



**PHOTONICS**  
DESIGN CENTRE

# NARROW LINEWIDTH LASERS FOR QUANTUM APPLICATIONS

# BACKGROUND

TÜV NORD GROUP

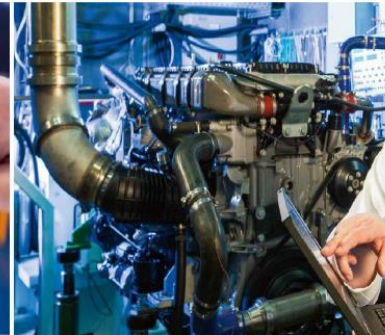
# ALTER TECHNOLOGY



ENERGY



IT



MOBILITY



HEALTH AND NUTRITION



NATURAL RESOURCES



AEROSPACE & ELECTRONIC

## ALTER TECHNOLOGY LOCATIONS

*Seville*

*Madrid*

*Toulouse*

*Livingston*

*Glasgow*

2003  
Optocap founded  
by Scottish  
Enterprise

2009  
Management  
Buy-Out

2016  
Acquisition by  
ALTER TÜV  
NORD

2019  
Alter  
Technology  
TÜV NORD UK

2021  
Alter opens  
Photonics  
Design Centre

# DESIGN & MODELLING

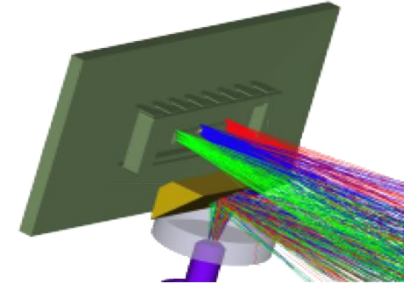
# ALTER TECHNOLOGY



Finite Element  
Analysis  
Optical Design

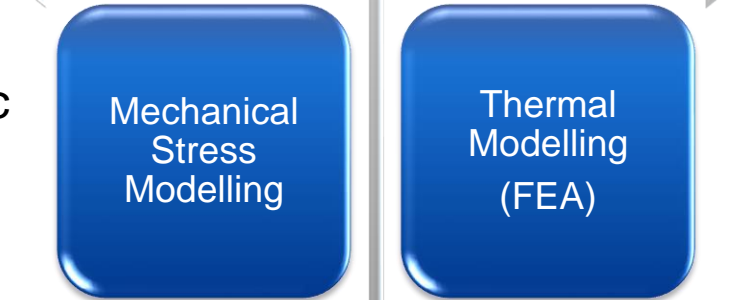


Hi-Reliability  
Packaging  
Optimisation



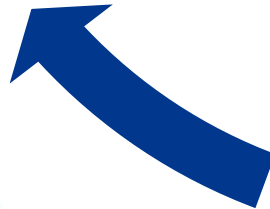
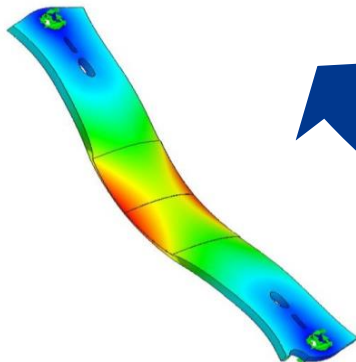
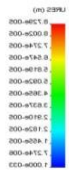
Custom  
Package  
Design

