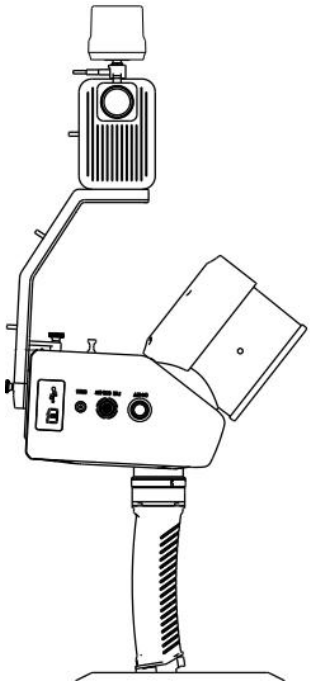
LiAir X4

Autonomous Flight LiDAR

Acquisition System

Handheld Kit（Panoramic camera）

User Manual



GreenValley International Inc.

Manual revision

Revised date	Revised times	Note
2025.5.22	1	First edition

User Instructions

This manual describes LiAirX4 handheld kit from installation, collection, calculation, and maintenance. Please follow the operation instructions, advice, warnings or precautions provided by the manufacturer in this specification.

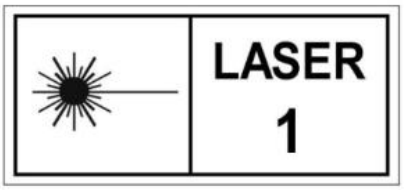
Symbolic tips

Note: Please read the information carefully during operation.

Warning: If you do not follow the instructions, it may cause equipment damage, data abnormalities and other conditions, please read it carefully.

Safety Precautions

1. LiAir X4 system uses Class 1 (IEC60825-1:2014) eye-safe laser sensors. If you have any concerns, please contact GVI for details.



2. Please stop using the system if you hear noticeable noises, warnings, or while the device is damaged. Contact the manufacturer's technicians for maintenance in time. Forcible use may cause permanent damage to the system.

3. Strictly follow the tutorials, advises, warnings, and other cautions included in this user guide as well as other documents provided by GVI.

4. Do NOT use any power supply outside the specified voltage range (12~28V，1.3A@24VDC). Incorrect voltage supply may cause permanent damage to the integrated instruments and other hazards. Damage caused by the use of an unauthorized power supply is not covered by the Product Warranty.

5. Keep the power, USB, network and other connector ports clean and dry, and do not insert other objects other than the connector.

6. Tampering with the product is strictly prohibited and will void the Product Warranty. Any repair, modification, or upgrade must be performed by GVI technician or authorized service provider.

7. This product is a high-precision mapping and surveying instrument that must be handled with care. This product should be stored and transported in the protective case provided with the LiAirX4 at the time of purchase or in a productive case authorized for use by GVI.

8. When not in use, store LiAirX4 system and accessories in a cool and dry environment. Make sure the device is powered off when performing maintenance and cleaning.

9. The working temperature of this equipment is -20℃~50℃. Below/exceeding this temperature range, it may cause wrong measurement results, data loss or equipment damage.

10. Before using the equipment, please ensure that the operating environment is far away from the source of electromagnetic interference.

11. There are corresponding specifications for battery use and storage. Please refer to the lithium battery use/storage specifications for details.

12. After the equipment is scrapped, please do not throw it directly into the trash can. It can be sent back to the manufacturer, and the manufacturer will handle it on your behalf.

GreenValley International Inc. reserves the right to explain the above terms.

GreenValley International Inc.

May 22, 2025

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Product Overview

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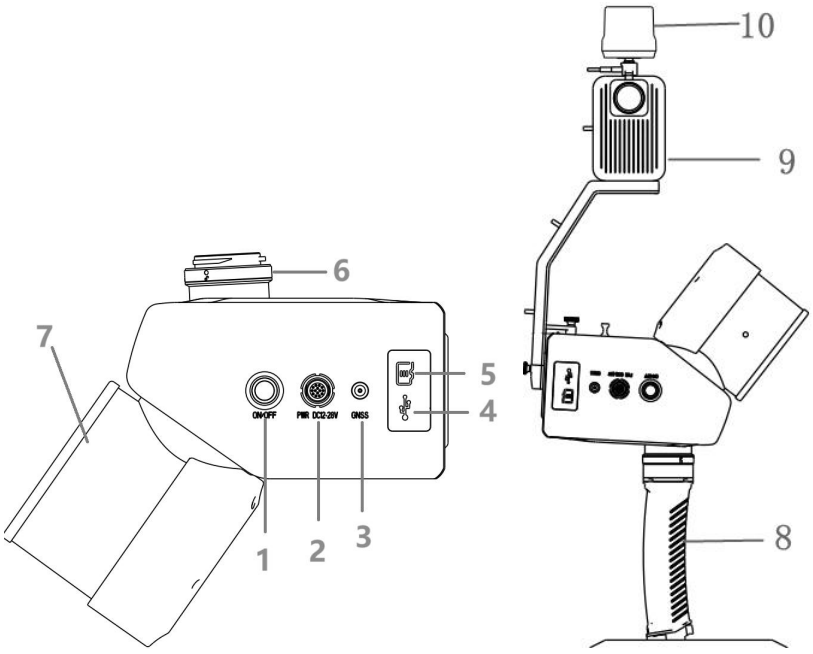
Product Installation

Product Introduction

LiAirX4 is the new generation of autonomous flight LiDAR data acquisition system developed by GreenValley International. It integrates a lightweight 32-line laser scanner, a high-precision inertial navigation system, a high-resolution camera, and a high-performance edge computing platform. The X4 handheld kit is a complementary accessory for the X4 product, which can be used to collect data in areas that are not accessible to airborne solutions, generating precise true-color 3D point cloud data in indoor or outdoor areas without GNSS signals by utilizing SLAM algorithms. It supports both pure SLAM calculation and PPK-SLAM calculation.

Product Structure



1. Power button (ON/OFF) and indicator light: Device power-on and project creation button (shared), also display device working status.
2. Power Connection Port (PWR): Connect the OSDK communication cable to communicate with aircraft, or connect power cable to power the device for handheld solution.
3. GNSS Interface: Connect the GNSS antenna feeder to obtain GNSS signals.
4. USB-C interface: Used to connect device to computer to do system upgrades, data download, etc.
5. Memory card slot: Equipped with 256GB TF card for data storage.
6. Gimbal Interface: DJI SKYPORT interface for device mounting and power supply.
7. Laser Scanner: XT32M2X, 32-channel.
8. Handle: Connects to the SKYPORT for gripping device.
9. Panoramic Camera Kit: Comprising an antenna bracket, antenna feeder cable, and panoramic camera.
10. GNSS Antenna: Used to obtain GNSS signals.

Packing List

Handle×1

Battery Box×1

Battery×1

GNSS Antenna×1

4S Charger×1

Panoramic Camera Kit×1

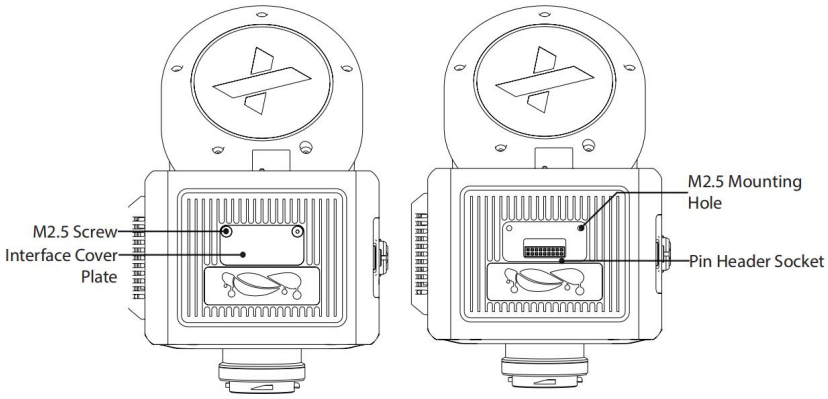
Power Cable×1

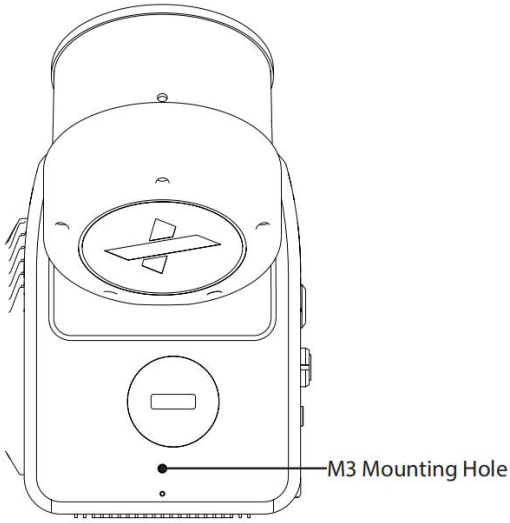
Shoulder Strip×1

Note: The actual product list is subject to delivery!

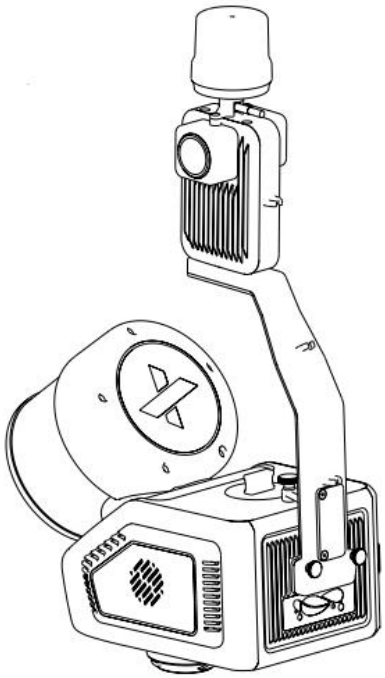
Product Installation

1. Remove the two M2.5 screws from the rear of the device. Detach the interface cover plate to reveal the pin header socket. Unscrew the M3 screw at the bottom of the device to reveal the mounting hole.

