EOS — Effective Optical Systems

analytik

A SPES ahead in particle analysis

CLASSIZER™ ONE
powered by SPES

CLASSIFICATION, ANALYSIS, and COUNTING of PARTICLE MIXTURES in biological, industrial, and environmental liquids

powered by patented SINGLE PARTICLE EXTINCTION & SCATTERING SPES TECHNOLOGY

CLASSIZER™ ONE
MULTIPARAMETRIC SINGLE PARTICLE ANALYSER

- Formulation **QbD** & **SbD**
- **Heterogeneous** Samples
- **Complex-But-Real Particles**

- Classify particle mixtures
- Formulation **behaviour**
- In target complex liquids

- **Continuos Flow Analysis**
- Process QC/**PCA**
- **Impurities** Identification

About EOS

"If you cannot measure it, you cannot improve it"
*Lord Kelvin 1824 – 1907*

EOS S.r.l. (Effective Optical Systems) has been founded in 2014 in Milano (Italy). Since the beginning, EOS develops and offers **novel scientific devices and technological solutions for the analysis, design, and formulation of particles in biological, industrial, and environmental heterogeneous fluids.**

EOS patented solutions are the game-changers for improving R&D, formulation, and process quality control of products based on particles and particle mixes in markets as **delivery systems, cosmetics, pigments, inks, specialty chemicals, abrasives, beverages, and life and environmental sciences**.

The legal and business headquarters of EOS are located in Milano, Italy (EOS S.r.l. – Viale Ortles 22/4 – I-20139 Milano – Italy)

S P E S

SPES (Single Particle Extinction and Scattering) is a patented light scattering technology highly suitable for the **classification and characterisation of mixtures of particles and complex samples**. Exploiting the unique optical properties of each particle measured, SPES classifies, analyses, and counts the particle populations in a heterogeneous fluids.

SPES SIMPLIFIED LAYOUT
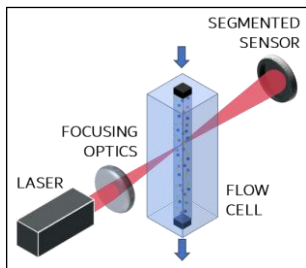
How CLASSIZER^TM ONE / SPES works. A sample is dispersed and diluted in a liquid, which is flowed through a scattering cell where a laser beam is properly shaped and focused. **As a single particle crosses the laser beam, the interference pattern between the transmitted beam and the forward scattered light is recorded on a sensor.** The interference pattern presents fringes **delivering the unique optical properties of the single particle illuminated**.

SPES FRINGES

Extinction Cross Section C_{ext} and **Polarizability** α^* are thus retrieved **for each single detected, validated, and counted particle** thanks to a robust **Pulse Shape Analysis** scheme and **proprietary algorithms.** Tens of thousands of particles are measured & classified based on optical properties in few minutes. Artifact signals are rejected increasing data robustness.

EOS CLOUDS

Select single PTC population
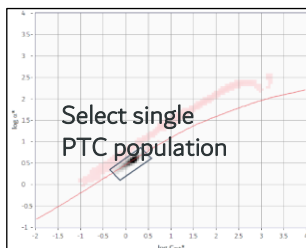
CLASSIZER $_{TM}$ONE creates the unique **EOS CLOUDS** histogram which is the optical fingerprint of the sample. **Mixes of optically different particles produce simultaneously different clouds for each particle population, which can be individually selected, analysed, and compared**. Particle size distribution, numerical concentration, and other insights are retrieved accordingly to selections, to whole sample, or for a time frame of the acquisition.

Added-value information is provided thanks to **SPES** and **EOS** unique data libraries:

PTC SIZE DISTRIBUTIONS
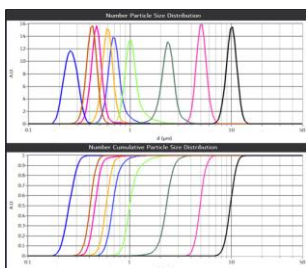
Optical Classification, Absolute **Particle Size Distribution,** and **Numerical Concentration** of each single particle populations irrespectively of polydispersity and particle mixtures.

Quality Control of optical **particle structures** as porosity, wetting, aspect ratio, payload, impurities, and shelf-life **without intermediate steps** (e.g., purification/filtration).

Measurement of the **particle behavior and the particle formulation stability directly** in **heterogeneous non-filtered target biological, industrial, or environmental fluids**.

