

PHOTONICS WEST 2024 SHOWCASE

Markets, Technology and Products

January 29, 2024

ALL OUR MARKETS ARE HEALTHY AND GROWING OVER THE LONG TERM

Aggregate CY23 TAM of **\$64B** growing at **14% CAGR** to **\$124B** within five years

Industrial



TAM: \$22B
CAGR: 9%

Sources: Optech Consulting, TechInsight, Strategies Unlimited, SEMI, Internal Estimates, DSCC

Communications



TAM: \$23B
CAGR: 16%

Sources: LightCounting, Omdia, Signal AI, Yole, Dell'Oro Internal Estimates

Electronics



TAM: \$13B
CAGR: 20%

Sources: IDC, Morgan Stanley, Research & Markets, Forbes, Yole, Strategy Analytics, IdTechEx, Internal Estimates

Instrumentation



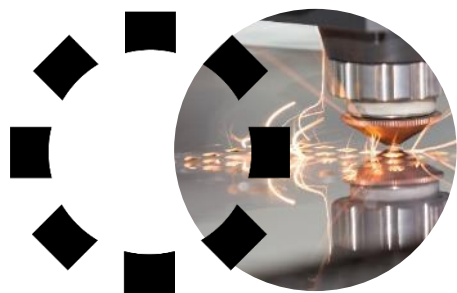
TAM: \$5B
CAGR: 8%

Sources: Strategies Unlimited, Markets & Markets, SDI (Strategic Directions), Internal Estimates

All CAGRs: Calendar 2023 to 2028

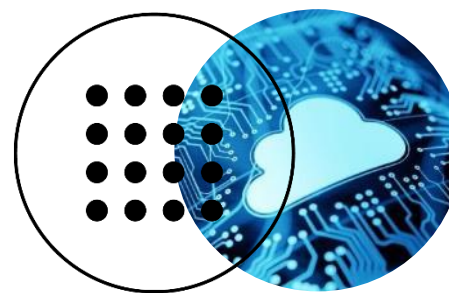
OUR MARKETS AND VERTICALS

Industrial Market



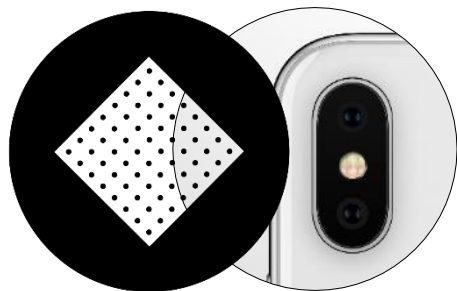
- **Precision Manufacturing**
Components, Lasers and Systems
- **Semiconductor Capital Equipment**
Optics, Materials, and Lasers
- **Display Capital Equipment**
Optics, Materials and Lasers
- **Aerospace & Defense**
Optics, Materials and Lasers

Communications Market



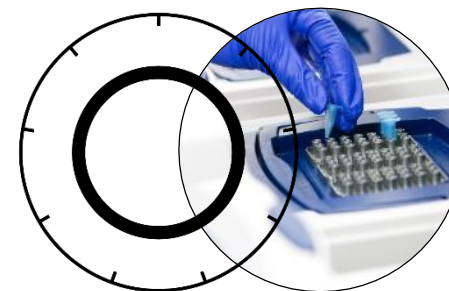
- **Datacom**
Lasers and Transceivers
- **Telecom**
From Materials to Systems

Electronics Market



- **Consumer Electronics**
Lasers, Optics, and Materials for Devices
- **Automotive**
SiC Devices, Lasers, Optics and Materials

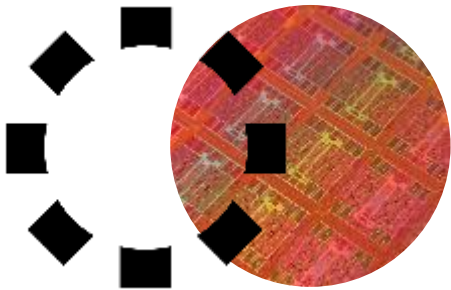
Instrumentation Market



- **Life Sciences**
Optics, Lasers, TEC and Subsystems
- **Scientific Instrumentation**
Lasers for Research

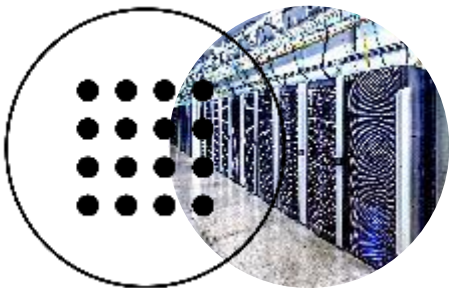
FY23: A YEAR OF RECORDS

FY 2023 Revenue
\$5,160M
(+7% YOY)



Industrial

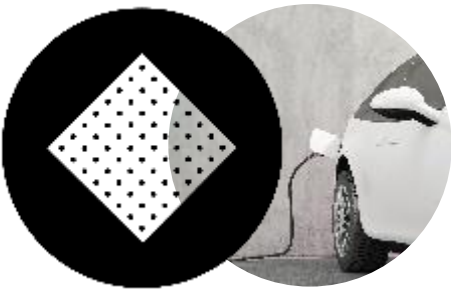
\$502M (+11% YOY)
Semiconductor
Capital Equipment



Communications

\$1,299M (+4% YOY)
Datacom

\$995M (+9% YOY)
Telecom

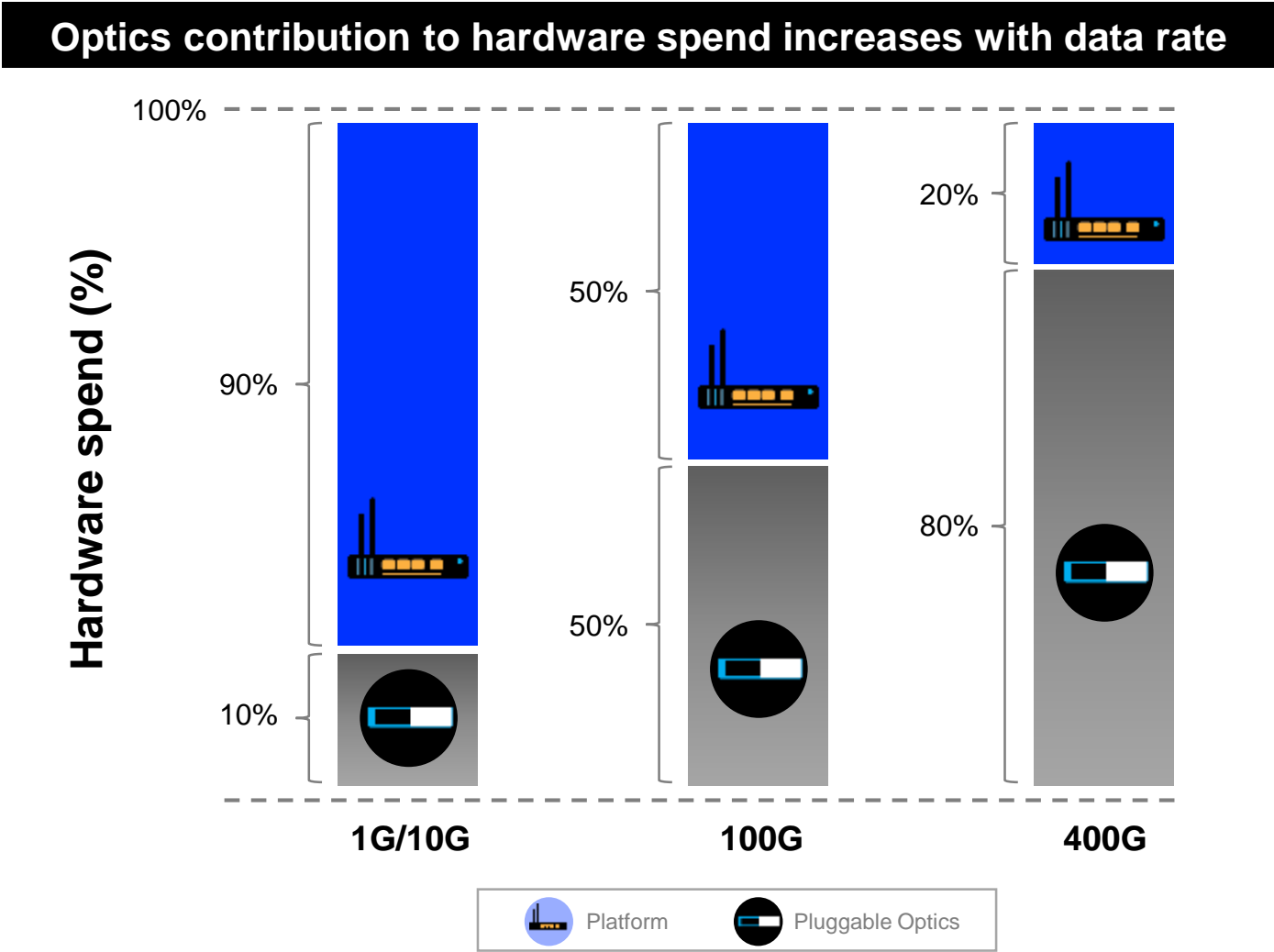
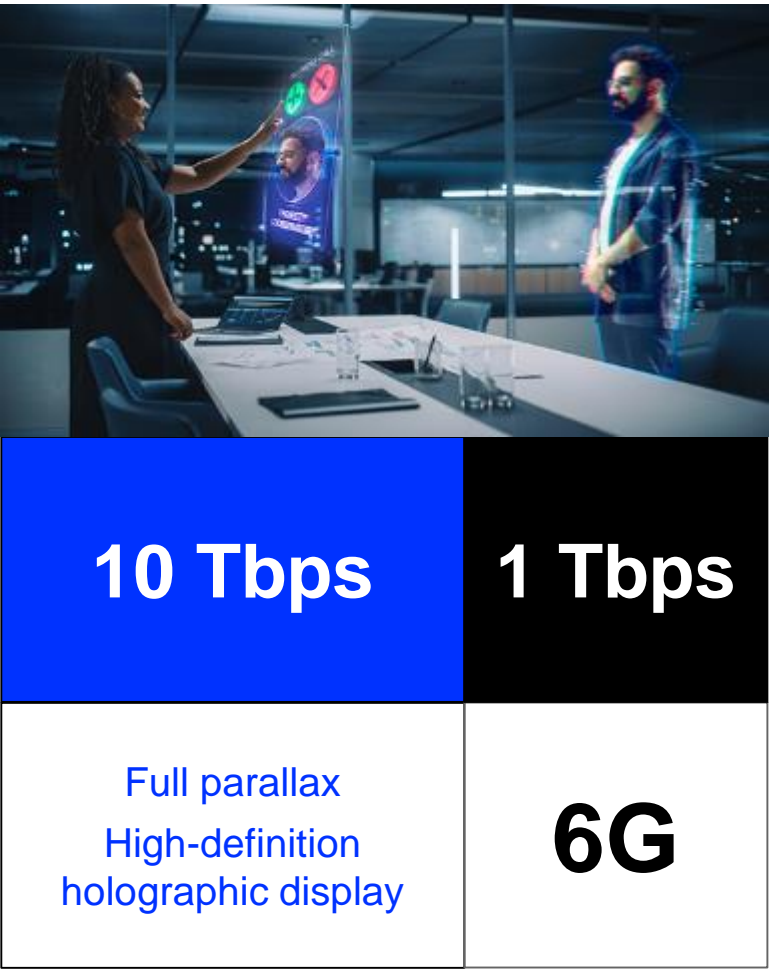


Electronics

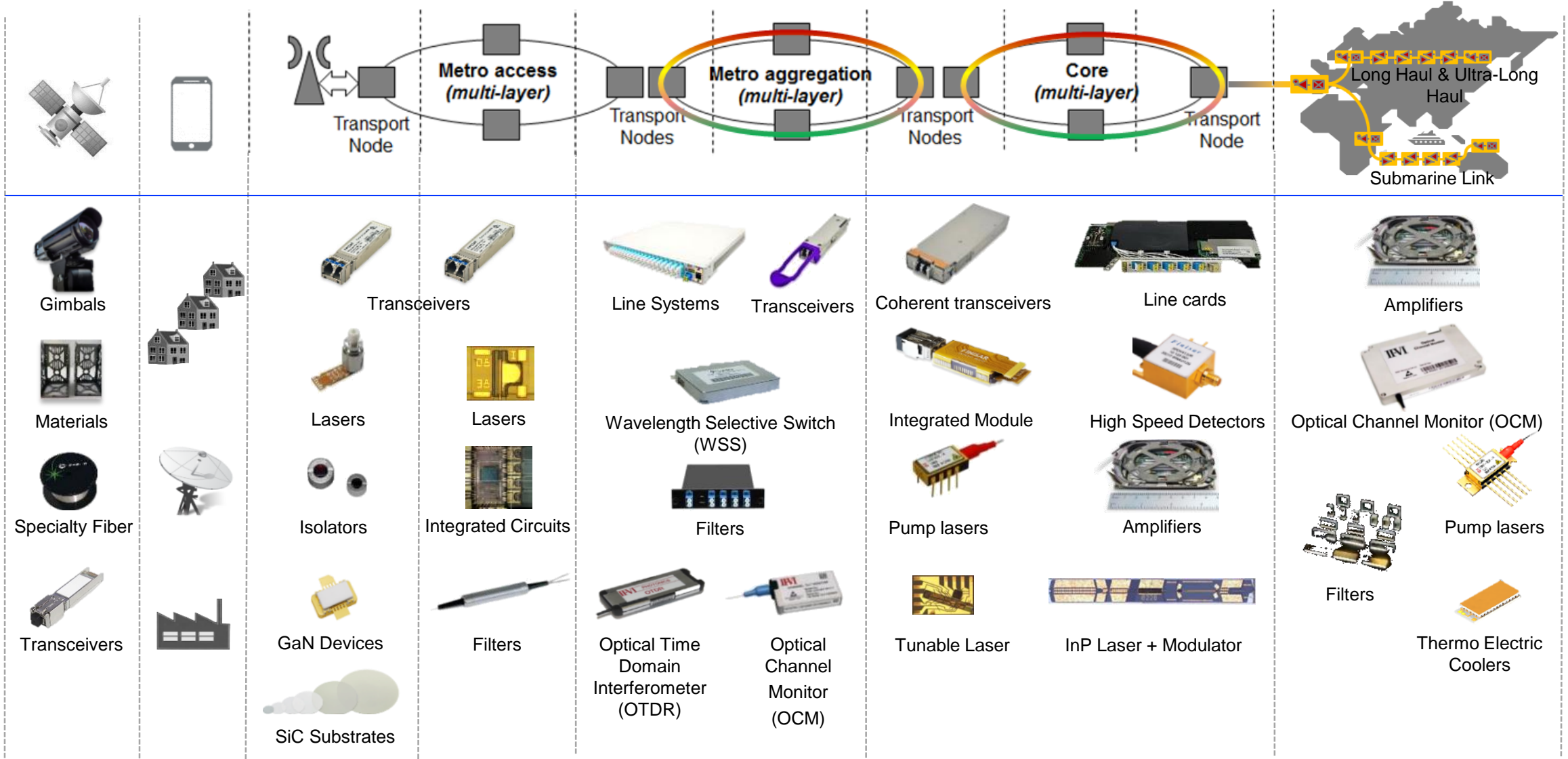
\$457M (+99% YOY)
Consumer Electronics

\$168M (+111% YOY)
Automotive & Other

COMMUNICATIONS MARKET DRIVERS AND DYNAMICS

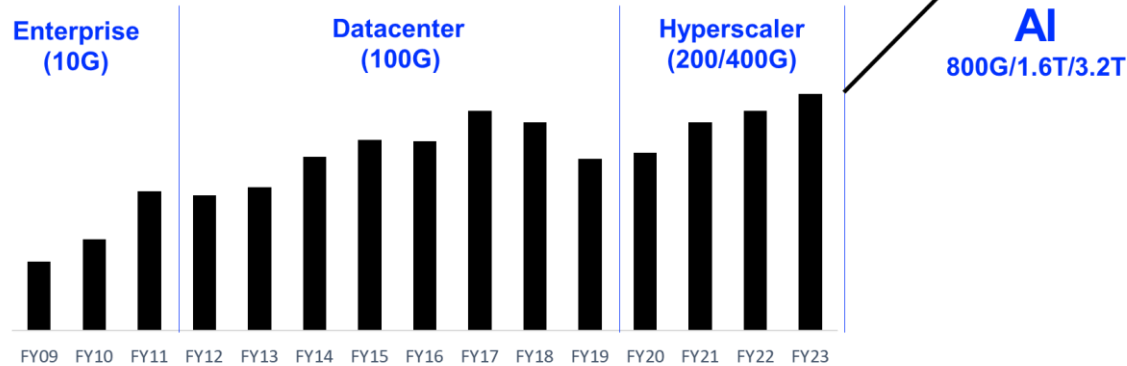


COMMUNICATIONS: BROADEST, VERTICALLY INTEGRATED, END TO END PORTFOLIO



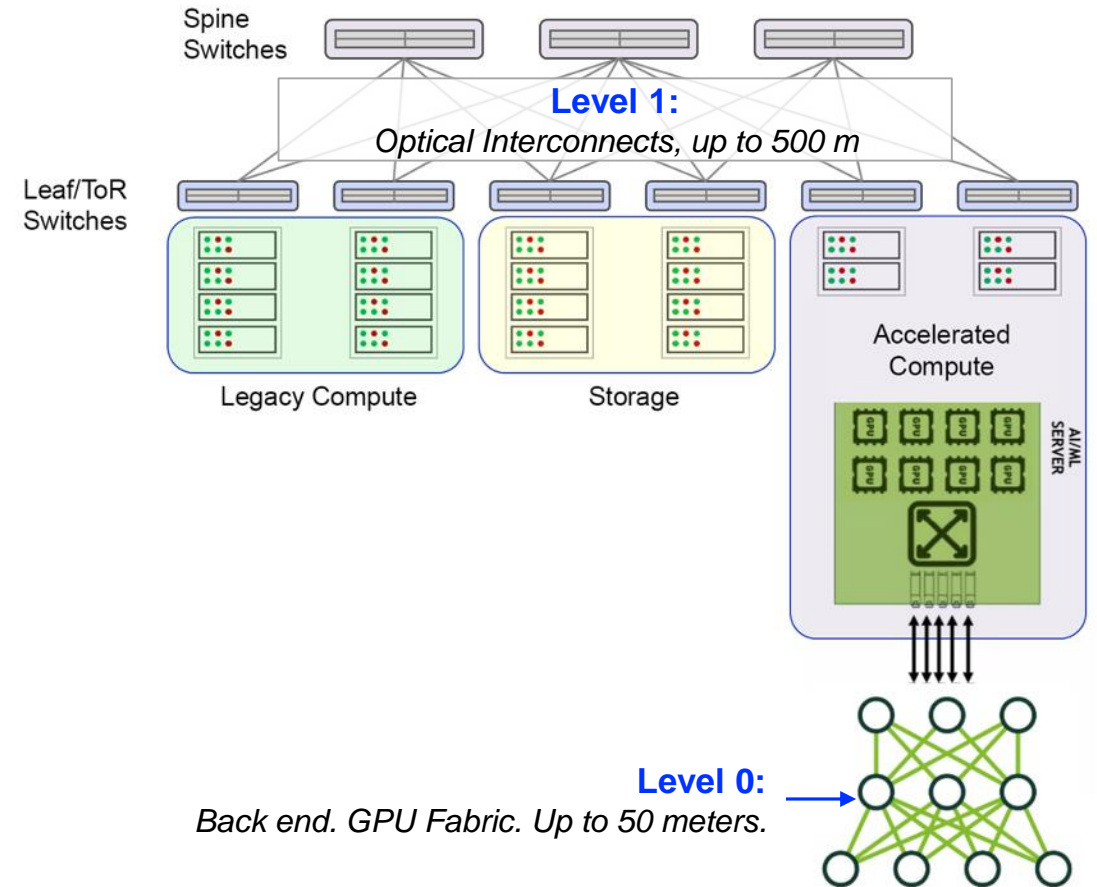
AI HAS RAPIDLY EMERGED AS A KEY CATALYST OF OUR LONG TERM GROWTH

Datacom transceiver revenue growth

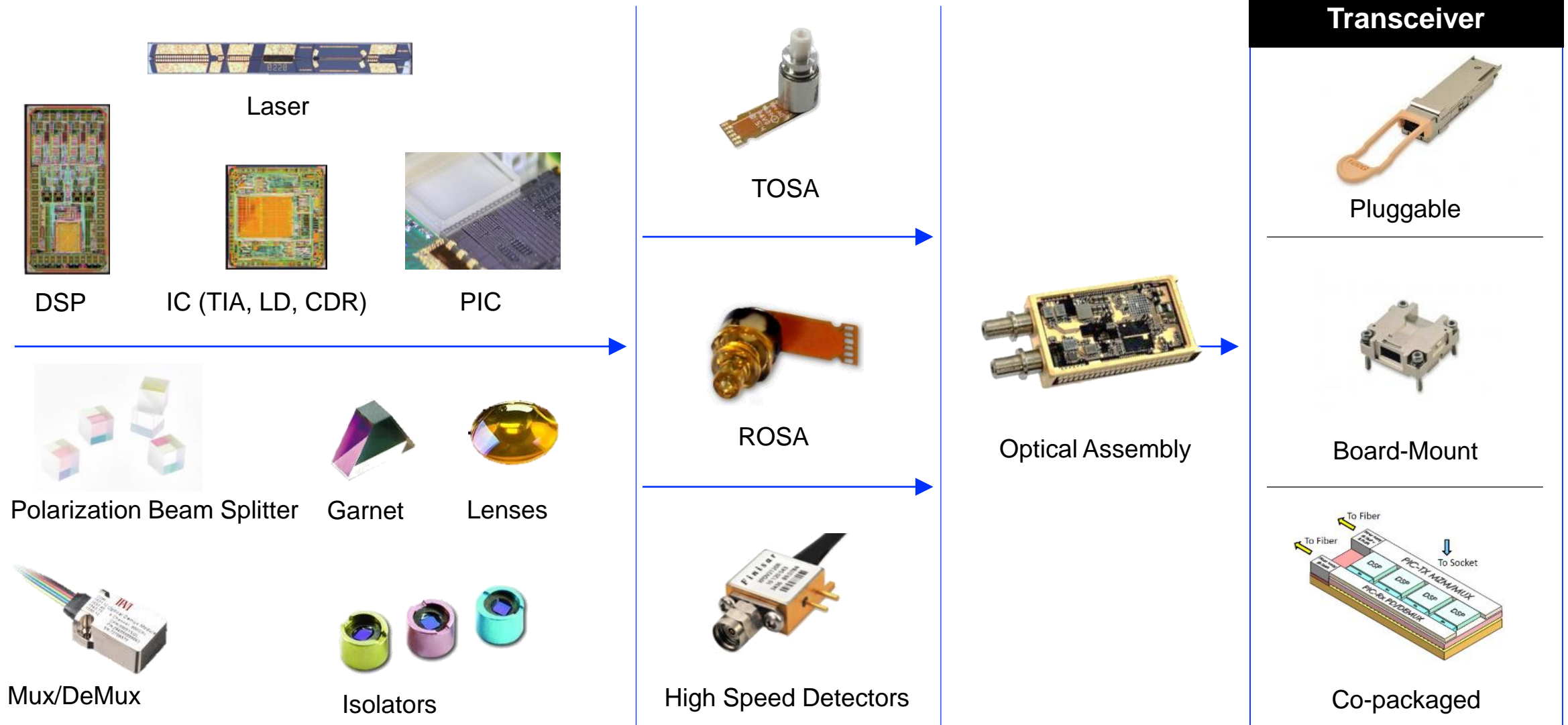


- Mainstream networking topology is giving way to a new topology to accommodate AI systems
- Both Level 0 and Level 1 connectivity will drive optics growth
- AI/ML networks add to compute and storage networks
- AI/ML applications drive transceiver growth

