COHERENT

More Power from Coherent's Industry Proven Monolithic Stack

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Product Line Manager

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EPIC Members New Product Release

EPIC
EUROPEAN PHOTONICS INDUSTRY CONSORTIUM

COHERENT AT A GLANCE

FROM A FOUNDATION OF MATERIALS AND IMAGINATION, WE ENABLE EXCITING MEGATRENDS

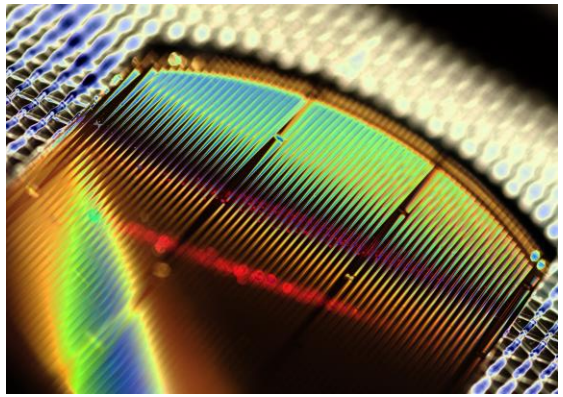
1971	Year Founded	**COHR**	NYSE
26,000+	Employees (1)	**$5.2 B**	FY23 Revenue
2,400+	Research & Development (1)	**$64 B**	Available Market (1)
3,000+	Patents (1)	**126**	Locations
VERTICAL INTEGRATION	Materials, Components, Subsystems, Systems and Service	**24**	Countries

(1) As of June 20, 2023

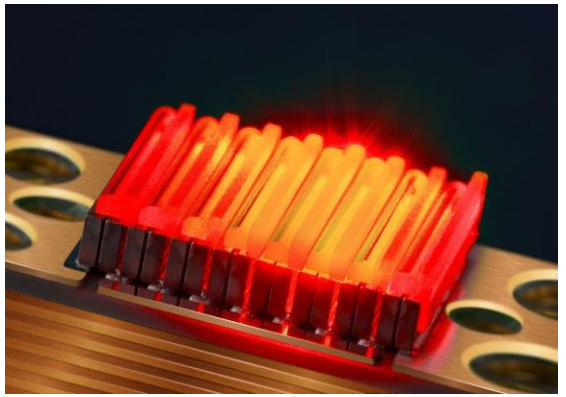
COHERENT

HIGH PEAK POWER ACTIVITIES – MAXIMIZING PERFORMANCE, EASE OF USE AND RELIABILITY

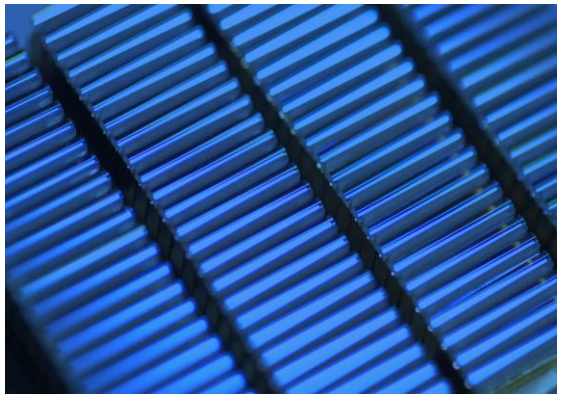
- **In-house growth of semiconductor bars**
  - Tailored filling factors, cavity lengths and number of junctions to maximize peak power
- **CTE-matched packaging and stacking**
  - Improved thermo-mechanical stability
- **Optical beam shaping and homogenization**
  - Maximize fluence
- **Dense mechanical integration and turnkey pump engines**



