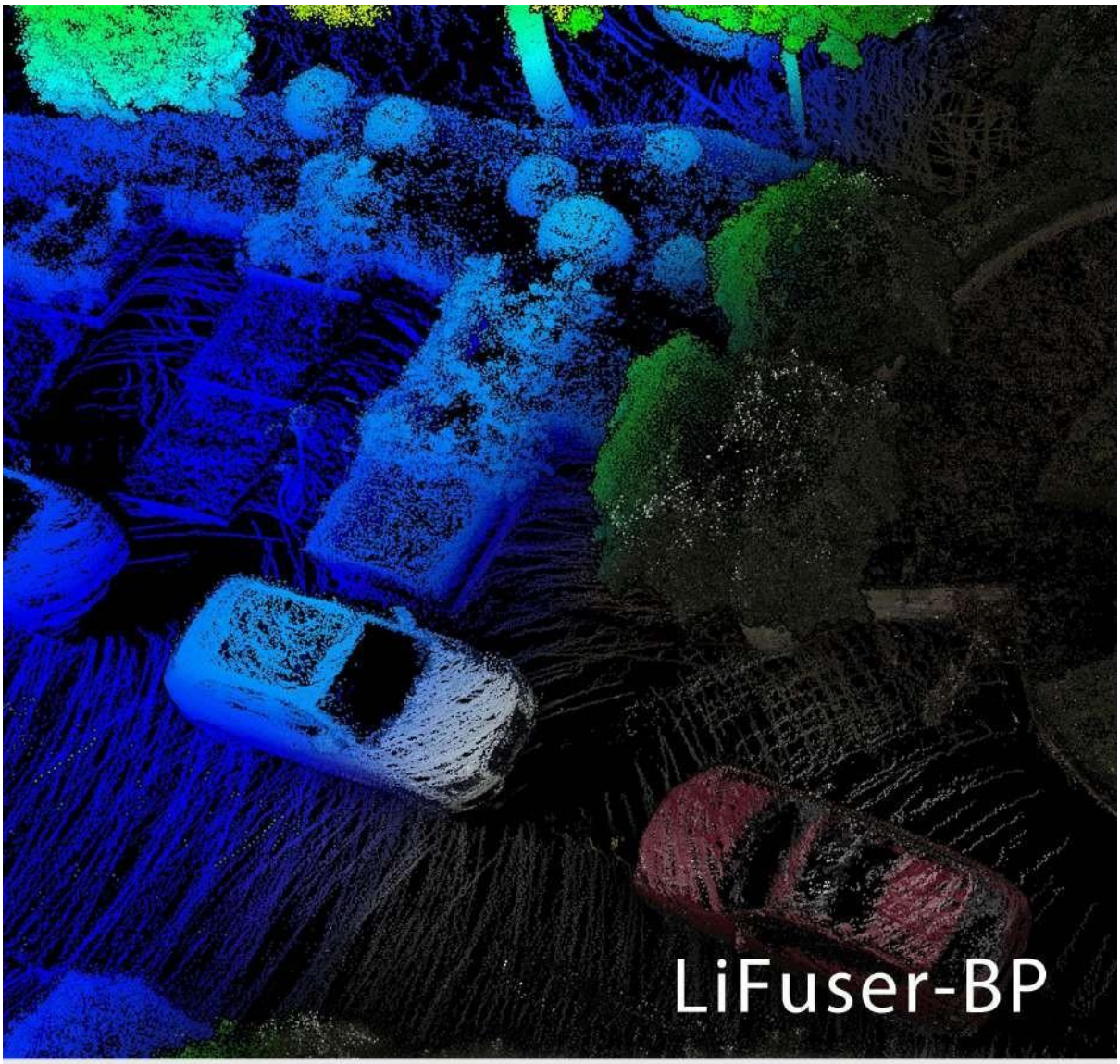

Mobile Scanning Data Fusion Software

User Guide

GreenValley International

Table of Contents

1. Copyright

GreenValley International

LiFuser-BP V1.5

User Guide

Imprint and Version

Document Version 1.5

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Dear Users,

Thank you for using LiFuser-BP software. We are pleased to be of service to you with LiDAR point cloud manipulation solutions. At GreenValley International, we constantly strive to improve our products. We therefore appreciate all comments and suggestions for improvements concerning our software, training, and documentation. Feel free to contact us via info@greenvalleyintl.com. Thank you.

Legal Notes

Date printed: 10th May 2023

2. Introduction

LiFuser-BP is a laser scanner data fusion software supporting the MLS LiDAR scanning systems developed by GreenValley International inc.

The main functions of the software include:

- High-precision point cloud solution
- TrajectoryProcess
- Point Cloud Data Visualization and Editing
- Point Cloud and Panoramic Image Roaming
- Point Cloud Registration
- Moving target removal
- Panorama Calibration

Other common tools include:

- Project Management
- Measurement Tools
- Profile Tools
- Batch Tools
- Viewing Tools
- Color Bar Tools
- Select Tools
- Cut Tools
- Export Tools
- Coordinate Conversion Tools

Multi-Project splicing includes:

- Multi-project splicing

3. Install

3.1 Operating Environment

A high-performance workstation is recommended, and the configuration requirements are as follows:

- **Memory (RAM)**: 32GB and above.
- **Central Processing Unit (CPU)**: Intel® Core™ i5/i7 recommended; 8-core 16-thread processor, single-core processing performance of 4GHz and above.
- **Hard Disk**: Computer processing data disk recommended SSD solid-state hard disk or computer built-in enterprise-level mechanical hard disk, transmission speed 100M/s and above.
- **Display adapter**: NVIDIA discrete graphics card is recommended, and the video memory is not less than 6GB.
- **Operating System**: Microsoft Windows 7 (64-bit), Microsoft Windows 8 (64-bit), Microsoft Windows 10 (64-bit),Microsoft Windows 11 (64- bit) or Windows Server 2012 and above.

> For Windows 8 , Windows 10 and Windows 11 if the software is installed on the system disk, it needs to be set to run as an administrator. Note: Please use the high-performance graphics mode to run the software, see [Adjustment of high-performance graphics mode] (Appendix_High-PerformanceGraphicsModeAdjustment.md) for the operation steps.

3.2 Installation steps

1. Run the LiFuser-BP data fusion software installer.
2. The installation dialog box appears, click "Next".
3. If you accept the terms in the license agreement, click "I Agree" to continue.
4. Select the installation path (or use the default settings) and click Install.
5. After the installation is complete, click Finish.

3.3 License Manager

There are two types of LiFuser-BP licenses, a hard-lock license and a soft-lock license. The hard-lock license provides a USB flash drive, and the soft-lock license provides an authorization code. The user is not allowed to format, delete, copy and other operations on the hard-lock license U disk, and the user must properly manage the hard-lock license U disk.

1) Hardlock license

At present, the LiFuser-BP software detects the hard-lock license in real time, and the user must correctly insert the hard-lock license U disk into the USB port of the host computer.

2) Authorization code

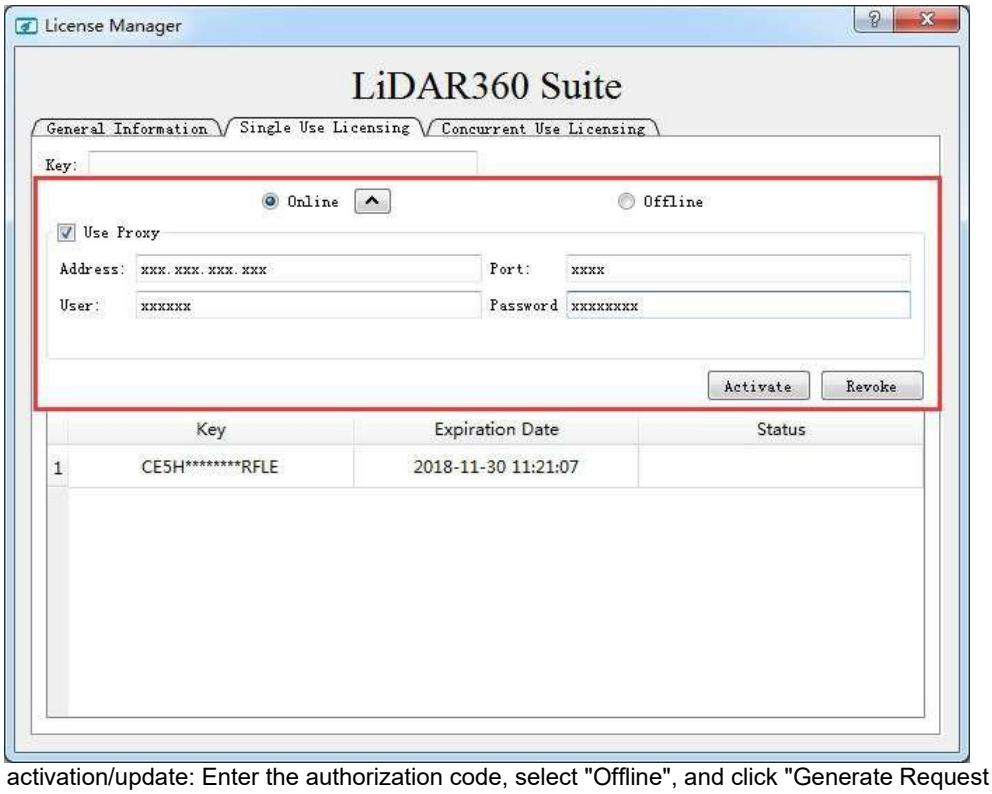
The authorization code is generated based on the activation information provided by the LiFuser-BP user. After purchasing an authorization code, follow the steps below to activate LiFuser-BP.

1. Run LiFuser-BP, the license management dialog box will appear.
2. Fill in the name and company name, select the module to be activated, and click "Copy".
3. Paste the copied information into the body of the email and send it to info@lidar360.com.

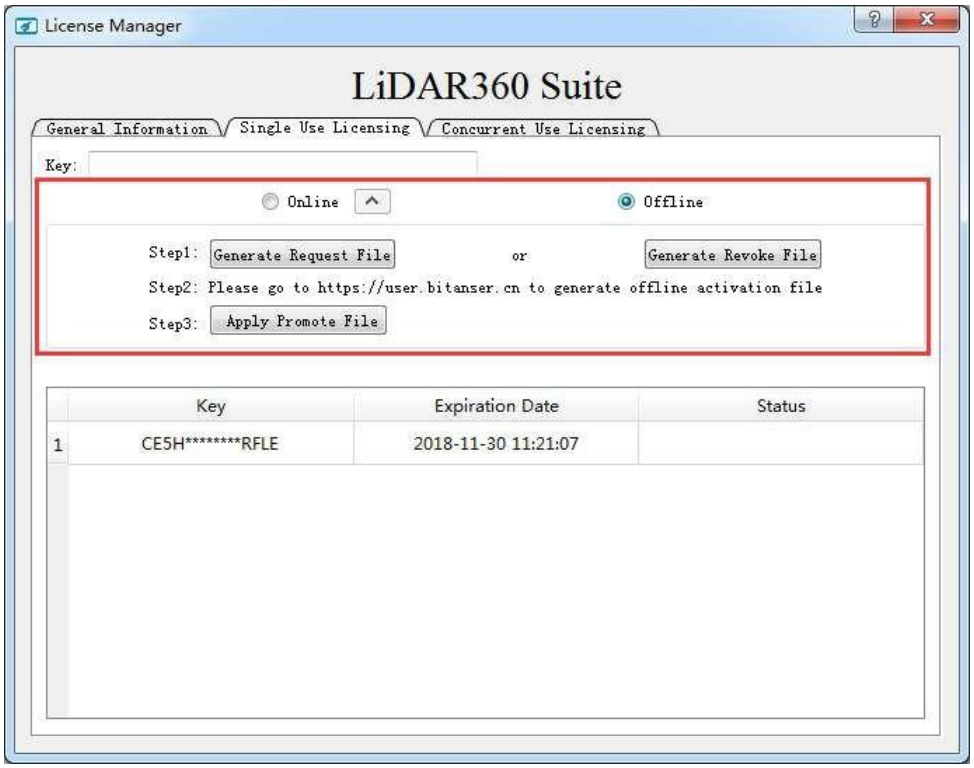
4. The software authorization mode is divided into stand-alone authorization and group authorization. After receiving the authorization code, it can be activated and migrated online or offline.

   - Stand-alone license
   - Activate/Update

   Online activation/update: When the user can connect to the Internet, enter the authorization code on the "Single-machine authorization" tab, select "Online", click "Activate" to activate or update online, or select the authorization code in the Key list and right-click , and select "Activate Key" from the pop-up menu. You can view the expiration time of the authorization code on the interface, select the authorization code in the key list, and view the expiration time of each module authorization in the software list interface supported by the current key. Click  , you can use the proxy, set the address, port, username and password.



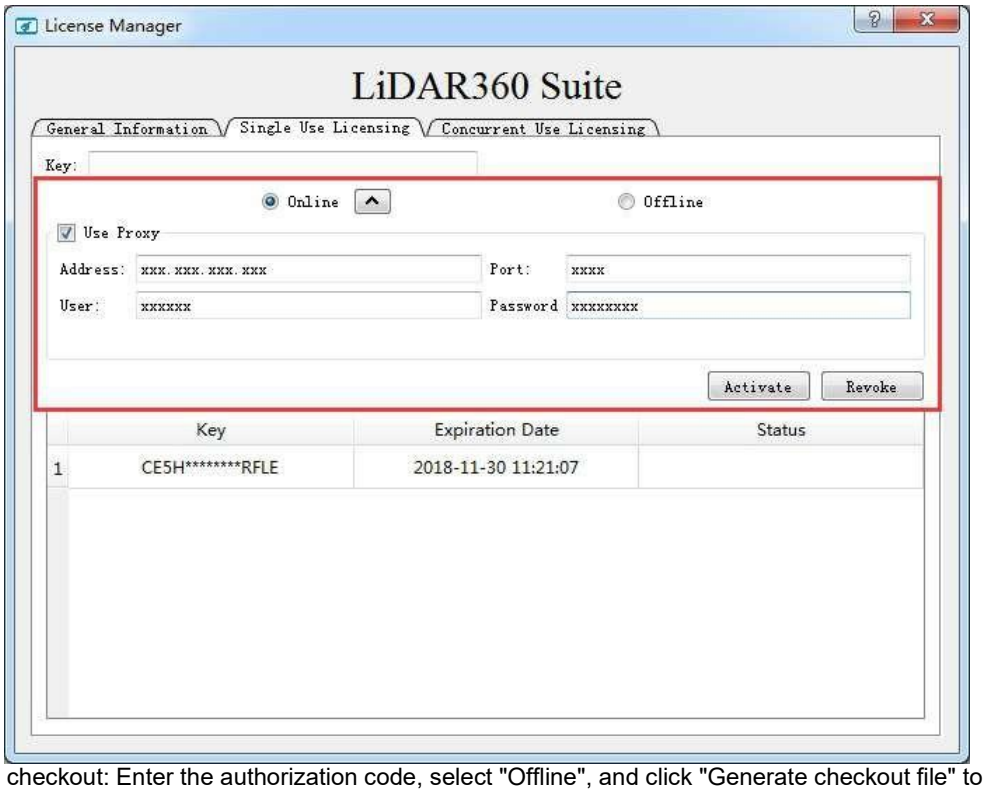
   Offline activation/update: Enter the authorization code, select "Offline", and click "Generate Request File" to generate a request file (.req). With a computer that can connect to the Internet, enter https://user.bitanswer.cn in the browser, enter the authorization code to log in, click "Offline Upgrade", upload the request file (.req), and download the generated upgrade file (.upd). On the license management interface, click Apply License File.



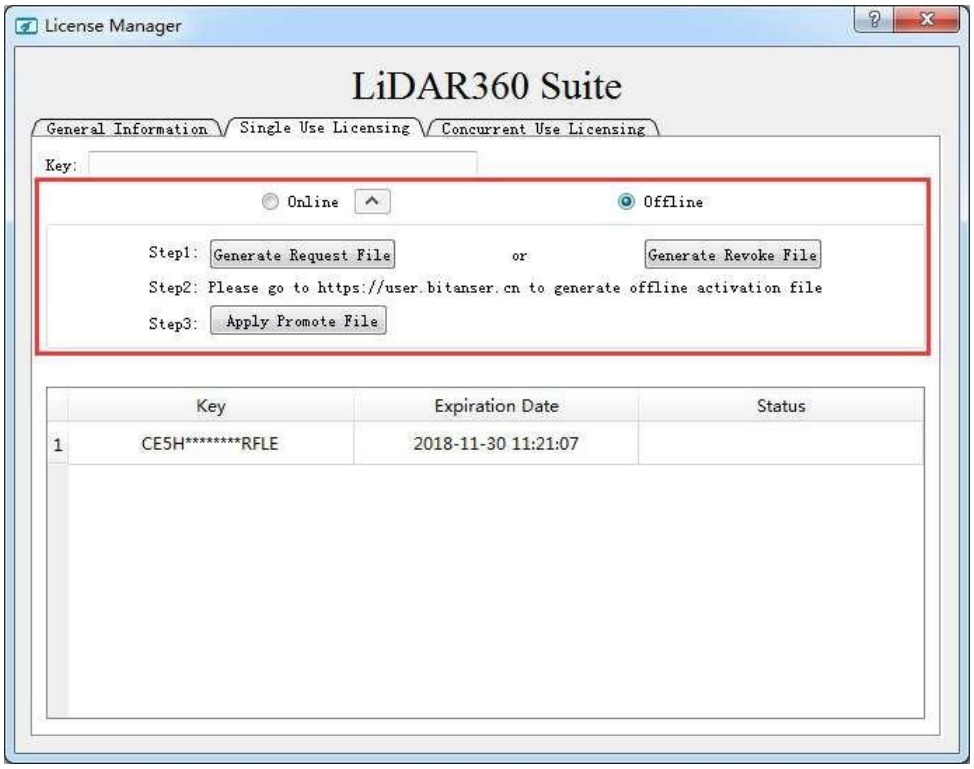
- Migration

  When the user needs to unbind the authorization code from the machine, the authorization code can be migrated online or offline. After the authorization code is checked out, it can be used on this machine and other machines by activating it again, and you can re-enter the authorization code for activation.

  Online migration: On the "Single-machine Authorization" tab, enter the authorization code, select "Online", and click "Migrate", or select the authorization code in the Key list, right-click, and select "Migrate key" from the pop-up menu. . Click ^, you can use the proxy, set the address, port, username and password.

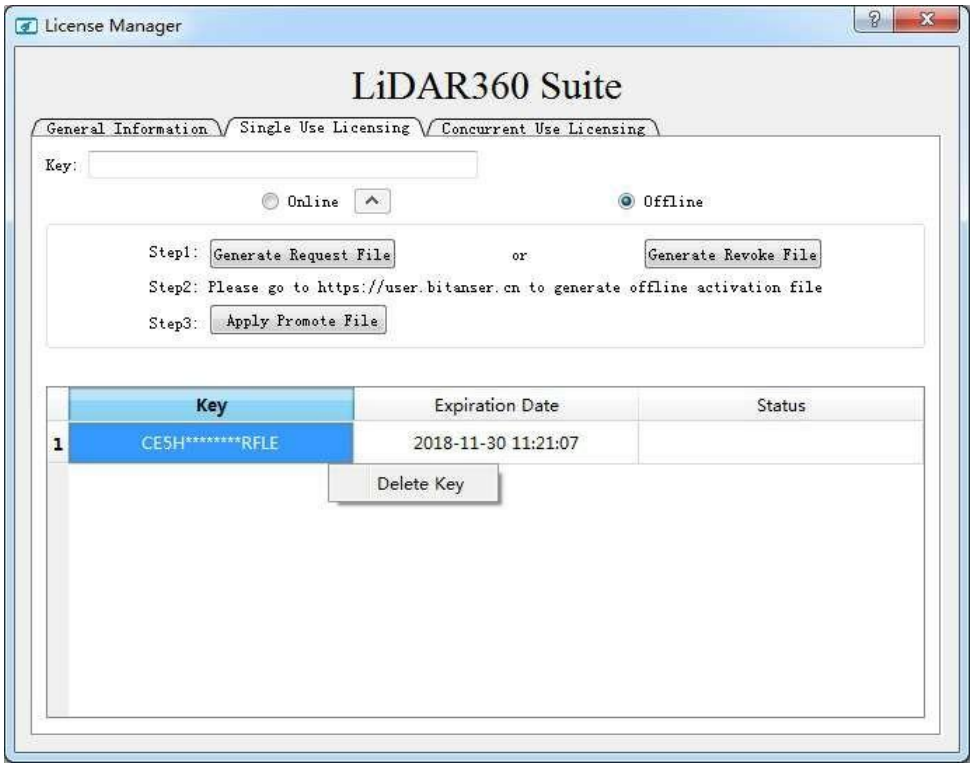


Offline checkout: Enter the authorization code, select "Offline", and click "Generate checkout file" to generate a checkout request file (.req). With a computer that can connect to the Internet, enter https://user.bitanswer.cn in the browser, enter the authorization code to log in, click Offline Upgrade, upload the request file (.req), and download the generated upgrade file (.upd). On the license management interface, click Apply License File.



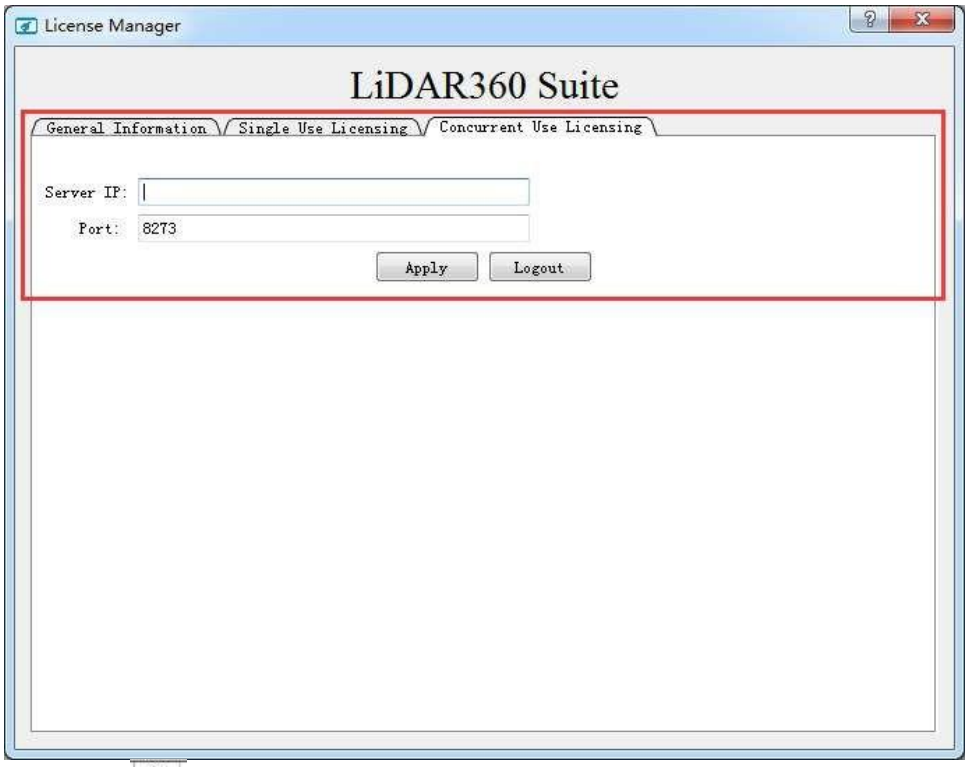
- delete

When the user needs to delete the authorization information from the machine, he can right-click the authorization code and select delete key. After the authorization code is deleted, it can be activated again on this machine and cannot be used on other machines.



- Group authorization

Install the group authorization service tool on the group server in the local area network and add the group service extension module. In the group authorization management center, activate the authorization code online or offline. Other users in the local area network enter the IP address and port of the server on the license activation interface. The default is 8273, no need to modify, click "Apply".



5. Click the help button in the upper right corner of the license management interface to view the license Administration help manual.

> Note: If the software is already open when the license code is updated, please restart the software after the update.
>
> Note: If the authorization code has been used on one of the machines and is now used on the other machine, the authorization code should be checked out on the first machine first. If the activation code has been deleted, it should be activated on this machine first, and then migrated out.
>
> Note: Please contact info@lidar360.com to inquire and purchase a license key to activate LiFuser-BP.

3.4 Programming language switch

The software currently provides three languages: English, Chinese,Japanese. Users can switch according to their needs. The switching steps are as follows:

1. Tap *Display* > *Language* > *English, Chinese,Japanese.*
2. Click "Yes" to restart the software and complete the software language switching. After selecting "Cancel", the software will not be restarted, but will be displayed in the set language when the software is launched next time.

4. Create/Open Project

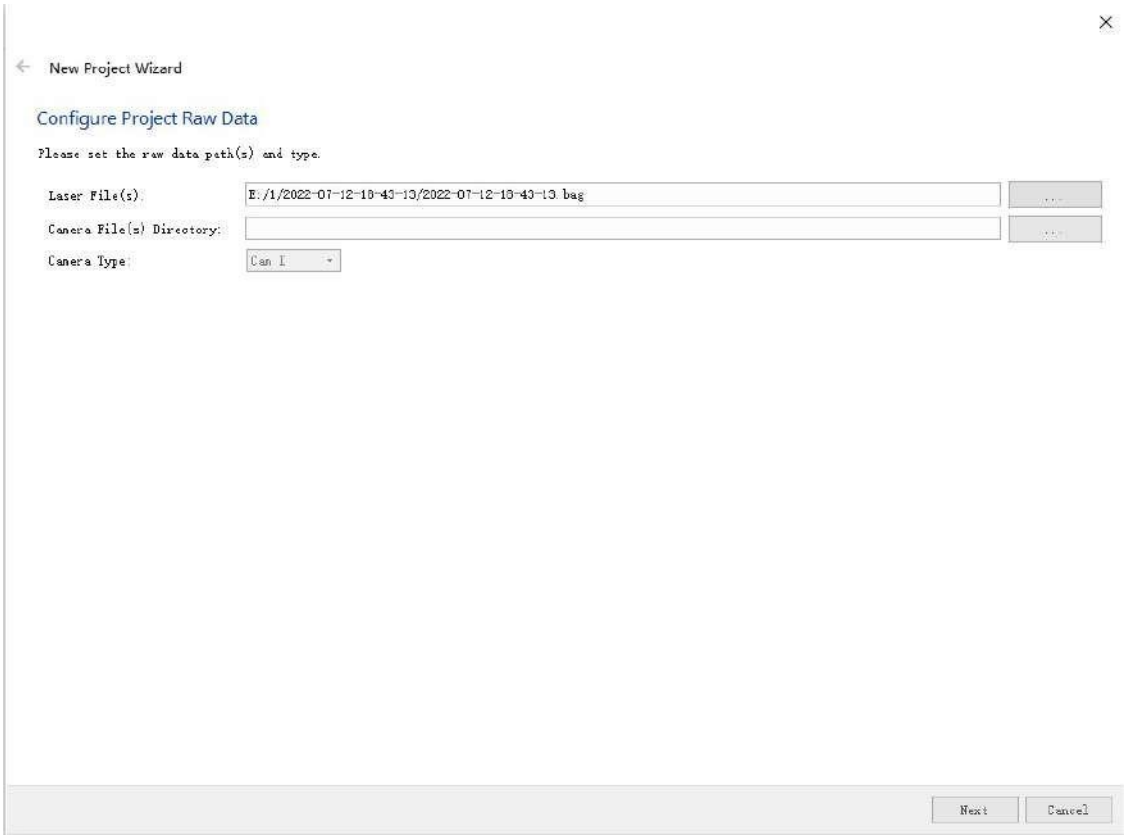
Before starting to process the data, it is strongly recommended that the data collected by LiGrip,LiBackpack are put in the computer's local disk, with a specific working directory. It's better to use letters and numeric characters as directory name, for example, "LiGripData,LiBackpackData00".

4.1 Create project

New Project Wizard includes 4 interfaces: Configure Project Raw Data, GNSS data, Coordinate System and Open Trajectory. Each one is used to configure corresponding data. Invalid data or configuration in any step will make the process be unable to processed. When project is finished, users can also set parameters in SLAM Process. Each step is explained as below:

4.2 Configure Project Raw Data

Launch the software, select **New**, click *Backpack*  , and the Configure Project Raw Data interface will appear:



Configure Project Raw Data

- **Laser Files**：The raw data (.bag) collected by LiGrip/LiBackpack can be downloaded from the Collection Interface. Click the button on the right side and import the .bag file required.
- **Camera Files Directory**（**Optional**）：The directory where the original video file (.mp4 or insv) is located, such as the LiGrip H300 device, if you want to get the color point cloud, you need to select the directory where the original video file (.mp4 or insv) is located. Click the button on the right and select the directory where the camera video is located. If there is no video data, this option can be skipped.
- **Camera Type**：default.

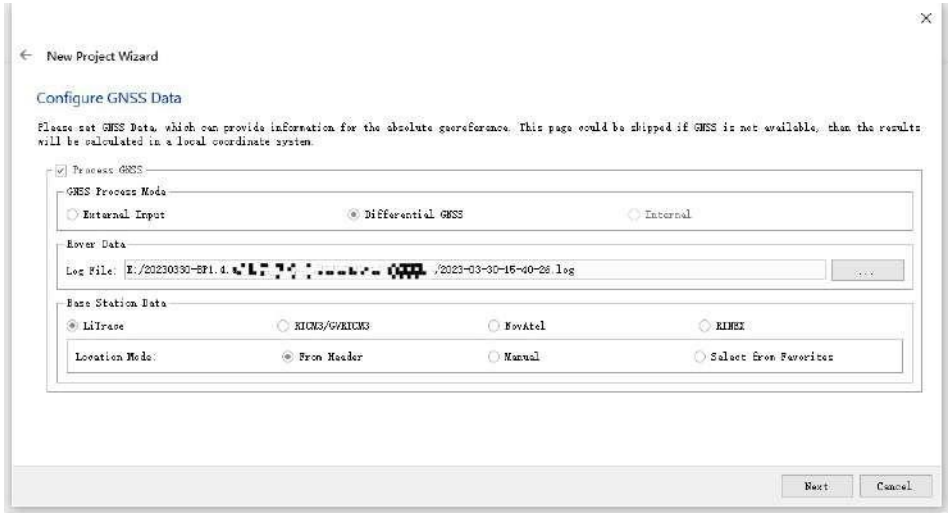
4.3 Configure GNSS Data

This step is only designed for a LiGrip/LiBackpack equipment with GNSS function, like LiBackpack DG50H. Users can skip this step if there is no GNSS data. The configuration of GNSS data includes 3 ways: External Input, Differential GNSS and Internal.

- **External Input**：Import trajectory file that already existed. For now, only .LiGNSS ,rtk,pos file is accepted. Check **Process GNSS**. Click **Extrnal Input** button after that page will go to external input mode. Choose responding tracjory file by click right button. When it is done, go to next step.
- **Differential GNSS**. Then the page will process Differential GNSS Model, in which users need to configure data of both base and mobile station. The solving result will be generate as .LiGnss.
  - **Rover Data**：Mobile station data (.log) acquired by LiGrip/LiBackpack. Click the button on the right to choose.
  - **Base Station Data**：Four formats, LiTrace、RTCM3/GVRTCM3、NovAtel and RINEX.
    - **LiTrace**：Applicable to the **Virtual Base Station** data constructed by the user in the GreenValley APP (Batch process is not currently supported).

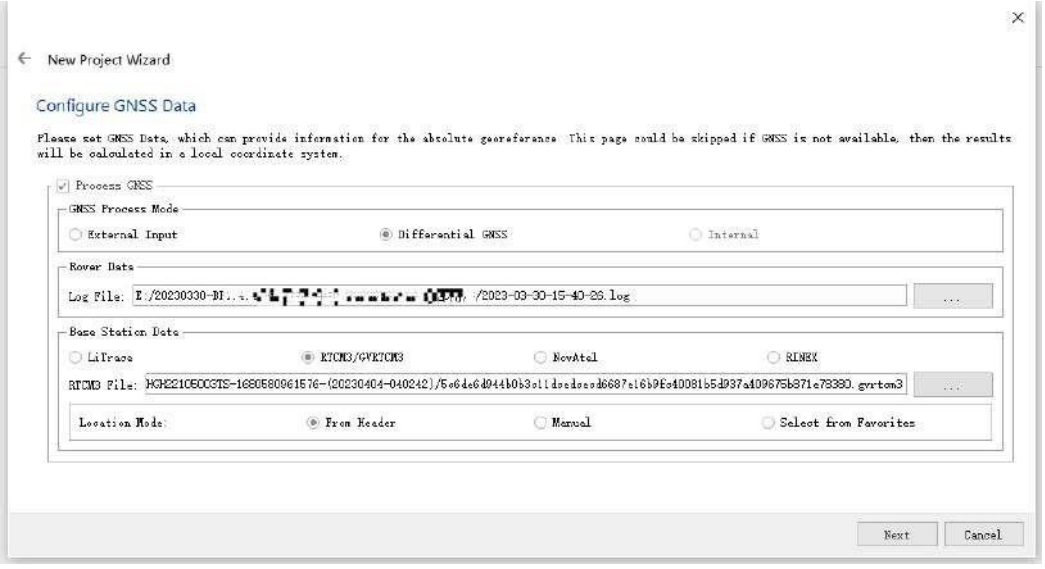
> Please read the following precautions carefully when using this function:
>
> | Type | Steps | LiTrace operation result |
> | --- | --- | --- |
> | 1 | ① ✓ App virtual base station erection
②✓ Check the virtual base station priority
③✓ LiTrace solution | The user sets up a virtual base station in the GreenValley APP, and logs in to the LiCloud account and checks the priority of the virtual base station when the BP software solves it. At this time, the BP software will give priority to downloading the virtual base station and bring it into the solution; |
> | 2 | ① ✓ App virtual base station erection
②✕Unchecked virtual base station priority
③✓ LiTrace solution | If the virtual base station is set up in the APP, but the virtual base station priority option is not checked, the post-event base station will be downloaded when the BP software LiTrace solves; |
> | 3 | ①✕ The app virtual base station is not set up
②✓ Check the virtual base station priorityCheck the virtual base station priority
③✓ LiTrace solution | If the virtual base station is not set up in the APP, and the virtual base station priority option is checked, the BP software LiTrace will not be able to solve the base station data when calculating, and an error will be reported when running. |
>
> precautions
>
> - When using this function, you need to log in to the LiCloud account in the **Account** settings. When the login is successful, it will prompt "Successful login!"; please ensure that the **Virtual base station priority** option is checked, and you must confirm the account number for downloading base station data and the account number for setting up the base station The account number is the same!
> - Please make sure that there are enough coupons in the LiCloud account. BP software will spend a certain amount of coupons (about 10 coupons per kilometer) when using **LiTrace** to solve the problem.

login account



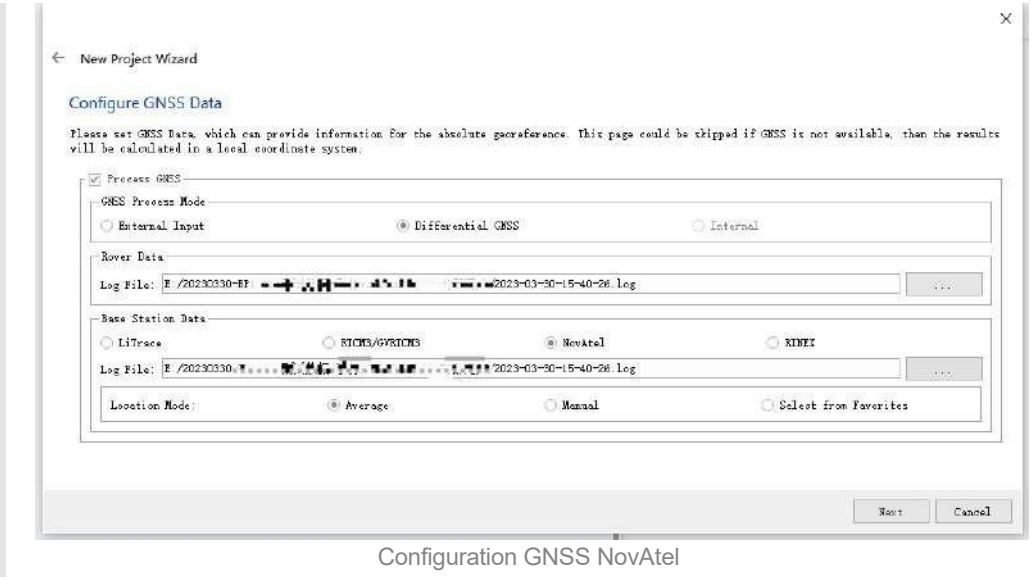
Configuration GNSS LiTrace

- **RTCM3/GVRTCM3**：For the data format of the Virtual Base Station, click the button on the right to select the base station raw data (.RTCM3 or .GVRTCM3).



Configuration GNSS RTCM3/GVRTCM3

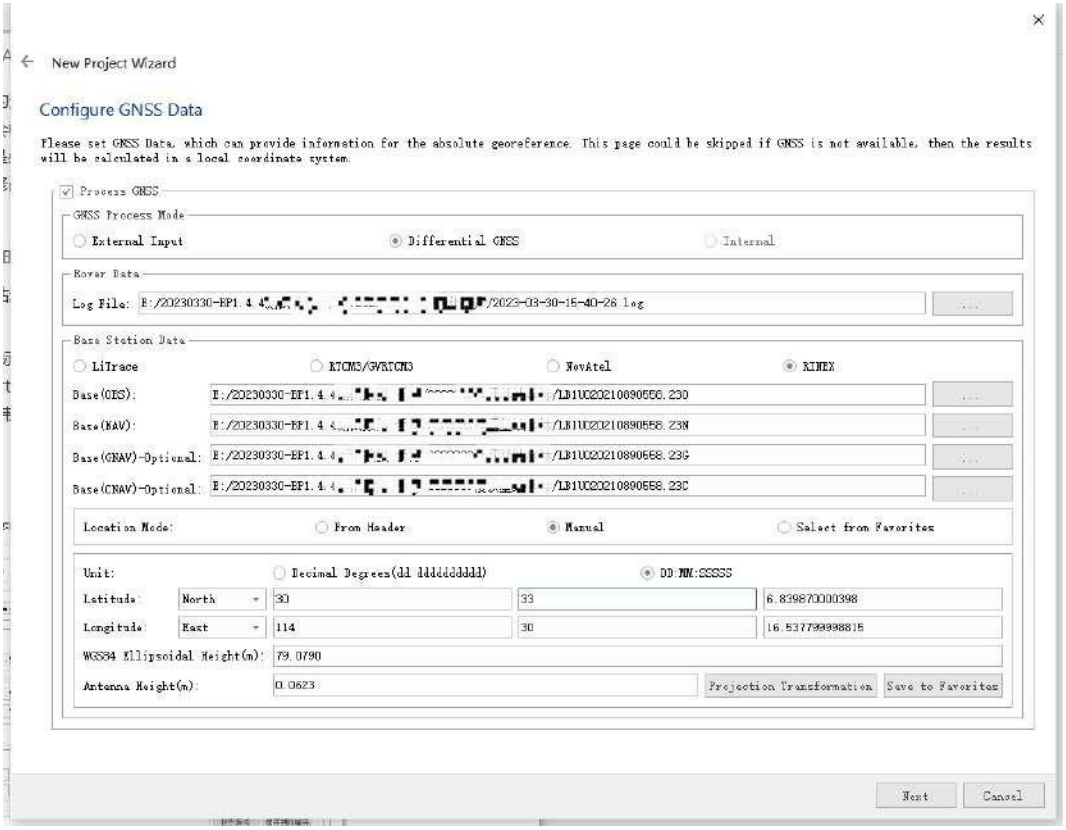
- **NovAtel**：Suitable for NovAtel base station.



Configuration GNSS NovAtel

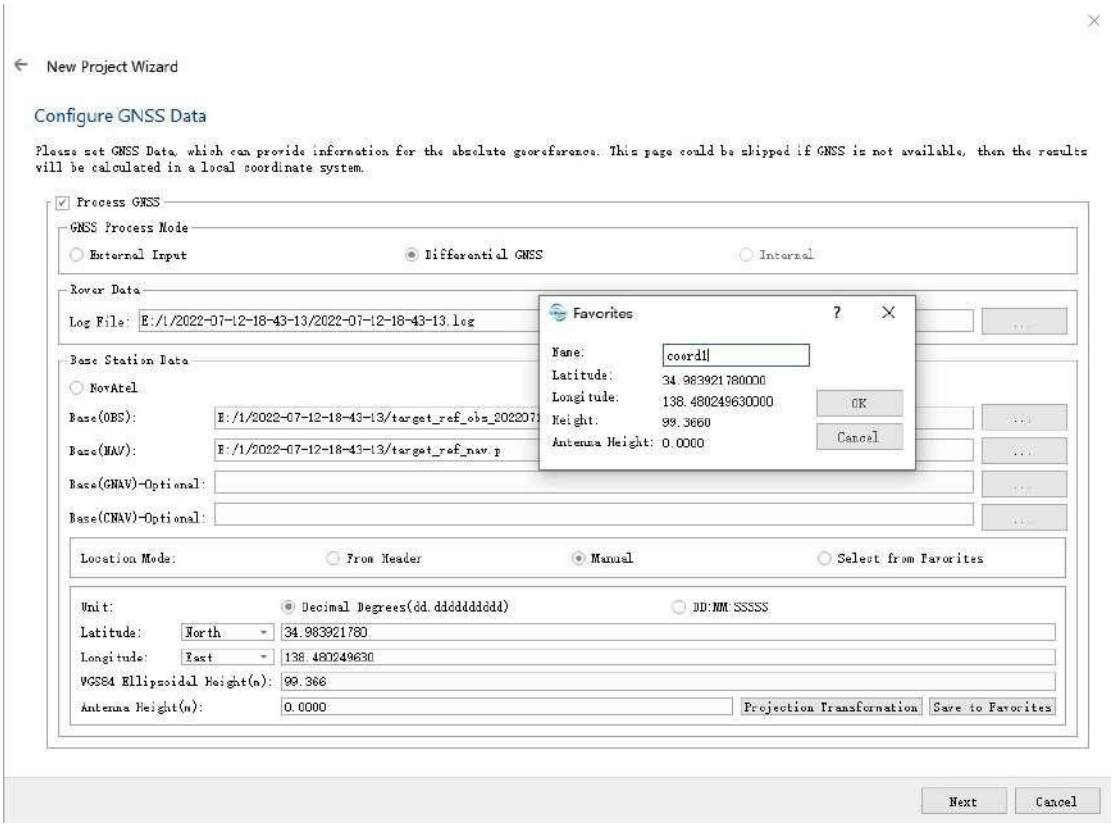
- **RINEX**：Suitable for base station data that have been transformed into common format. Click the button on the right side and select the base station file (RINEX OBS). If the file is loaded normally, the software will automatically add in the rest files (NAV、GNAV、CNAV) according to its format. It should be noted that OBS and NAV are mandatory file while others are optional. Users need to check if files are added in correctly, if not, modify manually.

- **Location Mode**：Base station coordinates solving mode.
  - **Average**：Calculate averagely. Default mode when choose NovAtel.
  - **From Head**：Read from head file(if exists). Default mode when choose LiTrace、RTCM3/GVRTCM3、 RINEX.
  - **Manual**：Add base station coordinates manually. Enter WGS84 coordinates, Ellipsoidal height and antenna height. Latitude and longitude values should be positive. If real latitude values is positive, select North(otherwise select South); if real longtitude values is positive, select East(otherwise select West).Steps are shown below:



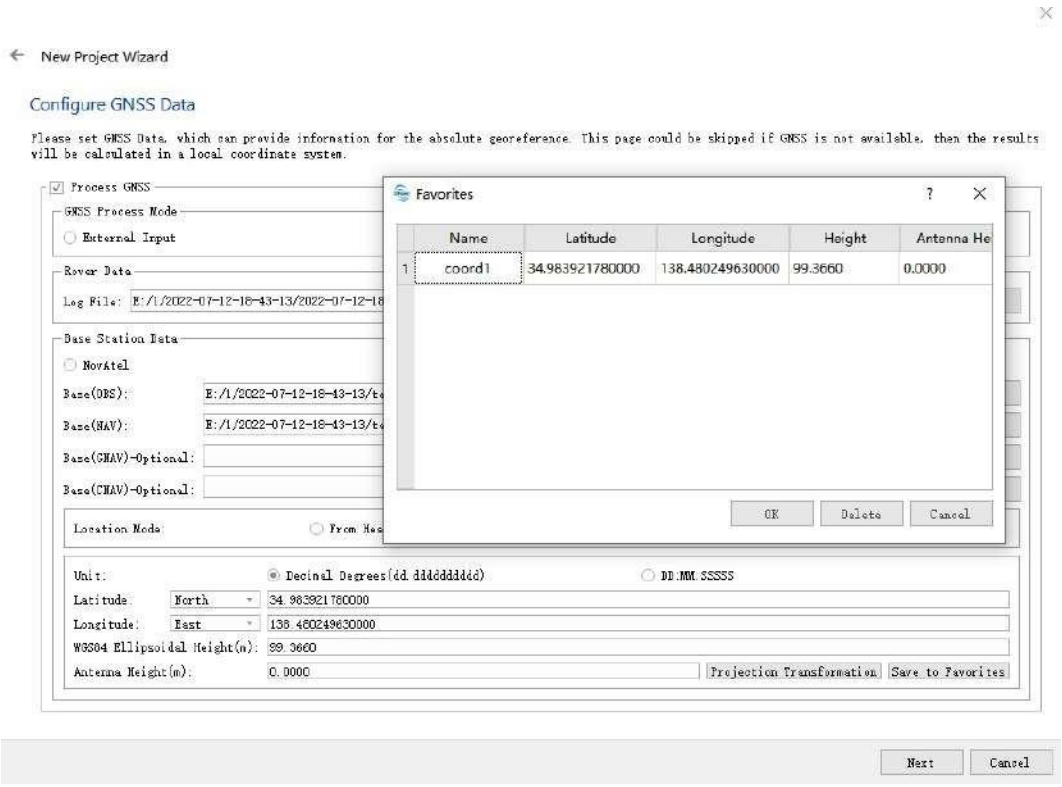
Add base station coordinates manually

Click **Save to Favorites** to save the current base station coordinate parameters:



save base station coordinate

- **Select from Favorites**：Select base station coordinates from favorite list. List is empty when first time using. And users need to manually enter and save their own base station coordinates under **Manual** mode.



Select from favorite list

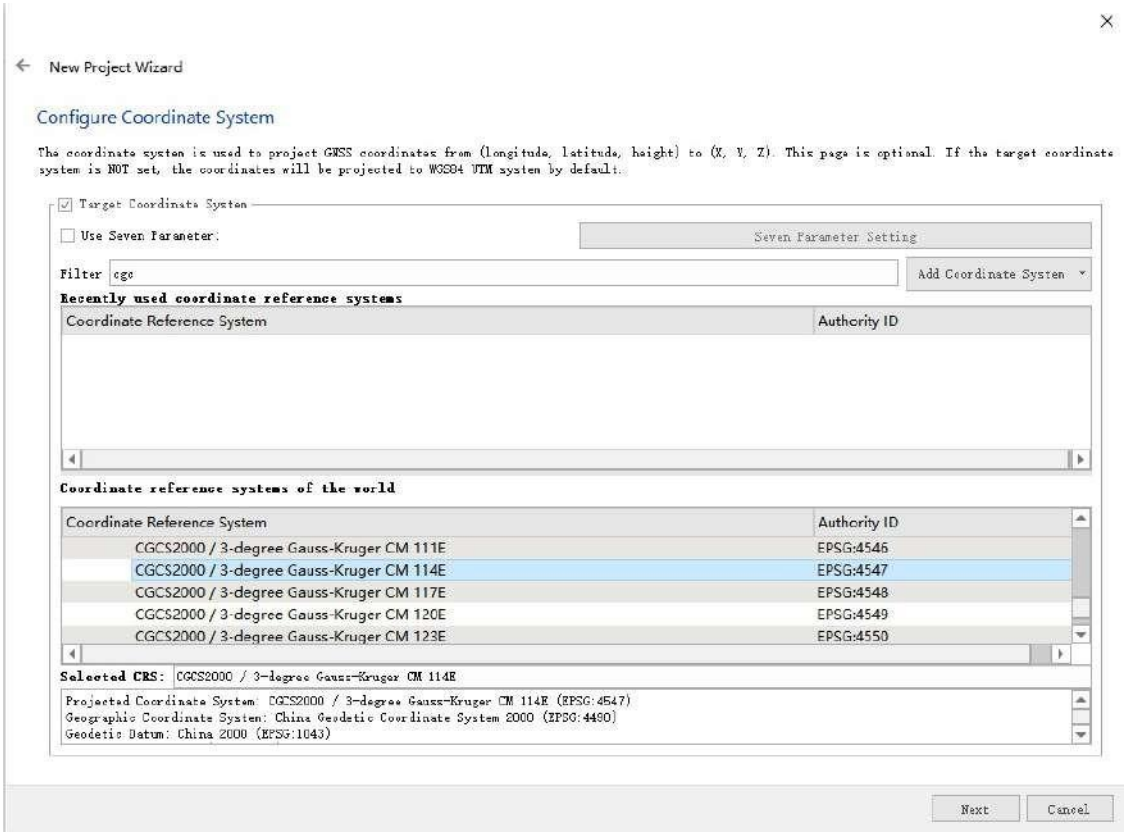
- **Internal**：Only show GNSS trajectory file directory used internally. When the wizard process is finished, if there does exist an internal trajectory file, the choice will be activated. Meanwhile, external trajectory file directory will be cleared.

4.4 Set Target Projection Coordinate System

Set coordinate system can reproject POS file imported or generated at the last step. If there is no GNSS data, users can skip this page. If **Target Coordinate System** is unchecked, the solving results will be transformed into UTM 6 degree zone with the WGS84 datum by default.

Note: rtk data does not need to set the target coordinate system, the software will automatically read the coordinate system information of the rtk file

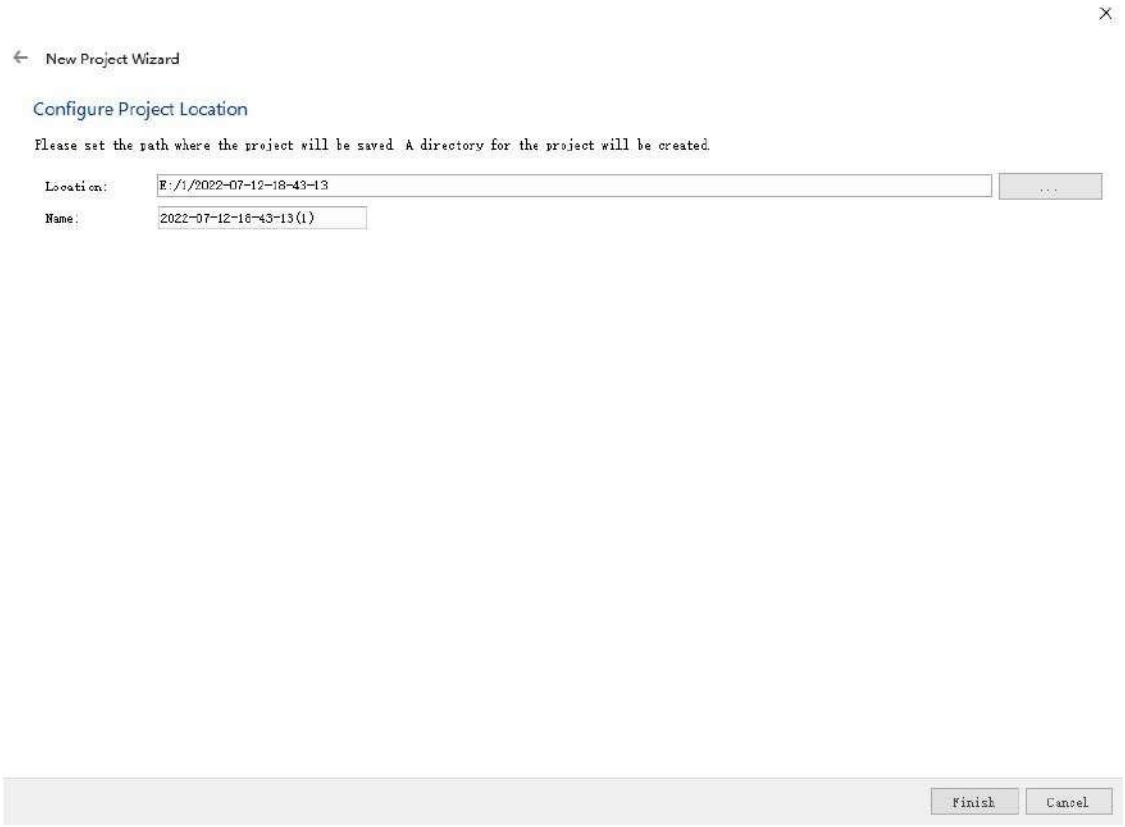
- **Use Seven Parameter**：Click the button to set Seven Parameter.
- **Filter**：Select coordinate system to project data. Key words can help search quickly. Users can also import external coordinate system.
- **Hide deprecated CRSs**：Hide deprecated CRSs.
- **Selected CRS**：The CRS selected currently and its WKT text file.



Set Projection Coordinate System

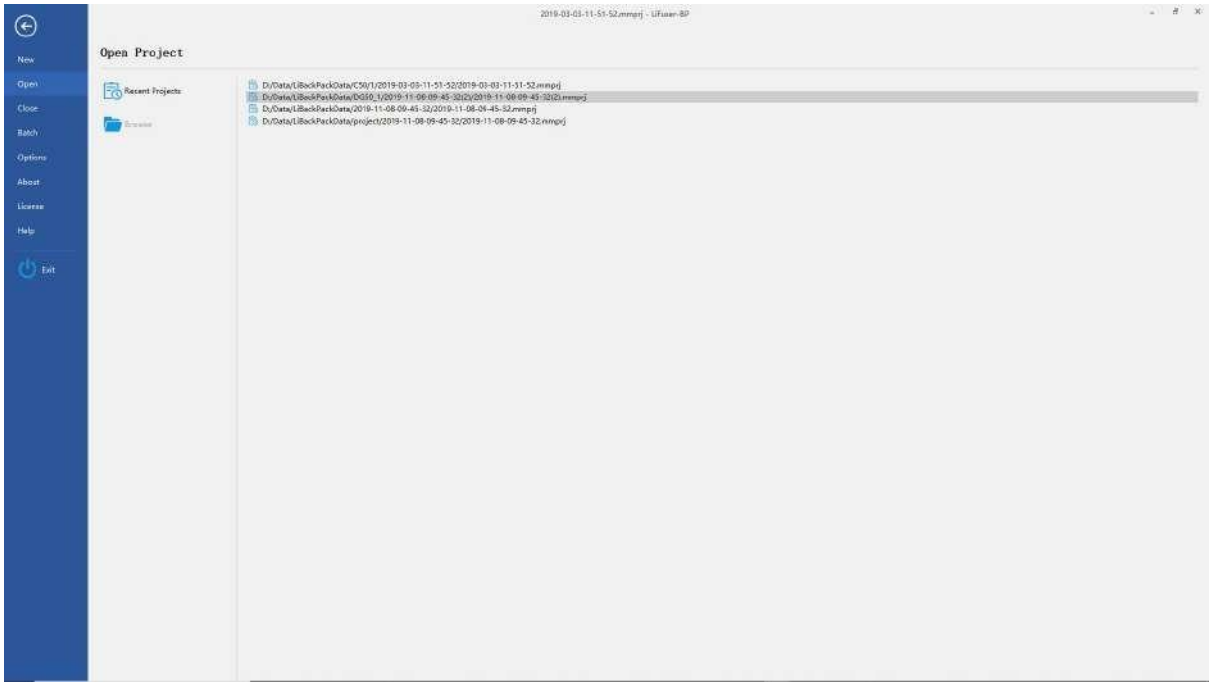
4.5 Set Project Directory

Users can change project directory at the Configure Project Location page. The default diretory is where LiDAR files are saved, and the directory name is the same as the corresponding LiDAR file. Click **Finish** when finish project setting.



Set Project Directory

Open Project Launch the software, click **Open**, select a recently saved project or open a project saved at a specific directory. - **Recent Projects**：select a recently saved project. - **Browse**：Browse a project at a specific directory.



Open Project

5. High Accuracy Process

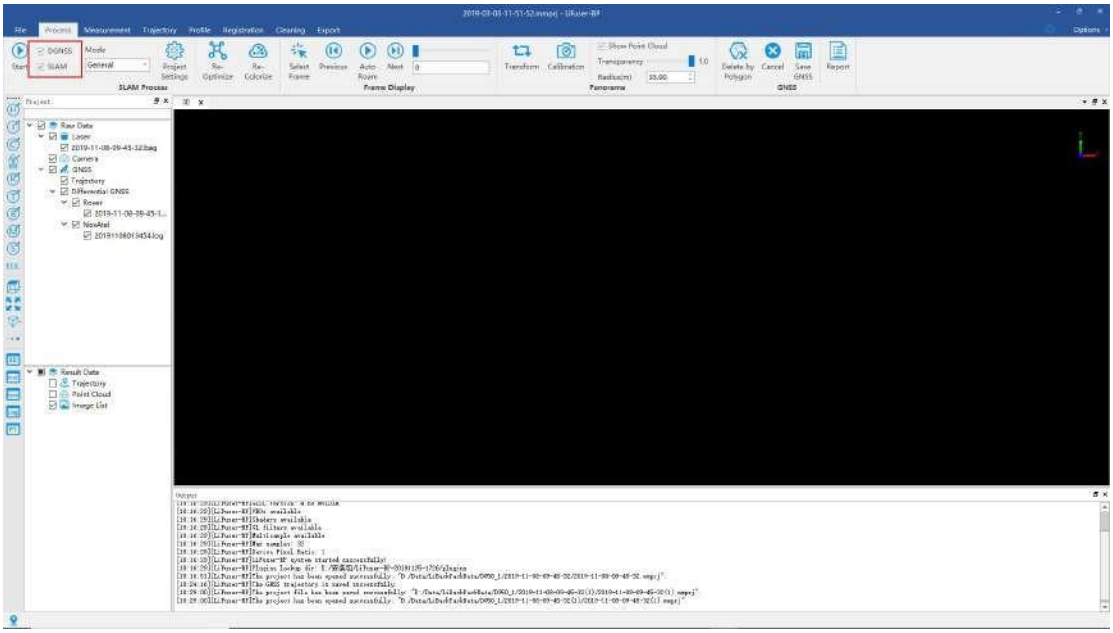
The point cloud calculation process of the libackpack and the ligrip are exactly the same, and no distinction is made here.

1. Switch to Process tab.

2. Select processing type by checking the corresponding button 

. There are 3 processing types:

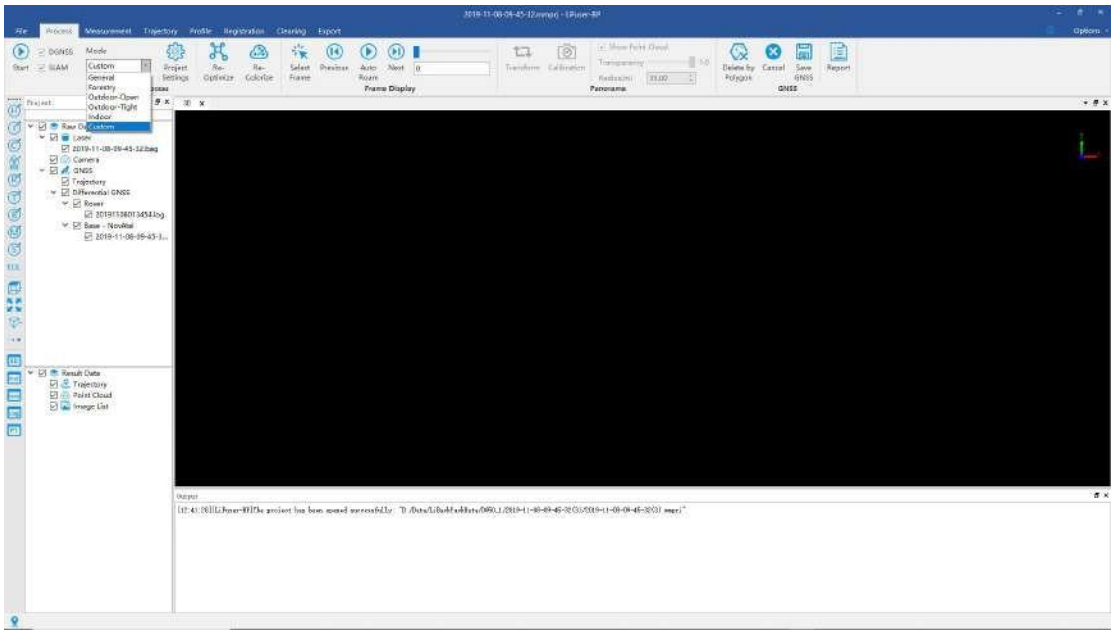
    - **DGNSS+SLAM(default)**：Generate GNSS trajectory by differential processing, and then use SLAM to obtain point cloud data with real geographical coordinates. If GNSS is not set, point cloud data with relative coordinates will be calculated.
    - **DGNSS**: Generate GNSS trajectory only by differential processing.
    - **SLAM**: Only uses SLAM to obtain point cloud data with high accuracy.



Select processing type

3. Select processing mode. There are 9 processing modes, click drop-down box to select:

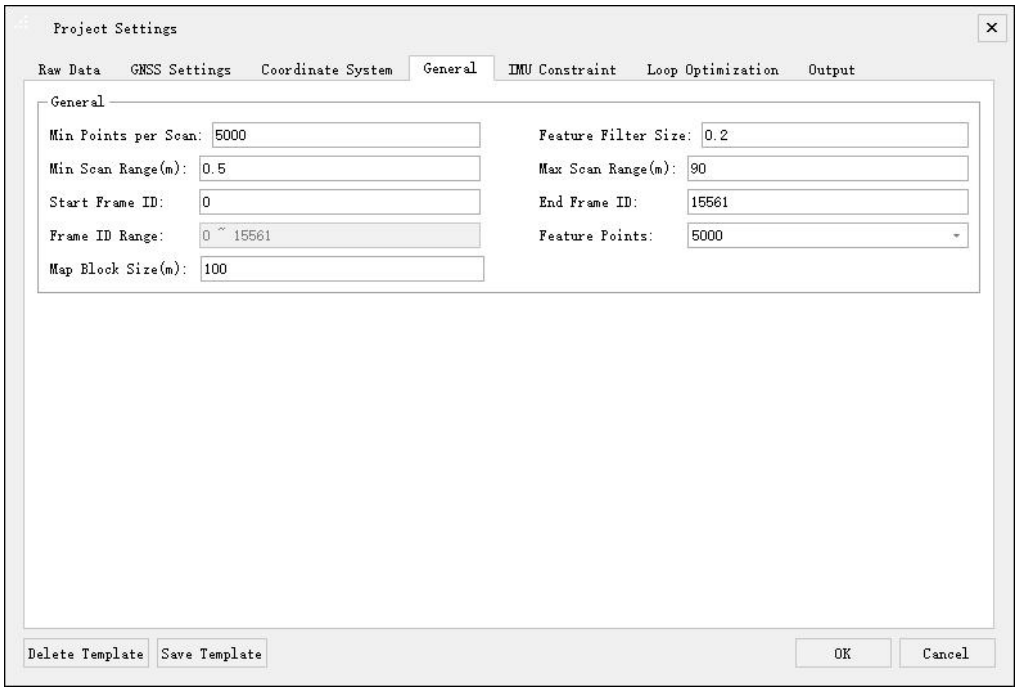
    - **General:** General mode
    - **Forestry:** forestry model
    - **Outdoor open:** the outdoor scene is relatively open
    - **Outdoor compactness:** outdoor scenes that are relatively narrow
    - **Indoor:** indoor mode
    - **Facade:** Facade mode
    - **Street:** Street mode
    - **Tunnel:** Tunnel mode
    - **Mine:** mine mode



Select processing mode

4. General setting Each processing mode has its default setting(Default setting is recommended). If users want to customize, click *Project Settings* to change the parameter values. Parameters explanations are shown below:

   - Raw Data：The .bag file, please see the process of importing laser scanner information for details.
   - GNSS Settings：Enter GNSS information, please see the process of importing GNSS information for details.
   - Coordinate System：Select target projection system, which only works after setting the GNSS. Please see detailed process at Set projection coordinate system.
   - General:



Genaral setting

Min Points per Scan：5000 by default.

Feature Filter Size：Set the minimum size of feature point bounding box. Higher value can lead to quicker processing speed but with lower accuracy.

Feature Points：Set the maximum number of feature point extracted by frame. Higher value can lead to slower processing speed but with higher accuracy.

Min Scan Range(m)：Set the minimum scan range by frame .
Max Scan Range(m)：Set the maximum scan range by frame.

Start Frame ID： Set the start frame ID. Only works when opening a project which has already been handled.

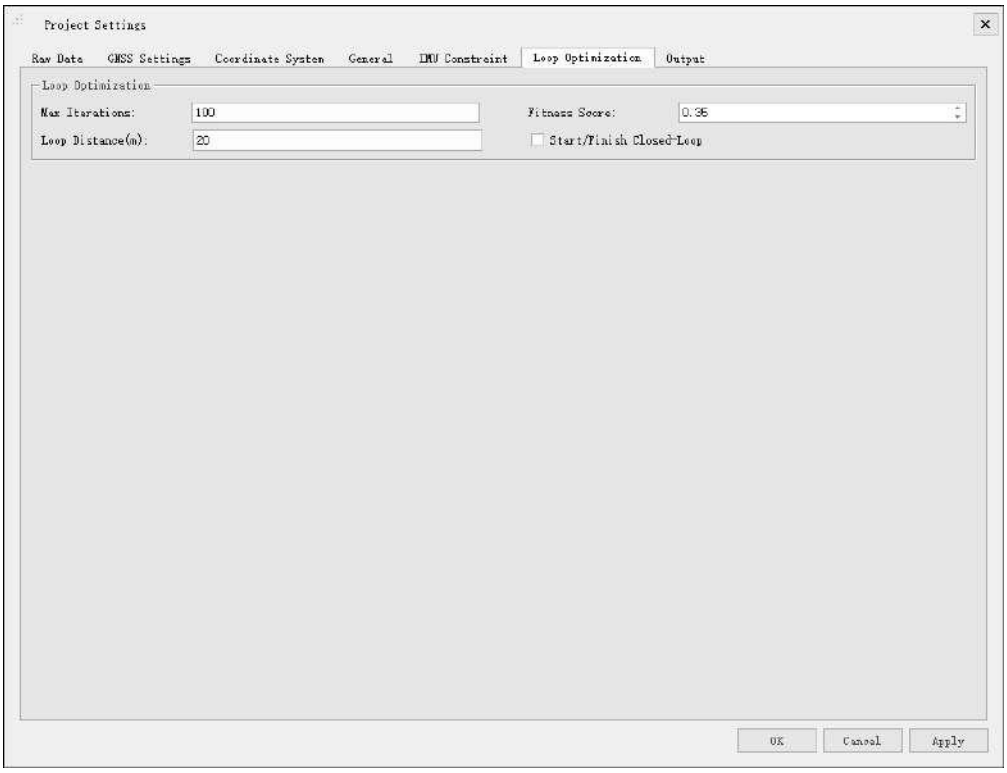
End Frame ID：Set the end frame ID. Only works when opening a project which has already been handled.

Frame ID Range：Set the range of frames to be processed.

Map Block Size: the storage range of SLAM intermediate results in memory, generally does not need to be changed

> Note: Users can check the corresponding frame ID of certain trajectory points from trajectory file.

- Loop Optimization:



Loop Optimization

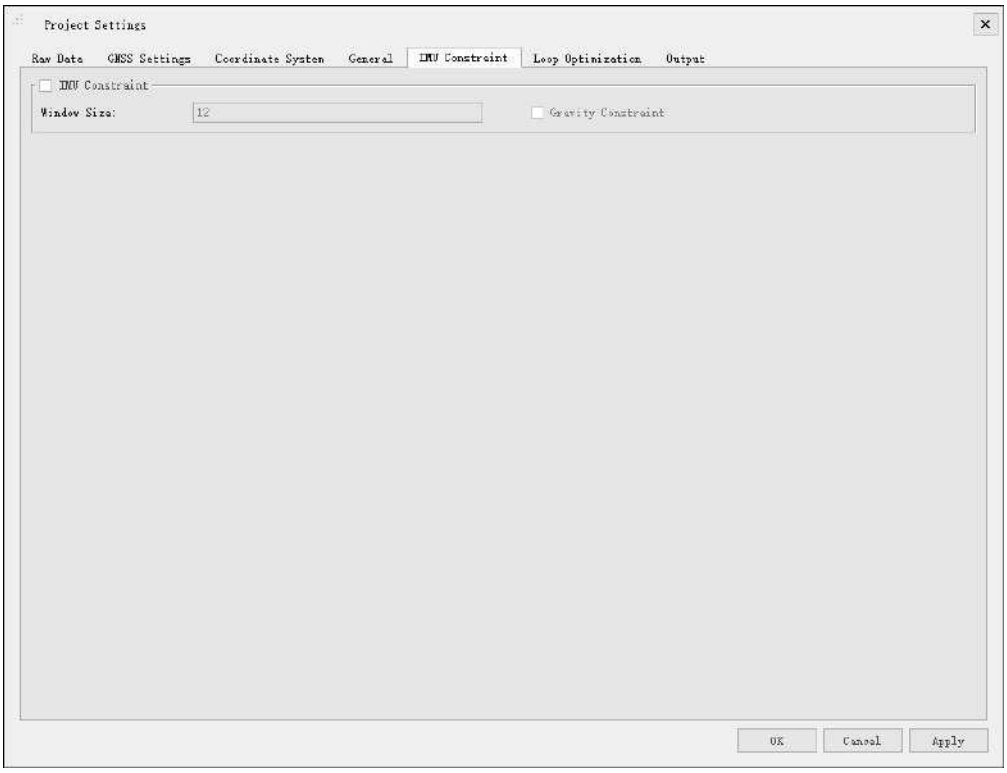
Max Iteration：Maximum iteration number of loop optimization. Higher value can lead to slower processing speed but with higher accuracy.

Fitness Score：Threshold of fitness inspection score. The lower the value, the higher the possibility of false inspection.

Loop Distance(m)：Neighbor distance value of loop inspection.

Start/Finish Closed-Loop：Set closed-loop or not.

- IMU Constraint:



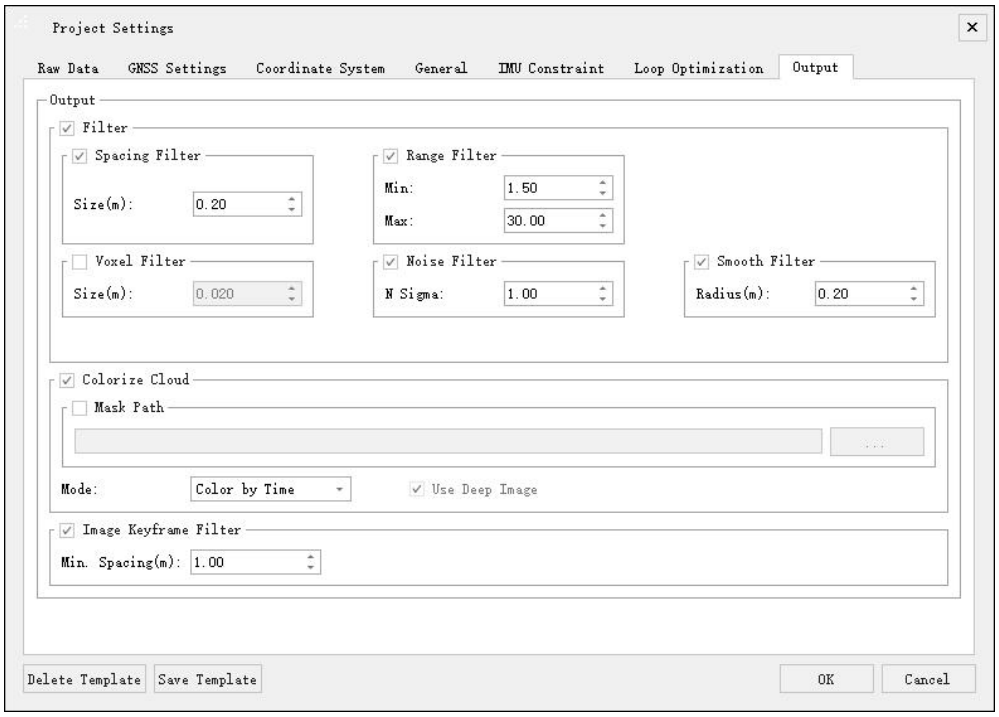
IMU Constraint

IMU Constraint：Whether to use IMU Constraint or not. Use IMU constraint can increase the accuracy but lower the processing speed.

Window Size：Set the window size of IMU processing.

Gravity Constraint：Whether to set Gravity Constraint or not.

- Output:



Output setting

Colorize Cloud：Choose to colorize point clouds or not.

- **Mask path**: The program will usually automatically read the built-in MASK file (located in the program installation directory \res\mask), and there is no need to check it separately. If you encounter a special scene, such as a car-mount, you need to create a MASK file separately, and then select the created MASK.
- **Modes**: time coloring and distance coloring. The default is 'Color by time', which is recommended for hand-held; the 'Color by distance' is generally used for backpacks;
- **Use the depth map**: It is recommended to enable it under the color of the distance.

Space Filter：Set space threshold when making data thinner.

Range Filter：Set threshold of data output.The data range kept by each frame must be within the threshold.

Voxel Filter：Voxel size is the minimum distance between two points, default value is 0.02m.

