NEON PREVENTIVE MAINTENANCE PROCEDURE: SUN PHOTOMETER

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See configuration management system for approval history.

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Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	12/01/2016	ECO-03960	Initial release
B	06/27/2017	ECO-04712	Updated collimator brush, minor edits
C	12/01/2022	ECO-06920	Updated NEON logo and minor formatting fixes

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1 DESCRIPTION

1.1 Purpose

The National Ecological Observatory Network (NEON) employ terrestrial and aquatic sensors to collect measurements from air, wind, soil, and sun across the United States (to include Alaska, Hawaii and Puerto Rico). Regular maintenance of these sensors and their infrastructure is necessary for the continued operation of the observatory, and to preemptively identify problems before they escalate.

This document details procedures necessary for preventive maintenance of the **Sun Photometer - Cimel CE318N**.

1.2 Scope

The procedures detailed in this document are strictly preventive. Any corrective maintenance issues uncovered while performing preventive maintenance should be addressed using the corrective maintenance procedure associated with this subsystem.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations.

AD [01]	NEON.DOC.004300	Environmental, Health, Safety and Security (EHSS) Policy, Program and Management Plan
AD [02]	NEON.DOC.004301	EHSS Environmental Protection Manual
AD [03]	NEON.DOC.004316	Operations Field Safety and Security Plan
AD [04]	NEON.DOC.050005	Field Operations Job Instruction Training Plan
AD [05]	NEON.DOC.001436	TIS Comm Interconnect Mapping
AD [06]	NEON.DOC.004257	NEON Standard Operating Procedure (SOP): Decontamination of Sensors, Field Equipment and Field Vehicles
AD [07]	NEON.DOC.002768	TIS Subsystem Architecture, Site Configuration and Subsystem Demand by Site - SCMB Baseline
AD [08]	NEON.DOC.001455	NEON Algorithm Theoretical Basis Document (ATBD) – Spectral Photometer

2.2 Reference Documents

Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document.

RD [01]	NEON.DOC.000008	NEON Acronym List
RD [02]	NEON.DOC.000243	NEON Glossary of Terms
RD [03]	NEON.DOC.000705	NEON Bolt Torque Specification
RD [04]	NEON.DOC.000501	Pre-Tower Climb JSA
RD [05]	NEON.DOC.002514	Procedure, Assembly, CD03060320 Spectral Photometer Control Enclosure
RD [06]	CD03060320	Assembly, Spectral Photometer Control Enclosure
RD [07]	NEON.DOC.002563	Procedure, Assembly, CD03060501 Spectral Photometer Sensor in shipping box with NEON added Components
RD [08]	CD03060501	Assembly, Spectral Photometer Sensor in shipping box with NEON added Components
RD [09]	NEON.DOC.004089	Instruction, Assembly, CD03060300 Spectral Photometer Control Mounting System
RD [10]	CD03060300	Assembly, Spectral Photometer Control System Mounting
RD [11]		Assembly, Spectral Photometer Corner Mount 3 inch L-Angle

2.3 External References

External references contain information pertinent to this document, but are not NEON configuration-controlled. Examples include manuals, brochures, technical notes, and external websites. If an issue with a product requires the involvement of the manufacturer, NEON Headquarters (HQ) will contact the manufacturer and/or provide Field Operations (FOPS) the authority to contact via the NEON Issue Management System.

ER [01]	CE318_SunPhotometer_Manual_v4.6.pdf SHA1 Checksum: bc25f6f3070b83691b73bee7a3bb9607e38299ec
ER [02]	AERONET_Cimel_Set_Up_Manual.pdf SHA1 Checksum: 228f3377bc1767f0a8d7678a50ee94f122aa563d
ER [03]	AERONET_Summer_Deployment_Handbook.pdf SHA1 Checksum: 26e2e872d0bf7d98ca2c158b65001cf8d574cf2b
ER [04]	AERONET (website) URL: http://aeronet.gsfc.nasa.gov/
ER [05]	Cimel Electronique (website) URL: http://www.cimel.fr/?lang=en

2.4 Acronyms

Acronym	Description
A/R	As Required
AERONET	Aerosol Robotic Network
AOD	Aerosol optical depth
InGaAs	Indium Gallium Arsenide
IR	Infrared
FOV	Field of view
LOTO	Lock Out/Tag Out
NASA	National Aeronautics and Space Administration
NIST	National Institute of Standards and Technology
USNO	United States Naval Observatory

2.5 Terminology

The use of common names for NEON instrumentation and subsystems vary across departments and domains. This section aims to clarify and associate the common names with the technical names herein.

SYNONYMOUS AND COMMON NAME(S)	NEON TECHNICAL REFERENCE NAME
Cimel, Sun Photometer	Spectral Photometer
The robot, robot	Two-axis motorized system

3 SAFETY AND TRAINING

This document identifies procedure-specific safety hazards and associated safety requirements. It does not describe general safety practices or site-specific safety practices. Refer to the site specific EHSS plan(s) via the NEON project document repository portal for electronic copies and conduct the appropriate Job Safety Analysis before conducting any preventive maintenance.

Personnel working at a NEON site must be compliant with safe field work practices as outlined in the Operations Field Safety and Security Plan (AD [03]) and EHSS Safety Policy and Program Manual (AD [01]). The Field Operations Manager and the Lead Field Technician have primary authority to stop work activities based on unsafe field conditions; however, all employees have the responsibility and right to stop their work in unsafe conditions.

All technicians must complete required safety training and protocol-specific training for safety and implementation of this protocol as required in Field Operations Job Instruction Training Plan (AD [04]).

4 SENSOR OVERVIEW (SENSORS ONLY) – SUN PHOTOMETER (CIMEL CE318N MULTIBAND SUN PHOTOMETER)

4.1 Associated Equipment

- Sensor head (see **Figure 1a**)
- Two-axis motorized system (aka 'the robot') (see **Figure 1b**)
- Environmental enclosure (see **Figure 7b**)
- Control box (see **Figure 2a**)
- Grape (see **Figure 2b**)
- Wet sensor (see **Figure 3a**)

4.2 Description

4.2.1 Overview

The Cimel CE318N is an automated sun tracking photometer that measures sun and sky luminance at discrete wavelengths over the visible to near infrared (IR) wavelengths. The discrete wavelengths are determined by eight interference filters within the sensor body at 340 nm, 380 nm, 440 nm, 500 nm, 675 nm, 870 nm, 1020 nm, and 1640 nm for measuring atmospheric aerosol optical thickness, and a 937 nm filter for measuring atmospheric water vapor.

4.2.1 Sensor head and two-axis motorized system

This instrument has a two-axis motorized system (referred to as 'the robot') (see **Figure 1b**) that moves the sensor through a defined pattern of sun and sky targets, and includes self-contained ancillary environmental detectors that inform the sensor of its performance, status, and operational interval. It tracks the sun using a built-in solar tracking algorithm based on the time of year and instrument location; a four quadrant light detector on the sensor body is used to fine-tune the solar tracking during measurements.

The sensor head is comprised of the sensor body (see **Figure 5i**) and a dual channel collimator (see **Figure 5j**). The sensor body includes two detectors: a silicon photodiode detector for the ultraviolet and visible spectrum and an InGaAs detector for the IR measurements. A filter wheel on a direct drive stepped motor positions each of the nine filters over the silicon photodiode and InGaAs detectors, as necessary. Each channel of the collimator has a field of view (FOV) of 1.2 degrees.

The two-axis motorized system includes a vertical arm that controls the azimuth angle (see **Figure 5d**), and a horizontal arm that controls the zenith angle (see **Figure 5e**). Attached to the vertical arm is a claw (see **Figure 5f**) with a buckle (see **Figure 5g**) and mounting strap (see **Figure 5h**) that secures the sensor head to the robot. This system is attached to a mounting and leveling base (see **Figure 5a**). Three cables are associated with this instrument; a thick cable from the sensor head to the control box (see **Figure**

5k) and two power cables for each motor. The cables are routed to not interfere with the full movement of the robot (see **Figure 6**).

Table 1. Photographs and descriptions of the Cimel CE318N and associated equipment.

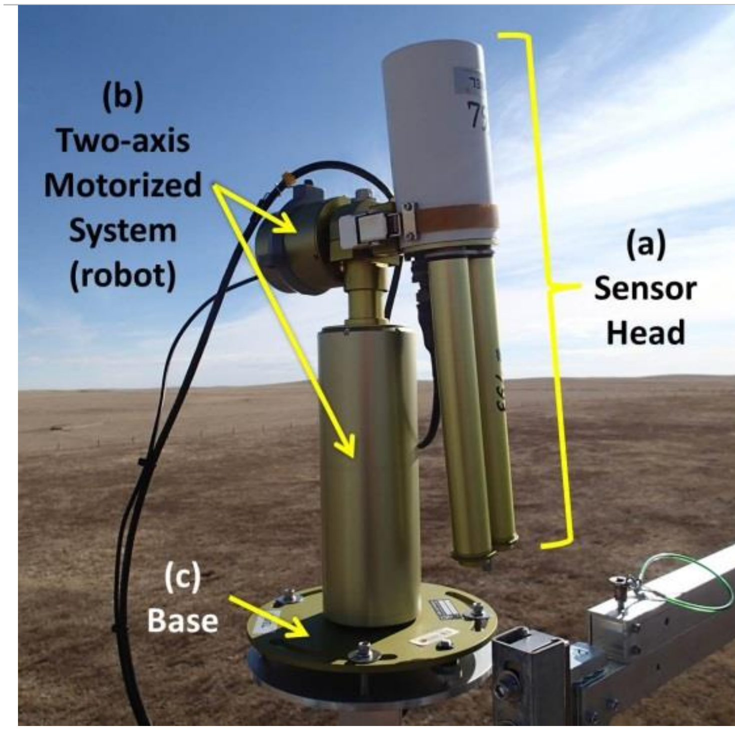


Figure 1. The main components of the Cimel CE318N includes the following:

(a) sensor head
(b) a two-axis motorized system
(c) mounting base, an
- control box (**Figure 2a**)
- Grape (**Figure 2b**)
- wet sensor (**Figure 3a**)

The two-axis motorized system is often referred to as 'the robot'. The control box is typically located away from the sensor. See **Figure 5** for additional details.

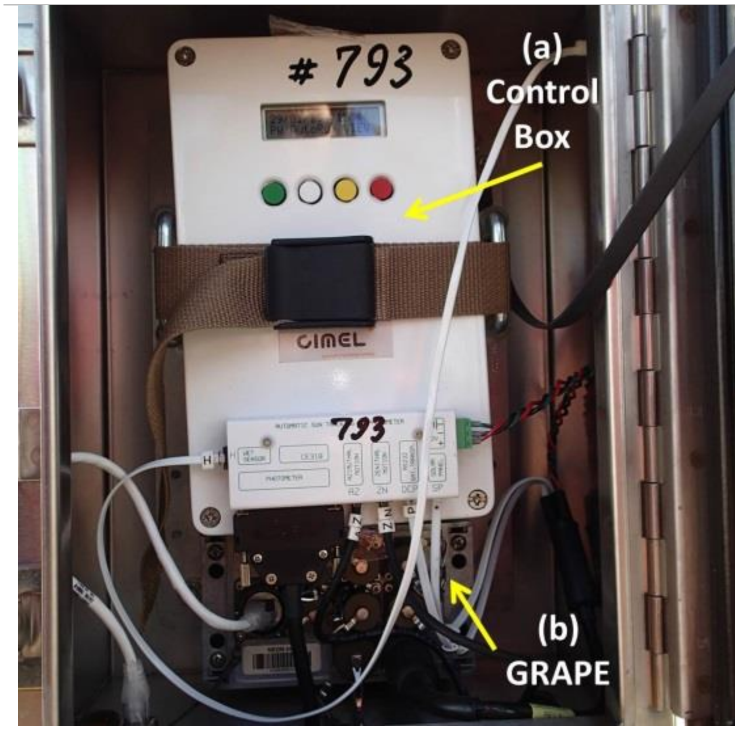


Figure 2. The (a) Cimel control box as mounted within the enclosure. It is mounted above its associated (b) GRAPE.

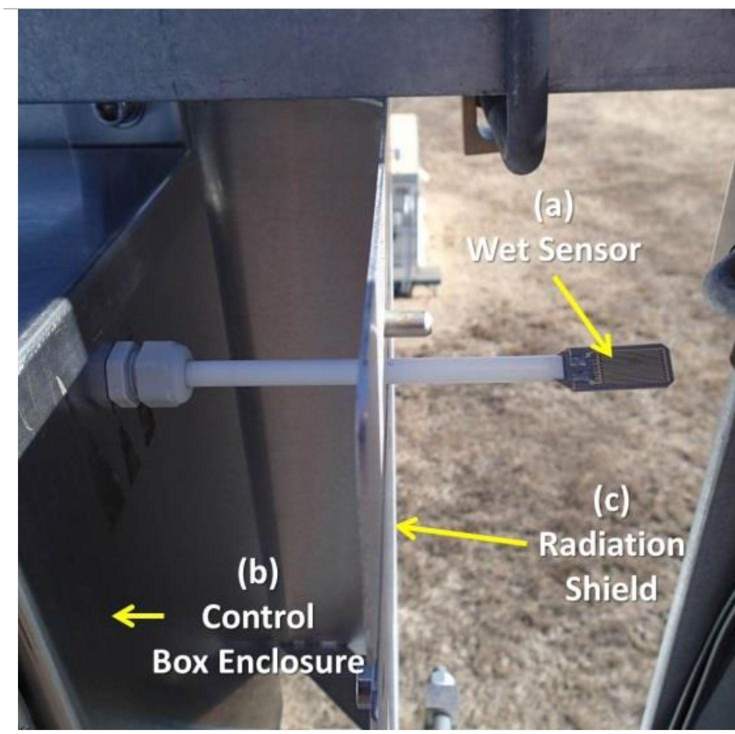


Figure 3. The Cimel (a) wet sensor is typically attached to the side of the Cimel (b) control box environmental enclosure, and through the (c) enclosure radiation shield.

Note: Some sites may have the wet sensor located elsewhere.

The wet sensor is angled at 45° from horizontal so water will run off and not pool on the sensor surface.

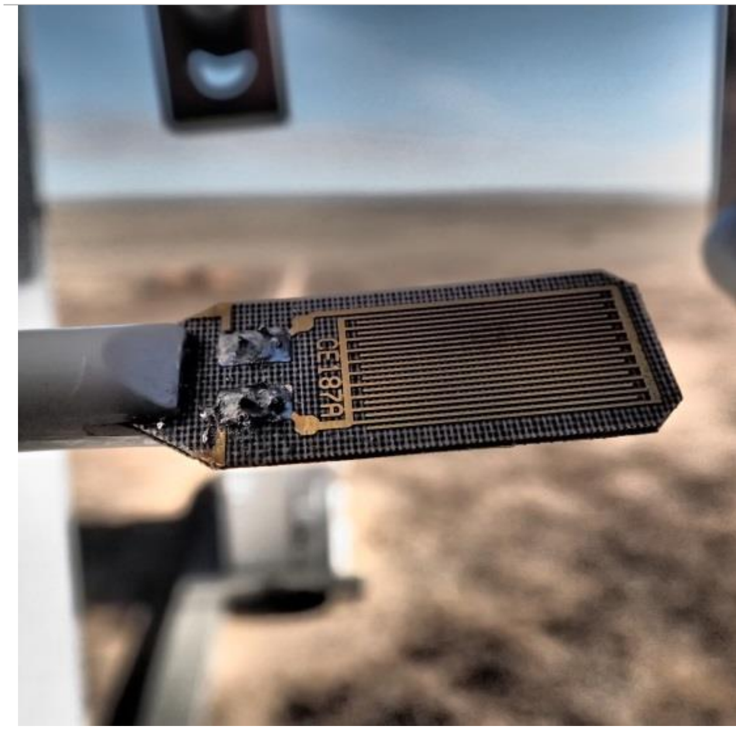


Figure 4. Close up view of the wet sensor.

This patterned side should be facing upwards and should be at a 45° angle from horizontal.

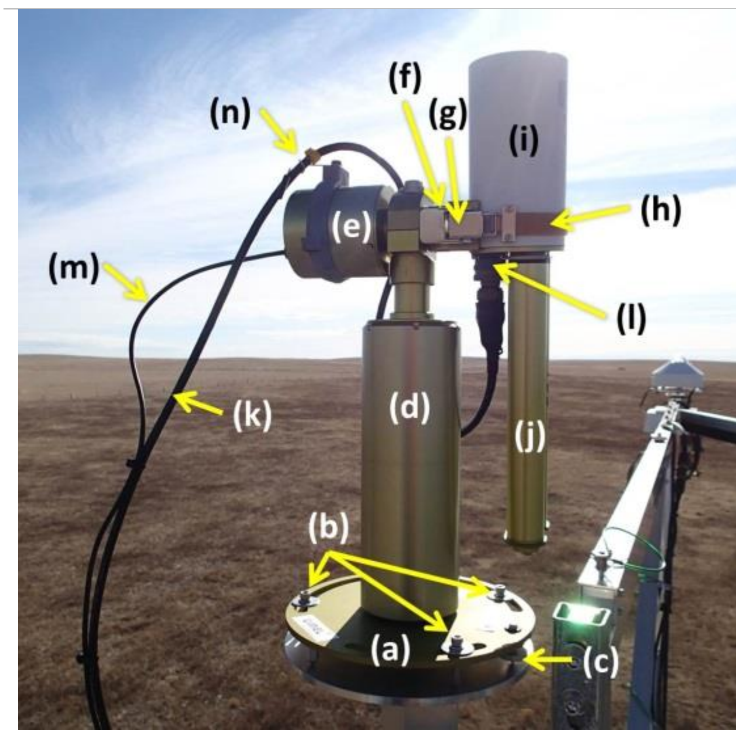


Figure 5. A detailed look at the Cimel CE318N. The instrument base comprises of the following:

(a) mounting and leveling base
(b) three mounting bolts
(c) two leveling screws
(d) vertical arm with an integrated motor that controls the azimuth angle
(e) horizontal arm with a motor that controls the zenith angle
(f) a 'claw'
(g) buckle
(h) mounting strap
(i) sensor body
(j) dual channel collimator
(k) thick sensor head cable
(l) waterproof connector to the sensor body
(m) power cable for the zenith motor
(n) cable holder that helps route the sensor head cable so it doesn't affect the full range motion of the robot

NOT SHOWN: A power cable for the azimuth motor is routed through the bottom of the mounting and leveling base.

Figure 6. Example of the cable routing for the sensor head cable. This routing should allow for full range motion of the robot.

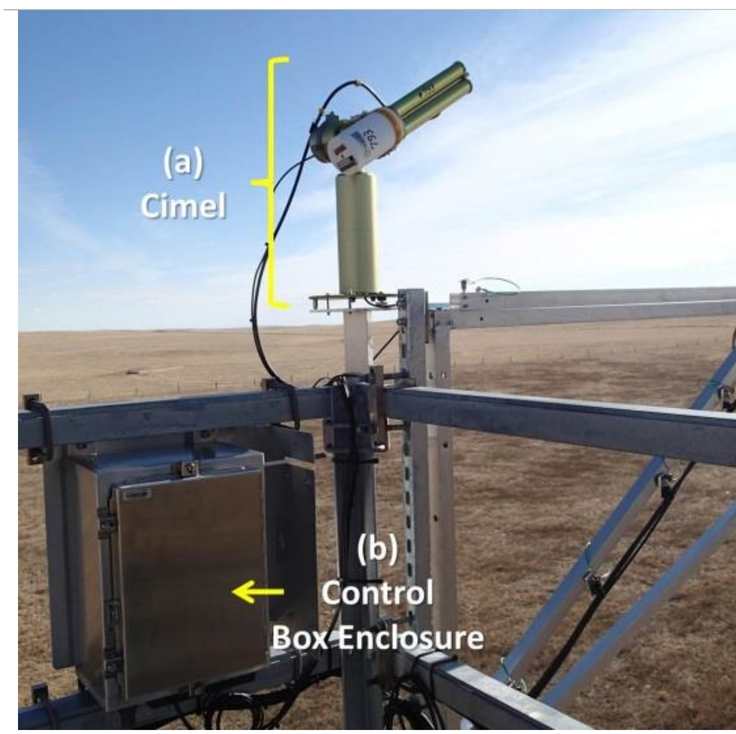


Figure 7. The (a) Cimel and the (b) control box enclosure as located on top of the tower. The location of the control box enclosure in relation to the Cimel may vary depending on the site.

Opening the control box enclosure requires a 7/16" nut driver, or wide slotted screwdriver.

