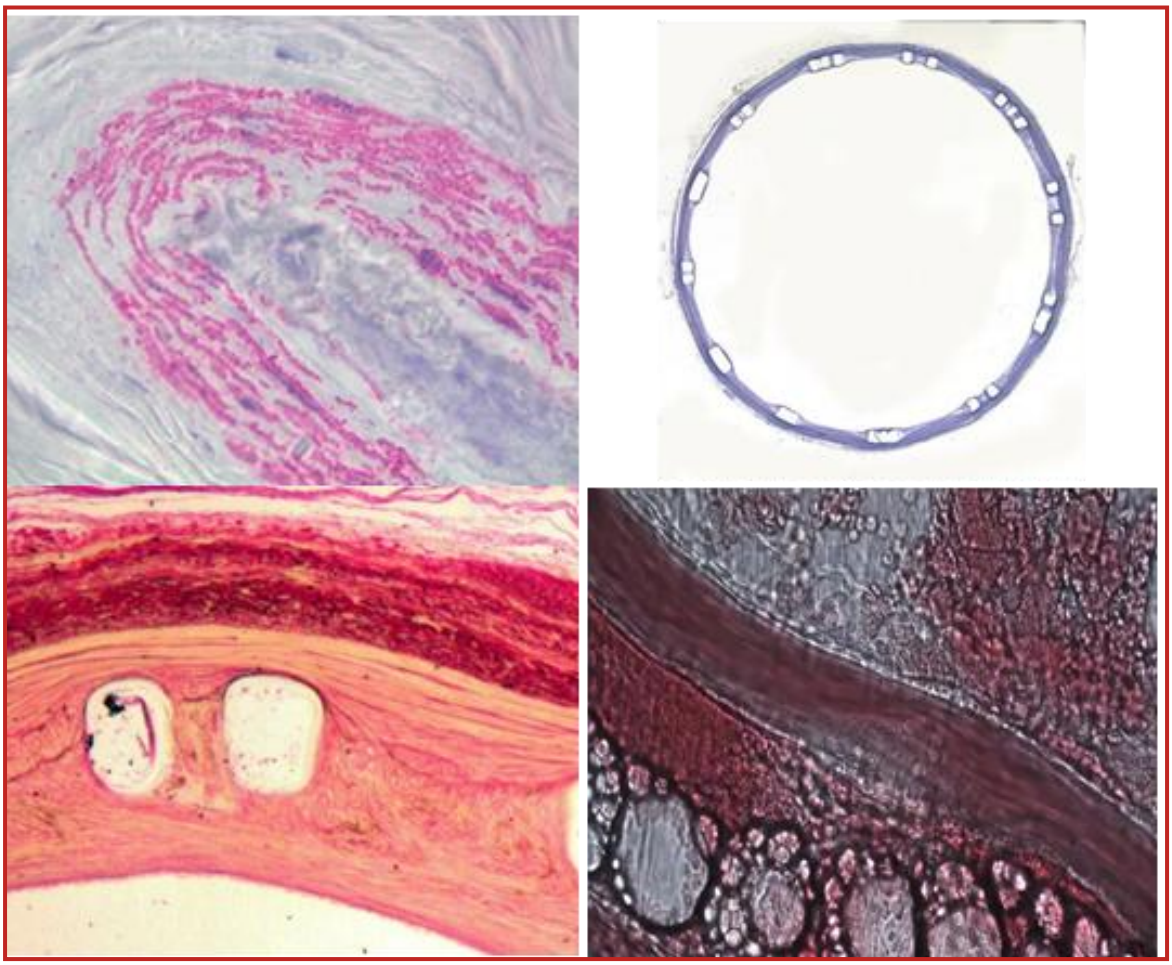
LLS ROWIAK LaserLabSolutions

Laser Based Tissue Processing and Imaging for Cardiovascular Medicine

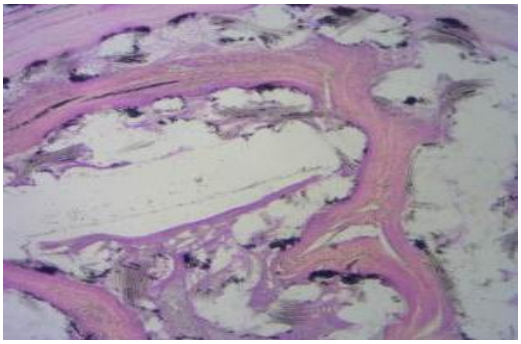


Cardio-Vascular Research
Stents and Implants
Tissue Engineering
Biomaterials

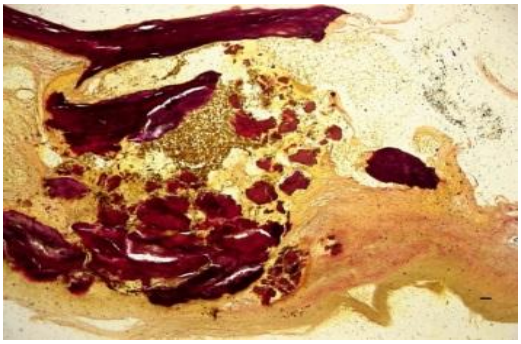
Laser Microtomy for Histology

The preparation of histological sections from cardiovascular vessels containing metal stents or calcified atherosclerotic plaques is challenging. Routine methods using a rotary or sledge microtome are limited in their cutting capabilities, and laborious ground sectioning leads to long preparation times and high material loss.

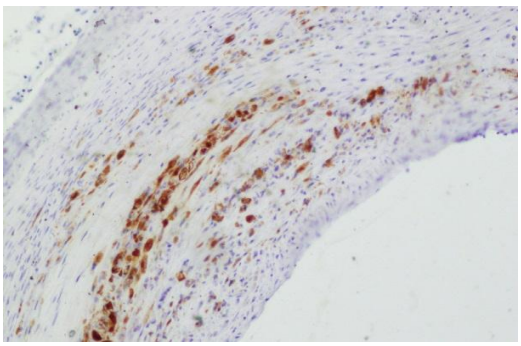
Stented pig artery, H&E, courtesy of MED Institute



