



FLYABILITY

INSPECTOR

3.0 Beta

USER MANUAL

VERSION 3.0.2

30/11/2020

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1 Overview

1.1 Inspector

Inspector is the official Flyability software used to analyze the inspection footage gathered by the ELIOS 1 and ELIOS 2 drones.

Flyability drones save the flight data in different locations.

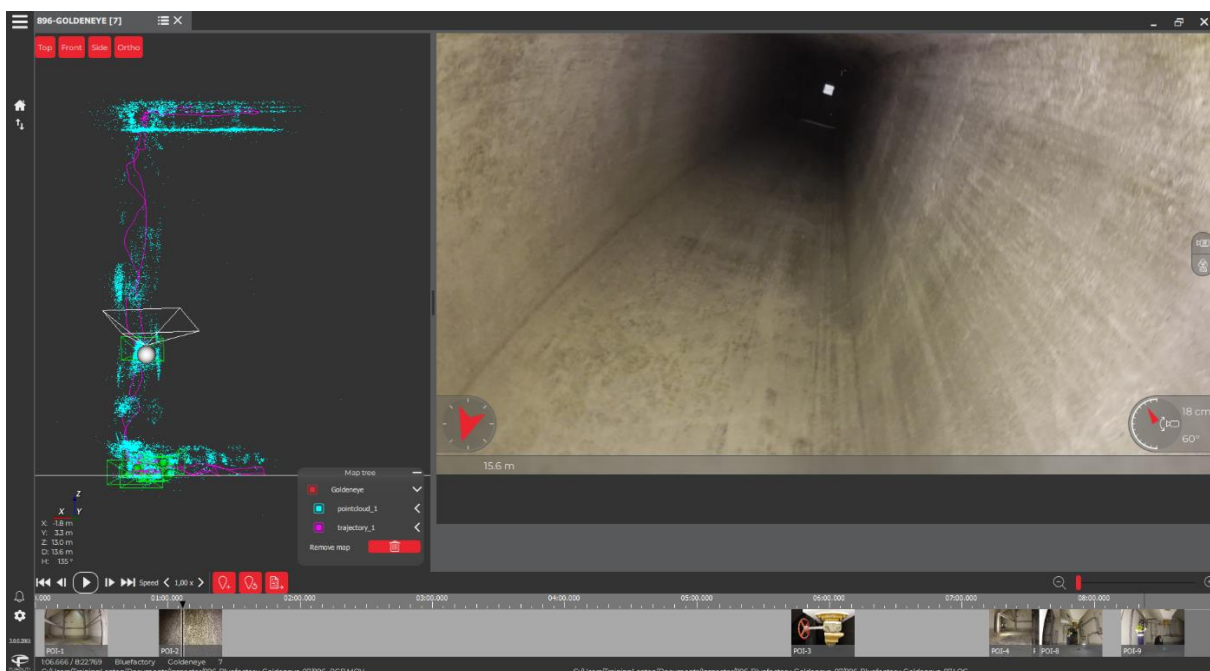
- The videos and still images are saved on the CAM SD card. A new video is created every flight, and when filming in 4K video, several videos can be created for one flight.
- The thermal camera data and flight altitude/direction are saved on the LOG SD card. A log file is created when a battery is connected and continues recording until it is disconnected.

Inspector can download data from the drone, automatically matching log files to their corresponding videos, splicing the videos for one flight together, and saves the data into a project folder on your PC. During post processing, Inspector allows for frame by frame video analysis, viewing the Thermal Camera data, making distance measurements, annotating points of interest, and exporting inspection reports.

1.2 Mapping

Inspector 3.0 has a mapping feature which uses Visual Inertial Odometry (VIO) to recreate 3D models of the flight environment based on video and avionics (gyroscope and accelerometer) data. This feature is compatible with Elios 2 only.

The output of the process is a sparse3D point cloud and the trajectory, linked with the drone footage



2 Installation

2.1 System requirements

Inspector requires a 64-bit machine running Windows 7 or newer.

The mapping feature requires Windows 10 Pro (2004+) or Windows 10 Home (1904+). It also requires Docker, a 3rd party Linux emulator. The mapping feature also has high computational requirements and needs at least 8GB of RAM to run reliably.

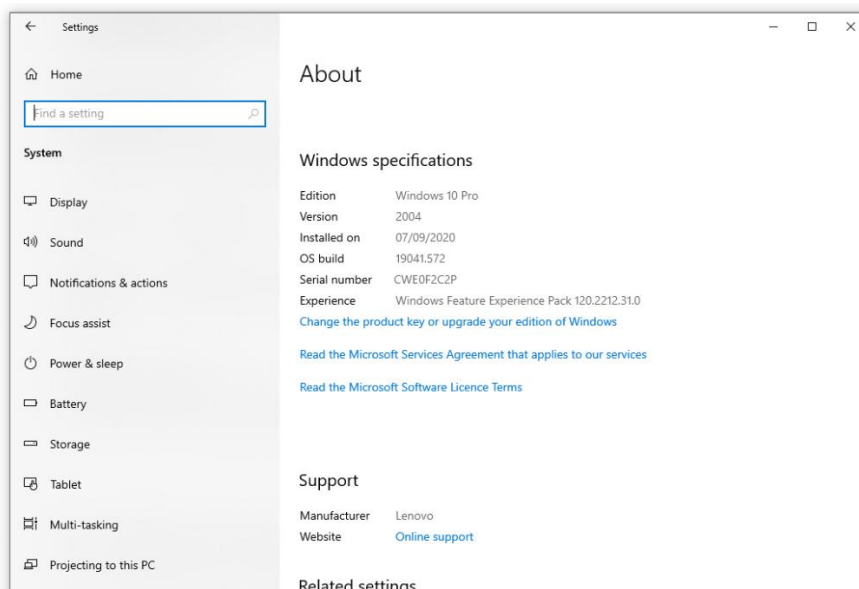
2.2 Installing Inspector

Inspector 3.0 is distributed as a standard executable installer (.exe), available on flyability.com. For now, it is limited to a public beta release and requires registration.

Run the installer and follow the instructions displayed. The mapping feature is included and automatically installed with the beta test release of Inspector 3.0.