AI systems integrated into data centers



OUR VERTICALLY INTEGRATED TRANSCEIVER ENABLING AI CONNECTIVITY



PRECISION MANUFACTURING MARKET SIZING & DYNAMICS

EV Battery Manufacturing



>11% CAGR
\$300M TAM

- Rapid expansion in N. America and Europe
- Opportunities beyond welding for drying and foil cutting

Source: Benchmark Minerals, Internal Estimates

Fiber Lasers for Manufacturing



>8% CAGR
\$1,700M TAM

- EV welding driving growth
- Handheld lasers drive component opportunities

Source: Optech Consultants

Medical Device Manufacturing



>5% CAGR
\$300M TAM

- Aging population driving market growth
- Emerging high growth regions of China and India

Source: KPMG, Internal Estimates

FIBER LASER INTEGRATED MACHINE MARKET: \$11 BILLION*



Systems



Lasers



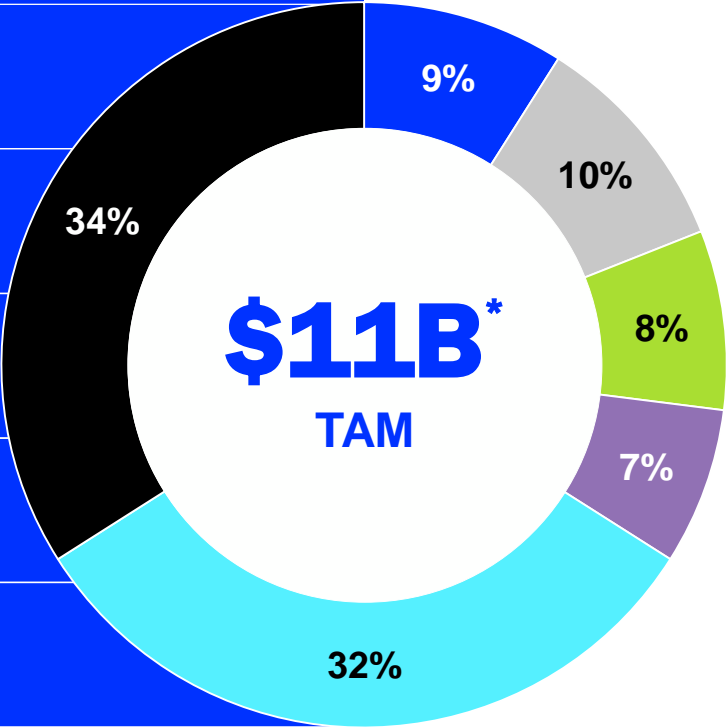
Components



Optics



Materials




\$11B*
TAM

- Welding - General Purpose
- Welding - Automotive
- Welding - Copper
- Cutting - 3D
- Cutting - Low Cost
- Cutting - High Power

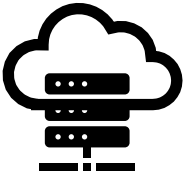
** Source: Optech, Internal estimates; 2023 TAM: \$11B; CAGR: 9%, 2023-2028*

THE SEMICONDUCTOR INDUSTRY ON ITS WAY TO \$1T MARKET BY 2030

2010s
75% of semiconductor growth
from mobile and compute











Smart phones



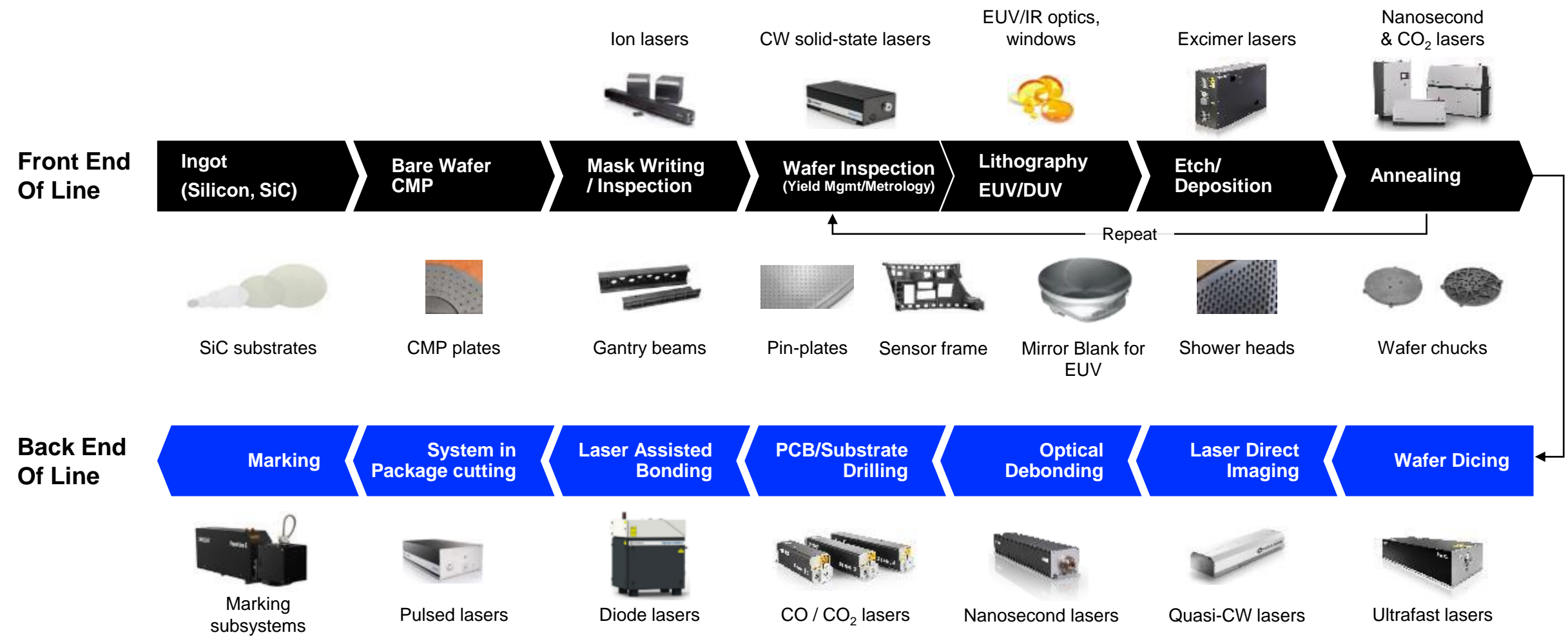
Data centers

2020s
AI, IoT and Smart Mobility

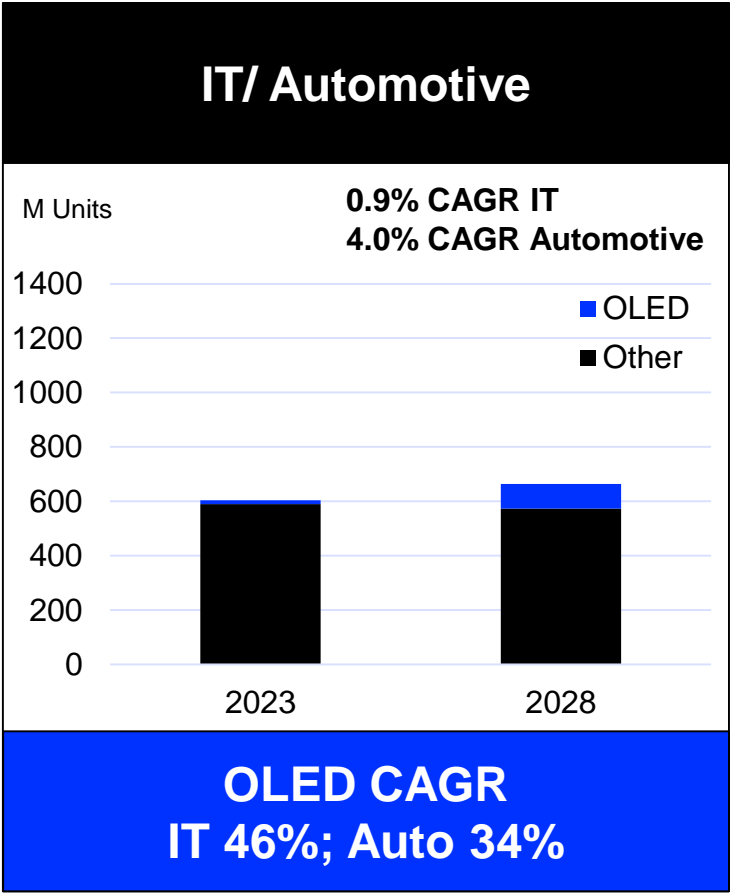
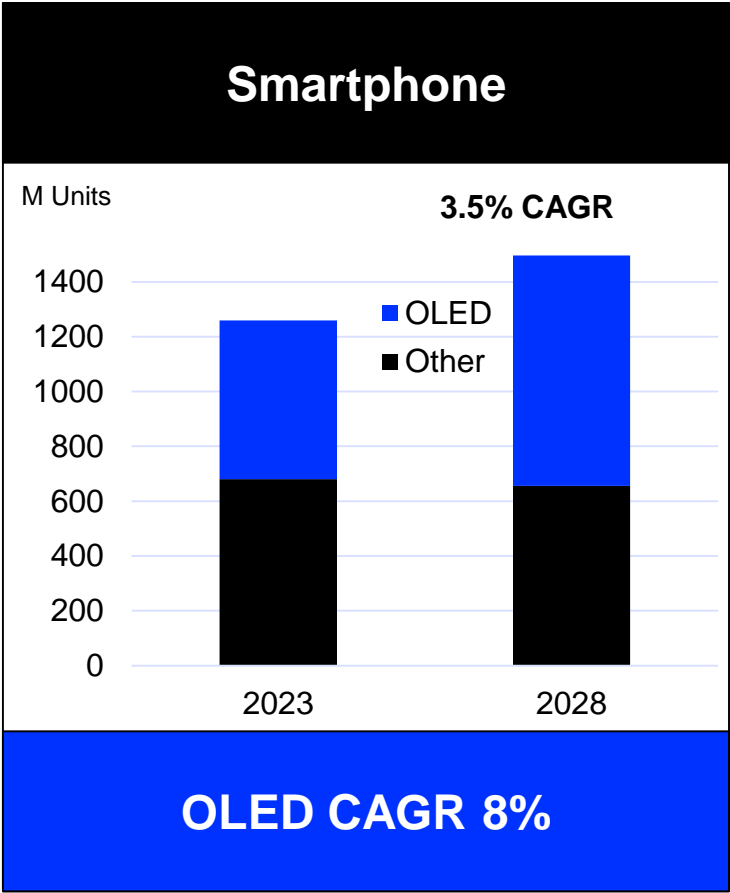
PATH TO \$1T

			
AI	AI/ML		
			
IoT	Industry 4.0	AR/VR	Intelligent Wearables
			
Smart Mobility	Electric Vehicles		

ENABLING SEMICONDUCTOR PROCESSES WITH LASERS, OPTICS, AND MATERIALS



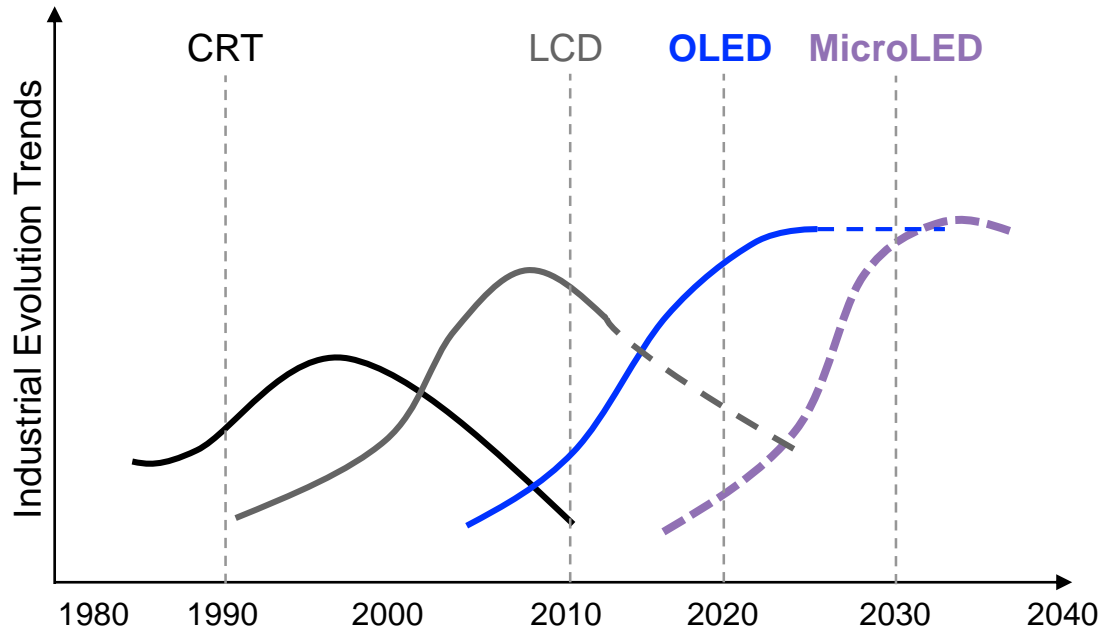
DISPLAY END MARKET DYNAMICS



OLED segment is growing

Source: OMDIA, DSCC and internal estimates

DISPLAY MARKET DYNAMICS



- Smartphones remain largest display market by units; OLED share growth leads to higher CAGR
- Increasing demand for OLED display equipment for tablets and automotive
- MicroLED market: strong growth forecasted over the next few years with production ramp-ups expected in 2024

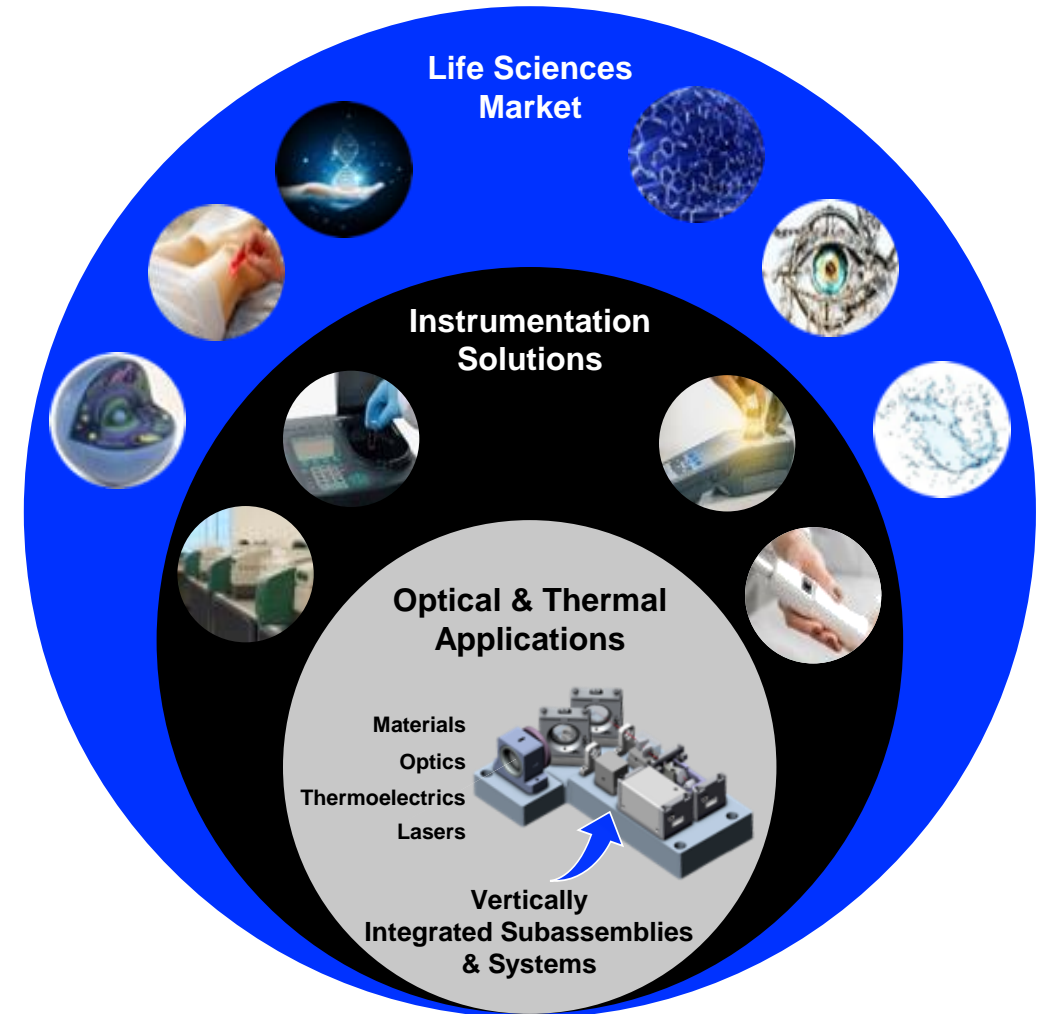


INSTRUMENTATION MARKET TRENDS AND DRIVERS

Global Healthcare Market - \$ 10 T

- World Health Organization: number of people over age 60 will increase from 1 billion in the year 2019 to more than 2 billion in 2050.
- Degenerative diseases, cancer, and Alzheimer's require challenging solutions
- Photonics technologies are driving an inflection point in modern medicine

Coherent Market Focus



UNIQUE CAPABILITIES FOR LIFE SCIENCES



Materials

Optics

Lasers

Thermoelectrics

**Vertically Integrated
Subassemblies & Subsystems**

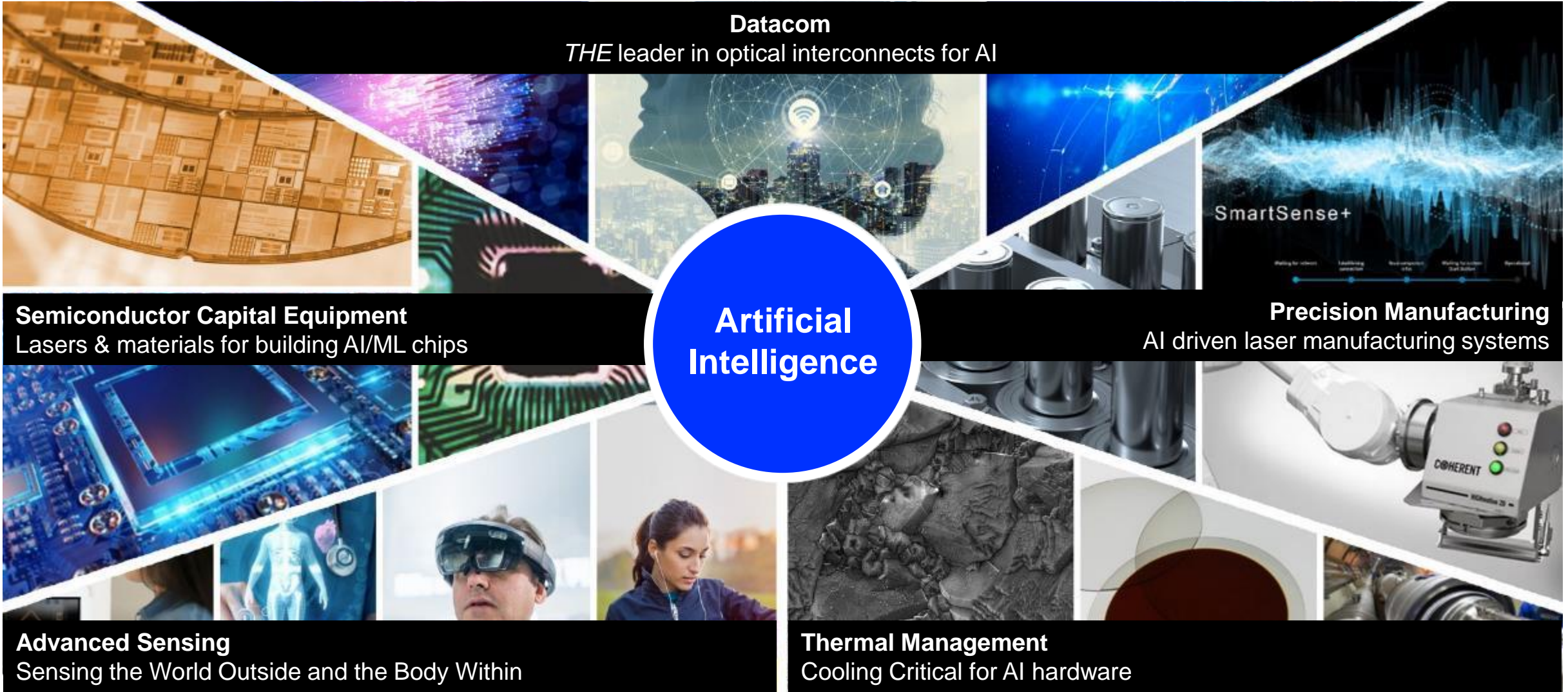
Solutions for Life Sciences



Greater scale reduces cost, enhancing competitiveness

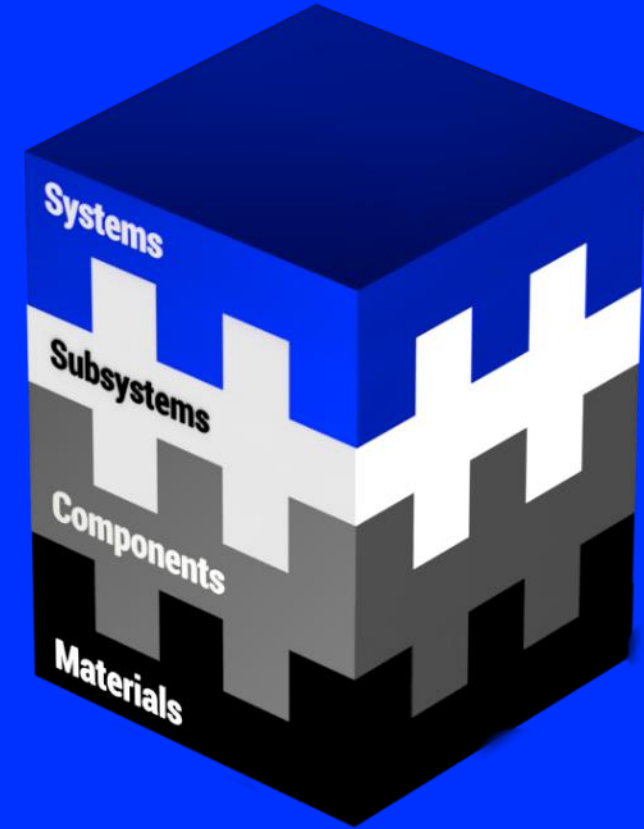
Complementary technology platforms open exciting new opportunities

OUR AI OPPORTUNITY - INTERSECTS WITH MULTIPLE VERTICALS



KEY DIFFERENTIATORS AND VALUE PROP

- Completely vertically integrated
- From materials to complete, deeply integrated systems
- Selling at all levels of the value chain
- Decades of application experience
- Global customer support network for products, applications, and service



BOOTH AREAS

LIFE SCIENCES

Optics. Lasers. Thermoelectrics. Subassemblies.



SCIENTIFIC RESEARCH

Reliability. Performance. Support.



MATERIALS AND COMPONENTS

Differentiated products for any level of integration.




SOURCES AND SUBSYSTEMS

Tailored solutions for any level of integration.










ADVANCED SENSING

Materials. Lasers. Optics. Modules.