Heart valve with implant, H&E



Non-decalcified artherosclerotic pla-que, Elastica van Gieson 40x, cour-tesy of Dr. G. Daum, UKE Hamburg



Vessel section with plaque, IHC Ram 11, courtesy of Prof. M. Joner, DHZ München

Laser microtomy as a non-contact laser-based sectioning process can overcome fundamental limits of classic microtomy and ground sectioning technology.

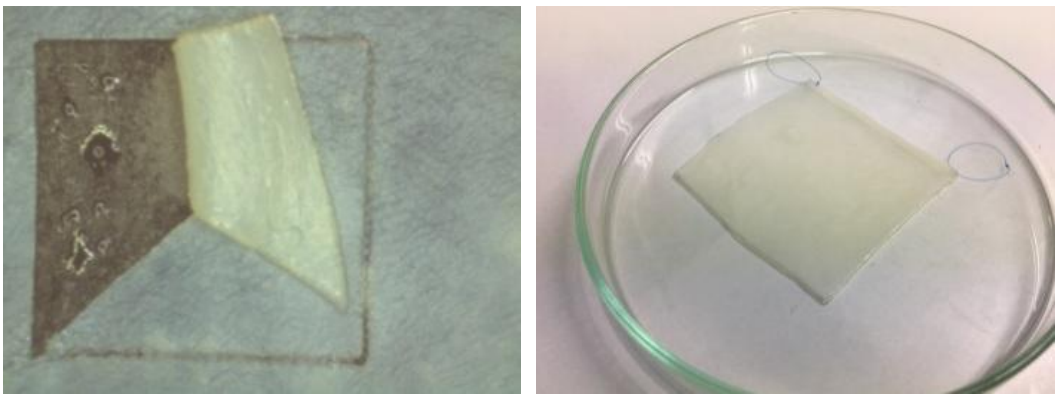
It enables

- Fast and easy cutting of undecalcified hard tissue and a broad range of implants and biomaterials.
- Semi-serial sectioning with minimal material loss.
- Quality control of sectioning via Optical Coherence Tomography.
- Minimization of sectioning artefacts
- Preservation of the integrity of implant-tissue interface.

