



NON-SOLDERED CLAMP-MOUNTED DIODE LASER BARS

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Introduction

High power laser bar mounting: *Soldering process*

Main problems and limitations:

● During the soldering process:

High temperature process

- ↗ soldering defects
- ↗ facet degradation
- ↗ contamination
- ↗ damage

Thermal expansion mismatch

- ↗ Induced strain:
LIFETIME REDUCTION
- ↗ Bar bowing of "Smile":
BEAM SHAPING DEGRADATION

● During laser operation:

Fatigue effect – Lifetime reduction:

- ↗ On/off thermal cycles ↔
expansion mismatch packaging
- ↗ Smile variation

Reduced range temperature:

- ↗ Storage and operation temperature
- ↔ solder degradation

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Introduction

High power laser bar mounting: Laser bar cooling

Main problems and limitations:

- Solder layer ↔ contact thermal resistance

The total heat resistance is limited

- Micro-channels heat sinks for high power

New bar mounting technology from MONOCROM

New way: mounting laser bars without soldering

Clamp-mounting technology

- 👉 High quality mechanics
 - 👉 Deformable isolator
 - 👉 Adaptable layer between electrodes and laser bar
- and laser bar

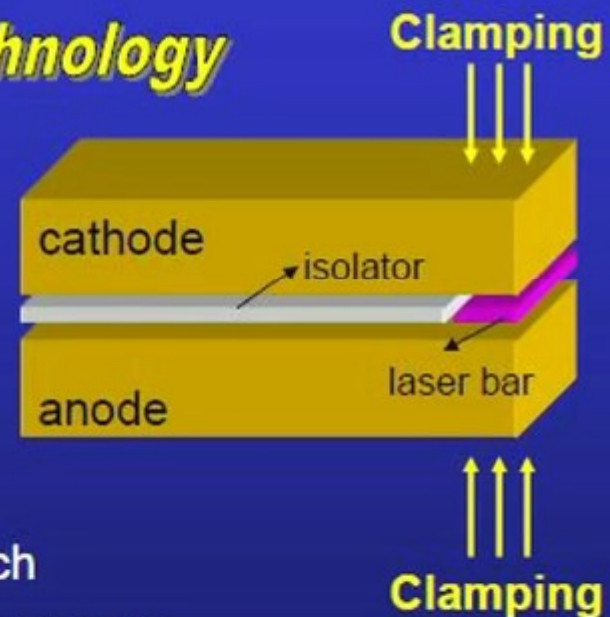
➤ Room temperature

⇒ No problem with the expansion mismatch

👍 No residual strain:

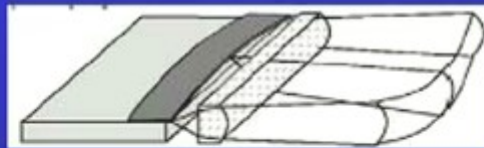
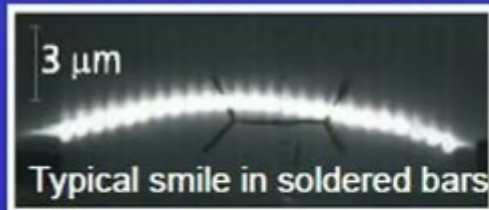
**LONGER LIFETIME
MINIMUM SMILE**

➤ Reversible



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Clamping technology: NO SMILE



The bowing of the bar (SMILE)
reduces the beam quality

Measurements methods based on imaging optics, accuracy $> 0,1 \mu\text{m}$



Soldered bars: Smile $> 1 \mu\text{m}$ (due to the induced strain when soldering)

● **CLAMPED BARS: Smile in the order of $0,1 \mu\text{m}$!**

↳ The smile is only limited by the flatness of the electrodes

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Clamping technology: **LARGE TEMPERATURE RANGE**

Requirement of high operation and storage temperature range

Automotion

Aeronautics

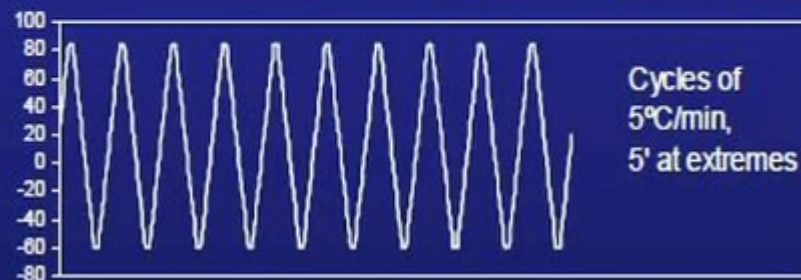
Aerospace

Defense

Soldered bars:

- 💡 solder material degradation
- 💡 Laser bar contamination by solder out gassing

● **CLAMPED BARS: The absence of solder increases the operation and storage temperature range**



Temperature test: laser test before and after the test

Storage temperature: (-60°C, +85°C)

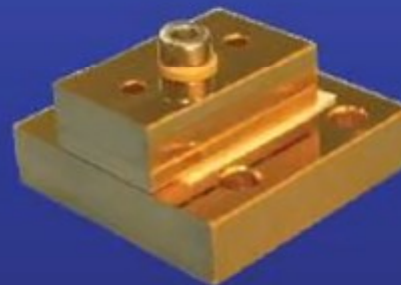
Use of ceramic parts. Materials and mechanics are being investigated to increase the temperature range

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Clamping technology: **LOW HEAT RESISTANCE**

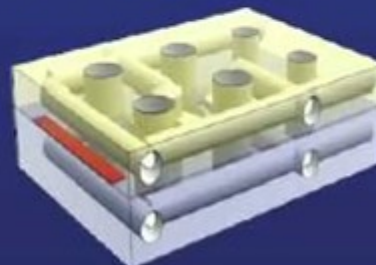
- Copper electrodes with high thermal conductivity (near to 400 W/km)
- No solder layer \Rightarrow No thermal barrier. $R_{\text{contact}} \rightarrow 0$
- Anode and cathode can be heat sinks

Conduction cooled mounts



$R_T = 0,6-0,8 \text{ } ^\circ\text{C/W}$

Water cooled mounts: One electrodes or the two electrodes with water channels



With Millimetre channels:

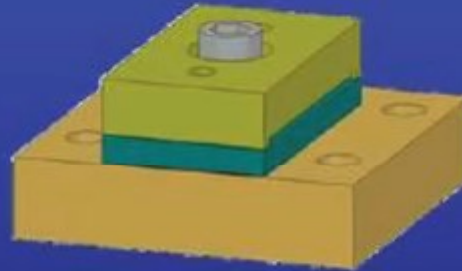
$R_T = 0,25-0,6 \text{ } ^\circ\text{C/W}$

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Clamping technology: **PACKAGING**

High versatility

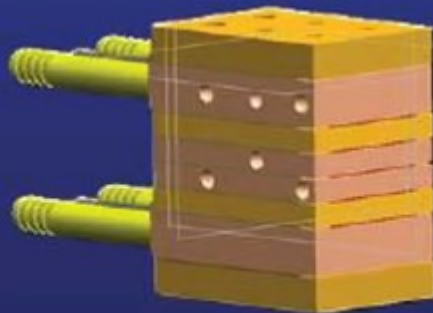
From standard mounts ...



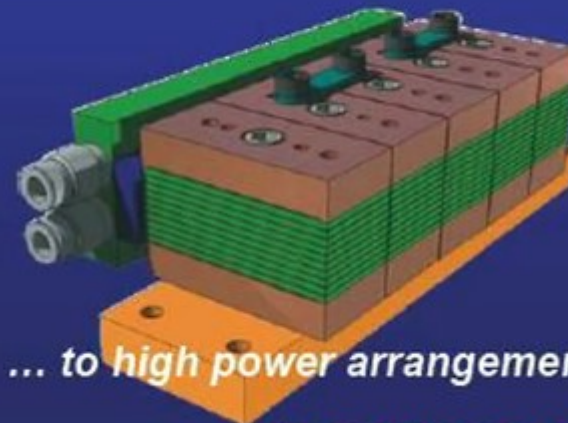
... to customised designs



From laser bar stacks ...



