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USER MANUAL

Pi RAPTOR Portable

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INTRODUCTION

System Description and Operation

The Pi RAPTOR Portable particle size and shape analyzer uses Dynamic Image Analysis for measuring particles. It is capable of measuring particles (organic and inorganic) ranging from 1 to 300 µm in diameter.

The Pi RAPTOR Portable's operation is based on a simple, yet efficient process. The sample being analyzed is recirculated through a Quartz sample cell using a peristaltic pump. Silhouette images are captured and analyzed. The Pi RAPTOR Portable particle size and shape analyzer is designed to acquire statistically valid measurements of a sample in a very short amount of time; a capability that is essential for quality control purposes in many manufacturing processes.

It differs from many microscopy-based systems in that it emphasizes speed and statistical assurance.

Although the Pi RAPTOR Portable's focus is on speed and simplicity, it offers all the particle characterization capabilities that are needed for most industrial processes. The system offers up to 30 different size and shape measures analyzed in real-time. The results are given instantaneously. No need to wait for data processing after analysis means that users have almost instant feedback on their process.

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Pi RAPTOR Portable Advantages

- *Real-time results* – Size and Shape analysis results as Size, Concentration, Shape information and thumbnail images are shown in real-time, providing instant results the moment analysis begins.
- *Obtain meaningful results* – Offering 30 size / shape measures. The ability to correlate multiple shape measures gives unprecedented power to single out key particle shapes of interest.
- *Multi-Run sample trending* - Ability to track size and shape changes over user defined time intervals, for statistical process monitoring and control.
- *Particle Tracking* - Ability to track particles as they pass though the sensing zone.
- *Particle Classification & Identification* - Ability to classify and identify particles based on shape criteria of interest. This is also applicable to the ISO4406 Oil Cleanliness requirements.
- *Real Time backup* - Data mirroring requires network access. This feature stores all analysis data in multiple locations simultaneously offering a real-time backup of data as well as giving lab managers the ability to review results remotely.
- *Statistical assurance* - Recirculating sample and unique optics assures statistical accuracy without the need of costly sheath fluids or complex optical components.
- *Data reporting flexibility* - Data for a sample is saved in the sample file and may be printed or exported to Microsoft .xlsx (Excel) format. A data summary from each of several runs may be combined into one worksheet.
- Continuous process monitoring - Capability of On-line continuous process monitoring.
- *Simulated sieve data* - Size distributions may be reported as fractional parts on a set of sieves, allowing comparison to real sieve data and easy technology comparison.
- *Rare event detection* - Particle Thumbnail feature extracts individual particle silhouettes from captured images that meet user-defined shape parameters. Correlation Plots are available to identify and view rare event particles and trends.
- *Sample handling & flexibility* - Disposable / interchangeable flow cells. Flexible fluidic design allows for various sample suspension options including on-line. Aqueous and Organic solvent-compatible system.
- *Security and Regulatory Compliance* - Compliant with the FDA 21 CFR Part 11 regulations with multiple levels of security and robust audit log that tracks all security-related actions.
- *Data Processing* –A Dashboard with an advanced feature for additional viewing and processing after the analysis.
- *Auto-Classification* – Feature allows the analysis of sub-components within the same mixed particle at the click of one button.

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- *Time series chart* -- This feature allows the evaluation of behavior from particles suspended in a solution by plotting results of pre-selected measures and statistics from a collection of run files, over a period of time under variable conditions and settings. The settings: run duration, delays between runs, measures and statistics can be set in advance. The charts created for each combination of parameters reflect the behavior of particles and can be used in different applications and processes like dissolution and crystallization in pharmaceutical industries.

Unique Features include

- Ruggedized case and battery operated for either field use or lab benchtop use.
- All raw images saved allow reanalysis of captured data.
- Full particle count codes compliant to ASTM, ISO, and NAVAIR oil wear particle requirements.
- Includes a touchscreen Microsoft Surface Pro computer, ideal for field use, compatible with networks.
- Overlay data for sample-to-sample or lot-to-lot comparisons.
- Smart phone App allows remote real-time monitoring.
- Onboard Lithium battery for up to 5 hours continuous use.
- Fully compatible with for ISO4406, NAS and NAVAIR wear debris identification

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Specifications

Size Range: STANDARD Magnification --- 1 to 300 µm

Image rate: The image rate of the camera can be up to 127 frames per second depending on camera resolution settings.

Shape Models:

- Circle Measures:
  Equivalent circular area diameter, Equivalent circular perimeter diameter, Bounding circle diameter, Mean diameter, Circularity, Smoothness, Compactness
- Ellipse Measures:
  Equivalent elliptical area width, length, Bounding ellipse width, Length, Elliptical aspect ratio, Ellipticity.
- Rectangle Measures:
  Bounding rectangle length, Width, Bounding rectangle aspect ratio; Rectangularity.
- Polygon Measures:
  Polygon order, Interior angles.
- Fiber Measures:
  Fiber length, Width, Fiber aspect ratio, Fiber curl
- Irregular Measures:
  Ferret length, Width, Ferret aspect ratio, Smoothness
- Pixel Intensity:
  Opacity and White fraction

Fluid compatibility: Compatible with most common suspension fluids (aqueous and organic). For details, please check Appendix F: Chemical Compatibility Chart.

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Voltage Supply: Battery LiFePO4 (Lithium Iron Phosphate) 12.8v DC , 5Ah

Temperature: 10 to 45 °C for operation. -10 to 55 °C for storing or shipping.

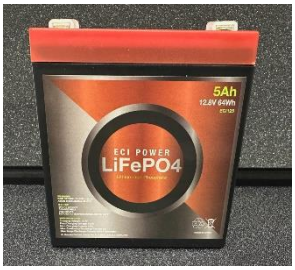
Humidity: 20 to 80% relative, without condensation

Width: 41.2 cm (16 ¼ in.)

Height: 17.7 cm (7 in.)

Depth: 34.2 cm (13 ½ in.)

Weight: 5.44 kg (12 lbs.)



Computer Requirement:

- Embedded Microsoft Surface Pro computer with touchscreen.

Battery Charger:

- Smart Battery Charger : ULTRAPOWER 12.8v DC, 10Amp, model EP15012N
- Input : 100 – 240V AC, 60/50 Hz
- Output : 12.8V DC
- Max Charge Current: 10A
- Weight: 400g

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Before you start: Warnings and Cautions.

⚠ WARNING

A warning message describes either a potentially hazardous situation which, if not avoided, could result in death or serious injury to the operator.

Electrical Warnings

- Always disconnect the instrument from the main power supply before removing the cover.
- Do not remove any board or sub-assembly while instrument is ON.

Mechanical Warning

- Do not use force to remove or replace any item. In the event of difficulty, consult a service representative from Vision Analytical for assistance.
- This instrument must be used in the manner specified in this User Manual. Any operation of this instrument outside the specified manner in this User Manual may impair the instrument and any protection provided, cause damage to the instrument or operator and is, therefore, prohibited.

Chemical Warning

- Proper handling procedures for diluents used in particle analysis should be adhered to at all times. Consult appropriate safety manuals and Material Safety Data Sheets for all samples, diluents used.
- Flammable solutions should be prepared for use in an appropriate environment and brought to the instrument only when required for analysis.
- Take care disconnecting sample lines. Open-ended tubing may allow liquid to spill over the Cell cartridge.
- 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.

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- 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 during measurement procedures, particularly where inflammable 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, scrupulously clean the system to remove any contaminants before making another measurement.
- Always label samples for analysis using industry standard labelling, particularly if they are handled by a number of staff or stored for long periods. Clearly mark 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 adopt 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 spilt on them. If a spillage does occur, disconnect the system from the power supply before scrupulously cleaning up the spillage.

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Fire Warning

- Many non-aqueous solutions are flammable. Where possible choose less flammable alternatives.

⚠ CAUTION

A caution message describes a potentially hazardous situation, which if not avoided, may result in minor or moderate injury. It can also be used to alert against unsafe practices.

Electrical Caution

- If the instrument is exposed to unwanted electrical interferences, the use of a constant voltage transformer or regulator would result in a benefit.

Chemical Caution

- Never place containers of liquids on top of the instrument. Repair of instruments damaged or affected by spilled liquids will not be covered by any warranty.

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Conventions

- The word “instrument” unless otherwise specified, refers to Pi RAPTOR Portable.
- The Microsoft Surface Pro is referred as “the computer”.
- **Bold** and *Italics* type letters refers to either a menu selection, a tool bar item or button text appearing on the screen of the computer that can be selected with the mouse or by keystrokes.
- *Italics* type letters are used to indicate screen messages.
- The symbol “►” indicates the software options you need to select. e.g. At the tool bar select **File ► Save.**
- Keys at the computer keyboard are boxed.
- Keys that are to be pressed simultaneously are printed with a sign “+” between the keys.

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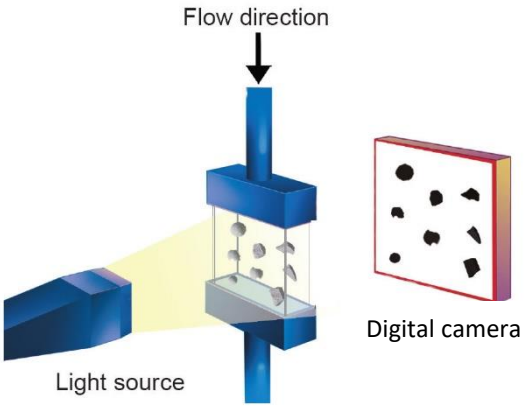
Chapter 1 - ANALYZER OVERVIEW

Principle of Operation



Particles flow through a view cell. An illumination source on one side of the flow cell shines light through the cell to a lens and digital camera on the other side. The camera records dark silhouettes of the particles and sends the images to the computer in grayscale format.

Software characterizes each particle based on the size and shape of the particle shadows using a pre-selected shape model that is appropriate for the kind of particles being analyzed.

In run mode, the camera images are analyzed as they come in, and the software accumulates statistics on the results of each image analysis. Data on individual particles can be saved while running. The statistical plots and values are shown on-screen while running and updated as the analysis is occurring. At the end of a run the accumulated particle statistics are available for display, printing, or export to Microsoft .xlsx (Excel) format.

The image rate of the camera can be up to 127 frames per second depending on camera resolution settings. The software attempts to capture and analyze every camera image but may run at a slower rate depending on the number and type of measures selected and particle density. Higher frame rates can be achieved if the resolution setting of the camera is reduced.

In addition to the normal number histograms, the software generates surface area-weighted and volume-weighted histograms for some of the shape models, making certain assumptions about particle size and shape in the third (unseen) dimension. The recirculating fluidic system presents particles for analysis in a random orientation. This is critical to ensure all dimensions of the particles in question are being measured, not just two dimensions.

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System Overview

The ***Pi RAPTOR Portable*** is a full-featured laboratory particle size and shape analyzer utilizing Dynamic Image Analysis technology. Housed in a ruggedized case with battery operation allows for laboratory as well as remote field use.

Ideal for applications where particle shape, not just the particle size, may be critical information for predicting raw material quality and maintaining a high level of process control. Particle morphology provides essential information regarding the physical shape properties of your sample. Particle shape can affect flowability, dispersion, packing density, and sample segregation. It can also identify aggregate formation. The fully automated ***Pi RAPTOR Portable*** is a well-suited research-grade instrument for use in a total production environment where speed, accuracy, and ease of use with the ability to also be portable in nature.

The system comes standard with one lens configuration but can be customized to meet any unique customer needs. Interchangeable and disposable flow cell design ensures the cleanliness of the system and no carryover of previous samples. Operates using a touch-screen Microsoft Surface Pro computer and has an internal battery for up to 5 hours of continuous use.

Flexible sampling system allows for adapting for online use, off-line use with an internal recirculating pump, or manually for small volumes using sterile syringes. All fluidic connections use standard Luer fittings.

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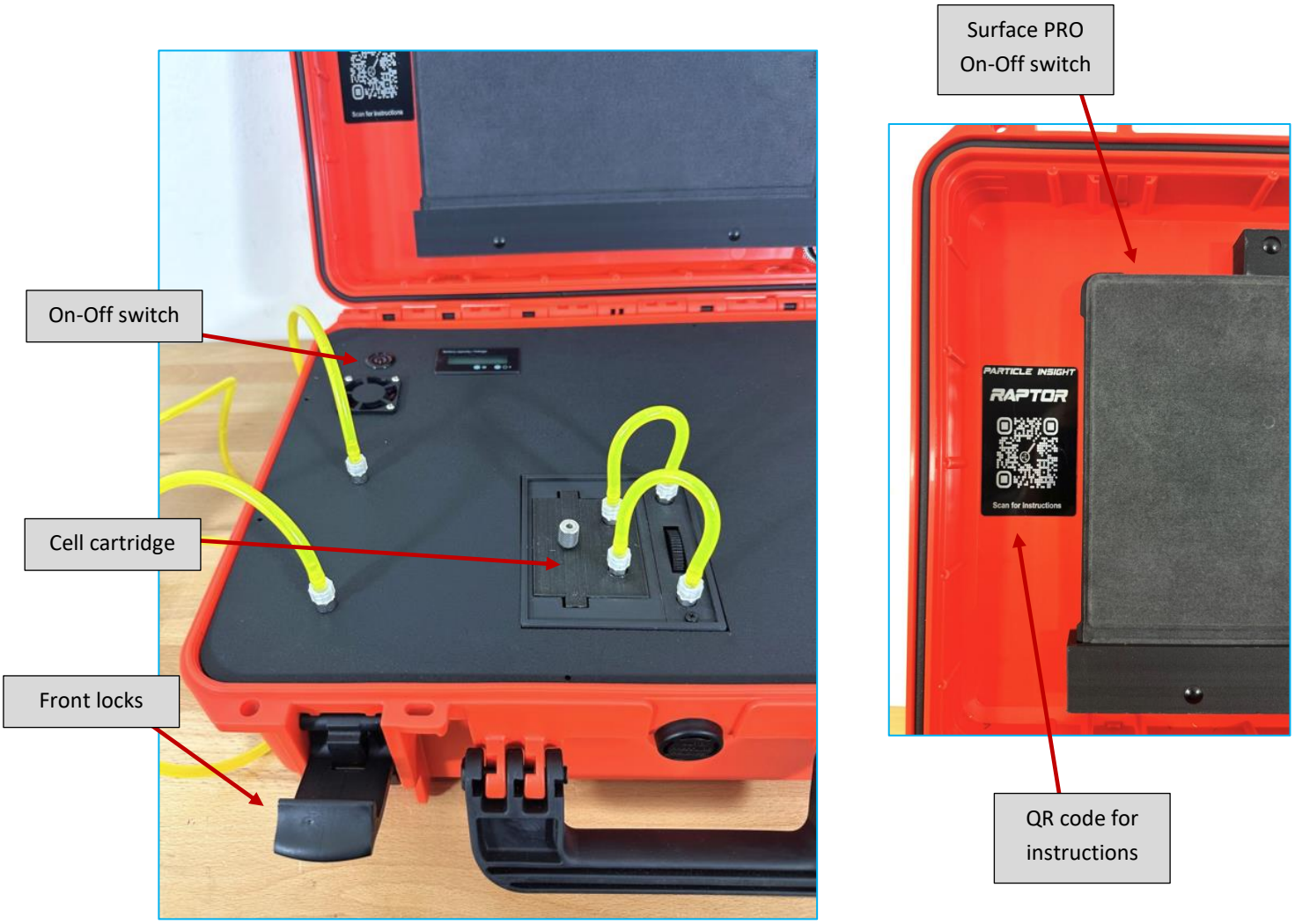
Initial setup

The Pi RAPTOR Portable operates on an internal 12V lithium battery. The battery MUST BE properly charged before attempting to use the instrument.

A battery charger can be connected at the rear of the box to keep the battery enable to supply the voltage to the instrument. The input voltage of the charger is from 100 to 240V AC. Therefore, there is no specific voltage configuration.

- Open the box by releasing the front locks (2).
- Install the cell cartridge.
- Turn the instrument On by pressing the On-Off switch located at the top cover.
- Turn the Surface PRO On and wait for the application software to open.



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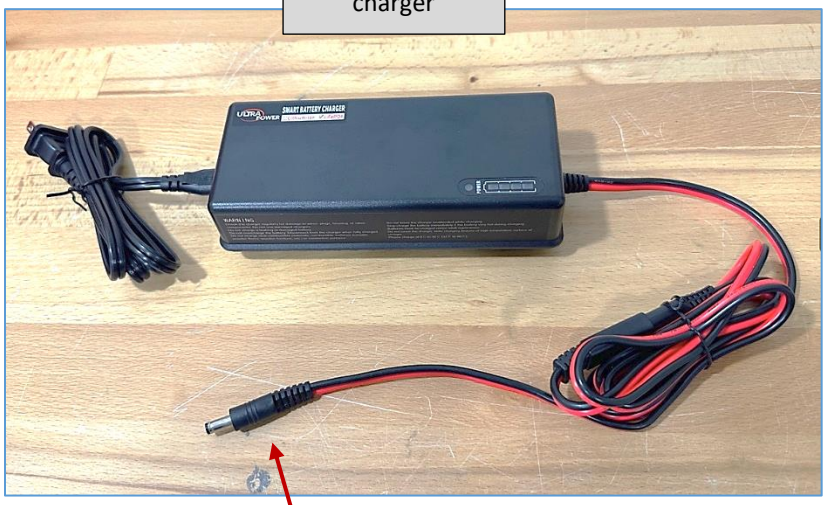
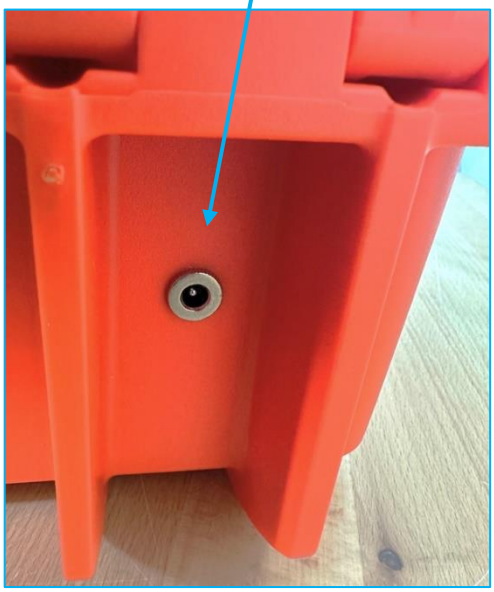
Battery Charger connection

12V DC Battery charger



12V DC plug

12V DC socket



Rear of the instrument

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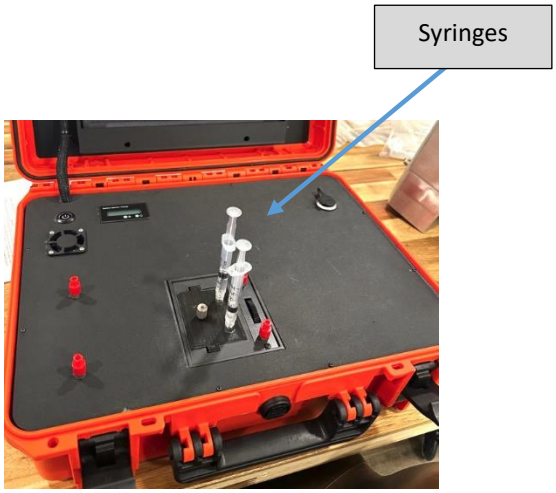
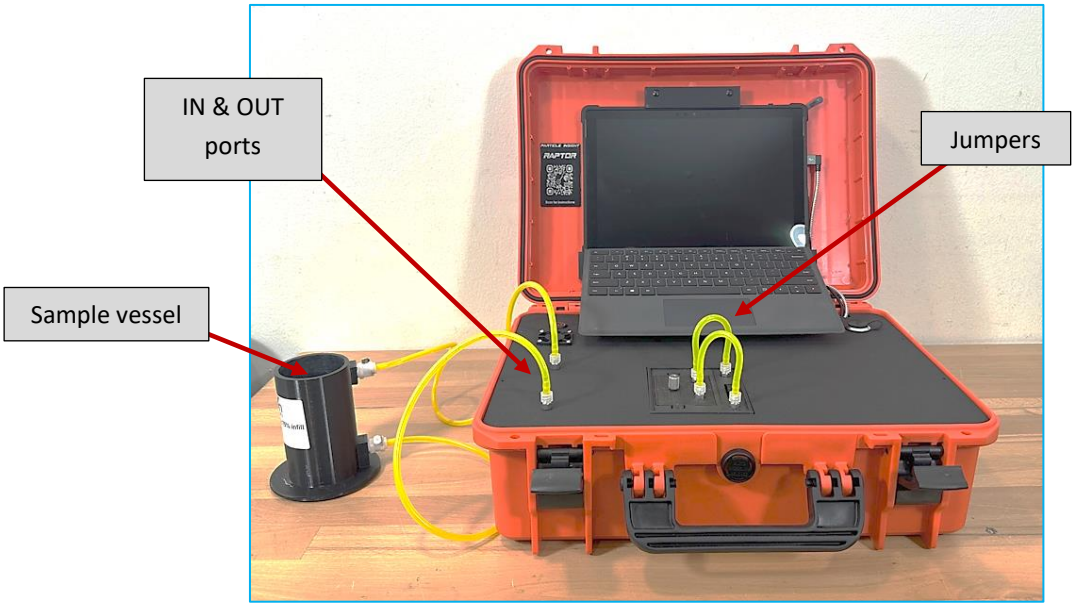
Fluidics Connections

The Pi Raptor Portable has two methods of operation regarding fluidics: Syringe or Pump.



Syringe method: With no jumpers attached, the syringes with particles should be directly connected to the Luer fittings of the cell cartridge to run the sample. Both plungers should be moved in and out alternatively to transfer the sample between the syringes and recirculate the sample through the cell for the analysis. The pump must be turned Off during run. See ***Settings***, section ***Hardware settings*** for details.

Pump method: Remove the four Luer caps from the IN & OUT ports and jumpers. Connect the jumpers to the fittings of the cell cartridge. Connect the tubing from the sample vessel to the Sample IN and OUT ports. Fill the vessel with water or the diluent to be used and add the sample. Turn the pump ON to recirculate the sample through the cell and the sample vessel. When analysis start, the pump will be turned On automatically and Off when the run is completed.



- Press the ***Preview images*** button to start capturing images.
- Once the particles are visible in the screen, your system is ready and operational.

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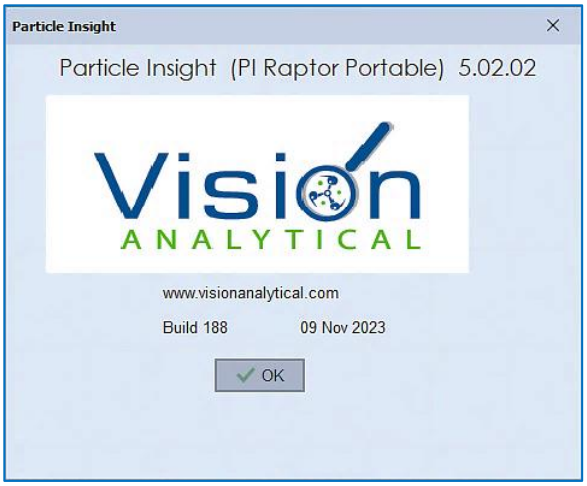
Chapter 2 - SOFTWARE OVERVIEW

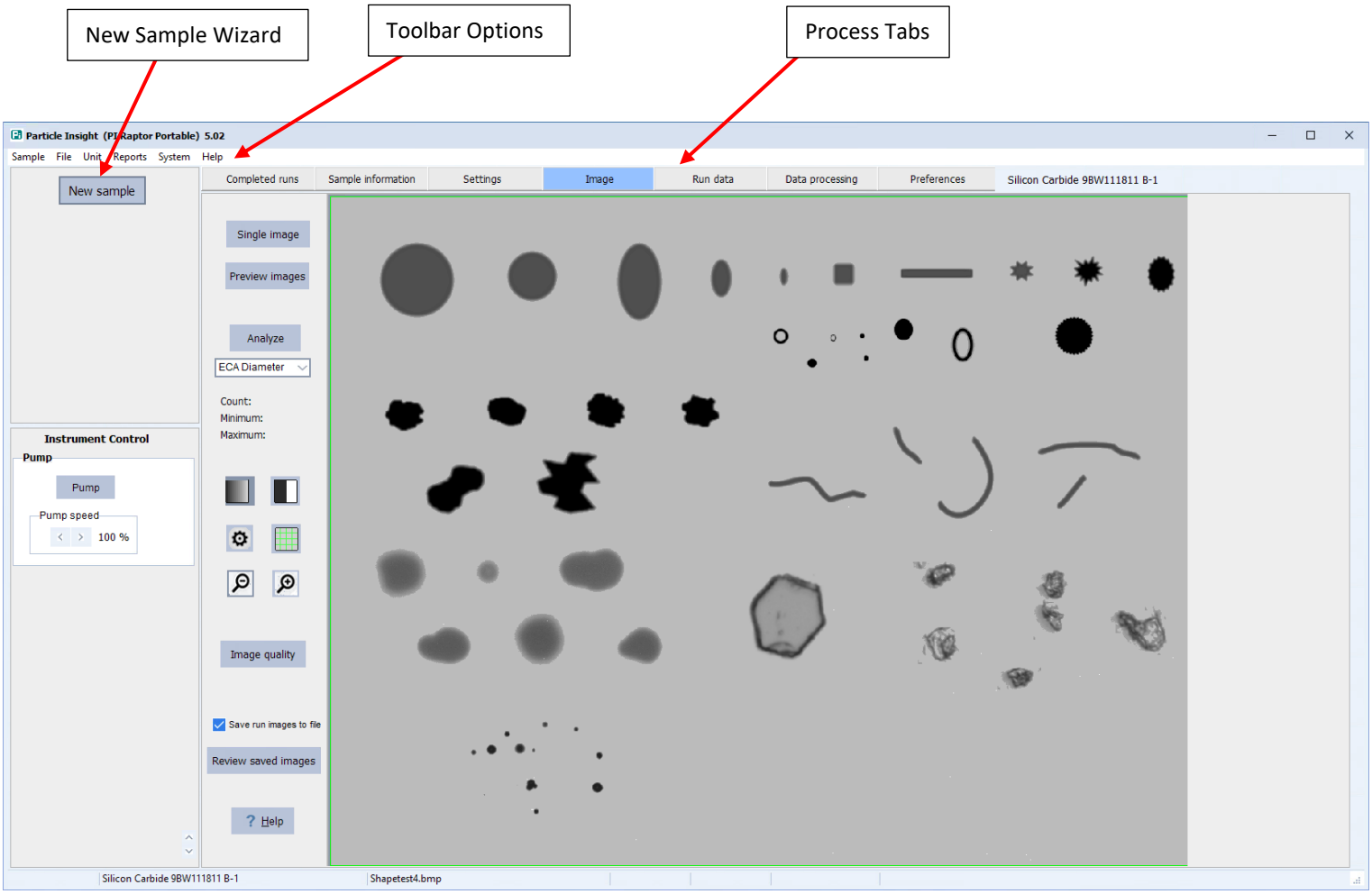
User Interface



The software covered in this User Manual is version 5.02

Below is the User Interface used by the Pi RAPTOR Portable.

Wherever you see this icon  you can click on it and there is a video available with more details.



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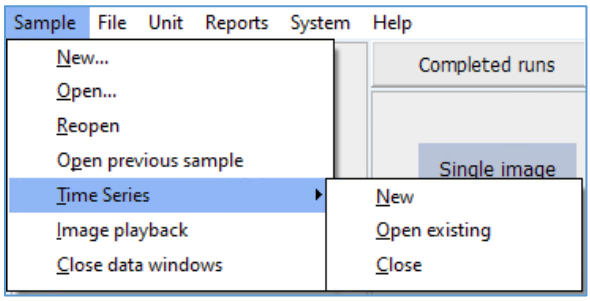
Toolbar options



Sample

New... Create a new sample file ready to accept data.

Open… Open a sample file or template file. The current Analysis specifications and Report Options settings will be overwritten with the values stored in the sample file.

Reopen: This option reopens the original file if you have made changes to the currently open file**.**

Open previous sample: Open the previously saved sample file.

Time series chart: This feature allows the evaluation of behavior from particles suspended in a solution by plotting results of pre-selected measures and statistics from a collection of samples run files, over a period of time under same conditions and settings. The run series settings: run duration, delays between runs, measures and statistics can be set in advance. The charts created for each combination of parameters reflect the behavior of particles and can be used in different applications and processes like dissolution and crystallization in pharmaceutical industries.

New - Create a new series chart

Open existing- Open an existing chart

Close - Close the currently open series chart.

Image playback: Review images from a runfile and allows reanalyze to generate new run data.

Close data windows: Close a currently open data window.

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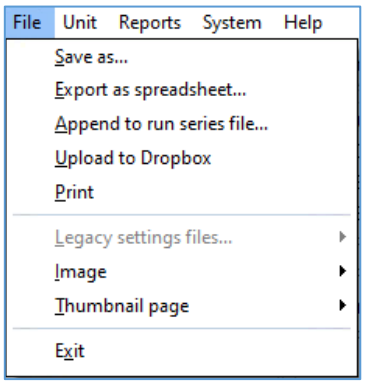
File



Save as … Save an open sample file under different name.

Export as spreadsheet … Test results will be written to a file in a Microsoft Excel format. The first worksheet contains the run name, plus the sample documentation. It then lists system performance data (from the System Data window), and the most important settings affecting the run. Then there is a separate worksheet for each measure. Each of these worksheets present the statistical means and percentiles, followed by the complete bin-by-bin distribution table.

Append to run series file … A one-line statistical summary of sample data currently showing will be appended to the file specified in ***Settings ➔ Run Control Specifications ➔ Completion Actions ➔ Append to run series file.*** This feature is useful to add statistics from different runs to do comparisons in Excel.

Upload to Dropbox … The current sample file can be uploaded into Dropbox for use with the Pi RAPTOR smartphone and iPad app. More information on this is discussed further in the manual.

Print … This option prints a report for the currently open sample. The contents of the report are controlled by the settings in ***Preferences ➔ Printed report***.

Legacy settings files …

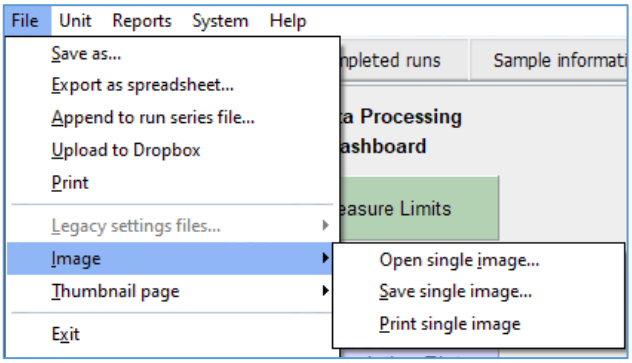
Open a file with extension *.ac containing analysis specifications previously saved.

Open a file with extension *.rc containing run control specifications previously saved.

Open a file with extension *.ro that contains the report options.

Image:

Open Single Image … Read in a stored image. The image can be analyzed with the current image analysis settings that are in effect.



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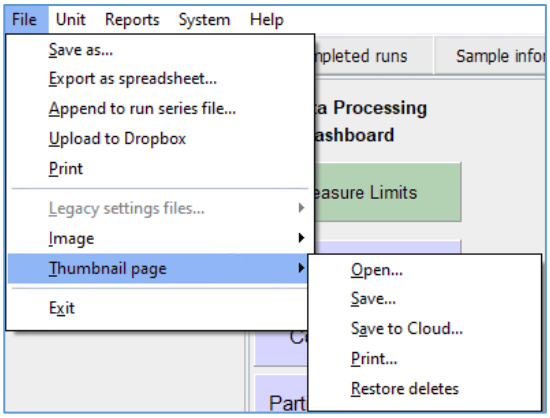
Save Single Image ... Save the image now showing on the main screen to a disk file, in 8-bit TIFF format. A dialog box will appear, allowing you to enter three lines of descriptive information that will be saved with the image.

Print Single Image ... Print the image currently on the main screen. The image will be printed as it is shown on the main screen, using the currently selected image display mode, i.e. full grayscale or black/white. A dialog box allows entering descriptive information that will appear under the printed image. The print may take from a few seconds to several minutes, depending on the amount of darkness in the image.

Thumbnail page:



Open ... Read in a stored thumbnail page.

Save ... Save the currently open thumbnail page.

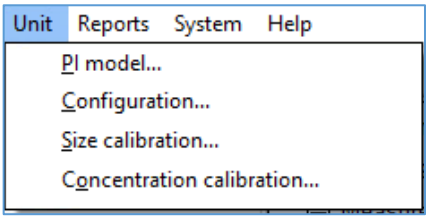
Save to Cloud ... Save the currently open thumbnail page to ParticleShape cloud.

Print ... Print the thumbnail page currently on the main screen. The image will be printed as it is shown on the main screen.

Restore Deletes ... Restore previously deleted thumbnails pages.

Exit: Exit the program.

Unit



Pi model ... Allows to select the model of the instrument.

Configuration ... Opens the ***Settings*** tab and shows the ***Harware configuration.***

Size Calibration ... Opens the ***Size Calibration*** dialog box (see **Calibrate** section of this manual for more information).

Concentration calibration ... Open the ***Concentration calibration*** dialog box. (see **Concentration Calibration** section of this manual for more information).

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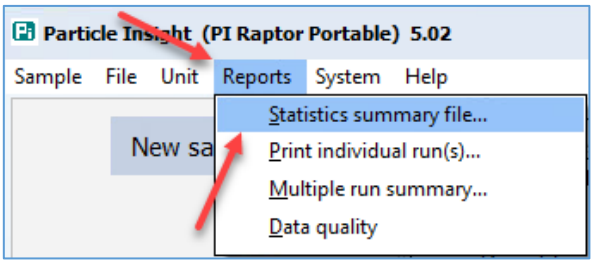
Reports

Statistic summary file …



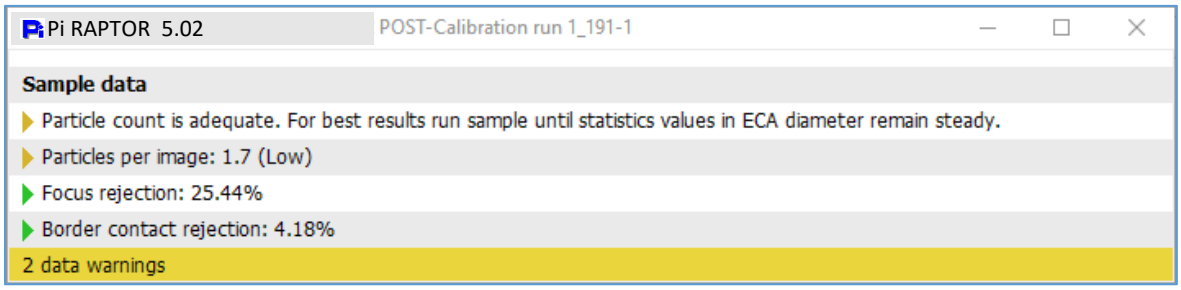
- Under ***Preferences*** select the Measure stastistics to be included in the Excel file.
- Open a sample run file, click on ***Reports*** ➔ ***Statistics summary file …***
- Select the subrange for size measures (minimum and maximum) to be included in the summary file and then click on ***Create file*** to save the info in .xlsx format file. The output file will be a spreadsheet, and the default filename is the current sample name with "ss1" appended saved in the folder ***export***.

Print Individual run(s) … First**,** you should open a sample run file, then click ***OK*** to print the sample run file.

Multiple run summary … Select one or more sample run files to be used to create a Multirun report, containing a line of statistical data for each sample. For detail, see the ***Multiple run summary …*** section in this manual.

Data quality:

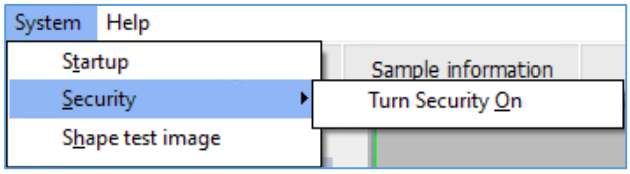
This option offers information regarding quality aspects of a currently open runfile.



System:

Startup: Allows you to select the ***Startup Settings*** and ***Startup Preferences*** files before running a sample.

Security: Allows to turn the security options **On** or **Off**.
For more detailed information, click HERE to visit the Chapter 8 - ***Security***.



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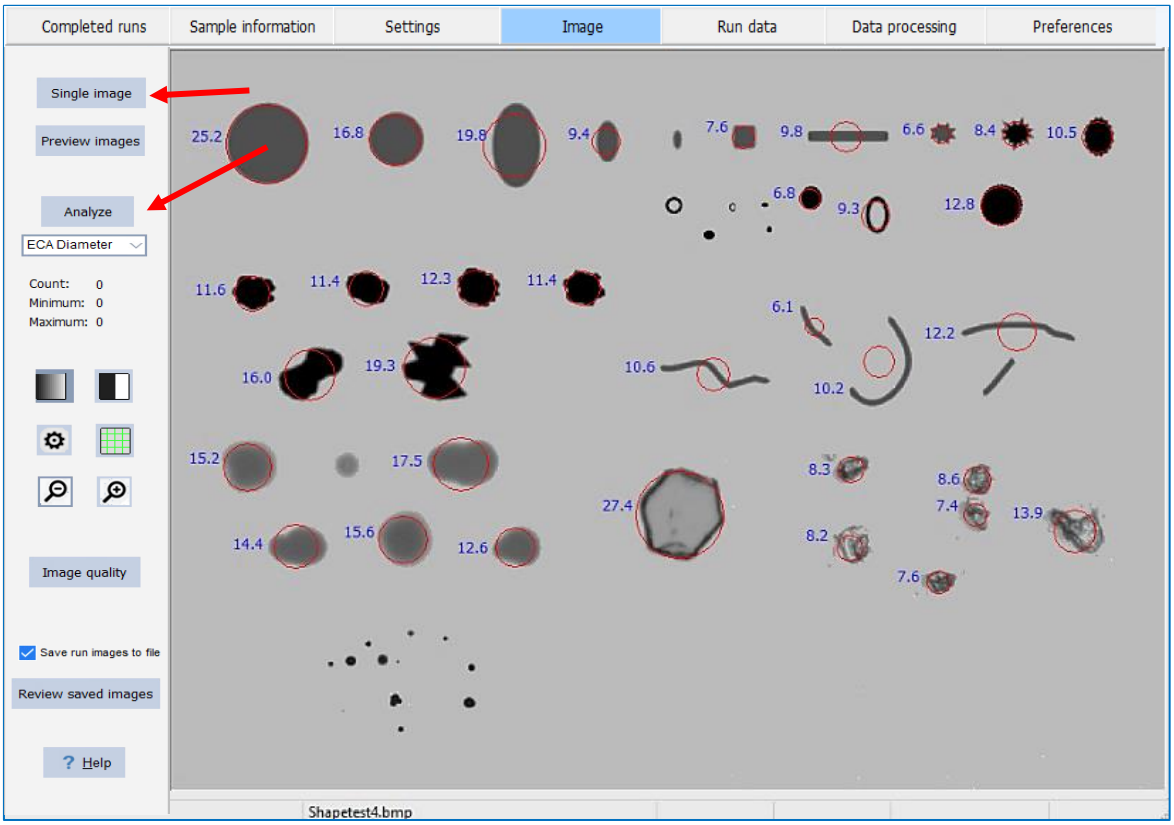
Shape test image: This image shows the differences among the various measures.
To see the differences visually, click on ***Analyze***, to do a single image analysis. The screen will show the measures selected in the pull-down menu. To see a different measure, click on the ***pull-down menu***, select other measure then click ***Analyze*** again.



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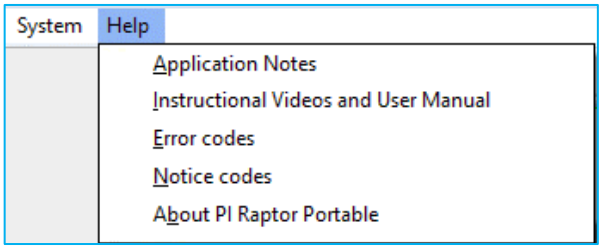
Help

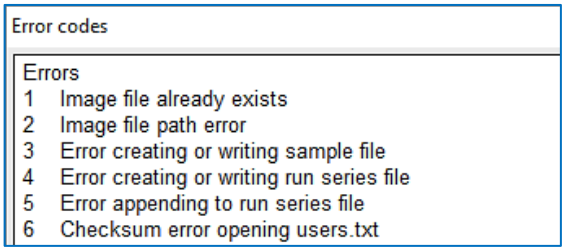
Application Notes (web page): This option contains a link to Vision Analytical website where you can open an Application Notes of your interest.



Instructional Videos and User Manuial (web page): This option contains a link to Vision Analytical website where you can open an application video of your interest and/or the User Manual.

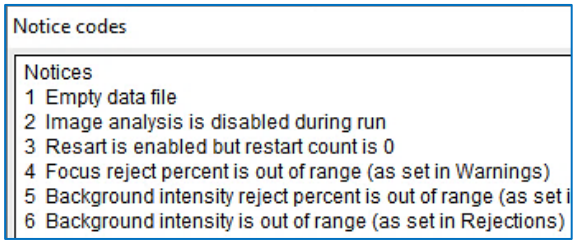
Error codes: This option shows a list of codes for errors that happens during the execution of a command.

Those codes are shown in the section 4 of the Status bat at the bottom of the screen.



Notices codes: This option shows a list of warning codes for notifications delivered to clarify the situation when any action, function or command cannot be completed.

Those codes are shown in the section 5 of the Status bar at the bottom of the screen.



About Pi RAPTOR Portable: Opens a window with the software name and version.

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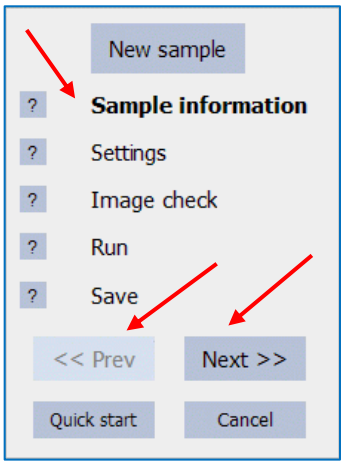
Wizard for running a new sample.



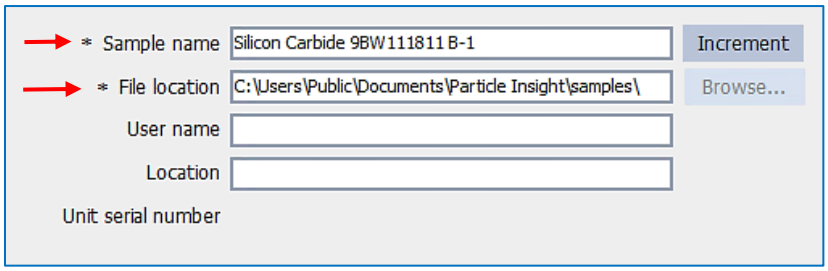
This wizard walks you through the process to run a new sample, assuming the system is full of liquid and circulating.

- Add the sample to the sample vessel.
- Click on ***New sample*** to start the Wizard.
- Then, click on **Next** after each step to navigate through the wizard.
- If a correction is needed on any information previously entered, click on ***Prev*** to go to the previous step.

Step 1 - Sample information

The user should enter a sample name and the file location if other than default.

User name and location are optional.



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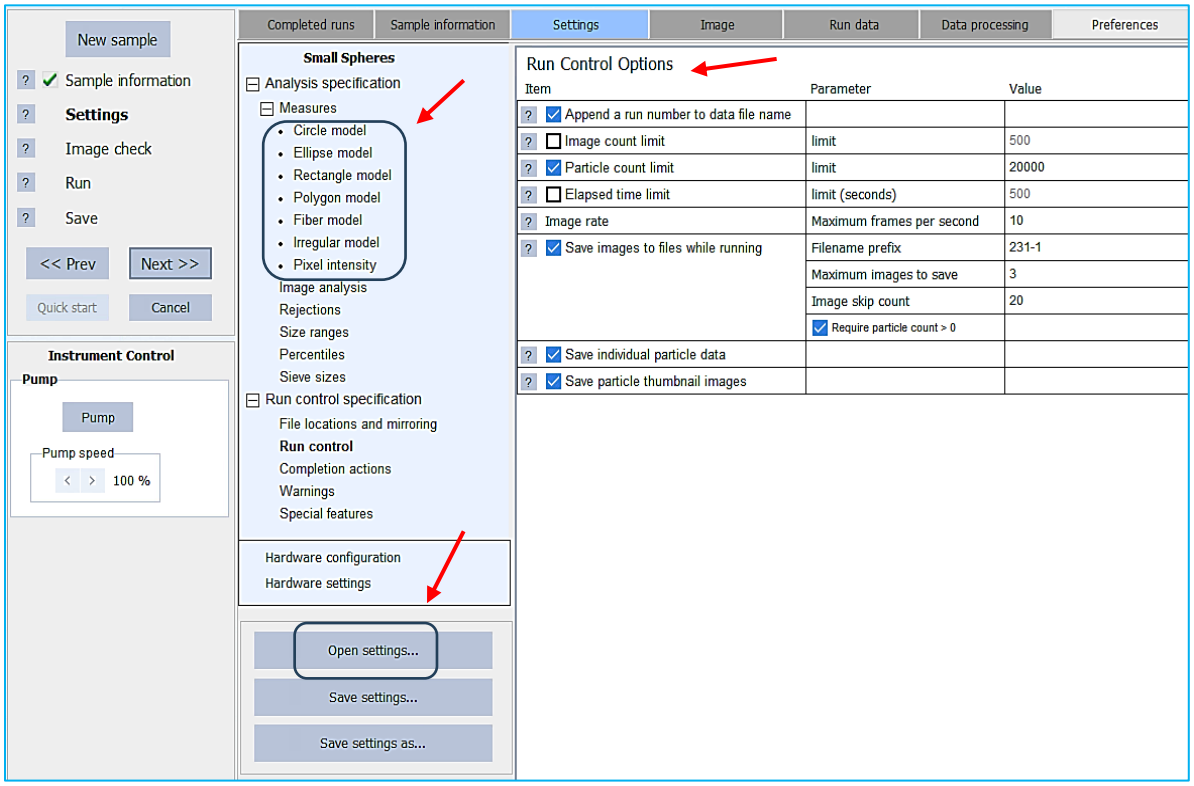
Next ➔ Step 2 - Settings

The user should do the following:

- Open a specific Settings file or adjust the current settings under ***Measures*** as well as the parameters to match the type of particles being measured.
- Select an additional parameter you want to be included under ***Run Control Options.***



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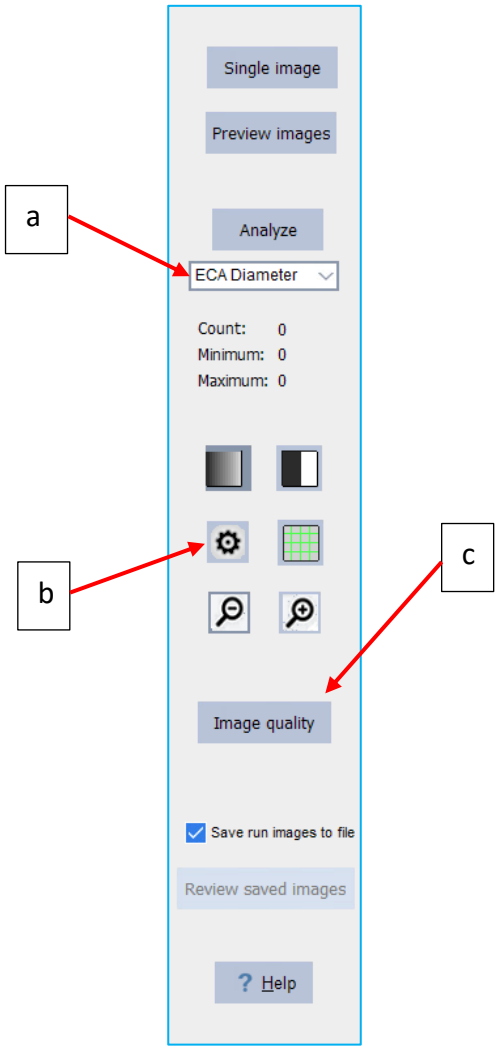
Next ➔ Step 3 - Image check

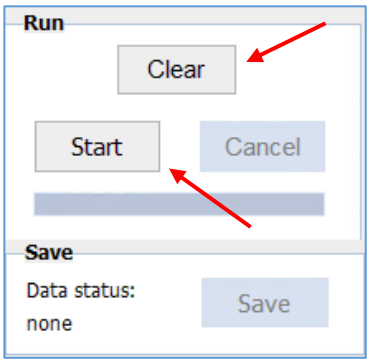
This step allows the user to verify and select different parameters related to the image like:

a. type of Measurements
b. quick adjust parameters
c. verify the background histogram



Next ➔ Step 4 - Run

To start the analysis in the Pi RAPTOR Portable, click on ***Clear*** then click on ***Start*** and the run should start.



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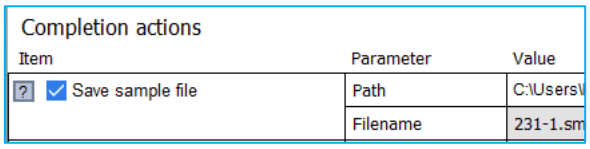
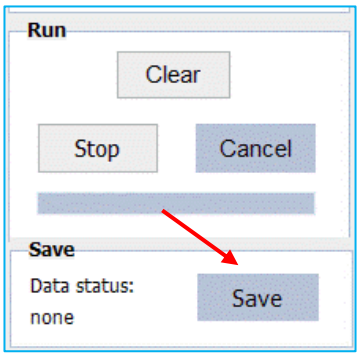
Next ➔ Step 5 - Save

After run is completed, the data is automatically saved if the ***Save sample file*** option has been pre-selected before starting a run.

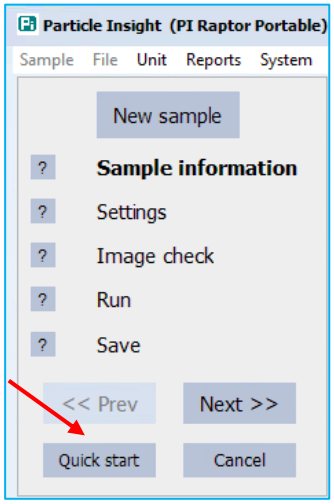
.



If no pre-selection was done, click on ***Save*** to save the data.
Otherwise, if the run is stopped, click on ***Save*** to save the data.



Quick Start: This option allows to initiate a run using the current Startup Settings and Preferences. No need to enter that info again and again as you are running the same sample.



