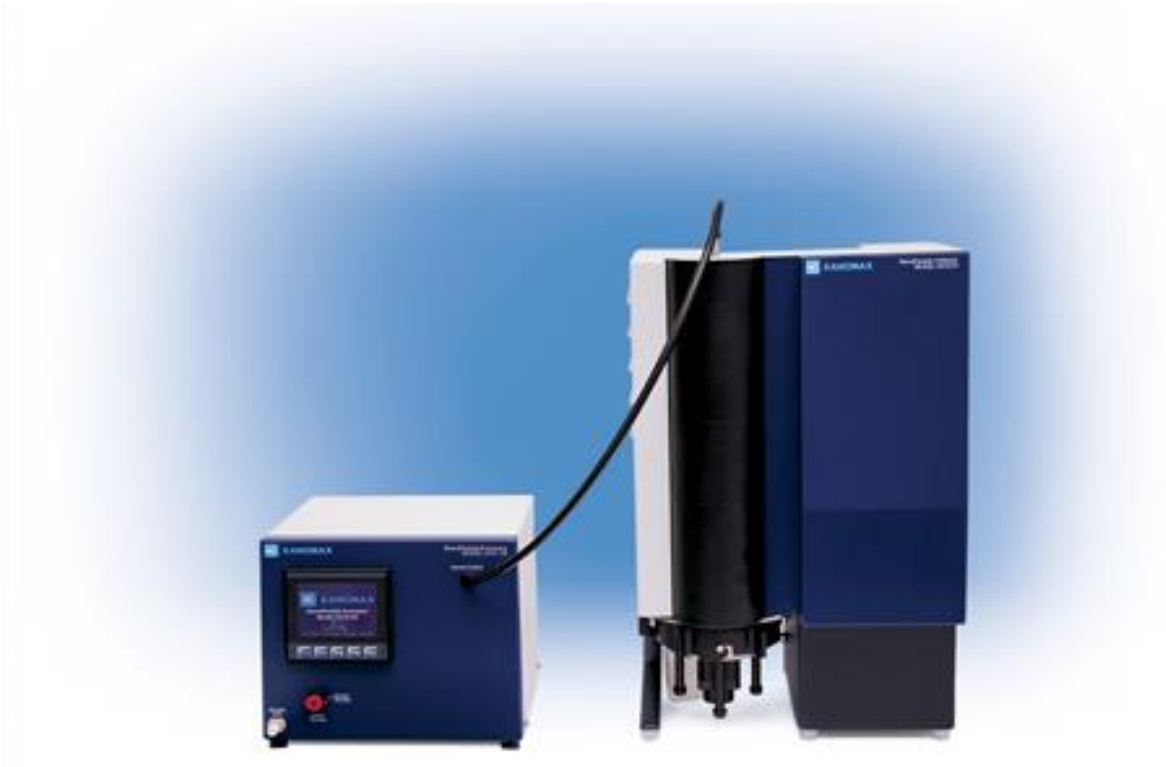
KANOMAX FMT
A Kanomax Company

Nano SpotLight Model 9410: User Manual



Part Number: 1979410 Version 1.0

Nano SpotLight Model 9410: User Manual

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The following is a history of the Nano Spotlight Model 9410 User Manual (part number 9410):

Version	**Date**	**Change**
Version 1.0	June 2019	User Manual Created

Limitation of Warranty and Liability

Kanomax FMT, Inc. offers a full 12-month repair or replacement warranty on all products sold. Warranty covers defects resulting from design or manufacturing. If any such product proves defective during this warranty period, Kanomax FMT, Inc., at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. This warranty is offered on a return to factory basis, with return shipping expense expressly at the cost of the customer. Kanomax FMT, Inc. will pay the return shipping on any materials repaired or replaced. Any repaired or replaced item assumes the remainder of the initial warranty period. Kanomax FMT, Inc. warrants only to the extent of replacement or repair of our products, and does not assume any responsibility for consequential damages. No warranty is offered on accounts with past due balances. In order to obtain service under this warranty, Customer must notify Kanomax FMT, Inc., of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. The Customer shall be responsible for packaging and shipping the defective product to the service center designated by Kanomax FMT, Inc. with shipping charges prepaid.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Kanomax FMT, Inc. shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Kanomax FMT, Inc. representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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Service Policy

Knowing that inoperative or defective instruments are a detriment to our customers' satisfaction, our service policy is to give prompt attention to any known problems. If you discover any malfunction of the Nano SpotLight, contact Kanomax FMT, Inc. at 651-762-7762 (USA). If you are outside of the USA, please call your authorized distributor.

Table of Contents

About This Manual

Intended Audience

The Nano SpotLight Model 9410 User Manual is intended to be used by qualified personnel (such as technicians and engineers) in a laboratory setting.

Scope of User Manual

This user manual contains detailed instructions for the installation and set up of the Nano SpotLight Model 9410. The manual also contains an explanation of how the nebulizer works.

Definitions

- UPW: Ultrapure Water
- EU: European Union
- RAE: Residue After Evaporation
- psi: Pounds per Square Inch
- kPa: Kilo Pascals
- SLPM: Standard Liter per Minute
- ml/min: Milliliter per Minute
- ccm: Cubic Centimeter per Minute
- PFA: Perfluoralkoxy (high purity, chemical resistant plastic)
- PTFE: Polytetrafluoroethylene (high purity, chemical resistant plastic)
- PEEK: Polyether Ether Ketone (high purity, chemical resistant plastic)
- VAC/VDC: Volts Alternating Current/Volts Direct Current
- AC: Alternating Current
- USB: Universal Serial Bus
- mA: Milliamperes
- NVR: Non-volatile Residue
- DNVR: Dissolved Non-volatile Residue
- PNVR: Precipitated Non-volatile Residue
- SEM: Scanning Electron Microscopy

Safety and Handling Procedures

Read this section to learn safe handling procedures for the Nano SpotLight.

There are limited user-serviceable parts inside the Nano SpotLight: all repair and maintenance must be performed by a qualified service technician.

When working with the Nano SpotLight:

- Do not remove any parts from the instrument unless this manual tells you to do so.
- Do not remove the instrument housing or covers while power is supplied to the instrument.

Safety Signals

The following warning symbols and labels are used in the documentation and on the Nano SpotLight. Follow the procedures described in this manual to use the instrument safely.

Warning

Warnings are used for the following purposes:

- To indicate that unsafe use of the instrument could result in serious injury to you or cause irrevocable damage to the instrument.
- To indicate that if you do not follow the procedures described in this manual, you may damage the instrument.
- To draw attention to important information about the operation and maintenance of the Nano SpotLight.

High Voltage Sticker

A High Voltage warning sticker attached to the Nano SpotLight warns you that un-insulated voltage within the instrument may be sufficient to give you an electric shock. Do not make contact with any part inside the instrument.

Grounding Connection Sticker

A Grounding Connection sticker attached to the Nano SpotLight indicates that the instrument is connected to earth ground and cabinet ground.

Warnings

Please familiarize yourself with the following warnings before operating the Nano SpotLight:

- The Nano SpotLight must be used following manufacturer's specifications otherwise safety cannot be guaranteed.
- All service work must be performed by qualified service technicians - only qualified service technicians should remove the cover.
- When the NanoParticle Extractor is running, there are hot surfaces inside the device. Do not remove the cover at any time unless you are a qualified service technician.
- To prevent electric shocks, ensure that all electrical outlets are grounded.
- Follow the instructions for all inlet and outlet connections. Incorrect connections will cause the nebulizer to malfunction.
- The air or nitrogen supplied to the NanoParticle Extractor must be clean, dried, oil-free and regulated at 50-60 psi.
- During normal operation, do not tilt the NanoParticle Extractor or Collector at angles >10°.
- You must drain both the NanoParticle Extractor and the NanoParticle Collector before you move or ship the instrument. Do not ship an undried/undrained instrument back to Kanomax FMT, Inc.: doing so might damage the device and invalidate the warranty.
- Do not subject an undrained NanoParticle Extractor or Collector to freezing temperatures: doing so might damage the device and invalidate the warranty.

How the Nano SpotLight Works

The Nano SpotLight is comprised of the following:

- NanoParticle Extractor (NPE). Extracts particles from a liquid sample through aerosolization.
- NanoParticle Collector (NPC). Collects the aerosolized particles through condensation assisted focused aerosol deposition.

Figure 1: Nano SpotLight

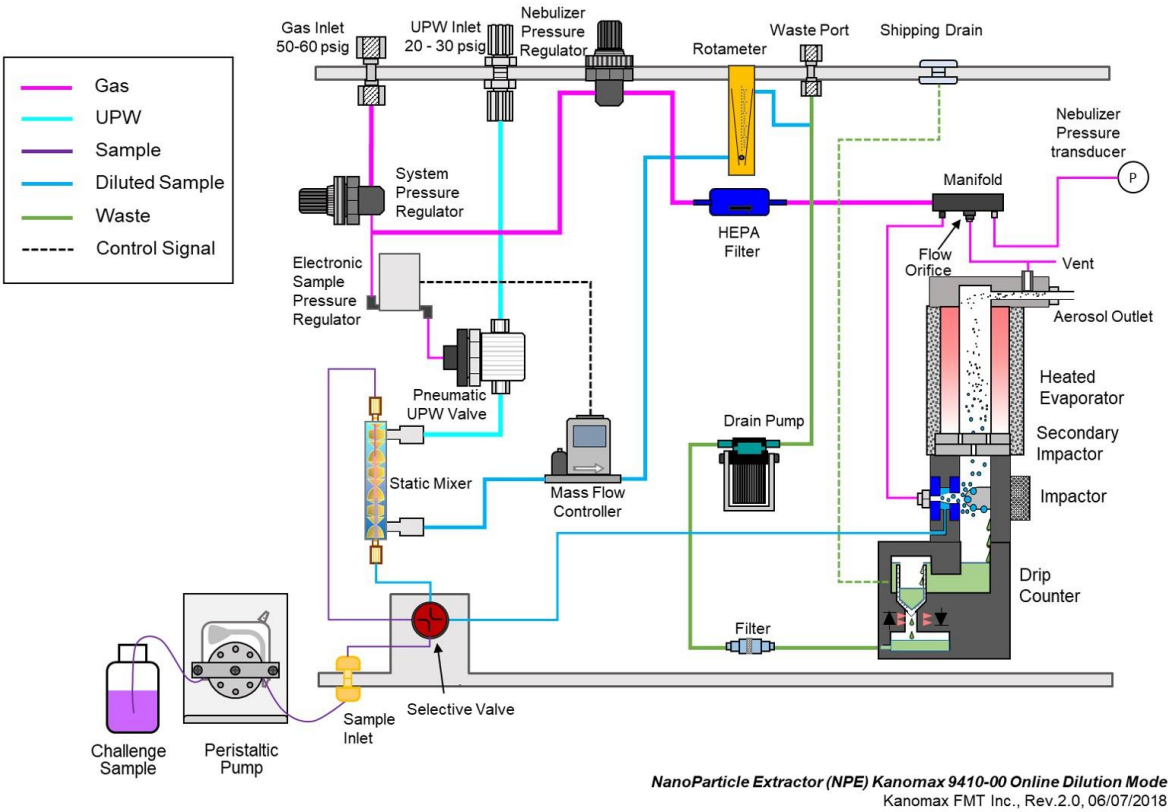
NanoParticle Extractor (NPE)

The NPE aerosolizes aqueous suspensions of particles with reduced interference from dissolved non-volatile residue (DNVR) present in the sample. During standard operation a continuous stream of ultrapure water is nebulized into fine droplets. An impaction pin positioned within 1.0 mm of the nebulizer nozzle removes the largest liquid droplets. The remaining wet aerosol has a nominal average droplet size of ~ 500 nm. The aerosol is conditioned at an elevated temperature to evaporate liquid, leaving only the particles and precipitated non-volatile residue from the sample. The aerosol is then combined with clean, dry air. Up to 1.5 SLPM of dry aerosol flow can be drawn from the aerosol outlet.

Using a traditional nebulizer to create an aerosol of colloidal particles often results in interference from any DNVR present in the sample. After droplet evaporation, non-volatile residue creates particles of precipitated residue regardless of whether the droplets contain colloidal particles or not. When there is a particle in a droplet, precipitated non-volatile residue forms a coating on the particle. This coating is problematic when you aerosolize small particles (<30nm) or particles where the surface properties are of concern (such as toxicology studies). The NPE mitigates precipitated non-volatile coating by minimizing the size of the nebulized droplet, thereby reducing the influence of precipitated non-volatile residue on the final aerosol properties.

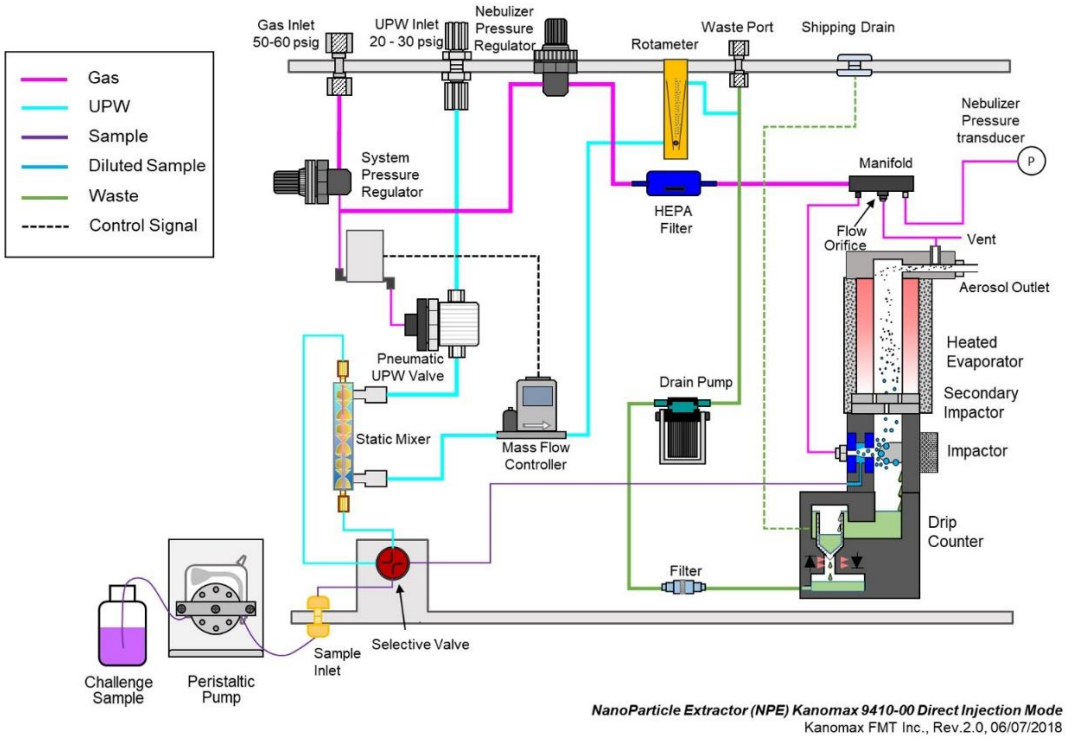
A sample port on the NPE allows for extraction and collection of particles in an aqueous sample either by direct nebulization or diluted online with UPW. In the online mode, the liquid sample is metered into the instrument via a peristaltic pump, combined with the ultrapure water stream set at a known volumetric flow rate. Figures 2&3 are schematic diagrams illustrating the main components of the NanoParticle Extractor.

Figure 2: Schematic Diagram of the NanoParticle Extractor, Diluted Flow.



NanoParticle Extractor (NPE) Kanomax 9410-00 Online Dilution Mode
Kanomax FMT Inc., Rev.2.0, 06/07/2018

Figure 3: Schematic Diagram of the NanoParticle Extractor, Direct Flow.



The NPE offers the following advantages over existing nebulizer technology:

- Produces droplets less than 1µm in diameter.
- Limits the influence of precipitated non-volatile residue on nebulized particles.
- High sample flow rate.
- Continuous on-line flow rate to the nebulizer.
- Ability to inject a small sample directly into the nebulizer.
- Does not require a conductive solution (unlike electrospray aerosolization).
- Integrated heated evaporator.
- Drip counter to monitor nebulizer sample flow rate.
- Temperature and pressure logging of on-line sample flow.
- Feedback control of evaporator and nebulizer housing temperatures to aid in stability.
- Online sample dilution with UPW minimizes contamination by non-volatile residue.

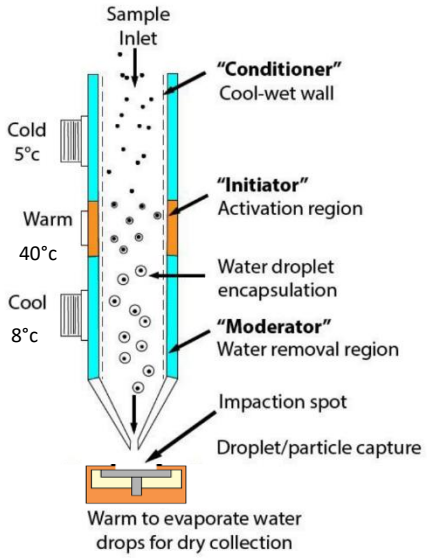
NanoParticle Collector (NPC)

The NPE generates aerosol particles composed of either precipitated non-volatile residue or liquid borne particles within the sample. These particles are sampled by the NPC for deposit onto a substrate.

The NPC uses a laminar-flow water-condensation technology for the collection to facilitate Focused Aerosol Deposition (FAD) of particles onto scanning electron microscopy (SEM) stubs and substrates.

Aerosol particles enter the NPC where they are exposed to a supersaturated water vapor environment. A moderated three-stage growth tube consists of three temperature regions (conditioner, initiator, and moderator) to control the vapor profile within the sample flow (Figure 4). The wetted walls are maintained by a single wick (formed from rolled filter media) aligning all three regions of the growth tube.

Figure 4: Schematic diagram of three-stage growth tube with dry particle collection.



The initial cold conditioner establishes a controlled vapor-saturated aerosol stream largely independent of the incoming sample flow conditions. Super-saturation occurs in the second region as a result of the difference in the diffusive rates of water vapor and heat transport. The warm walls of the initiator provide a region that has high partial pressure of water vapor relative to the saturation vapor pressure of the flow exiting the conditioner.

Because the mass diffusivity of water vapor is larger than the air warms. To reach a desired state of equilibrium, water vapor within the supersaturated aerosol condenses onto aerosol particles. The relative humidity in the initiator reaches values of 130-140%, which is sufficient to overcome the surface energy barrier associated with the curvature of the particle surface, and activate condensational growth of particles as small as 5-10 nm in diameter.

The final cool moderator region allows continued droplet growth while reducing the flow temperature and water vapor content. This brings the vapor content below saturation levels at ambient conditions and avoids unwanted condensation downstream of the collection region. Droplet growth occurs at temperatures close to ambient (25-30 °C in the flow stream) providing robust collection for volatile constituents, reducing changes in the particle chemical composition or biological structure of the collected particles.

Using condensational growth, the aerosol particles are enlarged into water droplets of ~ 3 μm in diameter. These large droplets facilitate inertial separation and collection of the incumbent aerosol particles. The water-encapsulated particles are deposited onto the warm SEM stub collection surface in the form of micro-droplets. The temperature-adjustable sample heater evaporates water from the droplets leaving behind the solid particles. The single-hole impaction nozzle produces a tight and uniform particle deposition of about 0.5 mm in diameter. The SEM stub sample platen holds five one-inch SEM stubs to allow for particle collection on suitable substrates (such as silica wafers) for direct analysis (see Figure 5).

Warning: To evaporate the water quickly and avoid water pooling on the collection surface, do not sample aerosol concentrations > 10,000 particles/cm^3.

Figure 5: 5-well SEM Stub Platen.

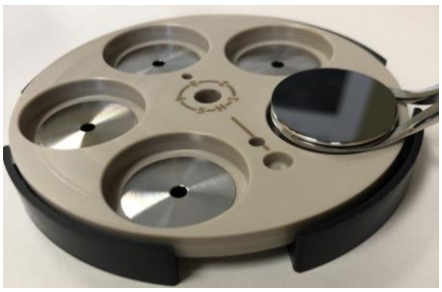
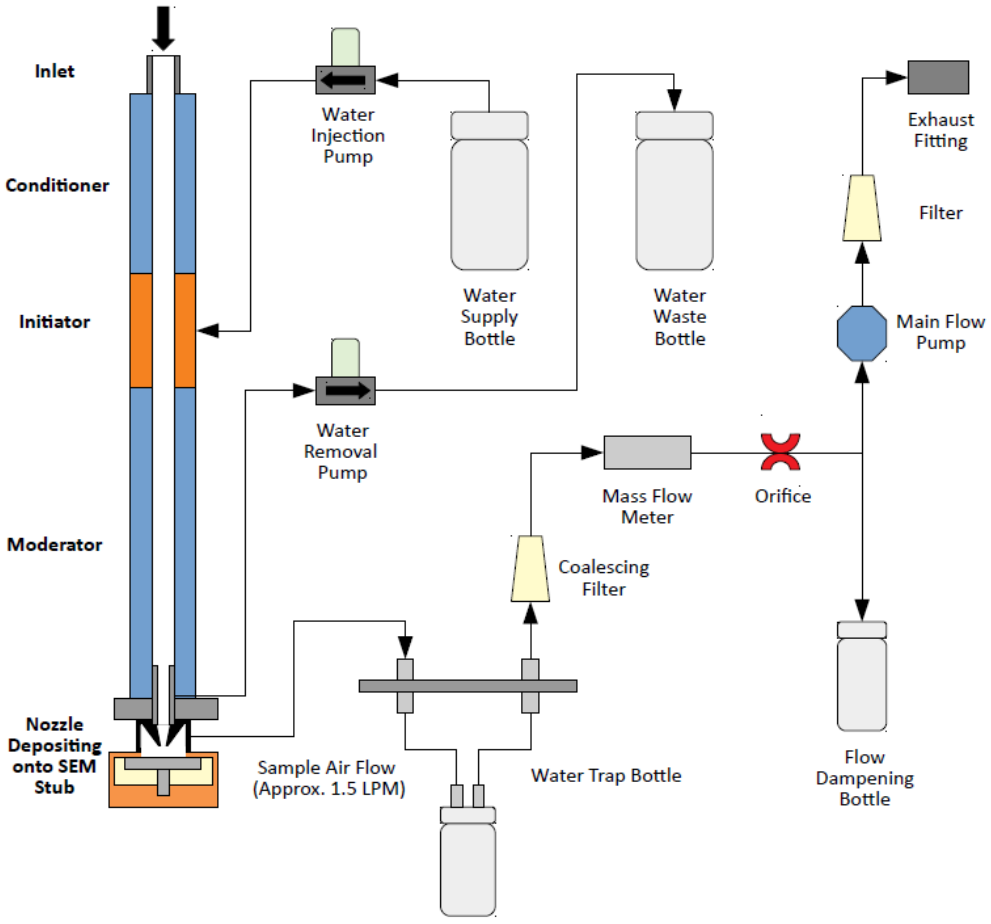


Figure 6 shows the NanoParticle Collector flow system, where 1.0 – 1.5 SLPM of aerosol sample flow passes through the inlet, growth tube, and nozzle to collect droplets. Liquid pumps handle injecting and extracting water from the wick, maintaining a wet wick without excess water. A water trap is installed on the access ports to prevent water from fouling the mass flow meter if liquid accidentally enters the sample flow. The sample flow line then passes through a coalescing filter, mass flow meter, restricting orifice, and pump. The sample flow system also includes a bottle to dampen pulsations from the diaphragm pump.

Figure 6: Schematic diagram of the NanoParticle Collector.



Nano SpotLight Applications

- UPW system monitoring.
- UPW system contamination mapping.
- UPW system troubleshooting.
- Analyzing Chemical-Mechanical Polishing (CMP) slurries.
- Characterizing the filtration performance of liquid filter media.
- Analyzing drugs and other medical nanoparticles in water.
- Analyzing environmental water samples.
- Filter retention testing.
- Component contamination profiling.
- Filter (MF and UF) shedding.
- IX resin release.
- Particle shedding from mechanical components (valves, regulator, tubing, etc.).

Acknowledgement

The ultrafine nebulization method used in this device is based on technology licensed from CT Associates, Inc. (CTA). We offer our sincere thanks to Don Grant, Gary Van Schooneveld, and Mark Litchy for their invention, their clever insights to this unique technology, and the gracious feedback they have provided during the development of this product. Patent numbers 8,272,253 and 8,573,034 have been issued to CTA and licensed by Kanomax FMT, Inc. Patent number 7,852,465 has been issued to Kanomax FMT, Inc.

The aerosol particle collector technology is licensed exclusively from Aerosol Dynamics Inc. with U.S. Patents #6712881, #7736421, #8801838, German Patent #10392241, and Japanese Patent #5908475. Other patents pending. A grant from the National Institutes of Health (1 RC3 ES019081-01) funded the original collector development at Aerosol Dynamics Inc.

Installing the Nano SpotLight

The Nano SpotLight includes a NanoParticle Extractor and NanoParticle Collector. Unpack the instruments and check that every item in the packing lists (shown in Tables 1 and 2) is included in the shipment.

Table 1: NanoParticle Extractor Packing List

Part Number	Description	Quantity
Model 9410-00	NanoParticle Extractor	1
1021000	Ismatec Precision Metering Peristaltic Pump, Cassette Cartridge, Cassette Cartridge with Pressure Lever, power cord, and Instruction Manual	1
1330001	Power Supply Cable (USA only)	1
1022495	CDA/N_2 Adapter Fitting	1
2002020	125mL Wash Bottle	1
1021049	0.64 Tygon Tubing	1
1610085	Particle Inlet Fitting	1
3020035	Conductive tubing, 2 feet	1
1330004	RS 232 Serial Cable	1
1979410	User Manual, Printed	1
2605004-NSL	USB Flash Drive containing the Nano SpotLight User Manual	1

Table 2: NanoParticle Collector Packing List

Model 9410-01	NanoParticle Collector	1
1330001	Power Supply Cable (USA only)	1
ASSY-0079	SEM Sequential Sampler	1
CP-0069	Impact Nozzle	1
CP 100-908	Sample Platen kit (includes 5-well platen, petri dish, SEM stub loading plate)	1
CP-0123	Stub Removal Tool	1
FLOW-0029	Syringe, 3mL, Plastic	1
FLOW-0022	¼ in OD Tubing	1
FLOW-0102	4 mm to 1/8 in Stem Adapter	1
FLOW-0039	Coupling Insert, 1/8 in Barb	1
TOOL-0002	8mm Hex Nutdriver	1
ASSY-0057	Water Supply Bottle	1
ASSY-0058	Waste Removal Bottle	1
ASSY-0074	Water Trap Bottle	1
FLOW-0039	Coupling Barb	1

Equipment You Need For Installation

To install the Nano SpotLight, you will need the following items:

- 9/16 wrench.
- A length of ¼ inch OD tubing sufficient to reach from the instrument to your waste drain (12 ft maximum length).
- A length of ¼ inch OD polyethylene tubing sufficient to reach from the instrument to your air supply.
- For online sample introduction:
- A length of ¼ inch OD x 0.156" ID High Purity PFA tubing sufficient to reach from the instrument to your water supply.
- PFA tubing flaring tool, tube gripper, and heat gun.
- Ultrapure Water supply. Note: Water supply at 100 ml/min, 25-70 psi.
- Conductive tubing for transporting the generated aerosol from the NPE to the NPC (supplied).
- A supply of clean, dry, compressed air at 2 SLMP, 50-60 psi.
- Access to a suitable liquid waste drain.
- 120-240 VAC power at 50/60 Hz.
- 8mm Hex nut driver (supplied) to install/remove the impaction nozzle.
- #2 Phillips cross-recess screwdriver.

Note: No gas or liquid tubing is supplied with the Nano SpotLight.

How to Install the NanoParticle Extractor

The NPE can be operated using online sample dilution or direct sample injection modes.

- Online sample dilution mode: Used for UPW contamination particle collection and to validate standards collection instrumentation.
- Direct sample injection: Used for grab samples that do not need further dilution.

Following is an overview of the steps required to get your NPE up and running. Please read the detailed instructions for each step before you set up the instrument.

- Unpacking the NanoParticle Extractor.

- Connecting the waste outlet.
- Connecting the air supply.
- Connecting the power.
- Connecting the water supply.
- Connecting the sample inlet.
- Connecting the aerosol outlet.

Warning: The aerosol particles created by the NPE may pose a health risk if inhaled. If not connected to other instrumentation, vent the aerosol output to a fume hood.

Unpacking the NanoParticle Extractor

To unpack the NPE, follow these instructions:

1. Carefully remove the NPE from its shipping container. Save the original packing materials for use when shipping the extractor back to Kanomax FMT, Inc. for service, or for moving the extractor to a different location.

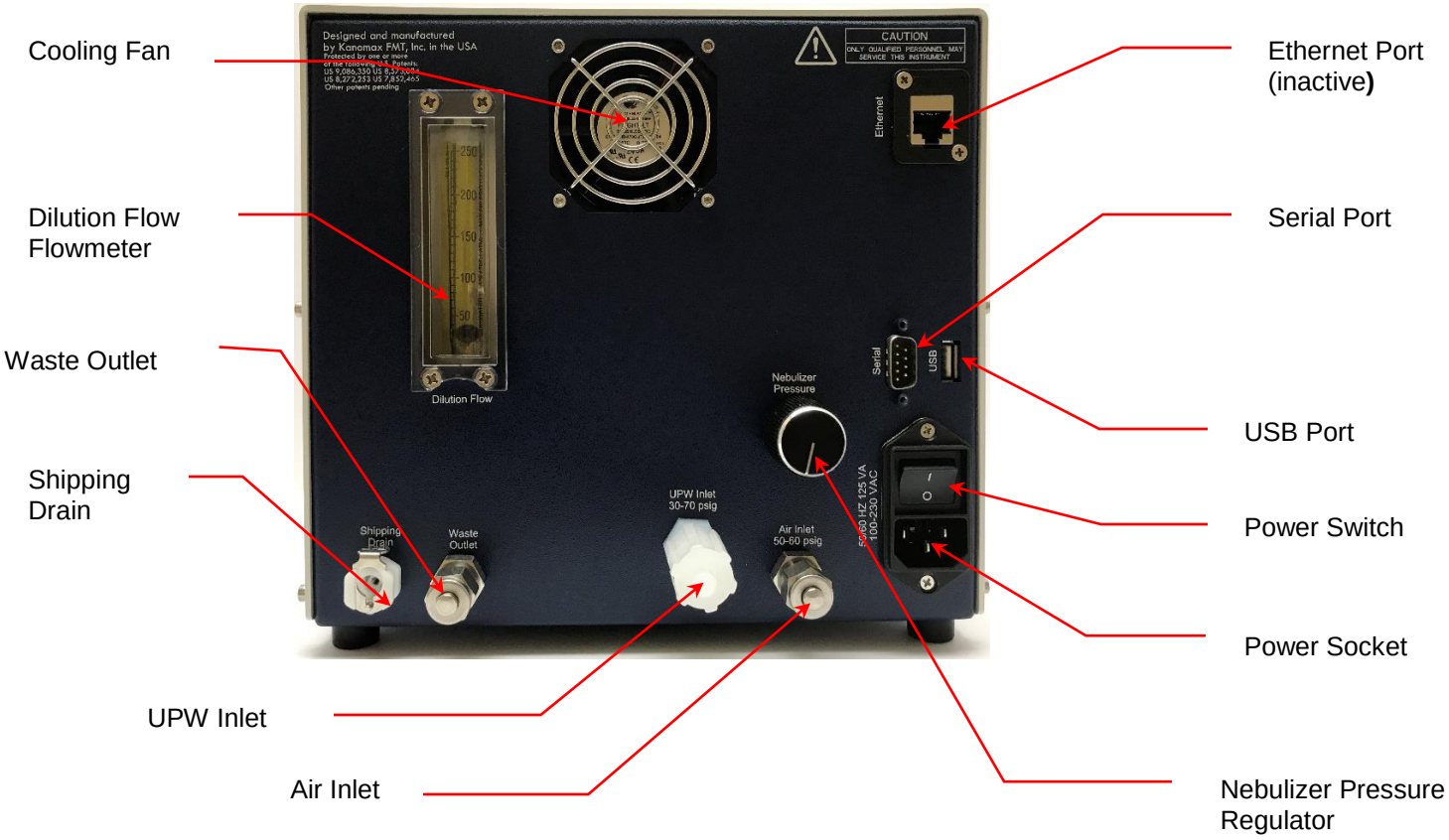
Warning. If the NPE is returned to Kanomax FMT, Inc. in anything other than the original shipping container, you will be charged for any damage that occurs during shipping. If you do not have the original shipping container, contact Kanomax FMT Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)
2. Place the NPE on a level surface.
3. Make sure there is an unrestricted air flow around the device. Kanomax FMT, Inc. recommends at least a 2-inch air gap on both sides and the top of the instrument.
4. Allow the NPE to reach ambient temperature, if necessary.
5. Make sure all the items listed in Table 1, were included in the Nano SpotLight shipment. If any of the items are missing, or damaged, please call Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

Installing the NanoParticle Extractor

Figures 7 & 8 show the front and back panels of the NanoParticle Extractor.