STATISTICAL ANALYSES
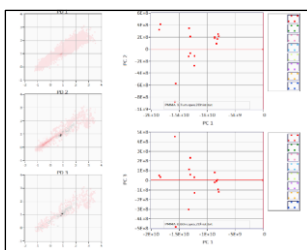
Hi-Resolution **Continuous Flow Analysis** of particles, ready to couple to other analytical devices and systems, as cFFF separators, small chemical reactors, and pilot lines.

Statistical approaches as **Oversize Measure** and **PCA** for Hi-Quality Batch-2-Batch analysis and out-of-specifics identifications in product formulation and production.

CLASSIZER™ ONE

CLASSIZER™ ONE delivers accurate, robust, reliable data based on patented **Single Particle Extinction and Scattering (SPES) method** for the **analysis, classification, and counting** of simple and mixtures of submicron and micrometric particulate systems in liquids. CLASSIZER™ ONE enables critical decision-making throughout research and development, particles formulation, and quality control in manufacturing processes driven decisions in delivery systems, cosmetics, cosmeceuticals, pigments, inks, specialty chemicals, food, beverage, microplastics, abrasives, life and environmental sciences.
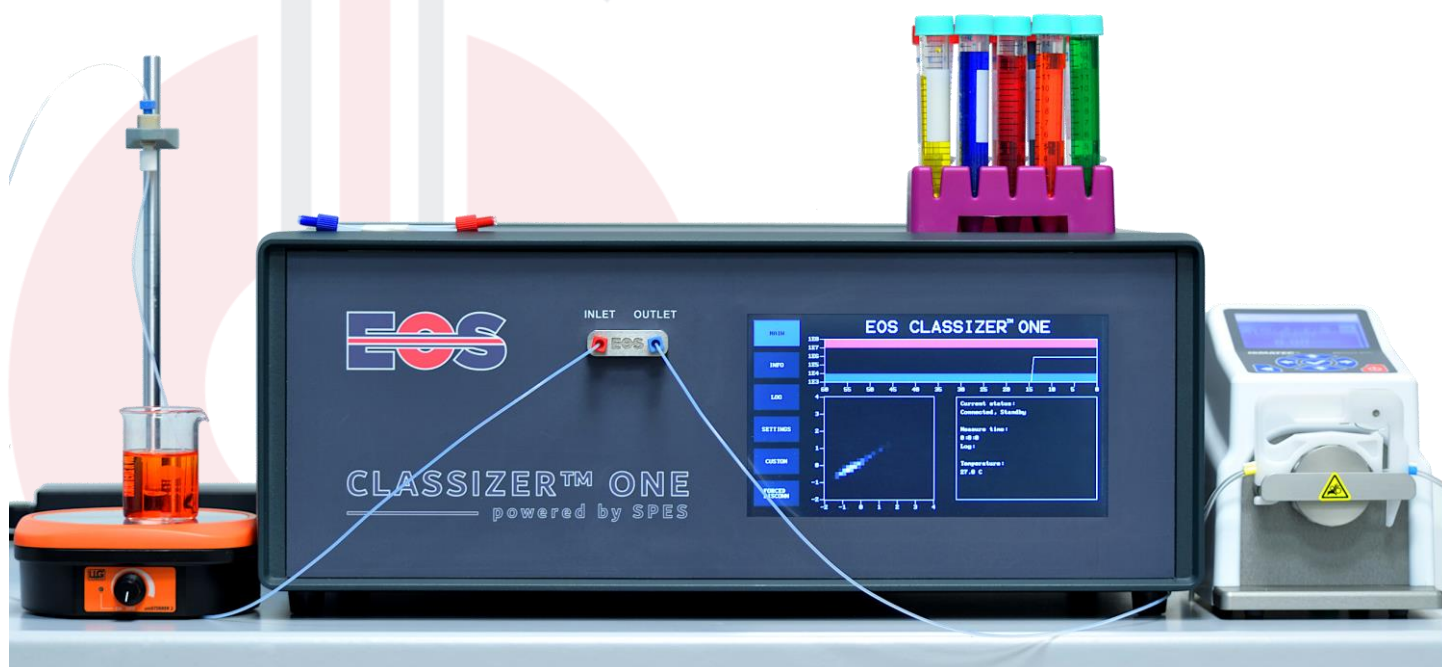

## Unique Patented Optical Layout – Industrial-grade – Touchscreen - Accessories

Quartz, Borosilicate Glass, PTFE, FEP, FFKM, FKM, and Stainless Steel wetted surfaces ensure high chemical compatibility. **CLASSIZER™ ONE** measures samples at laminar constant flows of 0.2, 0.5, 1.0, 2.0, 4.0 mL/min and viscosity up to 30cS.