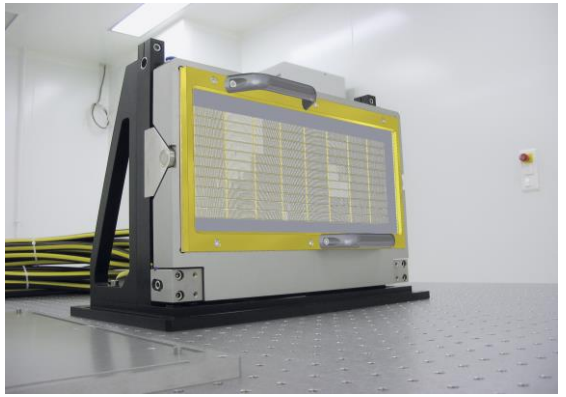
Semiconductor



CTE-matched packaging



Optical beam shaping



Densely integrated pump engine

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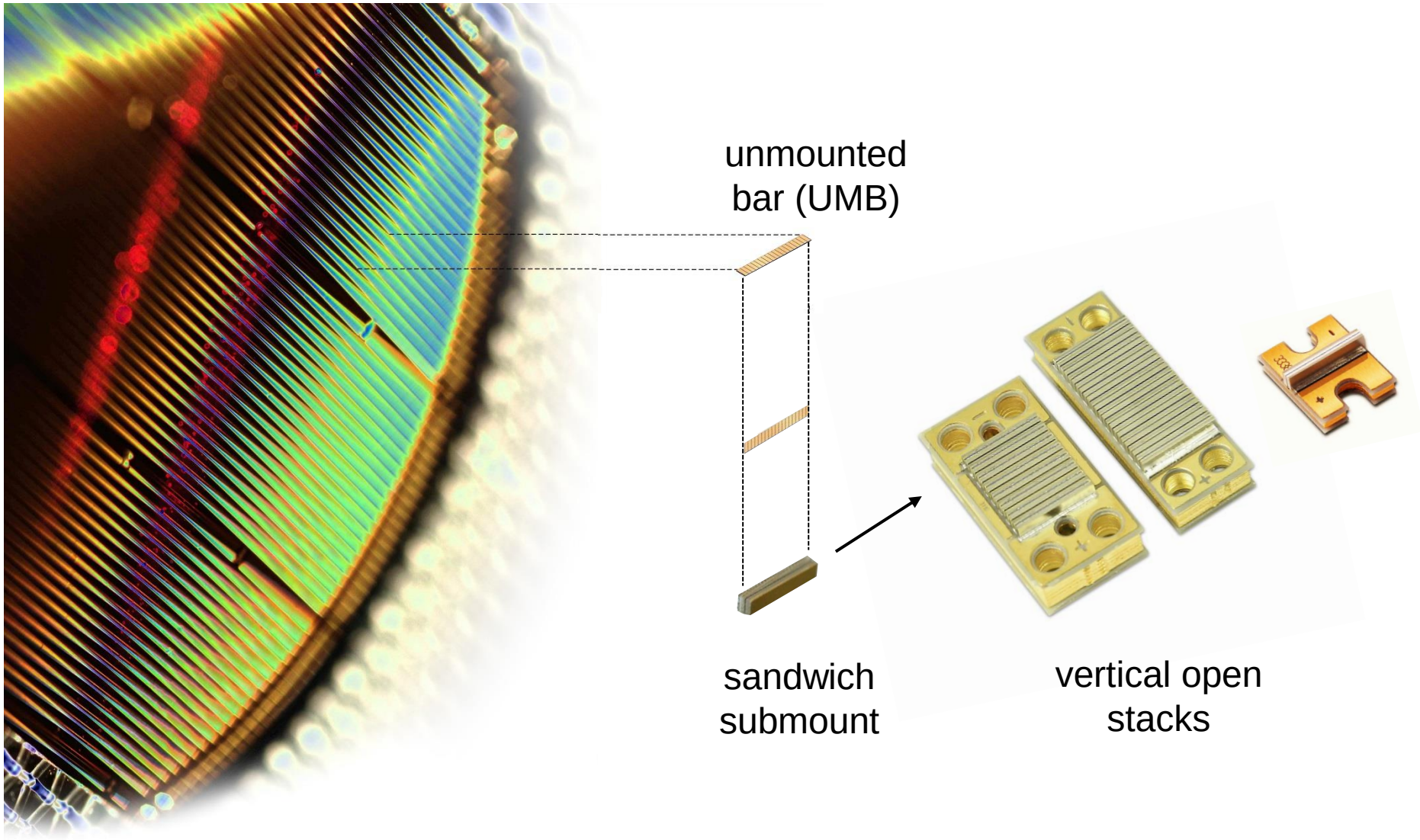
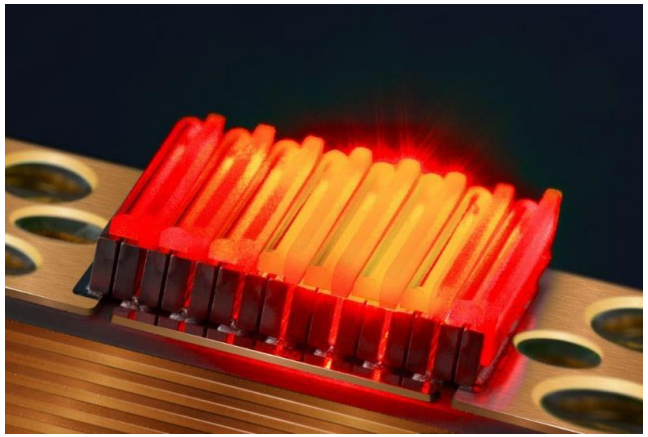
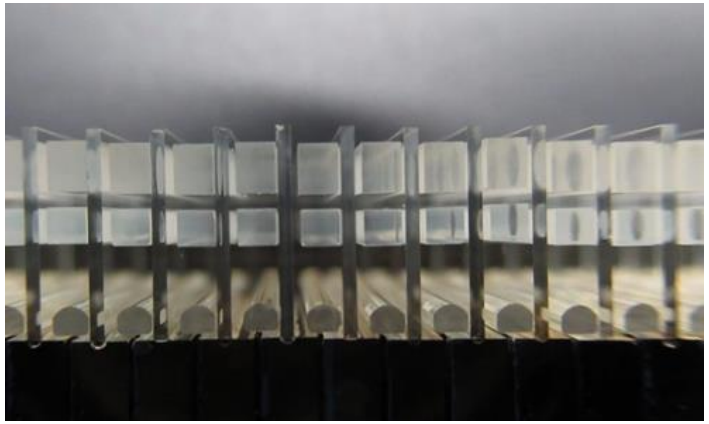
FROM WAFER TO STACK