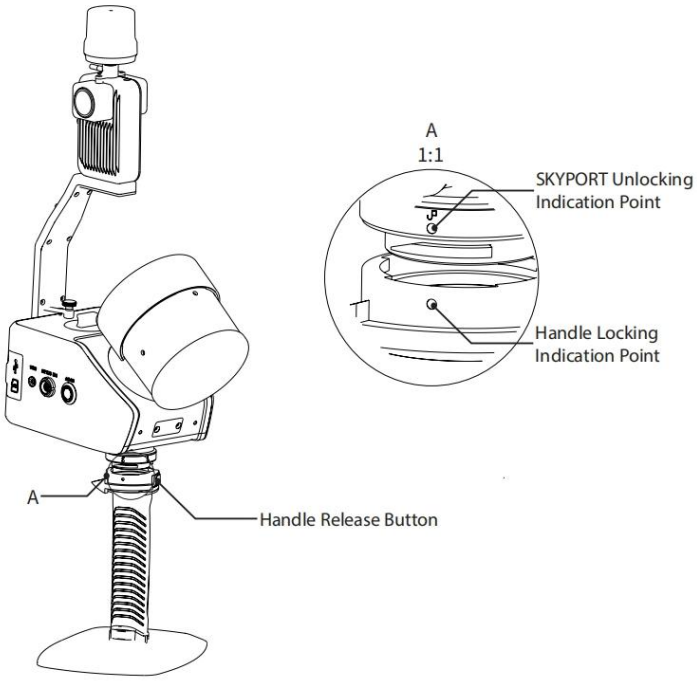




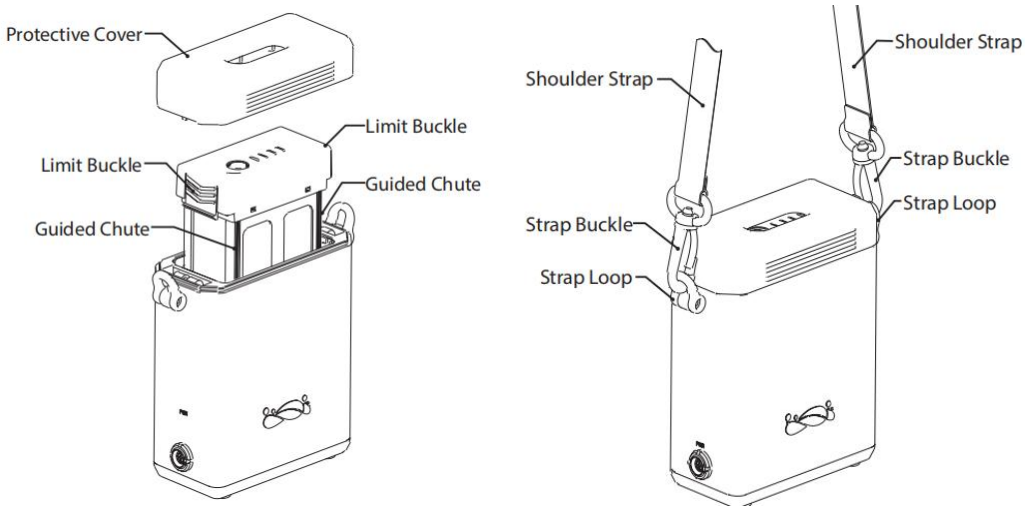
2. Align the pins of the handheld kit with the X4 device's pin header socket and insert firmly. Tighten the three thumb screws on the handheld kit to secure installation.



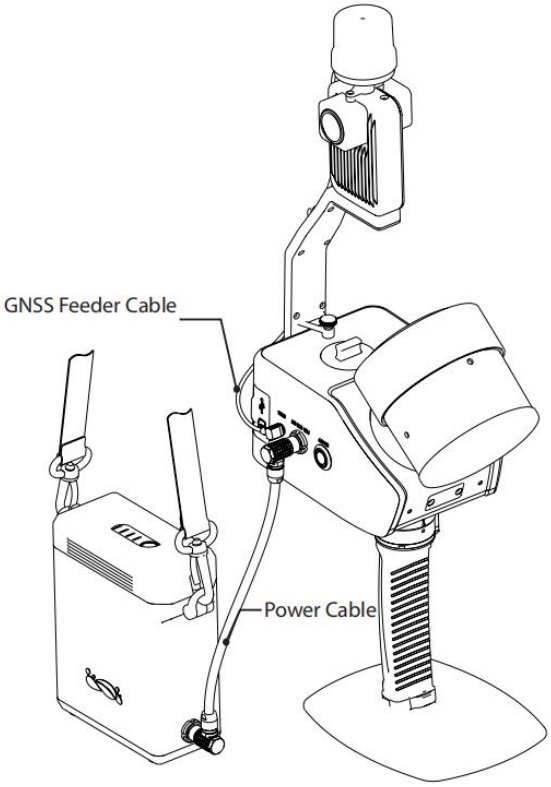
3. Align the SKYPORT unlocking indication point with the handle locking indication point, and insert the device. Rotate the device 60 degrees in the direction of the arrow, so that the SKYPORT locking indication point is aligned with handle locking indication point, and lock the device. Press the handle release button, and rotate the device 60 degrees in the opposite direction of the arrow to remove the device.



4. Unplug the protective cover of the battery box and press the limit buckles on both sides of the battery to insert it. When inserting the battery, make sure the correspondence of the guided chute and the guided rail in the battery box is correct, and do not insert it in reverse. Connect the shoulder strap buckles to the strap loops on both sides of the battery box.



5. Connect the Lemo end of the GNSS feeder cable to device's GNSS port. Connect the Lemo end of Power cable to the PWR port of the device, and the other end to the battery box. To disassemble the base, unscrew the thumb screw on counterclockwise on the base.


GNSS Feeder Cable
Power Cable

Data Acquisition

Base Station Setup

Parameter Setting

Path Planning

Data Acquisition

Base Station Setup

Set up the base station on the selected base station point. For surveying and mapping projects or other projects with high precision requirements, a tripod should be erected in accordance with specifications, and the base station should be erected on the tripod. The base station needs to start collecting data 5 minutes before the flight operation and stop collecting data 5 minutes after the operation ends.

- Open areas refer to those places which are not covered by high objects. The maximum elevation mask angle of surrounding objects should be less than 15°.

- The source of strong electromagnetic interference might be cellular base station, high voltage transmission lines, or objects with high reflectance (e.g., mirror, large water body) which may cause multipath propagation.

Note: If absolute coordinate point cloud data is not required and only pure SLAM computation is used, a base station does not need to be set up.

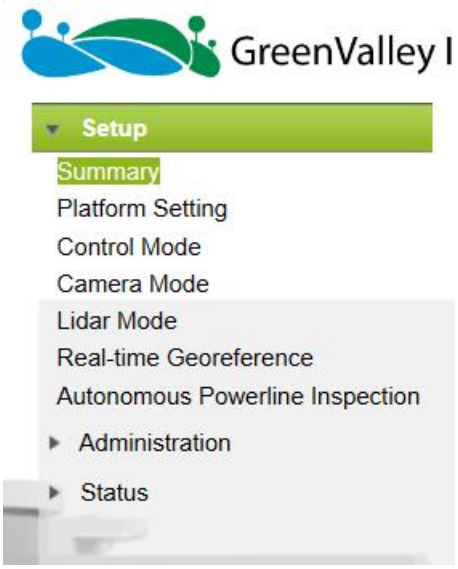
Parameter Setting

LiAir X4 will remember the parameters last set and you can skip this step if no modification is required. It can be modified by logging in to the device Web page, which mainly refers to modifying the device platform.

1. Establish communication between the device and a computer or smartphone via a WiFi network. After the device is powered on, search for the wireless network with the name LiAir_XXXXXX, click "Connect" and enter the password 66666666.

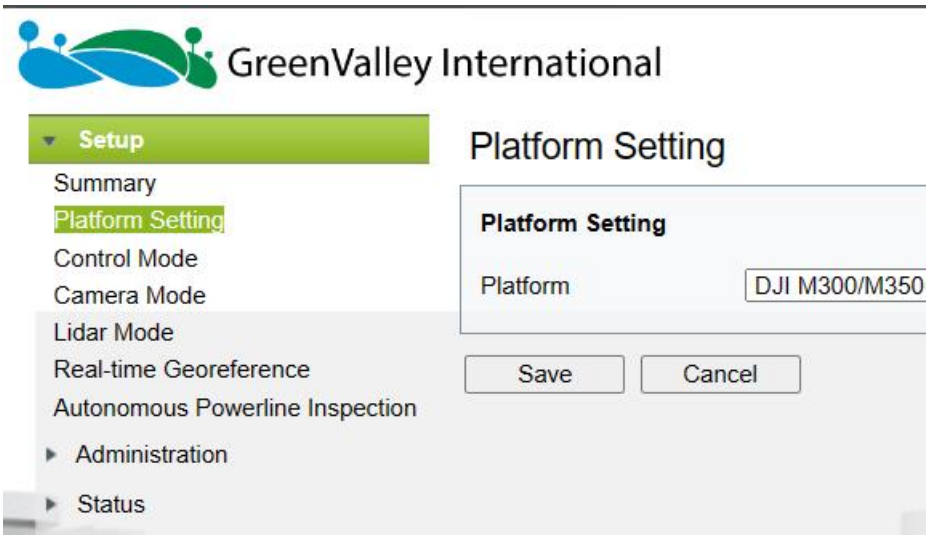
2. Enter 192.168.1.88 in browser to open the LiAir X4 Web Configuration page (username: root; password: 888888). Click "System Settings" to set the device

parameters.



