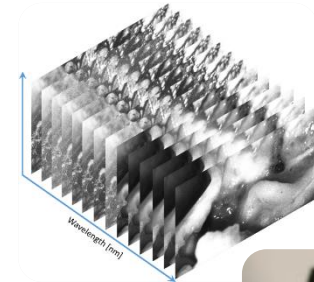
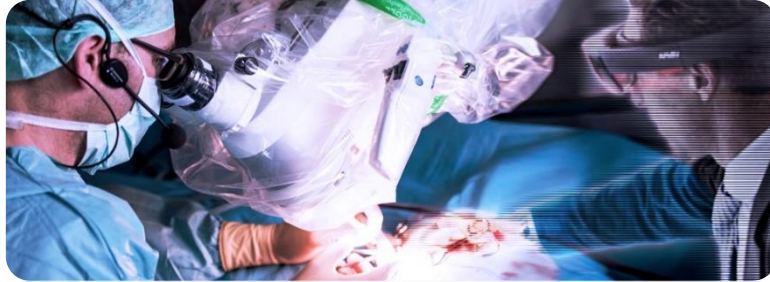


# MAKE THE INVISIBLE VISIBLE MULTISPECTRAL 3D-IMAGING FOR COMPUTER-ASSISTED SURGERY

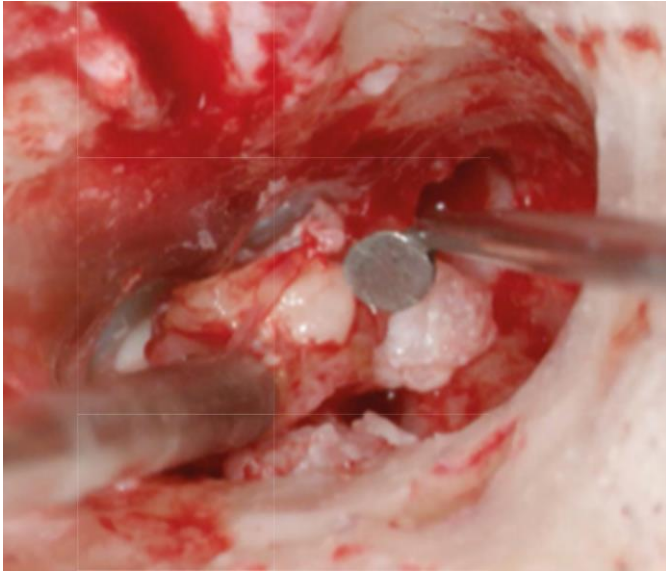
Eric L. Wisotzky, Fraunhofer HHI

27.07.2021

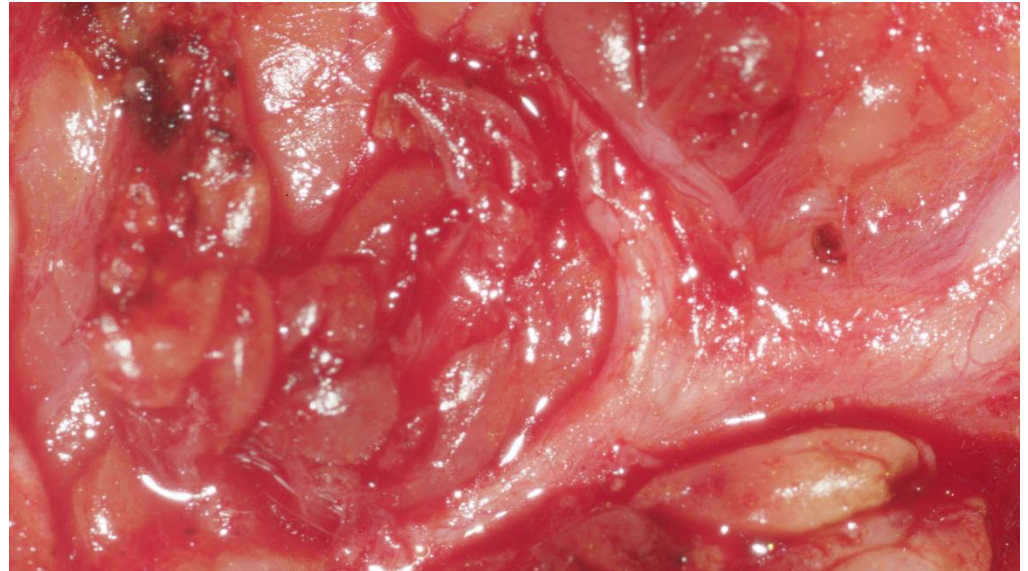


# Medical Need

Challenge: Identify different soft tissue types



