3D LS Spectrometer: Specifications

The 3D LS Spectrometer is the most popular configuration of the LS Spectrometer. Since it is equipped with the 3D cross-correlation technology, it allows both DLS and SLS in concentrated samples. The modular design allows further adaptions suitable for your specific requirements, without compromising neither precision nor quality. Ask the experts at LSI to configure the optimal solution for your laboratory.

Standard applications include:

- Particle sizing

  Hydrodynamic Radius: 0.15 nm – 5 micron*

  Radius of Gyration: 5 nm – 5 micron*
- Measurement of size distribution, polydispersity
- Diffusion coefficient, mean square displacement
- Molecular weight determination: 360 - 3600000 Dalton*
- Determination of 2nd virial coefficient
- Rayleigh ratio
- Determination of form and structure factor
- Inter particle distance in charged systems
- Process monitoring (e.g. gelation, aggregation, ageing...)

* maximum range, sample dependent

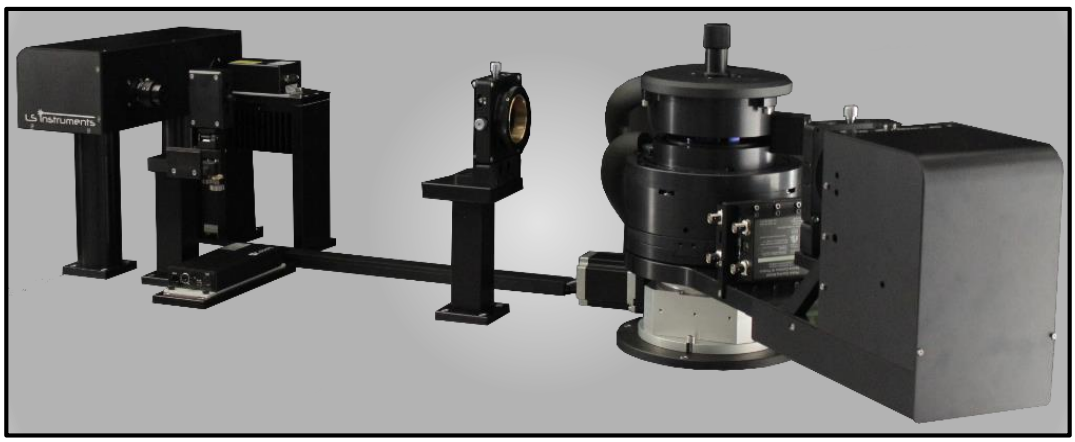
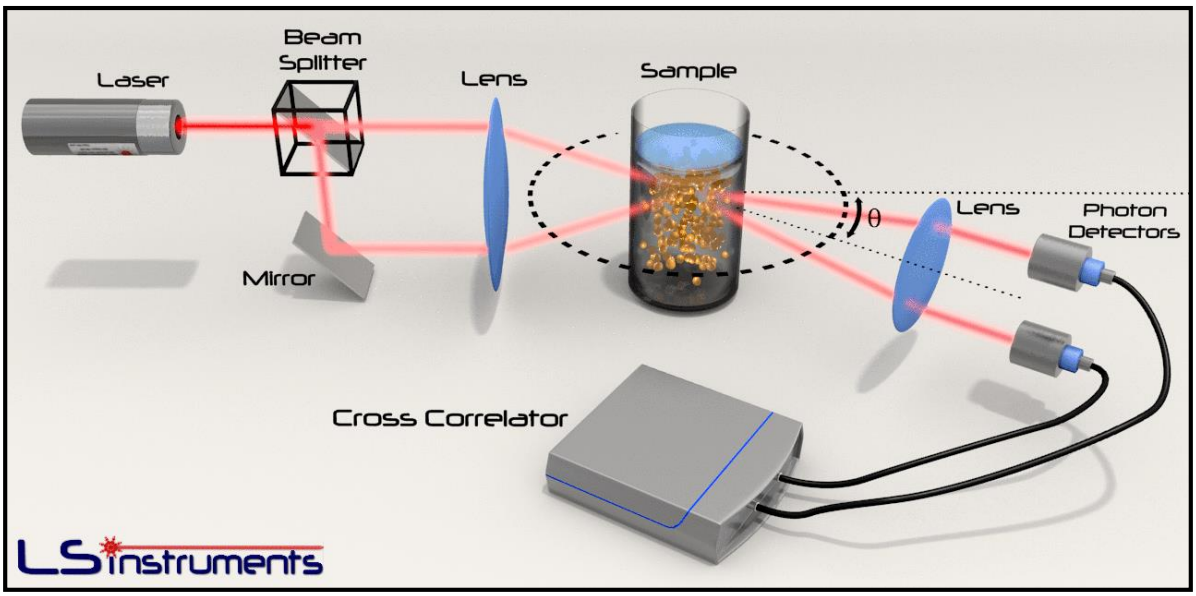


Image shows the 3D LS Spectrometer with optional items.

