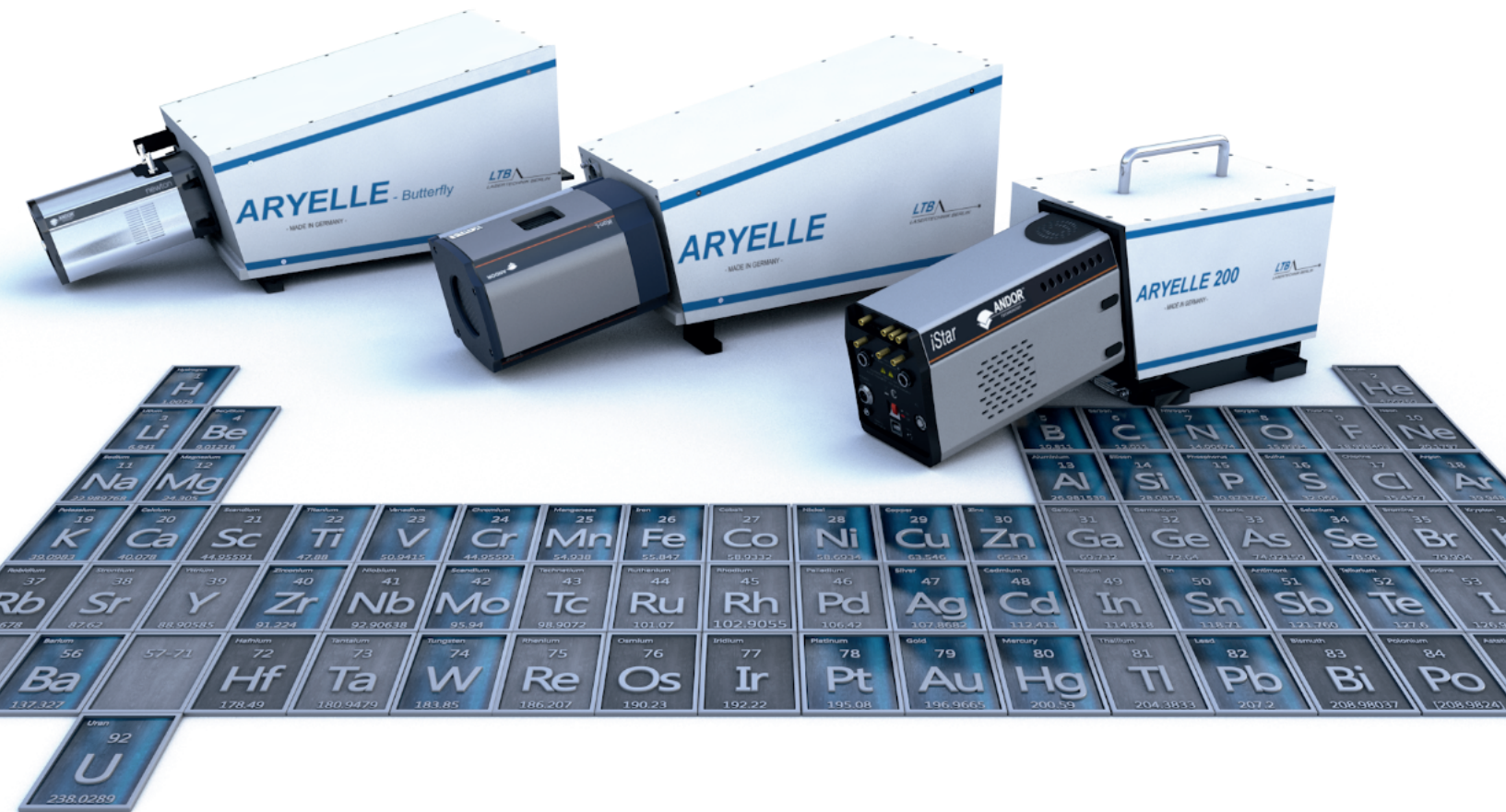
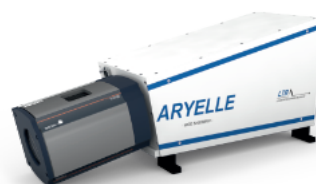
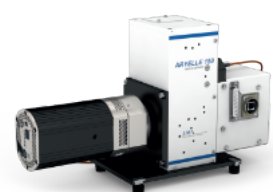


