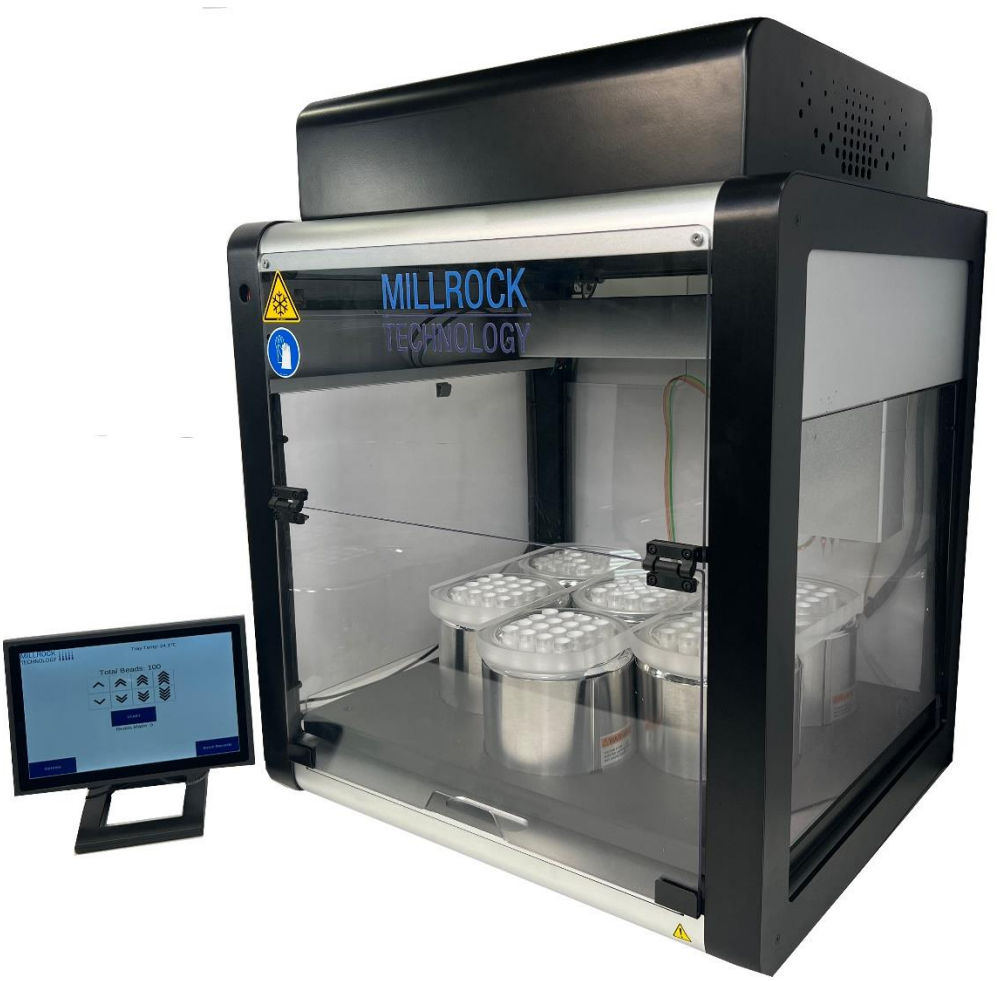
BeadLab 1
Instruction Manual



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CE

Thank you for your purchase of a Millrock Technology BeadLab. We understand that you have a choice of suppliers, and we hope to continue to deserve your business. Do not hesitate to contact us with any questions or concerns you may have about your equipment or the freeze-drying process.

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Copyright Information

Warranty

Millrock provides a warranty on all parts and factory workmanship. The warranty includes areas of defective material and workmanship, provided such defects result from normal and proper use of the equipment.

The warranty for all Millrock products will expire one year from date of installation, except when otherwise stated.

This limited warranty covers parts and manufacturer's factory labor, but not transportation, travel expenses and insurance charges. Under no circumstances shall seller, any subsidiary or any division thereof, have any liability whatsoever for loss of use or for any indirect or consequential damages. The warranty shall be void should the purchaser fail to adhere to maintenance programs prescribed by the seller, if replacement or spare parts not compatible with the machine are installed or if any alterations or repairs detrimental to the machine are performed. The warranty is limited to the first purchaser and is not transferable. No warranty shall apply in the event purchaser makes any change or modification to any part of the items ordered without the express written consent of seller.

Lamps and filters are not covered by this warranty.

Limitation of Liability

The disposal and/or emission of substances used in connection with this equipment may be governed by various federal, state, or local regulations. Millrock Technology is held harmless with respect to user's compliance with such regulations.

It is the responsibility of the customer to determine if the equipment is compatible with their application needs. At the user's request, Millrock will provide MSDS sheets on materials that are exposed to the product being processed. The customer must determine the compatibility of the construction materials of the equipment on their application.

Table of Contents

1. General Warnings/Notices

System Warnings	
	Do not use this Equipment for any purpose not described in this Manual.
	Do not operate this equipment without all guards and covers in place.
	Do not use lubricants in this equipment that are not specified in the Maintenance Manual.
	WARNING! Extreme Cold! Use appropriate Personal Protective Equipment (PPE) when performing maintenance operations.
	Use cryogenic safety gloves and other appropriate PPE when loading/removing Dewars with LN2 from the BeadLab, and at all times when handling LN2.

