AtomTrace®

Sci-Trace

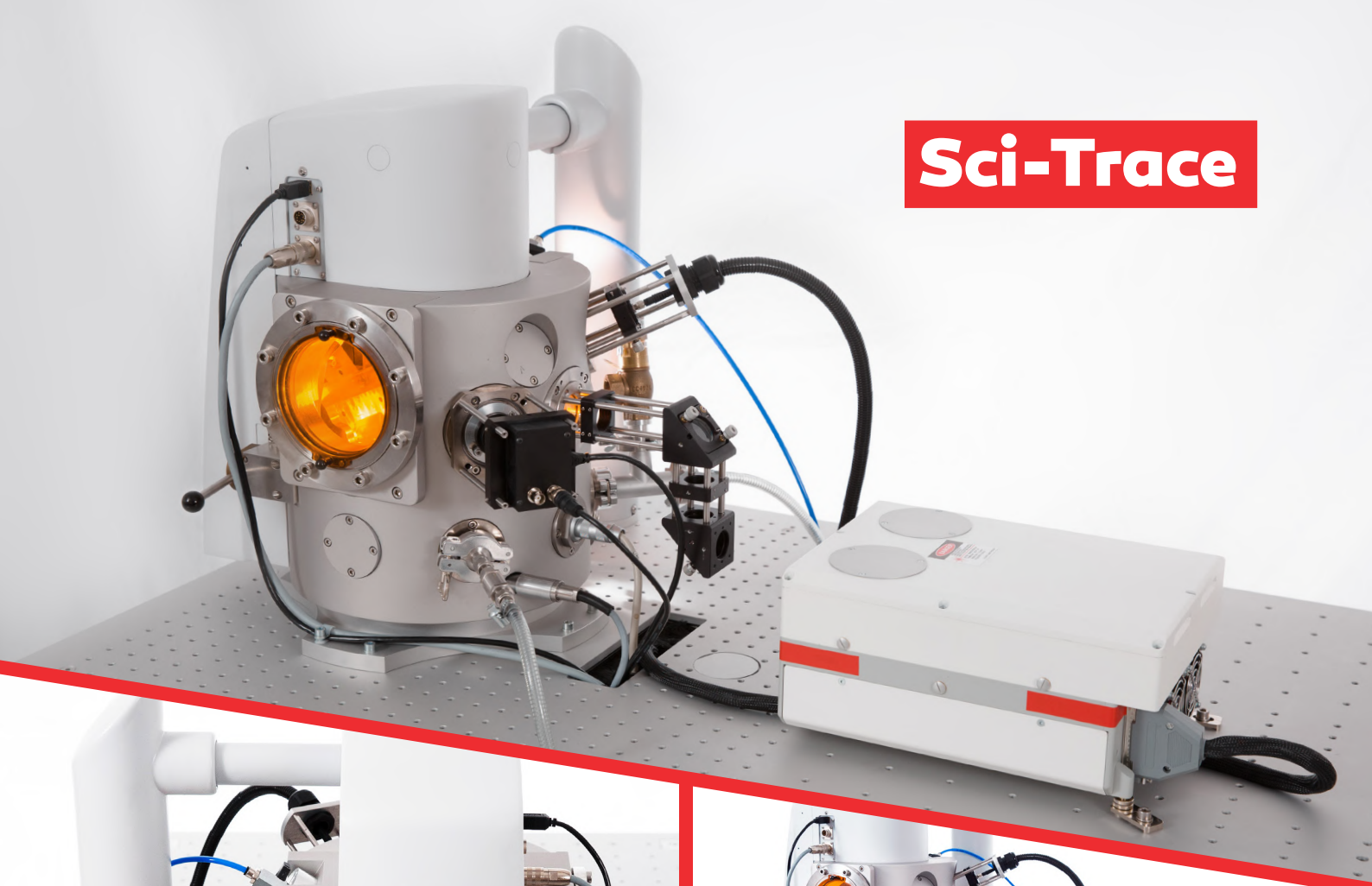
Fast and easy multi-elemental chemical analysis

With modular scientific system

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

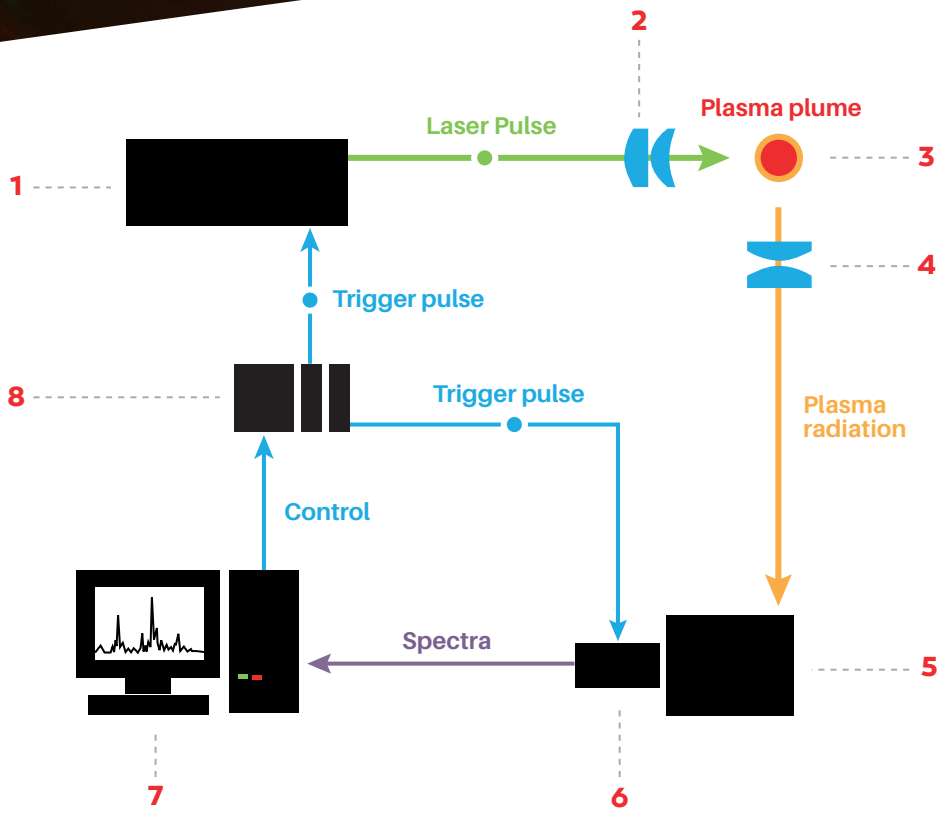
- Fast determination of elemental composition
- High resolution 2D chemical mapping, visualization of surface heterogenity
- Depth profiling of multilayer materials
- Light elements visibility

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**.

