



SigmaSpace
EXCELLENCE IN AEROSPACE TECHNOLOGY

Mini Micro Pulse Lidar System

MiniMPL-532-C

Sensor Suite Operations Manual

Version: June 2016



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MiniMPL Sensor Suite System: Record of Purchase

Thank you for your purchase of the MiniMPL Sensor Suite System from Sigma Space Corporation.

Please fill in the following system information for your records. This information may be requested by Sigma Space for obtaining service or for performing upgrades.

Customer Name	
Organization	
Date of Purchase	

	Model Number	Serial Number
MiniMPL	MiniMPL-532-C	
Scanner		
Weather Station		
Weather Camera		
GPS		
Configuration Notes		

Precautions

Electrical Safety

- E1. Adhere to the specified operating voltage for the MiniMPL electronics at all times. The MiniMPL has a power consumption of 100 W, and the default operating voltage is AC 110-240V, 50/60 Hz. The voltage specification on custom configured units is labeled accordingly.
- E2. Use grounded plugs and receptacles for power. It is recommended to use receptacles or power strips equipped with surge suppressors to protect the electronics from damage.
- E3. All electrical connections should be verified by qualified personnel prior to operating the instrument. Incorrect or poor connections may cause damage to the equipment.
- E4. Ground straps are recommended for handling connection cables of the MiniMPL to avoid damage due to electrostatic discharge.
- E5. Startup and shutdown procedures must be followed for the MiniMPL as described in the Operations Manual. Do not attempt to open or move the MiniMPL while the instrument is in operation.
- E6. The user should review all procedures listed in the Operations Manual.
- E7. The MiniMPL does not have any user serviceable components. Refer any service requirements directly to Sigma Space or an authorized representative.

Mechanical, Optical, and Environmental Safety

- M1. The MiniMPL is not weatherproof. The unit must not be exposed to rain or excessive humidity.
- M2. The surface of the MiniMPL aperture and scanner should not be touched by hand or cleaned in a manner that is outside of standard optical cleaning practices (gloves, acetone, lint free cotton wipes). The aperture must remain covered when not in use to protect against dust and accidental damage. Any dust accumulating on the aperture during normal operations should be periodically cleaned using filtered, pressurized air. Care should be taken to avoid contact with the optical surfaces.
- M3. Always use the attached handle to gently move the MiniMPL. Dropping or bumping the MiniMPL may cause serious damage to the components inside.

Laser Safety

- L1. ***Caution – Laser Radiation exposure may occur if the user modifies the controls or performance of the instrument with procedures other than those specified herein.***
- L2. The MiniMPL System is a Class II Laser Product as defined by the US CDRH 21CFR1040.10/.11; Class II Laser Product as defined by EN60825-1/2; and ANSI Z136.1 2000.
- L3. All operators of the MiniMPL should be trained in Laser Safety prior to operating the MiniMPL. Laser warnings should be observed at all times and direct viewing of the beam should be avoided.
- L4. If the transmitted beam quality or shape changes during use, shut down the instrument and contact Sigma Space for service.

Scanner Safety

- S1. While the scanner is operating, all people should be clear of the scanning area to avoid accidental exposure to the beam.
- S2. Always use the provided red lens cap to cover the scanner window when initializing. The scanner initialization process could rotate the beam towards the user.
- S3. Never point the scanner towards the user or other people.
- S4. Proper warning and notification should be given to all people in the vicinity of the scanning system.

1. Introduction

The Mini Micro Pulse LiDAR Sensor Suite provides a comprehensive view of the atmosphere. The heart of the Sensor Suite is Sigma Space's own Mini Micro Pulse LiDAR (MiniMPL), which provides continuous, unattended monitoring of the atmosphere. In addition to the MiniMPL, the Sensor Suite employs numerous options to provide a broad view of the atmosphere. Each option can be custom configured to suit the customer's needs. The options currently available on the standard Sensor Suite are the Two-Axis Scanner, Weather Station, Weather Camera, and GPS (GIS Package).

SigmaMPL, Sigma Space's custom software for processing and displaying Mini Micro Pulse LiDAR data, has been expanded to enable full functionality with the MiniMPL Sensor Suite. The software can be configured to display any combination of the options that are available with the Sensor Suite. The software comes pre-configured with every purchase to make the set-up as effortless as possible. Please refer to the included *SigmaMPL Software Manual* for software installation instructions and operation of the non-Sensor Suite specific components.

2. MiniMPL Sensor Suite Installation

The MiniMPL Sensor Suite comes with an outdoor rated enclosure and an electronics module. The electronics module provides connections between the LiDAR data acquisition computer, each Sensor Suite option, and the Local Area Network (LAN). **NOTE:** The electronics module is delivered mounted in the enclosure with all appropriate connections made and held in place. Each cable is labeled for ease of setup. If for any reason one of these connections comes loose or is damaged during shipment, please notify Sigma Space immediately.

Power: The Sensor Suite electronics requires AC 110V - 240V, 50/60 Hz. The provided power cord should be connected to the **110-240V AC** connection on the rear panel of the electronics module and then to the grounded Power Strip inside the enclosure.

Computer Control: The LiDAR data acquisition computer communicates with the Sensor Suite electronics using a USB connection. Connect the provided USB cable to a computer USB port and then to the connector marked **PC-USB** on the rear panel of the electronics module.

Two-Axis Scanner: There are two cables required to connect the Two-Axis Scanner to the Electronics Module. The first runs from the rear panel of the Electronic Module labeled **SCANNER**, to the 9-pin DB connector inside the LiDAR enclosure. The second cable runs from the panel on the outside of the LiDAR enclosure to the scanner head.

Weather Station: Connect the provided SMA Cable between the rear panel of the electronics module **ANT** connector to the inside enclosure panel **ANT** connector. The Weather Station is set up with a wireless connection to the data logger within the Sensor Suite electronics.

Weather Camera: Connect the provided Ethernet cable between the **CAMERA** connector on the electronics module and the Ethernet feedthrough connector on the inside of the enclosure marked **CAM**. The Ethernet cable from the camera should be connected to the **CAM** port on the exterior of the enclosure.

