TRUMPF

Whitepaper

Laser welding

Contents

For inquiries, please contact:

TRUMPF Laser Technology Center
47711 Clipper Street
Plymouth Township, MI 48170

Phone: (734) 454-7200
E-Mail: oeminfo@us.trumpf.com
Homepage: www.trumpf.com

Abstract

Are you tired of wasting valuable time and money on conventional welding methods? Then laser welding with TRUMPF is the solution for you. Often times, the high heat input of conventional welding causes discoloration of the workpiece, resulting in time-intensive reworking. Laser welding systems from TRUMPF produce high-quality, immaculate seams where reworking is no longer necessary as a result of the low heat input. This saves you not only time, but also money. You can read more about the benefits of laser welding to determine if this is the correct tool for you. Make the switch today!

5 indications that a laser is the right tool for your welding application

TRUMPF laser welding systems are the ideal tool when it comes to welding metals and other materials. Compared to conventional welding processes, a laser has many advantages. When joining sheet metal components, laser welding offers an enormous savings potential. Use our list to determine whether this is the right tool for your welding application.

01 You spend a lot of time welding one component

02 You use a lot of grinding disks every year

03 Visually, your components must meet a high standard

04 Your component accuracy requirements are high

05 You want to implement complex seam geometries

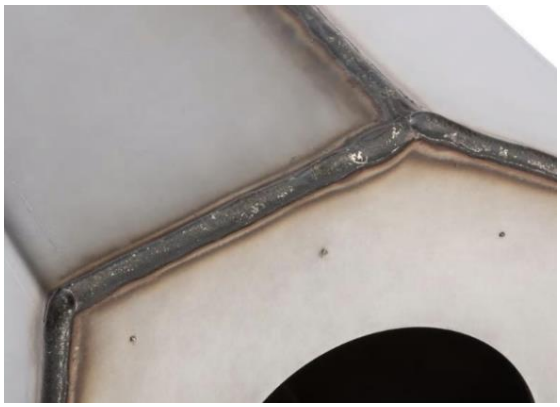

Figure 1:
A manually welded mild steel part.

Figure 2:
A laser welded mild steel part.

