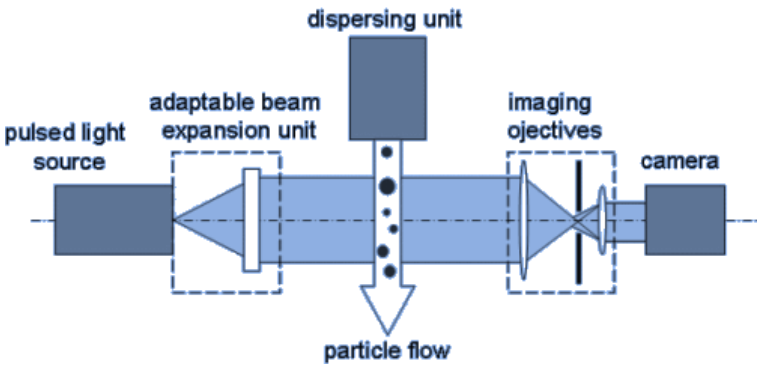
QICPIC quick-guide

GEOSCIENCE, AARHUS UNIVERSITY

*Particle size and shape parameters **sphericity, aspect ratio and convexity** in glacial tills can reveal information on how and to what degree particles have undergone mechanical impact during glacial erosion, transportation and deposition.*



The QICPIC system consists of a laser-source producing monochromatic light-pulses at 532 nm, a beam expansion unit, the measuring zone (using gravity dispersion, GRADIS, and a vibration feeder, VIBRI), an optical system (here the lens M8) and a high-speed CMOS camera operating normally at 70 Hz.

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MEASUREMENT

NEVER USE THIS INSTRUMENT WITHOUT PERSONAL INSTRUCTION FROM A TECHNICIAN!

1. **Pre-treatment:** Material[1] should be wet sieved[2] at 2-4 mm followed by drying at 50°C for 1-2 days. Before measurement, dry sieve at the smallest particle size (normally 2 mm). Make sure to clean the meshes thoroughly to avoid contamination: Not a single grain may be transferred to the next sample.

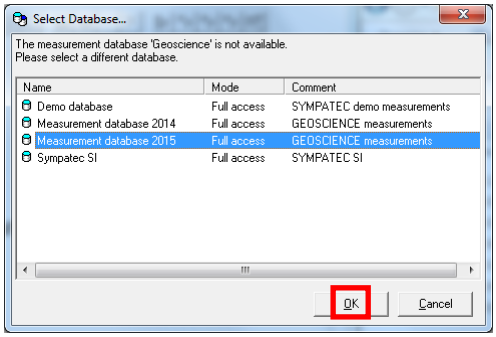
   In respect to statistical validity, you need to consider the amount of material before you start sampling: Less than 100 grains[3] are not considered reliable but this depends on the spread of data. If the results are clustered, then less grains may do.

2. **Turn on laser-system** by switching the key from off (O: Off) to the 1st position (⏻: Standby) and then to the 2nd (I: Working mode, light source and dispersing unit can be activated by software commands). The laser beam needs approximately 10 minutes for warm-up.

   Meanwhile, check the filter and bag in the vacuum cleaner. Clean if necessary.

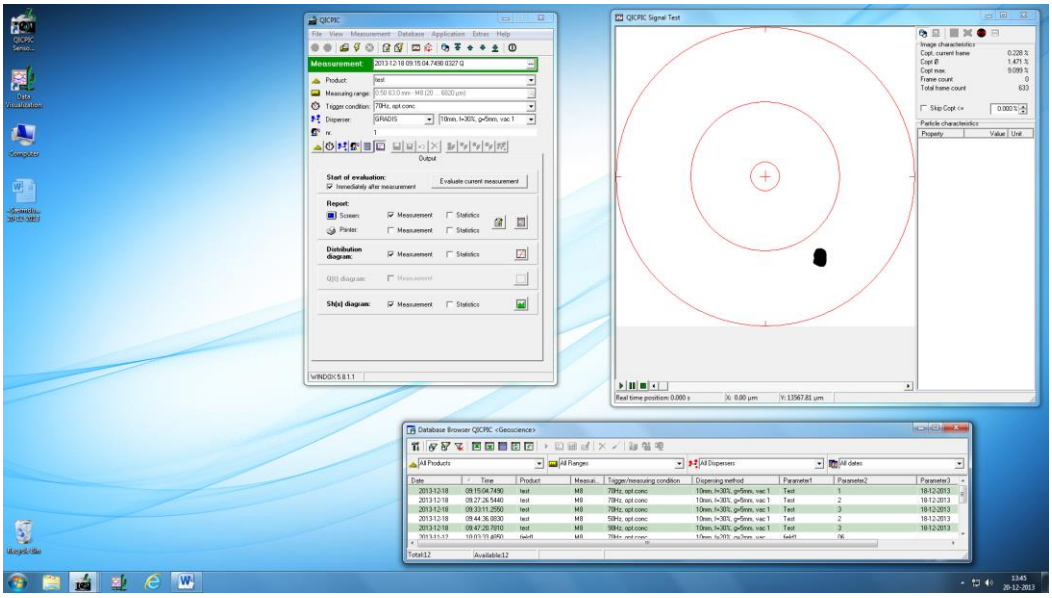
3. **Turn on computer-system**[4] and choose "Windox" user and corresponding password: *WINDOX*. The software will only run if the appropriate license-file is installed correctly (see appendix 4). Current version of the software (as of September 2015) is Windox 5, 9.0.2.

4. Select the icon **QICPIC sensor control** located on the desktop or in the Windows Start menu. Alternatively select a pre-defined QICPIC session file containing measurement conditions. If prompted, select the measurement database that you intend to work in (normally the current year, older databases are stored as read-only):



5. Three windows will now emerge: "Sensor control", "Signal Test" and "Database browser":

[1] From a 1-2 mm sieved sample, 1 tablespoon = 1.5 C_{opt}% (or 3500 measured particles) is produced.
[2] For specific experiments 1 mm can be used, but never <1 mm.
[3] In a classical manual pebble-shape morphology analyses often only 30-50 pebbles were measured.
[4] Switch on instrument first: Computer must find instrument through initial handshake process.



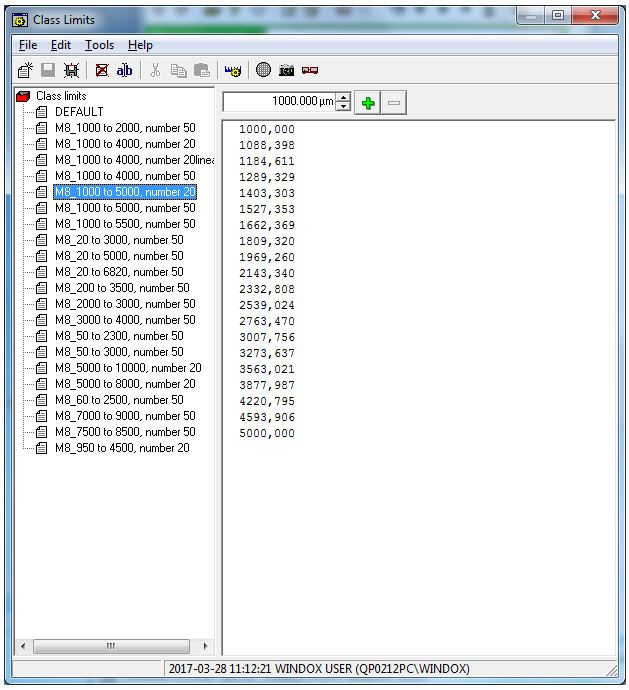
6. **Decide on what software setup suits the sample best and check the configuration** according to appendix 1. You should know in what context the data is to be used and interpreted to select the optimum measurement conditions. Apply individual settings in the "Sensor control" window. The system only contains one lens[5], making the option to change measuring range permanently unavailable. If you make any changes, save the session with a new name, never overwrite existing measurement sessions.

   Sessions (with all configurations) can be opened later for other projects. This will ensure the same settings are applied to measurements that require the same configuration.

7. **Perform measurement:**
   a. Load sample in the feeder. Make sure that some particles are placed close to the mount of the chute, otherwise there is a risk of time-out and the software initiates the cleaning process due to low concentration in the measuring zone. Refer to appendix 6 for approximate amount. The number of particles produced is material dependent: If your sample volume primarily contains large grains then less particles are being measured, as opposed to having primarily small grains at work.
   b. Conditions for running a normal sample using GRADIS:
      i. Feed rate[6]: 20%
      ii. Frame rate[7]: 70Hz (frames per second)
      iii. Outlet tip size: 2 x the size of the expected coarsest particle size [mm]
      iv. Gap width: 5mm
      v. Classes[8]: normally 20 (class limits: 1,000-5,000mm or 1,000-8,000mm)

[5] The lens, M8, has a magnification of 2. The size of 1 pixel is 10x10 microns. Particle size range covered by the lens is 20 microns and up to 20mm. However, considering the pixel size, Sympatec suggest the range starting point at 60 or 80 microns for proper shape recognition.
[6] Feed rate (the velocity of the feeder vibration) should not be > 50%. It can be anywhere from 0 to 100%.
[7] No matter what the settings are set to produce (i.e., 70 Hz), the *projected* frame rate is always 20 fps.
[8] The number of classes (or measuring points) is in principle unlimited but 100 should not be exceeded. "Too wide a selection, the sensitivity of evaluated results will become poor. Too narrow a selection, the percentages of the measured classes will be small (some even empty), yielding low statistical relevance and oscillating

Example of the selected class limit set in the range 1,000-5,000:



vi. Optical concentration (C_{opt}%)[9]: In principle 10-20%

vii. Choose either vacuum extraction ("vac" will discard the sample) or to collect the material in the drawer[10] ("no vac"). The latter will require a cleaning procedure after each measurement, refer to section 10.

One sample measurement takes approximately 5-10 minutes from start to finish (depending on the number of particles to be measured). Normally only 1 measurement is sufficient (if vacuum extraction is selected you also lose part of the material and will never have 2 identical measurements on the same number of grains). You should continuously monitor the value of the *threshold*[11] in the "Signal Test" window.

8. **Save data** results: Each measurement will produce a report-window containing PSD (cumulated values) and various shape information (see appendix 2). Choose "File/Save as…": Select destination O:\ST_Geo-Qicpic\Data\... and the rtf-format, name your file.