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A 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 the majority of chemical elements with limits of detections as low as 1-100 ppm.

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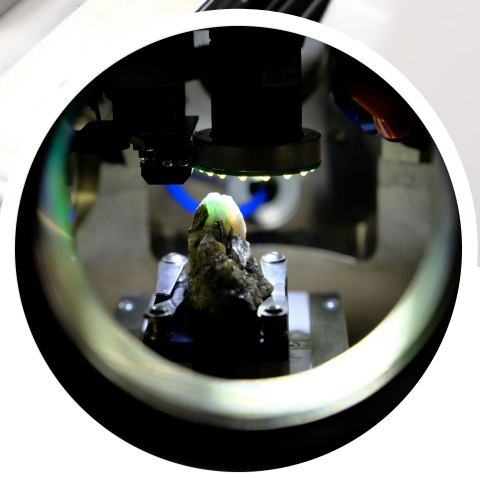
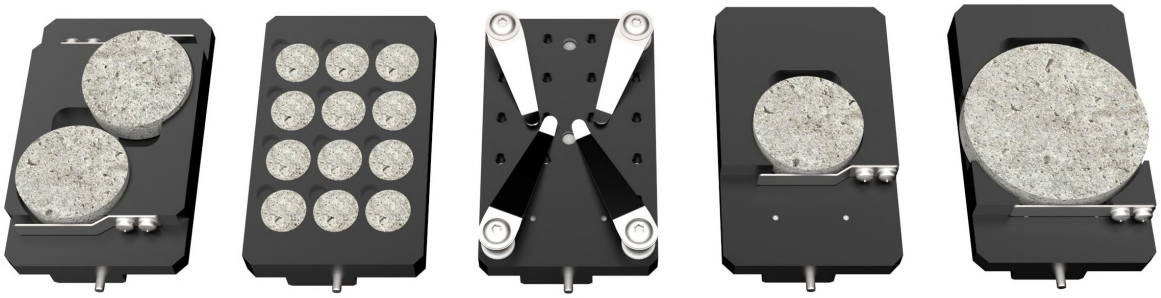
Place your sample on the High precision Motorized Manipulator

- 3-axis motorized movement
- Travel range: 60 x 80 x 45 mm
- < 2 µm movement resolution
- Very High Vacuum ready
- Mounted on the sliding door



A number of sample holders handle 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

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Manipulator with the sample forms the Interaction Area

Sci-Trace can be configured with 2 types of Interaction Areas

Cage Chamber for bacis experiments

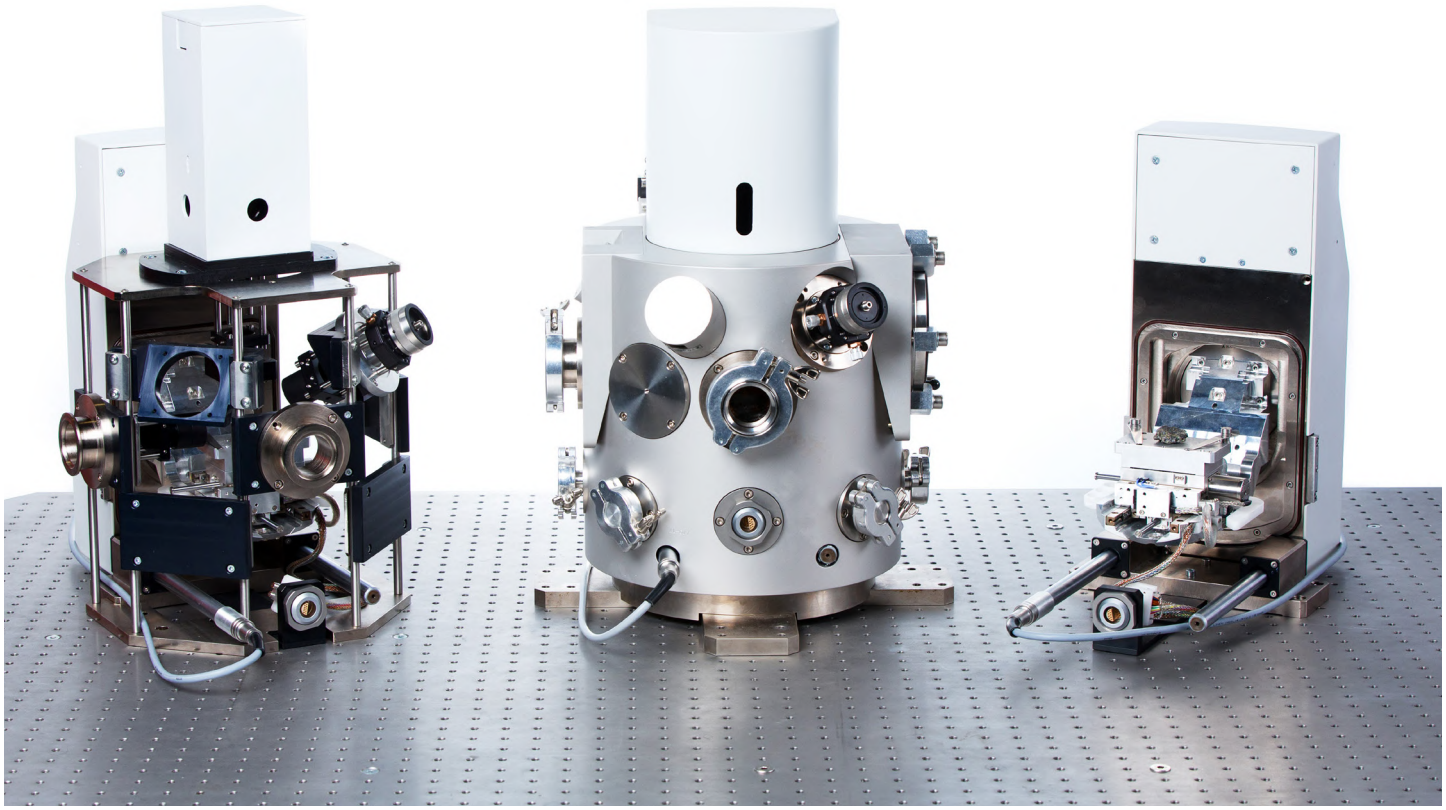
Cage body with 6 movable input ports, motorized manipulator included