C-STACK FEATURES

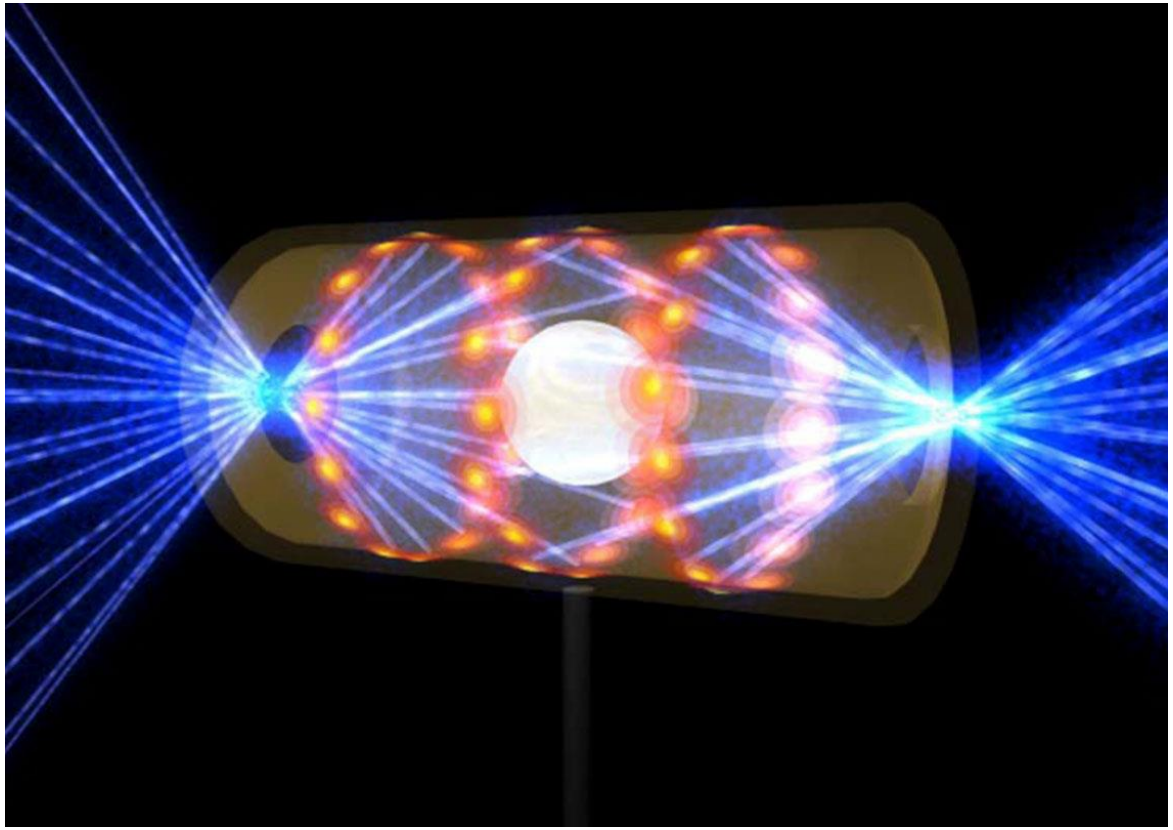
- Hard soldering of sandwich structure (submount-bar-submount)
- Backside soldering of sandwich structure onto ceramic plate
- Improved cooling via backside cooled ceramic plate
- Monolithic stack
- Optional micro optics





- Diode electrically isolated from water
- Conduction- and water cooled versions
- Operation of longer pulses are supported by water cooling (up to few 100 msec for hair removal application)

SCIENTIFIC: DIODE-PUMPED SOLID STATE LASER FOR HIGH- INTENSITY LASER FACILITIES



Pictures: Courtesy of National Ignition Facility

Applications: **DPSSL cryogenically-cooled Yb3+ laser media, also for Nd3+, Tm3+ and Er3+**
Scientific, e.g. Petawatt lasers, Inertial Fusion Energy,…

