We develop and use optical methods as OCT and spectroscopy to monitor or visualize the function of organs and cells in patients. Based on physical principles, clever engineering and biochemical knowledge we improve the detection of extra cellular vesicles.

- Clinical application: physiology of tissue, real time in vivo tumor detection and grading, liquid biopsies
- Biomedical research: oncology, urology, pulmonology, cardiology, neurology, forensic applications

In my teaching I combine optics/physics with biomedical and clinical applications.

Our work has resulted in various start-ups.
RESEARCH PROJECTS FOR MASTER STUDENTS

PHYSICS- SECTION BIOPHOTONICS AND MEDICAL IMAGING, GROUP MARLOES GROOT

Projects, ranging from physics and engineering to biology and clinical applications:

- OCT:
  - Development of a forward looking probe
  - Validation of methods for the detection and grading of tumors in patients
- Spectroscopy:
  - Development of single fiber spectroscopy
  - Combination with OCT
  - Detection and analysis of body fluids on the crime scene
- Liquid biopsy:
  - Detection and characterization of extracellular vesicles below 200 nm
- See https://www.amc.nl/web/research-75/bmep/internships.htm
BIOMEDICAL TECHNOLOGY AND PHYSICS

RESEARCHER PROF. DAVIDE IANNUZZI, PhD, MBA

Research: We develop new experimental approaches to solve urgent questions in life science research. Our strength is in the ability to combine microtechnology and photonics with out-of-the-box ideas.

Valorization: I am a frontrunner in the valorization activities of the VU. I am the director of the D-Lab, where I am currently helping more than 20 teams bring their ideas to market.

Clinical application: minimally invasive diagnostic tools
Biomedical research: brain, cartilage, embryos, muscles, ...

Teaching: I have been teaching courses in electromagnetism, quantum mechanics, and experimental physics (lab courses) both at the bachelor and master level. And I have also pioneered a series of courses on entrepreneurship for scientists.

Startup company OPTICS
Most of our projects are about the development and use of novel experimental techniques for life sciences research:

- **Needle-based mechanosensors**
  (e.g.: A micro-optical device for the measurement of cartilage damage after sport injury)

- **CoulterPress**: squeezing cells one at the time
  (a pioneering approach to measure the mechanical properties of cells (patent pending))

- **Cavitation assisted microscopy**
  (combining needle-based cavitation with state-of-the-art microscopy techniques)
We study inherited cardiac diseases. Our main interests are the biophysical and molecular changes that link genotype (mutation) to phenotype (enlarged heart muscle).

- Biomedical research: Inherited cardiomyopathies, contractile function, understanding disease mechanism & identifying novel therapeutics

In my teaching I combine basal physiology with molecular pathophysiology. I am the course coordinator and teacher of medical pathophysiology.
Projects based on contractile dysfunction as cause of cardiac disease such as hypertrophic cardiomyopathy (HCM)

- Molecular basis for loss of contractile machinery
- Mechanism behind impaired response to adrenaline in HCM
- Mosaic expression of mutant protein in inherited cardiomyopathies
We use set-ups to characterize cardiac muscle cells in different animal models (including human) to define pathophysiology of cardiac disease.

- **Clinical application:** Combination with in vivo imaging of heart function (human and animal models)
- **Bioengineering research:** Regeneration of cardiac muscle in a dish (engineered heart tissue).

In my teaching I combine teaching in basal physiology with pathophysiologic mechanisms in cardiovascular disease. I am chair of the Physiology department and teach students from Amsterdam UMC, Amsterdam University College and VU.

Collaboration with companies: Ionoptix & CytoCypher
Projects based on studies in cardiac muscle to understand pathophysiology of cardiovascular disease:

- Study effects of mutations
- Study effects of cardiac stress
- Study sex-differences
- Study relation between protein composition and cardiac function.
- Study effects of endothelial dysfunction on heart.
Het begint met een idee

We develop optical techniques and instruments for 3D microscopic visualization and characterization of tissue.

Physical models of light-tissue interaction to accurately determine tissue properties.

Optical instruments for measurements on patients.

In my teaching the physics of light-tissue interaction takes center stage. Equally important are the practical aspects when applied to clinical measurements.

I teach the Biomedical Optics course.

Clinical application.
Projects using optical techniques to image and characterize tissue:

- Optical Coherence Tomography
- Single Fiber Reflectance Spectroscopy
- Monte Carlo simulation to study light propagation in tissue
- Physical models for light-tissue interaction
- Calibration procedures and instruments
- Image processing and registration with pathology
We study blood vessels. These are so much more than simple pipes: their physical and biological properties are crucial for a healthy life.

- Clinical applications: ischemic stroke, Alzheimer’s disease, hypertension, atherosclerosis
- Research approaches: molecular-cellular-organ culture-in vivo techniques, clinical imaging, modeling,…

In my teaching I explain the relation between physics, function and structure of the cardiovascular system, and cardiovascular diseases. I provide the course Physics of Organs. In addition, I host many research interns at the Amsterdam UMC – location AMC.

European consortia: in silico clinical trials, small artery remodeling
Many projects are possible, ranging from modeling work to experimental work on cells, blood vessels.