MEET OUR MARKET VERTICAL LEADERS AT PHOTONICS WEST

INDUSTRIAL		COMMUNICATIONS		ELECTRONICS		INSTRUMENTATION
						
Geoffrey Shannon	Dr. Qiongying Hu	Vipul Bhatt	Dr. Jack Xu	Dr. Sridhar Nagarajan	Dr. Gerald Dahlman	Dr. Kim Netzeband
<i>Director Precision Manufacturing</i>	<i>Director Semiconductor Capital Equipment</i>	<i>Vice President Datacom</i>	<i>Vice President Telecom</i>	<i>Sr. Director Automotive</i>	<i>Sr. Director Consumer Electronics</i>	<i>Director Life Sciences & Scientific Instrumentation</i>

NEW PRODUCTS INTRODUCED AT PHOTONICS WEST 2024

■ Life Sciences:

- Cell X for microscopy
- OBIS XT 640 nm
- IR Polarizers

■ Precision Manufacturing:

- HyperRapid NXT 100 W green
- EOM package
- EOC 1 kW attenuator

■ Electronics:

- Dot projectors for depth sensing in consumer electronics
- VCSEL-Based Demonstrator of Short- and Mid-Range LiDAR

■ Measurement:

- Waveshaper U-band and Super C-band
- 10 kW Plus (Sensor)



HEAR OUR INVITED SPEAKERS

Invited speakers **SPIE. PHOTONICS WEST**

Photonics West Demo Series



Title: Lasers, Optics, and Thermoelectrics to Advance Life Science Instrumentation
Speaker: Kim Netzeband, Ph.D.
Date: January 30, 2024 – 2:00 to 2:30 pm

Industry Event



Title: Photonics Technologies for Datacom: Complement or Compete?
Speaker: Vipul Bhatt, VP of Marketing
Date: January 31, 2024 – 1:30 to 2:30 pm

Press and Market Analyst Coverage



FEEL OUR TECHNICAL PROWESS

Date	Paper #	Title	Authors/Presenters
1/28/24 10:35 am PST	12847-4	Laser innovations and techniques evolution in multiphoton microscopy: a close interplay	Mantas Butkus
1/28/24 5:30 pm PST	12847-70	Advancing studies of the brain with multiphoton microscopy	Ewa Zarnowska
1/28/24 8:30 am PST	SC752	Solid State Laser Technology	Norman Hodgson
1/28/24 4:20 pm PST	12865-24	Mitigating stimulated Brillouin scattering in single-frequency multimode fiber amplifier with diffraction-limited output	Peyman Ahmadi
1/29/24 8:30 am PST	SC1285	Industrial ultrafast lasers for micro-processing and applications	Norman Hodgson
1/30/24 8:00 am PST	12867-35	Ultra high-power and highly efficient 9xx nm single emitters with up to 65 W output power under CW operation	René Todt
1/30/24 5:00 pm PST	12865-26	A single mode fiber connector for multi kW fiber lasers	Conor Byrne
1/30/24 5:10 pm PST	12897-32	Design of metasurface polarizing beam splitters in the infrared	Yakov Soskind
1/30/24 6:00 pm PST	12865-86	Single frequency operation of an 1110 nm Yb-doped fiber amplifier used for non-linear frequency conversion	Clémence Jollivet
1/31/24 8:45 am PST	12868-2	Optically-pumped semiconductor lasers at Coherent: a historical perspective	Juan L. Chilla
2/01/24 2:30 pm PST	12865-57	PM single-mode Er:Yb co-doped fibers for mid-high power laser amplifiers	Clémence Jollivet

PHOTONICS WEST 2024

PRECISION MANUFACTURING VERTICAL

MATERIALS, OPTICS, COATINGS, COMPONENTS, SUBSYSTEMS AND SYSTEMS



10.6 and 1 micron Optics/materials
1971 - present



Components, Lasers, Subsystems & systems
1966 - 2022



Laser diodes
1911 - 2009



Isolators, crystals
1987 - 2020



Materials, optics, optical
assemblies
2003 - 2009



Active & passive fibers
2000 - 2008



Large scale optics
1929 - 2015



Focus and Scan heads,
Optical sub-assemblies
1995 - 2013



VHBG
2000 - 2018



Optical components, beam
switches, fiber assemblies
2002 - 2004



Fiber lasers and components
2003 - 2007



Laser diodes
1994 - 1997



Crystals
1990 - 2000



Specialty Materials
1993 - 2012



MATERIALS, OPTICS & COATINGS



Materials

- Nonlinear, Active, EO, Magneto Optic, Windows
- 25+ Crystals, 4+ Dopants; sole domestic options
- High performance coatings
- Sub-assemblies; EOM, Isolators, rotators, mounted crystals
- ZnSe, ZnS
- SiC/metal matrix composites specialty materials

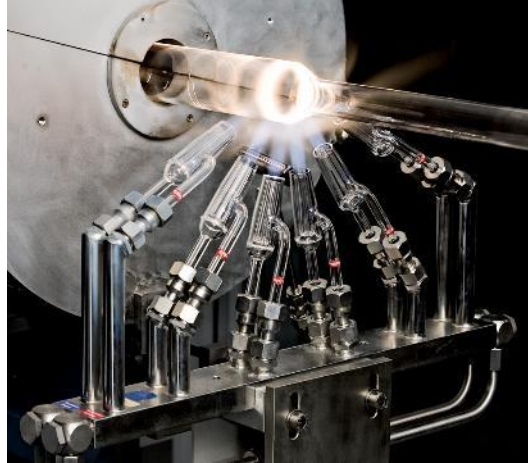
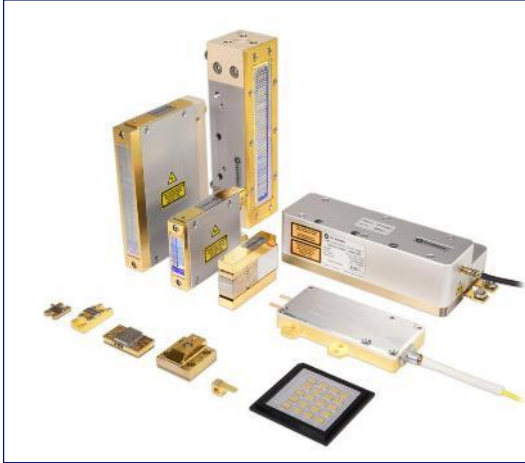
Laser Optics & Delivery Optics

- UV to IR, CW to fs
- SiC, Be, Zerodur, ZnSe, ZnS, Ge, Si, GaAs, CdTe, Moly, Sapphire
- Plano, spherical, cylinder, aspheric, prisms, DOEs, lens arrays adaptive, polygons
- Large format mirrors and lenses (>1 m class)

Coatings

- Transmission, partial & total reflectors, splitters, specialty
- AR, HR, BHR, DHR, PR, BPR, DPR
- Space qualified enhanced coatings to meter class
- Many substrate materials
- Design and manufacture to complex custom requirements

COMPONENTS, SUB-ASSEMBLIES & LASERS



Semiconductor/Laser Diodes

- 630nm to 2 μ m at W to kW
- Bare die to fiber coupled, customizable
- Tapered amplifiers SM to multi W
- Wavelength stabilized, scalable power by stacking

Fiber & Fiber Assemblies

- Active, Passive, PM, Dispersion Managed, Spun, Microstructured, XLMA, Radiation Resistant
- Gyro Coils, KW class, UF laser
- Fiber termination and FC devices (endcaps, isolators, combiners, ASE filters, etc.)



Optical Sub Assemblies

- F theta lenses, AOM, EOM, QS, beam expanders, switches, pulse pickers, FBG
- Isolators, rotators, mounted crystals

Lasers & Subsystems

- Lasers; Deep UV to IR, CW to fs
- Scan head subsystems

PRECISION MANUFACTURING



Systems



Lasers



Components



Optics



Materials

**Intersection with
many diverse
markets**



Automotive Manufacturing



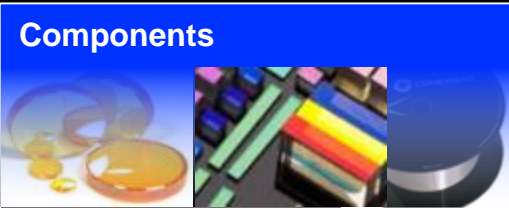
Machine Tools



Medical Devices



Electrical & Electronics



Components



Consumer Goods

NEW PRODUCTS FOR PHOTONICS WEST 2024

PRECISION MANUFACTURING

PAVOS ULTRA 1 kW OPTICAL ISOLATOR

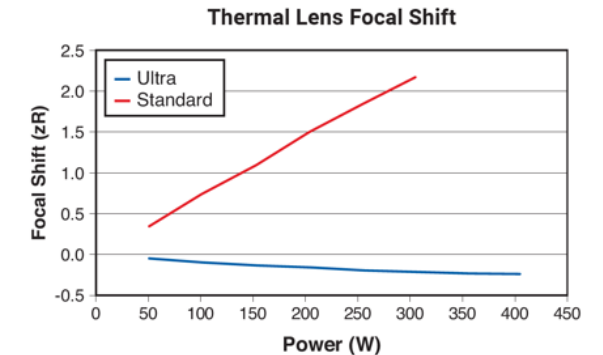
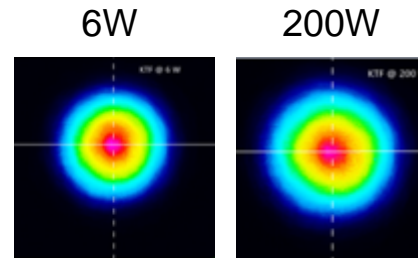


New
Product

Key Features

- Power Rating: **1000 W**
- Wavelength range: 1030 – 1064 nm
- Clear Aperture: 12 mm
- $Zr/kW \leq 0.5$
- Isolation: >23dB, transmission >90%
- No active cooling or birefringence compensation needed

Pavos
Ultra
1kW

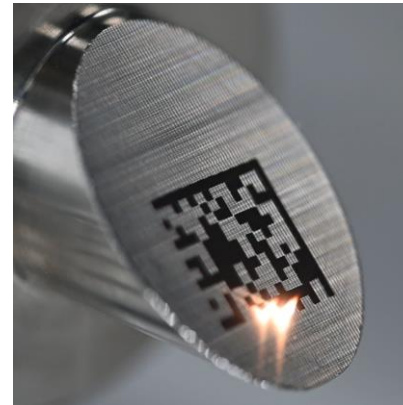


NEW MATRIX UV LASER



Key Features

- First 10W purely air cooled ultra compact UV laser
- Widest operation range in the market
- Based on decades of UV laser knowledge for performance and reliability
- Cost effective solution
- Wide range of applications from medical device to micro electronics



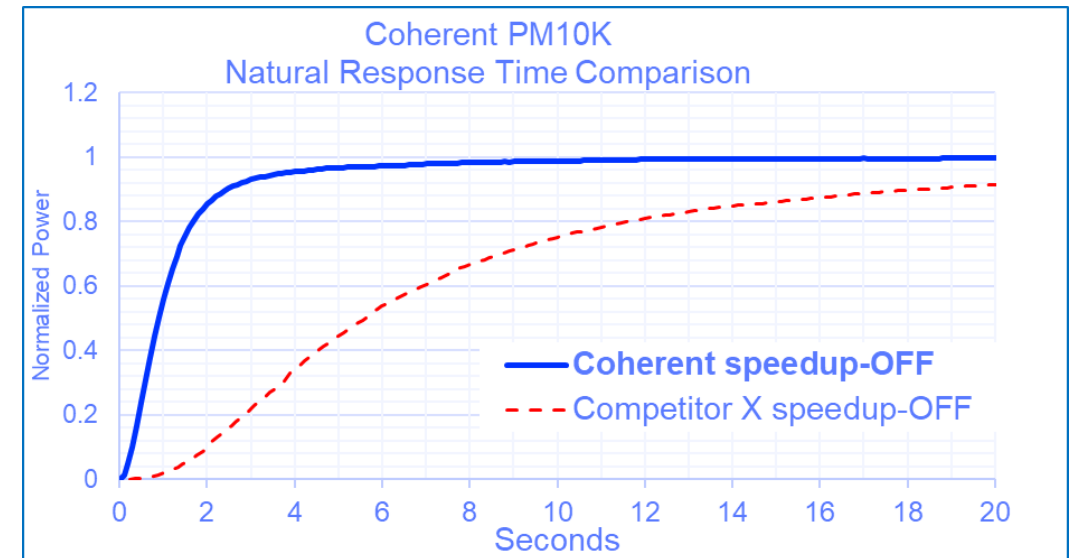
10 kW PLUS POWER METER



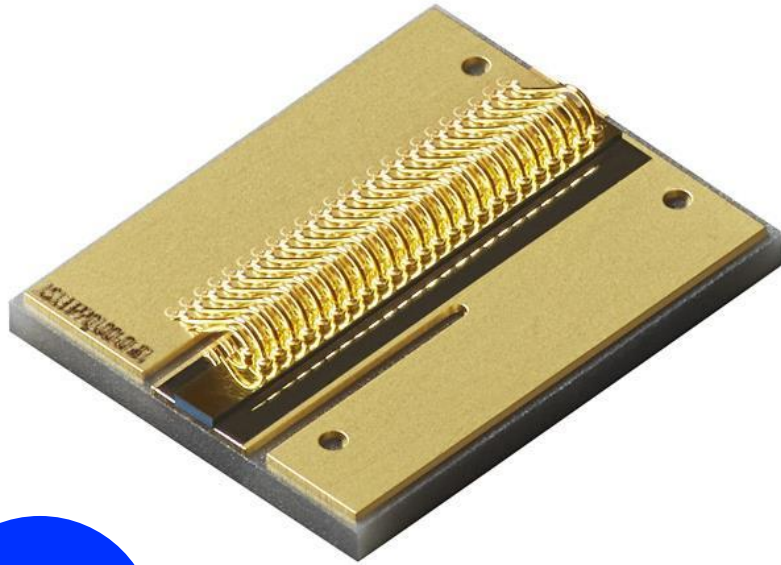
New
Product

Key Features

- Fastest response time in the 10 kW sensor class < 3s
- Dovetail features for easier mounting and alignment
- Operation: 10 kW continuous / 12 kW intermittent (5 min.)
- 65 x 65 mm (2.5" x 2.5") active area
- High laser damage threshold



NEW 65 W PUMP LASER DIODE



New
Product

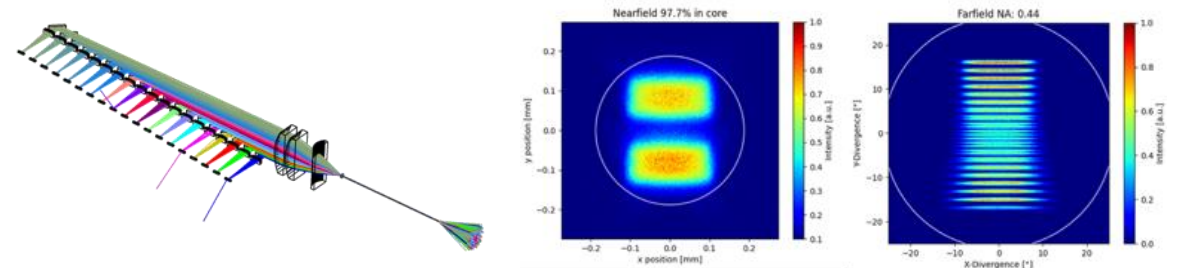
Example module: 1 kW pump – 19 emitters

Key Features

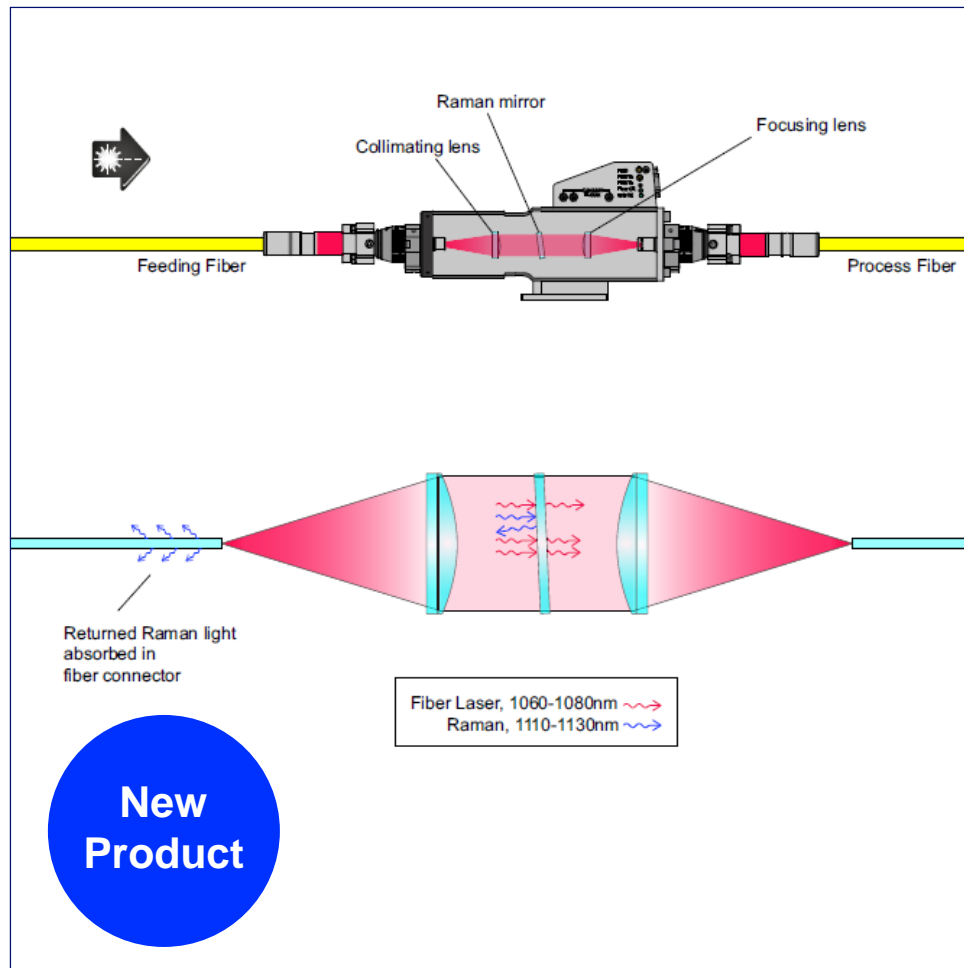
- Unmatched \$/W performance
 - Reduces module complexity
 - Enables savings on other components (optics & sub mounts)
- 30% power increase vs. best on market
- Best-in-class power conversion efficiency
- Low drive current
- Suitable for standard spatial, polarization & wavelength combining

Optimized for high-power (>1 kW) Pump modules

- Hand-held & Cutting Fiber Lasers



FIBER TO FIBER COUPLER (FFC) WITH RAMAN FILTER



FFC key features

- Change (+) of fiber core diameter
- Detachable/replaceable fiber to laser source
- Options include patented wavelength selective filter to remove Raman radiation
- Up to 10kW (min. core 22 μm)
- Standard connectors QBH, QD

Optional Raman Filter

- Stimulated Raman Scattering (SRS) a major limiting factor for HP, high brightness lasers
 - Restricts process fiber length
- Introduction of wavelength selective mirror in FFC completely removes Raman radiation
- Patented solution utilizing mode stripping tech of Coherent fiber optics

HIGHLIGHT FL-ARM & HIGHMOTION 2D UPDATE



Updated release of HighLight FL ARM

- 50/200 μ m center/ring configuration
- New 5+5 kW power distribution between center & ring
- Additional power in center enables deeper welding penetration with minimal spatter particularly for highly reflective materials e.g. copper

Updated HIGHmotion 2D High Brightness

- Main application deep copper welding (>3 mm) and general copper welding (8 kW rated)
 - Examples: Busbars, Hairpins for EV traction motors
- New f-theta lens (focal length 260 mm) allows magnification as low as 1.3 x
 - Large working field (for 1.3 x) of X 90, Y 160 mm
- Available with HIGHvision system for precise beam positioning

PHOTONICS WEST 2024

DISPLAY CAPITAL EQUIPMENT VERTICAL



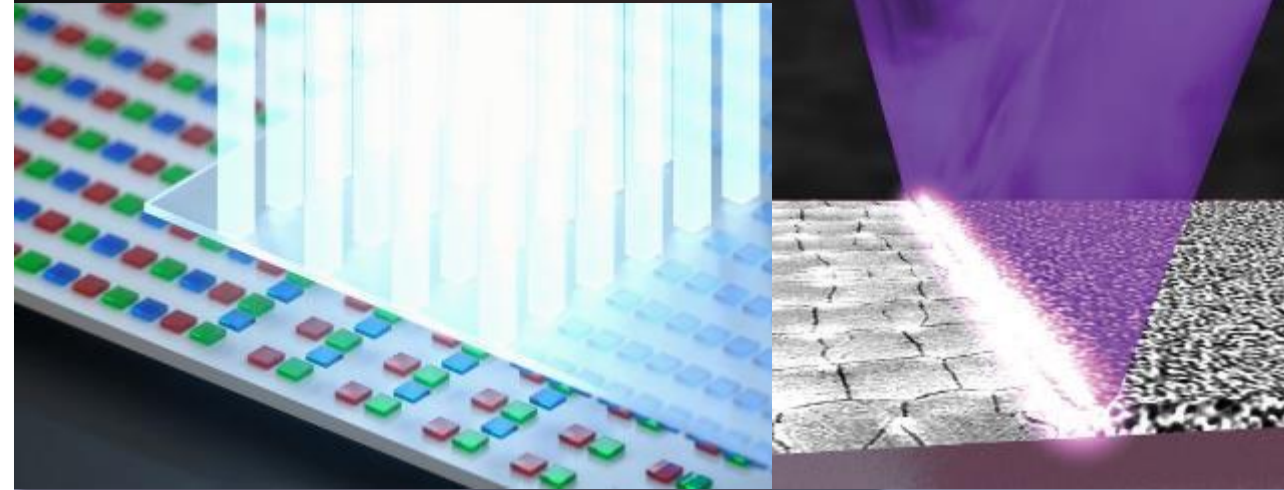
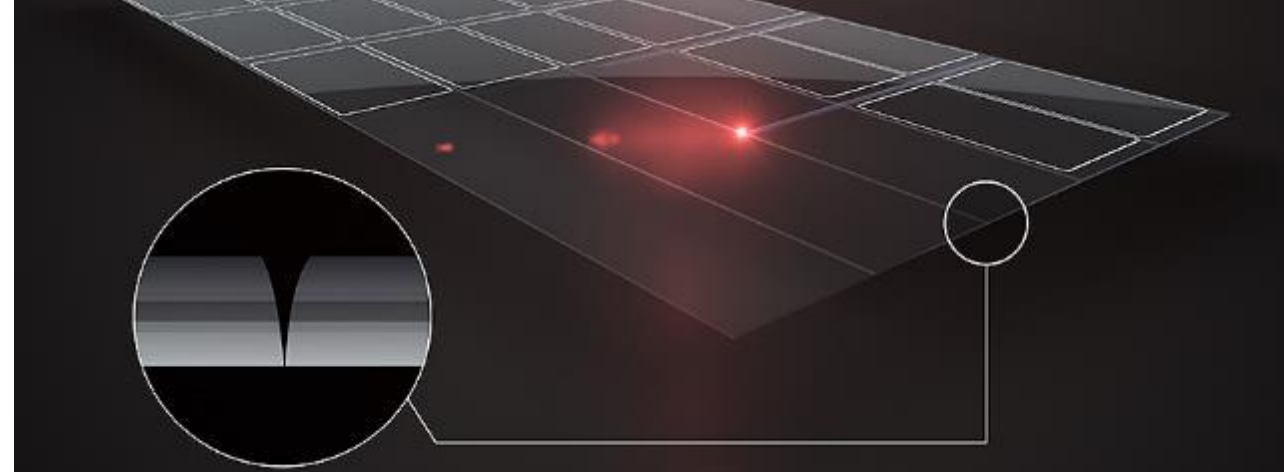
**DISPLAYS:
OUR WINDOW
INTO THE
CONNECTED
WORLD**