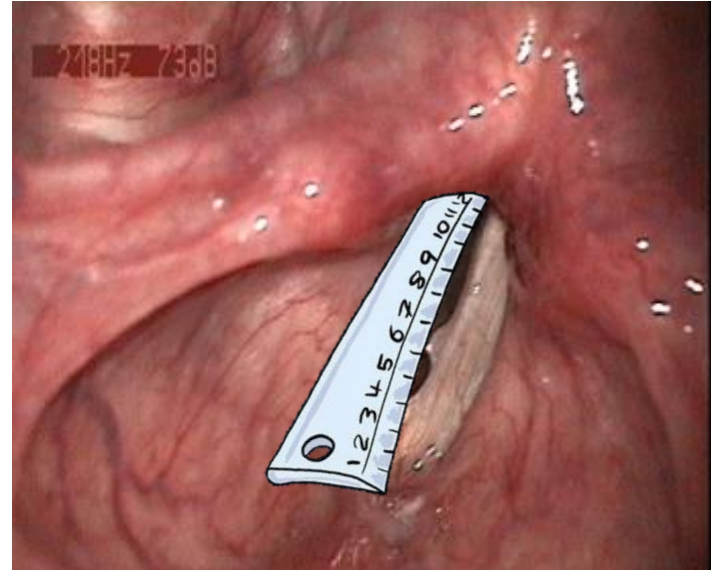
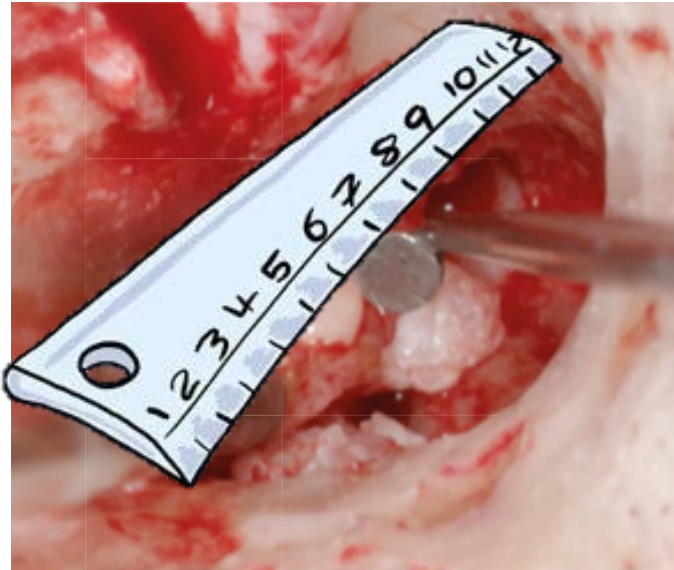
What shall be removed?  
What has to stay?



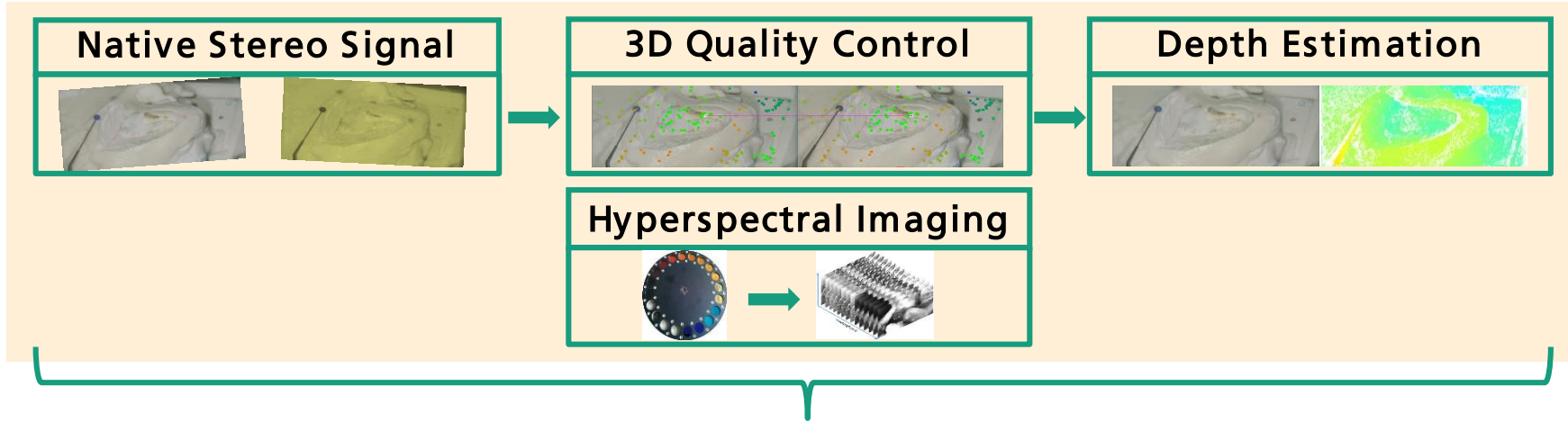
Where is the nerve?

# Medical Need

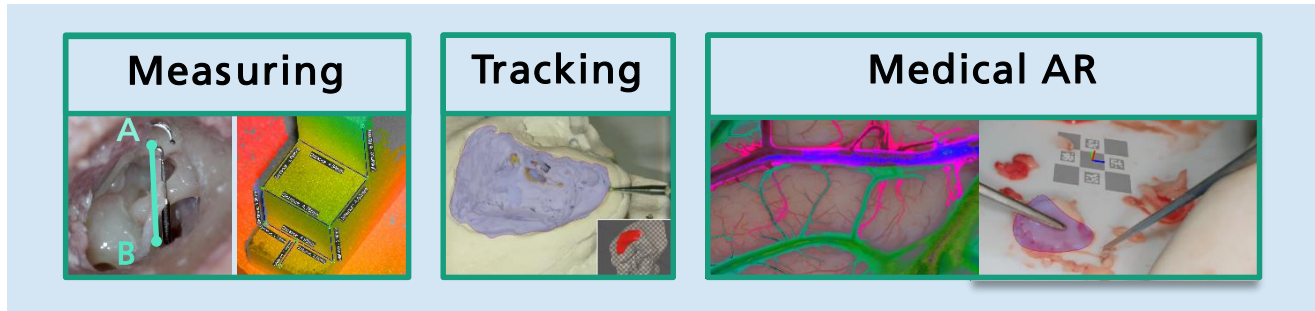
Challenge: What are the dimension of the different structures