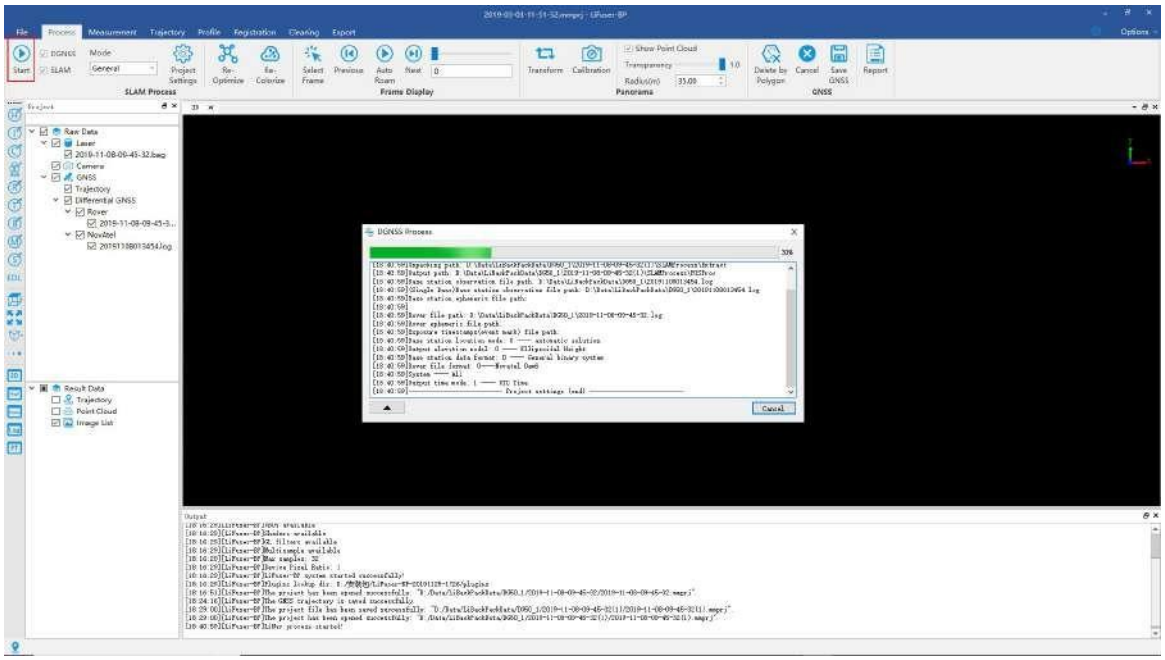
Noise Filter：It is not checked by default. After checking, set the standard deviation multiple. If it exceeds several times of the standard deviation, it is considered as noise and denoising is performed; generally, the smaller the setting, the better the denoising effect, but if the setting is too small, it may denoise too much, resulting in abnormal point cloud.

Smooth Filter：The default value is 0.2, which is mainly used to smooth the point cloud. If the setting value is too large, it will easily lead to ground object deformation or abnormal point cloud. In distance coloring mode, it is recommended to enable smoothing.

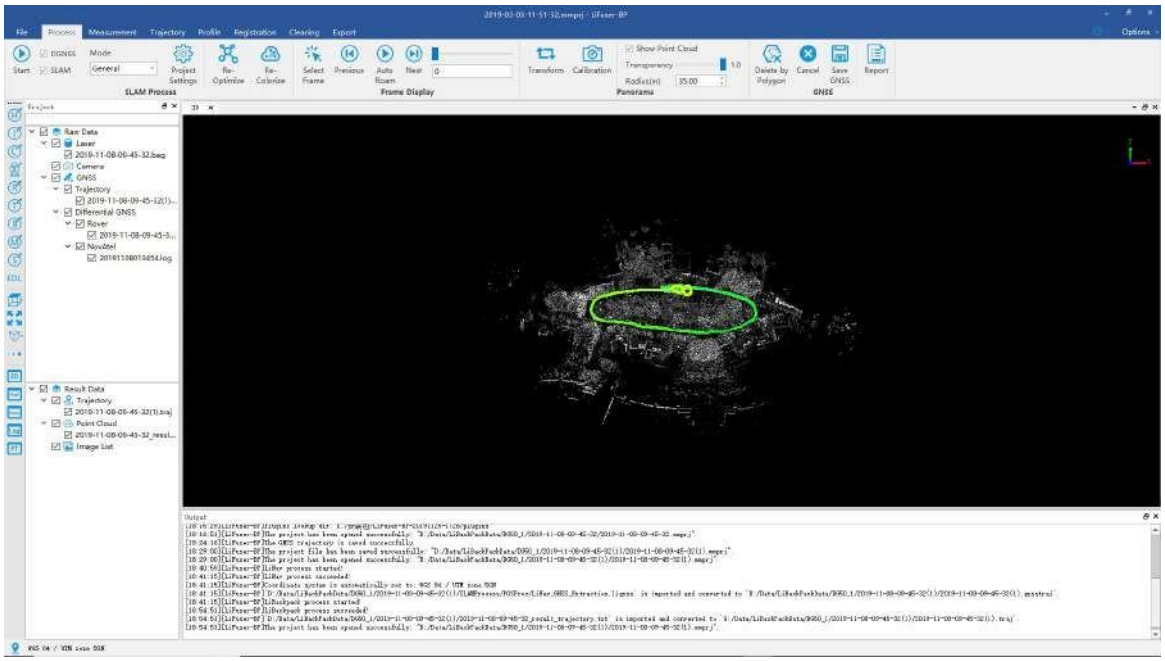
Image key frame filter: Used to control the number of image display frames. The number of image frames is displayed according to the distance. The smaller the distance, the more the number of displayed frames.

5. Start SLAM process

After finishing setting up the above-mentioned parameters, click *Start* to start SLAM process.Please be patient as this may take some time.



Start SLAM process



End SLAM process

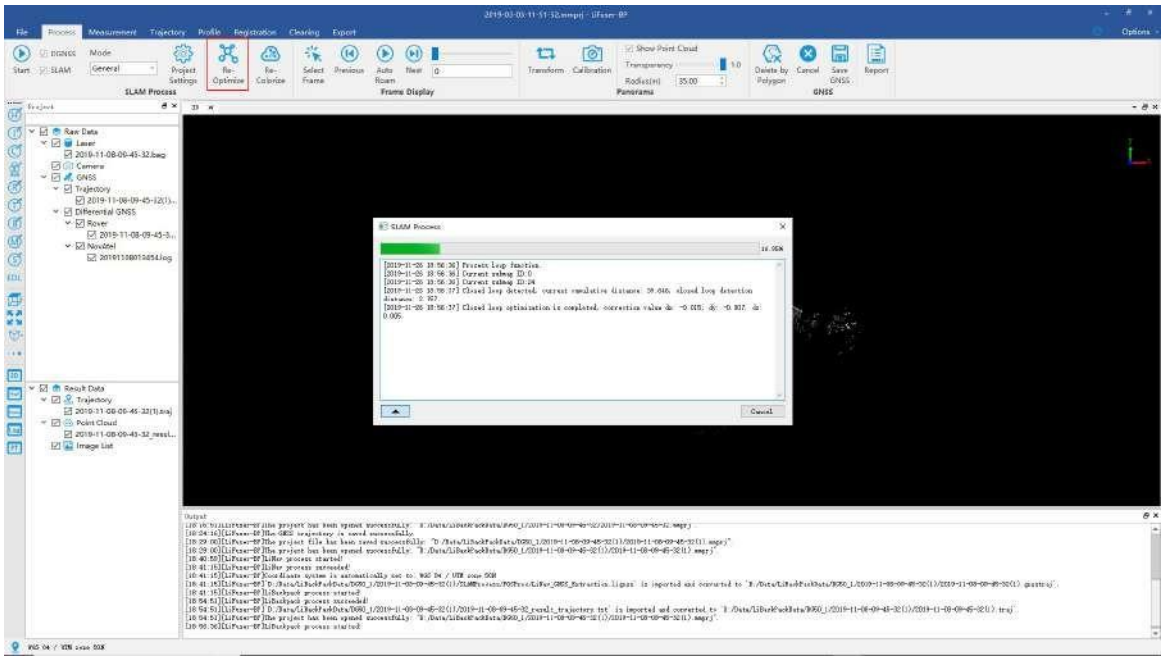
6. Re-Optimization

   Re-Optimization is targeted at two situations:

   (1) If current processing has a bad performance due to low accuracy of GNSS, users can improve it by editting GNSS manually. Click *Re-Optimize* and optimize again to improve the solving accuracy.

   (2) If the error comes from loop falses, users can correct it by changing parameters at step 4 **Loop Optimization**. Then click *Re-Optimize* and optimize again.

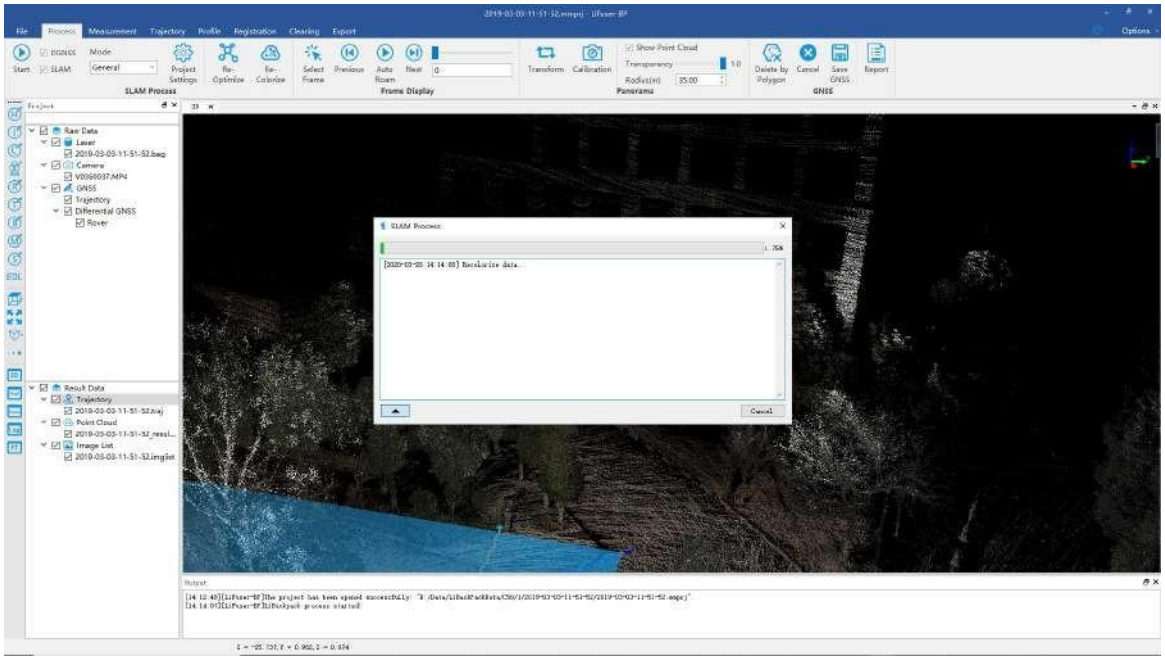
Suggestion: Since re-optimization is followed by re-output, in order to quickly determine the point cloud effect after re-optimization, you can first cancel all the filters in re-output. After the weight optimization is completed and the data is confirmed to be normal, check the filter option and re-output.



Futher Optimization

7. Reoutput(Optional)

   Modify the filter parameters in the output of the project settings, and click *Re-Output* to re-output the point cloud data according to the filter settings.

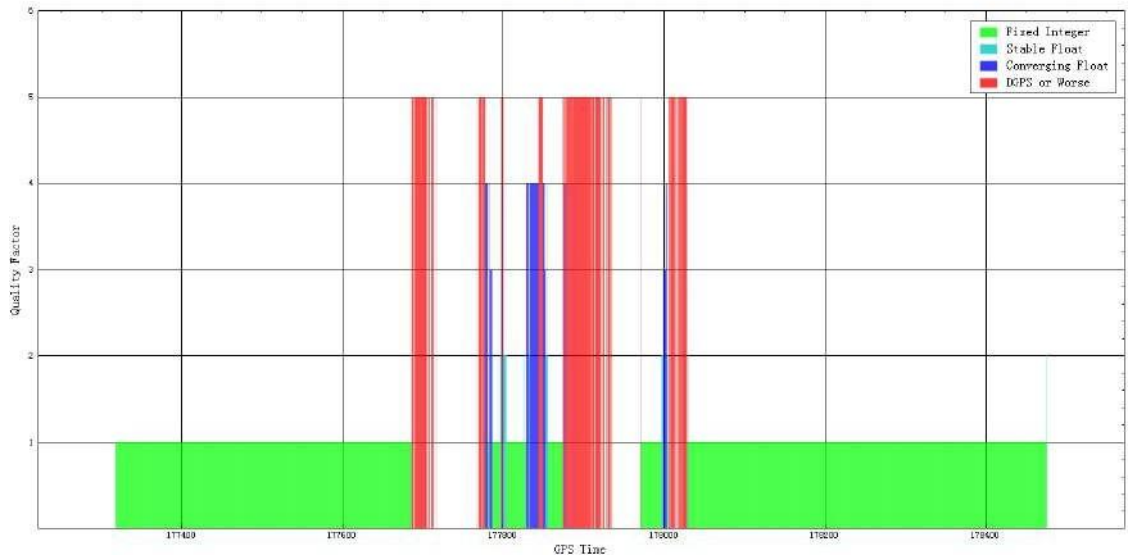


Reoutput

8. Check GNSS report

   If GNSS information has been imported, users can check GNSS report by click *Report* after data processing. Report includes figures of satellites number and quality, float or fixed ambiguity plot, PDOP plot, height profile plot, velocity profile plot etc.

Figure 1. Quality Factor Plot

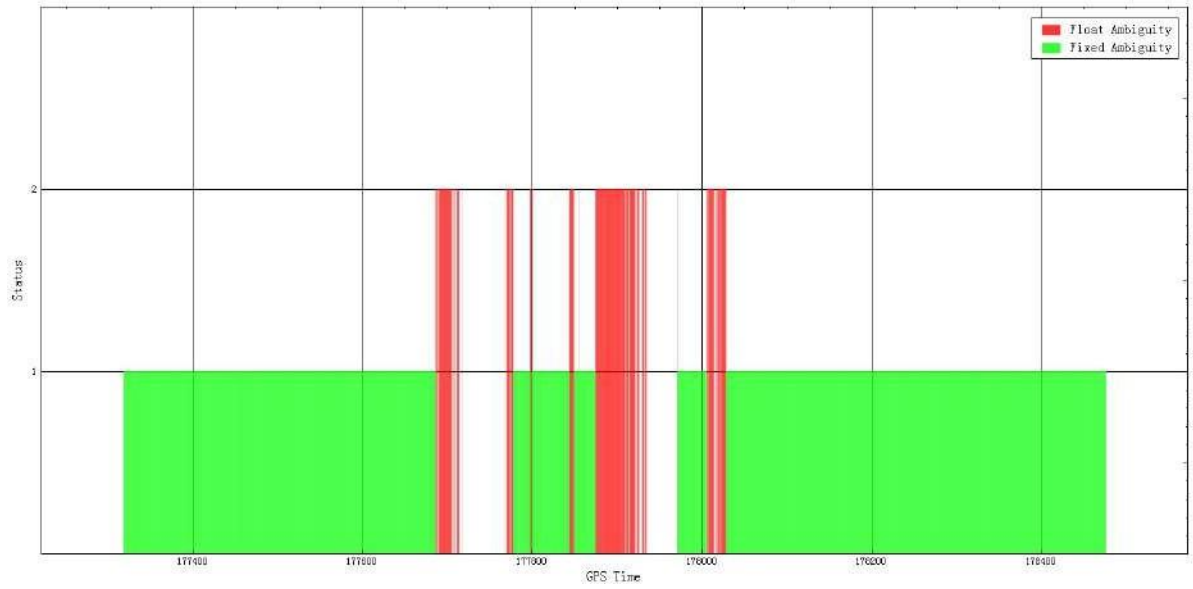


Quality factor plot

Figure 2. Number of Satellites Bar Plot

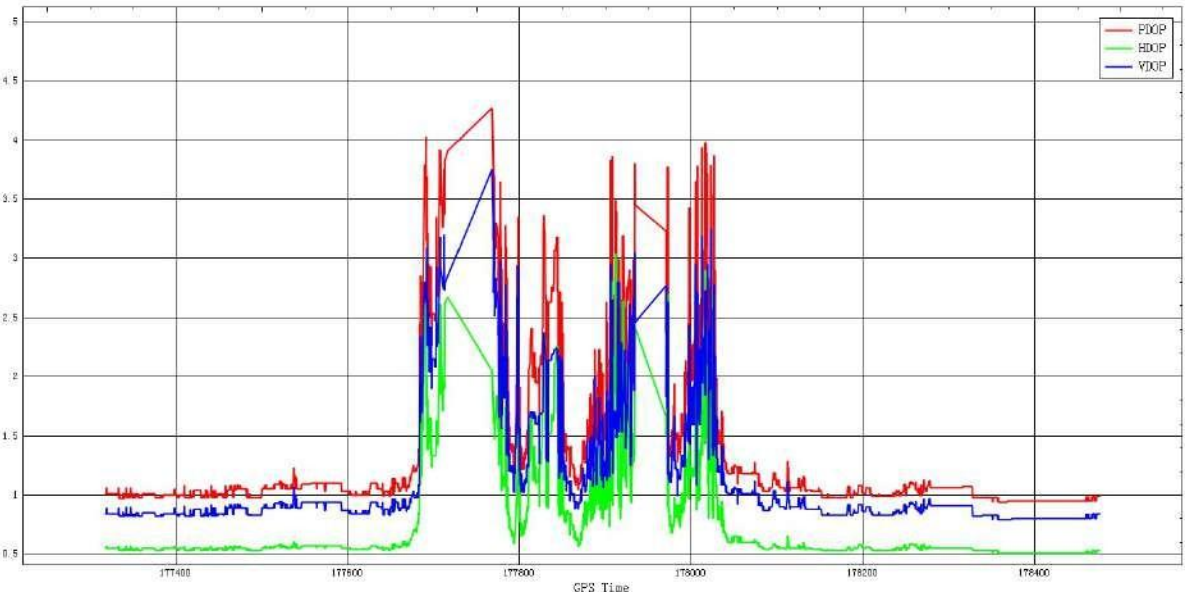
Number of satellites

Figure 3. Float or Fixed Ambiguity Plot



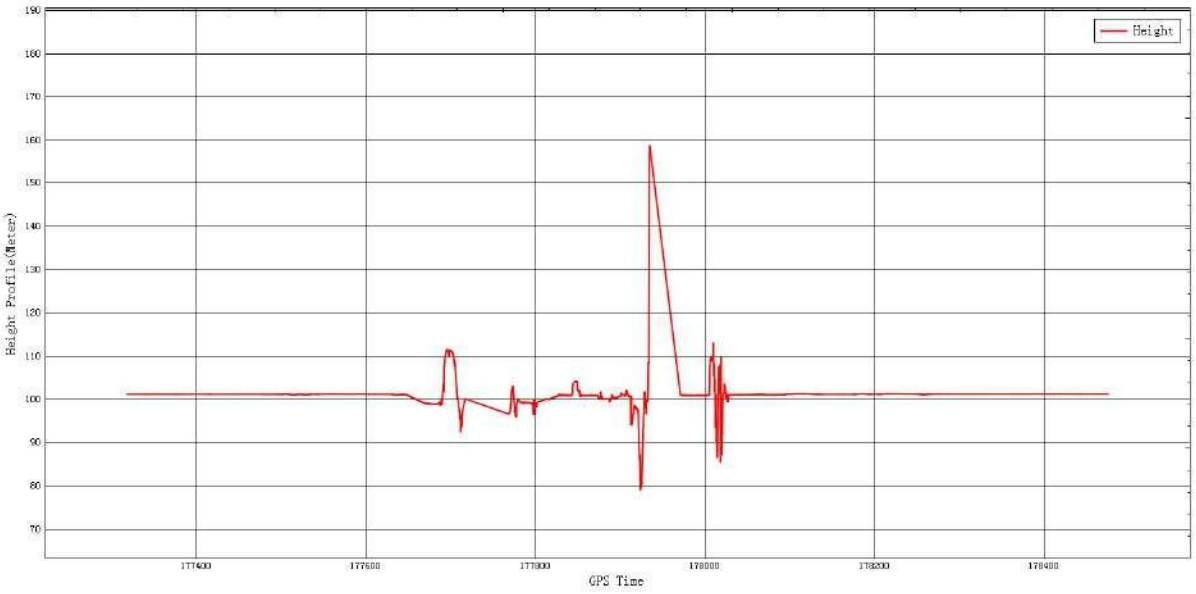
Float or fixed ambiguity plot

Figure 4. PDOP Plot



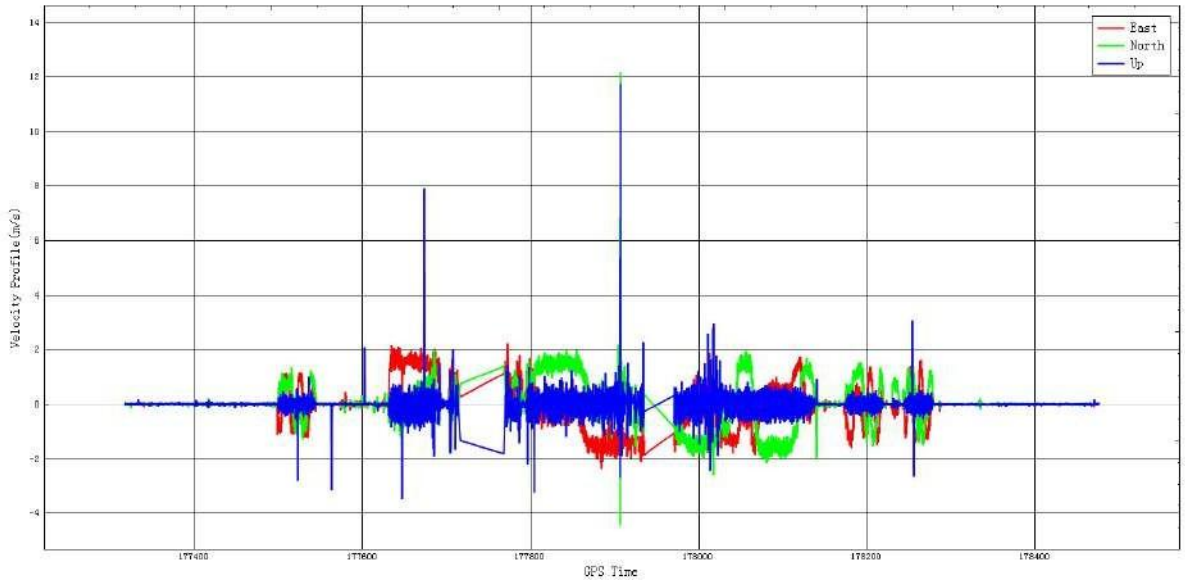
PDOP plot

Figure 5. Height Profile Plot



Height profile plot

Figure 6. Velocity Profile Plot



Velocity profile plot

6. GCP adjustment

Also known as SLAM optimization integrated with GCP, it is based on field management + control point pairs, which adjusts the data and assigns absolute coordinates. Compared with Georefernce Registration, its accuracy is higher, and it is currently the recommended method.

Data preparation: bag, image (if any), control point coordinate file (need to correspond to the dot one by one);

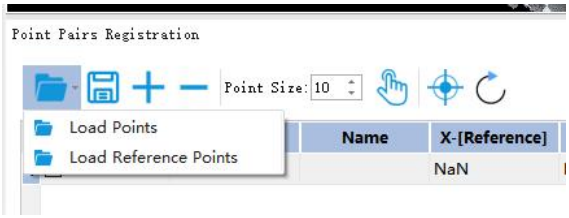
Control point format: name, X, Y, Z

The steps are as follows:

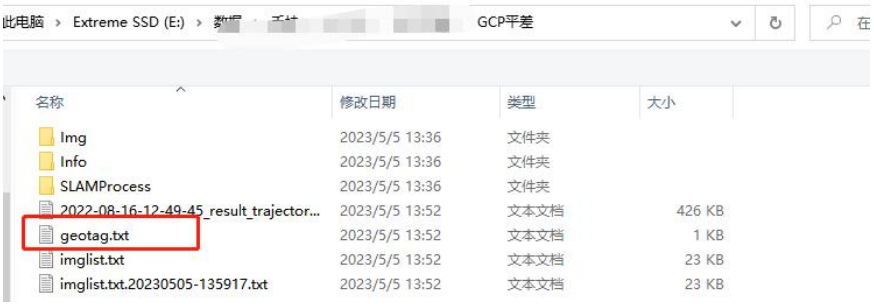
① Solve the project completely;

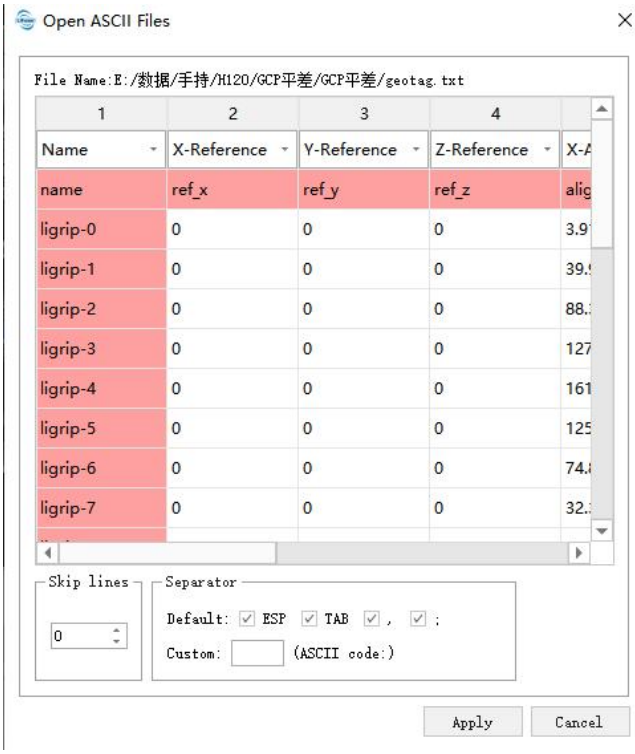
② In SLAM Process, the point pair registration interface appears. 

③ Click load points

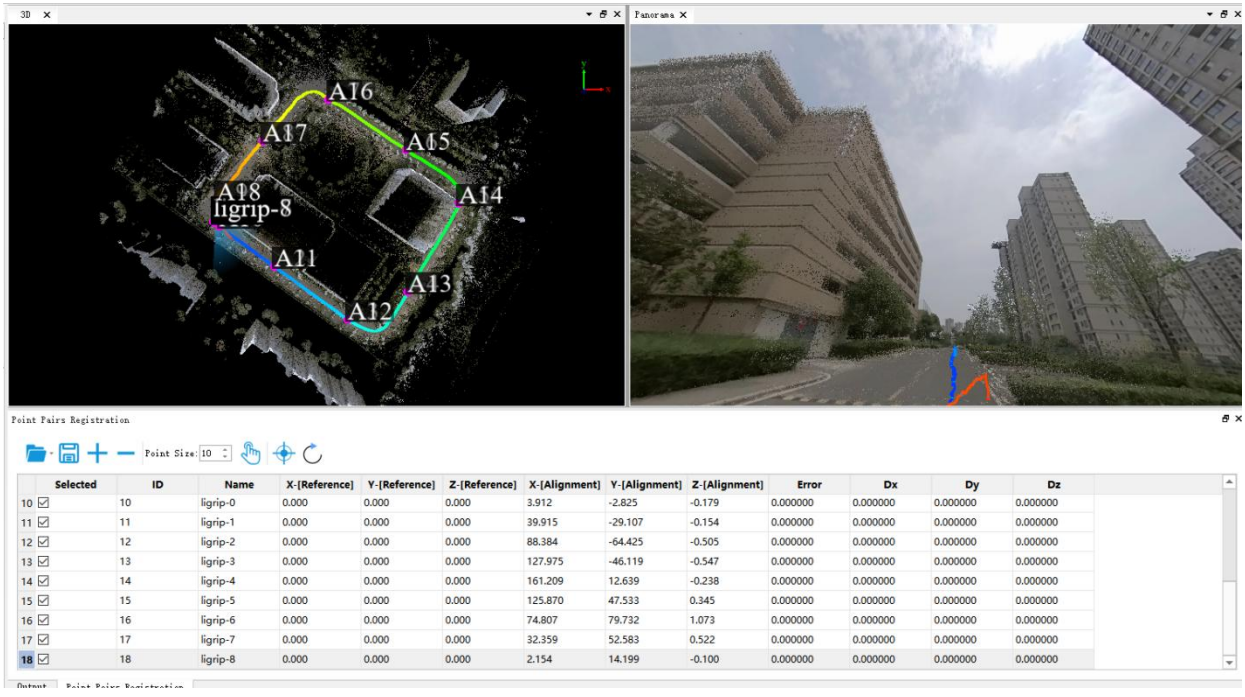


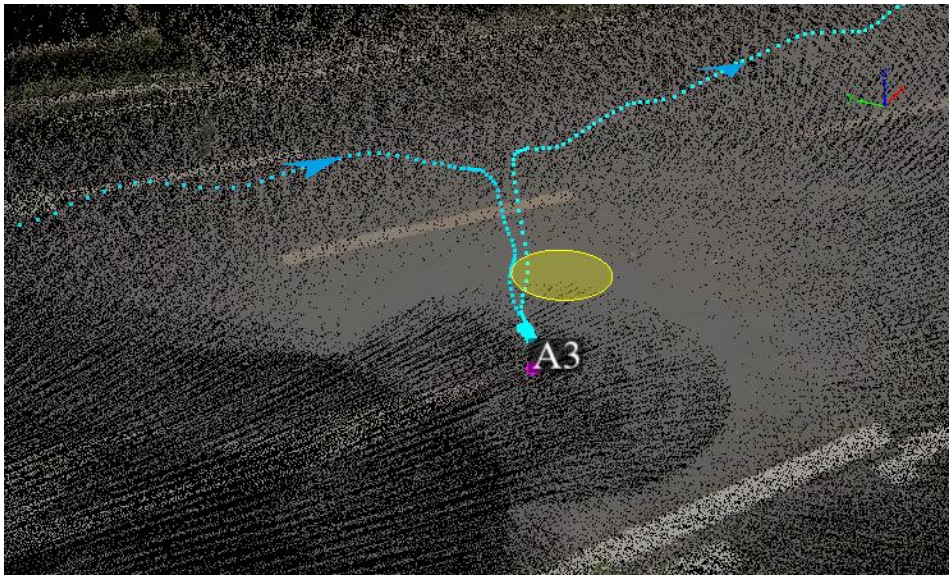
④ Open the geotag.txt, pop up dialog box and click "Apply"



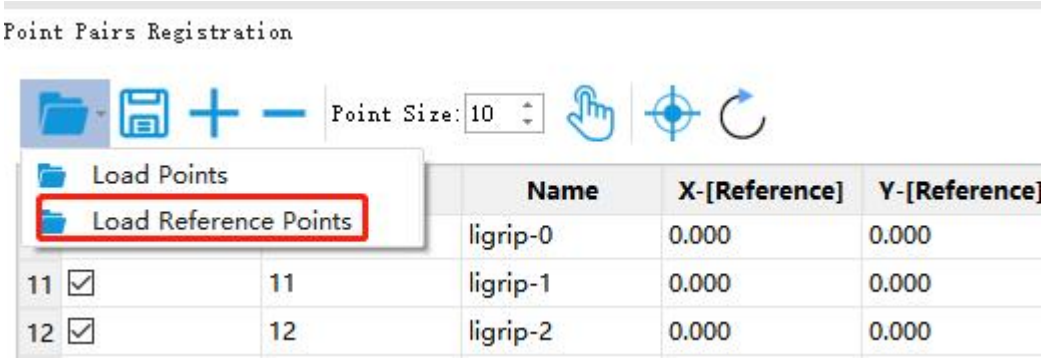


⑤ The program displays the location of the GCPs

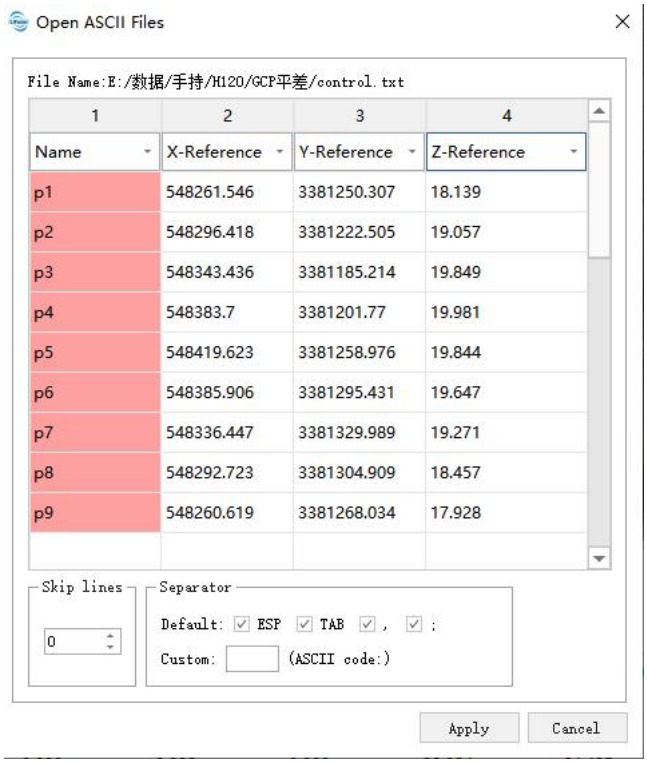




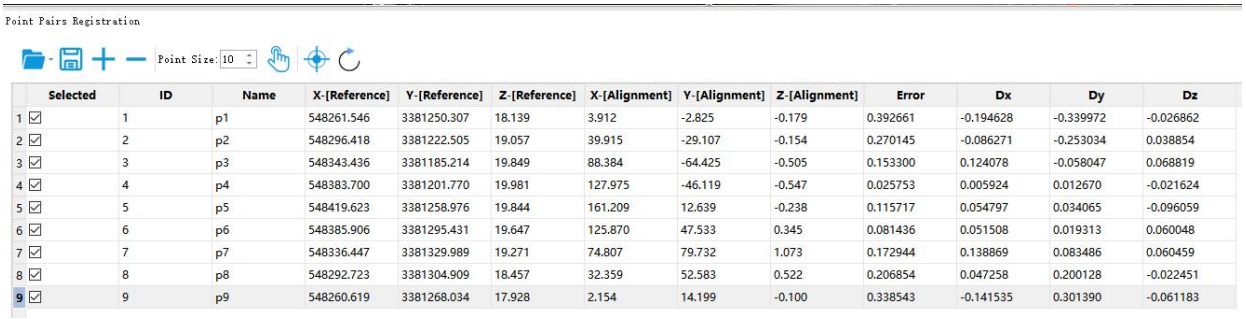
⑥ Control point coordinate input, can be manually input, or external import. Here is the way of external introduction. Click "Load the Reference Point"



In the pop-up prompt box, select Yes to open the control point file (txt csv format). Select the corresponding column attributes in the dialog box, note that "X" corresponds to the east coordinate and "Y" corresponds to the north coordinate. Click on "Apply".

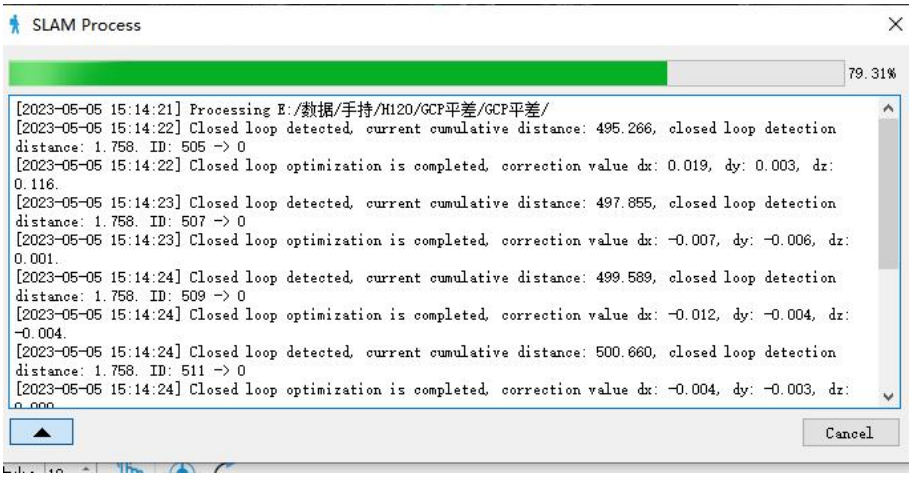


The system will automatically calculate an error value, which represents the error between the position of the control point and the GCPs before the optimization, only for reference.

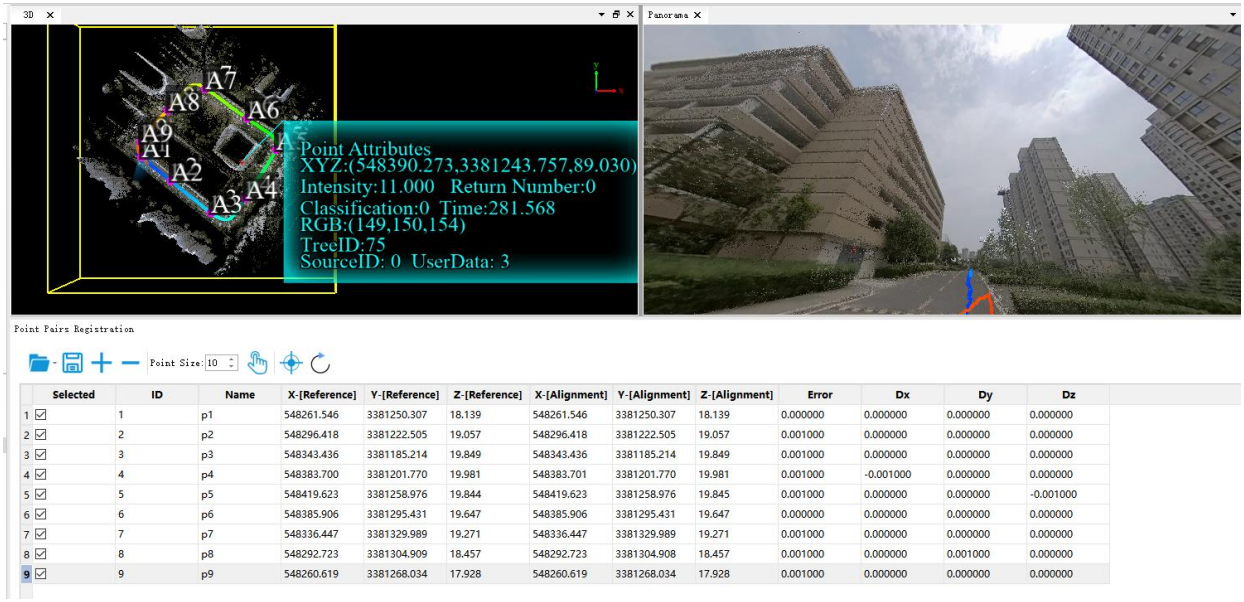


	Selected	ID	Name	X-[Reference]	Y-[Reference]	Z-[Reference]	X-[Alignment]	Y-[Alignment]	Z-[Alignment]	Error	Dx	Dy	Dz
1	☑	1	p1	548261.546	3381250.307	18.139	3.912	-2.825	-0.179	0.392661	-0.194628	-0.339972	-0.026862
2	☑	2	p2	548296.418	3381222.505	19.057	39.915	-29.107	-0.154	0.270145	-0.086271	-0.253034	0.038854
3	☑	3	p3	548343.436	3381185.214	19.849	88.384	-64.425	-0.505	0.153300	0.124078	-0.058047	0.068819
4	☑	4	p4	548383.700	3381201.770	19.981	127.975	-46.119	-0.547	0.025753	0.005924	0.012670	-0.021624
5	☑	5	p5	548419.623	3381258.976	19.844	161.209	12.639	-0.238	0.115717	0.054797	0.034065	-0.096059
6	☑	6	p6	548385.906	3381295.431	19.647	125.870	47.533	0.345	0.081436	0.051508	0.019313	0.060048
7	☑	7	p7	548336.447	3381329.989	19.271	74.807	79.732	1.073	0.172944	0.138869	0.083486	0.060459
8	☑	8	p8	548292.723	3381304.909	18.457	32.359	52.583	0.522	0.206854	0.047258	0.200128	-0.022451
9	☑	9	p9	548260.619	3381268.034	17.928	2.154	14.199	-0.100	0.338543	-0.141535	0.301390	-0.061183

⑦ After loading the control point, click the  to perform GCP adjustment.



⑧ After the adjustment is completed, the error of the control point becomes 0, and the point cloud has absolute coordinates.



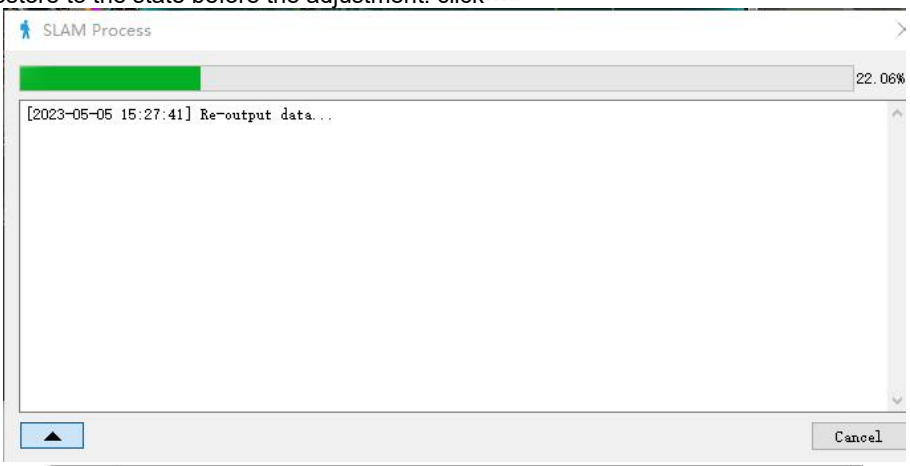
Point Pairs Registration

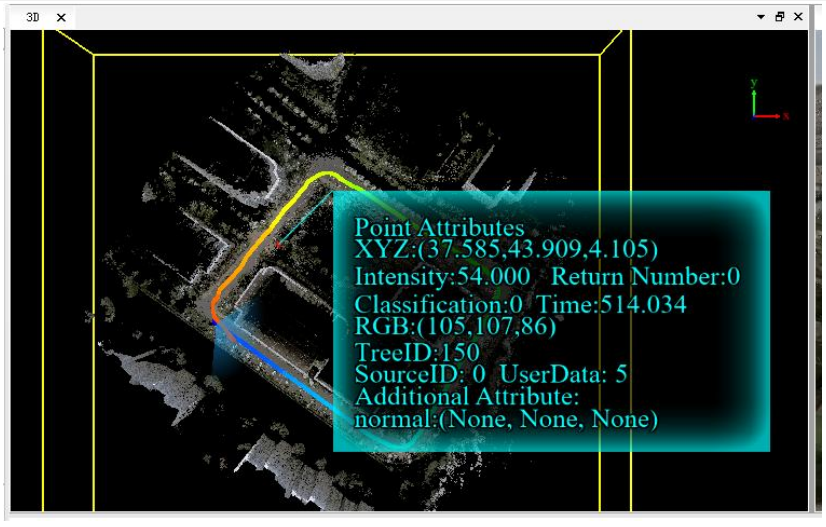
Point Size: 10

	Selected	ID	Name	X-[Reference]	Y-[Reference]	Z-[Reference]	X-[Alignment]	Y-[Alignment]	Z-[Alignment]	Error	Dx	Dy	Dz
1	☑	1	p1	548261.546	3381250.307	18.139	548261.546	3381250.307	18.139	0.000000	0.000000	0.000000	0.000000
2	☑	2	p2	548296.418	3381222.505	19.057	548296.418	3381222.505	19.057	0.001000	0.000000	0.000000	0.000000
3	☑	3	p3	548343.436	3381185.214	19.849	548343.436	3381185.214	19.849	0.001000	0.000000	0.000000	0.000000
4	☑	4	p4	548383.700	3381201.770	19.981	548383.701	3381201.770	19.981	0.001000	-0.001000	0.000000	0.000000
5	☑	5	p5	548419.623	3381258.976	19.844	548419.623	3381258.976	19.845	0.001000	0.000000	0.000000	-0.001000
6	☑	6	p6	548385.906	3381295.431	19.647	548385.906	3381295.431	19.647	0.000000	0.000000	0.000000	0.000000
7	☑	7	p7	548336.447	3381329.989	19.271	548336.447	3381329.989	19.271	0.001000	0.000000	0.000000	0.000000
8	☑	8	p8	548292.723	3381304.909	18.457	548292.723	3381304.908	18.457	0.001000	0.000000	0.001000	0.000000
9	☑	9	p9	548260.619	3381268.034	17.928	548260.619	3381268.034	17.928	0.001000	0.000000	0.000000	0.000000

The above GCP adjustment ends.

If it is found that the adjustment effect is not satisfactory, or the input is wrong, you can use the GCP restore function to restore to the state before the adjustment. click 





7. Trajectory Process

There are two types of trajectory process supported by software, GNSS trajectory process and result trajectory process.

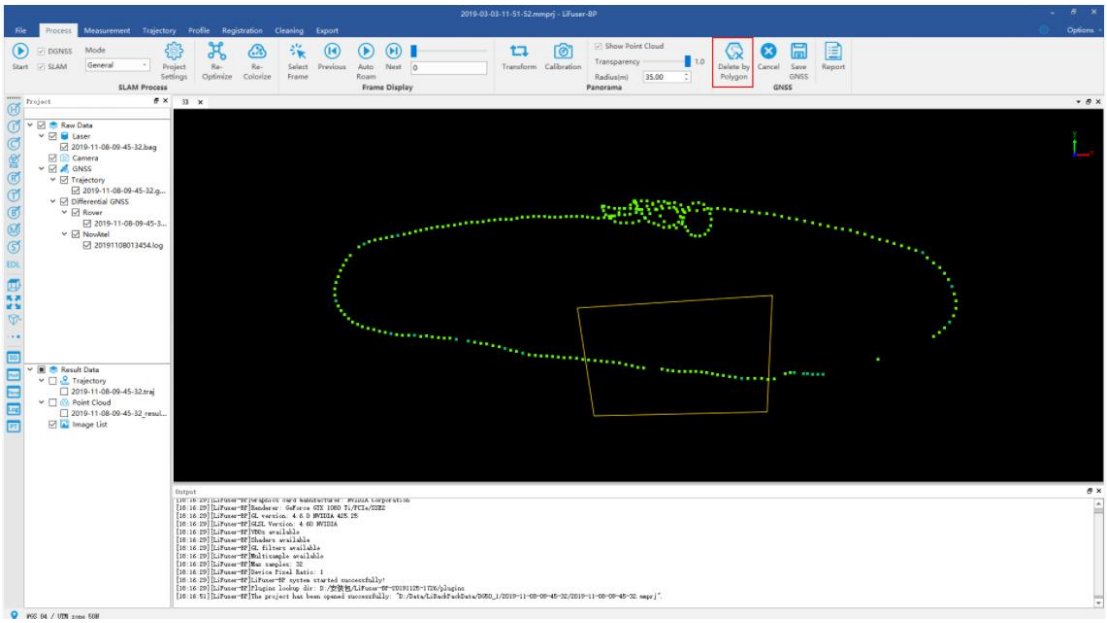
GNSS Trajectory Process

Result Trajectory Process

7.1 GNSS Trajectory Process

Due to blocking and multi-path effect in data acquisition, there are some inaccurate positioning points. After GNSS data processing, users can manually edit the data to remove the inaccurate points by following methods.

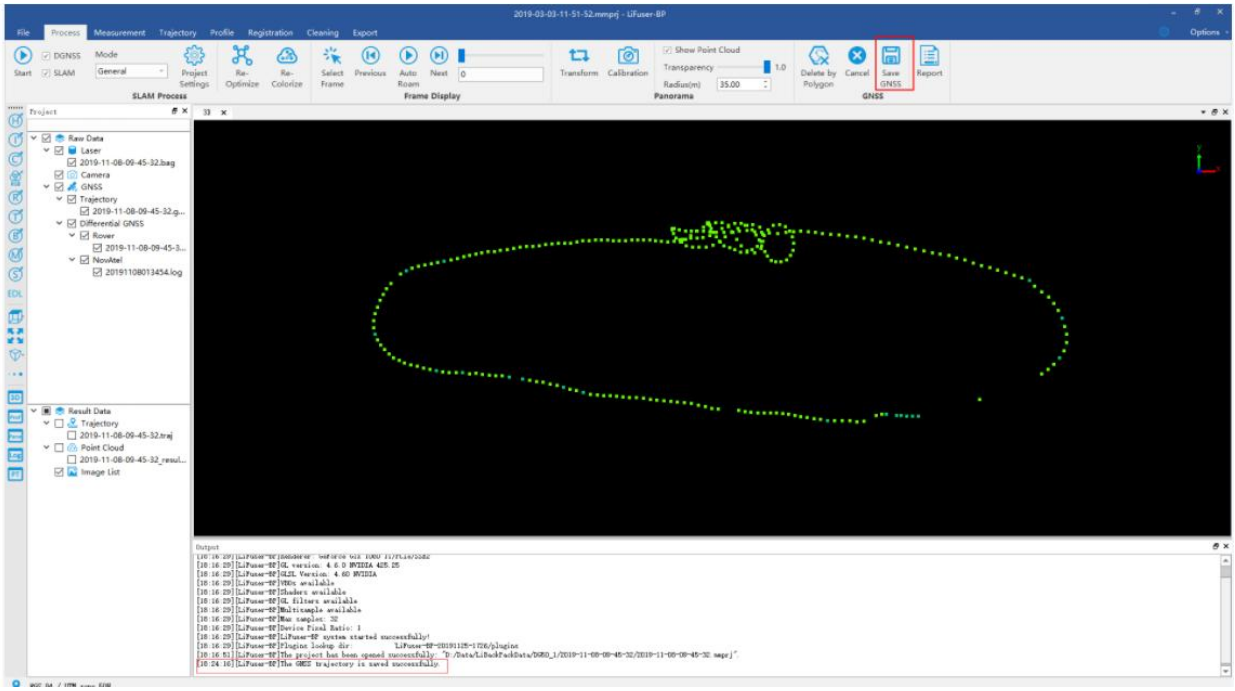
1. Delete by Polygon Click the button of Delete by Polygon  to start clipping. In the 3D window, left click is used to make a user-defined polygon which will be removed (right click is to cancel the current selection).



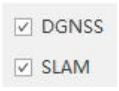
2. Double click to finish clipping.

3. To cancel clipping, click the button of Cancel  or use the shortcut of "Ctrl + Z".

4. Save GNSS，Click Save GNSS button  to save GNSS Trajectory.



5. Data Optimization

If users have already click the button of 

for SLAM Processing, then after finishing GNSS Trajectory Processing, users can click Re-Optimize  for a more accurate processing. If users do not use SLAM Processing, then click Start  button of SLAM processing.

7.2 Result Trajectory Process

After finishing High Accuracy Process, users can edit the result trajectory through *Result Data* selection.

Switch to *Trajectory* interface.

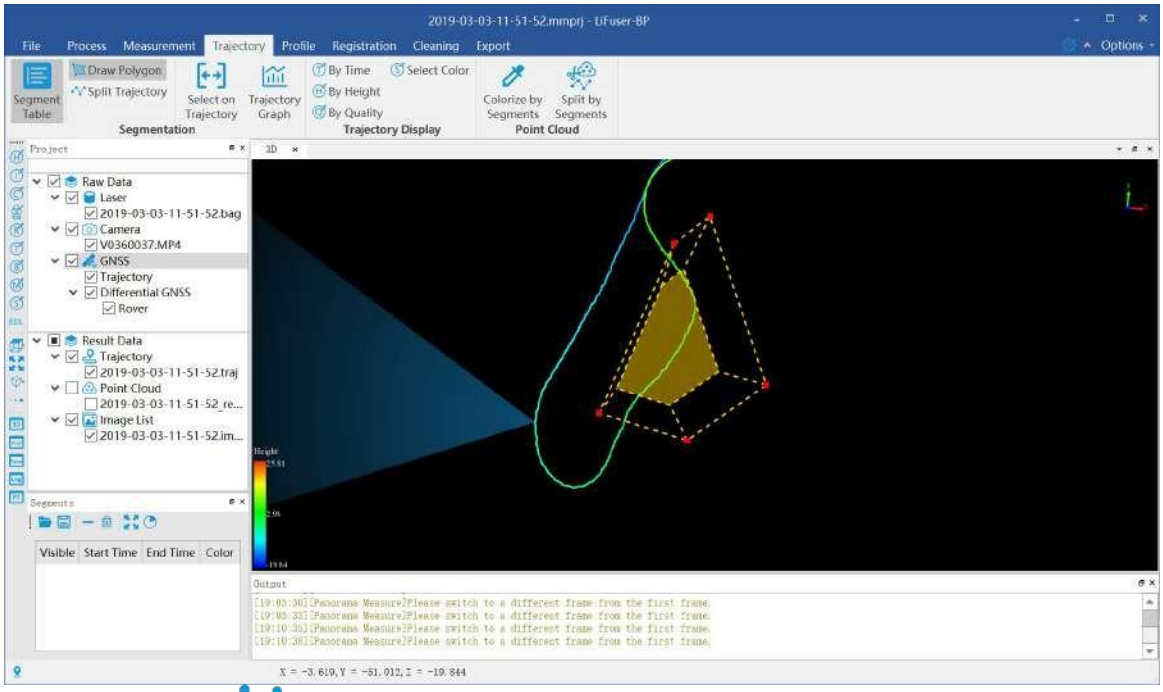
- Result Trajectory Segments
  - Segment Methods
  - Segment Result Table
  - Trajectory Graph
  - Colorize by Segments
  - Split by Segments
- Trajectory Display
  - Display by Time
  - Display by Height
  - Display by Quality
  - Display by Specific Color

7.2.1 Result Trajectory Segments

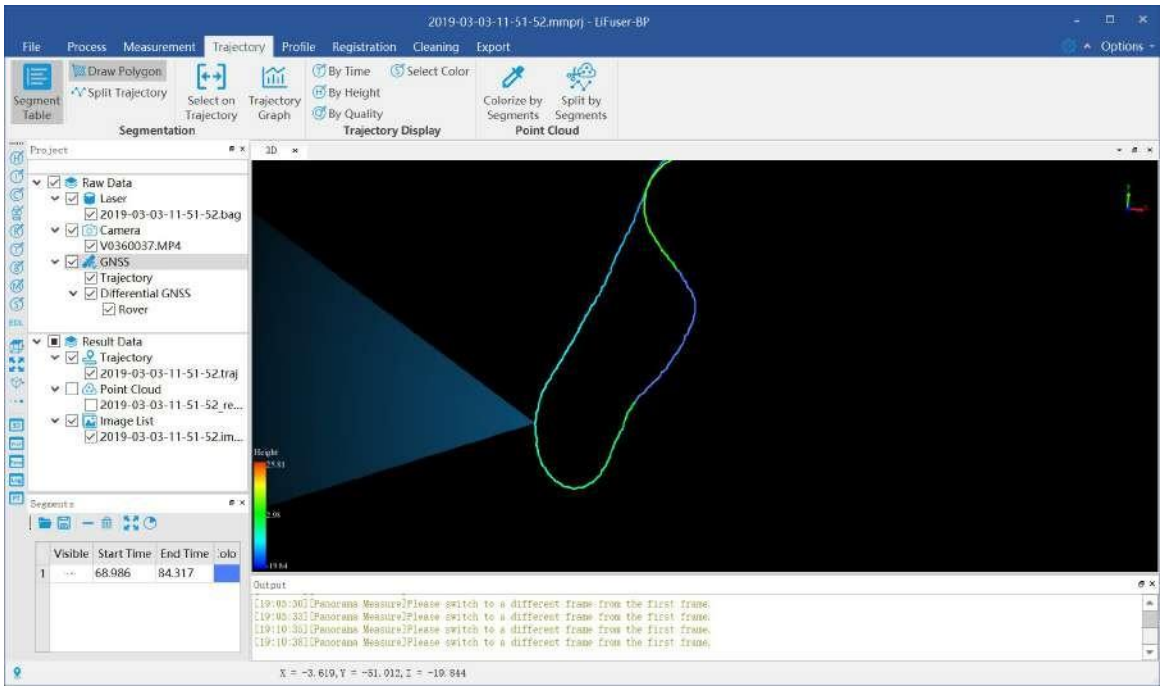
7.2.1.1 Segment Methods

7.2.1.1.1 Split by Polygon Step

- Click *Draw Polygon* button in *Segmentation* mode.
- In 3D display window, users can select the interest area by left click to make a user-defined polygon.

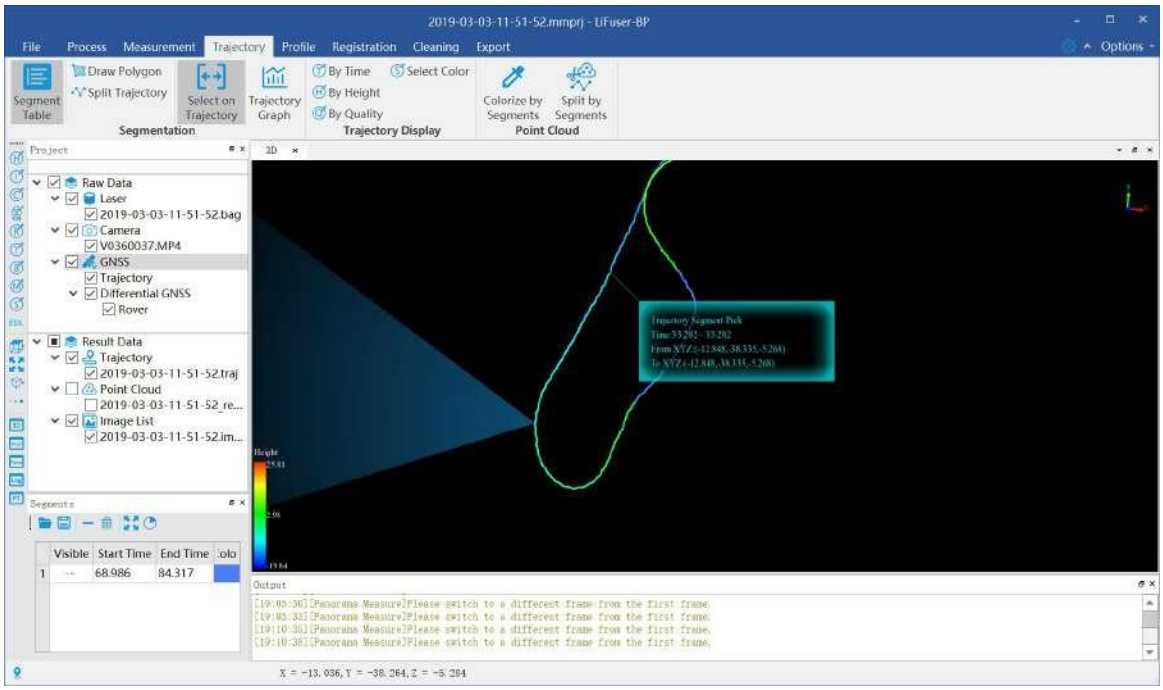


- Click *Split Trajectory* button to split trajectory in the area of user-defined polygon.

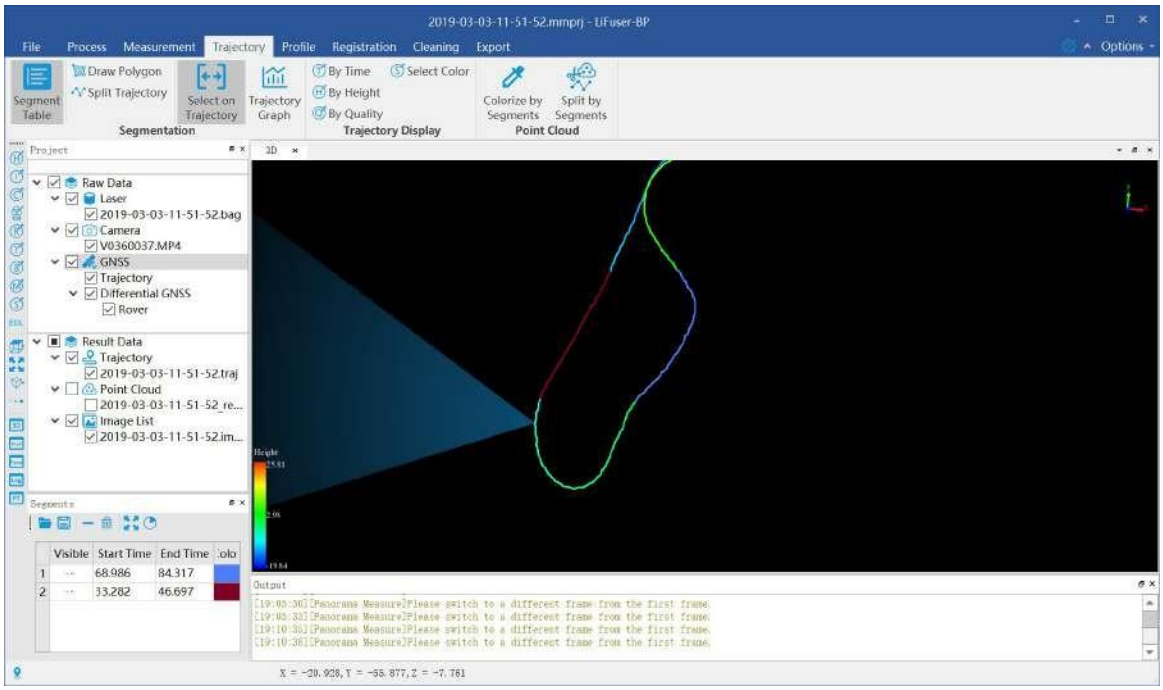


7.2.1.1.2 Split by Points

- Click *Select On Trajectory* button in *Segmentation* mode.
- In the 3D display window, left click to select the starting point.

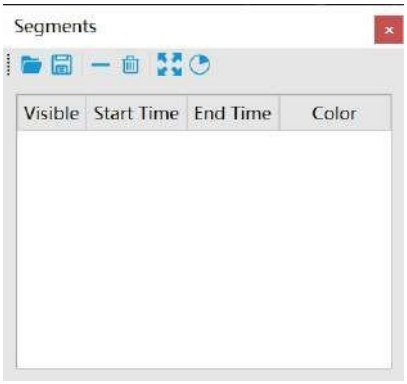


- Along the trajectory, select the ending point, the trajectory between the starting point and the ending point will be segmented.



7.2.2 Segment Result Table

Click *Segment Table* button in *Segmentation* mode, a segment table will pop up from the bottom right corner of user interface. The table records the details of segment information including segment visibility, start time, end time and the color information. Click on the menu bar above the segment table to enable the function of saving, opening, deleting, clearing, and hiding for unsegmented areas.



Save

Click *Save File* button , a window will pop up, save the trajectory to nominated position in hard disk. The *.xml format is supported to save.

Open

Click *Open File* button , a window will pop up, the trajectory information from nominated position in hard disk will be read, and the *.xml format is supported to read.

Delete

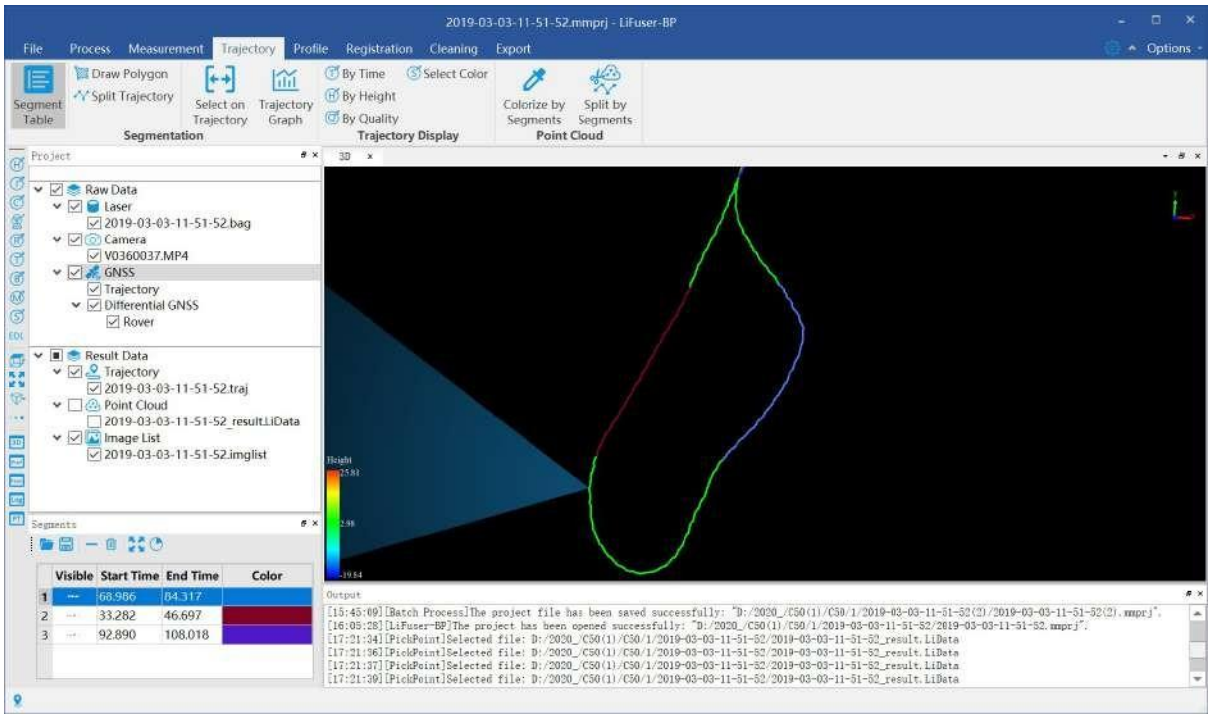
Click *Delete Segment* button , to delete the trajectory information of specified row in segment table.

Clear

Click *Delete All Segment* button , to delete all the trajectory information in segment table.

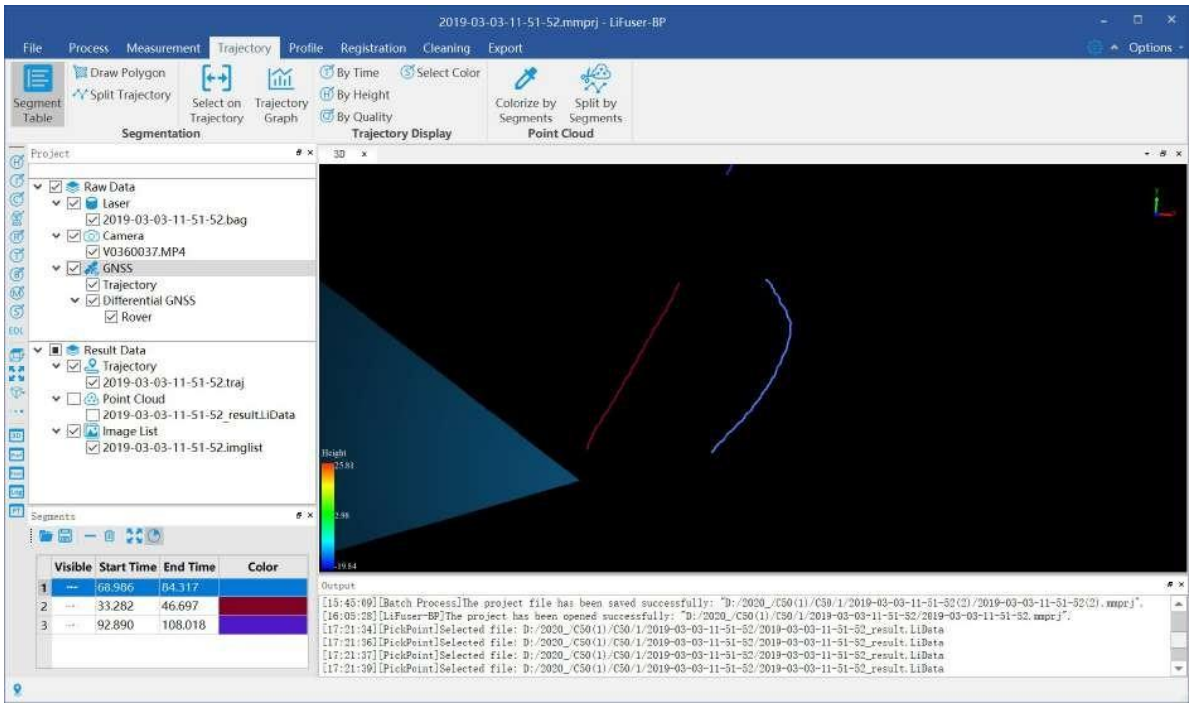
Extent

Firstly, click the specified row of sgment table. And click *Segment Full Extent* button , in 3D display window, the currently selected trajectory will be focused on.



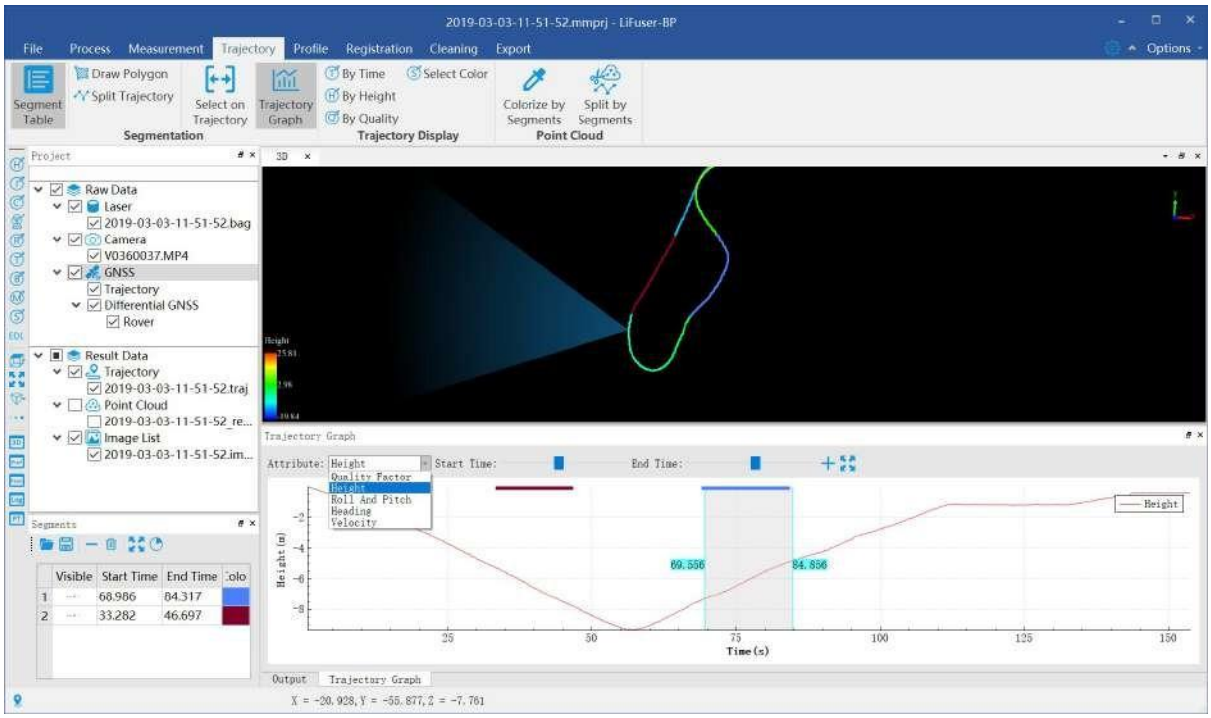
Hide

Click *Hide Remaining Part* button , in 3D display window, the unsegmented area will hide, and only trajectory information from segment table will display.



7.2.3 Trajectory Graph

Click *Trajectory Graph* button in *Segmentation* mode, the trajectory graph will pop up. The trajectory segment information at any time can be read from trajectory graph. Users can change the display attribute, add new segment, and change the display range. The detailed information is listed below:



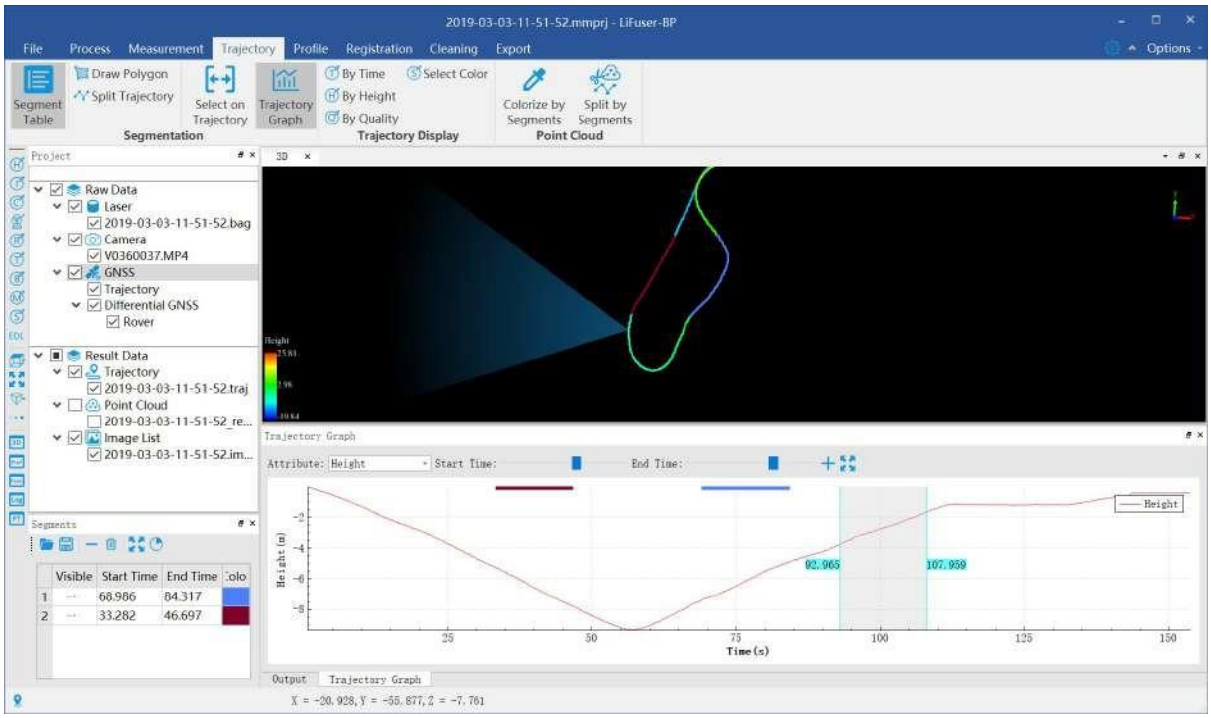
Attribute Display

Click *Atrribute* button, and users can select different display mode, including display by height, display by quality factor, display by roll and pitch angle, display by heading angle and display by velocity.