For more detailed information about navigation through the ***Wizard***, click HERE

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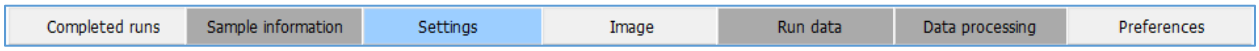
Process Tabs

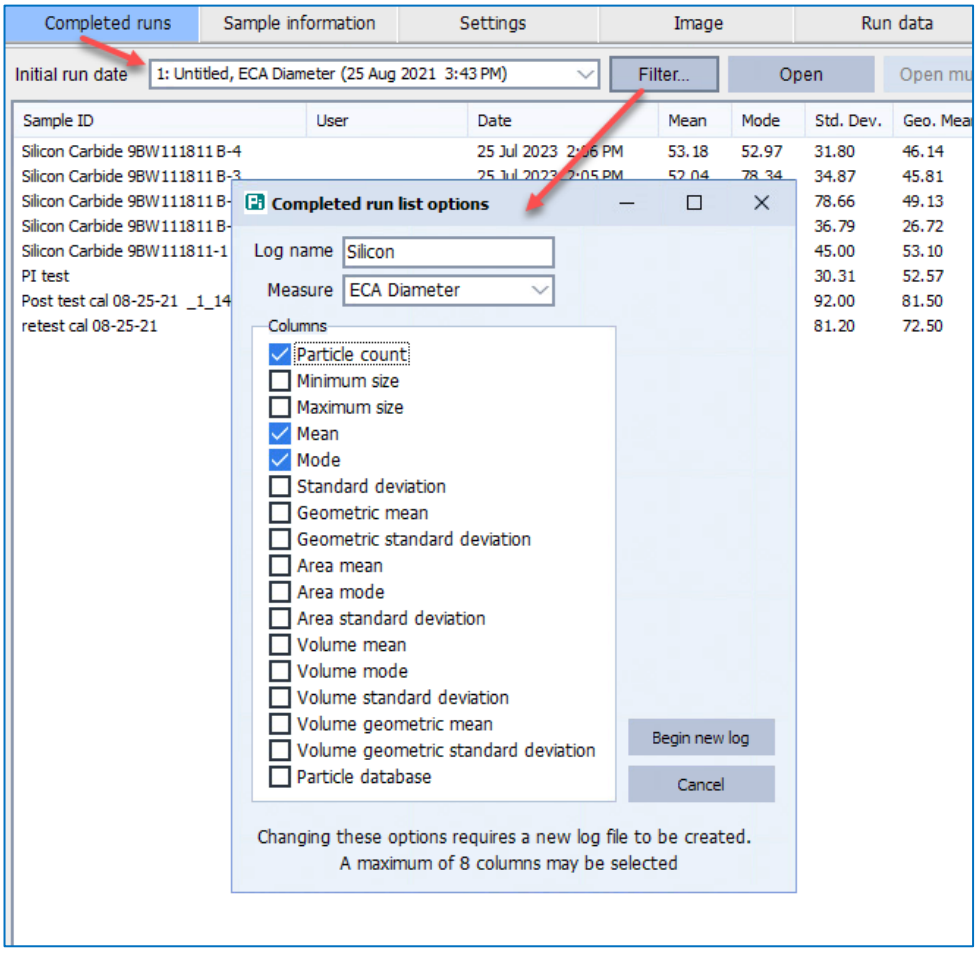
Process tabs are the high-level functions: ***Completed runs, Sample information, Settings, Image, Run data, Data processing*** and ***Preferences.***



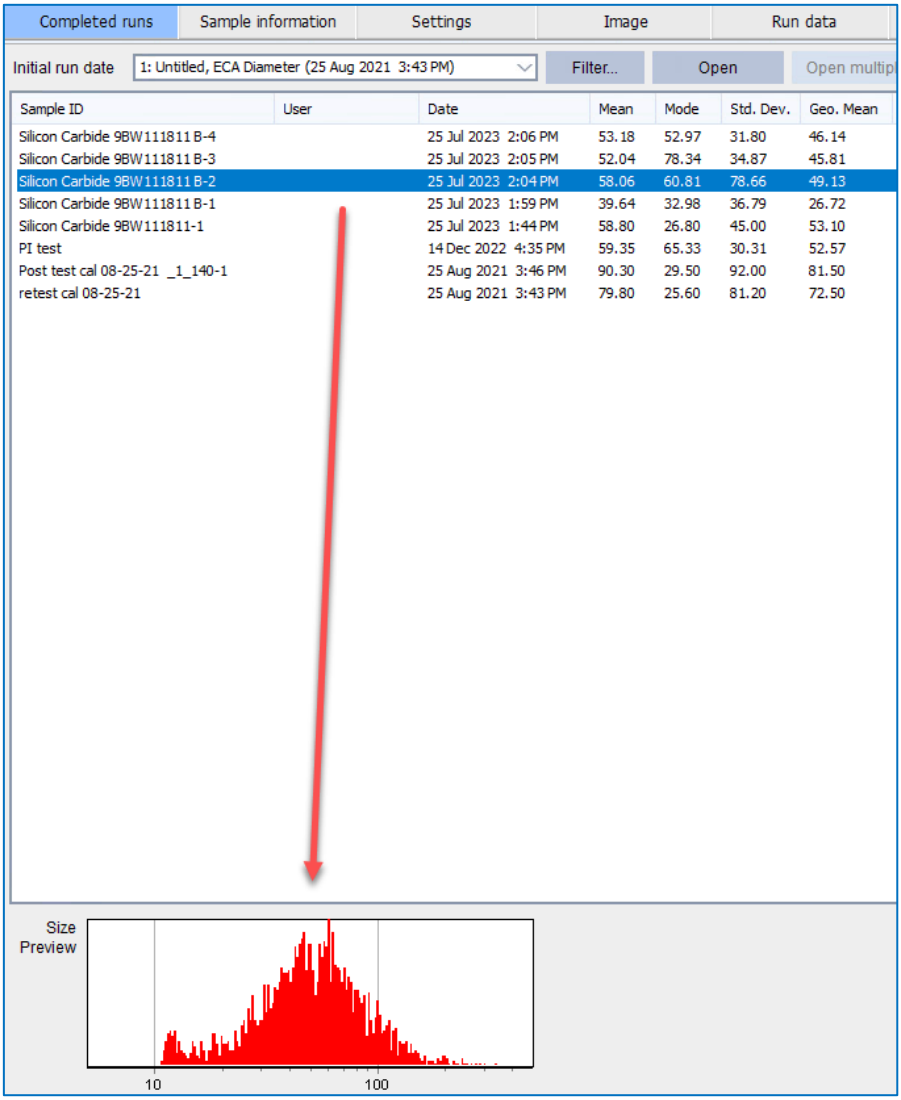
Completed runs.

This Tab shows a list of runs completed along with relevant info.

The user can select the ***initial run date*** for that list and the measurements that will be shown by opening ***Filter***. A ***Log name*** should be entered.



Click on a sample name and see the ***Preview*** of the histogram of the ECA Diameter before open the run.



Double-click on the sample name in the ***Completed runs*** list to open a run. Results will be displayed in the ***Run data*** tab. If individual particle data was saved during the run, the ***Data Processing*** tab will also be enabled.

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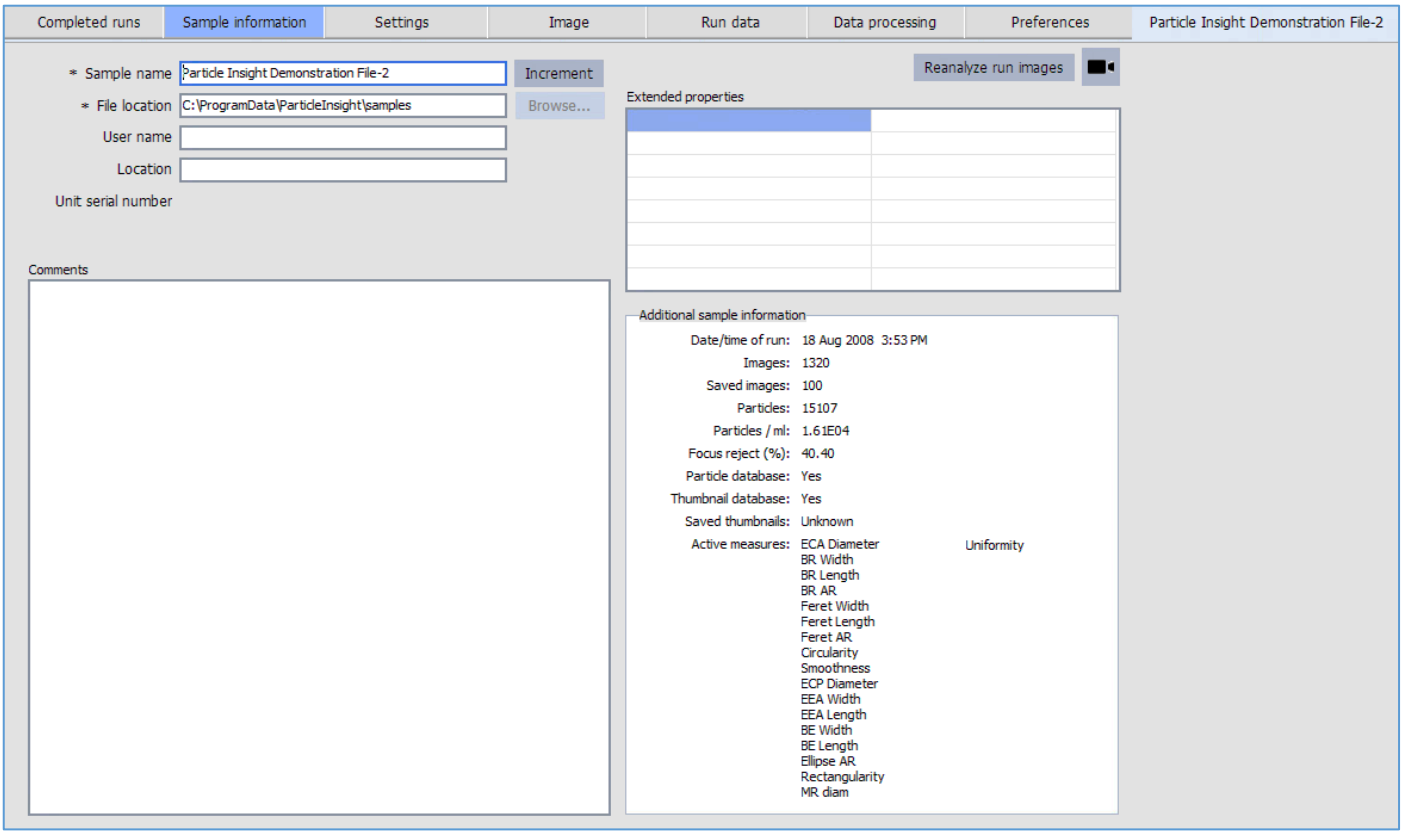
Sample information

The user can enter the Sample name, the file location where to save the file and add comments.



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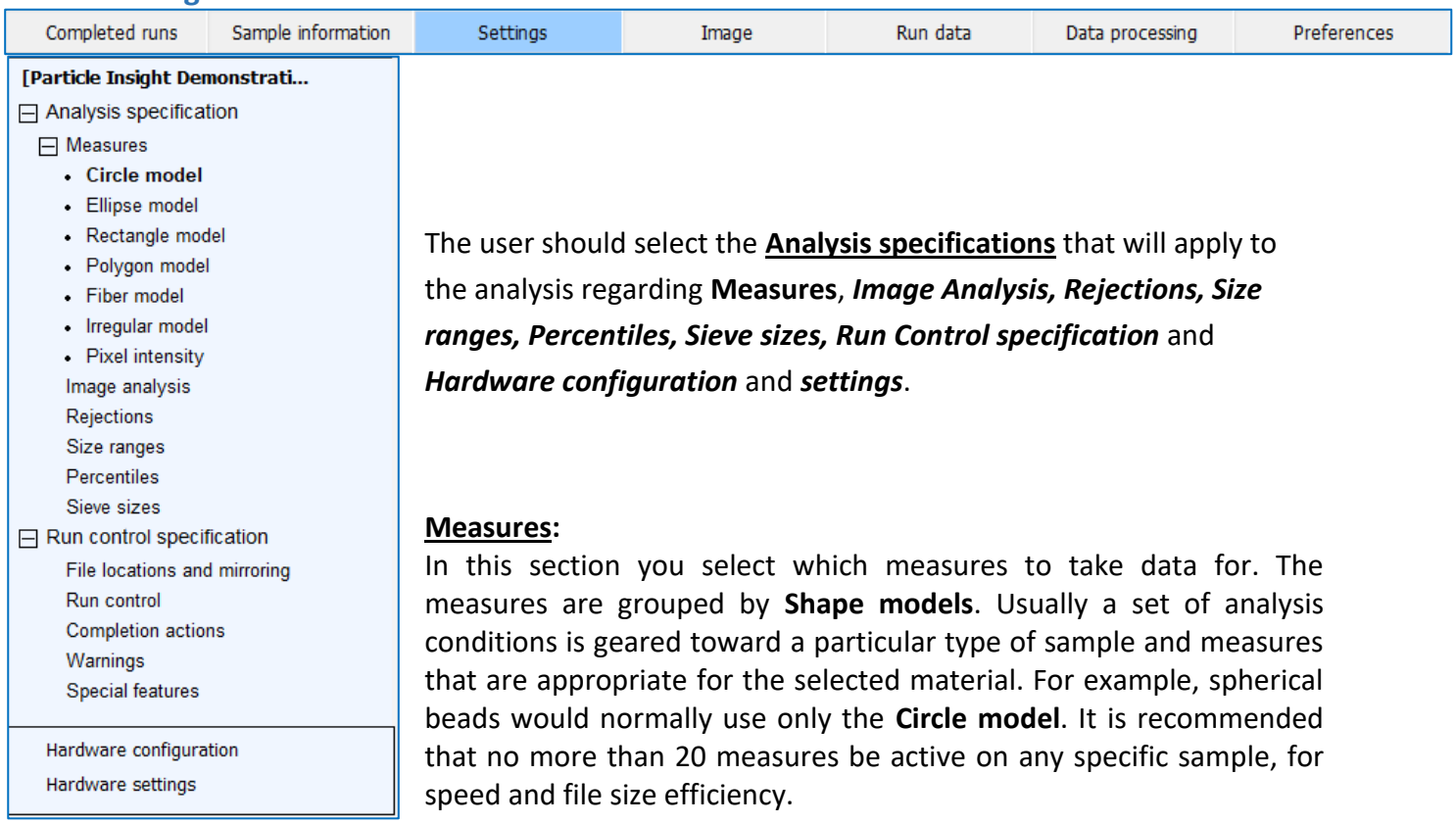
Settings



The user should select the **Analysis specifications** that will apply to the analysis regarding **Measures**, ***Image Analysis, Rejections, Size ranges, Percentiles, Sieve sizes, Run Control specification*** and ***Hardware configuration*** and ***settings***.

Measures:
In this section you select which measures to take data for. The measures are grouped by **Shape models**. Usually a set of analysis conditions is geared toward a particular type of sample and measures that are appropriate for the selected material. For example, spherical beads would normally use only the **Circle model**. It is recommended that no more than 20 measures be active on any specific sample, for speed and file size efficiency.

Image analysis: This section, together with Rejections, lists all the parameters that affect the raw results of an image analysis before the shape measures are calculated. These settings let you optimize the analysis for a certain particle type, particle density, and image features (brightness etc.).

Rejections: The various rejections are for bypassing particles or image artifacts that would not produce accurate data, such as out-of-focus particles, particles intersecting a border or non-particles ("debris"). The ranges can be restricted in ***Rejections*** ➔ ***Shape rejection*** separately for each FRACTION measure.

Size ranges: For size measure types (DIAMETER, LENGTH, WIDTH), specify the sizes range (min-max) that will be accepted. FRACTION type (circularity etc.) normally specifies 0 to 1.

Percentiles: The user can select the default percentiles (5) for the measurement.

Sieve sizes: In this section, the user must select the sieve sizes to implement on the simulated Sieve axis.

For more detailed information about **simulated Sieve axis**, click HERE.

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Run Control Specifications:

These specifications contain run control settings such as number of images or particles to take, and actions to carry out during and at end of run.

File locations and mirroing: Show the default file locations for sample files, XLS data files, text data files and database. Also, enable mirroing for sample, XLS and database files.

Run control:

- Append a run number to data file name: Append a run number (-n) to the data filename, where "**n"** is initially 1. "**n**" increments whenever ***Increment*** is clicked, or an auto-increment is done in a run series.
- Image count limit: Set the limits for when to stop a run according to the number of images.
- Particle count limit: Set the limits for when to stop a run according to the number of particles.
- Elapsed time limit: Set the limits for when to stop a run according to the elapsed time.
- Image rate: Set the maximum frames per secon.
- Save images to files while running: All images up to the limit previously set, are saved to files on a storage device as they come in. After the maximum count is reached the run continues but no further images are saved. ***Frame skip count*** is the number of frames to bypass between captured frames. If ***Require particle count > 0*** is Yes, only frames with accepted particles are saved. This option may affect the frames/second rate. Saved images may be reanalyzed post-run under different analysis settings. Each image uses between 1MB and 5 MB of disk or drive storage, depending on camera resolution. For this reason, it may be impractical to save all images that are taken during the analysis. For instance, 100 images could represent about 500 MB of storage space.
- Save individual particle data: The values of all selected measures for each particle are saved while running and may be queried in ***Data processing***.
- Save particles thumbnail images: Thumbnail images for each particle are saved to a disk file while running. The image database may be queried in ***Data processing***. Take note that the size of this file will be 1 to 2K per particle, depending on particle size. Thus, a run with 20,000 particles will have a thumbnail file size of at least 20 MB if the option is enabled.

Completion actions: Set the actions that will be completed automatically at the end of the run. This includes saving sample files and export Excel run reports. The user can select if they want the system to print results at the end of a run. This page allows the user to have several automatic re-starts of the analysis using the same aliquot that is recirculating. Each restarted run represents a separate sample file, with a different number suffix. This is a useful tool to do studies on how particle shape changes over time. It is also useful for repeatability verification. Also, the user can append the run to a Run series file.

Warnings: You may specify allowable ranges for ***Focus reject percent, Background intensity reject percent***, and/or ***Dark pixel percent***. Also, ***Inappropriate Threshold*** has default limits.
If the option is enabled and the variable goes outside the allowable range, the value is shown in red in the lower right portion of the display. In all other respects, the run continues normally.
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Special Features:

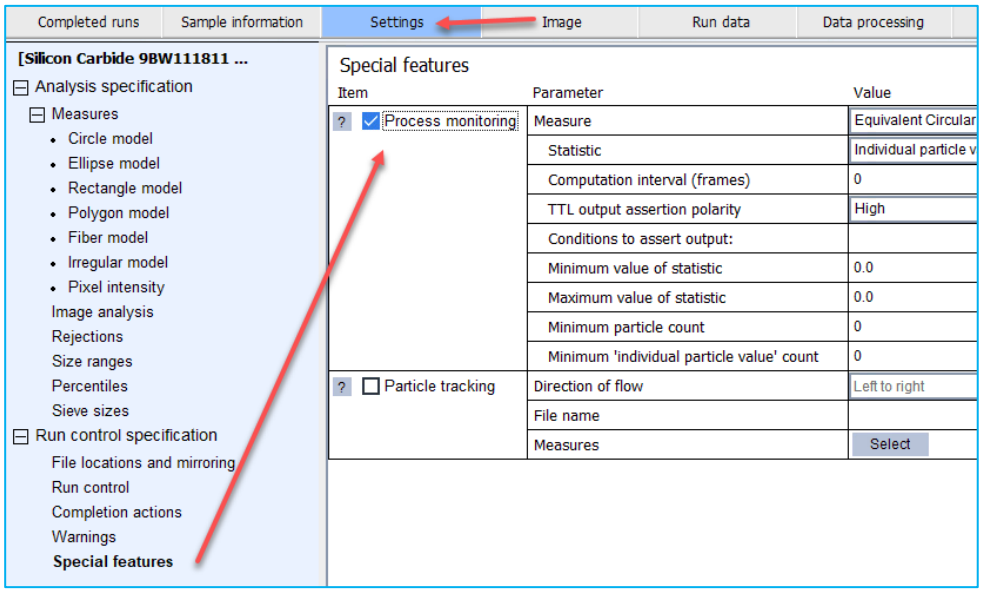
Contains settings for special features like ***Process monitoring*** and ***Particle tracking.***

Process Monitoring and Control

This feature can track the ECA Diameter value, or any other active measure value of particles, and generate a TTL output level when any of the following values falls within a specified range:

- Any individual particle measure value.
- Smallest particle measure value over the last N frames (images)
- Largest particle measure value over the last N frames
- Mean or standard deviation of the measure over the last N frames
- D10, D50, D90, DV10, DV50 or DV90 over the last N frames

Statistics (smallest, largest etc.) are recomputed and tested after each computation interval. Specify the computation interval in terms of a frame count (N in the list above).



Minimum particle count refers to the count of all particles in each computation interval (frames count).

- If the count in a specific computation interval does not meet the minimum, the output does not change. In other words, will remain in the current TTL level.
- If the count meets the minimum, the output will change the TTL level and will stay in that level until a subsequent computation interval does not meet the minimum.

Minimum 'individual particle value' count applies only if ***Individual particle value*** is the selected ***Statistics***.

- The count of all particles is reset to 0 after each computation interval is completed.
- To trigger the output on a single particle, set the ***Minimum individual particle count*** to 1.

FOR MORE INFORMATION ON THIS FEATURE, PLEASE CONTACT VISION ANALYTICAL INC.

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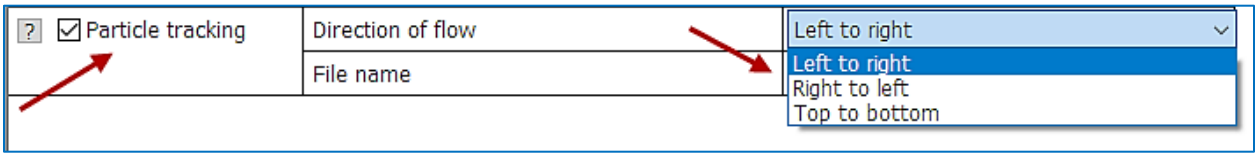
Particle Tracking

This feature is used when we wish to determine the speed of relatively slow-moving particles and possibly the change in their size over time. Particle Tracking tracks particles across successive frames, and at the end of the run, writes an output text file showing data about the tracked particles.

Assumptions and features:

- Particle concentration should be low.
- Particle size should not change appreciably from one frame to the next.
- To catch all particles, the speed of flow should be less than the image width/frame time. (Frame time can be determined by inverting the frames per second value.)
- The software can track up to 64 particles simultaneously; however, the particle density should be lower than 64 particles per frame for best results.
- All the normal analysis parameters apply, such as size limits and focus rejection.
- If normal size histogram data is also taken, the size data will contain multiple counts for tracked particles. Therefore, generating the normal size statistics is not recommended. The particle tracking data file contains information about particle size (but no histograms are computed).
- The direction of flow (left to right, right to left) must be defined if other than default direction (top to bottom).

The direction of flow and output filename should be entered before the run in ***Settings*** ➔ ***Run control specification*** ➔ ***Special Features***.



For every tracked particle, the output file lists:

- the frame number in which it was first seen.
- the offset (in microns) from the centerline of the flow.
- the ECA diameter (in microns) of the particle the last time it was seen.
- the velocity of it as determined by the last two times it was seen.
- the number of images it was seen in.
- Up to four active measures previously selected before starting the run, right after click on ***Clear*** and before click on ***Start***.

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The tracking file is written automatically when the sample is saved. This is what a typical tracking file looks like:

	A	B	C	D	E	F	G	H	I
1	1	1							
2	2	2							
3	2	2							
4	Total images:		29						
5	Elapsed seconds:		6.2						
6	Tracked particles:		484						
7									
8	frame	offset	diam	velocity	frames	BR Width	BR Length	BR AR	Rect
9	2	0.818	14.23	3.85	2	9.8	19.7	2.0	-1.0
10	1	0.020	30.34	1.02	3	25.1	41.7	1.7	0.7
11	2	0.040	126.23	2.53	2	139.9	170.0	1.2	0.5
12	1	0.629	84.85	4.17	3	80.3	106.4	1.3	0.7
13	2	0.764	33.36	3.15	2	27.8	47.1	1.7	0.7
14	2	0.757	6.77	0.06	3	6.3	7.3	1.1	-1.0
15	2	0.592	8.88	0.06	3	8.0	9.6	1.2	-1.0
16	2	0.012	32.33	0.07	3	34.6	40.4	1.2	0.6
17	3	0.163	10.09	0.06	2	9.1	12.4	1.4	-1.0
18	2	0.701	9.71	0.06	3	8.6	10.6	1.2	-1.0
19	4	0.289	8.81	0.04	2	6.5	12.5	1.9	-1.0
20	2	0.026	29.79	0.04	4	24.3	41.3	1.7	0.7
21	4	0.074	10.22	0.04	2	7.5	13.1	1.7	-1.0
22	2	0.693	93.37	9.73	5	92.1	121.1	1.3	0.6
23	4	0.232	9.10	0.24	3	7.5	10.6	1.4	-1.0
24	5	0.856	163.32	0.24	2	179.7	229.3	1.3	0.5
25	5	0.916	85.30	3.53	2	103.6	110.0	1.1	0.5
26	4	0.295	53.39	3.36	4	53.1	64.2	1.2	0.6
27	2	0.170	69.91	2.37	6	54.8	112.1	2.0	0.6
28	3	0.196	11.45	0.22	7	7.7	17.6	2.3	-1.0
29	4	0.106	83.72	2.36	6	85.5	100.2	1.2	0.6
30	4	0.109	13.68	0.15	7	12.9	14.6	1.1	-1.0

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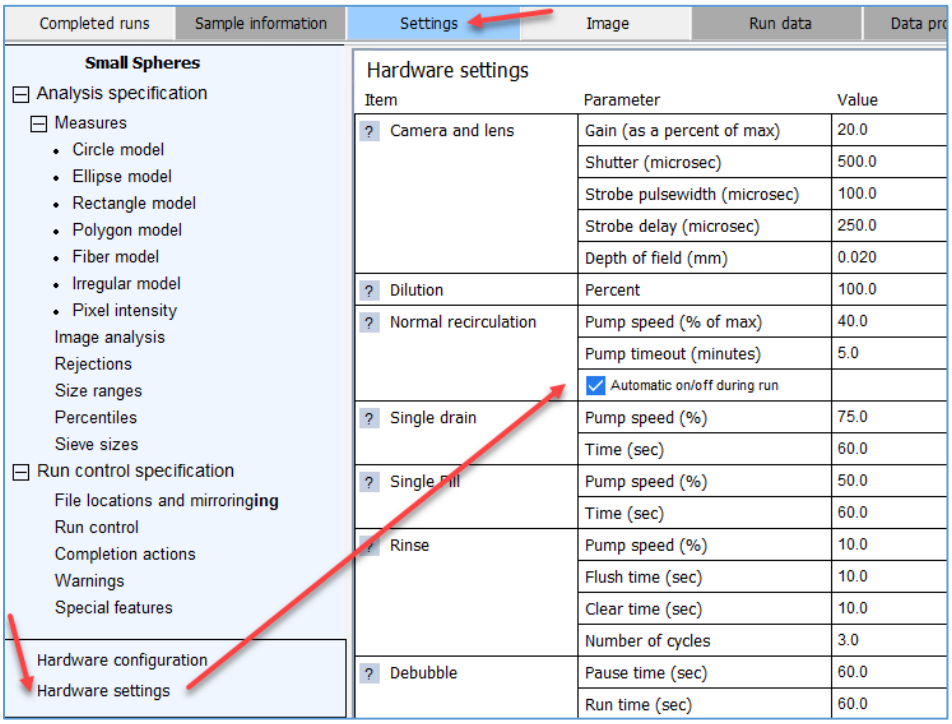
Hardware configuration:

This section contains information regarding Camera specification, Image resolution, Optics, Software version and serial number of the instrument.

Hardware settings

Contains Hardware settings related to Camera, Dilution and recirculation pump.

Important Note: When Syringe mode is going to be used, the option ***Automatic on/off during run*** MUST BE unchecked, as the syringes will move the sample through the cell instead of the pump.



Note: The options: ***Single Drain***, ***Single Fill***, ***Rinse*** and ***Debubble*** **ONLY** apply to the Pi Sentinel PRO instrument.

Open settings … Open a previously saved Setting file with extension ".psf"

Save settings Save the changes in settings to the currently open setting file.

Save settings as … Save the current settings into a file you designate with different filename.

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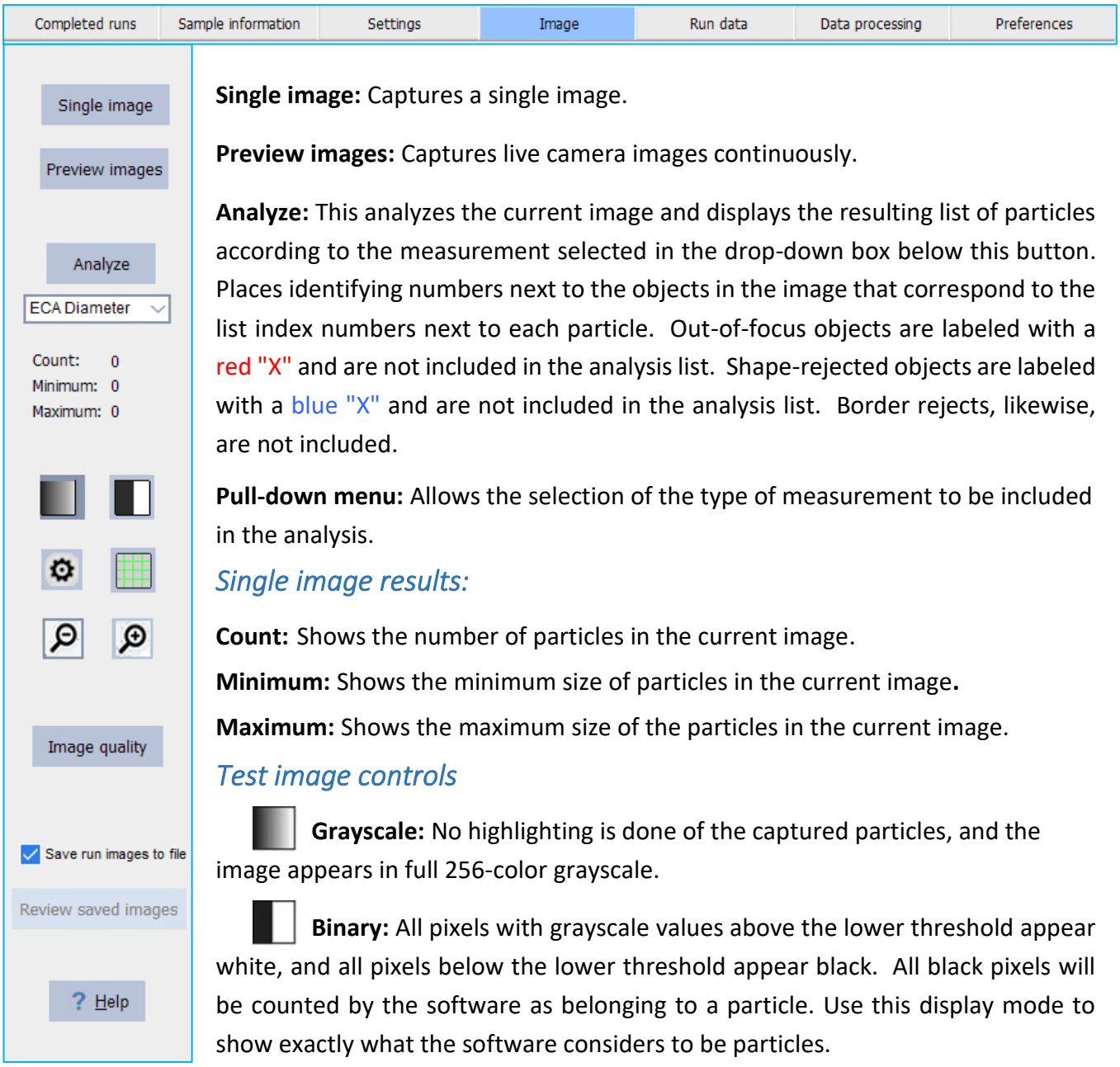
Image



Single image: Captures a single image.

Preview images: Captures live camera images continuously.

Analyze: This analyzes the current image and displays the resulting list of particles according to the measurement selected in the drop-down box below this button. Places identifying numbers next to the objects in the image that correspond to the list index numbers next to each particle. Out-of-focus objects are labeled with a red "X" and are not included in the analysis list. Shape-rejected objects are labeled with a blue "X" and are not included in the analysis list. Border rejects, likewise, are not included.

Pull-down menu: Allows the selection of the type of measurement to be included in the analysis.

Single image results:

Count: Shows the number of particles in the current image.

Minimum: Shows the minimum size of particles in the current image.

Maximum: Shows the maximum size of the particles in the current image.

Test image controls

Grayscale: No highlighting is done of the captured particles, and the image appears in full 256-color grayscale.

Binary: All pixels with grayscale values above the lower threshold appear white, and all pixels below the lower threshold appear black. All black pixels will be counted by the software as belonging to a particle. Use this display mode to show exactly what the software considers to be particles.

Size grid overlay on image: Displays a grid over the current image. The spacing of the grid is displayed in the main window status bar. To remove the grid, click on this button again.

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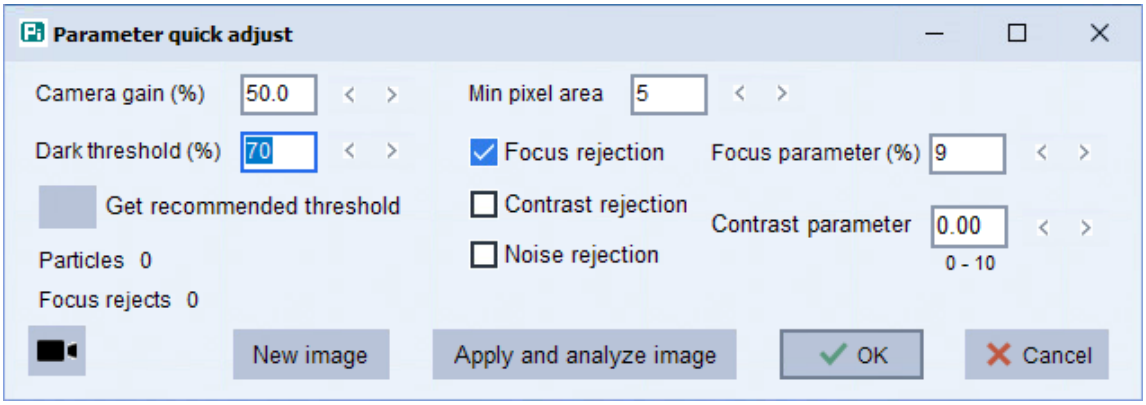
Camera Parameters quick adjust window:



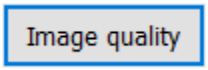
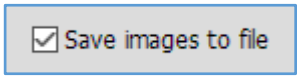


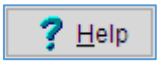
Image quality: Displays a histogram graph of all pixel values in the image. This is useful for checking uniformity of brightness and background gray level. For more on this subject, refer to the Advanced Tasks and Procedures sections of this manual.

Zoom in and **Zoom out** the image.



Save images to file.

Present images in a Show mode for images previously analyzed and saved.



Additional help related to imaging processing and parameters.

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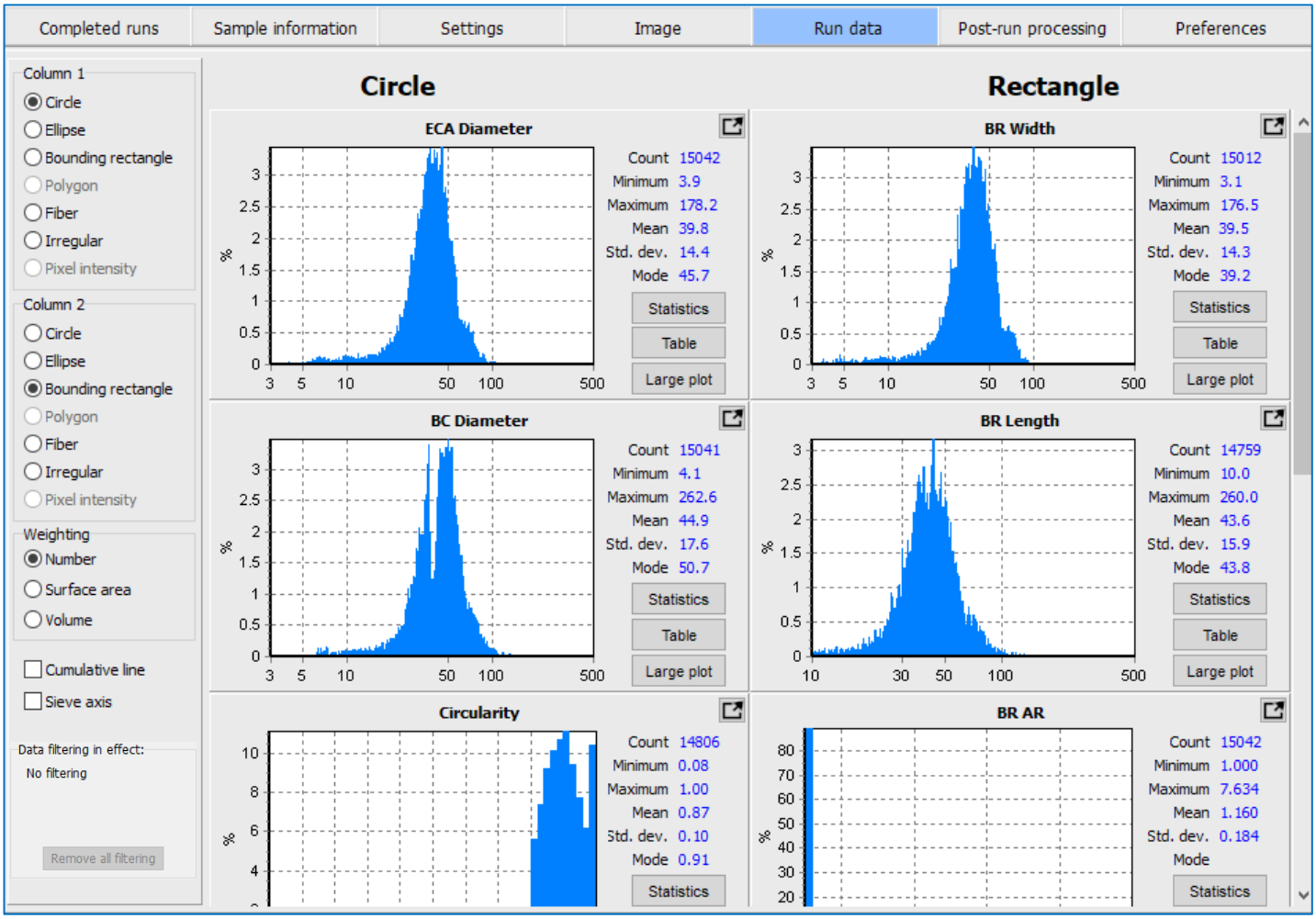
Run data

The user should select the **Shape Models** (*Circle, Ellipse, Bounding, rectangle, Polygon, Fiber, Irregular and Pixel Intensity*) for each of the two columns of data, as well as the plot ***Weighting*** (*Number, Surface area and Volume*) that will apply to the analysis result shown in screen below.



Use the vertical scroll bar to view ALL active measures (Shape models).

- Circle model:
  ECA diameter (Equivalent Circular Area), BC diameter (Bounding Circle), ECP diameter (Equivalent Circular Perimeter), Perim Circ (Perimeter Circularity), MR diameter (Mean radius), Circularity, Smoothness, Compactness.
- Ellipse model:
  EEA Width, EEA Length (Equivalent elliptical area) width, length, BE Width, BE Length (Bounding ellipse) width, Length, Ellipse AR (Ellipse aspect ratio), Ellipticity.

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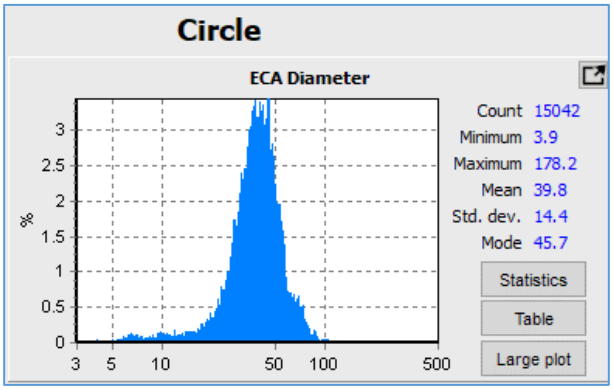
- Bounding Rectangle model:
  BR Width, BR Length (Bounding rectangle) Width, Length, BR AR (Bounding rectangle aspect ratio); Rectangularity
- Polygon model:
  Polygon order, Interior angles.
- Fiber model:
  Fiber Width, Length, Fiber aspect ratio, Fiber curl and Third dimension shape.
- Irregular model:
  Ferret Width, Ferret Length, Ferret aspect ratio, Martin Width, Martin Length, Surface uniformity.
- Pixel intensity:
  Opacity and White fraction

For more detailed information, click HERE to go to the ***Shape Models*** section.

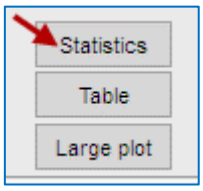
To view the results in detail, click on ***Statistic***, ***Table*** or ***Large plot***.



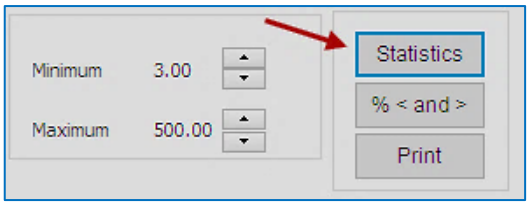
Statistic

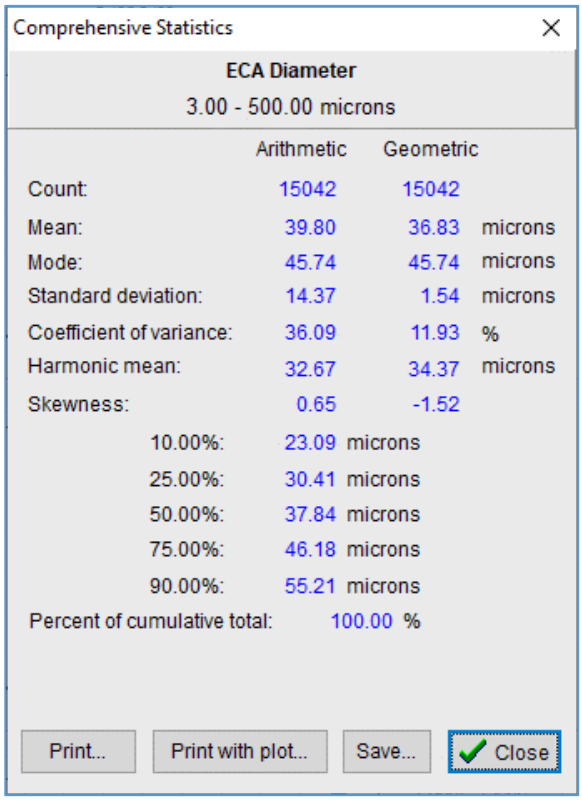
Click ***Statistics*** button either in the standard plot OR the Large plot to open the ***Comprehensive Statistics*** window. This window displays statistics for the defined range.

Standard plot



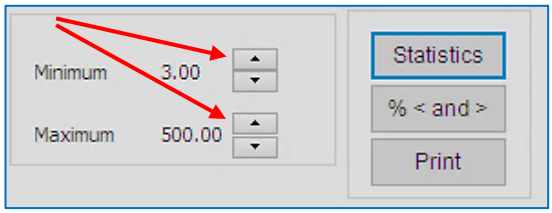
Large plot



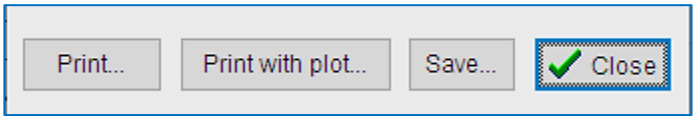


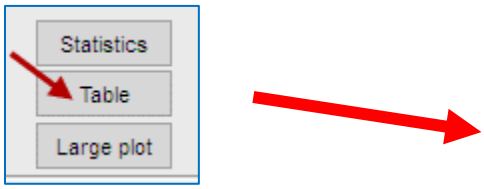
Return to TOC

If the size axis is not a sieve size axis, you can compute these statistics for a user-defined sub range of the Large plot. When first opening a plot, the endpoints contain the entire data range for the current plot, as defined in the settings. To change the analysis range, edit the endpoints above the plot, then click ***Statistics***. You can also change the sub range by dragging the red cursor lines.



Using buttons at the bottom of the statistics window, you can save this data to a text file with suffix .CSV, print it, or print it along with a small version of the plot.





Distribution Table

Click ***Table*** to the right of a data plot to get a bin-by-bin listing of histogram data.

Table

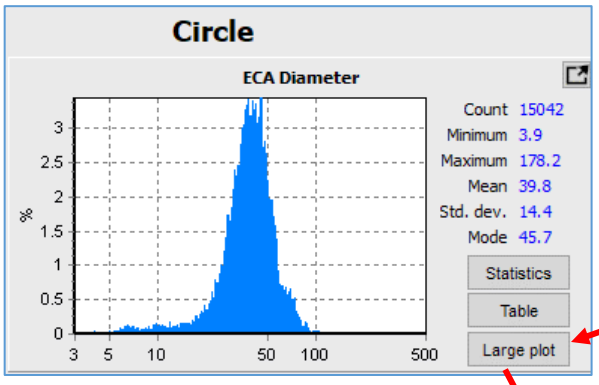
Measure ECA Diameter sieve axis Print Close

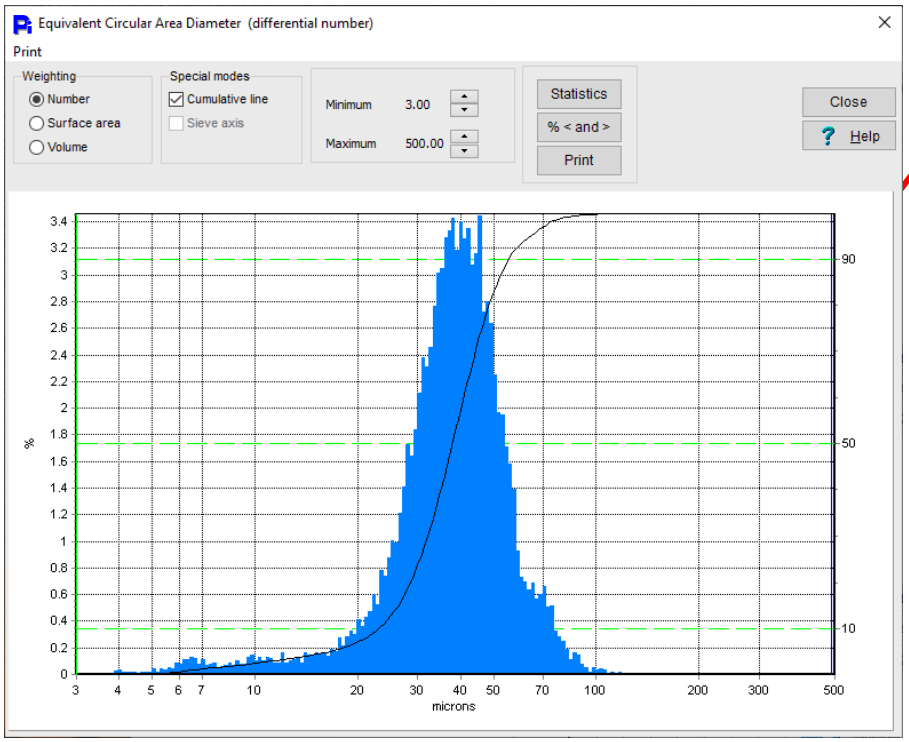
Min.	Max.	Count	% Num.	% Area	% Vol.	Cum. % Vol.
3.87	3.97	4	0.03	0.00	0.000	0.0000
3.97	4.08	5	0.03	0.00	0.000	0.0000
4.08	4.18	2	0.01	0.00	0.000	0.0001
4.18	4.29	2	0.01	0.00	0.000	0.0001
4.29	4.40	3	0.02	0.00	0.000	0.0001
4.40	4.52	2	0.01	0.00	0.000	0.0001
4.52	4.63	1	0.01	0.00	0.000	0.0001
4.63	4.75	2	0.01	0.00	0.000	0.0001
4.75	4.88	2	0.01	0.00	0.000	0.0001
4.88	5.00	2	0.01	0.00	0.000	0.0002
5.00	5.13	6	0.04	0.00	0.000	0.0002
5.13	5.27	2	0.01	0.00	0.000	0.0002
5.27	5.40	6	0.04	0.00	0.000	0.0003
5.40	5.54	5	0.03	0.00	0.000	0.0004
5.54	5.69	8	0.05	0.00	0.000	0.0005
5.69	5.83	7	0.05	0.00	0.000	0.0006
5.83	5.99	13	0.09	0.00	0.000	0.0008
5.99	6.14	11	0.07	0.00	0.000	0.0009
6.14	6.30	17	0.11	0.00	0.000	0.0012
6.30	6.46	17	0.11	0.00	0.000	0.0016
6.46	6.63	20	0.13	0.00	0.000	0.0020
6.63	6.80	18	0.12	0.00	0.000	0.0024
6.80	6.98	12	0.08	0.00	0.000	0.0027
6.98	7.16	17	0.11	0.00	0.000	0.0031
7.16	7.34	10	0.07	0.00	0.000	0.0034
7.34	7.53	12	0.08	0.00	0.000	0.0038
7.53	7.73	13	0.09	0.00	0.000	0.0042
7.73	7.93	8	0.05	0.00	0.000	0.0045
7.93	8.14	9	0.06	0.00	0.000	0.0049
8.14	8.35	10	0.07	0.00	0.000	0.0053
8.35	8.56	13	0.09	0.00	0.001	0.0059
8.56	8.78	10	0.07	0.00	0.000	0.0063

Return to TOC

Large plot

Click on ***Large plot*** to the right of a data plot to get a larger display of analysis results with more details can be achieved by click on Large plot.