Note: we recommend to use Google Chrome or IE11.

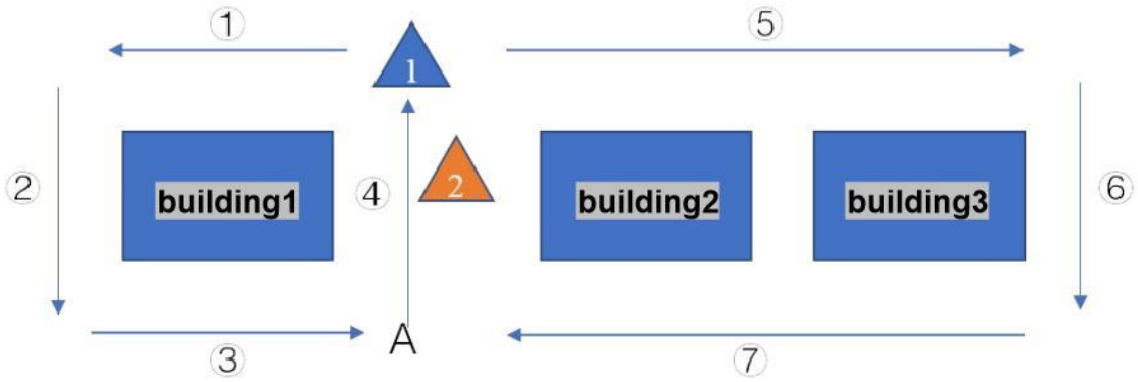
3. When the mounting platform is switched from an aircraft to handheld,the GNSS lever arm value will change, requiring the selection of the correct platform. The platform mainly includes DJIM300/M350, handheld platform,etc. The handheld platforms include the GV Hand and GV Hand (Pano),where the former refers to a non-panoramic camera configuration, and the latter is a panoramic camera configuration. After selecting the handheld platform, the built-in camera of the device will no longer take photos,and laser data acquisition will start synchronously after the project starts.



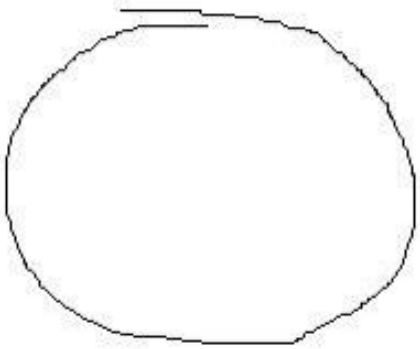
Path Planning

1. Closed Loop in Path Planning

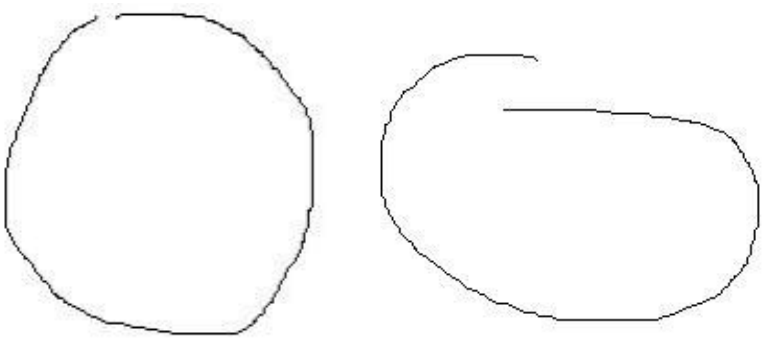
The closed-loop can better improve the reliability and accuracy of data. Therefore, when conditions permit, data should be collected in a closed-loop route as much as possible. As shown in Figure 3-1, buildings 1, 2 and 3 are the objects to be scanned. It is recommended to start scanning from 1 rather than 2. Before you start scanning, plan your scanning route. According to the above rules, the route you can take to scan in this scenario is ①②③④⑤⑥⑦ or ⑤⑥⑦④①②③.



In the closed loop, you need to walk an extra 5-10 m distance to ensure that the closed loop is correct.

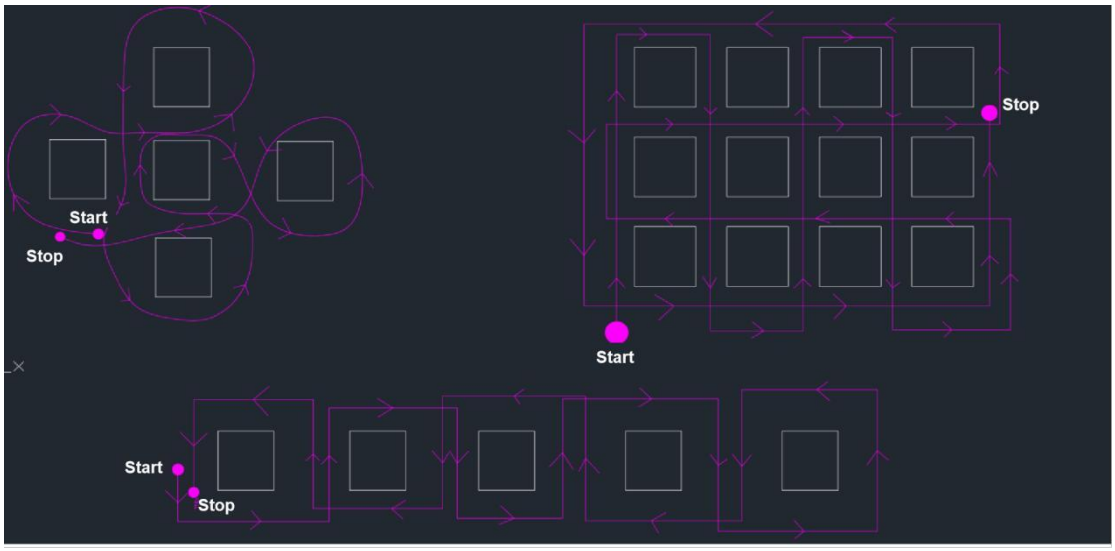


The following are examples of incorrect closed loops:



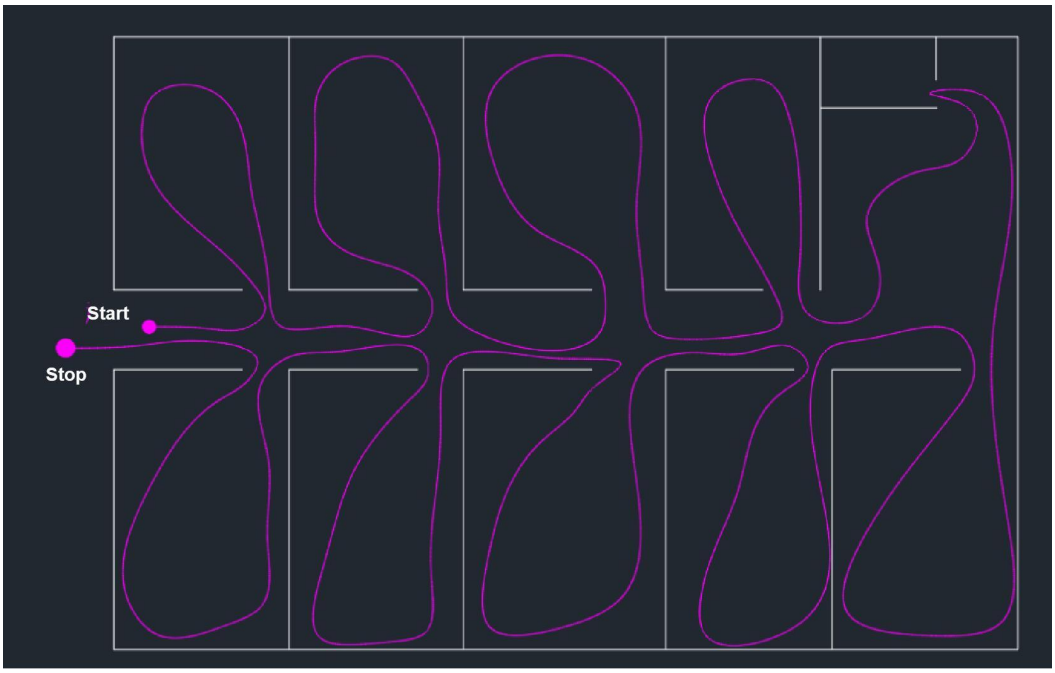
2. Path Planning for Outdoor Scenarios

The close-loop is an effective way to improve SLAM accuracy. The closed loop is an effective way to improve the accuracy of SLAM. Therefore, when conditions permit, take a closed loop as much as possible to reduce control points and improve accuracy. The ability to close the loop at the beginning and at the end can also improve the accuracy of the point cloud.



3. Path Planning for Indoor Scenarios

When conditions permit, take a closed loop for indoor scenarios as much as possible. Multi-floor Data Collection: If you want to collect multi-floor data (for example, there are a total of 5 floors), you can measure floors 1-3 and then floors 3-5. As a result, there is at least one floor of overlapping area.



