



# TNO VAN 'T HOFF PROGRAM

MICHEL ODERWALD

**TNO** innovation  
for life



## OUR MISSION

TNO connects people and knowledge to create innovations that boost the sustainable competitive strength of industry and well-being of society.

***‘INNOVATION FOR LIFE’***



# THE POWER OF TNO

## FROM IDEA TO INNOVATION

### DEVELOPING FUNDAMENTAL KNOWLEDGE



With universities

### KNOWLEDGE DEVELOPMENT



With partners

### KNOWLEDGE APPLICATION



Contract research  
for and with customers

### KNOWLEDGE EXPLOITATION



Embedding in the market  
(with TNO companies)



# THREE ROLES OF TNO



## TNO ACTS AS A CATALYST IN PUBLIC-PRIVATE PARTNERSHIPS

- › Through open innovation and demand from Top sectors Funding
- › Mix of private & public funding



## TNO PERFORMS CONTRACT RESEARCH FOR CUSTOMERS

- › Funding: 100% customer financed

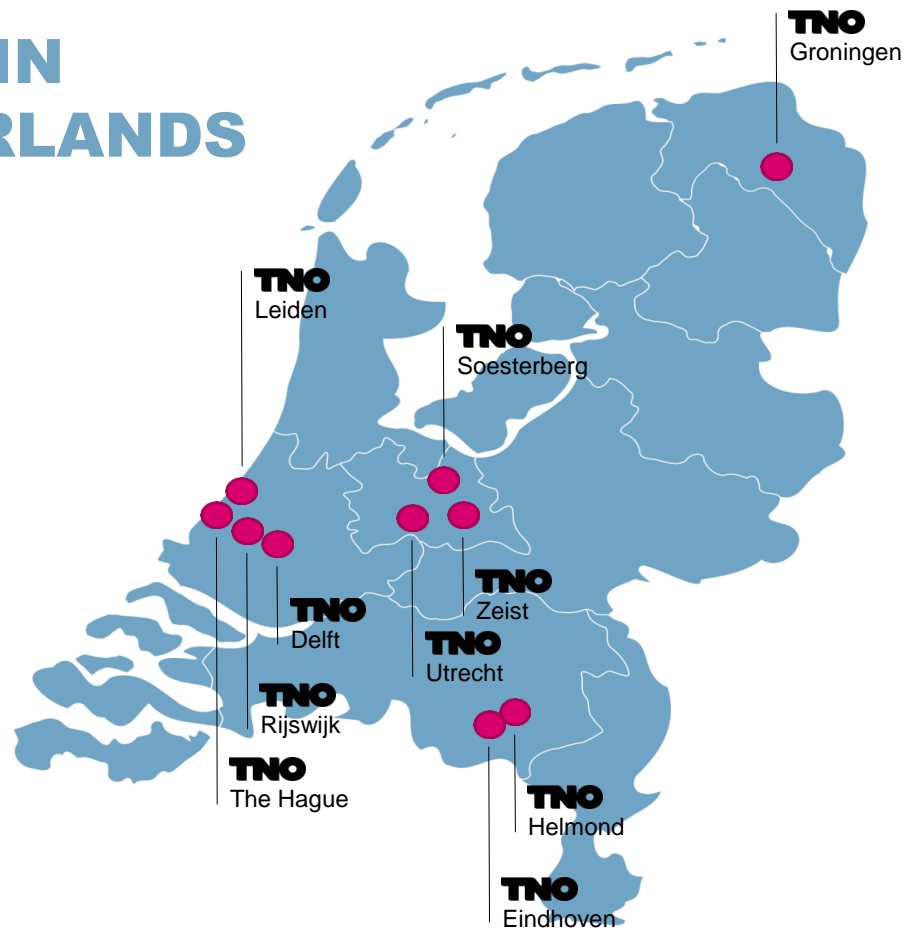


## TNO UNDERTAKES DESIGNATED TASKS

- › Geological Survey of the Netherlands
- › Research for the Dutch Ministry of Defence
- › Research for the Ministry of Social Affairs and Employment

