Vrije
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[for companies]

Technology
Transfer
Interface
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Vrije Universiteit Brussel
Technology Transfer Interface

-connecting science and society-

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Vrije Universiteit Brussel, innovation center in the heart of Brussels

The VUB – Vrije Universiteit Brussel - is a Flemish university known for its high level education and independent research. The VUB is situated in Brussels, the heart of Europe, **international decision center and talent pool.** The VUB counts about 12000 students and 2 campuses: its main campus with 7 faculties in Etterbeek and its medical campus in Jette, next to the university hospital UZ Brussel.
VUB's research is conducted with a strong motivation to **positively impact society and enabling technological innovation.** The ambition of VUB's Technology Transfer Interface (TTI) is to play an increasingly prominent role in **attracting and initiating economic activity** in Brussels and the Flanders Region: by taking care of the **VUB's knowledge transfer and business development.**

TTI, your one-stop-shop

TTI is a **multidisciplinary** team of experts in knowledge and technology transfer, business development, contract negotiation, funding resources, legal and IP aspects, event organization, marketing and communication. They work together to offer that **one-stop-shop** office that facilitates collaboration between the VUB, society and industry.

Vital link between university and industry

Through the TTI unit, the VUB **makes knowledge, know-how and research results available. It facilitates the commercial application of promising technologies** developed by our research teams. TTI also ensures that revenues are reinvested in an ecosystem of excellent researchers, open innovation and industrial collaboration. The VUB (co-)owns about **100 active patent families** and has generated about **20 spin-off companies.**

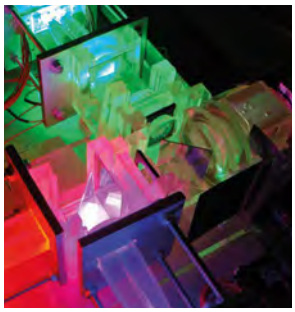
We can be your partner in

- applied and industrial research
- contract research
- consultancy & testing facilities
- licensing of technologies
- new spin-off companies
- accomodation & infrastructure (incubators)
- training & entrepreneurship

['We strive to deliver innovations that positively impact our society']

Prof. Hugo Thienpont

Prof. Hugo Thienpont
Chairman Innovation
and Industrial Policy
Vrije Universiteit Brussel



More Information

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VUB's Technology Transfer interface team

Funding for applied research

TTI supports projects financed by the **Industrial Research Fund** (IOF). Flemish universities receive this government funding according to their **valorization output performance** - contracts with industry, patents and spin-offs, share in the European Framework Programme for R&D.
The VUB invests IOF funding in **IOF knowledge centers** that exceed the average scale of a standard university's research unit. The funding supports them in carrying out **outstanding strategic research and developing new application-oriented inventions with economic potential.** The first priority of the IOF funding is the further establishment of a portfolio of **potentially applicable and transferable know-how with economic and societal value.** It also finances **short-term proof-of-concept projects.**

More info: **www.vubtechtransfer.be**

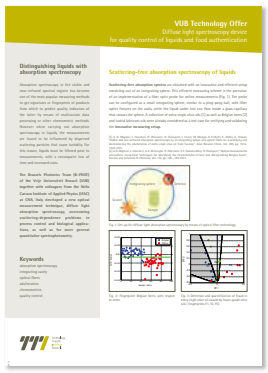
VUB's "IOF Knowledge Centers" for applied research

- Photonics
- Electronics & Informatics
- Industrial Microbiology & Food Biotechnology
- Electrochemical & Surface Engineering
- Chemical Engineering
- Diabetes Research
- Toxicology, Dermato-cosmetology & Pharmacognosy
- Mechanical Engineering
- Molecular & Cellular Therapy
- Structural Biology
- Wind energy
- Medical Imaging & Cellular Immunology
- Electrical Engineering & Mobility

Discover TTI's publications on:

- IOF knowledge centers for applied research
- spin-off companies
- technology offers

Interested?
Please contact TTI.



Spin-off companies

The VUB has now about 20 active spin-offs, based on research in many domains: engineering, life sciences, economy, ICT, sports ... In this context, TTI collaborates with strategic research centers, such as VIB, IMEC, iMinds and VITO.

INSILICO GENOMICS AT YOUR FINGERTIPS
agrosavfe
sportonova
SoftKinetic
elsyca
PharmaFluidics
Ablynx
Collibra
Double PASS QUALITY IN SPORTS
NUMECA INTERNATIONAL
blue planet ACADEMY & CONSULTING
UD
β cell
EQCOLOGIC
€SPACE

Looking for infrastructure?

Companies focusing on research and seeking collaboration with the VUB can find suitable accommodation and infrastructure at one of the university's **research parks or incubation centers:**

- **In Flanders**:
  Zellik Research Park - **www.researchparkzellik.be**
  Innovation and Incubation Centre (IICB) - **www.iicb.be**
- **In Brussels**:
  Brussels Mercator Research Park - **www.sdrb.irisnet.be**
  Incubatiecentrum Arsenaal Brussel (ICAB) - **www.icabrussel.be**

Qbic FUND Transforming knowledge

Interuniversity seed capital fund

The **Qbic Fund** is the first interuniversity seed capital fund in Brussels and Flanders. Its aim is to finance technology spin-offs from three **university associations – Brussels University Association, Ghent University Association** and the **Association Antwerp University & Colleges.** The Qbic Fund came into operation in June 2012. It is the successor of the VUB's BI3 Fund and Ghent University's Baekeland Fund II. These two universities have pooled the expertise of their respective tech transfer offices to improve the success rate of high-risk company creation. Through this strong alliance, we have succeeded in more than doubling the capital, resulting in a €30 million fund at first closing, possibly even increasing after the second closing.

For more information on Qbic

Please visit the Qbic website www.qbic.be
Or contact the VUB board representative in the Qbic Fund, **Prof. Jan Cornelis**
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crosstalks
crosstalks.vub.ac.be

The academic and corporate exchange platform in search of a future of prosperity and freedom without undermining nature and humanity.

Vrije Universiteit Brussel
Foundation
Investing in Excellence

With the support of our strategic partners and alumni community, we further improve our level of excellence in research and education.
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The VUB Technology Transfer Interface receives support from the Flemish and Brussels Governments.

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IOF Knowledge Center

Electrochemical and Surface Engineering

Electrochemical and Surface Engineering

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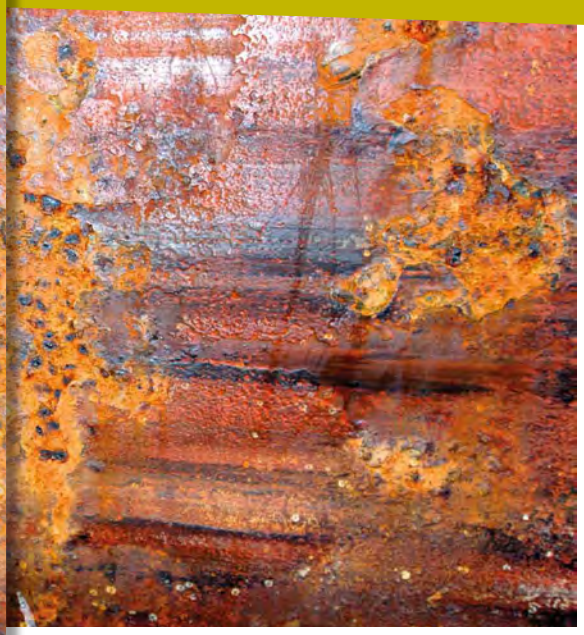

optimization of processes to perform dedicated surface treatments. Important is the ability **to make functional materials,** for example self-healing coatings.

SURF's approach to both the fundamental and the application driven aspects is **combining experimental and modeling techniques.** Experimental techniques are oriented towards surface characterization, in-situ and ex-situ, and electrochemical analysis. Modeling means development of simulation and prediction models and numerical tools to handle the mathematics.
The SURF group - counting over 50 people - is recognized as IOF Centre of Excellence within the VUB and internationally renowned. Industrial valorization is one of its key priorities. It has a prominent position in the EU research field and industrial valorization are it's key priorities. SURF has a leading position in new resarch disciplines of state-of-the-art electrochemistry and (nano)surfaces, such as:

- **Dimension 'downscaling' to nanometer resolution:** analyzing and manipulating the surface of the material on the very localized, nano-technological scale.
- **Multifunctional metals:** the creation and analysis of metal surfaces with a unique combination of functional properties on a very small dimension.
- **Process modeling:** quantitative modeling of electrochemical processes to get a better and quantified understanding

Expertise & Techniques

The research group of Electrochemical and Surface Engineering (SURF) is part of the department of Materials and Chemistry (MACH) of the Faculty of Engineering at the Vrije Universiteit Brussel. SURF concentrates its research around **5 cross-linked research domains: electrochemical engineering, electrochemical modeling, corrosion technology, surface engineering and in-situ and ex-situ surface characterization.** The unique combination of expertise and a state of the art research infrastructure promotes a multidisciplinary approach and focus in each of these research domains.

- In-situ & ex-situ surface analytical techniques:
  - scanning electron microscopy (FE-SEM)
  - auger electron spectroscopy (FE-AES)
  - X-ray photoelectron spectroscopy (XPS)
  - in situ spectroscopic ellipsometry (visual & infrared)
  - high resolution confocal raman spectroscopy
  - in situ atomic force microscopy - scanning tunneling microscopy (AFM-STM)
- Complementary electrochemical methods:
  - electrochemical impedance spectroscopy methods
  - electrochemical stationary and non-stationary techniques
  - electrochemical reactors operating under different flow regimes (e.g. rotating disc reactor, wall jet reactor, parallel flow reactor)
  - local electrochemical techniques (e.g. SECM, SVET/SIET, AFM-KP, LEIS)
- Electrochemical modeling tools:
  - numerical software for macro, meso & micro scale systems
  - dedicated fitting tools based on maximum likelihood estimator

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Towards the next generation of high performance & multifunctional materials

The **mission** of Electrochemical and Surface Engineering (SURF) is to build a solid knowledge and to be an international leader on how to manipulate, analyze and model metal and metal oxide surfaces from the macro to the nm scale, including nanoparticles and wires, in interaction with their environment. This knowledge can then be deployed to make tailored nanoscale structures for all kind of desired applications and contribute to the development of the next generation of high performance and multifunctional metals and hybrid materials, with a strong emphasis on durability and sustainability, responding to the needs and challenges that drive our society today and tomorrow. This mission is supported by large-scale programs, like the **Methusalem program NANOMET,** to develop this new and alternative approach to materials management.

Electrochemical and Surface Engineering

Electrochemical engineering covers the area of **controlled electrochemical processes** (such as electrolysis, batteries and fuel cells) as well as the study of **unintended processes,** such as corrosion. Surface engineering is aimed at the development and optimization of processes to perform dedicated surface treatments. Important is the ability **to make functional materials,** for example self-healing coatings.

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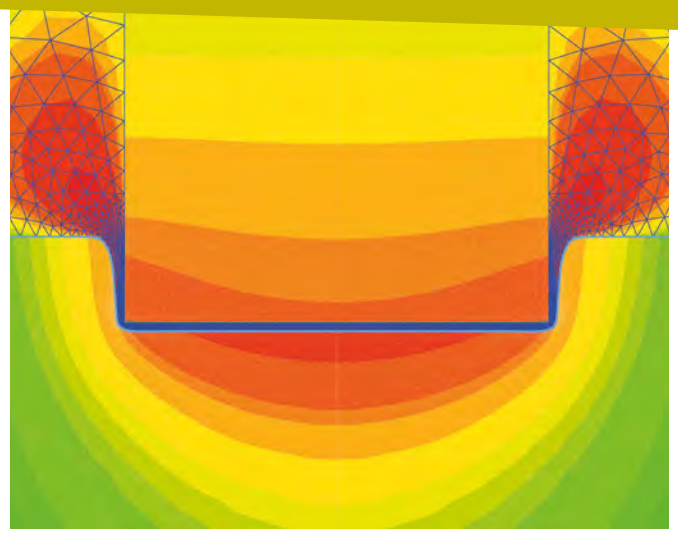


Simulation of nano-second pulse electrochemical micro-machining. Geometrical anodic shape change based on calculated dissolution rate combined with the temperature distribution, after two minutes of simulated time.

of the physics (transport), chemistry (reactions) and electrode processes.

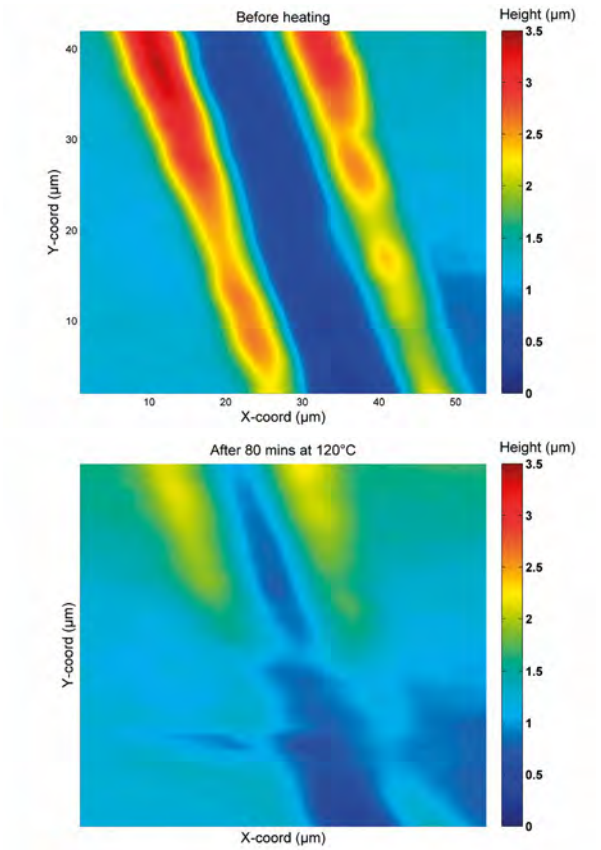
- **Functional modeling:** e.g. interpretation of experimental impedance data by modeling the transfer function between the input and the output signals; optical modeling, allowing us to predict the appearance of modified surfaces,...

Knowledge transfer

SURF has a track record in converting knowledge to societal value:

- **Elsyca:** Modeling algorithms for electrochemical systems developed within the group were taken to the market through **spin-off company** Elsyca. The models developed for fundamental research on predicting electrode behavior in aqueous solutions were transformed and rendered more robust. As such advanced simulations can be offered to plating companies or in aiding in the design stage for the protection of seagoing vessels.
- **SIM:** SURF is a steering committee member for surface technology within SIM (Strategic Initiative Materials) and an active partner in many SIM projects.
- **Zensor:** SURF's monitoring of metal corrosion is now taken to the industrial level through the start-up of a **spin-off company** Zensor (with application domains: offshore wind turbines, pipelines, storage tanks...).

