## LiDAR Payload

# USER MANUAL

| Revision | 1.14 |
| --- | --- |

# Revision History

| Revision | Date | Author | Description |
|---|---|---|---|
| 1.0 | Mar.09,2020 | WD | Released version. |
| 1.1 | Jun.02,2020 | AS | Added “Connectivity Tab” |
| 1.2 | July 14, 2020 | WD | White Label Version |
| 1.3 | Sept.11.2020 | WD | Added Sections 2.3.3, 2.3.4 and updated information in Section 2.3.1. Updated Figure references. |
| 1.4 | Oct. 2, 2020 | LW | Added Section 1 and added information to Section 3.1 |
| 1.5 | Dec. 14, 2020 | WD,LW | Added specific USB Section 2 |
| 1.6 | Feb. 3, 2021 | LW | Added section |
| 1.7 | Mar. 17, 2021 | WD | Reorganized Sections for readability; added information to Section 5.3.7 to support Livox Scanners. |
| 1.8 | Mar. 30, 2021 | LW | Added “Camera trigger period” to section 5.3.1. |
| 1.9 | Jun. 9, 2021 | TK | Reorganized Sections for readability, added information and specificity throughout to improve clarity. Added Sections 5.2, 5.3, 6.1, and 6.2. Transferred document to LaTeX. |
| 1.10 | July 5, 2021 | TK | Updated graphics to section 5.3 |
| 1.11 | Nov. 15, 2021 | TK | Updated sections 5.3.2 and 5.3.5. Added sections 6.1, updated sections 6.2 and 6.3 |
| 1.12 | Aug. 9, 2022 | AD,OR | Updated sections 4, 5.3.1, 5.3.3, 5.3.7, and 6.2. Added sections 5.1.2 and 5.1.3. Updated figure labels. |
| 1.13 | Nov. 10, 2022 | AD | Updated figure 4.1, 5.1, and added to section 5.3.2 |
| 1.14 | Jan. 9, 2023 | OR | Elaborated and provided better instructions for determining Vehicle to IMU Rotations to Section 5.3.1 |

# Table of Contents

# 1. Introduction

This manual was made to be used with the LiDAR Payload and its Graphical User Interface (GUI).

Please make sure to read through the entire manual before using the LiDAR Payload.

Please note that the diagrams used in this manual feature the Velodyne VLP-16 LiDAR scanner. Difference between this scanner and other LiDAR scanners are specified where necessary.

**Figure 1. 1 The LiDAR Payload.**

# 2. Key Operational Requirements

Operating Requirements.

1. Since the GUI is a web-based interface it only requires a computer (PC, laptop, tablet, smartphone) with Wi-Fi and a web browser. The GUI has been configured to work with the latest versions of common web browsers such as: Google Chrome, Mozilla Firefox, Safari, Microsoft Edge and Internet Explorer.
2. When performing pre-mission flight procedures (after the drone has started its flight but prior to its flight over the intended scanning area the drone must perform convergence maneuvers) please ensure that you do one figure-eight at the beginning of the flight.
3. To store flight data, the LiDAR payload must have the Samsung BAR Plus 256GB – 400MB/s USB 3.1 Flash Drive Champagne Silver (MUF-256BE3/AM) connected to the USB port.
4. For users that would like in-flight RTK corrections, the approved and suggested wireless modem is the ZTE MF833V - Amazon.com: ZTE MF833V USB Dongle Adapter 150 Mbps Wireless Modem Mobile Broadband 4G LTE Stick: Electronics which is to be connected to the USB port in addition to the above mentioned flash drive (on some devices there is only one available USB port, in which a standard USB hub may be used).

Interface summary. The GUI allows the user to control and monitor recording data for point cloud generation. It also allows the user to configure the payload and to service the components inside.

# 3. Understanding the LiDAR Payload

The LiDAR payload is comprised of a high-grade Inertial Navigation System (INS), an internal computer, and a datalogger. It has 2 USB ports and a primary (PRI) and secondary (SEC) antenna port used to connect the payload to antennas and supported interfacing devices (USB-based). The LiDAR payload can be integrated with a variety of LiDAR scanners including units from Livox, Velodyne, Ouster, and Quanergy.


**Figure 3. 1**

The power button. The power button (Figure 3. 1) is utilized for a variety of functions listed below.

- **Power On** - To power up the unit, simply tap the power button and wait until the 3 lights begin to glow.
- **Start Logging** – After powered, tap the power button to begin logging data. The boot light will begin to flash between red and green, which indicates that the payload is beginning to log data.
- **Terminate Logging** - To stop logging data, tap the power button again, which will make the boot light stop flashing.
- **Power Off** - Shutting down the payload requires the user to hold the power button for about 4 seconds, after this let go and after a few seconds the 3 lights will turn off indicating that the payload has shut down. To perform a forced shut down, hold the power button for about 10 seconds and the lights will turn off.

**Important note:** The drone supplies power to the payload, so it is important that the drone is powered on before the unit. With that relationship in mind, make sure to stop recording and shut down the unit before the drone. **Before shutting**

**off the drone, the BOOT light on the payload must stop flashing**. If this has not been done, the data from the flight may be lost.

How to see if the LiDAR payload is performing RTK corrections. When the payload is receiving RTCM traffic from the base station and can perform RTK corrections, the boot light on the payload will blink 3 times incrementally (solid green with 3 red flashes).

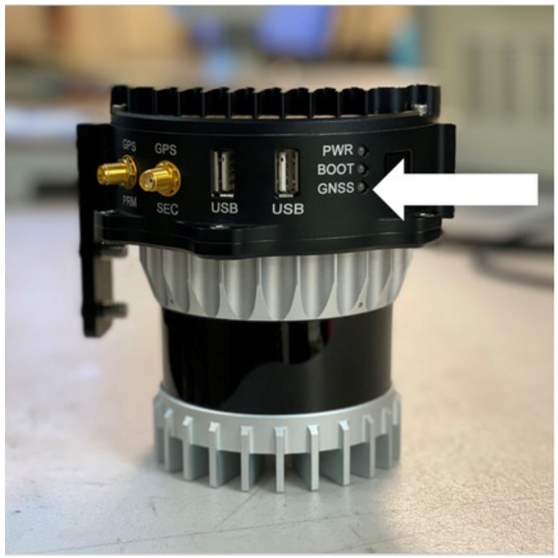


**Figure 3. 2**

# 4. Connecting to the LiDAR Payload

Begin by powering on the payload. After powering up the unit by holding the power button, open Wi-Fi settings on your host computer (tablet, smartphone, or PC) and look for the wireless network labeled:

**(Unit Name)-######**

This is the unit's WiFi SSID and it is located on the device next to the unit's serial number (for example, a WiFi SSID might look like: RSP-000001). For the password of the network use:

**LidarAndINS**

If this does not work please contact your local vendor for the correct password to the network. Next, open up the web browser of your choice and type in the IP address of the LiDAR payload. The IP address of the payload is:

**192.168.12.1**

The following window will appear as shown below in Figure 4. 1. This is the web-based LiDAR payload GUI.

