LiAir 220

UAV Lidar Scanning System

User Manual

GreenValley International

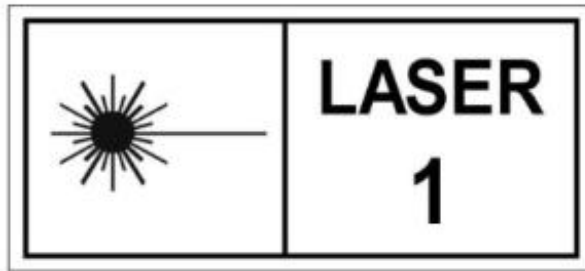# Contents Table

1 User Notice

ⓘ Safety Tips

1. The laser used in this device is a Class 1 laser product, so there is no need for personal protective equipment. It has been certified for eye safety by CB and complies with the IEC60825-1:2014 standard.

2. To ensure the safety of the operator and the device, please read this manual carefully before use and ensure that you have received qualified operational training. (Not to be used by individuals under 18 years of age)

3. Do not use the device if there is noticeable noise, alarm sounds, or damage. Contact the manufacturer's technical personnel for repairs in a timely manner. Forced use may cause permanent damage to the device.

4. Follow the operating instructions, suggestions, warnings, or precautions provided by the manufacturer in this manual, among others.

5. This device operates at a voltage of 12~24V, 1A@24VDC. Do not use power supply equipment outside this voltage range to prevent danger and permanent damage to the device.

6. Keep the power, USB, network cable, and other connectors clean and dry. Do

not insert objects other than the corresponding plugs.

7. Do not disassemble the device or replace parts not provided by the manufacturer without authorization, as this may cause danger and damage to the device. If disassembly is required, please contact the manufacturer and proceed under the guidance of the manufacturer's technical personnel.

8. This device is a precision instrument. Handle it with care, unload it from the platform, and transport it in a dedicated transport case.

9. The device should be stored in a cool and dry place. Clean it after use and make sure to disconnect the power during cleaning.

10. The operating temperature of this device is -20~50. Measurements may be inaccurate, data may be lost, or the device may be damaged if operated below or above this temperature range.

11. Before using the device, ensure that the operating environment is free from electromagnetic interference. Please refer to the user manual for specific standards.

12. There are specific guidelines for the use and storage of batteries. Please refer to the lithium battery use/storage guidelines.

13. This device is a precision electronic instrument. Do not dispose of it carelessly. When the device is scrapped, do not throw it directly into the trash. You can send it back to the manufacturer for disposal, or you can handle it yourself in

accordance with the "Regulations for the Recycling and Disposal of Waste

Electrical and Electronic Products". The final interpretation right belongs to

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GreenValley International Inc.

30/2/2023

2 Product Introduction

The LiAir 220 adopts an integrated design scheme, integrating a 40-line circular scanning LiDAR, an inertial navigation system, and a built-in 2600W high-resolution mapping camera. Paired with GreenValley's self-developed software such as LiPlan/LiGeoReference, it can provide integrated solutions for emergency mapping, forestry resource surveys, power inspections, and other fields.

1. A dynamic differential GNSS receiver used to measure the spatial position of the reference point of the LiDAR signal emission.

2. An attitude measurement device, i.e., an inertial navigation device, used to measure the attitude parameters of the main optical axis of the scanning device.

3. A laser rangefinder is used to measure the distance from the reference point of the LiDAR signal emission to the ground laser foot point, which is the core part of the entire integrated system, i.e., the laser scanning head.

4. A storage control system is used for data storage, device control, receiving signals sent from the ground to the airborne end, and controlling device parameter adjustment, data collection, and download functions.

5. A power system is used to supply power to the entire device.

Working Principle of the Product:

1. The system controls the device to collect data by receiving and executing commands sent by the hardware switch or the LiPlan flight assistant.

2. All the collected raw data is stored in the TF card. After data collection is completed, it is copied to the local computer for data processing.

3. The LiGeoreference software is used to fuse the position and angle information in the LiDAR system coordinate system with the POS data to obtain accurate geographic coordinates.

2.1 Product Parameters

LiAir 220 System Parameter Table

Weight	2.1kg
Scanning Range (Clear outdoor @100 klx)	0.3~200 m @ 10% Reflectivity
FOV	360°(Horizontal) ×40° (Vertical)
Number of Returns	Dual Returns

Scanning Rate	Single Return: 720,000 pst/s Dual Returns: 1,440,000 pst/s
Camera Pixels	2600W
POS Attitude Angle Accuracy (Post-processing)	0.008°
POS Azimuth Angle Accuracy (Post-processing)	0.038°
System Accuracy (Elevation)	5 cm@70m
Dimensions	189.7*104*169.2mm
Voltage	12~24V, 2A@12VDC
Power Consumption	24W
Working Temperature	-20~50℃
Storage Temperature	-30~60℃
UAV Model	M300 RTK
Communication	Wifi
Display Control Software	LiPlan
Data Processing Software	LiGeoreference

2.2 Product Structure Diagram
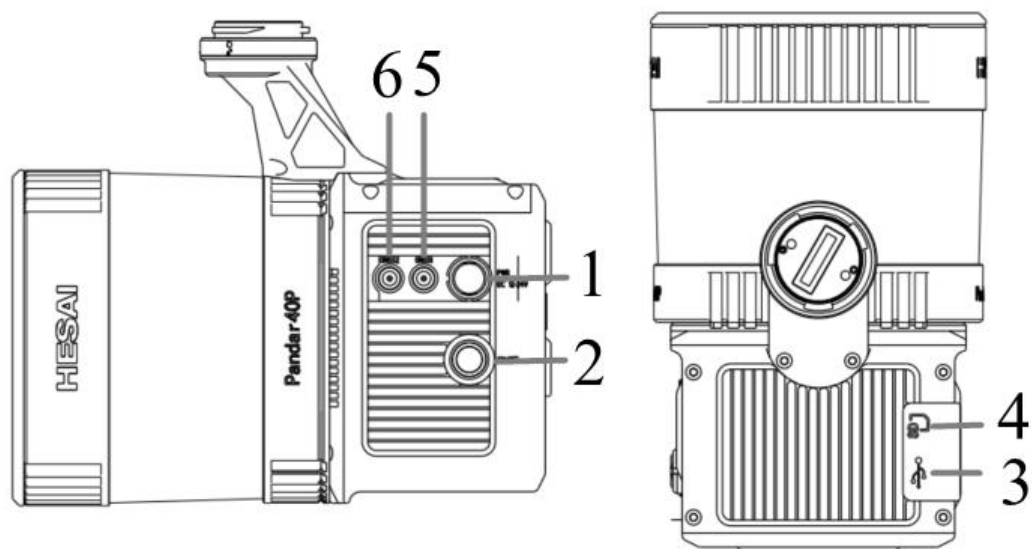
1— Power Interface (PWR): Connects the power cord to supply power to the device.

2— Switch Button (ON/OFF) and Indicator Light: The device power-on and project creation button (shared), displaying the working status of the device.

3— USB-C Interface: Used for communication between the computer and the device, including system upgrades, data downloads, etc.

4— Memory Card Slot: Built-in 256G TF card, used for data storage.

5— GNSS1: Main antenna interface.

6— GNSS2: Secondary antenna interface.

Switch Status Indicator Light Meaning:

| LED	Color/Status	Indications
ON/OFF	Red color fast flashing 4 times/s	Power-on success, system initializing
	Green color stay on	System initialization successful
	Green color slow flashing 1 time/s	Project created, inertial navigation data recording, system functioning normally
	Red color slow flashing 1 time/s	Project created, inertial navigation data recording, system malfunction
	Red color stay on	System status abnormal, reasons include: 1. TF card space less than 15G 2. M300 RTK aircraft PSDK module not activated 3. Inertial navigation not aligned 4. Camera self-check failure 5. Laser not synchronized

2.3 Product Composition

2.3.1 LiDAR Scanner

The laser scanning head is the core of the system. The LiDAR uses a laser as the

light source for emission and a photoelectric detection sensor as the receiving element. It measures and records the distance and angle based on the principle of laser ranging, thereby determining the azimuth information of the object being measured.

The transmitter in the LiDAR emits a beam of ultra-short light pulses that hit the object and diffuse back to the receiver. The speed of light is known, and the distance from the target object to the sensor is calculated by the flight time of the laser beam in the air.
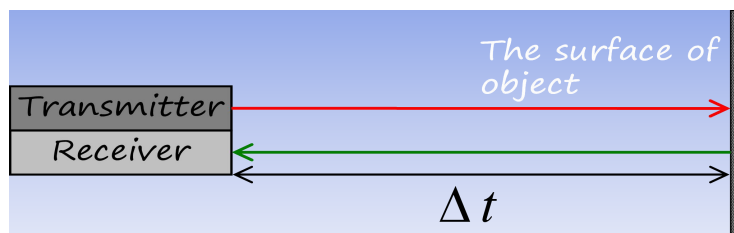
LiDAR Ranging Formula:

$$S = \frac{1}{2} \times c \times \Delta t$$

S is the distance from the sensor to the target object, c is the speed of light, and △t is the round-trip time of the laser.

The LiAir220 product integrates a HESAI 40-line circular scanner, with the

following parameters.

Scanner Parameter Table

Scanning Principle	**Rotating Motor**
Number of Channels	40
Scanning Range	0.3~200m (@ 10% Reflectivity)
Measurement Rate	1440 kHz (Dual Returns)
Scanning Rate	10HZ, 20HZ
Horizontal FOV	360°
Vertical FOV	40°
Vertical Angular Resolution	0.33°

Laser Level	Class 1 Eye-safe
Number of Returns	2
Scanning Accuracy	2cm

Note: The laser scanning head cannot be directly irradiated with strong lasers (including two sensors facing each other), to avoid damage to the receiving sensor by high-intensity lasers.

2.3.2 Combined Navigation System

The Position and Orientation System (POS) is formed by combining GNSS, INS, and attitude estimation software. Its main function is to provide position and orientation information for a laser scanning system through joint computation of GNSS and INS data.

1. GNSS System

The Global Navigation Satellite System mainly includes the American GPS navigation system, the European "Galileo", the Chinese Beidou navigation system, and the Russian GLONASS. The GNSS system of LiAir220 includes the GNSS aviation antenna installed on the aircraft and the ground base station.

