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## 1. INTRODUCTION

The ZEB-REVO RT portable laser scanner provides a rapid and simple means of capturing 3D point cloud data. Data is captured as the user walks through the area of interest. The ZEB-REVO negates the need for time consuming scanner set-ups and data registration associated with traditional terrestrial laser scanning methods.

Provided the simple guidelines set out in this manual are adhered to accurate 3D point clouds can be generated in a fraction of the time taken with traditional terrestrial laser scanning methods.

### 1.1 SPECIFICATION

<b>Maximum range</b>	Up to 30m in optimal conditions Typical max range 15-20m
<b>Points per scan line</b>	432 (0.625° interval)
<b>Field of view</b>	270° x 360°
<b>Scan rate</b>	100 lines/s 43200 points/s
<b>Scan range noise</b>	±30mm
<b>Laser safety classification</b>	CLASS I Laser Product (21 CFR 1040.10 and 1040.11)
<b>Laser wavelength</b>	905nm
<b>Operating conditions</b>	Temperature 0° C to +35° C Humidity – non condensing
<b>Power supply</b>	14.8VDC, approx. 5.0A
<b>Weight</b>	Scanning head 1.0kg Carry case and contents 4.1kg
<b>Dimensions</b>	Scanning head 80x113x140mm (287mm incl handle) Carry case and contents 470x220x180mm
<b>Battery life</b>	Approximately 90 minutes continuous use

**Table 1-1: Specification**

## 1.2 PRINCIPAL OF OPERATION

The ZEB-REVO RT consists of a 2D time-of-flight laser range scanner rigidly coupled to an inertial measurement unit (IMU) mounted on a motor drive. The motion of the scanning head on the motor drive provides the third dimension required to generate 3D information. A novel 3D simultaneous localization and mapping (SLAM) algorithm is used to combine the 2D laser scan data with the IMU data to generate accurate 3D point clouds.

The ZEB-REVO scanning head captures raw laser range measurement and inertial data. This data is registered into a homogenous 3D point cloud in near real time by the ZEB-REVO RT Data Processing Unit. The resulting point cloud data can be downloaded from the Data Processing Unit and imported into the GeoSLAM Hub desktop application for further processing and/or export in a range of standard point cloud file formats.

### 1.3 LIST OF PARTS

Part no.	Description
1 GS_610042	ZEB-REVO hand held laser scanner
2 GS_610070	ZEB-REVO RT Processing Unit
3 GS_610008	ZEB-REVO main cable
4 PAG_9307V	ZEB-REVO RT battery
5 PAG_9710	ZEB-REVO RT battery charger
6 MUS_40_1_5	Shoulder strap
7 RS_832-347	Ethernet cable
8 GS_610073	ZEB-CAM cable (compatible with RT Processing Unit)
9 GS_510072	Heavy Duty Carry case
10 GS_SW_LICENSE	GeoSLAM HUB license dongle and USB memory stick
11 GS_610071	Magnetic mount for tablet or cell phone

**Table 1-2: List of parts**







## 2. SAFETY

### 2.1 GENERAL SAFETY

The ZEB-REVO RT Portable Mapping System should only be used by trained operators. Always follow basic safety precautions when operating the ZEB-REVO RT Portable Mapping System to reduce the risk of personal injury and to prevent damage to the equipment. Do not operate the equipment with suspected defects or obvious mechanical damage. Please refer all servicing of the equipment to qualified service personnel. Only use the components and accessories supplied with your system or other accessories recommended by GeoSLAM Ltd. Before operating the system for the first time please read this manual in full.

The equipment contains sensitive electrical and mechanical parts and thus requires appropriate handling. Do not bend or pull the cables forcibly. Never push objects of any kind into the connectors or sockets. Keep the equipment out of the reach of children. Under no circumstances should any modifications be made to the ZEB-REVO Portable Mapping System without prior written permission from GeoSLAM Ltd.

### 2.2 LASER SAFETY



The ZEB-REVO incorporates a Hokuyo UTM-30LX-F laser scanner. The UTM-30LX-F is classified as a CLASS 1 Laser Product in accordance with IEC 60825-1 : 2007 (2nd Edition) *Safety of laser products. Equipment classification and requirements*. Class 1 Laser Products

are safe under reasonably foreseeable conditions of operation, including the use of optical instruments for intra-beam viewing.

### 2.3 ELECTROMAGNETIC COMPATABILITY

The ZEB-REVO RT Portable Mapping System meets or exceeds the following standards:

EN61326-1:2013 Electrical equipment for measurement, control and laboratory use - EMC requirements - Industrial Location Immunity - (immunity section only)

EN61326-1:2013 Electrical equipment for measurement, control and laboratory use - EMC requirements - Group 1, Class A equipment - (emissions section only)

CFR 47 Code of Federal Regulations: Pt 15 Subpart B- Radio Frequency Devices - Class A Unintentional Radiators The wireless module has single modular approval under FCC ID PD97265D2

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential

area may cause interference.

## 2.4 BATTERY SAFETY

DO NOT attempt to dismantle the battery.

DO NOT short circuit the battery.

ONLY use the charger supplied with the system.

Excess heat will degrade the battery rapidly. Always store the battery in a cool dry place.

DO NOT leave for long periods in the sun or in a hot vehicle.

The battery is splash proof but not water proof – do not immerse in water.

## 2.5 SYSTEM DISPOSAL



When the ZEB-REVO Portable Mapping System reaches the end of its life-cycle please dispose of the equipment in accordance with Directive 2002/96/EC on Waste Electrical and Electronic equipment (WEEE).

GeoSLAM Ltd is prepared to take back the waste equipment and accessories free of charge at the manufacturing unit in Bingham, UK for proper treatment with the objectives of the WEEE.

## 2.6 INSTALLATION

The ZEB-REVO RT can be used as a handheld device using the supplied removable handle or can be mounted to mobile platform using the optional mounting plate (see Section 15.2).

## 2.7 FURTHER HELP AND INFORMATION

Contact GeoSLAM by any of the following methods:

Phone: +44 1949 831814

Email: [info@geoslam.com](mailto:info@geoslam.com) or [support@geoslam.com](mailto:support@geoslam.com)

Website: [www.geoslam.com](http://www.geoslam.com)

## 3. DATA CAPTURE

This chapter describes how to connect the ZEB-REVO RT hardware, how to collect scan data and how to download the results file for post processing in GeoSLAM Hub desktop application.

### 3.1 CONNECTING THE HARDWARE

Connect the battery to the RT data logger (if not already connected). Ensure the battery is well charged before commencing data capture.

Connect the ZEB-REVO main cable to the 12 way socket on the side of ZEB-REVO scanner head.

Connect the other end of the ZEB-REVO main cable to the 12 way socket on the RT data processing unit.

Switch on the RT data processing unit by short pressing the switch on the front panel.

**! Only connect the REVO scanner head when the RT data processing unit is powered off**

To turn off the RT data processing unit long press (approx. 4 seconds) the switch on the front panel.

### 3.2 CONNECTING TO THE DATA PROCESSING UNIT

Communication with the ZEB-REVO RT system is carried out using a web enabled device, e.g. tablet, cell phone or laptop, a network. The connection can be made either wired by network cable or through a wireless connection.

#### 3.2.1 WIRED CONNECTION

For a wired connection, the host device network adapter TCP/IPv4 must be set to static IP address:

IP address 192.168.0.200

Subnet mask 255:255:255:0

On a Windows operating system this is done in Network & Internet Settings/ Ethernet/Change adapter options. Right click on the Ethernet icon and select Properties (See Figure 3-1)

In the Ethernet Properties dialogue box select Internet Protocol Version 4 (TCP/IPv4) and click the Properties button (see Figure 3-2)

In the TCP/IPv4 setting dialogue box set the “Use the following IP address radio button and set the IP address to 192.168.0.200 and the Subnet mask to 255.255.255.0 (see Figure 3-3

Click OK to apply the settings.

**! User should reset TCP/IPv4 settings back to their previous settings (usually “Obtain an IP address automatically”) before reconnecting to their office network!**

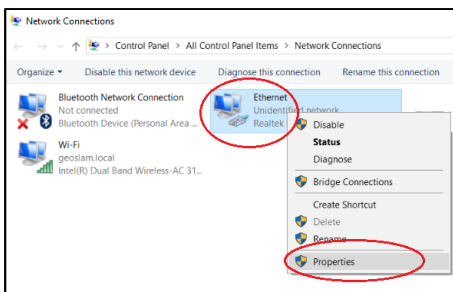


Figure 3-1

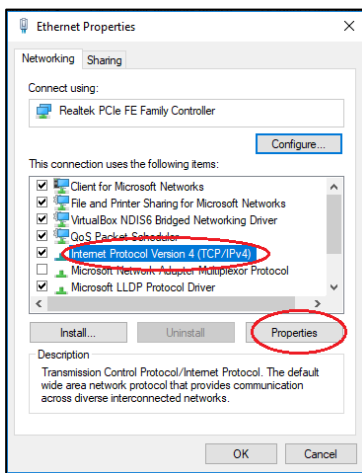


Figure 3-2

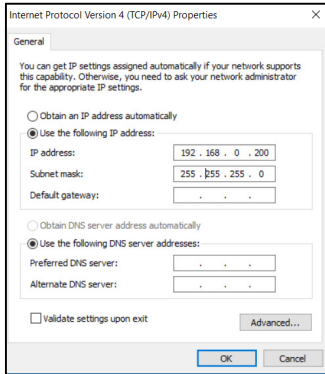


Figure 3-3

### 3.2.1.1 WIRELESS CONNECTION

For wireless connection, the RT data logger acts and Wi-Fi access point (see Figure 3-4).

SSID geoslam-rt  
Password zebedee12

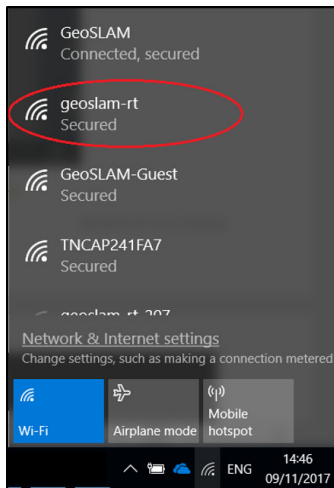


Figure 3-4

### 3.3 COLLECTING DATA

The process of collecting data using the ZEB-REVO RT scanning system is highly automated. However, care must be taken to ensure that the collected data can be successfully processed into a 3D point cloud using GeoSLAM's unique SLAM algorithm. It is strongly recommended that the user conducts a survey plan, taking into account the recommendations set out in the Usage Guidelines in Section 4, before commencing data collection.

When you are ready to start collecting data follow the steps below:

Step 1: Open a web browser in the web enabled device (tablet, cell phone) and enter:

- a. <http://192.168.0.204/> for wired connection
- b. <http://192.168.102.2/> for wireless connection

Step 2: The GeoSLAM logo will be displayed briefly while the connection is made then the Start screen is displayed (see Figure 3-5).

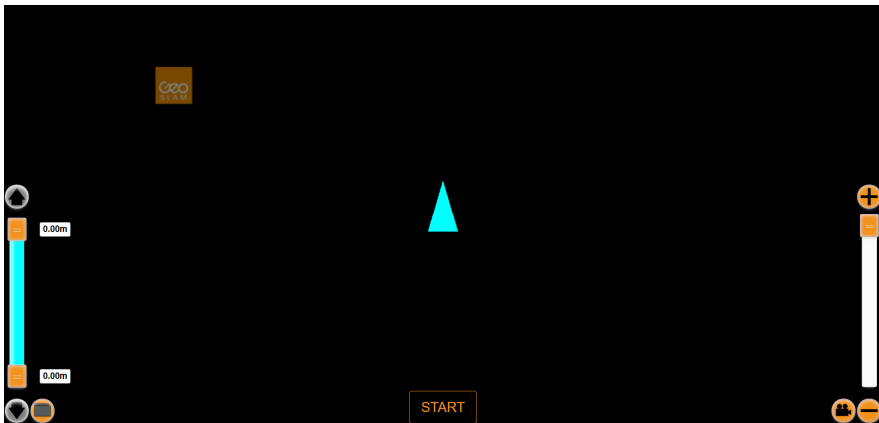
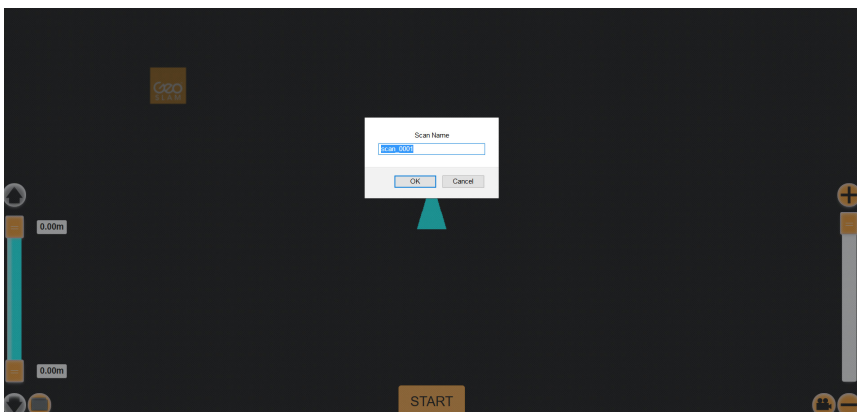


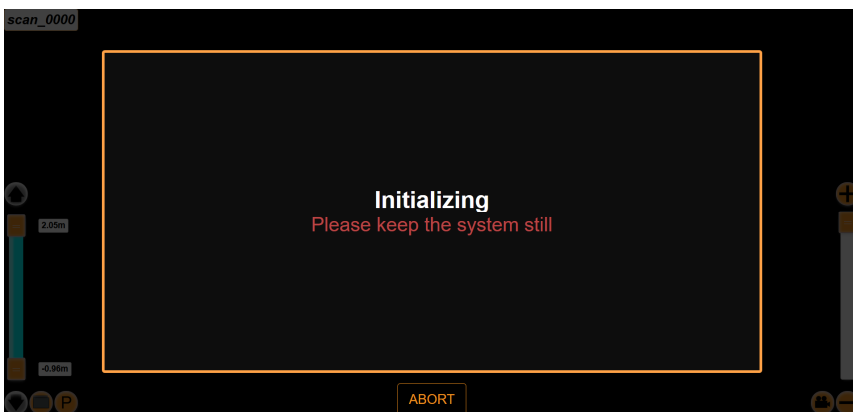
Figure 3-5

Step 4: To start a scan, position the REVO in a stationary position, click the START button and enter a scan name when prompted (see Figure 3-6).