- **STP (Services to Third Parties):** SURF has built up a vast collection of dedicated research equipment over the years and the knowhow of operating the instruments in optimal conditions for a wide variety of materials and surfaces. **This knowledge is made available to industry through SURF's STP activities.** Every company with a short term need for analysis and/or interpretation of a material, corrosion or surface based problem can call on SURF for assistance.
- **Greencoat:** SURF is also active in the development of novel or improved approaches for the protection of metallic surfaces against corrosion. This way a new concept has arisen for depositing protective layers on metals through ecologically less demanding ways. **This concept is offered to industry through the newly established knowledge center 'Capcoat' (www.capcoat.be).**



Healing of a scratch in a self-healing polymer by heating up to 80°C

Electrochemical and Surface Engineering

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10-13 - Published by: VUB - TTI, Sonja Haesen, Pleinlaan 2, 1050 Brussel

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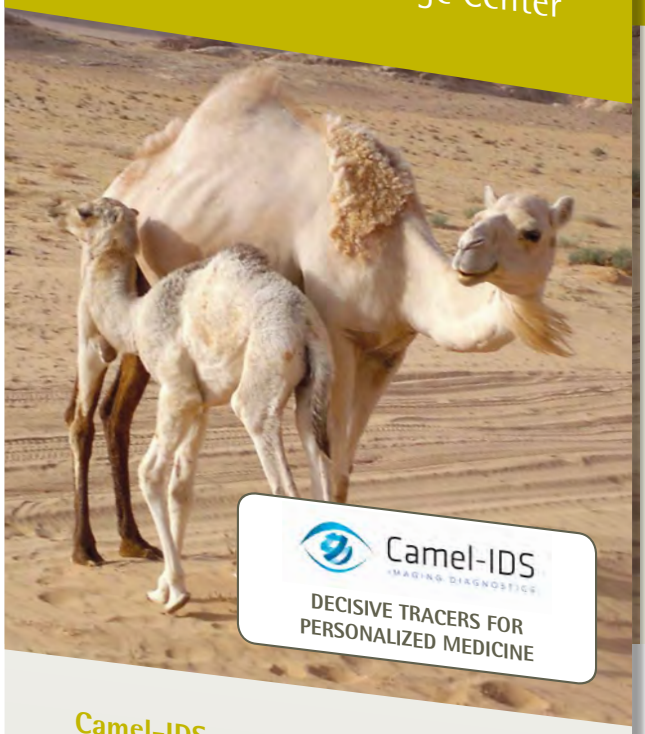
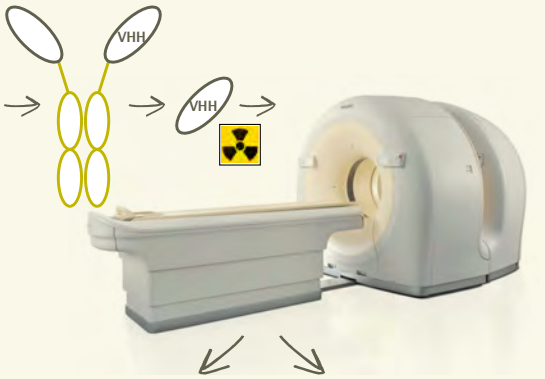
SURF Research Group Electrochemical and Surface Engineering

Vrije Universiteit Brussel





FROM TARGET VALIDATION TO DISEASE IDENTIFICATION

Pre Clinical Development	Clinical Development	Clinical Routine
Compound Selection	Patient Stratification	Personalized medicine

clearance of unbound sdAbs from the blood circulation. As a consequence, whole body images with a high target-to-background ratio can be obtained within a few hours after the probe inoculation. An ongoing first-in-human phase I clinical trial has also confirmed the game-changing potential of sdAbs for same-day molecular imaging in humans.

Camel-IDS: imaging diagnostics as novel application of sdAbs

Since 2003, the **VIB-VUB spin-off Ablynx** has brought sdAbs - named **Nanobodies®** - into clinical trials as therapeutics for cancer, inflammation and immune diseases. Since 2013, a new **spin-off Agrosavfe** is using sdAbs binding to leaves, seeds, fruits, and pests - called **Agrobodies®** - as tools in crop protection. The current valorization initiative offers a **platform for sdAbs-based preclinical and clinical imaging diagnostics under the name Camel-IDS.**

Key patents

- "Anti-VCAM-1 Nanobodies", WO2013026878
- "Anti-macrophage mannose receptor single variable domains for targeting and in vivo imaging of tumor-associated macrophages", US201113065794
- "Targeting and in vivo imaging of tumor-associated macrophages", US2012301394

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Vrije Universiteit Brussel

Expertise & Techniques

The **Cellular and Molecular Immunology** lab (CMIM), headed by prof. Patrick De Baetselier, combines scientific expertise and know-how on **cellular immunology, tumor immunobiology, immunoparasitology and antibody engineering.** A central research topic has been pioneering research on using **camelidae-derived single-domain antibody fragments (sdAbs)** for in vivo therapeutic targeting in cancer and infectious diseases and, in collaboration with the ICMI unit, for in vivo imaging of cancer and immune cells. The available CMIM facilities include an animal unit and separate laboratory rooms for mammalian cell culture, molecular biology, protein purification and phage display, including equipment for flow cytometry, cell sorting and Surface Plasmon Resonance.

The **In vivo Cellular and Molecular Imaging** lab (ICMI) and **Nuclear Medicine Department,** headed by prof. Tony Lahoutte, feature centralized multiple small animal imaging modalities including MicroCT, MicroSPECT, optical and near-infrared fluorescent (NIRF) imaging, together with a probe development unit and a vivarium for housing the animals. The main research topic is the **development, preclinical validation and clinical translation of sdAbs as molecular imaging probes** with applications in oncology, cardiovascular medicine and diabetes. A current step in the efforts of the group towards clinical translation of sdAbs as imaging tracers is a first-in-human phase I clinical trial for PET imaging of breast cancer patients.

[When Molecular Diagnostics become personalized]

www.camel-ids.com

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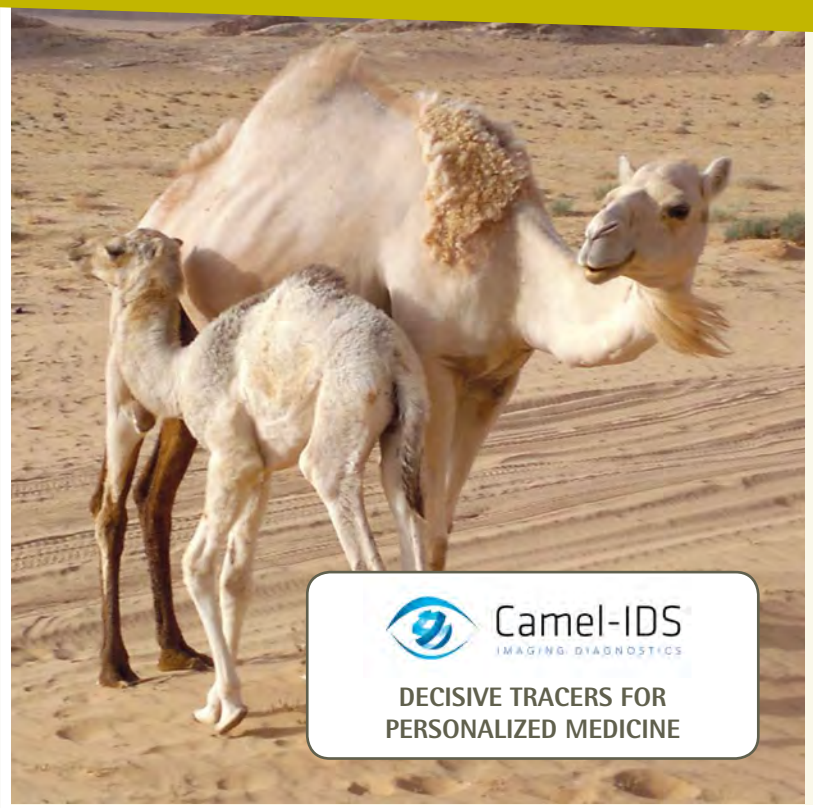

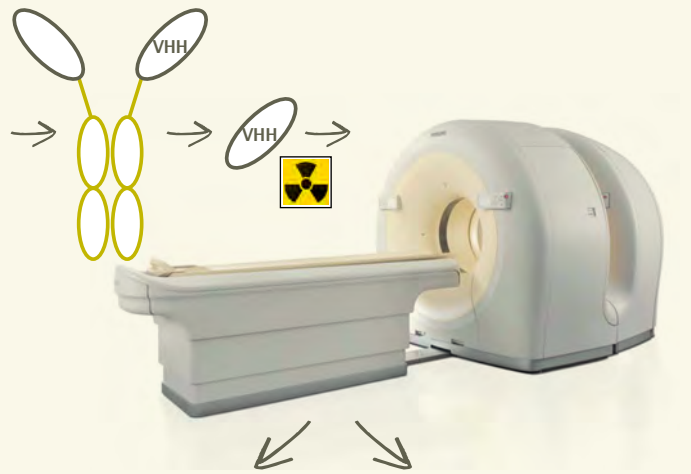

Camelidae-derived single-domain antibody fragments: from therapeutic to diagnostic applications

In 1992, the team of Emeritus Prof. Raymond Hamers made the seminal discovery that the serum of Camelidae contains bona fide antibodies devoid of light chains. The antigen-binding units of such heavy-chain-only antibodies consist of a single domain and thus offer many biotechnological advantages, including easy recombinant production and much smaller size as compared to conventional antibodies. Within the VIB department of Molecular and Cellular interactions at the Vrije Universiteit Brussel, this major discovery has over the years been translated into numerous applications of camelidae-derived single-domain antibody fragments (sdAbs), with Jan Steyaert and Lode Wyns developing them as tools in Structural Biology and Serge Muyldermans and Patrick De Baetselier focusing on their use in medicine.

In the context of biomedical applications of sdAbs, the focus was initially on **therapeutic targeting of cancer cells and parasites.** Recently, and in collaboration with Tony Lahoutte's group, sdAbs were also shown to be **excellent probes for molecular in vivo imaging in preclinical animal models** of cancer, atherosclerosis and auto-immune diseases such as arthritis. Due to their small size, sdAbs have an excellent tissue and organ penetration potential, combined with a rapid clearance of unbound sdAbs from the blood circulation. As a consequence, whole body images with a high target-to-background ratio can be obtained within a few hours after the probe inoculation. An ongoing first-in-human phase I clinical trial has also confirmed the game-changing potential of sdAbs for same-day molecular imaging in humans.

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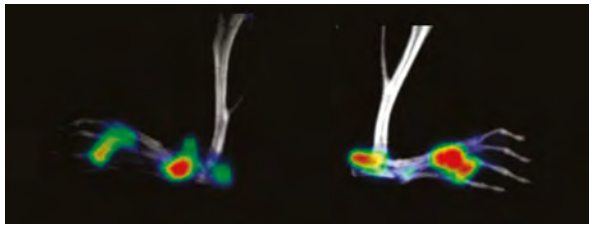
The multidisciplinary Camel-IDS platform

The groups of Patrick De Baetselier and Serge Muyldermans within the Cellular and Molecular Immunology lab (CMIM) are affiliated to the Faculty of Sciences and Bio-engineering Sciences at the Vrije Universiteit Brussel, as well as to VIB, a Flanders-based life science research centre of excellence. Tony Lahoutte's group at the In vivo Cellular and Molecular Imaging lab (ICMI) combines an affiliation to the Faculty of Medicine and Pharmacy at the Vrije Universiteit Brussel, with a clinical link to the UZ Brussel.

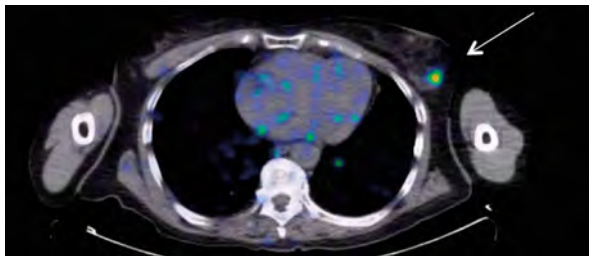
The various sources of external funding for the fundamental research in each of these groups are supplemented with VUB Strategic Research Programme financing, aimed at stabilizing centers of excellence within the university. Both groups have a history of valorization-oriented research in the context of IWT-SBO projects, of contract research for biotech and pharma companies and of fruitful joint research projects in the context of sdAbs-based molecular imaging.

The Camel-IDS platform is supported via VUB-IOF funding as Group of Expertise in Applied Research in order to consolidate and leverage our sdAbs imaging expertise into concrete industrial offerings. Our **pre-clinical imaging services** are offered as support for industrial development processes through sdAbs-based probes targeting selected markers. On the other hand, we aim to **exploit sdAbs as imaging probes in clinical settings,** potentially leading to patient stratification, monitoring and personalized diagnostics.. **Overall, we offer a multidisciplinary Camel-IDS team mastering among others preclinical and clinical translational expertise on in vivo animal models, sdAbs generation technology, cellular and molecular biology, radiochemistry and molecular imaging.**

Although several international research groups have specialized in individual aspects of such research, we are as yet the only ones able to go from bench to bedside, from selection of a target molecule to the development of a clinically-validated tracer.



Fused pinhole SPECT and micro-CT images of the hind paws of a mouse with experimental arthritis. Inflammation in the joints is visualized by radioactively labeled sdAbs targeting infiltrating immune cells.



Transverse slice of a PET/CT image in a patient with breast cancer. HER2-positive tumor cells are visualized by radioactively labeled sdAbs at 1 h post-injection in the left breast.