   If running a measurement on a sample within 1-4 mm, expect that 50% of the particles present in the batch are measured: The approximate "real" number of measured grains = 2 x the particle count by the Qicpic software.

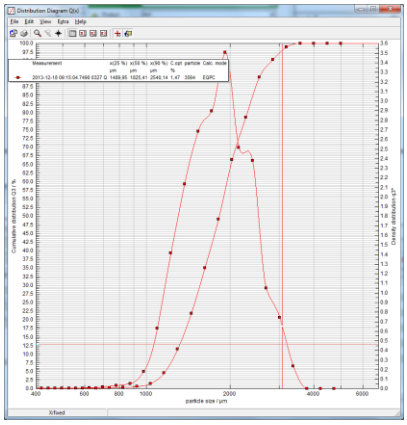
9. Close the 3 windows related to this measurement:

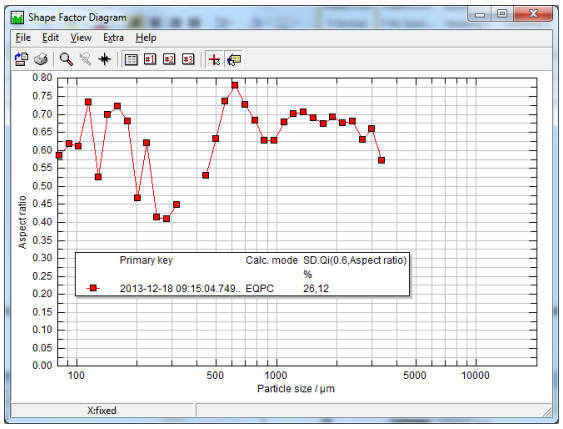
diagrams." (page 43, large Sympatec binder) It is important that the size classes are kept constant over a series of measurements to obtain comparable results.

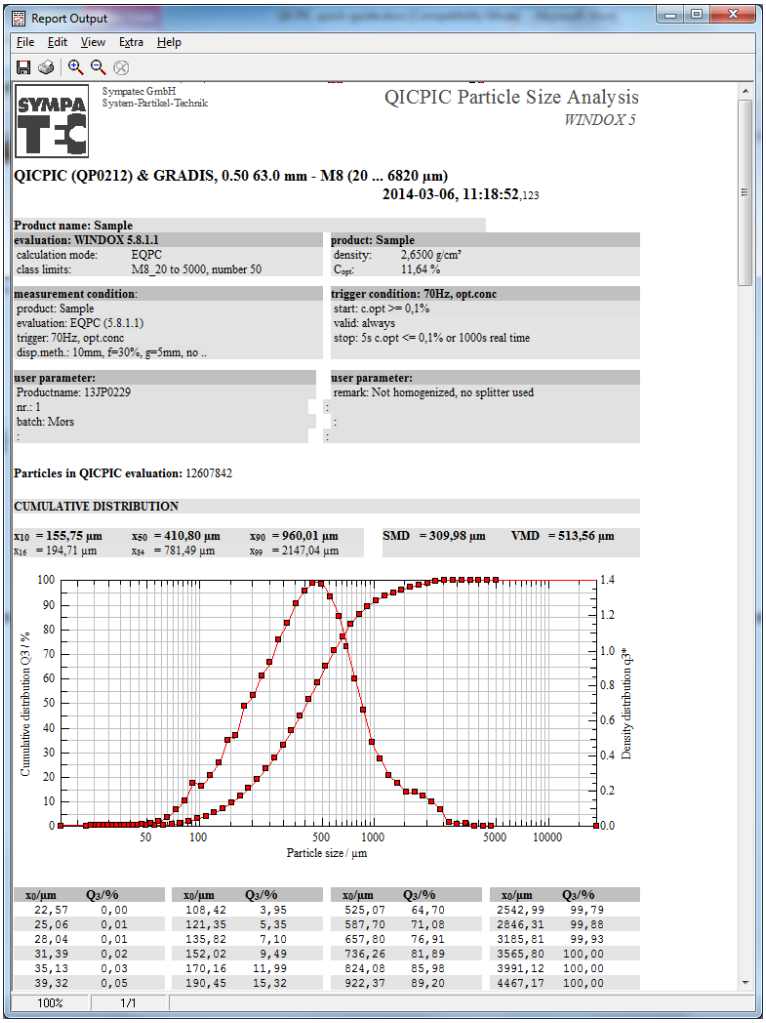
[9] The value is depending on many measuring factors and thus rarely in this range.

[10] The system will only run if the drawer is inserted correctly.

[11] The threshold should be >75 and preferably close to 90 without something in the measuring zone. If the threshold value is <70 then cleaning is necessary. The value for brightness should be in the range 198-218.







10. **Clean the system** by running a coarse[12] sample (i.e. fine gravel[13]) using normal measurement settings. A session entitled "Cleaning" has been created to automate the process. Afterwards, remove the contaminating grains from the material by performing a 1-mm sieving on a piece of paper. Check the data output with earlier measurements to ensure the

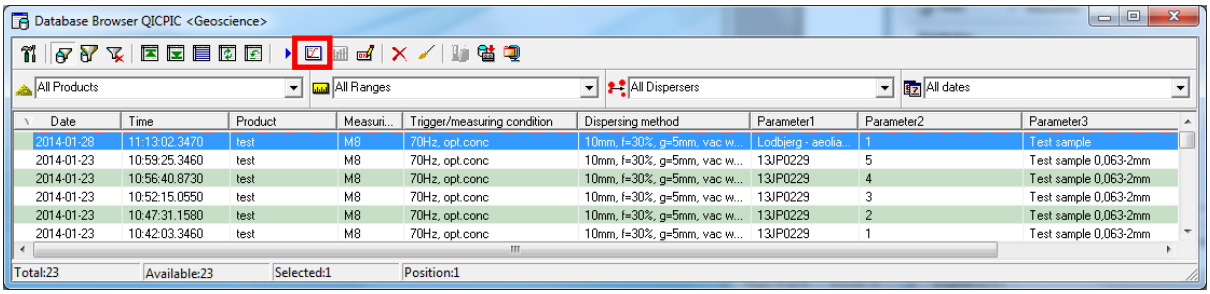
[12] Smaller particles may stick to the inner parts of the shaft but many will attach themselves to the coarser particles and be removed from the system. If they are not removed they will contaminate the next sample and additionally the particle count will become much too high.

[13] The "cleansing agent" 2-4 mm can be re-used many times, if washed and dried with regular intervals.

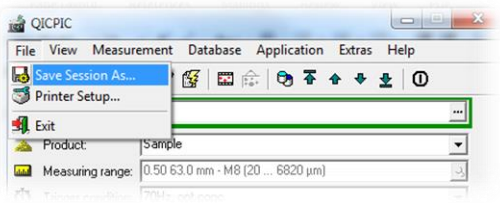
cleaning process is carried out correctly. Repeat this step until the particle count number is constant.

11. Continue with the next sample measurement, repeating step 6-9. If you don't want to compare with the previous measurement you have to close the graph and report windows related to the previous measurement before starting a new measurement.

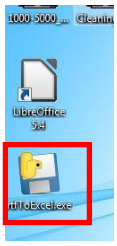
    If you want to compare different measurements later, select the measurements in the database browser (hold down the CTRL key while clicking) and select the graph icon to evaluate the highlighted measurements:



    If you want to save the local settings used during a measurement, go to the File menu of the "Sensor control" window and select "Save session as…" to save as a WXQ file. This file type can be re-opened in the "Sensor control" application later.

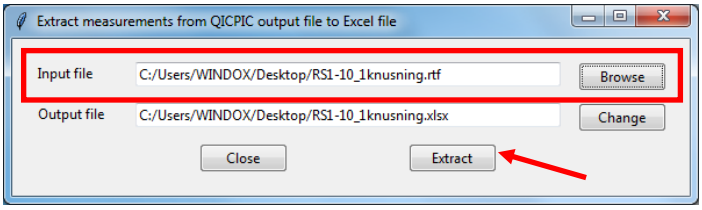


12. Once you have produced all your rtf-files for your project, **convert them to Excel**-format by running the rtfToExcel.exe-file[14] located on the desktop.



    Browse for the rtf-file, select *Extract* to convert. Note that the sample filenames (and the path to any individual file) may not include space or special characters such as æ, ø and å. To ensure a smooth conversion process, folders and files may need temporary renaming.

[14] The converter is dependent on the installation of LibreOffice on the computer as well as a change in the target-values in Windows. Refer to installation in the separate guide *Producing Excel-files for Qicpic.docx*.



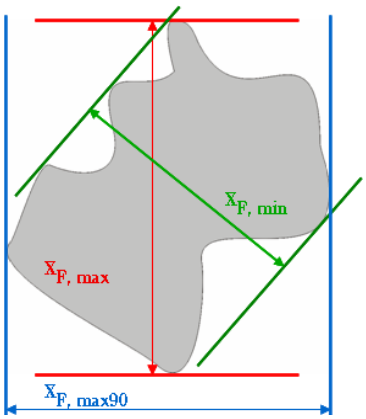
13. To **shut down**: Close the "Sensor control" window ONLY (*not* the "Signal test" or "Database" windows) and switch the key on the QICPIC to standby mode for a second and then to position Off.

14. **Cleaning** of the instrument:
    a. Always use pressurized air (gently) or special tissue cleaning paper to clean any glass surface.
    b. Make sure that no particles are blocking the outlet tip.
    c. Fine dust on the instrument should be removed with a vacuum cleaner.
    d. The attached vacuum cleaner should be used regularly to clean the vacuum outlet.
    e. Check (and empty) the bag and filter in the vacuum cleaner on a regular basis.

15. **Maintenance:** See appendix 3.

