



Sci-Trace

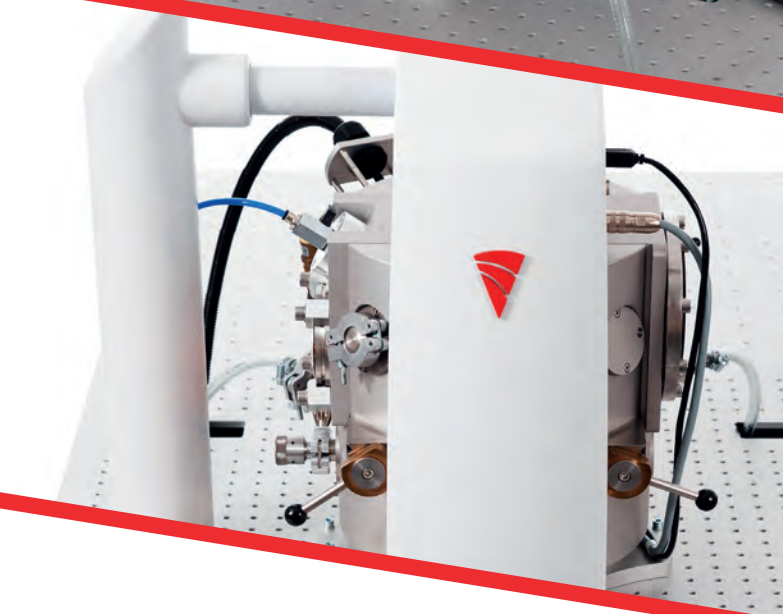
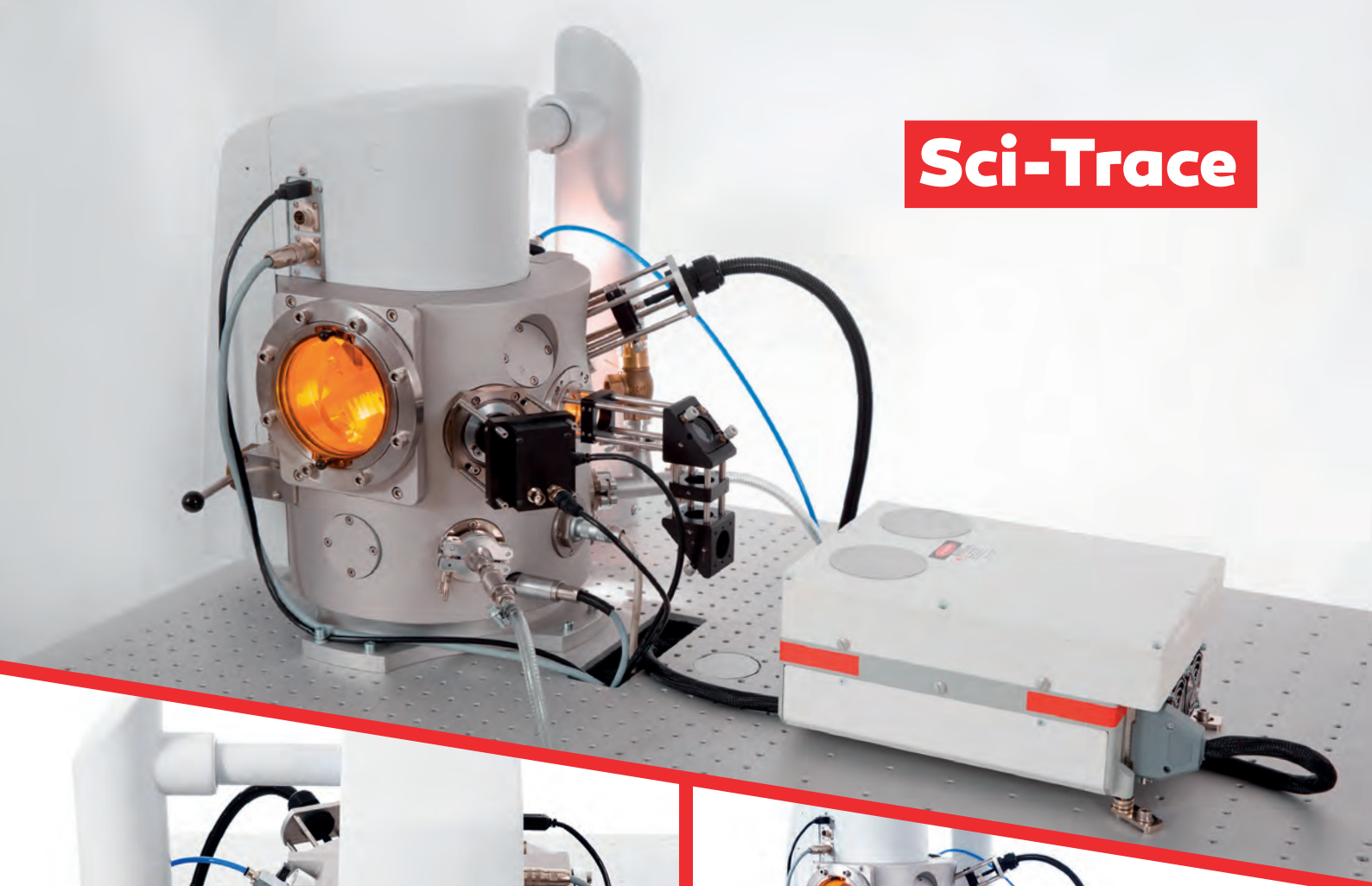
**Fast and easy multi-elemental
chemical analysis**

With modular scientific system

Utilizing one of the today's most promising
analytical technique: Laser-Induced Breakdown
Spectroscopy (LIBS)

