



**Malvern
Panalytical**
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Mastersizer Basic Guide



Mastersizer Basic Guide

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Contents

Chapter 1 Introduction	1
1.1 Introduction to this manual	2
1.2 Assumed information	3
1.3 Where to get help	4
Chapter 2 Health and safety	7
2.1 Mastersizer System: General safety	8
2.2 Instrument covers	12
2.3 Power cords and power safety	13
2.4 Aero Dry dispersion units	16
2.5 Hydro Wet dispersion units	19
2.6 Move the system	20
2.7 Sample handling warnings	22
Chapter 3 Site requirements	25
3.1 Operational environment	26
3.2 Space required for system	28
3.3 Services required	31
Chapter 4 Hardware features	37
4.1 Hardware introduction	38
4.2 Mastersizer compatibility	40
4.3 Mastersizer Optical unit	43
4.4 Connection panel	44
4.5 Measurement Cell	45
4.6 Wet dispersion systems	48

4.7 Dry dispersion system	55
4.8 Connection and setup overview	57
4.9 Temperature Control Unit	62
Chapter 5 Quick start: Using the system	75
5.1 Make a Measurement	76
5.2 Measure samples in SOP mode	76
5.3 Make a measurement - Wet dispersion units	79
5.4 Make a measurement - Dry dispersion units	83
5.5 Check the results	86
5.6 Check for problems	89
5.7 Run a Manual measurement	93
Chapter 6 Maintenance	95
6.1 General maintenance warnings	96
6.2 Optical unit specific warnings	97
6.3 Clean the covers	97
6.4 Clean the cell bay	97
6.5 Clean the Mastersizer optics	98
6.6 Clean the cells and dispersion units	100
6.7 Fuses	100
Appendix A Specifications and Regulatory	101
A.1 Specification	102
A.2 Chemical compatibility	109
A.3 Regulatory information	116

Chapter 1 Introduction

1.1 Introduction to this manual	2
1.2 Assumed information	3
1.3 Where to get help	4

1.1 Introduction to this manual

This manual covers the operation of the Mastersizer particle characterization systems. These instruments measure the size of particles contained within a sample, presenting data according to your needs.

Manuals available are:

- **Mastersizer Basic Guide**
- **Mastersizer User Guide**
- Additional manuals for the **Hydro Series Wet Dispersion Units** and **Aero Series Dry Dispersion Units**.

Electronic versions of all the manuals can be downloaded from the **Support & downloads** section of the Malvern Panalytical website and are also available in the Help system.



WARNING - General hazard

The instrument and the samples to be measured may be hazardous if misused. Users must read the **Health and Safety** information in this manual before operating the system.

1.1.1 About this manual

The operation and maintenance of the following units are covered:

Table 1.1 Mastersizer units

Item	Description	Model numbers
Mastersizer 3000	Mastersizer 3000 optical unit	MAZ3000

Item	Description	Model numbers
Mastersizer 3000E	Mastersizer 3000 entry level optical unit	MAZ3010
Mastersizer 3000+ Lab	Mastersizer 3000+ optical unit	MAP3020
Mastersizer 3000+ Pro	Mastersizer 3000+ optical unit	MAP3010
Mastersizer 3000+ Ultra	Mastersizer 3000+ optical unit with blue detector	MAP3000
Hydro SV	Small volume (SV) automatic wet dispersion unit	MAP3100
Hydro SM	Small volume (SM) manual wet dispersion unit	MAZ3150
Hydro MV	Medium volume (MV) automatic wet dispersion unit	MAP3210
Hydro LV	Large volume (LV) automatic wet dispersion unit	MAP3310
Hydro EV	Extended volume (EV) user-interactive wet dispersion unit	MAP3400
Aero S	Automatic dry dispersion unit - options include stainless steel and ceramic venturi dispersers	MAP3500
Aero M	Manual dry dispersion unit - options include stainless steel and ceramic venturi dispersers	MAP3550

1.2 Assumed information

To use this manual, you must understand the product naming convention and how menu commands are described.

1.2.1 Mastersizer versions and software

There are three core instruments in the Mastersizer range: the Mastersizer 3000E, Mastersizer 3000 and Mastersizer 3000+. The differences between these instruments are explained in [section 4.2](#).

The Mastersizer 3000E, 3000 and 3000+ are referred to as the Mastersizer (or “the optical unit” or “the instrument”), unless specifically named to highlight any differences.

The combination of the instrument, connected accessories and the computer is referred to as “the system”.

The software used to operate the Mastersizer instruments is referred to as Mastersizer Xplorer.

1.2.2 Menu commands

Menu commands are always shown in bold text in the form:

main menu > item

As an example, the command **File > Options** refers to selecting Options from the File menu.

1.2.3 Keyboard interaction

Keyboard interactions are shown in a shaded box. For example:

Press the **Ctrl** key.

1.3 Where to get help

This section gives information on the various channels in place to get help with your Mastersizer system.

1.3.1 Website - www.malvernpanalytical.com

Our website offers a comprehensive range of resources for use by customers. It gives free access to exclusive content including webinars, presentations, application notes, technical notes, whitepapers, software downloads and more.

1.3.2 Help system

A full help system is supplied with your Malvern Panalytical software system. This provides detailed reference information on all software features. To access this, press F1 or click the Help button within the application (sometimes indicated by a question mark icon).

1.3.3 Technical support

All queries about the system must be directed to your local Malvern Panalytical representative, quoting the following information:

- **Model and serial number** of the instrument (usually located on the outside casing of the instrument).
- **Software version** (see **File > About** in the software).
- **Firmware version** (Technical support will inform you how to locate this information).

Visit www.malvernpanalytical.com to find your local Technical Support representative.

Chapter 2 Health and safety

2.1 Mastersizer System: General safety	8
2.2 Instrument covers	12
2.3 Power cords and power safety	13
2.4 Aero Dry dispersion units	16
2.5 Hydro Wet dispersion units	19
2.6 Move the system	20
2.7 Sample handling warnings	22

2.1 Mastersizer System: General safety



WARNING - General hazard

Use of the system in a manner not specified by Malvern Panalytical may impair the protection provided by the system.



WARNING - General hazard

Use of accessories not provided or recommended by Malvern Panalytical may impair the protection provided by the Mastersizer and its accessories.



WARNING - General hazard

Before using the Mastersizer, a risk assessment must be completed for the system application. If that application is classified as hazardous, adequate safety precautions must be put into place such as but not limited to: Personal Protective Equipment (PPE), special Standard Operating Procedures (SOPs) and emergency shut off devices.



WARNING - General hazard

The Mastersizer and accessories are not designed to protect against explosion or designed for work with explosives. The system must NOT be used with explosives.

2.1.1 Site requirements

The Mastersizer has specific site requirements that must be followed for safe operation of the instrument. Refer to [Chapter 3](#).

**WARNING - General hazard**

Safety may be compromised if the system is used in an environment that does not conform to the site requirements.

**WARNING - General hazard**

The Mastersizer and accessories are not designed or suitable for use in hazardous atmospheres. The system is not tested or certified for use in hazardous atmospheres.

2.1.2 Connection cables

**WARNING - General hazard**

You must only use the power supply unit and connection cables provided with the instrument by Malvern Panalytical. Use of cables not provided by Malvern Panalytical will void the instrument warranty and may make the system unsafe.

All instruments are tested and certified prior to dispatch to make sure that they comply with appropriate regulatory governance. This includes the instrument or accessory plus any connection, communication or power cable that is used in the operation of the complete system.

2.1.3 Laser safety warnings

The **Mastersizer optical unit** is a **Class 1** laser product and there is no exposure to laser radiation in its normal operation. The laser passes through the cell area but this area is enclosed when the cell is fitted. When the cell is not fitted, a mechanical laser shutter prevents exposure to laser radiation.

**WARNING - Laser beam**

Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.

This diagram shows the location of the laser warning labels:

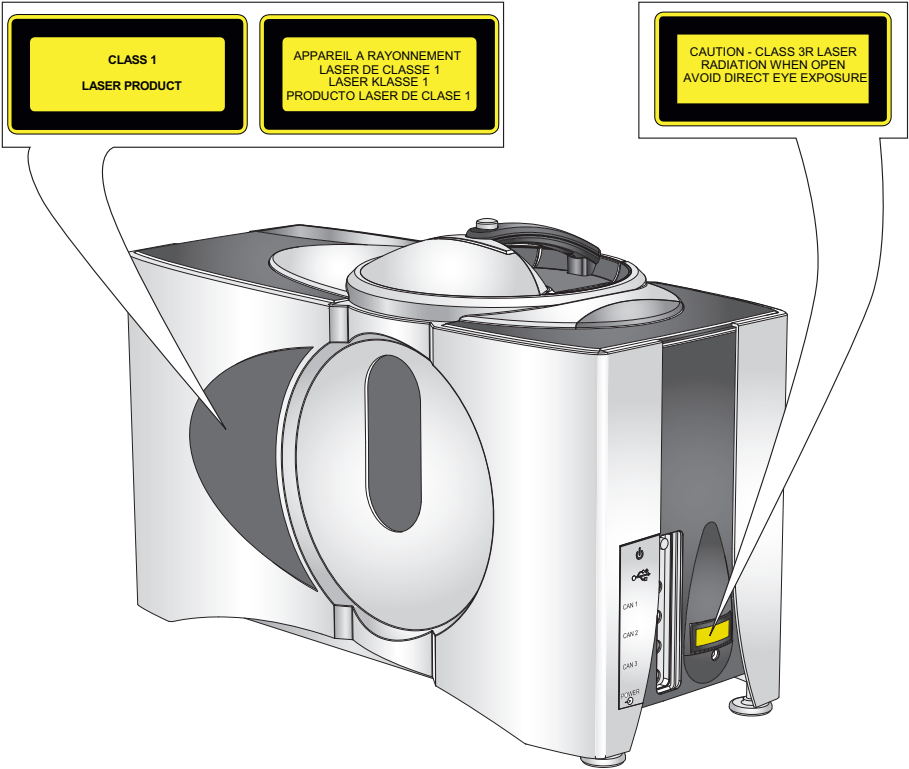


Figure 2.1 Location of laser warning labels

2.1.3.1 Red light specification

Table 2.1 *Specification of the red light*

Item	Specification
Light source	He-Ne Laser
Power	Internal laser maximum output of less than 4 mW (CW)
Beam wavelength	632.8 nm
Beam divergence	1.3 mrad

2.1.3.2 Blue light specification

Table 2.2 *Specification of the blue light*

Item	Specification
Light source	LED
Power	10 mW
Beam wavelength	470 nm

2.1.4 Electrical safety warnings

The Mastersizer, its dispersion units and the Temperature Control Unit are mains powered - treat input power cables accordingly. The metal parts of the system are earthed via a protective earth connection.



WARNING - General hazard

This product **must** be connected to a protective earth.

Take care when measuring samples not to spill liquid or powder over the instrument covers. Conducting materials or liquids can damage insulation and cause dangerous conditions. If a spillage occurs, disconnect the power and scrupulously clean up before re-applying power to the system. Users who suspect powder or liquid has entered the covers should call a Malvern Panalytical representative to arrange a service call.



WARNING - General hazard

Never attempt to remove the covers - always contact a Malvern Panalytical representative.

2.1.5 PAT testing

If PAT testing is required, please contact Malvern Panalytical for advice.

2.2 Instrument covers



WARNING - General hazard

Under no circumstances should you remove the main cover of the instrument. Failure to follow these guidelines could result in exposure to hazardous voltages or, on some instruments, exposure to laser radiation, which can be harmful to the body and cause permanent eye damage.



WARNING - General hazard

Malvern Panalytical personnel (service engineers, representatives, etc.) are the only people authorized to perform procedures that require the removal of the covers.

**WARNING - General hazard**

Removal of the covers by unauthorized personnel will void the warranty of the instrument. Unless advised within the content of this manual, only Malvern Panalytical trained personnel are permitted to remove the cover of any part.

2.3 Power cords and power safety

2.3.1 Power cord set requirements

Power cords must meet the requirements of the country where the product is used. For further information contact your Malvern Panalytical representative.

2.3.2 General requirements

The requirements listed below are applicable to all countries:

- The power cord must be approved by an acceptable accredited agency responsible for evaluation in the country where the power cord set will be installed.
- The power cord set must have a minimum current capacity of 10 A (7 A in Japan only) and a nominal voltage rating of 125 or 250 volts AC, as required by each country's power system.
- The area of the wire must be a minimum of 0.75 mm² or 18 AWG, and the length of the cord must be less than 3 m.
- The power cord must be routed to avoid: being walked on, pinched by items placed upon it or against it, or made wet. Pay particular attention to the plug, the electrical outlet, and the point where the cord exits the product.



WARNING - General hazard

Do not operate this product with a damaged power cord set. If the power cord set is damaged in any manner, replace it immediately.

2.3.3 Power safety information

The following notes indicate guidelines to follow when connecting the Malvern Panalytical power supply using single and multiple extension leads, connection via AC Adapters and use of Uninterruptible Power Supplies (UPS).



WARNING - General hazard

To prevent electric shock, plug the instrument or accessory into correctly earthed electrical outlets. Never use the system without a properly connected protective earth conductor.

The power cord supplied is equipped with a grounding connection to ensure grounding integrity is maintained.

2.3.3.1 Advice on use of extension leads

Follow this advice when using single or multiple socket extension leads. These are also called trailing sockets.

- Make sure the lead is connected to a wall power outlet and not to another extension lead. The extension lead must be designed for grounding plugs and plugged into a grounded wall outlet.
- Make sure that the total ampere rating of the products being plugged into the extension lead does not exceed the ampere rating of the extension lead.
- Use caution when plugging a power cord into a multiple socket extension lead. Some extension leads may allow a plug to be inserted incorrectly.

- Incorrect insertion of the power plug could result in permanent damage to the instrument or accessory, as well as risk of electric shock and/or fire. Make sure that the ground connection (prong/pin) of the power cord plug is inserted into the mating ground contact of the extension lead.

2.3.3.2 Advice on use of AC adapters



WARNING - General hazard

Do not use adapter plugs that bypass the grounding feature, or remove the grounding feature from the plug or adapter.

- Place the AC adapter in a ventilated area, such as a desk top or on the floor.
- The AC adapter may become hot during normal operation of the instrument or accessory. Use care handling the adapter during or immediately after operation.
- Use only the Malvern Panalytical-provided AC adapter approved for use with the instrument and/or accessory. Use of another AC adapter may cause a fire or explosion.

2.3.3.3 Advice on use of Uninterruptible Power Supplies (UPS)

To help protect the instrument and/or accessory from sudden, transient increases and decreases in electrical power, use a surge suppressor, line conditioner or UPS.