Figure 7: Front Panel of the NanoParticle Extractor.

Figure 8: Back Panel of the NanoParticle Extractor.

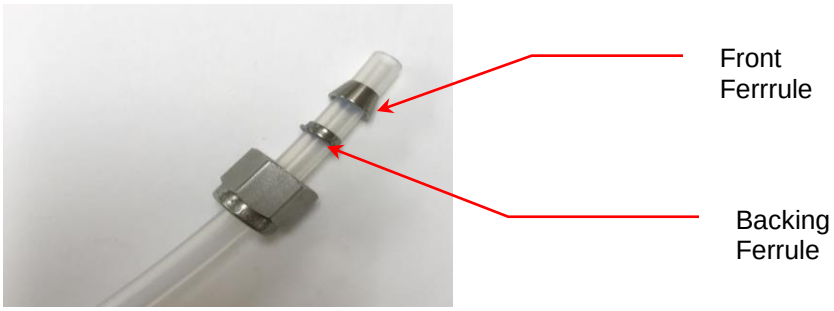


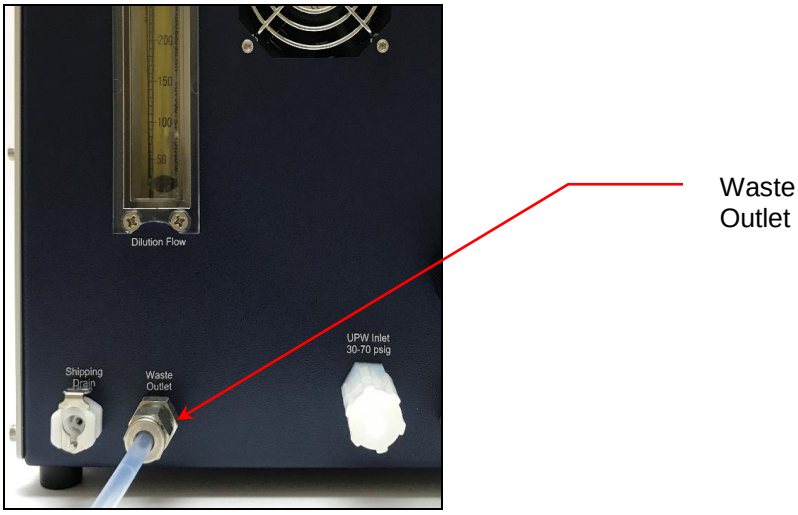
Connecting the Water Drain

Excess sample from the nebulization module is removed from the instrument using a solenoid pump. For online sampling, the excess total flow that is not delivered to the nebulization module is combined inside the device downstream of the pump.

Follow these instructions to connect the water drain:

1. Remove the protective cap from the **Waste Outlet** on the back panel.
2. Using a 6 ft length of ¼ inch OD polyethylene tubing with a Swagelok fitting on one end, insert the tubing into the **Waste Outlet** fitting on the back panel.





3. Using one adjustable wrench to hold the bulkhead and the other to turn the nut, tighten the Swagelok nut one turn past hand-tight to swage the ferrules onto the tubing. Once the ferrules have been swaged the fitting only requires slight tightening upon reassembly. **Warning**: Do not over-tighten the fitting or you will damage the tube and/or fitting.

4. Place the other end of the tube over your drain. Do not connect the waste line to a container where the pressure will fluctuate beyond ambient conditions.

Connecting the Compressed Air or Nitrogen Supply

The air or nitrogen supplied to the NPE must be clean, dried, oil-free and regulated at 345-414 kPa (50-60 psi) at 2 SLPM. Follow these instructions to connect the compressed air supply:

1. Remove the protective cap from the **Air Inlet** on the back panel.
2. Using a length of ¼ inch OD polyethylene tubing with a Swagelok fitting on one end, insert the tubing into the **Air Inlet** fitting on the back panel.

3. Using an adjustable wrench, tighten the Swagelok nut one turn past hand tight to swage the ferrules onto the tubing. Once the ferrules have been swaged, the fitting only requires slight tightening upon reassembly.
4. Connect the other end of the tube to your air supply.
5. Turn on the air at the source. The incoming pressure must be regulated at 345-414 kPa (50 - 60 psi).

Connecting the Power

To connect the power supply, follow these instructions:

1. Plug the supplied power cable into the AC power socket on the back panel of the extractor.

2. Plug the cord into an earth-grounded AC power source (100 to 240 VAC, 50 to 60 Hz, 0.6 A).

Warning: Ensure that the ground is secure. Connection to an improperly grounded electrical source is a severe shock hazard.

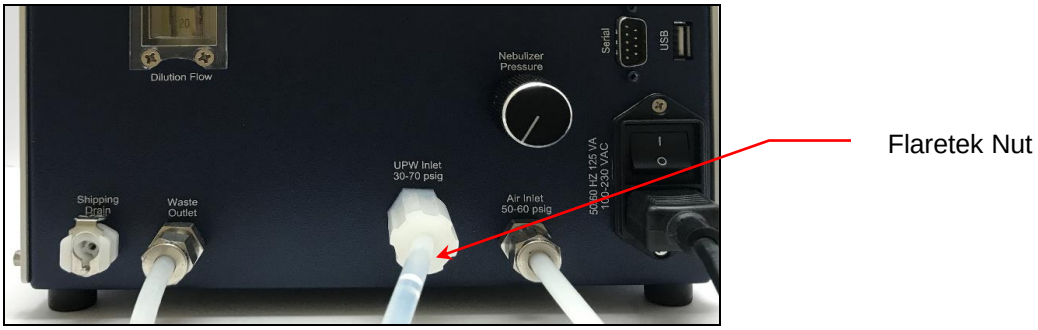
Connecting the Ultrapure Water Supply

Ultrapure water must be supplied to the NPE through a ¼-inch diameter Teflon PFA tube specially adapted to fit the **UPW Inlet** fitting on the front panel of the nebulizer. To prepare the PFA tube for attachment to the **UPW Inlet** fitting, take the following precautions:

- Make sure your hands are clean.
- Do not touch the end of the water supply tube - you may contaminate it.

To connect the ultrapure water supply, follow these instructions:

1. Cut the end of the PFA tubing evenly with a clean tube cutter.
2. Place a Flaretek nut over the end of the PFA tube before attempting to flare the end.
3. Flare the tube following the manufacturer's instructions.
4. Flush ultrapure water through the tube for several minutes to remove any debris created by the flaring process.
5. Remove the protective nut and plug from the **UPW Inlet** fitting. Keep this Flaretek nut and plug for use when moving or shipping the nebulizer. (See shutdown instructions on page 90).
6. Push the flared end of the tube onto the **UPW Inlet**.
7. Slide the Flaretek nut into place and hand-tighten.



8. Turn on the ultrapure water supply. Water then flows through the instrument and out through the waste line. Ensure that the **UPW Inlet** has no leaks. If you see any leaks, tighten the fitting.

Connecting the Sample Inlet

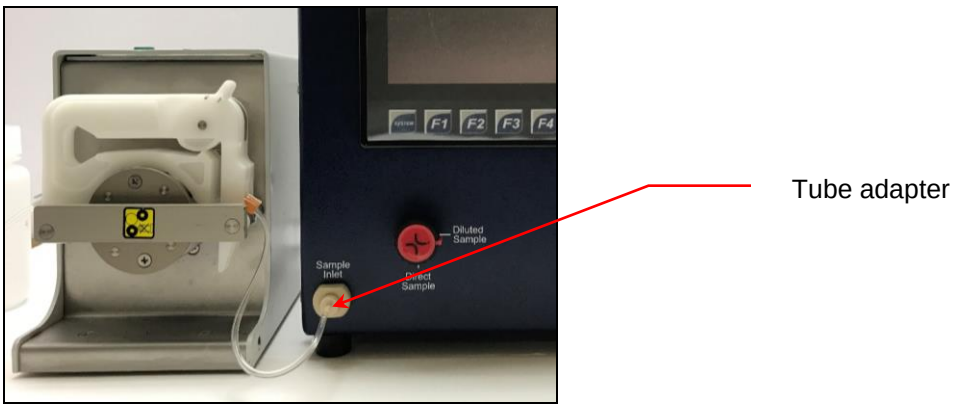
The Nano SpotLight allows for two sampling modes, Direct and Dilute, that can be configured using the Sample Selector Valve on the front panel:

- **Dilute** mode. Used when sampling directly from a UPW flow line when running standards for system validation. Turn the Sample Selector Valve to **Diluted Sample.**
- **Direct** mode. Used for UPW grab samples with low particle concentrations. Turn the Sample Selector Valve to **Direct Sample.**

To connect the Sample Inlet for the NPE, follow these instructions:

1. On the front panel, turn the Sample Selector Valve to the preferred setting (**Direct Sample** in these instructions).

2. Remove the 1/4-28 plug protective cap from the **Sample Inlet** fitting.
3. Install the supplied 1/4-28 tube adapter to the **Sample Inlet** and hand tighten.
4. Connect the supplied peristaltic pump Tygon tubing to the adapter and verify that the adapter is fully inserted into the pump tubing.

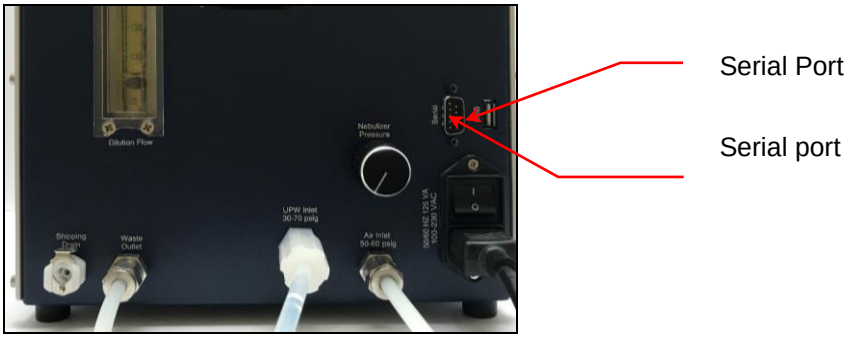


Connecting the Communications Port between the External Injection Pump and the NanoParticle Extractor

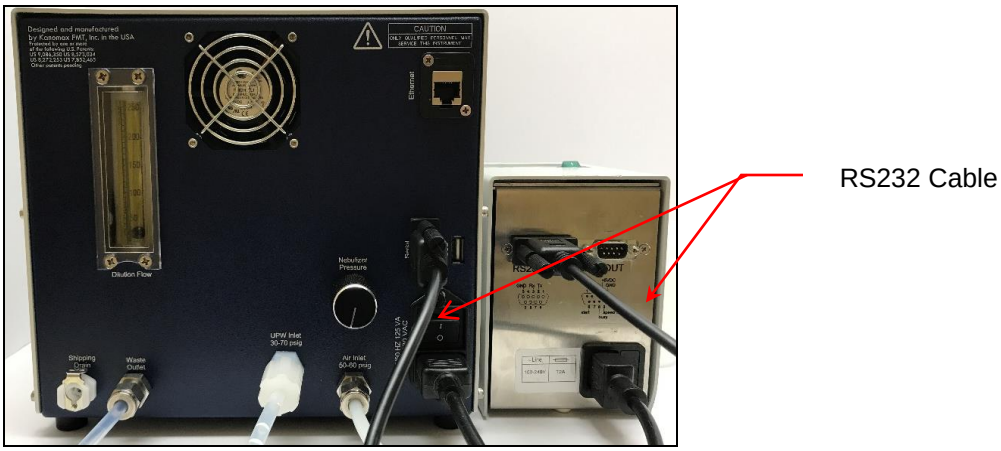
The external injection (peristaltic) pump can be controlled by the NPE.

To connect the pump and the NPE, follow these instructions:

1. Plug the provided RS 232 cable into the **Serial** port on the back panel of the NPE.



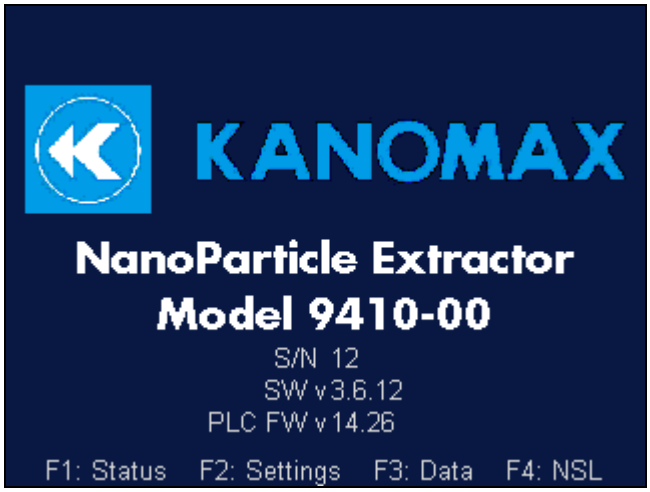
2. Plug the other end of the cable into the **RS232 IN** port on the back panel of the peristaltic pump.



Warming Up the Extractor

Using the rocker switch on the back panel, turn the power on. You see the instrument splash screen (shown below) and the extractor automatically begins its warm-up procedure. The warm-up procedure may take up to 30 minutes. Press **F1** to view the warmup status on the Extractor Status screen.

Figure 9: NanoParticle Extractor Display Home Screen.



How To Install the NanoParticle Collector

Following is an overview of the steps required to get your NPC up and running. Please read the detailed instructions for each step before you set up the instrument.

- Unpacking the NPC.
- Connecting the water supply.
- Connecting the waste bottle.
- Checking the water trap.
- Connecting the power.

Unpacking the NanoParticle Collector

To unpack the NPC, follow these instructions:

1. Carefully remove the collector from its shipping container. Save the original packing materials for use when shipping the collector back to Kanomax FMT, Inc. for service, or for moving the collector to a different location.

Warning. If the NanoParticle Collector is returned to Kanomax FMT, Inc. in anything other than the original shipping container, you will be charged for any damage that occurs during shipping. If you do not have the original shipping container, contact Kanomax FMT Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

2. Place the collector on a level surface.
3. Make sure there is an unrestricted air flow around the device. Kanomax FMT, Inc. recommends at least a 2-inch air gap on both sides and the top of the instrument.
4. Allow the collector to reach ambient temperature, if necessary.
5. Make sure all the items listed in Table 2, were included in the Nano SpotLight shipment. If any of the items are missing, or damaged, please call Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

Installing the NanoParticle Collector

Figures 10 & 11 show the front and back panels of the NanoParticle Collector.

Figure 10: Front Panel of the NanoParticle Collector

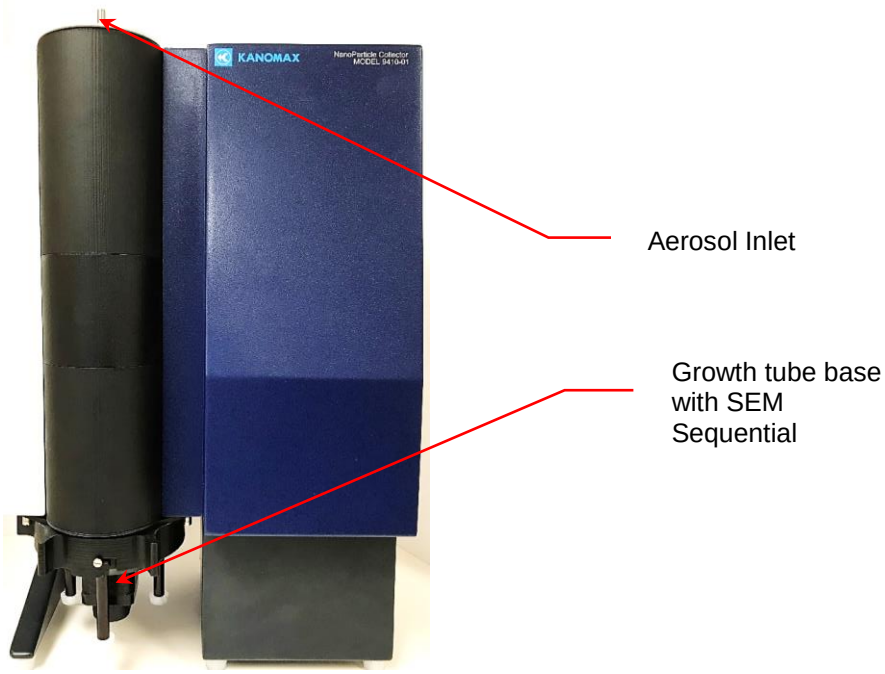
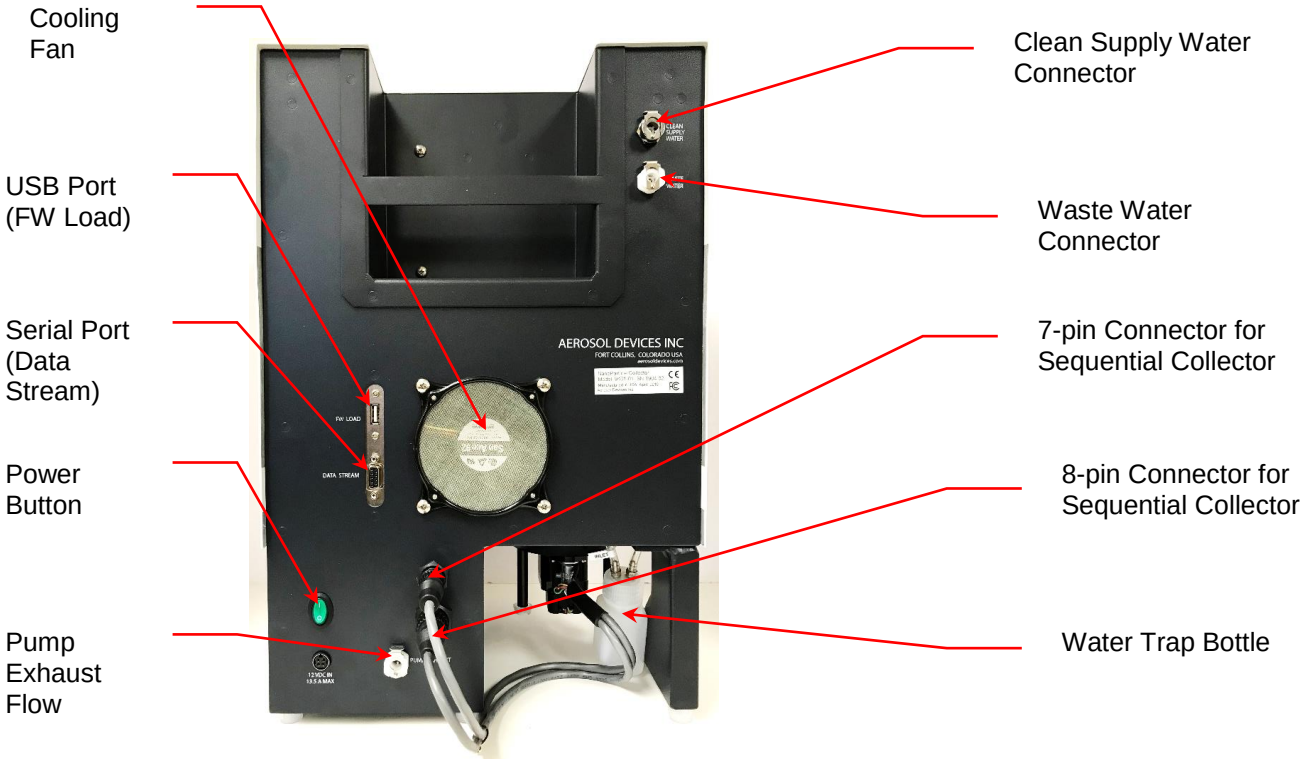


Figure 11: Back Panel of the NanoParticle Collector



Warning: The mass flow meter may be flooded or damaged if the red inlet cap is not removed before turning on the pump. To prevent inadvertent flooding you can make a small hole in the cap.

To prepare for installation, follow these instructions:

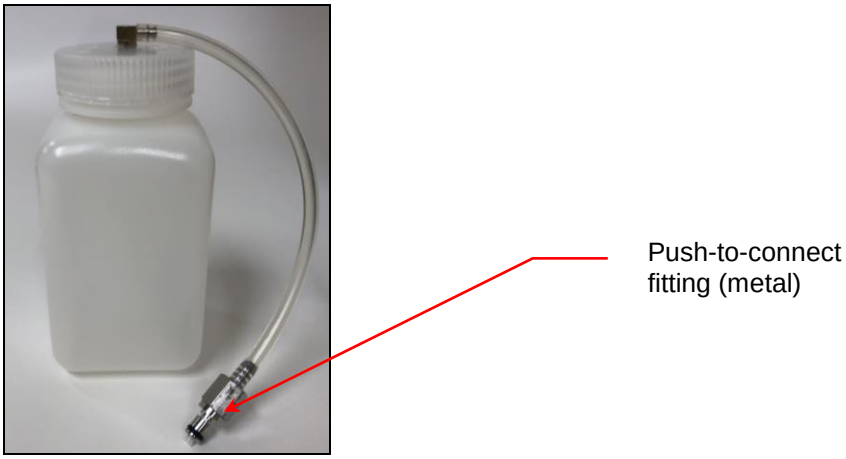
1. Remove the protective red caps from the aerosol inlet and base of the growth tube. Save the caps for use in moving or shipping.
2. Place the NPC on a secure flat surface. To allow for adequate ventilation, do not block the side vents or rear fan.

Connecting the Water Supply

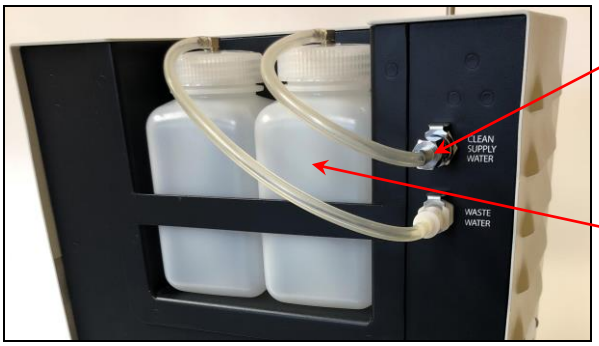
To connect the water supply bottle, follow these instructions:

1. Add UPW water to the clean water supply bottle and screw the cap hand tight. Note: The clean water supply bottle connector has a metal push-to-connect fitting.

Warning: Do not use tap water. Minerals and impurities in tap water will deposit on the growth-tube wick and may shorten the life of the wick.



2. Place the bottle in the right-side of the bottle holder (when facing the back panel of the NPC).
3. Push the connector into the CLEAN WATER SUPPLY fitting until it clicks.



Clean Water Supply connector

Clean Water Supply bottle

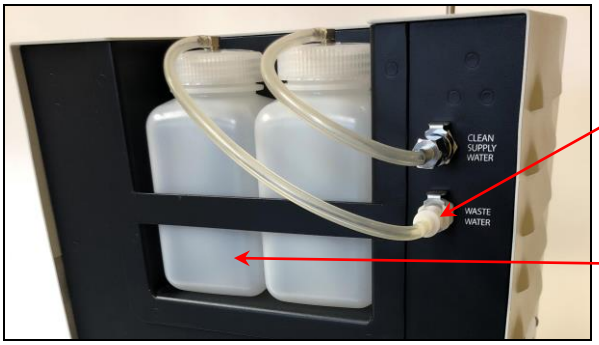
Connecting the Waste Water Bottle

To connect the waste water bottle, follow these instructions:

1. Place the empty waste water bottle in the left-side of the bottle holder (when facing the back panel of the NPC).

Push-to-connect fitting (plastic)

2. Push the connector into the WASTE WATER fitting.
   Note: The waste water bottle connector has a plastic push-to-connect fitting.



Waste Water connector

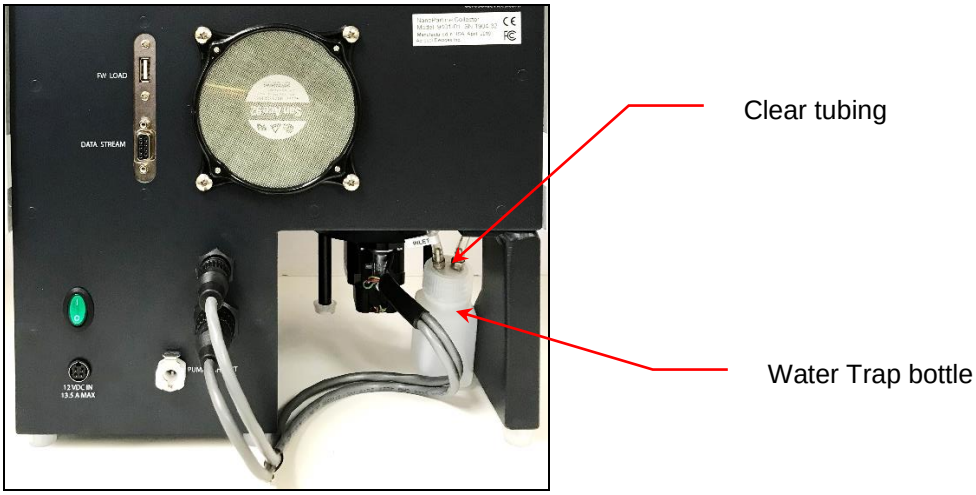
Waste water bottle

Checking the Water Trap

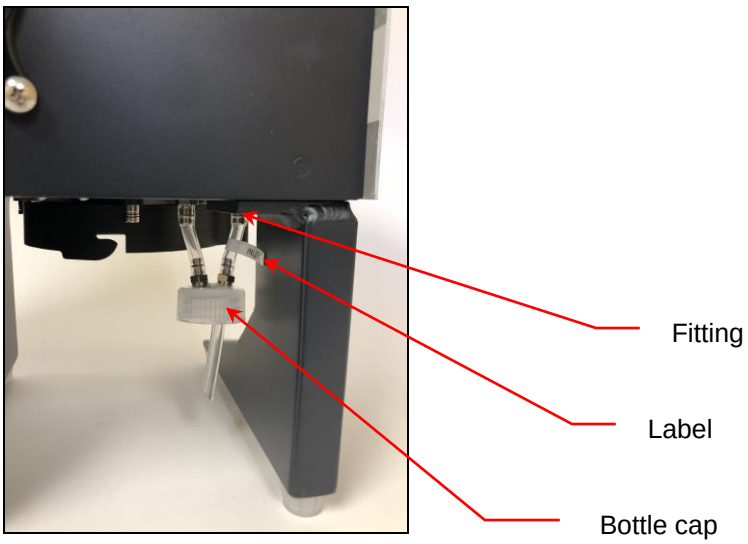
The pre-installed water trap prevents any water that accidentally enters the sample line from reaching the mass flow meter.

To check that the water trap is installed correctly, follow these instructions:

1. The NPC is shipped with a small water trap bottle attached to the base of the bottom panel. Check that the clear tubing from the bottle is connected to two barbed tube fittings on the instrument base.



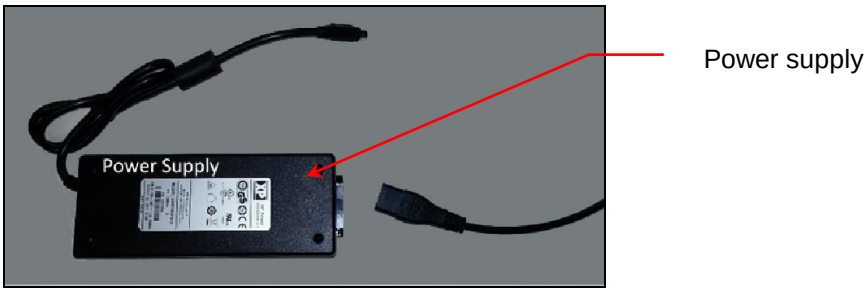
2. While the cap is still connected to the instrument unscrew the bottle from the cap.
3. Check that the tubing labeled INLET is attached to the brass port fitting that has the longer straw extending into the trap bottle.



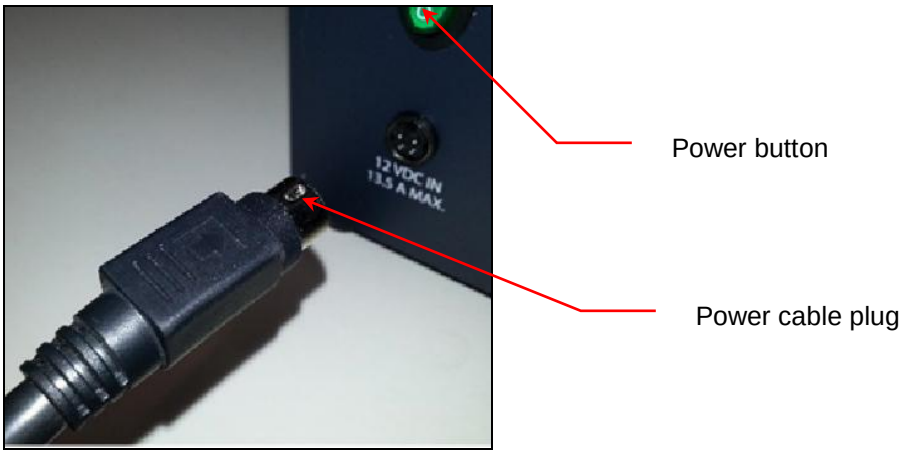
Connecting the Power

To connect the power, follow these instructions:

1. Connect the power supply and AC power cord to each other.



2. Connect the DC power cable to the back panel of the NPC by holding the power cable plug with the flat surface facing up. Make sure the DC power cable plug is fully inserted.



Warning: If you do not insert the DC power cable all the way in to the receptacle on the back panel of the instrument overheating may occur. When moving the instrument, first disconnect the DC power cable from the instrument and the AC power cord from the AC power receptacle. Check that the DC power cable is securely in place before plugging in the AC power cord.

