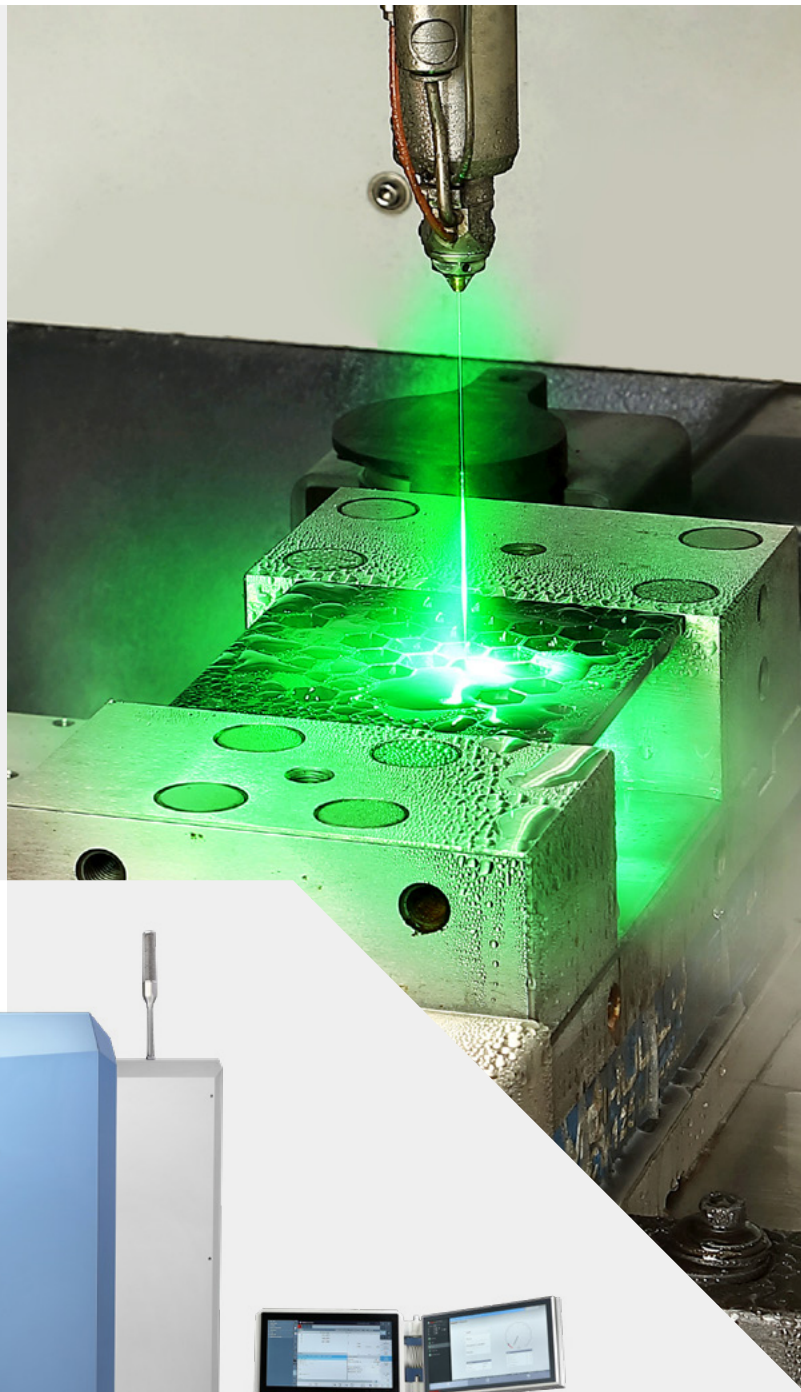


LASER WATERJET SOLUTION

FM 600/LW

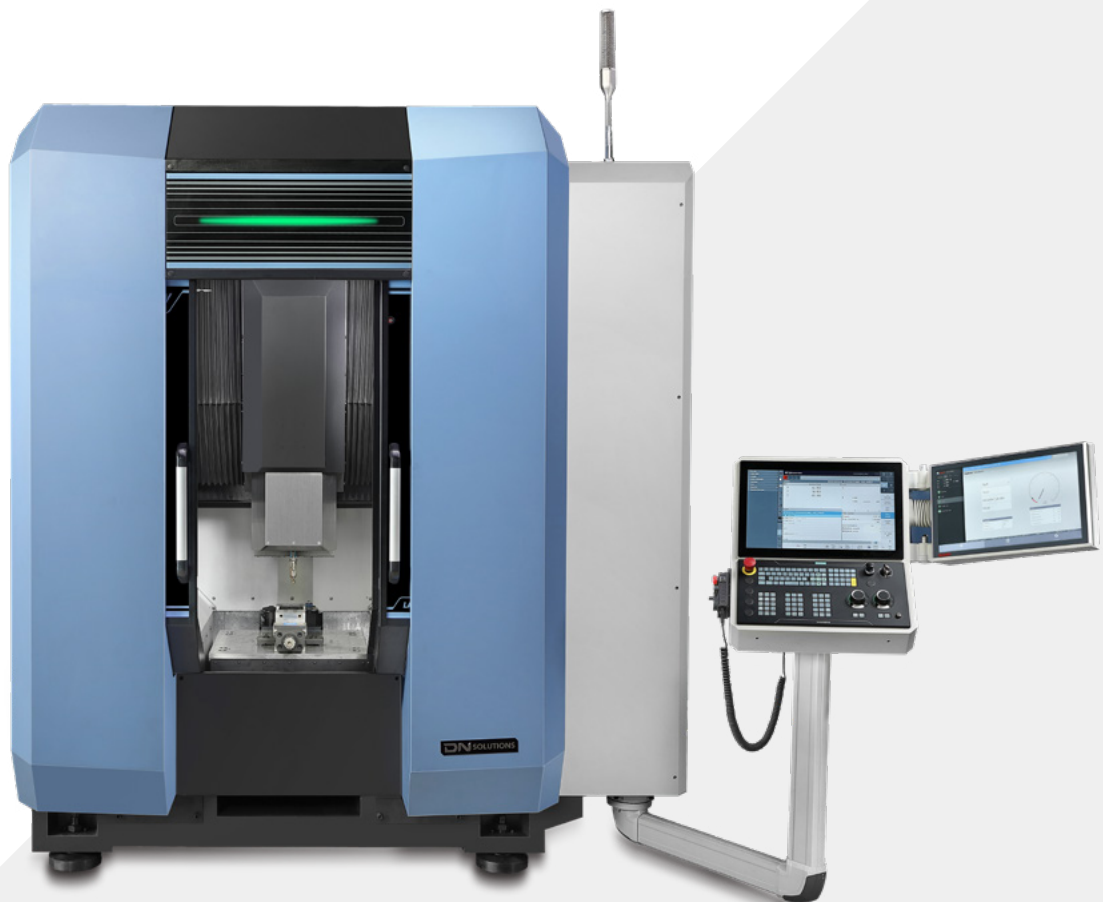


FM 600/LW

Laser-waterjet technology is a machining method in which a laser induced inside a waterjet irradiates the material, repeating a cycle of heating-ablation-cooling. Because water continuously cools the machining area, the ablated zone cools rapidly before the next laser pulse, enabling machining with minimal heat-affected zones. Additionally, since the waterjet optically guides the laser beam, no separate focus control is needed in the working area. Using a parallel laser beam, taper-free, high-aspect-ratio micro-machining is achievable.