LIGHT. PRECISION. ANALYTICS



PRODUCT OVERVIEW

High Resolution Spectrometer - LIBS & Raman Systems - OEM Modules



	ARYELLE 150*	ARYELLE 200*		ARYELLE 400 / Butterfly*		DEMON - Series		ELIAS*				
Aperture	f/7	f/10		f/10		f/10		f/50				
Spectral resolution capability l/min. measurable FWHM	4,000 - 10,000	7,000 - 15,000		9,000 - 50,000		60,000 - 200,000		2.25 million - 8.8 million				
Wavelength range max.	190 - 1,100 nm	190 - 1,100 nm		190 - 1,100 nm		190 - 1,700 nm		157 - 1,100 nm				
Simultaneous inspection range	up to 600 nm	up to 600 nm		up to 740 nm		1 - 10 nm		8 - 400 pm				
Standard configuration 16 bit A/D conversion**				UV-versions		VIS-versions			I	II	III	
Detector	EMCCD (16 bit A/D conversion)	CCD	ICCD	CCD	ICCD	CCD	ICCD	CCD	ICCD	CCD	CCD	CCD
Slit width	35 x 35 µm	50 x 50 µm	50 x 50 µm	50 x 50 µm	50 x 50 µm	50 x 50 µm	50 x 50 µm	25 x 3,000 µm	25 x 3,000 µm	25 x 1,000 µm	25 x 1,000 µm	25 x 1,000 µm
Spectral resolving power l/min. measurable FWHM	6,000	9,000	7,500	30,000	14,000	15,000	20,000	75,000	75,000	2,250,000	3,200,000	8,800,000
Wavelength range, typ.	220 - 800 nm	200 - 750 nm	200 - 750 nm	190 - 330 nm	192 - 433 nm	330 - 850 nm	425 - 750 nm	190 - 900 nm	190 - 900 nm	190 - 550 nm	190 - 550 nm	190 - 550 nm
Resolution FWHM	36 - 133 pm	22 - 83 pm	27 - 100 pm	6 - 11 pm	13 - 31 pm	22 - 57 pm	21 - 37 pm	2.5 - 12pm	2.5 - 12pm	85 - 240 fm***	60 - 170 fm***	22 - 63 fm***
Gate width	-	-	5 ns	-	5 ns	-	5 ns	-	5 ns	-	-	-
Step width	100 ns	100 ns	1 ns	100 ns	1 ns	100 ns	1 ns	-	1 ns	-	-	-
Absolute accuracy	spectral resolution / 4	spectral resolution / 4		spectral resolution/4		spectral resolution / 4		spectral resolution x 4				
Dimensions (L x W x H) (Spectrometer without Detector)	(210 x 120 x 85) mm	(260 x 160 x 185) mm		(438 x 200 x 232) mm / (450 x 280 x 240) mm		(750 x 310 x 230) mm		(1,400 x 310 x 250) mm				
Weight (Spectrometer without Detector)	2 kg	7.3 kg		12 kg / 20 kg		25 kg		50 kg				

Extremely compact and costefficient high-resolution spectrometer for the material / elemental analysis in industry by means of LIBS and Raman spectroscopy.

ARYELLE 150 is an inexpensive echelle spectrometer with fibre coupling for EMCCD image detectors. It is characterized by a high sensitivity and a high imaging quality. The dispersion unit with grating and prism can be easily configured for different applications.

Applications:

- Laser-induced breakdown spectroscopy (LIBS)
- Spectroscopic process control
- Raman spectroscopy
- Absorption spectroscopy

Compact high-resolution spectrometer for the material / elemental analysis in industry by means of LIBS and Raman spectroscopy.

ARYELLE 200 is a compact echelle spectrometer with fibre coupling for different CCD, EMCCD, ICCD and CMOS image detectors. It is characterized by a high sensitivity and a high imaging quality. The dispersion unit with grating and prism can be easily configured for different applications.

Applications:

- Laser-induced breakdown spectroscopy (LIBS)
- Spectroscopic process control
- Raman spectroscopy
- Absorption spectroscopy

Powerful high-resolution spectrometer for the material elemental analysis in industry and science.

ARYELLE 400 is an echelle spectrometer that can generate spectra of relatively arbitrary dimension with high wavelength stability, spectral resolution and radiation throughput. It is used for the highly resolving spectral measurement of plasma emission lines. The lines can be detected simultaneously within a large spectral wavelength range. LTB also provides complete systems including laser system, beam guidance and sample chamber.

Applications:

- Laser-induced breakdown spectroscopy (LIBS)
- Spectroscopic process control
- Raman spectroscopy
- LIBS-Raman spectroscopy in one instrument

Very high resolution and optical throughput for the production and quality control of diode and solid state lasers.

DEMON is an echelle spectrometer for the highly resolved spectral measurement of emission and absorption lines from the UV into the NIR range. By applying a CCD/ ICCD array detector, the lines and their spectral vicinity within the corresponding inspection range can be recorded simultaneously.

Applications:

- Plasma spectroscopy (ICP, MIP, LIBS)
- Spectrometric process control
- Precise absolute wavelength determination of emission lines
- Manufacturing and quality control of diode and solid-state lasers
- Isotope spectroscopy

Highest-resolution commercial spectrometer series, for the characterization of lasers in the microlithography.

