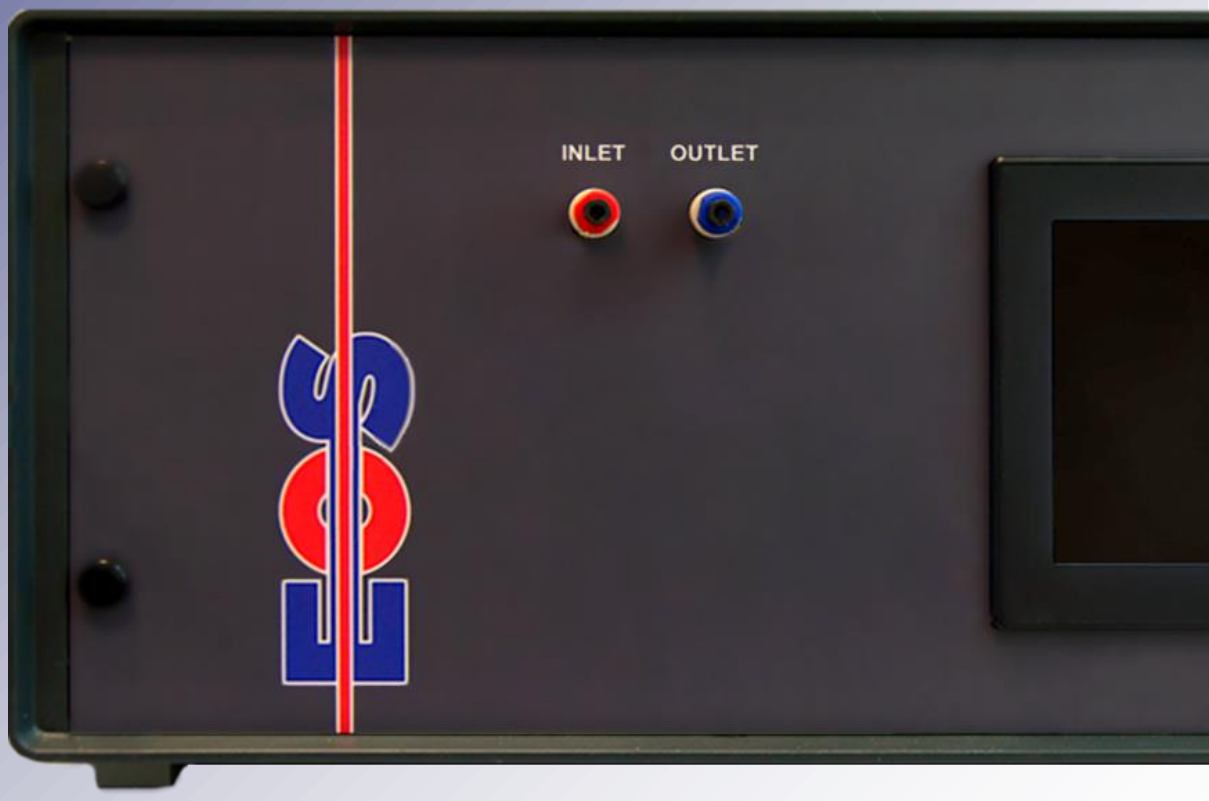
Effective Optical Systems

Particle Analyzer



Cutting-edge Platform for R&D and QC of particles in biological, industrial and environmental complex fluids

powered by patented ***Single Particle Extinction and Scattering*** *technology*

CLASSIZER™ ONE

multiparametric single particle analysis

About EOS

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

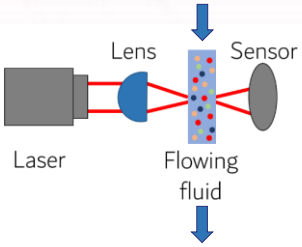
EOS (Effective Optical Systems) has been founded in July 2014 in Milano (Italy). Since the beginning, EOS develops and offers **novel devices and technological solutions for the analysis and design of particles in biological, industrial and environmental complex fluids.**

EOS unique solutions are the game-changers for improving R&D, formulation design and process quality control of products based on particles in key markets as **life sciences, pharmaceuticals, cosmetics, pigments, inks, foods, agrochemicals and environmental sciences**.

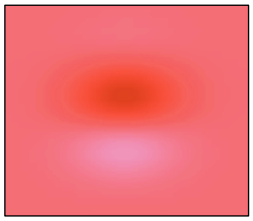
Thanks to its transversal experience in physics, engineering, material sciences and chemistry, EOS team brings cost effective and tailored innovations for any application and particle analytical problem.

SPES

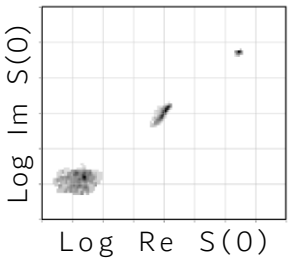
SPES (Single Particle Extinction & Scattering) is a novel patented light scattering technology which enables the analysis, classification and counting of single particles in fluid on the basis of their optical properties.