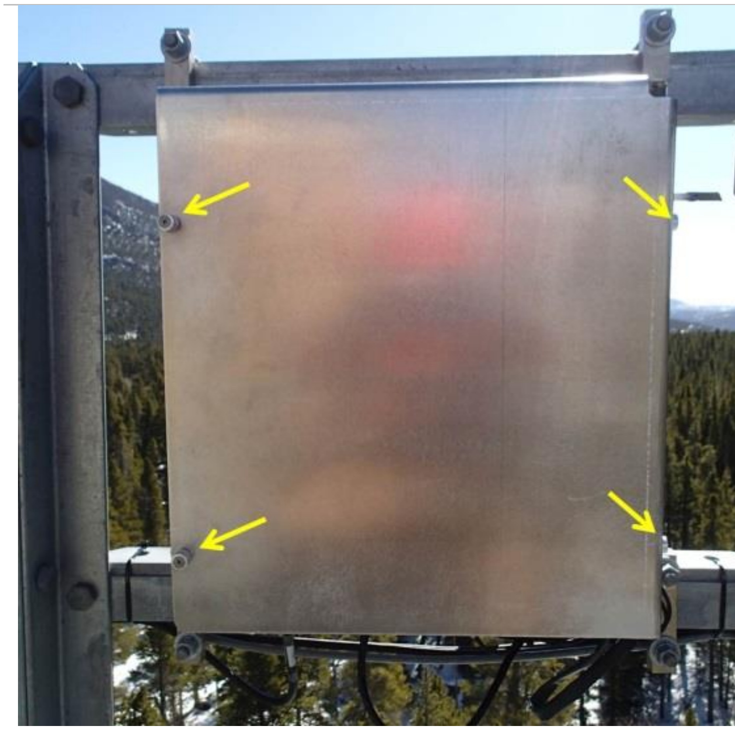


Figure 8. The control box enclosure will usually have an outer radiation shield covering it. The front of the shield can be removed with several self-retaining screws. Hand loosened and tightened screws.

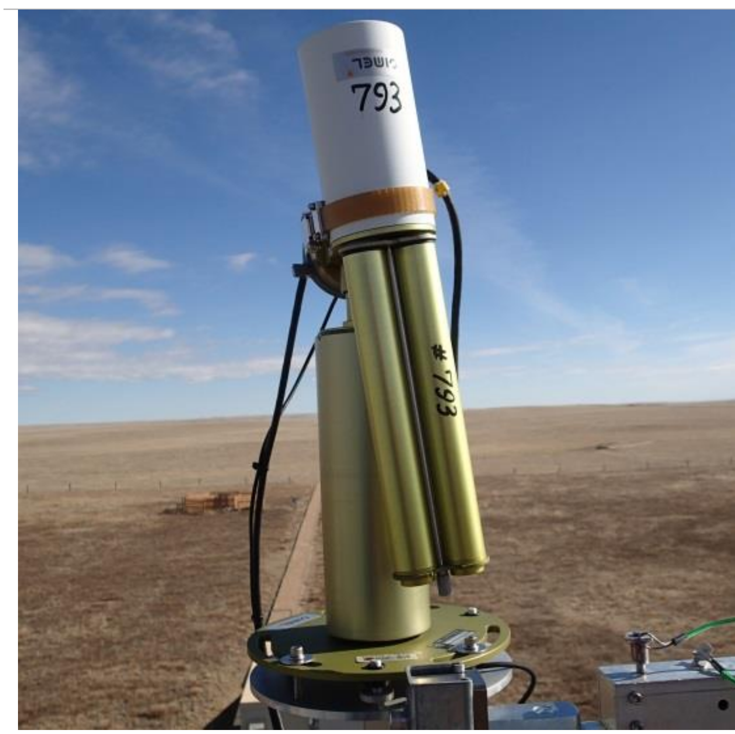


Figure 9. The sensor head when it is in Automatic Mode and parked. Notice that it is pointed downward, but slightly off center from vertical by a few degrees.

Figure 10. The sensor head when it is in Manual Mode, and manually parked. Notice that it is pointed downward and vertical.

4.2.2 Collimator and sensor body

The collimator is attached to one end of the main sensor body (see **Figure 5j**); the end opposite the sensor is the end of the instrument that is pointed towards sun and sky targets. The collimator is a dual open-path channel used to protect the sensor's lenses from environmental elements and narrow incoming light on the two detectors. Each collimator contains several baffles designed to minimize internal reflections. It is secured via a long screw that runs the length of the collimator body, which is located between the two open-path channels (see **Figure 12a** and **Figure 12b**). A knob at one end of the collimator (see **Figure 12b**) loosens and tightens the collimator to the sensor body. Installation of the collimator requires a particular orientation. Several indicators on the collimator and the sensor body (see **Figure 11** - **Figure 16**) exist to support this orientation.

The collimator body itself has two different ends: one faces the lenses, identified by black rubber gaskets with two small holes in the middle of those gaskets (see **Figure 11a**); and the other, which is open (see **Figure 12a**). The end that attaches to the sensor body (faces the lenses) has two rubber gaskets (see **Figure 11a**), a threaded end of the attachment screw (see **Figure 11b**), a half-circular notch for the four quadrant detector (see **Figure 11c** and **Figure 16**), and a solar alignment target dot (see **Figure 11d**). This end contains corresponding areas of attachment and alignment (see **Figure 14**, **Figure 15**, and **Figure 16**).

Table 2. Diagrams showing the collimator parts, sensor body, and alignment markers.

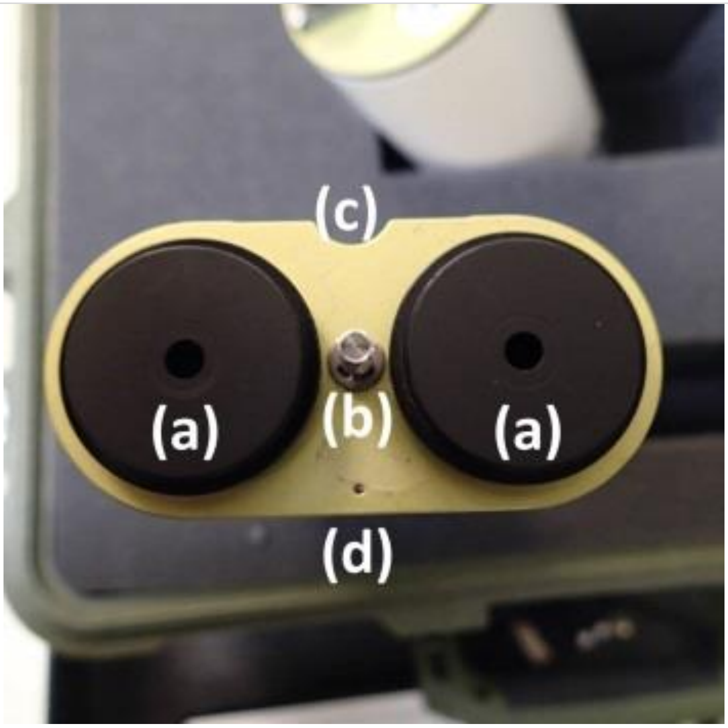


Figure 11. Collimator end that attaches to the sensor body. This is distinguished by the following:

- (a) two black rubber gaskets
- (b) the threaded end of the attachment screw
- (c) a small half-circular notch
- (d) sun spot alignment hole

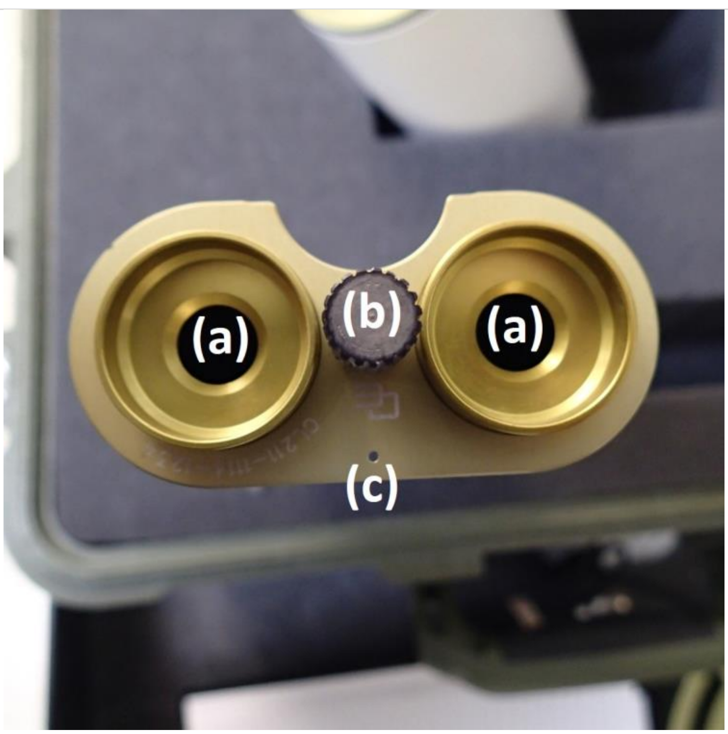


Figure 12. The open collimator end.

- (a) two openings
- (b) a knob used to attach and tighten the collimator to the sensor body
- (c) sun spot alignment hole

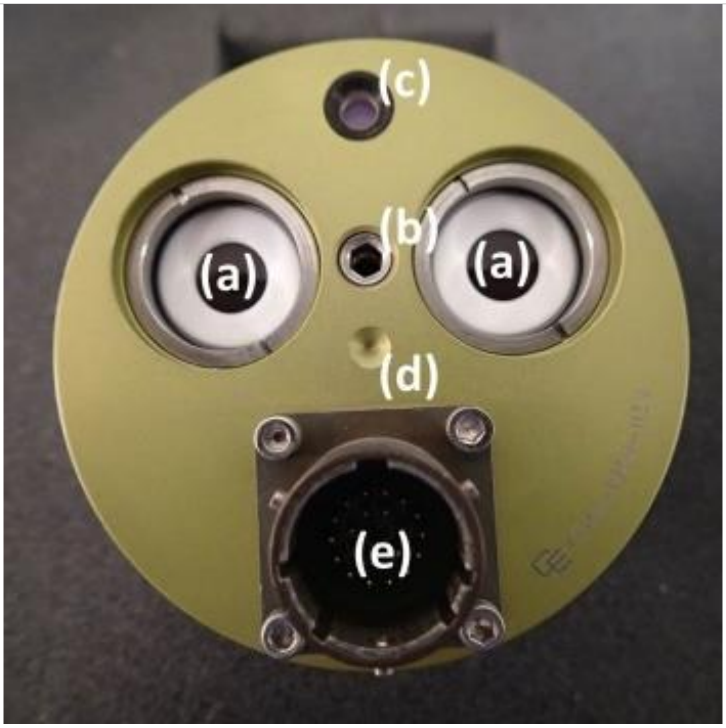


Figure 13. The lens end of the sensor body.

(a) two lenses
(b) screw threads for attaching the collimator
(c) four quadrant detector
(d) sun spot alignment hole
(e) sensor cable connector

The letters (a), (b), (c), and (d) also corresponds to the same letters in **Figure 11** and indicate where they would connect/attach to (see **Figure 14**).

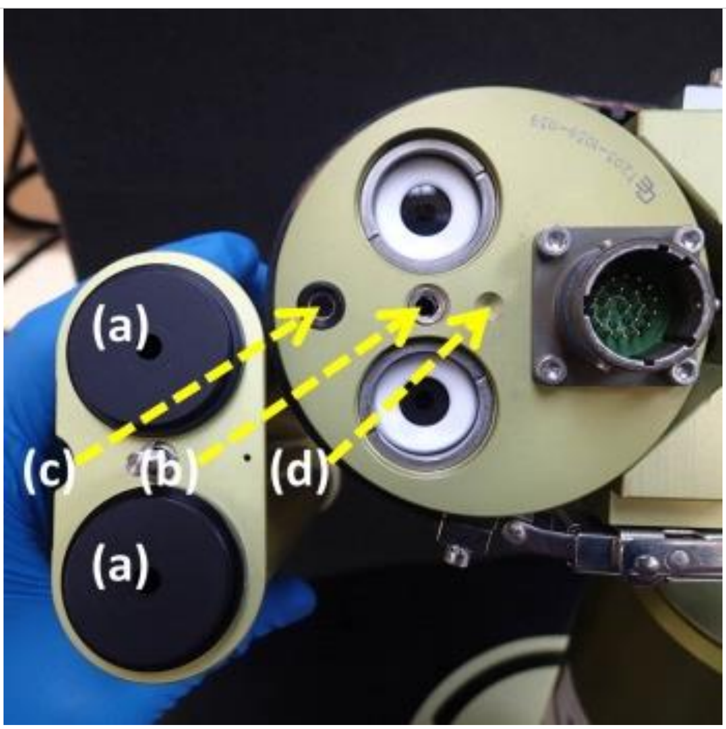


Figure 14. Alignment of the collimator is a matter of matching the (b) threaded screw to the sensor body, the (c) half-circular notch around the four quadrant sensor, and the (d) sun spot alignment hole. The collimator will only properly align in one orientation.

See **Figure 15** and **Figure 16** for additional images of alignment.

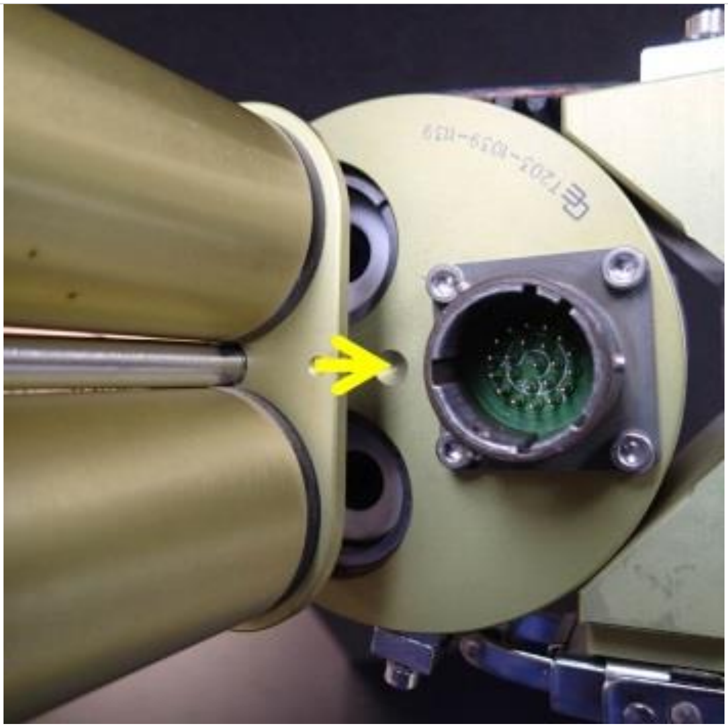


Figure 15. When attaching the collimator to the sensor body, match the alignment hole on the collimator to the hole in the sensor body (yellow arrow).

See also **Figure 16** for the other alignment check.

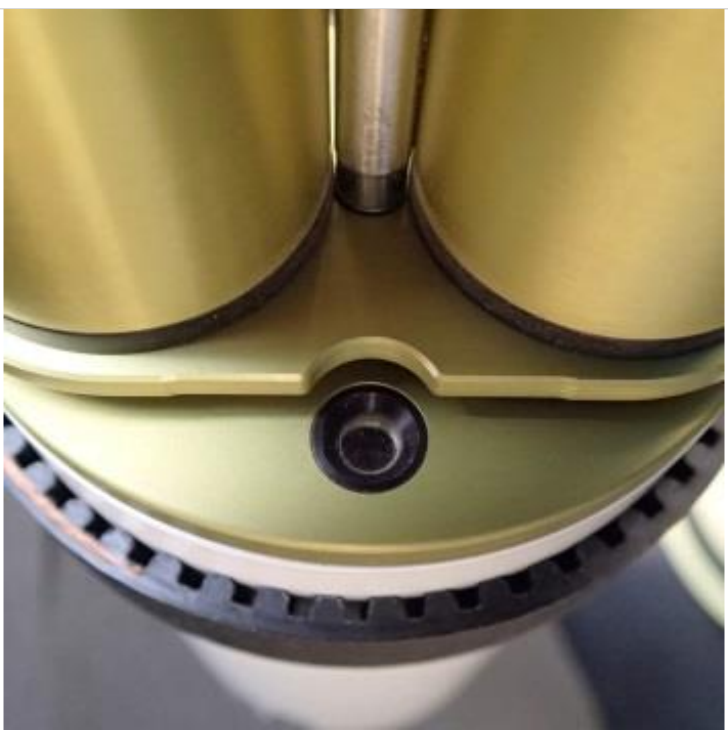


Figure 16. The half-circular notch on the collimator should align along the edge of the four quadrant detector, if properly aligned and installed.

See also **Figure 15** for another alignment indicator.

4.2.3 Control box

The Cimel control box is typically stored inside a weatherproof enclosure away from the instrument (see Figure 7). The weatherproof enclosure is surrounded by a solar radiation shield to help reduce solar heat loading on the enclosure and the internal control box and the Grape (data acquisition and control). The control box is secured within the enclosure with a strap and buckle (see **Figure 18**).

The control box (see **Figure 18**) contains a liquid-crystal display (LCD) panel; four circular user interface buttons that are green, white, yellow, and red (see **Figure 19** and **Figure 20**); and an area for the instrument and power connectors (see **Figure 21**). Cable inputs include those for the wet sensor, the sensor head, the azimuth and zenith motors, and an RS-232 signal connector, which is used for an optional satellite transmitter and/or solar panel, and 12 volts of direct current (VDC) power.

A blank LCD screen is activated with the touch of any of the four circular buttons; it times out in about 80 seconds with no button press activity.

The wetness sensor is a simple resistive type device that informs the instrument if it is raining or not. This sensor is generally mounted off of the Cimel control box enclosure (see **Figure 3**) and angled to allow for water to drain off to mitigate any accumulation.

Table 3. Photos of the Cimel control box.

Figure 17. An opened control box enclosure.

The feature circled in the picture is an aluminum standoff with a foam end that is designed to keep the white connector panel pushed in and secured when the enclosure door is closed.

Figure 18. The Cimel control box within the enclosure.

There is an associated Grape mounted below it, which enables data acquisition and control.

The control box is secured to the enclosure by a strap and buckle.

Figure 19. Zoom-in photo of the LCD panel and the instrument panel buttons.

The LCD panel is inactive unless engaged by selecting any of the four circular green, white, yellow or red buttons.

The LCD panel will time out in about 80 seconds without any button press activity.

Figure 20. The instrument panel buttons and the corresponding colors.

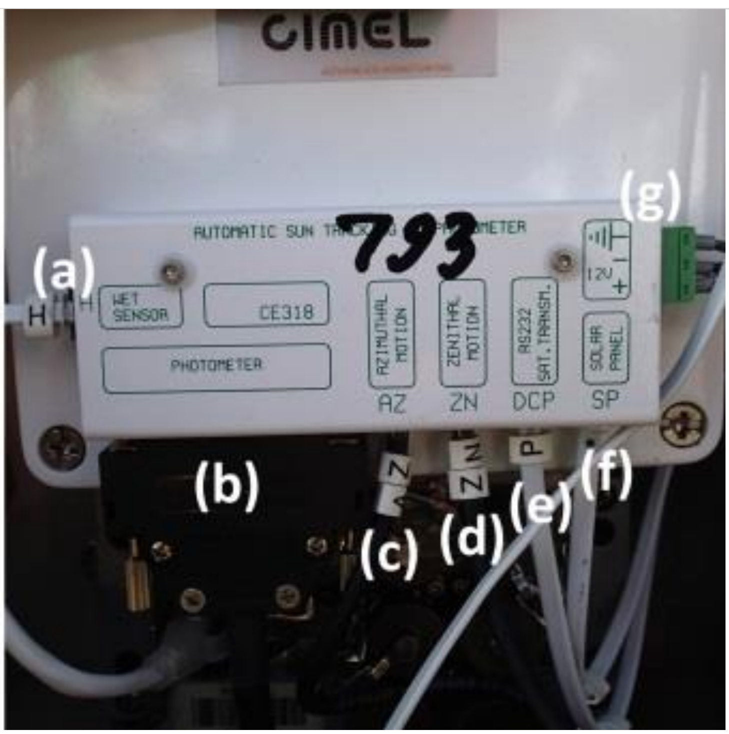


Figure 21. Connector panel on the control box. Inputs includes connectors for the:

(a) wet sensor

(b) the sensor head

(c) the azimuth

(d) zenith motors

(e) RS-232 signal or optional satellite transmitter

(f) optional solar panel

(g) 12 VDC power

The connector panel is secured to the control box by friction of the pins within the interface connector underneath the panel.