4. Path Planning for Strip Scenarios

When collecting data in scenarios such as roads, tunnels, mines, and electricity, it is not recommended to backtrack (unless it is necessary). When collecting data at wider roads, it is recommended to collect data once at one side. This can reduce part of the cumulative error by taking an S-shape walk. If the high accuracy is required, it is recommended to arrange a control point at every 50 m.

Note: If the traffic and pedestrian flow are dense, it is recommended to collect data at night (for example, 0:00 AM - 6 AM). Collect data in strip scenarios carefully. Do not set the control points in a straight line. Measure the control points on the left and right sides in the strip scenario.

5. Path Planning for Mine Caves

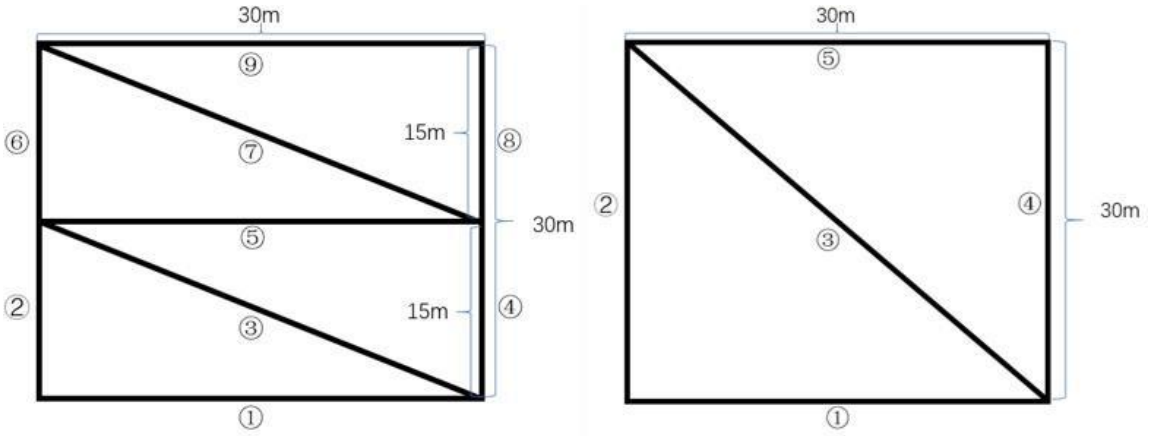
When conditions permit, take a closed loop for mine caves as much as possible. If it is not possible to take a closed loop, control points need to be laid out and the measurement time should be kept within 30 minutes (if there is no light or dim light in the mine and the camera is not very useful, we recommend turning it off to extend the single operation time).

6. Path Planning for Forestry

Take a 30 m*30 m forestry sample area as an example:

The path planning is carried out for the collection sample area. The purpose of path

planning is to collect all information about the trees with reducing data redundancy. For a 30 m*30 m sample area, if the trees are dense, use the path planning as shown on the left, if the trees are sparse, use the path planning shown on the right:



7. Measurement in Special Areas (Tunnels and Mines)

Where conditions permit, it is recommended that distinctive target objects, such as boxes, chairs, and tables should be set every 20m - 30m within the measurement area (objects should be large in size, with features distributed both horizontally and vertically).

It is recommended to scan in sections, with one section of 200m - 300m.

8. Zoning

If the survey area cannot be measured at one time, the area needs to be divided. The

division principles are as follows:

(1) Keep the measurement time for each area to a specified time.

(2) Maintain an overlap of 10%-20% in each area.

(3) The number of features within the overlapping area is sufficient.

Data Acquisition

1. To start collection, select an open initialization area with distinctive features. Make the handle stationary and steady by hand. Requirements:

   (1) Choose a steady and solid ground surface or platform.

   (2) If GNSS signals are accessed, ensure good conditions for searching satellites (usually greater than 20).

   (3) Avoid strong electromagnetic interference in the vicinity.

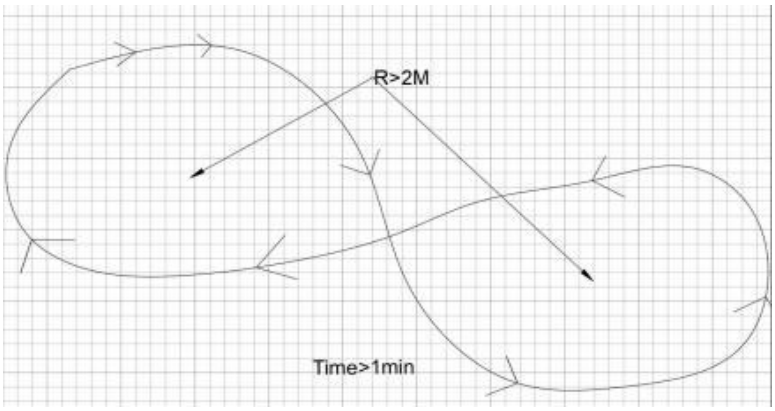
   (4) Do not initialize in areas with heavy pedestrian or vehicular traffic.

   (5) Do not initialize in open areas.

2. Short-press the battery for 1s and then press for 2s to power it up. Press the device ON/OFF button for more than 3 seconds to power it on. After the power is turned on, the laser will automatically rotate two circles, and after the red light is solid, it will automatically rotate one more circle to complete the self-test.

3. Wait until the indicator turns solid green. Press the ON/OFF button for 0~2 seconds. The indicator blinks in green once per second. A project is created, with starting to record IMU and laser data. The laser scanner will begin to rotate after 5-10 seconds.

4. After the start of data collection, the device needs to be placed on the ground to be stationary for 30s. At the end of the stationary period, it is necessary to carry out the movement in figure-8 trajectory, with a radius of not less than 2 m on the ground.



5. Use the device to collect data according to the route planned in advance. After the data collection is completed, move in figure-8 trajectory in an open area. After completing the movement in figure-8 trajectory, the device must remain stationary for 30 seconds.

6. Press the ON/OFF button for 0~2 seconds to stop IMU data recording and shut down the project. If you need to continue to collect data at this time, start operations directly from Step 1.

7. If you confirm that data is completely collected, press the ON/OFF button for more than 3 seconds. The ON/OFF indicator is off and the system is powered off.

Note: Be sure to keep the device's movement in figure-8 trajectory before data collection.

Meaning of status indicator status:

LED	Color/Status	Description
ON/OFF	Flashing Red (Four Times a Second)	System is powered on and initializing
	Solid Green	System initialization completed
	Flashing Green (Once per second)	The project has been created, the inertial navigation data is being recorded, and the system is working normally

	Flashing Red (Once per Second)	The project has been created, the inertial navigation data is being recorded, and the system is working abnormally
	Solid Red	The system status is abnormal, the reasons include: 1. TF card space is less than 15G 2. IMU misalignment 3. Camera self-test fails 4. The laser scanner is not synchronized

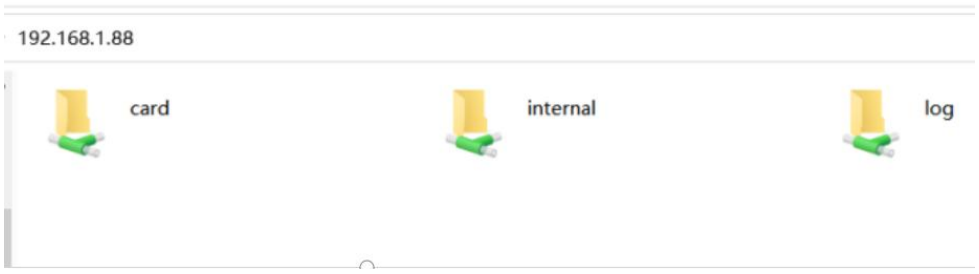
Data Download

The data of LiAir X4 can be stored in TF card or internal SSD. You need to insert the TF card into the computer or use a USB cable to copy the data from SSD to the local hard disk.

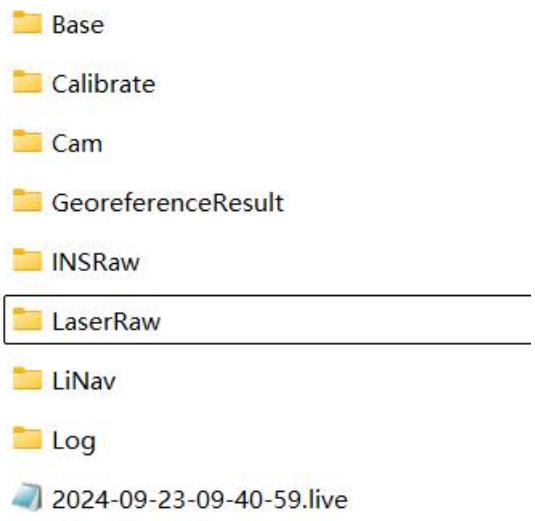
Copy the data from SSD

(1) Use the USB cable to connect the computer and the device. After the computer recognizes the device network, Change the IP address to 192.168.1.66, and the subnet mask is 255.255.255.0.

(2) Open my computer or any file, enter \\192.168.1.88 in the address bar, find the corresponding project in the internal folder and copy it to the computer.



Copy the base station data to the Base folder under the project folder.