LIBS Interaction Chamber for most advance experiment

Vacuum body with 15 input ports, motorized manipulator included

LIBS Manipulator operating in 3-axis

Standalone motorized manipulator, no frame for optomechanics



LIBS Interaction Chamber

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

Vacuum body provides:

Protection against laser reflections and potentially toxic ablated materials

Windows are covered with the laser filters

Rigid steel construction

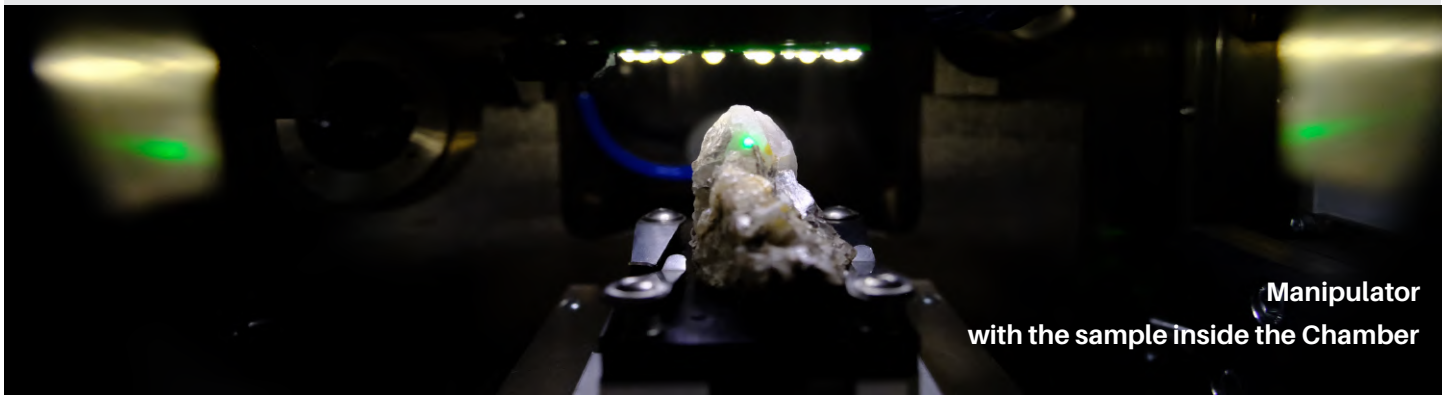
Eliminates shape deformation down to UHV (1E-8 Pa)

Allows the mounting of various coumponents 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

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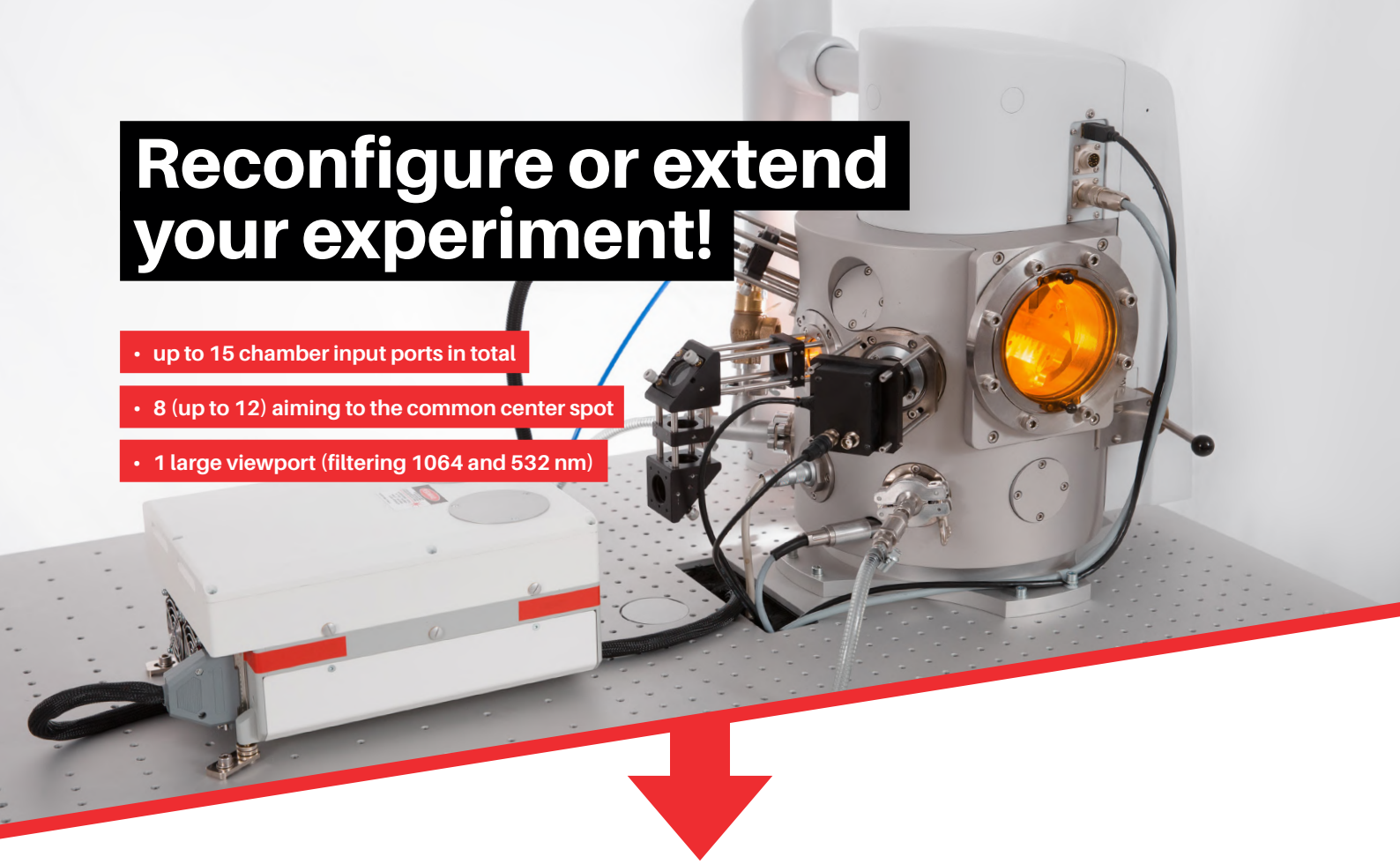
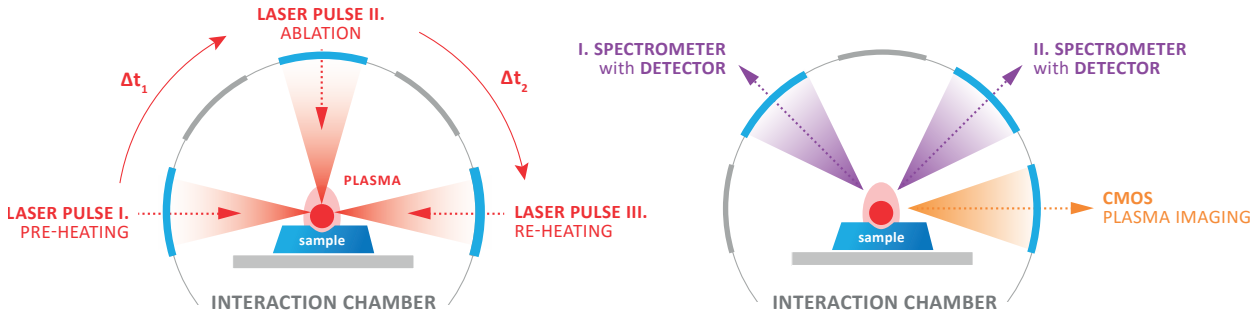
Reconfigure or extend your experiment!



