SEMICONDUCTOR LASER DIODES FOR BIO-SENSING IN MEDICAL AND CONSUMER WEARABLES

EPIC Technology Meeting on Photonics for Bio and Life Science Applications
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COHERENT

COMPANY BACKGROUND

II-VI IS NOW COHERENT

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

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

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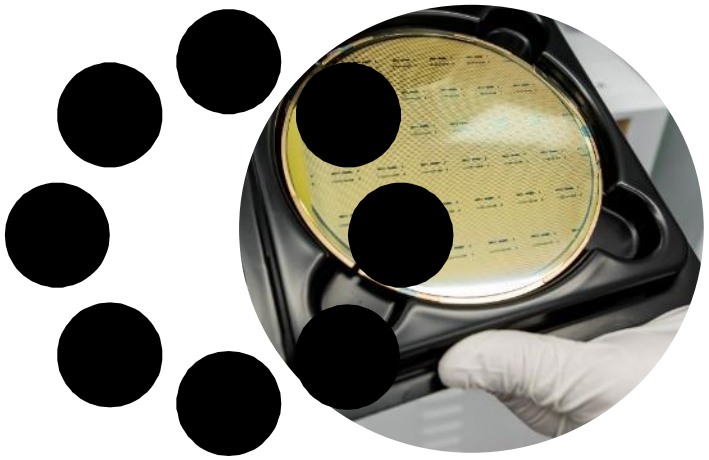
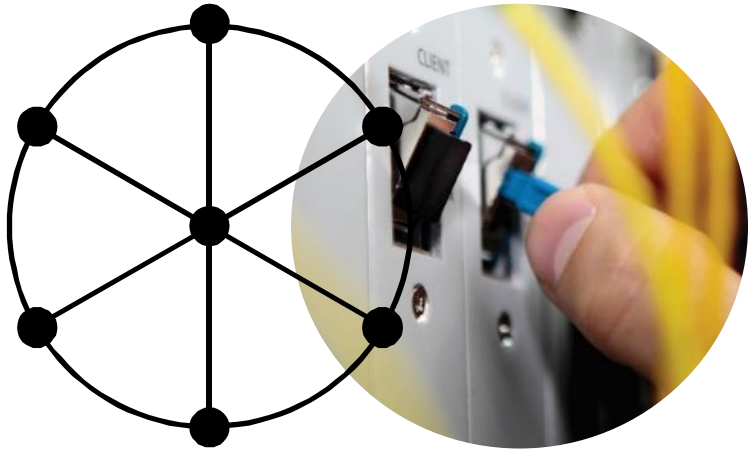
THREE BUSINESS SEGMENTS

MATERIALS



Engineered Materials,
Optics and Optoelectronic
Components for
Photonics Applications

NETWORKING



Optical Communications
Solutions for
Data Centers and
Telecom Networks

LASERS

Laser Systems for
Precision Manufacturing,
Life Sciences and
Instrumentation

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PRODUCT AND TECHNOLOGY PORTFOLIO FOR LIFE SCIENCES

Systems




Optomechanical Electrical Systems

Scientific Laser Solutions (End-user)