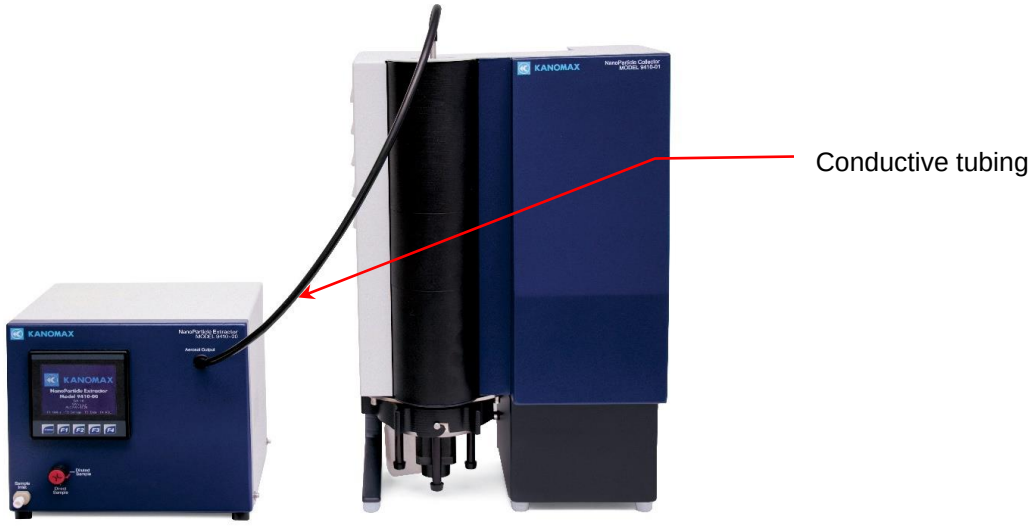
3. Plug in the AC power cord to the main AC power outlet.
4. Turn on the NPC by toggling the green power button to the I position.

Connecting the Extractor to the Collector

When the NPE and NPC are both warmed up with all temperature parameters reaching their setpoints, the Nano SpotLight system is ready to begin collecting particles and you can connect the NPE to the NPC.

To connect the NPE to the NPC, follow these instructions:

1. Using the provided ¼ in ID conductive tubing, connect the aerosol output from the NPE to the inlet of the NPC. Use the shortest practical length of tubing to minimize particle losses through diffusion and do not bend the tubing to plug the aerosol.

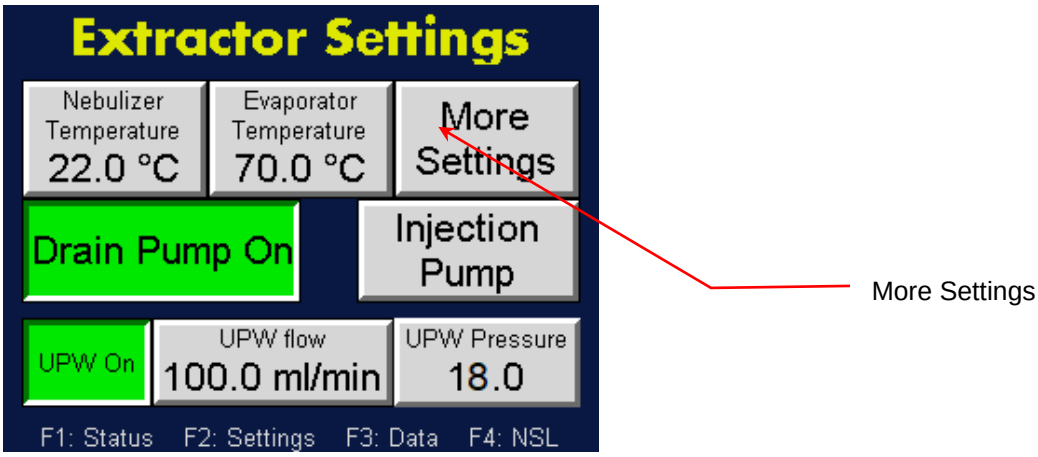


Warning: The Aerosol Output outlet of the NPE is at near-atmospheric pressure with an internal vent. If the measurement device draws more than 1.5 SLPM, ambient aerosol will be drawn into the sample stream. The device must draw no less than 1 SLPM to prevent condensation from forming in the aerosol lines. The NPC has a flow rate of 1-1.5 SLPM.

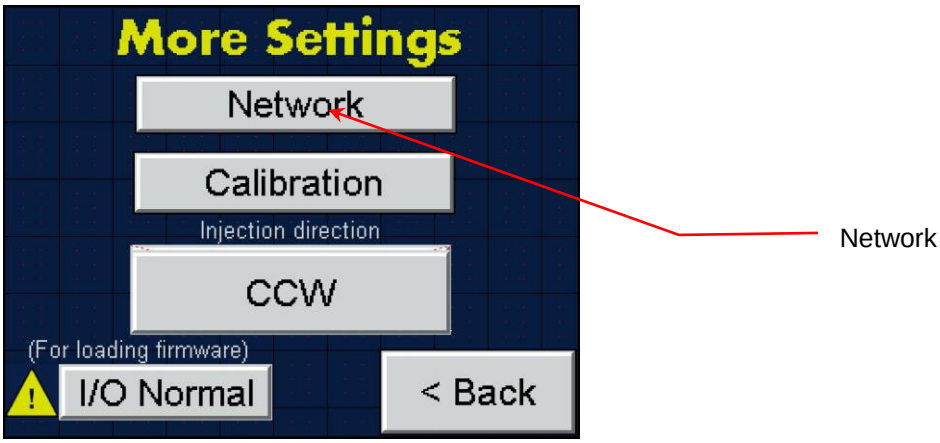
Connecting Communications Between the NPE and NPC

To connect communications between the NPE and NPC, follow these instructions:

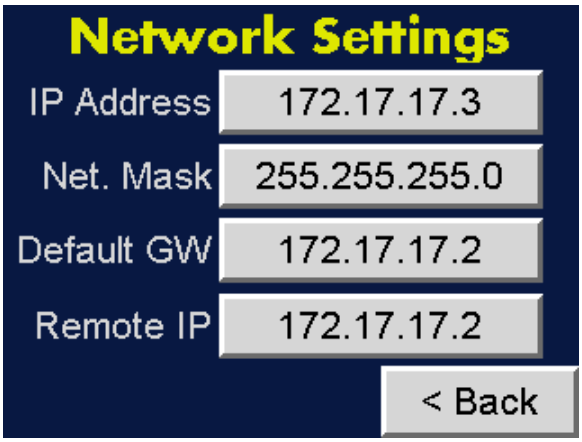
1. Press **F2** on the NPE display screen. On the **Extractor Settings** screen press **More Settings**.



2. On the **More Settings** screen press **Network**.



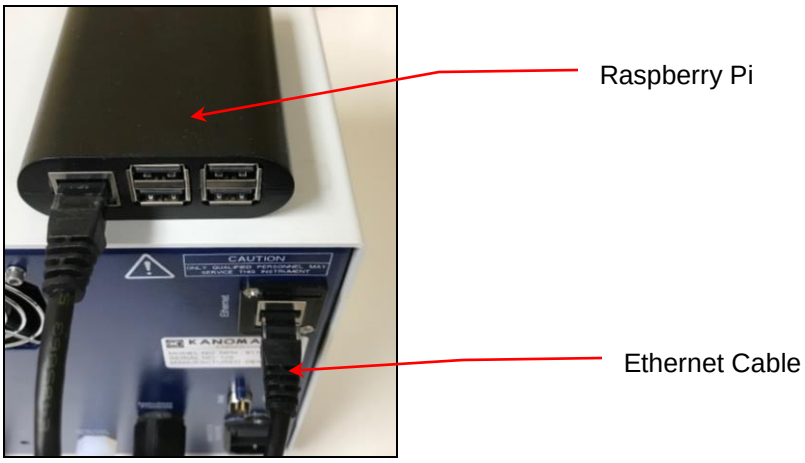
3. On the **Network Settings** screen configure the network settings.



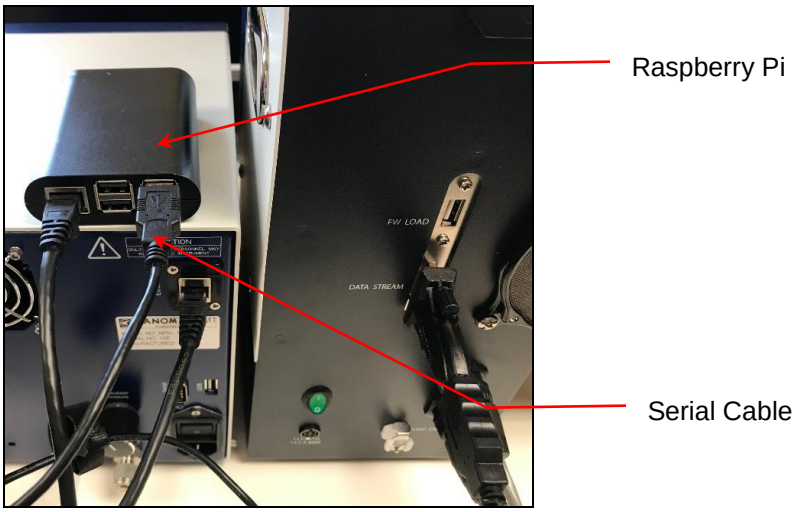
Press **IP Address** and use the on-screen keyboard to enter 172.17.17.3
Press **Net. Mask** and use the on-screen keyboard to enter 255.255.255.0

Press **Default GW** and use the on-screen keyboard to enter 172.17.17.2
Press **Remote IP** and use the on-screen keyboard to enter 172.17.17.2

4. Power off the NPE.
5. Insert one end of the provided Ethernet cable into the Ethernet port on the back panel of the NPE. Insert the other end into the Rasberry Pi.



6. Insert one end of the provided USB-Serial cable into the Data Transfer port on the back panel of the NPC. Insert the other end into the Raspberry Pi.



7. Power on the NPC and NPE.
8. Wait two minutes and then power on the Raspberry Pi.

If you experience any problems installing your Nano SpotLight, please contact Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

Operation Instructions

Once all installation procedures have been completed, you are ready to begin standard operation of the Nano SpotLight. The NanoParticle Collector is controlled through the NPE touch-screen display.

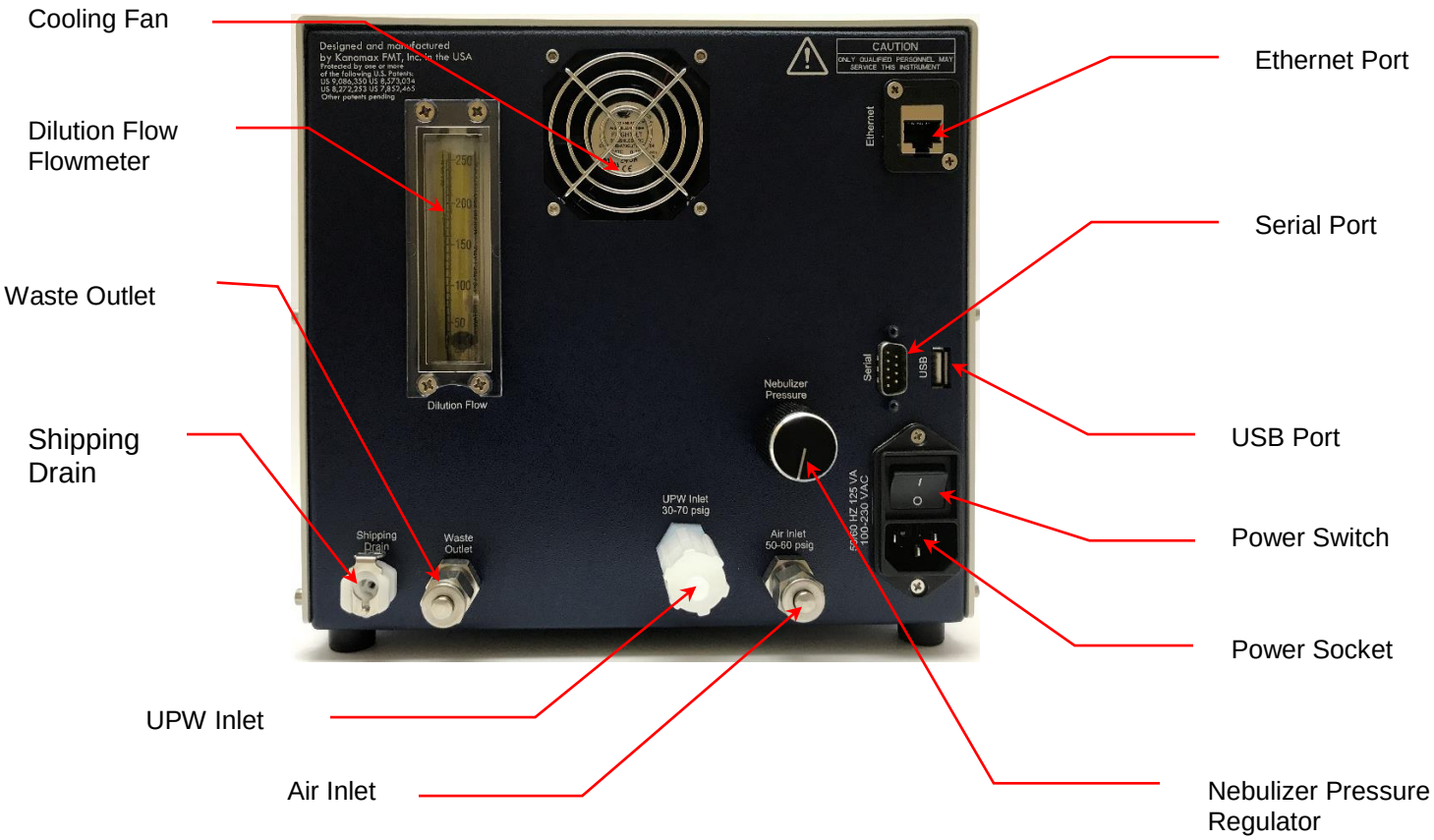
Operation Instructions for the NanoParticle Extractor

The Back Panel

Components of the NPE back panel include the following:

- Nebulizer Pressure Regulator.
- Dilution Flow Meter.
- Shipping Drain, Waste Outlet, UPW inlet, and Air Inlet.
- Data Communication ports.
- Power Switch and Socket.

Figure 12: NanoParticle Extractor Back Panel.



The Front Panel

Components of the NPE front panel include the following:

- Aerosol Output, Sample Inlet, and Sample Selector Valve.
- Touch-screen Display.

Figure 13: NanoParticle Extractor Front Panel.

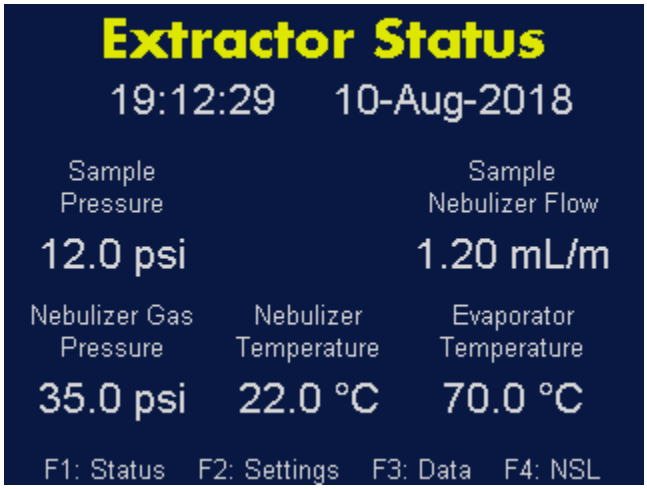
The Nano SpotLight is operated using the touch-screen display and the F1, F2, F3, and F4 buttons. The F buttons perform the following functions:

- F1: Press F1 to view NPE operation parameters.
- F2: Press F2 to view/change NPE settings.
- F3: Press F3 to view/change data collection options.
- F4: Press F4 to view the NanoSpotlight Panel that controls the NPC.
- System: the System button is for factory use only and is non-functional for the customer.

Checking the Extractor Status

Press **F1** to see the **Extractor Status** screen. The current time and date (hh:mm:ss, dd-mm-yyyy) are displayed below the screen heading. Any status readings displayed in red indicate that the status is outside the acceptable range or the set point has not been reached.

Figure 14: Extractor Status Screen.



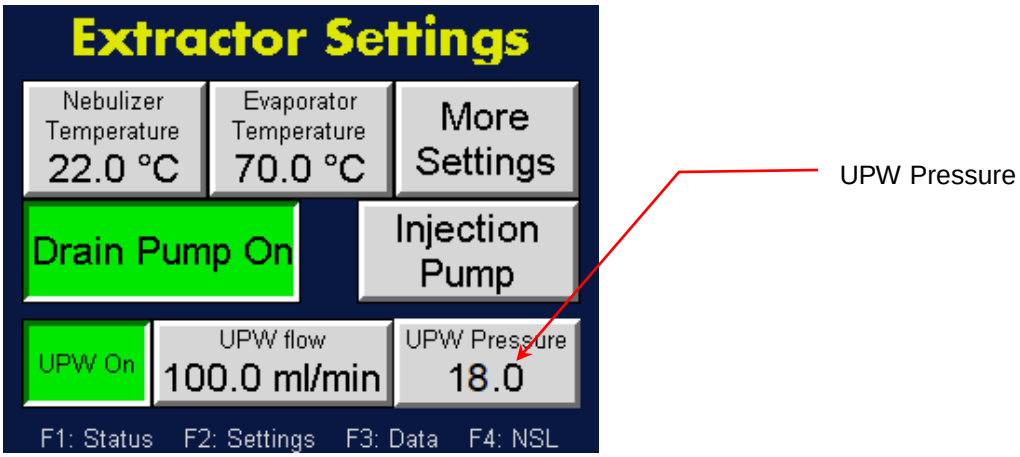
The Extractor Status screen displays the following instrument statuses:

- **Sample Pressure:** Online Sample Pressure in psi. The nominal value is 18 psi. Note: This pressure is only valid during measurements performed with the **Diluted Sample** mode.
- **Sample Nebulizer Flow**: Displays the sample flow to the nebulization module in ml/min. The nominal value is 0.5 – 4.0 ml/min.
- **Nebulizer Gas Pressure**: Displays the nebulizer gas pressure in psi. The nominal value is 35 psi. Adjust the nebulizer gas pressure using the Nebulizer Pressure regulator on the back panel.
- **Nebulizer Temperature**: Displays the nebulizer temperature in °C. The nominal value is 22 °C, but may need adjustment based on the ambient temperature and the sample temperature. Adjust to a point where the temperature is stable. Note: The nebulizer temperature should nominally be set to 5°C lower than the UPW temperature.
- **Evaporator Temperature**: Displays the evaporator temperature in °C. The nominal value is 70°C

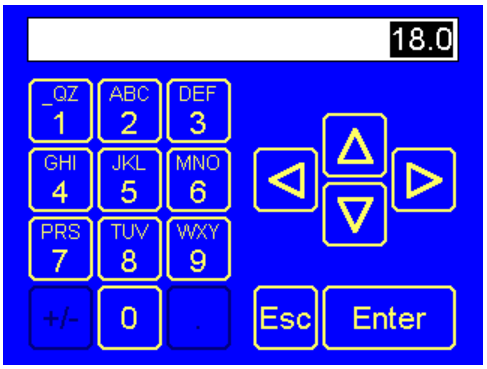
Changing the Sample Pressure/UPW Flow

To adjust the Sample Flow Pressure, follow these instructions:

1. Press **F2** to view the **Extractor Settings** screen.

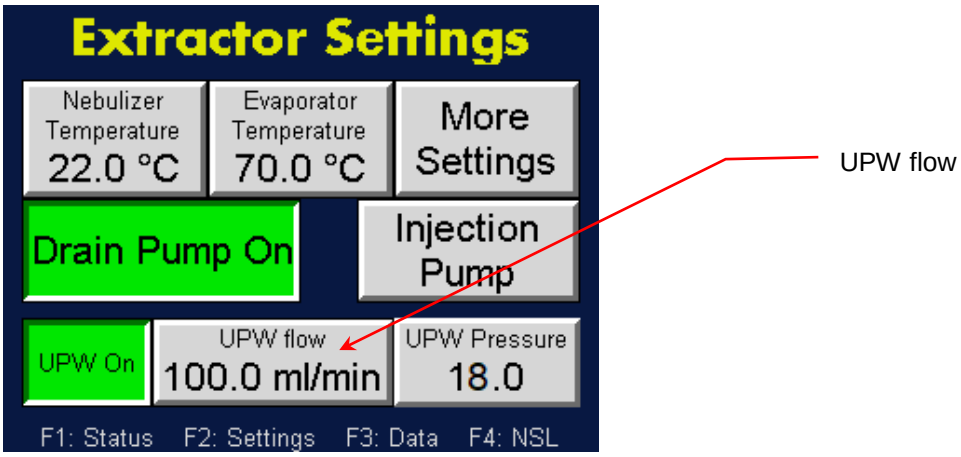


2. On the Extractor Settings screen, press **UPW Pressure**.
3. On the resulting on-screen keyboard, touch the numbers to enter the required pressure (14.0 for default setting) and then touch **Enter**.
   The updated set point appears on the **Extractor Settings** screen. Note: △ ▽ buttons index the pressure. ◁ ▷ buttons set the cursor. ± sets the sign on the number.

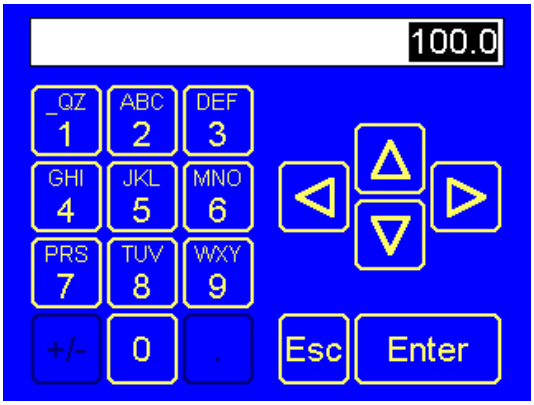


To adjust the UPW flow, follow these instructions:

1. Press **F2** to view the **Extractor Settings** screen.



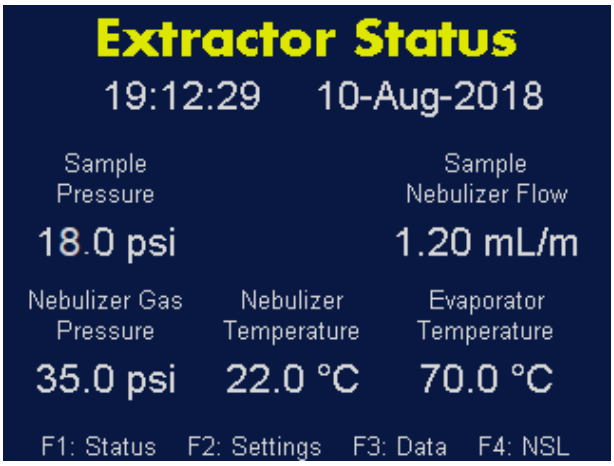
2. On the Extractor Settings screen touch **UPW Flow**.
3. On the resulting on-screen keyboard, touch the numbers to enter the required pressure (100.0 for default setting) and then touch **Enter**. The updated set point appears on the Extractor Settings screen. Note: △ ▽ buttons index the pressure. ◁ ▷ buttons set the cursor. ± sets the sign on the number.



Changing the Nebulizer Pressure

To adjust the Nebulizer Pressure, follow these instructions:

1. Press **F1** to view the **Extractor Status** screen.

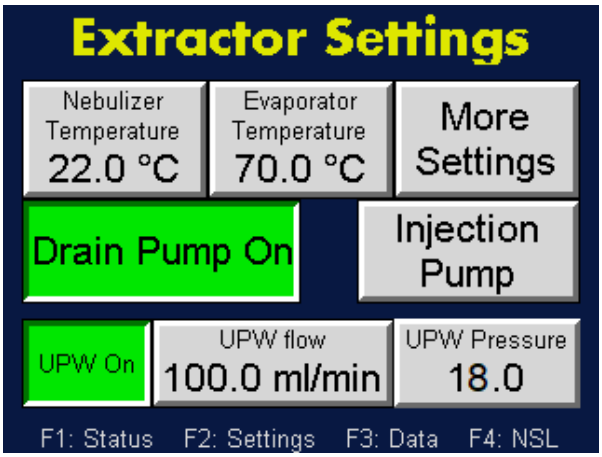


2. Turn the **Nebulizer Pressure** regulator on the back panel of the NPE until the **Nebulizer Gas Pressure** reads **35 psi** on the Extractor Status screen.

Changing the Extractor Settings

Press **F2** to see the **Extractor Settings** screen..

Figure 15: NanoParticle Extractor Settings Screen.



The Extractor Settings screen displays the following:

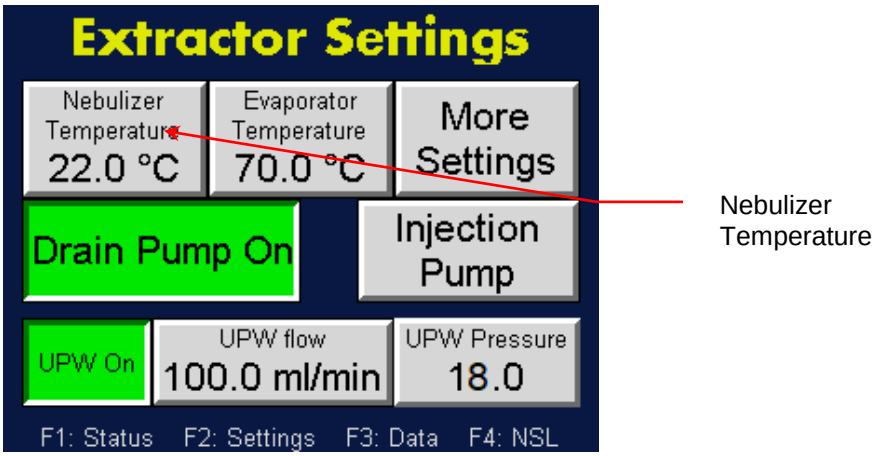
- **Nebulizer Temperature** allows you to set the nebulizer temperature.
- **Evaporator Temperature** allows you to set the evaporator temperature.
- **Drain Pump On/Off** allows you to turn the pump on and off to lengthen its life.
- **Injection Pump** allows you to access the settings for injection pump remote control.

- **More Settings** allows you to see options for Calibration, setting the injection pump direction and loading new firmware.
- **UPW On/Off** allows you to turn UPW supply on and off to avoid flooding before the instrument is warmed up.
- **UPW flow** allows you to set the online dilution flow rate.
- **UPW Pressure** allows you to set the sample pressure setpoint.

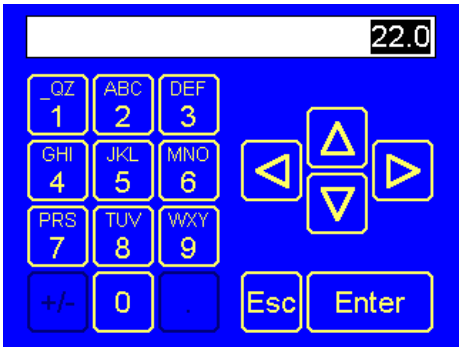
Adjusting the Nebulizer Temperature

The Nebulizer Temperature should nominally be set 5 °C lower than the UPW temperature. If the Nebulizer Temperature status indicator is red, the temperature is not within 2 °C of the temperature set point (as seen on the Status screen). To adjust the Nebulizer temperature, follow these instructions:

1. Press **F2**.
2. On the **Extractor Settings** screen, touch **Nebulizer Temperature**.



3. On the resulting on-screen keyboard, touch the numbers to enter the required temperature and then touch **Enter**. The updated set point appears on the Extractor Settings screen. Note: △ ▽ buttons index the temperature. ◁ ▷ buttons set the cursor. ± sets the sign on the number.

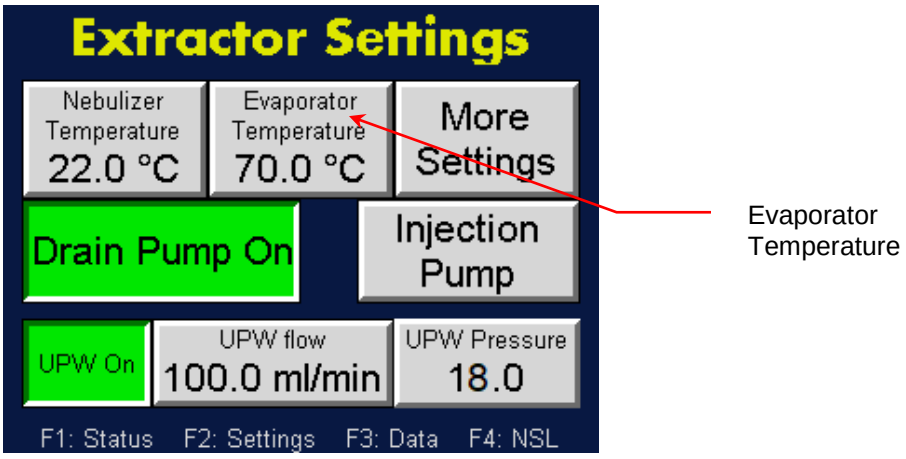


Adjusting the Evaporator Temperature

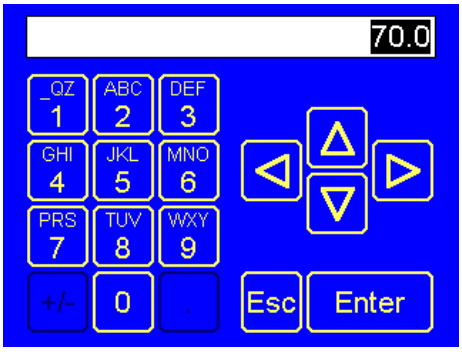
If the Evaporator Temperature status indicator is red, the temperature is not ±2 °C of the temperature set point (as seen on the Extractor Settings screen).

To adjust the evaporator temperature, follow these instructions.

1. Press **F2**.
2. On the **Extractor Settings** screen, touch **Evaporator Temperature**.



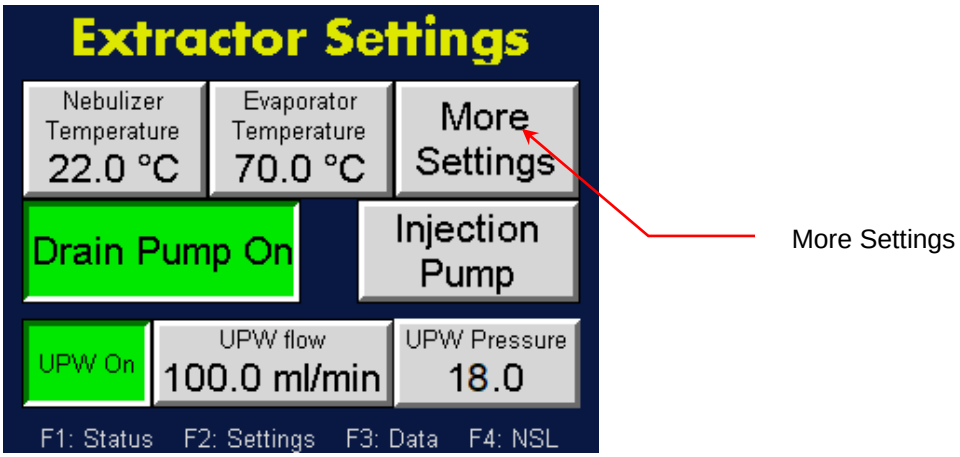
3. On the resulting on-screen keyboard, touch the numbers to enter the required temperature and then touch **Enter**. Note: △ ▽ buttons index the temperature. ◁ ▷ buttons set the cursor. ± sets the sign on the number. The updated set point appears on the Extractor Settings screen.



