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[Application note – Glasgow University, Glasgow]

Leica P40 scan colourisation with iSTAR HDR images

Date: 16 June 2016
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Organisations involved: NCTech, Leica Geosystems, Glasgow University
Products used: Leica Cyclone 9.1 with NCTech iSTAR image integration

NCTech iSTAR 360 camera to provide rapid HDR imaging for Leica P40 point cloud colourisation

The iSTAR 360 degree camera provides rapid, automatic HDR (High Dynamic Range) 360 imaging and can be used as a standalone device or for colourisation of point clouds created by spherical terrestrial scanners. Although Leica's P40 scanner can provide internal HDR colour capture, iSTAR can be used to provide HDR imagery with more exposure steps and with reduced capture time. A project was undertaken to scan and image the Glasgow University Building, using both technologies, to show their combined capabilities. The results of the project showed that iSTAR provides the ability to efficiently capture HDR colour and accurately combine this with the scan data for significantly improved 3D visualisation and time saving.

The aim if this report is to show the workflow used to achieve quality coloured point cloud using NCTech iSTAR imaging integrated into Leica Cyclone 9.1 and its advantages.

01. Software installation.
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03. Office-work.
04. Results.
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06. Leica TrueView.
07. Conclusion.
08. Acknowledgements.

01. Software installation

Installing Leica Cyclone:
hds.leica-geosystems.com/en/Support-Downloads-Cyclone-Downloads_27054.htm

02. Fieldworks

Working with NCTech solutions is the easiest, most accurate and highest speed method of colouring point clouds with iSTAR images:

02.01. PLANNING SCAN STATIONS no change to standard process for scanning with or without colour.

02.02. CAPTURING POINT CLOUDS with the Leica P40, select the Laser Scanner resolution you consider most suitable for the job as in normal use. NCTech solutions work irrespective of scan resolution.

Img. 02.01 and Img. 02.02 LaserScanner and iSTAR station.

02.03. CAPTURE iSTAR IMAGES by replacing the P40 with the iSTAR[1] camera each scan station, and capture 360 images in full colour.

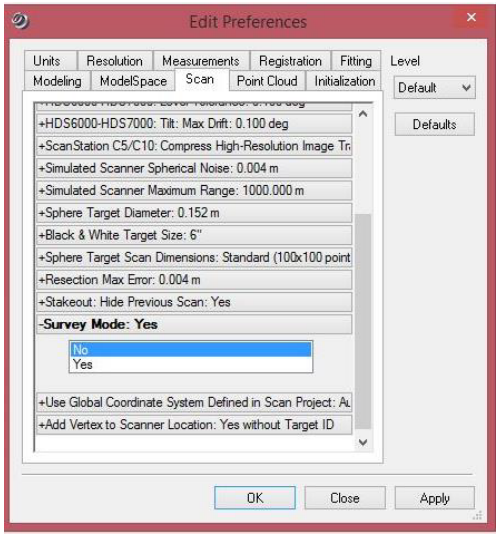
NCTech supply adaptor rods with a Tribrach quick release repeatable connector to accurately and quickly locate iSTAR at the same central capture position as the scanner. iSTAR has different HDR modes enabling single exposure, five exposure and nine exposure 360 images to be created. Five exposure HDR imaging was used here and additional capture time was approximately 30-75s[2] per scan position. iSTAR's on camera interface is designed to be like a regular automatic digital camera. Knowledge of photographic techniques is not required with iSTAR which automatically calculates the most suitable exposure value taking into account the entire 360 scene. Capture time saving is around 8-10 minutes per station compared to taking images with laser scanner internal camera. Typical comparative capture times are 12-14 minutes per station (point cloud scanned + internal camera images) against 5-6 minutes per station (point cloud scanned + iSTAR data).

Img. 02.03. Adaptor rod and Tribrach setting to achieve the right position for works with Leica P40 laser scanner.

03. Office-work

The whole colourisation workflow is fully integrated inside Leica Cyclone 9.1.

03.01. OPEN SCAN DATA IN LEICA CYCLONE.



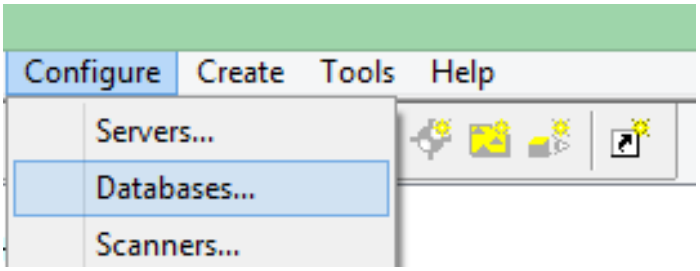
Img. 03.01 Editing preferences window the first time the user opens Leica cyclone.

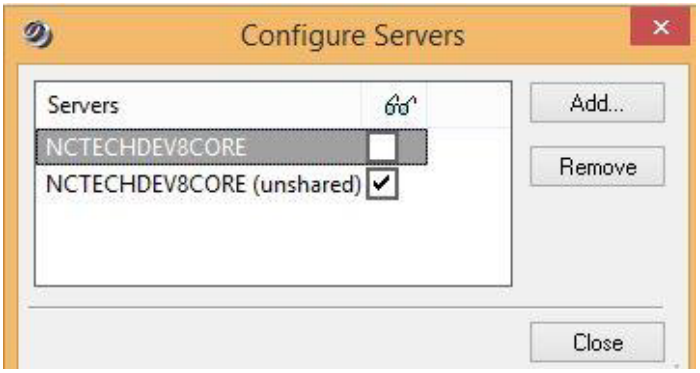
1 - NCTech recommend using its adaptor poles to accurately locate the camera in the correct position, different adaptors are used for other laser scanning systems (Leica, Faro,Trimble, Topcon, Surphaser, Z+F, etc).