2. INS Unit

INS, or Inertial Navigation, is composed of a high-precision three-axis gyroscope and accelerometers in three coordinate axis directions. It is also the reference

center of the entire LiDAR system. Its main advantage is that it can obtain real-time attitude and coordinate positions without external references.

Main components: Gyroscope + Accelerometer

The product host has a built-in 3-axis MEMS gyroscope, a 3-axis built-in MEMS accelerometer, and a dual GNSS/BD receiver. Through the new generation of satellite/inertial combined navigation algorithms, it can provide accurate, real-time, and reliable multi-parameter navigation information.

3. Inertial Navigation Accuracy Table

System Accuracy (Post-processing)	Heading	0.038°(1σ)
	Attitude	0.008°(1σ)
Data Frequency	200HZ	

2.3.3 Storage Control Unit

The main functions of the Storage Control Unit are as follows:

1. Receive ground control information and accurately transmit instructions to the corresponding sensors.

2. Control and coordinate the normal operation of various sensors.

3. Store data from the LiDAR, inertial navigation system, photos, and log information in the system's memory card.

2.3.4 Camera

The built-in camera in LiAir 220 has the following main parameters:

Sensor	APS-C Image Format
Lens	16mm Fixed-Focus
Pixels	2600 万
Pixel Size	3.76um
Image Format	6252*4168
DFOV	83°

2.3.5 Ground GNSS Base Station

The main function of the ground GNSS base station is to perform long-term observations at a fixed location, providing high single-point accuracy and serving as a reference for the differential positioning of unmanned aerial vehicles (UAVs). A GPS base station consists of a GPS antenna, GPS receiver, and power supply.

Base Station Overview

1 - Power Interface (9-30V, 0.3A@12V)

2 - USB Interface: Used to connect the base station to a computer for data transfer

3 - Base Station Status Indicator: Indicates the status of the base station

4 - Save Button: Used for data storage on the base station/stop storage (long press)

5 - GPS Antenna Feedline Interface: Used to connect the GPS antenna to the base station via the feedline

Meaning of Base Station Panel Indicator Lights:

LED	Color/Status	Indications
	Steady Red	Power supply voltage normal
	Flashing Red	Low power supply voltage, battery needs to be replaced
	Steady Blue	GPS position information storage has started
	Flashing Blue	System SD card mount failure or space less than 1G
	Off	GPS position information storage not started/ended
	Slow Flashing Orange	Base station position locking in progress
	Steady Orange	Base station position locked

Base Station Performance Parameters Table:

Performance Indicators	Signal Tracking	120 Dynamic Channels GPS:L1, L2, L2C,LC GLONASS: L1, L2, L2C BDS: B1, B2 GALILEO: E1, E5a, E5b, ALtBOC, SBAS, QZSS, L-band
	Horizontal Positioning Accuracy	Single Point L1: 1.5m Single Point L1/L2: 1.2m SBAS: 0.6m DGPS: 0.4m RT-2: 1cm+1ppm Initialization time: <10s Initialization reliability: >99.9%
	Data Update Rate	Raw data: up to 50Hz Location data: up to 50Hz
	Time to First Fix	Cold start: <50s Hot start: <35s
Physical	External	130 X 90 X 32mm

Dimensions and Electrical Features	Dimensions	
	Weight	300g
	Input Voltage	12V
	Power Consumption	4W
Communication Interfaces	Data Download Method	Provides USB port for automatic download via flash drive
Environmental Indicators	Temperature	Operating Temperature: -40°C - +75°C Storage Temperature: -40°C - +75°C
	Humidity	95% Non-condensing

3 Product Components

① LiDAR Gondola ×1 ② USB Cable ×1 ③ GNSS Antenna Component ×1

④ GNSS Antenna ×2 ⑤ 256G TF Card ×1 ⑥ Card Reader ×1 ⑦ USB Drive ×1

⑧ Tools ×2 ⑨ Documentation ×1

Note: The actual product list is subject to delivery.

4 Data Acquisition

4.1 Base Station Setup

1. Select the base station setup point

If there are known control points in the survey area, you can directly use this known point as the base station setup point. If there are no known control points in the survey area, you need to choose a suitable base station point in the survey area. The basic requirements for point selection are:

● The ground foundation is stable, and convenient for placing receiving equipment and operation.

● The field of view is open, and the elevation angle of obstacles around the field of view should be less than 10°~15° to ensure that the reception of satellite signals is not affected.

● There should not be objects that strongly reflect satellite models (such as large buildings) nearby.

● Stay away from high-power radio transmitters (such as TV stations, radio stations, microwave stations, etc.), the distance should not be less than 200m; stay away from high-voltage transmission lines and microwave radio signal transmission channels, the distance should not be less than 50m.

2. Set up the base station

Set up the base station at the selected base station point. For surveying and

mapping projects or other projects with high accuracy requirements, a tripod should be set up according to surveying and mapping specifications, and the base station should be set up on the tripod. The base station connection method is as follows:

Note: When connecting the base station and the base station power cord, you need to align the red dot on the power cord with the recessed part of the interface before connecting.

3. Obtain Base Station Antenna Height

Measure the height H1 from the ground center point of the base station setup to the lower edge of the GPS guard ring, measure more than 3 times and record the measurement values, the measurement position is as shown in the figure below:
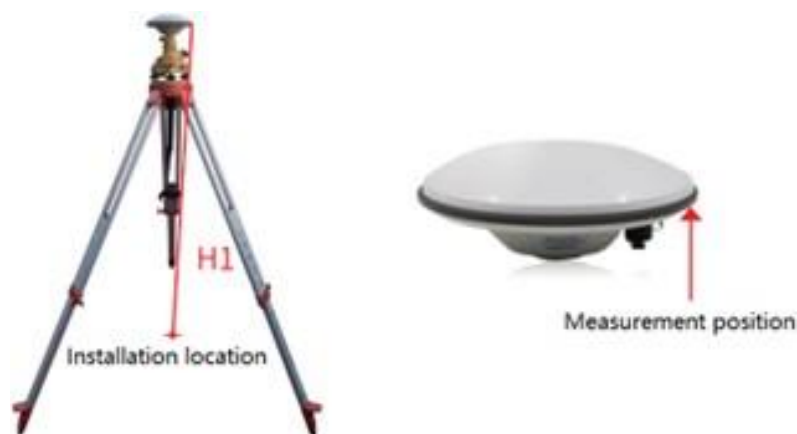
Actual base station antenna height =

Lower edge height of the retainer to the phase center L1 + √ H1² - GPS retainer radius²
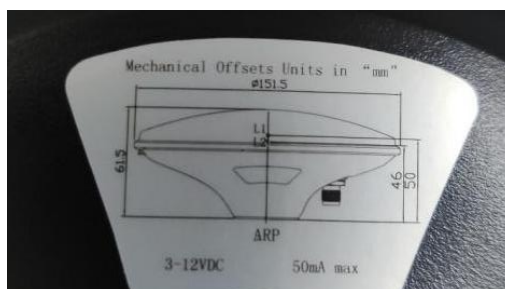
Taking the above figure as an example, if the height of the measuring instrument

is 1.6 meters, the actual base station antenna height is:

$$\text{Antenna Height} = (0.05 - 0.046) + \sqrt{1.6^{2} - \left(\frac{0.1515}{2}\right)^{2}}$$

4. Record Base Station Data

The specific operation steps are as follows:

a) Connect the base station power supply, the indicator lights are always

on;

b) Wait for the orange GPS satellite signal light

c) ![satellite icon] to stay on (this indicates that the GPS signal is stable), long press the data record Save button ![button icon] （release the button, ![save icon] the indicator light becomes always on, and start recording data.

d) After the outdoor data collection work is completed, press and hold the button ![button icon] for more than 1 second, ![save icon] the indicator light goes out, and stop recording GPS location information.

e) Turn off the base station power supply.

Note: The base station needs to start collecting data 15 minutes before the flight operation, and can only stop collecting data 15 minutes after the operation is over.

4.2 Device Installation

1. Mount the device on the M300 drone, and confirm that the shock-absorbing ball is intact and undamaged.
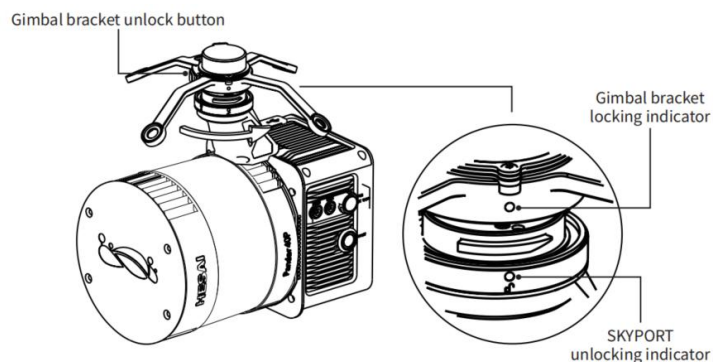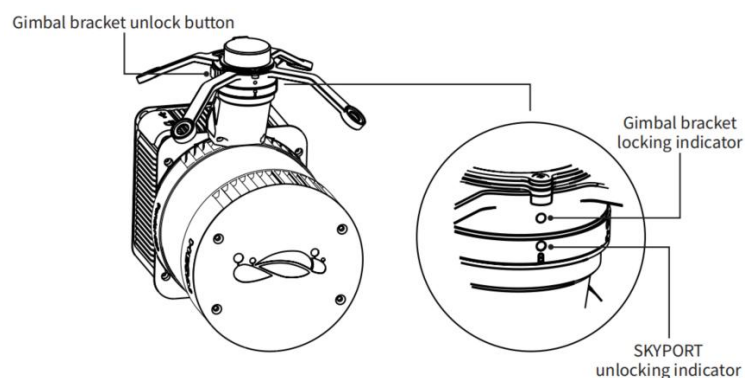
2. Install the GNSS antenna component, GNSS1 connects to the rear antenna, and GNSS2 connects to the front antenna. (The flight direction is forward).
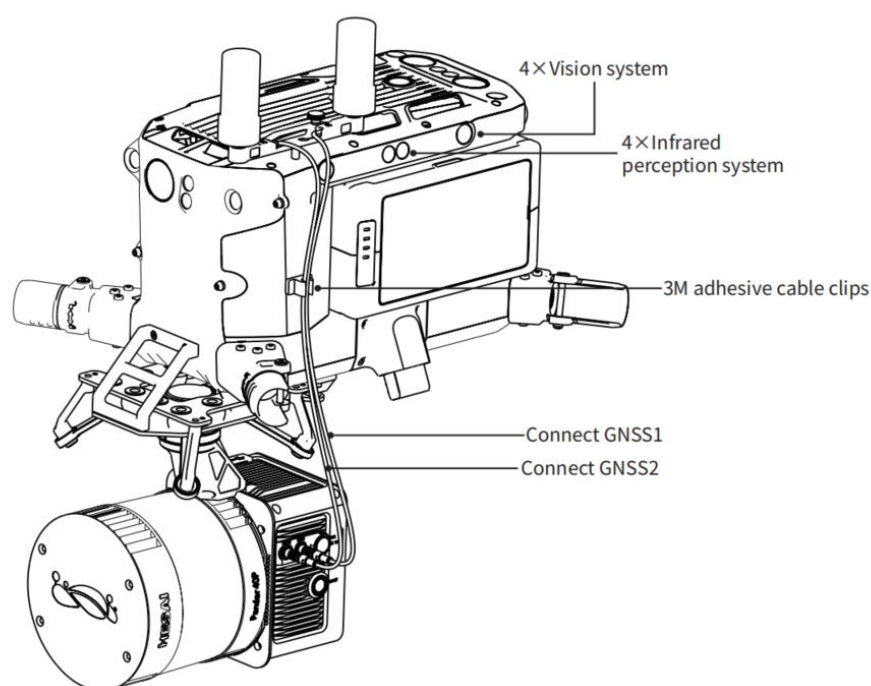
3. Confirm that the device TF card has enough space and insert it into the device, remove the protective cover of the laser and camera.