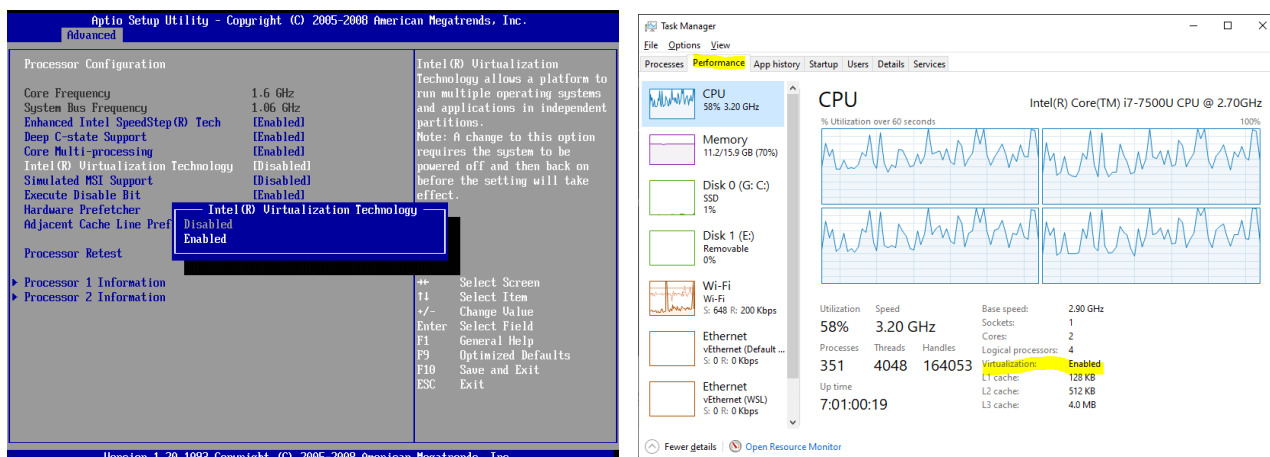
2.3 Installing Docker (required for Mapping)

Docker requires Windows 10 Pro (2004+) or Windows 10 Home (1904+). Make sure your Windows OS is up to date. You can go to [Windows settings > System > About] to verify the version. Use the [Windows 10 Update Assistant](#) to update your system if necessary.



Next, make sure that Virtualization is enabled in your BIOS. Restart your computer, enter the BIOS setup menu and enable virtualization. Typically, accessing the BIOS setup menu requires you to press a specific key during computer startup, but this procedure varies from one manufacturer to the next. Consult your computer's manual for more information about the BIOS setup menu.

You can check the performance tab in the task manager (Ctrl+Shift+Esc) to verify that virtualization has been successfully enabled.



You are now ready to download and install Docker Desktop, this software is available free of charge on docker.com/products/docker-desktop

Launch the installer and follow the installation instructions. If prompted, keep "Enable WSL 2 Windows Features" enabled.



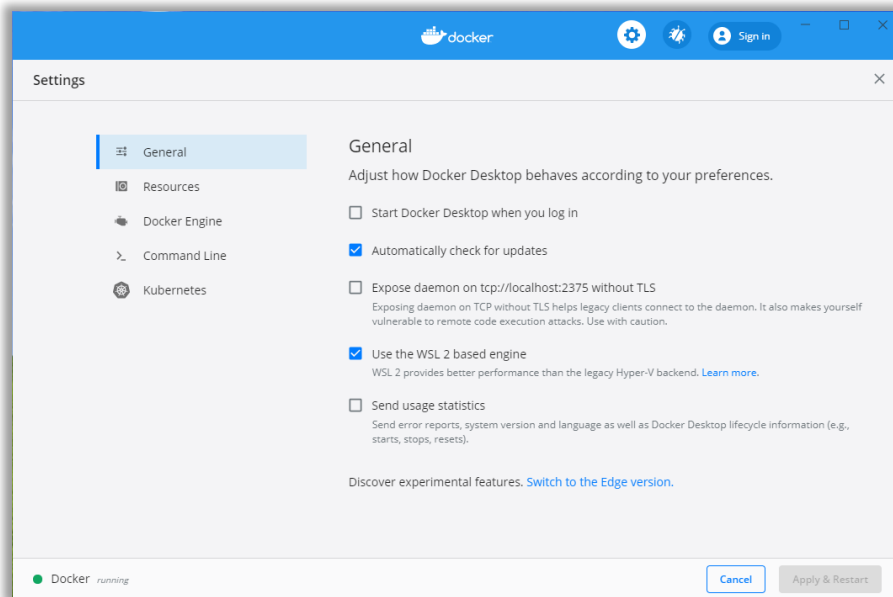
Restart when asked

After restart, this warning might pop up.



Proceed with the installation of WSL2. [This Microsoft support page](https://aka.ms/wsl2kernel) will explain how to install and activate WSL 2. If you did not receive the error, you can skip this step.

In Docker's settings > General, make sure "Use the WSL 2 based engine" is enabled



Docker is now installed and configured. You can now use the mapping feature on Inspector 3.0.

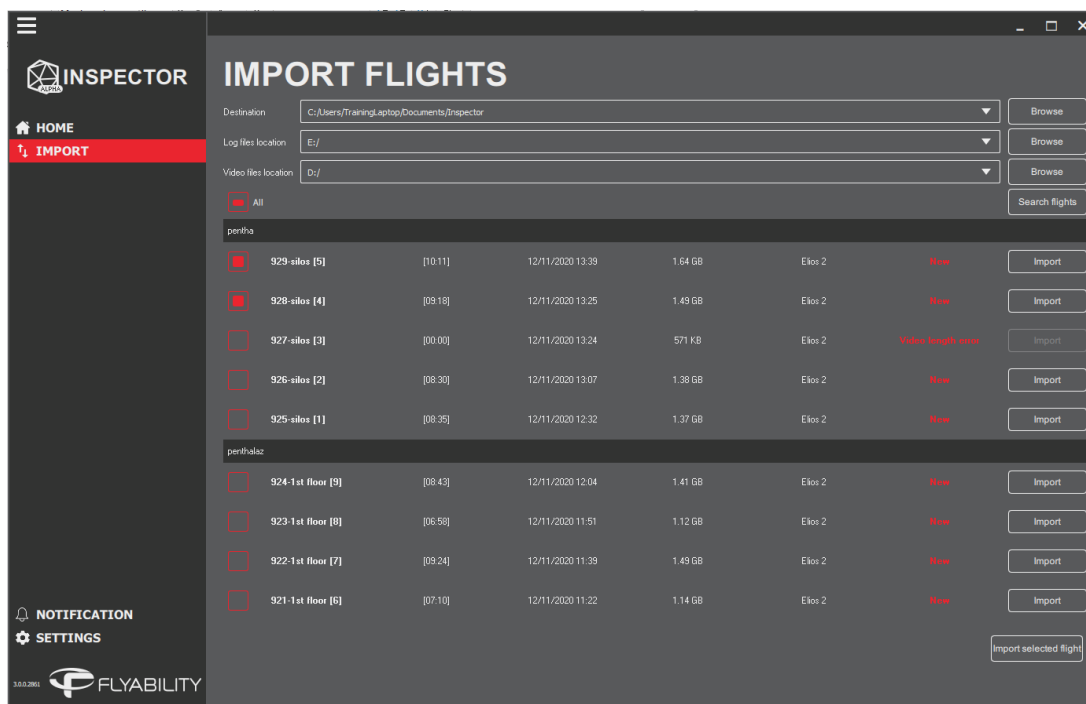


This warning might pop up while running Docker, but it can be ignored.