- Flushing the brain: how to keep our neurons clean?
- A sudden stroke: what happens when a brain vessel becomes obstructed?
- We are many: how do the billions of blood vessels work together to regulate oxygen delivery to tissue?
We use Positron Emission Tomography to quantify physiologic processes.

Clinical applications:
- Development of pharmacokinetic models for new PET tracers
- Validation of semi-quantitative / simplified measures for known PET tracers

In my teaching, I combine PET, physics, and clinical application (ex. neurology and oncology).

I am a teacher for Tracer Kinetic Modeling course.
Projects based on kinetic modeling of PET tracers:

- Understanding PET data formats
- Development or using various tools for preprocessing
- Development or applying methods for kinetic analysis
- Statistical differentiation of signals from various clinical groups or clinical states (e.g. baseline vs response)
We use MRI to measure and understand changes in the brain due to MS and Alzheimer’s disease.

- Clinical application:
  - quantifying treatment response
- Biomedical research:
  - understanding the relation between different changes in MS
- Methods development:
  - clinically applicable volumetric measurements
  - optimized for each disease

In my teaching I combine image analysis and acquisition with clinical (research) applications. I teach Introduction to Medical Image Processing.

Crowd sourcing: recruiting the general public to analyze images.
RESEARCH PROJECTS FOR MASTER’S STUDENTS

RADIOLOGY AND NUCLEAR MEDICINE – IMAGING

METHODOLOGY – STRUCTURAL BRAIN IMAGING GROUP

Current internship topics:

- **Realistically simulate MS lesions**
  - to validate and develop brain volumetry

- **Decrease variability between different MR scanners**

- **Develop software and hardware for standardizing brain volumetry**
BIOMEDICAL TECHNOLOGY AND PHYSICS

RESEARCHER PROF. DR. MARLOES GROOT

We use 3D nonlinear optical microscopy to visualize cells and other components in live tissue.

- Clinical application: Instant pathology
- Biomedical research: Alzheimer, skin & regeneration of tissue

In my teaching I combine optics/physics with clinical applications. I am coordinator of the course Current Clinical Issues and program director of the master Biomedical Physics and Technology.

Startup company: Tritos Diagnostics
Projects based on the label free microscopic technique of higher harmonic generation:

- Bioptic Needle: development
- Bioptic Needle: light induced damage in brain tissue
- The relation between ROS and amyloid beta in the brain
- The pathology of lung tissue visualized by SHG/THG
- Deep learning algorithms for automated diagnosis based on SHG/THG images
Het begint met een idee

**BIOMEDICAL TECHNOLOGY AND PHYSICS**

**MEDICAL PHYSICIST JOOST KUIJER**

My focus is medical imaging with MRI

- Involved in a variety of research projects involving novel MR imaging techniques

In my teaching I build the MR physics from theory to clinical applications. I am lecturer in the course Medical Imaging, and one of the coordinators for projects in the VUmc

Working at the Amsterdam UMC, location VUmc, dept. Radiology and Nuclear Medicine
RESEARCH PROJECTS FOR MASTER STUDENTS

AMSTERDAM UMC, LOCATION VUMC, DEPT. RADIOLOGY AND NUCLEAR MEDICINE

Projects around Medical Imaging in a clinical environment.

- Nuclear Medicine, PET imaging
- Radiology, MRI
- Image analysis
BIOMEDICAL TECHNOLOGY AND PHYSICS

SCIENTIST & TEACHER
PROF. ERWIN J.G. PETERMAN

We develop and apply single-molecule techniques to visualize and manipulate biomolecules like DNA, DNA-binding proteins and motor proteins, in living organisms and \textit{in vitro}.

Fundamental biophysical research on:
- DNA and DNA repair
- Transport processes in cilia
- New instrumentation for groundbreaking research

In my teaching I focus on biophysics: both on (optical) techniques and more theoretical aspects of biophysics. I am involved in the course Dynamics of Molecules and Cells.

Startup company LUMICKS b.v.
Projects focusing on single-molecule biophysics:

- See individual motor proteins in action in living *C. elegans*.
- Build a new light-sheet fluorescence microscope.
- Follow the repair of DNA in real life using optical tweezers and single-molecule fluorescence microscopy.
- Use acoustics to pull on biomolecules or cells, in order to study conformational changes or adhesion.
We develop new optical imaging techniques for in the hospital to better visualize disease and improve the treatment of patients. Our imaging techniques provide new insight into the development of disease by providing more detailed information than currently available.

- Clinical applications: Eye disease, lung and esophageal cancer
- Biomedical Research: Immuno-fluorescence and Optical Coherence Tomography

*In my teaching* I combine my research of the retina and endoscopy of internal organs with the properties of light and tissue. I teach the course biomedical Optics and I am a member of the “Opleidingscommissie” MNW/MNS.

- We use physical principles and our knowledge of the human body to visualize for instance the complete vasculature of the retina (see background image)
Projects based on Optical Coherence tomography, immuno-fluorescence, Raman microscopy and Endoscopy:

- Catheters: New catheter development and characterization for the esophagus
- Doppler measurements of the retinal vasculature to determine flow velocity
- Determination of the fiber direction from PS-OCT images of muscle and nerve tissue
- Oxigenation determination of blood by spectroscopy
- Raman spectroscopy of Alzheimer disease