**WE HAVE THE
LASER SOLUTIONS
FOR TODAY,
TOMORROW AND
BEYOND**

LASER SOLUTIONS FOR OLED, MICROLED, AND 3D HOLOGRAPHIC DISPLAYS

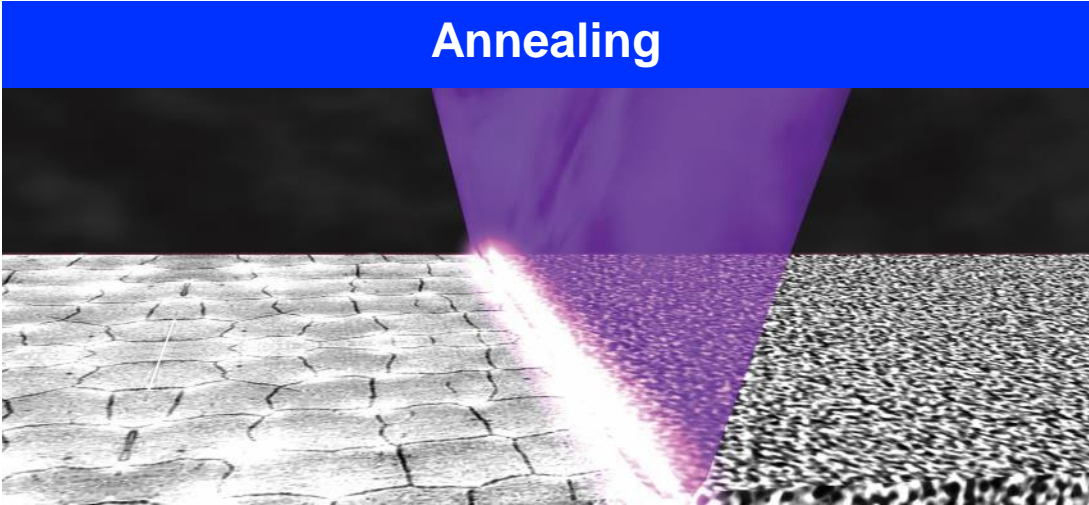
Laser & system capabilities:

- Line Beam systems for display backplane annealing (ELA) and Laser Lift-Off (LLO)
- Ultrafast and CO₂ lasers for OLED display cutting
- MicroLED UV Laser processing solutions
- Laser sources for Holographic Optical Element recording



DISPLAY MANUFACTURING – A TASK FOR UV LASERS

Annealing



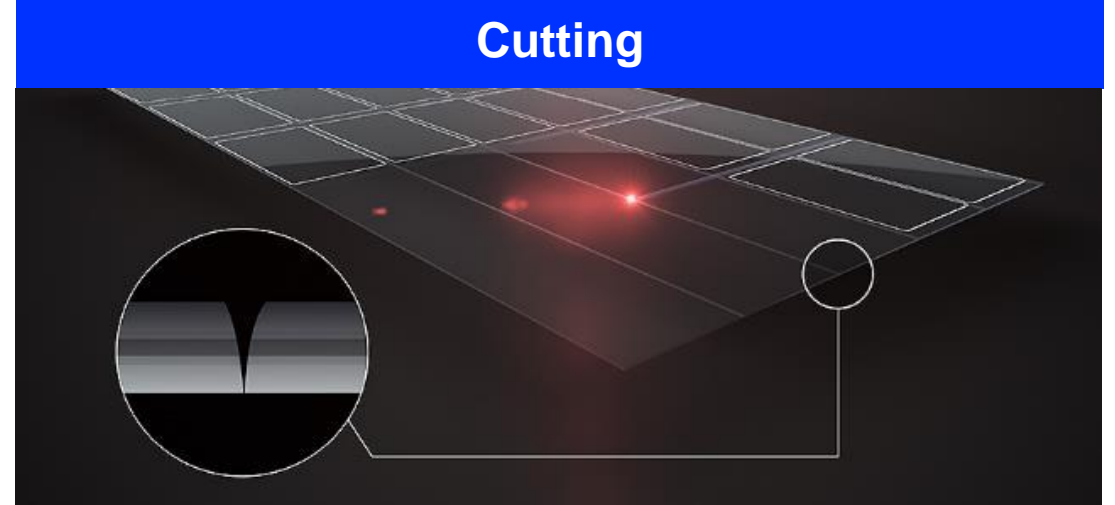
DPSS ns Laser



355 nm Python DPSSL

- Excimer and DPSS Laser now available

Cutting



Picosecond Laser 10W UV



266 nm HyperRapid NXT

Femtosecond Laser 50W UV

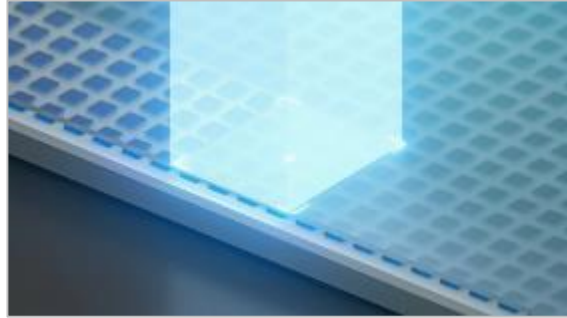


343 nm Monaco

- **50W UV** is state-of-the-art in industrial display cutting
- We do offer both **50W UV** pico and femto
- DUV offers again better cutting quality and we gain some interests from display manufacturers

COHERENT POSITIONING AND WIN FACTORS FOR MicroLED

Laser LIFT-OFF



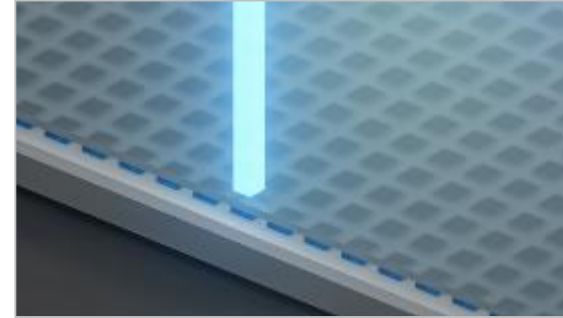
Release from EPI Wafer

Mass Transfer



Parallel Pitch Conversion

Laser Repair

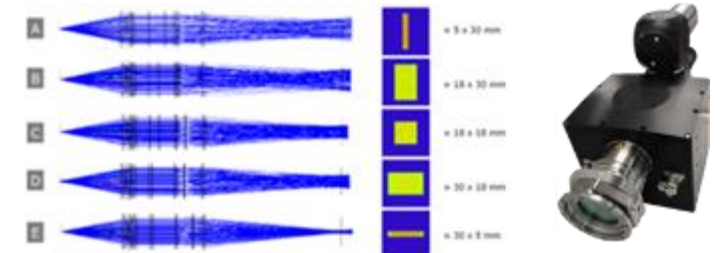


Individual Remove and Refill

Laser Assisted Bonding



Selective Bonding



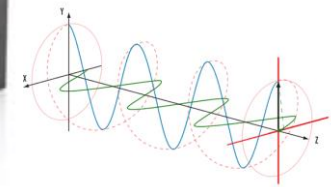
- Well positioned in the early stage - shaping processes of record
- Vertical integrated, offering laser, OEM systems, and a turn-key solution for mass transfer including optimized DUV laser sources

LASER RECORDING OF HOLOGRAPHIC OPTICAL ELEMENTS



- Holographic optical element recording by using single mode continuous wave laser in a few Watt range
- Photo polymers used in the holographic combiner devices
- Laser recording in R, G, B wavelength for color imaging

Moving from a physical world into virtual reality



PHOTONICS WEST 2024

SEMICONDUCTOR CAPITAL EQUIPMENT VERTICAL

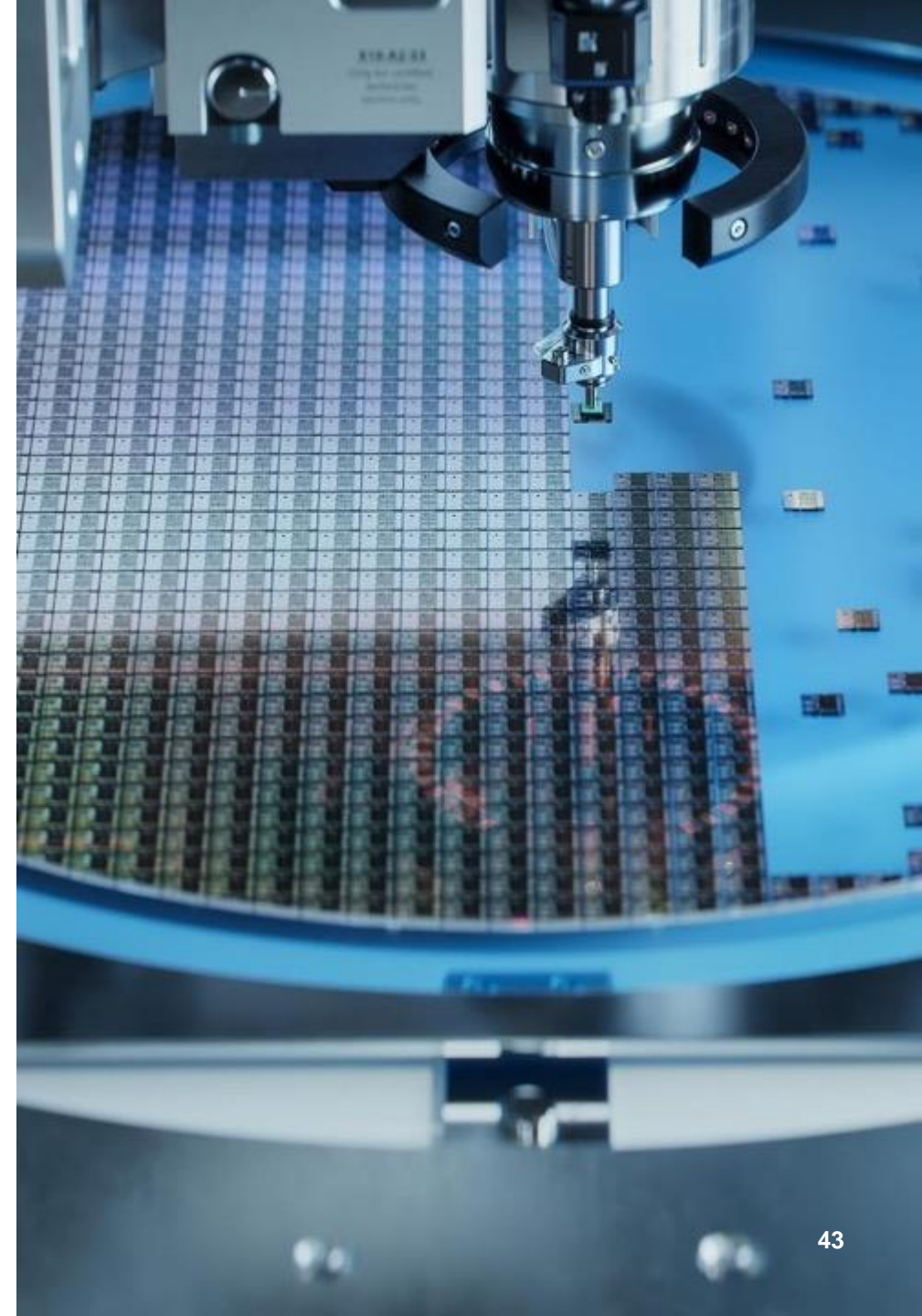
SEMICONDUCTOR CAPITAL EQUIPMENT

Global market leader offering highly differentiated products:

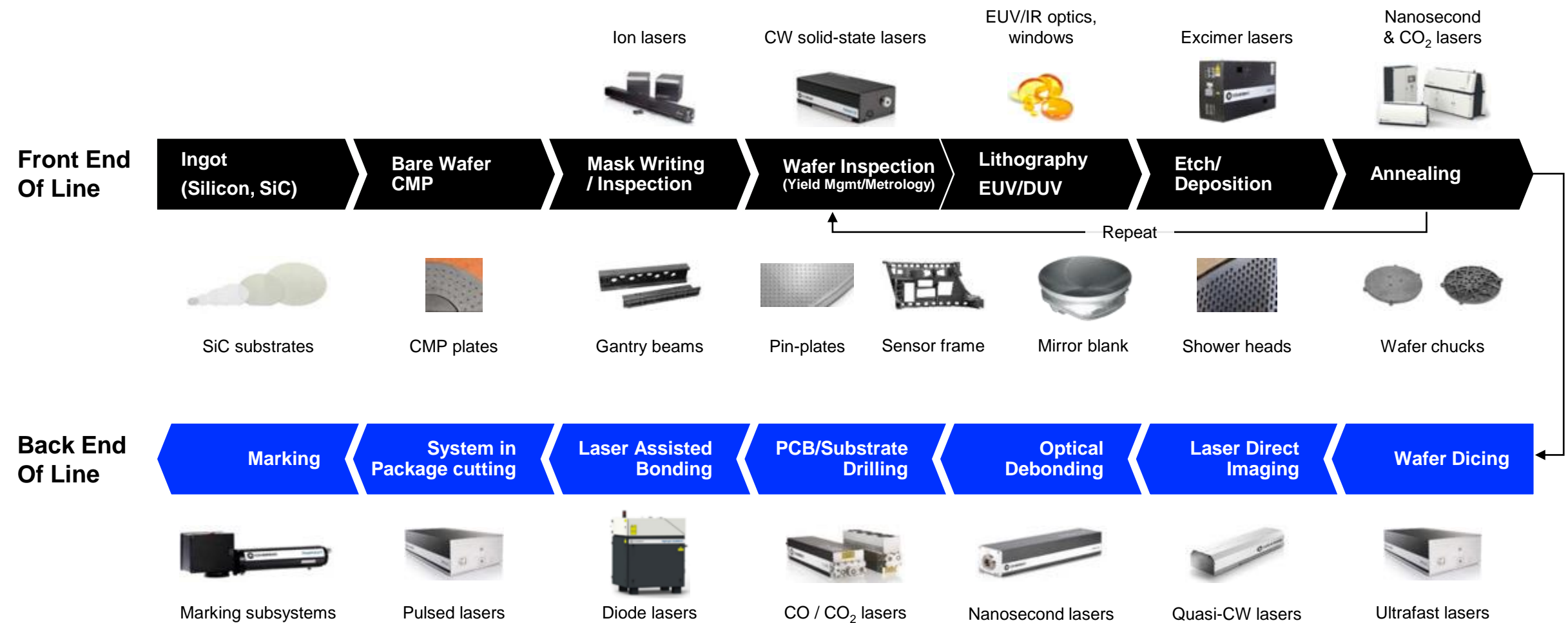
- Laser sources (DUV-UV-VISIBLE-IR)
- Advanced CO₂ laser optics (IR)
- Precision optical solutions and coatings (DUV-UV-VISIBLE-IR)
- High performance ceramics (Si/SiC, Metal matrix composites)

Customized solutions for subsystems:

- Fully integrated laser sources, beam delivery, focus heads and control software



ENABLING SEMICONDUCTOR PROCESSES – MATERIAL, LASER & OPTICS



HRNXT 532-100W PRODUCT RELEASE



Key application:

- Solar Market: thin film scribing and grooving
- SEMI: wafer scribing

Available in Q3 CY2024

New laser built on the standard picosecond HyperRapid NXT platform

- 100W average power at 532nm
- 100uJ of output pulse energy
- High beam quality, high throughput
- Alternative to nanosecond or lower power Ultrashort pulse lasers

ELECTRO-OPTIC MODERATOR (EOM)



Key application: SEMI Via drilling

Used By: VIA drilling machine manufacturers or manufacturers needing to pulse a laser beam

Why needed: Can drill holes faster in nano-second timing to replace acoustic-optic modulator (AOM)

Features and Benefits:

- Switching speeds unobtainable by AOMs
- Modulate on the nano-second scale
- No beam off-set or angular deviation
- Modulate beams at higher powers up to 1000w
- Stable pulse profile and minimal residual ringing
- Provided as a complete system as driver and power source

SHORT FOCAL LENGTH SCAN LENSES



Key application: SEMI Via drilling

Used By: VIA drilling machine manufacturers

Why needed: Smaller spot sizes in drilling Printed Circuit Boards (PCB) to 40 μm

Features and Benefits:

- 891point inspection of 100% of parts
- Focal length limited telecentricity
- Low coating absorption
- Low thermal shift
- Size variation of $\pm 5\%$

PHOTONICS WEST 2024

AUTOMOTIVE VERTICAL

OFFERING A WIDE PORTFOLIO ACROSS WAVELENGTHS

		532 nm	808 nm	850 nm	905 nm	940 nm	980 nm	1064 nm	1310 nm	1550 nm
EELs (SE, Bars, Pumps, Seeds)			✓		✓	✓	✓	✓	✓	✓
DPSS Modules		✓						✓		
VCSELs		✓	✓	✓	✓	✓	✓	✓		
Fiber Amplifiers & Components							✓	✓	✓	✓
Optics, Polygons, Galvo Mirrors		✓	✓	✓	✓	✓	✓	✓	✓	✓
High Performance Filters				✓	✓	✓			✓	✓
Windows		✓	✓	✓	✓	✓	✓	✓	✓	✓
VCSEL Modules						✓				

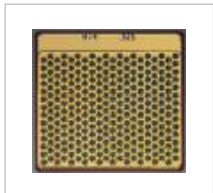
OPTICAL SOURCES AND COMPONENTS FOR AUTOMOTIVE SENSING

Components for In Cabin Automotive & LiDAR

- Semiconductor Lasers: VCSELs & Edge Emitting Lasers, Illumination modules
- Optics: Diffusers, dual band pass filters, glass diffusers, wide incidence angle mirrors
- COHR vertically integrated 6" GaAs compound semiconductor platform is the largest in the world

Applications:

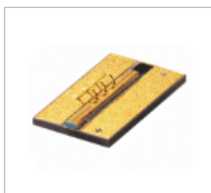
- In Cabin Automotive: OMS, DMS, Gaze tracking, Gesture Control
- Automotive LiDAR: Short Range, Long Range, Time Of Flight



VCSEL
arrays



Illumination
Modules



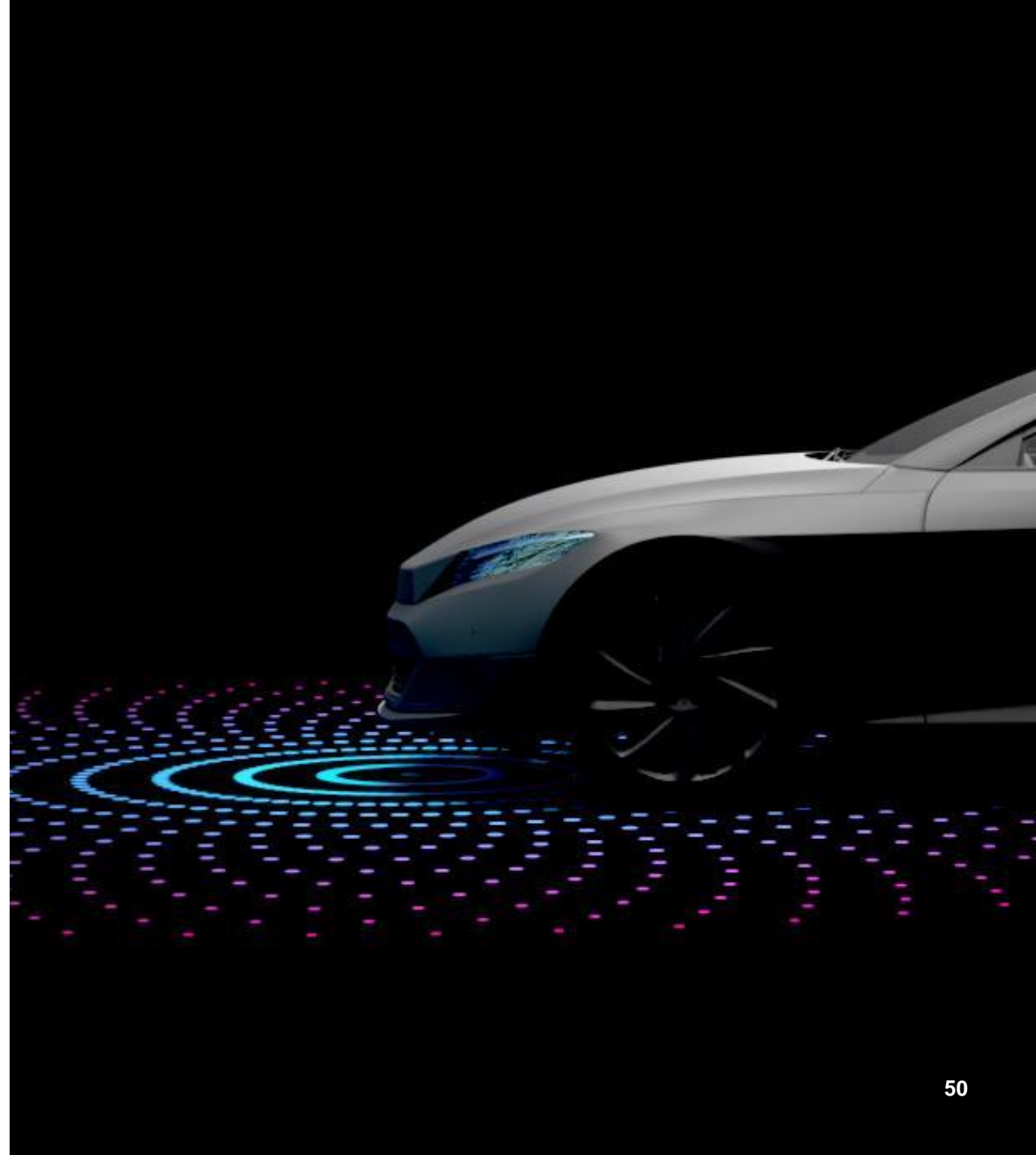
Edge
emitters



Dual pass
band filters



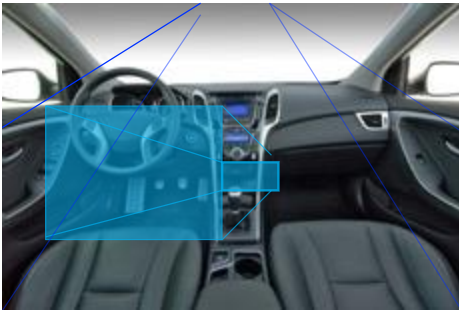
Wide incidence
angle mirror



DRIVER MONITORING AND OCCUPANCY MONITORING

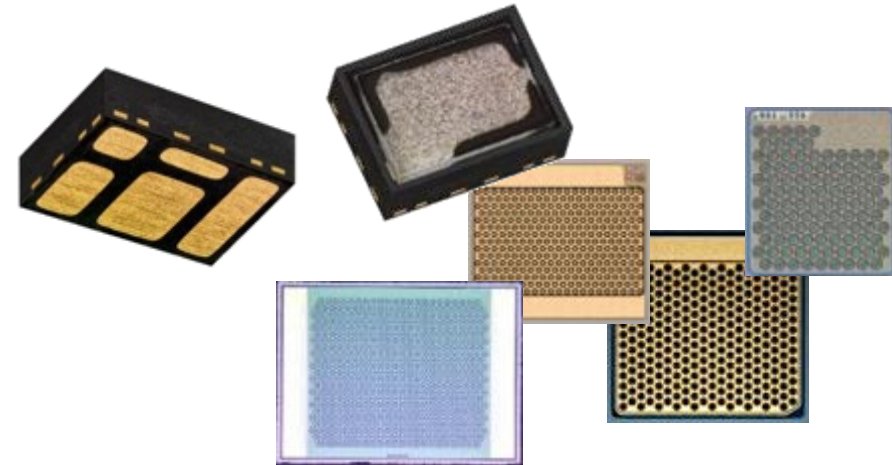
Criteria for illumination

- Indirect Time Of Flight – 2D imaging
- Power 1-5W
- Wavelength: 850, 940 nm
 - Non-visible light preferred (near infrared)
 - Eye-safety
- High Reliability, AECQ qualification
- Environmental: -20°C – 105/125°C
- Tailored FOI to application
 - Eg: 60x45 (DMS), 110-140 x 85-110°(OMS)
- For gaze tracking: Low speckle
- For 3D scan: Modulation frequency