Sub-systems

LED Light Engines

Objective Lenses

Collimators

Detection Modules

Laser Modules

CellX Engines

Galaxy Fiber Combiners

Axon

Genesis

Excistar

CO2 Lasers

Components

Optical Filters

Flow Cells

Grisms

Waveplates

Lenses

Precision Optics

Chips, Bars, Stacks

OPSL Lasers

Sapphire Lasers

Chips, Bars, Stacks

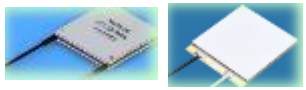
Diode Lasers

Gratings

Al Mirrors

VCSELs

Laser Solutions



Thermoelectrics

Chips, Bars, Stacks

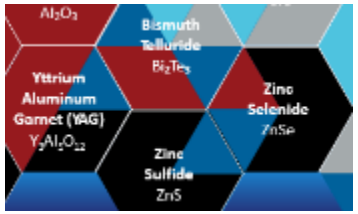
Isolators

Fibers

Raman Components

Specialty Optics

Materials



ZnSe
ZnS MS
Silicon

SiC Substrates

Na_2SeO_3,
Na_2SeO_4
Tellurium
Selenium

Crystals

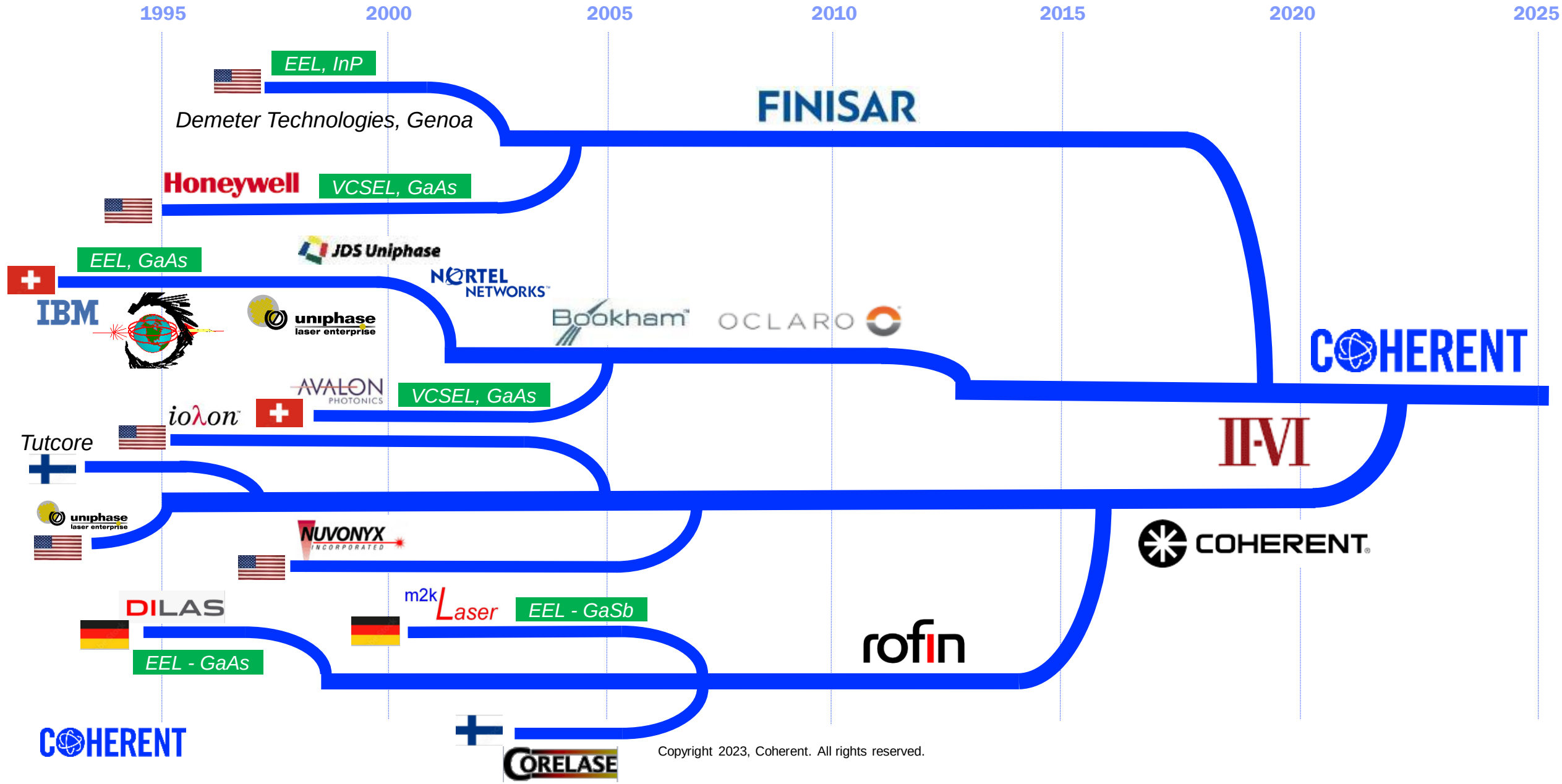
InP

GaAs

Diamond

Crystals

30+ YEAR JOURNEY IN DIODE LASER TECHNOLOGY



LASERS IN CONSUMER ELECTRONICS

LASERS IN CONSUMER ELECTRONICS - WHAT COMES NEXT?