Zemax Optical  
Modelling

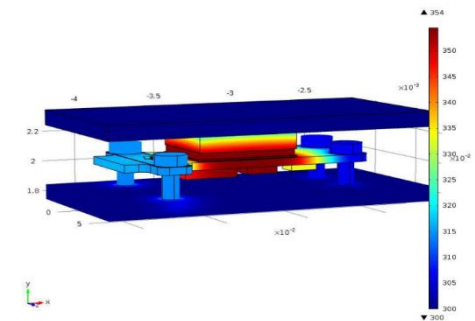


Microelectronic  
& MEMS  
Packaging

New Product  
Introduction



Optoelectronic  
& Optical  
Packaging

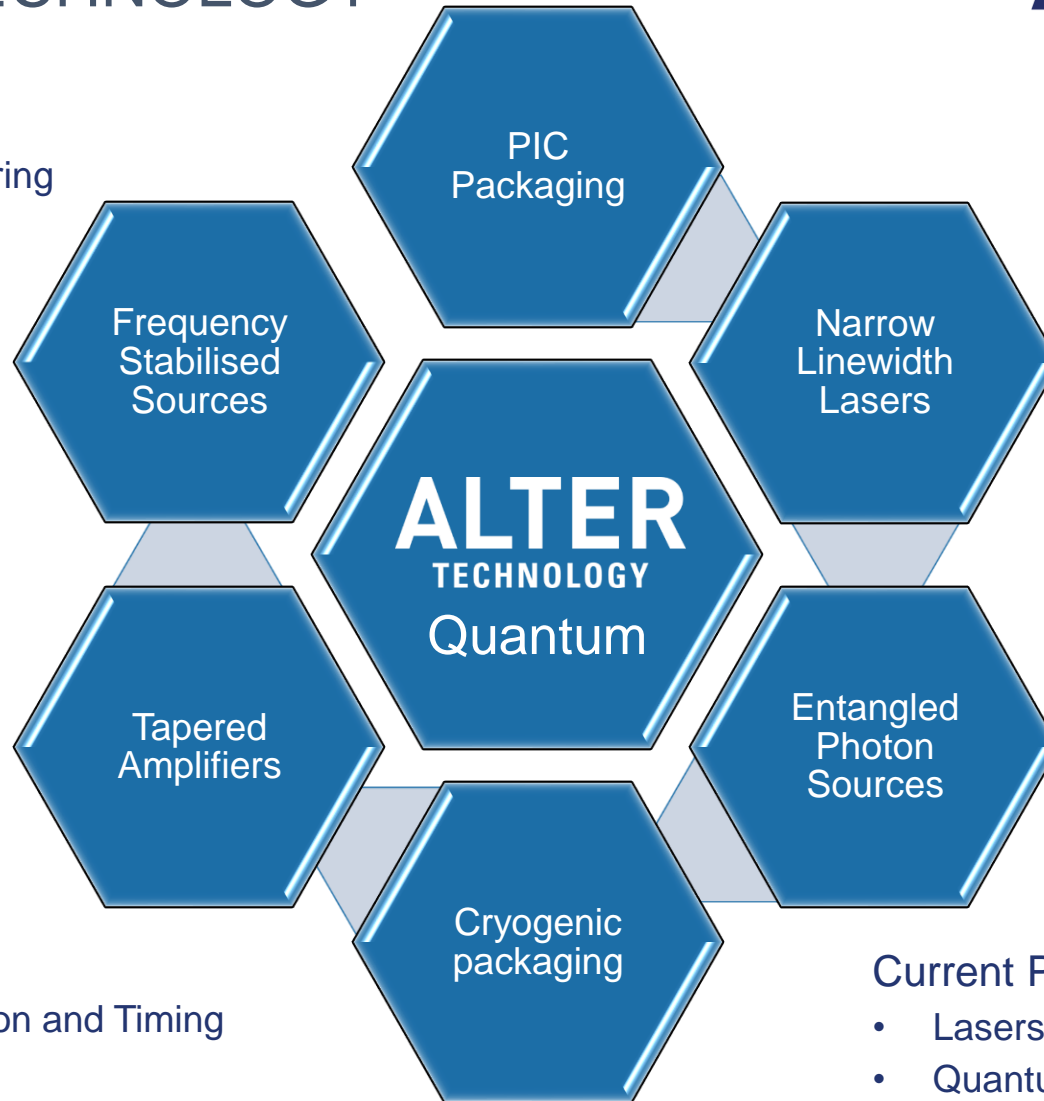
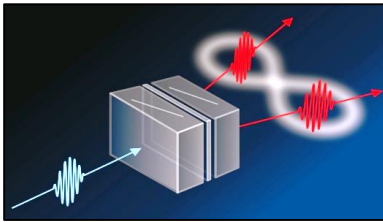


# QUANTUM TECHNOLOGY

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TECHNOLOGY

## R & D

- Low cost manufacturing
- Ease of integration
- Standardisation
- Scalability



## Applications

- Sensors
- Position, Navigation and Timing
- Atomic clocks
- Secure communications (QKD)
- Quantum computing

## Current Projects

- Lasers for atom trapping
- Quantum for space
- Entangled photon sources



# QUANTUM: WHY DO WE CARE?

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TECHNOLOGY

Quantum technologies have revolutionised the world, and continue to do so.

