MIRACLE involves 4 disciplines:

Planning & Navigation
- Planning in virtual reality
- Augmented reality in surgery
- Endoscope navigation

Medical Robotics & Mechatronics
- Robotic endoscope
- Telemanipulation and concurrent feedback
- Force sensing technologies

Smart Laser Osteotome
- Optimized laser technology
- Waveguides for high energy laser
- Real-time tissue monitoring and analysis

Smart Implants
- Personalized implants
- Smart implant design
- At the point of care

Funding:

WSS
WERNER SIEMENS-STIFTUNG

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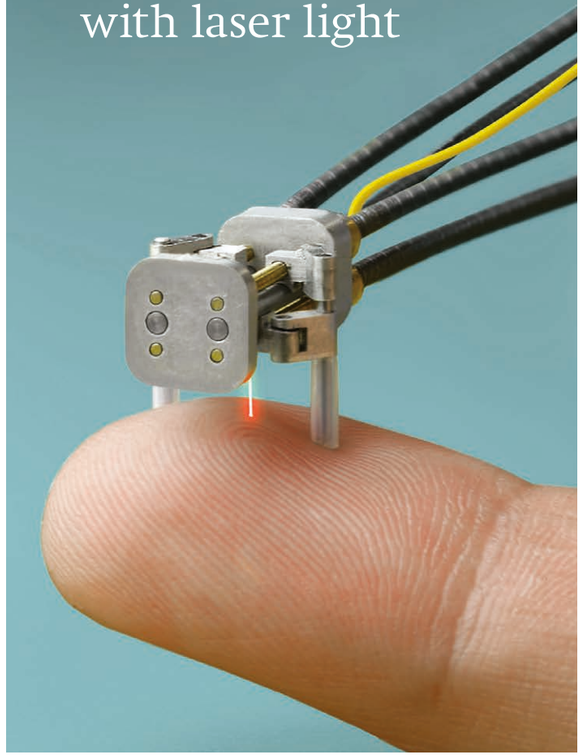
The MIRACLE Project
Cutting bones minimally invasive with laser light



Project MIRACLE
Minimally Invasive Robot-Assisted Computer-guided LaserosteotomE

The project Minimally Invasive Robot-Assisted Computer-guided LaserosteotomE (MIRACLE) combines natural sciences and medicine. It will enable minimally invasive laser osteotomies (bone cuts) using integrated miniaturized systems.

Planning & Navigation

The Planning and Navigation team develops novel navigation technology in order to control the robot-assisted laser system during surgery. One outcome is the groundbreaking SpectoVR software. SpectoVR is a renderer for three dimensional medical data such as Computer Tomography (CT) data sets and enables visualizing images in three dimensions using virtual reality. Since 2018 all operations with patients undergoing elective aneurysm repair at the University Hospital Basel, Switzerland are prepared with SpectoVR technology. In spring 2018, for the first time SpectoVR technology was used successfully during a consultation to inform a patient about his operation.

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Medical Robotics & Mechatronics

In order to achieve repeatable high precision cuts even in minimally invasive procedures, for the first time worldwide, the Bio-Inspired RObots for MEDicine-Lab (BIROMED-Lab) has developed a parallel-robotic endoscope-tip. This tip attaches to the target tissue, precisely guides the laser, and decouples mechanically from the endoscope and the robotic structure.
Thus, if the patient is moved or if the surgeon touches the surgery robot, disturbances will not be transferred to the endoscope tip. Planned applications for this MIRACLE endoscope will be in the fields of orthopedics, cranio-maxillofacial surgery, neurosurgery, otolaryngology, traumatology, and spinal column surgery.

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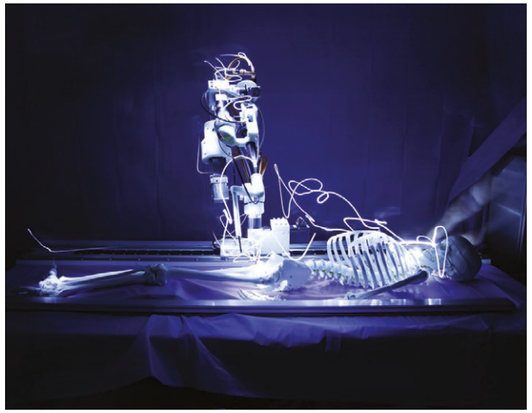

Smart Laser Osteotome

The Biomedical Laser and Optics Group (BLOG) provides laser and optical solutions to build the laser for in-vivo laser osteotomy and deliver the laser beam inside the human body through an endoscope. The team develops a laser with feedback system which guarantees for extremely precise cuts of almost all shapes in minimally invasive surgery. The laser system will not only cut bone but also provide important information for the surgeons. It will be able to monitor the laser cutting process and to detect the type of tissue being cut in real-time. This enables the laser osteotome to immediately shut down in case of unexpected events like cutting through a nerve or other soft tissues that should be preserved.

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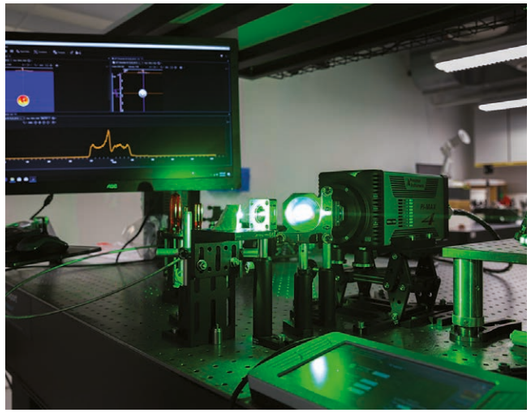

Smart Implants

The future in surgery is SMART. Smart implants are personalised human implants with multiple capabilities: they imitate nature perfectly, they are made of extremely strong, durable or flexible biomaterials. Some can slowly dissolve over time and release active compounds that are converted into new tissues such as bone. Others have customised geometries, integrated sensors or shape memory. Ideally, smart implants are manufactured quickly and cost-effectively at the point-of-care. We aim to design and engineer implants in bioreactors or manufacture them outside and even inside the human body using innovative robotic bio-printing technology. The Smart Implants group focuses on developing novel and minimally invasive implant and device technologies.

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