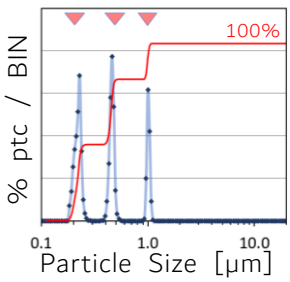
Particles are suspended in a liquid and driven at a constant flow rate through a scattering flow cell where a laser beam is properly focused. As a single particle crosses the beam, exploiting the **SPES** technology, **CLASSIZER™ ONE** records the interference pattern between the transmitted beam and the light scattered in the forward by the illuminated particle via a segmented silicon photodiode.



The interference pattern presents dark and bright fringes delivering the information about the unique optical properties of the single particle observed: size, refractive index, internal structure, aggregation state, payload, shape, etc. A dedicate Pulse Shape Analysis retrieves a couple of independent, calibration-free optical parameters, namely the real *Re* and imaginary *Im* components of the forward scattered field *S(0)*.



From a statistically meaningful number of measured particles, **CLASSIZER™ ONE** creates the unique **EOS CLOUDS**: a 2D histogram which is the optical fingerprint of the sample. Heterogeneous samples produce simultaneously more clouds for each particle population which can be selected and analyzed separately. Grey tones are proportional to the number of particles per milliliter having a given optical property.



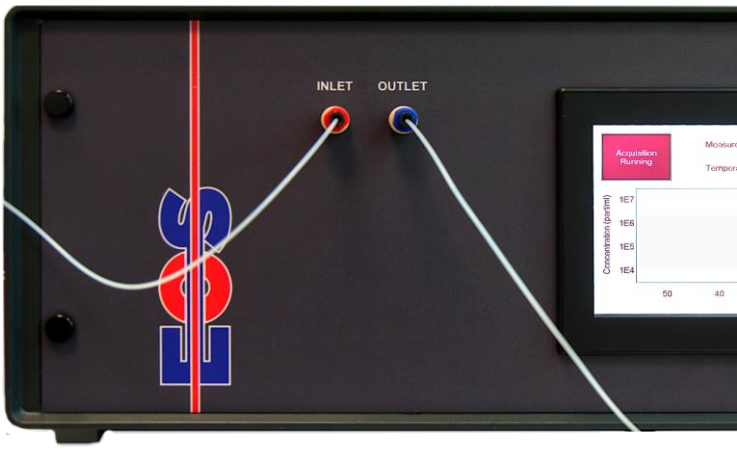
Added-value information is provided thanks to **SPES** and **EOS** unique data libraries:

- Absolute **Particle Size Distribution** and **Particle Numerical Concentration** of each single populations irrespectively of polydispersity and composition.
- Quality Control of **particle porosity, wetting, payload, impurities, synthesis scraps and shelf-life without intermediate steps** (purification/filtration).
- Measurement of **particles behavior and formulation stability directly** in real non-filtered biological, industrial or environmental **complex fluids**.
- Hi-Resolution **Continuous Flow Analysis** of particles coupling with other analytical devices as CF3 separators, small chemical reactors and pilot line.

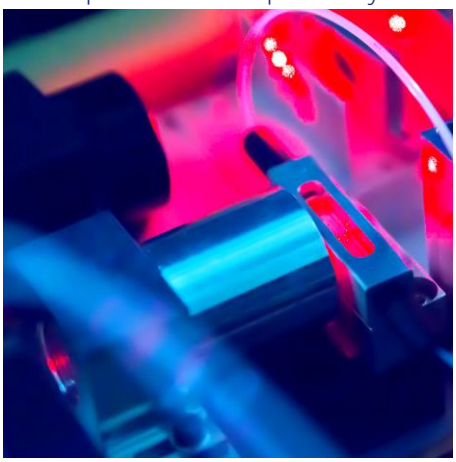
CLASSIZER™ ONE

CLASSIZER™ ONE is a unique multiparametric particle analysis platform based on SPES patented technology. CLASSIZER™ ONE is the cutting-edge solution for research & design, formulation and quality control in life sciences, pharmaceuticals, cosmetics, pigments, cements, foods, agrochemicals & environmental sciences.

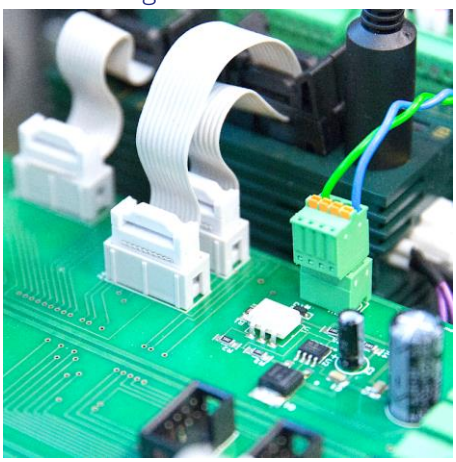
A small aliquot of the sample to be analyzed is dispersed or diluted in a filtered solvent and has flowed through the device at a constant flow. **CLASSIZER™ ONE** analyses particles, emulsions, powders and microcapsules present in the fluid. Via the unique patented **SPES** optical scheme, **CLASSIZER™ ONE** retrieves to user the **SPES CLOUDS** of the sample in a few minutes guaranteeing precise and unique information. Accurate production design, custom electronics and medical grade components ensure durability, reliability and robustness.



