# innovation & entrepreneurship

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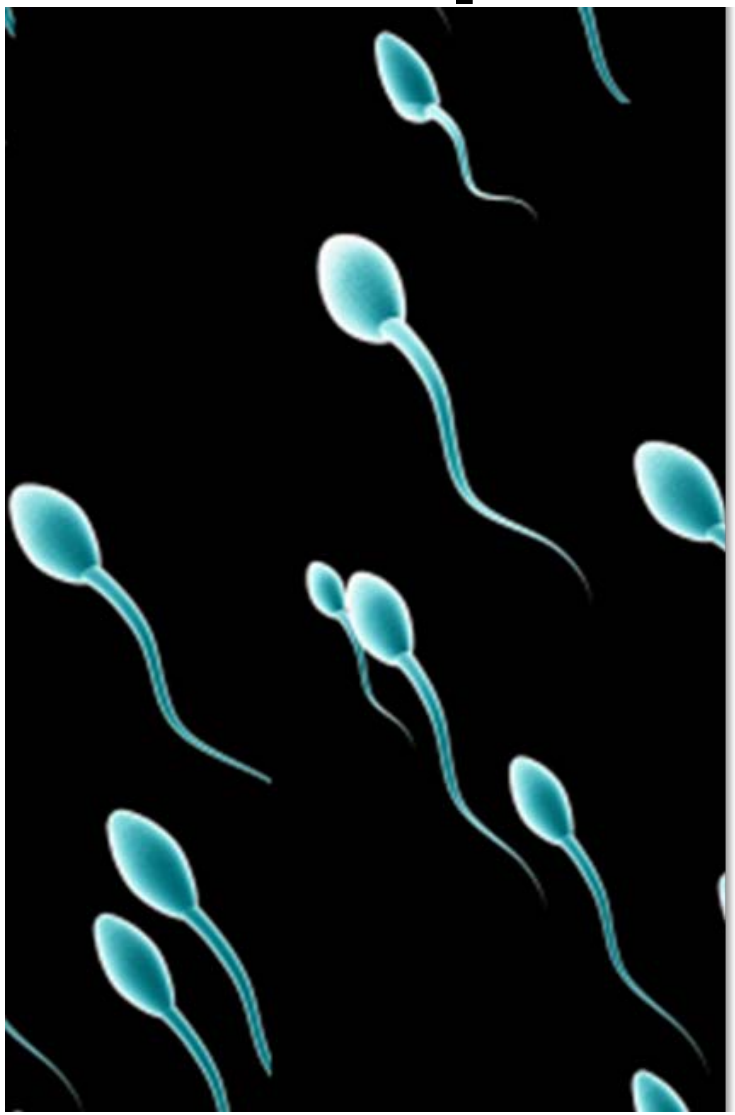
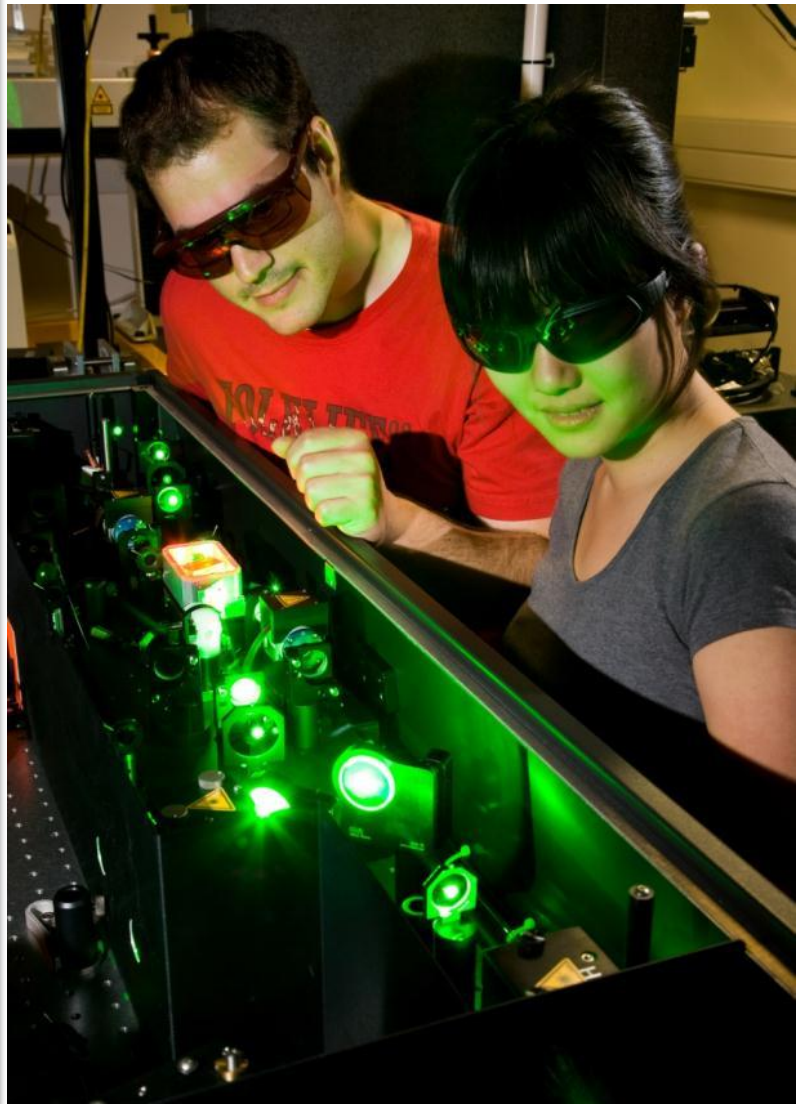
THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

Photon Factory

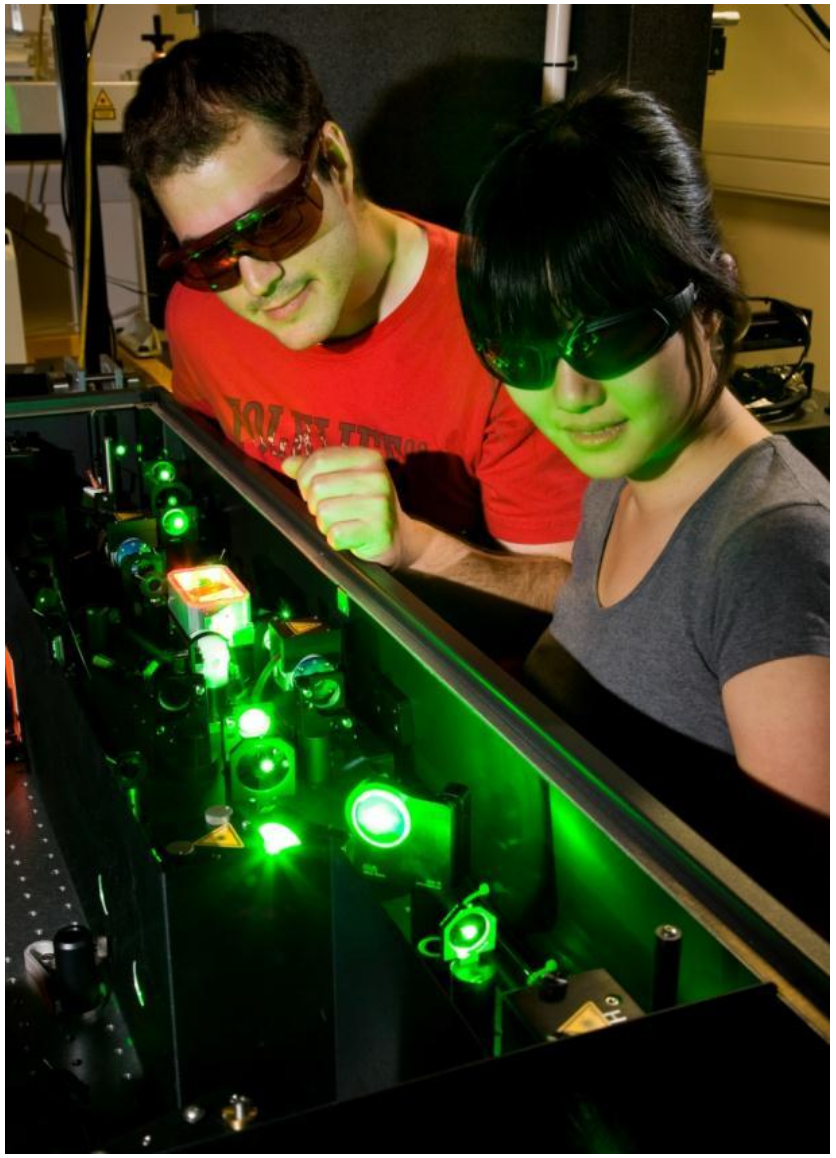
DODD-WALLS CENTRE
FOR PHOTONIC & QUANTUM TECHNOLOGIES

The MacDiarmid Institute
*for Advanced Materials and Nanotechnology*

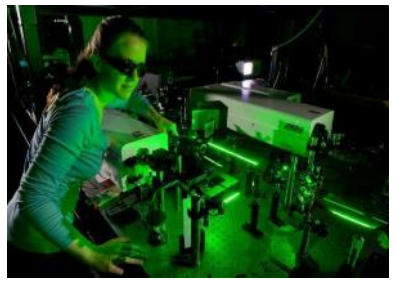


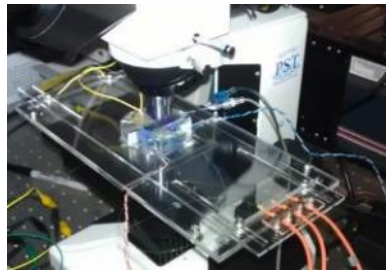


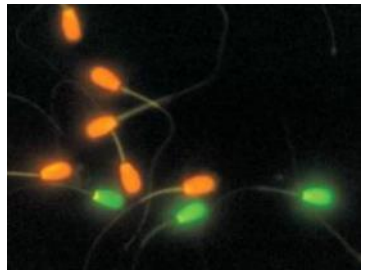
# Photon Factory: Exotic laser pulses for science & high-tech industry



# Photon Factory: Basic & applied research & entrepreneurship







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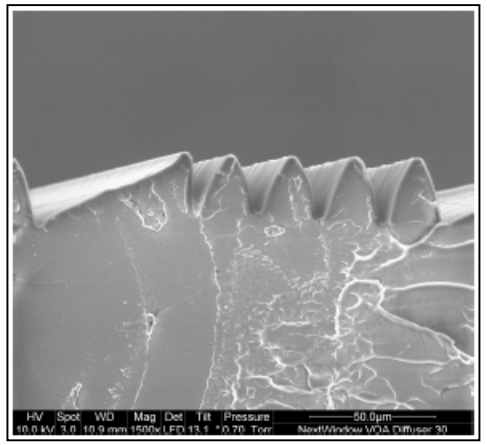
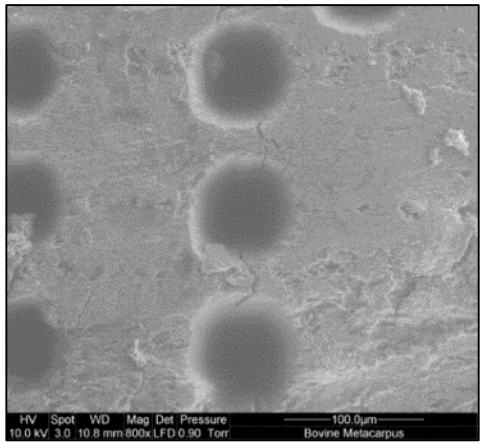
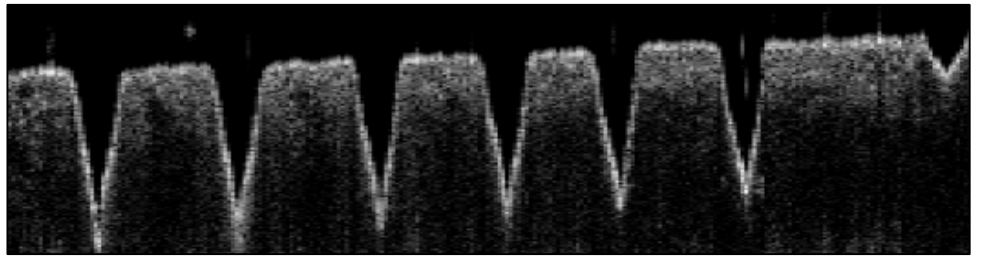
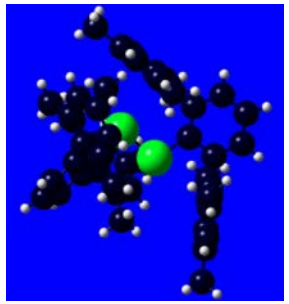
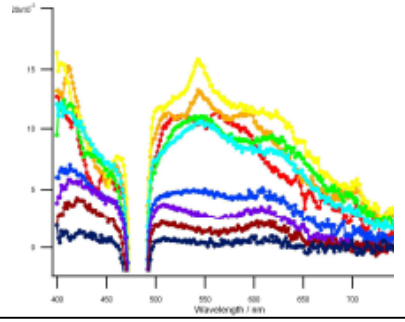










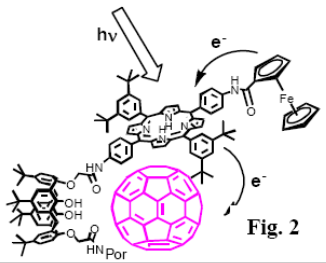
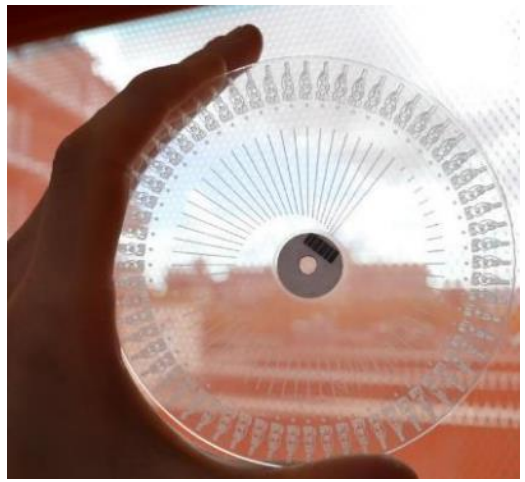