**Figure 3-6**

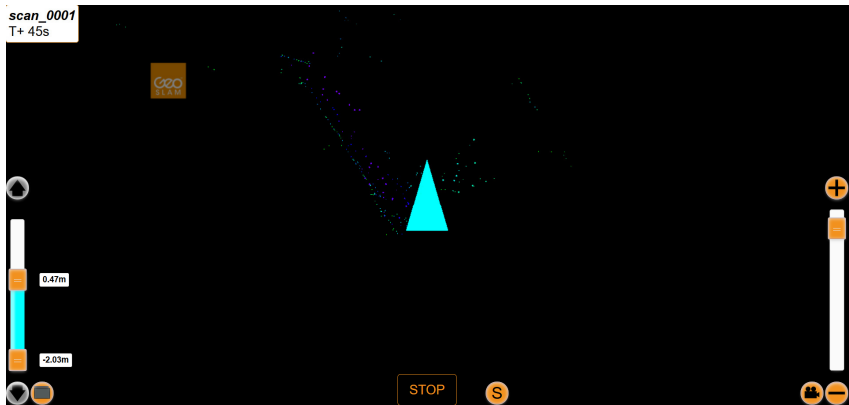
Step 5: The system will initialise for approximately 10 seconds (see Figure 3-7). The REVO must remain stationary during this period.




**Figure 3-7**

Step 6: When the initialisation screen closes manually start the REVO rotation by pressing the motor start/stop button on the side of the scanner head to start the scanner rotation and commence the survey.

A 3D representation of the scan can be seen in the graphics screen (see Figure 3-8).



**Figure 3-8**

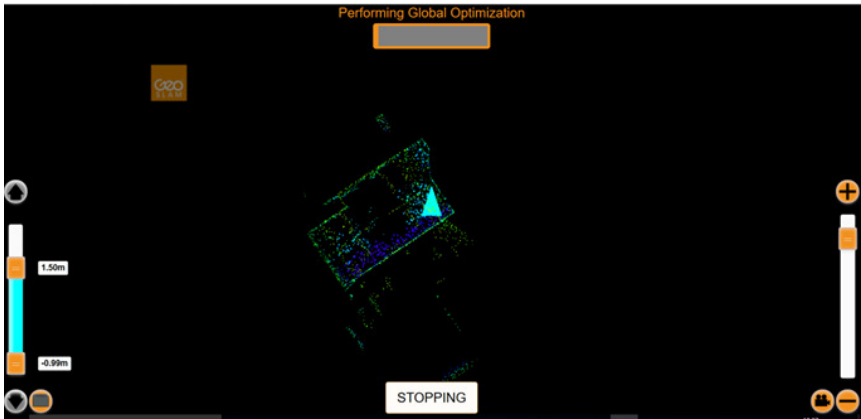
It is possible to cycle through different camera views by clicking the camera icon  in the bottom right hand corner of the screen. The slider on the left of the screen can be used to clip the scan vertically to remove the ceiling or floor.

The slider on the right of the screen can be used zoom in and out.

Conduct the scan using the best practice guidelines in the REVO user manual.

- Step 7: When the survey is complete position the ZEB-REVO scanner in approximately the same position as used for initialisation and click the STOP button on the display screen then press the motor start/stop button to stop the scanner rotation.
- Step 8: The display will indicate that Global Optimisation is being performed (see Figure 3-9).





**Figure 3-9**


Step 9: Once complete the display will revert to the Start screen ready for the next scan.

To repeat the scan, or start a new scan, simply position the REVO in a stationary position, click the START button and enter a scan name when prompted.

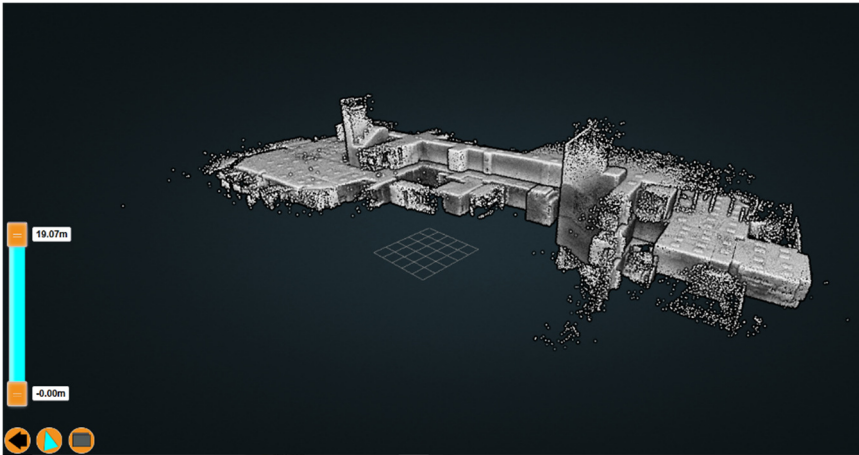
To shut down the system, press and hold the RT data logger power button for approximately 4 second.

**! Do not unplug the ZEB-REVO scanner until the unit is switched off**


### 3.4 DOWNLOADING THE SCAN DATA

Once a scan has been completed a preview of the resultant point cloud can be displayed by clicking the Preview icon  in the bottom right corner of the screen (see Figure 3-10). The preview file is decimated (9% of points) coloured by Shading (ambient occlusion grey scale).

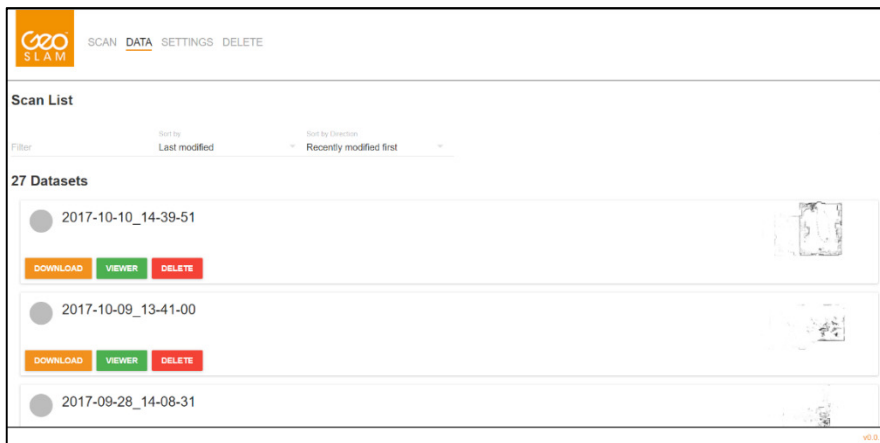
The slider bar on the left of the Preview display can be used to vertically clip the displayed point cloud.



**Figure 3-10**

A full list of the processed files can be shown by clicking the File icon  in the bottom right corner of the screen.

A file browser resembling GeoSLAM Hub is displayed (see Figure 3-11). Files can be downloaded to the connected device by clicking on download, and selecting file type, .geoslam or .ply (see Figure 3-12). The ply file is the 9% shaded file used in the previewer.



**Figure 3-11**



Figure 3-12

### 3.5 DELETING DATA SETS

It is recommended that data sets are deleted from the RT data processing unit after they have been downloaded to free up space for subsequent scans. The RT data processing unit should not be used as a data storage device.

Data sets can be deleted one at a time by clicking the DELETE button under the target data set on the DATA page.

To delete more than one file at a time select the DELETE page, check the check box against the target data sets and click the DELETE button (see Figure 3-13).

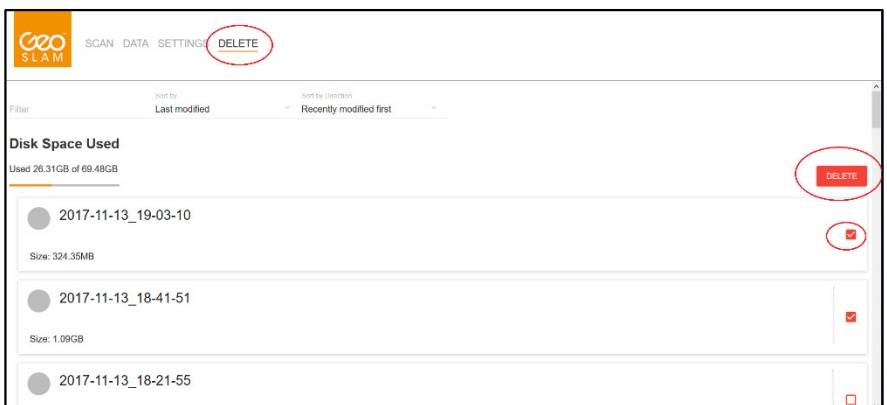


Figure 3-13



## 4. USAGE GUIDELINES

This chapter provides guidelines for how the ZEB-REVO RT Portable Mapping System should be used to achieve the best possible results. Prior to conducting a survey, the user should plan the proposed survey path in order to identify potential problem areas, e.g. feature poor environments, doorway transitions and stairwells. In these areas, the user should plan how to conduct the survey taking into account the recommendations in this chapter. The plan should also make provision for “closing loops” wherever possible. Please adhere to these guidelines in order to achieve the best results. It is recommended that users also watch the accompanying training videos provided on the GeoSLAM YouTube channel.

### 4.1 THE ENVIRONMENT

The SLAM algorithm used to process the raw laser scan data into a 3D point cloud relies on there being features in the scanned environment that are repeatedly scanned as the operator passes through the scanned environment. For a feature to be significant the ratio of its size to its range must be approximately 1:10, e.g. at 5m range for a feature to be significant it must be >0.5m in size. ‘Feature poor’ environments include open spaces and smooth walled passageways. In smooth walled passage ways there may not be sufficient features in the direction of travel for the SLAM algorithm to determine forward motion. In feature poor environments we recommend the following steps are taken:

- If possible augment the environment with additional features. e.g. boxes in a corridor or a parked vehicle in an open field.
- Ensure that whatever limited features are available are scanned repeatedly as you move through the environment by pointing the ZEB-REVO in the direction of the feature. By doing so more measurement points are made of the feature increasing the likelihood that it will be used by the SLAM algorithm. This is particularly important when the feature is at long range (>10m). e.g. when scanning a smooth walled passageway where the only feature in the direction of travel is the end wall or door.
- Avoid scanning moving objects (e.g. passing pedestrians or vehicles) as the SLAM algorithm may lock on to these objects as static features.

### 4.2 LOOP CLOSURE

The SLAM algorithm used to process the raw scan data into a point cloud uses a method analogous to the Traverse technique used in survey practice, in that a previously known position is used to determine its current position. This method can result in the compounding of any error introduced causing measure position to “drift”. It is good survey practise to “close the loop” by re-surveying a known position so that the compounded error can be spread around the loop.

As a minimum, it is required that the operator must start and end the survey in the same position to ensure at least one loop closure. However, it is recommended where possible that the operator closes the loop as often as possible in order to minimise error and improve the accuracy of the resulting point cloud.

In general, it is better to do circular loops rather than “there and back” loops where the survey path simply doubles back on itself. This applies to horizontal and vertical loops, i.e. if possible enter and exit through different doors, move between floors via different stair wells.

It is important to scan the closed loop regions carefully to ensure the key features are scanned from a similar perspective. It may be necessary to turn around if you return to a region from a different direction. This is particularly important in feature poor environments.

#### 4.3 TRANSITIONING BETWEEN ENVIRONMENTS

Extra care must be taken when transitioning between environments, for example passing through a doorway or turning through a tight bend to avoid introducing errors. When transitioning between environments the local view may change abruptly and the SLAM algorithm may have difficulty placing the new environment relative to the previous environment. This may result in rooms either side of a doorway being slightly misaligned.

Transition through doorways slowly and ensure that there is a period when the scanner can view features on both sides of the doorway (i.e. into both rooms).

Try to open all doors before starting the survey. Avoid scanning doors as they are being opened. If necessary, face away from the door and open from behind then pass through the doorway backwards.

Transition around tight bends slowly and ensure that there is a period when the scanner can view features on both sides of the bend.

Take care when transitioning from an enclosed feature rich environment to an open feature poor environment, for example exiting a building. It may be necessary to turn and face the exit and the exterior of the building if no other features are within range.

Avoid scanning any other moving objects (e.g. walking pedestrians) as you pass through a transition.

#### 4.4 WALKING SPEED

It is recommended that data is captured at a slow walking pace to ensure good coverage and high resolution data. If the forward movement is too fast there may not be enough repeat scans of features for the SLAM algorithm to be able to process the raw laser data into a point cloud.

#### 4.5 MINIMUM AND MAXIMUM RANGE

Data within a small range value is not processed (by default) to eliminate data from the scanner operator being included in the final point cloud. Avoid close proximity to walls and ceilings.

The maximum range of the scanner is 30m. This range will only be achieved in optimal conditions (indoors with good target reflectivity). The typical maximum range will be 15-20m in most conditions. It is recommended that the range is kept to less than 10m where possible to ensure good point density and to assist the SLAM algorithm.

#### 4.6 DURATION OF SCANNING

For very large surveys the project should be broken down into more than one scan mission. This is to avoid very large file sizes as well as reduce any drift that might be created in the data. It is recommended that each survey is limited to 30 minutes. At slow walking pace, it is possible to cover 1000-3000m of survey distance.

