Operator Manual

CuraTerrae

CONTENTS

FIGURES

1.0 Specification

1.1 General Specifications

Measured Parameters	• Single-Particle Light Scattering • Single-Particle Fluorescence (Three Emission Wavebands) • Particle Size • Particle Asymmetry Factor (AF)
Derived Parameters	Particle Concentration
Particle Size Range	0.5 µm to 30 µm
Maximum Concentration (calculated)	466 particles/cm^3 for fluorescent particle counting (10% coincidence) 9,500 particles/cm^3 for sizing and counting (10% coincidence)
Fluorescence excitation	Dual Wavelength, 280 nm and 370 nm
Fluorescence detection	Dual Waveband, 310-400 nm and 420-650 nm
Flow Rate	• Sample Flow: 0.3 L/min • Sheath Flow: 2.1 L/min
Front Panel Features	• ON/OFF LED (Blue) • Pump Status LED (Green) • Particle Detection LED (Yellow) • 2 x USB Connector • Ethernet Port • VGA
Rear Panel Features	• Power Connection • Sample Flow Exhaust Port (Unfiltered)
Laser	Class I Laser Product Contains internally a Class3B 635 nm diode laser, 15 mW
Pump	Diaphragm Pump
Power Requirements	100 - 240V ~ 3A 50-60Hz
Embedded Computer	Intel Core i7 6600U Dual Core 2.6Ghz 8.0G Ram Windows E7 64bit
Use Conditions	• Class I Equipment – Grounding required for safety • Mains supply voltage fluctuations may not exceed +/-10% of the rated supply voltage range • Over-voltage category II – Transient over-voltages
Maximum RH%	5% to 90%, non-condensing
Electrical Rating	100-240V~50/60Hz 10A
Pollution Rating	Degree 3 Harsh Environment
Ingress Protection Rating	IP 54
Operating Temperature Range	5°C to 40°C (40°F to 104°F)
Storage Temperature Range	-40°C to 70°C (-40°F to 158°F)
Maximum Aerosol Sampling Altitude	12192m (40,000 ft) – Instrument contained in pressurized aircraft
Maximum Operating Altitude	0 to 2000m (6562 ft) Contact DMT for guidance to operate at altitudes >2000m
Fuses	(2) 250V 5 A T

1.2 Physical Specifications

Weight	28 lbs (12.7 kg)
Dimensions	17.825” W x 14.825” L x 11.5” H (with inlet) 13” H (with zero filter) 45.3 cm W x 37.7 cm L x 29.2 cm H (with inlet) 33 cm H (with zero filter)

2.0 General Information

In no event will Droplet Measurement Technologies, LLC (DMT) be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omissions in this manual.

DMT reserves the right to make changes to this manual and the products it describes at any time, without notice or obligation. Revised editions can be found on the manufacturer’s website.

All DMT product names and the Droplet Measurement Technologies Logo are trademarks of Droplet Measurement Technologies, LLC.

All other brand and product names are trademarks, or registered trademarks, of their respective owners.

2.1 Product Safety Information

DMT is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay special attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

2.2 Laser Safety Information

The WIBS-NEO is distributed as a Class 1 Laser Product and is intended to be serviced only by factory trained personnel. Never remove, modify, or defeat safety controls. Contact DMT for instrument service or applications assistance.

The WIBS-NEO product contains a fully enclosed path 635nm, 15mW Class 3B laser.

CAUTION *– Class 3B lasers are hazardous for eye exposure. They can heat skin and materials but are not considered a burn hazard. For visible-light lasers, Class 3B laser output power is between 5 and 499 milliwatts. Class 3B is the same as the Roman numeral "Class IIIb" visible on some product safety labels.*

CAUTION *– Strict observance of the following Warning labels is advised:*

Class 1 Laser Product Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice no. 50, dated June 24, 2007	**CAUTION** **CLASS 3B LASER RADIATION WHEN OPEN** **AVOID EXPOSURE TO BEAM**

Back panel of the WIBS-NEO

Exterior of the laser frame:

DROPLET MEASUREMENT TECHNOLOGIES INC.

Model: **WIBS-NEO**

S/N: **1404-0011**

Manufacture Date: **April 2014**

www.dropletmeasurement.com

Longmont, CO, Patent 7,436,515

Back panel of the WIBS-NEO

3.0 Introduction

The Wideband Integrated Bioaerosol Sensor-New Electronics Option (WIBS-NEO) is designed to provide highly sensitive measurements of bioaerosols. The instrument uses two UV filtered flashlamp sources to excite fluorescence in individual particles. Detection wavebands have been selected to optimize detection of common bioaerosol components such as tryptophan and nicotinamide adenine di-nucleotide (NADH).

The original WIBS detector was developed by the University of Hertfordshire and is licensed to and manufactured by Droplet Measurement Technologies, LLC (DMT).

4.0 Unpacking the Instrument

Each shipped system contains the following items (Figure 1):

- Pelican Case, Power Cord, Combo Keyboard/Mouse, International Plug Adapters, and a Zero Count (HEPA) filter.
- USB storage device containing the WIBS-NEO Toolkit and supporting documentation.
- Operator Manual, WIBS-NEO Toolkit Software manual, and NEO Calibration/Data sheet.

The Pelican case should be saved and used to return the analyzer to DMT if service or calibration is needed. Check shipped items for damage immediately upon receipt. Notify both the carrier and DMT if any damage is noted.

Figure 1: Shipped System Components

5.0 WIBS-NEO Quick-Start

5.1 Set Up

The WIBS-NEO power entry port is located on the rear panel (Figure 2) of the WIBS-NEO instrument. Be sure to use the appropriate region power cord adapter (supplied) to connect the cord to an outlet.

Figure 2:Power Cord and Rear Panel

Warning: This equipment must be grounded. Never defeat the ground conductor or operate the equipment in the absence of a suitably installed ground connector. Contact the appropriate electrical inspection authority or an electrician if you are uncertain suitable grounding is available.

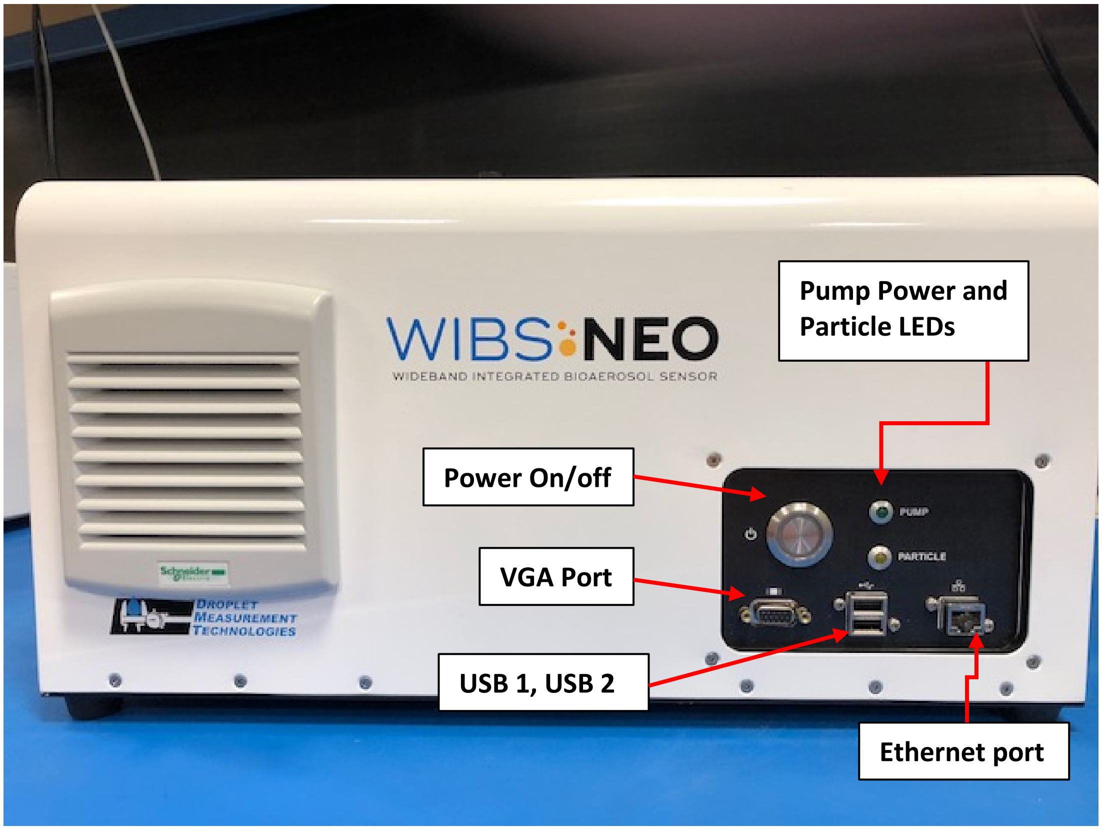


Figure 3:Connecting the Peripherals

1. Connect the Monitor to the VGA port, and the supplied combination USB keyboard/mouse to the 2 USB ports in front of the instrument (Figure 3).
2. System access passwords are available for Administrative use, please see caution below:

   WIBS-NEO Admin Password: Yogi

***CAUTION**: The **Administrative** password allows access to default and calibration settings that when either accidentally or intentionally changed may produce invalid data and affect the accurate performance of this unit. It is recommended that only certain default settings are changed, which are highlighted in this manual. Pay close attention to the written **Cautions and/or Warnings** contained in the following sections before changing any settings. Change settings only with the guidance of an experienced user of this unit.*

5.2 Instrument Operation and Data Collection

1. Once the WIBS-NEO is connected to power and peripherals, depress the main Power button,  (Figure 3) found on the front of the unit, this action will start the computer.

2. Click on the NEO shortcut icon found on the windows desktop to start the program or, it can be also be found in the **Start Menu > All Programs > NEO** list.

3. The NEO software starts up automatically in data acquisition mode. The system will start the instrument pump and begin displaying data within a few seconds. A heart symbol located at the upper right-hand corner of the display will alternately flash red to green to indicate that the software is operating normally.

NOTE: The embedded computer is intended to run the software for the WIBS-NEO instrument. Installing and running additional programs on the computer including Anti-Virus software, may compromise the performance of the system.

NOTE: *If the pump is not set to "ON" at startup, a window will automatically pop up indicating that the pump is set to "OFF" and display a "button" that must be checked to keep the pump in the off position. The software will pause for 30 seconds to allow the operator time to override the pump start command. If the "button" is not clicked, the software will close the window and start the pump automatically.*

Once the program and pump are running you can choose to perform several actions including: Record and save data; acquire Forced Trigger data; manually record Forced Trigger data; automate Forced Trigger data.

NOTE: *Refer to section 7.0 WIBS-NEO Software for details.*

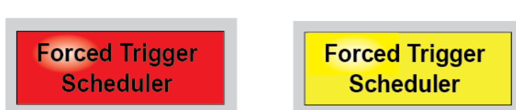
4. **Record** and save data by clicking the tab on the Main Interface as shown below:

(Red=off) (Green=Recording)

5. **Acquiring and saving a Forced Trigger data set is recommended before each experiment.** The Forced Trigger (see section 8.2) background file can be subtracted from the standard data set to account for background noise in the cavity. Forced trigger data may be collected manually or automatically according to the user's preference.

6. To **Manually** acquire a Forced Trigger data set, toggle the "Forced Trigger" switch on the **System Settings** Tab to the ON position. The pump will automatically turn off during this operation and will automatically turn back on when the "Forced Trigger" switch is toggled back to the OFF position.

7. To **Automate** a Forced Trigger data file during data saving ONLY, **Enable the Forced Trigger Scheduler** via the check box found in Data Storage window Section. Forced Trigger Data will



be recorded at pre-set intervals (See Section 7.4 for more information). If the buttons below are flashing between yellow and red, Forced Trigger data is being recorded.

6.0 Logging onto the Remote WIBS-NEO network

The remote NEO wireless network (Host) can be utilized by a remote computer workstation to access and control the WIBS-NEO instrument without a direct interface. The network is set-up as an access point in order to simplify the connection. When using the Windows Remote Desktop to remotely connect to the instrument, the user has full access to the embedded computer and can start the sampling process, load experiments, and acquire data as if they were directly connected to the system.