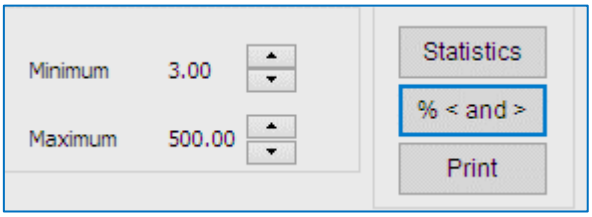


You can have a maximum of eight large windows open at once. The window can be resized by dragging any edge or corner of the window.

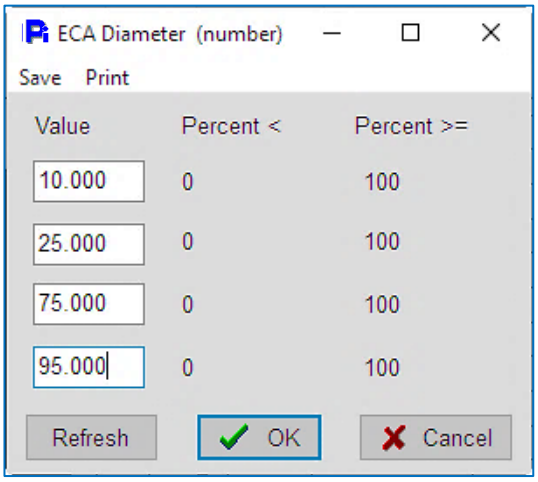
The **Number, Surface area**, and **Volume** options control the moment weighting of the size distribution. The ***Cumulative line*** option overlays a cumulative line on the plot, which is essentially the integral of the density distribution. The percent scale on the right axis relates to this line, and any point on the line can be interpreted as a percentile. For example, the 50th percentile size is the point on the x axis where the line reaches 50% on the y axis.

Return to TOC

% <= and > :

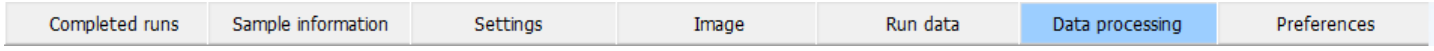


Enter up to four measure values, and the percent of the total by number that is less than or equal to, and greater than, each entered value will be presented. The calculation is over the entire allowed range of the measure. The calculation is only as precise as the histogram bin boundaries.

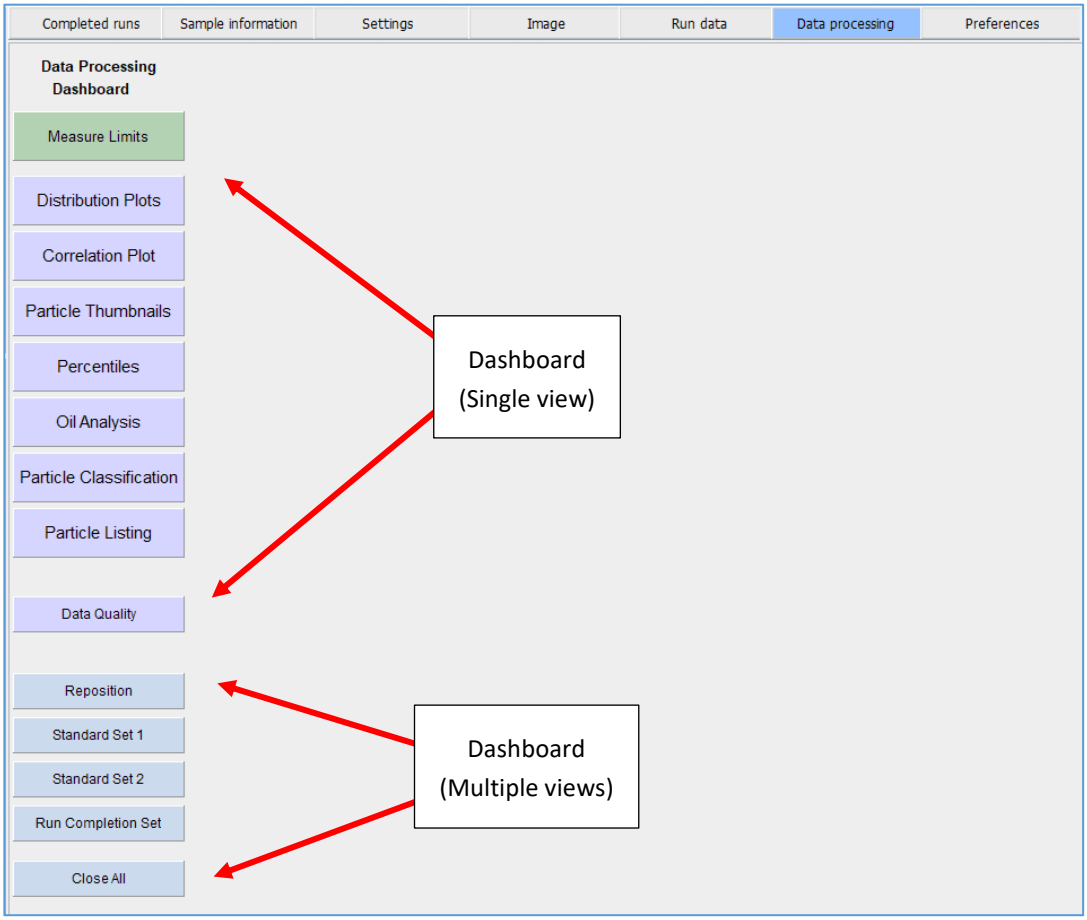


Return to TOC

Data processing



The Pi RAPTOR Portable provides a flexible way to present data (Dashboard) from a run beyond the normal data windows if the particle data and the thumbnail images have been saved. The information and results able to be shown in the Dashboard can be combined and is composed of: Measure Limits, Distribution Plots, Correlation Plot, Particle Thumbnails, Percentiles, Oil Analysis, Particle Clasification and Particle Listing.



In order to use the ***Data functions*** from the Dashboard, the following options must be enabled before starting a run:

Under ***Settings*** ➔ ***Run control***

- Select ***Save individual particle data***
- Select ***Save particle thumbnail images***

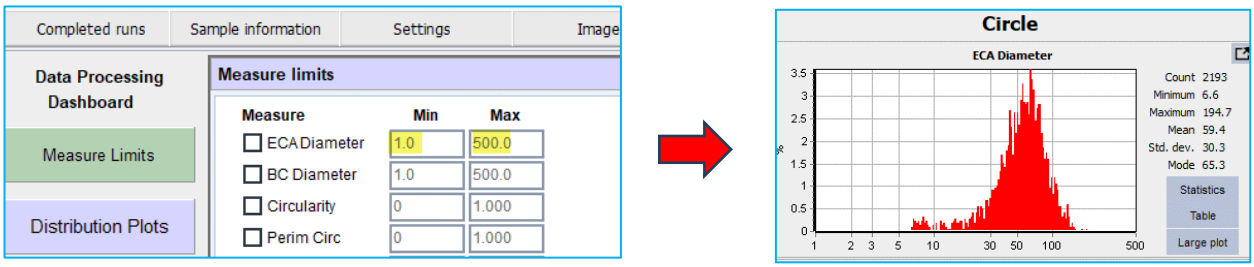
Return to TOC

Values of all measures are stored in the particle database file for every particle.

The Data Processing does not reanalyze images; it just uses the stored measure values.

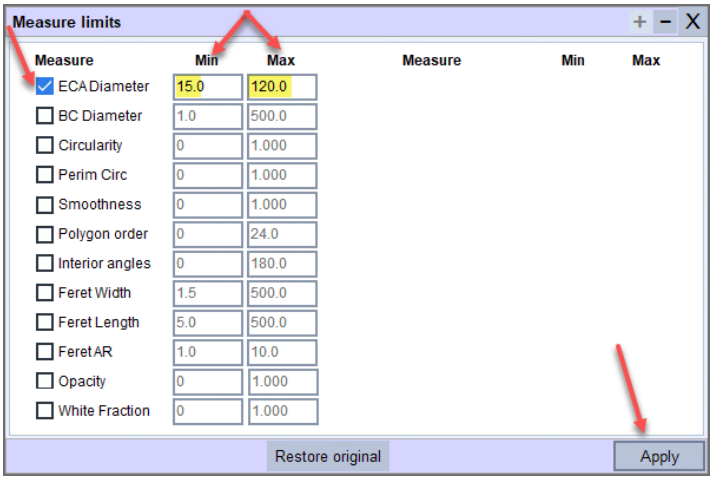
Measure Limits

Click on ***Measure Limits*** to specify a reduced range for any measure.

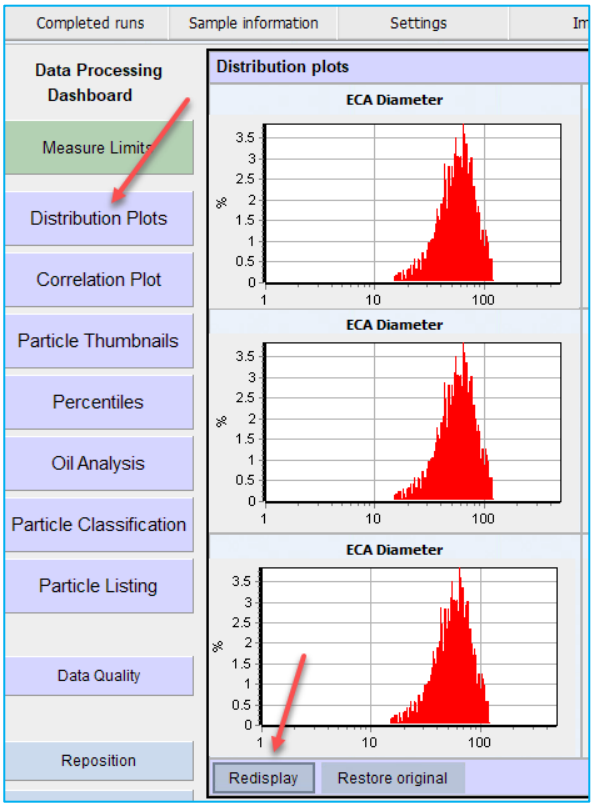


Default values for ECA Diameter: 1 – 500 µm

Check the box in front of the desired measure and enter the new limits. Click on ***Apply*** to take effect. Only the checked measures will be filtered; all others will be included at their full range. Be aware though, that limiting the range of one measure may reduce the observed range of other measures.



Reduced range: 15.0 – 120.0 µm



Return to TOC

New Statistics and Percentiles change the results showing in the ***Run data*** windows, if any of the measures are given a reduced range.

Reduced range: 15.0 – 120.0 µm

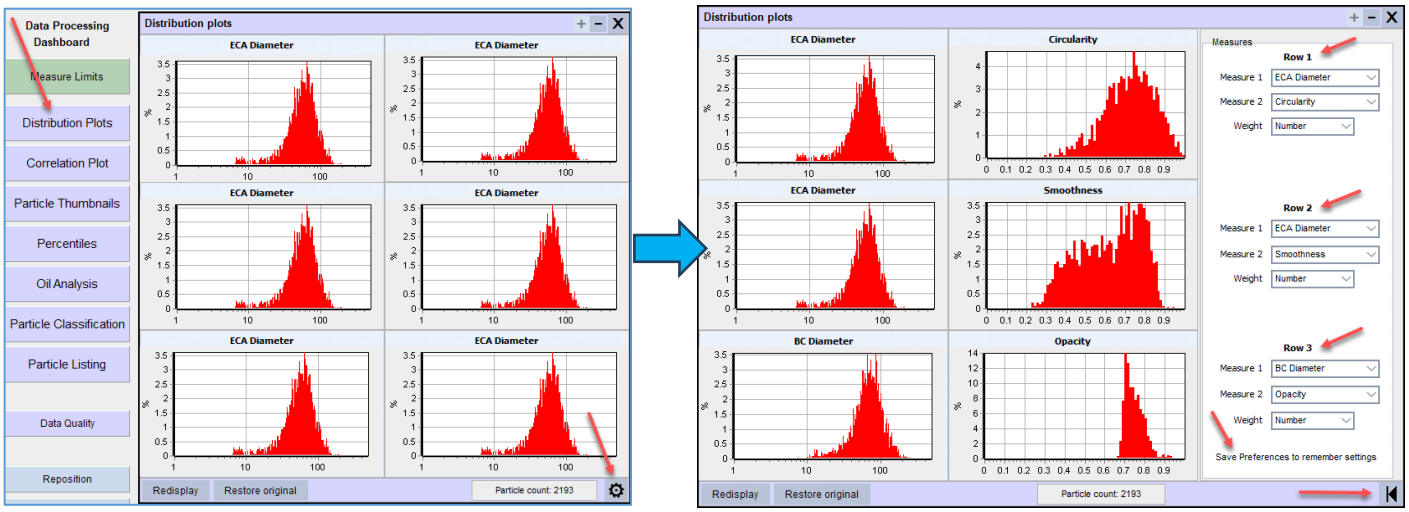
A * in front of the sample name means that the results showing may have been altered from the original results for the sample due to filtering. To save the filtered results, use ***Save As.*** However, the sample file still contains the original results, which may be restored on screen using ***Reopen***.

To return to the original values, click on ***Restore original*** button in the Distribution Plots window.

Return to TOC

Distribution Plots

This feature allows you to configure three rows of Distribution Plots by selecting through pull-down menus, what measures desire to be shown.



To open the pull-down menus, click on the gear at the right-bottom corner of the left screen.

Select the **Measures** and the **Weight**. After this step, these settings will remain effective while the software is open. After closing the software, the settings are gone and return to default.

To remember the settings, ***Save Preferences***.

To close the extended window, click the icon at the right-bottom corner of the right screen.

To return to the original parameters, click on ***Restore original*** button.

Return to TOC

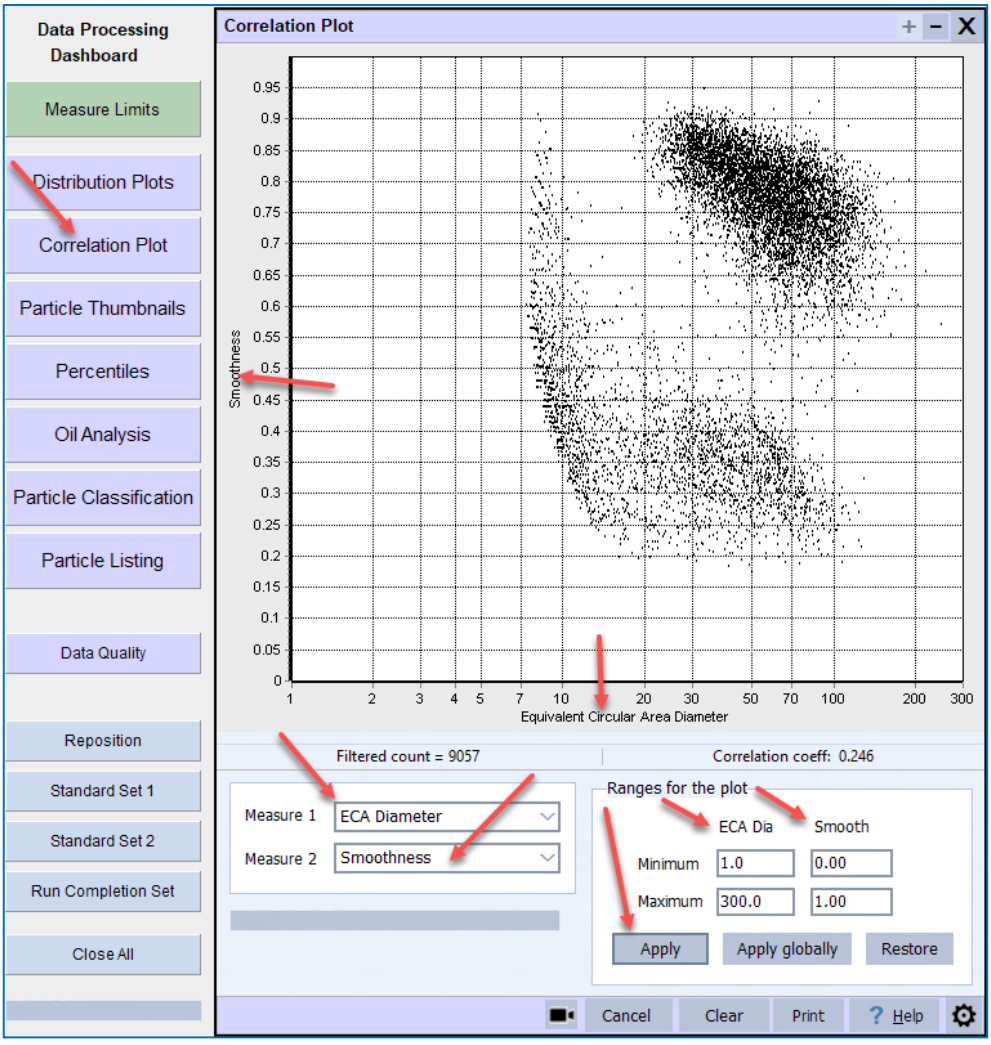
Correlation plots

In the Correlation plot a point is plotted in the scatter chart for every particle in the particle database. Correlations plots allow to view how one measure changes in relation to another measure among the particles of a sample. This is a powerful tool useful in fully characterizing a sample.

If more than one kind of particle is present, the subclasses will sometimes show up as a separate group of particles in some of the scatter charts. Use the limits or the Separation line utility to obtain data on a particular subclass of particle.

A Correlation coefficient greater than about 0.7 in absolute value indicates the two measures are related.

- Select ***Correlation Plot***.
- Select the two measures to be correlated, ***Measures 1*** and ***Measure 2*** to generate the plot.
- Enter the ranges for the plot and click on ***Apply***.



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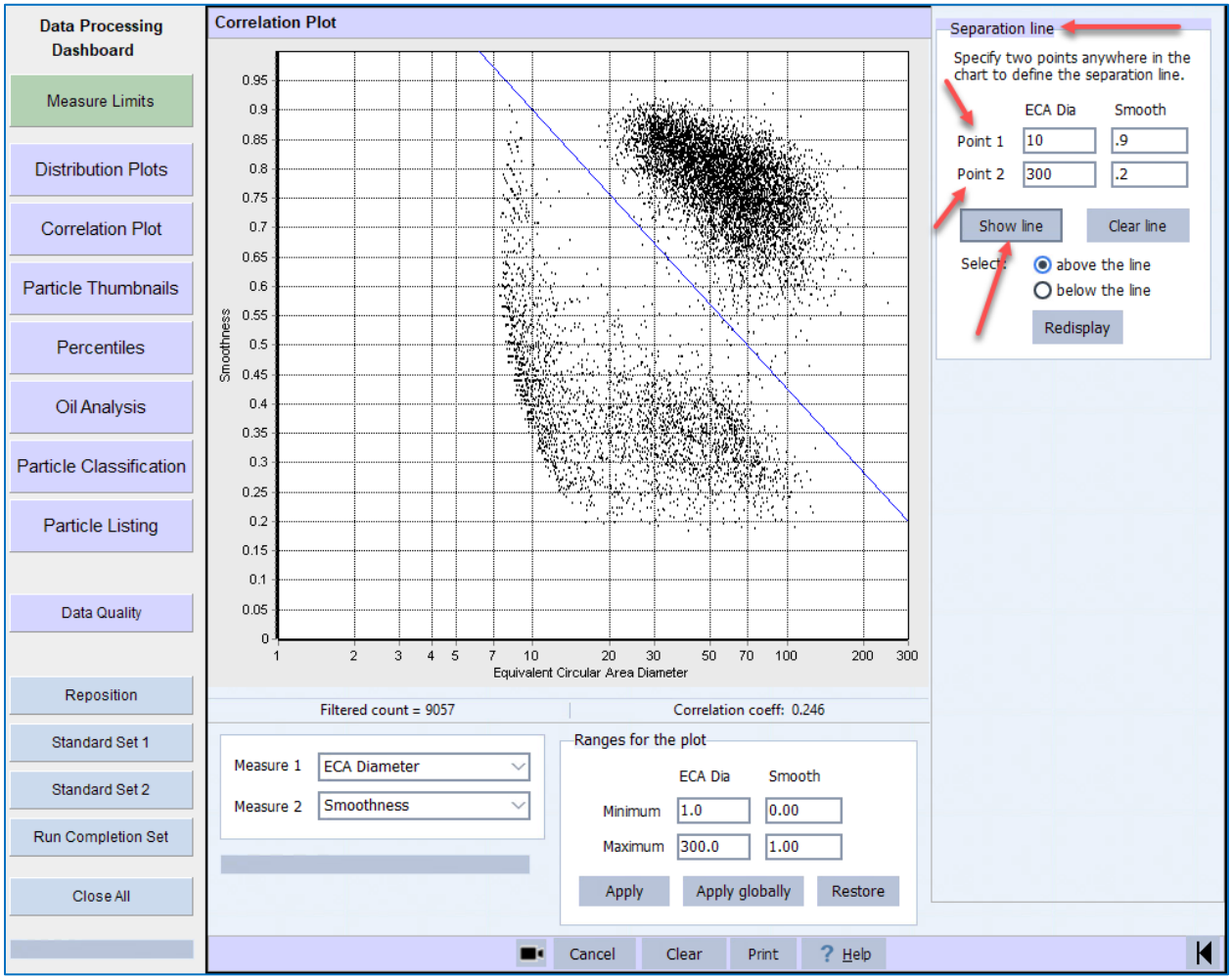
The **Separation Line** utility (blue line) can split a sample into two parts, and each part can be analyzed separately. The example below shows a plot of **ECA Diameter** vs. **Smoothness**.

To activate the Separation line:

- Click on the **gear icon** to expand and set the values.
- The **Separation line** is defined by the values for **Point 1** and **Point2**.
- Set the points for each measure.
- Click on ***Show Line***, a line is drawn through the two points.

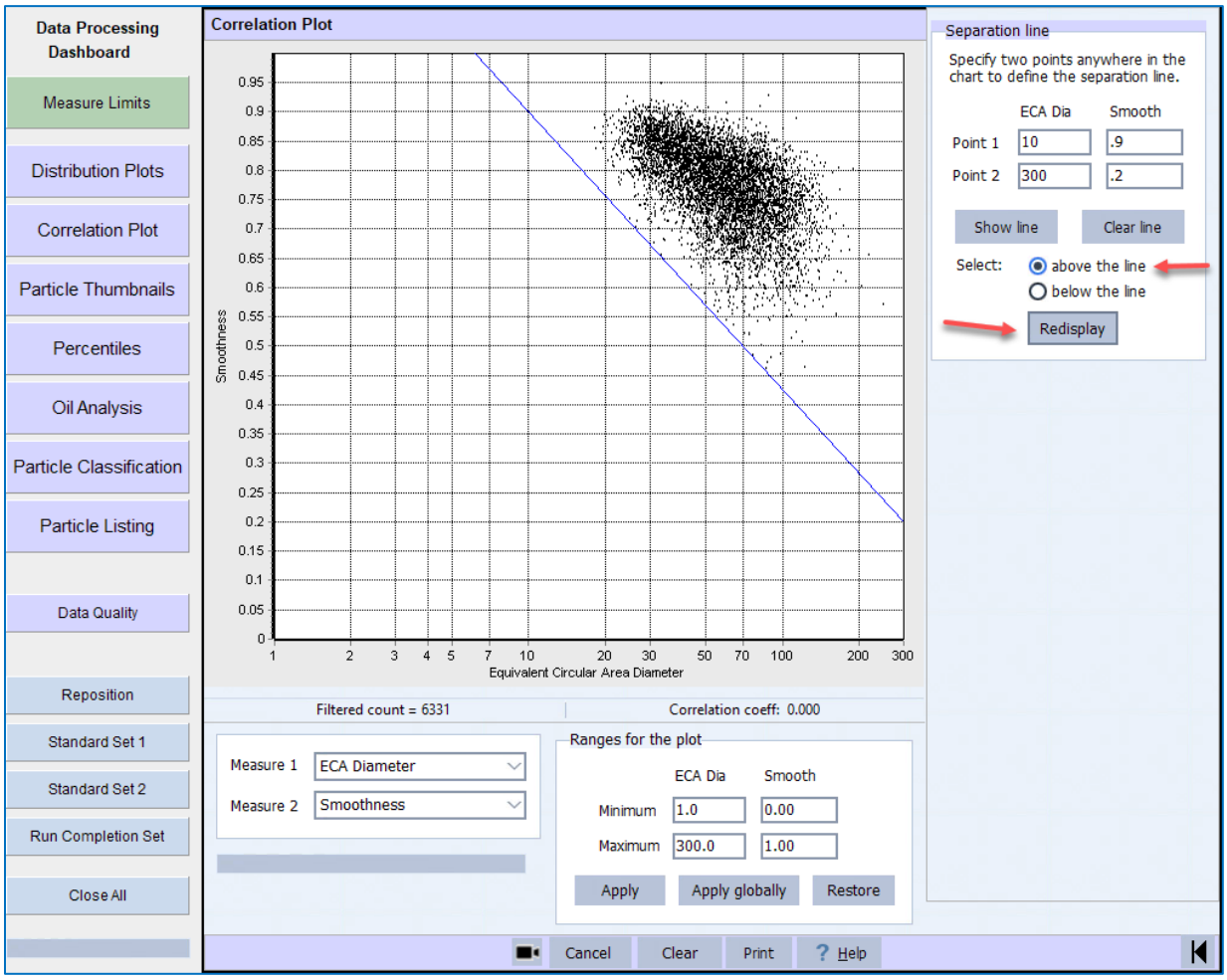


Return to TOC

To analyze only one group of particles if the separation line has divided into two well defined groups:

- Select ***above the bar*** OR ***below the bar*** then click on ***Redisplay***.

Redisplay will remake the chart with only the points on one side of the line, either above or below it.

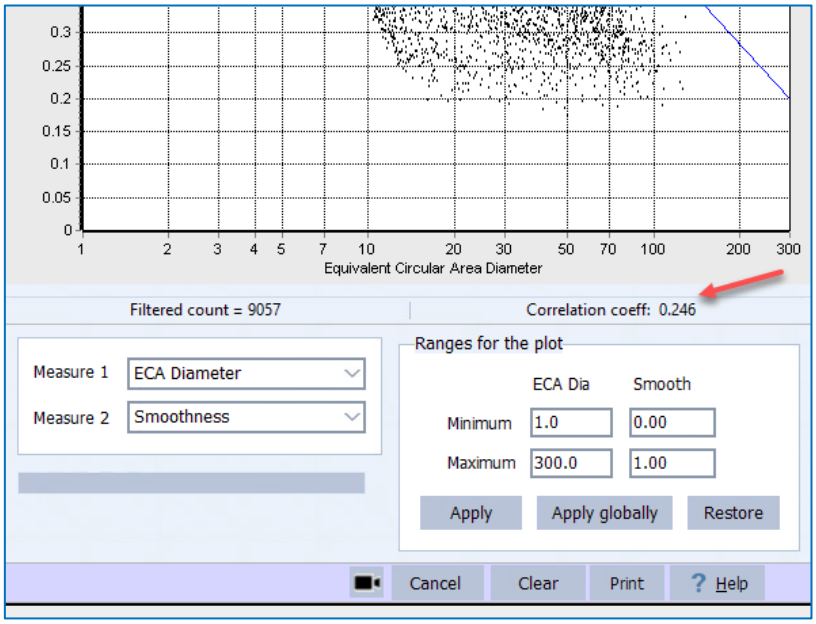


- Click on ***Print t***o print the graph. Only **Number** data are used, not **Volume** data.
- Click on ***Apply globally*** to update the **Data processing** and becomes able to see the thumbnails belonging to that group of particles through the Dashboard.

Return to TOC

In statistics, the **Pearson product-moment correlation coefficient** (sometimes referred to as the **MCV** or **PMCC**) (*r*) is a common measure of the linear correlation between two variables *X* and *Y*. When measured in a population, the Pearson Product Moment correlation is designated by the Greek letter rho (ρ).

When computed in a sample, it is designated by the letter "r" and is sometimes called "Pearson's r." Pearson's correlation reflects the degree of linear relationship between two variables. It ranges from +1 to -1.
A correlation of +1 means that there is a perfect positive linear relationship between variables.
A correlation of -1 means that there is a perfect negative linear relationship between variables.
A correlation of 0 means there is no linear relationship between the two variables.
Correlations are rarely if ever 0, 1, or -1



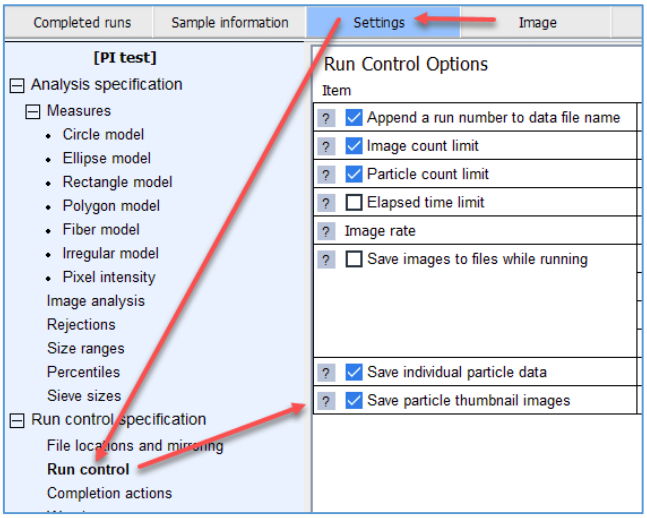
- To return to the original graph, click on ***Restore***.

Return to TOC

Particle thumbnails

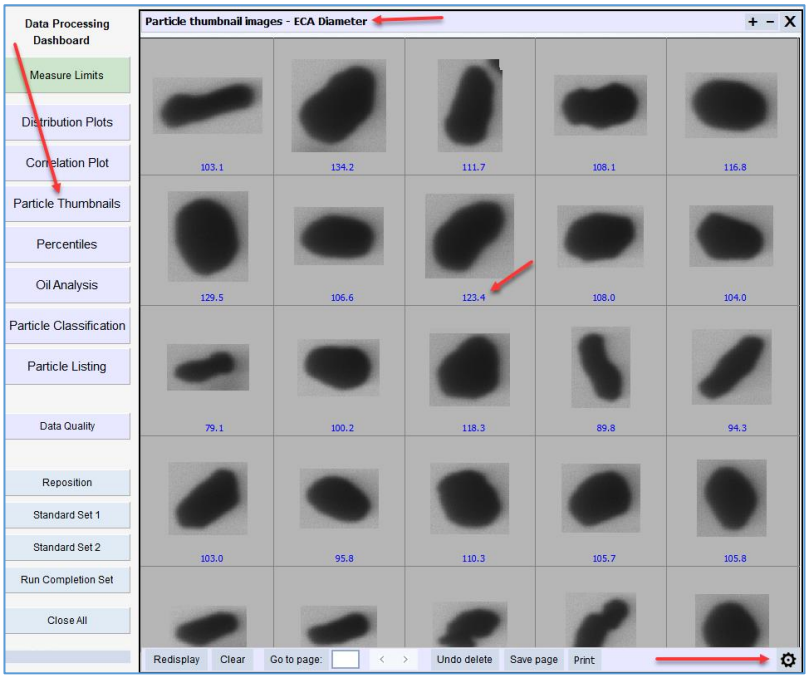
To enable this action, check the option ***Save particle thumbnail images*** under ***Settings ➔ Run control*** before starting the run.

There is an upper size limit of 200 MB on the file that saves the thumbnails.



By selecting the ***Particle Thumbnails*** feature in the Dashboard, you view small images of all accepted particles in decreasing value order, even if the full run images are not saved.

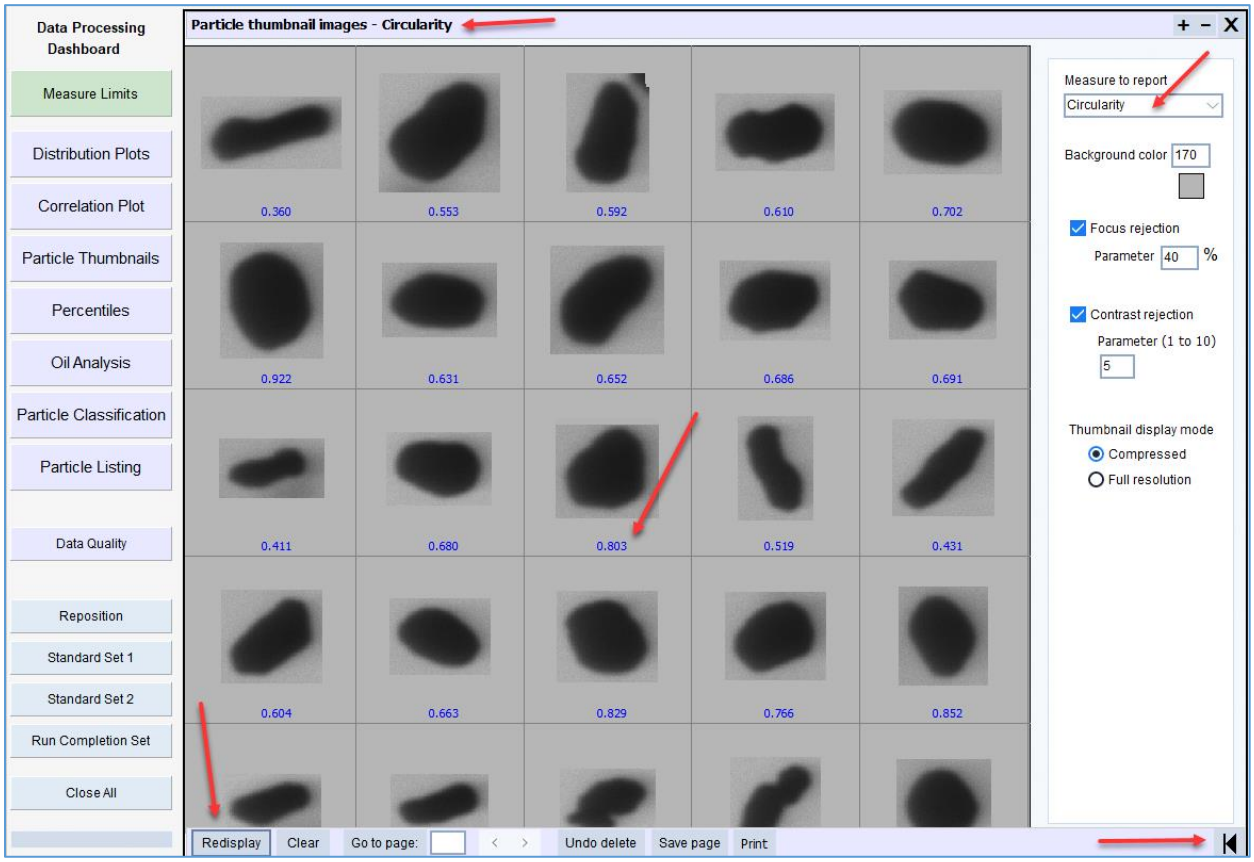
In this case, ECA Diameters are shown.



Click on the gear icon at the right-bottom corner to open the parameters to be selected.

Return to TOC

In this case, ***Circularity*** is shown.

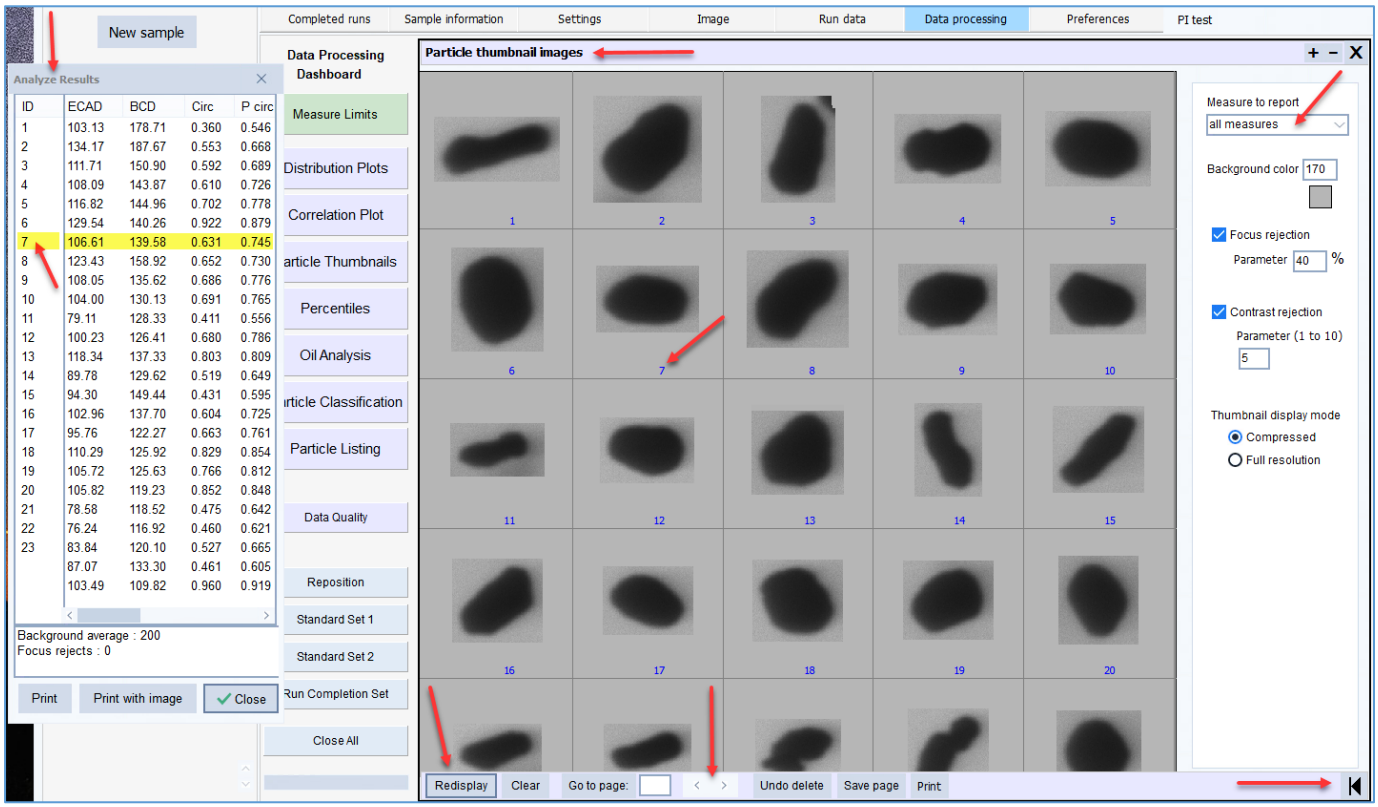


Select Circularity in the pull-down menu ***Measure to report.***

Click on ***Redisplay*** button and the circularity value will be shown for each particle image.

If the drop-down menu is set to a particular measure, the values of that measure will show up below each particle of the thumbnails screen after click on ***Redisplay***.

Return to TOC



If the drop-down menu is set to "**all measures**", after click on Redisplay, the thumbnails screen has an **ID** numbers below each particle, referencing the **Analyze Results** list which appears at the left of the screen.

If the drop-down menu is set to a particular measure, the values of that measure will show up below each particle of the thumbnails screen after click on ***Redisplay***.

Use the **Direction arrows** (< >) to step through the pages of thumbnails. There is an upper limit of 256 thumbnail pages, and the limit on the number of thumbnails is 100,000.

Any page may be saved as a TIFF image using the ***Save page*** button or ***File ➔ Image ➔ Save single image ...*** in the toolbar options or printed using ***Print***. The TIFF file will not have the number overlays, but they will show on the printed image.

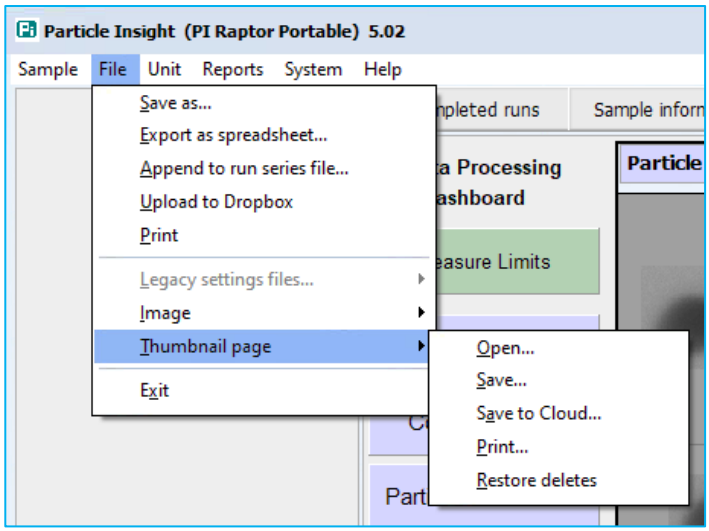
Use the "**X**" **Closing button** to close out the thumbnail screen.

There are other parameters: ***Background color, Focus rejection, Contrast rejection*** and ***Thumbnail display mode*** to be modified looking for better thumbnails images of the particles. The images won't be deleted just temporarily not shown.

Return to TOC

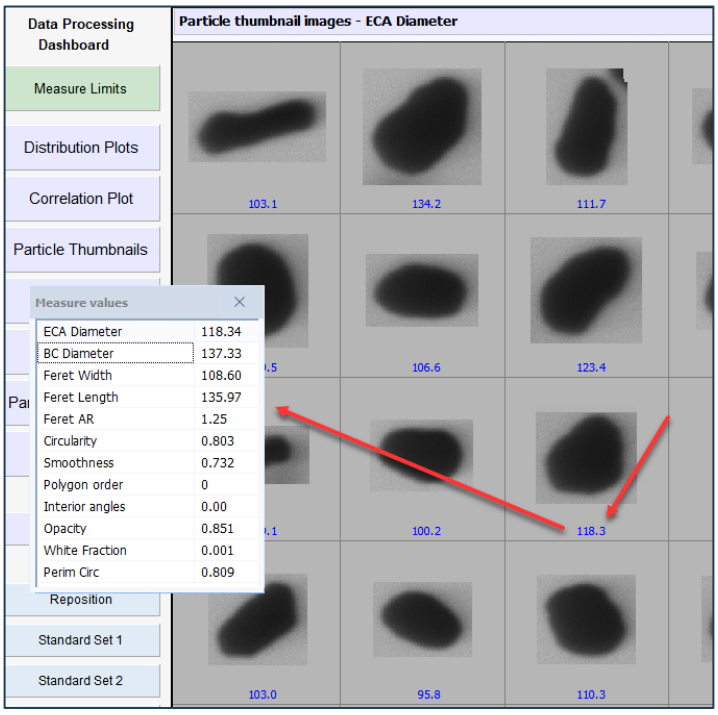
Individual thumbnail pages may be opened, saved, Saved to Cloud, printed or Restore deletes. These options are under

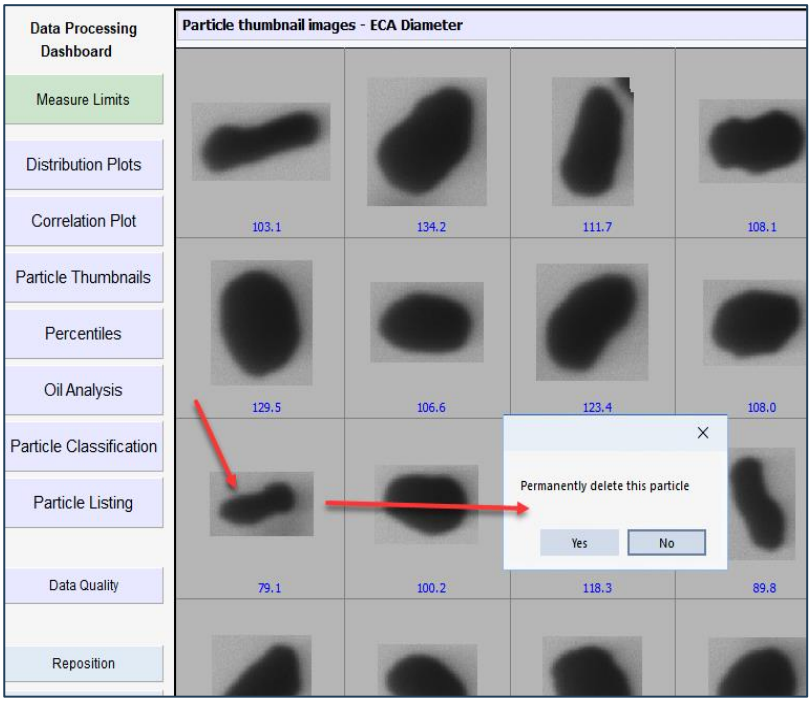
File ➔ *Thumbnails page*



Thumbnail images are different in size from normal run images

- **Left** click on the particle image will show the **Measure values**.
- **Right** click on the thumbnail image offers the possibility to **delete** the particle image.

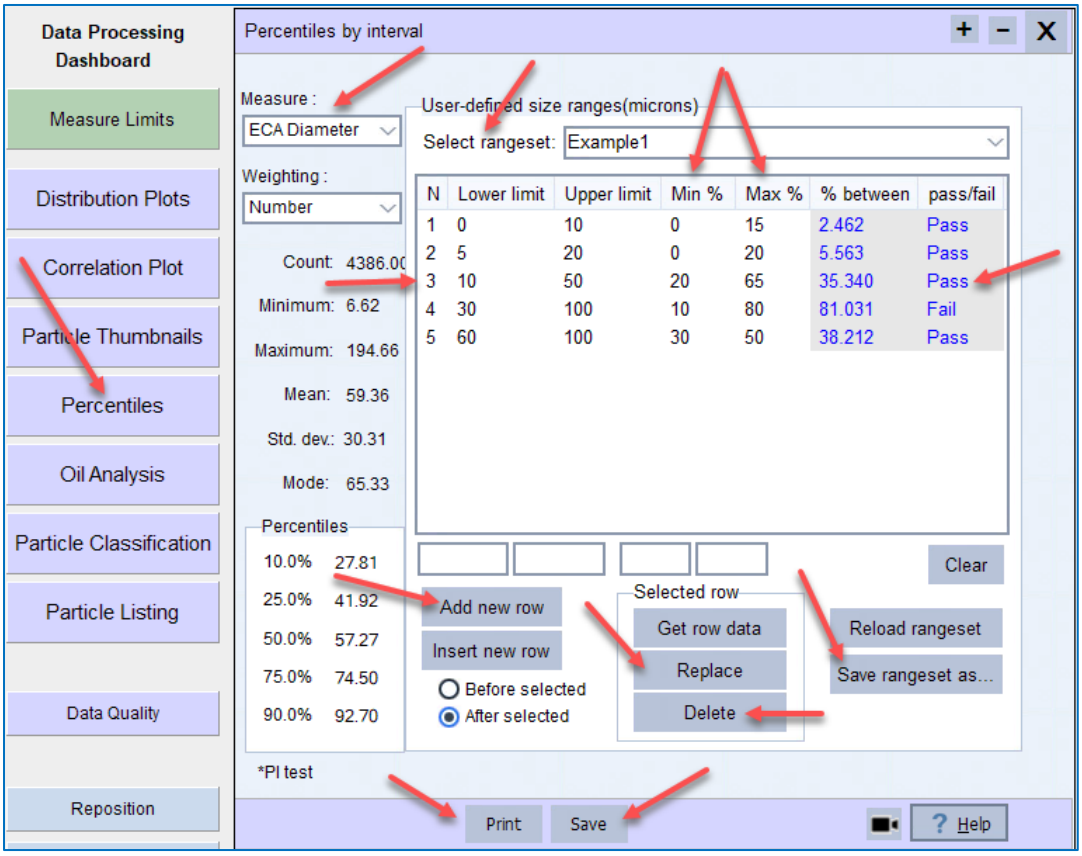




Return to TOC

Percentiles statistics

In the production of powders, it is often necessary to find out how much of a sample lies between two cumulative percentile points in the size distribution. The ***Percentiles*** feature can do this determination. In addition, if you specify upper and lower bounds for the percent in each percentile band, the screen will show whether the sample lies within the bounds of acceptance ***Pass/Fail.***



- Select the measurement to be applied to the current data in the ***Measure*** Pull-down menu.
- Each row of the table represents a percentile band, with the upper and lower limits of acceptance.
- You can ***Add new row***, ***Replace*** or ***Delete*** a selected row.
- Additionally, the whole table of limits can be saved as a **Rangeset** file, printed using the ***Print*** button and export as Excel file using the ***Save*** button.

