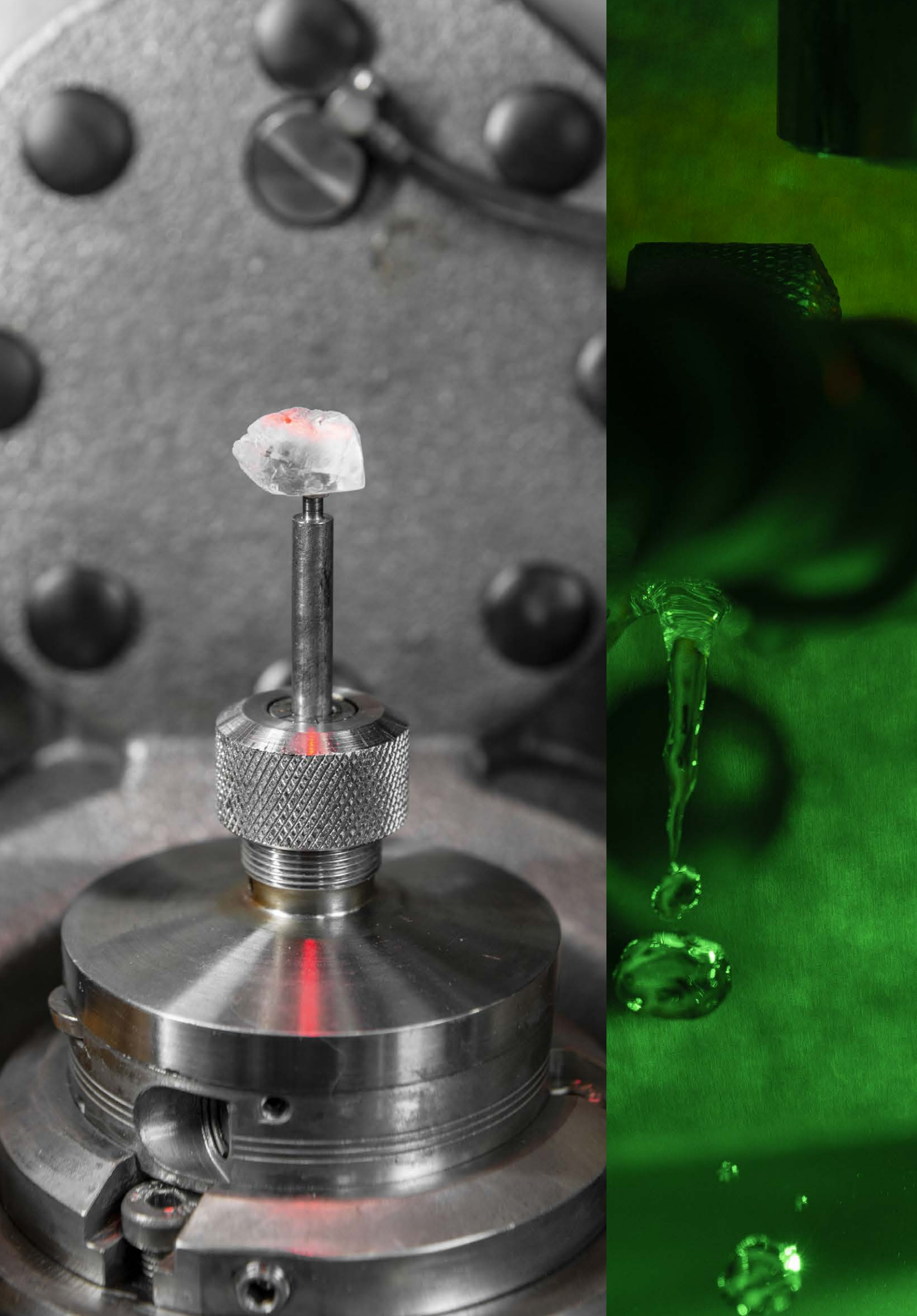
SYNOVA

Cool Laser Machining

LASER MICROJET® TECHNOLOGY

www.synova.ch



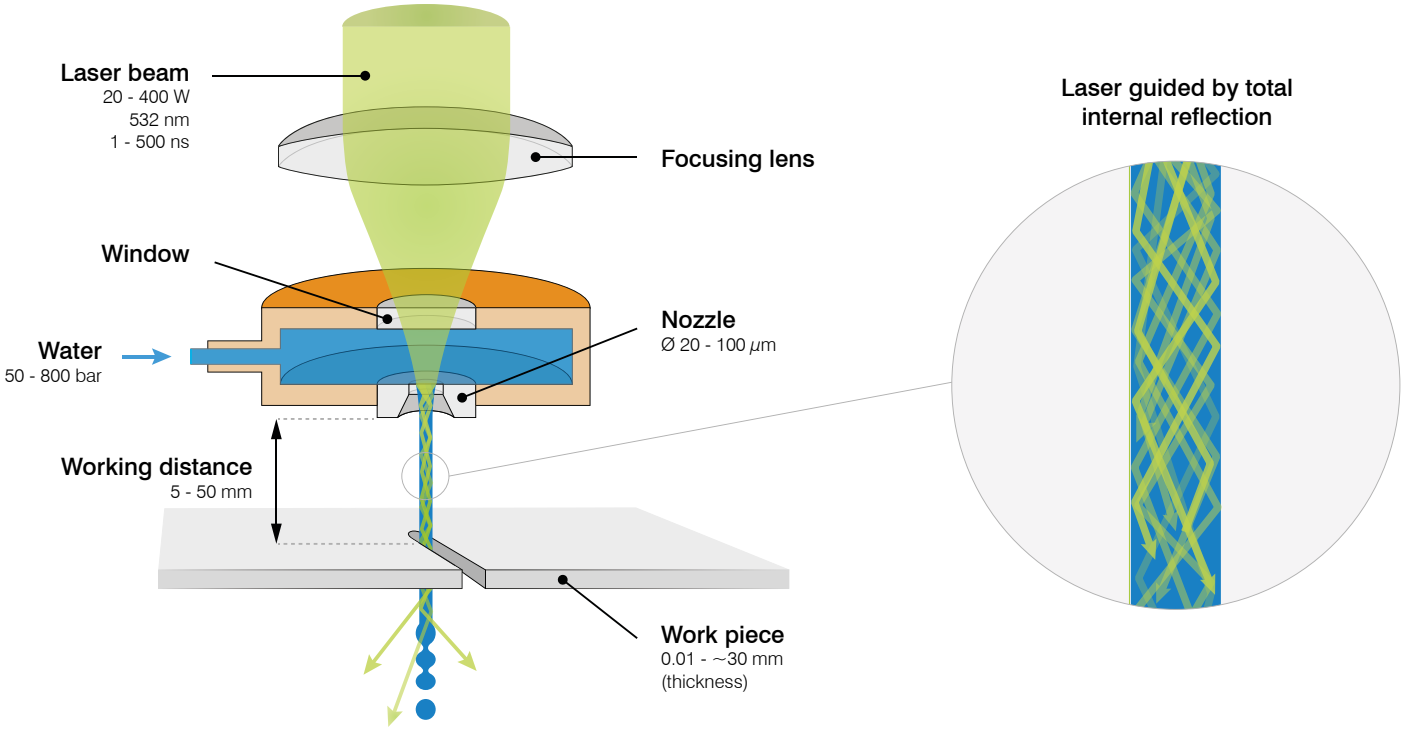
Synova S.A., headquartered in Duillier, Switzerland, manufactures unique laser cutting systems since 1997 that incorporate the proprietary water jet guided laser technology (Laser MicroJet®) in a true industrial CNC platform. Customers benefit from significant yield and quality improvements in cutting, as well as enhanced capabilities for micro-machining a wide range of materials. Synova is a privately owned company with subsidiaries in North America and the Asia/Pacific region.

The Laser MicroJet® Technology

A SIMPLE PRINCIPLE

The Laser MicroJet (LMJ) is a hybrid method of machining, which combines a laser with a “hair-thin” water jet that precisely guides the laser beam by means of total internal reflection in a manner similar to conventional optical fibers. The water jet continually cools the cutting zone and efficiently removes debris.

As a “cold, clean and controlled laser”, Synova's LMJ technology resolves the significant problems associated with dry lasers such as thermal damage, contamination, deformation, debris deposition, oxidation, micro-cracks, lack of accuracy and taper.



Technical Parameters

Lasers

- Diode-pumped solid-state pulsed Nd:YAG lasers with pulse durations in the micro- or nano-second range, operating at 1064 or 532 nm
- Average laser power ranges from 20 to 400 W

Water

- Pure deionised and filtered water
- Water consumption is low due to “hair-thin” jet: approx. 10 litres/hour at 50-800 bar pressure
- Resulting forces exerted are negligible (<0.1 N)

Nozzles

- Nozzles made of sapphire or diamond, as these materials’ hardness enables the generation of a long, stable water jet over a long period of time
- Diameter range: 20-100 µm

