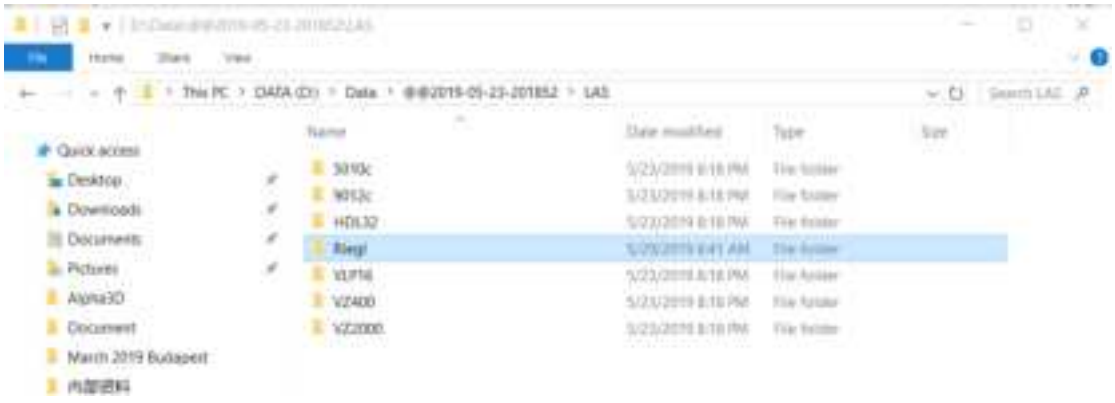
- **LAS**:

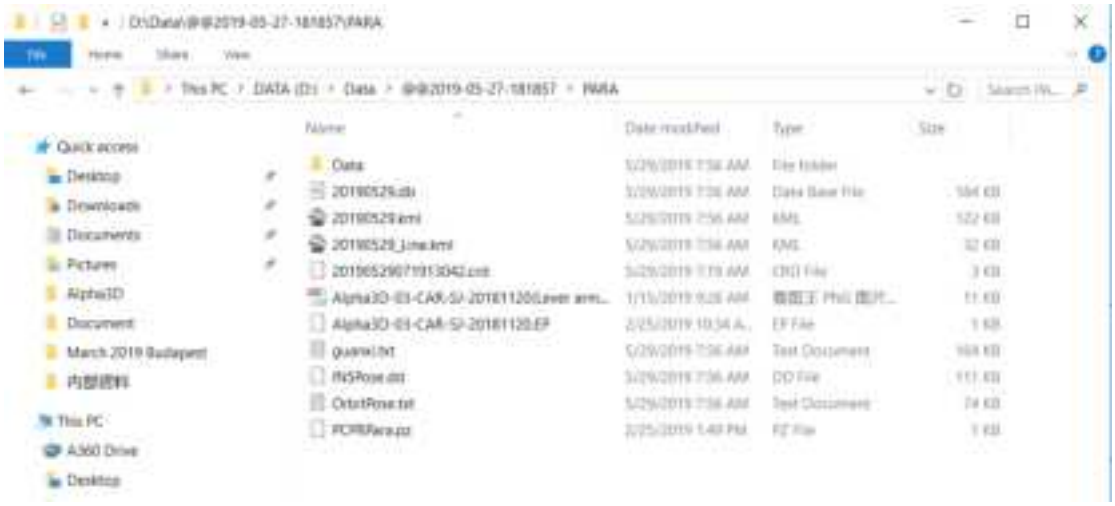
This folder contains point cloud raw data. For Alpha3D, the point cloud raw data will be saved in **Riegl** folder automatically. Other folders are useless as they were designed for other LiDAR system.



- **PARA**:

This folder contains four initial parameter files. For Alpha3D, this folder should contains below listed files after all data processing.

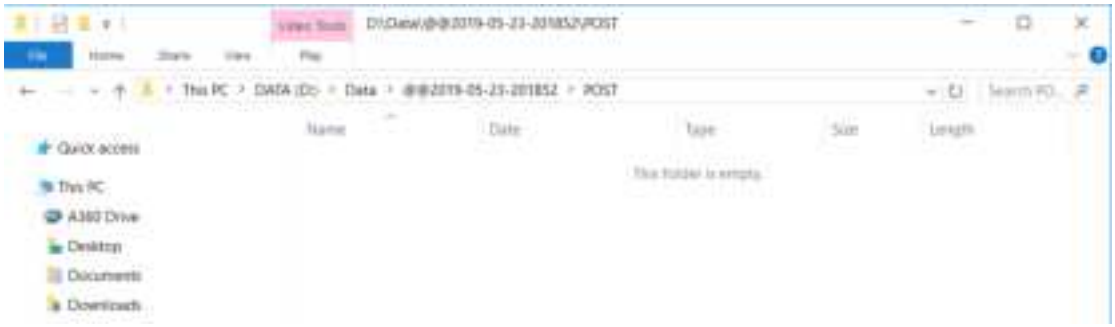
Initial Folder



After processing folder

- **POST**:

This folder should contain both IE project file and POS file which generated after IE processing. The initial **POST** folder is empty.



- **ROVER**:

This folder contains GNSS data and IMU data which recorded by Alpha3D. These two files will automatically save in this folder.

- **SYNC**:

This folder contains **log** data and **trig** data of Alpha3D.

- **TRACE**:

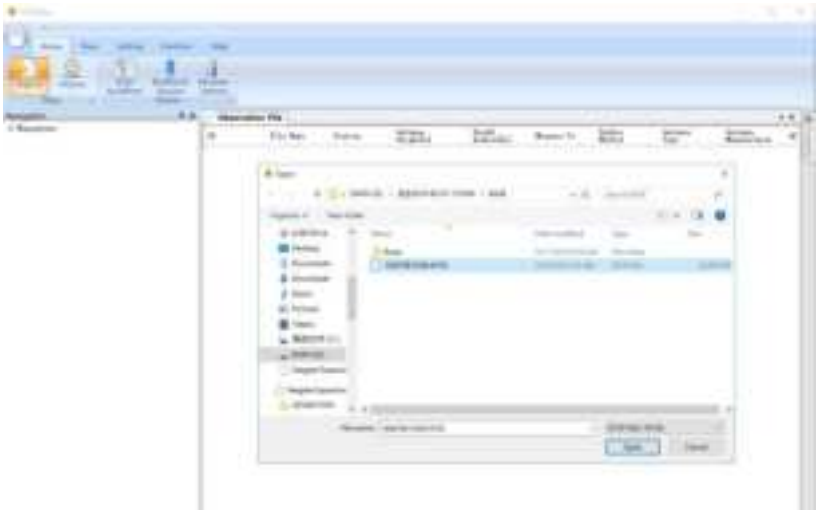
For Alpha3d, this folder is empty.

5.2.2.2 Base Data Processing

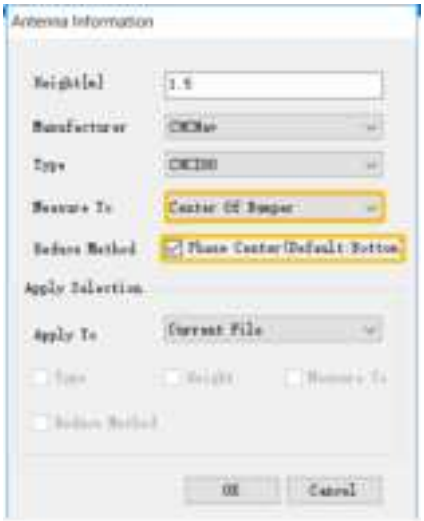
GNSS data of base station is saved in receiver. Take CHC i80 as example, there are three download methods. First is USB mode download, copy static data form repo folder into computer; Second is Webpage mode download. Connect computer with receiver via Wi-Fi and input **http://192.168.1.1** to log in. Both username and password are **ftp**; Third is ftp mode download. Connect computer with receiver via Wi-Fi and input ftp://192.168.1.1 in **My Computer**. Both username and password are **ftp**.

CHC i80 will export HCN file which need to be converted using **CHCData** software. Detailed steps are shown below:

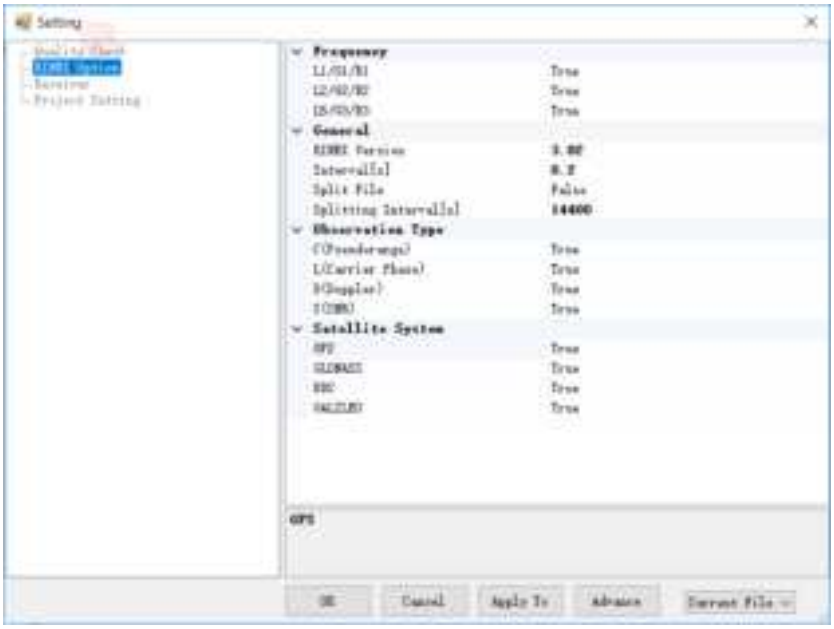
- Click "**Import**" to import an HCN file:



- Right click HCN file and click "**Antenna Setting**". Input measured antenna height and select "**Center of Bumper**", finally click "**Phase Center**" – "**OK**".



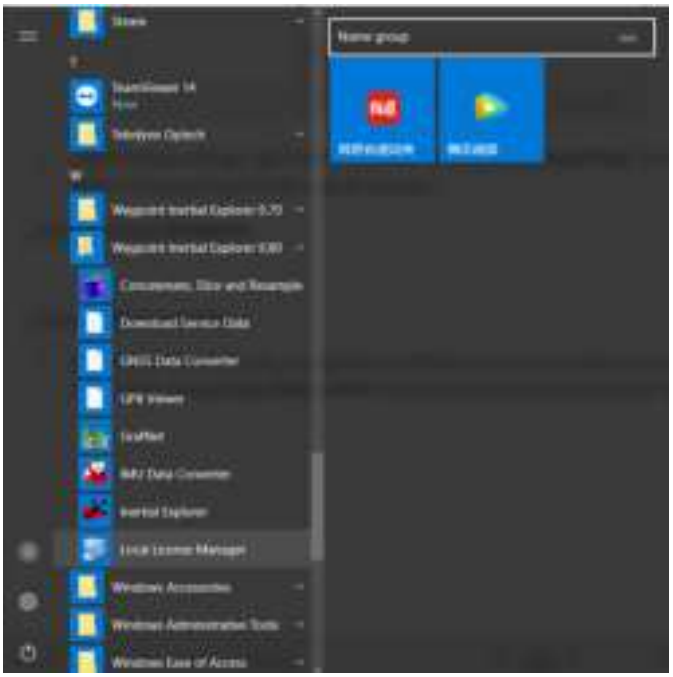
- Right click HCN file and click "**RINEX Option**". Change "**RINEX version**" as 3.02, change "**Interval**" as 0.2 and change "**Splitting Interval**" as 14400.



