Investec Site Visit
G&H Ilminster

24th January 2023

Site Visit Agenda

10:30	Arrival and refreshments	Display Room
10:40	Introductions and Group Presentation	**Charlie Peppiatt** & **Chris Jewell**
11:00	Ilminster Site Presentation	PO/Systems **Nick Matthews**
11:30	Site Tour	Ilminster Factory/Offices Two Groups • Group 1 – **Nick Matthews** & **Jonathan Ironside-Smith** • Group 2 – **Josh Fade** & **Pete Williams**
12:30	Lunch	Display Room
13:00	Presentations	G&H Technology and NBO Update Advanced PO and sighting systems for A&D **Pete Williams** – 20 mins Photonics sensing and semiconductor manufacturing **Toby Reid** - 20 mins Engineering Quantum Photonics solutions **Peter Kean** – 20 mins
13:45	Q&A	
14:00	Close & depart	There is a train at 14:43 – 16:29

G&H

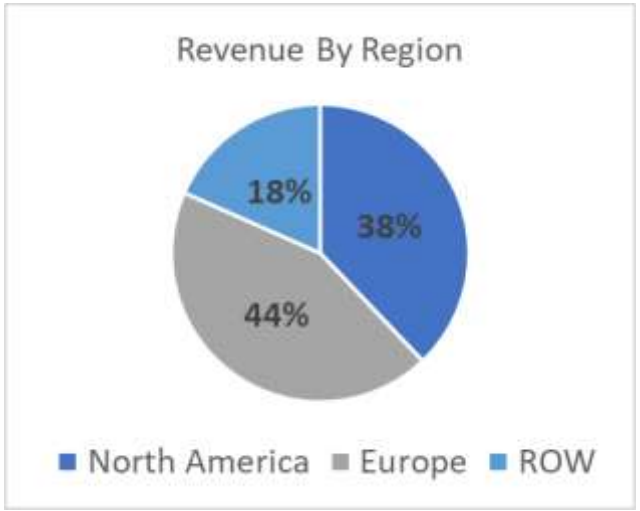
Global Reach and Expertise

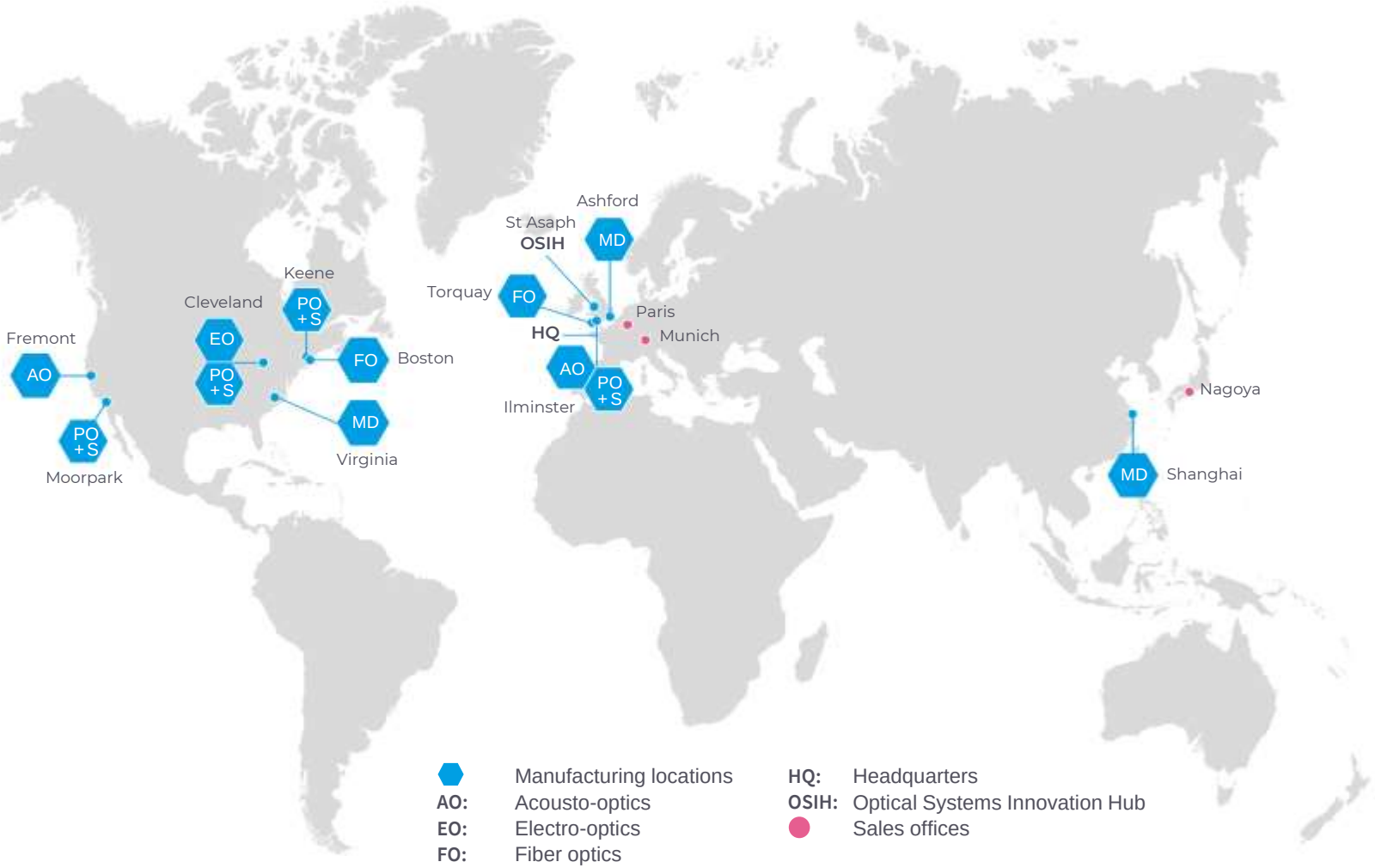
Our excellence in engineering and manufacturing is based on the following core technologies:

- Acousto-optics
- Electro-optics
- Fiber optics
- Precision optics and systems

In addition:

- Medical device manufacturing (ITL)
- Optical Systems Innovation Hub





2022 Results Overview

- Record order book of £147.7m up 51% reflecting strong end market demand (FY2021: £97.8m)
- Revenue of £124.8m unchanged on prior year (FY2021: £124.1m)
- Growth in both Industrial and Life Sciences offset by decline in Aerospace and Defence
- Adjusted profit before tax declined 35.4% to £8.1m (FY2021: £12.6m)
- Investment to increase capacity but challenges with recruitment, operations and supply chain constraints
- Net debt up to £19.1m (FY2021: £9.2m) reflecting inventory investment to alleviate supply chain shortages
- Proposed final dividend of 7.9 pence per share, giving a total of 12.6 pence per share (FY2021: 12.2p)
- Review of the Group's strategy underway

Revenue by Sector

2022 Total Revenue: £124.8M

We serve and provide value for three markets:

- Aerospace and Defense
- Industrial and Telecom
- Life Sciences

Industrial and Telecom
£64.6m
51%

Aerospace and Defense
£30.6m
25%

Life Sciences
£29.7m
24%

Revenue figures from 2022 Annual Report

Photonics – The Future

- Photonics is the study and design of systems that depend on the transmission, modulation or amplification of light (streams of photons)
- Photonics is transforming manufacturing, aerospace, communications and medicine
- Optics and electronics are becoming inextricably linked and we believe the application of photonics will become ubiquitous
- Photonic components global TAM $120B in 2021 with CAGR >10% to 2025*
- G&H has world class photonics components and systems capabilities
- G&H is well placed to take advantage of and enable what is a transformational shift in technology. We aim to be a go-to expert partner for demanding OEM photonics component and subsystem projects

* Mckinsey & Co – Photonics Next Wave of Growth April 2022

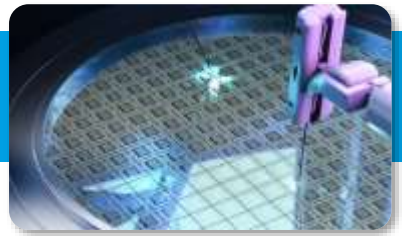
G&H Focus Areas by Market

Industrial

Quantum Photonics for Comms & Sensing

LiDAR for Wind Sensing

Semiconductor & Microelectronics



High-capacity Telecom Fibre Networks

Aerospace & Defence

Imaging Systems for UAVs, Space & Turrets

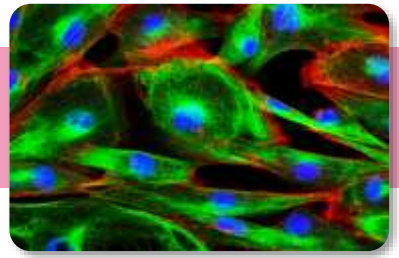
Armoured Vehicle Imaging Systems

Laser Comms for UAVs & Satellites

Laser Directed Energy Weapons

Life Sciences

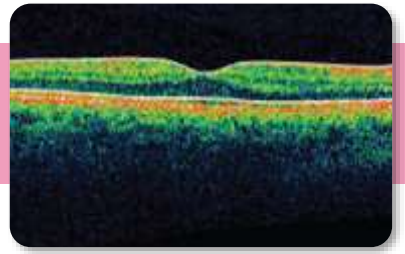
Confocal Fluorescence Microscopy



Medical Lasers in Aesthetics & Dentistry

In-Vitro Diagnostics Instruments

Ophthalmic & Intra-coronary Imaging



Summary and Outlook

- Well positioned for growth with record order book and robust pipeline
- Positive progress addressing operational output challenges
- Manufacturing partner producing at volume and additional products being qualified
- Supply chain constraints and input cost inflation pressures persist
- Growth in financial performance in 2023 though at a lower level than previously assumed
  - Accelerated R&D investment focused on growth markets
  - Addition of further capacity to service strong demand
- Review of the Group's strategy is underway

Ilminster Site Presentation

24th January 2023

History G&H Ilminster (ILM)

- Archie Gooch and Les Housego founded Gooch & Housego in 1948, in the centre of Ilminster specialising in manufacture of Precision Optics
- Started work on Acousto Optic products in 1982
- Due to expansion & development moved to Dowlish Ford March 2008
- G&H Glenrothes integrated into Ilminster facility 2020/21
- Systems manufacturing transferred from G&H St Asaph 2021
- Precision Optic System Design and Innovation Centre in St Asaph - Responsible for designing, prototyping, testing & qualifying new optical systems

New ILM site management team and a restructured G&H Operations function driving operational excellence

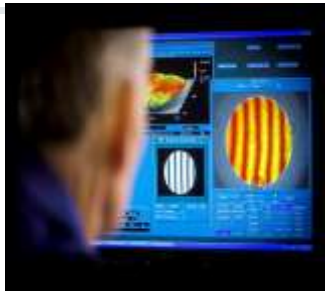
G&H Ilminster today

- 184 employees
- ISO9001 approved, AS9100 approved
- CM for (AO) in Thailand

ILM Manufacturing Capabilities

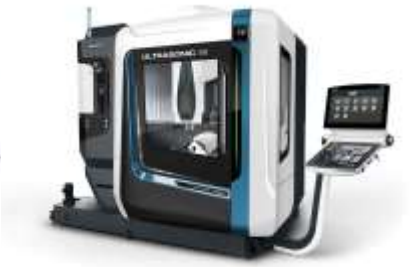
CNC Lens Manufacture

- **Including generating, polishing and edging**



Single Point Diamond Turning and MRF (Magnetic finishing)

- **0.3 Micron Capability**



AR (visible) & IR Coating & Environmental Testing

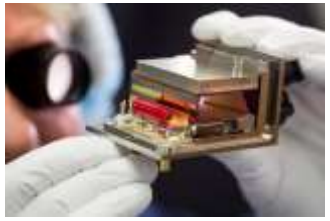
- **Lower Wavelength 244 nano-meters - Higher Wavelength 14000 nano-meters**

Prism and flat optics manufacturing & Polishing (coated)