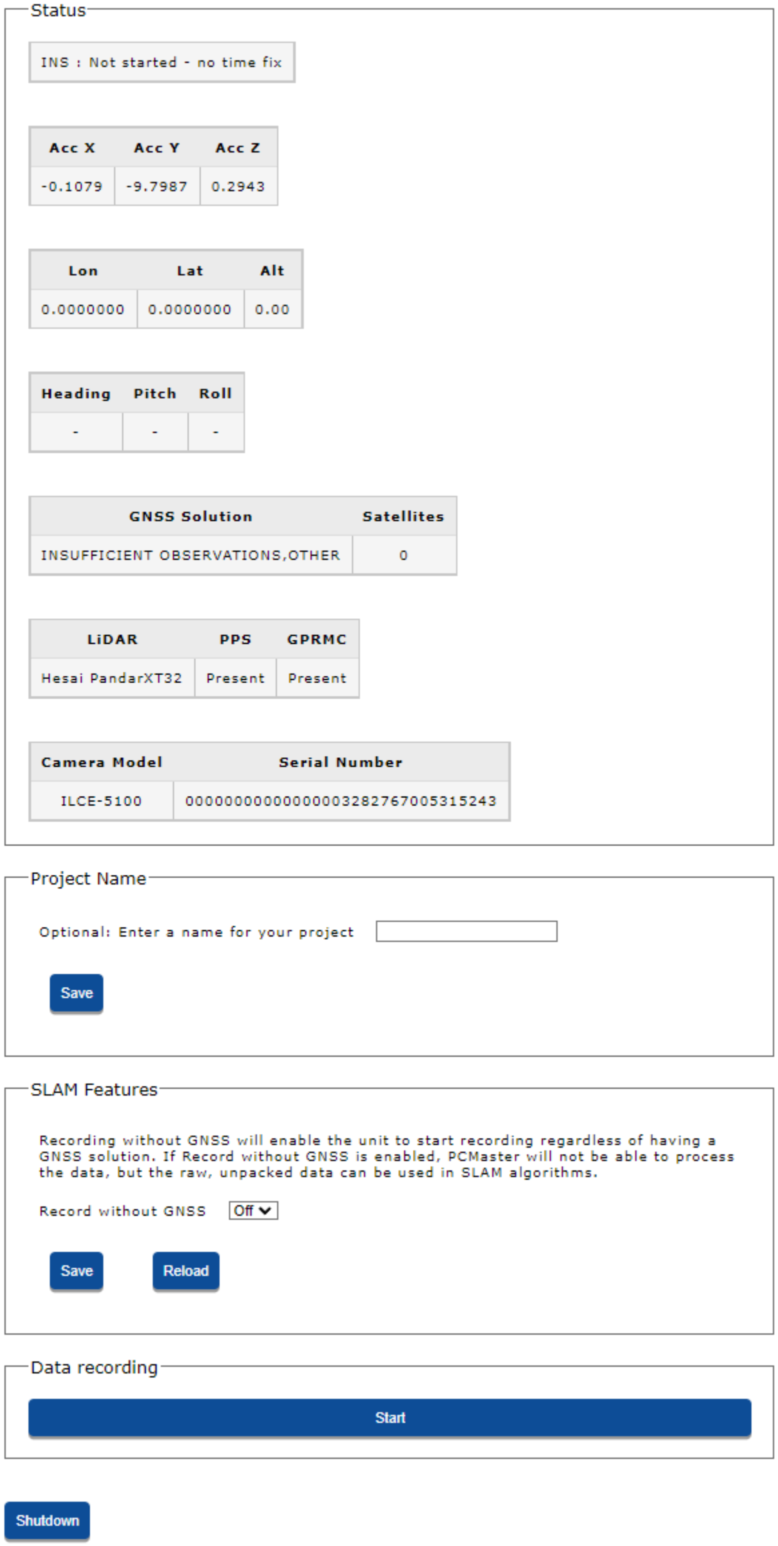


**Figure 4. 1 Web page after the user connects to the unit.**

# 5. Navigating the LiDAR Payload GUI

The GUI navigation bar has three main menu options. "Status", "Storage" and "Settings". This section will discuss each menu window.

## 5.1 Status Menu Window

Beginning at the top, the "Status" option shows the immediate status of the payload. An example of this is shown below in Figure 5. 1. The "Status" section shows the current state of the device for position, attitude, receiver status, LiDAR status, and camera status.

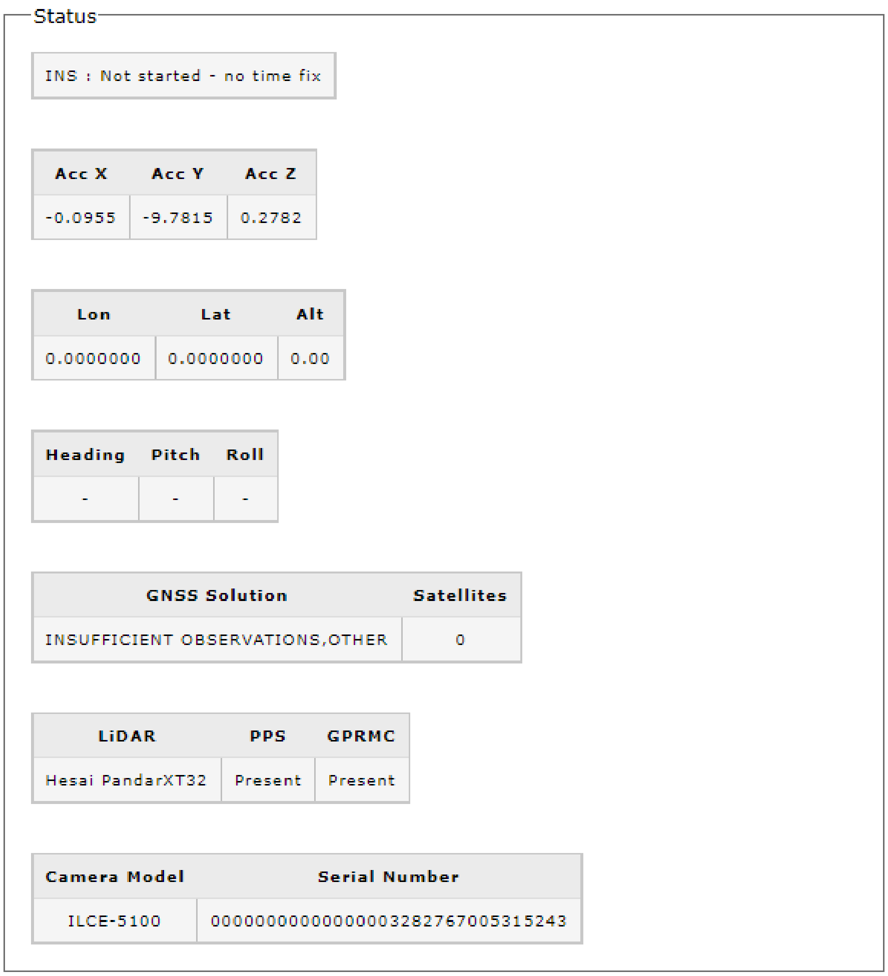


**Figure 5. 1 The idle status of the Payload.**

1.
2.
3.
4.
5.
5.1.

### 5.1.1. GNSS Solution

The GNSS Solution window shows the status of the connection between the device and GNSS satellites.

| GNSS Solution | Satellites |
|---|---|
| COMPUTED,SINGLE | 11 |

**Figure 5. 2 GNSS Solution Window**

When recording with PPK corrections:

- Wait for the status in this window to read “Computed, Single”.

When recording with RTK corrections:

The unit is receiving RTCM traffic if the “GNSS Solution” window is displaying “psrdiff”, “Computed, Narrow Float”, or “Computed, Narrow Integer”. These are all indicative that Differential GNSS (DGNSS) augmentation is being performed. To obtain the best accuracy from RTK, the carrier phase ambiguities should be fixed to integer numbers. Therefore, if the user would like to perform in-flight RTK corrections, it is recommended that the “GNSS Solution” window reads “Computed, Narrow Integer”. The order above is also the order in which they will appear when waiting for “Computed, Narrow Integer”.

### 5.1.2. Project Name

As of firmware 3.7.7.0, the Project Name option allows the user to enter a project name. This name will be added as a prefix to the automatically configured flight name. After the user has entered their desired project name, they can select “Save” to apply the desired flight name.


**Figure 5. 3 The “Project Name” section in the Status Menu Window**

### 5.1.3. SLAM Features

As of firmware 3.7.7.0, users can begin recording data without sufficient satellite coverage by configuring “SLAM Features” to be “On”. The “Save” button saves the current options from the drop-down box (shown in Figure 5. 4). The “Reload” button refreshes the current selection option.

Note: By default, when “Record without GNSS” is set to be “On”, laser settings for the Livox AVIA will be by default configured to: scanning mode = non-repetitive circular scanning pattern, and high sensitivity will be set to be “On”.

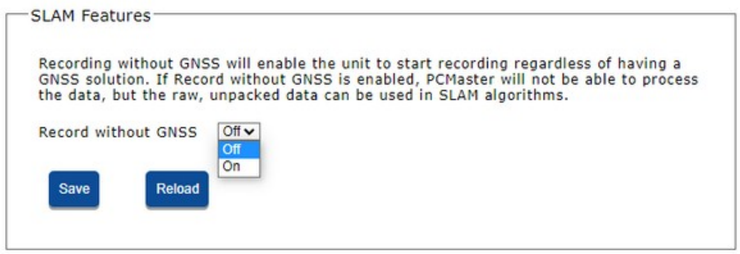


**Figure 5. 4 The “SLAM Features” section in the Status Menu Window**

### 5.1.4. Data Recording

Below the “Status” option is the “Data recording” option. The user can toggle between “Start” and “Stop” as shown below in Figure 5. 5.

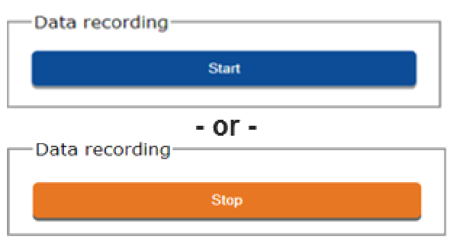


**Figure 5. 5 The “Data recording” section located in the Status Menu Window.**

When the user is ready to begin recording data, click “Start”. At this time please keep the carrier object static for the amount of time set up in the “Static Alignment” option discussed in Section 5.3.1 Geometry Tab Window (shown specifically in Figure 5.15). Once this time has passed, the user may continue normal operation.

> **Note:** 6 will appear in the Status section next to INS until the carrier object reaches a velocity of four meters per second for a duration of four seconds.

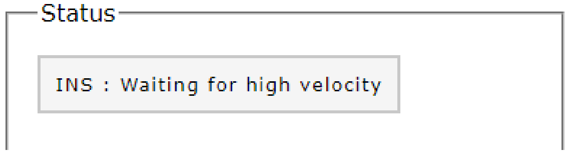


**Figure 5. 6 INS message while the system is waiting for carrier object to achieve a higher velocity.**

When the user has finished recording data, click the “Stop” button shown in Figure 5. 5.

If the user has finished using the payload, click the button labeled “Shutdown” (shown in Figure 5. 7) at the bottom of the Status Menu Window to power off and disconnect from the unit.


**Figure 5. 7 The “Shutdown” button located in the Status Menu Window.**

## 5.2 Storage Menu Window

Figure 5. 8 shows the Storage Menu Window when the USB storage device is connected to the unit and the user has clicked “Re-attach”. At this time the user will have the ability to access, download, and view stored files on the USB memory stick.

