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Made-to-measure medicine thanks to computer simulation

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The ETH spin-off ZMT Zurich MedTech AG and the IT'IS research foundation have developed a simulation platform which makes patient-specific medicine and treatment planning possible. Using complex anatomical modelling, the effect and safety of new implants and procedures can be predicted.

Headed by founder and director Niels Kuster, the research group at the IT'IS Foundation, which has close links with the ETH Zurich, initially developed testing processes to establish how the human body is exposed to radiofrequency energy from mobile phones. Nowadays this technology is used to test almost all mobile phones and smartphones that come onto the world market.

Since 2005 the Foundation has focused its expertise in the medical field, e.g. developing and improving the safety of MRI technologies, or improving therapeutic hyperthermic and ultrasound applications. In an initial CTI project, IT'IS developed the Sim4Life simulation platform, which can be used to reliably predict the effect of medical equipment on the human body.

Between one and two man-years of work per model

To develop this platform, IT'IS drew up complex, high-resolution body models based on the MRI data from a selected group of individuals. This allowed them to develop an accurate picture of the main anatomical and physiological characteristics of all relevant patient groups. "Between one and two man-years of work have gone into each of these models," explains Niels Kuster. "But we can now alter both posture and the degree of obesity," adds Esra Neufeld, Chief Scientific Officer of the spin-off ZMT Zurich MedTech, which Kuster and his research colleagues founded in 2006.

The first version of Sim4Life was successfully launched on the market in 2014. Over 100 applications for medical

The simulation platform predicts the effect of medical devices on the human body.

Niels Kuster, Director of the IT'IS Foundation and Esra Neufeld, CSO ZMT Zurich MedTech

implants received by the Food and Drug Administration (FDA), the US licensing authority, have been drawn up using the platform. "Sim4Life and the models have already been mentioned in over 580 scientific papers, and they are generally considered the gold standard at conferences," says Kuster proudly.

A second CTI project, entitled S4L-Capitalis, was launched to achieve the next milestone: functionalising the existing models. The platform was extended so that the private sector, regulators and researchers can analyse and optimise under realistic conditions neurological devices (e.g. retinal implants and stimulators) and treatments for epilepsy, Parkinson's disease, depression and aneurysms.

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Niels Kuster, Director of the IT'IS Foundation for Research on Information Technologies in Society

For example, taking a high-resolution model of the head, it is possible to plan how to irradiate certain tumours with electromagnetic energy in such a way that they are more receptive to radiotherapy and chemotherapy. Clinical trials have shown that this increases the five-year survival rate from 0% to 50%. "All the major manufacturers are interested in using our software for personalised treatment planning," explains Kuster.

Despite its high complexity, the Sim4Life platform can be used for a wide variety of applications on a normal desktop computer and it is relatively easy to use. For example, the software can be used to observe design and safety aspects of cardiac pacemakers, which would not be possible in vivo or in vitro. This opens up a whole range of new possibilities. Kuster's team is currently working with the Zurich children's hospital on how to carry out neurosurgical operations without opening up the skull. The researchers are also working with the FDA on realising their next vision – developing the software so that it can replace or aid in expensive clinical trials.

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