2.4 Drone Firmware

The Mapping feature is only compatible with flight data recorded by an Elios 2 drone with the latest firmware (v1.4). Be sure to update your drone firmware and tablet cockpit app to the latest versions.

3 Import Screen



DESTINATION

Specifies the location on your computer to where the flight data will be imported. Default is documents/Inspector.

LOG FILES LOCATION

The path to the log files of the flight you wish to import. If an Elios 2 is connected via USB-C then this will automatically read from the LOG SD card.

VIDEO FILES LOCATION

The path to the video files of the flight you wish to import. If an Elios 2 is connected via USB-C then this will automatically read from the Camera SD card.

SEARCH FLIGHTS

List all the flights from the specified directories, SD cards, or a connected Elios 2 drone. Inspector automatically matches videos and log files. They must be imported and saved as a project locally before viewing.

All flights found will be displayed in a list, ordered by mission name and flight number.

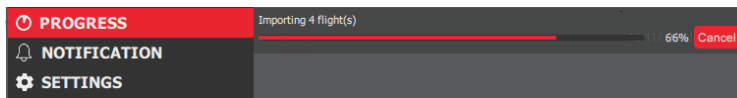
IMPORT

Click this button to import an individual flight. This will create a flight project folder in the specified destination, containing the following data:

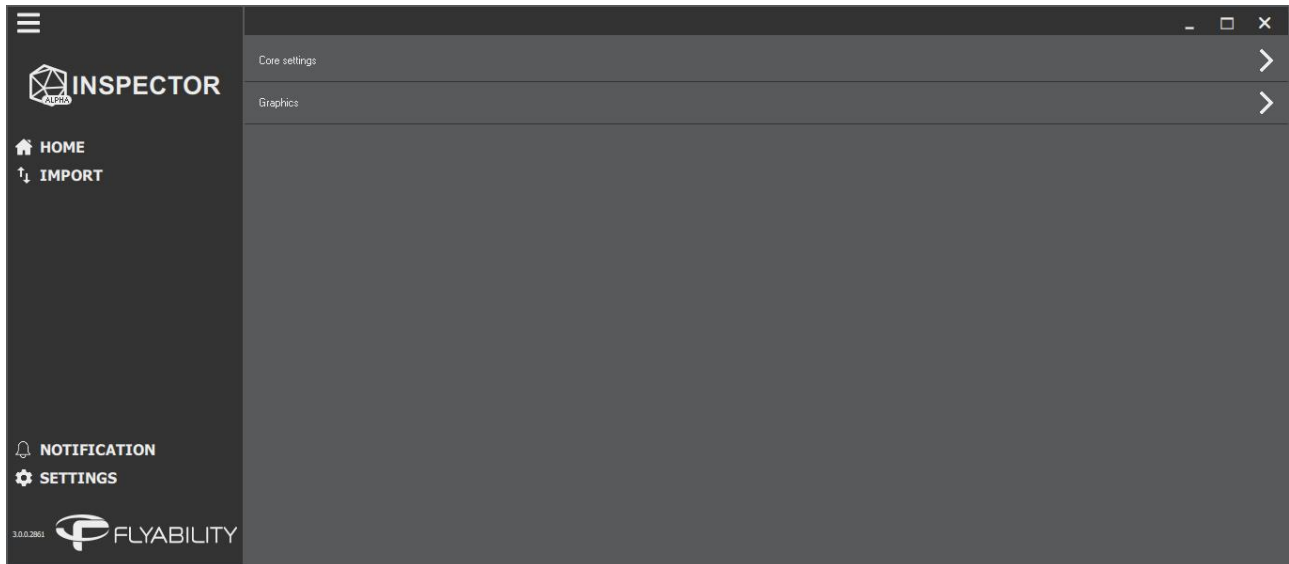
1. The Video file (.mov format)
2. Still images of POI's taken in flight (.jpeg format)
3. The Inspector Project file (.efly)
4. The Drone's inertial and visual sensor data (.LOG)
5. The thermal camera data, later converted to a video file (.thm and .mp4)

IMPORT SELECTED FLIGHTS

Batch import several flights by checking the boxes on the left and clicking on 'import selected flights'. The progress can be displayed by clicking the progress icon on the left-hand side.



4 Settings



CORE SETTINGS

- File import folder: Allows you to set the default import folder when importing new flights.
- Unit system: Change the unit system in which flight data is displayed.