For serious problems (Geoscience technicians only): Contact service@sympatec.com

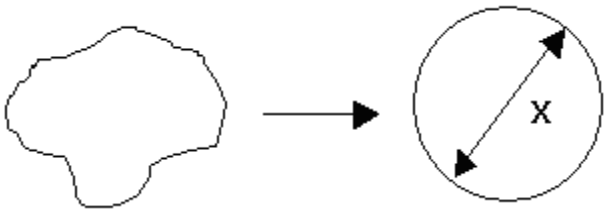
DEFINITIONS

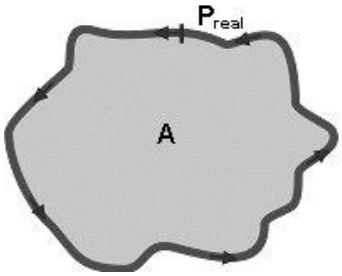


- *Feret diameter:* The measure of an object size along a specified direction (in general the distance between two parallel lines restricting the object perpendicular to that direction). Maximal or minimal Feret diameter after consideration of all possible orientations (0°...180°). The Feret diameters for a sufficient number of angles are calculated, and their maximum or minimum is selected. $X_{F,\ max}$ is the longest distance, $X_{F,\ min}$ is the shortest distance. Also, $X_{F,\ max90}$ is the Feret diameter measured at an angle of 90 degrees to that of the maximal Feret diameter. For a perfect sphere $X_{F,\ min} = X_{F,\ max}$.

- *EQPC:* The diameter X_{EQPC} of a sphere which would contain the same volume (3D) or surface area (2D) as the (irregular) particle:

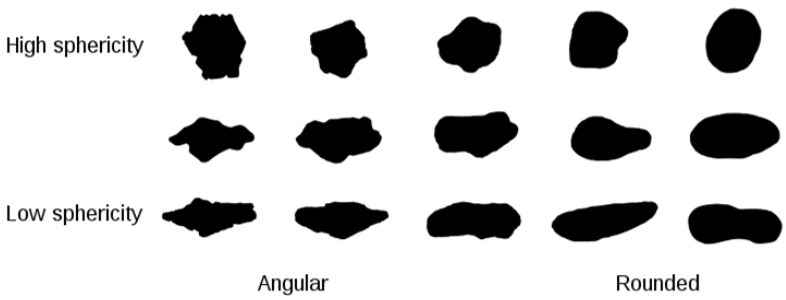
$$X_{EQPC} = 2\sqrt{A/\pi}$$





- *Sphericity* (0<S<1)[15]: The ratio of the perimeter P_{EQPC} of a circle with diameter X_{EQPC} to the perimeter P_{real} of the corresponding projection area A. A sphere has S=1. The smaller the value: The shape of the particle is more irregular.

$$S = \frac{P_{EQPC}}{P_{real}} = \frac{2\sqrt{\pi \cdot A}}{P_{real}}$$

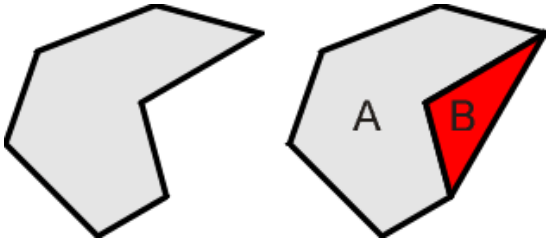


- *Aspect ratio* ($0<y_A<1$)[16]: The ratio of the Minimum to the Maximum Feret Diameter, or

$$Y_A = X_{F,min}/X_{F,max}$$

[15] In sedimentology this description applies to the definition of *angularity*.
[16] In sedimentology this description applies to the definition of *sphericity*.

- *Convexity:* The convexity is an important shape parameter describing the compactness of a particle. The figure below shows a particle with projection area A (grey) leaving open a concave region of area B (red):



  Convexity is defined as the ratio of the projection area itself (A) and the area of the convex hull (A+B):

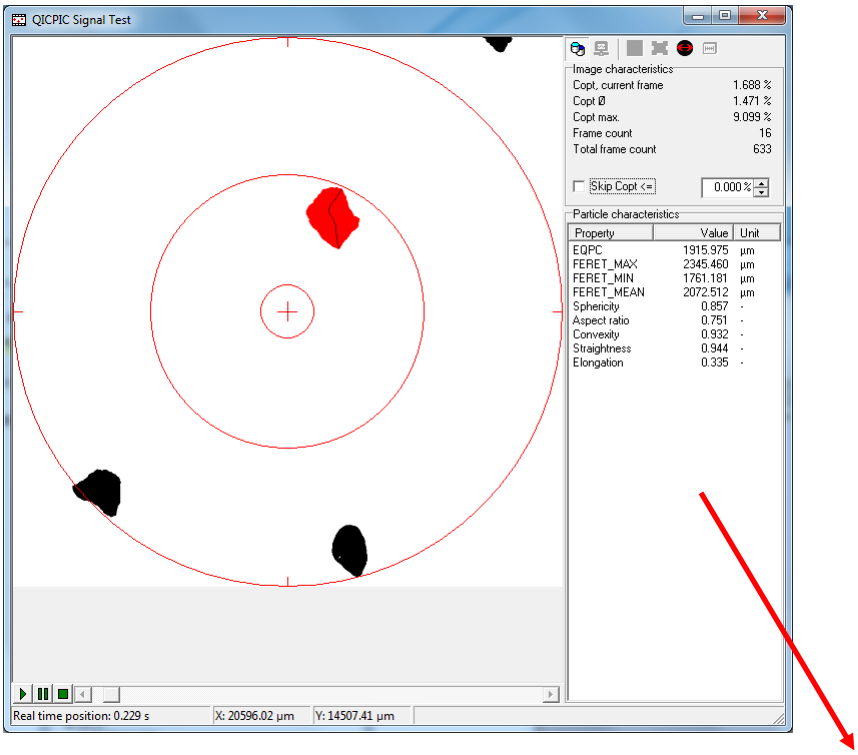
$$\psi_c = \frac{A}{A+B} = 1 - \frac{B}{A+B}$$

  The maximum theoretical convexity is 1, if there are no concave regions. Due to the detector design of a digital camera (square pixels), however, all particles seem to have small concave regions, corresponding to the tiny steps with every pixel in the perimeter line. Therefore, the maximum convexity calculated is mostly limited to 0.99.

- *SMD (Sauter Mean Diameter) and VMD (Volume Mean Diameter):*
  https://www.sympatec.com/EN/Software/FAQs/02_Calc_Results/0201_VMD_Formula.html
  https://en.wikipedia.org/wiki/Sauter_mean_diameter

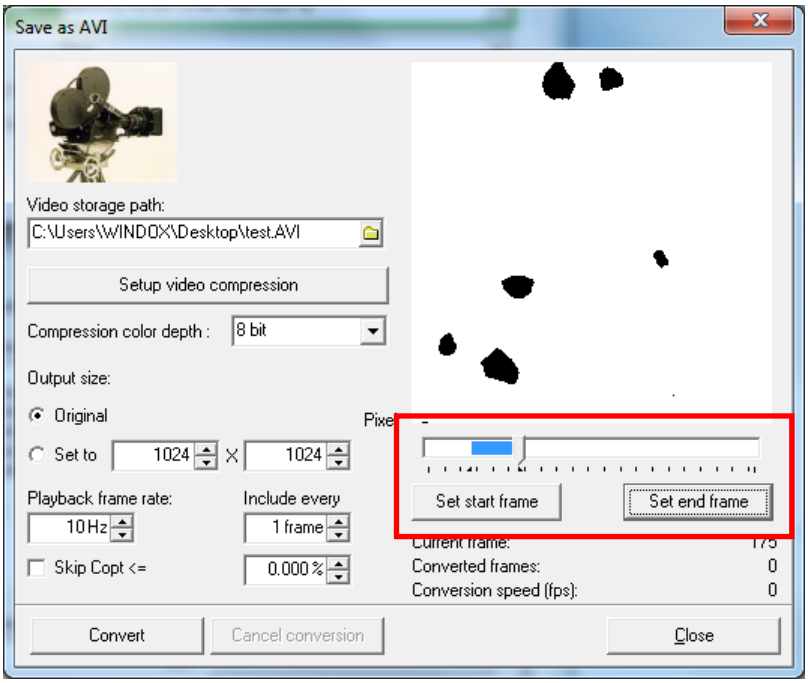
Sources: http://www.sympatec.com/EN/Science/Characterisation/05_ParticleShape.html and http://www.sympatec.com/EN/ImageAnalysis/Fundamentals.html

VIDEO OUTPUT

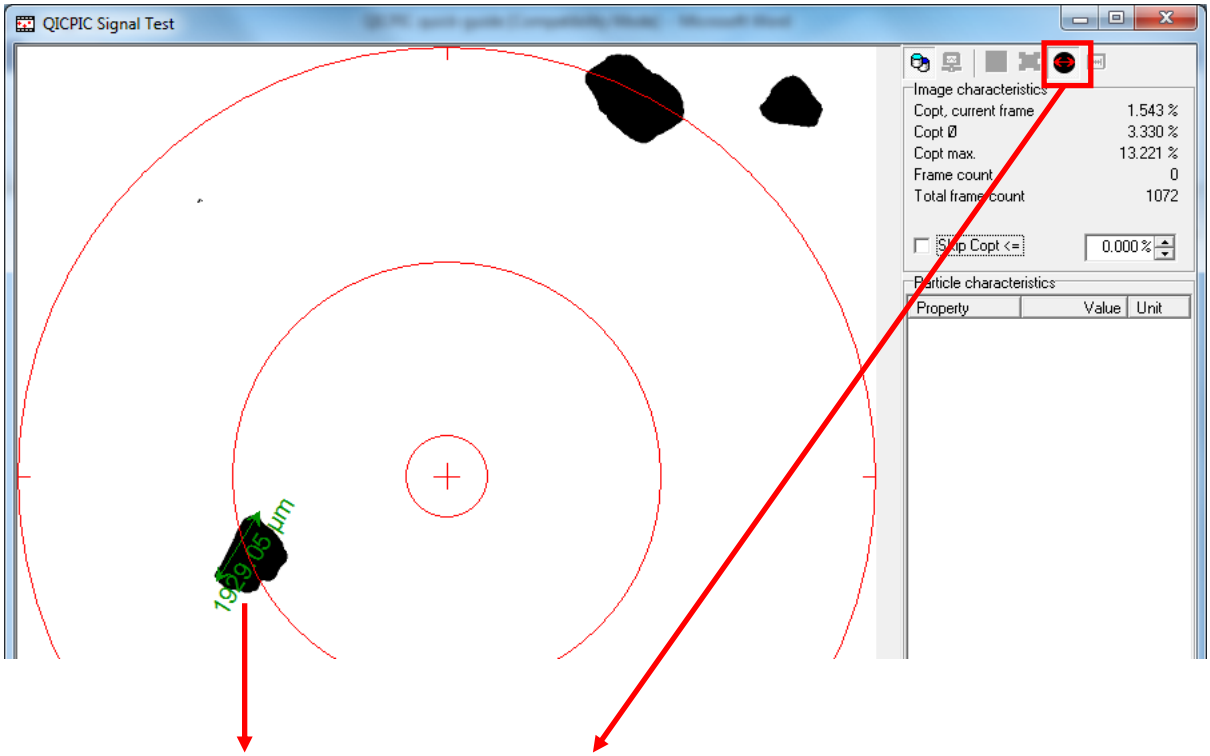


To create a video-file (or “moving images”) from the recorded images: Right-click on the white area and select “Save as AVI-file”.