- up to 15 chamber input ports in total
- 8 (up to 12) aiming to the common center spot
- 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!

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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 exhchange of the focusing lenses and objectives

Motorized refocusing enables to change the laser spotsize

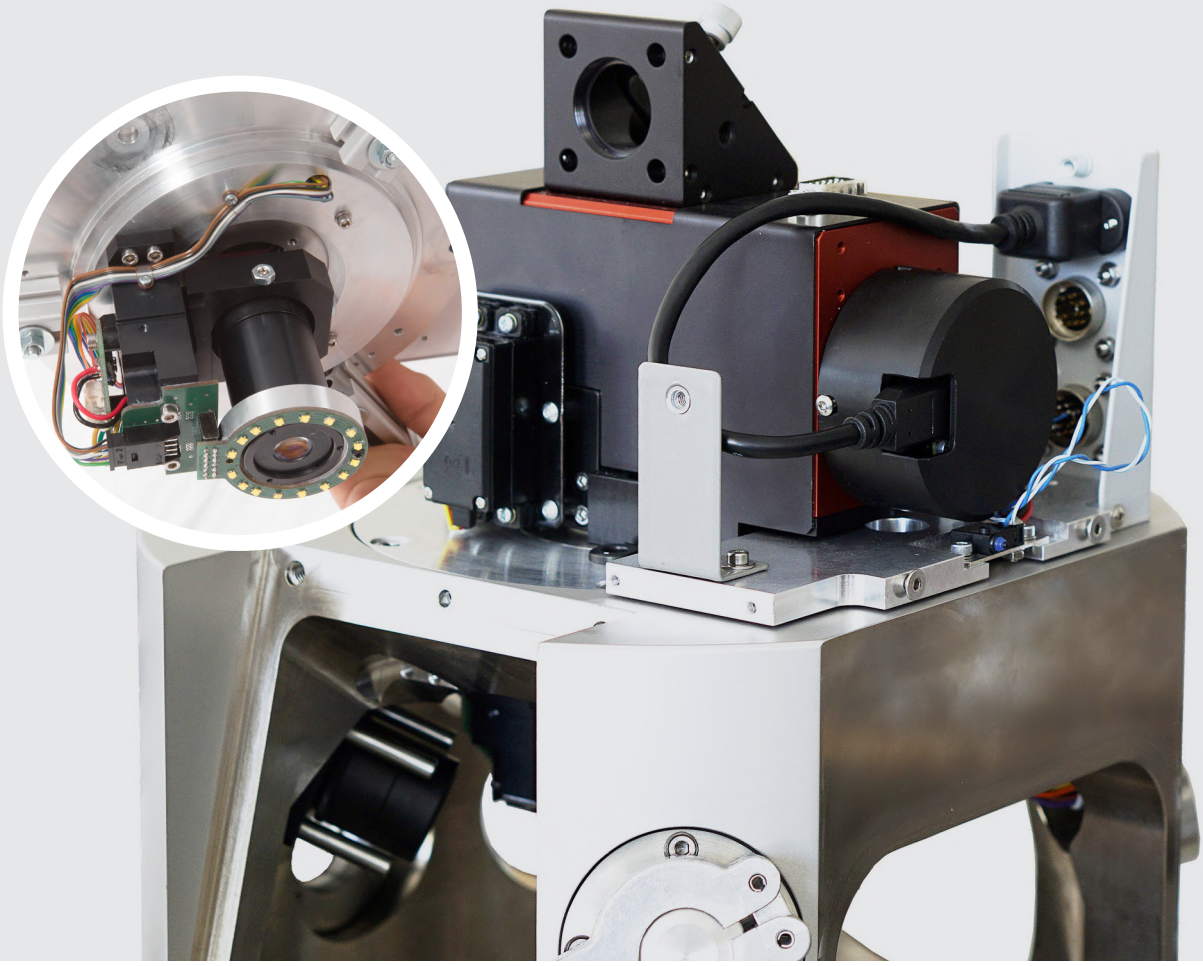
Sample view camera

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 of the individual samples



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Additional Modules

MPR Pressure Regulating Module

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

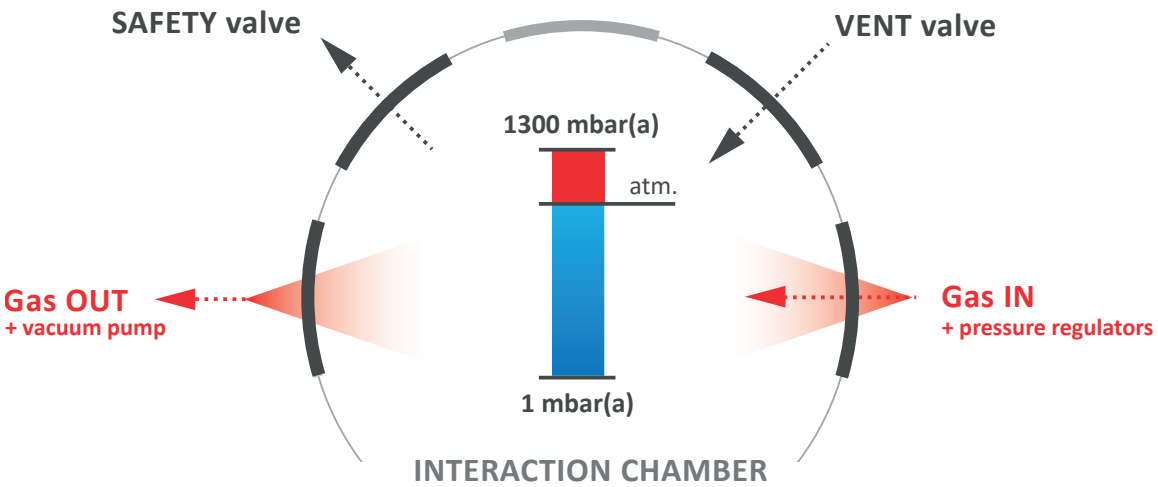
Underpressure and/or inert gas atmosphere can dramatically increase Signal to Background and Signal to Noise ratio of the LIBS analysis thus enhance the limits of detection.