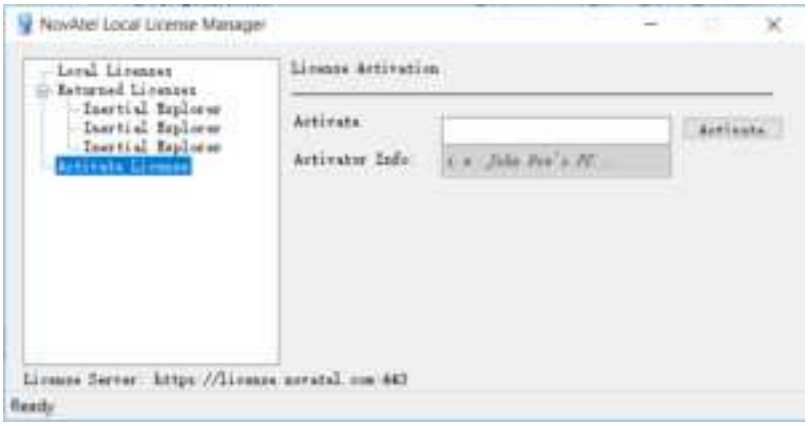
- After all above settings, right click HCN file and click "**Convert Selected Files**". A new Rinex folder will be generated under original catalogue:

5.2.2.3 License Activation

- Click Windows and find the "**Local License Manager**" under Waypoint Inertial Explorer 8.80 folder.



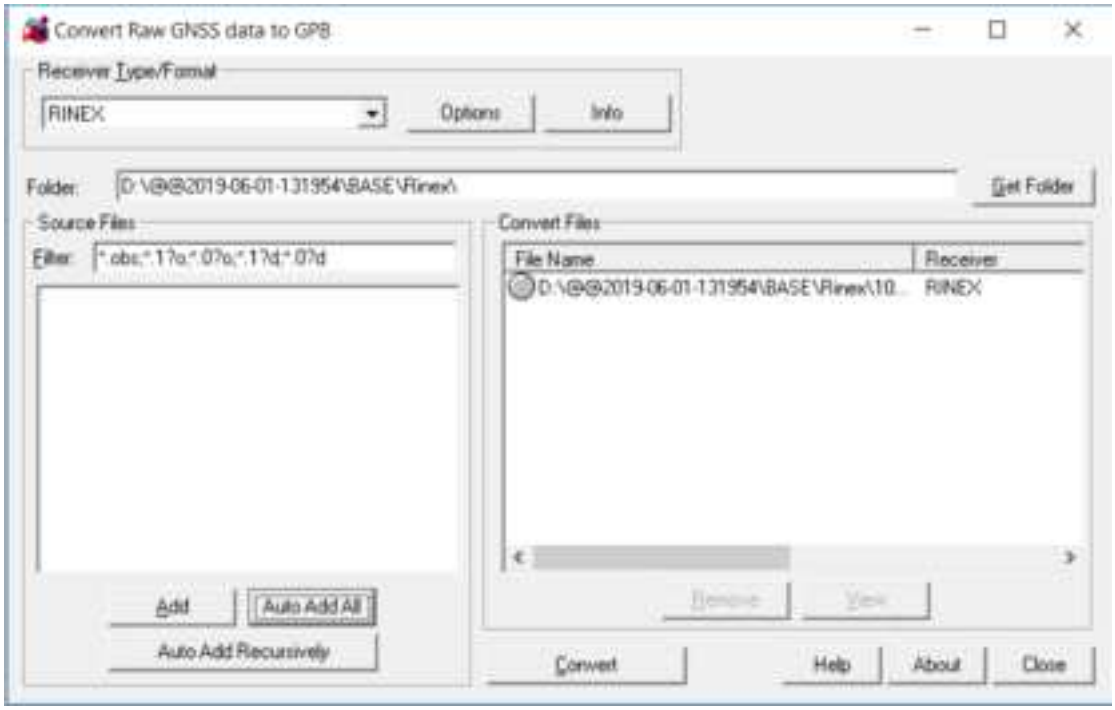
- Enter activation code here and click **Activate** to complete activation.



- If you want to log out, go to Local Licenses and click **Return**.

5.2.2.4 Data Format Conversion

Double click IE icon to begin work. Before start POS processing, the data format of both base and rover need to be converted. Click "**Tools - Convert Raw GNSS to GPB**" to add all needed files and finally click "**Convert**".

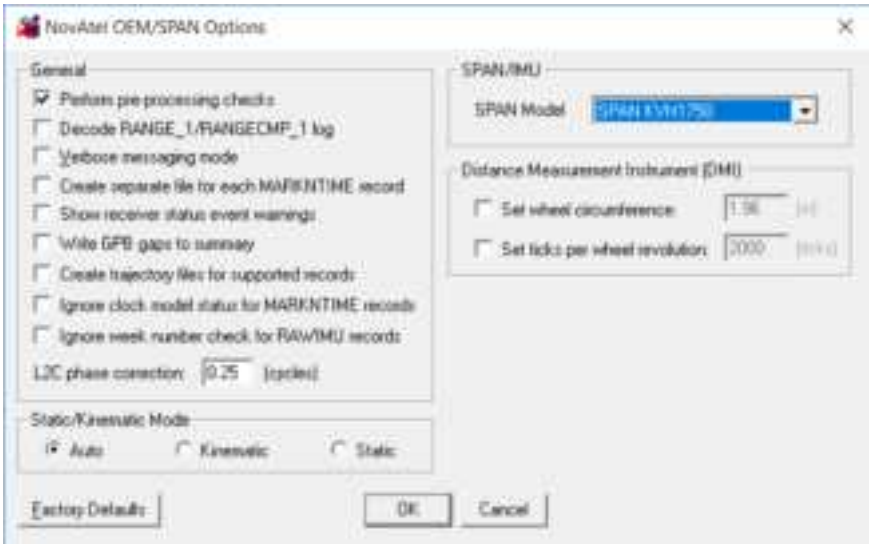


Comparison before and after format conversion:

Rover:

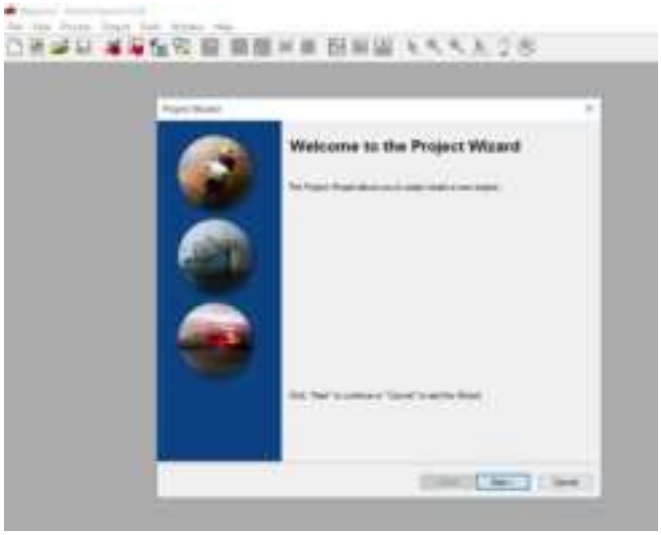
Base:

Notice: When convert rover files, double click IMU file and select **SPAN Model** as **SPAN KVH1750**.

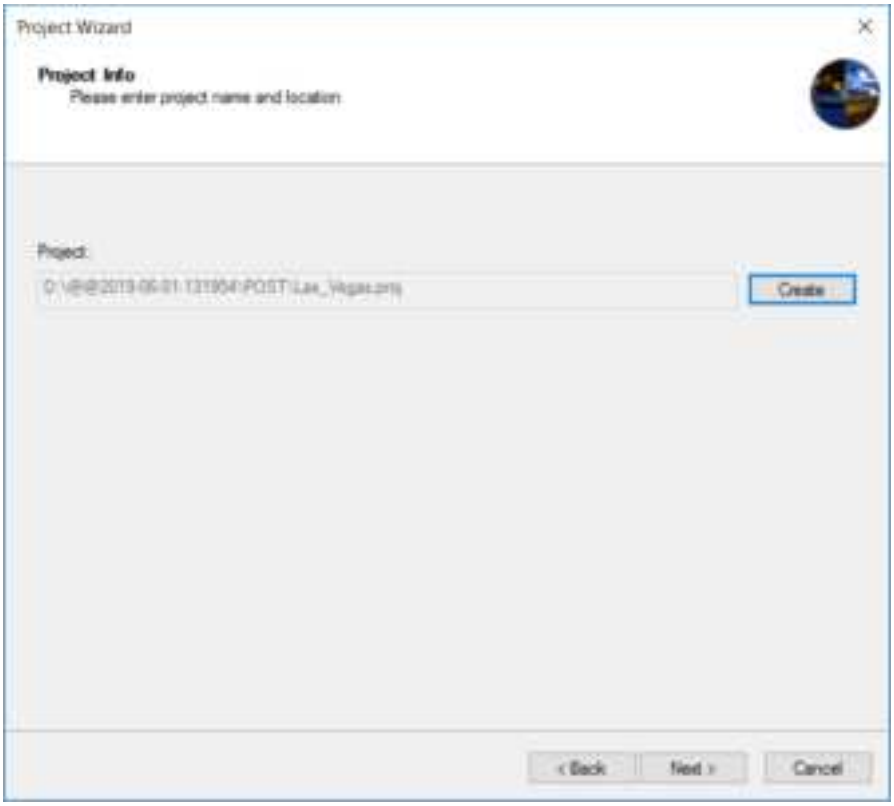


5.2.2.5 POS Processing

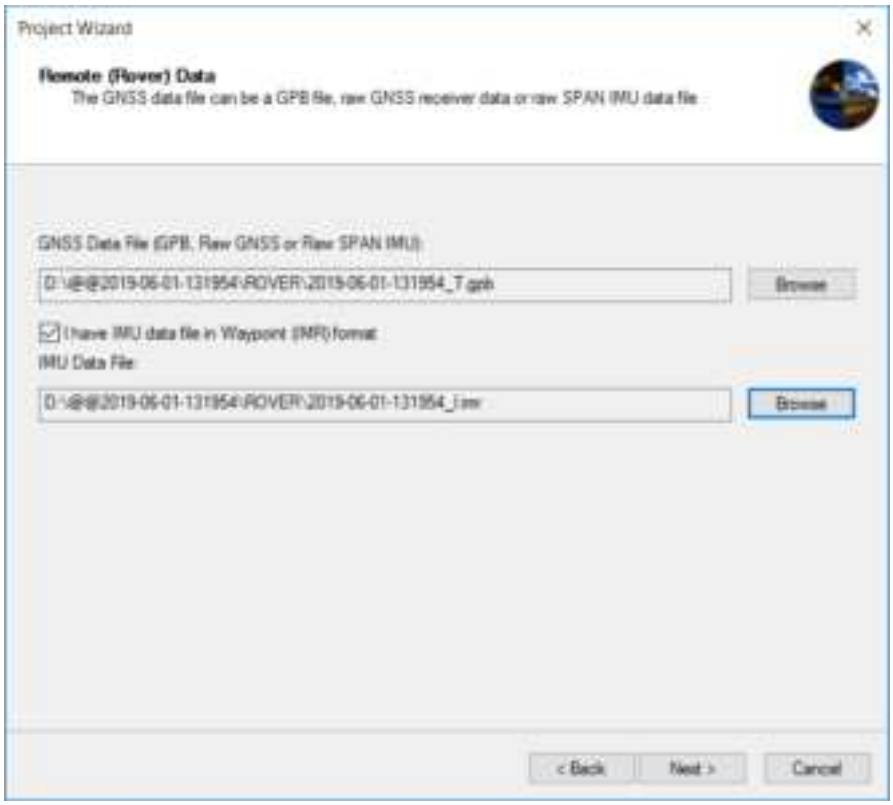
- Click "**File - New Project - Project Wizard**" to create an IE project.