GPS/GIS Option: Connect the provided USB cable between **GPS** on the electronics module and the USB feedthrough connector on the inside of the enclosure marked **GPS**. The USB cable from the GPS module should be connected to the **GPS** port on the exterior of the enclosure.

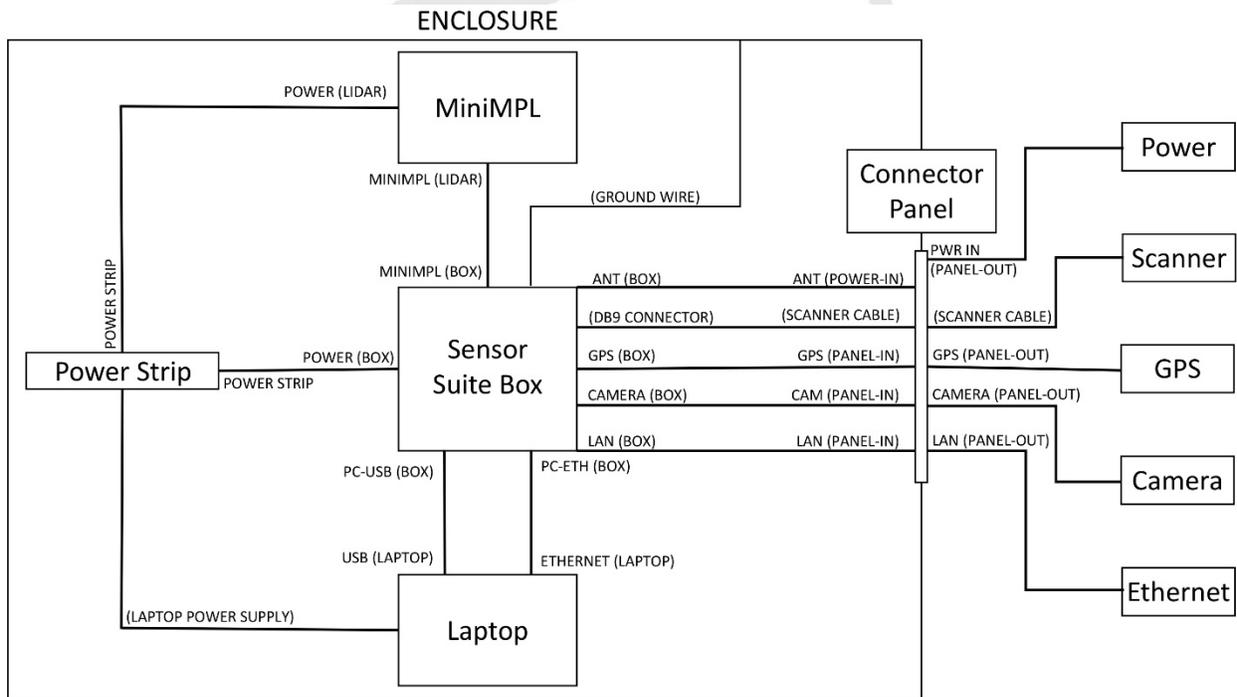


Figure 1: MiniMPL Sensor Suite Wiring Diagram



Figure 2: MiniMPL Sensor Suite Electronics Module. Rear panel showing connections.

3. Device Driver Installation

The device drivers required for the following suite options are pre-installed on the computer supplied with the MiniMPL system, and are included with the provided setup software. The Sensor Suite data connections use USB and Ethernet protocols to communicate with the computer. See Figure 3 for the 4-port Ethernet router setup. The connections shown in Figure 3 are for informational purposes only, and should not be altered by the user.

- Two-Axis Scanner (connected via USB hub)
 - Device driver: FTDI USB-COM485-PLUS2
 - Website: <http://www.ftdichip.com/Drivers/CDM/CDM%20v2.12.00%20WHQL%20Certified.exe>
- Weather Station (connected via 4-port Ethernet hub)
 - Device driver: None
 - Device ID: Located on the front of the Electronics Module.
 - Default IP address: 192.168.10.102
- Weather Camera (connected via 4-port Ethernet hub)
 - Device driver: None
 - Default IP address: 192.168.10.10
 - Default user name: *root*
 - Default password: *mpl*
- GPS/GIS Package (connected via USB hub)
 - Device driver: GPS 18x USB software version 2.60
 - Website: http://download.garmin.com/software/GPS18xUSB_260.exe

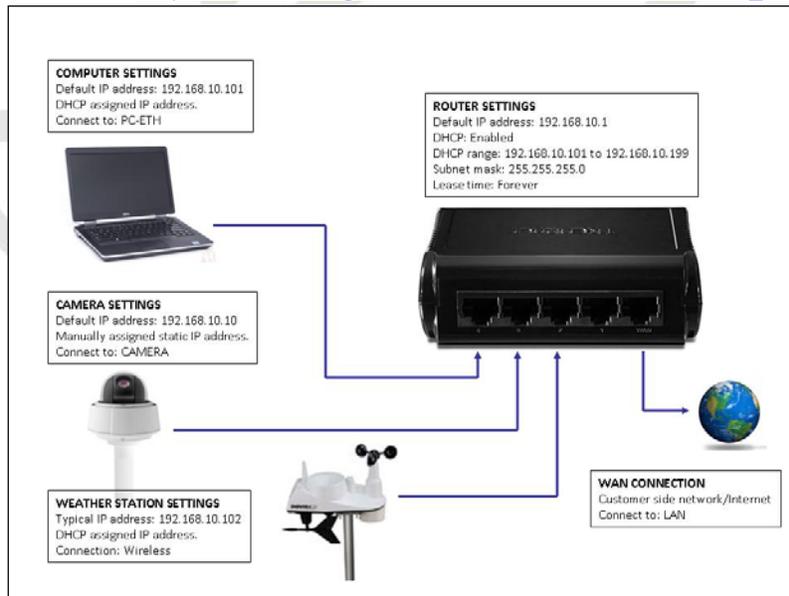


Figure 3: Router Connections

4. Scanner Installation

The scanner comes packaged in its own shipping case with red covers on the window and over the lower opening to protect the interior components. There is a shipping lock installed to prevent rotation of the elevation stage during shipping and installation. The case should contain:

- Two-Axis Scanner
- Scanner Cable (interfaces with scanner and connector panel on enclosure)
- Mounting Hardware: 8-32 screws and washers (6 each required for installation)
- 9/64" Ball-Point Hex Driver (to install the scanner on the enclosure)
- 5/32" Ball-Point Hex Driver (to remove the shipping lock)
- Instruction Manual and Documentation



Figure 4: MiniMPL Scanner Installed on Enclosure

Installation Instructions:

1. Remove the scanner from the shipping case.
2. Remove the red bottom cover and place the scanner on top of the enclosure, ensuring the orange gasket stays in place.
3. There are two sets of arrow labels associated with the scanner: one set is for alignment between the scanner and the scanner base, and the other is for alignment between the scanner base and the enclosure. When installing the scanner onto the enclosure, ensure that both arrow sets are aligned.

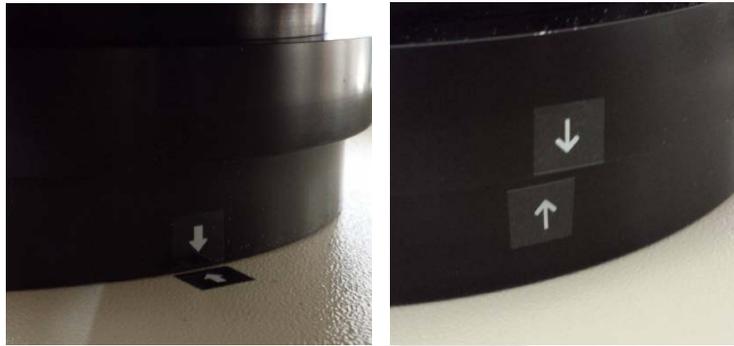


Figure 5: Scanner Alignment Guides

4. Align the mounting holes on the scanner to the mounting holes on the enclosure.

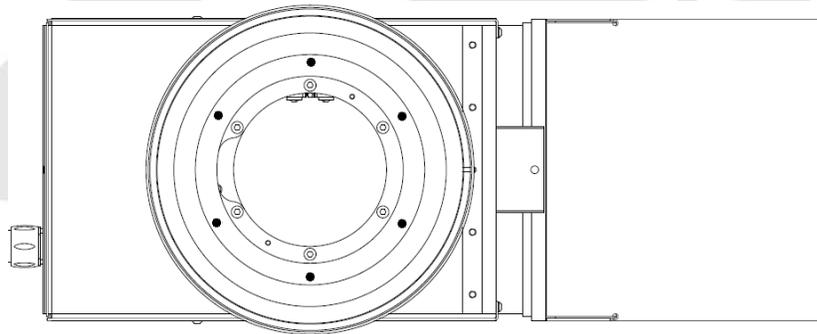


Figure 6: MiniMPL Scanner Bottom - Mounting Screw Locations

5. Insert the (6) 8-32 screws plus washers and tighten with the 9/64" ball-point hex driver.

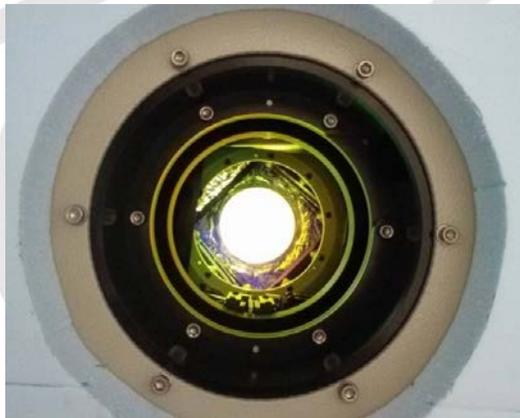


Figure 7: MiniMPL Scanner Bottom View through Enclosure

6. Remove the Shipping lock (Shown below in black) with the 5/32" ball-point hex driver.

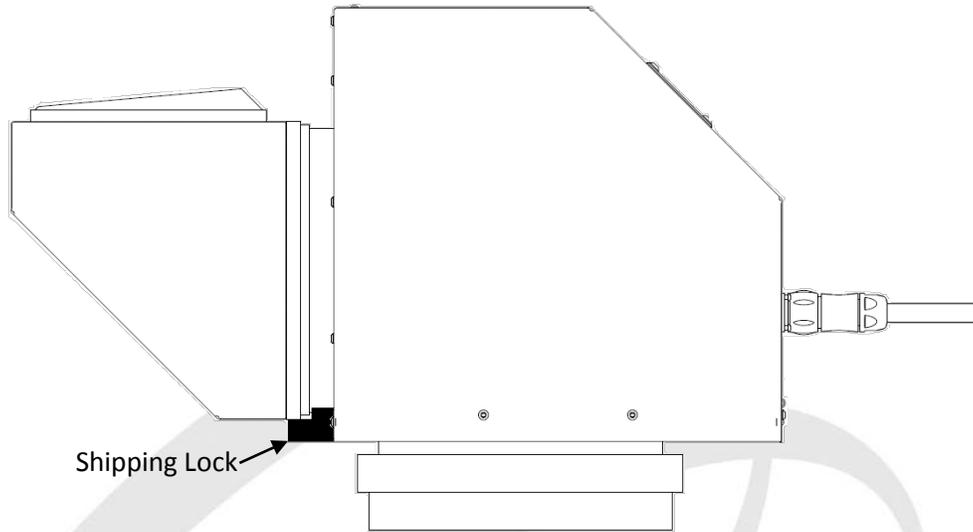


Figure 8: MiniMPL Scanner Shipping Lock Location

7. Plug the cable into the back of the scanner and then into the **SCAN** connector on the outside of the enclosure connector panel.



Figure 9: MiniMPL Scanner Cable Connections

5. Weather Station Installation

Refer to the included manufacturer's installation guide to properly install the Weather Station.

6. Weather Camera Installation

Refer to the included manufacturer's installation guide to properly install the Weather Camera.

7. Sensor Suite Software Operation

7.1. Scanner

The Two-Axis Scanner option allows the user to monitor and track aerosols and plumes across an area. This section will walk through controlling the scanner and saving custom scan patterns for repeated measurements.