Quantum tech allows us to

See round corners

Map the gravitational field of the Earth

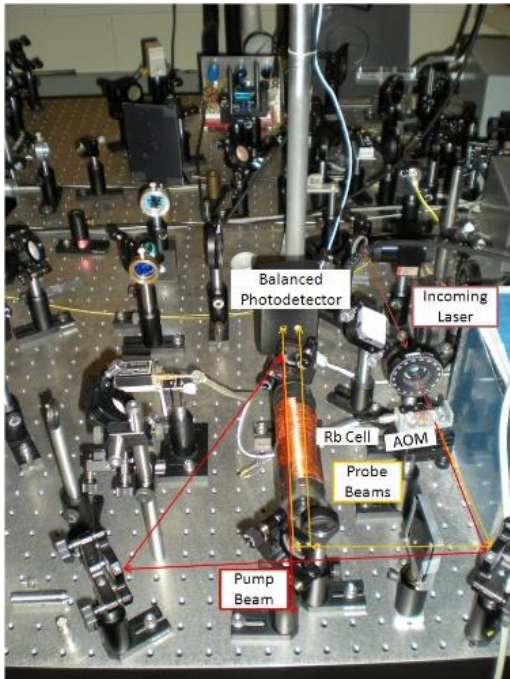
Locate an object in the ocean to within a few metres

Detect the magnetic field of a heartbeat or a brainwave



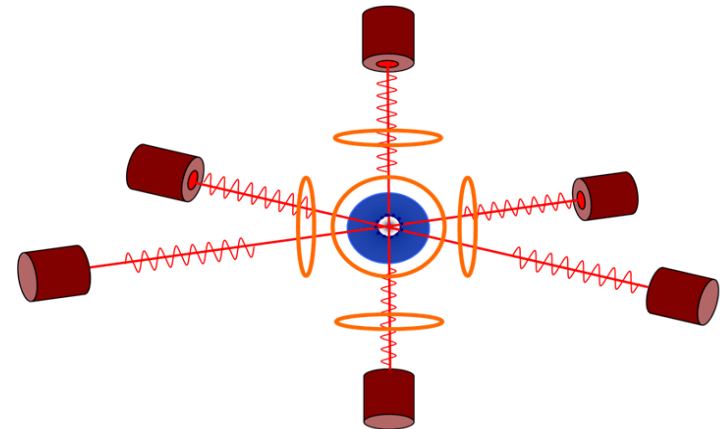
# QUANTUM LASERS OVERVIEW

The Need: Lasers for quantum applications



Available options:

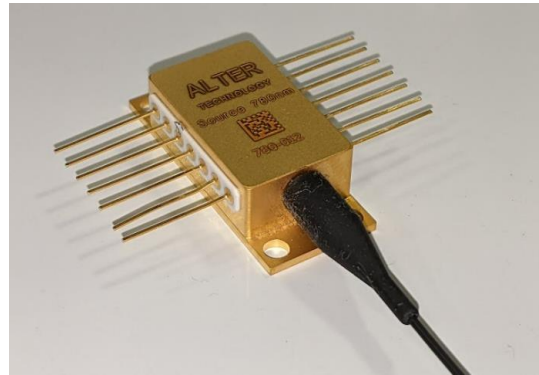
- Benchtop setups that take a long time to install and are difficult to adjust and operate
- Large, expensive commercial sources



# THE SOLUTION: ALTER'S SUITE OF QUANTUM LASER PRODUCTS

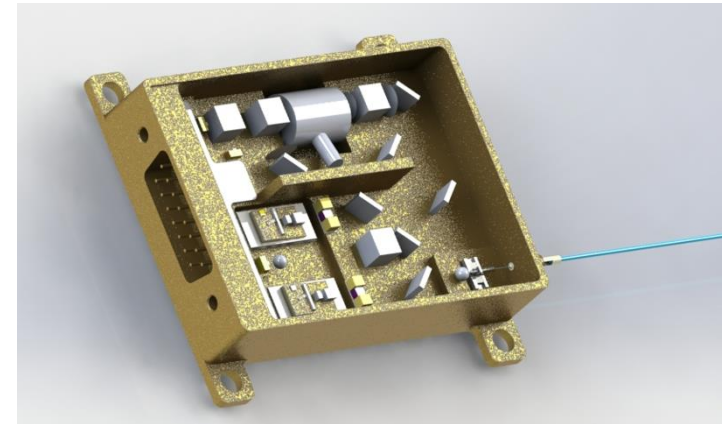
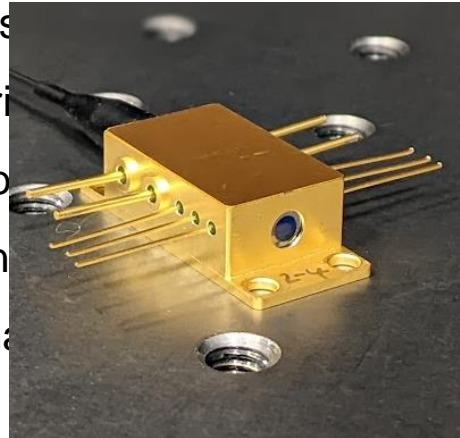