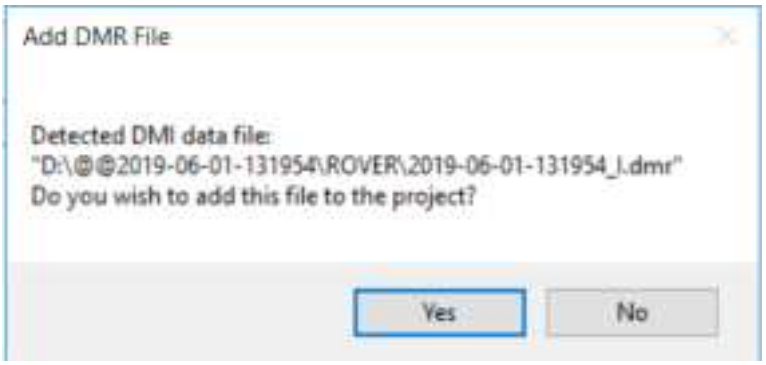
- Give it a directory location and project name. For convenience, it is recommend saving project in **POST** folder. Click **Next.**



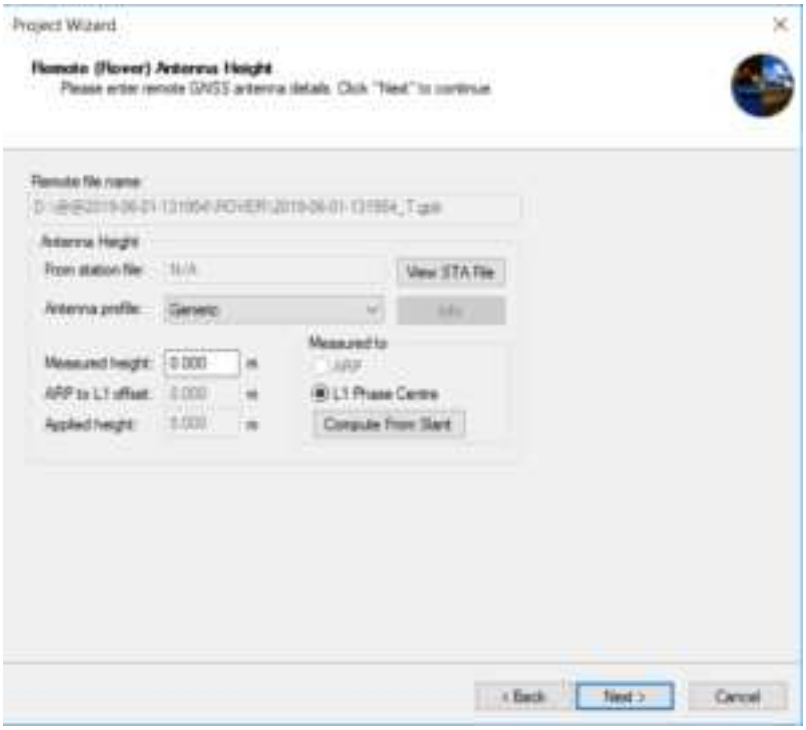
- Choose gpb file of GNSS and imr file from IMU. These two files can be found in **ROVER** folder.



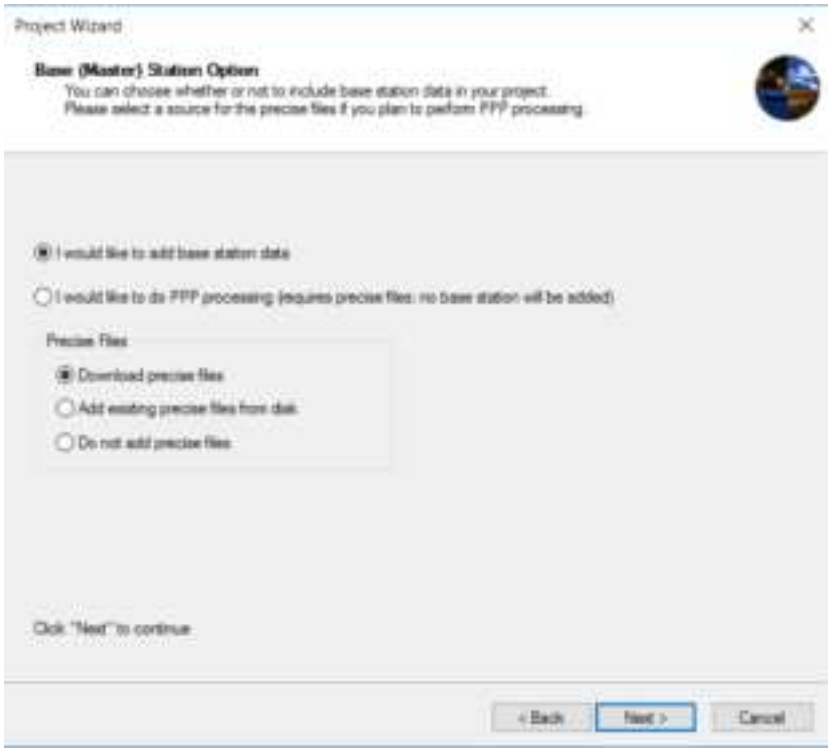
- After clicking **Next**, an information will pop up which ask to add dmr file. Click **NO** as it's an empty file unless Alpha3D connect to ODOmeter this sensor.



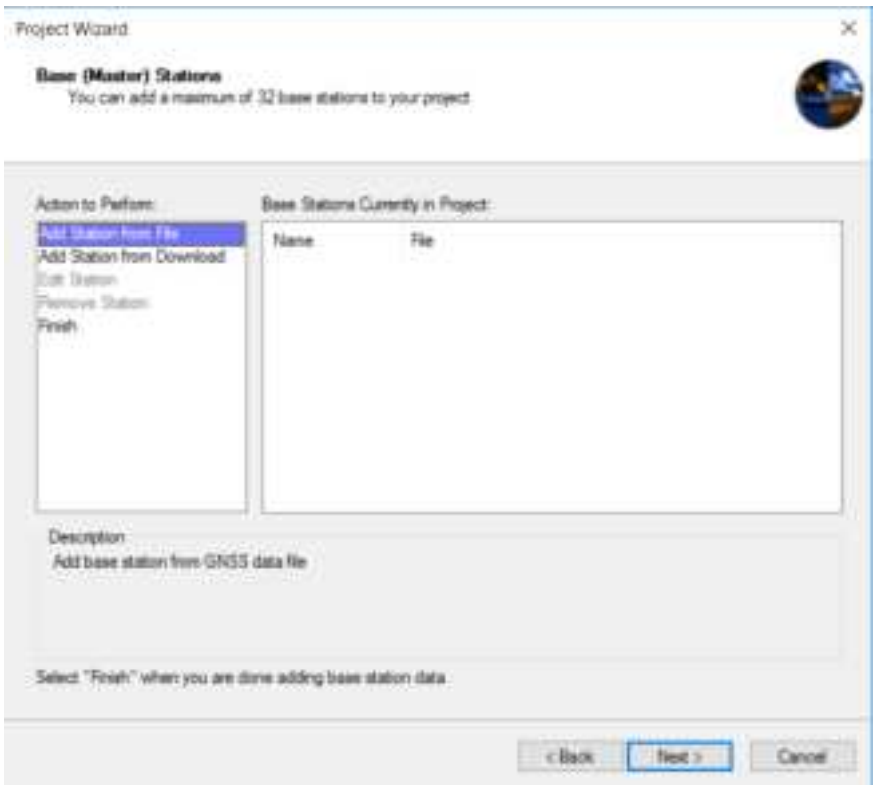
- For remote antenna height, keep all values as default and no need to change. Click **Next**.

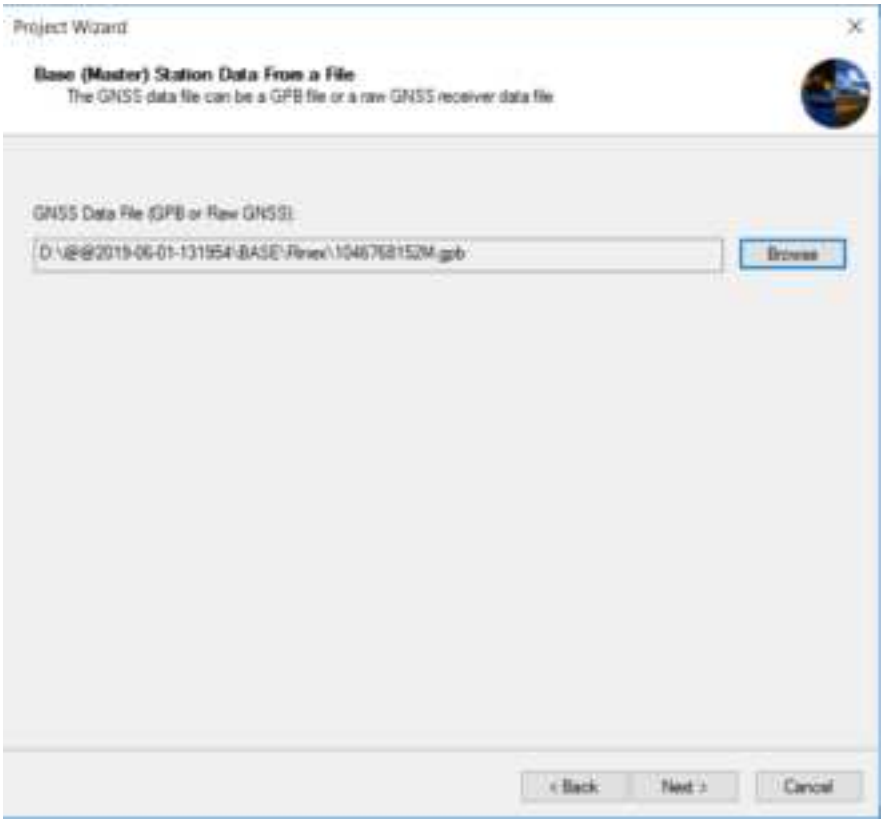


- For base data, IE supports two options to load: First is from base station and second is download via PPP mode. Also, the precise file can also be downloaded to improve accuracy. Click **Next**.