- **Including wire saw, CNC generating, polishing and coating**

AO & PO Assemblies

- **Including bonding and laser testing**



Systems assemblies

- **Sights and Periscopes**

G&H

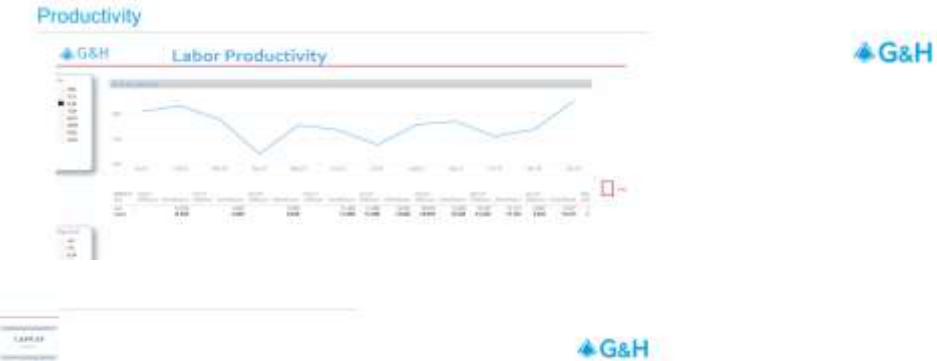
ILM Continuous Improvement

Site Manufacturing Leadership

- Safety and Quality processes
- Visual Management, Standard Work and Daily Accountability
- Leading to Manufacturing excellence through Continuous Improvement
- High & Low Volume Manufacturing

Site Manufacturing Engineering

- Working on Process Efficiency, Variability Control and COPQ Improvements



Advanced Precision Optics and Sighting Systems for A&D

Peter Williams
Head of Systems & Optics UK
Product Line Director

January 24th 2023

Our Precision Optics Capabilities and target markets

Differentiator

Broad spectrum of material expertise coupled with state-of-the-art equipment and added-value specialized manufacturing processes

Unique differentiator

- Glass & Crystal Components
- Infrared Components
- Specialist Processes
- Metrology
- Optical Coatings
- Design-for-Manufacture
- Opto-mechanical Analysis
- Assembly Integration & Test

Build on high-growth opportunities

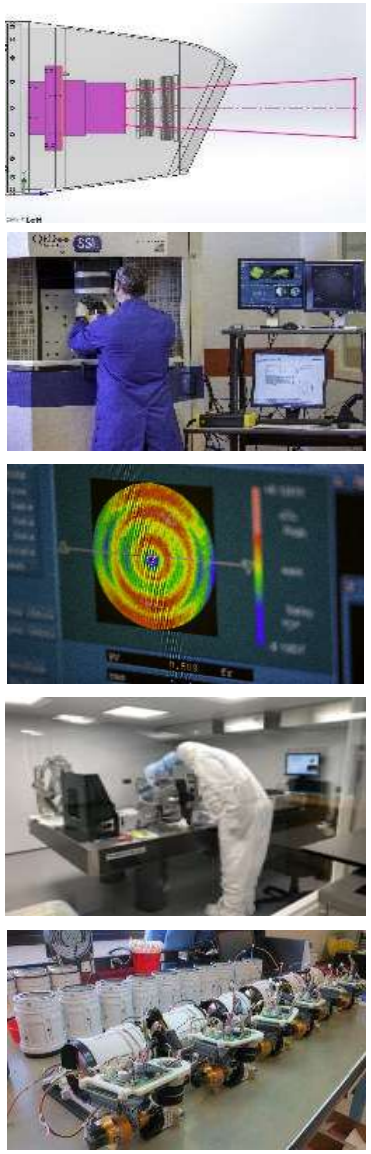
- Aerospace & Defence sub-systems
- Satellite communications and Ground Stations
- Laser surgery
- Medical Diagnostics
- Remote sensing

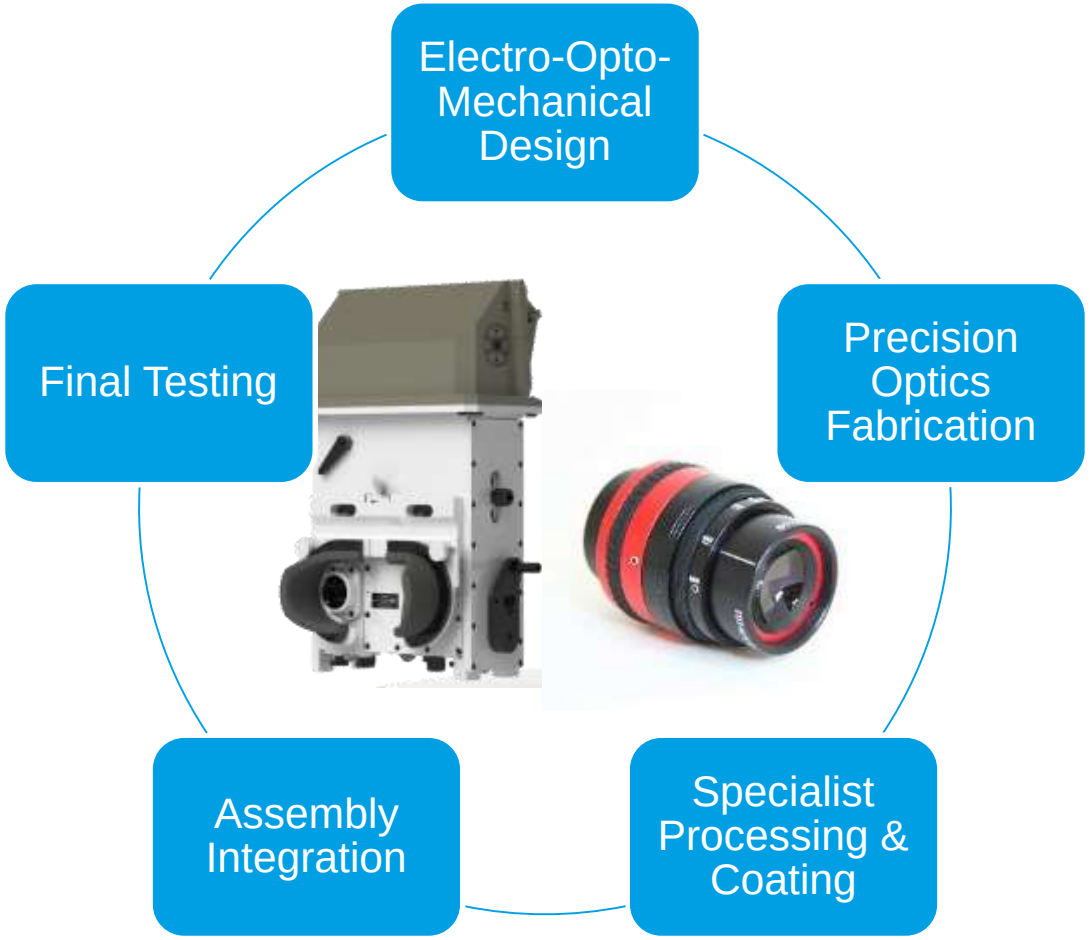
Optical components for A&D, Life Science and Semicon fabrication

G&H

Moving up the value chain with Design-For-Manufacture

From design to manufacture… all in-house





To extend the current capability in producing precision optical components G&H have established the process of mounting optics and integrated sub-assembly and test.