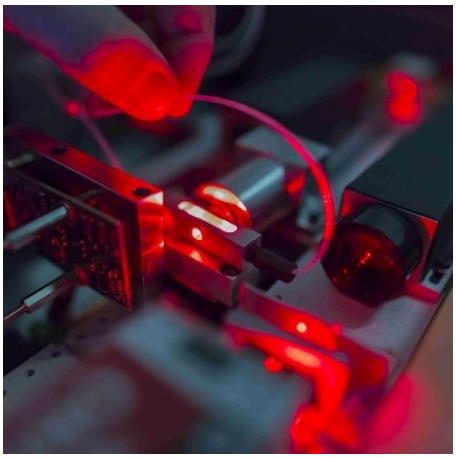
Unique Patented Optical Layout

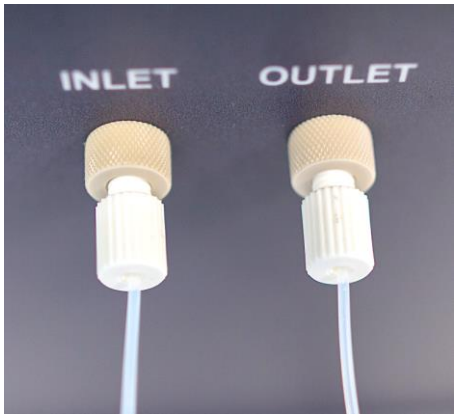


Industrial-grade PLC & 7-inch HMI



Custom Hardware Solutions





Quartz, PTFE and PEEK wetted surfaces and couplings ensure high chemical compatibility. **CLASSIZER™ ONE** works with laminar constant flows in typical range of few millilitres per minute [customizable].

CLASSIZER™ ONE can be coupled with standard syringe pumps and hi-quality peristaltic pumps for standard R&D activities as with automatic wet dispersion units and autosamplers to deliver high measurement throughput and reliability in formulation and Quality Control activities.

Hardware tailored solutions on single user needs are available. **Contact EOS team to discover more!**

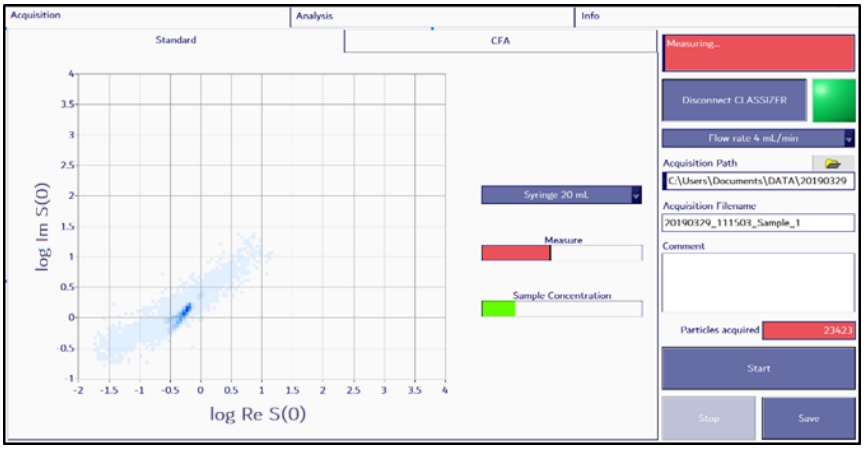
IDEAL FOR: emulsions – microcapsules – microplastics – pigments abrasives – pesticides – fertilizers – additives – colloids – inks ceramics – drug delivery systems – lubricants – environmental waters

USER SOFTWARE

USER FRIENDLY CONTROL & EVALUATION PLATFORM

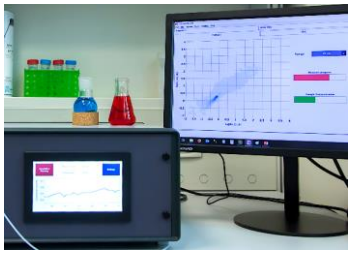
All-in-one software with dedicated tabs for acquisition and analysis offers intuitive solutions for easy-to-use and reliable measurements. Standard operations and add-ons for advanced data acquisition and analysis are available and ready to use. Tailored Operative Procedures can be developed in the software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

Several internal checks are performed continuously to ensure to the user high quality and reliability of the SPES data. Warnings and expert advices are provided in real time during the data acquisition to save time and increase the quality of the SPES analysis.



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

Comments and operator observations can be added to data during acquisition and analysis. Data are saved continuously limiting data loss and unintentional file overwriting. Compliance with 21 CFR part 11 and device connectivity via industry standard IoT protocols are possibile via dedicate software packages. Customization of the Graphic User Interface and data analysis available on request.