2.4 Aero Dry dispersion units

This section lists safety issues common to the dry dispersion units.



WARNING - General hazard

The air pressure regulator fitted to the Aero has a maximum input pressure limit of 10 bar.

If there is a possibility that the air supply could exceed this, then a protection device ensuring this limit is not exceeded must be fitted.



WARNING - General hazard

Typically the Aero is not suitable for measuring hazardous materials. However, if extra precautions are taken (e.g. using a fume cupboard or efficient exhaust filtering) this may be possible.



WARNING - General hazard

Static discharge can occur around the exit and feed pipe regions under certain combinations of material, flow rate and humidity. If this is a concern contact your Malvern Panalytical representative.



WARNING - General hazard

If the unit is used with a vacuum unit not supplied by Malvern Panalytical, this must meet the specification: air flow 39 l/s (minimum rate), vacuum 20.4 kPa.



WARNING - Pinch hazard

Take care when removing the venturi not to trap fingers between the tray holder and the venturi.



WARNING - Magnetic field

Pacemakers or other similar implanted devices may be affected. Wearers must stay back at least 10 cm from instrument.

2.4.1 Warning labels

The following warning triangles warn of the potential risk of danger to user or damage to dispersion unit.

Table 2.3 Warning labels

Label	Text	Location	Meaning
	Warning: To prevent electric shock do not remove screws. No user serviceable parts inside. Refer servicing to authorized personnel.	Ancillary Switching Unit	As described
	None	Behind venturi on unit body	Warning: Operator exposure to noise levels increases with the use of higher pressures and operator proximity to the unit. Always wear suitable ear protection.
	None	Air connection port	Warning: The port is for air only, maximum pressure 1000 kPa (10 bar).

2.4.2 Pneumatic safety

Observe all local regulations and recommendations on the use of compressed air.

Do not direct a compressed air line at the human body.

During installation and maintenance, make sure that the supply pressure regulator is adjusted to zero and the on/off supply valve is in the OFF position.



WARNING - General hazard

Do not attempt to remove any compressed air pipe without first reducing and switching off the air supply as well as venting the dispersion unit.

Always use pipes of a suitable pressure rating. The air inlet pipe must have a normal operating rating of 10 bar g.

Some dispersion unit fittings are of the push-in quick-release collet type.

2.4.3 Dust hazards

To provide operator protection, protective filter dust masks and suitable safety spectacles are recommended for handling dry powders.



WARNING - Inhalation hazard

Do not use any powders in the dry dispersion units that are hazardous to health when inhaled.

2.4.3.1 Dust extraction systems

Use ducting to discharge contaminated exhaust air from the dispersion unit to the outside atmosphere. An efficient extraction filtration system must be fitted to ensure safe discharge.

Make sure that all air filters are efficient and that replacements, when fitted, meet the correct specification. Replace elements at specific intervals of time to meet the requirements of the installation. Do not allow filters to clog or become inefficient. Dispose of used filters safely.

Note: It is recommended that any vacuum unit used with the dispersion unit is equipped with HEPA filters, or can have HEPA filters fitted.

2.4.4 Noise emissions

Operator exposure to noise levels increases with the use of higher pressures and operator proximity to the unit. Always wear suitable ear protection.



WARNING - Sound level

Do not run the dispersion unit without the air filter fitted, otherwise acceptable sound emissions will be surpassed.

2.5 Hydro Wet dispersion units

This section lists safety issues common to each of the wet dispersion units including the Hydro EV, LV, MV, SV and Hydro SM.

2.5.1 Fumes

Use the system in a fume cupboard if using dispersants that emit hazardous fumes. Contact Malvern Panalytical before using dispersants with ignitable vapor.

2.5.2 Hydro EV, Hydro LV, Hydro MV and Hydro SM



WARNING - General hazard

Due to the possible risk of sonication of the blood, never put fingers in the tank when the ultrasonic probe is operating.



WARNING - Pinch hazard

Never put fingers in the tank when the pump/stirrer shaft is rotating.

2.5.3 Hydro SV



WARNING - Magnetic field

Pacemakers or other similar implanted devices may be affected. Wearers must stay back at least 10 cm from instrument.

2.5.3.1 Cleaning



WARNING - Wear safety goggles

Make sure the cuvette is fitted correctly before using the syringe, otherwise you may be sprayed with dispersant or other cleaning chemicals. Eye protection must be used.

2.6 Move the system

If it is necessary to move the system, follow these guidelines.

2.6.1 Move the optical unit



WARNING - Lifting hazard

The optical unit weighs 30 kg. Adopt proper lifting techniques to avoid back injury. Wear appropriate protective footwear. One person alone must not try to lift the optical bench.

- Disconnect the computer and power supply before trying to move the system.
- Always lift the instrument by holding it under both of its short sides, with a firm grip on the metal base plate. Never lift an instrument by its covers.
- If moving the instrument large distances, repack the instrument in its original packaging.

2.6.2 Move sample dispersion units



WARNING - Lifting hazard

The dispersion units weigh up to 10.5 kg. Adopt proper lifting techniques to avoid back injury.

- Disconnect the power supply before attempting to move the dispersion unit.
- Disconnect and drain or vent any pipes carrying fluids or compressed air, including sample pipes, before moving the dispersion unit.
- Lift the dispersion unit by holding it under the base.
- If moving the unit large distances, we recommend repacking the unit in its original packaging.

2.7 Sample handling warnings

- Before using the Mastersizer, a risk assessment must be completed for the sample and dispersant materials being used. If any of the materials used are classed as a flammable, toxic or hazardous fluids, adequate safety precautions must be put into place such as but not limited to: Personal Protective Equipment (PPE) and special Standard Operating Procedures (SOPs).
- If any of the materials used are classed as biohazardous, a biological risks warning label to standard ISO 7000-0659 (2004-01) must be applied to the accessories, flow cells and drain piping in use with those materials.



Figure 2.2 Biological risks warning label

- Always handle all substances in accordance with the COSHH (Control Of Substances Hazardous to Health) regulations (UK) or any local regulations concerning sample handling safety.
- Before using any substance, check the *Safety Data Sheets (SDS)* for safe handling information.
- Use the instrument in a well ventilated room, or preferably within a fume cupboard, if the fumes from the sample or dispersant are toxic or noxious.
- Wear personal protective equipment as recommended by the *Safety Data Sheets* if toxic or hazardous samples are being handled, particularly during sample preparation and measurement.
- Wear protective gloves when handling hazardous materials, or those that cause skin infections or irritations.

- Do not smoke or vape during measurement procedures, particularly where flammable samples are used or stored.
- Do not eat or drink during measurement procedures, particularly where hazardous samples are used or stored.
- Take care when handling glass (e.g. microscope slides and beakers). Hazardous materials may enter a wound caused by broken glass.
- Always test a new sample or dispersant for chemical compatibility before use.
- After measuring hazardous samples, clean the system to remove any contaminants before making another measurement.
- Always label samples for analysis using industry standard labeling, particularly if they are handled by a number of staff or stored for long periods. Clearly label any operator hazard and associated safety precautions that are required for the handling of dangerous materials.
- Keep a record of all hazardous substances used in the system for protection of service and maintenance personnel.
- Always use responsible procedures for the disposal of waste samples. Most local laws forbid the disposal of many chemicals in such a manner as to allow their entry into the water system. The user is advised to seek local advice as to the means available for disposal of chemical wastes in the area of use. Refer to the *Safety Data Sheets*.
- The surfaces of the system may be permanently damaged if samples are spilled on them. If a spillage does occur, disconnect the system from the power supply before cleaning the spillage.

Chapter 3 Site requirements

3.1 Operational environment	26
3.2 Space required for system	28
3.3 Services required	31

3.1 Operational environment

This section outlines the site requirements for a Mastersizer. Make sure all of these are met before the Malvern Panalytical engineer arrives to install and commission the system.

3.1.1 Environmental conditions

The site must be:

- Away from strong light sources (e.g. windows).
- Away from strong heat sources (e.g. radiators).
- Well ventilated (for noxious samples).
- On a horizontal vibration-free bench built to support the weight of the system.

Table 3.1 *Environmental conditions*

Unit	Weight	Model numbers
Mastersizer	30 kg	MAZ3000 / MAZ3010 / MAP3000 / MAP3010 / MAP3020
Hydro SV	4.55 kg (3.05 kg + 1.5 kg)	MAP3100
Hydro SM	9.75 kg (1 kg + 8.75 kg)	MAZ3150
Hydro MV	5 kg	MAP3210
Hydro LV	5 kg	MAP3310
Hydro EV	5 kg	MAP3400

Unit	Weight	Model numbers
Hydro wet cell	2.46 kg	MAP2010 / MAP2020
Aero S	10.5 kg	MAP3500
Aero M	10.5 kg	MAP3550
Aero dry cell	2 kg	MAP2050

Store/operate the system in the following conditions (accurate measurements are sample-dependent, for example dry powders may stick together in high humidity):

Table 3.2 *Storage and operational conditions*

Item	Specification
Operational conditions	5 °C to 40 °C (41 °F to 104 °F)
Storage conditions	-20 °C to 50 °C (-4 °F to 122 °F)
Humidity	Maximum humidity 80% for temperatures up to 31 °C, decreasing linearly to 50% relative humidity at 40 °C
Usage	Indoor use only
Altitude	Up to 2000 m
Mains supply voltage fluctuations	Up to $\pm 10\%$ of nominal voltage
Overvoltage category	II (IEC 60664-1)
Pollution degree	2 (IEC 60664-1)

In addition:

- Do not obstruct power sockets as they may need to be disconnected during an emergency.
- Avoid passing electrical cables through areas where liquids can be spilled.
- Pipes must be routed under the instrument as shown in the illustration:

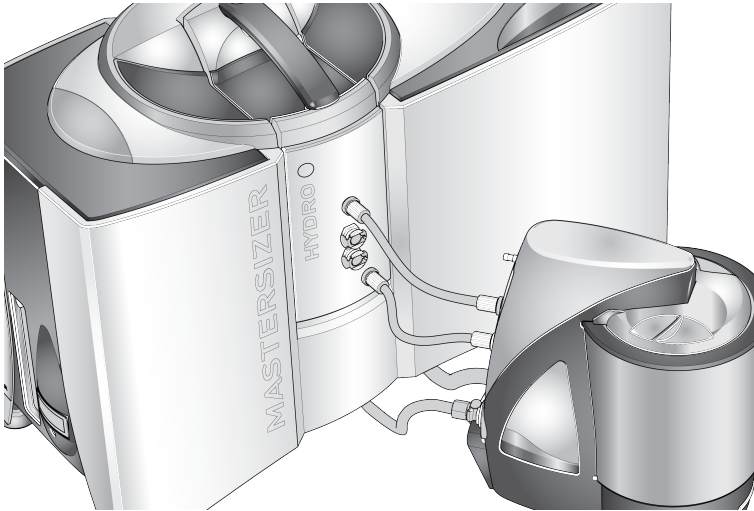


Figure 3.1 Instrument tubing

3.2 Space required for system

Provide enough space to allow easy access to all components of the system. Allow at least 800 mm above the bench surface for access to the cell and dispersion unit. Any drain pipes from the Hydro LV/MV or SM units must not exceed **2.0 m** in length.

Table 3.3 *Space required*

Component	Length	Width	Height
Optical bench	690 mm	300 mm	450 mm
Hydro SV	215 mm	110 mm	275 mm
Hydro SM			
- Dispersion unit	140 mm	175 mm	390 mm
- Dispersion unit controller	225 mm	170 mm	70 mm
Hydro LV / MV	280 mm	180 mm	300 mm
Hydro EV	220 mm	150 mm	300 mm
Aero S / M	260 mm	180 mm	380 mm

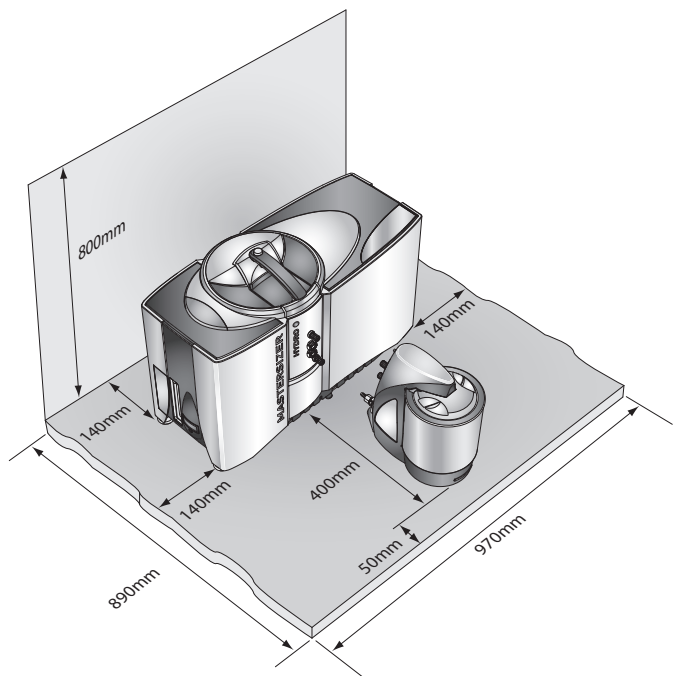


Figure 3.2 Minimum recommended space for a wet system

3.3 Services required

This section describes the services that are required for installing the Mastersizer system.

3.3.1 General

Table 3.4 General requirements

Requirement	Optical bench	Hydro SV	Hydro SM	Hydro MV	Hydro LV	Hydro EV	Aero S/M
Power sockets	1	-	-	-	-	-	1 (a)
Direct plumbed dispersant (option)	No	No	No	Yes	Yes	No	No
Drain	No	No	Yes	Yes	Yes	Yes (b)	No
Vacuum unit	No	No	No	No	No	No	Yes
Air line	No	No	No	No	No	No	Yes
Efficient extraction system	No	No	No	No	No	No	Yes

- a. The ancillary switching unit for the vacuum requires a power socket.
- b. The drain does not need to be within 2 m on the Hydro EV or SV. The EV uses a beaker and the SV a cuvette to hold the sample. Both are emptied by the operator.

In addition, the computer system requires one or more power sockets and the Temperature Control Unit, where fitted, requires one power socket.

3.3.2 Power specification

The mains power supply must be clean and filtered. If necessary, fit an uninterruptible power supply (UPS) to remove any spikes or noise.

Note: The instrument provides power directly to the connected dispersion unit via the CAN connection. The power requirement is given below.

3.3.2.1 Mastersizer optical unit

- 50 W - with no dispersion units connected.
- 200 W (maximum) - with 2 dispersion units connected.
- The Mastersizer can supply up to 96 W to any one dispersion unit, and up to 150 W in total to the dispersion units fitted.