Fig. 2

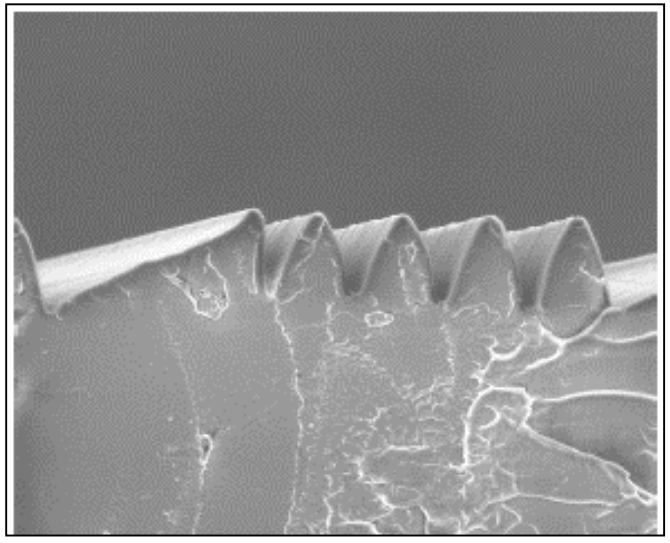


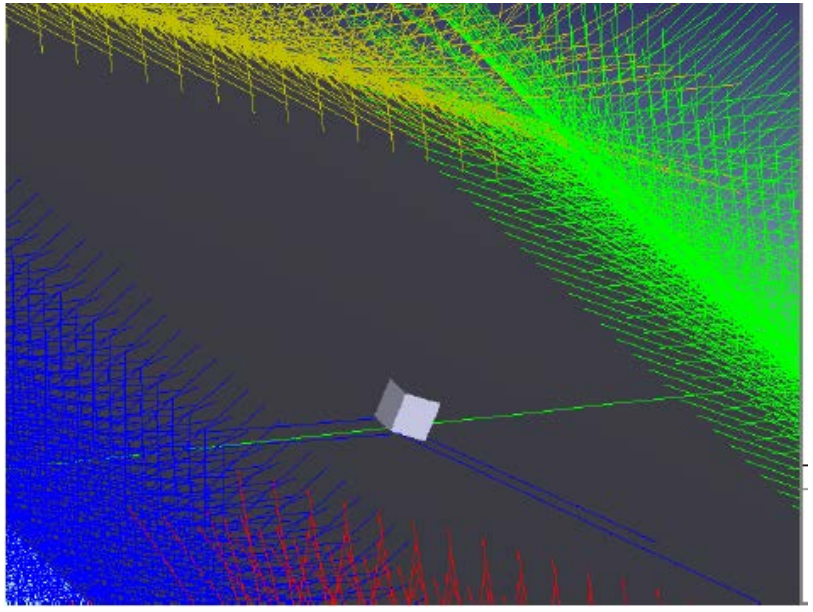
ORBiS
MILK ON A DISK

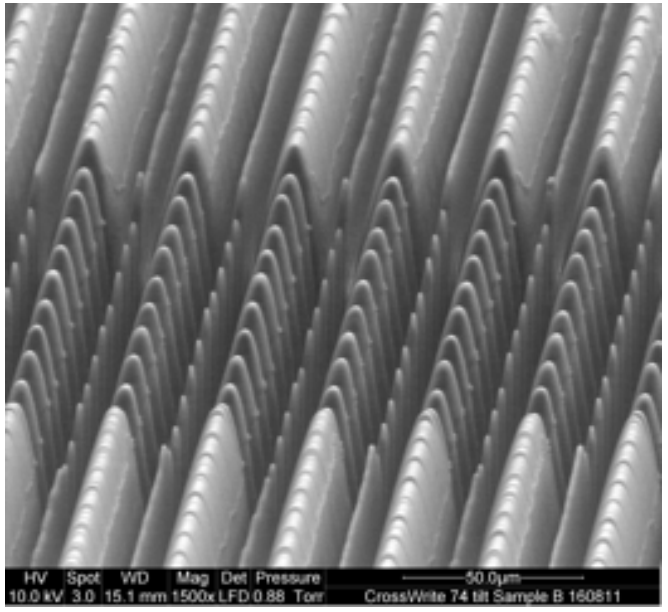
# *Innovation – with companies*

nextwindow

A SMART Technologies company



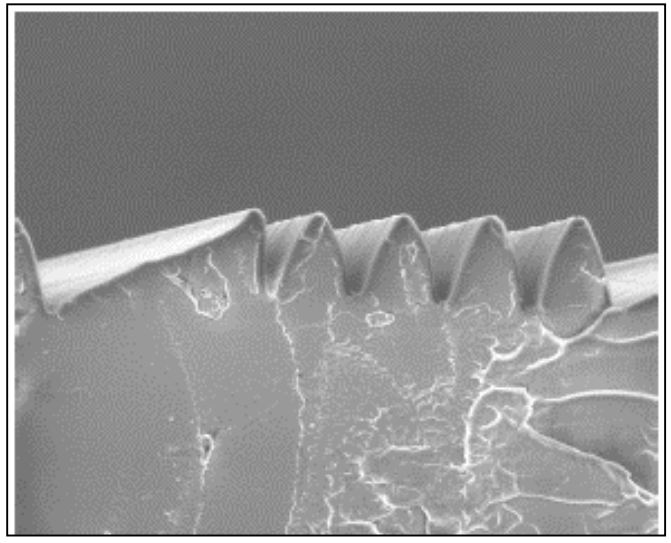


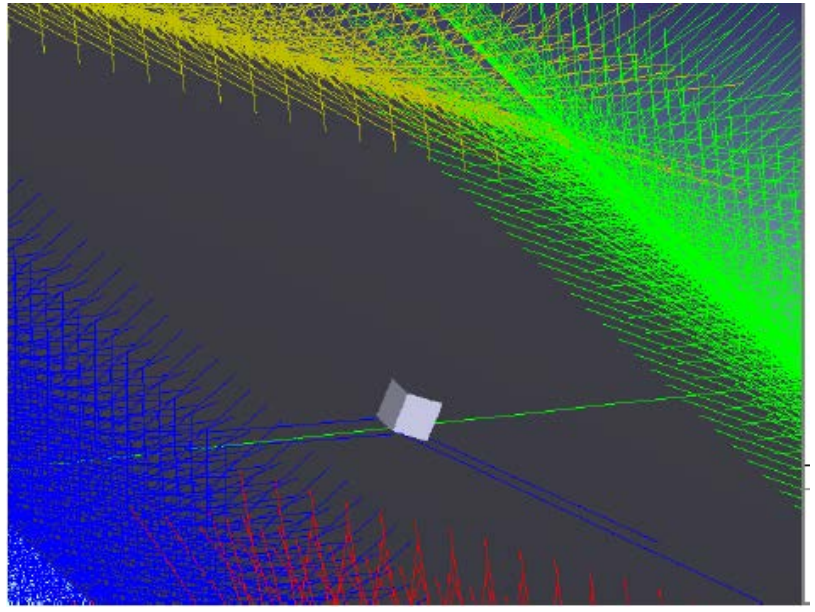


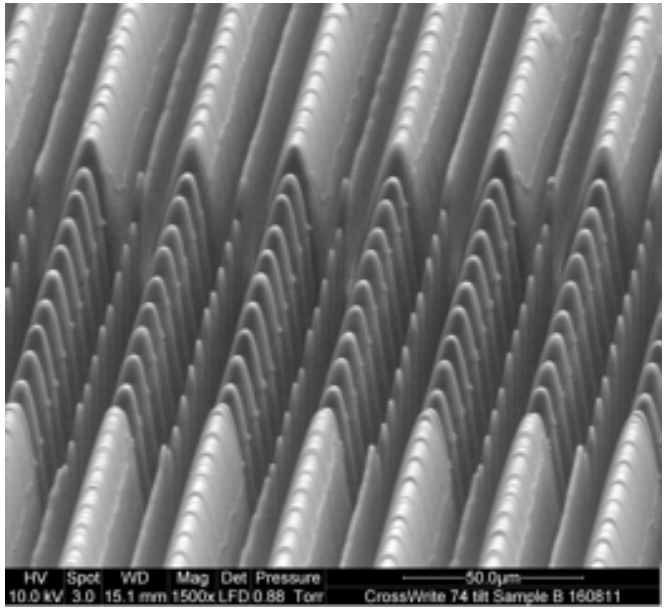
# *Innovation – with companies*

nextwindow
A SMART Technologies company

*"We are extremely pleased with the result, and I am personally very pleased with the University's performance ... You have demonstrated that you can deliver solutions within, and to be frank, often ahead of business time frames."*
*Gareth Bell, NextWindow*

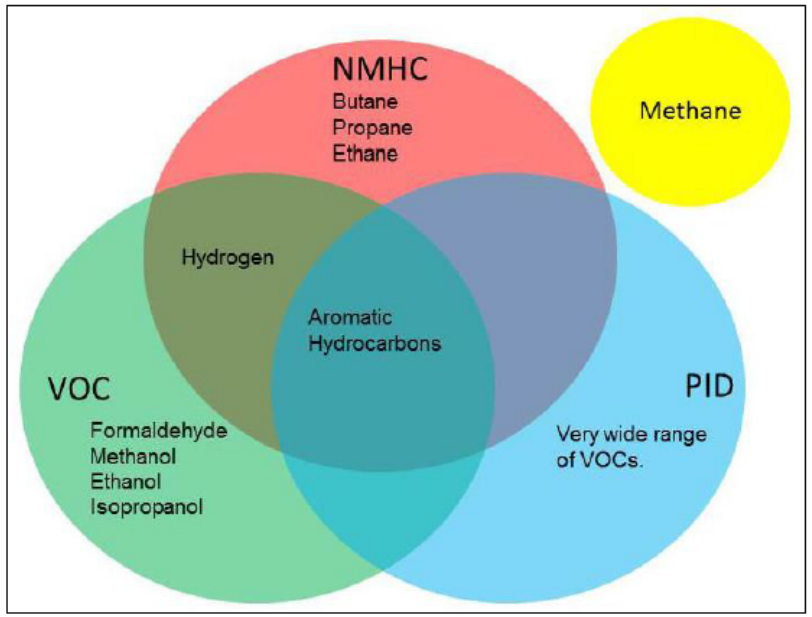


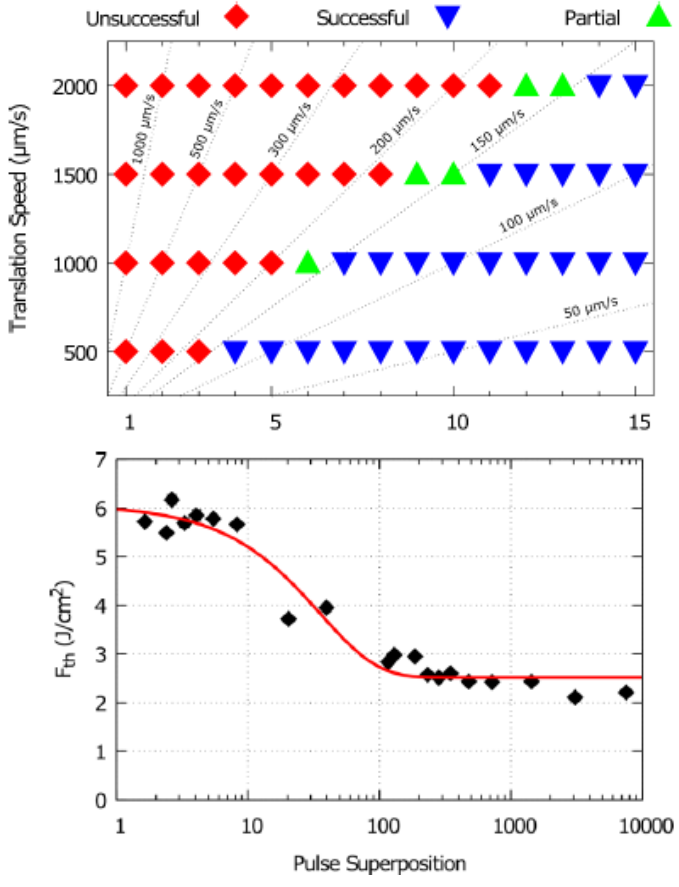


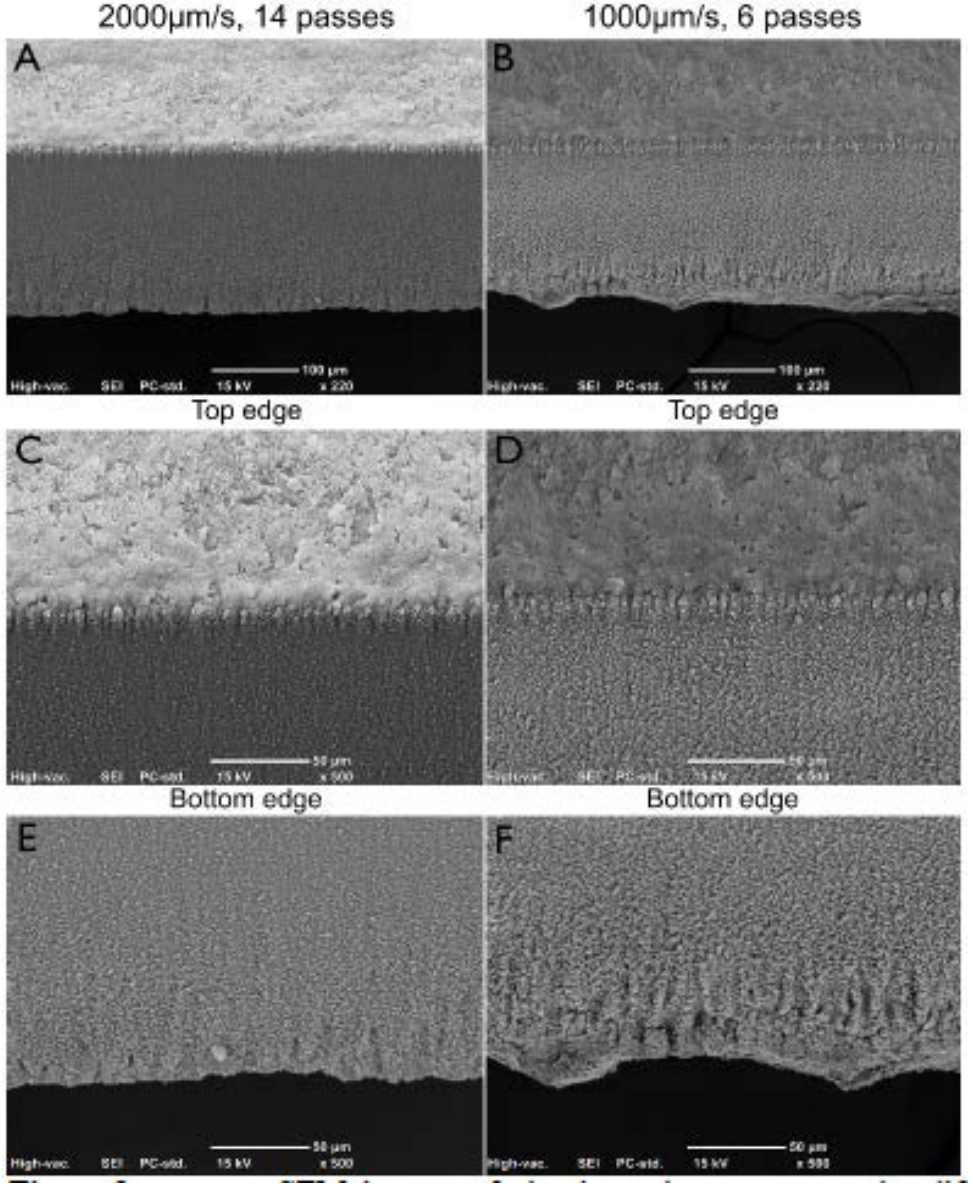



aeroQUAL

*2016 - Innovative Hardware Award*
*Hi Tech Awards*






*Optics and Lasers in Engineering 84:105-110.*

aeroQUAL

*"The Photon Factory developed an efficient alumina laser machining process that enabled the yield of Aeroqual's gas sensor chips to be increased from 40% to >95% from non-optimum printed tiles. This increased yield contributed to Aeroqual's 32% revenue growth in FY15. It was great to work with a top university research lab that really understood our needs."*