7.1.1. Configuring the mpl.ini file

NOTE: This step is already completed on all new purchases.

To enable the scanner options in *SigmaMPL*: Open the *mpl.ini* file located in the main SigmaMPL folder (C:\Program Files (x86)\SigmaMPL) and change the following lines as shown below.

Section	Parameter	Value
[MAIN]	SCANNER	1
[SCANNER]	CONTROL	1

These changes will enable the scanner display in *SigmaMPL* and allow the software to control the scanner.

7.1.2. Hardware Tab Options

Upon opening *SigmaMPL's Real Time Hardware Control* option, the “Scanner” section will be displayed in the Hardware Tab. This is the section where the user can control the scanner.

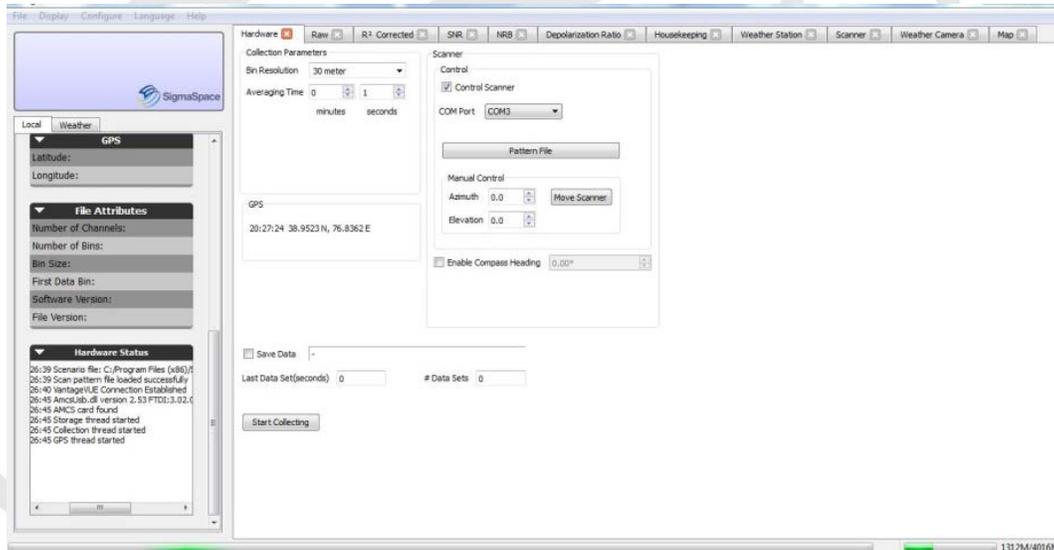
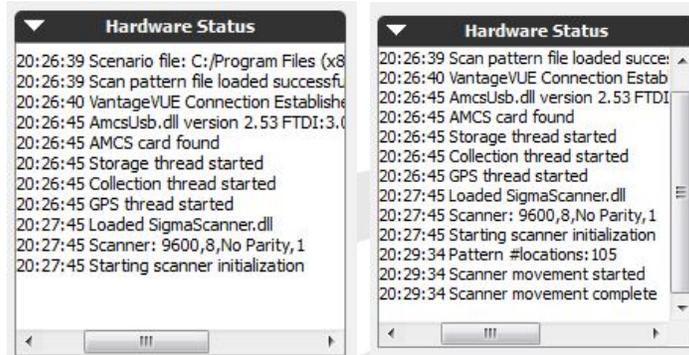


Figure 10: *SigmaMPL* Hardware Tab for Scanner Control

The following Scanner options are available:

- **Control Scanner** – Check to enable scanner control.
- **COM Port** – Select the proper COM port to move the scanner. Always select the lowest COM port.
- **Pattern File** – Click to load a custom scan pattern. This will override the *Manual Control* settings. Refer to Section 7.1.3 for details on how to create a scan pattern.
- **Manual Control** – Input the desired Azimuth and Elevation angle settings. Click “Move Scanner” to have the scanner move to the desired position. **NOTE:** The scanner will not move if *SigmaMPL* software is collecting data. Every time *SigmaMPL* software is opened, the scanner will go through an initialization sequence to determine its position. This

initialization sequence takes approximately 1 minute and 45 seconds to complete. If a scan pattern file is loaded, then the pattern will override the Azimuth and Elevation settings. The status of the scanner is displayed in the *Hardware Status* section on the left side of *SigmaMPL*.



- **Enable Compass Heading** – Enter the pointing of the scanner in relationship to true North. This offset will be added to the scanner coordinates in the “Local Tab” and the “Map Tab”.

7.1.3. Creating Custom Scan Patterns

The Scanner Tab is where the user can create custom scan patterns. A scan pattern is a file that stores a series of moves to let the scanner operate without the user being present. There are two ways to create a scan pattern: Basic and Advanced.

Basic – The basic scan pattern option allows the user to create a scan pattern by selecting the Start Angle, End Angle and Increment for both the Azimuth and Elevation axes.

