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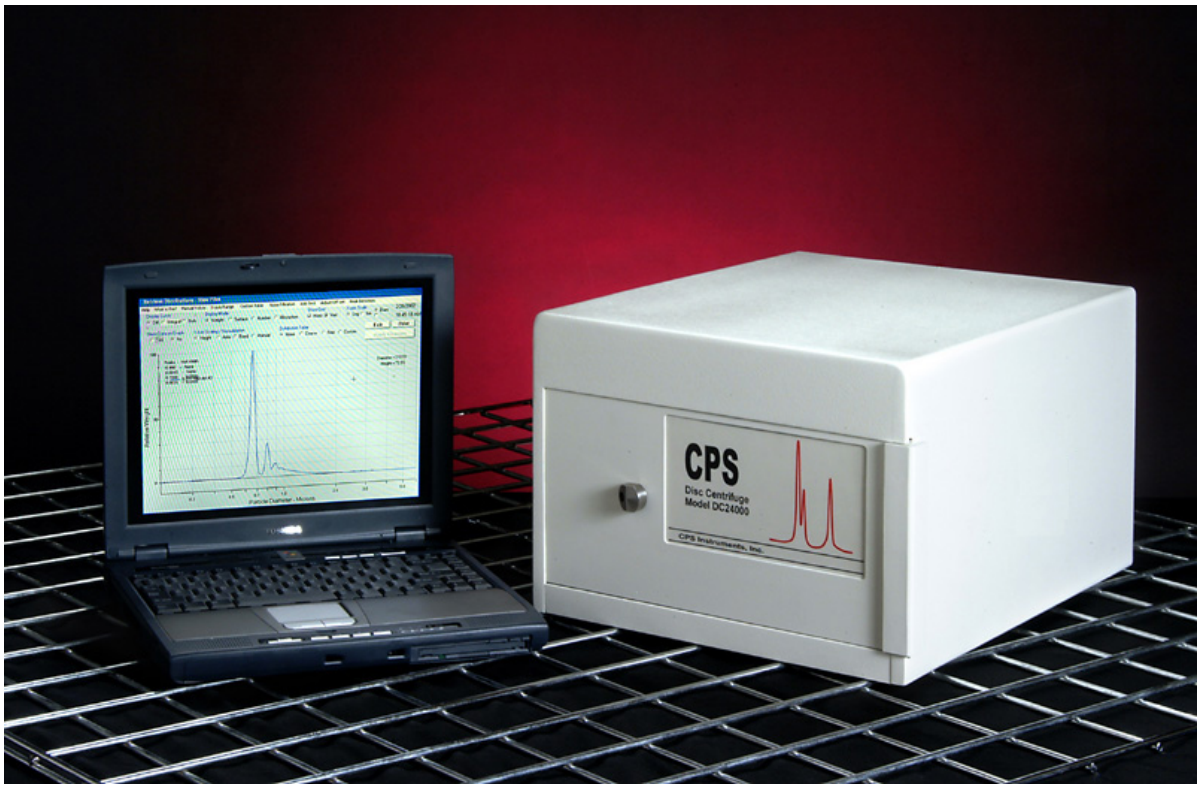
CPS Disc Centrifuge™

Nano Particle Size Analysis



HOW DO YOU KNOW THE SIZES OF YOUR PARTICLES ARE CORRECT?

Get Accurate and Reliable results with CPS Particle Size Analysers.
From 5 nm up to 75 μm!

In contrast with other particle size techniques, like laser diffraction, the CPS Disc Centrifuge is the only instrument which measures the sizes of your particles under 100 nm or even < 10 nm.