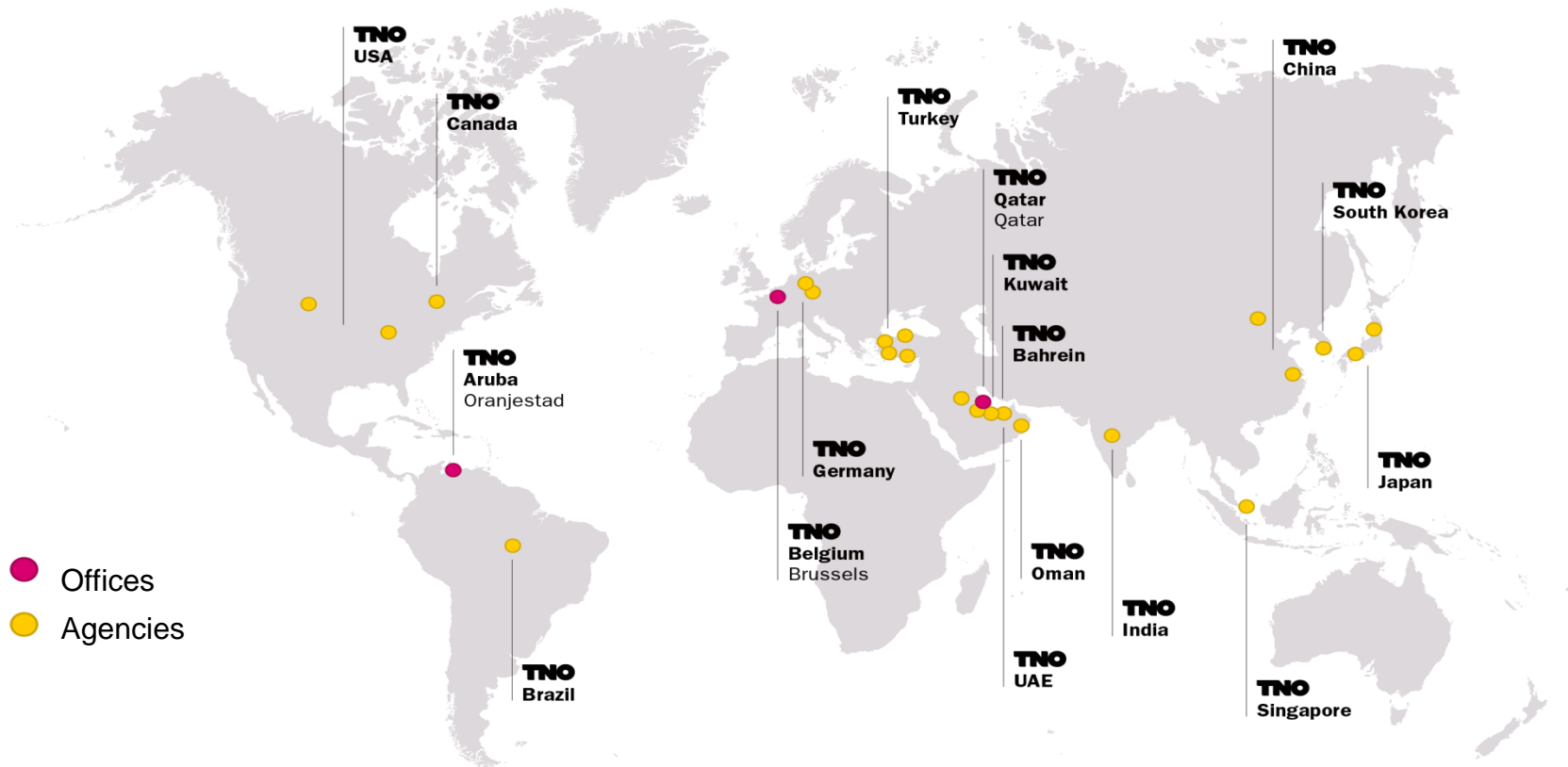


# LOCATIONS IN THE NETHERLANDS





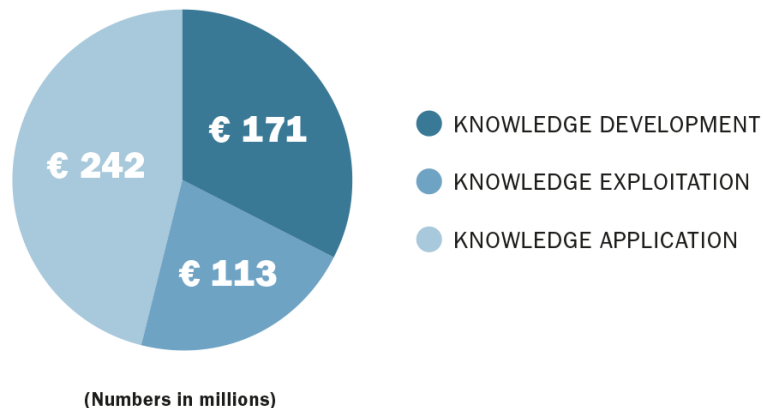
# INTERNATIONAL OFFICES AND AGENCIES



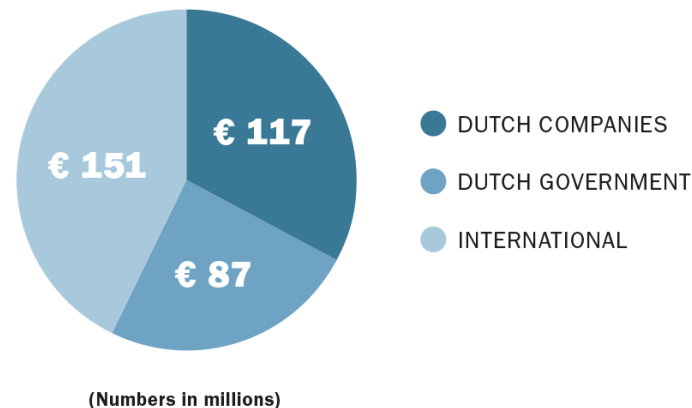


# TNO IN NUMBERS 2014

## CONSOLIDATED TURNOVER 2014 (€ 526 million)



## CONSOLIDATED MARKET TURNOVER 2014 (€ 355 million)



**staff establishment**  
**3009**  
2014  
**3276**  
2013



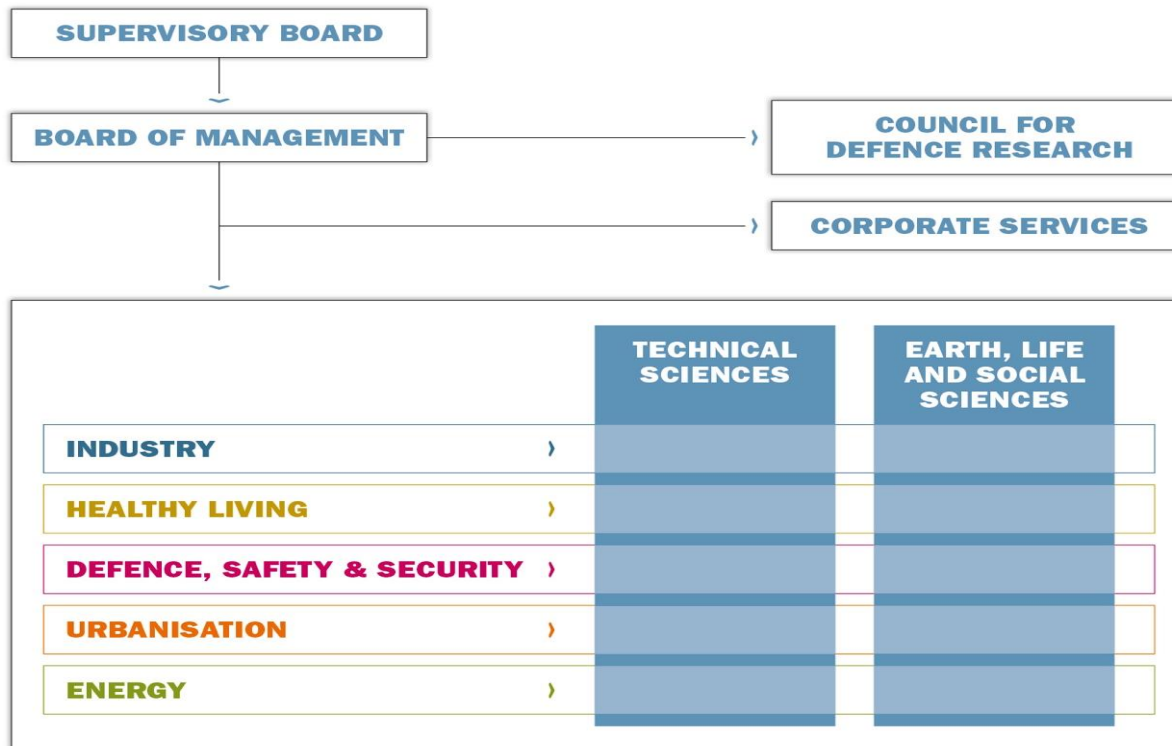
# TNO IN NUMBERS 2014







# TNO ORGANISATION





# THEMES & ROADMAPS

**INDUSTRY**

**HEALTHY LIVING**

**DEFENCE, SAFETY & SECURITY**

**URBANISATION**

**ENERGY**



**FLEXIBLE & FREE-FORM PRODUCTS**  
**SPACE & SCIENTIFIC INSTRUMENTATION**  
**SUSTAINABLE CHEMICAL INDUSTRY**  
**SEMICONDUCTOR EQUIPMENT**  
**NETWORKED INFORMATION**

**FOOD & NUTRITION**  
**PREDICTIVE HEALTH TECHNOLOGIES**  
**PREVENTION, WORK & HEALTH**

**MISSIONS & OPERATIONS**  
**FORCE PROTECTION**  
**INFORMATION SUPERIORITY**  
**HUMAN EFFECTIVENESS**  
**CYBER SECURITY & RESILIENCE**  
**NATIONAL SECURITY & CRISIS MANAGEMENT**

**MOBILITY & LOGISTICS**  
**ENVIRONMENT & SUSTAINABILITY**  
**BUILDINGS & INFRASTRUCTURES**  
**SMART CITIES**

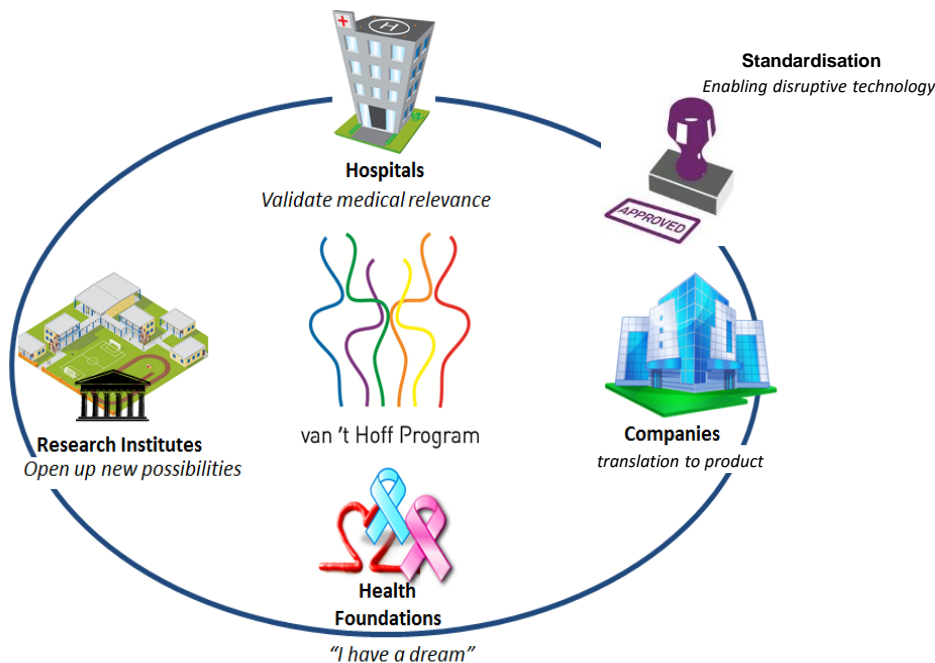
**SUSTAINABLE ENERGY**  
**GEO ENERGY**  
**GEOLOGICAL SURVEY OF THE NETHERLANDS**  
**MARITIME & OFFSHORE**



Van 't Hoff Program



# VAN 'T HOFF 'ECO SYSTEM'



- › Shared innovation: sharing results, reducing risks and costs
- › EU and other mixed funded projects as additional leverage
- › Dedicated projects to accelerate industrial take up and market introduction



# VAN 'T HOFF PROGRAM

Innovation of medical technology and healthcare by:

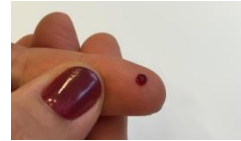
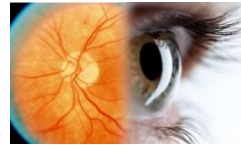
- › Developing innovative medical applications based on photonics and biomedical technologies for improved medical (early)diagnosis.
- › Ensuring application of our developments and creating economic impact by innovating together with industry.