# Image Processing for Surgical Use Cases



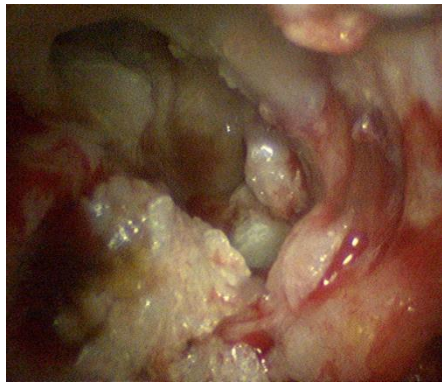
Core Processing



Medical Applications

# Setups for Multispectral 3D Imaging

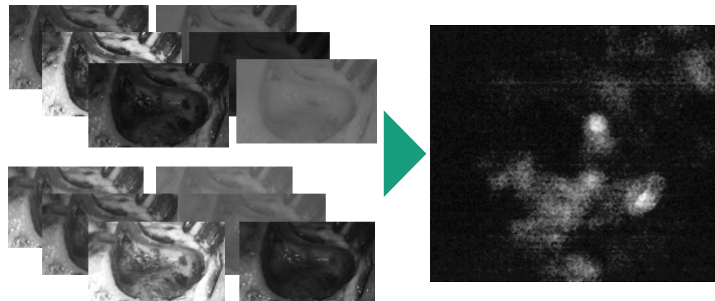
## Multispectral pipeline of our 2 setups



Live view



AR visualization



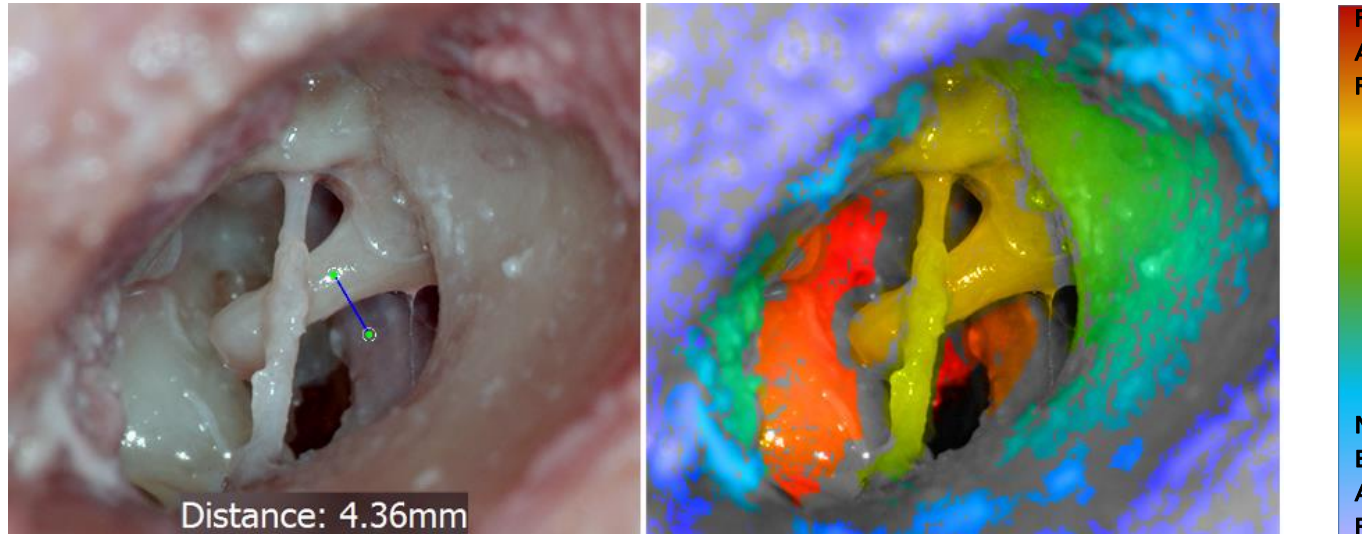
Spectral selection

# 3D Reconstruction and Measurement

# Stereo-Image-Based Measurements

## Principle of triangulation

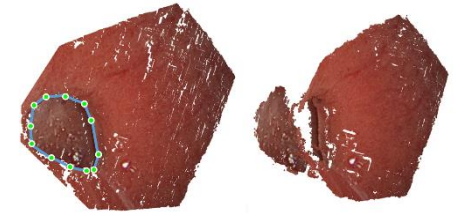
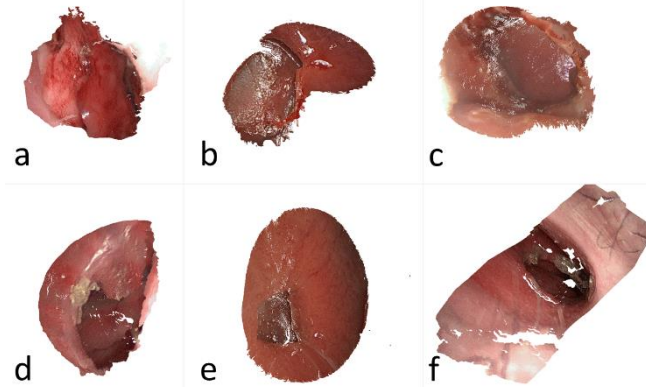
- Find feature point correspondences
- Calculate depth from disparity:  $Z = f(D)$