CONTENTS

Product Overview	Basic Information	Detailed Information	Customer Support Service
	04 Necessity & Advantages of Laser Waterjet Technology	09 SINUMERIK ONE	15 Customer Support and Services
	05 Applicable Industries & Applications	11 External Dimensions	15 Global Network
	06 Basic Structure	12 Working Range	
	08 Laser Waterjet Process Performance	13 Machine Specifications	



INTEGRATED MACHINING SOLUTION



- Integrated machining solution combining advantages of laser and waterjet machining
- Parallel laser beam machining (No taper, no focus control required)
- Ultra-thin waterjet providing cooling and burr removal
- Ideal for machining high-hardness and high-strength materials

EXCELLENT MACHINING CAPABILITY

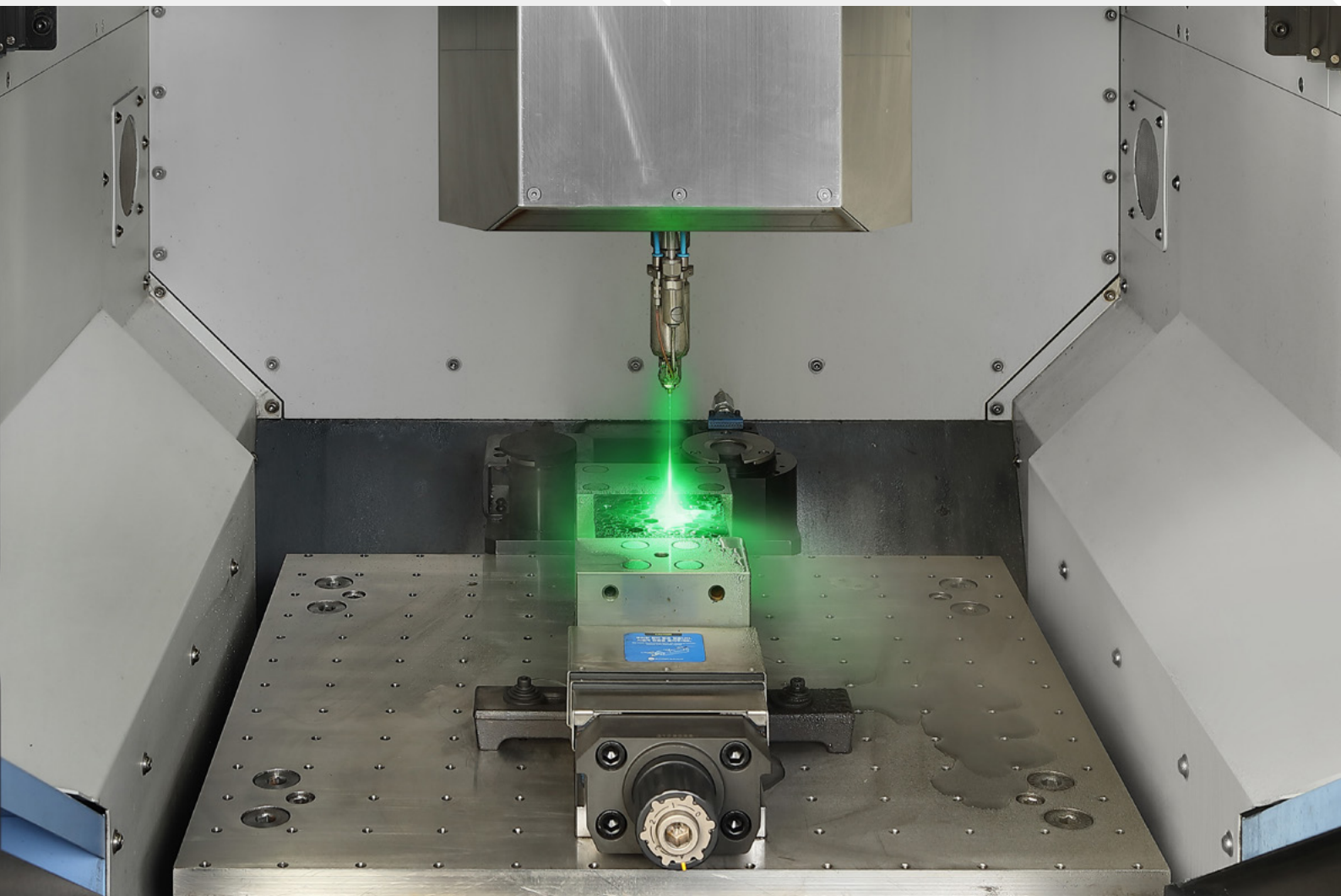


- Applying table for large working area (600 × 600 × 350 mm)
- Capable of machining various materials and complex geometries and applying to thickness from a few micrometers to several tens of millimeters depending on material

HIGH-PRECISION PLATFORM



- High-precision machining performance (Repeatability within $\pm 1 \mu\text{m}$)
- High-precision, high-speed and Stable acceleration and deceleration traverse system using LM guides & linear motors
- Mineral-casting bed minimizing vibration and thermal displacement
- High stability, flexibility, and openness for integrated control and efficient production



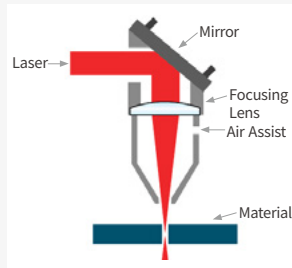
NECESSITY & ADVANTAGES OF LASER WATERJET TECHNOLOGY

Laser Processing



GOOD

Fast machining speed,
Suitable for hard/
high-strength materials



BAD

Cannot achieve perfectly
vertical cutting surfaces,
Heat hardening/thermal
stress of machining surface