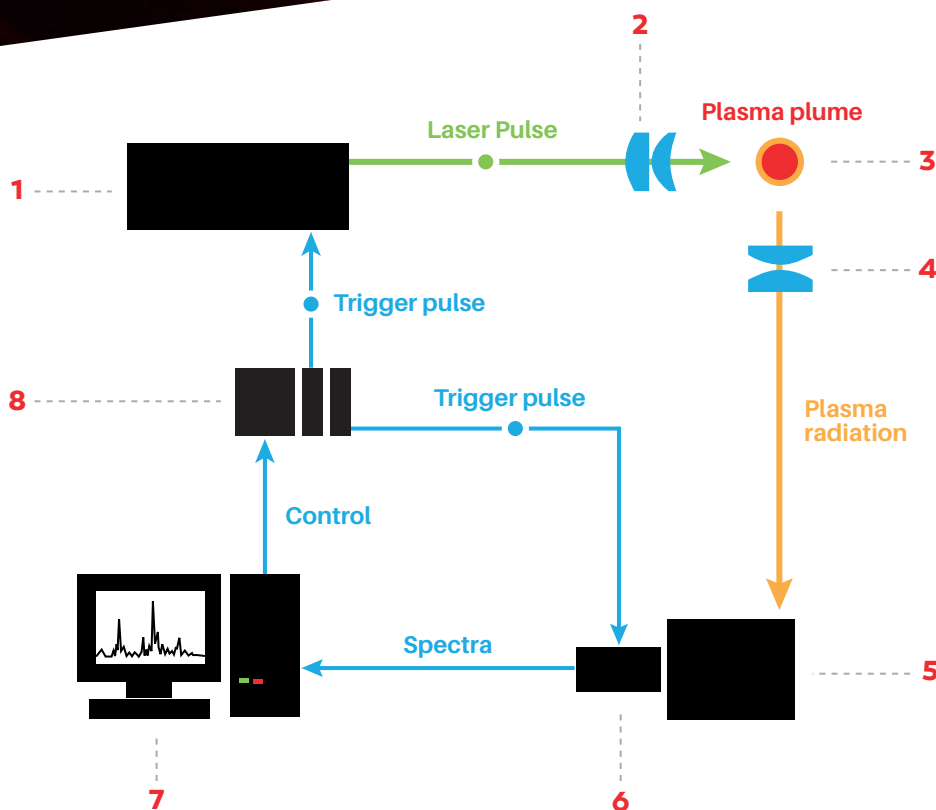
- Fast determination of elemental composition
- High resolution 2D chemical mapping, visualization of surface heterogeneity
- Depth profiling of multilayer materials

Sci-Trace



Laser-Induced Breakdown Spectroscopy (LIBS)

LIBS is a modern analytical technique, which utilizes a laser pulse for fast determination of chemical composition of the sample. It is an effective combination of laser ablation with an atomic emission spectroscopy.



LIBS principle explained

1. Laser pulse is generated by the **Laser Head**
2. and focused on the sample by the **Laser-focusing Optics**.
3. Due to the high irradiation the **Microplasma** is induced on the sample surface.
4. Plasma radiation is collected by the **Collecting Optics**,
5. transmitted and dispersed by the **Spectrometer**.
6. Dispersed radiation is captured by the **Detector**.
7. Resulting spectrum is processed in the **PC**.
8. Whole system is precisely synchronized by the **Digital Delay Generator**.

Number of benefits enables LIBS to analyze solid, liquid or gaseous samples without need of any sample preparation in a matter of seconds.



LIBS is sensitive to majority of chemical elements with limits of detections as low as 1-100 ppm.

Place your sample on the High precision Motorized Manipulator

- 3-axis motorized movement
- Travel range: 80×50×43 mm
- < 2 μm movement resolution
- Very High Vacuum ready
- Mounted on the sliding door



Number of sample holders handles various shapes and sizes of your samples

Holders are automatically detected by the system and visualized in the Sample View window of the control software