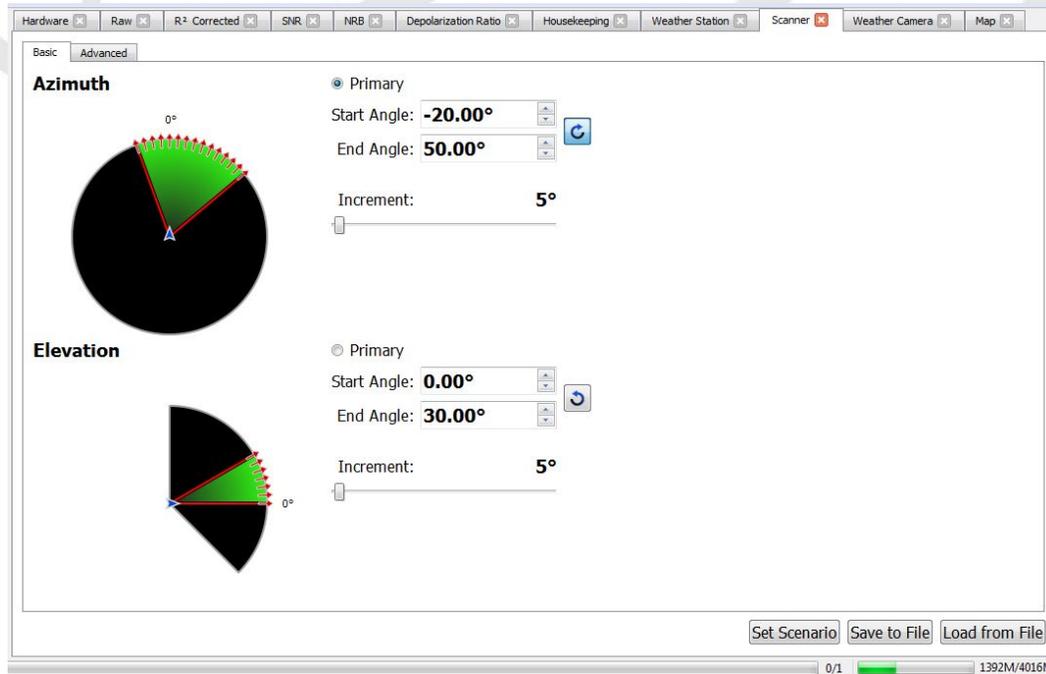


Figure 11: Basic Scan Pattern Setup

The selected sweep of the scanner is displayed in Green on the left side. The Red arrows show the number of steps (based on the desired increment) that the scanner will take to move from the Start Angle to the End Angle. Click the rotation arrow to select the desired rotation direction of the scanner (Clockwise or Counterclockwise).

Once the desired angles are set, select the Primary axis (azimuth or elevation). The Primary axis will complete its sweep before the secondary axis moves. For example, In Figure 11 above, the scanner will move in the azimuth direction (Primary axis) from -20° to 50° in increments of 5° with the scanner at 0° elevation. Once the scanner hits 50° azimuth, it will move back to -20° and move in the elevation direction from 0° to 5° then sweep azimuth from -20° to 50°.

After deciding on a scan pattern, click “Set Scenario” to load the pattern immediately or “Save to File” to save the pattern for future use. If a pattern is already created, click “Load from File” to open it.

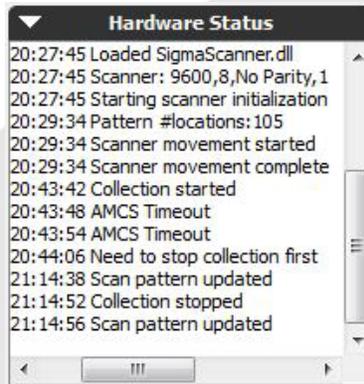


Figure 12: Hardware Status Message Denoting Updated Scan Pattern

Advanced – The advanced option allows the user to input Azimuth and Elevation coordinates in any order to move the scanner in a non-sequential way.

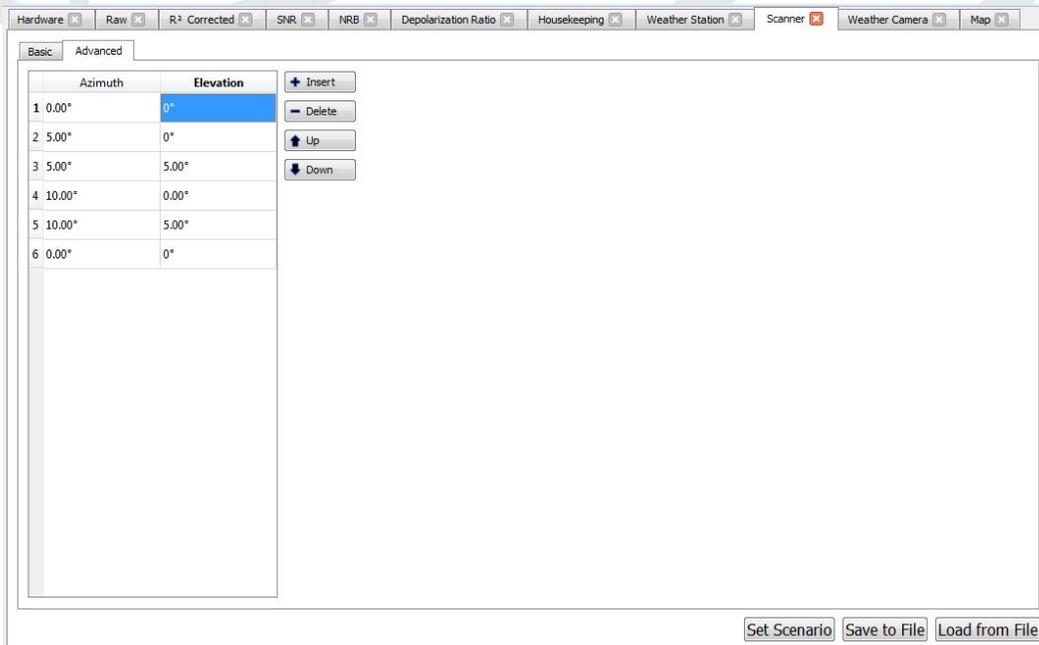


Figure 13: Advanced Scan Pattern Setup Menu

Click “Insert” to add a new line, “Delete” to remove a line, and the “Up” and “Down” buttons to re-order the coordinates. The options to “Set Scenario”, “Save to File”, and “Load from File” from the Basic option menu are still available.

Once a Scan pattern is Set or Loaded, the Hardware Status will update with “Scan Pattern Updated”. When the “Move Scanner” button is clicked, the scanner will move according to the selected Scan Pattern.

7.2. Weather Station

The Weather Station option incorporates real time weather data with the MiniMPL data. The Weather Station provides Temperature, Humidity, Barometric Pressure, Wind Speed, Wind Direction and Dew Point data.

7.2.1. Configuring the mpl.ini file

NOTE: This step is already completed on all new purchases.

To enable the Weather Station data in *SigmaMPL*: Open the *mpl.ini* file located in the main SigmaMPL folder (C:\Program Files (x86)\SigmaMPL) and change the following line as shown below. Use the device ID found on the front of the Sensor Suite Control Box.