4. Turn on the remote control and power on the aircraft.

5. Press and hold the device ON/OFF button for more than 3 seconds to turn it on. Observe the button indicator light status, the red light flashes quickly means the system is powered on and is initializing, the green light is always

on means the system initialization is completed, and the device is working normally. For more specific meanings of the indicator lights, please refer to the system light meaning.

4.3 Parameter Setting

The LiAir 220 system will remember the parameters set last time. If there is no need to modify, you can skip this step. The parameters of the LiAir 220 mainly include laser parameters, camera parameters, etc. They can be modified through logging into the device Web end or the LiPlan flight assistant. The parameters supported by the two methods are not exactly the same.

1. Setting Method

   (1)   Web End Setting

a) Use WIFI to establish communication between the device and the computer or mobile phone. After the device is powered on, search for the wireless network named LiAir_XXXXXX, and click "Connect", the password is 66666666.
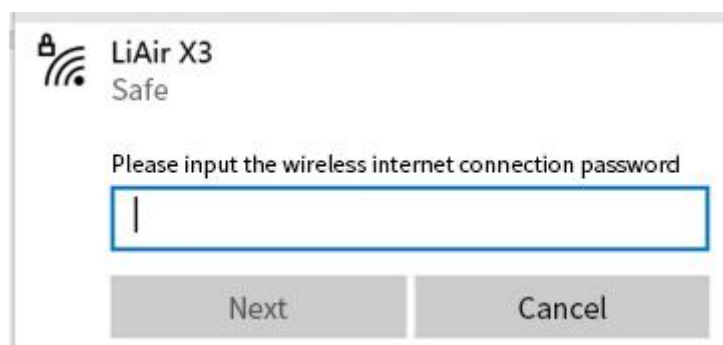
b) Enter http://192.168.1.88 in the browser, open the LiAir 220 web

configuration interface, username: root, password: 888888. Click "System

Settings" to set device parameters.
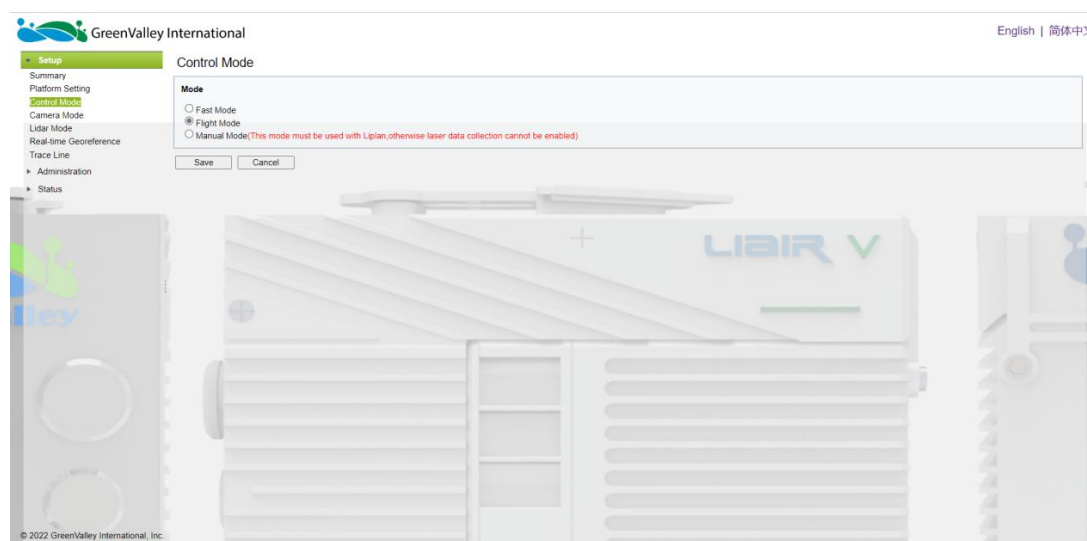
Note: It is recommended to use Google Chrome or IE11 browser.

(2)   LiPlan Setting

Open the LiPlan software, click "Route Flight" to enter the route design interface.

Click the setting button to set device parameters.

2.   Set Parameters

This document only introduces commonly used device parameters. For a

complete explanation of parameters, please refer to the LiAcquire-Web manual.

a) Control Mode

This section can be used to configure the data collection mode of the laser and

camera. The LiAir 220 device has several collection control modes:

Flight Control Mode: This mode is the default factory setting. In this mode, when

the device is stationary on the ground, the device does not collect LiDAR and camera data. After the aircraft takes off into the air, it automatically starts collecting LiDAR and camera data, and automatically stops collecting LiDAR and camera data after landing and being stationary.

Fast Mode: In this mode, short press the switch button (ON/OFF), and the device will create a project and start collecting LiDAR and camera data simultaneously.

Manual Mode: In this mode, the device automatically starts collecting LiDAR and camera data when it reaches the first waypoint, and automatically stops data collection when it reaches the last waypoint.

Note: The manual mode must be used with LiPlan, otherwise, the LiDAR and camera data collection cannot be started.

b) Camera Mode

Camera Switch: Used to set whether to activate the camera

Trigger Mode: Periodic mode is time-triggered, that is, trigger shooting according to the set time interval, default is 2s, the range is 1-50s. Distance mode is distance-triggered, trigger shooting according to the set distance interval, the default is 10m.

Configuration Information: Set the size of the time or distance interval, which is consistent with the "Camera Interval" setting function of the LiPlan software.

4.4 Firmware Upgrade

The device supports online firmware upgrades. When the remote control is connected to the internet, the LiPlan software can download the latest version of the firmware from the cloud for device upgrades. The upgrade process is as follows:

1. Power on the aircraft, press and hold the device ON/OFF button for more than 3 seconds to turn it on, and wait for the indicator light to be always green, indicating that the device status is normal.

2. Turn on the remote control and ensure that the remote control is in a networked state.

3. Open the LiPlan software and log in.

4. Click the setting button in the upper right corner , a red exclamation mark in the upper right corner of the "System Settings" firmware version indicates that there is a new version of the firmware.

5. Click the "Firmware Version" option to start downloading the latest firmware. After the firmware download is completed, click "Upgrade", and LiPlan will automatically connect to the device and upgrade the firmware for the device.

6. After the firmware upgrade is completed, LiPlan will automatically restart. After the restart is completed, check whether the firmware version has been successfully upgraded.

Note: If LiPlan cannot connect to the device after automatically restarting, you

can manually restart LiPlan and try to connect again.

4.5 Data Collection

1. Power on the aircraft, press and hold the device ON/OFF button for more than 3 seconds to turn it on, and wait for the indicator light to be always green, indicating that the device status is normal.

2. After the device indicator light is normal, short press the ON/OFF button for 0-2 seconds, and the indicator light flashes green (1 time/second), create a project, and start recording IMU data.

3. After the aircraft takes off, the laser and camera data will automatically start collecting.

4. After completing the flight operation according to the designed route and landing, the collection of laser and camera data automatically stops, and the ground remains stationary for 5 minutes.

5. Short press the ON/OFF button for 0~2 seconds, stop recording IMU data and close the project, the indicator light is always green.

6. Press and hold the ON/OFF button for more than 3 seconds, the switch indicator light goes out, and the system is powered off.

7. Turn off the drone power.

Note: To improve the accuracy of inertial data, it is recommended to circle an "8" after takeoff and before landing.

5 Data Download

5.1 LiAir 220 Data Download

All data from the LiAir 220 is stored on the TF card, including project files, camera images, LiDAR data, IMU data, log files, etc. To download, insert the TF card into your computer and copy the corresponding project files (excluding those in the _NAV folder).

5.2 Base Station Data Download

To download data from the base station, use a double-headed USB cable. Connect one end to the USB port of the base station and the other end to your computer. The base station will be accessed as a removable disk, allowing you to directly read and copy the stored data. Base station data should be stored in the following location: create a 'Base' folder within the project folder and copy the base station data into the 'Base' folder within the project file.
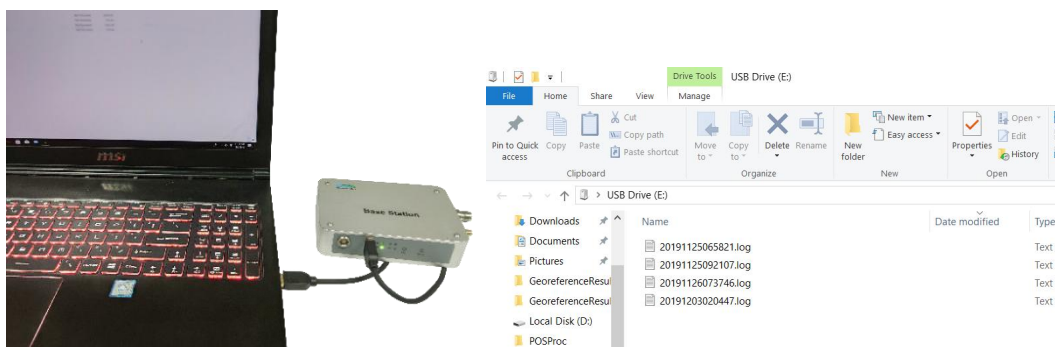
Note: The base station file name on the SD card is formatted as UTC time + suffix (log), for example 20170810063808.log.