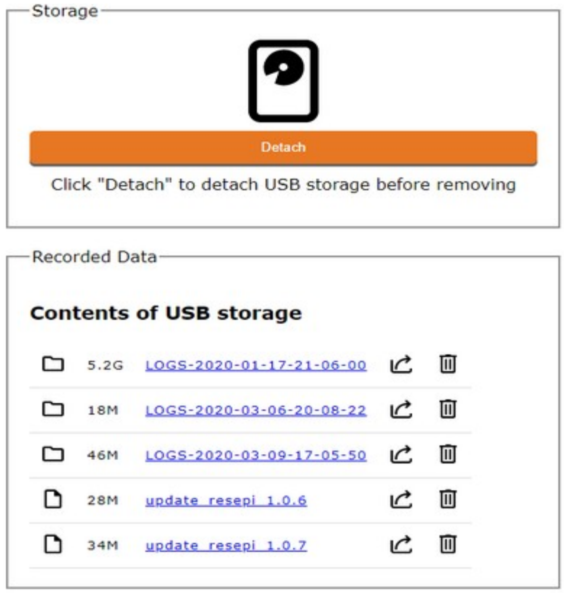


**Figure 5. 8 Shows the Storage Menu Window with access to recorded data when USB stick is attached.**

The storage indicator at the top of the screen will be green if storage space is within normal range. It will turn yellow when storage is at 75% max capacity, and turn red when it is at 95% max capacity as shown below in Figure 5. 9.

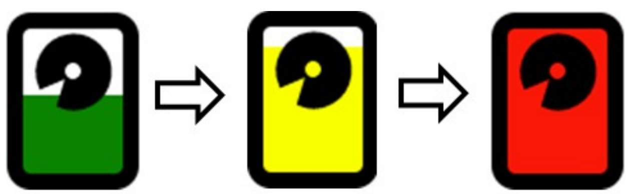

**Figure 5. 9 Storage indicator based on available USB storage space.**

The user can download or erase data files by clicking on the download button or the trash button (shown in Figure 5. 10). For user convenience, an additional line of protection is added when erasing data files. The interface will display a message indicating “Are you sure you’d like to erase this data?” prior to removing data from the device’s storage.

> **Note:** It is recommended to remove the USB drive from payload and plug it into the host computer instead of downloading files over Wi-Fi. This method is much faster because scan files are usually quite large.

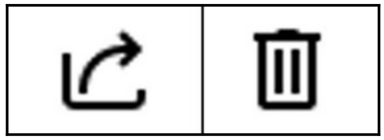

**Figure 5. 10 Download, and erase buttons.**

When the user wishes to remove the USB drive from the payload, click the "Detach" button shown in Figure 5. 8.

> **Note:** To protect the user from accidently attempting to record data while the USB is unattached, the user does not have the ability to "Start" data recording in the "Status" window when the USB is unattached. When unattached the user will see the message shown below in Figure 5. 11.

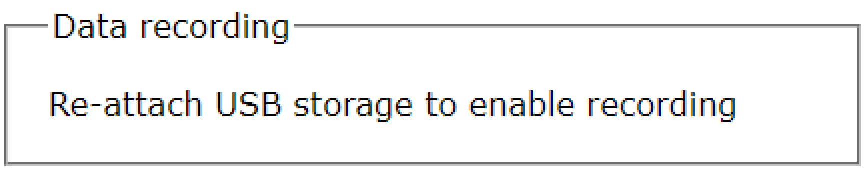


**Figure 5. 11 Message displayed when trying to record data while USB is unattached.**

## 5.3 Settings Menu Window

To increase point cloud accuracy and configure specific settings for the LiDAR, use options from the Settings Menu Window.

### 5.3.1 Geometry Tab Window

Figure 5. 12 and Figure 5.13 shows the coordinate axes of the IMU in the payload. These are the same for all RESEPI units, however some units may be rotated so take note of the orientation.

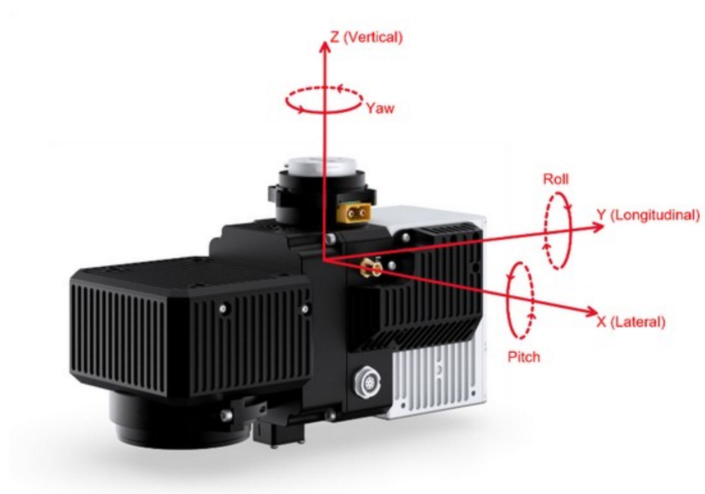


**Figure 5. 12 Orientation references shown on the Livox Avia payload.**


**Figure 5. 13 Orientation references shown on the Hesai XT-32 payload.**

Figure 5. 14 shows the location of the IMU inside the payload. Dimensions for this drawing are in millimeters.

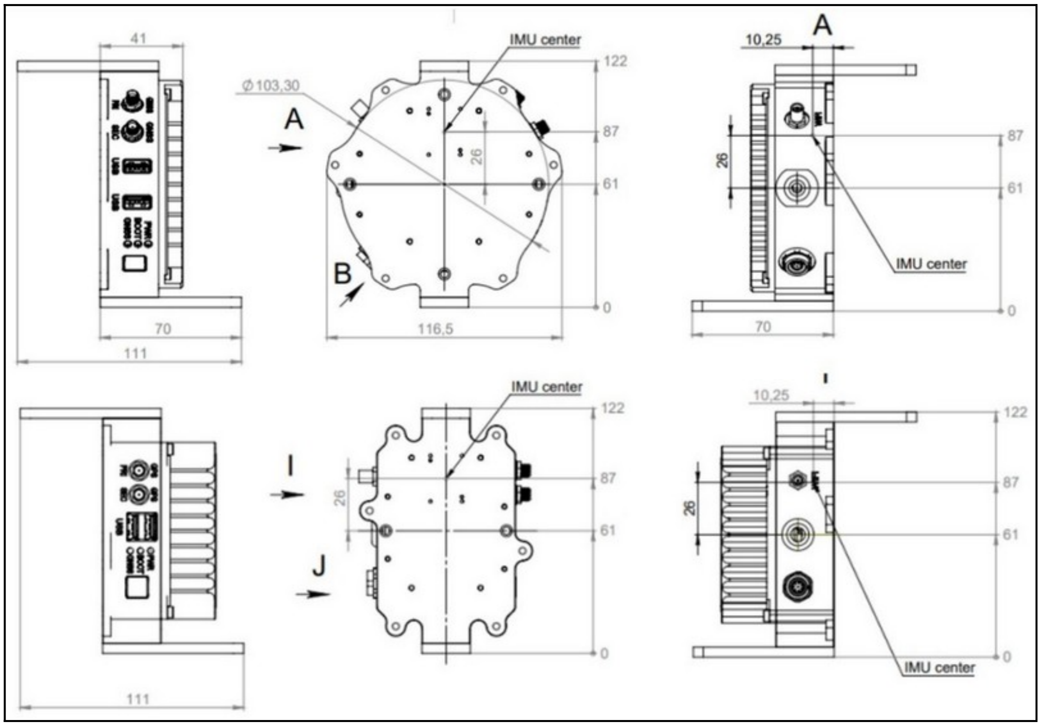


**Figure 5. 14 Location of the IMU center inside the payload for measuring antenna offset. Dimensions are in millimeters.**

In the "IMU to Antenna Offset" option (shown in Figure 5. 15), enter the correct location of the antenna relative to the internal IMU using Figure 5. 12, Figure 5.13, and Figure 5 14. These values are measured using the vehicles reference frame. Therefore, measure the distance from the IMU to the center of the antenna mounted on the vehicle to get an estimate of these values. Use negative values if the antenna is left, behind, or below the unit.

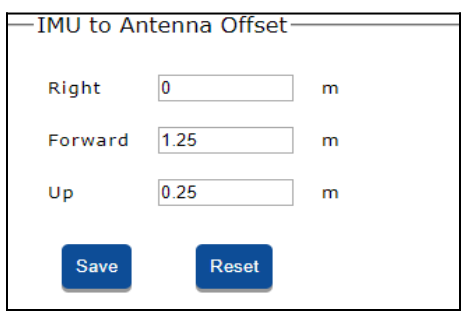


**Figure 5. 15 IMU to Antenna Offset option for correctly measuring position and attitude.**

Similarly, if a dual antenna setup is being used, enter in the relative location of the second antenna in relation to the IMU in the "IMU to Second Antenna Offset" section (shown in Figure 5. 16), measuring from the location of the internal IMU to the location of the antenna in the right, forward, and up directions.