- Remote
- FLAME
- Tapered amplifier
- FISH



## Requirements

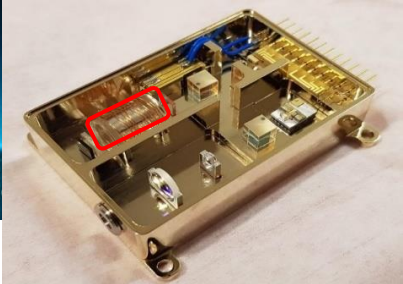
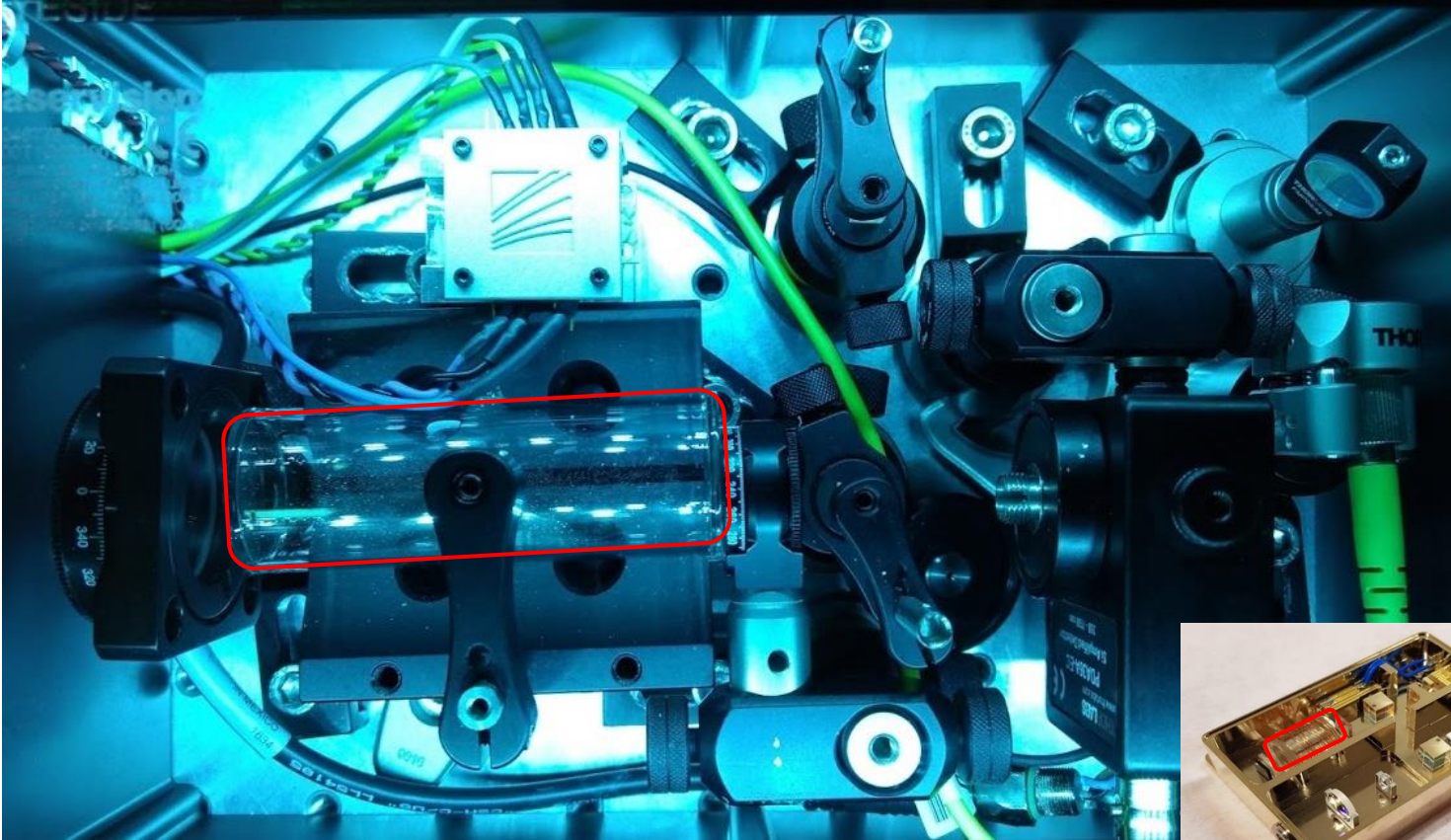
1. Miniaturization
2. Affordability
3. Robustness
4. Performance
5. Ease of integration