Base
Calibrate
Cam
GeoreferenceResult
INSRaw
LaserRaw
LiNav
Log
2024-09-23-09-40-59.live

Data Georeferencing

Project Folder Structure

Opening Project

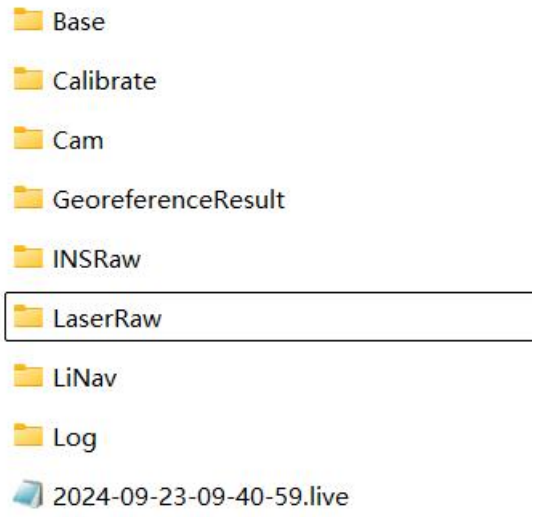
Configure Parameters

Georeferencing Point Cloud Data

Data Quality Assessment

LiAirX4 Handheld data processing uses the **LiDAR360MLS** software independently developed by GVI.

Project Folder Structure



The project folder is named UTC Time, and including:

-Base folder is used to store the ground GPS base station data.

-Calibrate folder is used to store calibrated files (*.cal). Please notice that: do not remove or delete this folder, otherwise, the performance of georeferencing will fail.

-Cam folder is used to Store device camera images (Images files) and panoramic camera images (Panorama folder) and the information of exposure time, location, and attitude angles of each image (.cam).

-GeoreferenceResult folder is used to store the post-processed point cloud data calculated by the LiGeoreference software.

-INSRaw folder is used to store the raw IMU data (*.rgps,*.rimu,*.rnav).

-LaserRaw folder is used to store the raw data of laser scanner's point cloud (*.vpts) and rotlog file of encoder .

*Note: *.vpts is the default format developed by GVI.*

-LiNav folder is used to store the intermediate file when processing the data of integrated navigation system. What's more, the finial-georeferencing results of POS data are suitable to be stored as well.

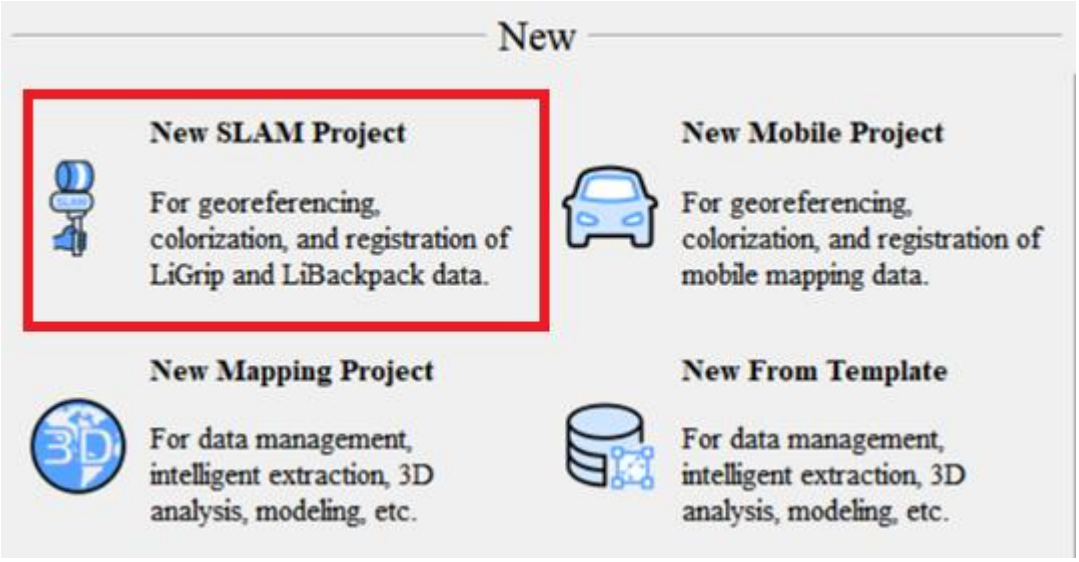
-Log folder is used to store the log information of the project showing detailed operation process.

-*.Live (project file) is used to record the information of project organization, configuration values, etc.

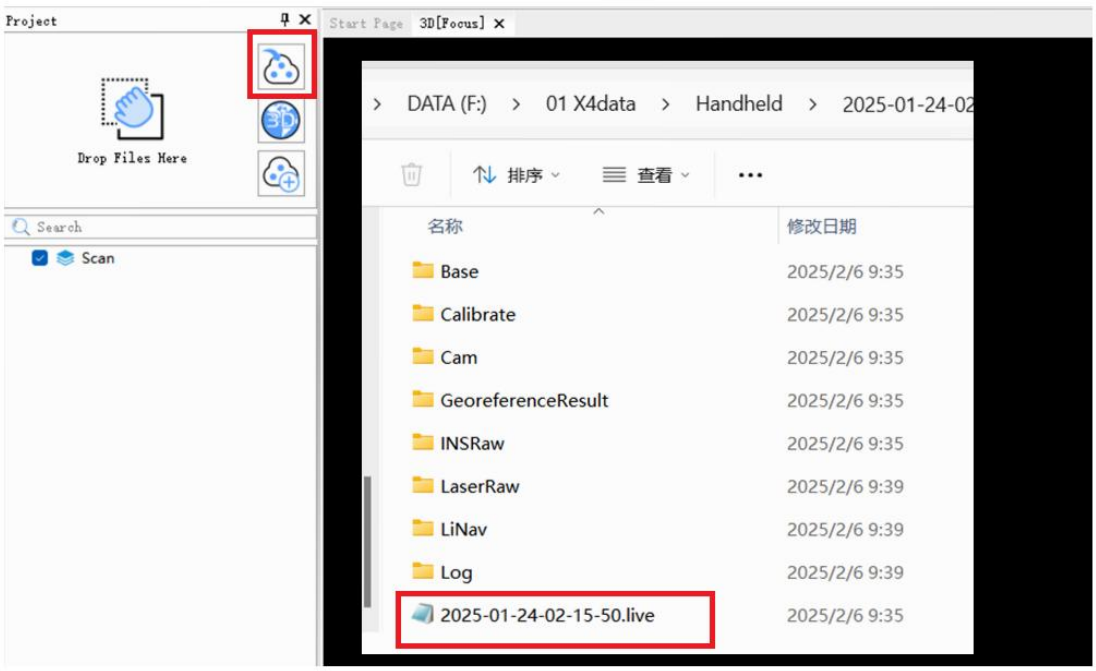
Warning: Do not modify or delete any original data files in the project, such as calibration files (.cal), otherwise the data cannot be processed.*

Opening Project

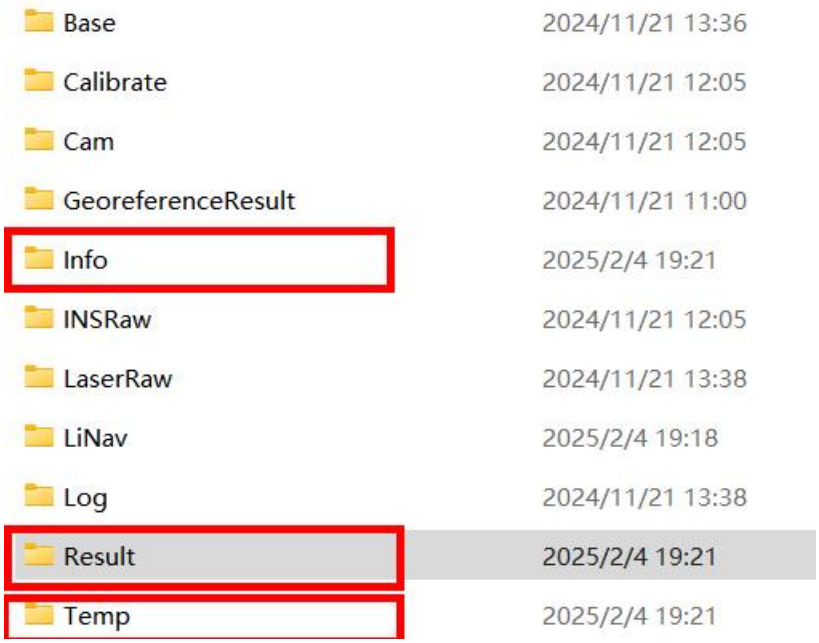
Click on the MLS interface to create a new SLAM processing project. Alternatively, go to "File" -> "New"->"Slam".



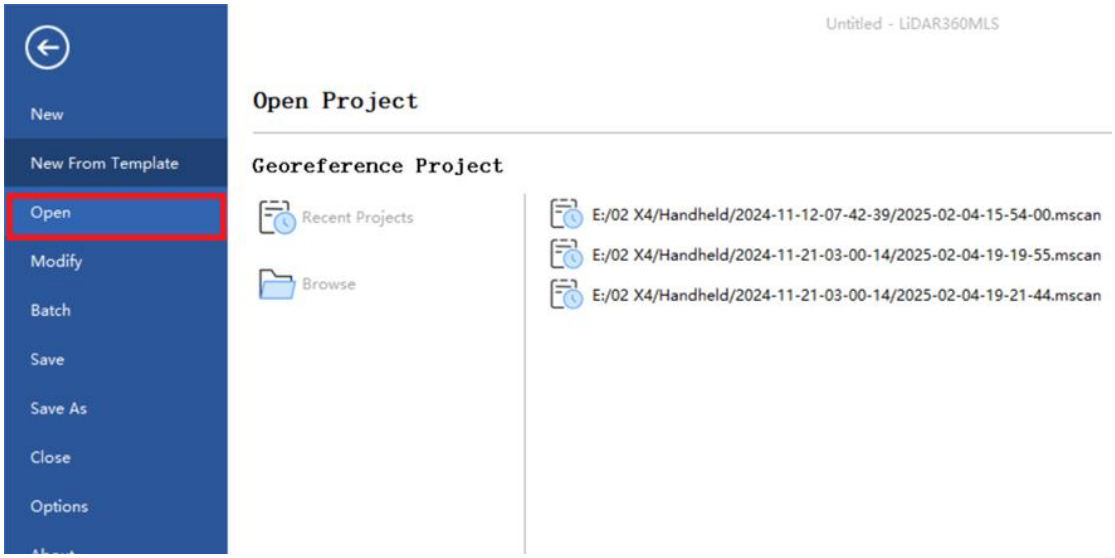
Drag the *.live file under project directory to the project window, or click the "Add" button to select the file.