Waterjet Processing



GOOD

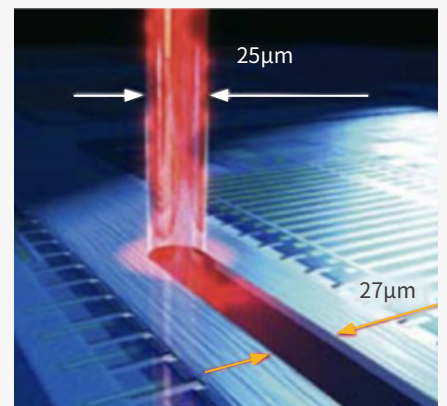
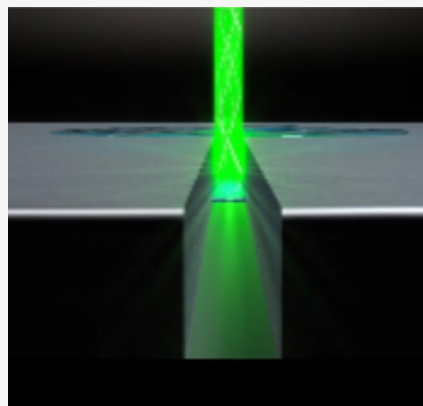
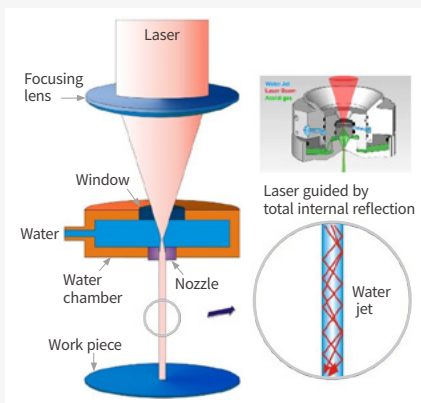
Vertical cutting surfaces
possible,
Automatic removal of
micro-chips by water



BAD

High-pressure water
: Crack on the surface,
Slow machining speed and
difficult for high-hardness/
strength materials

Strategic integration of laser for high productivity and waterjet for stability Integrated Laser and Waterjet Machining System



* Since the laser beam is focused on the machining point, the shape of the machining surface through the beam has an inverted cone shape.

- High-energy laser combined with mid/low-pressure waterjet
- High productivity and suitable for high-hardness/high-strength metals/non-metals by laser solution
- Mid-low-pressure waterjet ensuring vertical cutting, eliminates heat effects, prevents cracks
- Stable machine platform supporting various application demands
- Industries: semiconductor consumables, energy components, aerospace, automotive, etc.

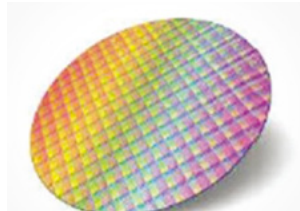
APPLICABLE INDUSTRIES & APPLICATIONS

Applicable Materials



Metals/alloys

Al, Fe, Au, Ag, Cu, CuBe, Mg, W, WC, CuW, Mb, Ni, Ti, Co, Cr



Semiconductors

Si, Ge, SiC, GaAs, InP, GaP, CdTe, SiGe



Ceramics/hard materials

AlN, AlO, SiN, AlTiC, LTCC, ZrO₂, CBN, PCD



Diamond

ND, PCD, SCD, CVD, HPHT



Composite material

CMC, SiC, CFRP



Plastics

Black or dark color plastic

Not possible: Transparent or clear color plastics, glass, wood, paper or textiles

Industries & Applications



Aerospace

Turbine blades. Drilling diffusers and holes in oneprocess on TBC + superalloy



Tool Manufacturing

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



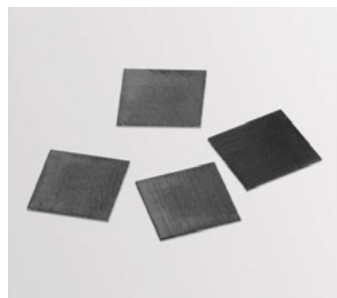
Micro-Machining

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



Natural Diamonds

Shaping facets of 3.2 carat stone in 3 hrs.



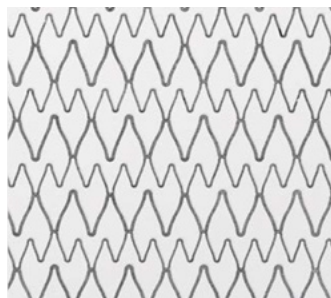
Lab-grown Diamonds

Slicing of 10 mm CVD diamond in 15 min



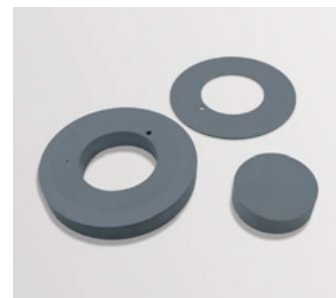
Watchmaking

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



Medical

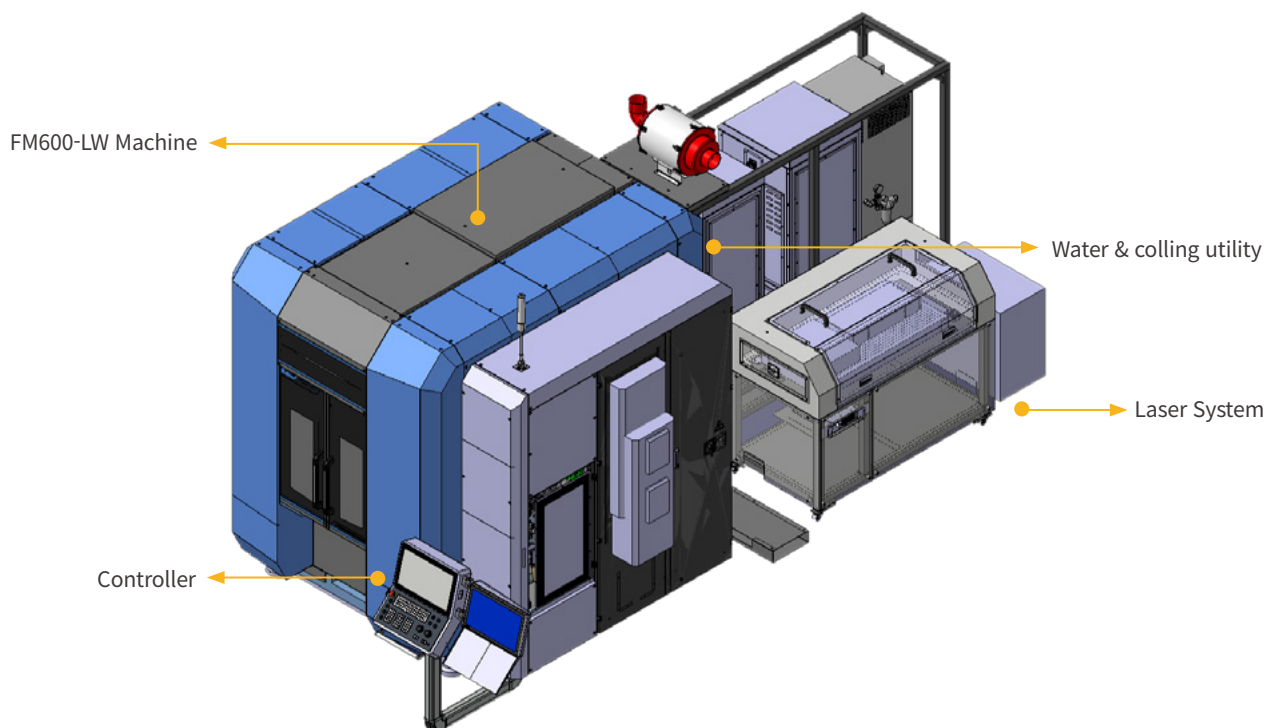
Flat stents. Cutting of 0.2 mm NiTi: 300 mm/min