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 electromagnetic valves and filters.

MPR features:

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

Ar, He, CO_2, N_2 atmosphere



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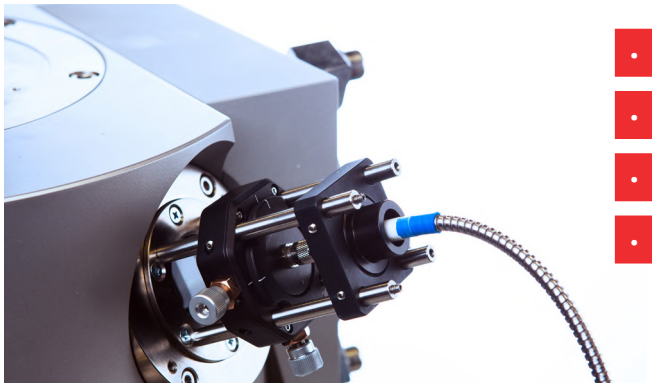
Additional Modules

MRC Radiation Collecting Module

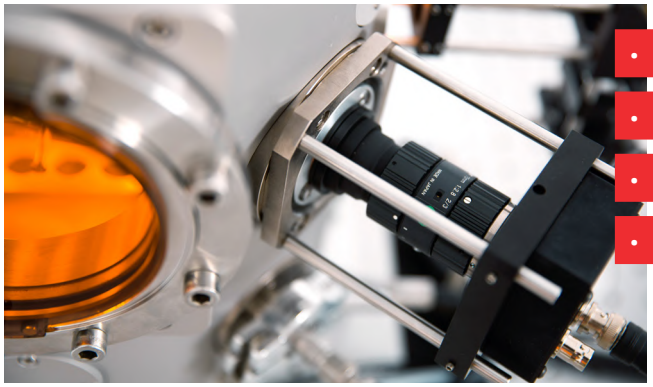
MRC is optomechanical system for the effective collection of the plasma radiation.



- UVFS/CaF_2 adjustable multilens system
- Spectral range 200-1000 nm
- SMA fiber output
- Mounted in one of the Chamber ports

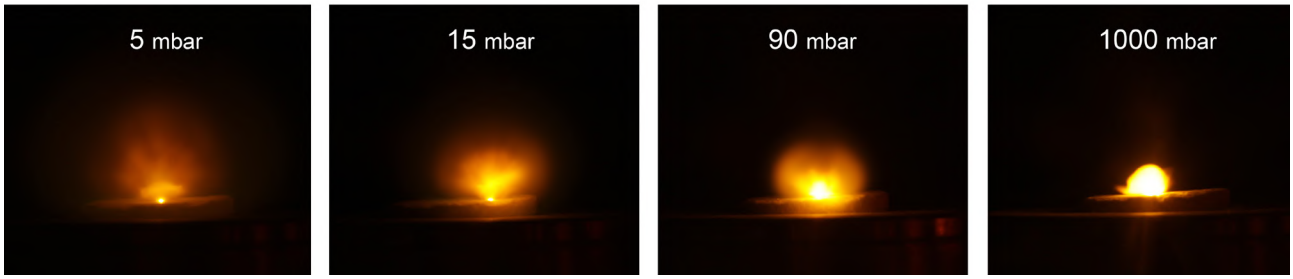
MSC Secondary Camera Module

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



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

Different plasma shapes under the different pressure conditions.



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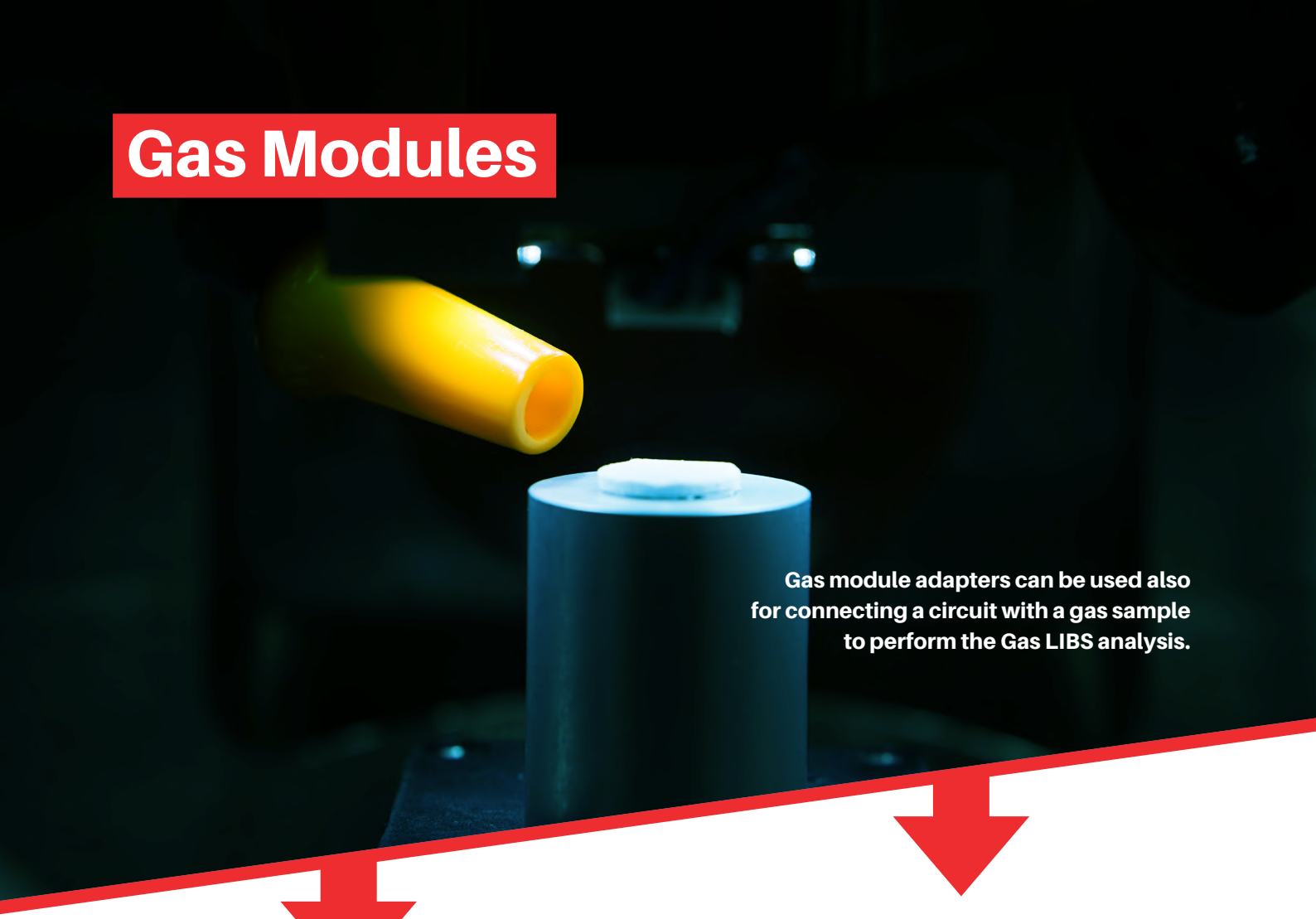
Gas Modules