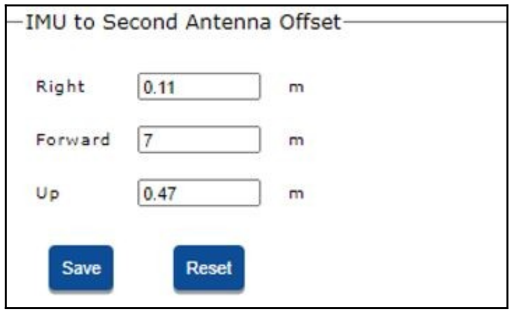


**Figure 5. 16 IMU to the Secondary Antenna Offset for correctly measure attitude.**

PCMaster version 2.3.2.0 saves the IMU to Antenna Lever Arm offsets that are calculated when processing the “ppk.cpmp” file. This allows the offsets to be uploaded into the unit directly from the “ppk.pcmp” file through the “Boresight” tab of the GUI. This will allow for faster processing times with PPK in PCMaster.

In the “Vehicle to IMU Rotation” option (pictured below in Figure 5. 17), enter in the relative offset angles (axis misalignment; alignment angles) between the payload’s IMU coordinate axes and the vehicle’s coordinate axes. This must be done prior to starting data capture for a mission or else the data most likely will not process correctly. This can be done by finding the angle (in degrees) that the vehicles coordinate system must be rotated to match the IMU’s coordinate system, using yaw, pitch, and roll. The rotations can be done in any order, as long as the vehicle’s system is rotated as a whole. However, none of the values for yaw, pitch, or roll can exceed the bounds of -180 to 180 degrees in the web interface.

The two most common configurations that can be seen on units are a yaw, pitch, roll of 0, 0, 0 or 180, 0, 0 respectively. Example configurations can be seen below after Figure 5.17. If you are unsure of your specific orientation, please send an email to support@phoenixlidar.com including an image of your unit mounted on the vehicle to be used.

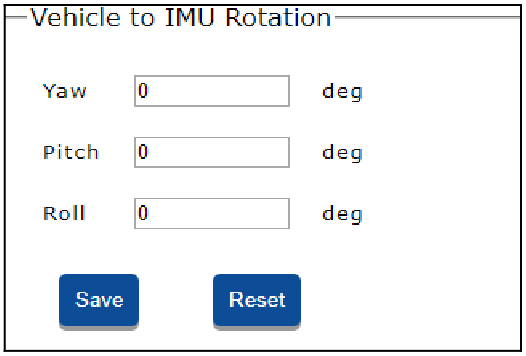


**Figure 5. 17 The Vehicle to IMU Rotation options section for correctly measuring and logging vehicle attitude data.**

Below are four examples of unit configurations and their corresponding vehicle to IMU rotation. The blue marks the vehicle's original coordinate system of motion, while the red marks the IMU's coordinate system. The vehicle to IMU rotation in the caption of each figure is the values that will used to rotate the vehicle's system (blue) to point in the same directions as the IMU's system (red).

