



FLYABILITY  
INSPECTOR 3.0

**USER MANUAL**

**v3.0.0.4401a**

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# 1 Overview

## 1.1 Inspector

Inspector 3 is the official Flyability software used to analyze the inspection footage gathered by Elios 2 drones. It is not compatible with ELIOS 1 data, so the previous Inspector 2.2 should be used here instead.

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 automatically created every flight. The maximum file size is 4GB, so when recording in 4K, several videos can be created during 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 is used to download data from the drone, automatically matching log files to their corresponding videos, splicing the videos from one flight together, and saves the data into a project folder on your PC.

During post processing, Inspector allows you to:

- Analyze the video frame-by-frame
- View the Thermal Camera data
- Make distance measurements
- Annotating points of interest
- 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.

The output of the mapping process is a sparse 3D point cloud of the flight environment and the trajectory of the drone. The flight path is linked with the drone footage, which allows the user to quickly and intuitively verify where a particular image is taken within the flight environment.

## 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+), capable of running WSL2. The feature also has high computational requirements and needs at least 8GB of RAM to run reliably.

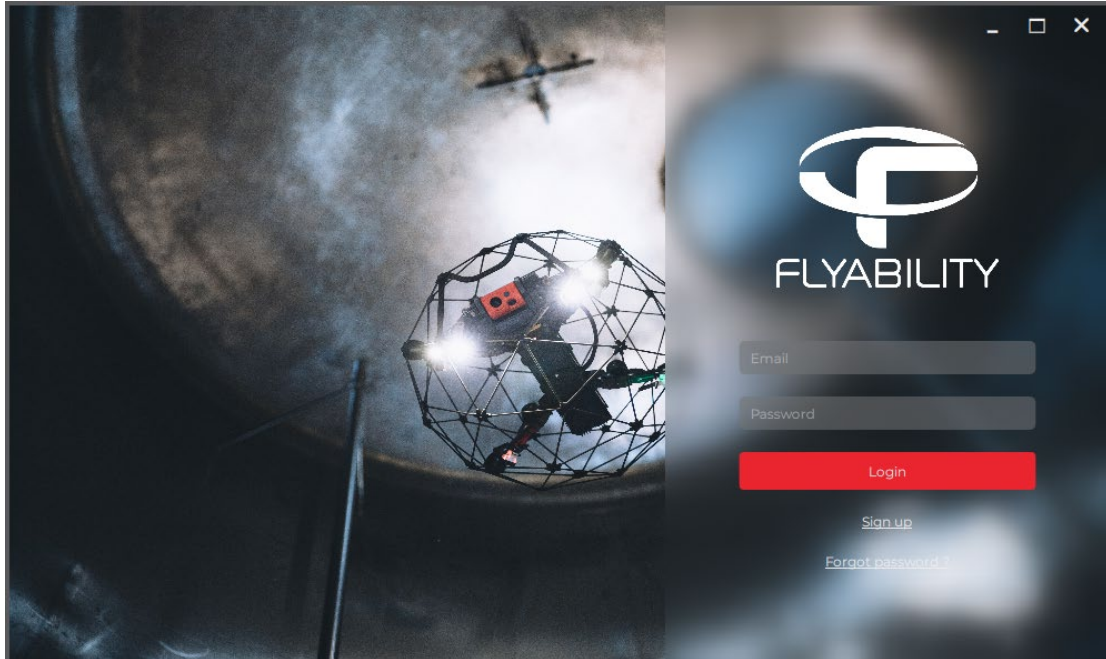
### 2.2 Installing Inspector

Inspector 3.0 is distributed as a standard executable installer (.exe), available on [flyability.com](https://flyability.com). Run the installer and follow the instructions displayed. The mapping feature has a 30 day free trial period, after which a license must be purchased to create and open 3D maps. All other features of Inspector remain available in the free version.

### 2.3 Drone Firmware

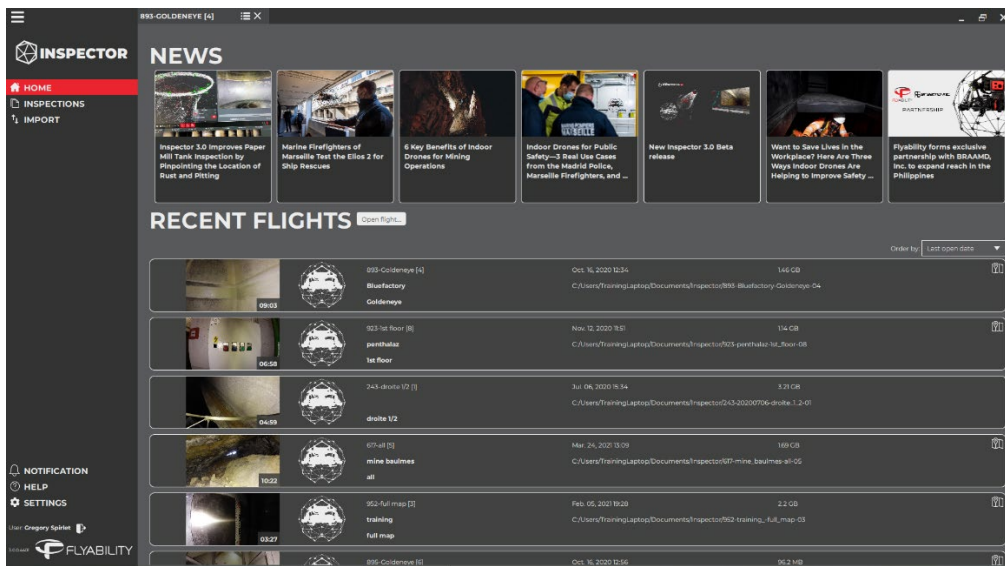
The Mapping feature is only compatible with flight data recorded by an Elios 2 drone with firmware v1.4 and higher. Be sure to update your drone firmware and tablet cockpit app to the latest versions to improve compatibility.