Note: Only use the power supply unit (PSU) and cables provided. Using another PSU voids any warranty and may be unsafe.

3.3.3 Services specification

3.3.3.1 Direct plumbed dispersant specification (Hydro LV/MV only)

For most applications, the liquid dispersant is water from a header tank or the mains supply. If the input pressure to the dispersion unit exceeds 4 bar g, an external pressure regulator **must be fitted** to reduce this to 4 bar g.

The dispersant input must be filtered to remove particulates. The filtering depends on the size of the sample. If the sample contains a significant proportion of sub-micron particles the dispersant input must be filtered to remove them.

Hydro MV

- Minimum input pressure: 1 bar g (100 kPa g) @ 25 mL/s-1
- Maximum input pressure: 4 bar g (400 kPa g) @ 25 mL/s-1

Hydro LV

- Minimum input pressure: 1 bar g (100 kPa g) @ 25 mL/s-1
- Maximum input pressure: 4 bar g (400 kPa g) @ 25 mL/s-1

3.3.3.2 Hydro wet cell water jacket requirements (Hydro LV/MV/EV/SM)

- The Maximum pressure for water jacket connections is 0.5 bar g.

3.3.3.3 Drain requirements

Always dispose of waste dispersant and sample mixtures responsibly. Many local laws forbid disposal of chemicals in ways that allow their entry into the water system. Seek local advice on disposal of chemical waste.

Hydro LV/MV/SM

To allow liquid to drain efficiently the drain/waste must:

- Be within 2 m of the dispersion unit
- Be lower than the bench surface
- Slope gently downwards
- Contain no loops or kinks

Discharge to a normal sink is sufficient, provided the sample and dispersant are non-hazardous.

It is important that the draining end of the drain pipe is above the level of the waste liquid at all times. It must not be under the surface of the liquid otherwise the dispersion unit will not drain efficiently.

Hydro SV/EV

The EV uses a beaker and the SV a cuvette to hold the sample. Empty either unit manually into the drain/waste, either directly or via a washstation (Hydro SV). This can be a normal sink, provided the sample and dispersant are non-hazardous.

3.3.3.4 Air line specification (Aero S/M)



WARNING - General hazard

The air pressure regulator fitted to the Aero has a maximum input pressure limit of 1000 kPa (10 bar). If there is any possibility that the air supply could exceed this, fit a protection device.



WARNING - General hazard

The air line supply must be dry, free from oil and filtered to less than 0.01 mm. Failure to meet the air line specification will permanently damage the dispersion unit and invalidate the warranty.

Air line specification

Table 3.5 Specification for the air line

Item	Specification
Air line pressure	5.5 to 8 bar g, but must nominally be set to 6 bar g
Air flow	At least 82 l/min at 6 bar (87 psi g).
Air line particulate filtering	To Class 1 of ISO8573.1:2010
Air line water filtering	To Class 4 of ISO8573.1:2010
Air line oil filtering	To Class 1 of ISO8573.1:2010

The outlet from the compressor must be fitted with a push-fit adapter capable of taking a 6mm o/d polyurethane pneumatic pipe.

Sound emissions from the system (including the compressor) must be less than 85 dBA, (measured at the operator's position). Malvern Panalytical can supply a compressor meeting this specification.

3.3.3.5 Vacuum unit specification (Aero S/M)

The exhaust from the Aero air cell must be extracted by an extraction system/vacuum unit.



WARNING - General hazard

Never let the exhaust discharge into an enclosed room.

If Malvern Panalytical does not provide the vacuum unit used with the Aero unit, any vacuum unit used must conform to the following specification (minimum specification before exhaust filter fitted).

Vacuum unit specification

Table 3.6 Specification for the vacuum unit

Parameter	Condition	Value
Power	Continuous	2.8 kW
Air flow	—	39 liters/sec
Vacuum	—	20.4 kPa
Suction power	With hose fitted to air cell output port.	182 W
Diameter of Vacuum hose	38 mm (inside diameter)	To connect to vacuum port on Mastersizer optical unit

Malvern Panalytical can supply a vacuum unit meeting this specification.

Note: An adaptor cable is required to connect an IEC 60320 C13 power cable (as used by the Nilfisk GM80 vacuum cleaner) to the higher-rated IEC 60320 C20 connector on the ancillary switching unit.

This is available from your Malvern Panalytical representative.

Ancillary switching unit (Aero S/M)

The Ancillary switching unit is an external control accessory that is used to switch on the vacuum unit required for the sample extraction during each measurement.

This must be used in conjunction with any vacuum unit.

Chapter 4 Hardware features

4.1 Hardware introduction	38
4.2 Mastersizer compatibility	40
4.3 Mastersizer Optical unit	43
4.4 Connection panel	44
4.5 Measurement Cell	45
4.6 Wet dispersion systems	48
4.7 Dry dispersion system	55
4.8 Connection and setup overview	57
4.9 Temperature Control Unit	62

4.1 Hardware introduction

The Mastersizer is comprised of the main optical unit, one or more dispersion units and a measurement cell. Commonly, a dispersant such as de-ionized water is also connected directly to the dispersion unit.

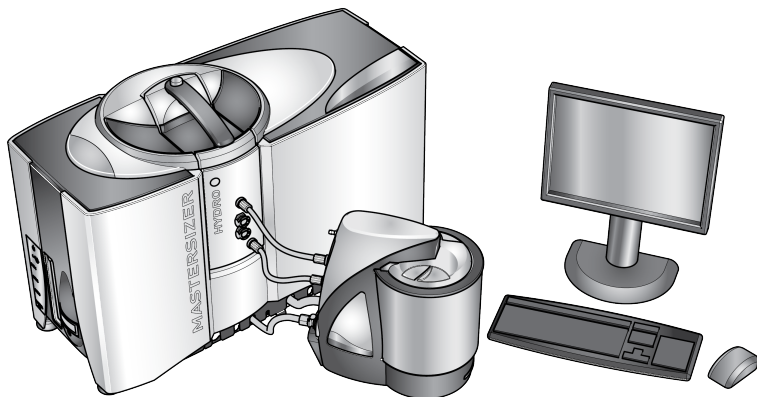


Figure 4.1 Typical system set up

4.1.1 Optical unit

The optical unit, sometimes referred to as the optical bench, is the heart of the Mastersizer system. Its purpose is to transmit red laser light and blue light through a sample and then use its detectors to generate data about the light scattering pattern caused by the particles in the sample. The data gathered is interpreted by the Mastersizer Xplorer software to provide accurate particle size information. The additional blue light used on the Mastersizer 3000 and Mastersizer 3000+ Ultra provides improvements in the measurement resolution below $1\text{ }\mu\text{m}$ in size.

4.1.2 Dispersion units

There are two types of dispersion unit:

- Wet units (**Hydro MV/LV/EV/SV/SM**) control the dispersion of a sample suspended within a liquid.
- Dry units (**Aero S/M**) allow a dry sample to be dispersed and evenly fed to the measurement cell within a continuous stream of air.

Table 4.1 Description of dispersion units

Dispersion unit	Description
Hydro LV/MV	The Hydro LV and MV are wet dispersion units designed to circulate a liquid sample through the Mastersizer's measurement cell.
Hydro EV	The Hydro EV is a wet dispersion unit designed to circulate a liquid sample held within a standard glass beaker through the Mastersizer's measurement cell. The filling and emptying of the glass beaker is a manual process. This unit is designed to create a suspension of particles in water or other liquid media. The large capacity of this unit makes it ideally suited to the measurement of larger materials with broad size distributions. Use standard laboratory beakers of 600 ml or 1000 ml capacity.
Hydro SM	The Hydro SM enables the Mastersizer to be used measurements of smaller volumes of material than the EV but larger than the SV, typically 50-120 ml. This is ideal when the sample or dispersant is toxic or expensive. The SM is operated manually.
Hydro SV	The Hydro SV manual dispersion unit is designed for the measurement of small amounts of a sample with a particle size typically less than 200 μm .

Dispersion unit	Description
Aero S/M	The Aero units allow the Mastersizer to be used for particle-in-gas particle size measurements. In the majority of cases the gas will be air. The software gives you direct software control over the feed rate and air pressure, allowing a wide range of particle sizes and densities to be delivered to the optical bench. This can help when you are optimizing your dispersion and performing representative sampling. The unit can be controlled either independently of measurement or from within a manual/SOP measurement.

4.1.3 Measurement cell

The cell is the interface between the dispersion unit and the optical unit. The sample is routed between measurement windows in the cell so that the laser can pass through it in order to make a measurement.

4.1.4 Computer

The Mastersizer Xplorer software controls the optical unit and dispersion unit hardware, and also processes the raw data gathered by the system, providing flexible data analysis and reporting features.

4.2 Mastersizer compatibility

The different Mastersizer variants are:

- **Mastersizer 3000+** - available in Lab, Pro and Ultra variants.
- **Mastersizer 3000**
- **Mastersizer 3000E** - available in Basic and Extended variants.

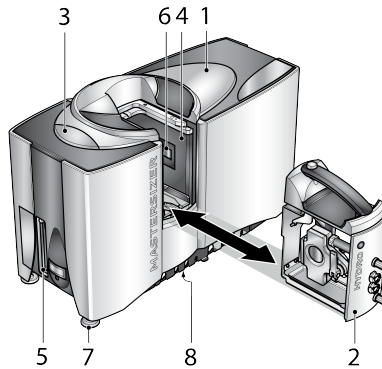
Table 4.2 Mastersizer variant hardware compatibility

Hardware	3000+ Ultra	3000	3000+ Pro	3000E Extended	3000+ Lab	3000E Basic
Particle size range	0.01 – 3500 µm	0.01 – 3500 µm	0.1 – 2500 µm	0.1 – 1000 µm	0.1 – 1000 µm	0.1 – 1000 µm
Manual Hydro wet dispersion units (Hydro EV / SM)	•	•	•	•	•	•
Automated Hydro wet dispersion units (Hydro SV)	•	•	•	•	•	•
Automated Hydro wet dispersion units (Hydro MV / LV)	•	•	•	•		
Automated dry dispersion unit (Aero S)	•	•	•			
Manual dry dispersion unit (Aero M)	•		•	•	•	•
Heat management solution	•		•		•	

Note: A software upgrade (from basic to extended software) is required to operate the Hydro MV and Hydro LV dispersion units, plus the additional functionality of the Hydro SV. Contact your Malvern Panalytical representative to upgrade your software.

4.3 Mastersizer Optical unit

The optical unit is the main component of the Mastersizer system.

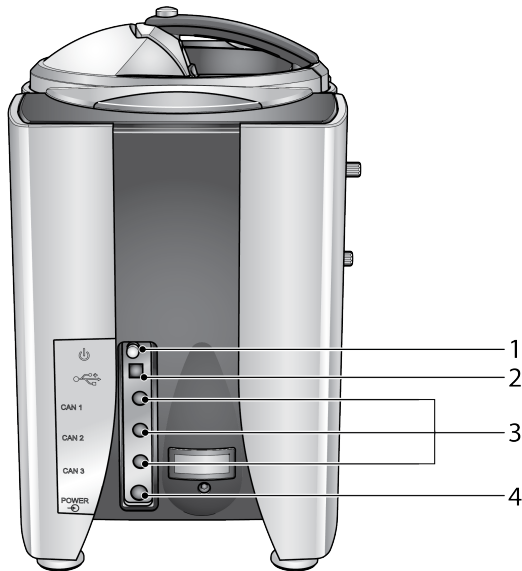


1. **Optical unit** – Directs red and blue light through sample and collects the light scattered by the sample's particles using detectors. This data is used to calculate particle size.
2. **Measurement Cell** – In this example, the wet cell is shown. Refer to the *Hydro and Aero dispersion unit guides* for more information on the dispersion units available.
3. **Instrument status LED** – Status indicated as follows: **Standby** - pulsating dim, **Active** - constant bright, **Error** - flashing bright.
4. **Cell bay** – Holds the cell securely in the instrument so that the sample passing between the cell windows can be analyzed by the optical unit's laser beam.
5. **End panel** – Provides communication connectors for the optical unit plus power connection and switch. Refer to [section 4.4](#)
6. **Protection window** – Stops dust/dirt entering the system. Clean this window periodically. Refer to [section 6.5](#) for information on cleaning the protection window.
7. **Adjustable feet** – Important: adjust the feet individually to level the instrument on the bench.
8. **Drain** – Allows any spillages in the cell area to exit onto the laboratory bench.

Figure 4.2 The optical unit

4.4 Connection panel

The connection panel provides the communication and power connections.



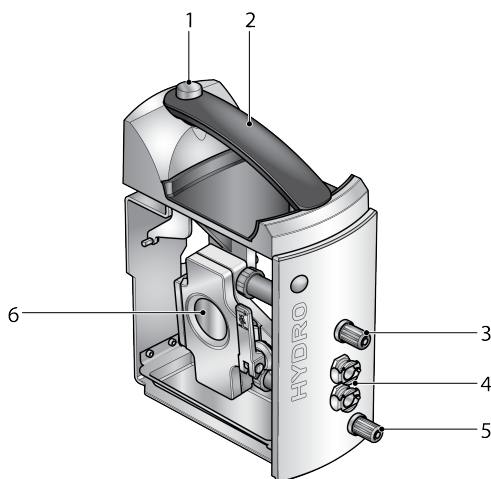
- 1. **Power switch** – Press once to power on the unit, press again to power off.
- 2. **USB** – Provides data communication with the PC. For best performance connect to a high speed USB port on the computer.
- 3. **CAN 1-3** – Supplies power and data communication to the dispersion unit.
- 4. **Power input** – Input for 24 V power supply unit.

Figure 4.3 Mastersizer connection panel

4.5 Measurement Cell

4.5.1 Cell components

The following illustration shows the key parts of a wet cell. For a more detailed description of both the wet and dry cells, as well as the Hydro SV cell, refer to the *Hydro* or *Aero Series Dispersion Units Guides* respectively:



1. **Cell release button** – Ejects the cell from the cell bay locking mechanism so that it can be withdrawn from the cell bay.
2. **Cell handle** – Only lift the cell by this handle.
3. **Sample outlet (blue)** – Connected to the sample inlet (blue) on the dispersion unit.
4. **Optional heater/chiller connections.**
5. **Sample inlet** – Inlet from the dispersion unit.
6. **Cell windows** – Sample passes through the window and is measured by the system. Keep the cell windows clean to give accurate measurements – Refer to the *Hydro Series Wet Dispersion Units guide*.

Figure 4.4 Key components of a wet cell

4.5.2 Inserting and removing the cell

Always follow this process when inserting or removing the cell from the instrument. This section assumes that all relevant pipe connections between the dispersion unit and cell have already been made. Refer to the dispersion unit manuals for verification of these connections.