#### 4.7 SURVEY AREAS WITH RESTRICTED OR DIFFICULT ACCESS

The scanning head can remain stationary for short periods of time whilst the operator negotiates difficult access points (e.g. tight squeezes in cave systems). The scanning head can also be held in the hand and moved up and down to mimic the normal oscillating motion for short periods of time to assist transition through survey areas with restricted or difficult access.

#### 4.8 MOVING OBJECTS IN THE ENVIRONMENT

In most cases the SLAM algorithm is able to handle moving objects in the environment. In order to estimate the scanner motion the algorithm must assume a large proportion of the environment is static. However, in some feature poor environments where 3D structure is lacking in some dimensions, moving objects can have a greater impact on the solution. In particular, moving objects should be avoided in long tunnel-like environments (e.g. corridors), relatively open spaces and when transitioning through doorways.

It is best practice not to have other people closely accompany the operator during the scan acquisition as they will be scanned throughout the map leaving streaks of data and potentially corrupting the solution in feature poor environments. If people are required to follow the operator they should ideally maintain a distance of 20m or more from the operator.





## 5. POST PROCESSING

It is necessary to process the raw data collected by the ZEB-REVO portable mapping system using GeoSLAM's novel 3D SLAM algorithm to generate a 3D point cloud of the environment that has been mapped. This is done using the GeoSLAM Hub processing software.

### 5.1 GEOSLAM HUB SOFTWARE

Installation of GeoSLAM Hub software is described in a separate User Guide.

Start the GeoSLAM Hub application and click on the *PROCESS DATA* button. The application will switch from the *START* page to the *DATA* page as shown in Figure 5-1.

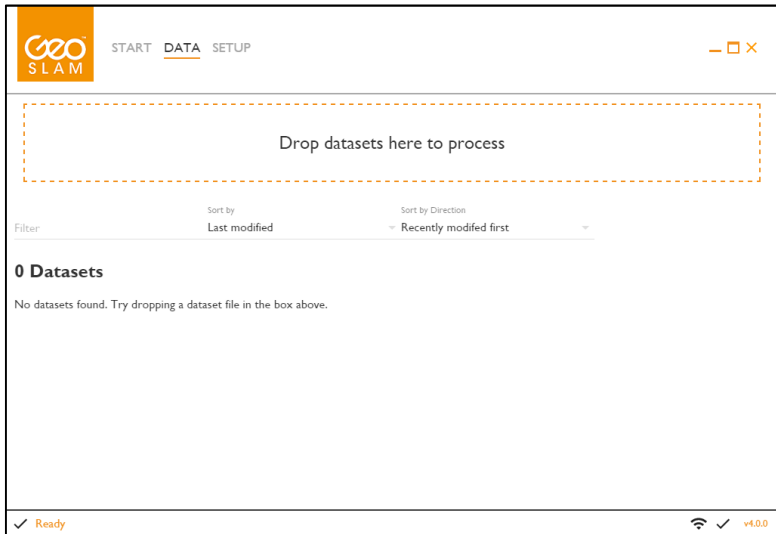


Figure 5-1

Open Windows Explorer and navigate to the location of the data set zip file to be processed. Drag and drop the zip file in the “Drop datasets here...” field on the user interface. The application will copy the dataset into a processing folder and then open the Options dialogue page shown in Figure 5-2. The Options dialogue page presents the user with two option settings tabs: *OUTPUT* tab and *PROCESSING OPTIONS* tab. These configuration options are described in more detail in Chapter 6. In general, the default settings can be used unless you need a specific output file format or you need to re-process the data with non-standard processing parameters. Once the output and processing options have been set, click the *PROCESS* button.

The display will switch back to the *DATA* page and a processing progress bar is displayed against the data set being processed. The data will take approximately as long to process as it did to capture (using default output and processing options). Data processing may take considerably longer if none default settings are selected. In particular, processing of

video data from ZEB-CAM can add considerably to the data processing time. Once the data has completed processing the user is presented with the options shown in Figure 5-3. The user can either:

- Save the results folder to another location (in order to access the point cloud data files). The results files are described in more detail in Chapters 6 and 8.
- View the data in GeoSLAM Viewer (provided this option was enabled before processing). The GeoSLAM Viewer is described in more detail in Chapter 7.
- Reprocess the data using different output and processing options.

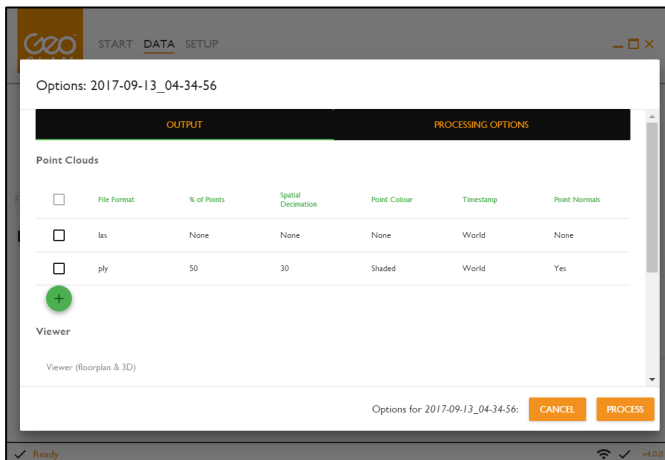


Figure 5-2

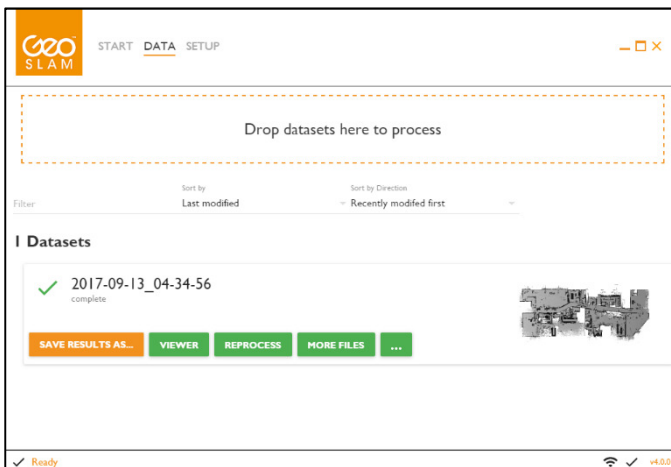


Figure 5-3

## 5.2 FLAG FOR SUPPORT

If you find an error in a processed dataset, this can be reported to GeoSLAM support through the **ZEB-REVO Uploader** desktop application. Only accounts with a valid maintenance and support contract will be eligible for data support.

See Appendix 1 – GeoSLAM Data Set Flagging for instruction on how to use this service.



## 6. OUTPUT AND PROCESSING OPTIONS TAB

### 6.1 OUTPUT OPTIONS TAB

The OUTPUT tab (Figure 6-1) enables users to:

1. Select the configuration of point clouds output after processing
2. Enable or disable output of files for the GeoSLAM viewer
3. Enable or disable processing of ZEB-CAM video data for inclusion in the GeoSLAM viewer files (so called Videolink)



Figure 6-1


### 6.2 OUTPUT FILE CONFIGURATION

Users can select from the following options:

File Format	select from	e57 las laz ply txt (ascii)
% of points	Enter percentage of points to be output Enter 100% to output all points	
Spatial decimation	Enter a value in millimetres to spatially decimate the output. Groups of points within this distance are averaged into a single point resulting in a more consistent and smoother point cloud Leave blank for no spatial decimation	

Colour by	Writes a colour value (RGB 0-255) for each point		
	select from	Height	Single colour gradient
		Time	Colour scale from red to blue
		Shaded	Ambient occlusion grey scale
		SLAM Condition	Colour scale of SLAM condition, blue good, red poor
Shape	Flat surfaces are coloured pink, non-flat surfaces coloured blue to green		
ZebCam	Requires optional ZEB-CAM accessory. Points that are observed by the ZEB-CAM are coloured from ZEB-CAM data. Unobserved points are not included in the output file		
	ZebCam + Shaded	Requires optional ZEB-CAM accessory. Points that are observed by the ZEB-CAM are coloured from ZEB-CAM data. Unobserved points are coloured by ambient occlusion grey scale (shaded)	
	None	No colour value is written	
Timestamp	select from	World	Unix timestamp when the data was captured
		Scan time	Time since start of scan
		None	No time stamp
Include normals	Check the checkbox to include point normals in the output file (This option is not supported in las and laz formats)		

To create a new file format, click the  button, select the file attributed required from the drop down lists and click ADD.

There are two default file formats preselected. To deselect either of these output files check the checkbox next to the file definition and click the  button.

### Enable/Disable Viewer (default Enabled)

To enable the viewer simply check the Viewer Enable checkbox. The viewer uses a PLY formatted file in the 3D viewer. A PLY formatted file must be defined in the file output field. If multiple PLY files have been defined the user must select the desired ply file to use in the viewer.

The viewer will generate simple “floor plan” views for each discernible floor that was scanned. These floor plans are generated primarily for use when displaying the contextual

images generated from the ZEB-CAM video file but can also be used as a quick check for how well the data has processed.

## ZEB-CAM Video

To view the contextual images generated from the ZEB-CAM video, drag and drop video files downloaded from ZEB0-CAM into the ZebCam video box.

An additional checkbox is provided to enable/disable **Enhanced video synchronisation**. Enabling this feature will result in better synchronisation of the video images at the expense of significantly increased processing time.

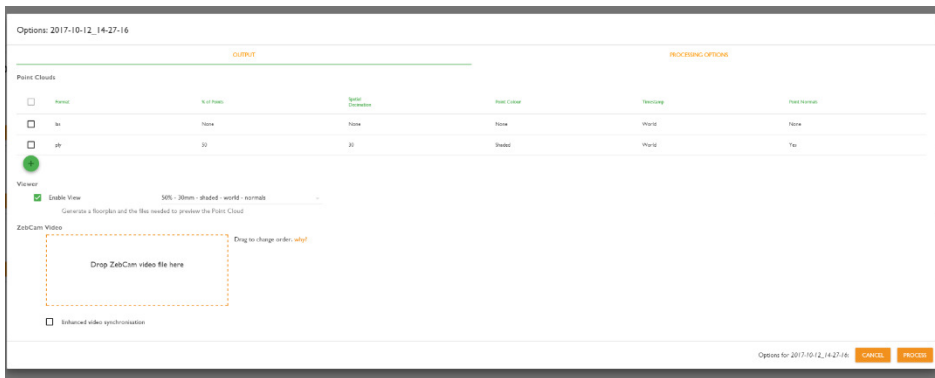



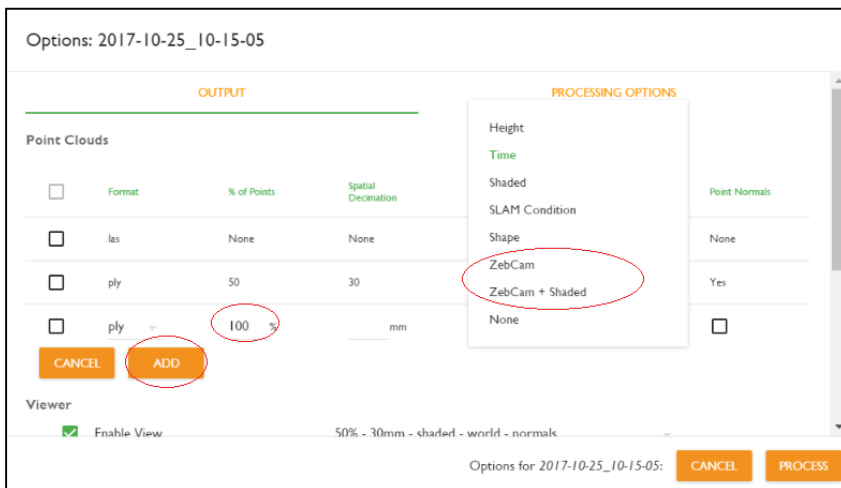
Figure 6-2

## 6.3 POINT COLOURISER

To create ZEB-CAM coloured point cloud data, select the  button on the Processing Output Tab to add an additional output file, select a file format, file decimation (it is recommended to select 100% to maximise coloured point density) and select one of the colour by ZEB-CAM options:

- |                 |  |
|-----------------|--|
| ZebCam          | Coloured points only   |
| ZebCam + Shaded | Coloured points + “un-coloured” points (with shaded grey scale colour) |

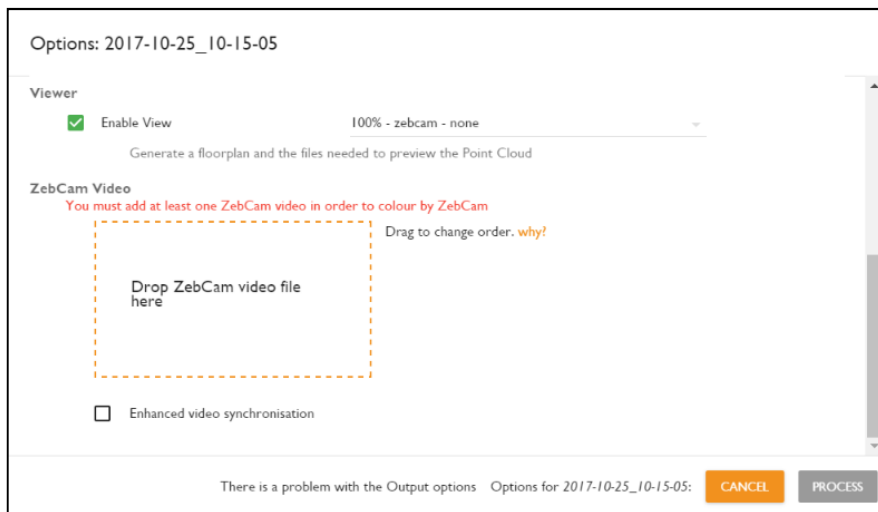
Note: Point Colouriser requires optional ZEB-CAM accessory. The field of view of the scanner is greater than the field of view of the ZEB-CAM. It is not possible to colourise all the points. Two options are provided, coloured points only or coloured points + “un-coloured” points (with shaded grey scale colour)



It is recommended that 100% of points is selected to achieve maximum coloured point density.