WARNING

It is the end user's responsibility to ensure that proper safety instructions regarding personnel protective equipment used when handling potentially hazardous products are provided to the personnel designated as machine operators. Millrock may not be held liable for any workplace injury/machine damage which occurs as a result of improper handling of processed product.

Do not attempt to operate or maintenance machine without proper training or in the presence of trained professional personnel.

Drawings, diagrams, electromechanical schematics, and all other relevant machine literature can be obtained from Millrock directly.

2. Setup and Installation

General Operating Conditions

Relative Humidity
The equipment will operate correctly within an environment at 50% RH, 30°C.

Transportation and Storage
This equipment will withstand, or has been protected against, transportation and storage temperatures of -25°C to +55°C.

It has been packaged to prevent damage from the effects of normal humidity, vibration and shock.

Utilities Required for Operation

Electrical
115-230VAC, 50/60Hz

Equipment Installation

Unpacking your System
The system has been packaged to prevent damage from the effects of normal humidity, vibration and shock. Carefully unpack your system and inspect it for damage.

If your equipment is damaged, you should immediately:

- Notify the carrier and retain the entire shipment intact for inspection by the carrier.
- Contact the Millrock factory for assistance. 845-339-5700
- Obtain a Return Authorization Number should the equipment need to be returned.
- Do not discard the shipping material until the entire system has been operated and been deemed satisfactory.

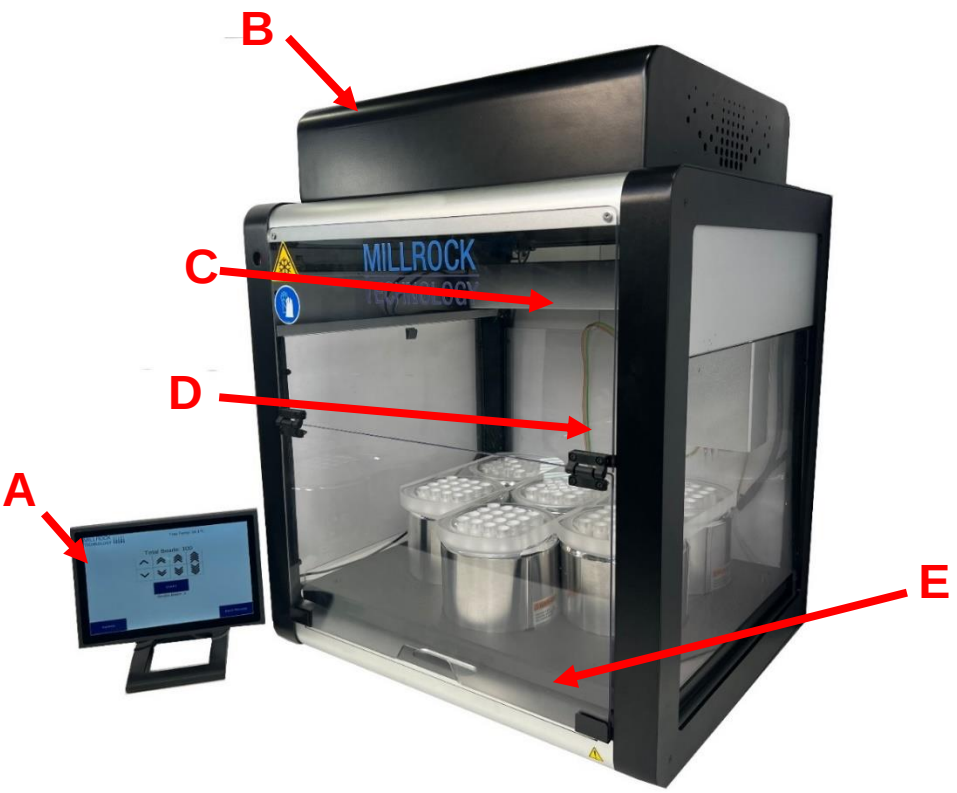
System Location
The workstation typically used for this unit is a clean room or non-clean room lab environment. The BeadLab system should be located on a stable table, bench, or other work surface.

3. BeadLab System Overview

Specifications

Weight	120 lbs. (55 kg)
Bead size range	2.0 – 25.0 µl
Accuracy	2% CoV
Production Rate	10,000 beads/hr
User Interface	10” Touchscreen

Major System Components



A. Touch Screen Control Panel
B. Electrical and Pump Cabinet
C. X-Y Gantry
D. Dispensing Head Fixture
E. Platform with Dewars

Touch Screen Control Panel

The touch screen control panel is the main user interface with the BeadLab software. All operation of the BeadLab unit is conducted through this intuitive interface. On system startup, the touchscreen may take several minutes to boot up and load the BeadLab software.

Electrical and Pump Cabinet

The enclosure on the top of the BeadLab unit is the Electrical and Pump Cabinet, which contains the critical electrical and fluid dispensing equipment. The cabinet can be opened by turning the two latches under the front of the lid, and then lifting the front of the cabinet. The cabinet top will pivot on a hinge in the back, allowing full access to the electrical panel and fluid dispensing pumps.

X-Y Gantry

The X-Y Gantry and box enclosure form the main structure of the BeadLab unit.

Dispensing Head Fixture

The Dispensing Head Fixture holds the four dispensing tips and the solenoid actuator that shakes the fixture for each bead formation.