Scan QR codes for 3D rotating images

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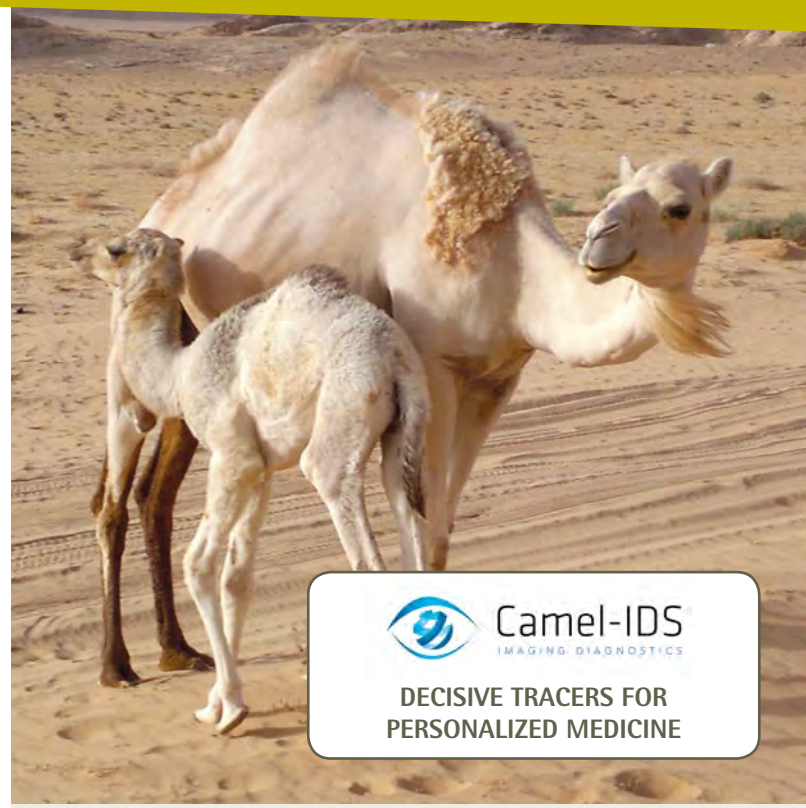

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08-13 - Published by: VUB - TTI, Sonja Haesen, Pleinlaan 2, 1050 Brussel

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Camel-IDS IMAGING DIAGNOSTICS

Vrije Universiteit Brussel

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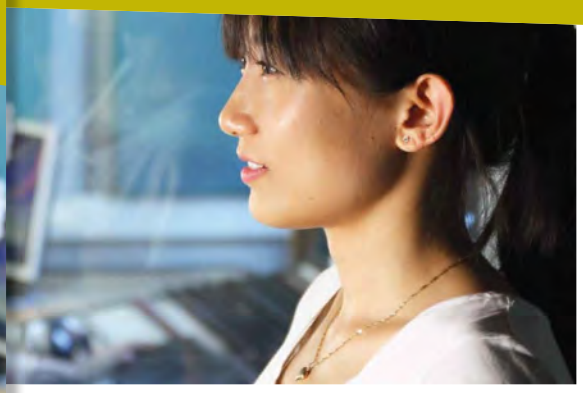
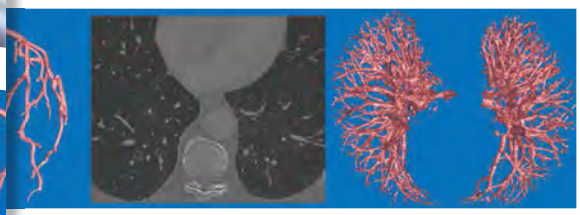
Vrije Universiteit Brussel

Electronics and Informatics



Audiovisual content creation and man-machine interaction at AV Lab.



Blood vessel tree segmentation in medical images.

they go beyond laboratory simulations, considering computational complexity, execution speed-up and power minimization, leveraging on their experience in **parallel computing,** processing architectures and embedded systems. When needed, **optimized implementations** making use of GPU's and FPGA's, are also targetted. ETRO is also recognized for its expertise in **medical image analysis** and its contribution to **e-Health** via the development of personalized health systems. Researchers at ETRO developed several unique **media coding technologies** and contributed substantially to the standardization of image, video and 3D graphics representation and coding (JPEG and MPEG). **Strategic research** at ETRO is clustered in three ETRO-wide transdisciplinary areas: (i) Combined physical **image generation and image processing** for superior imaging systems, (ii) Audiovisual signal processing for **man-machine communication,** (iii) ICT Systems and applications based on wired/wireless **communication, on broadband networks and ad-hoc sensor networks.**

Focussed on **end-to-end system design** in its strategic research, ETRO fully understands the ecosystem in which its technical expertise and novel ICT components can be embedded. Evidence thereof can be found in the commercialization of a novel capacitive blindspot sensor for commercial vehicles by its latest spin-off **'eXia',** in the 3D time-of-flight sensor

Expertise

The Department of **Electronics and Informatics** - ETRO, was established in 1971 and is part of the VUB Faculty of Engineering Sciences. As key **industrial research pole** - creator of four **spin-off companies** - and **group of excellence in Fundamental Research**, ETRO is a reliable partner for local and international industry, public services and hospitals. The multidisciplinary research group of more than 120 people gets inspired by unexplored engineering bottlenecks at the interface of various application domains: health care, automotive, media, surveillance, security, public safety, remote sensing, energy, telecommunications, creative industries...

In its **application driven research,** ETRO upholds a **close cooperation** with Belgian and international research institutes. A Joint Laboratory on audio-visual signal processing (AVSP) was founded with **Xi'an North Western Polytechnical University in China.** Research on integrated mm-wave sensors and their applications is carried out within ETRO's associated **IMEC** laboratory (BISENS - Brussels Integrated Sensor Laboratory). As co-founder of **iMinds,** ETRO is embedded in iMinds' Future Media and Imaging Department and ETRO is also partner of **Intel's Exascience lab.** The ETRO Department owns a **modern research infrastructure** including a state-of-the-art audiovisual recording studio, advanced high frequency measurement equipment (up to 700 GHz), a test lab for the visual quality of images, high-end sealed and non-sealed CO2 lasers used for rapid prototyping in micro fluidics and microchemistry research. This infrastructure is used to **make sense of audio, video, hyper-dimensional signals and sensors** for various sectors and to deliver **unique value** through the **multi-disciplinary engineering** approach.

Audiovisual content creation and man-machine interaction at AV Lab.

Blood vessel tree segmentation in medical images.

Technology
Transfer
Interface
Brussels

Crossing boundaries with visionary electronics and ICT

The department of **Electronics & Informatics** is built on three research groups that cover a wide range of generic technologies in **Micro- and Optoelectronics** (LAMI), **Speech & Audio Processing** (DSSP) and **Multidimensional Signal Processing & Communication** (IRIS). Staying ahead of obvious R&D tendencies in demand-driven research, fundamental research is oriented towards creating disruptive innovation in the knowledge society. Illustrations of such out-of-the-box thinking capacity are the early adoption of wavelets for coding and challenging the – at that time – dominating image compression paradigm of interband coding in favour of intraband and mixed intra-interband coding, the early invention of the now widely used WSOLA algorithm for time-scaling of audio & speech signals, and more recently the theoretical foundations for a new generation of millimeter-wave sensors. ETRO developed a culture of tackling the unknown which led to a broad scale of **2D/3D imaging** HW/SW expertise and new insights into dielectric **imaging and sensing** in applications ranging from process and product quality assessment, automotive technology, to material identification and non-destructive material testing. As designers of new algorithms in **image/video processing and analysis,** they go beyond laboratory simulations, considering computational complexity, execution speed-up and power minimization, leveraging on their experience in **parallel computing,** processing architectures and embedded systems. When needed, **optimized implementations** making use of GPU's and FPGA's, are also targetted. ETRO is also recognized for its expertise in **medical image analysis** and its contribution to **e-Health** via the development of personalized health systems. Researchers at ETRO developed several unique **media coding technologies** and contributed substantially to the standardization of image, video and 3D graphics representation and coding (JPEG and MPEG). **Strategic research** at ETRO is clustered in three ETRO-wide transdisciplinary areas: (i) Combined physical **image generation and image processing** for superior imaging systems, (ii) Audiovisual signal processing for **man-machine communication,** (iii) ICT Systems and applications based on wired/wireless **communication, on broadband networks and ad-hoc sensor networks.**

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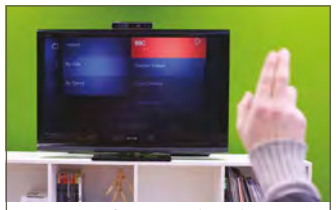
chips brought to market by an earlier spin-off **'Softkinetic-Optrima',** in the equalizer technology that **'Eqcologic'** successfully develops and in the multimedia platform offered by spin-off **'Universum Digitalis'.**



Softkinetic/Optrima (2009) demonstrates the world's first close interaction 3D camera capable of tracking hands and fingers from as close as 15cm.

Eqcologic (2005) showcases a transceiver circuit that sends signals bi-directionally over a single coax cable.

Universum Digitalis (2008) brings a huge collection of image data from the masterpiece 'The Ghent Altarpiece' to the public in a user friendly way.

eXia (2013) develops unique sensor-based detection and warning systems for active guarding of the blind spots around commercial vehicles.

Future challenges

Driven by end-to-end (E2E) interactive, distributed and mobile system design, by the invention of new devices (sensors and circuits), by signal processing, data acquisition, modeling and representation, data transmission and storage, visualization, machine learning and data analysis, ETRO has acquired a solid reputation in **application driven R&D.** Main challenge today is to unfold a department-wide global fundamental research strategy - **processing of large multi-dimensional, multi-spectral, multisensorial and distributed data** - that further seeds the culture of fundamental research on ICT modules and their diverse associated application fields.

Sensor Design

- Mm & THz wave sensors
- Multi-spectral sensors
- Focus on sub-ns gating to improve Time Domain Reflectometry at pel-level

Data Modeling and Representation

- Data reduction and flexible coding
- Exploit distributed nature in the spatio-temporal domain (correlation noise modeling & coding)
- Exploit sparsity in large data sets (adaptive multiresolution dictionaries, matching pursuits, compressive sensing & coding)
- Exploit simultaneous feature selection and classification in ill-dimensioned datasets

Data Analysis and Rendering

- New algorithms, E2E system design and support via distributed network topologies (load balancing), parallel processing (reduction techniques), system architectures (e.g. embedded systems, field programmable gate arrays, ...)

Seeded strategic application domains

- Sensing systems with focus on body area networks (smart pills);
- Sensing systems in production and distribution chains (food industry, retail);
- Bio-informatics systems (high-throughput sequencing, CAD tools);
- Multispectral systems for forensic analysis (art analysis, biometrics);
- Vision systems (plenoptic/lightfield camera systems, SAR systems);
- Medical imaging and computer based diagnosis (multimodal image analysis, perfusion imaging);
- Personal health systems (adapted to specific target groups like senior citizens, cerebral palsy children, ...);
- Remote sensing (humanitarian demining);
- Affective computing and man-machine interaction (dancing robot, serious gaming, ...);
- Audio-visual signal processing (avatars, text-to-visual speech, ...)

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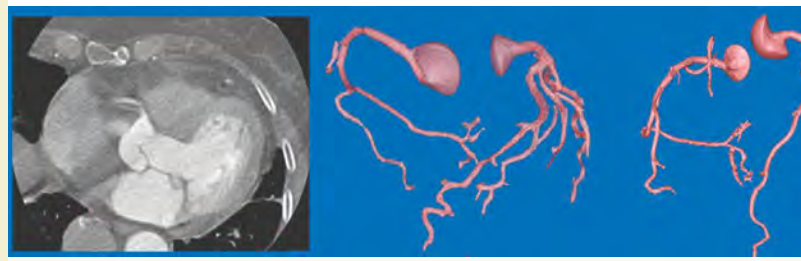

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ETRO VUB-DEPARTMENT OF ELECTRONICS AND INFORMATICS

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Vrije Universiteit Brussel

Chemical Engineering

Multidisciplinary and innovative separation solutions for a greener chemistry and sustainable processes.

In the last years, a relatively new research topic has organically grown from these two topics, resulting in a build-up of additional experience on several aspects of microreactor technology. The expertise is built upon **a solid basis of multidisciplinarity, which focuses on exploiting the advantages of order and confinement for a greener chemistry and sustainable processes.**

From molecular scale to real life application level

The department of Chemical Engineering of the VUB has the ambition to stay at the forefront of the **research on liquid chromatography and adsorptive separations,** and expand its activities into **other areas of low-energy cost liquid-phase separation techniques,** such as **membrane separations and micro-scale extractions.**
CHIS largely owes its international reputation to the fact that it has positioned itself as a research group developing innovative solutions that bridge the gap between the molecular scale and the micro- to millimeter scale of the packing or housing materials typically used in chemical processes. To capitalize on this successful strategy, the group runs a dedicated research program focusing on "Exploiting the Advantages of Order and Confinement for a Greener Chemistry", as a backbone

Expertise & Techniques

The Department of Chemical Engineering (CHIS), headed by Prof. Gert Desmet, is specialized in 3 main fields, i.e. Adsorption, Chromatography, Microreactors & Microfluidics.

The CHIS **adsorption team** studies the most advanced nanostructured porous solids for new or improved separation processes. This includes materials characterization, thermodynamics of adsorption and transport phenomena, separation tests in lab scale or larger research setups and modeling. This team also offers new solutions in fuel cell design and improvements for biomass recuperation processes. The **chromatography team** studies the analytical separation and chromatography systems, aiming to better understand the methods and systems currently used to conduct (bio-)analytical separations, mainly high performance liquid chromatography (HPLC) and capillary LC. These insights are acquired through experimental techniques and computer simulations of the flow and diffusion.

Combining know-how on chemical engineering, precision and micro-machining technology, CHIS is ideally positioned to develop novel devices and processes for **microfluidics and microreactor technology,** tailoring shaped micron-sized structures. In addition, the Department also has vast modeling capabilities, supported by a range of modeling and simulation tools, including commercial packages such as Ansys, Athena, Aspen, and a large library of in-house developed simulation software.

Technology
Transfer
Interface
Brussels

Multidisciplinary and innovative separation solutions for a greener chemistry and sustainable processes.

Innovative separation solutions

The Department of Chemical Engineering (CHIS) develops **creative solutions to challenging problems in the fields of separation technology and catalysis** by exploiting new possibilities in materials engineering and nanotechnology. The two main topics covered by our research are **liquid chromatography** and **adsorptive separations.**
Key to this development process is a thorough understanding of the fundamental events, from the molecular scale to the real life application level. In our group, **advanced experimental techniques** (microfluidics technology, ultra high pressure instruments, high-throughput experimentation…) are combined with **state-of-the-art computer modeling methods,** including molecular modeling and computational fluid dynamics, to obtain **insight in the fundamental adsorption, diffusion, reaction and mass transfer effects.** Integration into the traditional engineering methods allows a rational design of improved or innovative applications. Examples of current research themes are hydrocarbon separations using microporous solids development of novel capillary LC column formats, flow and mass transfer phenomena in HPLC, miniaturization and on-chip chromatography, controlled release of bio-active compounds, high-throughput adsorbent screening…

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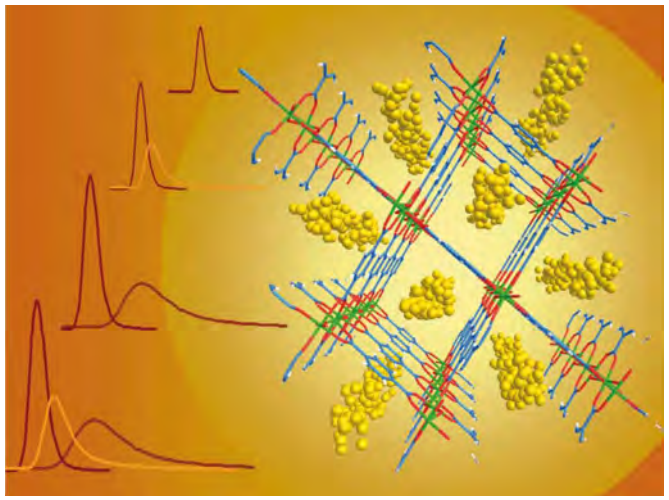

Adsorptive separations of alkanes on metalo-organic frameworks
(Cover article of journal PCCP, vol.11, n.18, 2009).