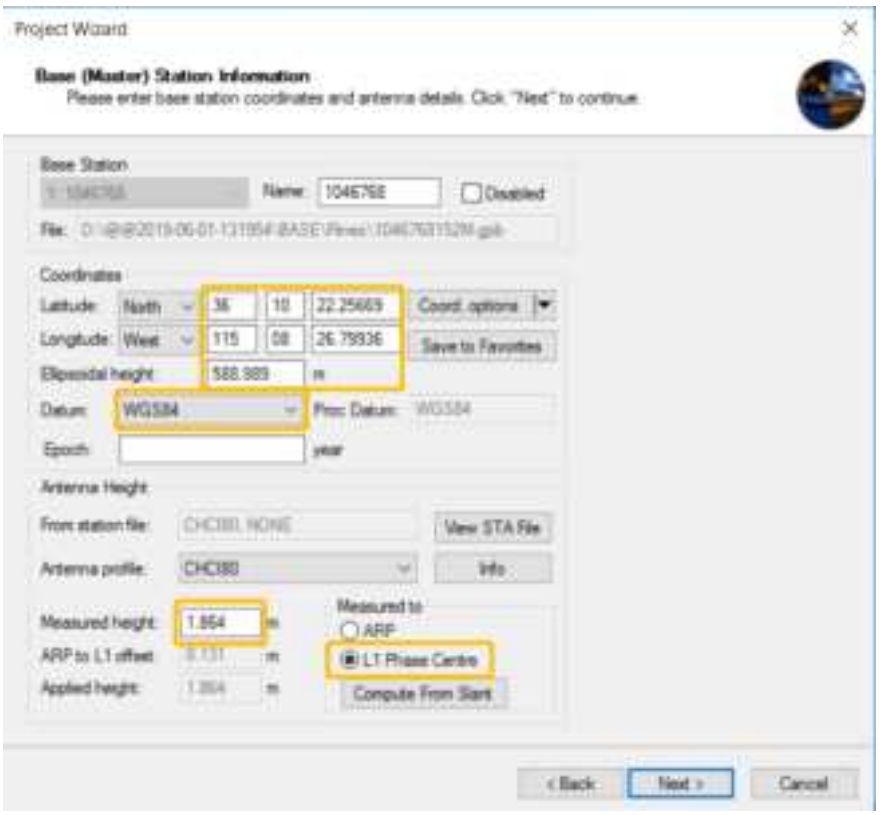


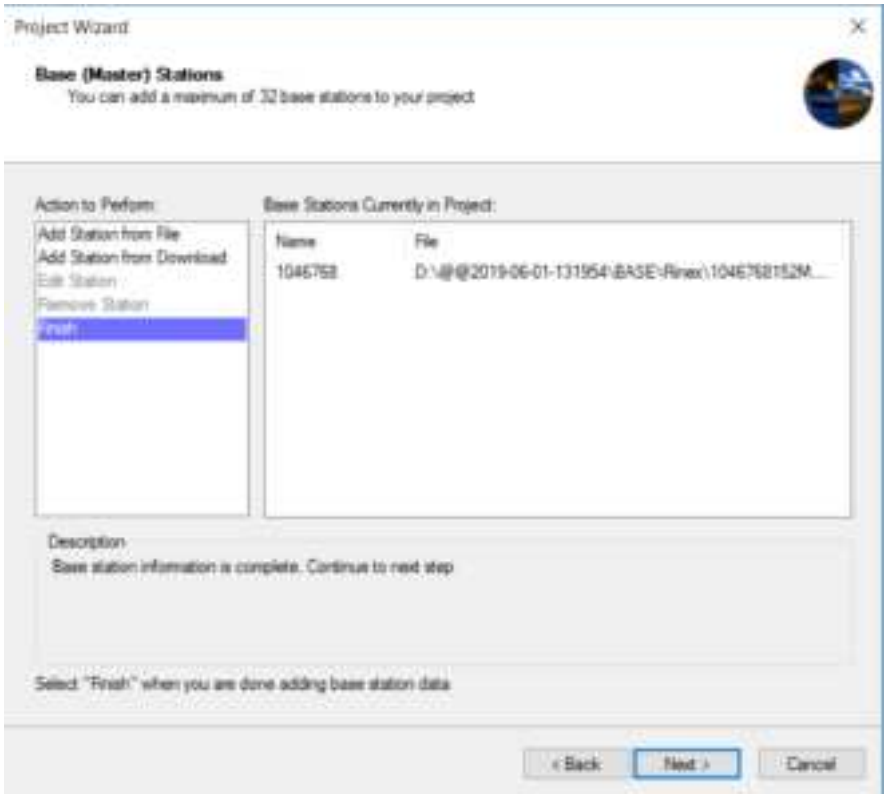
- IE supports maximum 32 base stations data for one project. Click "**Add Station from File**" and click **Next** to add base station data.



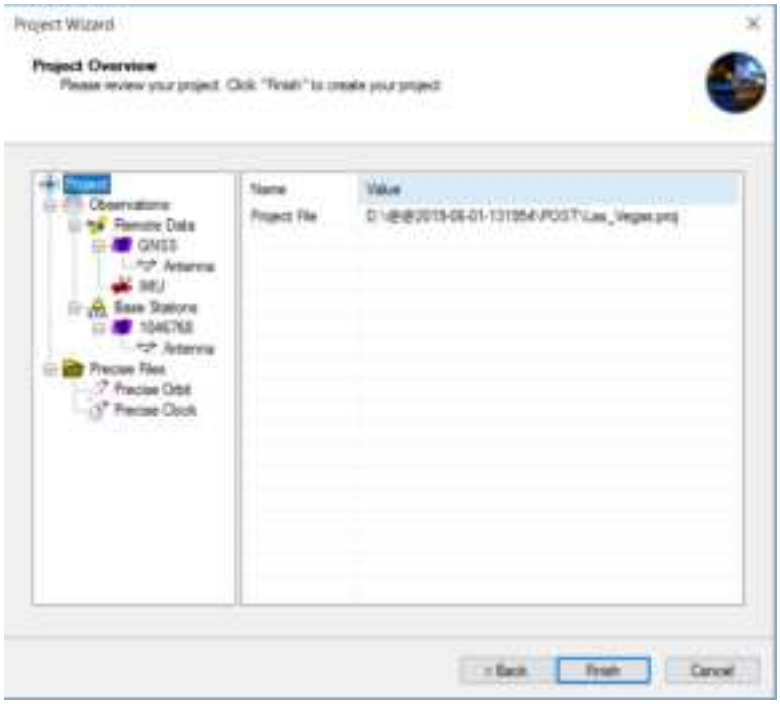


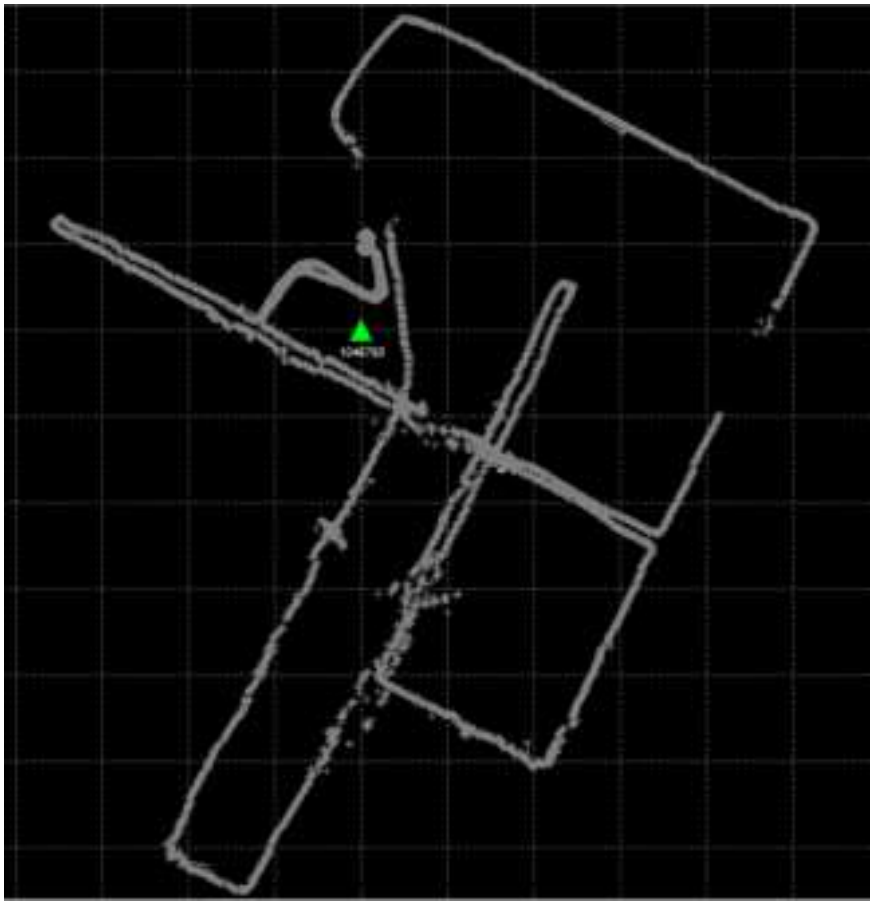
- For base station data, the coordinates, ellipsoidal height and datum information are needed. Enter the measured height value and choose relative measure type. Click **Next**.





- Finally, the project wizard will show details of this project. Click **Finish** to load trajectory.

