Micro Pulse LiDAR
EST. 1997

MPL-4B-IDS

Operations Manual

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DROPLET
MEASUREMENT TECHNOLOGIES

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Micro Pulse LiDAR (MPL) System: Record of Purchase

Fill in the following system information for your records.

Customer Name	
Organization	
Date of Purchase	

	Model Number	Serial Number
MPL		
Configuration Notes		

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Precautions

Electrical Safety

E1. Adhere to the specified operating voltage for the MPL electronics at all times. The MPL has a power consumption of 500 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 MPL to avoid damage due to electrostatic discharge.

E5. Startup and shutdown procedures must be followed as described in Section 4 of this Operations Manual. Do not attempt to open or move the MPL while the instrument is in operation.

E6. The user should review all procedures listed in this Operations Manual.

Mechanical, Optical, and Environmental Safety

M1. The MPL is not weatherproof and must not be exposed to rain or excessive humidity levels above 80%. The operating and storage temperature of the instrument should always be between 10°C (50°F) and 35°C (95°F).

M2. The surface of the MPL aperture 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.

Laser Safety

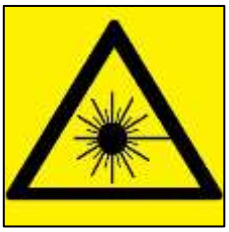
L1. ***Caution – Laser Radiation exposure may occur if the user modifies the controls or performance of the instrument with procedures other than those specified herein.***

L2. The MPL 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 MPL should be trained in Laser Safety prior to operating the MPL. 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 us for service.

L5. Location of FDA/CDRH Laser labels:

Label Type	Description and Location
	Laser caution symbol. One on the base of the MPL, and one on the opposite side on the MPL.
	MPL unit information label. One on the base of the MPL, and one on the opposite side on the MPL.
	Laser aperture warning label. Four around the top edge of the emission aperture

	Laser caution label. One on the base of the MPL, and one on the opposite side on the MPL.

1. Introduction

The Micro Pulse LiDAR (MPL) is an elastic backscatter LiDAR developed at NASA Goddard Space Flight Center[1] and deployed at a number of locations worldwide for long-term, autonomous aerosol and cloud monitoring. The MPL is comprised of an optical transceiver unit, laser power supply, and a laptop computer (**Error! Reference source not found.**). The optical transceiver houses the laser transmitter (operating at a 532 nm wavelength) and the photon counting detection system. The signal is transmitted and received using the same built-in athermal telescope. The range resolved signal is collected and displayed in real time on the data acquisition computer. The optical transceiver is mounted on a swivel mechanism that allows elevation adjustment for vertical or off-zenith measurements. The data acquisition software provided can also be used to playback previously recorded data files.

Figure 1: Micro Pulse Lidar System

[1] Licensed from the National Aeronautics and Space Administration under U.S. Patent No. 5,241,315

The MPL is a precision optical instrument and should be handled with extreme care during transportation and use. It should not be operated or stored in extreme humidity or temperature conditions. Although the laser output energy from the unit is designed to meet the ANSI Z136.1–2000 standard for eye safety, direct viewing of the laser beam for extended periods of time may damage the retina. This manual assumes that the user has fundamental working knowledge of lasers and laser safety. *All MPL operators must read through this Operations Manual prior to operating the instrument.*

2. Unpacking and Installation

Table 1 shows a packing list of components included with the MPL shipment. Inspect these items for any visible damage upon receiving the instrument and report any discrepancies as soon as possible.

Table 1: MPL Packing List

Item	Description	Quantity
1	MPL Unit (Optical Transceiver)	1
2	Laser Power Supply	1
3	Shielded USB-A/USB-A Cable	1
4	BNC/BNC Cable	1
5	Power Cable	2
6	Data Acquisition Computer and Charger	1
7	Documentation Package and *SigmaMPL* Software	1
8	Shipping Case	1

The MPL is a delicate instrument and extreme care must be exercised while unpacking from the shipping case. Dropping or bumping the MPL may cause serious damage to the components inside. Since the optical transceiver is locked in position for shipping, use a 5/32” hex driver to loosen the 10-32 socket head screws and adjust the instrument’s angle.
The MPL may be stored in its original shipping container when not in use between 10°C (50°F) and 35°C (95°F) in a location with low humidity.

2.1 Power Requirements at MPL Site

The MPL system requires an AC 110-240 V, 50/60 Hz supply with a grounded connection for proper operation, and has a power consumption of 500 W. For improved protection, a surge protected power supply is recommended.

