A close-up photograph of a microchip mounted on a printed circuit board (PCB). The chip is square and has a blueish-purple surface. It is surrounded by intricate copper wiring and other components on the board. The lighting is dramatic, with strong highlights and deep shadows, giving it a technical and futuristic feel.

Bachelor- and Master-  
thesis topics in

Medical Physics/Detector  
Development

2020/2021



## DOSEPIX

- Spectroscopic photon counting  
x-ray Pixel detector
- Development CERN-ECAP

# Theses topics

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## **Biomedical Application: Molecular Imaging with Nanoparticles (Collaboration with U Magdeburg):**

- GEANT4-simulations for cylindrical detector concept (Master)
- First measurements of x-ray fluorescence on Molybdenum with new liquid metal jet x-ray tube (Bachelor)

## **Medical Physics: Eye lens dosimetry (Collaboration with Physikalisch Technische Bundesanstalt, UK Erlangen)**

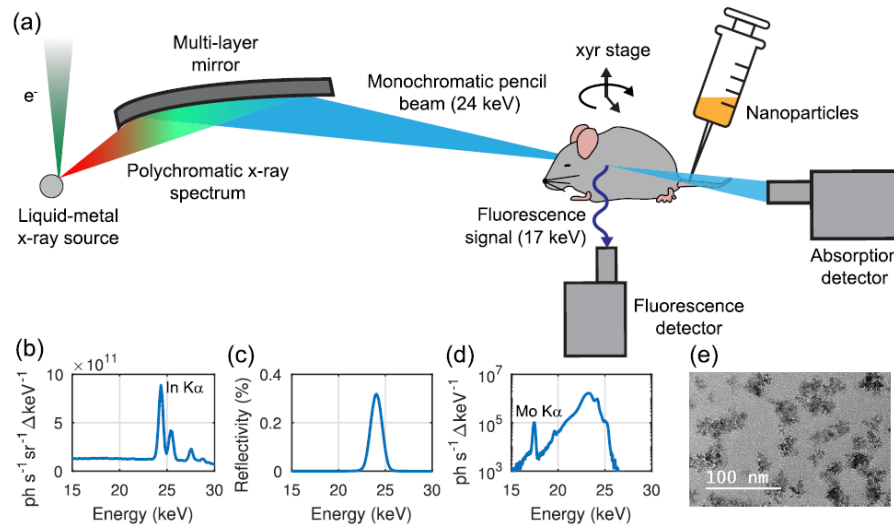
- Dosimeter Development: Dosimetry of the human eye lens in interventional radiography (Master)

## **X-ray spectroscopy: (Collaboration with Physikalisch Technische Bundesanstalt and U Prague)**

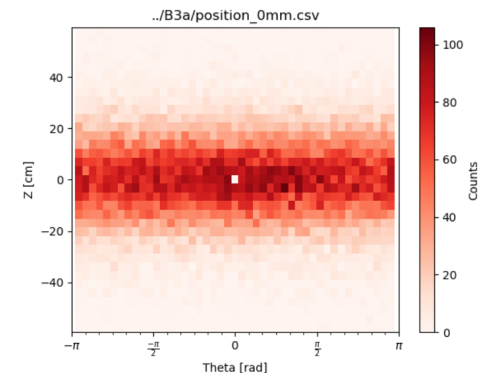
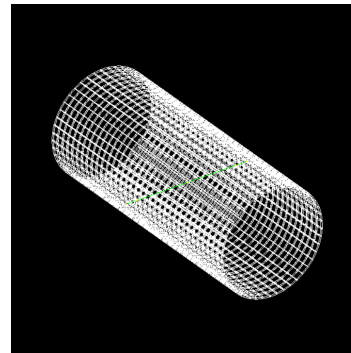
- Measurement and reconstruction of x-ray spectra from extremely pulsed (picoseconds) plasma x-ray sources (e.g. facility ELI in Prague)

# Molecular Imaging with Nanoparticles

- „Standard“



- Improved setup using a cylinder with many Dosepix to shorten measurement:



# Molecular Imaging with Nanoparticles

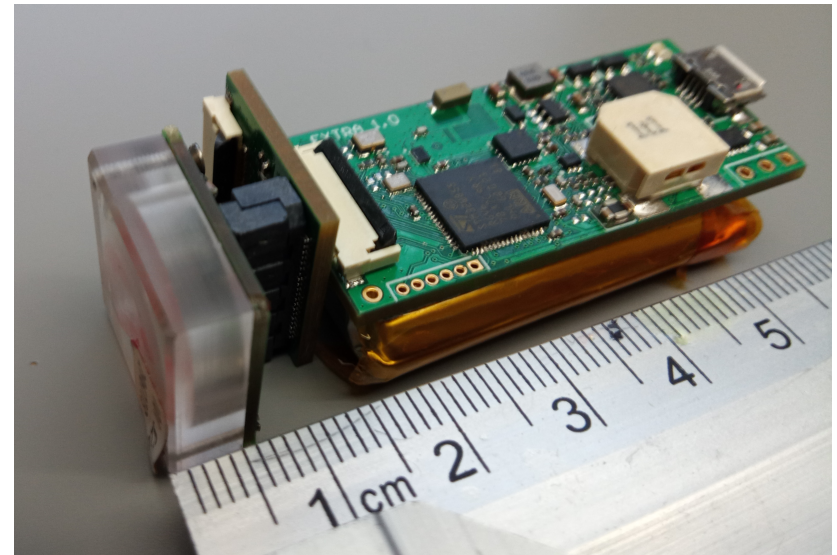
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- Basic Idea:
  - Label proteins or cells with high- or intermediate Z-elements such as Molybdenum or Gold
  - Use a high-intensity liquid metal jet x-ray source
  - Image the distribution of the nanoparticles by exciting by shining x-rays and detecting x-ray fluorescences
- Standard: use a few high-energy-resolving x-ray detectors
- Our approach:
  - Shorten measurement time using a close-to-4- $\pi$  cylindrical detector arrangement with Dosepix detectors with Silicon, CdTe or GaAs sensor layers
  - Exploit imaging capability of detector with neural networks to reconstruct nanoparticle distribution

# Medical Physics: Eye lens dosimetry

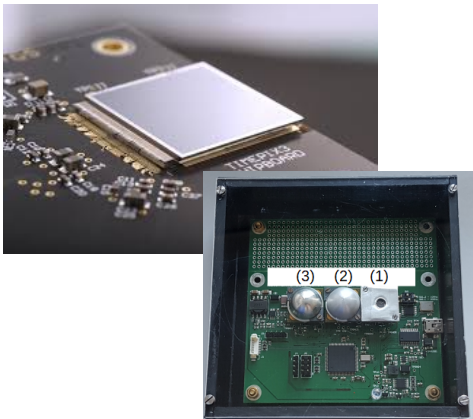
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- Basic Idea:
  - The human eye lens is a very radiation sensitive organ
  - In interventional radiology (surgery while taking x-ray films) the doctor's eyes are exposed to x-ray even while using protective glasses
- Standard solution for monitoring exposure: None
- Our approach:
  - Develop an instrument to measure, warn and train doctors to reduce their own dose
  - Use Dosepix as it is very compact

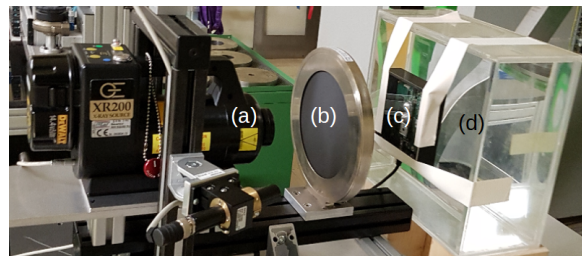


# Laboratory astroparticle physics

- Basic Idea:
  - Extremely short X-ray “flashes” are used for plasma and biomedical research to image fast processes
  - Usually x-ray spectrum varies from shot-to-shot
  - There is no established device to measure the x-ray spectrum of such short pulses in real time
  - Solution: Sample the spectrum with a plurality of pixels (Dosepix, Timepix); use deep neural networks to analyze
  - Collaboration CTU Prague, PTB (Braunschweig), CERN, GSI



Detectors



Testing at PTB



# Contacts at the Erlangen Centre for Astroparticle Physics

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