Applications

The CPS Disc Centrifuge is an excellent tool for particle size analysis of virtually any material between 5 nm and 75 µm. It can be used in a very wide range of particle sizing applications:

Chemical:

- **Polymer latexes and emulsions**
- **Fillers ($CaCO_3$, clay, barites, etc.)**
- **Ceramic oxides (SiO2, TiO2, ZrO2, ZnO2, etc.)**
- **Abrasives (of all types)**
- **Impact modifier particles**
- **O/W and W/O emulsions**

Pharmaceutical & Biological:

- **Virus particles/virus-like particles**
- **Cells (culture) and cell fragments**
- **Protein clusters**
- **Liposomes**
- **Particles in diagnostic tests**
- **Micro-encapsulated drugs**

Semiconductor:

- **Nano-abrasives of all types**
- **CMP abrasives for semiconductors**

Printing and painting:

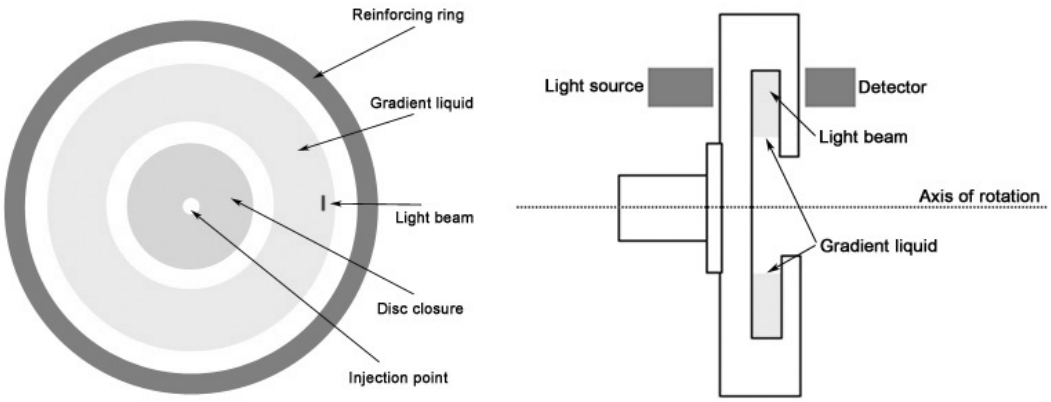
- **Pigments - water and oil based**
- **Micro-fiber paint viscosity modifiers**
- **Printer/copier toner powders**
- **Inkjet inks**
- **Carbon black**
- **Magnetic iron oxide**

Others:

- **Micro-spheres**
- **Agglomeration patterns**
- **Starch/flour particles**
- **Oil emulsions (food, cosmetic)**
- **Many others!**

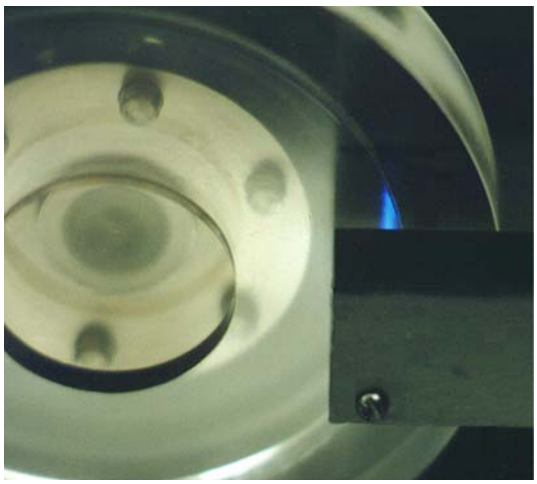
Differential Sedimentation Method

The CPS Disc Centrifuge measures particle size distributions using sedimentation, a well known and reliable method of particle size analysis. Particles settle in a fluid under a gravitational field according to Stokes' Law. Sedimentation velocity increases as the square of the particle diameter, so particles that differ in size by only a few percent settle at significantly different rates.