CLASSIZER™ ONE works with standard syringe pumps for standard manual usage. EOS offers liquid sample managers and autosampler to deliver highest measurement throughput and reliability in particle analysis and batch-2-batch QC.
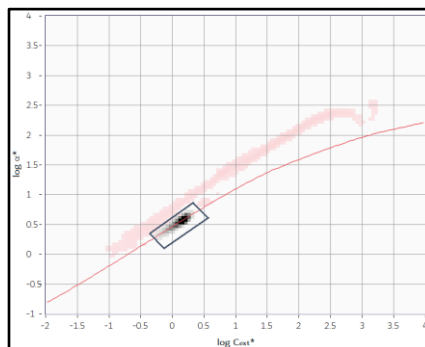
Tailored hardware and software solutions are available and can be developed on the basis on the single user needs.
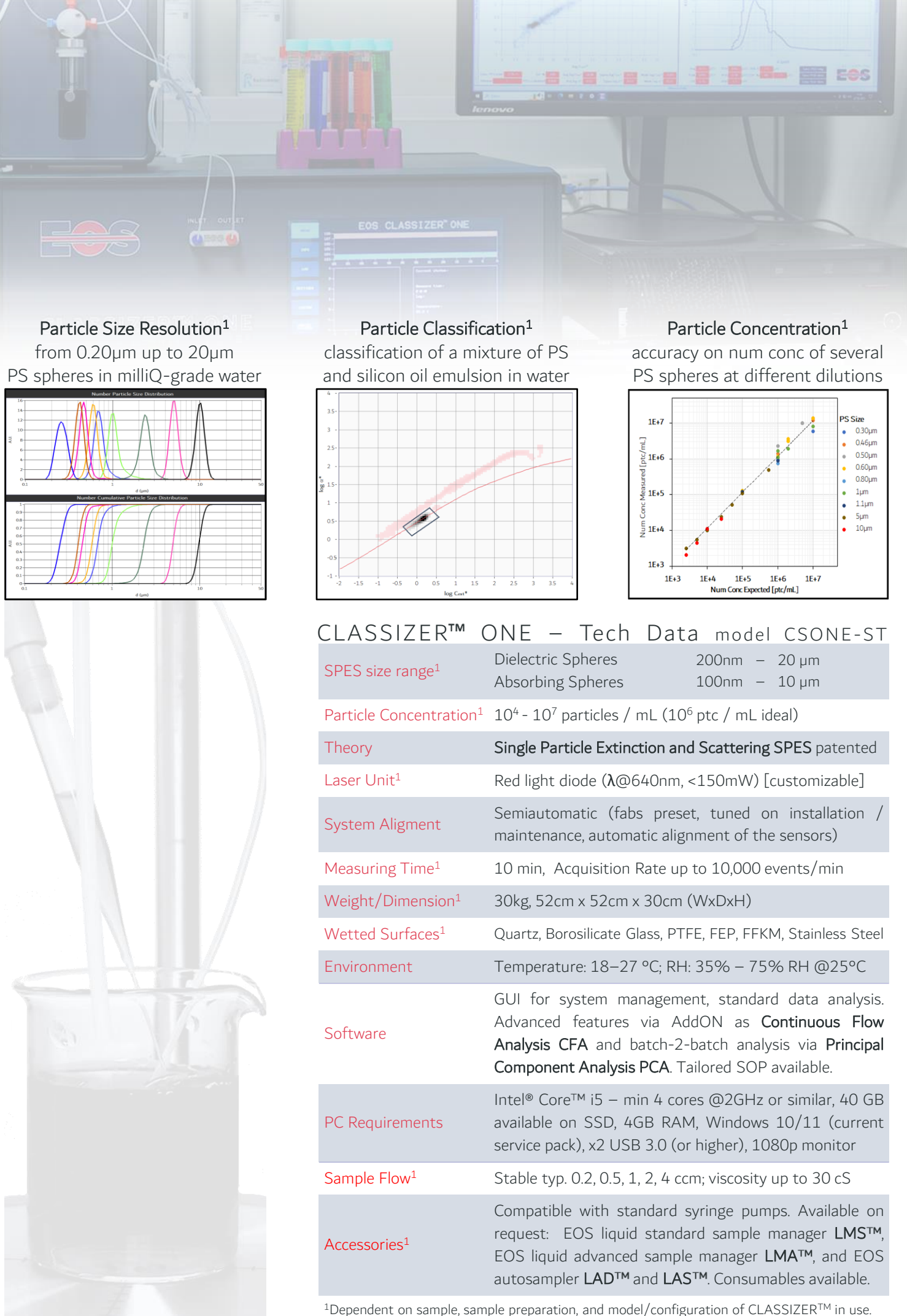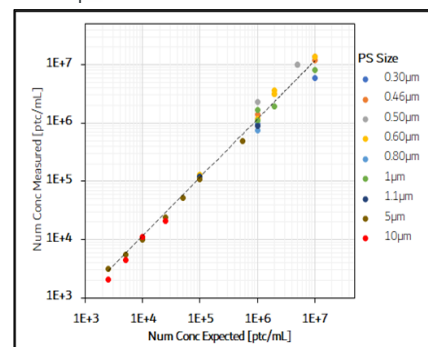
Particle Size Resolution[1]
from 0.20μm up to 20μm
PS spheres in milliQ-grade water
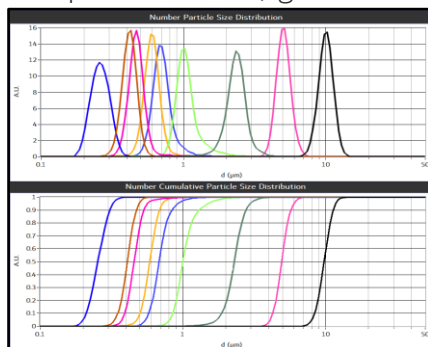
Particle Classification[1]
classification of a mixture of PS and silicon oil emulsion in water