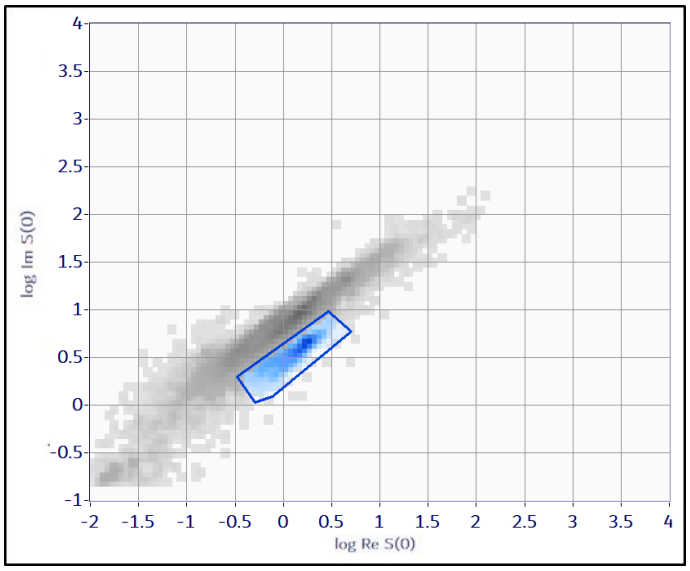


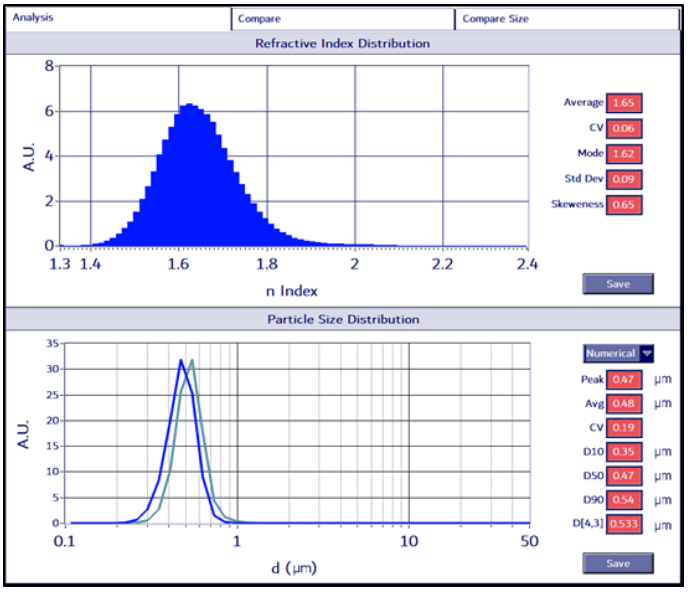
CLASSIZER™ ONE is the perfect solution for Continuous Flow Analysis of particles in fluids and as unique sensor for FFF applications as AF4/CF3. Real-time monitor of the SPES CLOUDS and of the particle numerical concentration are retrieved with a time resolution of one second. Precise time laps can be selected for in detailed offline analysis of particles characteristic and concentration transitions of single particle population.

Suitable for process control coupled to pilot line and small chemical reactors to improve synthesis quality and yield of particles, powders, emulsions and microcapsules regardless the presence of scraps and impurities.

Analysis tab allows the operator to have the sample characteristics at a glance. CLASSIZER™ ONE software provides many ways to perform a thorough analysis and retrieve valuable information precluded to standard and ordinary particle sizers and counters. Advance knowledge of products based on particles is finally achievable.

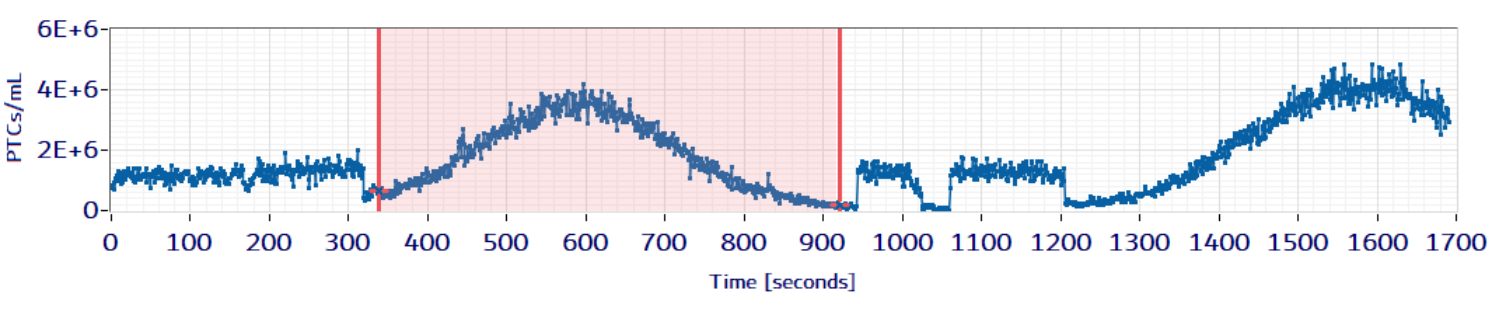
Thanks to the unique **SPES CLOUDS** and SPES data, the user can easily **select** any single particle population detected in the fluid and represented in the 2D histogram. Numerical particle size distribution, statistical parameters and concentration are retrieved accordingly to the selection and/or to the whole sample. Advanced feature as aggregation state, particle payload and aspect ratio are provided via software add-on. Advanced algorithms as Principal Component Analysis (PCA) are available to compare and correlate the behaviour of the single components in heterogeneous products and for batch-to-batch and raw material Quality Controls.



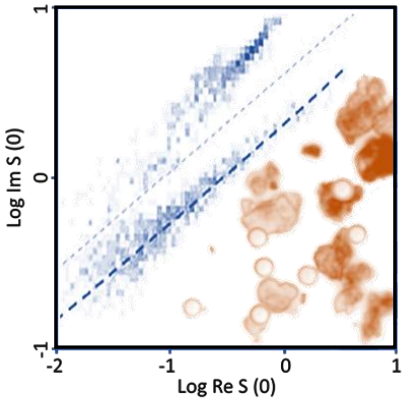


Default analysis assumes particles as standard dielectric spherical particles. **Benefits from SPES technology loading specific data library** for the unprecedented analysis and interpretation of

- core-shell and payload estimate
- particle aging and shelf life
- aggregates and meso-porosity
- non-spherical microparticles
- absorbing and metallic materials
- and any of your specific needs!