ELIAS is an echelle spectrometer with an extremely high resolution capability. It is used for the highly resolving spectral measurement of emission and absorption lines, particularly of laser lines. The line profiles can be detected simultaneously within their spectral vicinity with a signal-to-noise ratio of up to 40,000 by means of a CCD. Besides the high-resolution spectral measuring of laser lines, the intensity dynamics of up to 4 orders is of the utmost importance.

Applications:

- Excimer laser lithography
- Measuring of the spectral and temporal stability of diode lasers, solid-state lasers and emission lines of lamps

** Other configurations within the range of a/m values possible

*** Depending on the adjusted wavelength

* The spectrometric systems are a result of the very close co-operation between the ISAS und LTB. They were developed (patented) by the ISAS - Institute for Analytical Sciences, Department Berlin, and engineered for commercial use by LTB Lasertechnik Berlin GmbH.

LIBSlab



Why LIBS?

- Qualitative and quantitative multi-elemental analysis
- For solid, liquid and gaseous samples
- Almost non-destructive
- No sample preparation necessary
- Short measurement times
- Sample mapping

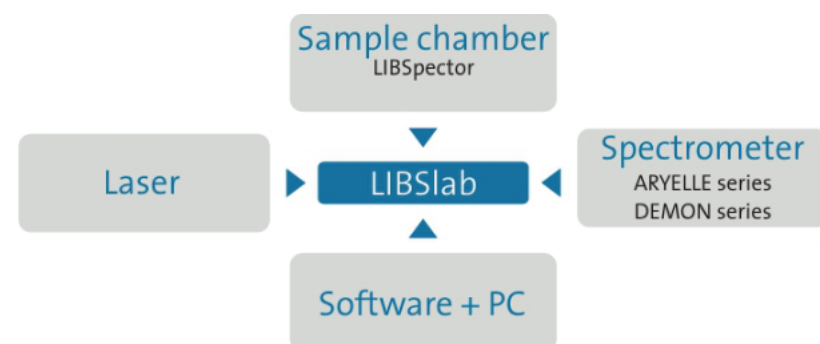
The LIBSlab is a compact and easy to use measuring instrument for the qualitative and quantitative multi-elemental analysis by means of laser-induced breakdown spectroscopy (LIBS). Due to its modular design, the LIBSlab provides individual configuration options to meet your requirements for a flexible use of LIBS technology in the scientific and industrial sectors.

LIBS technology

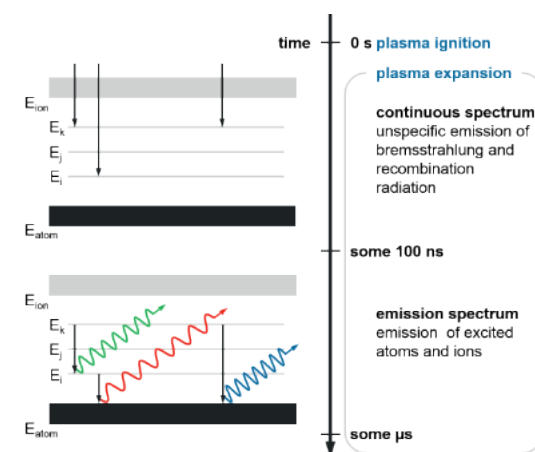
Laser-induced breakdown spectroscopy (LIBS) is a type of atomic emission spectroscopy, utilizing laser ablation and the subsequent atomic emission from the generated plasma for elemental analysis. Laser ablation is at present the only analytical method that offers direct sampling from any kind of material (solids, liquids, gases) without sample preparation. Short pulse laser radiation that is focused on the surface of a sample causes a local heating of some 10,000 °C and leads to the generation of a light emitting plasma - consisting of atoms and ions of the ablated material. The spectral analysis of characteristic atomic and ionic emission lines allows the determination of the atomic composition of the sample.

4 modules = LIBSlab

By individually combining and customizing the 4 modules - sample chamber, spectrometer, laser as well as software and PC - the LIBSlab can easily be adapted to customer needs, thus opening a wide range of applications.



Modular hardware and software components of the LIBSlab.

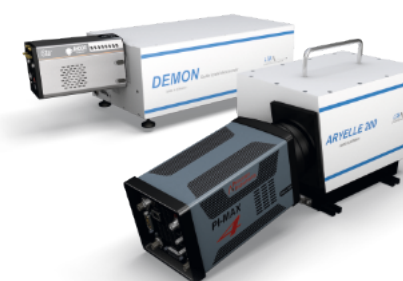


Applications:

- Laboratory measuring instrument
- Quality control
- Material characterization
- Scientific and industrial applications



LIBSpector – compact sample chamber for the LIBS analysis of solid, liquid and gaseous samples.