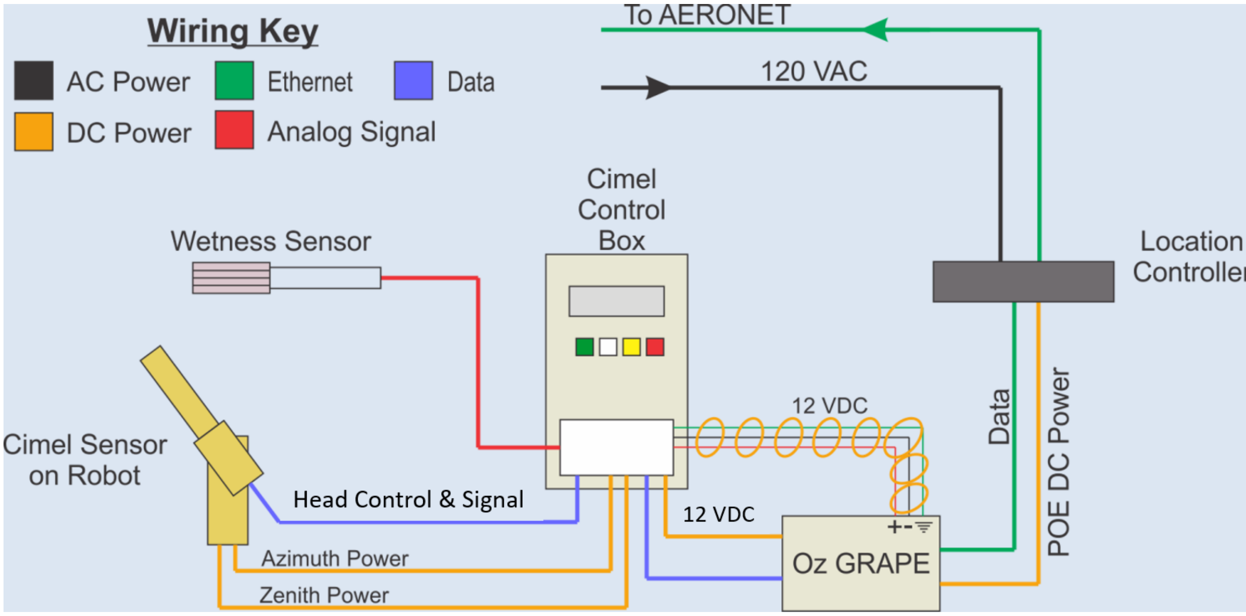


Figure 22. Electrical schematic for the Cimel.

4.3 Sensor Specific Handling Precautions

The sensor body is delicate and care must be taken while handling the instrument. Avoid negligent handling (i.e., inadvertent dropping and/or bumping) the internal electronics of the sensor body to mitigate any potential damage.

The two-axis motorized system has moveable parts that are at risk for damage if their movement is obstructed or blocked. Ensure the system is unhindered; clear away any objects, mounts, cables, etc., that may interfere with the full range of movement of the instrument.

4.4 Operation

The Cimel activates and initiates its measurement sequence several times during daylight hours (i.e., sun above the horizon) to capture a series of automated sun and sky measurements.

Measurements of direct solar irradiance are collected by pointing the collimators in the approximate direction of the sun via an internal algorithm. This algorithm incorporates the instrument location and the time of year (these are input into the control box during installation). Once it points in the approximate direction of the sun, the four quadrant detector fine-tunes the position so the sun is in the center of the FOV of the detectors where internal filters cycle over the detectors and measurements over nine spectral bands (340, 380, 440, 500, 675, 870, 937, 1020 and 1640 nm).

Each measured wavelength takes approximately 10 seconds, and a sequence of three measurements are taken 30 seconds apart, creating a triplet measurement per wavelength. The collection of triplet observations occur during the morning and afternoon Langley calibration sequences. The calculation of optical depth result from the spectral extinction of the direct beam radiation at each wavelength based on the Beer-Bouguer Law. Attenuation due to Rayleigh scattering and absorption by ozone and gaseous pollutants are estimated and removed to isolate the aerosol optical depth (AOD).

Two measurements of sky radiance (Langley sky) develop over four spectral bands (440, 675, 870, and 1020 nm).

- The first set is established along the solar principal plane, where the sensor points at the sky along a plane with the same azimuth angle as the sun and varying the zenith angle (i.e., constant azimuth angle with varied scattering angles), up to nine times per day.
- The second set is established along the solar almucantar plane, where the sensor points at the sky along a conical surface with the same zenith as the sun and varying the azimuth angle (i.e., constant elevation angle with varied azimuth angles), up to six times per day. This is to acquire aureole and sky radiance through a range of scattering angles from the sun through a constant aerosol profile to retrieve size distribution, phase function, and AOD.

The sky radiance measurements are analyzed with inversion algorithms to provide aerosol properties of size distribution and phase function over particle sizes of 0.1 to 5 µm. Optical and physical properties are determined via AOD, Angström coefficient, single scattering albedo, scattering phase function, asymmetry factor, complex refractive index, and size distribution.

Table 4. Observations taken and measurement sequences for the Cimel CE318N.

	SPECTRAL RANGE (NM)	TARGET	NUMBER OF OBSERVATIONS	INTERVAL BETWEEN OBSERVATIONS
BASIC DIRECT SUN	340 to 1640	Sun	1 per filter	~8s between 2 observations with the same filter
Triplet observation	340 to 1640	Sun	3 times the basic direct sun every 30s	~10s for 3 consecutive observations and 30s apart
Standard measurement	340 to 1640	Sun	Variable	Ever 15 min between m=2am and m=2pm
Langley	340 to 1640	Sun	17	m=2 to 5 every 0.25 m=5 to 7 every 0.5
BASIC SKY	440 to 1640	Sky	1 per filter	None
Langley Sky	440 to 1640	Sky	17	m=2 to 5 every 0.25 m=5 to 7 every 0.5
Almucantar	440 to 1640	Sky	72	M=4, 3, 2, 1.7, then hourly between 9am and 3pm
Polarization	870	Sky	42	Hourly between m=3am and m=3pm

	SPECTRAL RANGE (NM)	TARGET	NUMBER OF OBSERVATIONS	INTERVAL BETWEEN OBSERVATIONS
Principal plane	440 to 1640	Sky		Hourly between m=3am and m=3pm

Note: Units, m=air mass

This sensor defaults to an inactive and parked state (see Figure 9); however, it activates multiple times during the day and the robotic mechanism moves the sensor head to cycle through its defined pattern of targets. This action takes several minutes to complete, resulting in the sensor returning back to its parked state. The timing of sensor activation varies as it is site and season specific; activation time may range from every 15 minutes to every few hours. There are no predefined times or simple ways to determine when the instrument will become active as it also depends on an additional variable, the air mass throughout each day.

The Cimel collects measurements only if the sun is above the horizon. It does not collect measurements during rain events or at night.

Once set up, instrument operation is fully automated and data is seamlessly transmitted for processing to Aerosol Robotic Network (AERONET), a global federation of aerosol networks established by the National Aeronautics and Space Administration (NASA). Once processed, those data are pushed back to the observatory for additional actions.

5 INSPECTION AND PREVENTIVE MAINTENANCE

NOTE: If the sensor is active, wait until it completes its measurement routine and returns to its parked state (see **Figure 9**). There may be a delay of up to two minutes after the sensor completes a measurement before the buttons on the control box becomes active again. If already parked, proceed with preventative maintenance.

Prior to conducting maintenance, technicians should review Section 5.1, Preventative Maintenance Procedural Sequence, to understand the order of the full maintenance procedure.

5.1 Preventative Maintenance Procedural Sequence

The sequence for routine preventative maintenance of the Cimel CE318N is, as follows:

1. Place system into Manual Mode (Section 5.4.1)
2. Verify system integrity (Section 5.4.2)
    a. Cables, connectors, sensor head strap, wet sensor
    b. Date and time
    c. Internal battery voltage
    d. Functional check of wet sensor
3. Manually park the system (Section 5.4.3)
4. Verify full range of motion of the robot (Section 5.4.4)
5. Verify that the robot is level (Section 5.4.5)
    a. Adjust level (as needed)
6. Verify that the sensor head is level (Section 5.4.5)
    a. Adjust level (as needed)
7. Check instrument tracking (Section 5.4.6)
    a. Adjust azimuth (as needed)
8. Check for and clear obstructions in collimator (Section 5.4.7)
9. Clean the four quadrant detector (Section 5.4.8)
10. Reattach the collimator (Section 5.4.9)

11. Place system into Automatic Mode (Section 5.4.10)

5.2 Equipment

Table 5. Tools, consumables, and resource lists for maintenance.

Item No.	Description	Quantity
Tools		
1	Small container or bucket	1
2	Line level, bubble, 3”	1
3	Electronic level	1
4	Camel hair brush	1
5	Low scratch nylon tube brush, 3/4” diameter, 4” long (see **Table 6)**	
6	Pliers/Channel Lock pliers	1
7	7/16” nut driver	1
8	3/16” hex bit	1
9	4 mm hex bit	1
10	13 mm socket	1
11	Torque wrenches (in-lb, and ft-lb)	1 or 2
12	Large tool lanyard	1
13	Small tool lanyard	1
14	Telescoping hand mirror	1
15	Small torque wrench socket adapter (1/4” to 3/8”)	1
16	Torque wrench socket adapter (1/2” to 3/8”)	1
17	Torque wrench socket extension (~3”)	1
Consumable items		
1	Distilled of Deionized water (spray or squirt bottle)	~22 oz. bottle
2	95% ethanol (spray or squirt bottle)	~22 oz. bottle
3	0.1M acetic acid	
4	Clean cotton swabs	25
5	Can of compressed air	~10 oz. can
6	Clean lint-free cloths or Kimwipes	A/R
Resources		

Table 6. Sensor-specific parts list to be used for Cimel routine maintenance.

Picture	Item	Specifications and Information
	Cut Off Tip Brush, Black Nylon† † The cut ends should be wrapped with heat-shrink tubing to cover the sharp cut ends.	**Vendor:** Tanis Incorporated **Website:** https://www.tanisbrush.com/catalog/root/06169 **Model Number:** 06169 **Description:** Cut Off Tip Brush **Brush Diameter:** 3/4" **Brush Length:** 4" **Overall Length:** 12" **Bristle Diameter:** 0.008" **Bristle Type:** Black Nylon

5.3 Subsystem Location and Access

The Cimel and its associated control box are located in one of the corners of the tower top (see **Figure 7**). Location of the Cimel on the tower top is site specific.

5.4 Maintenance Procedure

See AD [05] for a comprehensive table of required and recommended preventive maintenance schedules.

5.4.1 Place system into Manual Mode

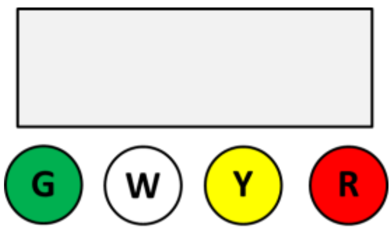
Placing the instrument into Manual Mode before conducting maintenance ensures that the instrument does not activate during this process. The instrument must always be in Manual Mode before performing any service or maintenance.

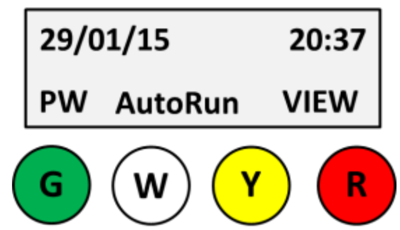
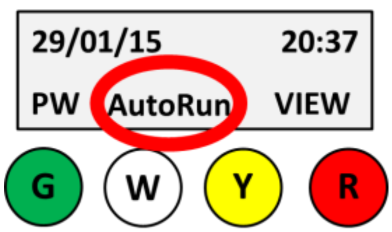
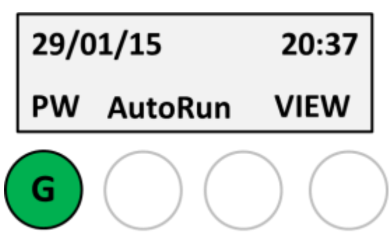
Note: The LCD screen on the control box deactivates if there is no button press activity within 80 seconds. As described in earlier sections of the procedure, pressing any of the four circular buttons reactivates the screen.

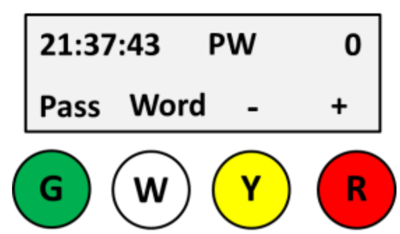
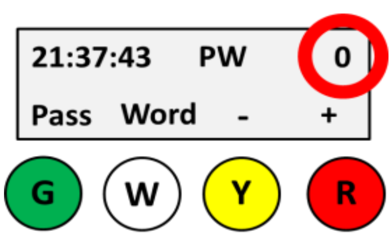
Note: If the sensor is or becomes active before placing the system into Manual Mode, allow the instrument to complete its measurement cycle, then resume placing the system into Manual Mode. This may incur a delay of up to 2 minutes after the sensor completes a measurement before the buttons on the control box are active again.

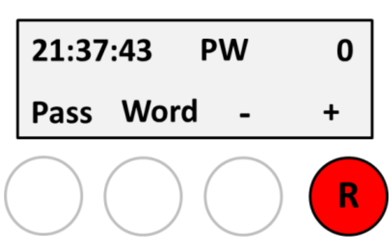
The system may not allow access to the parameters for several minutes after a measurement sequence has completed. Additionally, near solar noon, the system may start a new sequence without allowing access to the parameters. This can create a delay of 30 minutes or more.

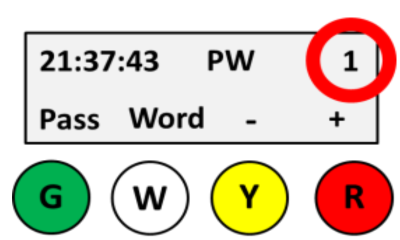
Table 7. Procedure and diagrams for placing the instrument into Manual Mode.

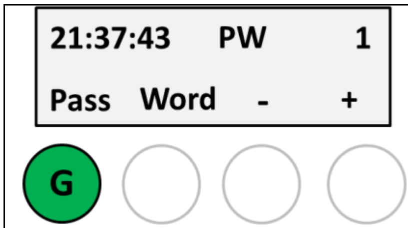
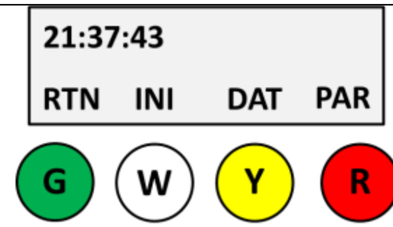
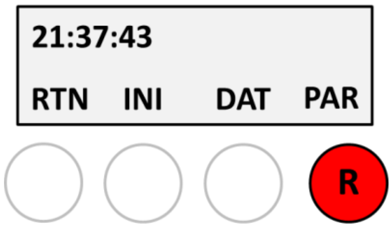
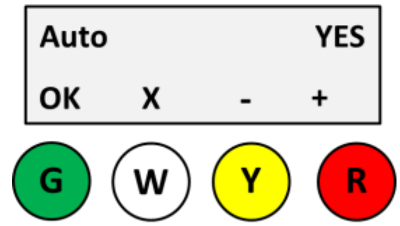
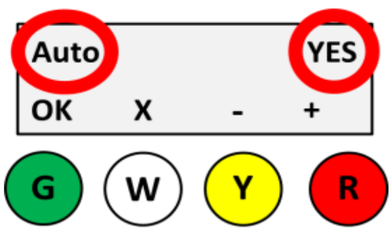
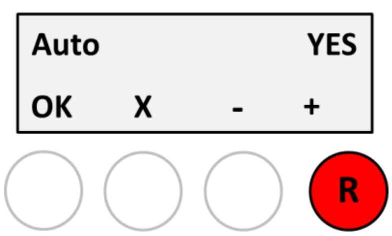
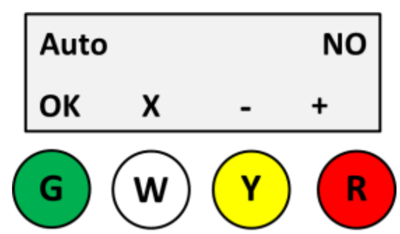
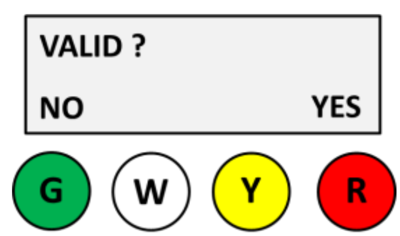
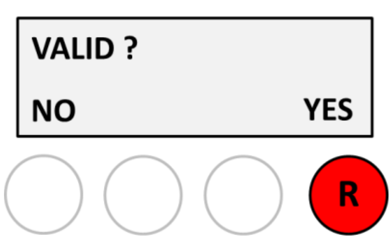
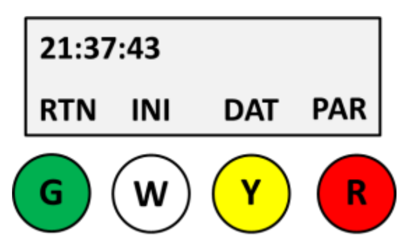
<table>
<tr><td>
</td><td>Step 1. If the LCD screen is blank, select any of the four buttons to activate the menu system.

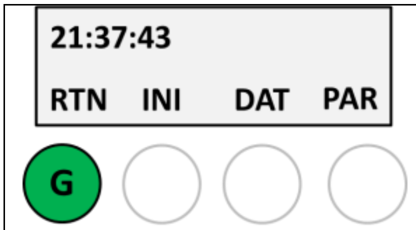
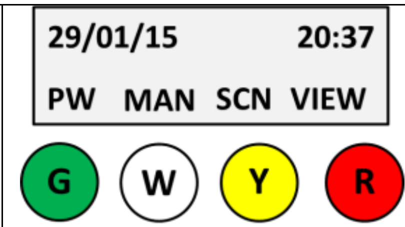
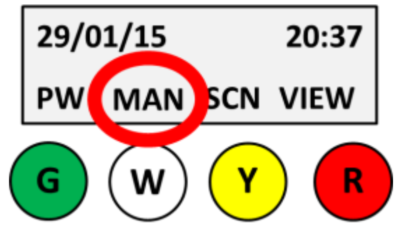
Panel screen will change to this →</td><td>
</td></tr>
<tr><td>
</td><td colspan="2">Step 2. Notice the ‘AutoRun’ above the {White} button. This indicates that the instrument is in Automatic Mode.</td></tr>
<tr><td>
</td><td>Step 3. Select [PW] {Green} button.

Panel screen will change to this →</td><td>
</td></tr>
<tr><td>
</td><td colspan="2">Step 4. Notice the ‘0’ in the upper right of the screen.

This is the password menu level, where 0 is password level 0, and 1 is password level 1, etc. (there are several password levels). This changes in the following step.</td></tr>
<tr><td>
</td><td>Step 5. Select [+] {Red} button. Selecting this button will advance the number in the upper right from ‘0’ to ‘1’. It should be set to ‘1’.

Panel screen will change to this →</td><td>
</td></tr>
<tr><td></td><td>Step 6. Select [Pass] {Green} button.</td><td></td></tr>
</table>

	*Panel screen will change to this →*	
	**Step 7.** Select **[PAR]** {Red} button. The screen will briefly show: "Reading EEPROM. ." *Panel screen will change to this →*	
	**Step 8.** Notice the '**Auto**' in the upper left, and the '**YES**' in the upper right. This indicates that you either want to put it into Automatic Mode (selecting YES), or Manual Mode (selecting NO).	
	**Step 9.** Select **[+]** {Red} button to advance it to 'No'. *Panel screen will change to this →*	
	**Step 10.** Select **[OK]** {Green} button. *Panel screen will change to this →*	
	**Step 11.** Select **[YES]** {Red} button. The screen will briefly show: "Writing EEPROM" *Panel screen will change to this →*	
	Step 12. Select **[RTN]** {Green} button.	

	*Panel screen will change to this →*	
	**Step 13.** Notice the 'MAN' above the {White} button. This indicates that the instrument is in Manual Mode.	

5.4.2 Verify system integrity

Verifying system integrity includes: (1) a visual inspection and check of the instrument cables and connectors; (2) a check of the date and time in Coordinated Universal Time (UTC); (3) a check of the internal battery voltage; and (4) a visual and functional test of the wet sensor.

5.4.2.1 Check cables, connectors, sensor strap, wet sensor

See **Figure 5**, **Figure 6**, and **Figure 21** for examples of the cables and connectors.

1. Visually inspect and check the cable and connectors between the control box and the Grape. Ensure both ends are connected. Examine the cable for any damage.
2. Visually inspect and check the zenith and azimuth cables are connected to the control box. Ensure the cable does not prevent the instrument from full rotation. Examine the cable for any damage.
3. Visually inspect and check the cable and connectors between the sensor head and the control box. Examine the cable for any damage.
4. Check the sensor head cable routing (see **Figure 6**) and ensure the cables do not prevent the instrument from operating through its full range of motion. A subsequent procedure to follow verifies the full range of motion.
    a. If the sensor head cable routing is not as shown in **Figure 6**, disconnect the sensor head cable, reroute, and reconnect.
5. Visually inspect the buckle and strap holding the sensor head to the claw (see **Figure 5g**, **h**). Examine it for any damage, cracks, or corrosion.

If there are cracks in the strap, or corrosion on the buckle submit a ticket via the issue reporting system.