To do this you need to set a start frame and an end frame:



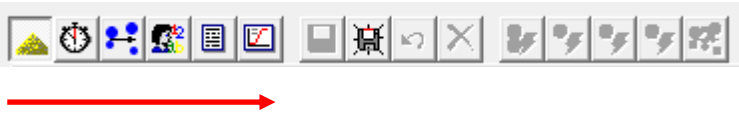
Use the settings above and choose a destination (“video storage path”). Save the video by clicking “Convert”.

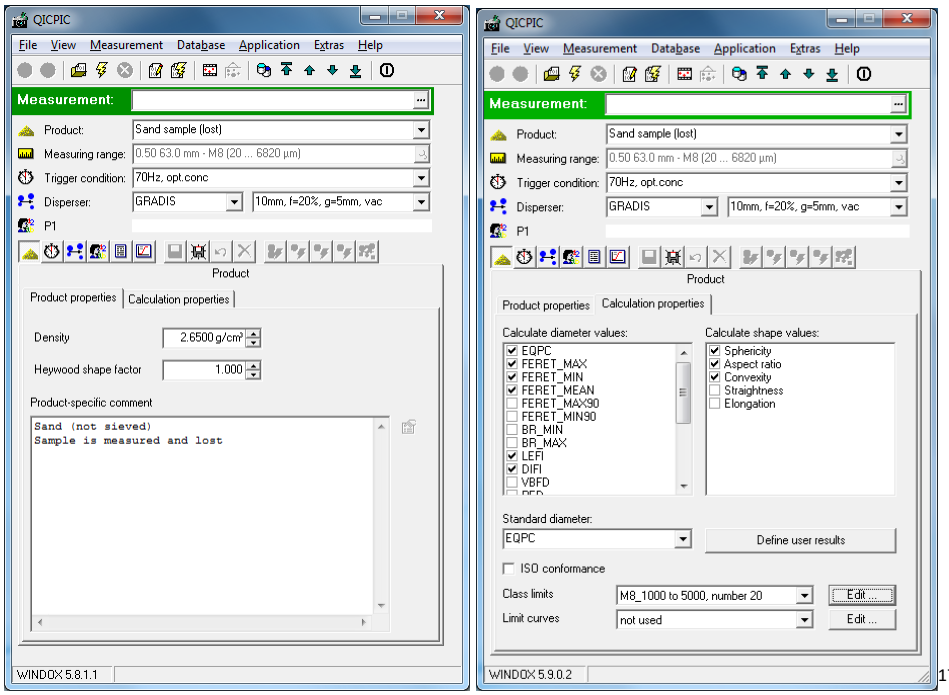


When selecting the icon “Dimensioning mode” in the Signal Test window it is possible to measure the size of one or several particles. This is done by clicking the start and end position of the particle. The result is shown in green highlighted text.

APPENDIX 1: SCREENSHOTS

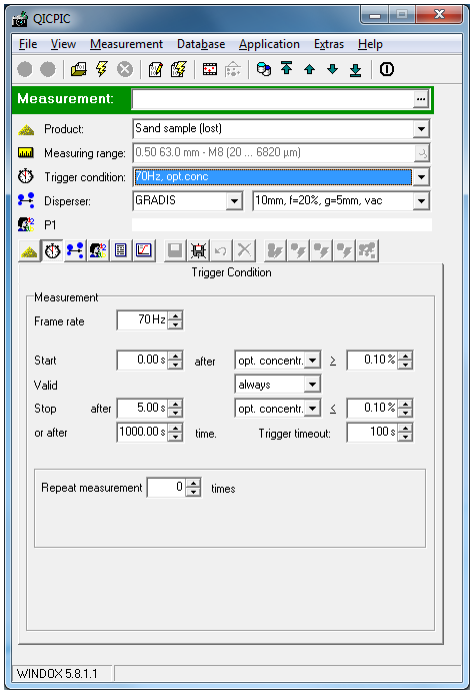
The following screenshots from the QICPIC "Sensor control" shown the icons (from left to right):

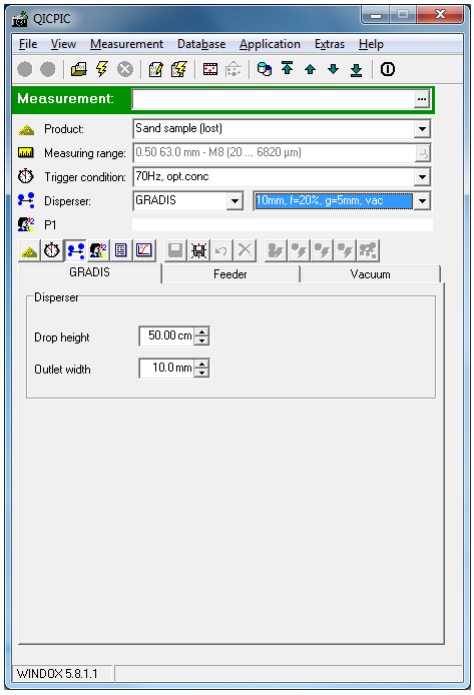


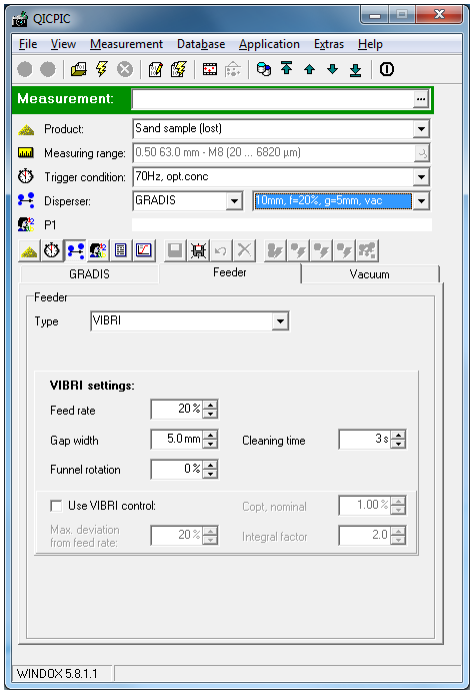


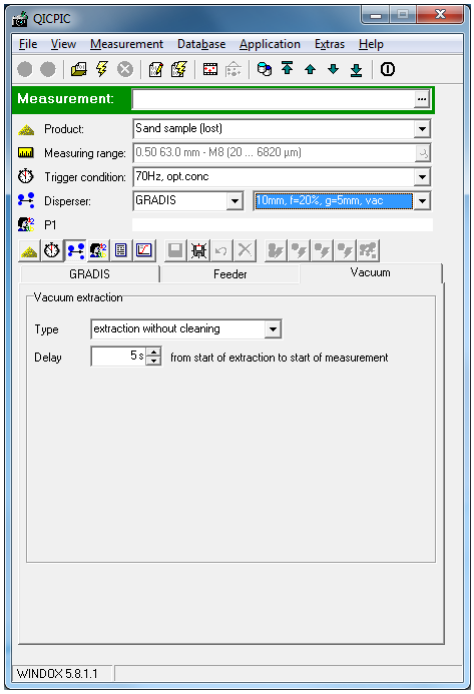
[17]

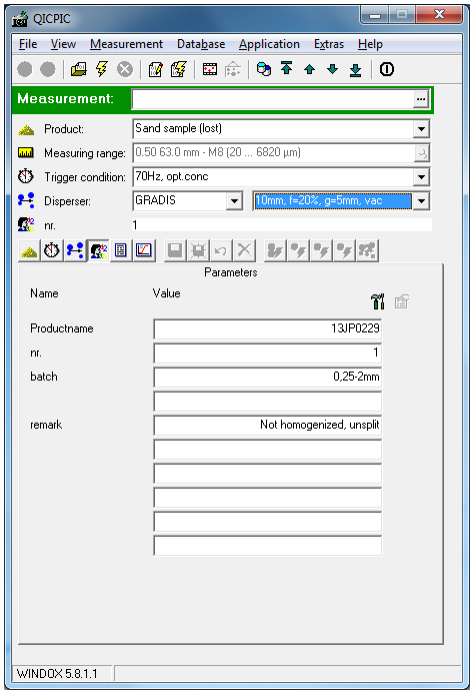
[17] User-defined calculation properties can be used, i.e., a personal filter criterion from the Particle Gallery.