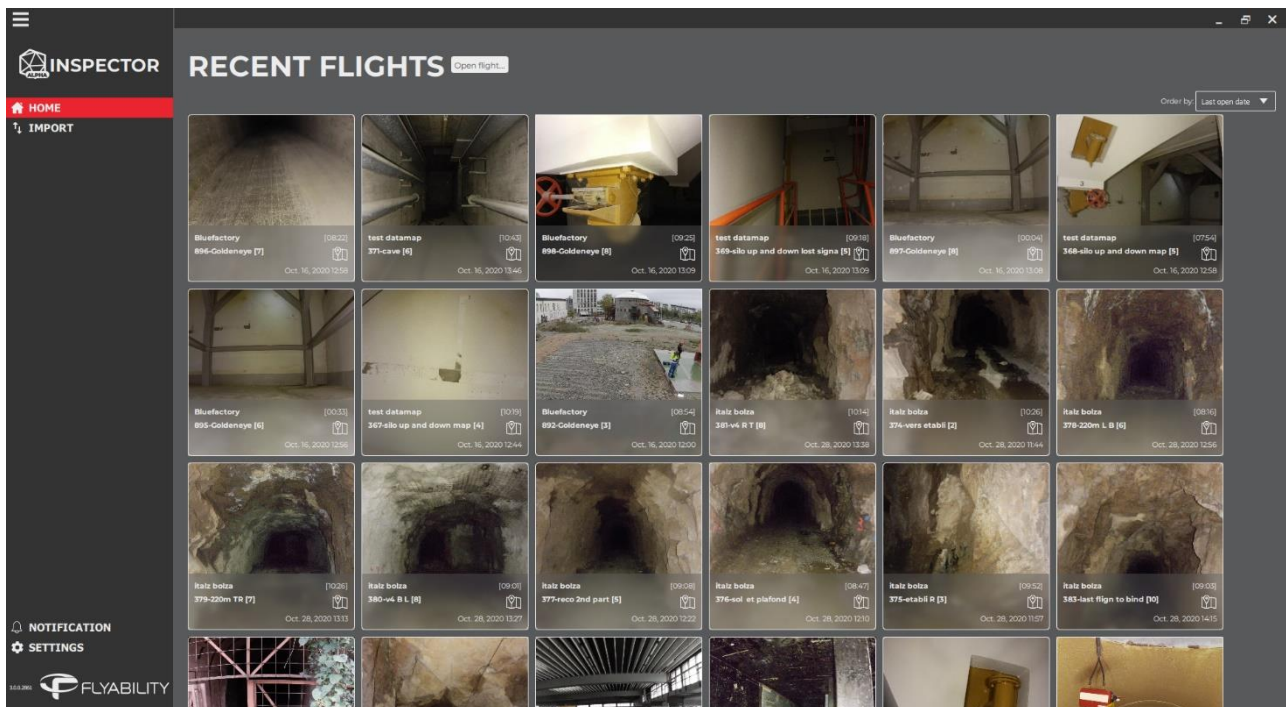
GRAPHICS

- Palette: inspector comes in a light and a dark color palette; choose whichever one best matches your mood.

5 About

Click the Flyability icon in the bottom left corner to review the License Agreement.

6 Home screen



RECENT FLIGHTS

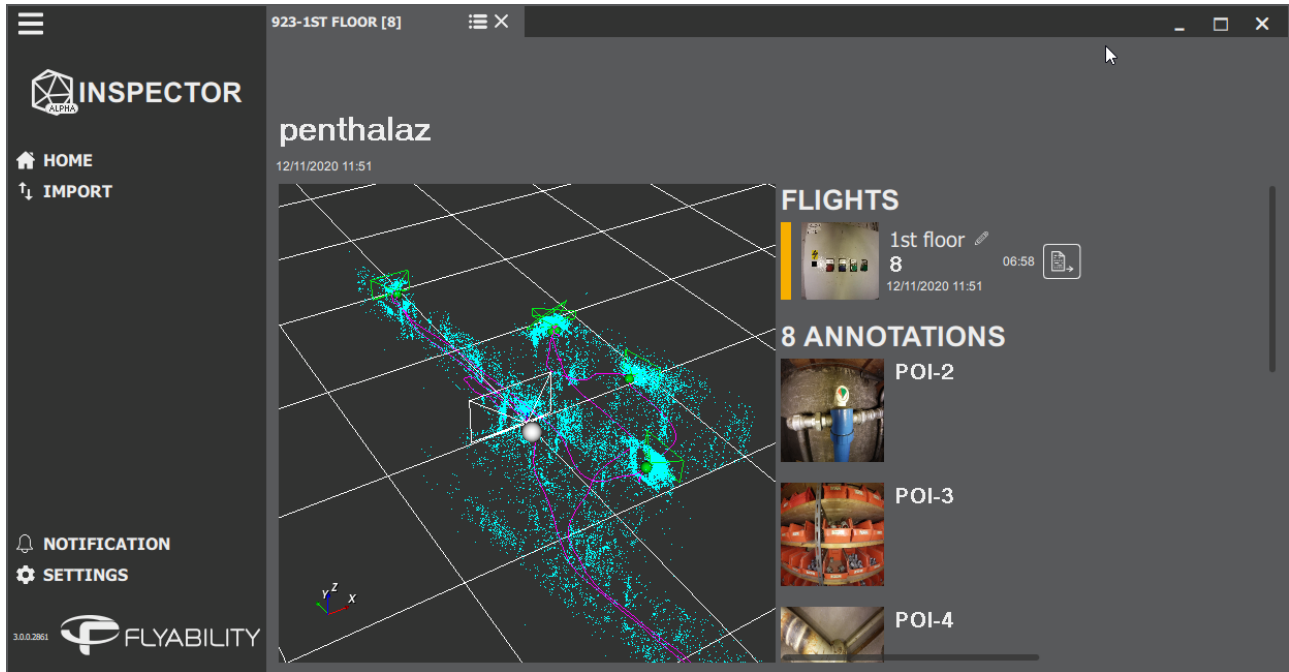
The home screen displays a list of projects which have been recently opened or imported. If you have not imported or opened any projects yet, it displays the Flyability news feed.

OPEN FLIGHT

If the flight you are looking for is not shown in the list, then you can use this button to browse for it on your computer.


7 Preview Screen

To open a flight, click on its thumbnail in the Home Screen, use the 'open flight' browser, or double click the .efly project file.

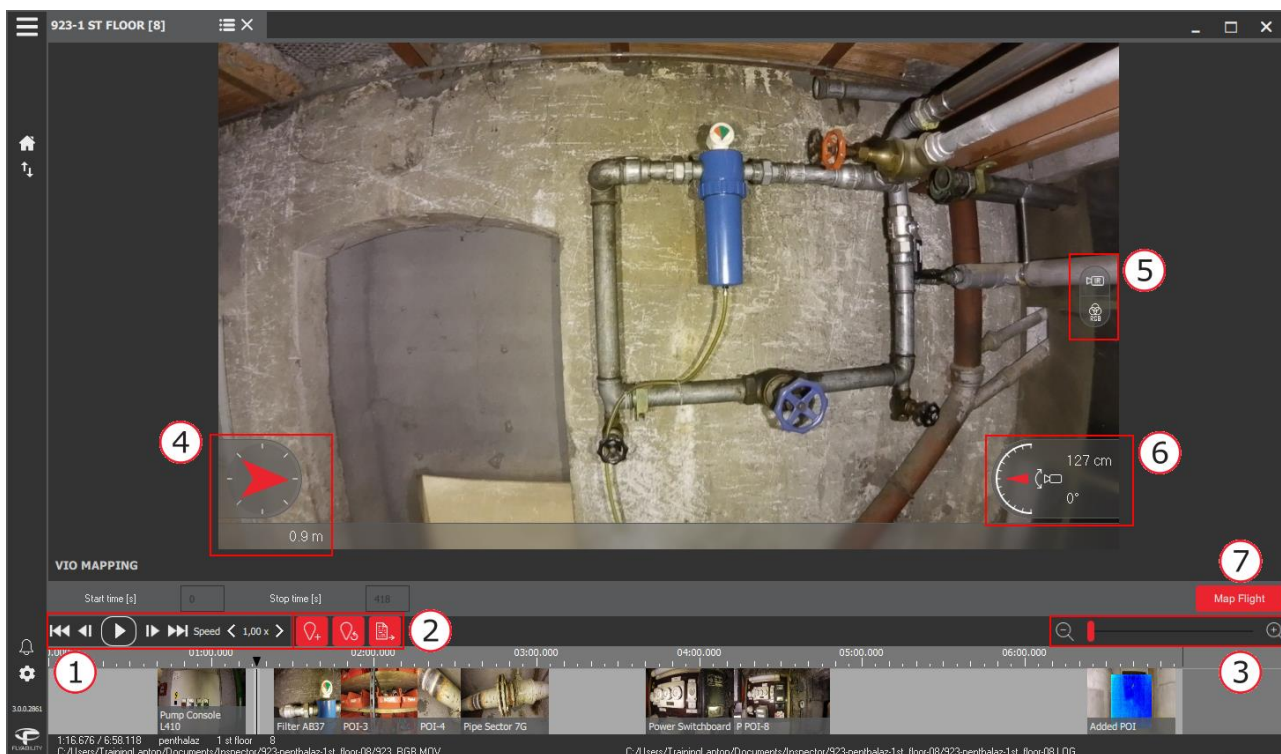


On the preview screen you will see a preview of the 3D map (this will not be generated the first time you open a new project), and a preview of the points of interest.