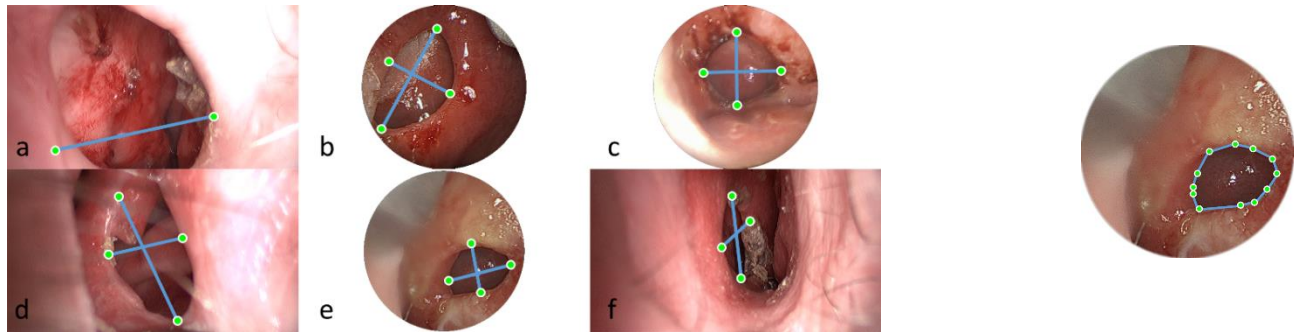
# Endoscopic Single Shot 3D Reconstruction