High-resolution echelle spectrometer series ARYELLE and DEMON made by LTB Lasertechnik Berlin.

Sample chamber

The LIBSpector is a compact sample chamber for the LIBS analysis of solid, liquid and gaseous samples. It comes with a laser class 1 housing and is equipped with safety interlock, laser protection window for observation and exhaust flange for safe use. No additional laser safety precautions are therefore required at installation site. The beam of the laser, whose head can be incorporated in the chamber housing, is directed to the sample via telescope optics and generates a light emitting plasma. The plasma light is guided to the spectrometer via mirror and fiber optics. Sample mapping is provided by an integrated motorized and software-controlled XYZ stage. For precise sample positioning and focusing, a pilot laser and a real-time video monitoring based on a high-resolution CMOS camera are installed. Several sample holders for solid, liquid and gaseous substances provide universal application capability and can be adapted to your individual requirements.

Spectrometer

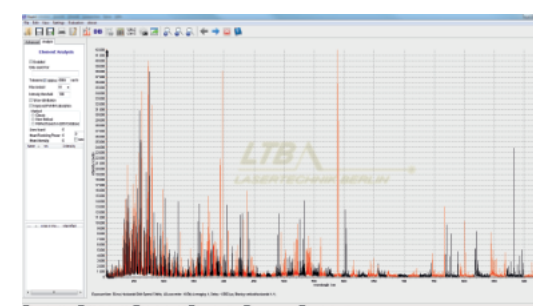
All spectrometers made by LTB Lasertechnik Berlin are based on a dispersion unit with echelle grating and prism and feature high spectral sensitivities and excellent imaging qualities. The LIBS emission spectrum of a sample can be measured simultaneously from the UV to the NIR range by using a high-resolution spectrometer from the ARYELLE and DEMON series. In combination with different CCD-, EMCCD-, ICCD- and CMOS detectors the spectrometers provide a wide range of customer applications.

Laser

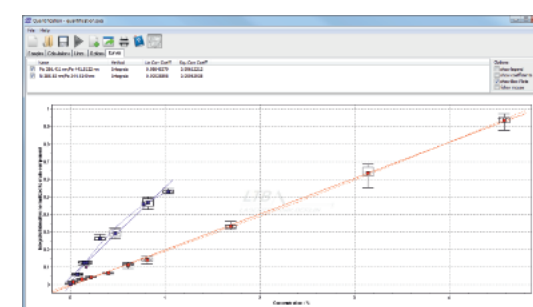
For plasma generation, various Nd:YAG and excimer lasers with different wavelengths and pulse energies can be applied. The choice of the optimal LIBS laser setup depends on your individual application and can be made by yourself. Many years of experience gained with diverse laser types and manufacturers enable us to give you competent advice.

Software and PC

The operating and evaluation software Sophi developed by LTB Lasertechnik Berlin provides access to all device functions of the spectrometer-detector unit, the LIBSpector and laser via notebook or PC-based user interface. After transforming the detector information into wavelength-dependent intensity values, all lines of the gained LIBS spectrum are automatically analyzed with the integrated NIST atomic data base and qualitatively assigned to the corresponding elements. For quantitative multi-elemental analysis of unknown samples, calibrations with reference materials are a precondition. The implemented script-based control allows the automatization of recurring measuring and evaluation procedures and provides you maximum flexibility. Recalibration of the wavelength scale of the spectrometer-detector unit are easily performed with the auto-calibration function by using the included mercury lamp.



User interface of the operating and evaluation software Sophi.



Calibration curves for quantitative analysis.

Applications:

- Geology
- Metallurgy
- Environment
- Gemology
- Forensics



CALIBSO

All-in-one LIBS System

CALIBSO is a laboratory measurement solution based on laser-induced breakdown spectroscopy (LIBS). The technology allows qualitative and quantitative multi-element analysis. By means of a high-quality sample imaging, pre-selected measurement positions are analysed contact free and with high spatial and spectral resolution. The easy-to-use software Sophi nXt ensures the reliable control of all components and forms the central interface between operator and technology. The robust housing with its integrated interlocking circuit ensures safe handling and a long-term protection of the implemented cutting-edge components.