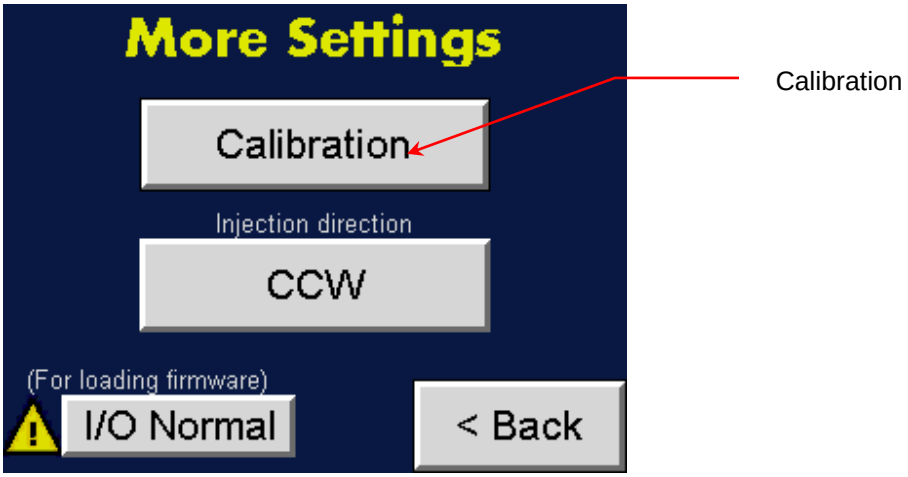
Changing the Date and/or Time

To change the date and time, follow these instructions:

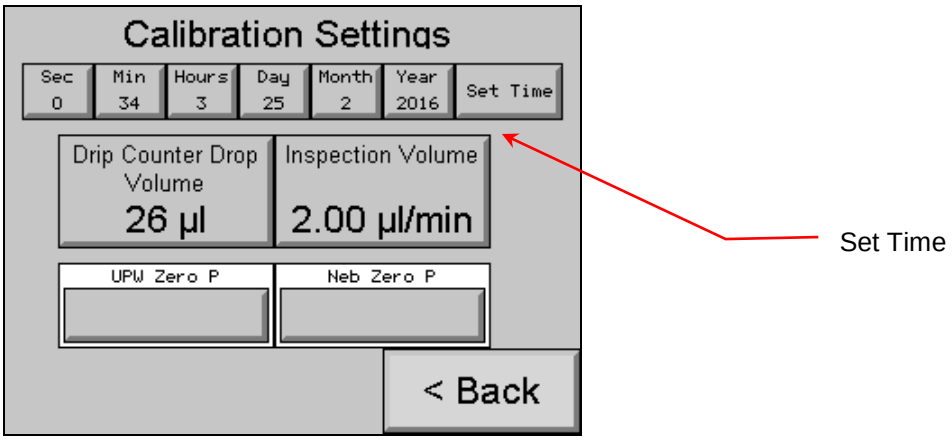
1. Press **F2**.
2. On the **Extractor Settings** screen touch **More Settings.**

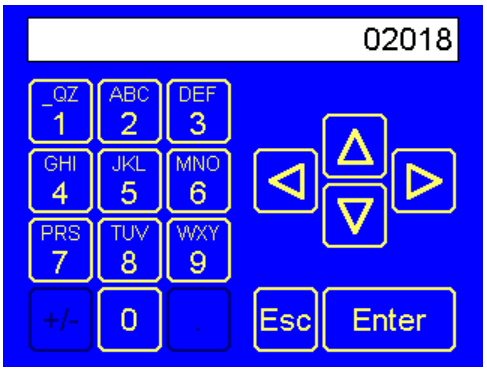


3. On the **More Settings** screen touch **Calibration**.



4. On the **Calibration Settings** screen touch **Sec** to change the seconds, **Min** to change the minutes, **Hours** to change the hours, **Day** to change the day, **Month** to change the month, and **Year** to change the year. Use the on-screen keypad to enter a value for any of the parameters you wish to change, then touch **Enter**.





Note: △ ▽ buttons index the temperature. ◁ ▷ buttons set the cursor. ± sets the sign on the number.

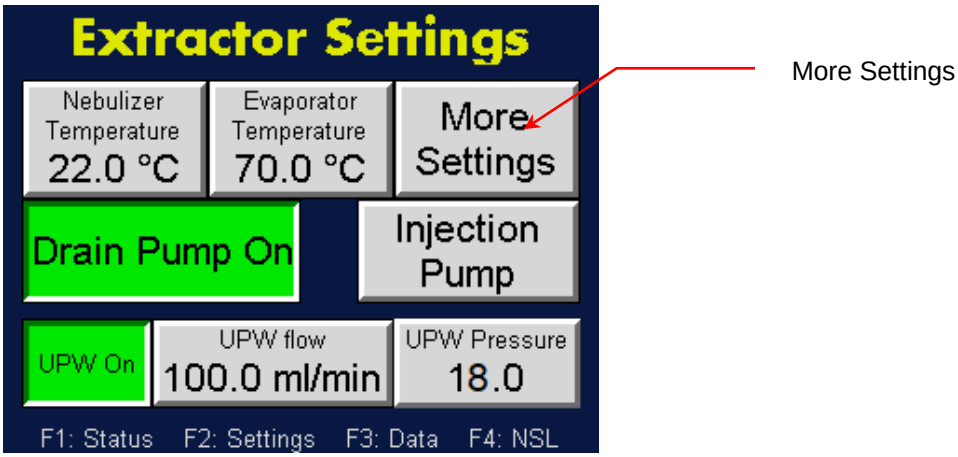
5. Press **Set Time**. The date and time appear below the heading on the Extractor Status screen.

Setting the Drip Counter Drop Volume

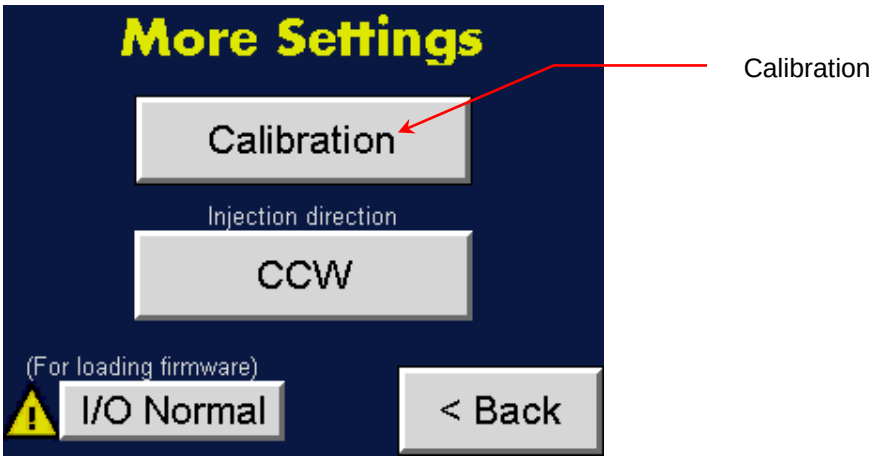
The Drip Counter Drop Volume is set at the factory and is used to calibrate the drip flow meter used to indicate the flow rate to the nebulizer module. If necessary, the Drip Counter Drop Volume can be calibrated using the direct injection method. To calibrate the drip counter drop volume, follow these instructions:

1. Turn the Sample Selector valve to **Direct Sample**.
2. Inject UPW at a set volume flow rate (2mL/min) into the Direct Sample inlet using the peristaltic injection pump.

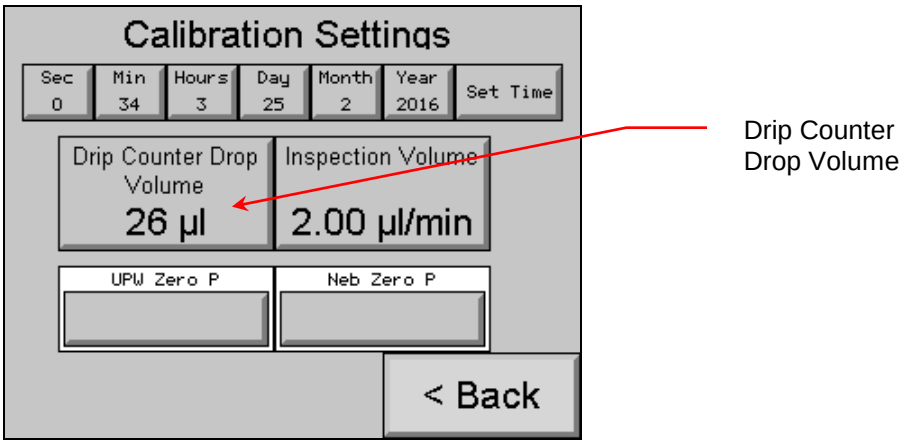
3. After 5 minutes, record the nebulizer flow rate displayed on the **Extractor Status** screen.
4. Press **F2.**
5. On the **Extractor Settings** screen touch **More Settings.**



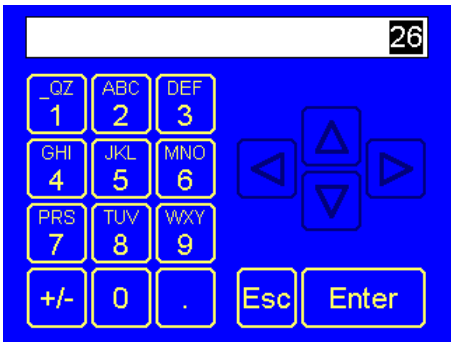
6. On the **More Settings** screen touch **Calibration**.



7. Calculate the new Drip Counter Drop Volume using the following formula:
   Drip Counter Drop Volume (New) = Drip Counter Drop Volume (Old) x Pump flow / displayed nebulizer flow rate
8. On the **Calibration Settings** screen, touch **Drip Counter Drop Volume**.



9. Use the on-screen keyboard to change the Drip Counter Drop Volume to the Drip Counter Flow (new) value calculated in step 7 above.

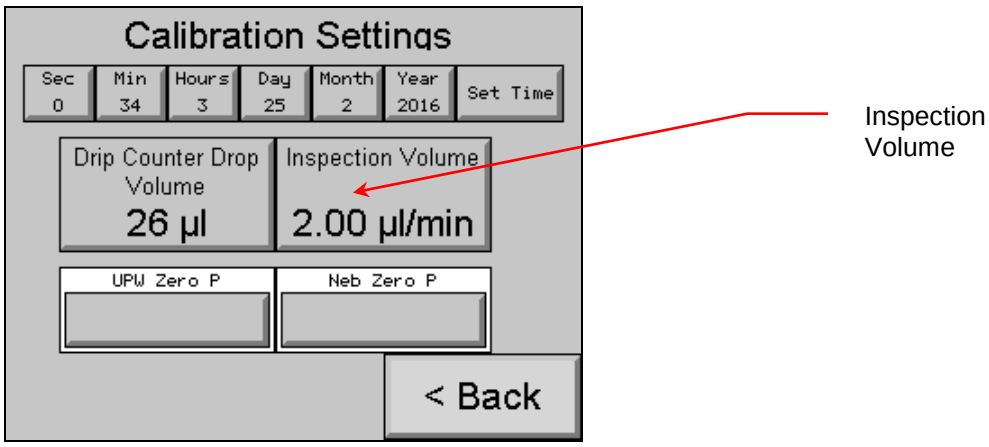


Note: △ ▽ buttons index the volume. ◁ ▷ buttons set the cursor. ± sets the sign on the number.

10. Wait two minutes and then check the Nebulizer Flow on the Extractor Status screen. It should match the peristaltic pump flow. (Note: 2 ml/min suggested in step 2 above.)

Setting the Inspection Volume

The inspection volume (displayed on the **Calibration Settings** screen) is set at the factory and requires a Kanomax FMT Liquid NanoParticle Sizer System (with a known volume standard provided by Kanomax FMT, Inc.) for calibration.

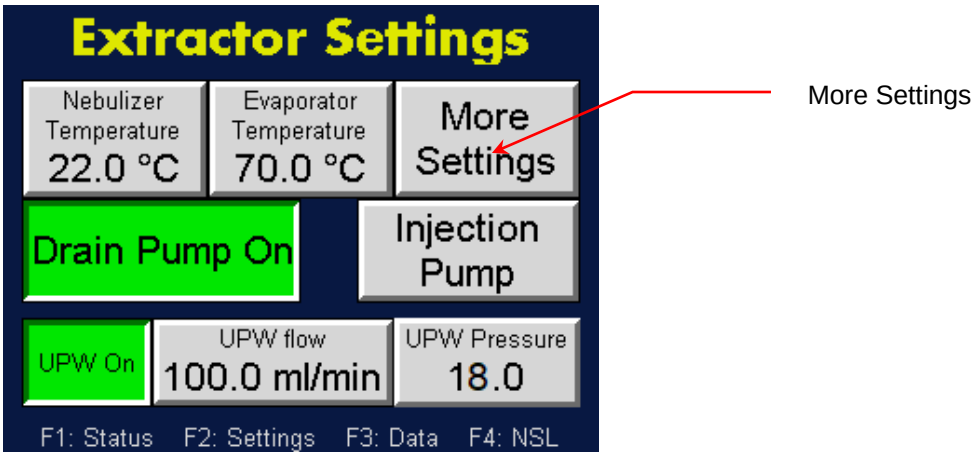


Setting the Nebulizer Pressure to Zero

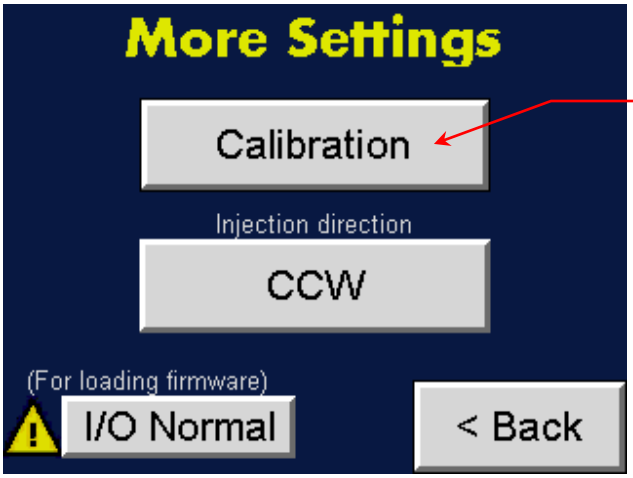
If the air and water supplies to the instrument are turned off, the **Nebulizer Gas Pressure** on the **Extractor Status** screen should be 0. If it is not, you must recalibrate the baseline of the pressure transducer (reset the Nebulizer Gas Pressure to zero).

To reset the nebulizer gas pressure, follow these instructions:

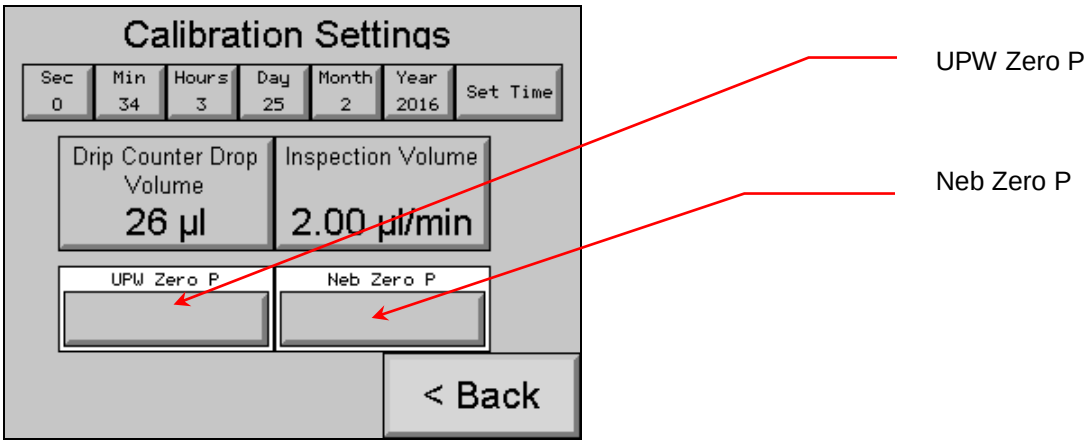
1. With the air and water supplies turned off, press **F2.**
2. On the **Extractor Settings** screen, touch **More Settings**.



3. On the **More Settings** screen, touch **Calibration.**



4. On the **Calibration Settings** screen touch **Neb Zero P** or **UPW Zero P**. The zeros are reset.

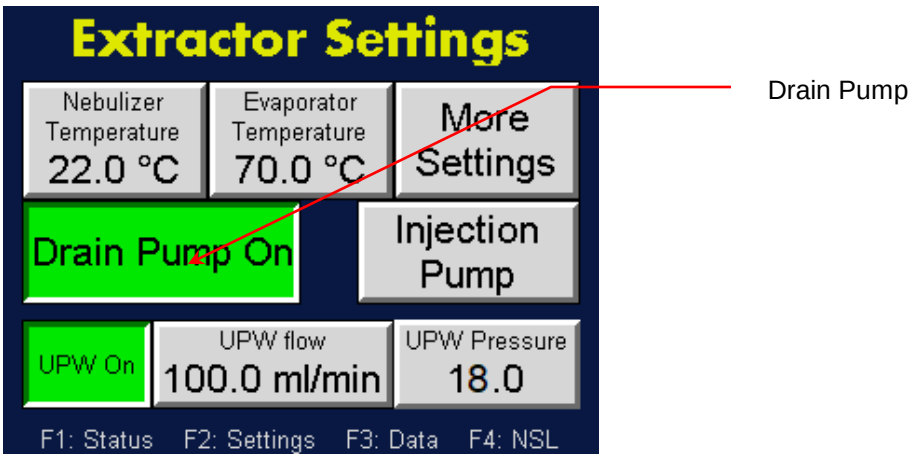


Managing Internal Pump Life

The NPE contains a solenoid-type liquid pump to drain sample that has been nebulized but removed from the aerosol before evaporation (only 0.1% of the nebulized sample is aerosolized and measured by the device). The pump has a finite life which can be extended by turning off the pump when no liquid is being delivered to the system.

To turn the drain pump on/off, follow these instructions:

1. Press **F2**.
2. On the **Extractor Settings** screen, touch the **Drain Pump On/Off** toggle button to turn the pump on or off.



Managing the External Injection Pump

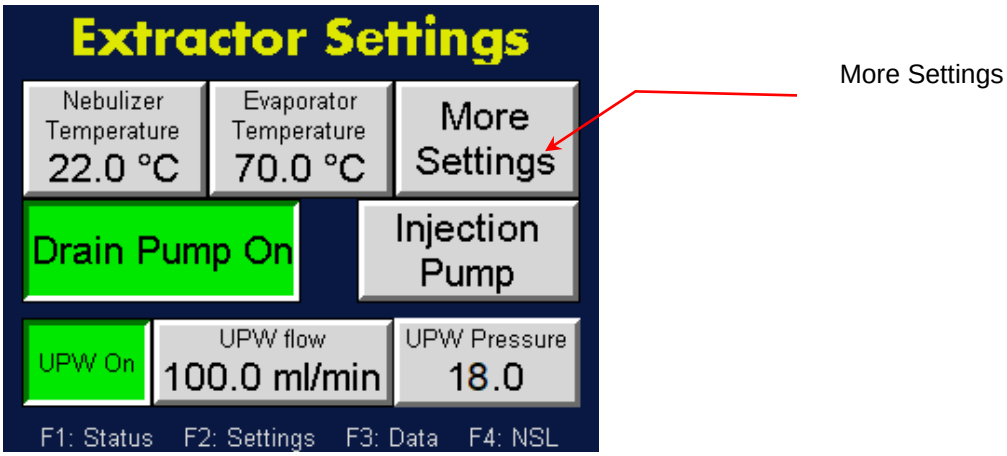
The NPE can control the external sample injection peristaltic pump. The pump can operate at either a steady flow or with a programmed cycle. The following options are available for managing the injection pump:

- Set external pump direction.
- Set pump control source.
- Choose manual or automatic pump control.
- Set flow parameters for manual and automatic flows.

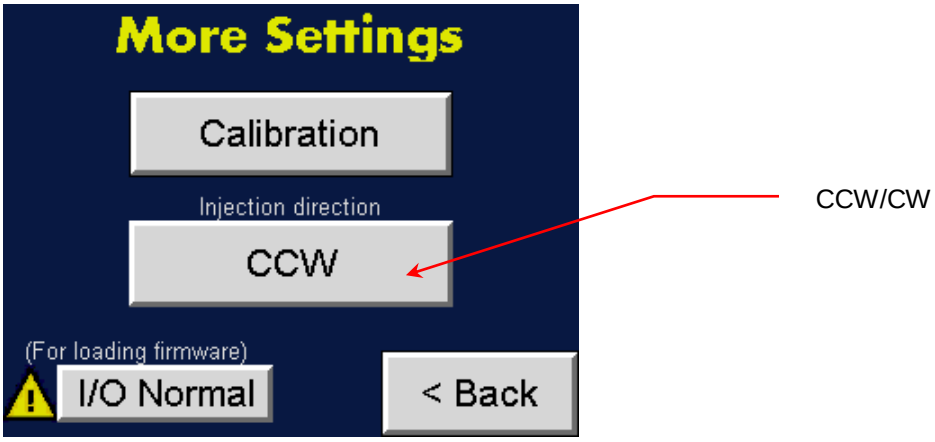
Setting the External Pump Direction

To set up the external pump direction, follow these instructions:

1. Press **F2.**
2. On the **Extractor Settings** screen, touch **More Settings.**



3. On the **More Settings** screen touch the **CCW/CW** toggle button to change the direction of injection into the nebulizer. CCW indicates a counter-clockwise direction; CW indicates a Clockwise direction.

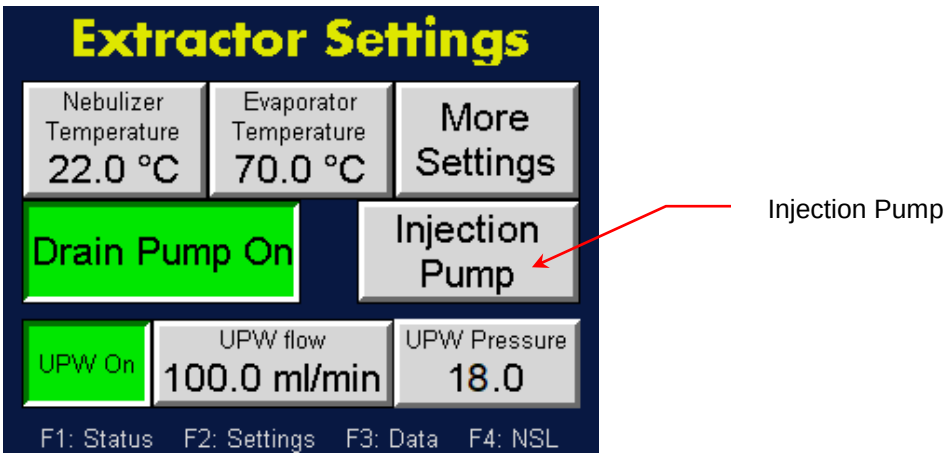


Setting Manual or Instrument Control for the Injection Pump

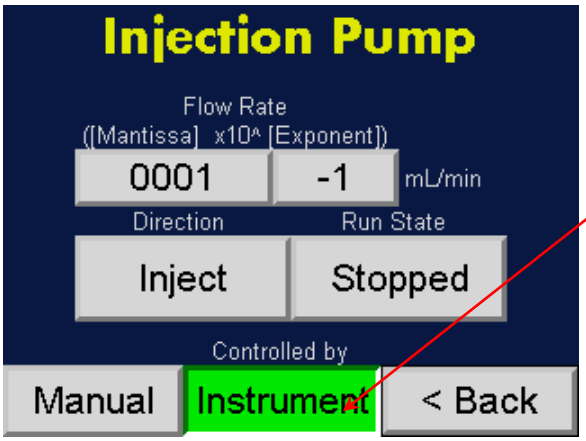
The external peristaltic pump can be controlled manually using the buttons on the pump or it can be controlled automatically by the NPE.

To set the injection pump control, follow these instructions:

1. Press **F2.**
2. On the **Extractor Settings** screen touch **Injection Pump**.

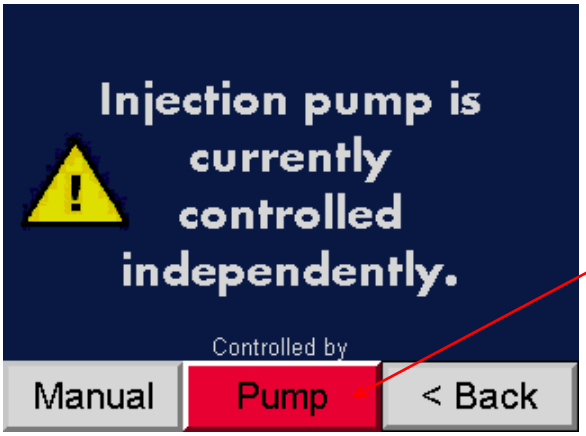


3. The **Controlled by** button toggles between **Instrument** and **Pump**. When the injection pump is controlled by the NPE the green **Instrument** button should be active.



Controlled by instrument pump

When the injection pump is controlled manually using the buttons on the pump itself the red **Pump** button should be active. Note: When you switch from the Instrument to the Pump mode a caution message is displayed.



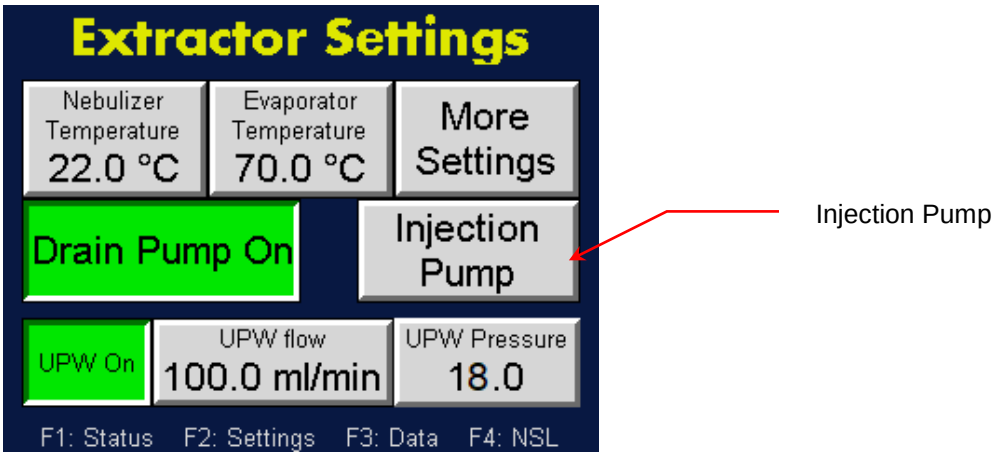
Controlled by external pump

Choosing Instrument Control Settings (Manual or Automatic) for the Injection Pump

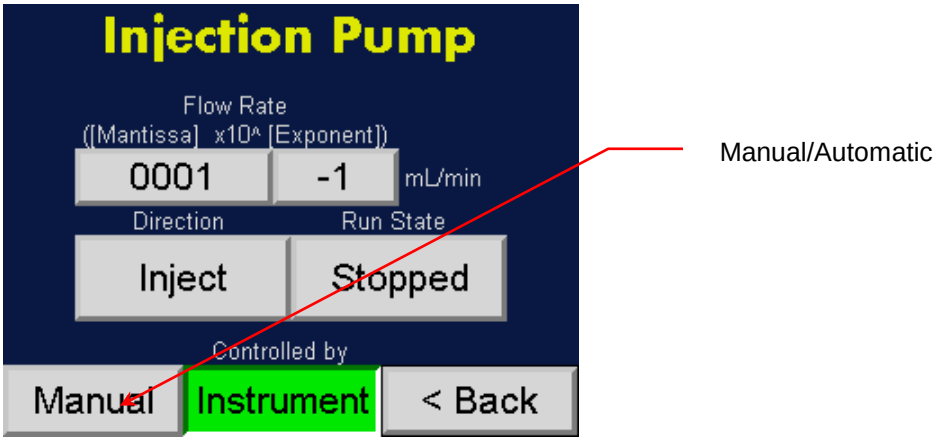
When the external injection pump is controlled by the NPE, you can select manual or automatic control and then set the flow rate, run state, and direction of flow.

To specify manual or automatic control, follow these instructions:

1. Press **F2**.
2. On the **Extractor Settings** screen touch **Injection Pump**.

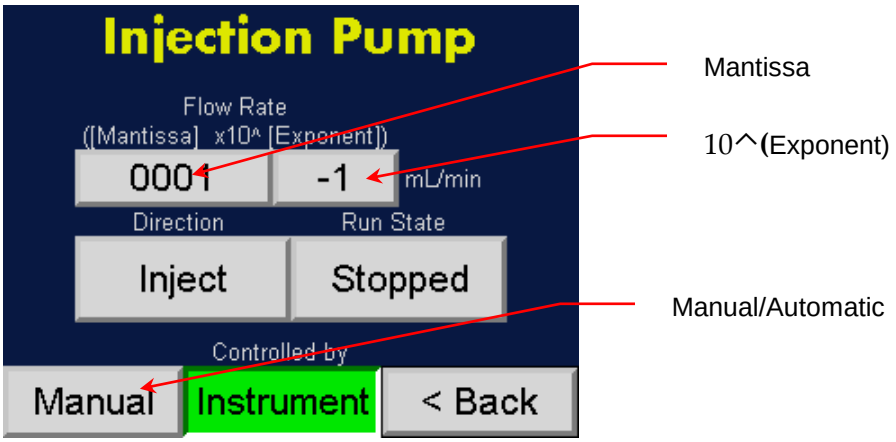


3. On the **Injection Pump** screen touch the **Manual/Automatic** button to toggle between the two settings.

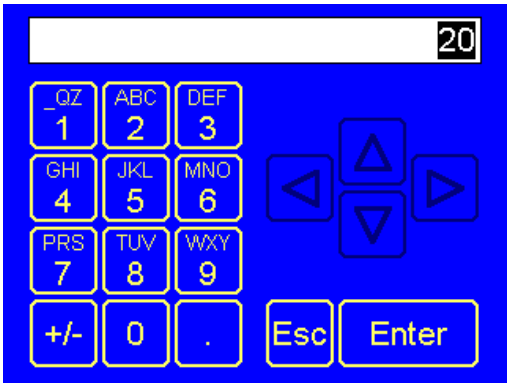


To specify Manual control settings, follow these instructions:

1. Press **F2** > **Injection Pump**. On the **Injection Pump** screen, the **Manual/Automatic** toggle button should display **Manual**.



2. Set the **Flow Rate** by touching the **(Mantissa)** and **10^(Exponent)** buttons and using the on-screen keyboard to enter values. Example: 100x10^{-3} ml/min sets the pump to operate at 0.100 ml/min.