*Geoff Henshaw*
*Co-founder, CTO Aeroqual (2016)*

*2016 - Innovative Hardware Award*
*Hi Tech Awards*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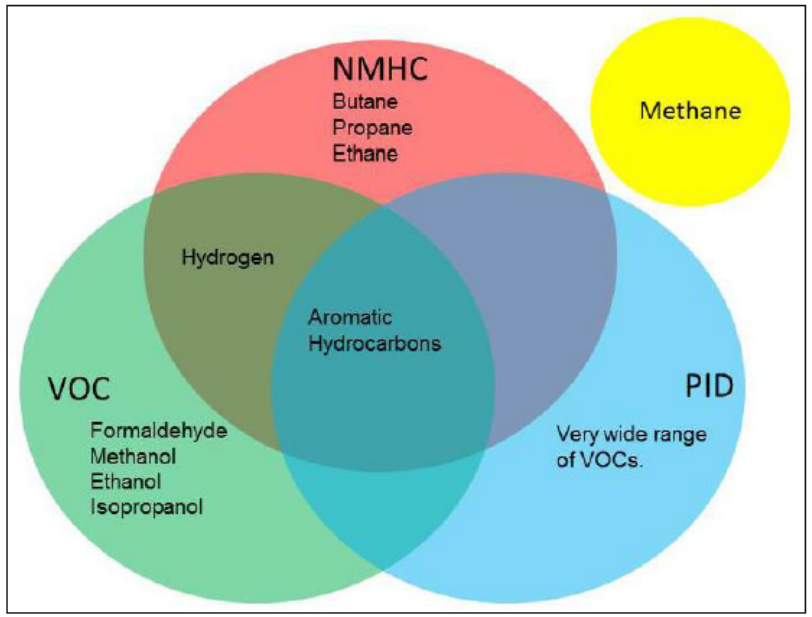

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Fisher&Paykel HEALTHCARE

$3.5m

Fletcher Building

puredepth® MULTI LAYER DISPLAY™

Footfalls & Heartbeats

ORBIS

INTUITIVE SURGICAL®

PacificChannel Life Sciences and Clean-Tech Ventures

Finisar

MORNINGSIDE

Fonterra™

Dairy for life

rakon

SPRINGFIELD Springfield Financial Advisory Ltd.

e4

PPG

iZON

Fisher&Paykel

ENGENDE

nextwindow™ A SMART Technologies company

ZENITH TECNICA

$26m

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT HĪKINA WHAKATUTUKI

Ministry for Primary Industries Manatū Ahu Matua NEW ZEALAND

MilkTestnz™ LEADING IN MILK TESTING

# Science & impact

THE UNIVERSITY OF AUCKLAND
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NEW ZEALAND

SCIENCE


Ministry for Primary Industries
Manatū Ahu Matua

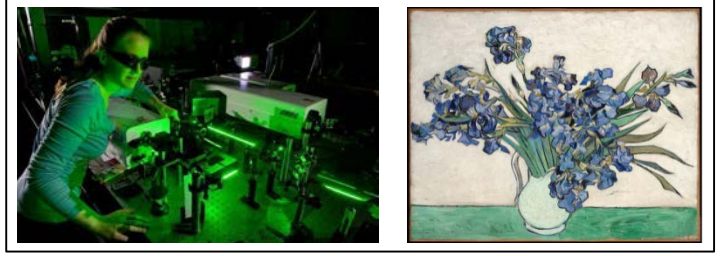
NEW ZEALAND

# Science & impact

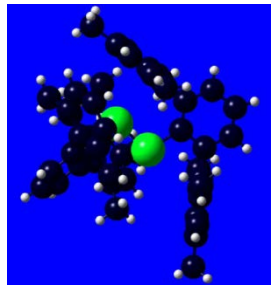
THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

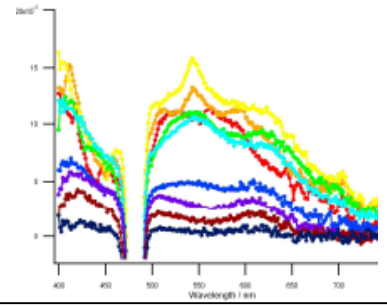
SCIENCE

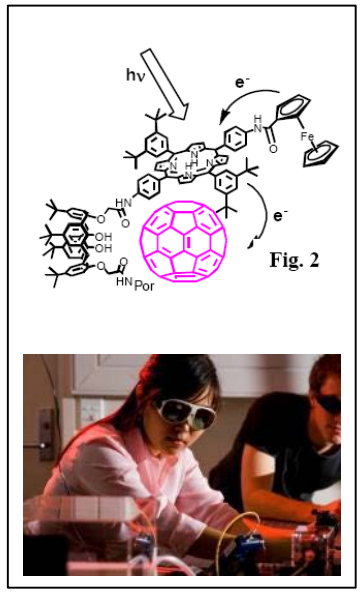
# *Photon Factory – Research & Innovation*

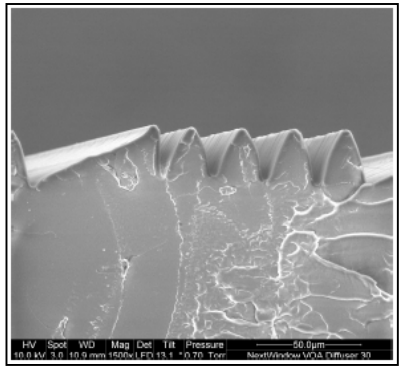


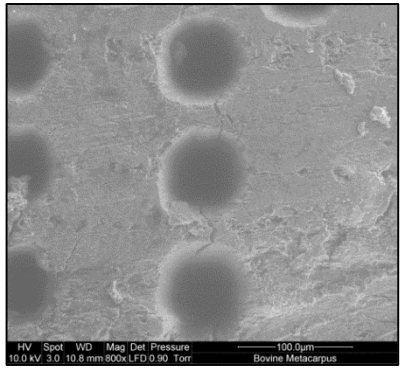




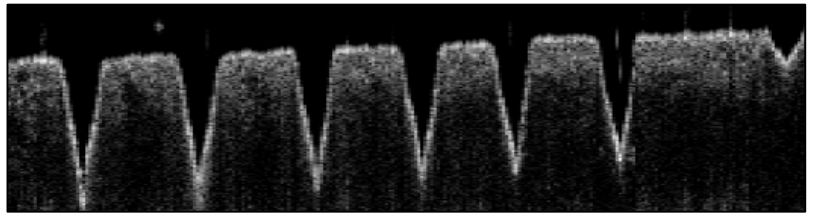


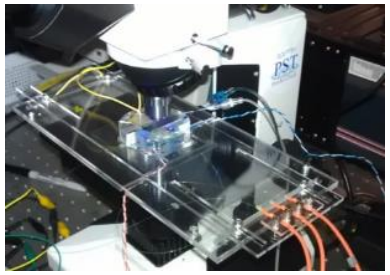


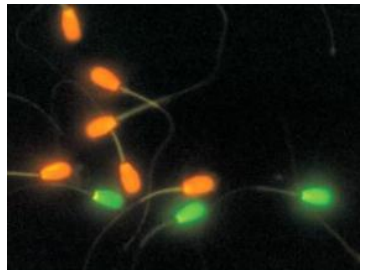













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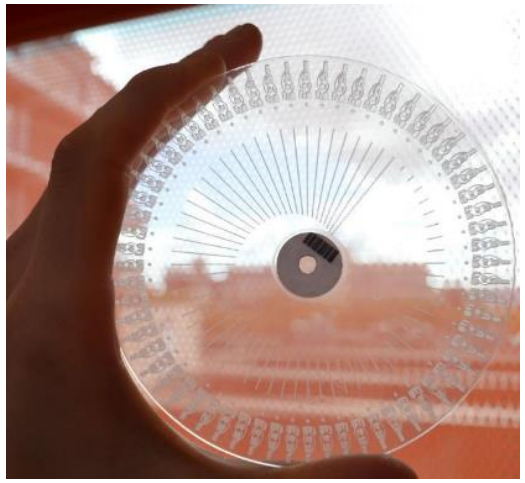

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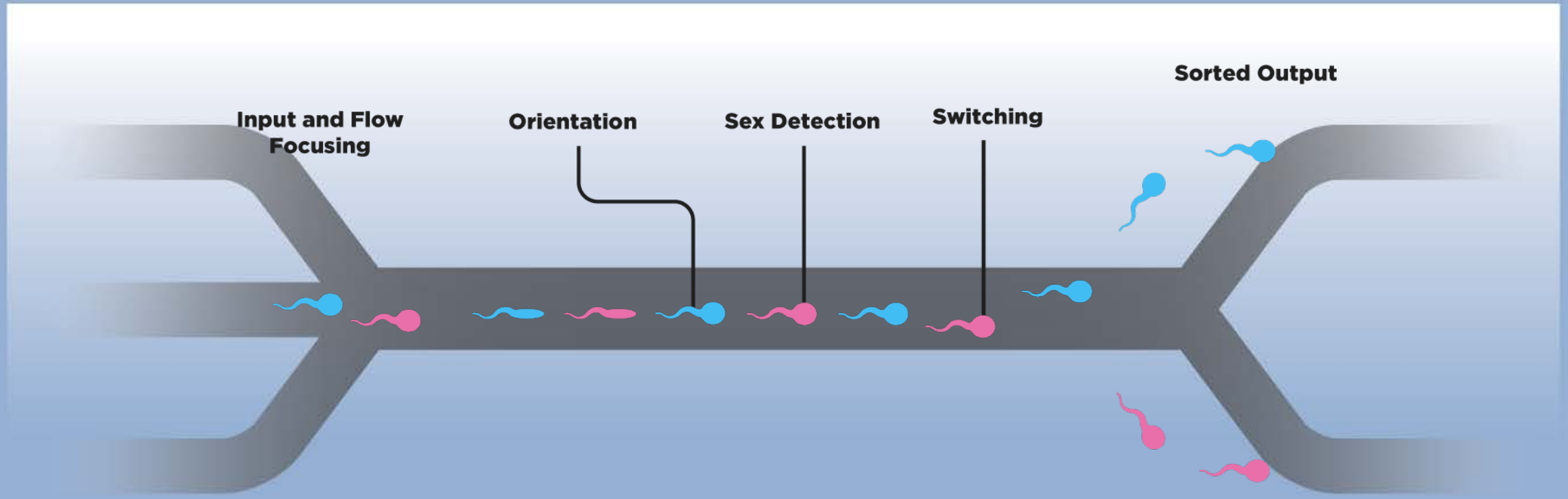
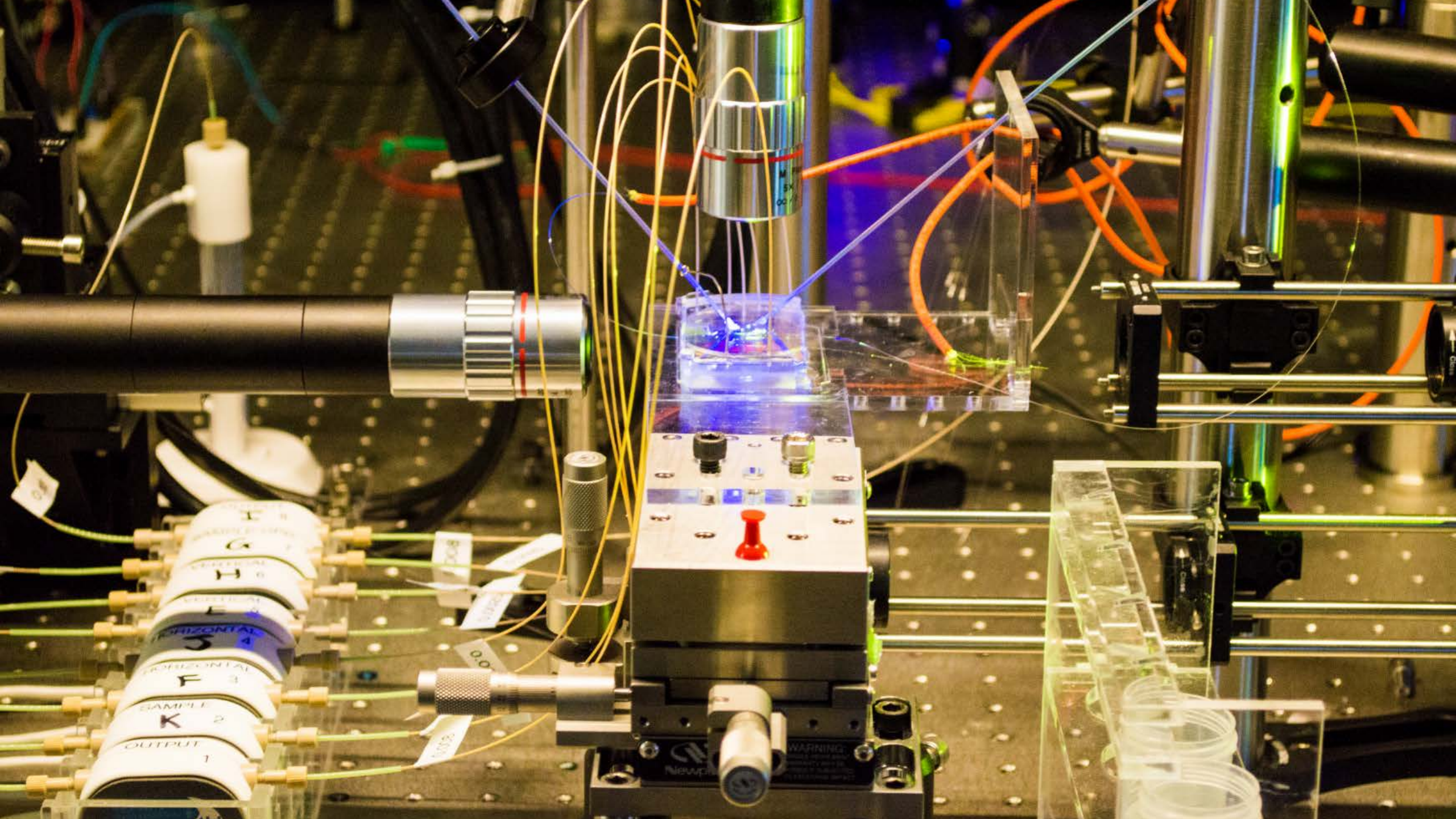
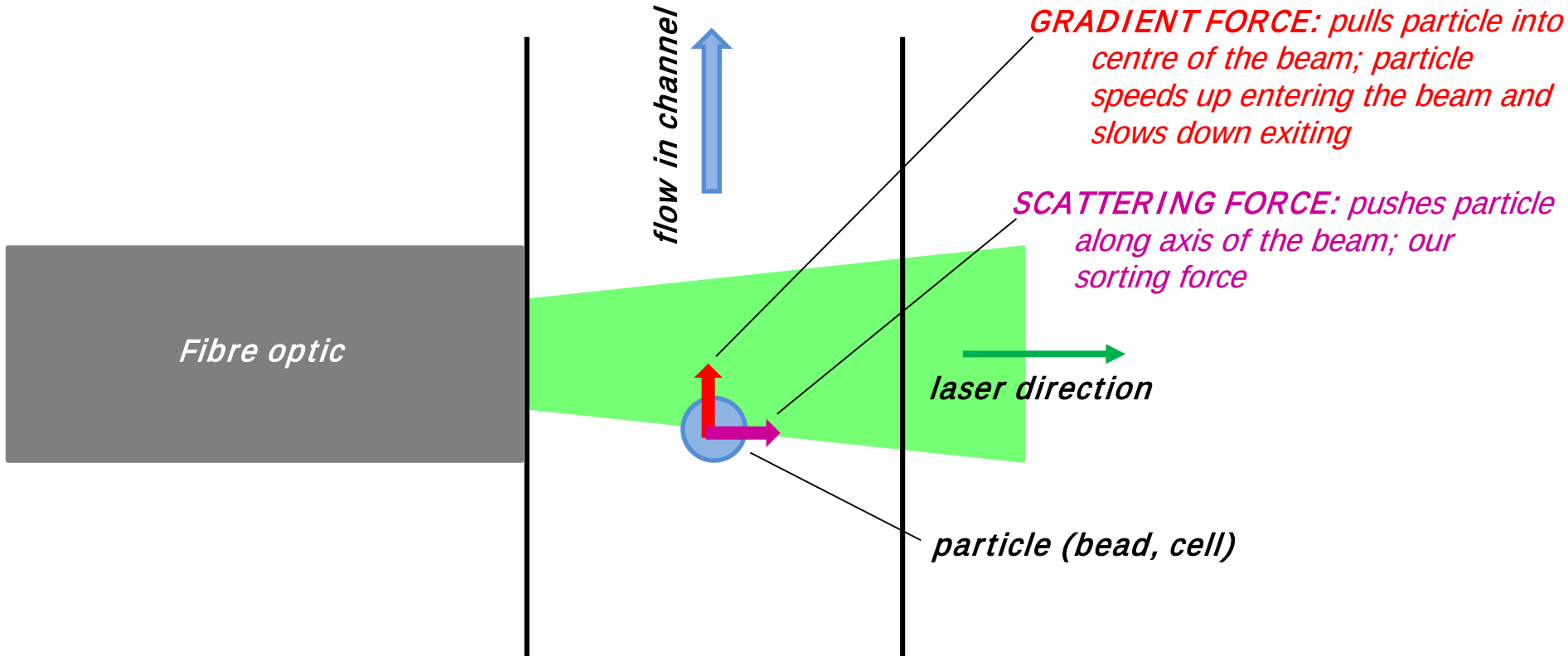
# How does it work?