6. Check that the strap holding on the sensor head to the claw is snug. It should hold the sensor head securely.

If the strap is loose, it may have to be replaced, submit a ticket via the issue reporting system.

7. Check that the top of the sensor head is flush (or within 3mm of flush) with the bottom of the claw (see **Table 13**, Step 16).
    a. If greater than 3 mm, this may indicate the strap is loose, see Step 6 above.
8. Check the alignment of collimator is aligned with the back end of the claw (see **Table 13**, Step 18).
    a. If the alignment is off, loosen the strap and align properly.
    b. If the alignment is off, this could indicate the strap is loosening up, see Step 6 above.
9. Check the white connector panel (see **Figure 21**) is properly attached to the control box. If it's seated properly, it should be secure and not loose.
10. There is an aluminum standoff with a foam piece attached to the door of the enclosure that aids in keeping the white connector panel pushed in (see **Figure 17**). Ensure the foam is intact and in good condition.
11. The control box is secured to the enclosure by a strap and buckle (see **Figure 18**). Ensure the strap is tight and holding the control box in place.
12. Visually inspect the wet sensor (see **Figure 3**). Verify it is clear of debris, dirt, or animal droppings. Cleaning of this sensor occurs during the wet sensor functional test (see **Table 8**, Step 7).
13. Verify the wet sensor angle (i.e., not horizontal or vertical). The angle should be about 45° with the patterned surface facing up (see **Figure 4**).

5.4.2.2 Check the date, time, and internal battery voltage

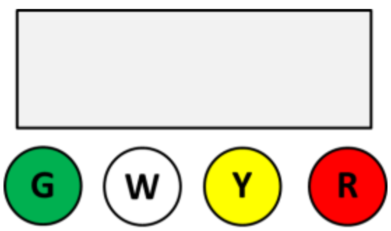
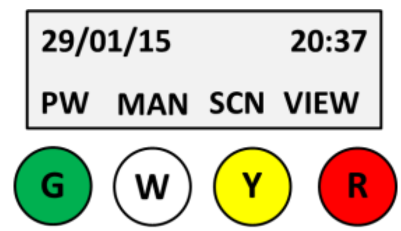
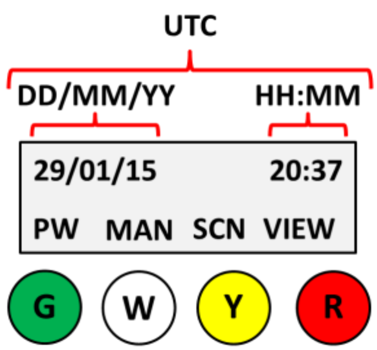
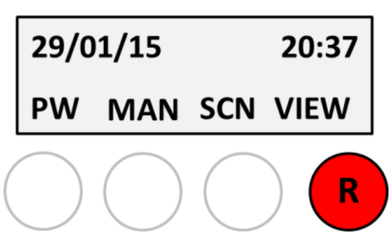
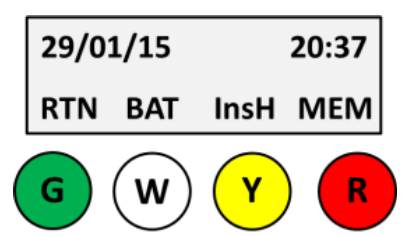
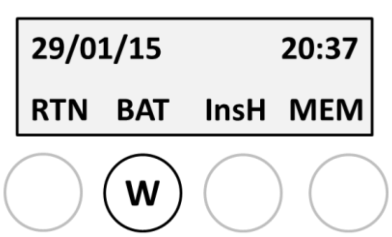
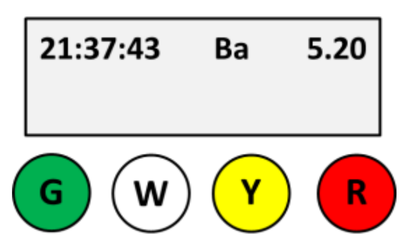
The instrument has an internal clock that is automatically synchronized via the Grape. Verify synchronization to the Grape.

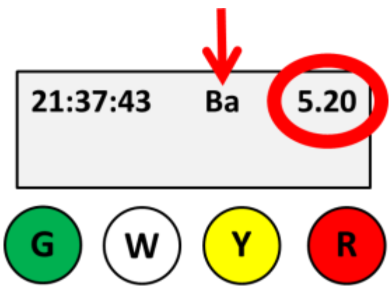
If the internal clock is off by more than one minute, there is a problem with the communications between the Grape and the control box. Submit a ticket via the NEON project Issue Management System.

Technicians require access to an accurate clock, preferably one that is or has recently been synchronized to the National Institute of Standards and Technology (NIST) or the United States Naval Observatory (USNO) time servers. If internet access is available, technicians are recommend to use the online clocks from NIST (http://www.time.gov/) or the USNO (http://tycho.usno.navy.mil/simpletime.html) for accurate time. Additional accurate clocks are the NEON Location Controller (LC) and Global Positioning system (GPS) time (if available and able to achieve a position fix).

Note: The internal clock on the Cimel defaults to UTC. See Appendix Section 8.2 for a list of US time zones and the offsets from UTC.

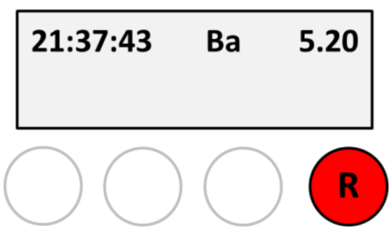
Table 8. Procedure and diagrams for checking the date, time, battery, and wet sensor.

	**Step 1.** If the LCD screen is blank, select any of the four buttons to activate the menu system. *Panel screen will change to this →*	
	**Step 2.** Look at the upper left of the screen and verify that the date is correct (remember that the date and time are UTC). Also, check that the time is within 1 minute of an accurate clock. *If the clock is more than 1 minute off, submit a ticket via the NEON project Issue Management System.*	
	**Step 3.** Select **[VIEW]** {Red} button *Panel screen will change to this →*	
	**Step 4**. Select the **[BAT]** {White} button. *Panel screen will change to this →*	



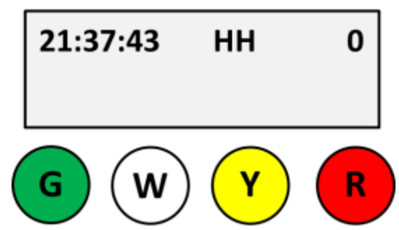
Step 5. The **Ba** indicates that you are monitoring the internal battery. In the example, the battery voltage is 5.20 V.

If the battery voltage is lower than 5.00 V, submit a ticket via the NEON project Issue Management System.



Step 6. Select the {Red} button until the screen reads "**HH**" in the middle.

Panel screen should look like this →



Step 7. Visually inspect the wet sensor for caked on dirt, or bird droppings.

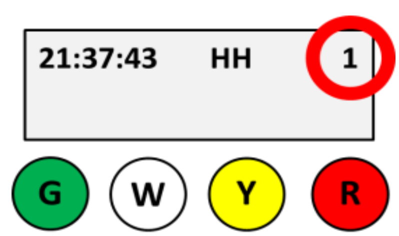
a) If the sensor is clear of caked on dirt of bird droppings, proceed to next step.

b) If the wet sensor is dirty, or has bird droppings, clean the sensor by first spraying distilled or deionized water on it and allow the water to run off, and also allow it to "soak in". Wipe the wet sensor with a clean and dry lint free cloth. Repeat if necessary. Dry thoroughly and make sure the back is dry too. The screen should display a "0" within a minute if dried properly. If not, continue drying until the display shows a "0".

Step 8. Wet the sensor with water and observe whether the HH status changes to '1' within a minute.

Panel screen will change to this →

If the HH is still displaying a '0' after a minute, the connector to the control box may be loose. Disconnect and reseat the connector.



Step 9. If the HH status changes to '1', dry the sensor with a clean and dry lint free cloth and

21:37:43 HH 1 G W Y R	observe that HH changes to a '0' again within a minute. Some wet sensors may take longer than a minute. Be patient. *Panel screen should look like this →*	21:37:43 HH 0 G W Y R

Step 10. Repeat Step 8 and Step 9 once more to verify the wet sensor is functioning properly.

21:37:43 HH 0 G	**Step 11**. Select the {Green} button until you are back to the main screen. *Panel screen should look like this →*	29/01/15 20:37 PW MAN SCN VIEW G W Y R

5.4.3 Manually park the instrument

1. Place the instrument into Manual mode (see Section 5.4.1 and **Table 7**), if not done previously.

Table 9. Procedures and diagrams for manually parking the instrument.

G W Y R	**Step 1.** If the LCD screen is blank, select any of the four buttons to activate the menu system. *Panel screen will change to this →*	29/01/15 20:37 PW MAN SCN VIEW G W Y R
29/01/15 20:37 PW MAN SCN VIEW Y	**Step 2**. Select the **[SCN]** {Yellow} button *Panel screen should look like this →*	← 7.5→v 7.5^ RTN GO - + OFF G W Y R
	Step 3. Select the {Red} button to advance the screen until the text '**PARK**' shows on the lower right of the screen (above the {Red} button).	

← 7.5→v 7.5^ RTN GO - + OFF R	*Panel screen should look like this →*	← 7.5→v 7.5^ RTN GO - + PARK G W Y R
← 7.5→v 7.5^ RTN GO - + PARK W	**Step 4**. Select the **[GO]** {White} button. The screen will briefly show: "activating PARK" The instrument will now move and park the instrument facing downward (see **Figure 10**). *Panel screen should look like this →*	← 0.0→v 0.0^ RTN GO - + PARK G W Y R
← 0.0→v 0.0^ RTN GO - + PARK G	**Step 5**. Select the **[RTN]** {Green} button to return to the main screen. *Panel screen should look like this →*	29/01/15 20:37 PW MAN SCN VIEW G W Y R

5.4.4 Verify the full range of motion of the robot

This section of the procedure verifies the operational capability of the robot to move through its full range of motion without hindrance (e.g., having the sensor head cable binding around the robot or base).

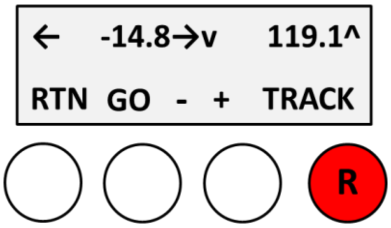
The steps to follow allows a technician to manually run a pre-programmed scenario called the 'Almucantar Scenario', which will take an initial direct sun observation while maintaining the same solar zenith angle and moving through a range of azimuth positions. The Almucantar Scenario is automatically divided into two steps; scanning 180° on each side.

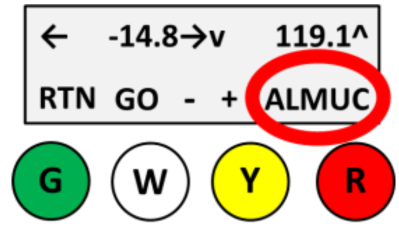
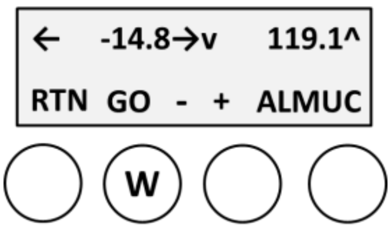
Table 10. Procedure to verify full range of motion of the robot (i.e. Almucantar Scenario)

G W Y R	**Step 1.** If the LCD screen is blank, select any of the four buttons to activate the menu system. *Panel screen will change to this →*	29/01/15 20:37 PW MAN SCN VIEW G W Y R

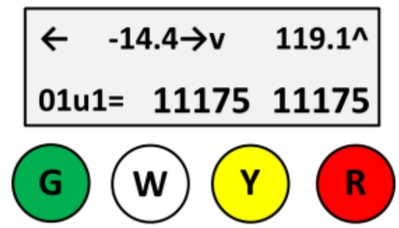
Step 2. Manually [PARK] the instrument (see **Table 9**).

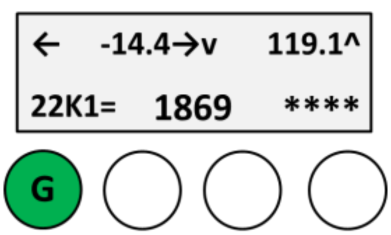
29/01/15 20:37 PW MAN SCN VIEW Y	**Step 3.** Select the **[SCN]** {Yellow} button *Panel screen should look like this →*	← 0.0→v 0.0^ RTN GO - + PARK G W Y R
← 0.0→v 0.0^ RTN GO - + PARK R	**Step 4.** Select the {Red} button to advance the screen until the text '**GOSUN**' shows on the lower right of the screen (above the {Red} button). *Panel screen should look like this →*	← 0.0→v 0.0^ RTN GO - + GOSUN G W Y R
← 0.0→v 0.0^ RTN GO - + GOSUN W	**Step 5.** Select the [**GO**] {White} button. The screen will briefly show: "activating GOSUN" The instrument will now move and point towards the direction of the sun (see **Figure 7**) *Panel screen should look something like this →*	← -10.2→v 103.5^ RTN GO - + GOSUN G W Y R
← -10.2→v 103.5^ RTN GO - + GOSUN R	**Step 6.** Select the {Red} button to advance the screen until the text '**TRACK**' shows on the lower right of the screen (above the {Red} button). *Panel screen should look like this →*	← -15.2→v 119.6^ RTN GO - + TRACK G W Y R
← -15.2→v 119.6^ RTN GO - + TRACK W	**Step 7.** Select the [**GO**] {White} button. The screen will briefly show: "activating TRACK" The robot will make micro-adjustments to precisely align itself with the sun.	← -14.8→v 119.1^ RTN GO - + TRACK G W Y R

<table>
<tr><td></td><td>Panel screen should look like this →</td><td></td></tr>
<tr><td>
</td><td>Step 8. Select the {Red} button to advance the screen until the text ‘ALMUC’ shows on the lower right of the screen (two button presses).

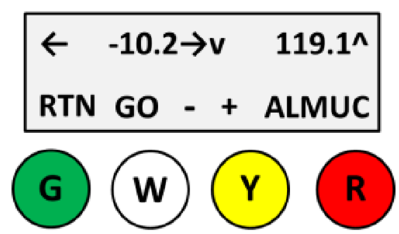
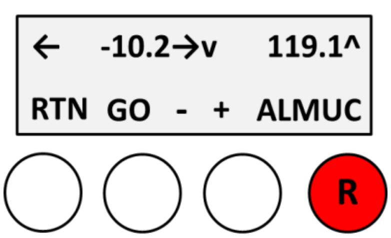
Panel screen should look like this →</td><td>
</td></tr>
<tr><td>
</td><td>Step 9. Select the [GO] {White} button.

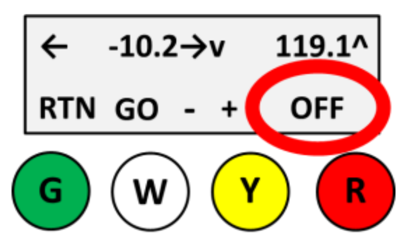
The instrument will now move and rotate 180° on one side, return so it points back to the sun, and then rotate 180° on the other side. It will repeat this indefinitely until stopped.

Panel screen will constantly change as the instrument runs the Almucantar scenario →</td><td>
</td></tr>
<tr><td colspan="3">Step 10. While the Almucantar scenario is running, observe that the full range of motion of the sensor head and robot is not being inhibited by its cables, either by the cables contacting the robot, or the sensor head. Observe at least one pair of 180° rotations.

If the cables are binding the robot or sensor head, stop the scenario (see Step 11 below) and follow the instructions in Section 5.4.2.1, Step 4.</td></tr>
<tr><td>
</td><td>Step 11. Select the {Green} button to stop the Almucantar scenario.

The instrument will stop moving.

Panel screen should look like this →</td><td>
</td></tr>
<tr><td>
</td><td>Step 12. Select the {Red} button to advance the screen until the text ’OFF’ shows on the lower right of the screen (above the {Red} button).

Panel screen should look like this →</td><td>
</td></tr>
<tr><td></td><td>Step 13. Select the [GO] {White} button.</td><td></td></tr>
</table>

← -10.2→v 119.1^ RTN GO - + OFF W	*Panel screen should look like this →*	← -10.2→v 119.1^ RTN GO - + OFF G W Y R
← -10.2→v 119.1^ RTN GO - + OFF R	**Step 14.** Select the {Red} button to advance the screen until the text '**PARK**' shows on the lower right of the screen (above the {Red} button). *Panel screen should look like this →*	← -10.2→v 119.1^ RTN GO - + PARK G W Y R
← -10.2→v 119.1^ RTN GO - + PARK W	**Step 15**. Select the **[GO]** {White} button. The screen will briefly show: "activating PARK" The instrument will now move and park the instrument facing downward (see Figure 10) *Panel screen should look like this →*	← 0.0→v 0.0^ RTN GO - + PARK G W Y R
← 0.0→v 0.0^ RTN GO - + PARK G	**Step 16**. Select the **[RTN]** {Green} button to return to the main screen. *Panel screen should look like this →*	29/01/15 20:37 PW MAN SCN VIEW G W Y R

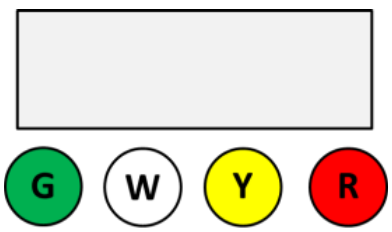
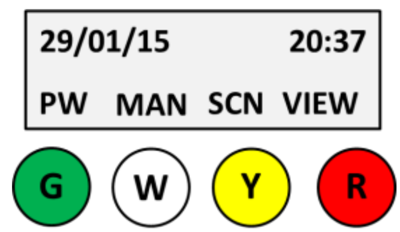
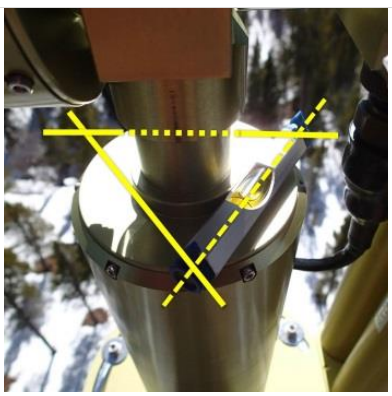
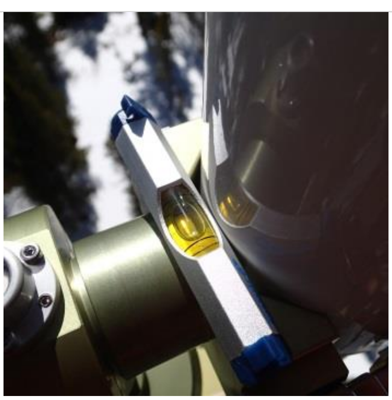
5.4.5 Verify that the robot and parked sensor head are level

The robot and parked sensor head must be level. To properly level the instrument, it must be in Manual mode and in the parked position. A parked sensor in Manual Mode is in a vertical alignment (see **Figure 10**).

Note: If the instrument is parked and in Automatic Mode, it will not be level (see **Figure 9**). It must be in Manual Mode and in the parked position.

5.4.5.1 Check the level of the robot and sensor head

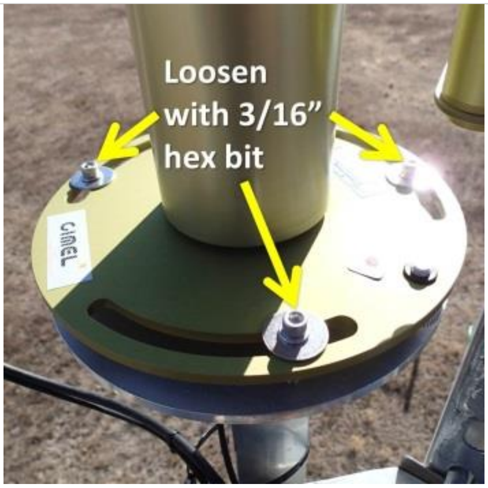
Table 11. Procedure and diagram to check the level of the robot and sensor head.

	**Step 1.** If the LCD screen is blank, select any of the four buttons to activate the menu system. *Panel screen will change to this →*	
Step 2. Manually [PARK] the instrument (see **Table 9**).		
	**Step 3.** Place a small precision spirit level at the top of the vertical motor cylinder. Check the level along three horizontal planes as shown to the left. a) If it is level, continue to next step. b) If it is not level you will have to level the robot base, see Section 5.4.5.2 for leveling procedures.	
	**Step 4.** Place a small 3” precision spirit level at the top part of the claw and check level. a) If it is level, continue to Section 5.4.6. b) If it is not level you will have to level the claw, see Section 5.4.5.3 for leveling procedures.	

