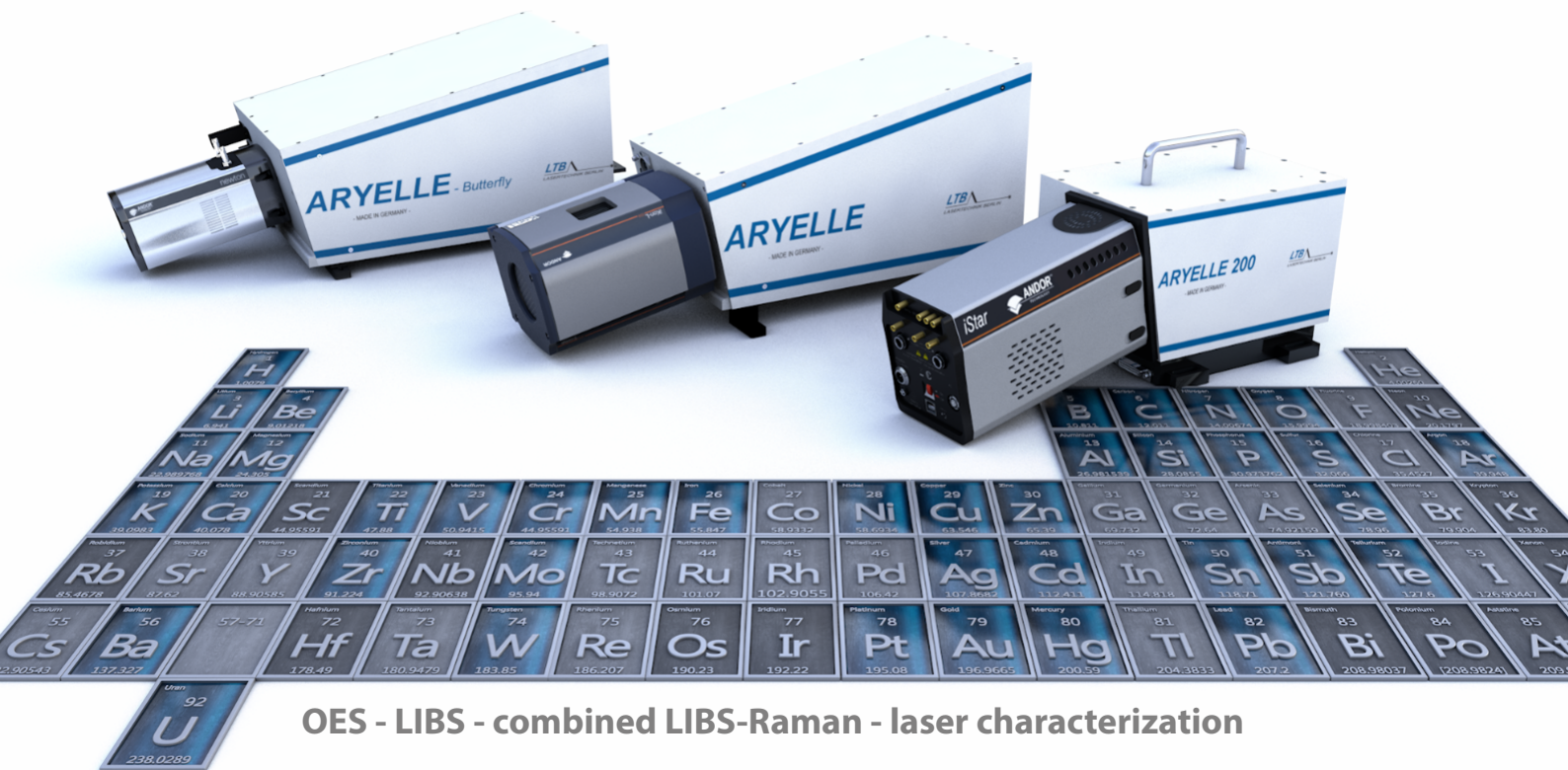


**LIGHT. PRECISION. ANALYTICS**

**High-Resolution**  
**4,000 - 8,800,000**

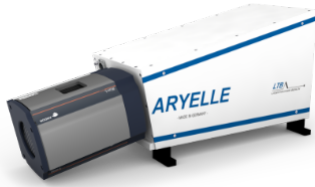
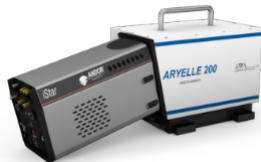
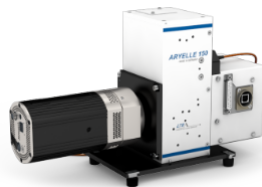
**UV-VIS-NIR range**