High-quality sample imaging with micrometer sized resolution, single spot measurement or area scans



Durable diode pumped laser with a spot size of $\sim 70\mu\text{m}$ on sample surface for high spatial resolution



High-resolution echelle spectrometer with spectral resolving power in the pm-range and a large simultaneous wavelength range



Material identification, classification and quantification of bulk materials or surfaces with univariate or multivariate data analysis



Fig. 1: Sample image - steel plate

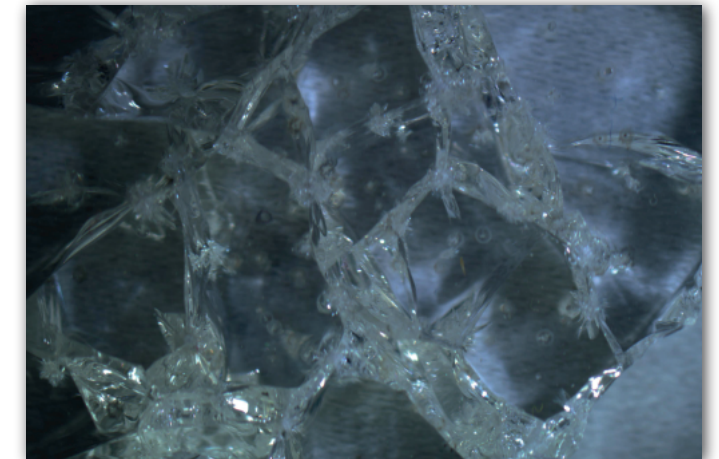
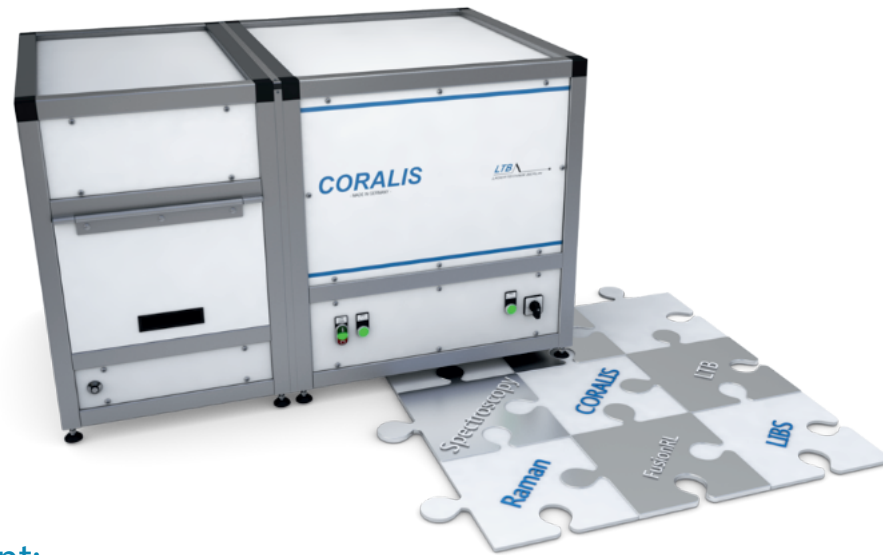


Fig. 2: Sample image - shattering glass

Specifications

Measuring technique	Laser-induced breakdown spectroscopy (LIBS)	Qualitative and quantitative multi-element analysis
	Imaging	High quality imaging on a coaxial beam path with a high spatial resolution better than $50\mu\text{m}$
Samples formats	Solid	Bulk samples, any shape Sample size up to $50 \times 50 \times 50\text{mm}^3$
	Liquid	In sample vessel (cuvette, Petri dish, multiwell plate, etc.)
LIBS	Wavelength laser	1064 nm
	Excitation	Diode pumped
	Laser repetition rate	40 Hz
	Pulse energy on sample	1 - 26 mJ, stepless adjustable
	Wavelength range	210 nm - 850 nm
	Spectral resolution	28 pm - 113 pm
XYZ stage	Travel range	X = 145 mm, Y = 95 mm, Z = 50 mm
	Resolution	10 μm
	Repeatability	10 μm
Sample Imaging	CMOS camera	6 Mpixel
	Image field	$\sim 17 \times 25\text{mm}$
General properties	Dimensions	810 mm x 1100 mm x 590 mm
	Weight	< 200 kg
	Safety	Laser class 1
	Temperature range (in operation)	15 - 30 °C
	Relative air humidity	15 - 80 %, non-condensing
Software	Measuring methods	Single measurement
		Continuous single measurement
		Multipoint measurement
		Mapping
		Depth profile combined with single, multi-point measurements, mapping
Analysis	LIBS	Measurement "On the fly"
		Elemental analysis (NIST database emission lines)
		Material classification (PCA or PLS-DA)
		Material quantification univariate
Accessories	Standard samples	Material quantification multivariate (PLS, Lasso)
		Reference materials for LIBS integrated in sample table