HORIZONTAL
SAMPLE
OUTPUT
WARNING

# *The basic idea that underpins Engender's technology*

- *the interaction of light with matter generates a force (nudging)*
- *the interaction of light with an asymmetric particle generates a torque (orientation)*



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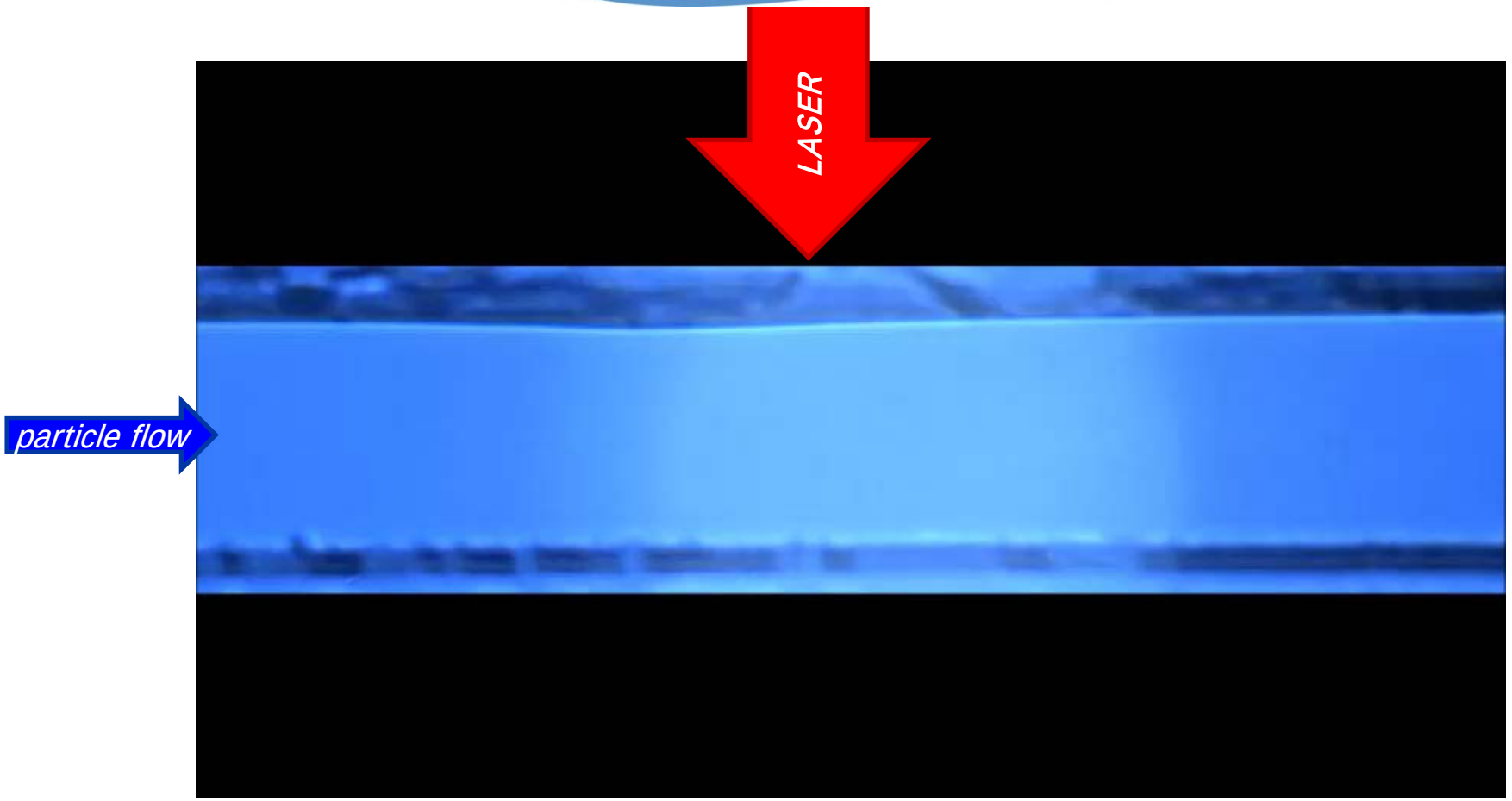

# 2018 Nobel Prize in Physics

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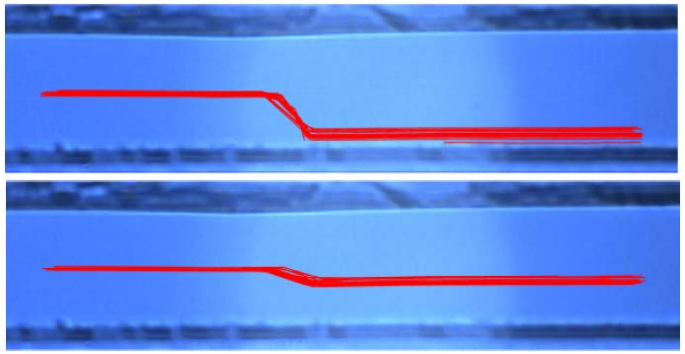
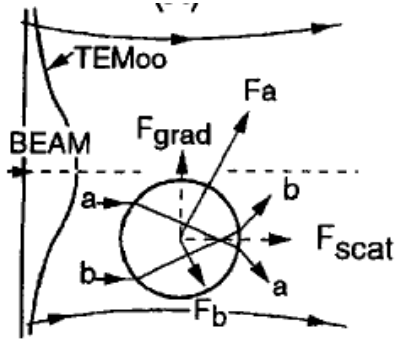
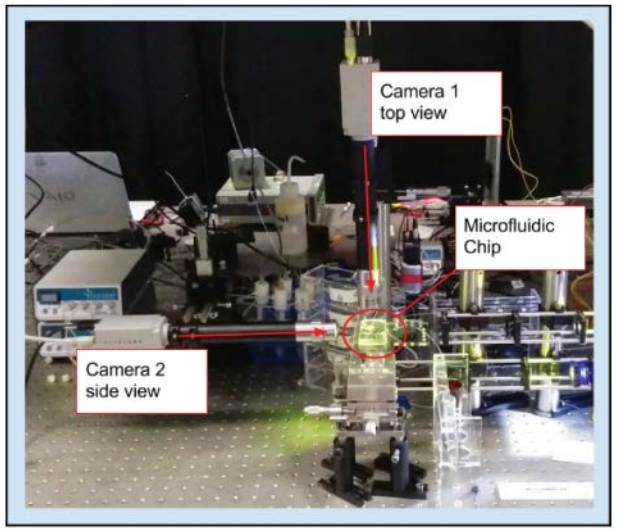