1. You spend a lot of time welding one component

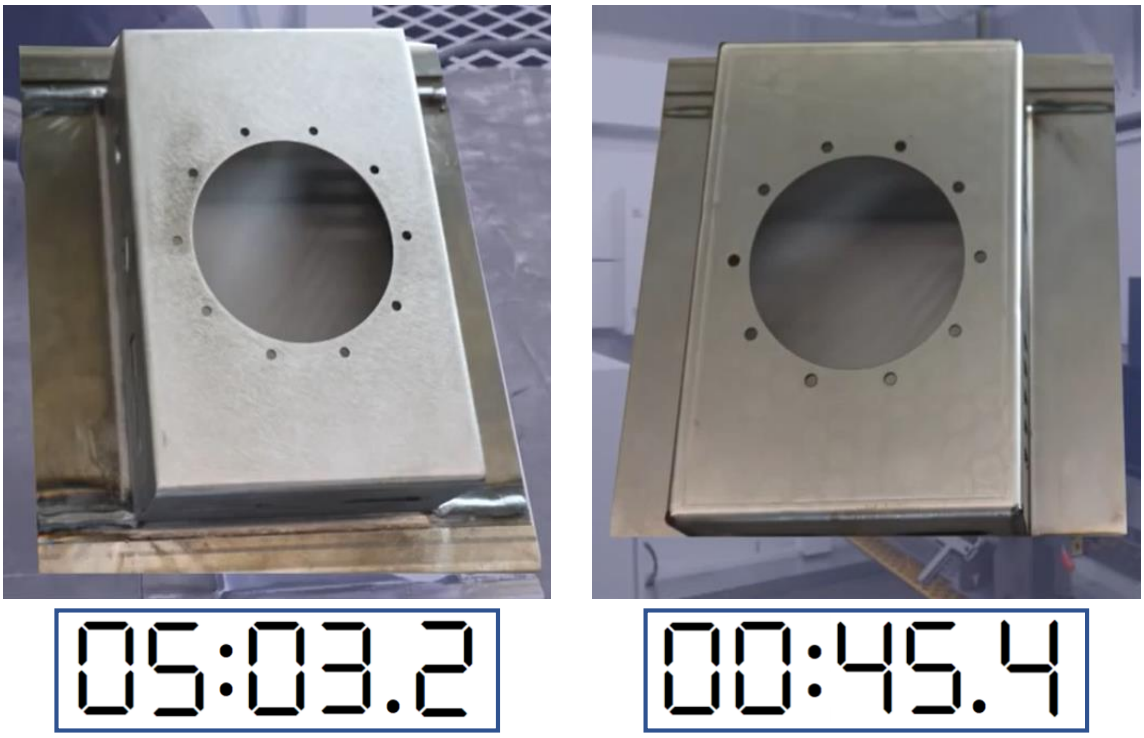

Figure 1:
A time comparison of MAG welding (left) vs. laser welding (right).

Laser welding has a far greater process speed compared to conventional welding. MAG welding of a 60-centimeter-long weld seam in one-millimeter thick structural steel takes about 59 seconds. Lasers can complete this job on the same machine in as little as four seconds. The two figures above show the difference in time it takes to automate the welding process compared to conventional welding. The processing time that is saved makes laser welding the ideal tool for your component costs. After all, with every minute, the machining, operating, and personnel costs mount up.

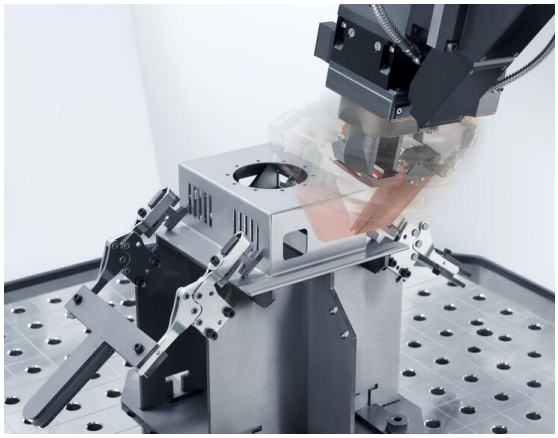

Figure 2:
The rotary module makes your parts more accessible, boosting welding speed considerably.

2. You use a lot of grinding disks every year

A lot of time and effort is spent post-processing different components during conventional welding. Reworking costs time, ties up personnel, and results in the use of a significant number of grinding disks. Lasers allow you to weld in a fraction of the time, while producing high-quality seams, which means little to no finishing or grinding is required. This can be seen in the laser-welded, stainless steel water tank pictured to the right. The water tank showcasing high-quality seams demonstrates how seam corrections are no longer necessary with laser welding. Because reworking is often times unnecessary in the case of laser welding, these types of time and cost-consuming processes are a thing of the past.

Figure 1:
Laser welded, stainless steel water tank.