Our solution

- High reliability / High performance VCSEL
- Array configurations to scale power
- Power scalable with Several tens to hundreds of emitters
- Standard Emission wavelength: 940nm
- Automotive Certification: AEC-Q102
- Assembled in IATF certified facility
- Fast modulation for high depth resolution
- Narrow spectral width



VCSEL-BASED ILLUMINATION MODULE PLATFORM FOR LIDAR



New
Product

Features

- Eight 940 nm VCSEL modules
- State of the art five junction technology
- Enables module to go up-to 200W (output power)
- Customize an optimized solution up to 30 meters of depth sensing in bright daylight
- Ability to adjust the duration of the driving pulses
- FOI slices – dynamically selectable
- Low voltage (21V) – higher efficiency

Highlights

- A solution with several selectively addressable horizontal slices of the field of illumination (FOI)
- Compact form factor (one-third the size of a credit card)
- Excellent power conversion efficiency (>30%)
- Lower-cost alternative than using large addressable VCSEL arrays

A demonstrator available for customers to explore multiple VCSEL module positioning configurations and scanning algorithms for various depth sensing modalities and types of scenery

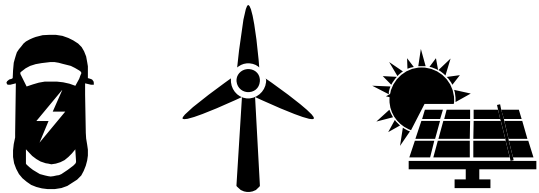
PHOTONICS WEST 2024

THERMAL MANAGEMENT SOLUTIONS

OUR THERMAL MANAGEMENT SOLUTIONS



EVs, renewable energy
and energy storage



Datacom/Telecom



Industrials & Semi capital
equipment

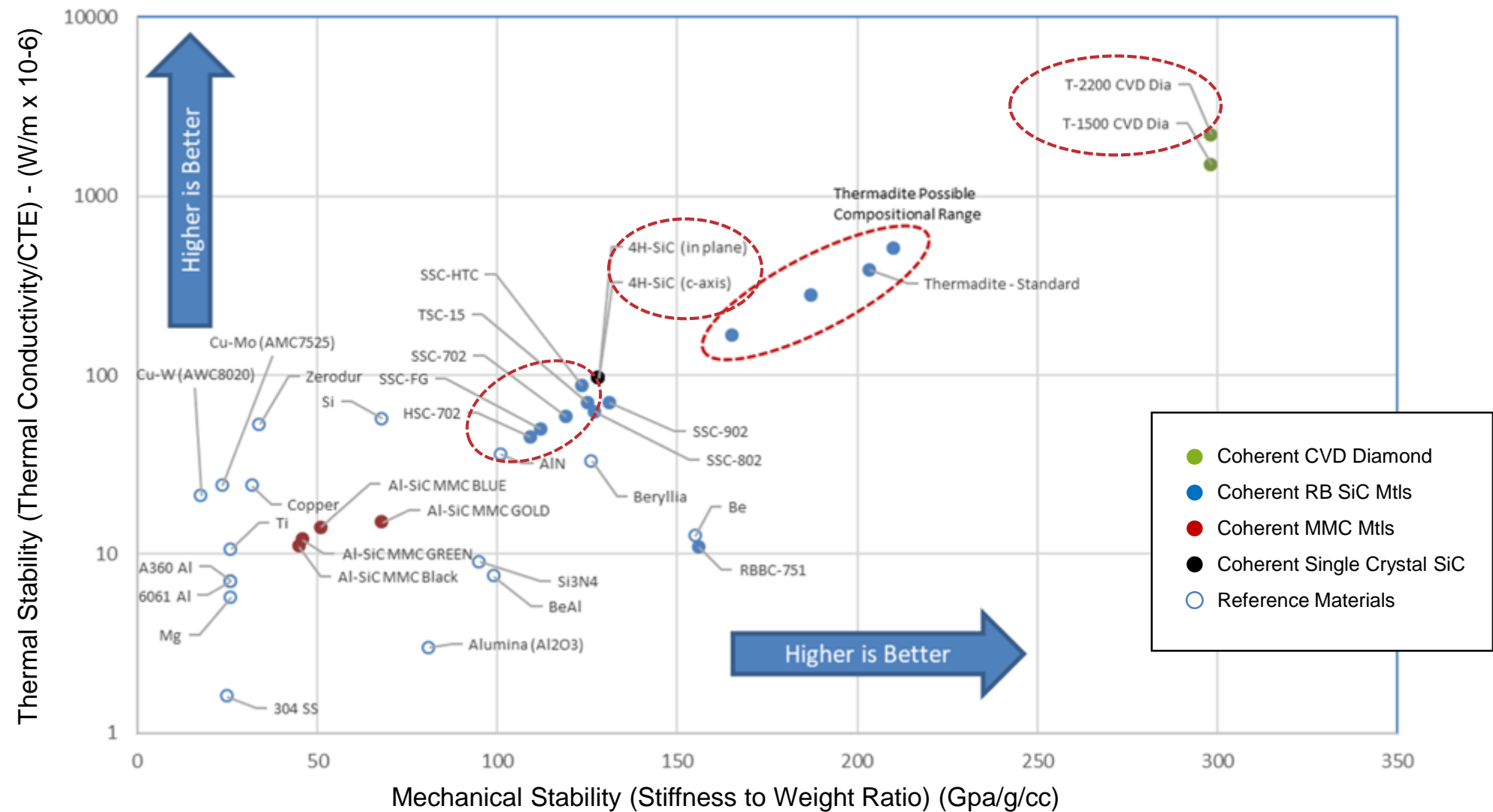


Enabling a greener future

COHERENT THERMAL MATERIALS SUMMARY

Material Family	Application Markets	
Reaction Bonded Si/SiC (RB SiC) Materials	<ul style="list-style-type: none">• Semi capital equipment• Automotive & Energy• Consumer	<ul style="list-style-type: none">• Life science• Industrial
Al/SiC Metal Matrix Composites (Metal Casting)	<ul style="list-style-type: none">• Semi capital equipment• Automotive & Energy	<ul style="list-style-type: none">• Life science• Industrial
CVD Diamond	<ul style="list-style-type: none">• Industrial• Aerospace and Defense• Life science	
Single Crystal SiC	<ul style="list-style-type: none">• Semi capital equipment• Industrial	<ul style="list-style-type: none">• Consumer
Thermoelectric coolers	<ul style="list-style-type: none">• Automotive• Life science• Consumer	<ul style="list-style-type: none">• Defense• Telecom

MECHANICAL AND THERMAL PERFORMANCE



VALUE OF COHERENT FOR PROCESSOR COOLING

- Broad range of high thermal conductivity materials
- Expertise in thermal design for load and CTE management
- Transformation processes from meter to nanometer scale
- Semiconductor process and test knowledge

THERMAL MANAGEMENT (SEMI, AUTOMOTIVE, INDUSTRIAL, OPTICS,...)

Key Attributes

- Localized loading of custom material
- Tailorable CTE matching
- High thermal conductivity (also tailorable)
- Complex structures
- Internal cooling channels
- Solderless bonding (AlN to Si/SiC+Al)



Electrostatic chuck baseplates



Internal Cooling Channels



Additive manufacturing printed heat sinks/cooler



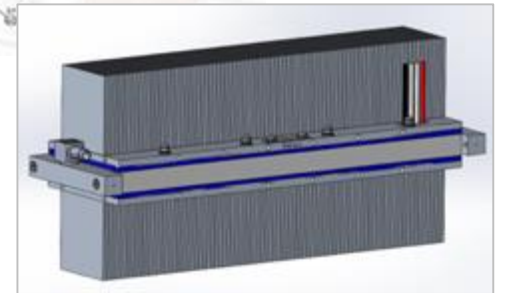
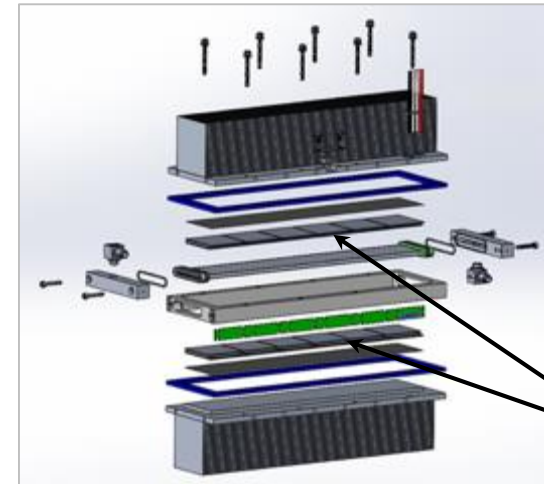
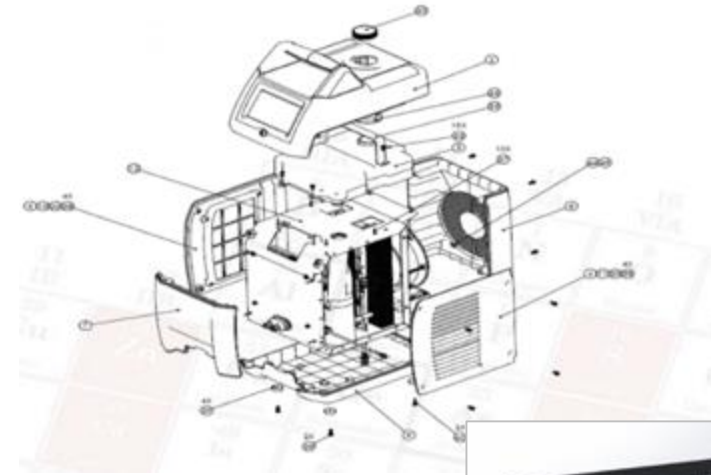
IGBT & Power Electronics Baseplates



Optoelectronics Packages

THERMOELECTRIC APPLICATIONS IN SEMI-CAP EQUIPMENT

- **Remote Chillers**
- **Integrated Cooling Systems**
 - Compact air-to-water or water-to-water cooling systems
 - Integrated directly into hardware
 - Rapid thermal response/precise temperature control
- **Actively Cooled/Temperature Controlled Chucks**
 - Thermoelectrics mounted directly to chuck
 - Rapid Thermal Cycling – Heating and Cooling
 - Precise Temperature Control
 - Variable heat flux/zonal temperature control providing precise temperature and uniformity



High Performance Liquid to Air Thermoelectric Exchanger

Arrays of Custom TECs

PHOTONICS WEST 2024

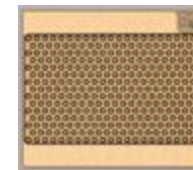
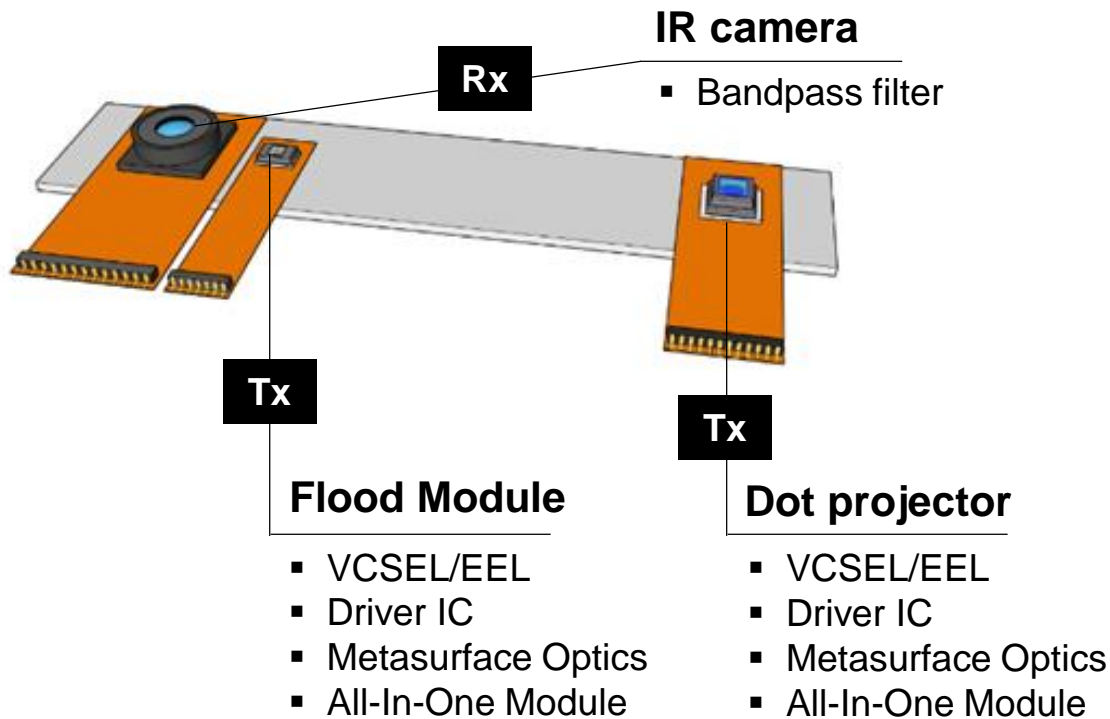
CONSUMER ELECTRONICS VERTICAL

ADVANCED OPTICAL-SENSING IN CONSUMER ELECTRONICS

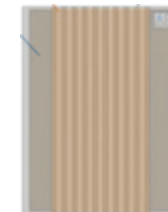


COMPONENTS AND MODULES FOR ADVANCED SENSING

3D Camera/ Sensor



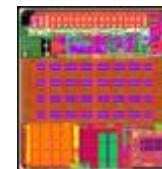
VCSEL arrays
(NIR, SWIR)



Edge Emitters
(NIR, SWIR, MIR)



Photo Detectors
(NIR, SWIR)



Laser Driver ICs



Diffractive Optics



SMT Illumination
Modules

HIGHLIGHT - NEW DOT PROJECTOR MODULE



Built around our world-class VCSEL technology for reliable performance, these SMT dot projector modules emit a matrix of infrared dots, for high-resolution 3D sensing.

Applications:

- Precise 3D spatial mapping in:
 - Secure face authentication
 - Robot navigation
 - Body tracking

Key Features:

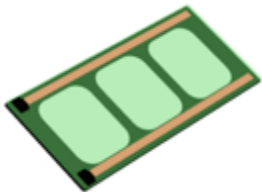
- [Surface Mount Technology \(SMT\)](#)
- Seamless integration in high-volume manufacturing
- Small Size: 4.15 x 4.1 x 4.0 mm
- Different FOI available
- Spot Size: 0.1-0.5 degrees
- Number of Spots: 0.6k - 3k (up to 50k on request)
- High Contrast Ratio: >50
- [Customization available](#)

COMPONENTS FOR AR-DISPLAYS

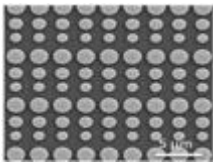
AR Display

Display Projector (Engine)

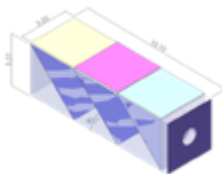
- Micro-Lens Arrays for Collimation
- RGB Beam Combiner
- Optical Windows and Mirrors



Windows, Mirros, Filters



Meta-Surface Lenses



RGB beam combiner

Optical Combiner

- High-Index Crystal Substrates
- Glass Wafer Manufacturing
- Waveguide Manufacturing
 - Optical Coatings
 - Diffractive Couplers



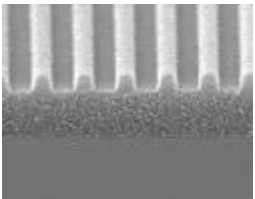
High-Index substrates



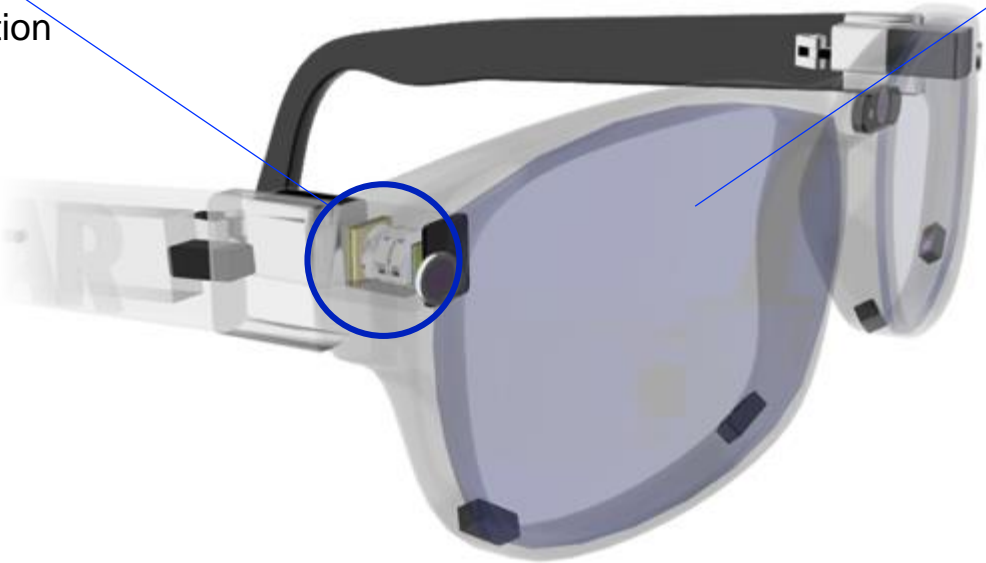
Glass wafers



Optical Coatings



Diffractive Couplers



CONSUMER ELECTRONICS MESSAGING

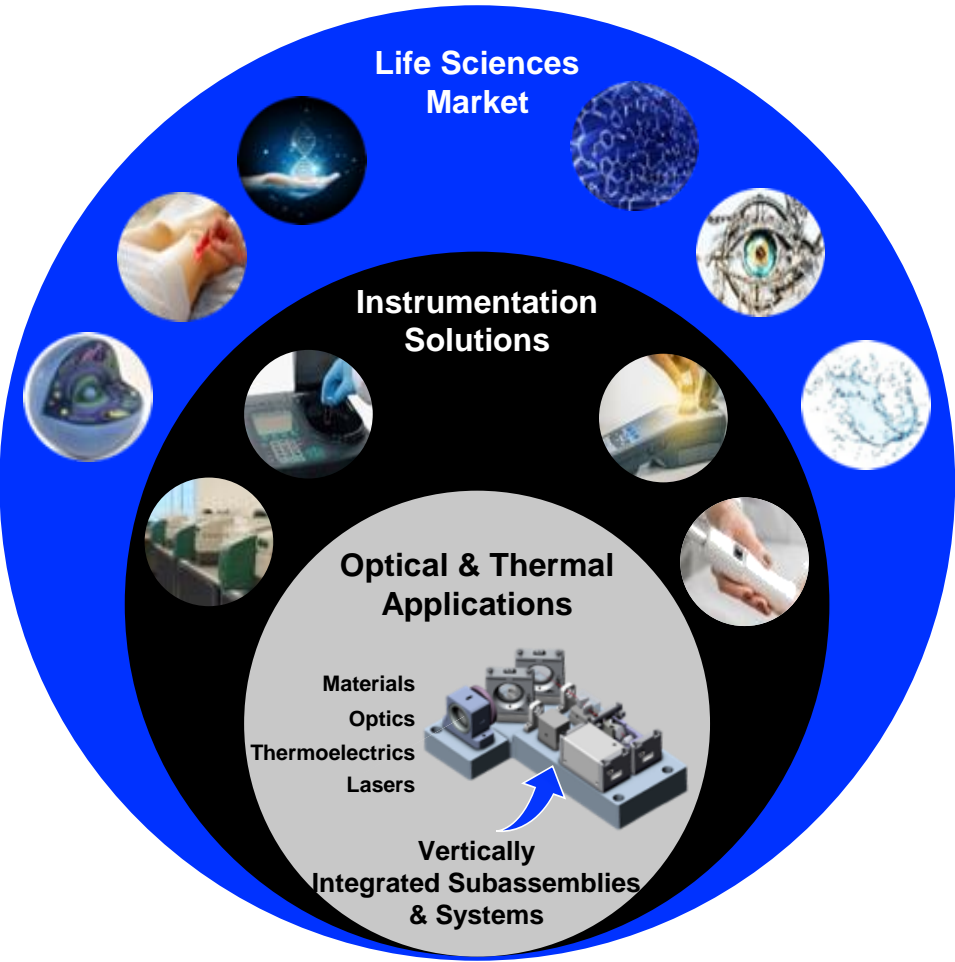
- Augmented and virtual reality headsets are bound to become the next major personal computing platform.
- As a vertically integrated supplier of optics and opto-electronics, we offer a wide range of innovative technologies and solutions, from the material to the module level.
- With our comprehensive portfolio of lasers, optics and modules for sensing applications, we design custom solutions with ultra-compact form factors and low power consumption.
- We offer unique solutions for advanced near-eye displays enabling highly immersive AR experiences.

