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Challenges in Industry

Confidential Information

LA^{3}NET, School Ganil, France, 19 October 2012

Jonas Hellström Ph.D.
Chief Technology Officer, Cobolt AB

Outline

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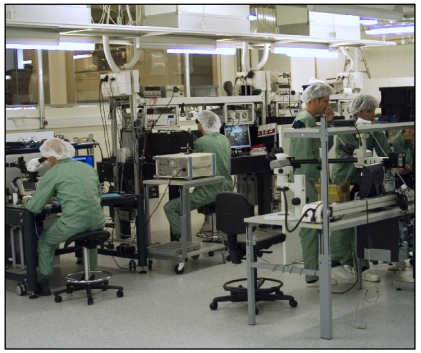
- Introduction
- Cobolt today
- The road from academia to small company
- Summary of challenges



Highest creditworthiness
©Soliditet 2011

Cobolt Today

Cobolt's Business Concept

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Cobolt supplies high performance, compact and efficient solid-state lasers for advanced analytical instrumentation equipment

Cobolt has developed wavelength flexible and power-scalable technology platforms based on mature laser materials, which combined with a unique manufacturing technology for ultra-robust lasers forms the basis for a broad and market-adapted portfolio of high-quality laser products

Cobolt's Location

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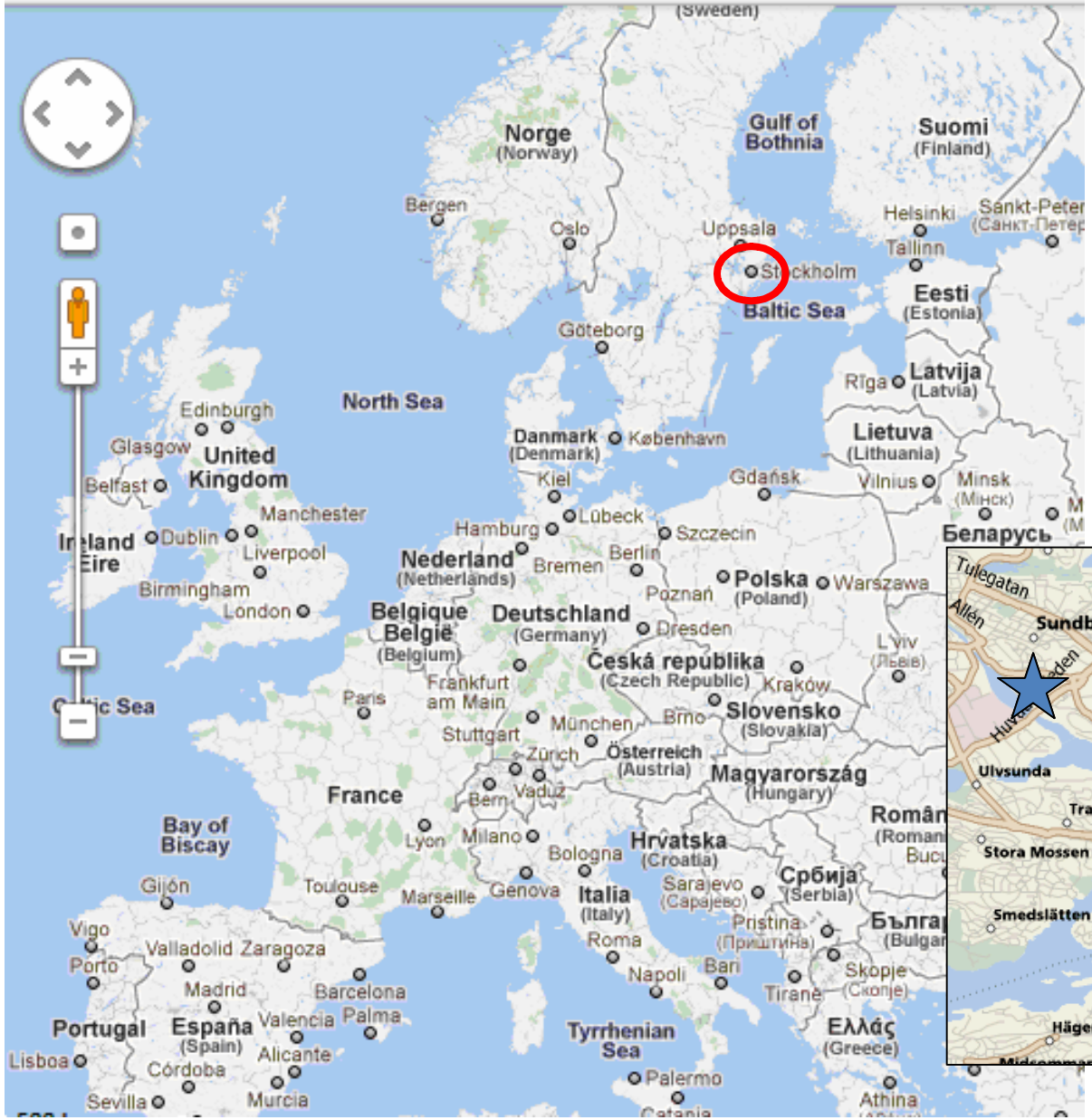

Sweden

Stockholm

Solna

Organization

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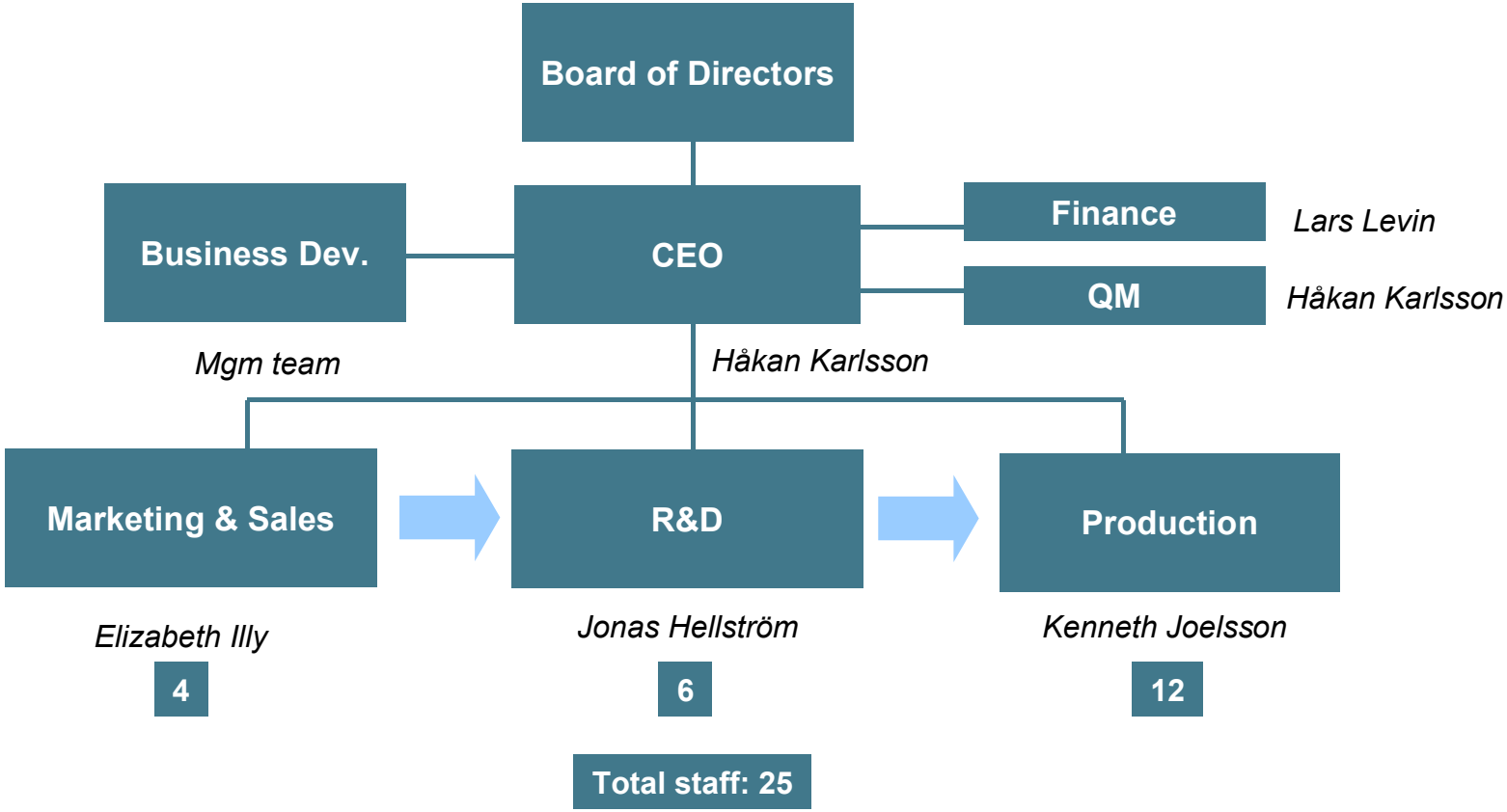

Sales channels

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New 2013
US Sales Office
www.coboltinc.com

Benelux
Laser 2000 Benelux
www.laser2000.nl

France
Optoprim
www.optoprim.com

UK and Ireland
Laser Lines Ltd
www.laserlines.co.uk

Italy
Optoprim Srl
www.optoprim.it

Spain & Portugal
Laser technology SI
www.laser-technology.com

Germany, Austria, Switzerland
von Gegerfelt Photonics
www.vongegerfeltphotonics.com

Sweden
Cobolt AB, HQ
www.cobolt.se

Israel
Lahat
www.lahat.com

India
New Age Instruments
& Materials
www.newagein.com

Australia
Warsash Pty Ltd
www.warsah.co.uk

Japan
Kantum Electronics Co Ltd
www.kantum.co.jp

PNEUM
www.pneum.co.jp

South Korea
SM Tech
www.lasersystem.co.kr

China
China Daheng Group
www.cdhcorp.com

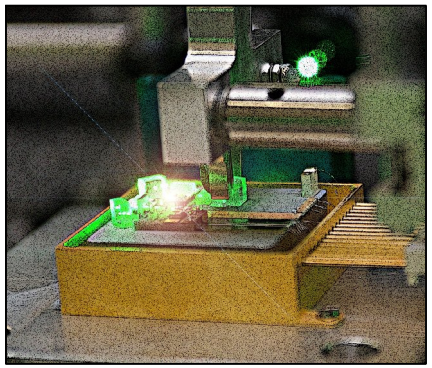
Singapore, Malaysia, Thailand
Photonitech Pte Ltd
www.photonitech.com