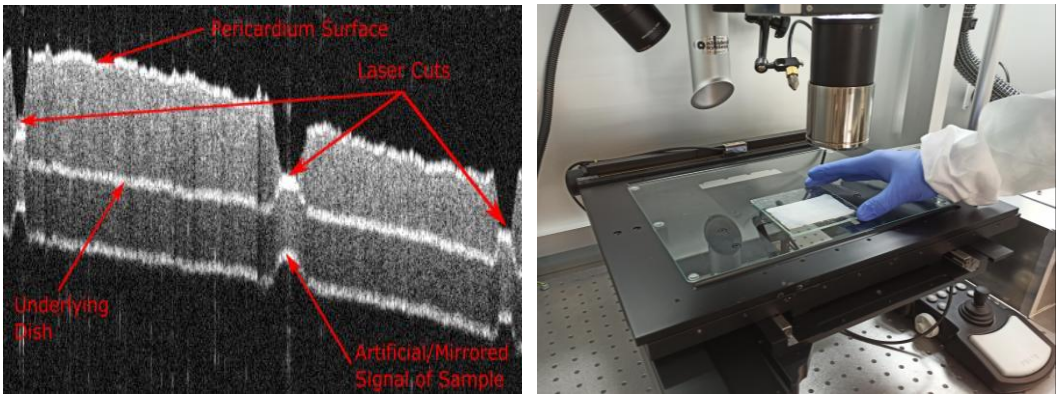
Laser Based Trimming of Pericard

For several tissue engineering applications biological materials such as collagen sheets, extracellular matrix or decellularized pericard has to be trimmed to a standardized or personalized size and form. This can be performed by mechanical tools, or as an alternative solution, by laser cutting, e.g. TissueTrim

- Depending on the specifications defined for the trimmed materials different laser technologies can be applied.
- Integration of OCT-imaging into the process quality control of the cutting is ensured.
- Any shear stress during the trimming process associated with mechanical processing is avoided.



Trimming of pericard using erbium laser (left) and femtolaser technology (right)

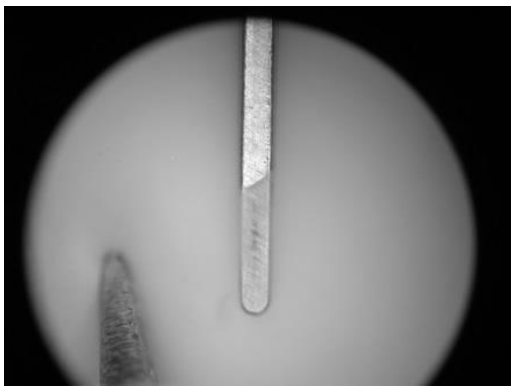


OCT-imaging for control of laser based pericard trimming (left) and customized laser cutting system TissueTrim for artificial pericard (right)

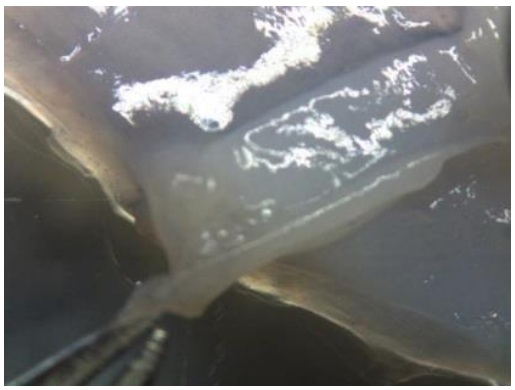
Customized Cutting and Imaging

Cardiovascular research and medical device development implies the use of cell and tissue based materials, biomaterials, active and passive implants, in vitro and in vivo models. Thereby laser cutting and imaging can be of great benefit for preparation and analysis. The combination of laser cutting with appropriate imaging offers individual solutions for a broad range of questions raised, such as

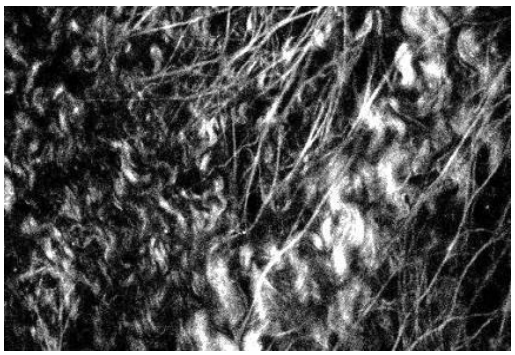
- Image guided preparation of tissue layers for biomechanical tests
- Nonlinear imaging of natural and artificial heart valve tissue
- Preparation of in vitro aneurysm model structures
- Isolation of cell clusters from model organism such as zebrafish embryo and mouse embryo