4.5.2.1 Inserting the cell

1. Lift the cell by the **cell handle**.
2. Insert cell into the instrument as shown in the Mastersizer optical unit overview illustration. Refer to [section 4.3](#).
3. Do not force the cell into the instrument - only lightly place it in the cell holder. The cell now automatically locks into place within the cell bay under motor control.

4.5.2.2 Removing the cell

1. Press the **cell release button** to eject the cell from the cell bay.



CAUTION

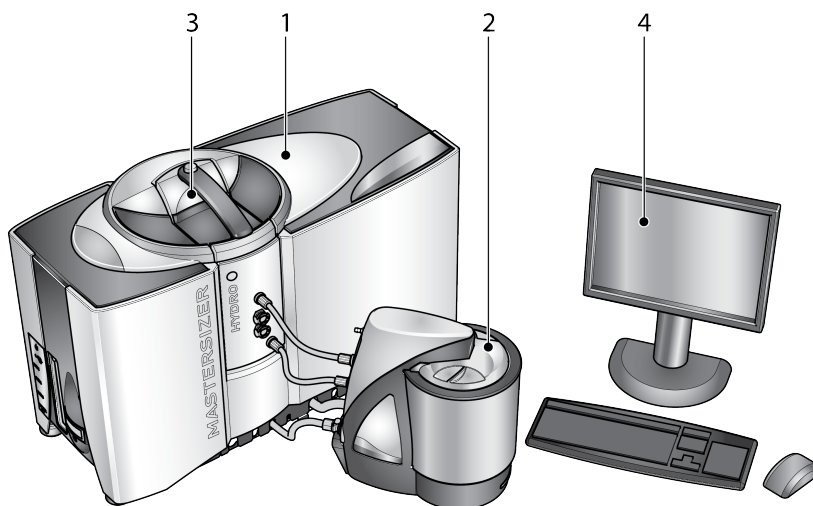
Do not try to remove the cell from the cell bay without first pressing the **cell release button** as this could damage the locking mechanism.

2. Withdraw the cell from the instrument using the **cell handle**, in the direction shown in the Mastersizer optical unit overview illustration - [section 4.3](#).

Note: If the cell is raised and lowered too many times in a short period, the firmware will lock the cell in place for a period of time before it can be ejected again to prevent damage to the locking mechanism.

4.6 Wet dispersion systems

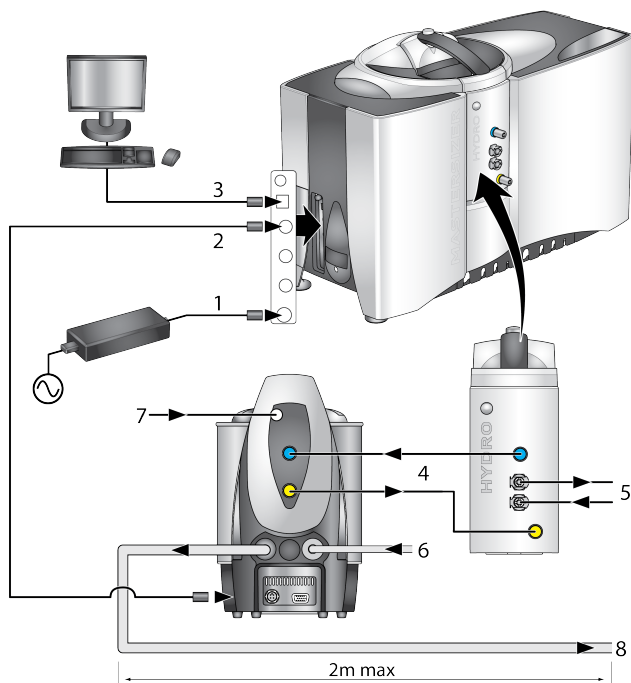
A wet system consists of the optical unit and at least one of the wet dispersion units (Hydro LV/MV/EV/SM or SV). The wet dispersion units are designed to circulate a liquid sample through the Mastersizer's measurement cell.



1. **Optical unit** – Measures the sample using red laser and blue light detection. Refer to [section 4.3](#) for a full description.
2. **Wet dispersion unit** – (Hydro LV shown). Circulates sample throughout cell. Other wet dispersion units include the Hydro MV, Hydro EV, Hydro SV and Hydro SM.
3. **Wet cell** – Sample and dispersant flows through the cell so that they pass through the instrument's laser path.
4. **Computer running Mastersizer software** – Controls both optical unit and attached dispersion unit, as well as processing and presenting the measured data.

Figure 4.5 Typical wet dispersion unit installation

4.6.1 Hydro LV and MV connections



- | | |
|-----------------------------------|--|
| 1. Power cables from External PSU | 5. Heater/chiller connections (optional) |
| 2. CAN cable | 6. Dispersant input: aqueous |
| 3. Computer connection (USB) | 7. Dispersant input: non-aqueous |
| 4. Sample pipes to and from cell | 8. Drain pipe to waste |

Figure 4.6 Hydro LV and MV connections

To allow liquid to drain efficiently the drain/waste must:

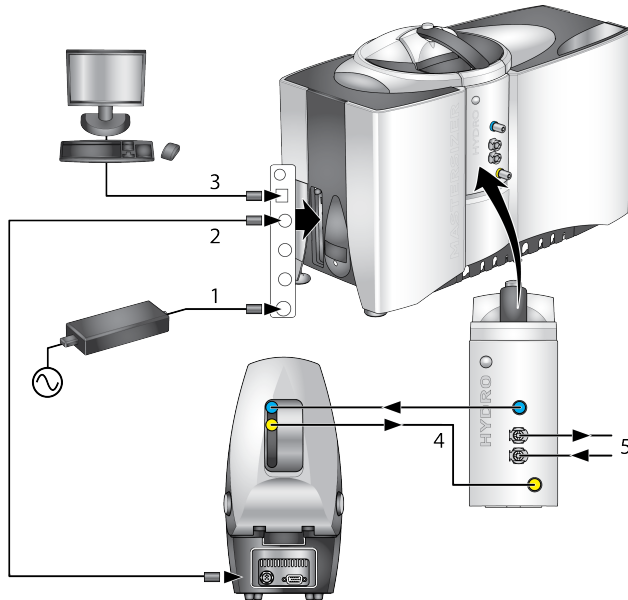
Chapter 4 Hardware features

- Be within 2 m of the dispersion unit
- Be lower than the bench surface
- Slope gently downwards
- Contain no loops or kinks.

Note: Discharge to a normal sink is sufficient, provided the sample and dispersant are non-hazardous.

If connecting an external dispersant pump to the Hydro LV or MV units, refer to the *Hydro Series Wet Dispersion Units guide*.

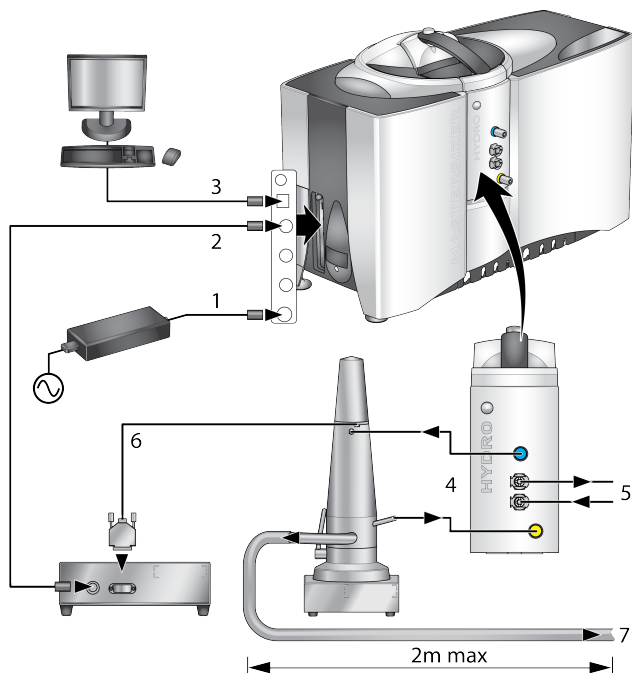
4.6.2 Hydro EV connections



- | | |
|----------------------------------|--|
| 1. Power cable from External PSU | 4. Sample pipes to and from cell |
| 2. CAN cable | 5. Heater/chiller connections (optional) |
| 3. Computer connection (USB) | |

Figure 4.7 *Hydro EV connections*

4.6.3 Hydro SM connections



- | | |
|----------------------------------|-------------------------------|
| 1. Power cable from External PSU | 5. Heater/chiller connections |
| 2. CAN cable | 6. Controller unit connection |
| 3. Computer connection (USB) | 7. Drain pipe to waste |
| 4. Sample pipes to and from cell | |

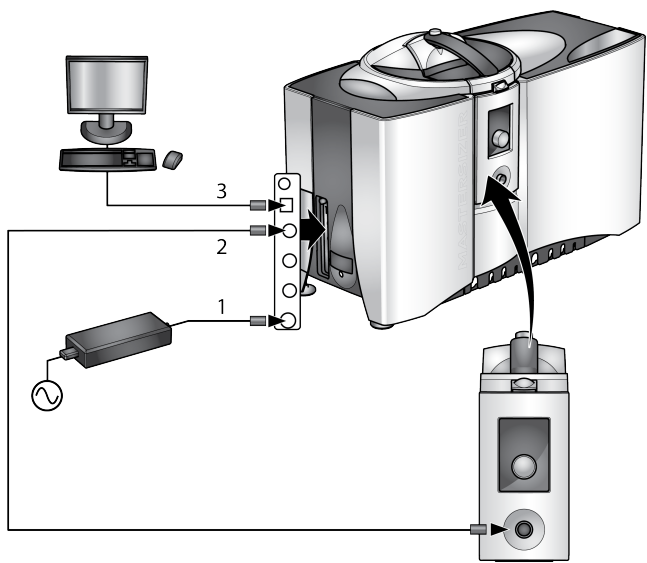
Figure 4.8 Hydro SM connections

To allow liquid to drain efficiently the drain/waste must:

- Be within 2 m of the dispersion unit
- Be lower than the bench surface
- Slope gently downwards
- Contain no loops or kinks.

Note: Discharge to a normal sink is sufficient, provided the sample and dispersant are non-hazardous.

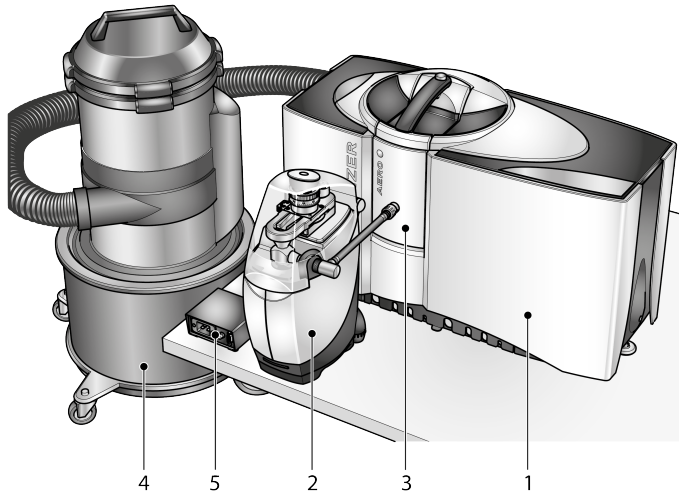
4.6.4 Hydro SV connections



- | | |
|----------------------------------|------------------------------|
| 1. Power cable from External PSU | 3. Computer connection (USB) |
| 2. CAN cable | |

Figure 4.9 Hydro SV connections

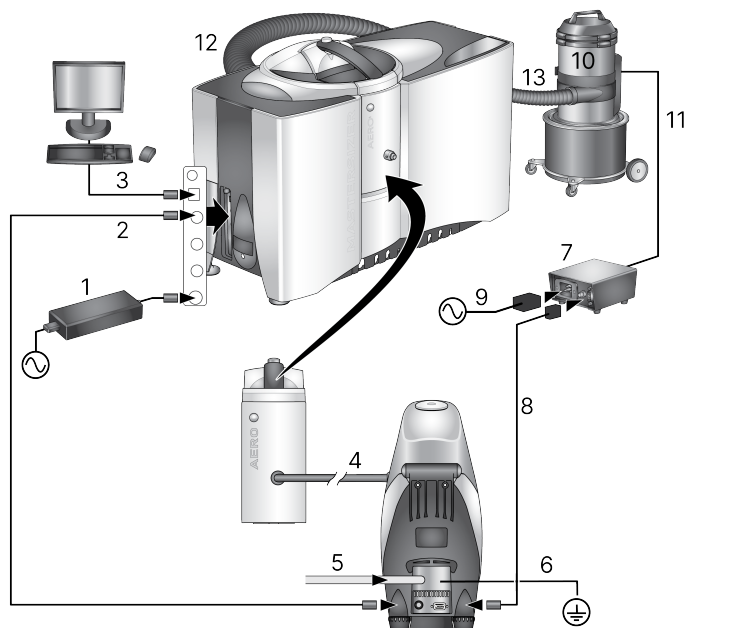
4.7 Dry dispersion system



1. **Optical unit** – Measures the sample using red laser and blue light detection. Refer to [section 4.3](#) for a full description.
2. **Dry dispersion unit** – Circulates the sample through the cell.
3. **Dry cell** – The sample flows through the cell so that it passes through the instrument's laser path.
4. **Vacuum unit** – Removes the sample from the cell exhaust once it has been measured.
5. **Ancillary switching unit** – An external control accessory that is used to switch on the vacuum unit.
6. **Computer (not shown)** – This controls both the optical unit and the attached dispersion unit, as well as processing and presenting the measured data.

Figure 4.10 Typical dry dispersion unit installation

4.7.1 Aero connections



- | | |
|----------------------------------|---|
| 1. Power cable from External PSU | 8. Auxiliary control cable |
| 2. CAN/Power cable | 9. Power cable to ancillary switch unit |
| 3. Computer connection (USB) | 10. Vacuum unit |
| 4. Sample pipes to cell | 11. Power cable to vacuum unit |
| 5. Air supply input | 12. Vacuum elbow/pipe to optical unit |
| 6. Earth connection (optional) | 13. Vacuum pipe to vacuum unit |
| 7. Ancillary switch unit | |

Figure 4.11 Aero connections

Note: Depending on the vacuum cleaner attached, an additional power cable [10] may be required.

4.8 Connection and setup overview

Systems **must** be commissioned initially by a Malvern Panalytical representative or be set up following the instructions in the Smart Installation. Commissioning is the process of ensuring that a safe physical installation of the Mastersizer has taken place together with a formal verification process to make sure that measurements are accurate.