5.4.5.2 Adjust the level of the robot base

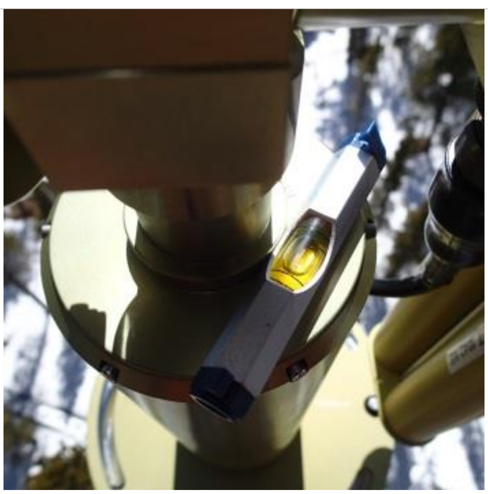
If the robot is not level, as determined in **Table 11**, Step 3, follow the procedure in **Table 12** for directions on how to level the base.

Table 12. Procedures and diagrams for leveling the base.

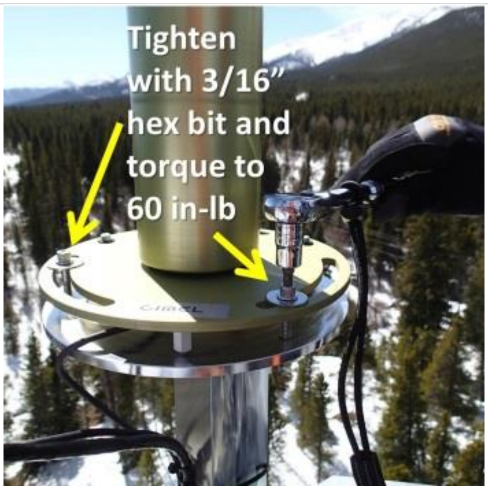
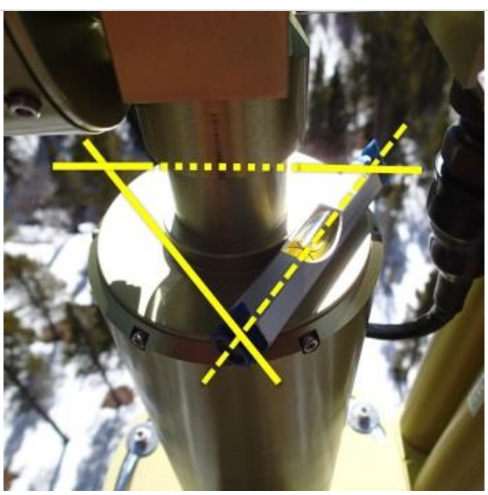


Step 1. Loosen the three socket head screws with a 3/16" hex bit.

Care should be taken not to back the screws all the way out, as they can easily drop.



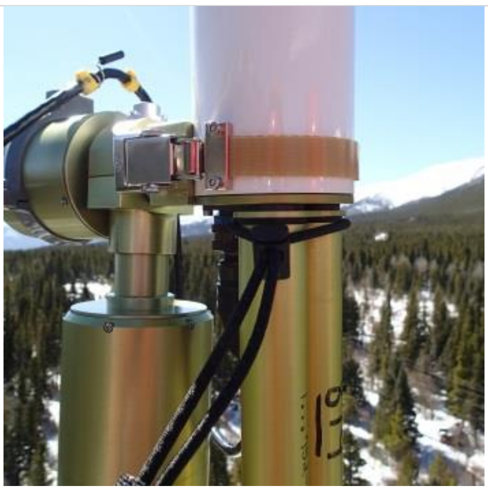
Step 2. Place a small precision spirit level at the top of the vertical motor cylinder.

	**Step 3.** Adjust the two thumbscrews up or down on the base until level. Make minor adjustments and recheck level along the three horizontal planes (see **Table 11**, Step 3) frequently, as adjustments are made.
	**Step 4.** Once level, tighten down the three socket head screws with a 3/16" hex bit, and torque to **60 in-lb**.
	**Step 5.** Verify level once more along three horizontal planes.

5.4.5.3 Adjust the level of the sensor head

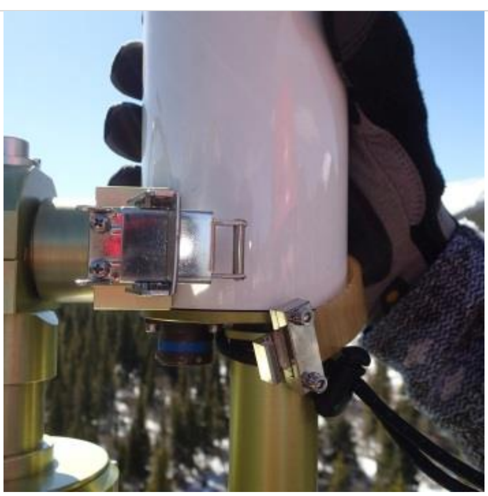
If the sensor head is not level, as determined in **Table 11**, Step 4, refer to Table 13 for directions on how to level the sensor head.

Table 13. Procedures and diagrams for leveling the sensor head.

Step 1. Manually [PARK] the instrument (see **Table 9**).	
	**Step 2.** Attach a large tool lanyard to the collimator as shown to secure it from falling to the ground.
	**Step 3.** Hold the sensor body and disconnect the sensor head cable from the sensor body. Slightly rotate the sensor head to allow for easier removal of the connector, if necessary. Once removed, you can let the sensor head cable dangle out of the way as it should still be attached to the cable holder on the robot. The sensor head cable connector is a MIL Spec twist connector.

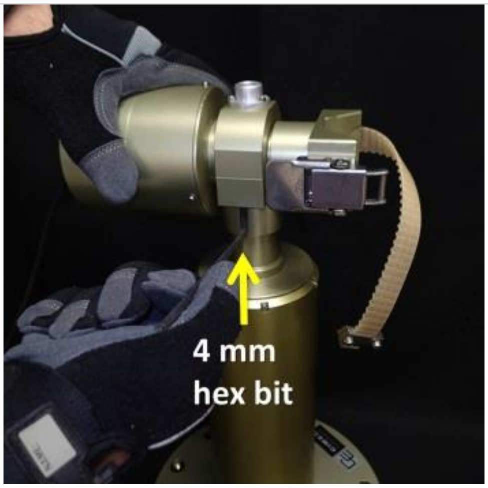
Step 4. Hold the sensor body and unbuckle the strap that holds the sensor body to the claw.

Step 5. While holding the sensor body, release the clasp that attaches the strap to the buckle.



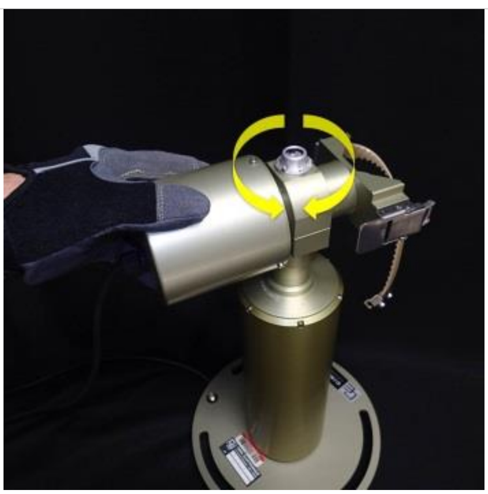
Step 6. Gently remove the sensor head and place in a secure location away from the elements, and in an area where it will not get damaged.

Step 7. Manually [PARK] the instrument (see **Table 9**).



Step 8. Hold the zenith motor and with a 4 mm hex bit, loosen the screw ¼ turn.

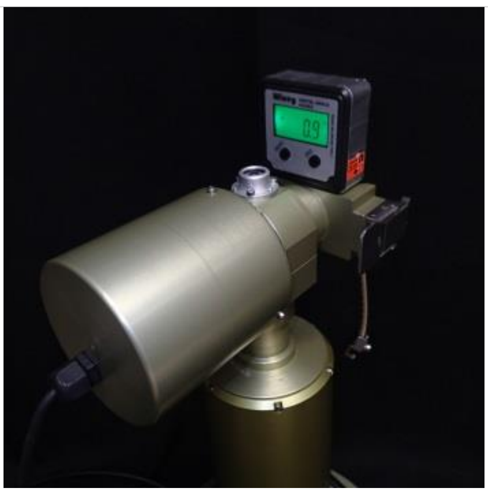
To keep the mounting bracket evenly secured, each hex screw should be loosened by the same amount when doing this procedure.



Step 9. Holding the zenith motor, rotate the motor and claw 180° to access other side.

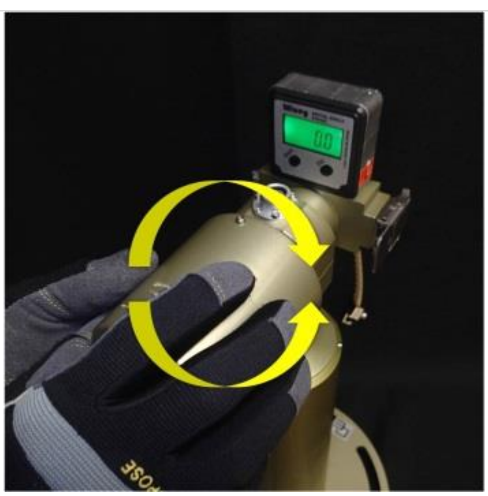
Step 10. Hold the zenith motor and with a 4 mm hex bit, loosen the screw ¼ turn.

To keep the mounting bracket evenly secured, each hex screw should be loosened by the same amount when doing this procedure.

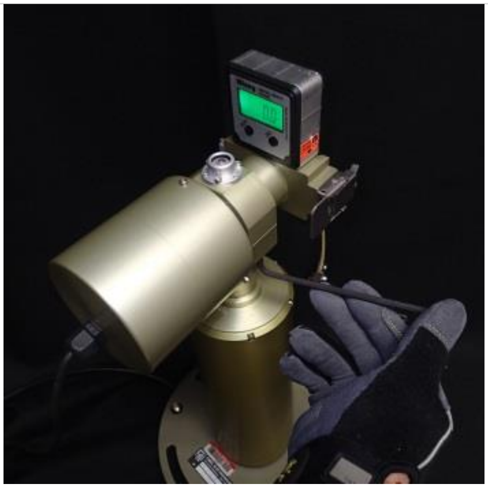


Step 11. Place an electronic level on the claw and check if it is level.

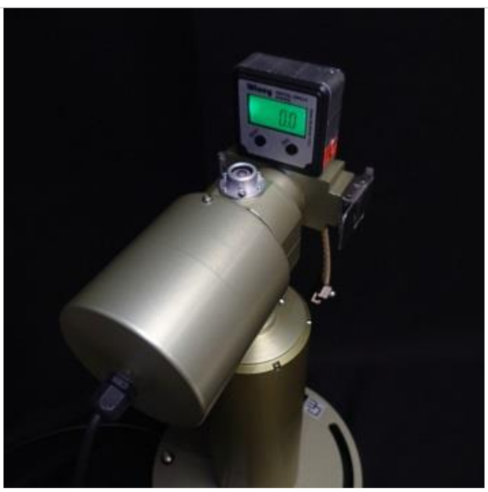
If not, proceed to the next Step.

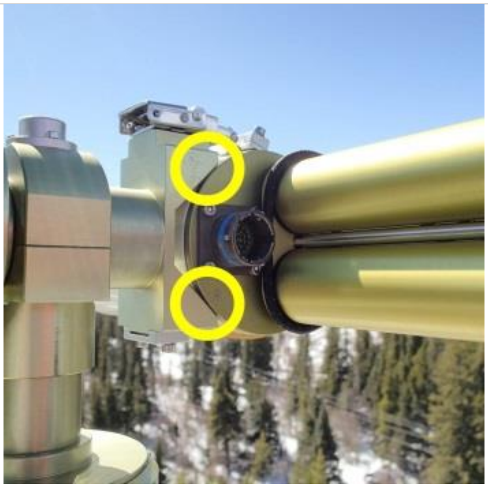


Step 12. To level the claw, hold the zenith motor and rotate along the motor's axis until the claw is level.

	**Step 13.** Re-tighten box hex screws with a 4 mm hex bit. To keep the mounting bracket evenly secured, each hex screw should be tightened by the same amount when doing this procedure.

Step 14. Manually [PARK] the instrument (see **Table 9**).

	**Step 15.** Verify the level once more.

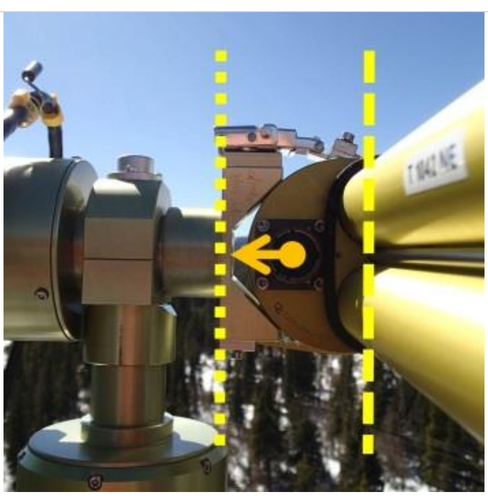


Step 16. Re-install the sensor head, and secure the strap. Remember the sensor head will be pointing downward.

Align the face of the sensor body so it is flush with the bottom of the claw (or within 3mm).

Step 17. Gently rotate the sensor head so it is horizontal and the collimator is facing towards you.

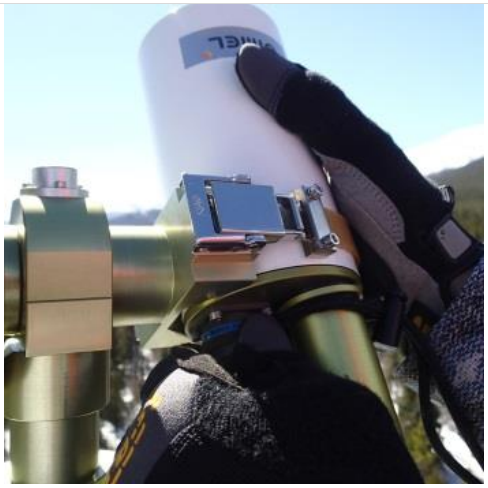
This will make it easier to align the sensor head with claw.



Step 18. Align the sensor with respect to the back edge of the claw. The collimator should be parallel with the back edge of the claw.

The alignment of the sensor head with respect to the claw should be as shown in the picture to the left.

The sensor head cable connector should be directly opposite the zenith nut (orange arrow), and the long axis of the collimator (dashed line) is parallel with the back edge of the claw (dotted line).



Step 19. Remove or slide the tool lanyard down the collimator and reconnect the sensor head cable to the sensor head. The MIL Spec connector should 'click' in place when fully secured.

The tool lanyard may get in the way of fully securing the MIL Spec connector, so it is suggested to slide it down the collimator and out of the way or just remove the tool lanyard.

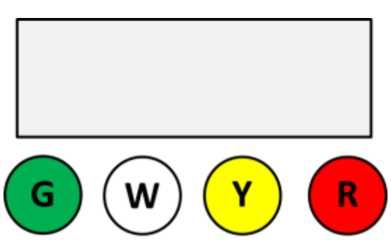
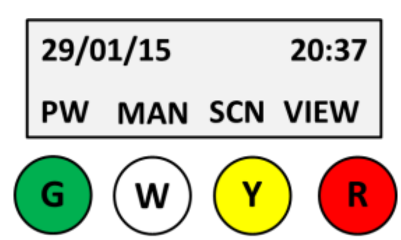
Step 20. Manually [PARK] the instrument (see **Table 9**).

5.4.6 Check instrument tracking

Note: Checking the instrument tracking can only be done on sunny days or days when the sun is not completely obscured by clouds. If the sky is overcast and/or the instrument does not have a clear view of the sun, checking the instrument tracking can be postponed until there is a clear view of the sun.

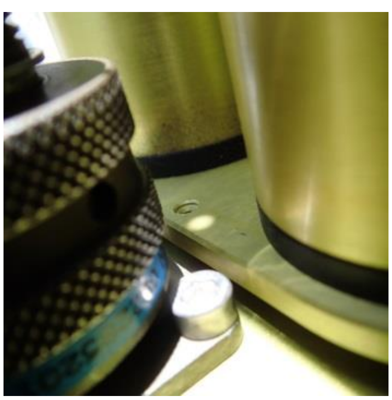
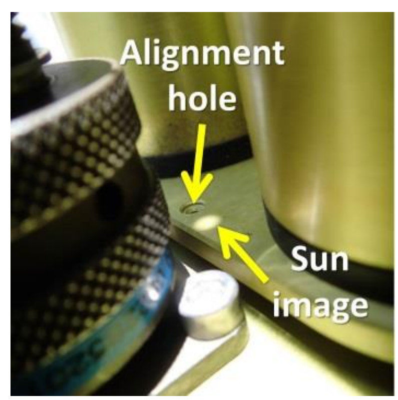
Note: The GOSUN scenario described below runs as if it is currently manually parked, therefore the instrument must ALWAYS be manually parked (see **Table 9**) before running the GOSUN scenario. If the GOSUN scenario is run before manually parking the instrument, it will point inaccurately, and the instrument tracking cannot be performed. ALWAYS manually park the instrument before running each GOSUN scenario.

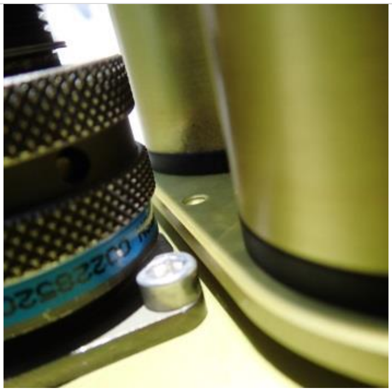
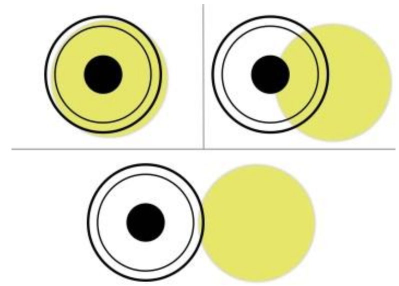
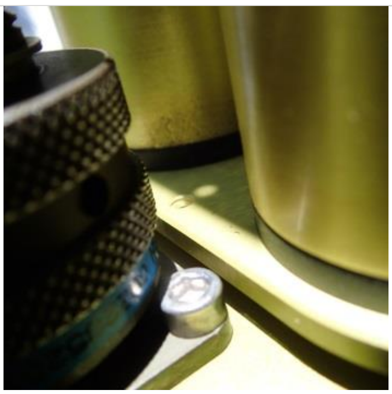
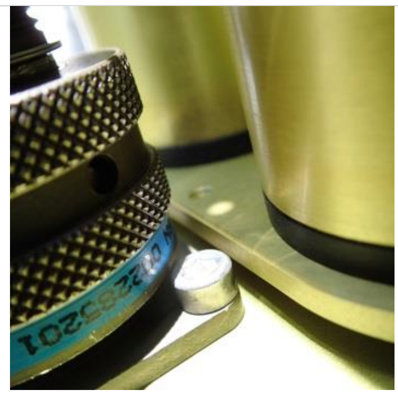
Table 14. Procedures and diagrams to check instrument tracking.

	**Step 1.** If the LCD screen is blank, select any of the four buttons to activate the menu system. *Panel screen will change to this* →	

Step 2. Manually [PARK] the instrument (see **Table 9**).

29/01/15 20:37 PW MAN SCN VIEW Y	**Step 3.** Select the **[SCN]** {Yellow} button *Panel screen should look like this →*	← 0.0→v 0.0^ RTN GO - + PARK G W Y R
← 0.0→v 0.0^ RTN GO - + PARK R	**Step 4.** Select the {Red} button to advance the screen until the text '**GOSUN**' shows on the lower right of the screen (above the {Red} button). *Panel screen should look like this →*	← 0.0→v 0.0^ RTN GO - + GOSUN G W Y R
← 0.0→v 0.0^ RTN GO - + GOSUN W	**Step 5.** Select the [**GOSUN**] {White} button. The screen will briefly show: "activating GOSUN" The instrument will now move and point towards the direction of the sun (see Figure 7) *Panel screen should look something like this →*	← -10.2→v 103.5^ RTN GO - + GOSUN G W Y R

	**Step 6.** A sun image will shine through the pinhole at the top end of the collimator and onto the base of the collimator (by the sensor head cable connector). A telescoping mirror may make it easier to see the sun image as the Cimel is mounted above the tower top rail.	