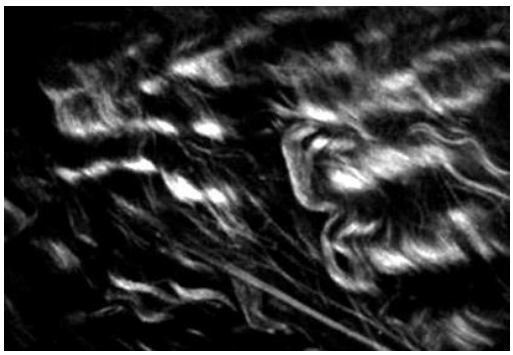


Cutting a pocket into a vein for an aneurysma model



Laser preparation of leaflet, separation of the collagen rich layer of a heart valve.

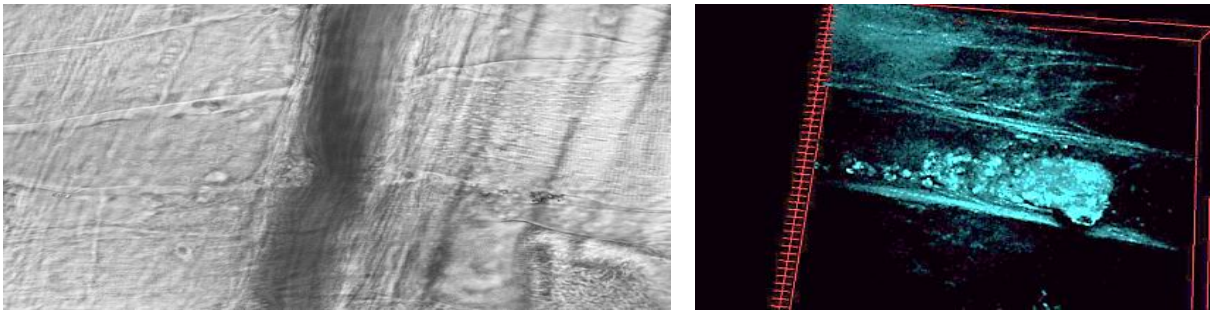




SHG-imaging and autofluorescence of a collagen and elastin network in a leaflet from a pig heart valve (left) and in a decellularized bovine pericardium (right)

In Vivo Small Animal Thrombosis or Stroke Models

A broad range of in vivo models from zebrafish embryo to murine animal models are central for understanding of thrombosis or stroke mechanism and drug development. Induction of thrombosis or vessel occlusion by chemical factors can lead to unwanted side effects in drug testing. Mechanical methods as clamping lack precision. By placing the injury at the vessel wall by precise laser manipulation, a high precision and reproducibility can be achieved.



Thrombus formation after laser induced blood vessel injury, brightfield (left) and multiphoton 3D-reconstruction (right)

2-Photon-Imaging of temporal development of clot formation in mouse blood vessels after laser injury @30fps, FITC-Dextran staining

The combination of the laser cutting with an appropriate microscopic imaging system such as intravital microscopy or multiphoton microscopy enables for long term monitoring of e.g. thrombus development, 3D-reconstruction of thrombus or identification of genetically modified cells in zebrafish models.
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Services for Cardiovascular Medicine

LLS ROWIAK LaserLabSolutions laser systems are designed for cutting and manipulating cells, tissue and materials from a submicrometer to a macroscopic scale. Take advantage of our expertise and experience in developing laser based solutions for cardiovascular research, development or preparation of cell and tissue based vascular devices. We offer service, support and development in following fields:

- Histology services from fixation, resin embedding, cutting and staining including a broad range of histological, histochemical and immunohistochemical stainings.
- Customized specimen preparation beyond histology, e.g. 3D cutting of native tissue.
- Application and process development of laser based solutions for tissue processing and imaging in cardiovascular medicine.
- Laser system development for tissue processing and imaging in cardiovascular medicine.

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