Semiconductors

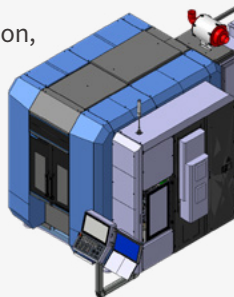
Disks. Cutting and slicing of 10 mm SiC: 26 mm/min

BASIC STRUCTURE



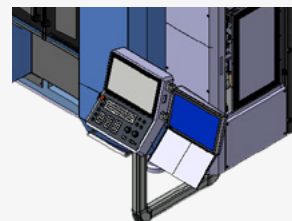
FM600-LW Machine

Linear motors for high-precision, high-speed, Mineral casting bed for vibration damping and thermal stability



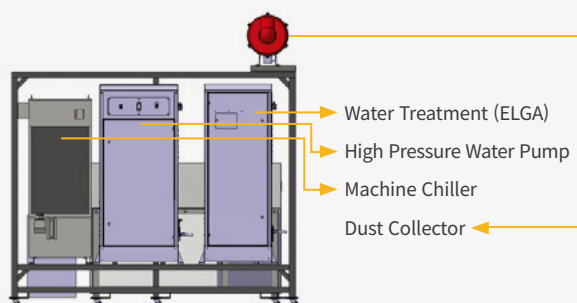
Controller

SIEMENS SINUMERIC One + Synova IPC (LW Module)



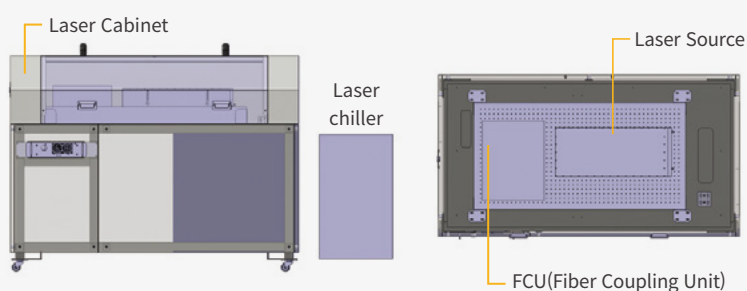
Water & colling utility

High Purity/High Pressure waterjet



Laser System

High Power/NS Pulsed Laser
Wavelength 532nm



BASIC STRUCTURE

Laser Waterjet Solution

Laser Waterjet Solution Development Based on Component Expertise

LW Module (DN Solutions& SYNOVA)

- Commissioning
- Process-technology support
- LMJ Unit Warranty [MOU/NDA in place]

LW Module

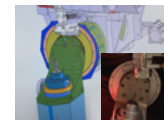


+



FM 600/LW

CAM

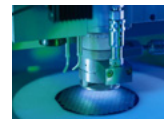


+

LW-Compatible CAM (DN Solutions& SYNOVA)

- CAM Customization
- Optimized strategies for representative geometry
- Process technology support [MOU/NDA in place]

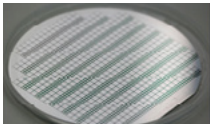
Hybrid Process



Hybrid Process Technology / DB (DN Solutions& SYNOVA)

- Process validation for representative geometry
- Hybrid process DB [MOU/NDA in place]

Ceramics



SiC

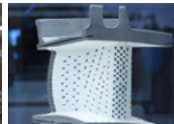


Focus Ring

Metals

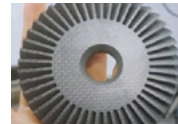


Gas turbines engine



Turbine blades

Fiber reinforced plastics



Aerospace parts



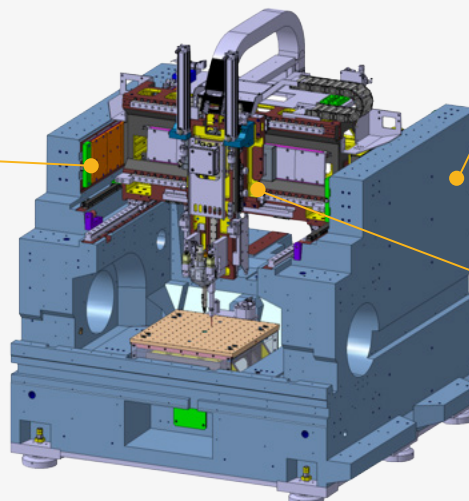
Automotive part

Motion Freedom & Enhanced Precision Platform



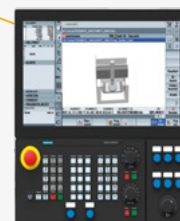
Linear Motors

High-precision, high-speed linear motion, and stable acceleration/deceleration performance



Mineral Casting Base

- Excellent vibration-damping for high-speed motion
- Low thermal conductivity & thermal expansion → minimized thermal displacement