**2 × 30 mm
pellet holder**



**12 × 12 mm
pellet holder**



**Universal
clamp holder**



**30 mm
pellet holder**



**50 mm
pellet holder**

Manipulator with the sample forms the Interaction Area

Sci-Trace can be configured with 3 types of Interaction Areas



**Cage Chamber
for more advanced
experiments**

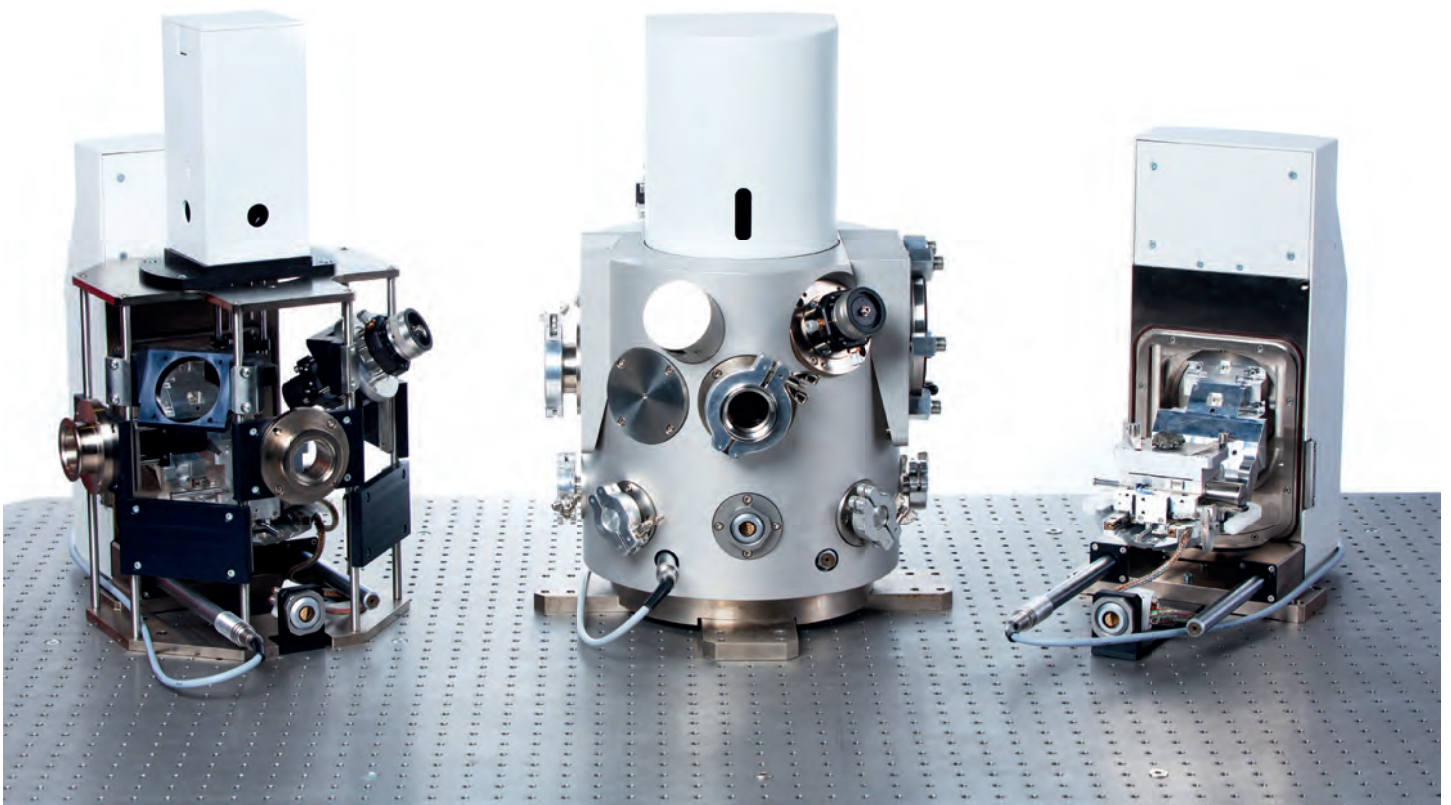
Cage body with 6 movable
input ports, motorized
manipulator included

**LIBS Interaction
Chamber for most
possibilities**

Vacuum body with 16 input
ports, motorized manipulator
included

**Just the Manipulator
for basic LIBS
experiments**

Standalone motorized
manipulator, no frame
for optomechanics



LIBS Interaction Chamber



Manipulator mounted on the sliding Chamber door to easy access the sample



Vacuum body provides:

Protection against laser reflections and potentially toxic ablated materials

Windows are covered by the laser filters

Massive steel rigid construction

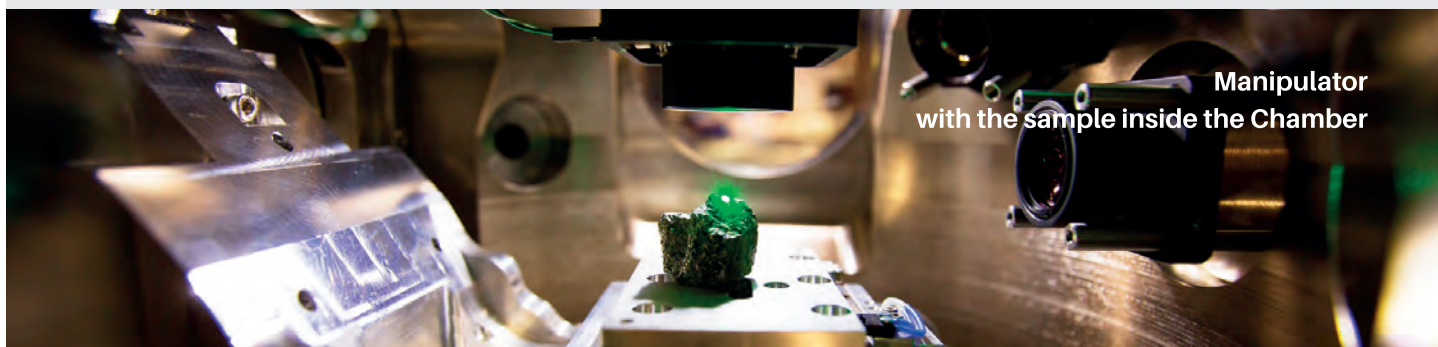
Eliminates shape deformation down to UHV ($1\text{E-}8\text{ Pa}$)

Allows to mount various components directly on the Chamber body

Vacuum sealed

Enables to set diverse environmental conditions

Underpressure/overpressure, inert gas atmosphere



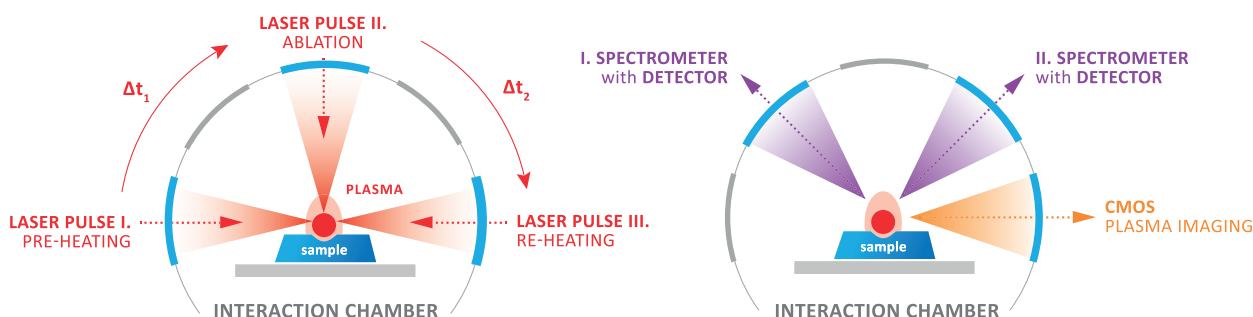
Manipulator with the sample inside the Chamber

Reconfigure or extend your experiment!