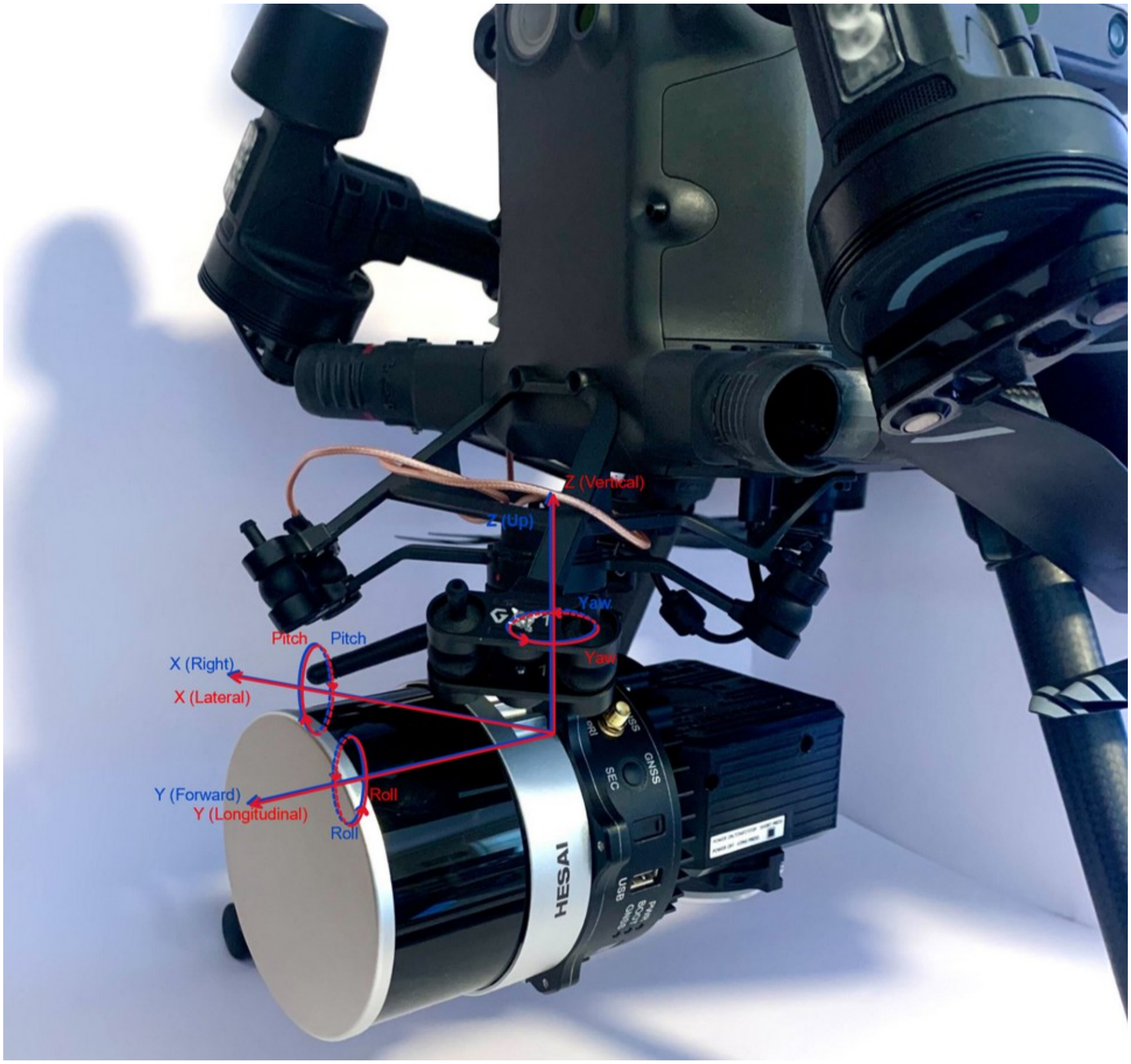


**Figure 5. 18 A payload with a "Vehicle to IMU Rotation" of 0, 0, 0. No rotation is needed.**

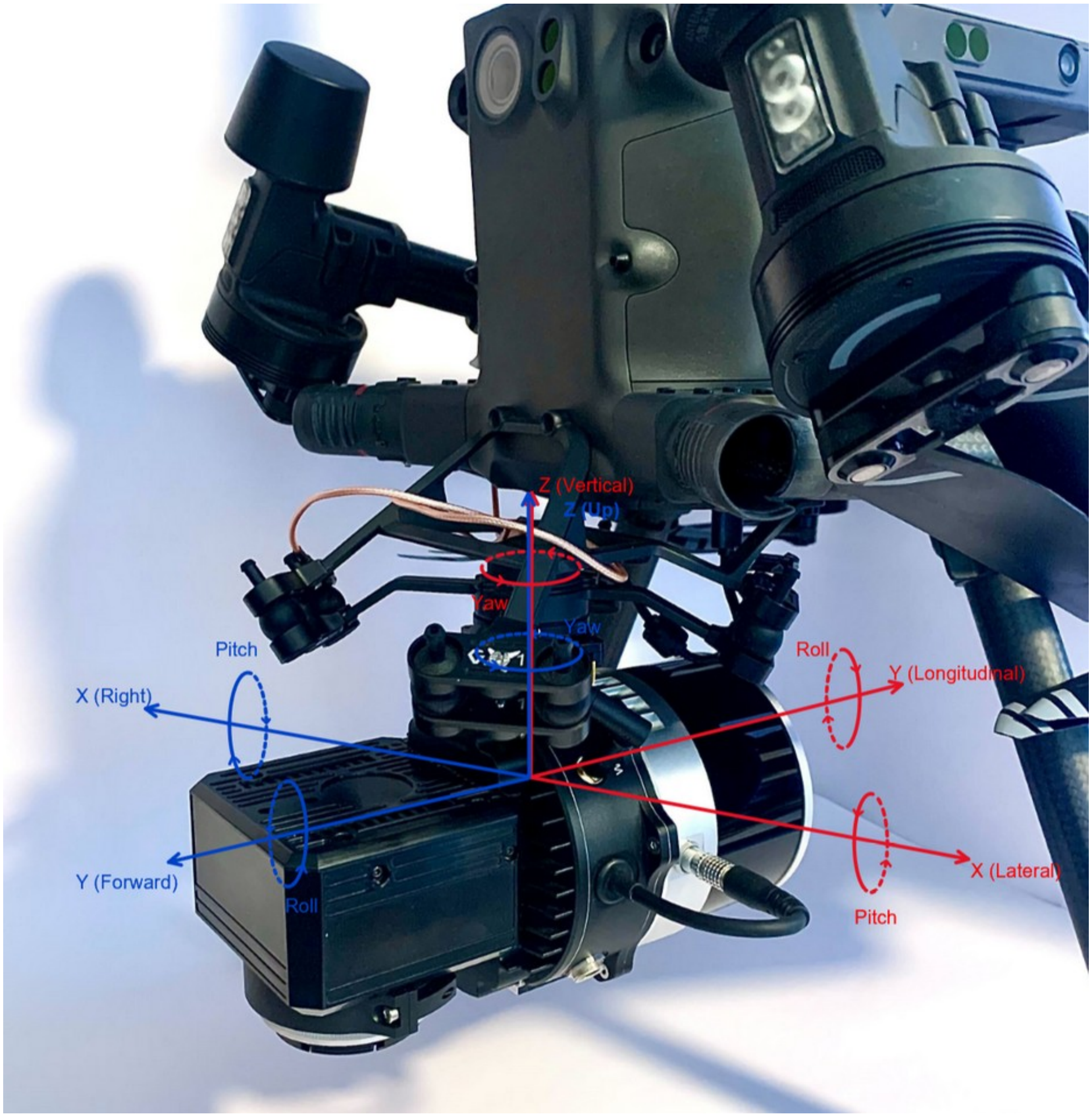


**Figure 5. 19 A payload with a "Vehicle to IMU Rotation" of 180, 0, 0. A rotation of 180 in yaw is needed.**

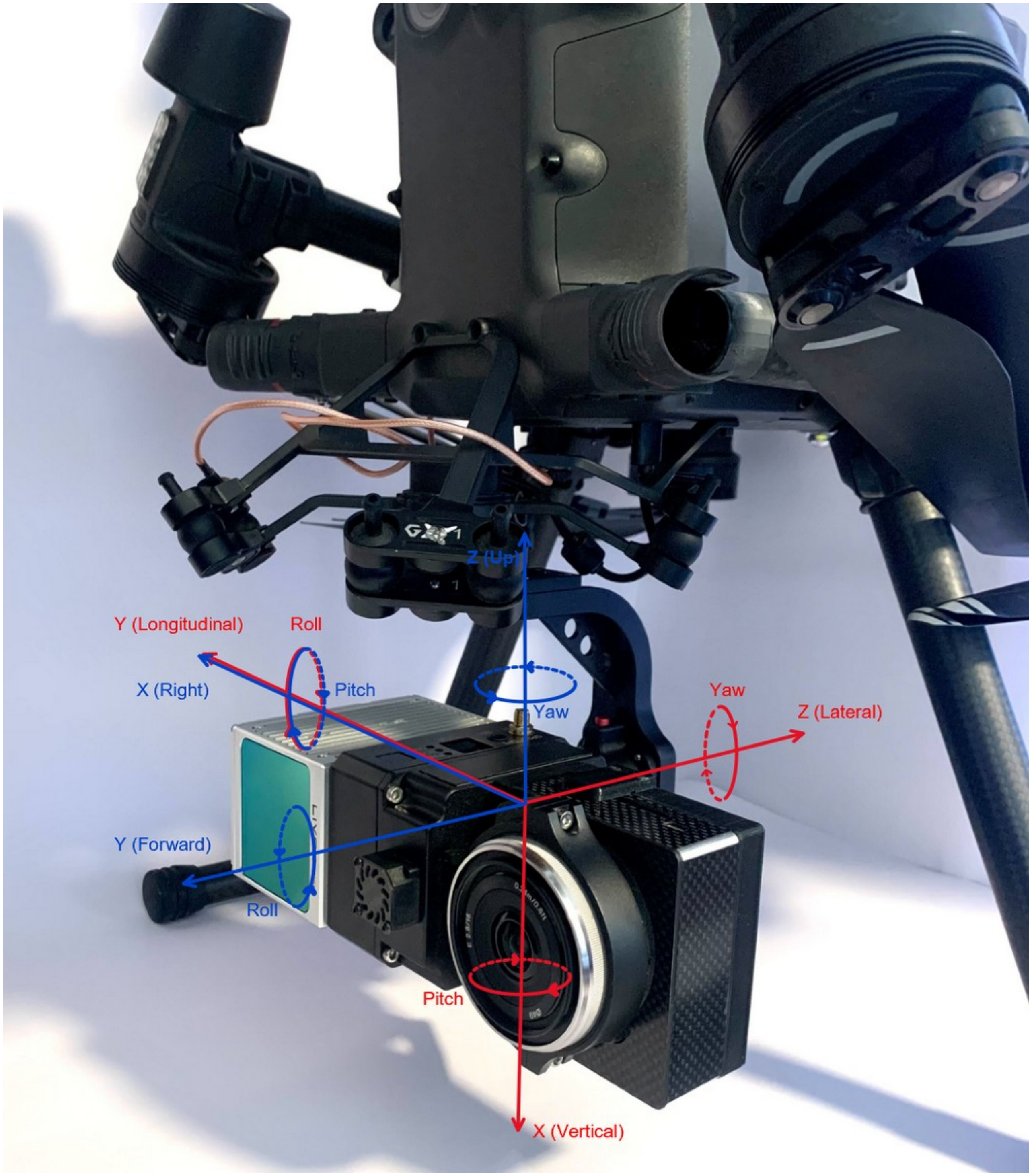


**Figure 5. 20 A payload with a "Vehicle to IMU Rotation" of -90, 0, 90. A rotation of -90 in yaw and 90 in roll is needed.**

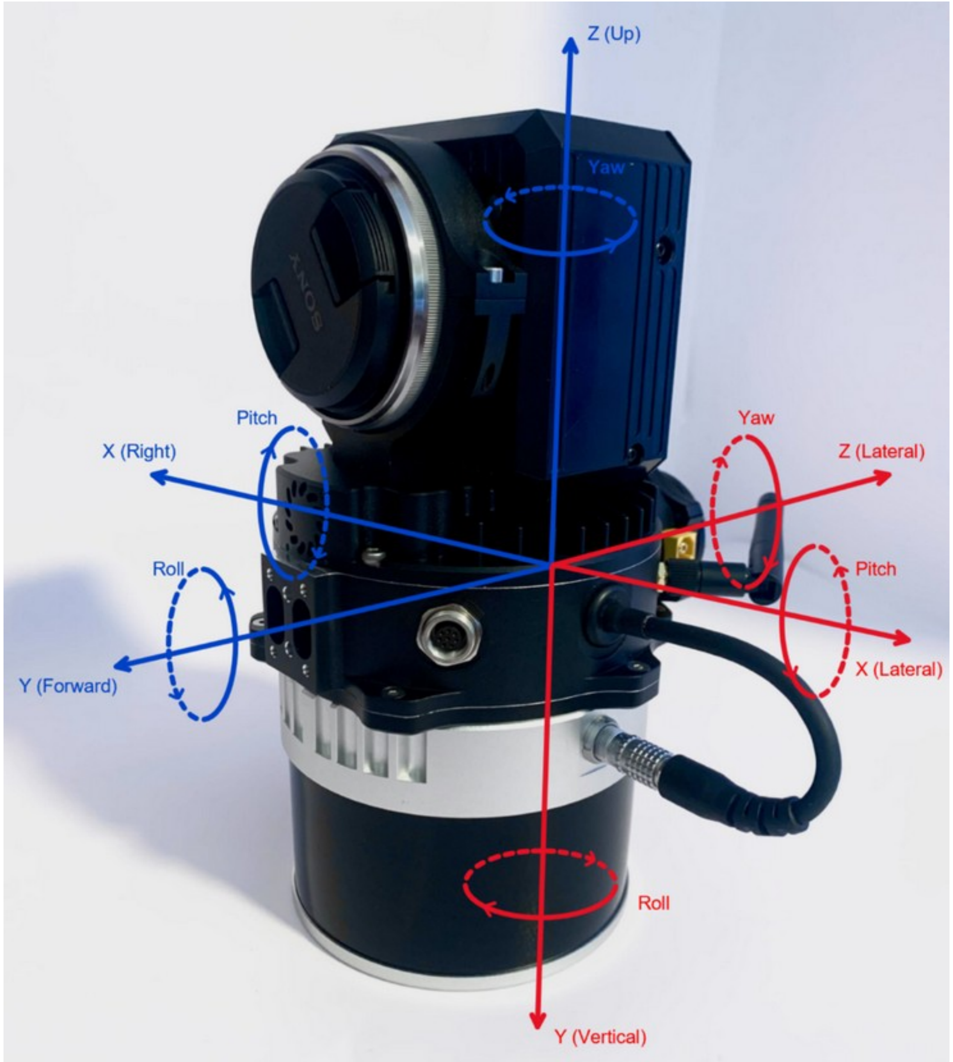


**Figure 5. 21 A payload with a "Vehicle to IMU Rotation" of 180, -90, 0. A rotation of 180 in yaw and -90 in pitch is needed.**

The "Alignment" window (shown in Figure 5. 22) contains settings that can be adjusted depending on time-dependent solution requirements:

- "Static Time" should be kept at 5 seconds (recommended) unless the carrier vehicle is unable to remain in a static position for this amount of time. Based on the data collected during this static alignment period, gyro biases will be estimated and will then be used in data filtering processes when data-recording has started on the payload.
- "Kinematic Time" is useful for heading correction and by default should be left on 4 seconds.

- "Kinematic Velocity" is the velocity requirement that is used with "Kinematic Time". Once this velocity threshold is reached, for the duration of time as specified in "Kinematic Time", the payload with use the fused inertial/GNSS solution to correct heading for the system.