**OES - LIBS - combined LIBS-Raman - laser characterization**

# **Echelle** **Spectrometers** **& LIBS systems**

**for laboratory and industrial applications**



	ARYELLE 150*		ARYELLE 200*		ARYELLE 400 / Butterfly*				DEMON - Series		ELIAS*		
Aperture	f/7		f/10		f/10				f/10		f/50		
Spectral resolution capability I/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 I/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 with LIBS and Raman spectroscopy 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.



CORALIS

Combined Raman LIBS System

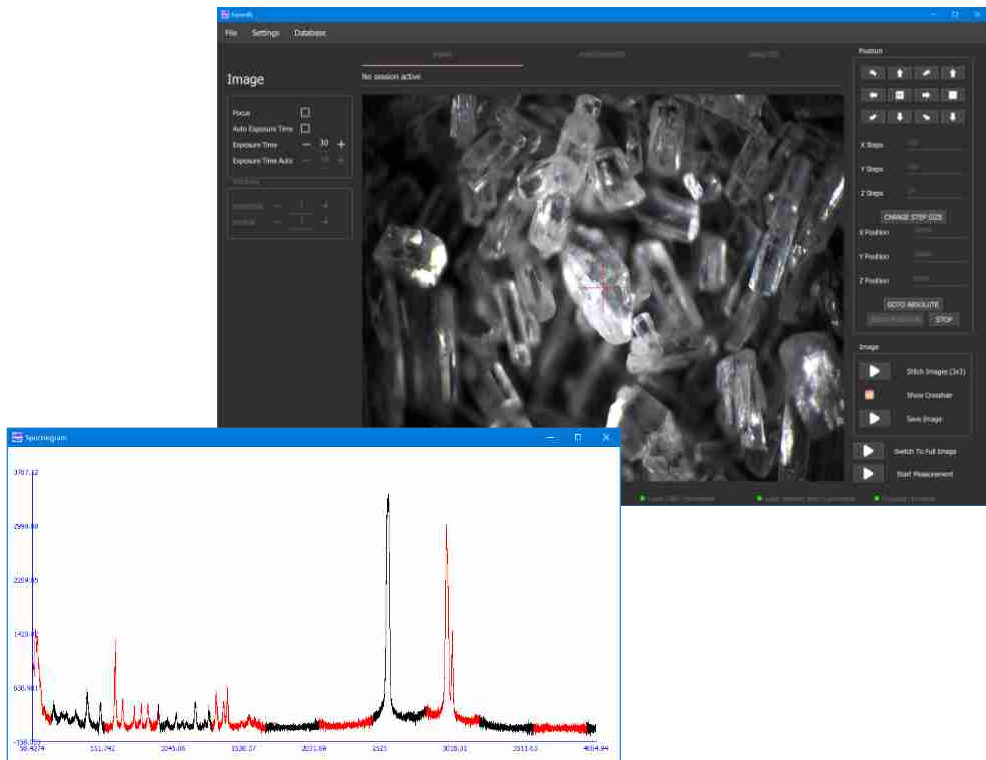
The CORALIS system unites the two high complementary techniques LIBS and RAMAN. By means of a high-quality sample image, pre-selected measurement positions are analysed either with Raman or LIBS or with both methods sequentially of solid and liquid samples. The unique two wing echelle spectrometer as core part is able to provide high resolution, large range and high light-throughput on an unbeatable level. The laser-safe housing and the integrated interlocking circuit ensure user-friendly handling of the device and protection of the installed components.

