The Precession Elephant 2 is the world's leading scan head for high-precision laser drilling, cutting and micromachining applications. It offers numerous process control and set-up options specifically designed for highest-quality mass production. This ARGES scan head can be used with all ultra-short pulsed laser sources available on the market today.
Micromachining in mass-production

The Precession Elephant 2 is the leading industry-proven scan head for complex and precise drilling, trepanning, cutting and micromachining applications. It offers maximum flexibility for the production of innovative drill hole and edge geometries with different conicities, taper angles and shapes. The scan head provides the highest drilling speed available today, and its detailed process control and monitoring options ensure high-quality, burr-free and reproducible micromachining for mass production with low downtimes.

The Precession Elephant 2 can be used to produce perfectly round, elliptical, and custom-shaped micro holes. Hole diameters between 25 and 700 µm, an aspect ratio larger than 12:1, a diameter repeatability with less than 0.25 % of variation, and full taper angles larger than 16 degrees are possible. The process control and set-up options include sample observation and measurement, extensive laser monitoring, as well as tools for software-controlled beam alignment, polarization control and calibration.

The Precession Elephant 2 is available for ultraviolet, green, and two infrared wavelength ranges, each with two different focal lengths.

This state-of-the-art scan head is used in numerous factories around the world in 24/7 operation, together with femtosecond and picosecond lasers from a wide range of manufacturers. On request, ARGES also provides laser-specific customization, subsystems that include laser and beam path, customer-specific software-extensions, laser process development, and sample production.

APPLICATION FIELDS
• Automotive industry
• Aviation and aerospace industry
• Electronics industry
• Telecommunications industry
• Clock and watch industry
• Textile industry
• Filter industry
• Medical technology

High-precision drilling and cutting using the Precession Elephant 2 is possible in metals, ceramics, silicon, glass, polymers, and many other materials.

TYPICAL APPLICATION REQUIREMENTS
Laser processing with highest precision is required for the drilling of all kinds of nozzles, such as the drilling of conical holes in diesel fuel injectors, standard fuel injectors, or spinnerets.

All these processes require shortest processing times, high flexibility, high quality of the micro holes and a high degree of dimensional reproducibility and precision. Nozzle production also requires short cycle times, tight process control and low downtimes.

The Precession Elephant 2 scan head provides the reliability, the track record, the process and monitoring capabilities that allow meeting the most demanding laser processing requirements.
Precession scanning with highest reliability

The Precession Elephant 2 allows the user to control both the position of the laser spot on a work piece as well as the beam incidence angle. For drilling processes, the beam incidence angle is also called the precession angle.

The scan head generates the desired motion of the beam focus and of the precession angle as a sequence of elementary motions. Each elementary motion is described by a defined set of parameters. Sequences of elementary motions then allow the user to generate circular, elliptical, spiral, helical or other focus motions, and to vary the precession angle.

The extremely flexible programming approach enables the user to drill holes with innovative geometries: it is possible to vary between different shapes, conicities and taper angles along the height of the hole. To realize the shortest possible drilling times, the Precession Elephant 2 achieves a trepanning speed of up to 600 Hz, or 36 000 rpm, and contains a fast focus shifter. With an increased mirror aperture and improved objective lens systems, the scan head yields a very small focus size; this improvement allows the user to drill holes with large aspect ratios and highest processing precision.

PROCESS CONTROL

The Precession Elephant 2 provides extensive process control options. The work piece can be illuminated and observed with a coaxial, through-the-lens vision module. A beam attenuator and a beam energy monitor are available. A new suction cup and a nozzle with variable process gas pressure ensure the best possible debris and particle extraction. This combination prevents burns for all sample geometries and process steps.

EASY ALIGNMENT AND SET-UP

The Precession Elephant 2 offers the option to include a safety shutter, beam position and beam direction sensors, as well as two alignment cameras that observe the entrance of the beam and the beam position on the X-galvanometer mirror. Tools for the setting and calibration of the beam polarization are available. Improved mechanical precision mounting is built into the scan head housing. Extensive and enhanced system status signals are available.