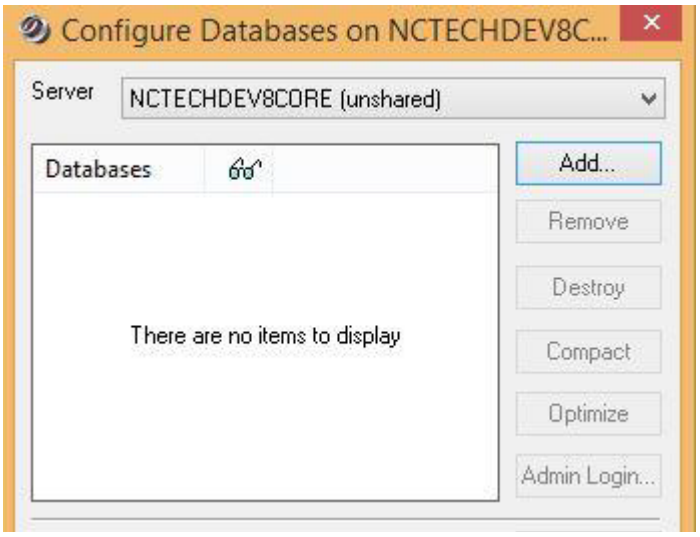
2 - The full iSTAR capture process includes "Analysing time", "Capturing time" and "Saving time". During saving time the "OK to move iSTAR" message will appear on the iSTAR screen, at which point iSTAR can be moved to the next capture position.. For this reason in this example 30-75s doesn't include "Saving time".

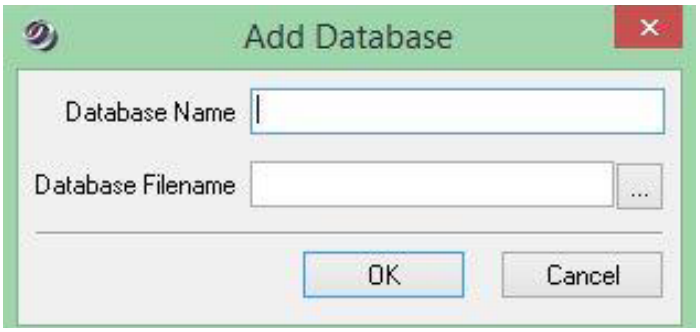
The first time you run Leica Cyclone, you should turn off Survey mode since it displays the individuals scans in their own folders. Edit>Preferences>Scan>Survey Mode: No. Check that level is set to default.

To import raw files from a scanner, you need to first create a Cyclone database.
Configure> database>add.Add any filename that you choose. Leave Database Filename field empty (no Cyclone database has been created yet).





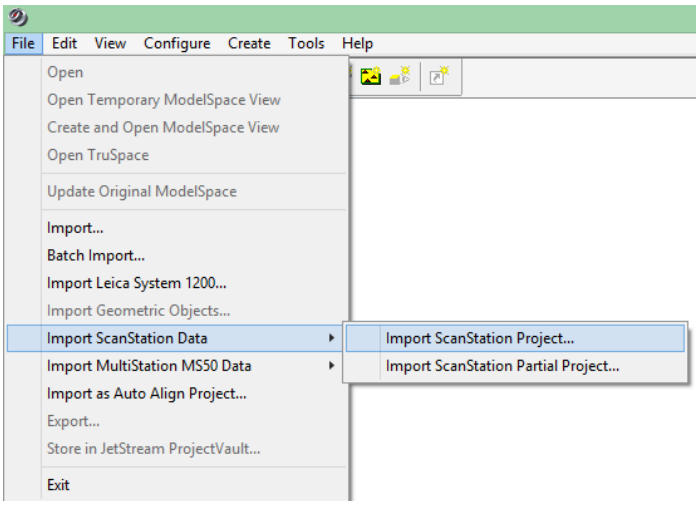




Img. 03.02. Database creation in Leica Cyclone 9.1.

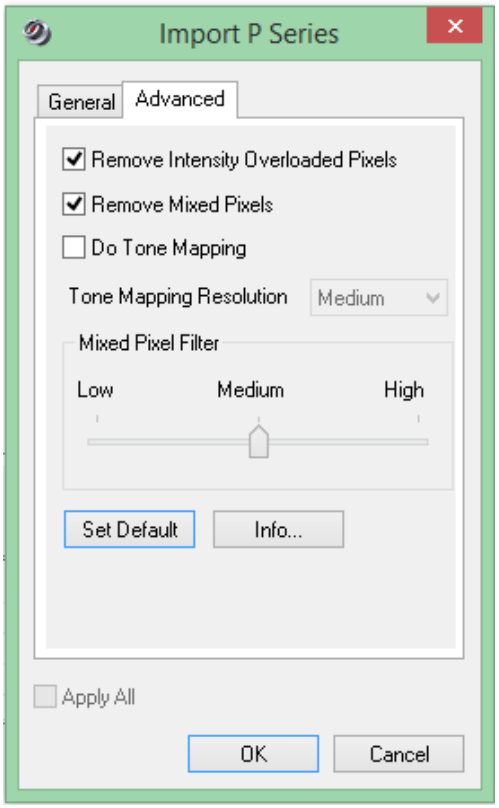
Now, you can import the scan data to the new database which has been created before.

File>Import>Import ScanStation Data> Import ScanStation Project to import scan station data for a new project.



Img. 03.03. Import StationProject in Leica Cyclone 9.1.

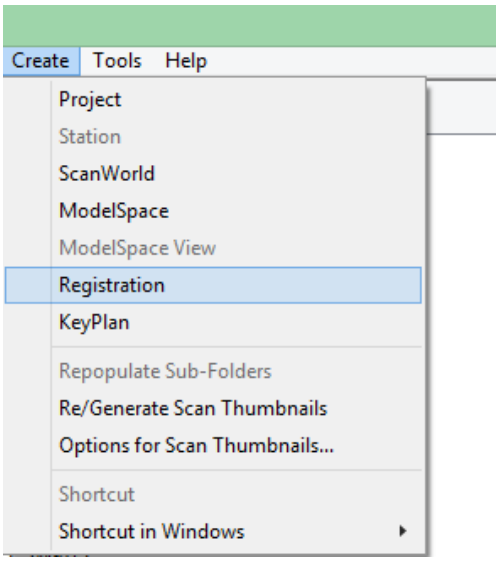
When importing scan data into cyclone ensure you have selected "remove mixed pixels" during data import. This will reduce the amount of noise.



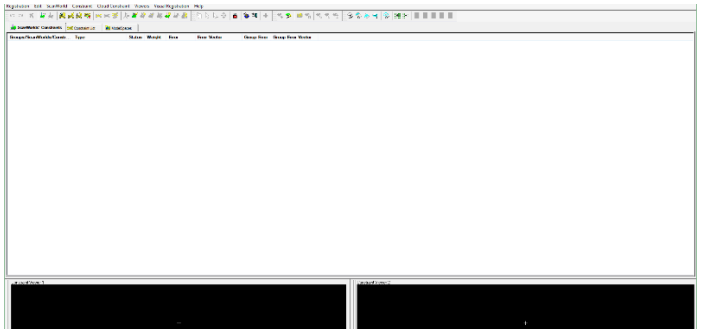
Img. 03.04. Import StationProject parameters in Leica Cyclone 9.1.