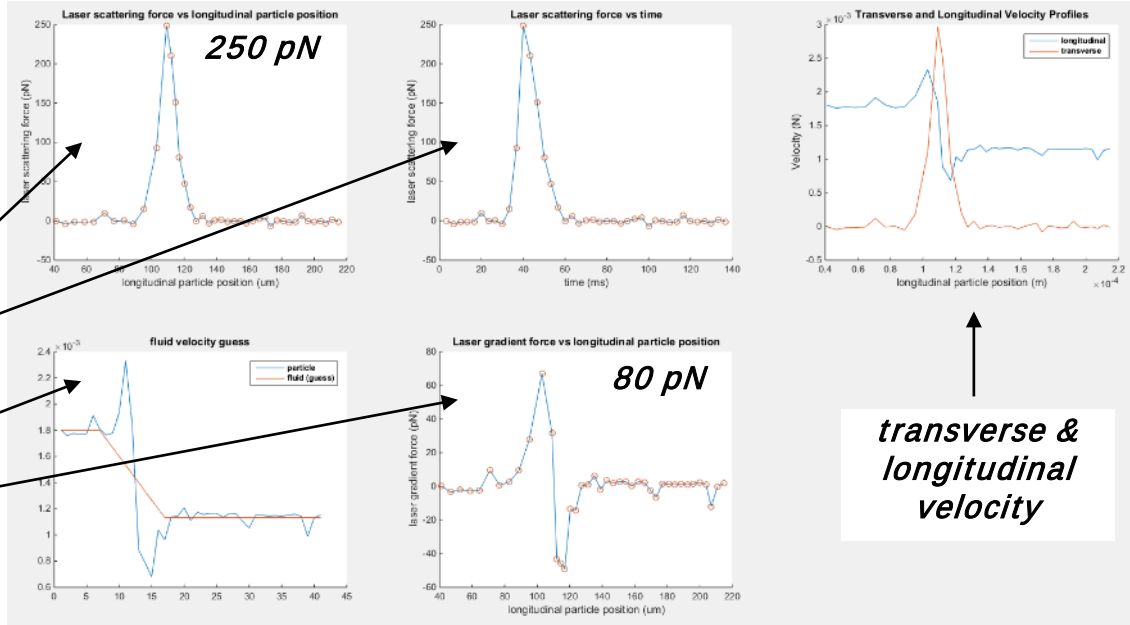




*scattering force vs longitudinal position*

*scattering force vs time*

*fluid velocity*

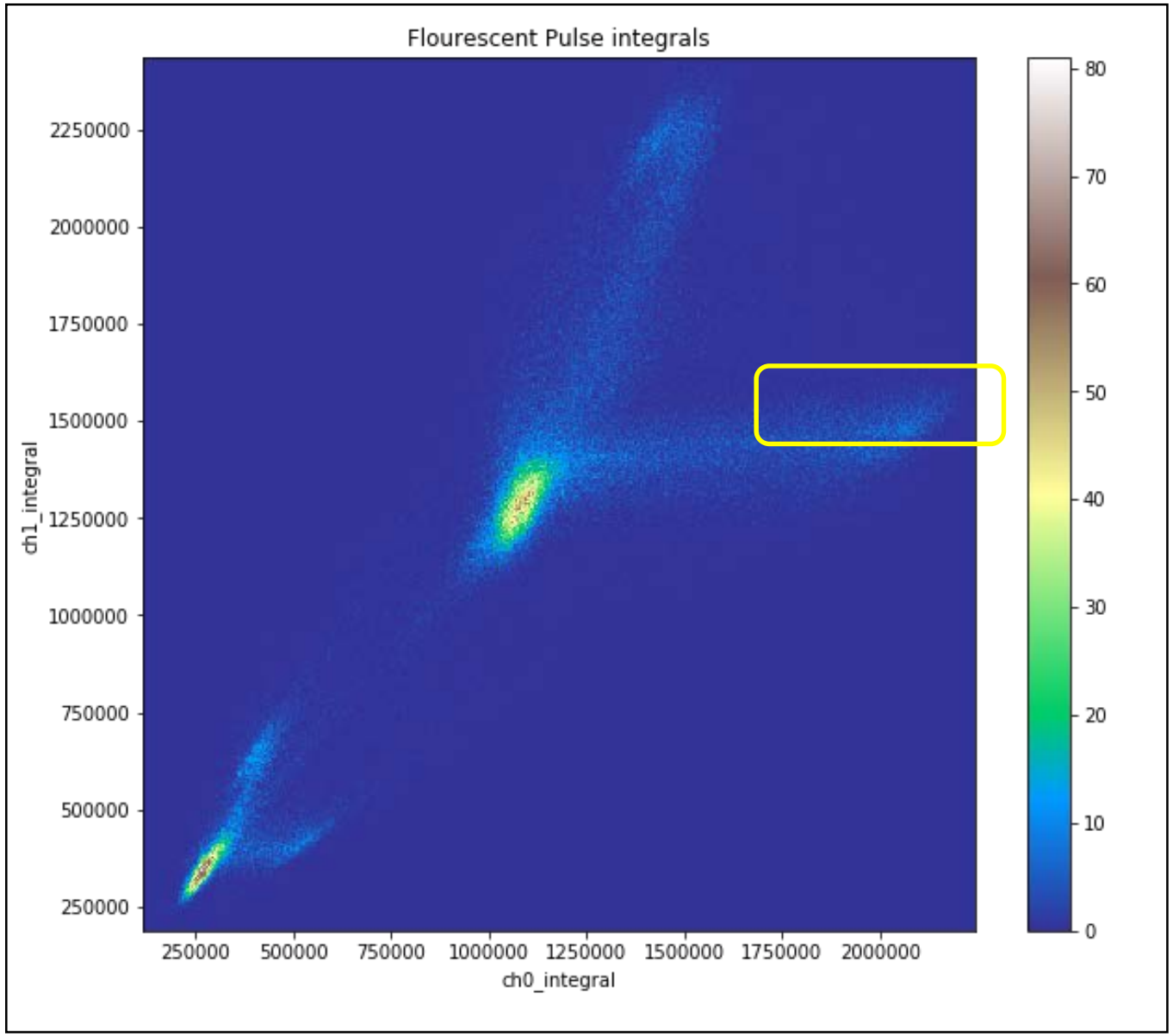
*Gradient force vs longitudinal position*




*transverse & longitudinal velocity*

# Sperm are not simple!

| Dimension | Bull |
|---|---|
| Length (μm) | 9.1 |
| Head sagittal section |  |
| Width (μm) | 4.7 |
| Head profile |  |
| Area (μm$^2$) | 34.5 |
| X–Y difference (%) | 3.8 |
| Sorting index[b] | 131 |



# Economic impact of artificial insemination (dairy)

***Unsorted semen***

*$4-10 per straw*

*>175 million straws pa*

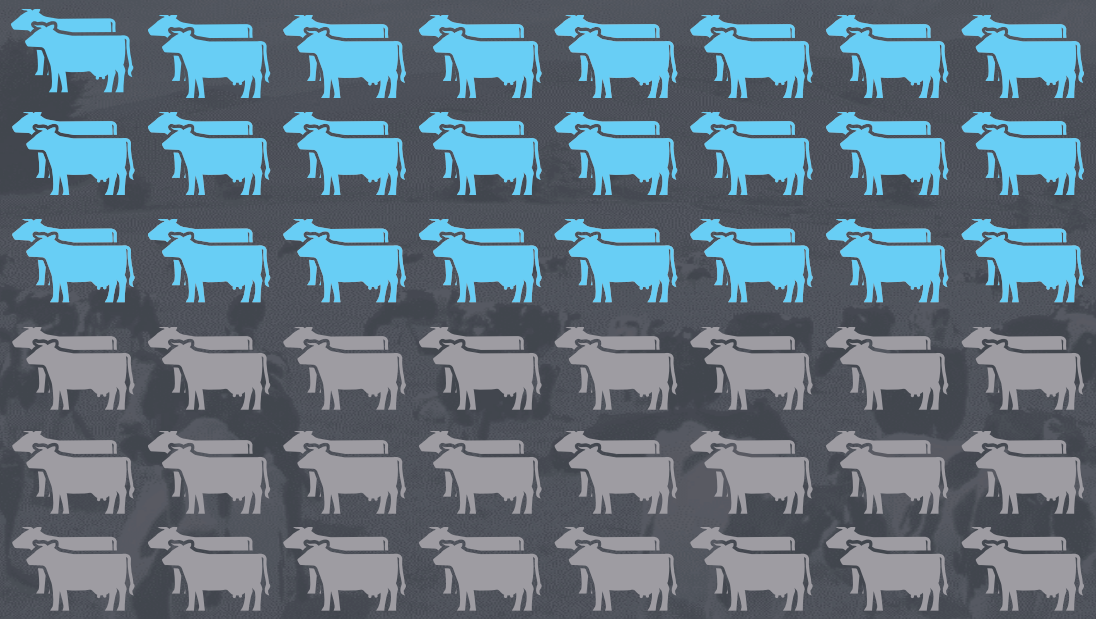
***US$2+ billion pa market***

# Economic impact of sex-sorted semen today

*$10 – 40+ per straw*
*~5 million straws pa*

***~US$220 million***

# Economic impact of sex-sorted semen tomorrow



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*$10 – 20 per straw*
*50% of total market within 5 years*

***>US$250 million revenue***

# Economic impact of sex-sorted semen tomorrow

# *Dairy – an amazing food*

- *recommended as part of a healthy diet in most countries*

| | Global Supply |
|---|---|
| • *contributes 134 kcal per capita per day* | *5%* |
| • *contributes 8.3 g protein per capita per day* | *10%* |
| • *contributes 7.6 g fat per capita per day* | *9%* |

***#5 provider of energy***

***#3 provider of protein, fat***

## *Dairy – an amazing food & environmental challenge*

***pollution*** *of our soil, waterways*

*manure, fertilizers*

***climate change*** *from atmospheric pollution*

*greenhouse gas emissions*

***biodiversity*** *under threat*

*animals, pastures, feed crops*

## *more and more dairy cows*

*1961*
*177.3 m*

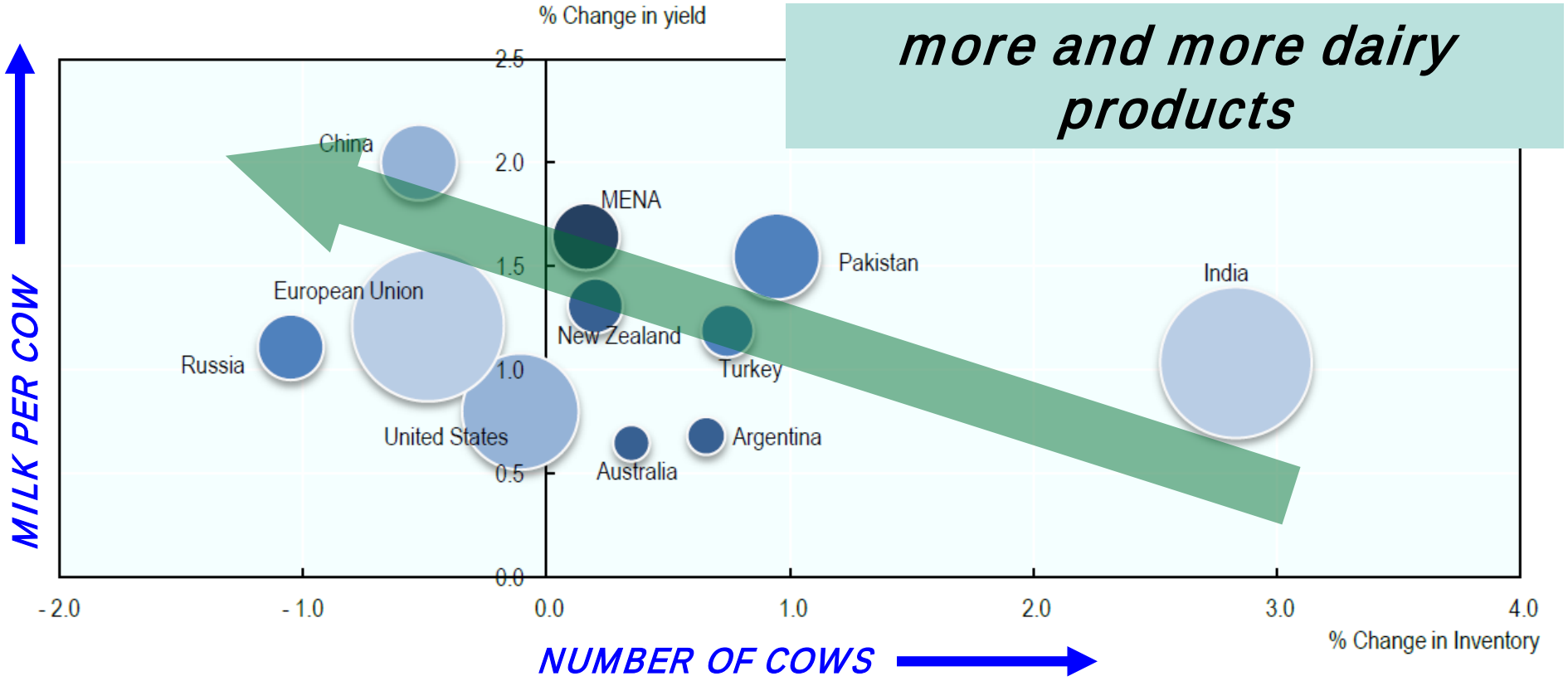
*2016*
*273.8 m*

60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
0

1961 1971 1981 1991 2001 2011

*India*
*Brazil*
*China*
*USA*
*Turkey*

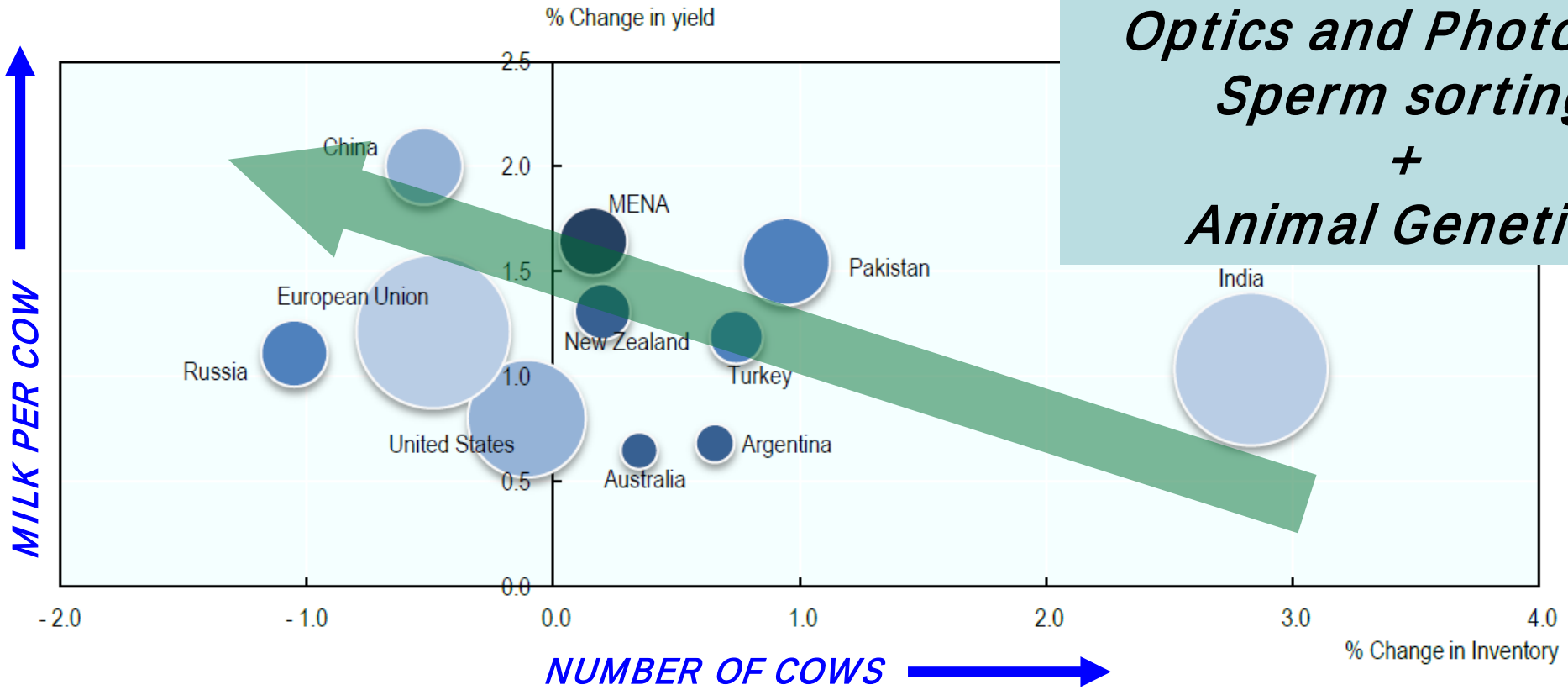
**Figure 7.3. Annual changes in inventories of dairy herd and yields between 2017 and 2027**




*Note*: The size of the bubbles refer to the total milk production in the base period 2015-17.
*Source*: OECD/FAO (2018), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

StatLink http://dx.doi.org/10.1787/888933743480

**Figure 7.3. Annual changes in inventories of dairy herd and yields between 2017 and 2027**




*Optics and Photonics*
*Sperm sorting*
*+*
*Animal Genetics*

*Note*: The size of the bubbles refer to the total milk production in the base period 2015-17.
*Source*: OECD/FAO (2018), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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# The future for Engender Technologies

## ~US$18m for ~45% of the company.

- Commercial-ready microfluidic chip and instruments
- IVF alpha prototype launch (Y1)
- AI alpha prototype launch (Y2)