... to high power arrangements

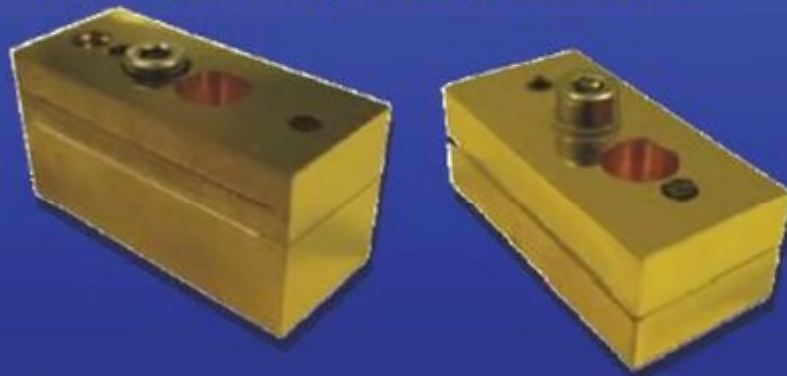


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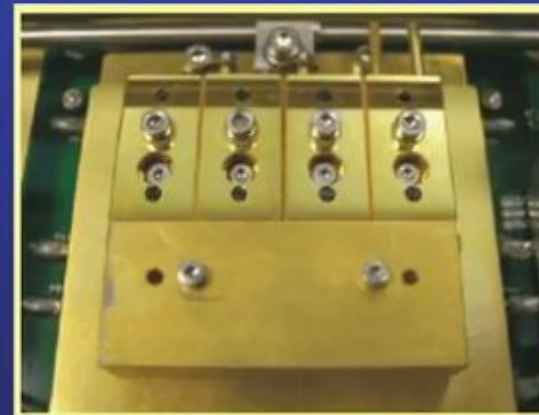
Clamping technology: 1 bar mounted

CONDUCTION MOUNTS

Special designs for pumping cavities ...



... for fibre coupling



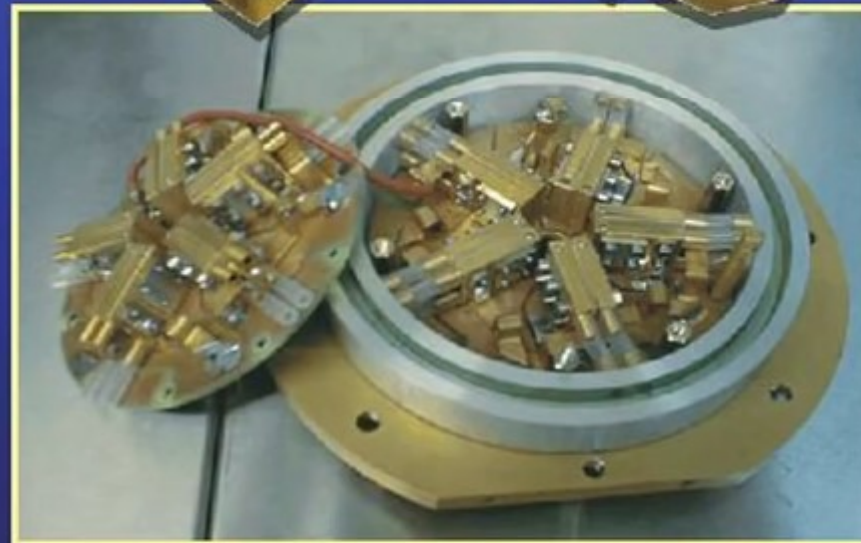
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Clamping technology: 1 bar mounted

WATER COOLED MOUNTS

Special designs for
pumping cavities ...

... individual lasers



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Clamping technology: multi-bar stacks