### 3 Login screen



You will be asked to log in the first time you open Inspector. Users who previously had a beta account will be required to sign up again and create a new account.

## 4 Home Screen



### NEWS

This section will display recent updates and information concerning our products and software.

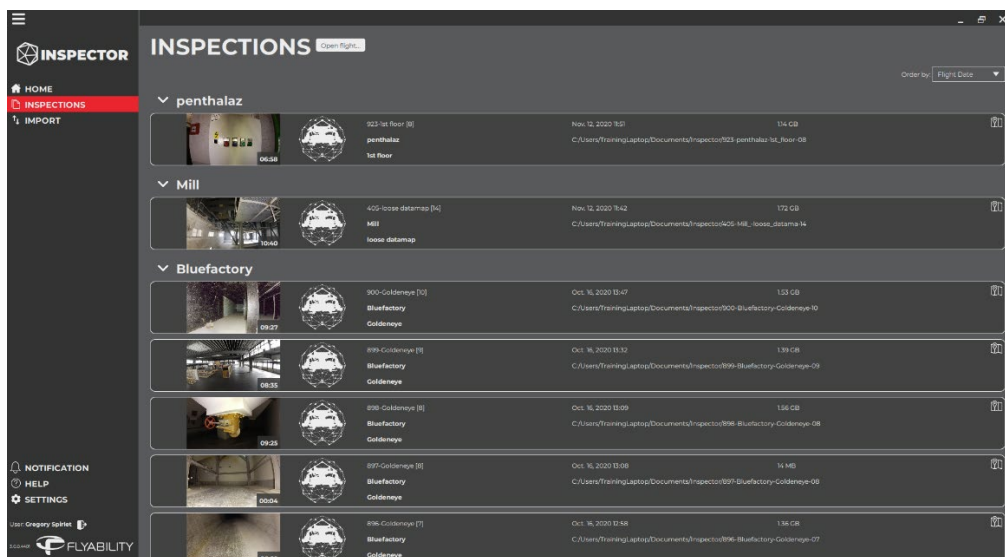
### RECENT FLIGHTS

This is a list of projects which have been opened or imported on your computer. Flights can be sorted according to: flight date, last open date, or flight name.

### 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.

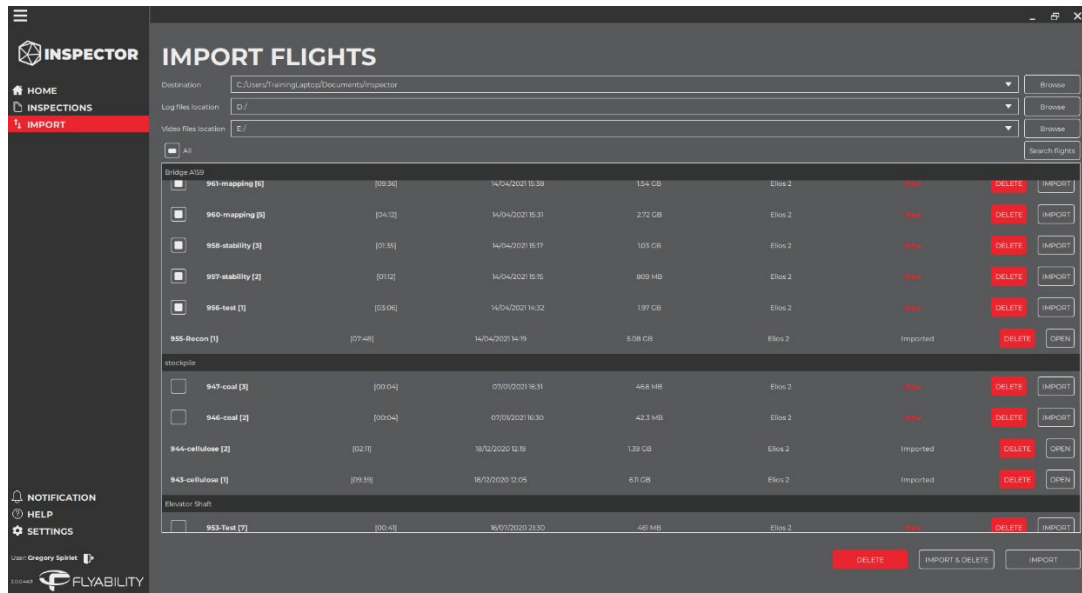
## 5 Inspections Screen



Like the Home Screen, this lists all flights found on your computer, with the difference that they will appear grouped by mission name. This makes it easier to find all flights from a specific inspection.

## 6 Import Screen

This screen is used to import flights from your drone onto your computer. The SD cards of Elios 2 will be automatically recognized and selected as source locations when the drone is connected via the USB-C cable.



### DESTINATION

This is the location on your computer to where the flight data of imported flights will be saved. The default destination is <documents/Inspector>.

### LOG FILES LOCATION

The location of 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 location of 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

This will list all the flights found in the selected LOG and Video files locations. Inspector automatically matches videos and log files. They must be imported and saved as a project locally before viewing. All flights found will 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:

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

### IMPORT SELECTED FLIGHTS

You can batch import several flights by checking the boxes on the left and clicking on 'import selected flights'. The progress will be displayed on the lower right corner of the window.

### DELETE

Delete the selected flights from the drone's SD card. Copies previously imported onto your PC will not be affected.

## 7 Menus

Miscellaneous menus and options are displayed in the lower left corner of the window.

### 7.1 Notification

Any error messages or available updates will appear here.

### 7.2 Help

Contains a link to the on-line support page.

