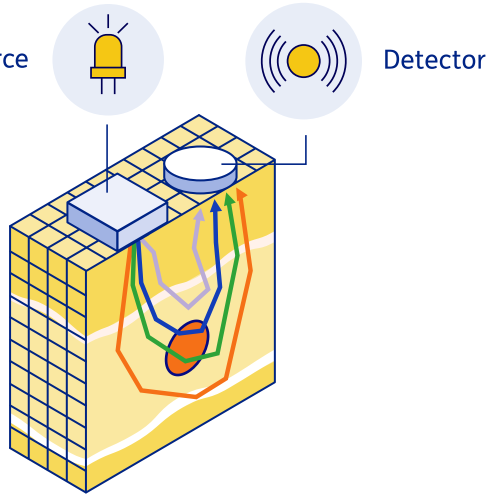
Health Medical Devices

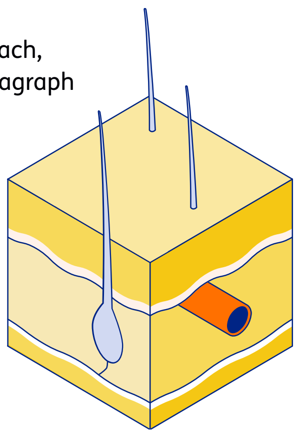
TOMCA®
Tissue Optics Monte Carlo Analysis



TNO supports companies with the design and optimisation of photonic devices for the diagnosis and monitoring of health, such as wearables, health patches and retinal imaging devices.

Sensors that monitor health parameters using light need to be sufficiently accurate and reliable, especially when used as a medical device. To enable the development of photonic medical or health devices it is essential to have an optimal sensor design, including a robust and accurate sensor algorithm. What makes this challenging is the amount of human variables that have to be taken into account. TNO offers TOMCA® as a service to investigate the optical response of human tissues (such as skin and retina) to different sensor configurations (wavelengths and layout). An inclusive set of tissue models (including variations due to gender, skin tone, age and body locations) combined with thousands of analysis runs with these variations in tissue composition provide the perfect tool for your photonic health sensor design.

TOMCA® follows a stepwise approach, which is described in the next paragraph for a skin sensor case.



Tissue model
First a tissue model is realized. Skin structure and skin composition are different for each individual and many skin variables will also change over time. Your skin can for example tan in the sun and your blood flow changes depending on the skin temperature. The different types of skin and the interindividual variations in composition can strongly influence the accuracy of the health parameter to be measured. To address this variability TNO analyses thousands of skin models using TOMCA®. These skin models typically exist of multiple skin layers (e.g., epidermis, dermis, subcutaneous fat). The composition of the skin and the thickness of each layer can be adapted. Furthermore, blood vessels can be added with variations in blood vessel diameter simulating arterial pulsations.

Voxels and marching cubes algorithm
The skin model is converted to a grid of cubic voxels. Each voxel gets its specific representative set of validated optical tissue properties (scattering and absorption). For more complex shapes such a blood vessels the "marching cubes" algorithm is used which ensures a better representation of curved surfaces.