- up to 15 chamber input ports in total
- 11 aiming to the common center spot
- 3 types of interchangeable sideplates
- 1 large viewport (filtering 1064 and 532 nm)

Add more lasers to perform **Double/Multi-Pulsed LIBS**

To enhance the limits of detection or the resolution of the Chemical Mapping



Add second spectrometer

To analyze different plasma parts or capture more spectral regions with different resolution at the same time.

Add some of the additional modules

Gas modules, camera modules, etc.

...or design your own!

Additional Modules

MPI Primary Input Module

MPI is the core module of the Sci-Trace, it focuses the laser onto the sample and provides the sample view capability of the software. It is usually mounted on the top of the chamber.

Primary laser input with the laser-focusing module

Bayonet system enables to easy exchange focusing lenses and objectives

Motorized refocusing enables to change the laser spotsize

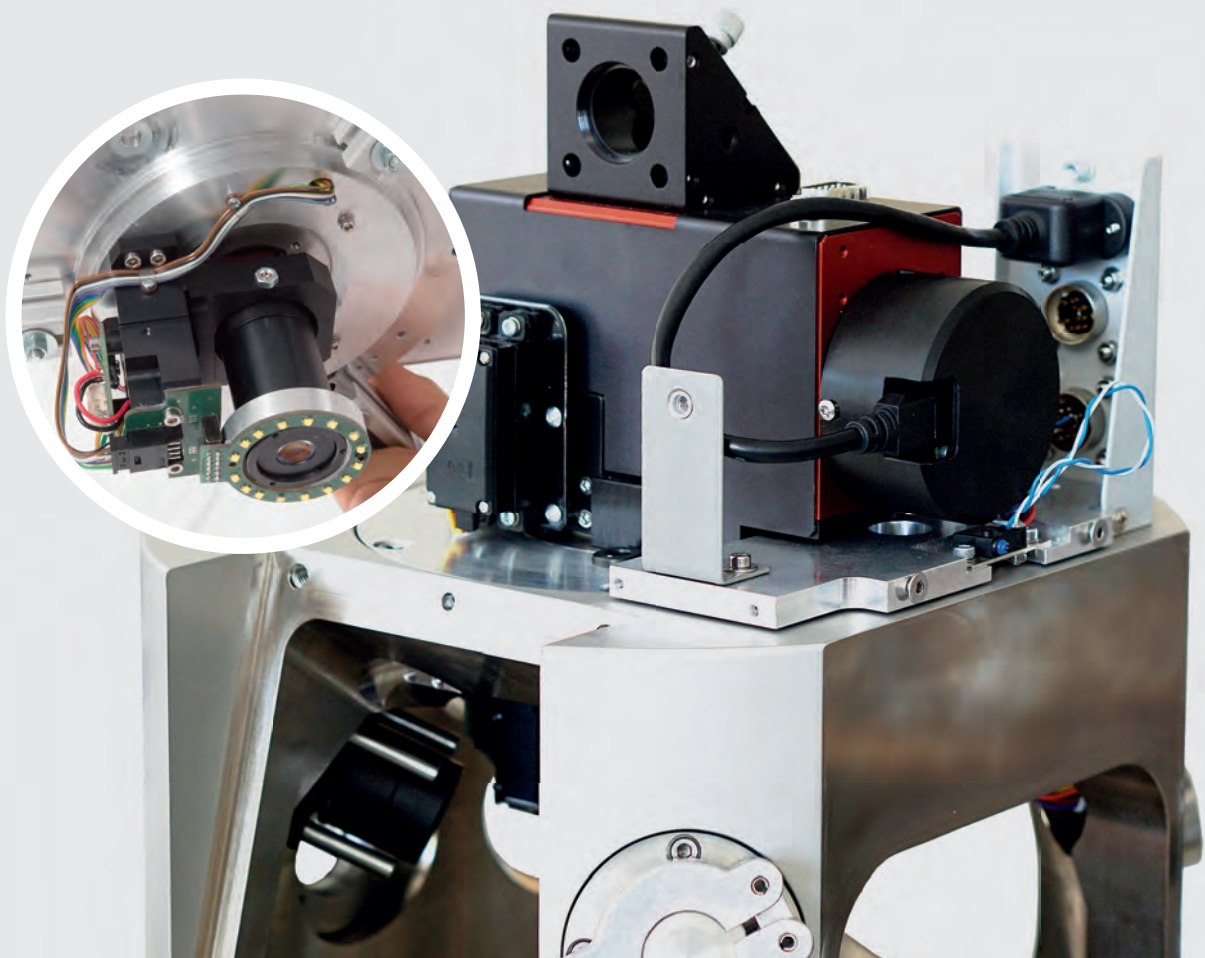
Sample view camera

Enables to show a live image of the sample surface

Capability to create a sample overview with large field of view

4-segment LED illumination

The power of each segment can be continuously adjusted to set the optimal illumination for the each individual sample



MPR Pressure Regulating Module

MPR enables a quick regulation of the pressure inside the chamber.

Underpressure and/or inert gass atmosphere can dramatically increase the Signal to Background and Signal to Noise ratio of the LIBS analysis thus enhancing the limits of detection.