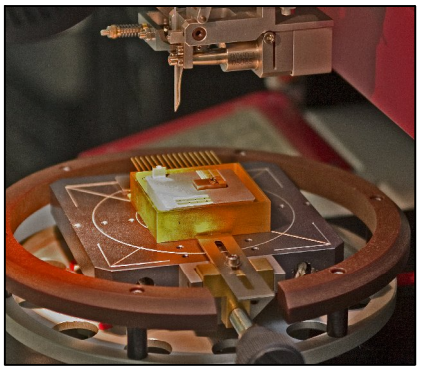
Taiwan
Tayhwa Technology Co., Ltd
www.tayhwa.com.tw

World-wide network of contracted sales representatives with developed market knowledge, professional teams and complementary offerings

Cobolt's Production Capcity

- 600 m^2 modern clean-room factory
- Optimised for volume DPSSL manufacturing
- Semi-automated preparation of platforms
- Capacity from 2012 to meet increasing demand of >1500 units/year





Cobolt Production Facility

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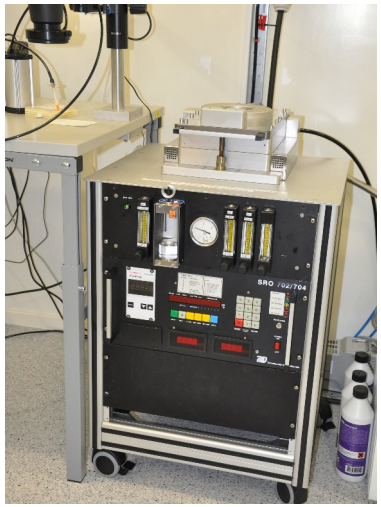




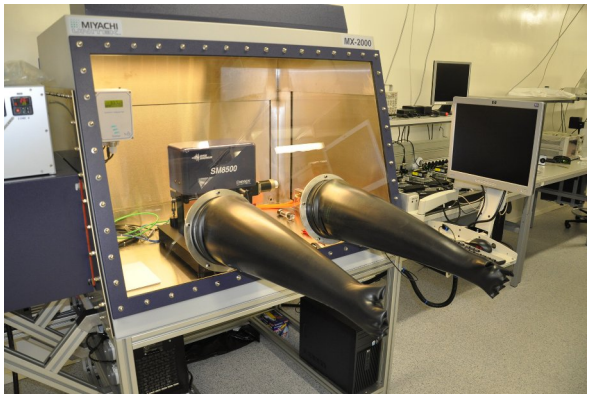

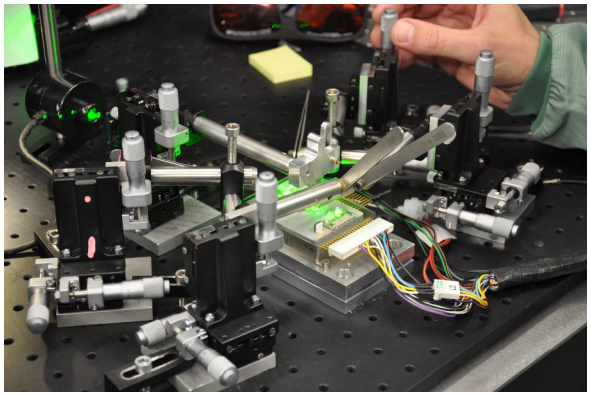


Cobolt HTCure™ Laser Manufacturing

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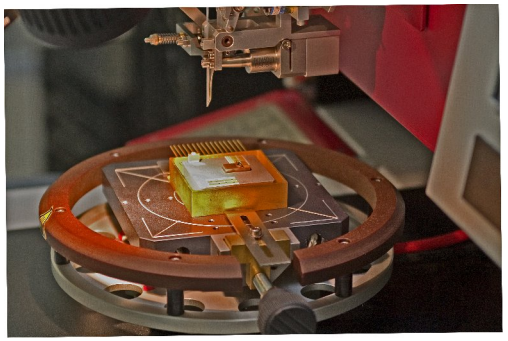
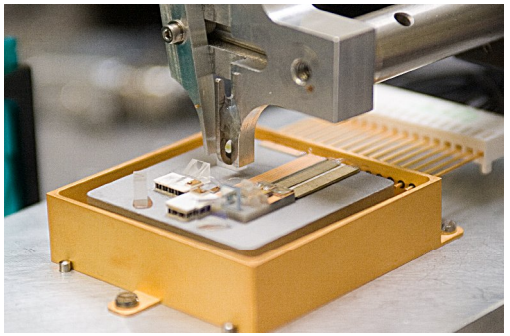
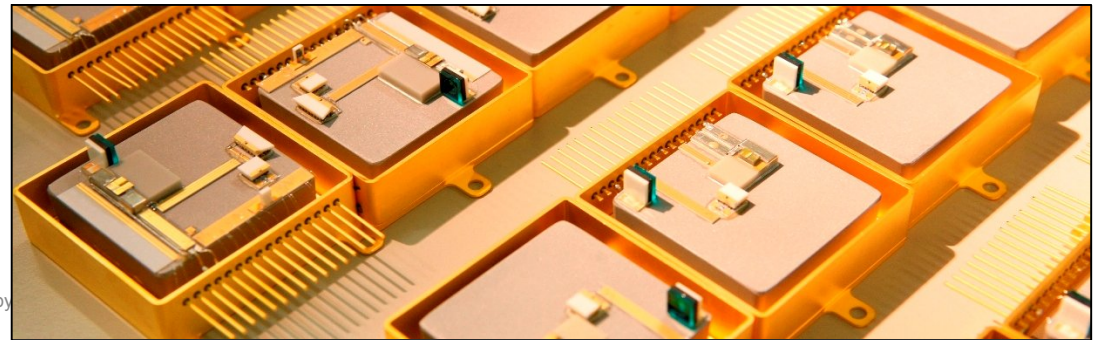
- Extreme thermo-mechanical stability allows for a completely new high temperature (>100°C) curing process for high precision mounting & fixation of laser cavity elements (US patent).
- Planar architecture, totally free from metallic mounts, after-curing processes and out-gassing.
- Hermetically sealed package
- Very tough environmental specifications:
  - Storage temperature: -30°C to +70°C (the whole laser is baked at >100°C during manufacturing)
  - Shock resistance: >60 g at 8 ms in operation (tested up to 200g at 2 ms non-operation)
- Very high level of power stability and pointing stability
- >4 500 installed units since 2007
- Secured reliability and lifetime



Pre-assembly (wire-bonding)



Active alignment of laser cavity prior to fixation using HTCure



Product Portfolio - CW DPSS Lasers

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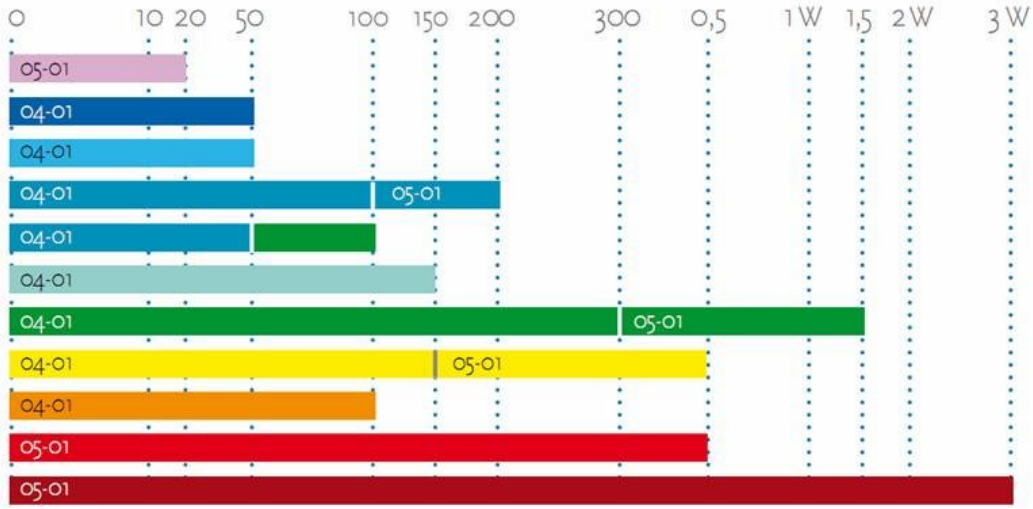
CW DPSS Lasers	
Zouk™	355 nm
Twist™	457 nm
Blues™	473 nm
Calypso™	491 nm
Dual Calypso™	491 + 532 nm
Fandango™	515 nm
Samba™	532 nm
Jive™	561 nm
Mambo™	594 nm
Flamenco™	660 nm
Rumba™	1064 nm



04-01 Series
Compact and low noise

- Compact and powerful SLM DPSS lasers
- CW power up to 300 mW in a perfect beam
- Ultra-robust hermetically sealed packages
- True fiber pigtailed option
- Low noise, <0.25 % rms

05-01 Series
Single frequency & High power ultra-low noise

- Single frequency, high power DPSS lasers
- CW power up to 2000 mW in a perfect beam
- Ultra-robust hermetically sealed packages
- Ultra-low noise, <0.1 % rms
- Immunity to optical feedback

Product portfolio – Diode lasers & Light engine capabilities

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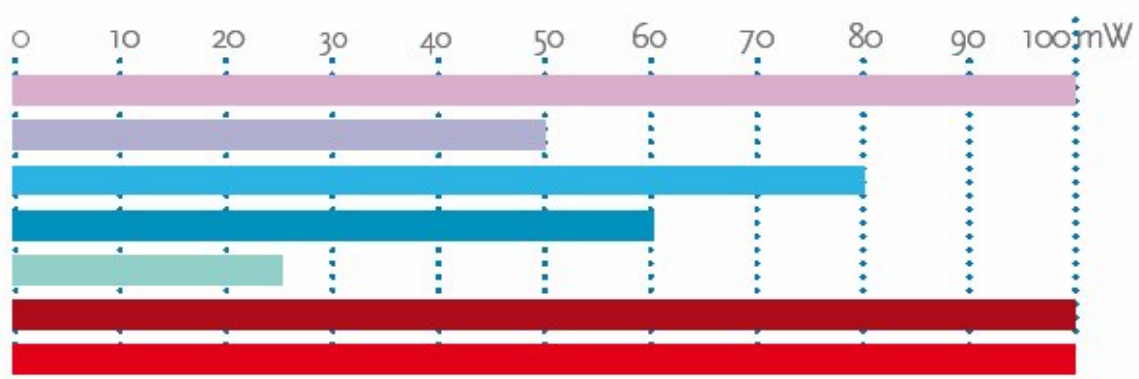
Diode Laser Modules