Dewar Platform

The Dewar Platform contains recessed locations for each of the six Dewars. Each Dewar fits in a recessed position, and then a plate with tubes is placed over the Dewars.

Equipment Accessories

Dispensing Tips/Needles

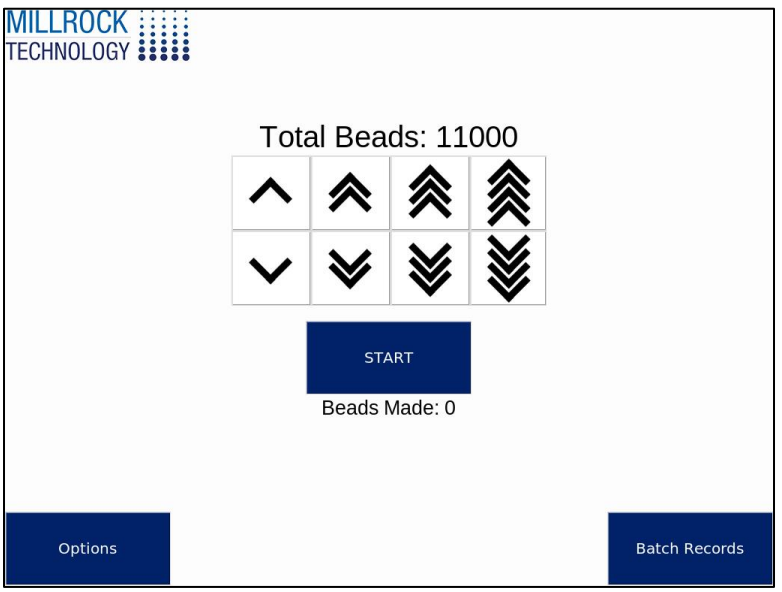
The dispensing tips that are supplied with the BeadLab system are not sterile and are intended for testing and calibration purposes only. Once the necessary needle gauge is determined for the desired bead size, it is recommended to source sterile needles for lyobead production.

Reservoir

The liquid reservoir that is supplied with the BeadLab system is not sterile and is intended for testing and calibration purposes only.

4. BeadLab Control Software

The BeadLab internal control system will power on when the gantry is powered. The touchscreen control system must be powered with a separate adapter. The BeadLab software will load on display on the BeadLab touchscreen when power is supplied.



4.1 Main LyoBead Production Cycle

The main window of the BeadLab control system is the interface for controlling a LyoBead production cycle. The user can adjust the total number of beads to be produced in the cycle, start, pause, resume, and stop a bead production cycle. From here, the user can also access Batch Records and other Options for the BeadLab.

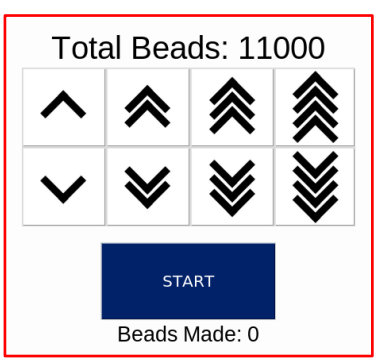
Adjusting Total Beads

Use the arrow buttons to adjust the total number of lyobeads to be produced in the next LyoBead Production Cycle. The buttons can be used to adjust the total number of beads by ±10, 100, 1000, or 10,000. Once the desired number of beads to be produced is set, the Start button will initiate the cycle.

Start/Stop/Pause a LyoBead Production Cycle

Start – Initiates a LyoBead Production Cycle. The gantry will automatically travel to the first dispense position, dispense a bead, and then move to each sequential position and continue dispensing.

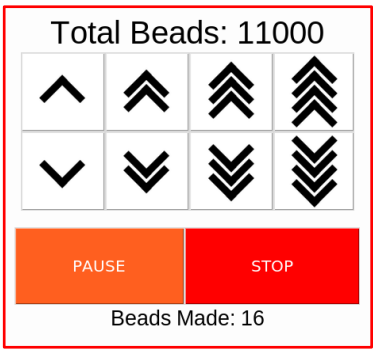
The number of beads that have been produced in the cycle is continuously updated and displayed.

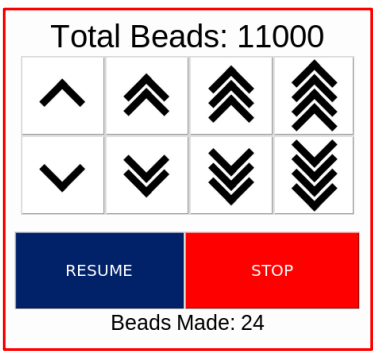


Pause – Pauses the LyoBead Production Cycle at the current position. If the access door the BeadLab is opened during a LyoBead Production Cycle, the cycle will automatically pause at the current position.

Resume – The Resume button will appear when an active LyoBead Production Cycle is paused. Pressing the button will resume a paused LyoBead Production Cycle from the current dispensing position. The access door must be closed for the cycle to resume.