Experimental micro-reactor setup with several inlet and outlet connections.

Optimisation of liquid chromatography separation columns and technology.

program to grow into one of Europe's leading Centers of Expertise in separation science. CHIS pays a lot of attention to **sustainability,** and concentrates on making separation solutions faster, more efficient, less energy-consuming and by using less chemicals.

In this way CHIS improves adsorption technology, processes and materials for industrial applications in CO2 capture and separation, CH4 purification for gas extraction, removal of contaminants in flue gas from waste incineration plants or biomass gasification plants and the production and purification of biofuels, biochemicals, fine chemicals and bulk- and petro chemicals.

Through our research into liquid chromatography, the control of flow and diffusion effects in separation columns is increased, procedures are developed to characterize separation columns and innovative hardware solutions and separation column types are designed and prototyped. The knowledge gathered during this research is used to improve the efficiency and expand the possibilities of liquid chromatography separation solutions.

Microfluidics technology has led us to miniaturized, ultra high efficiency separation chips, devices for separation based on molecular size exclusion (including length separation of dsDNA), 2D and 3D separation devices containing polymer packings. The newest research topic on microreactor technology has produced microreactors capable of handling particles in liquid flows, emulsification and crystallization and membrane reactors for extraction and reaction equilibrium shifting. These devices have applications in pharmaceutical and life science analysis and in pharmaceuticals and chemical production processes (i.e. for consumer goods).

The IOF funding has provided CHIS with dedicated manpower to support and expand their services towards industrial partners. Please feel free to contact CHIS for collaborations on measurement services, shared research, consultancy, development of proof-of-concept devices and licensing opportunities.

Chemical Engineering

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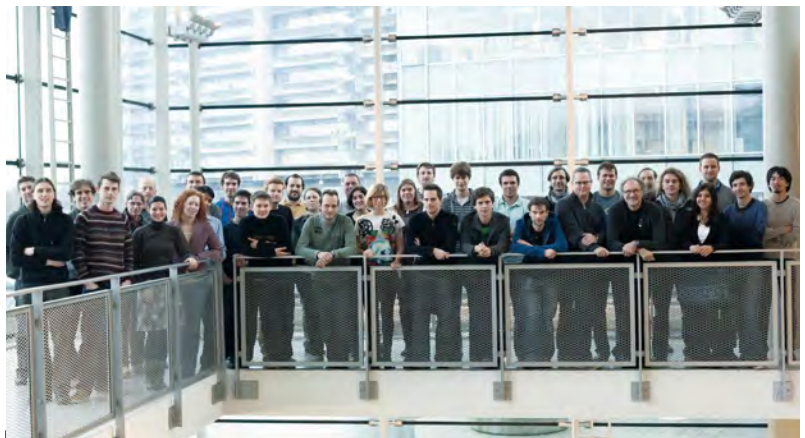

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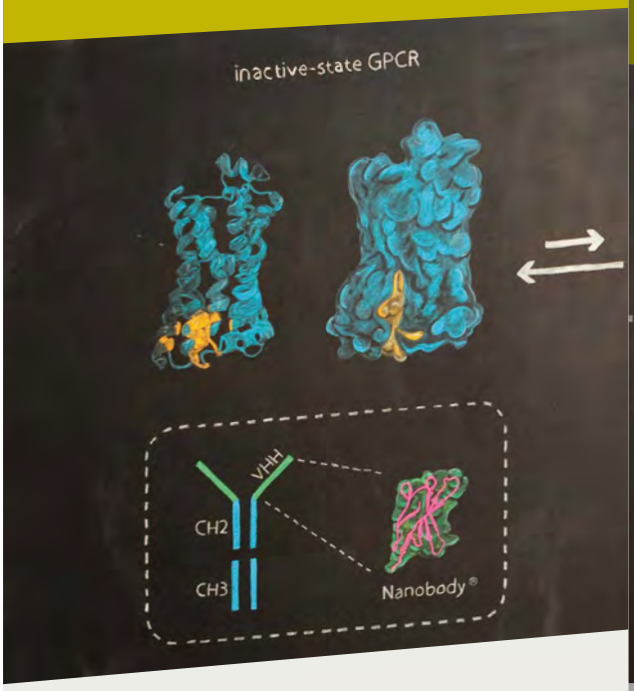
IOF Knowledge Center



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Vrije Universiteit Brussel

Structural Biology Brussels

Turning on a GPCR

therapeutics for cancer, inflammation and immune diseases. In 2013 a second spin-off called Agrosavfe spun out from the Nanobody technology. **Agrosavfe** uses Nanobodies that bind to leaves, seeds, fruits, and pests - called Agrobodies - to develop better tools for crop protection, minimizing impact on the environment, growers, processors and consumers.

Because Nanobodies bind conformational epitopes, these antibodies turned out to be exquisite tools for the study of protein structure and function, the expertise of Jan Steyaert's lab.

Structural Biology Brussels

Today, the VUB **Structural Biology Brussels Lab** (SBB), led by Prof. Steyaert, also part of the VIB **Structural Biology Research Centre** (SBRC) unravels the structures and dynamics of the molecular players in biological processes to explain their mode of action. Its integrated approach combines state-of-the-art structural technology with biophysics and biochemistry. Its novel insights enable targeted interventions in health and disease and are translated into biotechnological applications ...

Expertise & Techniques
Key References

The Structural Biology Brussels Lab (SBB), headed by Jan Steyaert, was founded by Lode Wyns in the seventies at the Vrije Universiteit Brussel and is part of one of the Flanders Institute for Biotechnology (VIB) departments, a Flanders-based life sciences research center of excellence.

Situated in Brussels, a multidisciplinary team of international researchers combines extensive expertise in protein chemistry, biophysics and molecular biology. SBB masters technologically advanced techniques such as genetic engineering, protein purification, enzymology, calorimetry, crystallography, surface plasmon resonance, atomic force microscopy, X-ray crystallography and Nuclear Magnetic Resonance (NMR).

Major research interests include Biomedical targets, Structural enzymology, Bacterial adhesion, Toxin-antitoxin systems, Microgravity research and Biomolecular NMR. Translational research is intrinsic to its programs, with possible applications in medicine. The SBB lab was involved in the pioneering work in which Brian Kobilka's research team revealed the structure and inner workings of an important family of G-protein–coupled receptors. This led to two joint publications in "Nature":

- **Structure of a nanobody-stabilized active state of the ß2 adrenoceptor**
  NATURE, 469, 175-80, 2011

- **Crystal structure of the beta2 adrenergic receptor-Gs protein complex**
  NATURE, 477, 549-55, 2011

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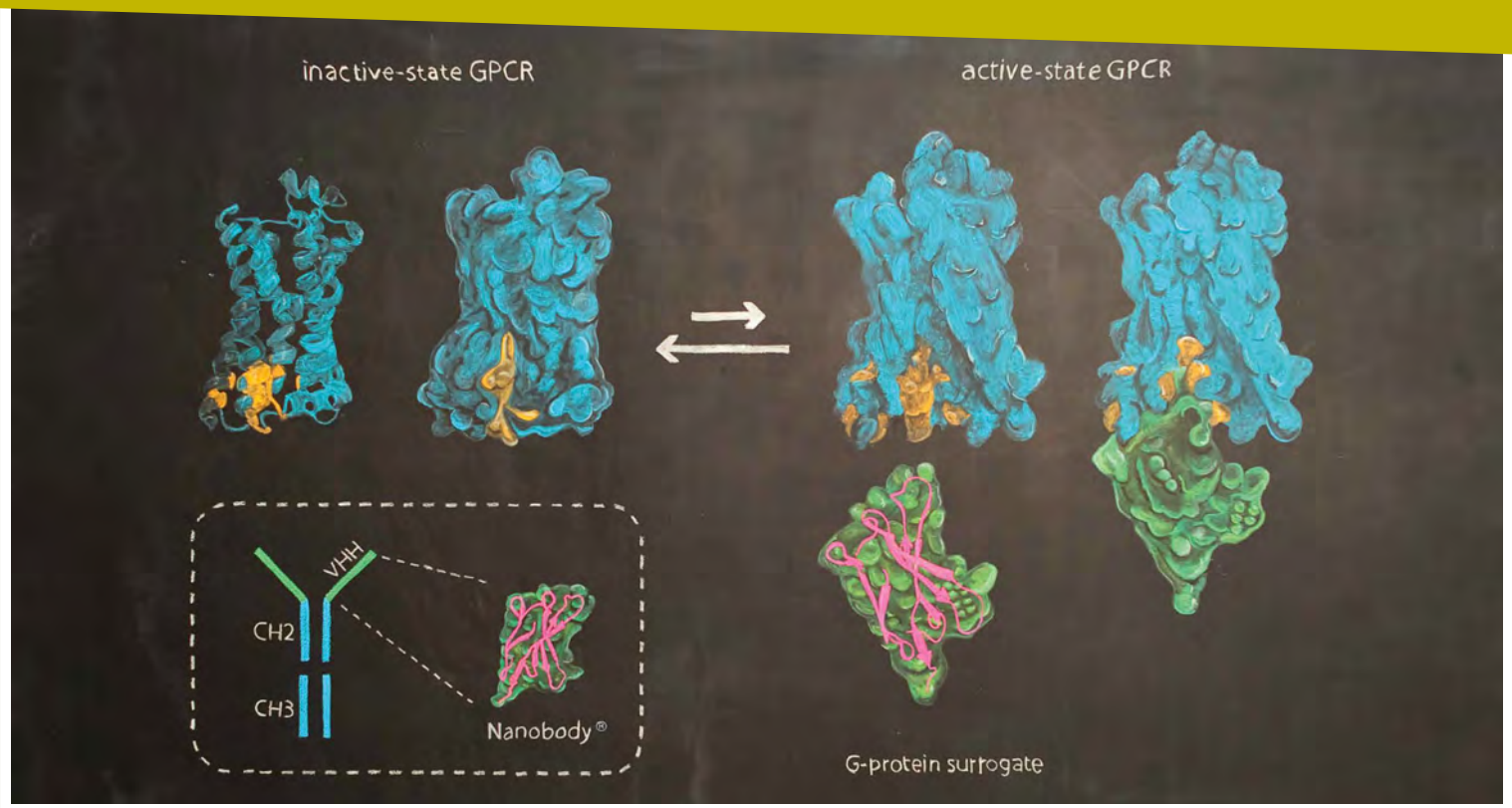

Turning on a GPCR

Proteins: building blocks of life

What does life look like at its smallest scale? And how can we use that knowledge to combat diseases?

It was in 1992 that prof. Hamers' team - while studying the proteins of the immune system - stumbled upon the occurrence of bona fide antibodies devoid of light chains in Camelidae. Over the years, this major discovery has been translated into numerous applications with Serge Muyldermans and Patrick De Baetselier focusing on their use in medicine and Jan Steyaert and Lode Wyns developing them as tools in Structural Biology.

The unique characteristics of single-chain camelid antibodies have strong benefits over conventional antibodies. **Nanobodies®,** the recombinant antigen binding fragments of camelid heavy chain antibodies, are a lot smaller than human antibodies, making it easier to penetrate into organs or tissues. No surprise that antibodies directed against 'disease causing proteins' have found their way into the clinic. The **technology platform** developed at the VIB department of Molecular and Cellular interactions at the Vrije Universiteit Brussel resulted in the successful VIB-VUB spin-off company **Ablynx.** Ablynx translates our scientific work into new Nanobody®-based therapeutics for cancer, inflammation and immune diseases. In 2013 a second spin-off called Agrosavfe spun out from the Nanobody technology. **Agrosavfe** uses Nanobodies that bind to leaves, seeds, fruits, and pests - called Agrobodies - to develop better tools for crop protection, minimizing impact on the environment, growers, processors and consumers.

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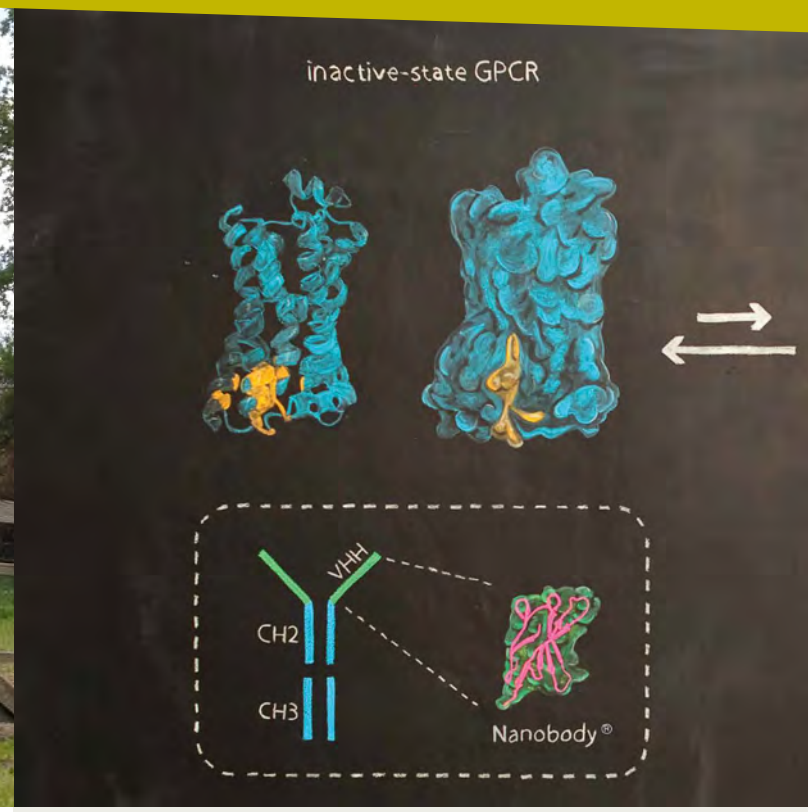
Xaperones
Nanobodies® as crystallization chaperones

In recent years, the Steyaert lab proved that Nanobodies can be successfully used as crystallization chaperones for the structure determination of the most challenging proteins including intrinsically disordered proteins, proteins from larger molecular complexes, aggregating proteins, oligomerizing proteins and membrane proteins that would prove unsolvable using more conventional strategies. Recent highlights include the elucidation of the first GPCR structure in its active state using a conformational selective Nanobody (Nature 469, 175-180, 2011) and the structural investigation of the GPCR-G protein complex by Xaperone-assisted X-ray crystallography (Nature 477, 549–555, 2011). With this groundbreaking work, **the Steyaert lab contributed to the Nobel Prize in Chemistry** that was awarded to Prof. Brian Kobilka and Prof. Robert Lefkowitz in 2012 for **the discovery of G-protein-coupled receptors.**

Based on Nanobody-assisted X-ray crystallography, the Steyaert lab developed a new Business unit, **Xaperones**, to produce Xaperones for the pharmaceutical Industry. The applications of Xaperones in structural biology are numerous. Xaperones increase the hydrophilic surface of integral membrane proteins, reduce their conformational heterogeneity and can trap unstable structural intermediates along the fibrillation pathway of amyloidogenic proteins. A multidomain protein is more rigid in a complex with a Xaperone than the multidomain protein by itself. In complex with a Xaperone, the total amount of structured polypeptide increases, providing a much better starting point for the crystallization of intrinsically unfolded proteins. Xaperones are suitable to stabilize the protomers of larger protein assemblies in one-to-one heterodimers or transient protein complexes.