Unified Individual Steps into 1 Chip

Laboratory Prototype Chip/Instrument

Enrichment

Partnership with US-based Product Development firm

IVF Trial and IVF Prototype Launch

AI Field Trials

AI Prototype Launch

KiwiNet Kiwi Innovation Network

bnz Be good with money

AgFUNDER

Baldwins intellectual property

WINNER - AGTECH GROUP WORLD CUP TECH CHALLENGE 2016

TIN100

# The future for Engender Technologies

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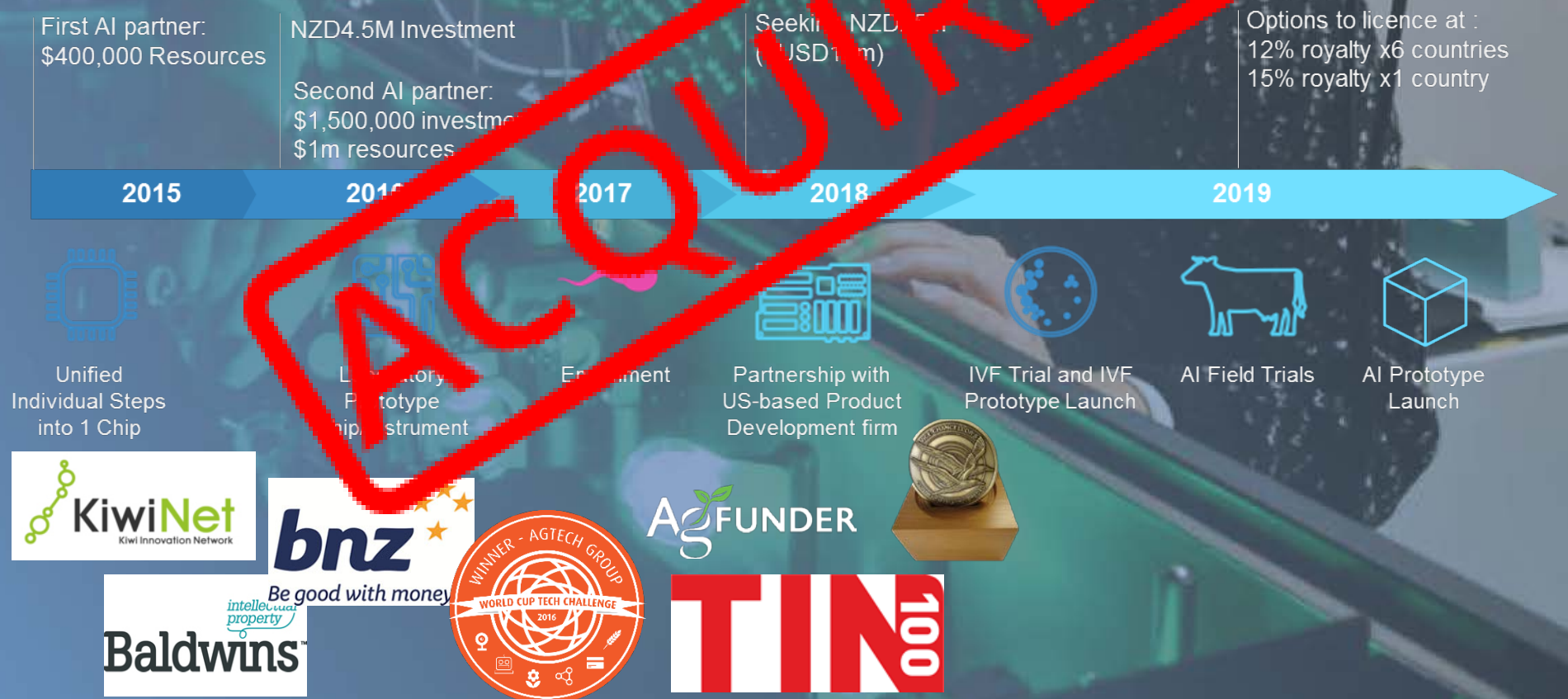


ACQUIRED

# Management & Governance

**Brent Ogilvie**
Managing Director

**Prof. Cather Simpson**
Chief Scientist

**Kieran Jina**
Operations Manager

**Jim Mervis**
Chairman

**Dr Gary Pace**
Director

Director

Representative of one of the World's largest animal genetics companies

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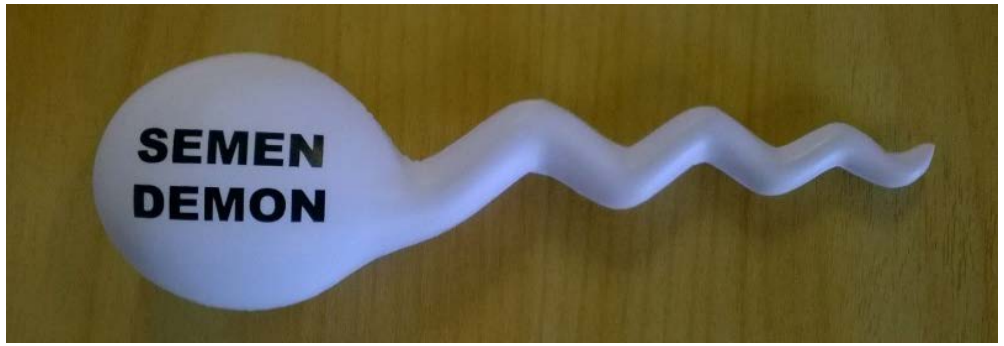
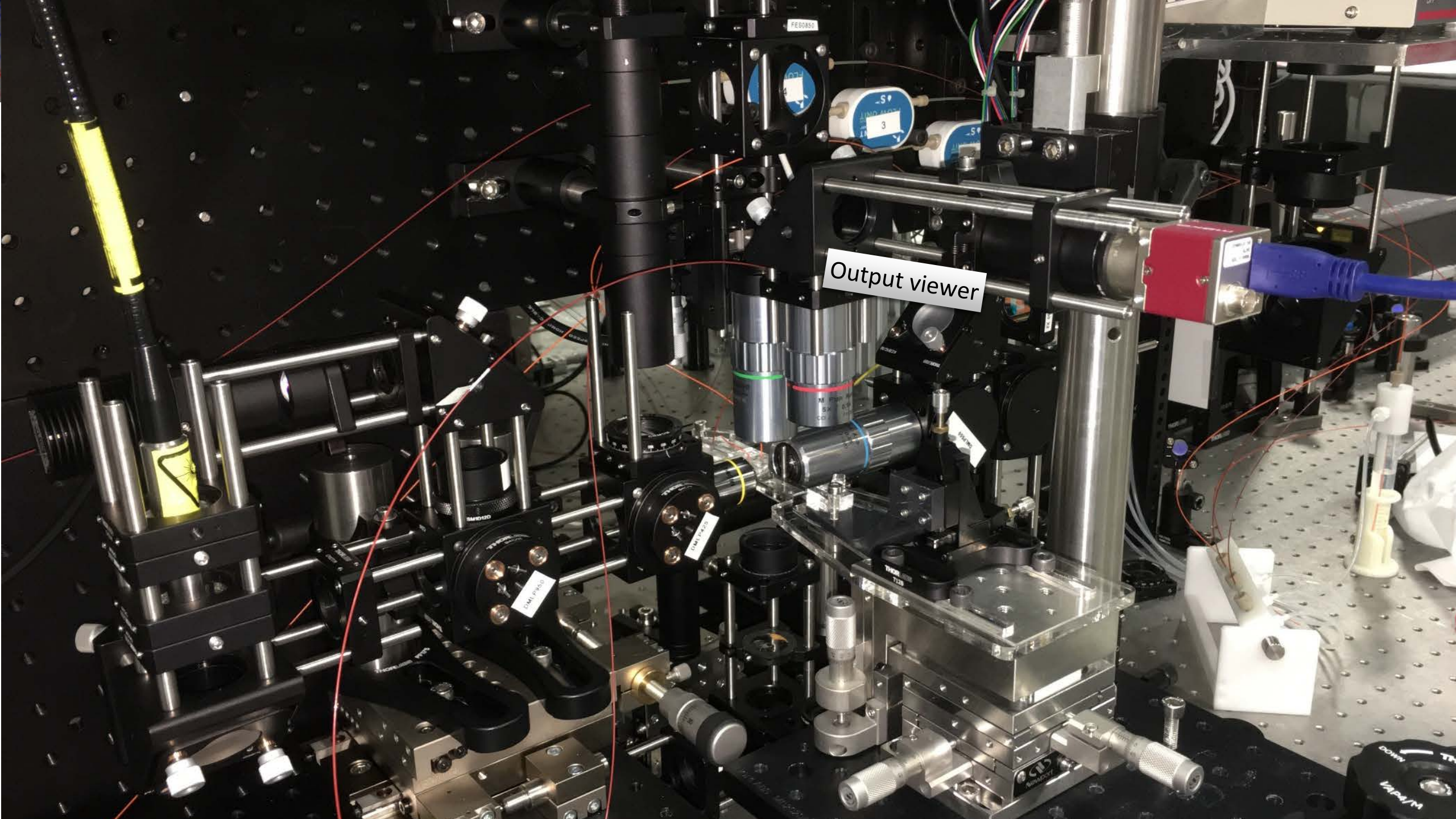



*Lots of others along the way ...*


Output viewer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ORBiS
MILK ON A DISK

# “point of cow” diagnostics – making complex solutions simple for farmers

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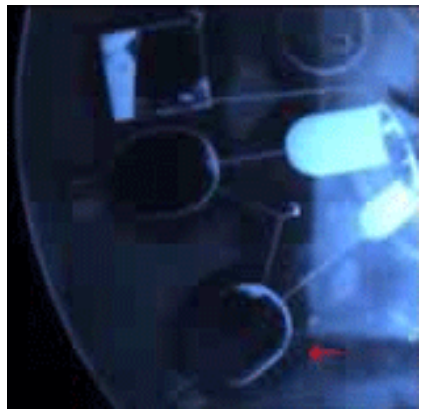
MILK ON A DISK

## automated milk composition “lab” in the shed

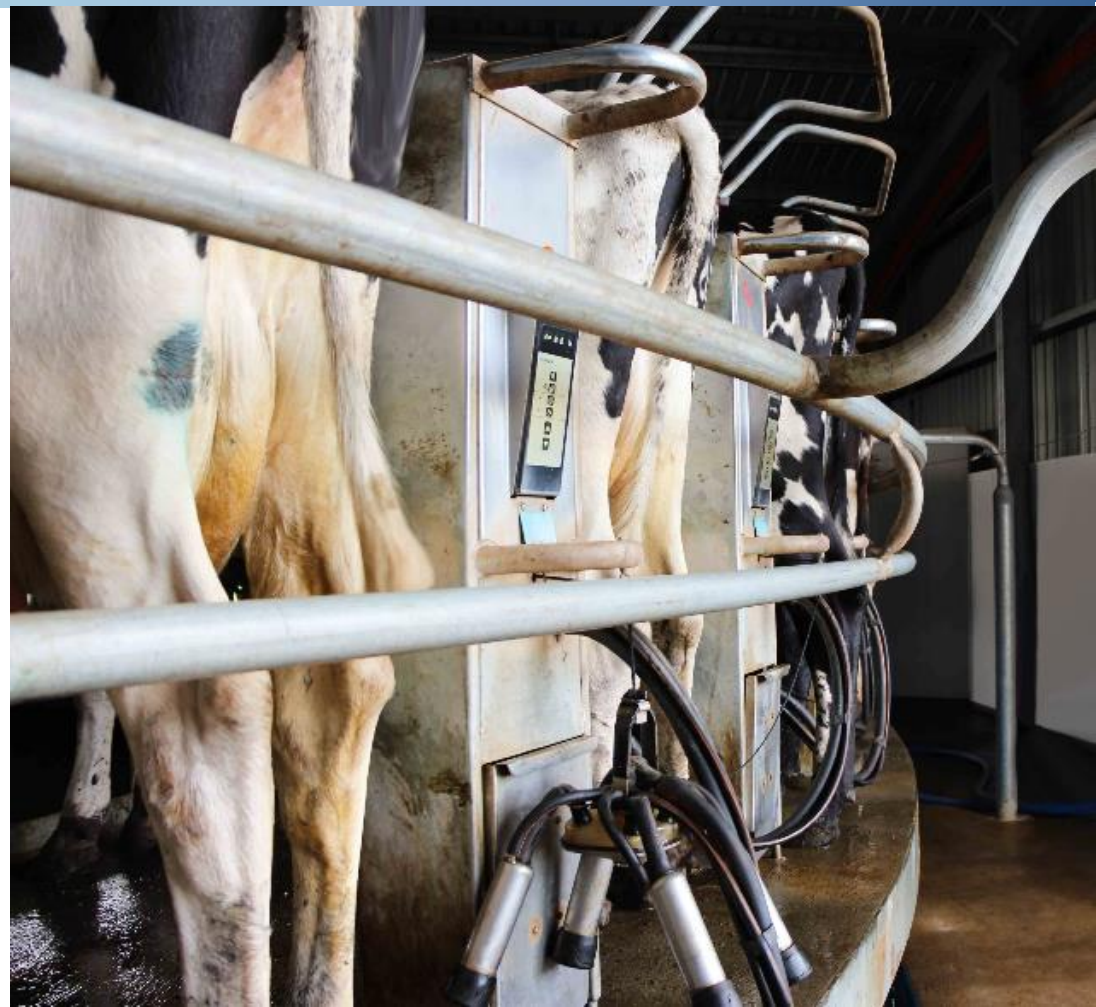


# The pain

Global cost of mastitis = $35B pa

Cost of missed impregnation
= $150k per 1000 head herd pa

Value of increased genetic gain
= $90k per 1000 head herd pa



# How does it work?

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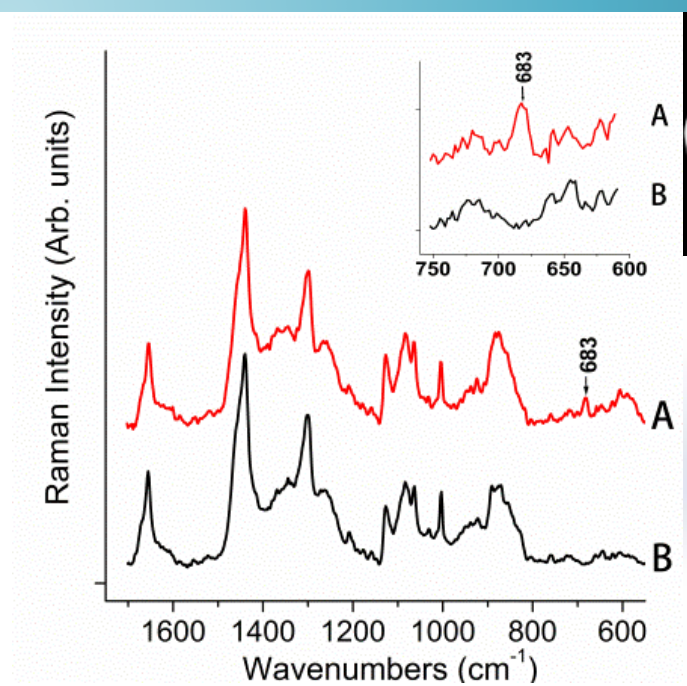
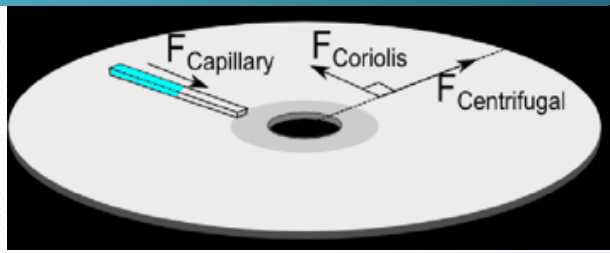
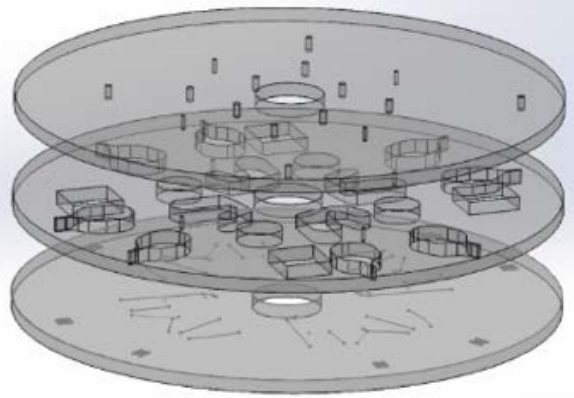
## CENTRIFUGAL MICROFLUIDICS + PHOTONICS
## =
## ROBUST SENSOR PLATFORM