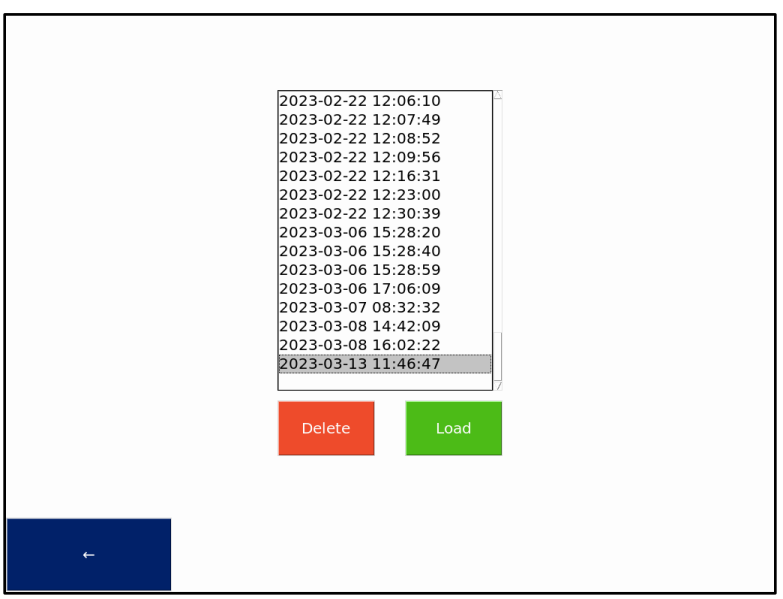
Stop – The system will end the current LyoBead Production cycle. The gantry will travel to the rear center of the BeadLab platform to allow for easy removal of the Dewars.



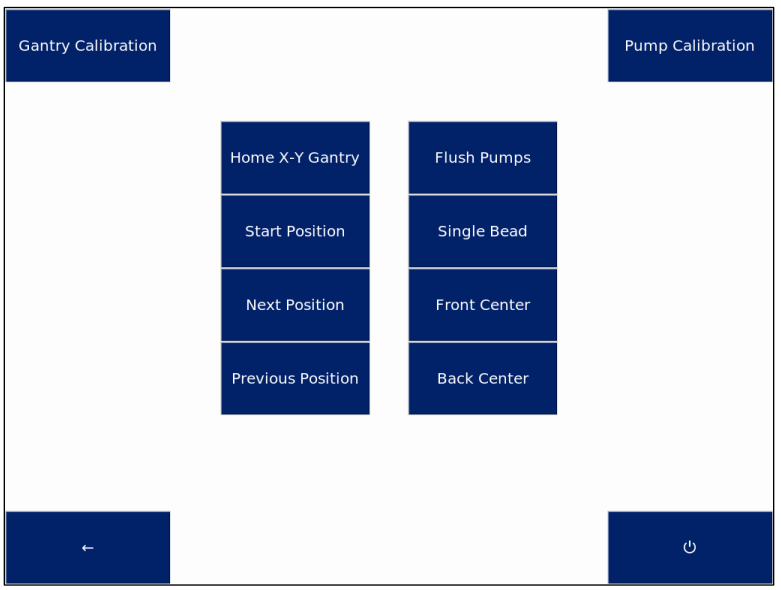


4.2 Batch Records

Batch records are stored each time a bead production cycle is started. The batch record includes the start time, end time, number of beads set to produce, and number of beads produced. The batch records are saved according to the date/time that each cycle was started. Each batch record can be viewed and deleted in the Batch Records window.



4.3 Options



Home X-Y Gantry

Note: Ensure that the gantry bed is clear of obstacles in the way of the dispensing head fixture before performing the Home Gantry routine.

Gantry performs homing routine, first homing horizontally to the right, and then vertically to the rear. While the gantry is running the Homing routine, the other buttons in the Options window will be disabled and a Stop button will appear. Upon successful completion of the homing routine, the Stop button will disappear, and the Options buttons will be enabled. If gantry pauses for more than 3 seconds during the Homing routine, press Stop and then Home X-Y Gantry once more. The gantry will complete the homing routine.

Start Position

Gantry moves to the first dispensing position that will be used during a lyobead production cycle.

Next Position

Each time Next Position is pressed, the gantry will move its position to the next dispensing position that will be used during a lyobead production cycle. When the Next Position button is pressed while the gantry is in the last position, it will move to the first position.

Previous Position

Each time Previous Position is pressed, the gantry will move its position to the previous dispensing position. When the Previous Position button is pressed while the gantry is in the first position, it will move to the last position.

Flush Pumps

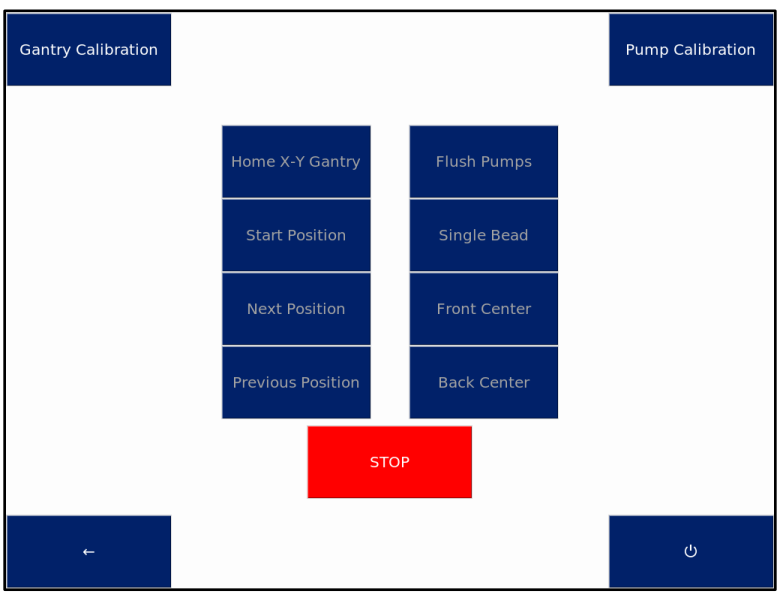
When the Flush Pumps button is pressed, each pump that is enabled will continually cycle to draw in new fluid and prime the pumps or expel any fluid from the tubing and purge the pumps. When the Flush Pumps function is active, the other buttons in the Options window will be disabled, and a Stop button will appear. The pumps will continue to cycle until the stop button is pressed.