APPLICATIONS

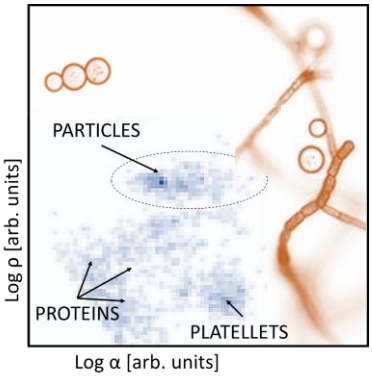


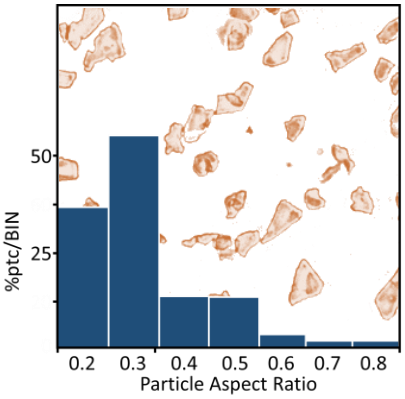
Single population analysis in heterogeneous systems

One measurement allows to analyze the single component of a complex formulation with API, excipients, scraps and contaminants. Components of the samples with different optical properties generate different clouds of data in the unique 2D **EOS CLOUDS**: each of them can be selected and analyzed by user limiting the operator time needed and expensive sample preparation.

Monitor behavior in real complex fluids

Select and recognize the particle signals in real complex medium as **plasma**, **blood**, **cell lysate** or sampling coming from environment waters (sea, peatbog, lake). SPES opens new opportunities for understanding interactions between materials and real biological components in terms of sizing, concentration, aging, particle-particle or particle-medium interactions and sample stability.



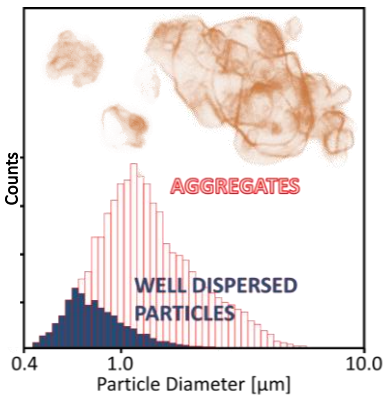


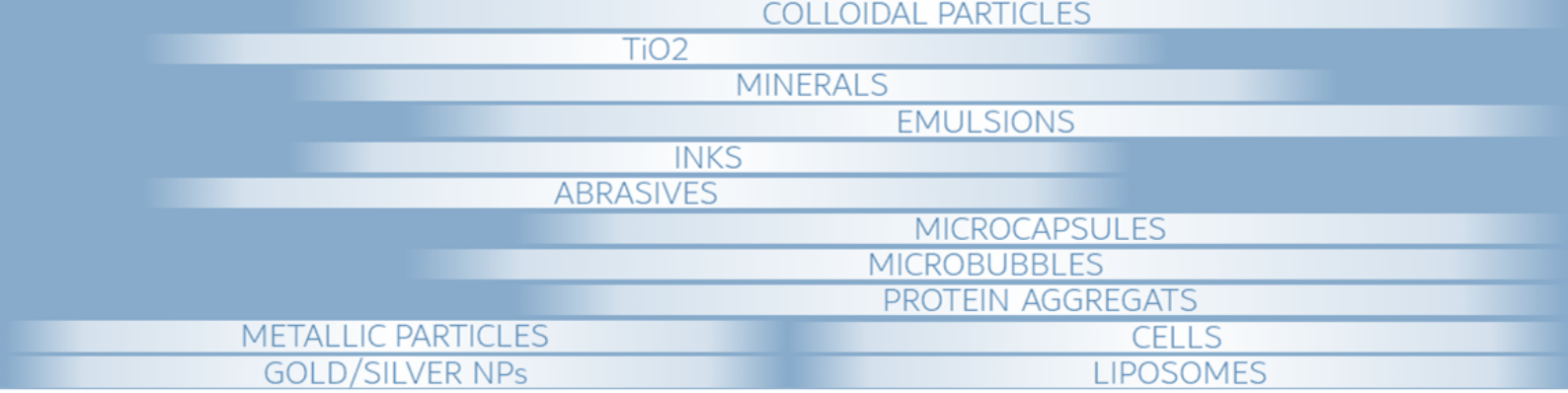
Non-spherical particles

Particle shape strongly influences size distribution and interpretation of light scattering signals. Traditional approaches fail in the task, while CLASSIZER™ ONE opens new insight on your powder via custom data library. Retrieve particle aspect ratio and obtain more realistic and reliable particle sizing for non-spherical objects, such as oblate (platelets) and prolate (needle-like) particles.

Analysis of aggregates

Aggregates have a lower effective refractive index respect to native particles or bulk material and are easily recognizable in the **EOS CLOUDS** histogram. Take advantage by SPES analysis to detect the presence and quantify the compactness of the aggregates to improve formulation stability and prevent out-of-specifics due to instabilities, poor wetting or grinding problems.