1980s

Laser Printer

Laser Writing

CD/DVD

Read/Write Head

2000s

Mouse

Position Sensing

2010s

Gaming

Full Body Tracking

Mobile

Proximity Sensor

Range Sensor

Biometric Authentication

3D Scanning

2020s

VR/MR

3D Scanning

Leg-/Hand Tracking

Facial Expression Capture

Eye Tracking

AR

Wearables

Vital-Sign Sensing

Bio-Sensing

Environmental Sensing

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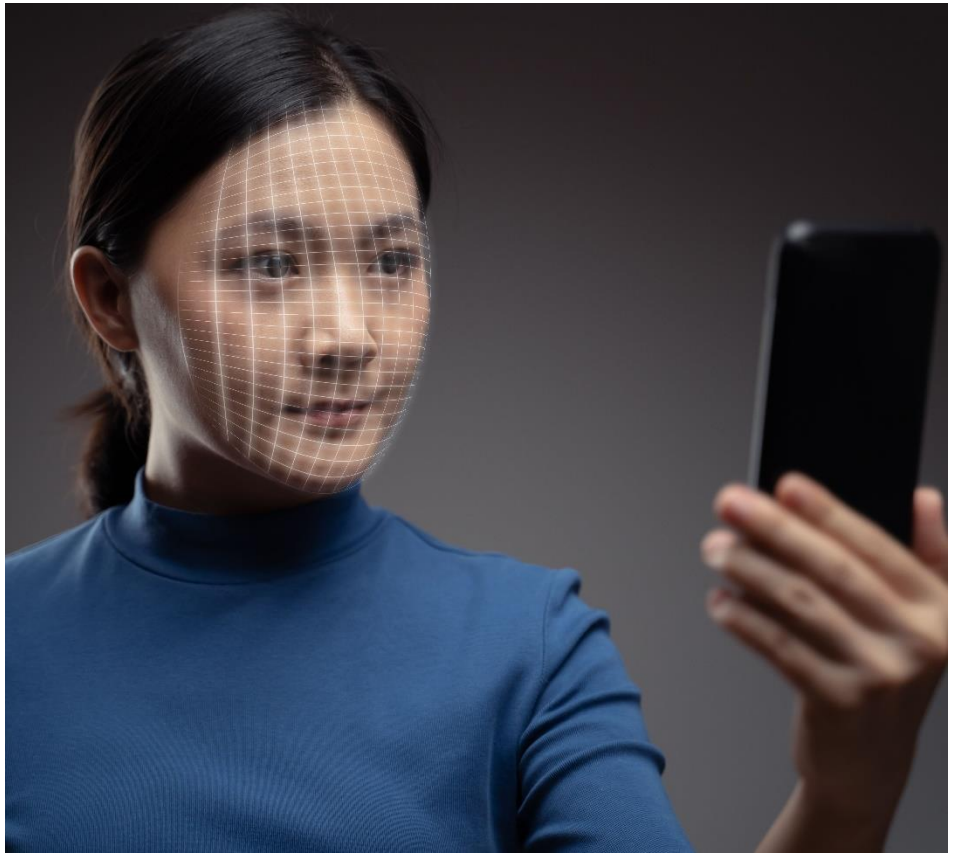
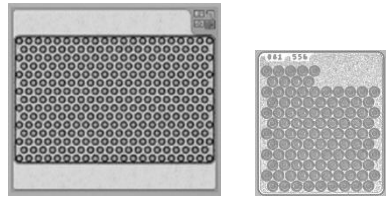
FACIAL RECOGNITION IN SMARTPHONES