Single Bead
The system will activate the actuator and enabled pumps to form and dispense one bead from each dispense tip.

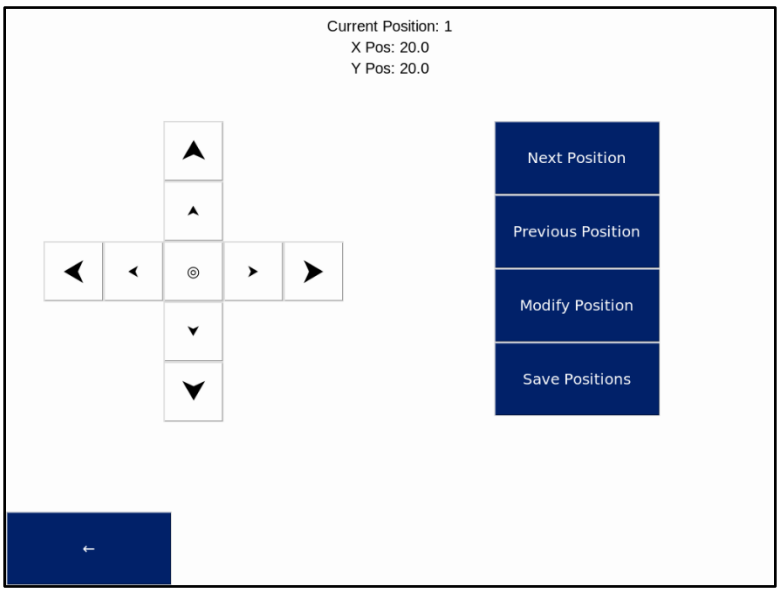
Front Center
The gantry will move to the front center of the unit. This positions is useful for changing dispensing tips on the gantry fixture.

Rear Center
The gantry will move to the rear center of the unit. This position is useful to move the gantry fixture out of the way when loading/unloading the Dewars from the system. The gantry will automatically move to the rear center position at the end of a lyobead production cycle.

Stop
The stop button will appear when the gantry is performing a homing routine or the pumps are while the flush pumps function is active. While Stop is visible, all other Options buttons are disabled. Pressing Stop will end the current action (homing or pump flushing) and enable all other buttons in the Options window.



4.4 Gantry Calibration

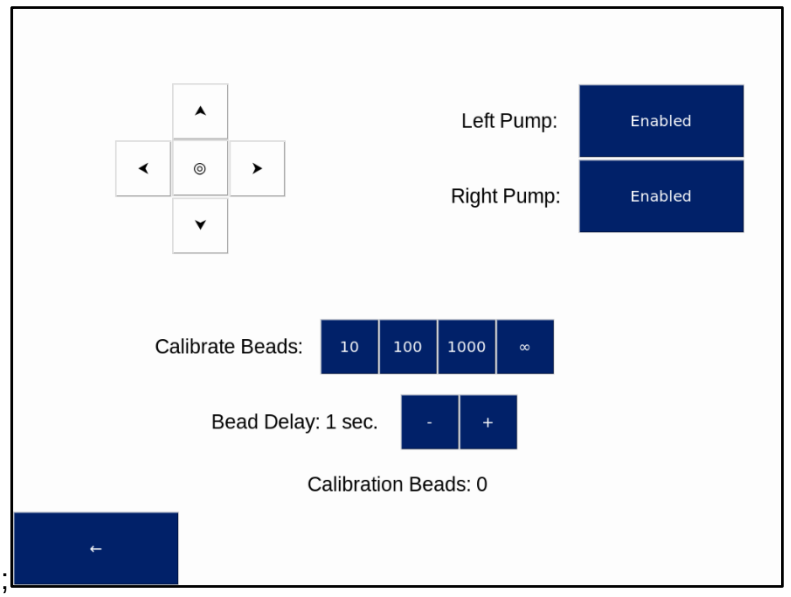


Note: The X-Y Gantry must be homed before performing a calibration of the gantry positions.

The directional pad can be used to move the gantry in increments of 1mm or 1cm in each direction. If the gantry limit is reached in one direction, the gantry will not move. The center button will create a Single Bead.

The exact location of each dispensing position can be calibrated through this window. First each position is selected using the Next Position and Previous Position buttons, with the Current Position and coordinates displayed at the top of the screen. Once selected, each position can be adjusted using the directional pad to precisely line up the dispensing tips with the Dewar tubes. The center button can be used to dispense beads during this process to verify that the beads are dispensed through the center of each tube. Once the position is properly adjusted, its coordinates are temporarily modified by pressing the Modify Position button. Once the locations of all dispensing positions have been modified, the Save Positions button must be pressed to confirm and save the coordinates of each position.