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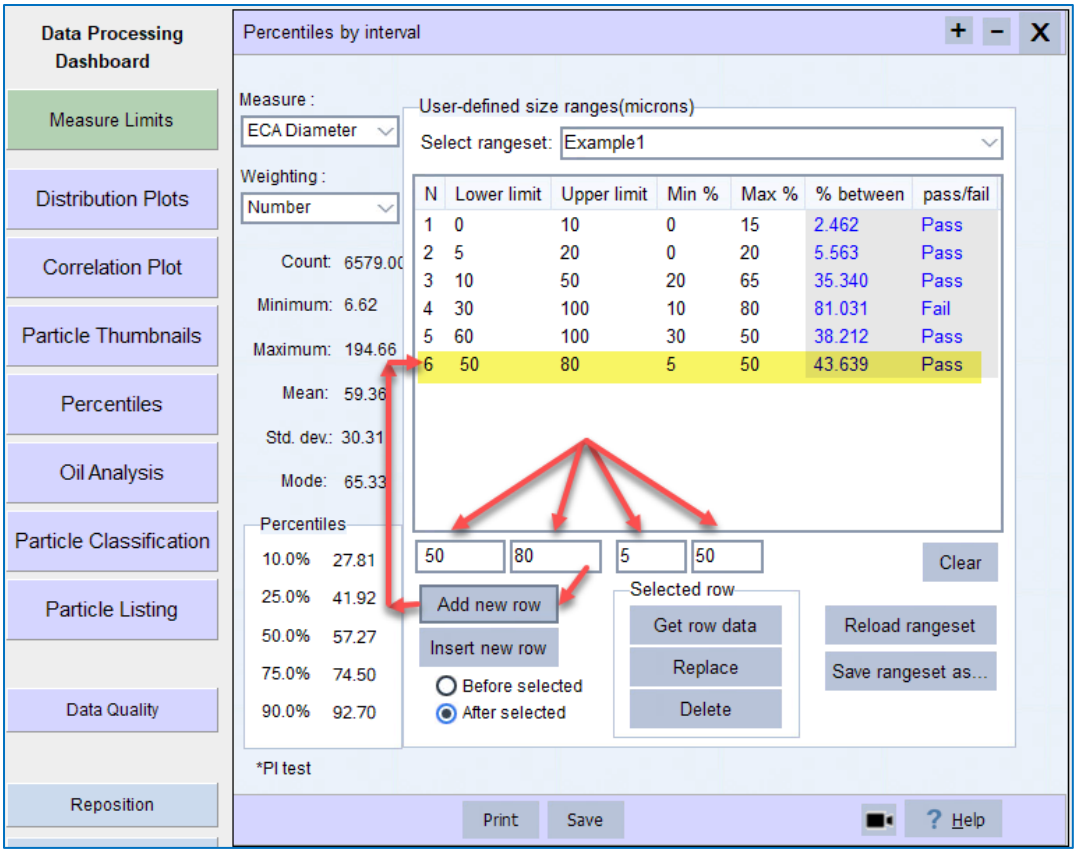
Add a new row

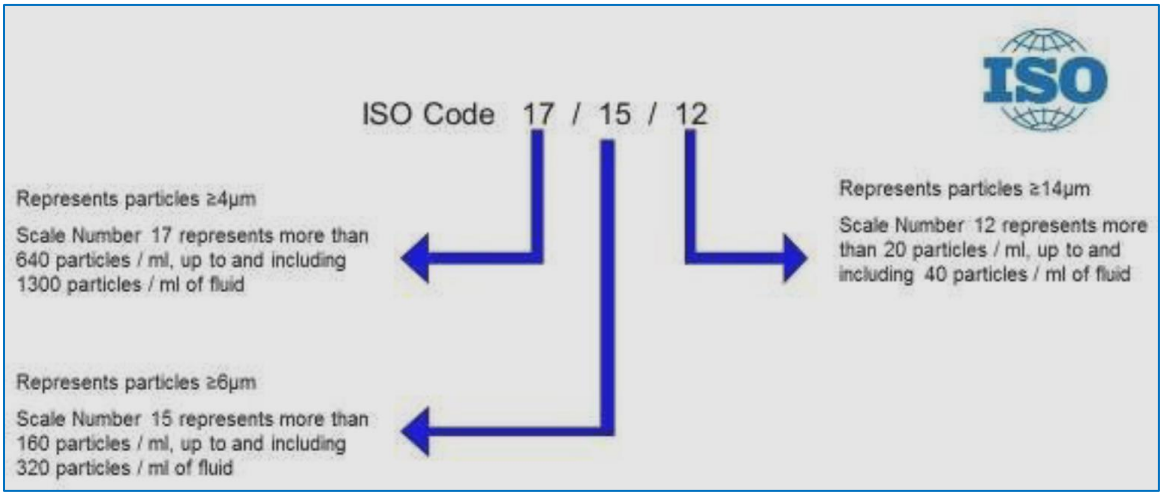
- Enter the values for: Lower limit, Upper limit, Min % and Max % at the four blank fields below the table.
- Click on ***Add new row.***
- The new row number 6, will be added to the table



Return to TOC

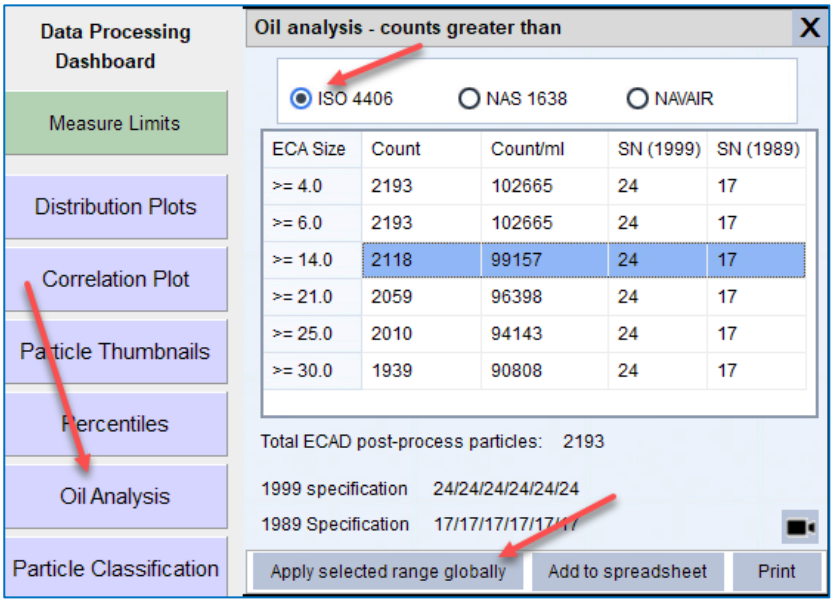
Oil Analysis (ISO 4406)

Early detection of wear particles in lubricating and hydraulic fluids is critical to having a proper predictive maintenance program. It is this early detection and identification of wear particles that permits the extension of engine life and can minimize down-time of equipment.
The Pi RAPTOR Portable combines the classification of particles required by industry standards (ISO 4406, NAS 1638) with the reporting of up to 30 size and shape measures for all particles identified.
The instrument also provides particle thumbnails for each particle allowing the user to make more educated decisions on the quality of their lubricating fluids.
ISO 4406 established a method of coding the level of particle contamination of hydraulic fluids into a set of "scale numbers". The process begins by finding the particle counts above each of a set of fixed sizes: 4, 6, 14, 21, 26 and 30 microns. Then based on the particle concentrations, scale numbers are assigned.
This diagram gives an idea of how they are determined: The ISO 4406 standard was established as a method of coding the level of particle contamination of hydraulic fluids. The Pi RAPTOR Portable provide results correlated to the ISO standard 4406.



Return to TOC

ISO 4406: The protocol for determining the scale numbers changed in 1999. The Particle Insight lists scale numbers for the 1989 and 1999 standards, along with the particle counts and concentrations.



- Click on ***Oil Analysis*** and select the standard (ISO, NAS or NAVAIR).
- Select the **ECA size**.
- Click on ***Apply selected range globally*** to update the **Data processing**.
- Select ***Particle Thumbnails*** and click on ***Redisplay*** to see the particle images for that class.
- You can also click on ***Add to spreadsheet*** to export the table to an **Excel file**.
- Also, you can print the table by clicking on ***Print*** button.

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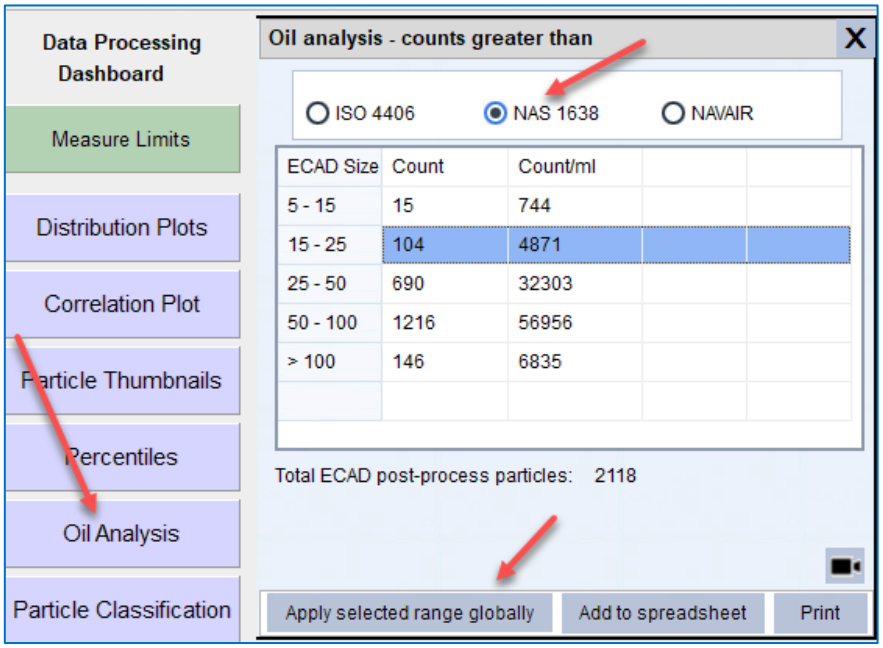
NAS 1638: This protocol is similar but older standard developed in 1964. It also provides a way of documenting contamination levels in hydraulic fluid.
Differential rather than cumulative particle counts are determined for each size bin in the standard. In this sense it is like the Percentiles tool described earlier, because it finds out the amount of sample between a pair of breakpoints. The size breakpoints are different from ISO 4406.



- Click on ***Oil Analysis*** and select the standard (ISO, NAS or NAVAIR).
- Select the size.
- Click on ***Apply selected range globally*** to update the **Data processing**.
- Select ***Particle Thumbnails*** and click on ***Redisplay*** to see the particle images for that class.
- You can also click on ***Add to spreadsheet*** to export the table to an **Excel file**.
- Also, you can print the table by clicking on ***Print*** button.

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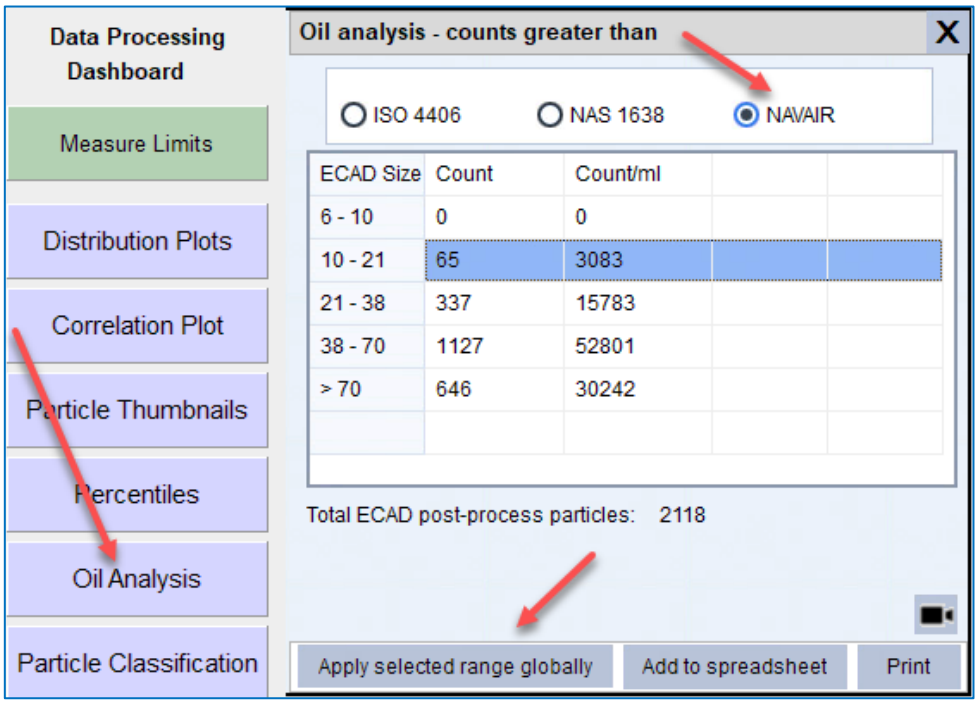
NAVAIR: This is also a standard protocol similar tool for describing contamination in hydraulic oil and other fluids. Like NAS 1638, it uses differential counts.



- Click on ***Oil Analysis*** and select the standard (ISO, NAS or NAVAIR).
- Select the size.
- Click on ***Apply selected range globally*** to update the **Data processing**.
- Select ***Particle Thumbnails*** and click on ***Redisplay*** to see the particle images for that class.
- You can also click on ***Add to spreadsheet*** to export the table to an **Excel file**.
- Also, you can print the table by clicking on ***Print*** button.

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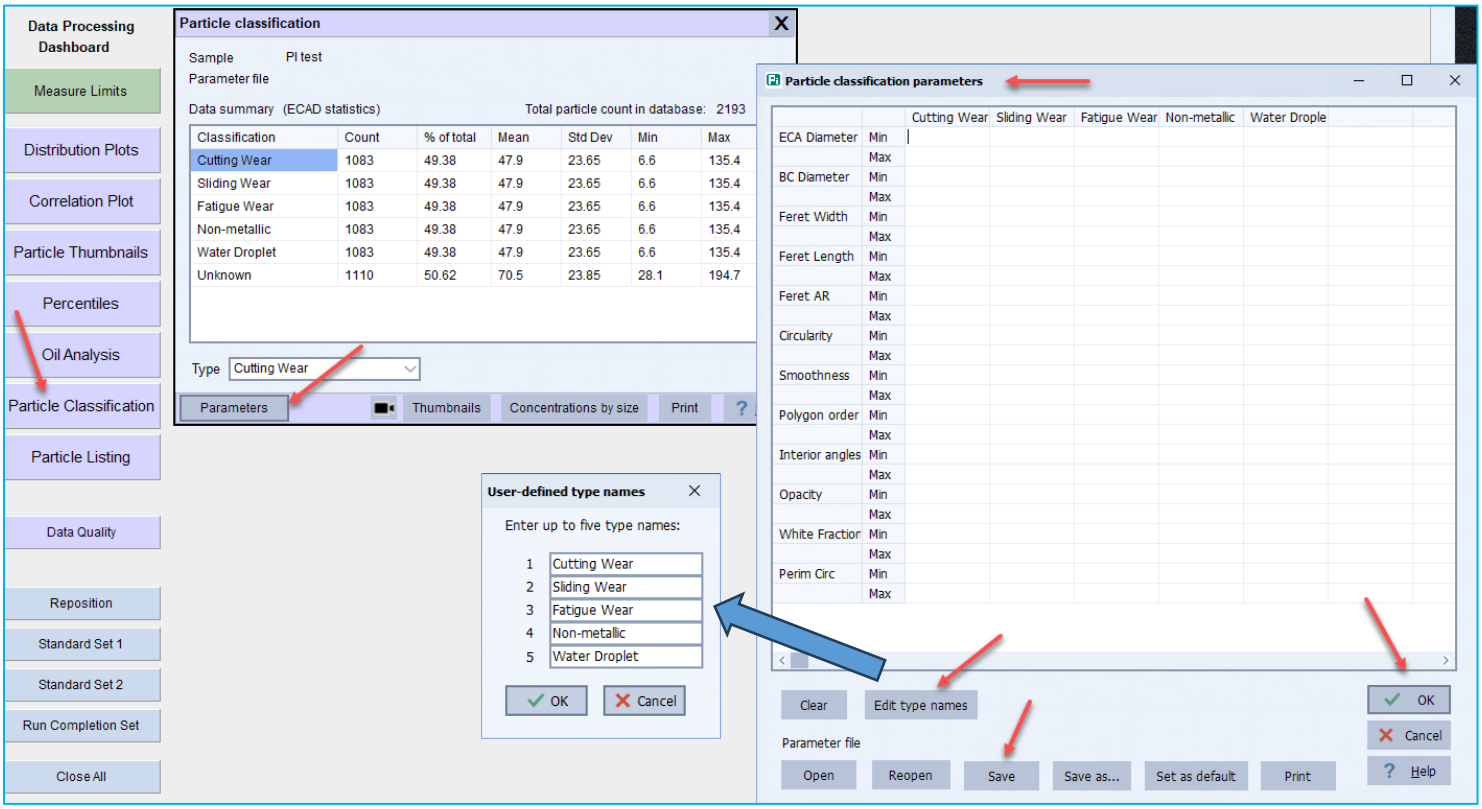
Particle classification

With this tool, you can define several types or classes of particles by name. Each class is defined by specifying minimum and maximum limits for any or all active particle measures. The software will then determine the particle count in each class. Classes can overlap if the min/max limits are not mutually exclusive among the different classes. If there is overlap, the sum of counts for all classes may be greater than the total particle counts in the sample.
Particles are classified by imposing limits on the values of all active measures. A particle that meets all the limits for a ***Type*** is classified as belonging to that ***Type***. A particle can belong to more than one ***Type***.

- Click on ***Particle classification*** to begin the classification process.
- Click on ***Parameters*** to set the limits for the several classification types.
- If the type names need to be modified, click on ***Edit type names.***
- Save the form as a parameter set file with extension (*.occ).
- When limits and names are set, click on ***OK .***
- Also, you can print the table by clicking on ***Print*** button.



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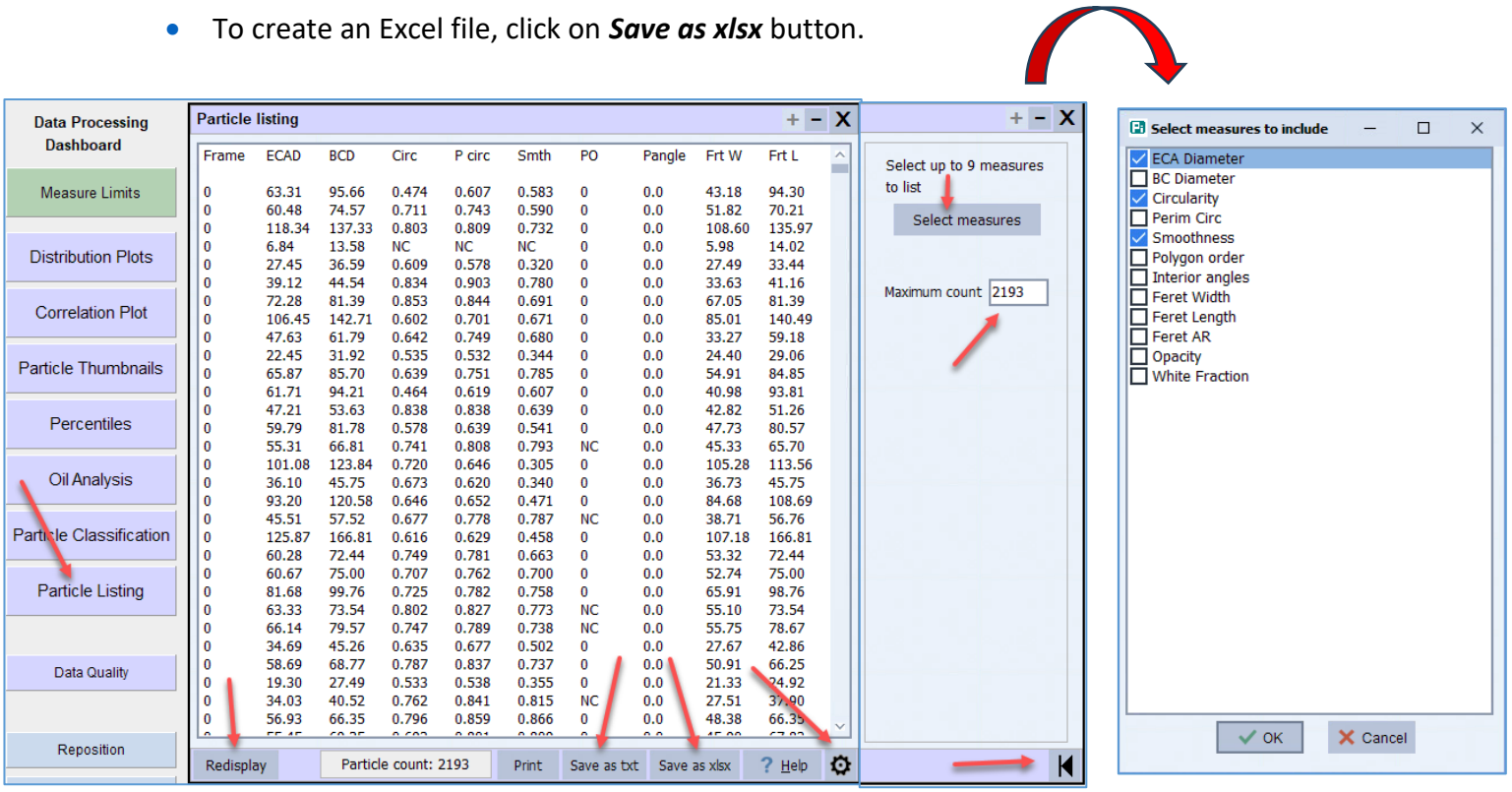
Create a particle listing

You can create a list of all particles with their measured values to process the data in a spreadsheet in **.xlsx format** or maybe generated as a simple **Text file.**

- Click on the ***gear icon*** to expand and select the parameters.
- Select the **measures** to list. (max 9)
- Use ***Maximum count*** field to limit the size of the file.
- Once measures and max count are selected, click on ***Redisplay***.
- To create a text particle file, click ***Save as txt*** button.
- To create an Excel file, click on ***Save as xlsx*** button.



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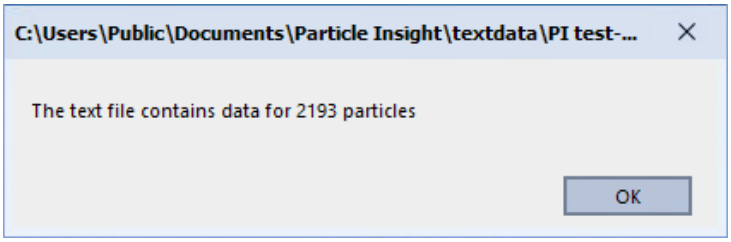
Create a text particle listing file

To create a text particle file, click ***Save as txt*** button.

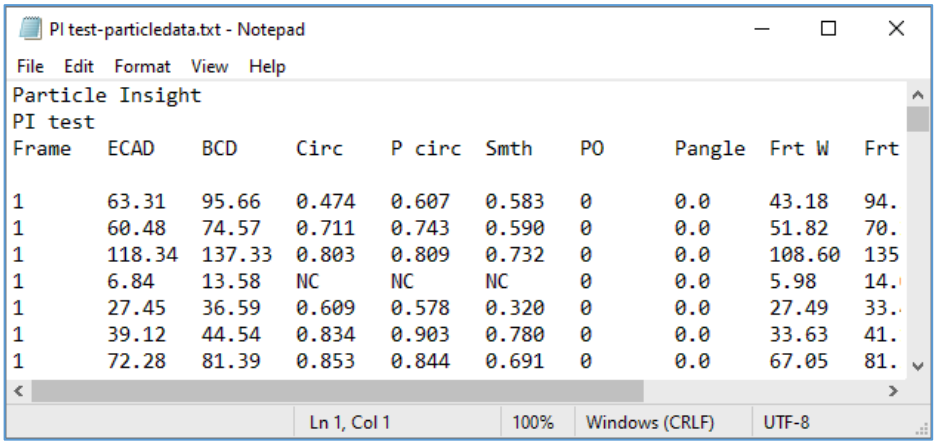
The Excel file created will be saved in the following location:

The following message will show up after the file is saved.



A text file will be generated, with each line in the file containing data for one particle.

The first entry in the line is the Frame number, then an entry for each active measure.



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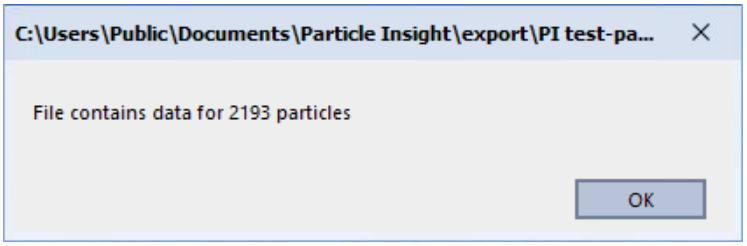
Create a XLS particle listing file

To create an Excel file, click on ***Save as xlsx*** button. Use this option to save particle data in excel format.

The Excel file created will be saved in the following location:

The following message will show up after the file is saved.



An Excel file will be generated, with each row in the file containing data for one particle. The first column in the file is the **Frame** number. Following that, there is a column for each active measure.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2													
3	Particle Insight (PI Raptor Portable) 5.02.02												
4	Individual particle listing												
5	PI test												
6													
7	Frame	ECAD	BCD	Circ	P circ	Smth	PO	Pangle	Frt W	Frt L	Frt AR	Opac	White
8	1	63.31	95.66	0.474	0.607	0.583	0	0.0	43.18	94.30	2.18	0.742	0.000
9	1	60.48	74.57	0.711	0.743	0.590	0	0.0	51.82	70.21	1.35	0.705	0.008
10	1	118.34	137.33	0.803	0.809	0.732	0	0.0	108.60	135.97	1.25	0.851	0.001
11	1	6.84	13.58	NC	NC	NC	0	0.0	5.98	14.02	2.34	0.920	0.222
12	1	27.45	36.59	0.609	0.578	0.320	0	0.0	27.49	33.44	1.22	0.796	0.170
13	1	39.12	44.54	0.834	0.903	0.780	0	0.0	33.63	41.16	1.22	0.684	0.006
14	1	72.28	81.39	0.853	0.844	0.691	0	0.0	67.05	81.39	1.21	0.736	0.004
15	1	106.45	142.71	0.602	0.701	0.671	0	0.0	85.01	140.49	1.65	0.776	0.005
16	1	47.63	61.79	0.642	0.749	0.680	0	0.0	33.27	59.18	1.78	0.704	0.002
17	1	22.45	31.92	0.535	0.532	0.344	0	0.0	24.40	29.06	1.19	0.925	0.264

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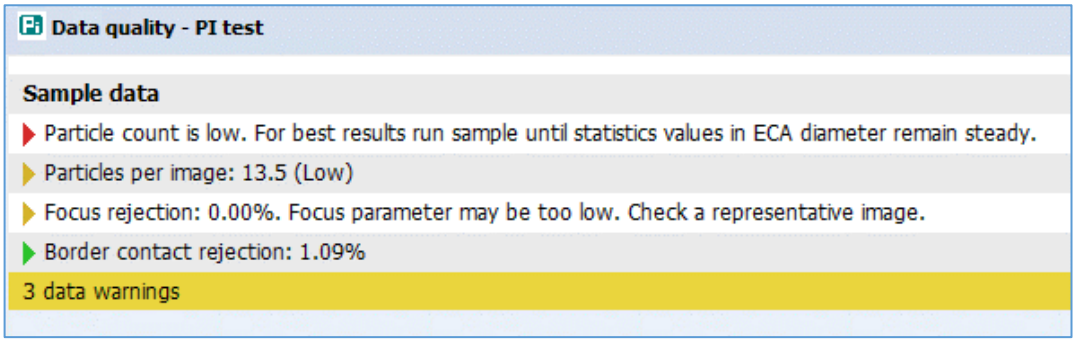
Data Quality

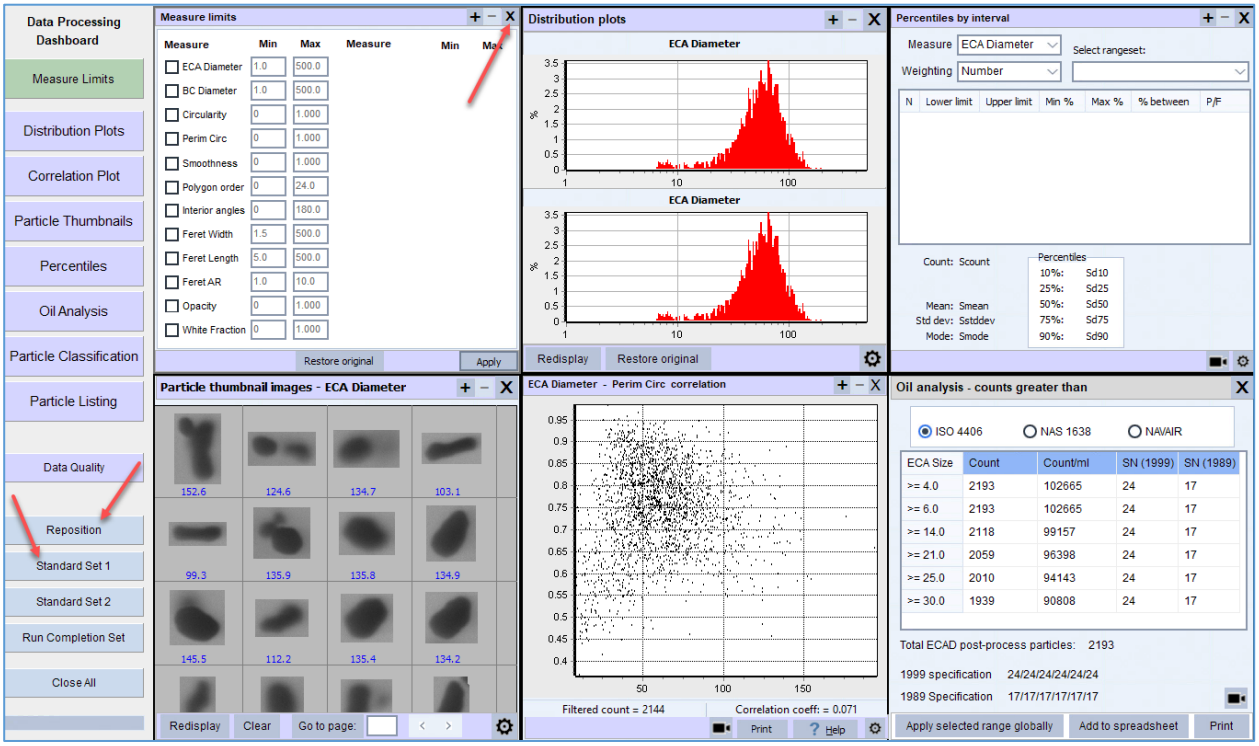
Data quality shows a quick report of the main parameters and weak points of the data and the recommendations to improve the quality and consistency on results

Example for the PI test run:



Standard 1

This feature consists of a pre-configured group of results window shown all together. You can remove any of the results window by clicking on the "X" at the upper-right corner of the window. Then, you can reorganize the display of the remaining windows by clicking on the ***Reposition*** button.



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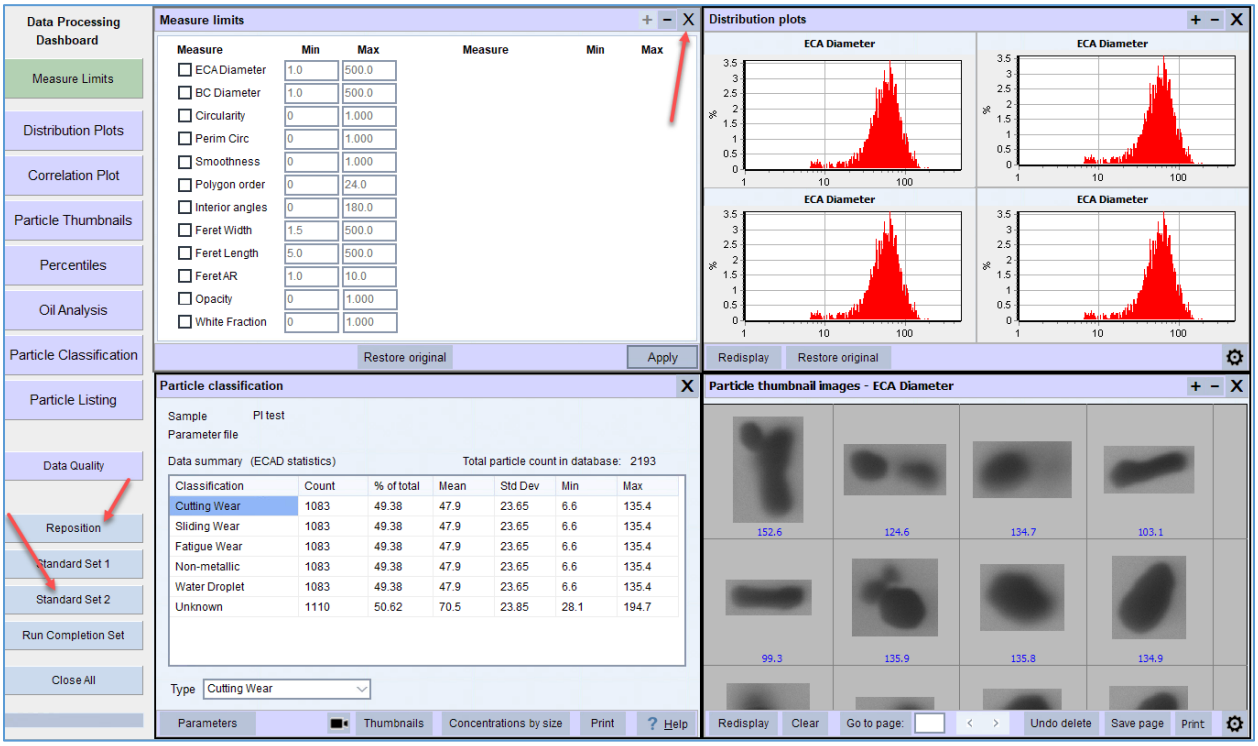
Standard 2

This is another pre-configured group of results windows shown all together.



Reposition

You can remove any of the results window by clicking on the “X” at the upper-right corner of the window.

Then, you can reorganize the display of the remaining windows by clicking on the ***Reposition*** button.

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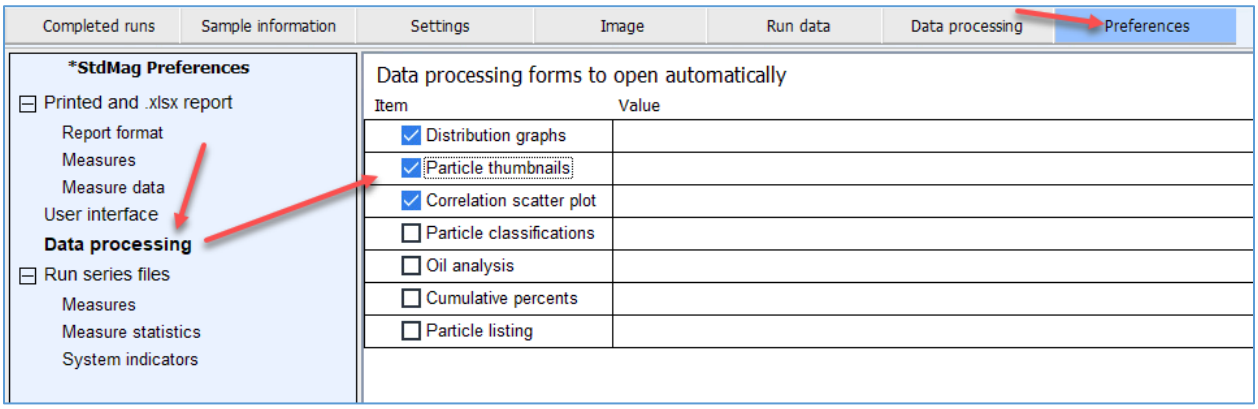
Run Completion set

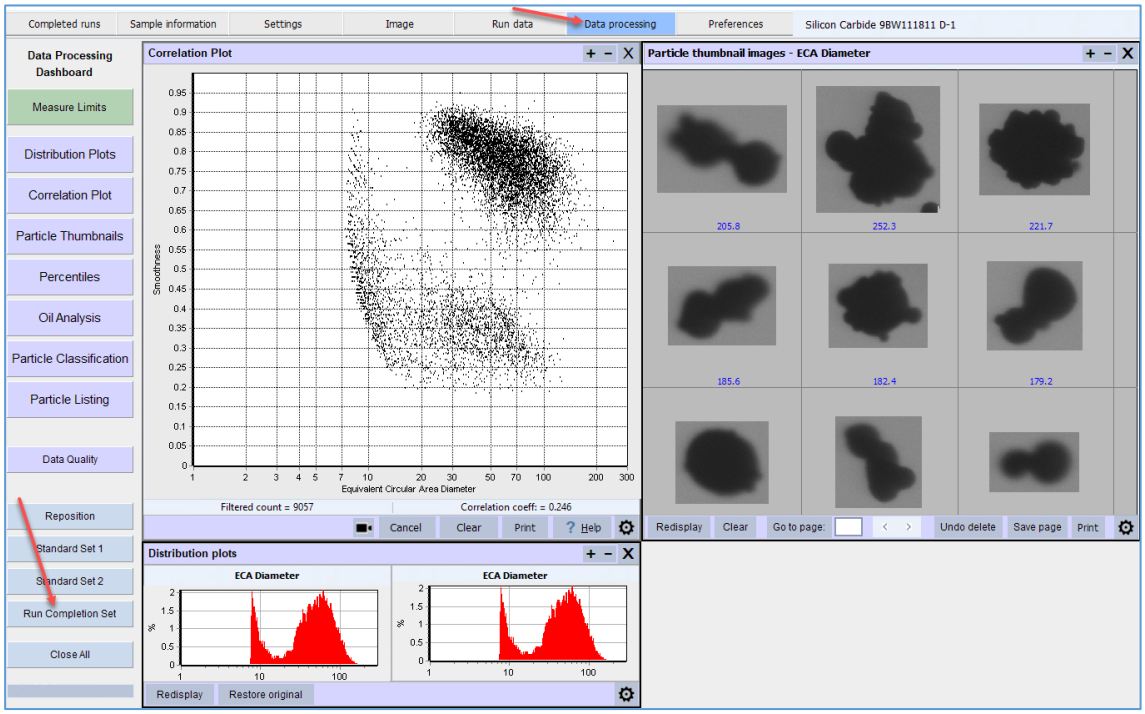
This option allows you to open a configured group of results windows created by you according to specific needs.

To create a group of results:

- Select ***Preference***.
- Click on ***Data processing*** then select the forms you want to be shown.



- Once completed, select ***Data processing***.
- Click on ***Run Completion Set*** and the forms (result windows) previously selected will be shown together.

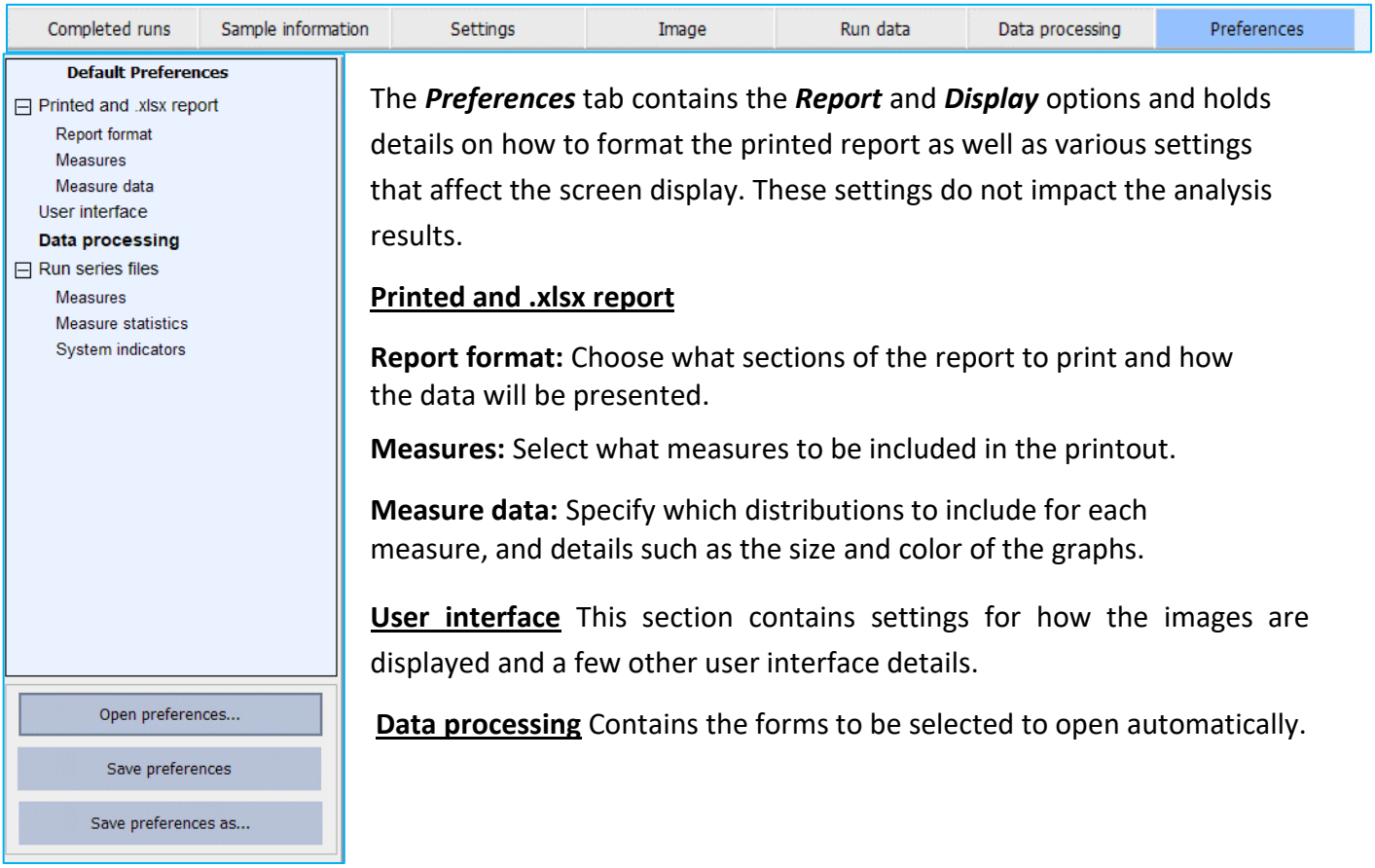


Return to TOC

Close All

Close all the windows.

Preferences



The ***Preferences*** tab contains the ***Report*** and ***Display*** options and holds details on how to format the printed report as well as various settings that affect the screen display. These settings do not impact the analysis results.

Printed and .xlsx report

Report format: Choose what sections of the report to print and how the data will be presented.

Measures: Select what measures to be included in the printout.

Measure data: Specify which distributions to include for each measure, and details such as the size and color of the graphs.

User interface This section contains settings for how the images are displayed and a few other user interface details.

Data processing Contains the forms to be selected to open automatically.

Run series files

Measure: Select the measures to include in run series files.

Measure statistic: Select the statistics to include in run series files.

System indicators: Select the indicators like Date/time, Concentration, temperature to include in run series files.

Open Preferences ... Open a previously saved preferences file with extension ".prf"

Save Preferences ... Save the changes in preferences to the currently open preferences file.

Save preferences as ... Save the current preferences to a file you designate with a different filename.

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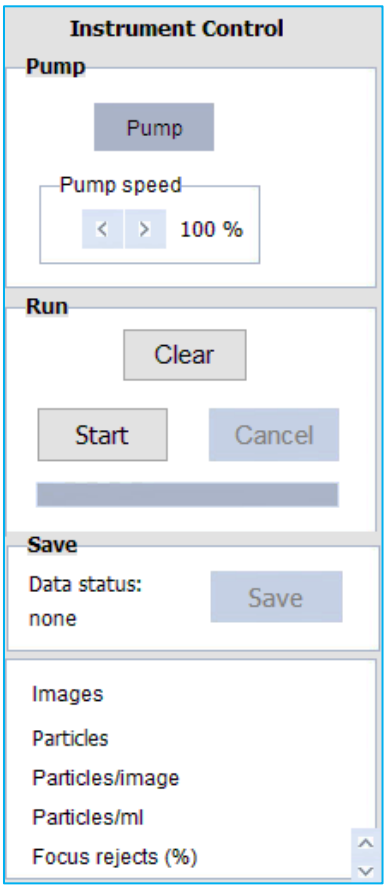
Instrument Control



Pump: Turn the pump On /Off and change the pump speed.

Run: This section controls the execution of an analysis:

- **Clear:** To clear the statistics and the histogram of the current and unsaved data.
- **Start**: To start continuous data capture: strobe images continuously, analyze image, update the accumulated statistics after each frame, and periodically update the screen display. After starting, this button changes to **Stop** run.
- **Stop:** Suspends the run but does not carry out any save actions. Changes to "**Resume"** run after being clicked.
- **Resume:** Data acquisition resumes, with new data being added to what was taken previously.
- **Cancel** the run momentarily. The button will change to **Resume** to continue the run.
- A **progress bar** that shows the progress of the process.

Save: This section allows to save the data of a run that has not met the end condition.

Note: When the run reaches the end condition, the software automatically save the data If the option ***Save sample file*** under ***Settings*** ➔ ***Completion actions*** was enabled.

The bottom section shows some statistics regarding: **Images, Particles**, **Particles/images, Particles/ml, and Focus rejects (%)** in the completed analysis.

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Status bar

The status bar along the bottom of the main screen contains several sections.

Section 1:

- The current username if security is enabled.
- ***Filtered count*** in ***Correlation Form***.

Section 2:

- Sample filename
- ***Correlation coefficient*** in ***Correlation Form***

Section 3:

- Image filename
- ***Measure*** name in ***Thumbnails***.

Section 4: Shows error codes.

Section 5: Shows notice or warning codes.

Section 6:

- Shows the number of runs remaining in an auto-start run sequence.
- ***COMPLETED*** at end of a run.
- ***Particle count*** in ***Thumbnails***
- Grid spacing when the grid overlay is present.

Section 7: ***Page n*** when ***Thumbnails*** are open.

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Chapter 3 - GETTING STARTED

Startup

- Plumbing the Pi Raptor Portable according to the desired Fluidics Connections method: Syringe or Pump.

- Open the application software by double left-click the icon in the desktop.

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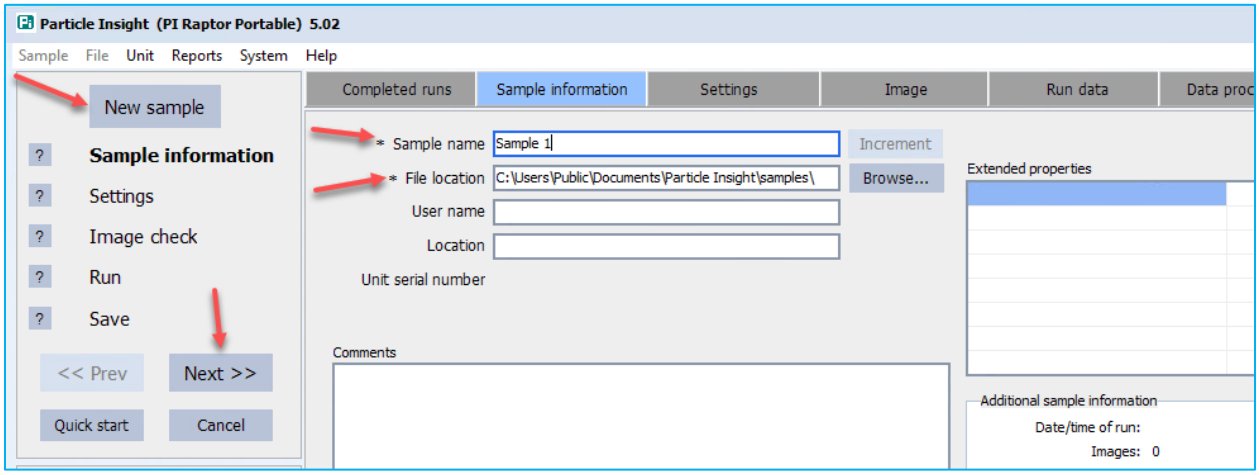
Beginning a new run

To begin a new run, click on ***New sample*** (Wizard).

Sample information

- Enter a ***Sample name*** and the ***File location*** if other than default.
- ***User name*** and ***Location*** are optional.

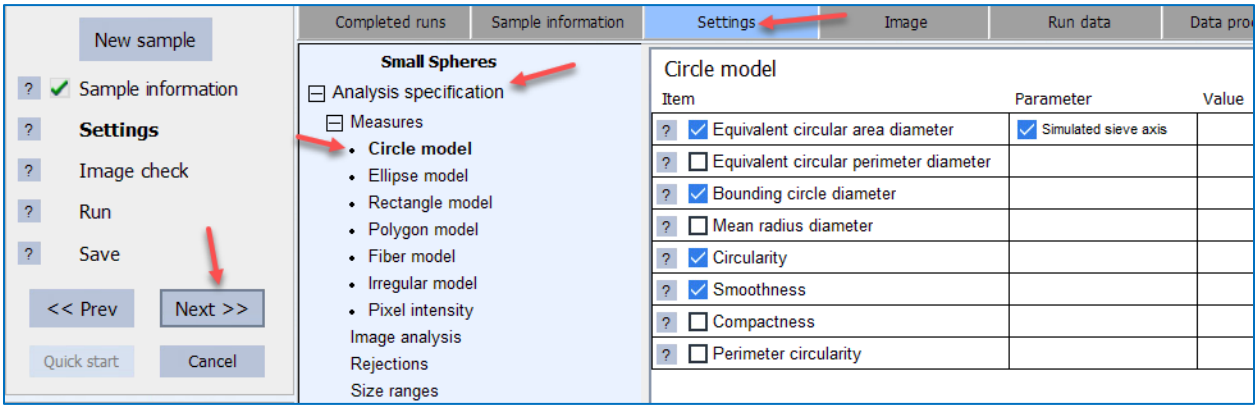


- You may also open a previous sample and increment the name using ***Increment***, to the right of the sample name.
- You may enter any ***Comments*** and/or ***Extended properties*** of the sample to be analyzed.
- When ready click ***Next*** in the left-hand panel to jump to the next step.

Return to TOC

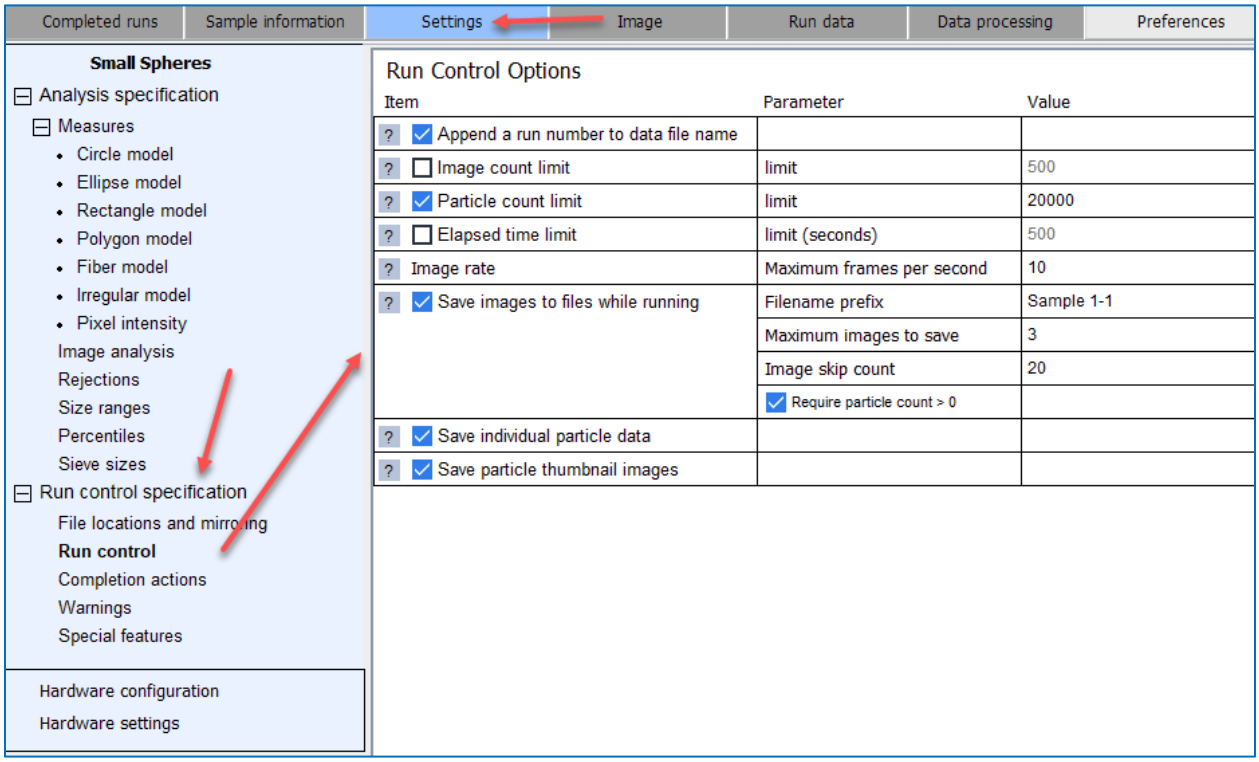
Settings

- Select the ***Settings*** tab.
- Open a specific Settings file or adjust the current settings under ***Measures*** as well as the parameters to match the type of particles being measured. These settings affect the image analysis, and therefore the results of a run. This includes the measures to use.
- You may need to return to this page during the ***Image Check*** section of ***New Sample Wizard***.