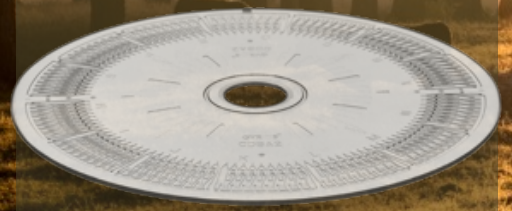
- MOU with a world leading milking equipment company
- PCT patent filed
- $500k POC funding in place

- Secure option to out-license to milking equipment company

Significant upfront licensing payments on completion of MVP

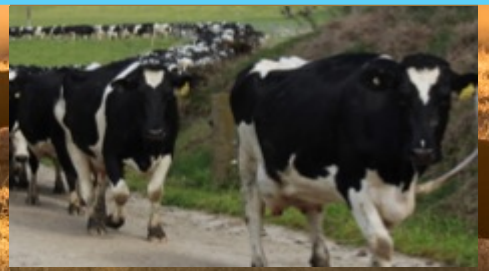
Full Product Launch

**2017** **2018** **2019** **2020**



Development of fat, protein and progesterone

Prototype instrument to operate disk and finalise tests. Develop mastitis (udder infection) test



Integrate into milking equipment
&
Field trials

Further dairy tests (infections, nutrients, distinguishing features...)

Review other apps: Beverage, Waste water

# Management and Directors

COLIN HARVEY
Chairman &
Investor Director

Founded, grew and sold one of NZ's largest animal health companies

PROF. DAVID WILLIAMS
Founding Scientist &
Chair of SAB

Led development of world's first home pregnancy test

PROF. CATHER SIMPSON
Founding Scientist & Director

NZ Primary Industries Champion, CSO Engender

BRENT OGILVIE
Manager

Proven deal-making experience with agricultural companies over five continents

KIERAN JINA
Operations

# R&D Team

TOM WARD
Engineer & Project Manager

MATHEUS VARGAS
Chemistry

VIBHA SEBKAR
Biochemist

CHERIE TOLLEMACHE
Chemistry

LAKSHIKA PERERA
Chemistry

MICHEL NIEUWOUDT
Senior Research Fellow

***Technical expertise***

***Milk ⟶ Data ⟶ Knowledge***

SPIE. The international society for optics and photonics

# where are we headed?

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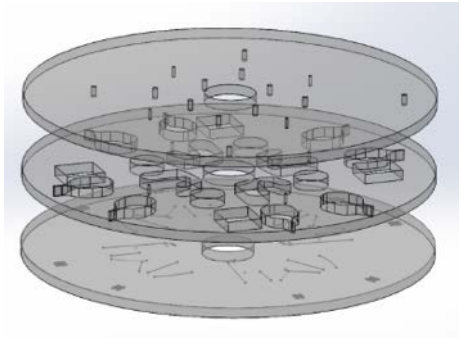
MILK ON A DISK



- Fat (total and components)
- Protein (total and components)
- Somatic cell count
- Progesterone, luteinising hormone etc.
- Ketosis (beta hydroxybutyrate)
- Bacterial identification (i.e. Gram-ve/+ve)
- Lactose
- BVD
- Tuberculosis
- Johnes Disease
- Mycoplasma bovis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MILK ON A DISK

# Photon Factory: Innovation & entrepreneurship

*Sorting sperm by sex for agriculture*

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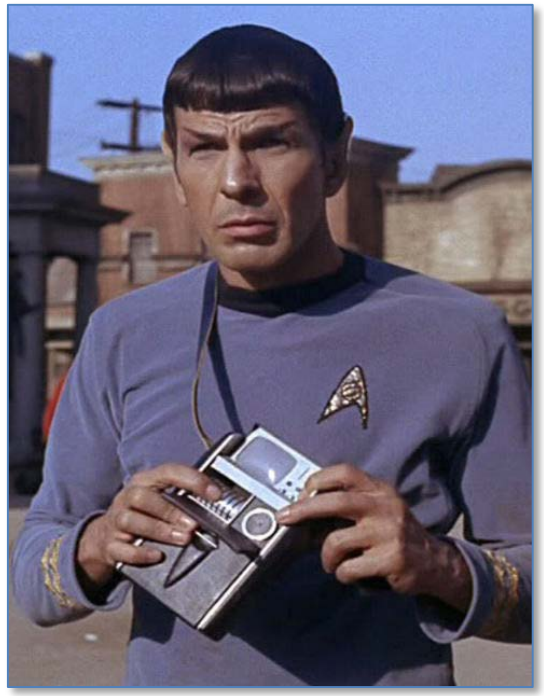
MILK ON A DISK

*"point of cow" diagnostics on milk*



*diagnose & type skin lesions with hand-held, portable device*

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*Sorting sperm by sex for agriculture*

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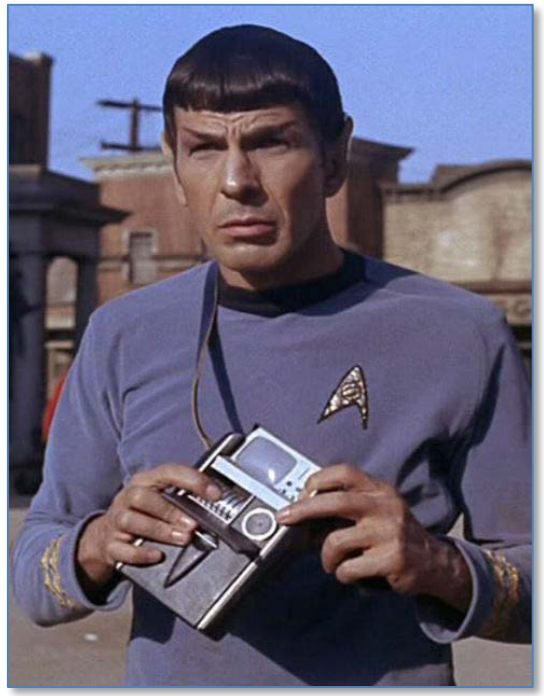
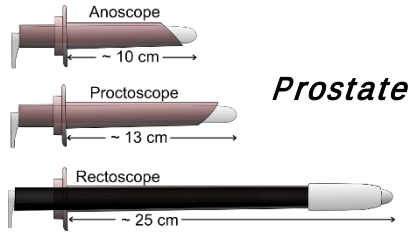


*diagnose & type skin lesions with hand-held, portable device*

*Mussel farm*


*Prostate probe*

*advanced fibre lasers for distributed manufacturing*

THE UNIVERSITY OF AUCKLAND
BUSINESS SCHOOL

# Photon Factory: Innovation & entrepreneurship

*Sorting sperm by sex for agriculture*

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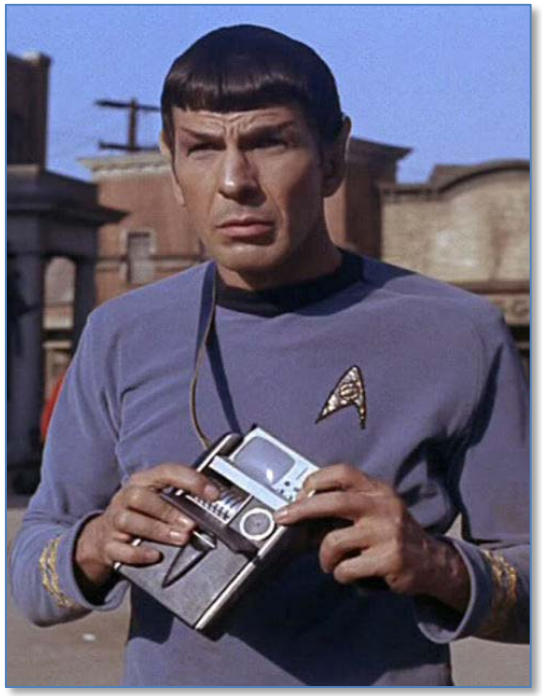

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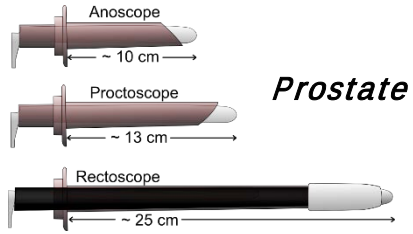


*Prostate probe*

*advanced fibre lasers for distributed manufacturing*

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*Sorting sperm by sex for agriculture*

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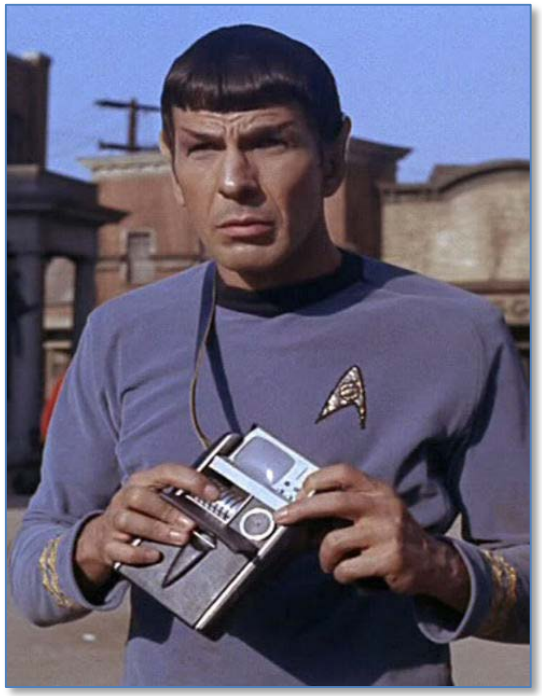

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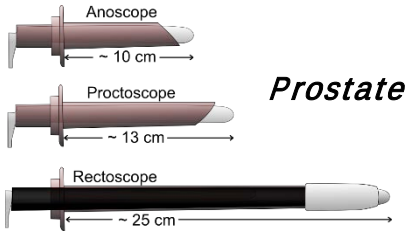


*Prostate probe*

*advanced fibre lasers for distributed manufacturing*

# Photon Factory: Innovation & entrepreneurship

*Sorting sperm by sex for agriculture*

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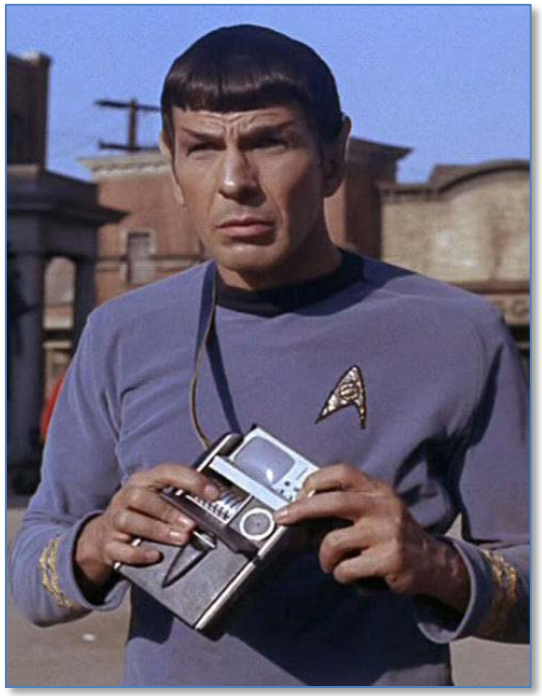

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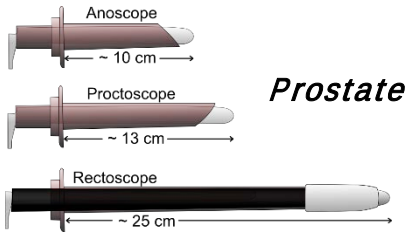
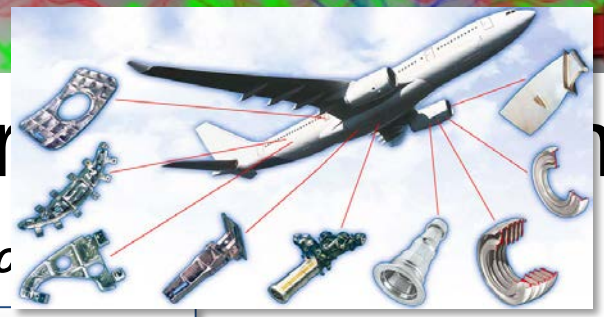



*Prostate probe*

*advanced fibre lasers for distributed manufacturing*


# Photon Factor n & entrepreneurship



*Sorting sperm by sex fo*

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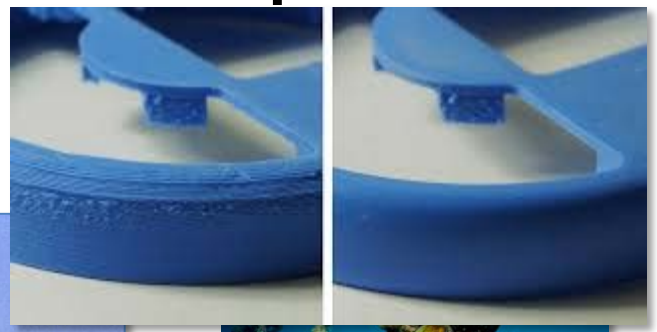