# MINIATURISATION

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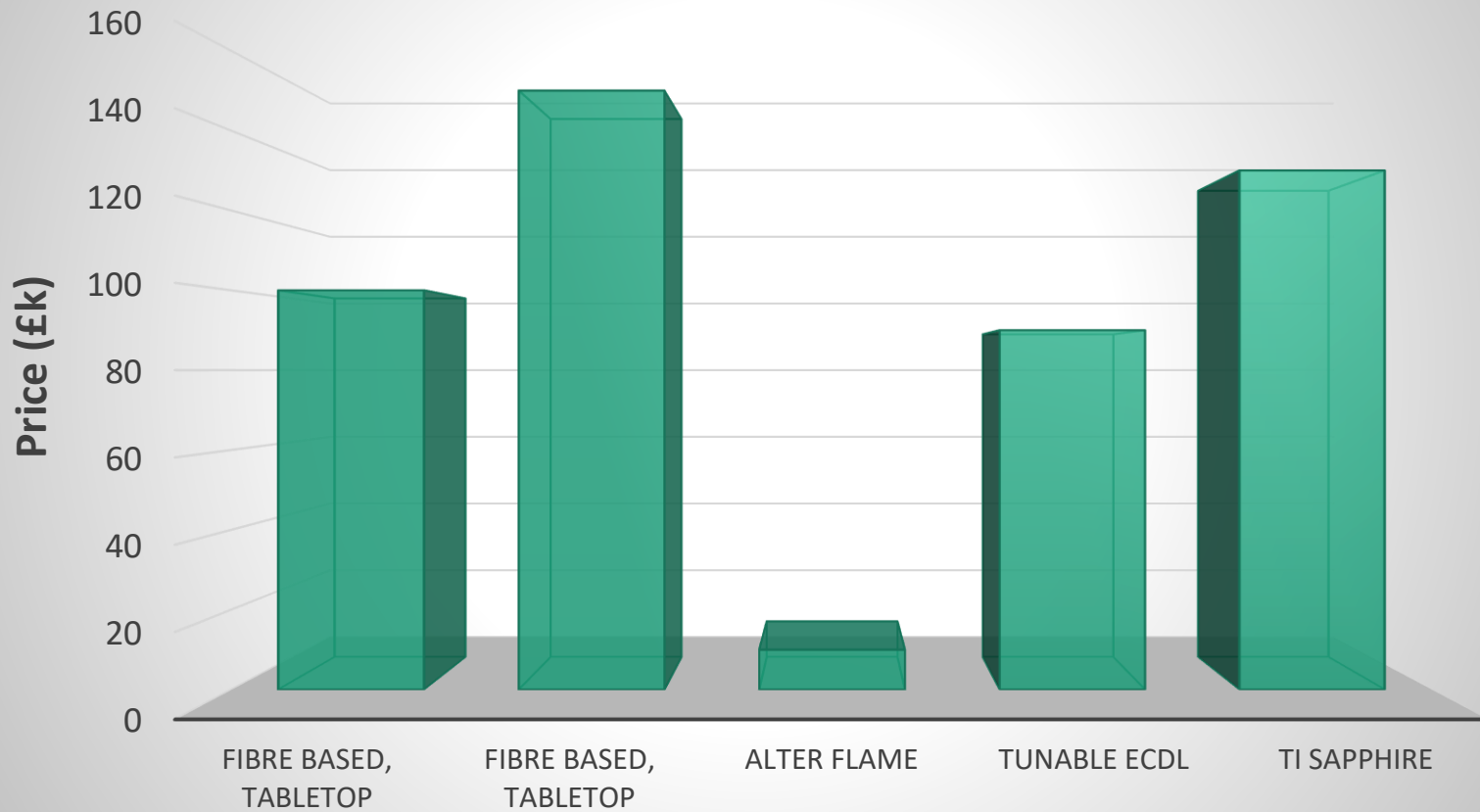
# COMPETITIVE COMPARISON - SIZE