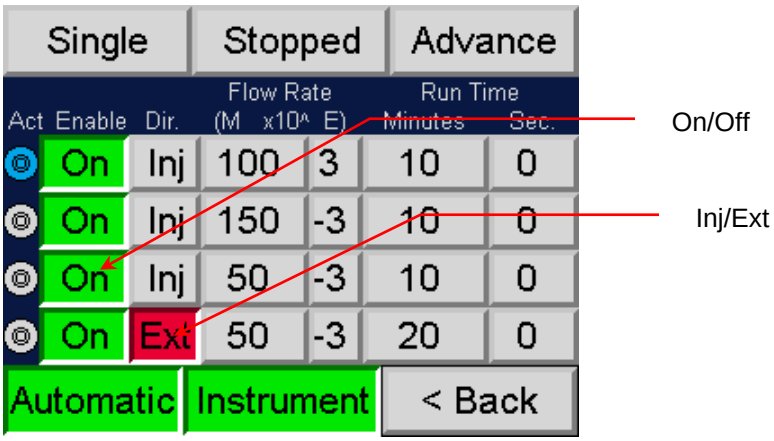


3. To set the **Direction** of flow press the **Inject/Extract** toggle button to choose **Inject** (flow runs from the pump to the NPE) or **Extract** (flow runs from the NPE to the pump or a bottle).
4. To set the **Run State** press the **Running/Stopped** toggle button to start or stop the flow.

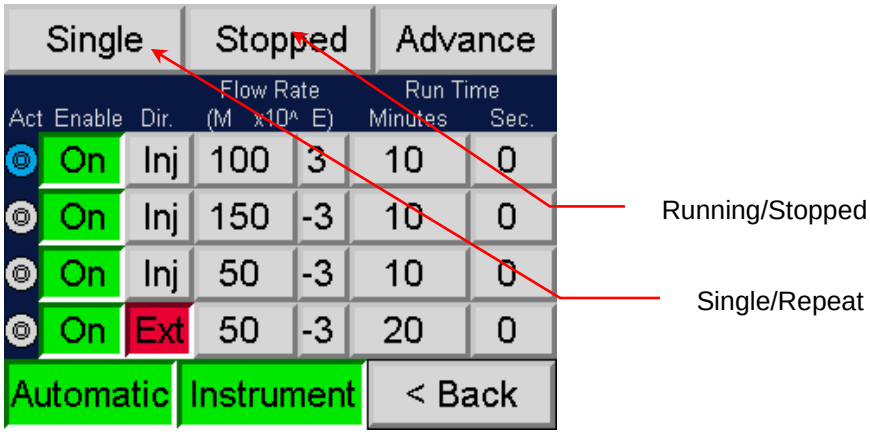
To specify Automatic control settings, follow these instructions:

1. Press **F2** > **Injection Pump**. On the **Injection Pump** screen the Manual/Automatic toggle button should display **Automatic** and the Pump/Instrument toggle button should display **Instrument**.

2. To activate specified pump settings press the **On/Off** toggle button in the **Enable** column to display **On**. Note: If **Off** is selected, those settings are skipped. **Act** indicates which settings are currently active.



3. To specify the pump settings press the buttons in the columns.
   a. Change the pump flow direction by pressing the **Inj/Ext** (Injection/Extraction) button in the **Dir** column.
   b. Set the flow rate by entering the Mantissa (**M**) and exponent (**E**) values in the Flow Rate column. Example: $100x10^{-3}$ sets the pump to operate at 0.100 ml/min.
   c. Set the run time for the pump by entering the minutes and seconds in the **Run Time Minutes** and **Sec** columns. Use the on-screen keyboard to enter the values.
   d. Choose to run a single cycle or repeat the cycle by pressing the **Single/Repeat** toggle button**.**

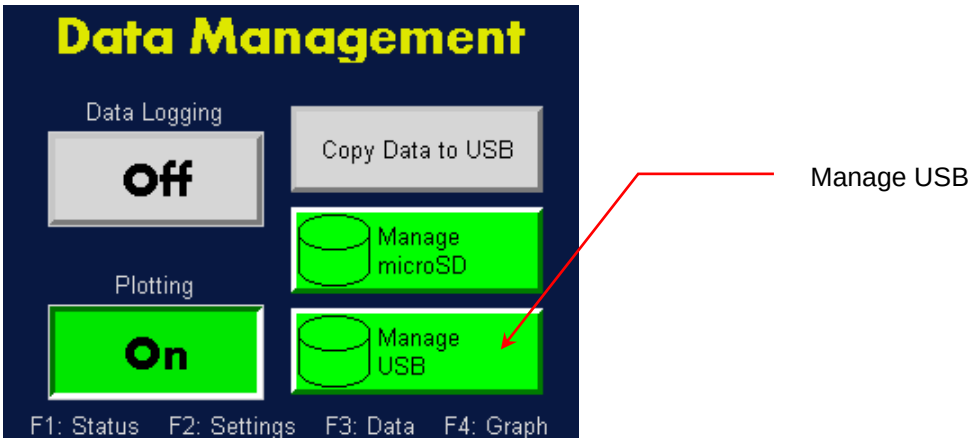


4. While you make your selections, the **Running/Stopped** toggle button displays **Stopped**. Press Stopped to begin the sequence and the button displays **Running**.
5. To advance the sequence to the next row, press **Advanced**.

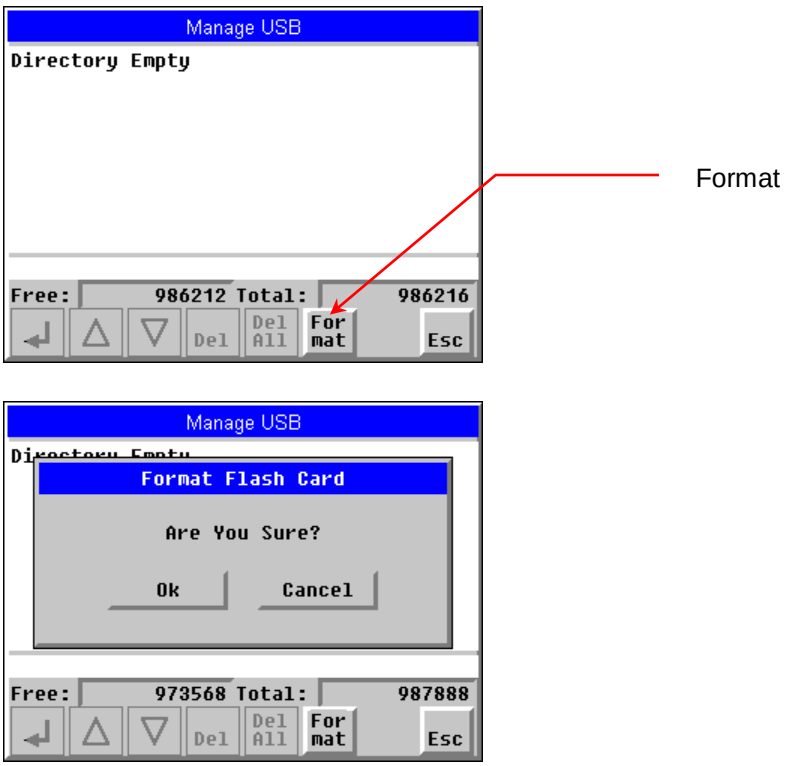
Formatting a USB Drive

To format a USB drive, follow these instructions:

1. Press **F3**.
2. On the Data Management screen touch **Manage USB**.



3. On the **Manage USB** screen touch **For/mat**, then touch **OK.** Touch **Cancel** to cancel the formatting. Note: any data stored on the USB drive will be erased.

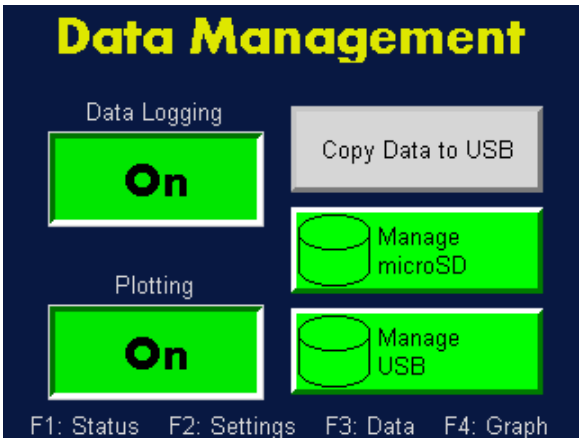


Managing Internal Memory

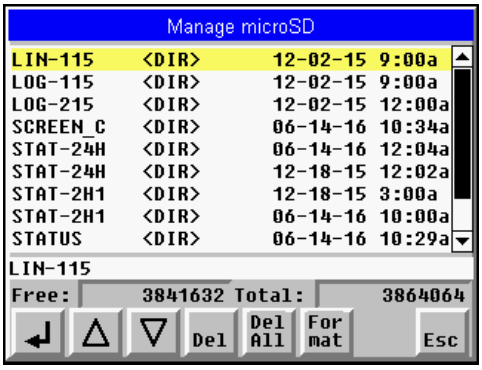
To manage the internal memory you can view the data record files, check the available memory and the total memory used, format the drive, and delete the stored data.

To manage the stored data, follow these instructions:

1. Press **F3.**
2. On the **Data Management** screen touch **Manage microSD**.



3. A list of data folders is displayed on the **Manage microSD** screen. Use the △▽ arrows to scroll between the folders and then press ↵ (Enter) to see the contents of the folder. Note: The data files for each day that data was collected are displayed in comma delimited records.
   Free: indicates the amount of memory available in kB.
   Total: indicates the memory usage in kB.
   Del deletes the selected folder or data file.
   Del All deletes all folders or data files.



Controlling the NanoParticle Collector

The NPC is controlled through the NPE touch-screen display. Before you begin sampling familiarize yourself with the screens and operation parameters. Instructions for loading the samples begin on page 68.

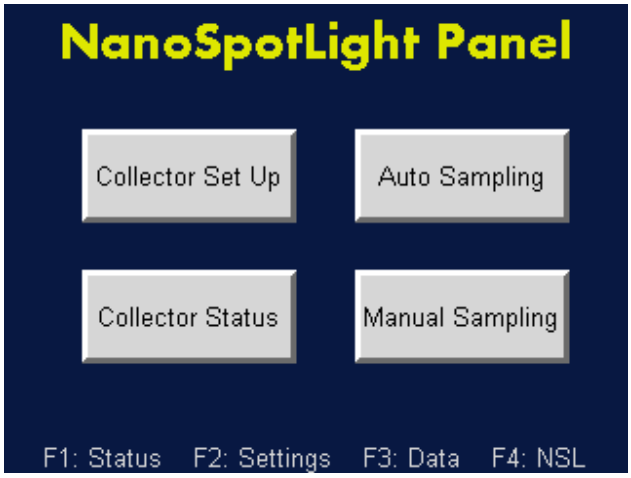
The default temperatures for the NPC are shown in Table 3. You cannot change the temperature parameters.

Table 3: NPC Default Temperature Settings

Conditioner	10 °C
Initiator	40 °C
Moderator	8 °C
Nozzle	29 °C
Sample	45 °C

Press **F4** on the NPE front panel to see the **Nano SpotLight Panel** screen.

Figure 16. NanoSpotLight Panel Screen.



The on-screen buttons perform the following functions:

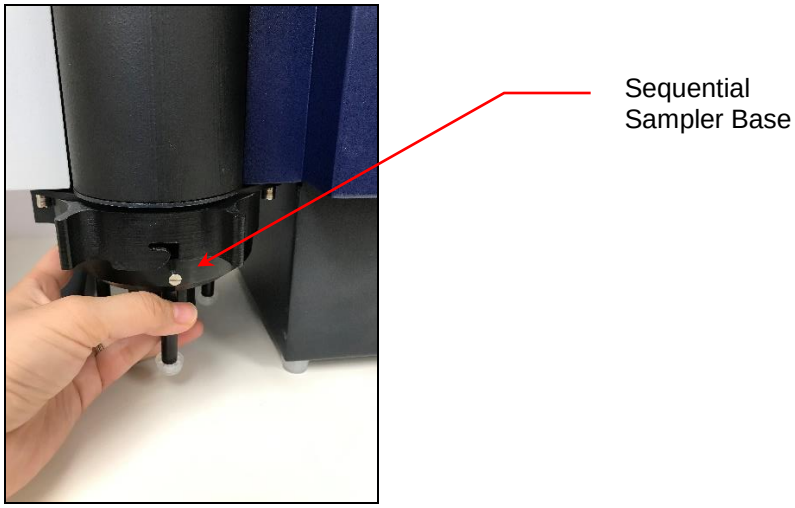
- **Collector Set Up** allows you to prime the wick, drain or dry the supply bottle and change the air flow rate.
- **Auto Sampling** allows you to configure auto sampling settings in single or sequence sample modes.
- **Collector Status** displays the status of the operation parameters, such as air flow rate.
- **Manual Sampling** allows you to configure manual sampling settings.

Collector Set Up

The **Collector Set Up** allows you to prime the wick, drain or dry the supply bottle and change the air flow rate.

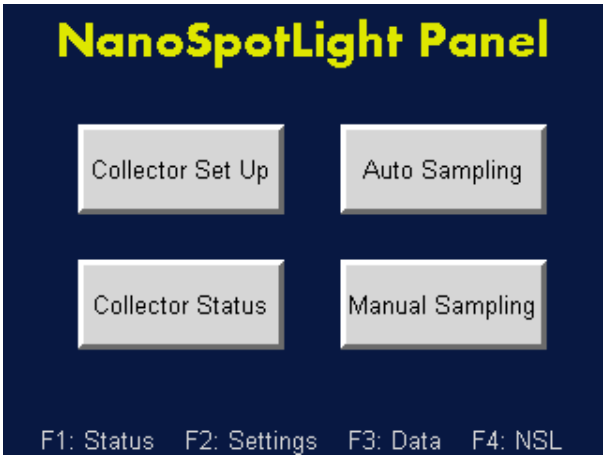
Priming the Wick

The water injection pump adds approximately 20 µL of water per audible injection into the initiator region of the growth tube.
Warning: To prevent flooding into the vial when wetting the wick, disrupt the sample flow by removing (rotate counter-clockwise and unlock) the sequential sampler base from the bottom of the growth tube during the injections.

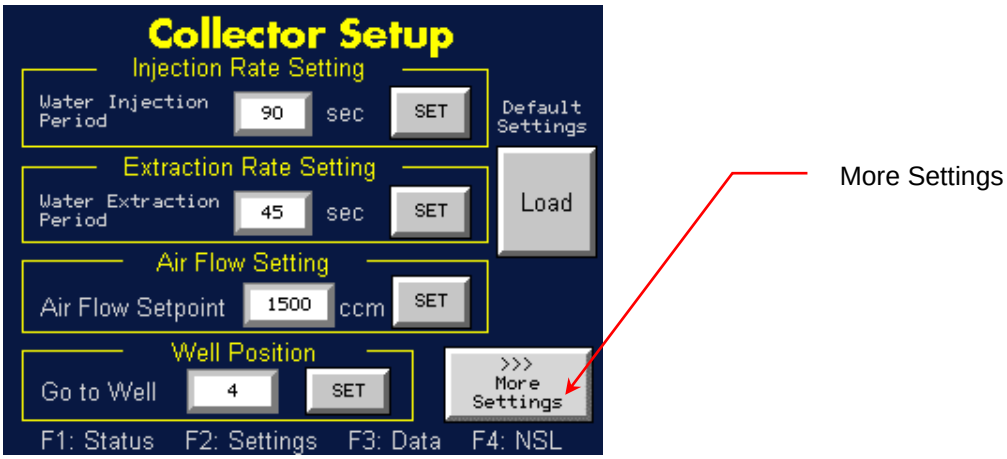


To prime the wick, follow these instructions:

1. Touch **F4** on the NPE front panel.
2. On the **NanoSpotlight Panel** screen, touch **Collector Set Up**.

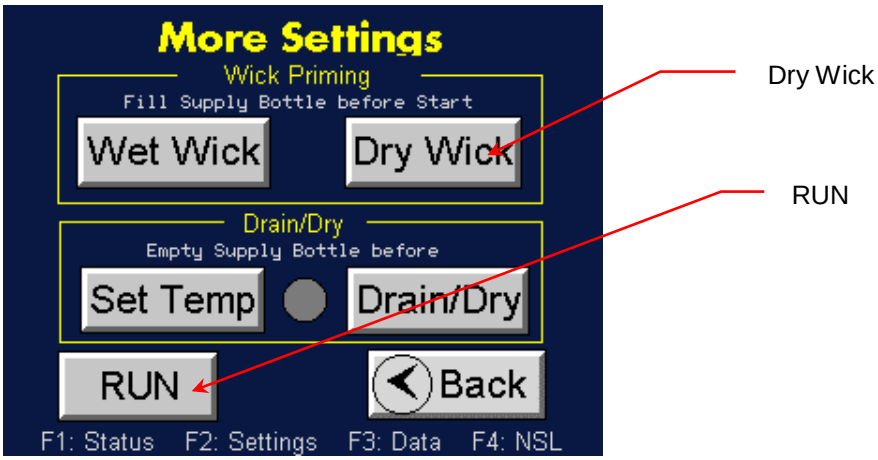


3. On the **Collector Setup** screen, touch **More Settings**.

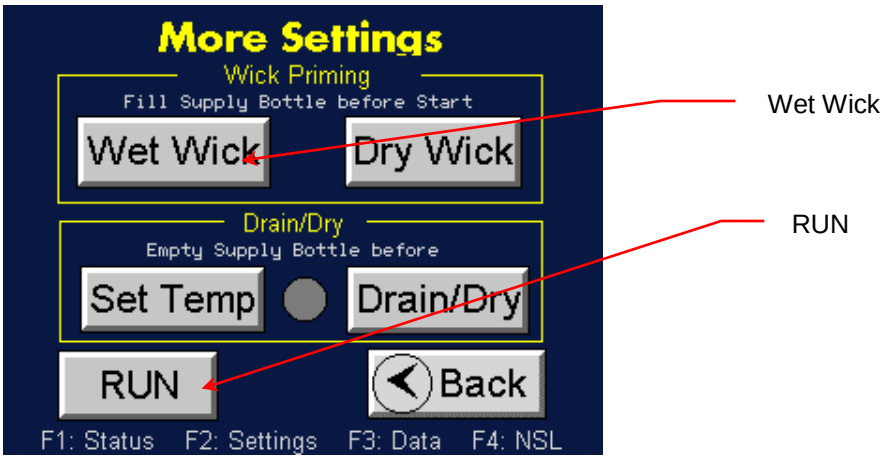


4. If the wick is dry or the sampler has not been used for a while, you should wet the wick by adding water with up to 600 continuous injection counts (each audible count injects approximately 20 µL of water). See step 5.
   If the wick has only been unused for 1-2 days, you should wet the wick by adding water with up to 50 continuous injection counts (each audible count injects approximately 20 µL of water). See step 6.
   To interrupt a Wet or Dry Wick operation, see step 7.

5. On the **More Settings** screen, touch **Dry Wick** then touch **RUN.** The instrument injects 600 continuous counts of water into the wick.



6. To wet a wick that has been unused for 1-2 days, on the **More Settings** screen, touch **Wet Wick** then touch **RUN**. The instrument injects 50 continuous counts of water into the wick.



7. To interrupt or cancel a Wet Wick or Dry Wick operation, touch either the **Wet Wick** or **Dry Wick** button to halt water injection into the wick. The button turns gray. Then touch **RUN** to send the command.

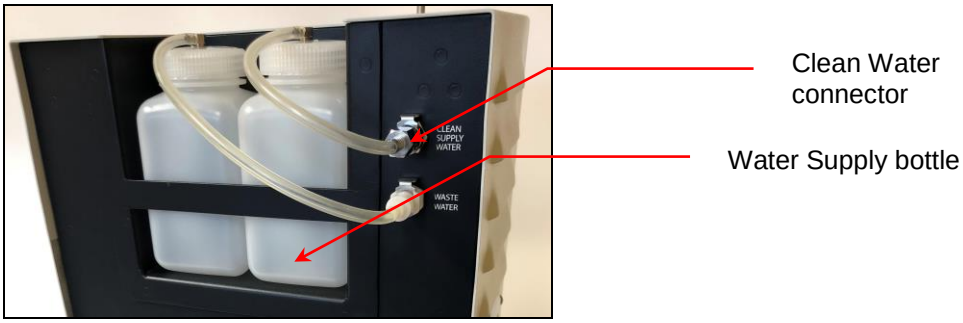
Note: To periodically add more water to the wick while sampling, the injection period is set in seconds. The recommended period frequency depends upon the humidity of the sampled aerosol; a dry aerosol needs water adding more frequently than a humid aerosol. Since the NPC is in line with the NPE the air exiting the extractor is humid and the default interval is 60 seconds. This interval cannot be adjusted by the user.

Draining/Drying the NanoParticle Collector

You should drain and dry the NPC if you plan to move it to another location or will not use it for several days.

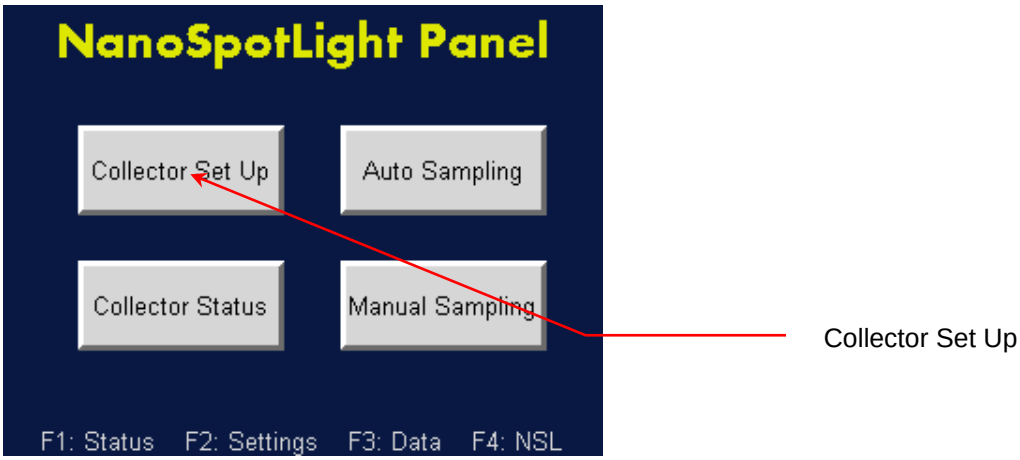
To drain and dry the NPC, follow these instructions:

1. Empty the water supply bottle and then replace it in the bottle holder.
2. Reconnect the tubing to the NPC and ensure that the Waste Water bottle is in place and tubing connected.

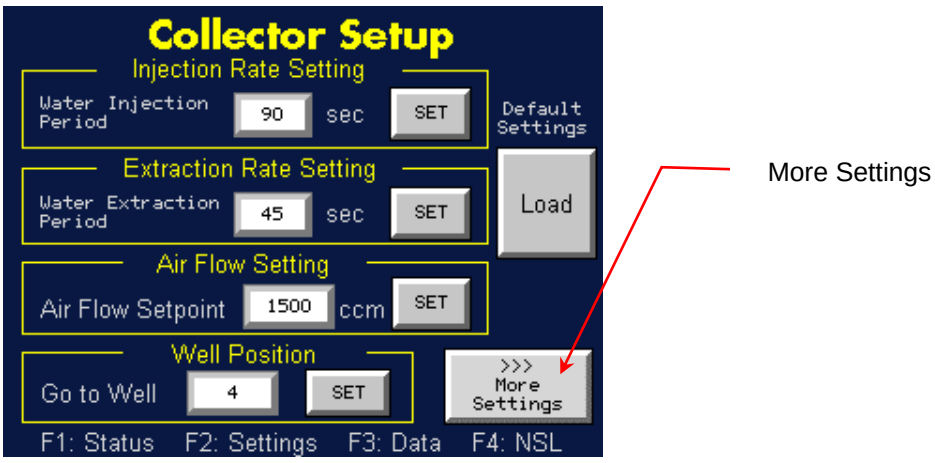


3. Place an air filter (HEPA filter) on the air inlet.

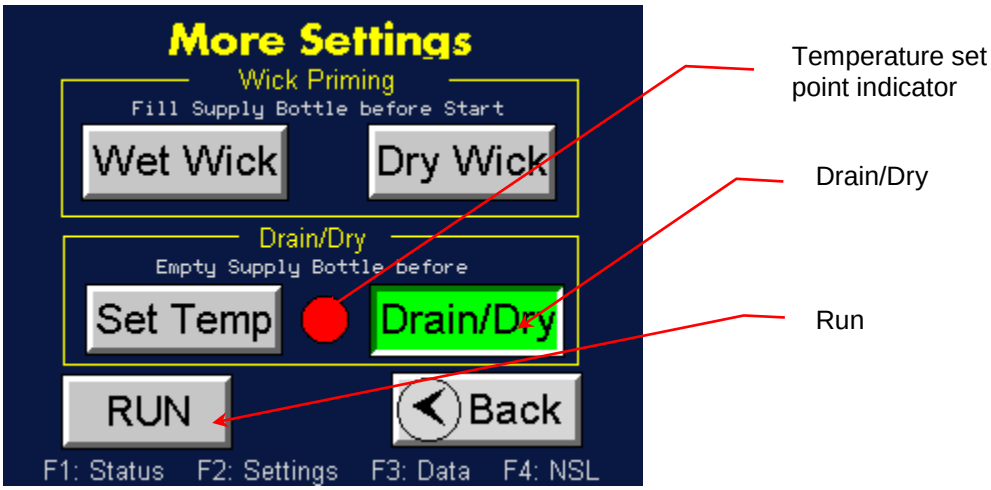
4. Touch **F4** on the NPE front panel.
5. On the **NanoSpotLight Panel** screen, touch **Collector Set Up**.



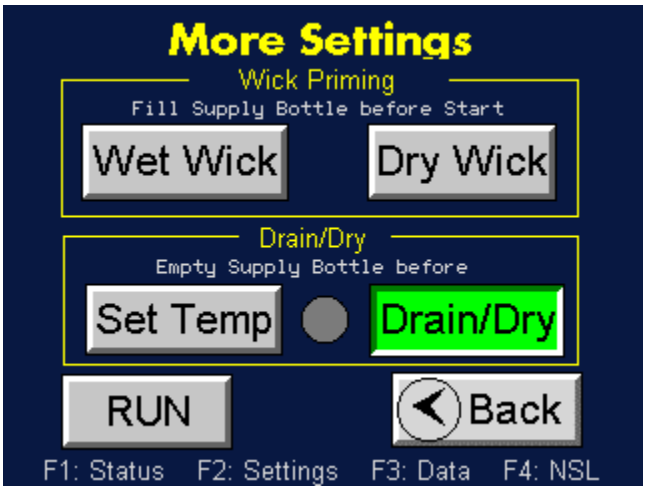
6. On the **Collector Setup** screen touch **More Settings**.



7. On the **More Settings** screen, touch **Drain/Dry** to activate the Drain/Dry process. When the **Drain/Dry** button turns green, touch **Set Temp.** This will set the NPC conditioner and moderator temperatures at 25 °C. The round indicator will turn green when the temperature set points are reached.



8. When the temperature set points are reached, touch **RUN.** 500 injections of air are sent into the system. Since the water supply bottle is empty the remaining water in the lines is pushed through the instrument and into the waste water supply.



Note: When you power-cycle the Nano SpotLight, the conditioner and moderator temperatures return to their operating set points.

9. To reset the temperature set points to default operating conditions, touch **Drain/Dry** (button turns gray) to reactivate the process, and then touch **Set Temp.** The conditioner and moderator temperature set points are

restored to default values (10 and 8 °C respectively). The set point indicator turns green when temperatures are reached.

10. To interrupt or cancel a Drain/Dry operation, touch the active (green) **Drain/Dry** button to halt the process. The button turns gray. Then touch **RUN**. Air injection into the wick is halted.

Changing the Air Flow Rate

The sample volumetric flow must be operating at 1500 ccm. The sample flow is actively measured and controlled with a mass flow meter. The mass flow meter is temperature-compensated and calibrated for standard barometric pressure conditions of 101.3 kPa (1 atmosphere, 14.7 psi). When sampling at non-standard conditions, the volumetric flow will vary according to the formula:

$$\text{Volumetric Flow} = Q * \left(\frac{Pstd}{Pact}\right)$$

Where Q = standard mass flow rate
P_{act} = actual absolute pressure of the aerosol

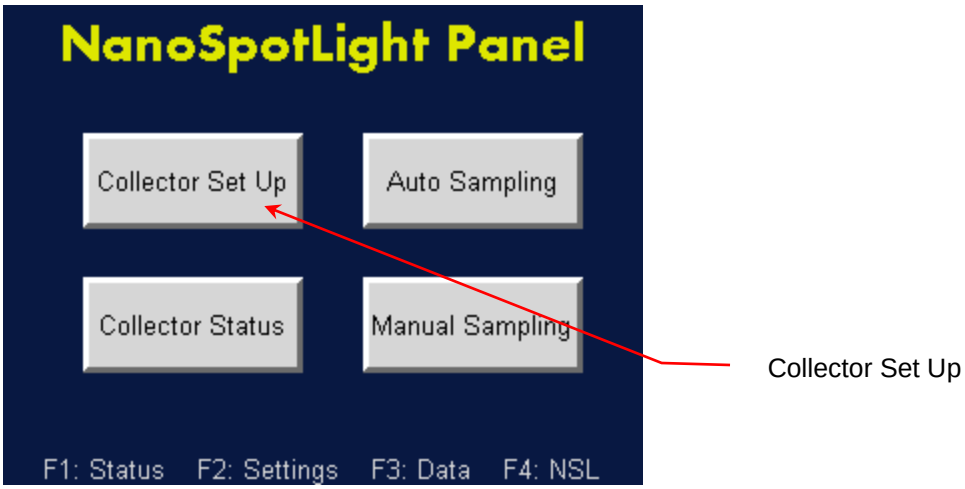
Example: The mass flow reading of the sample flow rate is 1.26 std L/min at 85 kPa absolute (conditions often found at the Aerosol Devices factory in Colorado, USA). The volumetric flow rate is calculated to be:

Volumetric Flow = 1.26 *L/min* * (101.3 *kPa* / 85 *kPa*) = 1.5 L/min

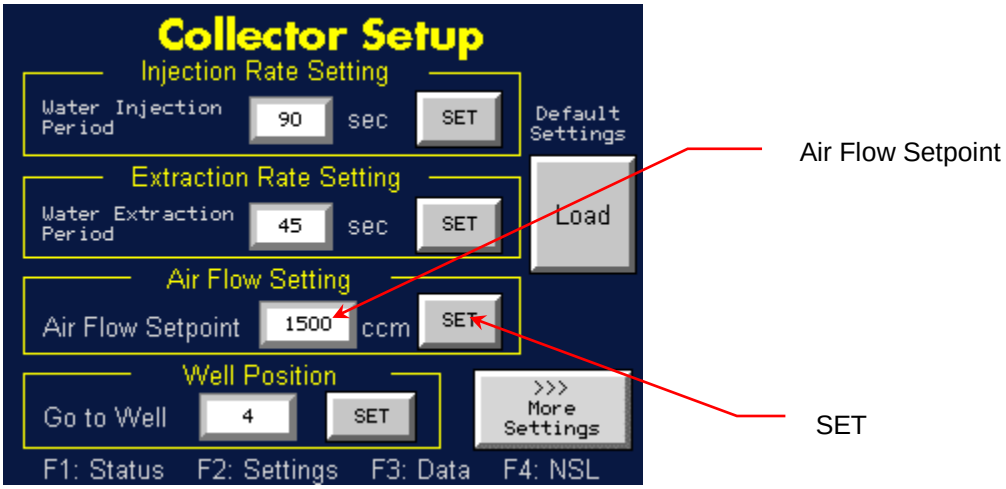
An easy way to set the volumetric flow is to calibrate the inlet flow using an external volumetric flow meter. We recommend using a bubble flow meter because of its low flow resistance.