03.02. REGISTRATION INTO LEICA CYCLONE

Select your project folder under your data base and click "Create>Registration" Double click on registration icon to open it.

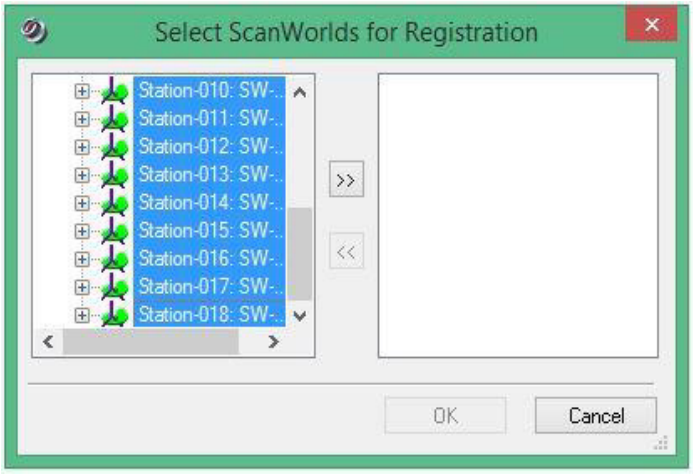


Img. 03.05. Registration creation in Leica Cyclone 9.1.



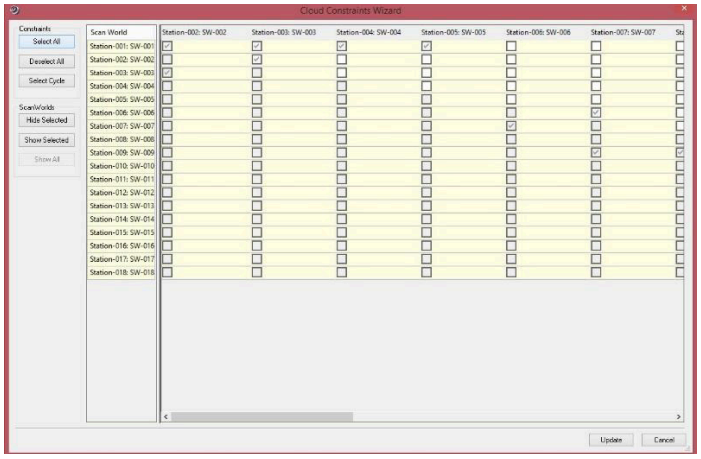
Img. 03.06. Registration window in Leica Cyclone 9.1.

Once registration has been created you can add your scans clicking ScanWorld>Add and selecting all scans you want to register in the emergent window.

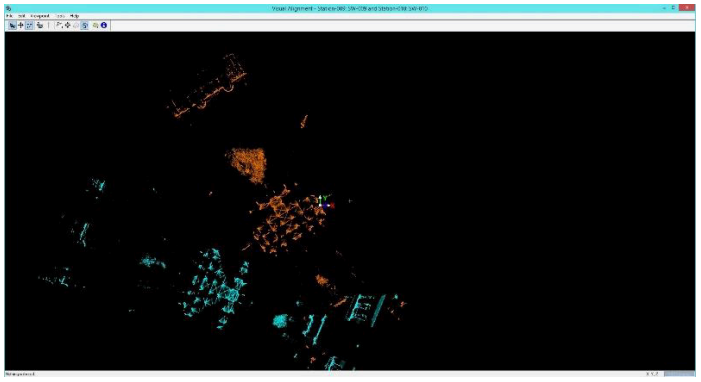


Img. 03.07. Adding scans to the registration in Leica Cyclone 9.1.

If targets have not been used, as in this case of study, you must manually identify common points or areas between two scans. You can do this using the "Cloud Constraint Wizard" by selecting those point clouds which have common areas (Cloud Constraint> Cloud Constraint Wizard) or you can do it using "Visual Registration" (Visual registration>Visual alignment).

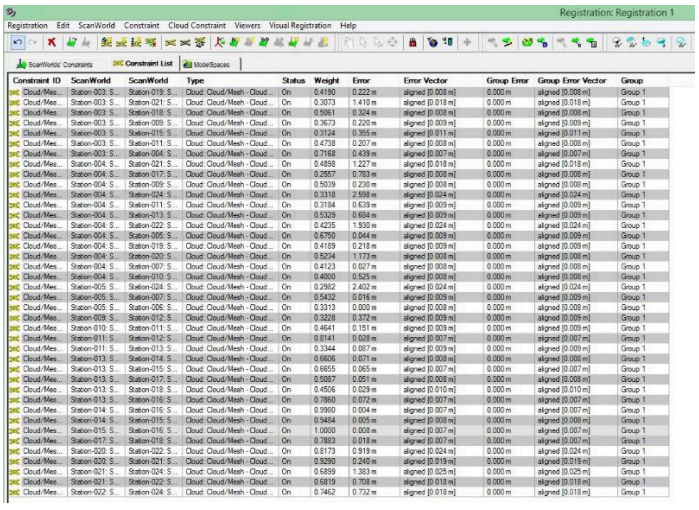


Img. 03.08. Cloud Constraint Wizard in Leica Cyclone 9.1.



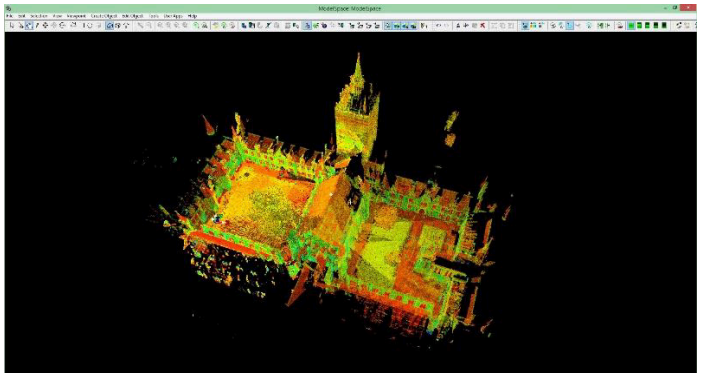
Img. 03.09. Visual alignment in Leica Cyclone 9.1.