# TISSUE RECOGNITION AND FLUID ANALYSES

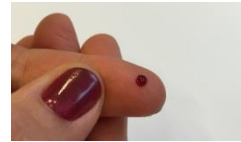
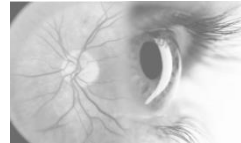
- › Selective ion and molecule measurement for dialysis
- › Non-invasive glucose measurement
- › Retinal imaging
- › Nano-photonic biosensing
- › Fiber optic sensors for non- and minimally invasive diagnostics and surgery
- › Image guided surgery





# TISSUE RECOGNITION AND FLUID ANALYSES

- › **Selective ion and molecule measurement for dialysis**
- › Non-invasive glucose measurement
- › Retinal imaging
- › **Nano-photonic biosensing**
- › Fiber optic sensors for non- and minimally invasive diagnostics and surgery
- › Image guided surgery





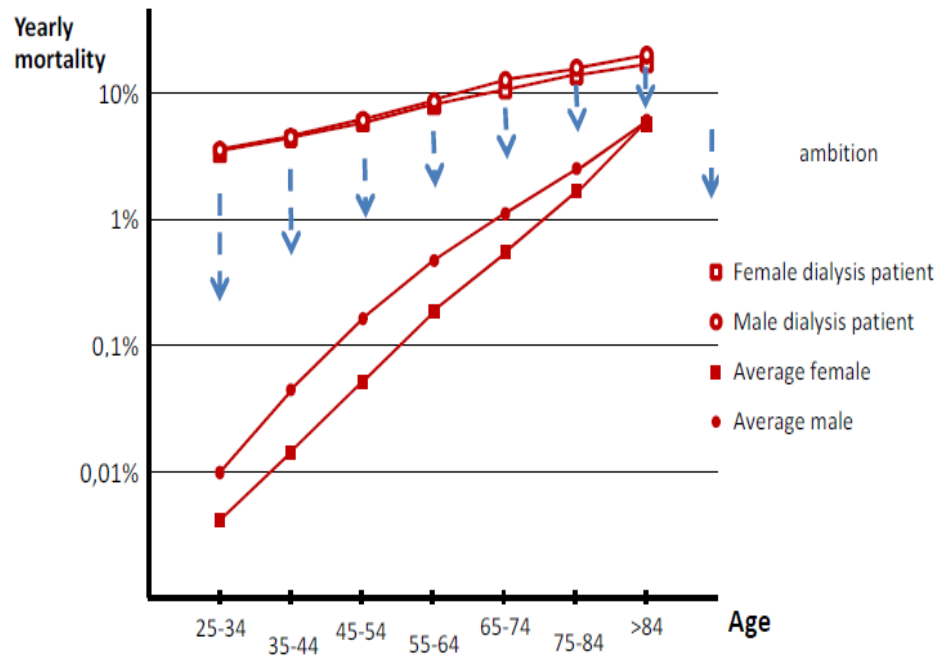
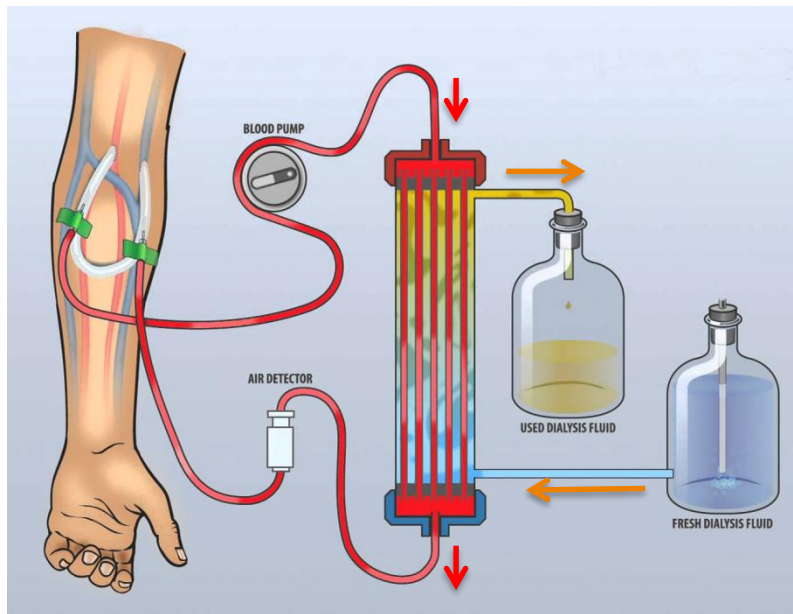
# SELECTIVE ION MEASUREMENT FOR HAEMODIALYSIS

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# MORTALITY RATE OF HAEMODIALYSIS DIALYSIS PATIENTS







# THE CASE FOR HAEMODIALYSIS: MATCH INTAKE AND EXCRETION



Calcium intake



Calcium excretion  
via dialysis



# SELECTIVE ION MEASUREMENT FOR DIALYSIS

## Goal

A miniature selective ion sensor (Na, K, Ca) to enable personalized haemodialysis and the reuse of dialysate in portable artificial kidneys

## Approach

- › Laser Induced Breakdown Spectroscopy (LIBS) based sensor system

## Key features

- › Accurate and reliable selective ion measurement in dialysate
- › Non-invasive optical detection (no contact with dialysate)
- › Monitor patients ion mass balance

*endorsed by*



International Federation  
of Kidney Foundations  
improving kidney health worldwide





# SELECTIVE ION MEASUREMENT FOR HEAMODIALYSIS

## **Increase the quality of clinical dialysis treatments**

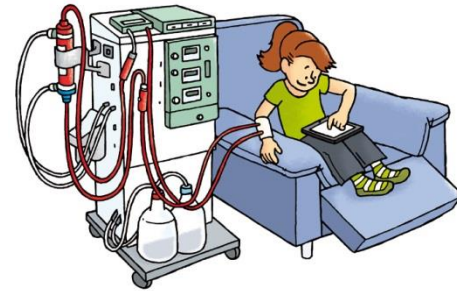
- › Increase quality of life for patients by profiled treatment
- › Decrease hospitalisations

By measuring the ion mass balance of the patient

## **Enabler for sorbent technology in portable kidney machines**

- › Use way less dialysate by reusing dialysate with sorbent technology
- › Enabling home dialysis, every night

By measuring the ion concentrations in reused dialysate



Clinical dialysis

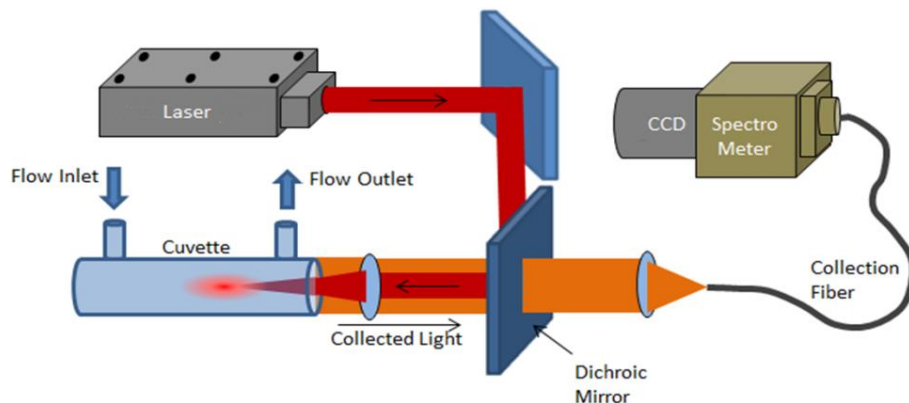


Portable Artificial Kidney

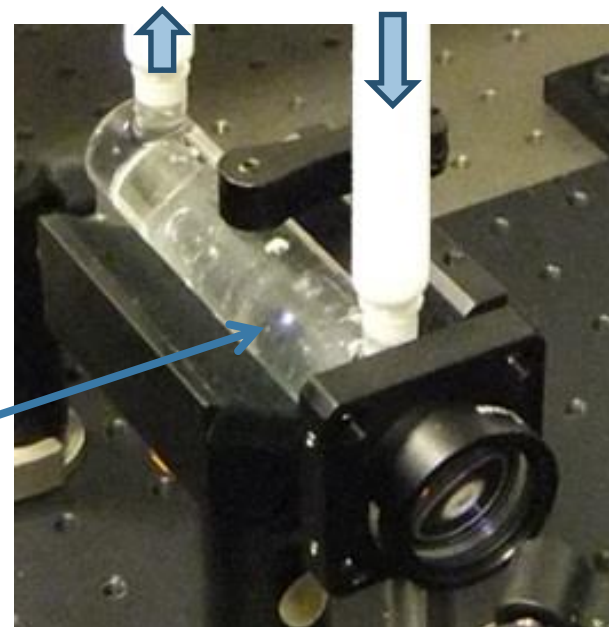


# ION SELECTIVE SENSING LASER INDUCED BREAKDOWN SPECTROSCOPY

- › Short laser pulse generates a plasma in fluid
- › Plasma emits white light and spectral lines
- › Ion concentration determined by algorithm using amount of light coming from spectral lines