Specifications: Version 1.05

- The 3D LS Spectrometer performs both static (SLS) and dynamic light scattering (DLS) experiments at all scattering angles from 15° to 150° with a resolution better than 0.01°.
- 3D cross-correlation technology: DLS and SLS experiments are based on the assumption that only singly scattered light is detected. Already a small amount of multiple scattering can result in significant errors. This is why DLS and SLS frequently require dilution of the sample to avoid multiple scattering. With the 3D cross-correlation technology, multiple light scattering is suppressed efficiently, thus allowing measurements of many samples in their natural undisturbed state, without any need for dilution. Two simultaneous light scattering experiments are performed at the same scattering vector on the same sample volume in order to extract only the single scattering information common to both. The obtained intercept is > 17%.



3D cross-correlation technology: Instead of using only one beam, as in standard DLS & SLS, two beams are used to probe the sample. Cross-correlation of the two signals suppresses the contribution of multiple scattering.

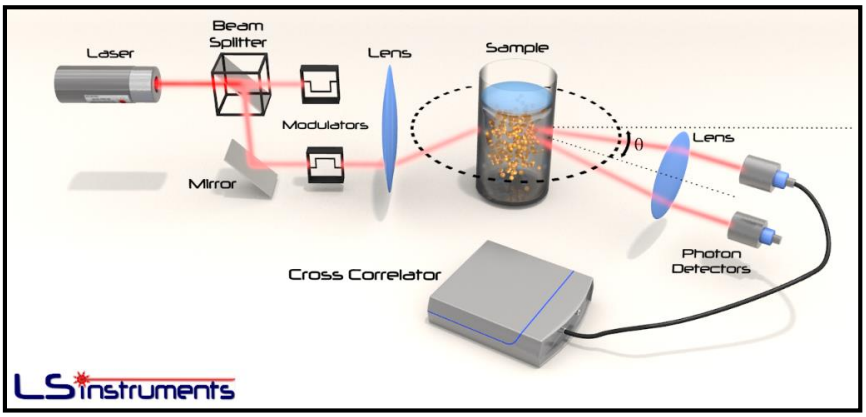
- Pseudo cross-correlation technology: all photon detectors have a certain probability to produce a second electronic pulse after they detect a photon (the so-called "after-pulsing-effect"), this results in significant errors for lag times lower than 1 µs. Since the 3D LS Spectrometer is equipped with two detectors that are assembled in pseudo cross-correlation mode, it automatically eliminates the after-pulsing-effect, thus allowing measurements down to 25 ns lag time which is required typically for small or fast diffusing particles.
- Two supplied cuvette holders allow measurements with cylindrical scattering cells of two different diameters (10 mm and 5 mm nominal outer diameters). Use of the 5 mm cylindrical cell reduces required sample volume to about 50 µL.