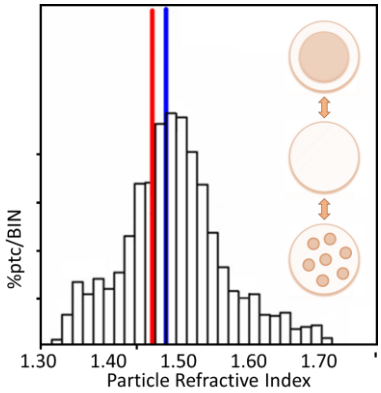


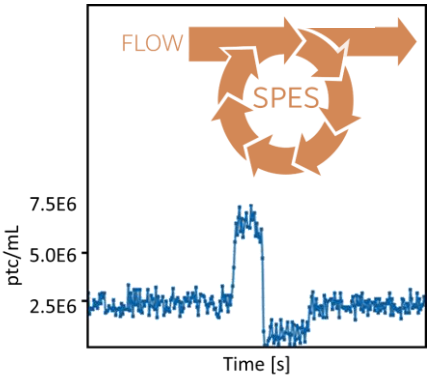


MORE APPLICATIONS ON www.eosinstruments.com

Particles Internal Structure and Payload

Particle internal structure for mesoporous material, API in homogeneous or core shell particles and degradation processes affect the SPES signals on **EOS CLOUDS**. Quantify the payload, the core-shell ratio, the porosity or assess how the aging modifies your product. Operative procedure for data analysis and comparison with placebo or reference standards can be tailored on user needs.





Continuous Flow Analysis

On-Line / In-Line / Real-Time SPES analysis regardless to the presence of bubbles, immiscible droplets and impurities in aqueous liquids, solvents and lubricants. Couple CLASSIZER™ ONE with other CFA equipment as Flow Field Fractionation separators in pilot line and small reactors to support product formulation. Contact us and devise how SPES can become your OEM sensor.

Selection of publications and references:

Presentation of Single Particle Extinction and Scattering (SPES) method for particle analysis:
Measuring the complex field scattered by single submicron particles, *AIP Advances* 5 (2015)
https://aip.scitation.org/doi/full/10.1063/1.4935927

Example of SPES application to aggregates:
Single-Particle Extinction and Scattering Method Allows for Detection and Characterization of Aggregates of ..., *ACS Earth Space Chem* (2017)
https://pubs.acs.org/doi/10.1021/acsearthspacechem.7b00018

Examples of SPES application to non spherical particles:
Measuring shape and size of micrometric particles from the analysis of the forward scattered field, *J. Appl. Phys.* 119 (2016)
https://aip.scitation.org/doi/abs/10.1063/1.4953332?journalCode=jap

Particle shape accounts for instrumental discrepancy in ice core dust size distributions, *Clim. Past.* 14, 601-608, 2018
https://www.clim-past.net/14/601/2018/cp-14-601-2018.pdf

Example of SPES application to emulsion and polymeric particle analysis w/o drug loading:
Single particle optical extinction and scattering allows real time quantitative characterization of drug payload and degradation..., *Scientific Reports* 5 (2015)
https://www.nature.com/articles/srep18228

Example of SPES application to oxide particles, abrasives and industrial slurries w/o impurities:
Optical characterization of particles for industries, *KONA Powder and Particle review* 33 (2016)
https://www.jstage.jst.go.jp/article/kona/33/0/33_2016016/_article

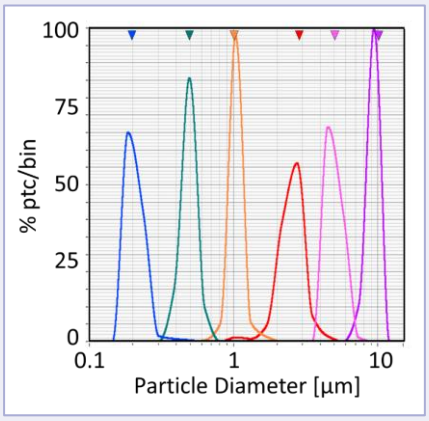
Example of SPES application to particle analysis and behaviour characterization in complex media:
Single particle extinction and scattering optical method unveils in real time the influence of the blood components on ..., *Nanomedicine* 13 (2017)
https://www.sciencedirect.com/science/article/pii/S1549963417301387

Example of SPES application to aerosol analysis
Single Particle Extinction and Scattering allows novel optical characterization of aerosols, *J Nanopart Res* (2017)
https://link.springer.com/article/10.1007/s11051-017-3995-3

TECHNICAL DATA

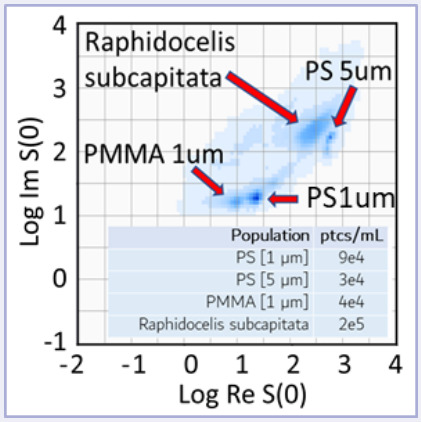
Particle Size Resolution[1]