Section	Parameter	Value
[TOOLBOX]	WEATHER_STATION	Weather Station Device ID (DID) in the following format (00:00:00:00:00:00)

These changes will enable the Weather Station Tab in *SigmaMPL* and allow the software to stream the Weather Station data.

7.2.2. Weather Tab

The Weather Tab on the left side of the *SigmaMPL* displays the real time Weather Station data. The data displayed here will update according to the averaging time set for the MiniMPL.

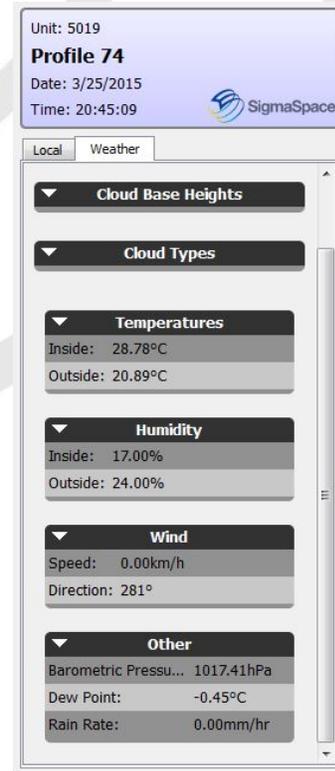


Figure 14: Weather Tab

7.2.3. Weather Station Tab

The Weather Station tab displays plots of the weather data over time. The weather data is time tagged to the MiniMPL data for easy viewing and processing.

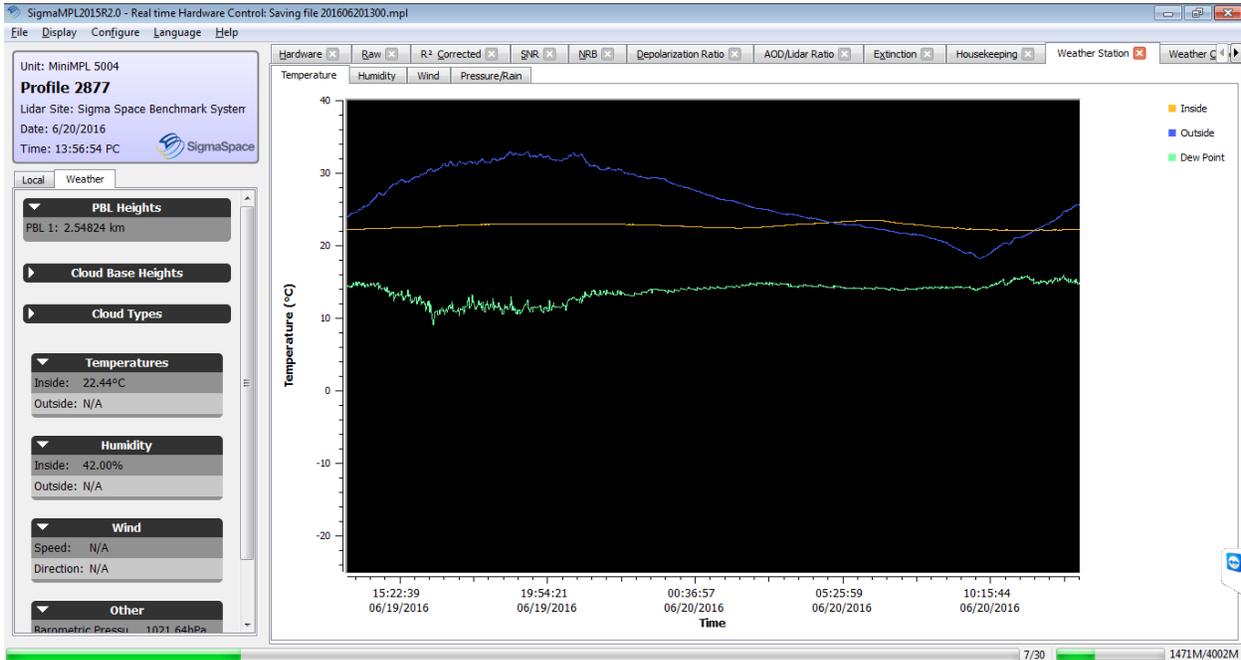


Figure 15: Example Screen of Weather Station Data

7.3. Weather Camera

The Weather Camera option expands the capability of the MiniMPL data by helping the user see how LiDAR data translates into visible atmospheric conditions.

7.3.1. Configuring the mpl.ini file

NOTE: This step is completed on all new purchases.

To enable the Camera in *SigmaMPL*, open the *mpl.ini* file located in the main *SigmaMPL* folder (C:\Program Files (x86)\SigmaMPL) and change the following line as shown below.

Section	Parameter	Value
[TOOLBOX]	PTZ_CAMERA	1

These changes will enable the Weather Camera Tab in *SigmaMPL* and allow the software to control and stream the Weather Camera Images.

7.3.2. Weather Camera Tab

Camera Options

The Weather Camera tab enables the user to view and control the mounted weather camera option. To enable the router to connect to the camera, open the Camera Options menu by right-clicking on the right side of the Weather Camera window and selecting Camera Options.