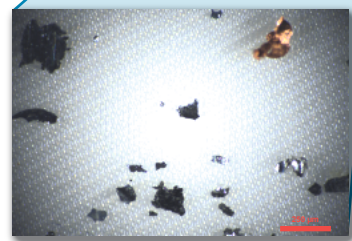
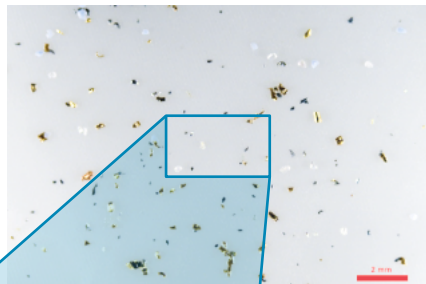
Analyze what you want:

- Elemental composition or chemical structure
- Material identification, classification or quantification
- Particles or surfaces
- Solid samples or liquids
- Single spots or area scans

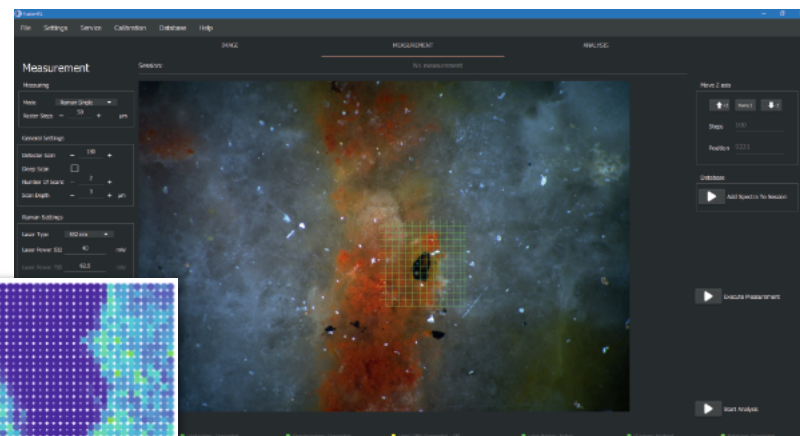
CORALIS

Combined Raman LIBS System

The CORALIS system unites the two high complementary spectroscopic techniques LIBS and RAMAN. The combination allows the determination of elemental and molecular and/or structural composition of a sample on the same sample spot. With CORALIS single and multiple point measurements or large area maps pre-selected from the high quality sample image are possible. Solid and liquid samples can be analyzed either with Raman or LIBS or with both methods sequentially. The ablative nature of LIBS qualifies the instrument for depth profile investigations. The unique two-wing echelle spectrometer as core part is able to provide high spectral resolution, large detection range and high light-throughput on an unrivaled level. The robust housing and the integrated interlocking circuit ensure safe handling of the device and protection of the installed components. Due to the exceptional combination of imaging, molecular and elemental analysis CORALIS provides unique advantages for applications in many fields e.g. technical cleanliness, forensics, geology and battery research.



Images of particles taken with the CORALIS in "Full Image" and "Detail Image" view.



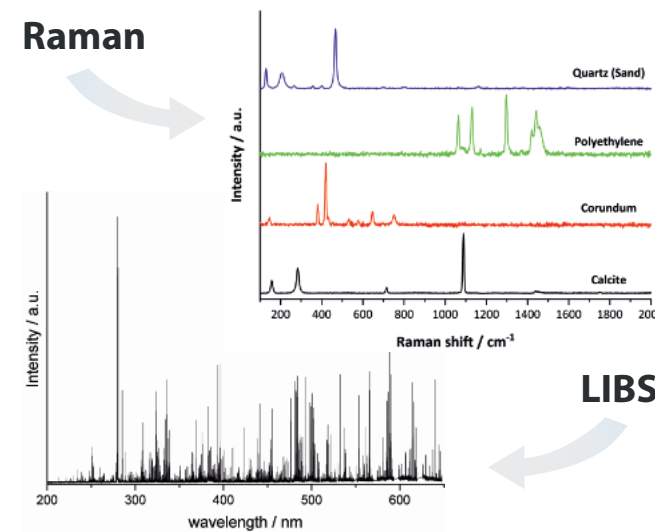
Si-288

FusionRS interface and Intensity map of different LIBS lines reveal the spatially resolved elemental distribution on large sample areas.