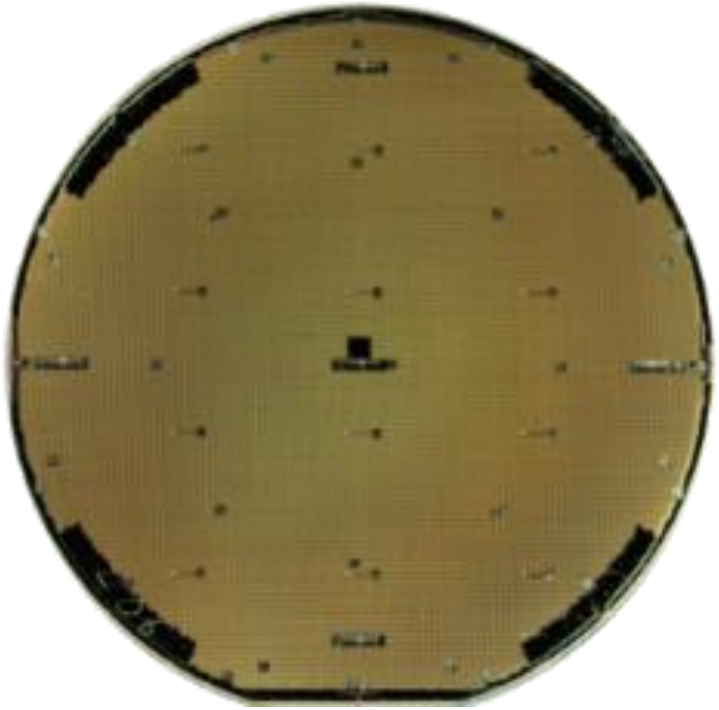


940nm VCSELs

- Two VCSEL chips per sensor module
- In volume production since 2017
- Several hundred million units in the field
- Application has transformed laser industry

CONSUMER ELECTRONICS APPLICATIONS DRIVE ROADMAP FOR DIODE LASERS

- GaAs and InP diode lasers already in smartphones
- Shipped 1 billion diode laser chips
- Investments in new compound semiconductor fabs
- Production scaled up to larger wafer format
- Improved performance and reliability
- Improved quality
- Lower cost



A 150mm VCSEL wafer contains up to 400'000 laser diodes

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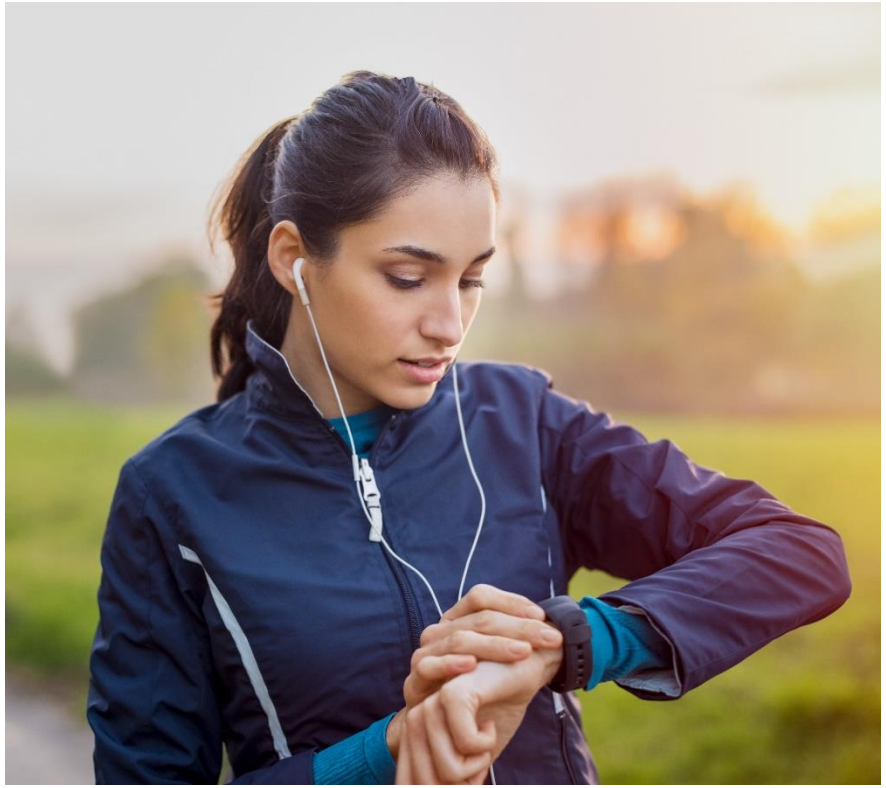
LASERS ENABLING PERSONALIZED MEDICINE