0.2µm, 0.5µm, 1µm, 2.9µm, 5µm, 10µm PS spheres



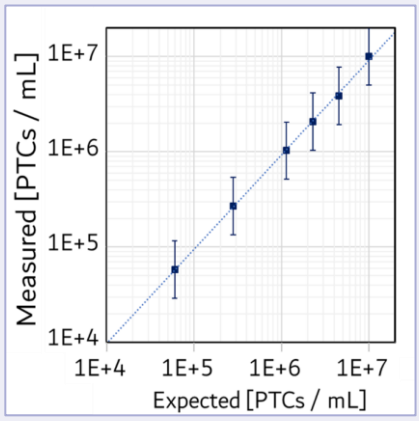
Particle Classification[1]

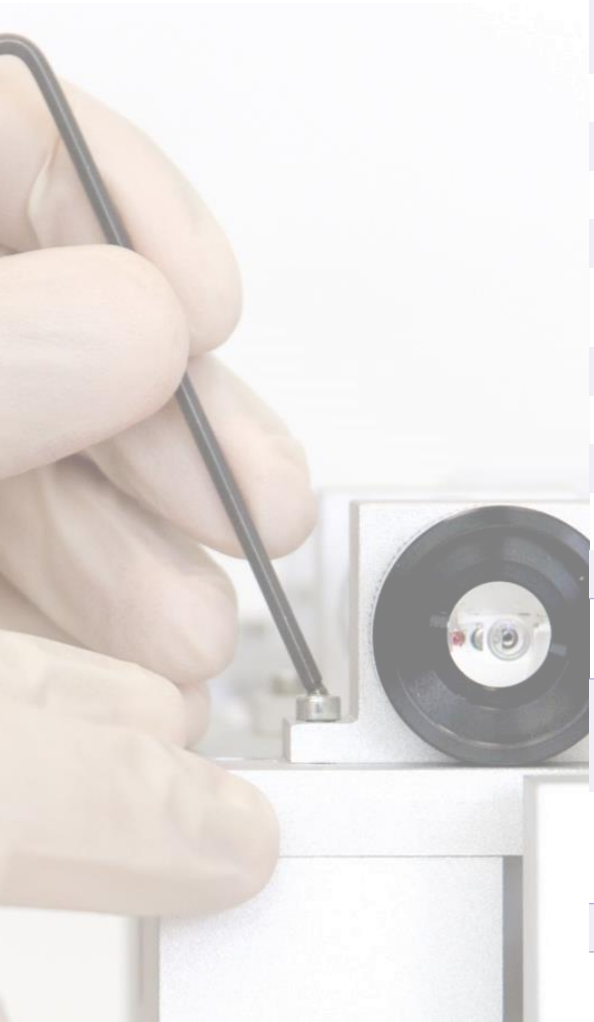
classification of a mix of 1um, 5um PS spheres, 1 um PMMA and microalgae



Particle Concentration[1]

precision on num conc of 1µm PS spheres at different dilutions





CLASSIZER™ ONE v0.83

SPES measuring range[1]	Dielectric Spheres 200nm – 20 µm Metallic Spheres 100nm – 10 µm
Particle Concentration[1]	10^5 – 10^7 particles / mL (10^6 particles / mL ideal)
Theory	**Single Particle Extinction and Scattering** (patented)
Type of Analysis	Laser light scattering analysis of wet samples
Laser Unit[1]	Red light diode (**λ**=640nm, <50mW) [customizable]
System Aligment	Manual (fabs preset, tuned on installation / maintenance)
Measuring Time[1]	10-15 min, Acquisition Rate up to 10,000 events/min
Net Weight	25 kg (depending on configuration)
Dimension (WxDxH)	50cm x 50cm x 25cm (depending on configuration)
Wetted Surfaces	Teflon, Quartz, PEEK [customizable]
Environment	Temperature: 18–27 °C; RH: 35% – 75% RH @25°C
CE	Compliance with **FDA 21 CFR Part 11**, **ISO 21501 up to 50 µm**, **USP <729>** and **USP <788>** via Add-ONs
Software	Standard GUI for system management and standard data analysis, custom Add-ONs for tailored SOPs and advanced data analysis (aggregation, payload, CFA, etc)
PC System Requirements	Intel® Core™ i3 @ 2GHz or similar, 40 GB available on SSD, 4 GB RAM, Windows 10 (current service pack), x2 USB 3.0 (or higher), 1080p monitor preferably
Sample Flow[1]	Stable, laminar flow, typ. 0.5, 1, 2, 4 ccm [customizable]