MLD Series

High performance laser diode modules

- Direct intensity modulation capability
- Fast and deep modulation from versatile input signals
- All controll electronics fully integrated into laser head

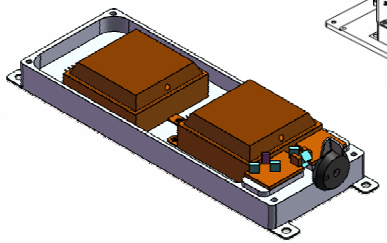
Light Engine Capabilities

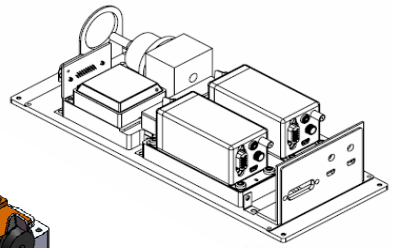
Dual Combiner™

- Compact 2-line laser combiner
- Permanently aligned
- Drop-in Ar+ laser replacement
- Modulated output option

Fiber pigtailed lasers

- SM/PM fiber
- Permanent and stable fiber delivery
- True pigtailing inside hermetically sealed package





Coming Products – Nanosecond Pulsed DPSSL

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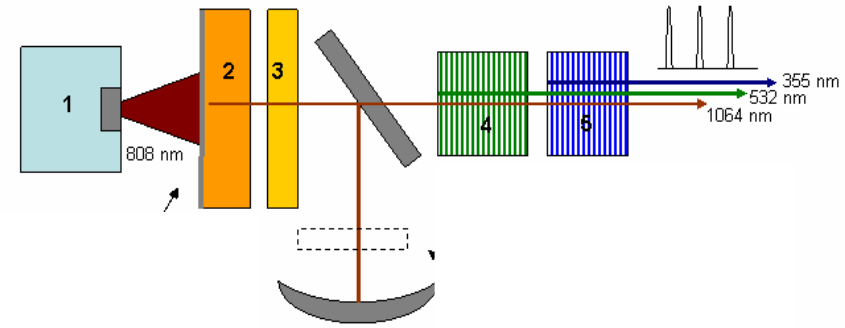
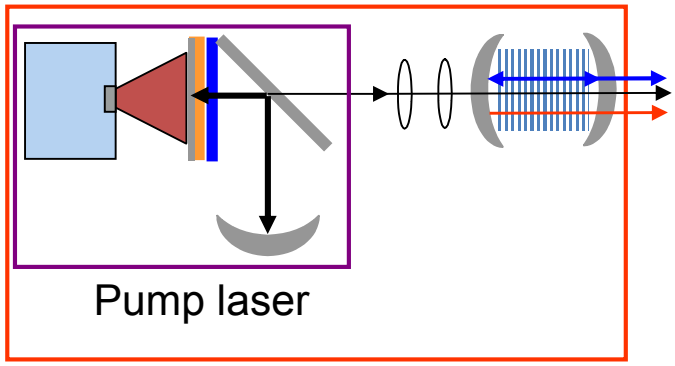
Cobolt compact ns pulsed 1064, 532, 355 nm



355 nm	0.1 W, 10 µJ
532 nm	1 W, 100 µJ
1064 nm	2 W, 200 µJ



Mid-IR OPO

1.35 µm – 2.13 µm	0.4 W, 40 µJ
1.06 µm	2 W, 200 µJ
2.13 µm – 5.00 µm	0.2 W, 20 µJ

- Compact (125x70x45 mm), efficient and robust laser in wavelength region 1.3 µm – 5 µm
- Pulsed output in 1 – 5 nanosecond range
- Average output power ~200 mW in mid IR range (3450 nm)
- Pulse energies ~20 µJ
- Bandwidth of output possible to tailor make, either narrow bandwidth or broad bandwidth
- Wavelength tuneable

R&D Capabilities Larger Laser Systems

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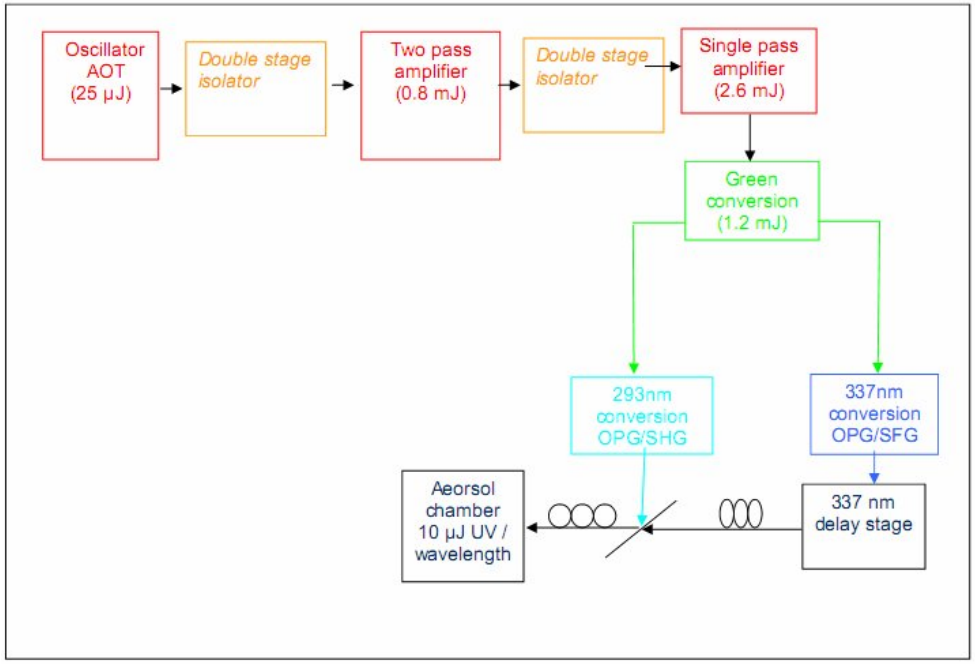
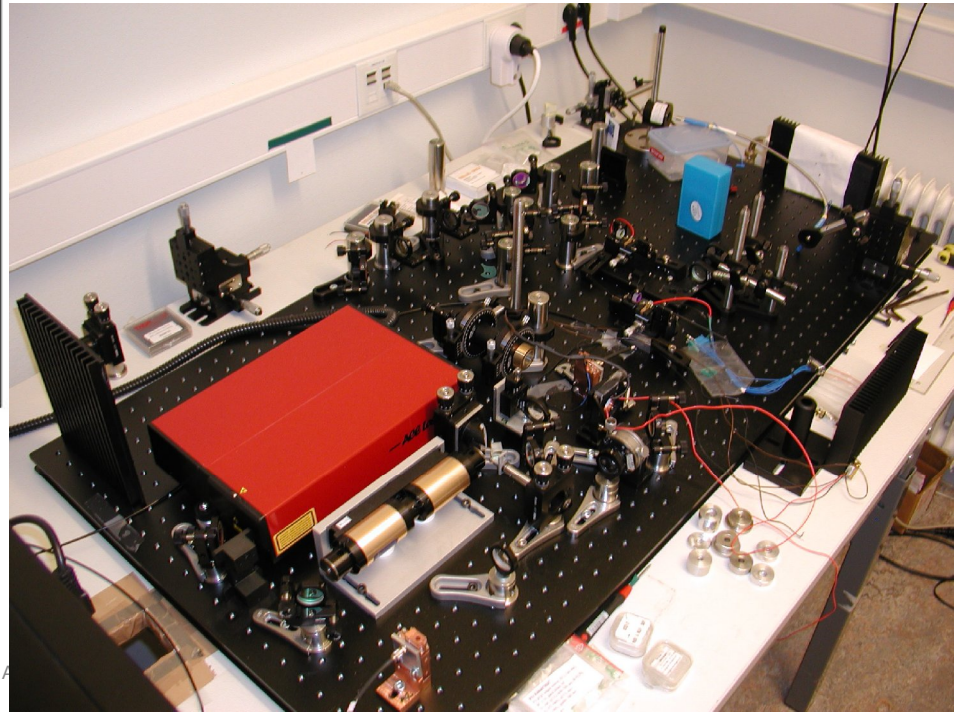
- High level of competence in laser physics from UV to mid IR (7 Ph.D.:s in physics)
- cw and nanosecond pulsed lasers
- µJ – mJ and mW – W // energy and power levels

FABIOLA



FABIOLA project

- 4 years project, 6 countries
- SME:s, large companies and Universities
- Complex laser source, detection and analysis equipment Integrated to one final system
- Application Biological Threat Alert System



Cobolt Market Segments - Overview

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1. BIOANALYSIS

Fluoresence Microscopy

Flow Cytometry

Bioscanners, Sequencing, Analysis

2. MEASUREMENT

Raman spectroscopy

Holography

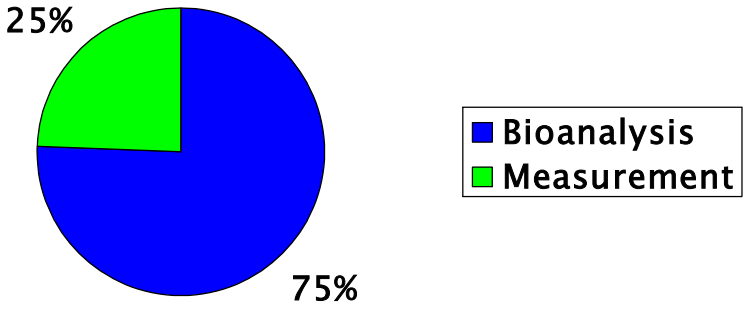
LDV, Fluid Dynamics

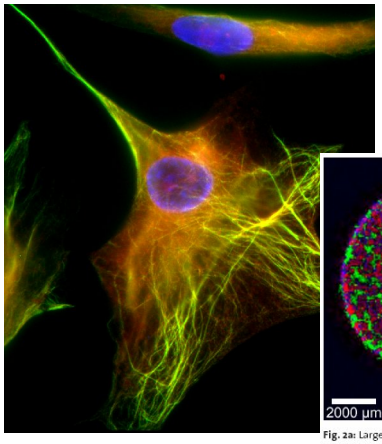
Quality control

3. Ns Pulsed

Range Finding

LIDAR, gas sensing





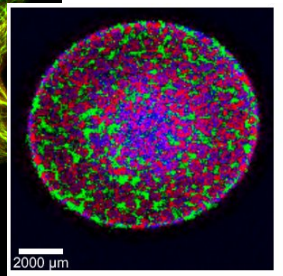


Fig. 2a: Large Area Raman image of ASA tablet (tablet B), scan range: 12.5 mm x 12.5 mm, 200x200 pixels (=40,000 spectra).