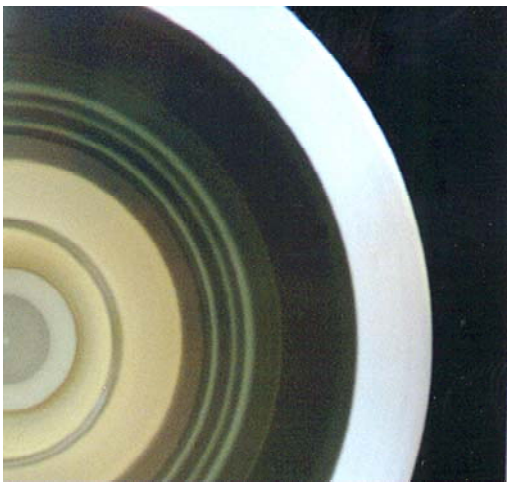


Hollow Disc Centrifuge Design

In differential sedimentation, all the particles in a sample begin sedimentation as a thin band. If all the particles are of the same size, they settle at the same speed and arrive at a detector beam as a thin band. The time needed to reach the detector is used to calculate the size of the particles. A broad distribution of sizes separates during sedimentation into a broad band, while a mixture of narrow sizes separates into separate and distinct narrow bands, each of which arrives at the detector at a different time.



Close up of Disc and Light Source



Three Bands of Particles During Sedimentation

Particles between **>**0.005µ and <75µ can be measured. The actual size range that can be measured depends on the difference in density between the particles being measured and the density of the fluid in which the analysis is run.

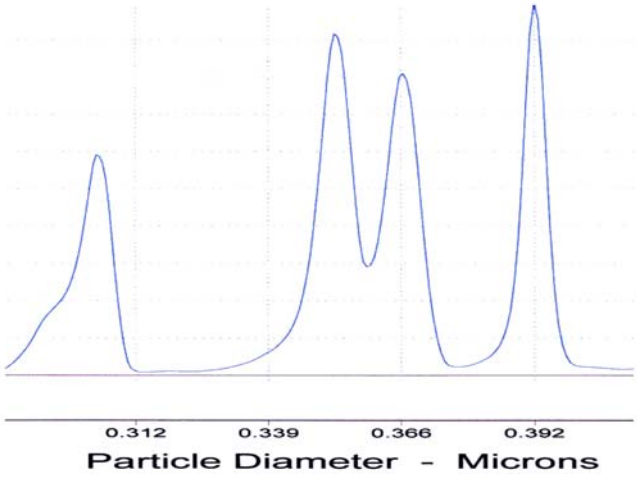
The CPS Disc Centrifuge can routinely separate particles that differ in size by less than 5%, and separation of particles that differ by as little as 2% is possible. This resolution is much higher than available from other particle sizing techniques.

Performance of the CPS Disc Centrifuge

CPS Disc Centrifuge particle size analysers provide high resolution, accurate results, even with very non-ideal samples that completely mislead other particle sizing methods.

Resolution

The size distribution graph shows typical resolving power of the CPS Disc Centrifuge. This distribution is from a mixture of narrow polystyrene calibration standards. The 0.366µm and 0.343µm peaks differ in size by only 6.5%, yet they are almost completely resolved. Most of the width of these peaks is real, not from the instrument. Very narrow peaks that differ by as little as 3% can be completely separated, while narrow peaks that differ by as little as 2% can be partly separated. No other particle sizing instrument can match this performance in resolution.



Accuracy and Precision

All analyses are run against a known calibration standard, so high accuracy is assured. Calibration can be either external (calibration standard injected before the unknown), or internal (calibration standard mixed with the unknown). Typical precision of reported sizes with an external standard is about ± 0.5% (95% confidence), and better than ± 0.25% with an internal standard. Replicate runs of the same sample produce virtually duplicate results in all cases.

Sensitivity

Even at 10^{-6} gram active sample weight, the CPS Disc Centrifuge reports an accurate particle size distribution. The lower detection limit for narrow samples is *well below* 10^{-8} *gram*, so even trace quantities of many kinds of particles can be detected. This high sensitivity allows accurate analysis of microgram samples on a routine basis.

Dynamic Range

Dynamic size range is the ratio of largest to smallest sizes that can be measured in one analysis. The CPS Disc Centrifuge has a practical dynamic range of up to 60 using a fixed centrifuge speed, and up to ~1000 using centrifuge speed ramping. The broad dynamic size range with speed ramping allows ultra high resolution analysis of very broad size range samples, which in the past could only be measured at lower resolution using light scattering methods.