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

CUSTOM SOLUTIONS

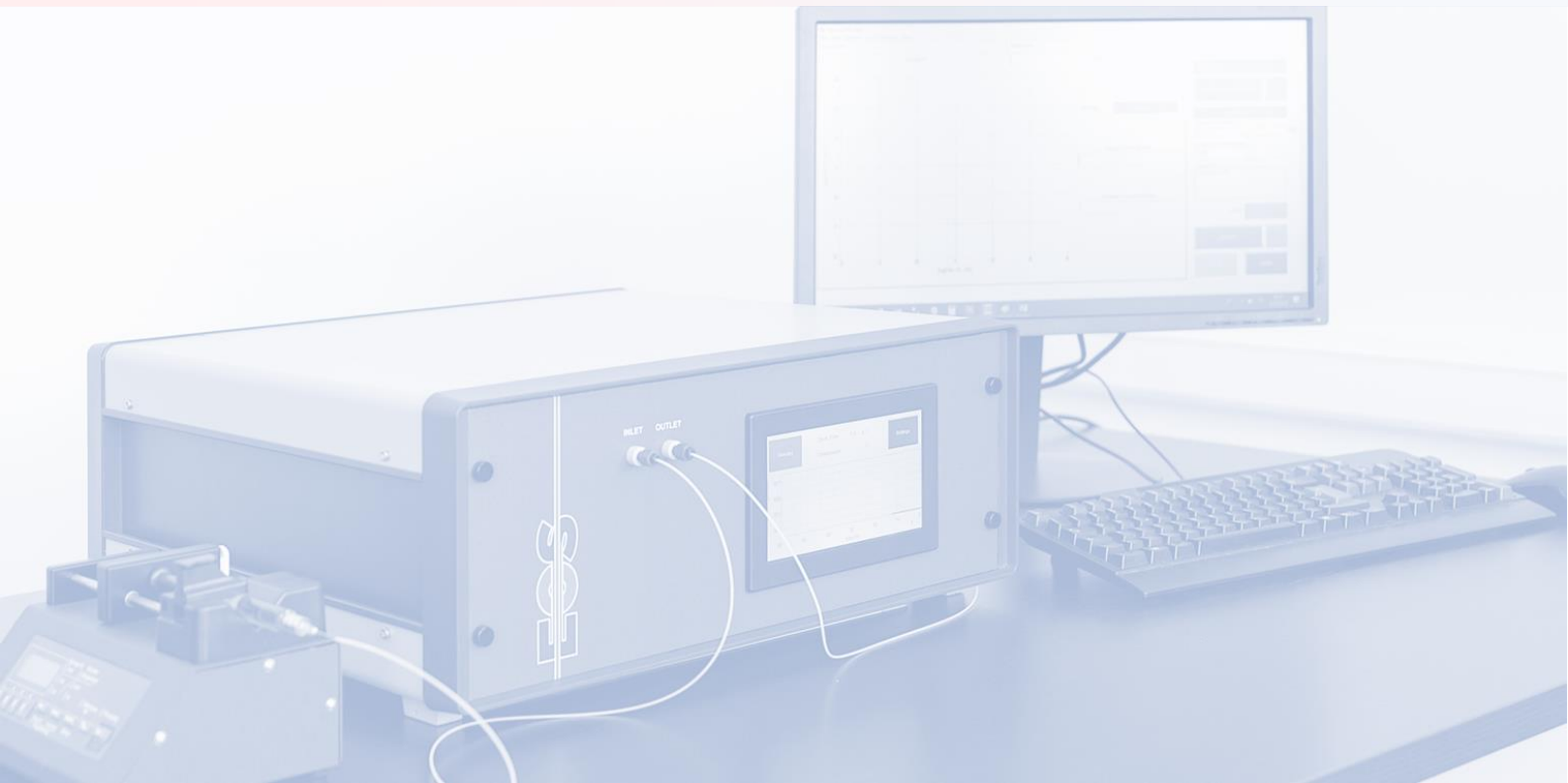
Contract Research Services_ EOS application specialists are available for every customer which requires the development of dedicated sample preparation and analysis protocols via Cooperation Agreement and Contract Research Services. Contact us for information.

Software Packages and Data Libraries_ CLASSIZER ONE is a highly configurable analytical platform. Advanced software packages are available and ready to expand the system capabilities and answer your R&D, formulation and Quality Control needs.

Remote Analysis Support_ EOS application specialists are available to provide tailored support for data analysis and interpretation to boost your particle analysis capabilities.

Training Activities_ EOS is available and willing to discuss your needs and training requirements. EOS provides multiple levels of support contracts, as telephone and video conference and training activities and demo at EOS and/or your laboratories.

Dedicate Customer Service_ EOS delivers exceptional support, provided by experienced SPES application performance of EOS technologies. EOS scientists and technical service personnel give you the assistance necessary for the best experience of SPES technology.



Effective Optical Systems

EOS Partner – Distributed by:

IT – OPTOPRIM Srl Via Carlo Rota, 37 20900 Monza MB +39 039 834977	FR – OPTOPRIM SAS 23 Rue Aristide Briand, 92170 Vanves, +33 1 41 90 61 80	DE – OPTOPRIM GmbH Max-Planck-Straße 3 85716 Unterschleißheim +49 89 80076252
BE – INVENTECH BENELUX BV Denariusstraat 21 4903 RC Oosterhout +31 (0)162 460404	NL - INVENTECH BENELUX BV Denariusstraat 21 4903 RC Oosterhout +31 (0)162 460404	LU -INVENTECH BENELUX BV Denariusstraat 21 4903 RC Oosterhout +31 (0)162 460404
SG – OMEGA SCIENTIFIC Pte Ltd 1 Kaki Bukit View #05-15/16 Techview (65) 6744 6645		

HeadQuarter - EOS S.r.l.
viale Ortles 22 | 20139 Milan | Italy
Phone +39 02 5666 0179
VAT IT08737210966
www.eosinstruments.com
info@eosinstruments.com

Effective Optical Systems

EU H2020 SME Instruments Ph 1 research & innovation programme under grant agreement n° 781906

located in FONDAZIONE FILARETE