td> <td>1.0000</td> <td>n/a</td> </tr> <tr> <td>1U</td> <td>CONTROL.txt...</td> <td>Station-001: S...</td> <td>Coincident: Vertex - Vertex</td> <td>On</td> <td>1.0000</td> <td>n/a</td> </tr> </tbody> </table>	Constraint ID	ScanWorld	ScanWorld	Type	Status	Weight	Error	1L	CONTROL.txt...	Station-001: S...	Coincident: Vertex - Vertex	On	1.0000	n/a	2	CONTROL.txt...	Station-001: S...	Coincident: Vertex - Vertex	On	1.0000	n/a	1U	CONTROL.txt...	Station-001: S...	Coincident: Vertex - Vertex	On	1.0000	n/a
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6	Register	On Registration window, Registration> Register																													

7	Check the error	<p>Every constraint will appear Sort by <i>Error</i>.</p> <p>Check the <i>Errors</i> in the <i>Constraint List</i> tab. Make an assessment as to the quality of the registration. (more than 6mm Error is considered large).</p> <p>For large errors, constraints can be disabled by right clicking/ "Disable" ("Status" will change to "Off")</p> <p>Note all <i>Errors</i> are now N/A. You now need to re-Register (repeat step 9) and note that the disabled point does not contribute to the registration.</p>	 <table border="1"> <thead> <tr> <th>Constraint ID</th> <th>ScanWorld</th> <th>ScanWorld</th> <th>Type</th> <th>Status</th> <th>Weight</th> <th>Error</th> </tr> </thead> <tbody> <tr><td>1</td><td>Station-002 S...</td><td>Station-004 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.000 m</td></tr> <tr><td>4</td><td>Station-002 S...</td><td>Station-003 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.001 m</td></tr> <tr><td>3</td><td>Station-001 S...</td><td>Station-003 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.001 m</td></tr> <tr><td>1</td><td>Station-002 S...</td><td>Station-003 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.001 m</td></tr> <tr><td>4</td><td>Station-002 S...</td><td>Station-004 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.002 m</td></tr> <tr><td>4</td><td>Station-003 S...</td><td>Station-004 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.002 m</td></tr> <tr><td>5</td><td>Station-001 S...</td><td>Station-002 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.002 m</td></tr> <tr><td>5</td><td>Station-002 S...</td><td>Station-004 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.003 m</td></tr> <tr><td>3</td><td>Station-001 S...</td><td>Station-002 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.003 m</td></tr> <tr><td>3</td><td>Station-002 S...</td><td>Station-003 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.003 m</td></tr> <tr><td>5</td><td>Station-001 S...</td><td>Station-004 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.003 m</td></tr> <tr><td>1</td><td>Station-001 S...</td><td>Station-004 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.003 m</td></tr> <tr><td>4</td><td>Station-001 S...</td><td>Station-002 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.004 m</td></tr> <tr><td>3</td><td>Station-001 S...</td><td>Station-004 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.004 m</td></tr> <tr><td>1</td><td>Station-001 S...</td><td>Station-003 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.004 m</td></tr> <tr><td>3</td><td>Station-003 S...</td><td>Station-004 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.004 m</td></tr> <tr><td>4</td><td>Station-001 S...</td><td>Station-004 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.005 m</td></tr> <tr><td>4</td><td>Station-001 S...</td><td>Station-003 S...</td><td>Coincident: Vertex - Vertex</td><td>On</td><td>1.0000</td><td>0.005 m</td></tr> <tr><td>3</td><td>Station-002 S...</td><td>Station-004 S...</td><td>Coincident: Vertex - Vertex</td><td>Off</td><td>1.0000</td><td>0.007 m</td></tr> </tbody> </table>	Constraint ID	ScanWorld	ScanWorld	Type	Status	Weight	Error	1	Station-002 S...	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8	Freeze registration Visually check data	<p>On Registration window, Registration > Create ScanWorld/Freeze Registration (This locks in your registration for this modelspace and can't be changed)</p> <p>Close Registration window</p> <p>Registration/ create/ Open model space</p> <p>Visually inspect data</p> <p>Edit preferences/ point cloud/ check Load max points 70(million)/ Display points 25(million) (This sets up the density of point cloud data)</p> <p>Check data overall</p> <p>Tools/scanner/Scanworld explorer</p> <p>Click apply scanworld colour to scans and colourise adjacent scans.</p> <p>*** (Craig refer to complete training manual with C10 Quickstart ~pp 42)</p>																																																																																																																																													

Notes about Geo-reference coordinates:

1. Targets are used as constraint to put multiple scans together and also reference points for Geo-reference. Targets can be placed on tripods above survey marks or placed anywhere else that is convenient. But consider the strength of the geometry of the solution like a 3D transformation problem and do not place all targets in a line or in one plane.
2. The targets can be measured to determine their geo coordinates before, during or after the laser scanning. This can be done by offset tape if above a survey mark, by GPS or by total station (or by some other method independent of the laser scanner). Do the measurements of the targets before 'putting them away'. This is very important to maintain the accuracy of the targets' coordinates – you shouldn't place the targets in the scene (unless on or vertically above a survey mark), scan them, take them away, and then try to put them back in the same place later on to survey them with GPS or total station.

3. Scale Factor considerations for project of large extent (e.g. a whole campus or a new freeway or mine site)

It is not yet clear with current software which is the best approach to geo referencing scan clouds to MGA or any other coordinate system that considers the earth's curvature. It is important to keep in mind that Leica C5 and Cyclone are not able to calculate or implement 2D scale factors as in UTM projections such as MGA. So if the distance from one end of the project to the other is large (100s of metres or more) geo-referencing will be problematical in Cyclone. Distances between points from MGA coordinates have a scale factor in Easting and Northing but not in heights. Scan clouds before geo-referencing do not have scale factors in them, so a metre is a metre in all directions. For scanning projects of a small area we could use local ENH coordinates, or convert MGA coordinates to a false local system. For larger areas using MGA EN + H and ignoring scale factor in the map projection will probably mean that the registration process will indicate large errors in some target points and will distort the scan cloud data. At UNSW for example, the combined scale factor to convert horizontal distances to MGA distances is 0.999924. So a 100m line measured horizontally will be scaled to 99.992m. This is an 'error' of 8mm per 100m if laser scan cloud data is forced to fit the geo reference coordinates. Think of the problem as follows. The entire laser scan 3D point cloud, after all the scans have been registered together, can be thought of like a 3D printed model sitting on a desk. To georeference it to MGA (or similar) we need to shrink (or stretch) the model from the sides to fit the control coordinates of the target but not compress (or stretch) from the top. The georeferencing also rotates the model and shifts it. We cannot simply multiply all laser scan coordinates or distances by 0.99924 because that would give us errors in heights of points.

4. Use total station rather than GPS will effect transformation

Since the best accuracy of GPS is about $\pm 3\text{mm}$ (Leica Viva GNSS). And accuracy of Total Station (Leica Viva TS11) is about $\pm 1\text{mm}$. If possible, try to get coordinate from existing survey mark using total stations. BRH says: total station coordinate accuracy above probably refers to measurements with prisms, if we use reflectorless EDM to coordinate the targets the accuracy may not be so good. Also, if long distances are measured the total station derived coordinates may not be so accurate or convenient and GPS may be preferable.