The mission and flight name will appear if they were filled in on the tablet before the flight. You can edit them here by double clicking on them.

Continue to review the video by clicking on the thumbnail under 'FLIGHTS'. You can always return to the preview screen by clicking the  icon at the top of the screen.

8 Flight Screen



The flight screen shows the flight video, along with the Points of Interest (POIs) in the timeline at the bottom.

The data and controls overlaying the video image can be toggled on and off by clicking the video area.

1 VIDEO CONTROLS

- Play or pause the video (Space bar)
- Move to the previous / next frame (arrow left/right)
- Move to the beginning / end of the flight
- Set the playback speed

2 POINT OF INTEREST CONTROLS



Add a POI



Restore original POIs from flight



Export the flight report

3 ZOOM CONTROL

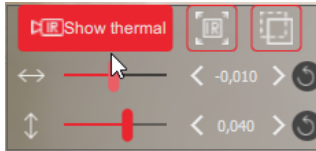
- Zoom in during playback

4 ALTITUDE AND ORIENTATION

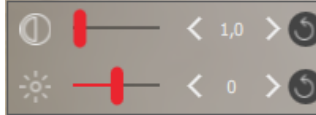
- Displays the altitude and orientation of the drone as shown on the cockpit display during flight.

5 IMAGE SETTINGS

- Clicking on the IR camera icon expands a menu, allowing the thermal camera video to be toggled on and off, in semitransparent mode or in full screen. Use the arrows to adjust the position of the video to correct for small differences in camera alignment.



Clicking the RGB icon expands contrast and brightness settings for the video camera.



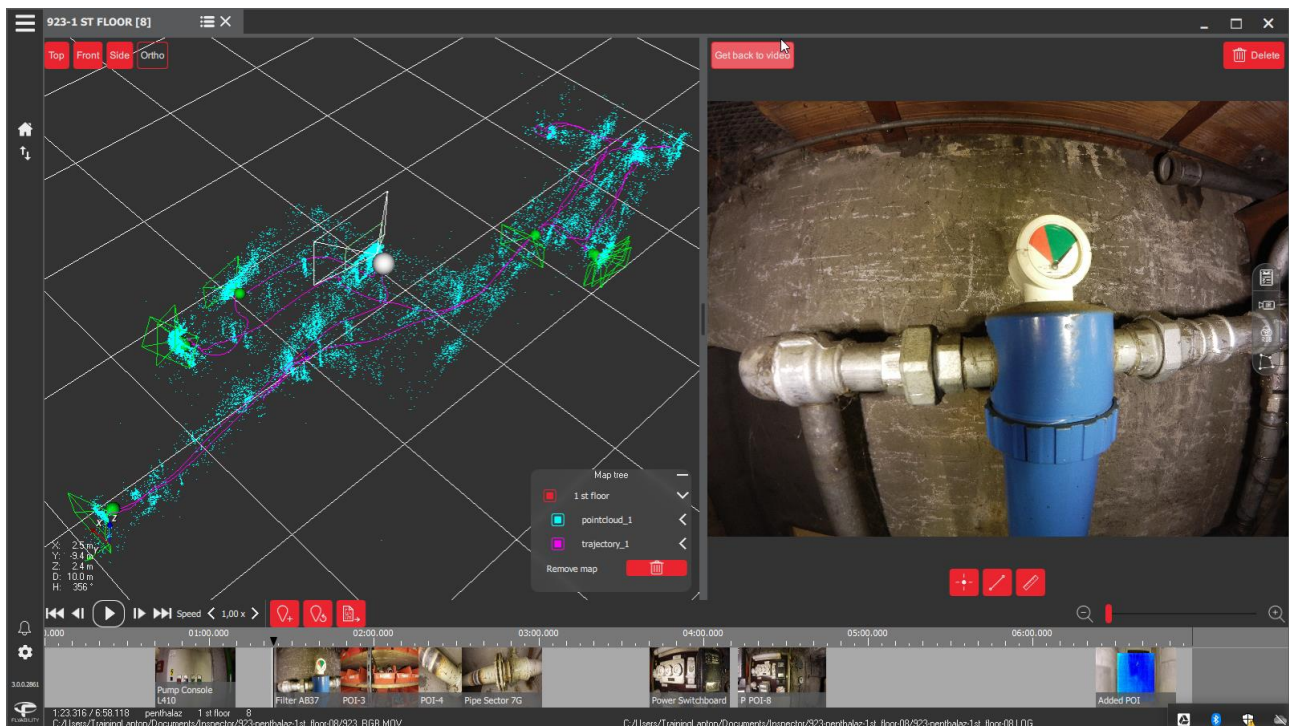
6 CAMERA TILT ANGLE AND DISTANCE MEASUREMENT

Displays the camera pitch angle and distance to the object in view, as shown on the cockpit display during flight.

7 MAP FLIGHT BUTTON

Pressing this button will start the mapping process for the current flight. Depending on your computer, this might take up to 45 minutes for a 10-minute flight. The progress is displayed by clicking the icon in the progress menu. Typically, the entire flight can be mapped, but a specific interval can be specified by editing the start time and stop time fields.

9 3D Model Window



When the mapping process is completed, the 3D model of the flight area will appear in an extra window next to the video. You can navigate this view with your keyboard and mouse:


Zoom in and out: mouse wheel or W and S

Move sideways: press mouse wheel or A and D

Rotate around point: press right mouse button

The current position in the video is represented in the model by a white icon which indicates the position and field of view of the drone. The POI's are likewise represented by green icons.