PHOTONICS WEST 2024

LIFE SCIENCES VERTICAL

LIFE SCIENCES MARKET FOCUS AND SEGMENTATION

Global Healthcare Market



Coherent Life Sciences - Instrumentation Segmentation

Biotechnology



Using living organisms (or their parts) for research or industrial purposes

Medical



Used in the direct treatment of patients

Analytical



For analytical science and environmental applications

COHERENT LIFE SCIENCES SERVED MARKET APPLICATIONS



BIOTECHNOLOGY

- Flow Cytometry
- Sequencing
- PCR
- Diagnostics/POC
- Microarrays
- Nucleic Acid Prep
- Cell Separation
- Electrophoresis
- In Vivo Animal Imaging
- Cell Counters
- High Content Screening
- Immunoassays
- Analyzers



MEDICAL

- Medical Laser**
 - Cosmetic & Dermatology
 - Ophthalmic
 - Surgical
 - Dental
- Medical Imaging**
 - Endoscopy
 - OCT
- Point of Care**
 - Diabetes Testing
 - Wearables
- Thermal**
 - Hospital Bedding
 - Hypertension Therapy
 - Migraine Relief
 - Joint, Limb, Muscle Therapy



ANALYTICAL

- Environmental Testing**
 - Air & Water
 - Food/Beverage
 - Pharmaceuticals
 - Agriculture
- Molecular Spectroscopy**
 - NMR
 - UV-Vis
 - IR
 - NIR
 - Color Measurement
 - Raman
- Imaging**
- AI**

COHERENT - LIFE SCIENCES EXAMPLE

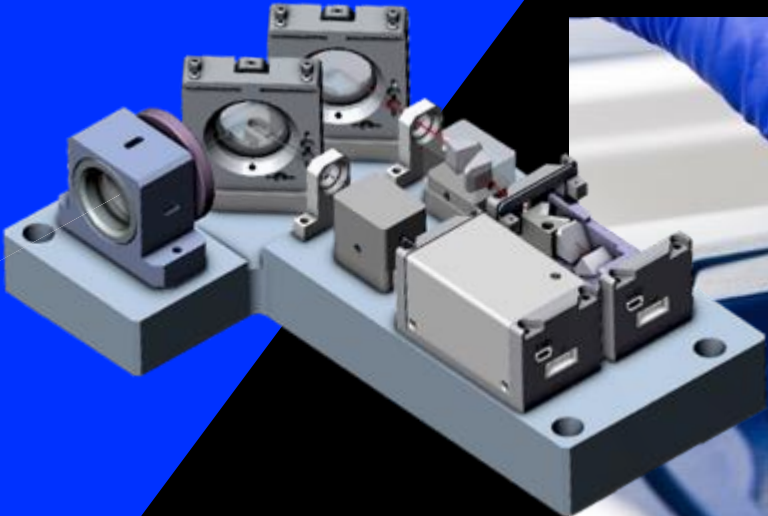


Materials

Optics

Lasers

Thermoelectrics



**Vertically Integrated
Subassemblies
& Subsystems**

Solutions for Life Sciences



Biotechnology



Medical



Analytical

Greater scale reduces cost, enhancing competitiveness
Complementary technology platforms open exciting new opportunities

EXPANSIVE COMBINED HERITAGE...SUPPORTING THE LIFE SCIENCES



130 Sites Total / ~17 Sites Supporting Life Sciences

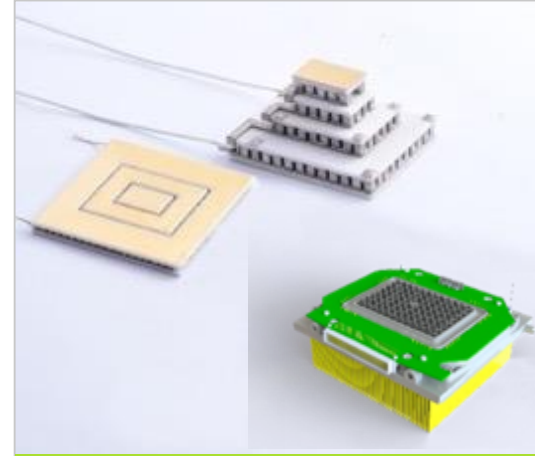
LIFE SCIENCES INSTRUMENTATION



Materials & Optics



Lasers



Thermal Control



Dallas, TX, U.S.
Fuzhou, China
Ho Chi Minh City, Vietnam

**ISO13485
Subassemblies**

Provides integrated solutions for Life Sciences Instrumentation Platforms –
DNA Sequencing, Flow Cytometry, Diagnostics, Medical Lasers, and Spectroscopy

Greater scale reduces cost, enhancing competitiveness
Complementary technology platforms open exciting new opportunities

EXPANDED LASER PORTFOLIO & EXPERTISE

Cytometry & Genomics



Medical

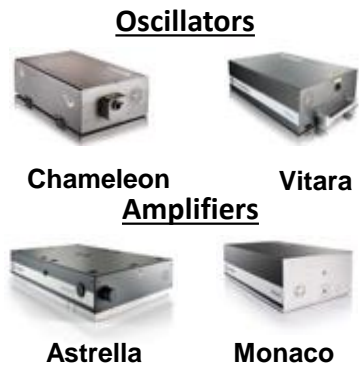


Imaging

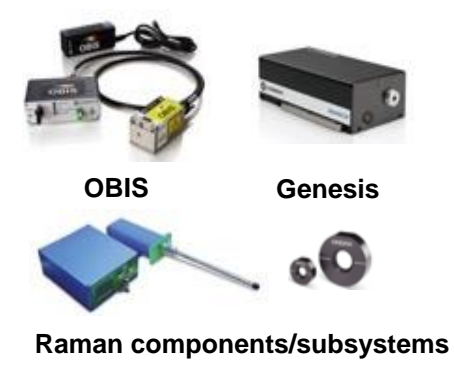


Ultrafast Research

(Physics, chemistry & materials)



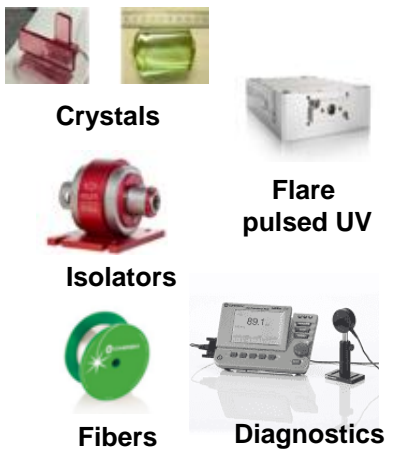
Life Science Research



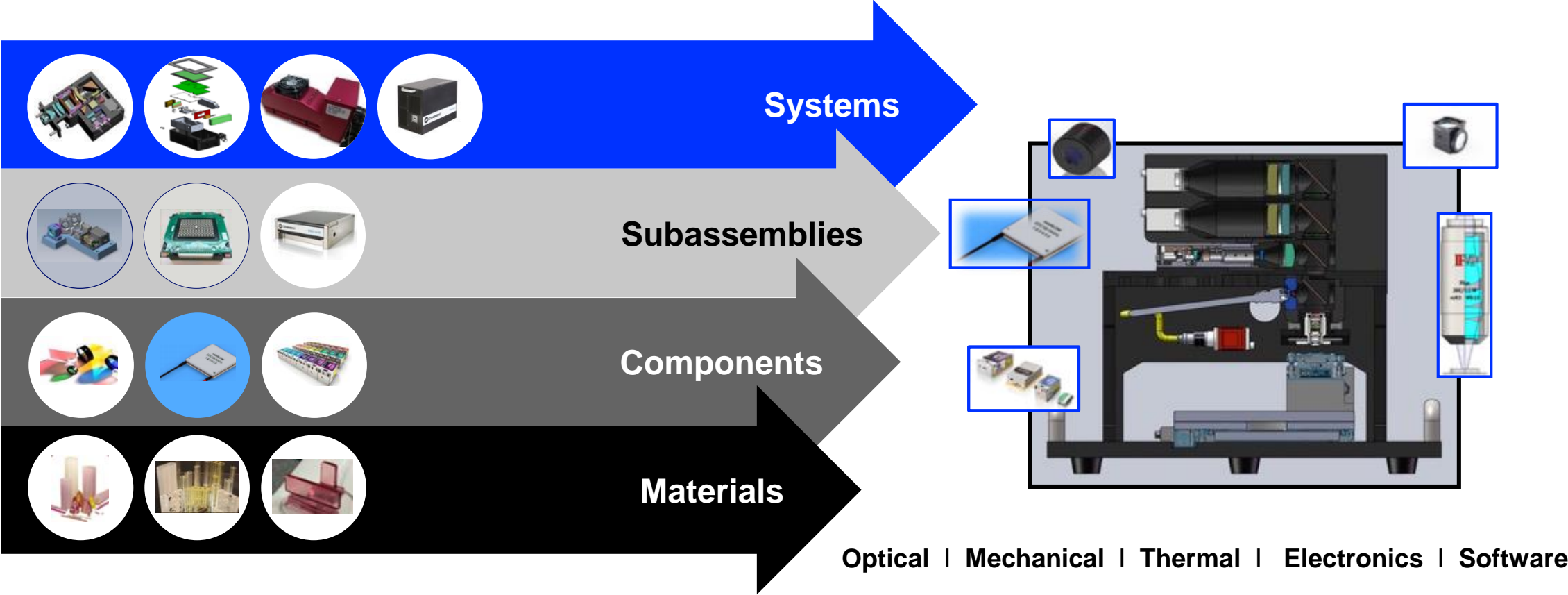
Interferometry, Testing, Sensing



Other

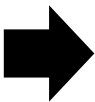
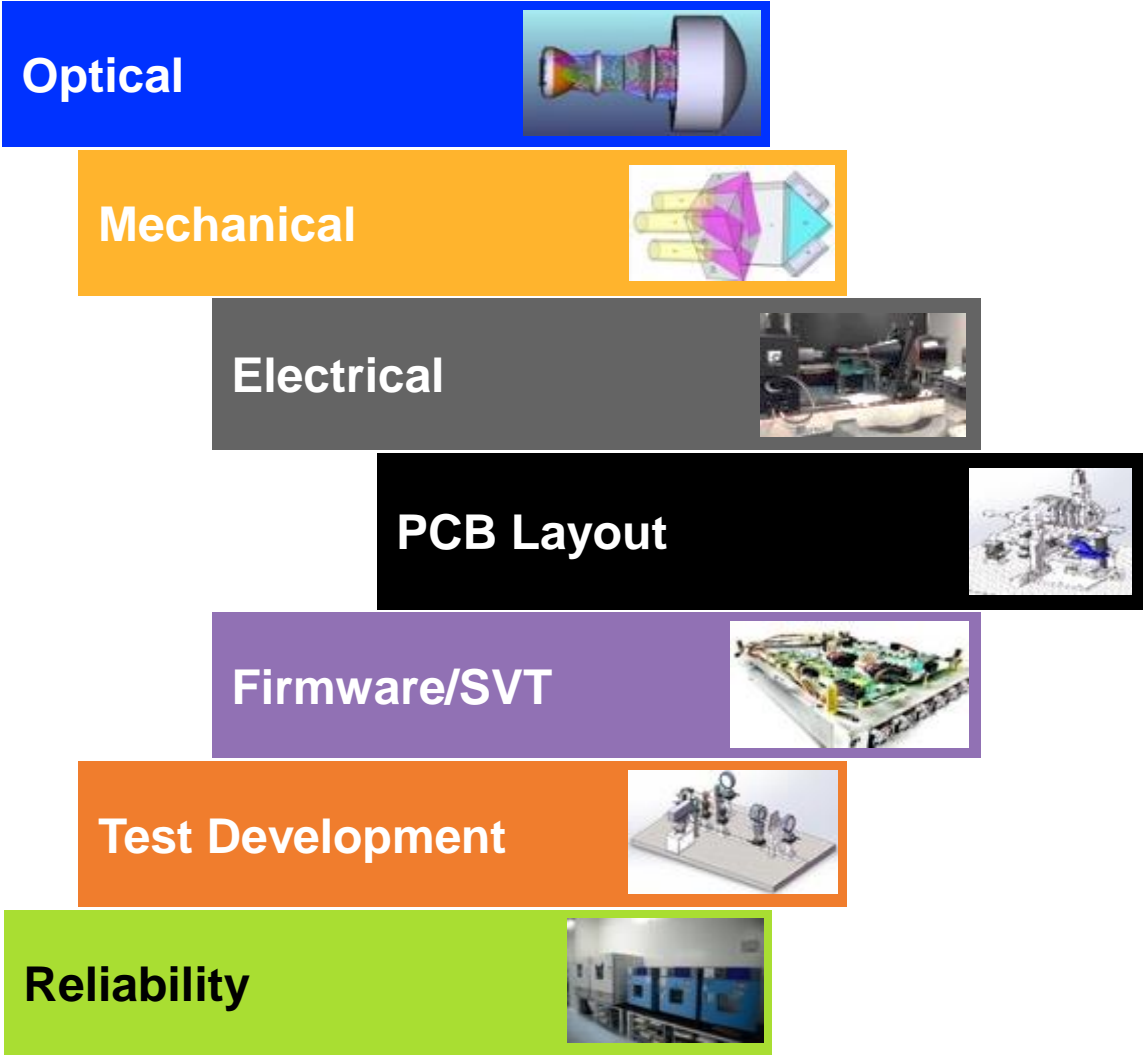


LIFE SCIENCES – VERTICAL INTEGRATION EXPERTISE



Supporting high-volume manufacturing and cost reduction efforts

SUBASSEMBLY/SYSTEM DESIGN ARCHITECTURE & EXAMPLES



Optomechanical
Lens Assemblies



LED Illumination
Modules



Laser Engines
(multi-wavelength)



Thermoelectric
Subassemblies

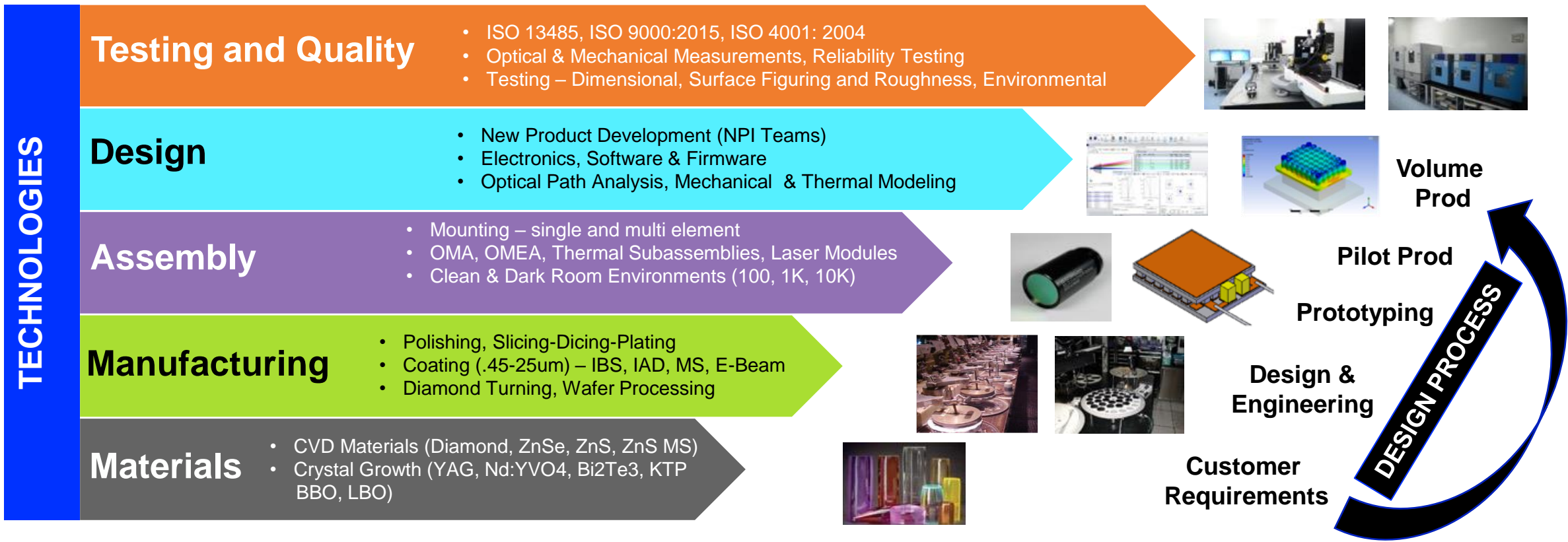


Custom Opto
Mechanical
Electrical
Systems



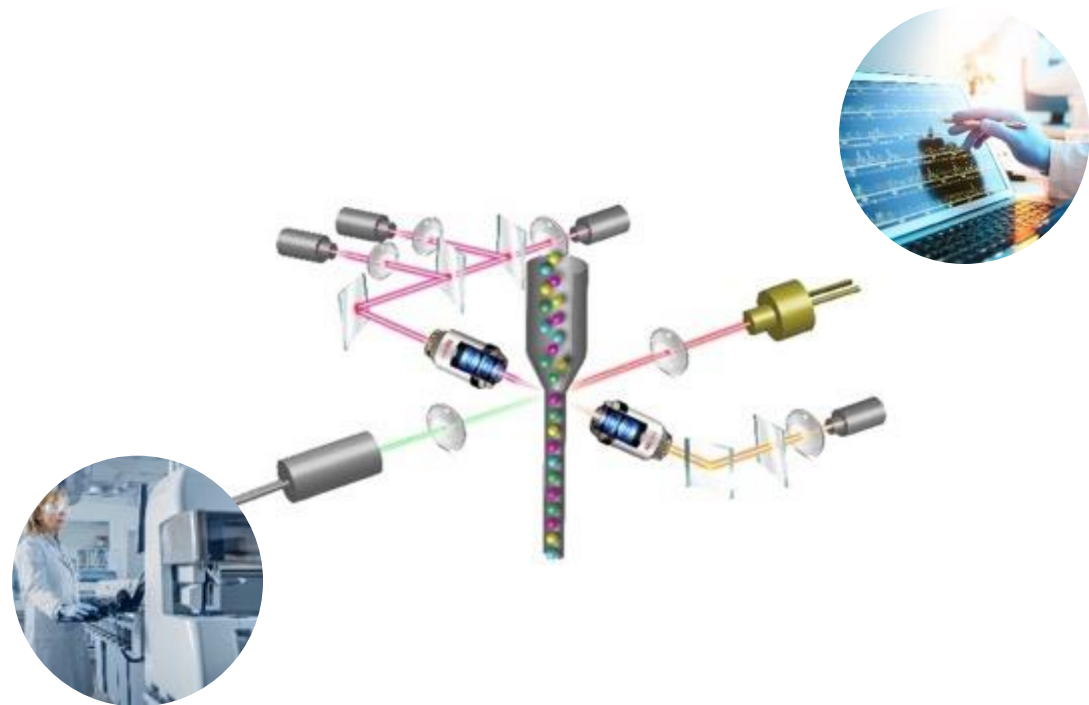
COHERENT IS A SYSTEM-LEVEL PARTNER, DELIVERING “SOLUTIONS FOR LIFE SCIENCES”

...from materials to components to subassemblies and system
...leveraging global manufacturing and vertical integration to meet performance, quality, and cost reduction requirements



COHERENT UNDERSTANDS APPLICATION DIFFERENCES

BIOTECHNOLOGY – Flow Cytometry



MEDICAL – Aesthetic Laser



Differences in samples, architecture, integrated optics, and critical system parameters

APPLICATION SOLUTIONS – BIOTECHNOLOGY



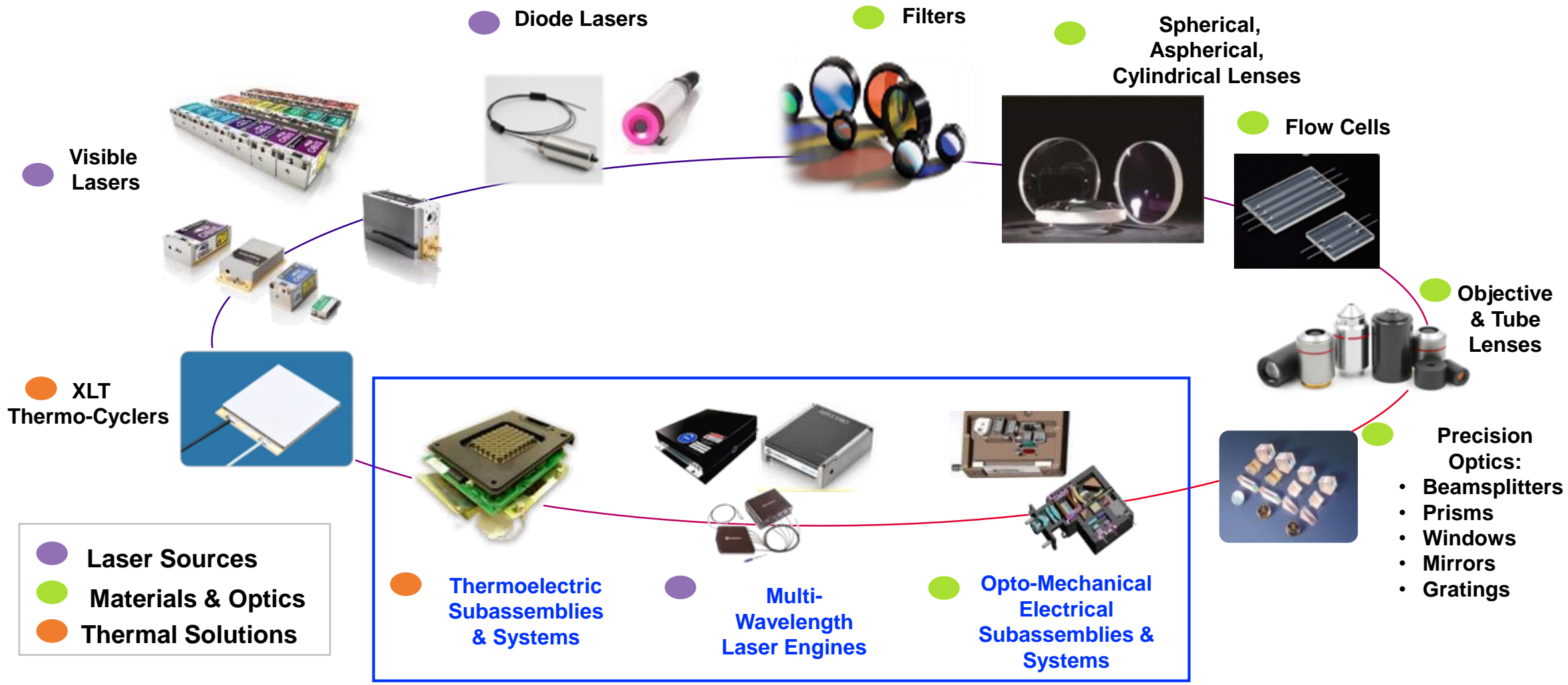
BIOTECHNOLOGY

- Flow Cytometry
- Sequencing
- PCR
- Microarrays
- Nucleic Acid Prep
- Cell Separation
- Electrophoresis
- In Vivo Animal Imaging
- Cell Counters
- High Content Screening
- Diagnostics/POC
- Immunoassays
- Analyzers

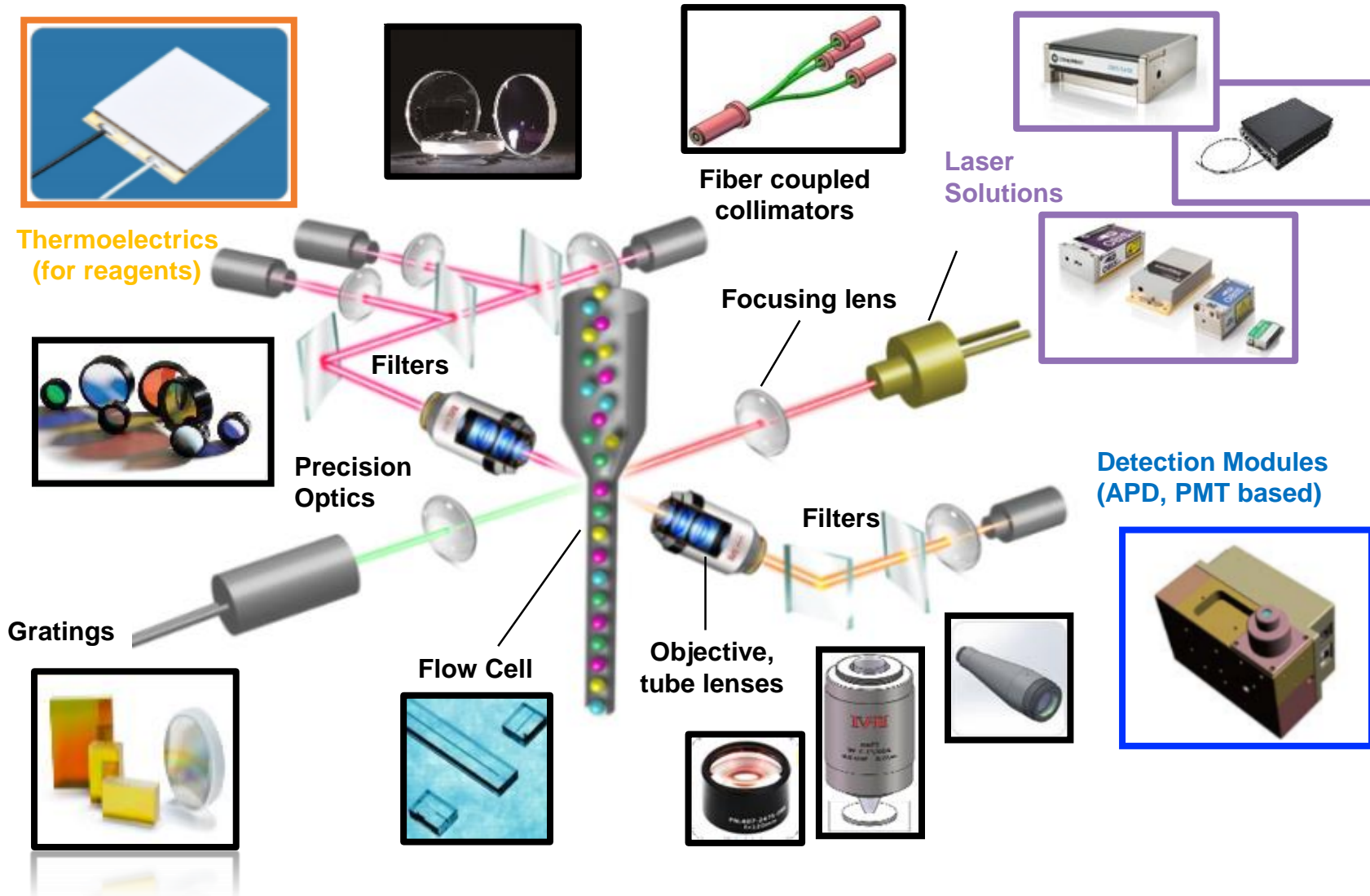


Accuracy, Speed/Throughput, Modularity, Multiplexing, Per Test Cost

SOLUTIONS FOR BIOTECHNOLOGY APPLICATIONS



EXAMPLE: FLOW CYTOMETRY



Illumination:

- OBIS Lasers (Visible, IR, UV)
- Laser-based light engines

Light Management:

- Fluorescence Filters (excitation, dichroic, emission), assemblies
- Lens assemblies
- Fiber coupled collimators
- Precision Optics (windows, mirrors, lenses)
- Gratings

Thermal Management:

- TEC (for reagents)

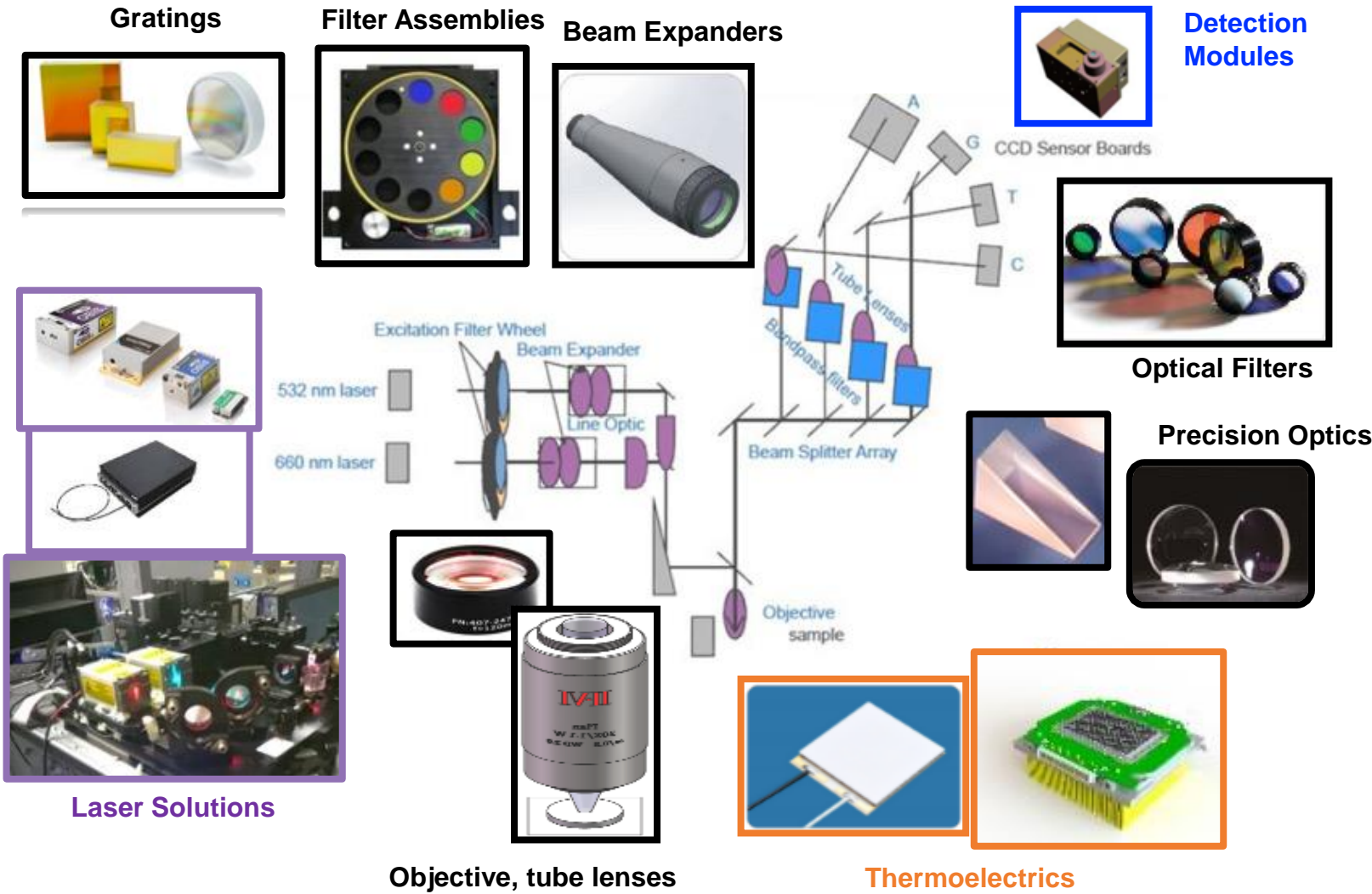
Specimen Loading:

- Flow Cells

Detection:

- Integrated Modules

EXAMPLE: SEQUENCING



Illumination:

- Visible Lasers
- Multiwavelength Laser Engines

Light Management:

- Fluorescence Filters (excitation, dichroic, emission), assemblies
- Beam expanders
- Tube & Objective Lenses
- Precision Optics (mirrors, prisms)

Thermal Management:

- TEC's/Assemblies

Specimen Loading:

- Flow cells

Detection:

- Integrated Modules

APPLICATION SOLUTIONS – MEDICAL



MEDICAL

Medical Laser

- Cosmetic & Dermatology
- Ophthalmic
- Surgical
- Dental

Medical Imaging

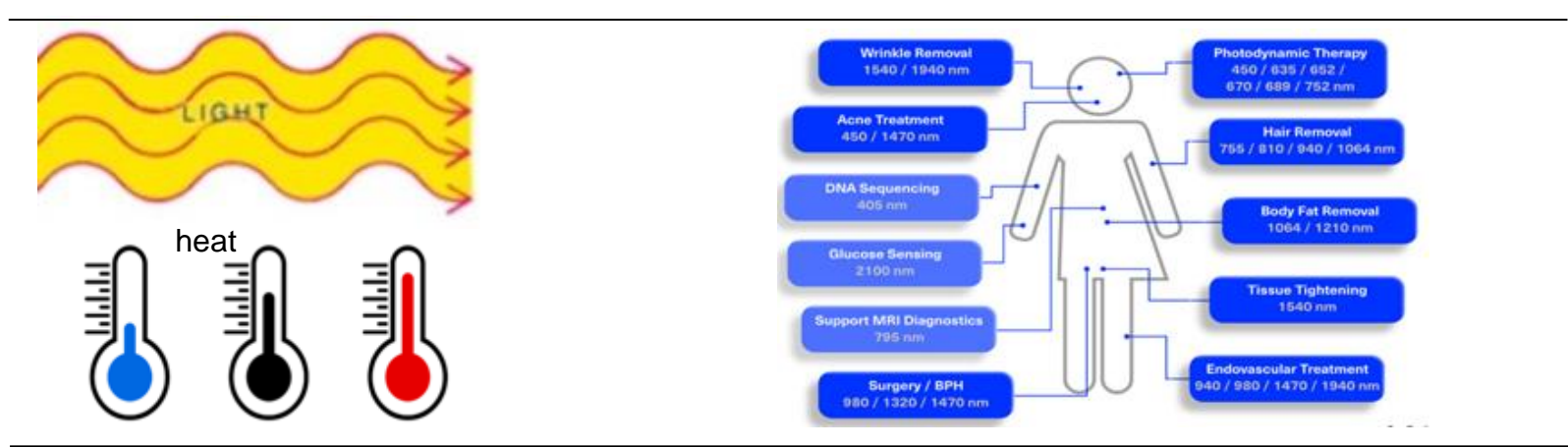
- Endoscopy
- OCT

Point of Care

- Diabetes Testing
- Wearables

Thermal

- Hospital Bedding
- Hypertension Therapy
- Migraine Relief
- Joint, Limb, Muscle Therapy



INTENSITY

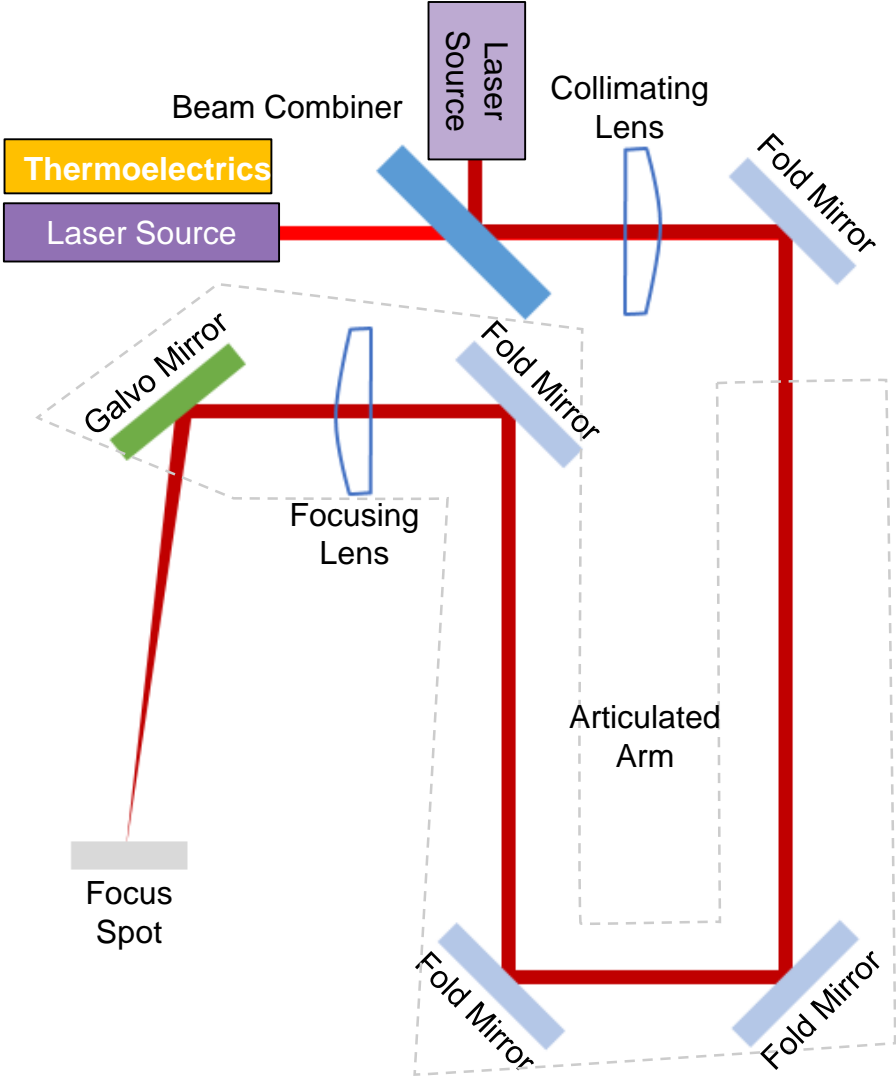
WAVELENGTH
(Safety, Regulations)

PULSE SHAPE

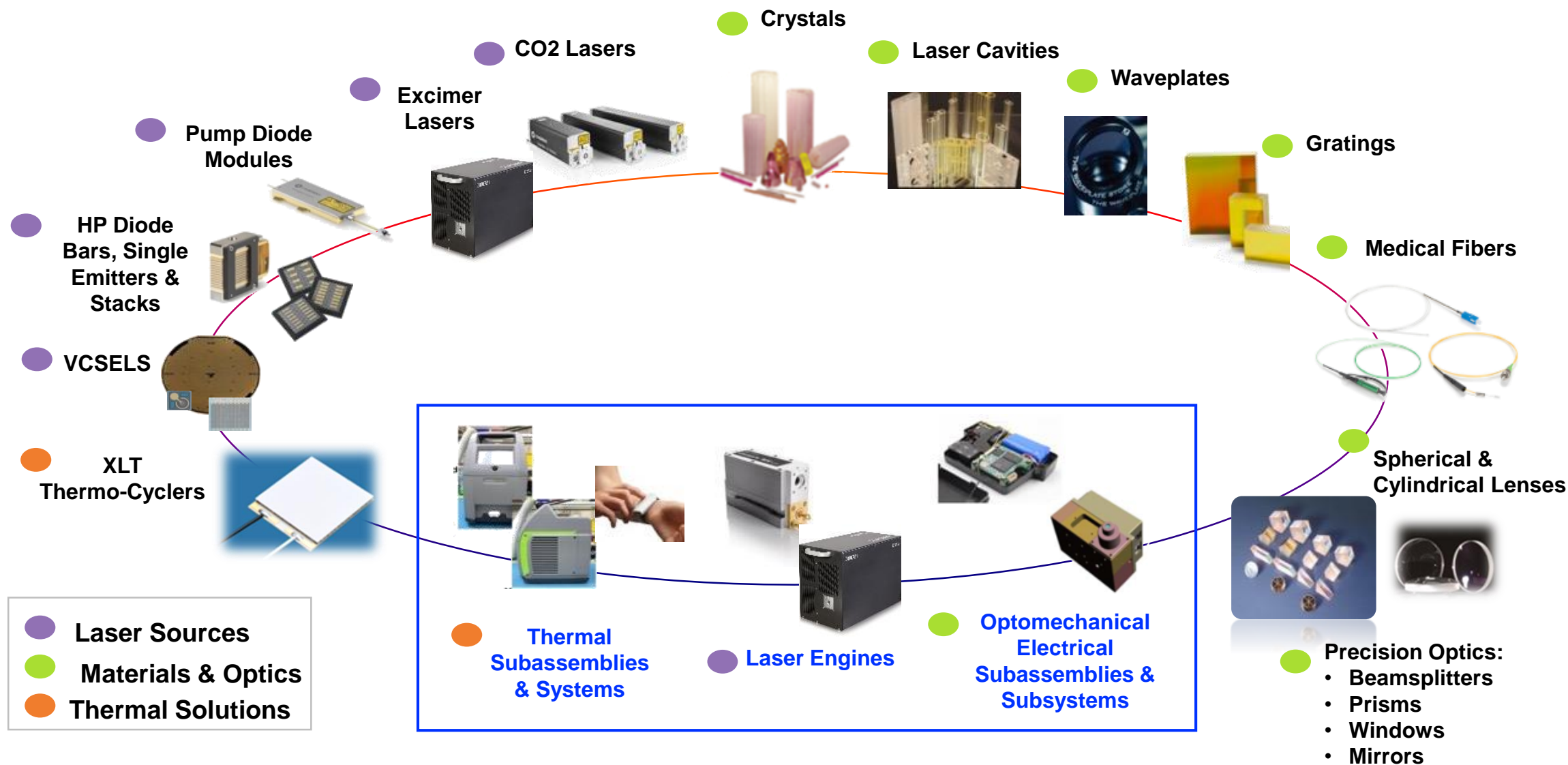
MEDICAL EXAMPLE - LASER TREATMENTS



Example Optical Components		Common Materials	
Galvo Mirrors		Low Roughness Aluminum, Copper, Silicon	
Fold Mirrors (Concave & Plano)			
Beam Combiner		Fused Silica Zinc Sulfide Multi-Spectral, Sapphire, Zinc Selenide	
Spherical and Aspheric Lenses			
Protective Windows (DOC Coated)			
Subassemblies & Subsystems			

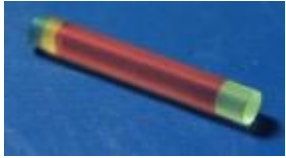


SOLUTIONS FOR *MEDICAL* APPLICATIONS



MEDICAL EXAMPLE – IMAGING

Endoscopy



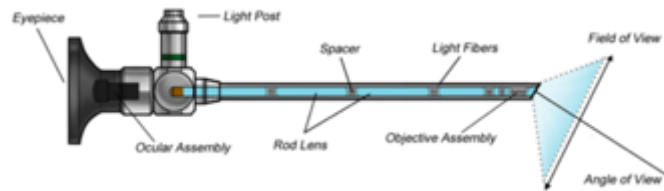
Rod-lenses Assemblies



Micro Lenses



Micro Prisms



Medical Fibers



Light Engines

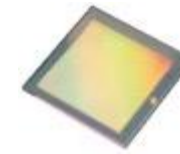


Optical Filters

OCT (Optical Coherence Tomography)



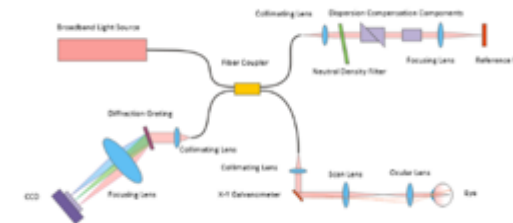
Prisms



Diffraction Gratings



ND Filters



Medical Fibers



Mirrors & Lenses



Fiber Couplers

MEDICAL EXAMPLE - WEARABLES

What we offer ...

Epitaxy
Wafers

VCSELs &
EELs

Driver ICs

Wafer-Scale
Optics

Modules &
Assemblies

Material-Level

Component-Level

Module-Level

Engineered Materials



Epitaxy wafers



Glass wafers



High-Index
Materials



CVD diamond



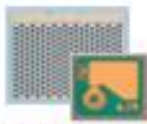
Crystals



Rare Earth
Minerals



Components



GaAs VCSELs



GaAs EELs



InP EELs



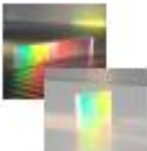
InP
photo diodes



Glass Optics:
Lenses, Prisms,
Windows



CMOS, BiCMOS
Integrated Circuits



Wafer-scale optics:
Gratings, Flat Lenses,
DOEs, Diffusers



InP coherent
detectors



Battery Electrodes

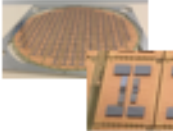


Thermoelectrics

Assemblies / Modules



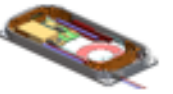
VCSEL
packages



Wafer Scale
Assemblies



Optical
assemblies



Opto-electronic
assemblies

APPLICATION SOLUTIONS – ANALYTICAL



ANALYTICAL

Environmental Testing

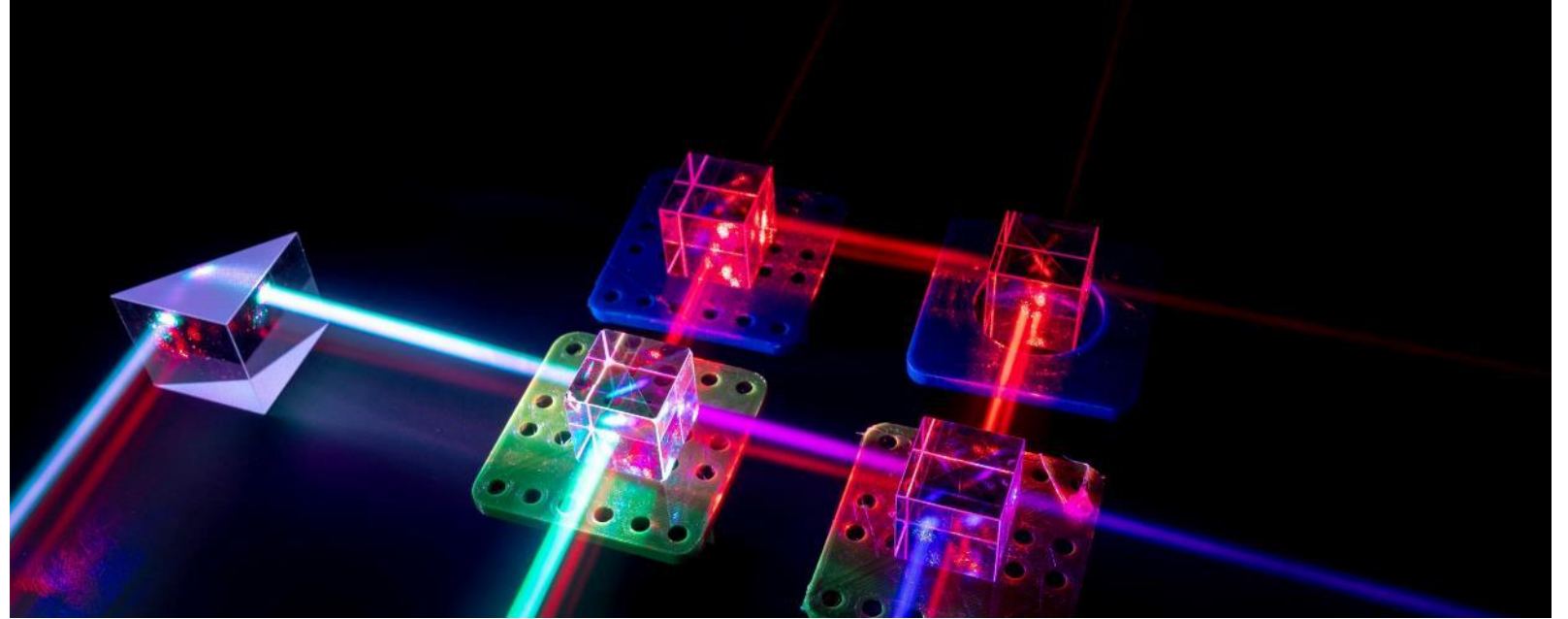
- Air & Water
- Food/Beverage
- Pharmaceuticals
- Agriculture