For QCW applications



Conduction mount

For CW



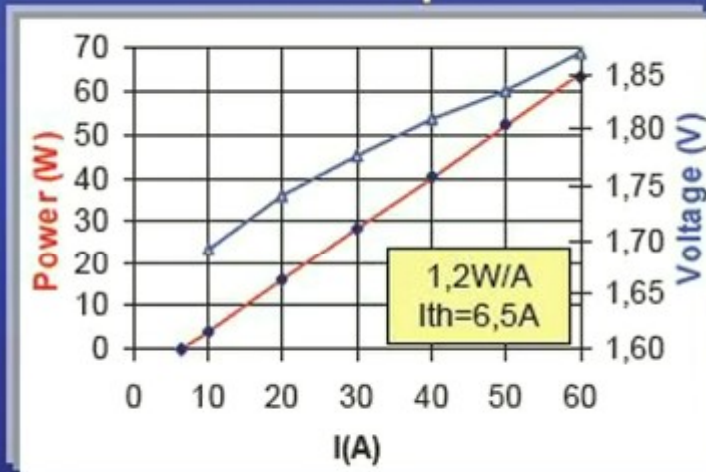
Water cooled mount

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Laser results: CW

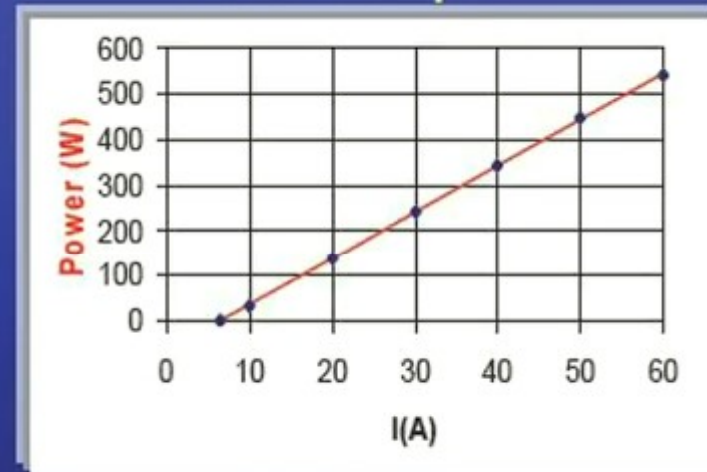
Competitive results

1 bar clamped



50 W
 $\Delta\lambda = 3,5 - 9 \text{ nm}$
($< 50^\circ\text{C}$ in the diode)
FWHM $< 3\text{nm}$

9 bars clamped



40 W/bar
 $\Delta\lambda = 8 - 9 \text{ nm}$

Values for production:

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Laser results: QCW

No fatigue effect \Rightarrow High reliability

Values for production:

High repetition rate (pumping application)

✓ 70 W / bar, 50%DC

✓ 110 – 120 W / bar ,10%DC

Long pulses (medical – aesthetical applications)

✓ 90%DC bars, 2 J/bar in 20 ms (120 A)

✓ 50%DC bars, 13 J/bar in 200 ms (80 A)

✓ 30%DC bars, 100 J/bar in 2000 ms (55 A)

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Preliminary life test

Great variety of different designs - preliminary life testing of 1000 hours

- ✓ CW
- ✓ Cycles On/off 50%DC

Main remarks:

- ✓ Variation in power $< \pm 5\%$. There is not a general trend to decrease with time; in general, it is not possible to do linear extrapolation
- ✓ Variation in wavelength $< 2 \text{ nm}$
- ✓ No variation in the smile

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SUMMARY

The solder free concept of the clamp-mounting technology results in a series of advantages:

- ❖ **Long lifetime**, due to the absence of the mechanical stress caused by the soldering process at high temperature
- ❖ **Minimum “smile”**, only limited by the flatness of the copper electrodes
- ❖ **Small thermal resistances**, owing to the reduction of the contact resistance between electrodes and laser bar. No micro channels is needed to reach low thermal resistances
- ❖ **Large storage temperature interval**, tested from -60°C to $+85^{\circ}\text{C}$

The clamped laser bars (singles or stacked) can operate in all the possible operation modes, from very short pulses at high repetition rate, to CW conditions. Very competitive lasers can be obtained:

- ❖ More than 120 W of peak power per bar at high repetition rate
- ❖ More than 10 J of pulse energy per bar at low repetition rate
- ❖ More than 50 W per bar under CW

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LDBA Description

monocrom has developed a new concept of mounting high power diode bars. In the patented technology, exclusive from monocrom, the laser bars are clamped without soldering within two copper blocks which serve as electrodes as well as heat sinks.

The main features of our laser diodes are:

- Long LIFETIME. >20.000 hours. No mechanical stress. No maintenance required.
- Widest OPERATION MODE RANGE: from nanoseconds to CW.
- High BRIGHTNESS with minimum "SMILE" <0.5µm.
- High EFFICIENCY >50% and compact size.
- High ENERGY per laser pulse at LOW COST per Watt.
- Custom BEAM DELIVERY. Fiber-coupled, direct irradiation, collimated modules.
- Efficient COOLING. Conduction-cooled, Water cooled (tap water compatible). No problems of micro-channel degradation.
- Broad range of WAVELENGTHS, 635-2000 nm.
- Wide STORAGE temperature, -60°C to +85 °C.
- High FLEXIBILITY, for a wide range of applications.

If we do not have it,
we can create it...