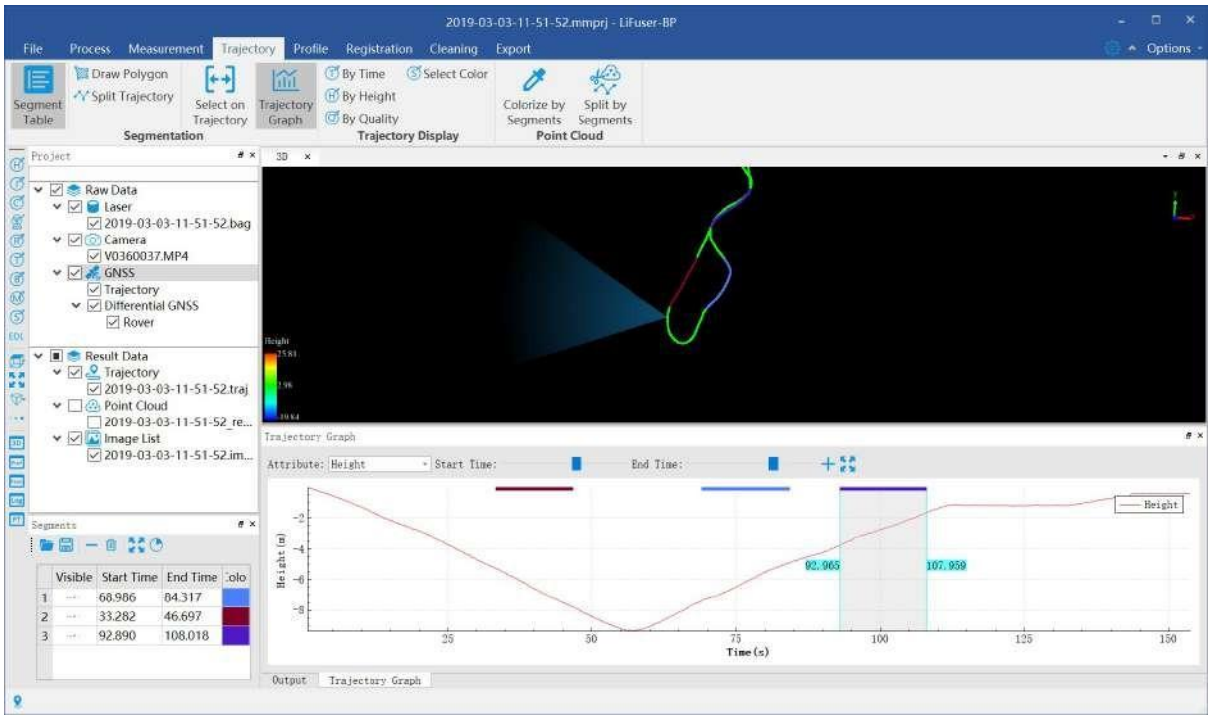
Add new Trajectory

Firstly, select both *Start Time* and *End Time* via scrollbars. And then click *Add Segment* button to add a new trajectory.

Select start and end time：



Add new trajectory：

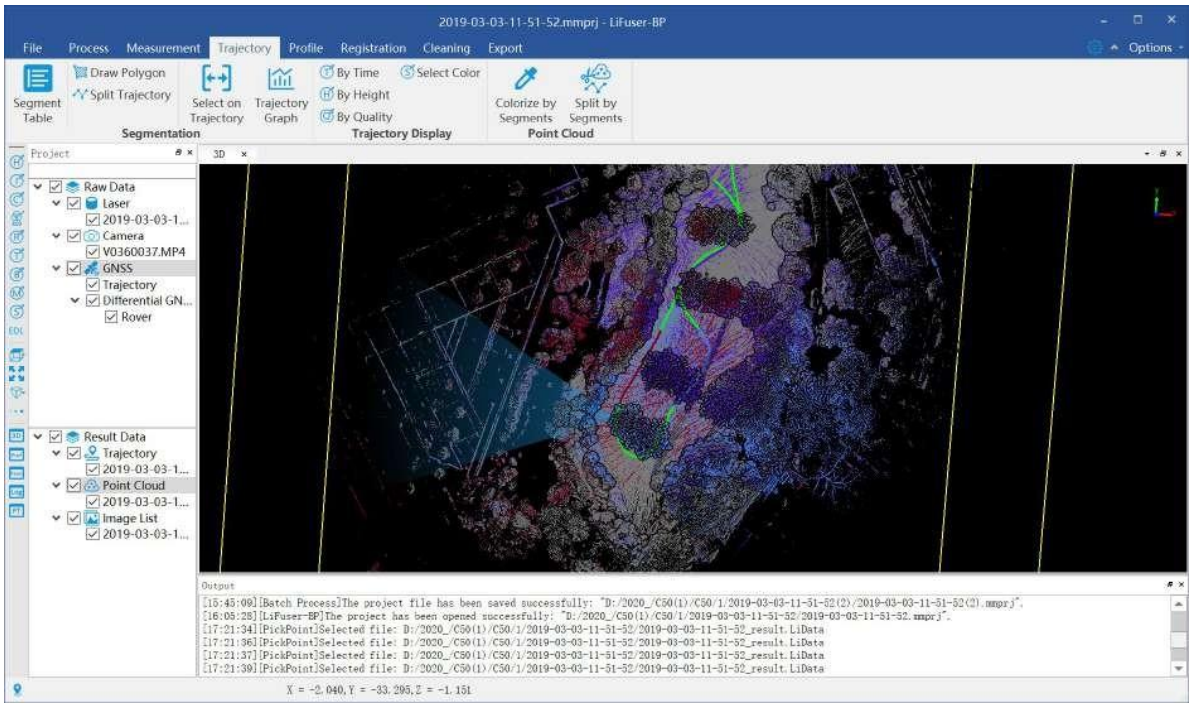


Change Display Range

All the trajectory information at any time will be displyed in trajectory graph as a default. Scroll up and down of mouse wheel to zoom in and out the display range. Click *Full Extent* button to restore the default display.

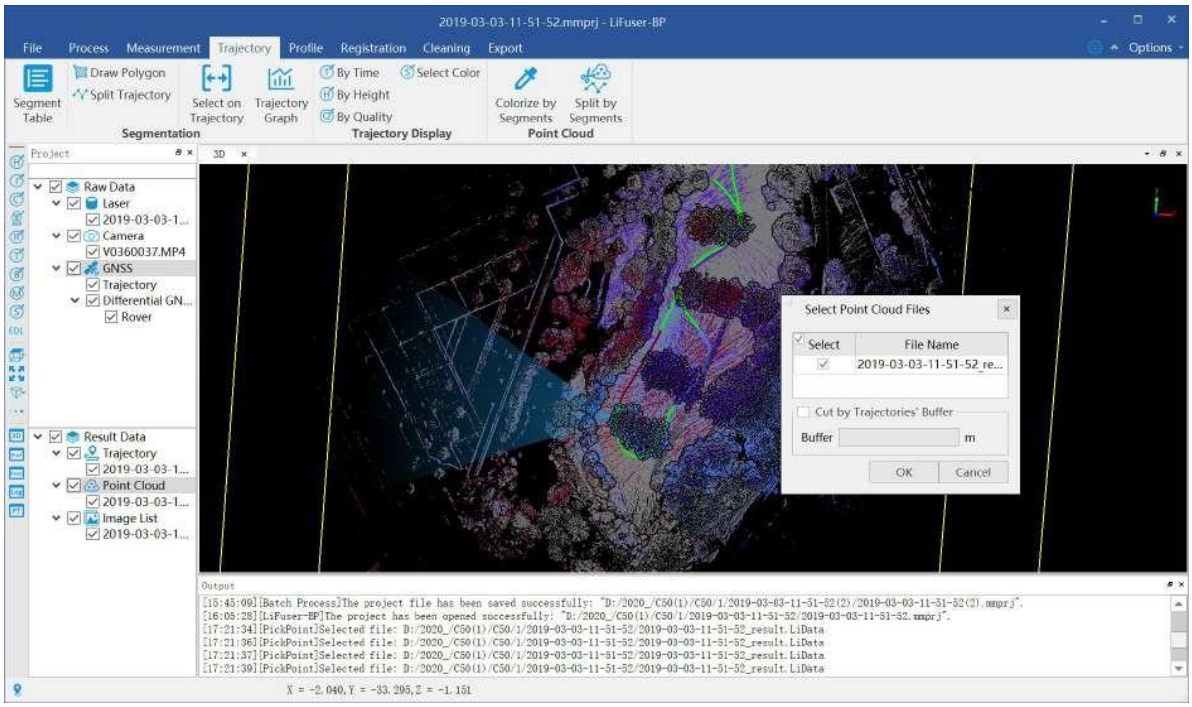
7.2.4 Colorize by Segments

Click the button of *Colorize by Segments* in *Point Cloud* Mode. In the display window, the point cloud will be colorized in specific color according to different trajectory segments. And if the point cloud is not segmented, the color will be gray.



7.2.5 Split by Segments

Click *Split by Segments* button in *Point Cloud* mode, click *OK* button in the pop-up window, the point cloud will be splitted into servel areas according to trajectory segment information. Click *Cut by Trajectorys' Buffer* button and edit the value of *Buffer*, the range of buffer value can be defined. And click *Cancel* button to stop segment operation.

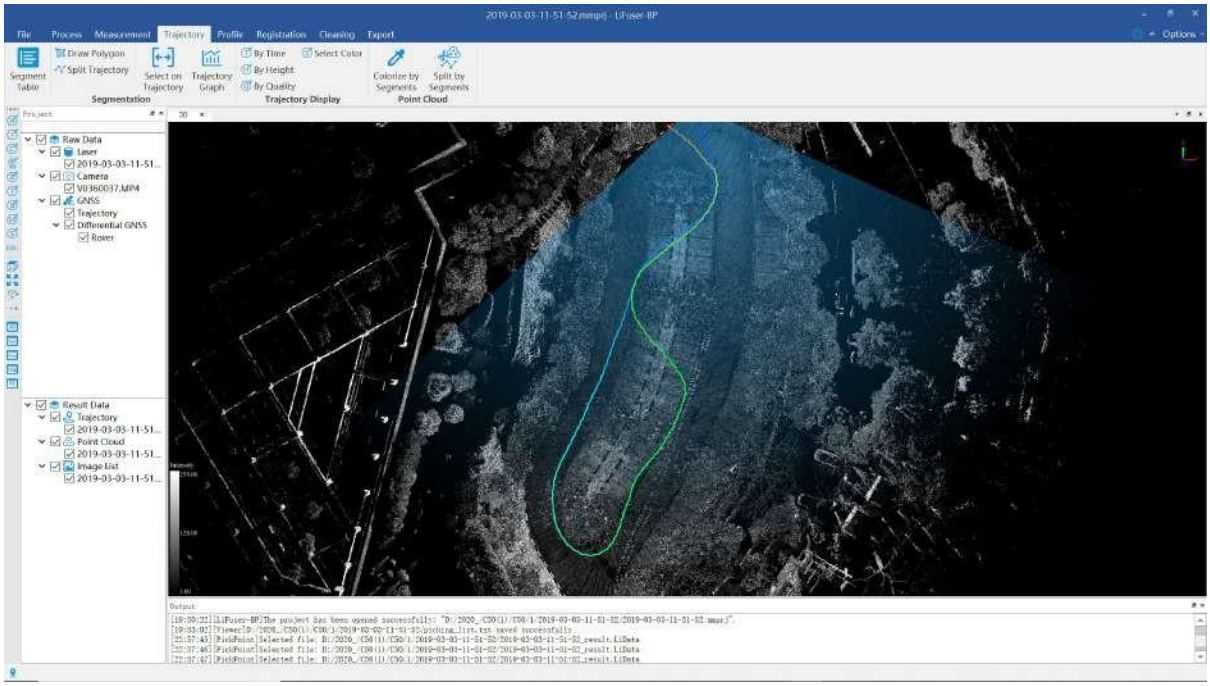


7.3 Trajectory Display

The software supports multi-displays:

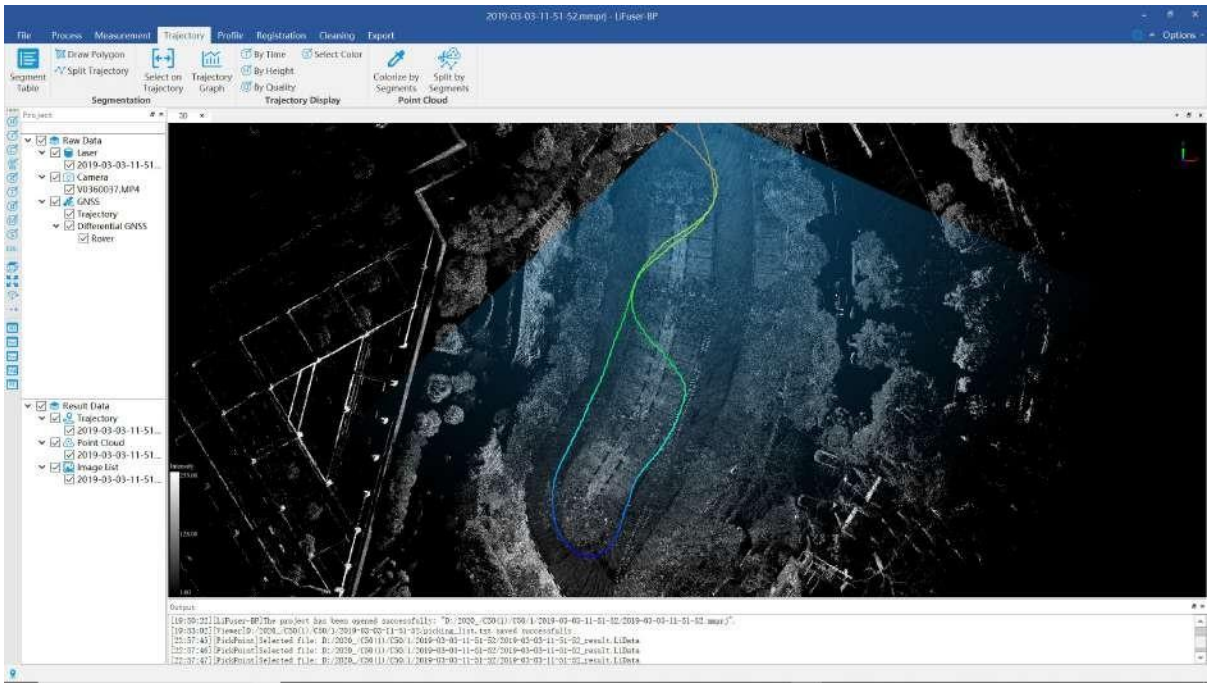
7.3.1 Display by Time (Default)

Click *By Time* button in *Trajectory Display* mode, the trajectory will be displayed in different color according to acquisition time, users can select the color bar in a pop-up window.



7.3.2 Display by Height

Click *By Height* button in *Trajectory Display* mode, the trajectory will be displayed in different color according to height information, users can select the color bar in a pop-up window.

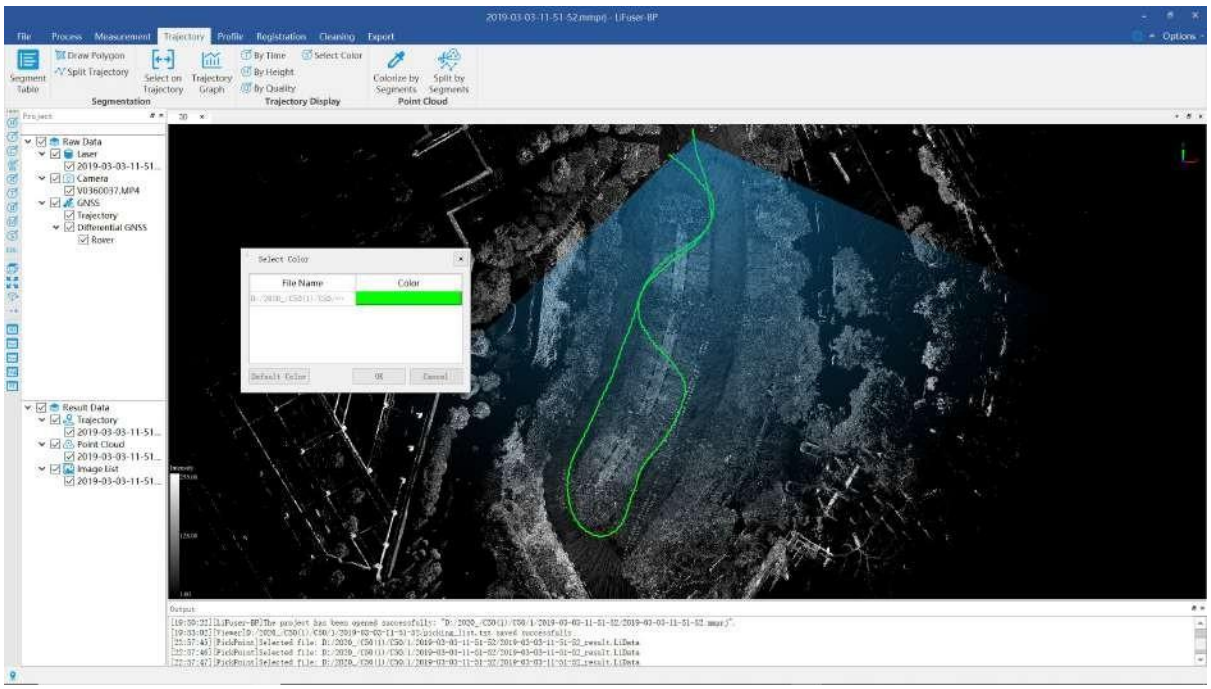


7.3.3 Display by Quality

Click *By Quality* button in *Trajectory Display* mode, the trajectory will be displayed in different color according to quality information, users can select the color bar in a pop-up window.

7.3.4 Display by Specific Color

Click *Select Color* button in *Trajectory Display* mode, the trajectory will be displayed in specific color according to user-defined color, users can select the color bar in a pop-up window.



8. Multi-project operation process

This chapter introduces LiFuser-BP's new multi-project, multi-station relative coordinate data splicing, and multi-station absolute coordinate data splicing functions.

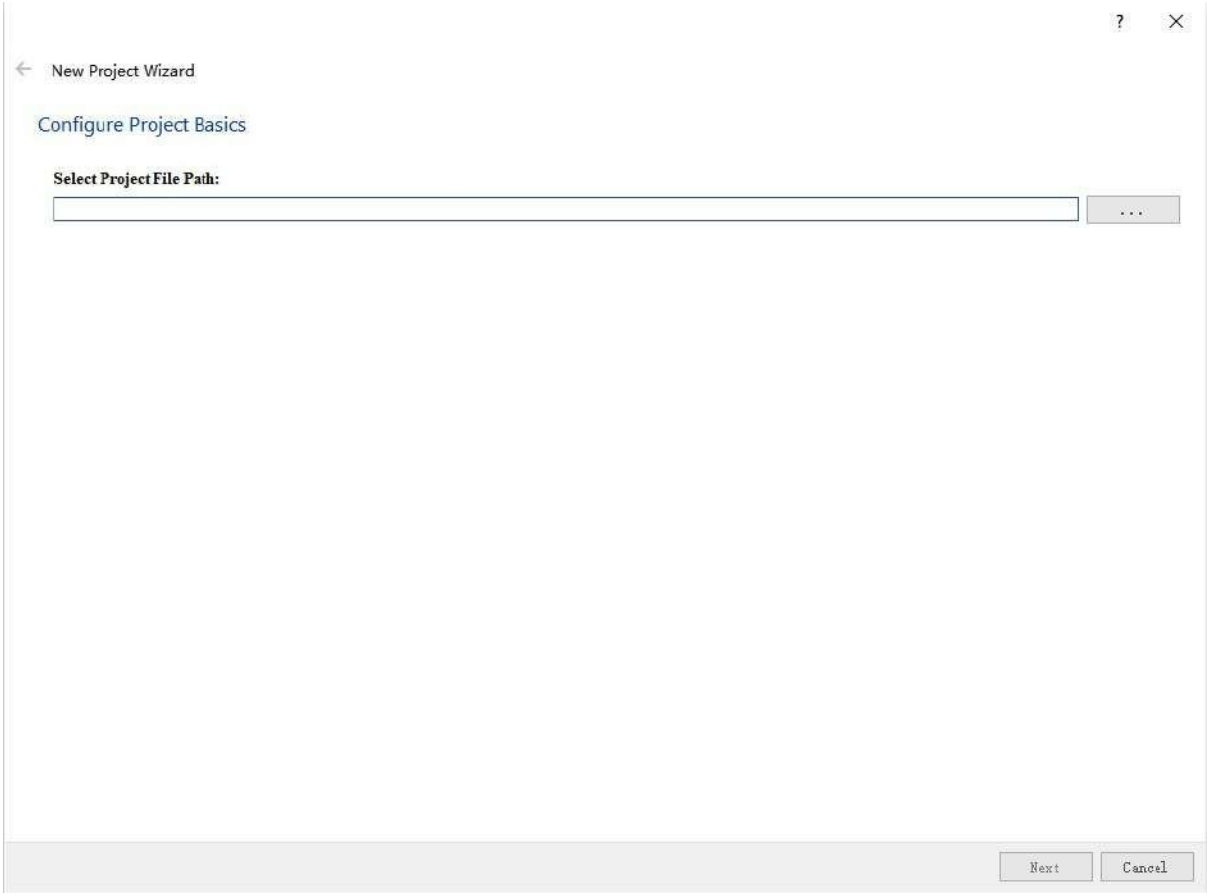
- New/Open Multi-Project
- Multi-station relative coordinate splicing
- Multi-station absolute coordinate splicing

8.1 New/open multi-project process

The new multi-project wizard mainly includes 4 pages of multi-project save path, original project data to be registered, coordinate system and project path configuration. Each page is used to configure the corresponding data. If the configuration of a page contains invalid data or does not meet the system requirements, the next step cannot be performed.

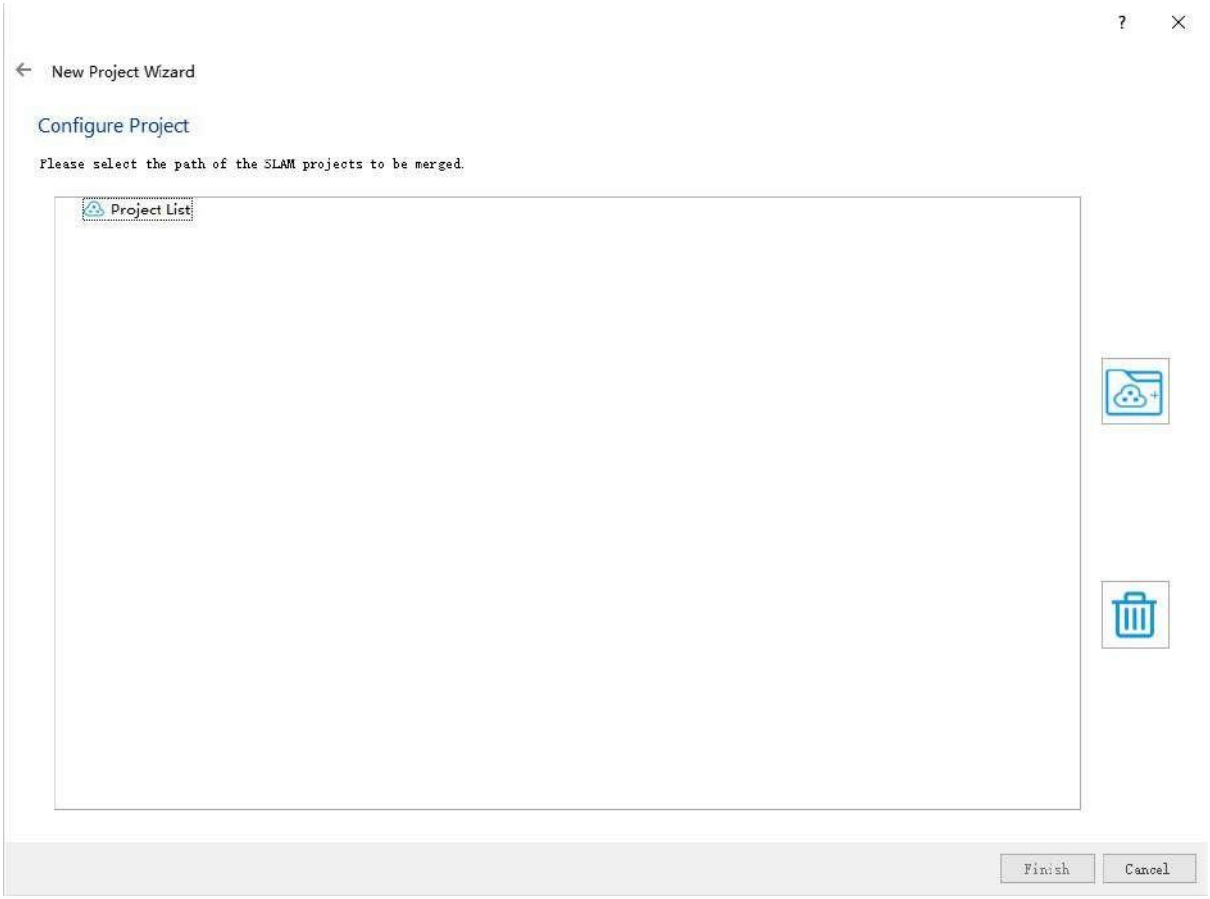
1. Click the Merge Project button  , the multi-project stitching wizard will pop up dialog.

2. Select the storage path for multi-project splicing and a storage path for multi-project splicing. It is recommended to create a new folder for separate storage

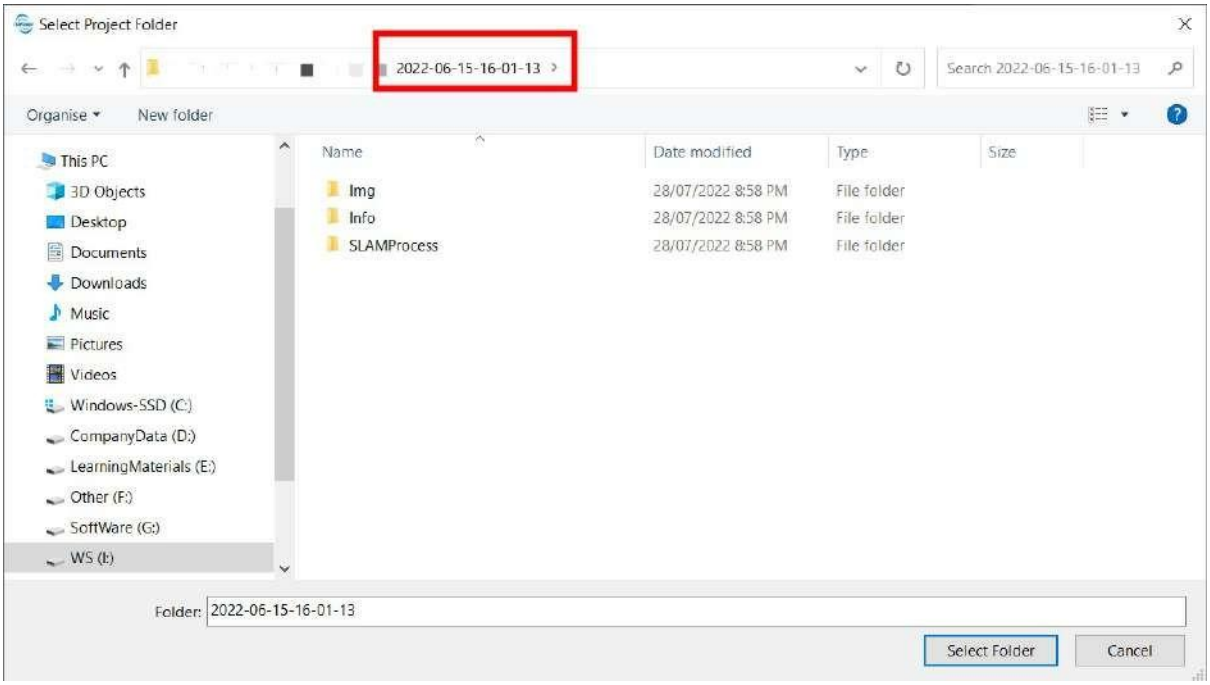


New project

3. Configure multiple single project data to be spliced, click the add data button on the right  , select the solution folder of each single project here. According to the project requirements, select multiple single project folders to the project list.



Configuration single project file



Select project file

4. Click Finish to complete the multi-project configuration

8.2 Multi-station relative coordinate splicing operation process

This process is suitable for the relative coordinates of the original project data or the relative coordinates of multiple sets of project parts and the absolute coordinates. The splicing steps are as follows:

The first reference station must meet the following requirements

1. Select the first reference station: After the new project is completed, the data of all stations will be listed in the **to be registered** list, and they will be sorted according to the collection project time (Sacn01-Scan**). One station needs to be selected as the first reference station, and the selection requirements are:

- If there are absolute coordinates in the multi-station data, the data with absolute coordinates will be given priority as the first station reference station
- If the multi-station data has a closed loop in part of the collection route, the closed-loop data is given priority as the first station reference station
- The survey area of the first reference station should be as large as possible in the multi-station data

The splicing process generally follows the following principles:

- Must be assigned to absolute coordinates through a single project
- First spell with control points or GPS, last spell without control points or GPS
- First spell with closed loop, last spell without closed loop
- The scope of the survey area is larger than that of other splicing stations.

2. Two-station connection: In the "Inter-station connection" under the "Merge Project" toolbar, select the reference station in the "To be registered" drop-down box, click the left button to add it to "Connected" , and then select the station to be registered in the drop-down box of "To be registered", and click the "Start" button to establish a connection relationship between the reference station and the station to be registered.

3. Manual rough registration: There are two methods of manual rough registration currently supported by the software, which can be selected according to your needs.

(1) Click the "Rotate/Translate" button to rotate and translate the point cloud to be registered to a position that basically matches the reference point cloud. You can click "View" to switch the viewing angle, and try to overlap the public areas of the two stations. Finally, click the "Apply Transform" button on the rotation matrix to save the "rotation/translation" rotation matrix.

> Note:
>
> - If a group of data is absolute coordinates and a group of data is relative coordinates, it is recommended to directly move the point cloud to be registered to the reference point cloud by pressing the "Match Center" button, and then perform rotation and translation.
> - The default setting of the "Rotate and translate" button only translates the X and Y directions, and does not modify the elevation. If you need to adjust the elevation, you can switch the side view display in the left toolbar, and the side view perspective only moves in the Z direction by default.

(2) Click the "Point Pair" button, and select no less than three control points with the same name in the to-be-registered point cloud and the reference point cloud, which are not located on the same straight line. You can judge whether the selected control points are the same name control according to the size of the error. Click to

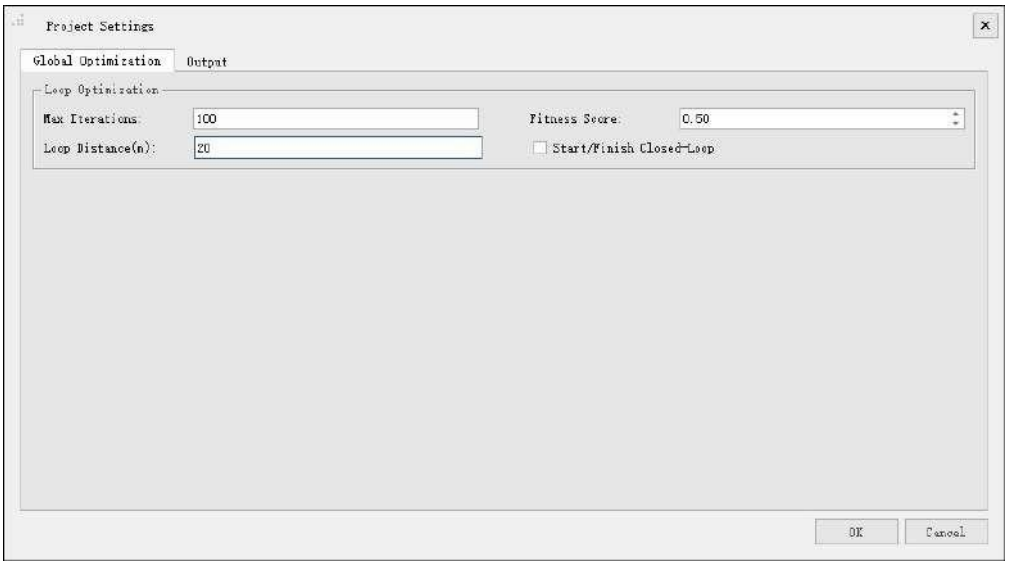
check if the wrong selection is made. After the judgment is correct, click the "Apply Transform" button to save the rotation matrix of "Point Pair Registration".

4. If there is multi-site data, repeat the above step 3: establish a connection relationship between the cloud data of two adjacent sites, and perform rough registration by means of "rotation/translation" or "point pairing".

> Note:
>
> 1) From the second time the connection relationship is established, for each subsequent connection, the reference station normally already exists in "Connected", you can directly select it in the drop-down box, and there is no need to move from "To be registered".
>
> 2) By default, the globally optimized base station is the reference station where the connection relationship is established for the first time, that is, move to the connected point cloud data by moving the left button. The accuracy of the data itself will affect the accuracy of the overall point cloud splicing. In order to ensure the splicing effect, the base station must meet the requirements in 1
>
> 3) The rough stitching result has a great influence on the final stitching accuracy. The finer and more accurate the rough stitching, the better the global optimization effect.

5. Global optimization: After the point cloud data of all stations are connected and the rough registration is completed, set the global optimization parameters in the project settings of the merged project, and then click the "Global optimization" button to start the global optimization. The parameter interface of the project setting is as follows:

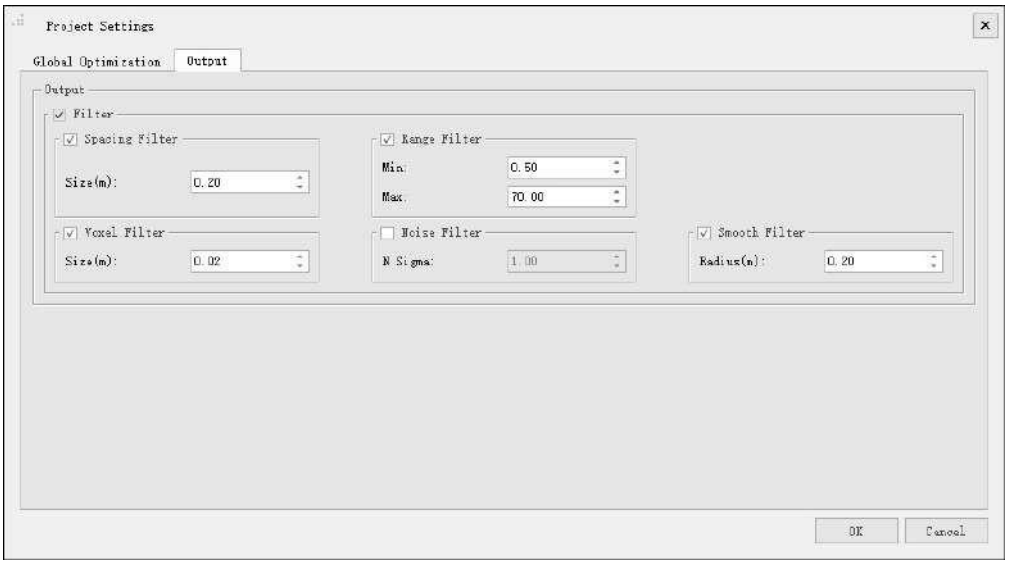
Global optimization parameters:



Configure global optimization parameters

- **Maximum number of iterations**: The maximum number of iterations for closed-loop optimization. The larger the value, the slower the processing speed and the higher the data accuracy. The smaller the setting, the faster the speed and the lower the accuracy.
- **Fitness Score**: The score threshold for closed-loop detection. The smaller the value, the more likely the false detection operation will occur. The larger the value, the more likely the missed matching phenomenon will occur.
- **Closed Loop Distance(m)**: The value of the surrounding neighborhood distance for closed loop detection.
- **Start/End closed loop**: Whether to set the first and last closed loop operation.

output:



Output parameter interface

- **Spacing Filter**: Set the spatial threshold for data thinning, that is, the moving distance of adjacent point cloud frames must not be less than the current threshold.
- **Distance Filter**: Set the threshold setting for data output, that is, the data range reserved for each frame of point cloud must be within the threshold.
- **Voxel filtering**: The size is the minimum distance between points, the default is 0.02m, and the points are evenly thinned according to the distance value.
- **Noise Filter**: Unchecked by default. After checking, set the standard deviation multiple. If it exceeds several times of the standard deviation, it is considered as noise, and denoising is performed. Generally, the smaller the setting, the better the denoising effect. But if the setting is too small, it may denoise too much, resulting in abnormal point cloud.
- **Smoothing Filter**: The default value is 0.2, which is mainly used to smooth the point cloud. If the setting value is too large, it will easily lead to deformation of the ground objects or abnormal point cloud.

6. Re-output (optional):

Modify the filter parameters in the output of the project settings, click *Re-output* to re-output the point cloud data according to the filter settings.

8.3 Multi-station absolute coordinate splicing operation process

This process is suitable for splicing data whose original engineering data are all absolute coordinates. The splicing steps are as follows:

1. Select the first reference station: After the new project is completed, the data of all stations will be listed in the **to be registered** list, and they will be sorted according to the collection project time (Sacn01-Scan**). One station needs to be selected as the first reference station, and the selection criteria are as follows:

- If the multi-station data has a closed loop in part of the collection route, the closed-loop data is given priority as the first station reference station
- The survey area of the first reference station should be as large as possible in the multi-station data

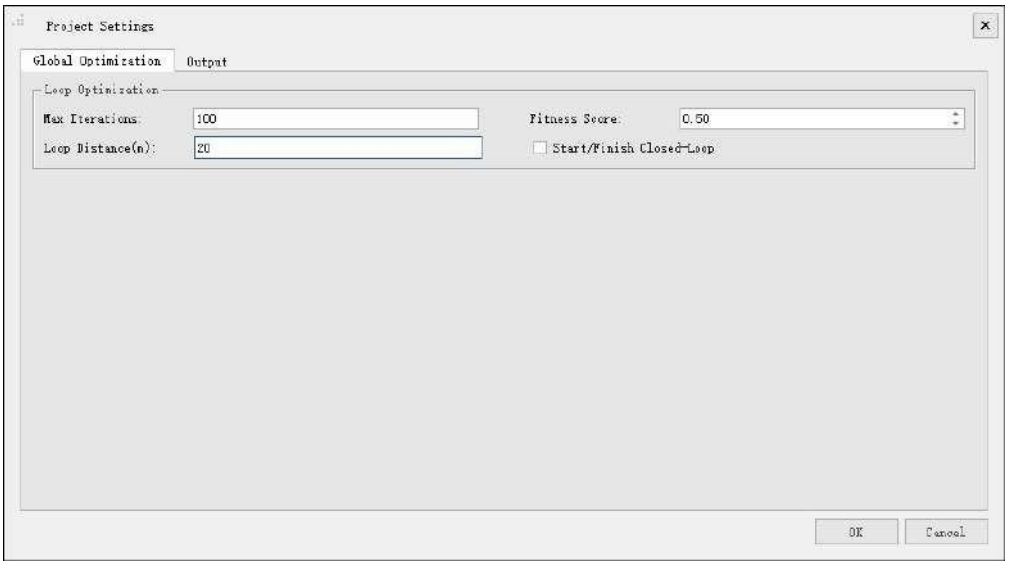
2. After determining the first reference station, click the left button in the inter-station connection <= to move it to the connected list.

3. In the to-be-registered list, select a station as the first station to be registered according to the splicing order, and click the left button in the inter-station connection <= to move it into the connected list. At this point, a connection has been established between the two stations.

4. Repeat the operations of steps 2 and 3 above until a pairwise connection relationship is established between all stations.

5. Global optimization: When the point cloud data of all stations are connected, in the project settings of the merged project, set the global optimization parameters, and then click the "Global optimization" button to start the global optimization. The parameter interface of the project setting is as follows:

Global optimization parameters:

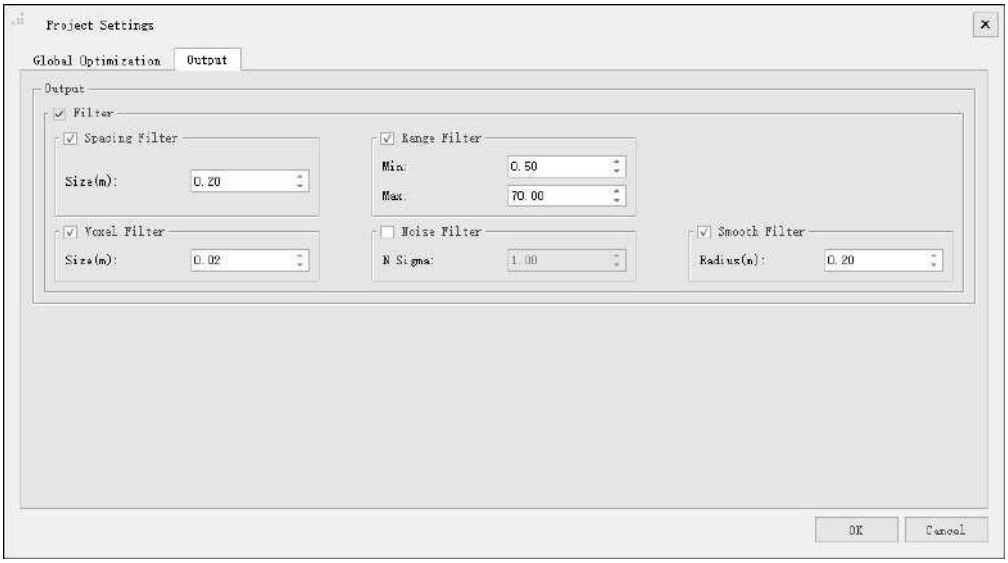


Configure global optimization parameters

- **Maximum number of iterations**: The maximum number of iterations for closed-loop optimization. The larger the value, the slower the processing speed and the higher the data accuracy. The smaller the setting, the faster the speed and the lower the accuracy.

- **Fitness Score**: The score threshold for closed-loop detection. The smaller the value, the more likely the false detection operation will occur. The larger the value, the more likely the missed matching phenomenon will occur.
- **Closed Loop Distance(m)**: The value of the surrounding neighborhood distance for closed loop detection.
- **Start/End closed loop**: Whether to set the first and last closed loop operation.

output:



Output parameter interface

- **Spacing Filter**: Set the spatial threshold for data thinning, that is, the moving distance of adjacent point cloud frames must not be less than the current threshold.
- **Distance Filter**: Set the threshold setting for data output, that is, the data range reserved for each frame of point cloud must be within the threshold.
- **Voxel filtering**: The size is the minimum distance between points, the default is 0.02m, and the points are evenly thinned according to the distance value.
- **Noise Filter**: Unchecked by default. After checking, set the standard deviation multiple. If it exceeds several times of the standard deviation, it is considered as noise, and denoising is performed. Generally, the smaller the setting, the better the denoising effect. But if the setting is too small, it may denoise too much, resulting in abnormal point cloud.
- **Smoothing Filter**: The default value is 0.2, which is mainly used to smooth the point cloud. If the setting value is too large, it will easily lead to deformation of the ground objects or abnormal point cloud.

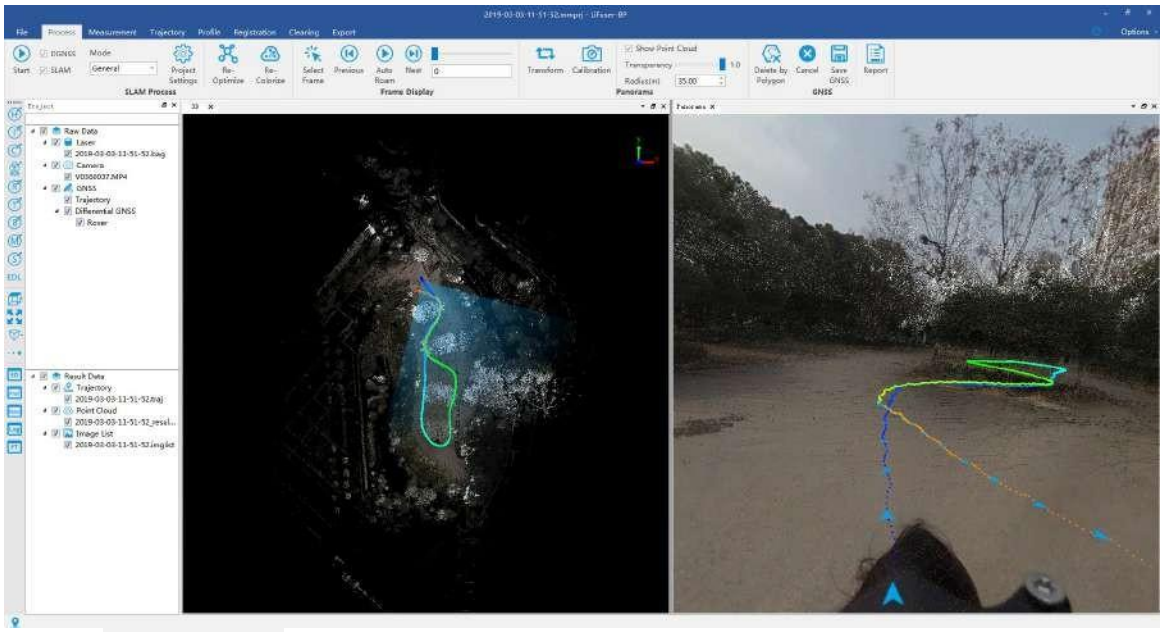
6. Re-output (optional):

Modify the filter parameters in the output of the project settings, click *Re-output* to re-output the point cloud data according to the filter settings.

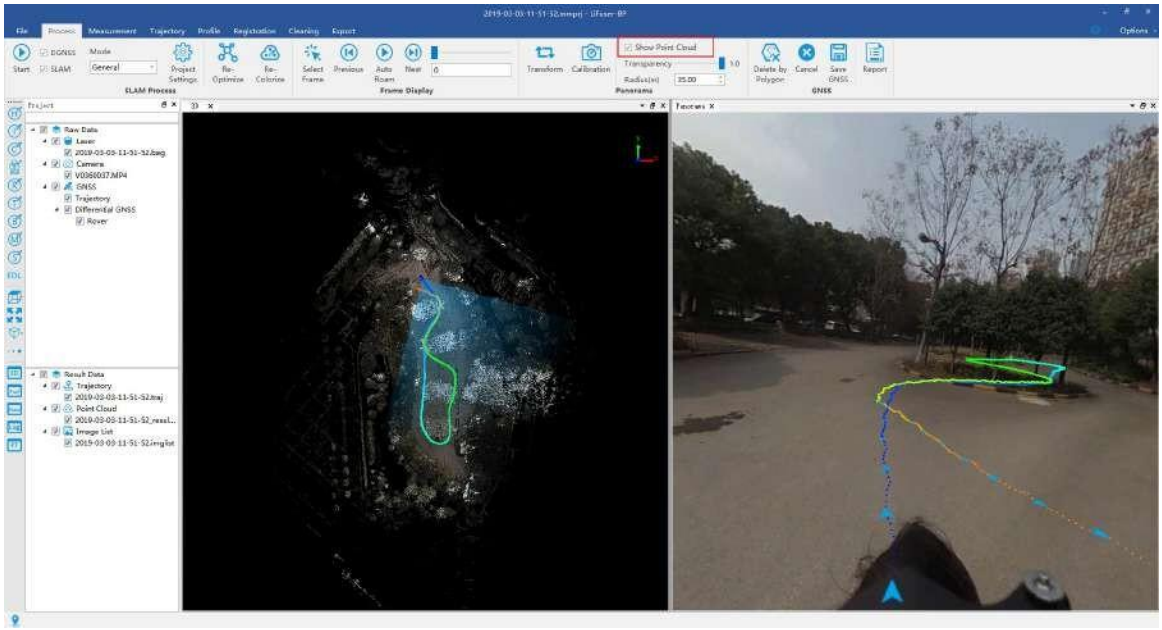
9. Point Cloud Roam

After finishing point clouds processing, the software supports Point Cloud and Panomatic Photo Roam. Note that there mush be video file for Panomatic Photo Roam. Open add video file reference wizard, and operate as below:

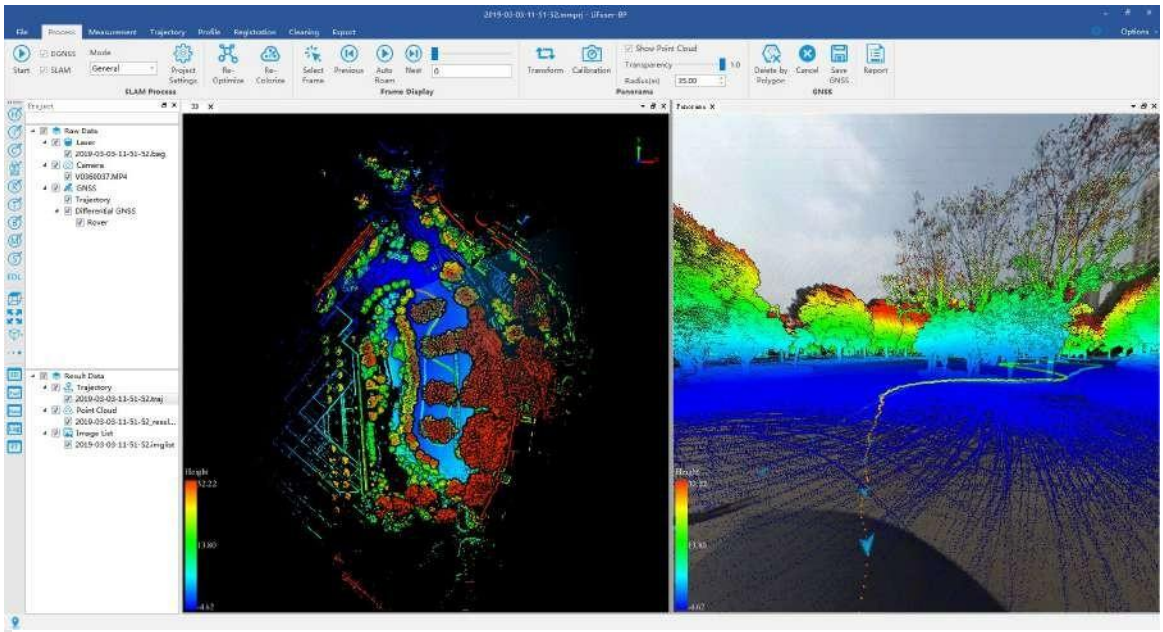
1. Create a new project and Process SLAM, or open a project which has been georeferenced.
2. There will be a 3D viewer and a panoramic viewer. Point cloud will be shown in both viewers while panoramic photo will only appear in panoramic viewer. By checking the data file to choose view it or not.



3. Uncheck ☐ Show Point Cloud for only viewing panoramic photo.



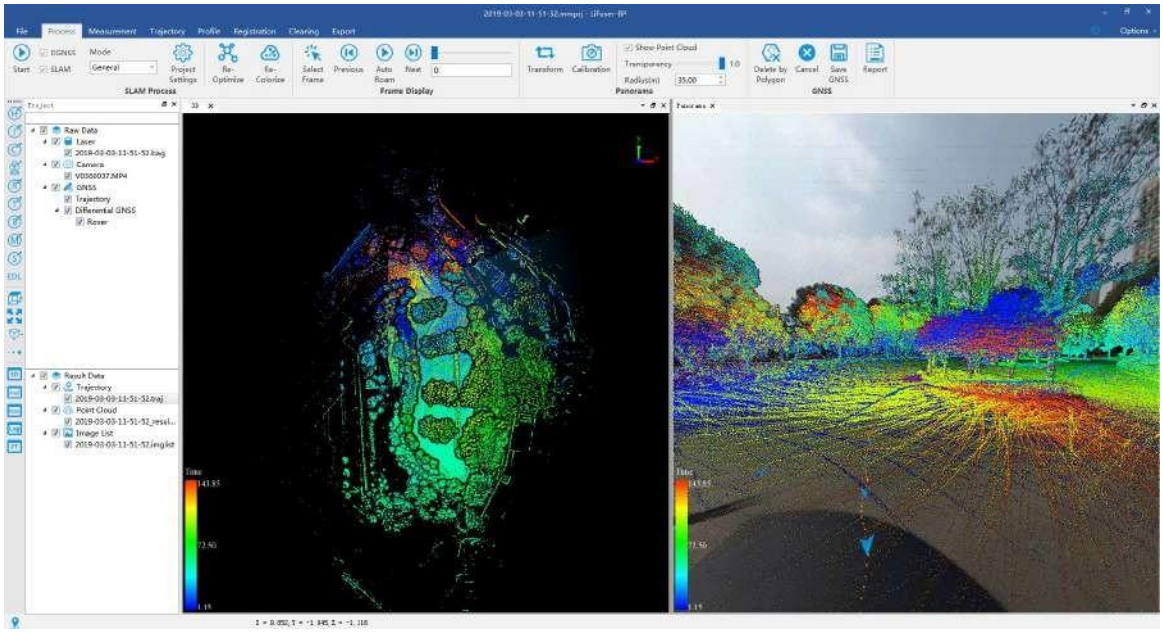
4. Click the colorize toolbar on the left window and change the display mode. EDL can be mixed with other mode to enhance the outline characteristic.



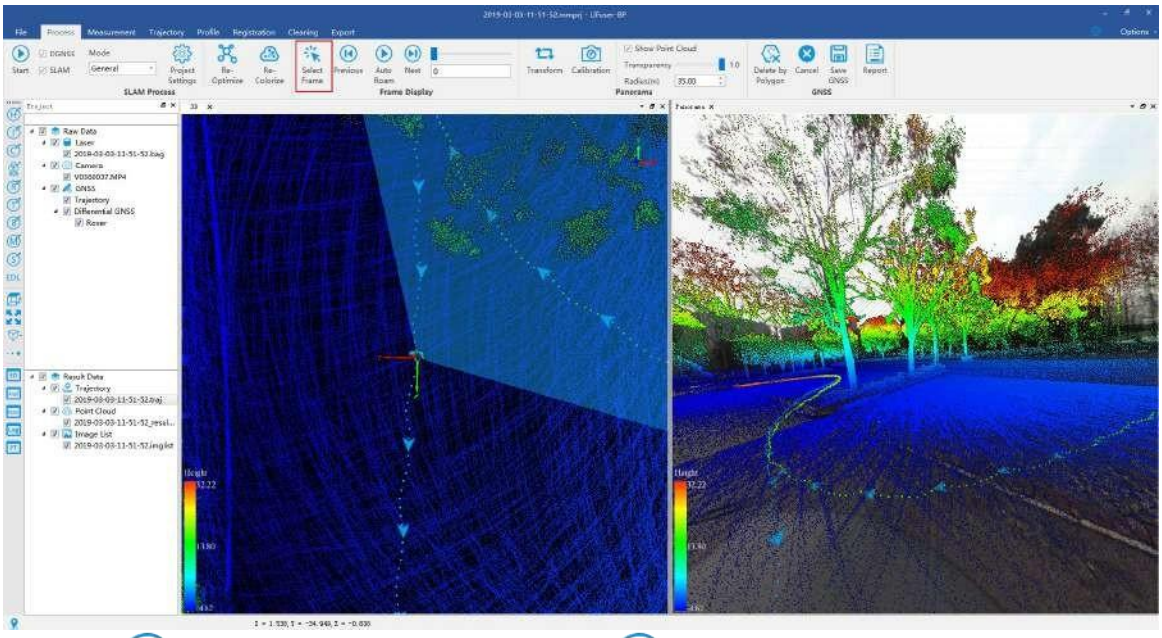
Note：Display mode in toolbar works for all point cloud, if users want to apply for a specific point cloud, right click on its name and choose View Mode > Display by Height / Intensity / Classification etc.

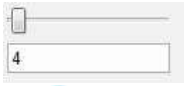
Note: Display by EDL is related to viewer. Please activate a viewer by click anywhere before choose display by EDL.

5. Users can right click point cloud file and tracjory file to change display mode including dispaly by tracjory quality,dispaly by time, dispaly by elevation or display by RGB. For example, display by time.



6. Click *Select Frame*  at Process page, users can choose exposure place in 3D or panoramic viewer (blue triangle by default, turn into orange after clicking), and redirect to the selected place.

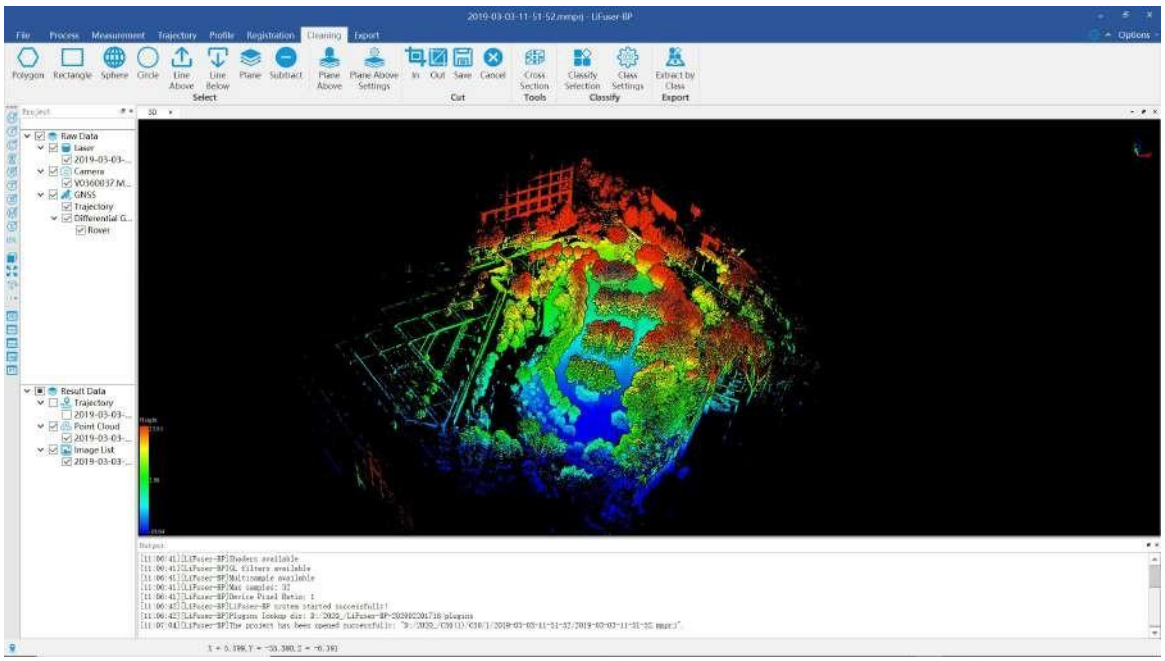


7. Click *Next*  to redirect to next frame. Click *Previous*  to the previous frame.
8. Drag the slider  to switch to different place or directly enter the frame number.
9. Click *Auto Roam*  to roam in panoramic viewer as user sight. Click again to stop roaming.

10. Clip by Cross Section

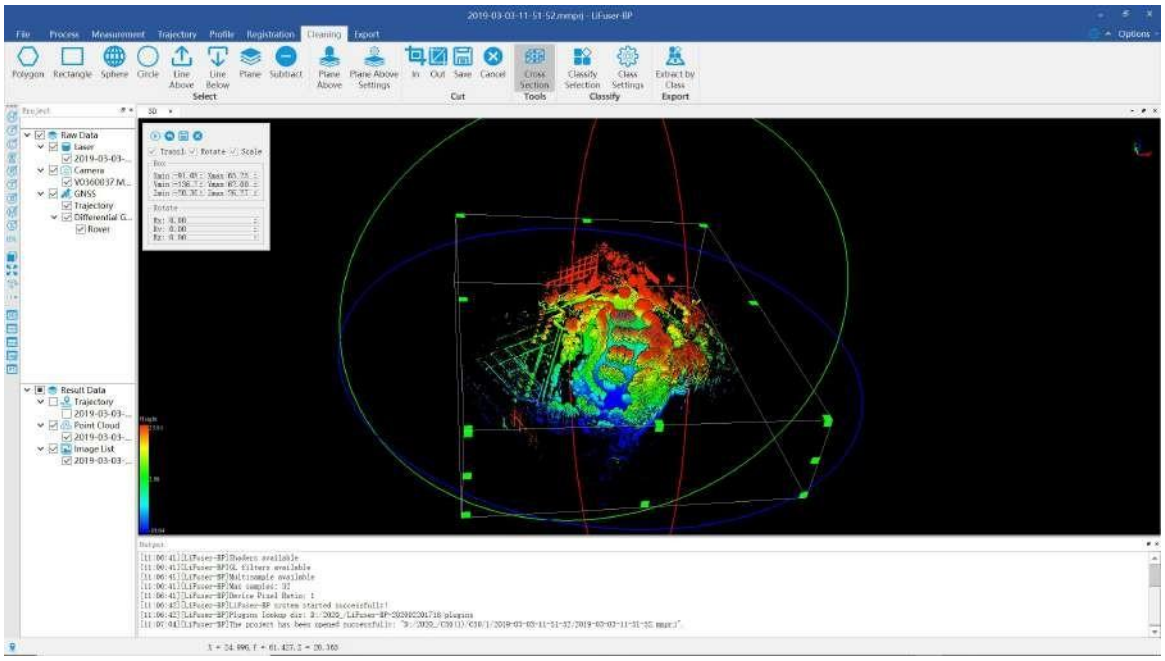
1. Launch LiFuser-BP software, and load the corresponding engineering files.

2. Set display mode as *Display by Height* + *Display by EDL*.



Set display mode as Display by Height + Display by EDL

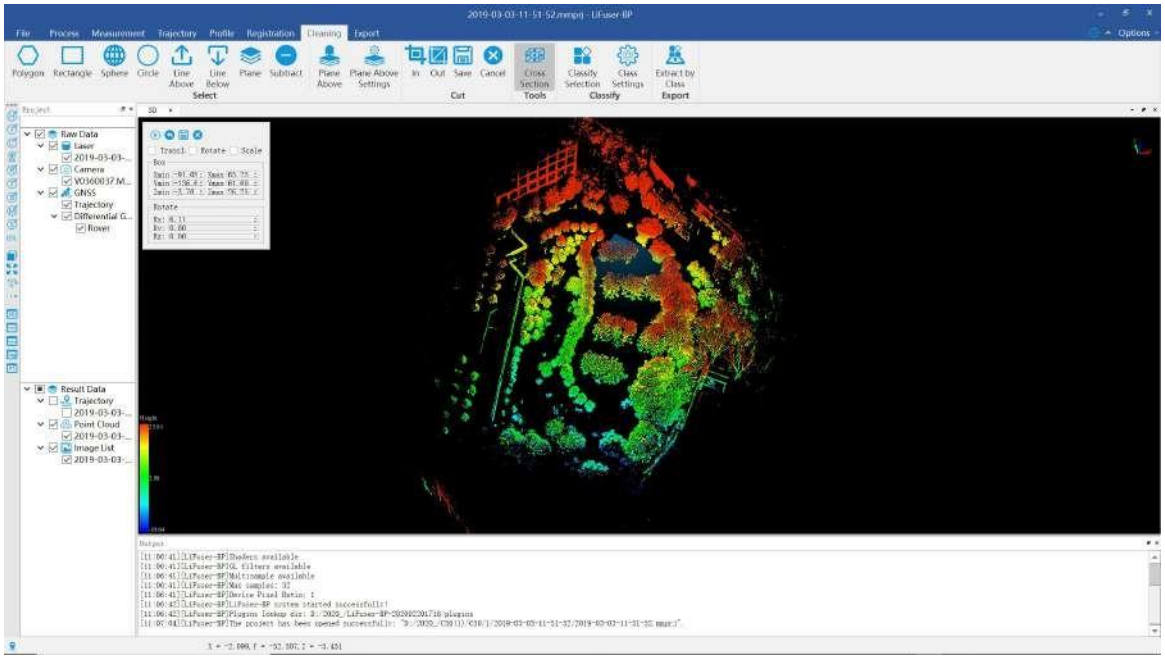
3. Switch to *Cleaning* mode, click *Cross Section*  button, a 3D window will pop up. Three selections on the left corner (*Translate*, *Rotate*, *Scale*) control the pan, rotate, and zoom operation of the bounding box, which works by ticking on the corresponding options.



Adjust the bounding box

4. (optional) Click  button, the bounding box will go back to initial status.

5. The following image is cropped according to the Z axis to remove the effect of the ground point.



Cutting along z-axis

6. Click  button to save the clipped point file.

7. Click  button button to pause intersection selection.

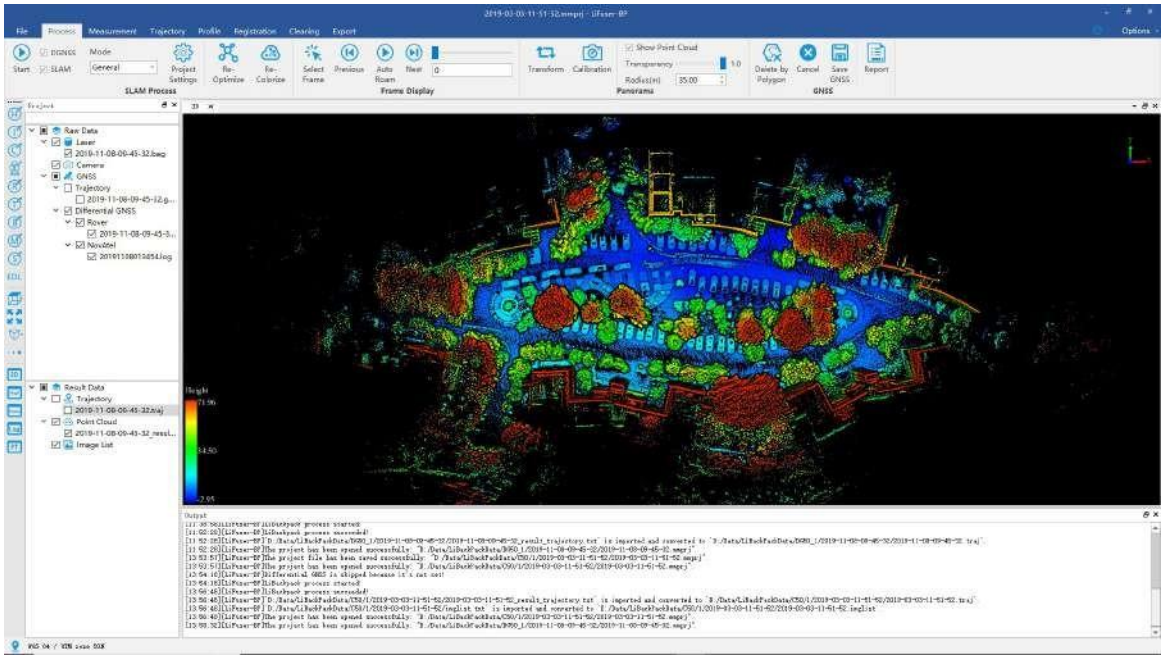
8. Click  buttom to quit intersection selection.

Parameters Setting

- **Translate**: Control the movement of the bounding box.
- **Rotate**: Control the rotation of the bounding box.
- **Scale**: Control the zooming of the bounding box.
- **Box**: It can be accurate to adjust the minimum and maximum value of x, y and z directions of the bounding box.
- **Rotate**: It can be accurate to adjust the angle value of x, y and z directions of the bounding box.

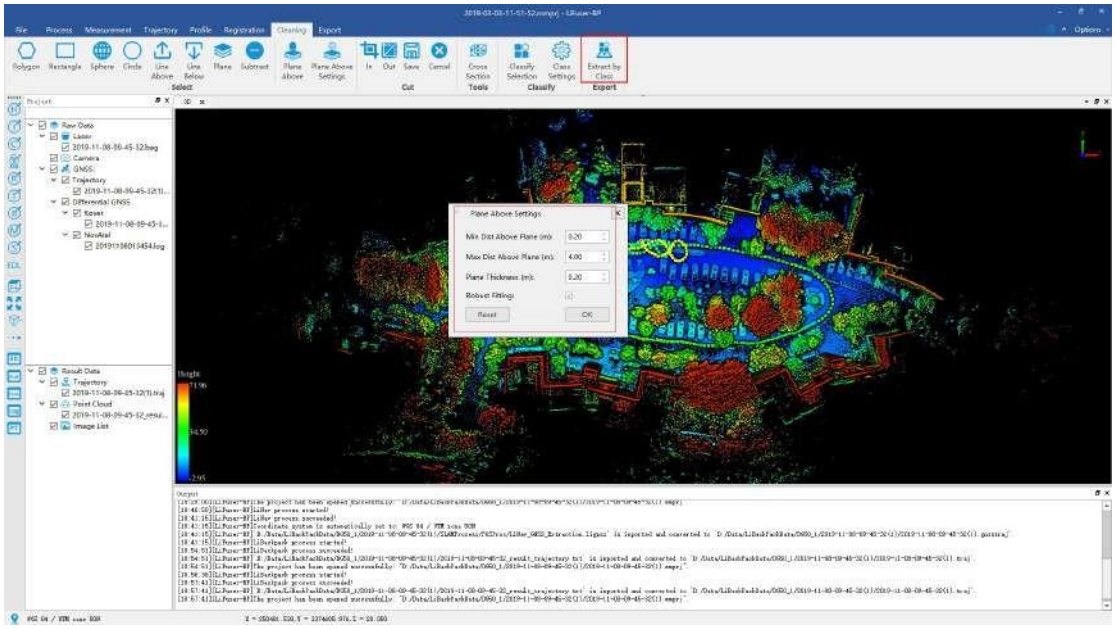
11. Clean Moving Targets

1. Launch LiFuser-BP, and load a project file.
2. Display the data by Height+EDL.



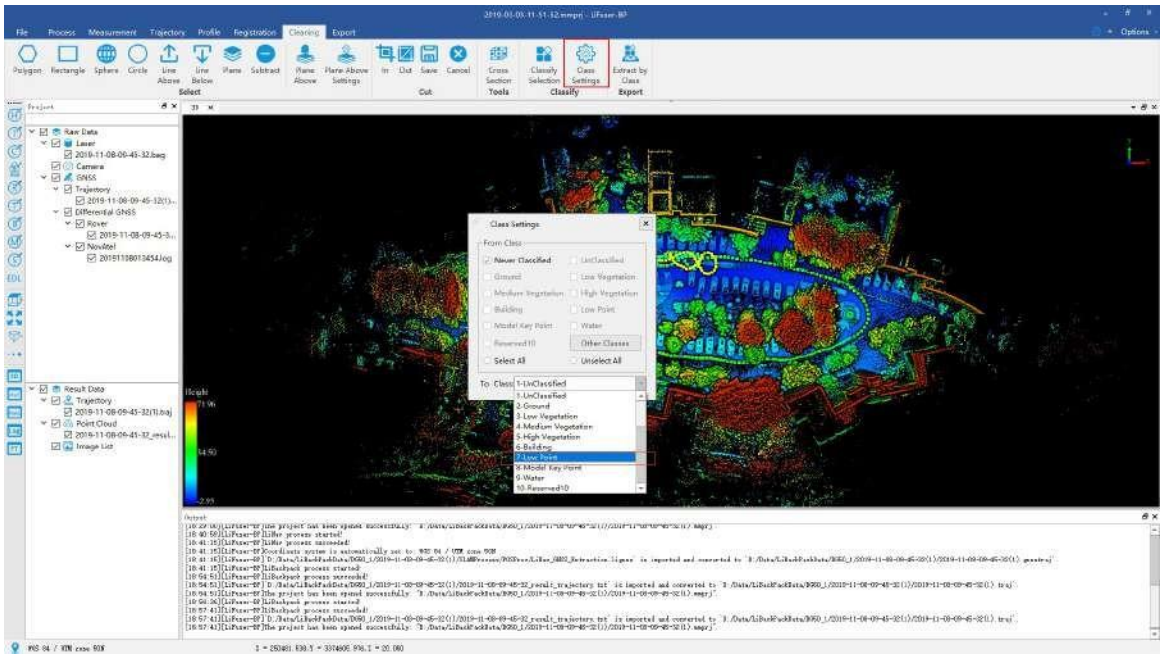
Display by Height+EDL

3. Click *Plane Above Settings*  at Cleaning toolbar, set parameters of designated point clouds above plane.
   - **Min Dist Above Plane(m)**：The minimum distance between the point cloud to the plane.
   - **Max Dist Above Plane(m)**：The maximum distance between the point cloud to the plane.
   - **Plane Thickness(m)**：The thickness of the fitted plane.
   - **Robust Fitting**：whether to use robust fitting or not.



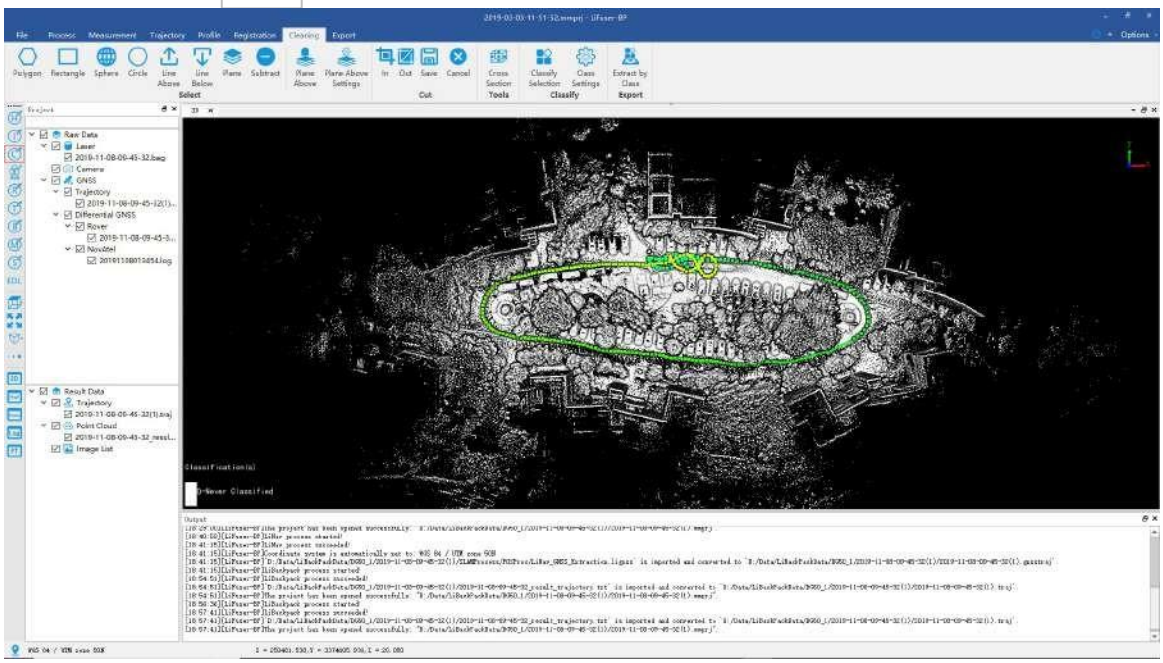
Plane above setting

4. Click *Class Settings button*  , set target classification in selected area and classify moving target to class as 7-Low Point.