Applications:

- Particle analysis
- Gemology
- Forensics
- Mineralogy
- Environmental
- Technical cleanliness

Raman



By means of the powerful software package FusionRL the CORALIS user is given:

- High quality sample imaging – with micrometer sized resolution and centimeter sample overview
- The free choice and free combination of LIBS or/and Raman measurements
- A convenient tool for rapid particle recognition
- An unbeatable flexibility in the design of the experiment
- FusionRL supports single spot measurements, area scans in one ROI (region of interest), multiple ROI's and mapping of depth profiles
- A powerful and yet continuously expanded data analysis software package
- It provides fast methods of material classification for both, LIBS and Raman data as state-of-the-art tools
- For sample quantification
- Included are advanced tools for data pretreatment (base line correction, normalization,...), calibration and uni- and multivariate data analysis

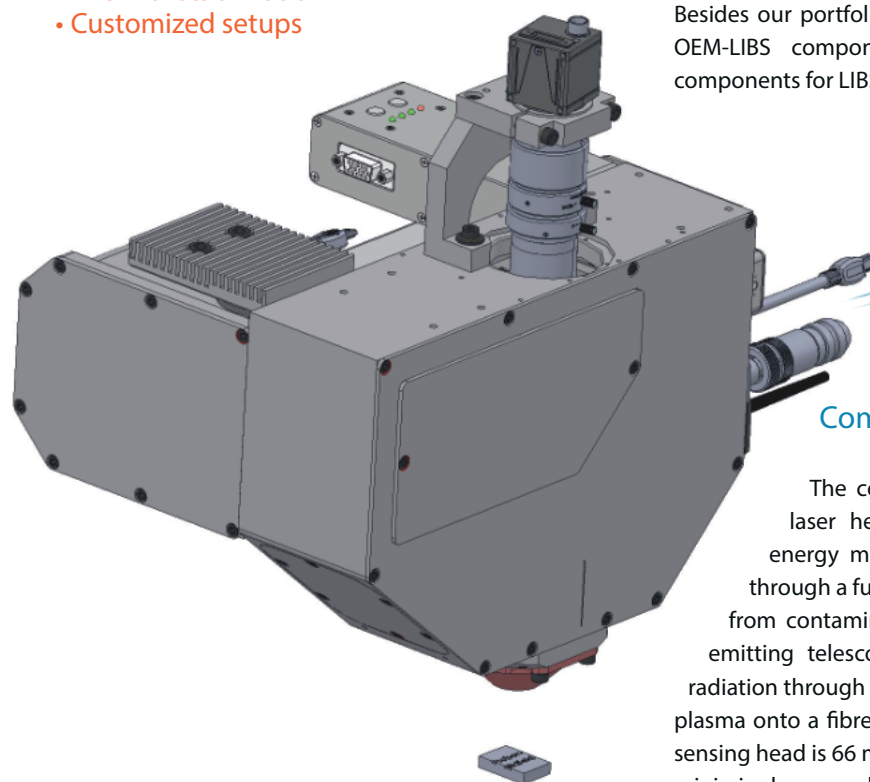
Specifications

Measuring technique	LIBS	Laser induced breakdown spectroscopy for qualitative and quantitative multi element analysis	
	Raman	For analysis of molecular or crystal structures	
	Imaging	Particle detection Particle size Particle area	
	Compatibility	To JOMESA HFD and JOMESA PSE regarding the transfer of spatial coordinates of particles Enables the precise targeting of particles previously measured with JOMESA	
Sample formats	Solid	Bulk samples, any shape, (minimum sample size up to 50 x 50 x 30 mm ³ is guaranteed), Particle on particle carrier (filter)	
	Liquid	In the sample vessel (cuvette, Petri dish, multiwell plate, etc.)	
LIBS	Wavelength laser	1064 nm	
	Impulse energy on sample	1.0 - 30 mJ, stepless	
	Wavelength range	193 nm - 520 nm	
	Spectral resolution	13 pm - 35.8 pm	
Raman	Wavelength laser	532 nm and 785 nm	
	Laser power on sample	0.5 - 50 mW, stepless	
	Detection range	532 nm: 100 - 4,500 cm ⁻¹ 785 nm: 100 - 3,000 cm ⁻¹	
	Spectral resolution	532 nm: 2.5 - 2.0 cm ⁻¹ 785 nm: 1.7 - 1.4 cm ⁻¹	
XYZ - Stage	Travel range	X = 50 mm; Y = 50 mm; Z = 35 mm	
Sample imaging	Overview image	Field of view (28 x 19) mm	
	Detail image	Field of view (3.5 x 2.5) mm	
General properties	Dimensions	1200 mm x 750 mm x 750 mm	
	Weight	225 kg	
Software	Measurement methods	Single measurement Continuous single measurement Multipoint measurement Mapping Depth profile combined with single and multi-point measurements, mapping	
	Analysis	LIBS	Element analysis (NIST database emission lines) Material classification (PCA or PLS-DA) Material quantification univariate Material quantification multivariate (PLS, Lasso)
		Raman	Baseline correction Peak identification Database comparison for sample identification Compatibility with Wiley KnowItAll® software
	Accessory parts	Standard samples	Reference materials for LIBS and Raman integrated on the sample table

- Adaption of standard solutions to customer's demand
- Pre-calibration or calibration tool for certain applications
- Increased robustness for harsh environment
- Integration into existing processes
- Thermal stabilization
- Customized setups

OEM-LIBS

Besides our portfolio of standard components LTB is providing a wide range of OEM-LIBS components. Based on the long-term experience customized components for LIBS applications are available.