AFFORDABLE DIODE LASERS WILL ENABLE PERSONALIZED MEDICINE

- Smart watches and other wearable devices are evolving into personal health monitors
- Ideally non-invasive, continuous monitoring
- Trend towards pro-active and preventive medicine, instead of "sick-care"
- Applications:
  - Heart rate monitoring
  - Blood-oxygen monitoring
  - Hydration monitoring
  - Glucose monitorting
  - Lactate monitoring



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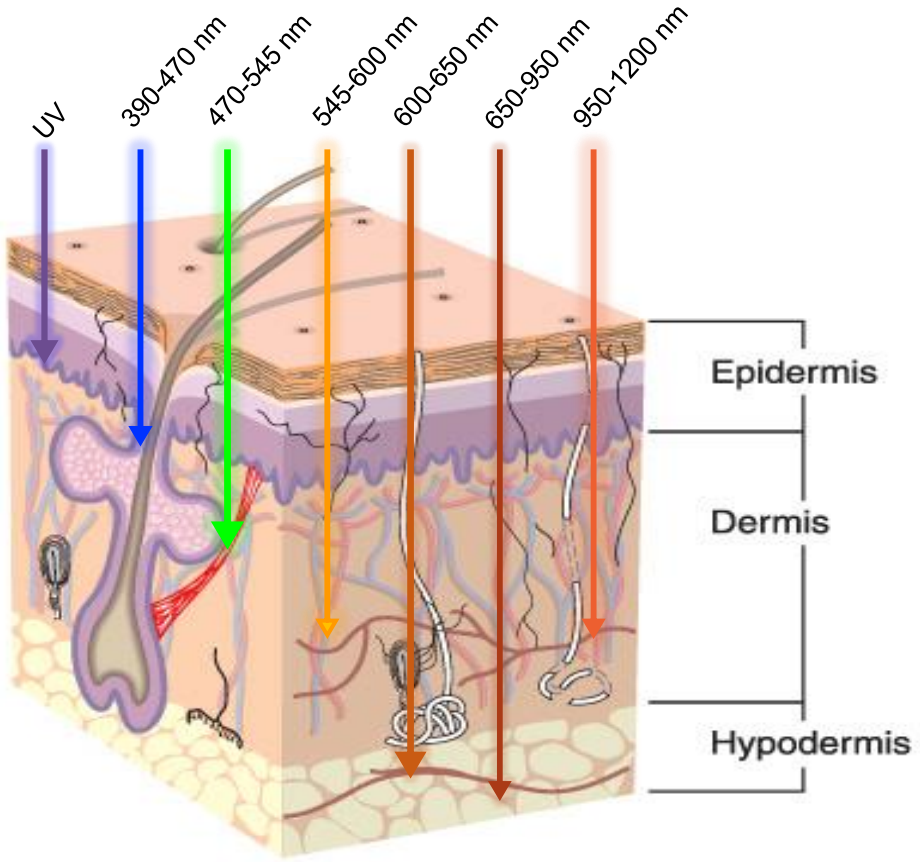
OPTICAL BIO-SENSING TECHNIQUES

Non-invasive optical bio-sensing is based on absorption or scattering of photons in the human body:

Common Techniques:

- Photoplethysmographie
- Raman Spectrosopy
- Absorption Spectroscopy
- Photo-Thermal Sensors
- Photo-Acoustic Sensors