To adjust the flow rate, follow these instructions:

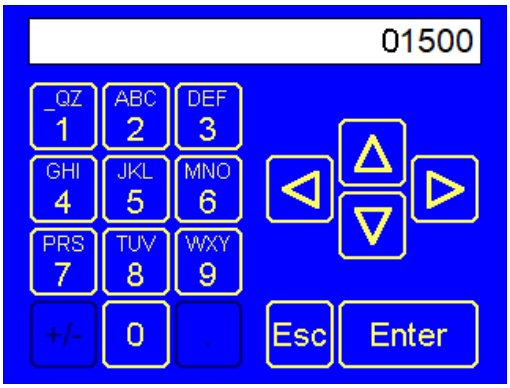
1. Touch **F4** on the front panel of the NPE.
2. On the **NanoSpotlight Panel** screen, touch **Collector Set Up**.



3. On the **Collector Setup** screen, touch **Air Flow Setting**.



4. Use the on-screen keyboard to change the Air Flow rate.
   Note: △ ▽ buttons index the rate. ◁ ▷ buttons set the cursor. ± sets the sign on the number.



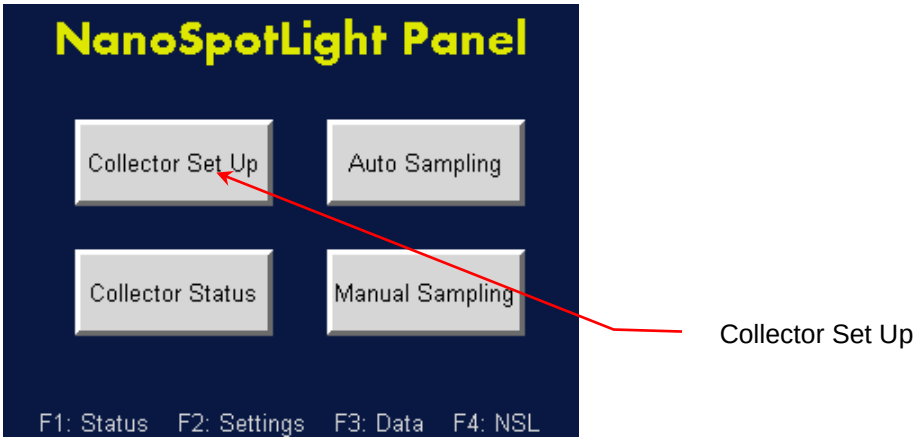
5. Touch **SET** in the **Air Flow Setting** field.

Changing the Extraction Rate

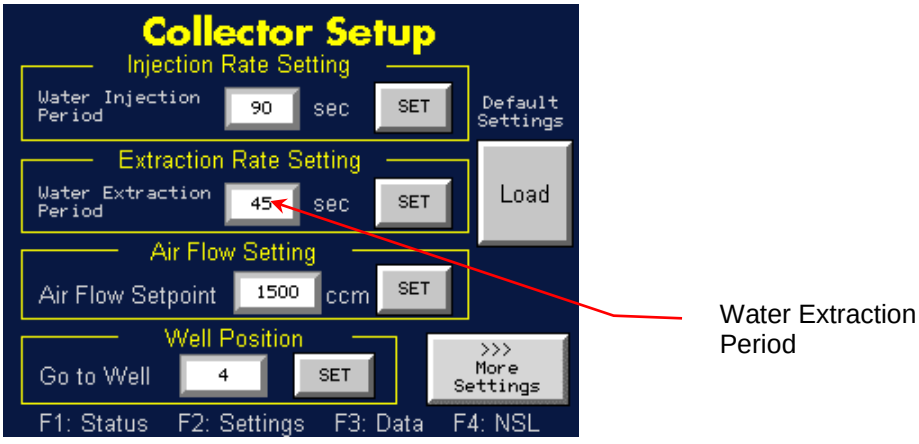
The water extraction pump removes approximately 20 microliters of water per extraction from the moderator region of the growth tube. As a general guide, the water extraction period cannot be less frequent than the injection period; we recommend making the extraction period more frequent than the injection period when the sample flow is high in relative humidity (RH) level (> 80%).

To adjust the extraction rate follow these instructions:

1. Touch **F4** on the front panel of the NPE.
2. On the NanoSpotLight Panel screen, touch **Collector Set Up**.

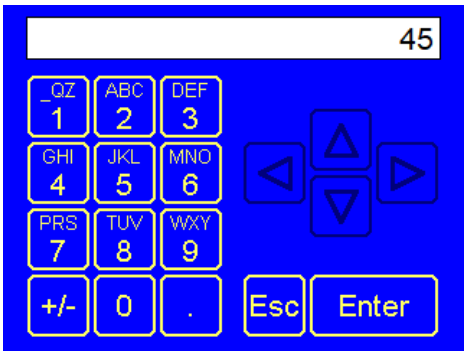


3. On the **Collector Setup** screen, in the **Extraction Rate Setting** field, touch **Water Extraction Period.**



4. Use the on-screen keyboard to change the water extraction period (in seconds). Note: △ ▽ buttons index the number. ◁ ▷ buttons set the

cursor. ± sets the sign on the number.



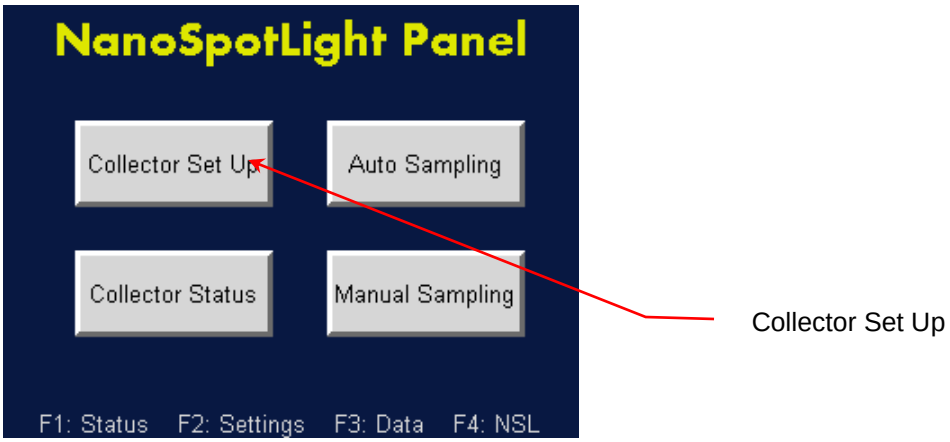
5. Press **SET** in the **Extraction Rate Setting** field.

Changing the Injection Rate

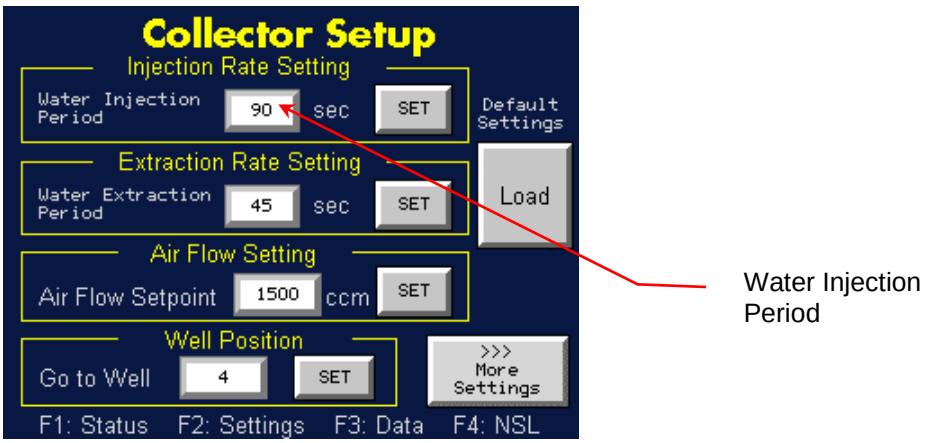
The water injection pump adds approximately 20 microliters of water per injection into the initiator region of the growth tube. As a general guide, for dry aerosol at 15-30% RH start by setting the injection period at 20-30 seconds. For humid aerosol at 80-90% RH start by setting the injection period at 200 or more seconds.

To adjust the injection rate, follow these instructions:

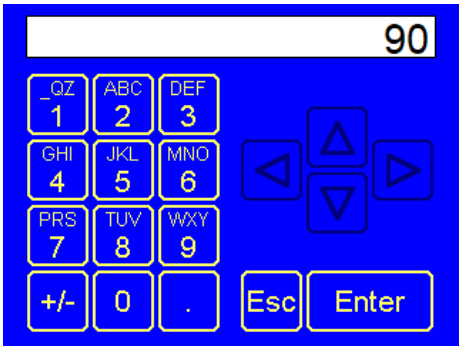
1. Press **F4** on the front panel of the NPE.
2. On the **NanoSpotlight Panel** screen, touch **Collector Set Up**.



3. On the **Collector Setup** screen in the **Injection Rate Setting** field, touch **Water Injection Period**.



4. Use the on-screen keyboard to change the water injection period (in seconds). Note: △ ▽ buttons index the number. ◁ ▷ buttons set the cursor. ± sets the sign on the number.



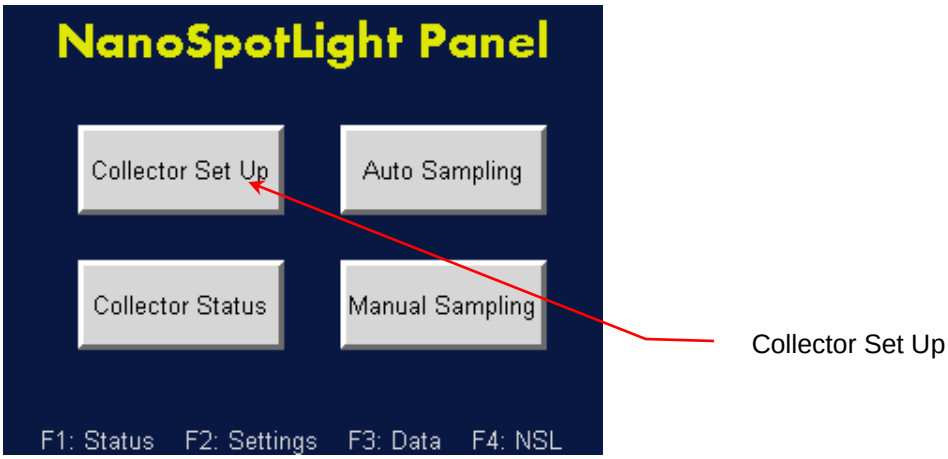
5. Press **SET** in the **Injection Rate Setting** field.

Changing the Well Position

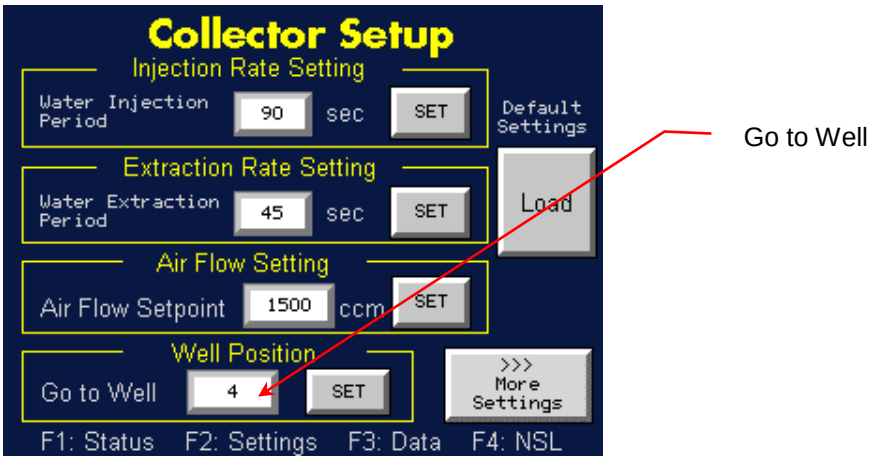
The well position defines which well on the sample platen to use for collecting one specific sample.

To change the well position, follow these instructions:

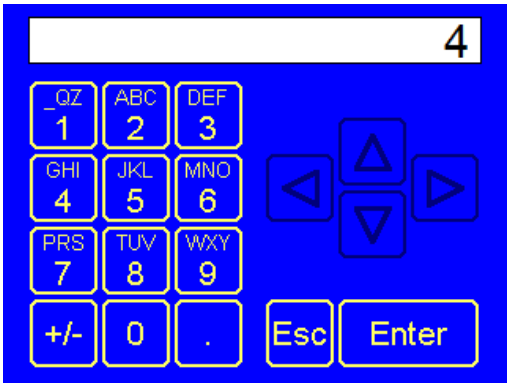
1. Press **F4** on the front panel of the NPE.
2. On the **NanoSpotlight Panel** screen, touch **Collector Set Up**.



3. On the **Collector Setup** screen in the **Well Position** field, press **Go to Well**.



4. Use the on-screen keyboard to change the well position. Options are 0-5 where 0 is the "Home" position. Note: △ ▽ buttons index the number. ◁ ▷ buttons set the cursor. ± sets the sign on the number.

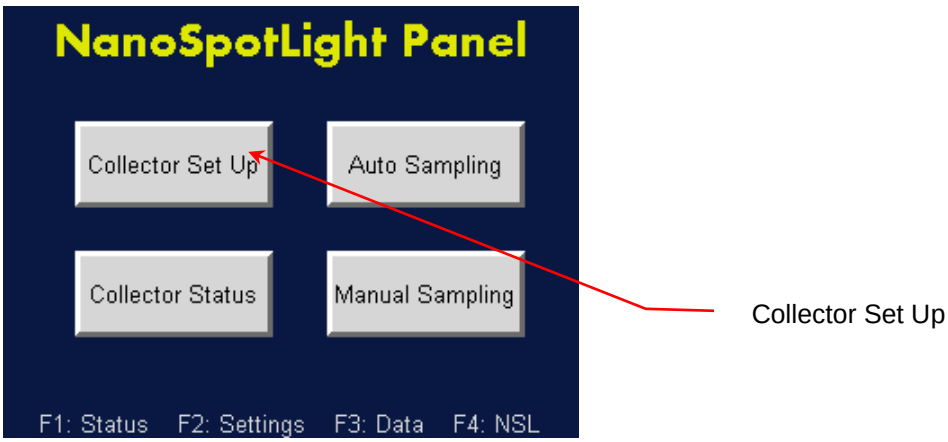


5. Press **SET** in the **Well Position** field.

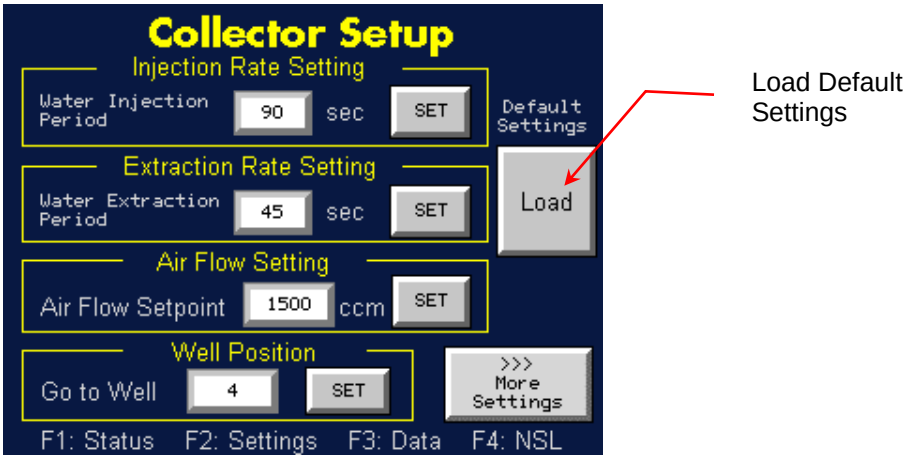
Load the Default Settings

To restore the injection rate, extraction rate, air flow, and operating temperatures to their default settings, follow these instructions:

1. Press **F4** on the front panel of the NPE.
2. On the **NanoSpotLight Panel** screen, touch **Collector Set Up**.



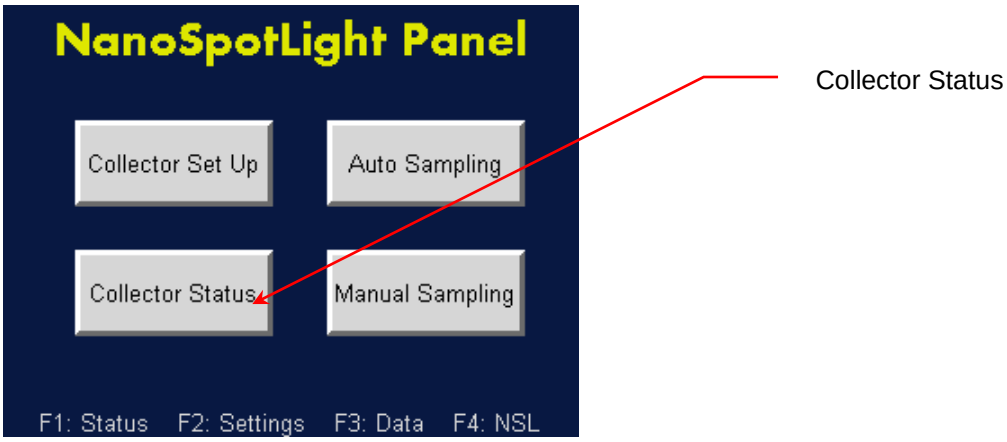
3. On the **Collector Setup** screen, touch **Load** (beneath **Default Settings**). The default parameters are restored.



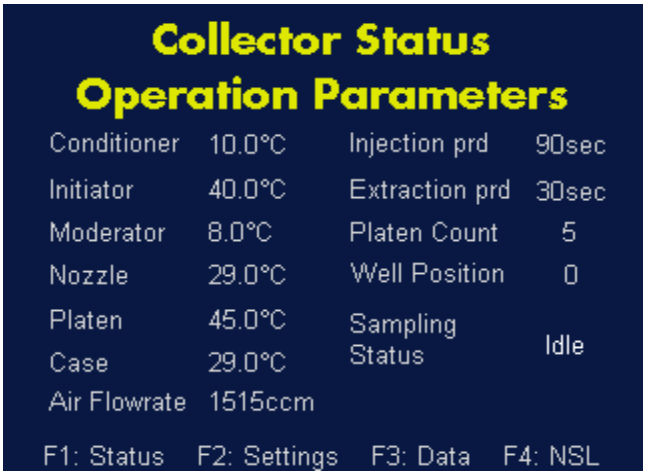
NanoParticle Collector Status

To view the status of the NPC operation parameters, follow these instructions:

1. Touch **F4** on the front panel of the NPE.
2. On the **NanoSpotLight Panel** screen, touch **Collector Status**.



View the parameters listed on the **Collector Status Operation Parameters** screen.



- Conditioner: First growth tube region. Default temperature is 10 °C.
- Initiator: Second growth tube region. Default temperature is 40 °C.
- Moderator: Third growth tube region. Default temperature is 8 °C.
- Nozzle: Default temperature is 29 °C. [Increase in temperature prevents condensation on the nozzle.
- Sequential: Temperature of the sample stub. Default temperature is 45 °C.
- Case: Temperature of the cabinet interior.
- Air Flowrate: Sample flow rate. Nominal value is 1500 ccm.
- Well position: Current sample number (1-5).

- Sampling Status: Sampling status. Can be Idle (not sampling), Auto (sampling using auto advance), or Manual (manual sampling).

  Note: Any parameters outside their normal operating range are indicated in red.

Collecting Samples

KFMT nSL Silicon SEM Starter	Silicon Wafer SEM Starter Kit (Heavy Duty Box, Stub Gripper, 7 Wafers)	1
KFMT nSL Silicon SEM Replenish	Silicon Wafer SEM Replenishment Kit (Light Duty Box, 8 Wafers)	1
KFMT nSL Poly SEM Starter	Polycarbonate Wafer SEM Starter Kit (Heavy Duty Box, Stub Gripper, 7 Wafers	1
KFMT nSL Poly SEM Replenish	Polycarbonate Wafer SEM Replenishment Kit (Light Duty Box, 8 Wafers)	1

The Nano SpotLight gives you the following options for collecting samples:

- Auto sampling for single-source samples.
- Auto sampling for multiple-source samples.
- Manual sampling.

Note: The sample platen is PEEK (Polyetheretherketone) which is highly resistant to a wide range of organic and inorganic chemicals. The only solvents that will attack PEEK are concentrated nitric acid and sulphuric acids. Avoid using methylene-chloride, DMSO and THF as these may cause the PEEK to swell. PEEK can be autoclaved. Stainless steel is compatible with organic acids and can be autoclaved. Hydrochloric acid is not recommended to use with stainless steel parts.

Loading the Sample Platen with SEM Stubs

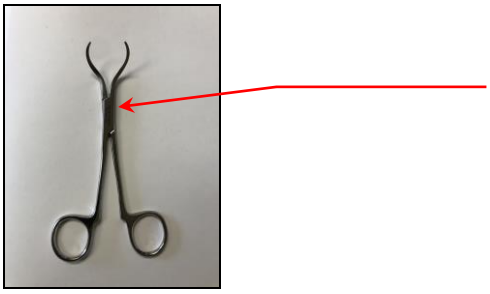
Before loading the sampling platen with SEM stubs you will need the following items:

- A clean work area (ISO Class 7 or better or the location where stubs are processed for SEM). This procedure can be done in the SEM lab. DO NOT follow this procedure in a sub-fab facility.
- 5-Well Sample Platen.
- Platen Standoff Block.
- 100 mm x 20 mm petri dish.

- 25 mm SEM stub mount gripper.
- Prepared sampling stubs in their shipping container.
- Unprepared sampling stubs (used as transition stubs).
- ISO Class 5 Clean room gloves.
- Clean room wipes wetted with IPA or UPW.

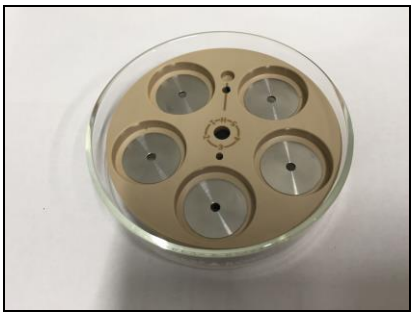
To load the sample platen, follow these instructions:

1. Put on clean room gloves.
2. Wipe the SEM stub grippers with clean-room wipes wetted with IPA or UPW.

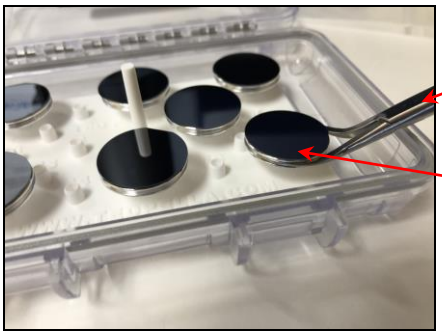


3. Place the stand off block in a clean 100x20 mm petri dish.

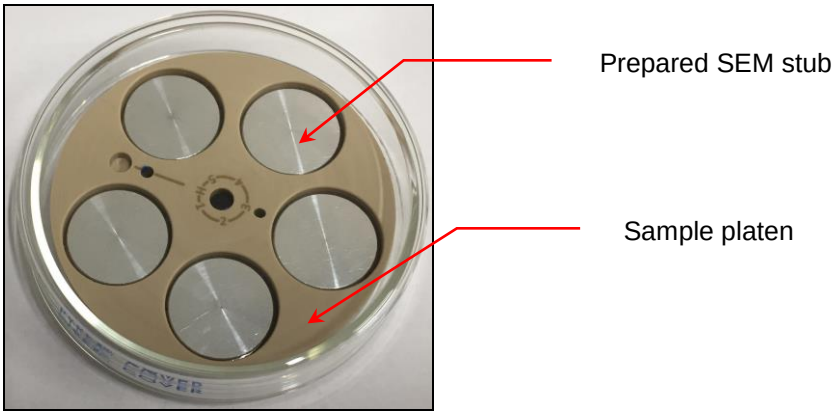
4. Wipe the SEM sample platen with clean-room wipes wetted with IPA or UPW.
5. Place the sample platen onto the stand off block in the petri dish.



6. Using the SEM stub grippers, remove a prepared SEM stub from the sealed container. (The grippers fit into the groove between the stub and pin.)



7. Load the stub into the sample platen in the petri dish.
8. Repeat steps 6 and 7 to load the rest of the stubs into the platen. Note: Place a transition stub (unprepared stub) between each prepared sample stub. There should be a transition stub in the last position. Example: If you are using transition stubs for the pause position during auto sampling, well positions 1 & 3 should have prepared sample stubs and positions 2 & 4 should have unprepared transition stubs.



9. Place the cover on the petri dish and carry it to the Nano SpotLight.

Making the Electrical Connections

To make the electrical connections, attach the two electrical cables from the SEM sequential sampler to the appropriate connectors on the NPC.
Note: The seven pin connectors are identified with silver banding tape.

Loading the Sample Platen into the NanoParticle Collector

The sample platen is loaded into a sequential sampler that is then installed on the NPC growth tube. Figures 19, 20, and 21 show the sequential sampler and its base and bayonet assemblies.

Figure 19: SEM Sequential Sampler.

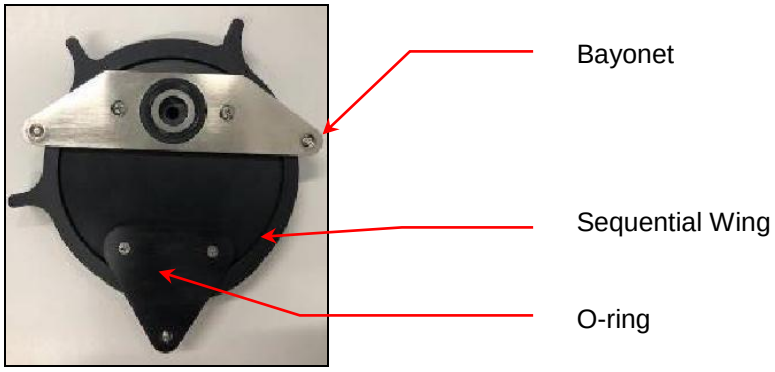


Figure 20: SEM Sequential Sampler Bayonet Assembly.

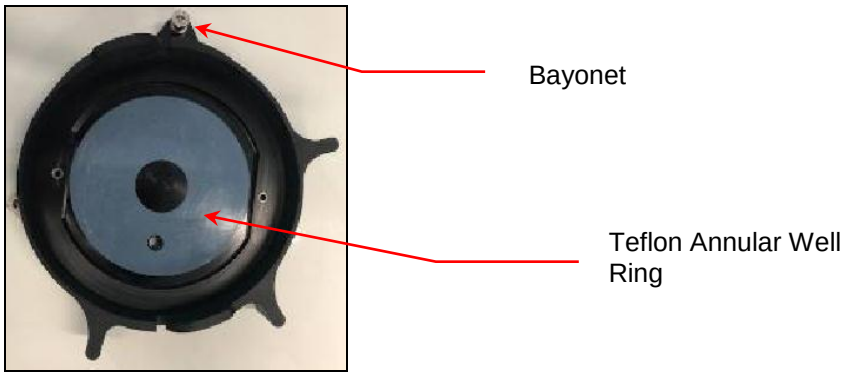
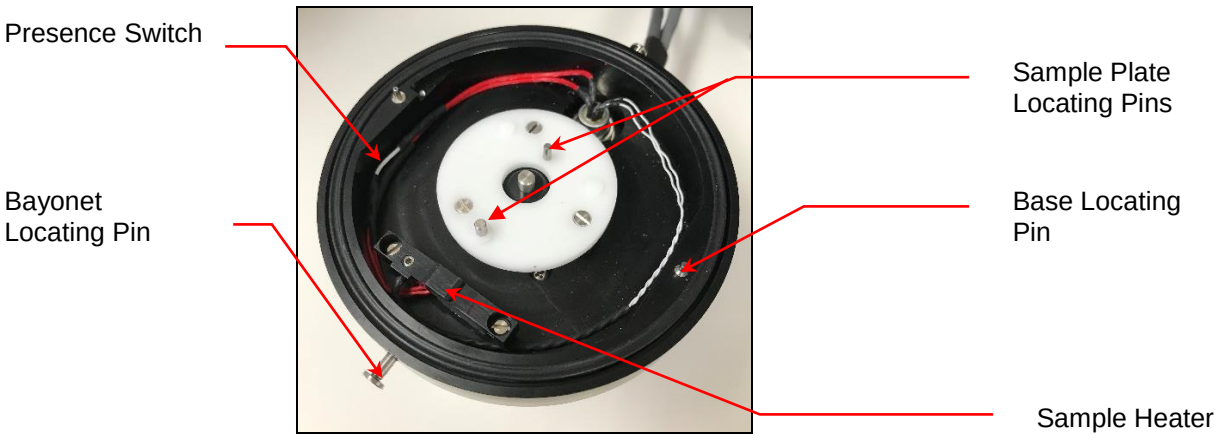
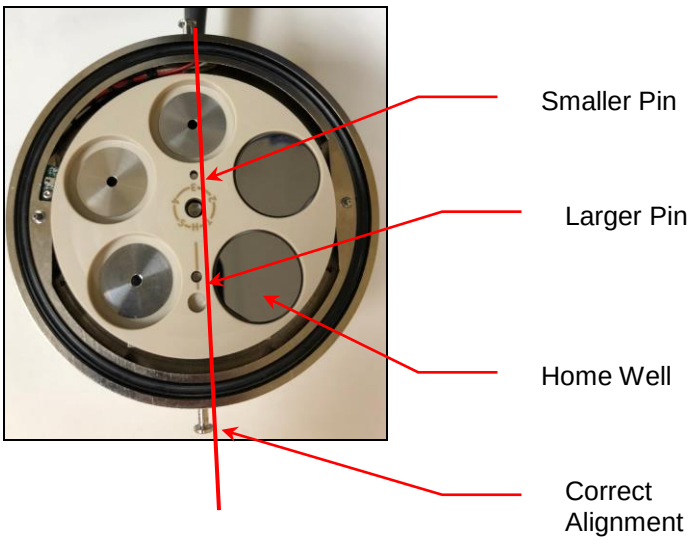


Figure 21: SEM Sequential Sampler Base Assembly.