After the project is opened, several new folders will be generated in the project directory to store the results and intermediate files generated by SLAM solution, and Result file is used to store the point cloud data after SLAM solution.

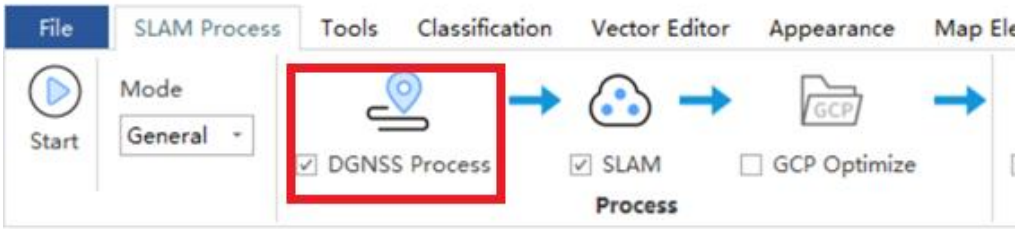


For the open project, select the “file”-> “open”, and select the open project file on the interface.



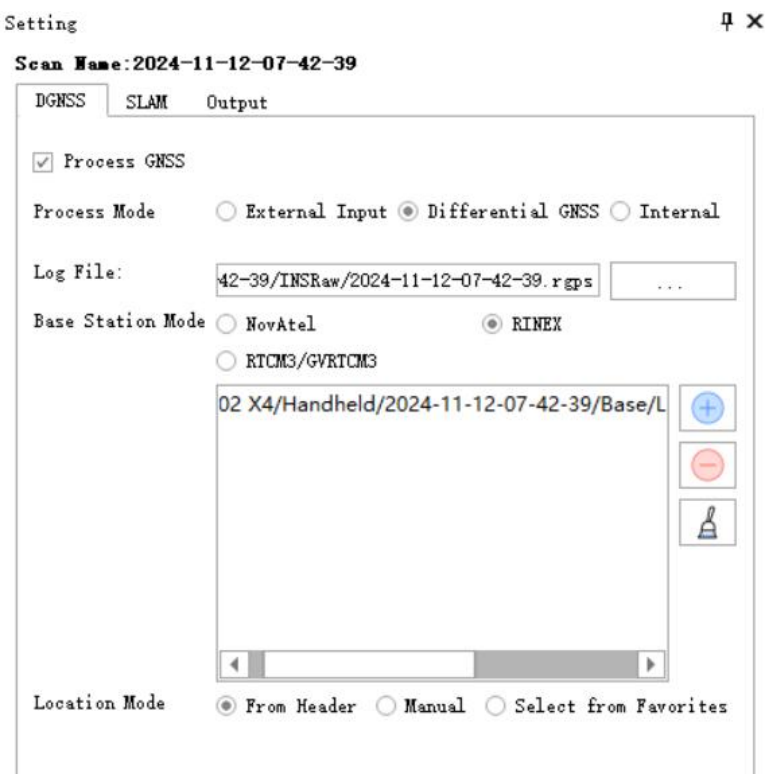
Configure Parameters

The software supports two modes: PPK-SLAM and pure SLAM solution. PPK-SLAM solution requires to performing DGNSS processing. During data processing, DGNSS calculation will be perform to generate point cloud data with absolute coordinates. Pure SLAM solution does not need to perform DGNSS processing, but only conducts SLAM processing to generate point cloud data with relative coordinates.



1. DGNSS setting

GNSS mobile station data and base station data should be imported in PPK-SLAM mode.



Check the “Process GNSS” and set the following parameters:

(1) **Process mode:** Including External Input and Differential GNSS. External input is to import the trajectory generated by the third-party software, and Differential GNSS is to solve the trajectory using MLS.

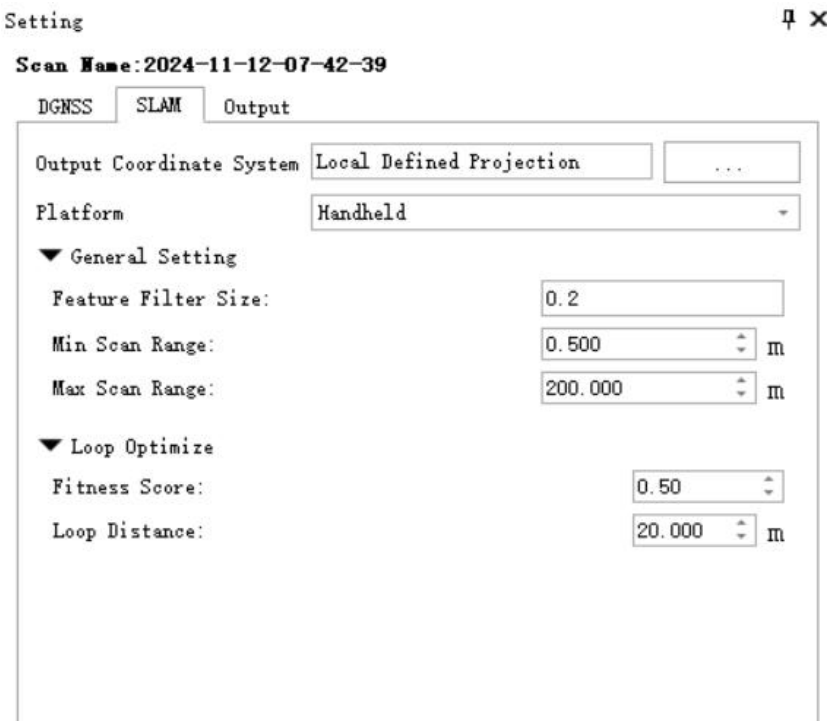
(2) **Log File:** To import the mobile station data, select the *. rgps data from project folder-> INSAW folder.

(3) **Base Station Mode:** Including NovAtel, RINEX and RTCM 3 formats.

- Select the RINEX format and import the *.OBS file, and the other files can be automatically read by the software.
- If the base station is *. log file, select the NovAtel format.
- If the base station is *. RTCM3 file, select the RTCM3/GVRTCM3 format.

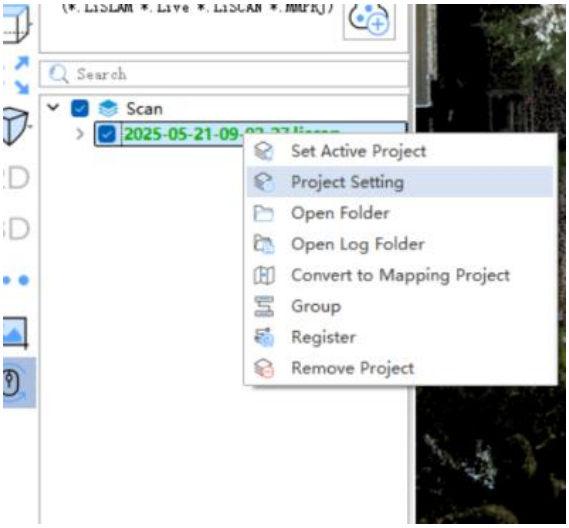
2. SLAM setting

Including the output coordinate system setting, general setting and loop optimize.

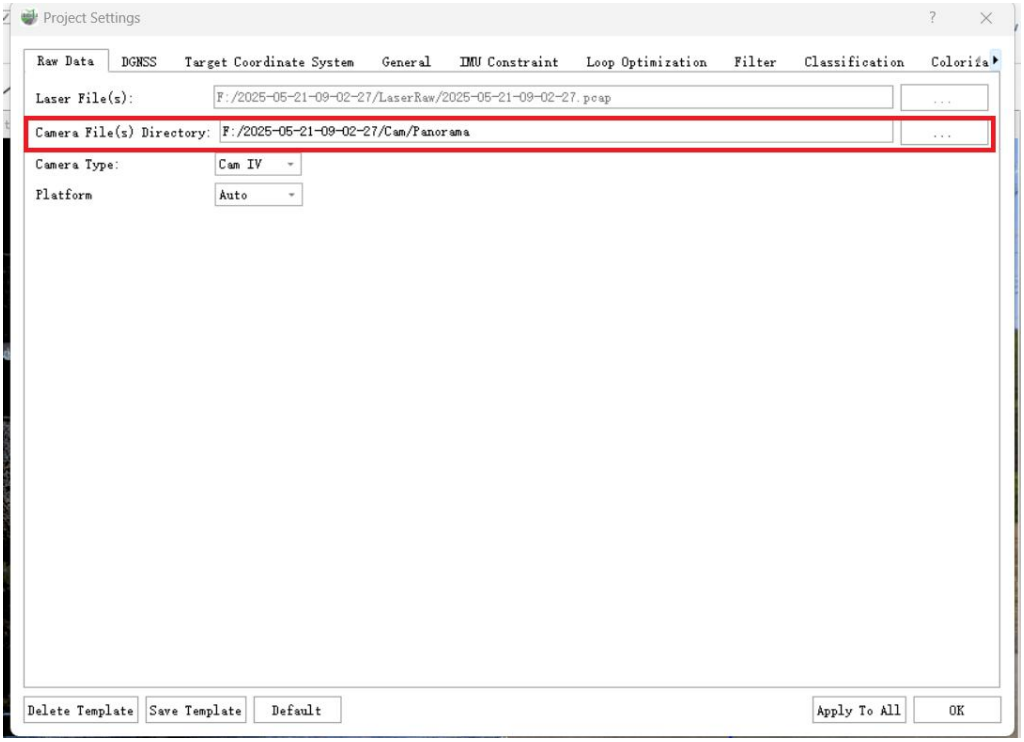


3. File path of panoramic camera setting

If you need to color the point cloud, you need to first set the panoramic camera folder path, right-click on the project directory, and click "Project Settings" in the pop-up box.