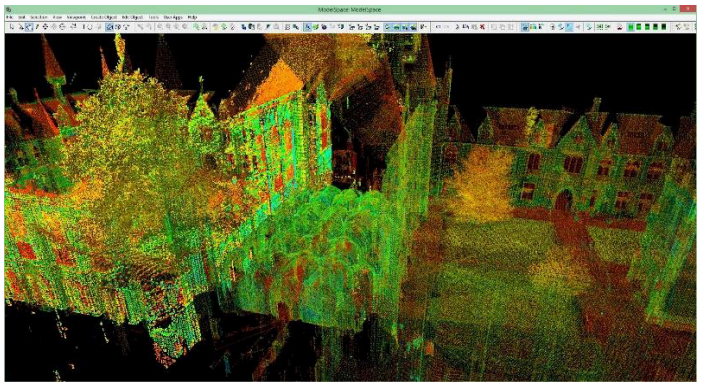
To calculate the errors, click Registration>Register. You can check the error results at "Constraint list" tab. Once the error values were ok for you, click Registration> Create Scanworld/Freeze Registration.



Img. 03.10. "Constraint list" tab in Leica Cyclone 9.1.

To view the data Registration>Create and Open ModelSpace.



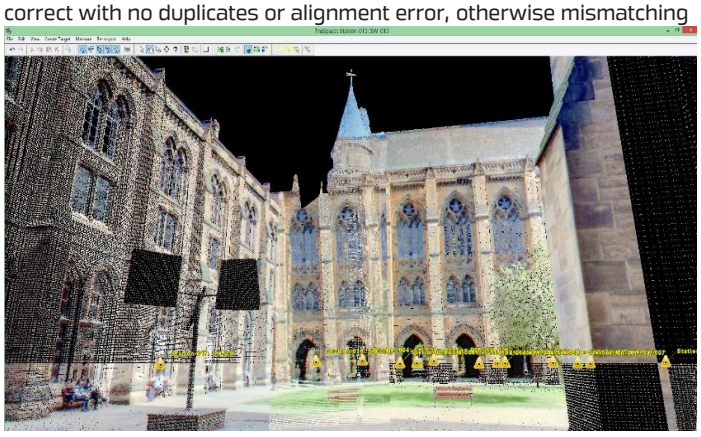


Img. 03.10. Registered Point cloud in Leica Cyclone 9.1.

03.02 COLOURISATION INTO LEICA CYCLONE USING iSTAR DATA

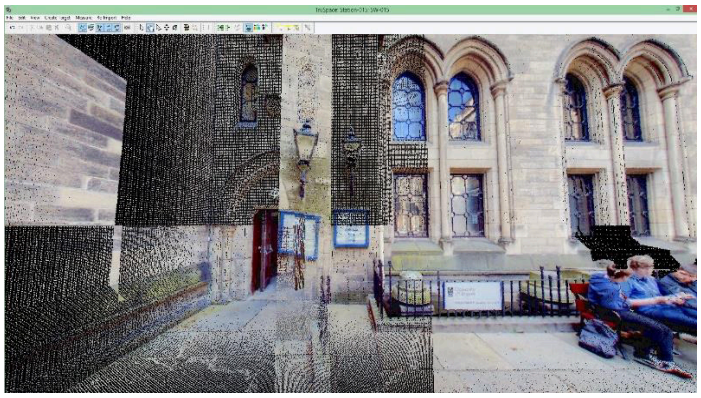
After registering the point clouds you can then colour them using iSTAR raw data directly within Leica Cyclone from version 9.1. This process does not require any pre-processing of images or exporting of point clouds in *.e57 format. The whole process of colourisation is done within Leica cyclone 9.1 and is totally integrated.

Before starting the colourisation process, ensure registration is correct with no duplicates or alignment error, otherwise mismatching

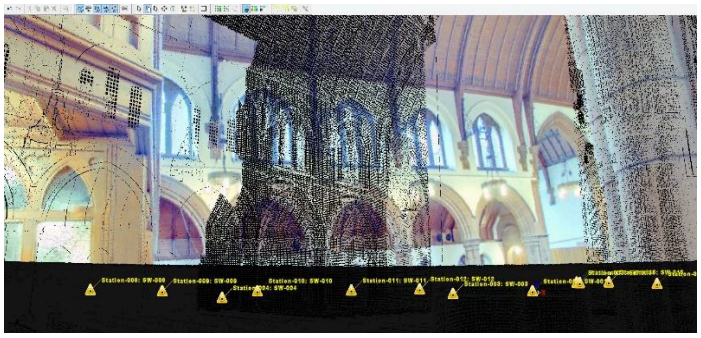


between iSTAR data images and point clouds may occur.

Img. 03.11. Example of partial mismatching between point cloud and colourisation data in Leica Cyclone 9.1.



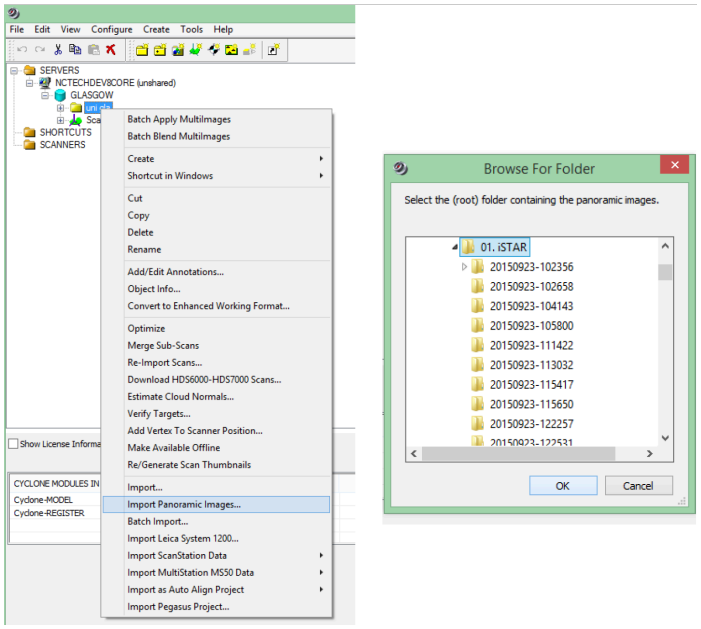
Img. 03.12. Example of partial mismatching between point cloud and colourisation data in Leica Cyclone 9.1.