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

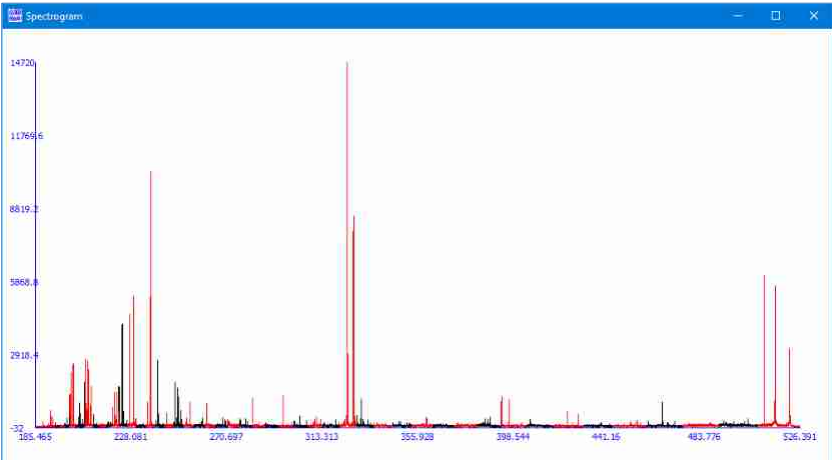
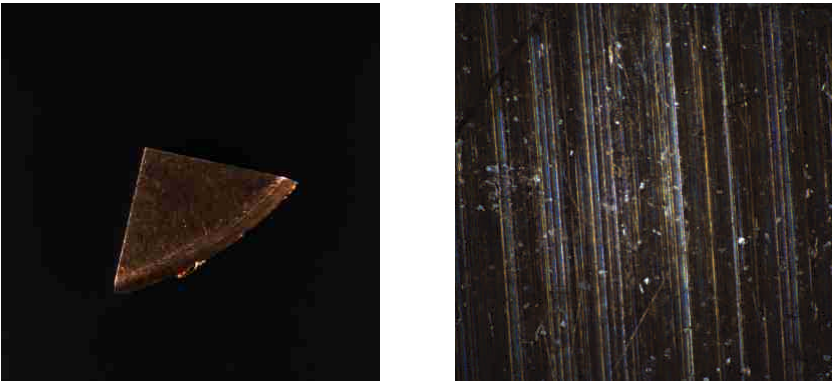
Applications:

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



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	Laser-induced breakdown spectroscopy (LIBS) RAMAN spectroscopy	Qualitative and quantitative multi-element analysis Analysis of molecule structures by the detection and interpretation of scattered light
LIBS	Laser Wavelength range Resolution	1064 nm (up to 50 mJ pulse energy) 193 nm - 520 nm 0.013 nm - 0.035 nm
Raman	Laser Wavelength range  Resolution	532 nm and 785 nm (up to 50 mW) 532 nm: 100 - 4,000 cm <sup>-1</sup> 785 nm: 100 - 3,000 cm <sup>-1</sup> 532nm: 2.5 - 2.0cm <sup>-1</sup> 785nm: 1.7 - 1.4cm <sup>-1</sup>
XYZ stage	Travel range Resolution Repeatability	X = 50 mm , Y = 50 mm , Z = 35 mm 1 µm 1 µm
Sample Imaging	Overview image  Detail image	Image field (28 x 19) mm magnification 10 x Image field (3.5 x 2.5) mm magnification 80 x
General	Dimensions Safety	1200 x 750 x 750 mm Laser class 1
Software Features	Measuring methods  Analysis	Single or average spectra recording Sample mapping and depth scans Particle and particle size identification Univariate and multivariate analysis Material identification analysis Database with reference spectra for fast sample identification
Accessories	Standard samples	Certified standard samples for size calibration Reference samples for LIBS and Raman