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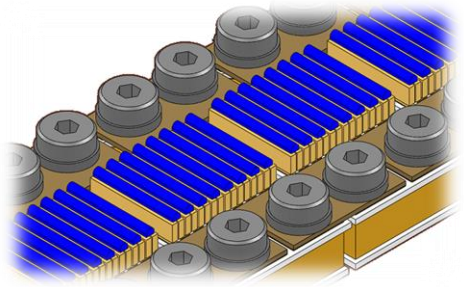
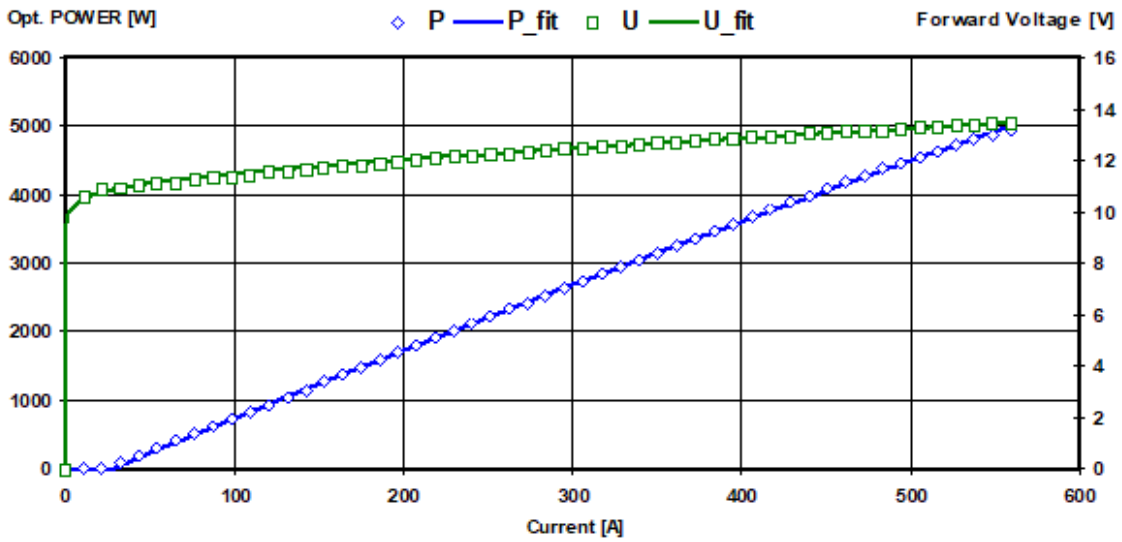
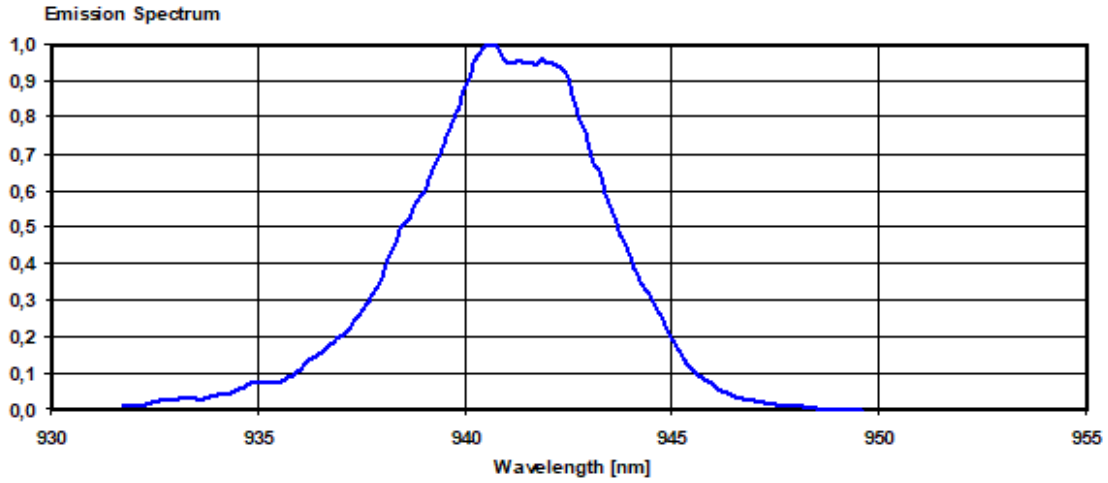
8-BAR SUBSTACK - PERFORMANCE

- **FAC lensed 8-bar substack**
- **Up to 600 W per bar 4800 W per stack**
- **„infinite“ stack assembly →**







P(550 A)	4917,6	W
I(4800,0 W)	536,2	A
Threshold	28,0	A
Slope	10,32	W/A
Overall efficiency	67,0	%
UF	13,37	V
UE	11,38	V
Rs	3,7	mOhm

Wavelength (FWHM)	941,1	nm
Line width	5,2	nm
Temperature	25,7	°C
Current	554,4	A
DutyCycle	4,000	%
Frequency	50,0	Hz

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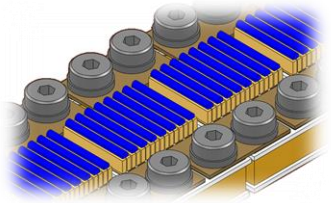
TURNKEY QCW HIGH-POWER PUMP ENGINE – 350KW QCW