6 Data Processing

The LiAir 220 data is processed using the LiGeoreference software. This software includes real-time IMU data processing, POS data processing and accuracy assessment, point cloud data processing, preliminary point cloud quality assessment, preliminary image quality assessment, 3D display of point cloud data, measurement, basic analysis, and other functions (see the LiGeoreference User Manual for more details). This section mainly introduces the process of using the LiGeoreference software to process LiAir 220 data.

6.1 Project Organization
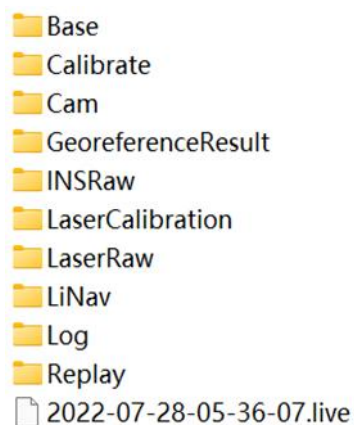
The project folder is named using UTC time and primarily contains the following files:

Base folder - This folder is generally used to store the base station data collected in the field. If no base station was set up in the field, you can use the software's 'green soil cloud trace' function to automatically download the base station file.

Calibrate folder - This folder stores the device calibration file (*.cal format), which is typically configured in the device at the factory. Do not change or delete these files; doing so could prevent data from being processed.

Cam folder - This folder stores the device camera images and exposure files (*.cam format). During the operation of the device, images are automatically saved in this folder.

GeoReferenceResult folder - This folder stores the point cloud results after calculation.

INSRaw folder - This folder stores the raw IMU data.

LaserCalibration folder - Empty folder

LaserRaw folder - Stores the raw data from the GreenValley laser radar (.vpts format). After data processing, the original laser data (.lvx format) will be added to this folder.

Note: .vpts is a data storage format unique to GreenValley.

LiNav folder - Used to store intermediate files of integrated navigation solution and the processed POS file.

Log folder - Used to store log files (.log format) that record operations during execution.

Replay folder - Empty folder.

*.Live - Project file, recording project organization, configuration content, and other information.

6.2 Open Project

1. Open LiGeoreference software, you can choose Open -> Browse, and select to open the corresponding project (*.live).

2. Projects that have been opened before will be displayed on the software interface, and you can also choose Open -> Recent Projects, and select to open projects that have been opened before, as shown in the following
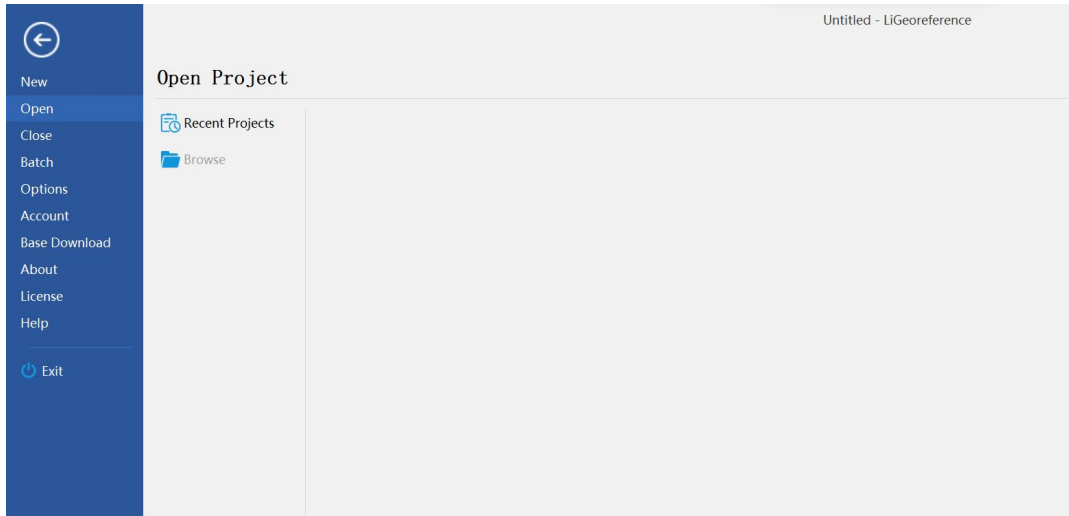
figure.

3. After opening, the software automatically imports the recorded IMU files, as shown in the following figure.
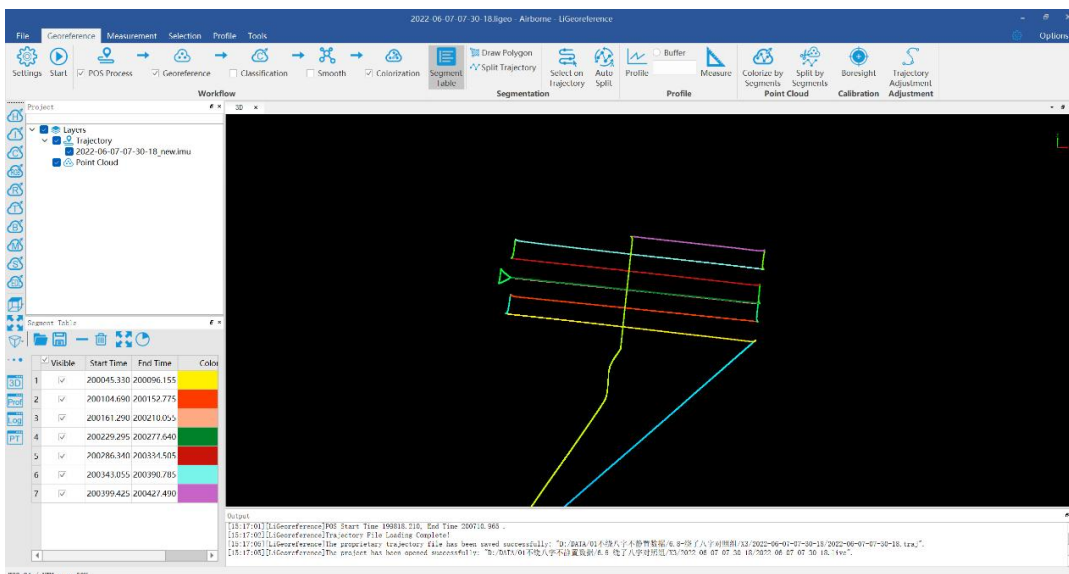
6.3 Parameter Settings for Calculation

Before calculation, the "Settings" function can be used to set calculation parameters, including laser settings, camera settings, POS processing, target coordinate system, classification, smoothing settings. Under normal circumstances, users only need to set POS processing.

6.3.1 POS Processing Settings

LiGeo software has the functions of POS calculation and point cloud calculation.
Users can directly use LiGeo software to calculate the POS of the LiAir220 device
or choose to use other third-party software for calculation.

1. POSUse LiGeo software to calculate POS
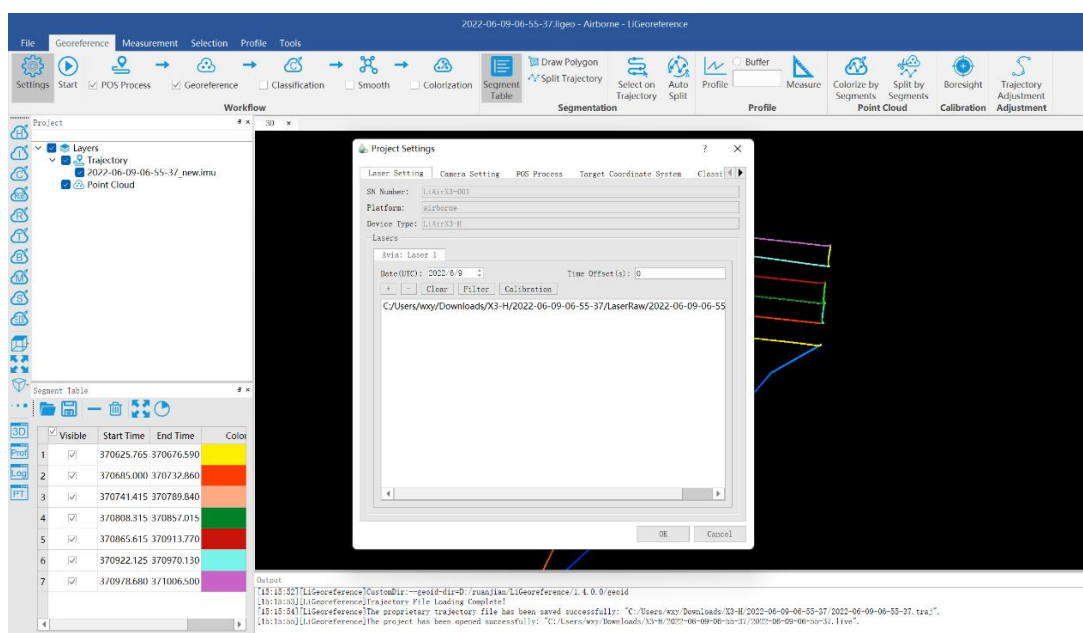
Select the "POS Processing" button in the settings interface, as shown below.
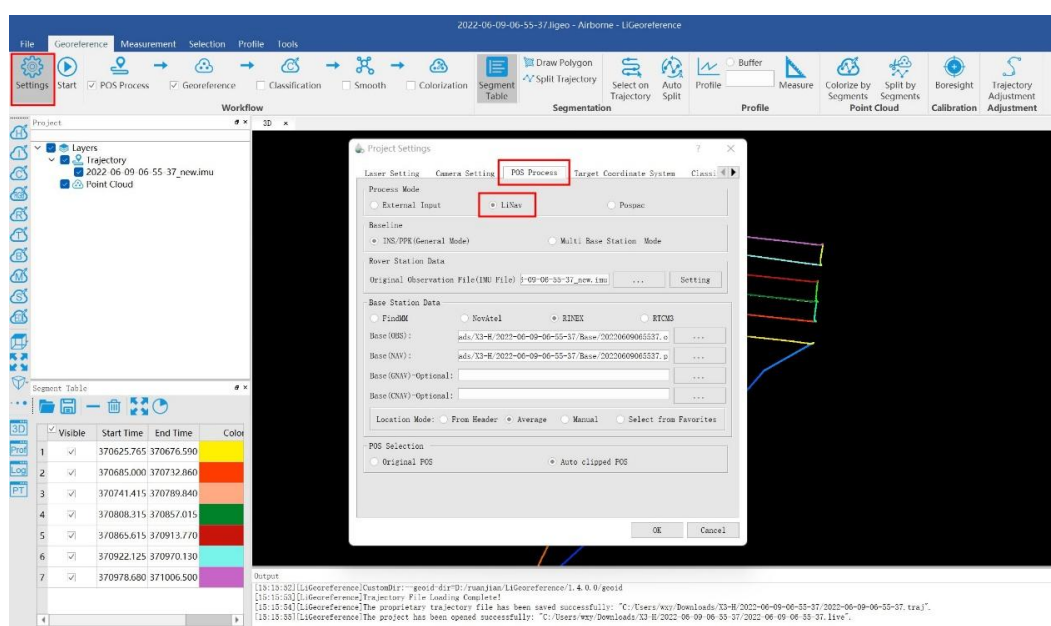
(1) Check the LiNav processing mode