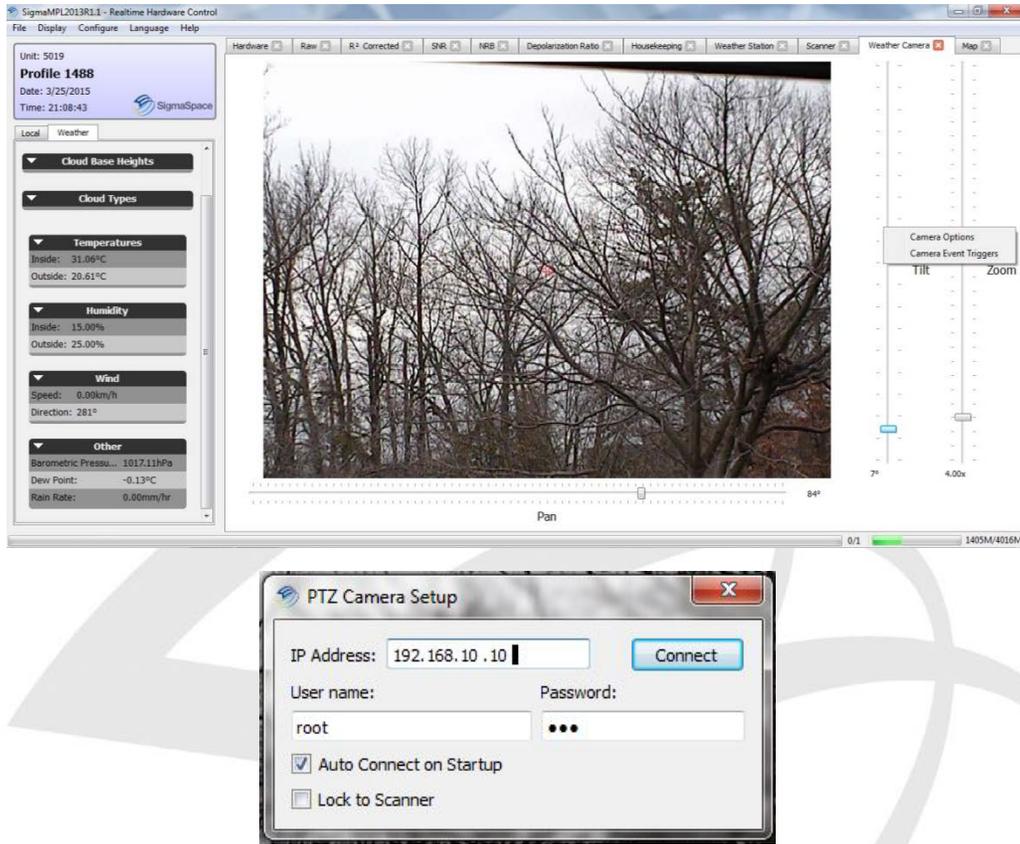


Figure 16: Accessing Camera Options (Top). Camera Option’s Menu (Bottom)

In the “PTZ Camera Setup” menu, the user can enter the IP Address, user name, and password to connect to the camera. **NOTE:** This step is completed on all new purchases. The default IP address and login information are listed in Table 1 below. Once set up, the camera will start streaming live video into *SigmaMPL*. Select the “Auto Connect on Startup” option to avoid having to enter this information every time the software is started. The “Lock to Scanner” option allows the camera to follow the scanner, and is only available if a scanner has been installed.

Table 1: Camera Connection Information

IP Address	192.168.10.10
User Name	root (all lowercase)
Password	mpl (all lowercase)

Controlling the Camera

To control the camera, use the “Pan”, “Tilt”, and “Zoom” sliders to move the camera. Currently the camera can only be controlled manually in *SigmaMPL* software. If a scanner is purchased and the “Lock to Scanner” option is selected, then the camera can move with the scanner.

Camera Event Triggers

The camera can be triggered to record an image at a specific profile or time of day as well as specific atmospheric event, such as the PBL descending below a predefined threshold.

The Camera Event Triggers menu is accessed by right-clicking on the right side of the Weather Camera tab and selecting “Camera Event Triggers”.

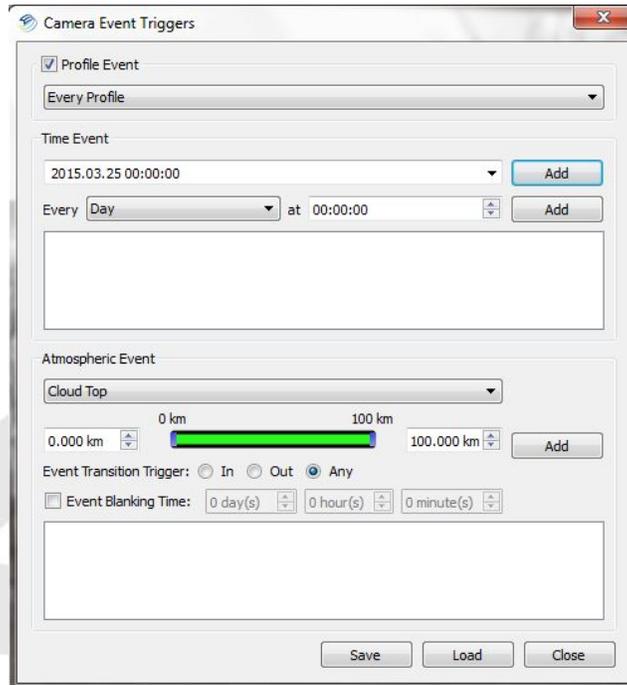


Figure 17: Camera Event Triggers Menu

This menu lets the user select a number of options for recording images. Click “Save” to save the desired options for future use. Click “Load” to open a previously saved camera event profile.

7.4. GPS/GIS

The GPS/GIS option allows the LiDAR data to be tagged with a location. This is useful for MiniMPL networks and mobile measurements. In addition, if a scanner is purchased, the GPS coordinates and scanned aerosol data can be overlaid onto a Google map to bring the data into context with the MiniMPL’s surroundings. This is called the Geographical Information Systems (GIS) option.

7.4.1. Configuring the mpl.ini file

NOTE: This step is completed on all new purchases.

To enable the GPS in *SigmaMPL*, open the *mpl.ini* file located in the main SigmaMPL folder (C:\Program Files (x86)\SigmaMPL) and change the following line as shown below.

Section	Parameter	Value
[TOOLBOX]	GPS	1
[TOOBOOX]	GIS	1

These changes will enable the Map Tab in *SigmaMPL* and display the GPS coordinates.

7.4.2. GPS Coordinates

The GPS coordinates are displayed in two locations within *SigmaMPL* software. They are displayed in the Hardware Tab and in the Local Tab on the left side of *SigmaMPL*. GPS data will update with each profile, according to the averaging time set for the MiniMPL.