Img. 03.13. Example of general mismatching between point cloud and colourisation data in Leica Cyclone 9.1.

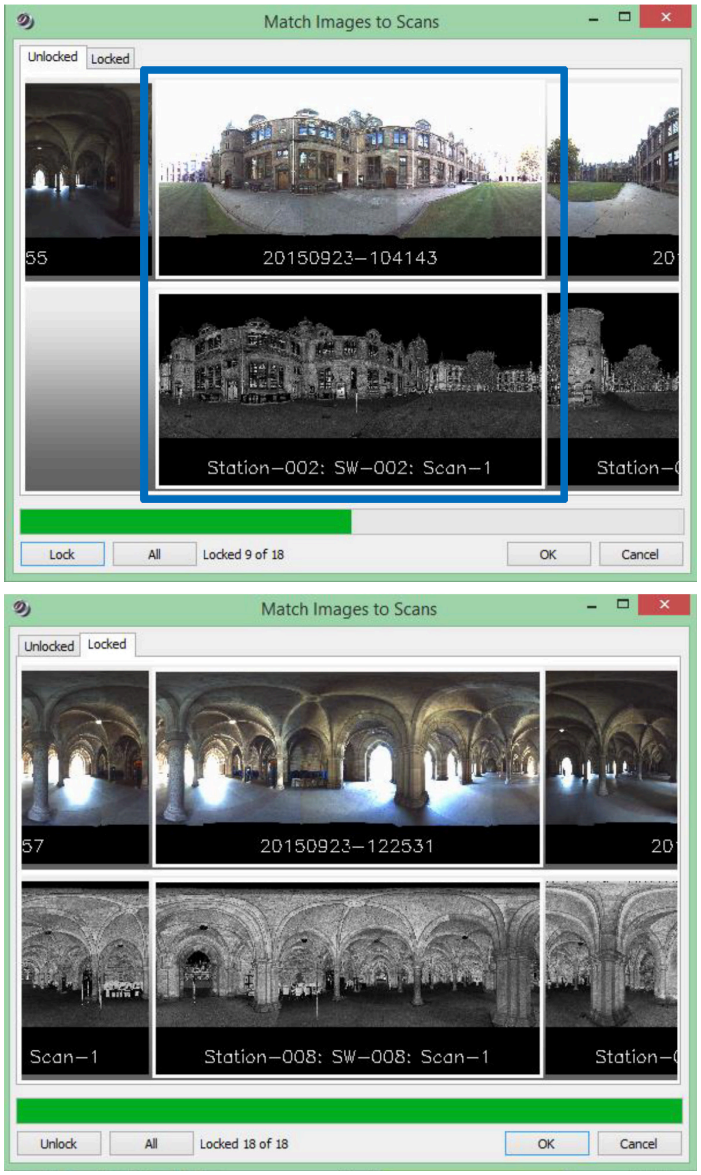
To colourise your point cloud you need to import the iSTAR raw data file into Cyclone as Panoramic Image and match each iSTAR image data with the corresponding scan station. You can then apply the image to the point cloud.

Firstly, import iSTAR data by using the option corresponding to panoramic images by clicking the right button mouse >Import Panoramic Images on the main folder database. An emergent window will appear in which iSTAR main folder need to be selected.



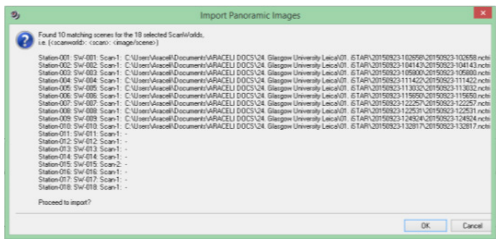
Img. 03.14. Import iSTAR image raw data folder in Leica Cyclone 9.1.

Secondly, the "Match image to Scans" window will appear automatically where a scan and image data preview are shown. Match each image data to the corresponding scan station. Lock each correspondence by clicking on "Lock" button. If "Lock" button is pressed without any pre-selection image, scan data matching will be automatically done following the proposed order. Thus, locked pairs will be moved to the "Locked" tab.



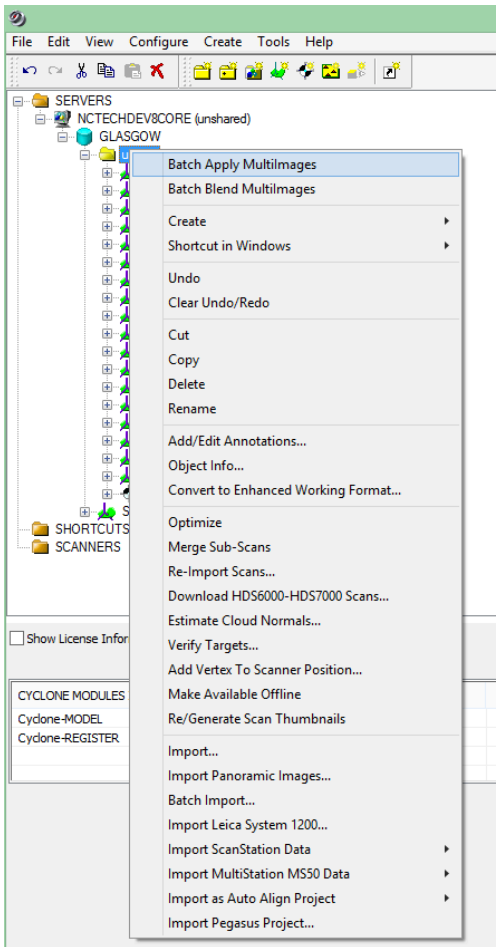
Img. 03.15. iSTAR: Leica P40 data matching in Leica Cyclone 9.1.

Once the scan station scan data is matched, click on "OK" to launch the data alignment process. When complete the "Import Panoramic Images" window will appear. Select "OK" to import the iSTAR data in cube format. Finally, just apply the colour to the images by right clicking on the main project folder and selecting "Batch Apply MultiImages".



Img. 03.16. Import iSTAR image raw data folder in Leica Cyclone 9.1.