### 7.3 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; you can choose whichever one best matches your mood.

#### ANALYTICS

- Inspector Analytics: Lists the Inspector application data being gathered by Flyability for analytical and debugging purposes.
- Drone Data: Lists the drone data being gathered by Flyability for analytical and debugging purposes.

### 7.4 User

This shows the user currently which is currently signed in, click the exit icon to sign out.

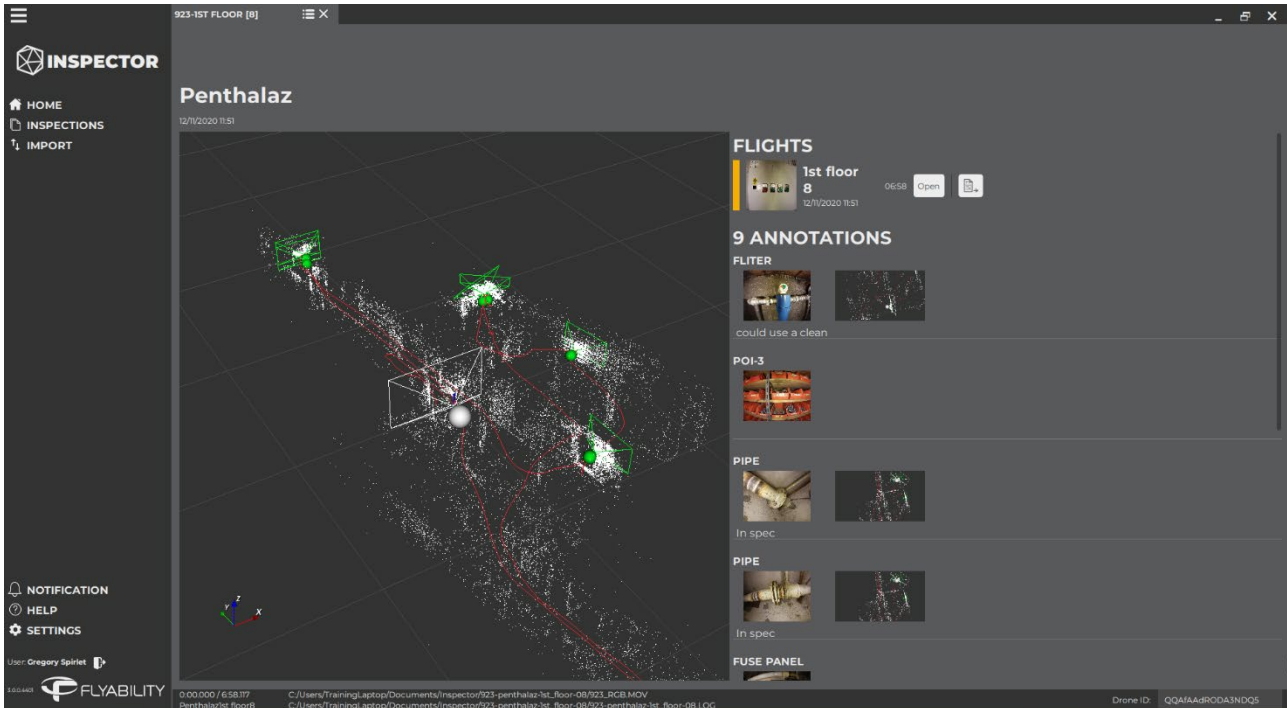
### 7.5 About

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




## 8 Preview Screen

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



On the preview screen you will see a preview of the 3D map (this will not be generated on the first time you open a new project), and a preview of the points of interest taken during the flight, along with annotations already made in post processing.

The mission and flight names will appear, provided that they were filled in on the tablet before the flight. You can also change the name by double clicking and editing the text.

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

## 9 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. Double clicking toggles full screen mode.

### 1 VIDEO CONTROLS

- Play or Pause the video (Space bar)
- 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 in 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.



Clicking the **Clipboard icon** will save the current video frame to the clipboard.

Click the **Camera icon** to save the current video frame as a jpeg file.

#### 6 CAMERA TILT ANGLE AND DISTANCE MEASUREMENT

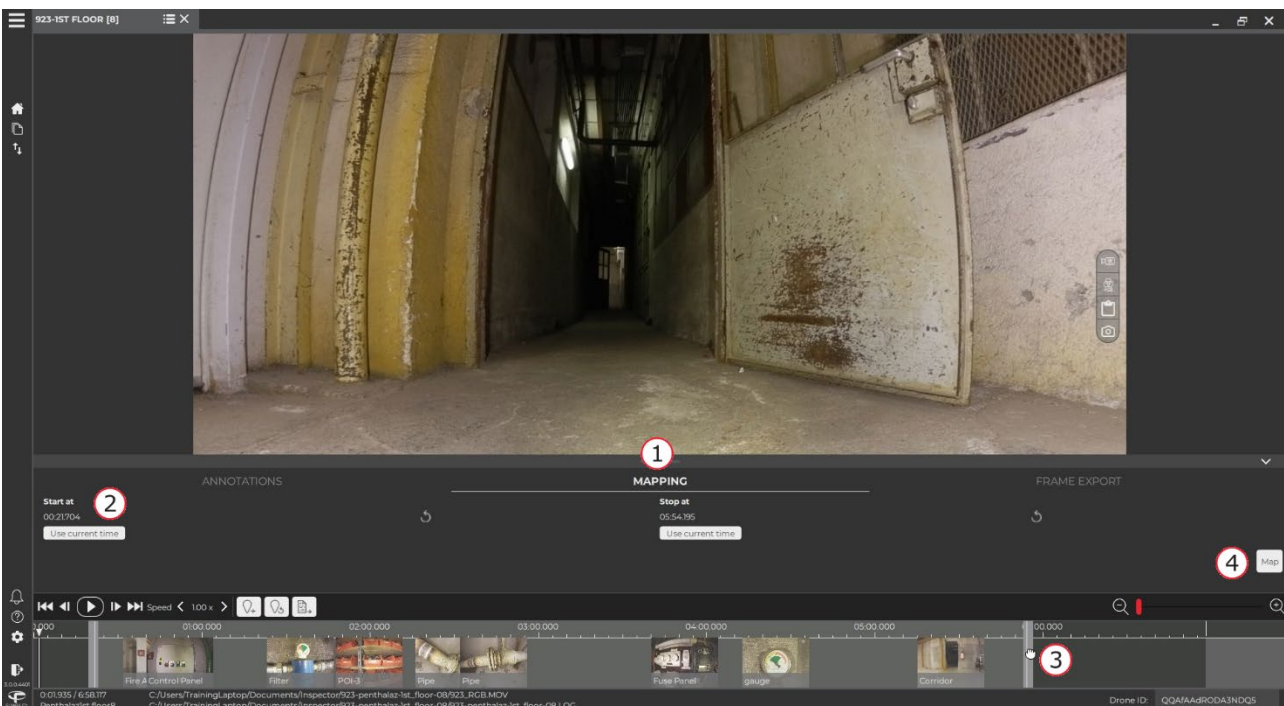
Displays the camera pitch angle and distance to the object in view, as shown on the cockpit display during flight.