Select the Cam/Panorama folder under the project folder in the Camera File （s） Directory.

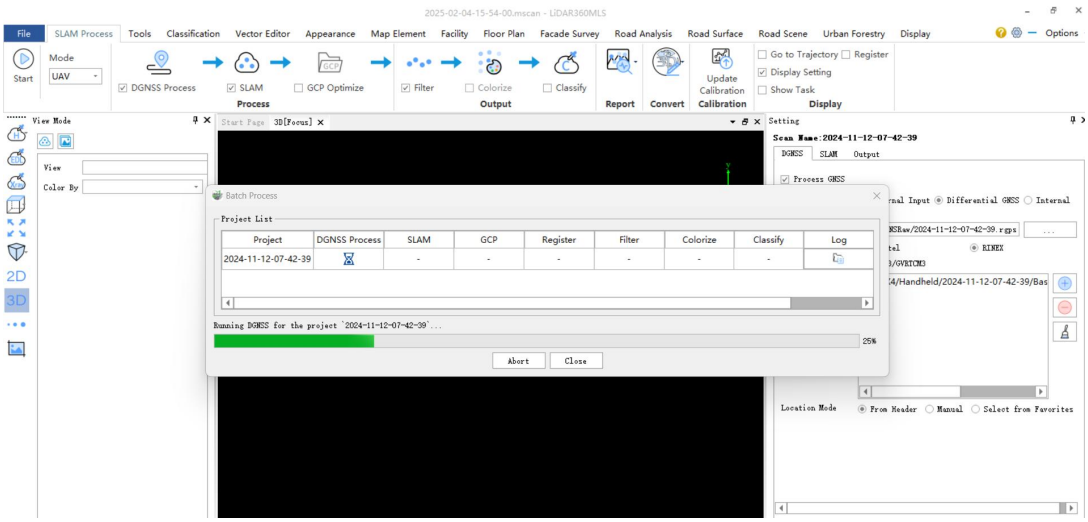


Note: If the panoramic camera file path is not set, coloring cannot be selected during georeferencing.

Georeferencing Point Cloud Data

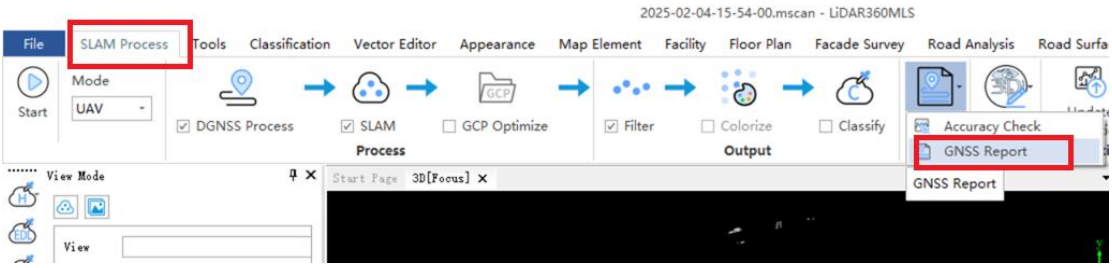
The default mode is **General**. For X4 handheld kit, it is recommended to select **UAV** mode. **Filter** can reduce the noise and thickness and improve the quality of point cloud.

Click “Start” to start processing, and you can view the current solution progress on the progress bar.



Data Quality Assessment

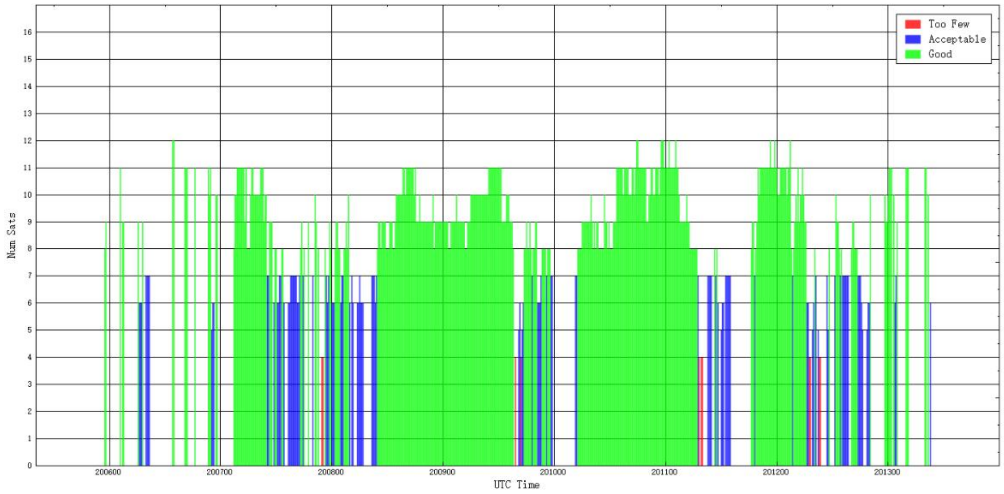
After the processing is completed, you can view the quality of the post-processing GNSS difference through the GNSS report, and click "SLAM Process" -> "Report" -> "GNSS Report" to pop up the GNSS report (only check the GNSS processing option).



Number of Satellites Bar Plot

Number of satellites involved in the PPK solution.

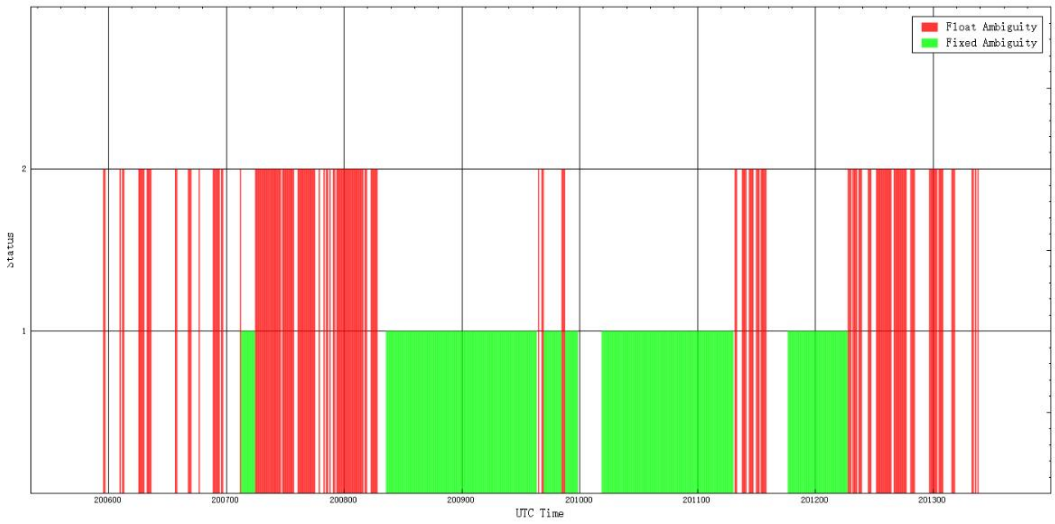
Figure 1. Number of Satellites Bar Plot



Float or Fixed Ambiguity Plot

Fixed or floating solutions change over time.

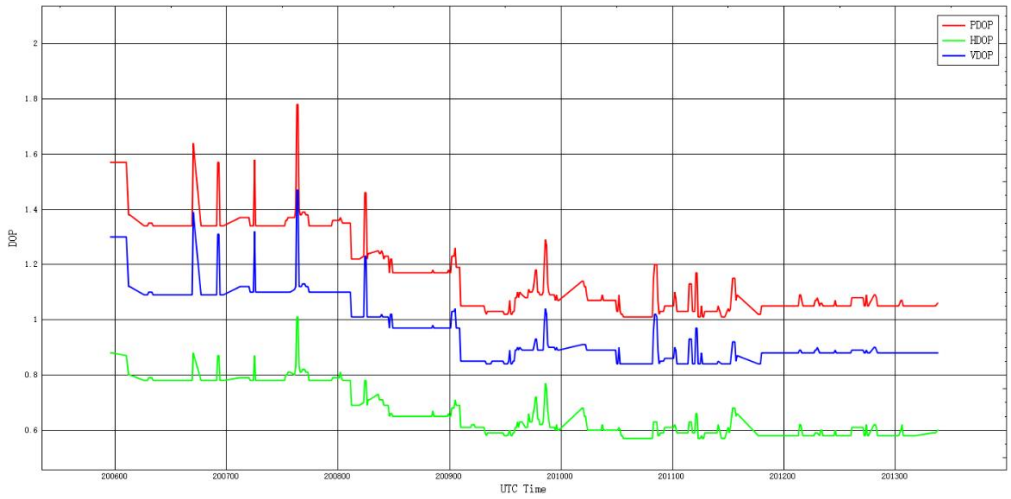
Figure 2. Float or Fixed Ambiguity Plot



DOP Plot

The spatial distribution of the satellites.