(2) Choose the processing mode according to the trajectory line length. The general mode is recommended. When the trajectory line length is >10km, you can choose the multi-base station mode.

(3) Load the mobile station data. Under normal circumstances, the software will automatically read the mobile station data in the project folder.

(4) Select base station data Under normal circumstances, the software will automatically read the base station data in the project folder, or you can manually load the base station data.

If the format of the local base station is the Rinex format, select the Rinex option to load the base station data.

If the local base station format is Log format, select the NovAtel option.

（5）Input base station coordinates

● When there are no precise base station coordinates during field work, select "Average", because the base station belongs to single point positioning, and there is a meter-level distance error between the point cloud coordinates solved by this method and the actual coordinates.

● When you have accurate base station coordinates, you can manually input the base station coordinates. At the same time, users can use the "Save to Favorites" function to save the input base station coordinates, and later can directly call the saved base station coordinates through "Choose from Favorites".

● From header parsing: Some base station files store base station coordinates in the header file

● Choose from the Favorites: You can select the base station coordinates stored in the software.
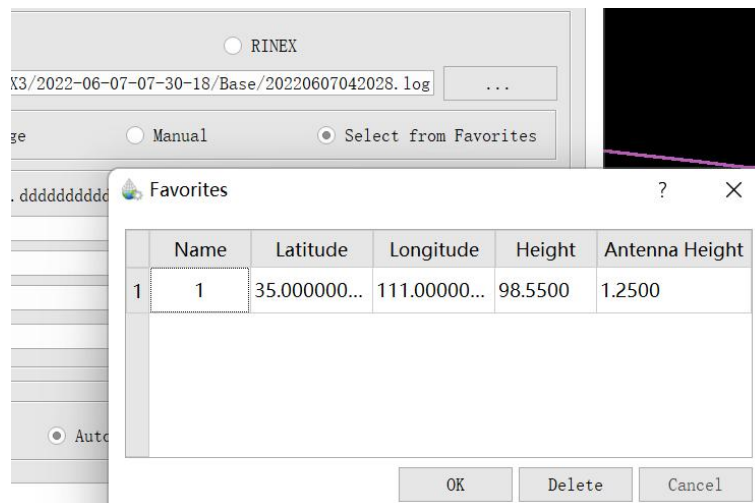
2. Import IMU or existing POS data externally

Select "External Input" under the "Processing Mode" in the POS processing interface, import the trajectory file, as shown in the figure below.
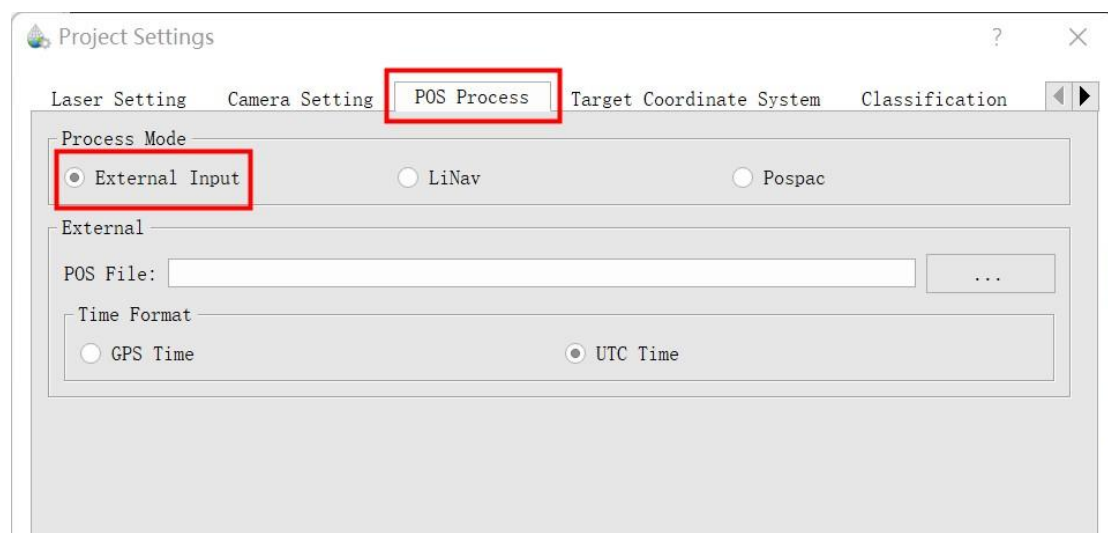
External input supports the import of raw IMU data and calculated POS data, the specific formats include *.POS, *.out, *.pof, *.sbtc, *.imu, as shown below.


6.3.2 Laser Settings

Under normal circumstances, users do not need to modify the parameters of the laser settings interface. If you want to limit the range of the output point cloud by reflectivity, distance from the laser, and scanning angle, you can enter the laser settings interface and click on "Filter" to set the range. For a detailed explanation of the parameters, please refer to the LiGeoreference software user manual.
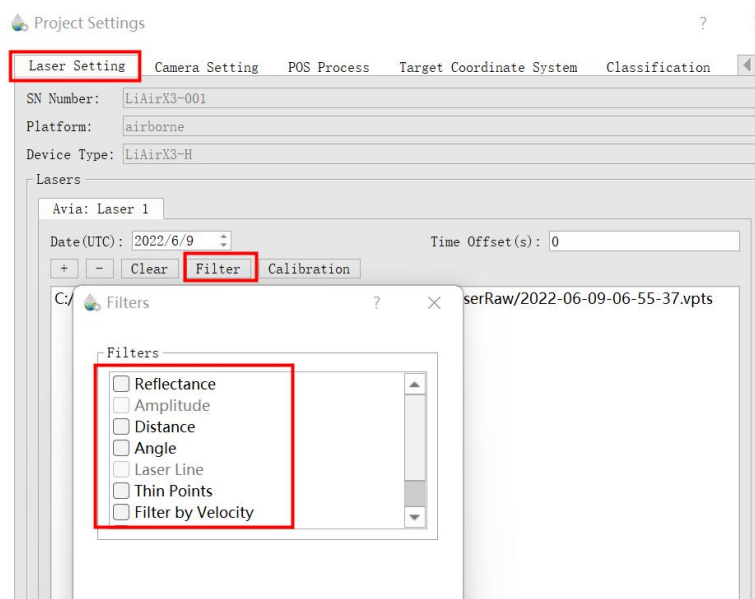
6.3.3 Camera Settings

Under normal circumstances, users do not need to modify the parameters of the camera settings interface.

Uniform color function: Sometimes, due to the influence of lighting, there can be a large difference in the brightness of the photos taken. This function will make the brightness more uniform, but it might slightly blur the colors.
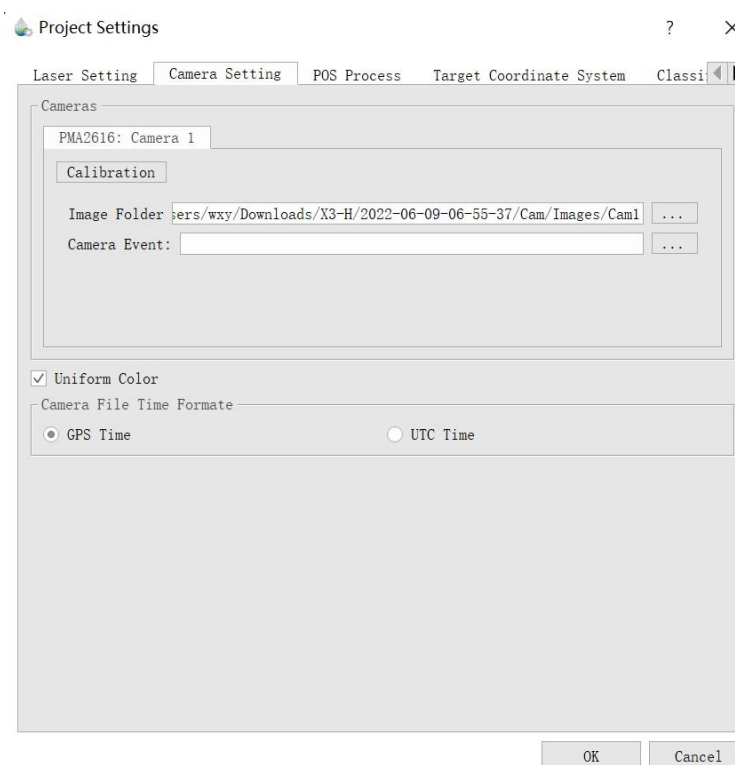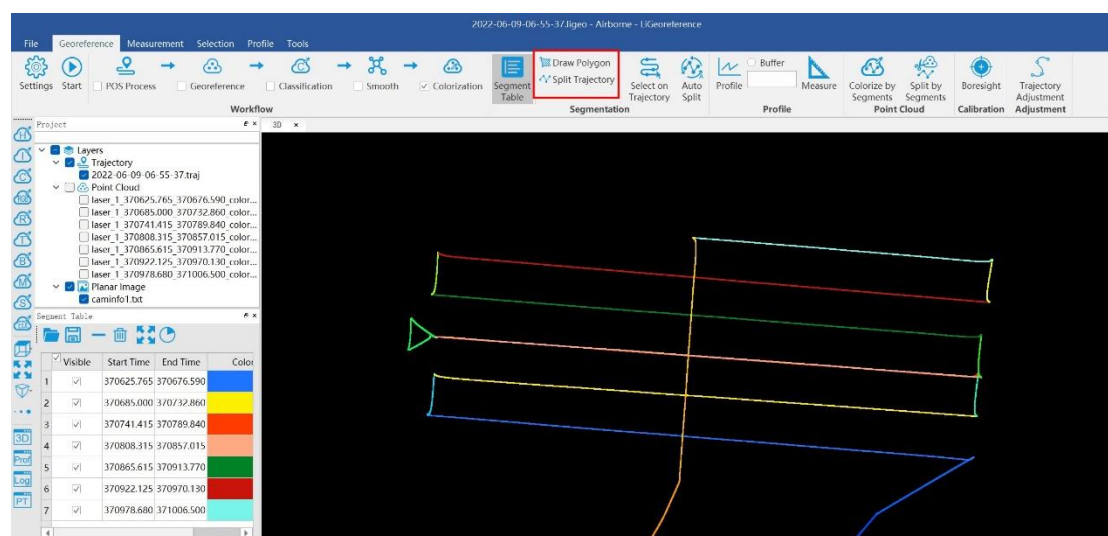
6.4 Data Calculation