2.2 MPL Site Environment

The MPL system is designed to operate in a controlled environment. To ensure accurate performance over an extended period of time, the location of the MPL must adhere to the following criteria:

- Operating temperature: 10°C to 35°C (50°F to 95°F)
- Relative humidity: <80%
- Well ventilated
- Dust free
- Vibration isolated
- Free from strong sources of EMI radiation

3. Hardware Setup

This section describes the systematic installation of the MPL system.

3.1 Instrument Placement

1. Place the optical transceiver on a firm, horizontal surface that is free from vibrations.

2. Place the laser power supply close enough to the optical transceiver to avoid straining any part of the umbilical cable.

3. Maintain at least 2" of clearance around the optical transceiver heat sink and laser power supply air vents for adequate air circulation.

3.2 Laser Power Supply Connections

1. See Figure 2 for laser power supply connections. The 'POWER' and 'LASER ENABLE' key switch on the front panel should be set to the 'OFF' positions.

2. Connect the power cord for the laser power supply unit to a grounded outlet. Soon after being connected, all LEDs will blink and the power supply will make a long 'beep'. Even when the main power switch for the power supply is 'OFF', the temperature controllers inside the laser are active.

3. Connect the D-connector on the umbilical cable (from the optical transceiver) to the connector labeled 'TO LASER HEAD' on the back panel of the laser power supply. Fasten the retaining screws on the connector with a flat-head screwdriver.

4. Connect the interlock cable to the D-connector labeled 'USER I/O' and tighten the retaining screws.

5. (Optional) If computer control is required for the laser, connect a serial (RS-232) cable to the connector labeled 'RS232' on the controller. Connect the other end to a COM port on the data acquisition computer. For some computers a serial-to-USB adapter may be required to establish this connection.

Figure 2: Laser Power Supply Front and Rear Panels

3.3 Optical Transceiver Connections

The connections on the MPL unit are all located on the rear panel of the optical transceiver. Rotate the MPL into a horizontal position by loosening the four telescope clamp screws with a 5/32" hex driver to access the connections. Handle the laser umbilical cable with care when rotating the unit.

1. The power switch on the MPL rear panel should be set to the 'OFF' (0) position.
2. Connect the power cord from the MPL 'POWER' connector to a grounded outlet.
3. Connect the BNC cable from the 'LASER SYNC' connector on the MPL to the 'EXT FREQ' connector on the laser power supply.
4. Connect the USB cable from the 'DATA' connector on the MPL to a USB port on the data acquisition computer.

Figure 3: MPL Optical Transceiver Rear Panel

4. MPL Operation Procedures

The MPL should be located with an unobstructed view of the atmosphere and the aperture lid should be opened carefully to avoid touching the lens. Make sure to tighten the telescope clamp screws to prevent unintentional rotation.
NOTE: All personnel in the vicinity of the MPL should be clear of the beam path before the laser is turned on.

4.1 Power up Sequence

1. The laser power supply should be plugged into a live power outlet for approximately 5 minutes to allow the internal laser temperature to stabilize.

2. On the MPL unit, flip the power switch to 'ON' (1).

3. Turn on the data acquisition computer.

4.2 Laser Control Using the Front Panel

1. On the laser power supply, flip the 'POWER' rocker switch to the 'ON' position. A short beep will sound and the display will initiate to the control screen.
2. Turn the 'LASER ENABLE' key switch to 'ON'.
3. Verify that the laser is set for an external trigger:

   3.1 Press the 'HOME' key. Press 'MENU' and select the 'Pulse Settings' option using the arrow buttons and then press 'ENTER'.

   3.2 Use the arrow buttons to select the 'PRF' value and press 'ENTER'. Set this value to 'PRF=Ext' using the arrow buttons and then press 'ENTER'.
4. Press the 'SHUTTER' button. The LED will turn on to indicate that the shutter is open.
5. Press the 'LDD' button to turn on the Laser Diode Driver. The LED should light up and the 'Actual Current' (Ia) will begin rising to the set current value. The 'Set Current' (Is) and 'Actual Current' (Ia) may vary from each other.
6. To change the 'Set Current', press the 'MENU' key, select 'LDD Settings', and press 'ENTER'. Use the arrow buttons to adjust this value, and then 'ENTER' to set the new current value.
7. Open the telescope cover to check emission.