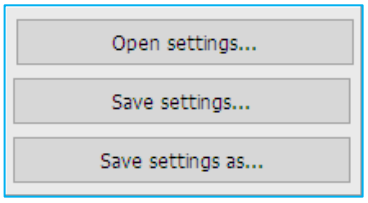


Return to TOC

- Under ***Run Control specifications ➔ Run control.***
- Check ***Image count limit*** to set to the maximum desired images to take.
- Check ***Particle count limit*** to set to the maximum number of particles count.
- Check ***Elapsed time limit and*** to set the limit for the length of the run in seconds***.*** The run will stop when one of these limits is reached.
- Check ***Save images to files while running*** and set the maximum images to be saved.
- Check ***Save individual particle data*** If ***Data processing*** will be used.
- Select ***Save particle thumbnail images*** if thumbnail images will be used.



- Use the buttons at the bottom of the panel to **Open** or **Save** settings.

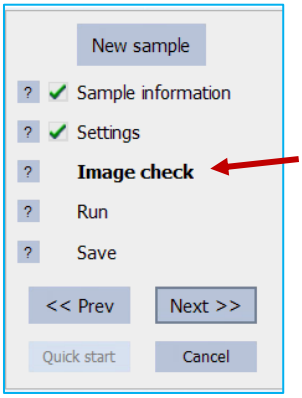


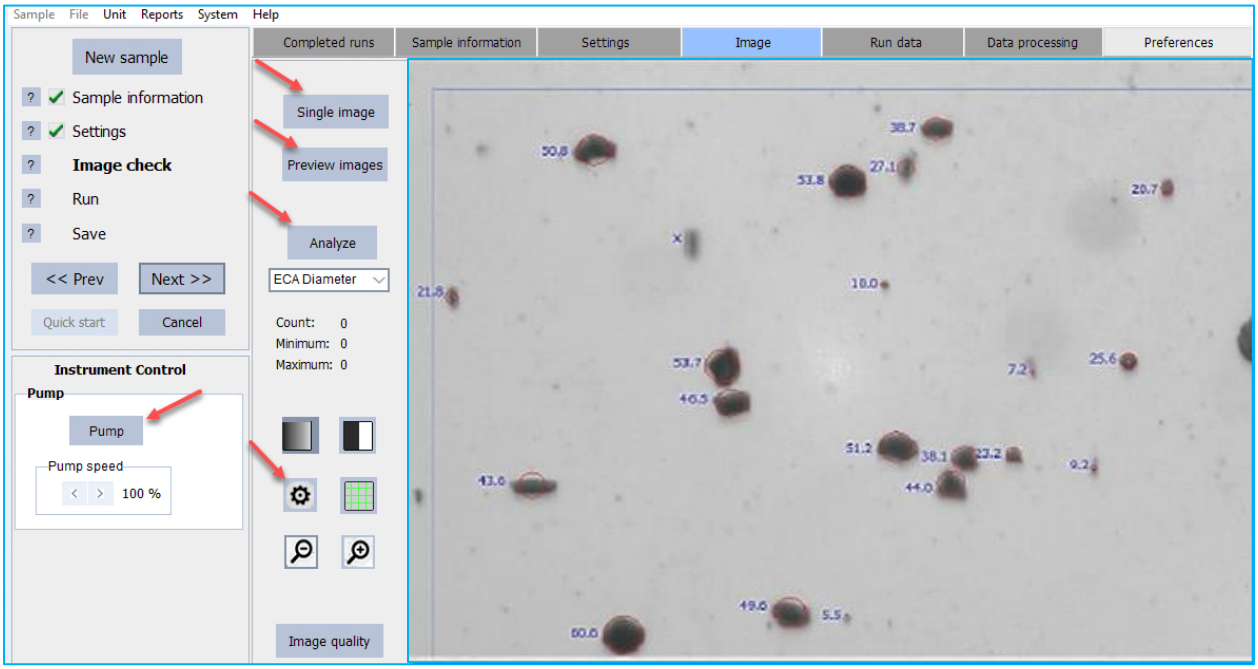
- When ready click ***Next*** in the left-hand panel to jump to the next step.

Return to TOC

Image check

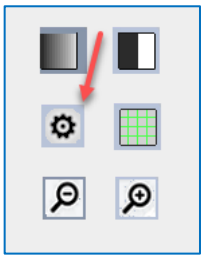
- Turn the pump ***On*** or transfer the sample between the syringes.
- Capture images using ***Single image*** or ***Preview images*** to check image quality and particle density.
- Click ***Analyze*** to obtain the preliminary results.
- Check that the number of focus rejections (red X's) and shape rejections (blue X's) (if enabled) are reasonable.
- Adjust image analysis settings if necessary.

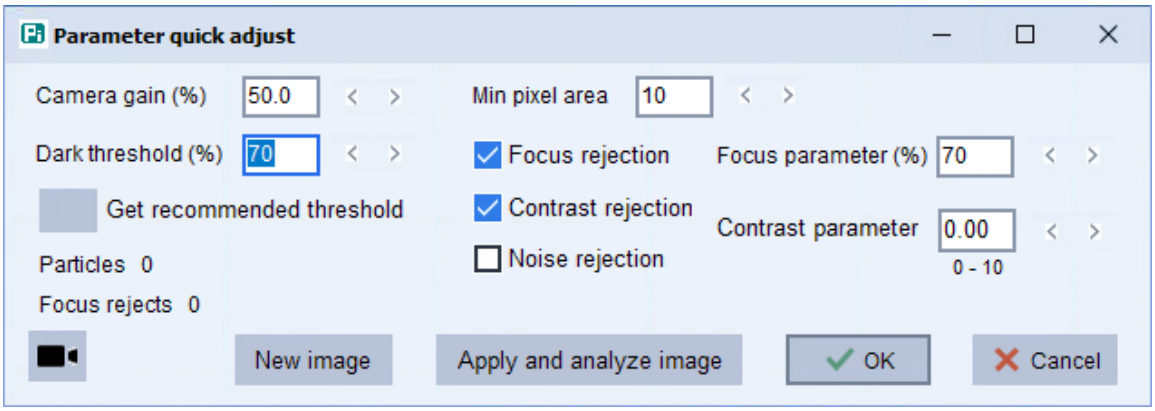




Return to TOC

- If necessary, adjust image analysis parameters in ***Parameter Quick Adjust*** (gear icon).





- Press ***Preview images*** again to stop capturing images.
- Turn the pump ***Off***.

- When ready click ***Next*** in the left-hand panel to jump to the next step.

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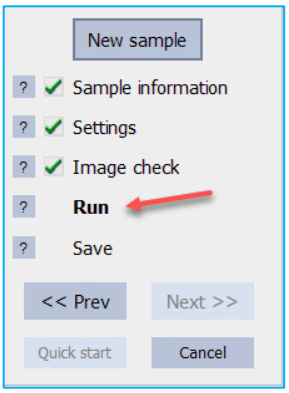
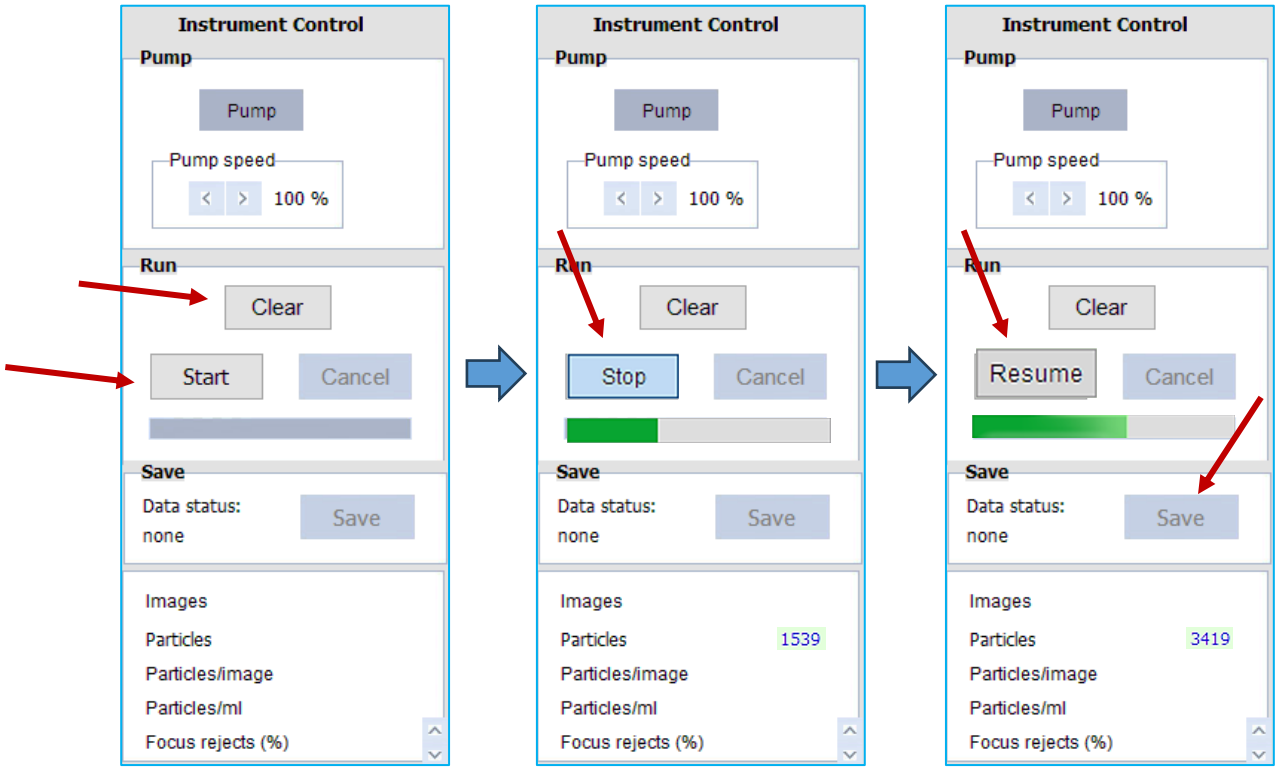
Run



1. Click on ***Clear*** then ***Start*** buttons to start the run.
2. Then, click ***Stop*** to end the run, or wait for a preset limit to be reached.
3. A run may be paused without loss of data by clicking ***Stop***, then ***Resume***.
4. To save a file before it reaches the set endpoint, click ***Stop*** the run and click ***Save***.
5. To cancel a run before it has completed, click ***Cancel***.

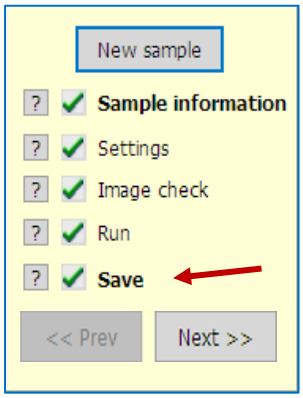


Note: If additional runs are required, click on ***Increment*** under **Sample Information** dialog box and complete Wizard again.

- At any time, the status of the run is shown in the bottom status bar: RUNNING, PENDING, or COMPLETED.
- After a run has been COMPLETED, click ***Next*** in the left-hand panel to jump to the next step.

Return to TOC

Save

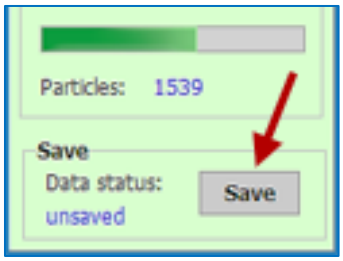


- If the option ***Save sample file*** under ***Settings*** ➔ ***Completion actions*** was enabled, the run will be saved automatically after run is completed.

Completion actions

Item	Parameter	Value
Save sample file	Path	C:\Users\Public\Documents\Particle Insight\samples\
	Filename	Sample 1-1.smp
Export sample results to Excel file	Path	C:\Users\Public\Public Documents\Particle Insight\export\
	Filename	Sample 1-1.xlsx
Save individual particle listing file	Path	C:\Users\Public\Public Documents\Particle Insight\export\
	Filename	Sample 1-1-PF
	Maximum count	1000
	File type	XLSX

- If ***Save sample file*** was not enabled, click ***Save*** to save the sample file. In the Save dialog box there are additional options for saving.



- If ***individual particle data*** was accumulated, ***Data processing*** tab will become enabled.
- Remove the cell temporarily from the instrument and rinse the cell using syringes and clean water.

To return **Step 5 – Save**, click HERE

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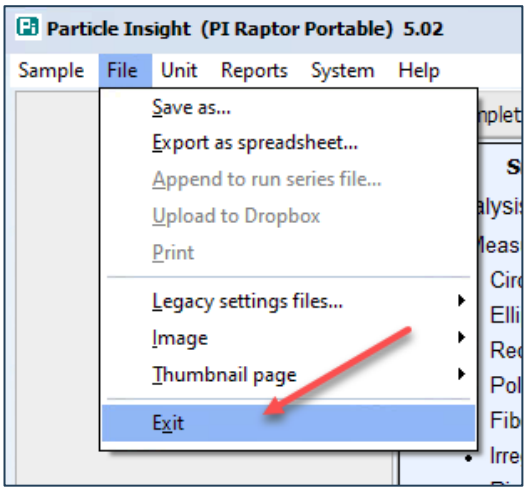
End-of-day shutdown procedure

- Remove the cell temporarily from the instrument and rinse the cell several times using syringes and clean water.
- Fill the cell with clean water, put the caps in the Luer fittings and reinstall the cell cartridge into the instrument.
- ***Exit*** the Pi RAPTOR Portable software.



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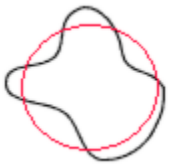
Chapter 4 - SHAPE MODELS

Circle model

ECA Diameter (Equivalent Circular Area diameter)



ECA Diameter characterizes the size of a non-spherical shape with a single number. With typical particle shapes that are not fibrous, ECA Diameter represents the diameter of a sphere that would have a volume close to the actual volume of the particle. Since the software has access only to a flat shadow or silhouette of the particle, ECA Diameter is defined in terms of the silhouette area. It is defined as the diameter of a circle that has the same area as the silhouette.

Practical Use – ECA Diameter is a measure that is commonly used to compare results of the **Pi RAPTOR Portable** to results available from other particle size analyzers that report equivalent diameter.

Note that the ECA Diameter for the **Pi RAPTOR Portable** can report:

Number weighted mean diameter (D [1,0])

Volume weighted mean diameter (D [4,3])

Surface weighted mean diameter (D [3,2])

Length weighted mean diameter (D [2,1])

Mean volume (D [3,0])

Mean surface (D [2,0]).

In addition to this, the ECA Diameter measurement in the **Pi RAPTOR Portable** will show cumulative curves real-time and give real-time correlation to Sieve data.

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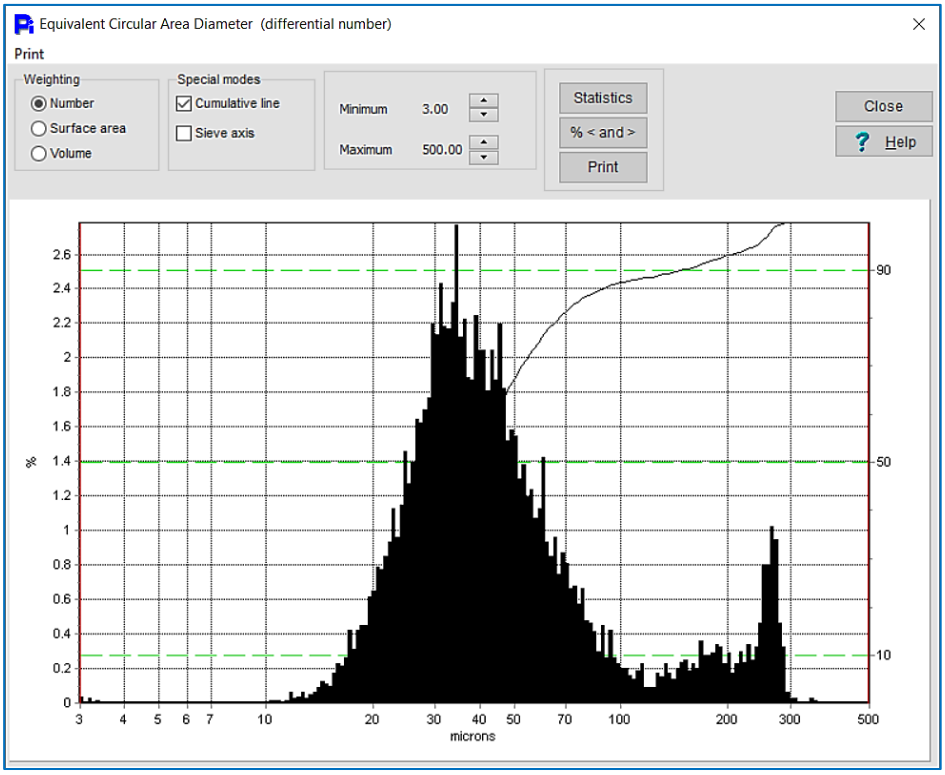
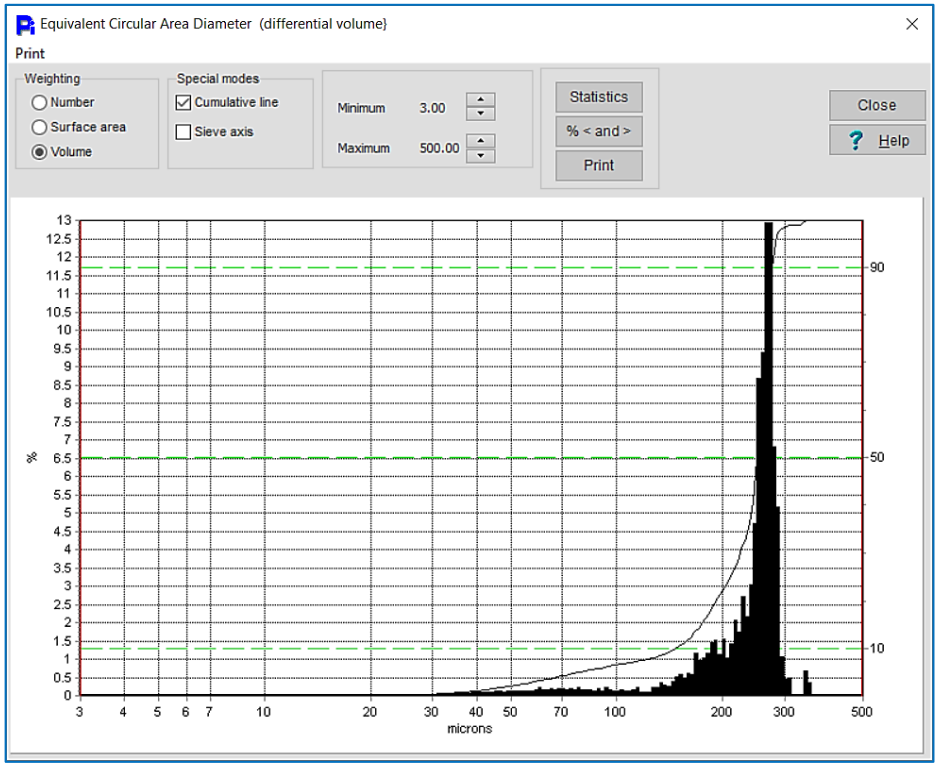
ECA Diameter graph shown with cumulative line for Number weighted mean.



ECA Diameter graph shown with cumulative line for Volume weighted mean.



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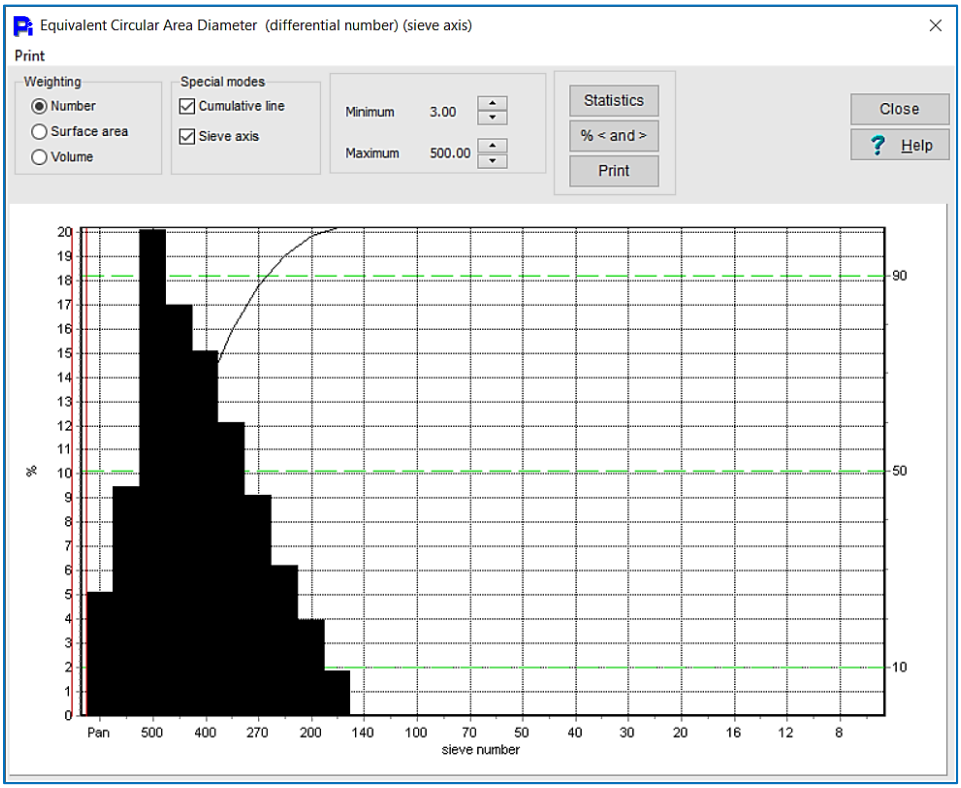
ECA Diameter graph shown with cumulative line for Number weighted mean and Sieve Equivalent results. This is particularly useful when trying to correlate more modern methods, such as Image Analysis to historical Sieve data.



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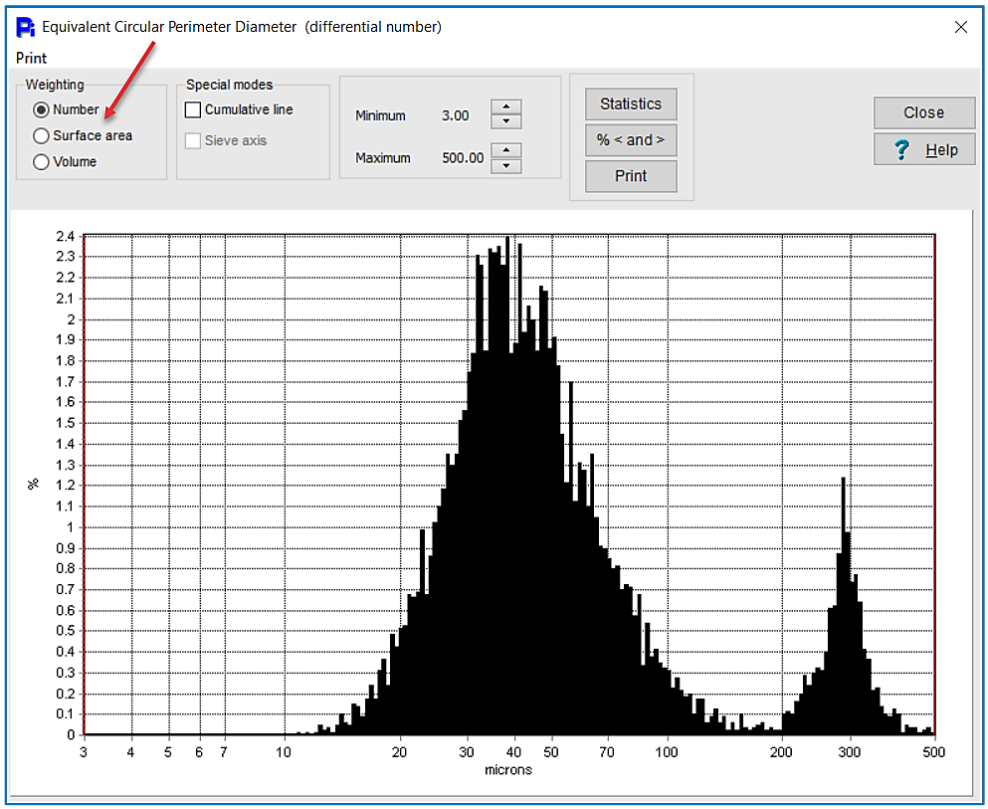
ECP Diameter (Equivalent circular perimeter diameter)

ECP Diameter is the diameter of a circle having the same perimeter as the actual shape. Whereas ECA Diameter relates to a particle's likely volume, ECP Diameter relates more to its surface area.

Practical Use – ECP Diameter is a measure that can be used to determine the surface area of the silhouette of a particle. A practical application of this would be particle coating. In such a case, the amount of coating a particle will require may be relatively controlled by monitoring the changes in ECP Diameter. If ECP Diameter is increasing in size, that means the greater the surface area of the particle and, therefore, the more required coating.



Typical ECP Diameter graph. Results can be displayed in Number weighted distribution, Volume weighted distribution as well as Surface Area weighted distribution. All can be displayed real-time with a Cumulative line.

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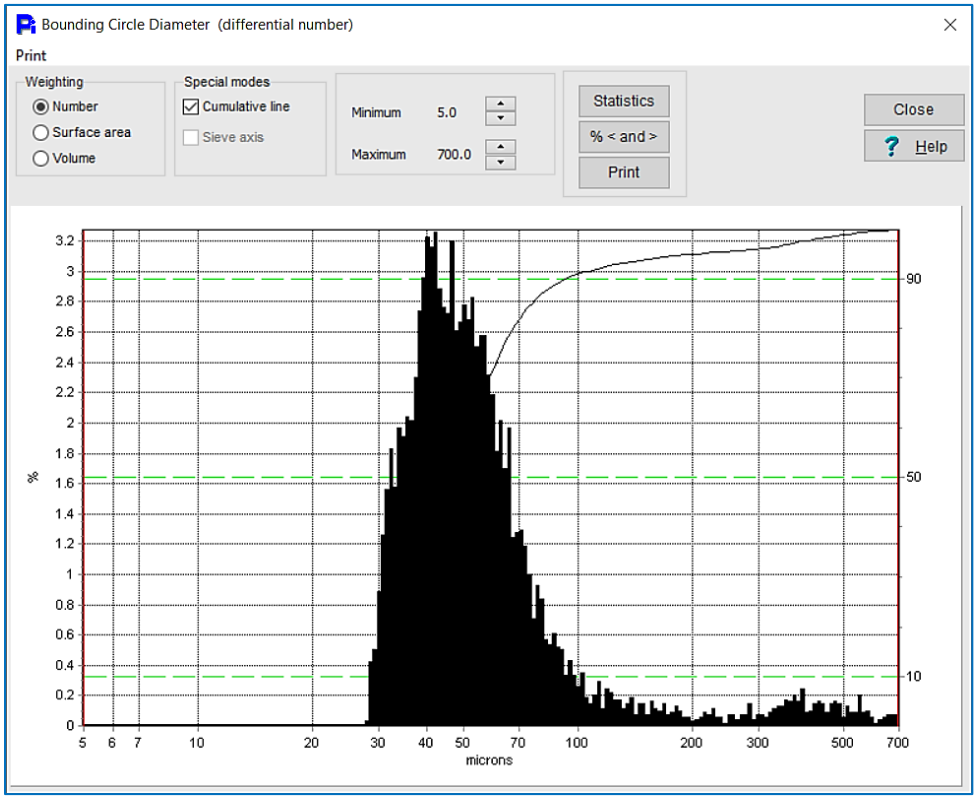
BC Diameter (Bounding circle diameter)

BC Diameter is also a single diameter value. But instead of being an "average" or representative diameter, it characterizes the "largest diameter" of a particle. It is defined as the diameter of the smallest circle that encloses but does not intersect the particle.

Practical Use – BC Diameter is a measure that can be used to monitor and control a process based on the maximum diameter of a particle. By monitoring the smallest circle that can encompass a particle in a process, the end user can ensure particle clogging or trapping in a process is controlled.



Typical BC Diameter graph. Results can be displayed in **Number** weighted distribution, **Volume** weighted distribution as well as **Surface Area** weighted distribution. All can be displayed real-time with a **Cumulative line**.

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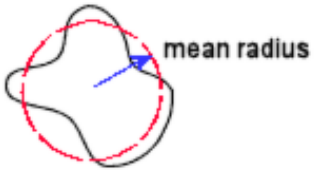
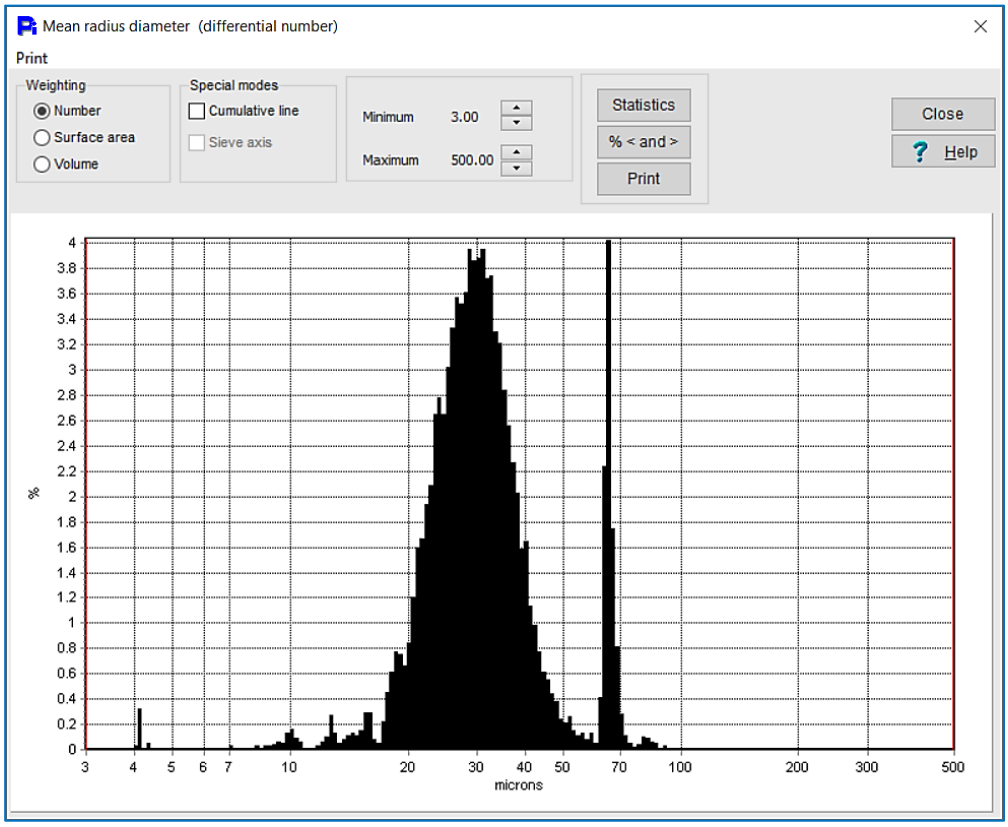
MR Diameter (Mean Radius Diameter)



First the radius from the centroid to the actual perimeter is determined at 36 equally spaced angles. The average of these distances is the mean radius, and the mean radius diameter is defined as double the mean radius.

These measures use a spherical model for estimated surface area- and volume-weighted histograms, means, and percentiles. That is, the relative surface areas of particles are assumed to be proportional to the square of the diameter measure, and the volumes are proportional to the cube of the diameter measure.



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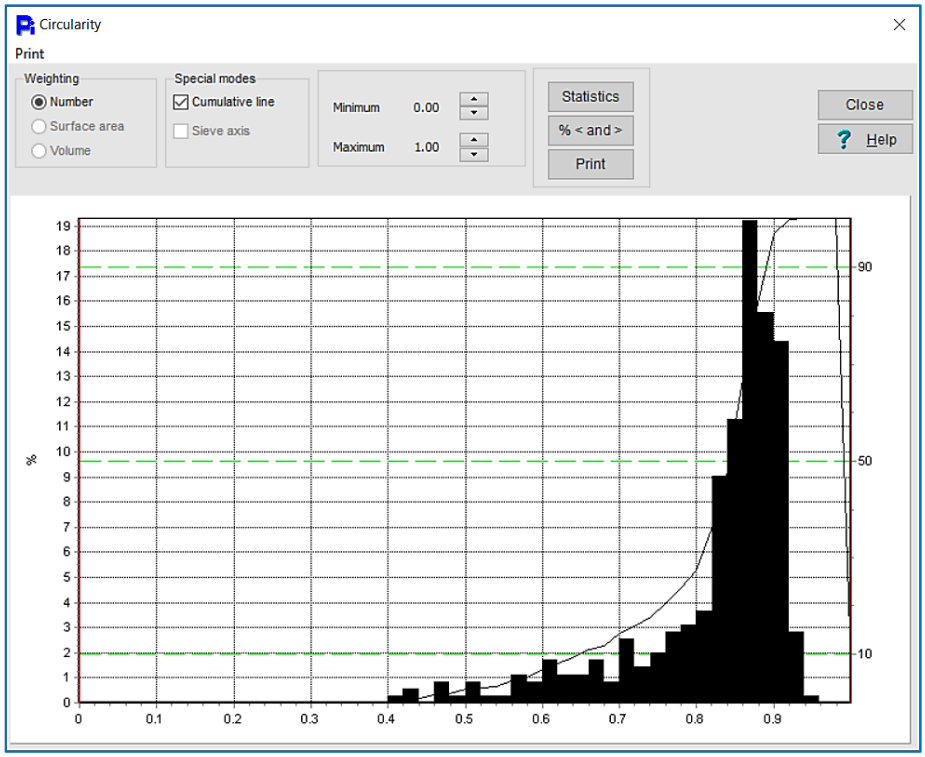
Circularity, Smoothness, and **Compactness** are commonly used measures of roundness and by inference, particle sphericity.

Circularity

Circularity is a commonly used measure of roundness and by inference, particle sphericity. It is a fractional measure, equal to 1 for a perfect circle. It can be thought of as the fraction of the bounding circle's area covered by the actual shape. Circularity is not affected by small irregularities in the perimeter and errors in perimeter measurement. It is not affected by any systematic size bias in perimeter determination. Circularity is computed from area (A) and bounding circle diameter (D_{BC}):

$$\text{Circularity} = 4\,A / \pi\, D^{2}_{BC}$$

Practical Use – Circularity is a measure that can be used to assess flowability of a particle in a process or, in the case of multi-component particles, how each particle will interact with others. Particles that are more circular in nature will flow and mix better. Particles with a lower circularity can get hung up with other particles or feeders which will impact mix-ability and flow-ability.



Typical Circularity graph. Results are shown in Number weighted distribution only and can be displayed real-time with a Cumulative line. Note that a distribution with circularity close to "1" would indicate mostly round particles in the sample population. In the case of these round glass beads particles, circularity is close to "1" which is expected.

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Smoothness

Smoothness is calculated from area (A) and perimeter (P) of the particle projection:

$$\text{Form factor} = 4\,\pi\,A / P^{2}$$

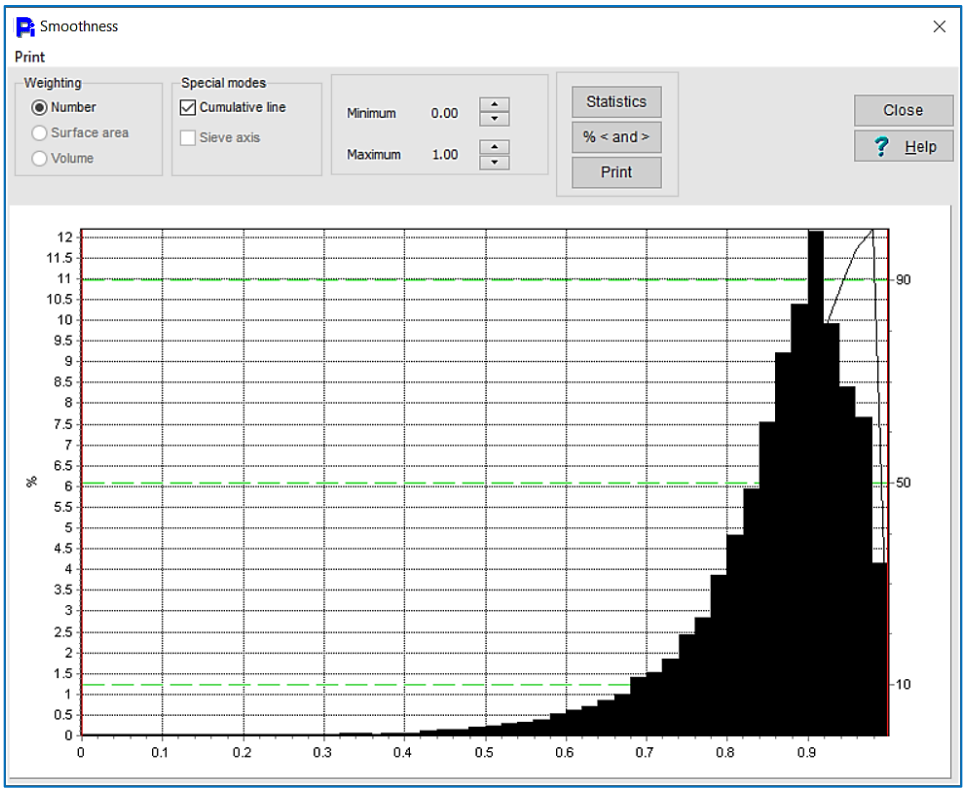
It is a number between 0 and 1, a perfect circle having Smoothness equal to 1.

Like circularity, Smoothness is affected by the degree of out-of-roundness of the general shape.

It is also affected by irregularity of the perimeter, which by inference is an indication of surface roughness. Particles having a pixel area smaller than 'minimum area' will not be smoothness-tested because they are too small for the procedure to work meaningfully. In general, 'minimum area' should be at least sensitivity*100; for example, 500 or more for sensitivity 5.

Particles should be in sharp focus; do not use Smoothness with out-of-focus particles.

Practical Use – Smoothness is a measure that can be used to monitor surface roughness. This can affect the performance of an abrasive particle and can also have an impact on how pharmaceutical powders flow and mix prior to granulation



Typical Smoothness graph. Results can be displayed in Number weighted distribution, Volume weighted distribution as well as Surface Area weighted distribution. All can be displayed real-time with a Cumulative line.

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Compactness

$$\text{Compactness} = 2\sqrt{A} / \sqrt{\pi D2_{BC}}$$

Compactness is the square root of Circularity and does not vary as greatly as Circularity.

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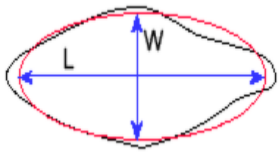
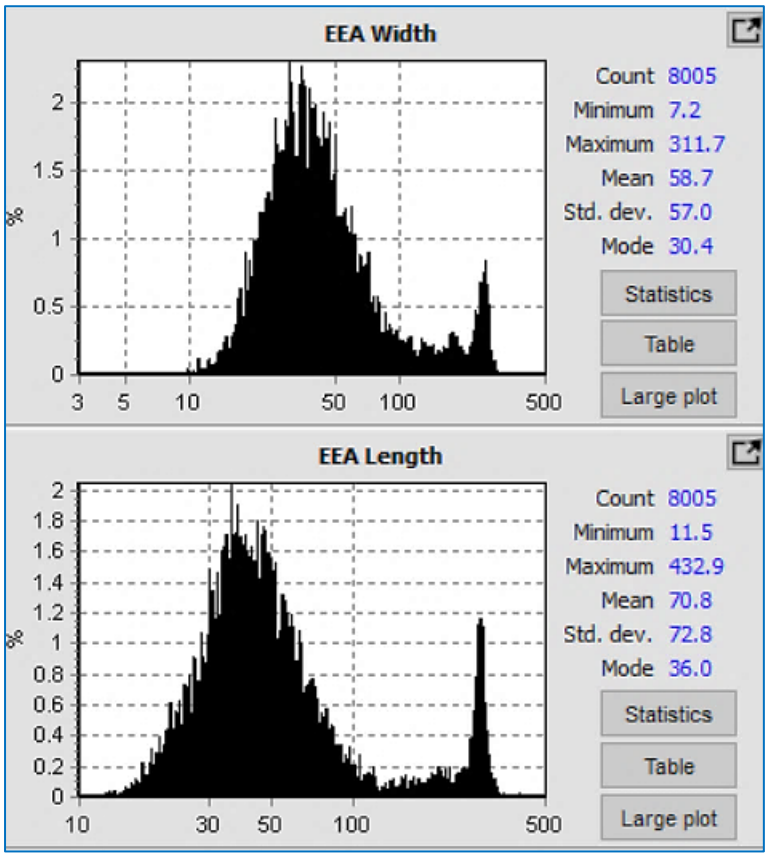
Ellipse model

EEA Width and EEA Length (Equivalent Elliptical Area Width and Length)



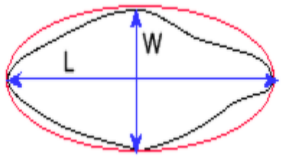
Of all equivalent area ellipses, the one chosen is the one that has the same aspect ratio as the bounding rectangle.



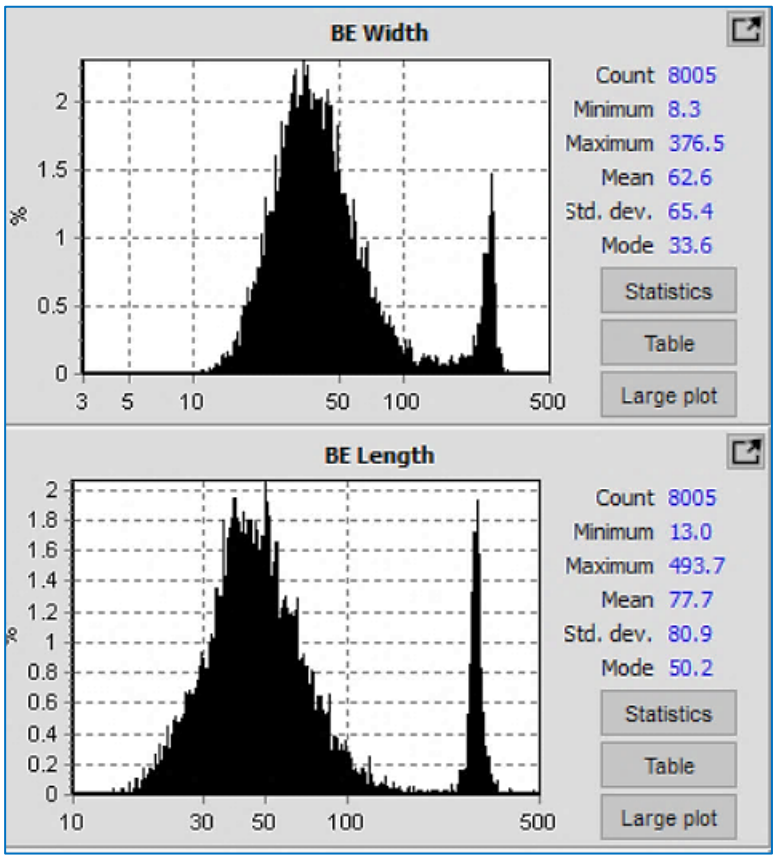
Typical EEA Width and Length graphs respectively. Results can be displayed in Number weighted distribution, Volume weighted distribution as well as Surface Area weighted distribution. All can be displayed real-time with a Cumulative line.

Return to TOC

BE Width and BE Length (Bounding Ellipse Width and Length)



The bounding ellipse is the ellipse of least area that bounds the shape.



Typical BE Width and Length graphs, respectively. Results can be displayed in Number weighted distribution, Volume weighted distribution as well as Surface Area weighted distribution. All can be displayed real-time with a Cumulative line.

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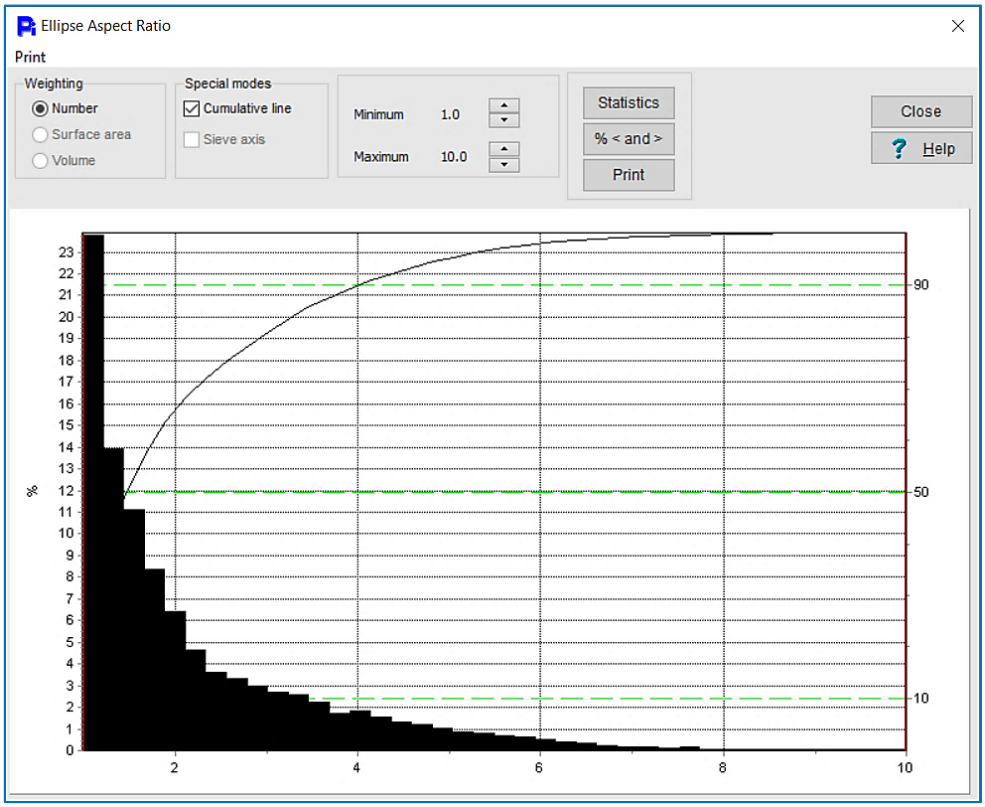
Ellipse AR (Ellipse Aspect Ratio)

Computed as the ratio of EEA Width EEA Length.



Typical Ellipse AR graph. Results can be displayed in Number weighted distribution, Volume weighted distribution as well as Surface Area weighted distribution. All can be displayed real-time with a Cumulative line.

Ellipsicity

Ellipsicity is the ratio of the shape's area to the area of the bounding ellipse.

Calculation of estimated surface area (A) and volume (V):

ecc = square root(1 - 1/(AR*AR)) where ecc is eccentricity and AR is the aspect ratio

A = (pi/2) * BEW*BEW*(1 + AR*arcsin(ecc)/ecc)

V = (4*pi/3) * BEL * BEW * BEW

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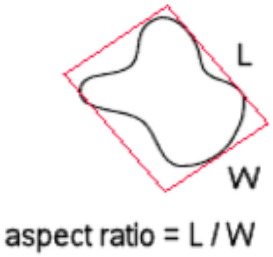
Rectangle model

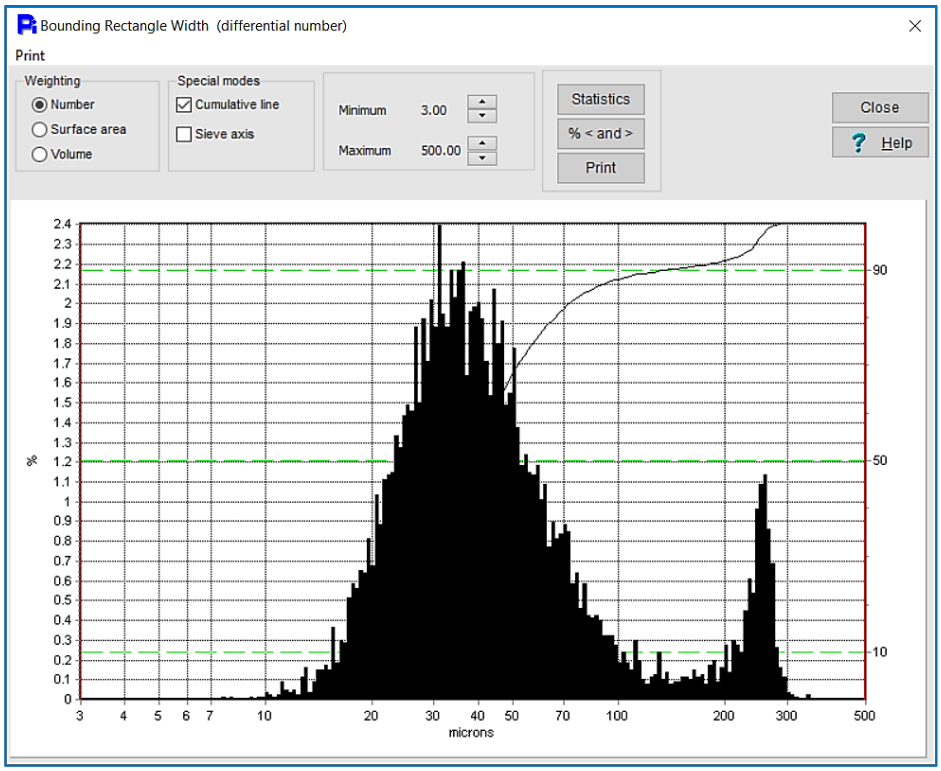


Bounding Rectangle is intended for non-fiber shaped objects, usually particles that are not perfectly round but still have low aspect ratio. It is defined as the rectangle of smallest area that encloses but does not intersect the object. The BR model assumes a thickness in the third dimension equal to the average of the other two distances, for purposes of calculating estimated surface area and volume.

Practical Use – Bounding Rectangle measures is a measure that can be used to determine the width and length of a particle as well as aspect ratio. One powerful use of this measure is using BR Width and its Sieve equivalence calculation. This would allow the estimation of what would pass through each predetermined standard sieve mesh based on the narrowest portion of the particle (BR Width).