10 Managing Points of Interest

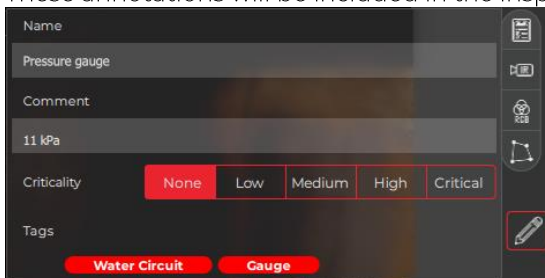
Points of Interest can be created during flight by pressing the POI button on the controller. They can also be created later in Inspector by clicking the  button.

POIs can be annotated for reporting purposes. Clicking on a POI in the video timeline opens the POI edit menu.



1. ANNOTATE POI

POIs can be annotated with a name, comments and tags. The criticality level can also be indicated. These annotations will be included in the inspection report automatically.



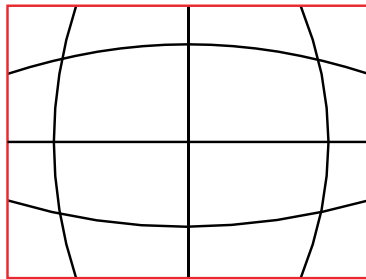
2. THERMAL CAMERA MENU

This allows you to show the thermal camera images over the video images. The settings changed here will only affect the current POI.

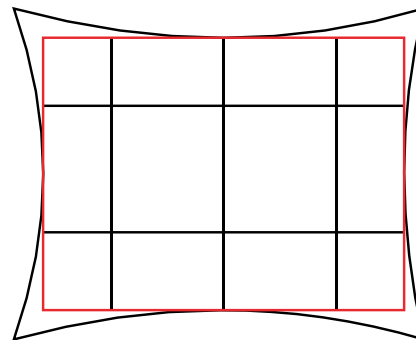
3. RGB CAMERA MENU

This allows you to modify brightness and contrast of the image. The settings changed here will only affect the current POI.


4. UNDISTORT



ORIGINAL IMAGE – DISTORTED



UNDISTORTED

 Border of displayed image

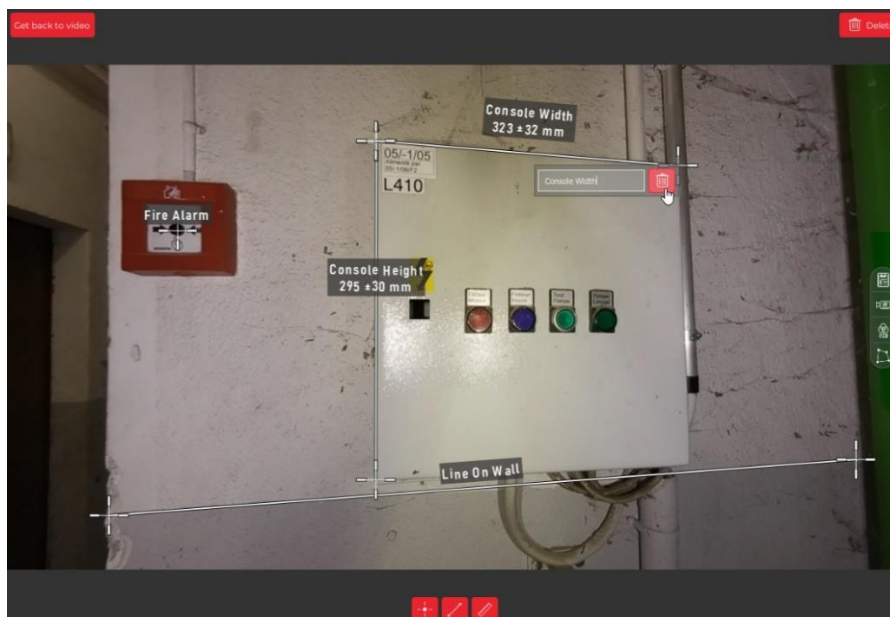
Due to the fish-eye effect of the optical camera, the image is distorted. Meaning, the straight lines are bent. In a POI the image can be undistorted or flattened. As the transformation stretches the image, the resulting frame displayed is slightly cropped.

5. ADD PLACEMARK

Specific areas on the image can be highlighted with placemarks. Click and drag to move an existing placemark, double click to edit the name or delete it.

6. ADD LINE

Specific areas on the image can be highlighted with lines. Click and drag to move an existing line, double click to edit the name or delete it.



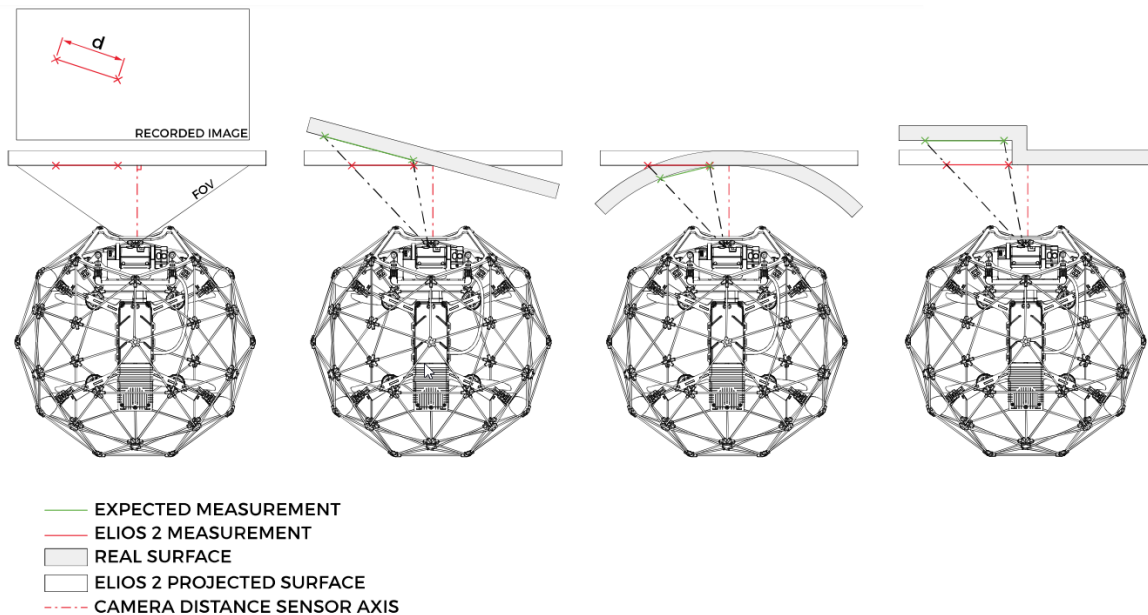
7. ADD MEASUREMENT

This feature uses information from the distance measurement sensor on the drone to make measurements using pixel calibration and triangulation. The measurement needs to be made on a

flat surface perpendicular to the camera's optical axis. The accuracy of the measurement is $\pm 10\%$ of the measured length with a maximum of $\pm 5\text{mm}$ accuracy.