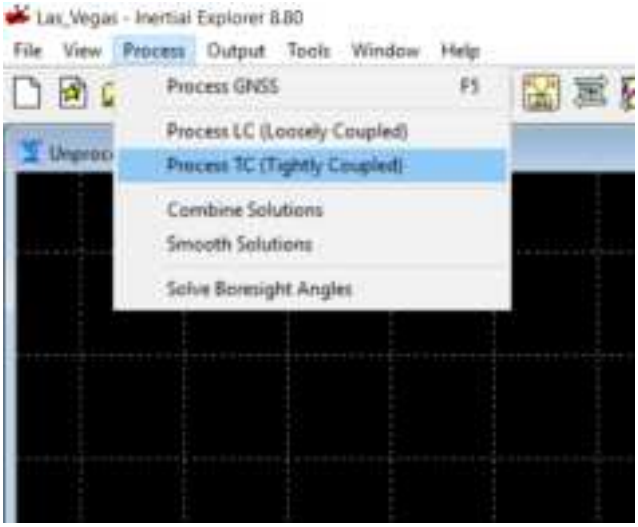


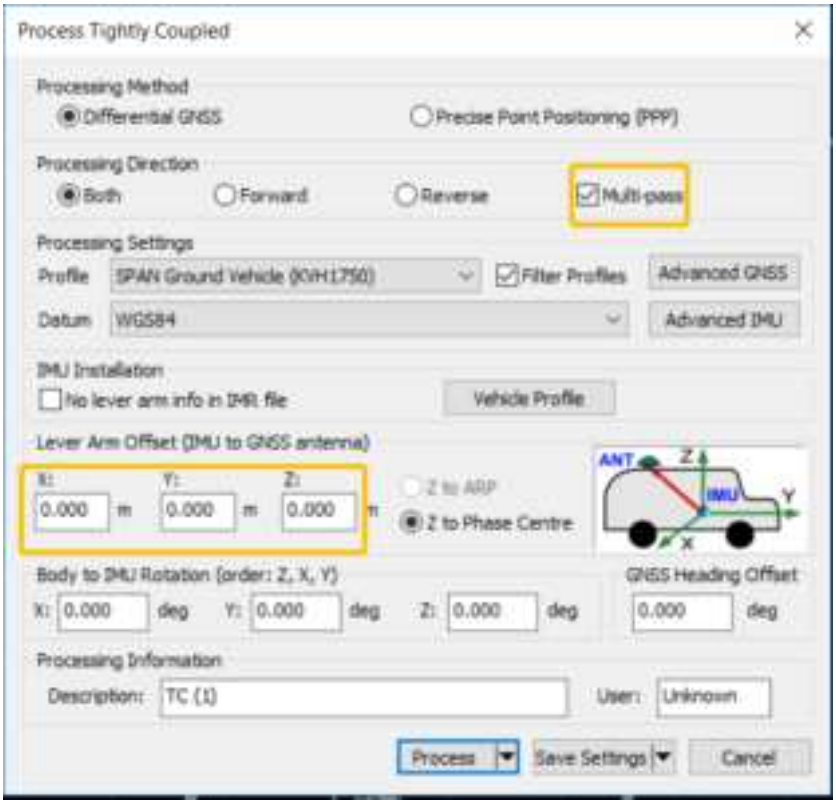


5.2.2.6 GPS/INS Combine Processing

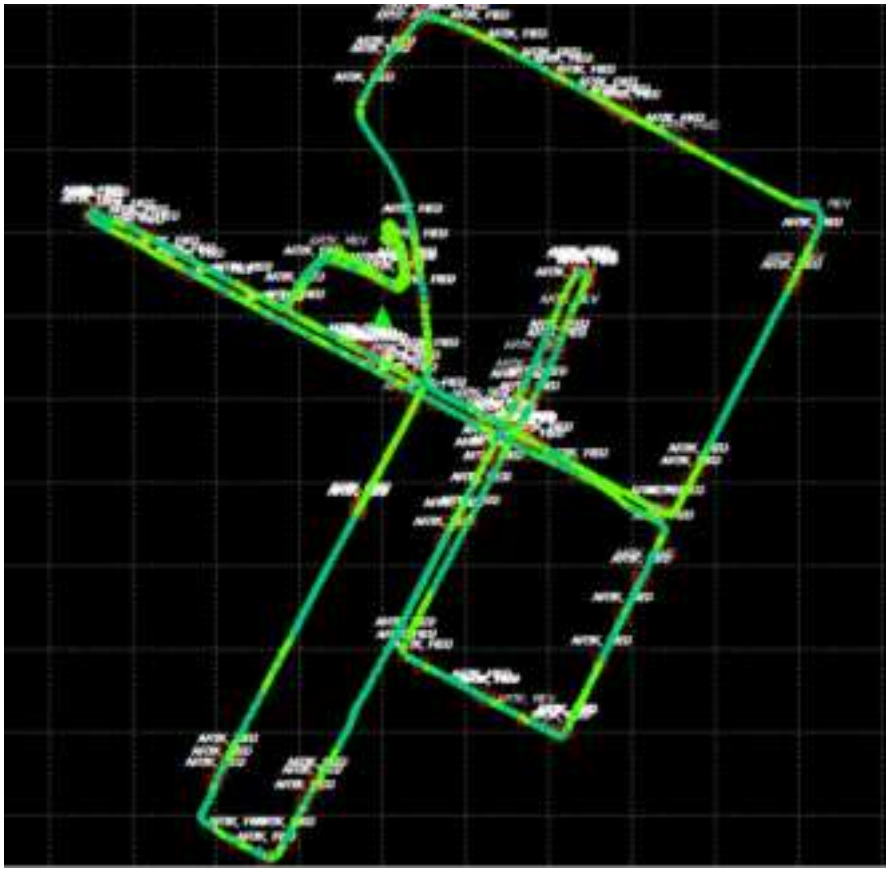
The IE software supports two INS processing dialogues: Loosely Coupled & Tightly Coupled. Loosely Coupled is a two-step process which is not suitable if GPS signal is bad; Tightly Coupled is a one-step process which always be chose in mobile mapping solution. Here take tightly coupled dialogue as an example:

- Click **Process - Process TC (Tightly Coupled)** to start processing. Select Multi-pass to improve accuracy and enter lever arm values in below. Click **Process**.



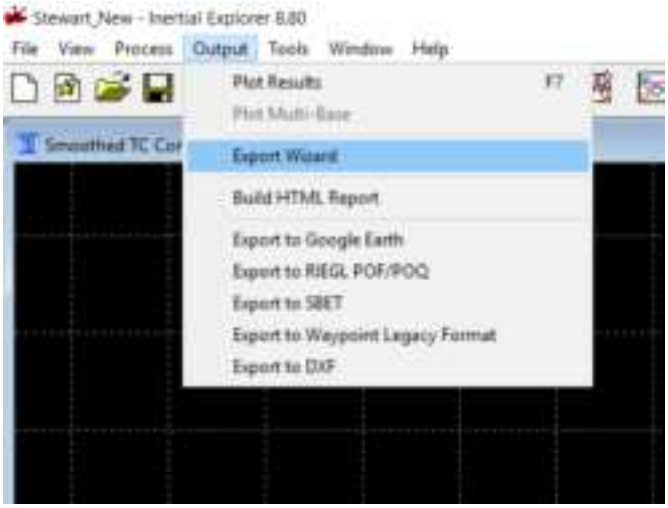


- When processing finished, the trajectory should be shown in interface:

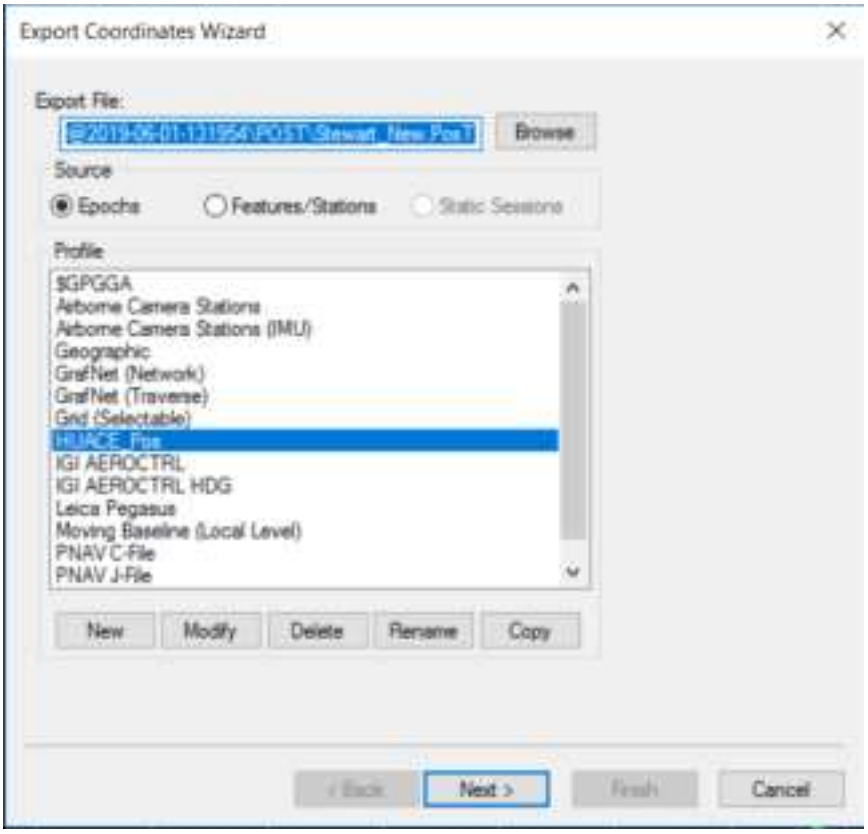


5.2.2.7 Export POS File

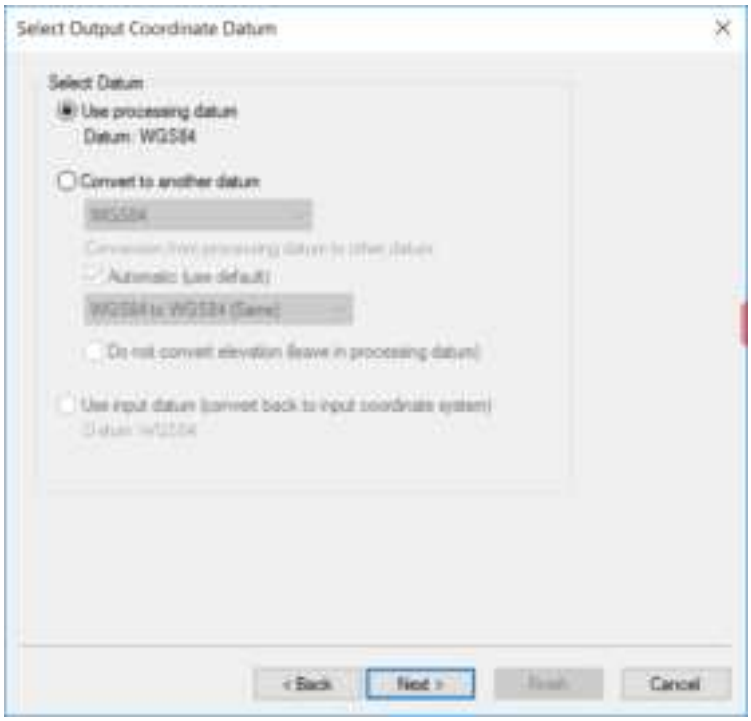
- Click **Output - Export Wizard** to export POS result.



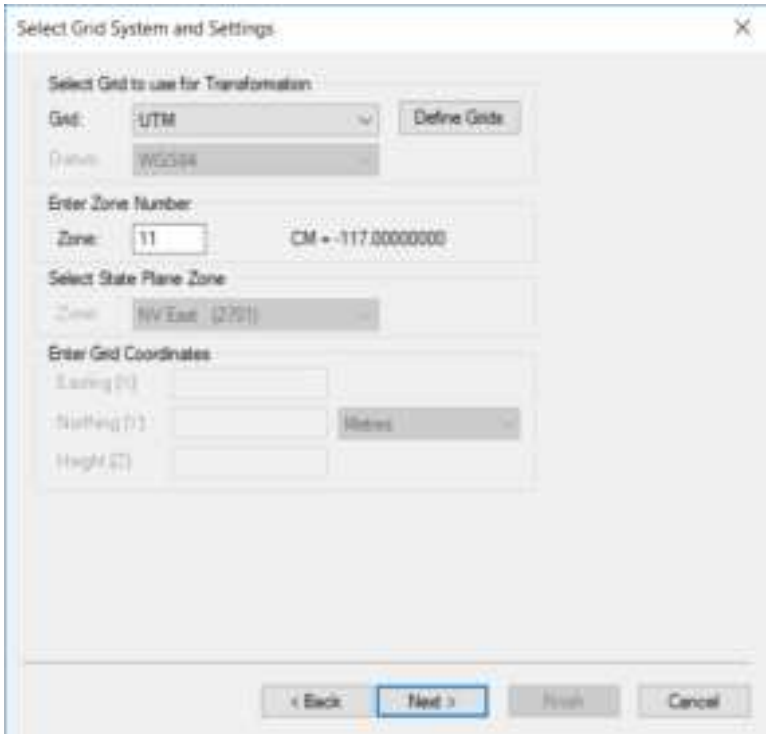
- Choose **HUACE Pos** profile which should be copied into **export_templates** folder under IE folder. For example: C:\NovAtel\InertialExplorer870\resources\export_templates.



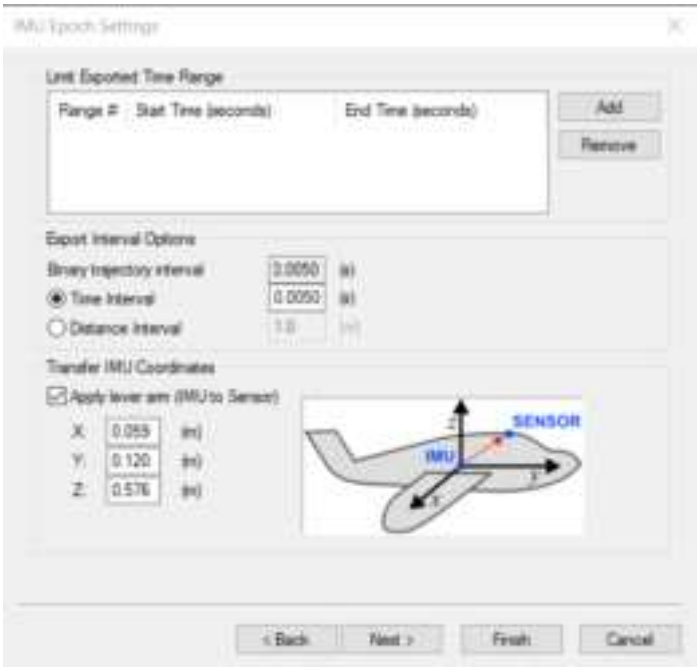
- Select **Use processing datum** and click **Next**



- Select suitable grid which used for transformation.



- Select **Time Interval** as **0.005s**, ensure below lever arm values are correct. Click **Finish** to export POS file which used for next step processing.