Fast, High Resolution A/D

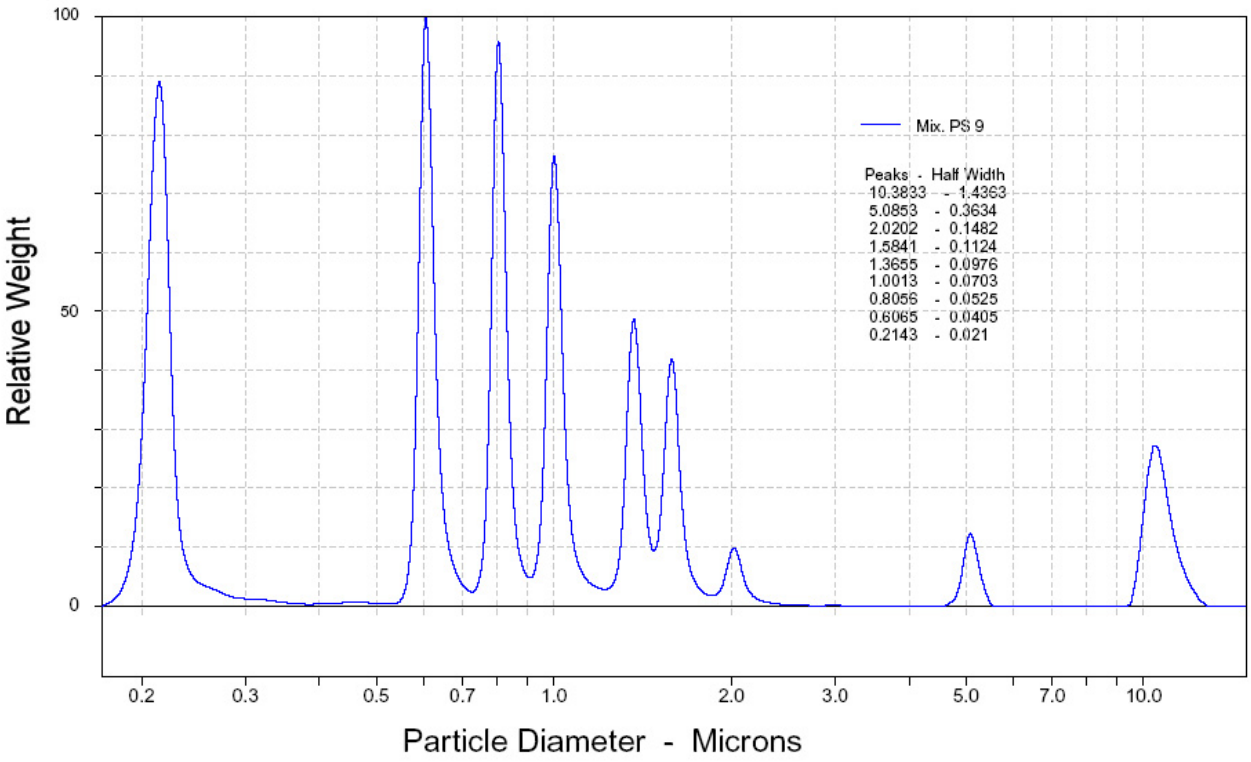
The usable signal resolution (what the software works with) is only as good as the analog to digital (A/D) conversion process. The A/D conversion in the CPS Disc Centrifuge is better than *20 bits at 31 readings per second*; a conversion error of less than ±1 part in 10^6.

Rapid Detector Response

The detector and electronics in the CPS Disc Centrifuge operate with an effective response time (to 95% accuracy) of ~0.1 second, while competitive sedimentation instruments have a response time of ~1 to 4 seconds. Rapidly moving peaks, which pass the detector beam during a period of only 1 to 2 seconds, are accurately recorded by the CPS Disc Centrifuge. The ability to accurately record rapidly moving peaks expands dynamic range by allowing higher centrifuge speed, and yields 4+ times faster analyses than competitive centrifuge instruments over the same range of sizes.

Conclusion

No other particle size analyser (using any analysis method) matches the performance of the CPS Disc Centrifuge. Clean separation of narrow peaks that differ by <3% is routine. The particle size distribution is shown more clearly than by any other instrument.