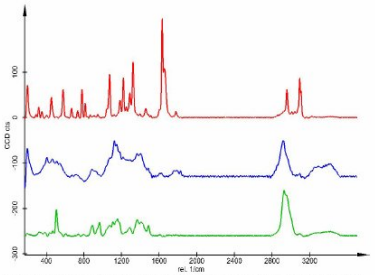


Fig. 2b: Corresponding spectra of the compounds contained within the tablet.

Laser Induced Fluorescence

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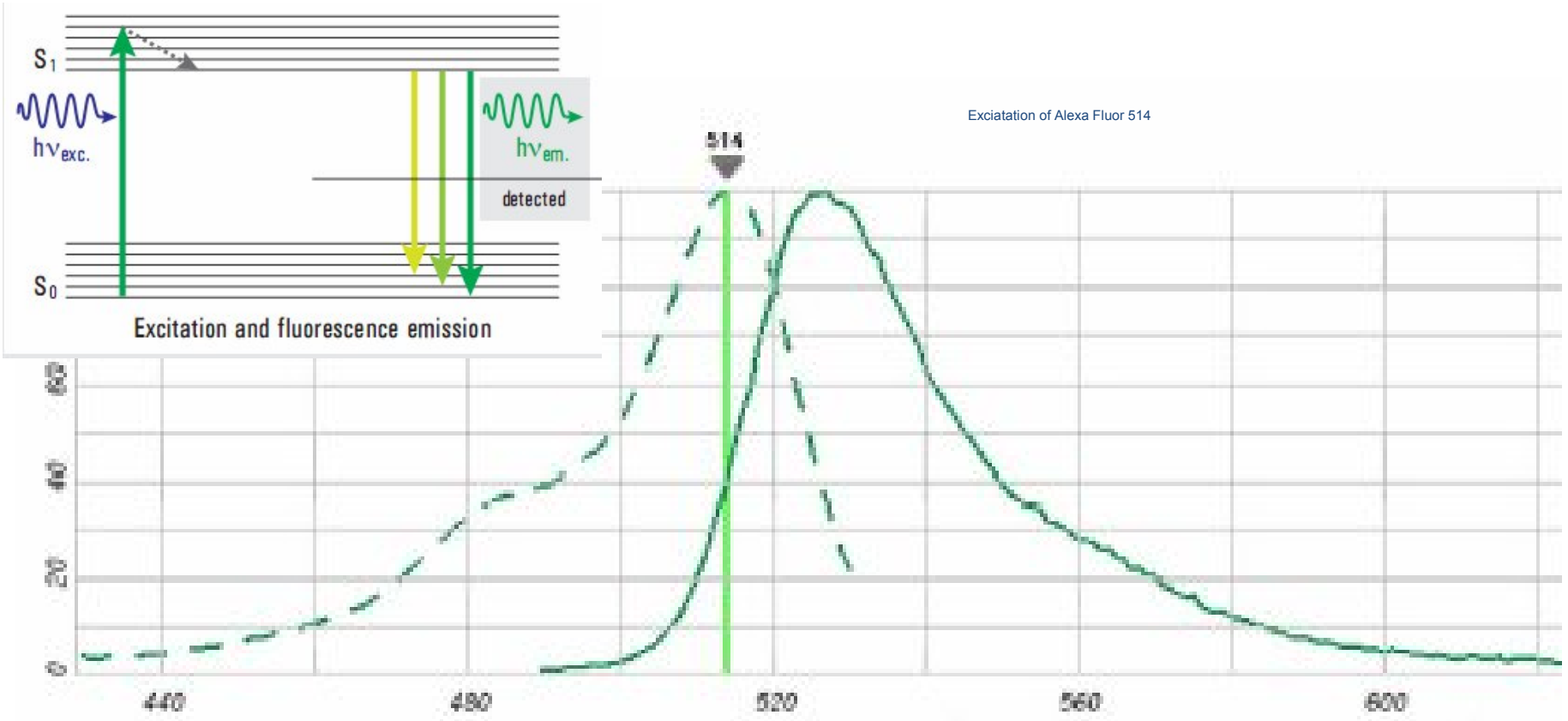
- Measuring and/or detection of fluorescence response after excitation with laser sources
- Extensively used in bioanalytical instrumentation technologies
- Studies of genes, proteins, cells, tissue etc marked with fluorophores (dyes, proteins etc)
- Imaging and/or quantitative data analysis
- Thousands of different fluorophores (need to match biochemistry/photochemistry properties for given application)



Confocal Microscopy

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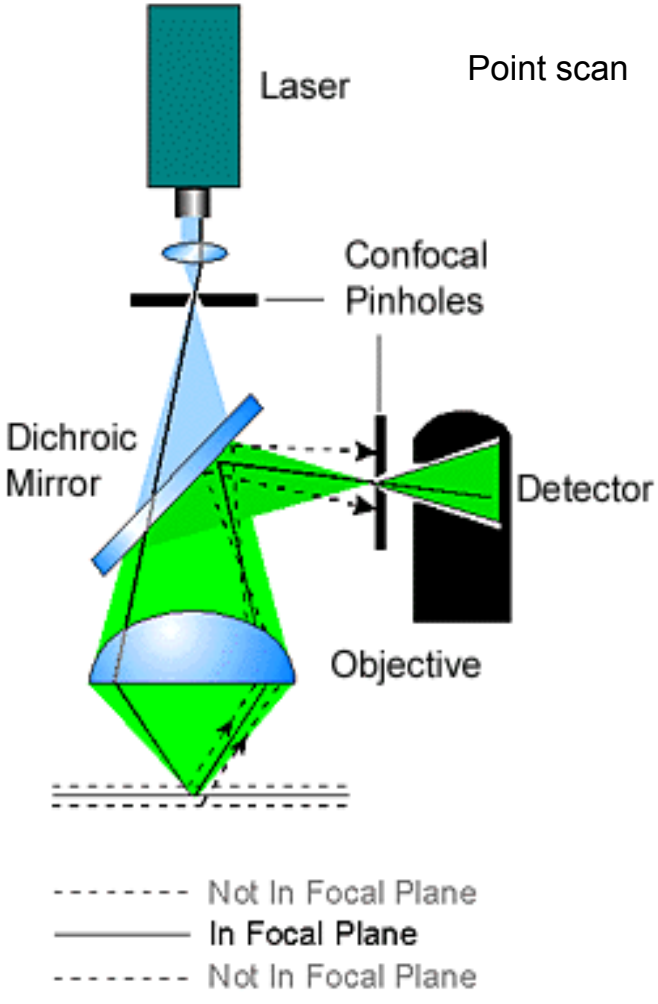
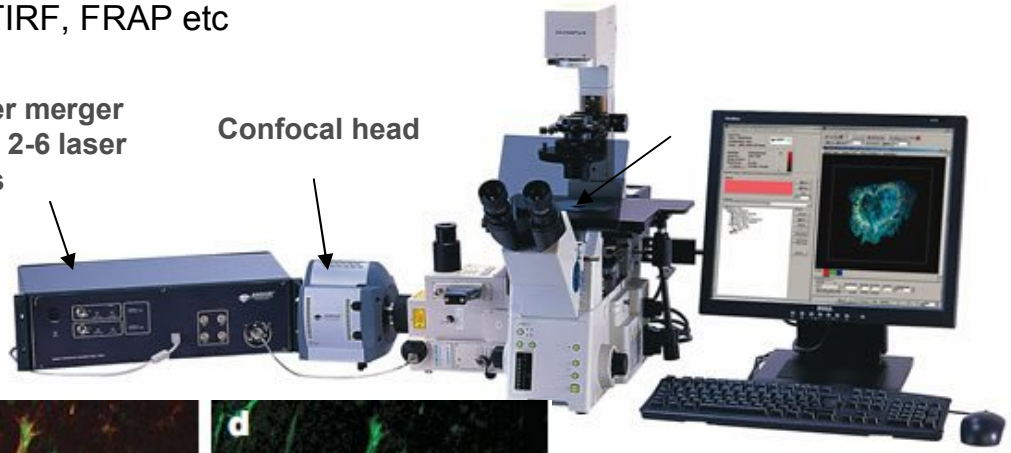
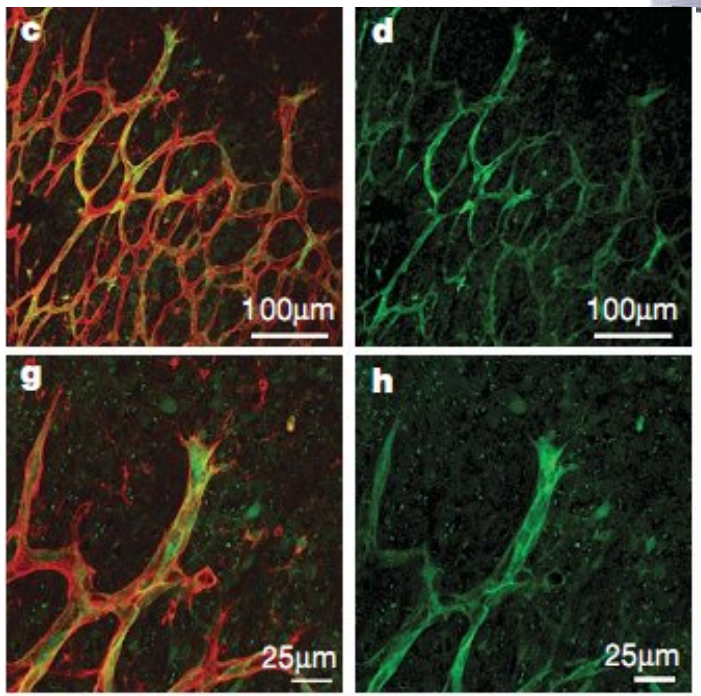
- 3-D imaging
- High resolution imaging tool
- Several methods: point scan, spinning disc, TIRF, FRAP etc