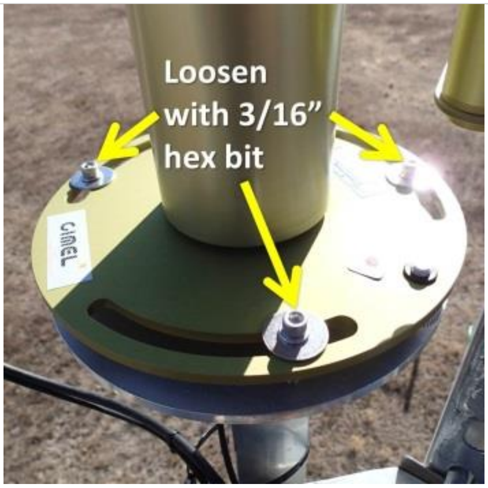
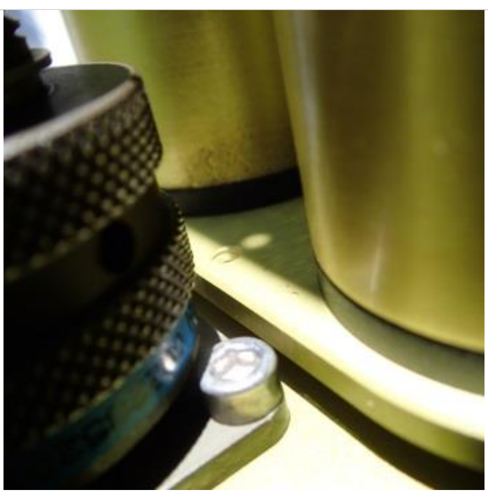
	**Step 7.** If perfectly aligned, the sun image should overlap with the alignment hole at the base of the collimator (left). As long as the sun image overlaps with the edges of the alignment hole (see examples to the right), then its considered properly aligned.	
	**Step 8.** Visually check to see if the sun image is overlapping the alignment hole (see **Table 14**, Step 7) (e.g. left image). a) If no adjustments are needed, continue to next Step. b) If the sun image is not overlapping (e.g. right image) the alignment hole, continue to Section 5.4.6.1 for adjusting the azimuth.	

Step 9. Manually [PARK] the instrument (see **Table 9**).

5.4.6.1 Adjusting the azimuth

If the sun spot does not align to within 2mm of the alignment target as determined in **Table 14**, Step 8, adjust the azimuth of the robot base.

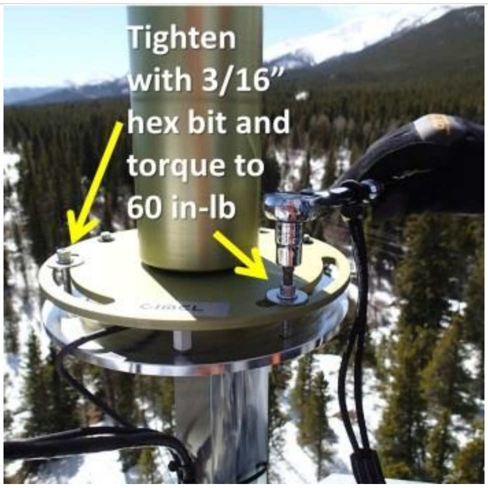
Table 15. Procedures and diagrams for adjusting the azimuth of the robot base.

	**Step 1.** Loosen the three socket head screws with a 3/16" hex bit. Loosen these screws enough to rotate the base.
	**Step 2.** Rotate the base and observe the direction the sun spot moves when rotated.
	**Step 3.** Rotate the base as needed until the sun spot is horizontally aligned with the alignment target.

Step 4. Re-run the [**PARK**] scenario (see Table 9) and [**GOSUN**] scenario (see **Table 14**) immediately afterwards and check the alignment again

You should re-run the [**PARK**] and [**GOSUN**] scenarios a minimum of three times to verify alignment.

The sun image should overlap the edges of the alignment hole (see **Table 14**, Step 7) at least three consecutive times.



Step 5. Once aligned, tighten down the three socket head screws with a 3/16" hex bit, and torque to 60 **in-lb**.

Step 6. Manually [PARK] the instrument (see **Table 9**).

5.4.7 Check for and clear obstructions in collimator

5.4.7.1 Removing the collimator

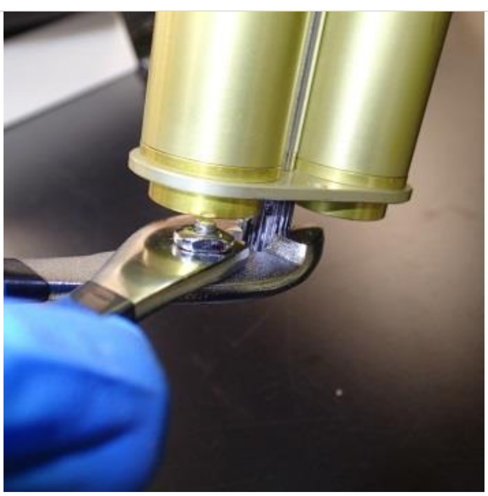
Table 16. Procedure and diagrams for removing the collimator.

Step 1. Gently grab hold of the sensor body and slowly rotate the body so the collimator is approximately 45° from vertical.

It may require a slight rotation along its azimuth so the collimator is over the tower platform.

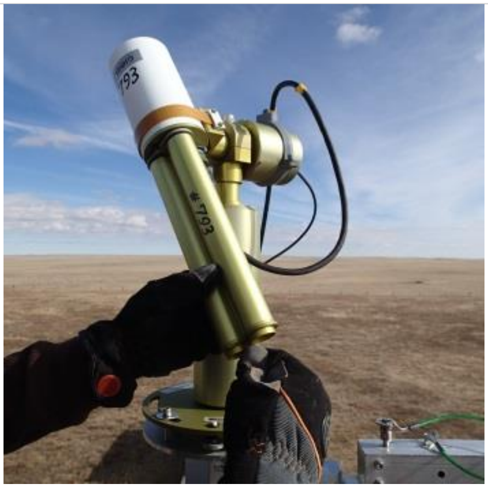
Step 2. The sensor body and collimator should be rotated so it is about a 45° angle from vertical, or enough to clear the mounting base or other tower support.

To prevent any debris from getting on the lenses, do not point the sensor body above horizontal.



Step 3. Hold steady the collimator, and use a pair of pliers to initially loosen the screw knob at the end of the collimator if cannot be loosened by hand.

When the collimator is attached, it is first finger tightened and then turned an additional quarter turn with a pair of pliers.



Step 4. While holding the collimator, loosen the screw knob the remaining way with your fingers.

Support the collimator while conducting this action as it may become loose.

Step 5. Once the collimator is loose, pull the collimator free along the same angle that the sensor body is already positioned.

⚠ **IMPORTANT:** At this point, the lenses are exposed! **DO NOT** allow anything to touch the surface of the lenses, and **DO NOT** clean the lenses!

If the lenses are accidentally touched while exposed, please make a note and submit a ticket via the NEON project Issue Management System indicating the date, time, and lense(s) were affected. This information is required in order for CVAL and AERONET to make appropriate adjustments to the data stream and data post-processing.

5.4.7.2 Cleaning the collimator

Table 17. Procedure and diagrams for cleaning the collimator.

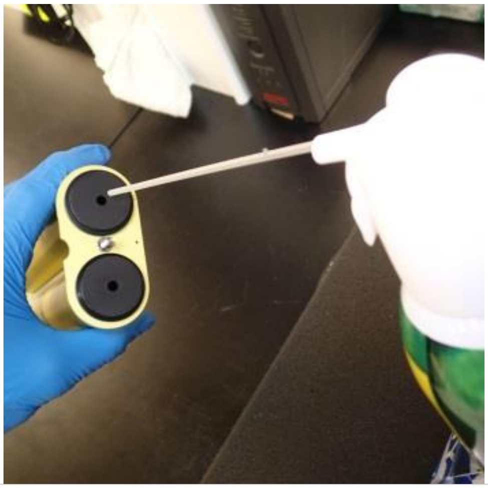
Step 1. Take a look through the open ends of the collimator. This is a check to see if there are any spider webs or other obstructing debris.

Step 2. Hold collimator so the end that attaches to the sensor body is facing you. Inspect the rubber gaskets for cracks or tears, particularly around the two center apertures. Cracks and tears will cause additional stray light to leak through to the detectors.

If cracks and/or tears are present in these gaskets, submit a ticket via the NEON project Issue Management System.

Step 3. Check to see that there is a metal clip still attached to the end of the threaded screw end.

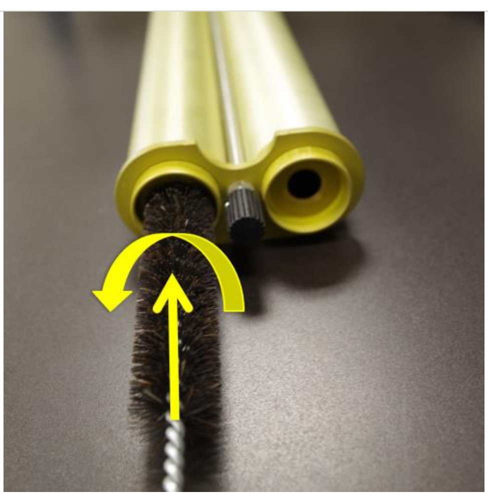
If the metal clip is missing, submit a ticket via the NEON project Issue Management System.



Step 4. Insert the tube from a compressed air canister and apply two short blasts of air. This will help quickly loosen any dust or spider webs.

If dust is encountered on top of the gaskets, gently blow it off.

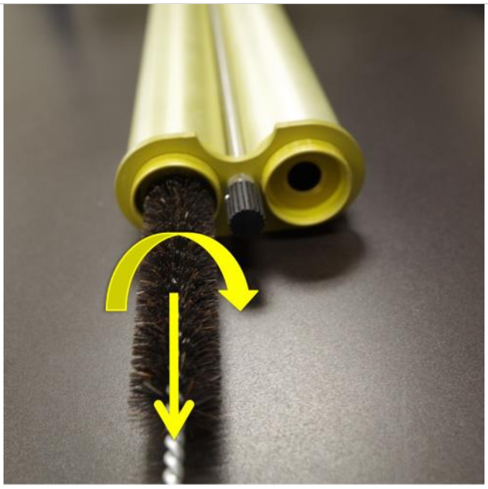
Step 5. Turn the collimator over so the open end is facing you.



Step 6. Insert the specified brush into the open end of the collimator and slowly move it through the column with a <u>counter-clockwise twisting motion</u> until the end of the brush hits the end of the collimator.

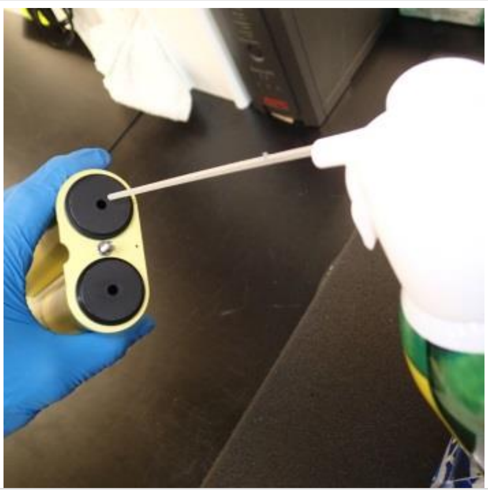
As you insert the brush you will “feel” the brush and bristles hitting up against the internal baffles. Gently twisting the brush counter-clockwise as you push in allows the brush to gently pass through the baffle holes without dislodging them.

Do not force the brush. If it gets ‘stuck’, gently twist the brush clockwise to slightly back out and remove, and then retry the counter-clockwise insertion.



Step 7. Once the brush hits the end of the collimator, slowly remove the brush by pulling it through the column with a <u>clockwise twisting motion</u> until completely removed.

Step 8. Repeat **Step 6** and **Step 7** one more time, and then proceed to the next Step.



Step 9. Follow with two more short blasts of air through each collimator side.

	**Step 10.** Take one last look through the open ends of the collimator to ensure that there isn't any remaining blocking debris. If so, repeat procedure until clear.

5.4.8 Clean the four quadrant detector

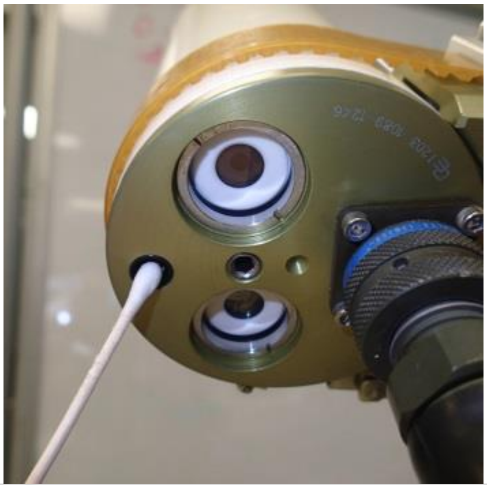
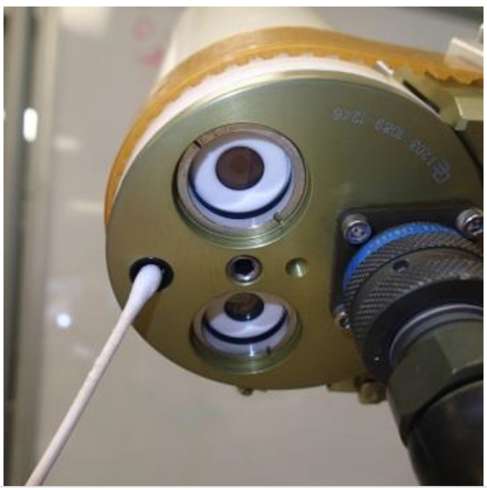
Now that the collimator is removed, it is a good time to check and clean the four quadrant detector. Follow the procedures in **Table 18**.

Table 18. Procedure and diagrams to clean the four quadrant detector.

IMPORTANT: The two lenses are exposed! **DO NOT** allow anything to touch the surface of the lenses, and **DO NOT** clean the lenses!

If the lenses are accidentally touched while exposed, please make a note and submit a ticket via the NEON project Issue Management System indicating the date, time, and lense(s) were affected. This information is required in order for CVAL and AERONET to make appropriate adjustments to the data stream and data post-processing.

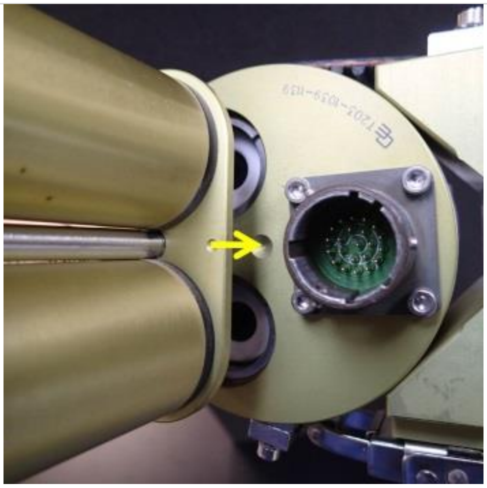
	**Step 1.** Visually inspect the four quadrant detector for dust, dirt, or spider webs.

	**Step 2.** Dampen a clean cotton swab with distilled or DI water and gently wipe clean the four quadrant detector window. Dry the detector with a dry cotton swab, lint free cloth, or Kimwipe.
	**Step 3.** Dampen a clean cotton swab with 95% ethanol and gently wipe clean the four quadrant detector window. Dry the detector with a dry cotton swab, lint free cloth, or Kimwipe.

5.4.9 Reattach the collimator

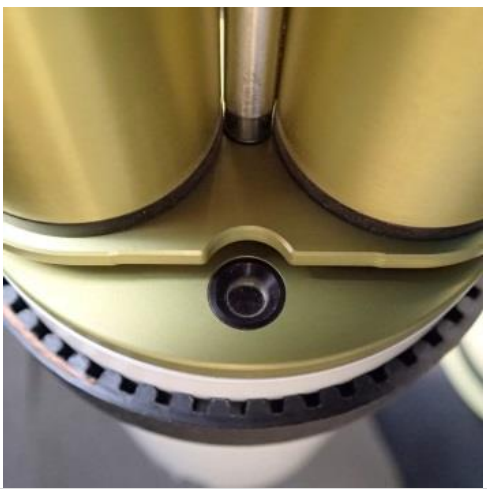
Reattaching the collimator is simply the reverse order of Section 5.4.7.1.

Table 19. Procedure and diagrams for reattaching the collimator.



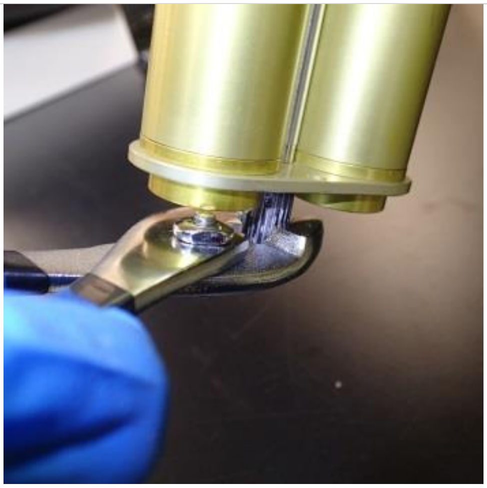
Step 1. Gently grab hold of the sensor body and carefully match the alignment hole with that on the sensor body. When attaching the collimator, orient it properly by aligning the notch on the collimator base and the sensor body.

See also **Table 2** for additional alignment information.



Step 2. When attaching the collimator, the other side of the collimator should also align along the outside of the four quadrant light sensor. See also **Table 2** for additional alignment information.

Step 3. Hold the collimator in place and finger tighten

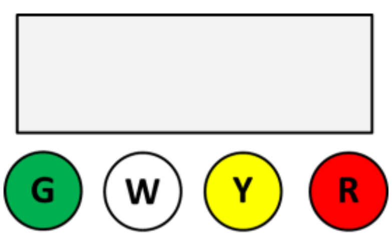
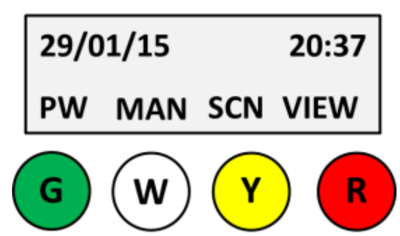
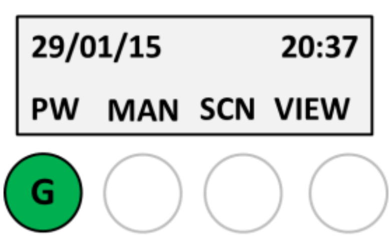
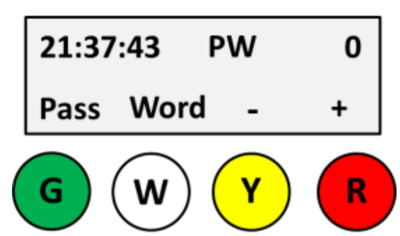
	**Step 4.** Once the screw knob is finger tight, hold the collimator while using a pair of pliers and tighten an additional ¼ turn.

Step 5. Manually [**PARK**] the instrument (see **Table 9**).

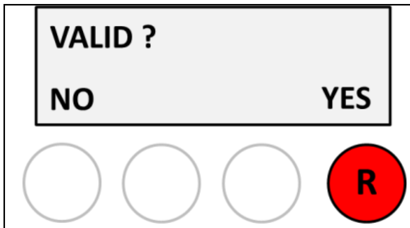
5.4.10 Place the system back into Automatic Mode

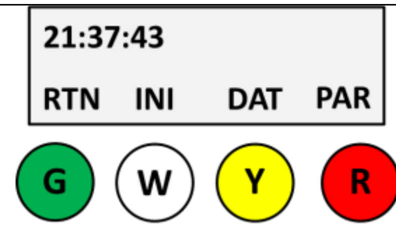
⚠**IMPORTANT:** It is critical that the Cimel be put back into Automatic Mode. If not, the sensor will not operate and once AERONET notifies NEON that the Cimel is not functioning properly, you WILL get a call to go back out and fix it right away. So please remember to put it back into Automatic Mode!

Table 20. Procedure and diagrams for placing the instrument into Automatic Mode.

	**Step 1.** If the LCD screen is blank, select any of the four buttons to activate the menu system. *Panel screen will change to this →*	
	**Step 2.** Select **[PW]** {Green} button. *Panel screen will change to this →*	
	Step 3. Notice that the number in the upper right of the instrument panel is "**0**".	

21:37:43 PW 0 Pass Word - + G W Y R		
21:37:43 PW 0 Pass Word - + R	**Step 4.** Select **[+]** {Red} button. Selecting this button will advance the number in the upper right from "0" to "**1**". It should be set to "1". *Panel screen will change to this →*	21:37:43 PW 1 Pass Word - + G W Y R
21:37:43 PW 1 Pass Word - + G	**Step 5.** Select **[Pass]** {Green} button. *Panel screen will change to this →*	21:37:43 RTN INI DAT PAR G W Y R
21:37:43 RTN INI DAT PAR R	**Step 6.** Select **[PAR]** {Red} button. The screen will briefly show: "Reading EEPROM" *Panel screen will change to this →*	Auto NO OK X - + G W Y R
Auto NO OK X - + R	**Step 7.** Select **[+]** {Red} button. *Panel screen will change to this →*	Auto YES OK X - + G W Y R
Auto YES OK X - + G	**Step 8.** Select **[OK]** {Green} button. *Panel screen will change to this →*	VALID ? NO YES G W Y R
	Step 9. Select **[YES]** {Red} button.	