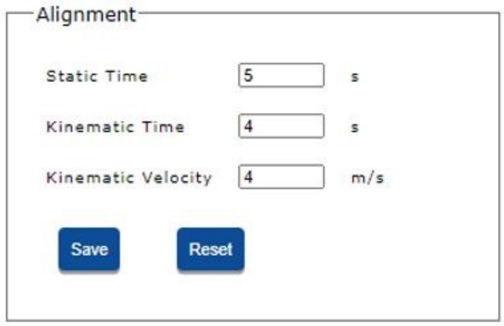


**Figure 5. 22 The "Alignment" option from the Geometry window located in Settings.**

The user can control the camera trigger period. This period represents the time between each camera image when the unit is recording data. For example, if the period is set to 5 seconds as shown in Figure 5. 23, then the unit will take a new picture every 5 seconds.

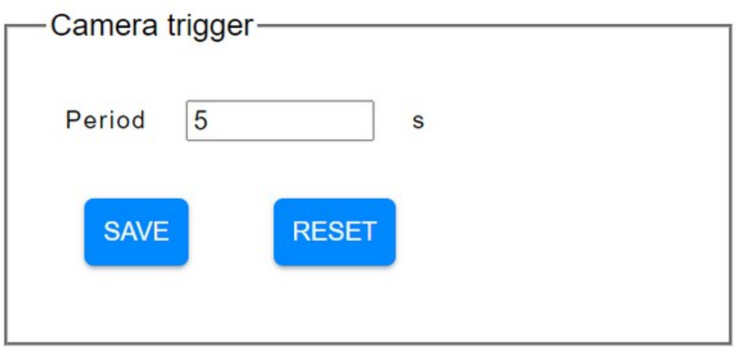


**Figure 5. 23 The "Camera trigger" option from the Geometry window located in Settings.**

As of firmware 3.7.7.0, the user can control the field of view of the LiDAR. This controls the default range of data points populated in PCMaster. It will not prevent data capture outside of this range, as the user is still able to increase or decrease the field of view in PCMaster after a flight. For example, if the field of view is set to 237 to 303 degrees as shown in Figure 5. 24, then PCMaster will only populate points inside that range.

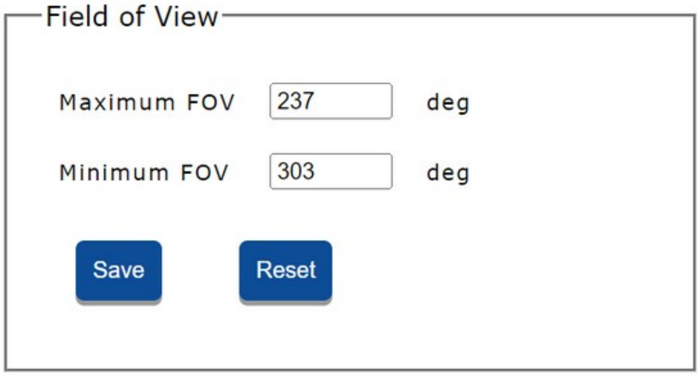


**Figure 5. 24 The "Field of View" option from the Geometry window located in the Settings menu.**

### 5.3.2 Connectivity Tab Window

The "Connectivity" tab has two sections: "Wireless Network" and "RTCM Corrections". A picture of this window can be seen in Figure 5. 25.

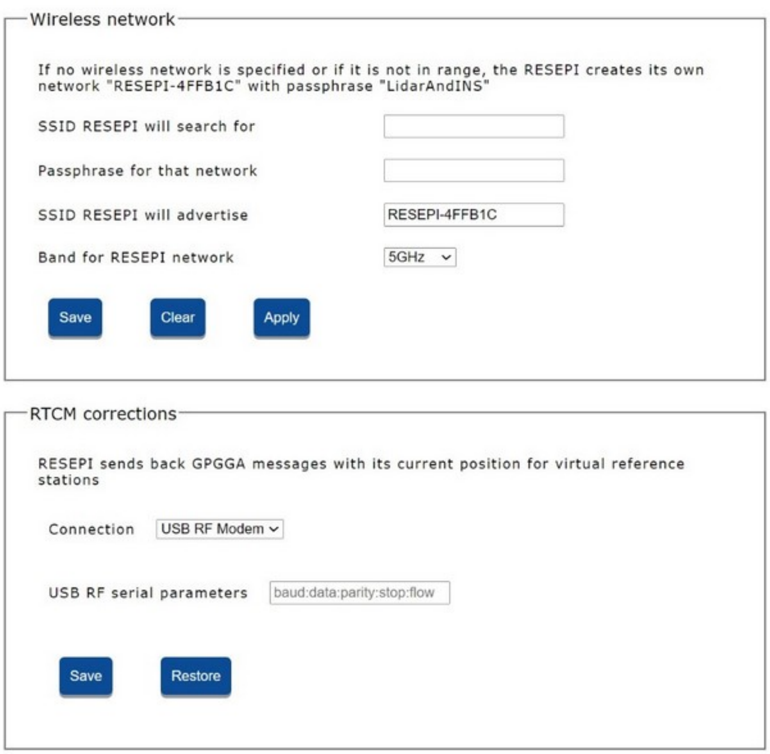


**Figure 5. 25 The Connectivity tab in the Settings drop-down menu.**

## Wireless Network Settings Window

In the “Wireless Network” settings the user can configure the payload to connect to an external WiFi network (only WPA/WPA2 Personal networks are currently supported). If the network is not configured or not in range, the payload will broadcast its own unique WiFi network, so the user can always connect to it. External WiFi networks can be useful for supplying differential GNSS corrections to the payload for RTK trajectory generation.

In the “Wireless Network” settings, the user can also change the frequency of the network provided by the payload. For use with drones with a 2.4 GHz signal from the drone to the controller, the 5 GHz band is suggested, and for use with drones with a 5 GHz band, the 2.4 GHz band is suggested. This can be changed in the drop-down menu and changes can be saved by clicking “Save”.

After entering the network SSID and the passphrase, click “Save” to save the values to the payload. When the network is in range, click “Apply” and the payload will try to connect to the network and obtain an IP address using DHCP. After that, refer to the wireless access point for details on how to identify the payload’s IP address. If connection fails for some reason, it will broadcast its own network again. Click “Clear” and then “Save” and “Apply” to remove the external wireless network configuration. To reset the unit’s wifi to it’s original SSID and passphrase, create an empty file named “wifi-reset” and save it on the USB drive. When the unit is turned on it will broadcast it’s original wifi network.

The default Wifi-SSID for the RESEPI payload is “RESEPI-” followed by the last six alpha-numeric characters of the IMU’s MAC Address. If you would like to change the Wifi-SSID, type the new SSID into the “SSID RESEPI will Advertise” field and select “Save”.

As of firmware 3.8.0.0, UBlox PVT and DOP messages are available via UDP packets on port 7000 over WiFi. Note that when using WiFi, the unit must be able to maintain a connection at all times. The PVT message has the following structure:

uint8_t header1 - 0xAA
uint8_t header2 - 0x55
uint8_t type (0x00 for PVT)
uint32_t msGPS - Time of week in milliseconds
int32_t lat - latitude 1e-7 degrees
int32_t lon - longitude 1e-7 degrees
int32_t alt - height above ellipsoid mm
uint8_t flag (see below)

uint32_t checksum, CRC-16 checksum with seed value of 1, MCRF4XX, poly=0x1021flag:
bit 0 - valid fix
bit 1 - differential corrections were appliedThe DOP message has the following structure:
uint8_t header1 - 0xAA
uint8_t header2 - 0x55
uint8_t type (0x00 for PVT)
uint32_t msGPS - Time of week in milliseconds
uint16_t gDOP (scale of 0.01)
uint16_t pDOP (scale of 0.01)
uint16_t tDOP (scale of 0.01)
uint16_t vDOP (scale of 0.01)
uint16_t hDOP (scale of 0.01)
uint16_t nDOP (scale of 0.01)
uint16_t eDOP (scale of 0.01)
uint32_t checksum, CRC-16 checksum with seed value of 1, MCRF4XX, poly=0x1021

## RTCM Corrections Window

In the options for “RTCM Corrections” the user can choose the delivery method for corrections to the payload. The options are:

- USB RF Modem like Holybro 915MHz
- NTRIP Client
- TCP Server the payload connects to
- TCP Client connecting to the payload’s pre-defined port

Click “Save” to save the changes. The payload will immediately start trying to connect to the selected channel.

- If “TCP Listen” is selected, the payload will always listen on the port, and once a client connects to the port, the payload will accept the connection.
- If “USB RF Modem” is selected, the payload will automatically detect connection of a compatible USB RF Modem and open the serial link.
- If “NTRIP Client” or “TCP Connect” is selected, the payloadwill keep trying to connect to the specified address until it succeeds.

Once a connection is established, the payload will start sending its position in a NMEA0183 $GPGGA message, so a virtual reference station can be generated.

Real base stations ignore those messages. Once the payload receives RTCMv3 corrections, it will use them to compute RTK position. It will also record the RTCMv3 messages it has received while recording data, so they can be used for post-processing as well.

Click “Restore” to discard any unsaved changes.