This higher level processing covers ultraviolet, visible and infrared wavelengths and extends from build-to-print to bespoke electro-opto-mechanical design.

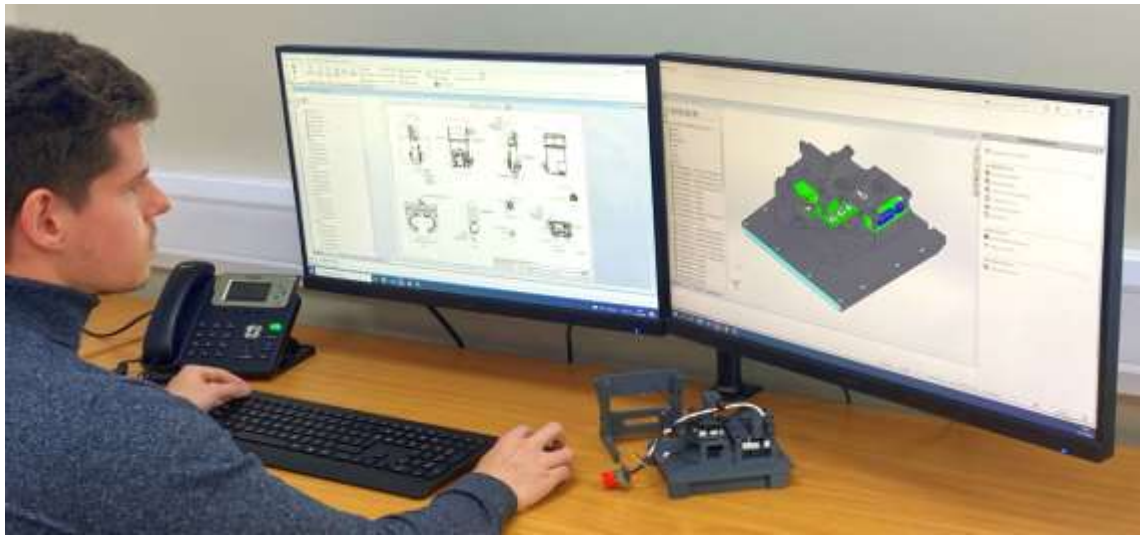
Strong presence as a fully integrated producer of high precision system assemblies including, mounted mirrors, windows and domes.

Excellence in components as a systems solutions provider

Optics + electronics + software + mechanics = added value

Materials => components => sub-assemblies => modules

The Innovation Hub – R&D



In order enable our growth strategy, we created the G&H Innovation Hub and invested in building a multi-disciplinary team of engineers with a broad range of expertise.

The North Wales located centre is responsible for designing, prototyping, testing & qualifying new optical systems and delivering a fully configuration-controlled product to the G&H Manufacturing Centres, primarily but not limited to Ilminster.

Key expertise in developing opto-mechanical and opto-electronic systems capable of withstanding harsh environments and to the most demanding of accuracies.

Firm foundation to deliver advanced state-of-the-art optical systems for Aerospace & Defence, Life Science and Industrial applications

Optical Systems Design and Integration for A&D

Feasibility / Proof of Concept / Prototypes

Early engagement with customers and product development

Explain physical & technical **advantages and limitations**

Analyse **cost drivers** ensuring commercial success

Offer flexibility to shop best solution for OEM products

Optical Design, Opto-Mechanical & Electrical Engineering

Tackle difficult system requirements with **unique** design solutions

Provide extensive design and fabrication expertise

Always designed with **manufacturability** in mind

Core / Camera & Electrical Integration

Talented & experienced technicians well versed with modern and legacy camera types and operation systems

Equipment and resources to integrate for optimized system

Verification of **compatibility** and **performance** pre-shipment

SATELLITE SYSTEMS

PORTABLE EQUIPMENT

GIMBAL PAYLOADS

JETS & MISSILES

IMAGING SUBSYSTEMS

THREAT DETECTORS

LASER WEAPONS

HELICOPTER PLATFORMS

AFV SYSTEMS

Electronic Periscopes for Armoured Fighting Vehicles

Increase situational awareness in the battlefield

Developing our new range of sighting systems with infrared overlays and added functionality

Patented & Patent Pending

Photonics sensing and semiconductor manufacturing

Toby Reid
Head of Fibre Optics
Product Line Director

24th January 2023

Fiber Optics – backbone of the internet

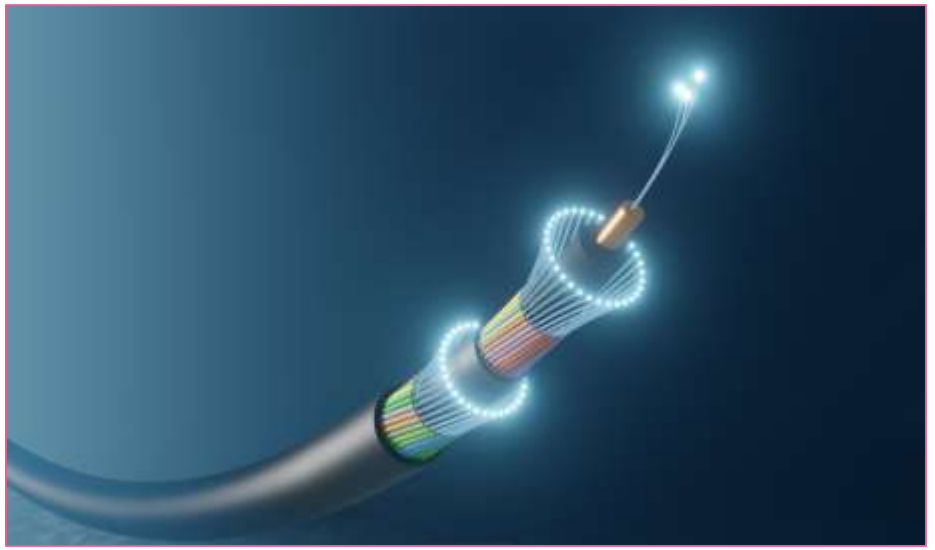
Optical fibre is a flexible and transparent medium for transporting light