Particle Concentration[1]
accuracy on num conc of several PS spheres at different dilutions

CLASSIZER™ ONE – Tech Data model CSONE-ST

|	
SPES size range[1]	Dielectric Spheres 200nm – 20 μm Absorbing Spheres 100nm – 10 μm
Particle Concentration[1]	10^4 - 10^7 particles / mL (10^6 ptc / mL ideal)
Theory	**Single Particle Extinction and Scattering SPES** patented
Laser Unit[1]	Red light diode (λ@640nm, <150mW) [customizable]
System Aligment	Semiautomatic (fabs preset, tuned on installation / maintenance, automatic alignment of the sensors)
Measuring Time[1]	10 min, Acquisition Rate up to 10,000 events/min
Weight/Dimension[1]	30kg, 52cm x 52cm x 30cm (WxDxH)
Wetted Surfaces[1]	Quartz, Borosilicate Glass, PTFE, FEP, FFKM, Stainless Steel
Environment	Temperature: 18–27 °C; RH: 35% – 75% RH @25°C
Software	GUI for system management, standard data analysis. Advanced features via AddON as **Continuous Flow Analysis CFA** and batch-2-batch analysis via **Principal Component Analysis PCA**. Tailored SOP available.
PC Requirements	Intel® Core™ i5 – min 4 cores @2GHz or similar, 40 GB available on SSD, 4GB RAM, Windows 10/11 (current service pack), x2 USB 3.0 (or higher), 1080p monitor
Sample Flow[1]	Stable typ. 0.2, 0.5, 1, 2, 4 ccm; viscosity up to 30 cS
Accessories[1]	Compatible with standard syringe pumps. Available on request: EOS liquid standard sample manager **LMS™**, EOS liquid advanced sample manager **LMA™**, and EOS autosampler **LAD™** and **LAS™**. Consumables available.

[1]Dependent on sample, sample preparation, and model/configuration of CLASSIZER™ in use.

ACCESSORIES
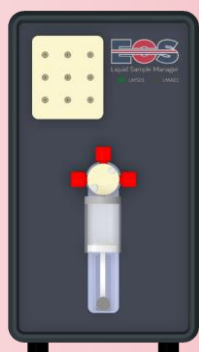
LMS™ Standard Liquid Sample Manager

EOS LMS™ standard sample manager enables Classizer™ ONE to operate in stable and repeatable conditions. It drastically reduces operator-dependent issues respect using a standard external pump; it occupies only a small space on the table. LMS™ relies on a robust syringe pump, PTFE and borosilicate syringe, plus a four-way valve for sample, simple cleaning, and waste management. LMS™ is designed to speed-up and standardize operations, to measure samples which are mostly already diluted, and for customers that do not want to lose time and energy in a search for compatible external pump.
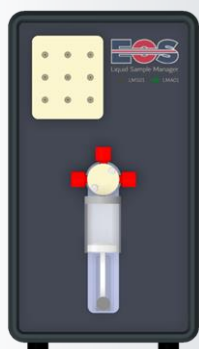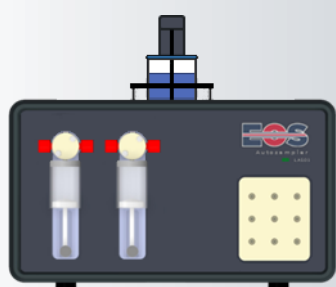
LMA™ Advanced Liquid Sample Manager