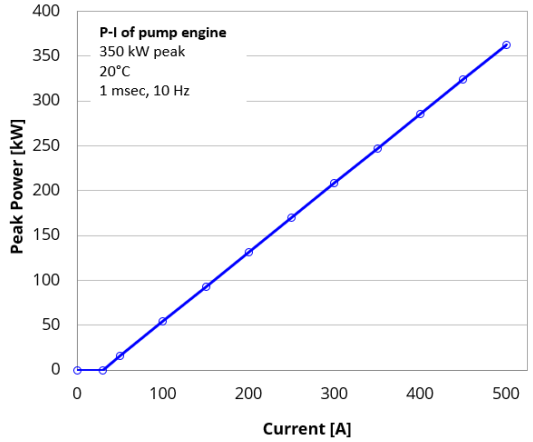
QCW HIGH-POWER PUMP ENGINE – 350 kW, HOMOGENIZED BEAM



Consisting of 4 towers (LD), with 25 stacks each, with 8 bars per stack

- 800 bars x 440 W peak power each
- Footprint ~1250mm x 750 mm

HIGH-POWER QCW SPECIFICATION AND PI-CURVE



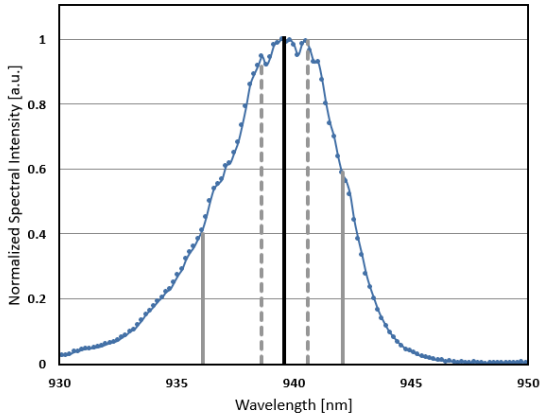
Up to 350 kW peak power

- **Repetition rate:** 1 – 10 Hz and single shot
- **Duty cycle:** max. 1.2% @ 500 A
- **Pulse length:** typ. 0.5 - 1.0 ms
- **Lifetime DL stacks** typ. 1 Gigashot

Ease of integration and control

- Control (chiller, pulser units, trigger)
- Diagnostics (spectra, interlocks, temperature)
- Remote access
- Pilot beam

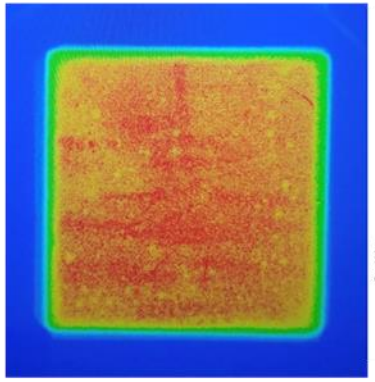
SPECTRUM AT FULL POWER (350 KW PEAK)



- **Central wavelength: 940 nm**
- **Tight energy „bucket“**
  - ≥ 30% within ± 1.5 nm
  - ≥ 75% in range of -3 nm to +3 nm

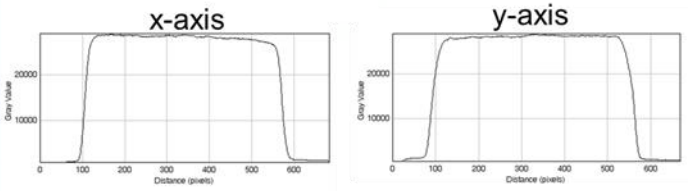
SQUARE BEAM PROFILE

at the image plane (– 5 cm to + 5 cm)