#### 7 MAPPING/ANNOTATION/FRAME EXPORT

Click the bar to expand the corresponding window.

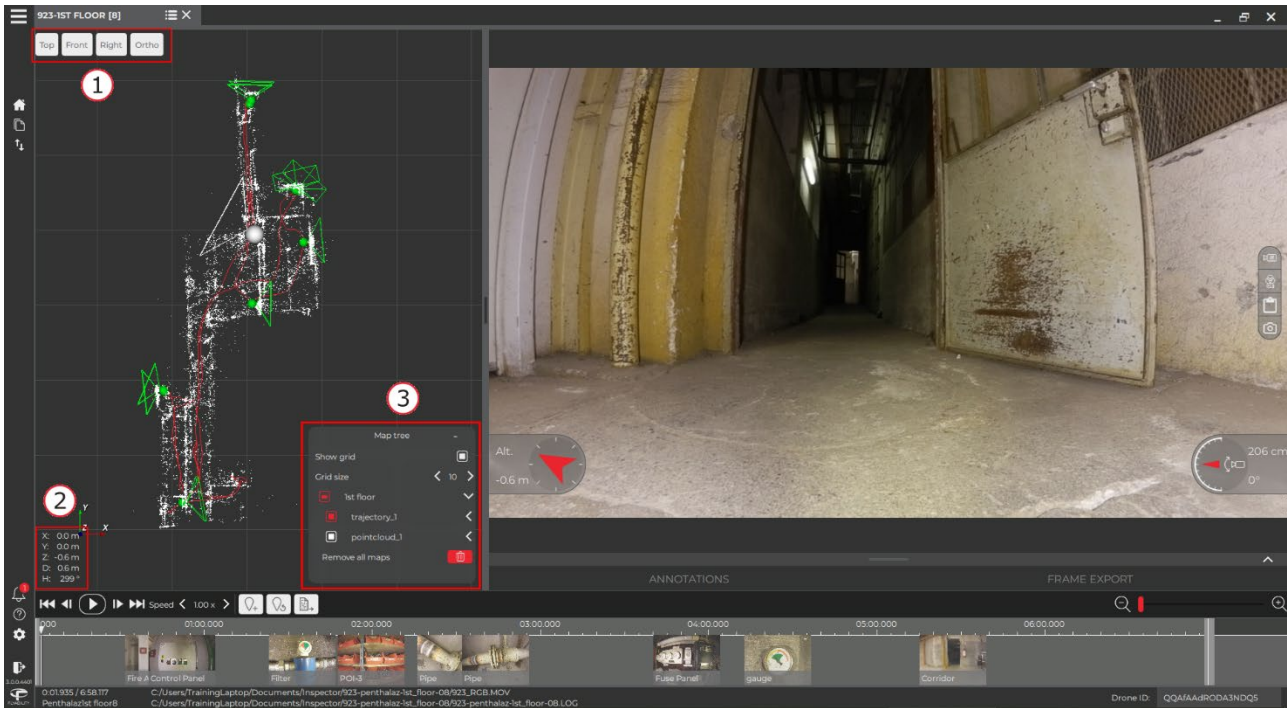
## 10 Mapping a Flight

Click on the mapping bar in the flight screen (1) to open the mapping window. You can either map the entire flight (default setting), or specify a start and stop time (2). This range can also be selected on the video timeline (3).



Click the map button (4) to start mapping. The progress will be displayed in the bottom right corner. The mapping button will be greyed out if you do not have a valid mapping license.

When the mapping process is complete, the 3D model of the flight area will appear in an extra window next to the video.



The buttons in the top left corner (1) can be used to select the viewing direction, and to switch between orthographic and perspective projection.

