Spectrometers

Specifications ARYELLE 400 - with CCD and Chopper

		ARYELLE-VUV	ARYELLE-UV-VIS-NIR	ARYELLE-Butterfly
Set-up 1	Wavelength range*	190 - 330 nm	330 - 850 nm	190 - 330 / 330 - 850 nm
	Spectral resolving power */**	30,000	15,000	30,000 / 15,000
	Spectral resolution*/**	6 - 11 pm	22 - 57 pm	6 - 11 / 22 - 57 pm
	Detector	CCD: 2,048 x 512 pixels, 27.6 x 6.9 mm image area		
	Step width, min.	0.1 µs with chopper		

		ARYELLE-VUV	ARYELLE-UV-VIS-NIR	ARYELLE-Butterfly
Set-up 2	Wavelength range*	192 - 420 nm	300 - 950 nm	192 - 420 / 300 - 950 nm
	Spectral resolving power */**	25,000	15,000	25,000 / 15,000
	Spectral resolution*/**	8 - 17 pm	20 - 63 pm	8 - 17 / 20 - 63 pm
	Detector	CCD: 1,340 x 400 pixels, 26.8 x 8 mm image area		
	Step width, min.	0.1 µs with chopper		

Specifications ARYELLE 400 - with ICCD

		ARYELLE-VUV	ARYELLE-UV-VIS-NIR	ARYELLE-Butterfly
Set-up 3	Wavelength range*	190 - 330 nm	275 - 750 nm***	190 - 330 / 275 - 750 nm
	Spectral resolving power */**	14,000	9,400	14,000 / 9,400
	Spectral resolution*/**	13 - 24 pm	29 - 80 pm	13 - 24 pm / 29 - 80 pm
	Detector	ICCD: 1,024 x 1,024 pixels, 13.3 x 13.3 mm image area		
	Step width, min.	1 ns		
	Gate width, min.	5 ns		

		ARYELLE-VUV	ARYELLE-UV-VIS-NIR	ARYELLE-Butterfly
General	Aperture	f/10	f/10	f/10
	Focal length	400 mm	400 mm	400 mm
	Slit width	50 µm	50 µm	50 µm
	Dynamic range	15 bit, AD-conversion 16 bit		
	Light coupling	Fibre or mirror optics		
	Wavelength calibration	Mercury spectral lamp		
	Absolute accuracy	Better than spectral resolution/4		
	Computer	PC with TFT and Windows		
	Software	Sophi		
	Dimensions without detector (L x W x H)	(438 x 200 x 232) mm (17.24x7.84x9.13) inch	(438 x 200 x 232) mm (17.24x7.84x9.13) inch	(450 x 280 x 240) mm (17.72x11.02x9.45) inch
	Weight	12 kg / 26.5 lbs	12 kg / 26.5 lbs	20 kg / 44.1 lbs

* Depending on the chosen grating and prism; other ranges are possible (down to 175 nm)

** Depending on the slit width; other widths are possible

*** Spectral gaps: 645.3 nm - 645.4 nm / 664 nm - 664.4 nm / 683.5 nm - 684.5 nm
704.2 nm - 705.9 nm / 726.2 nm - 728.7 nm

The above mentioned wavelength ranges are the standard configurations. **Other wavelength ranges as well as other spectral resolutions than specified can be offered on request.** Other camera models are available.

Subject to technical changes

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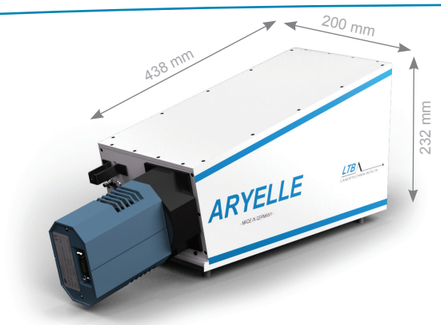
LTB LASERTECHNIK BERLIN

ARYELLE 400 Spectrometers

Interaction of light and matter –
induced and analyzed with lasers
and measuring systems of LTB

Spectrometers



ARYELLE 400*

ARra**Y** Ech**ELLE** Spectrograph

- **High resolution and sensitivity**
- **Large wavelength range**
- **Simultaneous detection**
- **High imaging quality**

ARYELLE 400 is an echelle spectrometer with a large spectral wavelength range, high spectral resolution and high light throughput. It features a very high accuracy and stability of the wavelength scale.