Click the ADD button to confirm the new output file selection.

A Drag and Drop box has been added to attach the corresponding ZEB-CAM video file(s). A video file must be provided to enable processing of data with colourisation by ZEB-CAM selected.



Point colourisation will typically double the processing time.



## 6.4 PROCESSING OPTIONS TAB

On the **Processing Options tab** users can change some of the processing parameters. Users can experiment with these parameter changes to try to improve datasets that do not process correctly with the default processing parameters:

---

Local Registration options	
Convergence threshold	Increasing this parameter increases the maximum number of iterations for each processing step and reduces the convergence threshold during the global registration phase. Increasing this parameter may improve the global registration (at the expense of processing time). Changing this parameter will not fix errors that occur during the local registration phase. Range 0 to 5 (default 0)
Window size	Increasing this parameter causes the algorithm to take larger samples of data for each processing step. This may help bridge slips that occur during the local registration phase. Increasing this parameter will increase the amount of memory required and the overall processing time. Range 0 to 5 (default 0)
Voxel density	Increasing this parameter causes the algorithm to use smaller voxels. This should enable more detail to be detected at close range and used during the SLAM processing. Increasing this parameter will increase the amount of memory required and the overall processing time. Range -1 to +3 (default 0)
Rigidity	Increasing this parameter will cause the algorithm to be more “rigid” during local registration phase. The algorithm will be more influenced by the raw IMU data and less influenced by laser point data when estimating the trajectory. Reducing this parameter has the opposite effect. The algorithm will be more influenced by the laser point data than the raw inertial data from the IMU Range -5 to +5 (default 0)
Modify bounding box	The user can change the default bound box used to eliminate the operator from the scan. All points inside the bounding box are ignored Increase the bound box size to eliminate more points around the scanner Reduce the bounding box if small spaces have been scanned
Process in reverse	This option will process the data set in reverse. This option can sometimes be used to fix data sets that do not process correctly in the forwards direction.

---

Conservative outlier pruning	By default, the processing algorithm filters and discards outlier points, i.e. those points that do not appear to be part of a continuous surface. This enables so called “edge effect” points to be removed creating a cleaner data set. The filtering can remove points on thin objects such as overhead cables. The filtering can be made more conservative by enabling this feature.
Large Range Filter Slope	By default, the processing algorithm filters and discards outlier points, i.e. those points that do not appear to be part of a continuous surface. This enables so called “edge effect” points to be removed creating a cleaner data set. In sparse environments (e.g. outdoors/forestry) this can result in significant removal of points. The filtering can be disabled by enabling this feature
End processing early	The user can specify an end time (in seconds) from the start. Only data up to this time is processed. This option can be used to recover part of a data set if an error occurs towards the end of the scan
Place Recognition	This feature will look for loop closures and pull them together during processing. This option can be used on large data sets where the drift during the SLAM processing causes loop closures not to close properly. Only use this option if processing with it disabled results in loop closures failing to close.
Convergence threshold	Increasing this parameter increases the maximum number of iterations for each processing step and reduces the convergence threshold during the local registration phase. Increasing this parameter may fix some processing errors (at the expense of processing time) Range 0 to 5 (default 0)
<b>Global Registration options</b>	
Prioritise planar surfaces	Selecting this option will cause the algorithm to only match very planar surfaces during the global registration phase. This can help improve the global registration of very large data sets provided there are sufficient planar surfaces at the points where there is loop closure
Start/finish closed loop	Unchecking this checkbox will force the start and end points to be pulled together before the start of the Global registration. The default for this setting is enabled. Disable this setting if the end of the scan is not in the same location as the start.
Convergence threshold	Increasing this parameter increases the maximum number of iterations for each processing step and reduces the convergence threshold during the local registration phase.

---

	Increasing this parameter may fix some processing errors (at the expense of processing time) Range 0 to 5 (default 0)
Rigidity	Increasing this parameter will cause the algorithm to be more “rigid” during the global registration phase. The algorithm will be more influenced by the raw IMU data and less influenced by laser point data when estimating the trajectory.  Reducing this parameter has the opposite effect. The algorithm will be more influenced by the laser point data than the raw inertial data from the IMU Range -5 to +5 (default 0)

---



## 7. GEOSLAM VIEWER

The GeoSLAM Viewer has two modes, 2D and 3D.

### 7.1 2D MODE

In 2D mode (Figure 7-1) an image of a horizontal slice from the point cloud at the height of the trajectory (floor plan) is presented. If multiple floors have been detected an image for the floor is presented. The user can cycle through the floors by clicking the + / - buttons in the top right corner of the display.

If a ZEB-CAM video file has been processed with the ZEB data, when the user clicks in the 2D view, images from the video file that are facing that point are displayed and the corresponding camera positions are displayed on the trajectory in the 2D view. The user can select the camera view and either drag it along the trajectory to see snap shots from video or double click to show/play the video from that camera position.



Figure 7-1

## 7.2 3D MODE

The user can switch to 3D mode by clicking the 3D View button at the top of the 2D display (or press the Tab key). The file displayed is the ply file you selected, when the Enable Viewer checkbox was selected. Depending on the size of the 3D file the 3D view may take some seconds to load.

The easiest way to navigate in the 3D view is to press the P key to lock the mouse and then use the keyboard arrow keys to zoom in and out and the mouse to turn left/right.

Press the H key to open the Navigation Help menu.

The following keys can also be used:

B – Toggles background colour from black to white

M – Cycles point size through 4 point sizes

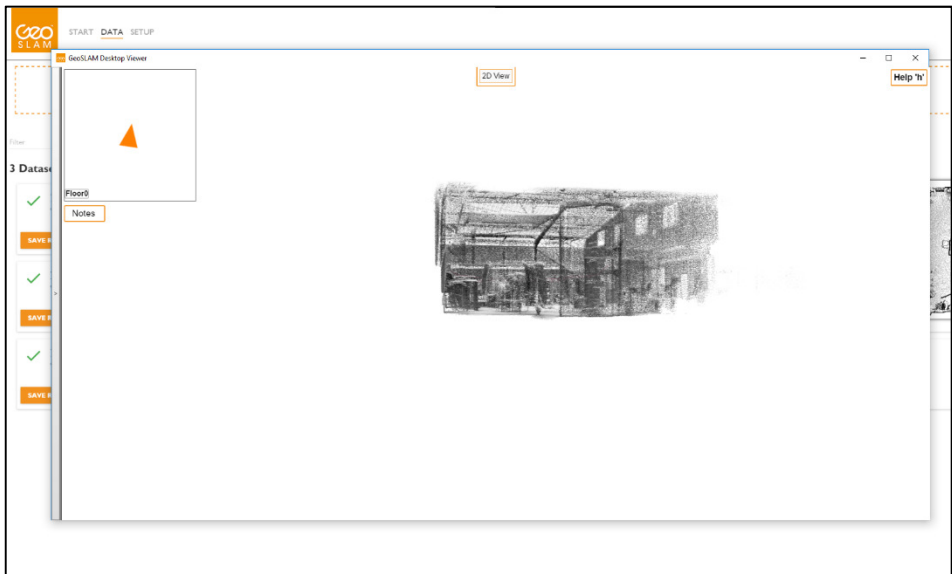



Figure 7-2

### 7.3 VIEWER ANNOTATION

An option to add user specified **Annotation** in the Viewer has been added.



To add a Note, simply click on the location you want to apply the note to in either the 2D or 3D view, click the Notes button and click + to add a Note. A dialogue box will appear requesting a Title and Description for the Note. Click Save to add the Note.

A  icon is displayed in the location of the Note. Click on the Note to display the Title and Description.



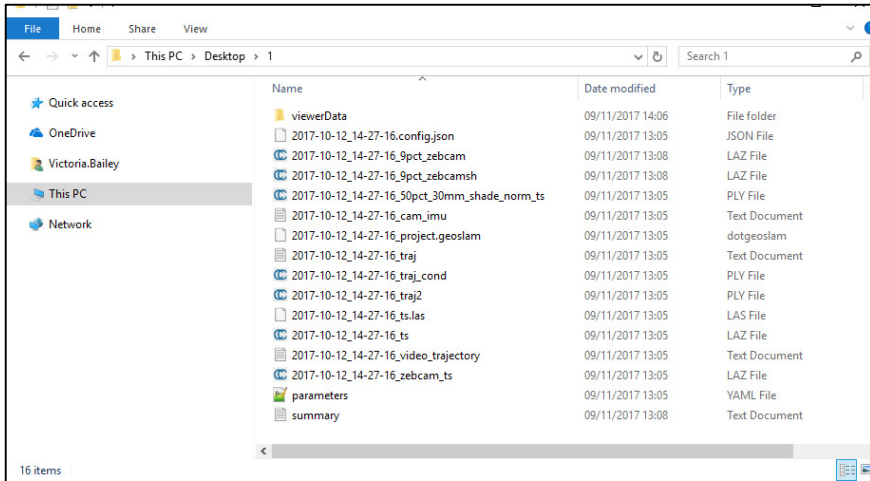


## 8. RESULTS FOLDER

The results folder contains the point cloud files selected on the Output Options dialogue page prior to processing. Each file name is prefixed by the file name of the ZEB data set that has been processed, followed by descriptors defining the configuration of the file (Figure 8-1).

Option	Descriptor	Description
% of points	_%X	Where X is the percentage of points selected Omitted if set to 100%
Special decimation	_XXmm	Where XX is the spatial decimation selected Omitted if no spatial decimation selected
Point colour	_height _time _shade _cond _shape _zebcam -zebcamsh	Height coloured Time coloured Shaded coloured (ambient occlusion) SLAM condition coloured Shape coloured ZEB-CAM coloured ZEB-CAM + shaded coloured Omitted if set to None
Timestamp	_ts _tss	World (UNIX) time timestamp Scan time timestamp Omitted if set to None
Normals	_norm	Normals included Omitted if set to None

**Table 8-1**



**Figure 8-1**

An ASCII txt file containing the scanner trajectory is also written to the results file. The trajectory file contains the following data:

Column	Descriptor	Description
1	time	Time in UNIX time
2	x	Scanner x coordinate in metres relative to scan origin
3	y	Scanner y coordinate in metres relative to scan origin
4	z	Scanner z coordinate in metres relative to scan origin
5	q1	Orientation quaternion
6	q2	Orientation quaternion
7	q3	Orientation quaternion
8	q4	Orientation quaternion
9	Userfields	Currently unused

**Table 8-2**

If colour by **Zebcam** or **ZebCam+shaded** is selected as an output option, an ASCII txt file containing the camera video trajectory is also written to the results file. The trajectory file contains the following data:

Column	Descriptor	Description
1	x	Scanner x coordinate in metres relative to scan origin
2	y	Scanner y coordinate in metres relative to scan origin
3	z	Scanner z coordinate in metres relative to scan origin
4	q1	Orientation quaternion
5	q2	Orientation quaternion
6	q3	Orientation quaternion
7	q4	Orientation quaternion
8	time	Time since start of scan (sec)
9	Image#	Image number
10	Image filename	Image filename as stored in the <i>filename_results\viewerData\thumbnails</i> folder

**Table 8-3**

For more information regarding the use of ZEB-CAM please refer to the separate ZEB-CAM User Manual.



## 9. MORE FILES

Data sets processed in GeoSLAM Hub V4.0 (or higher) can be reprocessed to generate different output files without having to run the full SLAM processing step. The More Files button against each data set can be used to select a different set of output file formats and specification (point colour, decimation, etc).

Click on the **MORE FILES** button (see Figure 9-1) and the File Output options dialogue box as described in Section 6.2 is displayed. Select the required output file configuration and click Process. The time taken to generate the new file configurations is a fraction of the time taken to run the entire SLAM processing step.

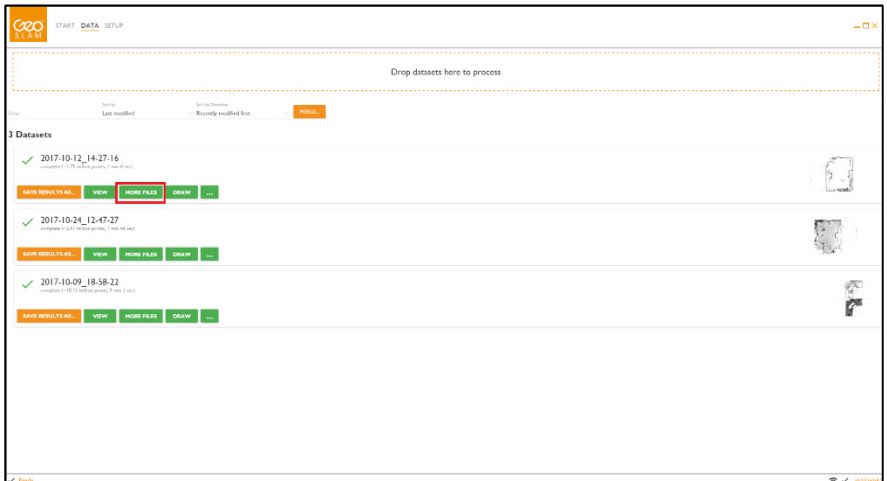


Figure 9-1



## 10. DATA SET MERGER

Data sets processed in GeoSLAM Hub V4.0 (or higher) can be aligned and merged with other data sets using the Data Set Merger feature. This feature performs a non-rigid registration of two or more ZEB data sets.

The data set merger requires LAS formatted files with “World” time stamps (see Section 3-1). Files with this configuration are automatically generated irrespective of the output file configurations selected prior to processing.

A coarse alignment of the data sets must be performed manually prior starting the merge algorithm.