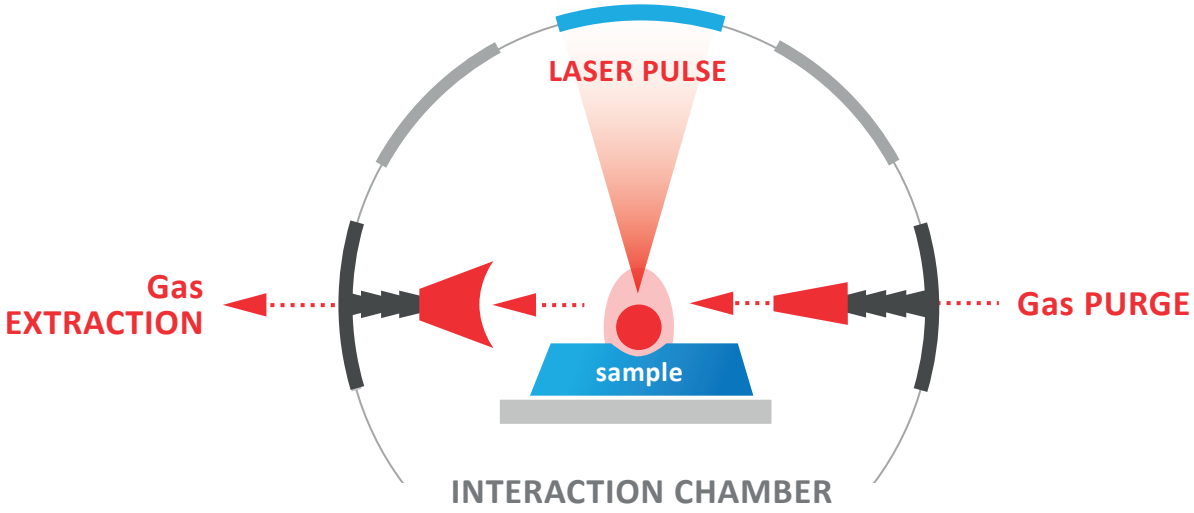
Gas module adapters can be used also for connecting a circuit with a gas sample to perform the Gas LIBS analysis.

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



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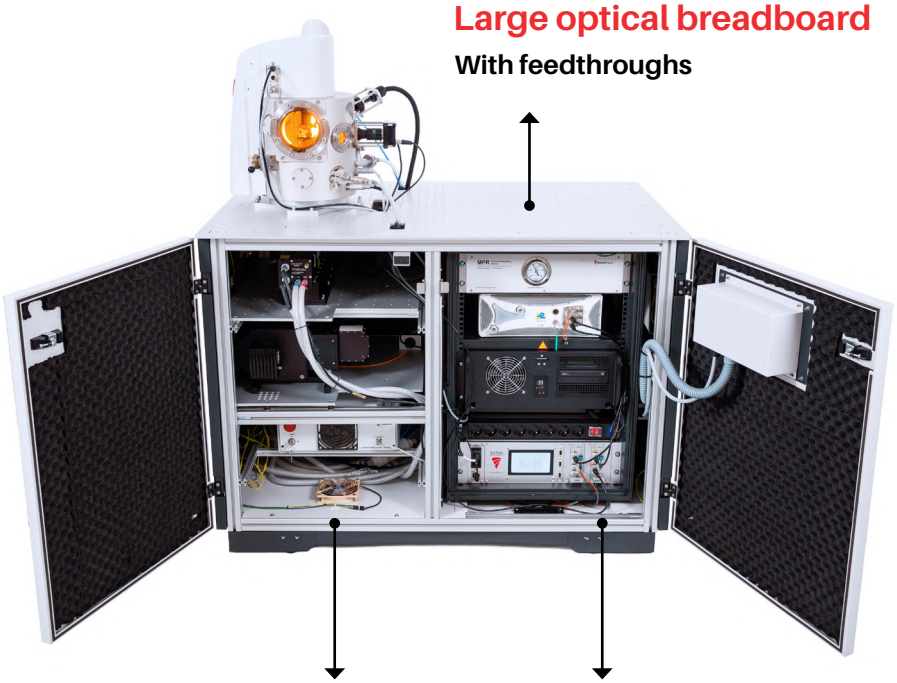
Instrumentation Carriage