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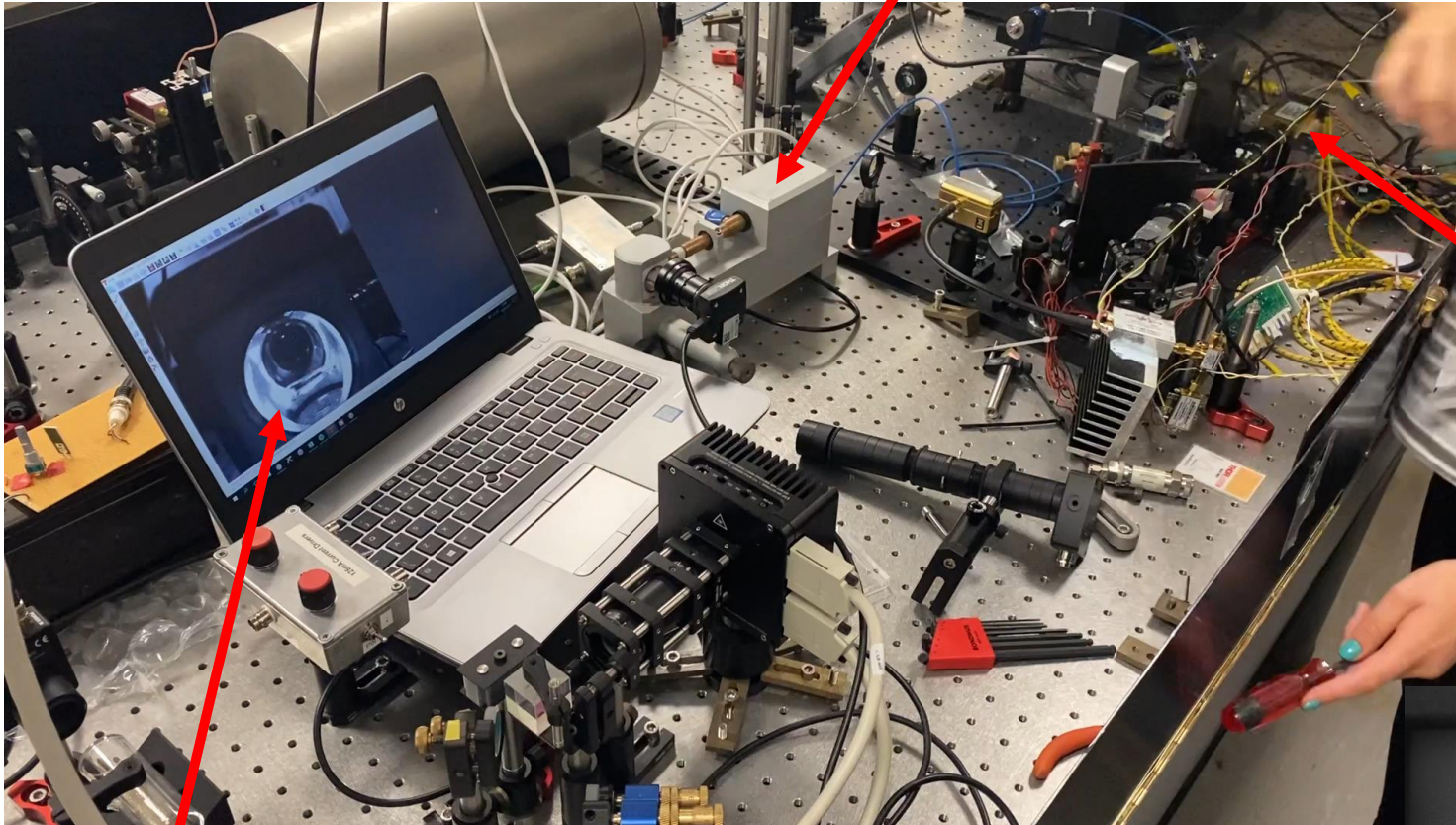
# AFFORDABILITY