### 10.1 SELECTING DATA SETS TO MERGE

To start the data set merging process, click the **MERGE** button on the top right of the DATA page as shown in Figure 10-1.

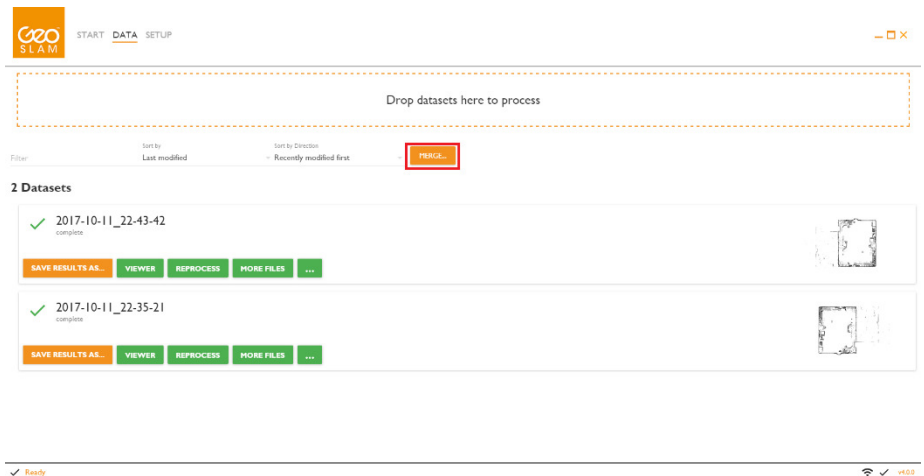


Figure 10-1

Data sets that have the requisite LAS file for merging will display a tick box next to them. Data sets processed in versions of GeoSLAM Hub or Desktop before V3.2.0 will not contain the requisite LAS file. The data sets will have to be reprocessed in order to generate the requisite LAS file. This file is automatically created in V3.2.0 irrespective of the file output options selected prior to processing.

Check the tick box next to the data sets you want to merge as shown in Figure 10-2 and click the **START MERGE** button.

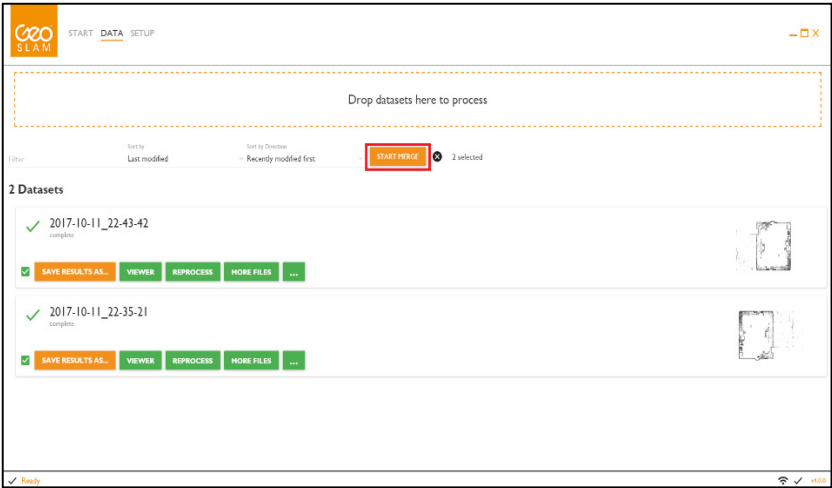


Figure 10-2

10.2 MANUAL COARSE ALIGNMENT

After clicking the START MERGE button a graphical display window is opened and the selected data sets are loaded in plan view as shown in Figure 10-3.

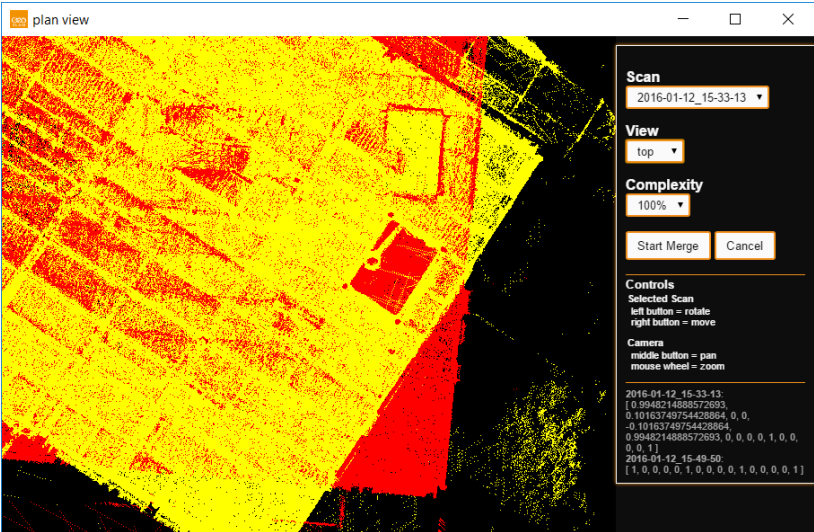


Figure 10-3



The currently active scan is shown in red. The other scans are shown in yellow. The name of the active scan is shown under the **Scan** heading in the information box (Figure 10-4). The other scans can be selected to become active by clicking on the drop down button adjacent to the scan name and selecting another scan from the drop down list.

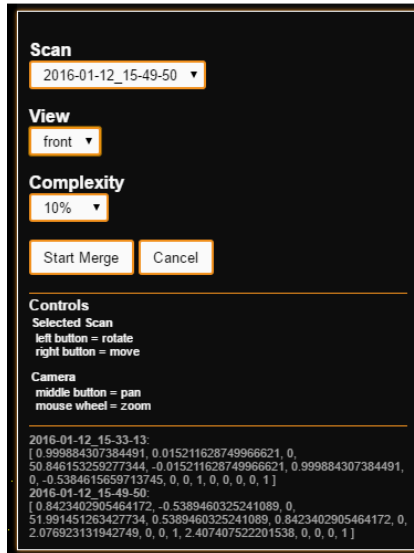


Figure 10-4

It is recommended that you open the merge graphics window to full screen.

For large data sets it is recommended the number of visible points is reduced using the drop down button against the **Complexity** setting (default 100%)

The currently active data set can be translated and rotated about the Z axis using the right and left mouse buttons respectively. The entire view can be zoomed in and out using the mouse scroll wheel and panned using the middle mouse button.

Translate and rotate the currently active (red) scan away from the others as shown in Figure 10-5

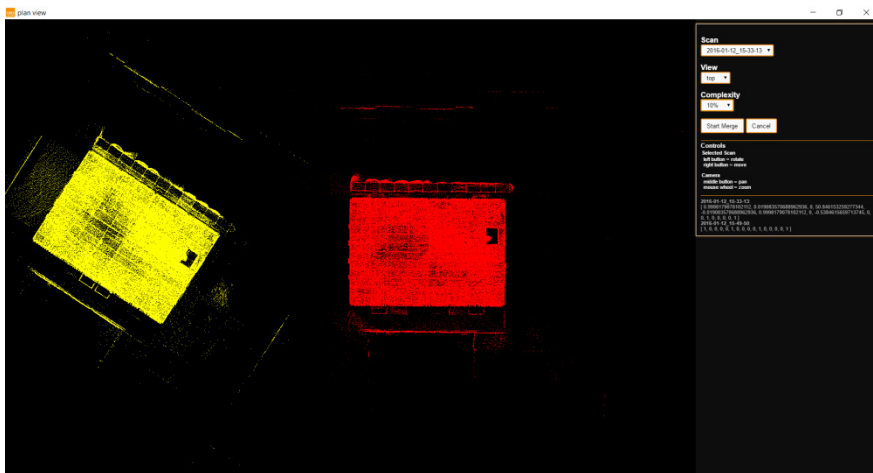


Figure 10-5

Select the next scan and translate and rotate to approximately align with the first scan as show in Figure 10-6.

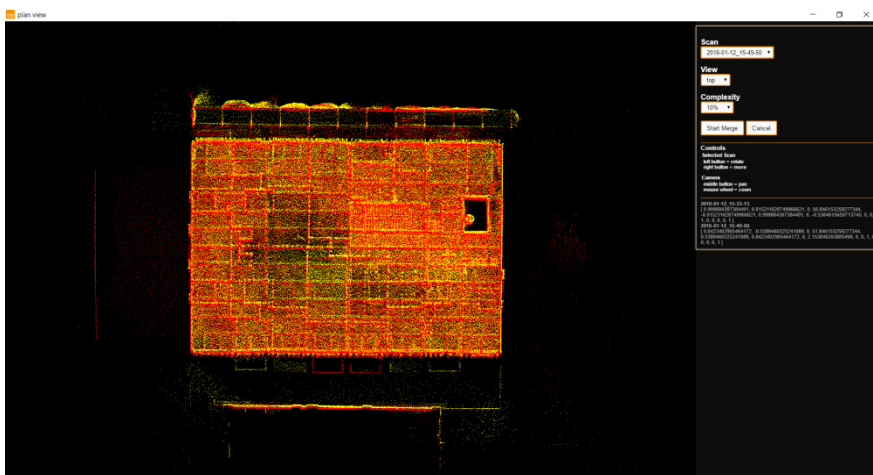
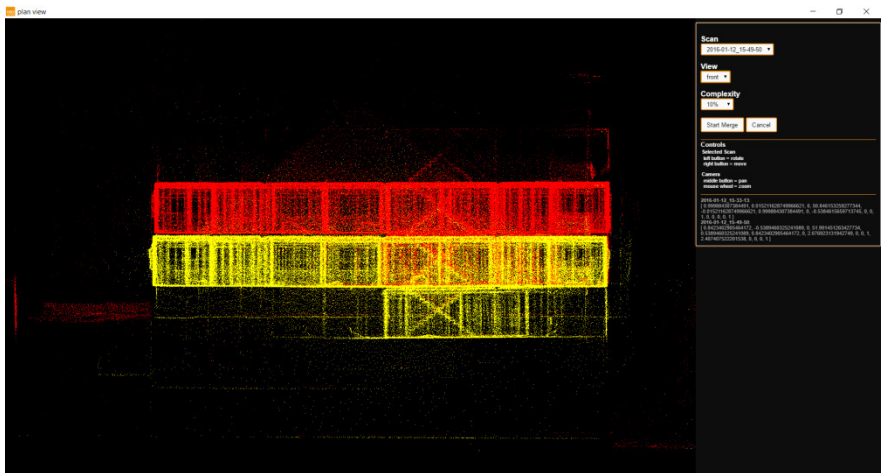


Figure 10-6

**IMPORTANT!** You must ensure the scans are approximately aligned vertically as well as horizontally. To do this click the **View** drop down button and select with Front or Side view. In these views only translation is enabled. Adjust the vertical position of the currently active to scan to approximately align with the first scan as shown in Figure 10-7.



**Figure 10-7**

Repeat the coarse alignment for all data sets. Once all the data sets are coarsely aligned click the **Start Merge** button. The graphical display window will close and the merge algorithm will perform a non-rigid registration of the coarsely aligned data sets.

When the merge processing is the file will be saved in the geoslam-processing folder. The default name for the results folder is **yyyy-mm-dd-hh-mm-ss\_merge\_results** where the date and time are the date and time the merge was performed. The results folder name can be changed prior to saving.

The results folder contains separate “merged” LAZ files for each data set along with the modified trajectory for that data set in ASCII text format (see Section 8).



## 11. GEOSLAM DRAW

GeoSLAM Draw enables users to create 2D layouts from ZEB-REVO data sets. GeoSLAM Draw is based on the PointCab Suite point cloud processing application.

To open a dataset in GeoSLAM Draw, click the DRAW button below the target dataset of the DATA page (see Figure 11-1). A dialogue box confirming that you wish to create a GeoSLAM Draw project file is displayed (Figure 11-2). Click Yes to continue

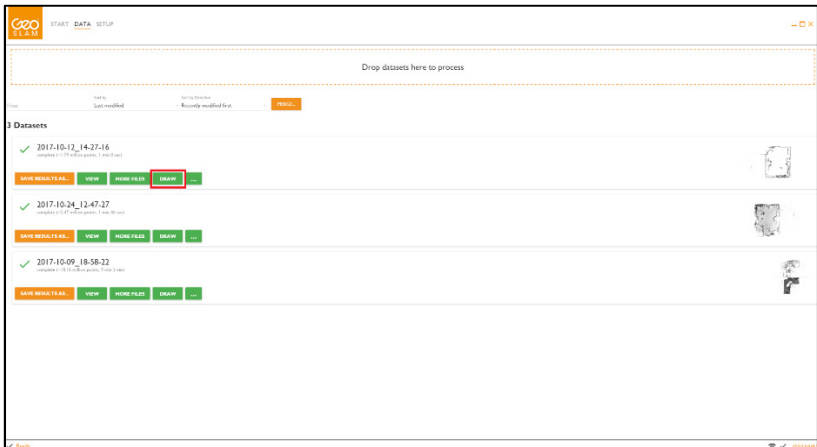


Figure 11-1

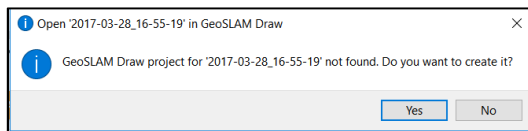


Figure 11-2

A file selection dialogue box will be displayed with a dropdown box listing all the available files that are compatible with GeoSLAM Draw (LAS and LAZ files) – see Figure 11-3

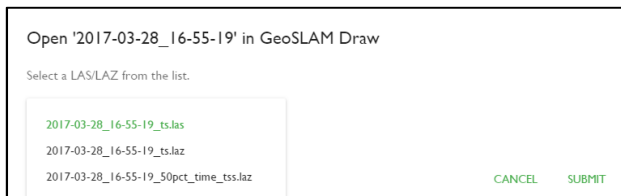


Figure 11-3

GeoSLAM Draw requires a separate license. The first time GeoSLAM Draw is started an error state will be displayed (Figure 11-4). Please contact [support@geoslam.com](mailto:support@geoslam.com) to request your license file.