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

Large optical breadboard

With feedthroughs



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

Automated temperature regulation

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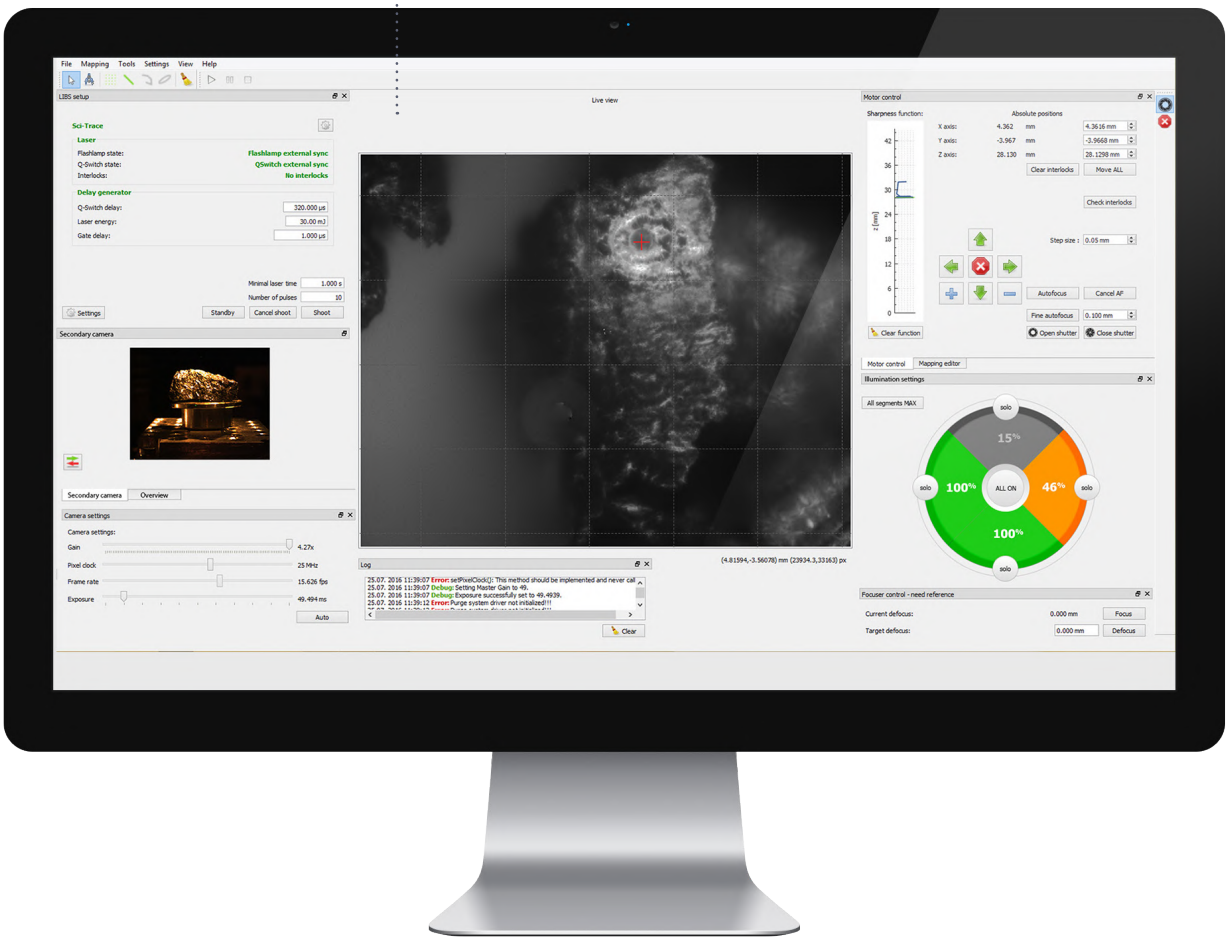
Control software

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



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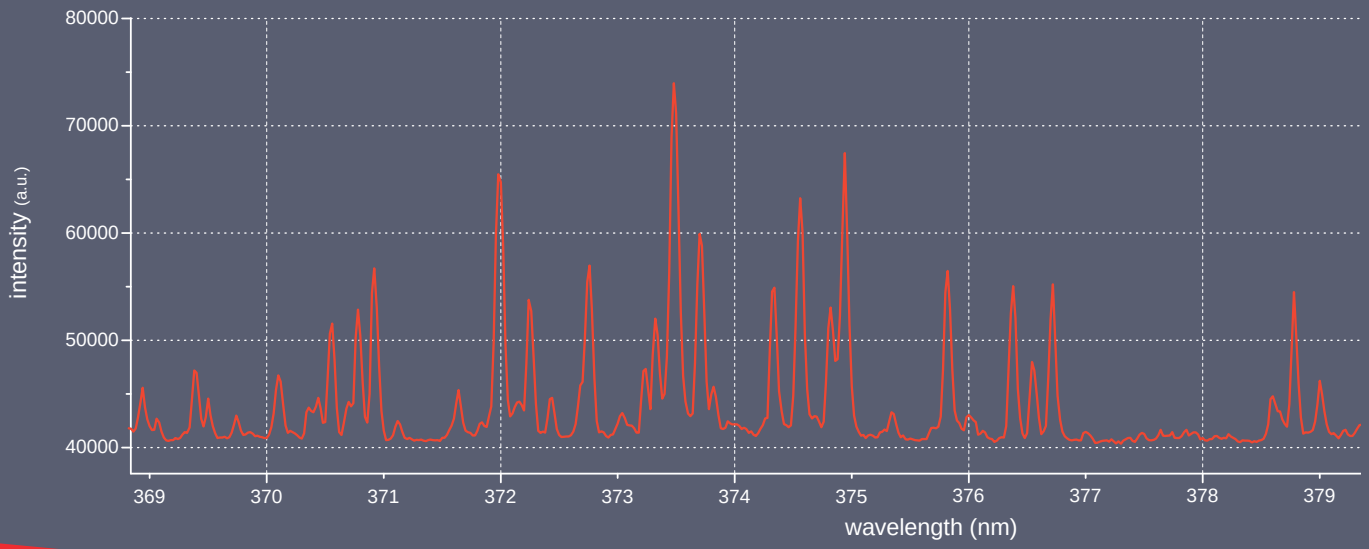

Spectra-processing software

AtomAnalyzer

AtomAnalyzer is software for the LIBS spectra processing.

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

Import data or connect the realitime spectra capturing from the Controller software. → Place and link to each other the desired Function nodes from the node library. → Start the spectra processing procedure. → Visualize or export the results. → Edit any part of the diagram and the relevant calculations will quickly proceed to refresh the results.

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

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Still growing number of ready-made Function nodes

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 "node" principle of the AtomAnalyzer is powerfull, yet intuitive and efficient for the user.