- Temperature controllable sample chamber with index matching vat for measurements in the suggested temperature range from 1ºC to 70ºC (requires additional thermal circulator, see options). Temperatures at or below the dew point (approximately 15 °C, but dependent upon relative humidity of environment) require purging with dry air or nitrogen in order to avoid condensation (purging facility not included). Direct on-line temperature measurement in the index matching vat via a PT-100 temperature sensor. Please note that the maximal guaranteed intercept of 17% gradually decreases at elevated temperatures. Maximum temperature can be increased with the High Temperature Module for 3D (see optional items).
- The two high sensitivity APD detectors of the LS Spectrometer allow measurement of samples with very weak scattering: quantum efficiency 65% at 660 nm, dark count < 250 count/s
- Two channel multi-tau correlator: auto and cross correlation, 12.5 ns minimum sampling time, 322 channels for multi-tau and more than 1000 channels for linear correlation, delay time range: 12.5 ns to 54976 s in multi-tau
- Laser not included (see options)
- Laser safety measures include an enclosed laser beam guide unit and beam shutter.
- Automated laser attenuation system combined with on-line laser intensity measurement. The Laser is automatically set to ideal measurement intensity. Manual setting is not required. This includes an automated safety control of the sensitive APD detector, such that it is only active under safe illumination conditions. Laser intensity can be recorded by the software for later normalization of the static light scattering data.
- 2.5 cm (1") diameter holders enable use of any standard optical filter in front of the detectors.
- PC (Windows) with flat screen (22") and preinstalled software
- Software (supplied) controls the spectrometer to acquire data for static and dynamic light scattering experiments. The standard software includes Cumulant and CONTIN Analyses for particle sizing as well as the LSI Zimm Plot analysis package. One free upgrade of the standard software will be provided free of charge within the first year after installation. Optional software packages (not included) are available to perform advanced analysis of dynamic and static light scattering data.
- Detailed manual
- The LS Spectrometer is delivered with and mounted on an aluminum bread board of 90 x 45 cm size. We suggest to mount this bread board on an optical table for optimum performance.
- The LS Spectrometer is a precision optical instrument that requires a laboratory environment for optimum operation. No more than 60% relative humidity, temperature range 17°-26°C, temperature stability +/- 1° C within 1 h and +/- 2°C within 24 h.

Suggested Optional Items

Modulated 3D

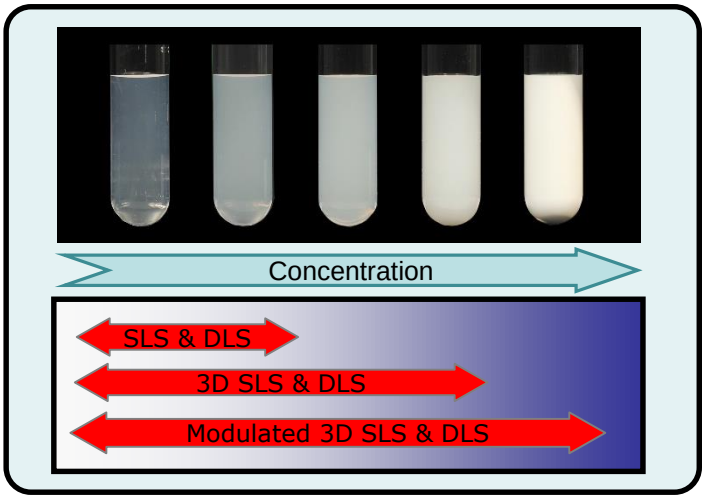
Although the 3D cross-correlation technique offers significant advantages to regular DLS and SLS, it also comes with a drawback. Because of cross-talk between the two detectors the maximal intercept is decreased from 1 to 0.25, effectively reducing the signal to noise ratio. The 3D modulation option eliminates this disadvantage. The two scattering experiments are temporally separated by modulating the incident laser beams and gating the detector outputs at frequencies exceeding the timescale of the system dynamics. This robust modulation scheme eliminates cross-talk between the two beam-detector pairs and leads to a four-fold improvement in the cross-correlation intercept.



By modulating the two illumination beams and synchronizing this with a modulation of the photon detectors, the signal to noise ratio can be improved significantly.

The modulated 3D cross-correlation mode is computer-selectable such that the standard 3D cross-correlation, pseudo-cross-correlation, and auto-correlation abilities are present and unaffected (>95% transmission through modulation unit).

Note: for Modulated 3D, the minimum available lag time is lengthened to 800 ns. Obtained intercept is > 65%.



The 3D cross-correlation technology significantly extends the range of accessible sample concentrations. The range is extended even further with the modulation technology while also improving the measurement quality significantly.

Laser Options

LSI provides high quality Lasers in a wide range of wavelengths and intensities that are suitable for the LS Spectrometer: 457 nm, 491 nm, 532 nm, 561 nm, 633 nm, 638 nm, 660 nm. Please contact LSI for quotes on specific wavelength and Laser intensities. To ensure a wide range of applications and good results even for small particle we suggest the DPSS Laser with 100 mW, 660 nm. Most frequently used Lasers:

- **DPSS 660 nm, 100, 300 or 500 mW:**

  Description: 660 nm, TEM00, coherence length > 10m, noise < 0.1% rms, Laser class 3B.