Compare Particle Sizing Instruments

Why does the CPS Disc Centrifuge give the best size distribution results? The best technology! The leading differential sedimentation technology.

Centrifuge Speed

The CPS Disc Centrifuge operates at up to 24,000 RPM. Analyses of very small particles are three times faster than competitive disc centrifuges. Analyses of samples with very wide size ranges can be completed rapidly through the use of centrifuge speed ramping. Many analyses that are impractically long (several hours or more) on competitive sedimentation instruments can be completed rapidly using the CPS Disc Centrifuge.

High Accuracy Calibration

The CPS Disc Centrifuge is always calibrated against known particle size standards. United States NIST traceable standards (or other internationally recognized size standards) insure that reported size distributions are both consistent and accurate. You can add a trace of calibration standard to an unknown so that analyses are *internally calibrated*. Internal calibration yields typical accuracies of better than ±0.25% for reported peak sizes.

Measure Low Density Particles

Differential sedimentation has historically been limited to particles more dense than the fluid in which they are suspended. CPS has developed a new differential technique (US Patent 5,786,898), where the sample is delivered to the *bottom* of the centrifuge chamber, rather than to the fluid surface. This method allows particles that are lower in density than the fluid to float toward the fluid surface. Even neutrally buoyant particles in water (density ~1.0 g/ml) can be measured by conducting the analysis in deuterium oxide (density 1.108 g/ml) instead of water. Many materials (like oil emulsions, wax emulsions, adhesive latexes, and liposomes) that were difficult or impossible to measure by differential sedimentation can now be measured easily and with very high resolution.

Speed Ramping

CPS has developed a special disc design that allows the centrifuge speed to be changed during an analysis, without creating turbulence in the sedimentation fluid. The centrifuge speed can be ramped up and down over a 20+ fold range of speeds without disruption of the fluid. A 20 fold range of speeds in a single analysis expands the dynamic range for the analysis by almost a factor of 20. Other disc centrifuges are limited to a dynamic range of ~40, but the CPS Disc Centrifuge has a dynamic range of *more than 1000*. Many kinds of samples that in the past could only be measured by light scattering methods at low resolution can now be measured by differential sedimentation, at much higher resolution.

Low Noise Light Source/Detector

The light source and electronics in the CPS Disc Centrifuge are carefully designed to minimize noise in the signal. Typical signal to noise ratio is in the range of ~50,000. Low noise in the signal gives very high sensitivity: *the detectable weight for a narrow peak is usually less than 10^{-8} gram*. High resolution analysis of a few micrograms (active) weight is routine.

The table below shows how the CPS Disc Centrifuge compares in some important characteristics with other particle sizing instruments. In cases where more than one competitive instrument of the same basic type is available, typical values are used.

Sizing Method	Resolution[1]	Medium	Total Range[2]	Dynamic Range[3]	Analysis Time[4]	Accuracy	Price[5]
Electrozone Particle Counter	15-20%	Water	500µ - 0.5µ	~ 30	~ 3 minutes	±2.5%	1.5
Low Angle Laser Light Scattering	15-20%	Most Liquids	2,000µ - 0.1µ	~ 20,000	3 - 10 minutes	±0.5%	1.8
Photon Correlation Spectroscopy	~ 70%	Most Liquids	~ 4µ - 0.004µ	~ 1,000	3 minutes	±1%	1.3
Capillary Hydrodynamic Chromatography	~ 15%[6]	Water[7]	1.1µ - 0.015µ	~ 73	~ 10 minutes	±1%	1.6
Optical Particle Counter	~ 20%	Most Liquids	2,500µ - 0.5µ	~ 200	3 - 5 minutes	±2%	1.3
Competitive Disc Centrifuge	~ 5%	Many Liquids	40µ - 0.03µ	~ 40	9 - 300 minutes[8]	±1%	1.2
CPS Disc Centrifuge	**~ 2%**	**Most Liquids**	**75µ - 0.005µ**	**~ 1,000[9]**	**3 - 40 minutes[10]**	**±0.25%[11]**	**1**