Quadratic, flat top beam profile

- Target size (FWHM): typ. 50 - 80 mm
- Plateau width >95% of FHWM



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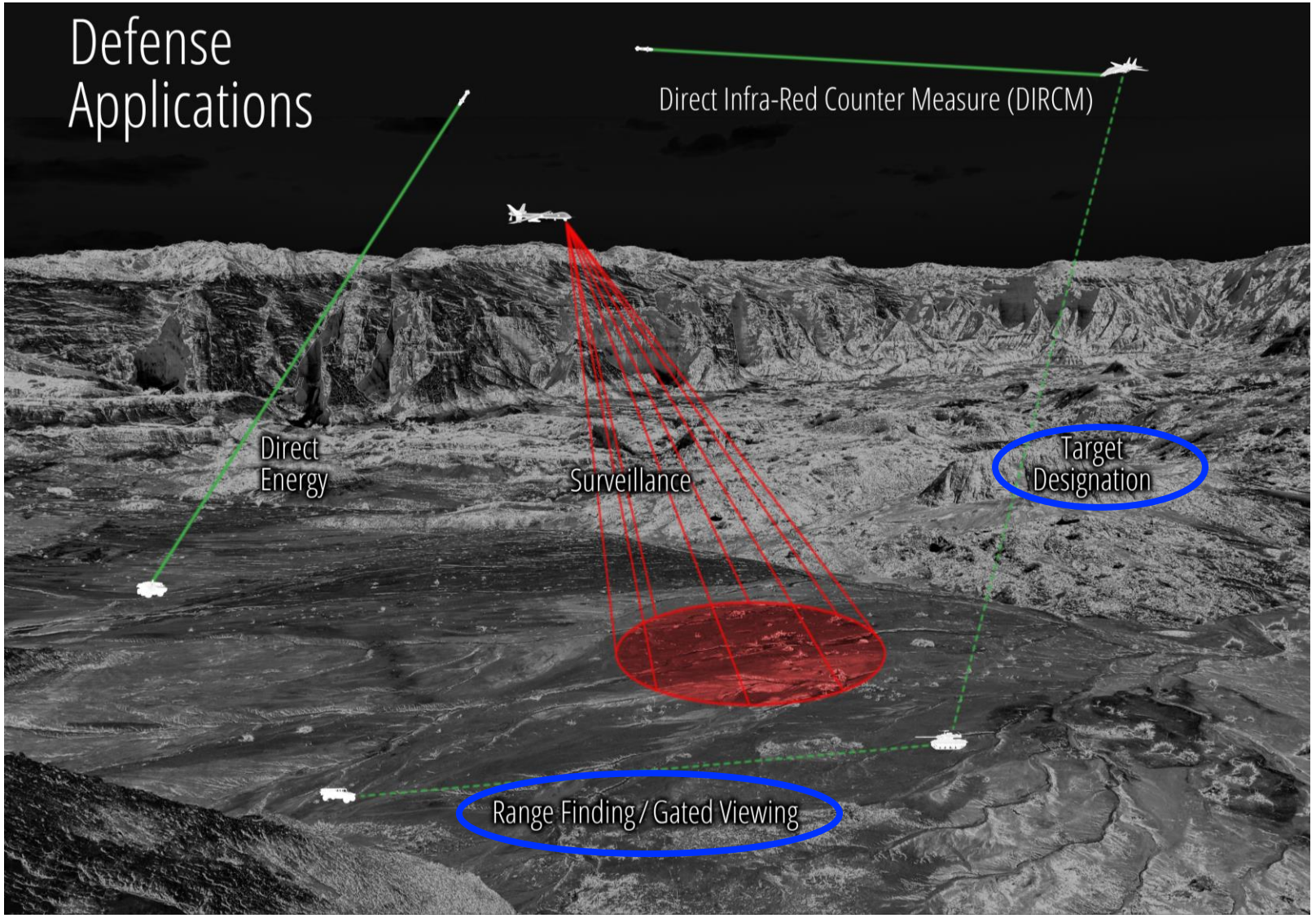
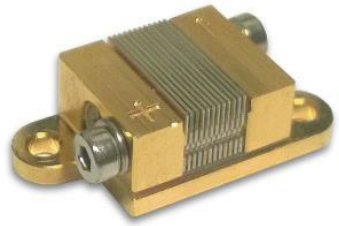
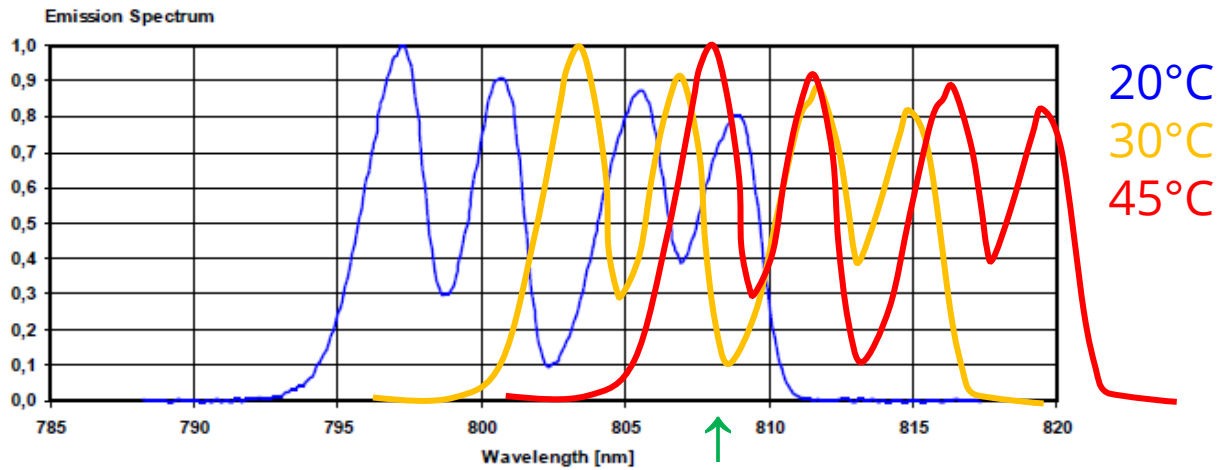
DEFENSE: TARGET DESIGNATORS, GATED VIEWING, RANGE FINDERS



CONDUCTION COOLED STACKS – APPLICATION: RANGE FINDING AND TARGET DESIGNATION



- 4-bar Multi-wavelength „Rainbow“ Stack
- low pitch
- QCW, low duty cycle
- High-temperature operation
- Shock- and vibration-qualified



- **Aim:**
  over larger temperature range, to have always power of one bar in the absorption line

P (	200 A)	878,9	W		
I (	800,0 W)	182,1	A		
Threshold		24,8	A		
Slope		5,71	W/A		
Overall efficiency		55,9	%		
UF		7,86	V		
UE		6,39	V		
Rs		8,1	mOhm		

Wavelength (cent.)	802,9	nm
Line width	13,5	nm
Temperature	20,0	°C
Current	183,0	A
DutyCycle	0,750	%
Frequency	25,0	Hz