You can also navigate the view with your keyboard and mouse:

- Zoom in and out: mouse wheel or W and S
- Move sideways: left mouse button or A and D
- Rotate model: press mouse wheel
- Rotate camera: press right mouse button

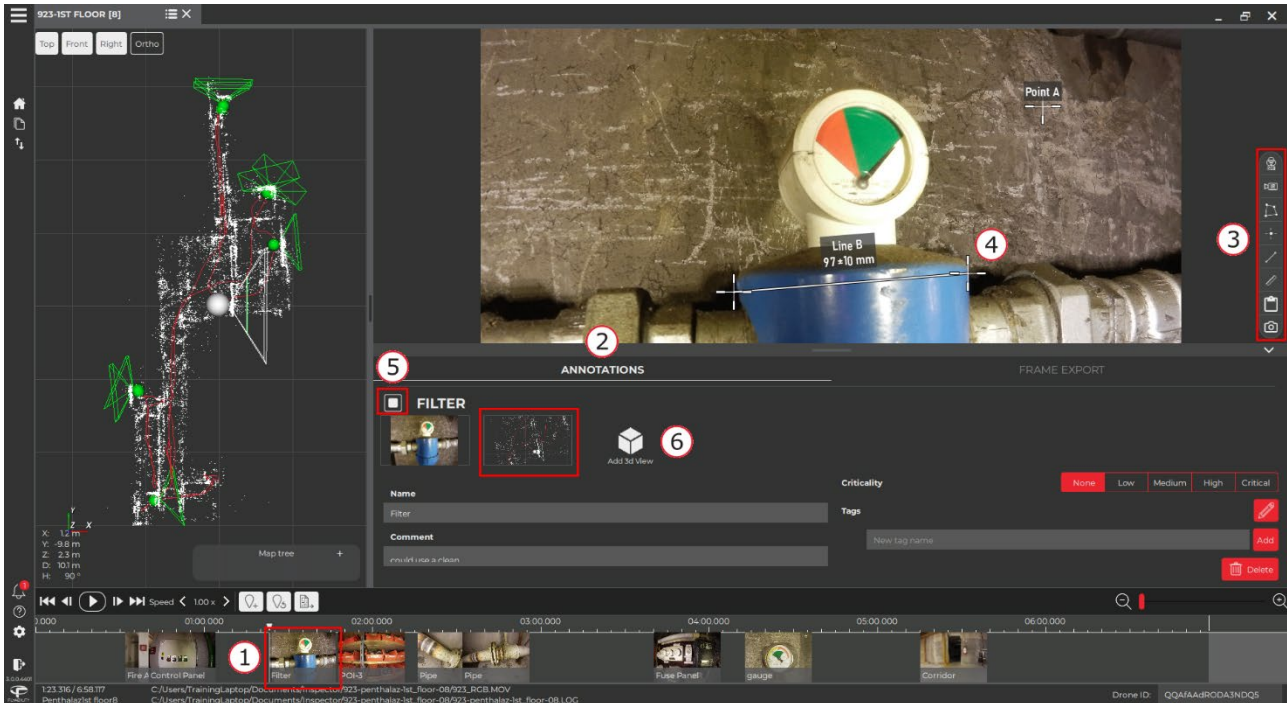
The drone's current position in the video is represented in the model by a white icon which indicates the position and field of view of the drone. The POI's are likewise represented by green icons.

The data in the lower left corner (2) indicates the x, y, and z position of the drone, as well as its absolute distance and heading with respect to its starting position.

The appearance of the models, grid and flight path can be modified in the map tree (3).

# 11 Managing Points of Interest

Points of Interest (POI) 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 above the timeline.



Clicking on a POI in the video timeline (1) opens the POI edit menu. A list of POIs and their annotations can be displayed by expanding the annotations window (2).

POIs are used to highlight observations made during the flight, they can also be used to make measurements, and can be annotated with a name, comments and tags. The criticality level can also be indicated. If the POI is checked (5) then all these elements will be included in the inspection report automatically, along with an image of its location within the 3D model (6).

A POI can also be deleted in the annotations menu by clicking delete (7).

## POI TOOLBAR

The toolbar on the right hand side of the screen will have more options when you are in the POI edit menu (3). The settings changed here will only reflect the current POI, and not the entire video.

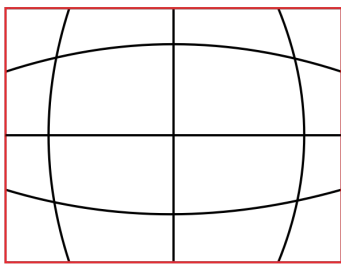
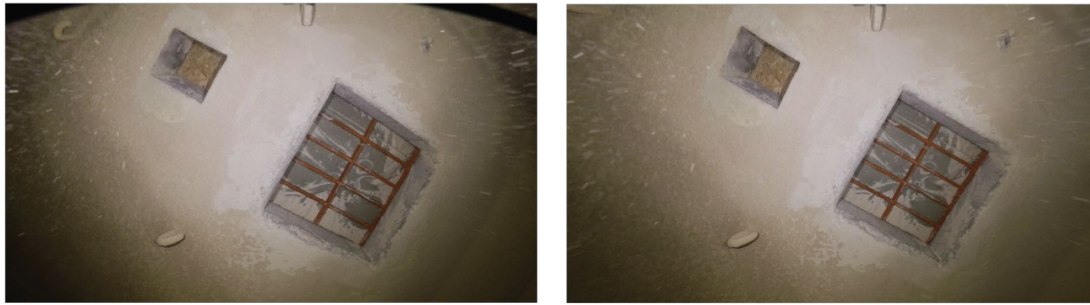
## RGB CAMERA MENU

This allows you to modify brightness and contrast of the POI image.

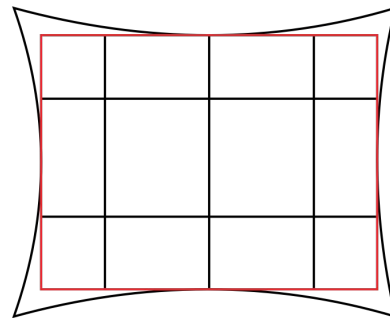
## THERMAL CAMERA MENU

This allows you to show the thermal camera images over the video images.