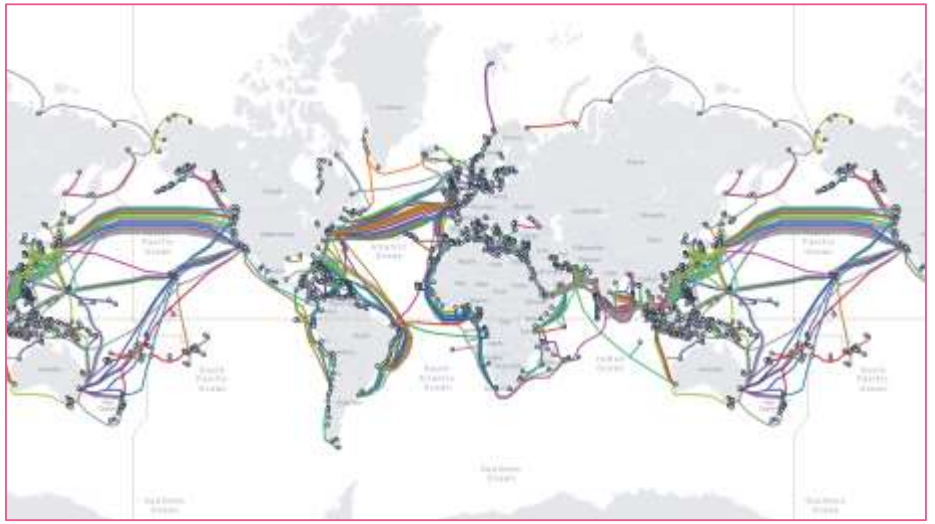
Light can carry information

- Internet data travels thousands of kilometres between continents along optical fibre cables on the ocean floor
- Optical fibres are also used as long, continuous sensing media detecting movement and changes in temperature and pressure. Photonics Sensing

G&H make fibre optic components to process light in fibre-optic systems

- Generate
- Direct & guide
- Detect
- Modulate (encode)

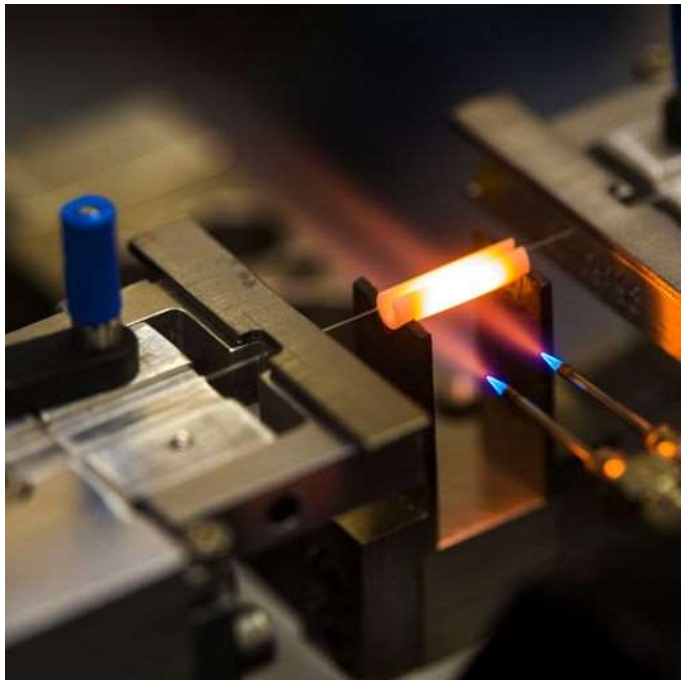




https://www.submarinecablemap.com/

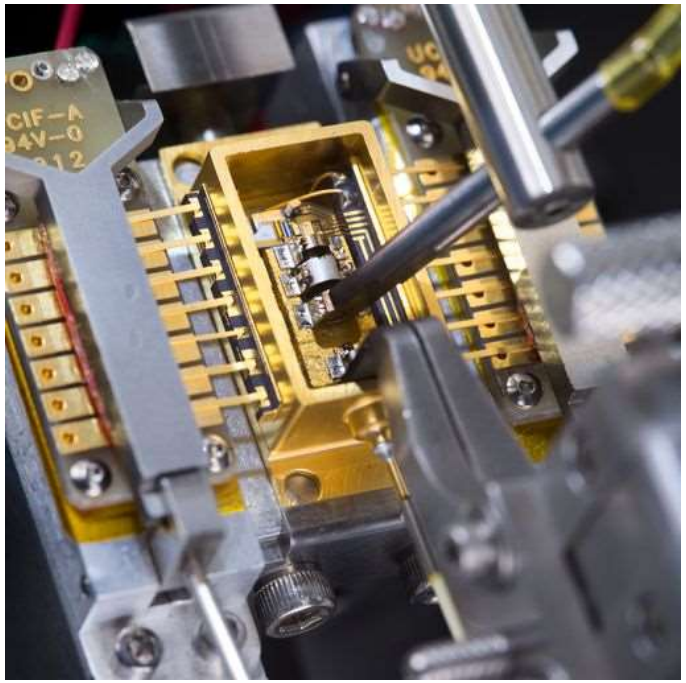
Fibre-Optic Component Technology

Guide light
Fused Fibre Couplers
Transfer light between fibres
Construct optical networks and circuits