# LIBSlab

Chemical multi-elemental analysis with LIBS in modular benchtop design



## 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

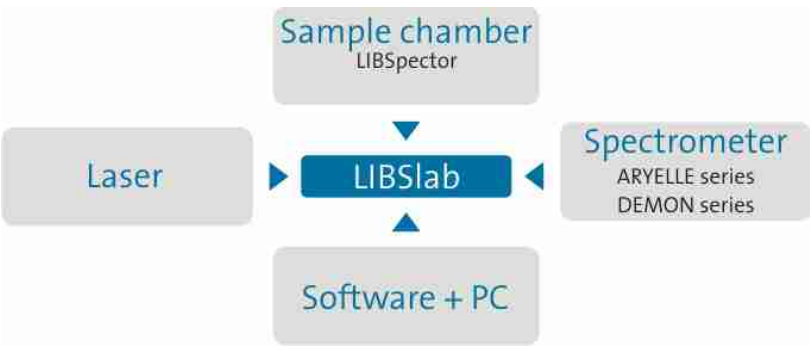
The LIBSlab is a compact and easy to use measuring instrument for the qualitative and quantitative multi-elemental analysis by means of laserinduced breakdown spectroscopy (LIBS). Due to its modular design, the LIBSlab provides individual configuration options to meet your requirements for a flexible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

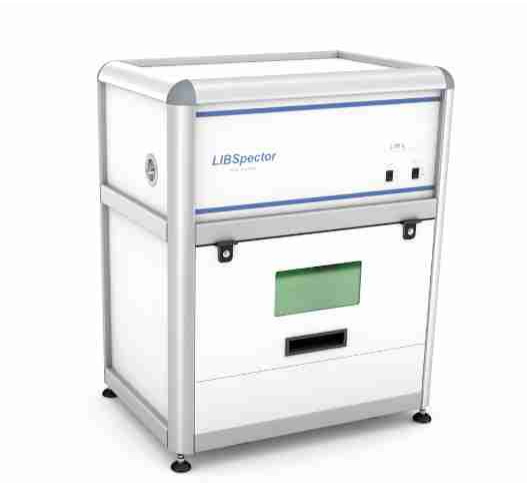
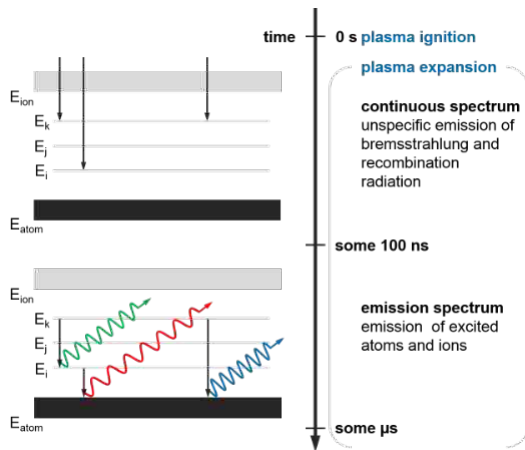
By individually combining and customizing the 4 modules - sample chamber, spectrometer, laser as well as software and PC - the LIBSlab can easily be adapted to customer needs, thus opening a wide range of applications.



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

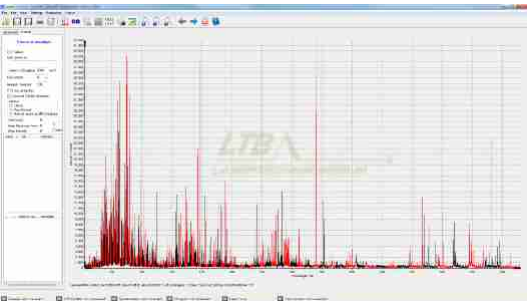
All spectrometers made by LTB Lasertechnik Berlin are based on a dispersion unit with echelle grating and prism and feature highspectral sensitivities and excellent imaging qualities. The LIBS emission spectrum of a sample can be measured simultaneously from the UV to the NIR range by using a high-resolution 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

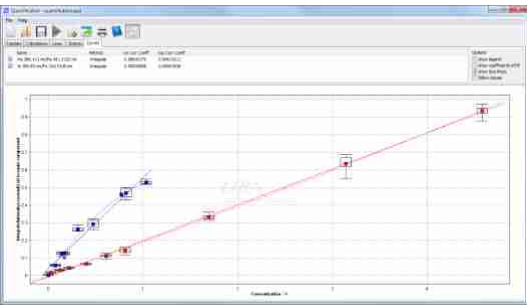
For plasma generation, various Nd:YAG and excimer lasers with different wavelengths and pulse energies can be applied. The choice of the optimal LIBS laser setup depends on your individual application and can be made by yourself. Many years of experience gained with diverse laser types and manufacturers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



## 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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