BR Width (Bounding Rectangle Width)

BR Width is the smaller side of the rectangle.



Typical BR Width graph. BR Width and Length results can be shown in Number, Volume and Surface Area weighted distribution and can be displayed real-time with a Cumulative line.

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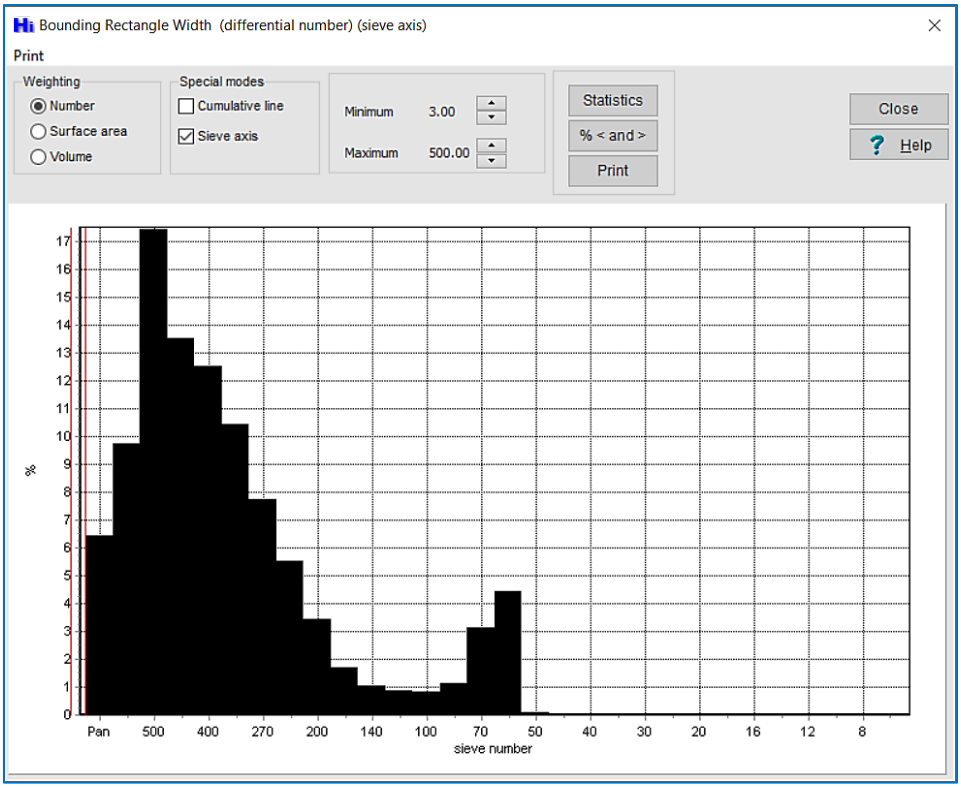
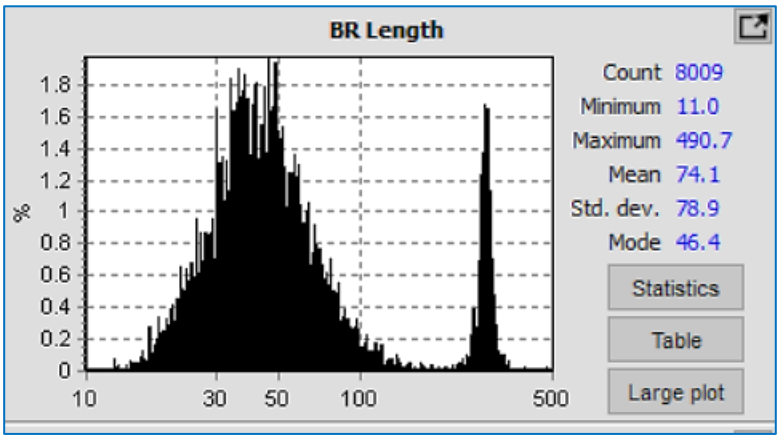


BR Width results can also be shown with Sieve equivalent results to enable comparable results to historical Sieve data. This would enable users to estimate which particles, if passed through a sieve via its narrowest dimension (BR Width), what would pass through each sieve.

BR Length (**Bounding Rectangle Length)**
BR Length is the larger side.



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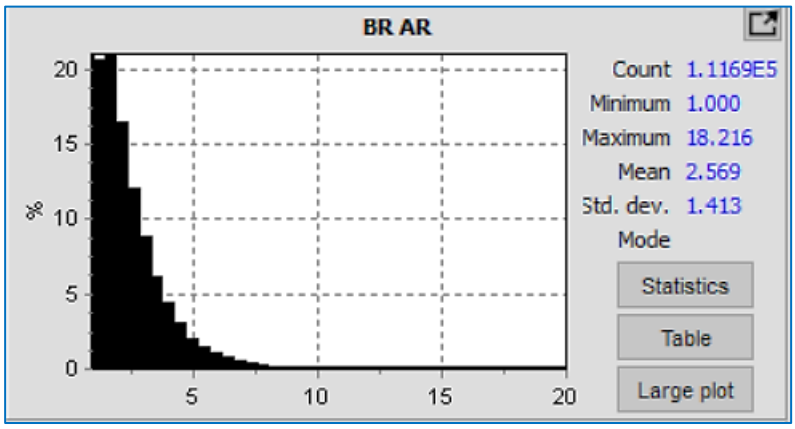
BR AR (Bounding Rectangle Aspect Ratio)

BR Aspect Ratio is the ratio of length to width.

Aspect Ratio is another very used measure in industry.



Typical BR Aspect Ratio graph. BR Aspect Ratio can be shown in Number, Volume and Surface Area weighted distribution and can be displayed real-time with a Cumulative line.

Rectangularity is a measure of how close to a rectangle the shape is, and can be useful with short, thick fibers for example.

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Polygon model

The Polygon model can characterize particles or bio-organisms that have a polygonal shape, recognizable corners and sides that are straight or approximately straight. If a shape is not drawn for a particle it means that 3 or more corners could not be determined, or the shape is outside the minimum and maximum pixel area settings. There is an automatic border contact exclusion.

Practical Use – these measures are useful with abrasives, crystals, and some types of flakes

This model finds an n-sided convex polygon that approximately bounds the shape.

Parameters for this model are:

Minimum angle represented by a side: sides that subtend a central angle smaller than this value are not counted in the number of sides.

Minimum area: objects smaller than this number, in pixels, are not included in the polygon data because the polygon fit cannot be done accurately.

Polygon order is the number of sides of the fitted polygon.

Polygon Interior Angles will accumulate angle statistics on objects that are larger than the minimum size entered for Polygon Order. Since this is a multi-valued measure for each particle, it is not available in places that require a single value. For example, when analyzing a single image, it will not appear in the analysis table.

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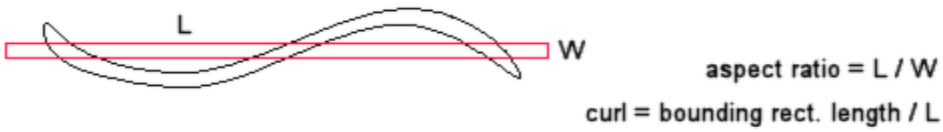
Fiber model

The Fiber model is optimal for long, thin particles that may be curved or bent, but having a fairly constant thickness over the entire length. If such a shape were straightened out and fit with a rectangle, that rectangle would represent the **Fiber Length** and **Fiber Width**.



The rectangle dimensions are computed only from the silhouette's area (A) and perimeter (P):

$D = (P^2 - 16\,A) / 4$

If $D > 0$,

$L = (P + 2\sqrt{D}) / 4$ (Fiber Length)

$W = A / L$ (Fiber Width)

With fibers that are always straight, even long, thin ones, Bounding Rectangle may be more accurate than the Fiber model, which computes length and width indirectly from area and perimeter and is thus subject to error from non-smoothness in the perimeter.

Nor should the Fiber model be used with low aspect ratios since the calculation is imprecise for aspect ratios less than about 3.

The analysis algorithm in its current form cannot separate two crossed fibers. They are counted as one fiber; whose length is the combined lengths of the two actual fibers.

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Fiber Aspect Ratio

Fiber Aspect ratio is the ratio of fiber length to fiber width.

Fiber Curl

Fiber curl is the ratio of bounding rectangle length to fiber length (smaller values indicate greater amounts of curl, so the value is really a degree of straightness. We have kept the definition that is common in industry).

The fiber model assumes either a cylindrical or rectangular solid shape ("flat") for estimated surface area and volume calculations. In the case of the rectangular solid shape, the thickness in the third dimension is assumed to be constant and is entered as a parameter in the settings.

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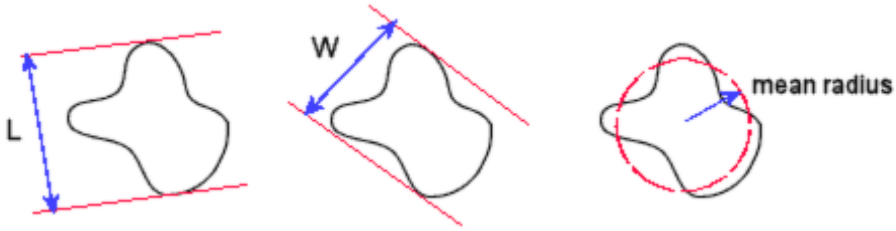
Irregular model

Feret Width and Feret Length

Feret Width and Feret Length are measures of the smallest possible and largest possible spacing between two parallel lines that contact but do not intersect the particle. These measures can be thought of as "caliper dimensions." The Feret measures are sometimes close in value to Bounding Rectangle length and width, but not always since they are not always orthogonal (at right angles to each other). There are no estimated surface area and volume statistics with the Feret measures since area and volume cannot be inferred from them.



Feret AR (Feret Aspect Ratio)

Feret Aspect ratio is Feret Length / Feret Width.

Martin Width

Martin Width is the narrowest width near the middle of the shape. It can be thought of as the “waist” of the particle shape.

Martin Length

Martin Length is the longest chord through the middle of the shape.

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Pixel Intensity

Intensity

The particle's intensity mean is calculated as a value between 0 (black) and 255 (white).

Opacity

Opacity is then computed as (256 – (Intensity Mean))/256.

1 is fully opaque, 0 is fully transparent

White Fraction

White fraction is the fraction of the particle area that is lighter than ***Dark Threshold*** in ***Settings*** ➔ ***Image Analysis*** options.

Further information regarding the models

The following models compute estimated surface area and volume distributions:

- Circle
- Ellipse
- Rectangle
- Fiber

The following measures can be used in simulated sieve mode:

- ECA Diameter
- Bounding Rectangle Width
- Fiber Width
- Feret Width

To return to **Run Data** section, click HERE.

Return to TOC

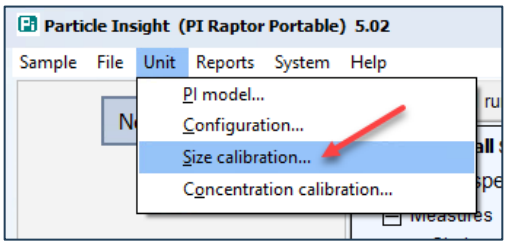
Chapter 5 - CALIBRATION

Calibration

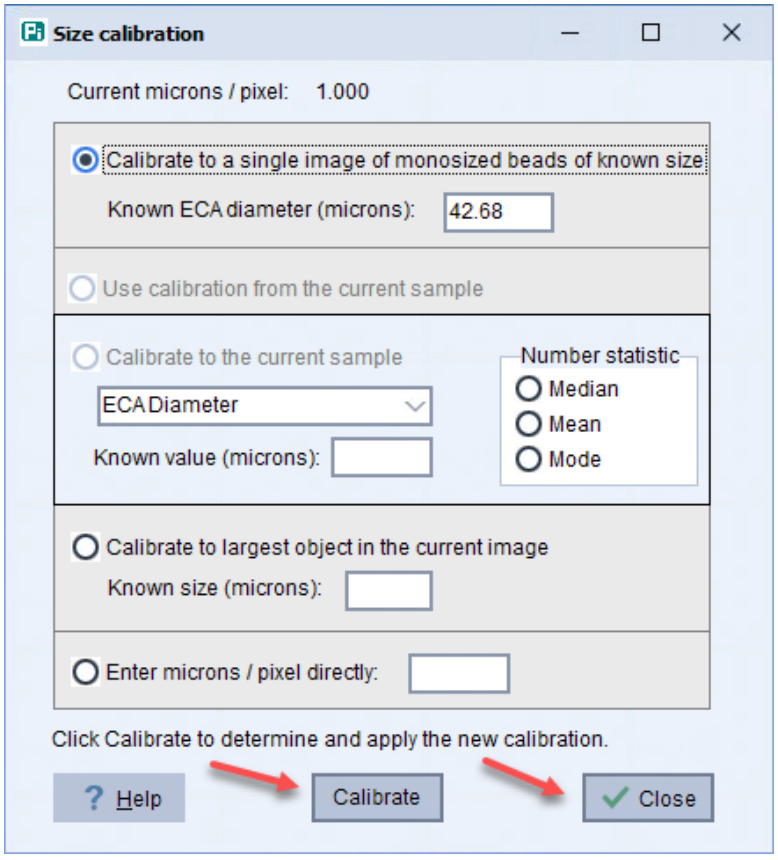
There are a few ways to calibrate the Pi RAPTOR Portable by using: A single image of monosized beads of known size, the curently open sample, the largest object in the image or entering the microns/pixel ratio directly.

It is highly recommended to use the **Shape Control** sample for calibration, that has a narrow size distribution, and the particle size is known. The **Mode** size of the entire sample will be used for calibration. For best accuracy, do two or more iterations of run/calibrate, unless the change in calibration factor is small.

In the toolbar, click on ***Unit*** ➔ ***Size Calibration*** to change/perform the size calibration.



Note: Administrator level is required if **Security** is in effect.



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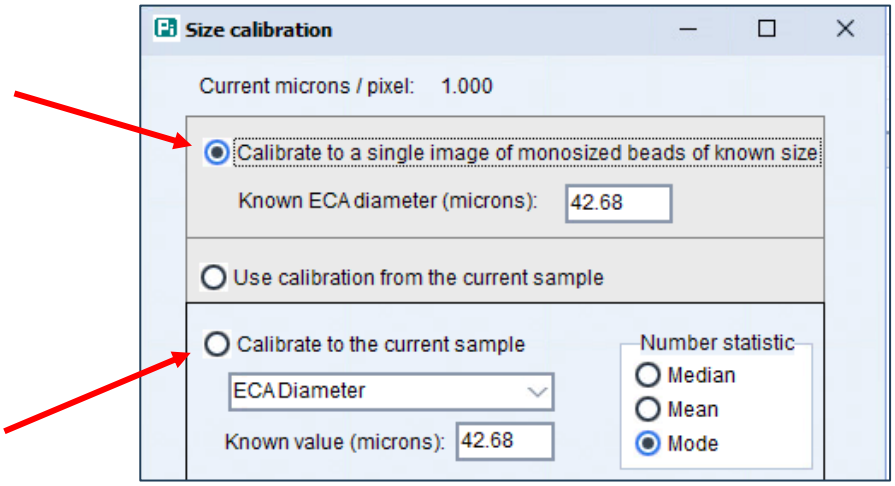
Calibrate to a single image:

Using monosize beads of known size, take an image containing at least 10 beads. Enter the micron size in ***Known ECA diameter (microns)*** and click on ***Calibrate,*** then ***Close***.

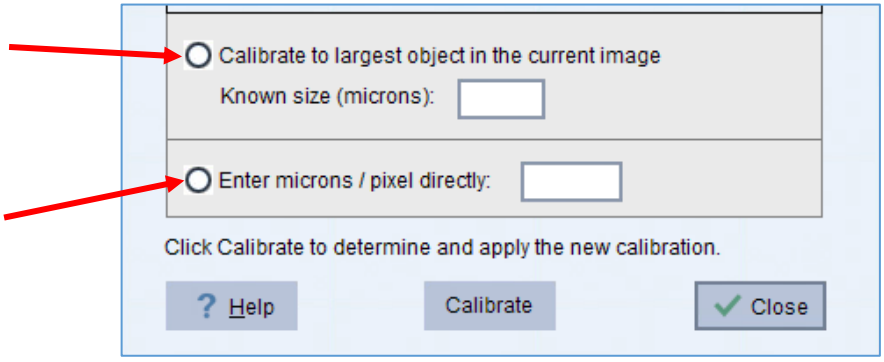


Calibrate to the currently-open sample: Recommended

Use a sample that has a narrow size distribution, and the particle size is known. The **Mean** or **Mode** size of the entire sample will be used as the standard. For best accuracy, do two or more iterations of run/calibrate, unless the change in calibration is small. (**Mode** is strongly recommended), enter the ***Known value (microns)*** and click on ***Calibrate*** then ***Close***.

Calibrate to largest object:

Take an image in which that object is the largest object in the image. Enter the ***Known size (microns),*** click on ***Calibrate*** then ***Close***.



To enter a calibration factor directly:

Enter a new calibration value ***microns/pixel*** and click on ***Calibrate*** then ***Close***.

The new Calibration factor (microns/pixel) will be shown (in blue) at the top of the dialog window.

Return to TOC

Running Shape control

Use the Shape Control sample that has a narrow size distribution and the particle size is known. The **Mode** size of the entire sample will be used for calibration. For best accuracy, do two or more iterations of run/calibrate, unless the change in calibration factor is small.

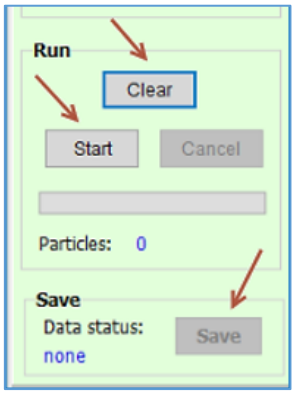
Depending on the method of fluidics connection selected, the pump operation is enabled or disable. By default, the pump will start/stop (ON/OFF) automatically.

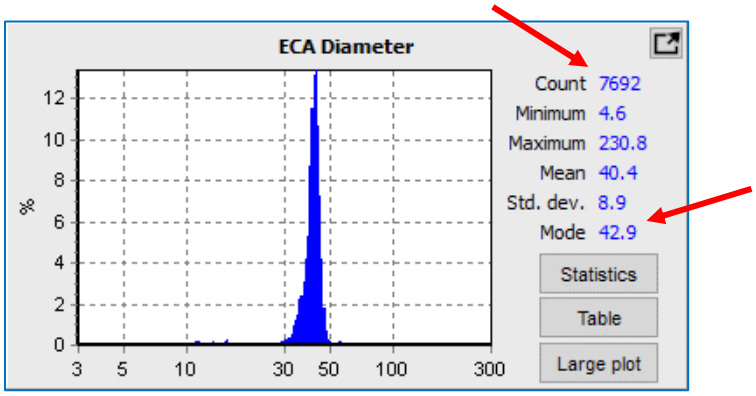
If the PUMP method is selected, pump is activated automatically during run.

If the SYRINGE method is selected, the pump must be disabled through ***Settings*** ➔ ***Hardware settings***.

SYRINGE mode: Disable the pump during run.

a. Load one syringe with sample + fluid. Leave the other empty.
b. Remove the Luer caps and connect both syringes to the Luer fittings of the cell cartridge.
c. Click on ***Preview images*** button to start capturing images.
d. Move both plungers in and out alternatively to transfer the sample between the syringes and to recirculate the sample through the cell.
e. Check the images and modify any settings if needed.
f. Click on ***New sample*** and follow the prompts from the Wizard.
   - Enter a ***Sample name*** and the ***File location*** if other than default.
   - Enter the **Sample parameters** according to the Shape Control Assay Sheet.
e. Click on ***Clear*** then ***Start*** buttons to start the run.
f. Move the plungers to recirculate the sample and accumulate more than 3000 particles Count, to become a representative sample.
g. Then, click ***Stop*** to end the run and click on ***Save*** to save the run data, or wait for a preset limit to be reached. If the second case happens, the run data is saved automatically. Below histogram belongs to 42 µm Shape Control





Good concentration run

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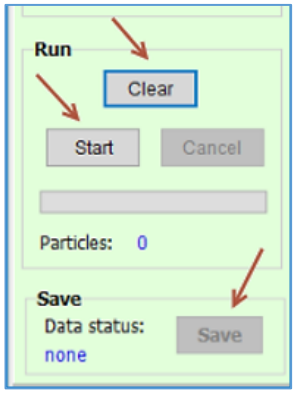
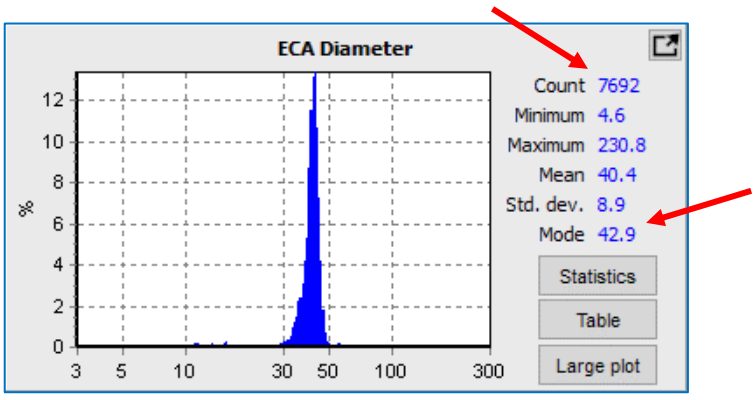
PUMP mode: Enable the pump if previously turned Off during run.

a. Fill the sample vessel with water or the diluent to be used.
b. Enable the pump ***ON*** to recirculate the fluid through the cell and the sample vessel.
c. Add Particle Shape control in the sample vessel.
d. Click on ***Preview images*** button to start capturing images.
e. Check the images and modify any settings if needed.
f. Turn the pump ***OFF***.
e. Click on ***New sample*** and follow the prompts from the Wizard.
   - Enter a ***Sample name*** and the ***File location*** if other than default.
   - Enter the **Sample parameters** according to the Shape Control Assay Sheet.
f. Click on ***Clear*** then ***Start*** buttons to start the run. The pump will turn ***ON*** automatically.
g. Accumulate more than 3000 particles Count, to become a representative sample.
h. Then, click ***Stop*** to end the run and click on ***Save*** to save the run data, or wait for a preset limit to be reached. If that happens, the run data is saved and the pump will turn ***OFF*** automatically.

Below histogram belongs to 42 µm Shape Control.





Good concentration run

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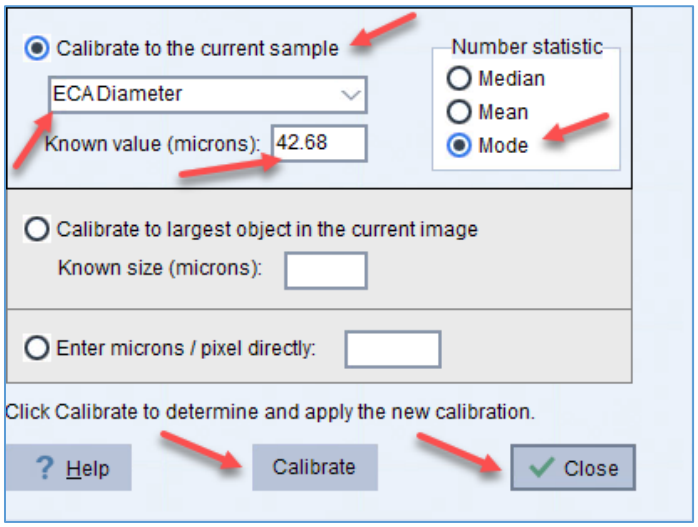
Calibration with Shape Control

1. In the toolbar, click on ***Unit*** ➔ ***Size Calibration*** to perform the size calibration.
2. Select ***Calibrate to the curently-open sample*** option.
3. Select ***Mode***.
4. Select ***ECA Diameter*** in the pull-down menu.
5. Enter the **Mode** value from the Assay Sheet into the ***Known value (microns).***
6. Press ***Calibrate*** then ***OK.***



7. The new Calibration factor (microns/pixel) will be shown (in blue) at the top of the dialog window.

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Verification

Perform a verification run right after calibration is completed using the same sample from the calibration process:

SYRINGE mode: Disable the pump during run

a. Click on ***Preview images*** button to start capturing images.
b. Move both plungers in and out alternatively to transfer the sample between the syringes and to recirculate the sample through the cell.
c. Click on ***New sample*** and follow the prompts from the Wizard.
   - Enter a ***Sample name*** (including Verification) and the ***File location*** if other than default.
   - Enter the **Sample parameters** according to the Shape Control Assay Sheet.
d. Click on ***Clear*** then ***Start*** buttons to start the verification run.
e. Move the plungers to recirculate the sample and accumulate more than 3000 particles Count, to become a representative sample.
f. Then, click ***Stop*** to end the run and click on ***Save*** to save the verification run data, or wait for a preset limit to be reached. If the second case happens, the run data is saved automatically.
g. Check the **Mode** for ***ECA Diameter*** to verify the calibration. The resulting ***Mode*** diameter should be within ± 10% of the Shape Control Assay value.
i. If not within ± 10%, perform another Calibration procedure until the verification passes.

Size calibration exists independently of all Settings. When a calibration is done, it will remain in effect even if a different sample is loaded to the user interface.

PUMP mode: Enable the pump if previously turned Off during run.

a. Click on ***New sample*** and follow the prompts from the Wizard.
   - Enter a ***Sample name*** (including Verification) and the ***File location*** if other than default.
   - Enter the **Sample parameters** according to the Shape Control Assay Sheet.
b. Click on ***Clear*** then ***Start*** buttons to start the run. The pump will turn ON automatically.
c. Accumulate more than 3000 particles Count, to become a representative sample.
d. Then, click ***Stop*** to end the run and click on ***Save*** to save the run data, or wait for a preset limit to be reached. If that happens, the run data is saved automatically. In both cases, the pump will turn ***OFF*** automatically.

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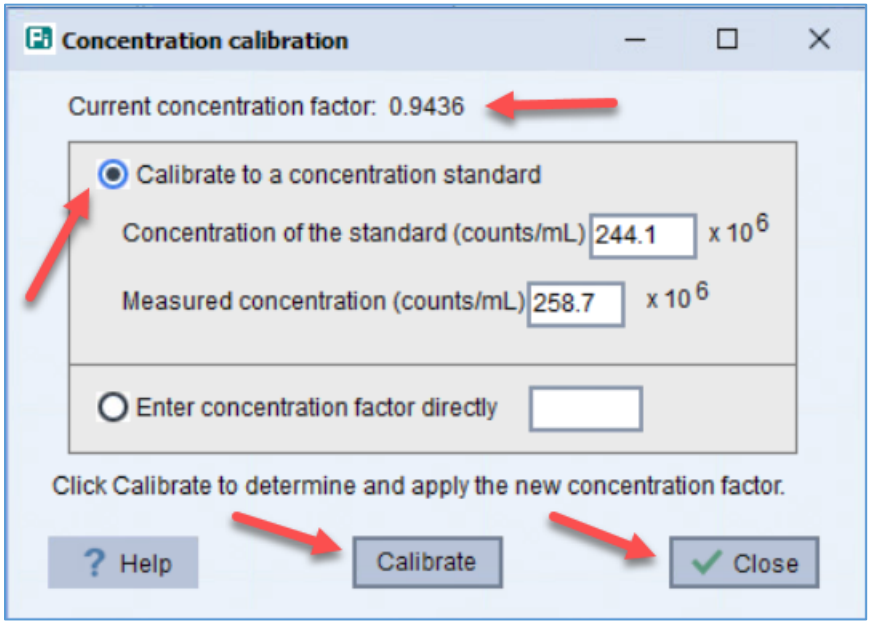
Concentration calibration

Click ***Unit*** ➔ ***Concentration calibration*** to open a form where the concentration factor may be changed, either directly or by reference to a sample of known concentration.



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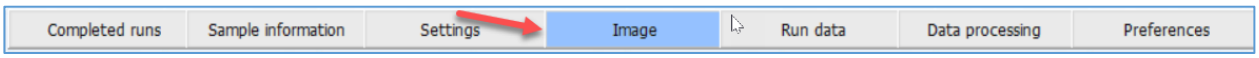
Chapter 6 - WORKING WITH HARDWARE

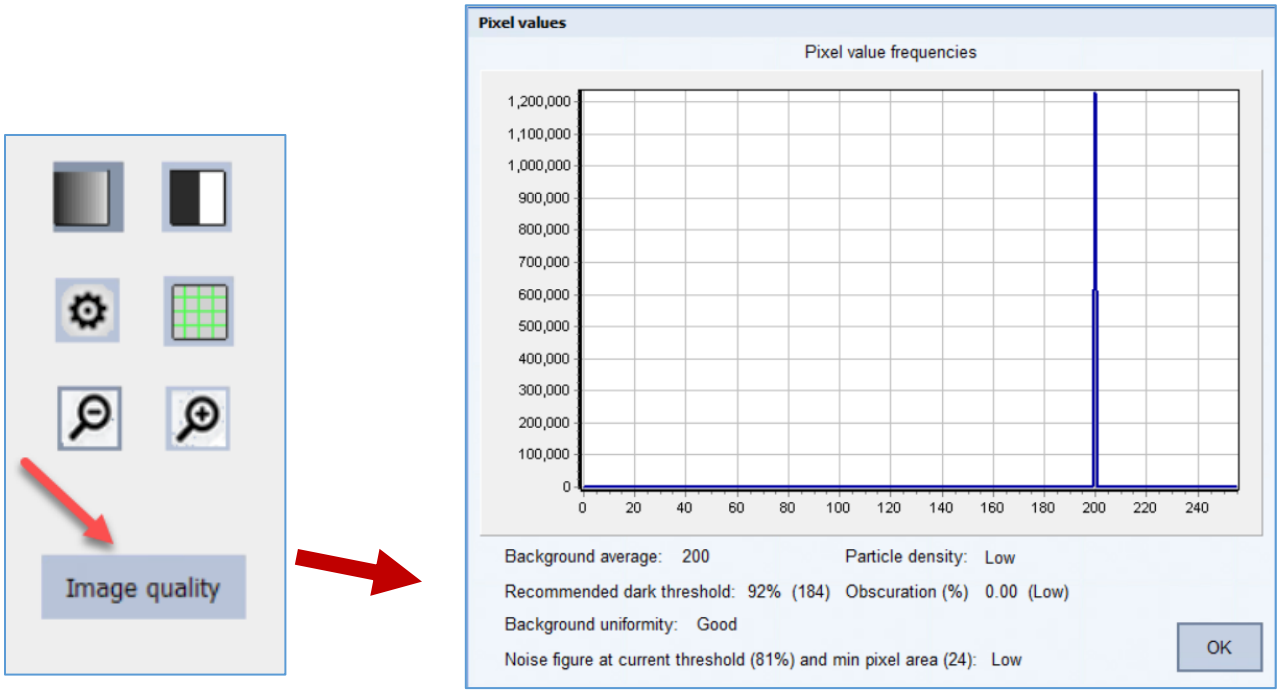
Check the Background intensity

Run the Pi RAPTOR Portable instrument with clean water (no particles)

Select the tab ***Image***.



- Click on the ***Image quality*** botton.
- Note the ***Background average*** intensity at the bottom left of the histogram.



- If the Background average is less than 140, increase the camera gain in ***Parameter quick adjust*** using the gear icon.
- Check the ***Background average*** intensity again for the new gain setting. Verify it is within 140 and 200.
- If the background is higher than 200, decrease the camera gain.

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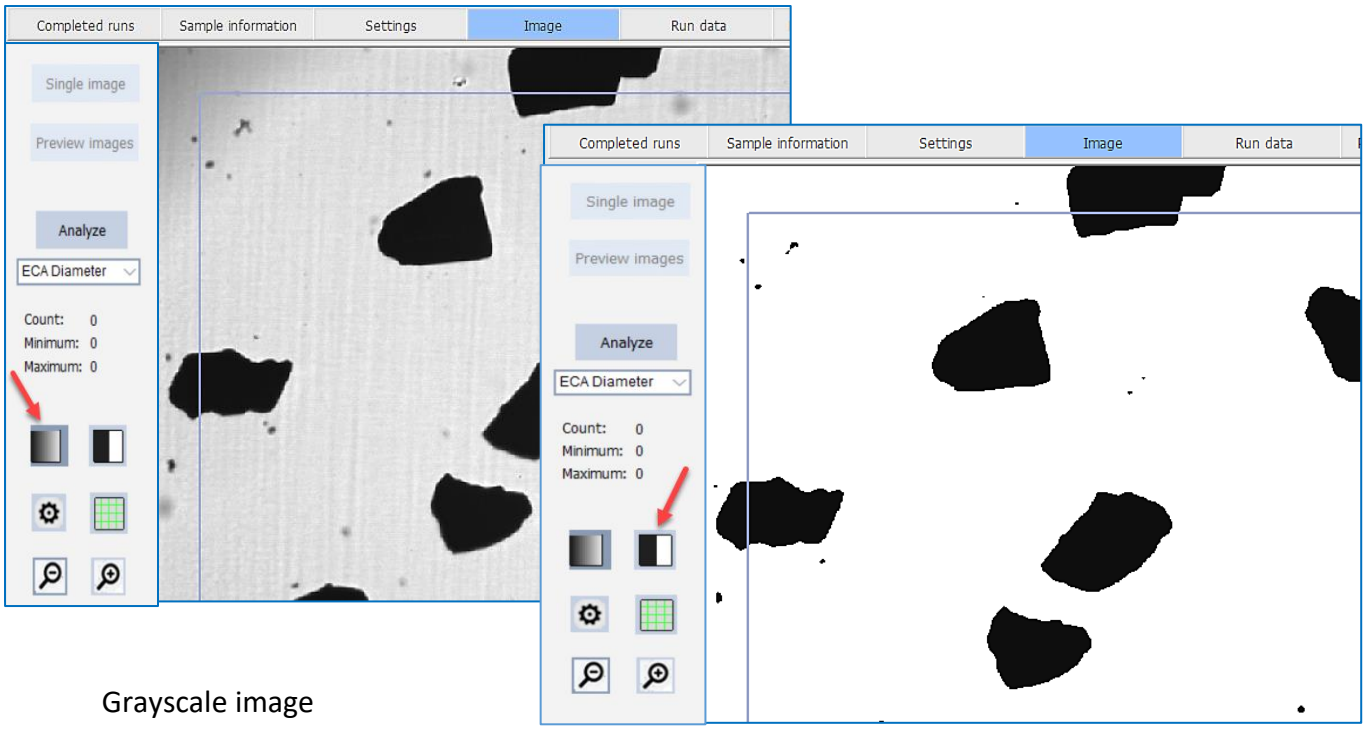
Adjusting the threshold

The internal analysis threshold is a gray level value between 0 (black) and 255 (white). In the settings, threshold is specified as a percent (0 to 100%) of the background average intensity. This method makes the analysis less sensitive to changes in light intensity due to varying particle densities, for example.

The threshold percent is the most critical parameter in ensuring that images are correctly analyzed. If the threshold is set too low, tiny particles may not be counted. If set too high, dark areas of the background may be counted as objects and particles that almost contact each other may be counted as one particle. Nevertheless, there is usually a range of values that produces consistent results.

The threshold is calculated automatically in software on every frame, based on the background average intensity in that frame and the threshold percent. Normally the threshold setting should be kept within the range 55 % to 75 %.

To check the threshold value, use the ***Binary image*** mode to verify that only actual particles appear as black objects, and that all actual particles appear.



Grayscale image

Binary image

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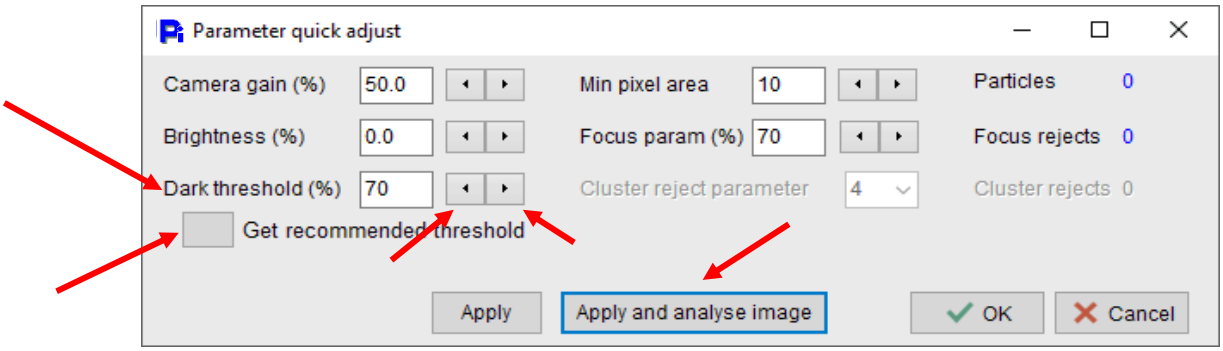
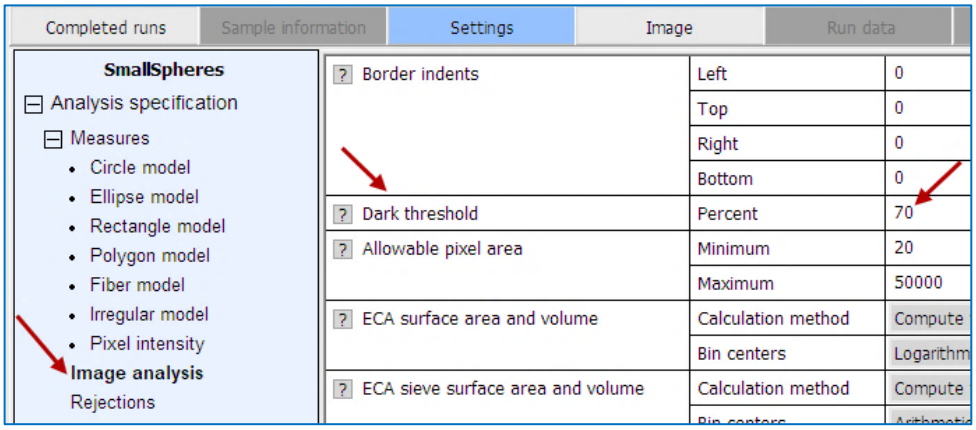
To adjust the **Threshold** setting, complete the following actions:

- Run **Shape Control** particles (nominal 42 um).
- Take an image using the ***Single*** button and click ***Analyze.***
- Click on the ***Binary*** button. 
- For an acceptable **Threshold** setting, particles should appear black, with no other areas of black in the image.
- If it appears incorrect, click on the ***Parameter Quick Adjust*** icon  to adjust the threshold (Dark threshold).
- Increase OR decrease ***Dark threshold*** then click on ***Apply and analyze image*** and verify the image. Otherwise, select the option ***Get recommended threshold*** for the best result.



- Repeat above step as needed, including pressing ***Analyze*** each time to verify ALL particles of interest have been analyzed.
- When finish, restore normal Grayscale image by pressing ***Grayscale*** icon. 
- Save the adjusted ***Threshold*** value in ***Settings*** ➔ ***Image analysis*** ➔ ***Dark threshold.***



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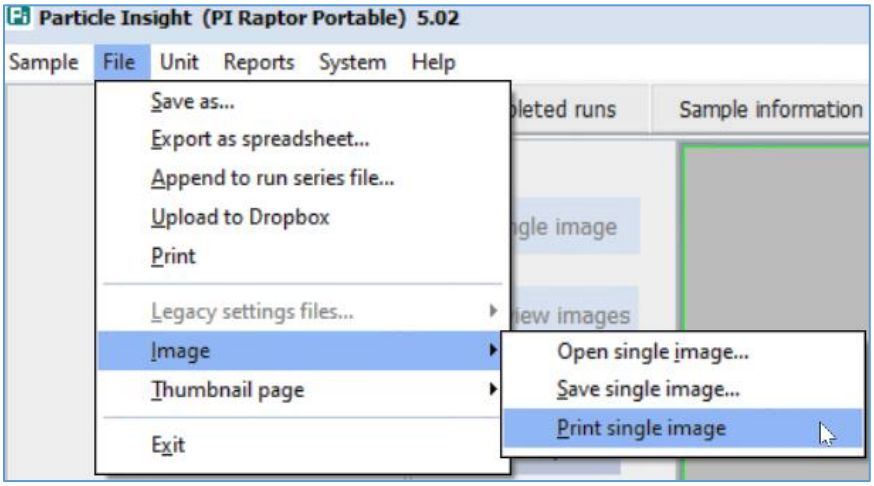
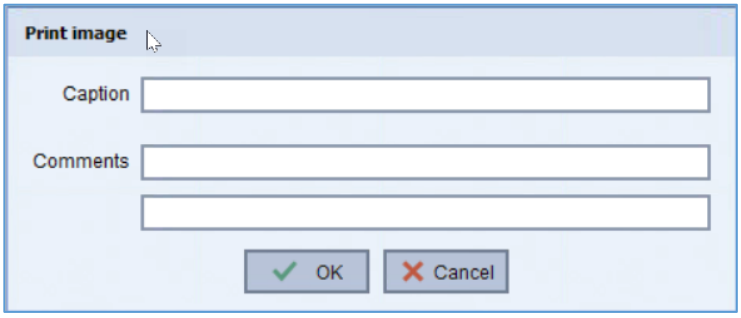
Chapter 7 - WORKING WITH DATA FILES

Printing a single image

To print an image as a TIFF file, use ***File*** ➔ ***Image*** ➔ ***Print single image***.



- A dialog window will open to enter some info.



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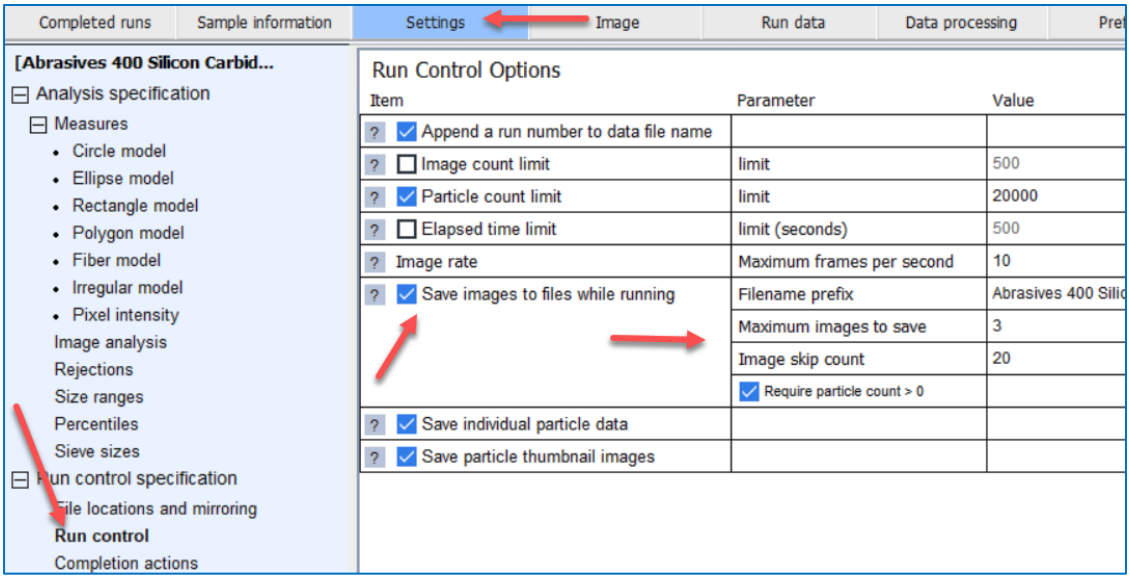
Save run images

Normally images are not saved during a run since a run may involve thousands of images. However, the Pi RAPTOR Portable system provides the option of saving run images while running the sample, which later may be reviewed and re-analyzed offline.

- To save the images while running the sample and before starting the run click on: ***Settings ➔ Run control.***
- Check ***Save images to files while running***.
- Set the option ***Maximum images to save*** equal to or greater than the intended number of images in the run.



- If ***Require particle count > 0*** is enabled, only frames with accepted particles will be saved.

Run images will be saved as Name-0001.TIF, Name-0002.TIF etc. where "Name" represents the current Run Name entry.

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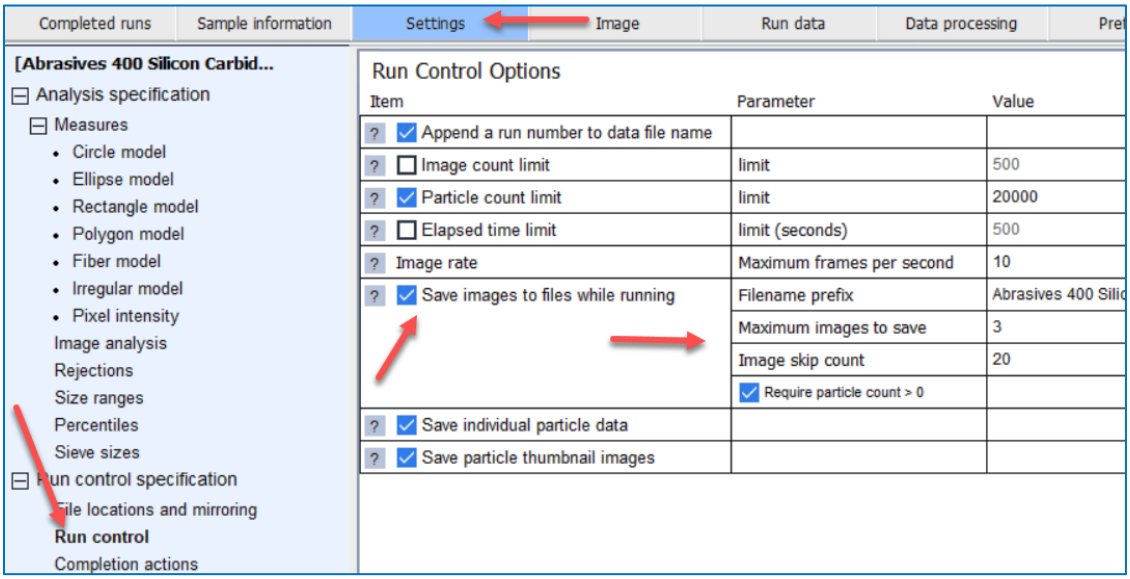
Prepare a re-analyzable run

Images saved during a run may be reviewed later and analyzed individually or all together. To be fully re-analyzable, a run must save all its analyzed images.

Before initiate a run, prepare the following settings:

- Click on ***Settings*** ➔ ***Run control.***
- Select ***Save images to files while running.***
- Set the option ***Maximum images to save*** equal to or greater than the intended number of images in the run.
- Check ***Require particle count > 0*** and only frames with accepted particles will be saved.
- Uncheck ***Require particle count > 0*** if you expect that the run may be re-analyzed under different settings. All frames will be saved.



If only some of a run's images are saved, they may still be re-analyzed offline, but the results will likely not agree exactly with the original run results.

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Review or re-analyze stored run images.

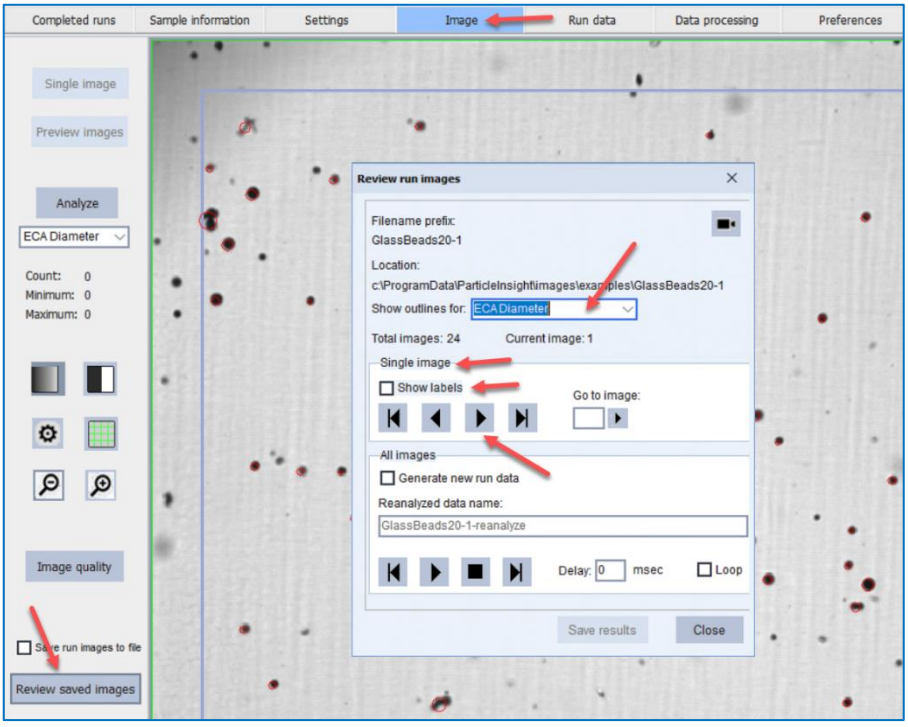
Image Playback is a feature of the Pi RAPTOR Portable that allows the user to replay saved images either step by step or in a continuous sequence. This feature can be used to simply examine the run images. If a significant number of images were saved, it can also be used to regenerate run results under different image analysis parameters or a different set of active measures. To playback images is required to have the images saved during a run.

Before initiate a run, prepare the following settings:

- Select ***Settings*** ➔ ***Run control***
- Check ***Save images to files while running***.

It is important to note that it may be impractical to save all images that are taken during the analysis because of the image file size. Each image file can represent from 1 up to about 5 MB, depending on the camera in use. Thus, 100 images could represent about 500 MB of storage space.
The Pi RAPTOR Portable system, when installed, comes with two sample demonstration files that have a sequence of 100/200 images.

- ***Open*** the run if it is not already open.
- Click on the tab ***Images***.
- Click on ***Review saved image.***
- Select the measurements in ***Show outlines for:*** drop-down menu.



- Under ***Single image*** use the icon  to review images individually. Select ***Show labels*** if you want to see the measurements previously selected attached to the particles.