4.5 Pump Calibration



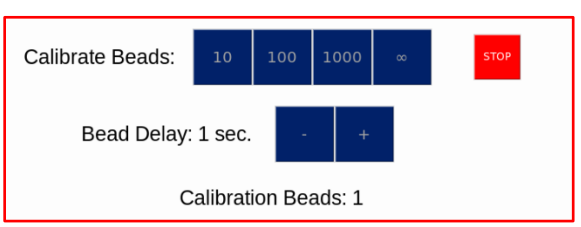
The Pump Settings window allows for convenient pump calibration by enabling the user to generate one or more beads from a fixed gantry position while adjusting the displacement volume.

The directional pad can be used to move the gantry in increments of 1cm in each direction. If the gantry limit is reached in one direction, the gantry will not move. This can be used to center the dispensing tip of the pump head that is being calibrated above the scale. The center button will create a Single Bead.

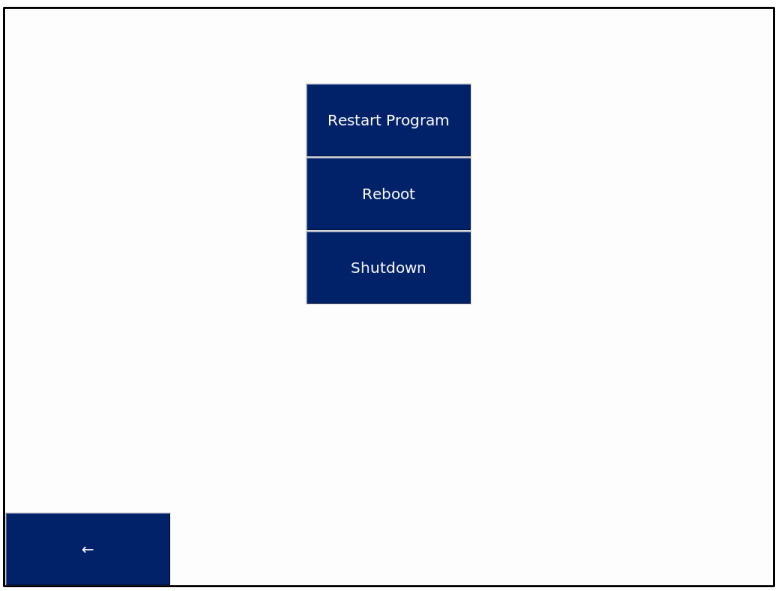
The buttons in the top-right of the Pump Options window can be used to enable and disable the left and right pump independently. When disabled, the respective pump will not activate, preventing liquid from being dispensed from the two respective dispensing tips. This can be used to calibrate one specific dispensing tip at a time more easily.

The Calibrate Beads buttons allow the user to dispense an exact amount of beads in a fixed position when calibrating/validating the dispensing volume of each pump head. The Bead Delay buttons are used to adjust the delay between each bead dispensing. When simply calibrating based on a mean volume, a small delay may be desirable. When calibrating and evaluating the Coefficient of Variation of the dispensed volume, it may be necessary to increase the delay between each bead to ensure an accurate scale reading between each bead that is dispensed.

The Stop button can be pressed at any time to stop calibration beads from being dispensed.



4.6 System Power Menu



Restart Program
The main BeadLab control software will automatically restart. The X-Y gantry will perform a homing routine.

Reboot
The control system will reboot. The main BeadLab control software will open and run automatically, and the X-Y gantry will perform a homing routine.

Shutdown
The control system will initiate a full shutdown. The only way to turn the system back on will be to turn the main power switch off and then back on.

5. LyoBead Production Cycle

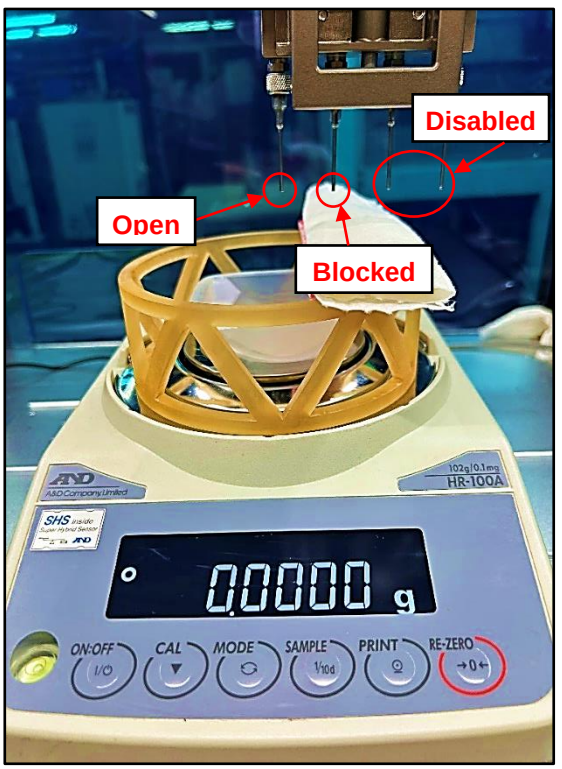
The following procedure is suggested sequence of steps for using the BeadLab during a LyoBead production cycle. Based on the specific application of this system, some of the below steps may need to be modified, omitted, or performed in a different order.