The data can then be transferred, copied, or shared so that the embedded computer hard drive has as little stored data as possible at any given time. There is access to the disk drives on the local computer during a Remote Desktop session. One can redirect the local disk drives, including the hard disk drives, CD-ROM disk drives, and mapped network disk drives so that files may be transferred between the local host and the remote computer in the same way that files can be copied from a network share by using the following procedure:

Start Microsoft Windows Explorer to view the disk drives and files for each redirected disk drive. Alternatively, there is access to view the files for each redirected disk drive in My Computer.

The drives are displayed as "drive_letter on terminal_server_client_name" in both Windows Explorer and in My Computer.

To view the disk drives and files for the redirected disk drive:

Click Start, point to All Programs (or Programs), point to Accessories, point to Communications, and then click Remote Desktop Connection.

Click Options, and then click the Local Resources tab.

Click Disk Drives, and then click Connect.

The data can now be transferred.

6.1 Remote NEO network (Windows 7)

See Appendix H to log onto the remote NEO network if you are using (**Windows 10)**

1. Click on the wireless connections icon,  on the lower right of your desktop. On the Pop-up screen, select the NEOXXXX (**where XXXX represents the last 4 digits of the serial number of the instrument**) (Figure 4) you want to connect to, and click on the "**Connect**" button.

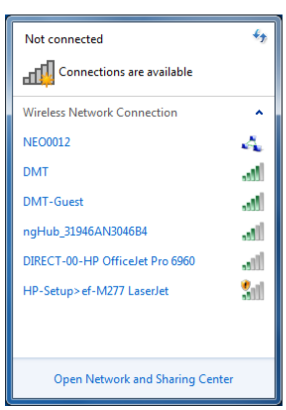


Figure 4:Find the Instrument (wireless)

2. The "**Connect to a Network**" window will pop up.

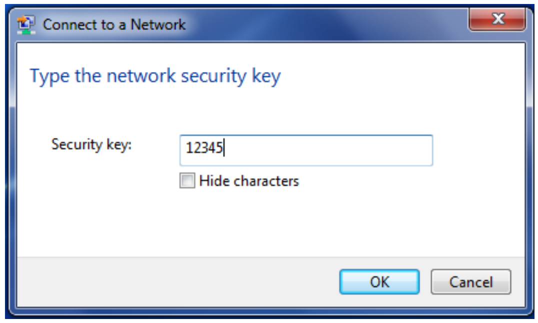


Figure 5:Wireless Network Password

3. Enter "**12345678**" (or "**0123456789**" for WIN10) as the security key (password) (Figure 5) for the network and click "**OK**", it may take several seconds for the connection to become active.
4. To start the remote desktop application, click on the Windows Start Button, and enter "**mstsc**" (Microsoft Terminal Server Client) into the search window (Figure 6) then choose "**run**" or hit the enter key. The Remote Desktop Connection utility may also be accessed directly from the Windows Start Menu.

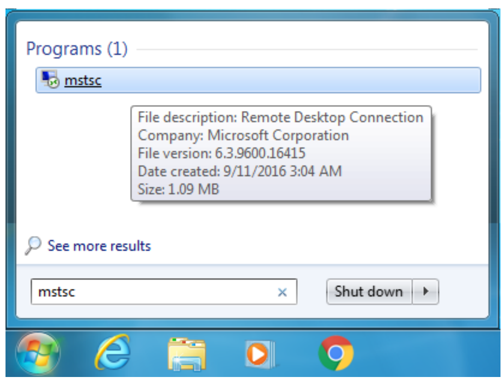


Figure 6:Search Windows for Remote Desktop

5. The Remote Desktop Connection window will pop up (Figure 7).
6. In the Remote Desktop Connection window, enter "**NEO**" into the Computer field, and "**NEO\user**" into the user name field.

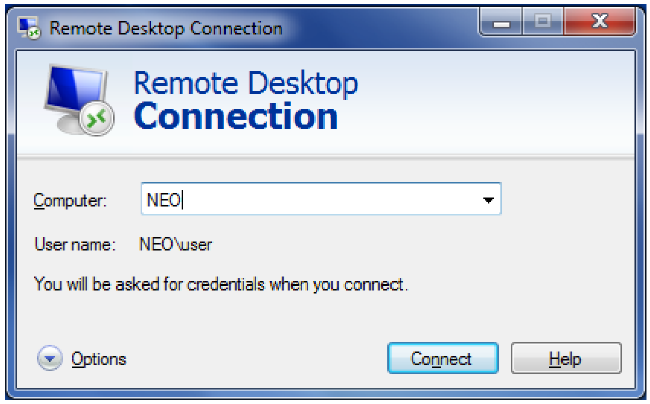


Figure 7:WIN 7 Remote Desktop Window

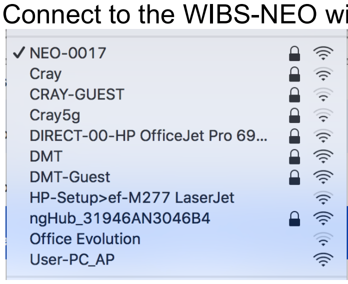
7. Click on "**Connect**" and a "**Windows Security**" popup window will appear.

Figure 8:Connect to the Instrument on the network

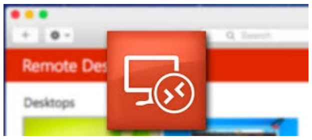
8. Enter "**neo**" for the password then check "**Remember my credentials**".
9. Click on the "**OK**" button and the connection to the NEO desktop will be established for remote access.
10. To return to normal operation and exit the remote desktop application, select the "**X**" near the upper right corner of the screen and the connection will be terminated. The NEO instrument will continue to remain active in the background.

6.2 Logging onto the RemoteNEO network from a MAC OS:

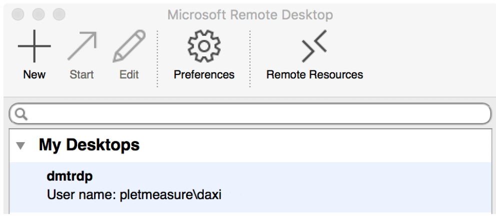
1. Connect to the WIBS-NEO wireless network.



2. Startup the Microsoft Remote Desktop application on the MAC



3. Select + to add a connection.



An "**Edit Remote Desktop**" window will pop up (Figure 9). In the connection field enter "**NEO**"

4. In the PC name field enter: 192.168.159.1. This is a static IP address range required to complete the connection. Enter: "**user**" into the user name field.
5. Enter: "**neo**" into the password field.

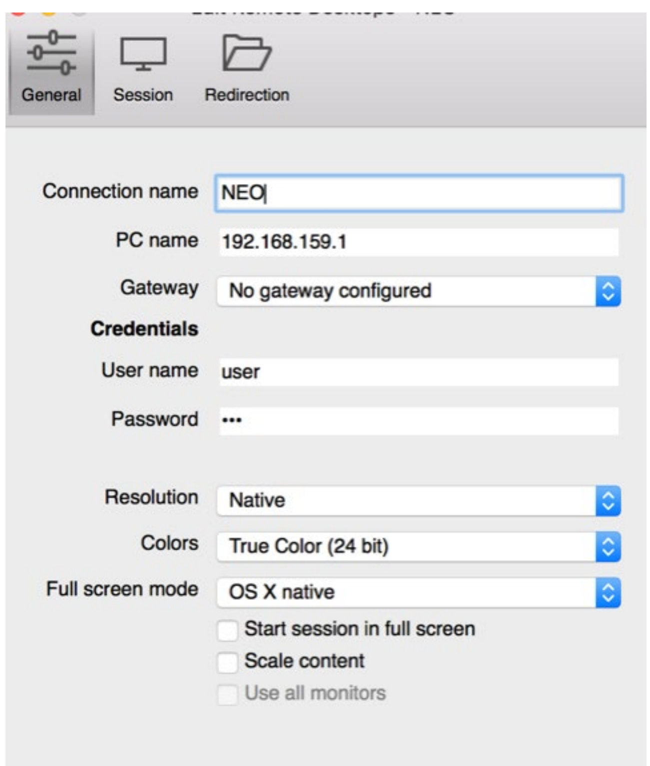


Figure 9:Mac Remote desktop connection window

6. There are no other configurations required. Gateway will be left blank.
7. Save the connection.

7.0 WIBS-NEO Software

The following software programs are provided with the unit:

- NEO.exe - Data acquisition and data playback.
- WIBS-NEO toolkit - reads HDF5 files for analysis of collected data in Igor.

NEO.exe is pre-loaded on the C: drive of the WIBS-NEO unit. The toolkit as well as a copy of NEO.exe will be located on the USB storage device that ships with the unit. Instructions for loading the toolkit program, Igor, and establishing the Igor license are included in the WIBS-NEO Toolkit Manual Doc-0433.

The particle data files collected during normal operation are stored directly as HDF5 to allow faster playback of the data and more efficient data storage compression. HDF5 compressed files are roughly 10% of the size of the file if it were written in CSV. The WIBS-NEO toolkit reads HDF5 files directly and can be used for quick data analysis. To avoid data loss, be aware of the remaining storage on your hard drive and be careful not to exceed that file size. The NEO software will warn the user when the hard drive is nearing capacity and will stop saving data when the storage location drive has less than 1 MB of storage remaining. In addition, we recommend that data is stored to or transferred to an external dedicated drive, instead of the WIBS on board computer to avoid running out of the disk space. The WIBS-NEO data storage partition (D:) contains ~90GB of data storage space.

The WIBS-NEO instrument uses several programs for different aspects of the data handling. The user interface is written using LabVIEW and provided as an executable. The data analysis or WIBS-NEO toolkit program is written in IGOR. An IGOR license and serial number is provided with each WIBS-NEO instrument.

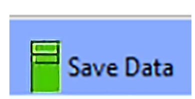
Each day the NEO.exe is loaded, a new directory labeled YYYYMMDD will be created in the target directory for data saving. Individual data directories are created each time the **Save Data** command is clicked on the NEO.exe program. If the user is only interested in analyzing particles that were excited by the flashlamp, the option to **Save Unexcited Particles (HDF5 Only)** should be selected.

The configuration of the NEO.exe program is found in the "NEOconfiguration.ini" file. This file is read each time the NEO.exe program loads and contains all of the operational parameters for the software and calibration. These parameters include flow rates, flashlamp settings, data display and storage options.

<u>HELPFUL SOFTWARE TIPS</u>

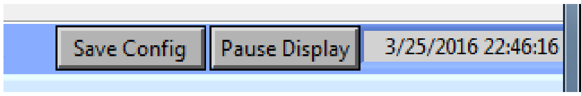
When the NEO.exe program is opened the main WIBS-NEO screen will appear with a frequency histogram plot detailing measured particles on the left and time series plots for (selectable) recorded housekeeping parameters on the right. Each of the tabs will bring up a new screen allowing for instrument control or display of selected WIBS-NEO parameters. The parameter that is displayed can be chosen by scrolling through the up and down arrows to the left of the displayed parameters or by clicking in the white box. This will cause a drop-down menu to appear and the parameter can be chosen from the list. The user can adjust minimum and maximum values of the graph by clicking inside the graph and entering the desired value.

The **Save Data** switch controls writing data to file. 



With this switch in the down position (shown in red) data is not written to file, only displayed on the screen. If you click the Save Data box, the switch will move to the up position and the switch display will change to green. Data will now be written to file. The data file name will be displayed in the **Data Folder** ('B' in Figure 10) box on the upper left of the main WIBS-NEO screen.

The grey **Save Config** box in the upper right-hand corner of any of the graphic display screens,



allows the user to save any configuration or display changes made during the **software session**.

If the **Pause Display** button is selected, the graphic display of data is paused, allowing for screen captures.

Under the **File** tab located at the upper left hand of the window, you can perform a screen capture which will save the current screen as a .jpg. There is also an option to **Exit** the WIBS-NEO software program under this tab.

7.1 NEO Main Window

(Figure 10) shows the WIBS-NEO main tab. The **Particles Saved** window **(A)** records particle data for the number of fluorescent, non-fluorescent and cumulative mass data for those particles, written to file. The **Data Folder** box **(B)** will show the current data file name and storage path. The time series plots on the right allow any housekeeping parameter which is written to file to be displayed in real time. The window **(C)** at the top of the graphs allows for the following parameters to be chosen:

Time(sec), Timestamp, Elapsed time, Error Code, TEC_T, Bias V, Board_1, Sys_V, HK1- HK12,

XE1 Power, XE2 Power, Concentration (Excited), Concentration (All), Sheath flow (L/Min), and Sample flow (L/Min).