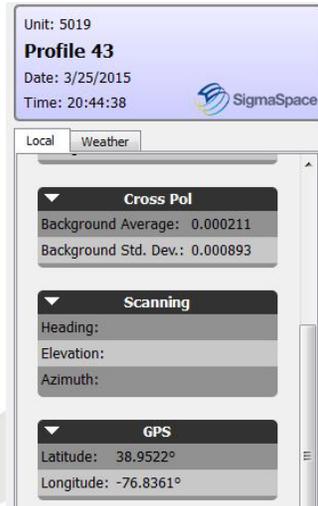


Figure 18: GPS Coordinates Display

If no GPS coordinates are displayed, check the GPS section in the Hardware tab for an error message. The two most common error messages displayed are “GPS Not Connected” or “Not enough satellites for fix”. If the first error message is displayed, check to make sure that the GPS is connected. If the second error message is displayed, make sure that the GPS has a clear line of sight to the sky. If there is thick cloud cover, or you are indoors, the GPS may not be able to connect to satellites.

7.4.3. Map Tab

The Map tab shows the MiniMPL’s location and any GPS data that is acquired by the LiDAR. The LiDAR’s location is denoted by the Sigma Space logo on the map. If the map does not update to show the LiDAR’s location, click on “Center to Unit” to center the map on the GPS coordinates.

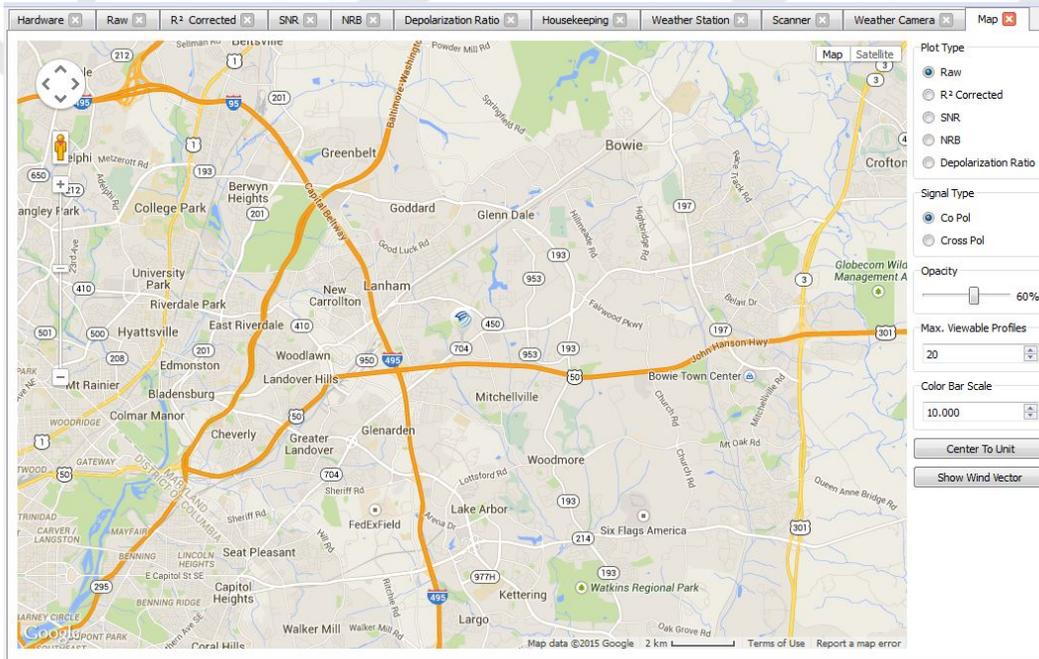


Figure 19: Map Showing LiDAR Location

7.4.4. GIS Option

Scanned aerosol data and mobile measurement can be overlaid onto the map as shown in the Figure 20 below. The options on the right side of the Map tab let the user control what type of data is displayed on the map.

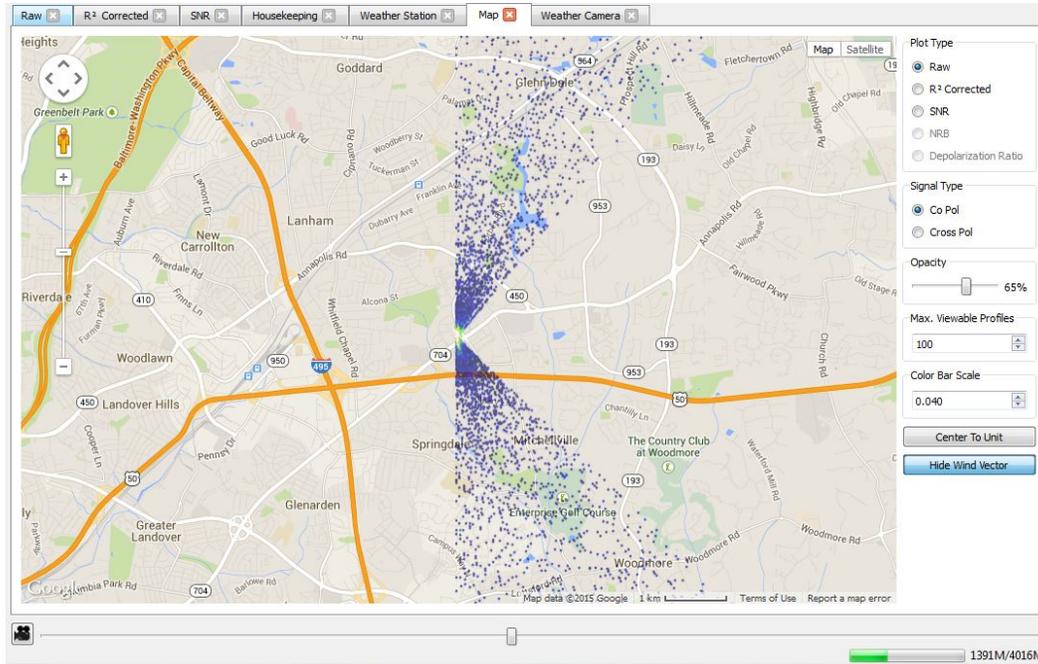


Figure 20: Map Showing Simulated Scanned LiDAR Data

If a Weather Station is being used in conjunction with the GPS, the “Show Wind Vector” button will display the wind direction on the map.

For all MiniMPL Sensor Suite service, please contact:

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