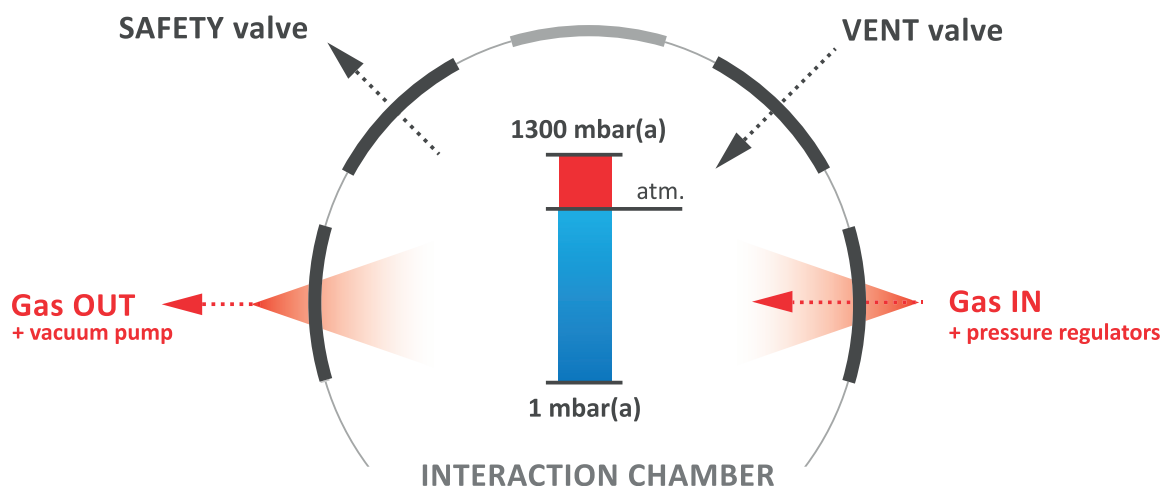
Main MPR components are hidden in the MPR rack shelf, which is linked to the vacuum Chamber body and to the IO panel by the pressure hoses with electromagnetetic valves and filters.

MPR features:

- Pressure range: 1-1300 mbar(a)
- Gas cylinder can be connected to the input
- Accurate automatic regulation to the chosen pressure value
- External indicator of the i pressure
- Vent valve, safety valve, oli/dust/contaminant filters



Ar, He, CO₂, N₂ atmosphere



Additional Modules

MRC Radiation Collecting Module

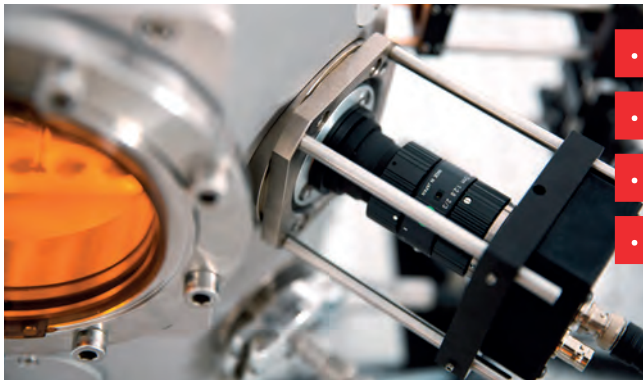
MRC is optomechanical system for the effective collecting of the plasma radiation.



- UVFS/CaF₂ adjustable multilens system
- Spectral range 200-1000 nm
- SMA fiber output
- Mounted in one of the Chamber ports

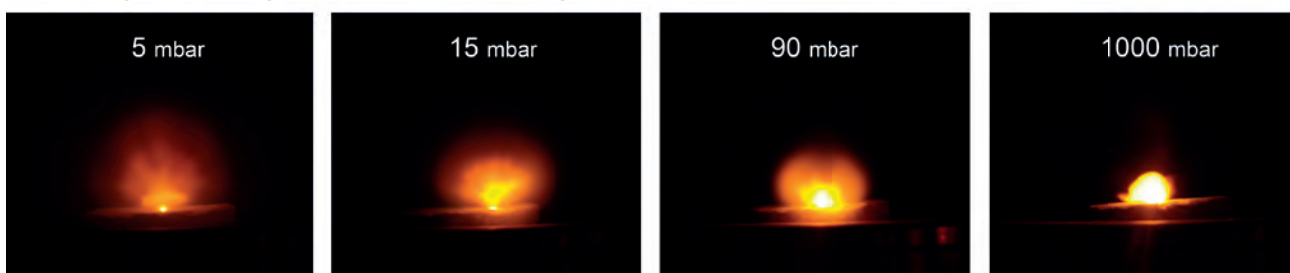
MSC Secondary Camera Module

MSC is a multipurpose camera modul. Live image can be displayed in the control software.



- CMOS camera with varifocal lens
- Externaly triggered
- Suitable for plasma imaging or for LIBS adjustment
- Mounted in one of the Chamber ports

Different plasma shapes under the different pressure conditions.