## Product Pricing Comparison



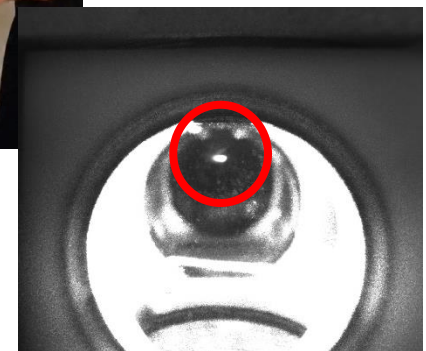
# ROBUSTNESS

Vacuum system



FLAME

Live video of MOT



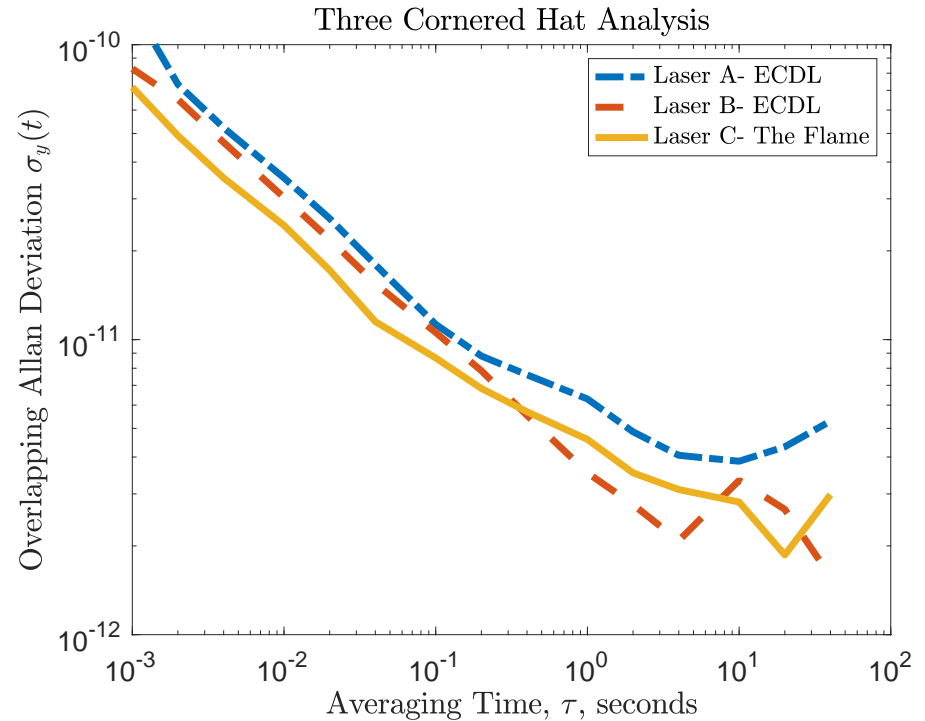
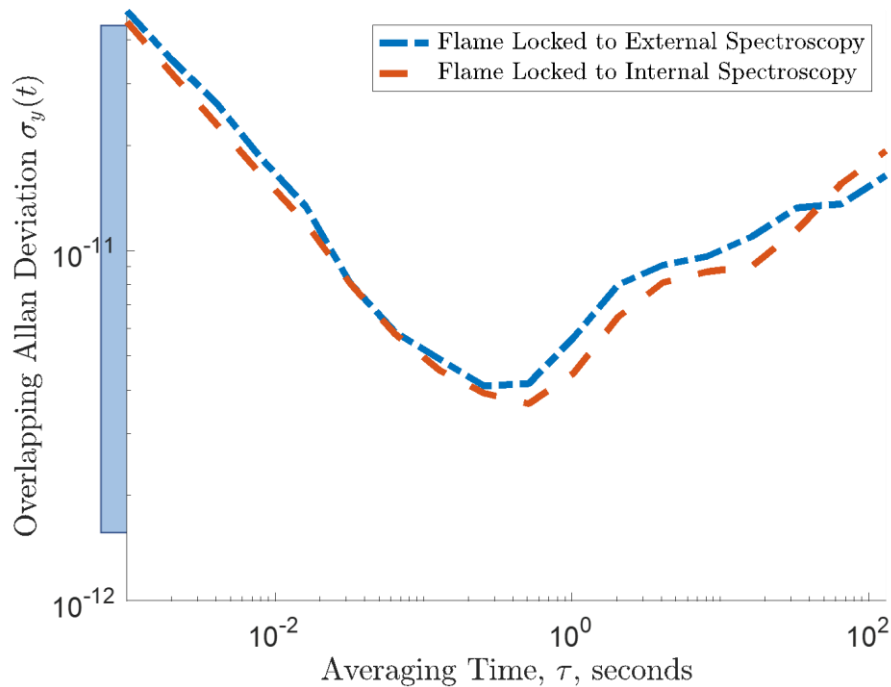
Extracted image of MOT