ORI
MIL

*"point of cow" di*

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*ate probe*

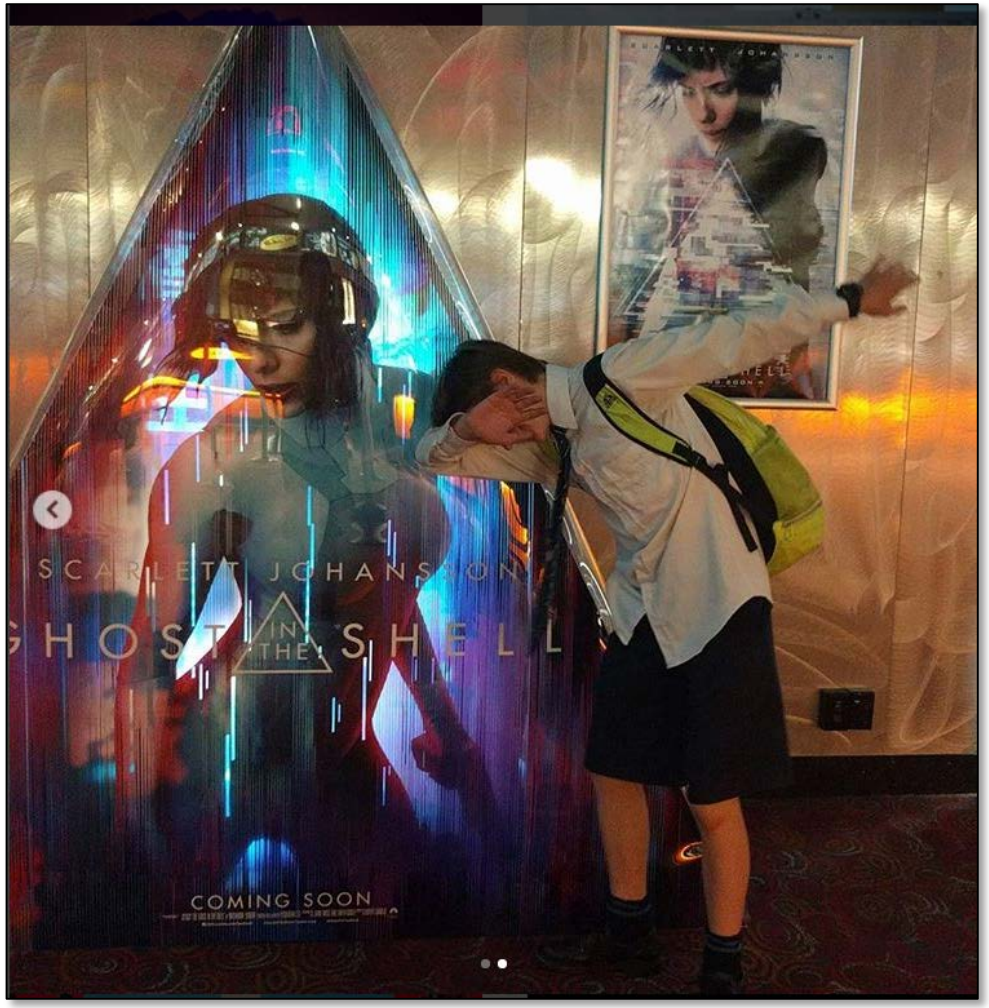
*diagnose & type skin lesio*
*hand-held, portable devi*

*advanced fibre lasers for*
*distributed manufacturing*

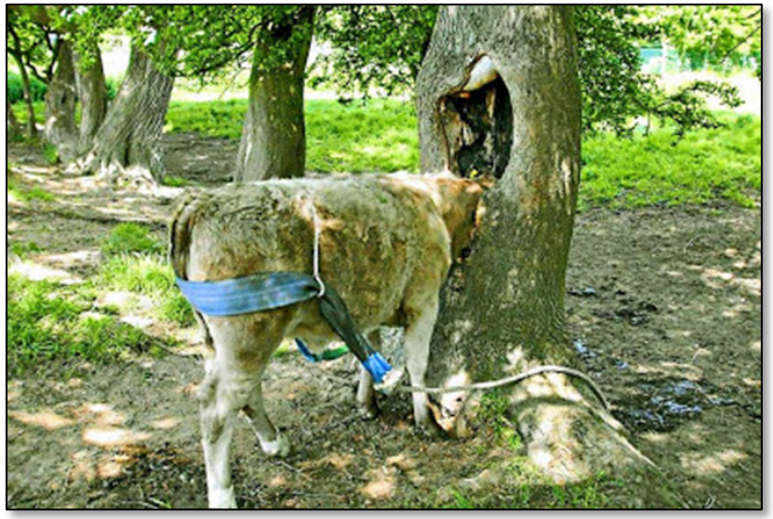

# Now what??

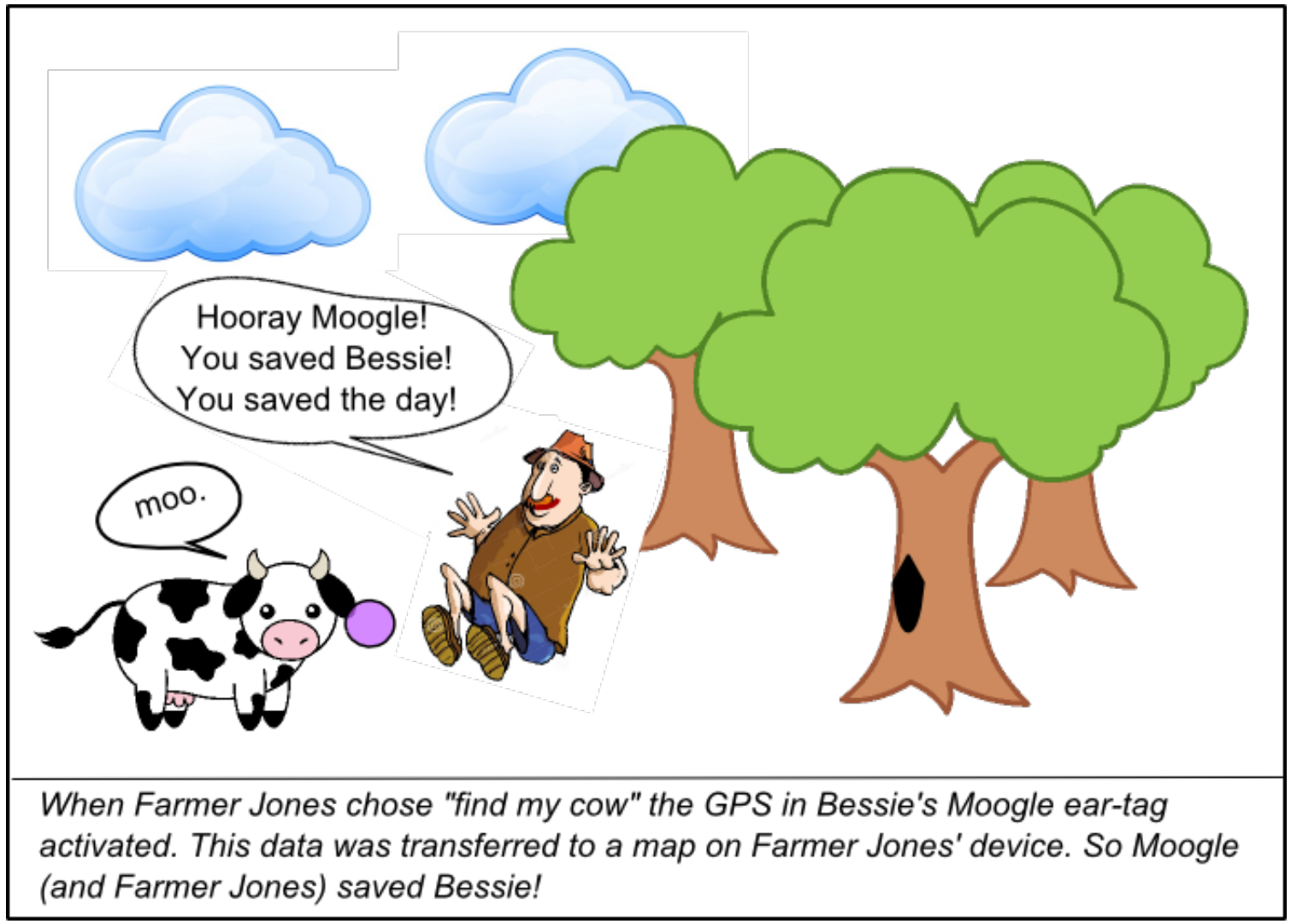
## *But … I'm just an emerging researcher!?*

## *But … I'm just an emerging researcher!?*

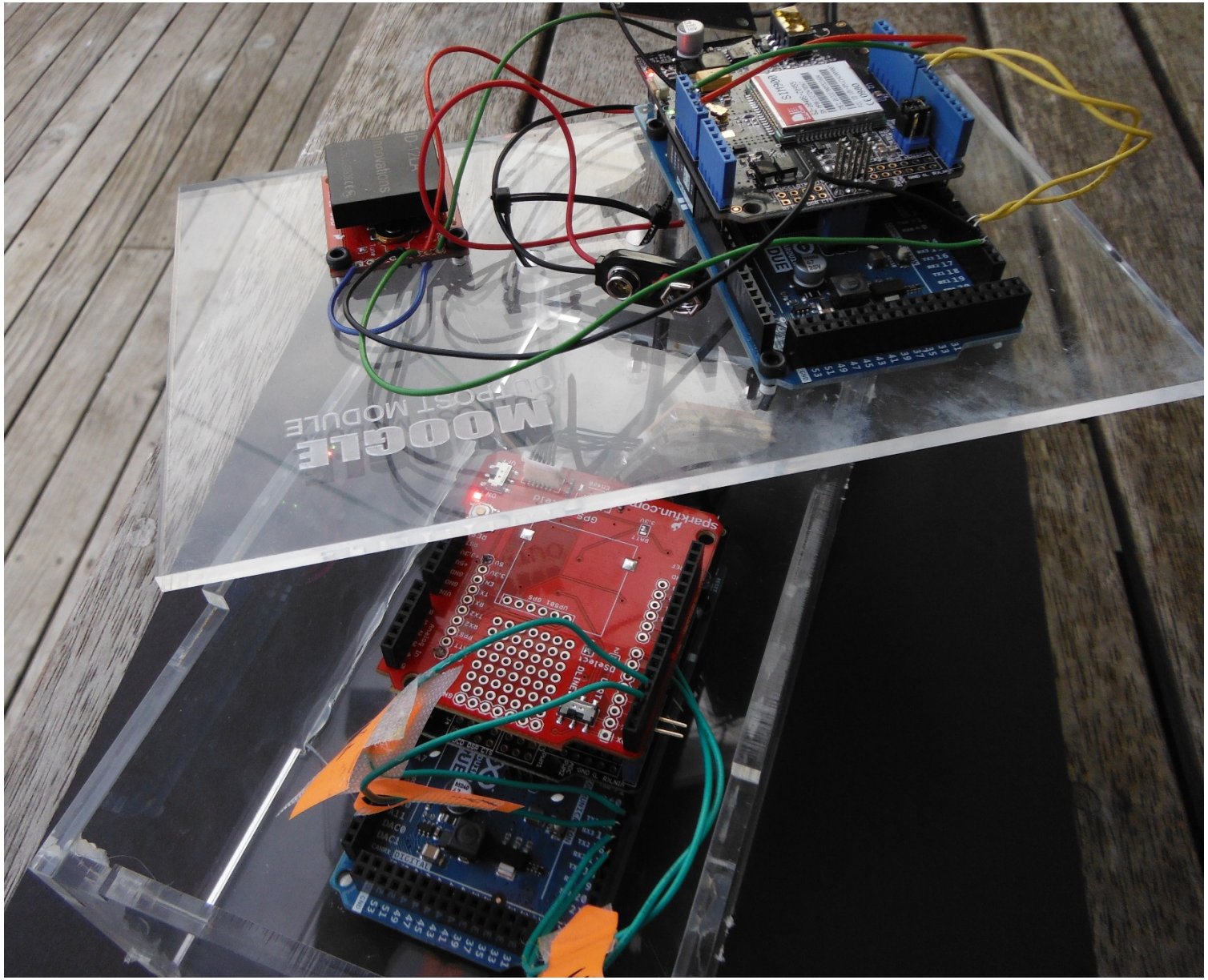


# *Tapping the problem-rich environment …*






*When Farmer Jones chose "find my cow" the GPS in Bessie's Moogle ear-tag activated. This data was transferred to a map on Farmer Jones' device. So Moogle (and Farmer Jones) saved Bessie!*

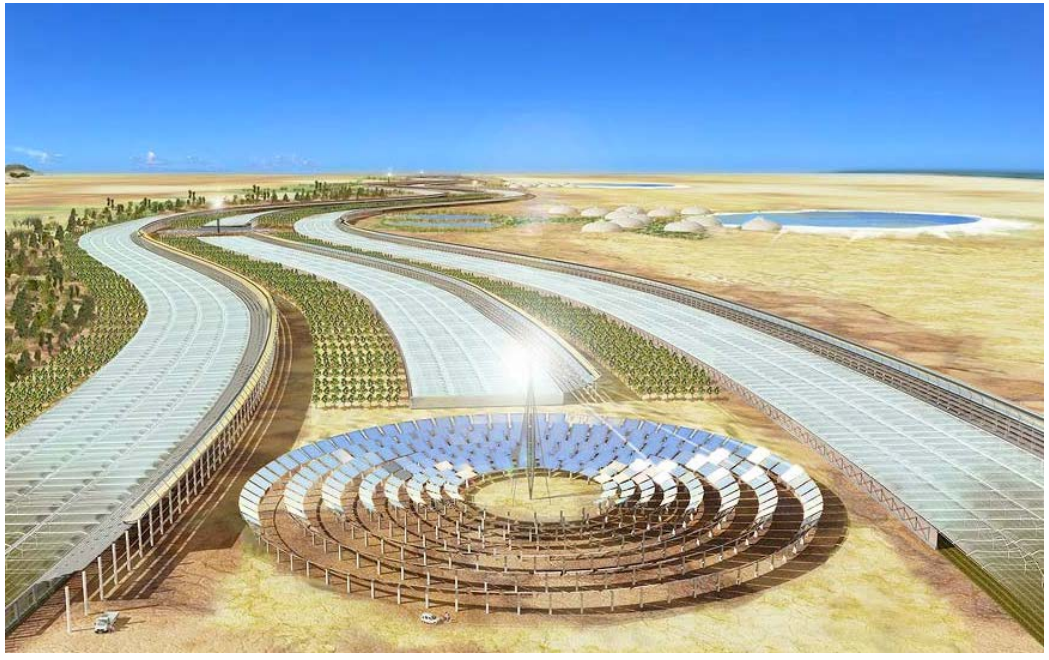

MOOGLE
GPS POST MODULE

## *But … I'm just an emerging researcher!?*

*But … I'm just an emerging researcher!?*

*listen to the problem-rich environment*
*come up with an idea …  then another one …*
*find people who can help you succeed*

## *the future …*

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*the future ...*

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Only the Finest Berries™


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