4.3 *SigmaMPL*: MPL Control and Data Acquisition Software

The *SigmaMPL* data acquisition software allows for real time operation of the instrument and data playback of previously stored data. This section describes the *Real Time Hardware Control* mode. For *File Playback* mode and other software and data processing features, refer to the *SigmaMPL Software Manual*.

4.3.1 Real Time Hardware Control

1. From the opening screen of *SigmaMPL*, press **Ctrl+R** or select **File→Real Time Hardware Control** (Figure 4).

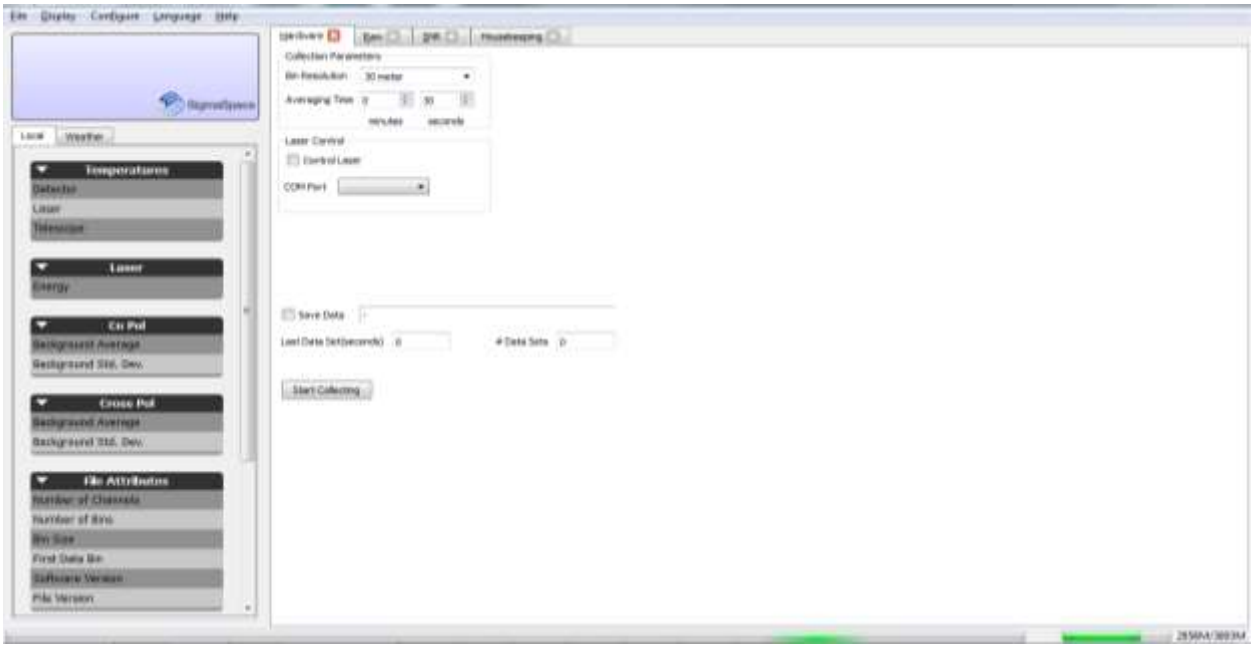


Figure 4: ***SigmaMPL Real Time Hardware Control*** **Window**

2. Tabs for Hardware, Raw Data, R^2 Corrected, SNR, and Housekeeping will appear in the plot area to the right of the left sidebar. A tab for NRB will be displayed only if the three configuration files for the MPL are loaded. See the *SigmaMPL Software Manual* for more information.

3. The software must be configured for the MPL before collecting data. To access configuration options, press **Ctrl+K+L**. This will enable the Collection Parameters to be adjusted in the Hardware tab. To configure the software for MPL, select **Configure→Algorithm Setup** and select **Default MPL Parameters**. Click **Apply** followed by **OK** to save the changes.

4. Select the desired **Bin Resolution** and **Averaging Time**.

5. Check the **Save Data** box to record the data. Data does not have to be saved. The saved files are automatically named using an YYYYMMDDHHmm.mpl format and can be found in **C:\Program Files (x86)\SigmaMPL\DATA**.

6. Toggle the **Start Collecting** button to begin collection.

7. The yellow **Acq Active** LED and green **Sync/USB** LED's will both be illuminated on the MPL. The **Sync/USB** LED will flash while data is being collected.

8. To stop collecting data toggle the **Stop Collecting** button.

The MPL displays signal and other instrument data as shown in Figure 5. For a more detailed explanation, refer to the *SigmaMPL Software Manual*.