EOS LMA™ advanced sample manager is designed to bring all the benefits of the standard LMS™ sample manager with the additional value to perform repeatable automatic dilutions and cleaning protocols. LMA™ relies on a robust syringe pump, PTFE and borosilicate syringe, plus integrates up to 6 valves and a mixing chamber to manage the samples and create custom operative procedures of sample analysis, dilution ramps up to 100 times, and advanced standard and custom cleaning protocols.
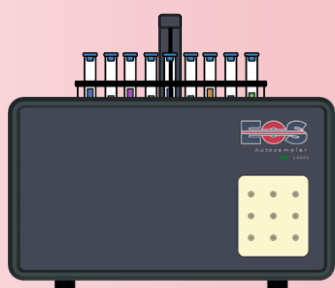
LAS™ Liquid Autosampler

LAS™ is an autosampler compatible with Classizer™ ONE and liquid sample managers LMS™/LMA™. Compatible with up to 20 test tubes and vials of 20mL. Settings, operative procedures, and the washing can be started and operated through the Classizer™ ONE software. Each sample may be stirred via a magnetic stirrer to prevent particle settling before the sampling. Via LMS™ / LMA™ internal washing is performed in order to prevent the cross contaminations between samples. Tested sample can be recovered for new analyses.

LAD™ Liquid Autosampler

LAD™ is a single point autosampler compatible with Classizer™ ONE and liquid sample managers LMS™/LMA™. LAD™ samples small aliquots at fixed times from a selected point in a vial or a bottle containing a solution in order to study the particle stability, aging, and settling over time. LAD™ integrates a dilution system to manage and dilute concentrated aliquots and a cleaning system.
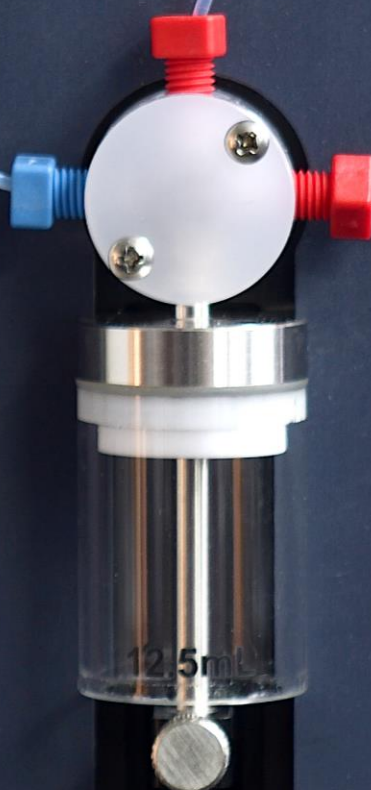
EOS SOFTWARE

USER FRIENDLY CONTROL & EVALUATION PLATFORM

All-in-one software platform with dedicated tabs for acquisition and analysis offers intuitive solutions for easy-to-use and reliable measurements. Standard operations and add-ons for advanced data acquisition and analysis are available and ready to use. Tailored Operative Procedures can be developed in the software to fit user needs.

Internal checks are performed continuously. Warnings and expert advices are provided to the user in real time to guarantee the highest data quality, accuracy, and repeatability.

Acquisition and analysis tabs provide a continuously increasing number of tailored customizations of acquiring, classifying, and interpreting the multiparametric SPES data.

Comments and operator observations can be added to data during acquisition and analysis. Data are saved continuously limiting the risk of data loss and unintentional file overwriting.

- Easy to use / Easy to clean
- Dedicated SOPs available
- No calibrations needed
- Robust Internal checks
- Real-time / In-Line / On-Line

Thanks to the unique **EOS CLOUDS** and **SPES** data, the user can **easily select any single particle population** detected in the fluid and represented in the 2D histogram. Numerical particle size distribution, statistical parameters, and concentration are retrieved accordingly to the selection and/or to the whole sample. Advanced feature as aggregation state, estimate payload, and aspect ratio are provided via tailored add-on.

Advanced algorithms as Principal Component Analysis PCA and Continuous Flow Analysis CFA are available to compare and correlate the behaviour of the single components in heterogeneous products and for batch-to-batch and raw material and production batch-2-batch Quality Controls.