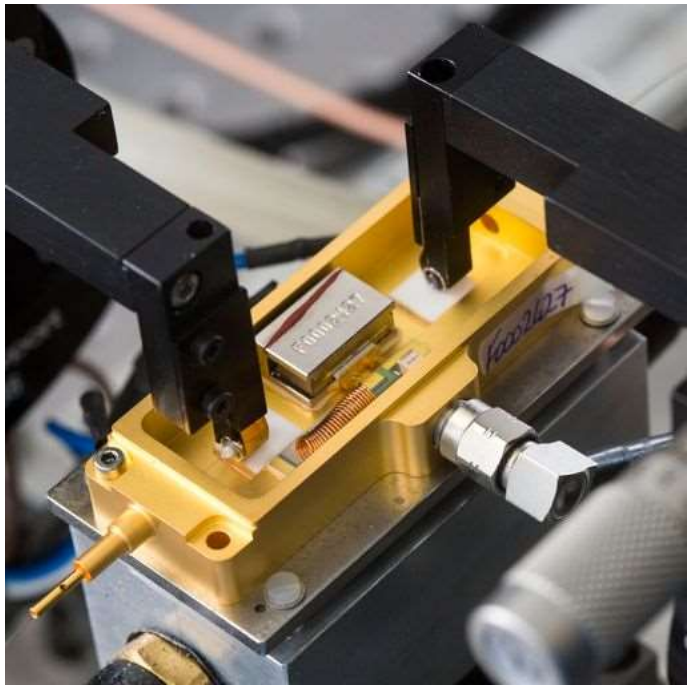
G&H fusion splicing

Create & Detect light
Lasers & Photodiodes with micro-optics
Convert electrons to photons & back
Construct Laser modules & engines



G&H micro-optics alignment

Modulate Light
Active photonic devices
Control light path & divert/switch
Construct pulsed & encoded systems



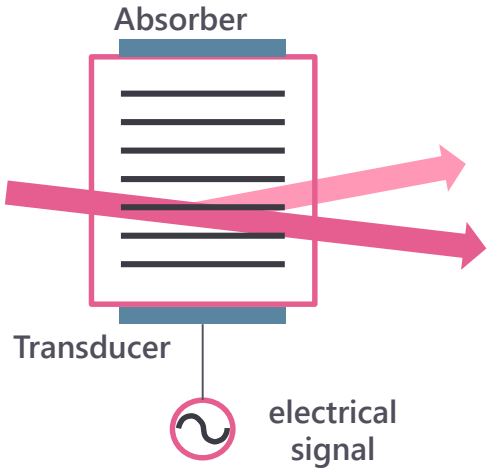
G&H optical switch integration

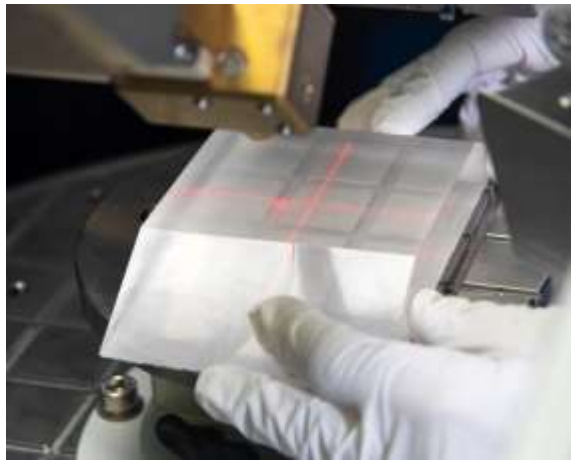
Acousto-Optics (AO) – at the heart of industrial lasers

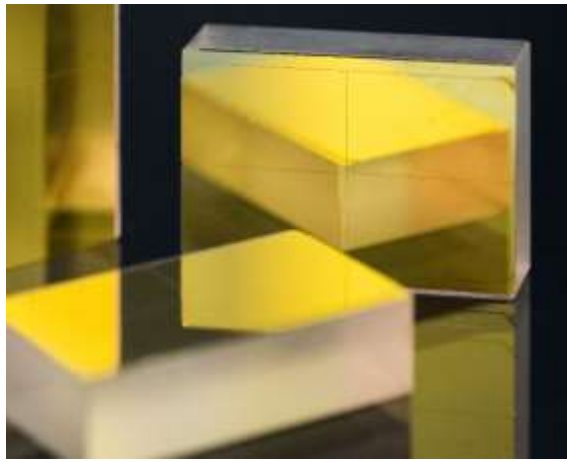
Acousto-Optic devices are made using Precision Optics technology with a piezoelectric transducer bonded to the glass material.

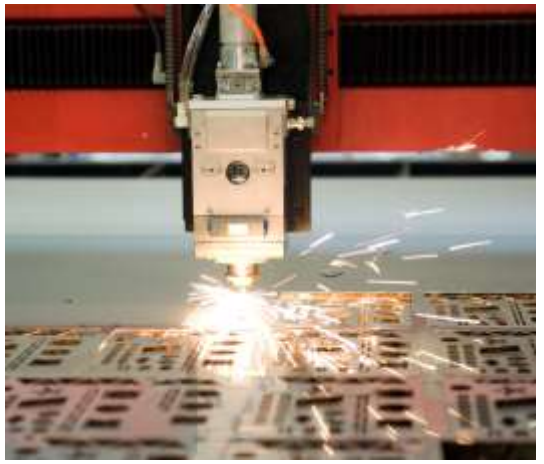
This transducer creates an acoustic wave within the glass and controls a beam of light:

- Direction
- Wavelength (colour)
- Power









The ability to change the properties of light in so many ways leads to a plethora of applications including many in Semiconductor Manufacturing

G&H vertical integration

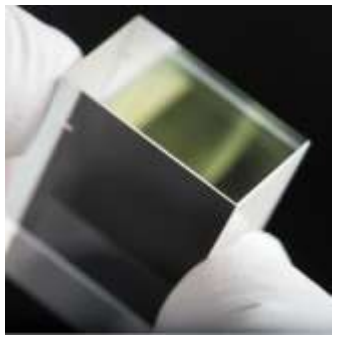
From material growth to system integration