## Application: Nasal septum perforation

### 3D Reconstruction:



### Measurements:

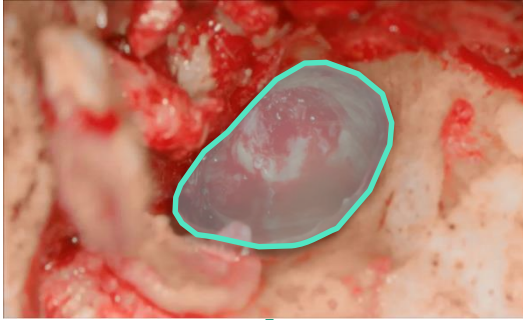




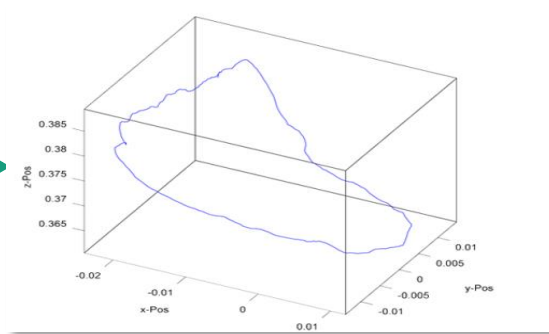
# Medical Need – Tympanoplasty

## Vision: 3D reconstruction to create stencil

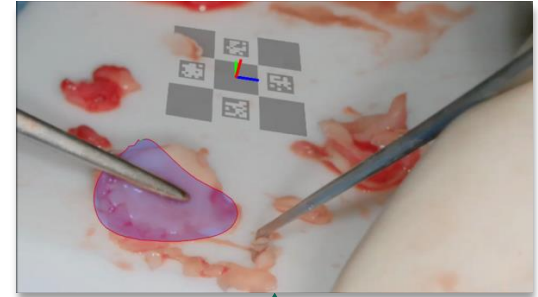
Selected shape



Reconstructed shape

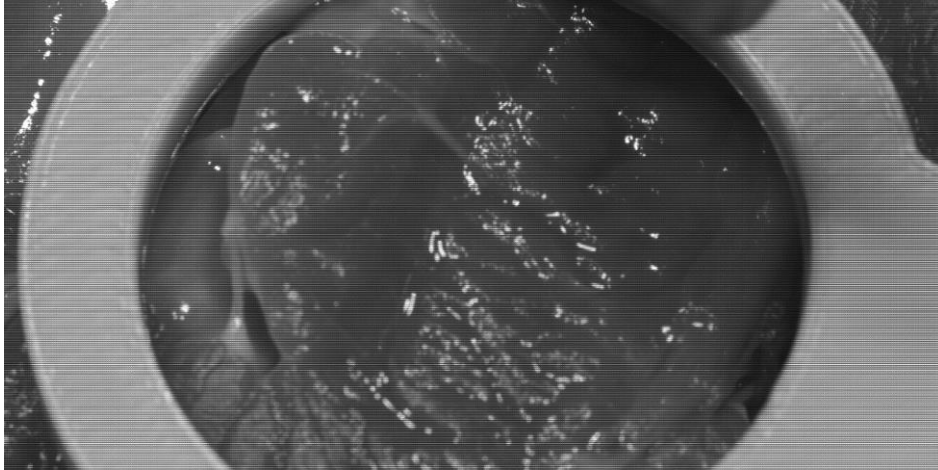


Live augmentation

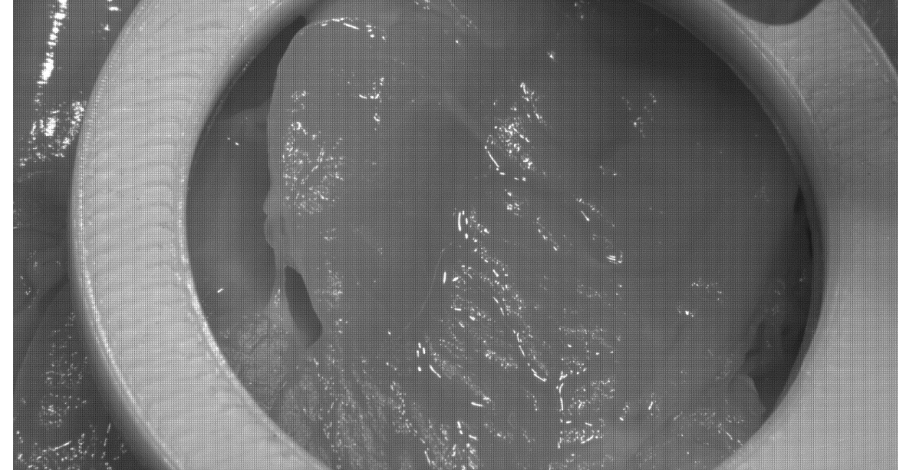