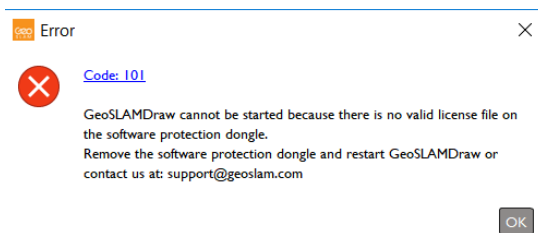


Figure 11-4

Once a valid license file has been installed the dataset will be converted to GeoSLAM Draw format and a GeoSLAM Draw window will open with the dataset loaded (see Figure 11-5).

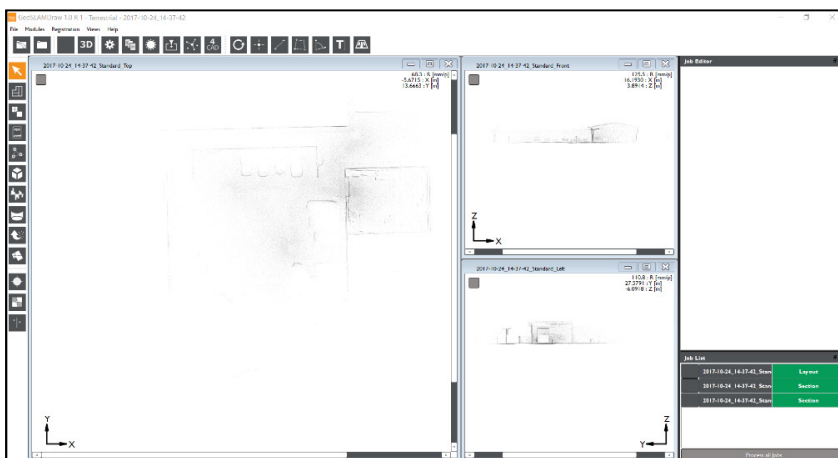


Figure 11-5

A series of GeoSLAM Draw instruction videos covering the following topics are available on via the following links:

### [Installing a license file](#)

[Basics](#) – loading a project - from GeoSLAM Hub and files

- Moving around – zoom, moving views, tiled view
- Align a project
- Create layouts
- Create sections

[Layouts](#) – Duplicating layouts

- Floor and ceiling plans
- Beams
- Facades

[Measuring](#) – measuring tool

- Distance measuring
- Angles measuring
- Texting tool
- Documentation

[Vectorization](#) – Manual vectorization (creating drawn plans)

- Automatic vectorization (creating drawn plans)





## 12. ADVANCED SETTINGS – GEOSLAM HUB

### 12.1 SETUP PAGE

The SETUP page (Figure 12-1) provides an interface for:

- Manually updating the software
  - Here you can drag and drop update files which will install small updates to the Virtual Machine. This is not used often but is an alternative to a full Virtual Machine install.
- Switch on Automatic Updates (recommended)
  - Having automatic updates allows us to connect to both the software and the dongle to issue updates before components expire. This is particularly useful if you are using a distributor dongle.
- Download dongle update
  - In the case that a dongle update has been issued but has not applied you can force the update by using the download dongle update option.

Advanced options for

- Opening the processing folder (if request by the GeoSLAM support team)
  - In this processing folder, you will have your raw data files and your results folder. You will also have a config folder which is used during processing. This information enables the processing to work correctly so do not alter unless instructed to do so by GeoSLAM staff.
- Hardware calibration update
  - If you have a new install, your dongle has been reassigned or you have recently purchased a new unit you will need the correct calibration information. This information is usually found on the installation USB or is automatically downloaded once the dongle is read. If for some reason you are missing this information using hardware calibration update allows you to call the calibration information associated with your dongle from the servers.
- Resetting the software interface (only if requested by the GeoSLAM support team)
  - Resets all settings top the factory install.
- Downloading the support log file (if requested by the GeoSLAM support team)
  - Allows you to save a copy of your log file to send to GeoSLAM staff when instructed to do so.

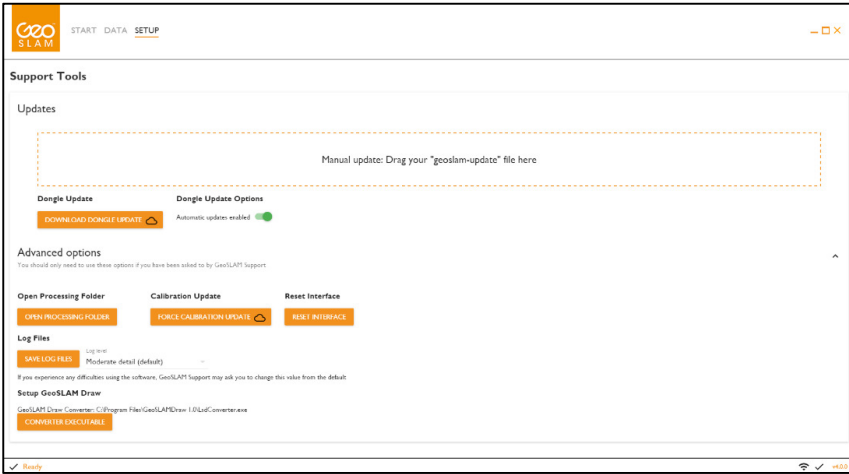


Figure 12-1

It should only be necessary to use this page if requested to do so by the GeoSLAM Support Team.

## 12.2 VIRTUAL MACHINE OPTIMIZATION

The GeoSLAM virtual machine running in VirtualBox can be optimized to make use of all of your machine's resources. You should only conduct optimization in consultation with the GeoSLAM Support Team.

The optimization process is carried out from the VirtualBox Manager window. To open the VirtualBox Manager, either click on the Oracle VM VirtualBox desktop icon or from the Oracle program group (search VirtualBox in the Windows start menus)

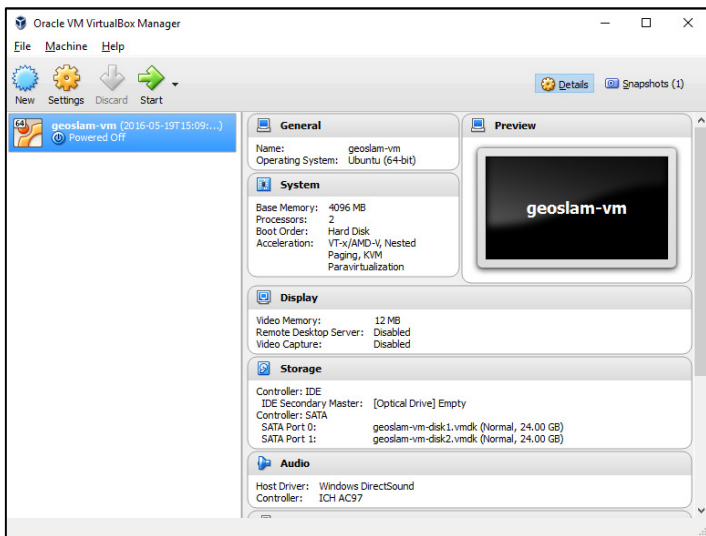
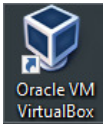



Figure 12-2

The **geoslam-vm** virtual machine must be "Powered Off" to enable optimization. To power the machine off, click *EXIT* on the top right of the GeoSLAM Hub window.

Click on the snapshots icon in the top left of the VirtualBox manager window (Figure 11-2).

Select the snapshot and click on the "Delete" icon  to delete the snap shot (Figure 11-3)

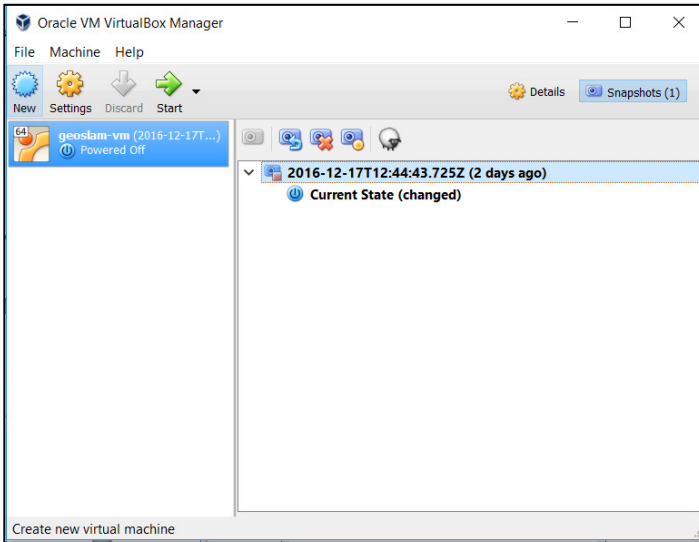


Figure 12-3

Click on the **Settings** icon in the toolbar and select **System** (Figure 12-4). To optimize the Base Memory, click and drag the blue slider to the furthest extent of the green range, without entering into the orange/red range (Figure 12-5).

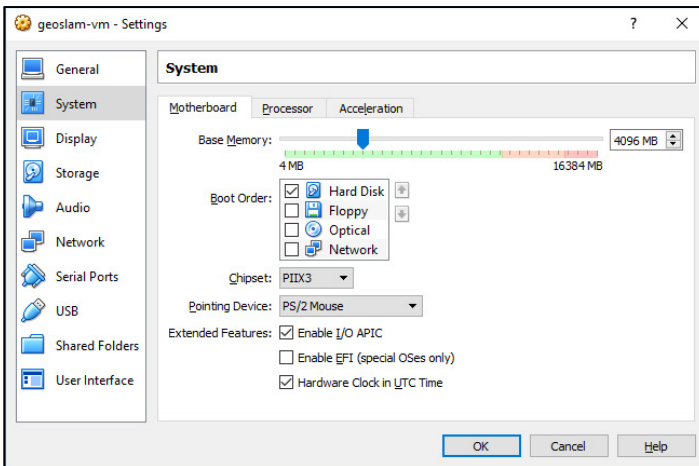


Figure 12-4

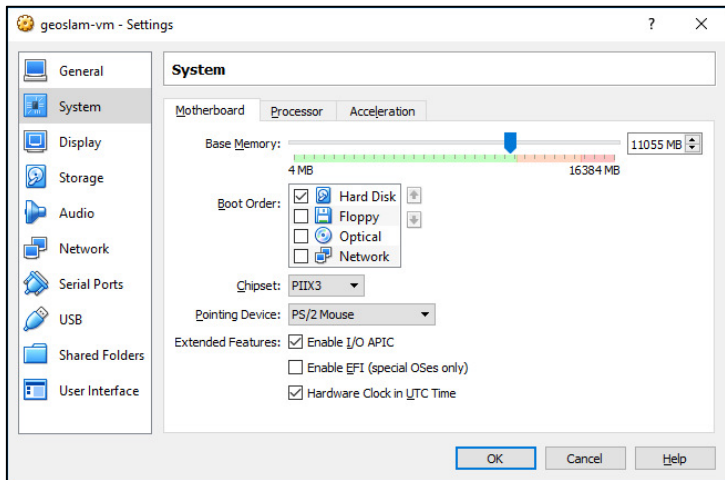


Figure 12-5

Next, click on **Processor** tab and optimise the number of Processor(s) used for processing by dragging the blue slider to the furthest extent of the green bar (Figure 11-6)

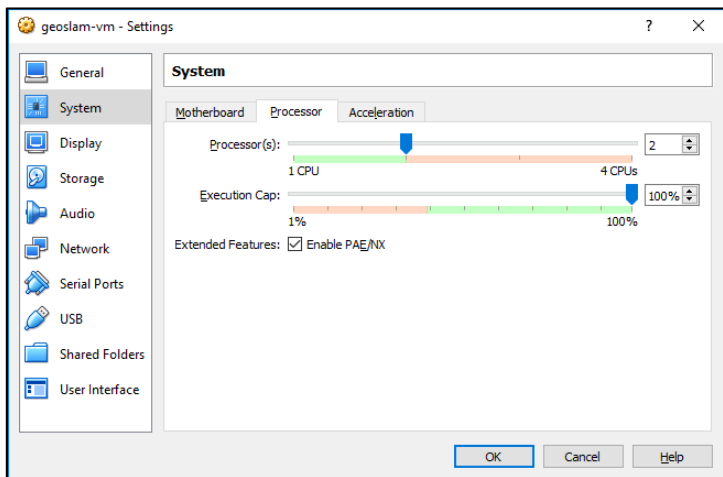


Figure 12-6

Once both the motherboard and processor have been optimized, click 'OK' to save the changes.

Restart the GeoSLAM Hub application either by clicking on the GeoSLAM Hub icon or from the GeoSLAM program group (search GeoSLAM Hub in the Windows Start Menu).

### 12.3 FURTHER HELP AND INFORMATION

Contact GeoSLAM by any of the following methods:

Phone: +44 1949 831814

General email: [info@geoslam.com](mailto:info@geoslam.com)

Support email: [support@geoslam.com](mailto:support@geoslam.com)

Website: [www.geoslam.com](http://www.geoslam.com)

## 13. ADVANCED SETTINGS – ZEB-REVO RT

**GeoSLAM** SCAN DATA SETTINGS DELETE

### Settings

#### System logs

DOWNLOAD LOGS

#### Disk Space Used

Used 2.14GB of 39.04GB

#### Change Date/Time

**Date**  
2017-10-25

**Time**  
09:16

SAVE

#### Timezone

Europe/London

SAVE

#### WiFi Name

geoslam-rt-204

SAVE

#### WiFi Password

SAVE ?

#### Wifi

Wifi enabled

#### Versions

- Software version: 1.0.93
- UI version: 0.0.1

v0.0.1

Figure 13-1

## 13.1 SETTING THE SYSTEM DATE/TIME

The date, time and time zone can be set on the ZEB-REVO RT SETTINGS page by clicking on the required field in the Change Date/Time section (see Figure 13-1).