This section explains how to reconnect the system if it is moved after it has been commissioned. This is done in the following steps:

- Pre-connection verification measurement.
- Install the software (if required).
- Connect the system.
- System power up.
- Test the system.
- Post-connection verification measurement.

4.8.1 Pre-connection verification measurement

Make a measurement of a standard sample **before** moving the system.

Another measurement will be made **after** the system has been moved and connected (Post-connection verification) for checking results against.

4.8.2 Install the software

Follow the procedure described in the **Software Update Notification (SUN)** document available to download from www.malvernpanalytical.com, which also details the minimum system requirements. If this document is not present, contact Malvern Panalytical.

Note: It is important that the software is installed before the Mastersizer instrument is connected to the computer and switched on. This will make sure that the instrument drivers are enabled, and that the firmware updates associated with this release are correctly downloaded to the instrument.

4.8.3 Connect the System

4.8.3.1 Connection prerequisites

Make sure that the new location of the system has the correct services and space before attempting to move the system (refer to [Chapter 2](#)). Before moving the system, drain any wet dispersion units, vent any air lines for dry dispersion units, and allow the system to cool. Disconnect all pipes and cables before moving a dispersion unit.



WARNING - General hazard

Do not site the computer next to the waste sink. Electric shock risk from contact with water.

4.8.3.2 Electrical connections

Follow the connection details in [section 4.6](#), or [section 4.7](#). Also refer to the *Aero and Hydro Series Dispersion Units guides*.

1. With the computer switched off, connect the USB cable to a free USB port on the Computer and the other end to the USB port on the optical unit.
2. Connect the dispersion unit's CAN port to an available CAN port on the optical unit (there are three CAN ports on the optical unit).
3. Plug the power cable into the power supply unit and connect the power cable from the power supply unit to the optical bench power input - but **do not** connect to the mains power supply at this point.

4.8.3.3 Sample flow connections

Follow the connection details in [section 4.6](#), or [section 4.7](#). Also refer to the *Aero* and *Hydro Series Dispersion Units guides*.

4.8.4 System power up

4.8.4.1 Power on the system



WARNING - Read the manual

Users must read and fully understand the health and safety instructions in [Chapter 2](#) before powering up the system.

To avoid the computer reporting communication problems, switch on the system in this order:

1. Optical unit.
2. Computer and software.

To power on the Optical unit:

1. Connect the optical unit mains power plug to the power supply and switch on.
2. Press the on/off switch on the end panel once to "ON".

To power on the computer and start the software:

1. Power up the computer and printer by following the instructions in the manufacturer's manuals.
2. Start the Mastersizer software by double clicking on the **Mastersizer Xplorer** icon on the desktop.

Note: Before using the instrument to measure a sample, wait for 30 minutes for the temperature to stabilize.

4.8.5 Test the system

Use the following checks to verify that the system is still working correctly. These are especially important for testing the system after a move.

- The indicator on the optical bench should be blue.
- The dispersion unit indicator (with cell inserted) should be blue.
- The software should indicate that the USB connection to the instrument is active (by showing this in green in the status bar) and also show any dispersion unit connected to one of the instrument's CAN ports.

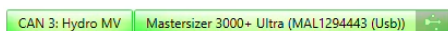


Figure 4.12 Software indication that USB and Hydro MV accessory are connected.

To verify that the system is still working correctly, make another measurement using the standard sample and compare the results to those obtained before moving the system.

If the instrument is not connected correctly, the status bar indicates:

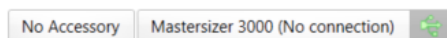


Figure 4.13 Software indication that no accessory or USB is connected.

If this is the case, check the instrument's connection to the USB port on the PC and the power connections to the instrument.

If the dispersion unit is not detected, the following is shown:

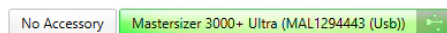


Figure 4.14 Software indication that no accessory is detected.

If this is the case, check the connection from the instrument to the dispersion unit. A blue pulsating power light on the dispersion unit indicates that it is connected correctly to the instrument.

Note: Before using the instrument to measure a sample, wait for 30 minutes for the laser to stabilize.

4.8.5.1 Post-connection verification measurement

Make a measurement of a standard sample. Check this against the measurement made before moving the system. If the results differ significantly, check the connections to see if any mistakes were made. Contact your Malvern Panalytical representative if the difference persists.

4.9 Temperature Control Unit

This section gives the procedures and function of the **Temperature Control Unit (MAZ2100)**. This has been developed for the Mastersizer system. It is compatible with the Hydro wet dispersion unit, when it is used with thermally volatile dispersants and saturated solutions.

The Temperature Control Unit reduces the time to achieve thermal equilibrium and acceptable scattering backgrounds when using organic solvents.

Note: The Temperature Control unit is intended to stabilize the dispersant temperature in the cell area. There are no user adjustments, all settings are factory set.

The delivered temperature at the cell is application dependent. On certain automated dispersion units (i.e. Hydro MV/ Hydro LV) there is a tank dispersant temperature indicator in the software.

If customers require further validation of temperature this is the responsibility of the customer.



Figure 4.15 Temperature Control Unit (MAZ2100)

4.9.1 Overview

The Temperature control unit consists of a **Heat exchanger** fitted inside the cell area of the Mastersizer instrument, and an external **Cooling unit**.

4.9.1.1 Heat exchanger

The **Heat exchanger** is fitted into the rear of the Mastersizer cell area. Pipes from the heat exchanger connect to the Cooling unit.

Note: The Temperature control unit can remain connected with concurrent Aero dry accessories when these are used in four of the six possible dry exit elbow positions.

4.9.1.2 Cooling unit

The main features of the Cooling unit are:



1. **Fan** - For cooling. Do not obstruct.
2. **Filler cap** - Unscrew to add coolant.
3. **On / Off switch**.
4. **Control and setup buttons** - Advanced settings only to be changed with guidance from Malvern Panalytical.
5. **Coolant level marker** - Level of coolant can be clearly seen.



WARNING - General hazard

Top up with coolant fluid (KOOLANCE liq-702 coolant) to between the Min and Max indicators. Never over or under fill as this could damage the Cooling unit.

6. **Coolant inlet (Labelled IN)** - This is the **filtered** connection. Use the straight in-line pipe assembly for connection. Connects to the **top** 'quick-fit' connector on the rear of the Mastersizer.
7. **Power supply connection** - Power supply cable connects here.
8. **Coolant outlet (Labelled OUT)** - Use the flow indicator pipe assembly for connection. Connects to the bottom 'quick-fit' connector on the rear of the Mastersizer.

Figure 4.16 Cooling unit features

4.9.2 Installation

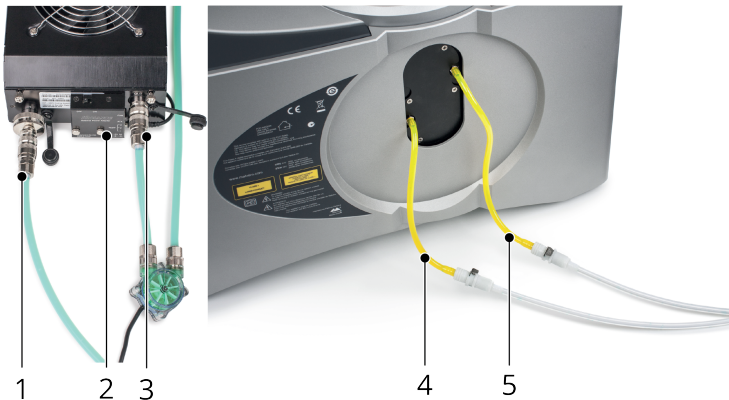


CAUTION

Never turn the Cooling unit on when dry. The Cooling unit must always be filled with coolant before operation.

4.9.2.1 Connect the Cooling unit pipes and power supply

Note: All pipes are provided cut to length and with the correct fittings attached. The system has been leak tested prior to shipment.



1. IN connection
2. Power supply
3. OUT connection

4. Top connector
5. Bottom connector

Figure 4.17 Cooling unit pipe connections

1. Place the Cooling unit on the bench beside the Mastersizer, with good ventilation, away from electric cables.
2. Check the ON/OFF switch is set **OFF**
 - The ON/OFF switch is on the top of the square connector block on the rear of the Cooling unit.
3. Connect the **Power supply** (do **not** switch the Cooling unit on).
4. Filtered inlet pipe connection: Connect the metal connector to the **IN connection** on the Cooling unit. Connect the yellow pipe onto the **top connector** on the rear of the instrument. Ensure it is pushed on fully.
5. Flow indicator connection: Connect the metal connector to the **OUT connection** on the Cooling unit. Connect the yellow pipe onto the **bottom connector** on the rear of the instrument. Ensure it is pushed on fully.
6. Organize all the flexible pipes so there are no sharp bends or kinking of the pipes.

4.9.2.2 Fill the Cooling unit with coolant



WARNING - Wear safety gloves

Gloves and eye protection must be used when you fill and drain the Cooling unit. Refer to the supplied Safety Data Sheet (SDS) for the coolant.



WARNING - General hazard

Top up with coolant fluid (KOOLANCE liq-702 coolant) to between the Min and Max indicators. Never over or under fill as this could damage the Cooling unit.

Coolant can be obtained from Malvern Panalytical or Koolance.com.

Fill the Cooling unit with the coolant as instructed below. The Cooling unit will need about 1/3 of a bottle of coolant. An additional piece of pipe is provided with the coolant bottle to help you fill the Cooling unit.

1. Ensure the Cooling unit is connected as described in [section 4.9.2.1](#).
2. The Cooling unit must be switched off.
3. Unscrew the filler cap using a coin.



Figure 4.18 Filler cap

4. Looking at the coolant level marker, fill up to the MAX level with the coolant.



- | | |
|-------------|------------|
| 1. Maximum | 3. Minimum |
| 2. 3/4 full | |

Figure 4.19 Coolant level markers

- 5. Switch the Cooling unit on.
- 6. The flow indicator will now rotate. As the coolant is fed through the system the coolant level will start to drop. Add more coolant until the level rests at about $\frac{3}{4}$ height on the viewing window level. The coolant must always be above the minimum level.



WARNING - General hazard

A subsequent dropping coolant level will indicate a leak and use of the Cooling unit should be ceased immediately.

7. Continue circulating the coolant for a few minutes until all bubbles have been removed from pipes and flow indicator. Inspect both to ensure no bubbles are present.
8. Refit the filler cap on the Cooling unit and tighten securely - do not over tighten.



WARNING - General hazard

Make sure that the filler cap is tightened securely so that the cap does not loosen in use (e.g. due to thermal cycling) and spray out hot coolant.

4.9.3 Cooling unit operation



1. Mode

2. Setting

Figure 4.20 Cooling unit operation

1. The Cooling unit must be switched on at the same time as the Mastersizer system.
2. Check the coolant level before use. Press the Mode button to cycle through the different settings and check that the pump and fan settings are set to maximum (10).

Note: These are the supplied default settings. Do not reduce these settings as they are required to provide sufficient performance.

4.9.4 Moving the Temperature control accessory



WARNING - Wear safety gloves

Gloves and eye protection should be used when filling and draining the Cooling unit. Refer to the supplied Safety Data Sheet (SDS) for the coolant. This is also available from Koolance.com.

4.9.4.1 Moving over short distances

1. Switch the Cooling unit off.
2. Disconnect either the white quick release connectors from the yellow pipes at the rear of the Mastersizer, the OUT and IN pipes from the Cooling unit. Both sets of connectors are dry break, but it is normal to experience some drops of coolant following disconnection.
3. Once moved, reconnect and switch the Cooling unit back on. No topping up should be required. Check that the coolant level is between the Min and Max indicators.

4.9.4.2 Moving for packing and shipment

- The Cooling unit and Mastersizer must be drained of liquid prior to packing or shipment.
- To drain the coolant, four drain pipes with white quick release connectors are provided.



Figure 4.21 *Drain pipes with quick release connectors*

Drain the instrument heat exchanger loop:

1. Switch the Cooling unit off and disconnect from the electrical outlet.
2. Disconnect the white quick release connectors from the yellow pipes at the rear of the Mastersizer.



1. Bottom yellow pipe

2. Top yellow pipe

Figure 4.22 Mastersizer Connection tubes

3. Connect a drain pipe to the **bottom** yellow pipe and place it in a suitable container (or use a large 50 mL syringe to draw it through).
4. Connect a drain pipe to the **top** yellow pipe, then raise it above the height of the Mastersizer. The heat exchanger loop within the instrument will drain by gravity.

5. Once the heat exchanger is empty, disconnect the drain pipes, then remove the yellow pipes from the barbed connectors.
6. Clean up any leaks.
7. Dispose of the used coolant as waste (it is water/propylene-glycol based, non-chlorinated). Refer to the SDS and local regulations.

Drain the Cooling unit

1. Switch the Cooling unit off and disconnect it from the electrical outlet.
2. Disconnect the white quick release connectors from the yellow pipes at the rear of the Mastersizer.
3. Connect a drain pipe to the OUT pipe (Flow indicator connection) then securely place this into a suitable drain container.
4. Connect a drain pipe to the IN pipe (Filtered connection).
5. To empty the Cooling unit reservoir:
 - Reconnect the Cooling unit to the mains and switch **On**.
 - The pump will start and empty the Cooling unit reservoir into the container.
 - Continue until the reservoir is empty - the pump noise will change at this point, and then immediately switch **Off**.
6. Disconnect the drain pipes from the OUT and IN pipes at the quick release connectors.
 - Any remaining coolant in the pipes and Cooling unit can be left in situ, the connections will prevent any liquid loss.
7. Disconnect the OUT and IN pipes from the Cooling unit.
8. Clean up any leaks.
9. Dispose of the used coolant as waste (it is water/propylene-glycol based, non-chlorinated). Refer to the SDS and local regulations.

4.9.5 Maintenance

Routinely do the following maintenance procedures:

- Check the push-in connectors on the Cooling unit and the back of the Master-sizer for leaks.
- Check that the tubing has not distorted over time and check for cracks and chafing damage.
- Check the coolant level by sight. To top up, unscrew the cap and top up with the correct coolant (this can be obtained from Malvern Panalytical).
- It is recommended to replace the coolant annually.

Chapter 5 Quick start: Using the system

5.1 Make a Measurement	76
5.2 Measure samples in SOP mode	76
5.3 Make a measurement - Wet dispersion units	79
5.4 Make a measurement - Dry dispersion units	83
5.5 Check the results	86
5.6 Check for problems	89
5.7 Run a Manual measurement	93

5.1 Make a Measurement

5.1.1 Introduction

This chapter provides information on how to make an initial measurement using the Mastersizer.