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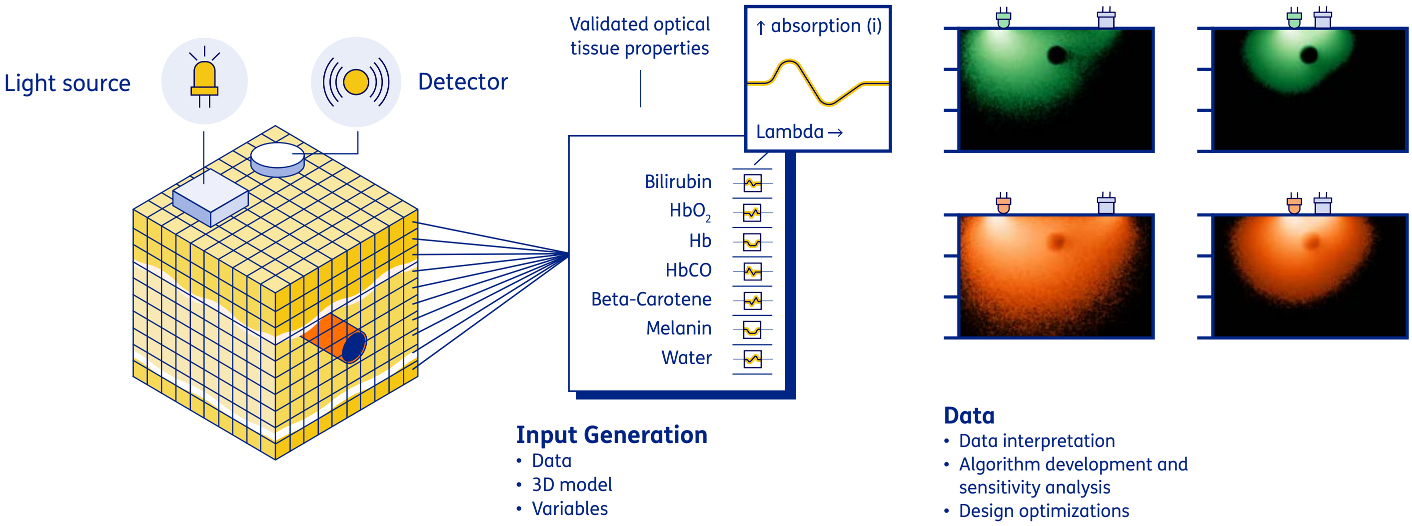
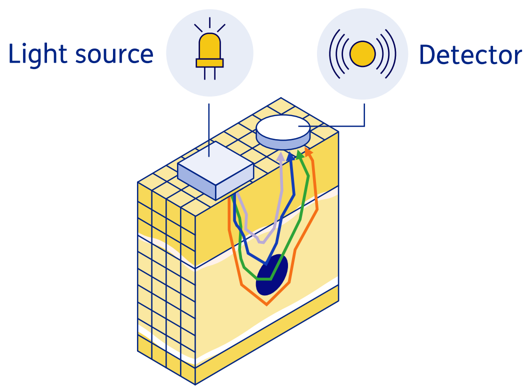


Optical configuration of the sensor

The optical configuration of the sensor is free to choose, including the type, emission spectrum and number of light sources as well as their angular emission profile. The same holds for the detector(s). The spatial distribution of sources and detectors is crucial as this has a strong influence on which tissue layers are visited by the majority of the photons.



Millions of analysis runs

The optical response of a specific configuration is calculated by means of a stochastic approach where millions of virtual photons are emitted from the source. The trajectory of the photons that make their way to the detector can be analysed for each specific wavelength.

To simulate an inclusive population with both inter- and intra-individual variations, thousands of tissue models are investigated. Hundreds of different sensor configurations may be simulated, to optimise the configuration towards a minimum amount of components (sources and detectors) while maintaining a robust and accurate algorithm to extract the desired information from the tissue. At TNO many supercomputers work in parallel for the TOMCA® analyses.

AI supported algorithm design and sensor optimisation

TNO uses AI (artificial intelligence) techniques to create and optimise both sensor configuration and biomarker detection algorithms. The extremely large datasets generated by TOMCA® are also used to analyse sensor robustness, which is regarded as a critical optimisation factor.

Sensor realisation and validation

After the design optimisation of the sensor, TNO can support in the realisation and validation of the sensor. Validation typically starts on tissue mimicking phantoms, followed by clinical studies. During the validation process TOMCA® is used together with the experimental and clinical data for further optimisation of the sensor design and algorithm.

Interested?

TNO manages the process from initial idea up to validation of clinical prototypes. Our mission is to support industry with the development of their sensors. TNO can also support in individual process steps if desired.

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