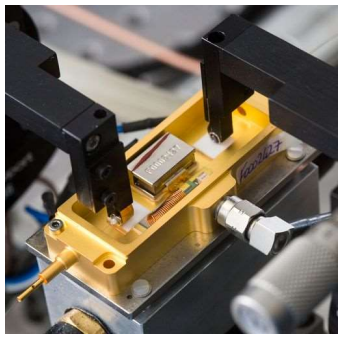
G&H CLEVELAND

G&H FREMONT

G&H ILMINSTER

G&H TORQUAY





Crystal Growth

Crystal cutting, grinding & polishing & Transducer bonding

Fibre coupling

System integration

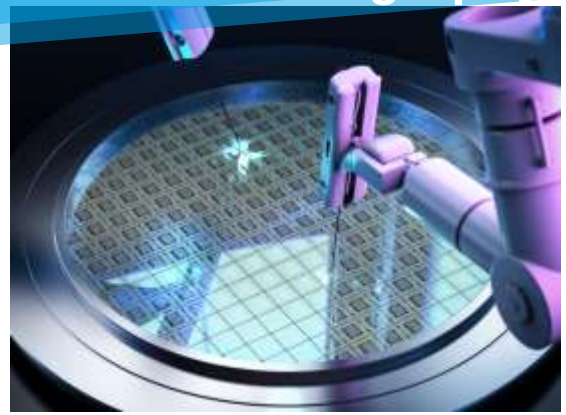
Diverse applications enabled

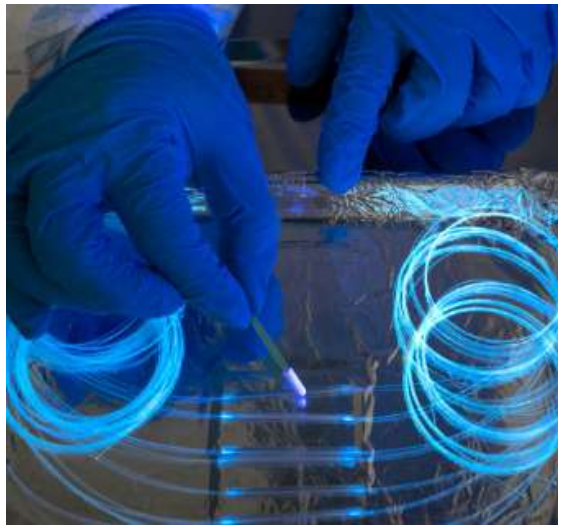
2015

G&H

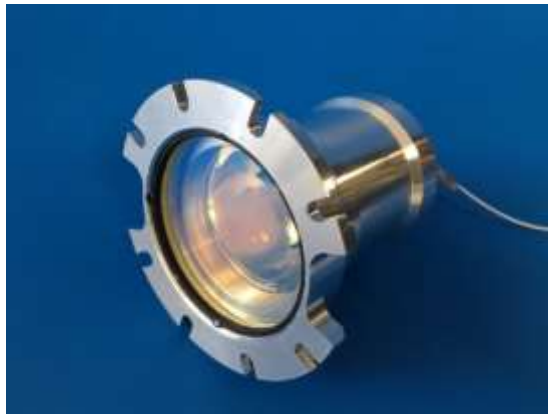
Key growth areas

Advanced Lithography

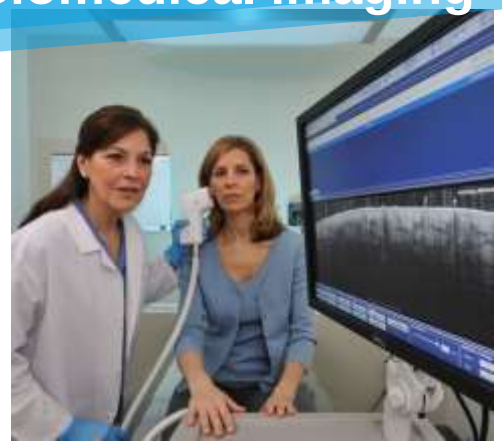




Quantum Photonics



Biomedical imaging



Engineering Quantum Photonics solutions

Peter Kean, PhD
Director R&D, Fiber-Optics

24th January 2023

What is Quantum Technology?

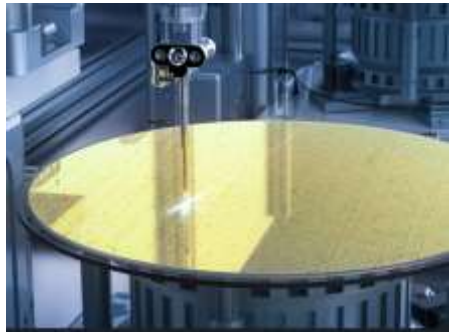
Quantum Systems

- Involve manipulating and measuring sub-atomic particles, atoms or photons
- Utilise non-intuitive ‘quantum’ properties such as entanglement, superposition and wave-nature

Applications and Markets

- Quantum Computing & Simulation
- Quantum Key Distribution for Secure Communications
- Quantum Repeaters for Terrestrial Communications
- Quantum Imaging for Biomedical, Defence and Environmental
- Quantum Timing for Space Navigation and Civil Transport
- Quantum Sensing for Defence, Civil & Space

