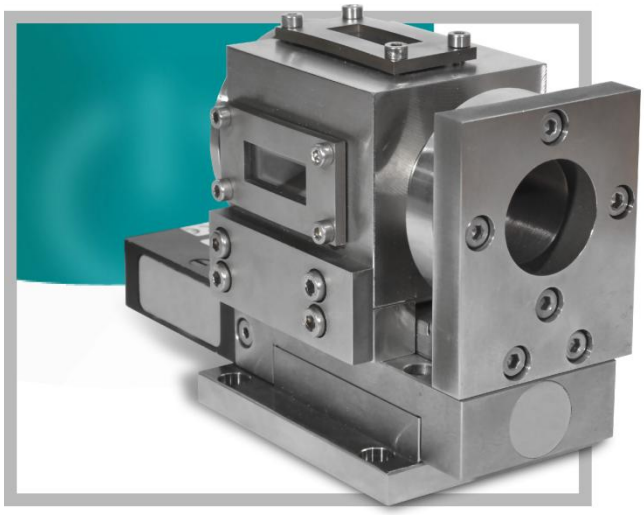
SourceLAB
Laser Plasma Technologies

SL-ALC series Gas Cell

Versatile on-line adjustable gas cavity



- **Reproducible and high-precision positioning**
- **Excellent plasma imaging conditions**
- **Fully motorized and easy to align**
- **Record lifetime**

The SL-ALC series comprises motorized cells of adjustable length, conceived for laser-underdense plasma interaction experiments requiring millimetre-to-cm long stable medium in general (electron acceleration and diffraction, inverse Compton scattering, gamma-ray generation, X-ray laser, high harmonic generation), and Laser Wakefield Acceleration (LWFA) at high repetition rate in particular. The solid and shielding metallic housing and specific in-out nozzle design enable very reproducible shots with a multi-Terawatt to Petawatt laser system without fatal damaging and dangerous light backscattering at normal laser incidence. The gas-tightness is tested for resisting up to few bars of flow pressure (approx. 10^{20} atoms/cm^3 at normal temperature). SL-ALC series devices are unique instruments to fine-study with optical diagnostics the physics of laser-plasma interaction in underdense regime.

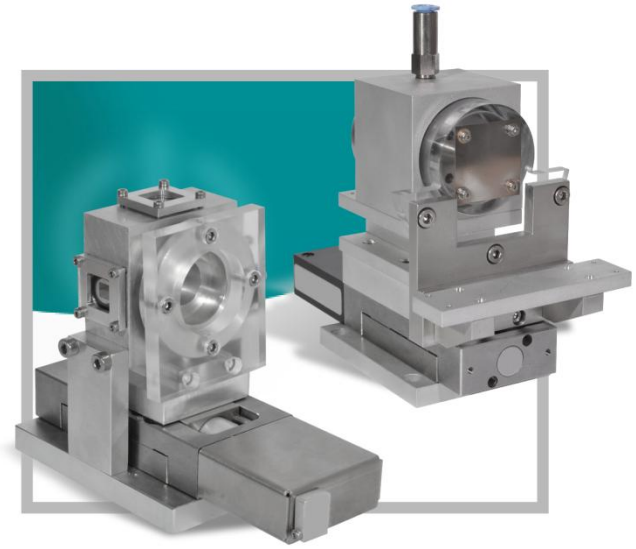
Examples of applications
Particle acceleration (LWFA)
Harmonic generation and X-ray laser
Plasma microscopy

➢ Design and hardware

The SL-ALC series is available in three versions depending mainly on the targeted application: SL-ALC-HI for high-energy electron application, SL-ALC-LO for low-energy electron acceleration, and SL-ALC-X for X-ray generation. All the three versions are suitable for high-resolution plasma microscopy.

The system comprises mainly:

- a cell body with designed windows (vacuum compatible).
- two mounted nozzles for coupling the laser and particle output.
- additional nozzles of different geometries for different input and output gradient conditions.
- a stepper motor (precision approx. 0.5 µm over 25mm, backlash approx. 5 µm).
- a gas flow quick-connector.
- a small breadboard base for easy fixing.



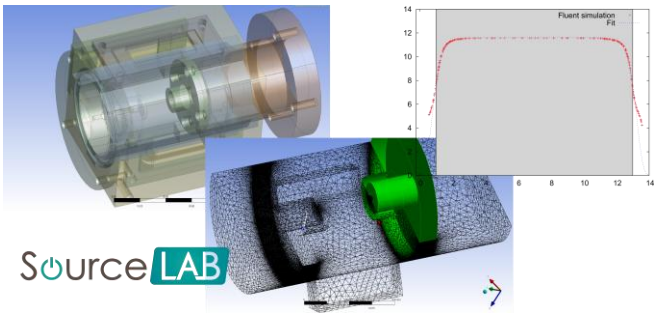
➢ Performances

The SL-ALC series devices are designed to offer perfectly reproducible laser-underdense plasma interaction conditions.

For specific applications, several body materials can be adapted (stainless steel, aluminium, plastic).
The gas-tightness of each device guarantees pressure levels required for laser-plasma interaction (better than 10^{-4} mbar).
With specially designed nozzle apertures, the coupling with the laser pulse can optimized to fit loose or tight

beam focusing. Also, the plasma gradient to be formed through the interaction with a laser pulse can be adjusted precisely with the appropriate nozzle diameter. The stepper motor offers micrometric precision on the cavity length and perfect reproducibility for relevant statistics.
For top-viewing (plasma self emission) and side-viewing (transverse illumination), wide windows of selected transparent materials (BK7, soda-lime glass, Plexiglas) allow high-aperture optical imaging to monitor for instance the plasma density evolution all along the laser pulse path.

Each SL-ALC series device can be provided with a full characterization in time a space.
Special interferometric procedures were developed to access in real-time the density in the cavity as the gas flows. Numerical fluid flow models of each device were validated in order to simulate to gas distribution in the cell and the gradient scale lengths at the boundaries of the cavity. These experimental and theoretical data bring accurate and valuable information for subsequent Particle-In-Cell simulations.



Scientific publication

- S. Corde et al, **Nature Communication**, 4, 1501 (2013)

Technical data

Item	SL-ALC-HI	SL-ALC-LO	SL-ALC-X
Performances	Stable gaseous medium up to several millimetres or centimetres in length		
Mass	1.5-2.5 kg	~1 kg	~1.5 kg
Dimensions (X x Y x Z)*	83 x 58 x 67 mm^3	70 x 40 x 68 mm^3	95 x 105 x 50 mm^3
Longitudinal translation X	20 mm	5 mm	20 mm
Motor type	Stepper motor (DB-25 connectors)		
Motor Encoder	yes		
Motor minimal increment	0.5 µm		
Motor rectitude	5 µm		
Nozzles diameter (I/O)	from 50 µm to 2 mm in diameter**		
Nozzle lifetime	More than 1000 shots***		
Inlet pressure	Max. 3 bar		
Specific options	Embedded diagnostics for on-line interferometry	input/output foil for very short plasma gradients	Independent output foil translation

* The dimensions are indicative. Whether applicable, they can be adjusted according to the requirements.
** To be defined regarding mainly the pumping capacity of the interaction vacuum chamber.
*** For a 30 TW peak power laser.