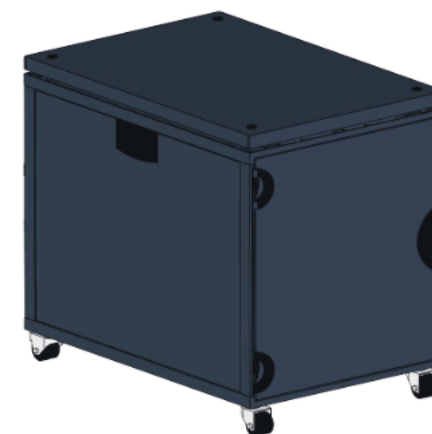


Compact Measuring Head CMH-66

The compact and robust LIBS measuring head CMH-66 combines laser head, transmitting/receiving optics, sample observation and energy monitoring in one compact housing. Compressed air purged through a funnel at the measuring head exit protects the entrance window from contamination and helps to reduce particles in the beam path. The emitting telescope is coaxial to the receiving telescope and focuses the radiation through the pierced main mirror of the receiving optics and images the plasma onto a fibre connected to the spectrometer. The working distance to the sensing head is 66 mm. The laser spot diameter on the sample is approx. 75 μm . To minimize losses and reflections in the optical path, all lenses are AR-coated. The use of broadband coated mirror optics has the advantage of avoiding chromatic errors.

Specifications - CMH-66

Measuring technique	LIBS	Laser induced breakdown spectroscopy for qualitative and quantitative multi element analysis
	Imaging (optional)	Sample observation
Laser	Wavelength	1064 nm
	Impulse energy on sample	1 - 30 mJ (integrated attenuator)
	Excitation type	Diode pumped
	Repetition rate	40 Hz
	Laser spot size on sample	~75 μm
	Spectrometer	Wavelength range typ.
	Spectral resolution typ.	27 pm - 100 pm
	Available detector	ICCD / CCD / CMOS
General properties	Dimensions (measuring head)	350 mm x 210 mm x 175 mm (without sample observation)
	Weight (measuring head)	8 kg
	Length supply line	5 m
	Working distance	66 mm
	Laser safety	Class 4
	Operating ambient temperature	+18° C ... +25°C
	Compressed air	Optional connection on measuring head
Imaging (optional)	Camera	CMOS
	Field of view	27 mm x 18 mm
	Minimal resolution	20 μm



Supply unit

The LIBS supply unit consists of a 19" rack cabinet with integrated plug-in modules for the individual components of the analysis system, including temperature-stabilized spectrometer and computer system.

The LIBS supply unit can be equipped with different spectrometer systems. Further components of a customer system can also be integrated. In combination with the CMH-66, a flexible, industrial LIBS system can be created which is applicable to a wide range of applications.

The included electronic box LIBSControl controls the interaction between software, laser system and spectrometer. It contains a mercury lamp which is used for automated calibration of the spectrometer. Fans installed in the supply cabinet ensure a sufficient ventilation of the supply unit.

LIBSControl

The LIBSControl forms the central interface between spectrometer, detector and laser source and thus enables easy handling of the timing. The provided inputs and outputs for the trigger signals are centrally controlled and evaluated via the connected interface in the software. Complex experimental setups such as laser-induced plasma spectroscopy (LIBS) can be performed intuitively. The integrated mercury lamp is used for fast and automated calibration of the spectrometer.



Industrial Rack

The Aryelle 200 together with its detector and cooling units are integrated in an industrial 19" rack for an easier assembling into an industrial system. Additionally, the optional LIBS Control and the thermal controller are arranged in the rack as well. For comfortable handling, all connectors for spectrometer and thermalization are accessible from the outside and can be easily connected / disconnected.

Specifications - Industrial Rack

Spectrometer	Integrated components	Aryelle 200, LIBScontrol, temperatur controller
	Chopper	Optional
	Detector	ICCD / CCD / CMOS
	Temperatur stabilization	Spectrometer, detector optional
General properties	Dimensions	55 mm x 483 mm x 265 mm
	Weight	~ 50 kg (incl. spectrometer, LIBScontrol, detector)

LTB Lasertechnik Berlin GmbH

established in 1990, is an innovative developer and manufacturer of short-pulse UV-lasers, high resolution spectrometers and laser-based measuring analyzers, marketing its products worldwide.

We provide you:

- Laser sources for the industrial analytics and medical diagnostics
- Highest-resolution spectrometers for the development and production of lasers, esp. diode lasers and for the laser lithography
- Laser-based measuring techniques for the spectroscopic material analysis and process analytics (LIBS and Raman)

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