Like its predecessor, the Precession Elephant 2 provides two methods to set the focus position at a desired height: one at the objective and one in the beam path. The second-generation objective with its improved precession properties also speeds up the set-up process.
8-axis laser processing

SET-UP OPTIONS
- Alignment cameras for beam adjustment
- Automatic beam position calibration
- Safety shutter

PRODUCT SPECIFICATIONS
- 8-axis scan head
- Weight: 22 kg
- Aperture: 26 mm
- Precession frequency: 200 – 600 Hz (12 000 – 36 000 rpm), depending on incidence angle
- Field size diameter: 0.8 mm
- Second generation objective lens system designed for drilling processes, available focal lengths: f = 60 mm, f = 120 mm
- Full beam precession angle up to 16°
- Input laser beam: diameter from 1 to 15 mm, M² up to 1.5
- Pulse energy of 100 µJ and more
- Possible laser wavelengths: 343 – 355 nm for ultra-high-precision applications, 515 – 532 nm, 1020 – 1080 nm, 1500 – 2100 nm
- Focus spot size: from 10 to 30 µm, depending on laser
- Fast 2-axis (+/- 1 mm), and mechanical focus translator (+/- 4 mm)
- Process gas pressure for particle extraction from 0 to 4 bar
- Separate purge gas inlets for head and for objective lens
- Water-cooled head for best process stability
- Dust-proof beam path for low maintenance
- 8-axis control in space via InScript® software and ARGES system controller
- Operating conditions: 15 °C to 35 °C, max 80 % humidity, non-condensing

PROCESS CAPABILITIES
- Typical material thickness: 0.02 – 1.5 mm
- Typical hole processing time: 0.5 s
- Hole diameters: 25 – 700 µm
- Negative taper full angle: > 16°
- Hole aspect ratio: > 12:1
- Diameter repeatability: < 0.25 % variation
- Hole diameter accuracy: < 0.2 µm
- Hole circularity: > 95 %
- Hole position accuracy: < 1 µm
- Wall surface quality: Ra < 0.1 µm

CIRCLES, ELLIPSES AND SPIRALS
- 2 axes
In order to create ellipses and spirals, the InScript® software from ARGES combines a sinusoidal motion of the X-galvanometer with a cosinusoidal motion of the Y-galvanometer. To generate the planar focus motions shown in the drawings, four parameters are needed for the two axes: the number of revolutions performed, the radius, and the two phases of the involved galvanometer motions.

PRECESSION
- 4th and 5th axis
The precession parameters allow the user to incline the laser beam. The inclination angle, or precession angle, can be varied along the motion of the focus. This enables the user to drill holes with negative taper or even with varying taper angles. With the second generation objective lens, the focus always remains on the plane that contains the circular, elliptical, or spiral paths – for all precession angles.

BEAM ATTENUATION AND POLARIZATION CONTROL
- optional 6th, 7th and 8th axis
The Precession Elephant 2 can be expanded with a beam attenuator and with a system that rotates and deforms the polarization ellipse. The beam attenuator is controlled in real time via the ARGES system controller. A unique future development is the electronic setting of the beam polarization ellipse.

HELIXES
- 3rd axis
In addition to the planar focus motions that trace out circles, ellipses and spirals, a superimposed variation of the Z-axis parameter, or focus shift, produces helical or conical focus motions with variable slope.

To control the laser process, the Precession Elephant 2 also offers:
- Customized suction cups for integrated particle extraction
- Through-the-lens vision module with internal sample illumination
- Polarization control for sharpest edges over complete circumference
- High-speed laser stop for consistent edge results on exit surface
- Energy monitor for long-time process stability
- Optical beam attenuator
- Optional confocal detector
- Optional plasma emission sensor
- Single pulse energy measurement sensor
- Beam position and profile monitor
### TECHNICAL SPECIFICATIONS

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### PROCESS CONTROL OPTIONS

- Customized suction cups for integrated particle extraction with external pressure control
- Through-the-lens vision module with internal sample illumination
- Polarization control for sharpest edges over complete circumference
- High-speed laser stop for consistent edge results on exit surface
- Energy monitor for long-time process stability
- Optical beam attenuator
- Confocal beam attenuator
- Plasma emission sensor
- Single pulse energy measurement sensor
- Beam position and profile monitor

### SET-UP OPTIONS

- Two alignment cameras for beam adjustment
- Automatic beam position calibration
- Safety shutter

### INTEGRATION OPTIONS

- Available as scan head
- Available as scan head, adjusted to your laser source
- Available as scan head with matched laser and beam path
- Stationary or moveable mounting

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Technical and constructional data are subject to change. Dated 05/2018