Angiogenes in-vivo:
Laser scanning confocal microscope
GFP (green),
isolectin B4 (red)

Courtesy: M.Hellström, Nature, 445 (2007)

Cell mitosis

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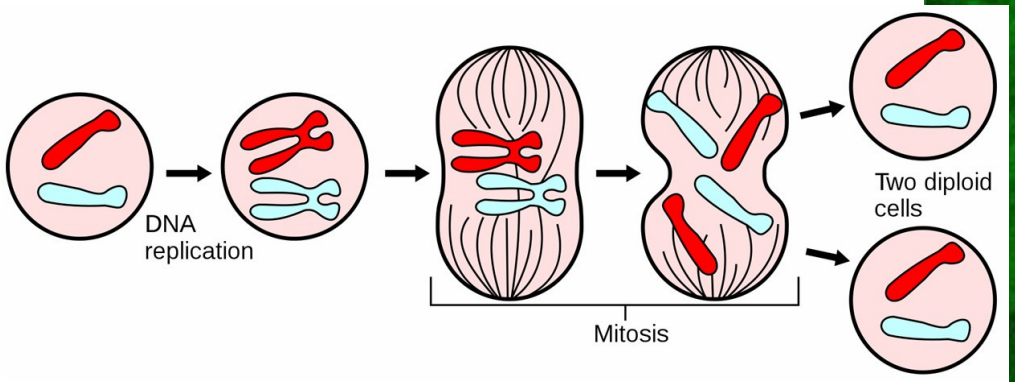
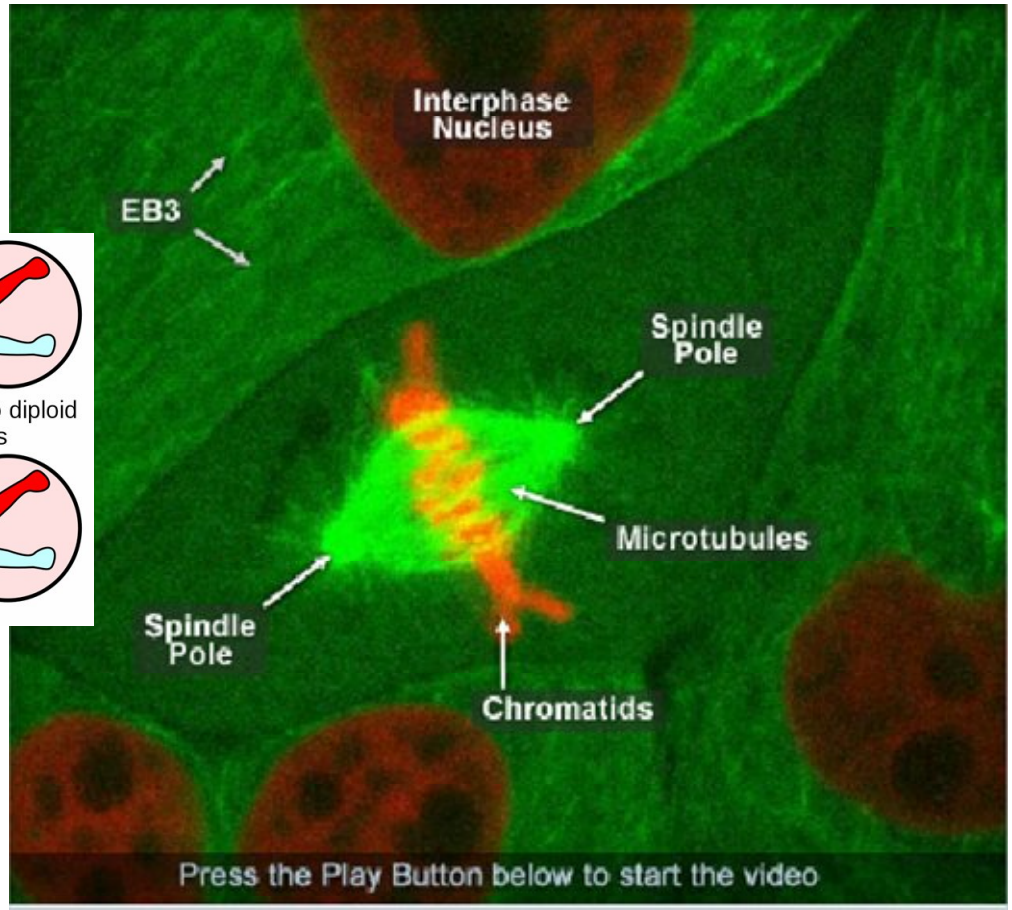
- **Observing mitosis in pig kidney Epithelial cells**

Courtesy: Nikon





Cell mitosis

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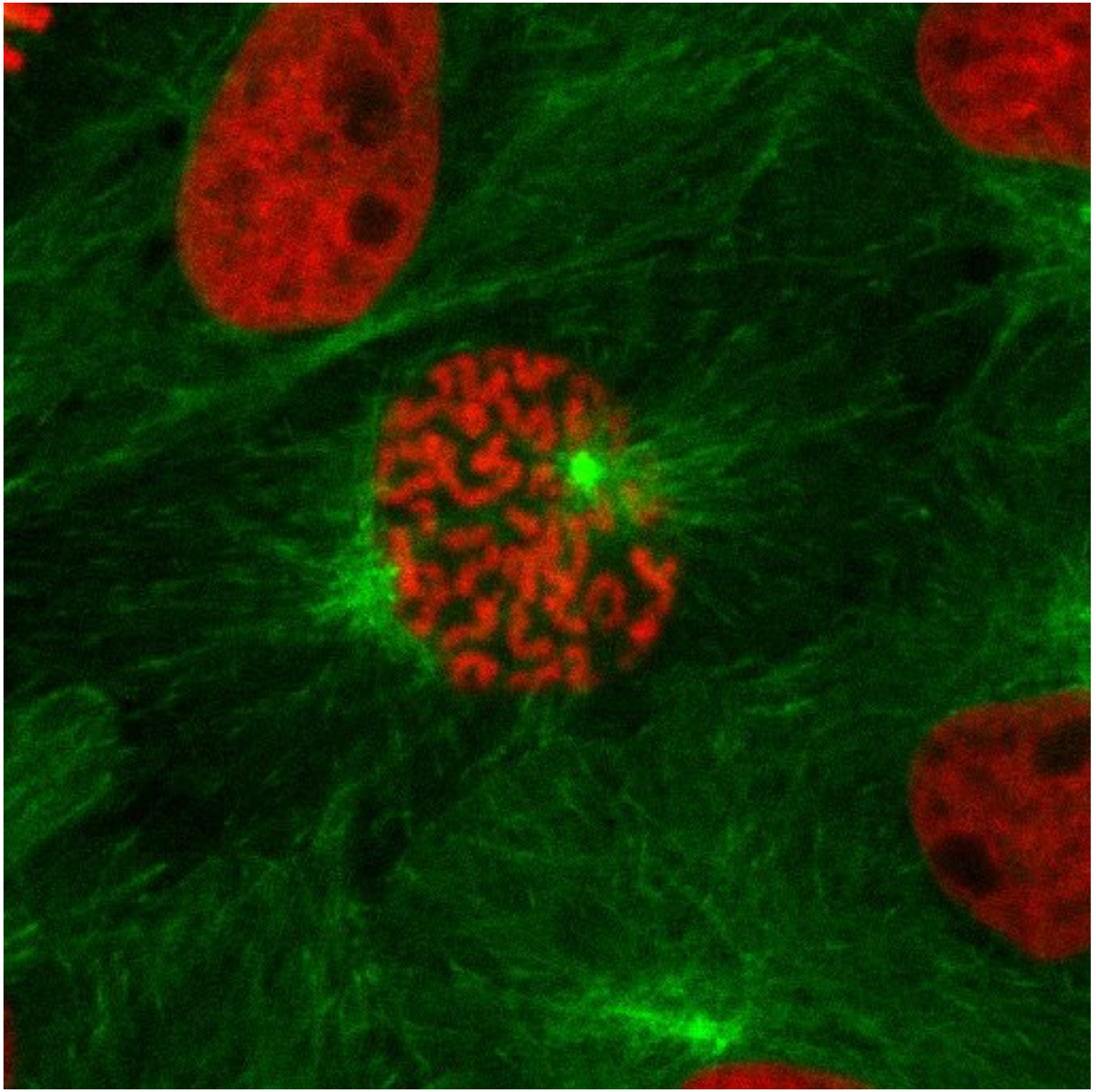

Flow Cytometry

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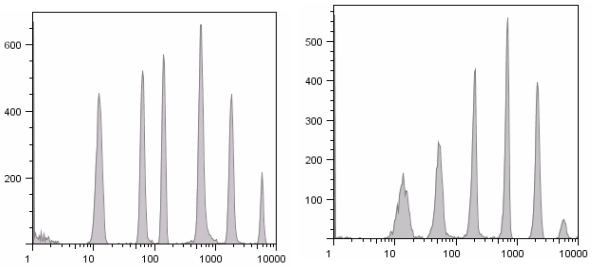
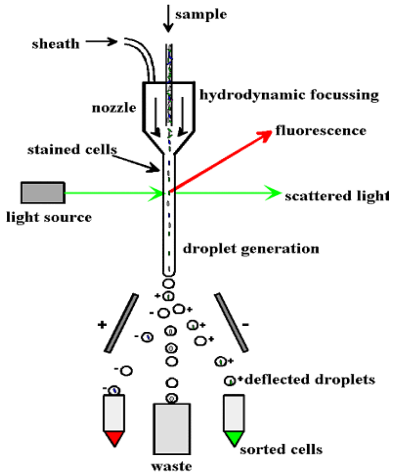
- **Statistical analysis of cell populations by scatter and/or fluorescence**
- **Counting or sorting**
- **Bench-top instruments for medical research, drug-development or diagnosis**