To adjust the date, select the required day on the calendar display, click OK and then click the SAVE button under the Date/Time section.

To adjust the time, select the required hours and minutes on the clock display, click OK and then click the SAVE button under the Date/Time section.

To adjust the time zone, select the required select the required Continent/City combination in the drop-down box and then click the SAVE button under the Timezone section.

## 13.2 WIFI SETTINGS

The WiFi Name (SSID) and password can be configured on the ZEB-REVO RT SETTINGS page by clicking on the required field in the WiFi Settings section (see Figure 13-1).

To change the Wifi Name, edit the existing name (default is **geoslam-rt-204**) and then click the SAVE button. It will be necessary to reconnect if WiFi Name is changed when the connection is made over WiFi

To change the WiFi Password, enter a new password in the blank password field and then click the SAVE button. The new password must contain the following:

- At least one digit;
- At least one special character;
- At least one letter of either case;
- Have a minimum length of 9 characters.

The WiFi can be disabled moving the WiFi Enable switch to the left. Once disabled, the only way to reconnect to the RT system is via a wired connection.

## 13.3 SYSTEM LOGS

The system log files can be downloaded from the RT system by click the DOWNLOAD LOGS button on the SETTINGS page (see Figure 13-1). The log files can either by displayed in Windows Explorer or downloaded as a single Zip file. The system logs files may be requested by the GeoSLAM Support Team if there is a problem with the RT system.



## 14. BATTERY

### 14.1 SPECIFICATION

Output voltage	14.8V nominal
Capacity	6.1Ah nominal 90Wh
Charge voltage	16.8V
Weight	0.57kg
Charging temperature	0°C to 40°C
Life cycle	>300 cycles
Protection	Over current, over voltage, under voltage, thermal
Transportation	UN 38.3 transportation test certified

**Table 14-1 Battery Specification**

### 14.2 RECHARGING

Plug the charger into the AC mains – the LED light will glow green.

Plug the charger lead firmly into the battery the LED light will change to red to indicate charging.

When the LED light changes back to green, the battery is fully charged.

Disconnect the charger from the battery and from the AC mains.

**! Do not leave the charger connected to the battery for long periods after the battery is charged.**

### 14.3 CAPACITY AND RUN-TIME DISPLAY

A single button press of the display button on the side of the battery shows a percentage figure of available capacity, to a resolution of 1%.



The accuracy of the display is maintained by tracking battery performance, and adjusting calibration values to compensate for the ageing of the cells.

When battery is fully-discharged the display will indicate as below.



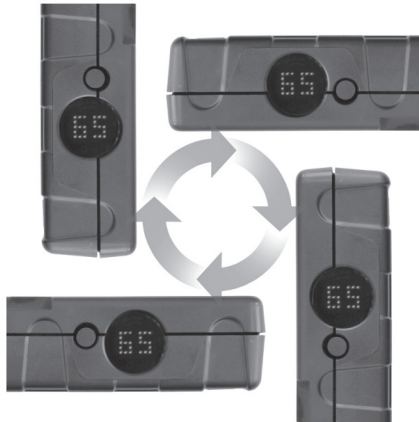
When the battery is fully charged the display will indicate 100%.



When connected to the ZEB-REVO RT that is powered on, two presses of the battery's display button will show a predicted run-time against the given load, expressed in hours and minutes.



The Capacity display senses the orientation of the battery and adjusts to ensure legibility.



#### 14.4 BATTERY CARE

DO NOT dispose of in normal household waste.

DO NOT attempt to dismantle the battery.

DO NOT short circuit the battery.

ONLY use the charger supplied with the battery.

The battery should be charged fully before use.

If storing the battery, store in a charged state. Recharge after every 6 months.

Excess heat will degrade the battery rapidly. Always store the battery in a cool dry place.

DO NOT leave for long periods in the sun or in a hot vehicle.

It is recommended to recharge the battery within 12 hours if fully discharged.

The battery is splash proof but not water proof – do not immerse in water.

#### 14.5 TRANSPORTATION

The battery has been tested and passed section 38.3 of the UN Manual of Tests and Criteria (UN Transportation Testing) as required by the IATA Dangerous Goods Regulations (2016), Section 2.3.5.9.. T

he battery is below the 100Wh limit for transportation on passenger planes. For the purposes of air transportation, the battery is classed as “Packed with equipment” (ICAO/IATA Packing Instruction 966, Section II) – Cells or batteries contained in a package with associated electronic equipment. Special rules may apply to the transportation of spare batteries. It is recommended that you check with your local air transportation safety authority and/or the proposed air carrier for specific requirements on lithium battery transportation.

Never ship a damaged battery by air transportation.

PAG Ltd.  
565 Kingston Road  
London SW20 8SA  
United Kingdom



## Air Transport Certificate for PAG Li-Ion Batteries

**PAG Ltd. London, England**

hereby declares that the PAG L90 Slim Lithium-Ion battery has been tested and certified by Intertek Group PLC to comply with the UN Manual of Tests & Criteria, Part III, subsection 38.3 as required by the IATA Dangerous Goods Regulations (2016), Section 2.3.5.9.

**PAG L90 Slim Battery Test Report Number: 102471069**

In addition to UN testing, this Li-Ion battery has an individual Watt-hour rating below 100Wh. This rating is in compliance with the IATA DGR (2016) which states:

- (a) each installed or spare battery must not exceed:*
- 2. for lithium ion batteries, a watt-hour rating of not more than 100Wh.*

Signed for and on behalf of PAG Ltd.

A handwritten signature in black ink that reads 'Alan Lavender'.

Alan Lavender  
Chief Executive  
Date: 01.04.16.



## 15. APPENDICES

### 15.1 APPENDIX 1 – GEOSLAM DATA SET FLAGGING

If you encounter a problem during data processing using GeoSLAM HUB and you have an up to date support and maintenance subscription you can upload the problem dataset to the GeoSLAM Cloud processing server using the ZEB Uploader application. After uploading to the Cloud server, a *Flag Data* icon can be activated to alert GeoSLAM support team that there is a problem with the dataset. Problem datasets are investigated during regular UK office hours. A member of the GeoSLAM support team will contact you by email and advise why the error occurred and whether it has been possible to fix the dataset.

To use the Uploader application, you must first have a user account on the GeoSLAM processing server. If you need help with installing this application or setting up a user account contact [support@geoslam.com](mailto:support@geoslam.com).

The application must be installed on a PC with a Microsoft Windows operating system (Windows XP or later) and internet access.



The ZEB-REVO Uploader application is installed in the GeoSLAM Program Group and can be accessed via the Windows start menu or via the shortcut installed in the Desktop folder. Start the **ZEB-REVO Uploader** desktop application and log on to the service using your account login details (see Figure 15-1).

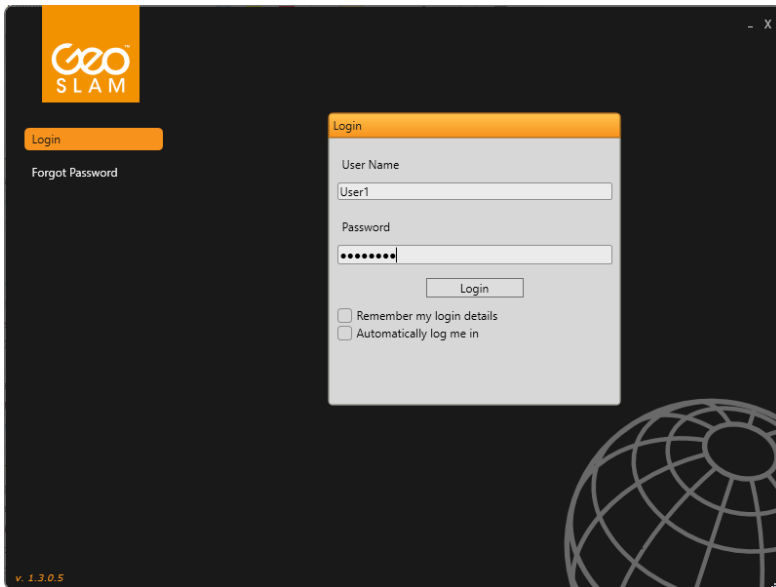


Figure 15-1

The application will open on the **Upload** page (see **Error! Reference source not found.**).

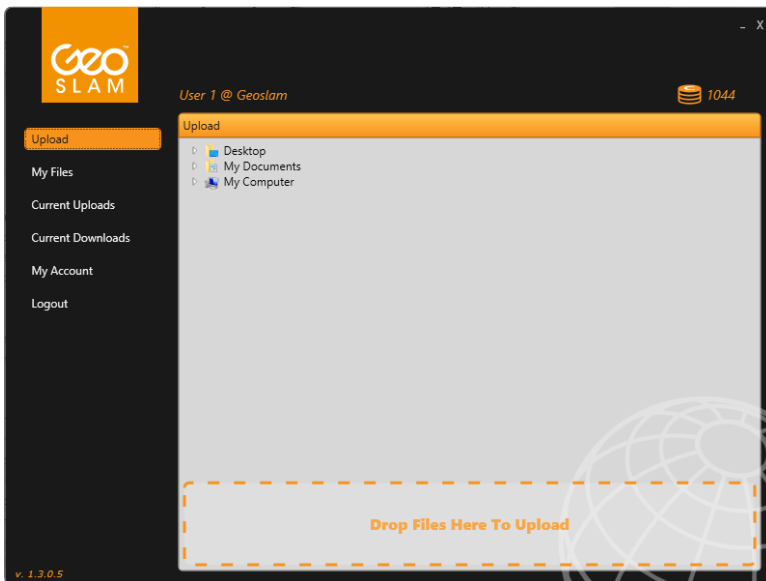


Figure 15-2

Either navigate to the location of the *filename.geoslam* file(s) from within the Upload page and double click the file(s) to be uploaded or 'drag and drop' files from Windows Explorer onto the Upload page. After the file(s) have been selected the application automatically switches to the **Current Uploads** page and progress bar(s) are displayed showing the progress of each file upload (see Figure 15-3).

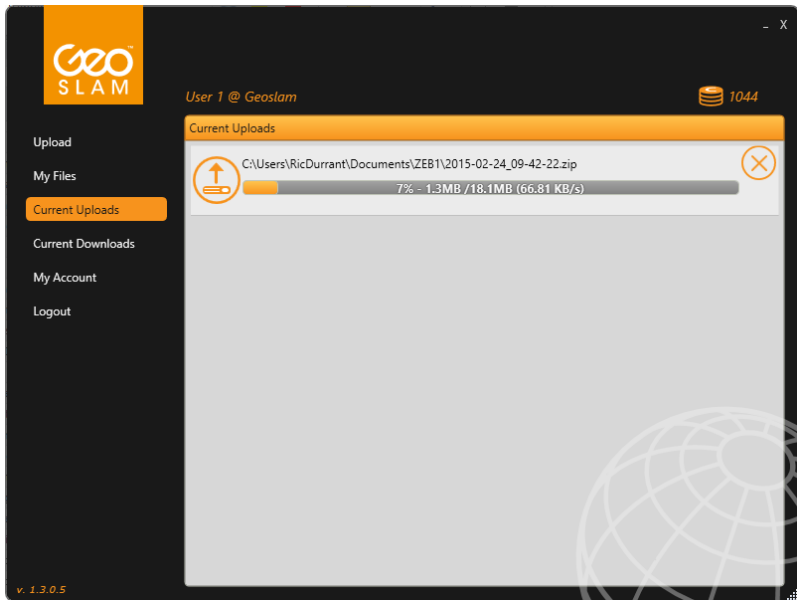


Figure 15-3

Once the upload is completed the file will be added to the **My Files** page. Click on **My Files** to display the page.

Three icons will be displayed next to the uploaded file.



Delete icon



Pay icon



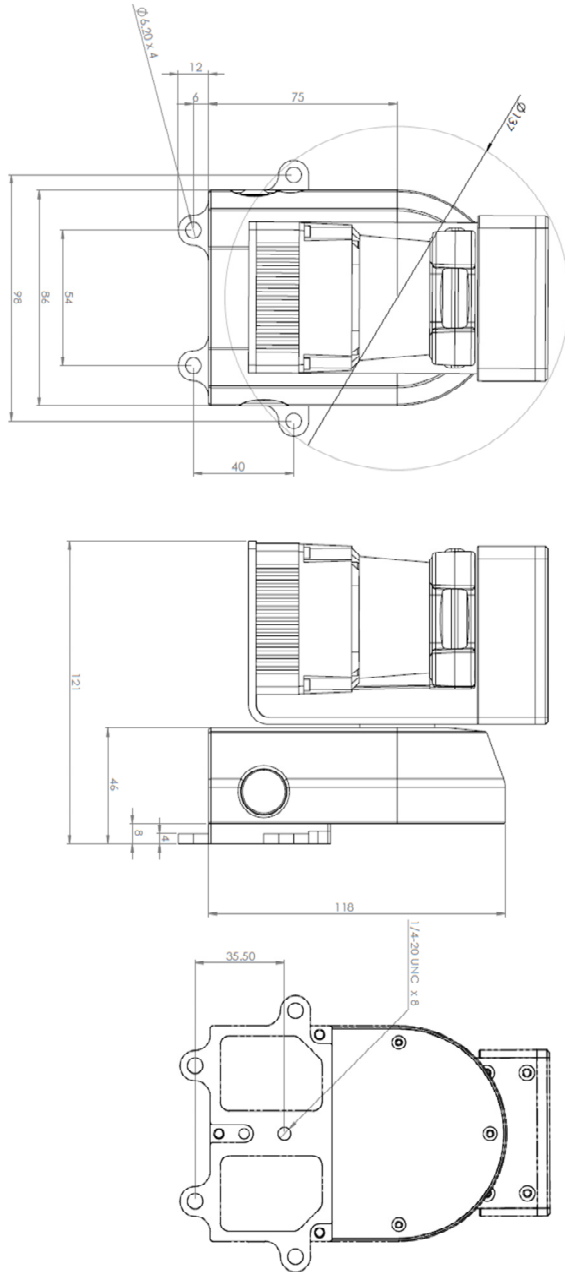
Flag for support

To flag an error in a processed dataset, click the *Flag Data* icon relating to the dataset on the **My Files** page. This will automatically alert a member of the GeoSLAM support team that there is a problem with the dataset. Problem datasets are investigated during regular UK office hours. A member of the GeoSLAM support team will contact you by email and advise why the error occurred and whether it has been possible to fix the dataset.