Traditional methods assumes particles as standard dielectric spherical particles. **Benefits from CLASSIZER™ ONE** for the unprecedented analysis and interpretation of particles and particle mixes in heterogeneous liquids.
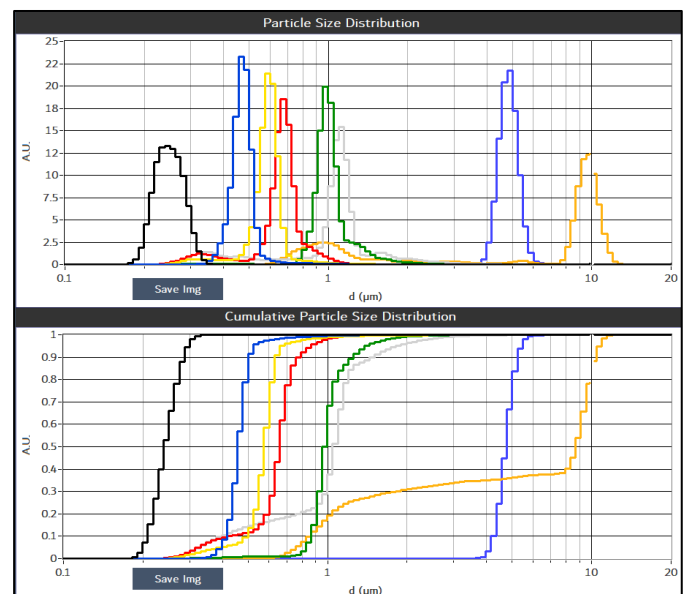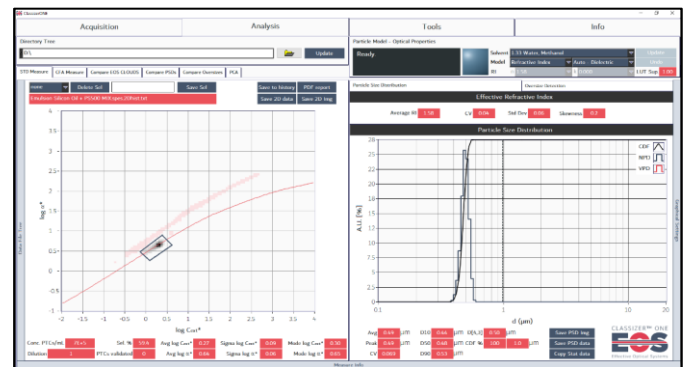
EOS add-on

CFA-SPES Add-On is the perfect solution for **Continuous Flow Analysis CFA** and real-time monitor of particles in for continuous flow applications. **SPES data** are retrieved with a time resolution of one second. Precise time laps can be selected for in detailed offline classification and analysis of particles and concentration transitions of single population.
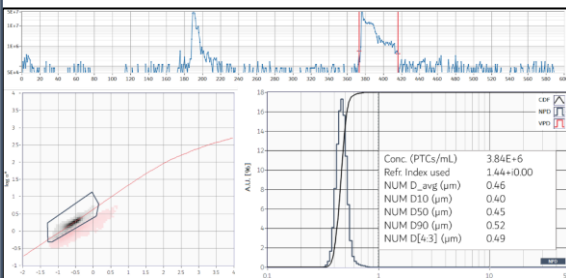
Online/InLine monitoring of particles during continuous flow processes lasting hours or for measuring samples injected using an external commercial autosampler. **CLASSIZER™ ONE** may start/stop acquisitions via an external communication protocols as RS485, square volt, or tailored com protocols developed to fit user needs.

CLASSIZER™ ONE measures particles either in the size range 0.1-2μm or 1-20μm, depending on settings. Two ergodic runs on the two ranges can be synchronised, merged, and analysed as a single acquisition.
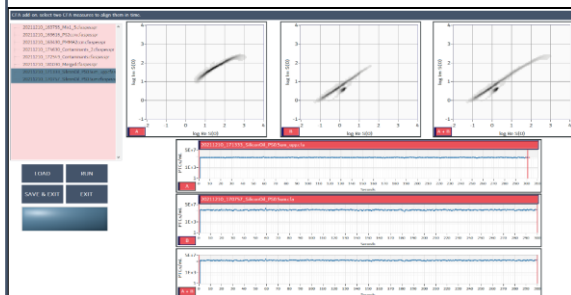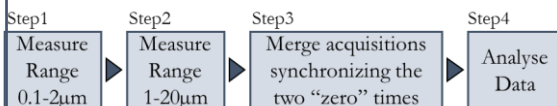

CLASSIZER™ ONE allows a high value and unique analysis of each single particle population classifying and extracting temporal resolved data od the single particle population in heterogeneous mix of particles in function of the single particle optical properties. The particle populations are detected and thus may be analysed separately by making a further selection in the EOS CLOUDS.