Quantum will outperform existing and future classical technologies

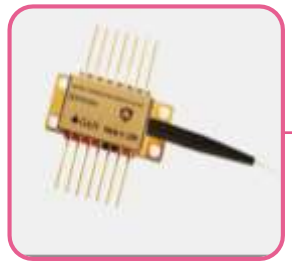


Cross-cutting into all market sectors

G&H

Quantum Photonics and its cross-section to G&H

The Cold Atom Trap – the key to unlock atom manipulation



G&H low-noise Laser

G&H low noise Amplifier

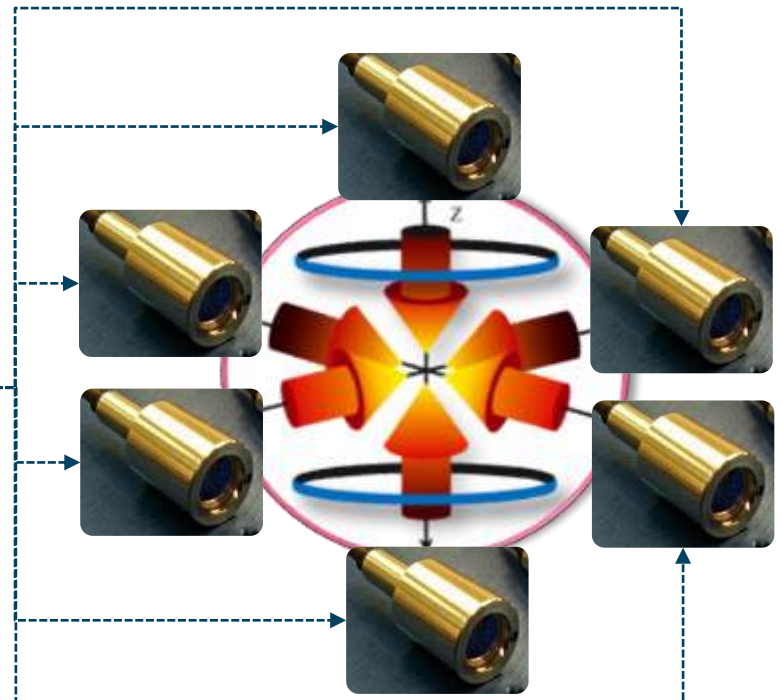
G&H frequency Converter

G&H High-power Amplifier

G&H RF Driver

G&H Fibre-Q

G&H Collimators

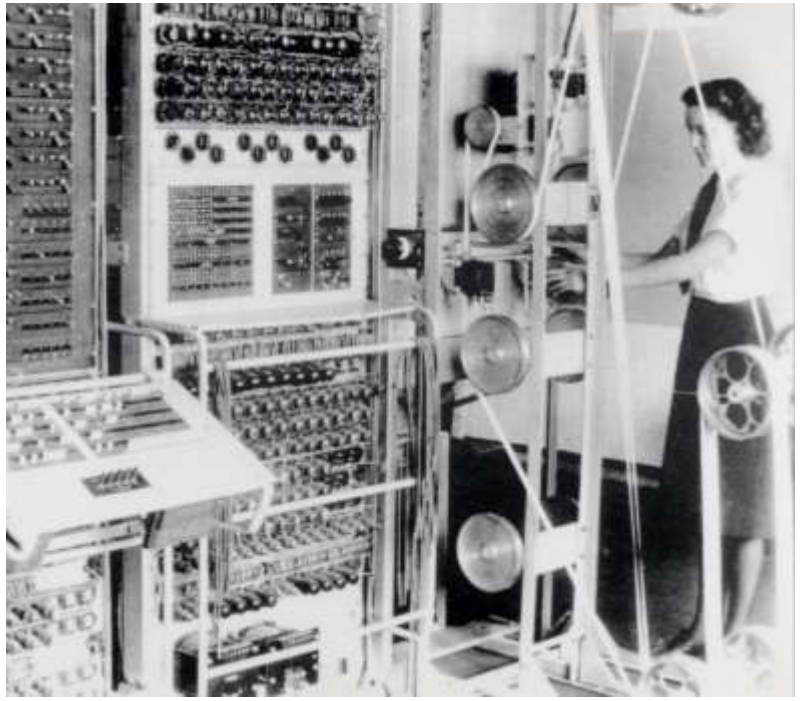


G&H Collimators

Today's Quantum Systems

Current Quantum computers and Quantum-based sensors are large, complex instruments*

Quantum Gravimeter by University of Birmingham using G&H ultra-stable laser source 2021



Colossus 1 Bletchley Park 1943

G&H mission is to dramatically improve performance of key components required and enable system integration of components to realise functionality required

** Remove words in blue and this could be a statement from the 1940s*

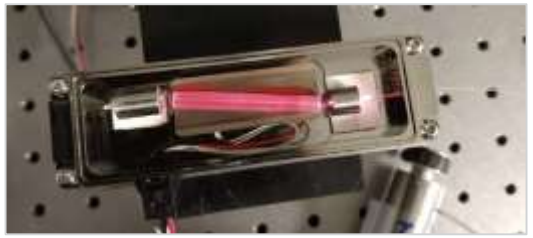
Key Photonics Technologies required

Rugged, compact cold atom traps (operating at room temperature!)

Phase locked laser modules

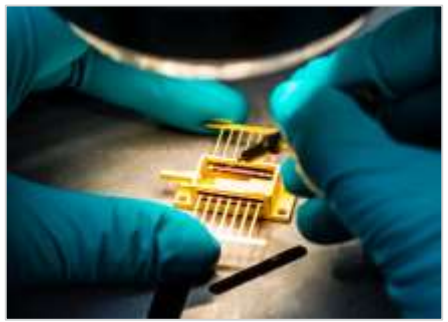
Optical frequency shifter arrays

Optical frequency doublers



Ultra-high extinction ratio modulators

Ultra-stable laser sources



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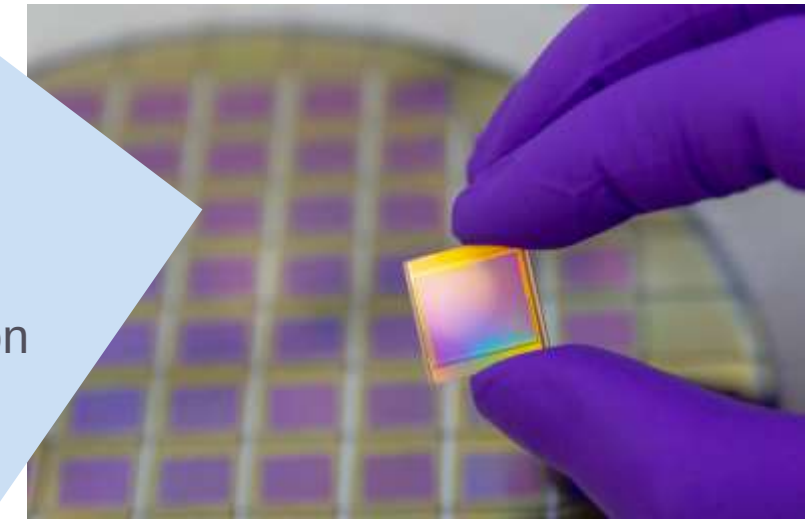
Technology roadmap

G&H prototype Laser source

G&H Stable Laser module

Concept of QT module



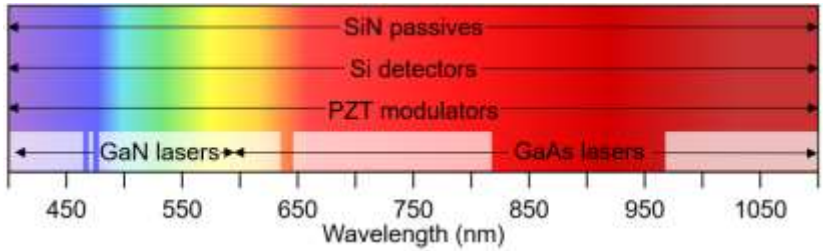
2nd generation chip-scale & mass deployment

New technology & early adoption

Demo phase with existing capabilities

G&H micro-optics module

Silicon-based Photonic Integrated Circuits



How can our expertise enable your success?