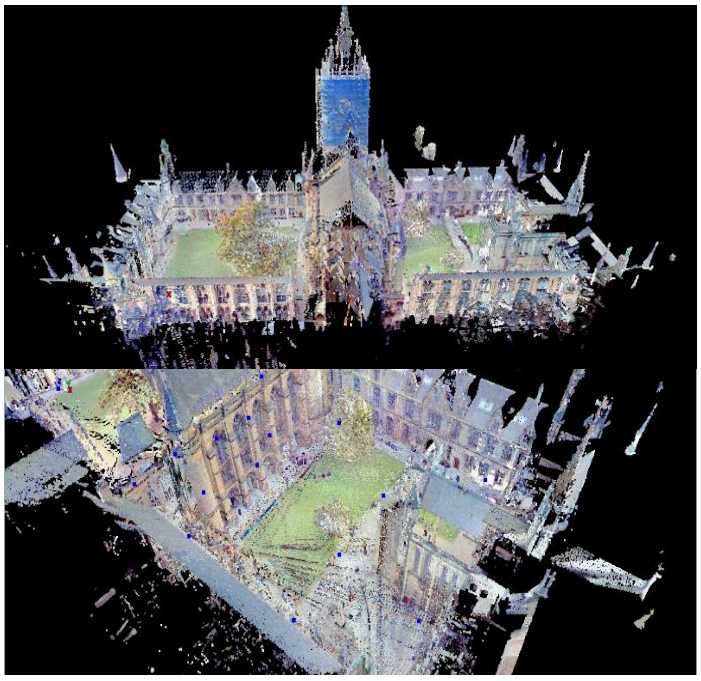
The same workflow for both import data and colourisation can be applied to a single scan station by right clicking on the scan station and selecting "Import Panoramic Images" or "Apply MultiImages".



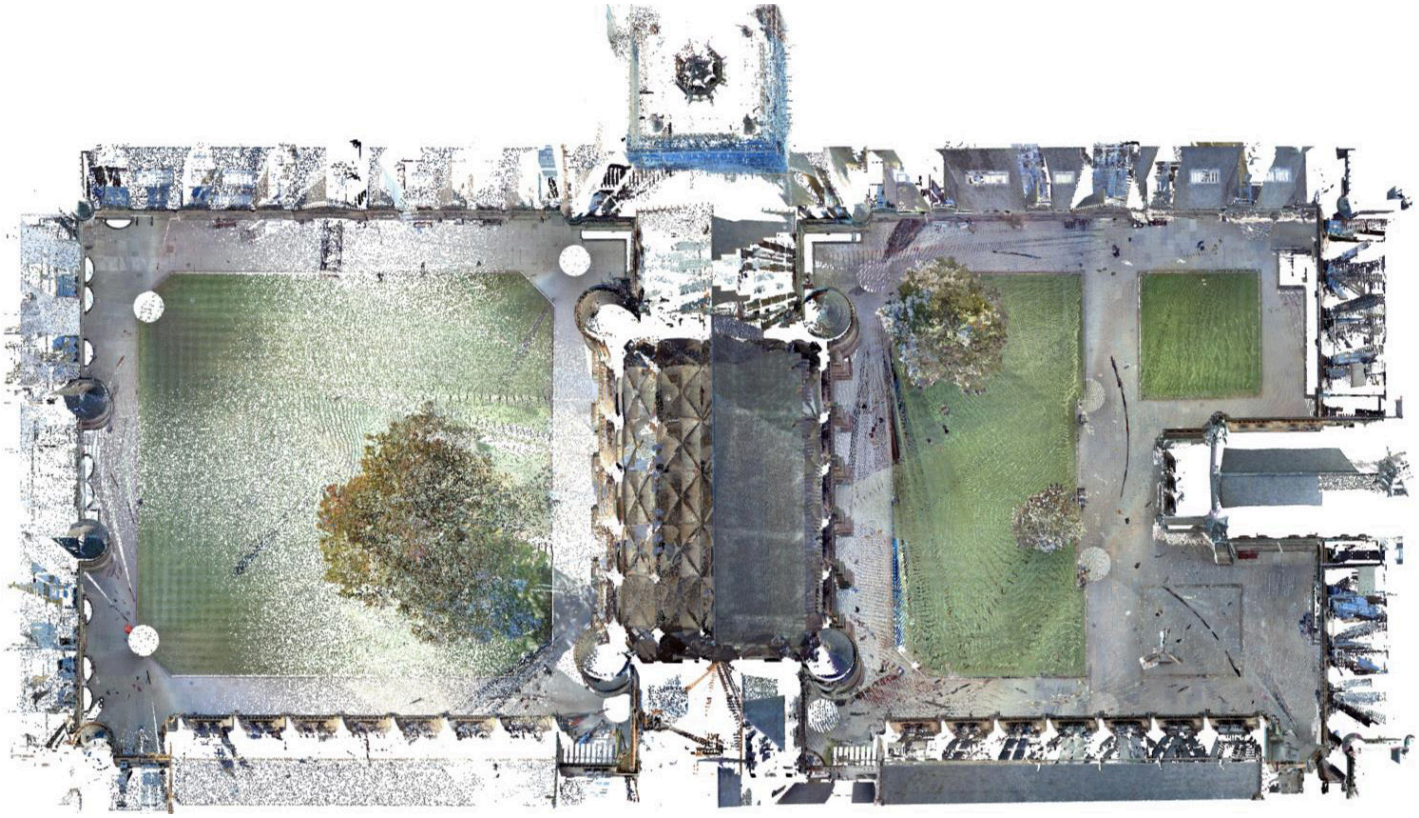
Img. 03.17. Point cloud colourisation by using "Batch Apply MultiImages" comand in Leica Cyclone 9.1.

04. Results

Coloured point clouds are obtained following described workflow. 18 Scan and iSTAR stations were used to obtain a merged coloured point cloud of Glasgow University Building. Results are showed in Leica cyclone 9.1. and also 3rd party software.



Img. 04.01. and Img. 04.02. Visualisation of Coloured Point clouds in ModelSpace of Leica Cyclone 9.1.

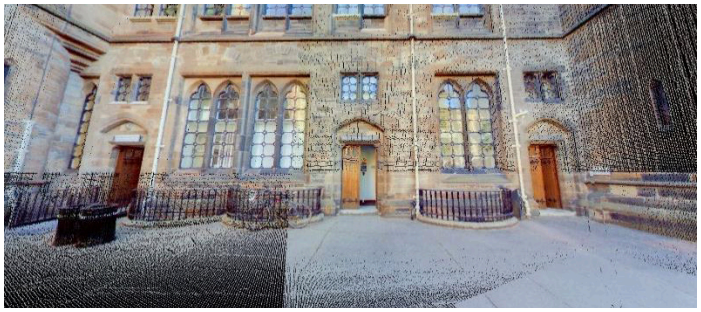


Img. 04.03. Visualisation of coloured point clouds with iSTAR data in 3rd party software. General view.