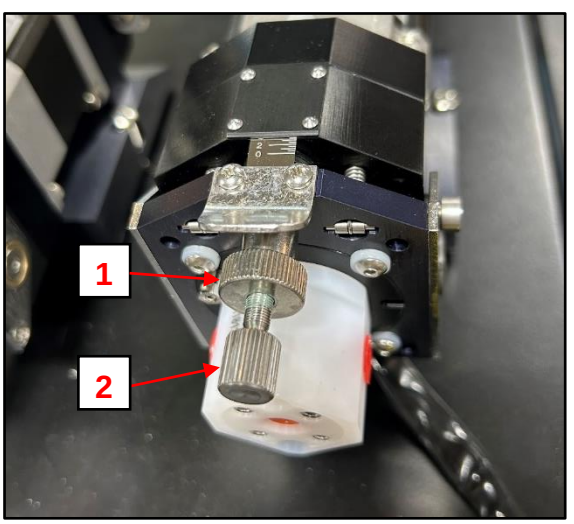
1. Prepare LyoBead solution
    a. Fill the reservoir with the lyobead solution or insert the inlet tubes into another vessel containing the lyobead solution.
    b. Prime the pumps with the lyobead solution
2. Verify Pump Calibration
    a. Verify the pump heads are calibrated to desired dispense mass/volume using the lyobead solution
3. Home X-Y Gantry
    a. Perform Home Gantry routine in Options
4. Verify Gantry Positions
    a. Place six Dewars on the BeadLab tray
    b. Place three plates with dispensing tubes onto the six Dewars.
    c. Jog through all positions using the Next Position and Previous Position buttons.
        i. At each position verify the dispensing tips are centered on each respective dispensing tube.
5. Fill Dewars with Liquid Nitrogen (LN2)
    a. Remove the three plates with dispensing tubes.
    b. Carefully transfer LN2 from supply vessel to each of the six Dewars. The liquid level of LN2 should be within one inch from the rim of the Dewar.
    c. Slowly replace the three plates with dispensing tubes.
6. Start LyoBead Production Cycle
    a. Close BeadLab door
    b. Confirm the setting for the number of lyobeads
    c. Press ‘Start’
7. Check system every 30-60 minutes
    a. Transfer frozen beads to storage Dewar
    b. Top off LN2 in each Dewar
    c. Check tubes, clear is necessary

6. Pump Calibration Procedure

CAUTION: If the piston is frozen in the cylinder, do not change the pump displacement either by auto positioning or depressing the thumb tab. Damage to the piston may result. Use the optional Pump Extractor Tool kit.

1. Prepare Calibration Scale
    a. Place the scale on a level surface on the BeadLab platform.
    b. Adjust the leveling feet until the bubble indicator is level.
    c. Place a weigh boat on the scale.
    d. Turn on and zero the scale.
2. Prepare Calibration Solution
    a. Prime the pump heads with solution until liquid is dispensed from the tips.
    b. Press ‘Single Bead’ several times to start consistent drop formation.
3. Open the Calibration Window, and disable one of the pumps (left or right)
4. Position the dispensing fixture above the scale.
    a. Use a paper towel or other absorbent material to block the liquid dispensed from one of the tips of the pump that is still enabled.
5. Tare the scale and dispense 10 beads from a single tip onto the scale.
    a. Determine the average weight/volume of each dispensed bead.
6. Make an appropriate adjustment to the dispensed volume for the selected pump head.
    a. Loosen thumbnut (**1**)
    b. Adjust angular position of displacement adjusting mechanism by turning displacement adjustment thumbscrew (**2**). Turning the thumbscrew clockwise will increase the pump displacement. Turning the thumbscrew counterclockwise will decrease the pump displacement.
7. Repeat steps 5 and 6 until the desired dispensed volume is reached for the pump head. Lock the thumbscrew (**2**) in place by tightening the thumbnut (**1**). Repeat the bead dispensing to confirm the dispensed volume still meets the acceptance criteria.
8. Repeat Steps 3 through 7 as needed to calibrate the remaining three pump heads.





7. Maintenance and Troubleshooting

Pump Module Maintenance

CAUTION: Ceramic piston/cylinder sets are particularly sensitive to neglect and may seize if allowed to dry out without adequate cleaning.
Never forcibly remove or install the piston into the cylinder housed within the Pump Module. Damage to the equipment may result.

The ceramic components for the Pump Module have been designed to last for millions of repetitions without wear. Preventative maintenance includes careful handling of the piston fabrication and cylinder housing when they have been removed from the Pump Module. Always take great care when removing the piston fabrication from the cylinder and replacing the piston fabrication into the cylinder. If the cleaning procedure includes removing the Pump Module and individually cleaning separate parts, always keep the Pump Module parts together, each piston fabrication with the cylinder housing to which it was originally mated. The number on the piston fabrication should match the number on the cylinder housing. To avoid damage or chipping, never clean in such a way that the ceramics can vibrate against each other.

Routine Flushing

Routine flushing with a compatible liquid after shutdown may suffice for most applications.