Note: It is expected that the user already has a working knowledge of how the system works either from observing a demonstration during installation or from formal training.



WARNING - Read the manual

Read the **Health and Safety** chapter before following these instructions.

There are two ways to make a measurement:

- **Use a Standard Operating Procedure (SOP)**
SOPs record all parameters associated with a measurement, improving its reproducibility. Malvern Panalytical supplies a number of SOP templates and others can be created by users.
- **Manually**
Used either to make "one-off" measurements or as part of method development prior to defining an SOP.

5.2 Measure samples in SOP mode

Note: This section assumes all connections have been made correctly. Connections vary depending on the dispersion unit. The system must be set up by a Malvern Panalytical engineer, or you must follow the set up

instructions in the Smart Installation. Refer to section 4.8 for basic connection reference. Also refer to the *Hydro and Aero Series Dispersion Units guides* for more detailed information.

This section describes how to create an SOP in order to make reproducible measurements. The example given uses the glass bead Quality Audit Standard (QAS) provided by Malvern Panalytical. Some degree of method development will be required to define settings that suit your own application and sample.

Note: If you have both a Hydro and Aero dispersion unit, use the Hydro unit first, clean the system and then measure again using the Aero unit.

The process described is divided into to the following sections:

- Power on the system and create a measurement file
- Make a measurement (for both wet and dry accessories)
- Check the results
- Check for any problems
- Clean the system.

5.2.1 Power on and create a measurement file

1. Switch on the optical unit. The blue light on the top of the instrument indicates that it is on.

Note: Leave the instrument powered on for 30 minutes before making a measurement to allow its temperature to stabilize.

2. After 30 minutes, switch on the computer, log in to Windows on the computer and start the software by double-clicking the **Mastersizer Xplorer** icon on the desktop:

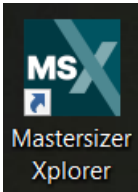


Figure 5.1 Mastersizer Xplorer icon

Note: If any of the functions described in this section are unavailable, this could be due to your login credentials. Contact your system supervisor for assistance.

- 3. Make sure that the status bar indicates that the instrument is connected correctly:

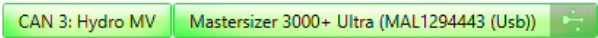


Figure 5.2 Instrument connected

- 4. If the instrument is not connected correctly, the following is shown:

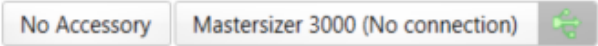


Figure 5.3 Instrument not connected

If this is the case, check the USB connection from the PC to the instrument and the CAN connection from the instrument to the dispersion unit. Then restart the software.

- 5. Create a new measurement file by selecting **New > Measurement file** from the *Documents* section of the *Home* ribbon:

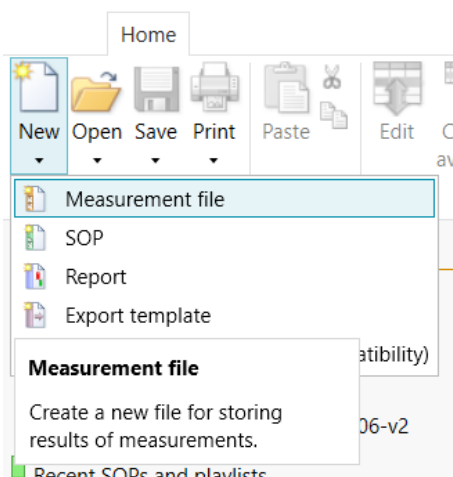


Figure 5.4 Create a new measurement file

6. Choose **Save** and then name the measurement file **Starter sample.mmes**.

5.3 Make a measurement - Wet dispersion units

If you are using a wet dispersion unit (the Hydro LV/MV/EV/SM) work through the steps in the order given here. No manual control of the dispersion unit is required after loading the sample. The software controls all dispersion unit settings.

Note: Use de-ionized water as the dispersant where possible.

1. Remove one bottle of the QAS standard from the consumables pack.
2. Select **Run SOP > Run SOP** from the *Measurements* section of the *Home* ribbon.

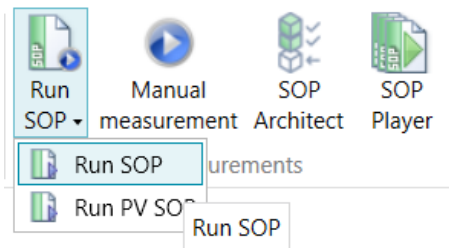


Figure 5.5 Run SOP

The **SOP Selector** window shows all available SOPs for the connected accessory.

3. Choose **Hydro LV Starter Sample.msop** (or the equivalently named versions of the SOP for the Hydro MV, EV or SM) and then click **OK**.
4. If the SOP specifies that the operator inputs the sample name, the Sample documentation window is displayed - enter a name for the sample and click **OK**:

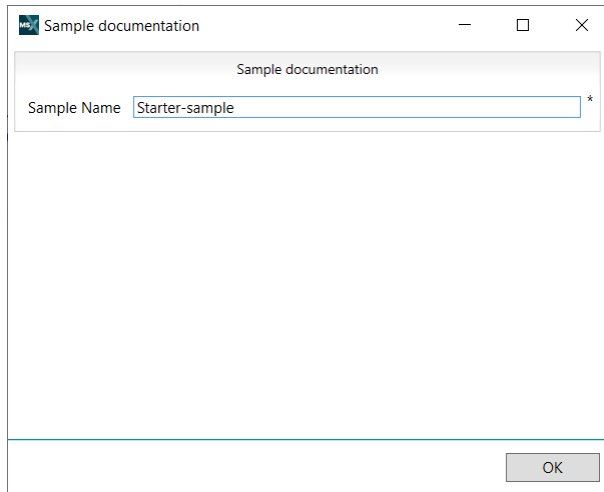


Figure 5.6 The Sample documentation window

5. Click the **Start** button  to **Initialize the instrument**, automatically fill the tank and cell (Hydro LV/MV only) and then **Measure Background** (the system measures both the red and blue light values of the background).

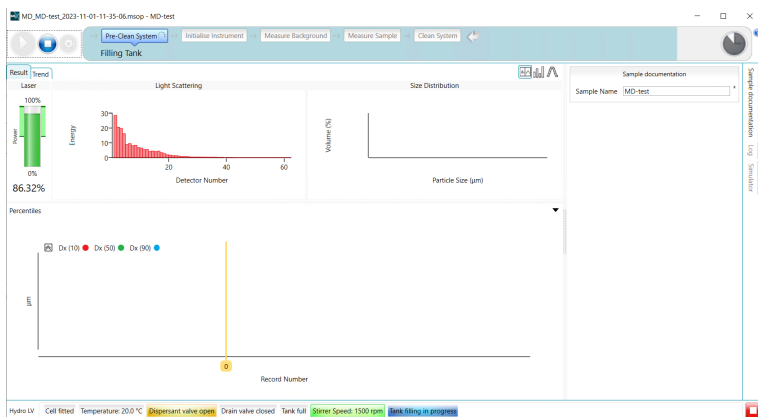


Figure 5.7 The Measurement display window

The progress status bar at the top of the window reports what is happening and shows what to do next.

6. When this is complete, the SOP pauses. The system now requests that you add sample - do this until the **Obscuration bar** (in the Laser panel) indicates about **10-20%**. This is a suitable sample value for a wet dispersion unit. The optimal obscuration value is sample-dependent. Refer to the Help system for more guidance.
7. Click **Start** to disperse the sample into the system and then begin the measurement. The system measures first the red and then the blue light values. This SOP makes several measurements. When complete, the **Trend view** is updated with the new measurement figures.

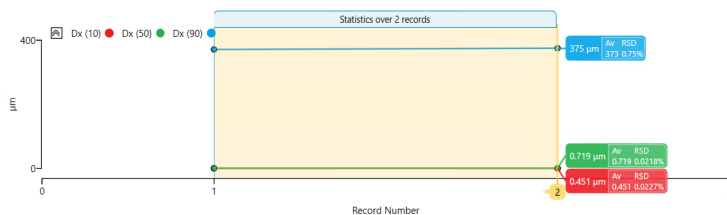


Figure 5.8 Trend view showing new measurement figures

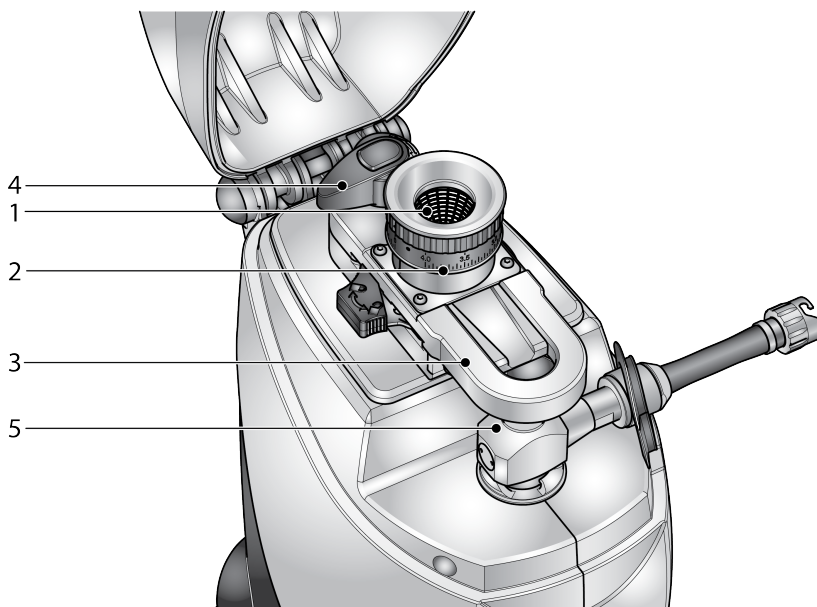
8. Complete the measurement by closing the *Measurement display* window.
9. The measurement is complete. Proceed to Check the results in [section 5.5](#).

5.4 Make a measurement - Dry dispersion units

Note: Aero S is only compatible with the Mastersizer 3000+ Ultra, Mastersizer 3000+ Pro and Mastersizer 3000 optical unit.

This procedure assumes an Aero S dispersion unit is being used. Operation with an Aero M is similar. The sample SOP used in this section is optimized for the dry dispersion unit. It will only make a measurement once the obscuration is within the specified range (1-10% obscuration is recommended for a dry dispersion unit. Refer to the Help system for further advice on obscuration setting).

The software controls most of the dispersion unit settings except the hopper height, which is a manual adjustment.



- | | |
|-----------------------------------|----------------------|
| 1. Mesh baskets and ball bearing | 4. Sample tray lock |
| 2. Sample hopper and flow control | 5. Venturi dispenser |
| 3. Sample tray | |

Figure 5.9 Aero dispersion unit sampling area

1. Open the Aero S sample area lid and set the hopper flow rate to an appropriate gap level using the Sample hopper flow control dial (marked from 0-4 mm - refer to the *Aero Series Dry Dispersion Units guide* for more information).
2. Empty the full contents of the QAS sample bottle into the **sample hopper**. The mesh basket accessory helps to break up agglomerates and is not required for this sample.

3. Close the lid of the Aero.
4. Select **Run SOP > Run SOP** from the *Measurements* section of the *Home* ribbon. The **Select SOP** window lists all available SOPs.
5. Select the **Aero S Starter Sample.msop** (there are two variants of this SOP, one for stainless steel venturi and one for the ceramic venturi - select accordingly) and then click **Open**.

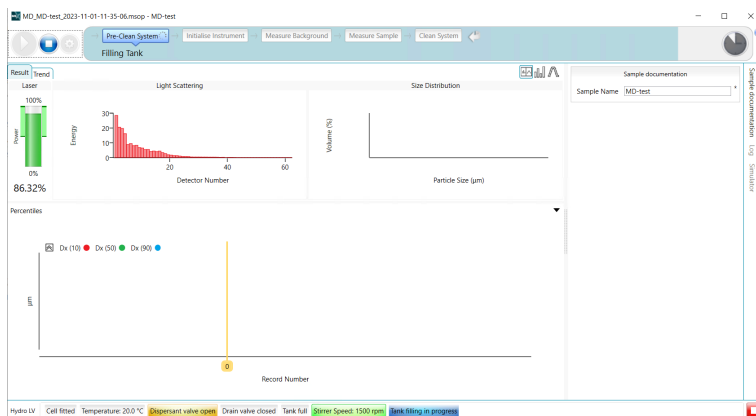


Figure 5.10 The Measurement display

6. Click **Start** . The SOP automatically turns on the air, aligns the optical system and then measures the background using red light. The sample tray starts vibrating and the air pressure specified in the SOP is applied. The overall rate at which the sample is fed into the cell is a function of the combination of air pressure, vibration rate and hopper flow-rate setting.
7. The system makes a measurement when the obscuration is within the specified range.
8. Results are shown in the *Trend* view as they are collected and the measurement records are automatically saved to the measurement file **Starter**

sample.mmes.

9. When the measurements have been made, the system pauses. If required, click **Clean System**, on the top progress bar, to start a cleaning cycle.

5.5 Check the results

A number of records will be created by the measurement and are shown as follows:

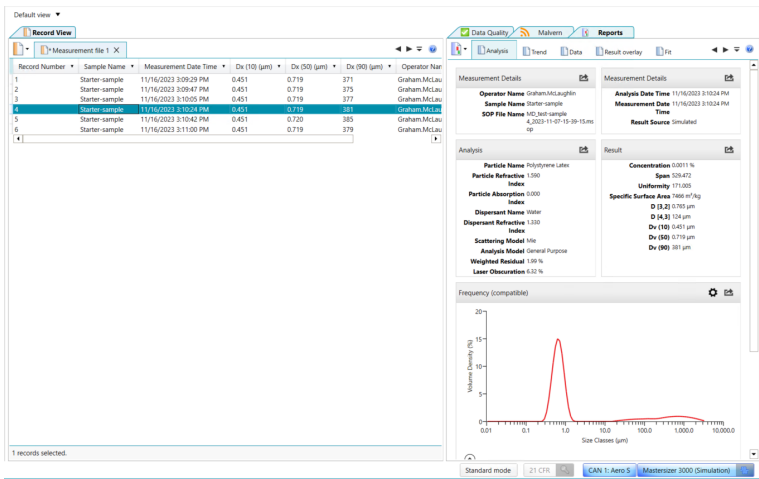


Figure 5.11 Records within a measurement

Note: This shows the results in a 2-pane view. Click **2-pane Vertical** from the **View** ribbon bar to activate this view.

5.5.1 Create an average result

An average result is very useful in assessing overall data quality. To create an average result:

1. Select all of the records and click **Create average** from the ribbon.
2. Confirm the **Sample name** and click **Create Average**.