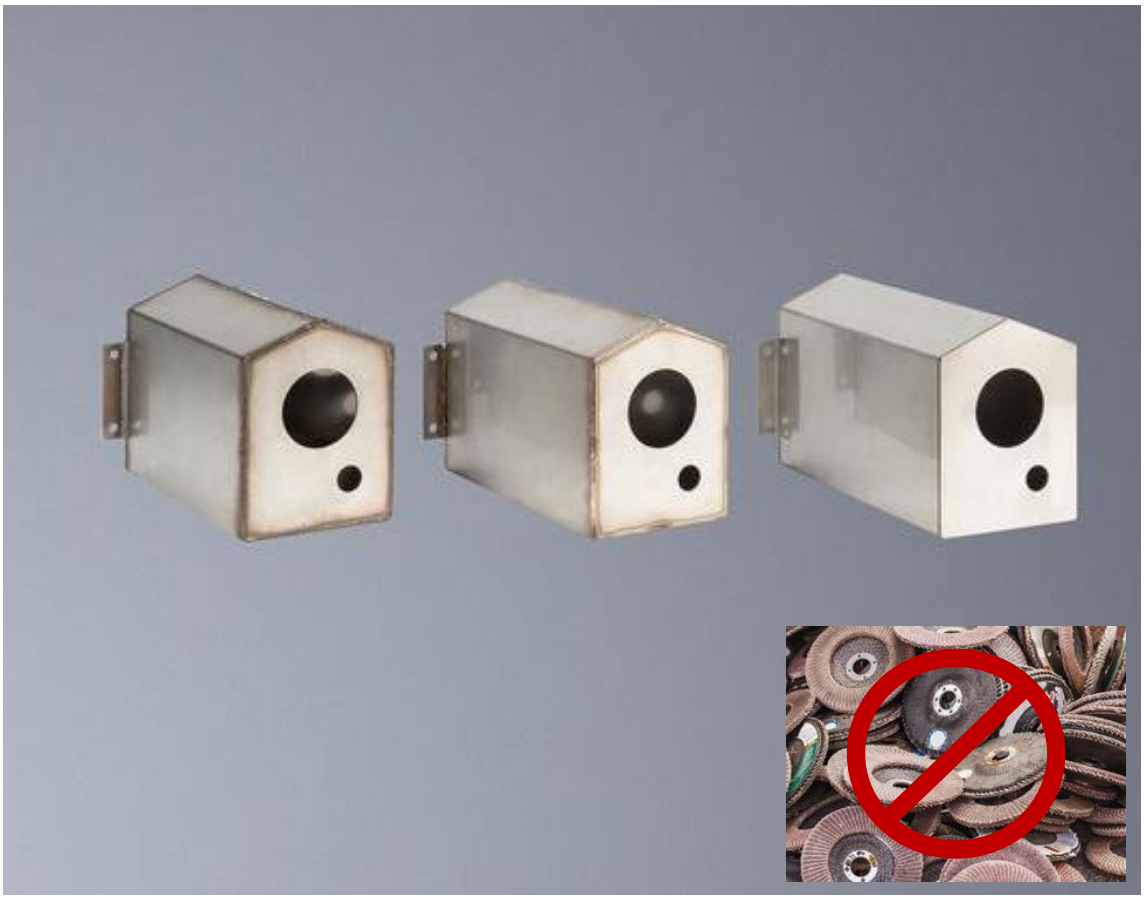

Figure 2:
Grinding disks are no longer necessary as a result of laser welding. Check out the immaculate seams of the laser welded water tank (far right) compared to conventional welding methods (far left and middle).

3. Visually, your components must meet a high standard

Lasers produce welded components that showcase visibly attractive seams. Heat conduction welding, for example, produces visibly smooth surfaces that usually do not require mechanical rework. In heat conduction welding, the laser beam melts the joining parts along a common joint. The melted materials flow together and solidify to form the perfect weld. The figures below demonstrate how lasers can produce a smooth, rounded seam that does not require any extra grinding or finishing. Energy is coupled into the workpiece solely through heat conduction, therefore the weld depth ranges from only a few tenths of a millimeter to 1 millimeter. The heat conductivity of the material limits the maximum weld depth. The width of the weld is always greater than its depth.

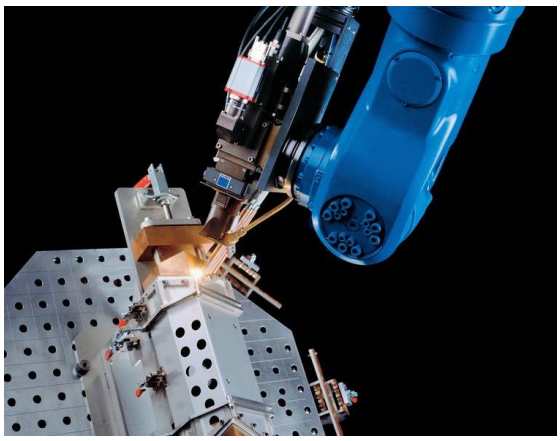

Figure 1:
Heat conduction welding with a solid-state laser and robot.