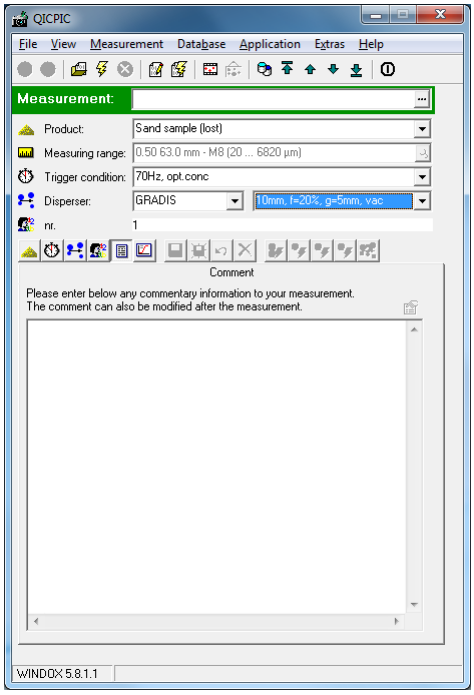

QICPIC
File View Measurement Database Application Extras Help
Measurement:
Product: Sand sample (lost)
Measuring range: 0.50 63.0 mm - M8 (20 ... 6820 µm)
Trigger condition: 70Hz, opt.conc
Disperser: GRADIS 10mm, f=20%, g=5mm, vac
P1
Trigger Condition
Measurement
Frame rate 70 Hz
Start 0.00 s after opt. concentr. ≥ 0.10 %
Valid always
Stop after 5.00 s opt. concentr. ≤ 0.10 %
or after 1000.00 s time. Trigger timeout: 100 s
Repeat measurement 0 times
WINDOX 5.8.1.1

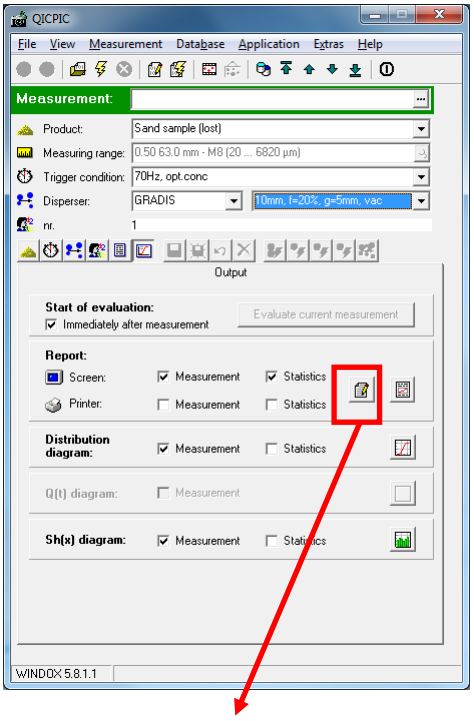

QICPIC
File View Measurement Database Application Extras Help
Measurement:
Product: Sand sample (lost)
Measuring range: 0.50 63.0 mm - M8 (20 ... 6820 µm)
Trigger condition: 70Hz, opt.conc
Disperser: GRADIS 10mm, f=20%, g=5mm, vac
P1
GRADIS Feeder Vacuum
Disperser
Drop height 50.00 cm
Outlet width 10.0 mm
WINDOX 5.8.1.1


QICPIC
File View Measurement Database Application Extras Help
Measurement:
Product: Sand sample (lost)
Measuring range: 0.50 63.0 mm - M8 (20 ... 6820 µm)
Trigger condition: 70Hz, opt.conc
Disperser: GRADIS 10mm, f=20%, g=5mm, vac
P1
GRADIS Feeder Vacuum
Feeder
Type VIBRI
VIBRI settings:
Feed rate 20 %
Gap width 5.0 mm
Cleaning time 3 s
Funnel rotation 0 %
Use VIBRI control:
Copt. nominal 1.00 %
Max. deviation from feed rate: 20 %
Integral factor 2.0
WINDOX 5.8.1.1

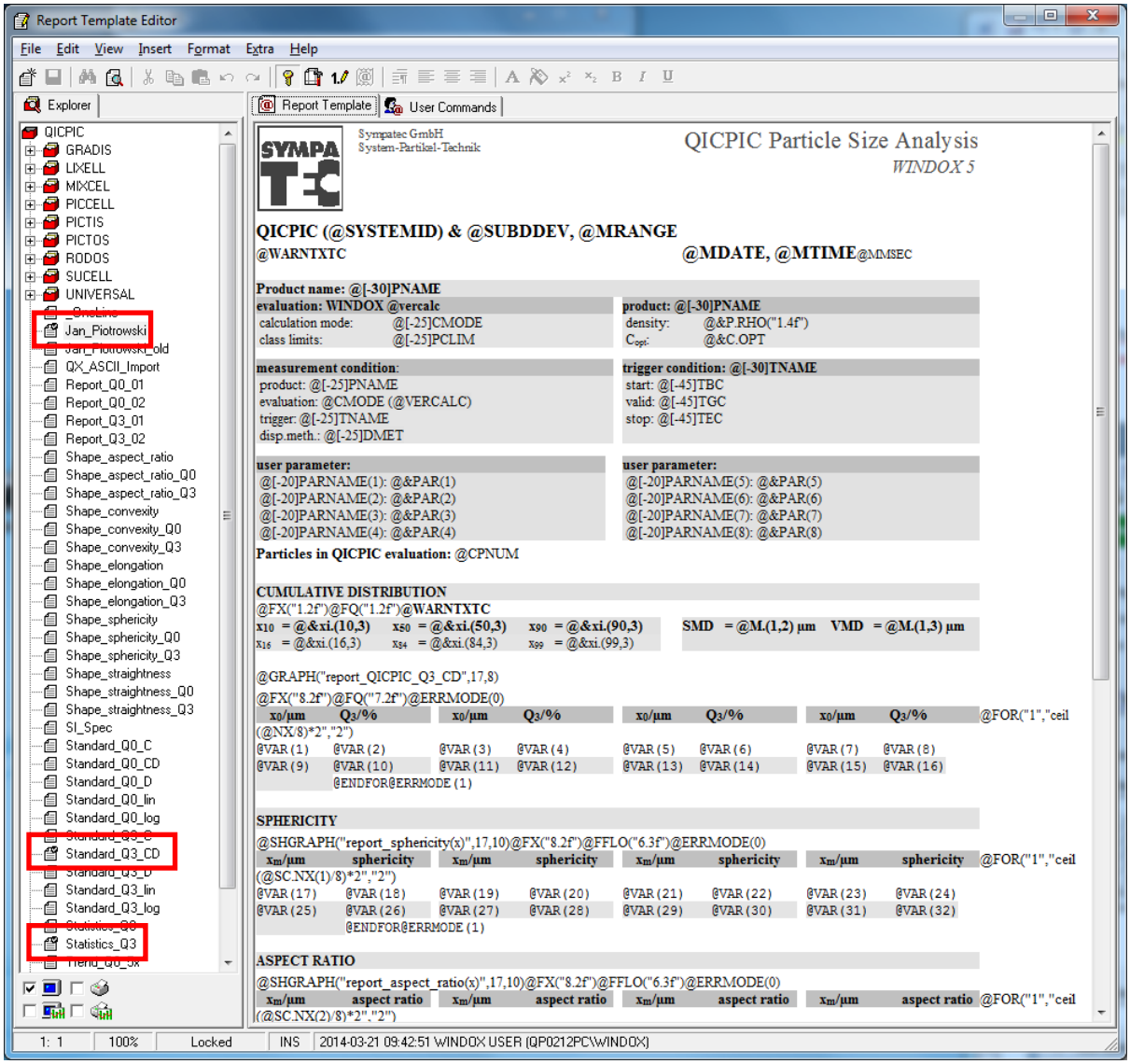

QICPIC
File View Measurement Database Application Extras Help
Measurement:
Product: Sand sample (lost)
Measuring range: 0.50 63.0 mm - M8 (20 ... 6820 µm)
Trigger condition: 70Hz, opt.conc
Disperser: GRADIS 10mm, f=20%, g=5mm, vac
P1
GRADIS Feeder Vacuum
Vacuum extraction
Type extraction without cleaning
Delay 5 s from start of extraction to start of measurement
WINDOX 5.8.1.1







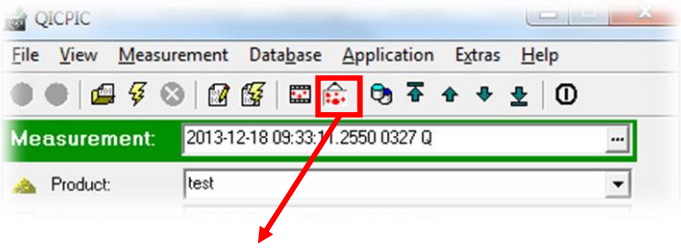
Check that the report output is as follows:



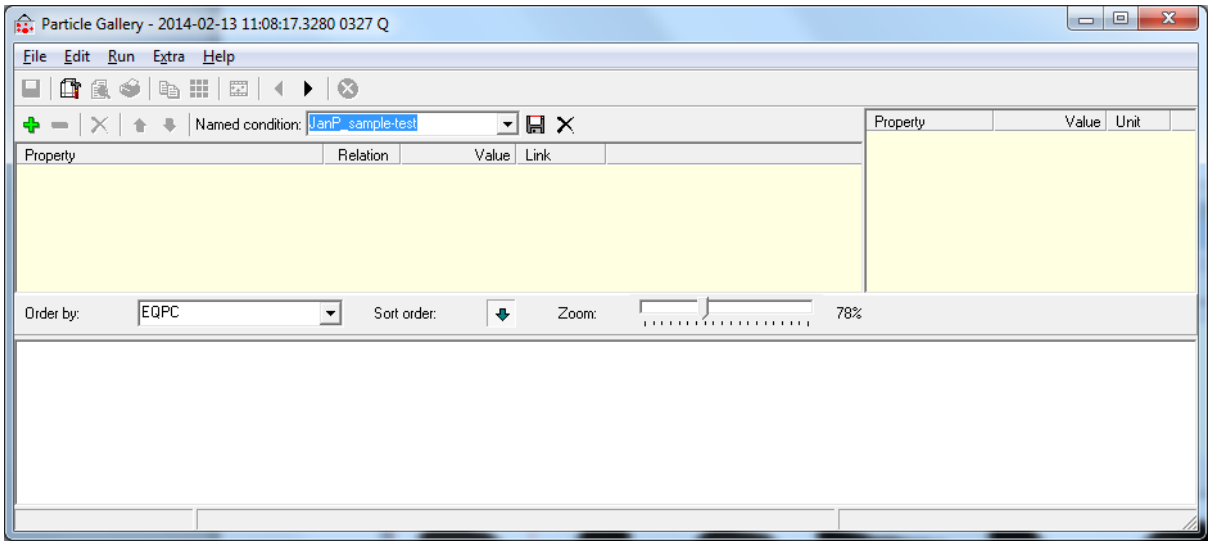
See the full list of command lines in the Jan_Piotrowski template in a separate pdf-file.

APPENDIX 2: RESULTS

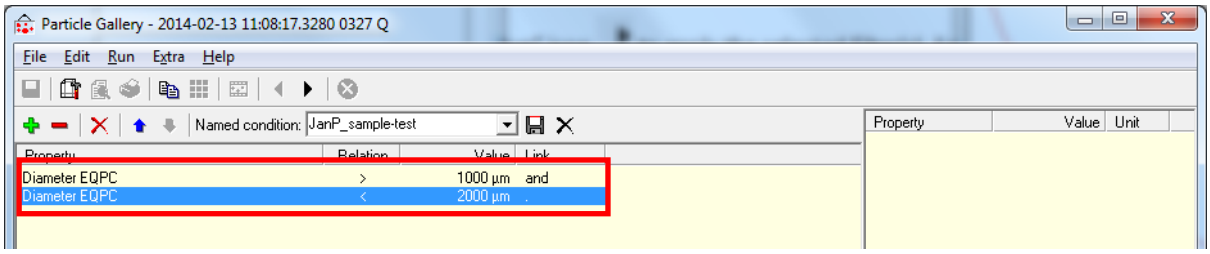
The report contains the cumulative size distribution as well as select shape parameters. When saving the report to the rtf (Raw Text Format) it allows the user to copy-paste data containing these parameters into Excel etc.