The scatter plot on the left of the screen **(D)** details the measured particles. The user can choose to display Xe1 (280 nm) excited particles or Xe2 (370 nm) excited particles by clicking inside of the **Channel Hist** box **(E)** at the top of the graph. The data points on the histogram are colored to indicate the emission wavelength band. To display a Frequency or PbP (particle by particle) plot use the switch **(F)** at the bottom of the graph; all plots on this page update at a 1Hz frequency. To choose the time duration of data to be displayed on the plot, select the time period using drop down box **(G)**.

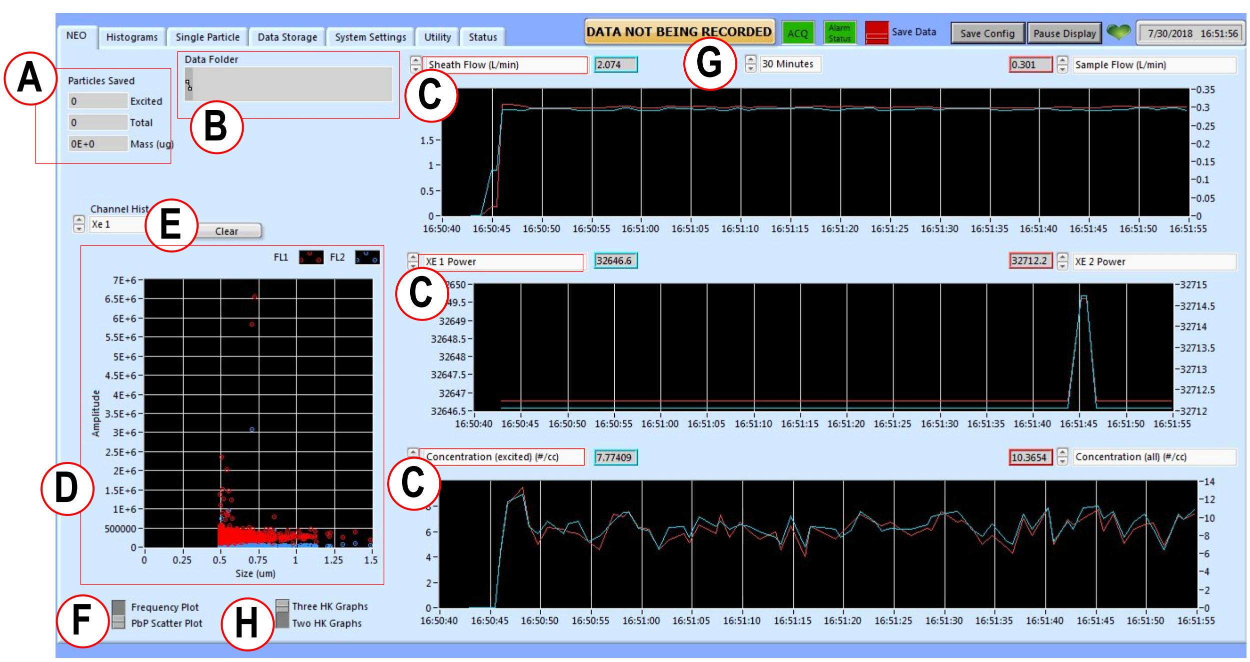


Figure 10:WIBS-NEO Main User Interface

The user controls whether two or three graphs are displayed by selecting the switch **(H)** under the histogram plot.

7.2 Histograms Window

(Figure 11) shows the Histograms Tab where detailed information is displayed for particles being measured in real time. The top three time series graphs allow the user to view the particle peak response for:

1. FL1_280nm Peak: 310-400 nm fluorescence emission detected by FL1 in response to the Xe1 280 nm excitation.
2. FL2_280nm Peak: 420-650 nm fluorescence emission detected by FL2 in response to the Xe1 280 nm excitation.
3. FL2_370nm Peak: 420-650 nm fluorescence emission detected by FL2 in response to the Xe2 370 nm excitation.
4. Asphericity of particle (see Appendix B), or time of flight for particle.
5. Size of particle in um
6. Excited particle concentration in #/cm^3

The Histogram types and corresponding fields (1-6) are called out in (Figure 12). These displays are 3D time series plots, with the color of the data symbol showing the number of particles as indicated by the color scale on the lower left. Display panels on the right are normally hidden, but when the "Show Freq vs. Size Plots" tab is clicked the plots are displayed and display one second cross sections of the data and the average, maximum, and minimum values for each measured parameter as shown in Figure 13.

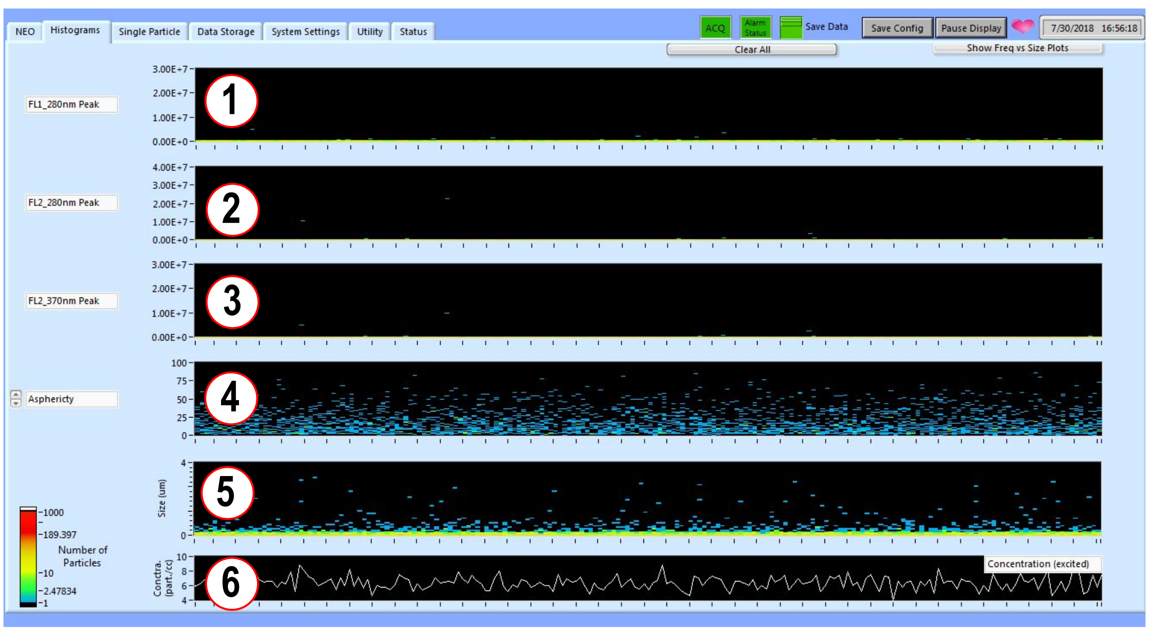


Figure 11:WIBS-NEO Histograms Tab

Clicking anywhere within the graph will trigger the software to open up a window enabling the user to edit the display parameters for the histograms.

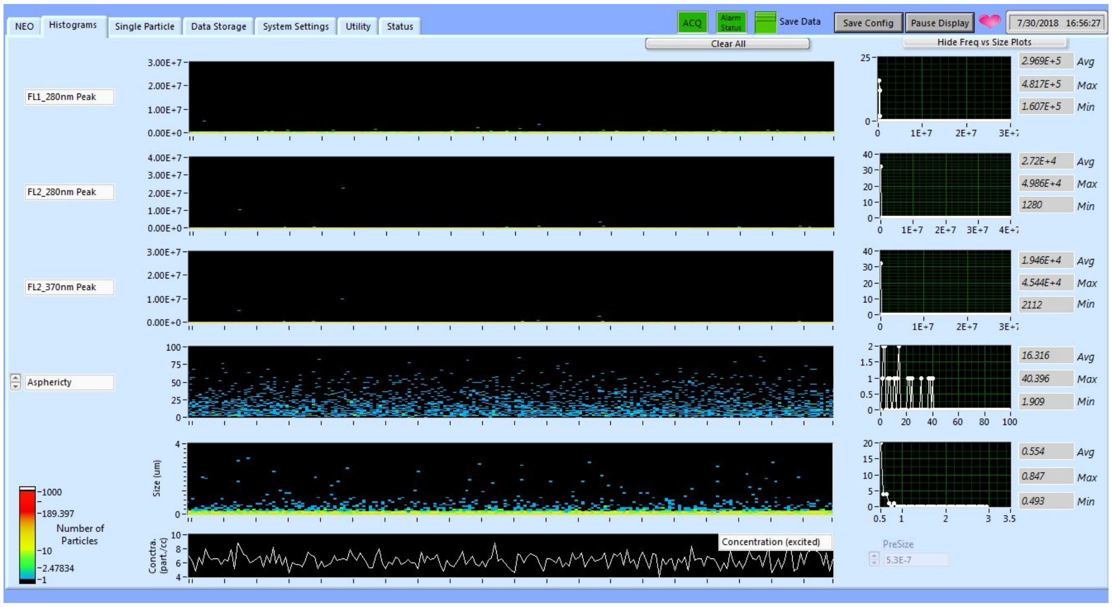


Figure 12:Frequency plots

The **Clear All** button on the top right of the page allows the user to clear all displayed data and restart the time series.

7.3 Single Particle Window

The **Single Particle** tab, shown in (Figure 13), shows an oscilloscope type view of the particle response. The axis scale can be changed by right-clicking on the axis, unchecking autoscale, and then updating the values. Two traces are displayed, one showing the FL2 signal which contains both the particle size trace and FL2 fluorescence emission trace and the other showing the fluorescence emission data for the FL1 channel.

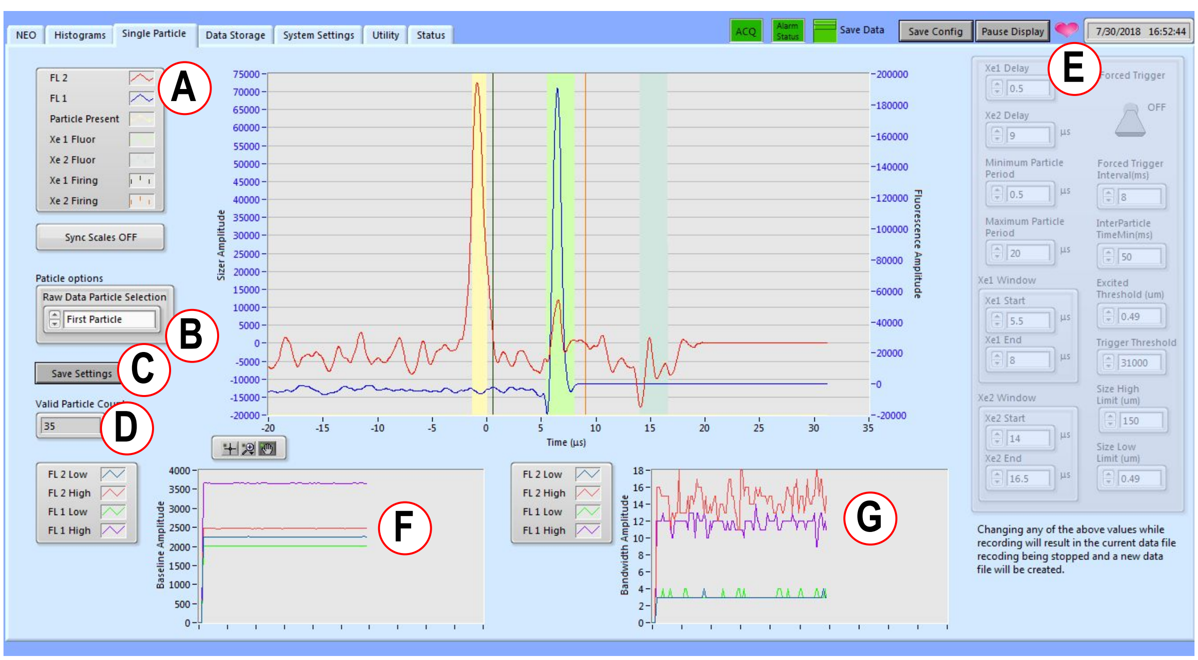


Figure 13:WIBS-NEO Single Particle Tab

FL1, FL2: (A) Identifies the detector channel chosen for display.

Particle options: **(B)** This selection box allows the user to display the **first, last, smallest, largest, fastest or slowest** particle in the last second of data.