1. Selection of Calculation Range

Users can select the range to be calculated according to the actual situation. You can use the "Track Selection" or "Draw Polygon" selection methods provided by the LiGeoreference software. For detailed function introduction, please refer to the LiGeoreference software user manual.

 (1) Click the "Track Selection" button on the main interface of the software, and click to select each part of the track that needs to be calculated.
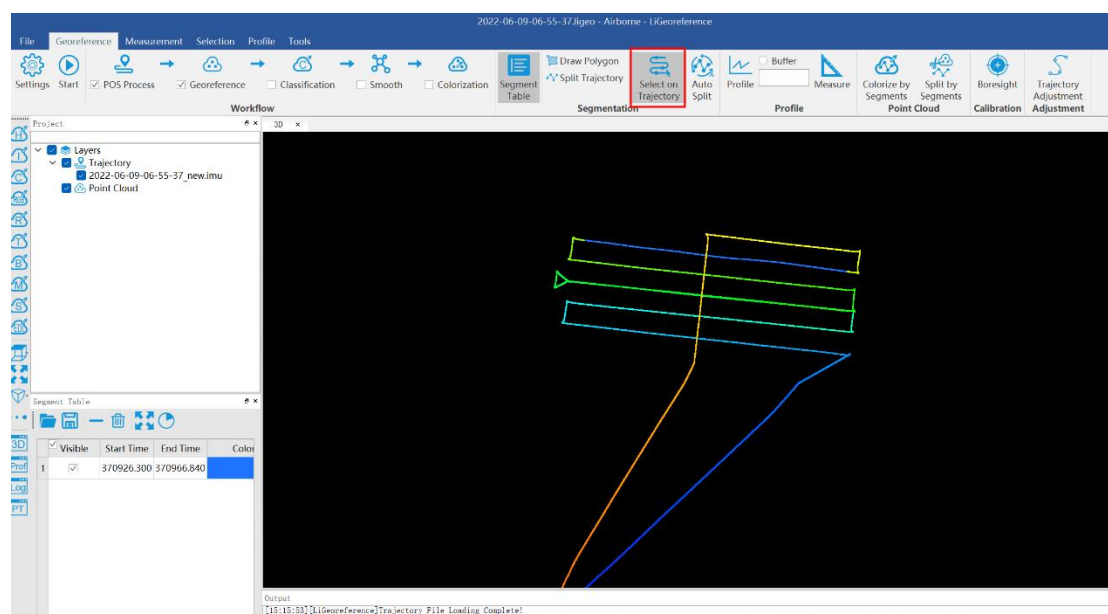
（2） If you need to select multiple flight paths, you can click "Draw Polygon" to select the range, click "Track Split" to split, and the selected track segments will be displayed in the cut table in the lower left corner, as shown in the figure below.


2.   Selection of Processing Modules

After opening the project, the program by default selects the POS calculation and point cloud calculation modules. Users can select the function modules to be used according to the actual data processing needs.
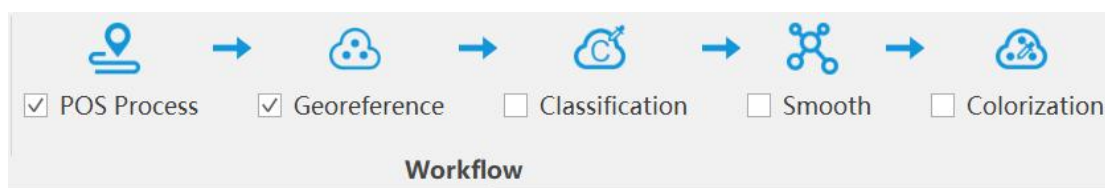
Note: If there is no image data in the data, do not select "Coloring", otherwise the program will prompt an error.

3. Data Calculation

Click the "Start" button to start the data calculation. After the calculation is completed, the point cloud is automatically displayed in the main window.
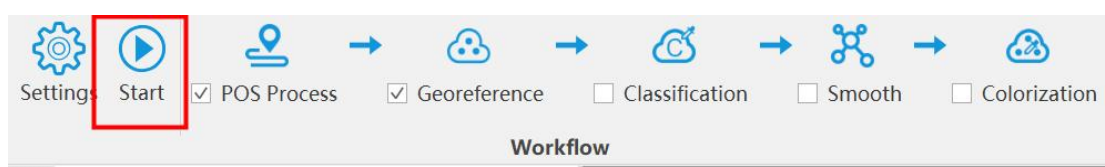

4. Calculation Report

If users need to view the POS track report and image overlap rate report, they can click "Track Chart" (or "Track Report") in the "Tools" column of the menu bar to view the POS track report and image overlap rate report (only for devices with cameras).
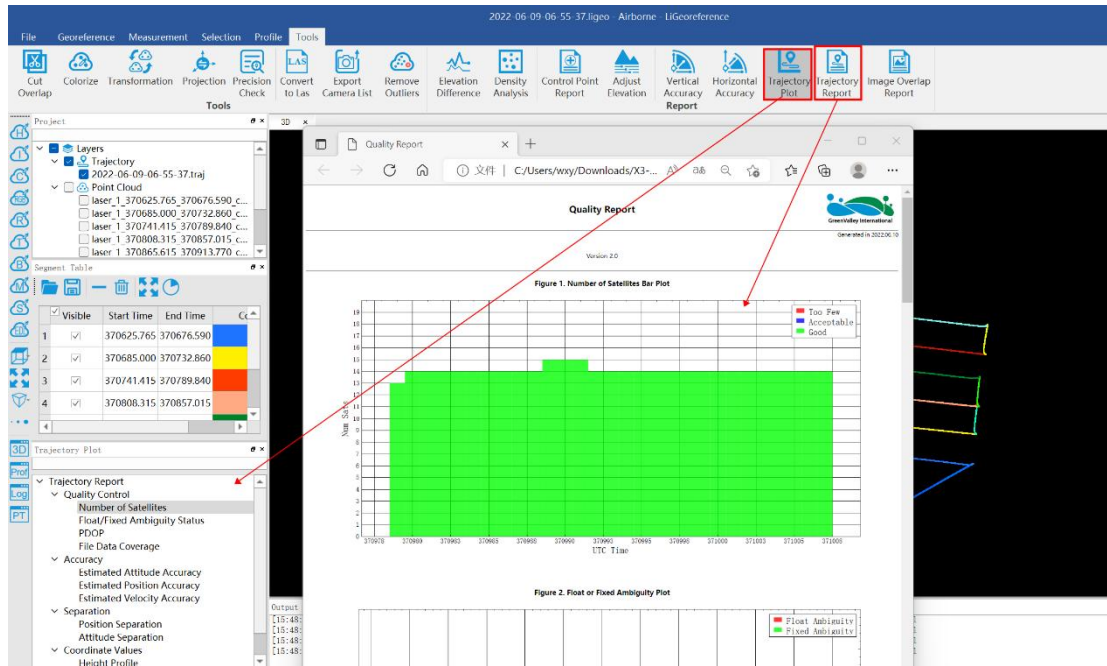
a) POS Trajectory Report

The software includes a total of 11 POS accuracy assessment standards, and when checking the data quality, it is mainly to check the number of satellites, data coverage, estimated attitude accuracy, estimated position accuracy, and PDOP value. Users can click on an evaluation index in the software to view the situation of this item, or directly click "Track Report" to generate a complete track accuracy report.

