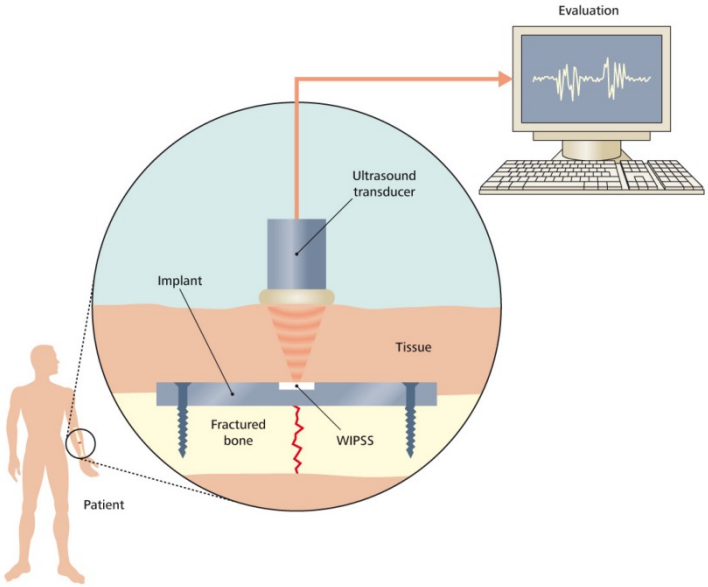
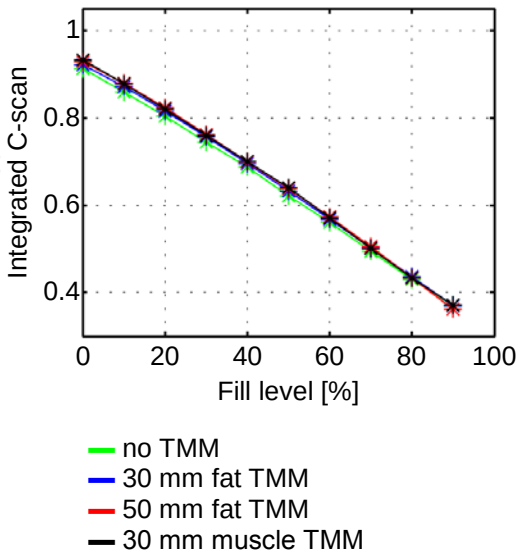
Ultrasound read-out for wireless implantable strain-sensor

In order to monitor the deformations of orthopedic implants, a novel sensor has been developed in collaboration with the Institute of Micro- and Nanosystems at ETH Zurich. The system consists of an implantable passive strain sensor (WIPSS) and an ultrasound-based read-out unit. The measured strain is displayed by a varying amount of fluid in a micro channel integrated into the sensor. By means of a novel ultrasound technology the fill level of the micro-channel is determined, which in turn enables the calculation of the strain. The sensor is completely manufactured of biocompatible polymer material.

The strain measured by the WIPSS will be read-out through human tissue by means of non-invasive ultrasound. The attenuation properties of the tissue require the use of ultrasound pulse frequencies in the range of 5 MHz. At these (low) frequencies the micro channel appears as a blurred spot in a 3D ultrasound image and therefore a straightforward determination of the fill level is not feasible. This situation has led to a new read-out principle based on a linear relation between the fill level and the area integration of a C-scan of the micro channel. Additionally, a calibration reflector inside the WIPSS is intended to provide a defined echo, which will be used to compensate amplitude variations of the ultrasound signals caused by the tissue that covers the WIPSS. Extensive in vitro ultrasound experiments as well as numerical simulations of the wave propagation were carried out in order to test the read-out method. Experiments with tissue mimicking materials (TMM) and inhomogeneous pieces of pork agree well with theoretical results.





References

F. Gattiker, Novel ultrasound read-out for a wireless implantable passive strain sensor, PhD thesis No 18583, ETH Zürich, 2009.

F. Gattiker, F. Umbrecht, J. Neuenschwander, U. Sennhauser, and C. Hierold, Novel ultrasound read-out for a wireless implantable passive strain sensor (WIPSS), Sensors and Actuators A: Physical, 145-146C (2008) 291-298.