# Hyperspectral Imaging

# Stereo-Snapshot Setup



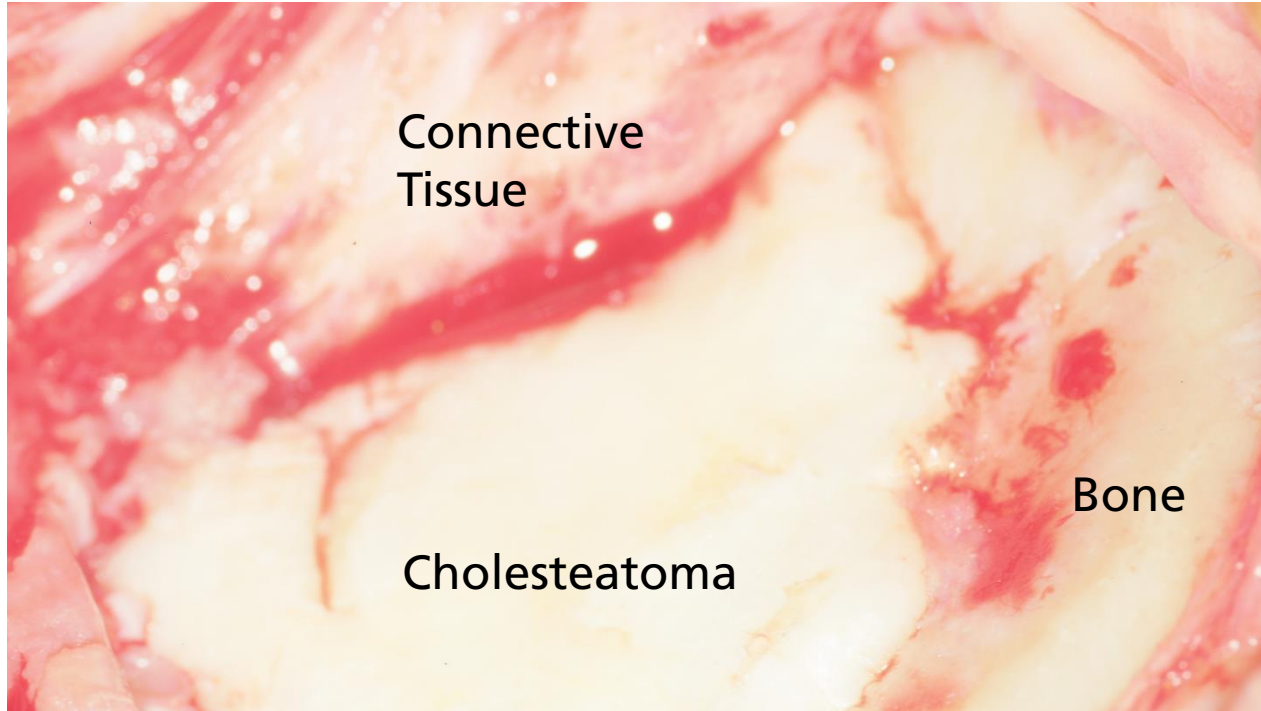
4x4 mosaic snapshot VIS - L



5x5 mosaic snapshot NIR - R

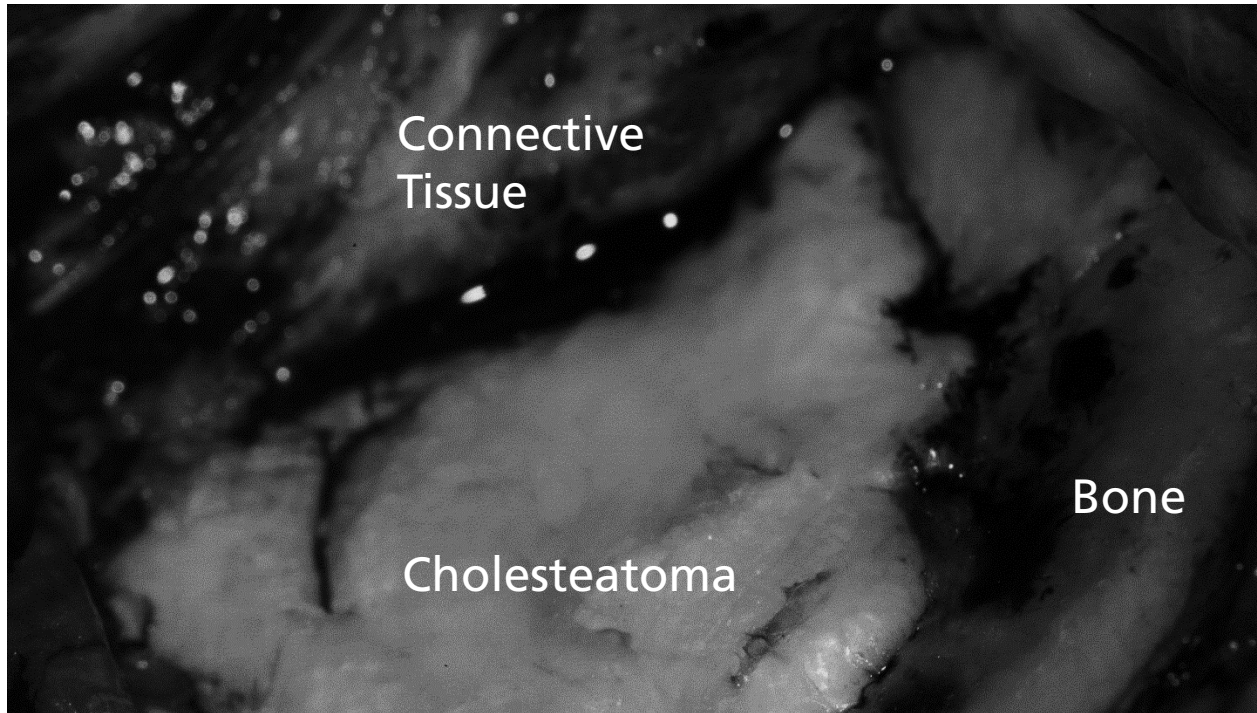
# Application: Cholesteatoma Removal

## White-light illumination



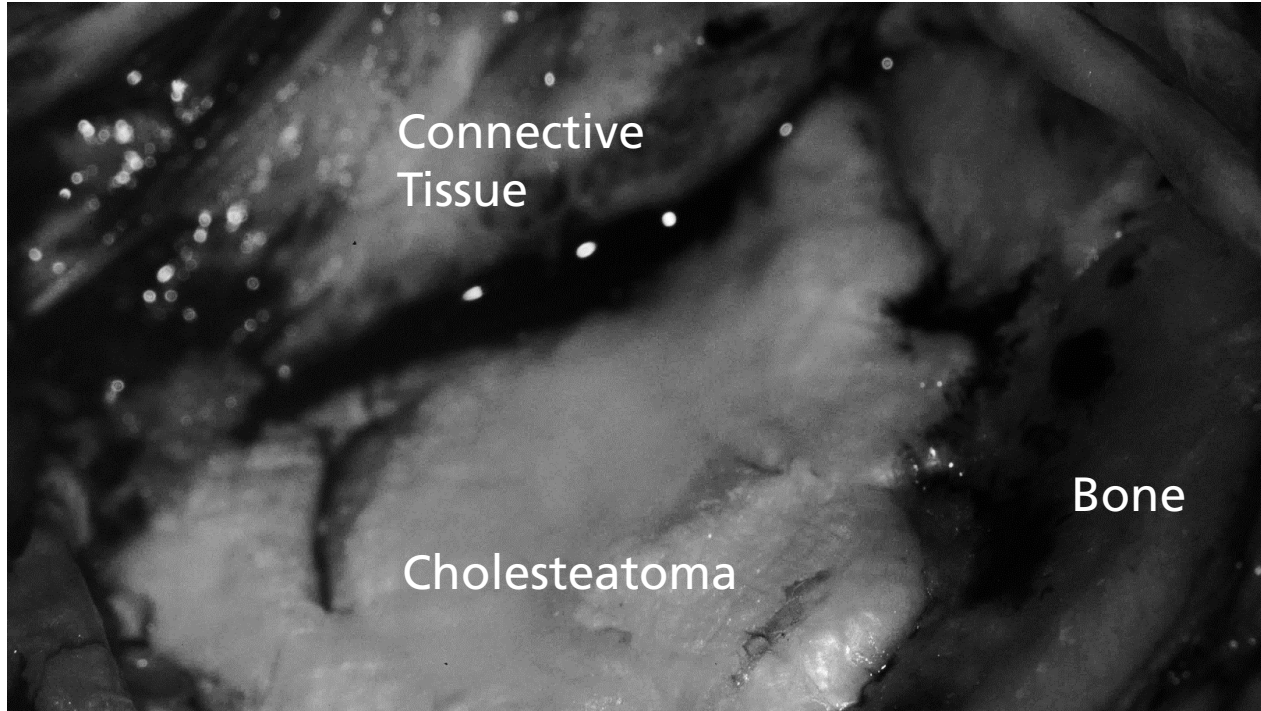
# Application: Cholesteatioma Removal

Spectral illumination with 540 nm



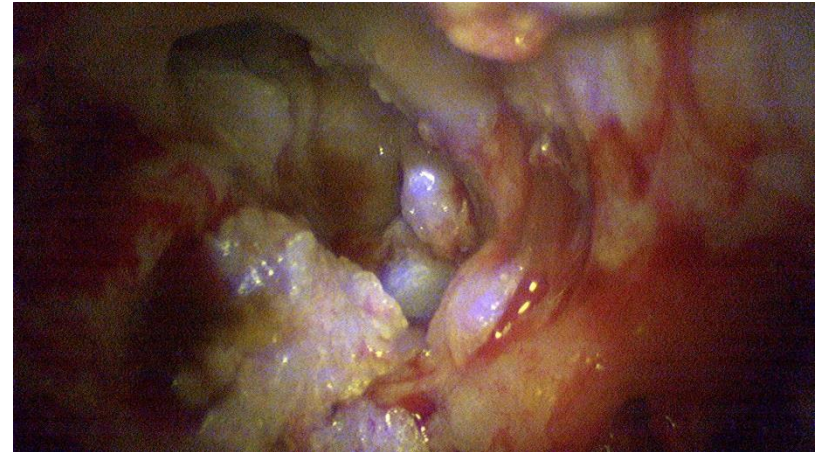
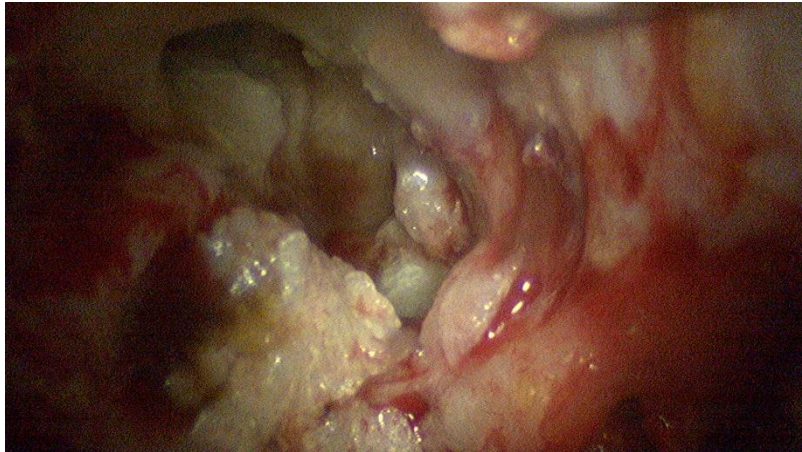
# Application: Cholesteatioma Removal