Gas Modules

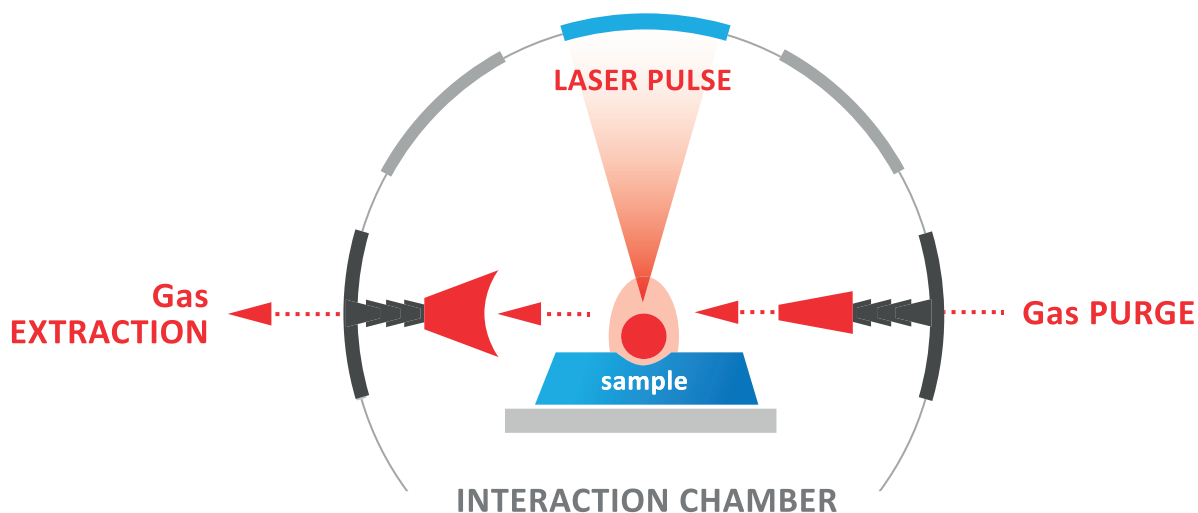
Gas module adapters can be used also for connecting a circuit with a gas sample to perform the Gas LIBS analysis.

MGE Gas Extraction Module

- Active extraction of ablated material from the chamber
- Filtrated output
- Mounted in one of the Chamber ports

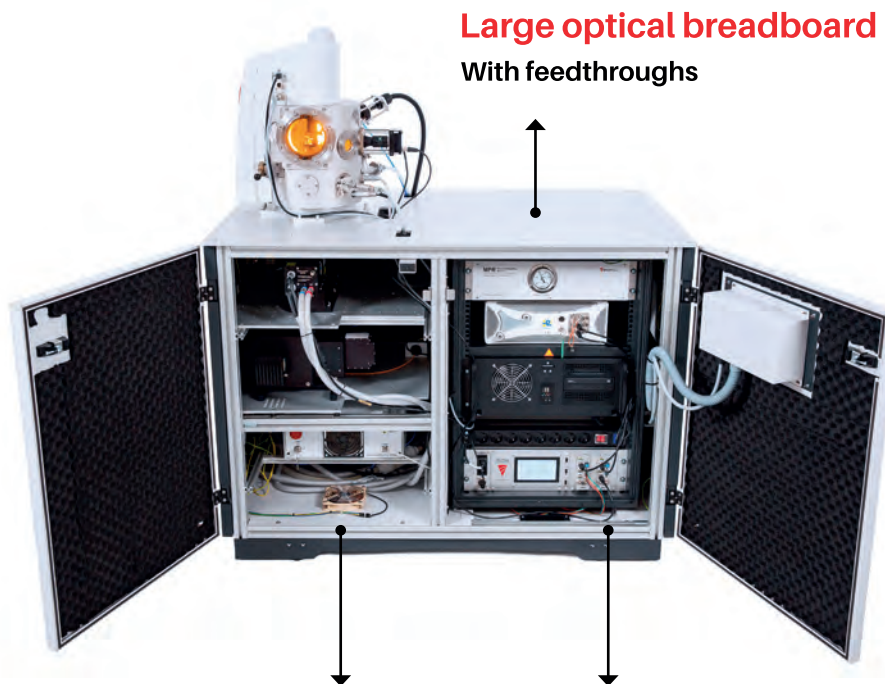
MGP Gas Purge Module

- Sample surface cleaning
- Creating a local inert gas atmosphere
- Continuous or triggered mode
- Mounted in one of the Chamber ports



Instrumentation Carriage

Instrumentation Carriage carries all the necessary LIBS instruments and control electronics and is divided into two compartments: the Instrumentation Compartment and the Rack Compartment.



Instrumentation compartment

System of reconfigurable shelves for LIBS instruments

- Laser head with accessories (Power Energy Meter)
- Spectrometers + Detectors
- Calibration lamp
- Alignment laser, etc.

Rack compartment

Standardized RACK frame for control electronics

- Control modules
- Control PC
- Digital Delay Generator
- Pressure Regulating Module
- Laser PSU
- Main PSU



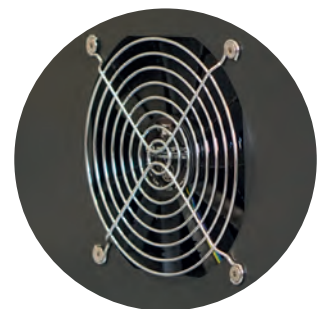
Protected by the interlock system



Covered by laser filters



Cabinet is acoustically isolated



Automated temperature regulation

Control software

Sci-Trace Controller

Control software for the Sci-Trace system enables to control all the functions of the Interaction Chamber and connected modules.