Number of Satellites: This tool can be used to check the number of satellites at each time point during the flight. When the color is green, it means that the number of satellites is qualified, when it is blue, it means that the number of satellites is available, and when it is red, it means that the number of satellites is less and there is a lack of GPS signal during flight. If the number of satellites is too small during a certain period, you can click on this area on the chart, right-click to select "Jump to Time", and then check the specific location of this area on the flight path in the data window.
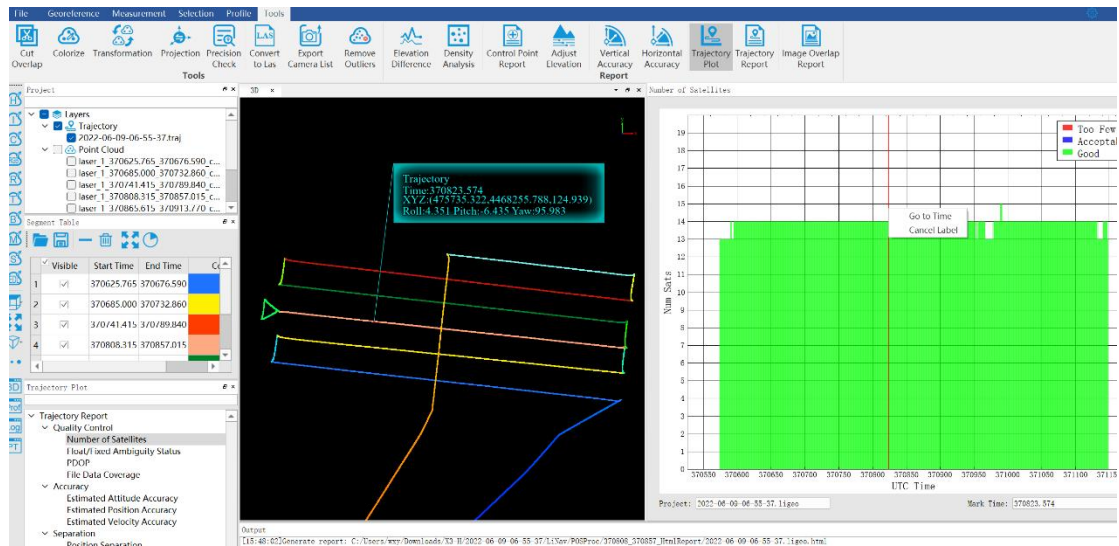
Floating/Fixed Integer Ambiguity: Can be used to explain the integer ambiguity calculation situation during post-differential calculation. If the status is green, it means that the integer ambiguity is a fixed solution. If the status is red, it means that the integer ambiguity is a floating solution.
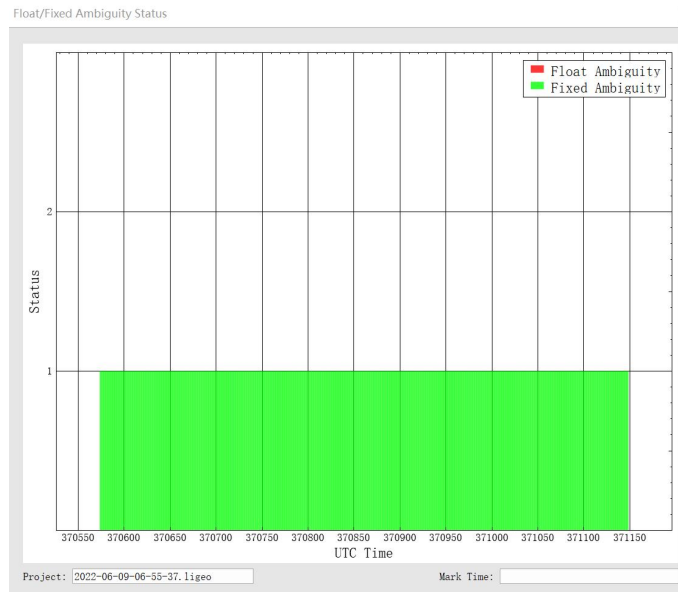

PDOP Value: A factor of spatial geometric strength of satellite distribution, used to reflect the distribution of GPS satellites. Click to pop up the PDOP rating table, generally the better the satellite distribution, the smaller the PDOP value.
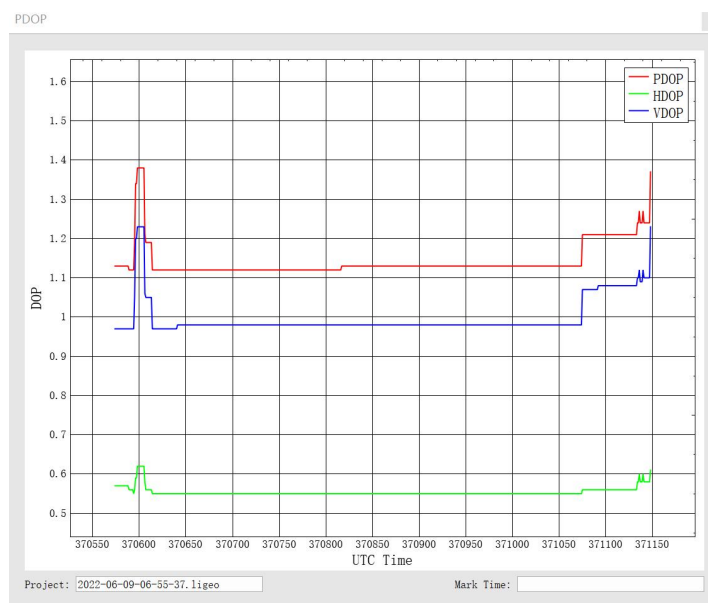
Data Coverage: Click to pop up the data coverage rating table, which represents the data time range coverage situation between the base station, the mobile station, and the IMU.
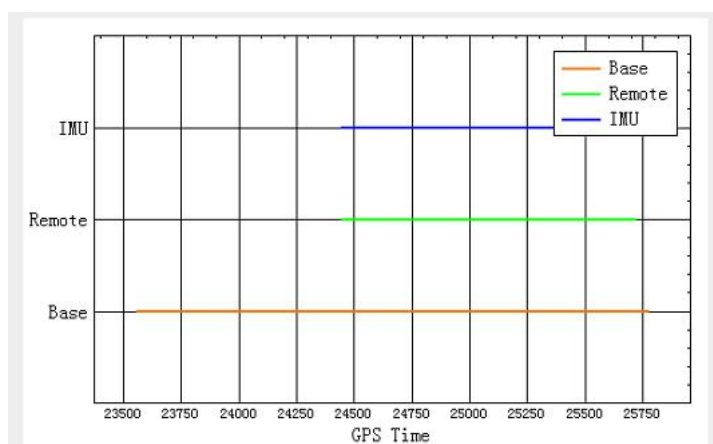
Estimated Attitude Accuracy: Attitude accuracy assessment. Click to pop up the attitude accuracy rating table. You can use this table to judge whether the inertial accuracy exceeds the limit during the flight. The horizontal axis in the figure is GPS time, and the vertical axis is the calculated angular variance value (in degrees). The red curve represents the calculated change of Roll, the green represents the Pitch angle, and the blue represents the Heading angle.
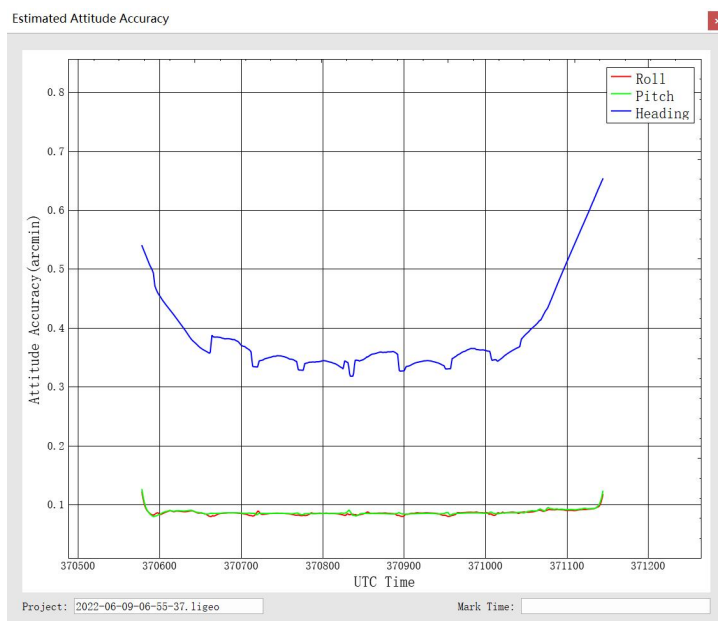
Estimated Position Accuracy: Position accuracy assessment tool, click to pop up the position accuracy rating chart. The horizontal axis in the figure is GPS time, and the vertical axis is position accuracy value (in meters). The red curve represents the position accuracy in the east direction, the green curve represents the position accuracy in the north direction, and the blue curve represents the position accuracy in the elevation direction.
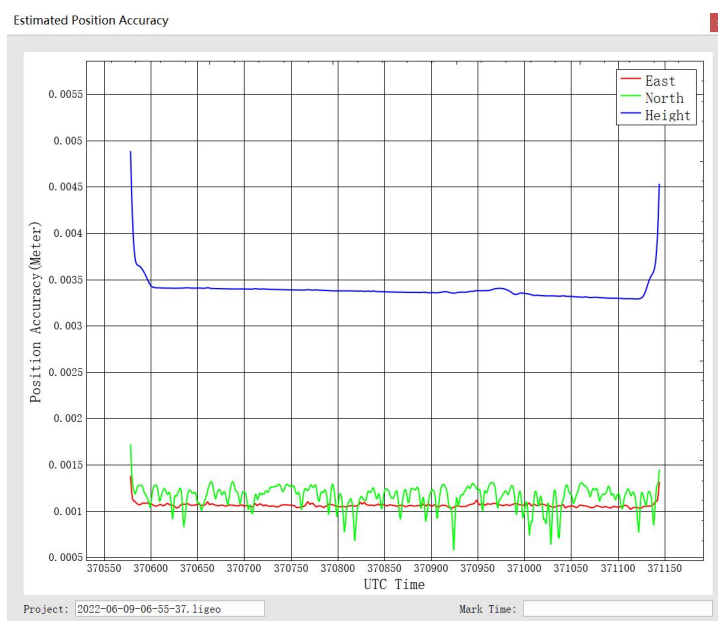

Estimated Velocity Accuracy: Click to plot the velocity accuracy. The X-axis shows

the GPS time. The Y-axis shows the velocity accuracy. Red line is for velocity accuracy in East direction. Green line shows the velocity accuracy in North direction. While the blue line shows the position velocity in height direction.
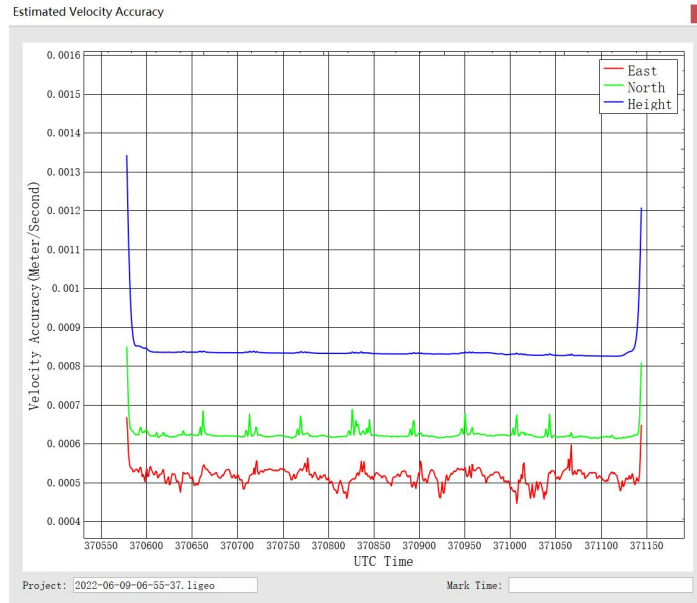