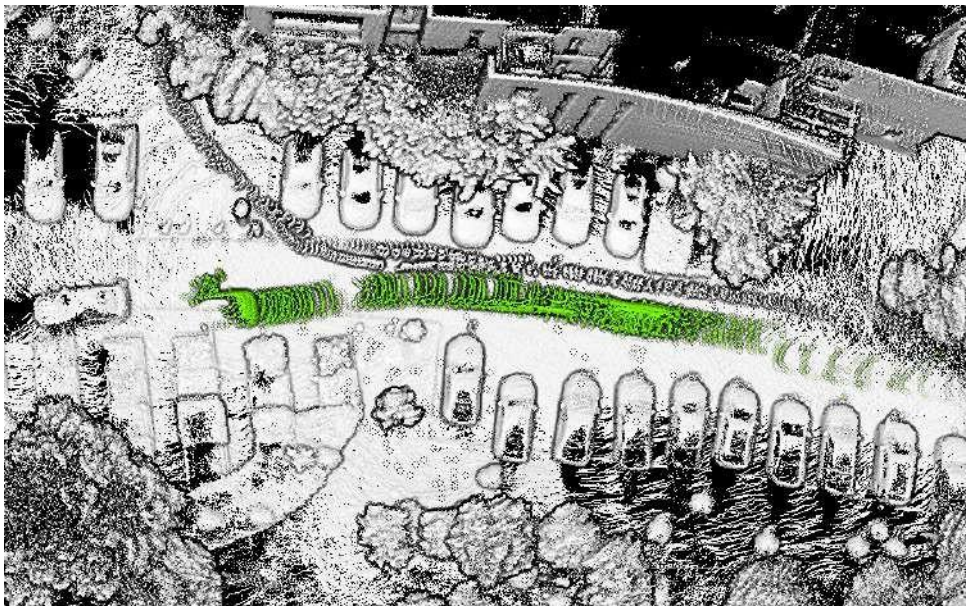
Class setting

5. Click *Display button*  , display the point cloud by classification.



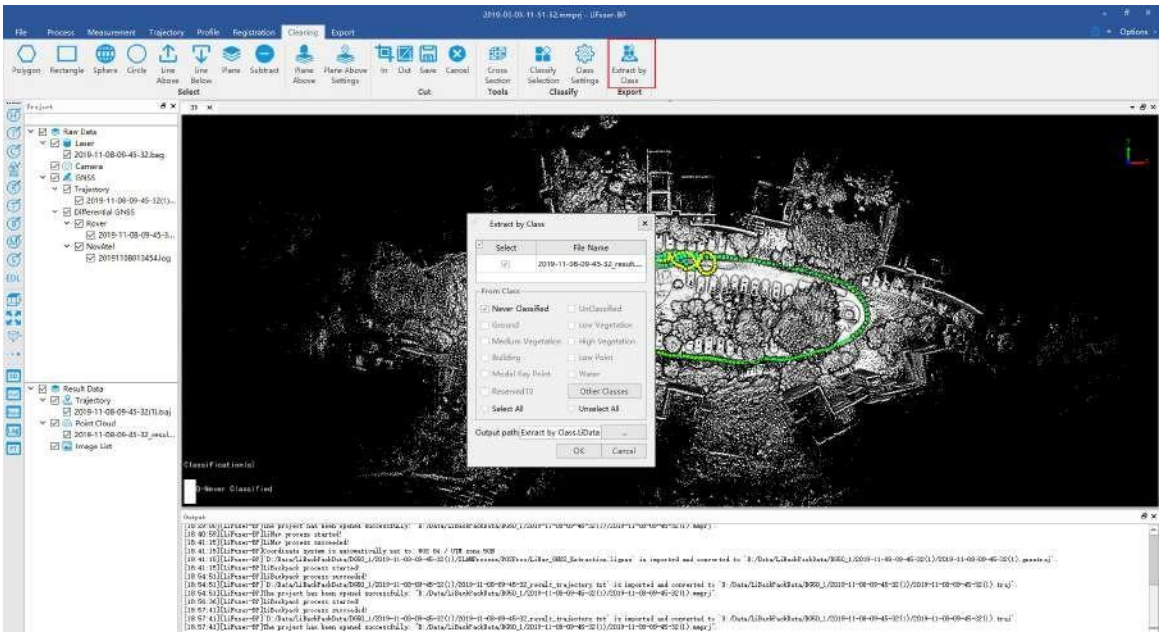
Display by classification

6. Click *Plane Above*  , choose moving objects area. Then click *Classify Selection*  , and the point cloud within selected area will be assigned to objective class.



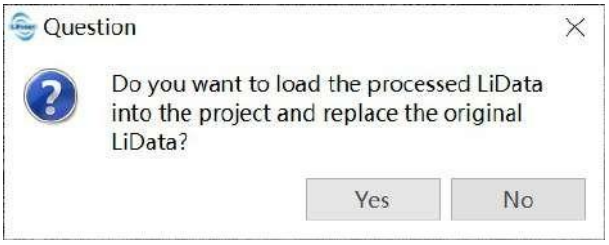
Extract and classify the moving objects

7. Click *Extract by Class*  , untick moving objects, then save the point cloud data to new LiData file.



Save new data by extracting by class

8. The pop-up dialog will ask if you want to load the previous saved point cloud and replace the project's existing point cloud file. If you confirm the replacement, click the *Yes* button, otherwise click the *No* button.



Question dialog

12. Panorama Calibration

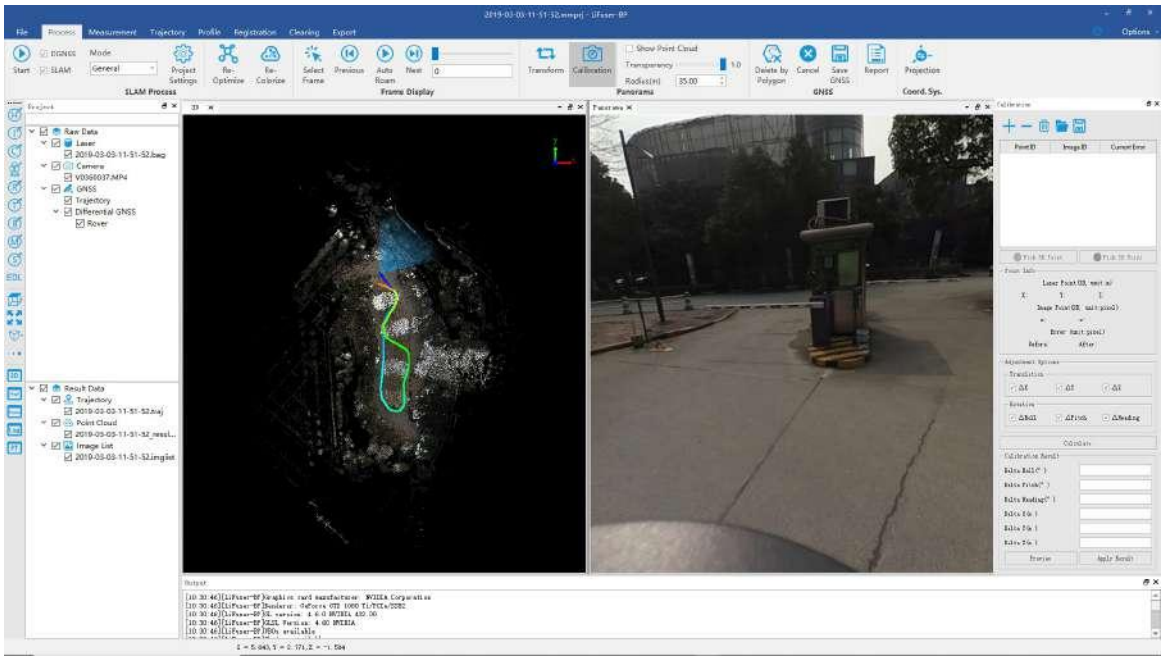
When Slam Process has been done, there is still deviation between panorama image and point cloud. This is caused by the installation deviation of panorama camera and laser scanner. The picture shows the mismatch between the image and point cloud.

LiFuser-BP provides panorama calibration module to evaluate the installation deviation between camera and laser scanner, so that the mismatch can be improved.

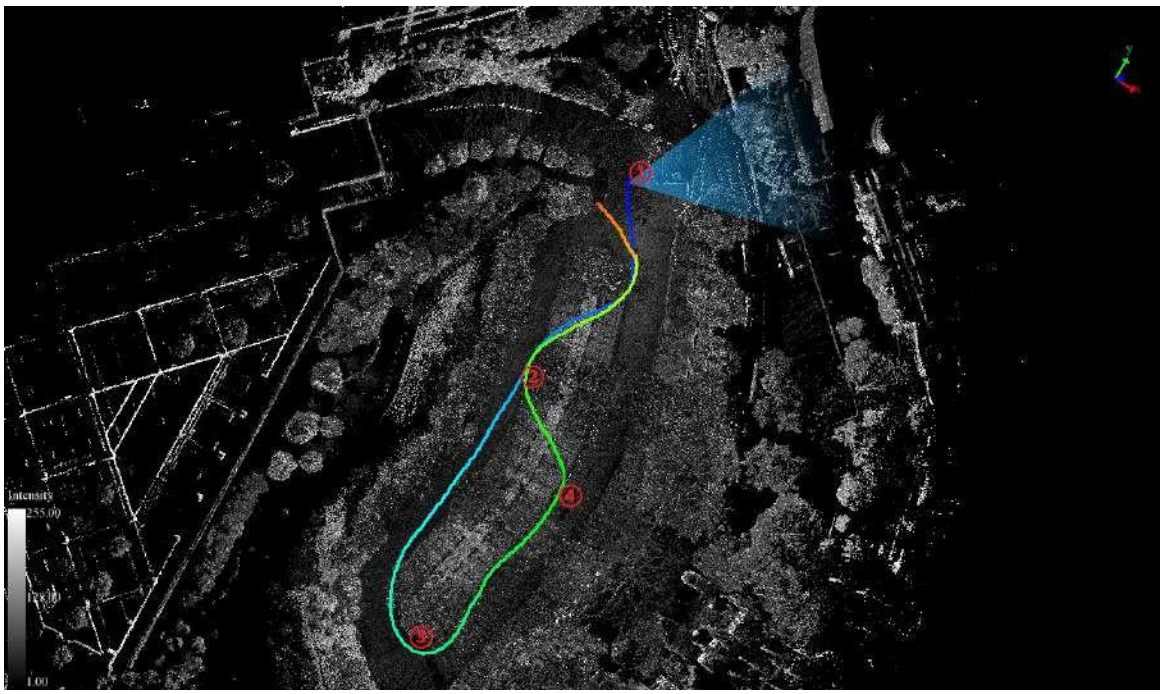
> Note: Go to Process->Panorama->Radius, set the display radius of point cloud, to only show the point cloud in interested area. You can use this tips for picking up calibration points.

Process

1. Switch to *Process* tab, click Panorama *Calibration*  , and calibration window will pop up.

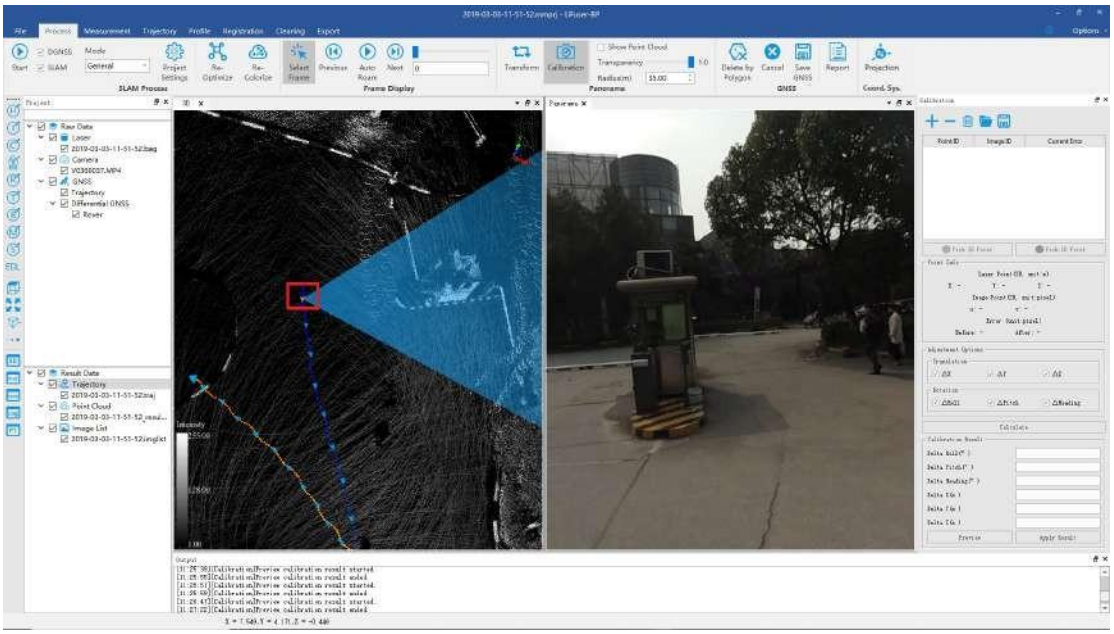


1. Add calibration point. We suggest to choose camera exposure points on multiple directions. Then select multiple point pairs(at least four pairs) at each site. For example, if we select four exposure points respectively on East/South/West/North, each site need four point pairs, i.e. 16 point pairs overall.



Detailed steps:

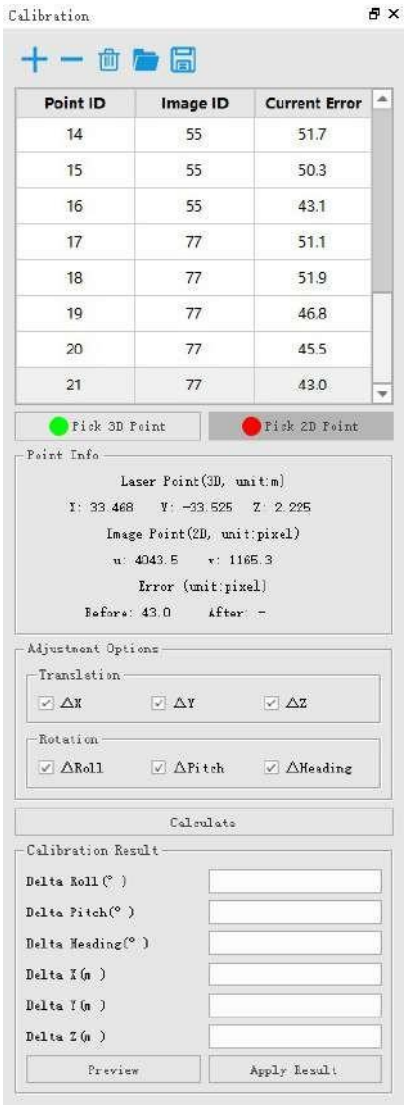
- Click *Select Frame* button, select a specific triangle arrow and the panorama viewer will automatically switch to that frame.



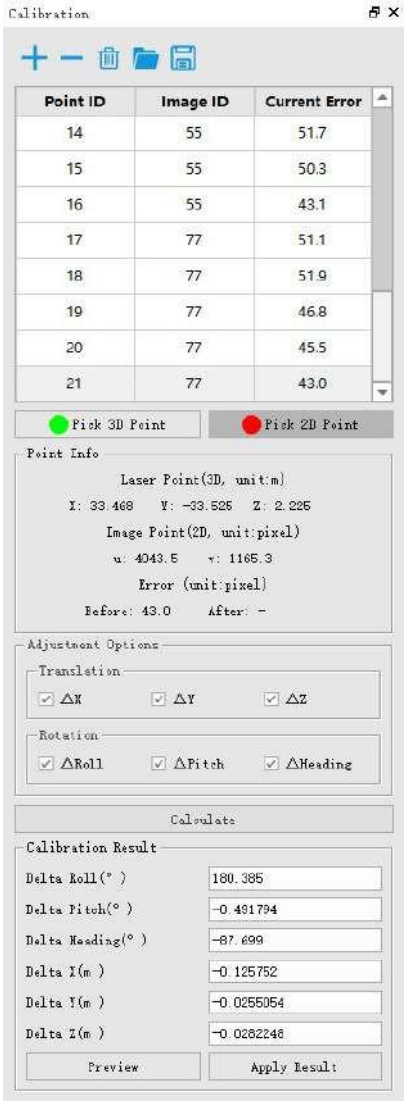
- Click *Add Point* button on the top of calibration window, and a new row will add to point list accordingly.
- Click *Pick 2D Point* button and select image points in panorama viewer. There's a magnifier above, to help you locate at the point.

- Click *Pick 3D Point* button and select corresponding point clouds.

- Repeat the above three steps untill enough point pairs are selected.
- Select frames on other three directions and repeat the above steps until all point pairs are selected.



2. Click *Calculate* button and start calibration calculation.



3. Click *Preview* button to preview the calibration result.

   Before:

After:

4. Apply the calculation. If you are satisfied with the preview performance, click *Apply* to apply the change to the data.

> Note:
>
> 1. There are two ways to show/hide point cloud: Click *Show Point Cloud* button; adjust *transparency*. By controlling show/hide point clouds, you can improve efficiency of point selection.
> 2. Generally, choose Display by Intensity is more convenient for point selection.

13. Registration

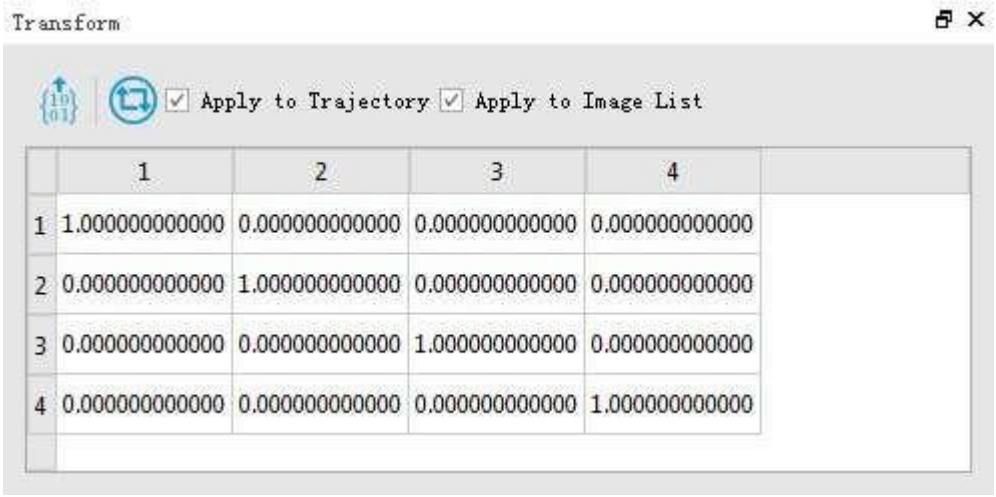
Point cloud registration includes data registration of multi-station scans in the same area, and absolute geographic coordinate correction of point clouds using ground control points. The registration of multi-site clouds in the same area can be done through manual rough registration, ICP (Iterative Closest Point, iterative closest point) registration, manual selection of point pairs with the same name, or target ball registration. Geographic coordinate correction can be done by manually selecting point pairs with the same name or target ball registration, TPS (Thin Plate Splines, thin plate splines) correction. Define the coordinate system You can interactively define the coordinate origin and three-axis direction of the local coordinate system through mouse operations, and transform the original point cloud into the specified local coordinate system through translation and rotation. The SLAM optimization integrated with GCP adds control point information to the SLAM closed-loop process to improve the registration accuracy.

- Course Registration
- ICP Registration
- Manual Registration
- Georeference Registration
- Define Coordinate System
- Set vertical

13.1 Coarse Alignment

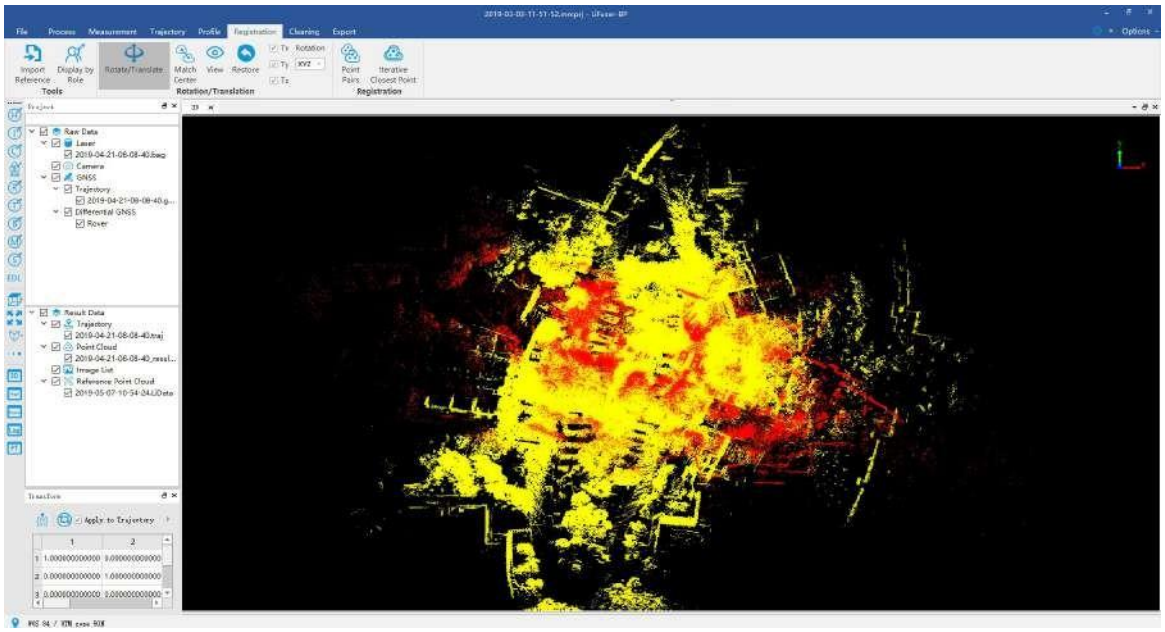
1. In Registration tab, click *Import Reference* , import reference point cloud, it will be added to the same view as the to-be-aligned point cloud.
2. Click *Display by Role* , this tool renders two point clouds in two different color.By default, point cloud to-be-aligned will be red, reference point cloud will be yellow. Users can click color bar to change it.

3. Click *Rotate/Translate* , Trasform window will pop up lower left.

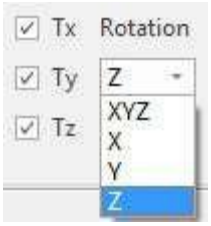


	1	2	3	4
1	1.000000000000	0.000000000000	0.000000000000	0.000000000000
2	0.000000000000	1.000000000000	0.000000000000	0.000000000000
3	0.000000000000	0.000000000000	1.000000000000	0.000000000000
4	0.000000000000	0.000000000000	0.000000000000	1.000000000000

4. (Optional)If two point clouds are far away with each other, users may click *Match Center* , which aligns the centers of the bounding boxes of these two point clouds. And the transformation parameters will appear in the Transform window.

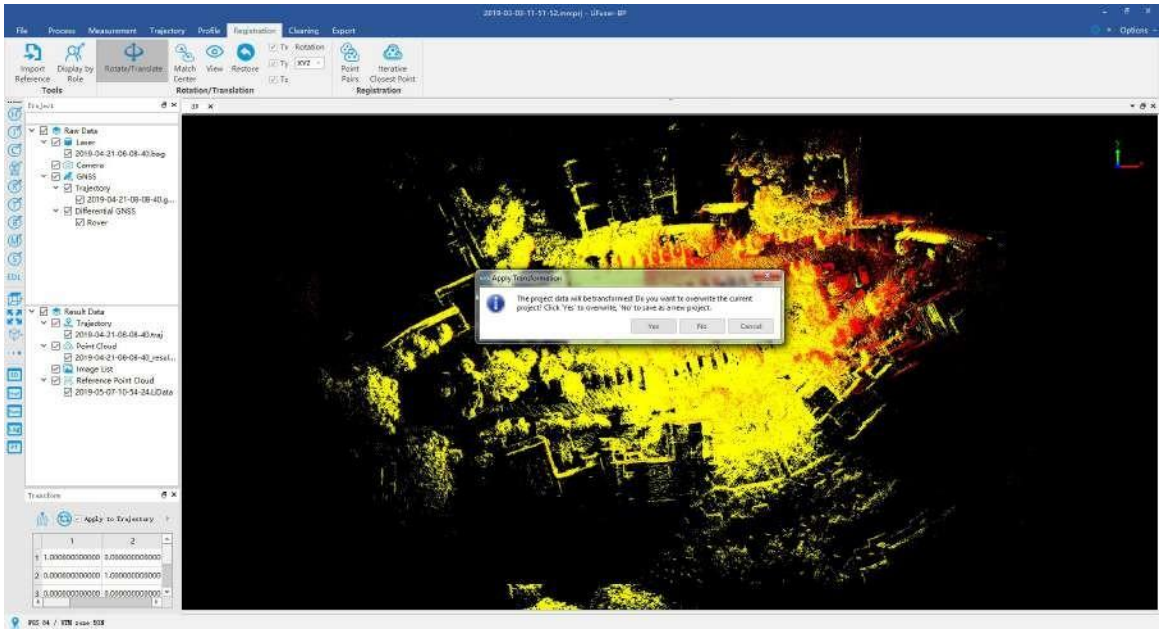


5. Adjust pan and rotate amount along X/Y/Z axises for manual registration. By tick/untick Tx, Ty and Tz to decide whether to pan by X//Y/Z direction or not. By Rotation drop-down box, users can control if rotate by single axis or all of the axises. Left click to rotate in the point cloud viewer, and right or middle click to pan.



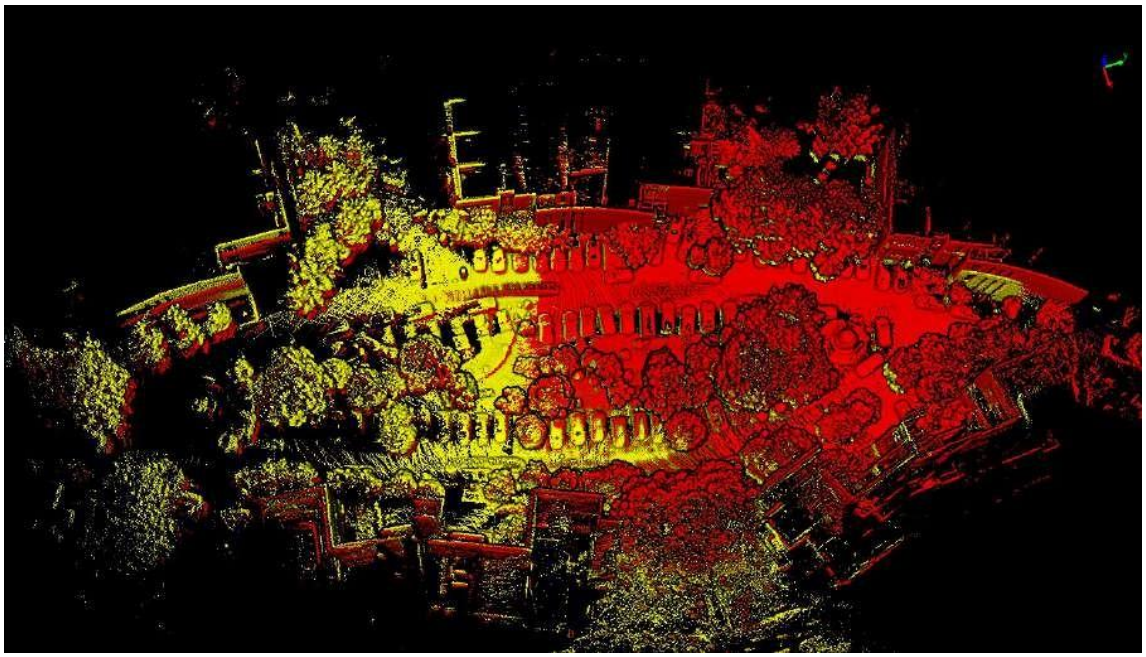
6. Users can check the registration performance by click *View* during the process.

7. When registration is done, click in Transform window to transform. In the pop-up window, click **Yes** to transform and overwrite the current point cloud, or click **No** to save a new transformed point cloud.



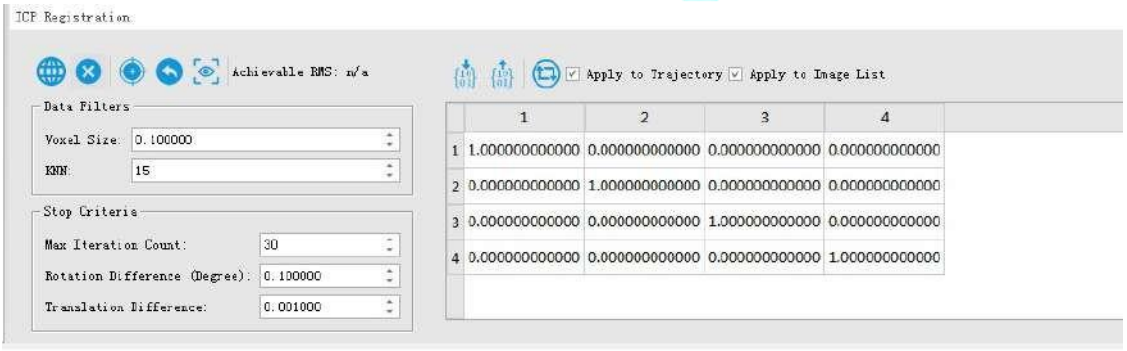
8. If click "No", after finishing transformation, the software will ask whether to open the new project or not, click OK.

9. Repeat step one and two to add reference point cloud, the result of course registration are shown as below:



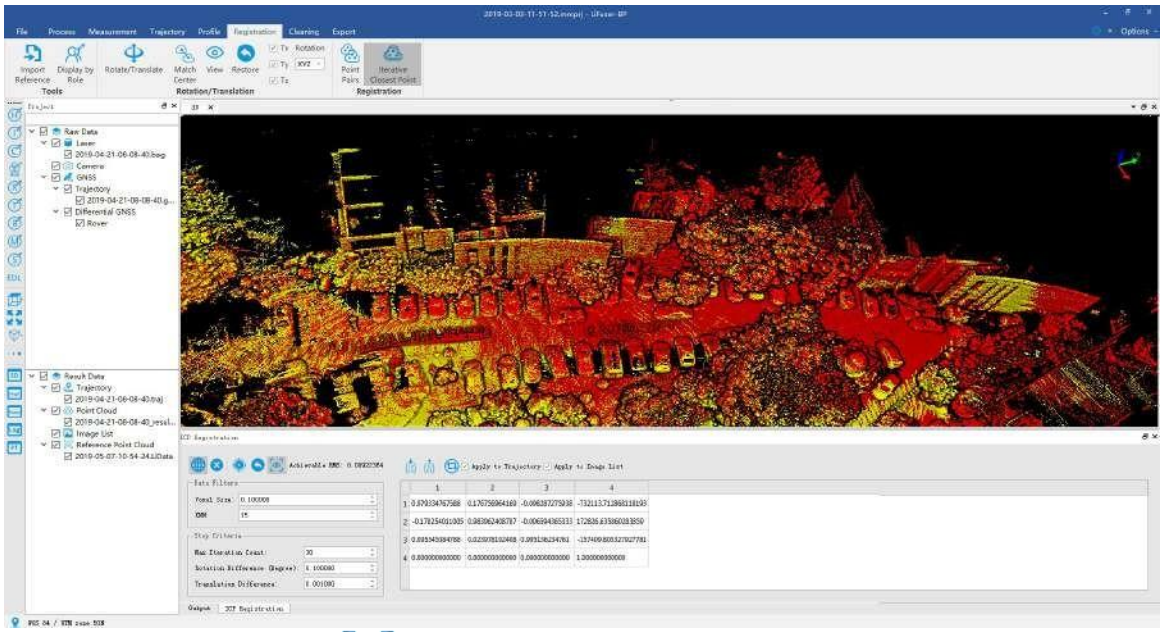
13.2 ICP Registration

1. After completing coarse registration, click *Iterative Closest Point* to activate the ICP registration tool.

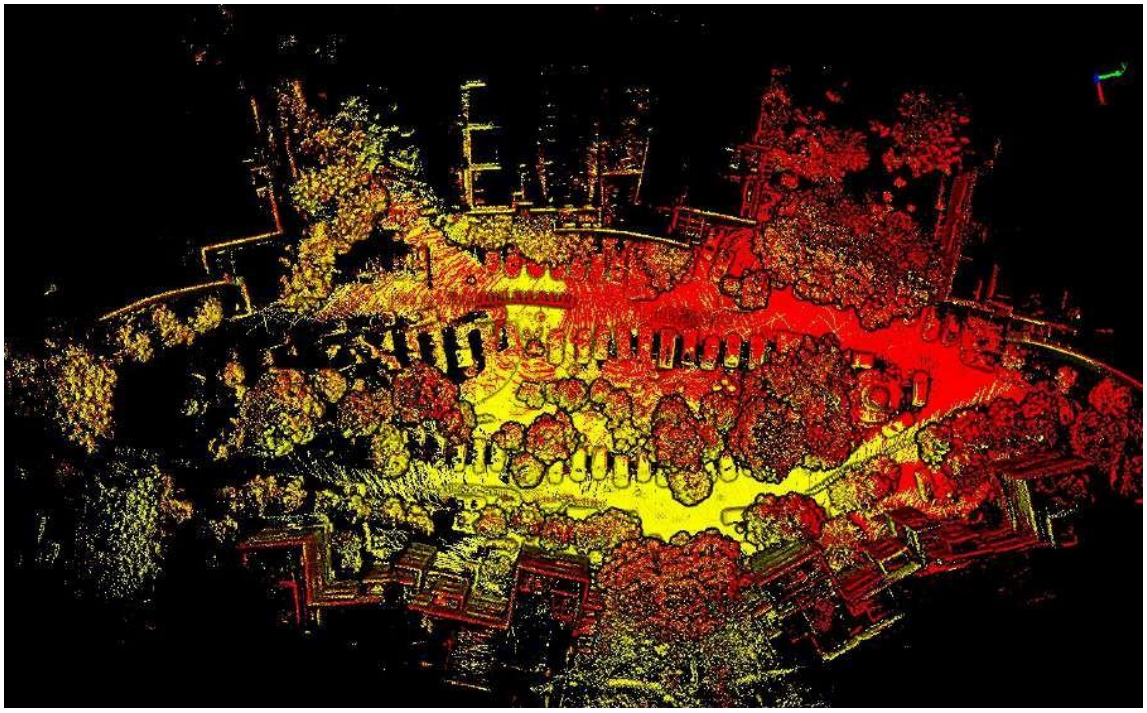


2. Click tool and click on an overlapping region of two point clouds. Drag and double-click to select. The selected overlapping region will be used for ICP. Multiple regions can be selected. Users can press ctrl+Z or click and re-select.

3. After selection, click to process ICP Registration.
4. Click to preview the registration results.

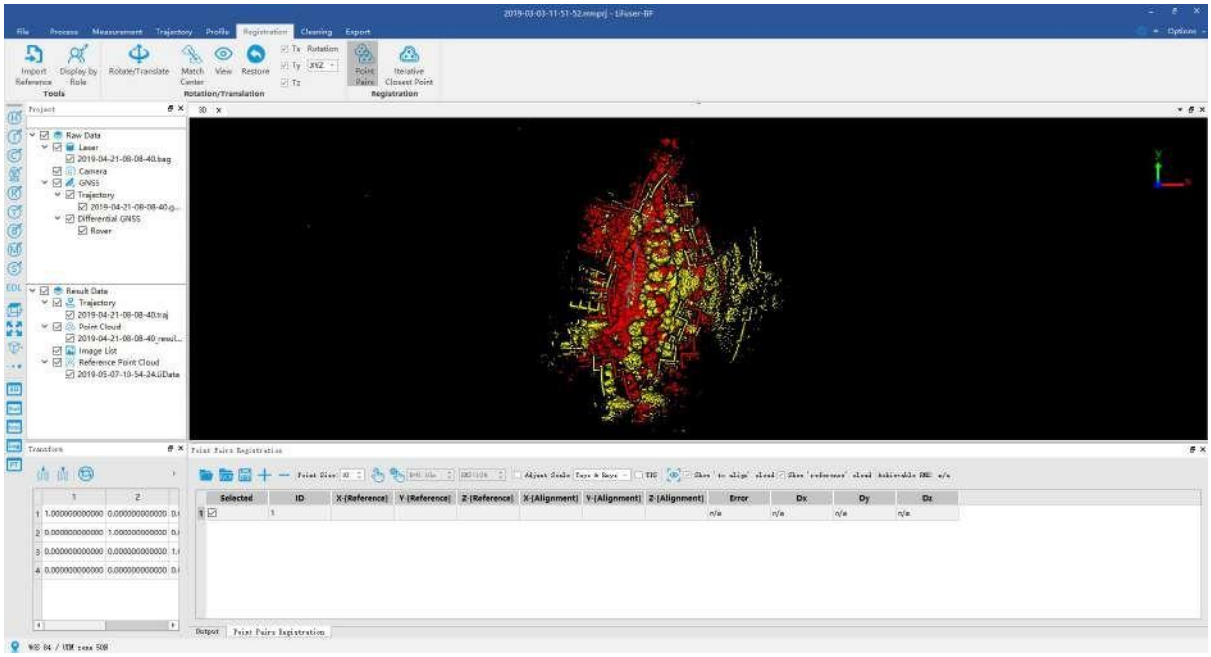


5. If unhappy with the result, click , close preview and repeat step 2 to 4 to re-register.
6. Once satisfied with the result, click **Apply Transform** to apply transformation. In the pop-up window, click **Yes** to transform and overwrite the current point cloud, or click **No** to save a new transformed point cloud.
7. If click "No", after finishing transformation, the software will suggest whether to open the new project or not, click OK.



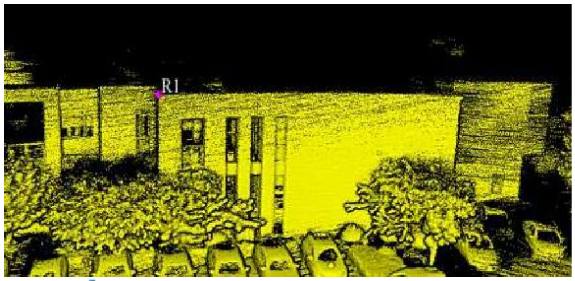
13.3 Point Pairs Registration

After completing coarse registration, click *Point Pairs* to activate the GCP registration tool. There are two ways of acquiring point pairs: pick manually or pick by registration sphere.

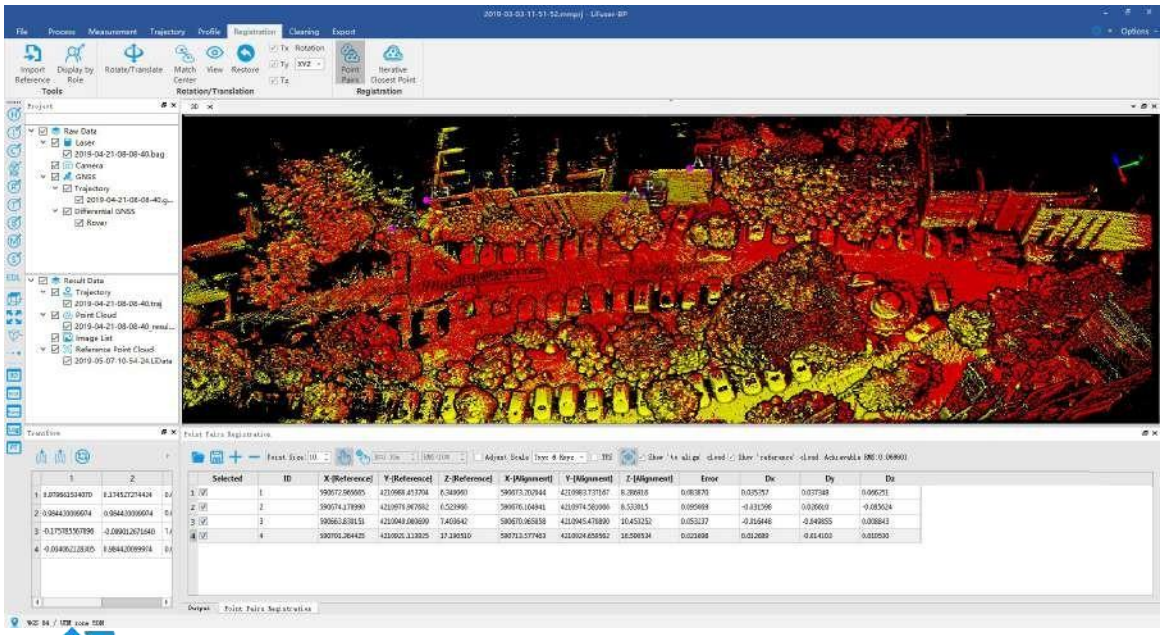


Pick manually

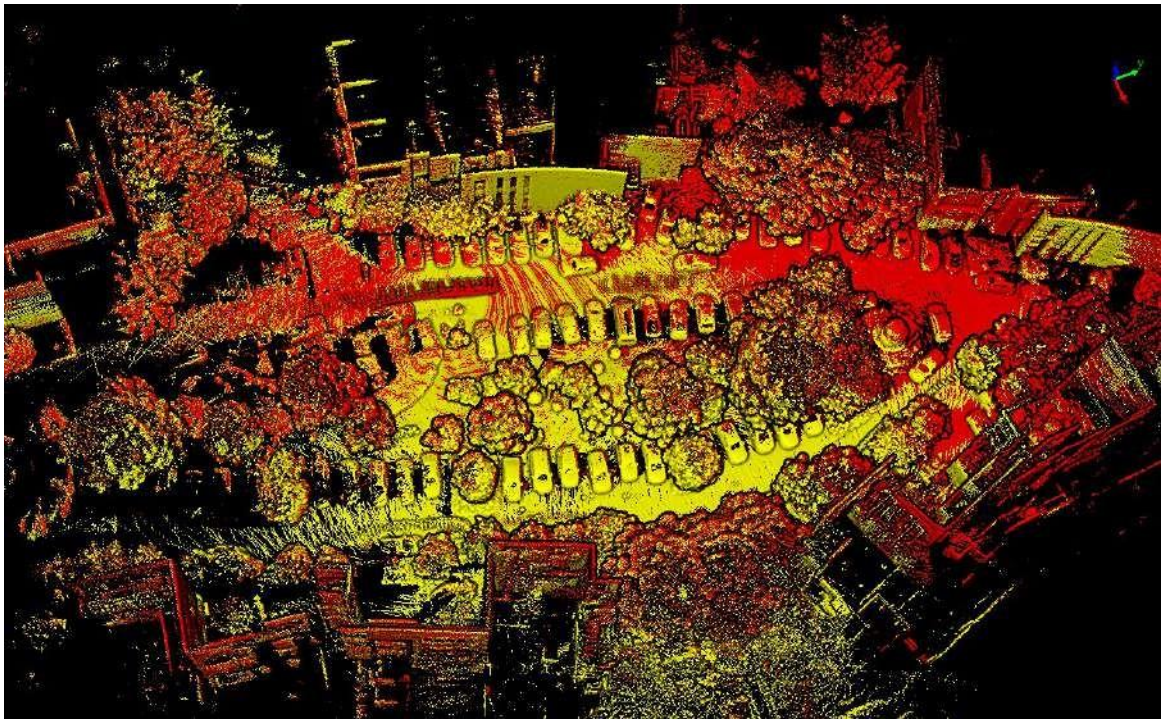
1. Click and pick point pair with obvious characteristic from both two point clouds.If point clouds due to block each other makes it hard to pick points, users can uncheck the box behind file name or check Show 'to align' cloud Show 'reference' cloud to view point cloud separately.



2. Click to add a row, and repeat the former step.
3. Repeat step 1 and 2, and pick at least three point pairs. When there are more than three point pairs picked, the registration error will appear in the table. Users can preview registration results by clicking .



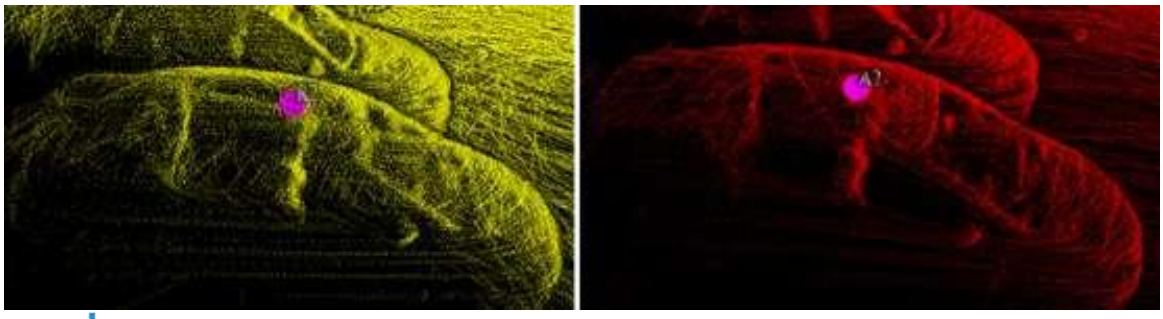
4. Click  in Transform window to transform the data. In the pop-up window, click **Yes** to transform and overwrite the current point cloud, or click **No** to save a new transformed point cloud.
5. If click "No", after finishing transformation, the software will suggest whether to open the new project, and click OK.



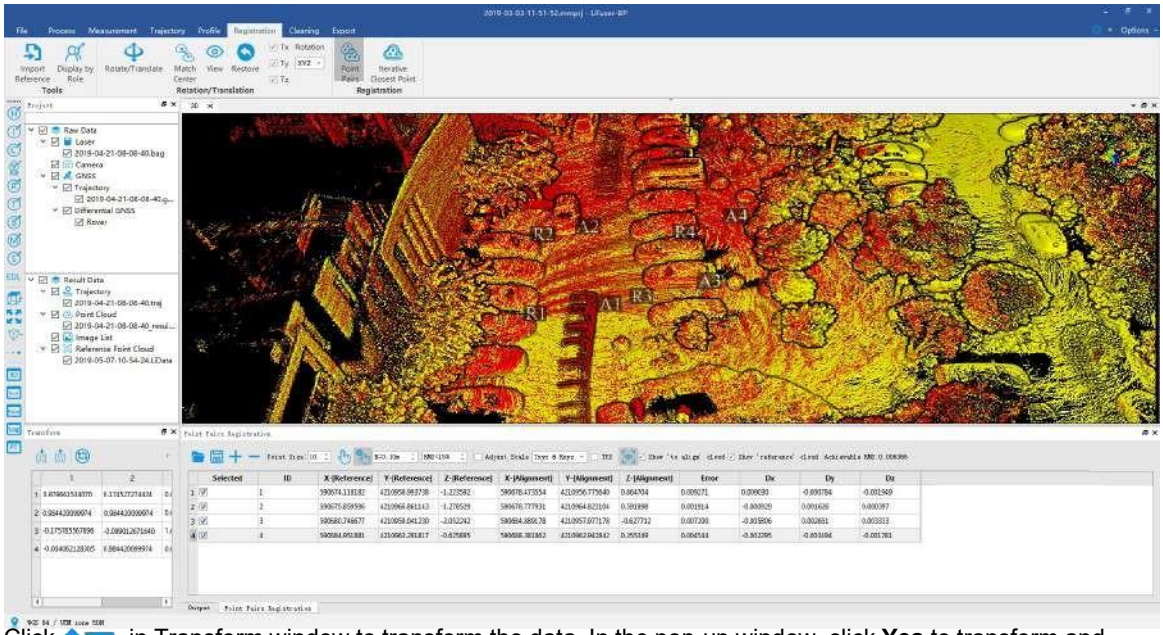
Pick by Registration Sphere

1. Click  and set the radius and RMS (The higher the value, the easier the fitting, but with a higher fitting error; vice versa). Find where sphere located in both point cloud file, then left click to fit the sphere. Spherical center coordinates will appear in the pair window. If point clouds due to block each other makes it hard to pick points, users can uncheck the box behind file name or check

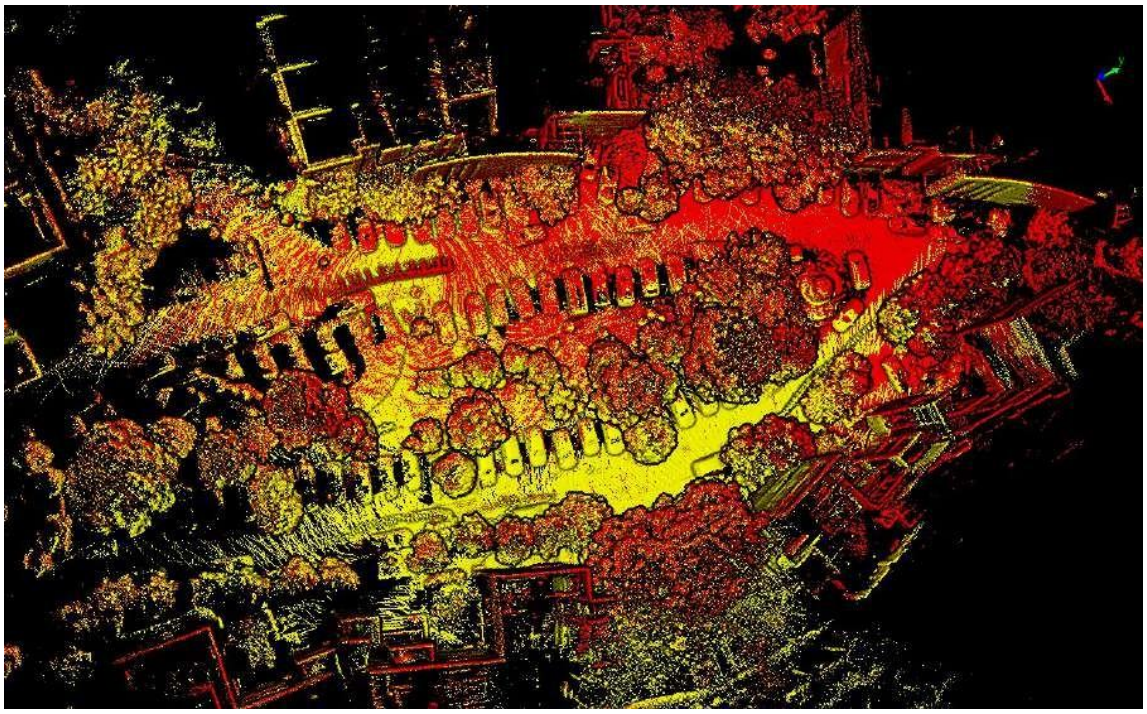
to view point cloud separately.



2. Click  to add a row, and repeat the former step.
3. Repeat step 1 and 2, and pick at least three point pairs. When there are more than three point pairs picked, the registration error will appear in the table. Users can preview registration results by clicking  .

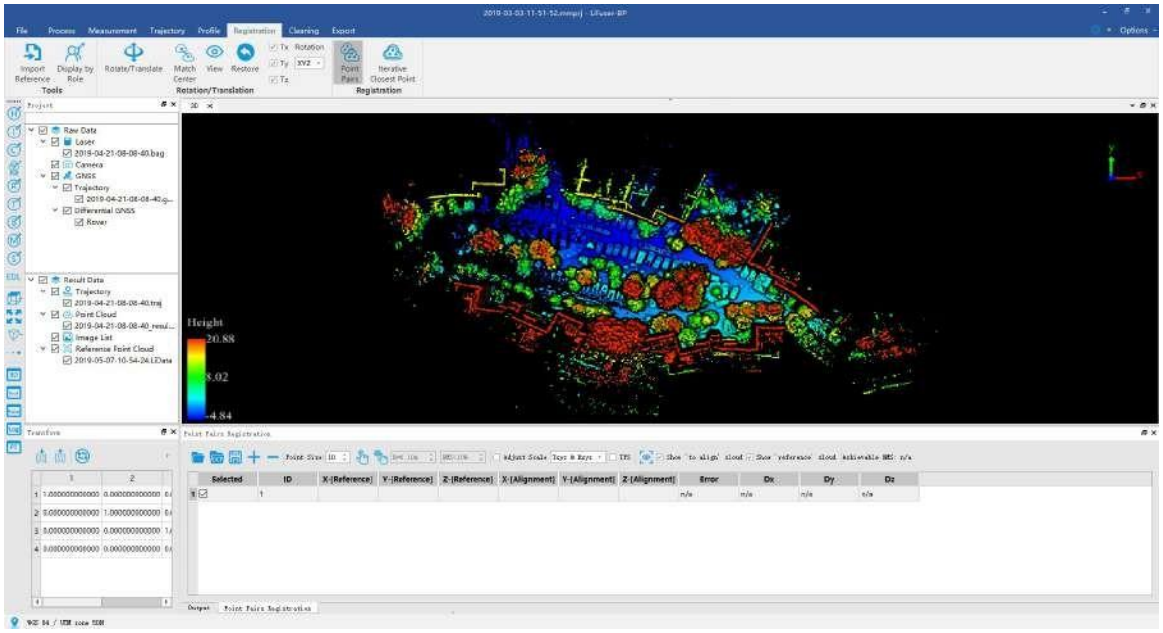


4. Click  in Transform window to transform the data. In the pop-up window, click **Yes** to transform and overwrite the current point cloud, or click **No** to save a new transformed point cloud.
5. If click "No", after finishing transformation, the software will suggest whether to open the new project, and click OK.

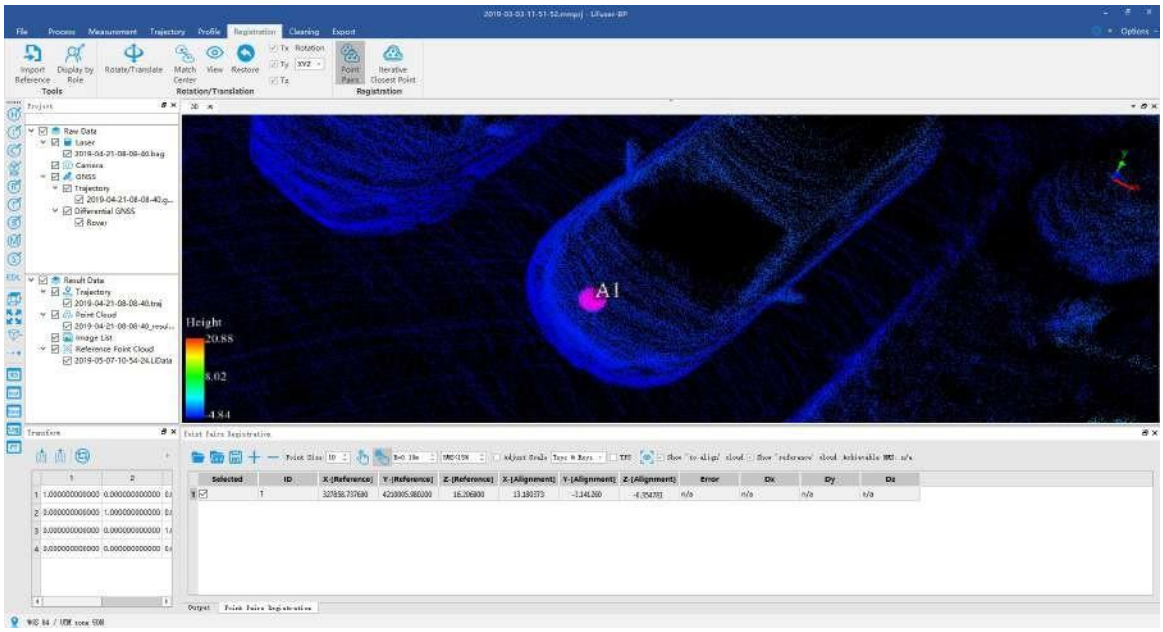


13.4 Georefernce Registration

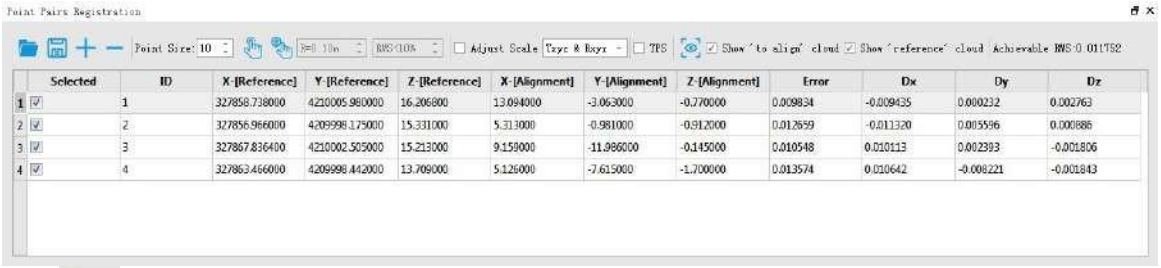
1. Click *Point Pairs*  under Registration tab, registration window and transform window will appear.



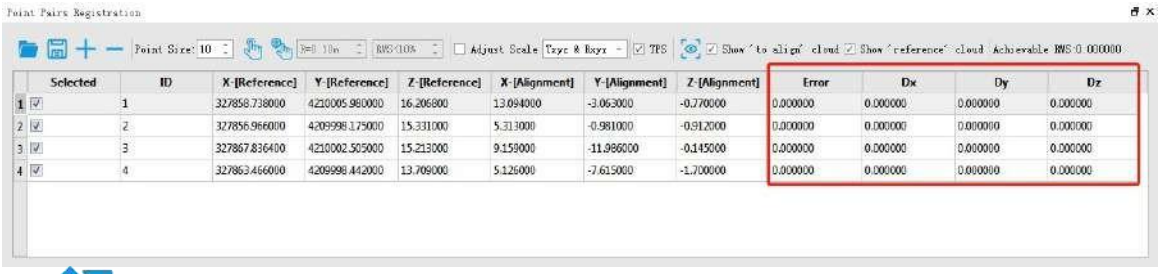
2. Enter the GCP coordinates into the reference window, and select the corresponding points as point pair. Points can be selected manually or by sphere registration.



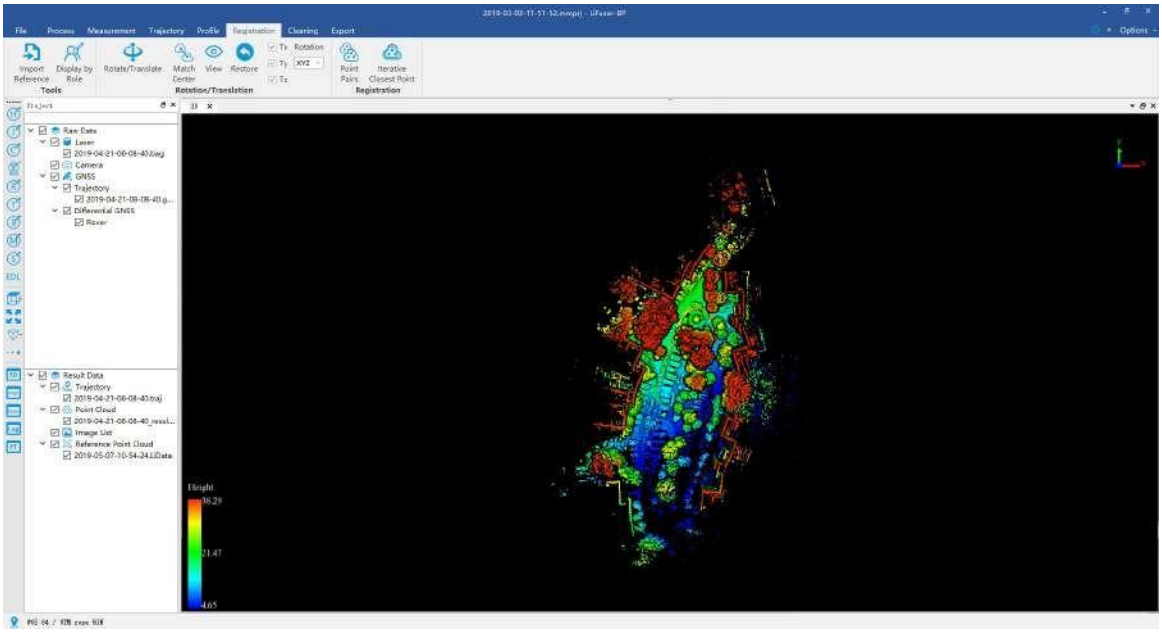
3. Pick at least three point pairs. When there are more than three point pairs picked, the registration error will appear in the table.



4. Click TPS , turn residual of GCPs into zero by plane fitting.

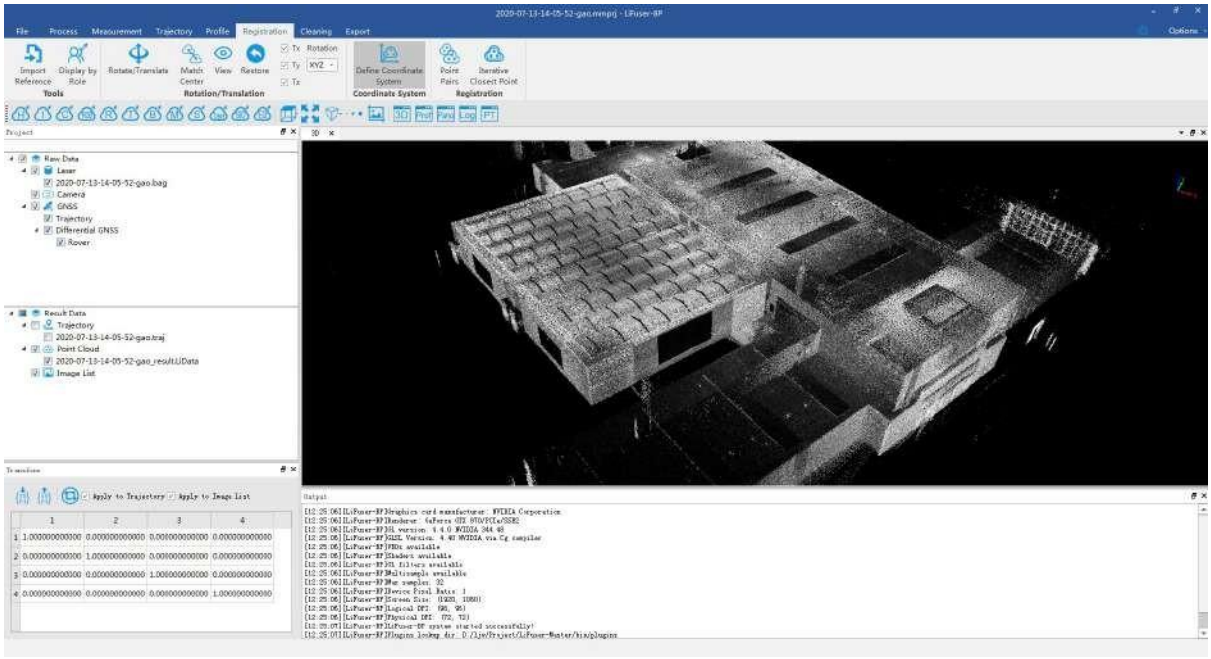


5. Click in Transform window to transform the data. In the pop-up window, click **Yes** to transform and overwrite the current point cloud, or click **No** to save a new transformed point cloud.
6. If click "No", after finishing transformation, the software will suggest whether to open the new project, and click OK.



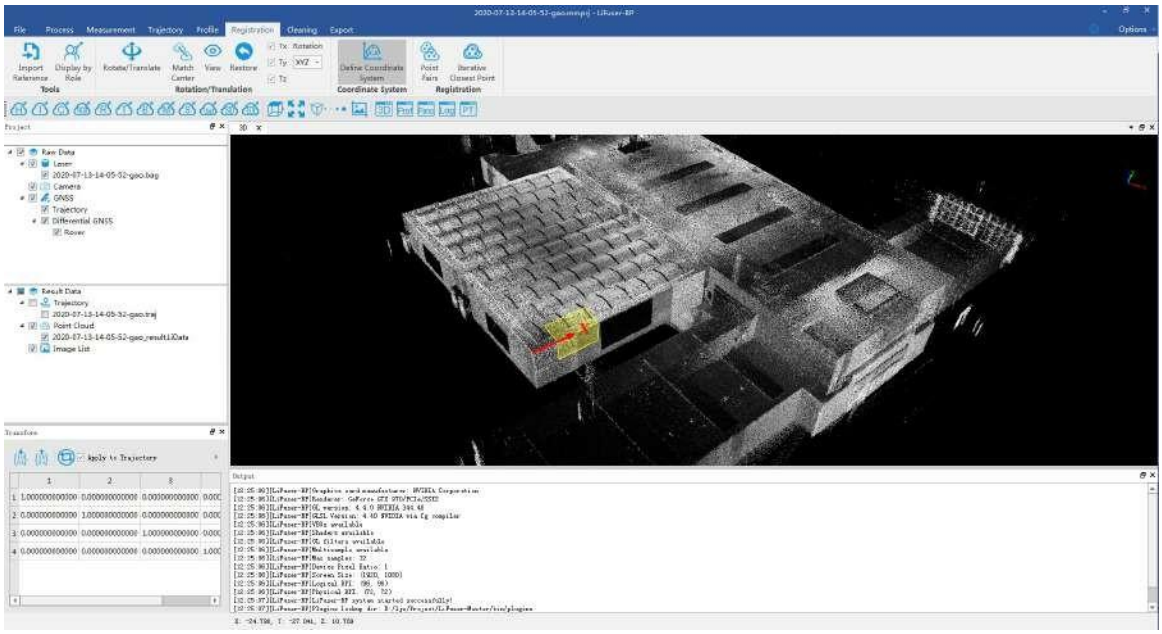
13.5 Define Coordinate System

Click *Define Coordinate System*  , and Transform window will appear as figure below:

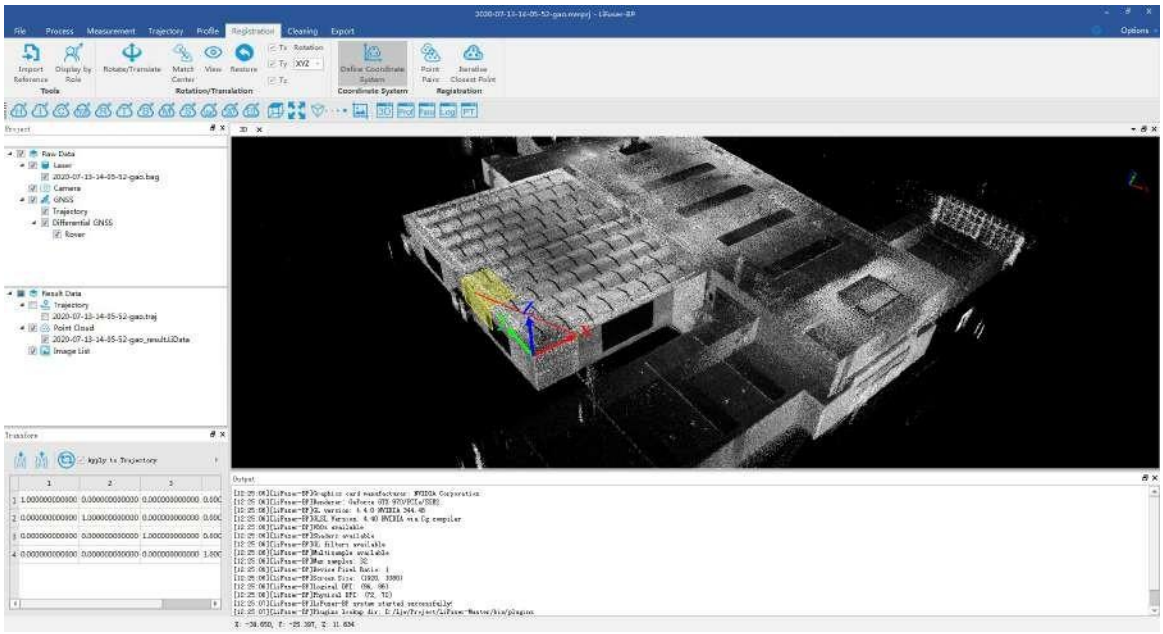


Steps

1. Left click the point cloud to set the coordinate origin of local coordinate system. Move the mouse to draw X axis, and double click to finish drawing.



2. Keep moving the mouse to draw Y axis, you can see a real-time XOY plane. Double click to determine the local coordinate system.



3. Right click the scene to go back to step 1 and redefine the local coordinate system.
4. Having defined the local coordinate system, you can go to Transform window, and apply the transformation matrix to the project or create a new project.

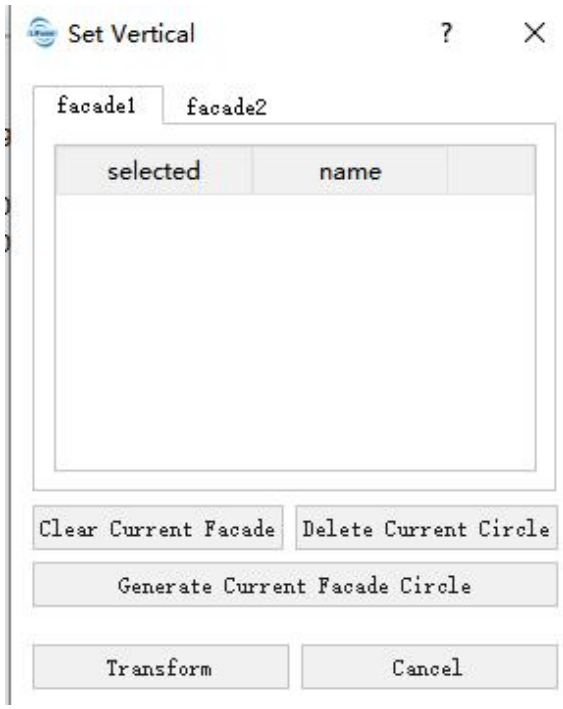
13.6 Set Vertical

Function description: Manually level the data.
Premise: Let the trajectory have as many closed loops as possible, especially the start-end closed loop.

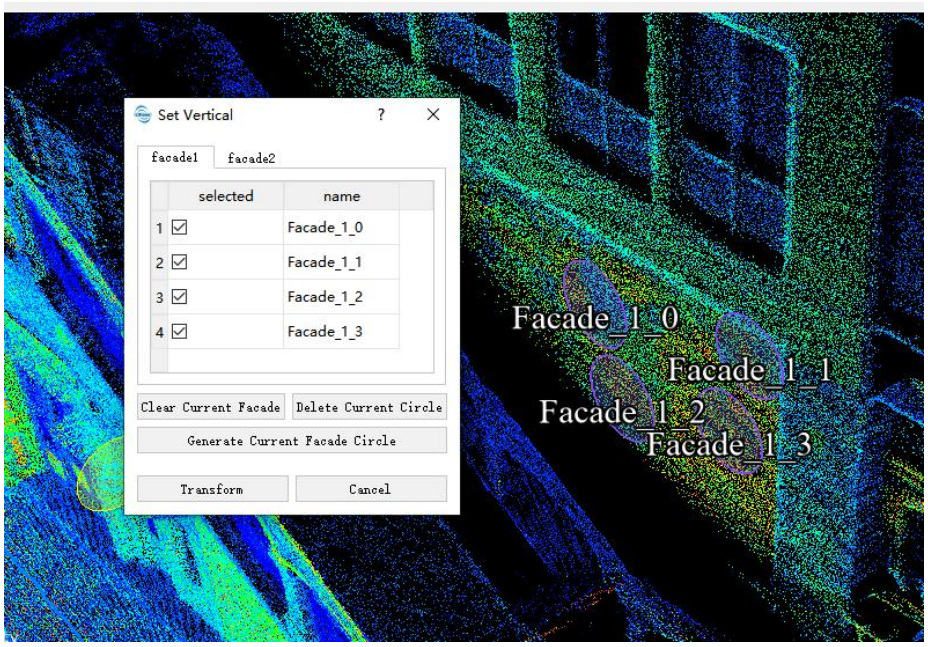
Steps

① Select two intersecting flat walls or other objects with flat surfaces perpendicular to the ground

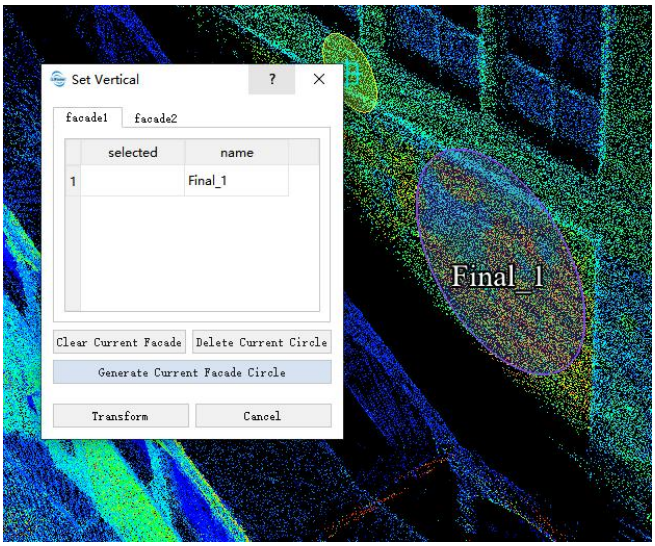
② CLICK 



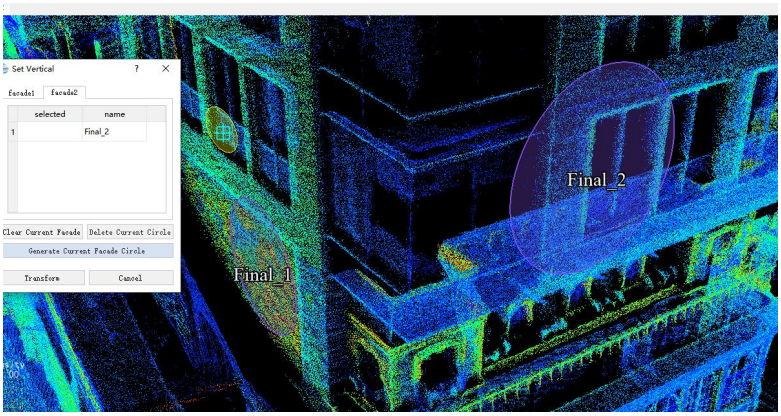
③ In the Set Vertical dialog box, specify the facad 1 and facad 2, for example, the facad 1, the selected point must be located on one flat surface.