- Laser, Detector and DDG parameters

- Secondary Camera window, Sample Overview window

- Primary Camera settings

- Manipulator control

- Chemical Mapping editor

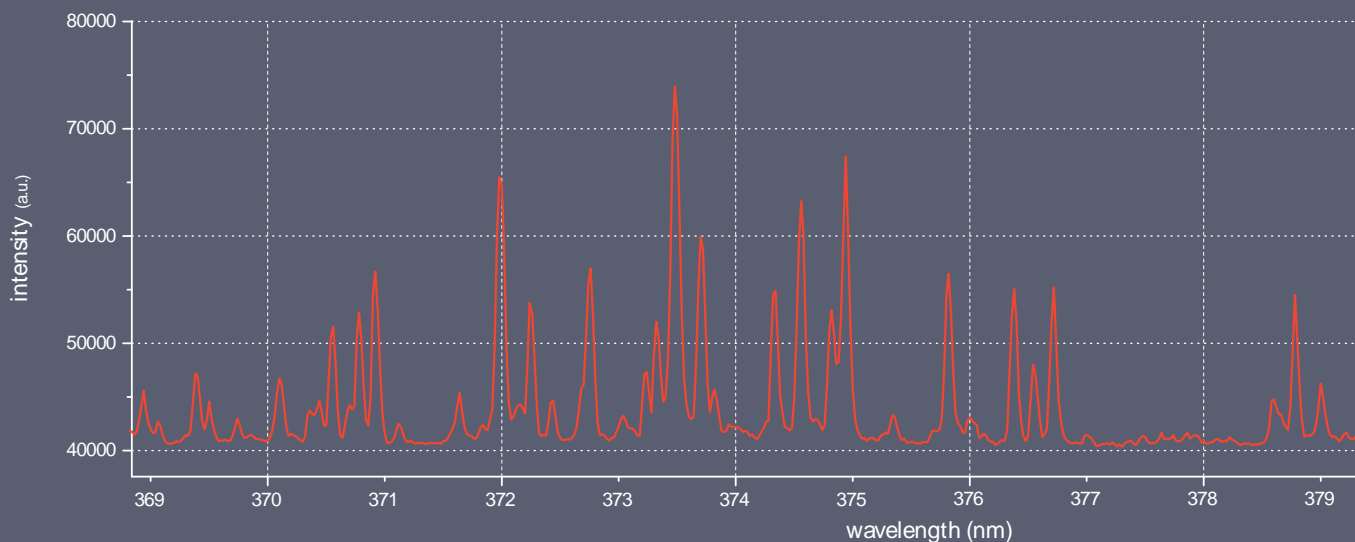
- LED Illumination control

- Motorized defocus control

- Primary sample view window

- Log messages





Spectra-processing software

AtomAnalyzer

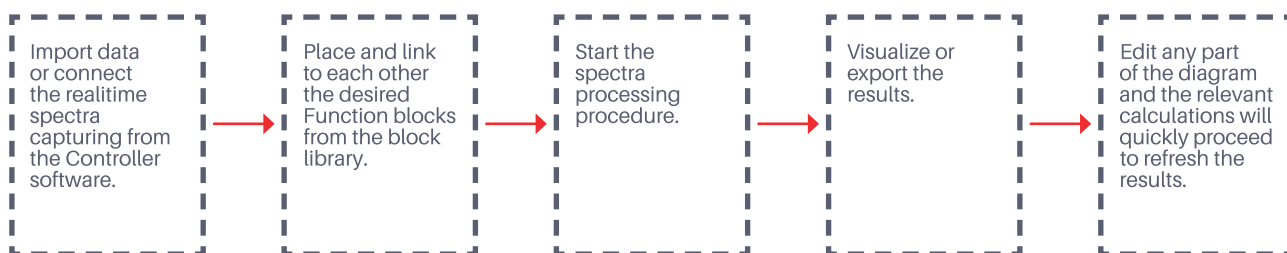
AtomAnalyzer is software for the LIBS spectra processing.

It has been designed to utilize a library of **Function blocks**.

Placing them on the graphical **Workspace** and linking them to each other results in creating the **Spectra processing procedure** in intuitive way.

This innovative approach makes the standard and often complex process quicker, easier and more transparent.

Workflow scheme:



Created procedures can be exported or any part saved as a macro.

Still growing number of ready-made Function blocks



GENERAL

Input data
Output data
Select region
Merge spectra
Edit metadata

MATH

Binary operation
(subtract, multiply)
Sum
SNV
Mean

PEAKS

Find peaks
Identify peaks
(AtomTrace LIBS + NIST
database)

VISUALIZERS

Line chart
Scatter plot (used also
for Calibration curves)
Chemical Mapping
Histogram

...and many
more are to come
(connection
to R, PCA, ...)

Graphical User Interface of AtomAnalyzer



The "block" principle of the AtomAnalyzer is powerful,
yet intuitive and efficient for the user.