UNDISTORT



ORIGINAL IMAGE - DISTORDED



UNDISTORDED

 Border of displayed imaged

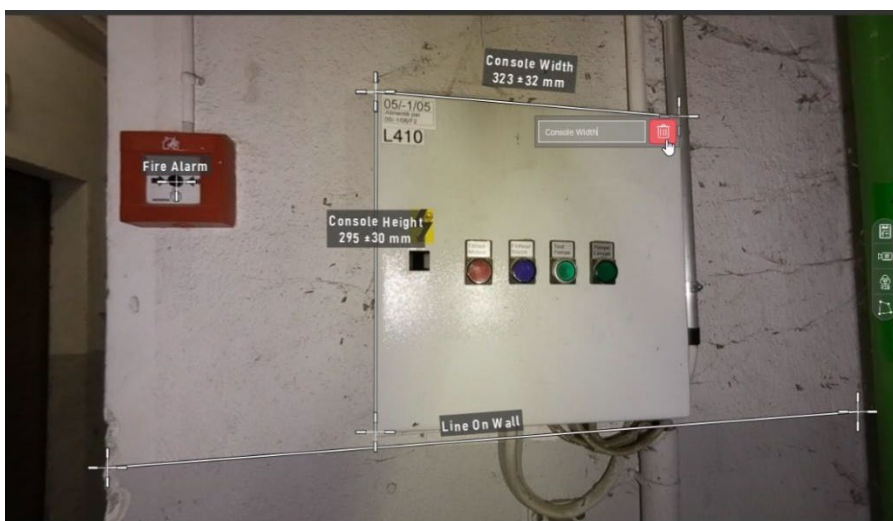
Due to the fish-eye effect of the optical camera, the image is distorted. Meaning the straight lines appear to be bent in the image. In a POI the image can be undistorted or flattened. As the transformation stretches the image, the resulting frame displayed is slightly cropped. This feature works best on images taken perpendicularly to a flat surface.

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.

ADD LINE

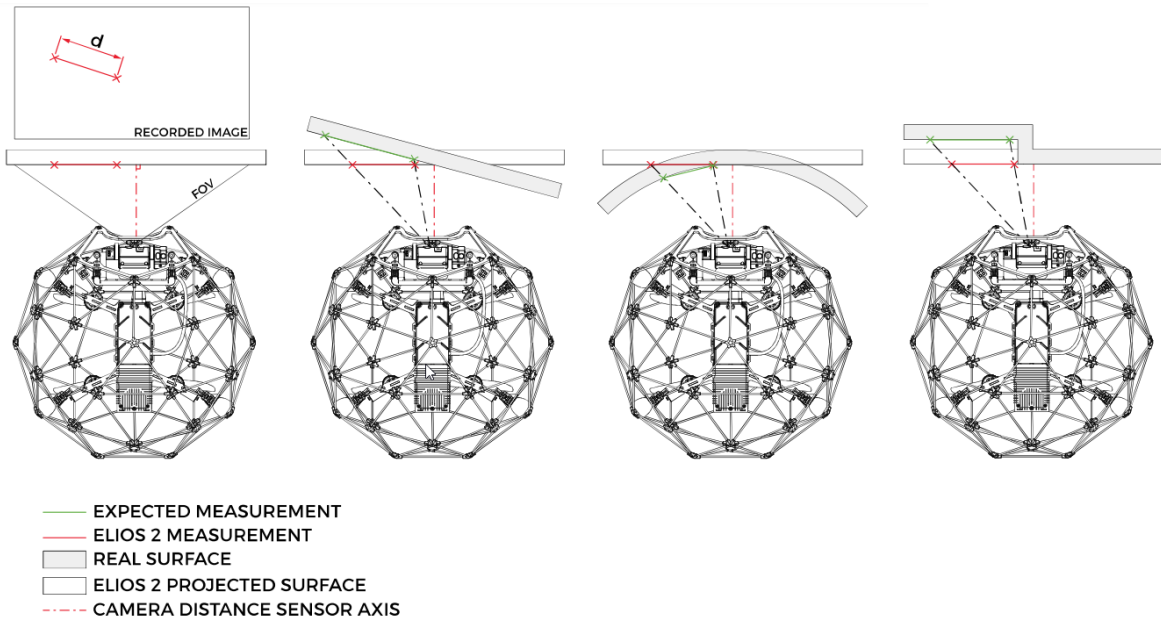
Specific areas on the image can be highlighted with lines. Click and drag to move an existing line, double click to edit the name or delete it.



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.

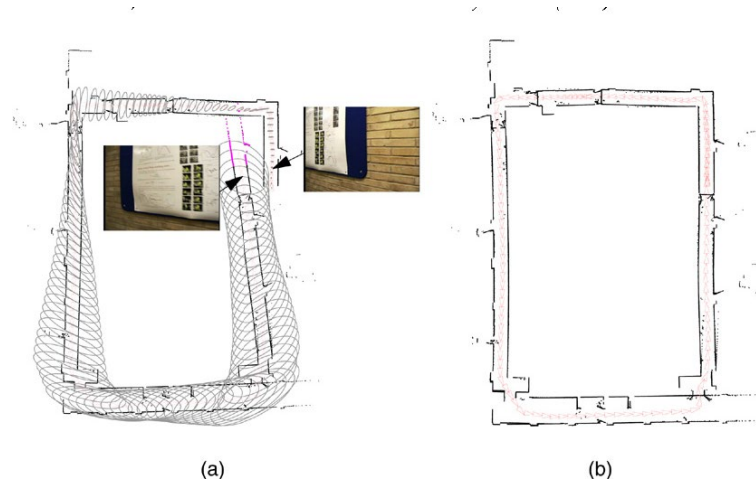
The 2D measurement result is displayed on the frame with its estimated accuracy.  
 The button is greyed out in case of unreliable camera distance data.