### 5.3.3 Boresight Tab Window

The “Boresight” Tab in the “Settings” drop-down menu (shown in Figure 5.26) gives the user the ability to view the currently configured Boresighting alignment and offset values that have been loaded to the system. These values can be updated and loaded to the payload by clicking on the “Read from PCMaster Project”. For information on creating PC Master Project files please reference the external document “PCMasterGL_Manual”.

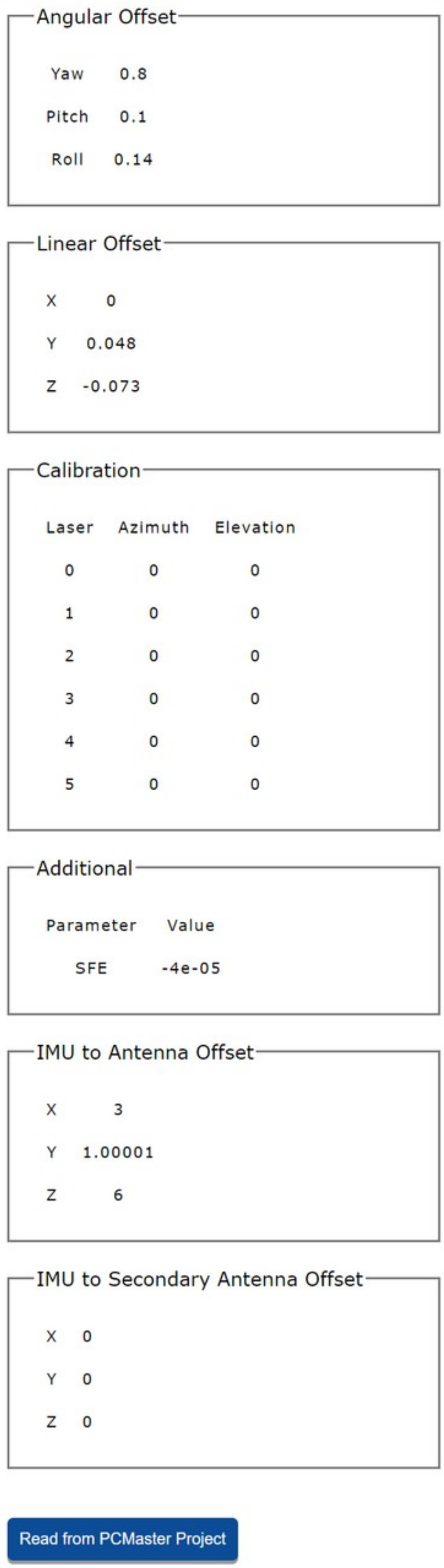


**Figure 5. 26 The “Boresight” tab window in the “Settings” drop-down menu.**

### 5.3.4 Camera Tab Window

The payload system has the ability to communicate with and log images from an external camera such as the Sony A6000 or Foxtech Map-01. The “Camera” tab window (pictured in Figure 5. 27) from the “Settings” drop-down menu gives the user the ability to view the angular offsets, linear offsets, and calibration parameters that were configured for the camera used in the PCPainterGL software. To load new parameters for the camera being used the user can select the “Read from PCPainter Project” button. For more information on creating a project in PCPainterGL please reference the external document named “PCPainterGL_Manual”.

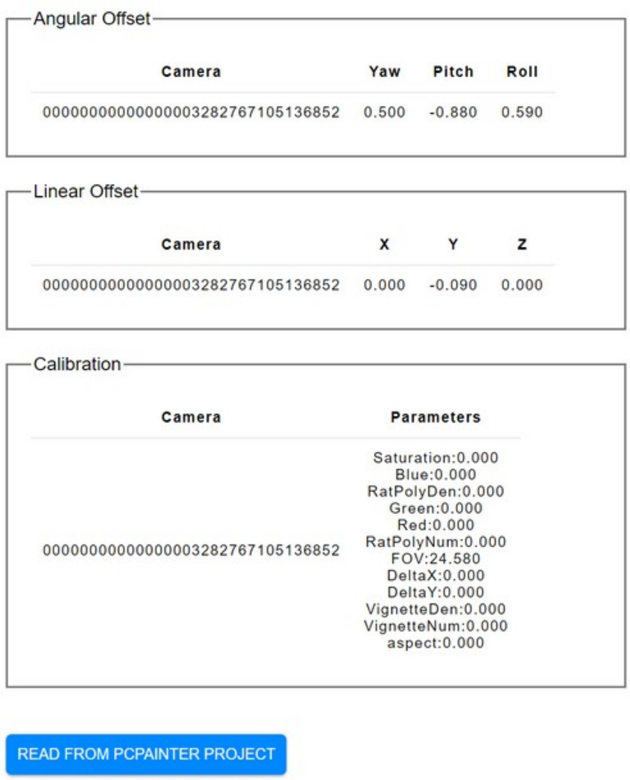


**Figure 5. 27 The “Camera” tab window from the “Settings” drop-down menu.**

### 5.3.5 Firmware Tab Window

Technical Support may occasionally provide a firmware update for the payload. When this occurs, load the firmware update file onto the USB drive and connect the drive to the payload. Inside the “Firmware” tab window under “Settings” (shown in Figure 5. 28), the user can install firmware updates by clicking on the button labeled "Install". The unit will install the new firmware and reboot, once this has occurred the new firmware is installed. The current firmware can be seen in the top right section of the GUI.

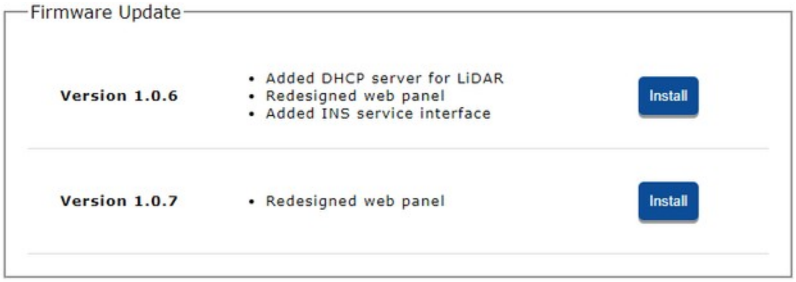


**Figure 5. 28 The "Firmware" tab option located in the Settings menu item.**

More information and a step-by-step instruction guide for updating the firmware can be found here.

### 5.3.6 INS Service Tab Window

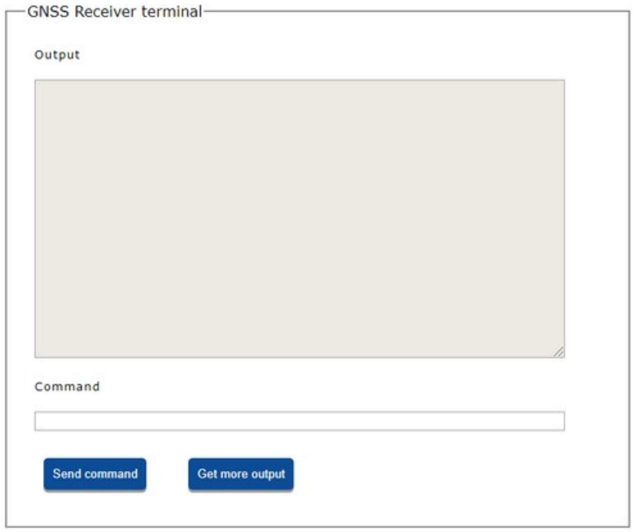


**Figure 5. 29 The INS Service option, used for communicating with the internal receiver.**

Figure 5. 29 above shows the "INS Service" window. Use this setting when there is a need to communicate directly with the GNSS receiver. Examples of when this may be necessary are enabling or disabling correction services; authorizing a firmware option in the receiver; enabling or disabling constellations; identifying the current position or GPS time; etc.

Use the "Command" line to type in commands and click "Send command" to send this command to the receiver. The receiver response will be shown in the "Output" window.

Optionally, the user can click on "Get more output"; which is used when the user wants continuous output from the receiver.

**Note: only use this window if advised by the manufacturer. Changing settings of the receiver may affect payload operation and point cloud accuracy.**

The user can view lists of commonly used receiver commands from the link below:

- Click Here to View Commonly Used NovAtel Receiver Commands

### 5.3.7 LiDAR Service Tab Window

Use the LiDAR Service tab window to configure LiDAR specific settings. The LiDAR Service tab window shows the user interface for the LiDAR sensor that is being used.

**Velodyne Scanners**

Below, in Figure 5. 30, the Velodyne LiDAR Service interface is shown with options of configuration that are described in the User Manual for the Velodyne LiDAR. The user should reference the user manual for the LiDAR that they are using for information on configuring these settings.