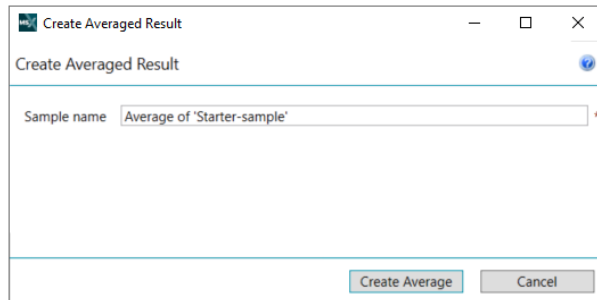


Figure 5.12 Name the average record

3. Now select this **Average** record from the *Record View* and click the *Analysis* report tab. An example of the Analysis report is shown:



Figure 5.13 Analysis report example

Measurement Details - details about the measurement, such as sample name, operator and date of the measurement.

Analysis - details about the analysis.

Result - particle size measurement breakdown.

Size Classes - histogram, which enables a quick visual analysis.

The lower part of the display provides data showing the percentage of material at different points in the size distribution.

For a QAS sample, all sample dispersion units should give a result showing a single peak with a median **dv 50** between 58.77 and 64.9 μm .

For fuller pass/fail criteria relating to an individual dispersion unit, check the **QAS datasheet**. Take care to choose the appropriate QAS type for the dispersion unit.

5.6 Check for problems

If the distribution histogram shows a similar pattern to those given in this section, this could indicate a problem.

5.6.1 Distribution containing very large particles

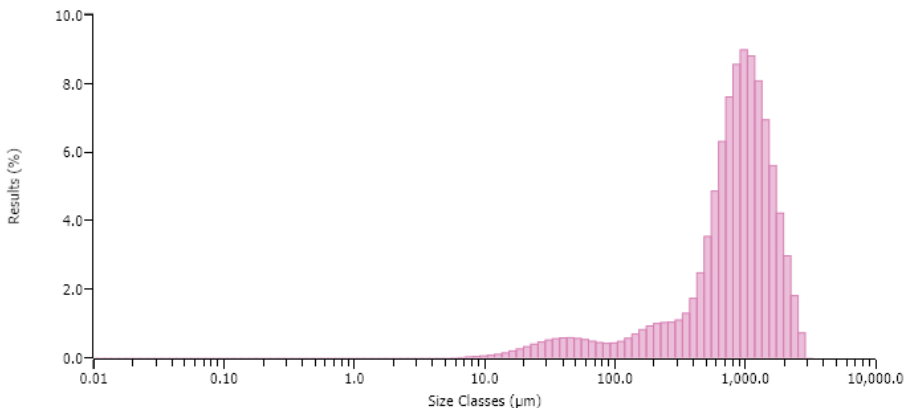


Figure 5.14 Distribution histogram showing very large particles

- Probably caused by bubbles.
- Check that stirrer speed is not too high.
- Check that air is not entering through a loose pipe connection.
- Measure again.

5.6.2 “Noisy” data

This can produce almost any pattern, but the pattern shown here is a typical example:

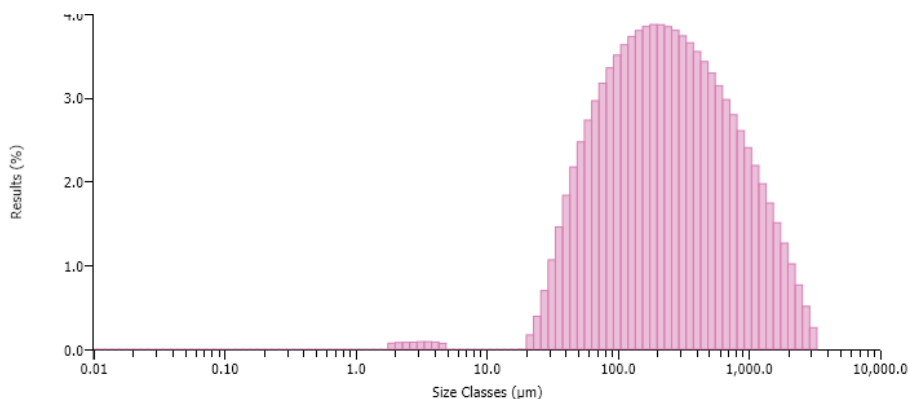


Figure 5.15 Distribution histogram containing very large particles

- Probably not enough sample added.
- Add more sample and measure again.
- Noisy data is also corroborated by a light energy graph (on the Data report) showing neither consistent nor significant light scattering across the range of detectors.

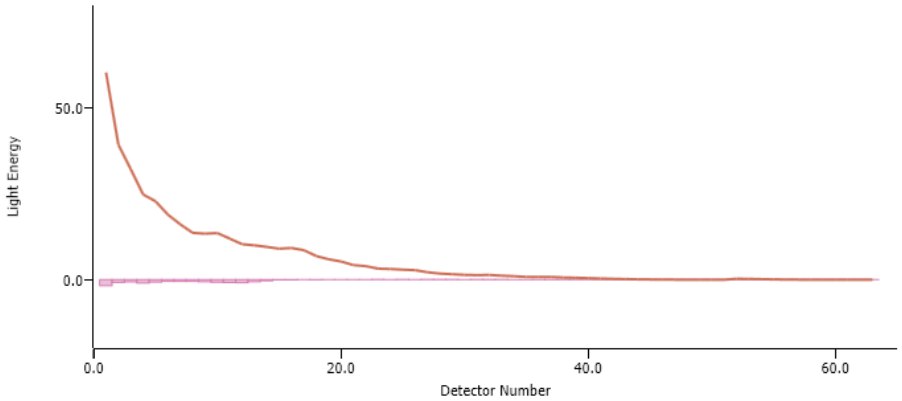


Figure 5.16 Noisy data shown by a light energy graph

5.6.3 Distribution with “tail” of particles

This should not be seen when using the QAS standard.

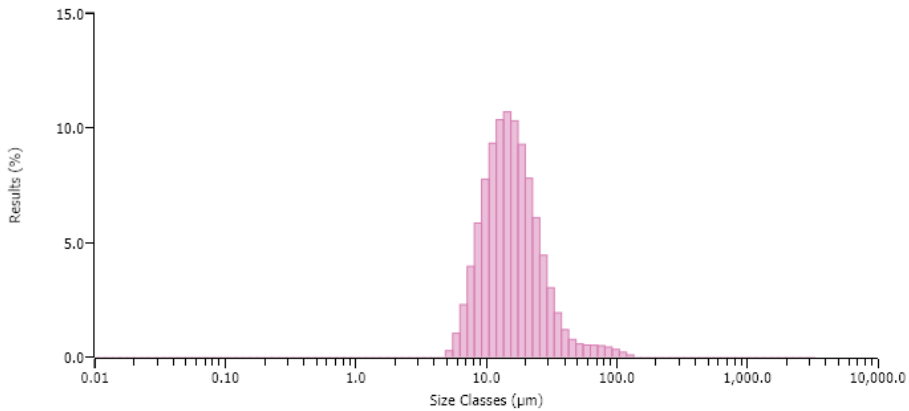


Figure 5.17 Distribution histogram with particle tail

- Probably caused by agglomerates in the sample.
- Add new sample and measure again.

5.6.4 Dirty windows

Dirt on windows causes problems when the instrument initially reads the background. The cell and cell window cleaning process is described in the dispersion unit guides.

5.6.5 Persistent problems

If the problem persists, contact the local Malvern Panalytical representative. Before calling, make a note of the instrument's serial number (shown in the status bar of the Mastersizer Xplorer software).

5.7 Run a Manual measurement

Manual measurements follow a sequence of events: alignment, background measurement, adding sample (wet measurements only), sample measurement and cleaning. The system pauses between each of these stages and prompts you when intervention is required.

1. Click **Manual measurement** in the *Measurements* group of the *Home* ribbon.

Note: The **Manual measurement** button is only shown if a dispersion unit is connected to the instrument, or the instrument is in simulation mode.

2. Configure the measurement settings and then click **OK**.

Note: In manual measurement mode you can control the accessory manually at any time using the *Accessory controls panel*.

3. From the *Initialize Instrument* menu, select the required alignment mode - Automatic is the default.

- For automatic alignments, the alignment is performed by the system.
- If you select manual alignment, adjust the settings in the pop-up *Manual Alignment* window, and close the window when complete.

4. Click **Start**  to measure the light background.

- For a wet measurement both the red and blue light measurements are made.
- For a dry measurement, only a red light measurement is performed. When this process is complete, the software pauses again.

Note: To reconfigure the measurement settings at any time during the measurement, click . To stop one of the measurement processes whilst in progress, click .

5. **Wet measurements only** - add sample until the obscuration is in range, observe the effect in the *Laser* display's Obscuration bar. If required, make further manual measurements by clicking **Start** again. Measurements will accrue in the *Trend* view.
6. **Dry measurements** - use a single measurement of long duration with obscuration filtering. This automatically starts the measurement when the obscuration is in range and stops when the obscuration falls below a certain level.
7. After the measurement has completed, you can optionally start the cleaning cycle by double-clicking **Clean System**.
8. When you have made all the measurements required, close the *Measurement display* window to return to the *Record* view.

Chapter 6 Maintenance

6.1 General maintenance warnings	96
6.2 Optical unit specific warnings	97
6.3 Clean the covers	97
6.4 Clean the cell bay	97
6.5 Clean the Mastersizer optics	98
6.6 Clean the cells and dispersion units	100
6.7 Fuses	100

6.1 General maintenance warnings

Note: Maintenance procedures and details of consumable parts kits for the Mastersizer dispersion units are provided in their respective user manuals.



WARNING - General hazard

Do not attempt any maintenance procedure not specified here.

Note: Before carrying out any maintenance operation, read and observe all other safety warnings listed.



WARNING - General hazard

The system contains no internal serviceable parts. Never attempt to remove the covers of the optical unit or an accessory or dispersion unit. Removal of the covers invalidates the warranty and may expose the user to dangerous laser radiation.



WARNING - Laser beam

Failure to follow these guidelines could result in the emission of laser radiation or exposure to hazardous voltages. Laser radiation can be harmful to the body and can cause permanent eye damage. Hydro and Aero dispersion units do not contain a laser but are connected to the optical bench that does.

6.2 Optical unit specific warnings



WARNING - General hazard

Before cleaning, always disconnect the unit from the power supply and computer and disconnect all electrical cables. Make sure the unit is completely dry before re-applying power.

6.3 Clean the covers



WARNING - General hazard

The surfaces of the system may be permanently damaged if samples or dispersants are spilled on them. If a spillage occurs, disconnect the system from the power supply before carefully cleaning it up.

- Periodically clean the covers thoroughly using a mild soap solution.
- Never use excessive liquid for cleaning and always avoid electrical components (connectors etc.) and the cell windows.
- Never use a solvent based solution for cleaning as it may damage the surface.

6.4 Clean the cell bay



WARNING - General hazard

The cell bay contains delicate optical devices that have their own cleaning procedures, outlined later in this section. Never use the procedure for cleaning the cell area to clean the optical devices.

- Periodically clean the cell bay using a mild soap solution.
- Never use excess liquid to clean the instrument.
- Always avoid optical components (detectors, protection window and lens).
- Never use a solvent-based solution to clean the cell area as it may damage the surface.
- Check the cell bay's cleanliness at least once a week.

6.5 Clean the Mastersizer optics

The cell bay contains delicate optics that require special cleaning procedures. Inspect the **protection window** for cleanliness every day.

Dust should be removed only using a specialist camera lens brush. Avoid handling the brush bristles as grease from fingers will be transferred to the optics. If unsure that the brush is clean, rinse it in ethanol and let it dry before use.



WARNING - General hazard

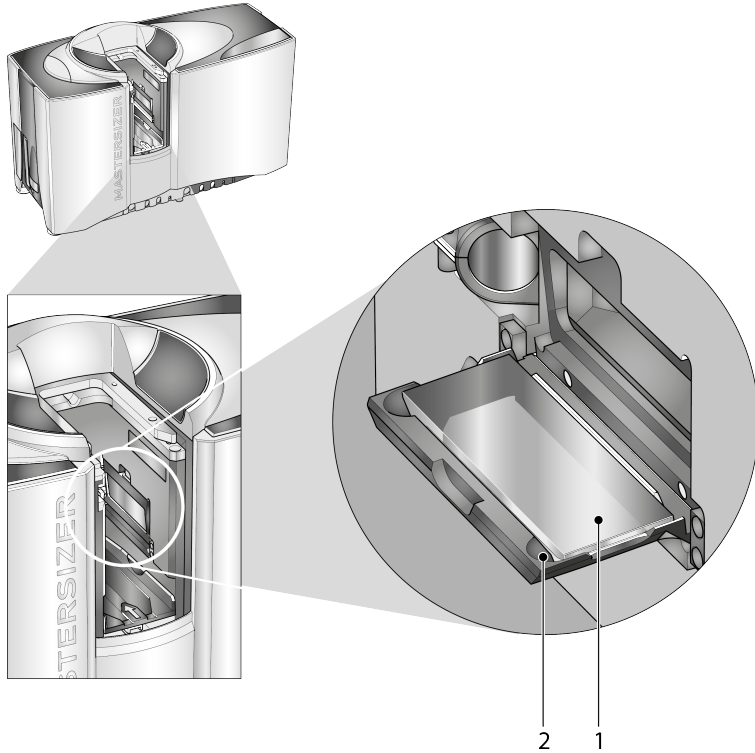
Do not wipe the optics with an ordinary dry cloth as this causes scratches. Always use the procedure below to clean the surfaces.

Inspect the protection window by reflected light for any smears or prints. If found:

1. Breathe on the device surface to wet it.
2. Gently wipe a good quality lens tissue over the wetted surface once. Do not touch the device while wiping it. Re-inspect and if still marked, repeat with another clean tissue.
3. If the mark remains consider using a liquid cleaner like Ethanol Absolute or Propan-2-ol. Soak a cotton wool bud and wipe it across the device **gently**. After one pass discard the bud to avoid scratching. Re-inspect and repeat until clean.

6.5.1 Removing the protection window

If the cleaning processes described above are insufficient to remove debris from the protection window, the following procedure may also be used:



1. Protection window

2. Finger access

Figure 6.1 The protection window

1. Remove the cell from the instrument.
2. Make sure that the instrument is switched off and then disconnect the power supply to the instrument.
3. Using the finger recess, gently lower the protection window mounting so that it rests in the position shown in the illustration.
4. Very carefully lift out the glass window to remove it.

Note: If placing the window on a bench to clean, make sure that it rests on a good quality lens tissue and not directly on the bench. It is also acceptable to immerse the window in a mild soap solution in order to clean it - always thoroughly dry the window with a lens tissue following immersion.