Spectral illumination with 500 nm



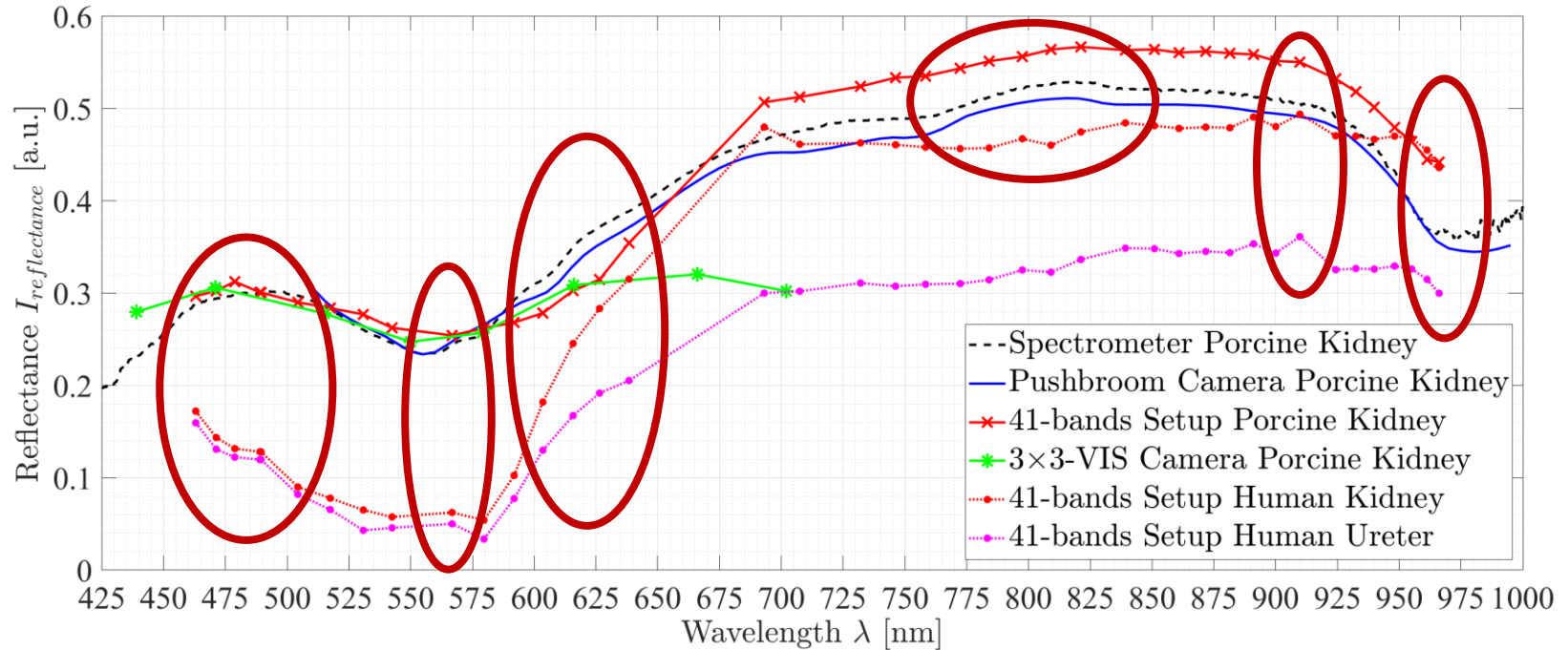
# Application: Cholesteatioma Removal

## AR-visualization results



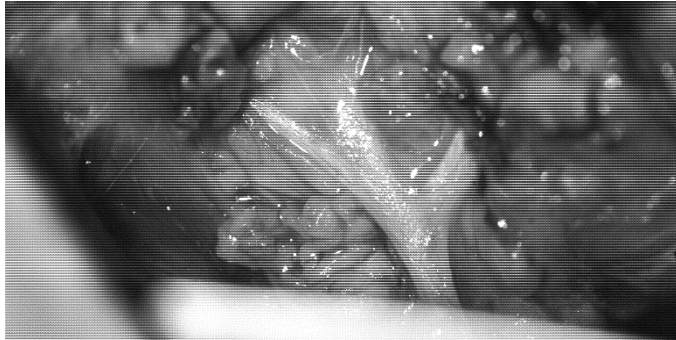
Reference: Surgical Guidance for Removal of Cholesteatoma Using a Multispectral 3D-Endoscope, Sensors, 20(18) 2020, doi: 10.3390/s20185334