④ Click Generate Current Facad Circle

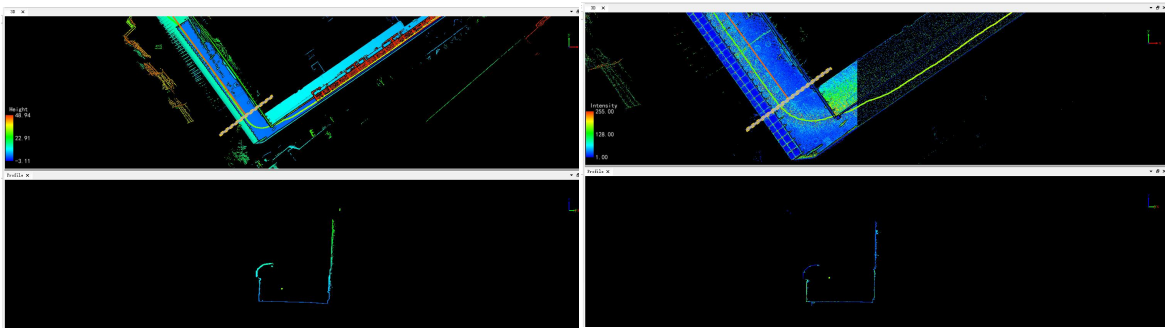


⑤ Perform the same operation on the facad 2



⑥ Finally, click "Transform", click "Yes" if you want to rewrite the project, and click "No" if you start a new project.

⑦ Use section plane to see the effect of setting vertical



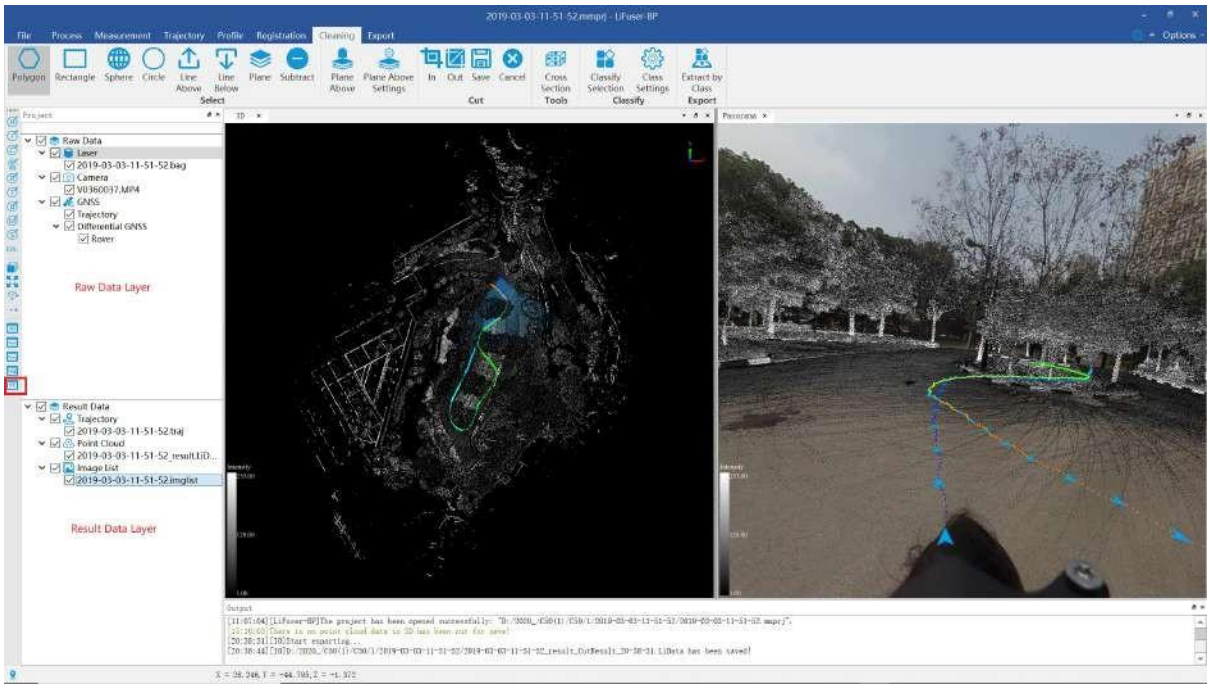
14. Project Management

14.1 Layer Management

Function Description

In the project layers the user can show/hide data in all windows by checking/unchecking the box before data node (or data type node). The data can be dragged from data node to different windows for display. The context menu (i.e. right-click menu) of data node, which differs depending on data types, is mainly used for data query, display, statistics, export, and removal, etc.

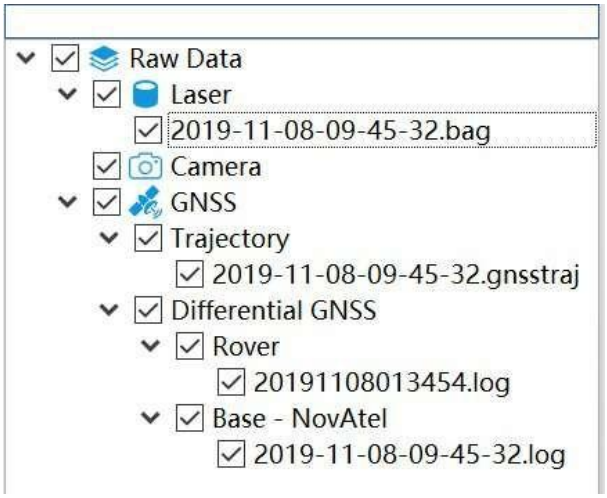
Click PT button to show project layers as follows:



There are two layers classified by source including:

- Raw Data Layer
- Result Data Layer

14.1.1 Raw Data Layer



Right-click Menu Introduction:

- GNSS Trajectory Right-click Menu

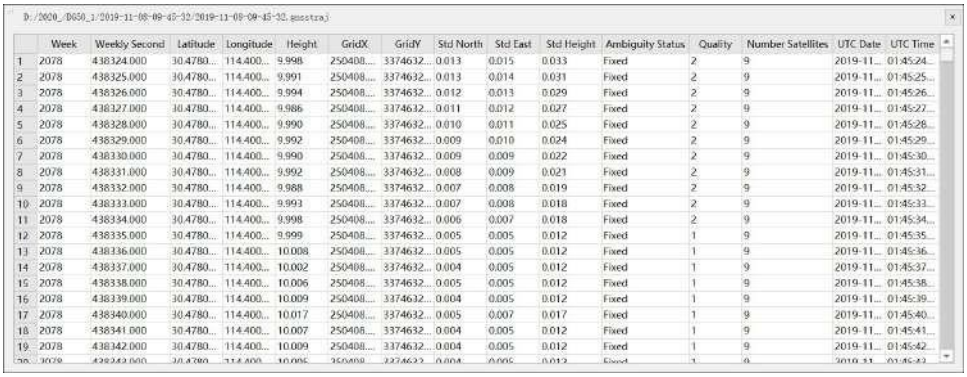
14.1.1.1 GNSS Trajectory Right-click Menu

Function Description

In raw data layer management, GNSS trajectory menu (i.e. right-click menu) of data node, is mainly used for data query, display, statistics, export, and removal, etc.

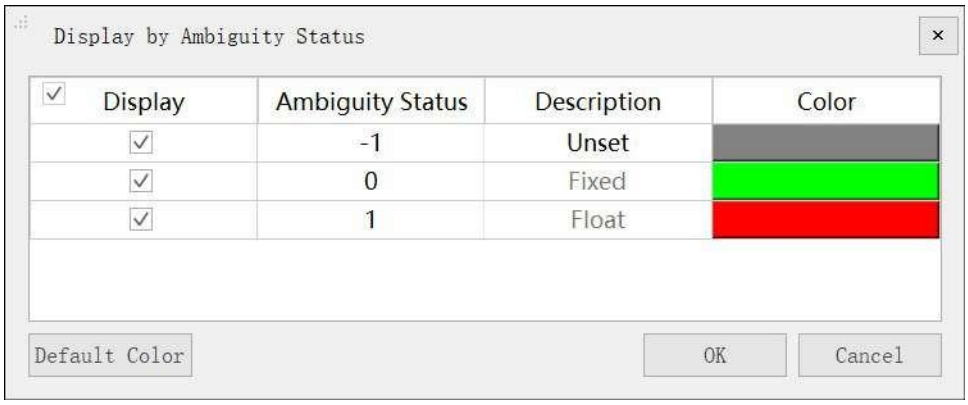
Data Right-click Menu

- **Info**: Check GNSS trajectory data information including cycle, cycle per second, longitude and latitude, ambiguity, altitude, quality and etc. as follows.

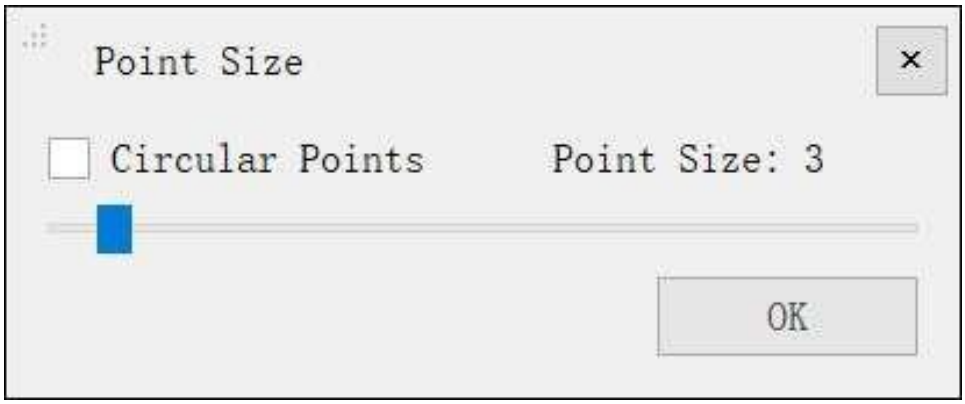


	Week	Weekly Second	Latitude	Longitude	Height	GridX	GridY	Std North	Std East	Std Height	Ambiguity Status	Quality	Number Satellites	UTC Date	UTC Time
1	2078	438324.000	30.4780...	114.400...	9.998	250408....	3374632...	0.013	0.015	0.033	Fixed	2	9	2019-11...	01:45:24...
2	2078	438325.000	30.4780...	114.400...	9.991	250408....	3374632...	0.013	0.014	0.031	Fixed	2	9	2019-11...	01:45:25...
3	2078	438326.000	30.4780...	114.400...	9.994	250408....	3374632...	0.012	0.013	0.029	Fixed	2	9	2019-11...	01:45:26...
4	2078	438327.000	30.4780...	114.400...	9.986	250408....	3374632...	0.011	0.012	0.027	Fixed	2	9	2019-11...	01:45:27...
5	2078	438328.000	30.4780...	114.400...	9.990	250408....	3374632...	0.010	0.011	0.025	Fixed	2	9	2019-11...	01:45:28...
6	2078	438329.000	30.4780...	114.400...	9.992	250408....	3374632...	0.009	0.010	0.024	Fixed	2	9	2019-11...	01:45:29...
7	2078	438330.000	30.4780...	114.400...	9.990	250408....	3374632...	0.009	0.009	0.022	Fixed	2	9	2019-11...	01:45:30...
8	2078	438331.000	30.4780...	114.400...	9.992	250408....	3374632...	0.008	0.009	0.021	Fixed	2	9	2019-11...	01:45:31...
9	2078	438332.000	30.4780...	114.400...	9.988	250408....	3374632...	0.007	0.008	0.019	Fixed	2	9	2019-11...	01:45:32...
10	2078	438333.000	30.4780...	114.400...	9.993	250408....	3374632...	0.007	0.008	0.018	Fixed	2	9	2019-11...	01:45:33...
11	2078	438334.000	30.4780...	114.400...	9.998	250408....	3374632...	0.006	0.007	0.018	Fixed	2	9	2019-11...	01:45:34...
12	2078	438335.000	30.4780...	114.400...	9.999	250408....	3374632...	0.005	0.005	0.012	Fixed	1	9	2019-11...	01:45:35...
13	2078	438336.000	30.4780...	114.400...	10.008	250408....	3374632...	0.005	0.005	0.012	Fixed	1	9	2019-11...	01:45:36...
14	2078	438337.000	30.4780...	114.400...	10.002	250408....	3374632...	0.004	0.005	0.012	Fixed	1	9	2019-11...	01:45:37...
15	2078	438338.000	30.4780...	114.400...	10.006	250408....	3374632...	0.005	0.005	0.012	Fixed	1	9	2019-11...	01:45:38...
16	2078	438339.000	30.4780...	114.400...	10.009	250408....	3374632...	0.004	0.005	0.012	Fixed	1	9	2019-11...	01:45:39...
17	2078	438340.000	30.4780...	114.400...	10.017	250408....	3374632...	0.005	0.007	0.017	Fixed	1	9	2019-11...	01:45:40...
18	2078	438341.000	30.4780...	114.400...	10.007	250408....	3374632...	0.004	0.005	0.012	Fixed	1	9	2019-11...	01:45:41...
19	2078	438342.000	30.4780...	114.400...	10.009	250408....	3374632...	0.004	0.005	0.012	Fixed	1	9	2019-11...	01:45:42...

- **View Mode**: Set display mode of GNSS trajectory data including:
  - **Display by Quality**: Please reference Display by Quality
  - **Display by Ambiguity Status**: Click to pop up the window, display by ambiguity status including unknown, fixed and unfixed status.



  - **Display by Height**: Please reference Display by Height
  - **Display by Time**: Please reference Display by Time
  - **Display by Specific Color**: Please reference Display by Specific Color
- **Zoom to Layer**: Calculate the bounding box of the current raster data. All the windows, in which the data object is loaded, will show full extent of the bounding box.
- **Point Appearance**: Users can select a circular or quadrate shape point and zoom in and out to change the point size.

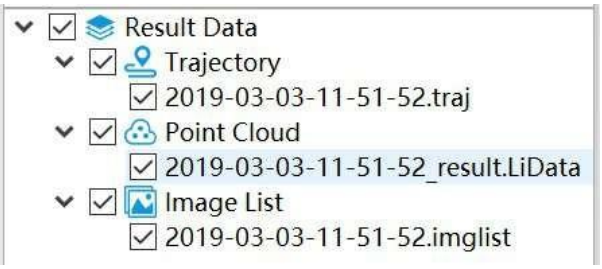


- **Open Report**: Open GNSS Report High Accuracy Process-GNSS Report

Parameters Setting

- **Point Attributes**
  - **Circular Points (optional)**: Set a circular or quadrate shape point for GNSS trajectory data.
  - **Point Size**

14.1.2 Result Data Layer



Right-click menu introduction:

- Point Cloud Right-click Menu
- Result Trajectory Right-click Menu
- Image List Right-click Menu

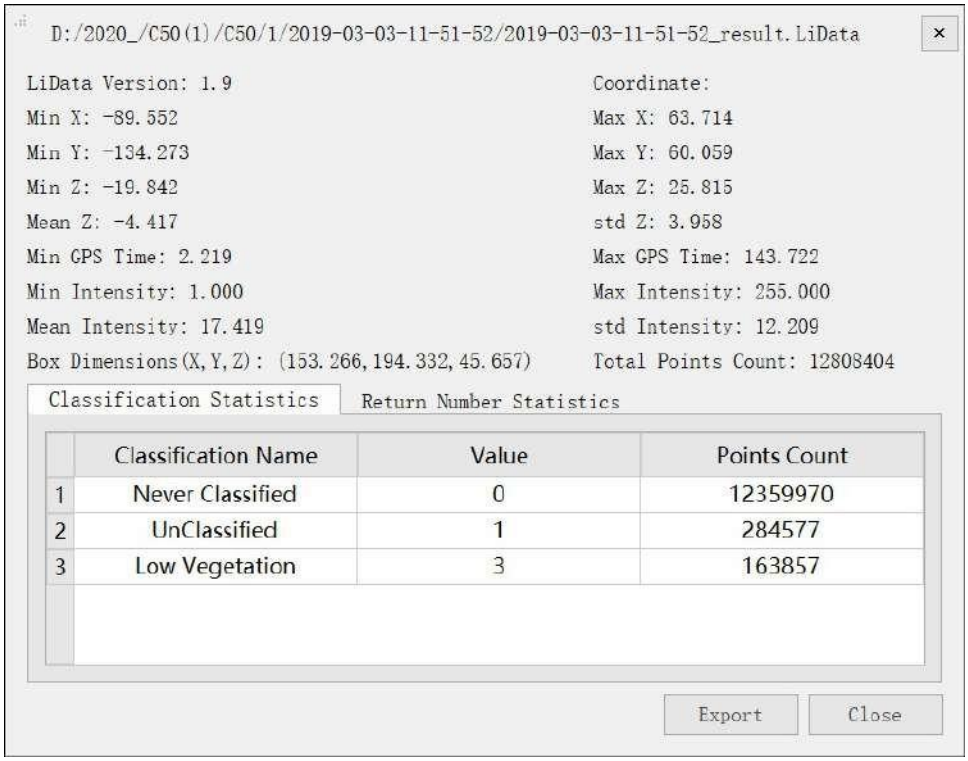
14.1.2.1 Point Cloud Data Right-click Menu

Function Description

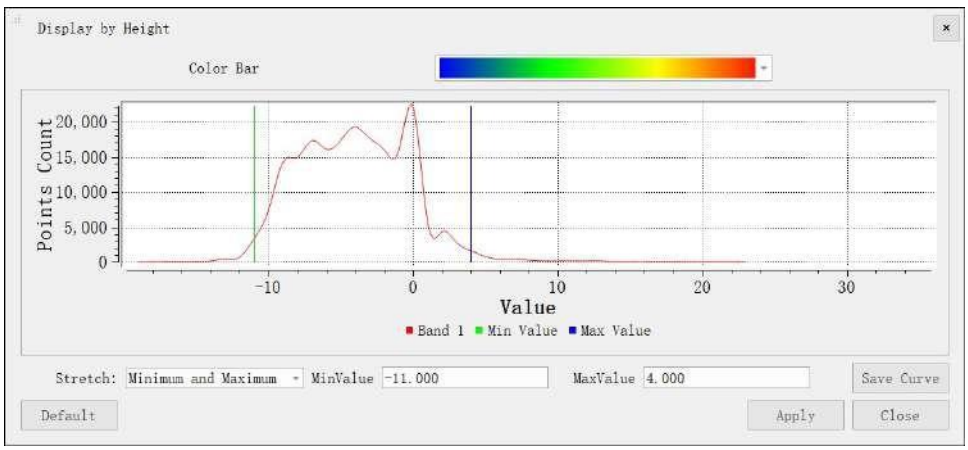
In result data layer management, point cloud menu (i.e. right-click menu) of data node, is mainly used for data query, display, statistics, export, and removal, etc.

Data Right-click Menu

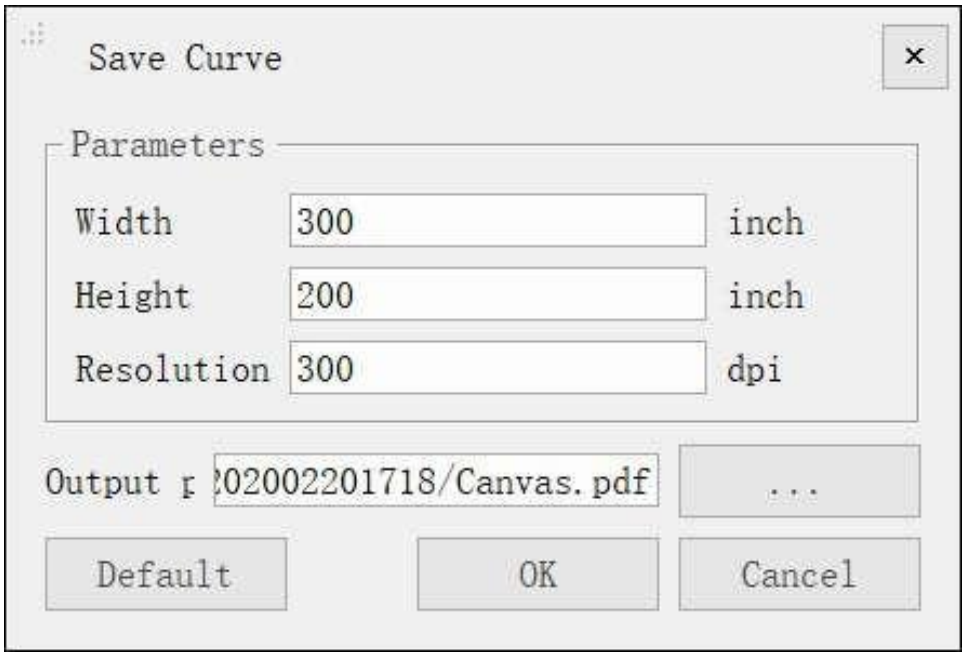
- **Info**: Check the point cloud information including data's path, coordinate information (minimum, maximum and mean value), GPS Time, intensity, the bounding box, total amounts of point cloud, classification and return of number information. Click "Export" buttton to save as *.txt formatted file.



- **View Mode**: Set display mode of point cloud including the following types.
  - **Display by Height**: Change the minimum, maximum or standard deviation value to enchance the display effect.

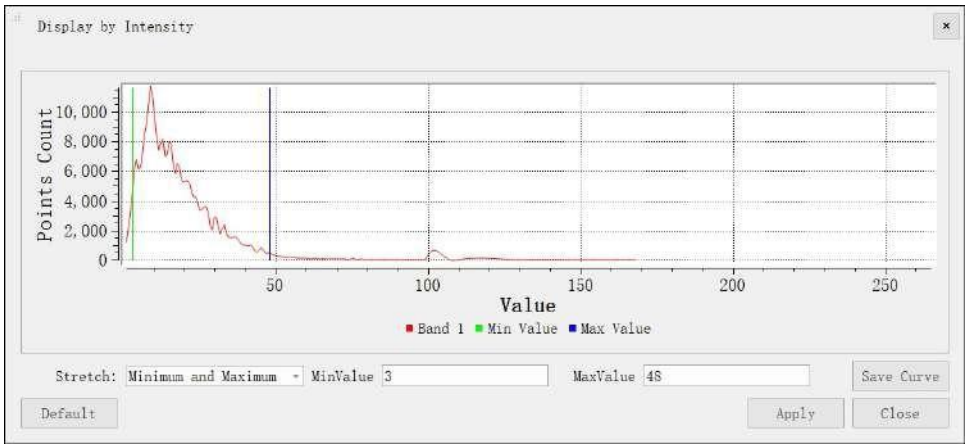


The histogram displayed on the interface can be exported in pdf format, and click on the "Save Curve" button to pop up the "Save Curve" dialog box, as shown. Select the width, height, and resolution of the export curve, select the output path, click the OK button, and save the curve.

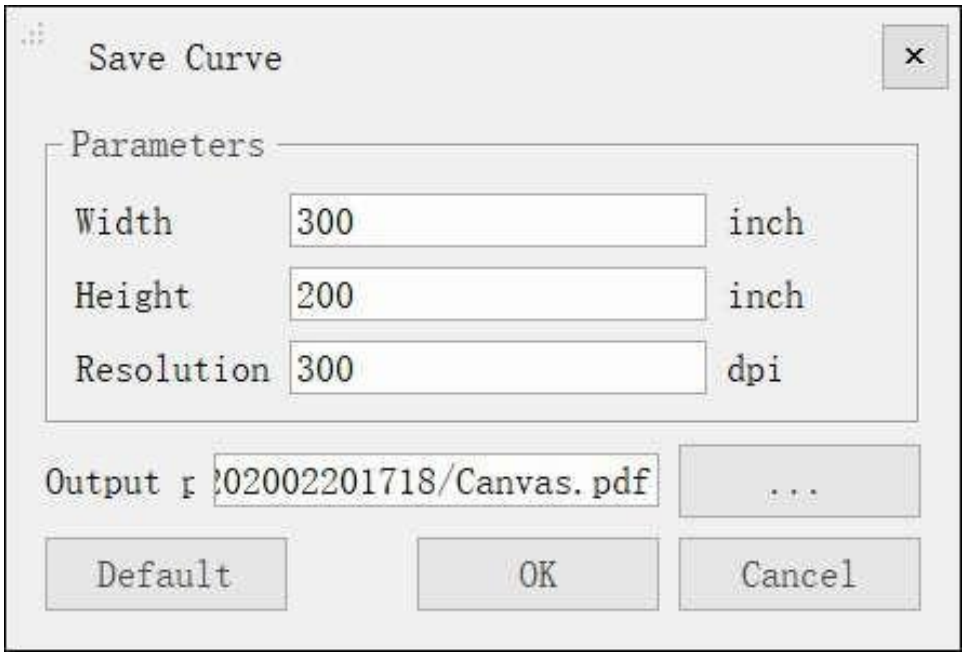


For more details please reference Display by Height。

- **Display by Intensity**: The interface pops up as shown and can be stretched by the minimum maximum or standard deviation value to improve the display.

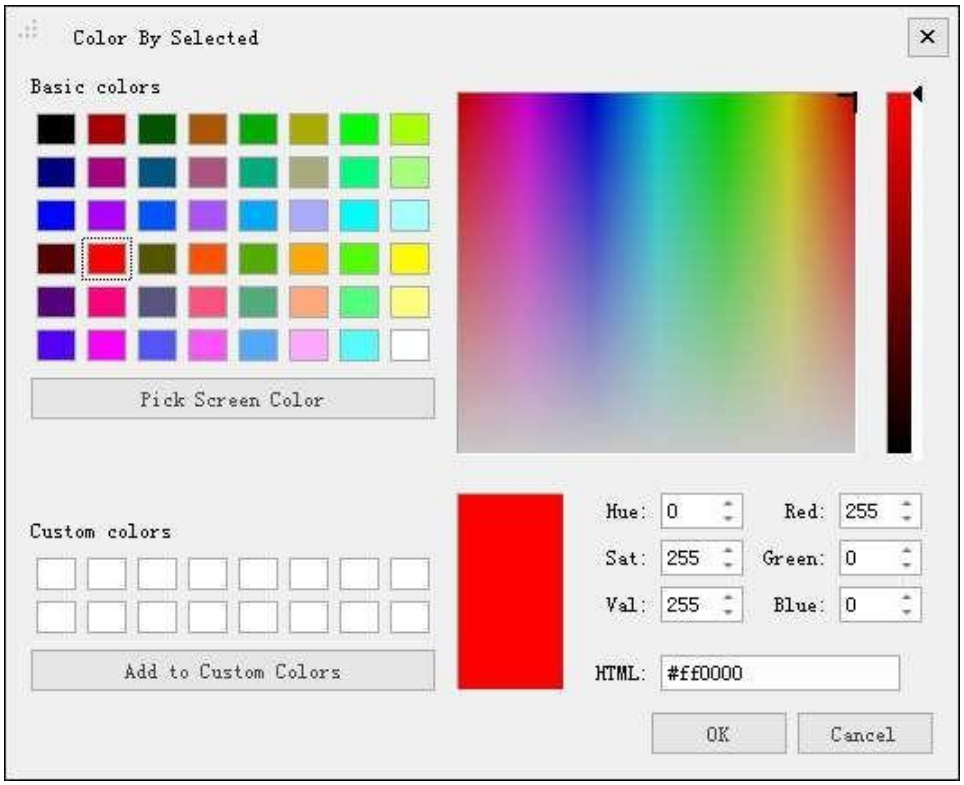


The histogram displayed on the interface can be exported in pdf format, and click on the "Save Curve" button to pop up the "Save Curve" dialog box, as shown. Select the width, height, and resolution of the export curve, select the output path, click the OK button, and save the curve.



For more details please reference Display by Intensity

- **Display by Classification**: Please reference Display by Classification
- **Display by RGB**: Please referenceDisplay by RGB.
- **Display by Return**: Please reference Display by Return.
- **Display by GPS Time**: Please reference Display by GPS Time.
- **Display by Specific Color**: Please reference Display by Specific Color



- **Display by Blend**: Please reference Display by Blend.
- **Display by Mix**: Please reference Display by Mix.

- **Zoom to Layer**: Calculate the bounding box of the current raster data. All the windows, in which the data object is loaded, will show full extent of the bounding box.
- **Export**: Export the data into LAS (.las, .laz) format.
- **Replace Data**: Replace the current point cloud data.

Parameters Setting

Display by Height:

- **Color Bar**: The color bar is used to reflect the elevation properties of the point cloud.
- **Stretch**: Set the stretch of histogram.
  - **Min, Max (default)**: The method uses the minimum and maximum pixel values as the endpoints of the histogram. For example, set the minimum and maximum values of the image to 2488 and 2656 respectively, and set the linear stretch pixel value sits between 0-255. It improves the brightness and contrast of the image by distributing the pixel values across the entire histogram range, and makes the features in the image easy to distinguish.
  - **Standard Deviation**: This method is used between the values defined by the standard deviation n. For example, the minimum and maximum values of an image are 2488 and 2656 respectively. If n is 2, the value above the 2nd standard deviation will become 0 or 255, and the other values are stretched between 0-255.

Display by Intensity :

Stretch

- **Min, Max (default)**: The method uses the minimum and maximum pixel values as the endpoints of the histogram. For example, the minimum and maximum values of an image are 2488 and 2656 respectively, and set the linear stretch pixel value sits between 0-255. By distributing pixel values across the entire histogram range, you can make the features in the image easily distinguish by increasing the brightness and contrast of the image.
- **Standard Deviation**: This method is used between the values defined by the standard deviation n. For example, the minimum and maximum values of an image are 2488 and 2656 respectively. If n is 2, the value above the 2nd standard deviation will become 0 or 255, and the other values are stretched between 0-255.

Save Curve:

- **Width**: Save the pixel width of the curve.
- **Height**: Save the pixel height of the curve.
- **Resolution**：Save the resolution of the curve.
- **Output Path**: Save the output path of the curve.

14.1.2.2 Result Trajectory Right-click Menu

Function Description

In result data layer management, point cloud menu (i.e. right-click menu) of data node, is mainly used for data query, display, statistics, export, and removal, etc.

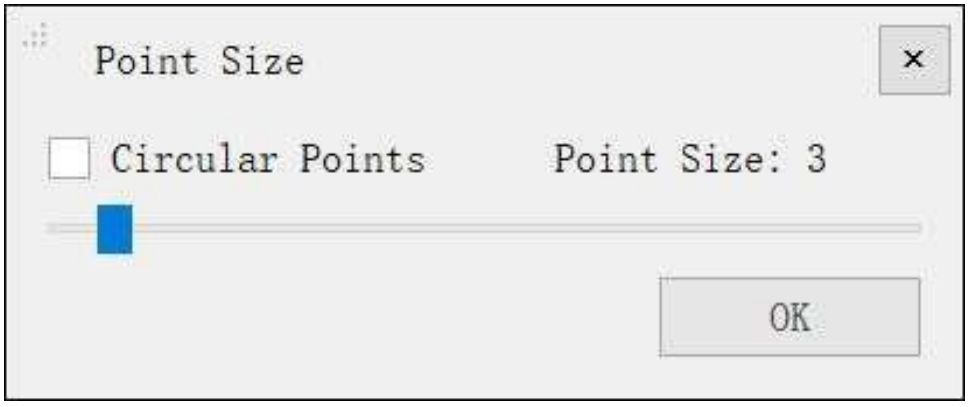
Data Right-click Menu

- **Info**: Check the result trajectory data information including GPS Time, Longitude and Latitude, altitude, angle (Roll, Pitch and Heading) information.

D:/2020_/C50(1)/C50/1/2019-03-03-11-51-52/2019-03-03-11-51-52.traj

	Time	Longitude	Latitude	Height	Roll	Pitch	Heading	GridX	GridY	VEast	VNorth	VUp	TotSlpDst	Quality
1	0.705	0.00000...	0.00000...	-0.009	0.000000	0.000000	0.000000	0.009	-0.185	0.000000	0.000000	0.000000	0	0
2	0.806	0.00000...	0.00000...	-0.031	0.000000	0.000000	0.000000	0.006	-0.256	0.000000	0.000000	0.000000	0	0
3	0.907	0.00000...	0.00000...	-0.052	0.000000	0.000000	0.000000	0.003	-0.327	0.000000	0.000000	0.000000	0	0
4	1.008	0.00000...	0.00000...	-0.056	0.000000	0.000000	0.000000	-0.019	-0.419	0.000000	0.000000	0.000000	0	0
5	1.109	0.00000...	0.00000...	-0.06	0.000000	0.000000	0.000000	-0.041	-0.511	0.000000	0.000000	0.000000	0	0
6	1.209	0.00000...	0.00000...	-0.065	0.000000	0.000000	0.000000	-0.037	-0.594	0.000000	0.000000	0.000000	0	0
7	1.310	0.00000...	0.00000...	-0.07	0.000000	0.000000	0.000000	-0.032	-0.677	0.000000	0.000000	0.000000	0	0
8	1.411	0.00000...	0.00000...	-0.095	0.000000	0.000000	0.000000	-0.006	-0.786	0.000000	0.000000	0.000000	0	0
9	1.512	0.00000...	0.00000...	-0.12	0.000000	0.000000	0.000000	0.019	-0.894	0.000000	0.000000	0.000000	0	0
10	1.613	0.00000...	0.00000...	-0.129	0.000000	0.000000	0.000000	0.060	-1.009	0.000000	0.000000	0.000000	0	0
11	1.714	0.00000...	0.00000...	-0.137	0.000000	0.000000	0.000000	0.100	-1.123	0.000000	0.000000	0.000000	0	0
12	1.815	0.00000...	0.00000...	-0.136	0.000000	0.000000	0.000000	0.117	-1.223	0.000000	0.000000	0.000000	0	0
13	1.915	0.00000...	0.00000...	-0.134	0.000000	0.000000	0.000000	0.134	-1.323	0.000000	0.000000	0.000000	0	0
14	2.016	0.00000...	0.00000...	-0.162	0.000000	0.000000	0.000000	0.146	-1.429	0.000000	0.000000	0.000000	0	0
15	2.117	0.00000...	0.00000...	-0.191	0.000000	0.000000	0.000000	0.159	-1.534	0.000000	0.000000	0.000000	0	0
16	2.218	0.00000...	0.00000...	-0.213	0.000000	0.000000	0.000000	0.148	-1.652	0.000000	0.000000	0.000000	0	0

- **View Mode**: Set the display mode of the result trajectory data, including the following types
  - **Display by Quality**: Please reference Display by Quality
  - **Display by Height**: Please reference Display by Height
  - **Display by Time**: Please reference Display by Time
  - **Display by Specific Color**: Please reference Display by Specific Color
- **Zoom to Layer**: Calculate the bounding box of the current raster data. All the windows, in which the data object is loaded, will show full extent of the bounding box.
- **Point Appearance**: Users can select a circular or quadrate shape point and zoom in and out to change the point size.



Parameters Setting

Point Appearance:

- **Circular Points (optional)**: Set a circular or quadrate shape point for result data trajectory.
- **Point Size**

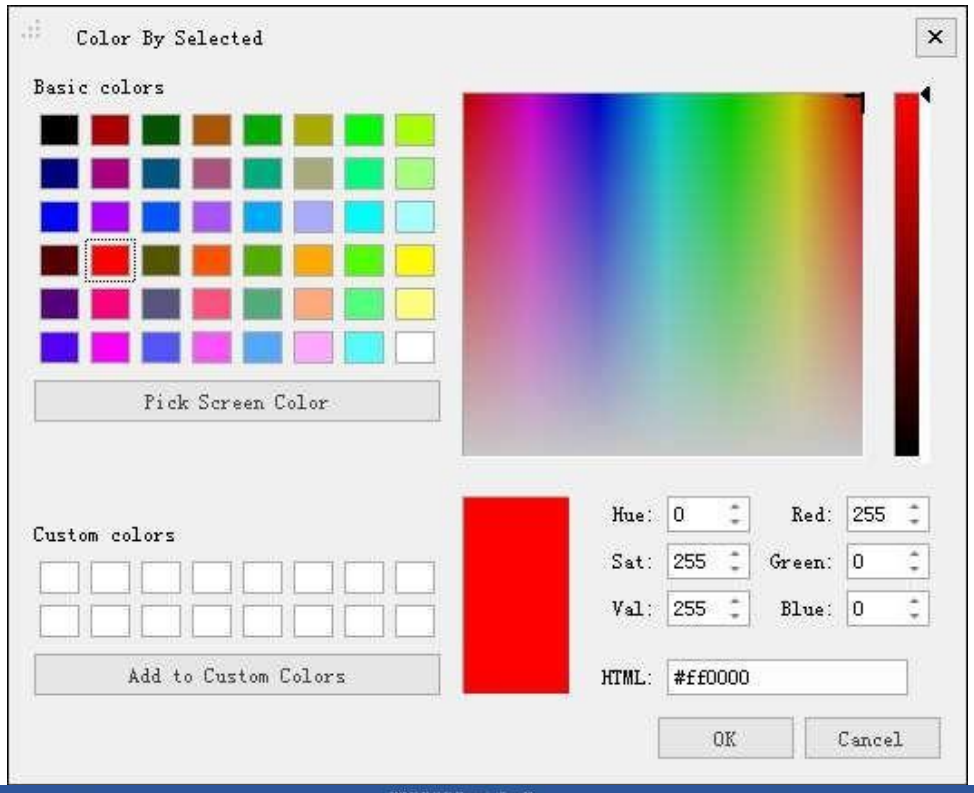
14.1.2.3 Image List Right-click Menu

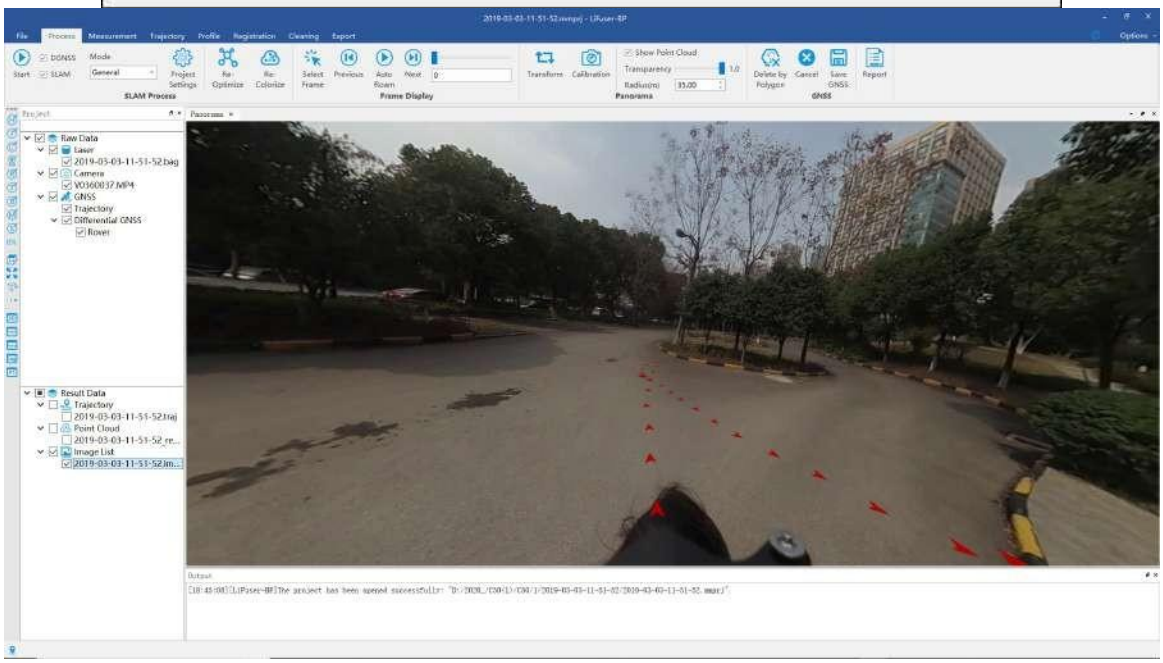
Function Description

Panorama data exposure display is managed by Right-click Menu in Result Data Layer Management Tree.

Data Right-click Menu

- **Select Color**: Click the window to select the specific exposure color as follows.





14.2 Window Management

Function Description

The display of project window is managed by window management tool.

Detailed Introduction

Display by 3D window.

Display by profile window.

Display by panorama window.

Display by log window.

Display by layer (Project Tree) window.

15. Measure Tools

The measure tools are used to measure geometric information about the data.The measurement tools in the software consist of two main types: 3D measure tools and panoramic measure tools. 3D measurements are for point cloud data in a 3D window, and panoramic measurements are for panoramic image data in a panoramic window. Besides, you can use Hover to measure plane, ridge and corner on point cloud.

15.1 3D Measure Tools

The measure tools are used to measure geometric information about the data.

- Pick point
- Multi Pick point
- Length Measurement
- Multi-Length Measurement
- Area Measurement
- Angle Measurement
- Height Measurement
- Volume Measurement
- Density Measurement

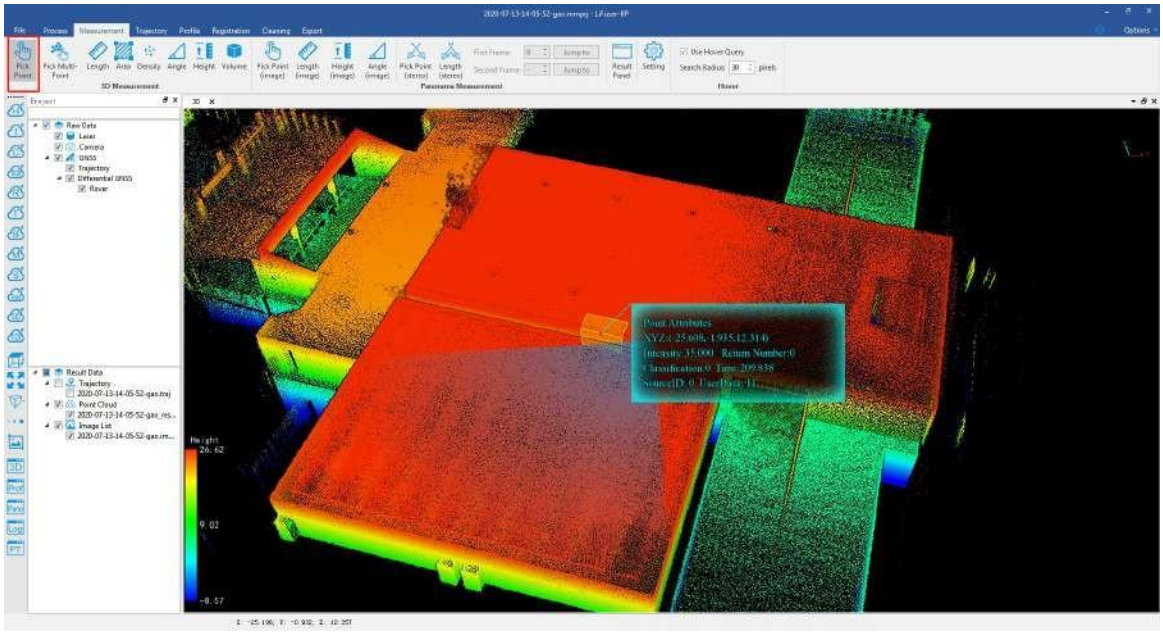
15.1.1 Pick Point

Function Description: This tool is applicable to point cloud data, the attributes that can be queried contain position, intensity, return number, classification and GPS time.

Step

1. Click *Pick Point* button via *3D Measurement* mode.
2. Click a valid point in the scene and a label that displays the point attributes will pop up.

   The label will show the position, intensity, return number, classification and GPS time.



3. Right-click to go back to the previous point during the measurement.

> Note: The tool is only available in the 3D window.

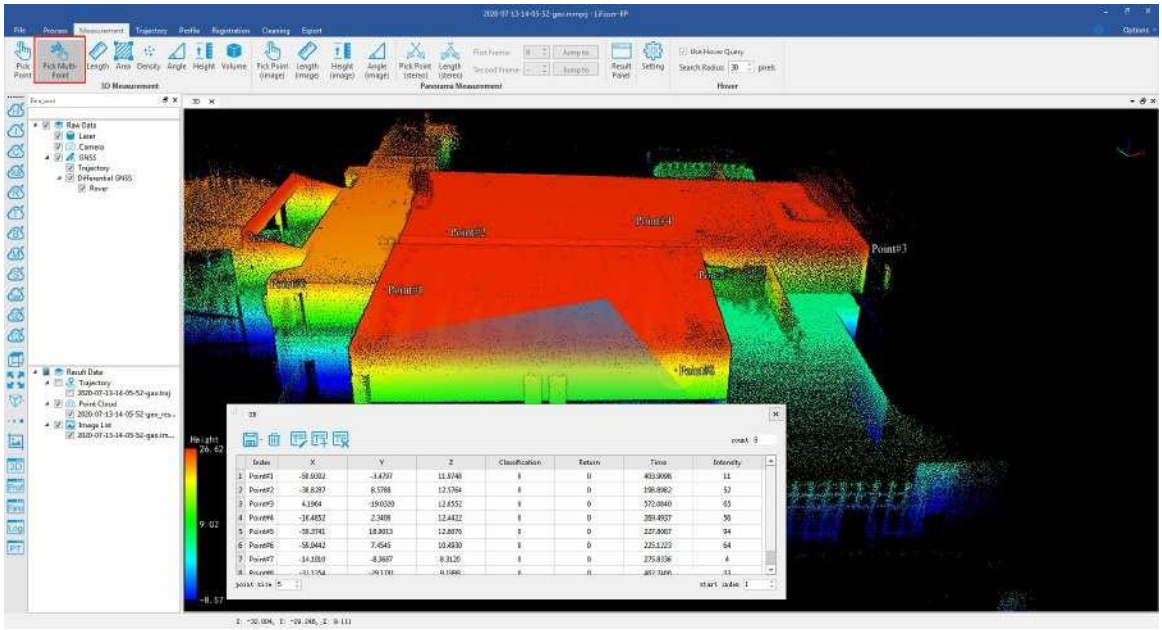
15.1.2 Multi Pick Point

Function Description: For point cloud data, the attributes that can be queried contain position, intensity, return number, classification and GPS time. Different from the pick point tool, this tool allows querying multiple points at the same time, and the selection set can be exported in txt, asc, neu, xyz, pts, or csv file.

Step

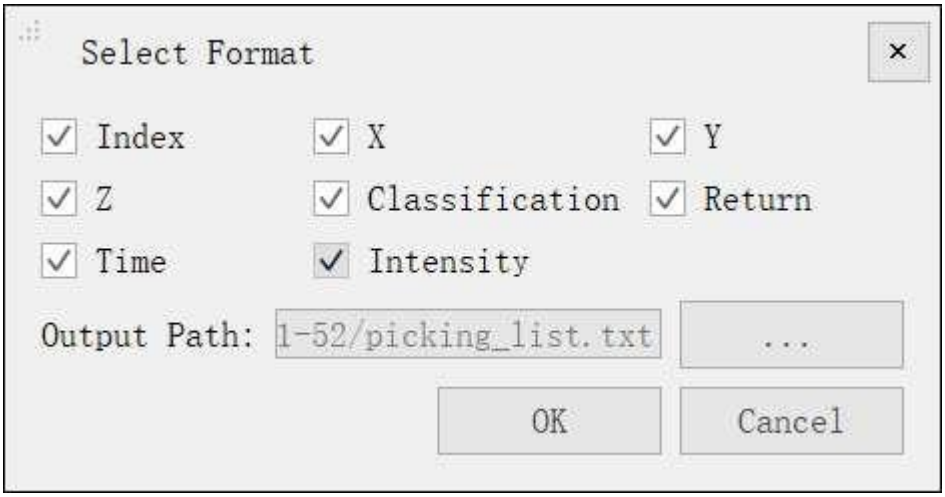
1. Click Pick Multi-Point button *via* 3D Measurement* mode. Left-click the points in the scene and the selection results are marked by labels. At the same time, a table that contains the attributes of the selection points will pop up, shown as follows.

   The attributes of point cloud data shown in the table contain index, position (XYZ), classification, return number, GPS time and intensity. The total number of the points is updated real-time above the table.



2. The "marker size" is used to set the point size of the marker in the scene. The "start index" is used to set the start index of the selected points.
3. Select a row of the table by left-clicking and click the button to delete the point.
4. After clicking the "Start Editing" button, the attribute values can be changed by double-clicking the cells in the added attribute columns, and typing in the new values.
5. After clicking the "Add Attribute" button, the following dialog will pop-up. Currently, it is supported for the following types of custom attributes: integer, float, text, date, and enum. After click "ok" button, the added field will be displayed in the attributes table.
6. The "Remove Attribute" button is not available when there is no custom attributes added. After adding custom attributes, the custom attributes can be removed by clicking "Remove Attribute" button (only the custom attributes can be removed).

7. The selection set can be exported as txt, asc, neu, xyz, pts, or csv file. Click the drop-down menu  to pop up "Select Format" dialog, as shown below. The menu "Save 3D points" is available. The coordinates information and other attribute information can be saved as .txt format.



8. Click ... to pop up the export dialog. Input the output path, and check the attributes that need to be exported. Click "OK" to complete the export. Click "Cancel" to cancel the export.
9. If the selected points have not been saved before quiting this tool, a message box will pop up as follows. Click "Save" to save the points. Click "Discard" to cancel the selections.

Parameters Setting

- **X**：X component of the coordinate.
- **Y**：Y component of the coordinate.
- **Z**：Z component of the coordinate.
- **Classification**: The class attribute of point cloud data.
- **Return**: The return number attribute of point cloud data.
- **GPS Time**: The GPS time attribute of point cloud data.
- **Intensity**: The intensity attribute of point cloud data.
- **Index**: The index of select point
- **Output Path**: The path of the output file.

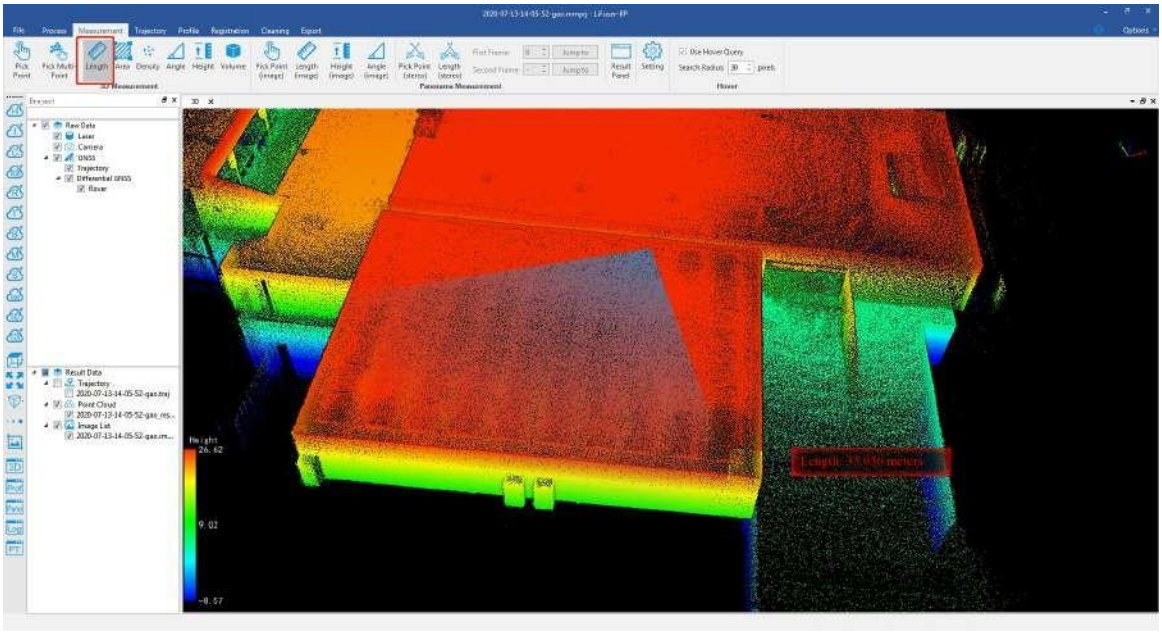
> Note: The tool is only available in the 3D window.

15.1.3 Length Measurement

Function Description: This tool is applicable to point cloud data, which calculates the distance between two consecutive points.

Step

1. Click *Length* button via *3D Measurement* mode.
2. Left-click at least two points in the scene and the corresponding polyline will be rendered real-time.
3. The measurement result is displayed in a label as follows. Double-clicking the last point will stop the measurement process, and the distance value will continue to be displayed in the label.
4. Right-click to go back to the previous point during the measurement.



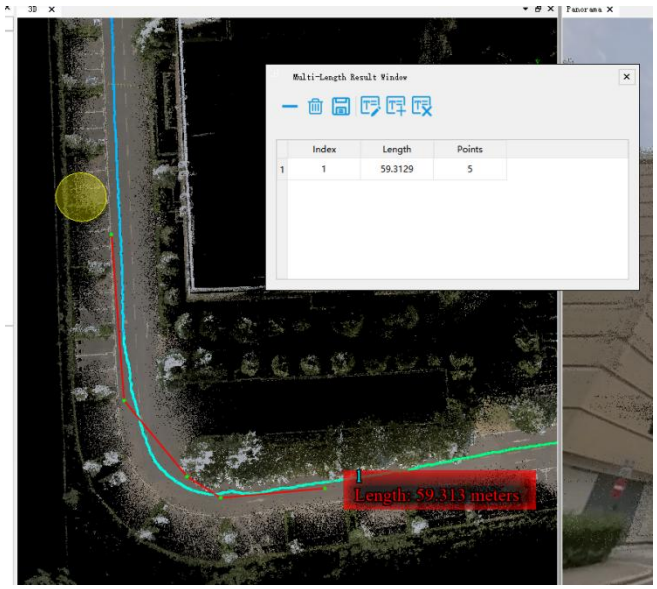
> Note: The tool is only available in the 3D window.

15.1.4 Multi-Length Measurement

Function description: Different from length measurement, multiple measurements can continuously measure the target object, that is, multiple points can form the measurement distance.

Step

Click on the 3D measurement interface, measure multiple times, select the target object to be measured, such as a road, and click the right mouse button to roll back a point before the measurement is completed.



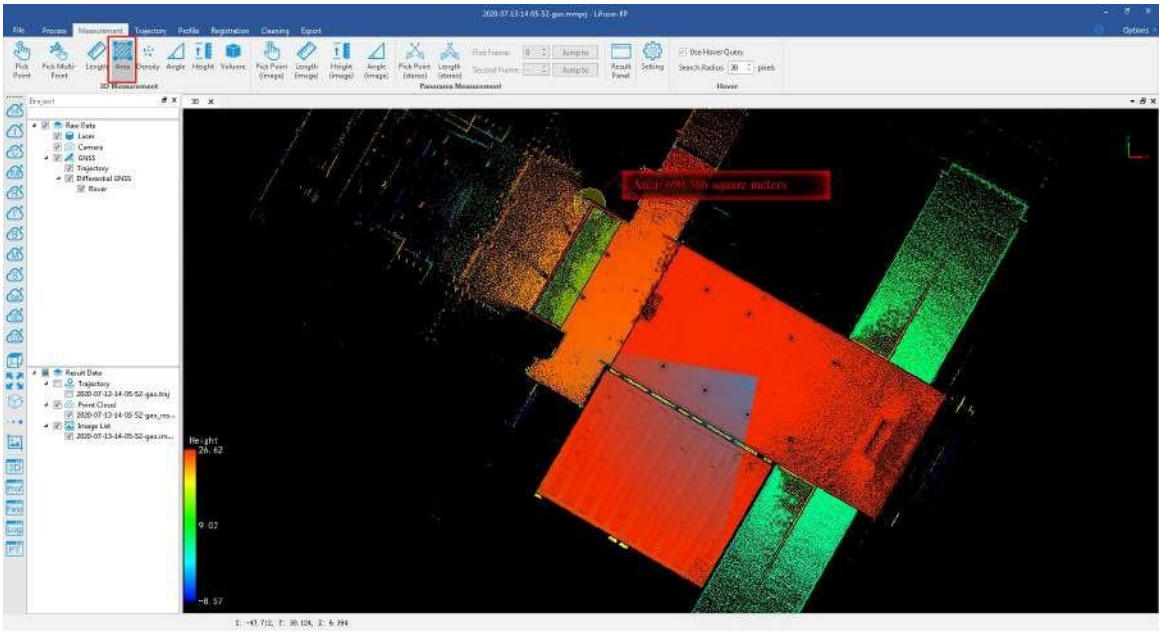
You can save and delete the measurement results.

15.1.5 Area Measurement

Function Description: This tool is applicable to point cloud data which calculates the projected area within the polygon region. Current window will switch to Orthogonal Projection automatically for 3D data.

Step

1. Click *Area*  button via *3D Measurement* mode.
2. Left-click at least three points in the scene and the corresponding polygon area will be rendered real-time. The measurement result is displayed in a label as follows.
3. Double-clicking the last point will stop the measurement process, and the measurement result will continue to be displayed in the label.
4. Right-click to go back to the previous point during the measurement.



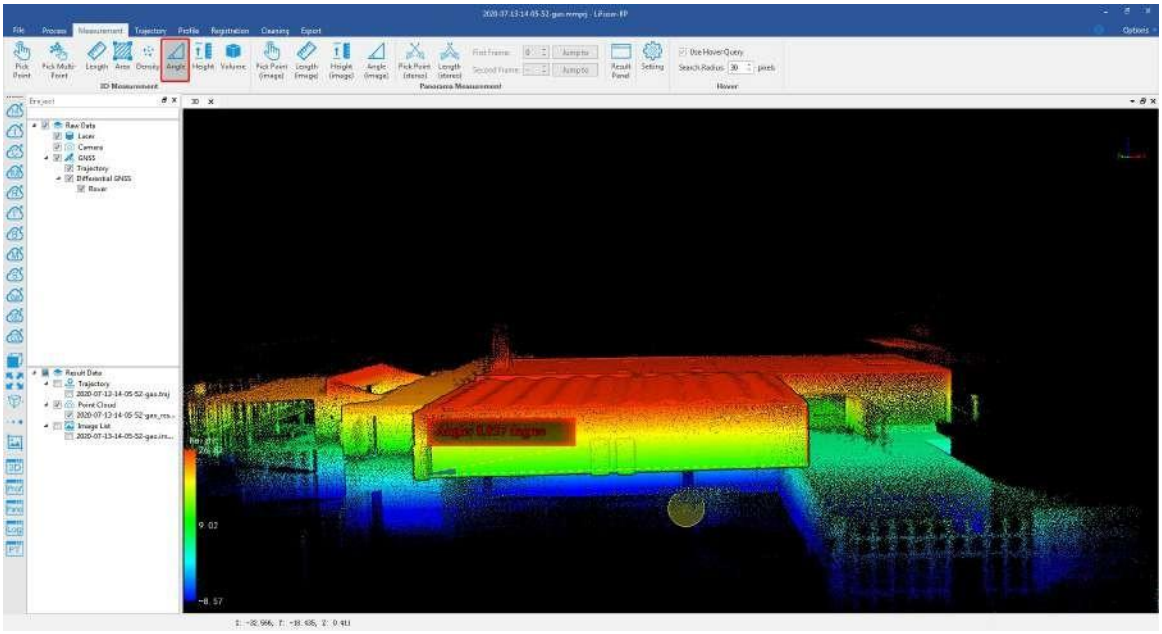
> Note: This tool only works under orthogonal projection. The tool is only available in the 3D window.

15.1.6 Angle Measurement

Function Description: This tool is applicable to point cloud data which calculates the angle of pitch between two points in 3D view and calculates the projection angle of three points on the horizontal plane in 2D view.

Step

1. Click *Angle*  button via *3D Measurement* mode.
2. Select the reference point of angle measurement by left-clicking.
3. Select the measurement point by double-clicking. The pitch angle between the reference point and the measurement point will be rendered in the scene and the measurement result is displayed in a label as follows.



4. Click the right mouse button, the menu "Back One Point" is used to go back to the previous step.

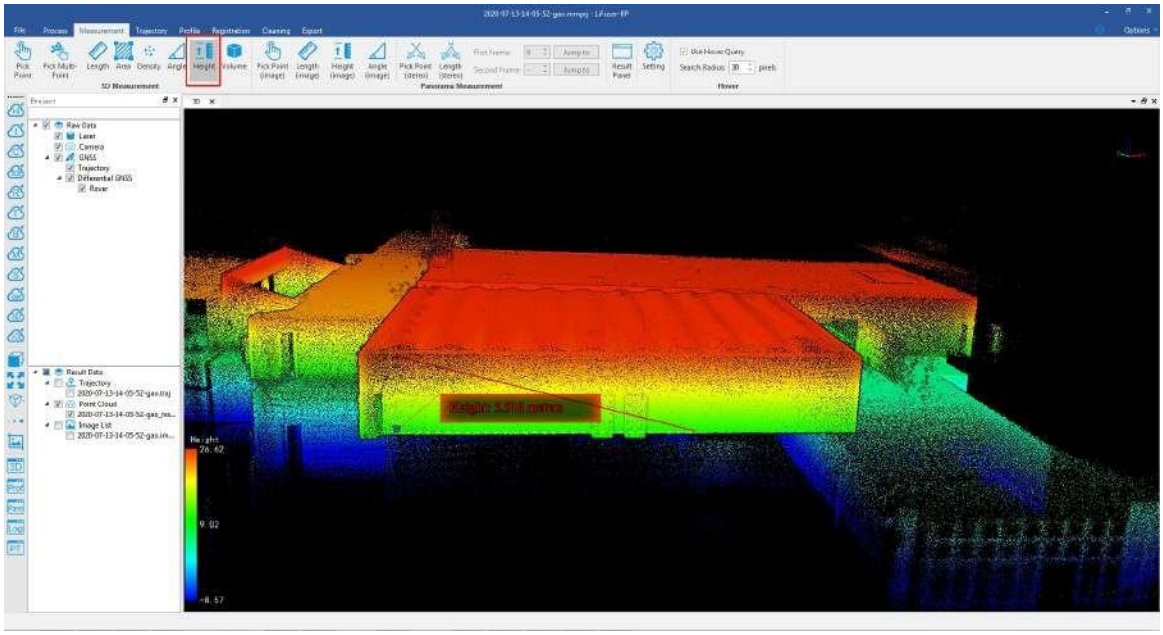
> Note: The tool is only available in the 3D window.

15.1.7 Height Measurement

Function Description: This tool is applicable to point cloud data which calculates the relative height difference between two points.

Step

1. Click *Height* button via *3D Measurement* mode.
2. Select the reference point of height measurement by left-clicking.
3. Select the measurement point by double-clicking. The relative height difference between the reference point and the measurement point will be rendered in the scene and the measurement result is displayed in a label as follows.



4. Right-click to go back to the previous point during the measurement.

> Note: The "Back One Point" is only available before the measurement is stopped and the tool is only available in the 3D window.

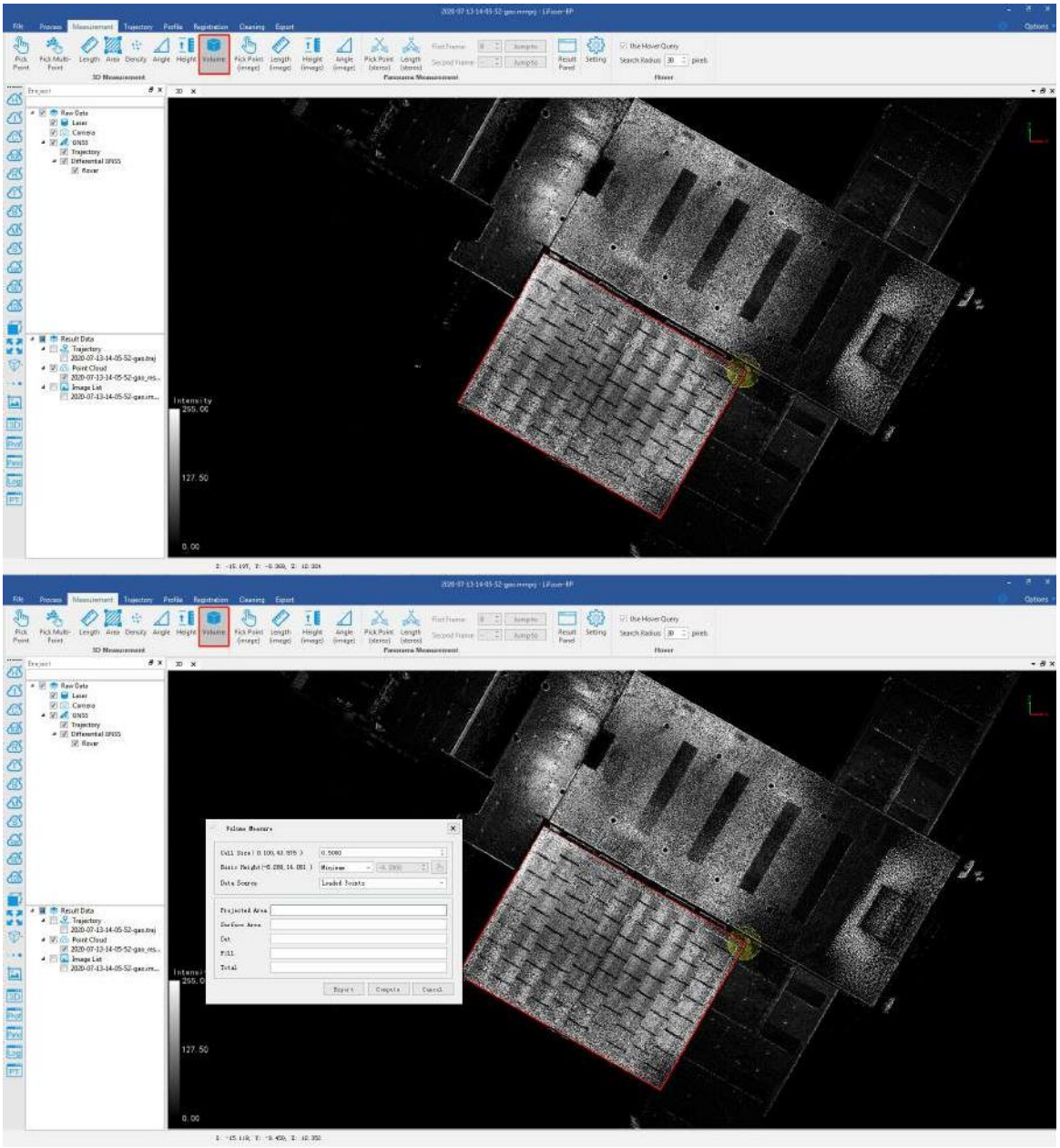
15.1.8 Volume Measurement

Function Description: This tool is applicable to point cloud data which calculates filling, cutting and total amount relative to a reference height. It's commonly used in volume measurement of coal pile and hull.

Step

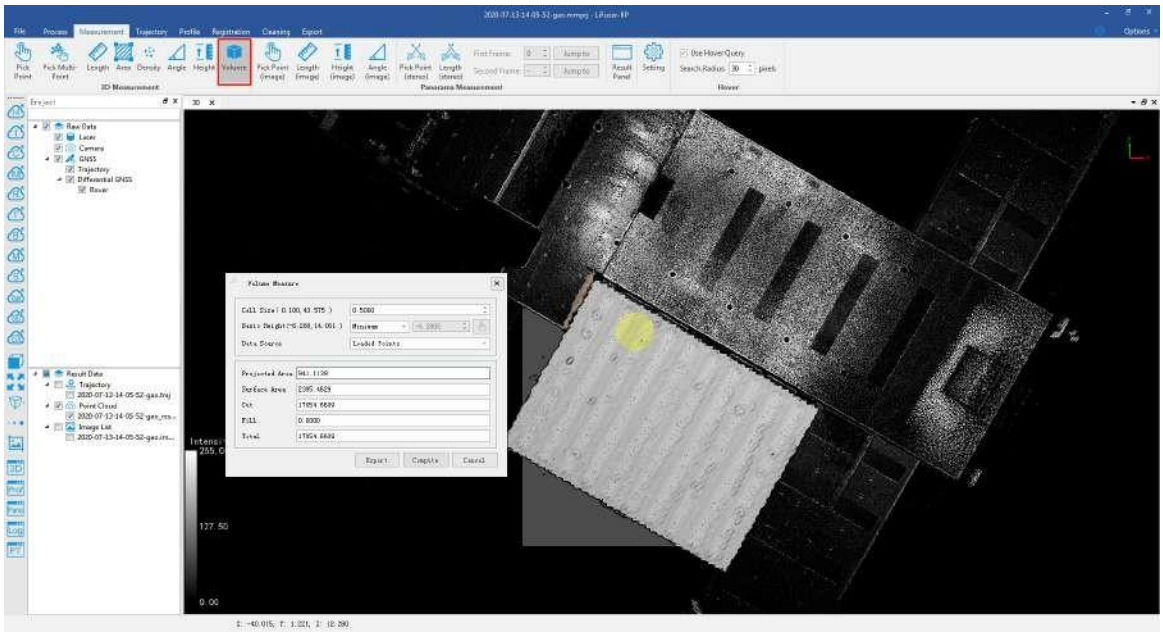
1. Click *Volume*  button via *3D Measurement* mode.

2. It is suggested to adjust the window to top view before the tool is used. Select at least three points to generate the reference plane for volume calculation by left-clicking. Select the last point by double-clicking. The border of the selected region will be rendered in red and the dialog "Volume Measure" will pop up.



3. Set the cell size.

4. Set the reference plane of volume measurement. The options include minimum value, fit plane, and customizing.
5. Click the "Compute" button to generate the measurement result, including Projected area, surface area, cut volume, and fill volume. The corresponding volume will be rendered in the scene, as shown below.



6. Click the "Export" button to export the result in *.pdf format.

Parameters Setting

- **Cell Size：** It defines the smallest unit size for calculation. The smaller the value is, the more accurate the calculation is.
- **Basic Height：** It defines the reference plane to calculate filling and cutting.
  - **Minimum (Default)**: Use the minimum height of the selected points as the height of the reference plane.
  - **Fitted Plane (Mean)**: Fit the best plane according to the selected points.
  - **Customize**: This value is specified by the user.

> Note: This tool only works with point cloud data and model data in 3D view.

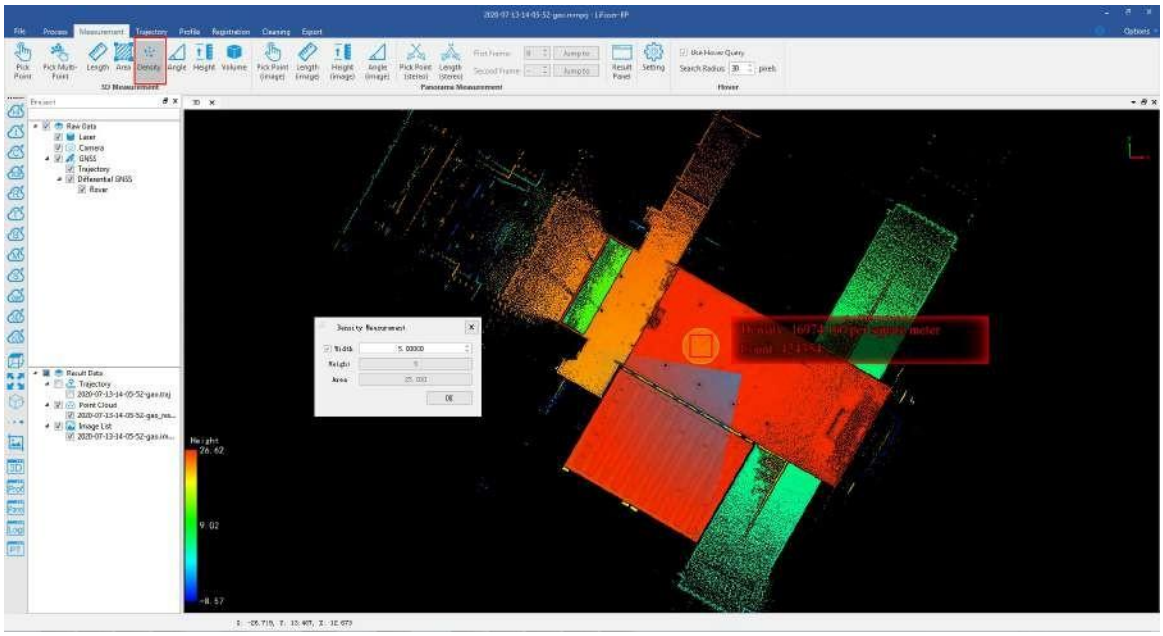
15.1.9 Density Measurement

Function Description: Point density is an important metric to measure the quality of point cloud data. The average number of points per square meter can be counted with this tool.

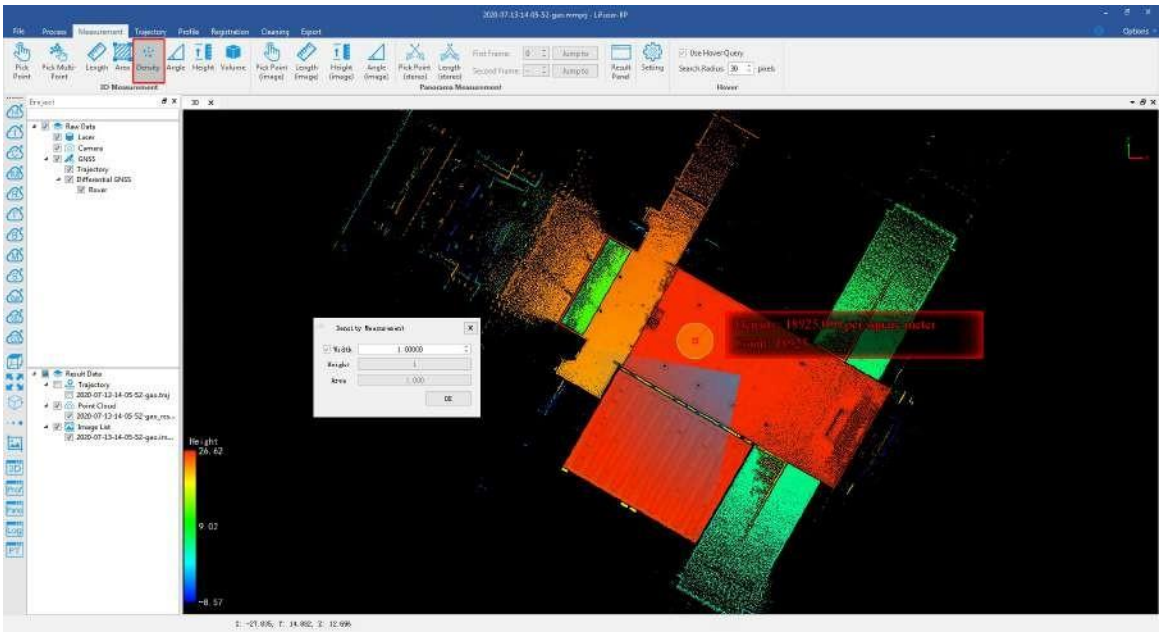
Step

1. Click *Density* button via *3D Measurement* mode.Active window is adjusted to orthogonal projection automatically when this tool is started.
2. Then the dialog "Density" pops up.
3. If the option "Width" is checked, the width value can be manually input, and the height value will be set to the same as the width value, then the area value will be decided by "Width" and "Height". The measurement region can be selected by left-clicking. If the option "Width" is unchecked, the width value and the height value will be decided by the size of the rectangle that is drawn interactively by left-clicking the upper left corner and the lower right corner. The area value will be decided by "Width" and "Height". The rectangle will be rendered in the scene and the measurement result (number of total points and point density) is displayed in a label as follows.