Img. 04.04. Visualisation of coloured point clouds with iSTAR data in 3rd party software. Detail.

05. Colourisation using iSTAR data compared to using internal laser scanner camera

As it is shown in the previous section, it can be observed (Img. 04.03 and Img. 04.04) that the representation of the colour in Leica Cyclone is different compared to visualisation using a 3rd party software. In this section the difference of colourisation using iSTAR data and internal laser scanner camera is analysed in both Leica Cyclone and 3rd party software.



Img. 05.01. Visualisation of Coloured Point clouds with iSTAR data in TruView from Leica Cyclone 9.1.

Img. 05.02. Visualisation of Coloured Point clouds with laser scanner internal camera data in TruView from Leica Cyclone 9.1.

Looking at Img. 05.01 and Img. 05.02 it can be observed that iSTAR data coloured point clouds give improved visual resolution for any occluded area through the interpolate and fill occluded areas function. This functionality is automatic within cyclone during colourisation, and corresponds to one of the several options that can be selected in NCTech ColourCloud.

Img. 05.03. Panorama corresponding to the raw data applied to the comparison station.

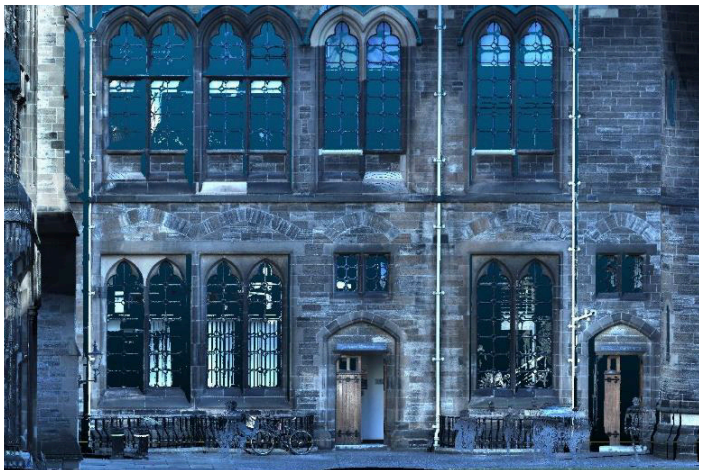
As we can see looking at the Img. 05.03. the representation of colour corresponding to iSTAR data inside Leica Cyclone looks different to the processed panorama belonging to the same raw data.

Thus, results obtained following different workflow for the same station are also compared in 3rd party software. As it is shown at Img 05.04 and Img. 05.05 the representation of colour in this 3rd party software matches with the corresponding panorama (Img. 05.03).

This allows us to compare the quality provided by each image source under the same conditions.

Img. 05.04. Visualisation of Point clouds with iSTAR data using NCTech ColourCloud in 3rd party software.

Img. 05.05. Visualisation of Point clouds with iSTAR data using Leica cyclone to colourisation in 3rd party software.



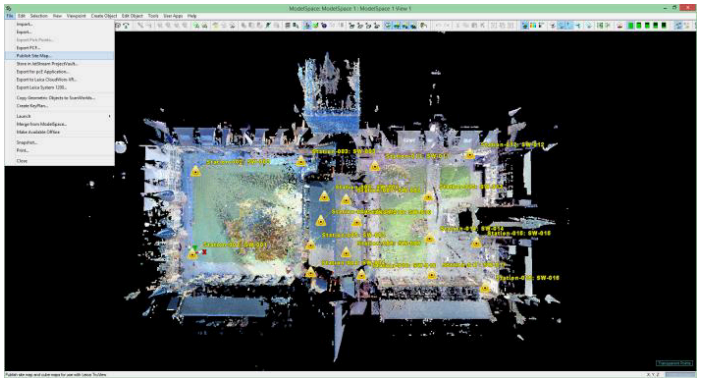
Img. 05.06. Visualisation of Point clouds with laser scanner internal camera data using Leica cyclone to colourisation in 3rd part software.

To conclude the comparison, observing the images Img. 05.04. Img. 05.05 and Img. 05.06 corresponding to the same station and visualizing in the same 3rd party software it can be noted that the results obtained from iSTAR data processed in NCTech ColourCloud or Leica Cyclone 9.1 have little discernible difference, however the using laser scanner internal camera gives lower visual quality.

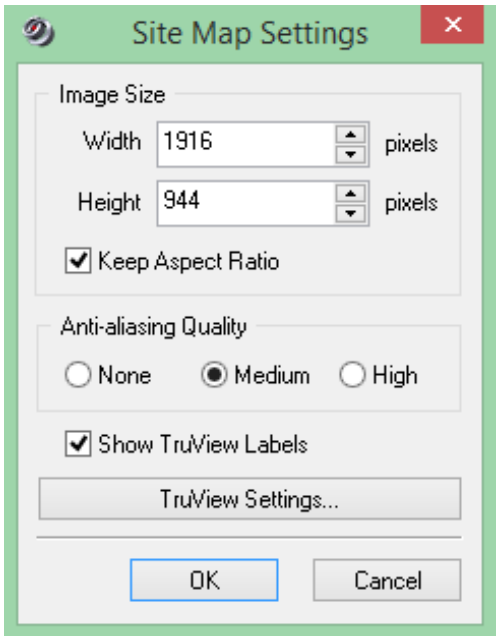
06. Leica TrueView

To view shared data with Microsoft Internet Explorer it is necessary to install the TrueView plugin for Internet Explorer which can be downloaded from hds.leica-geosystems.com/en/Leica-TruView_63960.htm

To create a TrueView, open the ModelSpace to be shared and position the model so that all scan positions can be seen, this will be the "Site Map". Then, go to File>Publish Site Map, select or create the corresponding folder and the Scan World and a "Site Map Settings" window will appear.