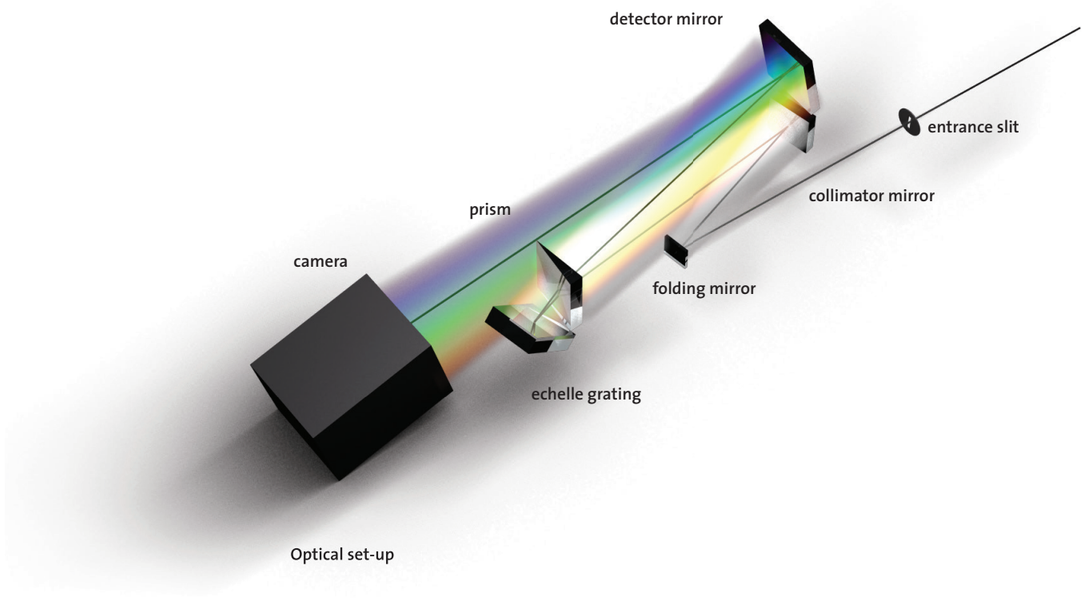
The ARYELLE 400 is used for the high-resolution measurement of plasma emission lines. The spectrometer can be equipped with many CCD, EMCCD, ICCD or CMOS cameras of different manufacturers. LTB also provides complete customized systems including laser system, beam guidance and sample chamber.

Application fields of the ARYELLE spectrometers are the material and elemental analysis by means of plasma and Raman spectroscopy. Due to its compact design it is well suited for the process control, e.g. in the steel, glass and ceramics industry, the geology, gemology and environmental analysis.

Spectrometer concept

Optic arrangements using echelle gratings are particularly suited for emission spectrometry. They achieve extremely high spectral resolution and broad-band efficiency by the diffraction of the light in a multitude of high interference orders. A prism separates the echelle orders in cross dispersion direction generating the typical two-dimensional image of the echelle spectrum on the detector. To effectively use the resolution capability of the echelle grating and to resolve the lines according to the typical pixel width of the array detector, high imaging quality is guaranteed by applying a patented optical layout. The excellent imaging quality allows to achieve a very high spectral resolution at a very low order crosstalk.

The ARYELLE can be freely dimensioned regarding the parameters of the entrance slit, the echelle grating, the prism and the imaging optics. This makes it possible to adapt the wavelength range and the spectral resolution to nearly all applications.



Optical set-up

Spectrometers are available e.g. for the VUV-UV range of 175 - 330 nm and the UV-VIS-NIR range of 330 - 850 nm. Moreover, it is possible to achieve very high spectral resolutions up to a resolving power of 50,000, if the covered spectral range is made smaller accordingly.

For measuring wide-range LIBS spectra and for combining LIBS and Raman spectroscopy, the

ARYELLE 400-Butterfly Spectrometer

has been developed. It consists in principle of two ARYELLE spectrographs; their spectra illuminate one shared detector.
Thus the double spectrograph ARYELLE-Butterfly provides the opportunity to measure spectra with an enormous variability. Separating the spectral range and using only one detector provides a cost-efficient solution to use the detector most efficiently, to shorten the read-out time and to flexibly arrange the illumination times.