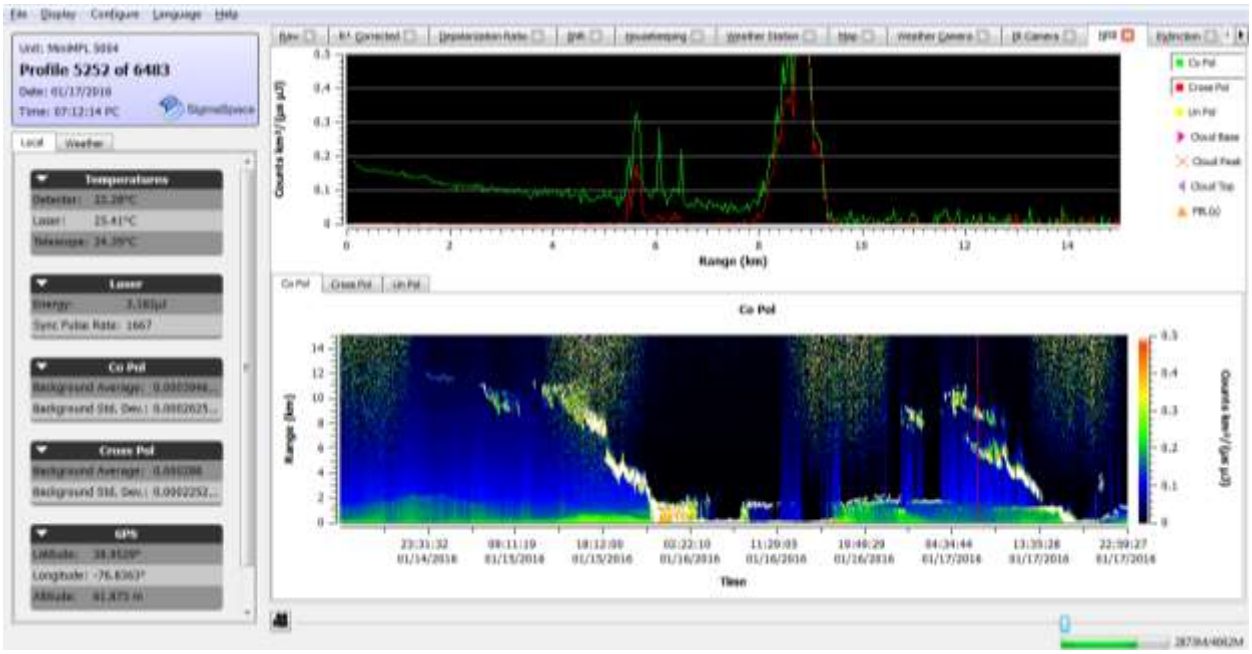


Figure 5: *SigmaMPL* Plot Display

5. System Shutdown

The MPL system should be shut down in the following sequence:

1. Click the Stop Collecting button in the SigmaMPL program to stop data acquisition.
2. Exit the SigmaMPL program.
3. On the MPL, flip the 'POWER' rocker switch to the 'OFF' position.
4. Push the 'LDD' button on the laser power supply and wait until the LED stops blinking.
5. Push the 'SHUTTER' button on the laser power supply, the LED should turn off.
6. Turn the 'LASER ENABLE' key switch to the 'OFF' position.
7. Flip the laser power supply 'POWER' rocker switch to the 'OFF' position.
8. Shut down the laptop computer.
9. Carefully replace the lid on the MPL without touching the optics.

6. MPL Specifications

Table 2: Nominal MPL Specifications

Dimensions	
Size	300 mm x 350 mm x 850mm (11.81” x 13.78” x 33.46”)
Weight	27 kg (59.5 lbs.)
Power	
Supply	AC 110-240V, 50/60 Hz
Consumption	500 W
Transmitter	
Laser Wavelength	532 nm Nd: YVO_4
Pulse Repetition Frequency	2,500 Hz
Pulse Energy	6-8 µJ
Laser Product Compliance	ANSI: Z136.1-2000 IEC: EN60825 USFDA/CDRH: 21 CFR 1040.10/.11
Receiver	
Telescope Type	Maksutov Cassegrain
Diameter	178 mm
Data	
Detector	Avalanche Photodiode, Photon Counting Mode
Range Resolution	5m, 15m, 30m, 75m (Programmable)
Detection Range	Up to 25 km
Multichannel Scaler	Two-channel photon counting, A/D converters for temperature and energy monitors, USB interface to computer

For all MPL service, please contact:

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