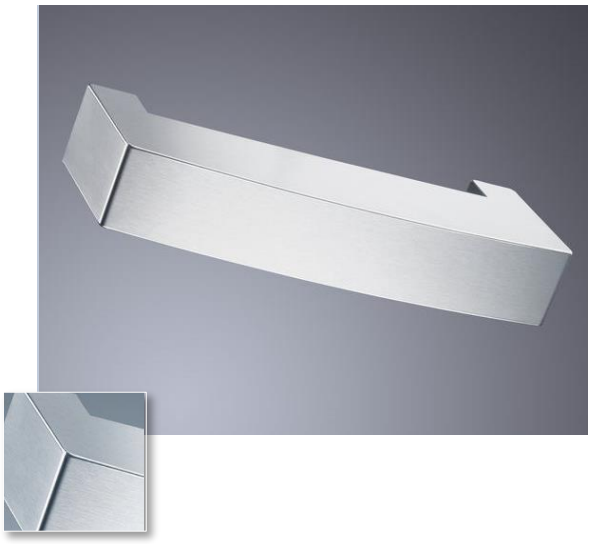

Figure 2-4:
The following figures include a catering container, housing, and counter segment. As you can see, each component displays attractive laser welded seams.

4. Your component accuracy requirements are high

Lasers have the ability to precisely control the energy input of a welded component. This causes the component to have a much lower heat input compared to arc welding. As a result, the welded components are rarely distorted and it is no longer necessary to level the component afterwards.

Figure 1:
Heat-sensitive implants such as electronic pacemakers can be reliably sealed using laser welding. Pulsed lasers accurately produce a tight weld seam without overheating the pacemaker.

Figure 2:
Components are joined through individual laser pulses in a way that protects materials during spot welding. The short pulse duration means that virtually no heat is introduced to the component, enabling components to be processed essentially warp-free.

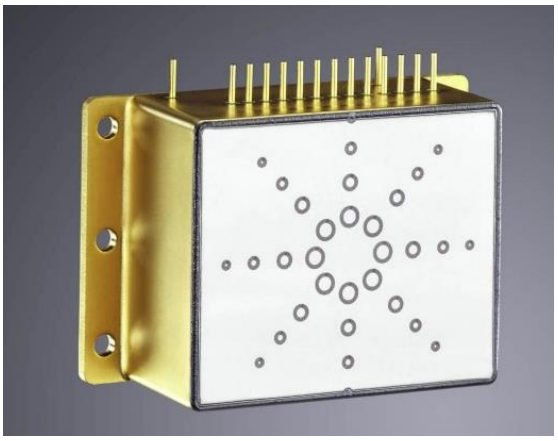

Figure 3:
During seam welding, the sensitive electronics of components are not affected.

Figure 4:
Heat conduction welding enables a quick and easy connection of thin-wall components. Lasers are perfect for welding applications such as sensors.

5. You want to implement complex seam geometries

Laser welding offers unlimited processing freedom. Lasers allow you to implement a large number of complex seam geometries, such as lap seams or a concealed t-joint, which cannot be done using conventional welding processes. Even if specific areas of the component require processing and can only be accessed from one side, the laser beam can be positioned and guided along any seam geometry.