Save Settings: **(C)** If any settings are changed, they can be saved to your data file.

Valid particle count: **(D)** Measure of the number of particles processed in that one second data period.

Trigger Settings: **(E)** Each of these normally greyed out parameters are set at the factory as part of calibration and should only be changed after consulting Droplet Measurement Technologies. These fields are **Administrator** password protected.

Baseline Amplitude: (F) This plot tracks and stores the baselines for the high and low gain detector channels for each detector in the system.

Bandwidth Amplitude: (G) This plot tracks and stores the detector bandwidth for the high gain and low gain detector channels in the system.

7.4 Data Storage Window

The **Data Storage** tab, (Figure 14) allows the user to configure the data to be saved and to add notes to the data files.

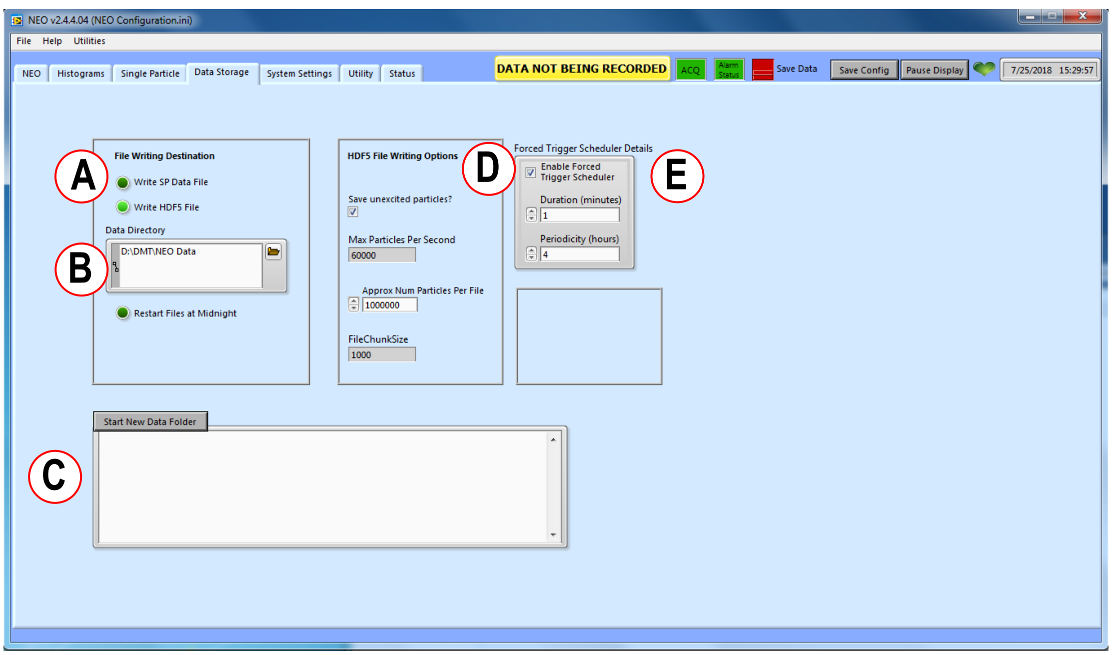


Figure 14:WIBS-NEO Data Storage Tab

The check boxes on the left of (Figure 15) detail the format in which particle data is stored.

- **Write SP Data File-** Single particle traces shown in 'single particle tab' (need SP data reader)
- **Write HDF5 File-** Particle data (HDF5) files that import directly into the WIBS-NEO toolkit.

- **Restart Files at Midnight –** When selected will create a new data file folder subheading for each new date.

The **Write HDF5** file box **(A)** should always be checked unless special experiments are underway.

The **Data directory box, (B)** allows the user to select where on the computer or network the data file is to be written. Each data set is named with the date and time. Data may not be written to the "C:" drive partition which is write protected to preserve the operating system settings.

The **Data File Notes box, (C)** allows the user to enter specific notes about the experiment which will be attached to the data file when writing to the file is stopped. The notes can be entered before writing to file or during the file writing process.

In the **HDF5 File Writing Options** box, **(D)** the user can choose to save either all particles or only those particles that are excited by the flashlamp and may also specify how many particles are written to a file before a new file is written. The "Max Particles Per Second" field is factory set to save disk space and flag particle data during periods when single particle data integrity is lost due to particle coincidence at high concentrations. Data will be written for particles up to the Max Particles field value, a data flag will be set indicating coincidence, and the remaining data for that second will be truncated.

Forced Trigger Scheduler Details: (E) Set duration and frequency of automatic Forced Trigger background data collection during data saving.

7.5 System Settings

The **System Settings** tab (Figure 15), allows the user to manually engage a **Forced Trigger** background. This setting may be manually triggered during data collection and will be written into a file that can be subtracted from the full data file for a focused data set the same as it would be written by the forced trigger scheduler program. The setting may also be manually engaged without data saving to view trigger background levels in real time on the Histograms software tab. More information regarding the use of **Forced Trigger** background files can be found in Section 8.3.

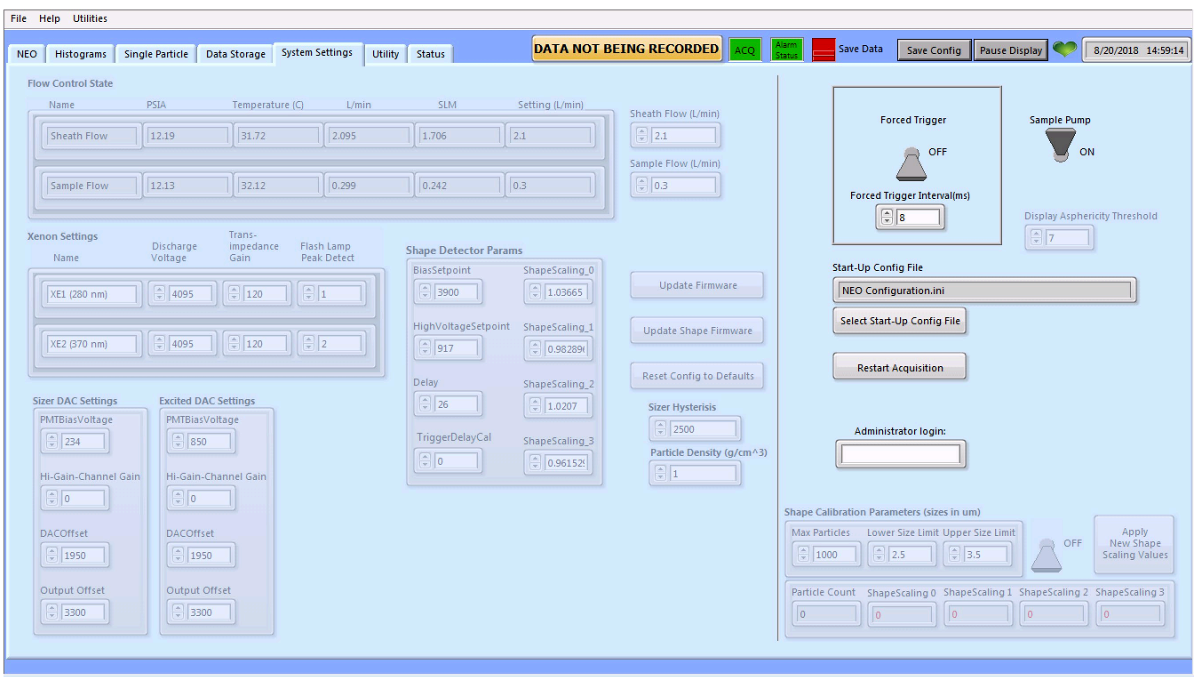


Figure 15: WIBS-NEO System Settings Tab

The Greyed-out areas on the Settings Tab above describe defaults, calibration factors, and Administrator functions.

- **Flow Control PSIA, Temperature, L/min (liters per minute), SLM (standard liters per minute).** Allows you to monitor the sheath and sample flow controllers in real time.
- **Sheath Flow/Sample Flow**: Can be changed from defaults (2.1/0.3 L/min) based on customer needs. Please consult factory prior to changing from default values.
- **Update Firmware** – Critical WIBS-NEO firmware releases will occasionally be sent out to customers and can be installed in the field through this feature.
- **Xenon settings**- Flashlamp settings based on calibration not typically changed.
- **Shape detector**- Quadrant PMT settings not typically changed.
- **Sizer DAC Settings**- Default settings for particle sizes not typically changed.
- **Excited DAC Settings**- Settings for data Acquisition not typically changed.
- **Shape Calibration** – Shape calibration dialogue is used as part of the factory setup and should not be changed by the end user.

7.6 Status

The **Status Tab, (**Figure 16) shows important alarm, program, and data folder information.

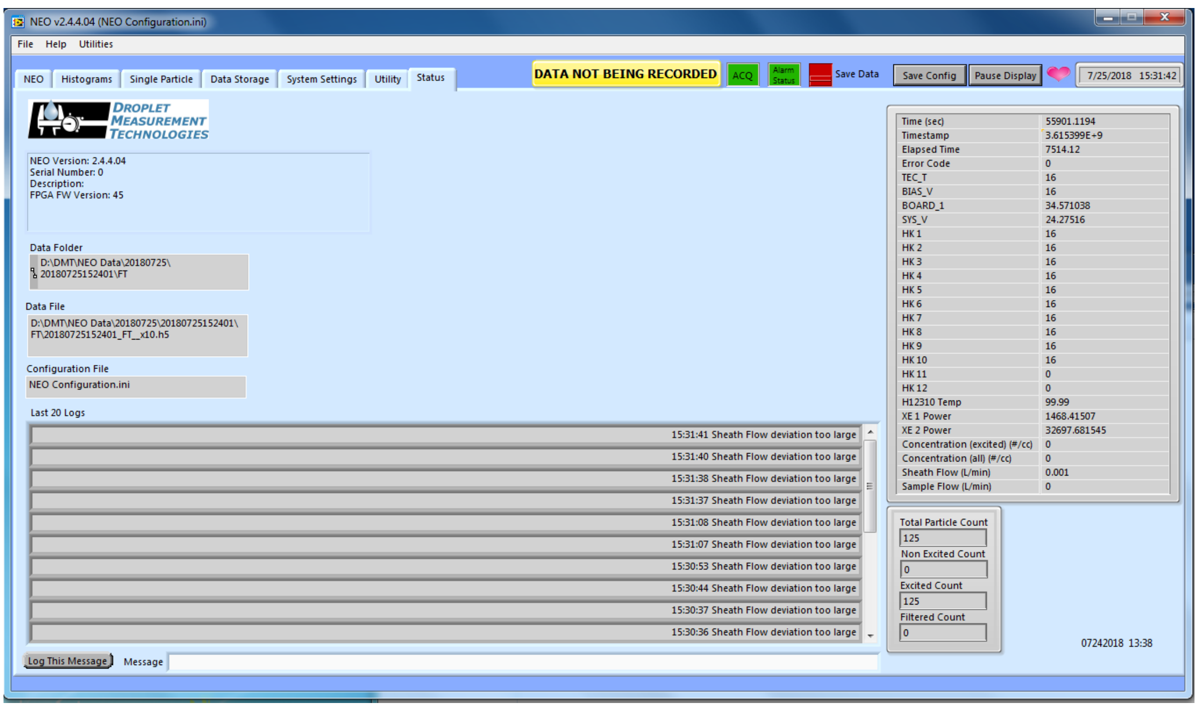


Figure 16:WIBS-NEO Status Tab

Below are descriptions of items on the status tab.

- Alarm status – Green when everything is running normally. Red when there is a critical alarm
- Data folder – records the location where data is being written
- Configuration file – Shows the current configuration file. If this is changed you will have to restart the program to use the new configuration.
- Last 20 log – records details for the last 20 actions.
- Total Particle Count - All qualified particles measured in the previous one second period.

- Non-Excited Count - The number of particles that were qualified that were measured but not UV excited due to flashlamp duty cycle or interparticle timing constraints in the previous one second period.
- Excited Count - The number of particles records containing full data for size, shape, and fluorescence for the previous one second period.
- Filtered Count - The number of particle events that did not meet qualification criteria and were discarded based on transit time, over/undersize, coincidence, or other particle qualification criteria.