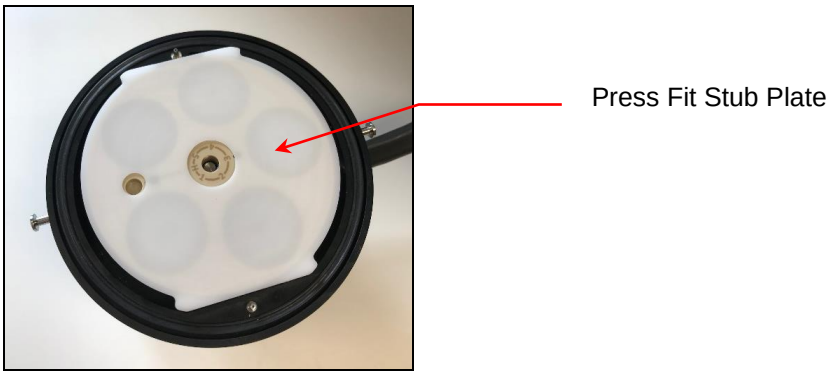


To load the sample platen into the sequential sampler, follow these instructions:

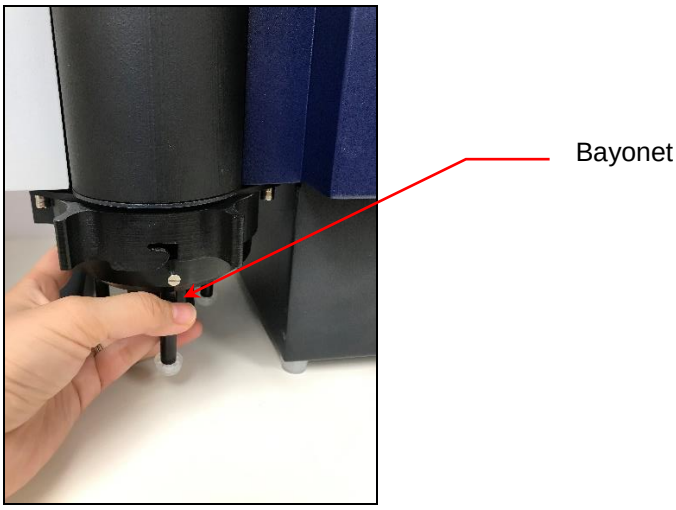
1. Place a loaded, clean SEM sample platen on the sequential sampler base, matching the two small locating pins (one pin is slightly larger than the other). Note: A correctly installed and homed sample platen has the 'home well' lined up with the locating pins and bayonet locking pins.



2. Cover the SEM sample platen with the Press Fit Stub Plate (ASSY-0075).



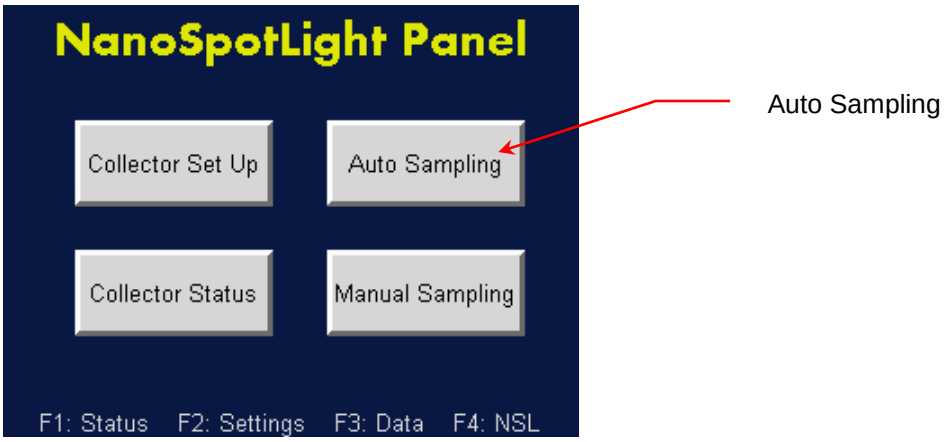
3. Install the sequential sampler onto the growth tube and secure by rotating the bayonet to lock the pins in place.



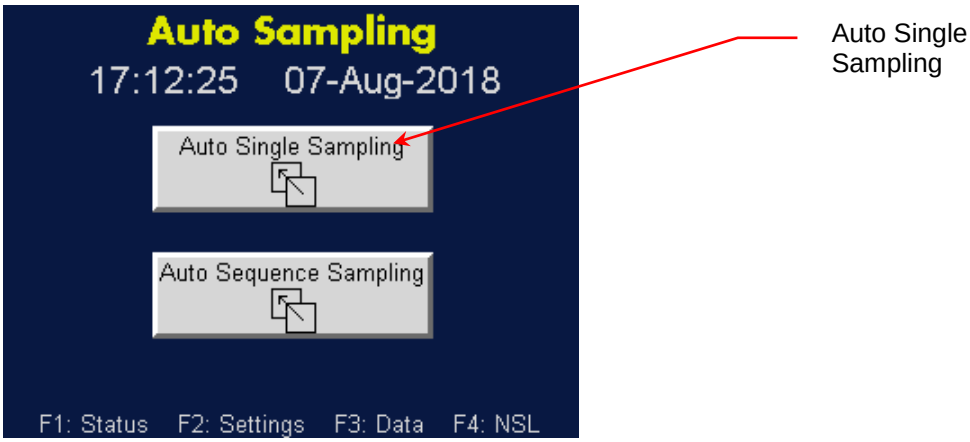
Setting Up Auto Sampling for Single Samples

To set up auto sampling for single samples, follow these instructions:

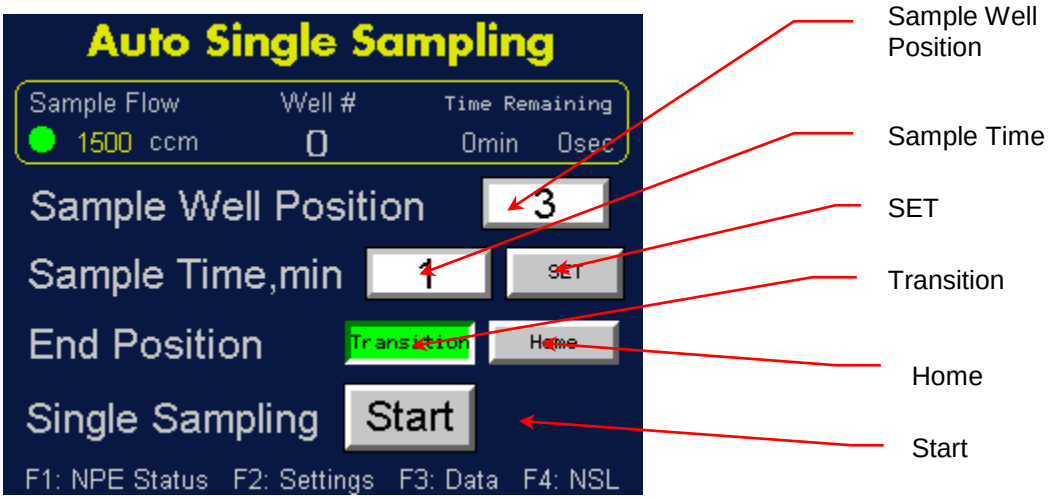
1. On the front panel of the NPE, press **F4.**
2. On the **NanoSpotLight Panel** screen, press **Auto Sampling**.



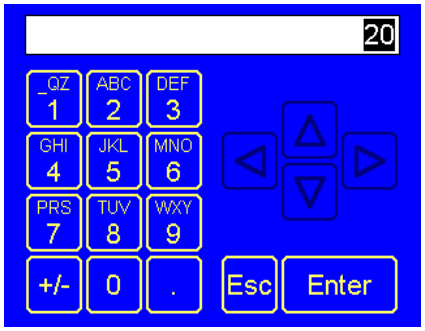
3. On the **Auto Sampling** screen, press **Auto Single Sampling**.



4. On the **Auto Single Sampling** screen, set the well position by pressing the **Sample Well Position** button.



5. Set the sample time (in minutes) by pressing the **Sample Time, min** button.
6. Use the on-screen keyboard to enter a sample time in minutes and touch **Enter**. Note: the sampling duration time range is 1 minute to 24 hours. △ ▽ buttons index the number. ◁ ▷ buttons set the cursor. ± sets the sign on the number.



7. When you have entered the sample time, press **SET**.
8. The **End Position** is the well position where the instrument pauses after sampling at one well. Choices for the pause position are a **Transition** well or the **Home** position. A transitional stub is often an unprepared stub that is located in the next stub position to the active sampling position.
9. Touching **Start** begins the sampling.
10. Check the sampling status at any time by reviewing the indicators at the top of the screen.

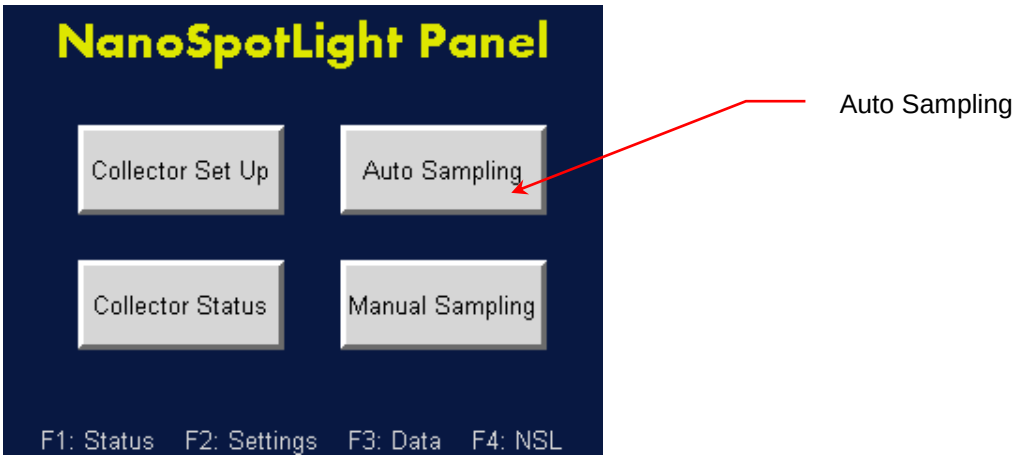
Sample Flow: Sample flow rate in ccm.
Well #: Active well.
Sample Time Remaining: Time left before the sampling is completed. It includes the stub warming time, the sample time of each active position and the time it takes to move the sample wells.

Setting Up Auto Sampling for Multiple Samples

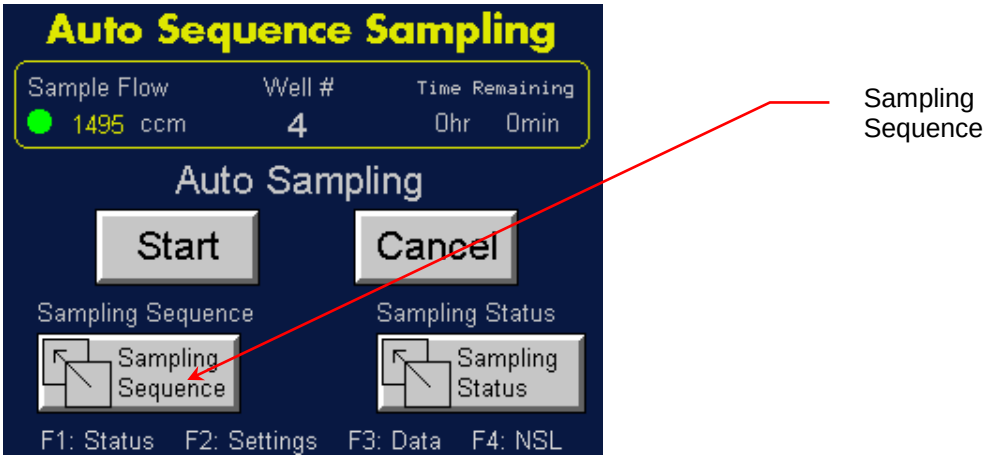
To set up a sampling sequence for multiple samples, follow these instructions:

1. On the front panel of the NPE press **F4.**

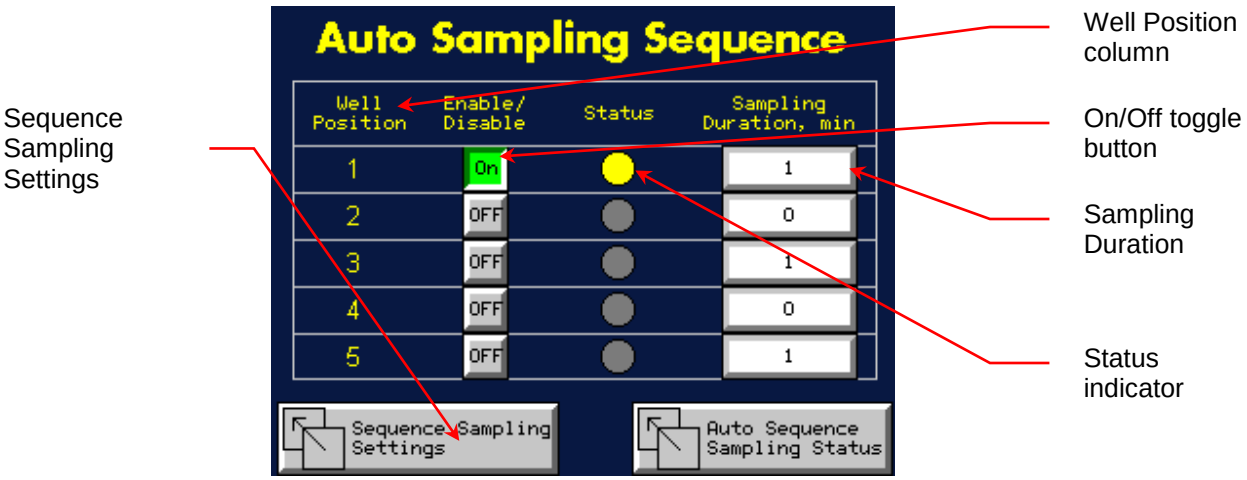
2. On the **NanoSpotLight Panel** screen, press **Auto Sampling**.



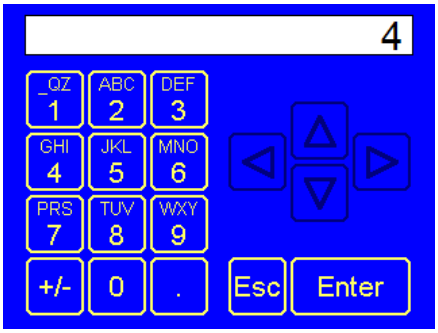
3. On the **Auto Sequence Sampling** screen, press **Sampling Sequence**.



4. On the **Auto Sampling Sequence** screen, select the specific sampling wells (indicated in the **Well Position** column) by pressing the **On/Off** toggle button in the **Enable/Disable** column.



5. To set the sample duration (in minutes) for a specific well, press the button in the **Sampling Duration, min** column.
6. Use the on-screen keyboard to change the number of the well position and press **Enter**.



Note: Only numbers 1-5 are valid. △▽ buttons index the number◁▷buttons set the cursor. ± sets the sign on the number.

7. Use the on-screen keyboard to change the sampling time in minutes and press **Enter**.

Note: the sampling duration time range is 1 minute to 24 hours. △▽ buttons index the number◁▷buttons set the cursor. ± sets the sign on the number.

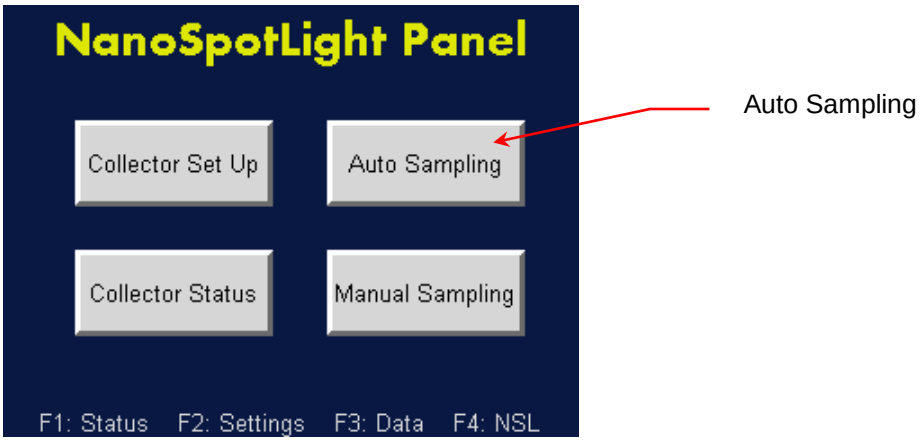
8. Repeat steps 5 - 7 for each of the enabled sampling wells.
   Note: The color of the **Status** column indicators shows the sampling status for each well position.
   Green: Indicates the well being sampled.
   Yellow: Indicates which wells are selected and waiting to be sampled.
   Red: Indicates the well to be sampled next.
   Gray: Indicates inactive wells that will not be used in this sampling sequence.
   Blue: Indicates completed sampling for that well.
9. Press **Sequence Sampling Settings** to return to the Auto Sequence Sampling screen.
10. On the **Auto Sequence Sampling** screen pressing **Start** begins the sampling sequence.
11. Check the sampling status at any time by reviewing the indicators at the top of the screen.

Sample Flow: Sample flow rate in ccm.
Well #: Active well.
Sample Time Remaining: Time left before the sampling is completed. It includes the stub warming time, the sample time of each active position and the time it takes to move the sample wells.

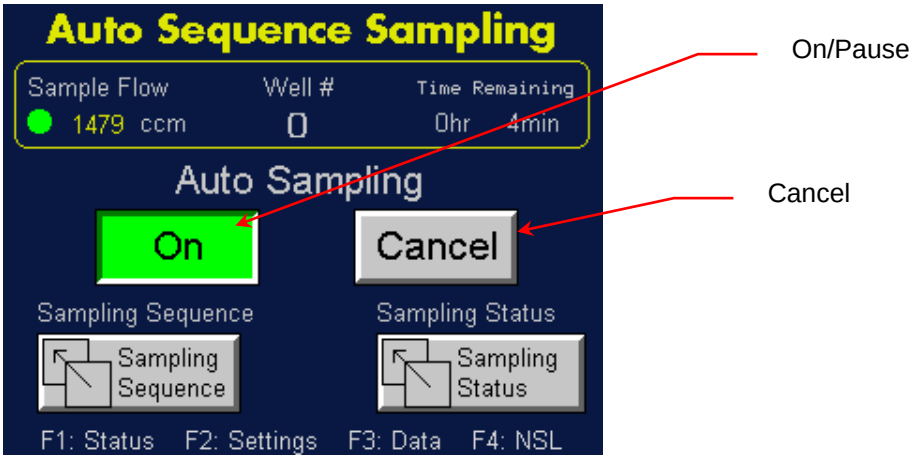
Pausing/Canceling Auto Sequence Sampling

To pause or cancel an auto sequence sampling, follow these instructions:

1. On the front panel of the NPE press **F4.**
2. On the **NanoSpotLight Panel** screen, press **Auto Sampling**.



3. On the **Auto Sequence Sampling** screen, when a sequence is running the **Auto Sampling** toggle button says **On**.

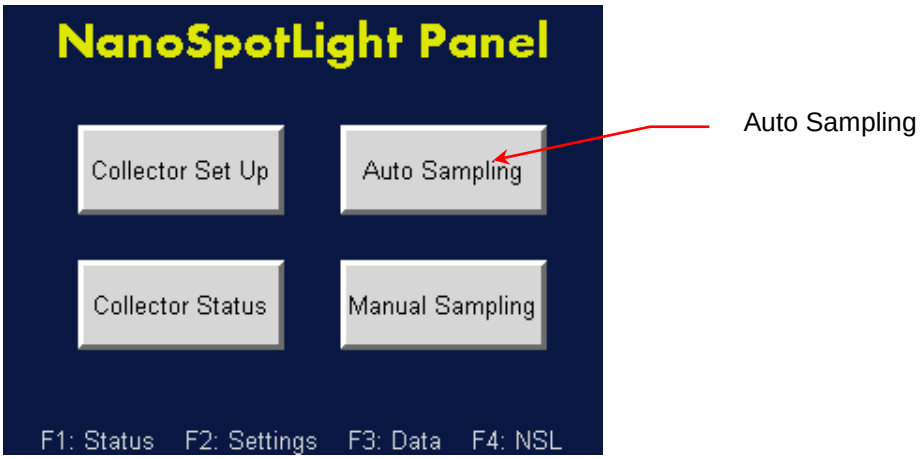


4. To pause a sequence, press the toggle button: the button turns gray and indicates **Pause**.
5. To cancel a sequence, press the **Auto Sampling Cancel** button.
   Note: When you cancel a sequence your pre-set well positions and duration times are lost.

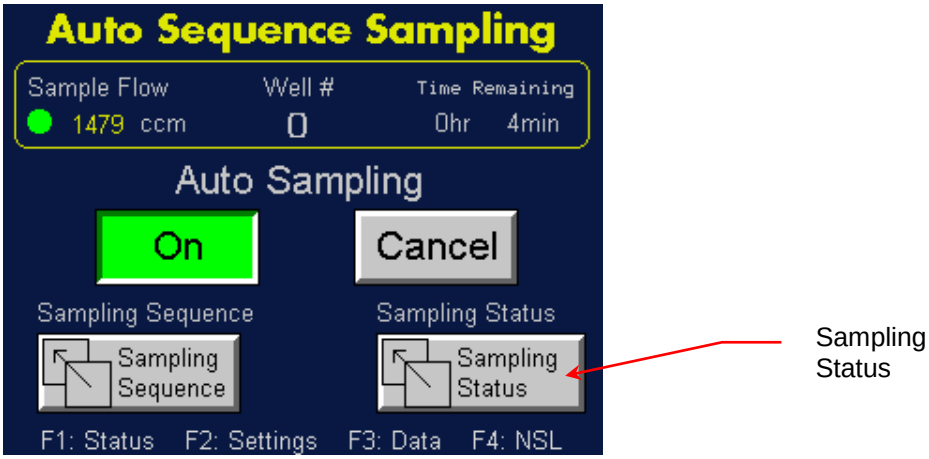
Checking Auto Sequence Sampling Status

To check the status of your current auto sampling for multiple samples, follow these instructions:

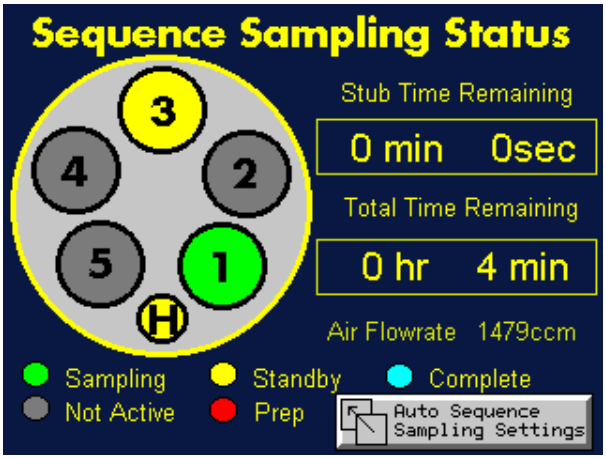
1. On the front panel of the NPE press **F4.**
2. On the **NanoSpotLight Panel** screen, press **Auto Sampling**.



3. On the **Auto Sequence Sampling** screen, press **Sampling Status**.



4. Check the sampling status on the **Sequence Sampling Status** screen.



Stub Time Remaining: Sampling time left (in minutes and seconds),

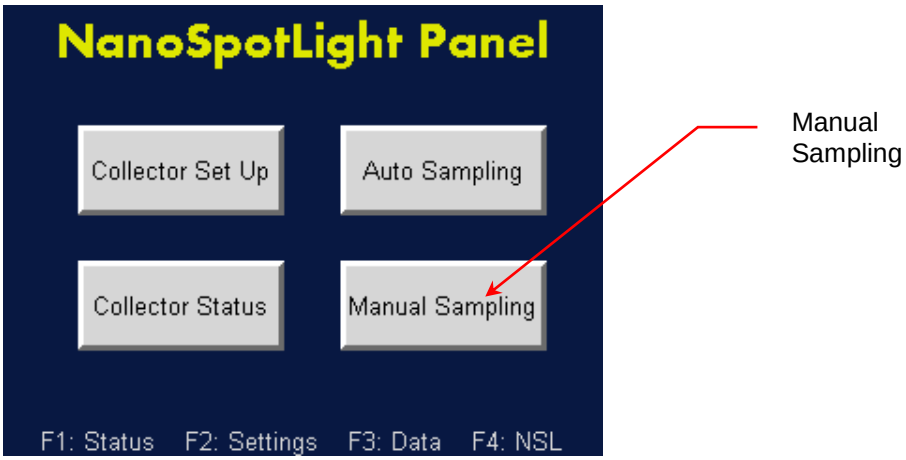
including the stub standby time, for the active stub.
Total Time Remaining: Sampling time left (in hours and minutes) for all stubs.
Stub status indicators:
Sampling: Green indicates the well being sampled.
Standby: Yellow indicates which wells are selected and waiting to be sampled.
Complete: Blue indicates wells where the sampling is complete.
Not Active: Gray indicates inactive wells not being used in this sampling sequence.
Prep: Red indicates the well to be sampled next.

Setting Up Manual Sampling

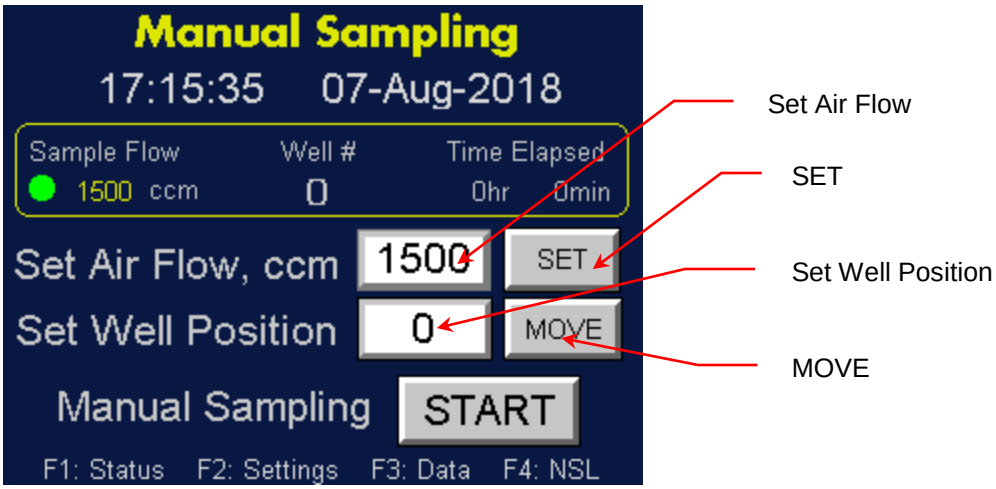
Manual sampling has no built-in clock for the sampling time and therefore no start or stop option.

To set up manual sampling, follow these instructions:

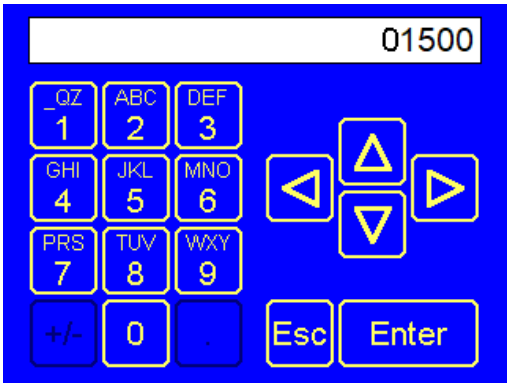
1. On the front panel of the NPE touch **F4.**
2. On the **NanoSpotLight Panel** screen, touch **Manual Sampling**.



3. On the **Manual Sampling** screen, set the air flow rate by touching the **Set Air Flow, ccm** button.

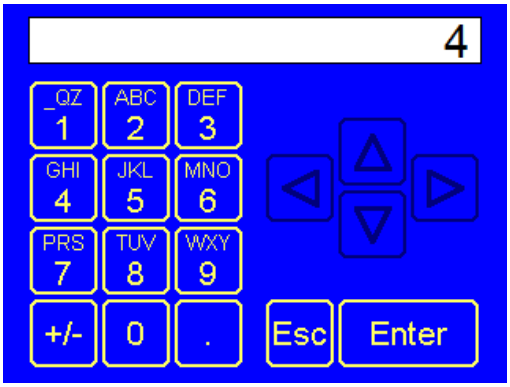


4. Use the on-screen keyboard to change the air flow rate.



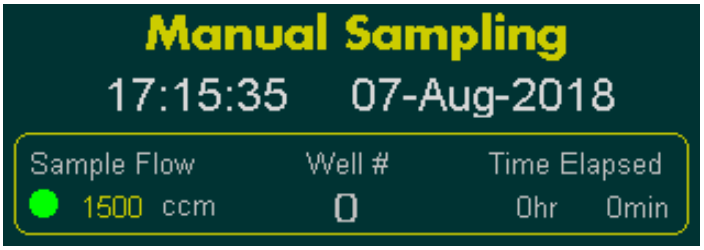
Note: △ ▽ buttons index the number. ◁ ▷ buttons set the cursor. ± sets the sign on the number.

5. Touch **SET**.
6. To change the well position, touch the **Set Well Position** button.
7. Use the on-screen keyboard to change the number of the well position and press **Enter**.



Note: Only numbers 1-5 are valid. △▽ buttons index the number◁▷buttons set the cursor. ± sets the sign on the number.

8. Touch **MOVE**.
9. Touching **START** begins the sampling.
10. Check the status of the manual sampling by viewing the indicators at the top of the screen.



Time: Current time in hours, minutes, seconds.
Date: Current date in month, day, year.
Sample Flow: Sample flow rate in ccm.
Well #: Position of well being sampled.
Time Elapsed: Elapsed sampling time in hours and minutes.

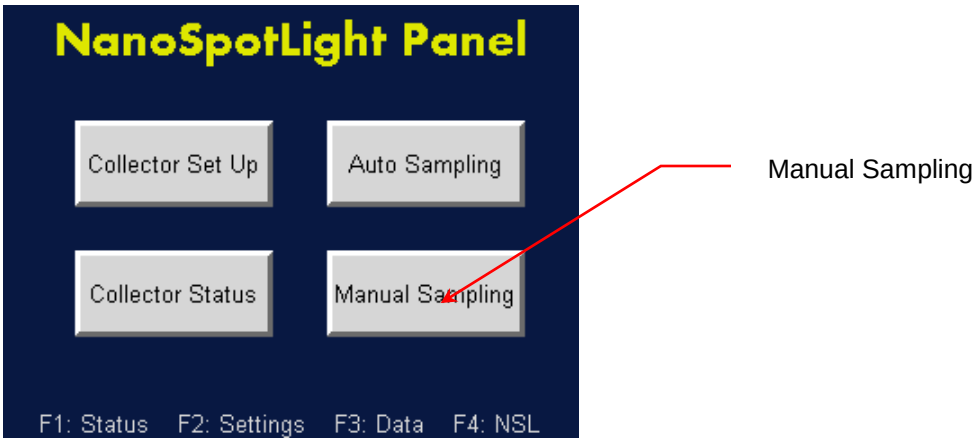
Collecting and Analyzing Samples

Collecting Single Source Manual Samples

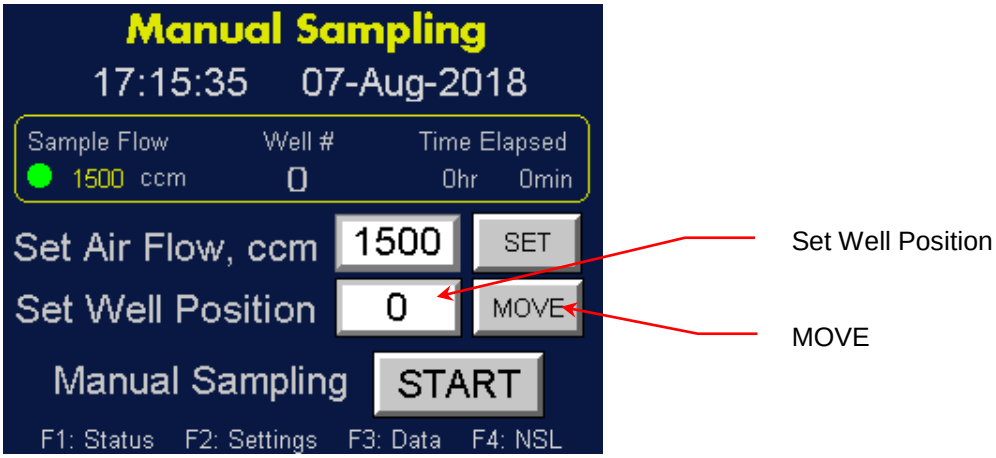
Follow these instructions to collect single source ("grab") samples:

1. Load the sample platen following the instructions beginning on page 68.
2. Press **F1** on the front panel of the NPE.
3. On the **Extractor Status** screen, confirm that the operating conditions are correct.
4. To clear out the tubing, run the NPC with the sample flow on for 10 minutes in the **Home** position.
5. Touch **F4** on the NPE front panel.