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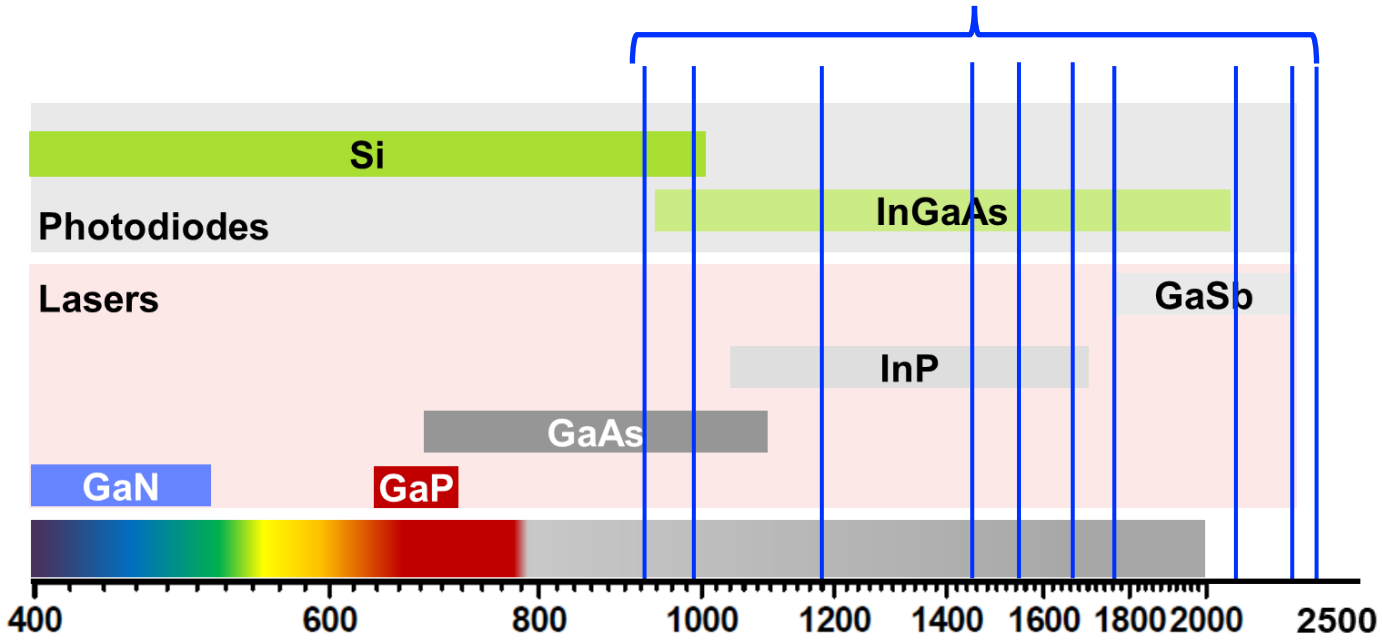
WEARABLE BIOSENSING: COMPOUND SEMICONDUCTORS HOLD THE KEY !

Semiconductor lasers and photonic integration are key enables for wearable biosensors

- Wavelength and linewidth choices
- Size and power consumption
- Hybrid photonic integration