Brian Kobilka and the llama that produced the Nobel Nanobodies. Kobilka received the Noble Prize in Chemistry 2012 for studies of G-protein-coupled receptors.



With the IOF funding, Structural Biology Brussels aims to translate the structural biology services of the current Business unit Xaperones into an intergrated company focusing on Xaperone-assisted drug discovery.

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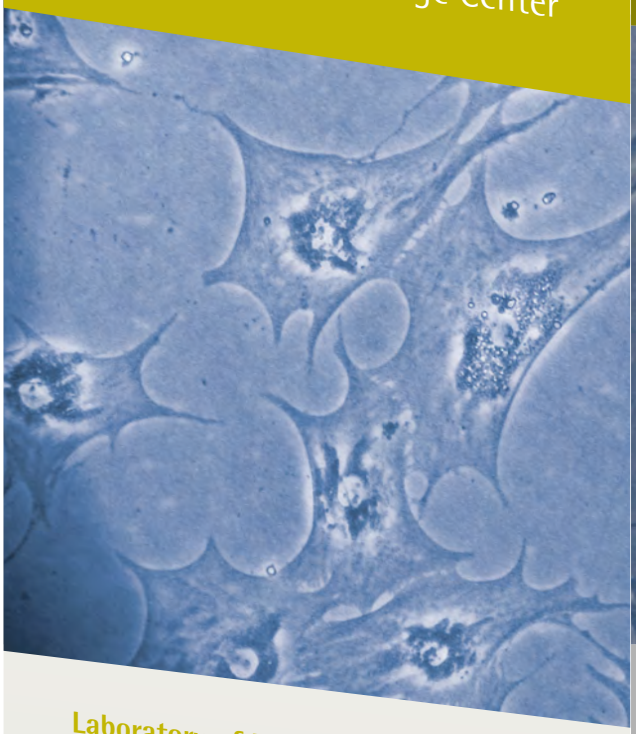

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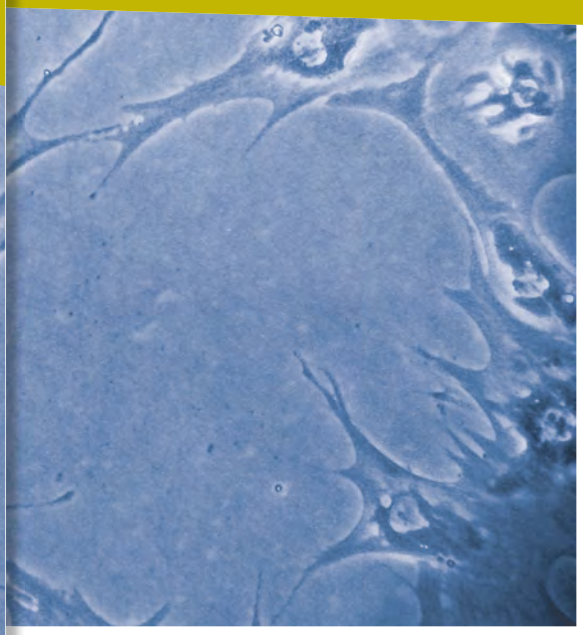

Dendritic cells

tious diseases. The LMCT developed different **strategies to genetically modify dendritic cells.** A first extensively studied platform uses **messenger ribonucleic acids (mRNA)** to reprogram dendritic cells. This approach has successfully been evaluated for *ex vivo* as well as *in vivo* modification of dendritic cells. The **TriMix technology** platform has been developed specifically for this approach and allows to optimize the stimulatory capacity of dendritic cells. The use of the TriMix technology represents a turning point in the quest for an effective dendritic cell-based immunotherapy.

A second platform uses **lentiviral vectors:** these are HIV-1 derived vectors that are targeted to specific cell types, based on the presence of nanobodies® that specifically bind to that cell type. A proof-of-concept on the **"nanobody display technology"** was generated in collaboration with the Cellular Immunology research team of Prof. Patrick De Baetselier (CMIM).

Oncology

Since tumor cells and their environment exploit a plethora of mechanisms to inhibit anti-tumor immune responses, LMCT's research has therefore furthermore been focused on understanding these mechanisms and designing strategies to counteract them. Dendritic cells can present tumor antigens to T cells and as such activate the latter to search for and destroy tumor cells. Today it is recognized that activation of T cells by

Expertise

The Laboratory of Molecular and Cellular Therapy (LMCT) is a **keyplayer in the field of immunotherapy and in cancer & infectious disease research.** Immunotherapeutic and immunomodulatory strategies are being tested in preclinical models and when succesful, translated towards clinical applications in phase I/II trials.

Major research interests and topics include:

- Dendritic cell *ex vivo* based immunotherapy in myeloma and melanoma patients
- Dendritic cell *in vivo* based immunotherapy in hepatocellular carcinoma patients and patients suffering from papilloma virus induced precancerous cervix lesions
- Role of immunomodulatory drugs in enhancing the efficacy of an anti-melanoma vaccination strategy
- Characterization of spontaneous and vaccine-induced immune responses and analysis of their influence on the clinical course of the disease
- Inhibitory mechanisms exerted by tumor cells and their environment
- Comprehensive biomarker profiling of the tumor microenvironment and the immune response during immunotherapy
- Study of the tumor microenvironment to develop predictive *in silico* models of personalized immunotherapy
- Multitargeted therapy: development of novel therapeutic combination for augmenting the potency of cancer vaccines
- Manipulation of the immune system using targeted lentiviral vectors
- Development of therapeutic anti-HIV and anti-HPV vaccines

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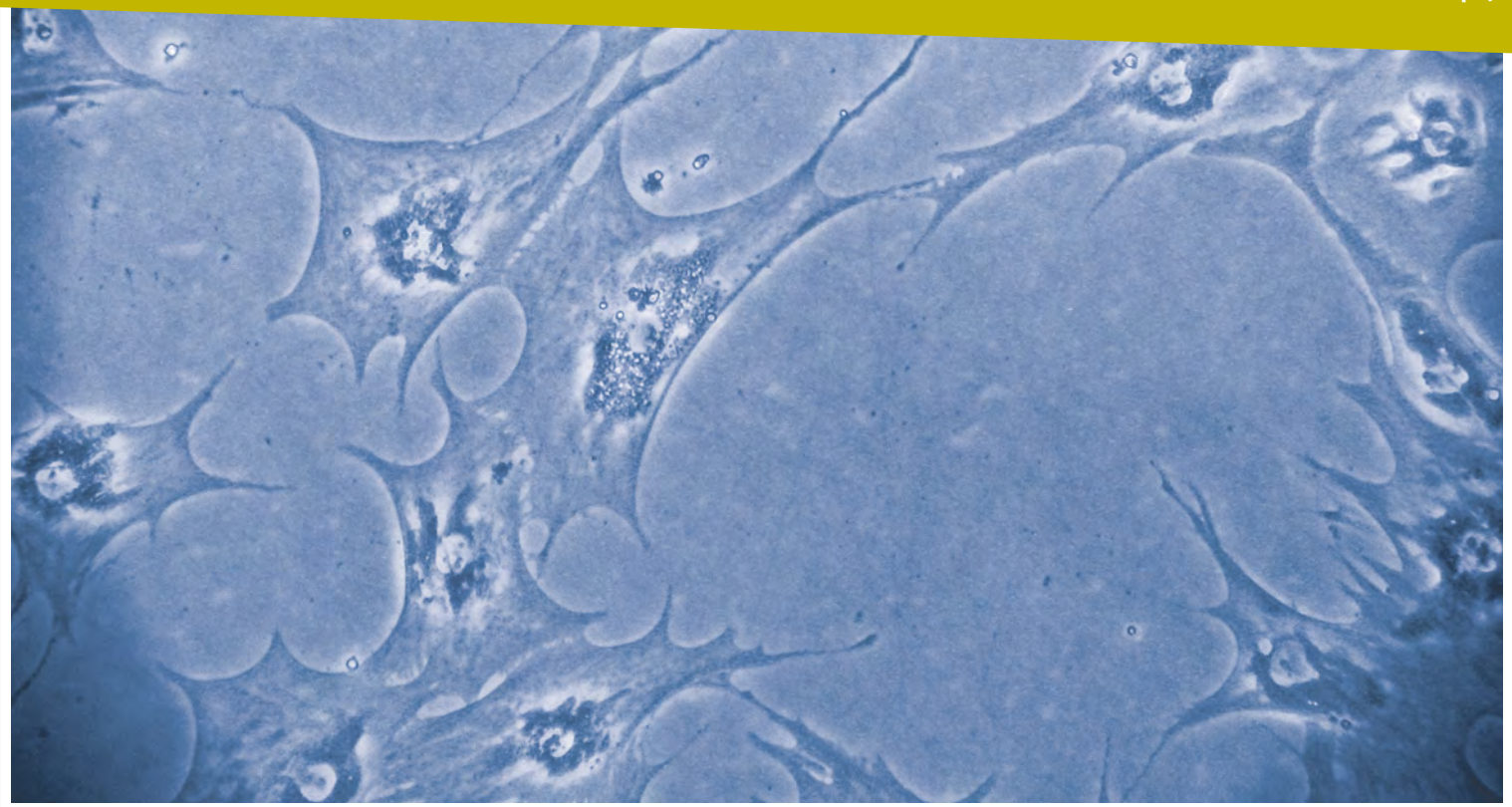

Dendritic cells

Innovative strategies for cancer & infectious disease treatment

The main goal of the research activities at the LMCT is **to develop an integrated partnership between innovative immunotherapeutic and immunomodulatory strategies.** The strategies under development include optimization of dendritic cell based immunization strategies and modes to engineer the tumor environment. These are extensively tested in preclinical mouse tumor models as well as *in vitro* models using human cells. When successful, these strategies are translated towards clinical applications in phase I/II trials.
Lessons learned from the cancer-immunotherapy approaches are being translated towards other domains such as HIV.

Dendritic Cells

Although our immune system is capable of discriminating healthy cells from tumor cells and infectious agents, it has failed in destroying tumor cells in cancer patients. Therefore, medical science has focused on the development of several strategies that aid the immune system in the surveillance and elimination of tumor cells and infectious agents. **Dendritic cells are 'the professional' antigen-presenting cells of our immune system and are recognized as key players in the instigation of immune responses.** Much effort has been put in their exploitation in immunotherapy for cancer and infectious diseases. The LMCT developed different **strategies to genetically modify dendritic cells.** A first extensively studied platform uses **messenger ribonucleic acids (mRNA)** to reprogram dendritic cells. This approach has successfully been evaluated for *ex vivo* as well as *in vivo* modification of dendritic cells. The **TriMix technology** platform has been developed specifically for this approach and allows to optimize the stimulatory capacity of dendritic cells. The use of the TriMix technology represents a turning point in the quest for an effective dendritic cell-based immunotherapy.

A second platform uses **lentiviral vectors:** these are HIV-1 derived vectors that are targeted to specific cell types, based on the presence of nanobodies® that specifically bind to that cell type. A proof-of-concept on the **"nanobody display technology"** was generated in collaboration with the Cellular Immunology research team of Prof. Patrick De Baetselier (CMIM).

Oncology

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dendritic cells was a major step forward in the treatment of cancer. However, tumor cells create an environment in which they can thrive and in which they collaborate with suppressive immune cells to counteract anti-tumor immune responses. Therefore, it is generally accepted that **an effective immunotherapy has to be multifaceted, aiming at stimulation of T cell responses, whilst reprogramming the immunosuppressive tumor environment.**

Both the use of lentiviral vectors as well as mRNA are under investigation at the LMCT for this purpose. Lentiviral vectors have already been used to directly manipulate tumor cells, evaluating strategies to induce tumor cell death or knock out molecules critical for the progression of tumor cells. Several strategies are in development to deliver mRNA to other cell types in order to enhance the prospective of mRNA for engineering of the tumor environment.

Infectious Diseases

The development of antiretroviral therapy has led to a significant improvement in life expectancy and quality of HIV-infected individuals. Nevertheless, several problems are associated with the long-term use of this therapy. Different alternatives are being explored of which **therapeutic vaccination** seems to be one with a promising potential. At the VUB LMCT, **HIV-derived antigens or fragments thereof are administered to the patient in an immunogenic context in order to stimulate CD4+ and CD8+ T cells.**

During the last years, the VUB LMCT has developed an extensive experience in HIV-1 immunotherapy and the administration of *ex vivo* generated, *in vitro* modified dendritic cells. The VUB LMCT is currently setting up a clinical trial where HIV patients are vaccinated intranodally with mRNA encoding on the one hand HIV antigens (covering the whole genome, based on a rational selection of protective regions) and on the other hand various activation signals (caTLR4, CD40L and CD70).

Immunomonitoring

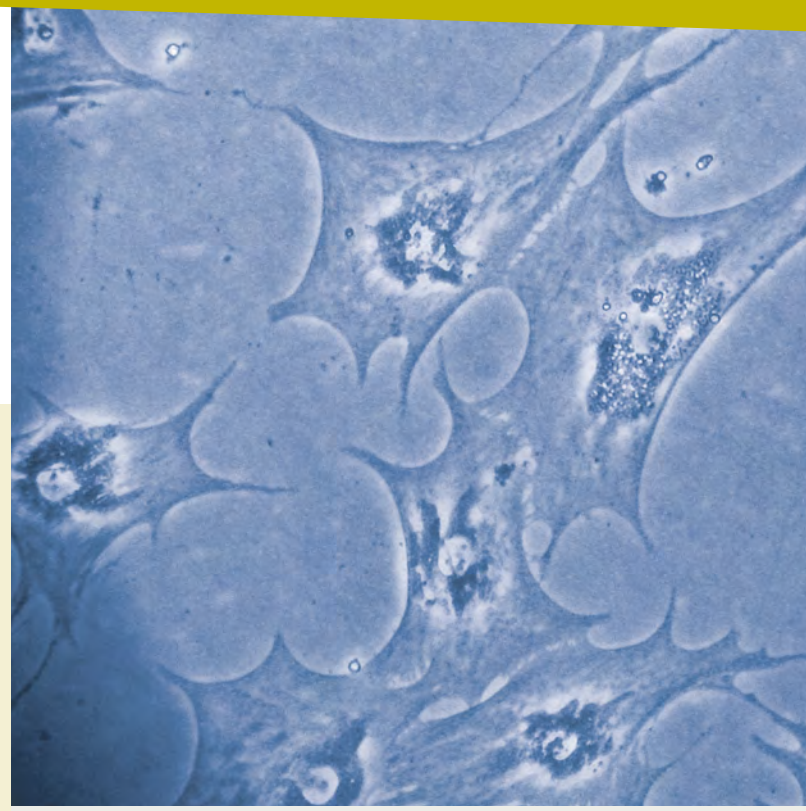
To understand how the immune system of a patient responds to the dendritic cell vaccine, an **immunomonitoring platform** was developed. Specific assays allow immunomonitoring using a small number of patients T cells and independent on prior knowledge of the patients HLA type or tumor antigen expression.