- **Application: Use in compact military equipment under changing environmental temperatures**

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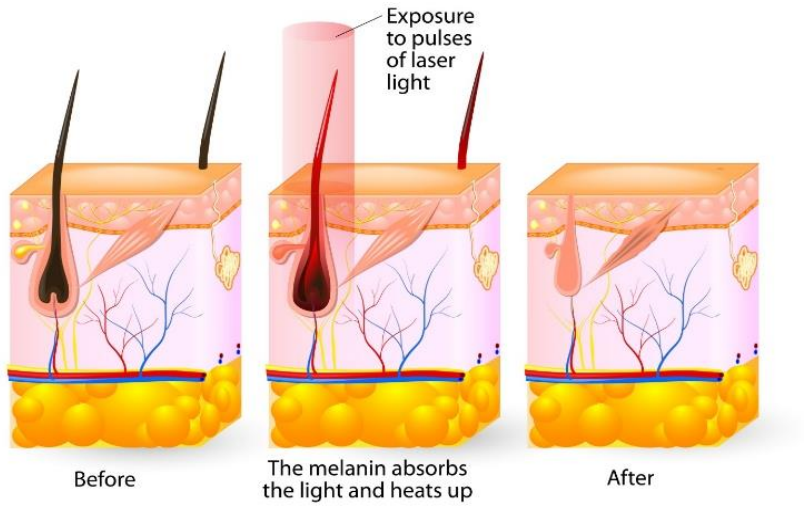
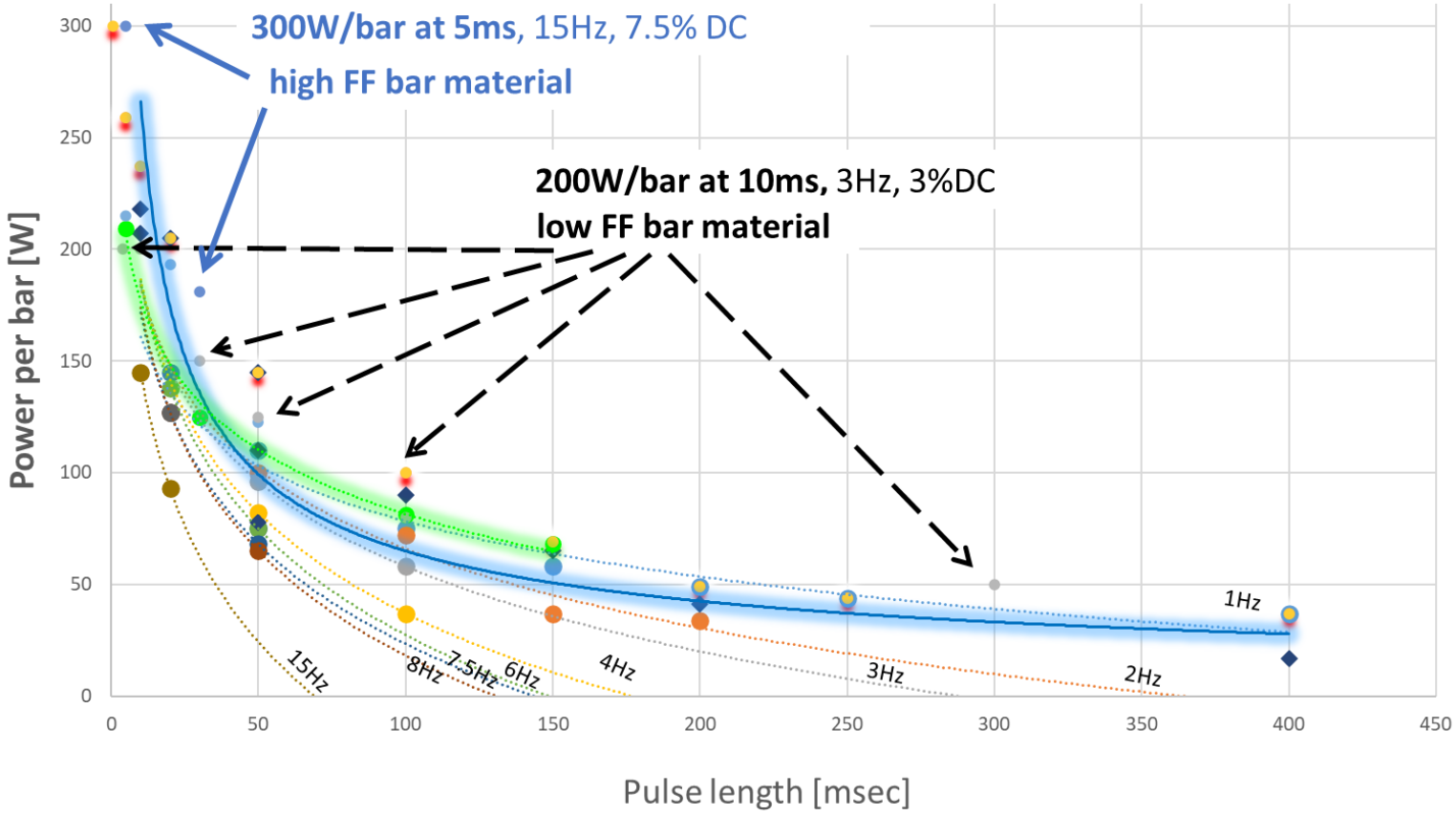
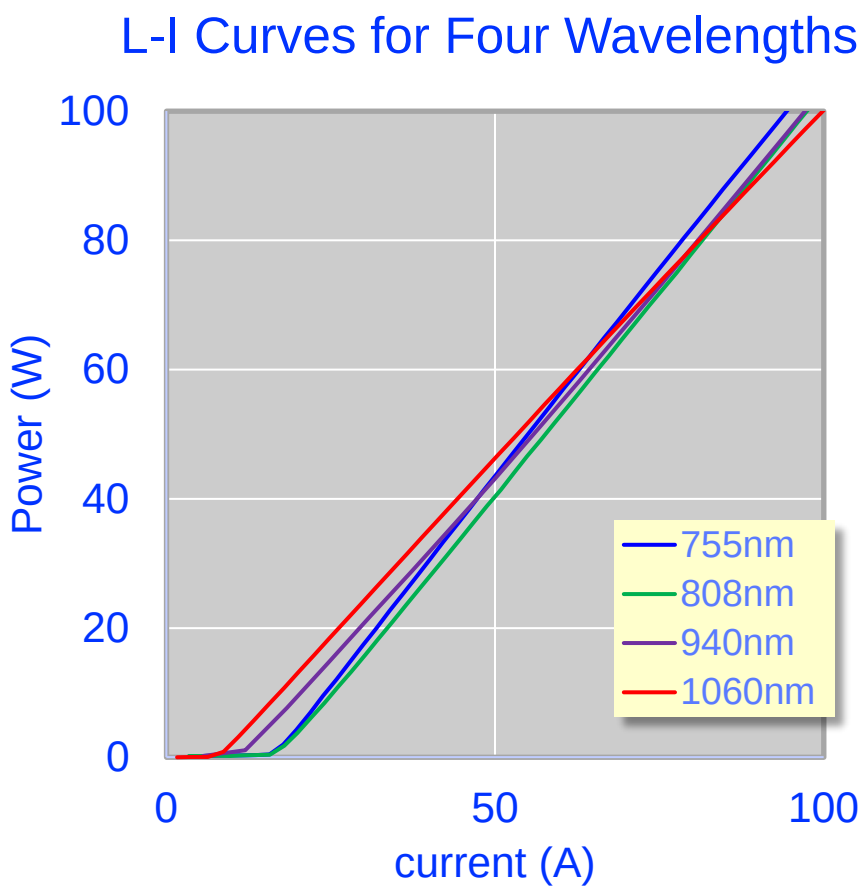
MEDICAL: DIRECT BEAM FOR HAIR REMOVAL