5. Carefully replace the glass window and close the mounting (a magnetic closure holds it securely in place when closed).

6.6 Clean the cells and dispersion units

Refer to the *Hydro and Aero Series Dispersion Units guides* for more information on cleaning a dispersion unit and its accompanying cell.

6.7 Fuses

There are no user serviceable fuses in the instrument.

Appendix A Specifications and Regulatory

A.1 Specification	102
A.2 Chemical compatibility	109
A.3 Regulatory information	116

A.1 Specification

All specifications are correct at time of publication but may be subject to alteration.

A.1.1 Mastersizer Optical unit

Table A.1 Optical unit specifications

Item	Specification
Size range: Mastersizer 3000+ Ultra	0.01 – 3500 μm^*
Size range: Mastersizer 3000	0.01 – 3500 μm^*
Size range: Mastersizer 3000+ Pro	0.1 – 2500 μm^*
Size range: Mastersizer 3000+ Lab	0.1 – 1000 μm^*
Size range: Mastersizer 3000E	0.1 – 1000 μm^*
Accuracy	Better than 1%**
Measurement principle	Mie and Fraunhofer scattering
Detection systems	Red light: Forward scattering, side scattering and back scattering. Blue light: Wide angle forward and back scattering.
Light sources	Red light: Max. 4 mW He-Ne, 632.8 nm Blue light: Max. 10 mW LED, 470 nm
Laser Class	Class 1, EN 60825-1

Item	Specification
Lens arrangement	Reverse Fourier (convergent beam)
Sample dispersion unit inter-change system	Sample dispersion units automatically recognized, configured and enabled on insertion of measurement cell cassettes into optical bench.
Operational conditions	5 °C to 40 °C (41 °F to 104 °F)
Storage conditions	-20 °C to 50 °C (-4 °F to 122 °F)
Humidity	Maximum humidity 80% for temperatures up to 31 °C, decreasing linearly to 50% relative humidity at 40 °C
Power Power consumption	100-240 V, 50-60 Hz 50 W - with no dispersion units connected 200 W (maximum) — with 2 dispersion units connected
Dimensions	Length: 690 mm Depth: 300 mm Height: 450 mm
Weight	30 kg

* Sample/preparation dependent. Refer to dispersion unit guides for wet/ dry size ranges.

** Accuracy defined for the recovery of the mean size of a narrow lognormal distribution. Sample and sample preparation dependent.

A.1.2 Hydro MV / Hydro LV

Table A.2 MV/LV specifications

Item	Specification
Dispersion type	Wet
Capacity	
- Hydro MV	120 ml
- Hydro LV	600 ml
Typical applications	
- Hydro MV	Solvent-based suspensions, Pharmaceuticals.
- Hydro LV	Minerals, fillers, chemicals, foodstuffs, emulsions
Sonication power / frequency	40 W max, 40 kHz (nominal)*
	* Dispersant dependent.
Dispersion mechanisms	Continuously variable pump / stirrer and ultrasonics.
Modes of operation	Automatic via SOPs. Manual via software control panel.
Weight	5 kg
Dimensions	Width: 180 mm / Height: 300 mm / Depth: 280 mm
Power	Supplied via CAN cable from the Optical unit
Power consumption	5 W - Standby / 80 W - Nominal* 96 W - Maximum operating power**
	* The power recorded on a typical unit using maximum pump speed and maximum ultrasonics, with water as the dispersant. ** The maximum power available through the CAN ports.
Maximum size of particles	
- Hydro MV	1400 µm (density 2200 kg/m ³)*
- Hydro LV	2100 µm (density 2200 kg/m ³)*
	* Dependent on sample and instrument model used.

A.1.3 Hydro EV

Table A.3 *EV specifications*

Item	Specification
Dispersion type	Wet
Capacity	600 ml / 1000 ml (standard laboratory beaker)
Sonication power / frequency	40 W max, 40 kHz (nominal)* * Dispersant dependent.
Typical applications	Minerals, fillers, chemicals, foodstuffs, emulsions
Dispersion mechanisms	Continuously variable pump / stirrer and ultrasonics.
Modes of operation	Automatic via SOPs. Manual via software control panel.
Weight	4 kg
Dimensions	Width: 150 mm / Height: 300 mm / Depth: 220 mm
Power Power consumption	Supplied via CAN cable from the Optical unit 5 W - Standby / 80 W - Nominal* 96 W - Maximum operating power** * The power recorded on a typical unit using maximum pump speed and maximum ultrasonics, with water as the dispersant. ** The maximum power available through the CAN ports.
Maximum size of particles	2100 μm (density 2200 kg/m ³)* * Dependent on sample and instrument model used.

A.1.4 Hydro SM

Table A.4 SM specifications

Item	Specification
Dispersion type	Wet
Capacity	120 ml maximum
Typical applications	Solvent-based suspensions, Pharmaceuticals. Minerals, fillers, chemicals, foodstuffs, emulsions
Dispersion mechanisms	Continuously variable pump / stirrer
Modes of operation	Manual via controller unit
Weight	9.75 kg
- Controller unit	1 kg
- Dispersion unit	8.75 kg
Dimensions	
- Controller unit	Width: 70 mm / Height: 225 mm / Depth: 170 mm
- Dispersion unit	Width: 390 mm / Height: 140 mm / Depth: 175 mm
Power	Supplied via CAN cable from the Optical unit
Power consumption	5 W - Standby / 10 W - Nominal* 96 W - Maximum operating power**
	* The power recorded on a typical unit using maximum pump speed, with water as the dispersant. ** The maximum power available through the CAN ports.
Maximum size of particles	Up to 600 µm *
	* Sample dependent.

A.1.5 Hydro SV

Table A.5 *SV specifications*

Item	Specification
Dispersion type	Wet
Capacity	7 ml maximum
Typical applications	Solvent-based suspensions, Pharmaceuticals. Minerals, fillers, chemicals, foodstuffs, emulsions
Dispersion mechanisms	Continuously variable stirrer
Modes of operation	Automatic via SOPs. Manual via Front panel control dial
Weight	
- SV cell and cuvette	3.05 kg
- Washstation	1.5 kg
Dimensions	Width: 280 mm / Height: 110 mm / Depth: 210 mm
Power	Supplied via CAN cable from the Optical unit
Power consumption	2 W - Standby / 5 W - Nominal*
	* The power recorded on a typical unit using maximum pump speed, with water as the dispersant.
Maximum size of particles	Up to 200 μm *
	* Sample dependent.

A.1.6 Hydro series wet cell

Table A.6 *Wet cell specifications*

Item	Specification
Weight	2.46 kg
Dimensions	Width: 106 mm / Height: 273 mm / Depth: 227 mm
Liquid temperature range (water jacket connections)	0 to 50 °C
Maximum pressure (water jacket connections)	0.5 bar g

A.1.7 Aero S / Aero M

Table A.7 Aero units specifications

Item	Specification
Dispersion type	Dry, with controllable airflow, controllable feed rate, and interchangeable feed trays automatically sensed by the unit.
Typical applications	Dry powders, pharmaceutical excipients, fillers, cements, flour, powder coatings.
Modes of operation	Automatic via SOPs. Manual via software control panel.
Weight - Aero dispersion unit - Aero cell	10.5 kg 2.0 kg
Dimensions - Aero dispersion unit - Aero dry cell	Width: 180 mm / Height: 380 mm / Depth: 260 mm Width: 106 mm / Height: 273 mm / Depth: 253 mm
Power Power consumption	Supplied via CAN cable from the Optical unit 5 W - Standby / 10 W - Nominal* 96 W - Maximum operating power** * The power recorded on a typical unit using maximum vibration. ** The maximum power available through the CAN ports.
Size range - Aero S - Aero M	0.1 to 3500 µm* 0.1 to 1000 µm* * Dependent on sample and instrument model used.

A.2 Chemical compatibility

Although the Mastersizer has been manufactured from materials considered to give the widest protection from chemical attack, it is important to check the chemical compatibility of a sample with any material with which it may come into contact.



WARNING - General hazard

The chemical compatibility should be checked against the materials identified below before a sample is inserted. It is also recommended that a test is performed on the material with the sample before more permanent usage is undertaken.

Cleanliness and maintenance procedures necessary are described in [Chapter 6](#).

In normal operation the sample and dispersant should not come into contact with any component of the optical bench (the sample path is contained within the dispersion unit and the sample cell). However, if a sample pipe or o-ring seal should fail then sample or dispersant may fall into the cell area of the optical bench.

Should a small leak occur the sample/dispersant may come into contact with the materials described.

A.2.1 Mastersizer Optical unit

Table A.8 *Optical unit compatibility*

Component	Materials
Detector lens	Glass
Protection window	Glass

Component	Materials
Cell bay windows	Aluminum (hard anodized)
Cell bay base	Aluminum (hard anodized)
Drain assembly	Stainless steel, Tygon tubing
Cell and dispersion unit	Refer to applicable dispersion unit manuals



WARNING - General hazard

The paint finish of the external covers may be permanently damaged if samples or dispersants are spilled on them. Clean up any spillage immediately.

A.2.2 Hydro EV

Table A.9 *EV compatibility*

Component	Materials
Pump assembly	Stainless steel 316
Stirrer	PEEK (Glass fiber reinforced)
Impeller	Stainless steel 316 / PEEK
Ultrasonic transducer	Stainless steel 316 / Titanium nitride / PTFE
Sample flow pipe (internal)	Stainless steel 316 / PEEK (Natural) / FFKM / PTFE/
Sample flow pipe (external to wet cell)	Tygon
Wet cell assembly	Borosilicate Glass / Stainless steel 316 / FKM / FFKM
Sample beaker	Glass
Drip tray	PEEK (Glass fiber reinforced)
Beaker holder	Stainless steel 316
Wet cell assembly	Borosilicate Glass / Stainless steel 316 / FKM or FFKM

A.2.3 Hydro MV / Hydro LV

Table A.10 MV/LV compatibility

Component	Materials
Splash guard	Acrylic
Tank surround	PEEK (Glass fiber reinforced)
Tank and pump chamber	PEEK (Glass fiber reinforced)
Pump shaft	Stainless steel 316
Stirrer	PEEK (Glass fiber reinforced)
Impeller	PEEK (Glass fiber reinforced)
Ultrasonic transducer	Stainless steel 316 / Titanium nitride
Dispersant input pipe (external)	PTFE
Dispersant input pipe, pipework and fittings (internal)	Stainless steel 316 / FEP/ PTFE/ Kalrez
Dispersant input valve (regulator)	Stainless steel 316 / PTFE
Solvent (non-aqueous) input pipework (internal)	Stainless steel 316
Drain Valve	Stainless steel 316 / PTFE / FFKM
Drain pipe (internal)	Stainless steel 316 / PTFE
Drain pipe (external)	PTFE / Acetal
Sample flow pipe (internal)	Stainless steel 316 / FEP/ PTFE/ FFKM
Sample flow pipe (external to wet cell)	Tygon

Component	Materials
Pipe connectors	Aluminum
Wet cell assembly	Borosilicate Glass / Stainless steel 316 / FKM or FFKM

Note: For the Hydro MV / LV Fluoroelastomer (FKM) seals in the wet cell can be upgraded to Perfluoroelastomer FFKM to improve the chemical compatibility. Contact your Malvern Panalytical representative for details.

A.2.3.1 Peristaltic pump

Table A.11 Pump compatibility

Component	Materials
Dispersant input pipe (external)	Tygon (MH2075 / HC F-4040-A) - Solvent compatible*
	* sample dependent

A.2.4 Hydro SM

Table A.12 SM compatibility

Component	Materials
Tank, pump chamber and body	PEEK (Glass fiber reinforced)
Pump shaft	Stainless steel 316
Stirrer	PEEK (Glass fiber reinforced)
Impeller	PEEK (Glass fiber reinforced)
Drain Valve assembly	Stainless steel 316 / PTFE / FFKM
Sample flow pipe (external to wet cell)	Tygon (St R-3603) - standard* Tygon (MH2075 / HC F-4040-A) - Solvent compatible* * sample dependent
Pipe connectors (at cell)	Aluminum
Wet cell assembly	Borosilicate Glass / Stainless steel 316 / FKM or FFKM

A.2.5 Hydro SV

Table A.13 SV compatibility

Component	Materials
Cuvette	Borosilicate Glass / Stainless steel 316
Stirrer bar	PTFE
Wash station	Stainless steel 316

A.2.6 Aero S / Aero M

Table A.14 Aero units chemical compatability

Component	Materials
Sample tray assembly	Stainless steel 316
Venturi disperser – Stainless steel – Ceramic	Stainless steel 303/410 hardened Stainless steel 303/410 hardened/High purity alumina
Mesh basket	Stainless steel 316
Ball bearings	Stainless steel 316
Sample pipes to cell	Carbon impregnated polyurethane
Cell	Borosilicate Glass / Stainless steel 316
Vacuum extraction elbow	Carbon filled acetal

A.3 Regulatory information

This section provides details of all applicable regulatory information.

A.3.1 EU Declaration of Conformity

The CE badge on this product signifies conformance to the relevant European Directives - consult the Declaration of Conformity certificate for the product for more information.

A.3.2 Canadian Regulatory Information (Canada only) - excludes the Temperature Control Unit (MAZ2100)

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Note that Canadian Department of Communications (DOC) regulations provide, that changes or modifications not expressly approved by Malvern Panalytical could void your authority to operate this equipment.

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

A.3.3 FCC Notice (US only) - excludes the Temperature Control Unit (MAZ2100)

The Federal Communications Commission (FCC) mark on this product signifies conformance to FCC regulations relating to Radio Frequency Devices. These have been satisfied by testing the product against, and being found to be compliant with:

FCC CFR 47 Part 15:October 2011.Class A digital device.

The device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Note: Changes or modifications not expressly approved by Malvern Panalytical could void the user's authority to operate the equipment.

A.3.4 Disposal of Electrical & Electronic Equipment

When the need arises to dispose of the system, this must be done in a responsible manner. Follow these guidelines:

- Refer to local regulations on disposal of equipment. In Europe refer to the information below.
- Seek advice from the local Malvern Panalytical representative for details.
- Decontaminate the instrument if hazardous materials have been used in it.

The following is applicable in the European Union and other European countries with separate collection systems.



This symbol on the product or on its packaging indicates that when the last user wishes to discard this product it must not be treated as general waste. Instead it shall be handed over to the appropriate facility for the recovery and recycling of electrical and electronic equipment.



By not discarding this product along with other household-type waste, the volume of waste sent to incinerators or landfills will be reduced and natural resources will be conserved.

For more detailed information about recycling of this product, please contact your local city office, your waste disposal service, or your Malvern Panalytical representative.



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