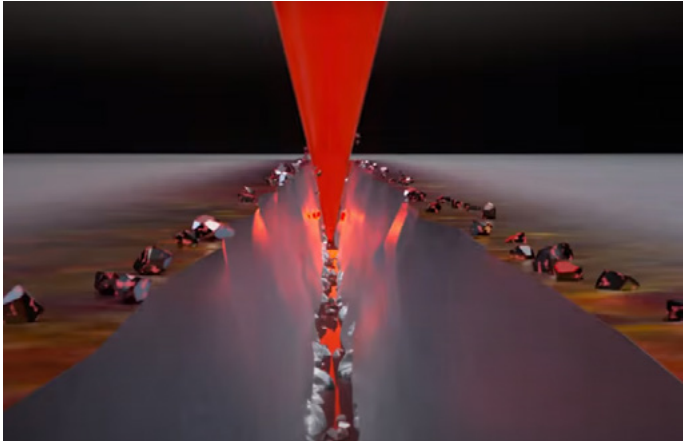


Premium CNC

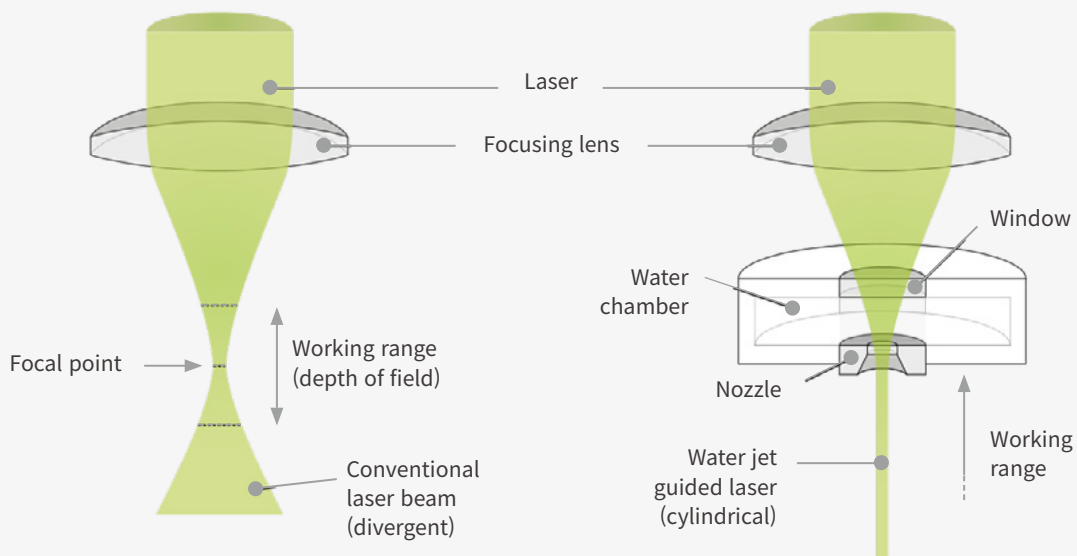
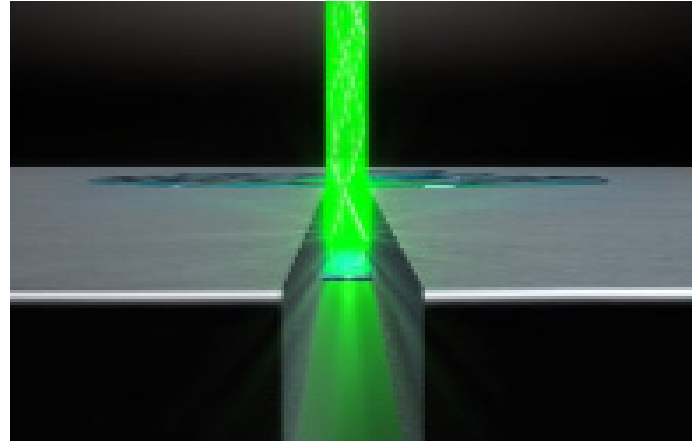
High stability, flexibility, and openness enabling reliable integrated control and efficient production

LASER WATERJET PROCESS PERFORMANCE

Conventional Laser Processing



Laser Water jet Processing



Source: SYNOVA

Comparison with Conventional Laser Processing

- Conventional laser machining has a short working distance due to beam divergence requiring precise focal-length control and limiting achievable aspect ratios.
- Laser Waterjet machining maintains a stable parallel beam within a working distance of up to ~10cm, enabling high-aspect-ratio cuts without focal adjustments.
- Fast cutting performance without the need for separate focus-distance control

Laser Water Jet

- Parallel laser beam (No taper, No focus)
- High-quality, high-precision (Down to $\pm 1\mu\text{m}$)
- Minimal heat-affected zone (No heat affect zone/No depositions)
- Supporting various materials and complex geometries (From a few micrometers to several tens of millimeters in thickness)
- Ideal for brittle and composite materials
- Low operating cost (Reduced tool wear and tool loss rate)

CONVENIENT OPERATION

SIEMENS SINUMERIK ONE

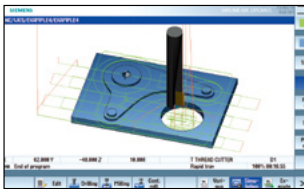
Faster data & PLC processing + 21.5" Screen

From programming to program verification, and from machine setup to actual machining, every step of the process has become faster and easier. The large 21.5" touchscreen enables intuitive and user-friendly operation.

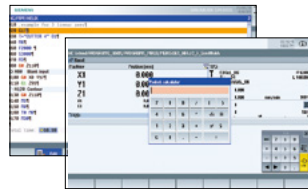
- 21.5" Screen
- 50% faster machining processing compared to S840D
- Graphic programming
- Flexible automation based on PLC



Interactive Operation Functions



Simulation & Machining
Shape Monitoring



Smart Control

CNC CONTROLLER SPECIFICATIONS

SIEMENS

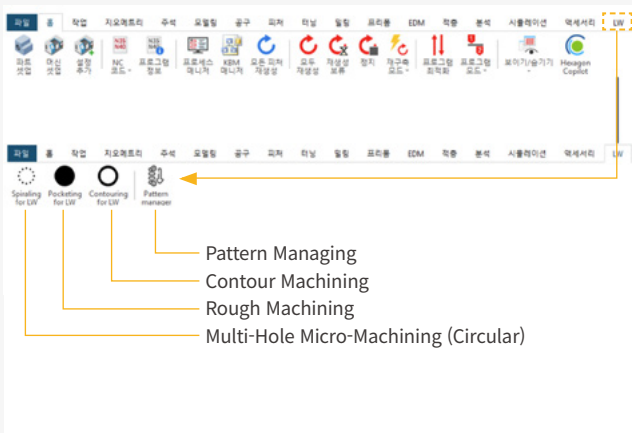
	Item	Specifications	S-ONE
Controlled axis	Controlled axes		3 axes (X, Y, Z)
	Simultaneously controlled axes		3 axes
Data input/output	Memory card input/output	(Local drive)	●
	USB memory input/output		●
Interface function	Ethernet	(X130)	●
Operation	Execution from External Storage (EES)		○
	On network drive	(without EES option, Extcall)	●
	On USB storage medium (e.g. disk drive, USB stick)	(without EES option, Extcall)	●
Program input	Workpiece coordinate system	G54 - G57	●
	Addition of workpiece coordinate system	G505 - G599	●
Interpolation & Feed function	Look ahead number of block		1000
Programming & Editing function	3D simulation, finished part		●
	Simultaneous recording		●
	DXF Reader for PC integrated in SINUMERIK Operate		○
Operation Guidance Function	ShopMill		●
	EZ Work		●
Setting and display Network	Operation via a VNC viewwe		●
	MTConnect		⊗
	OPCUA		○
Others	21.5" color display with touch screen		●
	CNC user memory	10 MB	●
	Max. CNC user memory	28 MB	○
	CNC user memory expanded		○