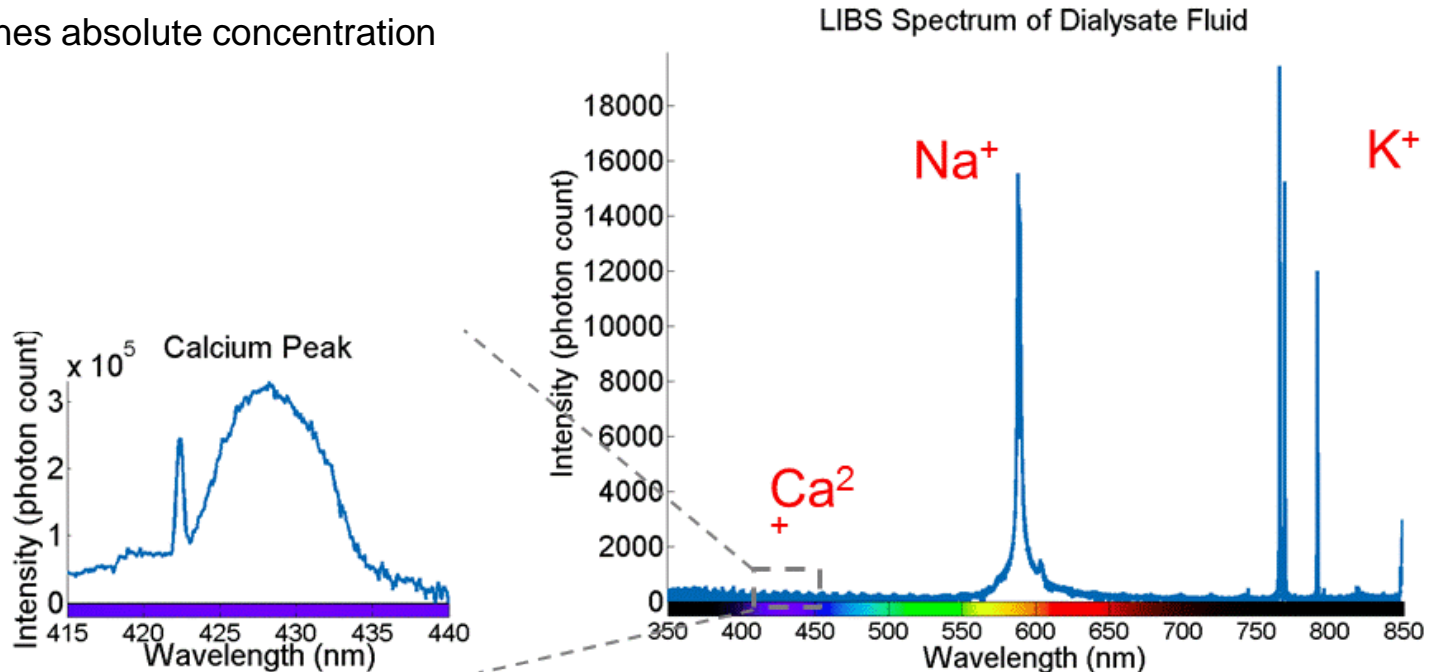
Plasma





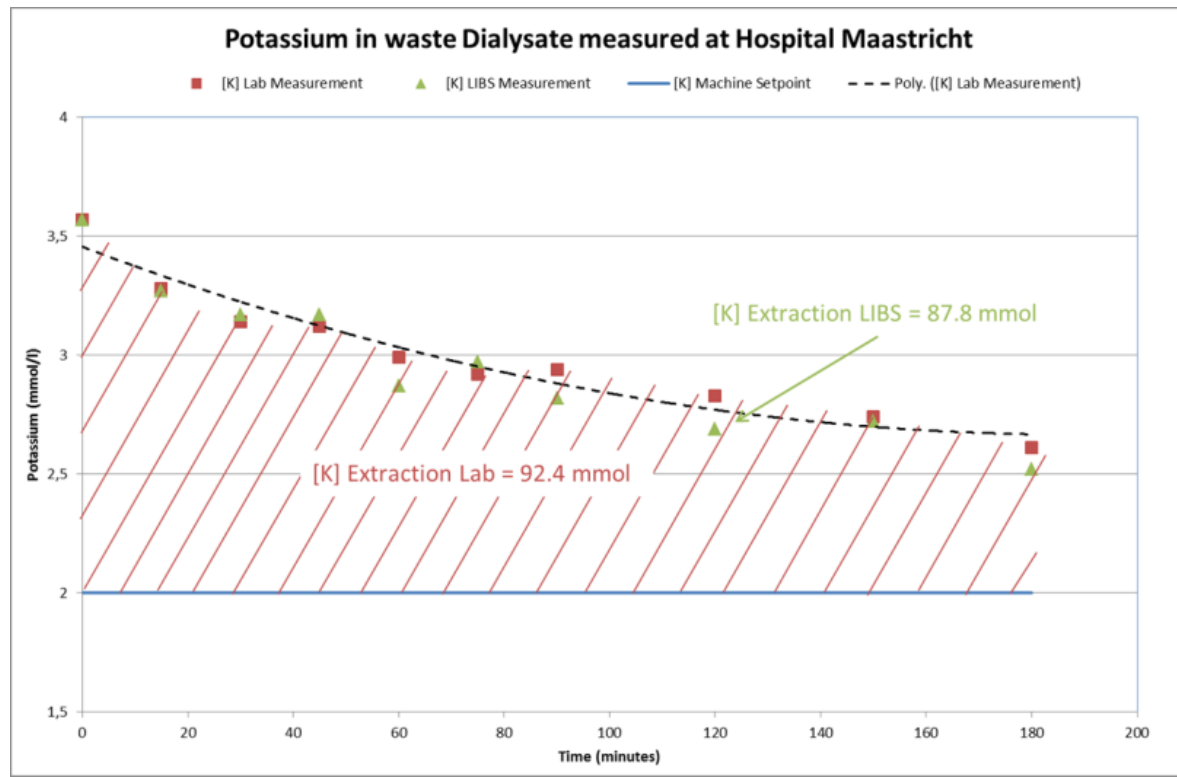
# LIBS SPECTRA IN DIALYSATE

- › Emission lines corresponding to  $\text{Ca}^{2+}$ ,  $\text{Na}^{+}$ , and  $\text{K}^{+}$  are visible
- › Magnitude of the peaks relates to concentration
- › Algorithm determines absolute concentration