Datasheet

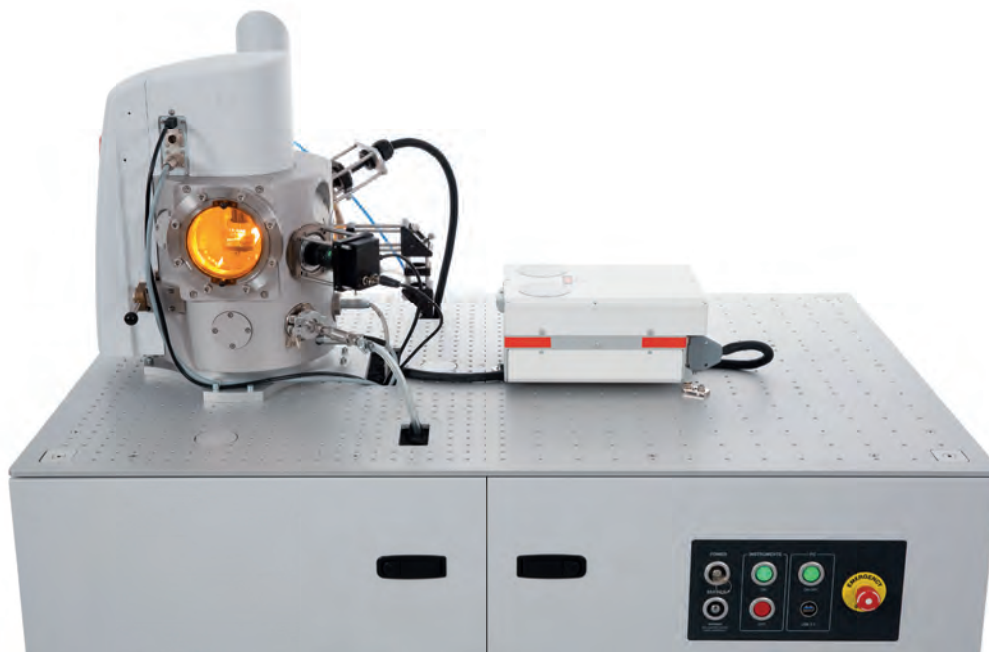
Interaction area

[alt] alternative configuration [opt] optional feature

Manipulator	Motorized manipulator <i>Movement range 40×40×40 mm, 2 μm resolution, High-Vacuum ready, including series of sample holders</i>
Interaction chamber	Vacuum LIBS Interaction Chamber <i>Airtight rigid body, 11 input ports aiming to a common center + 4 lateral input ports</i> [alt] Cage Chamber <i>6 mounting ports aiming to a common center</i> [alt] No chamber <i>Stand for manipulator</i>
Top optical breadboard	Anodized Al-alloy board, M6 threaded holes, dimensions: 1304 × 829 × 8 mm <i>Feedthroughs for cable management and laser beam delivery, USB connector panel, possible to mount corner rails for laser filter plates</i> [alt] Imperial threaded holes, magnetic steel board, different board dimensions upon request

LIBS instruments

Pulsed laser	Lamp-pumped (LPSS) Nd:YAG <i>532nm, 200 mJ, 8 ns, 20 Hz, compact design, including Power Meter and motorized Attenuator</i> [alt] Diode-pumped Nd:YAG (DPSS) [opt] Double pulsed feature [opt] Other Nd:YAG wavelengths (1064 nm, 532 nm, 355nm, 266 nm) [opt] Up to 800 mJ at 1064 (FPSS, single-pulsed)
Spectrometer	Echelle, 190-1100 nm <i>Focal length 120 nm, f/4, resolving power up to 5000 λ/FWHM</i> [alt] Czerny-Turner, multiple gratings on turret, USB control, multiple outputs
Detector	EMCCD, 180-1100 nm <i>1004 x 1002 px, 20 Hz, min 10 μs exposure time</i> [alt] iCCD detector, 1024 x 1024 px, 180-850 nm, USB [alt] Deep-UV (<200 nm) CCD detector (Chamber-mounted)
Digital Delay Generator	4 output, 5 ns time resolution [alt] 8 output, 5 ns time resolution
Accessories	Calibration lamp - continuous spectrum: Deuterium-Halogen Calibration lamp - line spectrum: Mercury-Argon Guiding laser, DPSS 532 nm, 4 mW Laser safety glasses, 35% visible light transmission, OD 7+ (190-534 nm), OD 6+ (925-1070 nm)

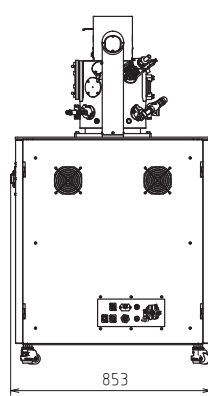
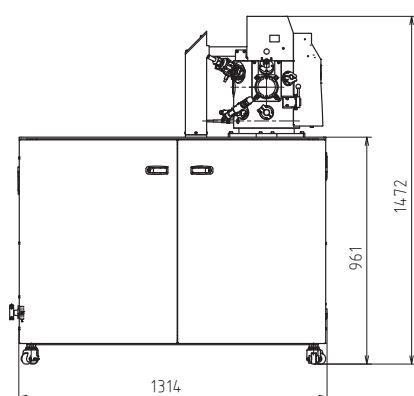


Modules overview

Primary Input Module (MPI)	Laser focusing optomechanics, sample view, sample illumination
Lateral Input Module	Laser focusing optomechanics
Radiation Collection Module (MRC)	Plasma radiation collecting optomechanics, 200-1000 nm
Pressure Regulating Module (MPR)	Setting the pressure in the chamber in the range 1-1300 mbar (a), Ar, He, CO ₂ , etc
Gas Purge Module (MGP)	Cleaning the sample, creating local atmosphere of inert gas, pulse mode
Gas Extration Module (MGE)	Extracting the ablated material from the Chamber
Motorized Defocusing Module (MDF)	Changing the laser spot size; mounted on MPI
Secondary Camera Module (MSC)	Plasma Imaging, adjustign procedures, triggered CMOS camera
Magnetic Feld Module (MMF)	Confining the plasma in the magnetic field; mounted on MPI

Instrumentation carriage

LIBS Instrument compartment	2 anodized Al-alloy shelves, M6 threaded holes <i>for mounting the laser head / spektroscope / optomechanics</i> [alt] Other number of shelves upon request
Rack compartment	19-inches rack, height 16U <i>Installed control electronics, control PC, laser PSU, DDG, MPR</i>
Safety elements	Interlock system on chamber door and cabinet door Laser beam hidden in tubes
I/O panel	2x HDMI (dual monitor support), LAN, GAS inlet, Gas outlet, Vacuum pump output, Mains
Control panel	Emergency STOP, key ON/OFF, electronics ON/OFF, PC ON/OFF, USB 3.0
Housing and construction	Al profile frame covered by steel plates Cooling fans, noise dampening materials 4 doors; 4 wheels with retractable stands
Dimensions & Weight	1314 × 853 × 1472 mm, 330 kg (in the default configuration)
Power requirements	~230 V, 50 Hz, 16 A





Designed by Scientists for Scientists

Sci-Trace has been developed in cooperation with the
Central European Institute of Technology, Brno University of Technology (CEITEC BUT) and
Tescan Brno, s.r.o.

Instrumentation for the Laser-Induced Breakdown Spectroscopy

AtomTrace is focused on the development and commercialization of promising technologies in the field of fast material analysis by the Laser-Induced Breakdown Spectroscopy (LIBS). Motivation and know-how is given by the years of research experiences of the Laboratory of Laser Spectroscopy (Brno University of Technology, Czech Republic).

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