   Default Width (the Width value is five)



   Reset Wigth (the Width value is one)



Parameters Setting

- **Width**: It defines the width of the reference rectangle.
- **Height**: It defines the height of the reference rectangle.
- **Area**: It defines the area of the reference rectangle.

> Note: This tool only works with point cloud data and model data under orthogonal projection.

15.2 Panorama Measure Tools

Panorama measurements consist of two methods: one is based on Point Cloud Depth Interpolation and the other is based on Forward Intersection.

Switch the software top menu to the Measurement mode before the measurement begins.

Panorama Measurements based on Point Cloud Depth Interpolation

Panorama Measurements based on Forward Intersection

Result Panel

Setting Dialog

15.2.1 Panorama Measurements based on Point Cloud Depth Interpolation

The principle of estimating the location information of measuring points is based on the point cloud data depth value and interpolation algorithm within a certain range around the measuring point.

The main functions are listed below:

Pick Point

Length Measurement

Height Measurement

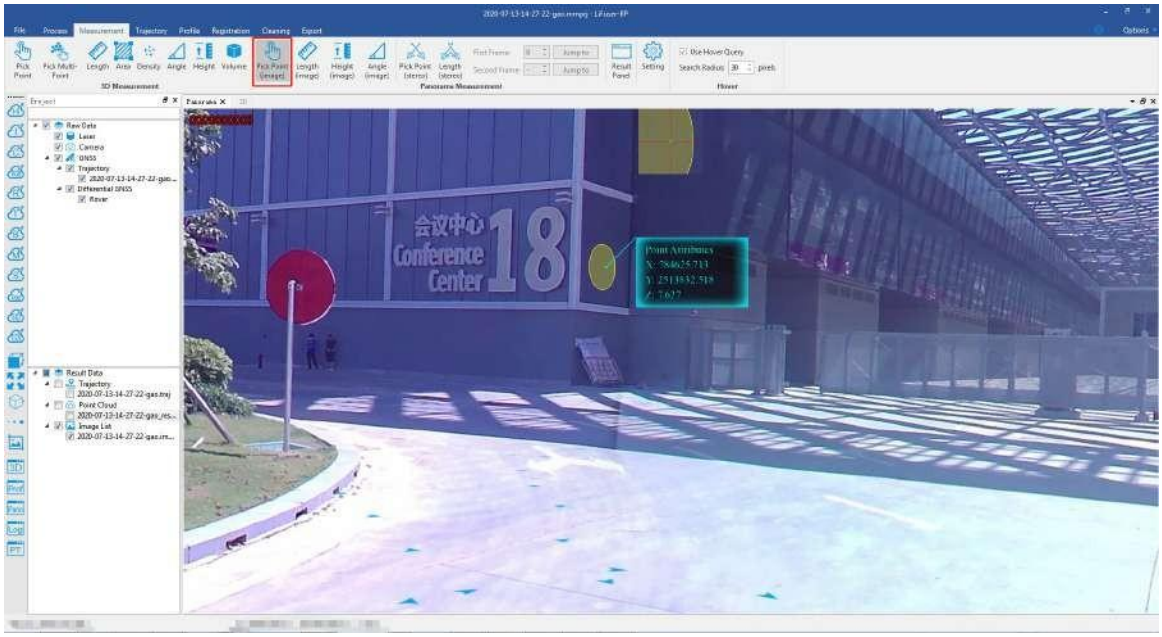
Angle Measurement

15.2.1.1 Pick Point (Depth Interpolation)

Function Description : This tool is applicable to panoramic data, the attributes that can be queried contain position information.

Step

1. Click *Pick Point(image)*  button via *Panorama Measurement* mode.
2. Select a point by left-clicking and the measurement result is displayed in a label as follows.



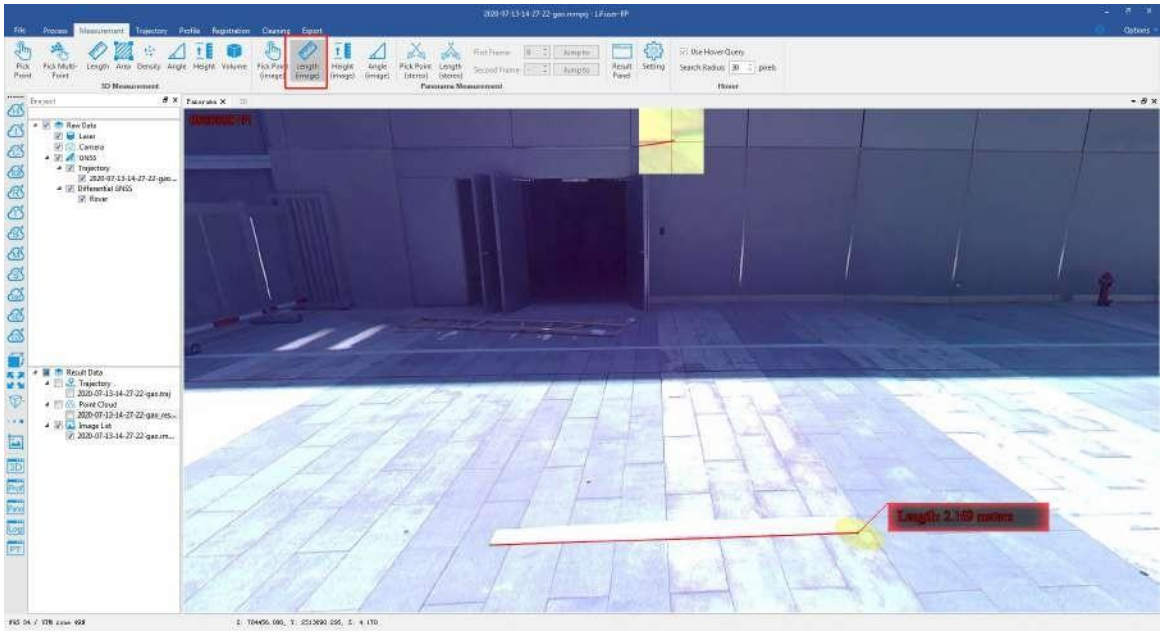
3. Right-click to go back to the previous point during the measurement.

15.2.1.2 Length Measurement (Depth Interpolation)

Function Description: This tool is applicable to point cloud data, which calculates the distance between two consecutive points.

Step

1. Click *Length(image)*  button via *Panorama Measurement* mode.
2. Left-click at least two points in the scene and the corresponding polyline will be rendered real-time.
3. The measurement result is displayed in a label.
4. Double-clicking the last point will stop the measurement process, and the distance value will continue to be displayed in the label.



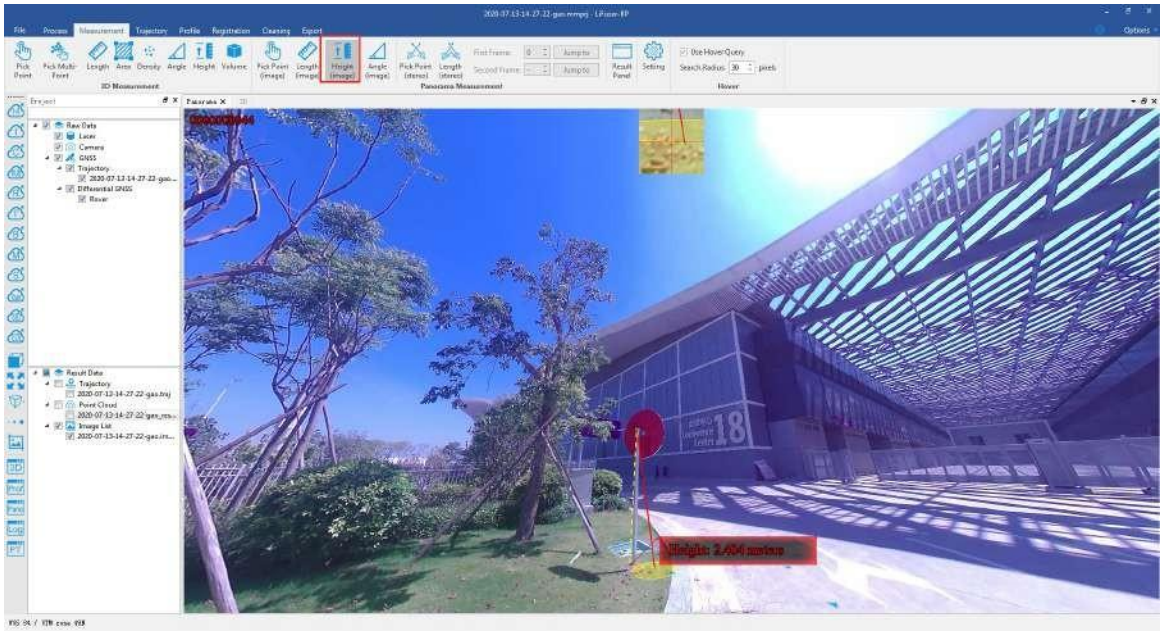
5. Right-click to go back to the previous point during the measurement.

15.2.1.3 Height Measurement (Depth Interpolation)

Function Description: This tool is applicable to point cloud data which calculates the relative height difference between two points in panorama window.

Step

1. Click *Height(image)* button via *Panorama Measurement* mode.
2. Select the reference point of height measurement by left-clicking in panorama window.



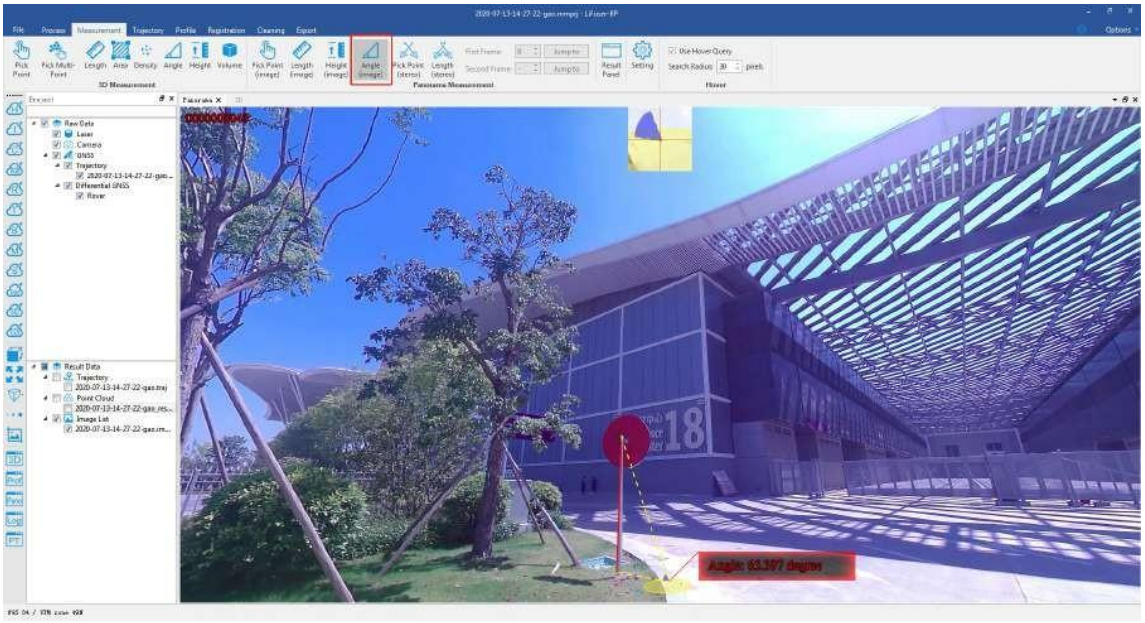
3. Right-click to go back to the previous point during the measurement.

15.2.1.4 Angle Measurement (Depth Interpolation)

Function Description: This tool is applicable to point cloud data which calculates the angle of pitch between two points in Panorama view.

Step

1. Click *Angle(image)*  button via *Panorama Measurement* mode.
2. Select the reference point of angle measurement by left-clicking in (*Panorama*) view.
3. Select the measurement point by double-clicking. The pitch angle between the reference point and the measurement point will be rendered in the scene and the measurement result is displayed in a label as follows.



15.2.2 Panorama Measurements based on Forward Intersection

Using the measuring point to select the tie-points on the two-frame image, and combined with the forward intersection algorithm, the measurement point position information is obtained.

The main functions are listed below:

Pick Point

Length Measurement

15.2.2.1 Pick Point (Forward Intersection)

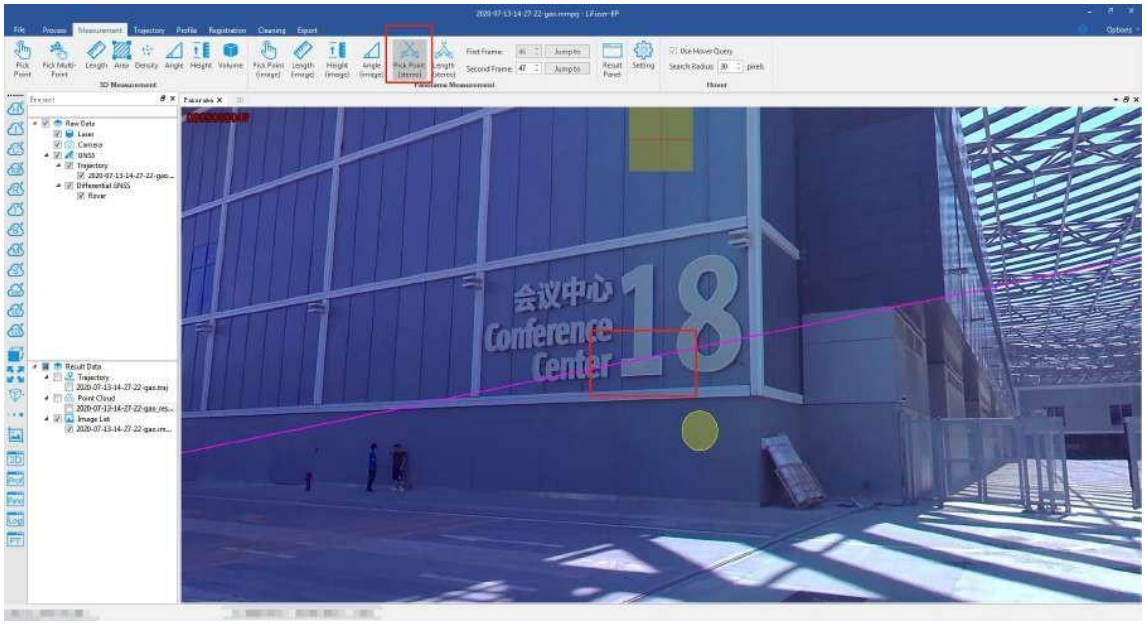
Function Description： This tool is applicable to panoramic data, the attributes that can be queried contain position information.

Step

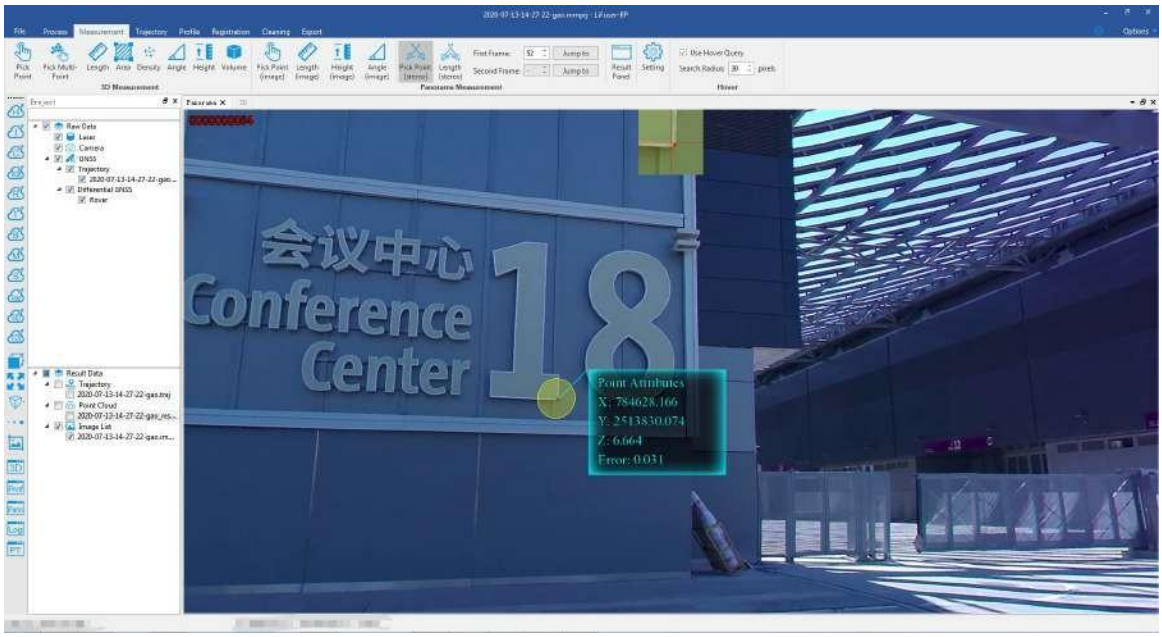
1. Click *Pick Point(stereo)*  button via *Panorama Measurement* mode.
2. Select the first corresponding point by left-clicking in panorama window.

3. The image will update automatically in panorama window.Select the second corresponding point point by left-clicking, and the auxiliary line shown on the image helps to select the point.

   The panorama window will switch to the second frame image automatically and the auxiliary line will display：



Select the corresponding point on the second frame image:



> Note:
>
> 1. In step 3, the auxiliary line is actually the epipolar line generated by the intersection of the epipolar plane with the image plane. If the installation errors between the panorama camera and lidar have been calibrated (The attitude of image is accurate under this condition). In theory, the second corresponding point we select is close by the epipolar line. So the auxiliary line is useful to locate the corresponding point.

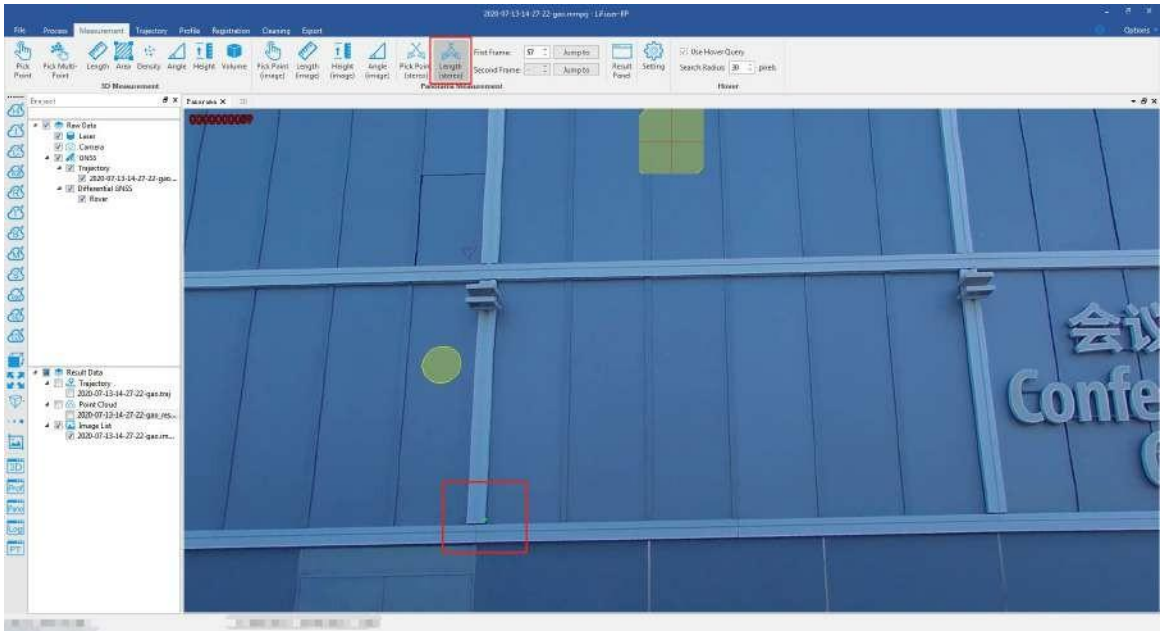
1. Switch to the first frame image which needs to be measured before selecting the first corresponding point. After selecting the first corresponding point, switch to the second frame image that needs to be measured. The specific switch method is to edit the frame number of *First Frame* and *Second Frame*. And click *Jump to* button or press the button of *Enter*.

15.2.2.2 Length Measurement (Forward Intersection)

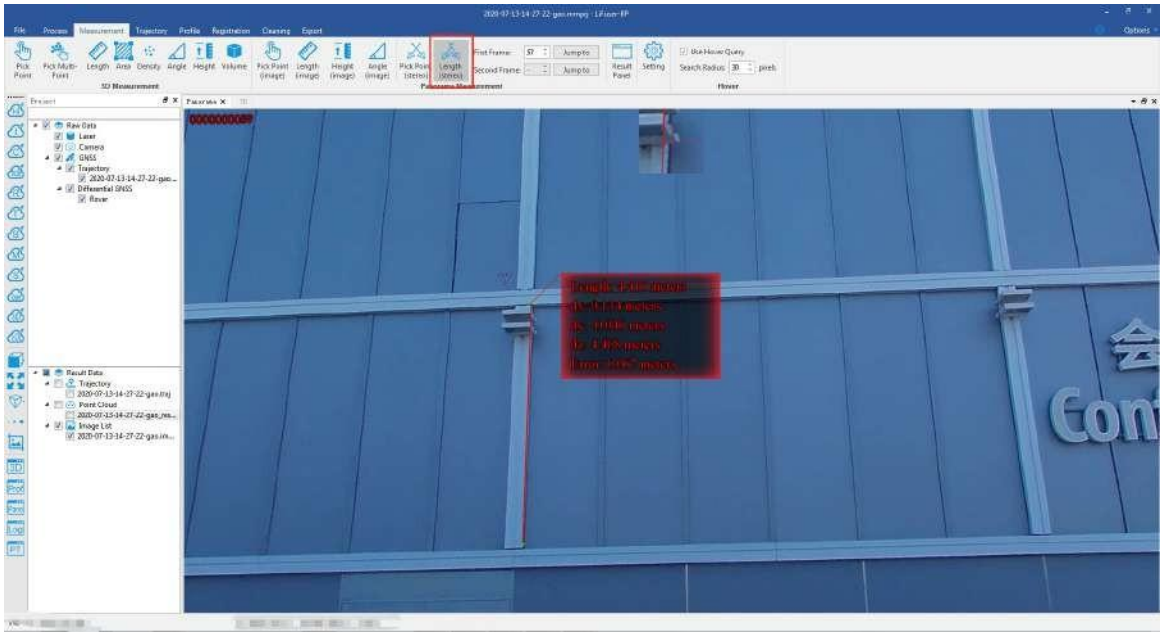
Function Description: This tool is applicable to point cloud data, which calculates the distance between two consecutive points.

Step

1. Click *Length(stereo)*  button via *Panorama Measurement* mode.
2. Left-click to select the starting point in the scene, the operation is the same as Pick Point step.



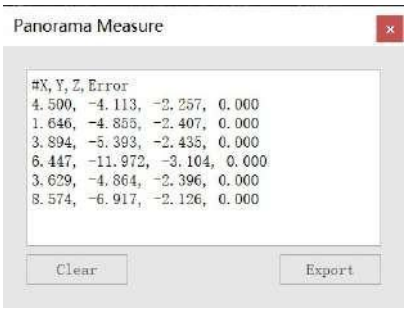
3. Select the end point, the operation is the same as Pick Point。



4. Right-click to go back to the previous point during the measurement.

15.2.3 Result Panel

The result of panorama measurements can be recorded in Result Panel. And it is supported to export measured points list.



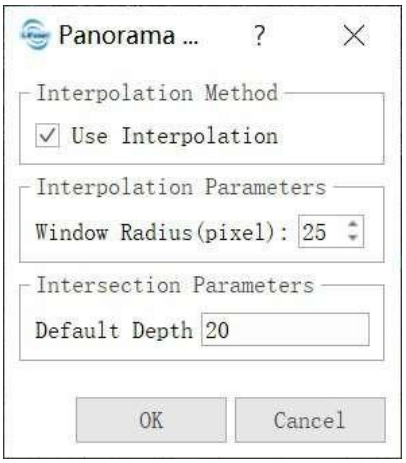
Step

1. Click *Result Panel* button via *Panorama Measurement mode. The Result Panel will pop up from the right corner.

2. Click *Clear* button to clear Result Panel.
3. Click *Export* button to export measured points list.

15.2.4 Dialog Setting

Dialog Setting is used to set parameters for running the function of panorama measurements.



Parameters Introduction

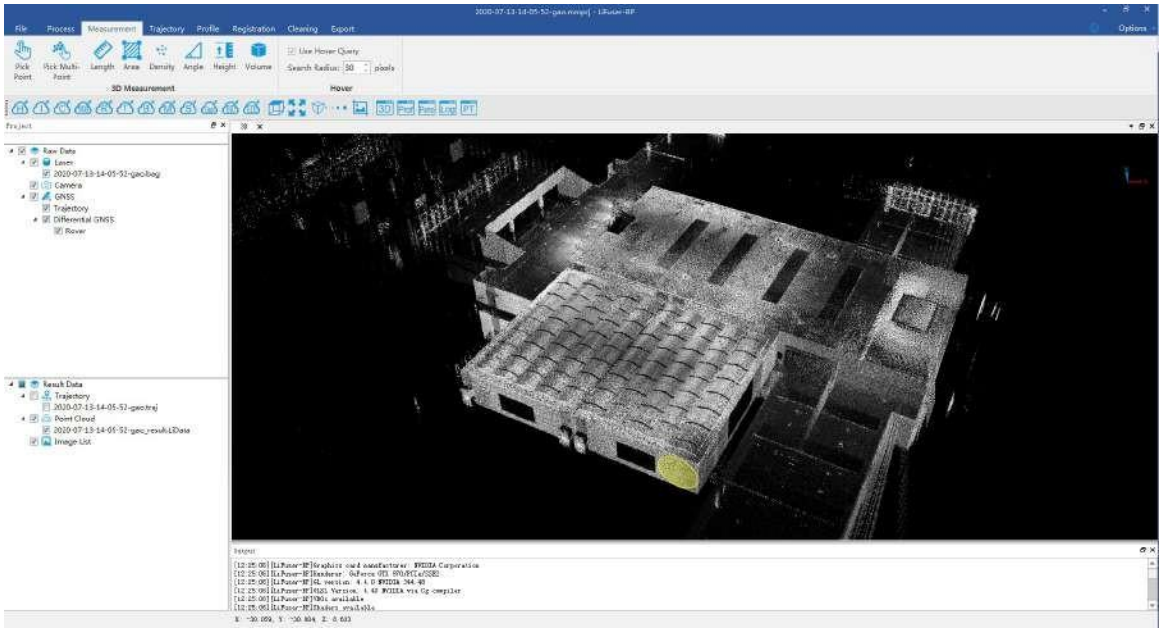
- **Use Interpolation** : This function is set by default. It is available to choose whether select the complex interpolation algorithm or not when using the function of Panorama Measurements based on Depth Interpolation. If unselect this function, nearest neighbor algorithm is used to calculate the point location information.
- **Windows Radius**: It is the windows radius to be used when running interpolation algorithm. For example, when the windows radius is N, all the depth value around the measured points in the square area whose length value is 2N + 1 (the unit is pixel) will be read. If the point density is not high and measurements can not perform with default windows radius, users can increase the value of windows radius.
- **Default Depth**: It is the assumed depth of measured points. And it is recommended in the second frame image when using the function of Panorama Measurements based on Forward Intersection

15.3 Hover

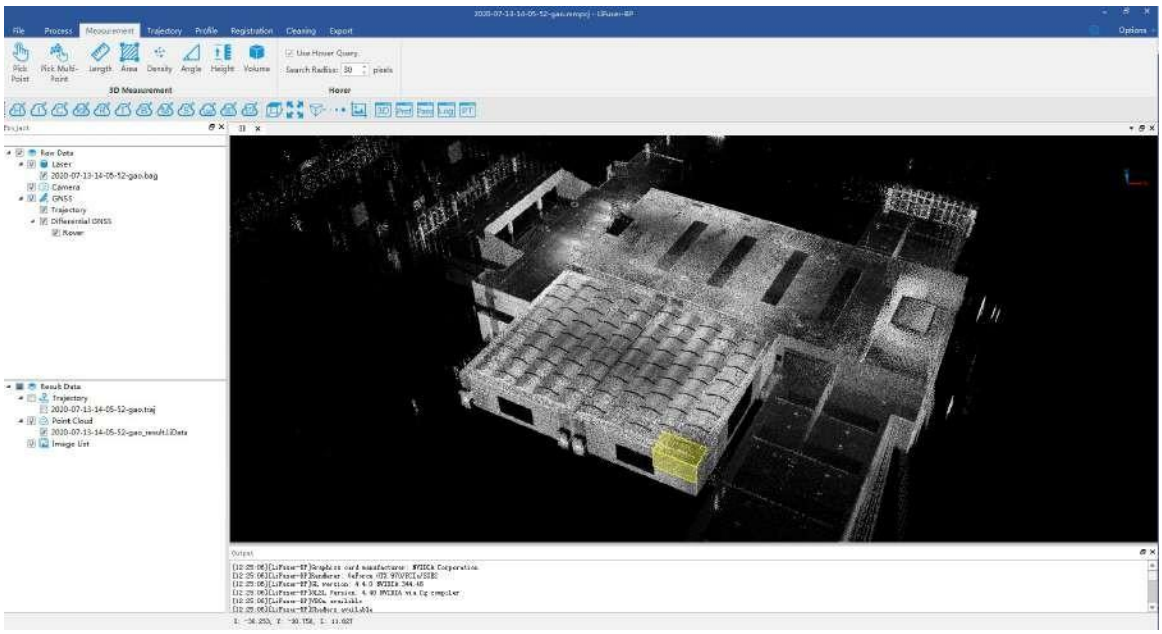
Description：Hover Query is used to fit feature on point cloud within specific radius, which can help measuring plane, ridge or corner etc.

Steps

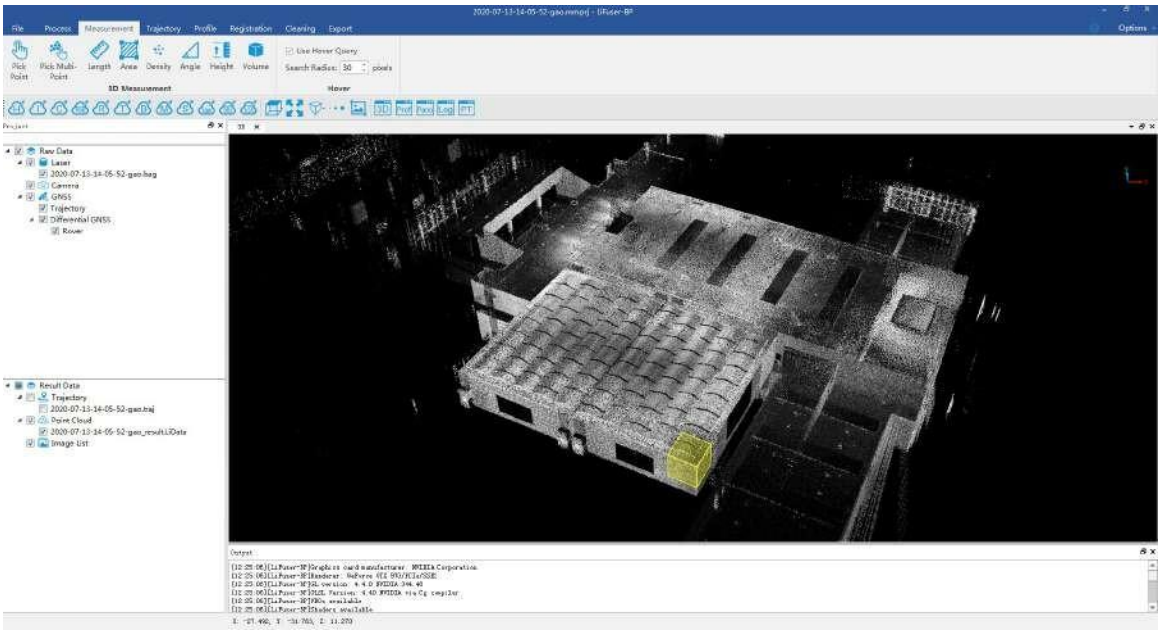
1. Go to *Hover* tab, and click *Use Hover Query* to activate the tool.
2. Set *Search Radius* to define the search radius.
3. The effect of plane detection is shown as figure below.



4. The effect of ridge detection is shown as figure below.



5. The effect of corner detection is shown as figure below.


File
Process
Measurement
Trajectory
Profile
Registration
Cleaning
Export
Options
Pick Point
Pick Multi-Point
Length
Area
Density
Angle
Height
Volume
3D Measurement
Use Hover Query
Search Radius: 30 pixels
Hover
Project
Raw Data
Laser
Camera
GNSS
Trajectory
Differential GNSS
Rover
Result Data
Trajectory
Point Cloud
Image List
Output

16. Profile Tools

Profile editing tool allows users to view the profile of the point cloud data in the selected rectangle area. Users can view, meansure, and edit the data in the profile window.

- Switch View
- Select Profile Region
  - Fixed Buffer
  - Move
  - Rotate
  - Expand
- Measure Tools
- Manual Classify

Profile and Measuring Tool

It is supported to use all the 3D measurements tools in *Measurement* mode.

> Note: If users switch the profile window to measurement tools interface, the measurement tools will activate. And to reuse the profile tools, it is necessary to reclick the profile tools.

Profile and Select Tool

> All the select tools (Cut tools included) are supported to use in the main profile window.
>
> Note: If users switch the profile window to select tools interface, the measurement tools will activate. To reuse the profile tools, it is necessary to reclick the profile tools. The sub-interface of profile tools only support selected tool in the profile interface,

16.1 Switch View

Function Description: By default, profile view shows the front view, rear view, left view and right view of selected rectangle area. However, under default condition, rotate operation is not supported.

Step

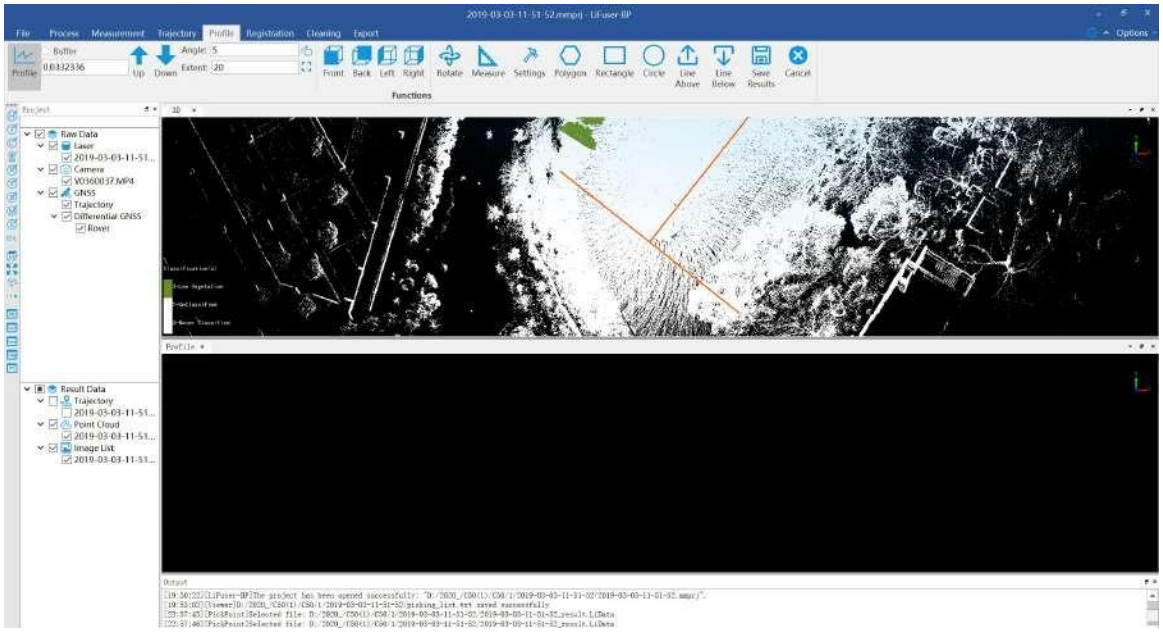
1. By default, profile view shows the front view.
2. **optional** Click  button to switch to front view.
3. **optional** Click  button to switch to rear view.
4. **optional** Click  button to switch to left view.
5. **optional** Click  button to switch to right view.

> Note: It is also supported to start  rotate mode under non-default settings.

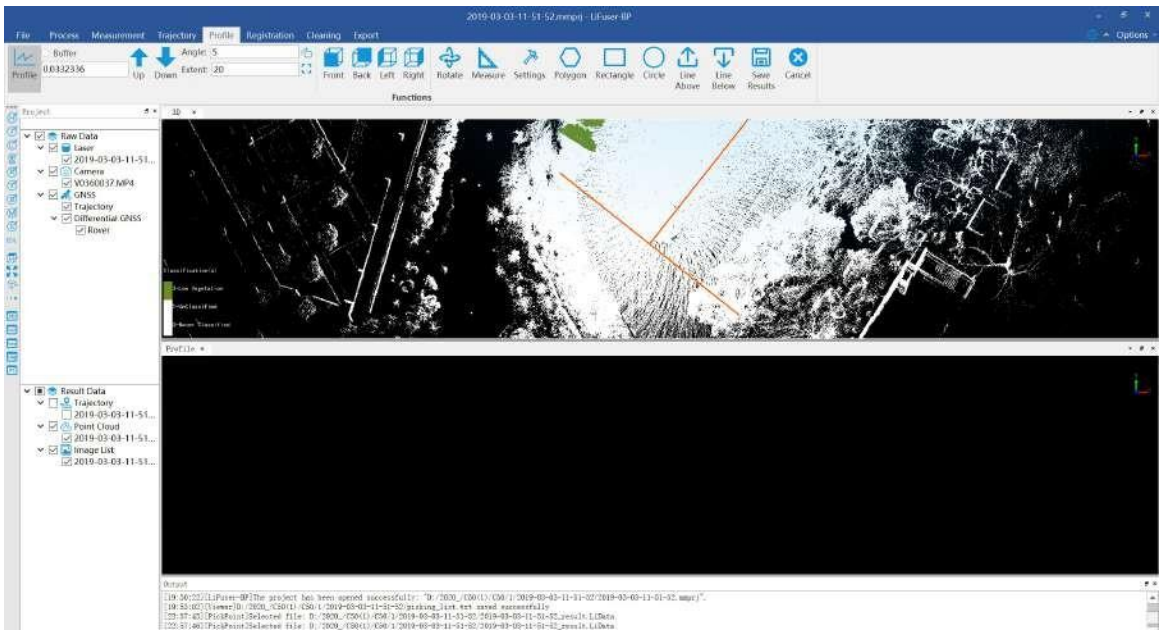
16.2 Select Profile Region

Step

1. Move the mouse to 3D window to zoom to interested area.
2. Select the first point by left-clicking, move the mouse to select the second point. The profile direction is done.



3. Move the mouse to select the profile width, double left-clicking to finish profile area. In profile window, the selected profile area will display.。



LiFuser-BP supports multi selection tools.

Fixed Buffer

Move

Rotate

Expand

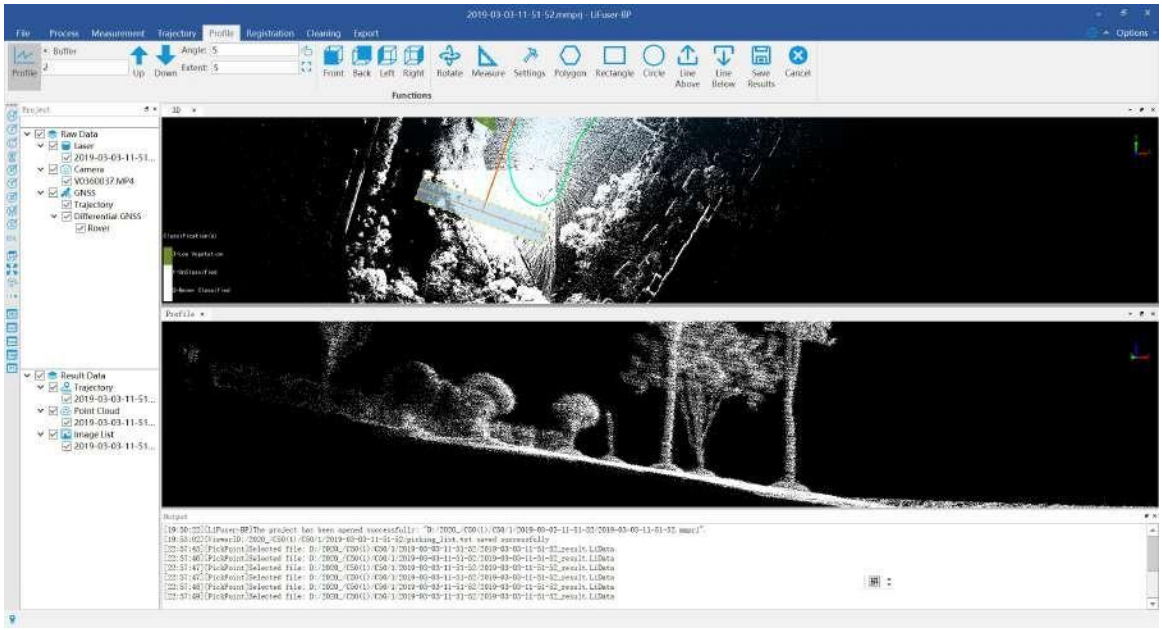
> Note: It is supported to mixed use of tools mentioned above.

16.2.1 Fixed Buffer

Fixed rectangular width is supported to use.This function can help users to fix the size of the buffer area.

Step

1. Set the buffer value, for example, set 2 meters as fixed buffer.



2. Click the buffer setting button.
3. Select the first point by left-clicking, move the mouse to select the second point. The profile direction is done.

16.2.2 Move

Used to move up (move down) the current profile to create a new profile with the same size and right above (below) the current profile.

Step

1. Select the first point by left-clicking, move the mouse to select the second point. The profile direction is done.
2. Move the mouse to select the profile width, double left-clicking to finish profile area.
3. **optional** Click  to move up the profile.
4. **optional** Click  to move down the profile.

16.2.3 Rotate

Function Description: Support to rotate the profile area based on the angle that users enter in the rotate settings window.

Step

1. Select the first point by left-clicking, move the mouse to select the second point. The profile direction is done.
2. Move the mouse to select the profile width, double left-clicking to finish profile area.
3. Set rotate angle (-360~360)
4. Click  button to rotate.

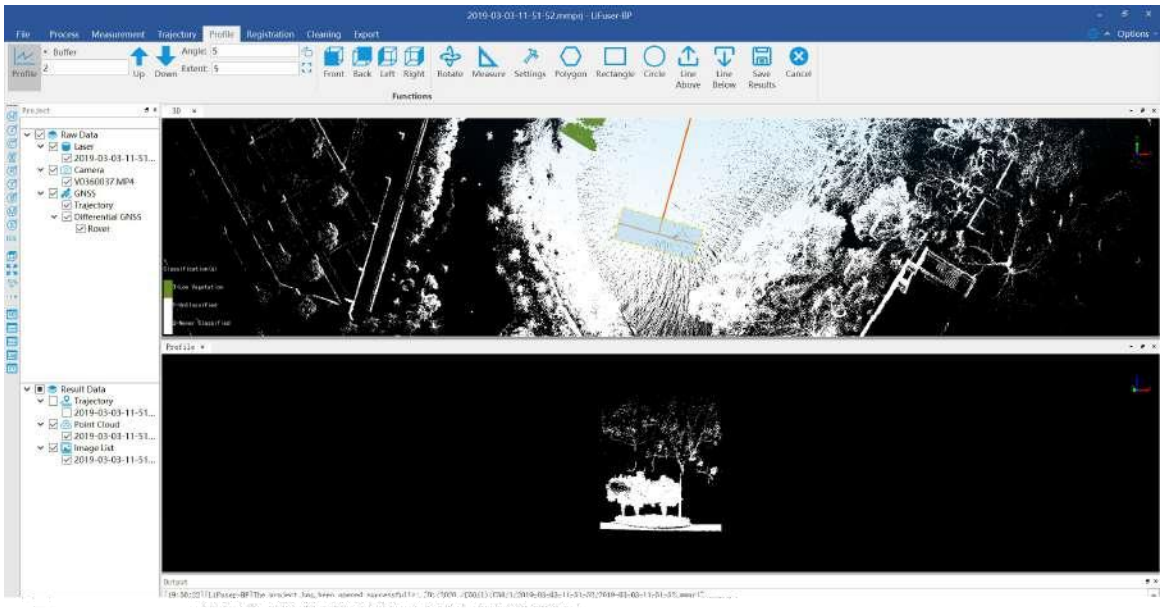
16.2.4 Expand

Function Description: Used to expand the width of profile area by the entered number.

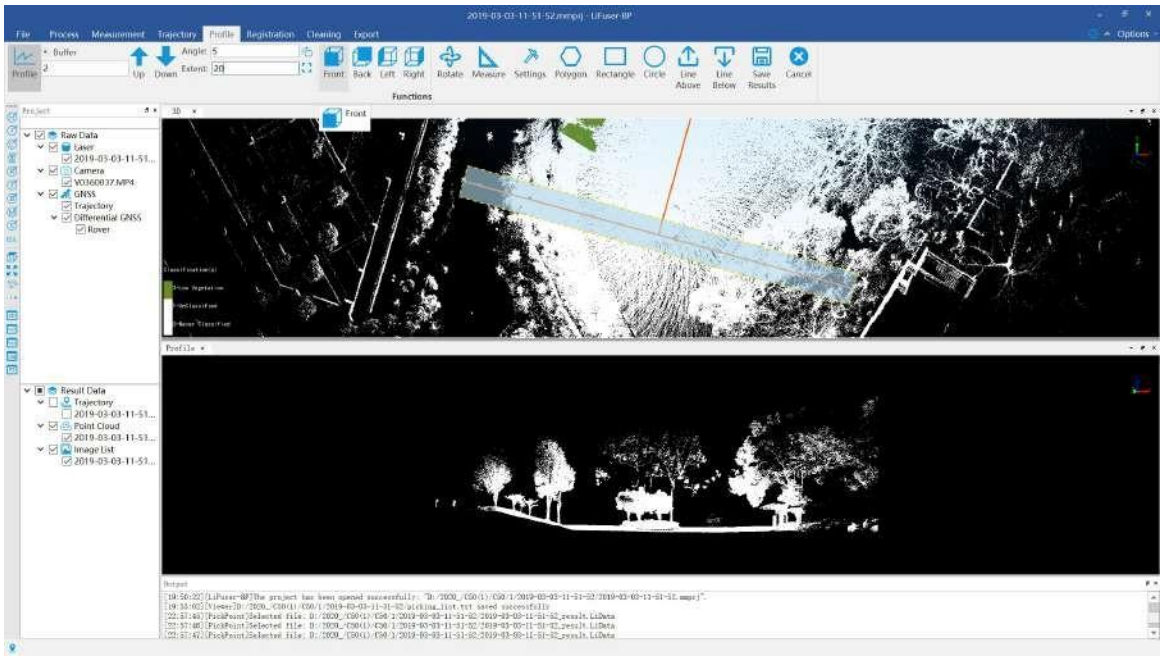
Step

1. Click *Expand* button to expand current selected area.

   Before expand：



   After expand:



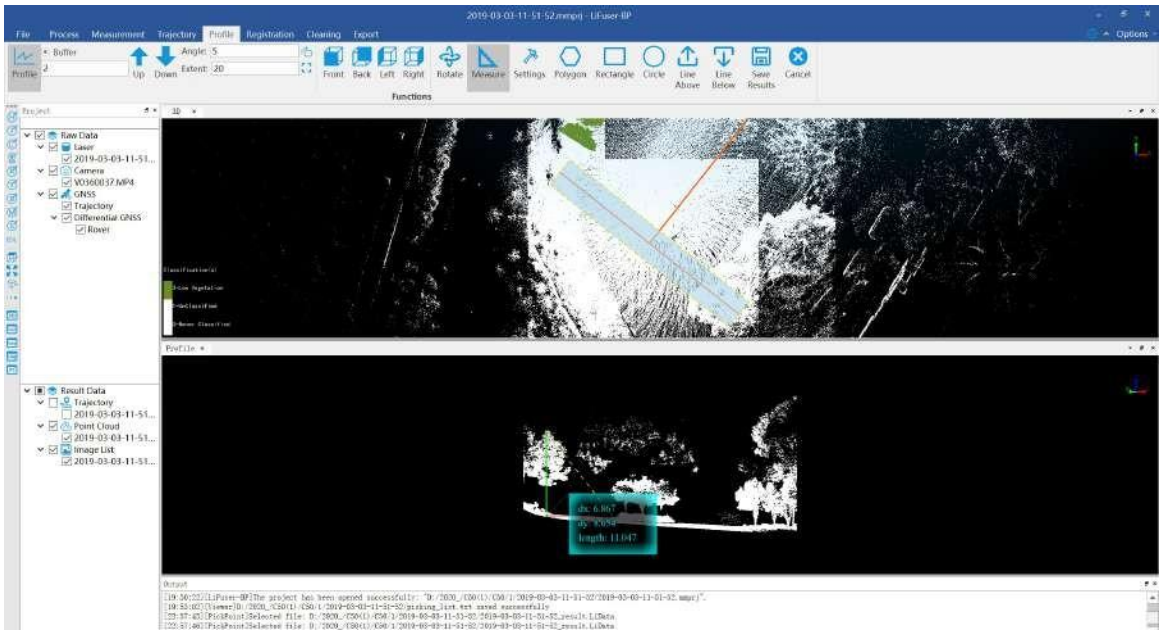
2. Click *Expand* button to change the expand length.

16.3 Measure Tools

Function Description: Orthogonal projection is as default for profile window, and it is convenient to calculate the horizontal and vertical distance.

Step

1. Click *Measure* button via *Profile* mode to start profile measurements.
2. Left-click to select the first point.
3. Select the second point by double-clicking to finish calculating the distance between two points.

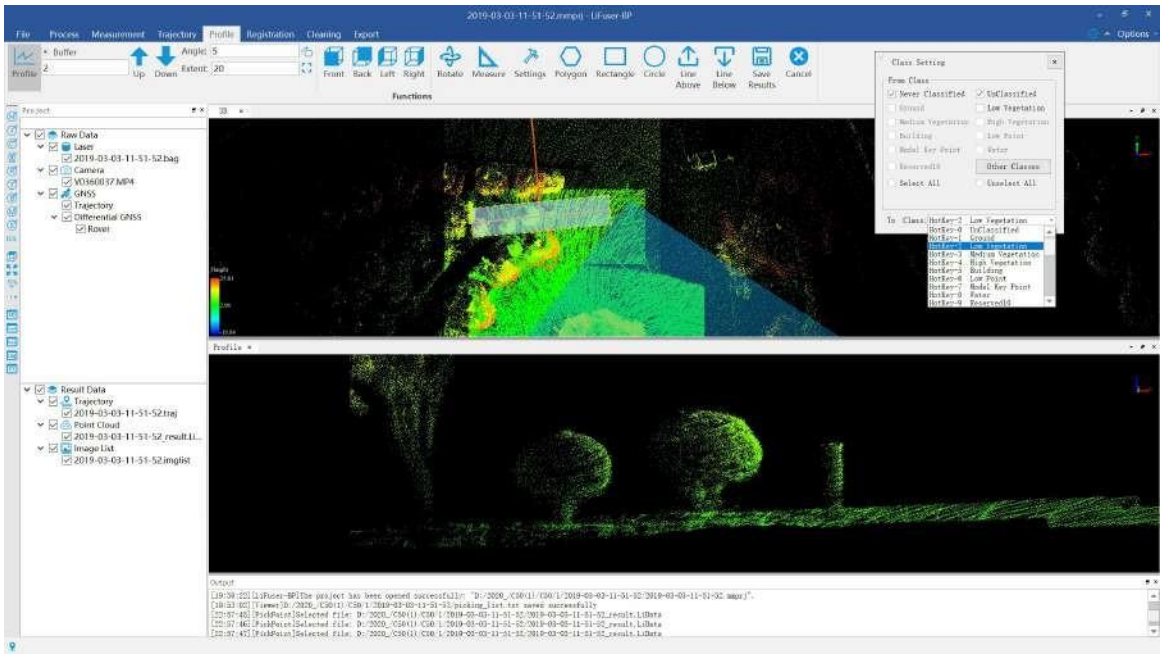


16.4 Manual Classify

Function Description: Use tools supported by profile window for manual classification.

Step

1. Click button to set modified classification and targeted classification.
2. Select "From Class" to "To Class" in Class Setting window. For example, users can classify unclassified points to low vegetation points as shown below.



3. Change attributes by selection tools.

   Polygon Selection:It is suggested for complexed polygons using Even-odd Rules. For example, a tree or a building.

   Rectangle Selection: It is suggested for simple shape object.

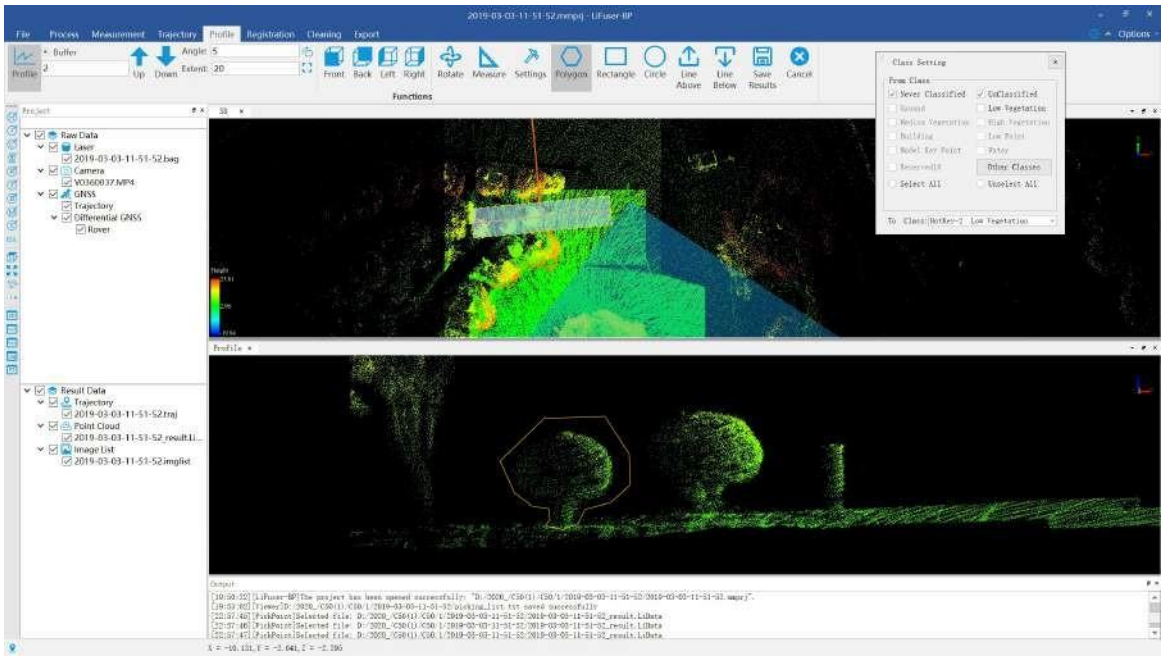
   Circle Selection.

   Select above the line.

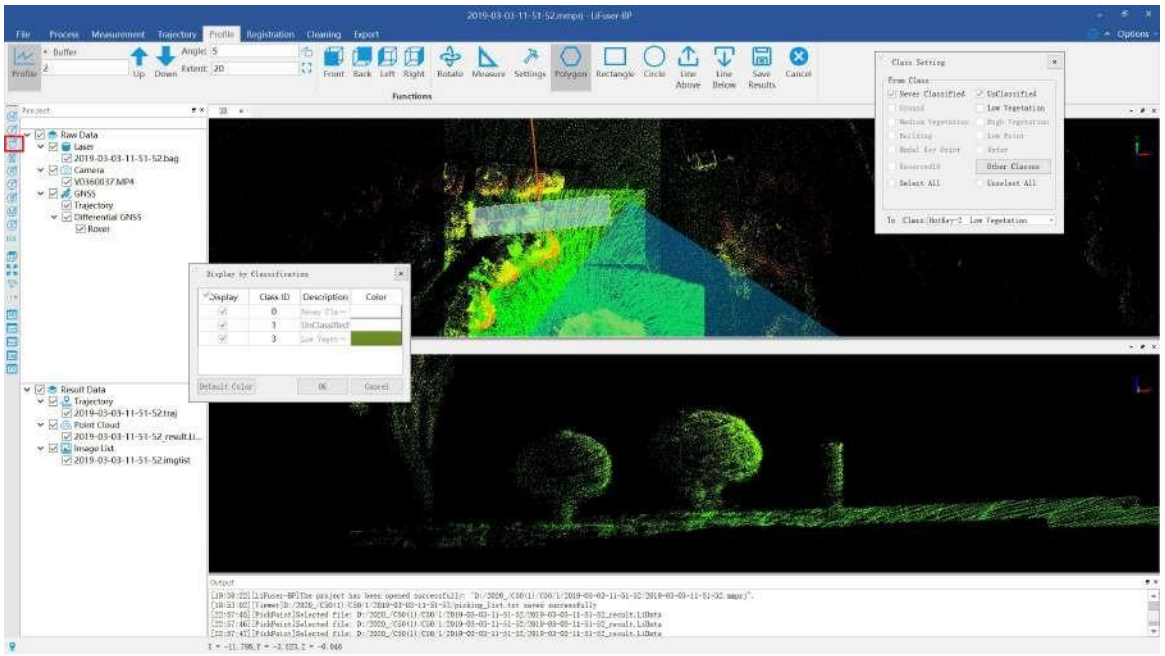
   Select below the line.

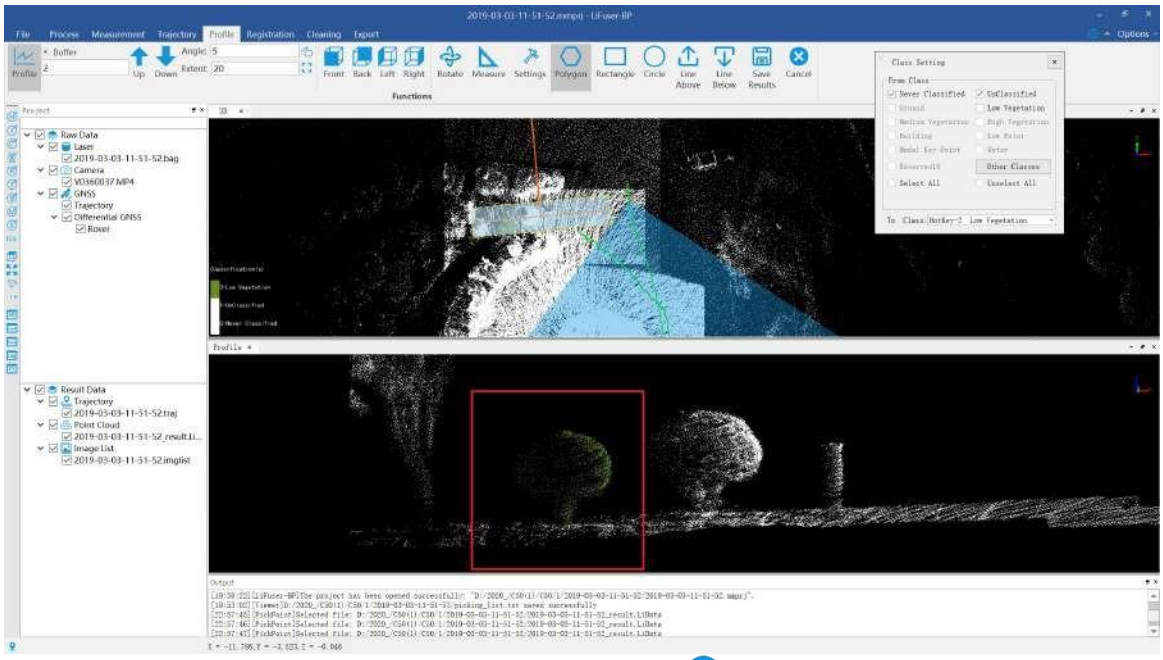
   For example:

   Draw polygon (double left-clicking to finish the selection)



4. Display by class to see previous selected points.

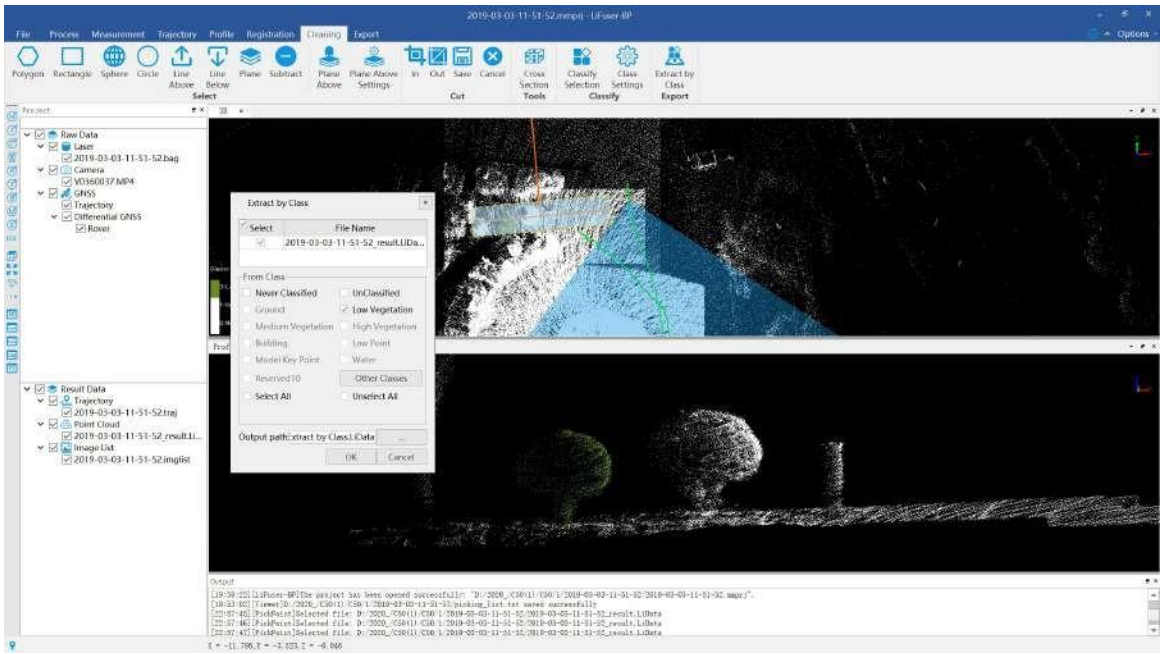


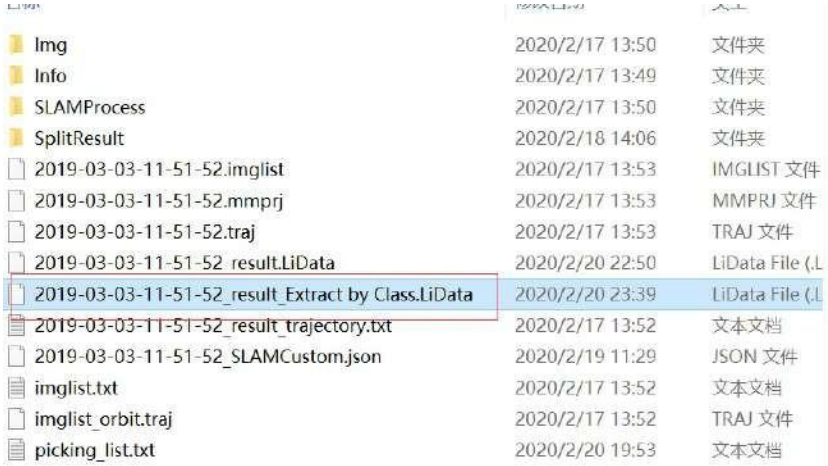


5. (**optional**) Use **Ctrl+Z** to undo the previous steps.Or by clicking button to clear all the unsaved steps.

6. Click to save the profile.

7. Click *Extract By Class* button via *Cleaning* mode, save the classified file in hard disk.

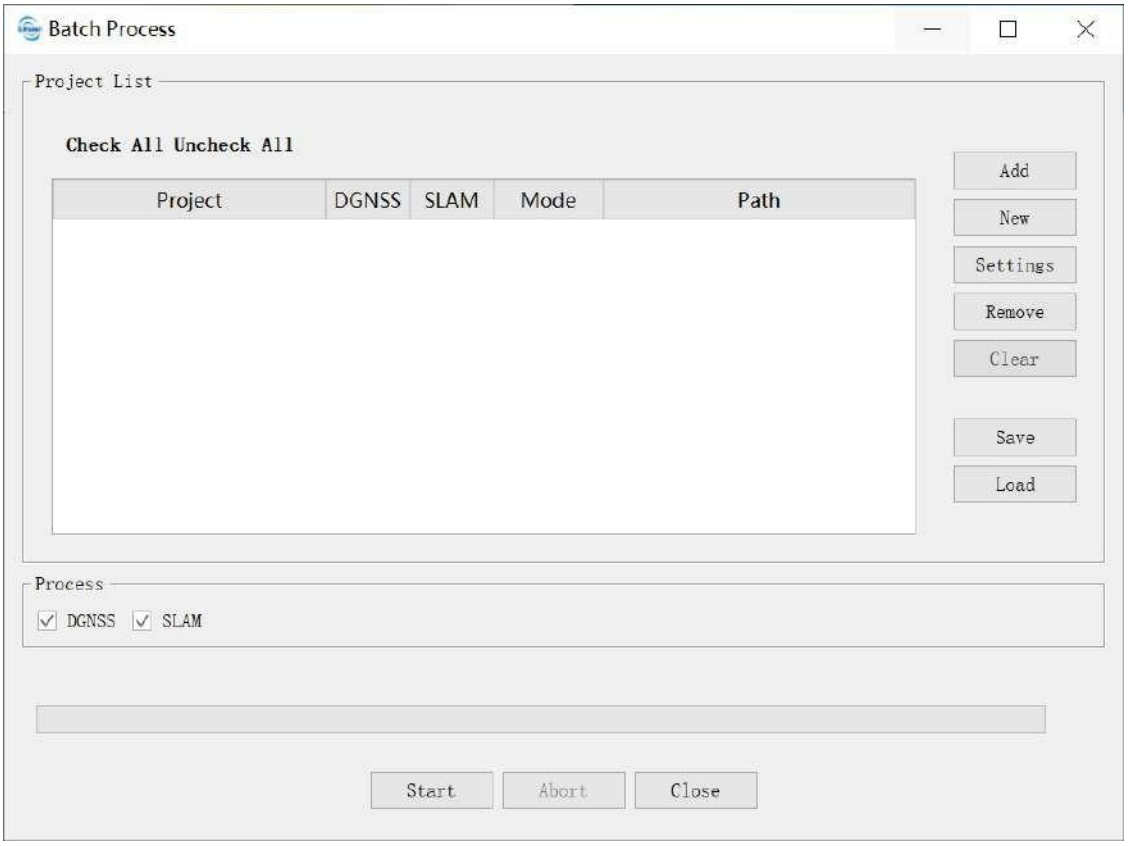




> Note: It is valid only after saving the classified files.

17. Batch Processing Tools

Launch the software, select *Batch* mode and click *Batch Process* button to display the interface below.



Batch processing interface

Add Project to Batch Processing List

There are two ways to add the project to batch processing list, one for adding existing project and the other for creating new projects.

- Add existing projects.

  Click *Add* button to import the project file.

- Create new projects.

  Click *New* button to create New Project, the created new project will be imported into batch processing list automatically.

Modify the Project Configuration in the List

There are two ways to modify the configuration:

- Double click on the list row which needs to be modified.
- After selecting the specified row and click *Setting* button. For more details please reference High Accuracy Process -Parameters Configuration

Modify the Project Processing Mode in the List

Modify by setting *Mode* and for more details please reference High Accuracy Process-Select Process Mode

Modify Process Procedure

Users can control processing workflow by deciding whether ticking conrespondnig buttons. For more details please reference High Accuracy Process-Select Process Procedure

Start Batch Processing

Click *Start* button to start batch processing.

Abort Batch Processing

Click *Abort* button to abort batch processing.

Close Batch Processing

Click *Close* button to close batch processing. Note: The batch processing cannot be closed while the batch is running thus it needs to be aborted first.

Save Batch Processing

Click *Save* button to save batch processing.

Load Batch Processing

Click *Load* button to load batch processing.

Remove Batch Processing

Click *Remove* button to remove batch processing.

Clear Batch Processing

Click *Clear* button to clear batch processing.

18. Viewing Tools

Set current active window to some views.

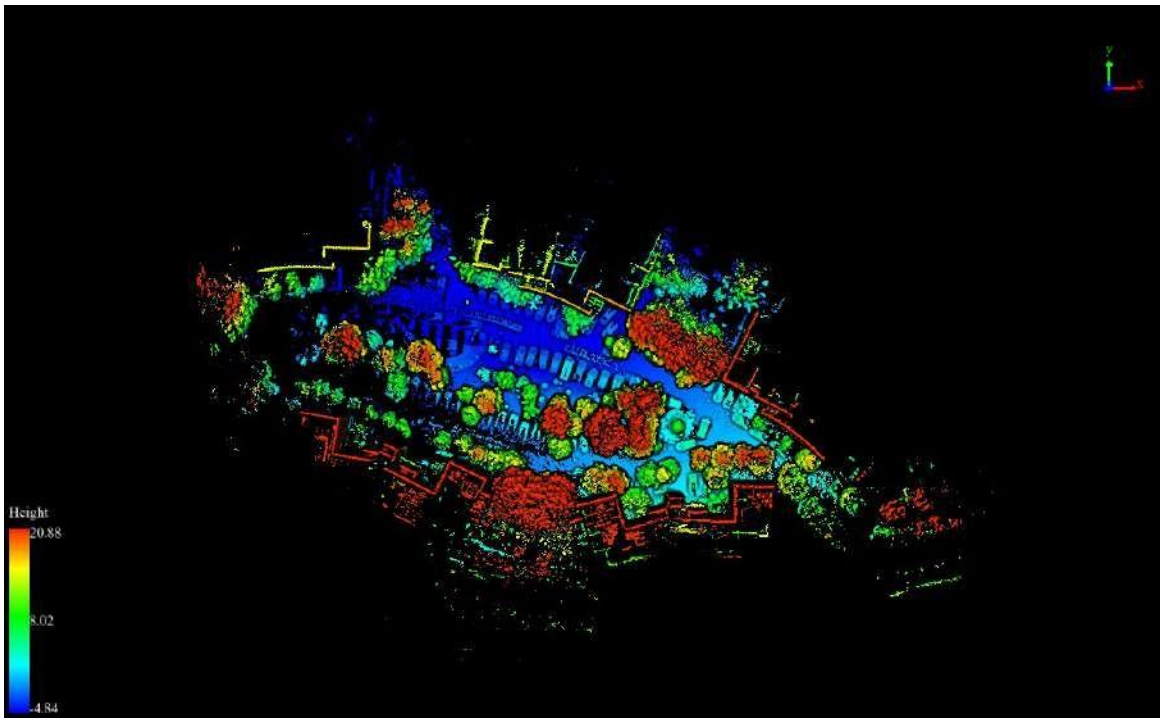
- Top View
- Bottom View
- Left View
- Right View
- Front View
- Back View
- Front Isometric View
- Back Isometric View
- Set View Mode
- Full Extent
- Configure Point Size and Type

18.1 Top View

Function Description: Set camera to top view. View data from +z to -z direction. View plane: x-y plan

Step

1. After clicking this button, current active window will be shown:



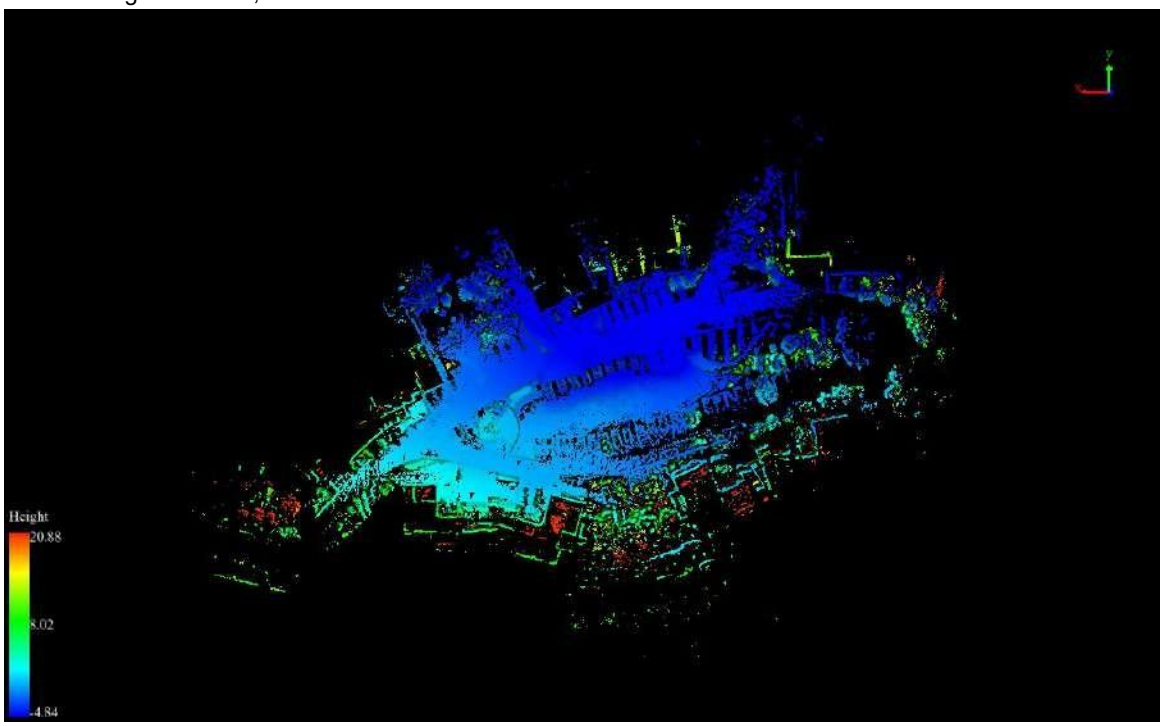
> Note: This tool is only for viewer in 3D mode, and it does not reset the center position of the viewer. If you need to reset to the default view, please click Full Extent。

18.2 Bottom View

Function Description：Set camera to bottom view. View data from -z to +z direction. View plane: x-y plane.