<table>
<tr>
<td>
</td>
<td>The screen will briefly show:
“Writing EEPROM”

Panel screen will change to this →</td>
<td>
</td>
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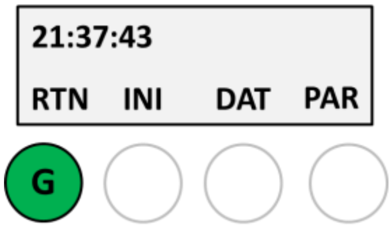
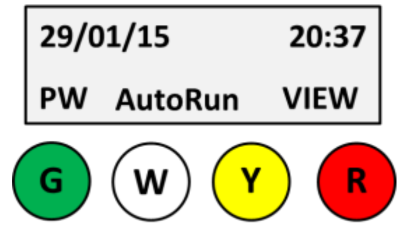
<tr>
<td>
</td>
<td>Step 10. Select [RTN] {green button}.

Panel screen will change to this →</td>
<td>
</td>
</tr>
<tr>
<td>
</td>
<td>Step 11. Verify the “AutoRun” above the {White} button. This indicates that the instrument is now Automatic Mode.</td>
<td></td>
</tr>
</table>

6 REMOVAL AND REPLACEMENT (SUBSYSTEM ONLY)

The Cimel is rugged and weatherproof, and requires minimal maintenance during adverse weather conditions. The Cimel fixture's state of health is determined by evaluating the data stream on the instrument hut computer. If the sensor subsystem is found inoperable due to unforeseen circumstances, document and report the incident via the NEON project Issue Management System for specific corrective action procedures.

6.1 Equipment

Table 21. Tools, consumables, and resource lists for removal and replacement of the Cimel.

Product No.	Description	Quantity
Tools		
	Slip joint pliers/Channel Lock pliers	1
	Line level, bubble, 3”	1
	Electronic level	1
	Large tool lanyard	1
	Small tool lanyard	1
	Telescoping hand mirror	1
	Torque wrenches (in-lb, and ft-lb) / Torque Wrench 16 ft-lbs	2
	Torque wrench socket extension (~3”)	1
	2mm and 4mm Allen Wrench	1
	Hex key set or Hex wrench	1
	Low scratch nylon tube brush, 3/4” diameter, 4” long	1
	Horse hair brush	1
	Camel hair brush	1
Consumable items		
MX100642	Lint-free Cloths/KimTech Wipes 4.5" x 8.5"	A/R
Generic	Deionized Water	A/R
Generic	Ethanol (95%)	1
Generic	Cotton Swabs	A/R
Generic	Can of Compressed Air	A/R
Generic	Squirt Bottle	1
Resources		
	Strap/Buckle	A/R
	External 8AH Battery (12V battery with 15-20 Amh capacity)	A/R
	Internal 5V Battery	A/R
	Power Cables	A/R
0351350000	E-style clip	

0319930000	Cable Seal Kit for Cabinets and Enclosures (includes screws, hex key and lubricant)/Roxtec Hardware	1
0303660001	Collimator Bolt (CIMEL P/N CE318NEBS9)	A/R
	Collimator Baffle	A/R
0314880012	Dust Cap	A/R
0303660008	Wetness Sensor	A/R
	Optical Filters: 440 + 675 + 870 + 936 + 1020 + 340 + 380 + 500 + 1640 Low Bandwidth/UV Filters (340nm, 380nm): ~1-3 years Middle Bandwidth Filters (440nm, 500nm): ~5 years High Bandwidth Filters (675nm, 870nm, 940nm, 1020nm, 1640nm): ~10 years	A/R
0313030000	Cimel Sensor Accessory Kit	1
0303660001	Cimel Shipping Container (CIMEL P/N CE318NEBS9)	1
Cimel equipment manufacturer states Cimel products do not require consumables, and only very few spare parts. Cimel ensures spare parts availability for over 10 years and provides free technical support to customers for the equipment's lifespan. The NEON project HQ coordinates with AERONET for Cimel technical support. A/R = As Required		

Note: It is recommended to take back up tools and consumables up the tower in the event of dropping the original tools/consumables.

6.2 Removal and Replacement Procedure

The Field Operations Domain Manager is responsible for managing the removal and replacement of the sensors on site. The NEON project Calibration, Validation and Audit Laboratory (CVAL) is responsible for the calibration and validation of sensors, as required. The Cimel CE318N requires annual calibration and validation. The wetness sensor does not require calibration after initial installation.

The Cimel is mounted on a short, fixed, corner boom at the tower top, and is accessible from the tower railing. Ensure the Cimel is in manual mode and parked.

Prior to removing the sensors for calibration or replacement, ensure the sensor is properly shut down. Conducting these procedures may consume several hours and compromises sensor data. Shutting down the power ensures safer working conditions and pauses the data stream back to NEON HQ.

To properly shut down the Cimel, locate the circuit breaker for the tower top sensors must be de-energized by engaging the switches down in the area labeled "COMM BOX" (the switch is up in **Figure 22** below).

To ensure control over hazardous energy, conduct Lock Out/Tag Out (LOTO) procedures after the circuit breaker is shut off. This will shut down power to the communication box, grapes and sensors at that level. (Interactive LOTO training and information can be found via the Occupational Safety & Health

Administration (OSHA) website and/or with the NEON project safety office.) Examples of LOTO are displayed in Figure ##.

Figure 22. LOTO Examples (Tagging/Connector Cap).

If the sensors incorporate heaters, the heater cable(s) must be disconnected from the communications box. Use insulated pliers and/or gloves to conduct this step. To follow proper LOTO procedures, a connector cap should be placed on the heater port and the cable end covered and locked. Replace the Amphenol cap on the communications box heater port.

To verify power is no longer on, use a voltmeter. Insert the red probe into connector location A and black probe into connector location B (see **Figure 23**).

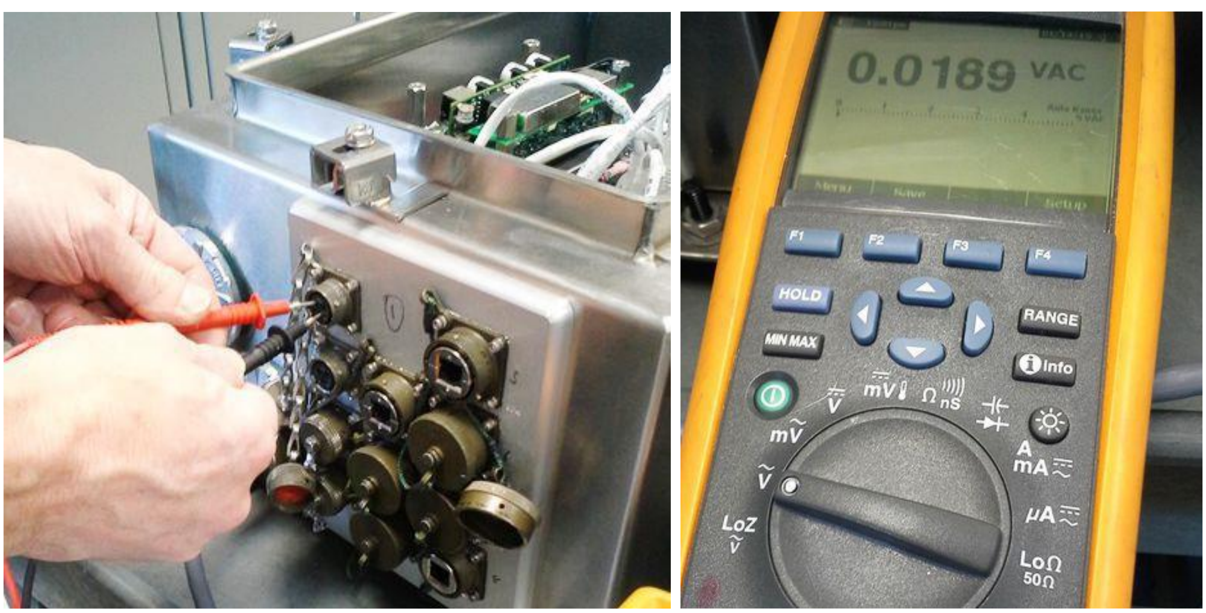


Figure 23. Verifying shut down procedures via the communications box heater port.

6.2.1 Removing the collimator

To remove the collimators, follow ***Section 5.4.7.1 - Removing the collimator.***

6.2.2 Attaching the collimator

To reattach the collimators, follow **Section 5.4.9 - Reattach the collimator.**

6.2.3 Removing the sensor head

To remove the sensor head, disconnect the sensor head cable, remove the collimators, and then unstrap the sensor from the V-shaped support part of the robot. Handle the sensor and collimators with care and ensure they are placed in a safe and secure area.

> **WARNING!** Prior to connecting or disconnecting sensor cables connected to the GRAPE, ensure the GRAPE is de-energized by opening the breaker inside the associated tower power box (See Figure 24 below). **FAILURE TO DISCONNECT POWER BEFORE PLUGGING OR UNPLUGGING SENSOR CABLES MAY PERMANENTLY DAMAGE THE EQUIPMENT.**

Figure 24. De-energize the GRAPE before disconnecting the sensor cables.

Table 22. Procedure and pictures to remove the sensor body for sensor removal.

Step 1. Manually [PARK] the instrument (see **Table 9**).

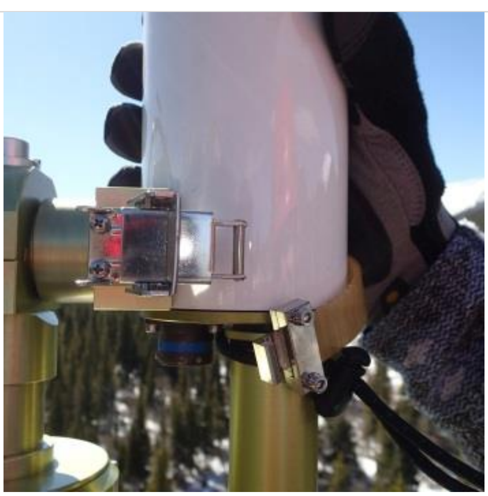
Step 2. Attach a large tool lanyard to the sensor body as shown to secure it from falling to the ground.

Step 3. Hold the sensor body and disconnect the sensor head cable from the sensor body. You may have to slightly rotate the sensor head to allow for easier removal of the connector. Once removed, you can let the sensor head cable dangle out of the way as it should still be attached to the cable holder on the robot. The sensor head cable connector is a MIL Spec twist connector.

Step 4. Remove the collimator. To remove the collimators, follow ***Section 5.4.7.1 - Removing the collimator.***

Step 5. Hold the sensor body and unbuckle the strap that holds the sensor body to the claw.

Step 6. While holding the sensor body, release the clasp that attaches the strap to the buckle.



Step 7. Gently remove the sensor head and place in a secure location away from the elements, and in an area where it will not get damaged.

IMPORTANT: The two lenses are exposed! **DO NOT** allow anything to touch the surface of the lenses, and **DO NOT** clean the lenses!

If the lenses are accidentally touched while exposed, please make a note and submit a ticket via the NEON project Issue Management System indicating the date, time, and lense(s) were affected. This information is required in order for CVAL and AERONET to make appropriate adjustments to the data stream and data post-processing.

6.2.4 Removing the robot

To remove the robot, unscrew the screws at the vertical base of the robot to remove it from the tower top mount (similar to **Figure 25** below).

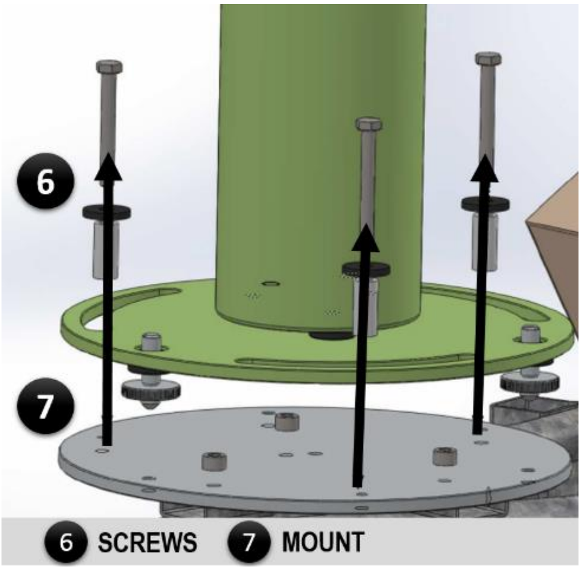


Figure 25. Screws to remove for removing the robot from the tower top.

Disconnect all wires connected to this structure (e.g., AZ (robot AZimuth motor), ZN (robot ZeNith motor), wetness sensor, power connectors). Most of the cables fit in one place and are labeled clearly (see **Figure 26** below).

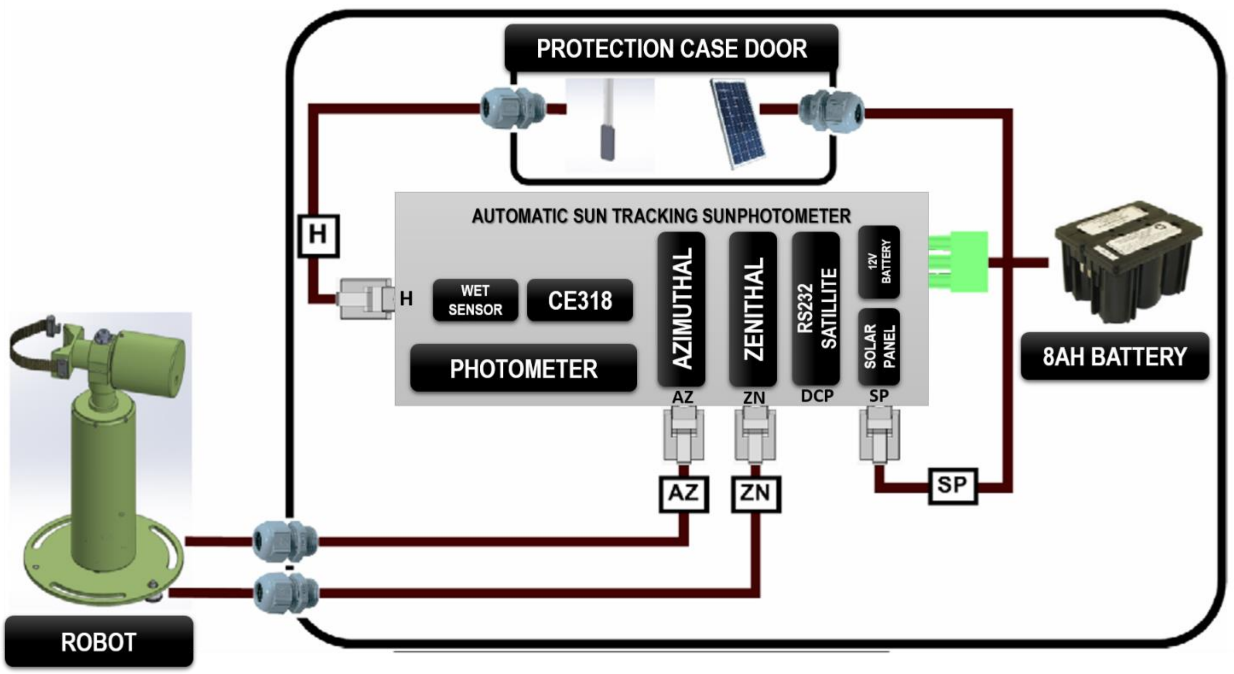


Figure 26. Disconnect all the wires connected to the Control Box when removing the robot from the tower top.

6.2.5 Removing and replacing the sensor head strap

The sensor head mounting strap identified in 25 may require replacement more frequently due to general wear and tear from use. The strap holds the sensor head in place and must be tight when latched.

To remove the strap, ensure the sensor has been removed from the robot and is placed in a safe and secure area (see

Table 22 for instructions on removing the sensor body).

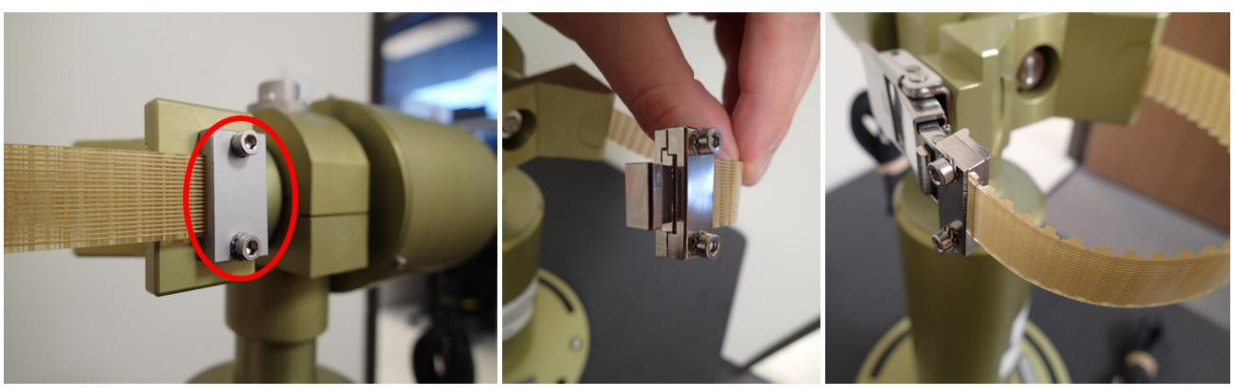


Figure 27. Photos for strap replacement and removal.

(1) Unscrew the two screws found at the opposite of the latch end of the strap (See **Figure 27**).

(2) Remove the latch at the other end of the strap and install it onto the end of the new strap.

(3) Install the new strap onto the robot with the two screws and verify the instrument head fits.

(4) If the strap is too loose, unscrew the two screws and use less strap length until instrument is secure (i.e., scrap is tight fit around the instrument and able to latch as displayed in **Figure 5**).

6.2.6 Removing the Cimel Control Box

(1) At the white Cimel Control Box connector panel (see **Figure 26**), remove all the attached cables.

(2) Release the strap securing the Control Box to the enclosure.

(3) Remove the Control Box from the enclosure.

6.2.7 Installing the Cimel Control Box

(1) Remove the Control Box from its packing, and press any button below the display. The display should light up, indicating that the battery is charged and hooked up.

(2) Install the Control box into Cimel environmental enclosure, and re-attach its retaining strap so it is snug.

(3) Re-connect all the connectors removed in Section 6.2.6 into the connector panel on the Control Box (see **Figure 26**).

6.2.8 Reassembling the sensor head and robot

These procedures may be necessary to follow in the event field operations requires troubleshooting guidance to tighten parts of the robot (i.e., azimuth or zenith motors), if issues are discovered with the sun photometer not pointing, tracking or moving properly. **<u>However, this should only occur after all other troubleshooting options are exhausted (e.g., verify software, firmware and level settings).</u>**

To reassemble the sensor and robot, follow the reverse order of these instructions. Two technicians are recommended to conduct these procedures. Employ safety straps/lanyard tools to ensure the sensor and associated parts, tools and consumables are not inadvertently dropped. Ensure the data cable is reconnected to the calibrated sensor to reestablish the data flow and follow the final configuration checklist.

Note: When reassembling the strap to the sensor head to the 'claw' of the robot, ensure two things: (1) align the sensor head front plate with the upper surface of the claw (see **Table 13**, Step 16), then (2) use the claw on the robot, and the cable connector and on the sensor head as a visual indicator to position the sensor head correctly (see **Table 13**, Step 18). Sensor head must be aligned properly.

6.2.9 Final configuration checklist

Once the Cimel has been successfully reassembled and the sensor head is properly aligned and secured within the claw of the robot, final configuration of the settings within the Control Box are checked.

1. Verify the Cimel control box TIME, DATE and LOCATION are correct and synchronized via the GRAPE. (See section ***5.4.2.2 Check the date, time, and internal battery voltage, Table 8***).

    a. Time must be set to UTC. The official U.S. UTC time is found at http://time.gov/.

    b. The Cimel should set the UTC automatically when connected to the LC. If not, manually set to UTC. Use the PW>1>PW>DAT command sequence, then scroll through the date/time settings using the **x** button and adjusting the values with the **+** or **-** buttons accordingly. Once you hit OK, the new time will be accepted.

    c. Cimel location is set using specific parameters that are calculated using site coordinates in decimal degrees (latitude and longitude).

        i. AERONET provides a calculator via http://aeronet.gsfc.nasa.gov/new_web/antenna.html to establish these parameters (see **Figure 28**).

        ii. The Cimel latitude and longitude can also be obtained by using the “Existing Aeronet Site” box in **Figure 28**. Scroll down to NEON and pick the site by name.

    d. For further support or verification on these parameters, contact CIMEL@battelleecology.org.