# Spectral Tissue Information





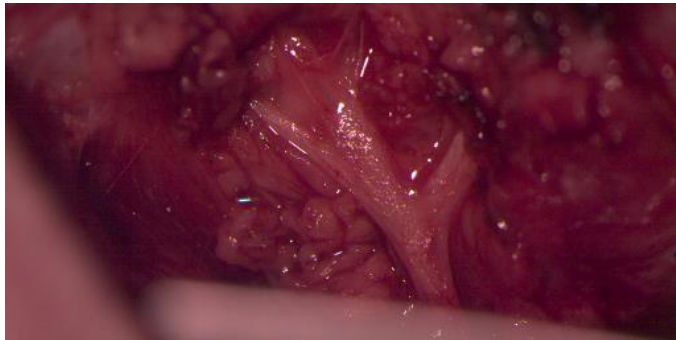
# Spectral Tissue Enhancement



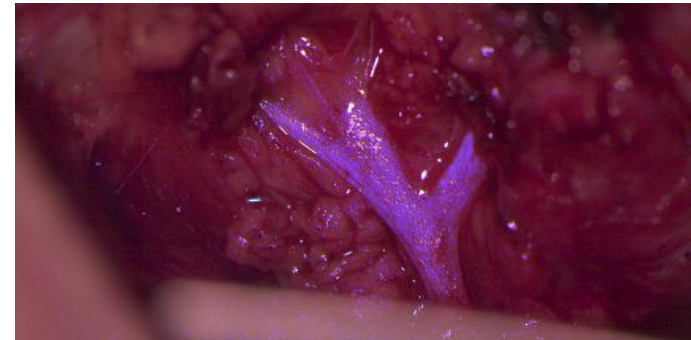
Measurement



Nerve Enhancement

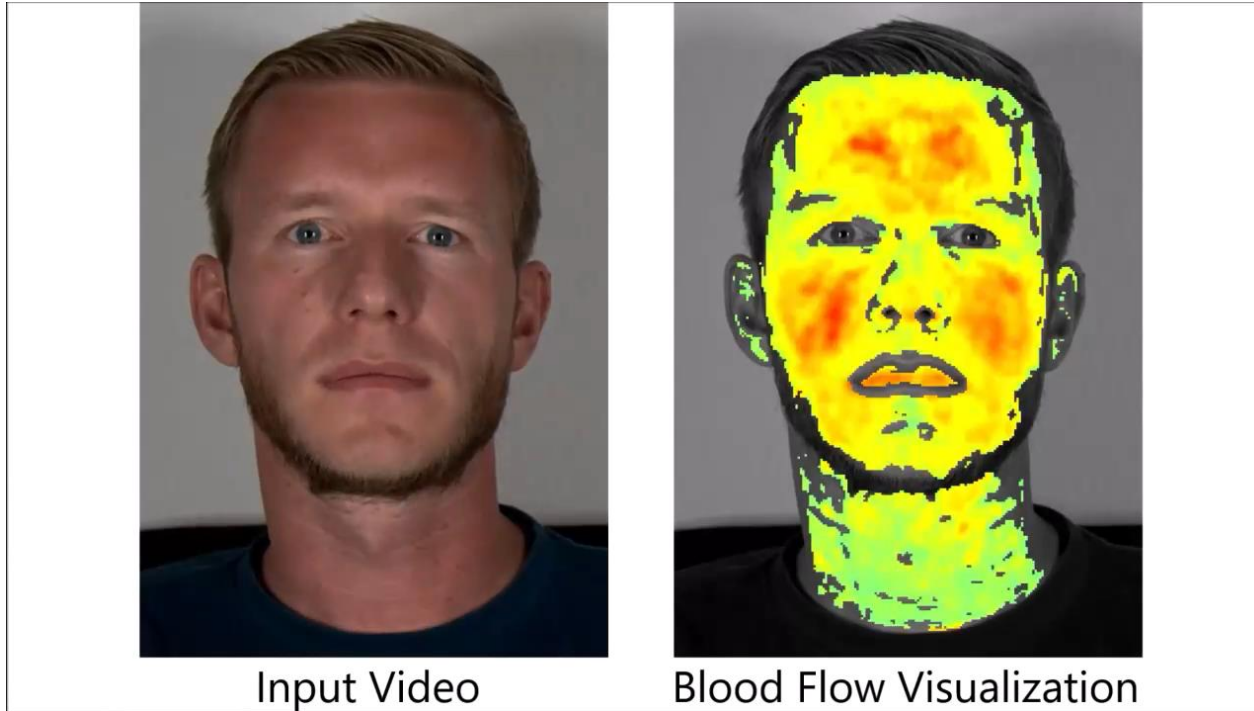


Calculation to RGB



Visualization

# Vital Signs & Blood Flow Visualization



Reference: Local blood flow analysis and visualization from RGB-video sequences,  
Current Directions in Biomedical Engineering 5(1) 2019, doi: 10.1515/cdbme-2019-0094

# Publications

**Intraoperative hyperspectral determination of human tissue properties**, Journal of Biomedical Optics  
23(9):091409 (2018). doi: 10.1117/1.JBO.23.9.091409

**Validation of two techniques for intraoperative hyperspectral human tissue determination**, Journal of Medical Imaging  
7(6):065001 (2020). doi: 10.1117/1.JMI.7.6.065001

**Interactive and multimodal-based AR for remote assistance using a digital surgical microscope**  
IEEE VR Workshop on Applied VR for Enhanced Healthcare (AVEH), Osaka, Japan, 2019. doi: 10.1109/VR.2019.8797682

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