CLASSIZER™ ONE classifies the single populations in a particle mixture monitoring particle time transient and behaviour.

PCA-SPES Add-On provides an easy to use and effective **Principal Component Analysis PCA** tool for the statistical classification and batch-to-batch Quality Control of samples based on multiparametric **EOS CLOUDS** data.

PCA-SPES classifies the EOS CLOUDS. Samples are clustered on the basis of secondary populations, difference in the shape of the main population, or changes in the absolute or relative numerical particle concentrations.

$$M_i = \sum_j PC_{ij} PD_j$$
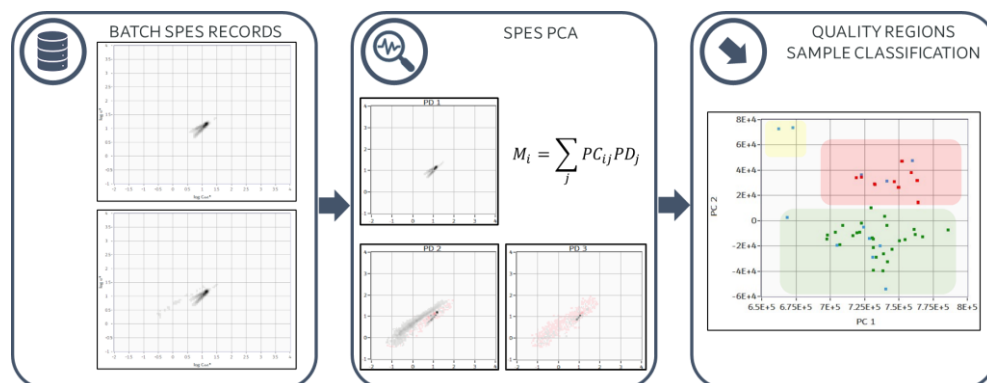
Supervised Machine Learning and K-nearest neighbour method available to classify batches using discrete labels as True/False, Yes/No, OK/Not OK, or Good/Bad to evaluate new data against library of previously measured batches.
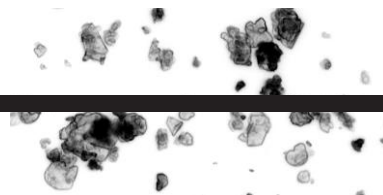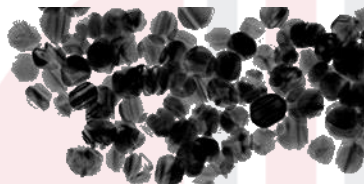
APPLICATIONS

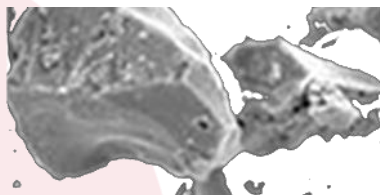## POLYMERICS / EMULSIONS
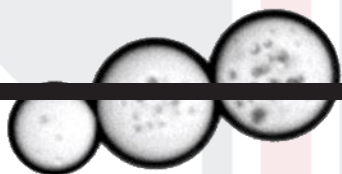
BIOFLUIDS / DELIVERY SYSTEMS

PIGMENTS / INKS

METALLICS /CARBONACEOUS

ABRASIVES / OXIDES

ENVIRONMENT / MINERALS

Presentation of Single Particle Extinction and Scattering (SPES) - Mixtures of polymeric particles and powders
AN001-2021 Analysis of Polymeric Particle Mixes via SPES Technology – an introduction to SPES method
AN006-2021 Multiparametric Classification of Particles as a Pathway to Oversize Analysis in Complex Fluids via SPES
Potenza MAC et al., «Measuring the complex field scattered by single submicron particles », AIP Advances 5 (2015)

Example of CFA application of SPES technology
AN002-2022 Continuous SPES Flow Analysis CFA-SPES

Example of PCA application of SPES technology
AN005-2022 Batch-To-Batch Consistency via Multiparametric SPES Principal Component Analysis PCA

Classizer™ ONE + Sample Managers & Autosampler
AN008-2022 Automatic Liquid Sample Management and System Cleaning with EOS LMS01™ and LMA01™
AN009-2022 Standardize SPES Operative Procedure and improve throughput of Liquid Samples via EOS LAS01™
Potenza MAC et al., «Single-Particle Extinction and Scattering Method …», ACS Earth Space Chem 15 (2017)

Example of SPES application to aggregates
AN003-2021 Addressing the Issue of Wetting and Clustering by Means of SPES Technology
Potenza MAC *et al.,* «Single-Particle Extinction and Scattering Method …», ACS Earth Space Chem 15 (2017)