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

## 12 Flying tips for Mapping

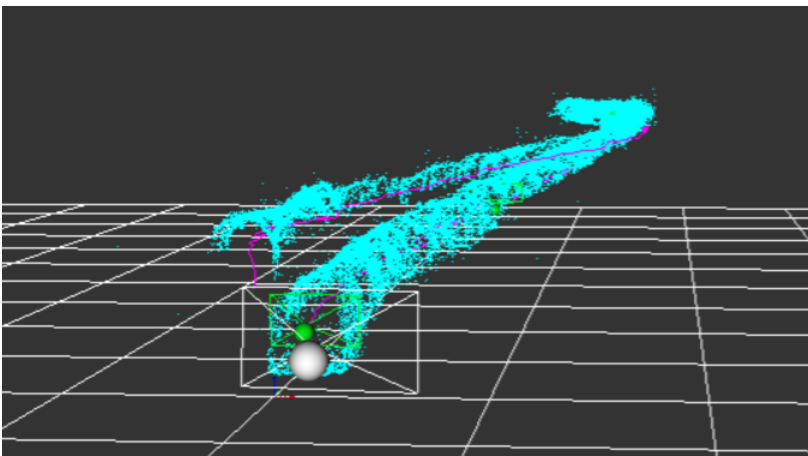
### 12.1 Takeoff and landing - Loop closure



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.

### 12.2 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.



## 12.3 Cage

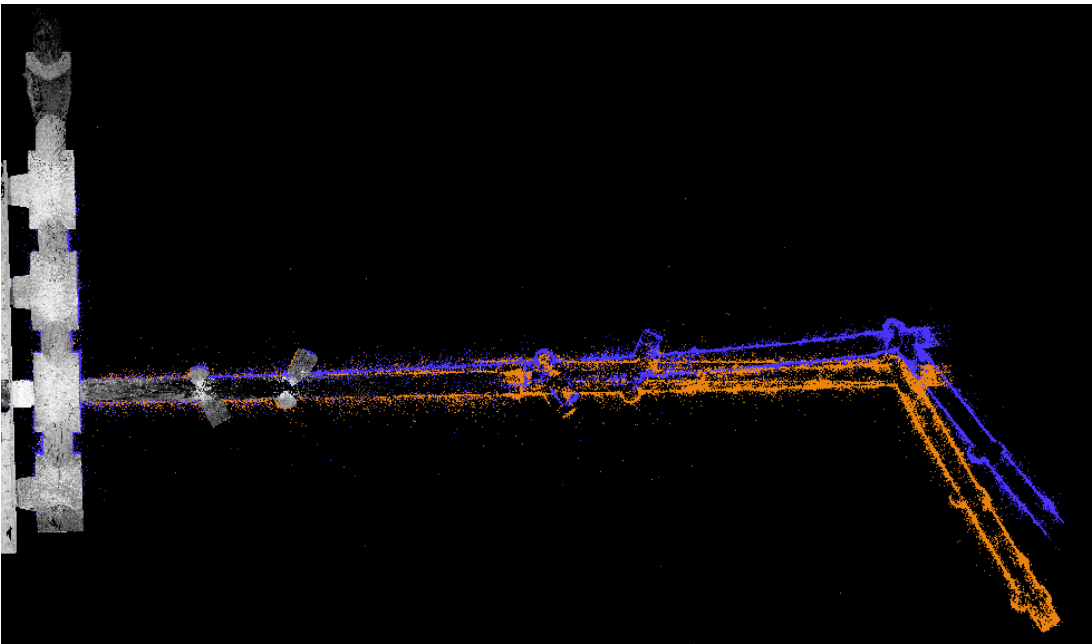
When looking too far up or down, the cage will block part of the field of view of the camera. This obstruction reduces the capability of the software to track visual features. Prefer flying with the “Cage free view” enabled or in “Photogrammetry mode”. In no case should the camera be tilted below  $-30^\circ$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

## 12.4 Collisions

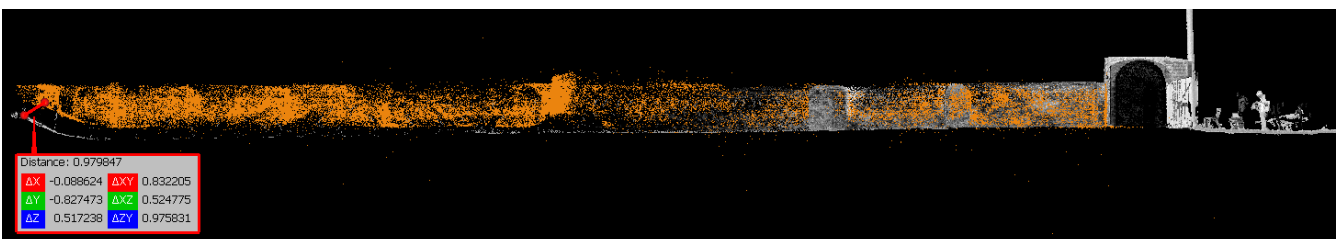
Collisions should be avoided as much as possible. Strong collisions will simultaneously saturate the IMU and create motion blur on the images.