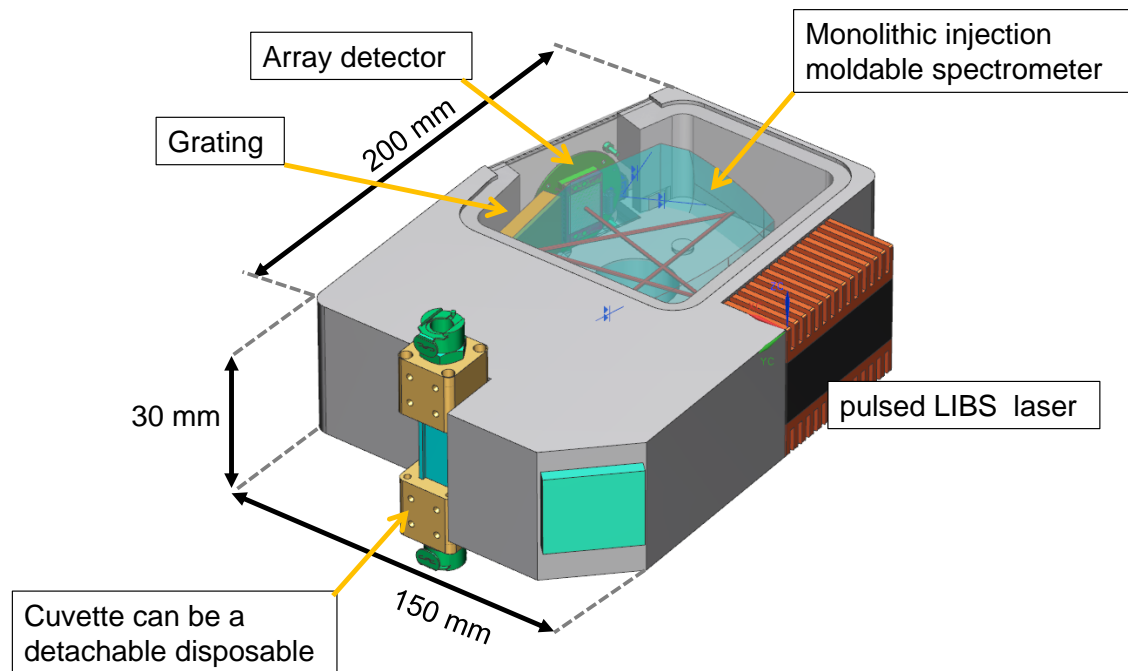


# POTASSIUM IN SPENT DIALYSATE AT MAASTRICHT UMC





# LIBS SENSOR CONCEPT DESIGN





**Maastricht UMC+**

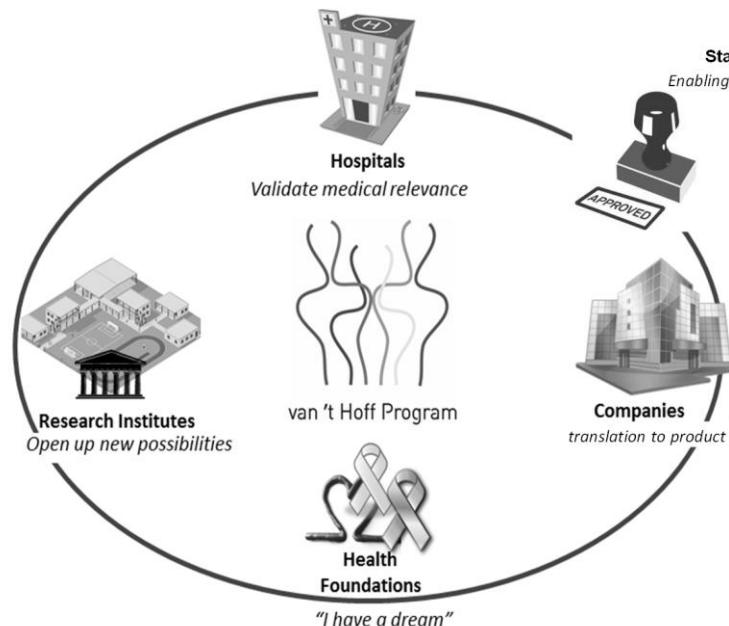


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**TC62D/MT20**  
“Dialysis Equipment”

**TNO**



Expanding with:

- Haemodialysis companies
- Dialysate concentrate equipment companies
- Exploring other market opportunities



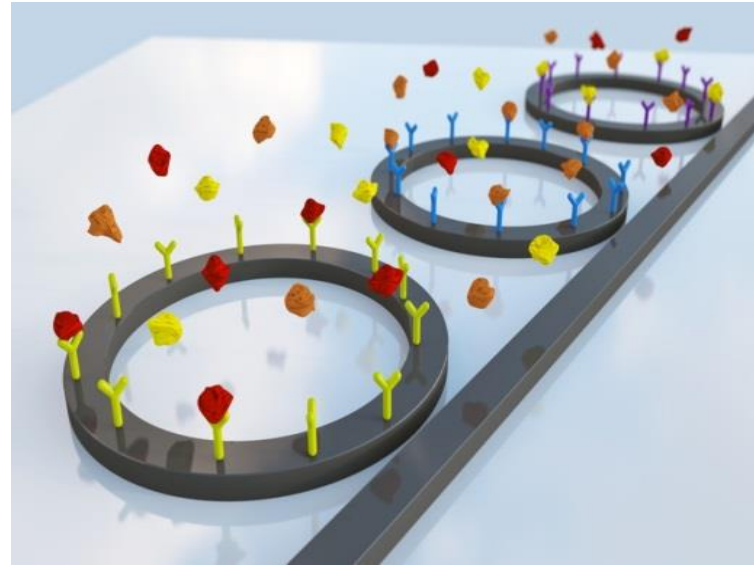
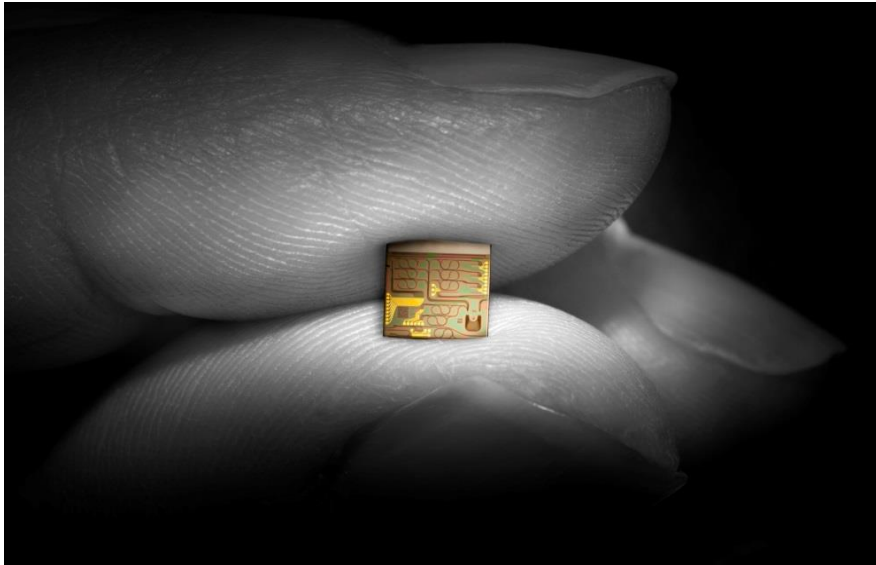




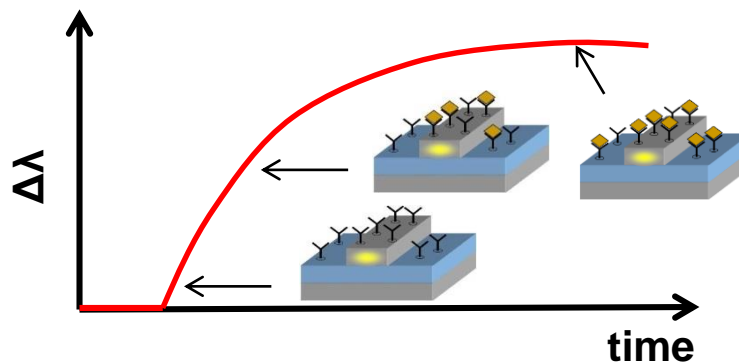
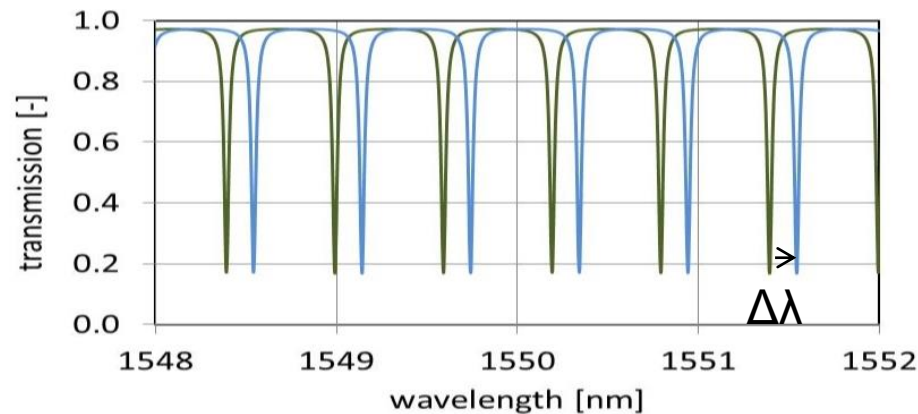
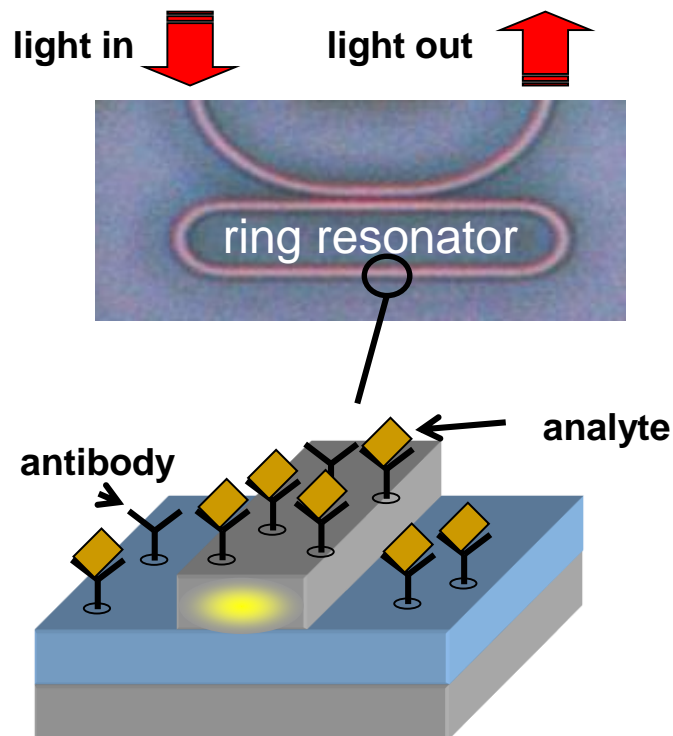
# › NANOPHOTONIC BIOSENSING