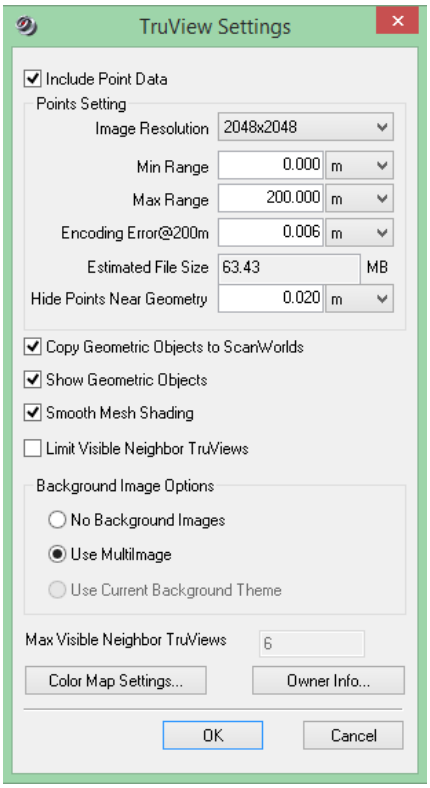


Img. 06.01. Visualisation of point clouds with laser scanner internal camera data using Leica cyclone to colourisation in 3rd part software.

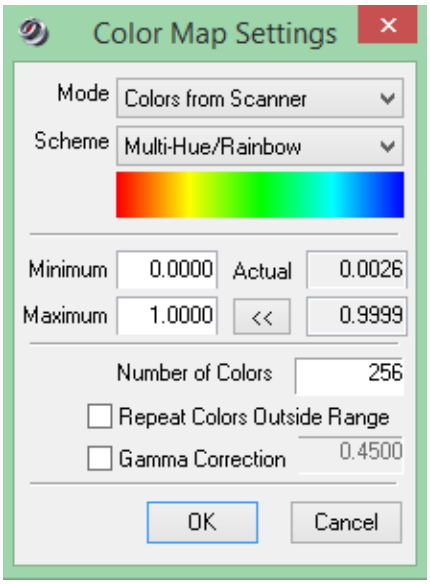


Img. 06.02. Site Map Settings window within Leica Cyclone.

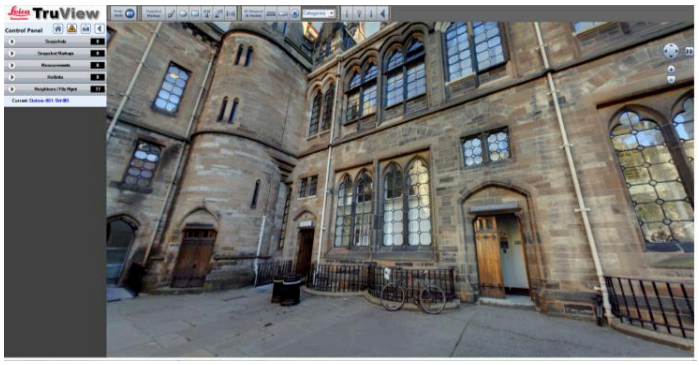
From this "Site Map Settings" window you can access to "TrueView Settings". Ensure that in "Color Map Settings" your model is set to "Color from Scanner".



Img. 06.03. TrueView Settings window within Leica Cyclone.



Img. 06.04. Color Map Settings window within Leica Cyclone.



Img. 06.05. TrueView for Internet Explorer.

Once the TrueView is created, click SiteMap.htm to open the project. The same exported data can be used within TrueView Global with no plugin required. For further information about TrueView Global visit www.leica-geosystems.co.uk/en/Leica-TruView-Global_106856.htm and truviewglobal.leica-geosystems.com/welcome

07. Conclusion

Coloured point clouds can be obtained through using iSTAR for image capture, then following the scan data colourisation method as described here. In the case described in this Application Note, the visualisation of coloured data in Cyclone could be improved compared to 3rd party software.

Despite this, working with NCTech solutions combined with the Leica P40 Laser Scanner for point cloud colourisation is considered advantageous to alternative techniques for a number of reasons:

Only one iSTAR shot is needed to colour the entire scene at each view instead of multiple shots and images per position. This means less time on site and also eliminates patchy colourisation experienced where individual images are optimised for their omnidirectional view, then combined.

Knowledge of photography techniques is not needed since iSTAR analyses the whole scene and work out the most suitable camera settings for the full 360 view.

Simple use, minimal training. iSTAR and NCTech software are designed to be highly automated and user friendly, with minimal training required.

Automatic overlay of iSTAR images to point clouds, avoiding having to manually define common points, eliminating user error and enabling batch processing for efficient operation.

High performance output in difficult lighting conditions. iSTAR can provide high visual quality images in a wide range of lighting environments as a result of the automatic HDR settings and EV range of 27 f-stops.

Reduced fieldwork data capture time. iSTAR can provide high visual quality images (HDR ON: 5 exposures, HDR PRO: 9 exposures) in less time than LaserScanner internal camera (HDR images with 3 exposures). Taking a HDR image with iSTAR takes from 1.50'corresponding to light conditions (4s Analysing + 7s Capturing + 1.39' Saving = 1.50' Total to 4.50' corresponding to dark conditions (1.40' Analysing + 1.20' Capturing + 1.90' Saving = 4.50' Total) depending on lighting conditions but it usually takes around 2.00' on average in normal light conditions. Nevertheless, taking photos with internal laser scanner camera increases the capturing time with laser scanner in 10 minutes on average.

Reduced office time for data processing. iSTAR data from each station is converted into 6 different images for Cyclone import whereas the internal laser scanner camera provides 259 images per station resulting in a longer import time and colourisation process.

Quality of coloured point clouds is improved. iSTAR data produce improved visual quality compared to the laser scanner internal camera. Further improvements are gained through additional features such as "interpolate and fill occluded areas", automatically applied when colourisation is processed in Leica Cyclone 9.1 and other options in NCTech ColourCloud.

Fully integrated workflow. NCTech ColourCloud technology is integrated within Cyclone from version 9.1 onwards and therefore, the user benefits from a workflow within his ususal point cloud software with no need to learn new software or change his workflow. In addition, benefits from using iSTAR data extends to Leica True View where data can be used within the same way as internal laser scanner images.

08. Aknowledgements

NCTech greatly thanks Leica Geosystems www.leica-geosystems.co.uk , especially Gary Kelly and Mark Benjamin for their collaboration and technical support in this Application Note.

For further information about iSTAR or NCTech software visit www.nctechimaging.com or contact us sales@nctechimaging.com