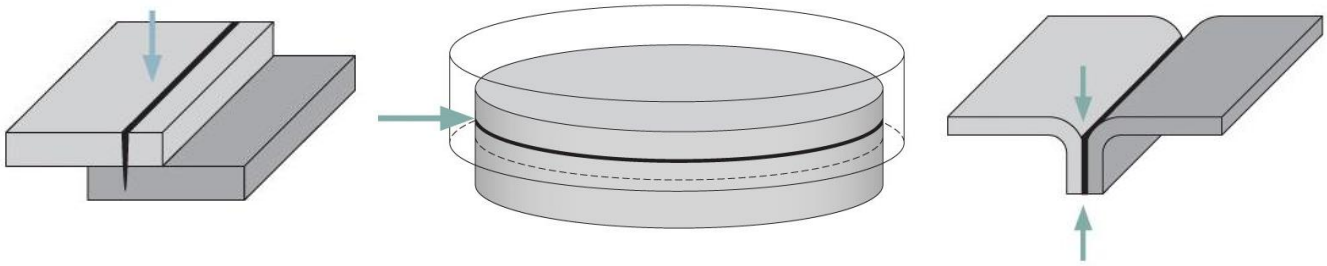

Figure 1–3:
From left to right: lap joint, flat arrangement, flange joint

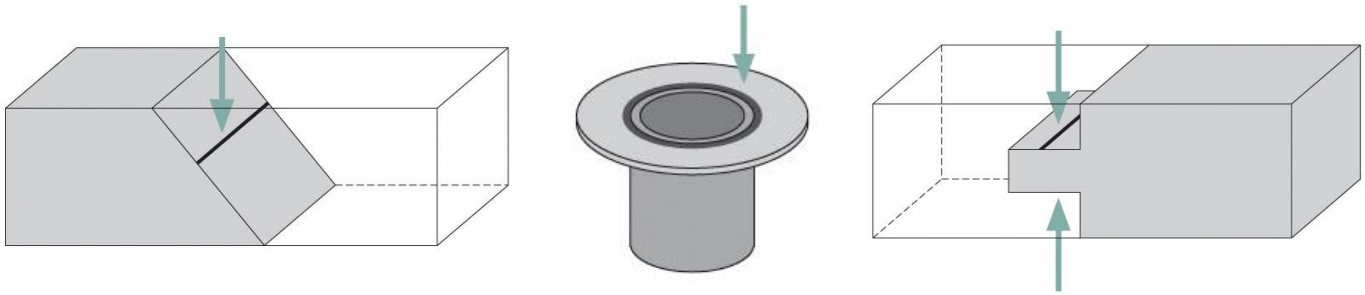

Figure 4–6:
From left to right: butt joint with angled edges, circular weld, butt joint with tongue and groove

Materials

There are few material restrictions when it comes to laser welding. The minimal melt with short, controllable duration means that laser welding systems can join materials that would otherwise not be weldable.