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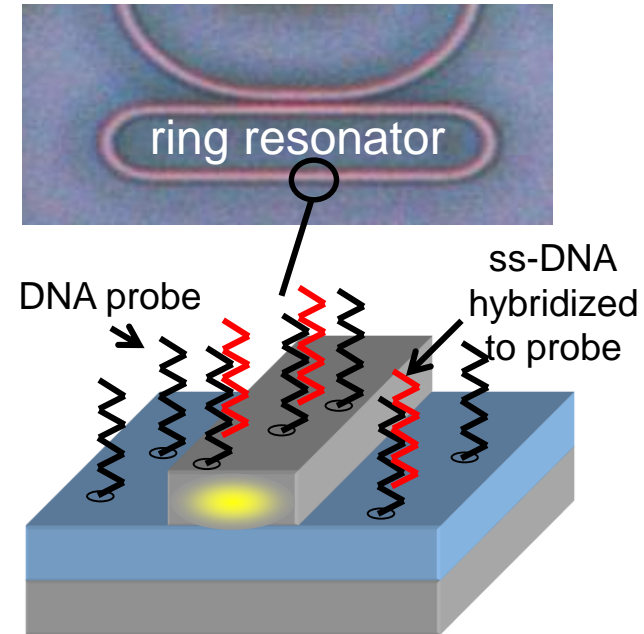
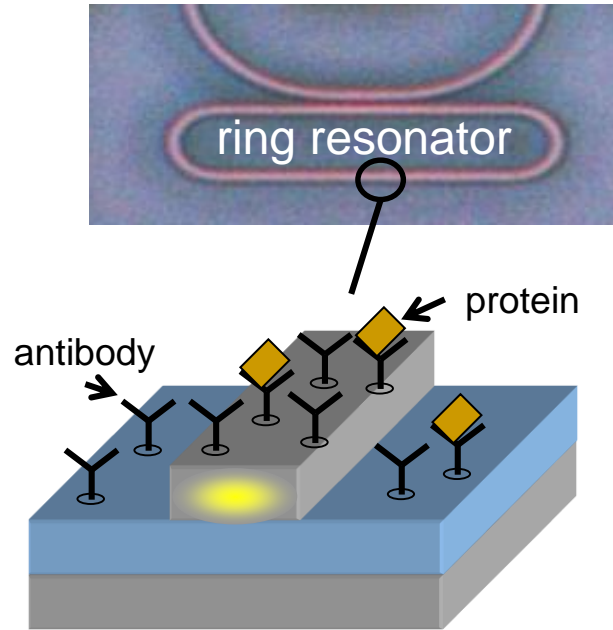
# RING RESONATOR BIOSENSING PLATFORM



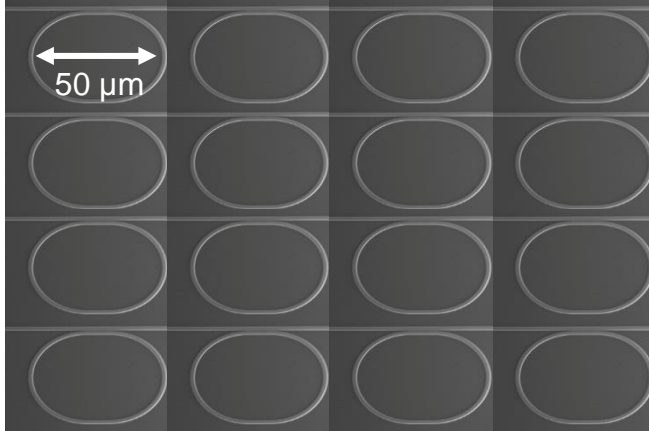
# RING RESONATOR BIOSENSOR TECHNOLOGY



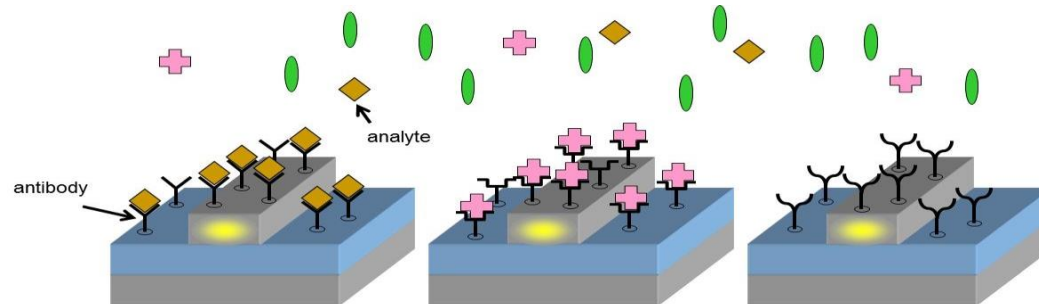
# BIOSENSOR FOR RAPID POINT-OF-CARE DIAGNOSTICS



# EXTREME MULTIPLEXING (UP TO 100 ANALYTES PER MM<sup>2</sup>)



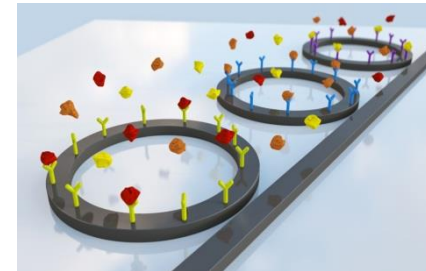
- Each ring has a different length and thus a different resonance
- Each ring contains a different antibody



# RING RESONATORS

## THE NEXT GENERATION IN POINT OF CARE

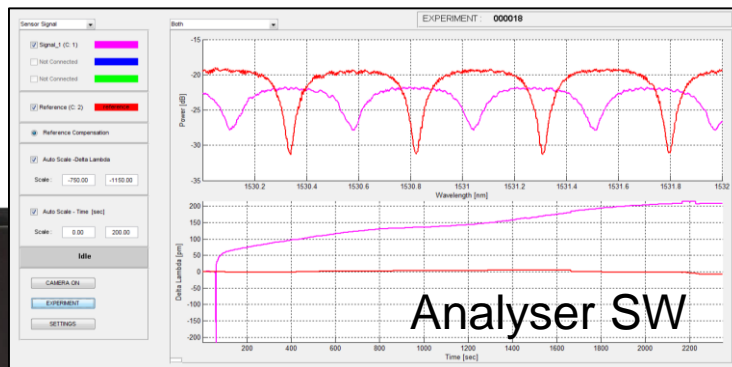
- › Label free detection possible
  - › High sensitivity
  - › High level of multiplexing in  $\mu$ liter samples
  - › Contactless optical wavelength readout
  - › Extremely small sensor area  $50 \times 50 \mu\text{m}$
  - › Chip
    - Size needed for 1 sensor:  $0.1 \times 0.2 \text{ mm}$
    - 100 different sensors on  $1 \text{ mm}^2$
    - Standard semicon production process
- Short total analysis time
  - Picomolar concentrations
  - E.g. 100 analytes / fingerprick sample
  - Robust, no contact wear, no contact noise
  - Small antibody volume needed
  - Low chip production costs  $< 0.05 \$ / \text{mm}^2$