Clinical Trials

LMCT's expertise on cancer immunology and the investment in technology has allowed the rational design of a dendritic cell-based active immunotherapy, delivering encouraging results in recent clinical trials:

1. "A Study on the Safety and Immunogenicity of Combined Intradermal and Intravenous Administration of an Autologous mRNA Electroporated Dendritic Cell Vaccine in Patients With Previously Treated Unresectable Stage III or IV Melanoma" EUDRACT Study Number: 2009-015748-40
2. "Autologous TriMix-DC Therapeutic Vaccine in Combination With Ipilimumab in Patients With Previously Treated Unresectable Stage III or IV Melanoma (TriMix-Ipi)" EUDRACT Study Number: 2010- 023058-35
3. "Randomized Controlled Phase II Clinical Trial on mRNA Electroporated Autologous Dendritic Cells for Stage III/IV Melanoma Patients who are Disease-free Following the Local Treatment of Macrometastases" EUDRACT Study Number: 2011-001410-33
4. "A phase I study on the feasibility and safety of mRNA immunotherapy in combination with RFA in patients with hepatocellular carcinoma" EUDRACT Study Number: 2012-005572-34
5. "A phase I/II study on the safety and immunogenicity of perilesional and intralesional administration of mRNA vaccine in patients with hr-HPV positive cervical intraepithelial neoplasia (CIN grade 2-3)" EUDRACT Study Number: requested
6. "A phase I/II study on the safety and immunogenicity of the intranodal administration of an mRNA vaccine in patients with HIV. FP7 project iHIVARNA, in preparation

07-13 - Published by: VUB - TTI, Sonja Haesen, Pleinlaan 2, 1050 Brussel



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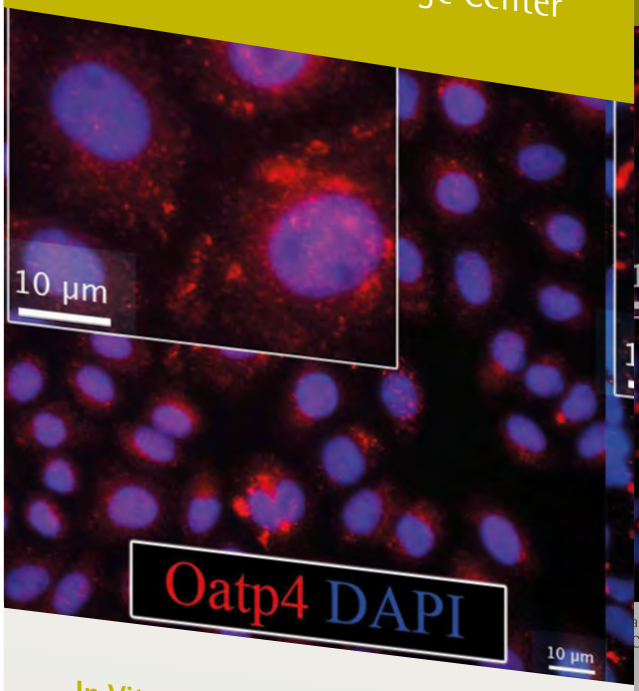

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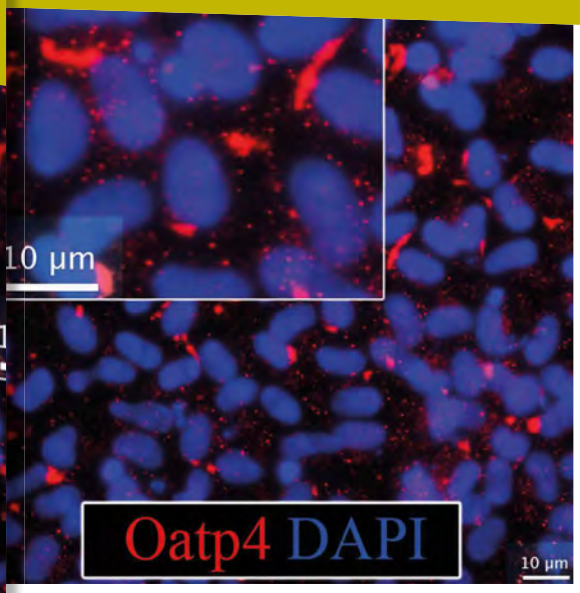

nsporting Polypeptide 4 (Oatp4), a drug transporter, in undifferentiated rLECs (left)
Cs-derived hepatocyte-like cells after 21 days of hepatogenic differentiation (right).

introduced in 1999, namely the interference with the epigenetic mechanisms of gene regulation i.e. histone deacetylation. In 2002, a parallel strategy was introduced, namely the use of stem cell technology to produce human hepatocytes (fig.3). The obtained hepatocyte-like cells have **potential for pharmaco-toxicological testing, but also have great value for clinical purposes (i.e. cell transplantation).**

In Vitro Toxicology and Dermato-cosmetology

Fig. 2: Summary of classical and novel approaches used to maintain primary hepatocytes in culture

Expertise & Techniques

The In Vitro Toxicology and Dermato-cosmetology (IVTD) research group, headed by Prof. Vera Rogiers, is specialized in the field of *in vitro* experimental toxicology. In essence, the IVTD team strives to **develop functional liver-based *in vitro* models to enable more accurate prediction of of the hepatotoxic potential of new drug candidates and alike.** IVTD constitutes one of the core groups of the Centre for Pharmaceutical Research (CePhaR) of the VUB, which aims at tackling key bottlenecks in the current drug development process. Additionally, the IVTD group endeavors **to find new drug targets and cell therapy options for the treatment of acute and chronic liver diseases.**

Located at the medical campus of the VUB in Brussels-Jette, the IVTD group has fully equipped cell culture facilities, a biosafety level 2 laboratory and an organ perfusion unit at its disposal. Moreover, an array of molecular biology techniques has been mastered to evaluate (stem) cell plasticity, functionality, proliferation potential, cell death and adverse effects of drugs. These techniques include gene-specific and genome-wide gene expression profiling, including toxicogenomics, diverse immunoassays, as well as spectrophotometry, fluorometry and radioactivity measurements.

Major research interests of the IVTD group include:
- *in vitro* toxicology
- hepatotoxicity
- liver disease
- alternative 3R methods*
- *in vitro* tissue modeling
- cell therapy and epigenetics

* Replacement, Refinement & Reduction - *in vitro* alternatives

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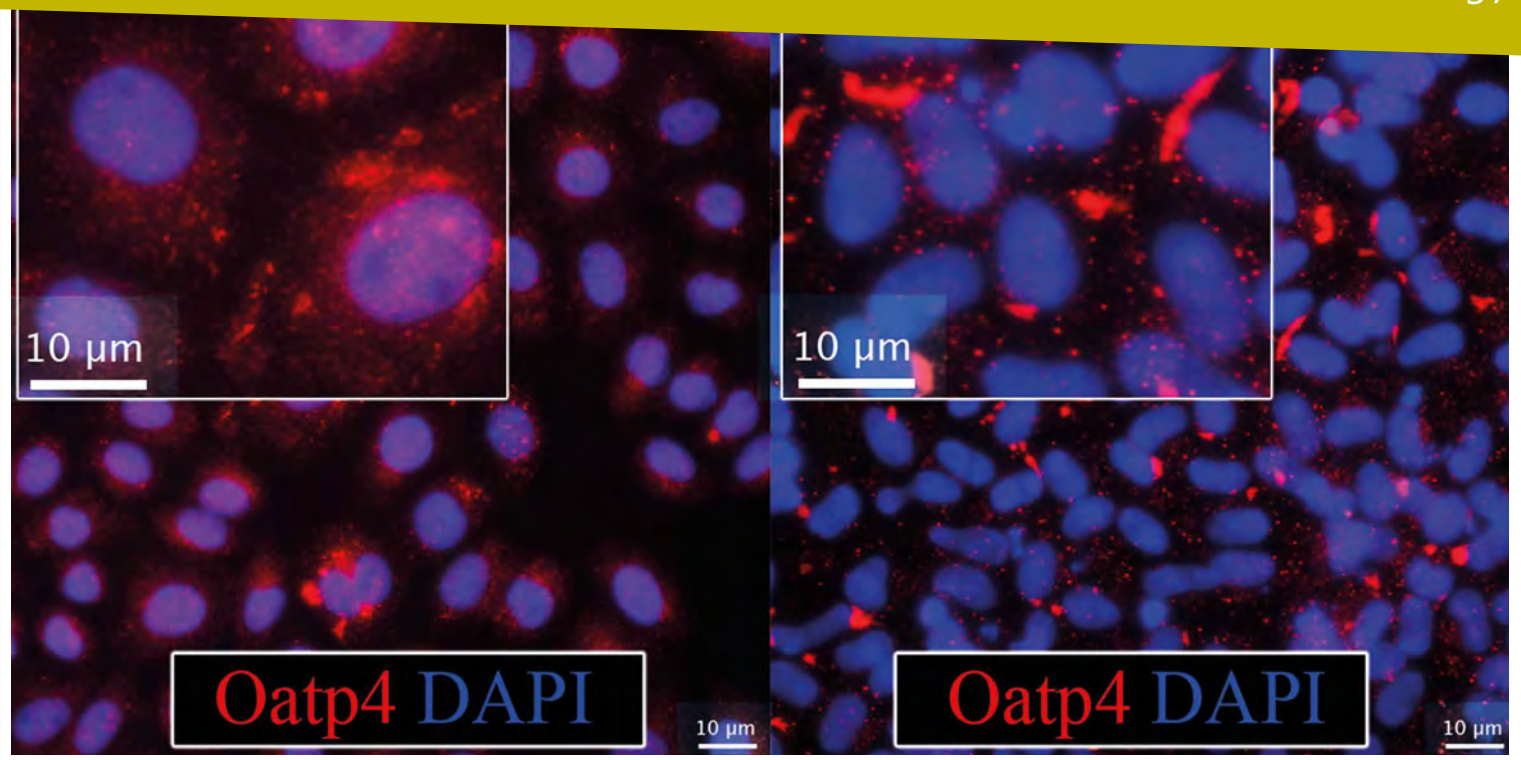


Fig. 1: Expression of Organic Anion Transporting Polypeptide 4 (Oatp4), a drug transporter, in undifferentiated rLECs (left) and rLECs-derived hepatocyte-like cells after 21 days of hepatogenic differentiation (right).

Liver in vitro models: why, what and how?

Retrospective analyses show that **adverse effects constitute major stumbling blocks during drug development.** Specifically, drug-induced liver injury currently is the main safety-related reason of post-marketing drug withdrawal. The inability of animal-based safety studies to predict the hepatotoxic potential of new drug candidates is one of the underlying causes. Moreover, animal tests are costly, remain a subject of ethical controversy and become gradually prohibited. Therefore, **human *in vitro* cell systems represent a highly desired alternative,** which could better reflect human toxicological response, would be ethically more acceptable, and, by increasing assay speed and throughput, would allow reduction of drug development costs.

The IVDT group represents **more than 20 years of experience in the field of liver-based *in vitro* modeling.** Initially, the efforts of the team focused primarily on the optimization of cultures of primary hepatocytes, the most prominent liver cell population and the most widely used liver model in pharmaceutical research. Nevertheless, a well-known drawback of primary hepatocytes is their progressive dedifferentiation (i.e. loss of liver-specific functionality) in *in vitro* setting. To hamper the disadvantageous gene expression changes occurring during hepatocyte dedifferentiation, a novel idea was introduced in 1999, namely the interference with the epigenetic mechanisms of gene regulation i.e. histone deacetylation. In 2002, a parallel strategy was introduced, namely the use of stem cell technology to produce human hepatocytes (fig.3). The obtained hepatocyte-like cells have **potential for pharmaco-toxicological testing, but also have great value for clinical purposes (i.e. cell transplantation).**

In Vitro Toxicology and Dermato-cosmetology

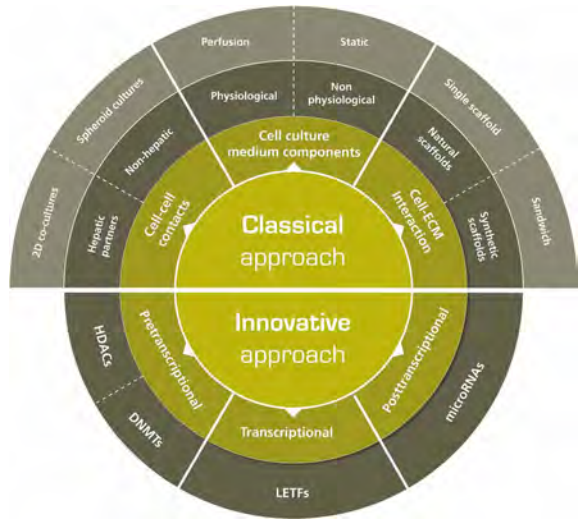


Fig. 2: Summary of classical and novel approaches used to maintain primary hepatocytes in culture

Today, the IVTD research group builds further on its fruitful past. Specifically, the role of other epigenetic mechanisms, such as **DNA methylation and microRNAs,** in the maintenance of *in vivo*-like phenotype of primary hepatocyte cultures is now being explored (fig. 2). The IVTD team is also **developing a fully differentiated hepatic cell line by the use of an innovative dual genetic-epigenetic immortalization strategy of human primary hepatocytes.**

Stem cells-derived models and expertise

With respect to stem cells-based hepatic *in vitro* models, the IVTD group has **developed an innovative protocol to produce hepatocyte-like cells out of various sources of adult progenitors by sequential exposure of the cells to hepatogenic growth factors.** In addition, cells are further maturated by the exposure to epigenetic modifiers. The robustness of the latter technique has been tested using diverse sources of postnatal human- and animal-derived stem cells. Specifically, **rat liver epithelial cells** (rLECs; postnatal stem cells of primitive bile cannalicular origin) proved a reliable and reproducible source of functional hepatocyte-like cells when cultured according to IVTD's sequential differentiation methodology. The reproducibility is a feature that is crucial for industrial application, since interindividual differences are a significant source of data variation. Moreover, undifferentiated rLECs can be easily cryopreserved and readily expanded according to the needs, reducing thus time and costs associated with animal handling. Data also indicate that the rLECs-derived hepatocytes acquire a normal hepatic morphology and demonstrate hepatic functionality, including CYP1A1 and CYP2B1/2-dependent activity, similar to cultured primary hepatocytes (fig. 1). **Both sequential differentiation and rLEC hepatogenic differentiation methodologies (EP1824965 (B1) and EP2041272 (B1), respectively), as well as rLEC cell bank, are available for out licensing.**

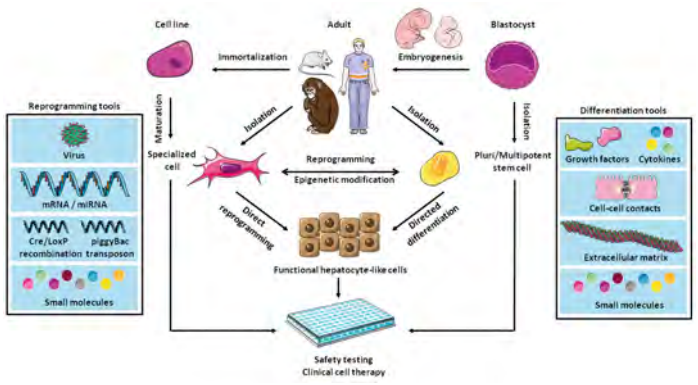


Fig. 3: Strategies for generating functional hepatocyte-like cells

Moreover, the IVTD team is highly skilled in the **isolation, characterization and differentiation of stem cells from various tissue sources,** including bone marrow, skin, adipose and umbilical cord tissues (fig. 4).