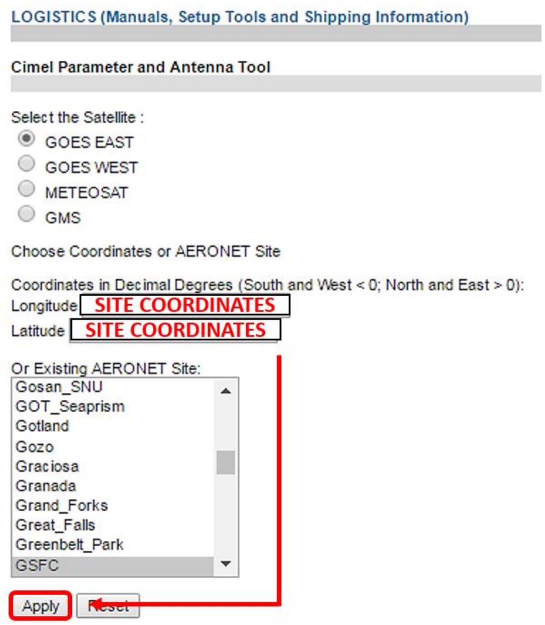


Figure 28. Enter site coordinates in decimal degrees**.**

2. Verify that the ROBOT itself is level. Do not use the embedded bubble level on top of the ROBOT. Place the supplied bubble level on top of the flat ledge of the central robot tubular body (below the sensor head motor). This should be level in both the N/S and E/W axes. (See section ***5.4.5.1 Check the level of the robot sensor head, Table 11***).
    a. If not, see section ***5.4.5.2 Adjust the level of the robot base, Table 12.***
3. Place the Cimel in manual mode using the white control box display screen. (See section ***5.4.1 Place system into Manual Mode, Table 7***).
4. Conduct a PARK procedure. When PARK is complete it should result in a parked position where the sensor head collimator is pointing down, perpendicular to the ground. Place the bubble level on the top of the metal claw arm and verify that this is level. (See section ***5.4.3 Manually park the instrument, Table 9***).
    a. If not, see section ***5.4.5.3 Adjust the level of the sensor head, Table 13***.

    Note: Perform another PARK procedure or two and make sure it is in fact level.

    Note: If the instrument is parked and in Automatic Mode, it will not be level (see Figure 9). It must be put into Manual mode and manually parked.
5. Initiate GOSUN scenarios. The sensor head should point to the sun (see section ***5.4.6 check instrument tracking, Table 14***). If the sun spot does not align to within 2mm of the alignment target as determined in **Table 14**, Step 8, you will need to adjust the azimuth of the robot base.

6. PARK the instrument. Perform another GOSUN to check that the alignment is still good. If not, ensure that the robot is level, and that the sensor head is level when manually parked. One note: when you level the sensor head and do a GOSUN, repeat this process a few times to be sure of the alignment. The first GOSUN after leveling is often not correct because moving the sensor head while leveling can temporarily mess up the robot's zeroing point. Re-PARKing and doing a second GOSUN will be more accurate. If the alignment seems accurate, and consistent on repetition, move to the next step.
7. Resume system in Automatic mode (see section ***5.4.10 Place the system back into Automatic Mode, Table 20***). Do not leave the site until the system resumes Automatic mode.

Note: Absolute time accuracy on the instrument is critical. Ensure that the 'Enable direct update of time' option is selected in 'Tools -> General Setup ->Communication Tab'. Also, ensure Windows operating system automatically updates the time.

For additional questions or guidance on CIMEL installation and configuration, please contact CVAL via CIMEL@battelleecology.org. If an issue is encountered requiring corrective action, please document using the NEON project's Issue Management System.

6.3 Cleaning & Packaging of Returned Sensor

Field Operations staff clean, package, and ship the sensors back to the CVAL at the NEON project HQ (Battelle Ecology). Remove any external debris and follow sections ***5.4.7.2 Clean the Collimator, Table 17. Procedure and diagrams for cleaning the collimator and 5.4.7.3 Clean the four quadrant detector, Table 18. Procedure and diagrams to clean the four quadrant detector***. The sensor body is delicate and must be handled with care, especially when shipping and handling the sensor for calibration. Package the collimator, sensor and control box via original packaging (Pelican shipping case or equivalent provided by CVAL for the annual sensor swap).

IMPORTANT: When cleaning the collimator, DO NOT allow anything to touch the surface of the lenses, and DO NOT clean the lenses! If contact to the lenses occurs, report the incident in the NEON project Issue Management System. This information is important for CVAL to be aware of for sensor configuration, calibration, and validation.

Please ensure there are no arachnids and/or insects hiding in the sensor components before packing.

Package sensor items via original packaging, as requested or outlined via the Issue Management System and return to the NEON project HQ using the following address:

BATTELLE ECOLOGY
1685 38TH STREET, SUITE 100
BOULDER, CO 80301

7 ISSUE REPORTING OUTPUTS

When doing maintenance on the sensor, some maintenance information should be recorded and saved. This would allow for linking maintenance to the collected data, as well as provide a maintenance record.

Below is a list of requested metadata for the Cimel CE318N to be recorded at every maintenance time.

See Section 8.9 for the Preventative Maintenance Datasheet.

Table 23. Description of the information needed for the Required Datasheet for the Cimel CE318N.

Datasheet field	Description
NEON Site Code	The date the maintenance was performed
Maintenance Date	Four letter site ID
Maintenance Start Time	Approximate start time of maintenance
Maintenance Time	Approximate end time of maintenance
Maintenance Technician	Technician's ID code
Preventative Maintenance	**Description**
Cables - Condition	Visually inspect cable condition
Cables - Connectors	Are connectors secure?
Sensor strap - Buckle	Visually inspect - sensor strap buckle
Sensor strap - Strap	Visually inspect - sensor strap
Sensor head - flush w/claw	Sensor head within 3mm of being flush with claw?
Control box - White connector panel	Is the white connector panel secure?
Control box - Securing foam	Is foam present?
Wet sensor - Clean	Is the wet sensor clean?
Wet sensor - 45 angle	Is the wet sensor at a 45 angle?
Date correct (UTC)	Is the date correct (in UTC)?
Time correct (UTC)	Is the time within 1m (in UTC)?
Battery voltage	Is the internal battery voltage above 5v?
Wet sensor - Wet check	Did the control panel show a '1' when wet?
Wet sensor - Dry check	Did the control panel show a '0' when dried?
Verify full motion	Does the instrument have full range of motion?
Robot - Level	Is the robot level?
Base leveled	Has the robot base been leveled?
Sensor head - Level	Is the sensor head level?
Sensor head leveled	Has the sensor head been leveled?
Instrument tracking - Aligned	Does the sun image align with the alignment hole?
Azimuth adjusted	Was the azimuth adjusted?
Collimator - Cleaned	Was the collimator cleaned?
Collimator - Gasket condition	Gasket condition checked and good?

Four quadrant - Cleaned	Has the four quadrant sensor been cleaned?
Placed back into Automatic	Following maintenance - Returned to Automatic Mode?

A field datasheet is presented in Appendix Section 8.9 and titled Preventative Maintenance Datasheet

8 APPENDIX

- 8.1 Torque and hardware spec table
- 8.2 UTC Time Conversion Chart
- 8.3 Quick Reference – Switching from Automatic to Manual Model
- 8.4 Quick Reference – Switching from Manual to Automatic Mode
- 8.5 Quick Reference – Manually PARK the instrument
- 8.6 Quick Reference – Performing the GOSUN scenario
- 8.7 Quick Reference – Performing the Almucantar (ALMUC) scenario
- 8.8 Notes about moving 'forward' and 'back' (i.e. 'scrolling') through LCD screen selections
- 8.9 Preventative Maintenance Datasheet
- 8.10 Troubleshooting

8.1 Torque and hardware spec table

Section / Step	Assembly Component	Tool / size	Torque Spec
5.6 / 7-3g	Sensor claw zenith nut	13mm socket and ft-lb torque wrench	**16 ft-lb target** (12 ft-lb min)
5.6 / 7-3q	Screws, robot base plate to mount plate	3/16" hex bit and ft-lb torque wrench	**60 in-lb target** (45 in-lb min)
5.10.3	Control enclosure box door	7/16" socket and wrench	N/A

8.2 UTC Time Conversion Chart

Timezone	Name	Offset from UTC
UTC	Coordinated Universal time	0
PST	Pacific Standard Time	-8
ALDT	Alaskan Daylight Time	-8
PDT	Pacific Daylight Time	-7
MST	Mountain Standard Time	-7
MDT	Mountain Daylight Time	-6
CST	Central Standard Time	-6
CDT	Central Daylight Time	-5
EST	Eastern Standard Time	-5
EDT	Eastern Daylight Time	-4
AST	Atlantic Standard Time	-4
ALST	Alaskan Standard Time	-9
HST	Hawaiian Standard Time	-10

UTC	PST ALDT	PDT MST	MDT CST	CDT EST	EDT AST	ALST	HST
0000	1600	1700	1800	1900	2000	1500	1400
0100	1700	1800	1900	2000	2100	1600	1500
0200	1800	1900	2000	2100	2200	1700	1600
0300	1900	2000	2100	2200	2300	1800	1700
0400	2000	2100	2200	2300	0000	1900	1800
0500	2100	2200	2300	0000	0100	2000	1900
0600	2200	2300	0000	0100	0200	2100	2000
0700	2300	0000	0100	0200	0300	2200	2100
0800	0000	0100	0200	0300	0400	2300	2200
0900	0100	0200	0300	0400	0500	0000	2300
1000	0200	0300	0400	0500	0600	0100	0000
1100	0300	0400	0500	0600	0700	0200	0100
1200	0400	0500	0600	0700	0800	0300	0200
1300	0500	0600	0700	0800	0900	0400	0300
1400	0600	0700	0800	0900	1000	0500	0400
1500	0700	0800	0900	1000	1100	0600	0500
1600	0800	0900	1000	1100	1200	0700	0600
1700	0900	1000	1100	1200	1300	0800	0700
1800	1000	1100	1200	1300	1400	0900	0800
1900	1100	1200	1300	1400	1500	1000	0900
2000	1200	1300	1400	1500	1600	1100	1000
2100	1300	1400	1500	1600	1700	1200	1100
2200	1400	1500	1600	1700	1800	1300	1200
2300	1500	1600	1700	1800	1900	1400	1300
2400	1600	1700	1800	1900	2000	1500	1400

Note: 0000 and 2400 are interchangeable

8.3 Quick Reference – Switching from Automatic to Manual Mode

Automatic Mode → Manual Mode

1	 G W Y R	6	Auto YES OK X - + R
2	29/01/15 20:37 PW AutoRun VIEW G	7	Auto NO OK X - + G
3	21:37:43 PW 0 Pass Word - + R	8	VALID ? NO YES R
4	21:37:43 PW 1 Pass Word - + G	9	21:37:43 RTN INI DAT PAR G
5	21:37:43 RTN INI DAT PAR R	10	29/01/15 20:37 PW MAN SCN VIEW G W Y R

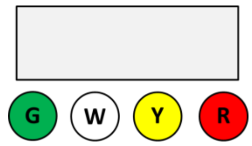
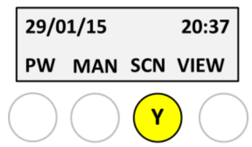
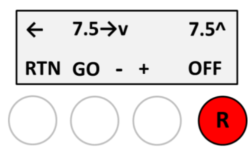
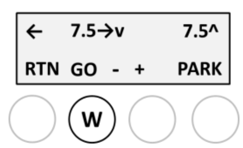
8.4 Quick Reference – Switching from Manual to Automatic Mode

Manual Mode → Automatic Mode

1	G W Y R	6	Auto NO OK X - + R
2	29/01/15 20:37 PW MAN SCN VIEW G	7	Auto YES OK X - + G
3	21:37:43 PW 0 Pass Word - + R	8	VALID ? NO YES R
4	21:37:43 PW 1 Pass Word - + G	9	21:37:43 RTN INI DAT PAR G
5	21:37:43 RTN INI DAT PAR R	10	29/01/15 20:37 PW AutoRun VIEW G W Y R

8.5 Quick Reference – Manually PARK the instrument

Note: The instrument must be in Manual Mode (see Appendix Section 8.3, or **Table 7**).

1	
2	
3	
4	
5	The instrument will now move and park the instrument facing downward (see **Figure 10**).

8.6 Quick Reference – Performing the GOSUN scenario

Note: The instrument must be in Manual Mode (see Appendix Section 8.3, or **Table 7**), and manually parked (see **Table 9** or Appendix Section 8.5).

1	G W Y R
2	29/01/15 20:37 PW MAN SCN VIEW Y
3	← 0.0→v 0.0^ RTN GO - + OFF R
4	← 0.0→v 0.0^ RTN GO - + PARK R
5	← 0.0→v 0.0^ RTN GO - + GOSUN W
6	The instrument will now move and point towards the direction of the sun (see **Figure 7**).

8.7 Quick Reference – Performing the Almucantar (ALMUC) scenario

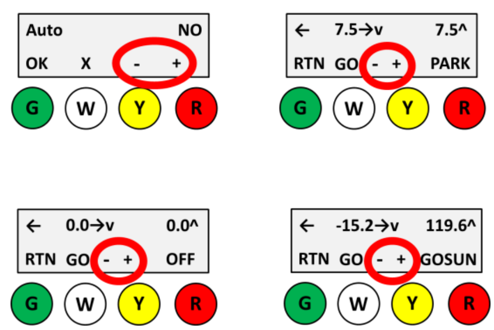
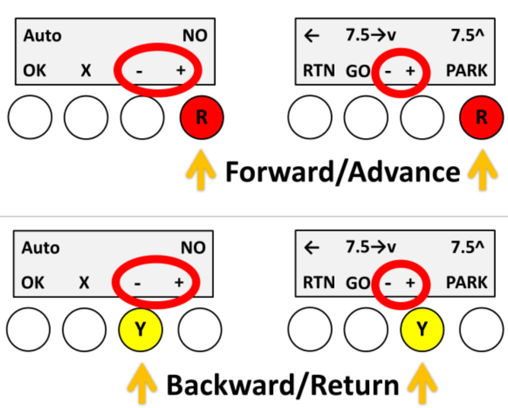
Note: The instrument must be in Manual Mode (see Appendix Section 8.3, or **Table 7**), and manually parked (see **Table 9** or Appendix Section 8.5).

1	G W Y R	9	← -15.2→v 119.6^ RTN GO - + ALMUC W
2	Manually [PARK] the instrument (see Table 9).	10	The instrument will rotate 180° on one side, return to the sun, and then rotate 180° on the other side. It will repeat this indefinitely until stopped.
3	29/01/15 20:37 PW MAN SCN VIEW Y	11	← -14.4→v 119.1^ 22K1= 1869 **** G
4	← 0.0→v 0.0^ RTN GO - + PARK R	12	← -10.2→v 119.1^ RTN GO - + ALMUC R
5	← 0.0→v 0.0^ RTN GO - + GOSUN W	13	← -10.2→v 119.1^ RTN GO - + OFF W
6	← -10.2→v 103.5^ RTN GO - + GOSUN R	14	← -10.2→v 119.1^ RTN GO - + OFF R
7	← -15.2→v 119.6^ RTN GO - + TRACK W	15	← -10.2→v 119.1^ RTN GO - + PARK W
8	← -14.8→v 119.1^ RTN GO - + TRACK R	16	← 0.0→v 0.0^ RTN GO - + PARK G

8.8 Notes about moving 'forward' and 'back' (i.e. 'scrolling') through LCD screen selections

Navigating through the Cimel control box screens is relatively straightforward as many times the selections or menu items will align with a corresponding physical button. However there are times where a selection or menu item does not appear to be aligned with a physical button (e.g. when 'scrolling' through menu items).

When it is required to 'scroll' through a bunch of selections or menu items, the forward/advance and backward/return physical buttons are offset from the LCD screen locations (see below).

<table>
<tr>
<td>
</td>
<td>When the LCD screen shows a [-] and a [+] on the screen like in the examples to the left, this means that you can 'scroll' through the menu items.</td>
</tr>
<tr>
<td>
</td>
<td>Moving forward and backward (i.e. 'scrolling') through menu selection items are usually done with the use of the {Red} button to Forward/Advance and the {Yellow} button to go Backward/Return.</td>
</tr>
</table>

8.9 Preventative Maintenance Datasheet

This datasheet is derived from Section 7, Issue Reporting Outputs. Information within this datasheet could be filled in while doing the maintenance, scanned, saved, and uploaded as part of the maintenance record.

Cimel Preventative Maintenance Datasheet	
Datasheet field	**Entry**
NEON Site Code	
Maintenance Date	
Maintenance Start Time	
Maintenance End Time	
Maintenance Technician	

Preventative Maintenance	**Performed**	**Notes**
Cables - Condition	□	
Cables - Connectors	□	
Sensor strap - Buckle	□	
Sensor strap - Strap	□	
Sensor head - flush w/claw	□	
Control box - White connector panel	□	
Control box - Securing foam	□	
Wet sensor - Clean	□	
Wet sensor - 45 angle	□	
Date correct (UTC)	□	
Time correct (UTC)	□	
Battery voltage	□	
Wet sensor - Wet check	□	
Wet sensor - Dry check	□	
Verify full motion	□	
Robot - Level	□	
Base leveled	□	
Sensor head - Level	□	
Sensor head leveled	□	
Instrument tracking - Aligned	□	
Azimuth adjusted	□	
Collimator - Cleaned	□	
Collimator - Gasket condition	□	
Four quadrant - Cleaned	□	
Placed back into Automatic	□	

Notes

8.10 Troubleshooting

Troubleshooting issues listed below were derived from JIRA Ticket: 103, 238, 281, 523, 1169, 1172, 1639, 2947, 567, 3570.

SYMPTOM	POSSIBLE CAUSE
Robot makes no attempt to move. No sound.	No power (12V)*, faulty GRAPE, port or cable
Robot operates normally but does not look in the direction of sun.	Wrong time/date/location set (set date and time to UTC and use accurate coordinates)
Robot doesn't operate when in AUTO mode. Bad temperature data. Sensor Head not operating normally.	Sensor head cable failure (check connections and integrity of cable)
Robot doesn't operate when in AUTO mode. Robot operates during periods of rain. Wet sensor not responding to water.	Wetness sensor failure (conduct wet-dry routine cleaning and re-test)
Axis rotates continuous without finding park position. Can't hear "click" of limit switch.	Micro-switch failure** (replace micro-switch)
Robot parks off level, looks over/under the suns position during GOSUN.	Loose ZN axis
Motor operating, but no movement. Axis can be turned by hand without resistance.	Severed drive belt (replace drive belt)
Robot axis rotates continuously without parking. Also, axis may make loud noise and vibrate back and forth.	Wiring failure (check all connections and integrity of cables)
Robot looks towards the sun, but not close enough to track.	Off level
Possible cable pulling or wrapping.	Incomplete rotation
Robot Axis has "play" and can be turned slightly by hand without turning the motor.	Excessive backlash***
Temperature data spike.	Disconnected or faulty sensor head cable, obstruction or loose baffle in collimator
Cimel does not find the sun after a GOSUN + TRACK sequence & azimuth angle is not level.	Robot is not aligning with tower mount (rotate base or mount plate requires additional 3 holes in mount to readjust base)
Water intrusion in secure enclosure.	Faulty Ethernet bulk head (no rubber ring)

No Almucantar data.	Off level
Sparse data.	Weather events blocking sunlight
Dislodged or loose stop and/or baffle in collimator.	Cleaning misstep or negligent handling/packaging/shipping (baffles need to be 162.5mm and 93.5mm in each tube; beveled edge towards sensor)
Wetness sensor reading 1 or wet when dry after wet-dry routine cleaning and connected to power.	Faulty wetness sensor (irreparable; report sensor failure and request replacement)
GRAPE not communicating to Cimel or streaming data.	Connection failure, faulty GRAPE (check connections and conduct manual power cycle)
Robot error, no data, and no motion in one axis.	Connection failure to control box (or requires re-seating control box internal board & cables - - *must occur at an ant-static workstation*)
Cimel range of motion seasonally interferes with current TIS tower infrastructure.	Planning oversight, report issue to the NEON project HQ for solution
AERONET has not received a K7 file from a site.	LC/K7 failure (re-boot and verify data are visible via AERONET and Demonstrat)

**11.8-11.9V is typical for sensor head measurements when powered by a grape.*

***The micro-switch is a small button in each axis inside the robot that tells the robot how to park.*

****Backlash is known as the ability to move the AZ or ZN axis without moving the motor drive. Backlash will normally feel like the axis is loose, and you'll sometimes hear a slight tapping sound as you rotate the axis back and forth. Backlash has a negative effect on the robots ability to track the sun, as it reduces the robots accuracy and ability to properly align the instrument.*

Note: Perform troubleshooting leveling procedure during the early morning (~8 a.m.) or late afternoon (~4 p.m.). If the alignment and level is correct, the issue may present itself at that time when observing the measurement scenario (e.g., robot does not point in the correct location or moves erratically).

Note: Connector Panel is subject to thermal expansion/contraction, which can cause data streaming problems. The common fix for this is a full unplug and re-plug of sensor cable and connector panel.