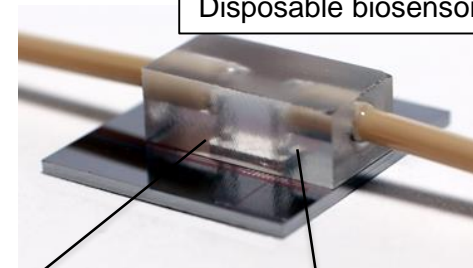
# BIOSENSOR EXPERIMENTAL SETUP

**“FRESCO”**



**Analyser SW**

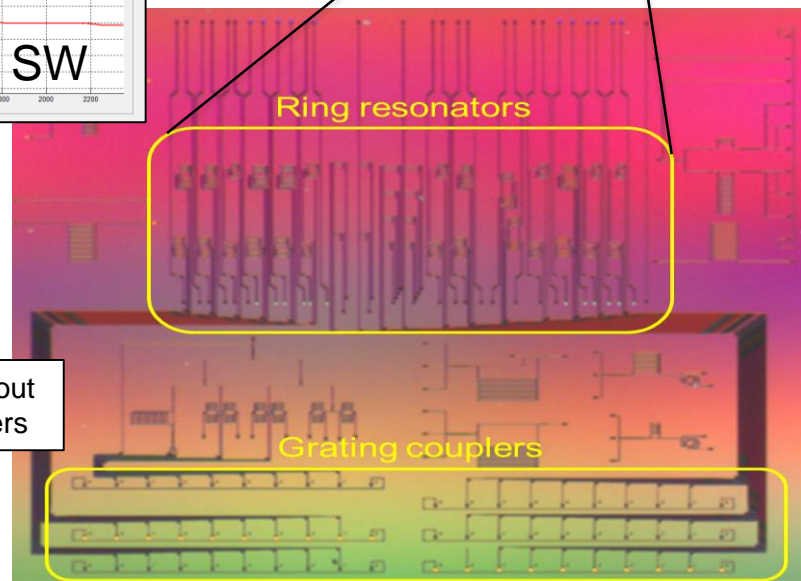
Disposable biosensor



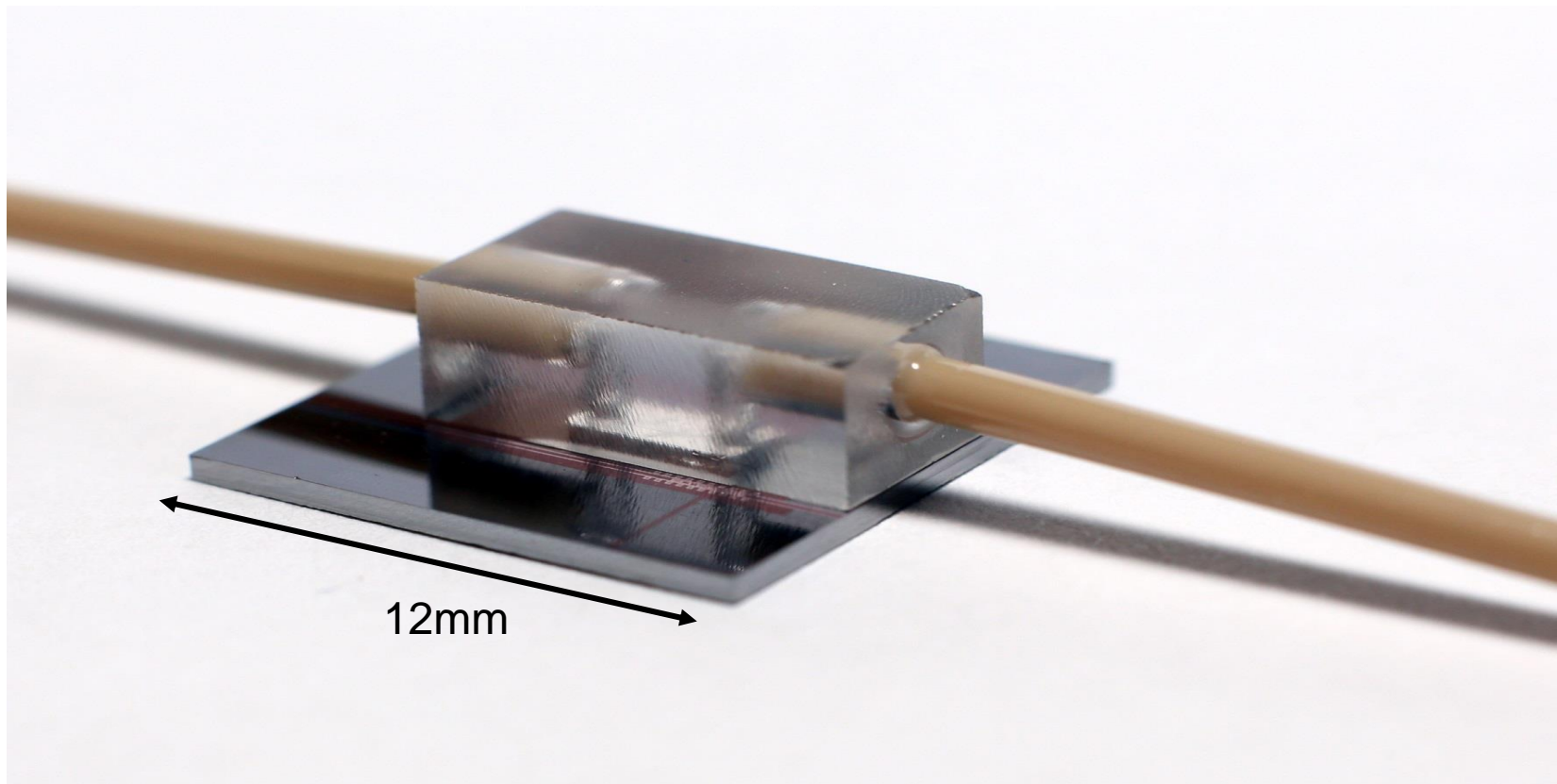
Ring resonators

Grating couplers

Contactless readout  
via grating couplers

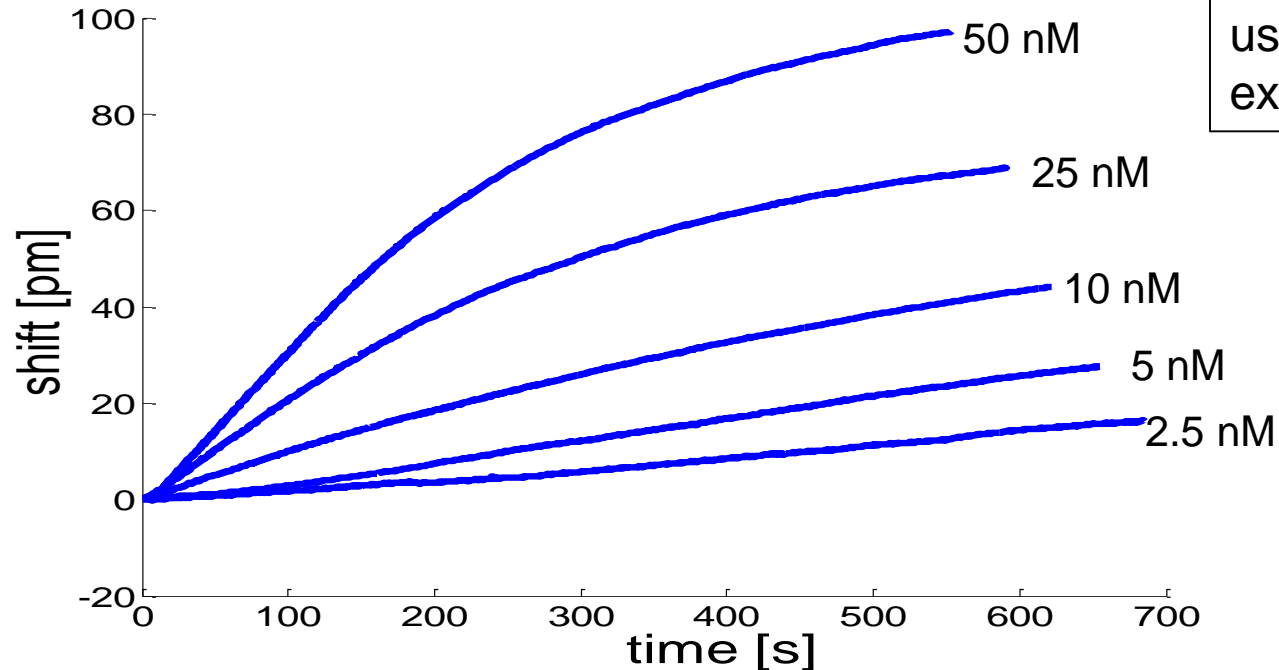


# DISPOSABLE BIOSENSOR



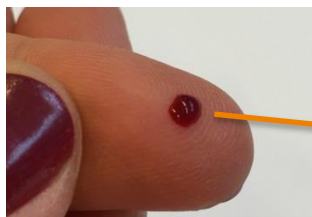
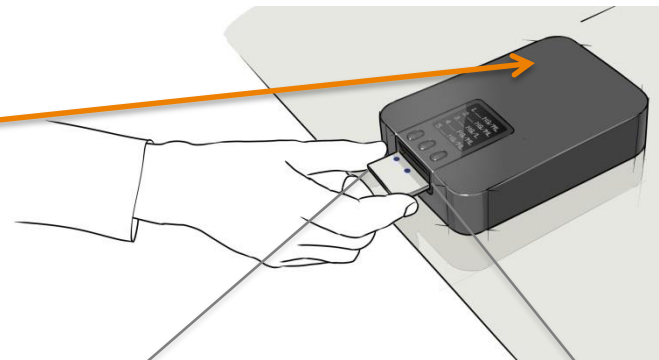
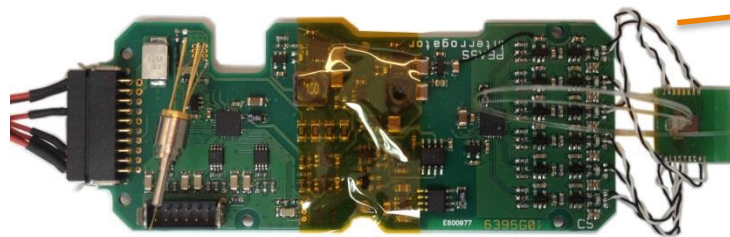