CONVENIENT OPERATION

Software for Laser Waterjet

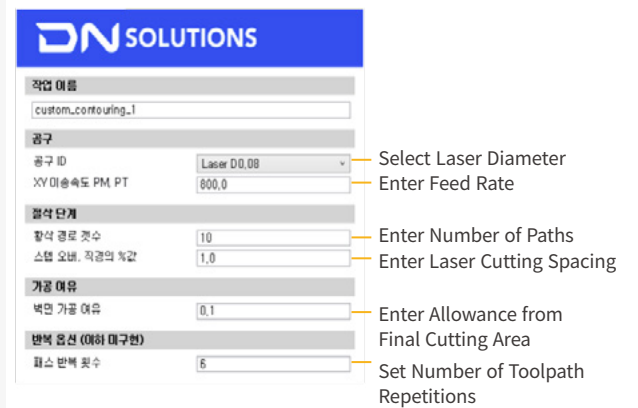
“Development of a Dedicated Laser Waterjet CAM to Deliver Optimized Toolpaths and Control for Difficult-to-Machine Materials.”

The CAM system supports various LW-specific machining strategies—such as Repetitive Path Machining for LW processes and Spiral Paths for micro-hole machining—while incorporating intelligent CAM functions tailored to the characteristics of waterjet-guided laser processing. These capabilities enable stable processing and efficient toolpath generation for micro-holes and complex geometries.



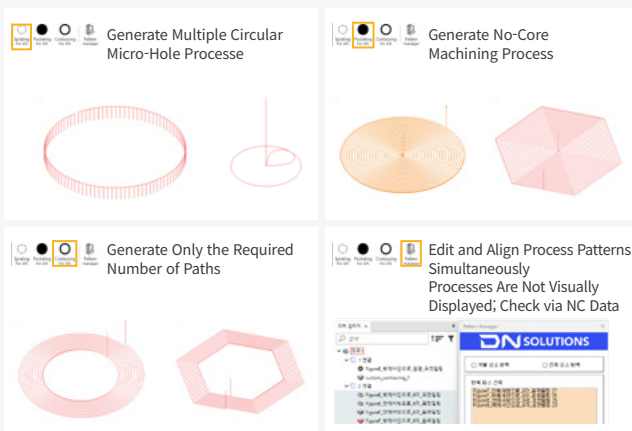
Development of Dedicated Laser Waterjet CAM Functions Differentiated from Conventional Cutting CAM

User-Focused Features Designed to Reflect LW Process Characteristics



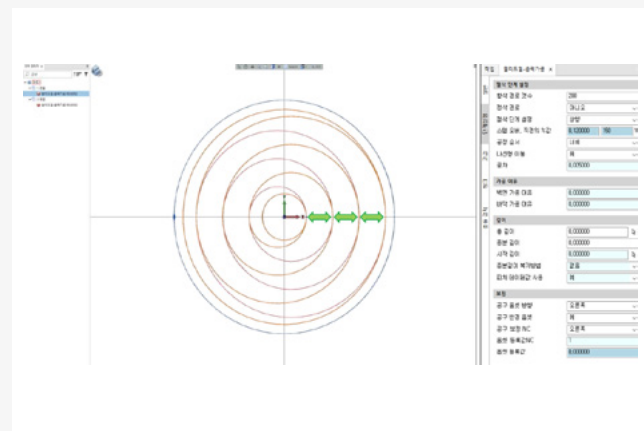
Example of CAM Toolpath Generation

Feature/Condition Input → Automatic Path Generation → Verification/Post-Processing (Optional) → NC Output



Laser Waterjet Path Generation

Automatic LW-Optimized Toolpaths (Spiral / Zig-Zag / Pattern)



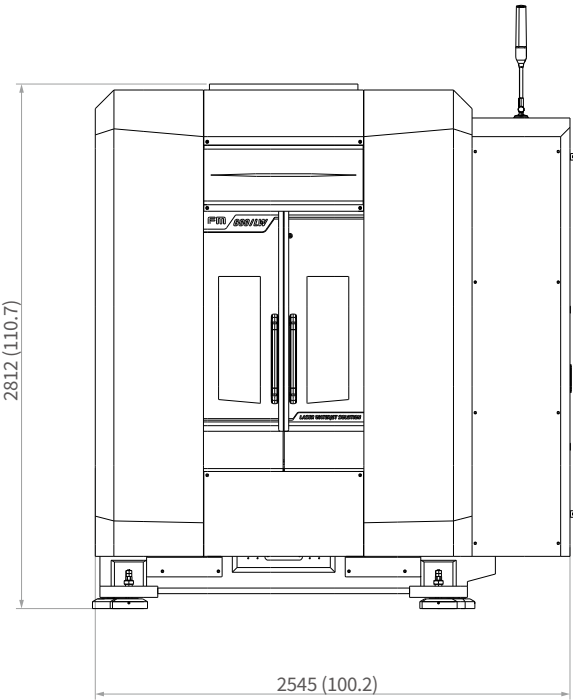
Micro-Hole CAM Path for Holes Under 1 mm