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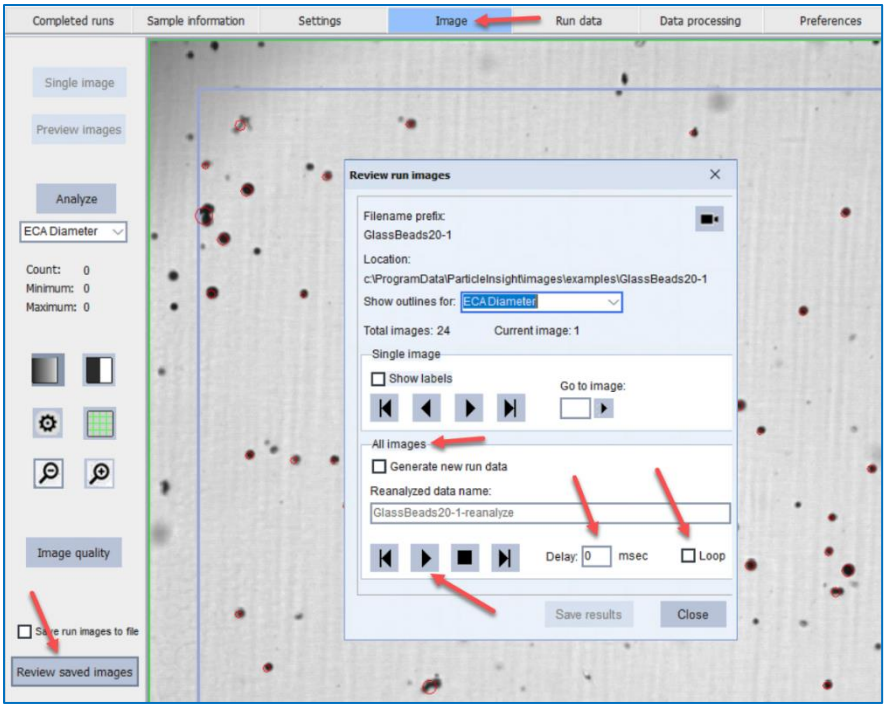

- Under ***All images*** check ***Loop*** and enter the ***Delay*** between images.
- Use the icon  to start an automatic playback.

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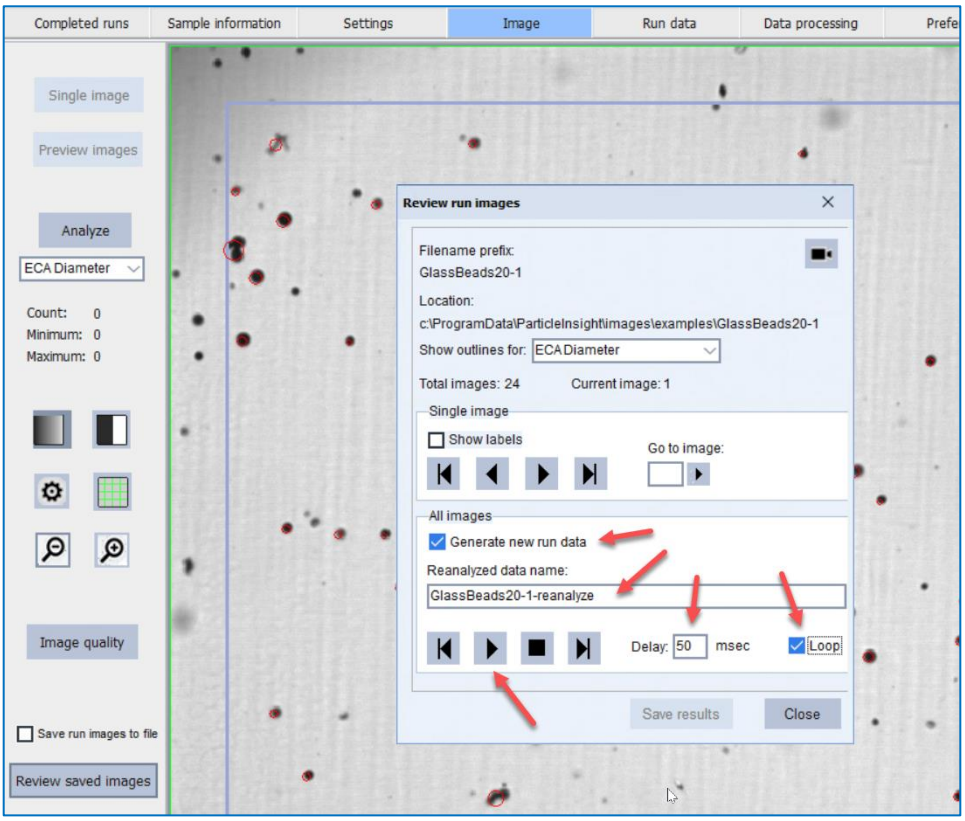
To re-analyze stored run images:

- Under ***All images***, check ***Generate new run data***.
- Enter a **name** for the new data***.***
- Check ***Loop*** and enter the ***Delay*** between images.
- Use the icon  to start an automatic playback and a reanalysis at the same time.



Note:

- You can always stop the playback manually by clicking the ***Stop*** icon.
- Automatic run completion actions do not happen when re-analyze ends, but the results may be manually saved or printed. Use the ***Save results*** button to save the new data.
- Images are not saved during re-analysis.
- Once done, you can re-load the original file and original results using ***Sample*** ➔ ***Reopen***.

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Creating a Time series chart

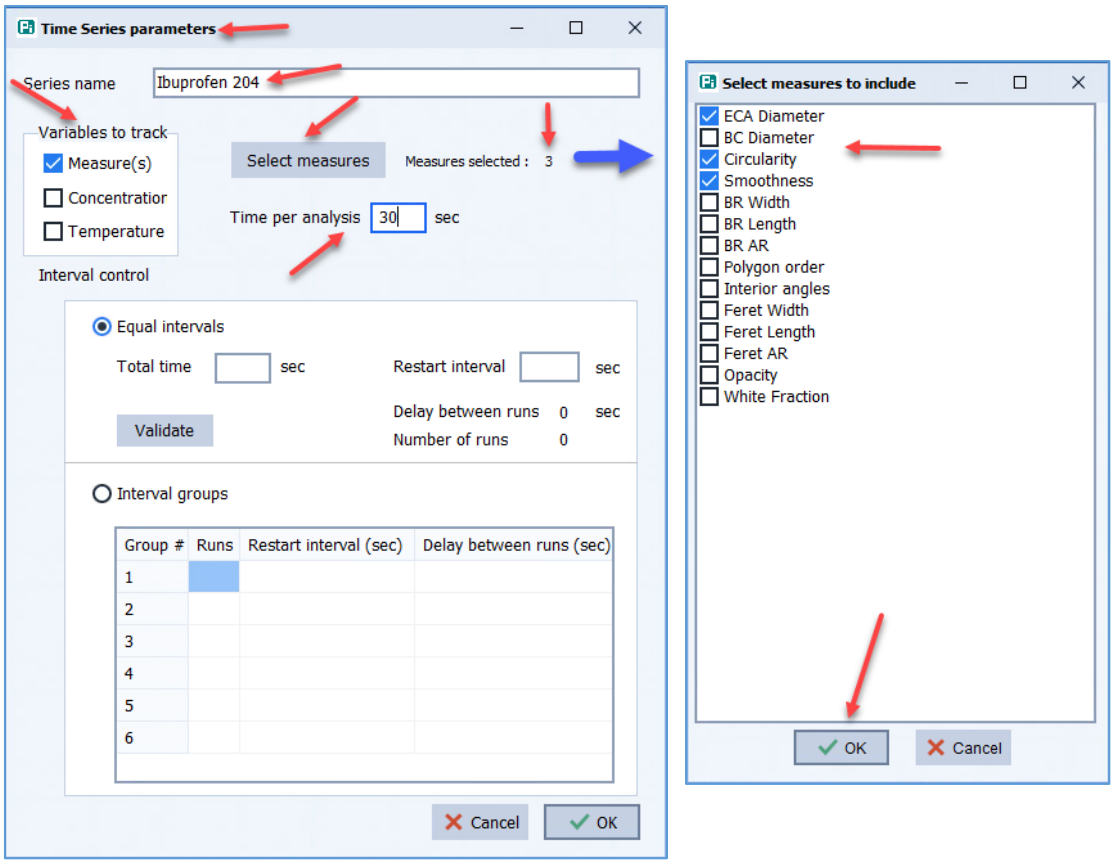
This feature allows the evaluation of behavior from particles suspended in a solution by plotting results of pre-selected measures and statistics from a collection of run files, over a specific time intervals. The run series settings: run duration, delays between runs, measures and statistics can be set in advance.

There are two posibilities to create a Times Series Chart regarding run time.

- One group of runs with equal time intervals.
- Multiple groups of runs with variable time intervals.

Equal time intervals:

- Under ***Sample*** select ➔ ***Time series*** ➔ ***New*** to open a new chart and set the parameters.
- Enter ***Series name.***
- Check the ***Variables to track***.
- If ***Measure(s)*** is checked, click on ***Select measures,*** check the measures to include and click ***OK***.
- Enter the run time for each analysis in ***Time per analysis*** field***.***



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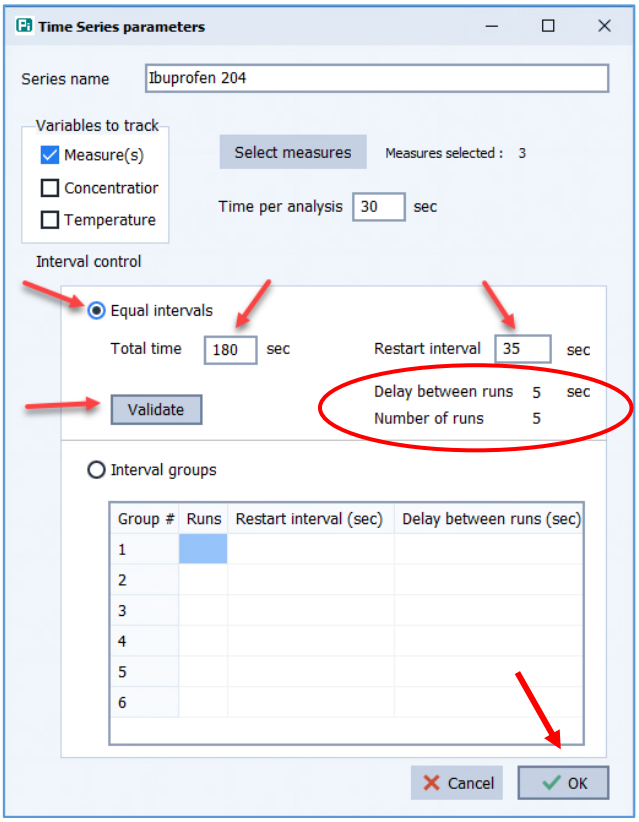
- Select ***Equal time intervals*** radio button.
- Enter the total expected run time for the entire sample reaction or study in ***Total run time*** field.
- Enter the ***Restart time*** as the sum of the Time per analysis plus any wait time you would like between runs.
  e.g. time per analysis 30 secs + delay between runs 5 sec = 35 secs Restart time.
- Click on ***Validate*** for the software to calculate the **Delay between runs** and the **Number of runs.**
- If ALL the parameters are correct, click ***OK***.



- Follow the promts for ***New sample Wizard*** until **ALL** runs are completed.

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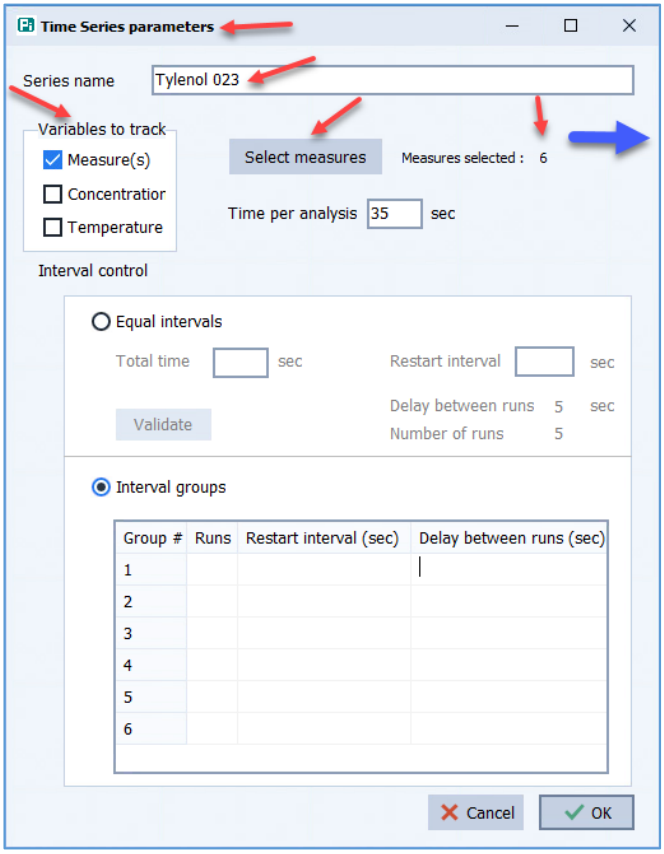
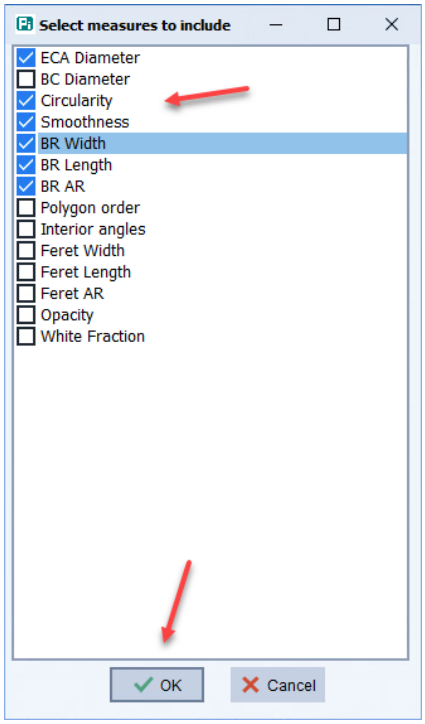
Variable time intervals:

- Under ***Sample*** select ➔ ***Time series*** ➔ ***New*** to open a new chart and set the parameters.
- Enter ***Series name.***
- Check the ***Variables to track***.
- If ***Measure(s)*** is checked, click on ***Select measures,*** check the measures to include and click ***OK***.
- Enter the run time for each analysis in ***Time per an alysis*** field***.***





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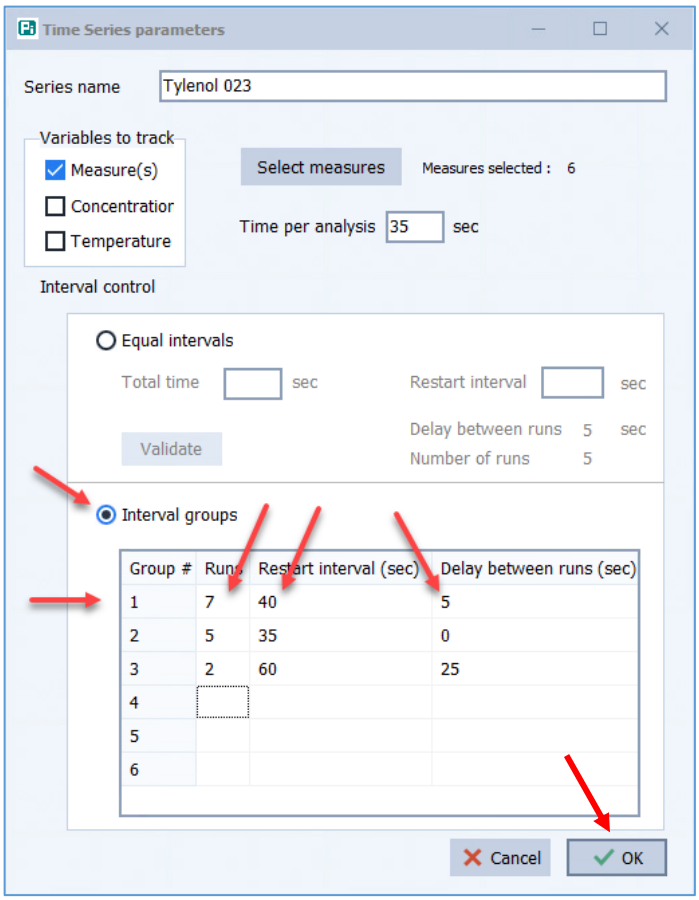
- Select ***Variable time intervals*** radio button.
- Enter the amount of runs for 1st group in the ***Runs*** field.
- Enter the ***Restart time*** as the sum of the Time per analysis plus any wait time you would like between runs.
  e.g. time per analysis 35 secs + delay between runs 5 sec = 40 secs Restart time.
- Click on the empty field below ***Delay between runs*** and the resulting delay will show up.
- Enter the amount of runs for 2nd group in the ***Runs*** field. Repeat the process for the remaining desired groups.
- If ALL the parameters are correct, click ***OK***.



- Follow the promts for ***New sample Wizard*** until **ALL** runs are completed.

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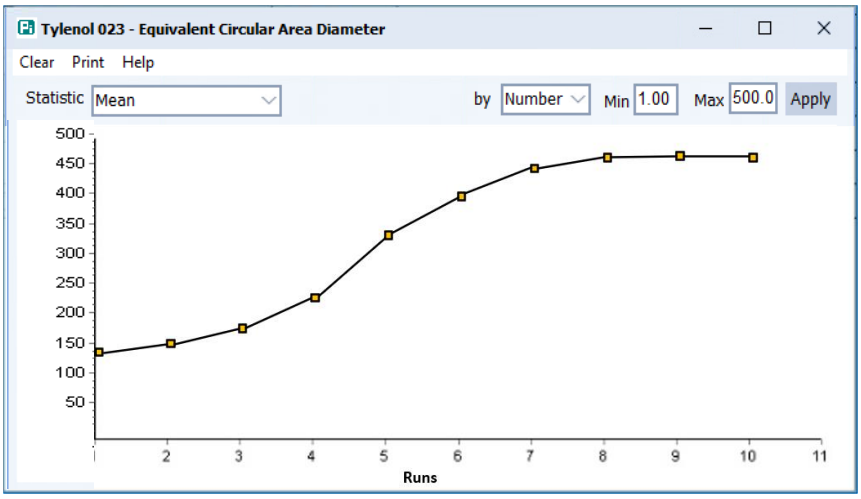
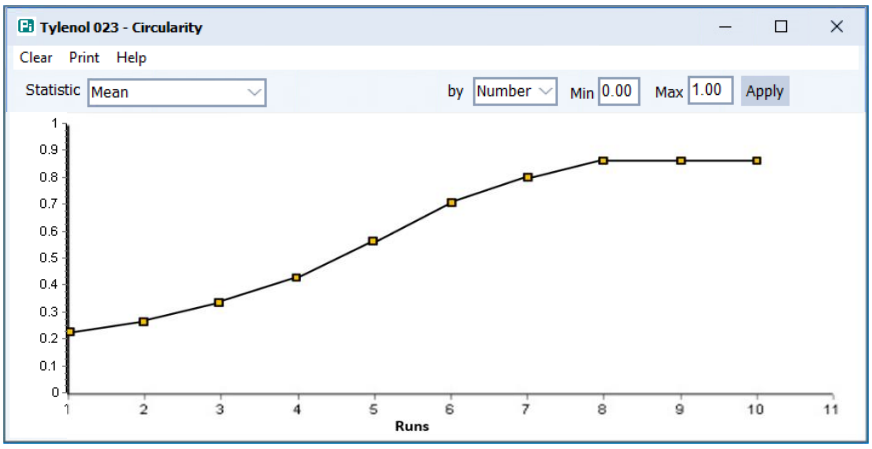
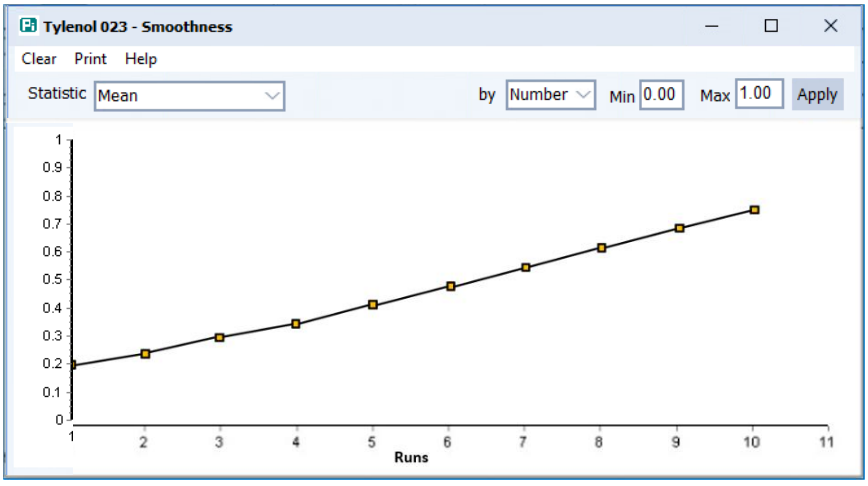
Below, a representation of a Time Series Charts, just for reference.







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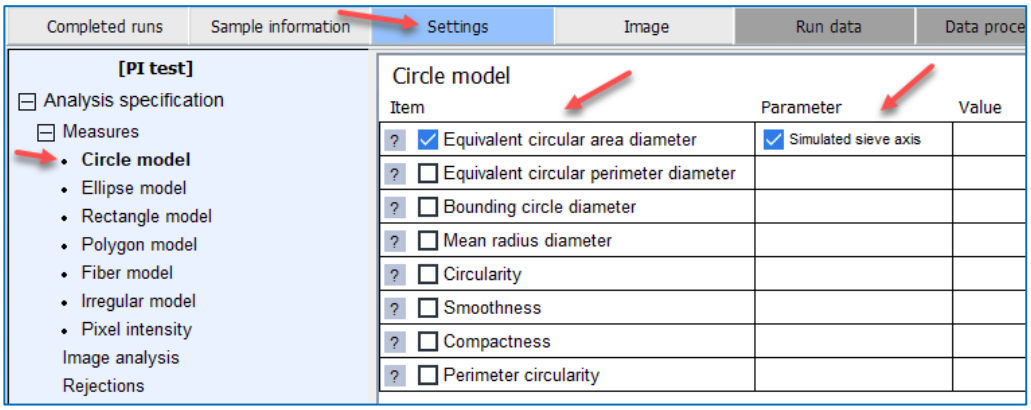
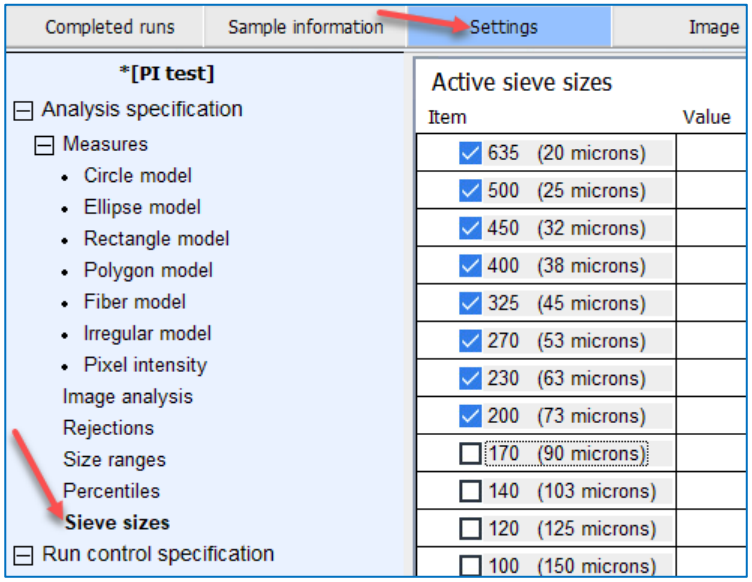
Using simulated sieve mode

In this mode, the user must select the sieve sizes to implement on the simulated Sieve axis. In simulated sieve mode, the size axis of distribution plots is divided into size classes that correspond to standard sieve sizes. The sizes used are selectable.
Simulated sieve mode is available only for Circle model (ECA Diameter), Rectangular model (BR Width), Fiber model (Fiber Width), and Irregular model (Feret Width).

In ***Settings*** ➔ ***Measures***, enable one or more measures that allows sieve mode, and enable the sieve option.



In ***Settings*** ➔ ***Sieve Sizes***, select all the sieve sizes that are to be simulated.



With this feature enabled and the user selected sieves chosen, several of the statistical histograms will report not only **Volume**, **Number** and **Surface Area** weighted results, but also will report results based on **Sieve** weigted data.

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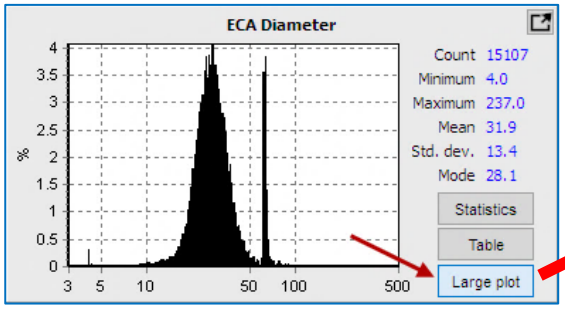
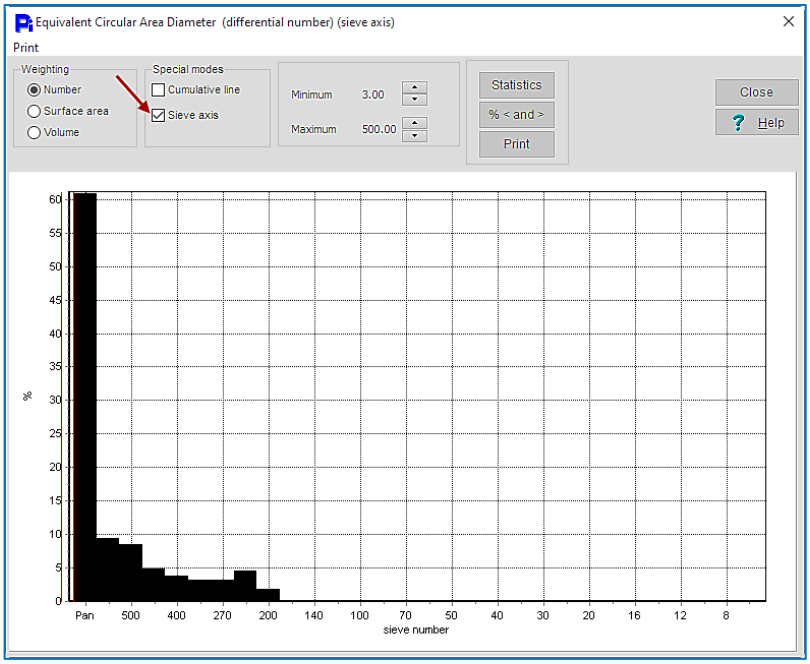
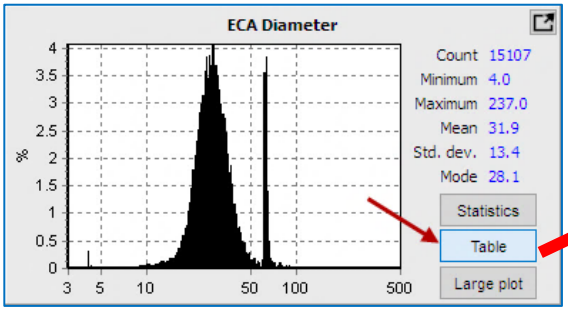
If sieve mode is in effect, both micron axis and sieve axis data are taken. Whether micron data or sieve data are shown on the screen plots during a run has no effect on what data are accumulated. Either or both kinds of plots may be viewed or printed after a run. If sieve mode is not enabled before starting a run, only micron data are accumulated.

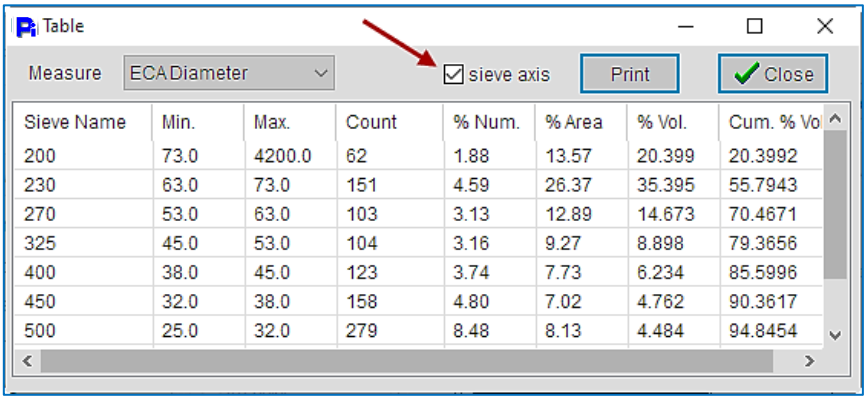
In a large plot window, check the Sieve axis option at the top.





In the Table window, check the Sieve axis option at the top.





Sieve Name	Min.	Max.	Count	% Num.	% Area	% Vol.	Cum. % Vo
200	73.0	4200.0	62	1.88	13.57	20.399	20.3992
230	63.0	73.0	151	4.59	26.37	35.395	55.7943
270	53.0	63.0	103	3.13	12.89	14.673	70.4671
325	45.0	53.0	104	3.16	9.27	8.898	79.3656
400	38.0	45.0	123	3.74	7.73	6.234	85.5996
450	32.0	38.0	158	4.80	7.02	4.762	90.3617
500	25.0	32.0	279	8.48	8.13	4.484	94.8454

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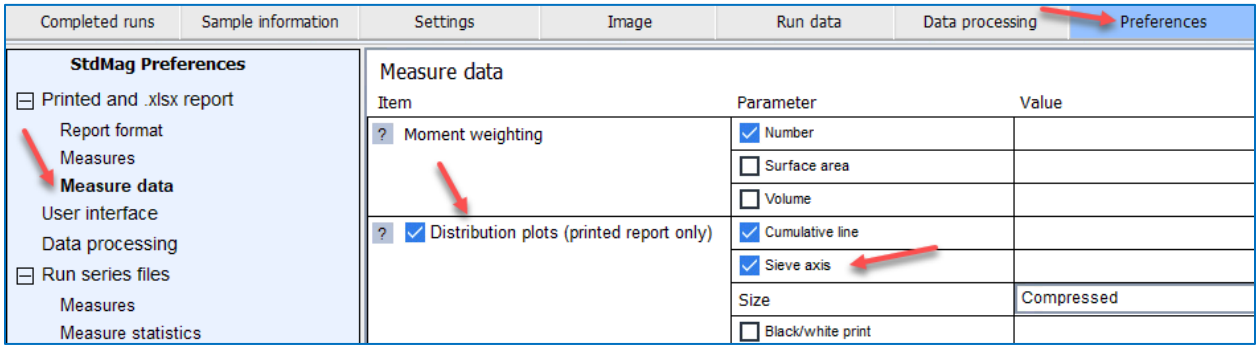
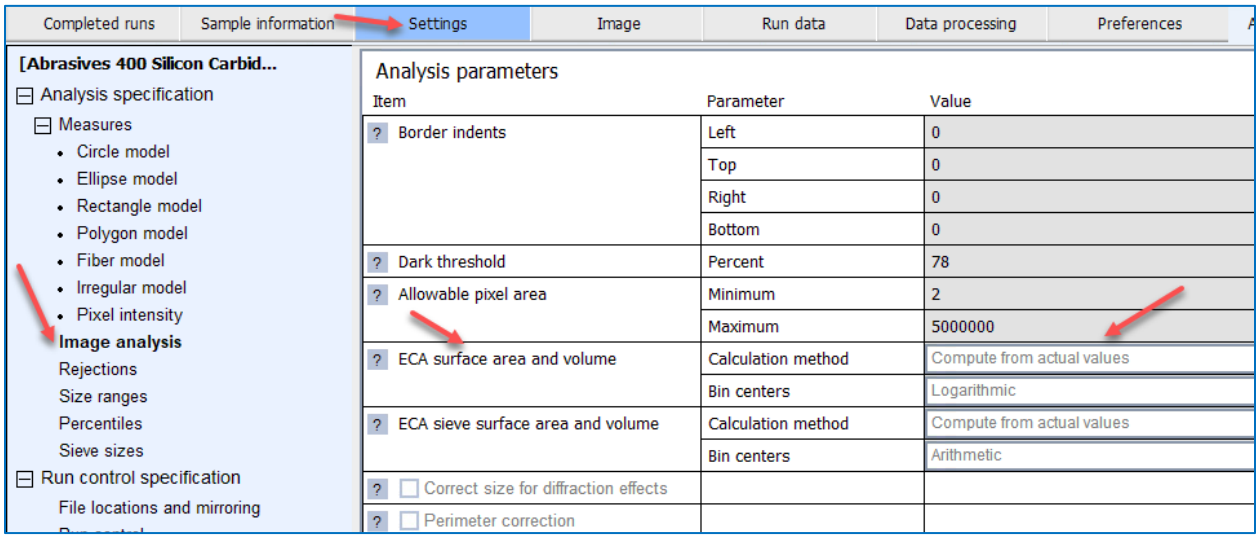
To include sieve mode graphs in a printed report, go to ***Preferences*** ➔ ***Printed Report*** ➔ ***Measure data*** ➔ ***Distribution plot(s)*** and enable **Sieve axis**.



If the sieve mode data is to be compared to actual sieve results, use volume-weighted data for the comparison. Also, if the material being tested is spherical, in ***Settings*** ➔ ***Analysis specification*** ➔ ***Image Analysis*** make sure that Calculation Method for ***ECA sieve surface area and volume*** is set to "**compute from actual values**."



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When comparing sieve axis results to micron results, be aware that the sieve axis size bin boundaries and the micron bin boundaries are not aligned. A sieve boundary may fall in the middle of a micron size bin, and vice versa.

Sieve size – micron correspondence

Sieve size	micron size
635	20
500	25
450	32
400	38
325	45
270	53
230	63
200	75
170	90
140	106
120	125
100	150
80	180
70	212
60	250
50	300
45	355
40	425
35	500
30	600
25	710
20	850

To return to ***Sieve sizes*** in ***Settings***, click HERE.

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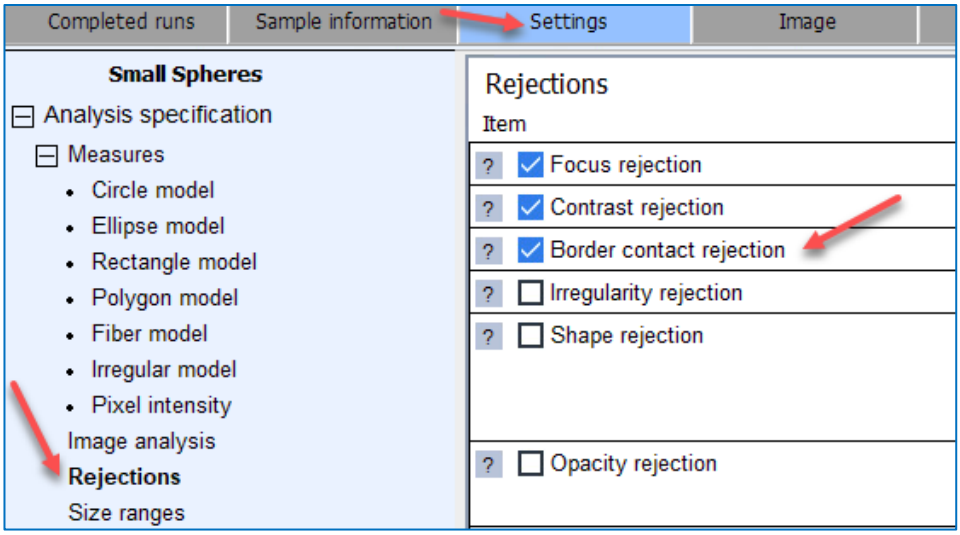
Border contact rejection

Under ***Settings*** ➔ ***Analysis specification*** ➔ ***Rejections*** enable ***Border contact rejection*** to reject particles that contact or intersect the image border.



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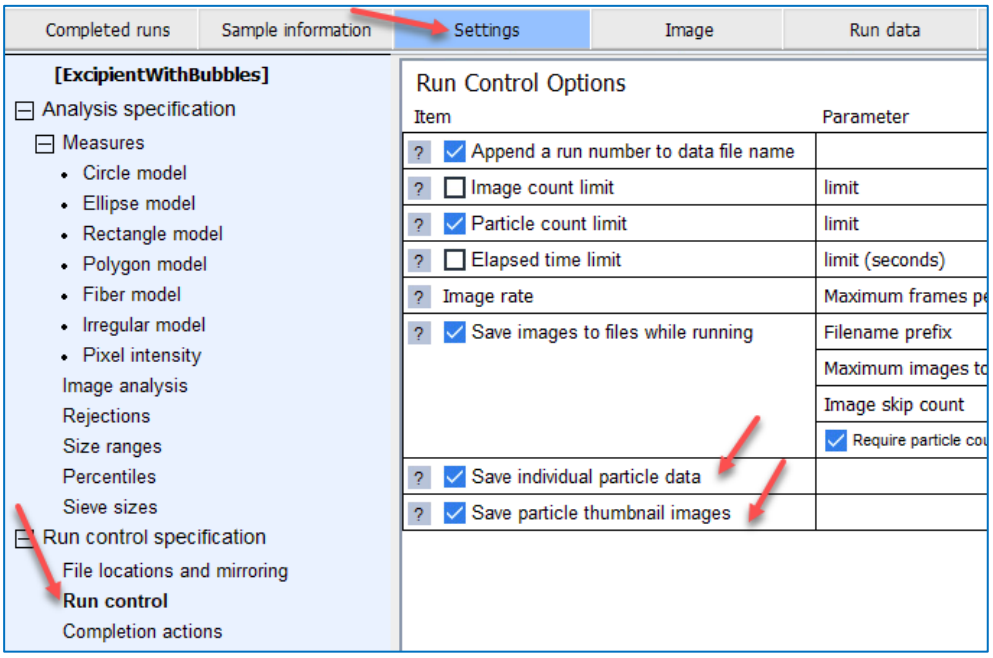
Saving data on individual particles

In a normal run, size and shape information is computed for each particle, but the data is not permanently saved; it gets added to the appropriate distribution arrays.

In order to use ALL the ***Data Processing*** functions in the Dashboard, the following options must be enabled before starting a run:

- Select ***Settings → Run Control specifications → Run Control.***
- Check ***Save individual particle data.***
- Check ***Save particle thumbnail images.***



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Creating a multirun report

You can print a report or create an ".xlsx" file consisting of a row of data for each of several sample runs. The runs should have been taken under identical settings and have the same root name, differing only in the number suffix, for example TestRun-1.xlsx, TestRun-2 etc. The line of data contains selected statistics for each active measure.

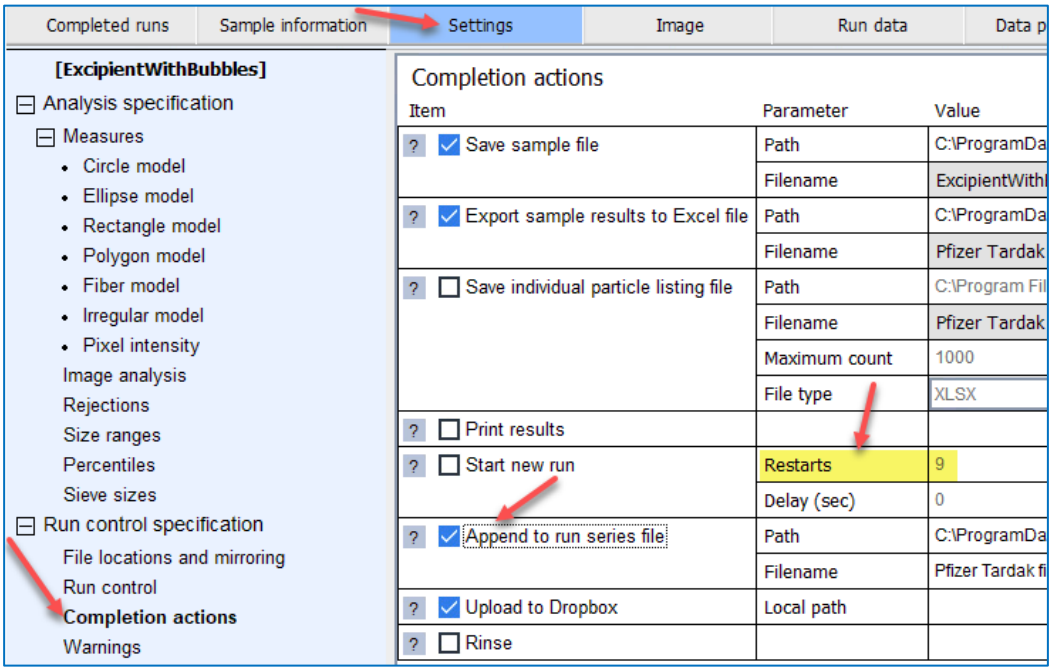
The statistics to include should be selected beforehand in ***Preferences ➔ Measure Statistics.*** Values for Mean, Standard Deviation, and Mode are always the "number weight" values, i.e., unweighted. The file name will be the series name with "-RS" as a suffix, for example TestRun-RS.xls. The runs series summary is in addition to the normal data files that are saved for each individual sample.

There are three ways to create a run series file:

1. **Automatic append**

To use the automatic method, enable the ***Append to run series file*** option under ***Settings ➔ Run control specifications ➔ Completion actions.*** A line is automatically added to the file upon completion of a run.

This method may be used in conjunction with the ***Restarts*** feature to create a summary file for a set of similar runs.



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Example: to take a data point every 30 minutes for five hours, using the series name "SampleXYZ":

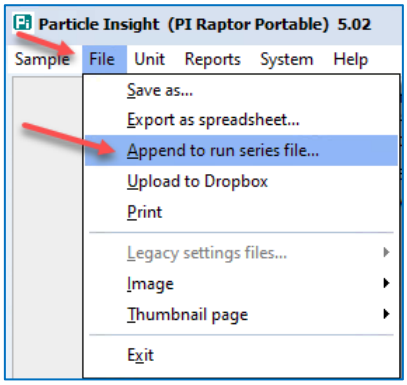
- Create a sample named SampleXYZ.
- The software adds "-1" as a suffix to the name of the first run.
- Under ***Settings*** ➔ ***Run control specifications*** ➔ ***Completion actions,*** enable ***Start new run*** and set ***Restarts*** to 9 and ***Delay (sec)*** to 1800.
- Check that a run limit is set by Image count, particle count or elapsed time under ***Run control***.
- Click ***Clear***, then ***Start***. After five hours, the run series file will be complete and will have the filename SampleXYZ-RS.xls and will be in the Export subdirectory.

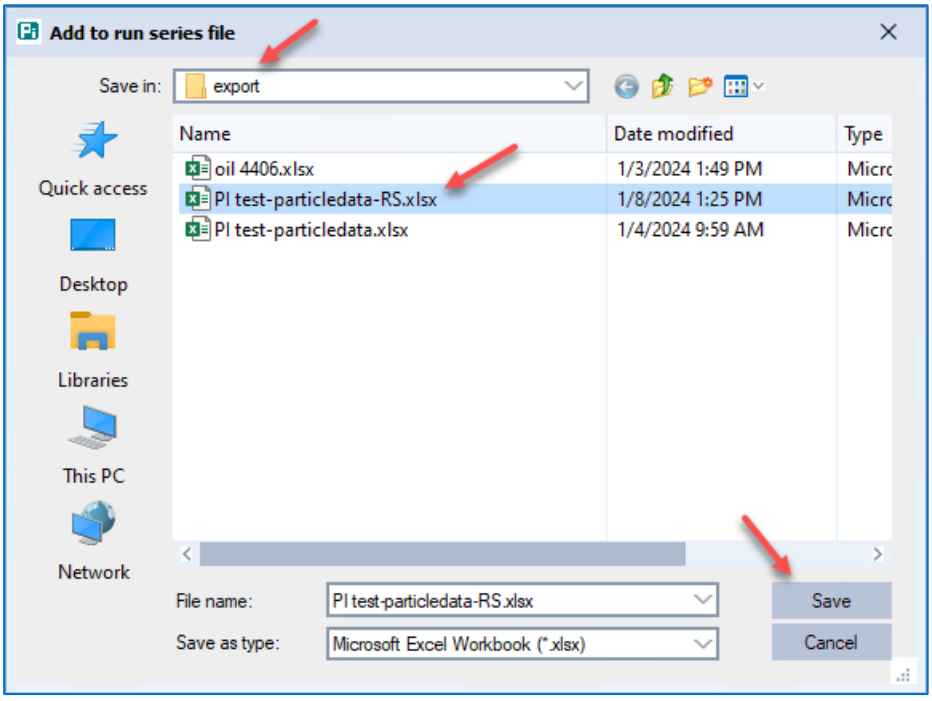
Complete data from the individual runs will be saved under the names:

SampleXYZ-1, SampleXYZ-2 …… SampleXYZ-9 . The run series may end before ten runs have been completed by simply clicking ***Cancel*** in the delay period between runs. The run series file will be retained and will have a line for each run up to that point in time.

2. **Manual append**

After a run finishes, you may select ***File*** ➔ ***Append to run series file*** to add data from the currently open run file into an existing Run Series file as a new line on the multi-run file.





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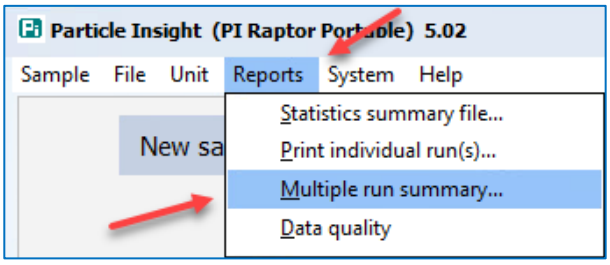
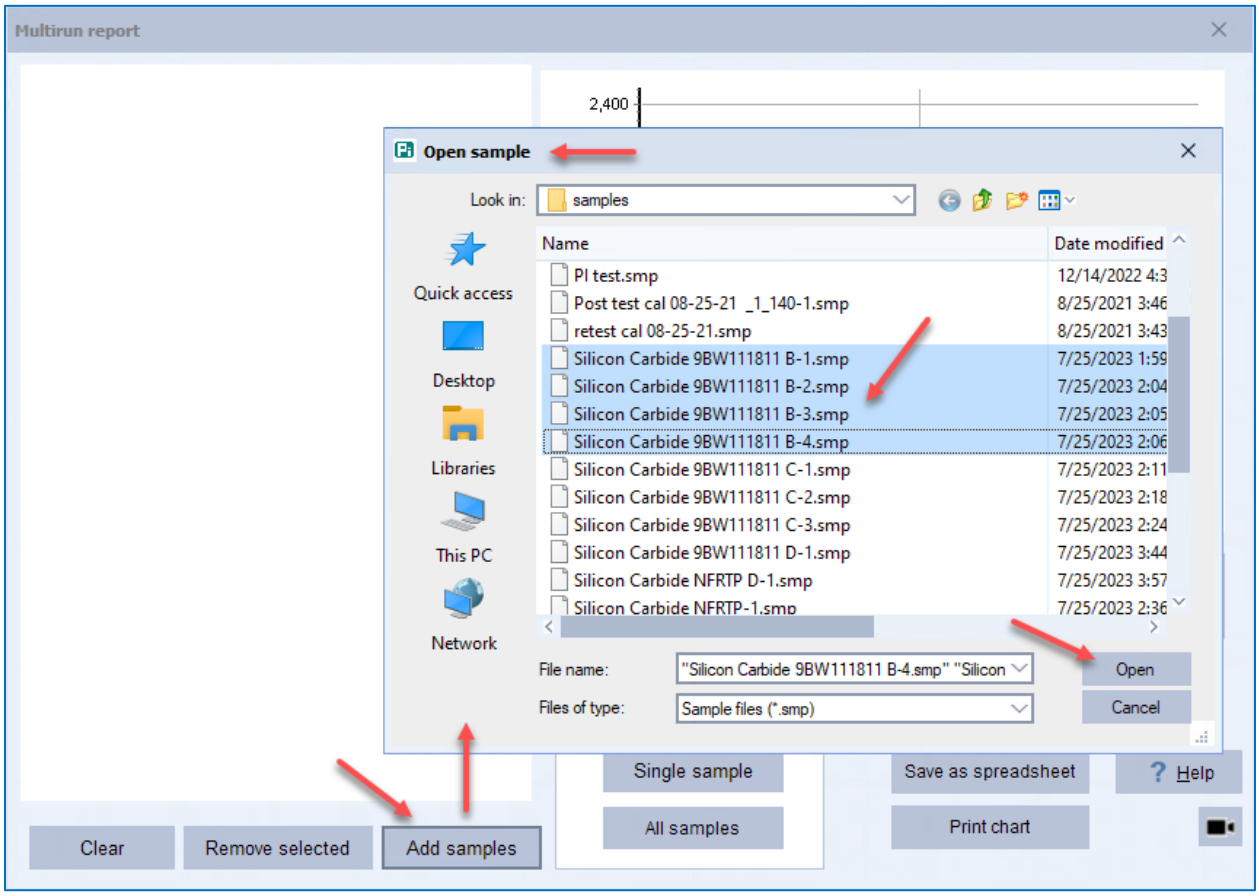
3. **All at once**

Use this utility to create a run series file from a previously saved set of runs, or to compare data values from a set of runs on-screen without saving as a file.

- Click on ***Reports*** ➔ ***Multiple run summary***.



- Click on ***Add samples***.
- Select and open the runs to be included. Use your mouse and ***Shift*** or ***Ctrl key*** to select multiple files and then click ***Open***.