## 12.5 Accuracy

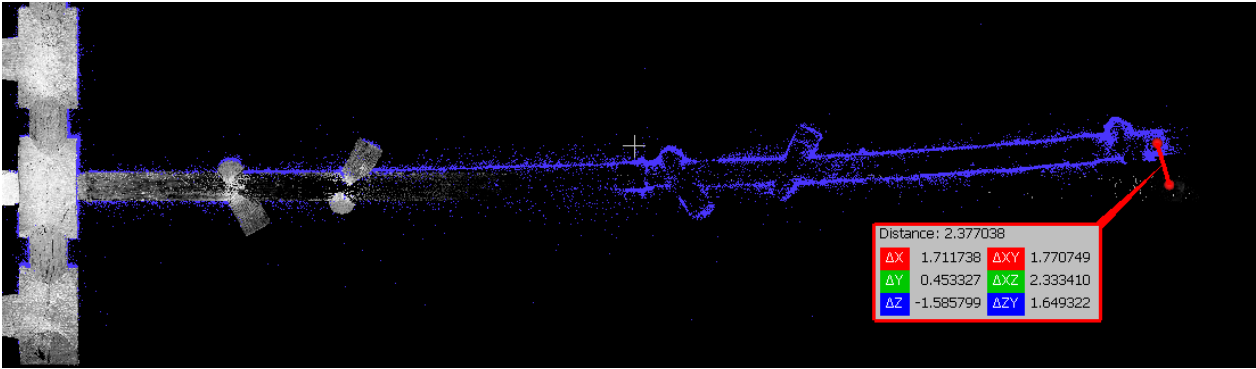
The Accuracy of the model depends on the flying style, flight path and the environment. Typically, the accuracy is within 10% of the length of the flight path, but it can change from one flight to the next depending on the flight path, flight speed and dust conditions.



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 Inspection Report

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

A report includes the following information:

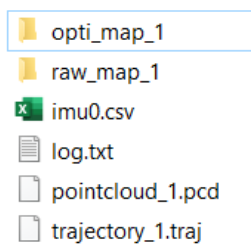
- Cover page with flight name and date
- One page per point of interest with image and properties of that point of interest, including measurements, lines or markers.

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

### 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

Expand the frame export menu (1) to export frames at a constant frame rate over a specific range of the video. These frames can be used in photogrammetry software to reconstruct 3d models of the flight environment. Inspector 3 is optimized for use with Pix4Dmapper, but any other photogrammetry software can be used as long as it can handle image files without GEOtags. The following settings are available:

### START/STOP TIME

This specifies the range over which the frames are exported, you can enter this manually or select this range in the timeline by dragging the grey markers.

### FREQUENCY

This parameter determines the rate at which images are exported in frames per second (FPS). Higher rates mean that more frames in total will be exported.

### EXPORT FOLDER

The folder where the frames will be saved, along with any processing templates.

### EXPORT PIX4D PROJECT

This will automatically create a Pix4D project with the exported frames.

### PROCESSING TEMPLATE

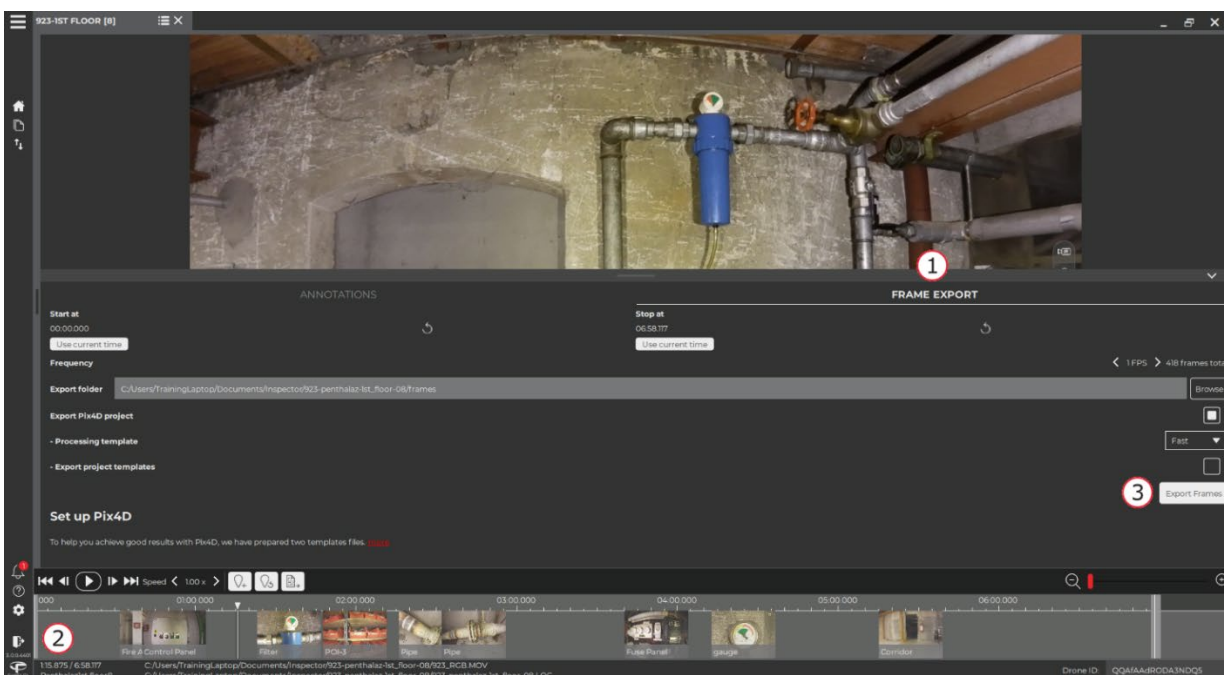
Flyability created two processing templates which are optimized for Elios 2 footage of indoor environments. The Fast template yield faster results but requires more overlap between images. The Robust template is computationally slower but will typically match more images from a given dataset. Check the Pix4D support site for more information on processing templates.

### EXPORT PROJECT TEMPLATES

This will export both Processing templates in .tmpl format. These can be manually imported into Pix4Dmapper.

### EXPORT FRAMES

Press this to start exporting the frames, process templates, and Pix4D project into the target folder.



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Content subject to change.

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