High-Precision Toolpaths Based on Micro-Hole Strategies and Parameters

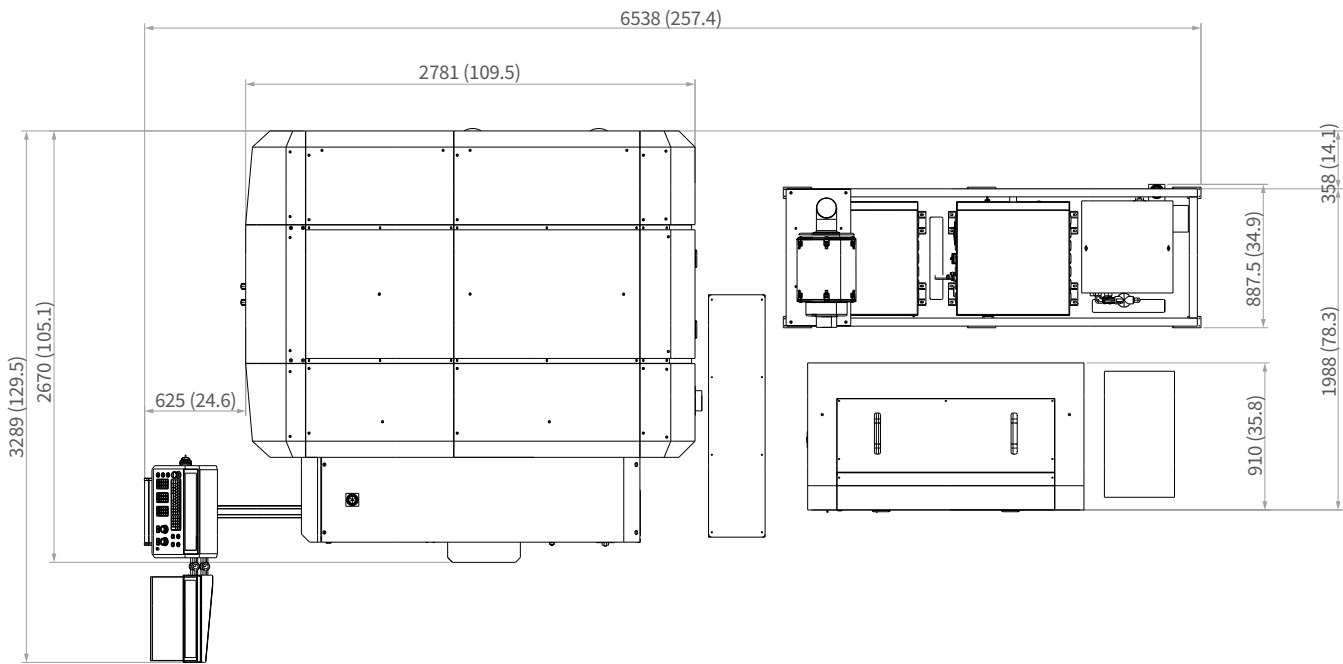
EXTERNAL DIMENSIONS

Unit : mm (inch)

FRONT



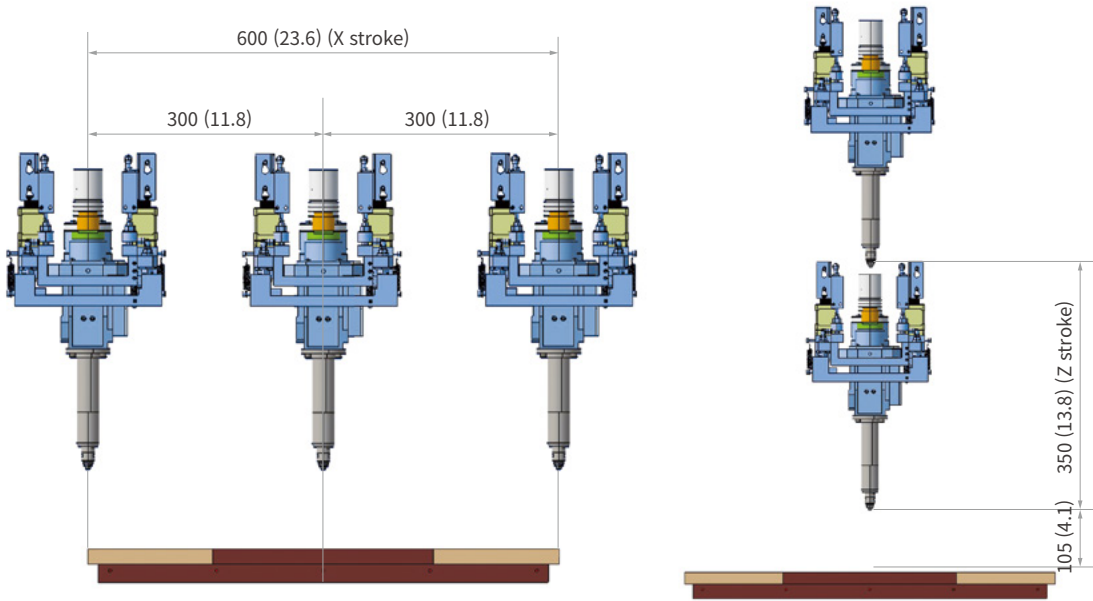
TOP



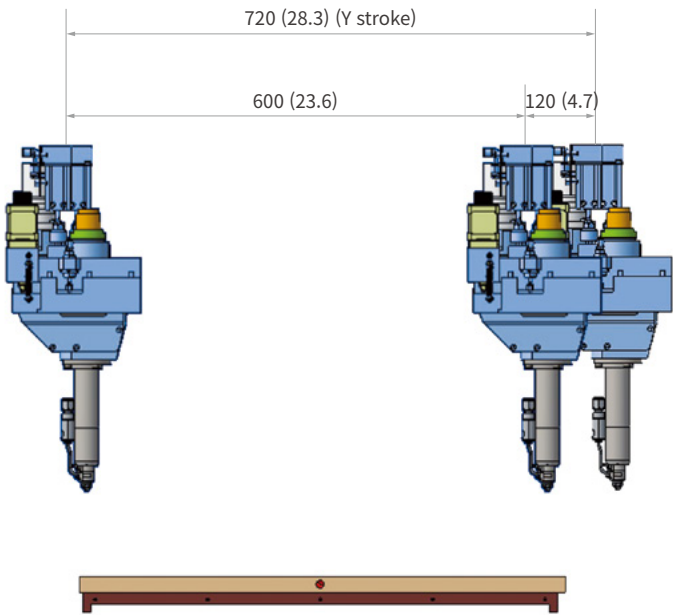
WORKING RANGE

Unit : mm (inch)