The Fusion of Water and Light

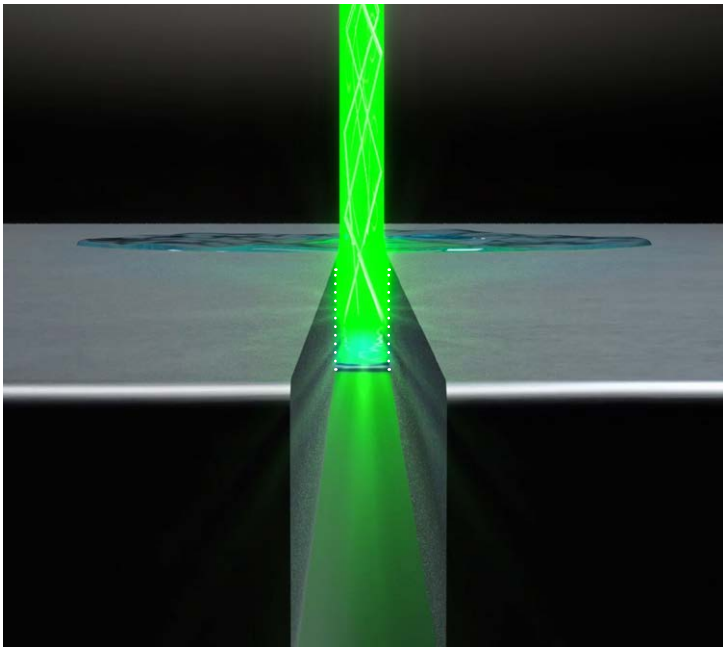
HIGH-PRECISION MICRO-MACHINING

The water jet guided laser is a revolutionary cutting technology, which combines the low-temperature and large working distance advantages of water jet cutting with the precision and speed of conventional laser cutting.

As a result, the Laser MicroJet has a remarkably wide range of applications and has established itself amongst other non-conventional machining methods (EDM, laser, grinding, AWJ).

The LMJ technology is particularly valuable for very thin kerf cutting, delicate surface coatings and high-precision processing of work pieces sensitive to deformation and heat as needed in the semiconductor industry, for instance.

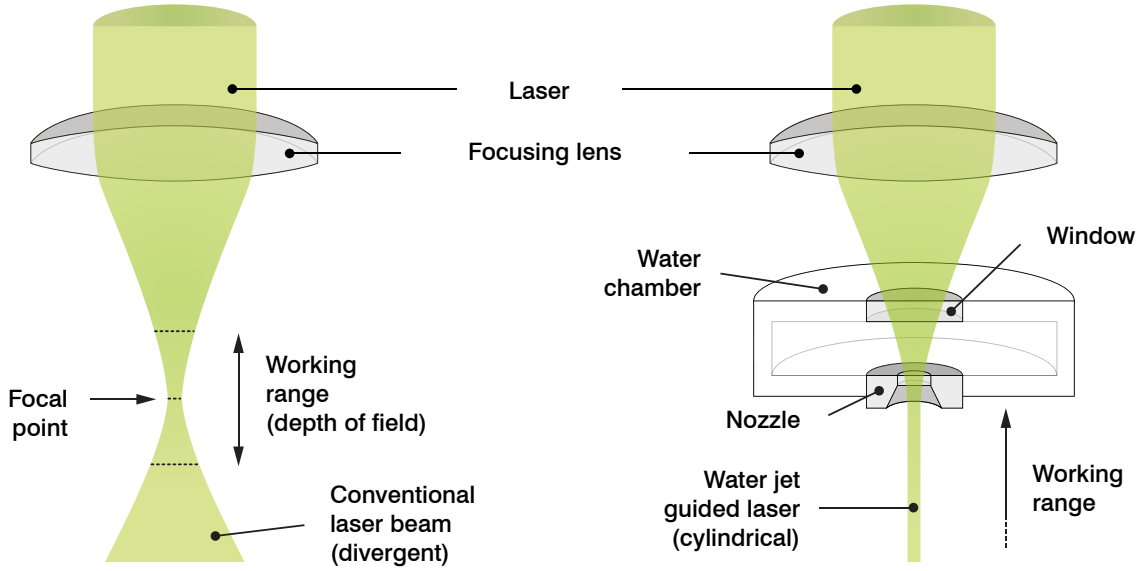
Finally, the cylindrically guided laser is ideal for the parallel cutting of brittle and hard materials with excellent quality and minimal material loss.



The cutting kerf width ranges from 25 to 120 μm, depending on the nozzle size. The laser energy is always guided to the bottom of the kerf.

The Perfect Shape

COMPARISON OF CONVENTIONAL AND MICROJET LASER BEAMS



The conventional focused laser beam has a limited working distance of just a few millimetres to even fractions of a millimetre due to beam divergence.
This not only makes precise focussing and distance control necessary, it also limits the ratio of kerf width to depth.

The Laser MicroJet technology employs a laser beam that is completely reflected at the air-water interface.
The beam can be guided over a distance of up to 10 cm, enabling parallel high aspect ratio kerfs.
No focussing or distance control is required.