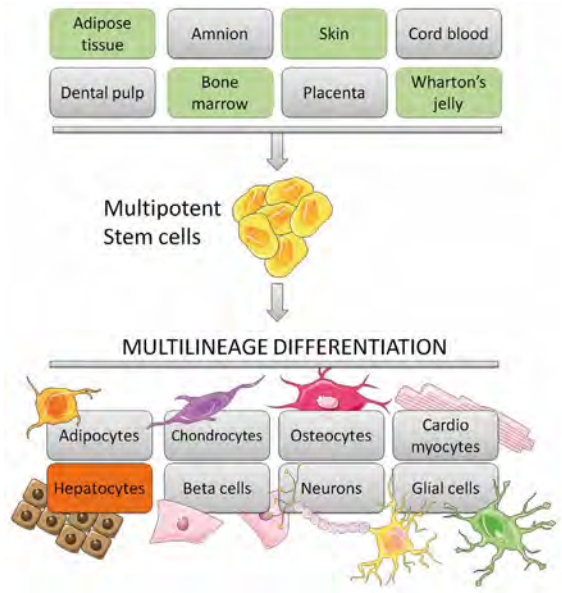
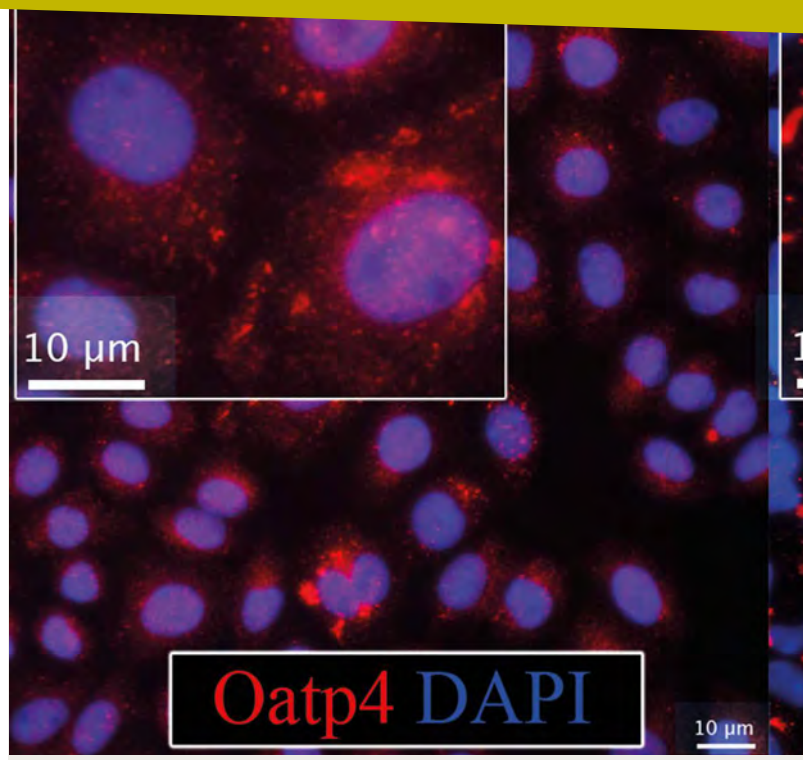


Fig. 4: Different tissue sources of adult stem cells (IVTD groups expertise confines to stem cell populations indicated in green).

The cells are evaluated for morphology, growth rate and expression of pluripotency, organogenesis and lineage-specific markers. As a result, **inherent plasticity and differentiation potential towards a specific tissue can be estimated, and a customized differentiation methodology for a given stem cell population can be developed. The IVTD group would be happy to share this know-how on a fee-for-service or collaborative basis.**



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Industrial Microbiology and Food Biotechnology (IMDO)

purpose of these studies is the **development of new, functional starter cultures, co-cultures, bio-protective cultures and health-promoting cultures for a controlled and/or steered fermentation process** of milk, meat, cereals, cocoa beans, raw vegetables, sour wort, etc., **with respect to food safety, food quality** (organoleptic properties such as texture and flavour), and authenticity, and **the development of new functional food ingredients** (in casu pro- and prebiotics).

Functional starter cultures, co-cultures, bio-protective cultures, and health-promoting cultures for the food industry

IMDO occupies a unique position in industrial food biotechnology research, in that it possesses **the competences to combine field experiments, isolations, identifications, functionality studies** (focusing on quantitative analyses and including mo-delling expertise), **and applications in one laboratory facility,** which gives the research group a particular competitive advantage and freedom to operate. Based on that, IMDO has an excellent relationship with the food industry, documented by the many research projects over the years in the frame of IWT-SBO, IWT-R&D, Flanders' FOOD, KMO-portefeuille, bilateral collaborations, etc.

Expertise & Techniques

The Research Group of Industrial Microbiology and Food Biotechnology (IMDO), headed by Prof. Dr. ir. Luc De Vuyst, has acquired great expertise in the study of the whole of **microbial factors that influence (fermented) food quality, in particular with respect to functional starter cultures to steer food fermentation processes, and gut health.**

IMDO has an extensive modern research infrastructure, ranging from basic equipment for microbiology and molecular biology, including equipment for culture-dependent and culture-independent identification of isolates, real-time PCR, as well as flow cytometry for the enumeration of anaerobic and/or uncultivable bacteria, over computer-controlled fermentors with a volume from 1.5 L to 15 L, a state-of-the-art analysis platform based on various chromatography separation and detection techniques, including mass spectrometry, such as HPLC-RI/UV/F/ELS, HPAEC-PAD/CIS, GC, GC-MS, HPLC-MS/MS, UPLC-MS/MS, and SIFT-MS, and a second-generation sequencing platform based on a non-optical sequencing technology (Ion Torrent) for (meta)genomic and metatranscriptomic sequencing and an in-house high-performance computer cluster for the downstream bioinformatics data analysis.

Unravelling food and colon fermentation processes

The main objective of the Research Group of Industrial Microbiology and Food Biotechnology (IMDO) is the qualitative and quantitative study of the species diversity, community dynamics, and meta-metabolomics of fermented food ecosystems (fermented dairy products, fermented sausage, sourdough, cocoa, fermented vegetables, sour beers, and water kefir). Further, the genomics, microbial physiology and modelling of fermentations with food-grade microorganisms (lactic acid bacteria, acetic acid bacteria, and coagulase-negative staphylococci) are studied.

Also, the human colon fermentation process involving bifidobacteria, lactobacilli, and propionic acid/butyric acid-producing bacteria is studied in view of their bifidogenic, butyrogenic and/or propionogenic effects.

The fundamental aims of these studies are **to unravel, by means of state-of-the-art technologies, why certain microorganisms prevail in certain ecosystems and how their competitiveness and functionality in these ecosystems can be explained biochemically and molecularly.** The ultimate purpose of these studies is the **development of new, functional starter cultures, co-cultures, bio-protective cultures and health-promoting cultures for a controlled and/or steered fermentation process** of milk, meat, cereals, cocoa beans, raw vegetables, sour wort, etc., **with respect to food safety, food quality** (organoleptic properties such as texture and flavour), and authenticity, and **the development of new functional food ingredients** (in casu pro- and prebiotics).

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As a result of its research activities, IMDO **has several patent families and has a portfolio of several interesting functional starter cultures, co-cultures, bio-protective cultures, and health-promoting cultures** that are backed by expertise and evidence concerning kinetics, performance, independence of process conditions, etc. **This research could be translated in dedicated applications by means of validation studies based on challenge tests and pilot-scale experiments in collaboration with industrial partners within Belgium and abroad. The valorisation of a selection of the current cultures portfolio is done through a license agreement with a starter culture producer, which produces IMDO's cultures at an industrial scale and takes care of the marketing and sales through its extended network worldwide.**

Thanks to its scientific excellence, IMDO is running a **Strategic Research Program (2013-2017)** and an **Interdisciplinary Research Program (since 2009)** of the Vrije Universiteit Brussel. Based on its track record concerning valorisation of research results, and to enforce the valorisation strategy of the portfolio of functional starter cultures, co-cultures, bio-protective cultures, and health-promoting cultures, IMDO is an IOF core* of the Vrije Universiteit Brussel since 2006. As such, IMDO is financed by the Industrial Research Fund (IOF) for carrying out outstanding strategic research and developing new application-oriented inventions with economic potential.

This IOF funding allows IMDO to set-up strategic partnerships with important players in the food industry to enforce the valorisation of the current portfolio and to further investigate bacterial strains that show a potential as functional starter cultures, co-cultures, bio-protective cultures, and health-promoting cultures, to enlarge the current portfolio with potential industrial interest.

***IOF knowledge center** that exceeds the average scale of a standard university's research unit

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Vrije Universiteit Brussel

Applied Physics and Photonics (TONA)

In 2004 a special type of government funding gave birth to the Industrial Research Fund (IOF – Industrieel Onderzoeksfonds). This funding supports the IOF knowledge centers at the Vrije Universiteit Brussel in carrying out outstanding strategic research and further developing new application-oriented inventions with economic potential. The first priority of the IOF funds is the further establishment of a portfolio of potentially applicable and transferable know-how with economic and societal value.

Keywords

photons, photonics engineering, micro-optics, datacommunication, biophotonics, Bragg-Grating-enhanced Photonic Crystal Fibres (BG-PCFs), nonlinear optics, radiation, micro-lasers

Main objectives

Photonics, the 'Science-and-Technology-to-Harness-Light', is a discipline that involves fundamental research on photons, on light-matter interactions, and on the development of novel technologies and applications based on the unique properties of light. Research at TONA is structured in 7 research teams, each lead by a senior researcher. The 7 teams, each about 3 to 6 researchers strong, are the **optical design** team, the **instrumentation and metrology** team, the **micro-optics fabrication** team, the **micro-laser** team, the **optical interconnect** team, the **micro-optical fibre sensor** team, and the team for **photonics in radiation and space environments**.

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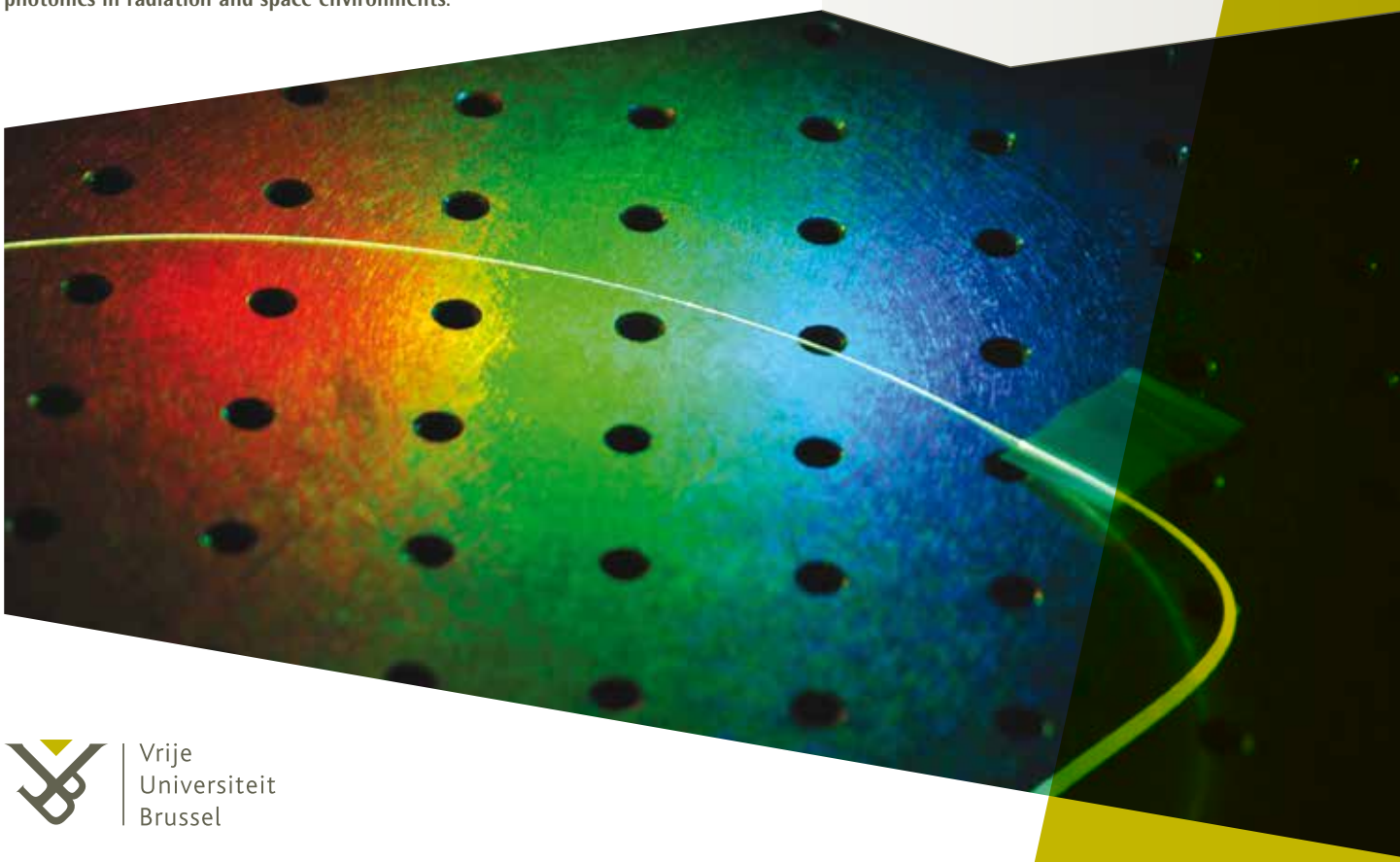
Group TONA: 50 team members



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Applied Physics and Photonics (TONA)

Strategic and applied research

Today TONA is one of the leading groups in the fascinating world of micro-photonics: a world and work area with numerous research challenges and countless valorisation opportunities. Micro-photonics is a generic technology that allows the manipulation of light and the management of photons with micron and sub-micron scale structures, components and devices. Micro-photonics is recognized as the key-link between optics and nano-electronics, the two dominant information technologies in tomorrow's society. Micro-photonics enables a wealth of industrial applications in the domains of information processing, data storage, display and printing technology, data- and tele-communications, health care and medicine, biotechnology, defence and security, automobile, lighting, sensing and measurement, and many more.