We are creating and manufacturing laser modules for our customers for more than fifteen years, thanks to the effort of a highly qualified, creative and motivated team. *Our courage, creativity and dynamism make us different.* We have demonstrated the applicability of new concepts in laser physics and technology, like our patented *clamped high power diode laser*, or our Q-Switched green SSL, capable of providing microseconds pulses and considered the most important development in Eye surgery from the last years. *Our present challenge is to design an ultra lightweight and resistant green laser device for a space mission to MARS.*

...and make it
come true

Our in-house facilities, including a wide machinery park together with Optics Labs allow us to keep all the development and manufacturing processes inside, at monocrom.

We design, manufacture and guarantee all our products. We also offer to our customers an After-Sales service in order to make sure that we meet our customers' expectations.

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Laser Diode **Bar Assemblies**



monocrom
LASER DIODE DEVICES

monocrom has developed a new concept of mounting high power diode lasers bars. In the patented technology, the laser bars are clamped without soldering within two copper blocks. This technology allows us to offer you the most reliable high power diode lasers.

Different solutions are available, from direct irradiation to fiber-coupled, from single bars to laser bar stacks of kW of power, from CW to nanosecond pulses, from visible to near-infrared, from conductive to water-cooled housing, and all adapted to our customers needs.

Laser Diode Bar Assemblies

OPEN PACKAGING

Reference:	LB-WWXY-ZZMM WW: Wavelength; X: Cooling, P for passive, A for water; YY: number or bars, from 01 to 10; ZZ: number of emitters; MM: operation mode, p, cw or qcw
Laser bars:	20-50 % fill factor, 0.5 to 3mm resonator
Wavelength:	635, 780, 810, 850, 880, 915, 940, 980, 1060 nm
Optical power:	up to kW
Operation mode:	pulsed (nanoseconds-milliseconds), QCW, CW
Housing:	standard, customised
Cooling system:	Conductive, Active (tap water can be used)
Beam delivery:	Non collimated, FAC, FAC collimated, fibre delivery



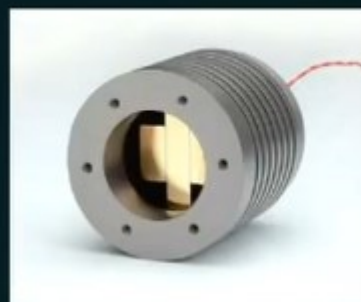
DIODE LASER PUMPING HEADS

Reference:	PH-PP-MM PP: Peak power; MM: operation mode CW or QCW
Wavelength:	1064nm - Nd:YAG 3mm 980nm - Diode Laser Pumping
Operation mode:	CW
Optical power:	<100W @ CW / <300W @ CW <600W @ QCW / <1800W @ QCW
Housing:	A10, A16, S36, L11
Cooling system:	Water cooled, without micro-channels



WATER COOLED DIODE LASER HEADS

Reference:	LBS-WWXX-SXS WW: Wavelength; XX: number or bars, from 01 to 50; SXS: output spot size
Wavelength:	780, 810, 915, 940, 980 nm
Optical power:	<5000 W
Operation mode:	QCW
Housing:	Customised
Cooling system:	Water cooled, high cooling off, without micro-channels
Beam delivery:	Fibre or lens duct (6x6, 8x8, 10x10, 12x12)
Main applications:	skin treatment, 40 J/cm² from pulses of 20ms



FIBER-COUPLED DIODE LASER HEAD

Reference:	LBS-WWXX-ZZMM-PPP-OOO (WW: wavelength; XX: number of bars; ZZ: number of emitters; MM: operation mode; PPP: peak power; OOO: fiber output)
Wavelength:	780, 810, 915, 940, 980 ... nm
Operation mode:	CW, QCW
Optical power:	<500 W
Housing:	Compact and light weight
Cooling system:	Water or conduction cooled
Beam delivery:	100-600µm fibre

NEW
on photo
not in the

CONDUCTIVE DIODE LASER HEADS

Reference:	LBS-WWXX-ZZMM-PPP-OOO (WW: wavelength; XX: number of bars; ZZ: number of emitters; MM: operation mode; PPP: peak power; OO: optical)
Wavelength:	780, 810, 915, 940, 980 ... nm
Operation mode:	QCW
Optical power:	<5000 W
Housing:	Customised
Cooling system:	TEC
Beam delivery:	Direct irradiation, FAC, SAC, customised