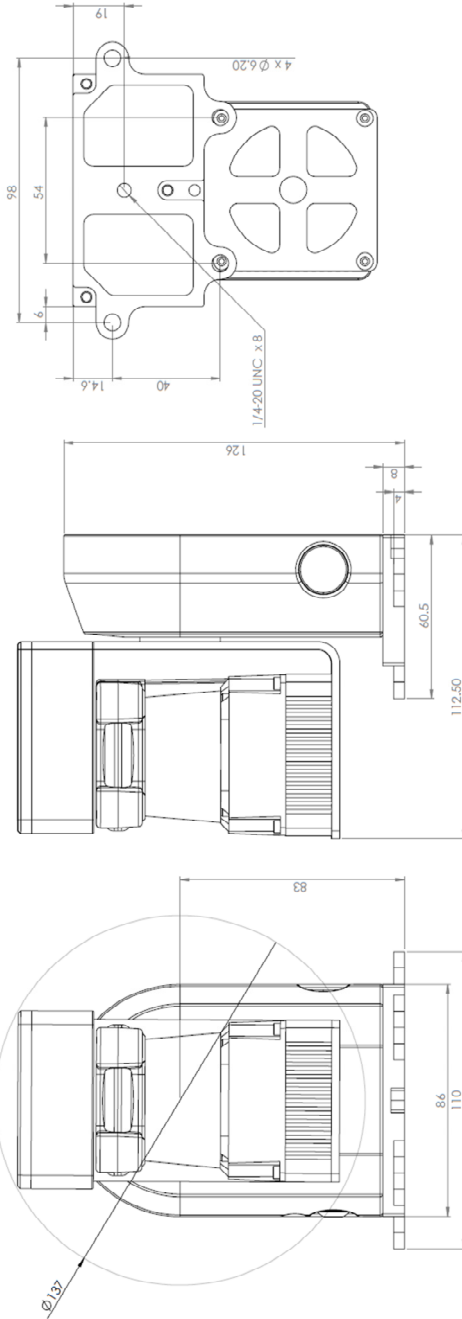
## 15.2 APPENDIX 3 – DIMENSIONAL DRAWINGS

Dimensional drawings with optional mounting plate on rear face





Dimensional drawings with optional mounting plate on bottom face



## GeoSLAM Limited

### End user license agreement

Please read this EULA carefully, as it sets out the basis upon which we license the Software for use.

By installing the Software, you agree to be bound by the provisions of this EULA. If you do not agree to be bound by the provisions of this EULA, you must not use the installation.

By agreeing to be bound by this EULA, you further agree that your employees / any person you authorise to use the Software will comply with the provision of this EULA.

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1.1 Except to the extent expressly provided otherwise, in this EULA:

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**"Effective Date"** means the date upon which the Licensee gives the Licensee's express consent to this EULA, following the issue of this EULA by the Licensor;

**"Force Majeure Event"** means an event, or a series of related events, that is outside the reasonable control of the party affected (including [failures of the internet or any public telecommunications network, hacker attacks, denial of service attacks, virus or other malicious software attacks or infections, power failures, industrial disputes affecting any third party, changes to the law, disasters, explosions, fires, floods, riots, terrorist attacks and wars]);

**"Intellectual Property Rights"** means all intellectual property rights wherever in the world, whether registrable or unregistrable, registered or unregistered, including any application or right of application for such rights.

**"Licensee"** means the person to whom the Licensor grants a right to use the Software under this EULA;

**"Licensor"** means GeoSLAM Limited, a company incorporated in England and Wales (registration number 7824395) having its registered office at Unit 1 Moorbridge Court, Bingham, NG13 8GG, UK;

**"Software"** means the GeoSLAM HUB Processing Software

**"Source Code"** means the Software code in human-readable form or any part of the Software code in human-readable form, including code compiled to create the Software or decompiled from the Software, but excluding interpreted code comprised in the Software; and

"Term" means the term of this EULA, commencing in accordance with Clause 2.1 and ending in accordance with Clause 2.2;

## **2. Term**

2.1 This EULA shall come into force upon the Effective Date.

2.2 This EULA shall continue in force indefinitely, subject to termination in accordance with Clause 9.

## **3. License**

3.1 The Licensor hereby grants to the Licensee during the Term a non-exclusive license to:

- (a) install the Software;
- (b) use a single instance of the Software in accordance with the Documentation; and
- (c) create, store and maintain up to 5 back-up copies of the Software, subject to the limitations and prohibitions set out and referred to in this Clause

3.

3.2 The Licensee may not sub-license and must not purport to sub-license any rights granted under Clause 3.1 without the prior written consent of the Licensor.

3.3 Save to the extent expressly permitted by this EULA or required by applicable law on a non-excludable basis, any license granted under this Clause 3 shall be subject to the following prohibitions:

- (a) the Licensee must not sell, resell, rent, lease, loan, supply, publish, distribute or redistribute the Software;
- (b) the Licensee must not alter, edit or adapt the Software; and
- (c) the Licensee must not decompile, de-obfuscate or reverse engineer, or attempt to decompile, de-obfuscate or reverse engineer, the Software.

3.4 The Licensee shall be responsible for the security of copies of the Software supplied to the Licensee under this EULA (or created from such copies)] and shall use all reasonable endeavours (including all reasonable security measures) to ensure that access to such copies is restricted to persons authorised to use them under this EULA.

3.5 The Licensor does not accept any liability in respect of the use of the Software by the Licensee. The Licensee is responsible for the verifying the validity of the output generated by the Software and indemnifies the Licensor against all claims, losses, costs and liabilities that may be suffered or incurred by the Licensor in respect of the use of the Software by the Licensee.

## **4. Source Code**

4.1 Nothing in this EULA shall give to the Licensee or any other person any right to access or use the Source Code or constitute any license of the Source Code.

## **5. No assignment of Intellectual Property Rights**

5.1 Nothing in this EULA shall operate to assign or transfer any Intellectual Property Rights from the Licensor to the Licensee or from the Licensee to the Licensor.

## **6. Warranties**

6.1 The Licensor warrants to the Licensee that it has the legal right and authority to enter into this EULA and to perform its obligations under the EULA.

6.2 If the Licensor reasonably determines, or any third party alleges, that the use of the Software by the Licensee in accordance with this EULA infringes any person's Intellectual Property Rights, the Licensor's sole obligation is to (in its sole discretion):

(a) modify the Software in such a way that it no longer infringes the relevant Intellectual Property Rights; or

(b) procure for the Licensee the right to use the Software in accordance with this EULA; or

(c) terminate this EULA and refund an appropriate portion of the fee.

6.3 All of the parties' warranties and representations in respect of the subject matter of this EULA are expressly set out in this EULA. To the maximum extent permitted by applicable law, no other warranties or representations concerning the subject matter of this EULA will be implied into the EULA or any related contract.

## **7. Acknowledgements and warranty limitations**

7.1 The Licensee acknowledges that complex software is never wholly free from defects, errors and bugs; and subject to the other provisions of this EULA, the Licensor gives no warranty or representation that the Software will be wholly free from defects, errors and bugs.

7.2 The Licensee acknowledges that complex software is never entirely free from security vulnerabilities; and subject to the other provisions of this EULA, the Licensor gives no warranty or representation that the Software will be entirely secure.

## **8. Limitations and exclusions of liability**

8.1 Nothing in this EULA will:

(a) limit or exclude any liability for death or personal injury resulting from negligence;

(b) limit or exclude any liability for fraud or fraudulent misrepresentation;

(c) limit any liabilities in any way that is not permitted under applicable law; or

(d) exclude any liabilities that may not be excluded under applicable law, and, if a party is a consumer, that party's statutory rights will not be excluded or limited by the EULA, except to the extent permitted by law.

8.2 The limitations and exclusions of liability set out in this Clause 8 and elsewhere in this EULA:

(a) are subject to Clauses 18.1 and 11.6; and

(b) govern all liabilities arising under the EULA or relating to the subject matter of the EULA, including liabilities arising in contract, in tort (including negligence) and for breach of statutory duty, except to the extent expressly provided otherwise in the EULA.

8.3 The Licensor will not be liable to the Licensee in respect of any losses arising out of a Force Majeure Event.

8.4 The Licensor will not be liable to the Licensee in respect of any loss of profits or anticipated savings.

8.5 The Licensor will not be liable to the Licensee in respect of any loss of revenue or income.

8.6 The Licensor will not be liable to the Licensee in respect of any loss of business, contracts or opportunities.

8.7 The Licensor will not be liable to the Licensee in respect of any loss or corruption of any data, database or software.

8.8 The Licensor will not be liable to the Licensee in respect of any special, indirect or consequential loss or damage.

8.9 The aggregate liability of the Licensor to the Licensee under this EULA shall not exceed the total amount paid and payable by the Licensee to the Licensor under the EULA.

## **9. Termination**

9.1 Either party may terminate this EULA immediately by giving written notice of termination to the other party if:

- (a) the other party commits any [breach / material breach] of the EULA[, and:
  - (i) the breach is not remediable; or
  - (ii) the breach is remediable, but the other party fails to remedy the breach within the period of 30 days following the giving of a written notice to the other party requiring the breach to be remedied; or
- (b) the other party persistently breaches the EULA (irrespective of whether such breaches collectively constitute a material breach).

9.2 Either party may terminate this EULA immediately by giving written notice of termination to the other party if:

- (a) the other party:
  - (i) is dissolved;
  - (ii) ceases to conduct all (or substantially all) of its business;
  - (iii) is or becomes unable to pay its debts as they fall due;
  - (iv) is or becomes insolvent or is declared insolvent; or
  - (v) convenes a meeting or makes or proposes to make any arrangement or composition with its creditors;
- (b) an administrator, administrative receiver, liquidator, receiver, trustee, manager or similar is appointed over any of the assets of the other party;
- (c) an order is made for the winding up of the other party, or the other party passes a resolution for its winding up (other than for the purpose of a solvent company reorganisation where the resulting entity will assume all the obligations of the other party under the EULA);
- (d) if that other party is an individual:
  - (i) that other party dies;
  - (ii) as a result of illness or incapacity, that other party becomes incapable of managing his or her own affairs; or
  - (iii) that other party is the subject of a bankruptcy petition or order.

9.3 The Licensor may terminate this EULA immediately by giving written notice to the Licensee if:

(a) any amount due to be paid by the Licensee to the Licensor under the EULA is unpaid by the due date and remains unpaid upon the date that that written notice of termination is given; and

(b) the Licensor has given to the Licensee at least 30 days' written notice, following the failure to pay, of its intention to terminate the EULA in accordance with this Clause 9.3.

## **10. Effects of termination**

10.1 Upon the termination of this EULA, all of the provisions of this EULA shall cease to have effect, save that the following provisions of this EULA shall survive and continue to have effect (in accordance with their express terms or otherwise indefinitely): Clauses 1, 3.1, 8, 10, 11 and 12.

10.2 The termination of this EULA shall not affect the accrued rights of either party.

10.3 For the avoidance of doubt, the licenses of the Software in this EULA shall terminate upon the termination of this EULA; and, accordingly, the Licensee must immediately cease to use the Software upon the termination of this EULA.

10.4 Within 10 Business Days following the termination of this EULA, the Licensee must:

(a) return to the Licensor or dispose of as the Licensor may instruct all media in its possession or control containing the Software; and

(b) irrevocably delete from all computer systems in its possession or control all copies of the Software.

## **11. General**

11.1 No breach of any provision of this EULA shall be waived except with the express written consent of the party not in breach.

11.2 If any provision of this EULA is determined by any court or other competent authority to be unlawful and/or unenforceable, the other provisions of the EULA will continue in effect. If any unlawful and/or unenforceable provision would be lawful or enforceable if part of it were deleted, that part will be deemed to be deleted, and the rest of the provision will continue in effect (unless that would contradict the clear intention of the parties, in which case the entirety of the relevant provision will be deemed to be deleted).

11.3 This EULA may not be varied except by a written document signed by or on behalf of each of the parties.

11.4 Neither party may without the prior written consent of the other party assign, transfer, charge, license or otherwise deal in or dispose of any contractual rights or obligations under this EULA.

11.5 This EULA is made for the benefit of the parties, and is not intended to benefit any third party or be enforceable by any third party. The rights of the parties to terminate, rescind, or agree any amendment, waiver, variation or settlement under or relating to this EULA are not subject to the consent of any third party.

11.6 Nothing in this EULA shall exclude or limit any liability of a party for fraud or fraudulent misrepresentation, or any other liability of a party that may not be excluded or limited under applicable law.

11.7 Subject to Clauses 8.1 and 11.6, this EULA shall constitute the entire agreement between the parties in relation to the subject matter of this EULA, and shall supersede all previous agreements, arrangements and understandings between the parties in respect of that subject matter.

11.8 This EULA shall be governed by and construed in accordance with English law.

11.9 The courts of England shall have exclusive jurisdiction to adjudicate any dispute arising under or in connection with this EULA.

## **12. Interpretation**

12.1 In this EULA, a reference to a statute or statutory provision includes a reference to:

(a) that statute or statutory provision as modified, consolidated and/or re-enacted from time to time; and

(b) any subordinate legislation made under that statute or statutory provision.

12.2 The Clause headings do not affect the interpretation of this EULA.

12.3 In this EULA, general words shall not be given a restrictive interpretation by reason of being preceded or followed by words indicating a particular class of acts, matters or things.