# LABEL FREE DETECTION OF BUTYRYLCHOLINESTERASE

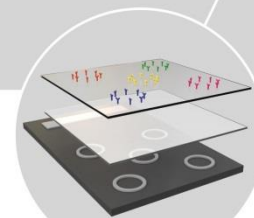
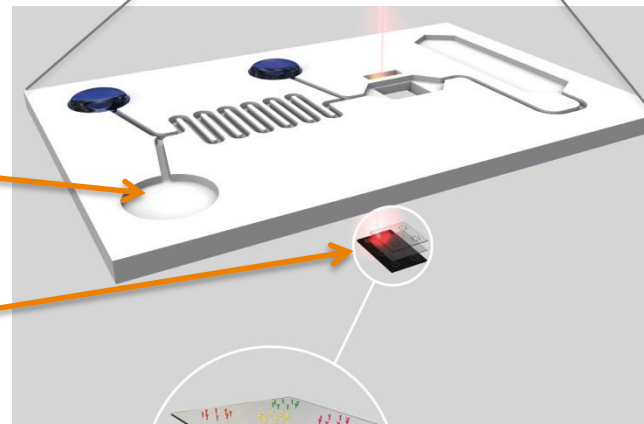
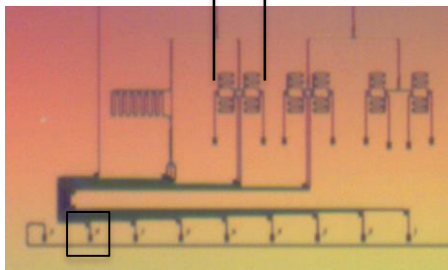


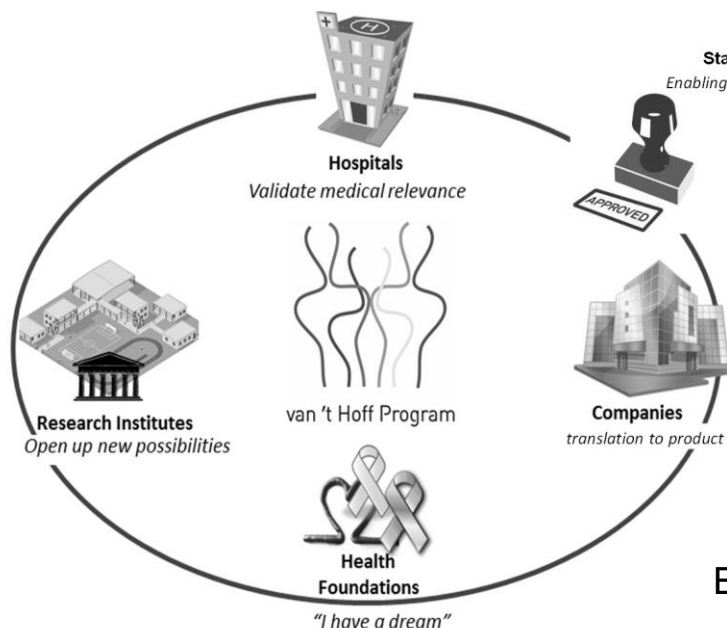
Butyrylcholinesterase is used to diagnose exposure to nerve agents

# POINT OF CARE INSTRUMENT



50  $\mu\text{m}$





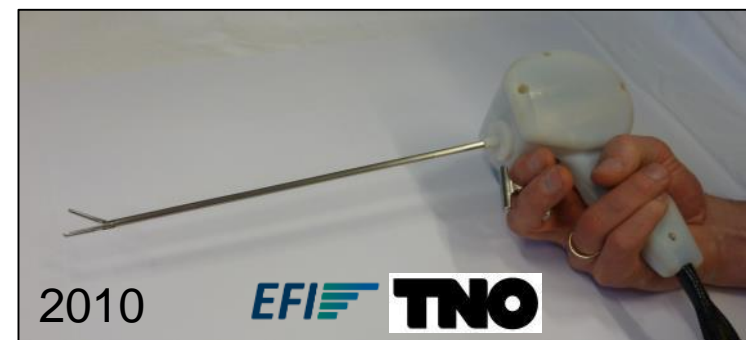
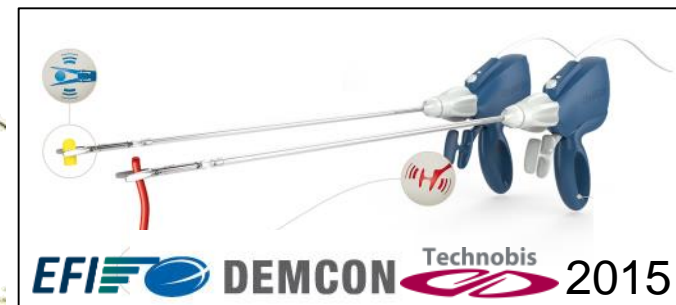
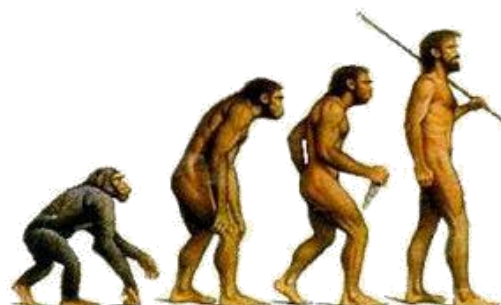
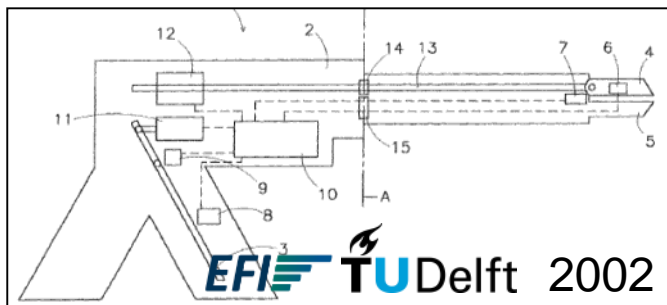
**Dutch biosensing SME “X”  
Clinical diagnostic instrument**

Expanding to more diagnostic companies

Other market “Defence” outside scope  
Van ‘t Hoff, but supports platform  
development

# THE EFI OPTIGRIP

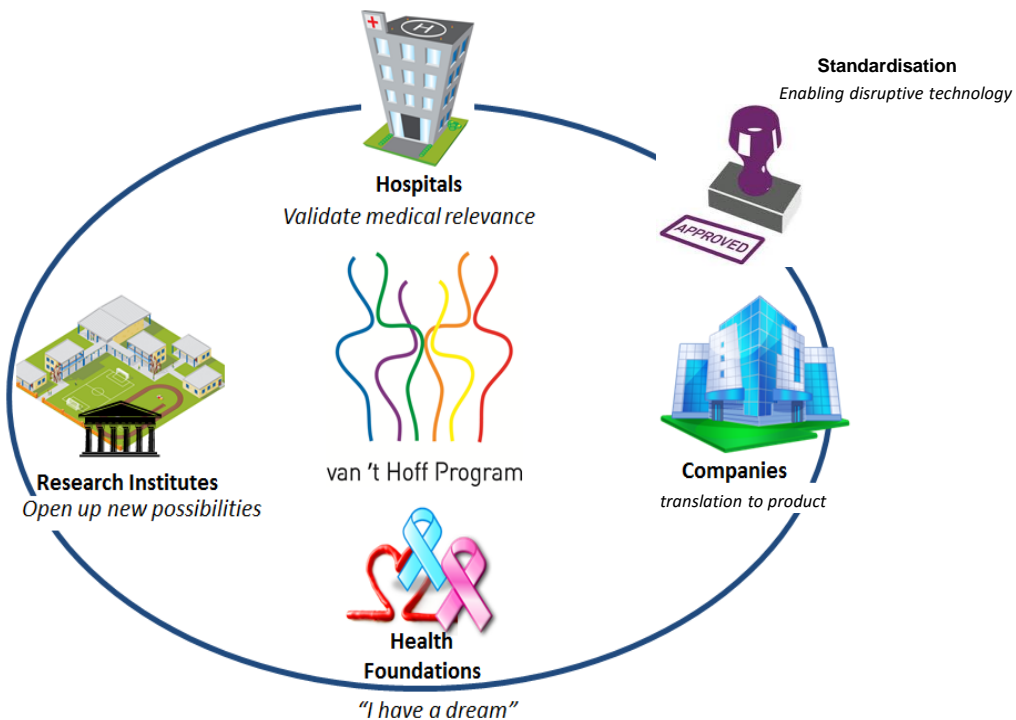
FIBER-OPTIC FORCE FEEDBACK INSTRUMENT FOR ENDOSCOPIC SURGERY



# SOCIETY OF LAPAROENDOSCOPIC SURGEONS INNOVATION OF THE YEAR 2015



# CONCLUSION & DISCUSSION





# THANK YOU FOR YOUR ATTENTION

**FOR MORE INFORMATION PLEASE CONTACT**

**Mr. Michiel Oderwald, MSc**

Business Developer Van 't Hoff Program

+31 888 666 336

[michiel.oderwald@tno.nl](mailto:michiel.oderwald@tno.nl)



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