Micro-photonic processing technologies are currently being adapted to a wide variety of specialty optical materials such as plastics, polymers, semiconductors, sol-gels and doped glasses. The application of these modified materials permits to widen the field of photonic functionalities to virtually any region of the optical spectrum and beyond, such that a wealth of novel optical and photonic applications can be realised. At the same time micro-photonic processing technologies are being made compatible with scalable industrial mass manufacturing and replication techniques. As such, micro-optic technologies can enhance the competitiveness of SMEs and large-scale companies through low-cost fabrication of photonic-based products, fully in line with the global trend of extreme micro miniaturization. This ensures an attractive route for the transfer of knowledge and technological know-how from university to industry, and enables the durable embedding of novel photonic functionalities in a myriad of novel products.

Equipment & Infrastructure

The research teams within TONA have access to 5 distinct photonic research and technology platforms:

- the general photonics laboratories platform, which consists of photonics research labs which feature state-of-the-art high-precision optical and opto-mechanical components, opto-electronic and photonic measurement equipment, lasers, and a variety of high-end optical sources
- a broad spectral laser system, which consists of a combination of high-end scientific-grade laser sources
- a powerful computer cluster equipped with a variety of professional modelling software to support optical modelling and photonic design efforts
- a unique rapid prototyping technology for the fabrication of high aspect ratio plastic micro-optical components, based on Deep Proton Writing: it is set up around TONA's large-scale ion accelerator facility, the same facility is used to investigate the behaviour of optical materials and microphotonic components in radiation environments
- the micro-optical measurement and nano-instrumentation facility, which hosts a unique collection of high-end instrumentation for the quantitative characterization of photonic micro- and nano-components and structures, under clean room conditions

Today TONA can make use of the following unique measurement instruments all accomodated in a class 100 cleanroom to characterize optical materials and photonic demonstrators:

- Wyko non-contact optical profilometer for measuring the geometrical characteristics and surface roughnesses of micro-optical and micro-mechanical components
- Atomic force microscope for measuring surface roughnesses and geometrical dimensions of nano- and micro-structures
- Dektak stylus profilometer for determining geometrical characteristics and surface roughnesses of micro-optical and micro-mechanical components
- Twyman-Green interferometer for measuring the sphericity and the radius of curvature of microlenses
- Mach-Zehnder interferometer for the optical characterization of microlenses
- Carl Zeiss microscopes for visual inspection of micro-optical components
- Scatterometer for measuring the light scattering profile in reflection and transmission
- Instrumentation for optical fiber characterization (optical spectrumanalyzer, polarisation analyzer, tunable lasers ...)
- Integrating sphere and optical spectrum analyzer for chracterizing optical sources.

Research collaboration

- Intra-university

  Chemical Engineering Techniques, Applied Mechanics, Metallurgy, Stomatology, Art Science and Archeology, Immunology and Microbiology, Physical Chemistry and Polymer Science, Chemistry Department.
- Inter-university & research centres

  Photonics Integration and Packaging Group of the UGent, Interuniversity Attraction Pole 'Photonics@be' (UGent - Université Libre de Bruxelles - Faculté Polytechnique de Mons).

  At the international level TONA has privileged collaborations with Stanford University and with the Sandia National Laboratories.

  Currently TONA is expanding its network of strategic partners by exploring collaborative research opportunities with photonic research institutes or networks in South Korea, in Australia, in Canada, the US and Japan.
- Industrial partners

  Fujitsu, Polish Telecom, NIPPON Telegraph & Telephone Corp. (NTT), Punch Graphix International, Umicore, Anteryon, Tyco Int., Barco, Melexis, Agfa, Intel, Philips, ICOS, FOS&S.
- Networks

  At the European level TONA is coordinating a Network of Excellence in Micro-Optics and is as such structuring and integrating the fragmented landscape of micro-optics in intensive collaboration with 30 European laboratories (see www.micro-optics.org). It also is a vice-coordinator of the Network of Excellence on Biophotonics 'Photonics for Life' (www.photonics4life.eu).

Diabetes Research Center – DRC
(Pathologic Biochemistry and Physiology – MEBO)

In 2004 a special type of government funding gave birth to the Industrial Research Fund (IOF – Industrieel Onderzoeksfonds). This funding supports the IOF knowledge centers at the Vrije Universiteit Brussel in carrying out outstanding strategic research and further developing new application-oriented inventions with economic potential. The first priority of the IOF funds is the further establishment of a portfolio of potentially applicable and transferable know-how with economic and societal value.

Keywords

Diabetes Treatment and Prevention
Cell Therapy – Regenerative Medicine - Drug Screening and Discovery

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Diabetes Research Center – DRC

Main objectives

Diabetes is a serious chronic disease with major health risks and heavy burden on patients and society, despite current treatment. Its most serious form is caused by a massive loss of insulin-producing beta cells in the pancreas. A cure requires restoration of an adequate beta cell mass through beta cell regeneration in the pancreas or through beta cell transplantation. The DRC at VUB has an internationally recognized expertise in the biology of beta cells. It uses its scientific and technologic knowledge as platform for developing these two therapeutic strategies towards applications in patients.

Organization

The DRC consists of

- **six collaborating research units** with complementary expertise covering disciplines from molecular biology to studies in man: Cell Therapy (D.Pipeleers), Cell Neogenesis (H.Heimberg), Cell Differentiation (L.Bouwens), Experimental Pathology (M.Marichal), Clinical Biology (F.Gorus), Clinical Trials (B.Keymeulen);
- **two core facilities** that provide specialized technology and advanced products : a Functional Cytomics Core and a Gene Expression Core.
- **a Diabetes BioBank** which consists of three parts: Blood Sample and Data Base (F.Gorus), Histopathology Bank Pancreas (P.in'tVeld), Beta Cell Bank (Z.Ling).

Translation in International Consortium

The DRC has helped found the **Belgian Diabetes Registry**, which recruits most Belgian recent-onset diabetic patients diagnosed under age 40 years, together with their first relatives, for a longitudinal data and sample base. BDR is a unique instrument for implementing novel or specialized tests for early diagnosis and disease follow-up; it allows selection and monitoring of biologically defined populations for prevention and curative trials.

DRC is closely associated to its biotech spin-off **Beta-Cell nv** with which it partners for the development of beta cell therapeutics.

DRC is since 2002 organizer of an international consortium, the **JDRF Center for Beta Cell Therapy in Diabetes**, founded with support of the Juvenile Diabetes Research Foundation (JDRF). The Center's objective is to develop and implement strategies for prevention and treatment of diabetes using beta cell biology as guide. Projects specifically focus on methods to preserve and replace beta cells, and to monitor their effects in vivo. It is composed of laboratory and clinical research teams, reference centers and bio-industrial partners, and a central unit on the medical campus of Brussels Free University-VUB. The Center is supported by supranational program grants from the Juvenile Diabetes Research Foundation (JDRF-New York) and the European Commission (coordinator of FP6 and FP7 programs on beta cell therapy).

Potentially applicable and transferable know how with economic value

The goal is to generate **beta cell therapeutics** for use in early and late phases of the disease.

To this end the following products and tools are developed:

- novel diagnostics that monitor the disease process and the effects of interventions
- a drug screening assay that detects compounds which induce beta cell regeneration in the pancreas and maintain their survival
- a laboratory source for mass production of insulin-producing cells and a graft construct in which they can correct diabetes long-term
- preclinical models for assessing novel drugs, products and interventions
- state-of-the art clinical trial procedures in regenerative medicine

Mechanical Engineering (MECH)

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Keywords

mechanics, acoustics, vibration, thermodynamics, fluidics, robotics, multibody systems

Main objectives

The department of Mechanical Engineering exists of three research groups:

- Acoustics & Vibration Research Group (AVRG)
- Robotics and Multibody Mechanics (R&MM)
- Thermodynamics and Fluid Mechanics (THFL)

The main goal of the **AVRG** group is to conduct fundamental and applied research in the broad field of **Acoustics & Vibration**, with special emphasis on **signal processing and system identification**. The acoustical research is focused on noise power

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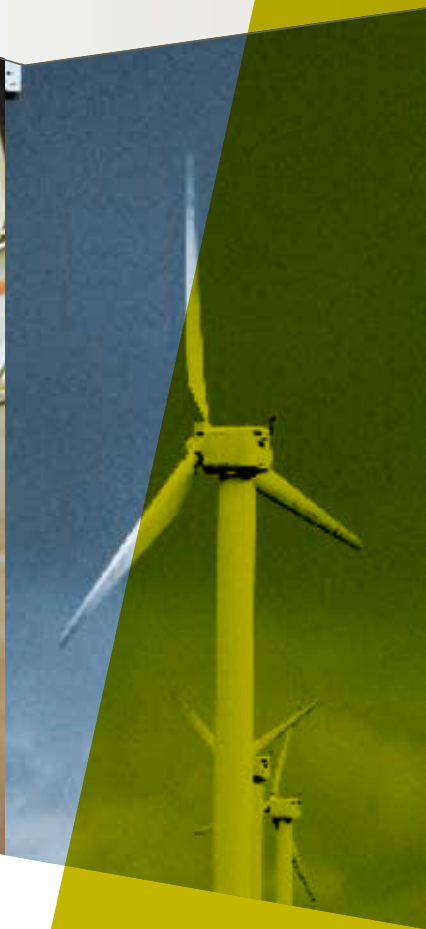
GROUP MECH: 62 researchers

(incl. technicians)



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Mechanical Engineering (MECH)

characterization of combustion engines, numerical calculation of sound radiating from ducts and sound quality of exhaust systems. The research in the field of vibration is mainly concentrated on experimental and operational modal analysis, in which the Group has a worldwide recognized expertise

The **R&MM** team's central goal is to conduct fundamental and applied research in the broad field of **robotics and multibody mechanics**. The group's special emphasis is the development of **complex mechatronic systems** such as lightweight actuation systems with adaptable compliance, a bipedal robot, a robotic assistant arm, actuated rehabilitation devices, and social robots.

The **THFL** group is mainly active in the fields of **Computational Fluid Mechanics (CFD), Experimental Fluid Mechanics, (Renewable) Energy, Turbulence and Combustion**. CFD has been in development for 30 years and benefits from a worldwide recognition. Activity in thermodynamics is focused on energy production from advanced thermal cycles and from renewable energies (biomass and wind) with several test facilities (two gas turbines, biomass combustor). Fundamental work in the field of combustion aims at the development of combustion kinetic models. The group is involved in different energy management projects (government, expert groups, power producers).

Strategic and applied research with economic value

- The "PolyMAX" modal parameter estimator (in collaboration with LMS International): a breakthrough in Experimental Modal Analysis (EMA) has been achieved.
- The "OMAX" concept : an advanced PolyMAX approach.
- Design of light-weight high-force dynamic actuators with pneumatic artificial muscles for fatigue testing (safety critical airplane components; this technology could be used to excited e.g. large structures such as bridges for experimental modal analysis).
- Automatic Structural Health Monitoring systems, which can continuously and autonomous monitor defects of structural systems (as for example oil drilling platforms).
- Pneumatic artificial muscles (PAMs) : actuator for rehabilitation devices, robots in direct contact with operator,....
- MACCEPA (The Mechanically Adjustable Compliance and Controllable Equilibrium Position Actuator) : articulated joint. In future robotic applications and rehabilitation devices,... the use of 'soft'actuators is a promising innovation. It contributes to safety and to wearability of the device. (Patent 05447118.0)
- ALTACRO (Automated Locomotion Training using an Actuated Compliant Robotic Orthosis). The ALTACRO-project focuses on improved mobility for patients and assistance for therapists, thanks to an automated locomotion therapy with a step rehabilitation robotic orthosis powered by biologically inspired lightweight pleated pneumatic artificial muscles with inherent adaptable compliance.
- System and Method for Simulating Motion of a Multibody System: real-time virtual prototyping is a powerful engineering tool of the future. (Patent WO2006/012709)
- "Apparatus comprising rolling surfaces" shows that a hyperboloid can roll without slipping on a helicoidal ruled surface (Patent 05447226.1). A joint in an orthosis is often designed as a 1 DOF joint (e.g. knee joint), while the real joint has a complex 3D movement. The patent has potential to be used as a tool to realise a more complex joint for an orthosis and as such impose a more natural movement of the ligament.
- AMP-foot (Intelligent transtibial prosthesis actuated by Pleated Pneumatic Artificial Muscles): to improve the gait pattern of transtibial amputees and try to let their pattern evolve in a more efficient manner by developing an intelligent prosthesis. (Patent application ref LRD-GB-6321, ism KUL).
- Probo : intelligent huggy robot that interacts with long-term hospitalised children.
- Process for the replacement of a limited part of natural gas by renewable energy in gas turbine plants (Patent WO2006/060883). Detailed combustion kinetic model : applicable in many industrial applications, going from safety to pollutant emissions. It can lead to reduced combustion mechanisms applicable in open CFD codes.
- System Perturbation Analysis (SPA) : new methodology for evaluation of the impact of renewable energy application inside a given system.
- CFD: New, accurate schemes and solvers for Computational Aerocacoustics and Combustion (CAC)
- CFD: Simulation of biological flows: to study and to improve the efficiency of aerosol therapy, a topic in which pharmaceutical industry is highly interested in.
- Wind energy: development of software codes for design and analysis of wind turbines (NUMECA)
- Development of design tools for reduction of aerodynamic noise in confined flows (ARN) (NUMECA, LMS, von Karman Institute)
- NODESIM: developed software tool , based on a polynomial chaos method, which simulates the impact of velocity and flight angle of an airplane movement (NUMECA).
- FWHA : software to measure sounds th the "far field" usin the Ffowcs-Williams-Hawking Analogy (NUMECA).
- TBM Biological Flows : the development of a software to help lung surgeons to predict the effect of thoracic surgery on the post-operative functional behavior of lungs.

Equipment & Infrastructure

- 2 Subsonic Windtunnels
- Anechoic Acoustic Room
- Polytec Scanning Laser Doppler Vibrometer
- IST Hydraulic Test Rigs
- LMS Scadas-III Front-End
- Combustion Engine Test Rig

Research collaboration

- Inter-university & research centres
  von Karman, KUL, RUG, UA, ULB, UCL, Delft University, IIT
- Industrial partners
  SUEZ-ELECTRABEL, ASCO, AIB VINCOTTE, NUMECA, AIRBUS, DASSAULT, LMS, 3E Engineering...

VUB Spin-off

NUMECA Int. NV – the expertise and know how of the THFL team has led to the creation of a spin-off company with a worldwide reputation in the simulation, design and optimization of fluid flows and heat transfers.