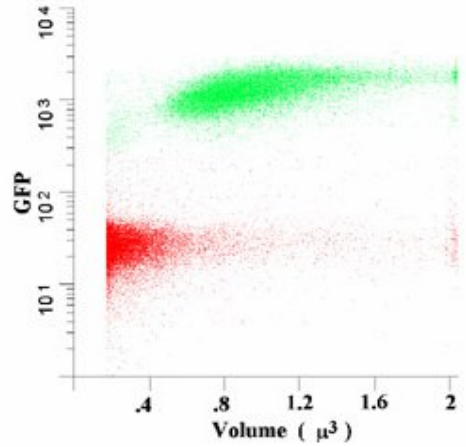
Dual
491 nm
532 nm
laser



Fluorescein bead array

Phycoerythrin-Cy5 bead array





Flow Cytometry

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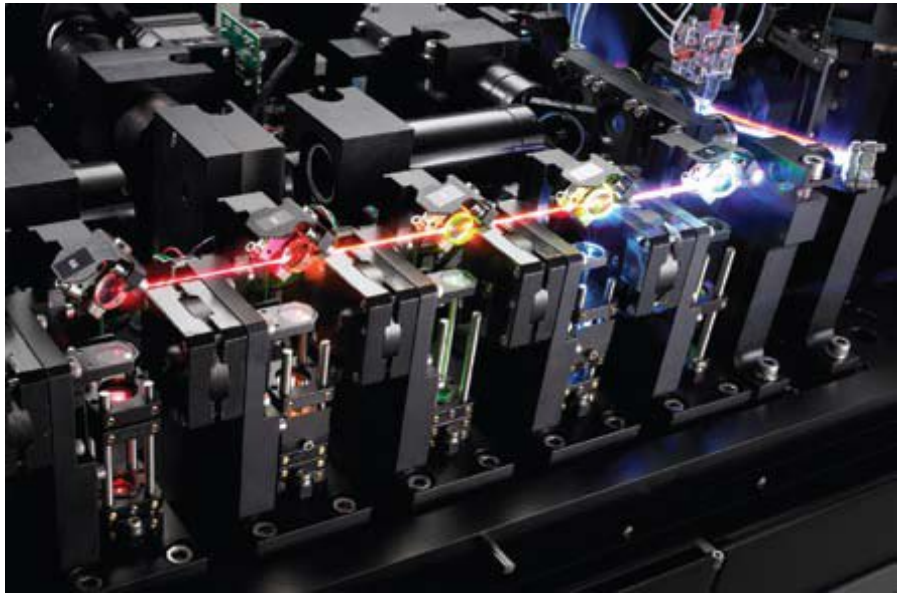
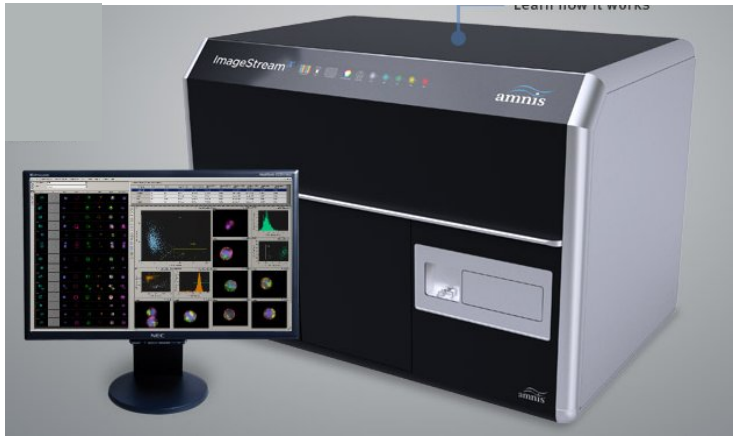
Courtesy: FACS Aria III cell sorter, BD



Courtesy: Imagestream, Amnis corp.



Raman spectroscopy

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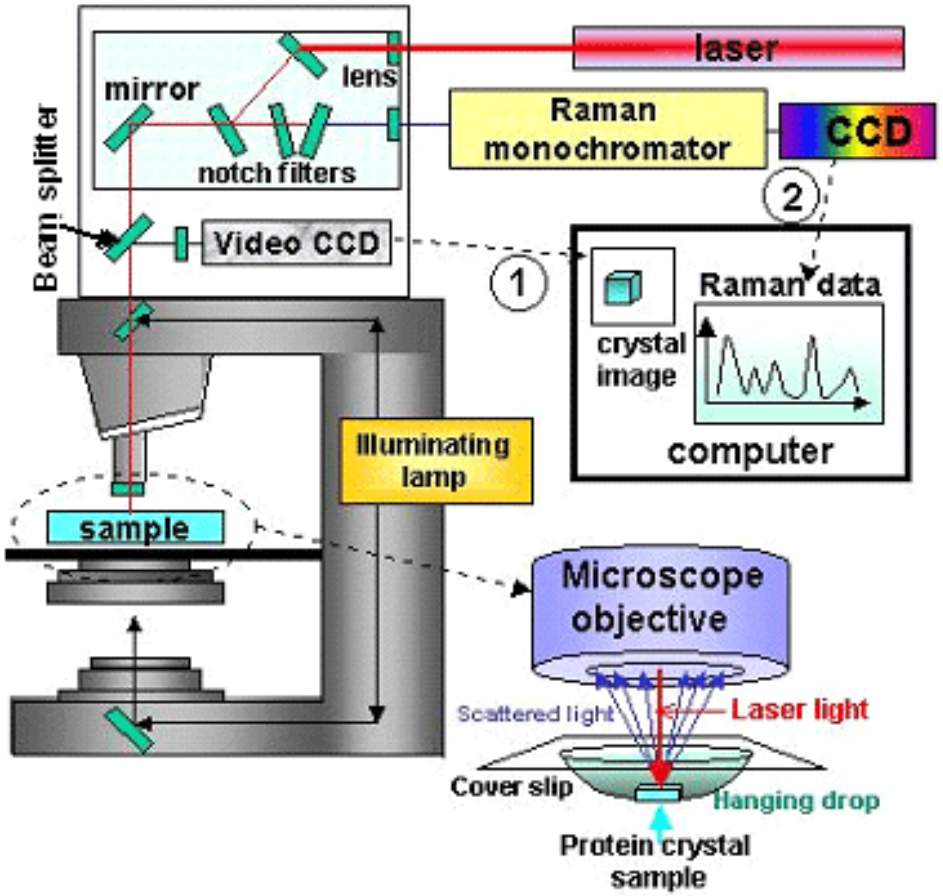
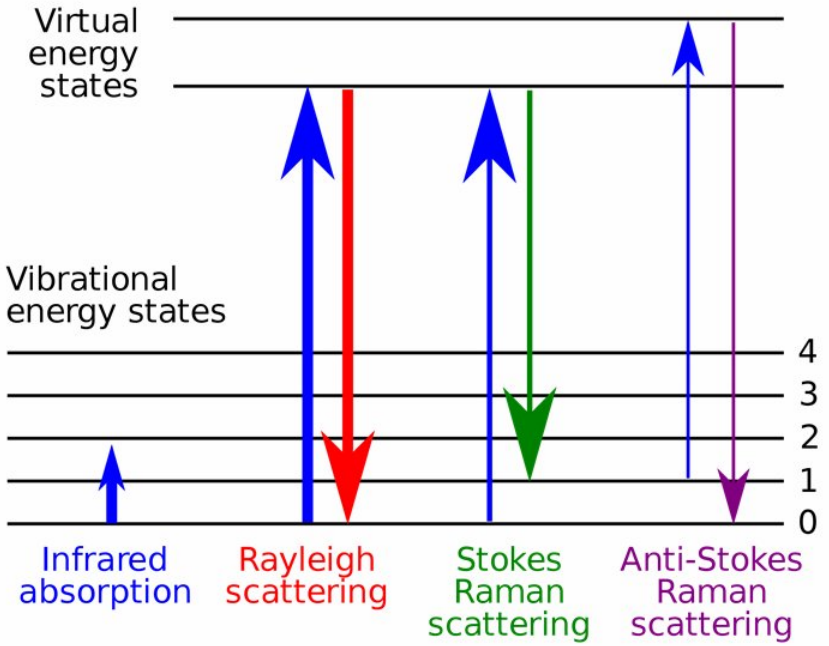
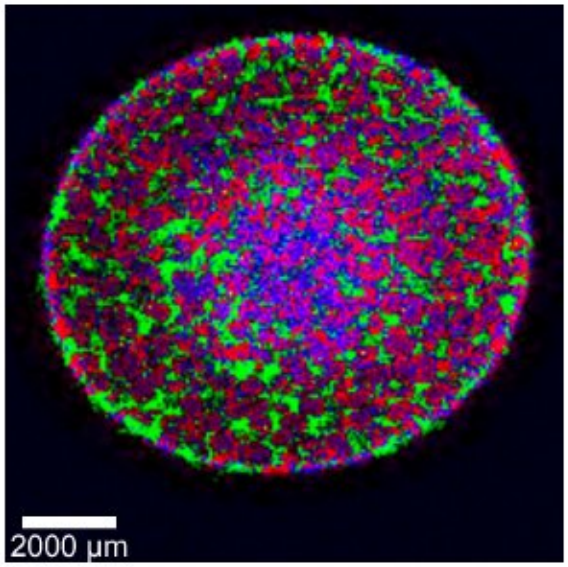




Raman Spectroscopy



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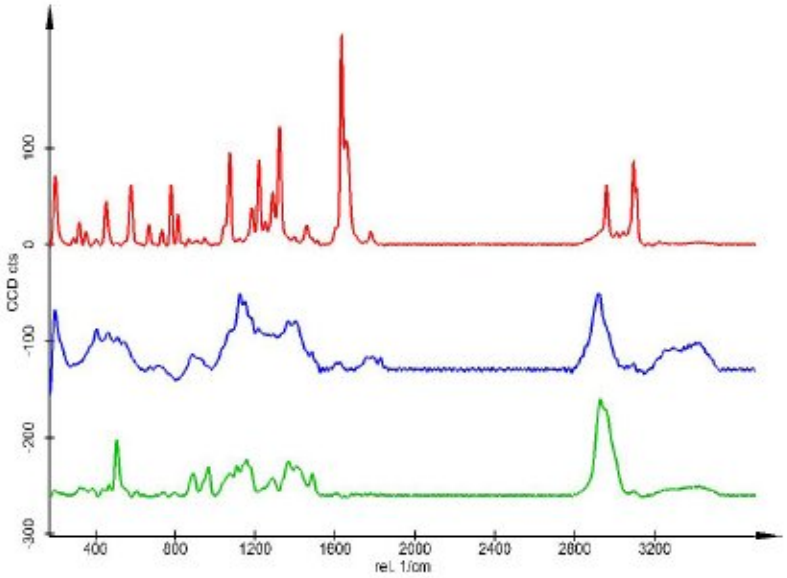

Fig. 2b: Corresponding spectra of the compounds contained within the tablet.