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Datasheet

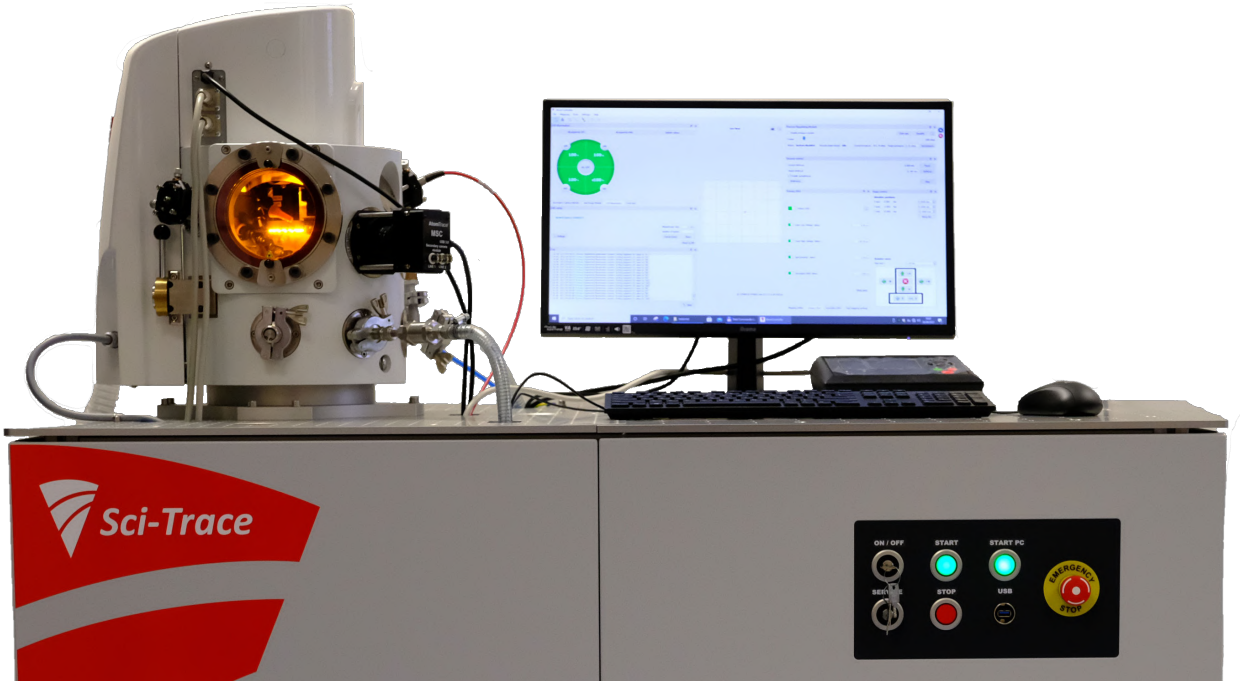
Interaction area

[alt] *alternative configuration* [opt] *optional feature*

Manipulator	Motorized manipulator *Movement range 60×80×45 mm, Vacuum ready, including series of sample holders*
Interaction chamber	Vacuum ready LIBS Interaction Chamber *with 8 (up to 12) inputs ports aiming to a common center, 5 lateral inputs, 2 replacable side panel*
Top optical breadboard	Anodized Al-alloy board, M6 threaded holes, dimensions: 1310 × 835 × 8 mm *Feedthroughs for cable management and laser beam delivery, USB connector panel, possible to mount corner rails for laser filter plates* [alt] Imperial threaded holes, magnetic steel board, different board dimensions upon request

LIBS instruments

Pulsed laser (example)	Compact nanosecond, Nd:YAG laser *energy; 200 mJ@1064 nm; 4-6 ns, 20 Hz, including motorized Attenuator* [alt] Lamp/ Diod-pumped ND:YAG (DPSS) [opt] Single/ Double pulsed feature [opt] Other Nd:YAG wavelengths (1064 nm, 532 nm, 355 nm, 266 nm)
Spectrometer (example)	Echelle *195 mm focal length, f/7 aperture, resolving power up to 5000/λ, 200-975 nm* [alt] Czerny-Turner, multiple gratings on turret, USB control, multiple outputs
Detector	ICCD *1024 x 1024 px, 190-850 nm* [alt] EMCCD, 1004 x 1002 px, 20 Hz [alt] Deep-UV (<200 nm) CCD detector (Chamber-mounted)
Digital Delay Generator	2xDDG - 4 output, pulse 10ns-1000s, resolution 5 ns, delay 0-1000s
Accessories (optional)	Calibration lamp Guiding laser Laser safety glasses Laser energy meter

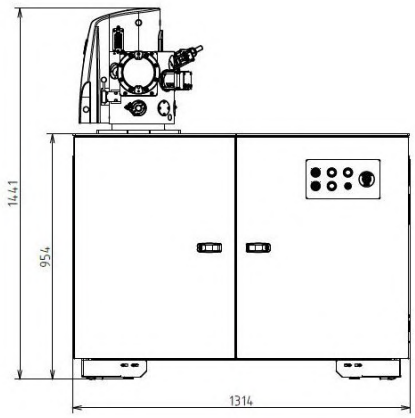


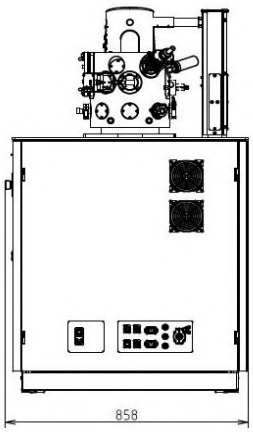
Modules overview

Primary Input Module including motorized defocus	Assembly directing laser radiation from a laser source to a sample with the function of tracking and mapping the surface of the sample containing a bayonet system for attaching the lens
Radiation Collection Module	Assembly focusing radiation into optical fiber via SMA connector
Pressure Regulating Module	Setting of the pressure in the chamber in the range 1-1300 mbar (a), Ar, He, CO_2, etc
Gas Purge Module	Cleaning the sample, creating local atmosphere of inert gas, pulse mode
Gas Extracion Module	Filter unit assembly with active carbon filter and continuous suction control, allowing the removal of ablated material from the interaction chamber
Secondary Camera Module	Camera set for real-time sample monitoring with the possibility of recording plasma evolution

Instrumentation carriage

LIBS Instrument compartment	2 anodized Al-alloy shelfs, M6 threaded holes *for mounting the laser head / spectroscope / optomechanics* [alt] Other number of shelfs upon request
Rack compartment	19-inches rack, height 16U *Installed control electronics, control PC, laser PSU, DDG, MPR*
Safety elements	Interlock system on chamber door and cabinet door Laser beam hidden in periscope Class 1 laser product
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 4 doors; 4 wheels with retractable stands
Dimensions & Weight	1310 × 850 × 1450 mm, 330 kg (in the default configuration)
Power requirements	~230 V, 50 Hz, 16 A





Designed by Scientists for Scientists

AtomTrace®

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).

AtomTrace, a.s.

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