Select this icon to perform further image manipulations in the "Particle Gallery":

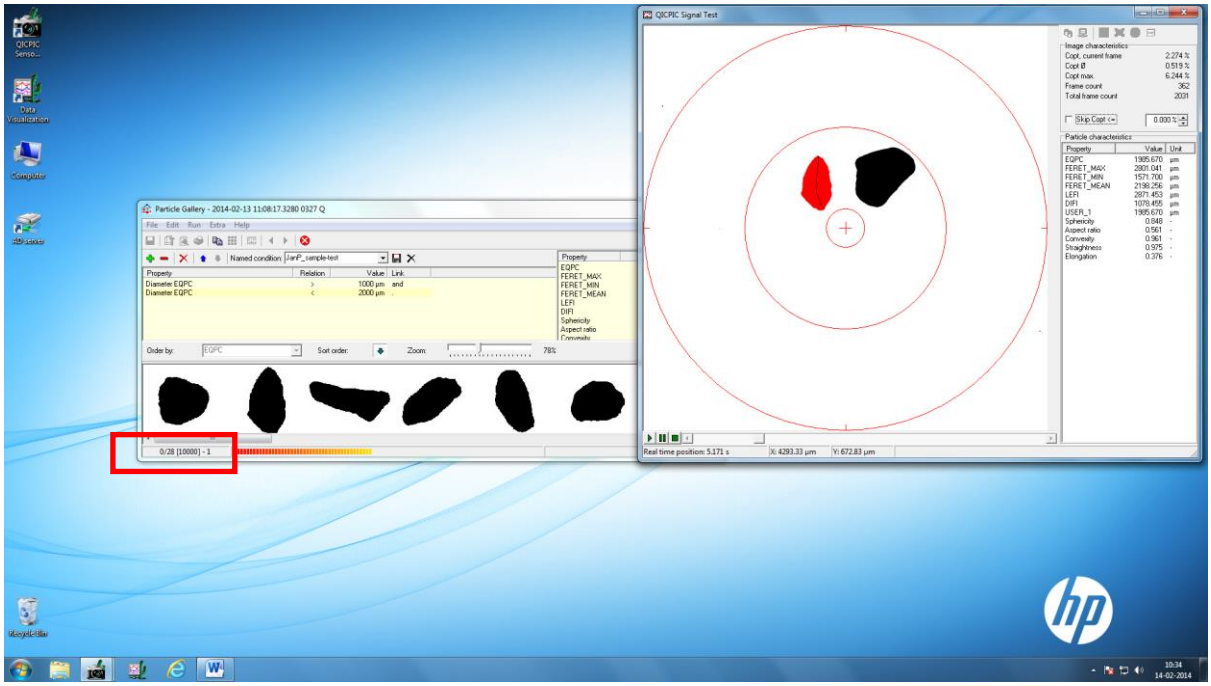


In this application all particles in a measurement can be sorted by applying different shape and size filters.

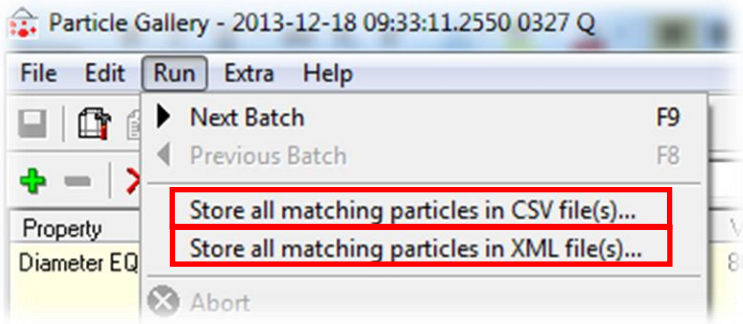


Select the "Run" icon to apply the selected filter(s). A set of particle images is produced. For easy comparison on other measurements later, the set of filter criteria can be saved (use the dropdown box "Named condition").

Note that the particle count of the batch is visible in the lower left corner of the window.



When clicking on one particle, the particle is highlighted in red[18] in the Signal Test window. There are several ways to save data from the Particle Gallery, either as CSV or XML files (go to the menu "Run" and select "Store all matching particles in [format]":

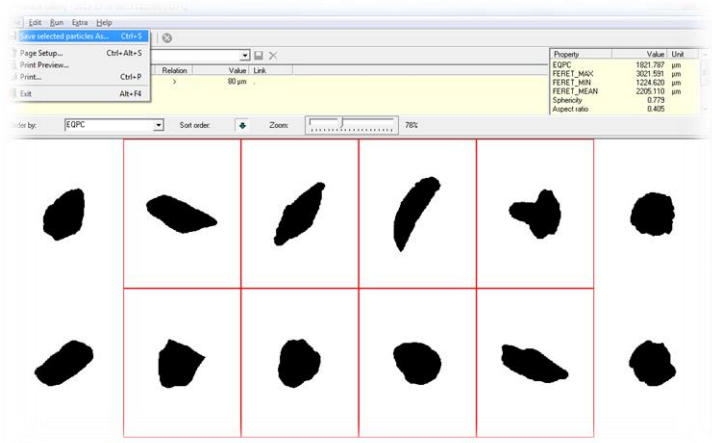


The CSV format is however not recommended by Sympatec[19]. Also, depending on the number of particles this export will produce several[20] files and not just a single output file.

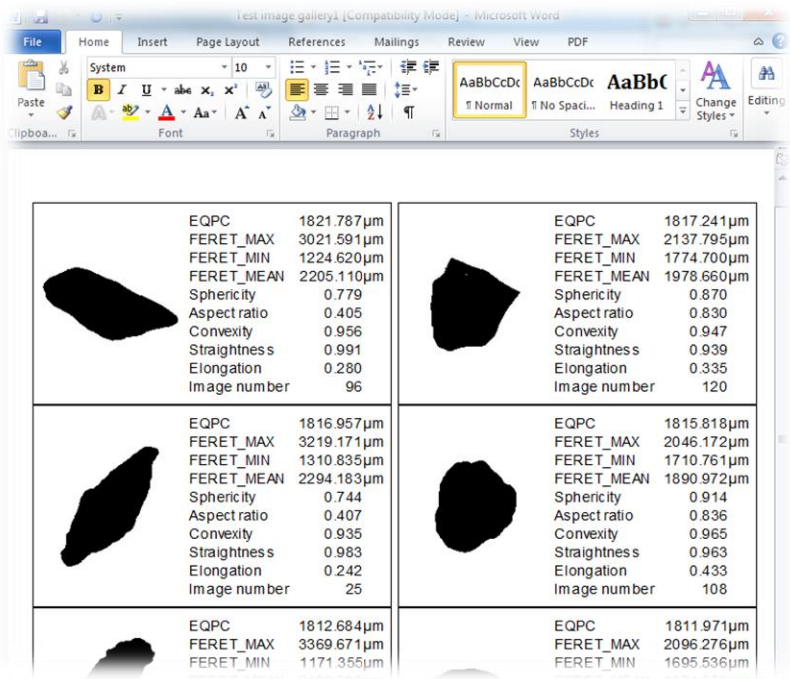
[18] The line crossing the particle is the LEFI.
[19] The output may be corrupted due to the use of national standards of punctuations.
[20] There is a limit of 10000 particles in the Particle Gallery, the maximum content of each output file is consequently limited to 10000 particles.

If exported to CSV, the file can be opened in Excel and the operation “text to cells” should be used. Hereby a single number is contained in each cell and data manipulation can be performed as needed. Otherwise, the Excel file will contain text lines.

A third option is to save a limited number of individual particles from the gallery: Select the necessary particles by clicking the first particle then hold down the CTRL key while clicking the next and so forth. The selected particles are highlighted with red lines. “Save selected particles as…” and choose the rtf-format and file destination.

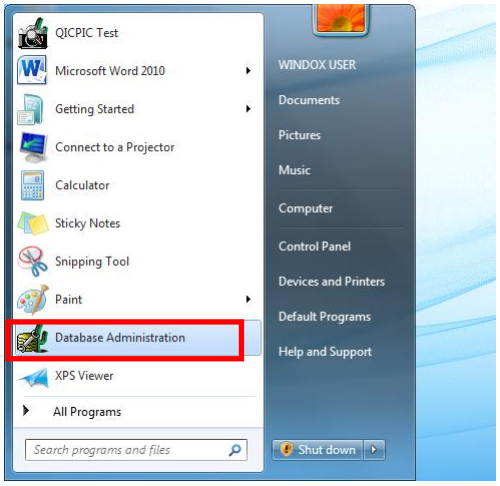


The rtf-file can be opened in Word and contains a graphical output and numerical size and shape information, as well as the exact image number where the particle was captured:



APPENDIX 3: DATABASE MAINTENANCE (technicians only!)

Open the "Database Administration" tool:



There are three types of databases used by the QICPIC software:

- *Measurement database:* Contains measured data and documentary information about all measurements. This database will change the most and it is very important to back it up regularly and perform maintenance of the file. The frequency of backups depends on the production of data. Currently a measurement database is used for 1 year only, from January 1 to December 31. When starting up in January a new database should be created for the coming year by a technician (see "how to create a new database" on the next page).
- *Presentation database:* Contains (user-defined) templates for reports and diagrams to present the results of the measurements.
- *Application database:* Contains WINDOX application programs that help with the automation of measurements. Every trigger condition, product and setting are stored here.

Backup procedures[21] should be carried out regularly, i.e., after larger projects and before and after software[22] updates. Backing up the databases is done either by creating copies of the 3 original FDB (database) files or alternatively by creating 3 archive-files with the FBK (archive) extension. After completing a backup procedure, a "maintenance" should be performed which deletes unnecessary space in the files.