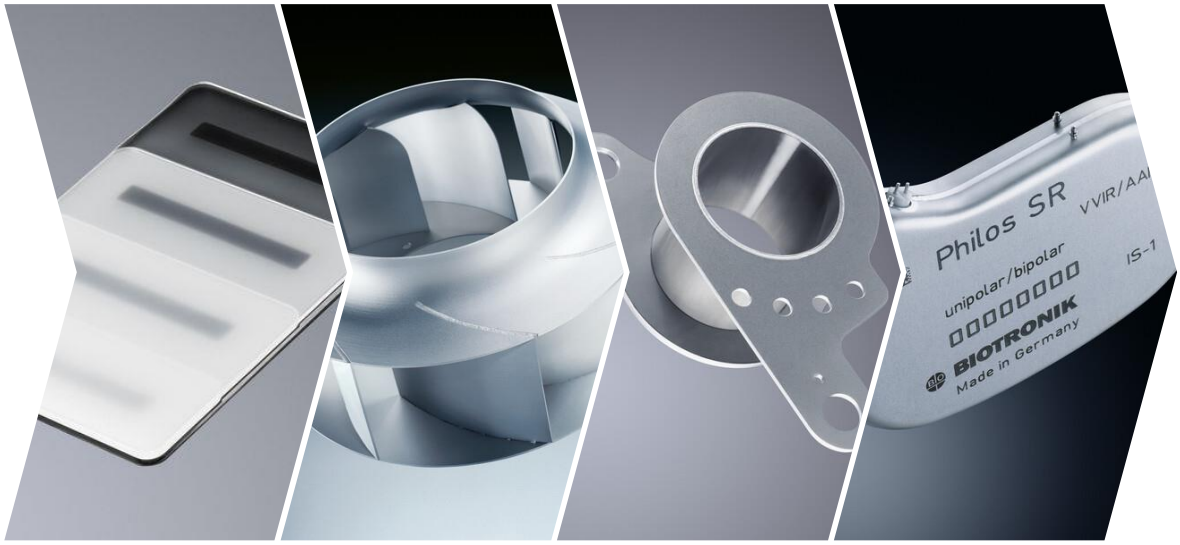

Figure 1–4:
Left to right: Thermoplastic, Stainless Steel, Mild Steel, Titanium
Laser welding includes but is not limited to the specific materials listed.

Process

Laser welding is the joining of metals and other materials with the use of a laser. A laser beam can join metal in different ways – it can join workpieces at the surface or create deep weld seams. It can also be combined with conventional welding processes, and can be used for soldering.

Whether it's ICE high-speed intercity trains, gearbox components in cars and trucks, airbag holders, or pacemakers – weld seams and weld points can be found in many different areas. Lasers offer almost unparalleled versatility in a range of applications, from creating fine weld points of just a millimeter in diameter in an instant, to producing deep-welded seams stretching over several meters. They produce minimal distortion and very slim seam geometries with a large depth to width ratio.

Figure 5:
With the help of the TruLaser Cell 3000, the components of the head plate of an operating table are laser welded together.

Equipment

TruLaser Cell 1100:
The TruLaser Cell 1100 is a flexible beam guidance system that can be easily integrated into your production line. It is specifically designed for the endless welding of any seam geometry on strips, tubes, and profiles, as well as welding of rotationally symmetrical parts.

TruLaser Cell 3000:
This 3D laser machine from TRUMPF can be used for two and three-dimensional cutting and welding, as well as for laser metal deposition (LMD). From prototypes to large-scale series production, this multi-talented machine displays its superiority across the board.

TruLaser Cell 7040:
Regardless of whether you're cutting, welding, or using laser metal deposition (LMD), you are always perfectly equipped with the modular TruLaser Cell Series 7040 laser system. The high flexibility of the machine enables you to process both two and three-dimensional components, and even tubes.

TruLaser Station 7000:
The TruLaser Station 7000 is a productive and compact 3D laser welding system for small assemblies. This highly flexible system has the largest work area in its class and allows you to weld complex seam geometries with high welding depths.