**Note:** *Only use this window if advised by the manufacturer. Changing settings may affect LiDAR operation and point cloud accuracy.*

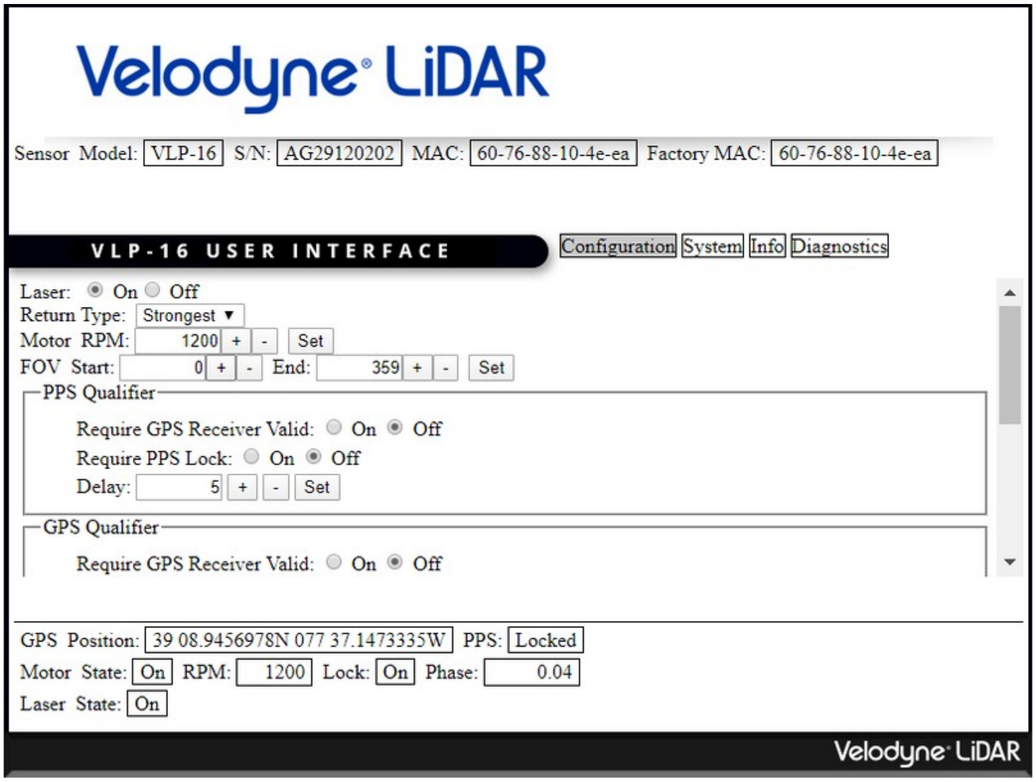


**Figure 5. 30 The LiDAR Service tab window in the Settings menu for Velodyne scanners.**

## <u>Livox Scanners</u>

For Livox scanners such as the AVIA, Mid-40, Horizon and Mid-70 an alternative menu will appear with options limited based on the scanner in use.

***<u>Note:</u>*** *Not all of the options listed below are available for each of the previously mentioned scanners.*

- <u>Returns:</u> This option (shown in Figure 5. 31) gives the user the ability to select the number of laser returns the scanner logs as data points when generating the point cloud.

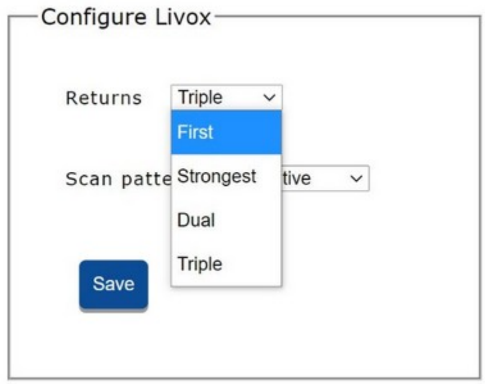


**Figure 5. 31 The LiDAR Service Tab showing options for number of returns for supported Livox scanners.**

- Scan Pattern: This option gives the user the ability to adjust the scanning pattern. For more information on the different scanning patterns available for Livox scanners please reference the laser's user manual.

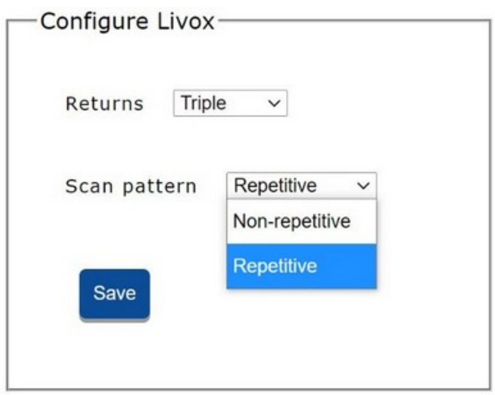


**Figure 5. 32 The LiDAR Service Tab showing scan pattern options for supported associated Livox scanners.**

- High Sensitivity: This option (shown in Figure 5. 33) allows for high detection range for smaller objects with low reflectivity. For more information on High Sensitivity for Livox scanners please reference the laser's user manual.

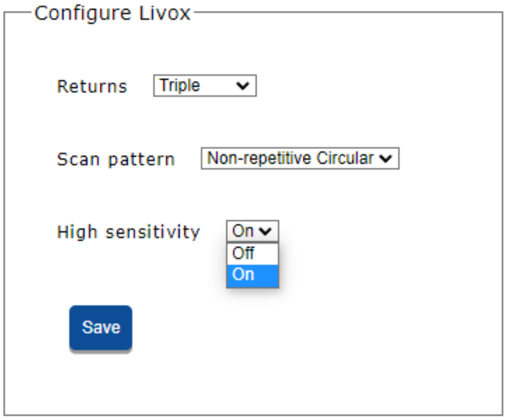


**Figure 5. 33 The LiDAR Service Tab showing High Sensitivity options for supported Livox scanners**

# 6. Workflow of a Payload Flight

# 6.

## 6.1. Convergence Maneuvers

Convergence maneuvers are a series of maneuvers that must be completed during a flight in order to obtain the best results. Failing to complete these convergence maneuvers well can cause inaccurate data or even un-processable data.

### 6.1.1. Initial Static Alignment

1. Begin recording data on your RESEPI payload.
2. Wait 30 seconds without moving device or drone.
3. Proceed to Initial Kinematic Alignment.

### 6.1.2. Initial Kinematic Alignment

1. Takeoff and fly vertically to a safe altitude.
2. Fly straight forward at a speed greater than or equal to 5 m/s for at least 5 seconds.
3. Complete at least one figure eight maneuver (as fast as safely possible).
4. Proceed with mission flight.

### 6.1.3. Final Kinematic Alignment

1. Finish mission flight.
2. Fly straight forward to landing area at a speed greater than or equal to 5 m/s for at least five seconds.
3. Land straight down to the landing pad. While adjusting landing position, do not exceed a horizontal speed of 2 m/s.
4. Proceed to Final Static Alignment.

### 6.1.4. Final Static Alignment

1. Wait 30 seconds without moving device or drone.
2. Stop recording data on your RESEPI payload.

## 6.2. Full Workflow of a Payload Flight with GUI

Flights can be performed with the GUI as shown below:

1. Turn on drone or other power source and then turn on the payload.
2. Connect to the drone and navigate to the GUI on a smartphone or other device as described above in Section 4.
3. Look at the GNSS Solution Window in the ”Status” tab to determine the GNSS solution status.
    a. If the GNSS solution status is “Computed, Single”, this means that the unit is connected to satellites but is not receiving RTCM traffic. Wait for this when using PPK corrections.
    b. If the GNSS solution status is “Computed, Narrow Integer”, this means that the unit is receiving RTCM traffic. Wait for this when using RTK corrections.
4. Enter desired project name in “Project Name” in the “Status” tab
5. Tap the ”Start Recording” button on the ”Status” tab to begin recording data.
6. Perform Initial Static Alignment as described in section 6.1 (wait 30 seconds).
7. Perform Initial Kinematic Alignment as described in section 6.1.
8. Perform mission flight.
9. Perform Final Kinematic Alignment as described in section 6.1.
10. Perform Final Static Alignment as described in section 6.1 (wait 30 seconds).
11. Tap the “Stop Recording” button and the boot light will stop flashing between green and red.
12. Shut off the payload first (on the GUI), and then turn off the drone or power source.

**Note:** It is good practice to leave the drone stationary for 30 seconds after recording has begun and for 30 seconds after the drone has landed before stopping recording to ensure accurate results.

Sometimes the drone will fly out of range of connection with your device, this is okay and will not affect your data collection. If this happens reconnect to the device when it finishes its flight.

## 6.3. Full Workflow of a Payload Flight without GUI

While the web-based GUI is a great tool for performing flights, flights can be performed without the GUI like shown below.

1. Turn on drone or other power source and then turn on the payload.
2. Look at the GNSS light to determine the GNSS solution status.
    a. If the light is blinking once incrementally, then the GNSS solution status is “Computed, Single”. This means that the unit is connected to satellites but is not receiving RTCM traffic. Wait for this when using PPK corrections.
    b. If the light is blinking three times incrementally, then the GNSS solution status is “Computed, Narrow Integer”. This means that the unit is receiving RTCM traffic. Wait for this when using RTK corrections.

   c. If the light is not blinking, then receiver is not receiving signals from satellites.
3. Tap the power button to begin recording data. The payload will indicate that data is recording when the Boot light begins flashing between green and red.
4. Perform Initial Static Alignment as described in section 6.1 (wait 30 seconds).
5. Perform Initial Kinematic Alignment as described in section 6.1.
6. Perform mission flight.
7. Perform Final Kinematic Alignment as described in section 6.1.
8. Perform Final Static Alignment as described in section 6.1 (wait 30 seconds).
9. Tap the power button to stop recording data; the boot light will stop flashing between green and red.
10. Turn off the payload first, and then turn off the drone or power source.

**Note:** It is good practice to leave the drone stationary for 30 seconds after recording has begun and for 30 seconds after the drone has landed before stopping recording to ensure accurate results.