Molecular Spectroscopy

- NMR
- UV-Vis
- IR
- NIR
- Color Measurement
- Raman

Imaging

AI



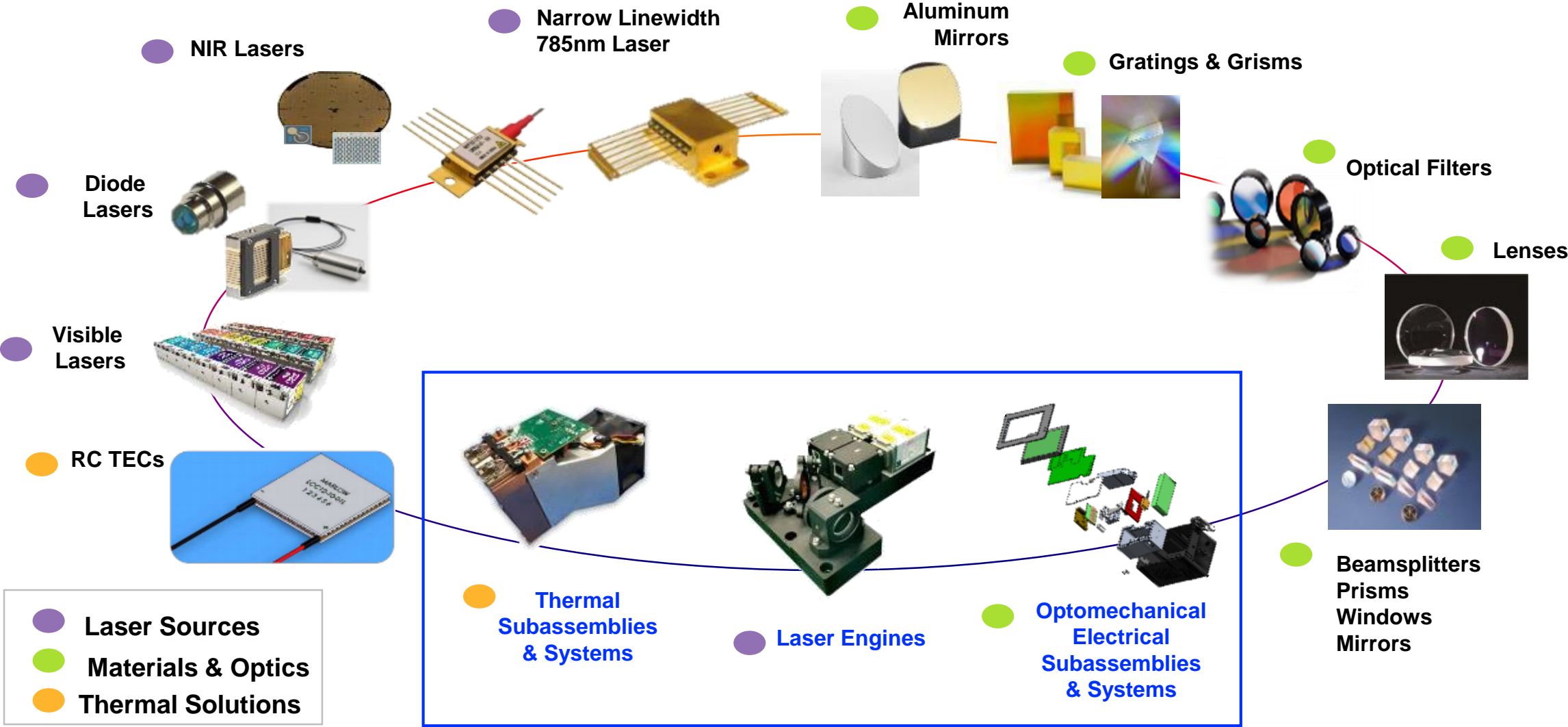
Drivers

- Safety Concerns
- Pollution/Environmental Concerns
- Pharma Quality Control
- Regulations

Instrumentation

- Miniaturization
- Field use
- Increased ruggedness
- Sample variety

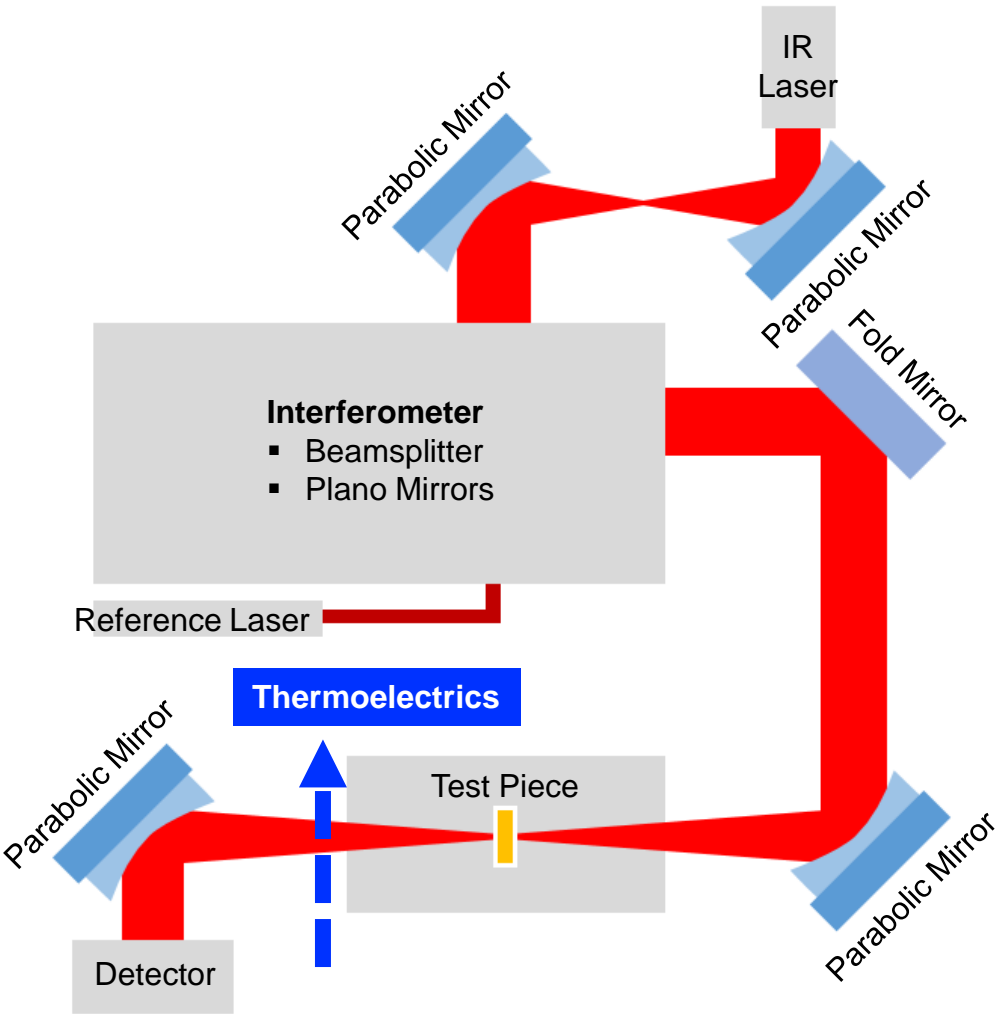
SOLUTIONS FOR ANALYTICAL SEGMENT



ANALYTICAL EXAMPLE - SPECTROMETER

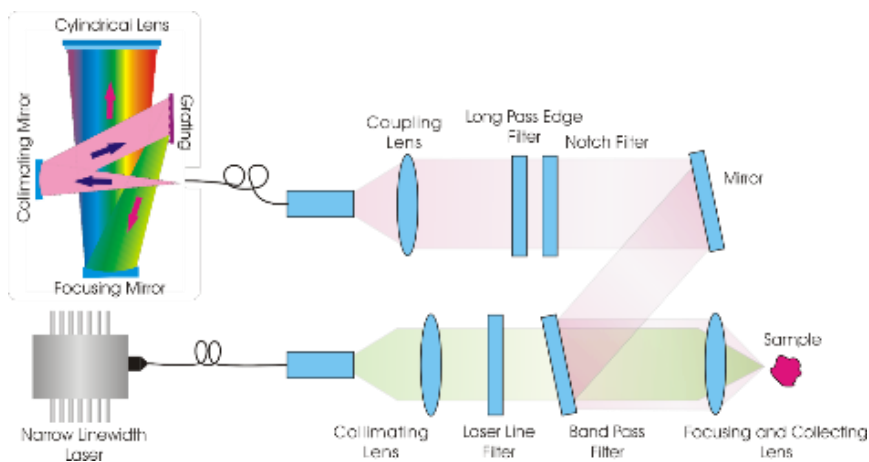


Example Components	Common Materials
Parabolic & Elliptical Mirrors	Low Roughness Aluminum, Copper, Silicon
Fold Mirrors (Plano)	
Beamsplitter	Fused Silica Zinc Sulfide Multi-Spectral, Sapphire, Zinc Selenide
Spherical and Aspheric Lenses	
Mounted Windows (Consumable)	
Subassemblies & Subsystems	

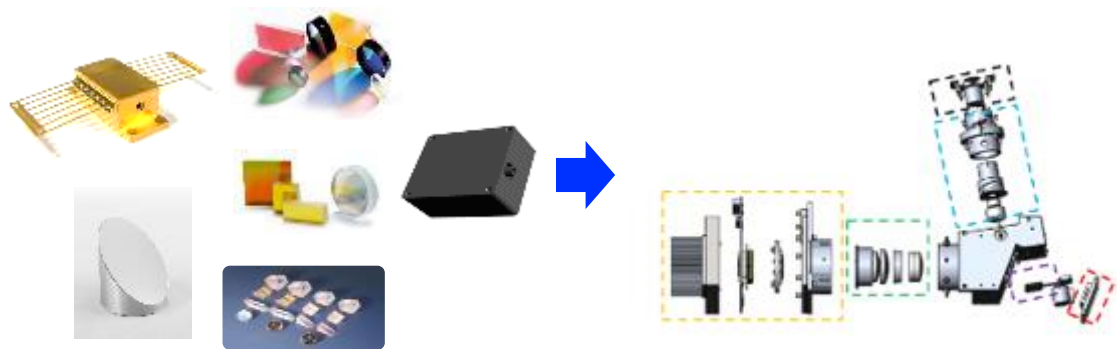


ANALYTICAL EXAMPLE - RAMAN SPECTROSCOPY

THz-Raman® Spectroscopy Product Line!

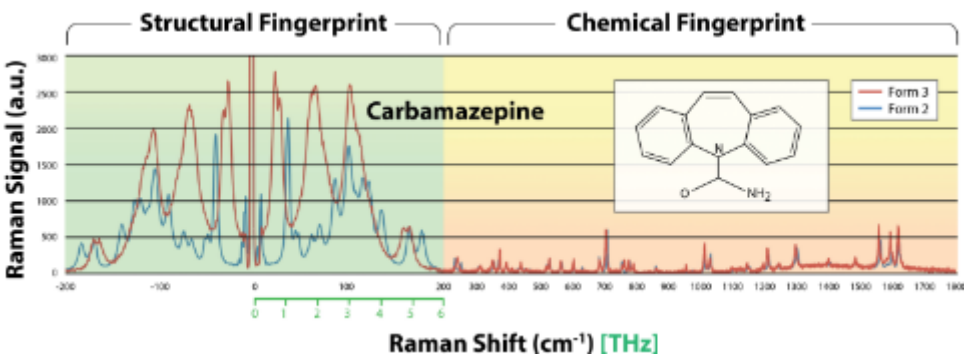


Custom OEM Solutions (Laser + Optics + Detection)



Versatile TR-Probe with accessories for inline, bench and microscope applications

WALDO - High Throughput Screening



COHERENT IS DRIVING NEXT GENERATION TECHNOLOGIES...



WHY COHERENT?



BIOTECHNOLOGY



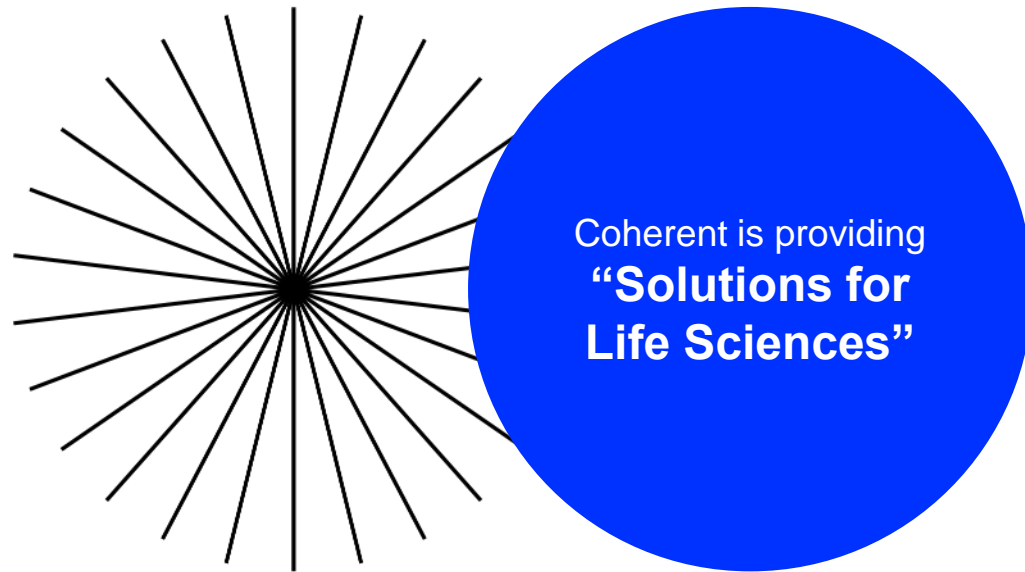
MEDICAL



ANALYTICAL

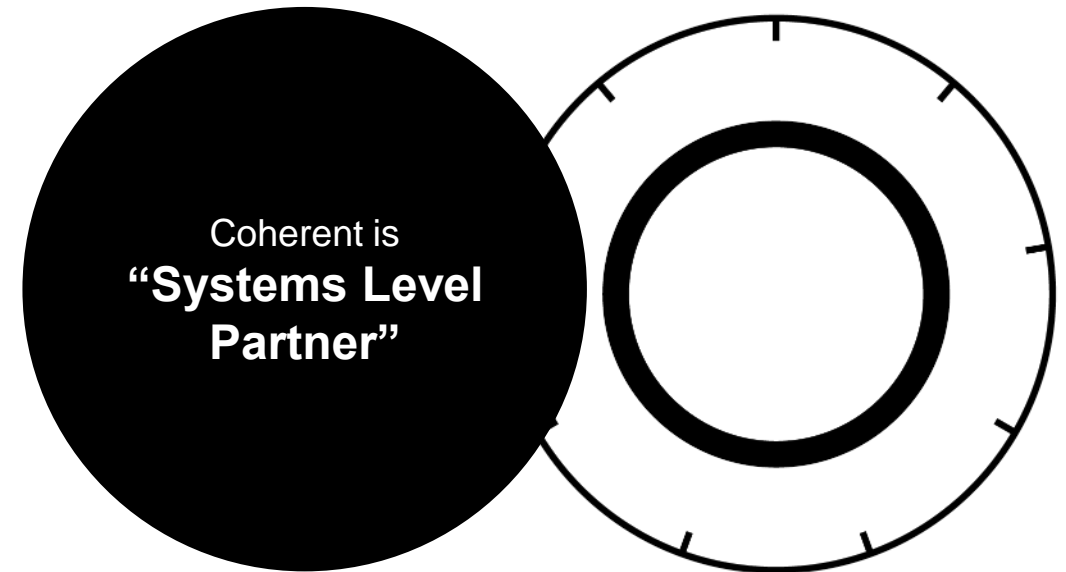
- Diversified product and application **portfolio**
- Extensive technology **innovation** capabilities
- Strong R&D/NPI and production **engineering**
- Unparalleled **vertical integration** capabilities from materials to systems
- **Capacity to scale** for volume manufacturing
- Design for manufacturability, targeting **cost reduction** efforts
- Integrated solutions to decrease **time to market**
- **Global manufacturing** footprint and supply chain
- **Quality commitment with dedicated metrology**
- Brand **reputation**, and earned **customer trust**

COHERENT DIFFERENTIATION



...from materials to components to subassemblies & systems

...leveraging global manufacturing and vertical integration to meet performance, quality and cost reduction requirements



...from proof of concept to design and volume manufacturing

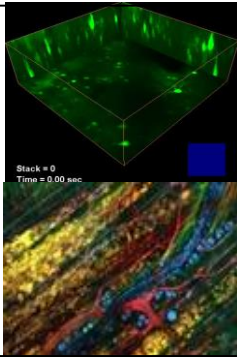
PHOTONICS WEST 2024

SCIENTIFIC INSTRUMENTATION VERTICAL

SCIENTIFIC RESEARCH - KEY MARKETS & SUPPORTING PRODUCTS

Multiphoton/confocal excitation microscopy

- Neuroscience
- Cell biology
- Disease studies



Ultrafast lasers (tunable and fixed wavelength)



Discovery



Axon



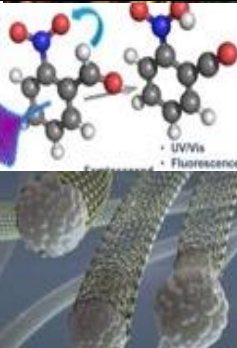
Monaco 1300



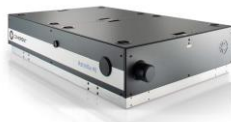
OBIS

Physical chemistry

- Femtochemistry
- Advanced materials spectroscopy



Ultrafast amplifiers (TiS & fiber)



Astrella HE



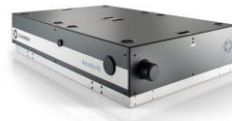
Monaco 1035-150

Applied physics & materials science

- Material modification studies
- Atomic & molecular physics



Ultrafast amplifiers & excimer lasers



Astrella HE

Femtosecond → time resolution, peak power

WHO WE ARE IN SCIENTIFIC RESEARCH

The widest scientific laser portfolio



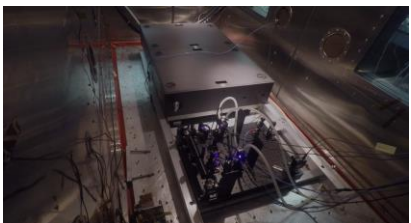
All the critical components



We push the limits to improve our products



We bring industrial reliability to the lab



HALT/HASS Chamber Testing
50% decrease in warranty activity
40% reduction in installation time

We support customers in unique ways



We enable research- to-industry transition



We support young scientists



In 2021 the II-VI Foundation pledged \$ 1M to students around the world

The Bernard J. Couillaud prize for contributions to UF optics and applications

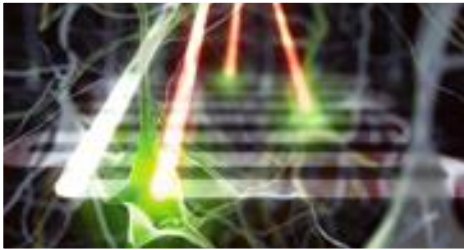


SCIENTIFIC RESEARCH



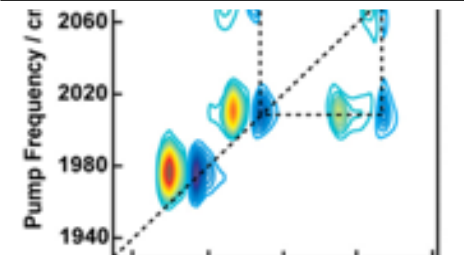
The Industrial Revolution In Ultrafast Science

- Approach to reliability matured through 24/7 industrial laser requirements
- All ultrafast products designed with HALT testing protocol to maximize lifetime
- Each ultrafast laser is HASS-tested for daily reliable, repeatable operations



The Right Laser For Every Imaging Need

- **Neuroscience** Unique integrated solutions for 2-photon, optogenetics and advanced applications
- **Cell biology** All the power and wavelengths you need – from confocal to super-resolution
- **Ready for the future** with compact platforms for translational imaging



Time-resolved Studies Made Easy, From EUV To Terahertz

- Plenty of energy to power up any experiment from attosecond pulses to THz pump and probe
- The broadest portfolio for time-resolved spectroscopy - Titanium sapphire and Ytterbium platforms
- Sophisticated accessories, inclusive of CEP stabilization



A Level Of Vertical Integration Unique In The Industry

- internal supply chain of diodes, crystals, optics, coatings, fibers for optimum quality and supply chain integrity
- Coherent and II-VI integration further expands material and component capabilities

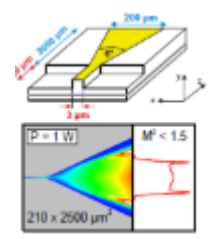
PUSHING THE ENVELOPE IN ALL DIRECTIONS



Active Fiber



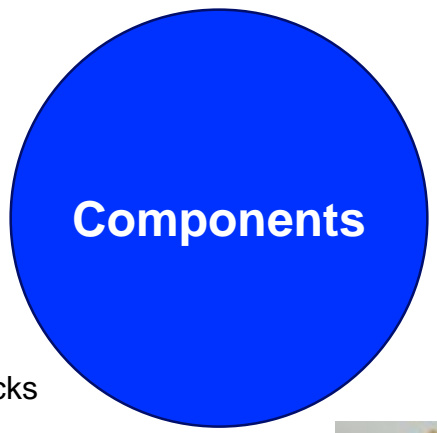
VBG Filter and Stretchers



Tapered SOAs



Diode Bars and Stacks



Fiber Isolators



Fiber Coupled Pumps



Active and Mounted Crystals

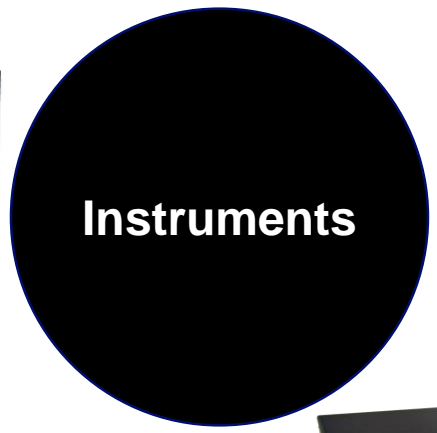
Extensively used also by DIY and laser mfgs.



200A Portable Optical Spectrum Analyzer



1500 S High Resolution Spectrum Analyzer



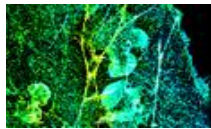
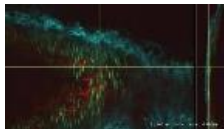
400A Optical Spectrum Analyzer

Target: telecom research labs, Universities

SCIENTIFIC RESEARCH - MICROSCOPY

Confocal and Superresolution Imaging

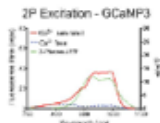
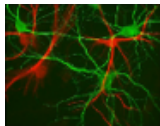
Beating the ultimate limit of light in cell biology



- Coherent lasers power all types of fluorescence microscope
- More wavelengths than any other suppliers
- Power scalability from mW to 10W
- Multiple technology platforms

Neuroscience Research

Understanding the Brain, Neuron by Neuron



- Over 3,000 femtosecond lasers powering thousands of multiphoton microscopes
- Multiple laser platforms enable imaging, neuron stimulation and calcium or voltage imaging

Optogenetics

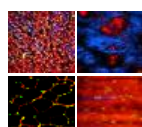
Research today, Brain Function Restoration Tomorrow



- Coherent lasers address every optogenetic probe
- Coherent femtosecond lasers are used to target individually hundreds of neurons in mice brains

Next-Gen Clinical Applications of microscopy

Laser and AI are enabling diagnostics and precision surgery

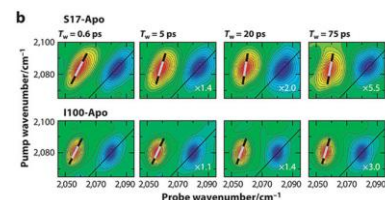
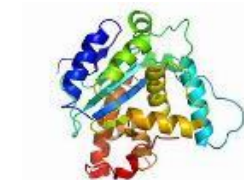


- Advanced lasers for flow cytometry
- Femtosecond lasers user-ready for integration in pathology lab or operating room

SCIENTIFIC RESEARCH - ADVANCED SPECTROSCOPY

2-Dimensional Infrared Spectroscopy

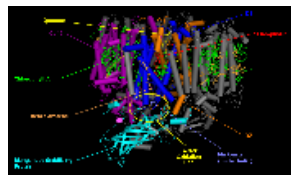
Uncovering Peptides and Protein Dynamics



- Coherent builds more ultrafast Titanium Sapphire amplifiers than any other laser manufacturer
- 3-20 mm MIR & IR wavelength coverage

2-Dimensional Electronic Spectroscopy

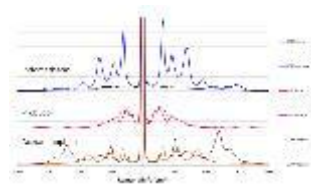
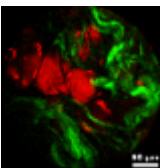
Unlocking the photosynthesis process



- Multiple ultrafast technologies (Titanium Sapphire, Ytterbium)
- Strong connection with the research community
- Trusted partner

Femtosecond and Terahertz Raman Spectroscopy

From fast protein dynamics to API crystallization



- Laser systems for Femtosecond Stimulated Raman Spectroscopy (FSRS)
- Full TH-Raman analytical systems for API screening

COHERENT