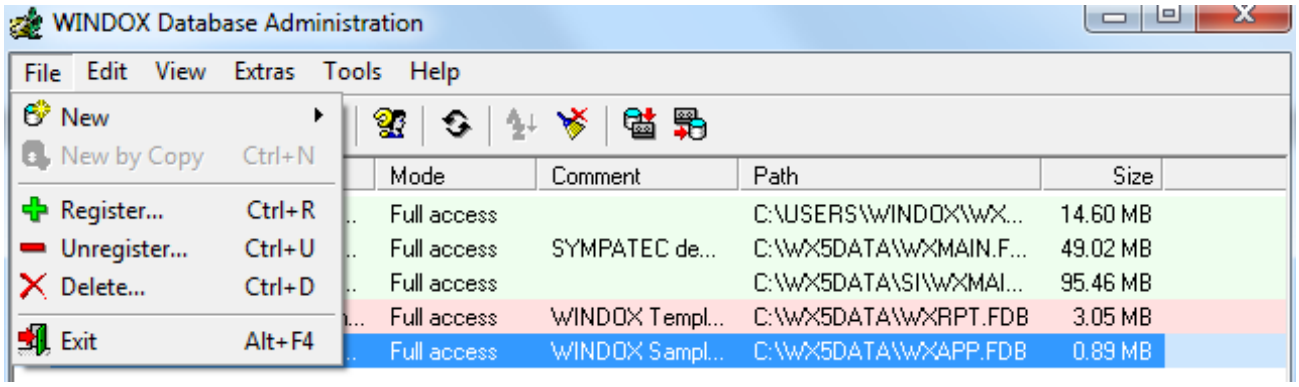
To save space in the measurement database, only preferred calculations properties for diameters and shape should be selected when performing a measurement. Until deletion of original image data in the database, it is possible to recalculate data at any time. Image data should be deleted at regular intervals; otherwise the database will grow uncontrollably. Even if image data is deleted, the size/shape info of a particular measurement is kept but the data cannot be re-calculated. Every

[21] The procedure is described on page 395 in the large Sympatec binder (version 5, 9-0-2).
[22] The latter requires logging into the Windows user "Administrator" on the PC. To complete the software upgrade the measurement database may have to be converted in the Database Administration module.

“product”, “trigger condition” or “dispersing system” setting may be deleted in the database[23], if it is not used in a stored measurement.

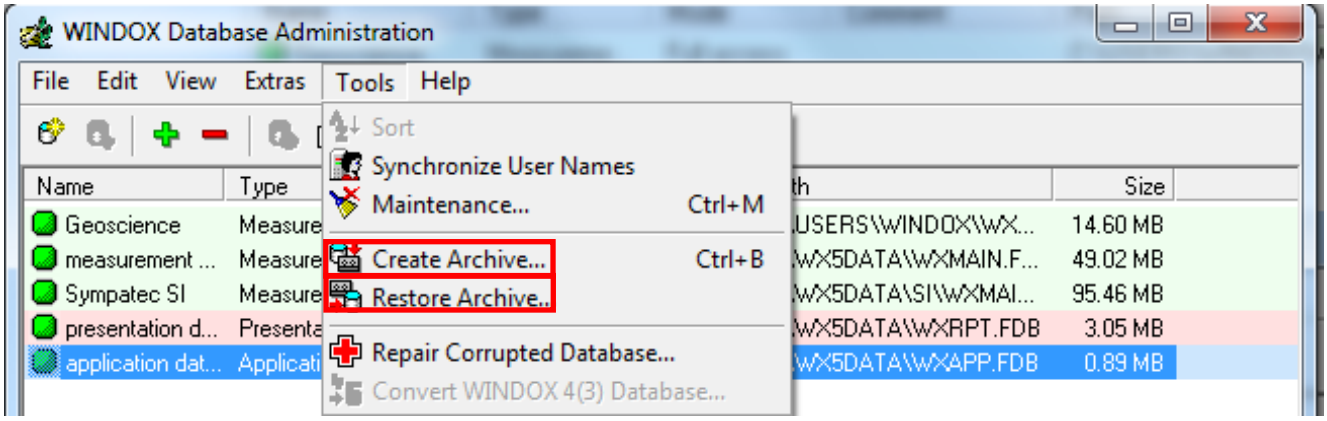
To avoid complications and corrupted files, it is not recommended to copy a FDB database-file directly. If you want to copy a file, the FDB database must be unregistered first and afterwards re-registered in the Windox Database Administration module.

To register or unregister a database, go to the “File” menu:



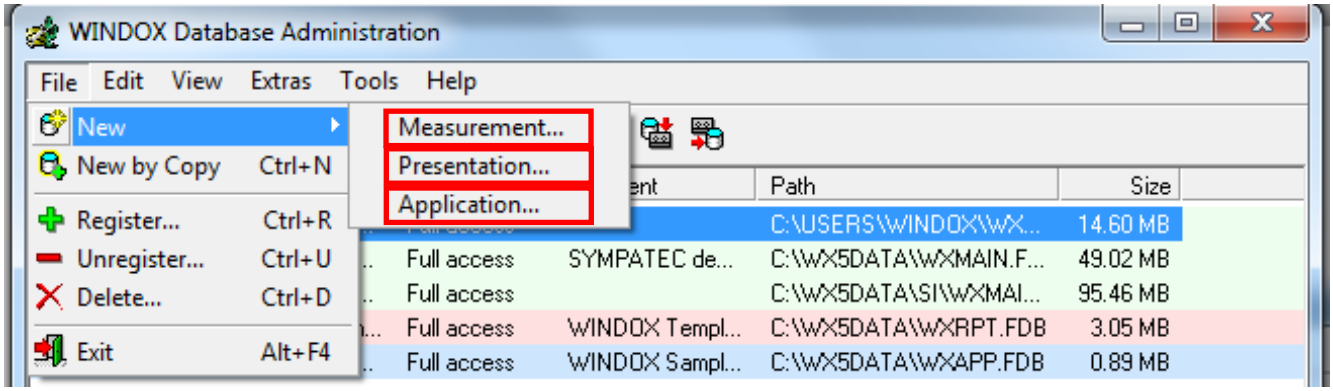
To copy a database-file, exit the Windox Database Administration module and open the folder[24] containing the file to be able to copy the file to a different location. Return to the Administration module to re-register the database afterwards. This procedure is carried out for all 3 types of databases.

To create or restore an archive file of a database, go to the “Tools” menu:



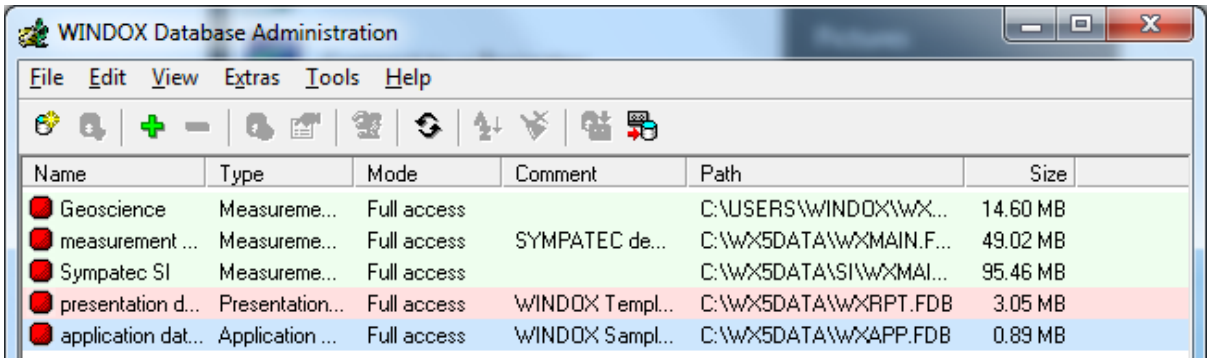
To create a new database (Measurement, Presentation or Application database), go to the File menu and select “New”:

[23] The procedure is described on page 400 in the large Sympatec binder (version 5, 9-0-2).
[24] Usually C:\WX5DATA\

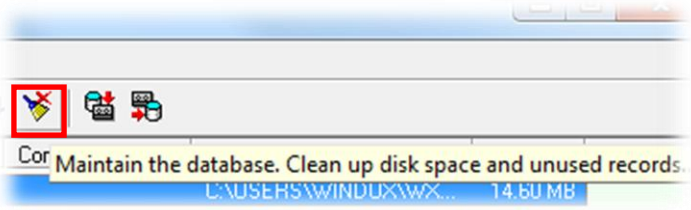


"New by copy" will create a database file based on already selected shape parameters. For instance, when creating a new Measurement database yearly this option is used, since all the basic settings and shape configurations are included by default.

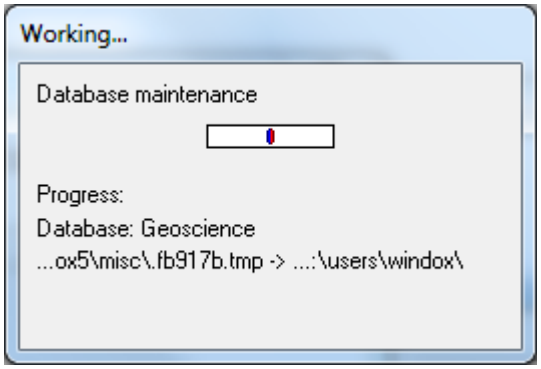
Maintenance of existing databases: When maintenance of a database is required, the system will warn you by flagging a red bullet at the database name:



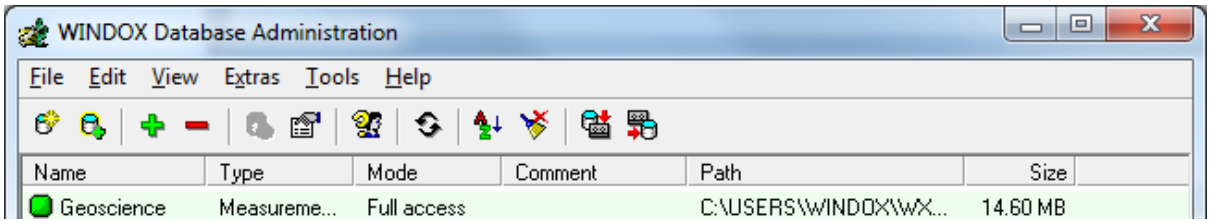
To run the maintenance wizard, select the maintenance icon:



The maintenance wizard initiates. Click "start" and a progress window will open briefly:



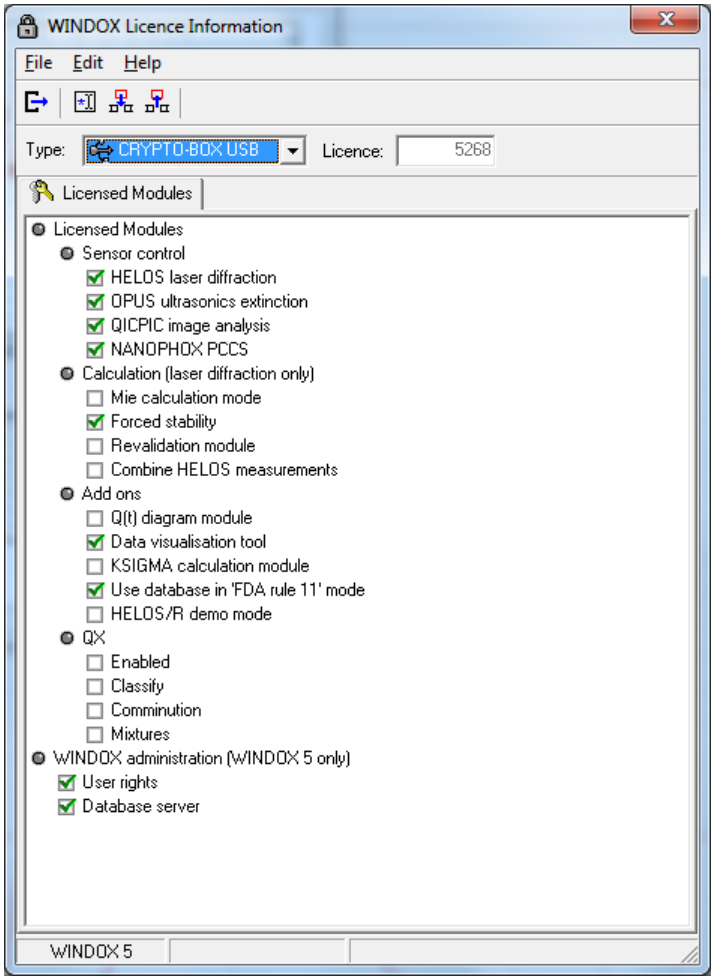
Wait until the process completes: The application will prompt you to click “finish”. The freshly maintained database will now be flagged with a green bullet:



Maintenance of the measurement database is required every 50 days, depending on the production of raw data.

APPENDIX 4: LICENSE INFORMATION AND LOCAL SETTINGS STORAGE

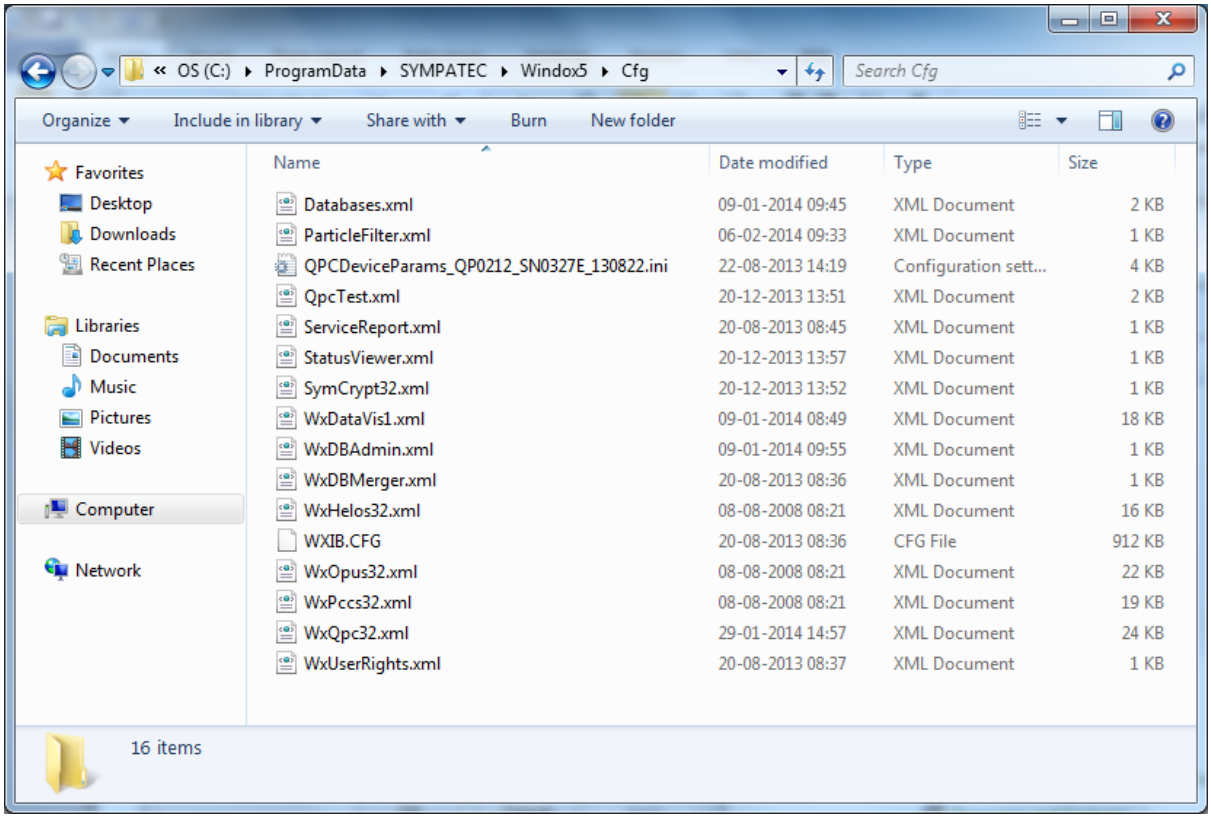
From the initial installation (November 2013) the license file contains the following information:



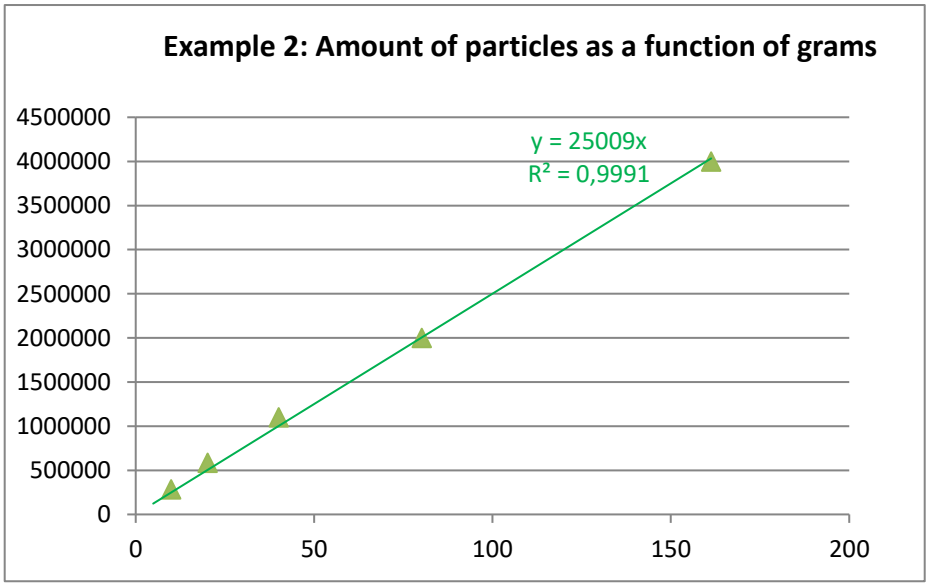
Local settings are stored in the directory C:\ProgramData\SYMPATEC\Windox5\Cfg

This folder contains configuration files of the QICPIC module (i.e. position of program windows, output settings etc.):

- The .cfg and .ini files are general configuration files associated with WINDOX modules.
- The .wxh files contain local settings for the HELOS “Sensor control” program.
- The .wxq files contain local settings for the QICPIC “Sensor control” program.


« OS (C:) ▸ ProgramData ▸ SYMPATEC ▸ Windox5 ▸ Cfg
Search Cfg
Organize
Include in library
Share with
Burn
New folder
Favorites
Desktop
Downloads
Recent Places
Libraries
Documents
Music
Pictures
Videos
Computer
Network
Name
Date modified
Type
Size
Databases.xml 09-01-2014 09:45 XML Document 2 KB
ParticleFilter.xml 06-02-2014 09:33 XML Document 1 KB
QPCDeviceParams_QP0212_SN0327E_130822.ini 22-08-2013 14:19 Configuration sett... 4 KB
QpcTest.xml 20-12-2013 13:51 XML Document 2 KB
ServiceReport.xml 20-08-2013 08:45 XML Document 1 KB
StatusViewer.xml 20-12-2013 13:57 XML Document 1 KB
SymCrypt32.xml 20-12-2013 13:52 XML Document 1 KB
WxDataVis1.xml 09-01-2014 08:49 XML Document 18 KB
WxDBAdmin.xml 09-01-2014 09:55 XML Document 1 KB
WxDBMerger.xml 20-08-2013 08:36 XML Document 1 KB
WxHelos32.xml 08-08-2008 08:21 XML Document 16 KB
WXIB.CFG 20-08-2013 08:36 CFG File 912 KB
WxOpus32.xml 08-08-2008 08:21 XML Document 22 KB
WxPccs32.xml 08-08-2008 08:21 XML Document 19 KB
WxQpc32.xml 29-01-2014 14:57 XML Document 24 KB
WxUserRights.xml 20-08-2013 08:37 XML Document 1 KB
16 items

APPENDIX 5: RELATIONSHIP BETWEEN SAMPLE AMOUNT AND NUMBER OF PARTICLES

Sample load, example 1	*0,063-2mm pre-sieved material*	
Tablespoon	C_{opt}%	Approximate number of measured particles
1	0.6	700,000
3	2	2,500,000
5	2.8	3,000,000
7	3	3,600,000

Sample load, example 2	*0,063-2mm pre-sieved material*	
gram	C_{opt}%	Approximate number of measured particles
161.3	4.2	4,000,000
80.2	2.6	2,000,000
40.1	1.4	1,100,000
20.1	0.9	585,000
9.9	0.6	285,000