The 2D measurement result is displayed on the frame with its estimated accuracy.

The button is greyed out in case of unreliable camera distance data.



THE USER MUST ASSESS IF THE MEASUREMENT MAKES SENSE BY UNDERSTANDING ITS LIMITATIONS. FLYABILITY DOES NOT GUARANTEE ITS ACCURACY.

8. GET BACK TO VIDEO

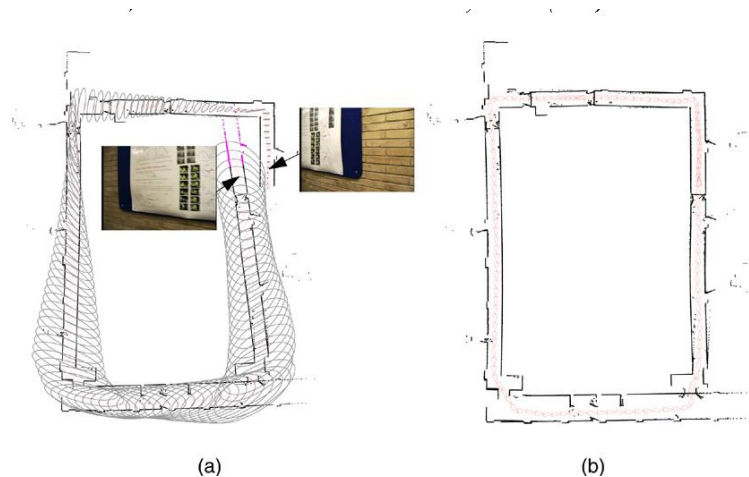
Clicking this will exit the POI screen and return to the video. This can also be accomplished by clicking on another part of the timeline.

9. DELETE POI

Click and hold, then click again to delete the current POI and all its annotations. This cannot be undone.

11 Flying tips for Mapping

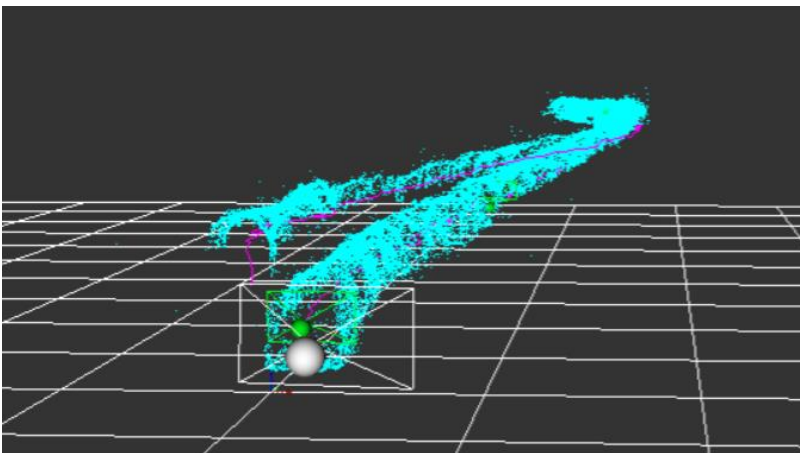
11.1 Takeoff and landing - Loop closure



ELIOS 2 must land close to the take-off position. While landing, the drone should face the same direction as during take-off. The software should recognize the similarity in the video images and snap closed the flight path, reducing position errors that may have accumulated during the flight.

Try to close the loop in several places during the flight by retracing the same path, while looking in the same direction.

For example, in tunnels this can be used to match outbound and inbound trajectories, reducing the probability of them appearing as double features in your model. You can also do a 360 degree turn before and after entering a manhole to reduce the chances of losing track while entering or exiting.



The image above shows a model with a 'double feature' error caused by improper loop closure.

11.2 Image Quality

The software tracks visual features on the video images to estimate the velocity and direction of travel. It is important that the image is properly lit at all times. Also, it is easier to track features close to the drone than far away. Try to keep high texture surfaces between 30cm to 5m from the drone at all times.

11.3 Cage

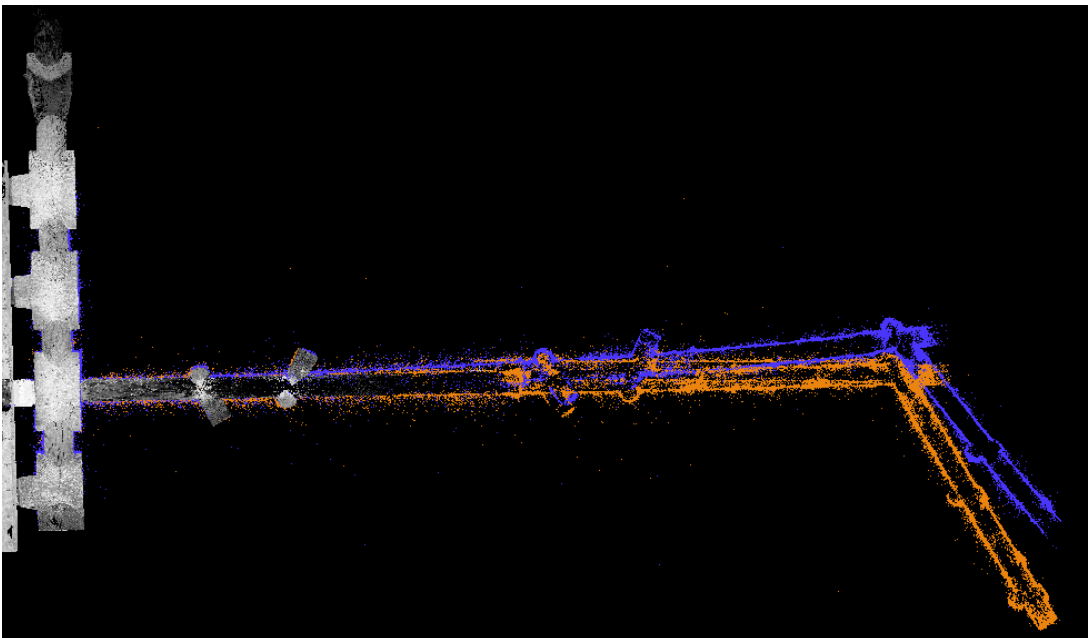
When looking too far up or down, the cage will block part of the field of view of the camera. This obstruction reduces the capability of the software to track visual features. Prefer flying with the “Cage free view” enabled or in “Photogrammetry mode”. In no case should the camera be tilted below -30° .