Step

1. After clicking this button, current active window will be shown:

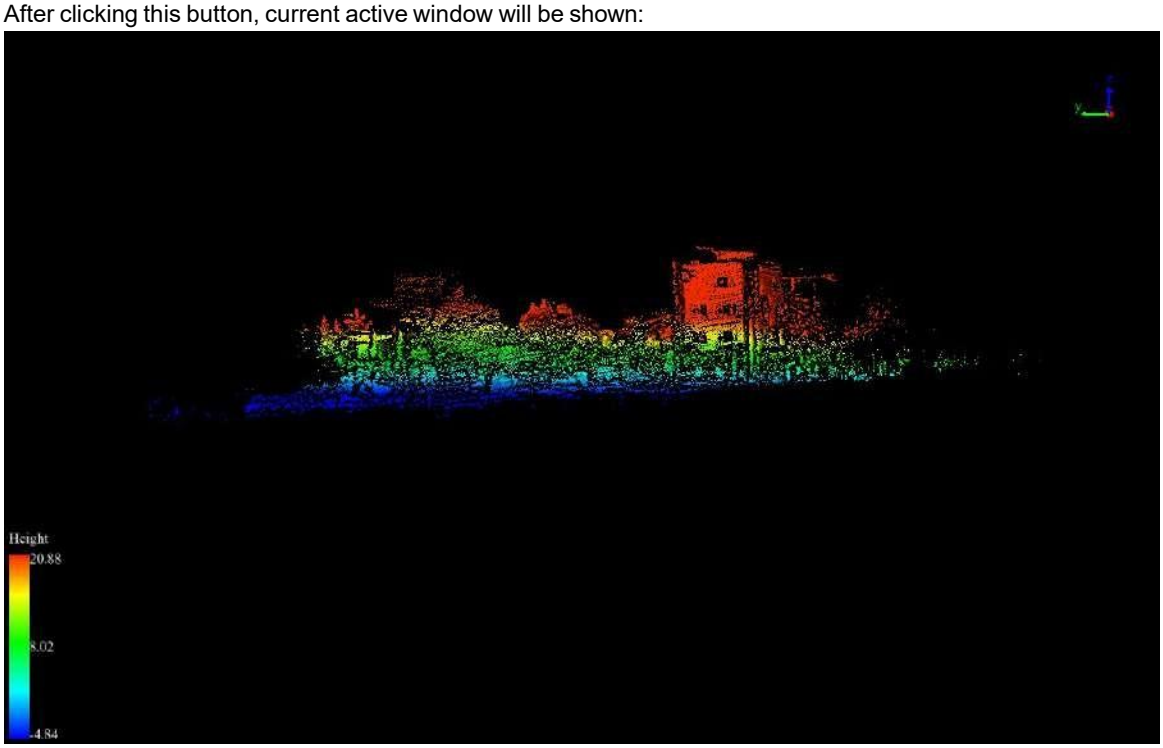


18.3 Left View

Function Description: Set camera to left view. View data from -x to +x direction. View plane: y-z plan

Step

1. After clicking this button, current active window will be shown:

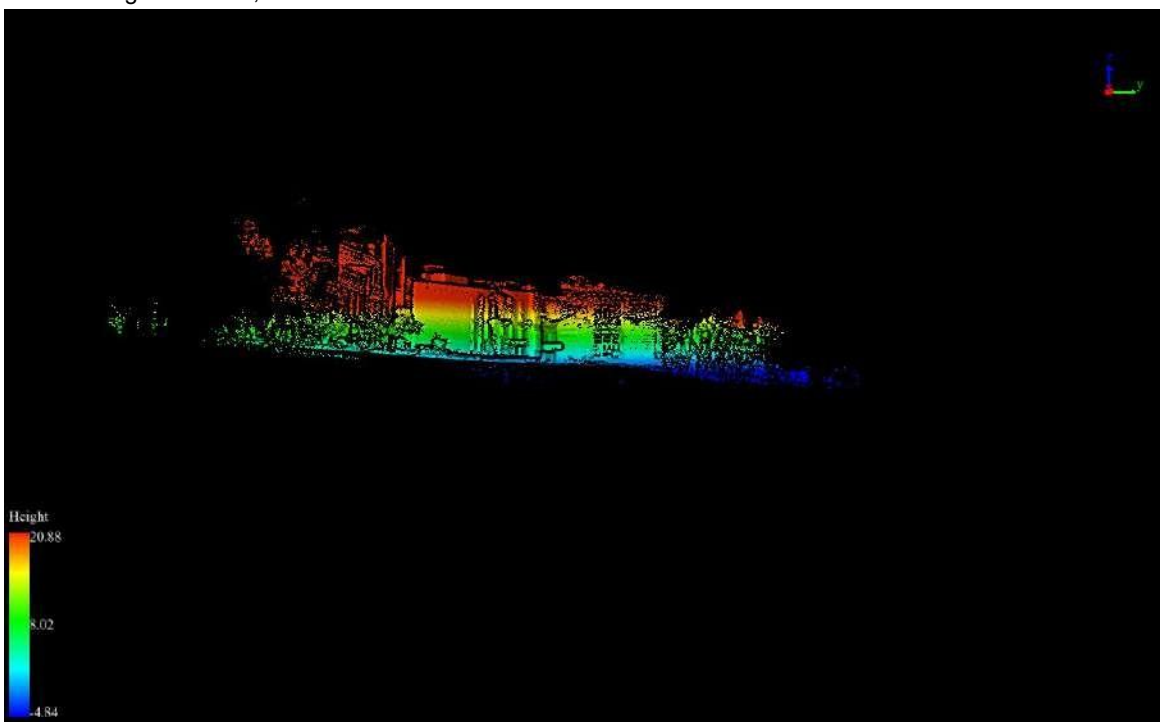


18.4 Right View

Function Description: Set camera to right view. View data from +x to -x direction. View plane: y-z plane.

Step

1. After clicking this button, current active window will be shown:

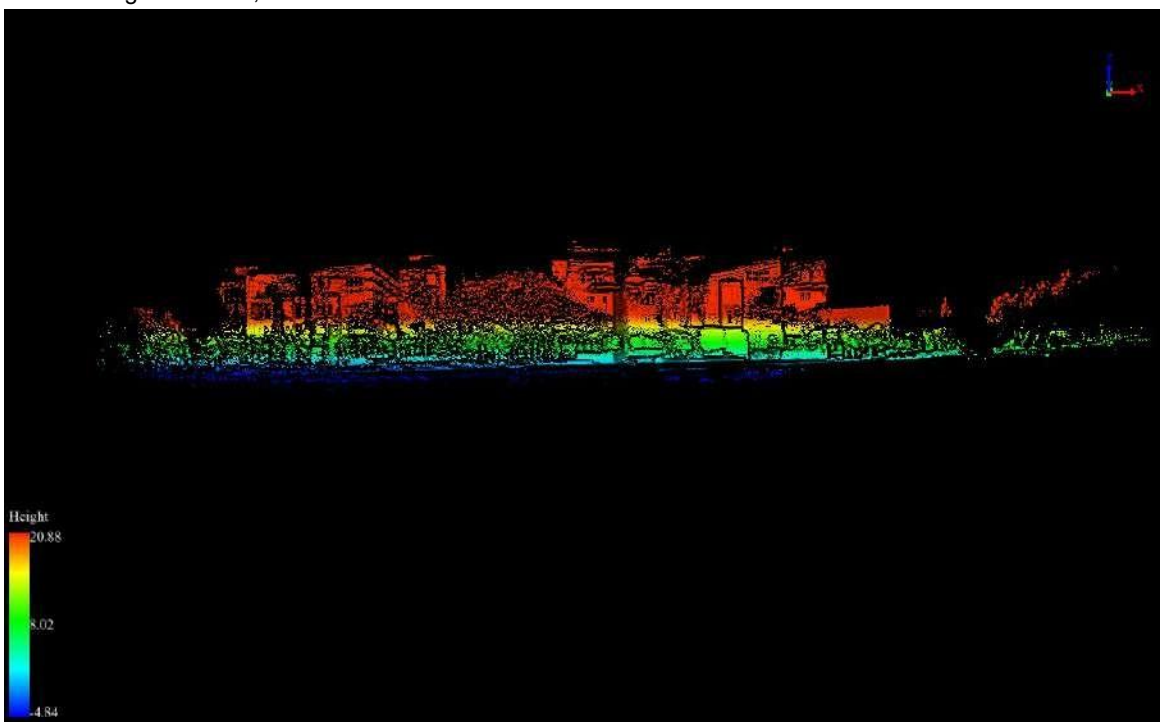


18.5 Front View

Function Description: Set camera to front view. View data from -y to +y direction. View plane: x-z plane.

Step

1. After clicking this button, current active window will be shown:

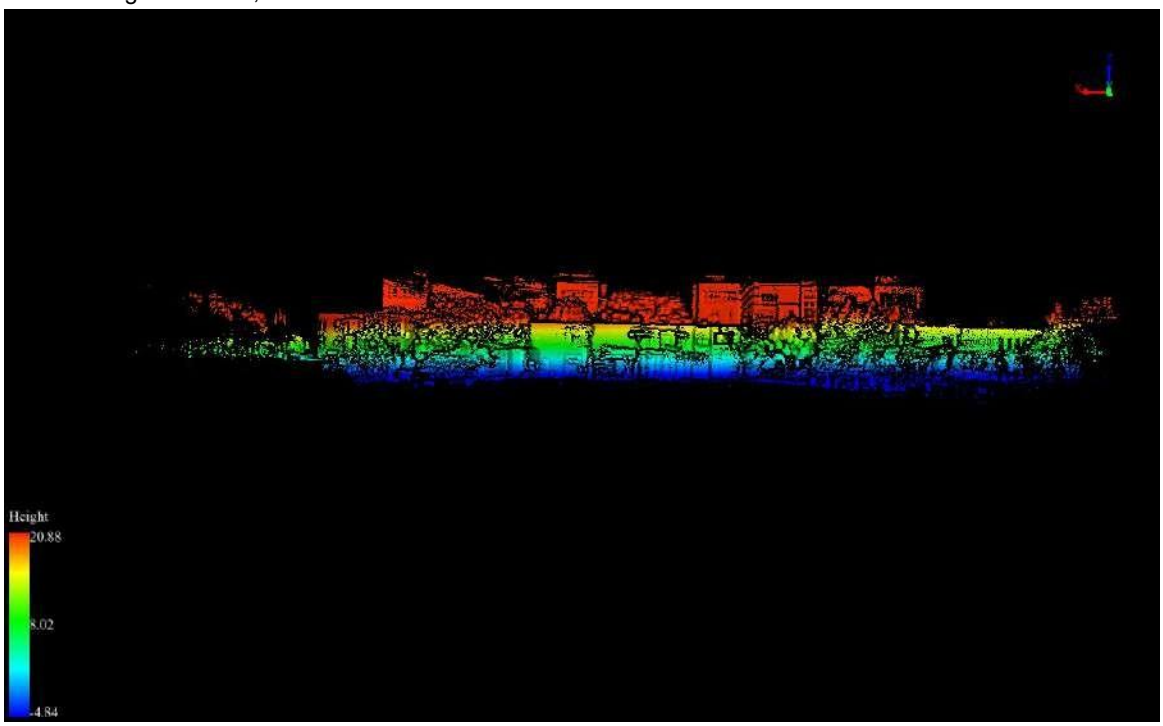


18.6 Back View

Function Description: Set camera to back view. View data from +y to -y direction. View plane is x-z plane.

Step

1. After clicking this button, current active window will be shown:

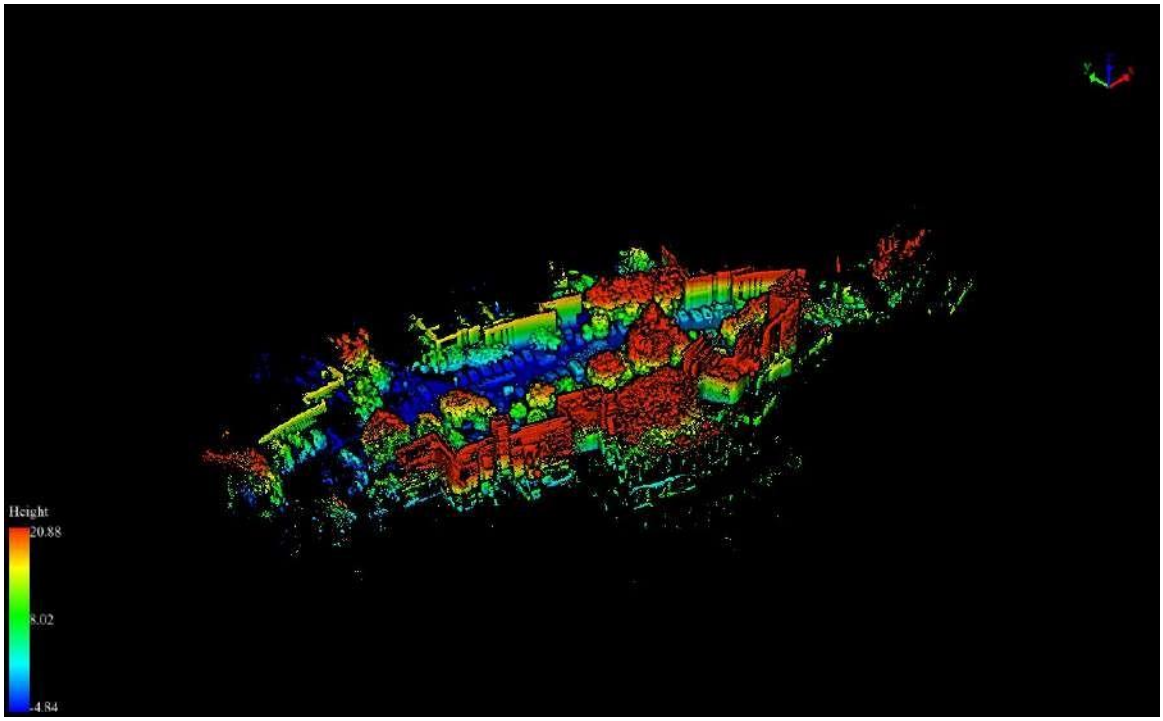


18.7 Front Isometric View

Function Description：Set camera position to front 45 degrees of X-Y plane.

Step

1. After clicking this button, current active window will be shown:

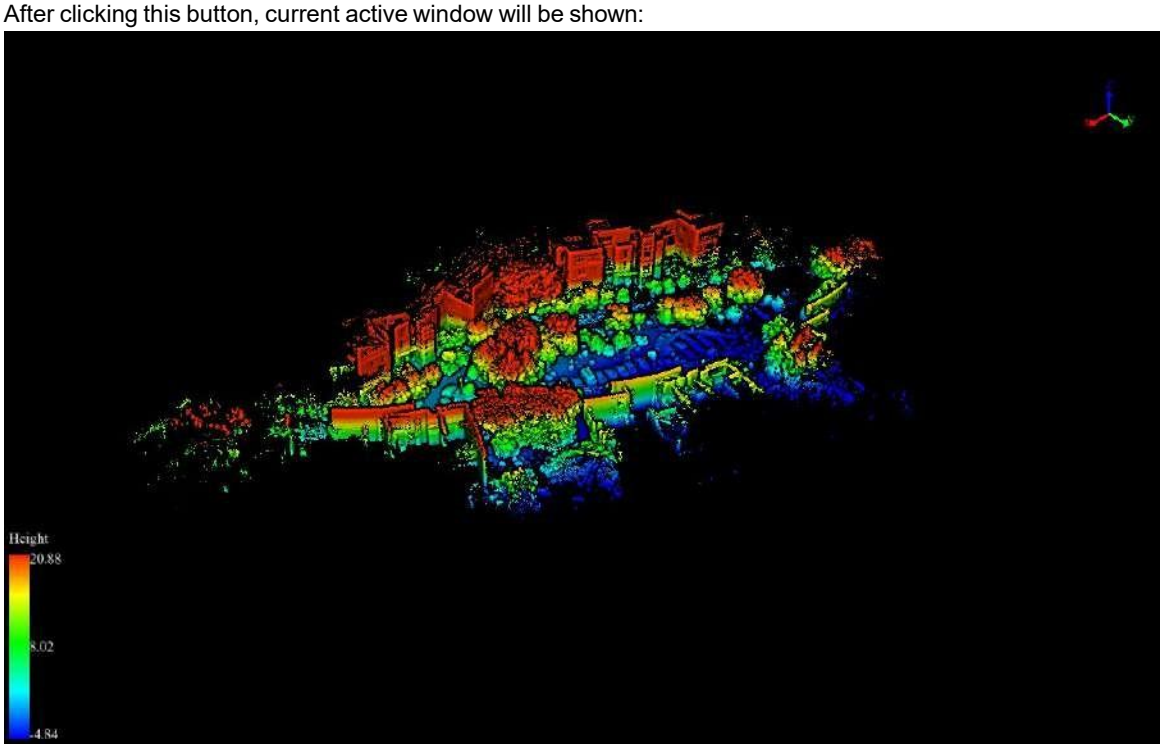


18.8 Back Isometric View

Function Description: Set camera position to back 45 degrees of X-Y plane.

Step

1. After clicking this button, current active window will be shown:

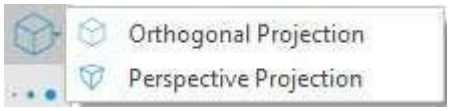


18.9 Set View Mode

Function Description: Select projection mode(orthographic/perspective).

Step

1. After clicking this button, the option of projection mode is popped up. If Orthogonal Projection is selected, current active window will be set in orthogonal projection. If Perspective Projection is selected, current active window will be set in perspective projection.



Parameters Setting

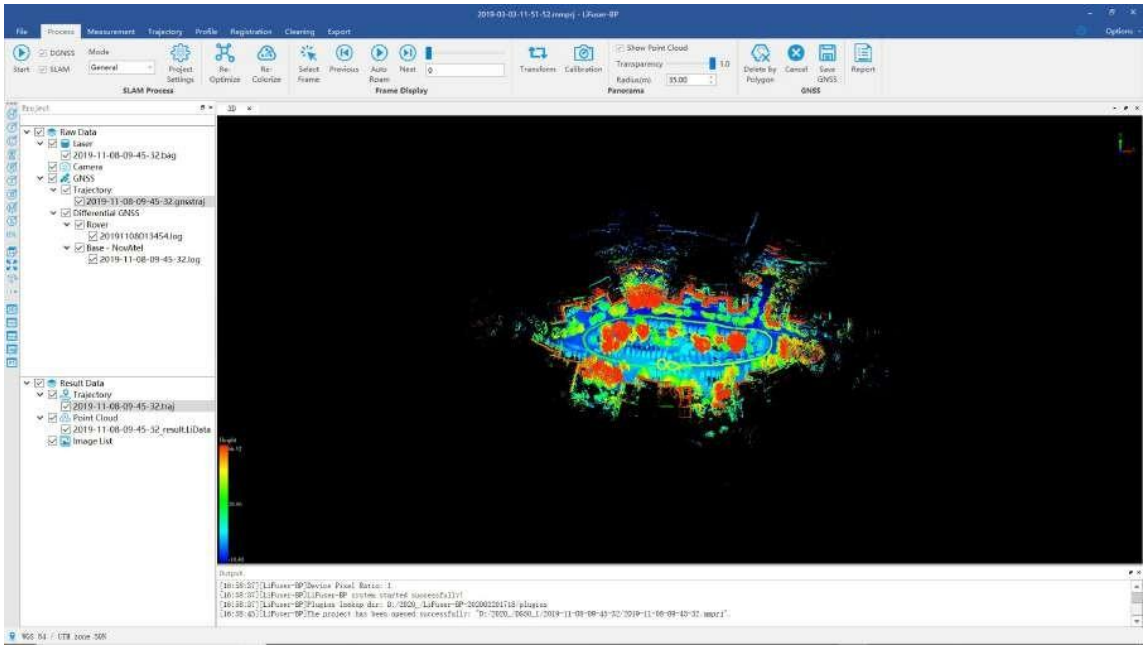
- **Shortcut Key**：F3

18.10 Full Extent

Function Description: The function of full extent is applicabale to 3D window in LiFuser-BP software t display all data in 3D window in the way of top view. Its aims to achieve global browing of data.

Step

1. Click  button in toolbar, the data in 3D windows will spread over the window automatically. The picture is shown below:

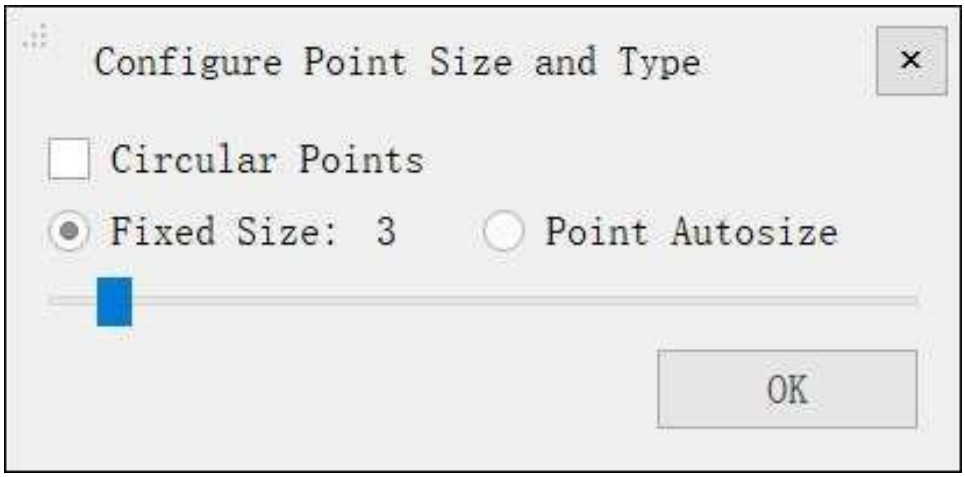


18.11 Configure Point Size and Type

Function Description: Configure point size and type.

Step

1. Click this button to open the dialog shown as below:



2. Configure point size and type.

Parameters Setting

- **Circular Points**: Determine point type. If checked, point will be rendered as circle, otherwise, point will be rendered as square.
- **Fixed Size**: If checked, point size would be fixed. User can adjust point size using the slider below (range 0-50 pixels).
- **Point Autosize**: If checked, point size is auto changing based on the depth of the viewer.

19. Color Tools

With tools in this section, LiFuser-BP allows you to visualize vast amounts of point cloud using the best data representations for your analysis. You can change the coloration of the point cloud displaying by classification (or intensity, GPS time, return of number etc.). You can also enhance the render effect using visualization tools such as EDL which is intuitive and helpful for quality check.

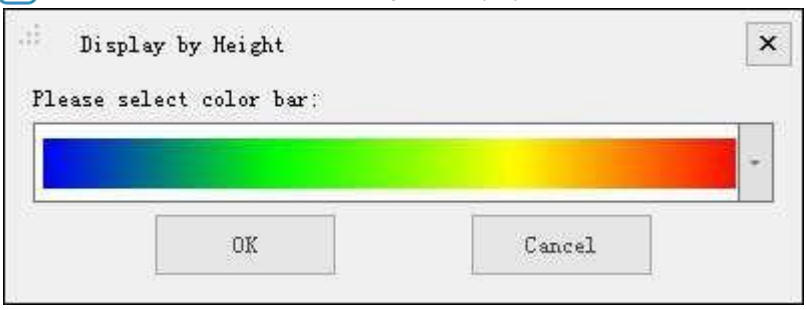
- Display by Height
- Display by Intensity
- Display by Classification
- Display by RGB
- Display by Return Number
- Display by GPS Time
- Display by Blend
- Display by Mix
- Display by Specific Color
- Display by User Data
- Display by Point Source ID
- Display by EDL

19.1 Display by Height

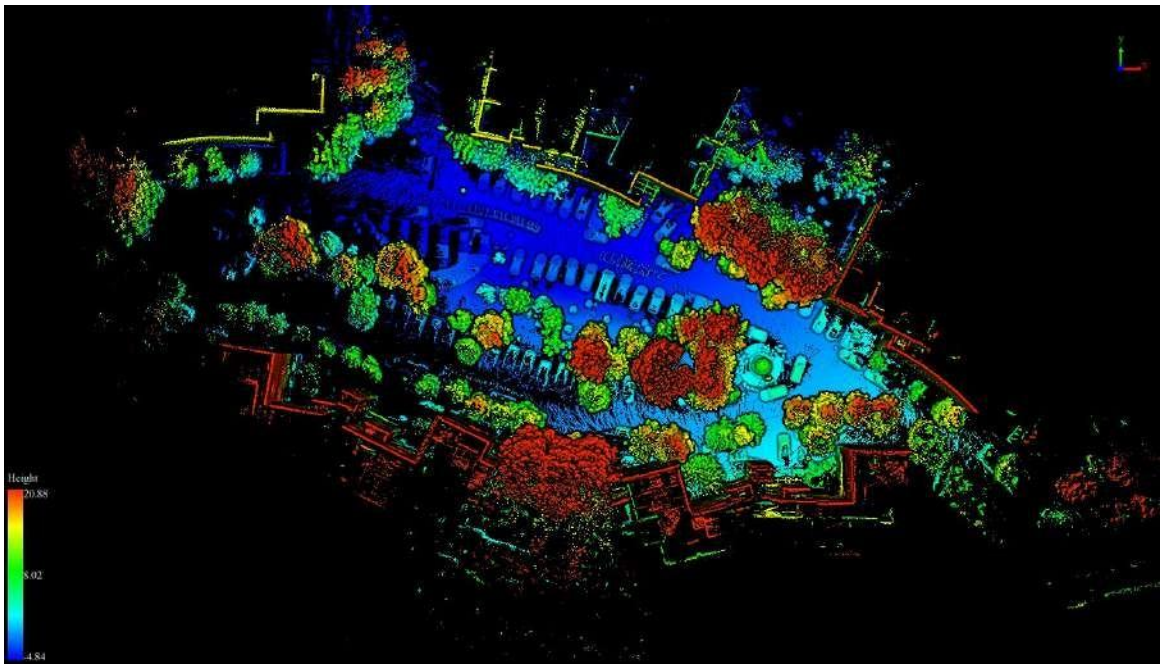
Function Description：this tool is used for displaying point cloud data. The elevation values of point cloud data are mapped to several uniformly varying color intervals, so as to display the variation of elevation values more intuitively.

Step

1. Click the button on the toolbar to pop up the dialog "Display by Elevation", as shown below.



2. Select the appropriate color bar in the combo box and click the "OK" button. The color indicator of the window will generate the corresponding color bar according to the elevation range of the point cloud data. At the same time, the data is displayed by elevation in the scene. The visual effects are better with EDL mode.



> Please note: this function only works for point cloud data.

19.2 Display by intensity

Function Description: this tool is used for displaying point cloud data. The intensity values of point cloud data are mapped to several uniformly varying color intervals, so as to display the variation of intensity values more intuitively.

Step

1. Click the button on the toolbar. The color indicator will generate the corresponding color bar by intensity range of the point cloud data. Users can select color of the color bar.Then the point cloud data is displayed accordingly by intensity in the scene.

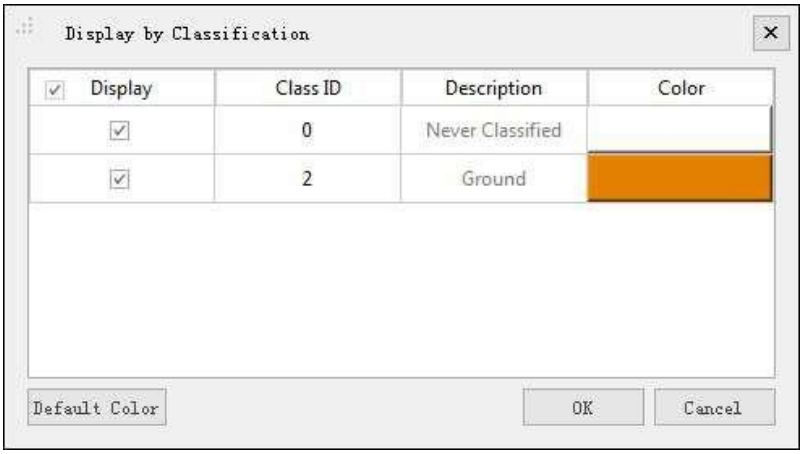
> Please note: this function only works for point cloud data.

19.3 Display by Classification

Function Description: this tool is used for displaying point cloud data. The classes of point cloud data are mapped to discrete color values, so as to distinguish different classes of point cloud data more intuitively.

Step

1. Click button on the toolbar, Display by Classification dialog will pop up.



2. Select the appropriate color for each class and click the "OK" button. The color indicator of the window will generate the corresponding color bar according to the class attribute of the point cloud data. At the same time, the data is displayed by classification in the scene. The visual effects are better with EDL mode, as shown below.

> Please note: this function only works for point cloud data.

19.4 Display by RGB

Function Description： this tool is used for displaying point cloud data. The point cloud data is displayed according to its own color value.

Step

1. Click the button on the toolbar, the data is displayed according to its own RGB values in the scene, as shown below.

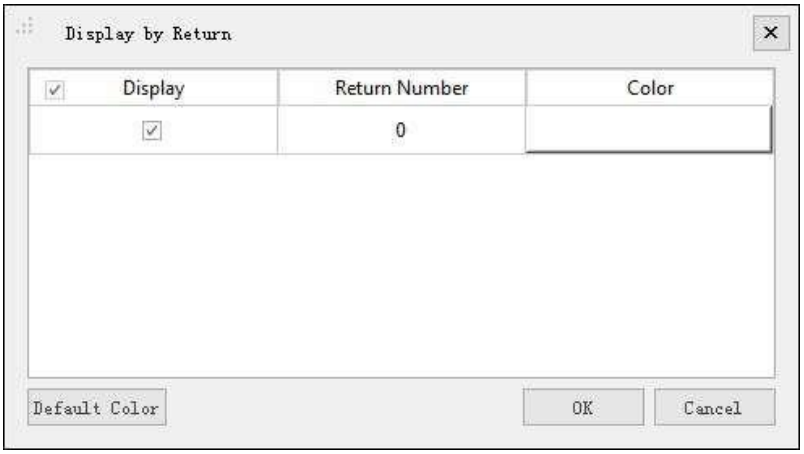
> Please note: this function only works for point cloud data.

19.5 Display by Return Number

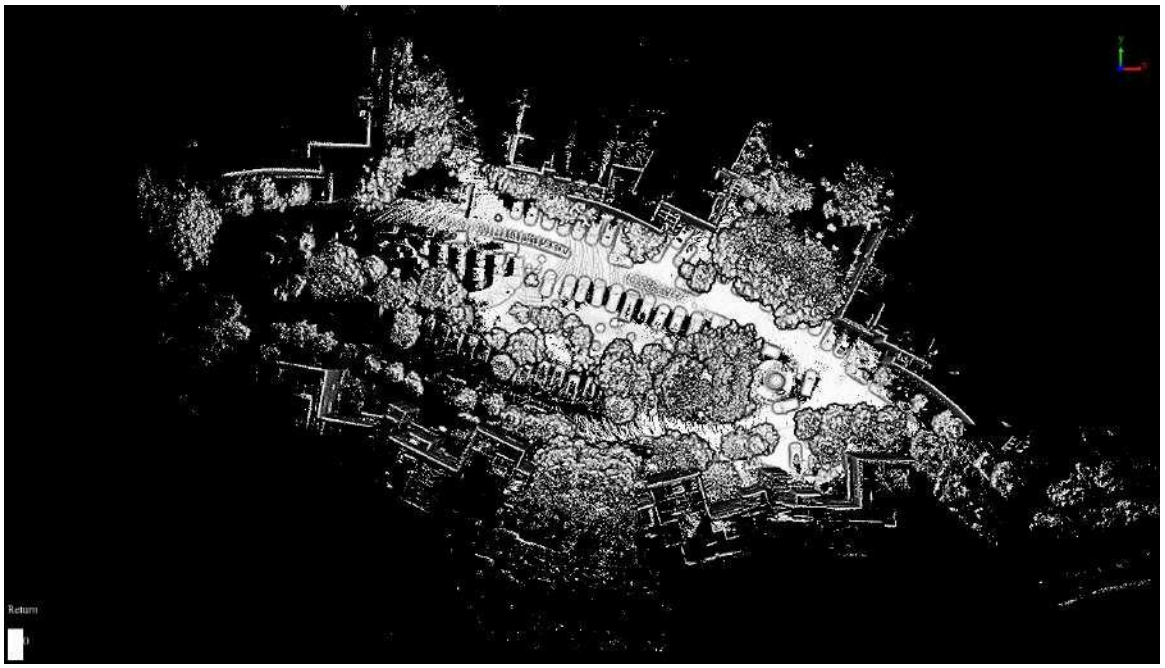
Function Description: this tool is used for displaying point cloud data. The return numbers of point cloud data are mapped to discrete color values, so as to distinguish different return numbers of point cloud data more intuitively.

Step

1. Click the button on the toolbar to pop up the dialog "Display by Return Number", as shown below.



2. Select the appropriate color bar for each return number and click the "OK" button. The color indicator of the window will generate the corresponding color bar according to the return number attribute of the point cloud data. At the same time, the data is displayed by return number in the scene. The visual effects are better with EDL mode, as shown below.



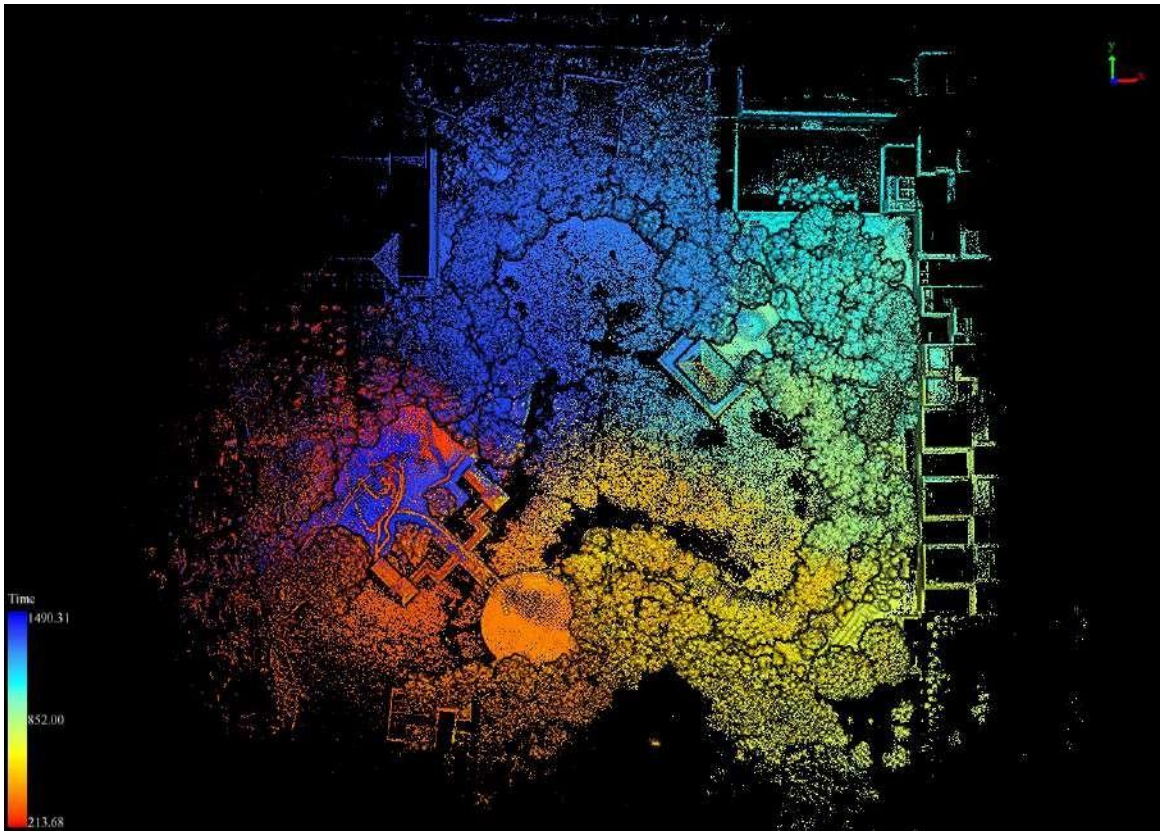
> Please note: this function only works for point cloud data.

19.6 Display by GPS Time

Function Description: this tool is used for displaying point cloud data. The GPS time values of point cloud data are mapped to several uniformly varying color intervals, so as to display the variation of GP time values more intuitively.

Step

1. Click the button on the toolbar,
2. Select the appropriate color bar in the combo box and click the "OK" button. The color indicator of the window will generate the corresponding color bar according to the GPS time range of the point cloud data. At the same time, the data is displayed by time in the scene.



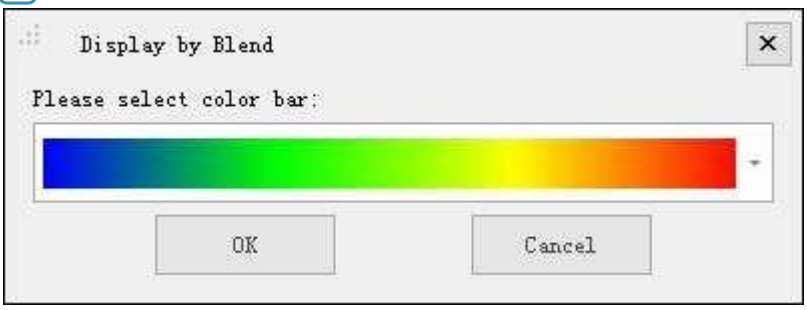
> Please note: this function only works for point cloud data.

19.7 Display by Blend

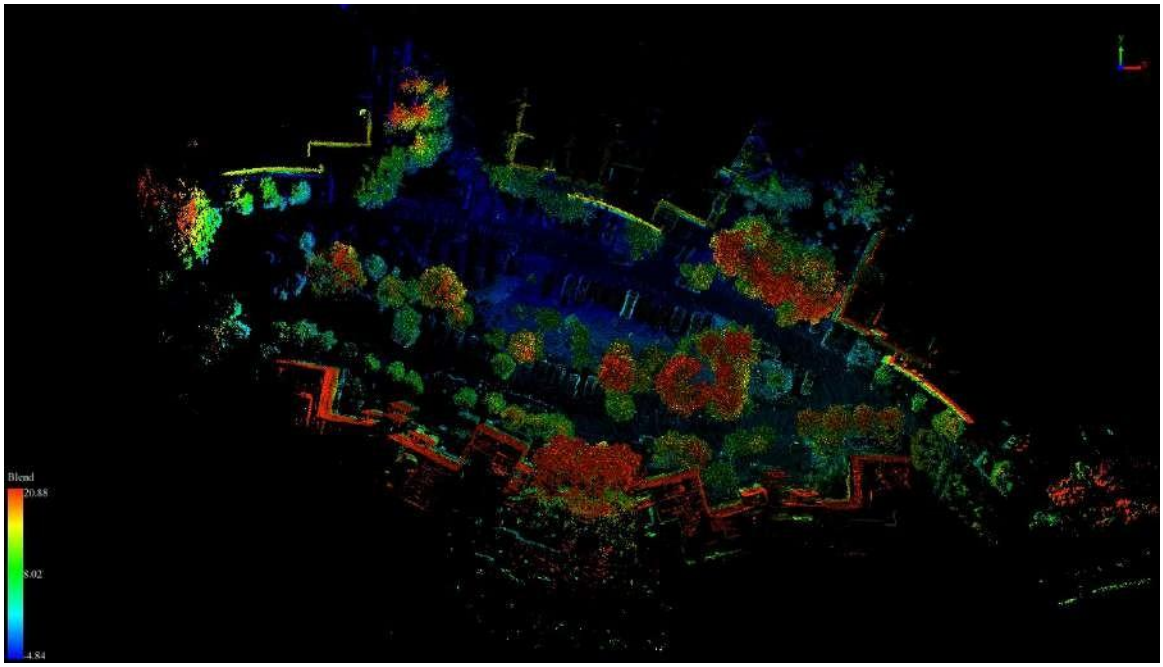
Function Description: it can be used for the display of point cloud data. Through displaying by blend, is more visual to demonstrate changes according to both point cloud elevation and intensity informatio and it is more clear to show the surface features and object boundaries as well.

Step

1. Click the button on the toolbar. Display by blend window will pop up:



2. Select the appropriate color bar in the drop-down box, click the OK button. The color indicator in the lower left corner of the window automatically maps the point cloud data elevation value to the selected color bar, and the display of point cloud data is mixed by elevation and intensity information. At the same time, the data is displayed by blend in the scene. The visual effects are better with EDL mode, as shown below.



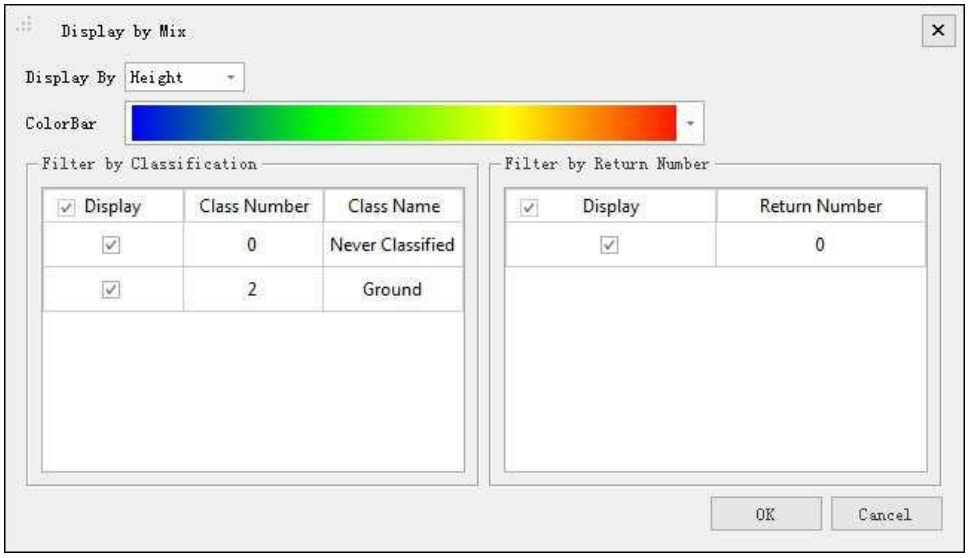
> Please note: this function only works for point cloud data, and it's better to have a PCV processing of point cloud data before displaying by blend.

19.8 Display by Mix

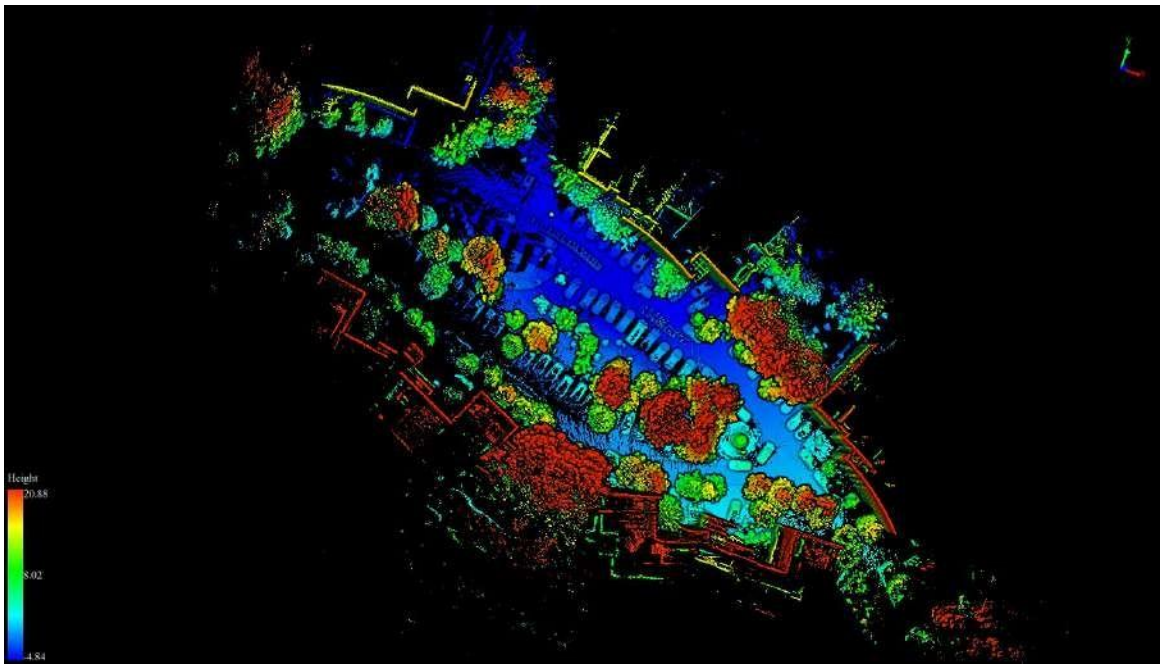
Function Description: this tool is used for displaying point cloud data. Different attributes of point clou data are mapped to several uniformly varying color intervals, at the same time different ways of attribut filtering are supported, so as to display the variation of a certain attribute of the filtered point cloud data more intuitively.

Step

1. Click the button on the toolbar to pop up the dialog "Display by Mix", as shown below.



2. Select the attribute to display.
3. Select the appropriate color bar in the combo box.
4. Check the classes and return numbers for filtering.
5. Click the "OK" button after that the color indicator of the window will generate the corresponding color bar according to the selected attribute range of the point cloud data. The data will be filtered by the specified attributes first and then be displayed by the specified attributes in the scene. The visual effects are better with EDL mode, as shown below.



Setting Parameters

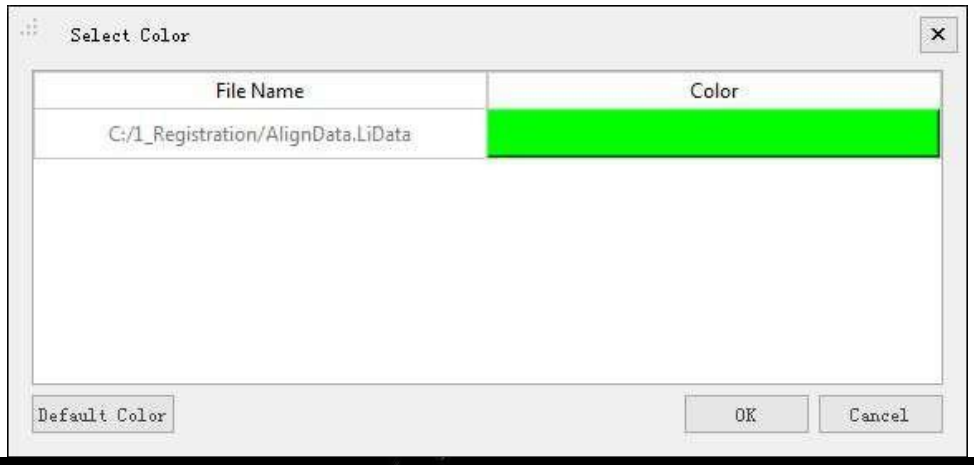
- **Display By**： The selected attribute will be mapped to specified color range.
  - **Height (Default)**：The elevation attribute of the point cloud data.
  - **Intensity**：The intensity attribute of the point cloud data.
  - **GPS Time**：The GPS Time attribute of the point cloud data.
- **ColorBar**：The color bar supports several uniformly varying color intervals for color mapping.
- **Filter by Classification**：List all the classes, users can choose them to filter the point cloud data.
- **Filter by Return Number**：List all the return numbers, users can choose them to filter the point cloud data.

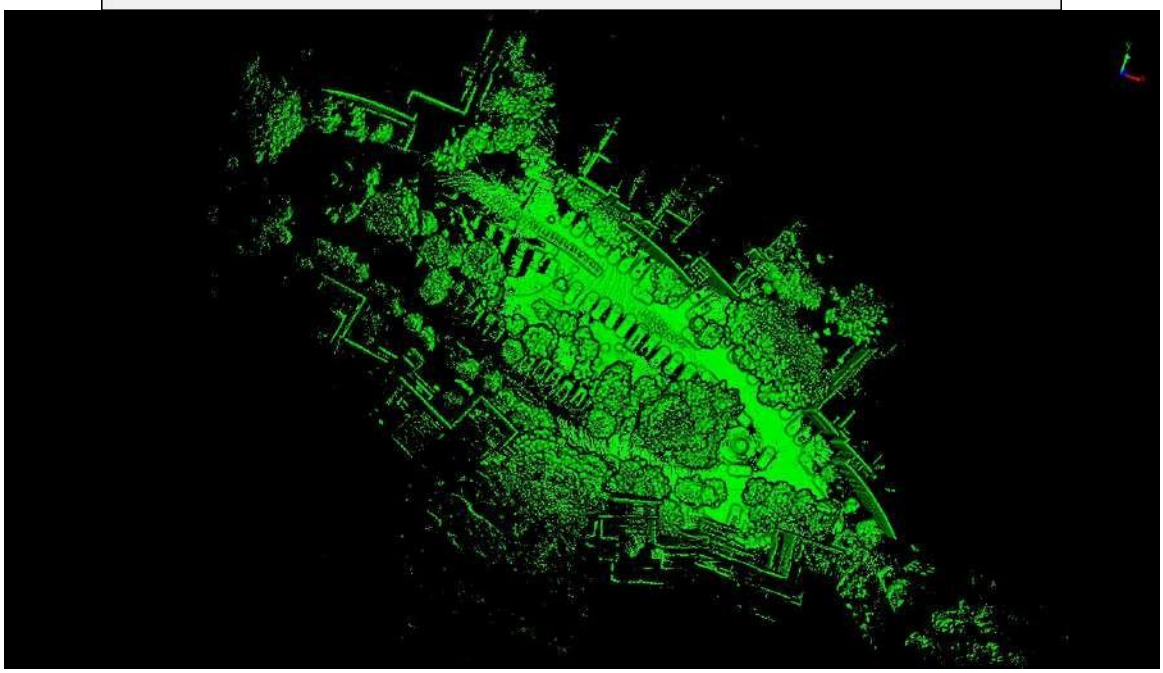
> Please note: this function only works for point cloud data.

19.9 Display by Specific Color

Function Description：This tool is used for displaying point cloud data. The point cloud data is displayed according to specified color.

1. Click the button on the toolbar, users can customize the color for point cloud display.



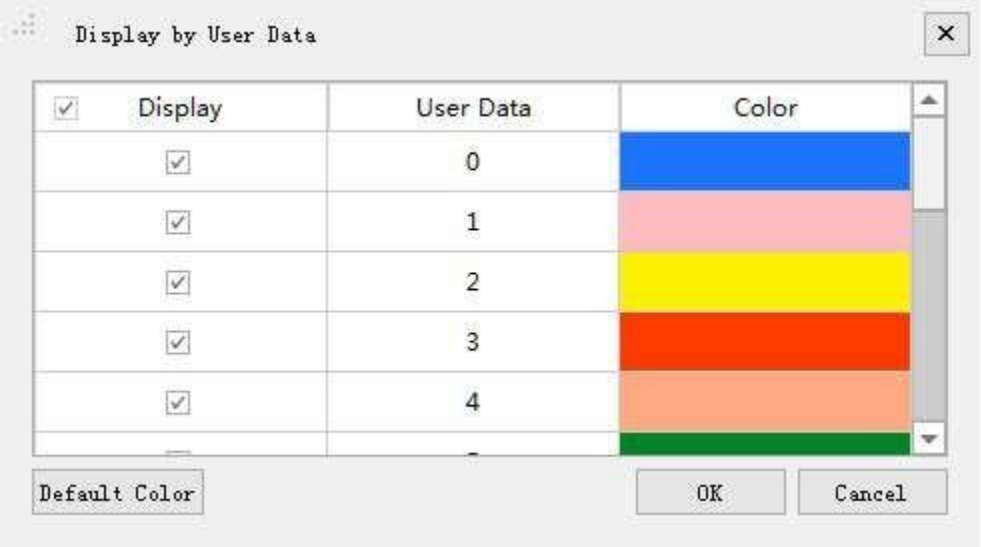


19.10 Display by User Data

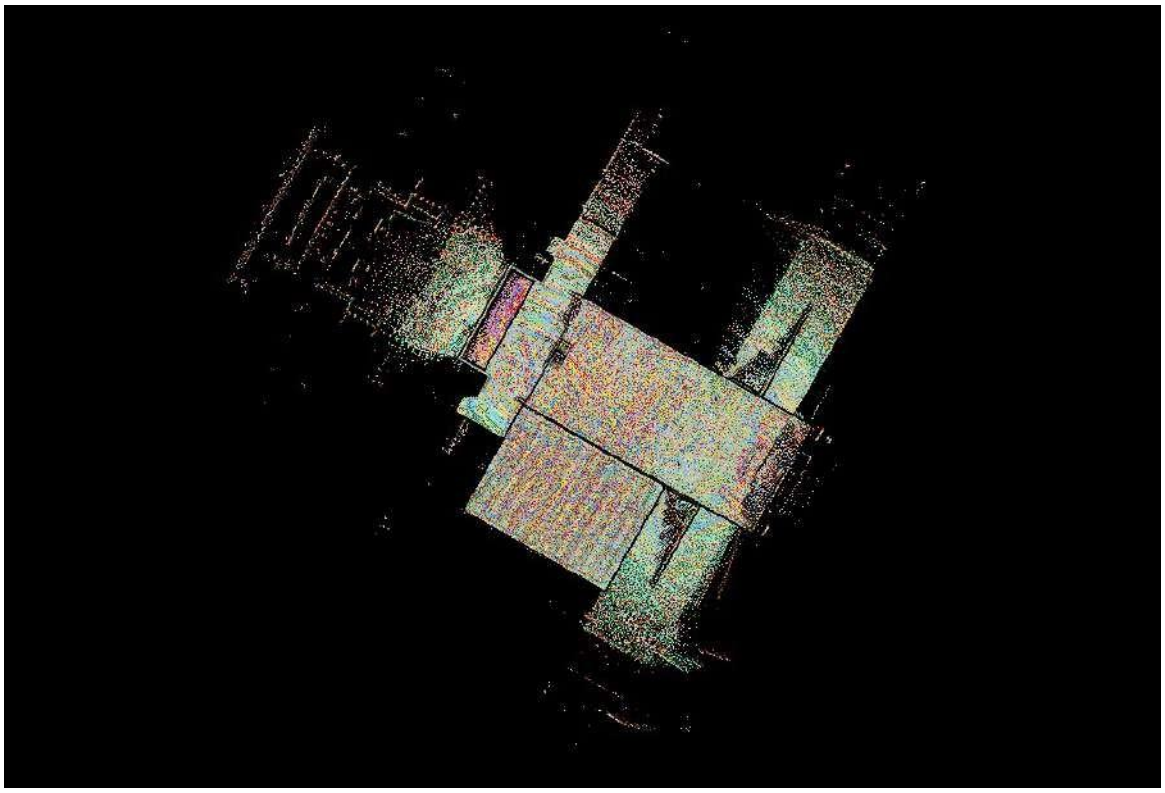
Description：Display point cloud data in different color according to user data, to distinguishes differe user data more directly.

Steps

1. Click in the tool bar, a dialog box called "Display by User data" will pop up.



2. Select color for different user data, and click OK. The color indicator in the lower left corner of the window automatically renders different user data to the corresponding colors. At the same time, the point cloud data in the viewer is displayed according to the user data. The display effect is better with EDL, as shown in the figure.



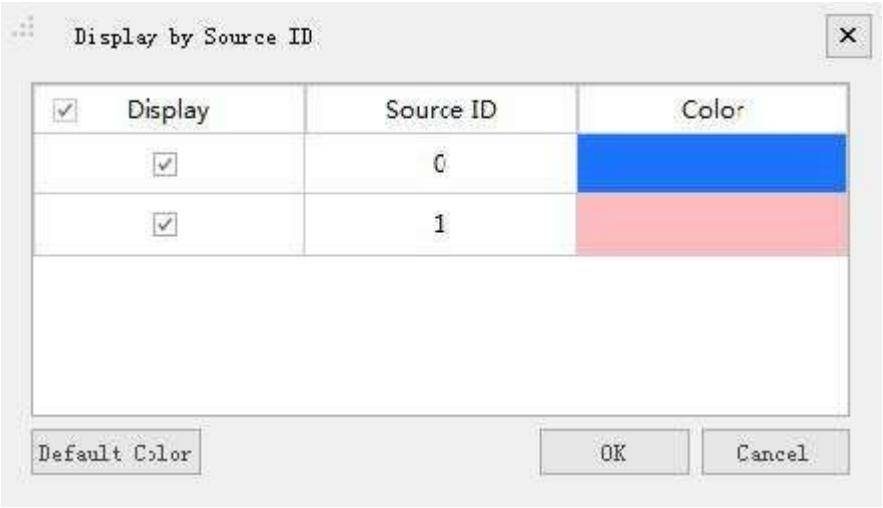
> Note: This display tool only works for point cloud data.

19.11 Display by Point Source ID

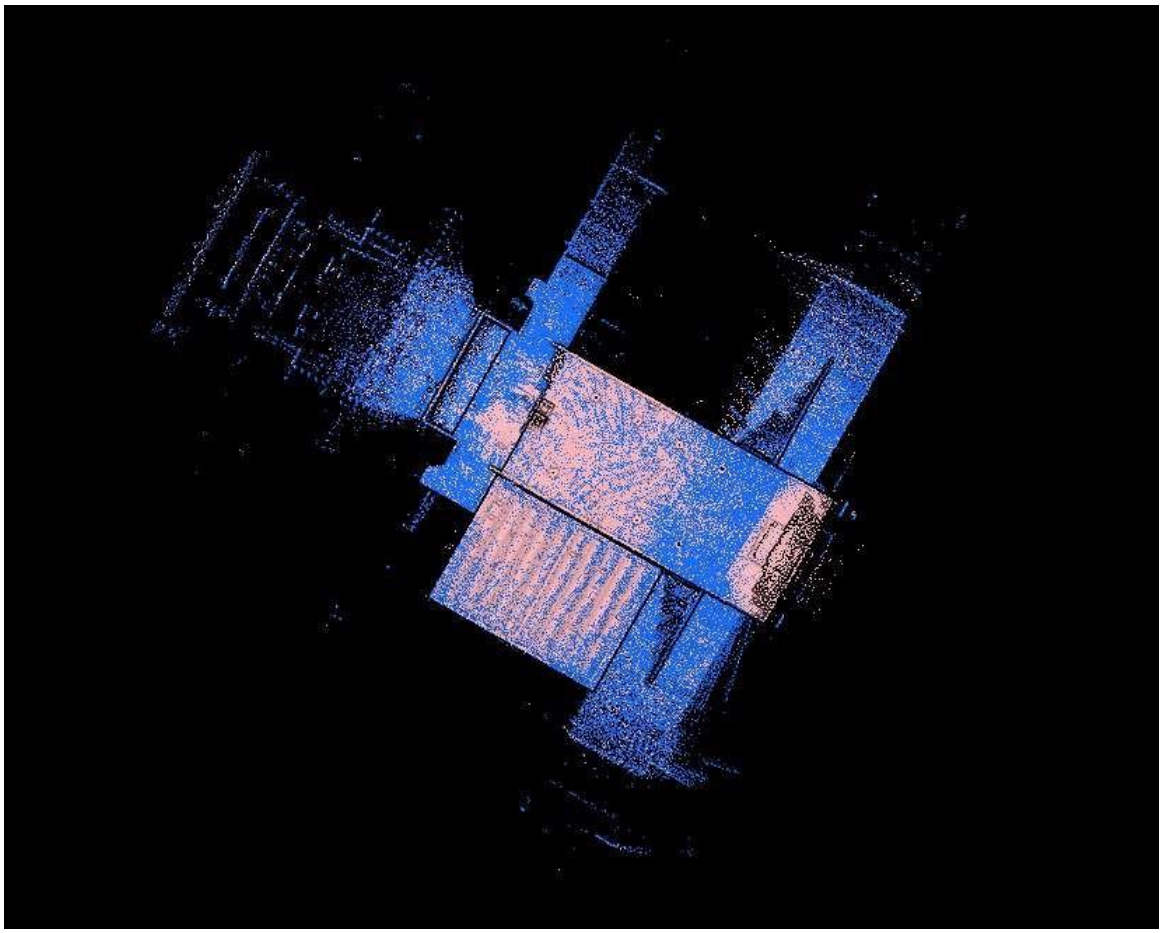
Description：Display point cloud data in different color according to point source ID, to distinguishes point cloud data of different point source ID more directly.

Steps

1. Click in the tool bar, a dialog box called "Display by Point Source ID" will pop up.



2. Select color for different point source ID, and click OK. The color indicator in the lower left corner of the window automatically renders point cloud data to the corresponding colors. At the same time, the point cloud data in the viewer is displayed according to the point source ID. The display effect is better with EDL, as shown in the figure.



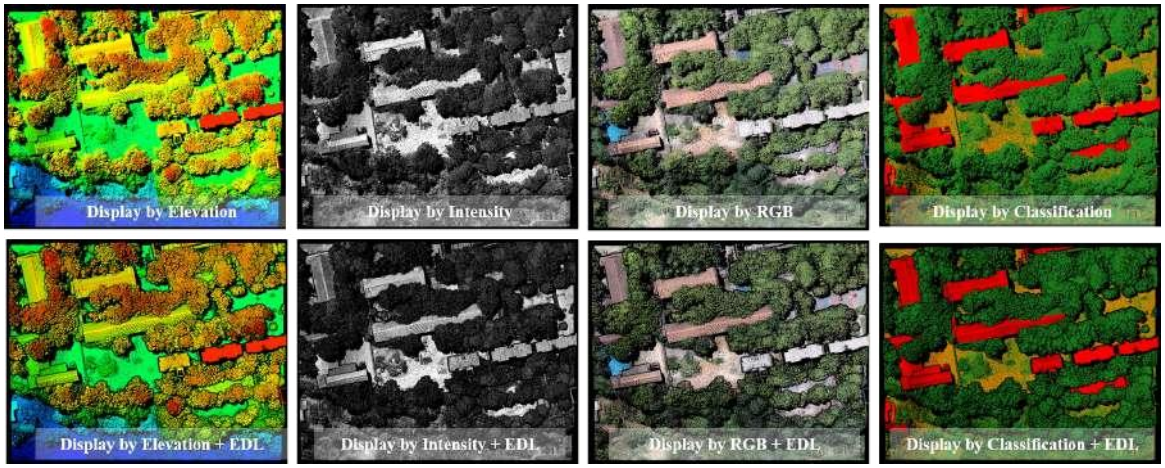
> Note: This display tool only works for point cloud data.

19.12 Display by EDL

Function Description： this tool is used to display the point cloud data and enhance the visual effect of the contour features by using the Eye Dome Lighting (EDL) mode. EDL is a shading technique that works with other display mode (e.g. display by height, display by intensity) to improve the depth perception in 3D point cloud visualization.

Step

1. Click the button on the toolbar, the visual effects of the point cloud data in the scene will be improved with EDL mode. The following picture shows the comparison before and after using EDL display mode.



> Please note: this function only works for point cloud data.

20. Select Tools

The main functions are listed as follows:

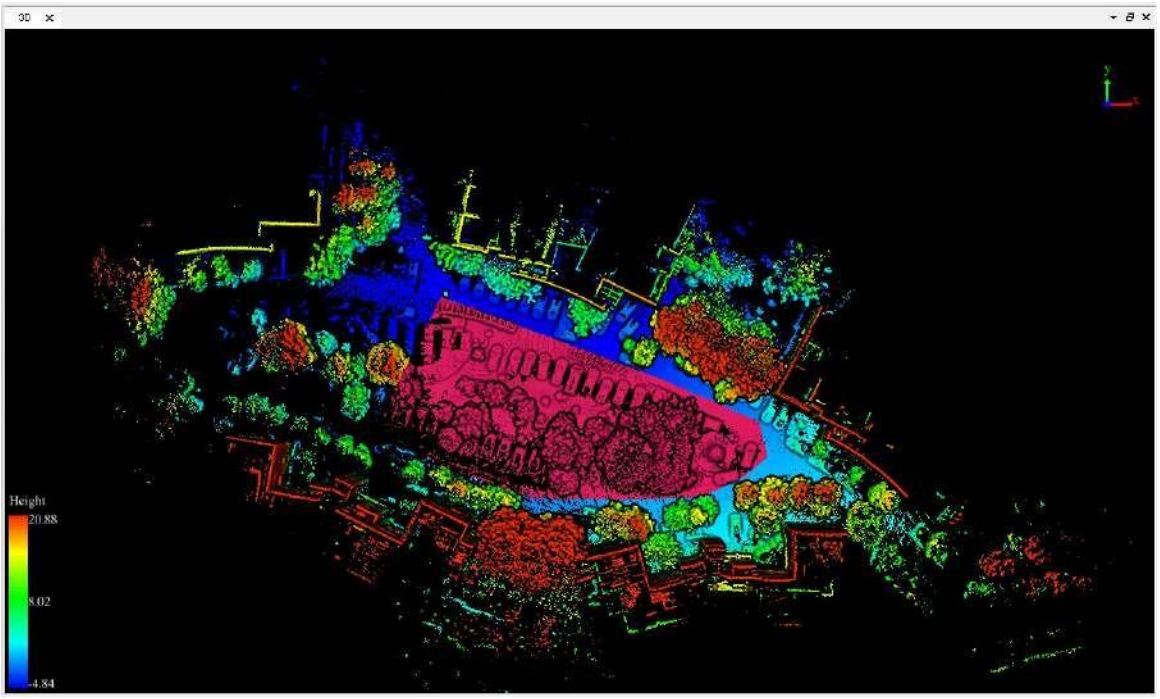
- Polygon Selection
- Rectangle Selection
- Sphere Selection
- Circle Selection
- Line above Selection
- Line below Selection
- Plane Selection
- Subtract Selection
- Cancel Selection

20.1 Polygon Selection

Function Description: Select point cloud data in polygon area.

Step

1. Click the button  to activate this function.
2. Add polygonal vertices by left click. At least 3 vertices are needed to form a closed loop.
3. (Optional) Delete added vertices in reverse order by right click, if some of them are unwanted.
4. Left double click to add the last vertex. The selected points in the polygon area are highlighted.



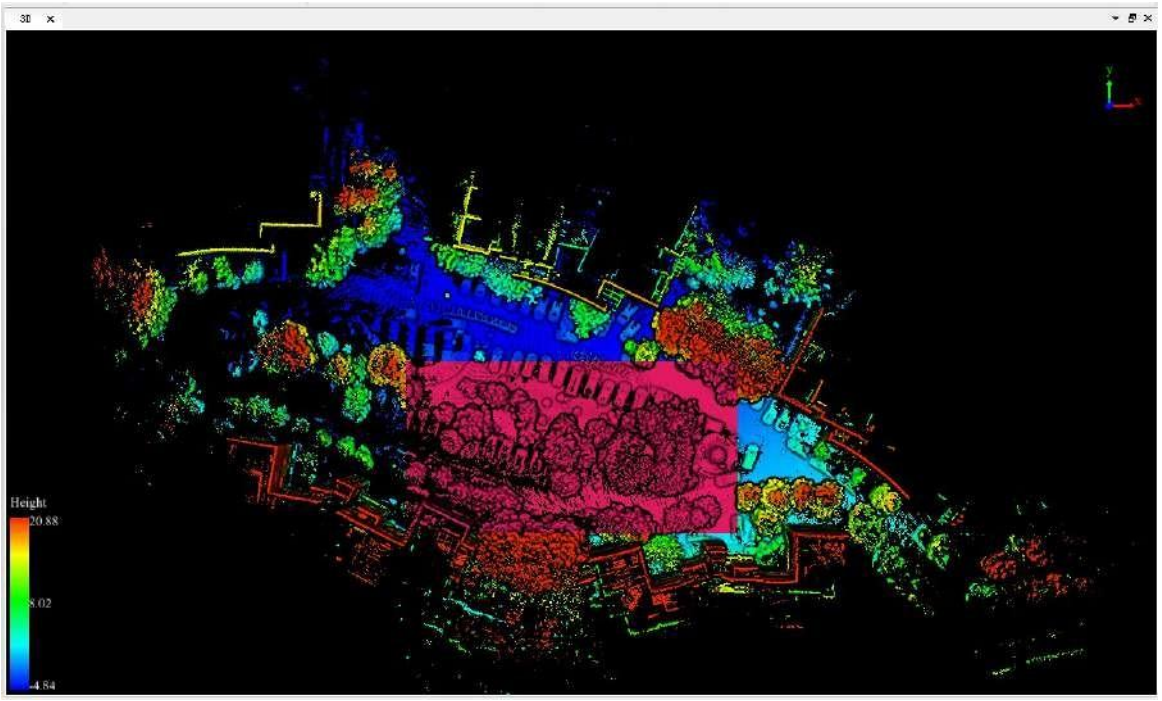
5. (Optional) Combine multiple selections.

20.2 Rectangle Selection

Function Description: Select point cloud data in rectangle area.

Step

1. Click the button to activate this function.
2. Add the first vertex by left click. Then move cursor to adjust rectangle size.
3. (Optional) Delete the first vertex by right click, if it's unwanted.
4. Left double click to add the second diagonal vertex. The selected points in the rectangle area are highlighted.



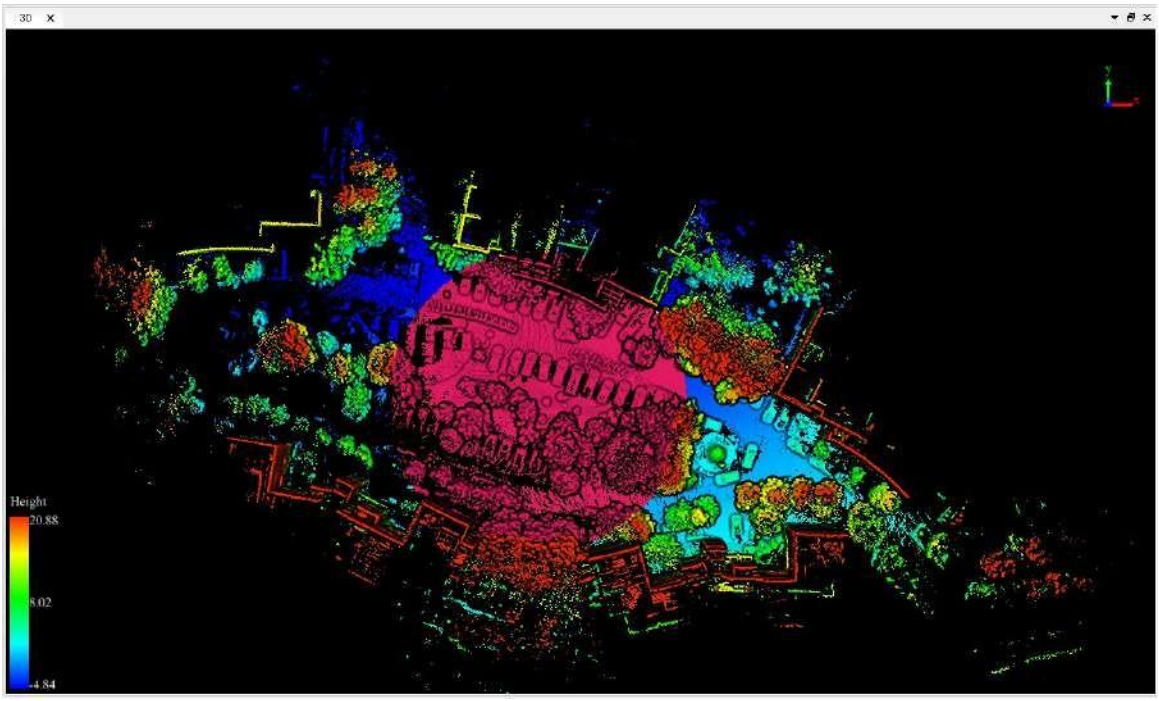
5. (Optional) Combine multiple selections.

20.3 Sphere Selection

Function Description: select point cloud data in sphere.

Step

1. Click the button to activate this function.
2. Add the center point of sphere by left click. Then move cursor to adjust radius.
3. (Optional) Delete the center point by right click, if it's unwanted.
4. Left double click to confirm the radius. The selected points in the sphere are highlighted.



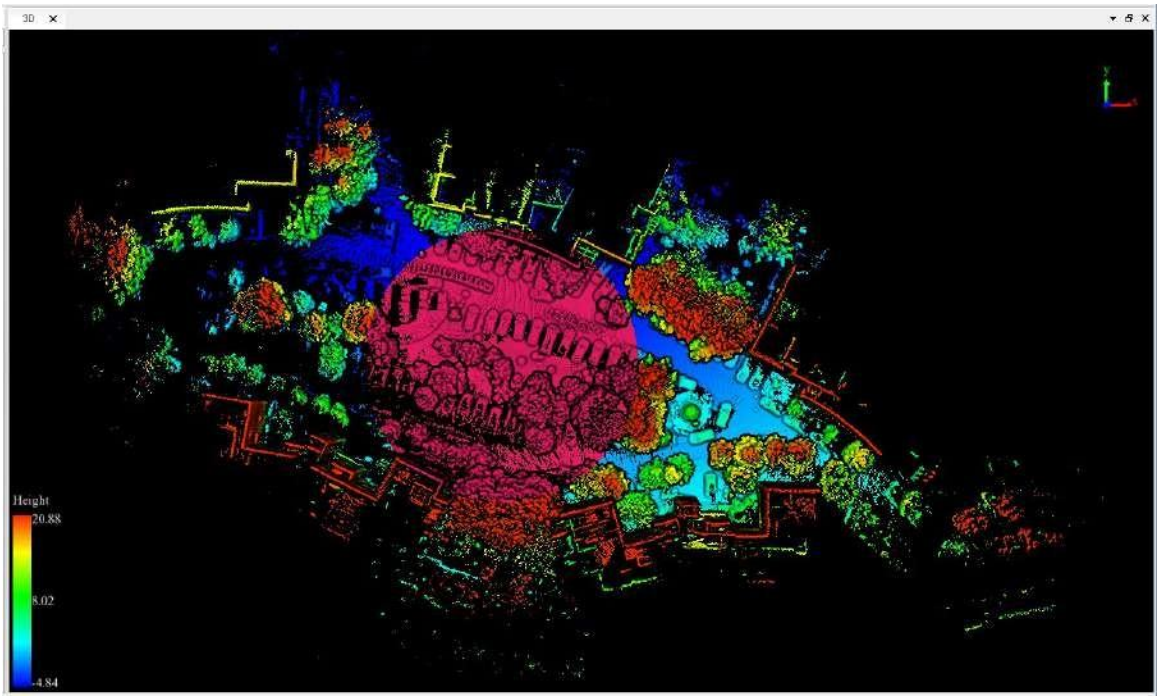
5. (Optional) Combine multiple selections.