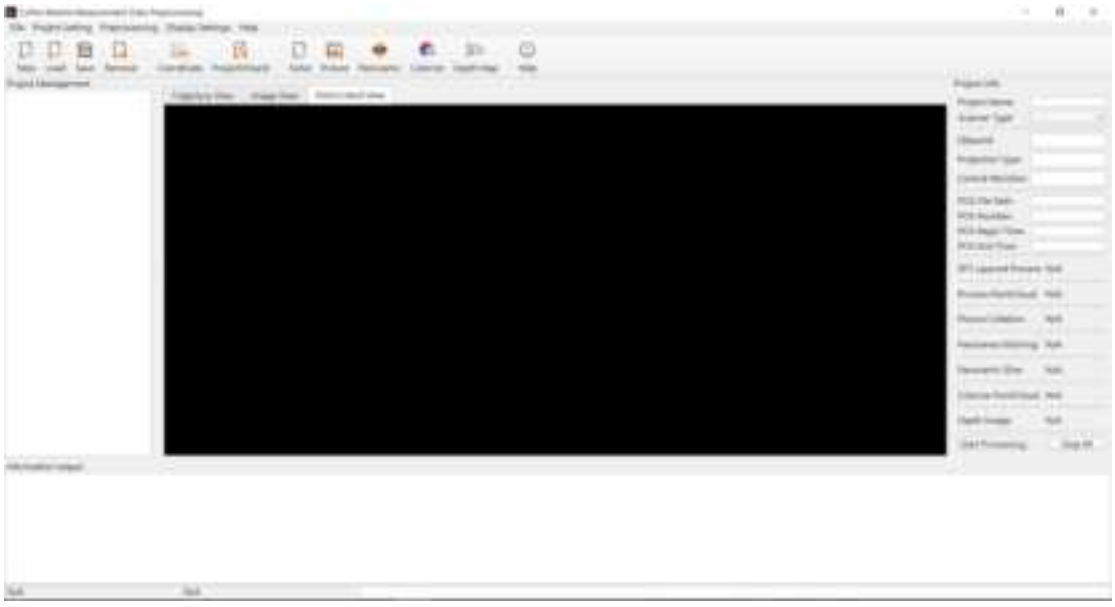



```
Project:    Stewart_New
Program:    Inertial Explorer Version 8.80.2308
Profile:    HUACE_Pos
Source:     GNSS/INS Epochs(Smoothed TC Combined)
SolFile:    D:\@@2019-06-01-131954\POST\Stewart_New.cts
ProcessInfo:  Stewart_New by Unknown on 6/11/2019 at 08:32:20

Datum:      WGS84
Master 1:   Name 1046768, Status ENABLED
        Antenna height 1.726 m, to L1PC [CHC360(NONE)]
        Lat, Lon, El Hgt 36 10 22.25522, -115 08 26.89080, 583.445 m [WGS84, N/A]
Remote:     Antenna height 0.000 m, to L1PC [Generic(NONE)]
IMU to GNSS Antenna Lever Arms:
        x=0.059, y=0.120, z=0.576 m (x-right, y-fwd, z-up)
Body to Sensor Rotations:
        xRot=0.000, yRot=0.000, zRot=0.000 degrees (Rotate IMU into Vehicle Frame)
IMU->Secondary Sensor Lever Arms:
        x=0.059, y=0.120, z=0.576 m (x-right, y-fwd, z-up, IMU->SENSOR)

Map projection info:
  Defined grid: UTM, Zone 11

SeqNum      GPSTime      Northing      Easting      H-Ell      Latitude      Longitude  HzSpeed      Roll      Pitch   Heading Project Name        Q
             (sec)          (m)          (m)          (m)       (deg)          (deg)    (m/s)     (deg)      (deg)     (deg)
     0     48014.200  4004771.8519  667234.3824    585.267  36.17329586509 -115.1404942396  0.0025  -0.43058  3.71070  -7.23330 Stewart_New        1
     1     48014.205  4004771.8519  667234.3824    585.267  36.17329586525 -115.1404942395  0.0025  -0.42789  3.71089  -7.23296 Stewart_New        1
     2     48014.210  4004771.8519  667234.3824    585.267  36.17329586538 -115.1404942396  0.0027  -0.42587  3.71119  -7.23303 Stewart_New        1
     3     48014.215  4004771.8518  667234.3824    585.267  36.17329586554 -115.1404942397  0.0029  -0.42521  3.71113  -7.23335 Stewart_New        1
     4     48014.220  4004771.8520  667234.3824    585.267  36.17329586569 -115.1404942400  0.0022  -0.42534  3.71078  -7.23369 Stewart_New        1
     5     48014.225  4004771.8520  667234.3824    585.267  36.17329586584 -115.1404942402  0.0017  -0.42561  3.71039  -7.23385 Stewart_New        1
     6     48014.230  4004771.8520  667234.3824    585.267  36.17329586597 -115.1404942404  0.0021  -0.42584  3.70990  -7.23372 Stewart_New        1
     7     48014.235  4004771.8520  667234.3823    585.267  36.17329586604 -115.1404942405  0.0028  -0.42629  3.70980  -7.23335 Stewart_New        1
     8     48014.240  4004771.8520  667234.3823    585.267  36.17329586607 -115.1404942407  0.0027  -0.42703  3.71000  -7.23296 Stewart_New        1
     9     48014.245  4004771.8520  667234.3823    585.267  36.17329586606 -115.1404942410  0.0023  -0.42881  3.71038  -7.23267 Stewart_New        1
    10     48014.250  4004771.8520  667234.3823    585.267  36.17329586602 -115.1404942414  0.0022  -0.43154  3.71072  -7.23324 Stewart_New        1
    11     48014.255  4004771.8520  667234.3822    585.267  36.17329586598 -115.1404942417  0.0024  -0.43466  3.71086  -7.23386 Stewart_New        1
    12     48014.260  4004771.8520  667234.3822    585.267  36.17329586595 -115.1404942420  0.0021  -0.43742  3.71079  -7.23440 Stewart_New        1
    13     48014.265  4004771.8520  667234.3822    585.267  36.17329586593 -115.1404942422  0.0017  -0.43894  3.71058  -7.23466 Stewart_New        1
    14     48014.270  4004771.8520  667234.3822    585.267  36.17329586590 -115.1404942421  0.0017  -0.43864  3.71039  -7.23455 Stewart_New        1
    15     48014.275  4004771.8520  667234.3822    585.267  36.17329586585 -115.1404942418  0.0020  -0.43684  3.71040  -7.23411 Stewart_New        1
```

5.3 CoPre - Point Cloud Processing Software

5.3.1 CoPre Software Overview

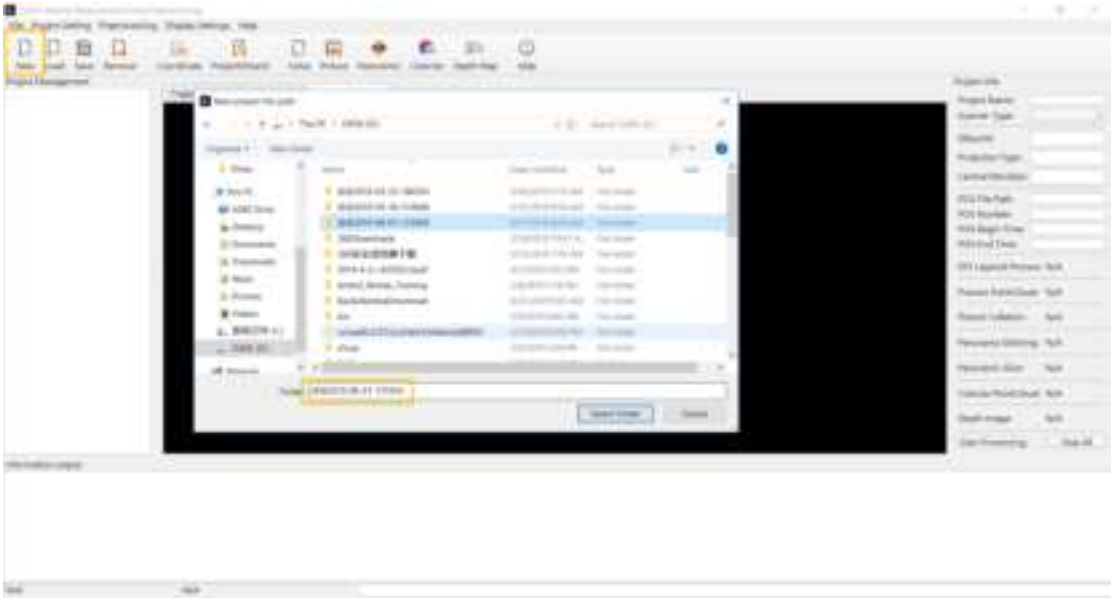
CoPre is a CHC designed one-button data pre-processing software enables both point cloud processing and panorama image collation. It also supports lots of powerful functions such as custom coordinate system, panorama stitching, point cloud colorized and depth image. Meanwhile, it can download & browse real-time map and manually select area which more interested from raw data based on GPS signal value, which is convenient and flexible for realizing the solution of the original scanner data. The static data can be automatically filtered during the solution process, and the data can be backed up multiple times and supported by distance filtering, gray value filtering and skip noise filtering.