8.0 Maintenance

The WIBS-NEO instrument contains no user serviceable components. All units are recommended to be returned to DMT for service on a yearly basis for inspection, update, and calibration. Any and all inquiries for service, repair, or replacement should be directed to the sales representative or may be submitted to DMT in writing by emailing info@dropletmeasurement.com.

8.1 Zero-Count Check

A zero-count check should be conducted weekly or if issues are suspected. To perform the check, place the (HEPA) filter that was supplied with your unit, on the inlet. Operate the instrument in sampling mode with the pump on for a minimum of five minutes. Particle counts should be less than 1 every thirty seconds after five minutes of operation with the filter in place. Remove the filter assembly to resume normal operation.

Users should also check the flow on a monthly basis. To check the flow, place a flow meter on the inlet. Run the WIBS-NEO in sampling mode with the pump on. The flow reading should be approximately 0.3 L/min.

8.2 Running WIBS-NEO in Forced Trigger Mode

The optical filters in the WIBS-NEO are designed to prevent the flashlamp light from reaching the photomultiplier detectors. Regardless, some light will reach this assembly due to the limitations of the optical filters and the buildup of contamination in the chamber. These factors will combine with some electronic noise from the instrument to result in a cavity background signal. In order to adjust the instrument data to account for background noise, the WIBS-NEO should be run in a **Forced Trigger** mode periodically. There is also an option to automate the Forced Trigger data using the Forced Trigger scheduler in the Data Storage window.

To manually create a file for the **Forced Trigger** background:

- Set the Forced Trigger interval to 8 ms or higher.
- Activate the Forced Trigger switch. The software will automatically turn off the sample pump and turn the pump back on when the Forced Trigger switch is turned OFF.
- A one-minute Forced Trigger will collect adequate data to define the background .
- Turn on the Save Data switch to write the file data.
- The data system will automatically write the file as a forced trigger file (FT) anytime data collection is turned on and the Forced Trigger is engaged manually.

The **Forced Trigger** mode provides a good check of basic instrument operation. Should the **Forced Trigger** levels change significantly, or if there is a significant drift noticed that deviates from normal averages, it can mean a change in the optical performance of the WIBS-NEO.

The **Forced Trigger** background should be run at least once a week, and if the WIBS-NEO is operated in a monitoring mode, it is recommended to utilize the forced trigger scheduler to automatically conduct a **Forced Trigger** measurement at least once a day. In order to obtain the most accurate fluorescence data, the **Forced Trigger** readings should be subtracted on a channel-by-channel basis from the sample data. This can be performed automatically when using the WIBS-NEO data analysis Tool Kit for data analysis.

To automate the **Forced Trigger** background file:

- Locate the software Data Storage Tab / Forced Trigger Scheduler details and select the “Enable Forced Trigger scheduler” button.
- The automated Forced Trigger Scheduler will write Forced Trigger data into separate data files for later review.
- Choose the period and duration for your Forced Trigger data and locate save location.
- A one-minute Forced Trigger will provide adequate data to define the background noise.

Appendix A: Theory of Operation

Design

The single-particle fluorescence sensor, WIBS-NEO, employs a central optical chamber around which are arranged the following components:

1. A continuous-wave, 635nm diode laser used as a light scattering source for particle sizing and shape detection
2. A quadrant photomultiplier tube (PMT) used to determine particle shape from forward scattered light.
3. Two pulsed Xenon sources emitting at different UV wavelengths.
4. Two detector channels:
    - FL1 – (Channel 1) Detects particle fluorescence emission.
    - FL2 – (Channel 2) Detects particle fluorescence emission, particle count, and particle size.

Aerosol Sampling System

In operation, aerosol is drawn from the ambient atmosphere via a laminar-flow delivery system. The system has been designed to maintain the particle flow velocity for altitudes up to 40,000 feet in a pressurized cabin. Recalibration is not necessary over a wide range of pressure differentials, which is a significant advantage of the NEO design. The NEO flow system renders suspended particles in a single file stream as they pass through the focused laser beam and will also tend to align fibrous particles lengthwise in the direction of flow. The total flow is approximately 2.4 SLPM, of which 2.1 SLPM is filtered before being re-introduced to form a sheath flow. The sample and sheath flow are adjustable through the software interface. The sheath flow serves to confine the sample flow (0.3 L/min) to maintain particle alignment with the 635nm CW laser gaussian peak. A small bleed flow is used to continuously purge the optical chamber of any remaining particles. The intersection of this aerosol sample flow and laser beam defines the scattering volume, a cylindrical area approximately 0.7 mm in diameter and 60 µm deep (Figure 17). Particle velocity is maintained in the 28 m/s range through the sample chamber. Each particle entering the scattering volume (position 1 in Figure 17) scatters light in all directions. The side-scattered light is collected by two high numerical-aperture chamber mirrors. The collected light passes through an aperture in one of the mirrors and onto a dichroic beam-splitter before being detected by the FL2 channel PMT. The light is converted to an electrical pulse as shown on the Single Particle tab, which is used to size the particle and trigger the flashlamps to fire in succession. The detector system is precisely timed to detect the 280nm emission response followed by the 370nm emission response following each respective excitation.

The FL1 detector is filtered to detect fluorescence emission only in the 310 to 400nm range and the FL2 detector is filtered to detect fluorescence emission only in the 420-650nm range as well as to serve as the optical particle counter in response to the 635nm CW laser used in the instrument. The system "dead time" is defined as the period between the moment a particle enters the laser and the 370nm emission response of the particle is recorded and represents the period of time where a new particle entering the laser cannot be detected by the system. Through the use of high speed electronics, system "dead time" is reduced to less than 15us for each particle fluorescence event recorded.

NOTE: Light scattered in the forward direction as a result of the particle interacting with the 635nm CW laser as part of the trigger sequence falls onto a separate Quadrant PMT and is also recorded and used to assess particle shape; see Appendix B.

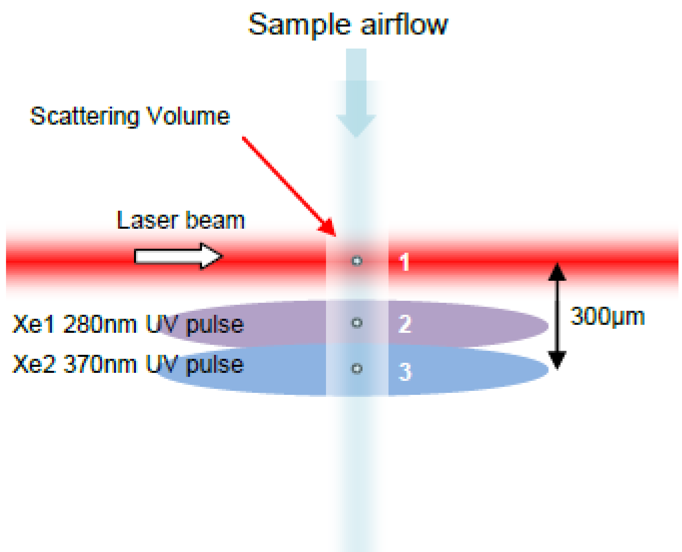


Figure 17:The WIBS-NEO Measurement Cycle

Flow System Diagram:

(Figure 18) shows a section view of the aerosol flow through the WIBS-NEO

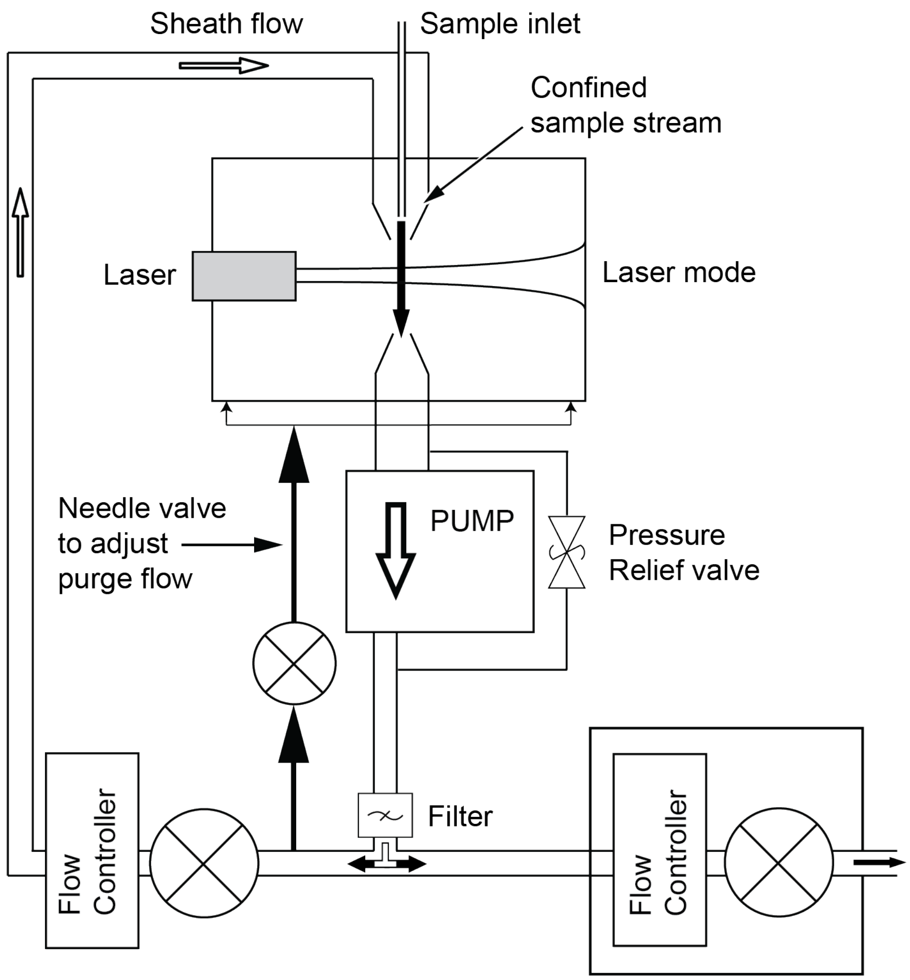


Figure 18:WIBS-NEO Flow System Diagram

Additional Notes on Aerosol Flow:

Once the aerosol has entered the Inlet assembly, the majority of the flow (approx. 90%) is directed through a HEPA filter and then returned as both a sheath flow (to surround the sample flow with particle-free air) and a small bleed flow of clean air into the chamber. The sheath flow has the effect of constraining the sample flow as the two flows pass through the tapered delivery nozzle, as illustrated in (Figure 19) below.

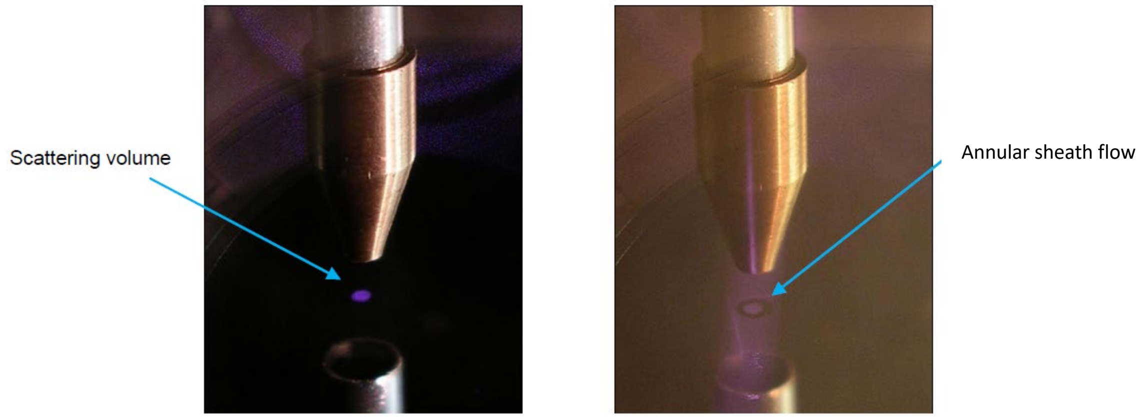


Figure 19: Visualization of Scattering Volume and its Surrounding Clean Sheath Flow

The full aerosol flow (sample + sheath + bleed) is drawn out of the chamber by the WIBS-NEO sampling pump and recycled through a HEPA filter. The outflow of the pump is delivered to an exhaust port adjacent to the power entry port on the WIBS-NEO rear connector panel.

Appendix B: Warranty and Contact Information

The seller warrants that the equipment supplied will be free from defects in material and workmanship for a period of one (1) year from the confirmed date of purchase of the original buyer.