Cobolt Samba used to analyse the distribution of compounds within Aspirin (Co Witec)

- requires excellent wavelength stability and spectral purity
- PPKTP is a natural spectral filter, no Raman shifts from laser crystal

From Academic Research To Small Company

Research at Royal Institute of Technology (KTH)

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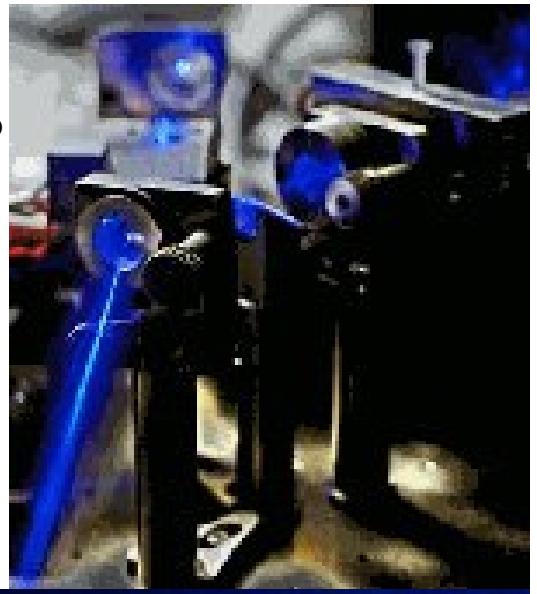
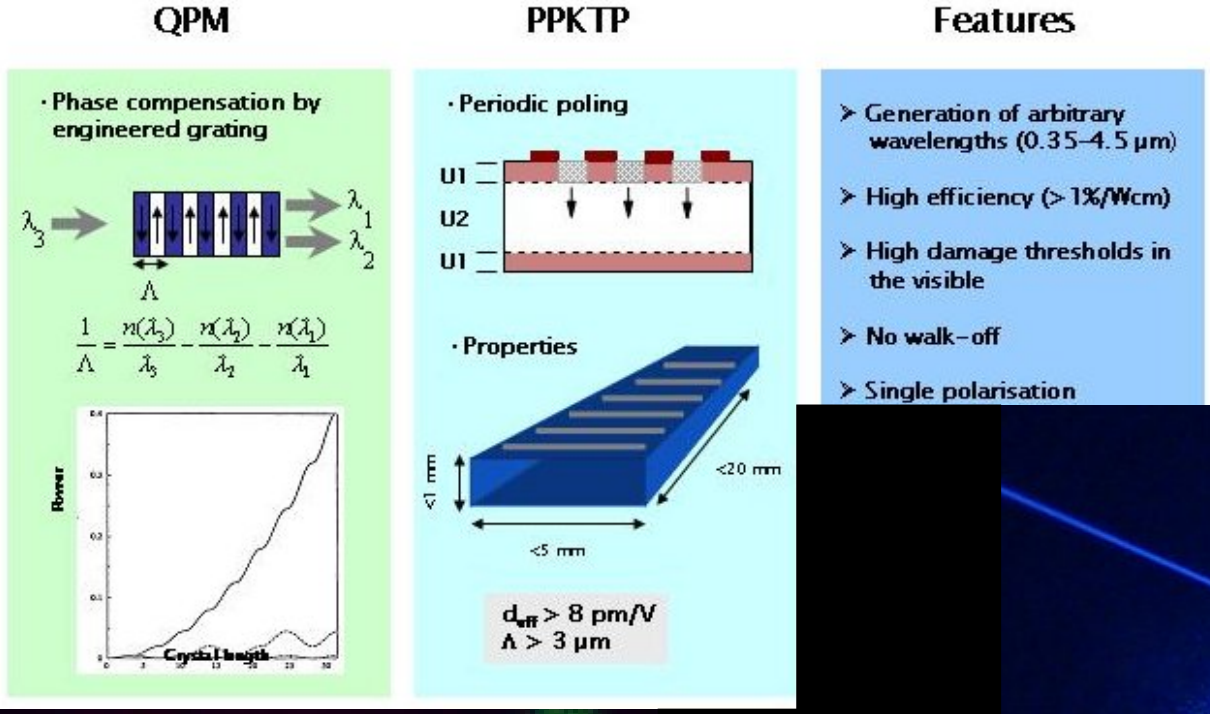
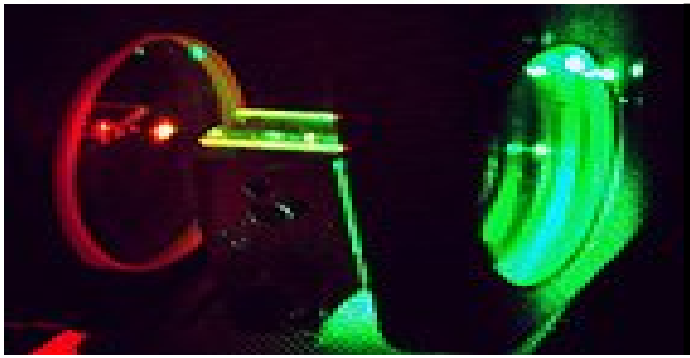
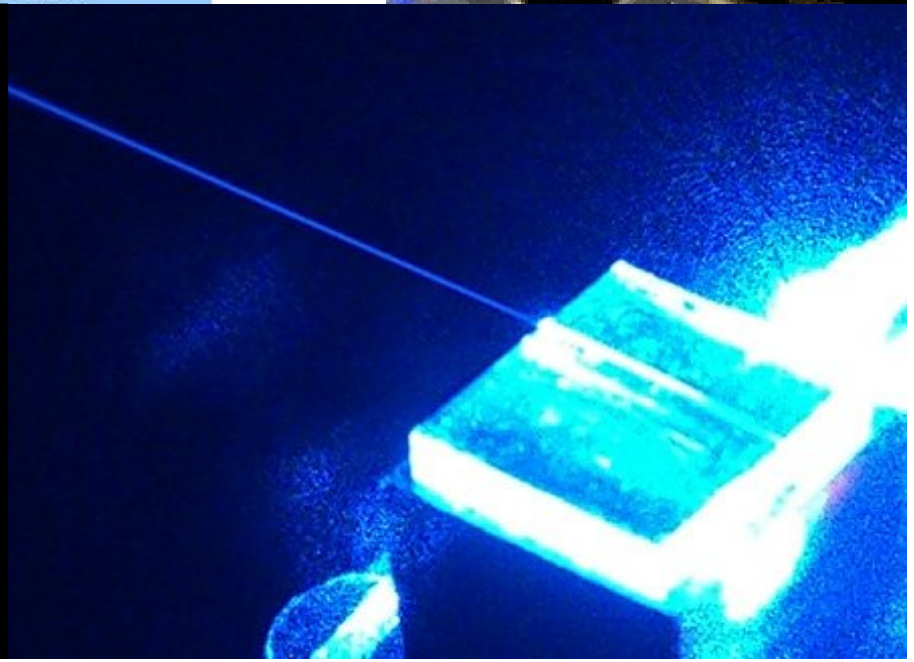
Laser physics and non-linear optics

The Key-Enabling Technology: Quasi-Phase Matching in PPKTP









The Starting Point

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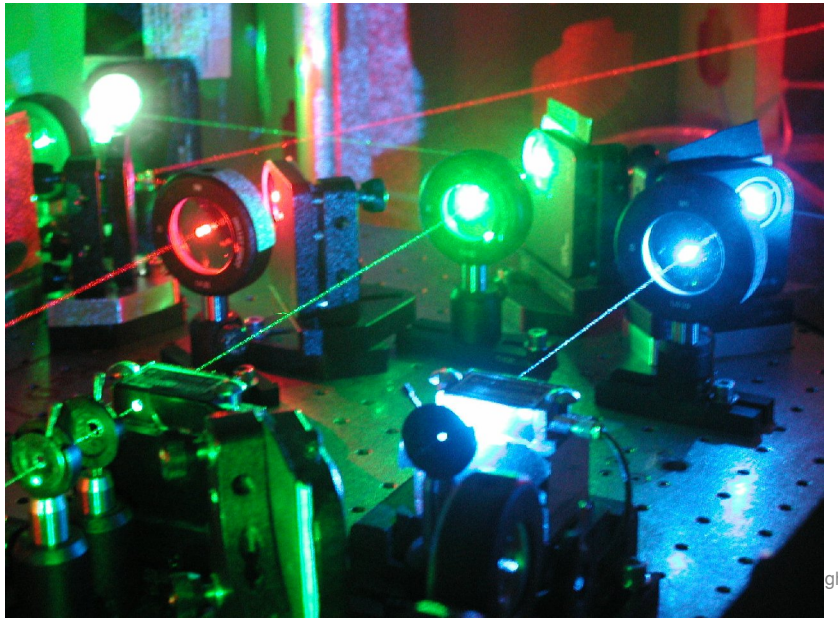
- Founded 2000 by Dr. Håkan Karlsson and Prof. Fredrik Laurell from Laser Physics group KTH, Stockholm.