Notes:

1. Resolution is the minimum difference in size between two perfectly narrow peaks that allows 95% separation.
2. Total range is from the largest practical size to the smallest practical size.
3. Dynamic range is the ratio of largest to smallest sizes in a single analysis.
4. Analysis time is total time, sample to sample.
5. Relative purchase price.
6. 15% resolution only after applying mathematical de-convolution; physical resolution is ~ 40%.
7. Only operates using a proprietary mixture of surfactants in water; solution must be purchased.
8. Maximum dynamic range for a 10 minute analysis is ~ 15.
9. With disc speed ramping; dynamic range is ~ 70 for fixed speed.
10. Maximum dynamic range for a 10 minute analysis is ~ 150.
11. ±0.5% accuracy with external calibration.

The CPS Disc Centrifuge offers an exceptional combination of resolution, operating range, and measurement accuracy, at a far lower price than competitive instruments.

Designed for Reliability

- The CPS Disc Centrifuge is designed for long life without maintenance. The instrument has only a few moving parts: the drive motor, the disc, the cooling fan, and the door safety lock.

- The system is mechanically robust and durable. The permanently lubricated, precision bearings have a projected lifetime of 10,000 hours; that's 3.5 years of operation 8 hours per day at maximum speed. If the centrifuge is used at less than maximum speed, the bearing lifetime will be much longer.

- All electronic components operate at 10% to 80% of their rated capacity, to insure extra long life.

- There is absolutely no scheduled maintenance, except to clean the disc chamber after use (normally with soap and water).

- The CPS Disc Centrifuge comes with a 1 year free replacement warranty on *any part* that fails in normal use.

24,000 RPM, Solvent Resistant Disc - Reinforced with High Strength Alloy

Some of our European references are: Agfa, Bayer, Clariant, Crucell, Fuji, GlaxoSmithKline, Jotun, Kodak, Microdiamant, Millennium Chemicals, OCÉ, Osram, Philips, Rohm and Haas, Siegwerk, Solvin and Xeikon.