Position Separation Value: Can be used to plot the data position difference in the east, north, and high directions during forward and backward calculations. Click Position Separation Value to pop up the Position Separation Value Rating Chart.
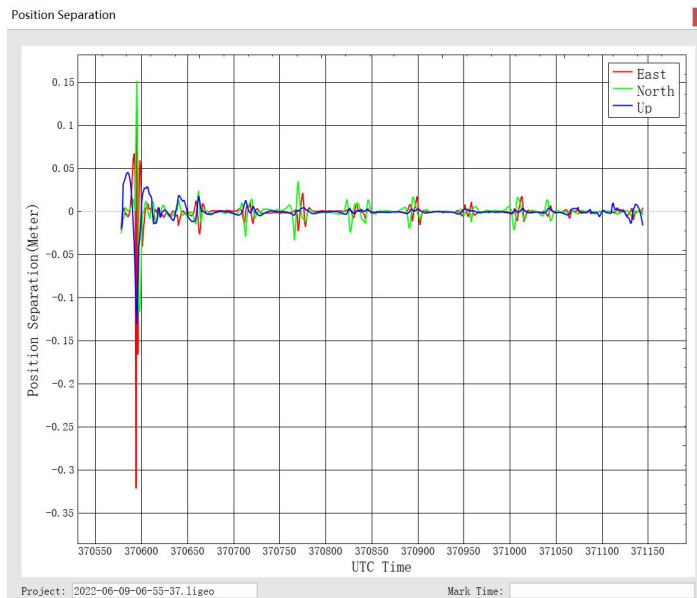

Attitude Separation Value: Represents the difference between Roll, Heading, and Pitch angles during forward and backward calculations. The smaller the value, the

higher the match degree of precision forward and backward calculation. Click Attitude Separation Value to pop up the Attitude Separation Value Rating Chart.
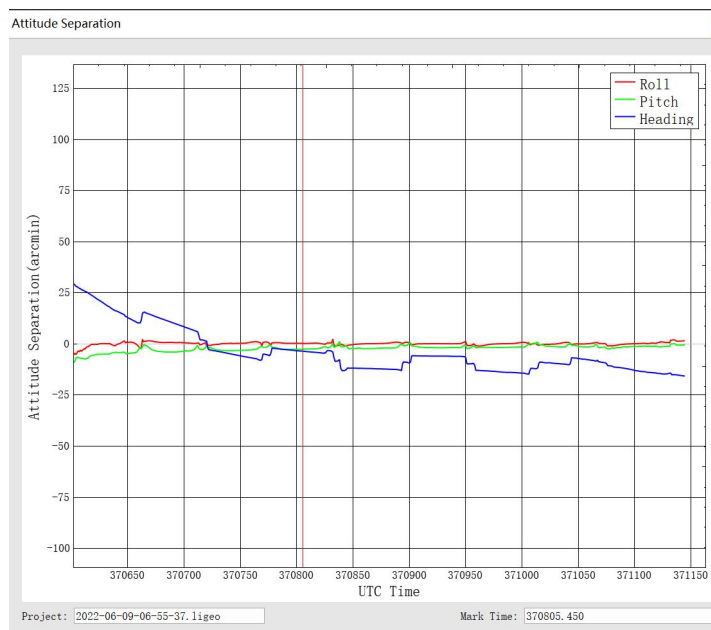

Height Graph: This graph can represent the height changes during the data collection process and the equipment operation process.
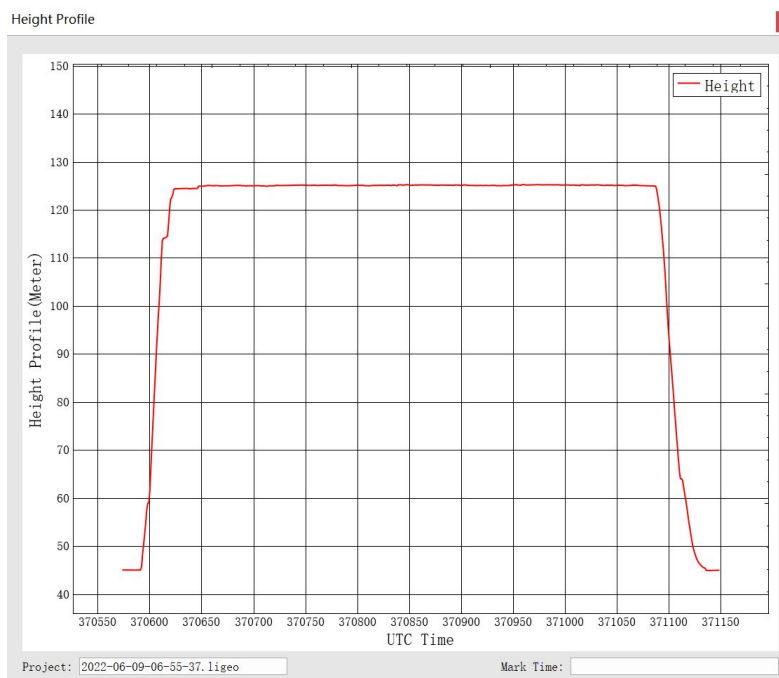
Velocity Profile: This plot shows the changes in velocity during the data acquisition. Red line is for the changes in East direction. Green shows the

changes in North direction. While the blue line shows the changes in up direction to the ground.
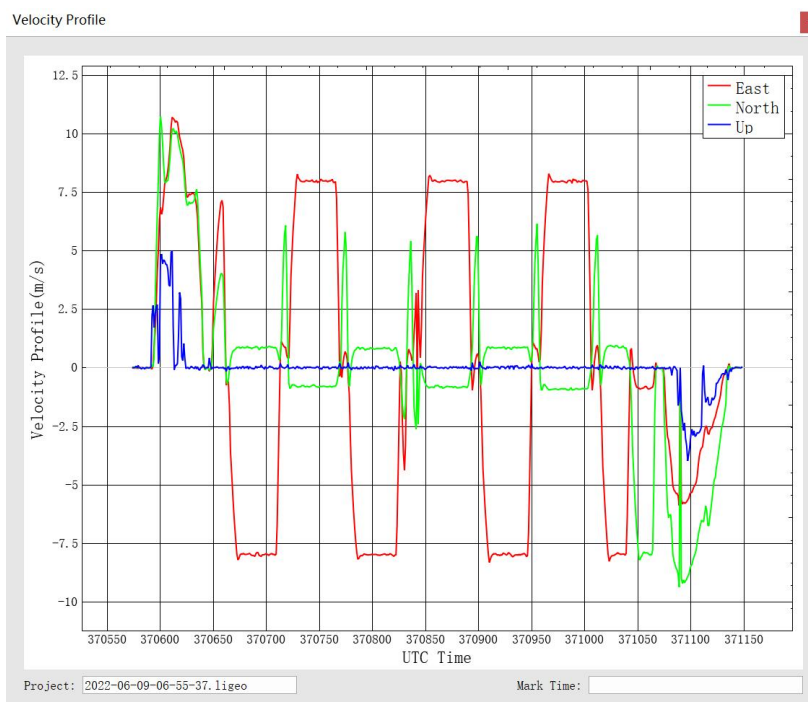
b) Image Overlap Rate Report (for devices with cameras)

The image report lists the image overlap graphs. Through this report, you can check whether there are missing images.

7 System Transport and Maintenance

7.1 Precautions for Equipment Use

To ensure reliable use of the equipment and personnel safety, please observe the following points during installation, use, and maintenance:

1. Pay attention to the protection of the scanning mirror to prevent scratches on its surface.

2. Handle with care during installation to prevent the instrument from falling or being impacted.

3. Before scanning, please ensure the scanning mirror is clean and dust-free.

4. Avoid working under sudden temperature changes to prevent equipment damage.

5. During operation, it is forbidden for any part of the body to directly touch the laser radar scanning head.

6. If the equipment needs to be transported, it must be packed in a box.

The operating environment of the equipment is -20°C to 50°C. In case of rain, snow, fog, sandstorms, and other severe weather, stop working to prevent equipment damage and ensure measurement accuracy. If severe weather occurs suddenly during work, please move the equipment to a safe place promptly.

7. When unplugging the GNSS antenna feed line, please pinch both ends of the connector. Violent plugging and unplugging are prohibited.

8. Non-professionals, without permission, please do not attempt to disassemble the equipment or perform unauthorized maintenance to avoid accidents or further equipment damage. If the equipment is modified or disassembled without authorization from GreenValley Inc., an after-sales warranty will not be provided.

7.2 Equipment Maintenance

1. Before turning on the equipment, check whether the scanner window is clean; if it is contaminated, it should be cleaned immediately.

2. After using the equipment, check whether the scanner window is contaminated; if it is, clean it immediately.

3. Routine cleaning: Use dedicated lens paper to gently wipe the laser radar scanning window in a circular motion from inside to outside.

4. The storage temperature range of LiAir equipment is -30°C to 60°C, and the storage environment requires ventilation and dryness.

5. Before storage, ensure all power sources are turned off, and the equipment is stored in a dedicated equipment box.

6. If stored for more than a month, a power-on test should be performed.

7. LiAir equipment should be transported in the packaging box provided at the time of purchase.

8. If you need to repack due to special circumstances, please ensure that the

packaging box has a certain resistance to pressure, and paste labels such as **"Precision Instrument", "Handle with Care", "Fragile"**, etc., on the outside of the box to avoid equipment damage.

9. The instrument is a precision instrument, and violent impacts should be avoided during transportation and handling to prevent damage or misalignment of the optical components inside the instrument.

10. During the warranty period, customers can enjoy free software upgrade services. After the warranty period, customers can purchase software upgrade services.