# PERFORMANCE – FREQUENCY STABILITY

## Allan deviation measurement

- Three-branch laser setup
- Each laser locked using identical SAS setup



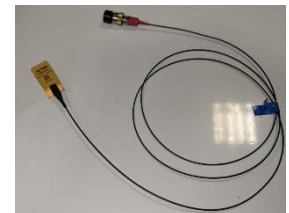
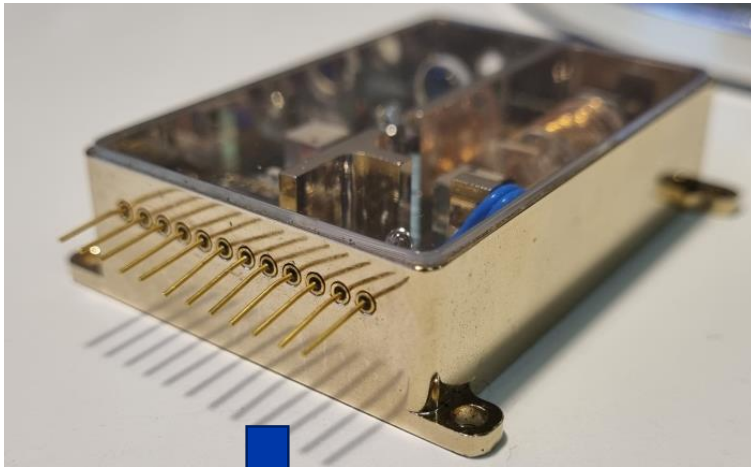
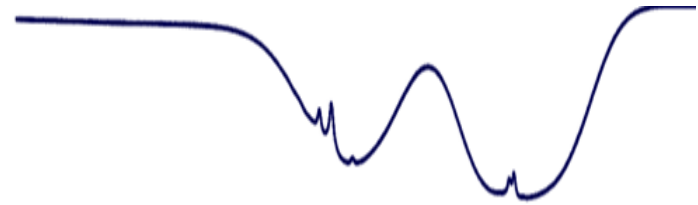
## Spectroscopy check - two sets of measurements:

- Flame locked to external gas cell
- Flame locked to its internal cell

# EASE OF USE

## Work underway

- Improved SNR
- Fibre interface
- Dedicated electronics: PD signal amplifier, drivers



# WHAT ELSE?



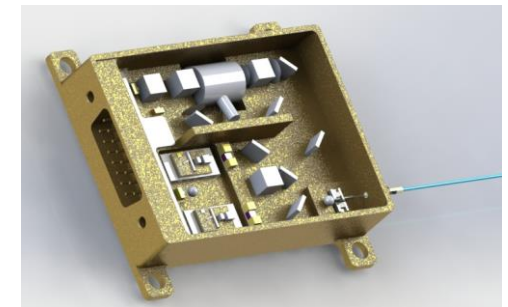
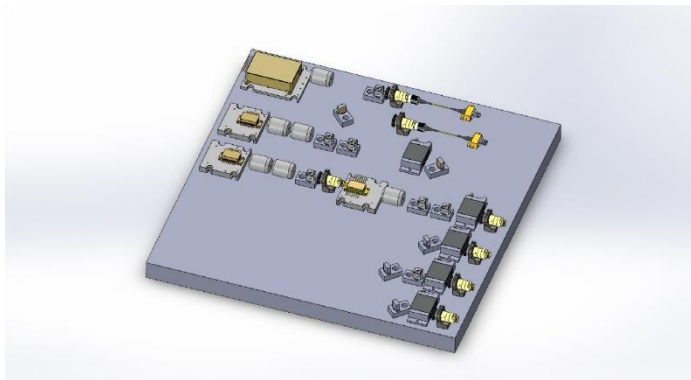
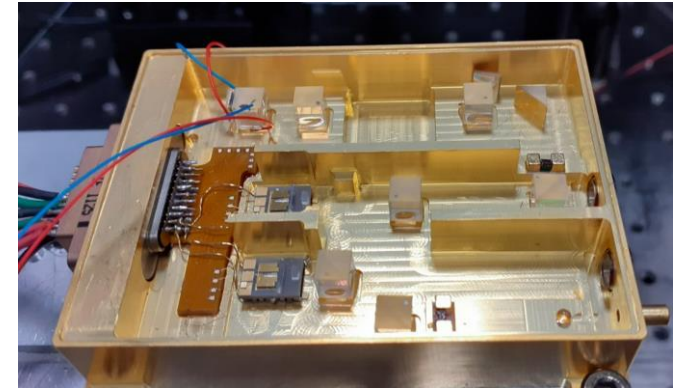
FISH: Cold atom laser engine

- Provides cooling and repump in a single device
- Facilitates offset locking

Manufacturing transfer for volume

Reliability testing

Space-suitable version (PASTEL)







THANK YOU!