20.4 Circle Selection

Function Descriptionf: Select point cloud data in circle area.

Step

1. Click the button to activate this function.
2. Click to select the center of the circle. Move the mouse, and the position of mouse will be recognized as the boundary of the circle.
3. Right-click to cancel the circle center selection. Go back to the second step and choose the circle center again.
4. Double-click to define the boundary of the circle. The selected points in the circle area are highlighted.



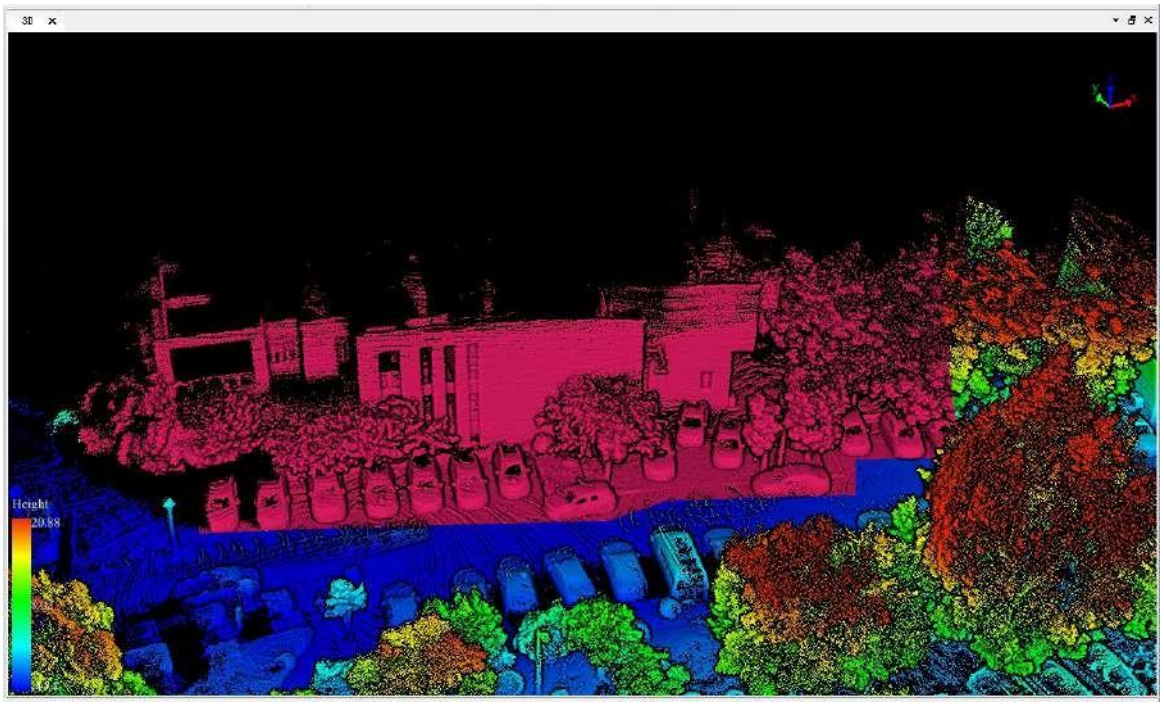
5. (Optional) Combine multiple selections.

20.5 Line above Selection

Function Description: Select point cloud data above line.

Step

1. Click the button to activate this function.
2. Add the first vertex by left click. Move the mouse, the mouse position is determined to be the boundary point of the area above the line.
3. Right-click to cancel the first vertex selection. Go back to the second step and choose the vertex again.
4. Left double click to finish selection. The selected area above the polylines are highlighted.



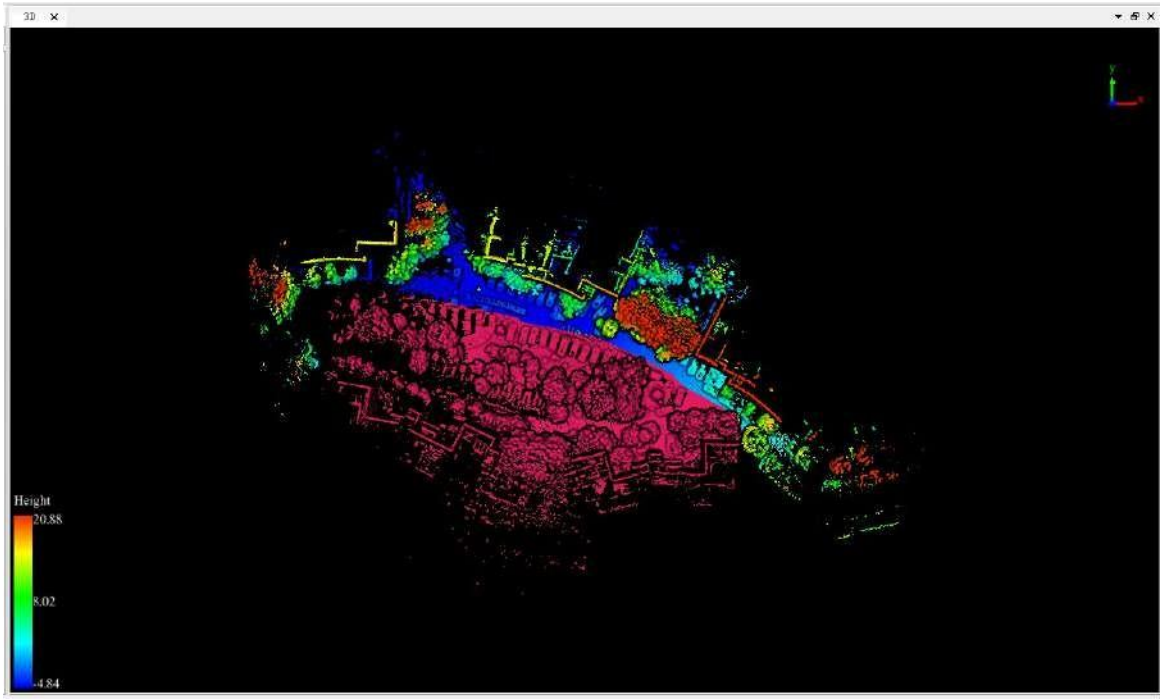
5. (Optional) Combine multiple selections.

20.6 Line below Selection

Function Description: Select point cloud data below line.

Step

1. Click the button to activate this function.
2. Add the first vertex by left click. Move the mouse, the mouse position is determined to be the boundary point of the area below the line.
3. Right-click to cancel the first vertex selection. Go back to the second step and choose the vertex again.
4. Left double click to finish selection. The selected area below the polylines are highlighted.



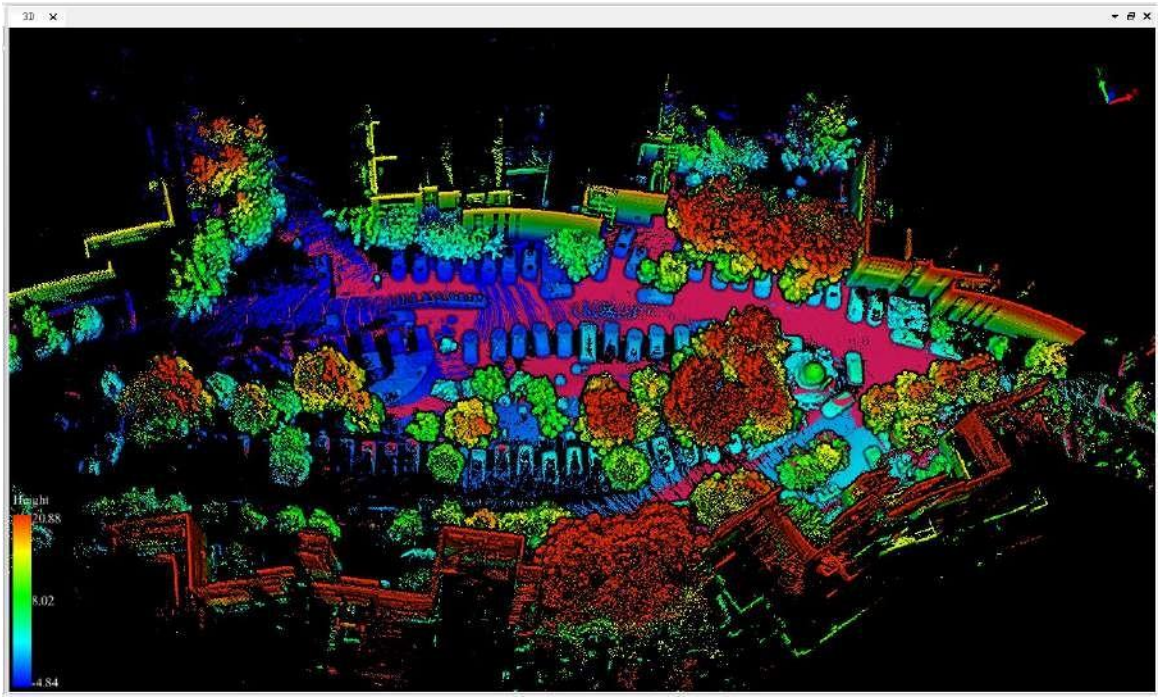
5. (Optional) Combine multiple selections.

20.7 Plane Selection

Function Description: Select point cloud data automatically in specific area.

Step

1. Click the button to activate this function.
2. In the window, select a polygon area and the point in this selected area will generate automatically.
3. Right-click to cancel the selection. Go back to the previous step and choose the selection again.
4. Left double click to finish selection. The selected plane are highlighted.



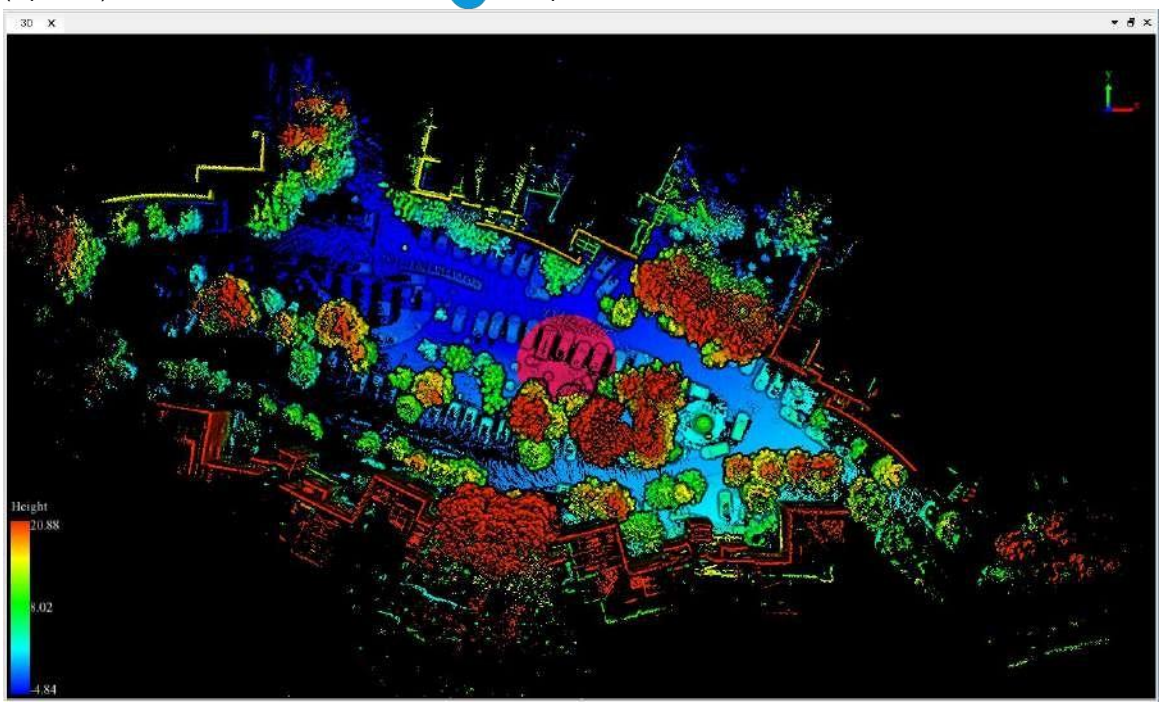
5. (Optional) Combine multiple selections.

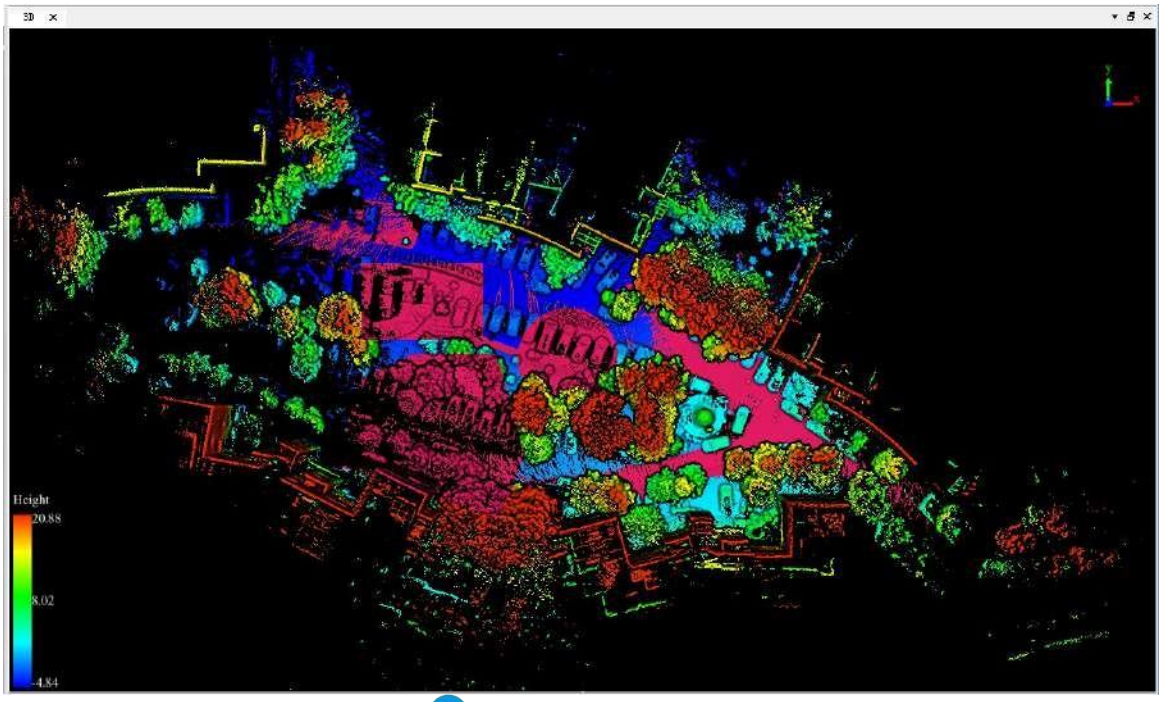
20.8 Subtract Selection

Function Description: If Subtract Selection is inactive, more points can be added to the currently selected. If active, unwanted points can be removed from the currently selected. This function is effective on one of the geometric selection tools including Polygon Selection, Rectangle Selection, Sphere Selection, Circle Selection, Line above Selection, Line below Selection, Panel Selection

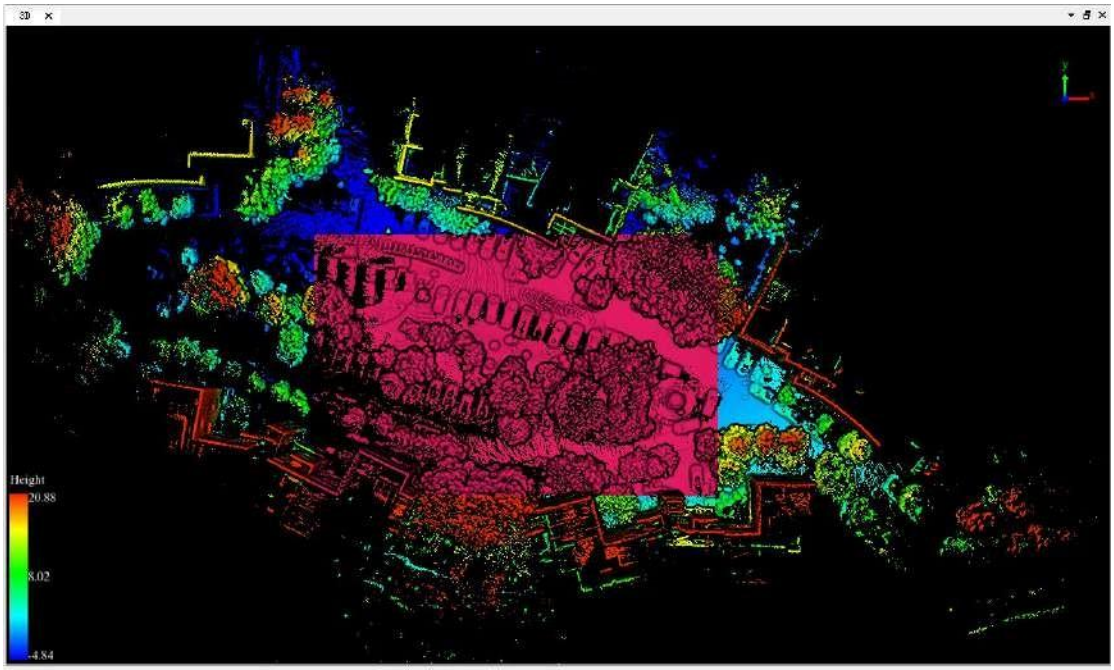
Step

1. Activate one of the geometric selection tools (Polygon Selection, Rectangle Selection, Sphere Selection, Circle Selection, Line above Selection, Line below Selection, Panel Selection) before using Subtract Selection. Then please activate/deactivate Subtract Selection by left click.
2. (Optional) If Subtract Selection is inactive , multiple selections can be combined.

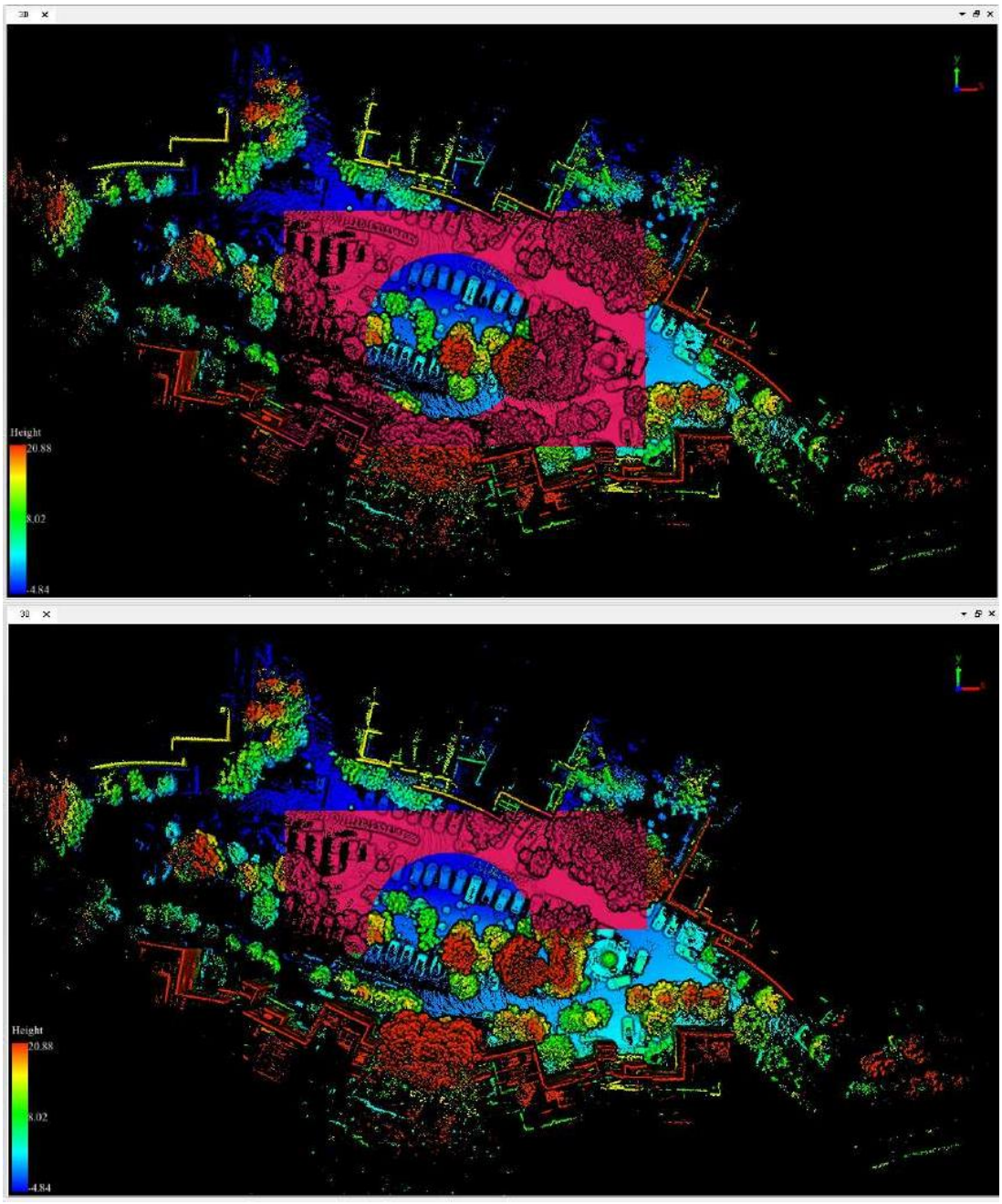




3. (Optional) If Subtract Selection is active , unwanted points can be removed from the currently selected.
   - 3.1 Select an initial selection area.



   - 3.2 Activate Subtract Selection, choose polygon selection and circle selection to delete the area.


Height
20.88
8.02
-4.84

Height
20.88
8.02
-4.84

27.9 Cancel Selection

Function Description: Cancel all the selections and cut operations.

Step

1. Click this button after selections (Polygon Selection, Rectangle Selection, Sphere Selection, etc.) or cut operations (In Cut, Out Cut).
2. Click the button  . All the selections and cut operations will be cancelled.

> Note: This function is only applicable to point cloud data.

21. Cut Tools

Cut point clouds after selection. Users can use Selection Tools to make an interest area first, and use cut tools to perform the job including Incut Tools, OutCut Tools, Save Cut Results and Cancel Selection.

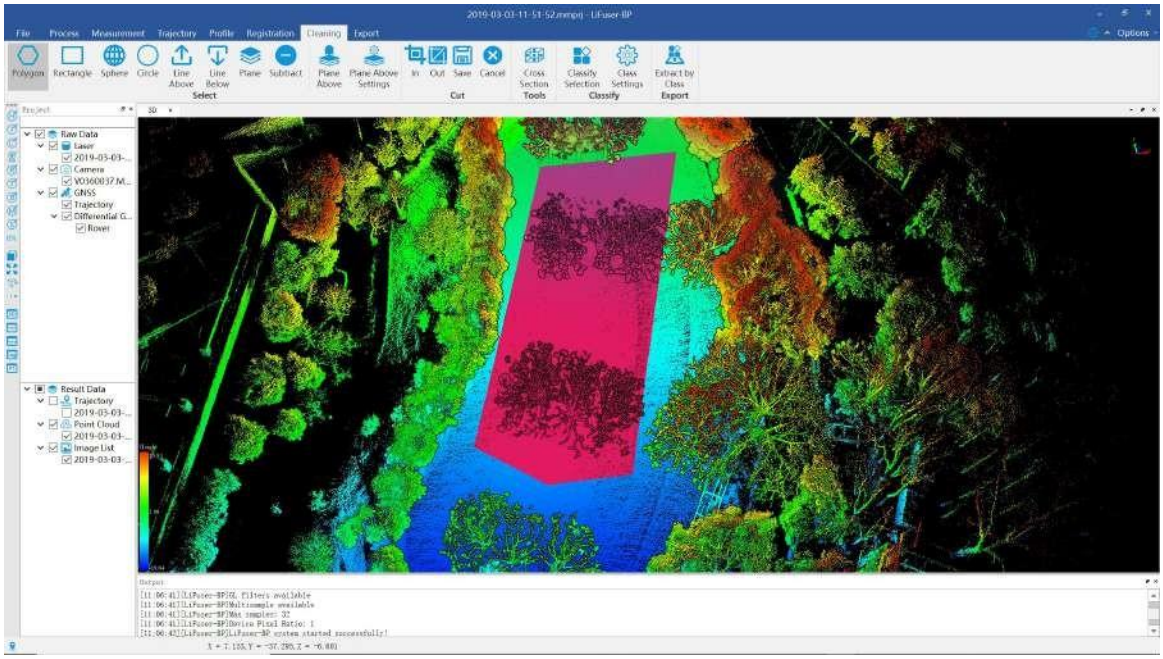
- InCut
- OutCut
- Save Cut Result
- Cancel Selection

21.1 InCut Tools

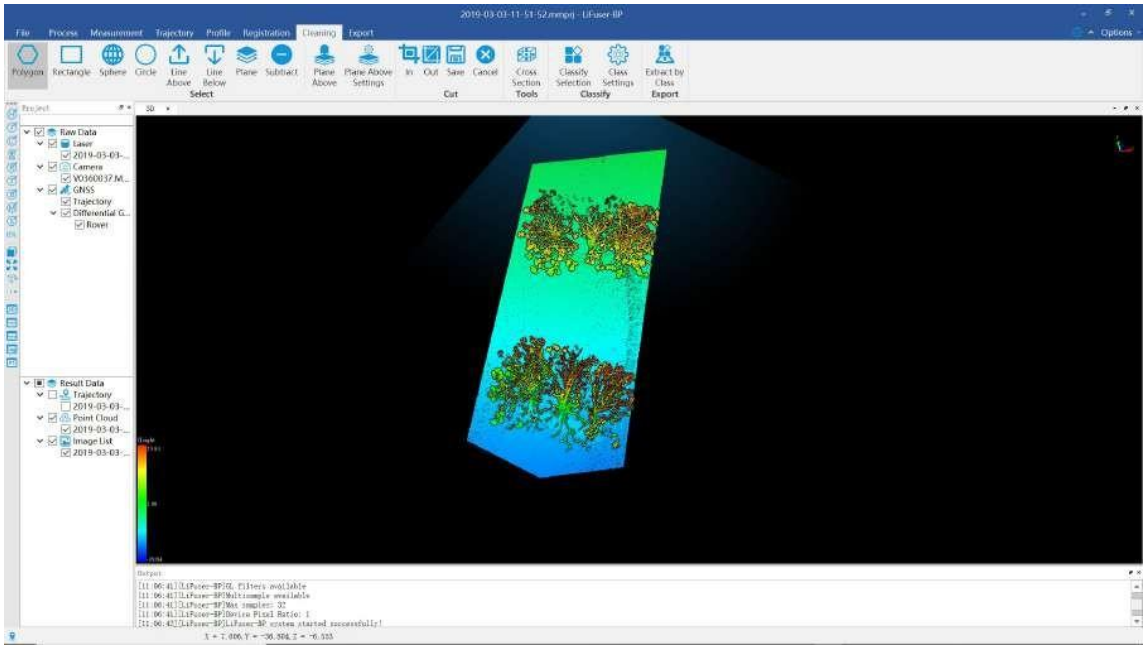
Function Description: users can select an interest area firstly and cut point clouds after selection. Th selected points are kept while the unselected are hidden.

Step

1. First, users could select an interest area using select tools including Polygon Selection, Rectangle Selection, Sphere Selection, Circle Selection, Line above Selection, Line below Selection, Plane Selection.



2. Use InCut Tools to perform your job.



3. (Optional) You can repeat this function several times to get the result you need with Polygon Selection , Rectangle Selection , Sphere Selection , Circle Selection , Line above Selection , Line below Selection , Plane Selection and Cut (OutCut) tools.

Parameters Setting

- **Shortcut Key**：Press **Ctrl + Z** to undo the cut operation. The corresponding selection is also cancelled.

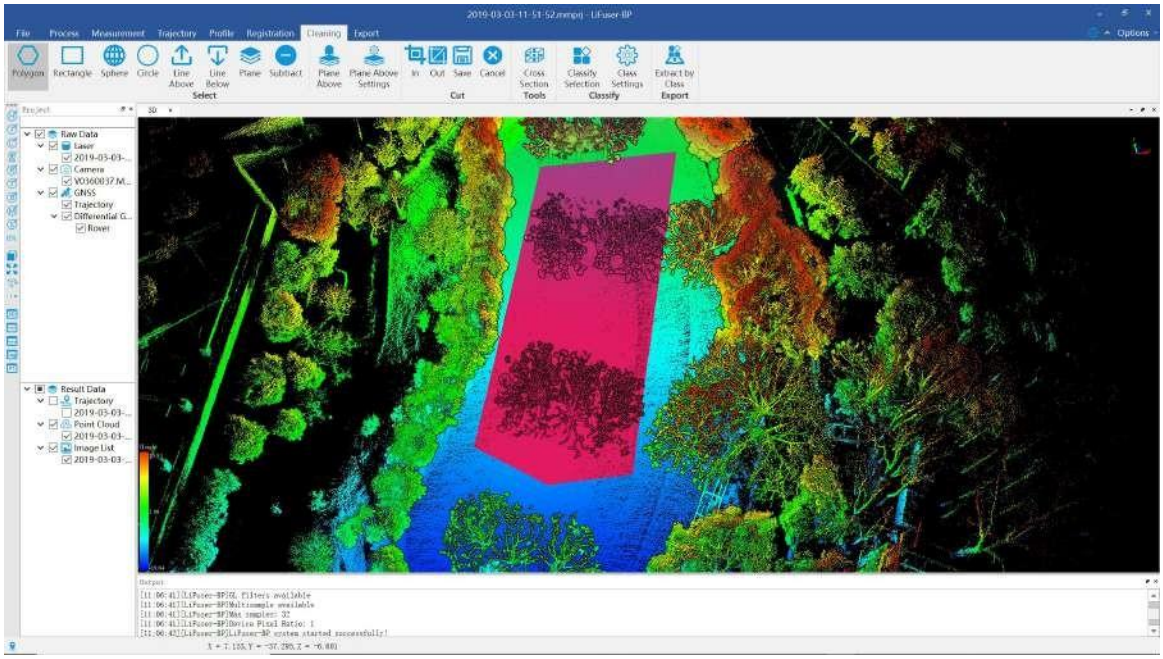
> Note: This function is only applicable to point cloud data.

21.2 OutCut

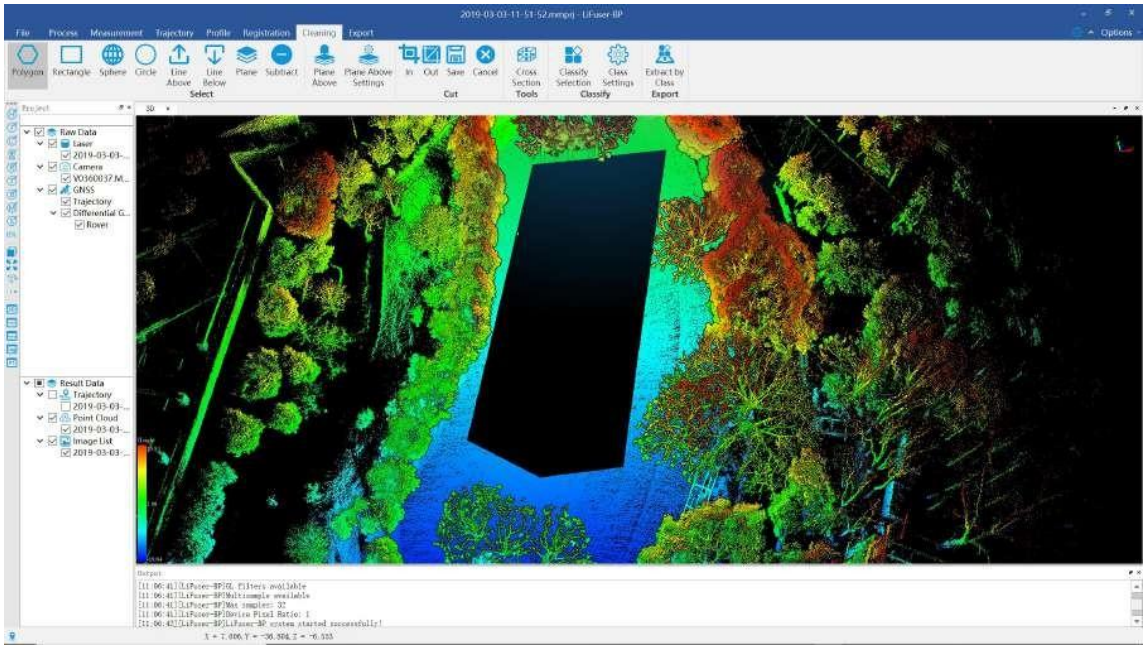
Function Description: Cut point clouds after selection. The selected points are hidden while the unselected are kept.

Step

1. Select points using (Polygon Selection, Rectangle Selection, Sphere Selection, Circle Selection, Line above Selection, Line below Selection, Plane Selection). The selected points are highlighted.



2. Click the Out Cut Button. The result is shown in the following figure.



3. (Optional) You can repeat this function several times to get the result you need with Polygon Selection, Rectangle Selection, Sphere Selection, Circle Selection, Line above Selection, Line below Selection, Plane Selection and Cut (InCut Tools also included)Tools.

Parameters Setting

- **Shortcut Key**：Press **Ctrl + Z** to undo the cut operation. The corresponding selection is also cancelled.

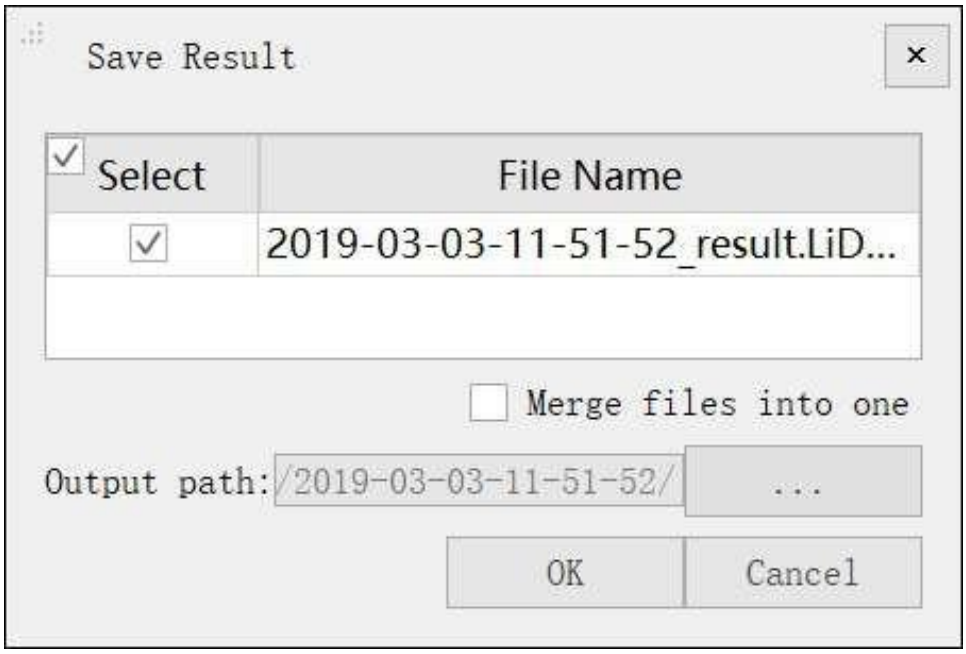
> Note: This function is only applicable to point cloud data.

21.3 Save Cut Result

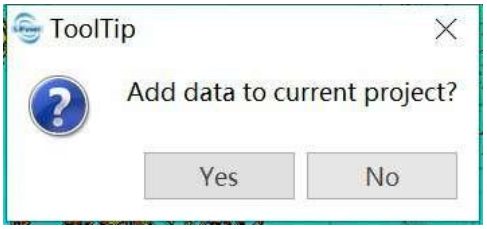
Function Description: Save results after cutting operation as new point cloud files. (OutCut) tools

Step

1. Use InCut or OutCut tools to perform your job.
2. Click this button after successful cutting operations (InCut, OutCut). An interface is shown as follows.



3. Select source point cloud files, from which new files are generated.
4. (Optional) Check/Uncheck the option "Merge files into one" according to demand.
5. Specify the output path. New file names are created based on the source file names and system time. An example of new file name is "SourceFileName_CutResult_SystemTime.LiData".
6. After data saving, a dialog will ask if you want to add the new files to current project.



7. Click Yes or No according to demand.

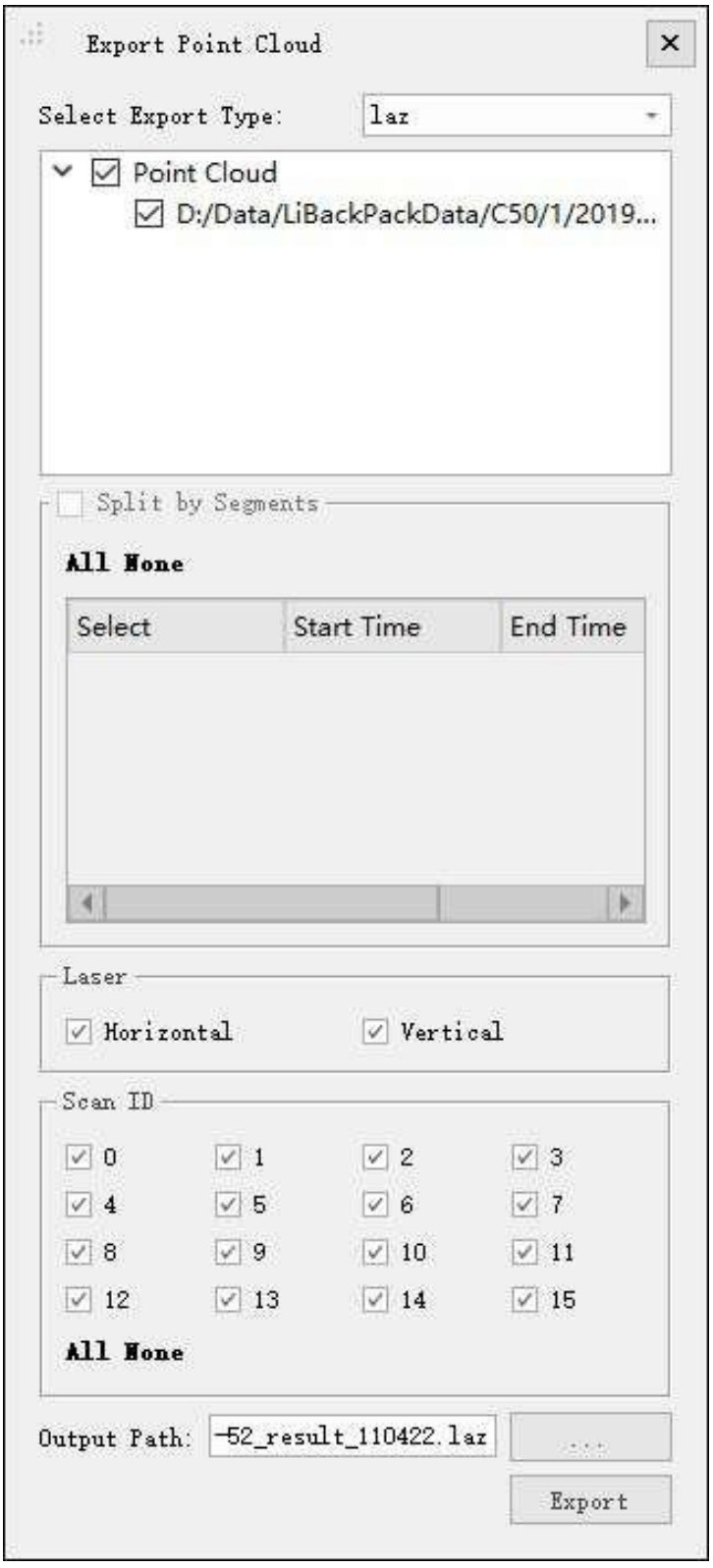
22. Export

You can export data to multiple data types for futher application or analysis.

Switch to *Export* tab.

22.1 Export Las/Laz

Click  and export las/laz file.



22.2 Export Orbit GT

Click and export data type compatible with OribitGT. The exported files include image list and high accuracy point cloud data.

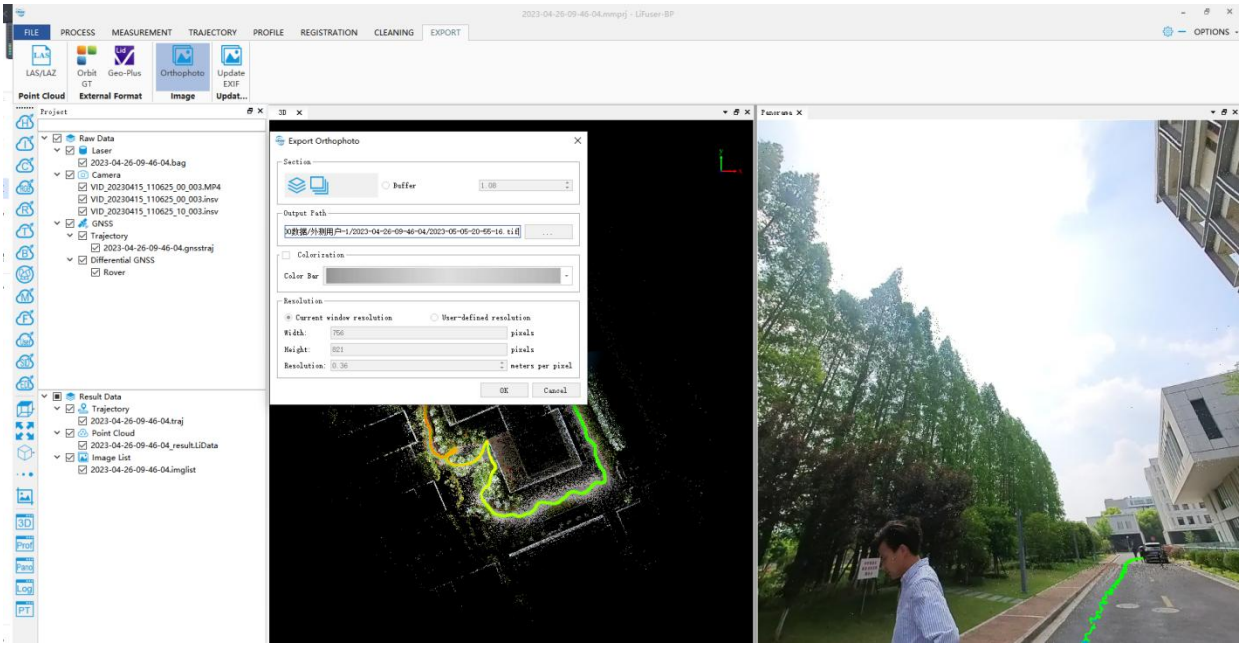
22.3 Export GeoPlus

Click and export data type compatible with Geo-Plus. The exported files include image list and high accuracy point cloud data.

22.4 Export Orthophoto

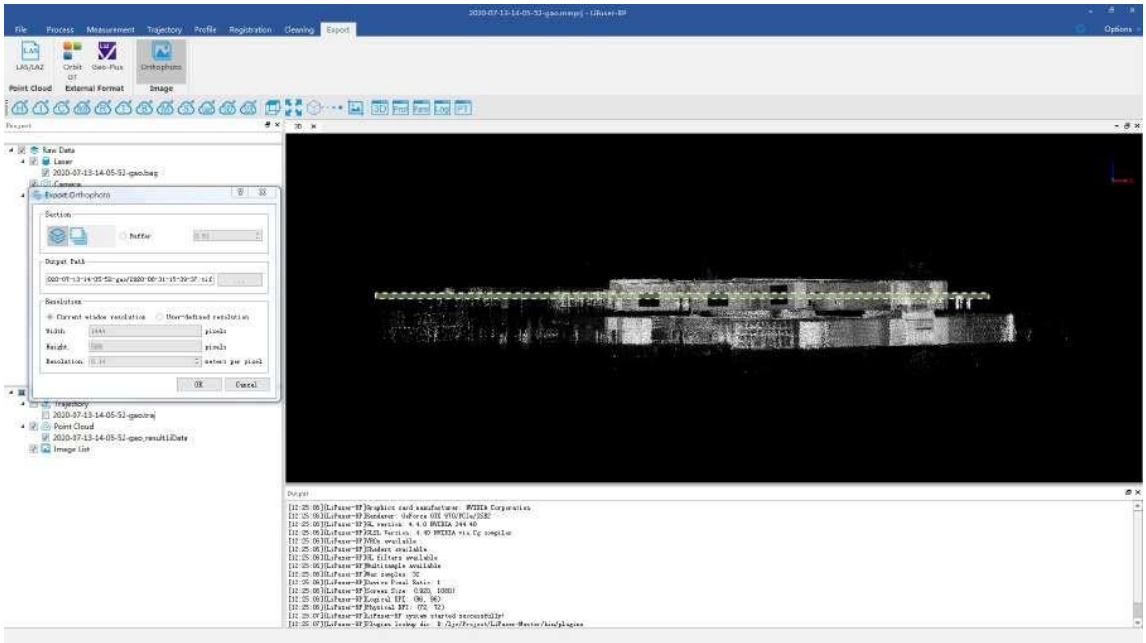
Click and export orthophoto generated by point cloud. Please refer to Export Orthophoto for detailed information.

Click *Orthophoto* , and the Export Orthophoto dialog box will appear, as shown in the figure. To export orthophoto, you can combine with the horizontal section tool and the vertical section tool. The orthophoto can be opened and measured in other GIS software.

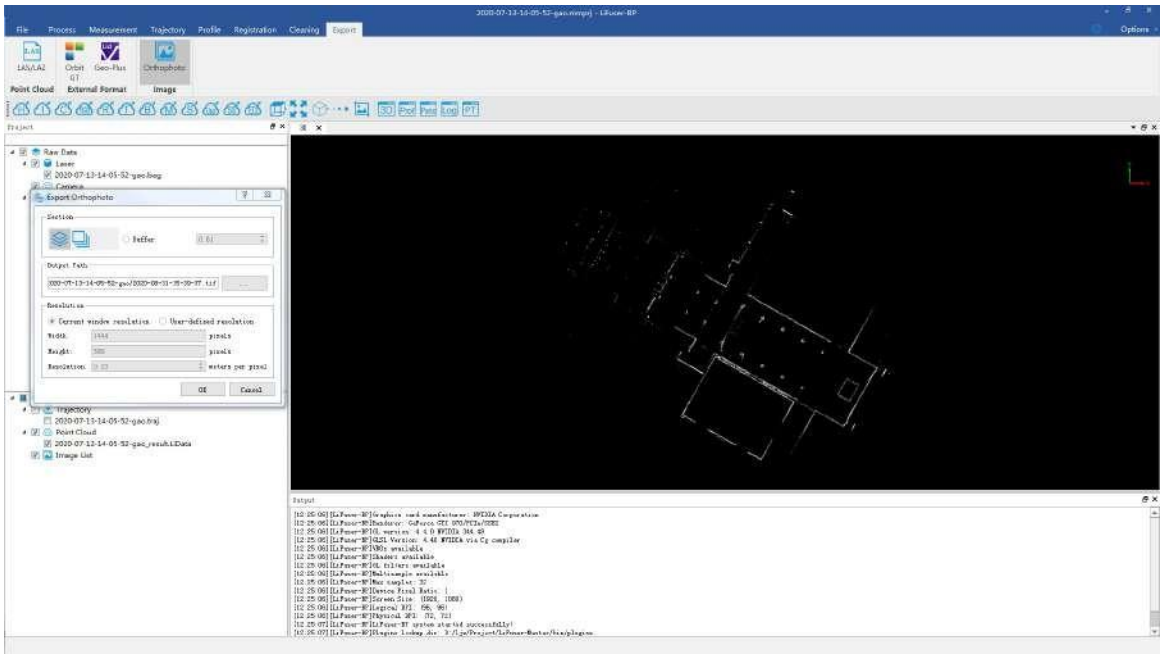


22.4.1 Horizontal Section Tool

1. Click , and 3D viewer will automatically change to front view.
2. Move the mouse to draw a rectangle box, double click to finish drawing the section.



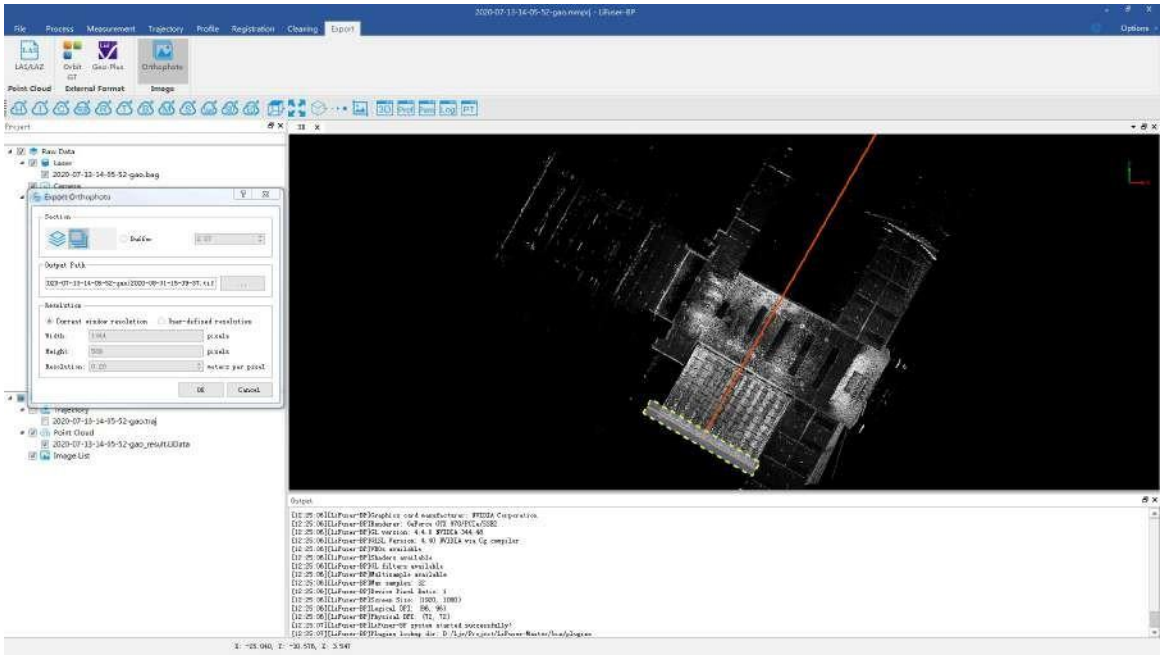
3. The 3D viewer will automatically change to top view.



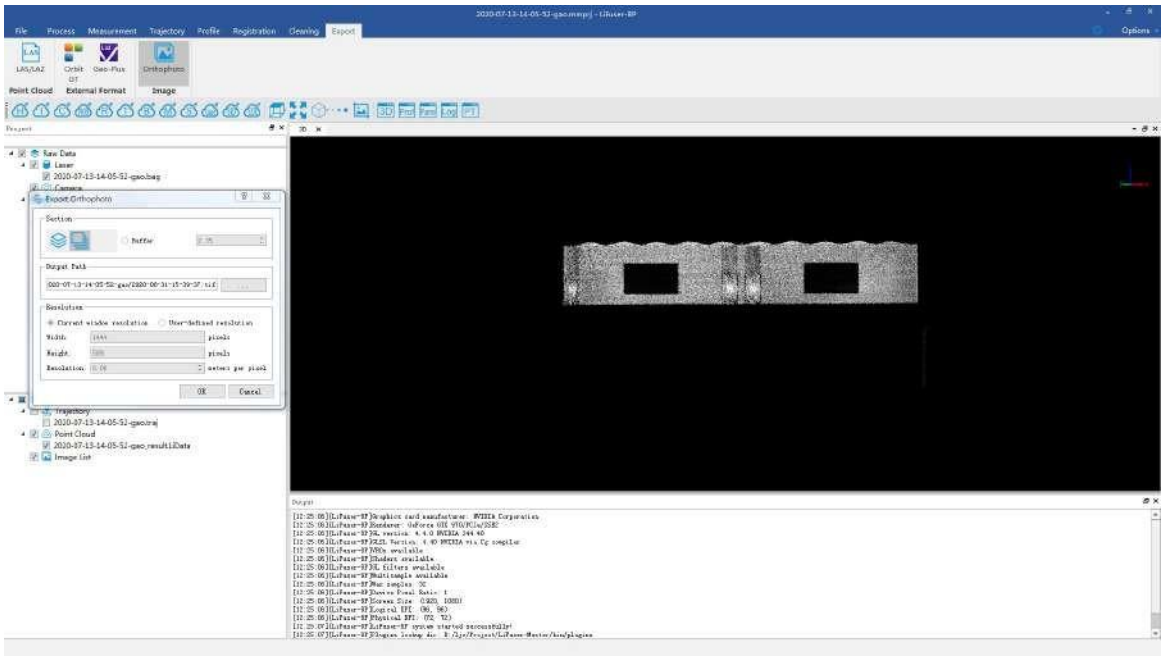
4. You can also click *Buffer* and set buffer size.

22.4.2 Vertical Section Tool

1. Click  , and 3D viewer will automatically change to top view.
2. Move the mouse to draw a rectangle box, the first two points determine the axial direction, and the third point determines the size of the buffer area. Double-click to finish drawing the section.



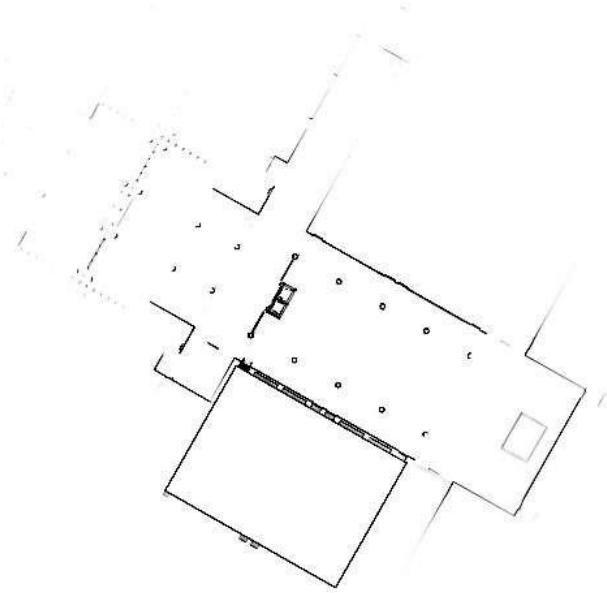
3. The 3D viewer will automatically change to front view.



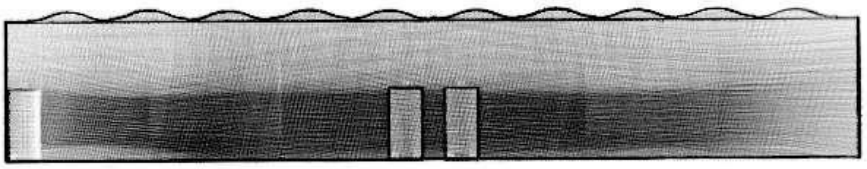
4. You can also click *Buffer* and set buffer size.

22.4.3 Export Orthophoto

1. Click *Output Path-> ...* to choose the export directory.
2. Select *Current window resolution*, and the orthophoto is exported according to the resolution of the current 3D viewer, and the *Resolution* will update in real time while zooming the viewer.
3. Select *User-defined resolution*, and the orthophoto is exported according to specific resolution.
4. Click *OK*, and export orthophoto.
5. The orthophoto exported with the horizontal section tool is shown in the figure.



6. The orthophoto exported with the vertical section tool is shown in the figure.



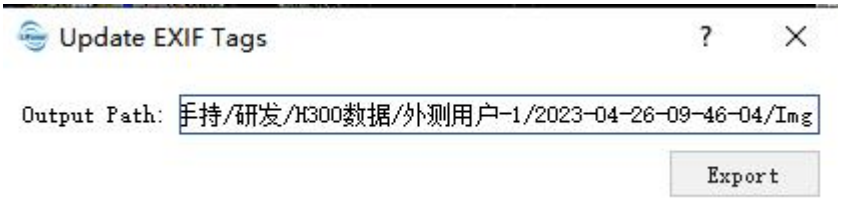
22.5 Update EXIF

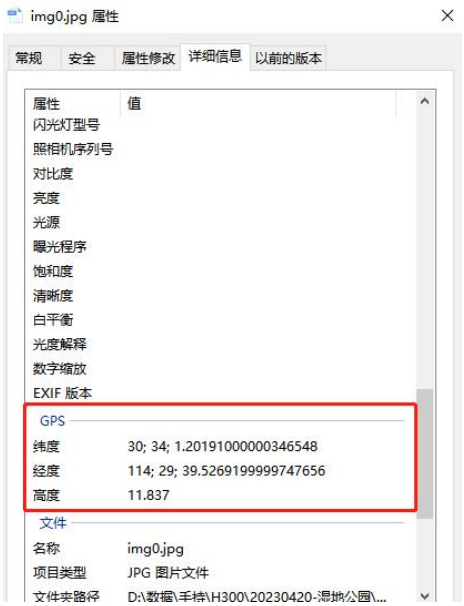
Add latitude and longitude information to panoramic images.

Premise: The point cloud has absolute coordinates and projection information

Click 

, the software automatically recognizes the directory of the panoramic image, and click Export. Finally, click on the properties of the panoramic image, and you can view the latitude and longitude information for detailed information.



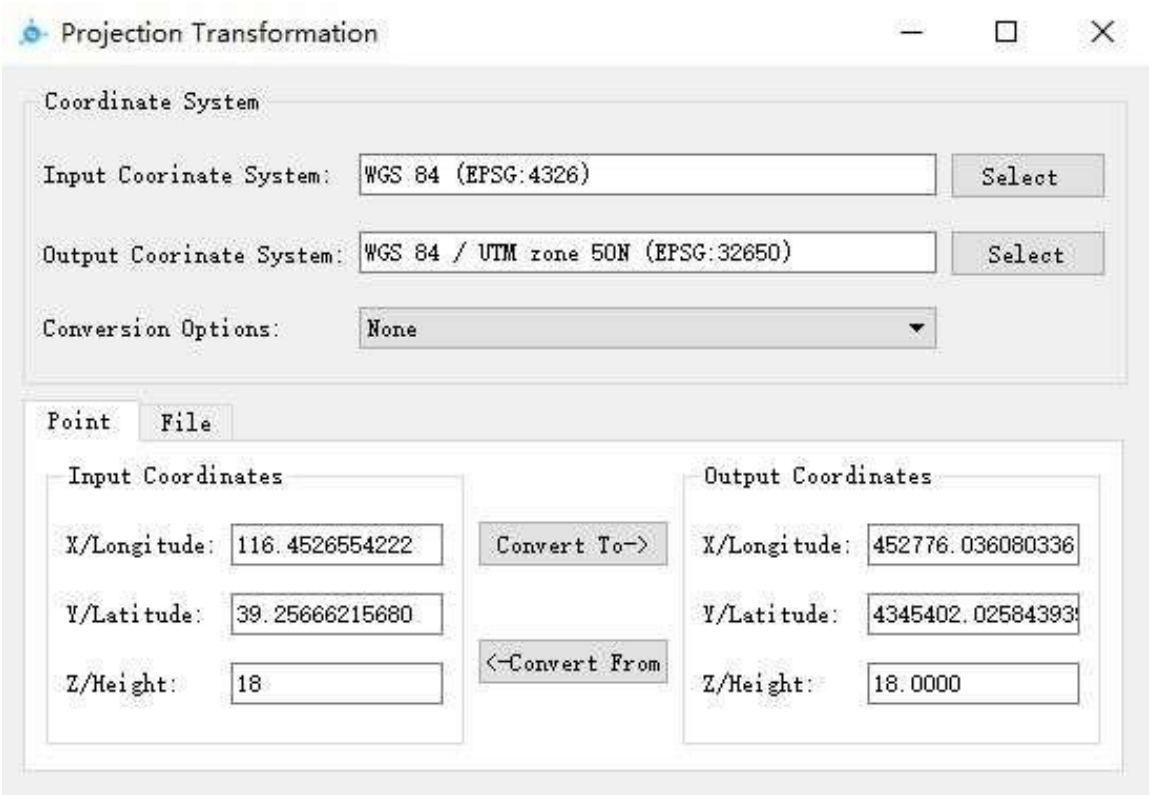


23. Coordinate Conversion

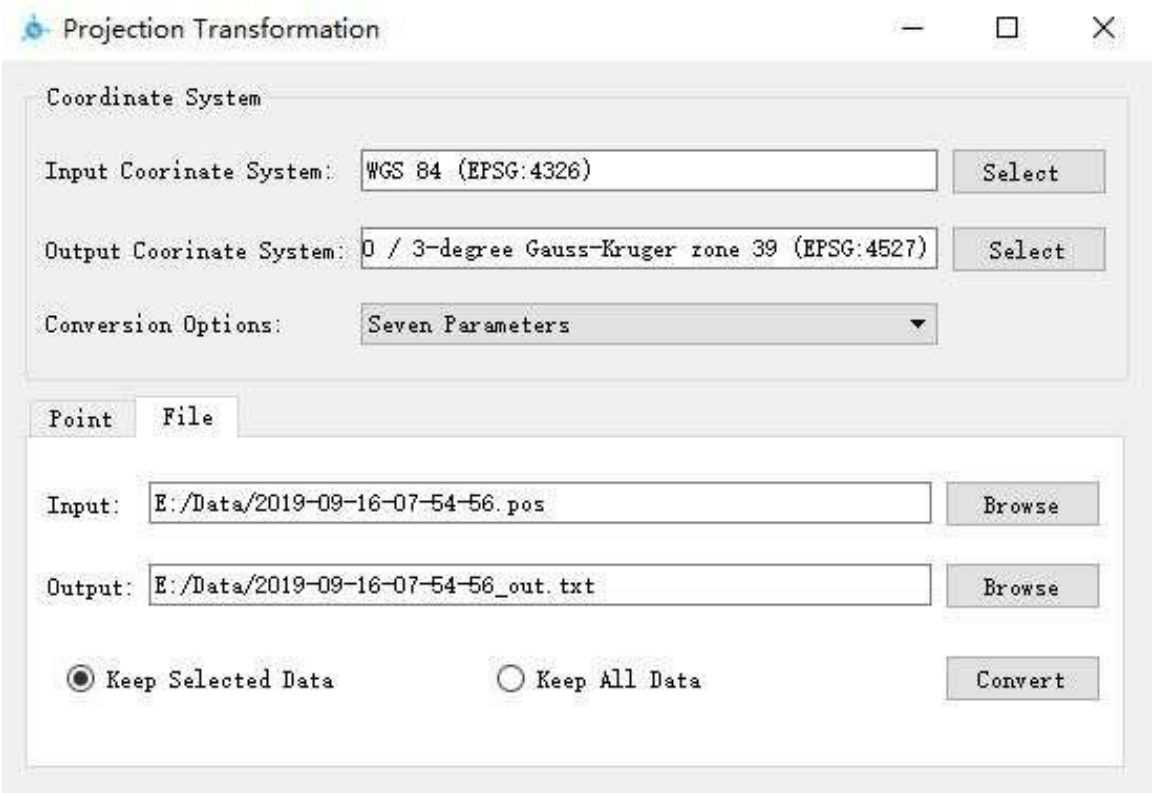
The coordinate conversion tool can convert the coordinate of a single point or file based on a specified coordinate system. The coordinate system includes geographic coordinate system, projected coordinate system, user-defined coordinate system, etc. Switch the top menu to the *processing* page, click the *projection conversion* button, and the coordinate conversion dialog box will pop up.

Steps

1. **Set Coordinate System**: Select Input Coordinate System and Output Coordinate System accordingly.
2. **Set Conversion Option**: Conversion options include Bursa seven-parameter and plane four-parameter models, and the default setting is None. When performing seven-parameter conversion, the seven parameters are only valid when the input and output coordinate system ellipsoid parameters are inconsistent, otherwise it is invalid.
   When performing four-parameter conversion, the set coordinate system should include at least one projection coordinate system, otherwise the coordinate system setting is invalid.
   There are three situations for four-parameter conversion: 1. Non-projected coordinate system -> projected coordinate system, the system first converts the input coordinate to the projected coordinate system, and then performs 4-parameter conversion; 2. projected coordinate system -> projected coordinate system, the system first perform 4-parameter conversion and then converted to the output projected coordinate system; 3. projected coordinate system -> non-projected coordinate system, the system first performs 4-parameter conversion on the input coordinates, and then converts to the target coordinate system.
3. **Point Conversion**: Enter the X/Longtitude, Y/Latitude, and Z/Height on *Input Coordinates*, then click *Convert To* to calculate the output coordinates.



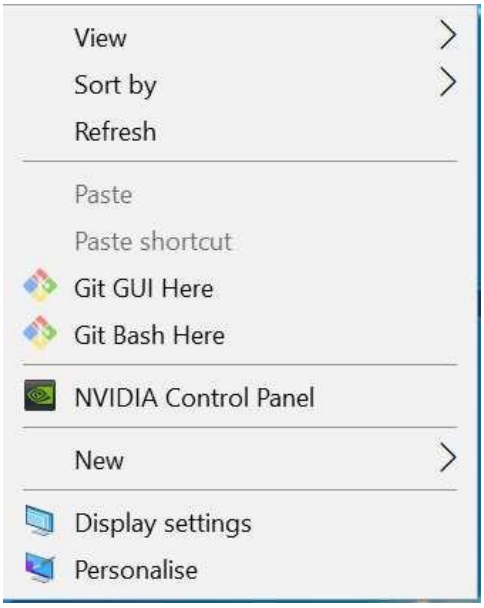
4. **File Conversion**: Set *Input* and *Output* on *File* tab. Currently, only text file is supported. After selecting the input file, the file header is availible for modification, and the user can choose according to the actual coordinate order correspondence. After completing the file header modification and selecting the retained data option, click the *Convert* button to complete the file coordinate conversion.
   Keep selected data option means that only the coordinate sequence in the file is saved, and *Keep all data* option means that the other columns of the file are also saved, only original coordinate is replaced.



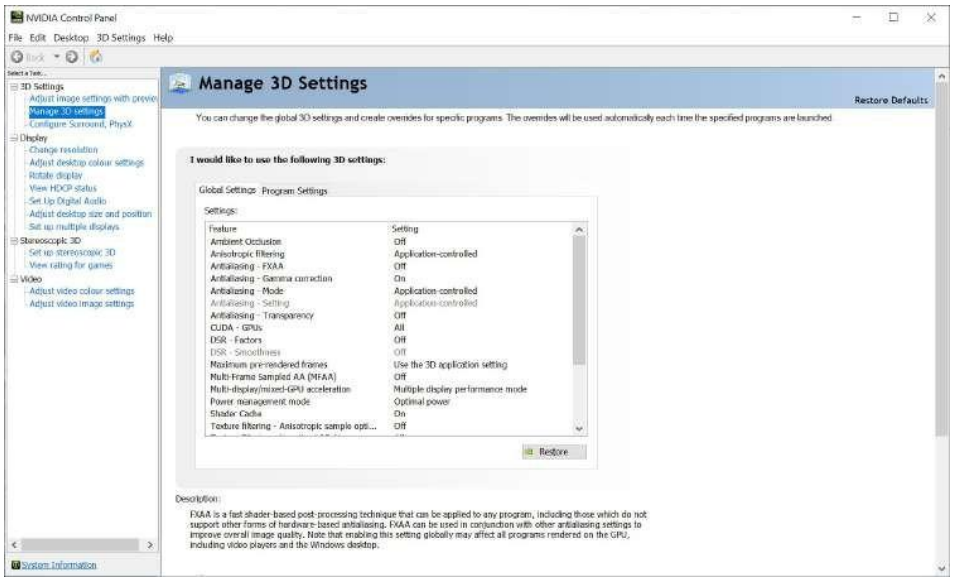
24. High-Performance Graphics Mode Adjustment

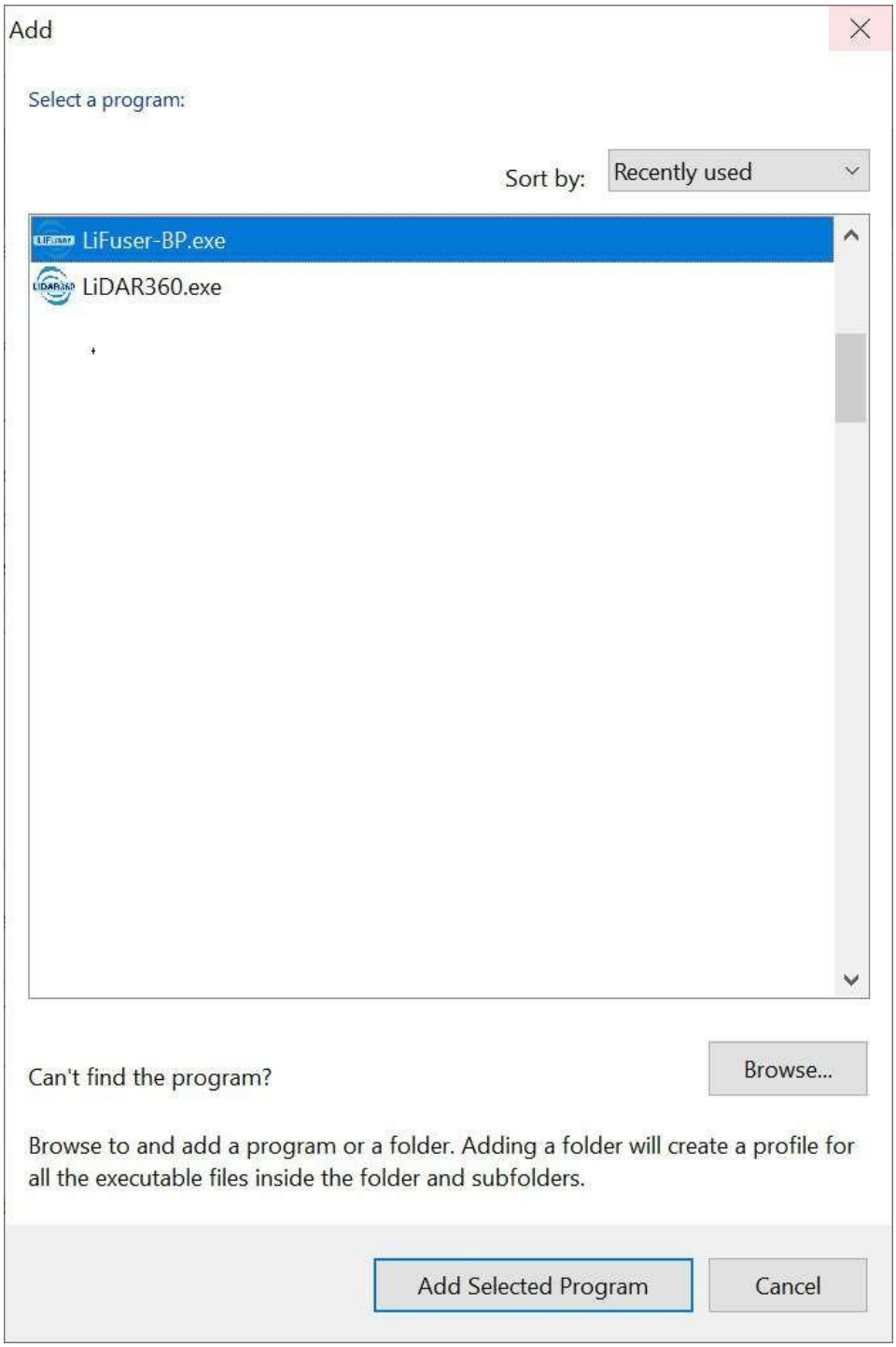
Follow the procedure below to optimize graphics for LiFuser-BP (for NVIDIA graphic cards).

1. Right click on desktop and select NVIDIA Control Panel.



2. Select **Manage 3D settings** > **Program Settings** > **Add** to add LiFuser-BP.exe to high-performance graphics mode list.




Add
Select a program:
Sort by:
Recently used
LiFuser-BP.exe
LiDAR360.exe
Can't find the program?
Browse...
Browse to and add a program or a folder. Adding a folder will create a profile for all the executable files inside the folder and subfolders.
Add Selected Program
Cancel

25. Vertical Datums

When performing coordinate conversion in the projection library, vertical datum is needed for coordinate system conversion. The software provides EGM2008 geoid model elevation conversion by default. If other geoid models need to be supported, you could download the corresponding grid datum files. Grid files are provided by the official PROJ library.You can download proj-data-1.2here, or go to https://proj.org/download.html for latest version. After downloading the file, copy all files in the folder to the *geoid* folder, under the software installation directory C:\Program Files\LiFuser-BP\1.4.0.0\geoid，“1.4.0.0” refers to software version.

> Note: Do not modify the tif file name and put the file directly in the geoid folder. Or the file will be unrecognizable.If the same file name exists, it can be replaced directly. If you cannot download the file or encounter difficulties, you can contact us via info@greenvalleyintl.com.

Software default shortcut key

Function	Shortcut key
Exit the LiFuser-BP software	Alt+F4
Orthographic / perspective projection Toggle	F3
Data pan up	↑
Data pan down	↓
Data pan left	←
Data pan right	→
View zoom in	+
View zoom out	-
Rotate	Left mouse button
Translation	Right click or press and hold the scroll wheel
Zoom	Roller
Global view	Space