Technology Benefits

Conventional Laser		Laser MicroJet
Requires precise focus adjustment		No focus adjustment required, non-flat surfaces are not an issue, 3D cutting possible, variable cutting depth of up to several cm
Conical laser beam leaves non-parallel kerf walls		Cylindrical beam results in parallel kerf walls, consistent high quality cutting
Limitations in cutting aspect ratio		High aspect ratio, very small kerf width (>20 μm), minimal material loss, with simultaneous deep cuts possible
Heat affected zone		Water-cooling process avoids thermal damage and material change, high fracture strength is maintained
Particle deposition		A thin water film eliminates particle deposition and contamination, no surface protection layer required
Inefficient material removal leaves burrs		High kinetic energy of the water jet expels molten material, no burrs form

EDM		Laser MicroJet
Only electrically conductive materials		Wide range of materials
Slow ablation process and time-consuming preparation		Fast machining
Expensive consumables (EDM wire)		Low running costs (Low tool wear, water consumption and waste rates)

Applications

Aerospace: Turbine blades. Drilling diffusers and holes in one process on TBC + superalloy

Tool Manufacturing: Indexable inserts. 3D cutting of 1 mm SCD: 2.6 mm/min

Micro-Machining: Spinnerets. Cutting of 4 mm stainless steel: 7 min/slot

Natural Diamonds: Shaping facets of 3.2 carat stone in 3 hrs.

Applications and Performance Capabilities

THE STRENGTHS OF THE LASER MICROJET

Materials

The water jet guided method allows the machining of a **broad range of materials**. Since it's a very gentle process, the LMJ is particularly well-suited for machining brittle materials that are easily damaged using traditional cutting processes:

- Diamonds: Natural and lab-grown diamonds (CVD, HPHT)
- Metals: Stainless steel, aluminium, Durnico, Phynox, CuBe, copper, brass, gold, shape-memory alloys (nitinol, cobalt-chrome), titanium, nickel, superalloys
- Superhard materials: Polycrystalline cBN (PcBN), polycrystalline diamond (PCD), single crystalline diamond (SCD), tungsten carbide (WC)
- Ceramics: Zirconia (ZrO2), HTCC/LTCC, aluminium nitride (AlN), aluminium oxide (Al2O3), silicon nitride (SiN)
- Semiconductors: Silicon (Si), gallium arsenide (GaAs), silicon carbide (SiC)
- Composites: Ceramic-matrix composites (CMCs), diamond-SiC/cBN composites, carbon fiber reinforced polymer (CFRP)

Operations

Thanks to its versatile technology, the LMJ can be used for a **multitude of processes** in 2 to 5 axes, including cutting, drilling, milling or turning.

Quality

Thanks to the water jet cooling capability there is virtually **no heat impact**. The ablated material is removed with the water flow leaving **clean surfaces** and **no depositions**.

Thickness

The LMJ can cut a **wide range of material thicknesses**, e.g. cutting of up to 30 mm thick diamond or silicon carbide or drilling of up to 15 mm thick superalloys (hole diameter 800 μm).

Speed

The usage of industrial high-power lasers enables **high cutting speeds**, for example up to 45 mm/min in 7 mm thick silicon or 5 mm/min in 4 mm CVD diamond.

Accuracy

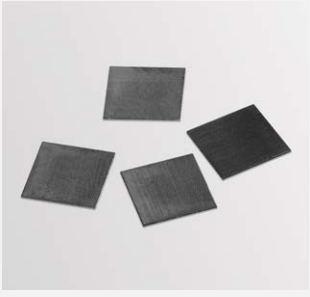
The lasers used in Synova's machines are **ultra-precise** tools which can achieve **tight parallel kerfs** – from 25 to 120 μm – with an absolute precision as low as +/- 1.5 μm, resulting in appreciable material savings.

Shapes

LMJ machines allow **omni-directional ablation** processes, making the creation of any shape possible. This provides customers with the flexibility to develop new ideas and applications, from making small wheels for the watchmaking sector to dicing chips of any shapes in the semiconductor industry.

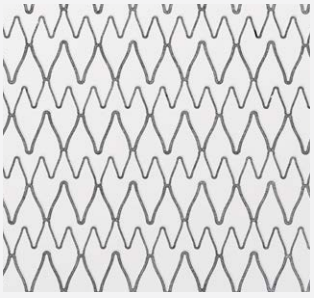
Costs

The efficient and precise LMJ technology enables **low running costs**: Few consumables, low tool wear and waste rates.



Lab-grown Diamonds:
Slicing of 10 mm CVD diamond in 15 min

Watchmaking:
Tourbillon bridge. Cutting of 3 mm brass: 12 mm/min



Medical:
Flat stents. Cutting of 0.2 mm NiTi: 300 mm/min

Semiconductors:
Disks. Cutting and slicing of 10 mm SiC: 26 mm/min

The Fusion of Water and Light

SYNOVA

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Contact information available at: www.synova.ch

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