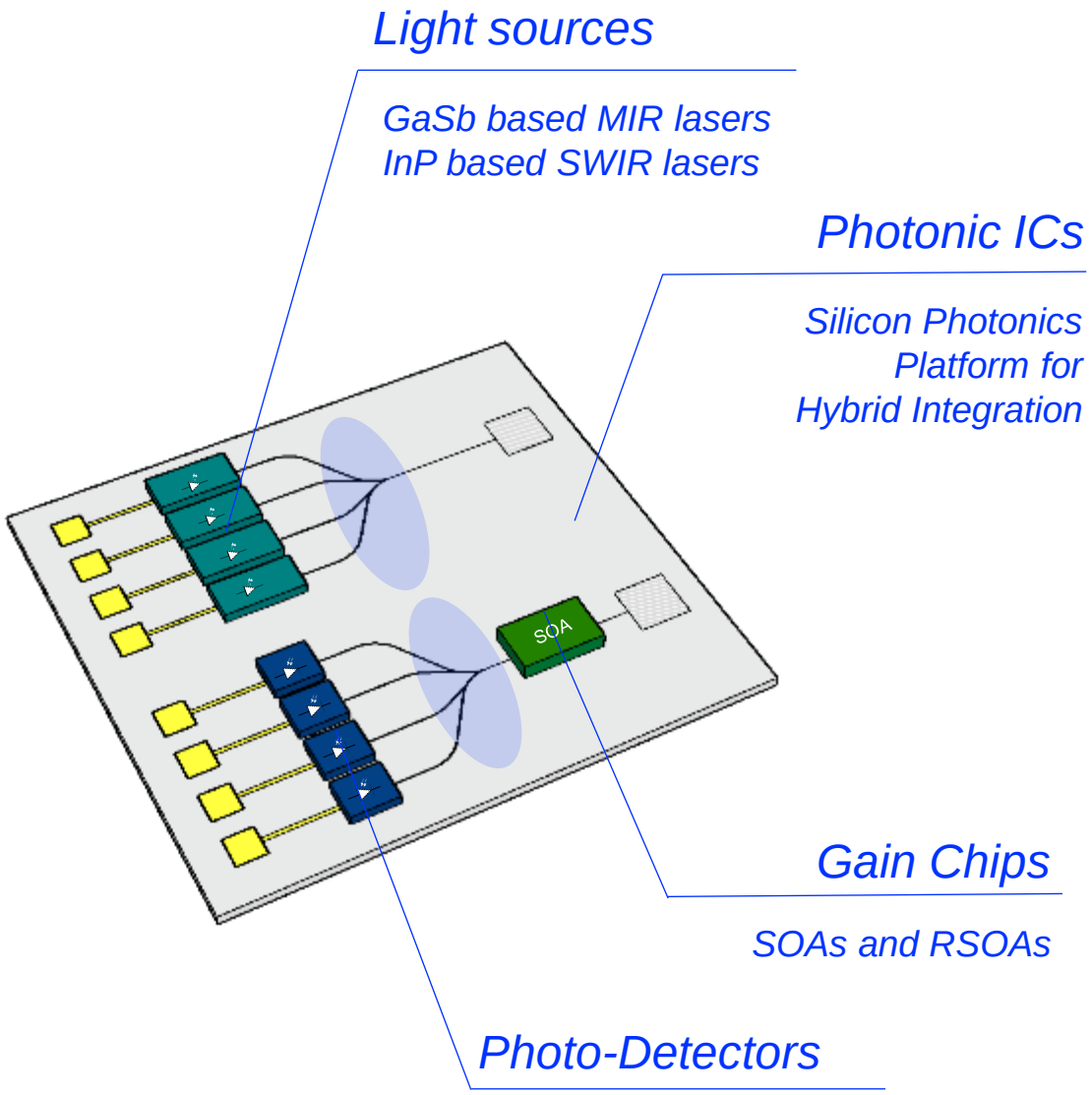
Example: Glucose peaks in NIR/MIR region



Semiconductor based lasers will make wearable biosensors a reality !

OUR VALUE PROPOSITION FOR BIO-SENSING

- We develop and manufacture optical engines for advanced bio-sensors:
  - Laser diodes, photodiodes and gain chips
  - NIR, SWIR and MIR wavelength ranges, from 750nm – 3µm
  - Monolithic InP photonic IC platform
  - Hybrid photonic IC platform on glass substrates
- In-house manufacturing for compound semiconductors (GaAs, InP, GaSb)
- Supplier into consumer electronics market (phones, tablets, watches)



SUMMARY AND TAKE-AWAYS

- **Coherent has broad technology portfolio for bio-sensing and other life-science applications**
- **Applications in consumer electronics have become driver for advances in diode lasers**
- **Affordable diode lasers will enable personalized medicine in wearable electronics**
- **Coherent has scale to support high-volume applications in consumer electronics.**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