Power per Bar vs Pulse Length
Water-Cooled C-Stack at 808nm



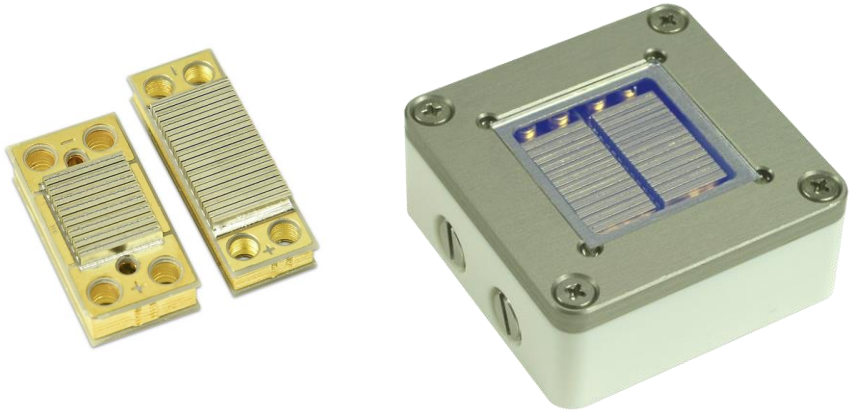
HAIR REMOVAL PERFORMANCE P-I AND ENERGY



Coherent diode lasers at the four hair removal wavelengths all exhibit the same slope, simplifying power balance.

C3N-VO99 (1x12) bar 2400W								
Energy (J)		Frequency (Hz)					Iop	
		1	1.5	2	2.2	3		
Pulse Width (ms)	10	24	24	24	24	24		~ 190A
	30	54	54	54	54			~ 155A
	50	75	75	75				~ 130A
	100	96	96					~ 100A
	300	180						~ 60A
Water Temperature T=25°C, Flow Rate: 0.3 L/min								

Energy per pulse e.g. on 808nm stack



SUMMARY

- **Scientific: High power pump engines for Petawatt lasers – 350kW QCW**
- **Defense: Rainbow configurations – pumping at high-temperature operation**
- **Aesthetics: Up to 300W/bar in hair removal**

INNOVATIONS THAT RESONATE