11.4 Collisions

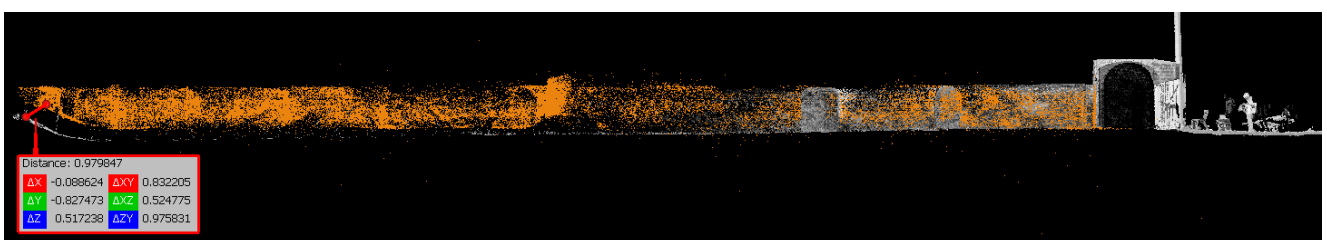
Collisions should be avoided as much as possible. Strong collisions will simultaneously saturate the IMU and create motion blur on the images.

12 Accuracy

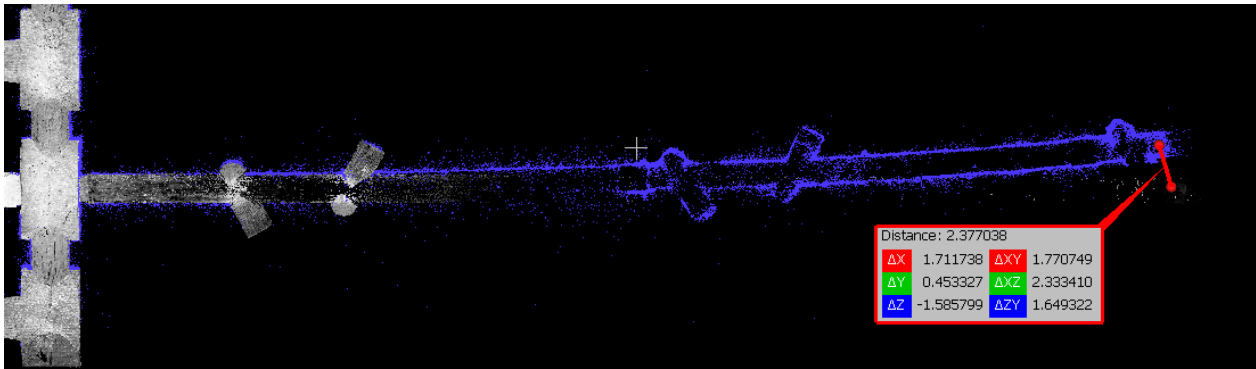
The Accuracy of the model depends on the flying style, flight path and the environment. Typically, the accuracy is within 10% of the length of the flight path, but it can change from one flight to the next.



The image above compares the point clouds created by Inspector 3.0 from two separate flights (orange and blue) compared to measurements of a handheld SLAM lidar (white). It shows how errors can accumulate, especially in long linear environments.



In this side view the Lidar point cloud seems to slightly pitch down, while the VIO point cloud does not. At the end of the tunnel (54m from take-off location) the error is about 1m or 2%. This error is mainly on the vertical axis



This top view of the blue point cloud shows the extent of the deformation in the model. The error is 2.38m (4.4% of the gallery length)

13 Exporting data

13.1 Export and Inspection Report

Inspector can generate a Microsoft Word document with detailed pages for each point of interest.

A report includes the following information:

- Cover page with flight name and date
- One page per point of interest with image and properties of that point of interest, including measurements, lines or markers.

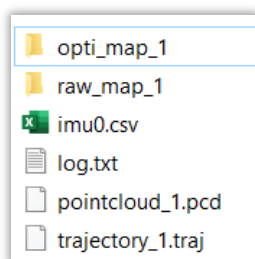
To export an inspection report, click on the Export Flight Report button.



13.2 Export the Point cloud of the 3D model

A .pcd format point cloud is automatically generated in the 'vio' subfolder in the flight folder. The flight folder can be opened by right clicking a flight in the home screen and clicking 'open explorer here'.

The 'vio' subfolder will contain the following files.



1. Pointcloud_x.pcd: Point cloud file
2. Trajectory_x.traj: trajectory file
3. Log.txt: Information about the processing

13.3 Export multiple frames for photogrammetry

This feature is not yet available in Inspector version 3.0 Beta.

14 Limitations

FEATURES MISSING FROM INSPECTOR 2.2

- Flight preview
- Frame export for photogrammetry
- Edit position of POI on video timeline
- Save frame / Copy frame to clipboard
- Importation of .efly projects created with previous version of Inspector.
- Dataset gathered with ELIOS 2 FW prior 1.4 might not work
- Elios 1 Compatibility

KNOWN ISSUES:

- Incorrect undistort for POI taken during the flight
- Mapping feedback stalling at 50% -- between tracking and optimization phase. Up to 10 min. If your computer is making noise, it means processing is still ongoing.
- SDI (low quality video transmission) recorded flights are not time and space synced properly
- If multiple trajectories are outputted from a single flight, it is not possible to re-align them.

15 Troubleshooting

To help us debug issues, please provide:

4. Step to reproduce
5. Dataset
6. vio/backend.log, vio/frontend.log, vio/docker.log
7. Corresponding inspector log located in %appdata%\Local\Flyability\Inspector\

15.1 Flight mapping is stuck at 0% for a couple of minutes

If it is the first time you are processing a flight, Docker needs to download the processing engine. This can take up to 30min.

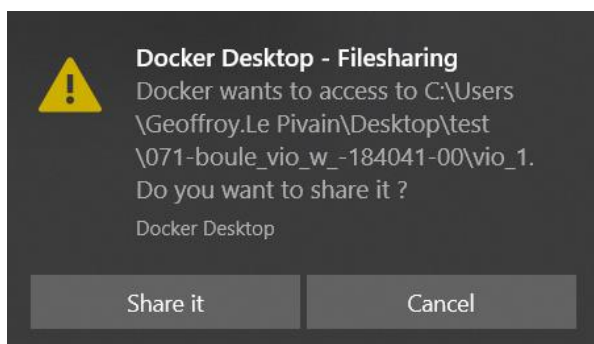
15.2 Mapping failed error



Docker needs to be running in the background. Launch Docker and try again.

15.3 Docker does not have access to your folder

You need to allow Docker to access your flight folder through the pop-up below:



If your computer is in Do not disturb mode, the notification will not be shown. You will have to click on the Notification center on the right side of your taskbar to access the pop-up and enable the access to the folder.



In the Docker settings, you can enable the access to a root folder and its subfolders to not have to grant further access.



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Content subject to change.
Find the latest version on:
flyability.com