The equipment owner will pay for shipping to DMT, while DMT will pay for the return shipping expense.

Consumable components such as tubing, filters, pump diaphragms, and Nafion humidifiers and dehumidifiers are not covered by this warranty.

Service procedures and repairs are warrantied for 90 days.

Droplet Measurement Technologies, LLC can be contacted at the following address:

Droplet Measurement Technologies, LLC
2400 Trade Centre Avenue
Longmont, Colorado USA 80503
Telephone: +1 (303) 440-5576
Fax: +1 (303) 440-1965
www.dropletmeasurement.com

Appendix C: Particle Size / Shape Determinations

Particle Size

Like most optical particle counters (OPCs), WIBS-NEO uses a particle size calibration based on the calculated MIE theory curve determined by the cavity and laser design. The size of each particle is calculated in real time to provide a true single particle sizing measurement. MIE theory assumes that particles are spherical, uniformly illuminated, and of a specified refractive index. In the case of the WIBS-NEO, the calibration curve is referenced to aerosols of standard monodisperse polystyrene latex (PSL) microspheres. PSL was chosen as the calibration standard for convenience since they can easily and safely be used in the lab and field using a simple nebulizer because the refractive index of PSL is close to that of many common ambient aerosol species. The refractive index of the NIST traceable PSL sizing standards used by DMT for calibration is 1.58.

Since this calibration curve is based on PSL spheres, the reported size should be taken only as an estimate when measuring spherical particles of different refractive index (e.g., water droplets) or non-spherical solid particles. The asphericity factor (AF) is also a good reference for sizing accuracy since irregular particle shapes will directly influence light scattering and reduce the accuracy of MIE calculations.

Particle Shape

WIBS-NEO incorporates an analysis of the forward scattered light captured by the Quadrant PMT to determine an estimate of particle shape, or more correctly, scattering asymmetry. This approach is used by a number of aerosol analysis instruments (e.g., references 8-12). The process used in WIBS-NEO is illustrated in (Figure 20) below.

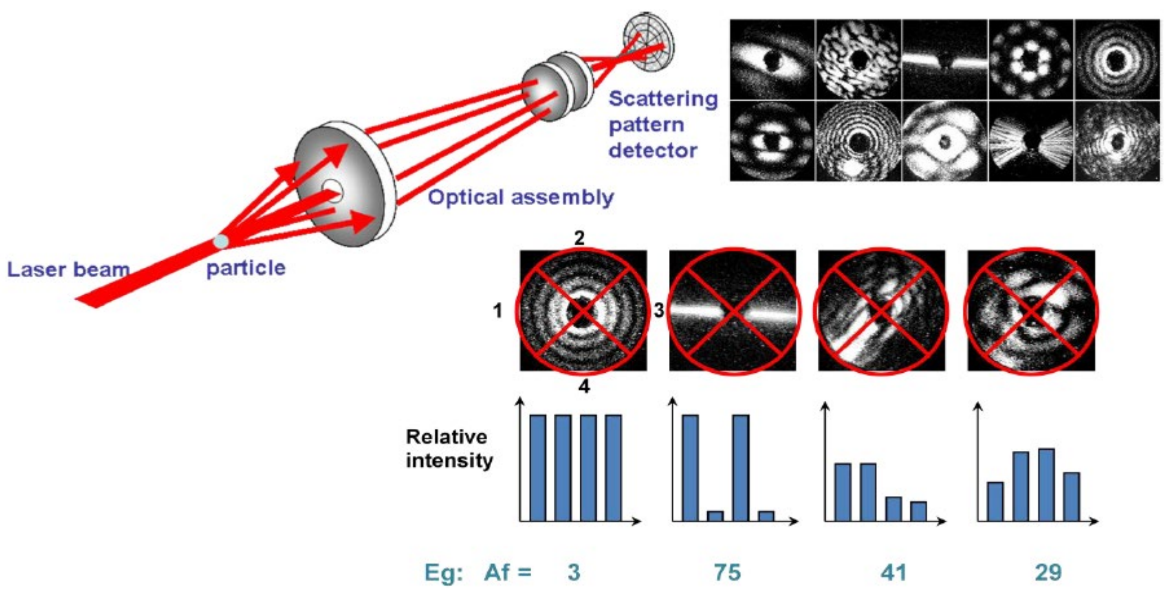


Figure 20:Derivation of particle Asphericity Factor, AF, measuring azimuthal variation in forward scattering of the particle

In (Figure 20), examples of typical forward scattering patterns produced by particles of differing shape are shown in the top-right. These images were recorded using a high-resolution intensified CCD camera. In WIBS-NEO, a much simpler detector configuration is used, based on the quadrant PMT.

This is for reasons of both cost and speed of response. The figure illustrates how the quadrant PMT would respond to particles of different shape – from left to right a droplet (spherical), fiber, flake, and irregular cubic particle. WIBS-NEO records the scatter intensity values received by each quadrant and determines the root-mean-square variation around the mean value to yield an Asphericity Factor, AF, such that a perfect sphere would correspond to AF = 0, and a high aspect ratio fiber to an AF approaching 100. In reality, the combined influence of electronic and optical noise in the scattering signal acquisition results in spherical particles having measured AF values less than 10, rather than zero.

Calculated AF data for each particle is provided in real-time to the user and the four individual quadrant peak values are recorded independently in the data file for later analysis by other methods if preferred.

Appendix D: Data Processing Recommentations

D.1 Overview

The WIBS provides eight essential pieces of information for every particle that is accepted, i.e., those that meets certain criteria associated with the light scattering intensity and transit time through the optical cavity:

1.) Equivalent optical diameter (EOD), Parameter name: NF_Sizer

2.) Fluorescence peak from excitation by the 280 nm and response at 310-400 nm, Parameter name: Xe1_FluorPeak1

3.) Fluorescence peak from excitation by the 280 nm and response at 420-650 nm, Parameter name: Xe1_FluorPeak2

4.) Fluorescence peak from excitation by the 370 nm and response at 420-650 nm, Parameter name: Xe2_FluorPeak2

5-8.) Shape factor quadrant detectors 1-4, Parameter names: NF_Shape_0, NF_Shape_1, NF_Shape_2, NF_Shape_3

These eight variables, taken in various combinations and permutations, provide a detailed description of aerosol particles over the nominal size range from 0.5 to 30 µm. However, prior to incorporating these parameters into an analysis methodology, the educated users should be aware of the limitations and uncertainties that are intrinsic to the operating principles of the WIBS and the processing techniques that are necessary to remove measurement artefacts and minimize the impact of the limitations. Some of the processing procedures that are mandatory are already included in the WIBS Tool Kit, while others are recommendations and are not included. Should you choose to perform your own analysis outside of the WIBS Tool Kit, you need to account for these processing procedures.

D.2 Measurement artifacts

By definition, we are labeling as an artefact any signals from the light scattering or fluorescence detectors that do not correspond to a particle whose properties we wish to analyze. The most common artefacts are electronic noise, particles that pass through a non-optimum part of the beam, coincident particles or non-FBAP (fluorescing biological aerosol particles) fluorescence. The WIBS-NEO signal processing software minimizes artefacts due to electronic noise, coincidence and erratic trajectory (**D.4)** and the filtering of non-FPAB fluorescence signals is left to the user, with some recommendations from Droplet (**D.5).**

D.2.1 Coincidence and Deadtime losses

There are two circumstances in which a particle that enters the WIBS will pass undetected, a condition that leads to subsequent underestimation of the concentrations, either of the total particle population, FBAP population or both. Figures D1 and D2 illustrate the sources of these losses.

Figure D1 illustrates four coincidence events that have different impacts. In all the cases, two particles are "coincident" in the laser beam and are counted and sized as a single particle. Hence, there are at least two errors here: 1) a particle is missed and 2) the derived EOD is oversized.

In addition, in the case shown in Fig. D1.a, there will be an undercounting of total particles but, the FBAP will not be undercounted because it gets detected in the excitation sections at T+ΔT and T+2ΔT. Likewise, in Fig. D1.b, since neither particle is an FBAP, only total particles are undercounted.

In the third case (Fig. D1.1c), since both particles are FBAPs, the total FBAPs get undercounted by one and, in addition to being oversized in the laser section, they produce a fluorescence signal that combines the fluorescence from both particles at T+ΔT and T+2ΔT. Since they may be two different types, the resulting signals will be unpredictable.

The final case (Fig. D1.d) is when both particles are FBAPs and are separated enough in space so that they are detected and sized individually in the laser beam; however, they are close enough together to get illuminated at the same time by each of the Xenon lamps and emit some combination of fluorescence that is detected as a single FBAP. This means that the FBAP total count will be undercounted by one and the fluorescence signals will be incorrectly interpreted.

Particle coincidence can't be avoided other than keeping the concentrations that are sampled as low as possible since the probability that two or more particles are close enough together to occupy the same laser or xenon lamp volume will increase with increasing concentration (see section **D.3)**.

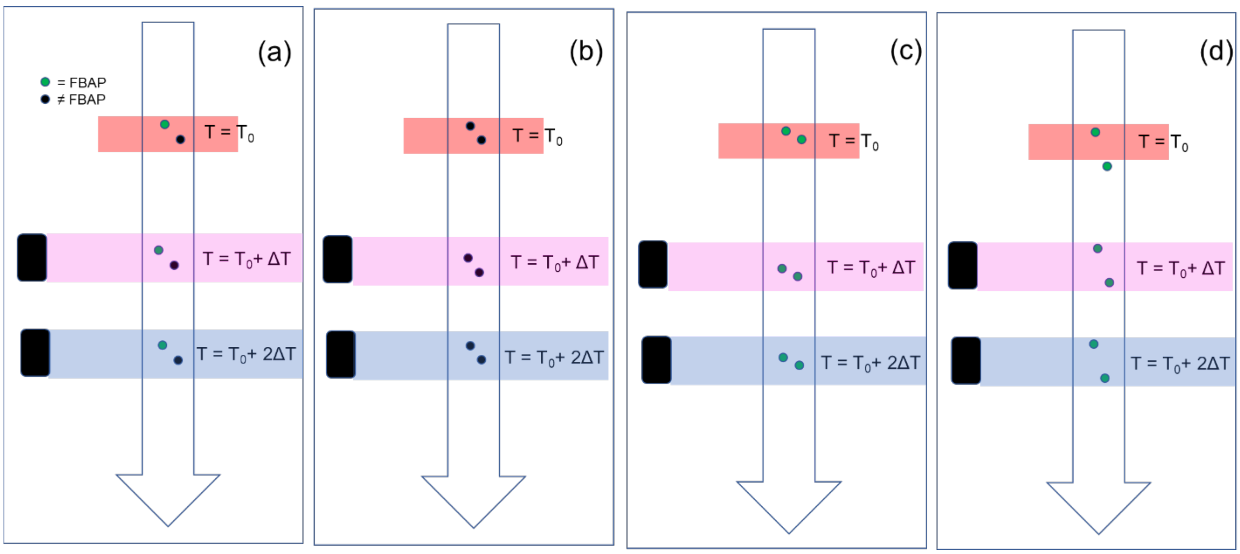


Figure D1. Examples of coincidence loss

Losses of FBAPs occur when an FBAP is not illuminated by the Xenon lamp when it is in its recharge state. Figure D.2 illustrates this condition. A measurement cycle during which particle P_1 is detected, triggers the xenon lamp and then is followed by another particle, P_2, that also triggers the xenon lamps and is excited, is shown in Fig. D2.a. In this case, the time interval between P_1 and P_2, ΔT, is longer than the lamp recharge time, T_{charge}, so that when P_2 initiates a lamp trigger, they will be ready to flash.