- Business idea: development and commercialization of lasers (blue and green) for laser-TV

Challenge No 1

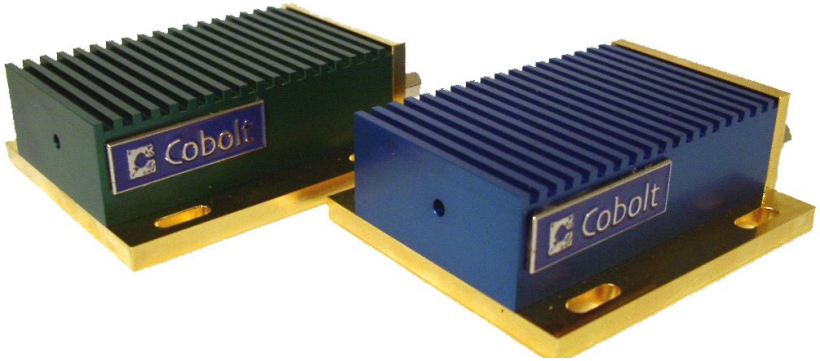
- Modified business idea 2002: develop lasers targeting biotech market

- Attract right amount and type of investment capital **Challenge No 2**



- Find good people with the right competencies

Challenge No 3



Product Development

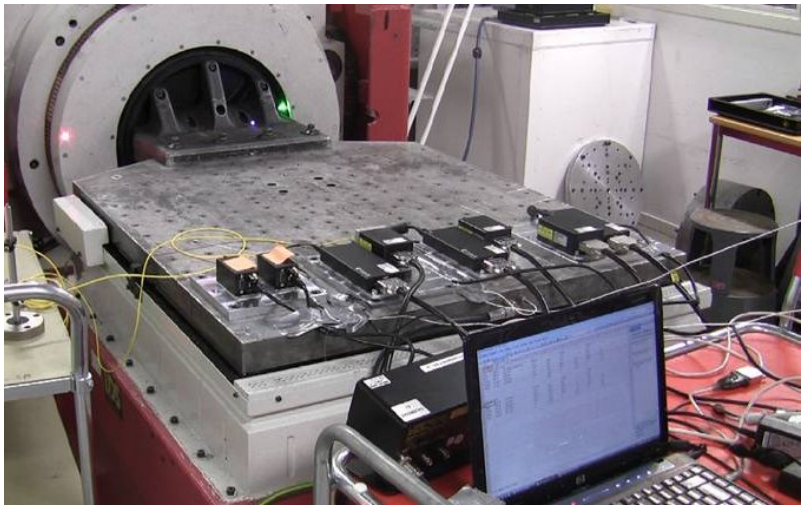
- **Demonstrators on optical table vs. Products for shipment**

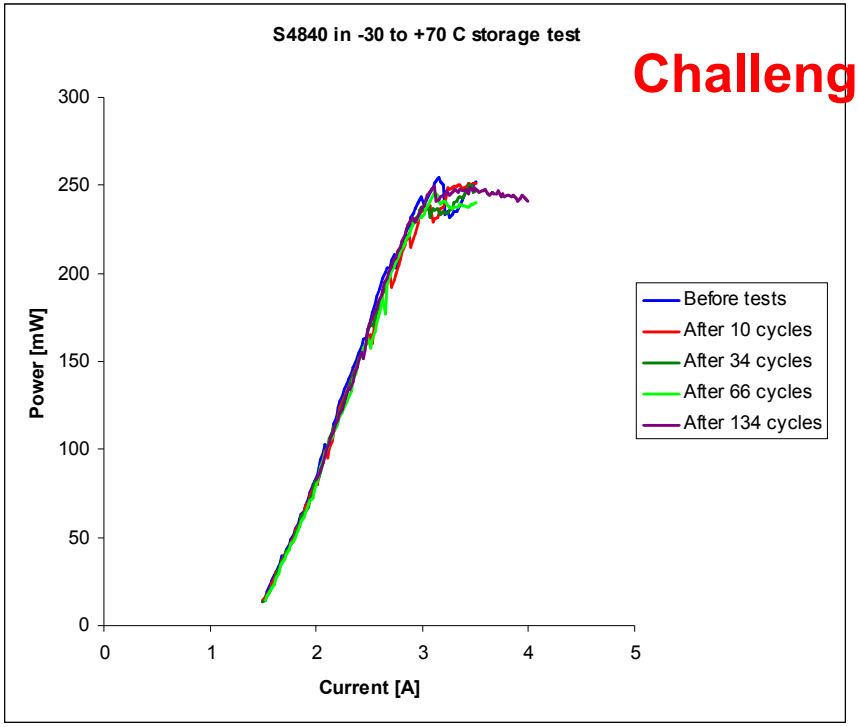
Challenge No 4

- **Release 04-01 platform Oct 2007**

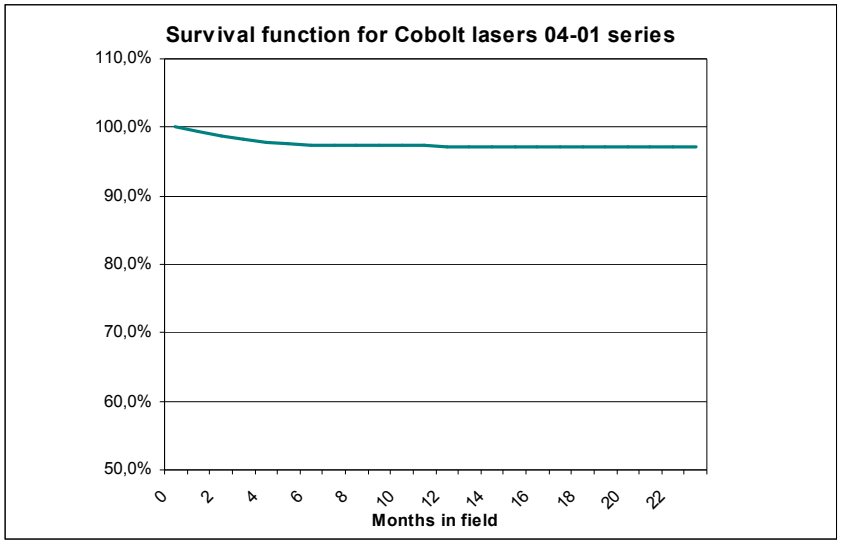
- **Best technical solution vs. good enough**

Challenge No 5





PI-slopes of Cobolt Samba 532 nm during non-operation temp.cycling 134 times -30 to 70°C



Survival function of Cobolt 04-01 lasers over 2 years. Include all kinds of reported issues. Very low risk of failure after typical installation period of 4-6 months

Product Development

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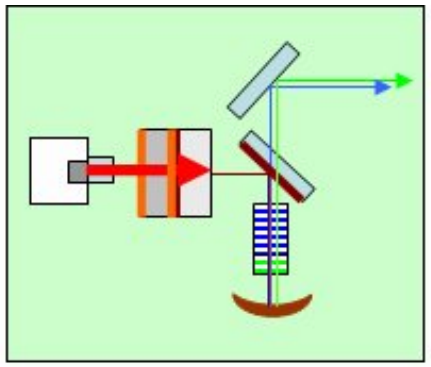
- **Staying ahead of competition: Through own innovation and close collaboration with academia**

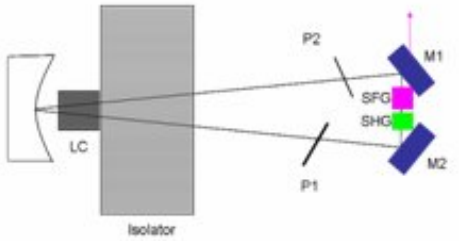
Challenge No 6

- **Multiple first-to-market releases 2006-2010**
- **Release 05-01 platform Oct 2010**
- **Release MLD-06 platform Nov 2011**

- **Multiple joint development projects national and international between Cobolt and Academia**



Cobolt 04-01: *Frequency doubling and mixing of compact standing-wave CW DPSSL*

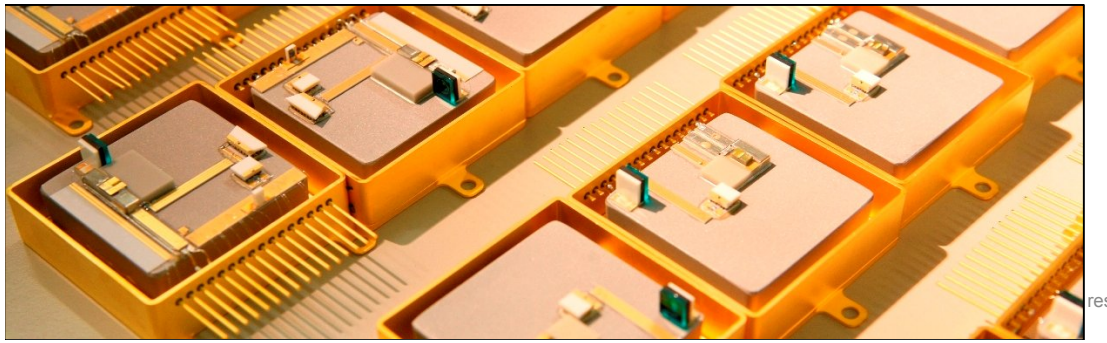


Cobolt 05-01: *Frequency doubling and mixing of ring-cavity CW DPSSL for ultra-low noise and power scaling*

Manufacturing

Challenge No 7

- **Facilities that is flexible and possible to expand.**
- **Cobolt have had four different localities. Moved in the latest facility 2007. Expanded manufacturing by 40% 2011. Capacity 1500 units per year.**
- **Choosen to make all assembly in house. But sourcing of components from where right quality and best price meet.**



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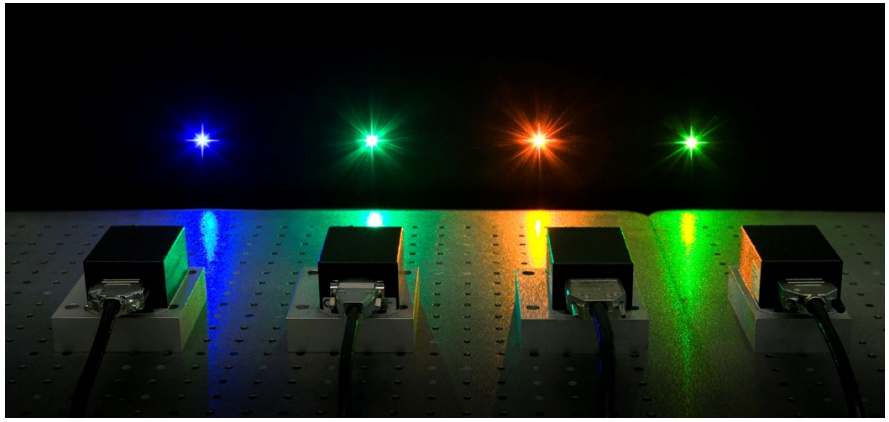
Knowing your customer and knowing what to offer!

Challenge No 8

- Best technical solution?
- Lowest price on the market?
- Highest quality?
- Best service?
- Most innovative products?
- Most customization possibilities?
- Upgrades?
- Consignment stock?
- Warranty?
- Other???



Summary Challenges

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- **Challenge 1: Timing of business idea**
- **Challenge 2: Attracting investment capital**
- **Challenge 3: The people and their competence**
- **Challenge 4: Understanding difference between Demonstrator and Products for shipment**
- **Challenge 5: Best technical solution vs. “good enough”**
- **Challenge 6: Staying ahead of competition**
- **Challenge 7: Manufacturing facility**
- **Challenge 8: Knowing your customer and what to offer**

Thank you!