Technical data

		TruLaser Cell 1100	TruLaser Cell 3000	TruLaser Cell 7040	TruLaser Station 7000
Axis positioning range					
X	in	11.8 x 19.7	31.5	157.5	25.6
Y	in	-	23.6	59.1/78.7	13.8
Z	in	11.8 x 19.7	15.7 (+11.8)[1)]	29.5	19.7
Q	in	±1.0	-	-	-
B/C[2)]	°	-	± 135 / n x 360	± 135 / n x 360	± 120 / n x 360
Max. payload	lbs	-	881.8	3527.4	110.2
Positioning accuracy X/Z	in	±0.004	-	-	±0.003
Positioning accuracy Q	in	±0.002	-	-	-
Repeatability X/Y/Z	in	-	-	-	±0.001
Speed					
X/Y/Z	ft/min	-	164.0	328.1	19.7
Simultaneous	ft/min	-	278.9	567.6	-
B/C[3)]	1/min	-	120 / 400	90 / 90	-
Acceleration					
X/Y/Z	ft/s²	-	32.8	29.5 / 32.8 / 32.8	-
B/C[3)]	rad/s²	-	125 / 500	200 / 100	-
Positioning deviation Pa					
Linear axes X/Y/Z	in	-	0.0006 (0.0002) [2)]	-	-
Rotational axes B/C[3)]	°	-	0.02 / 0.02	-	-
Maximum positioning variation					
Linear axes X/Y/Z	in	-	-	0.001	-
Rotational axes B/C[3)]	°	-	-	0.005	-
Maximum positioning deviation					
Linear axes X/Y/Z	in	-	-	0.003	-
Rotational axes B/C[3)]	°	-	-	0.015	-
Laser					
Max. laser power	W	8,000 (TruDisk, TruDiode) 15,000 (TruFlow)	8000[4)]	6000[4)]	2000[4)]
Available lasers		TruDisk, TruDiode, TruFlow	TruDisk, TruPulse, TruDiode, TruFiber, TruMicro	TruFlow, TruDisk	TruDisk, TruPulse, TruDiode, TruFiber, TruMicro
Available technologies		-	Laser welding, laser cutting, laser deposition welding	Laser welding, laser cutting	Laser welding
Rotating changer					
Diameter	in	-	34.3	181.1	30.3
Max. payload per side	lbs	-	209.4	1653.5 / 2204.6	77.2
Stations	Number	-	2	2	2
Rotation time	s	-	3	3	-
Total typical nonproductive time	s	-	5.2	7	-
Dimensions					
Width/depth/height	in	-	63.0 / 111.8 / 104.3	[5)]	45.3 / 55.3 / 78.7

[1)]With additional W1 axis. [2)]High-accuracy axis system. [3)]C180 rotational axis. [4)]Higher laser power upon request. [5)]Dimensions are listed in the standard layout of the custom machine.

Subject to alteration. Only specifications in our offer and order confirmation are binding.

Programmable optics

Technical data			
	PFO 20-2	**PFO 33-2**	**PFO 3D-2**
Laser parameters			
Wavelength	-	-	-
Power	up to 2000 W (cw)	up to 8000 W (cw)	up to 8000 W (cw)
Numerical aperture	typ. 0.11 / max. 0.12	typ. 0.11 / max. 0.12	typ. 0.11 / max. 0.12
Laser light cable type	LLK-D, LLK-B, LLK-A	LLK-D, LLK-B	LLK-D
Optics configuration[1)]			
Collimation	35 / 56 mm	60 / 90 / 150 mm	138 mm
Focal length	100 / 160 / 163 / 254 / 330 / 420 mm	160 / 255 / 345 / 450 / 600 / 900 mm	255 / 345 / 450 / 600 / 900 mm
Z stroke for local length of lens	-	-	f255: ± 22 mm, f345: ± 40 mm, f450: ± 70 mm, f600: ± 100 mm, f900: ± 220 mm
Field size (ellipse Y X X) for focal length of lens	f100: 47 mm x 18 mm f160: 110 mm x 75 mm f163: 110 mm x 70 mm f254: 170 mm x 120 mm f330: 220 mm x 178 mm f420: 286 mm x 230 mm	f160: 56 mm x 34 mm f255: 180 mm x 104 mm f345: 240 mm x 140 mm f450: 320 mm x 190 mm f600: 376 mm x 230 mm f900: 520 mm x 310 mm	f255: 174 mm x 102 mm (z=0) f345: 240 mm x 140 mm (z=0) f450: 320 mm x 190 mm (z=0) f600: 376 mm x 230 mm (z=0) f900: 525 mm x 340 mm (z=0)
Structural design			
Dimensions (W X H X D)	278 mm x 391 mm x 202 mm (configuration example with fc56 and f160)	379 mm x 421 mm x 202 mm (configuration example with fc150 and f450)	412 mm x 266 mm x 366 mm
Weight	15 kg	25 kg	35 kg
Compatibility			
Available lasers	TruDiode, TruDisk, TruMicro	TruDisk, TruFiber, TruMicro, TruPulse	TruDisk
Available sensor system	-	VisionLine, CalibrationLine	VisionLine, CalibrationLine, SeamLine Remote, OCT seam position control
Options			
Available options	Crossjet, camera monitoring	Crossjet, MVE nozzle, smoke bell, sensor interface, lighting	I-PFO, crossjet, MVE nozzle, smoke bell, lighting version
Available software options	TruTops PFO, PFO Smart Teach App	TruTops PFO, PFO Smart Teach App	TruTops I-PFO and TruTops PFO, PFO Smart Teach App