6. On the **NanoSpotLight Panel** screen, touch **Manual Sampling**.



7. On the **Manual Sampling** screen press **Set Well Position**. Use the on-screen keyboard to set the well position to **1** and then press **MOVE**.



8. Press **START** to begin sampling.
9. When the **Time Elapsed** reaches the desired sampling time, press **STOP** to stop the clock.
10. Use the on-screen keyboard to set the next well position then press **MOVE**.
11. Press **START** to begin the sampling.
12. When you have finished sampling, use the on-screen keyboard to set the well position to **0** (the Home position).

Unloading the Sample Platen

Before unloading the sampling platen you will need the following items:

- A Class 10000 (or lower) work area (or the area where subs are processed for SEM).
- SEM Platen Handling Tool (CP-0123).
- 100 mm x 15 mm petri dish.
- 25 mm SEM stub mount gripper.
- ISO Class 5 Clean room gloves. If clean room gloves are not available, wipe hands with a wetted cloth before performing any procedures.

To unload the platen, follow these instructions:

1. Wearing clean room gloves in the SEM preparation area (or cleaner), use clean room cloths wet with UPW or IPA to clean a petri dish, the stand off block, and the SEM platen handling tool.
2. Place the standoff block in the center of the petri dish to prevent the platen from tipping, cover the petri dish and bring the items cleaned in step 1 to the Nano SpotLight.
3. With the air pump on, rotate the bayonet to unlock the sequential sampler base. Unscrew and lower the base to confirm the platen is positioned on the well indicated on the Collector Status screen.
4. Lift and remove the platen from the sequential sampler and place it on the standoff block in the petri dish.
5. Keeping the platen level, place the cover on the petri dish and carry it to the SEM preparation area.
6. While the stubs are in the platen in the petri dish, record a microscope image of each of the sample stubs.
7. Using the cleaned 25 mm SEM stub mount gripper transfer the stubs from the platen to the SEM stub storage box for analysis or to a sealed container.
8. Record the box number and SEM placement number in the container.

Preparing a Sample Stub for SEM Analysis

A coating of sputtered nanoparticles (down to 10 nm in particle size) applied to the stubs before SEM analysis to reduce surface charging and maintain good imaging quality is recommended. If available, a 2 nm coating thickness of iridium can be a successful starting point for unknown samples. A silicon

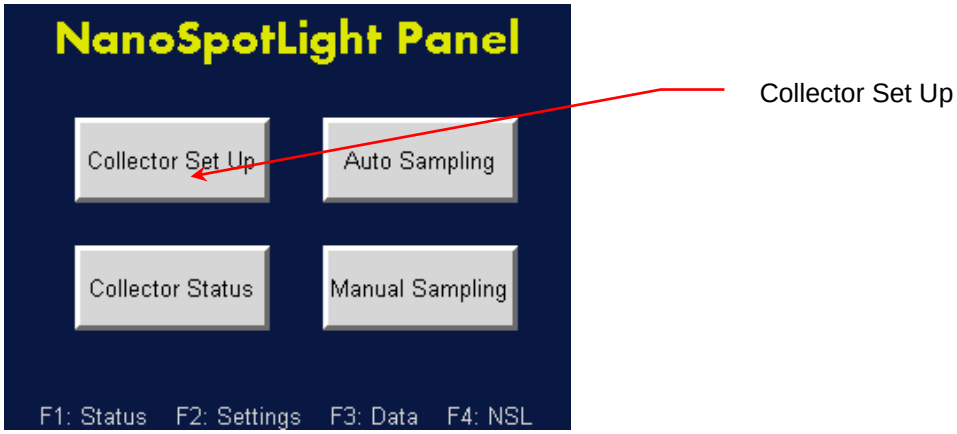
wafer substrate provides the best surface for most analyses. Polycarbonate substrates are helpful when silica contamination is suspect however it is more difficult to find the deposit on these stubs as the organics are essentially invisible and the run time may be longer than that of the silicon wafer stubs.

Qualifying the Nano SpotLight

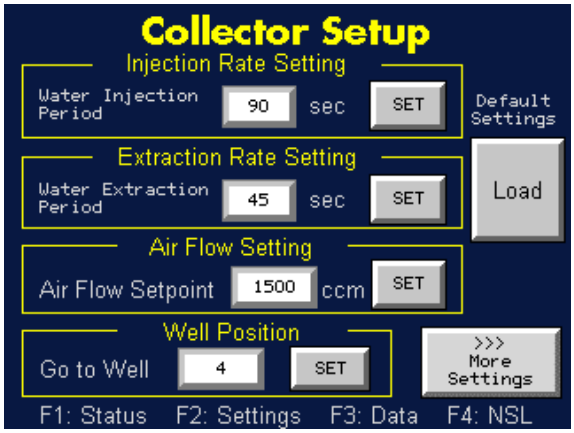
Kanomax FMT recommends that you qualify your Nano Spotlight every two weeks. To purchase a Qualification kit, contact Kanomax FMT.

To qualify the Nano Spotlight, follow these instructions:

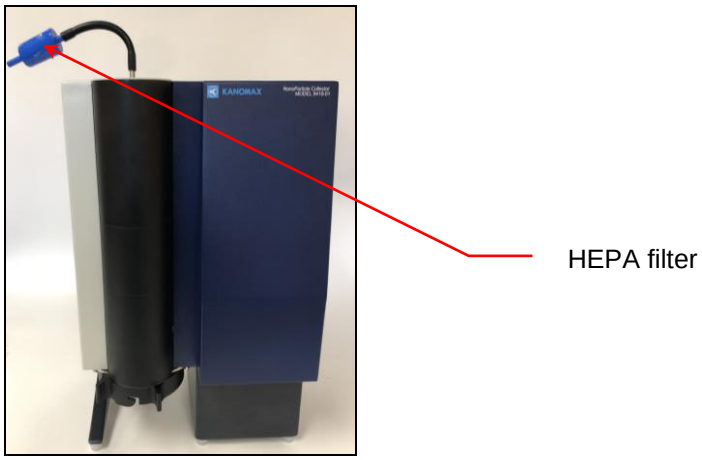
1. Load the sample platen with SEM stubs. (See page 68.) Use 3 sample stubs and 2 transition stubs.
2. Home the sample platen by setting the Well position to 0.
3. Press **F4** on the NPE front panel.
4. On the **NanoSpotLight Panel** screen, press **Collector Set Up**.



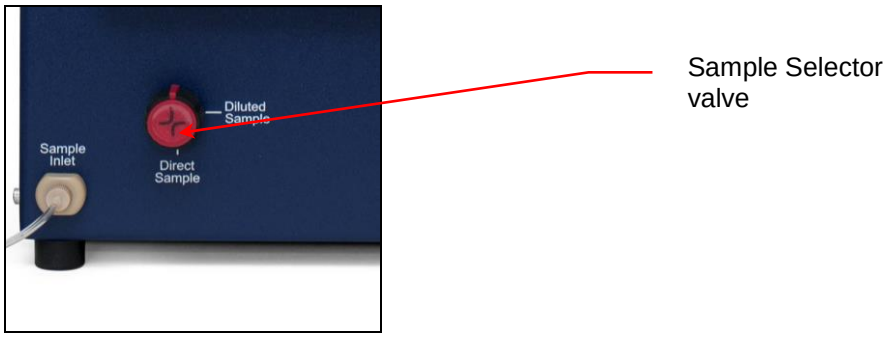
5. On the **Collector Set Up** screen, press **Air Flow Setpoint**.



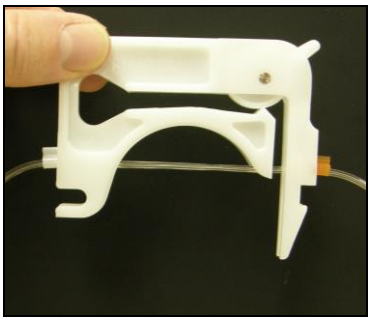
6. Using the on-screen keyboard set the air flow to **0** to turn off the NPC air pump.
7. Disconnect the connective tubing between the NPE and NPC.
8. Connect a HEPA filter to the NPC sampling inlet.



9. On the **Collector Setup** screen turn on the NPC air pump by setting the **Air Flow Setpoint** to **1500 ccm**.
10. Run for 10 minutes on the **Home** (0) well position then press **Well Position** and use the on-screen keyboard to set the well position to **1**. Press **MOVE**.
11. On the front panel of the NPE, turn the **Sample Selector** valve to **Direct Sample**.



12. Install a Tygon tube into the peristaltic pump cassette and set the tensioner. Note: If you are replacing tubing that is damaged or discolored, do not shut off the water supply.



13. On the front panel of the NPE, turn the **Sample Selector** valve to **Diluted Sample**.
14. Set the external peristaltic pump direction using the RESET button. Operate the pump in "extract" mode at 0.1 ml/min for 1 hr.

15. When the extract flushing is complete, on the **Collector Setup** screen, press **Well Position** and use the on-screen keyboard to set the well position to **2**, then press **MOVE**. (Note: Well 2 should be loaded with a transition stub.)
16. On the **Collector Setup screen**, press **Air Flow Setpoint**. Using the on-screen keyboard set the air flow to **0** to turn off the NPC air pump.
17. Remove the HEPA filter at the NPC sample inlet.
18. Reconnect the NPE and the NPC using the conductive tubing.

19. On the **Collector Setup** screen turn on the NPC air pump by setting the **Air Flow Setpoint** to **1500 ccm**.
20. Inject the tracer particles provided in the Qualification Kit**:**
    a. Weigh the tracer particle vials and record the weight.
    b. Rinse the outside of the peristaltic pump tubing with UPW.
    c. Stop the external peristaltic pump by pressing the RUN/STOP button.
    d. Insert the loose end of the Tygon tube into a tracer particle bottle.
    e. Start the external peristaltic pump injection by pressing the RUN/STOP button. Confirm that the pump is in "inject" mode at 0.1 ml/min. (It should be pulling the tracer particle sample from the bottle.)
21. Run for 10 minutes on the transition stub.
22. On the **Collector Setup** screen, press **Well Position** and use the on-screen keyboard to set the well position to **3**, then press **MOVE**. (Note: Well 3 should be loaded with a prepared sample stub.)
23. Collect tracer particles for 1 hour.
24. On the **Collector Setup** screen, press **Well Position** and use the on-screen keyboard to set the well position to **4**, then press **MOVE**. (Note: Well 4 should be loaded with a transition stub.)
25. Stop the external peristaltic pump by pressing the RUN/STOP button.
26. Remove and cap the tracer particle bottle.
27. Re-weigh the tracer vial to confirm that the sample was injected.
28. Rinse the outside of the external peristaltic pump tubing with UPW.
29. Change the external peristaltic pump direction to "extract" mode by pressing the RESET button.
30. Start the external peristaltic pump and confirm that the pump is pulling UPW away from the NPE at 0.1 ml/min flow rate.
31. Unload the Sample Platen.
32. Prepare the sample stubs for SEM analysis following instructions on page 85.
33. Use SEM analysis to confirm there are no tracer particles collected in the Qualification Sample.
34. Use SEM analysis to confirm that the stub in well 5 is not contaminated.

How to Shut Down the Nano SpotLight for Moving or Shipping

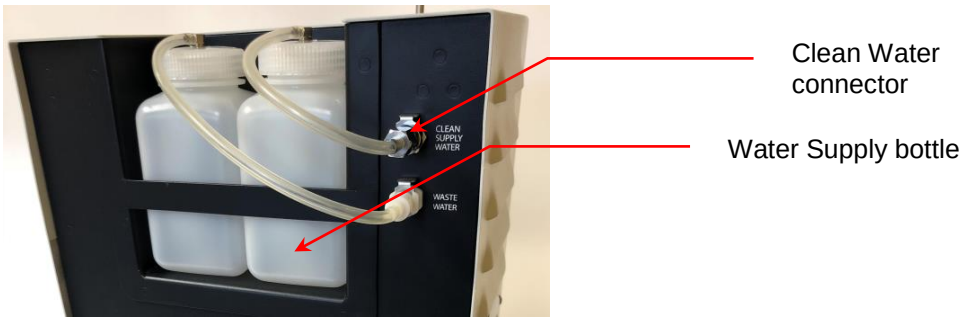
If you need to move the Nano SpotLight to another lab or facility or ship it for service, read this section to familiarize yourself with the precautions you should take and the procedures you should follow.

Performing any of the following improper handling techniques may damage the instrument and will invalidate the warranty:

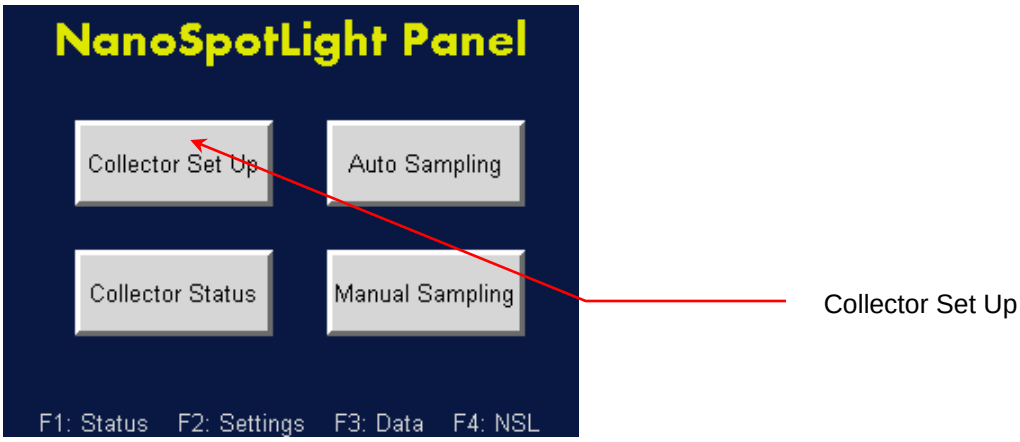
- Shipping/transporting an undried/undrained instrument.
- Tipping > 10° during normal operation.
- Subjecting an undried/undrained instrument to freezing temperatures.

To prepare the Nano SpotLight for shipping, follow these instructions:

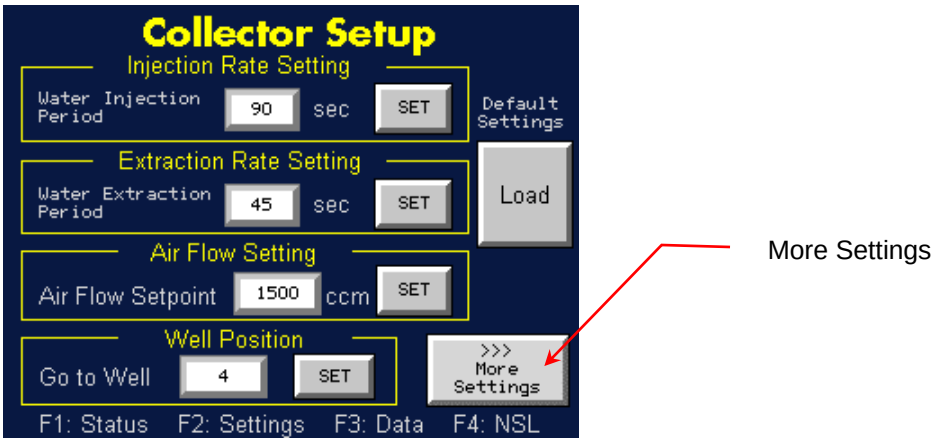
1. Turn off the NPC air pump.
2. Disconnect the conductive tubing between the NPE and the NPC.
3. Unload the sample platen from the NPC.
4. Empty the water supply bottle and then replace it in the bottle holder.
5. Reconnect the tubing to the NPC and ensure that the Waste Water bottle is in place and tubing connected.



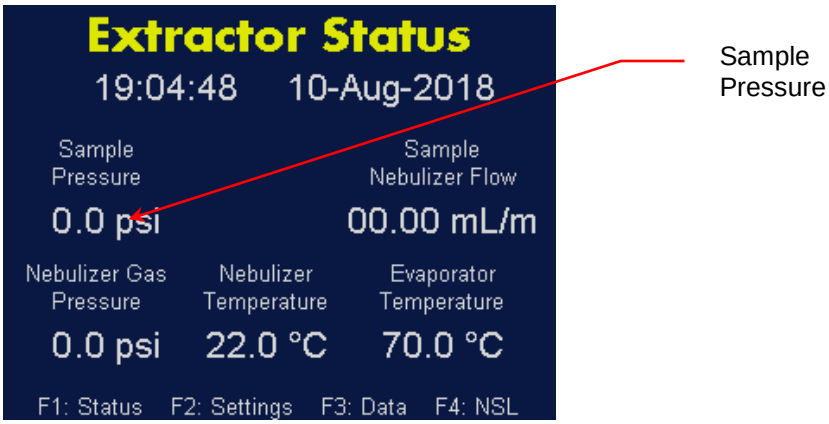
6. Touch **F4** on the NPE front panel.
7. On the **NanoSpotLight Panel** screen, touch **Collector Set Up**.



8. On the **Collector Setup** screen touch **More Settings**.



9. On the **More Settings** screen, follow the instructions in Draining/Drying the NanoParticle Collector on page 57.
10. Turn off the water supply to the NPE and wait a few seconds for the water pressure to drop to zero.
11. Touch **F1** on the front panel of the NPE. On the **Extractor Status** screen, confirm that the **Sample Pressure** is zero.



12. Keep the NPE power turned on and the compressed air flowing into the **Air Inlet** on the back panel.
13. Connect the CDA/N_2 adapter fitting (provided with the instrument) to the UPW inlet port and apply clean dry air or nitrogen at 30 psi to the port. Run for 2 hours.
14. Remove the adapter and cap the **UPW Inlet** on the front panel.
15. Remove the **Shipping Drain** cap. Water will drain from the fitting. Tilt the NPE towards the back to allow the nebulizer module reservoir to empty completely. Note: If necessary, you can install tubing to take the waste flow to a suitable drain.
16. Disconnect the air or nitrogen supply line and the water waste line from the NPE and turn off the power.
17. Place all the caps that you received with the extractor on the inlets and outlets to prevent material from entering the instrument. The NPE is now prepared for shipping or moving.
    Note: If you did not save the original protective caps, find suitable alternatives.
18. Turn off the power to the NPC.
19. Place the original red protective caps on the inlet and base of the growth tube on the collector. The NPC is now prepared for shipping or moving.
    Note: If you did not save the original protective caps, find suitable alternatives.
20. Place the instruments in their original packing materials for shipping.

If you have any questions about shipping or moving the NanoParticle Nebulizer, contact Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

Troubleshooting

Instructions for the NanoParticle Extractor

All repair and maintenance of the NPE must be performed by a qualified service technician.

When working with the NPE:

- Do not remove any parts from the instrument unless this manual tells you to do so.
- Do not remove the instrument housing or covers while power is supplied to the instrument.

Problem	Cause	Action
Nebulizer Flow is 0.	UPW flow is not turned on.	Press **F2** to see the Extractor Settings screen. Turn on the UPW Flow. Wait for the evaporator temperature to reach 50°C.
	UPW pressure is out of range.	Touch **F1** to see the Extractor Status screen, check that the UPW Pressure is 18 ± 0.2 psi. If the pressure is not correct, adjust the pressure (see Changing the Sample Pressure/Dilution Flow on page 34.) If the pressure does not reach the correct operating level, verify the UPW supply pressure is >30 psi.
	Drip Sensor is wet.	Check beneath the nebulizer to see if drops are forming at the drip counter. If drops are forming, the sensor is probably wet. Turn off the UPW supply and allow the instrument to dry for 24 hours. Turn the UPW supply back on. If the

		sensor is still wet, check that gas bubbles are present in the waste line. If not, contact Kanomax FMT.
	Nebulizer is clogged.	Check beneath the nebulizer to see if drops are forming at the drip counter. If no drops are forming the nebulizer may be clogged. (See Unblocking Orifices on page 95).
Bubbles observed in flowmeter.	UPW pressure is out of range.	Touch F1 to see the Extractor Status screen. Check that the UPW Pressure is 18 ± 0.2 psi. If the pressure is not correct, adjust the pressure. (See Changing the Sample Pressure/Dilution Flow on page 34). If the pressure does not reach the correct operating level, verify the UPW supply pressure is >30 psi.
	Nebulizer is clogged.	See Unblocking Orifices on page 95.
Water leaking from NPE.	Loose fitting.	Check all fittings and tighten any that are loose. Note: Do not over-tighten.
	Water flowing from base of NanoParticle Nebulizer. Waste pump not operating properly	Check that gas bubbles are present in the waste line. If not, contact Kanomax FMT.
Water pressure > or < 18 ± 0.1 psi.	UPW or gas supply pressure changed.	See Changing the Sample Pressure/UPW Flow on page 34.
Nebulizer gas pressure not reading 35 psi.	Gas supply pressure changed.	See Changing the Nebulizer Pressure on page 34.
Evaporator temperature does not reach set point (nominally 60°C).	Nebulizer evaporator may be flooded.	Check that gas bubbles are present in the waste line. If not, contact Kanomax FMT.
Water present in aerosol output fitting.	Extraction flow is low.	Press F4 > Collector Setup. On the Collector Setup

		screen confirm that the Air Flow is set to 1500 ccm.
	Nebulizer evaporator may be flooded.	Check that gas bubbles are present in the waste line. If not, contact Kanomax FMT.
NPE unable to hold set point temperature (22°C).	Extreme ambient temperature conditions or defective cooling components.	Contact Kanomax FMT, Inc. for instructions.
NanoParticle Extractor does not recognize external USB Flash drive	**Media Card not Present** is displayed on **Manage Data>Manage USB** screen.	Power cycle the NPE.
Aerosol output is erratic.	Drip counter trap may not be set.	Verify that the Shipping Drain is capped.
	Flow and or pressure at Aerosol Output is not in the specified range.	The aerosol output must be near ambient pressure (+/- 1 cm H_2O) and within 1-1.5 L/pm.
Water spotting on sample stubs.	Aerosol concentration too high.	Use a Condensation Particle Counter to confirm that the aerosol concentration is <10k #/cc.
Tracer particles not present.	Nebulizer clogged.	See Unblocking Orifices on page 95.
	Peristaltic pump run incorrectly.	Check that the tubing tensioners are set correctly and the pump is running in the correct direction.

Unblocking Orifices

Occasionally orifices or tubes within the NPE become blocked which may be indicated by a low nebulizer flow rate. If you suspect a blockage, follow these instructions:

1. Turn the Sample Selector valve on the front panel to **Diluted Sample**.
2. Remove the water inlet tubing and run compressed air through the instrument.
3. If the problem is not resolved, turn the Sample Selector valve to **Direct Sample** and remove the direct injection plug to force air back through the nebulizer supply tubing.

4. If a clog persists, turn off the gas supply and inject water into the sample inlet for 1 hour with the Sample Selector valve turned to **Direct Sample**.

If the nebulizer flow rate does not recover, it is possible that the internal orifices are clogged and the device must be returned to Kanomax FMT, Inc. for service.

Instructions for the NanoParticle Collector

Procedure	Frequency
Replace wick	6-12 mths
Change filters	Annual
Factory Service	Annual

The NPC should be shipped to Kanomax FMT for a standard annual factory service that includes the following:

- Inspection.
- General cleaning.
- Wick, filter, and battery replacement.
- Leak check.
- Firmware update.
- Functional performance check.
- Service report.

The following as needed services can also be applied:

- Replace flow orifices.
- Replace water check removal valve.
- Replace O-rings.
- Replace tubing.
- Replace or repair insulation.
- Align sequential stepper motor and optical encoder.

Problem	Cause	Action
Home command fails to find Home when start position is not zero. Or, well position not shown on display.	The SEM Sequential Collector cables are not securely connected to the back of the instrument. The SEM platen is not placed securely on the locating pins.	Check that the SEM Sequential Sampler cables are securely connected to the back of the NPC. (See Making the Electrical Connections on page 71). If Home position is still not found, contact Kanomax FMT.
Negative numbers on the display screen.	Thermistor not connected.	Contact Kanomax FMT.
Dash marks on the display screen.	Sample heater not connected.	Connect the Sequential Sampler cables on the back of the NPC. See Making the Electrical Connections on page 71.
Water in the Sample Line	Water trap not installed.	Check the water trap following the instructions on page 26.
Mass Flow Meter is wet.	Erroneous readings.	Empty the water supply bottle and the trap bottle. Drain water from the sample line and run the NPC overnight. If the readings still contain errors, contact Kanomax FMT, Inc.

Water collecting in the water trap.	Inlet cap left on when pump running.	Turn pump off. Remove inlet cap and empty the water trap.
	Sequential base connected to the bayonet during wick wetting process.	Turn pump off. Disconnect the sequential base before continuing with the wick wetting process.
	Water not being injected or extracted from the system.	Prime the internal and external pumps. See instructions below.
	Excessively high sample rate.	The sample flow rate should be equal to or less than 1.5 mL/min.
	Instrument has been tipped on its side with water in the supply and extraction lines.	Turn off the sample pump. Disconnect the sequential base. Empty the water trap bottle. Drain the lines using the Draining/Drying the NanoParticle Collector described on page 57. Dry the instrument for 24 hours. On the NPE display screen (NanoSpotLight Panel > Collector Status), check the air flow reading. If it outside of the 1.5 l/min air flow rate, or is fluctuating wildly, the mass flow meter is damaged. Contact Kanomax FMT.
Water exiting the nozzle during repeated injections.	Extraction pump stuck.	Prime the extraction pump following the instructions below.
No water in the extraction line to the waste bottle, or exiting the nozzle, during repeated injections.	Injection pump stuck.	Prime the injection pump following the instructions below.

Bio-decontamination Procedure

To prevent growth of microbes on the wick and in the plumbing system, we recommend performing the following bio-decontamination procedure once a month if the Nano SpotLight is in continuous use. To perform this procedure you need the following:

- A chemical hood.
- 70%ethanol or 70% isopropyl (isapropanol).
- Deionized (or cleaner) water.

To bio-decontaminate the NPC, follow these instructions:

1. Turn off the NPC.
2. Place the NPC in a chemical hood.
3. Disconnect and empty the water supply bottle.
4. Disconnect and empty the waste bottle.
5. Place the 70%ethanol or 70% isopropyl in the water supply bottle.
6. Reconnect the water supply and waste bottles.
7. Disconnect the sequential sampler from the bayonet.
8. Turn on the NPC but do not turn on the sample pump.
9. Press **F4** on the display panel. On the **Nano SpotLight Panel** screen choose **Collector Setup>More Settings>Wick Priming> Dry Wick**. 600 counts are assigned to the injection pump.
10. When the repeated injections are finished, disconnect and empty the water supply bottle.
11. Fill the supply bottle with clean water and reconnect it to the NPC.
12. Disconnect and empty the waste bottle.
13. Reconnect the waste bottle to the NPC.
14. Inject 500 more counts into the NPC to flush the alcohol out of the lines.
15. When the injections are complete, disconnect the waste bottle and discard the waste.
    Note: 70%ethanol or 70% isopropyl should be discarded into appropriate waste containers.

Appendix A: Nano SpotLight Specifications

Table 4: NanoParticle Extractor Specifications

Peak droplet diameter	< 1.0 micrometer (nominally 0.2 micrometer)
Droplet dN/dLogDp > 10µm	< Peak dN/dLogDp x 10^{-5}
Inspection volume rate	0.2-1.0 µL/min
Total Liquid Flow Rate (online)	50-280 mL/min
Nebulizer Flow Rate (direct)	0.5-3.0 mL/min
Aerosol Flow Rate	1.0 – 1.5 L/min
Response time to concentration change	< 90 seconds
Inlet Water Pressure (online)	200-500 kPa (29 – 72 psig)
Compressed air flow rate/pressure	3 std L/min CDA or Nitrogen, (345-414 kPa, 50-60 psi)
Wetted Surface Materials	PFA Teflon, PTFE, sapphire, 316L, stainless steel, PEEK
Ambient Temperature Range	15-35°C, 59-95°F
Ambient Relative Humidity Range	0-85%
Maximum Water Temperature	80°C, 176°F
Dimensions (WxDxH)	23 (9) x 23 (9) x 35.5 (14) (46 (18) with fittings)
Weight	6 kg (13..2 lb)
Power	Universal 100 - 230 VAC 50/60 Hz, 90 W max
Output	RJ-45 for Modbus, USB FlashDrive
Internal storage	Micro SD
Ultrapure Water Inlet	¼ inch PFA Flaretek®
Waste Outlet	¼ inch SS Swagelok®
Compressed Air inlet	¼ inch SS Swagelok®
Detector vacuum	¼ inch SS Swagelok® port
Display	3.5 inch TFT Color, touch panel

Table 5: NanoParticle Collector Specifications

Particle Size Range	5 nm -2.5 µm
Collection Efficiency	>95%
Aerosol Concentration	Up to 10^4 partricles/cm^3
Condensing Fluid	Water, distilled or cleaner
Wick Material	DVPP00010 Durapore Membrane Filter (Millipore) formed into a 30 cm long (6.35 mm OD x 4.8 mm ID) roll
Inlet/Sample Flow Rate	1.0 L/min
Sampled Aerosol Conditions	Non-corrosive

	0 – 40 °C
Sequential Sampling onto SEM Sample Platen	6 mounting holes for SEM stubs (plus a home set up well), mounting plate made of PEEK® polymer with Stainless Steel 304 bottom heating plugs. Other materials and configurations are possible.
SEM Stub Dimensions	Accepts round SEM stubs – 25.4 mm (1 inch) stub main diameter maximum, 3.2 mm mounting pin diameter maximum, 9 mm mounting pin length maximum
Sequential Sample Time	User-selectable timed-sample on each stub from 1 minute to 24 hours
Dry Deposition Area	Approx. 0.5 mm diam
Display	LCD Display, 4 lines x 20 charcaters
Communications	USB communications output for sampling parameters and instrument status
Environmental Operating Conditions	15 – 30 °C 10 – 95% RH
Sample Inlet	6mm OD SS tube
Power	Universal 100 - 230 VAC 50/60 Hz, 140 W max
Dimensions (WxDxH)	305 mm (12 in) x 255 mm (10 in) x 500 mm (19.5 in)
Weight	Growth Tube Unit: 6.8 kg (15 lb) Sequential SEM Collector module: 1.1 kg (2.5 lb)

Specifications subject to change without notice.

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