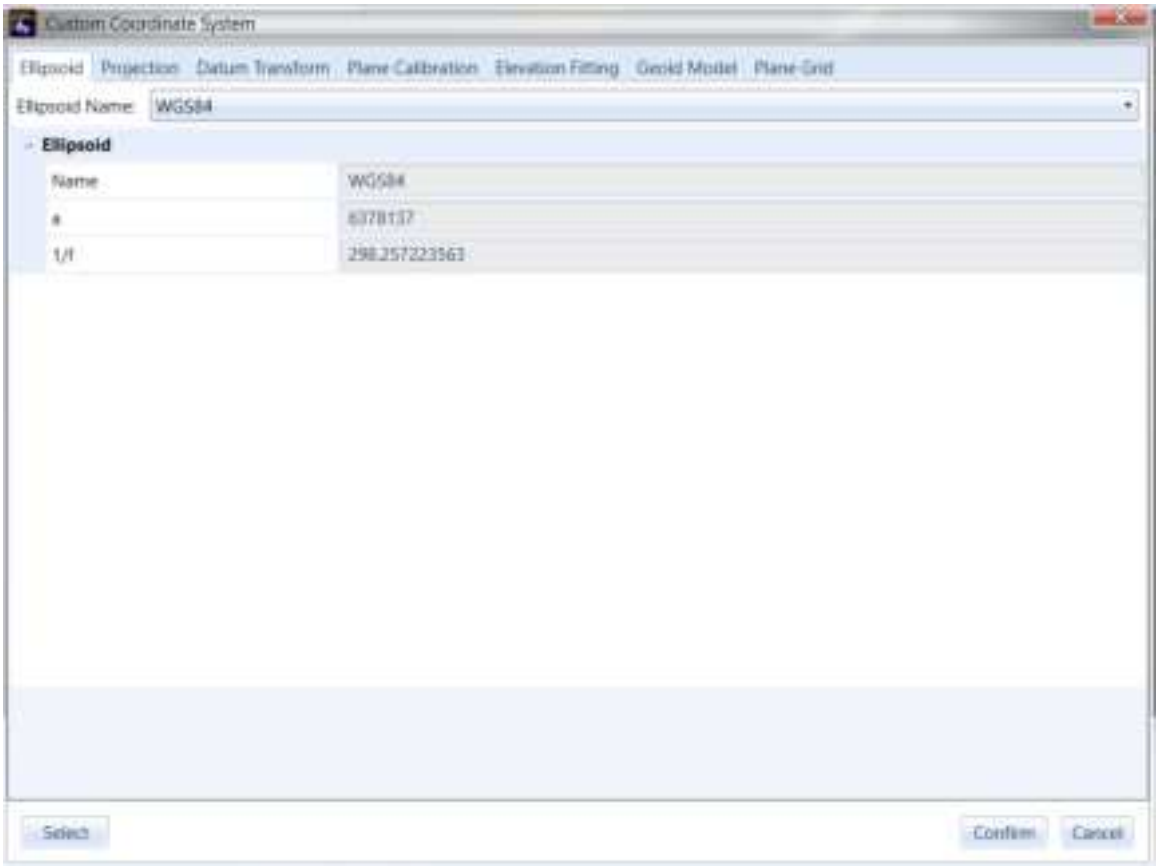
5.3.2 CoPre Quick Guide

5.3.2.1 Import Project

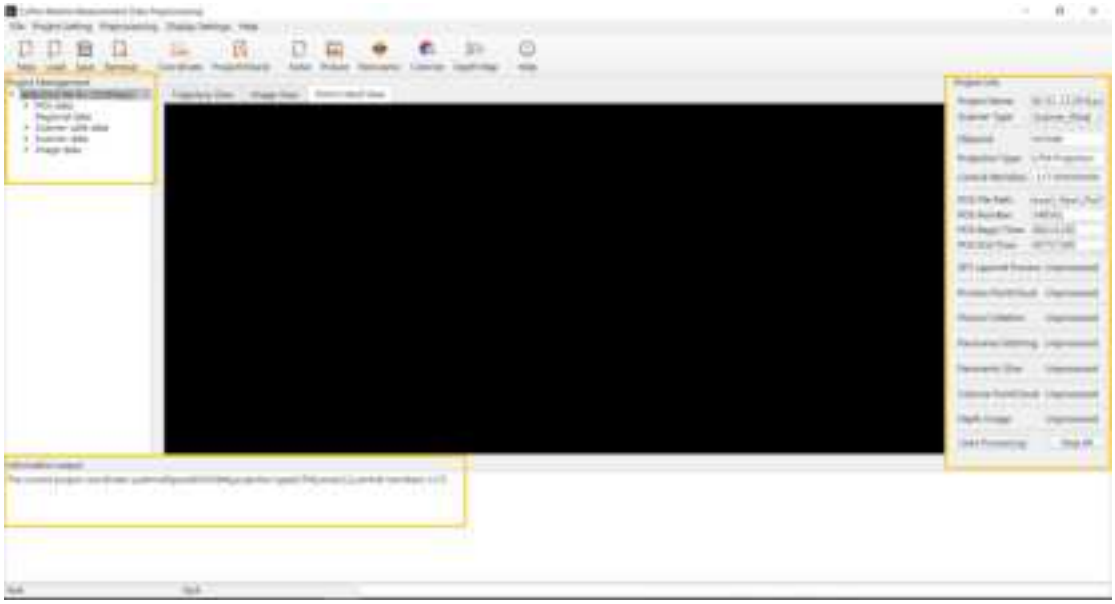
- Click **New** to import data project folder which start with "@@" and click **Select Folder**:



- The custom coordinate system interface should pop up. Ensure Ellipsoid and Projection information are correct, then click **Confirm**.

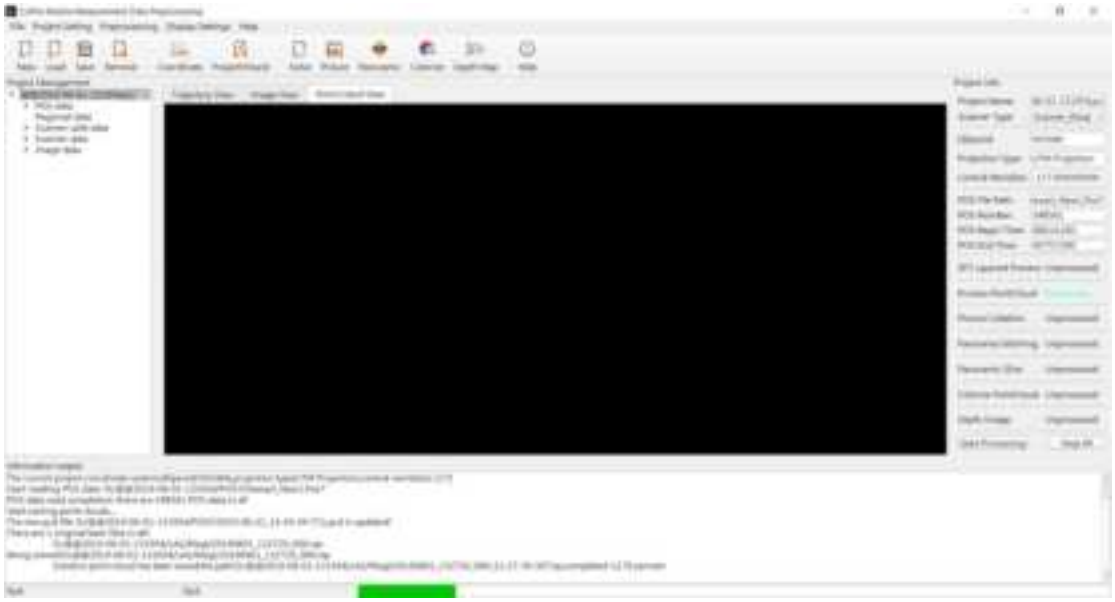


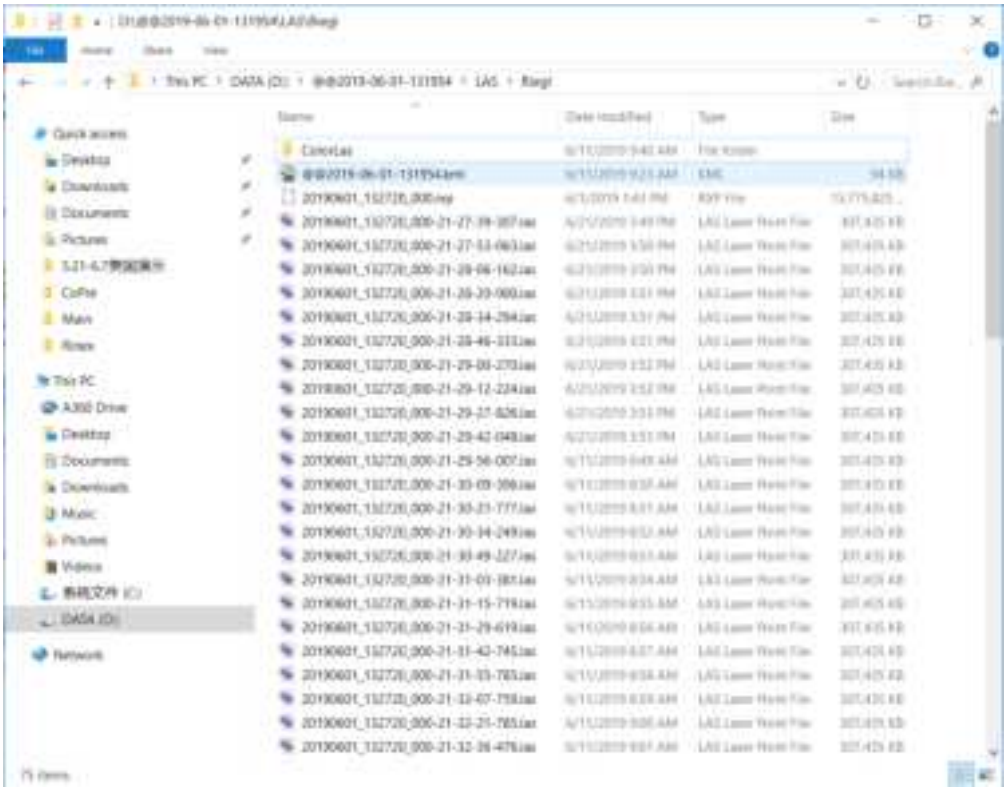
- In project wizard interface, keep all settings as default and click **Next**. Next page is a processing flow which supports automatically processing data. Here we choose manually processing data so click **Finished**. The interface will show project information on right side and relative files will be read automatically if they saved in correct folders before.



5.3.2.2 Solve Point Cloud Data

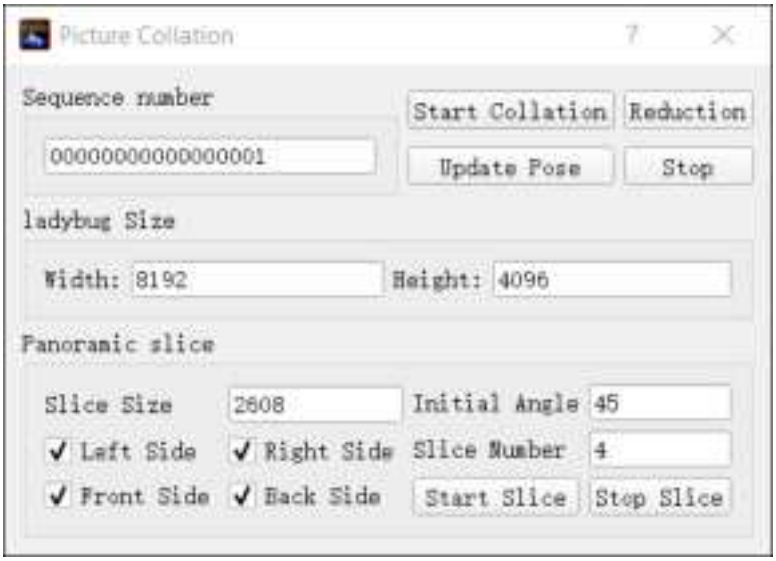
- Click **Solve** to automatically start raw lidar data (rxp format) processing. It will generate las format point cloud data in Riegl folder.