FRONT WORKING AREA



SIDE WORKING AREA

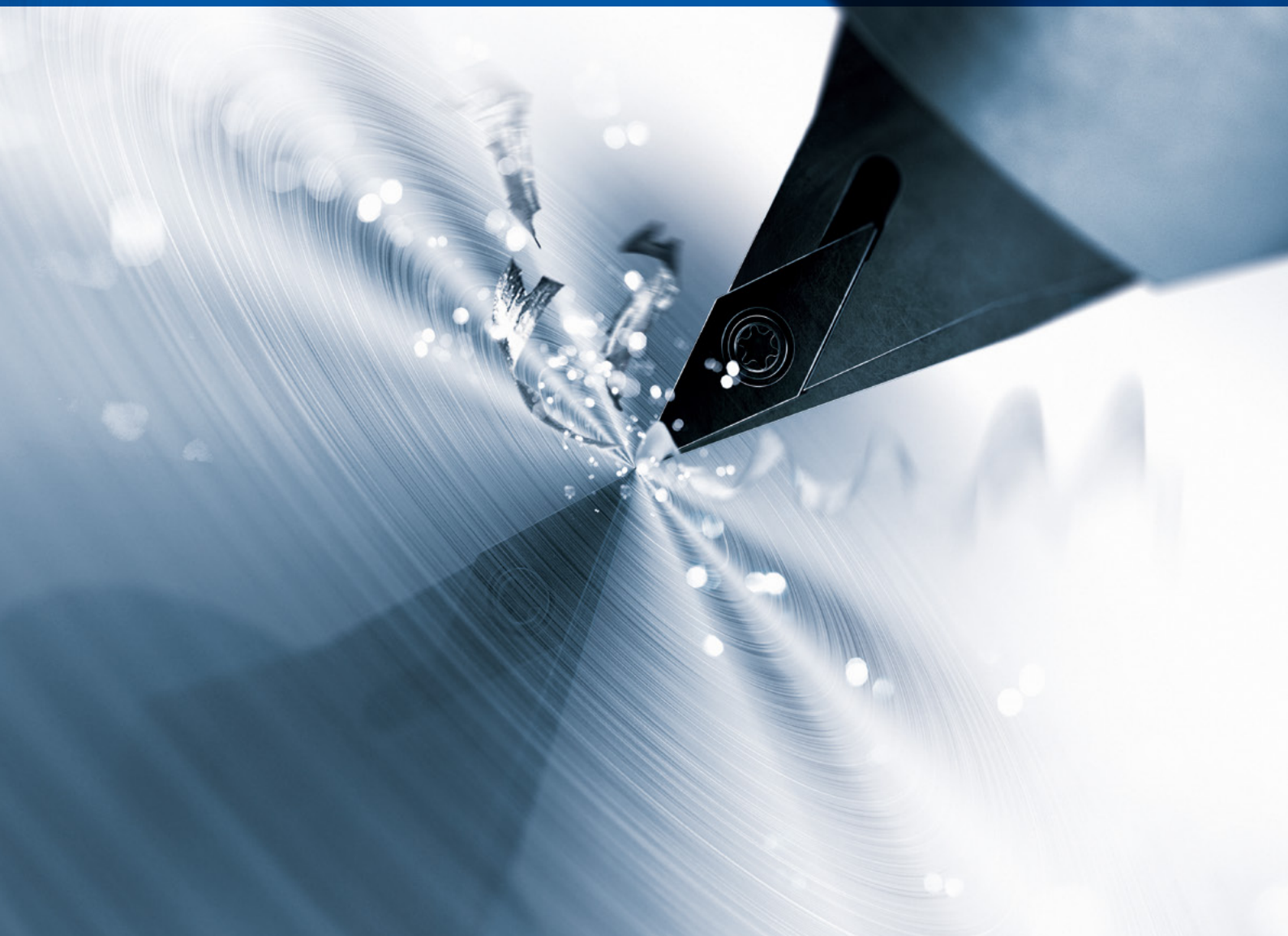


MACHINE SPECIFICATIONS

Description		Unit	FM 600/LW
Table	Table size	mm (inch)	640 X 610 (25.2 X 24.0)
	Max. Work size	mm (inch)	600 x 600 x 350 (23.6 x 23.6 x 13.8)
	Max. Workpiece load	kg (lb)	600 (1322.8)
Travel distance	X Axis	mm (inch)	600 (23.6)
	Y Axis	mm (inch)	600 (23.6)
	Z Axis	mm (inch)	350 (13.8)
Rapid Traverse Rate	X Axis	m/min (ipm)	60 (2362.2)
	Y Axis	m/min (ipm)	60 (2362.2)
	Z Axis	m/min (ipm)	60 (2362.2)
Acceleration	X Axis	G	1
	Y Axis	G	1
	Z Axis	G	1
Accuracy	Positioning	μm	+/- 3 μm
	Repeatability	μm	+/- 1 μm
Laser Source	Wavelength	nm	532
	Average Power	W	150W@10kHz
	Pulse Energy	mJ	15mJ@10kHz
	Pulse Width	ns	~200ns@10kHz
	Repetition Rate	kHz	Single Shot to 50kHz
Water Pump	Water Pressure	Bar	~600
Machine Layout(Width x Length)		mm (inch)	2585 X 2669 (101.8 X 105.1)
Weight		kg (lb)	12,000 (26455.1)
CNC SYSTEM			Siemens Sinumerik One

WHY DN SOLUTIONS

The DN Solutions promise, MACHINE GREATNESS, has two important meanings. The first is simple: DN Solutions makes great machines. The second is a challenge to our end-users. With a product line that is this comprehensive, accurate and reliable, we equip our customers to machine greatness. The big question: ***Why should you choose DN Solutions over other options?*** Here's why...



UNBEATABLE MACHINES

You won't find a more comprehensive range or a better combination of value, performance and reliability anywhere else.

ROBUST PRODUCT LINE

We offer an impressive range of machine models and hundreds of configurations. Whatever your machining needs and requirements, there's a DN Solutions for you.

READILY AVAILABLE - ANYWHERE IN THE WORLD

Machining centres (including 5-axis machines), lathes, multi-tasking turning centres and mill-turn machines, and horizontal borers with best-in-class specifications are all available...ready to install.

EXPERT SERVICE

Our dedicated, experienced and knowledgeable team is totally committed to improving your productivity, growth and success.

RESPONDING TO CUSTOMERS **ANYTIME, ANYWHERE**

DN SOLUTIONS GLOBAL NETWORK

66 COUNTRIES | **140** + SALES NETWORKS | **3** FACTORIES | **6** REGIONAL HQS



CUSTOMER SUPPORT AND SERVICES

WE'RE THERE FOR YOU WHENEVER YOU NEED US.

We help our customers operate at maximum efficiency by providing them with a range of tried, tested and trusted services - from pre-sales consultancy to post-sales support.



FIELD SERVICES

- On-site service
- Machine installation and testing
- Scheduled preventive maintenance
- Machine repair service



PARTS SUPPLY

- Supplying a wide range of original DN Solutions spare parts
- Parts repair service



TRAINING

- Programming, machine setup and operation
- Electrical and mechanical maintenance
- Applications engineering



TECHNICAL SUPPORT

- Supports machining methods and technology
- Responds to technical queries
- Provides technical consultancy

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