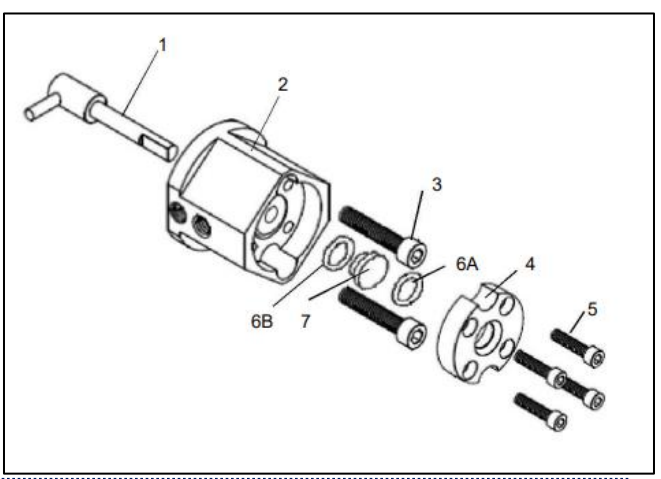
1. Disconnect intake tubing from process liquid supply container.
2. Cycle pump in continuous mode until the remaining process liquid has been purged from the Pump Module liquid path.
3. Connect the intake tubing to the cleaning liquid supply container.
4. Cycle pump in continuous mode using Flush Pumps to flush the cleaning liquid through the entire liquid path.

Pump Assembly/Disassembly Procedure

WARNING Make sure the power is OFF and all hazardous liquids have been flushed from the system prior to performing any disassembly or assembly procedures.

The Pump Module contains the following replaceable parts. Also contained in this section are the procedures for assembling and disassembling the Pump Module from the Motor/Base Module.

- End Cap Retainer (4)
- Sight Glass End Cap (7)
- O-Rings (6A and 6B)
- Cylinder/Case and Piston Assembly (1 and 2)



Disassembly

1. Loosen the two #8-32 socket head cap screws (3) securing the Pump Module to the face plate.
2. Pull the Pump Module away from the face plate until the piston fabrication is approximately 2/3 of the way out of the cylinder.
3. Determine the location of the spherical bearing and move the Pump Module laterally away from it until the pin in the piston fabrication slides out.
4. Remove four #4-40 socket head cap screws (5) securing end cap retainer (4) to cylinder housing (2).
5. Remove end cap retainer (4).
6. Remove inner O-ring (6B), sight glass end cap (7) and outer O-ring (6A).

Clean and inspect all parts before assembly. The piston and cylinder are a matched set. If either the cylinder/case or piston needs replacing, both parts must be replaced.

Assembly

1. Position outer O-ring (6A), sight glass end cap (7) and inner O-ring (6B) into the recessed diameter of end cap retainer. Install sight glass end cap with the reduced diameter facing towards the cylinder housing.
2. Position end cap retainer (4), with installed components into the recessed diameter of cylinder/case fabrication (2).
3. Secure with four #4-40 socket head cap screws (5) and torque to 5 in. lbs.
4. Rotate the spindle on the Motor/Base Module so the spherical bearing is at the 3 O'clock position.
5. Extend the piston, which is housed in the Pump Module, approximately 2/3 of the way out of the cylinder.
6. Slide the drive pin, which is pressed into the piston end cap, into the center bore of the spherical bearing.
7. Position the Pump Module on the face plate aligning over the mounting key.
8. Secure the Pump Module to the swing plate by installing and tightening the two #8-32 socket head cap screws (3) torque to 5 in. lbs.

Resolving a Seized Piston in the Cylinder

If the piston seizes in the cylinder perform the following steps.

CAUTION: Do not try to force the piston free! Damage to the piston/cylinder set or Motor/Base Module may occur.

1. Remove four #4-40 socket head cap screws (5).
2. Remove end cap retainer, sight glass/Teflon seal and O-ring/s.
3. Remove two #8-32 socket head cap screws (3).
4. Install end cap extractor with countersink out using the four #4-40 socket head cap screws (5).
5. Insert correct size extractor tip into the thumb screw knob.
6. urn (by hand) the thumb screw knob (clockwise) into the end cap extractor until cylinder housing (2) becomes loose from piston fabrication (1).
7. Remove cylinder housing (2).

   If step 7 cannot be performed, move the cylinder housing (2) laterally until the pin in the piston fabrication slides out of the spherical bearing then perform steps 8 and 9.

8. Soak the whole assembly in a liquid compatible with the materials and process liquids.
9. After soaking, try removing the piston from the cylinder by applying a light torque to the piston using only your fingers (no tools).

Periodic Maintenance

Operation	Frequency	Comment
Examine tubing and connections for potential leaks.	Weekly	Visually inspect the tubing and connections at the reservoir, pumps, and dispensing head.
Flush Rotary Pump heads	After Every Use	Flush with RO water or 70% IPA
Clean Rotary Pump heads	As Needed	
Replace dispensing tips.	As Needed	
Replace tubing	As Needed	

Troubleshooting

Symptom	Problem	Solution
System does not start lyobead production cycle.	BeadLab door is open.	Close BeadLab door.
Touchscreen unresponsive	Loose USB connection	Check all USB cable connections.
Pump piston seized	Improperly seated or worn end cap retainer, sight glass, end cap, or O-ring	Disassemble pump head and clean all parts.
Gantry does not complete homing after several attempts	Broken or misaligned limit switch.	Replace limit switch.

Spare Parts

Part #	Description	Consumable Item
Various	Blunt Tip Stainless Steel Needles, 25 count, multiple gauges	X
2080810	PTFE Tube, 1/16" OD, 50ft.	X
5130081	Flangeless fittings, ¼-28, 1/16”OD tubing, PEEK, 10 count	X
5100006	LN2 Dewar, 850mL	
5300051	Rotary Pump Head, 3A	

For Service, please contact:
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