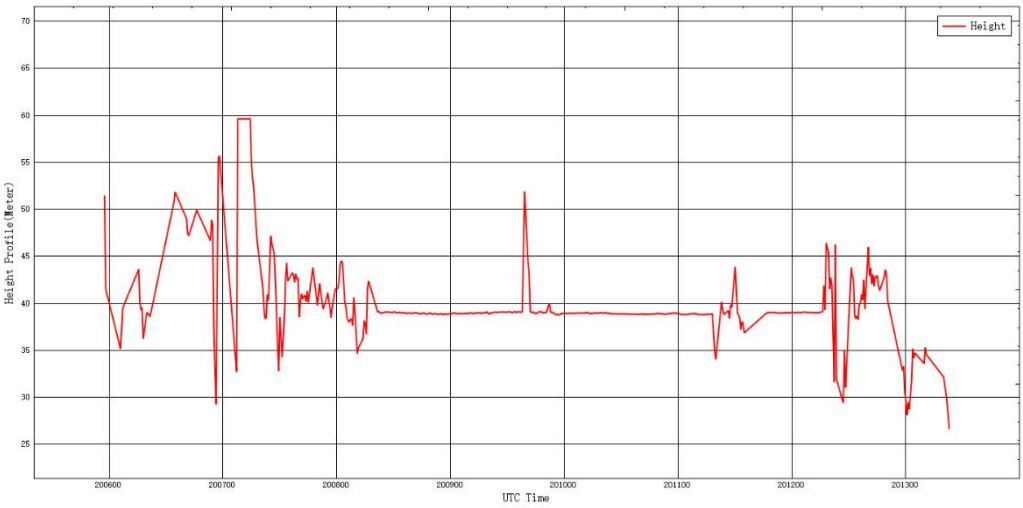
Figure 3. DOP Plot



Height Profile Plot

Represents the height change of the trajectory.

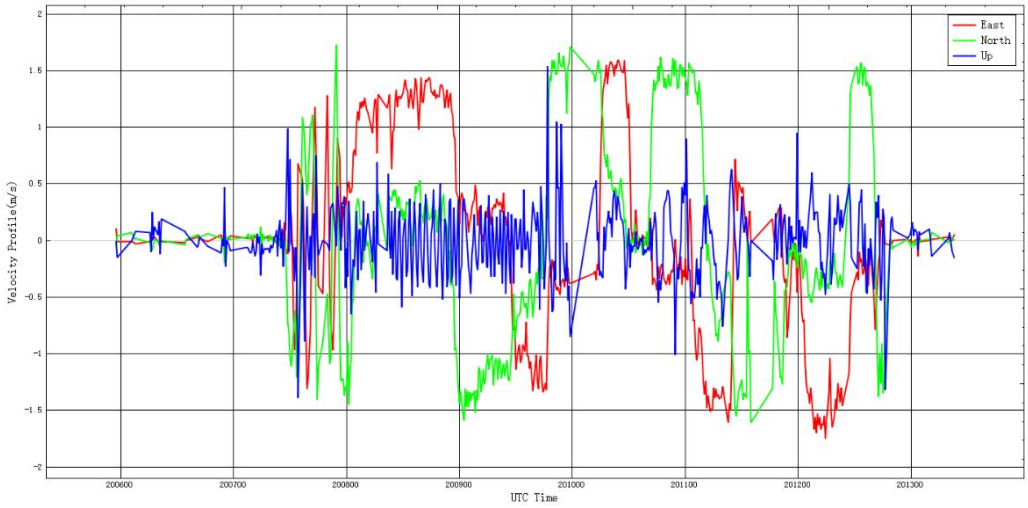
Figure 4. Height Profile Plot



Velocity Profile Plot

Represents the velocity change in three directions.

Figure 5. Velocity Profile Plot



Accuracy statistics

Contains DOP statistics, position accuracy statistics, trajectory accuracy statistics, and trajectory separation statistics.

DOP Statistics

Type	Max Value	Mean Value
PDOP	1.78	1.14876
HDOP	1.01	0.652909
VDOP	1.47	0.00338403

Position Accuracy Statistics

Type	Max Value (Meter)	Mean Value (Meter)
X(E)	0	0
Y(N)	0	0
Z	0	0

Attitude Accuracy Statistics

Type	Max Value (arcmin)	Mean Value (arcmin)
X(E)	0	0
Y(N)	0	0
Z	0	0

Position Separation Statistics

Type	Max Value(Meter)	Mean Value(Meter)
X(E)	0.00000	0.00000
Y(N)	0.00000	0.00000
Z(Meter)	0.00000	0.00000

System Transportation and Maintenance

Operation Notice

To ensure the reliable use of the system and the safety of the operation personnel, please observe the following notices during installation, use and maintenance.

1. Pay attention to the protection of the scanning lens to prevent scratches.
2. Handle with care during installation to prevent the system from falling or being impacted.
3. Before scanning, please make sure the scanning lens is clean and dust-free.
4. Avoid sudden changes in temperature to prevent damage to the system.
5. During the operation, it is forbidden to directly contact the laser scanning lens with any part of the body.
6. If the system needs to be transported, it must be stored within appropriate packages.
7. The operating temperature of the system is -20℃~50℃. In case of rain, snow, fog, sand and other bad weather, the operation should be stopped. It can prevent equipment damage and on the other hand, it can ensure the measurement accuracy. In case of sudden bad weather during work, please move the device to a safe place in time.
8. When removing the OSDK communications cable and GNSS antenna feeder, hold the both ends of the connector. The removal should be gentle and appropriate.
9. Non-professionals, without permission, please do not try to disassemble the equipment, do not repair it without permission, so as to avoid accidents or aggravate the damage of the equipment. If the equipment is modified or

disassembled not authorized by GreenValley International Inc., the warranty will be void.

Equipment Maintenance

1. Before turning on the device, check whether the scanner lens is clean, if there are any stains, it should be cleaned immediately.
2. After the equipment is used, check whether the scanning window of the scanner is dirty. If it is dirty, it should be cleaned up immediately.
3. The storage temperature range of LiAir X4 is -30℃~+60℃, and the storage environment requires ventilation and dryness.
4. Make sure that all power is turned off before storage, and the equipment is stored in an appropriate box.
5. If the storage time is more than one month, the power-on test should be carried out.
6. During the transportation of LiAir X4, the packing box equipped at the factory should be used.
7. If it needs to be packed separately due to special circumstances, please ensure that the packing box has a certain pressure resistance, and label the outside of the box with signs such as "**Precision Instrument**", "**Handle with Care**", "**Fragile**", etc. to avoid equipment damage.
8. The instrument is a precision instrument, and avoids violent impact during transportation and handling, and avoids damage to the optical components in the instrument or causes direction deviation.
9. During the warranty period, customers can enjoy free firmware update services. After the warranty period has expired, customers can purchase firmware update services.

Appendix1 Troubleshooting-related Issues

I. Considerations for Initialization

① The laser should not face the areas with few features, for example, walls, ground, and sky.

② Do not initialize in locations with a high volume of pedestrian and vehicle traffic. Do not initializing at intersections.

③ Do not initialize in areas with dense weeds or shrubs.

④ When initializing in the densely vegetated areas, ensure that the site is wind-free.

⑤ When collecting data from the outside into scenarios such as tunnels and mines, initialize with facing the cave entrance.

⑥ When collecting data in a normal environment, initialize with the laser facing the collection scenario.

⑦ The initialization process of the device should be kept strictly stationary. It is recommended that the device should be placed on a stable surface and fixed with the aid of a hand, to avoid shaking of the device due to the rotational inertia of the laser.

⑧ The initialization should be sufficient, with more than 30s.

⑨ For the measurement of multiple stations, the initialization area should be within the previous measurement area. Ensure that there is a 10-20% overlap in each measurement area.

⑩ When GNSS signals need to be accessed, stationary initialization is required, with the movement in figure-8 trajectory before and after the data collection.

II. Things to Keep in Mind

① The data should be collected at a speed of not more than 1 m/s. The fast driving speed is not required.

② When collecting data in indoor scenarios, open the doors in advance. Do not move the door during the collection.

③ Plan the path in advance. Take a closed loop as much as possible if conditions permit.

④ The laser should always aim at the effective ground object.

⑤ Pass slowly in the confined space or move slowly in case of scenario switching.

⑥ In the collection of elevation information, it is recommended that the laser should face the elevation. You should operate when there are few moving targets. This can reduce data noise and errors.

⑦ When scanning multi-floor staircases, start by tilting the device back a little at each floor, scan the whole staircase and then lower the device to a normal angle before moving up.

Appendix2 Handheld Kit Specifications

System Parameters	
Handheld Size	L222.9mm*W119.8mm*H515.5mm
Battery Box Size	L134mm×W64.6mm×H167mm
Handheld Weight	1.9kg（excluding battery）
Panoramic Camera Pixel	12MP*2
Panoramic Camera FPV	H190°*V190°
Voltage	15.2V
Battery Capacity	5870mAh
Antenna	HX-CH7609A
Protection Level	IP54
Working Time of One Battery Block	2.5h
Single-Flight Continuous Operation Time	Maximum 55min
Mapping Method	
Mapping Principle	SLAM、PPK-SLAM
Real-Time Calculation	Not Supported
Data Results	
Absolute Accuracy	≤5cm
Point cloud thickness	≤2cm
Point Cloud Format	LAS, LiData