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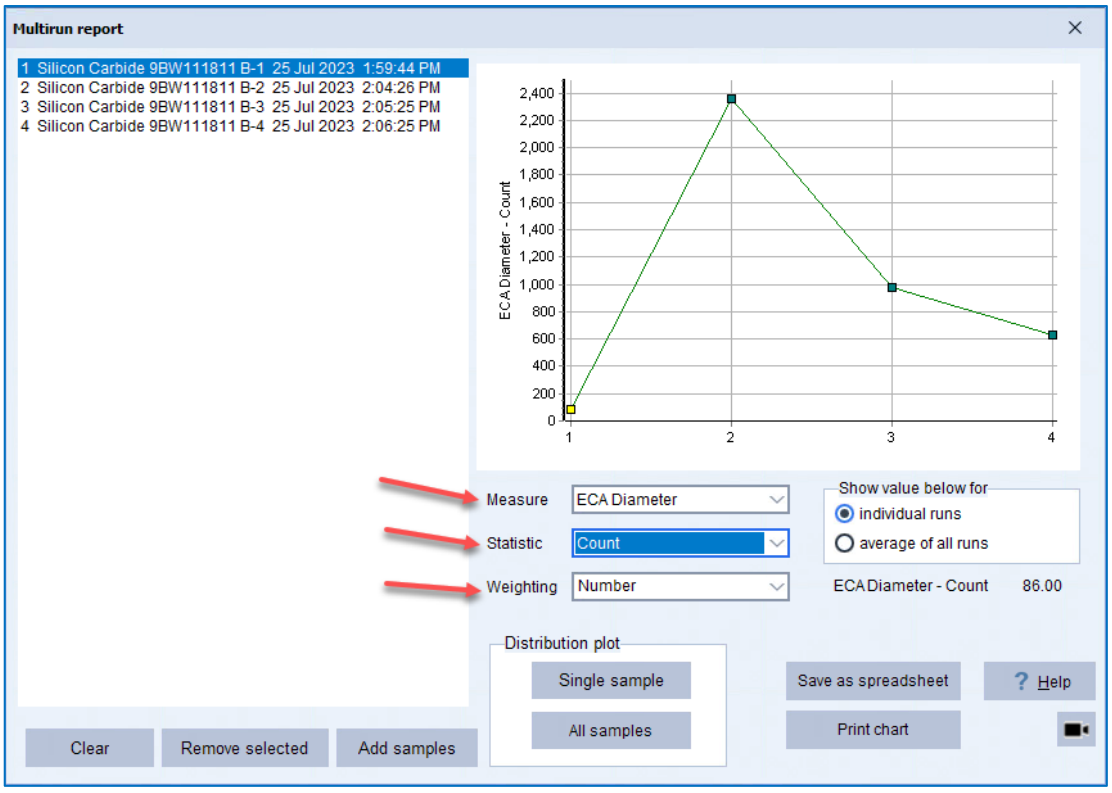
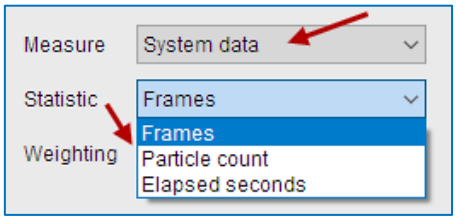
Multirun report

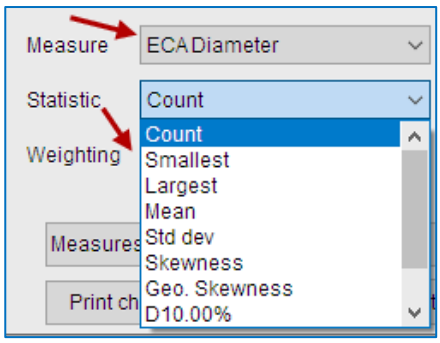
- Once the files are opened, a screen will show all the selected files on the **Multirun Report** screen, as showm below. The graph will show a set of nodes, one node for each run in the series.
- The left axis variable is determined by the **Measure** and **Statistic** options selected below in the chart. The selections will determine the statistical value that is plotted in the chart.



- If ***System data*** is selected in the ***Measure*** drop-down, the options for Statistic to plot are ***Frames***, ***Particle count***, and ***Elapsed seconds***.



- If an actual M***easure*** is selected, the options for Statistic to plot are Count, Smallest value, largest, Mean, Std Deviation, Geometric Skewness, and three percentiles (10%, 50%, 90%).



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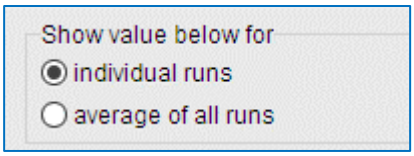
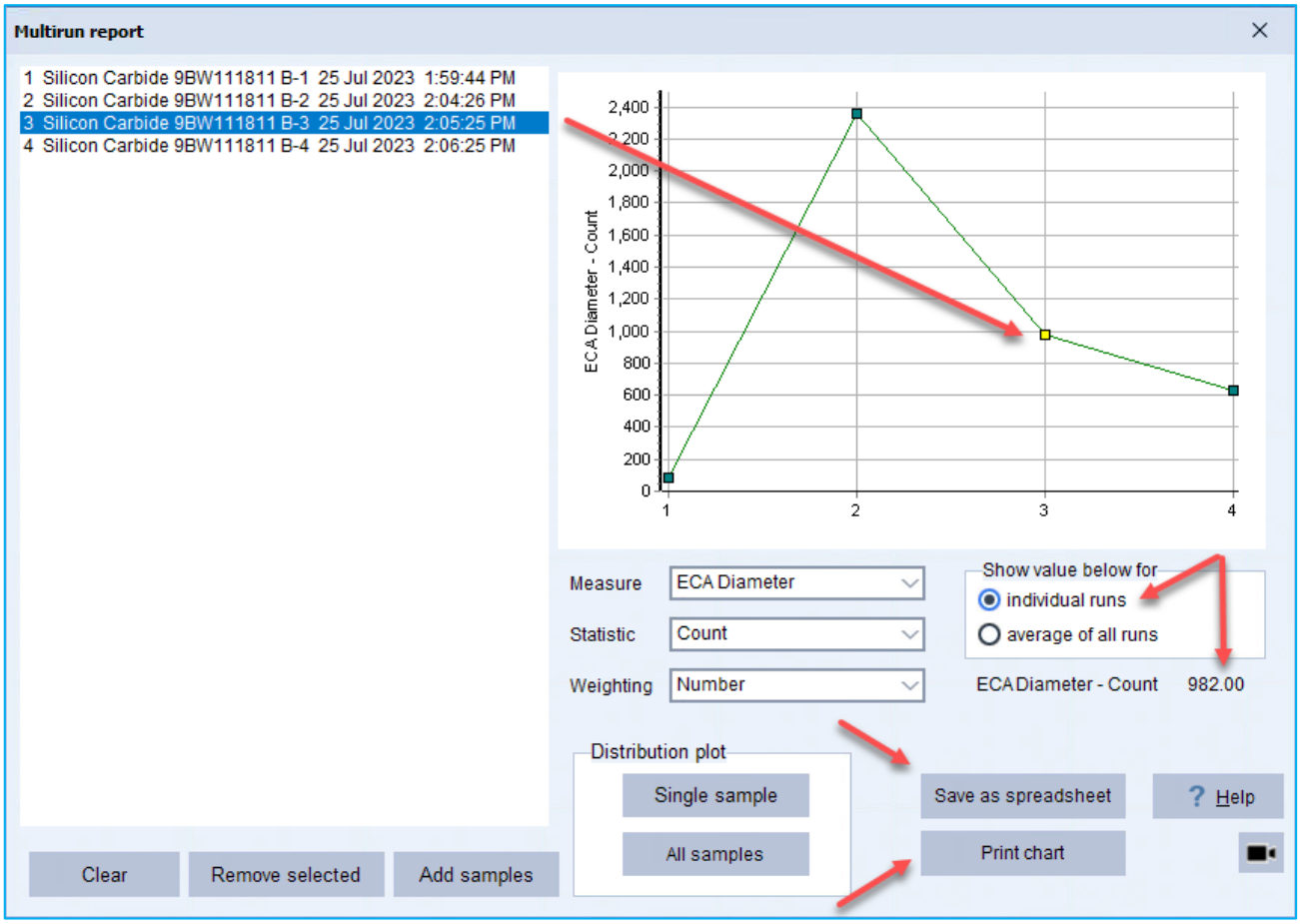
- The ***Show value below for*** box contains two options:
  - **individual run**: click on one of the runs in the list to the left of the chart or one of the nodes in the graph. The node representing that run becomes yellow and the numeric value of the selected statistic is displayed at the bottom of the panel.



  - **average of all runs:** displays the averages of all the runs listed at the bottom of the panel. .



- The ***Print chart*** button prints the graph as it currently appears.
- The ***Save as spreadsheet*** button exports the Multirun report as an .xlsx file to the export folder.

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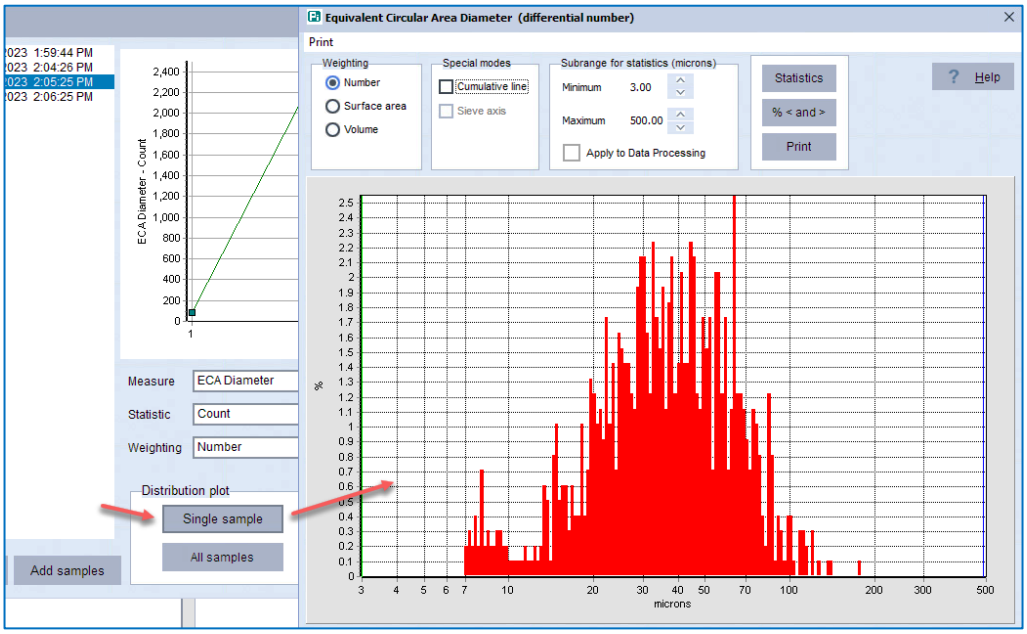
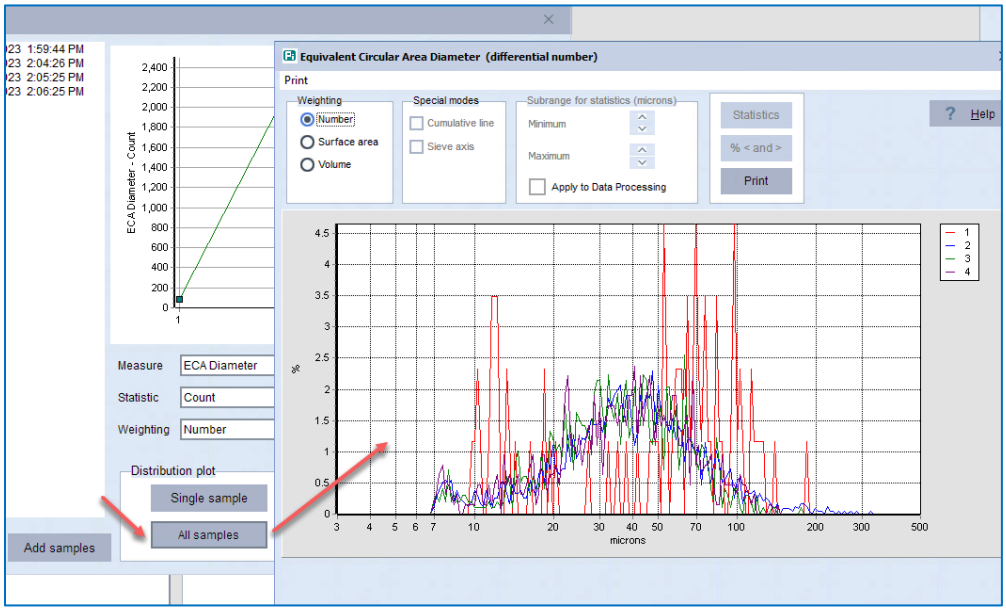
Distribution plots

Another available feature of the Multirun report is to display the distribution plot of a single sample or All the samples.

- Check ***Single sample***.



- Check ***All samples***.



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Chapter 8 - SECURITY

Security features

When security is on, there is always a current user (Normal User or Administrator), identified at the lower left of the screen.

- An Administrator can turn security On or Off, add a new user, disable, or enable any user, and change any user's password.
- A Normal user can change only his own password.

When a new user is added, a password should be created for the user. Passwords must contain at least 8 characters and must be renewed every 60 days.

User information is recorded in the file "users.txt." This file contains for each user:

- date/time the user was added
- user's security level
- date/time of the last password change for that user
- user's password, in encrypted form
- whether the user is enabled or disabled

There can be any number of users of each level in users.txt. It will always contain at least one Administrator and at least one Service User. Users.txt contains a checksum which is read on program startup. If the file has been modified outside of the PI software, ***Error 6*** will be flagged.

When security is on, these features are enabled:

- Users must log in at startup, and when the software has been idle for more than 15 minutes.
- The following events are logged into the audit trail:
  - user login
  - login failure
  - switch to a different user
  - a user's password changed
  - checksum error reading users.txt
  - the audit trail was archived
  - security was turned on or turned off
  - a new user was added
  - a user was disabled or enabled
  - a user was removed (by an Administrator)

Maximum audit trail file size is 512 KB.

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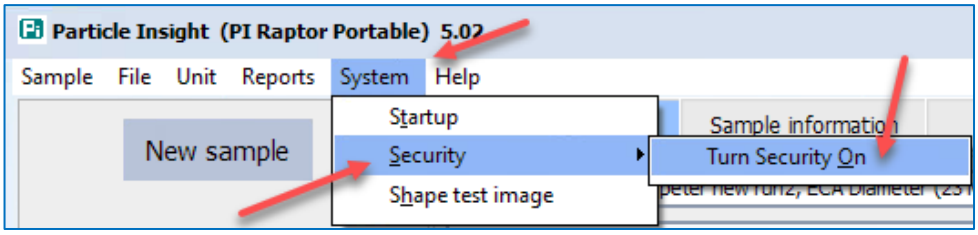
Security options

Security: Allows to turn the security options **On** or **Off**.



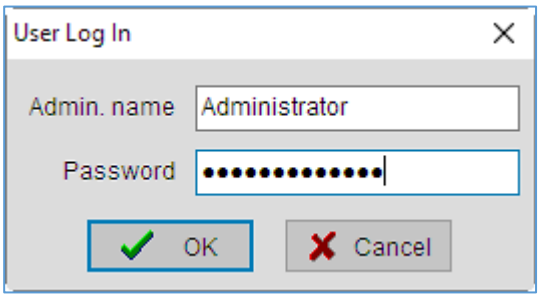
When turned **On,** the following dialog windows shows up:

You must enter the default values:

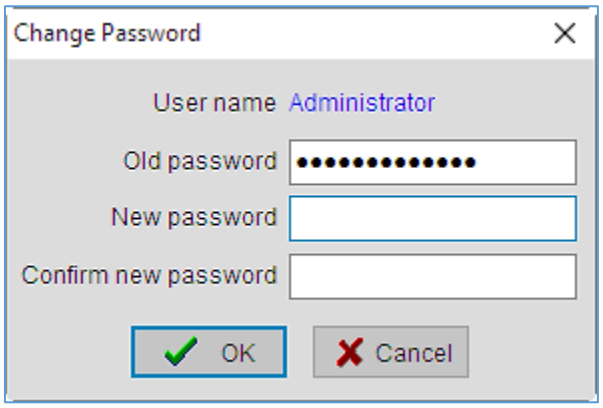
Admin. Name: Administrator

and

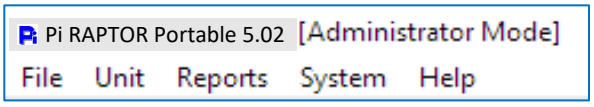
Password: Administrator



Once accepted, the administrator must change the password to their own password.



Then, the top left of the software interface will show:



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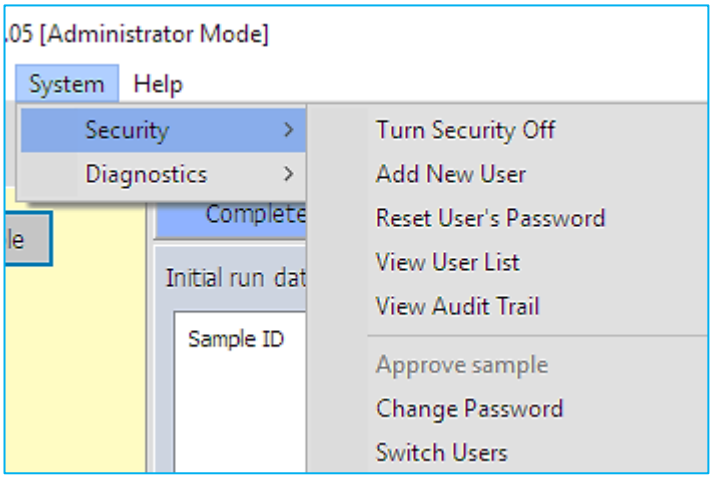
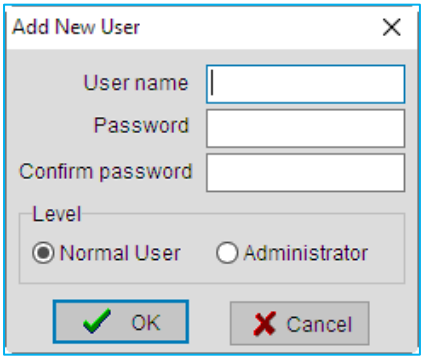
Below an overview of Security options. These menu items are available only to administrators:

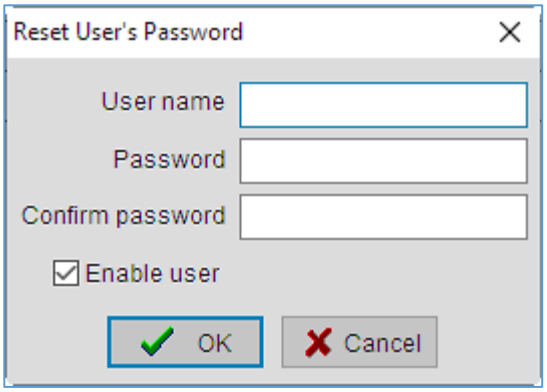


Turn security off: disables all security features. Security can be turned Off only while in Administrator mode.

Add new user: Administrator can add a new username as well as a password and the access level for that user.



Reset User's Password: Administrator may change any user's password with this item. In the event a user forgets their password, the Administrator can change the user's password. In the event a user is no longer active; the Administrator should disable the user. This retains the username in the system (required to ensure audit trail shows user activity) but it will not be active.



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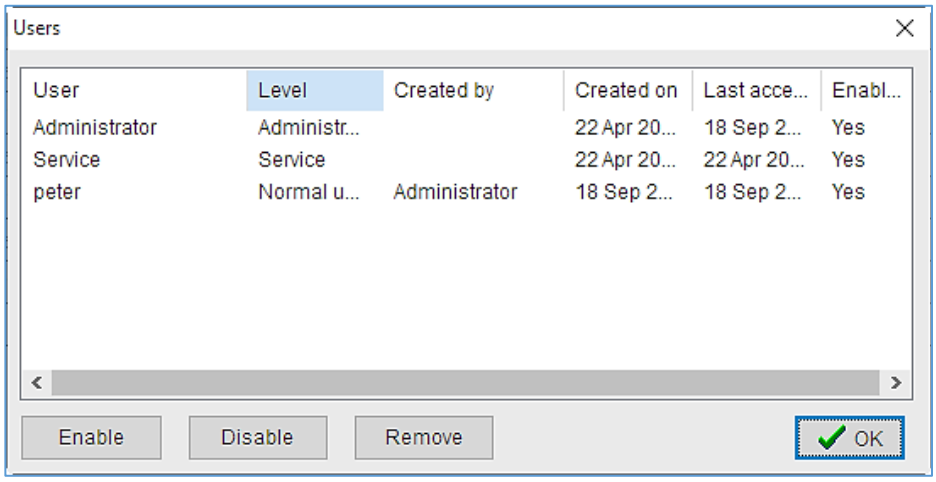
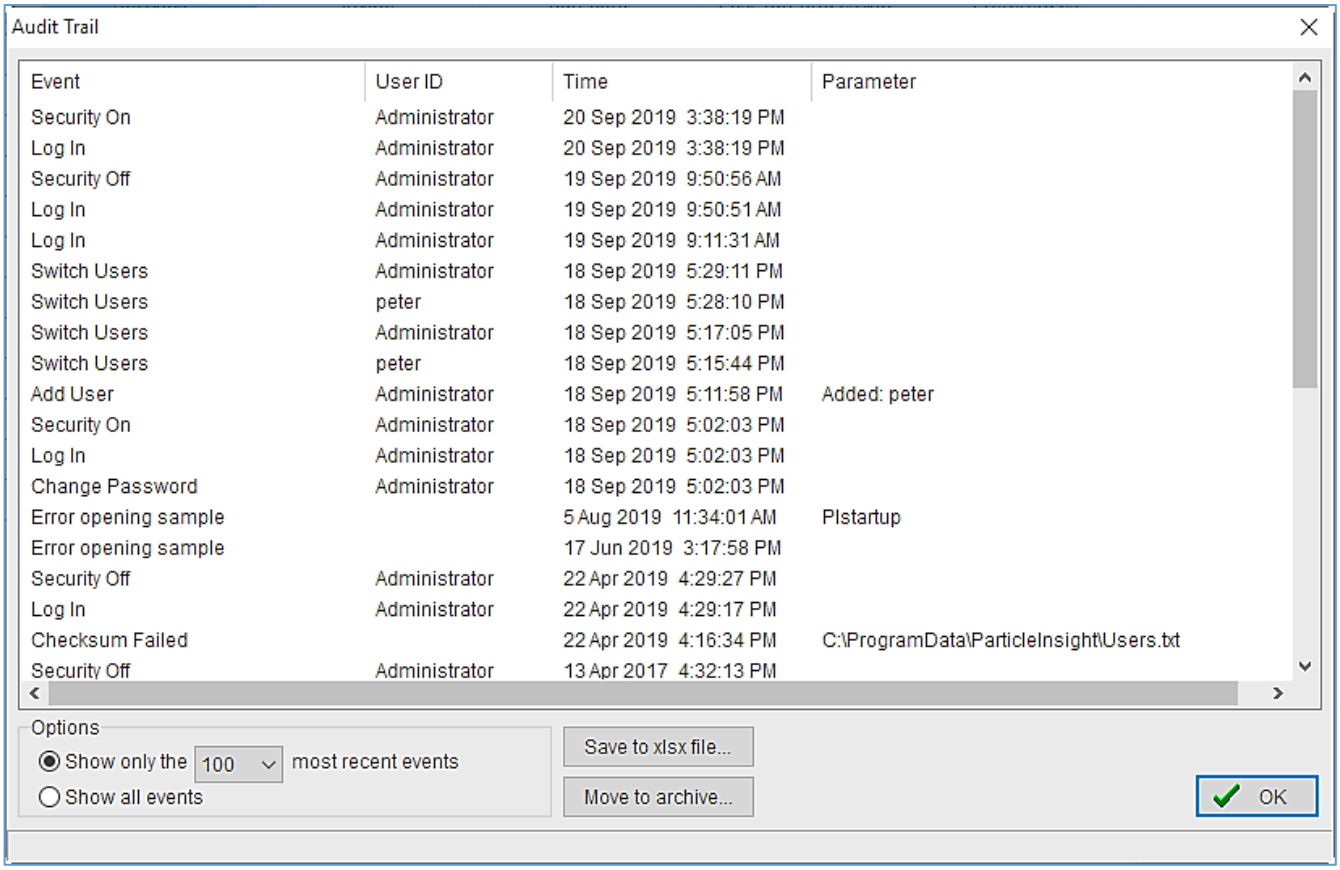
View User's list: Open a list of all users with status information. The administrator can Enable, Disable or Remove any user.



View Audit Trail: Opens a window showing events in the audit trail, most recent event first.



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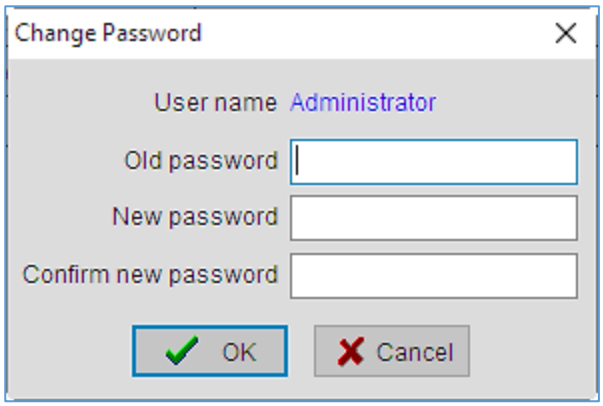
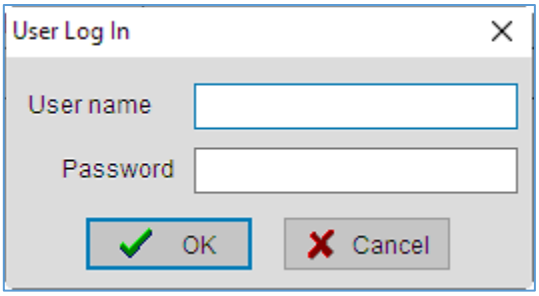
These menu items are available only for administrators:

Approve sample … A user may add a signature to a run file. This may be done when the file is saved, or at any later time. Only one signature may be added, and once a run is signed the signature is permanent. The signature consists of the username and date of signing.

Change Password: Administrator may change his password.



Switch Users: Change to a different active user.



To return to ***Toolbar options*** ➔ ***System***, click HERE.

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Chapter 9 – CONSUMABLE PARTS LIST

P/N	Description	Picture
6601133	Disposable Pipette – 10/pack	
6600990	Disposable Spatulas – 10/pack	
6601170	Particle Shape Control - Glass Spheres 42 µm (nominal)	
6601257	Dispersant	
6601132	Sample vial 25mL, 10/pack	
6601168	Lens cleaner - Carl Zeiss Lens Cleaning Spray 2oz - 60ml	
6600989	Lens Paper, 4" L x 6" W (10.1 cm x 15.2 cm) Booklet	

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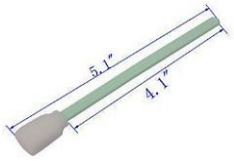
P/N	Description	Picture
6601138	Swabs – 5/pack	
6600991	15 Amp Blade fuse, 2/pack	
6603059	500 µm Disposable sample cell	
6603003	Syringe plastic plunger, 10/pack	
6603004	Syringe rubber plunger, 10/pack	

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For pricing and availability, please contact Vision Analytical Inc.

APPENDIX A

A.1 - File system reference

The following is the structure and location of the different files used in the Pi RAPTOR Portable:

Sample File

The software is organized around the concept of the **sample file**, which holds the data from an analysis along with information about the sample and settings of the analysis, plus reporting options.

Template file is a special kind of sample file. Several template files are provided in the samples folder to provide an easy way to create a sample file that is suitable for a standard particle type. Templates are provided for small spheres, large spheres, crystals, thin fibers, and thick fibers. To use a template file, open one in the software and then use ***Save As*** to create a copy of it under a new filename.

- Data cannot be taken into an original template file.
- A template file cannot be modified.
- A user-defined template file may be created by opening an existing template file and using ***Save As*** with "Template" as part of the new filename.
- If the new filename does not include "Template", the new file is not a template file.

Filename structure
Sample filename: if number suffix option is Off <samplename>
if number suffix option is On <samplename>-n, where n = 1, 2, 3 …
Template filename: <samplenameTemplate>
File extension: ***.smp**
Default location: This PC › Windows (C:) › Users › Public › Public Documents › Particle Insight › samples ›

Image files

Image files are monochrome 8-bit-per-pixel format, which encodes 256 gray levels.

Filename structure:
<samplename>-n-xxxx, where n = 1, 2, 3, … ; xxxx = 0001, 0002, ...

n: increments every time you press the ***Increment*** button in ***Sample information*** OR you set ***Start a new run*** and including more than 1 restart under ***Settings ➔ Run control specification ➔ Completion actions.***

xxxx: increments up to the number of images saved.

File extension: *.tif or ***.bmp.**
*.tif files are TIFF format; *.bmp files are Windows bitmap format.
Default location: This PC › Windows (C:) › Users › Public › Public Documents › Particle Insight › images ›

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Spreadsheet files

There are several types of spreadsheet files created from different files:

- From a sample file - contains the same information to be included in the printed report for a sample run. The first page is sample documentation, settings, and system values. Succeeding pages are one page per measure and contain histogram listings.

  Filename structure:
  <samplename>-n, where n = 1, 2, 3, …

- From a Multirun or run series file - contains a line of summary data for each run in the series.

  Filename structure:
  <samplename>-n-RS, where n = 1, 2, 3, …

- Particle listing - contains a line of data for every particle in the sample database.

  Filename structure:
  <samplename>-n-PF, where n = 1, 2, 3, …

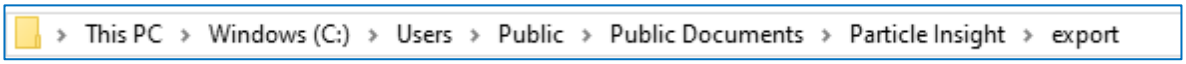
- Listings from the Percentiles, Oil Analysis and Classification features in Post-run Processing.

  Filename structure:
  user-specified

- From the Comprehensive Statistics form. The values shown in the form are written as a .csv (comma-separated values) text file.

For all types of spreadsheet files:

File extension: ***.xlsx** (Microsoft Excel file format) or ***.csv** in the case of Comprehensive Statistics.

Default location: 

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Particle database files

These are optional files for saving data on individual particles.

- Particle data
  Filename structure:
  <samplename>-n-**pd**, where n = 1, 2, 3, …

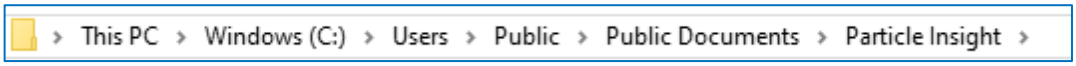
- Particle thumbnails
  Filename structure:
  <samplename>-n-**id**, where n = 1, 2, 3, …

File extension: ***.dat**
Default location: 

System files

There are several files with different extensions that are used by the security system and at startup.

- **Users.txt**: contains usernames, dates of creation and encoded passwords.
- **AuditTrail.**txt: maintains the security audit trail.
- **PIstartup.smp**: contains certain values that load at program startup.

Default location: 

Settings files

These files hold Analysis Specification and Run Control Specification settings.

Usual filename: <particle type> where particle type is **"Small Spheres"** etc.
File extension: *.psf
Default location: 

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Preference files

Filename structure:
Usual filename: <name> where name is indicative of either a type of sample, or of a user's default preferences for reports and user interface.

File extension: *.prf
Default location: This PC › Windows (C:) › Users › Public › Public Documents › Hydro Insight › settings

Text files

Certain features generate text files. These include individual particle listings and particle tracking listings.

Filename structure:

- particle listings - Usual filename: <samplename>-PF
- particle tracking files - <samplename>-PT.

File extension: .txt
Default location: This PC › Windows (C:) › Users › Public › Public Documents › Particle Insight › textdata

Thumbnail image files

Thumbnail pages are able to be saved as image files. These images are of a smaller size than the normal camera images.

Filename structure:
Usual filename: <samplename>-n-thumbsX where n = 1,2,3… and X = 1,2,3…
File extension: *.tif
Default location: This PC › Windows (C:) › Users › Public › Public Documents › Particle Insight › thumbnails

Classification files

The Particle Classification feature in Post-run Processing saves classification limits and category names.

Classification limits are saved in files with extension: ***.occ**

Category names are saved in files with extension: ***.ini**

Default location: This PC › Windows (C:) › Users › Public › Public Documents › Particle Insight › classification

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APPENDIX B

B.1 - GLOSARY

Frames: The number of images captured.

Particles: The particle count (after edge contact correction if enabled).

Particles/frame: Average particle count per frame.

Particles/ml: A concentration figure, equal to total particles/(probe volume * frames).

Elapsed seconds: The time duration of the actual data-taking.

Frames per second: Total frames/elapsed seconds

Background average: The average pixel value, from 0 to 255, of the image background.

Contrast: (Lb-Ld)/Lb where Lb = background gray level; Ld = average particle gray level.

Background reject: Percent of images that was not counted because their intensity (background value) was outside the range specified in Rejections.

Focus reject: The number of particles not counted due to their being out of focus.

Shape reject: The number of particles not counted due to their failing the shape reject criteria.

Border reject: The number of particles rejected due to contacting the border.

Dark pixels: Percent of the total image area that was counted as particles.

Depth of Focus: This is the distance, centered at the focal plane, over which objects will be accepted, if Focus Rejection is in effect. It is determined by the Focus Parameter and the current magnification but is limited to the view cell thickness.

Probe volume: Volume of space in which particles are counted; equal to image size x depth of focus.

Sample volume: The total volume contained in all the particles included in the sample.

Area density: The average surface area density, expressed as square cm per cc. The calculation assumes spherical particles.

Volume density: The average particle volume fraction in the probe volume. This is a dimensionless fraction (cc per cc).

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APPENDIX C

C.1 - FILE SUFFIXES

Suffix	File
-dat	Particle ata file
-pd.dat	Particle Data file
-id.dat	Thumbnail Data file
-rs	Run series file
-rc	Run Condition file (legacy file)
-smp	Sample Run File
-prf	Preferences file
-psf	Settings file
-ro	Report Options file (legacy file)
-ac	Analysis Condition file
-xls, - xlsx	Microsoft Excel file
-tif	Tiff Image files
-cs	Comprehensive statistics file
-occ	Clasification file
-ini	Category names file

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APPENDIX D

D.1 - STATISTICAL DEFINITIONS

MEANS: The D_{pq} means are a way of characterizing a particle sample by a single number and are often used in particle technology. Each D_{pq} mean characterizes the sample in a different way.

The standard method of computing Dpq from number diameter data is:

$$D_{pq} = [\ \sum(n_i\ d_i^p) / \sum(n_i\ d_i^q)\ ]^{\ 1\ /\ (p\ -\ q)}$$

where i ranges over all particles in the sample and d_i is the i^{th} bin center In this definition q is always smaller than p.

The P^{th} power geometric mean, D_{pq}, is defined as

$$D_{pq} = \exp\ [\sum(n_i\ d_i^p\ \ln(d_i)) / \sum\ (n_i\ d_i^p)\ ]$$

The D_{pq}'s may be computed more accurately from the surface area and volume distributions. This calculation (for p not equal to q) is

$$D_{pq} = [\sum\ (p^{th}\ \text{power array})[i] / \sum\ (q^{th}\ \text{power array})[i]\ ]^{\ 1\ /\ (p\ -\ q)}$$

In Sample Types / Image Analysis, there is an option specifying how the higher power arrays are to be generated. This choice also dictates which D_{pq} computation method will be used.

The commonly used means are:

D10 (arithmetic mean): Average diameter (or other measure) of all particles in the sample.

D20 (mean surface diameter): Diameter of a particle having the average surface area (total surface area in the sample divided by number of particles).

D30 (mean volume diameter): Diameter of a particle having the average volume (total volume in the sample divided by number of particles).

D32 (Sauter mean or surface-weighted mean diameter) : The moment mean of the surface area frequency distribution. Also, the diameter of a particle having the same volume to surface ratio as the entire sample.

D43 (volume-weighted mean diameter): The moment mean of the volume frequency distribution.

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STANDARD DEVIATION: The arithmetic standard deviation of any histogram is calculated as:

$$SD = \sqrt{(\sum (Y_i (X_i - X_m)^2) / \sum Y_i)}$$

WHERE: Y_i = the histogram y-axis values

X_i = the x axis values

X_m = the mean X

PERCENTILES: **DVXX** : The XX^{th} percentile by volume. It is computed as the diameter such that the collection of particles having that size or less represents XX % of the total volume. The commonly used ones are DV10, DV50 and DV90.

DV50 is also called the **volume median**. It is the diameter that divides the sample into two equal halves, by mass or volume.

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APPENDIX E

E.1 ERROR CODES

Code #	Description
1	Image file already exists
2	Image file path error
3	Error creating or writing sample file
4	Error creating or writing run series file
5	Error appending to run series file
6	Checksum error opening users.txt
7	Error creating or writing mirror sample file
8	Error creating or writing mirror image file
9	An image file prefix has not been entered in Run / Basic Settings
10	A limit must be set in Run Options / Run Control to use auto restart
11	Run name, measures, or statistics options does not match what is already in the run series
12	Error writing image file
13	Error writing TIFF file (unknown cause)
14	A sample file was not found
15	Camera not found or bad connection or adapter not powered
16	Could not create particle tracking file
17	Could not create or write sample xls file
18	No run series files were found
19	Individual particle data file not opened; possibly filename already exists
20	Error removing user
21	Error changing user attribute
22	Error writing rangeset fractions file
23	Error creating individual particle data file - name may already exist
24	Error creating individual particle thumbnail file - may already exist
25	Error creating particle text file
26	Error creating individual particle data file at mirror location
27	Error creating particle thumbnail file at mirror location
28	Filename error
29	Could not create stat summary xls file
30	Error during sample upload to website
31	File not created because no data exists
32	Syringe pump initialization or communication error
40	Unknown error

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APPENDIX F

F.1 Chemical Compatibility Table.

CHEMICAL COMPATIBILY CHART

for the tubing and O-rings used in the Pi Sentinel PRO

CHEMICAL	COMPATIBILITY	
	VITON	CHEM-DURANCE-BIO #16, #25
Acetaldehyde	D - Severe Effect	C - Fair
Acetate LMW	E - Info not available	D - Severe Effect
Acetic acid <5%	E - Info not available	A - Excellent
Acetic acid >5%	B - Good	A - Excellent
Acetic anhydride	D - Severe Effect	A - Excellent
Acetone	D - Severe Effect	B - Good
Acetonitrile	D - Severe Effect	B - Good
Acetyl bromide	E - Info not available	D - Severe Effect
Acetyl chloride	A - Excellent	D - Severe Effect
Air	A - Excellent	A - Excellent
Aliphatic hydrocarbons	E - Info not available	D - Severe Effect
Aluminum chloride	A - Excellent	A - Excellent
Aluminum sulfate	A - Excellent	A - Excellent
Alums	A - Excellent	A - Excellent
Ammonia, gas / liquid	D - Severe Effect	B - Good
Ammonium acetate	D - Severe Effect	A - Excellent
Ammonium carbonate	A - Excellent	A - Excellent
Ammonium chloride	A - Excellent	A - Excellent
Ammonium hydroxide	B - Good	A - Excellent
Ammonium nitrate	A - Excellent	A - Excellent
Ammonium phosphate	A - Excellent	A - Excellent

Ratings - Chemical Effect

A - Excellent

B - Good: Minor Effect, slight corrosion, or discoloration.

C - Fair: Moderate Effect, not recommended for continuous use.

D - Severe Effect: Not recommended for any use.

E - Info not available

WARNING

The information in this chart has been supplied from reputable sources and is to be used ONLY as a guide in selecting the appropriate solvent to suspend your sample. Chemical compatibility should be observed.

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CHEMICAL	COMPATIBILITY	
	VITON	CHEM-DURANCE-BIO #16, #25
Ammonium sulfate	A - Excellent	A - Excellent
Amyl acetate	D - Severe Effect	D - Severe Effect
Amyl alcohol	A - Excellent	A - Excellent
Amyl chloride	A - Excellent	D - Severe Effect
Aniline	B - Good	D - Severe Effect
Aniline hydrochloride	B - Good	D - Severe Effect
Aqua regia (80% HCl, 20% H)	B - Good	A - Excellent
Aromatic hydrocarbons	A - Excellent	D - Severe Effect
Arsenic salts	D - Severe Effect	A - Excellent
Barium salts	A - Excellent	A - Excellent
Benzaldehyde	D - Severe Effect	C - Fair
Benzenesulfonic acid	A - Excellent	D - Severe Effect
Bleaching liquors	A - Excellent	A - Excellent
Boric acid	A - Excellent	A - Excellent
Bromine	A - Excellent	D - Severe Effect
Butane	A - Excellent	B - Good
Butanol (butyl alcohol)	A - Excellent	A - Excellent
Butyl acetate	D - Severe Effect	D - Severe Effect
Butyric acid	B - Good	D - Severe Effect
Calcium oxide	A - Excellent	A - Excellent
Calcium salts	A - Excellent	A - Excellent
Carbon bisulfide	E - Info not available	D - Severe Effect
Carbon dioxide	A - Excellent	A - Excellent
Carbon tetrachloride	A - Excellent	D - Severe Effect
Chlorine, dry	A - Excellent	C - Fair
Chlorine, wet	B - Good	C - Fair

Ratings - Chemical Effect

A - Excellent

B - Good: Minor Effect, slight corrosion, or discoloration.

C - Fair: Moderate Effect, not recommended for continuous use.

D - Severe Effect: Not recommended for any use.

E - Info not available

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Return to TOC

CHEMICAL	COMPATIBILITY	
	VITON	CHEM-DURANCE-BIO #16, #25
Chloroacetic acid	D - Severe Effect	A - Excellent
Chlorobenzene	A - Excellent	D - Severe Effect
Chlorobromomethane	A - Excellent	D - Severe Effect
Chloroform	A - Excellent	D - Severe Effect
Chlorosulfonic acid	D - Severe Effect	D - Severe Effect
Chromic acid, 30%	A - Excellent	B - Good
Chromium salts	E - Info not available	A - Excellent
Copper salts	A - Excellent	A - Excellent
Cresol	A - Excellent	A - Excellent
Cyclohexane	A - Excellent	D - Severe Effect
Cyclohexanone	D - Severe Effect	C - Fair
Diacetone alcohol	D - Severe Effect	A - Excellent
Dimethyl formamide	D - Severe Effect	A - Excellent
Dimethyl Sulfoxide (DMSO)	E - Info not available	E - Info not available
Essential oils	E - Info not available	D - Severe Effect
Ethanol (ethyl alcohol)	A - Excellent	A - Excellent
Ether	D - Severe Effect	D - Severe Effect
Ethyl acetate	D - Severe Effect	D - Severe Effect
Ethyl bromide	A - Excellent	D - Severe Effect
Ethyl chloride	A - Excellent	D - Severe Effect
Ethylamine	D - Severe Effect	B - Good
Ethylene chlorohydrin	A - Excellent	A - Excellent
Ethylene dichloride	A - Excellent	D - Severe Effect
Ethylene glycol	A - Excellent	A - Excellent
Ethylene oxide	D - Severe Effect	A - Excellent
Fatty acids	A - Excellent	C - Fair

Ratings - Chemical Effect

A - Excellent

B - Good: Minor Effect, slight corrosion, or discoloration.

C - Fair: Moderate Effect, not recommended for continuous use.

D - Severe Effect: Not recommended for any use.

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Return to TOC

CHEMICAL	COMPATIBILITY	
	VITON	CHEM-DURANCE-BIO #16, #25
Ferric chloride	A - Excellent	A - Excellent
Ferric sulfate	A - Excellent	A - Excellent
Ferrous chloride	A - Excellent	A - Excellent
Ferrous sulfate	A - Excellent	A - Excellent
Fluoboric acid	E - Info not available	A - Excellent
Fluoroborate salts	E - Info not available	A - Excellent
Fluosilicic acid	A - Excellent	A - Excellent
Formaldehyde	D - Severe Effect	C - Fair
Formic acid, 25%	D - Severe Effect	A - Excellent
Freon® TMS	E - Info not available	A - Excellent
Gasoline, high-aromatic	A - Excellent	D - Severe Effect
Gasoline, nonaromatic	A - Excellent	D - Severe Effect
Glucose	A - Excellent	A - Excellent
Glue, P.V.A.	A - Excellent	A - Excellent
Glycerin	A - Excellent	A - Excellent
Hydriodic acid	A - Excellent	A - Excellent
Hydrobromic acid, 30%	A - Excellent	A - Excellent
Hydrochloric acid (conc)	A - Excellent	A - Excellent
Hydrochloric acid (dil)	A - Excellent	A - Excellent
Hydrochloric acid (med)	A - Excellent	A - Excellent
Hydrocyanic acid	A - Excellent	A - Excellent
Hydrocyanic acid, gas, 10%	A - Excellent	A - Excellent
Hydrofluoric acid, 50%	D - Severe Effect	A - Excellent
Hydrofluoric acid, 75%	D - Severe Effect	C - Fair
Hydrogen peroxide (dil)	A - Excellent	A - Excellent
Hydrogen peroxide, 90%	A - Excellent	B - Good

Ratings - Chemical Effect

A - Excellent

B - Good: Minor Effect, slight corrosion, or discoloration.

C - Fair: Moderate Effect, not recommended for continuous use.

D - Severe Effect: Not recommended for any use.

E - Info not available

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CHEMICAL	COMPATIBILITY	
	VITON	CHEM-DURANCE-BIO #16, #25
Hypochlorous acid	A - Excellent	A - Excellent
Iodine solutions	A - Excellent	A - Excellent
Iodoform	C - Fair	D - Severe Effect
Kerosene	A - Excellent	D - Severe Effect
Ketones	E - Info not available	C - Fair
Lacquer solvents	D - Severe Effect	D - Severe Effect
Lactic acid, 3–10%	A - Excellent	A - Excellent
Lead acetate	D - Severe Effect	A - Excellent
Linseed oil	A - Excellent	B - Good
Lithium hydroxide	C - Fair	B - Good
Magnesium chloride	A - Excellent	A - Excellent
Magnesium sulfate	A - Excellent	A - Excellent
Malic acid	A - Excellent	A - Excellent
Manganese salts	A - Excellent	A - Excellent
Mercury salts	A - Excellent	A - Excellent
Methane	A - Excellent	A - Excellent
Methanol (methyl alcohol)	B - Good	A - Excellent
Methyl chloride	B - Good	D - Severe Effect
Methyl ethyl ketone (MEK)	D - Severe Effect	C - Fair
Mixed acid (40% H2SO4, 15% HNO3)	E - Info not available	A - Excellent
Molybdenum disulfide	A - Excellent	A - Excellent
Monoethanolamine	D - Severe Effect	D - Severe Effect
Naphtha	A - Excellent	D - Severe Effect
Natural gas	A - Excellent	A - Excellent
Nickel salts	A - Excellent	A - Excellent

Ratings - Chemical Effect

A - Excellent

B - Good: Minor Effect, slight corrosion, or discoloration.

C - Fair: Moderate Effect, not recommended for continuous use.

D - Severe Effect: Not recommended for any use.

E - Info not available

WARNING

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Return to TOC

CHEMICAL	COMPATIBILITY	
	VITON	CHEM-DURANCE-BIO #16, #25
Nitric acid (conc)	A - Excellent	A - Excellent
Nitric acid (dil)	B - Good	A - Excellent
Nitric acid (med)	A - Excellent	A - Excellent
Nitrobenzene	B - Good	D - Severe Effect
Nitrogen oxides	D - Severe Effect	A - Excellent
Nitrous acid	E - Info not available	A - Excellent
Oils, animal	A - Excellent	B - Good
Oils, mineral	A - Excellent	D - Severe Effect
Oils, vegetable	A - Excellent	B - Good
Oleic acid	B - Good	C - Fair
Oxalic acid, cold	A - Excellent	A - Excellent
Oxygen, gas	B - Good	A - Excellent
Palmitic acid, 100% in ether	A - Excellent	C - Fair
Perchloric acid	A - Excellent	A - Excellent
Perchloroethylene	A - Excellent	D - Severe Effect
Phenol (carbolic acid)	A - Excellent	A - Excellent
Phosphoric acid, 50%	A - Excellent	A - Excellent
Phthalic acid	B - Good	A - Excellent
Plating solutions	A - Excellent	A - Excellent
Polyglycol	A - Excellent	B - Good
Potassium carbonate	A - Excellent	A - Excellent
Potassium chlorate	A - Excellent	A - Excellent
Potassium hydroxide (conc)	D - Severe Effect	A - Excellent
Potassium hydroxide (med)	D - Severe Effect	A - Excellent
Potassium iodide	A - Excellent	A - Excellent
Propanol (propyl alcohol)	A - Excellent	A - Excellent

Ratings - Chemical Effect

A - Excellent

B - Good: Minor Effect, slight corrosion, or discoloration.

C - Fair: Moderate Effect, not recommended for continuous use.

D - Severe Effect: Not recommended for any use.

E - Info not available

WARNING

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CHEMICAL	COMPATIBILITY	
	VITON	CHEM-DURANCE-BIO #16, #25
Pyridine	D - Severe Effect	C - Fair
Silicone fluids	A - Excellent	A - Excellent
Silicone oils	A - Excellent	A - Excellent
Silver nitrate	A - Excellent	A - Excellent
Soap solutions	A - Excellent	A - Excellent
Sodium bicarbonate	A - Excellent	A - Excellent
Sodium bisulfate	A - Excellent	A - Excellent
Sodium bisulfite	A - Excellent	A - Excellent
Sodium borate	A - Excellent	A - Excellent
Sodium carbonate	A - Excellent	A - Excellent
Sodium chlorate	A - Excellent	A - Excellent
Sodium chloride	A - Excellent	A - Excellent
Sodium ferrocyanide	A - Excellent	A - Excellent
Sodium hydrosulfite	E - Info not available	A - Excellent
Sodium hydroxide (conc)	A - Excellent	A - Excellent
Sodium hydroxide (dil)	A - Excellent	A - Excellent
Sodium hydroxide, 25%	A - Excellent	A - Excellent
Sodium hypochlorite, <5%	A - Excellent	A - Excellent
Sodium hypochlorite, >5%	A - Excellent	A - Excellent
Sodium nitrate	A - Excellent	A - Excellent
Sodium silicate	A - Excellent	A - Excellent
Sodium sulfide	A - Excellent	A - Excellent
Sodium sulfite	A - Excellent	A - Excellent
Steam, up to 40 psi	B - Good	D - Severe Effect
Stearic acid	A - Excellent	C - Fair
Styrene	A - Excellent	D - Severe Effect

Ratings - Chemical Effect

A - Excellent

B - Good: Minor Effect, slight corrosion, or discoloration.

C - Fair: Moderate Effect, not recommended for continuous use.

D - Severe Effect: Not recommended for any use.

E - Info not available

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CHEMICAL	COMPATIBILITY	
	VITON	CHEM-DURANCE-BIO #16, #25
Sulfuric acid (conc)	A - Excellent	A - Excellent
Sulfuric acid (dil)	A - Excellent	A - Excellent
Sulfuric acid (med)	A - Excellent	A - Excellent
Sulfurous acid	B - Good	A - Excellent
Tannic acid	A - Excellent	A - Excellent
Tanning liquors	E - Info not available	A - Excellent
Tartaric acid	A - Excellent	A - Excellent
Tin salts	E - Info not available	A - Excellent
Toluene (toluol)	A - Excellent	D - Severe Effect
Trichloroacetic acid	C - Fair	A - Excellent
Trichloroethylene	A - Excellent	D - Severe Effect
Trisodium phosphate	A - Excellent	A - Excellent
Turpentine	A - Excellent	D - Severe Effect
Urea	E - Info not available	A - Excellent
Uric acid	E - Info not available	A - Excellent
Water, fresh	A - Excellent	A - Excellent
Water, salt	A - Excellent	A - Excellent
Xylene	A - Excellent	D - Severe Effect
Zinc chloride	A - Excellent	A - Excellent

Ratings - Chemical Effect

A - Excellent

B - Good: Minor Effect, slight corrosion, or discoloration.

C - Fair: Moderate Effect, not recommended for continuous use.

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