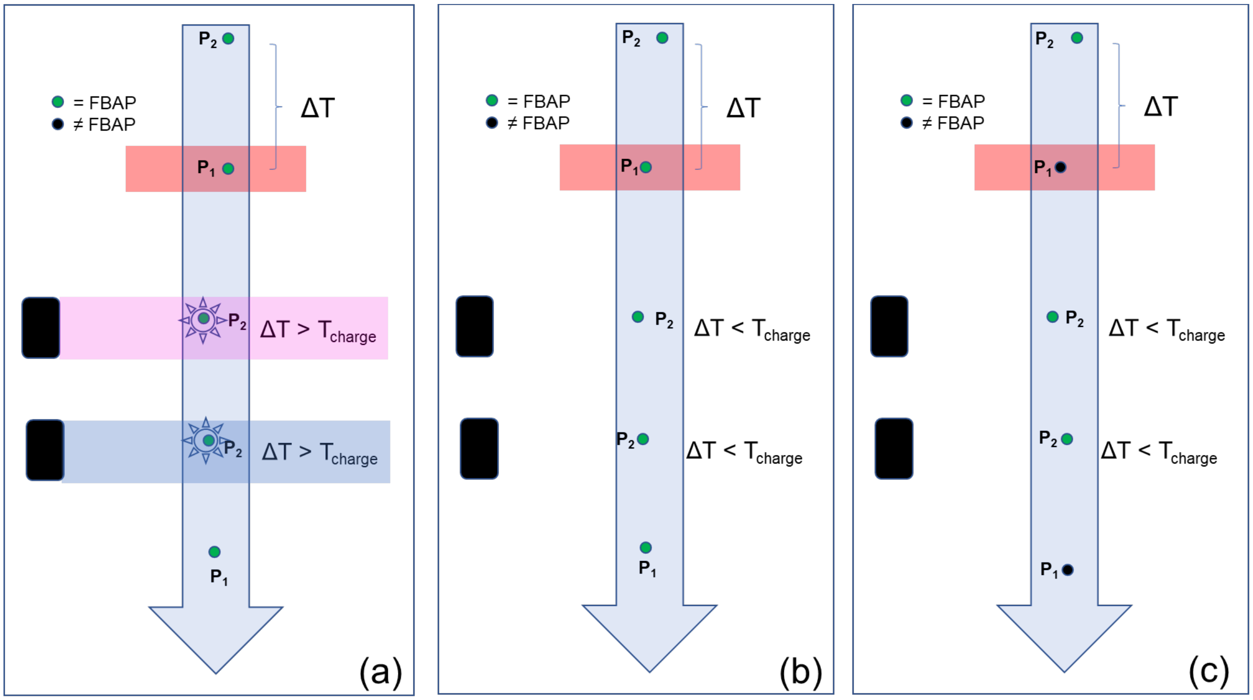


Figure D2. Examples of deadtime loss

When a particle, P_2, is detected following the passage of P_1, and ΔT, is shorter than the lamp recharge time, T_{charge}, then the trigger sent by P_2 to the xenon lamp flash circuit will have no effect, the FBAP will not be excited and will subsequently be recorded has having no fluorescence signal. This condition is shown in Figs. D2.b and D2.c, where the difference in the two figures is the composition of particle P_1. Figure D2.b shows P_1 as an FBAP while Fig. D2.c illustrates a deadtime loss where P_1 is a non-FBAP. This is an important distinction because it shows that non-FBAPs as well as FBAPs send trigger signals to the flash lamps and since the concentration of non-FBAPs is typically much higher, the probability that the detection of a non-FBAP will lead to a deadtime event is higher than an FBAP doing so.

The recharge time of the flashlamps limit them to a maximum of approximately 125 excitations each second, i.e. 125 particle detections each second. The sample volume flowrate of the instrument is 5 $cm^3\ s^{-1}$ so that 125 particle each second is a concentration of 25 cm^{-3}. When total number concentrations exceed this value, many FBAPs will be detected as a particle but not excited.

D.2.2 Optical noise

The optical filters in the WIBS-NEO are designed to prevent the flashlamp light from reaching the photomultiplier detectors. Regardless, some light will reach this assembly due to the limitations of the optical filters. An additional source of noise is due to non-laminar flow and turbulence that will deposit some very small fraction of the particles passing through the excitation chamber onto the chamber walls. Some of these particle will be FBAPs that will fluoresce when the lamps are triggered by other FBAPs and non-FBAPs. This background contamination will usually be relatively small but needs to be taken into account and removed from the analysis.

An additional source of fluorescence, which isn't actually background noise, are non-biological particles that fluoresce, e.g., certain organic aerosol (Toprak and Schnaiter, 2013). These can be taken into account and either removed or flagged if certain processing methodologies are followed (see section **D3.3).**

D.3 Corrections for and filtering of measurement artifacts

D.3.1 Coincidence corrections

Coincidence

The probability that two or more particles are in the laser beam at the same time is the same as the probability that the spacing between particles, Δw, is less than or equal to the width of the laser beam, BW in centimeters. Under the assumption that the particles are arriving to the beam with a randomly spaced distribution, we can estimate this probability (Knoll, 1980; Baumgardner et al, 1985) using Poisson statistics,

$$P\,(0< \Delta w \leq BW) = 1-e^{(-BW/w)} \qquad (1)$$

where w is the average spacing between particle, given by

$$w = N^{-1/3} \qquad (2)$$

where N is the concentration of particles in number per cubic centimeter. For example, the average spacing between particle when N=100 cm^{-3} is 0.21 cm. The nominal width of the WIBS NEO's laser beam is 0.0078 cm. According to (1), the probability of a coincidence is 0.036, or 3.6%. Likewise, when N -> 1000 cm^{-3}, the probability goes to about 8%. Figure D3.a illustrates this relationship for the probability of coincidence in the laser beam.

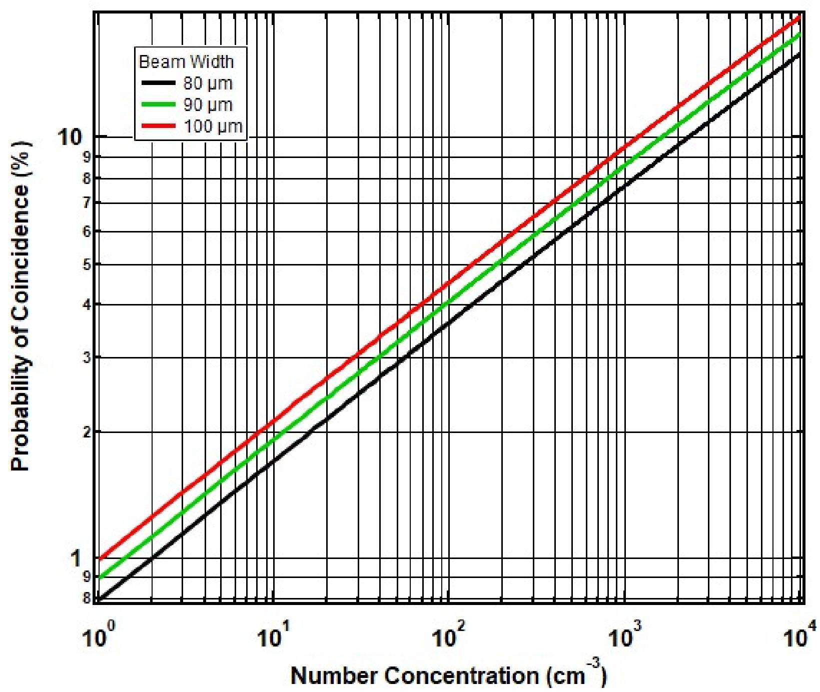


Figure D.3

In most environments, the particles in the size range of the WIBS, 0.5 – 30 µm, rarely exceed 1000 cm^{-3}, so corrections for undercounting due to coincidence in the laser are relatively small.

D.3.2 Deadtime corrections

Section D.2.1 described particles that are not counted when coincident in the laser beam and FBAPs that are not labeled as FBAPs due to xenon lamp recharge time (deadtime). Corrections for coincidence were described in D3.1, corrections for deadtime are presented here.

The lamp recharge time is approximately 8 ms so that if particles were arriving in the trigger laser at regular intervals, spaced slightly more than 8 ms apart, the WIBS would detect precisely 125 particles each second. This rarely, if ever, occurs in the natural environment, as discussed in the previous section, because nature tends to order particle spacing in a more random, exponential distribution as could be seen in equation (1) that describes the probability that the particle spacing is Δw. This can be demonstrated with actual measurements from the WIBS. Two of the parameters that are measured in the instrument, and output every second, are "Valid_Particle_Count" and "Total_Particle_Count". The first parameter is the number of lamp flashes, i.e., the number of times that the trigger sent to the flashlamp circuit produced an excitation. The second parameter is the number of triggers that were sent to the lamp circuit, regardless of whether the lamps flashed or not. If we compare these two parameters, we can show that the particles are not uniformly spaced in time. Figure D.4 demonstrates this using two data sets taken with different instruments, one mounted on a ship making measurements over the ocean (blue markers) and the other in the laboratory measuring a mixture of NaCl crystals and coli bacteria. Data courtesy of Professor Evelyn Freney, University of Clermont Ferrand, Observatoire de Physique du Globe de Clermont-Ferrand, France and Dr. Paolo Prati, University of Genova, Italy.

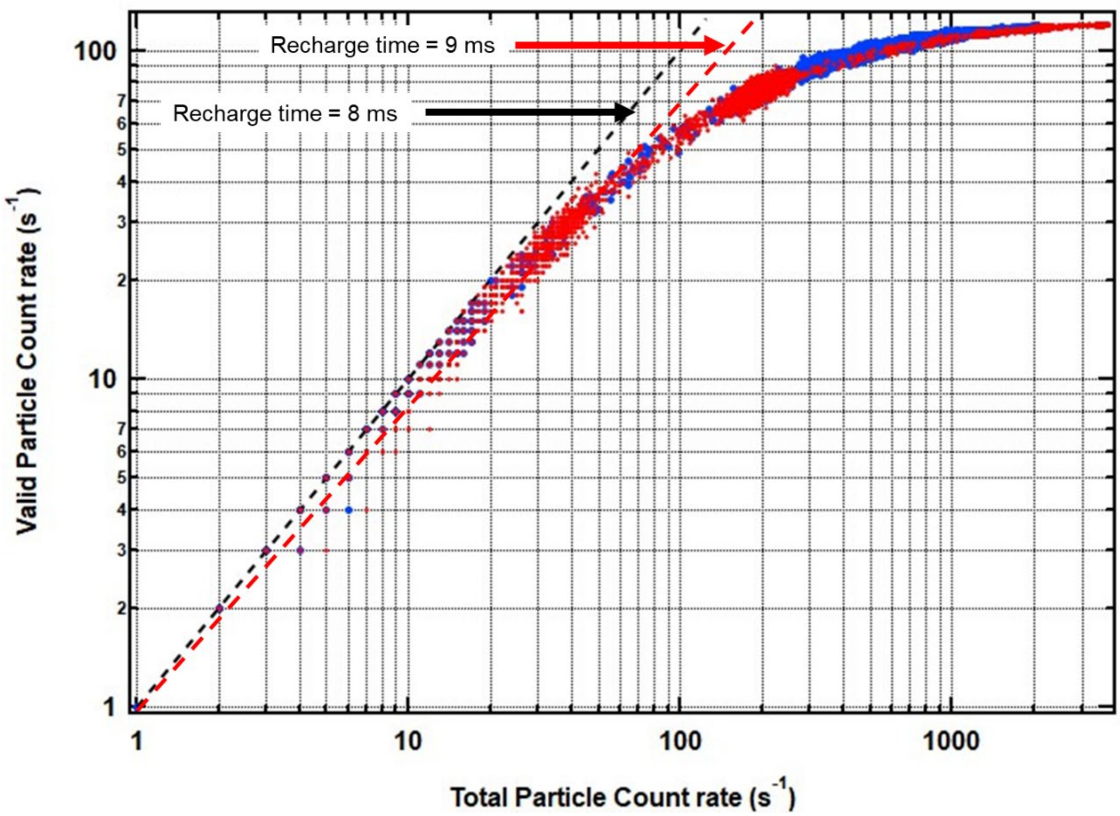


Figure D.4

In this figure, the black and red dashed lines mark the expected relationships between the valid and total counts for lamp recharge times of 8 ms and 9 ms. If the particles were uniformly spaced, then the markers should fall on the dashed line until 125 or 115 counts, respectively. Clearly this isn't the case and in fact, starting around 10 counts the valid count begin falling below the one-to-one line, indicating that particles are arriving with elapsed times < 8 ms. Some of the scatter is because the lamps do not recharge at exactly the same rate each time, but the large decrease with total counts > 100 is a result of the randomness in spacing.