[1)]Other optics configurations are available on request.

Subject to changes to technology, equipment, price and range of accessories.

Focusing optics

Technical data			
	BEO D35	**BEO D50**	**BEO D70**
Laser parameters			
Wavelength	-	-	-
Power	up to 4000 W (cw)	up to 8000 W (cw)	up to 8000 W (cw)
Numerical aperture	typ. 0.11 / max. 0.12	typ. 0.11 / max. 0.12	typ. 0.11 / max. 0.12
Laser light cable type	LLK-D, LLK-B, LLK-A	LLK-D, LLK-B, LLK-A	LLK-D, LLK-B, LLK-A
Optics configuration[1)]			
Collimation	35 / 80 / 100 mm	35 / 100 / 125 mm	150 / 200 mm
Focal length	70 / 100 / 140 / 200 / 300 mm	150 / 200 / 250 / 300 mm	100 / 150 / 200 / 300 / 400 / 600 mm
Structural design			
Dimensions (W X H X D)	166 mm x 313 mm x 62 mm (configuration example with camera monitoring and crossjet)	128 mm x 407 mm x 100 mm (configuration example with camera monitoring and crossjet)	189 mm x 524 mm x 78 mm (configuration example with camera monitoring and crossjet)
Weight	2.5 kg (configuration example with camera monitoring and crossjet)	3.5 kg (configuration example with camera monitoring and crossjet)	6 kg (configuration example with camera monitoring and crossjet)
Compatibility			
Available lasers	TruDiode, TruDisk, TruPulse	TruDiode, TruDisk, TruFiber, TruPulse	TruDiode, TruDisk, TruPulse
Available sensor system	-	VisionLine, CalibrationLine Power	VisionLine, CalibrationLine Power, welding depth sensor system
Options			
Available options	90° version, crossjet, shielding gas supply, bifocal module, camera monitoring, sensor interface, lighting, cartridge module, 15 g version	90° version, crossjet, MVE nozzle, shielding gas supply, bifocal module, camera monitoring, sensor interface, lighting, cartridge module	90° version, crossjet, MVE nozzle, shielding gas supply, bifocal module, sensor interface, lighting, cartridge module, protective glass monitoring unit, power measuring cartridge, pilot laser, compensation cartridge

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Good to know

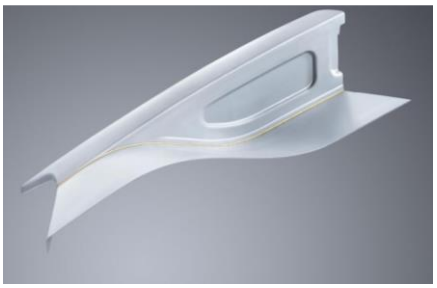
Scanner welding

Heat conduction welding

Deep welding

Laser welding is incredibly versatile

Hybrid welding



Soldering

Spot and seam welding

Conclusion

There are many disadvantages when it comes to conventional welding methods. More times than not, reworking is required which consumes valuable time. Effortlessly achieve high quality, durable, and visibly immaculate seams with laser welding. TRUMPF offers a line of laser welding systems that can accomplish multiple different welding applications. Take advantage of the benefits of laser welding with TRUMPF.

For more information about TRUMPF laser welding systems, please visit our website.

TRUMPF

TRUMPF Laser Technology Center
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