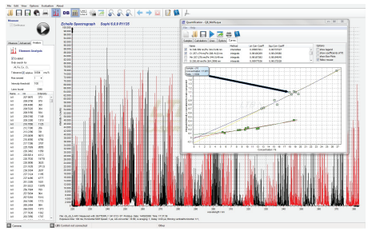
The optical and mechanical concept result in a compact, thermally and mechanically extremely stable set-up. It has an automatic internal calibration. By exclusively applying reflection optics with broad-band UV coatings, chromatic aberrations are avoided and there are no limitations in choosing the measurement wavelengths. The light coupling into the spectrometer is realized via a SMA fibre coupling for the UV-VIS-NIR range or via pure reflection transfer optics for the VUV range.

LTB Lasertechnik Berlin offers its ARYELLE-Butterfly spectrometer either with a CCD with chopper or with an ICCD. Applying a CCD in combination with a chopper instead of an ICCD as detector allows to achieve a higer spectral resolution as a result of the higher spatial resolution of the detector. Compared to the ICCD, an approximately 10 times better signal-to-noise ratio is achieved due to the lower dark noise. Moreover, the price is lower. Advantages of the ICCD are the better time resolution and the higher controlling variability. A powerful cooling of the detector system reduces the dark noise of the detector and improves the signal-to-noise ratio significantly. The limit of detection (LOD) for LIBS experiments depends on the sample matrix and the element to be detected; in general LODs in the range of 10-500 ppm are achieved for the majority of elements in solid state matrices, for a few elements (e.g. Mg) LOD in the ppb range can be achieved. The typical accuracy is better than 10 % of the measured value. However, the limits of detection do not only depend on the spectrometer, but also on the transfer optics and on the overall setup of the system.

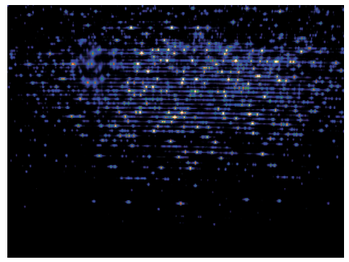
Software

The controlling and evaluation software Sophi for ARYELLE controls all spectrometer and detector functions. After assigning the raw data to the corresponding wavelengths, all lines of the spectrum are automatically analyzed with an integrated data base and if possible assigned to the corresponding elements and specified. Comprehensive quantitative analysis algorithms are integrated as well. For a quantitative evaluation, a calibration with comparable samples is necessary. Calibration curves can be generated and graphed with few mouse clicks and used for the quantitative analysis of samples subsequently.

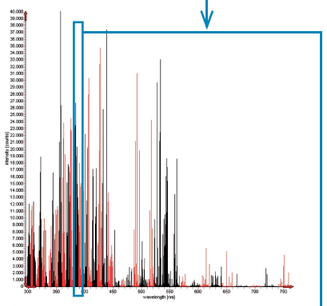
A comprehensive scripting language with an integrated Pascal compiler allows to automate complex measurement routines as well as the calibration. Accessory components like xyz- tables, lasers, energy monitor can be fully integrated via the scripting language.



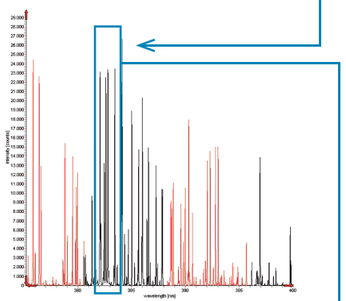
Software



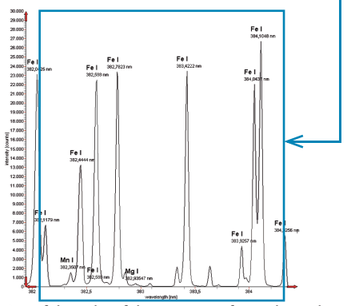
Raw data / detector image



2D spectrum of a steel sample



Four orders of the total spectrum of a steel sample



Part of the order of the spectrum of a steel sample

We deliver complete solutions

* The spectrometric system ARYELLE was developed (patented) by the ISAS Institute for Analytical Sciences, Department Berlin, and engineered for commercial use by LTB Lasertechnik Berlin GmbH.