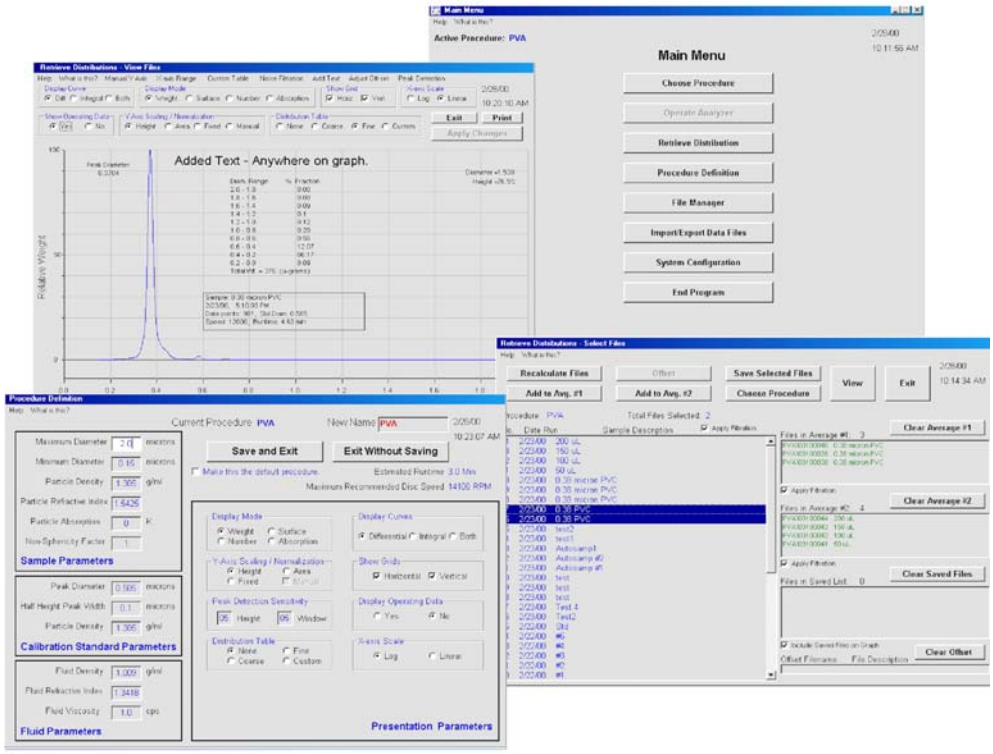
Software

Operating software for the CPS Disc Centrifuge is completely graphical (Windows native), and is easy to learn and to use. The software handles all data collection and analysis, and has the following capabilities, plus many more:

- Background data collection
- Publication quality graphs; full page or half page, on any available printer
- Weight, surface, number, and absorption distributions
- Log or linear scaling
- Graphical overlays of up to 20 distributions
- Create averages of multiple distributions
- Overlay of two or more averages
- Overlay average and individual distributions
- Notations can be added to graphs before printing, 8 point to 24 point letters
- Custom distribution summary tables
- Complete distribution statistics
- Password protected file manager utilities
- On-screen centrifuge speed control
- Import and export of distributions
- Adjustable data functions, including noise filtration and resolution enhancement.

When there is a software function you need that is not available, CPS can usually customize the operating software to meet your needs (software development charges may apply). The software also controls the CPS Autosampler, which allows completely unattended instrument operation, with automatic injection of up to 20 samples and calibration standards.

The screen images below show a few examples of the operating software. The software operates under MS Windows 95, 98, NT, ME, 2000 or XP.



System Configuration

Basic Systems

- Model DC18000 - 18,000 RPM Maximum Speed
- Model DC20000 - 20,000 RPM Maximum Speed
- Model DC24000 - 24,000 RPM Maximum Speed
- Two Calibration Standards
- Operating Software and User Manual
- Starter set of sedimentation fluids and sample preparation fluids

Disc Options[1]

- Solvent Resistant Disc
- Disc for Low Density Particles
- Disc for Speed Ramping

Other Options

- Computer System
- Automatic Density Gradient Builder
- Automatic Sample Injector
- Color Printer

Dimensions Disc Centrifuge:

- 36cm (W) * 26cm (H) * 45cm (D)

Weight Disc Centrifuge:

- 38.5 kilograms

Note:

1. All disc options may be combined in a single disc if desired.

For More Information

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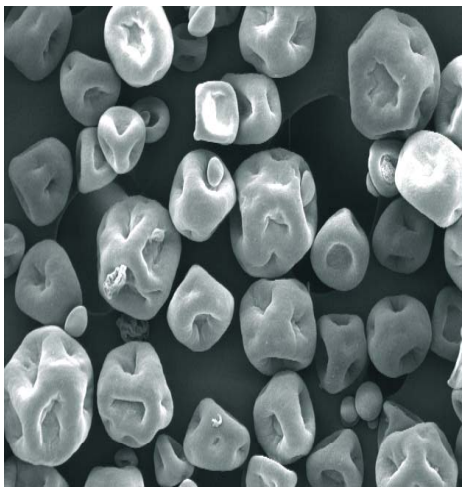
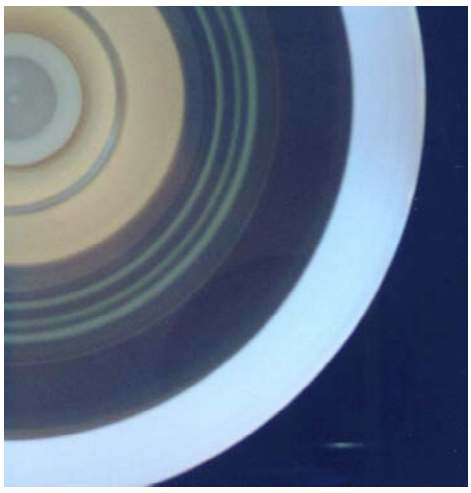
Your local distributor:

ARE YOUR PARTICLE SIZE RESULTS REAL?





Get realistic results with CPS Particle Size Analysers