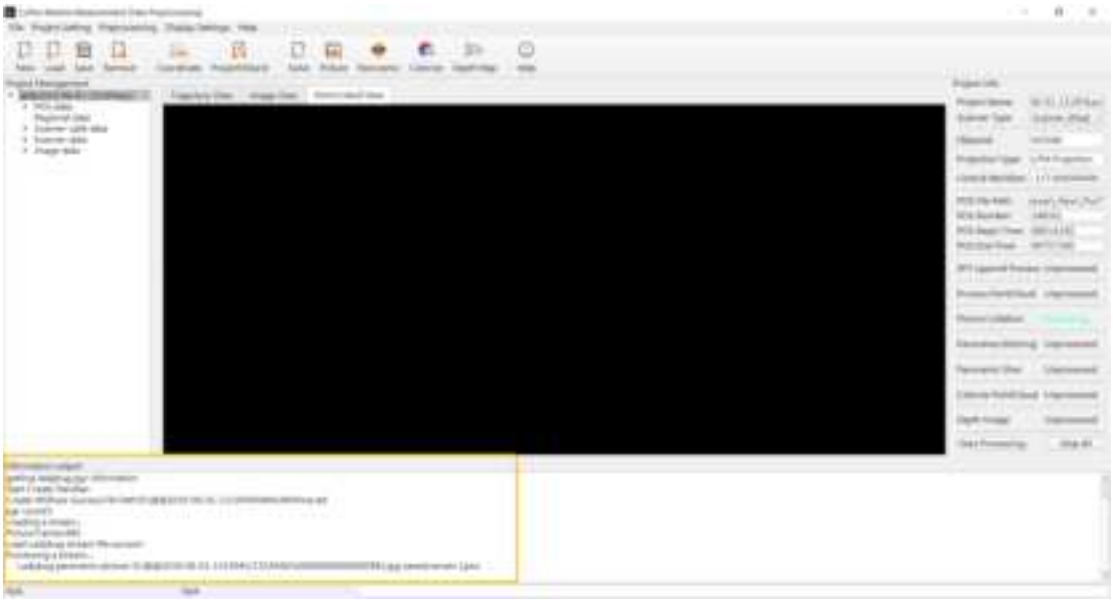


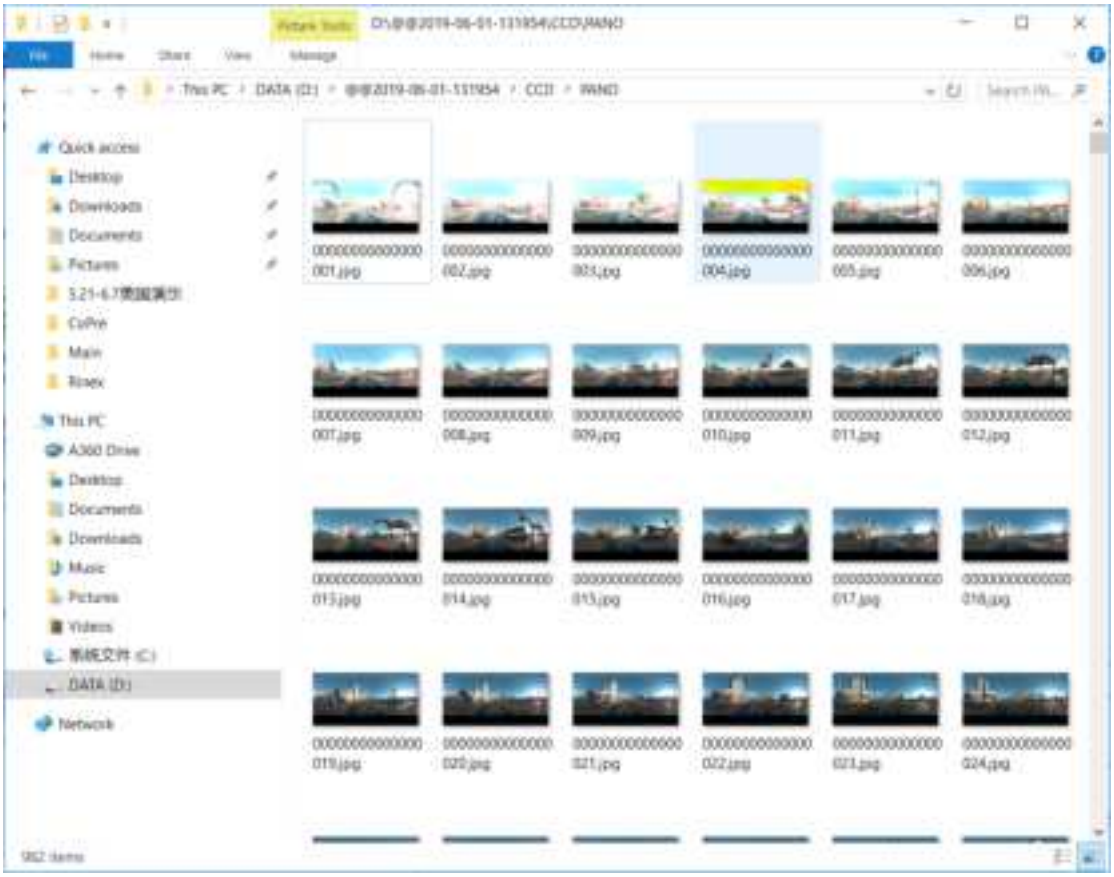


5.3.2.3 Picture Collation

Click **Picture** to prepare picture collation. Ensure sequence number is start from 1 and keep all settings as default. Click **Start Collation**. Detailed progress is shown in below information box. It will generate jpg format picture in **PANO** folder.

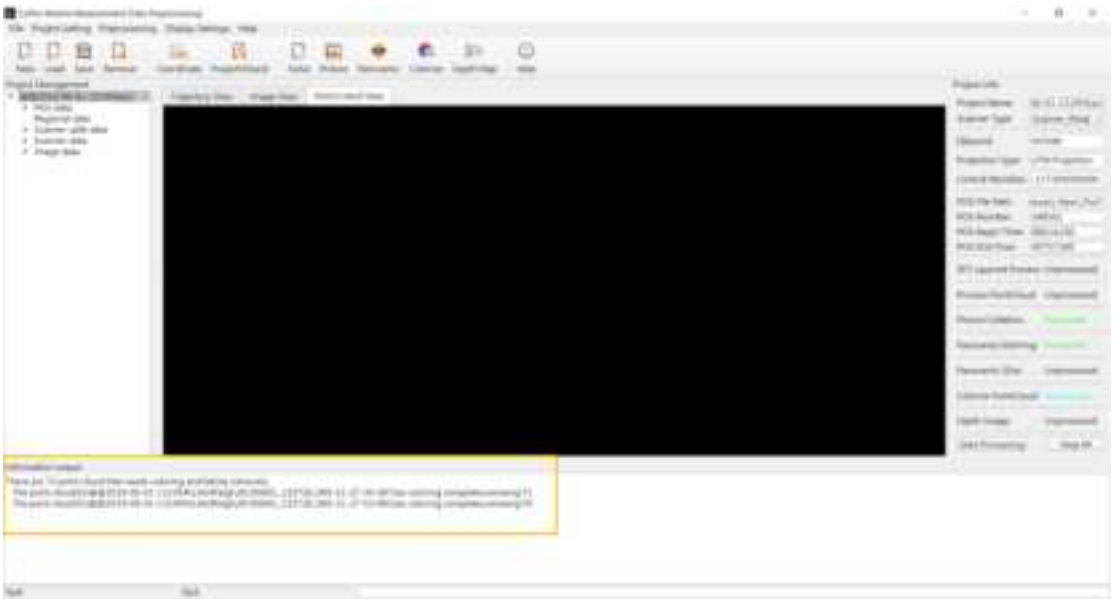


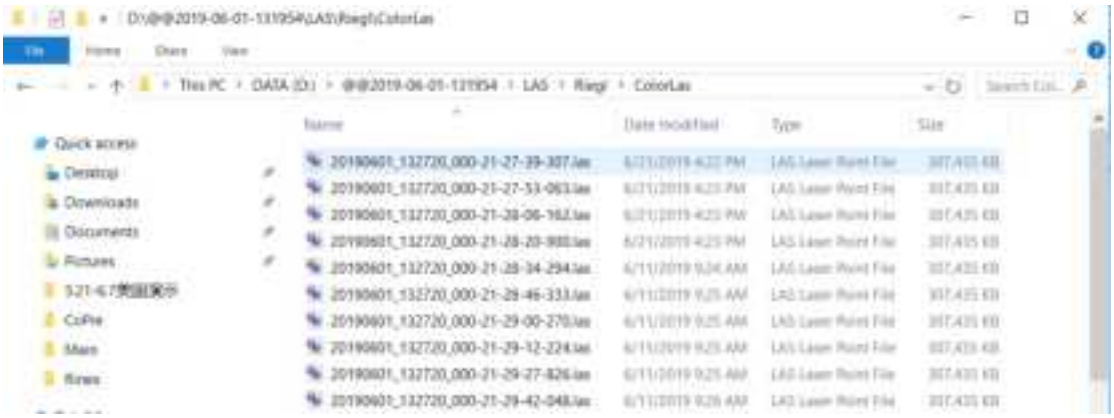




5.3.2.4 Point Cloud Colorized

Click **Colorize** to start point cloud colorized. Both needed files will be automatically read in software and click **Start** to begin. It will generate colorized las format point cloud data in **ColorLas** folder.





6 Alpha3D Operation Quick Guide

6.1 Pre-Requirement for Installation

In order to install and use Alpha3D, the following requirements must be covered:

 For safety, at least 2 persons to lift and mount the unit.

 A vehicle with roof bar to assemble system.

 A base station to post-processing data.

6.2 Operation Steps

First, assemble extension with roof bar which above the vehicle and then mount Alpha3D system, detailed steps please check *Part 3.6.1*. Make sure all screws are tightened and then remove the protective cap of laser scanner.

Second, use power cable to connect Alpha3D and battery box. Plug one cable side into DC24 interface and another side into battery power output interface. Press controller box button to switch on battery.

Third, set a base station at a known point and start static mode which used to post-process trajectory. Notice, if you use CORS data as base here, this step can ignore but the final data accuracy is depending on the length of base line.

Fourth, park vehicle in an open sky area and long-press button to power on system. After WiFi is connected, using CoCapture to start work. Detailed steps please check *Part 5.1.4*.

Notice: Before start scanning, the IMU system needs both static and kinematic alignments. First is do a static alignment: Click **NEW PROJECT** in CoCapture to start record time. Keep both car and system as stable for 5 minutes to make a proper static alignment. Then, take a 3 minutes figure-eight route driving to make a proper kinematic alignment. Finally, click **START** to capture laser data two minutes before entering scanning area. Similarly, both static and kinematic alignments are also needed when scanning finished, but the order is different: take another 3 minutes figure-eight route driving first and finally keep stable for another 5 minutes.

Finally, when work is finished, mount protective cap first for safety. Then, disassemble battery cable, unit and roof rack extension in order. Make sure all accessories are kept in container.

6.3 Data Pre-Processing Steps

Pre-processing is the first stage in the data processing process which can generate trajectory, point cloud and panoramic pictures finally. During this process, there are two software will be used: Inertial Explorer and CoPre. Inertial Explorer is first used to combine both base and rover data to generate trajectory POS file. Detailed steps please check *Part 5.2.2*. CoPre is second software used to process raw lidar data to generate point cloud and panoramic pictures. Detailed steps please check *Part 5.3.2.*

7 Safety Directions

7.1 General Requirements

LiDAR system is a complex and precise surveying system. During daily carry, transport, use and store process, only correct using and proper maintenance can ensure the accuracy of unit and extend the durable years of unit. There are follow requirements need to be noticed:

- Users are not allowed to disassemble unit by self. If unit occurred problems, please contact CHC support team first.
- Please use original battery and accessories. If use non-original battery, the charger may occur explode or burning accidents. Non-original accessories are not eligible for warranty.
- When using charger to charging unit, please keep away from fire, inflammables and explosive materials in order to avoid fire or other serious consequences.
- Please don't abandon waste batteries and It should be disposed in accordance with local regulations as special wastes.
- Please follow user manual's steps to connect device with cable. Pay attention to plug all accessories tightly and turn on all switches in order.
- Don't plug in or pull out any cables without power off.
- Don't keep using any broken cables. Please pay and replace new cables immediately to avoid any unnecessary damage.
- Protect the device from strongly impact and shake.
- Please use rugged weather cover or umbrella for waterproof if necessary.
- Please back device to container timely after using. Make sure the device and container are dry before return unit.
- If user needs using device for very long time or under special environment conditions such as high humidity environment, please contact CHC support center first. Generally, the device occur malfunction under special conditions is not covered by the product warranty.

7.2 System Delivery Tips

- Alpha3D is equipped with special instrument container. During vehicle transit, please put container or device on seat with people to care about in order to avoid vibration.
- During shipping process, in order to avoid damage by mis-operation of staff, user should inform relative staff that Alpha3D is a precise instrument and it needs transport carefully with fragile label.
- If using express service to transport device, the instrument container needs an outer

carton and filling with shock absorbing cotton or foam inside. Buy a special insurance and labeled as dangerous package.

- Alpha3D should be used and storage by special person and don't rent device to other people.

7.3 Alpha3D Using Tips

- During usage process, Alpha3D must be handled with care in order to avoid dirty and scratch. Don't sit on instrument container or packing box.
- After work finished outside, user should clean device's surface regularly (3-5 days) with wet tissue or alcohol cotton cloth. In addition, user should also check whether screws & external cables are fixed.
- After long time storage, user should do power-on test regularly (1 month) to check whether the function is correct.
- System using temperature is -10℃~+40℃ and using humidity is less than 80%RH. No condensation.
- During assemble and test process, please put unit on cabinet or special shelf, and covered by dust covers. The scanner part should cover by dust cap.
- If Alpha3D is disassemble or loose, it should be re-calibrated before next time work.
- If any part of device occurred rotation difficulty, don't rotate forcedly. If Alpha3D is break down, it should not be used to avoid damage increase and user should ask professional staff for indoor maintenance. Don't disassemble device outdoor.
- If face rain or snow during field work, please put device into container immediately. Don't work under low temperature in winter in order to avoid water vapor condensation inside.

7.4 Alpha3D Storage

- When Alpha3D is not in use, the battery should be handled with care and it cannot be placed upside down as it's an accumulator. The screws side should in upward.
- Alpha3D should store in dry warehouse tidily and try to avoid long-time storage.
- Alpha3D storage room should clean, dry, bright and excellent ventilation. Please place device in flat or upright in order to avoid transformation.

FCC WARNING STATEMENT

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Caution: Any changes or modifications to this device not explicitly approved by manufacturer could void your authority to operate this equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The device has been evaluated to meet general RF exposure requirement. This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

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