The undercounting due to deadtime only impacts FBAPs since they are the ones that are being labeled in the lamp chamber. For example, if the total particle count is 100 (concentration of 25 cm^{-3}), the valid counts are around 60 (concentration of 12 cm^{-3}). The actual total concentration will be correctly calculated since the only losses to the total particles are by coincidence in the laser beam (~2% at 25 cm^{-3}). If FBAPs are 20% of the total particles, however, this means that 20% of the unexcited particles are FBAPs, i.e. 8 out of the 40 lost particles. If no corrections are made, instead of a calculated number concentration for the FBAPs of 5 cm^{-3} (20% of 25 cm^{-3}), we will instead calculate a concentration of 3 cm^{-3}, or underestimate of 40%. This also means that when reporting what fraction of the population were FBAPs, rather than using the true fraction of 20%, we will instead state that it was 3/25, or 12%. As the concentrations increase, the error becomes increasingly significant. Hence the need to apply corrections to the measurements to account for these deadtime losses. The methodology is straight forward since the valid counts (VC) and total counts (TC) are directly recorded. If we assume that the ratio of measured FBAP counts (MFC) to VC is the same as the ratio of total FBAP counts (TFC) to TC, then

$$TFC/TC = MFC/VC \qquad (3)$$

$$TFC = MFC(TC/VC) \qquad (4)$$

$$\text{Correction Factor } CF = TC/VC \qquad (5)$$

Using the same data set that was incorporated in Fig. D.4, the correction factor CF is shown as a function of the total particle concentration in Fig. D.5. This figure clearly highlights the need to apply a correction factor to all data, since even concentrations as low as 20 cm^{-3} require a factor of 2 correction on the FBAPs concentrations, not only on the total FBAP concentrations, but on all of the FL-1, FL-2 and FL-3 components.

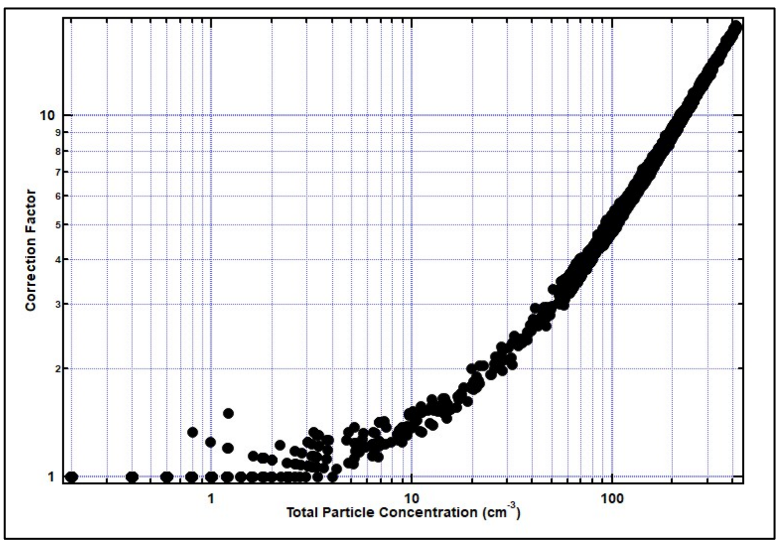


Figure D.5

D.3.3 Background removal

One of the methodologies for removing the influence of non-FBAP artefacts caused by either the bleed-through to the detectors or fluorescence of contamination on chamber walls is to use the instrument's internal system that triggers the lamps when there are no particles in the chamber. This is described in section 8.2, "Running WIBS-NEO in Forced Trigger Mode". The forced trigger (FT) is run either manually by the user or enabled to activate at a user selected interval, automatically. In either case, a data file will be created that contains individual particles with fluorescence intensities associated to FL1, FL2 and FL3 (Xe1_FluorPeak1, Xe1_FluorPeak2, Xe2_FluorPeak2, respectively). These are also sometimes labeled Channels A, B and C. From these data, histograms are constructed of the frequency of occurrence of fluorescence intensity for the three channels. Figure D.6, taken from Perring et al. (2015), illustrates an example of the Channel A intensity histogram (black curve). Assuming that most of the artefacts are represented within this distribution, the analysts selects some cutoff point as a threshold for accepting particles for evaluation. The interested user is encouraged to read the publications by Toprak and Schnaiter (2013) and Perring et al. (2015) for much more detail about how to select and apply these thresholds.

Many researchers have approached the problem differently, preferring to use all of the data within a selected time period to construct a similar histogram because this allows the analyst to further filter any non-FBAPs that are known to fluoresce, e.g., many polycyclic aromatic hydrocarbons (PAHS). The red curve in Fig. D.6 shows that in this particular example the shapes are almost identical, but in the study from which was published (Perring et al., 2015), the authors show that this is not always the case and argue that using the complete data set is a more robust methodology.

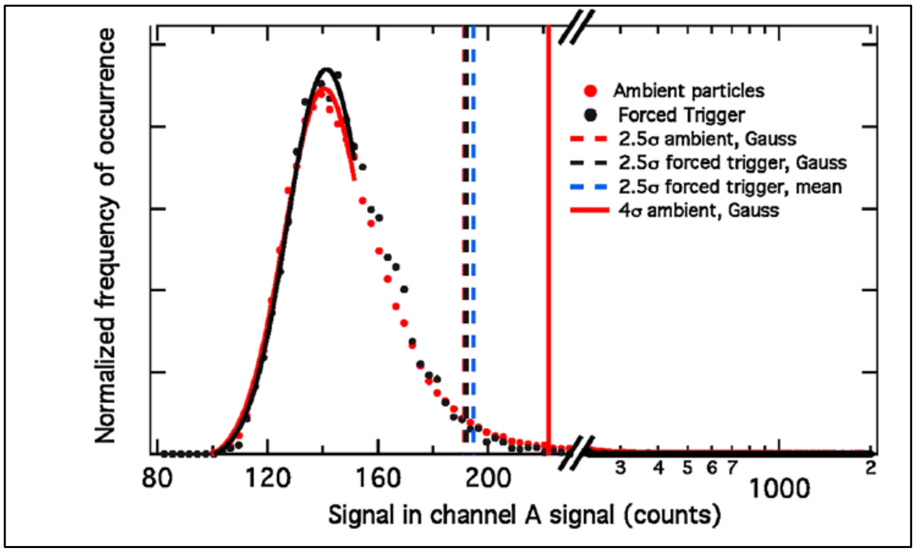


Figure D.6

D.4 References

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Perring, A. E., J. P. Schwarz, D. Baumgardner, M. T. Hernandez, D. V. Spracklen, C. L. Heald,R. S. Gao, G. Kok, G. R. McMeeking, J. B. McQuaid, and D. W. Fahey, 2015: Airborne observations of regional variation in fluorescent aerosol across the United States, J. Geophys. Res. Atmos., 120, doi:10.1002/2014JD022495.

Toprak, E., and M. Schnaiter, 2013: Fluorescent biological aerosol particles measured with the Waveband Integrated Bioaerosol Sensor WIBS-4: Laboratory tests combined with a one-year field study, Atmos. Chem. Phys., 13(1), 225–243.

Appendix E: Data Files and description

HDF5 Particle by Particle Data file description

The WIBS NEO instrument includes place holders for additional channels and new instrument capabilities that may not be currently available or installed on all instruments. Some of the channel outputs within the data stream output will contain either floating data lines, NAN (Not A Number), or no data at all. As Always, we welcome you to contact DMT for support, to share ideas for new capabilities, suggestions for software improvements, or requests for customization for your specific needs.

The following list contains the relevant data channel names and descriptions for the WIBS-NEO data stream:

Board_1: Temperature of the 408 Board
Conc_Excited_cm3: Excited particle count/sample flow rate concentration of total particles (#/cm3)
Conc_Total_cm3: Total particle count/sample flow rate Concentration of total particles (#/cm3)
H12310_Temperature: Not currently implemented
Max_Transit_Time_Counts: # of all particles in data stream that exceed max particle period time as set in the NEO software configuration settings
Min_Transit_Time_Counts: # particles in data stream that fall below min particle period time as set in the NEO software configuration settings
Num_Discarded_Particles: Total # of particles that either exceed the coincidence threshold set in the configurations settings as max particles per second value, exceed Min or Max particle period, or exceed the SIZE HIGH LIMIT as set in the NEO software configuration (Default =100000 counts)
Num_oversize_Rejects: Total # of particle events that saturate the A/D converter
RH: Not currently implemented
SYS_V: System Power measured at the control board reference
Sample_MassFlow: Sample mass flow rate read from MFC
Sample_PSIA: Sample pressure read from MFC
Sample_SetPoint: Flow rate set point read from MFC
Sample_Temperature: Sample temp read from MFC
Sample_VolumetricFlowRate: Sample flow rate read from MFC
Seconds: Seconds since 1/1/1904, EPOCH timestamp. Will match computer timestamp
Sheath_MassFlow: Sample mass flow rate read from MFC
Sheath_PSIA: Sample pressure read from MFC
Sheath_SetPoint: Flow rate set point read from MFC
Sheath_Temperature: Sample temp read from MFC
Sheath_VolumetricFlowRate: Sample flow rate read from
Temperature: Not currently implemented
Total_Particle_Count: Total number of particles displayed and written to file that are not rejected by any criteria and used as # particles for concentration calculations
Valid_Particle_Count: Total number of particles displayed and written to file that are not rejected by any criteria and have been excited by the flashlamps - used as # particles for excited concentration calculations the excited particle count duty cycle Max is 125/s based on maximum flashlamp duty cycle
Xe1_Power: Flashlamp intensity monitor

Xe2_Power: Flashlamp intensity monitor
Asphericity: AF value calculated using the scaled voltage response of the four shape quadrants
Density_g_cm3: User defined constant in the NEO configuration file used to estimate the total mass of sampled particles during data saving only. Default is 1g/cm3
EP_Overflow_Flag: Excited Particle Overflow Flag - Diagnostic value for troubleshooting data in the excited particle stream – No end user utility
Flag_Excited: Particle excited by flashlamps = 1, Not excited = 0
Mass_ug: Mass of the particle calculated from particle size and Density_g_cm3 variable as set in configuration file settings
NF_Shape_0-3: ADC value recorded from each individual quadrant of the 4 channel PMT corresponding to a valid particle trigger
NF_Sizer_Relative_Peak: Height of peak in ADC value relative to ADC baseline value used for particle sizing
NF_Sizer_Transit_Time_nsec: Transit time of particle through 635 nm laser beam reported as the number 25 ns clock cycles and is based on the system clock 40 MHZ sampling rate
Size_um: Calculated size of particle (um) based on ADC value of Peak Detector
Xe1_FluroPeak: Fluorescence peak intensity ADC value based on Xe1 excitation
Xe2_FluroPeak: Fluorescence peak intensity ADC value based on Xe2 excitation

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HDF5 (Hierarchical Data Format 5) Software Library and Utilities

NCSA HDF5 (Hierarchical Data Format 5) Software Library and Utilities

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Appendix H: Logging onto the Remote NEO Network (Windows 10) using Ethernet

The WIBS-NEO instrument can be connected to the intranet or a single computer using an ethernet cable and the instrument's Ethernet port, which is located with the other interface connections. Remote Desktop is one example of a remote program that can be run on a host machine to connect to the WIBS-NEO instrument over the Internet.

To connect to the remote WIBS-NEO computer, that computer must be turned on, and it must have a network connection. Remote Desktop must be enabled on the WIBS-NEO computer, and you must have permission to connect. For permission to connect, you must know the list of users.

The WIBS-NEO wireless network is named NEO0XXX; where XXX is the serial number of NEO.

Wireless Connection:
 Wireless Network ID: NEO0XXX
 Password: 12345678

If your user account doesn't require a password to sign in, you'll need to add a password before you are allowed to start a connection with a remote computer.

Remote Desktop: Static IP 192.168.159.1
 User: neo\user
 Password: neo

File Transfer:

Files can be transferred from the WIBS-NEO onboard computer to the host machine using the **right click copy** and **paste** features. To transfer files, navigate to the WIBS-NEO data folder. Select the files to transfer, and copy them by right-clicking and selecting **Copy**. Then minimize the remote desktop function, navigate to the desired file location, and paste the files using the right-click function. After right-clicking to paste the files, it may take up to a minute for the program to respond.

Another option for copying files is to put them on a shared folder. You can share a folder on the remote machine by double-clicking on it and then selecting **Share This Folder** under the **File and Folder tasks.** This will bring up a window where you can select **Share This Folder** using a radio button. After clicking **OK**, navigate back to the host machine desktop. Bring up Windows Explorer and in the path field type "\\" followed by the IP address of the remote desktop computer. The shared folder should now be visible, and you can copy its files to any other location.

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