SPES application to non-spherical particles
AN004-2021 Addressing the Classification of Non-Spherical Particles by Mean of the SPES Technology
Simonsen MF et al., «Particle shape accounts for instrumental discrepancy in …», Clim. Past 14 (2018)

SPES application to emulsions, emulsion mixtures, blends
AN015-2022 Classification of Oil and Oil Mixes Emulsions

Examples of SPES application to particle analysis and behaviour characterization in biotech applications
AN011-2021 Quantitative Classification of Particles in Biological Liquids via SPES Technology
AN016-2021 Multiparametric Determination of Yeast Cell Viability via SPES Technology
AN017-2022_SPES Classification of Probiotic Formulations
Sanvito T et al., «Single particle extinction and scattering optical method unveils in real…", Nanomedicine 13 (2017)

Examples of SPES application to inks, pigments, coatings
AN018-2022 Classification of Inks and Pigments via SPES Technology
AN019-2022 SPES Classification of Vinyl Glues

Example of SPES application to oxide particles, abrasives, and industrial slurries w/o impurities and w/o emulsions
AN013-2022 Analysis of Abrasives via SPES Technology
Potenza MAC et al., «Optical characterization of particles for industries», KONA Powder and Particle 33 (2016)

Example of SPES application to particle degradation in target food environmental liquids and ecotoxicity analysis
AN012-2021 Monitoring the Fate of a Lipid/ZnO Emulsion in Environmental Waters
AN020-2023 Quantify Particle Release from Food Packaging
Maiorana S et al., «Phytotoxicity of wear debris from traditional and innovative brake pads», Env Int., 123 (2019)

The EOS CLASSIZER™ family

Code	Description
C S O N E - S T	CLASSIZER ONE – benchtop unit based on SPES for multiparametric particle analysis in the size range 0.1-20µm @ 0.2-4mL/min
CSONE-ST-90	CLASSIZER ONE – benchtop unit based on SPES and SPES² for multiparametric particle analysis in the size range 0.1-20µm @ 0.2-4mL/min
C S O N E - H F	CLASSIZER ONE HF – benchtop unit based on SPES for multiparametric particle analysis in the size range 0.1-20µm @ 20-200mL/min
CSONE-HF-90	CLASSIZER ONE HF – benchtop unit based on SPES and SPES² for multiparametric particle analysis in the size range 0.1-20µm @ 20-200mL/min
C S P A T - S	CLASSIZER PAT – online rack 19" unit based on SPES for particle analysis in the size range 0.1-2.0µm @ 20-200mL/min – computer integrated
C S P A T - M	CLASSIZER PAT – online rack 19" unit based on SPES for particle analysis in the size range 0.5-5.0µm @ 20-200mL/min – computer integrated
C S P A T - L	CLASSIZER PAT – online rack 19" unit based on SPES for particle analysis in the size range 1.0-20.0µm @ 20-200mL/min – computer integrated
C S E N V - S	CLASSIZER ENV – portable battery powered unit based on SPES for the analysis of particles in the size range 0.1-2.0µm – pump integrated
C S E N V - M	CLASSIZER ENV – portable battery powered unit based on SPES for the analysis of particles in the size range 0.5-5.0µm – pump integrated
C S E N V - L	CLASSIZER ENV – portable battery powered unit based on SPES for the analysis of particles in the size range 1.0-20.0µm – pump integrated
C S A I R - S	CLASSIZER AIR – rack 19" unit based on SPES for the analysis of airbone particles in the size range 0.1-2.0µm @ 1-10L/min – computer integrated
C S A I R - M	CLASSIZER AIR – rack 19" unit based on SPES for the analysis of airbone particles in the size range 0.5-5.0µm @ 1-10L/min – computer integrated
C S A I R - L	CLASSIZER AIR – rack 19" unit based on SPES for the analysis of airbone particles in the size range 1.0-20.0µm @ 1-10L/min – computer integrated
S W v 1 . 5	Standard software platform for the managment of EOS devices
L M S	Liquid Manager for standard sample management and basic system cleaning
L M A	Liquid Manager for advanced sample management, dilution, system cleaning
L A S	Liquid AutoSampler up to 24 vials of 20mL, coupling with LMS/LMA
L A D	Liquid AutoSampler for evaluation of particle aging and settling over time in a vial, coupling with LMS, dilution and cleaning
A M S	Aerosol Standard Manager – automatic aerosol managment
A D C	Aerosol Dilution Chamber for the analysis of high concentrate aerosol with AMS

Manufactured by Microfluidics, distributed in the UK and Ireland by **analytik**.