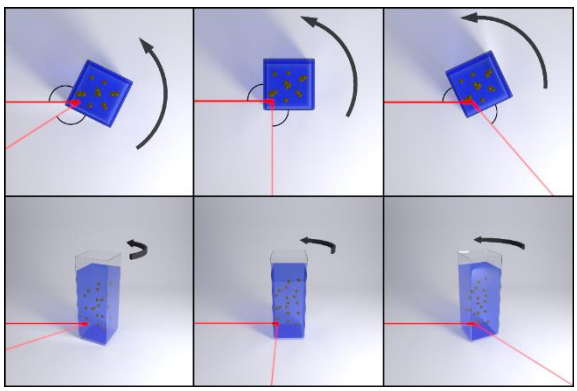
- **DPSS Laser 532 nm, 100 mW**

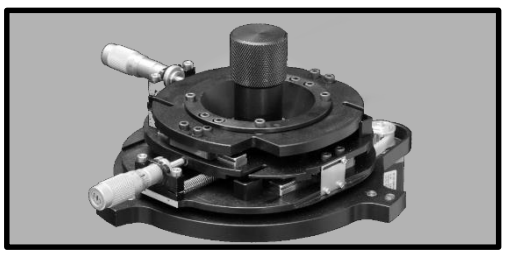
  Description: 532 nm, TEM00, coherence length > 10m, noise < 0.1% rms, Laser class 3B.

Other Lasers available at request. Please contact LSI for additional options.

Sample Goniometer

Sample goniometer for measurement of non-ergodic systems (e.g. gels, glasses, foams) by continuous rotation of the sample. Additionally this allows for DLS and SLS experiments with extremely turbid samples in square cells using the so-called θ-2θ detection, where the optical path length in the sample can be adjusted and significantly reduced (as low as 0.2 mm).





The main and sample cell goniometer can be controlled separately via the spectrometer control software. The optical path length in the sample is adjustable when rectangular cells are used.

External Circulator for Temperature Control: Julabo CF31

Constant temperature bath from -30° to 200°C with a temperature stability of +/- 0.02°C. This powerful circulator is perfectly suited for the LS Spectrometer. It reduces heating and cooling time significantly compared to other circulators. It can be pre-programmed to conduct measurement series at different temperatures with the software module of LS Instruments.

Included: Temperature bath and circulator, setup, calibration, software module for the LS Spectrometer

Notes: The suggested temperature range of the instrument itself (-5° to 70°C) is not increased with this circulator. Extending the temperature range requires the High Temperature Module.

High Temperature Module for 3D: 130° C

The 3D Cross-Correlation and Modulated 3D techniques offer significant advantages compared to regular DLS and SLS. These techniques are however very sensitive to temperature changes. The variation of refractive index induced by changing the sample temperature result in a decrease of the cross-correlation intercept due to a shift of the focal position of the 3D Cross-Correlation beams. The HT temperature module corrects the focal position automatically, such that the intercept remains sufficient for measurements at temperature even above 70°C.

Includes: all items in the standard High Temperature Module plus: two motorized lens holders, a software module to automatically and optimally position the lens holders depending on the selected sample temperature, the refractive index of the sample solvent and the type of cell used.

Requires: Julabo CF31; 3D Cross-Correlation Module, 3D Modulation Unit

Not Compatible with: Sample Goniometer

Note: Enables a guaranteed maximum sample temperature of 130°C, but typically temperatures as high as 140° can be reached (depends on sample, humidity and room temperature). Obtained intercept for a LUDOX© TM-50 diluted sample at 80°C typically is > 80% of the original intercept at 20°C, Guaranteed: > 70% of the original intercept at 20°C. At temperatures above 80°C the intercept will further decrease. The maximum temperature for which a sufficient intercept is typically still available is 130°C. The maximum accessible scattering angle is reduced to 145° when this module is mounted.

Laser Enclosure System

Depending on the equipped Laser and the laser safety standards of your laboratory, it might be necessary to enclose the LS Spectrometer with a laser protection system to fulfil the highest safety requirements possible.
For this purpose, we offer a suitable enclosure that can be mounted on an optical table (160 x 90 cm, please contact us for custom sized solutions).
The enclosure consists of a metal frame that supports a retractable laser curtain, certified according to EN 60825-4 (Laser Guards).