

μ CT with GaAs:Cr detectors

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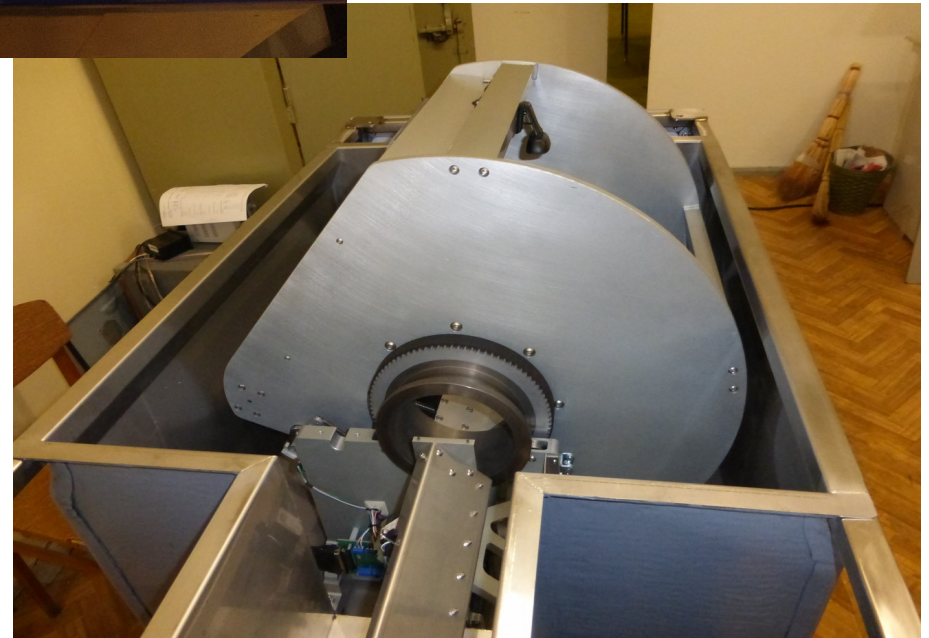
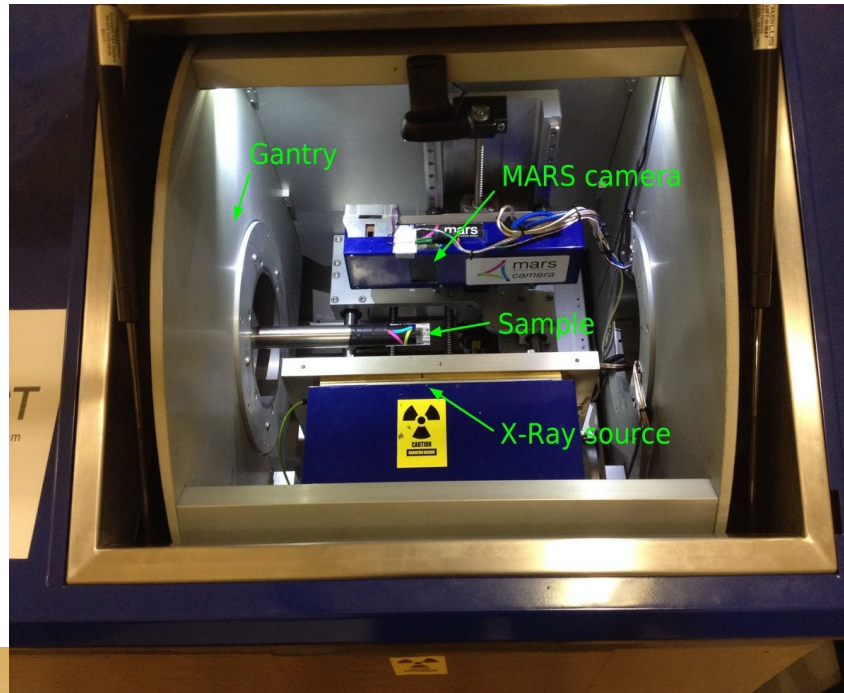
2017

MARS-CT

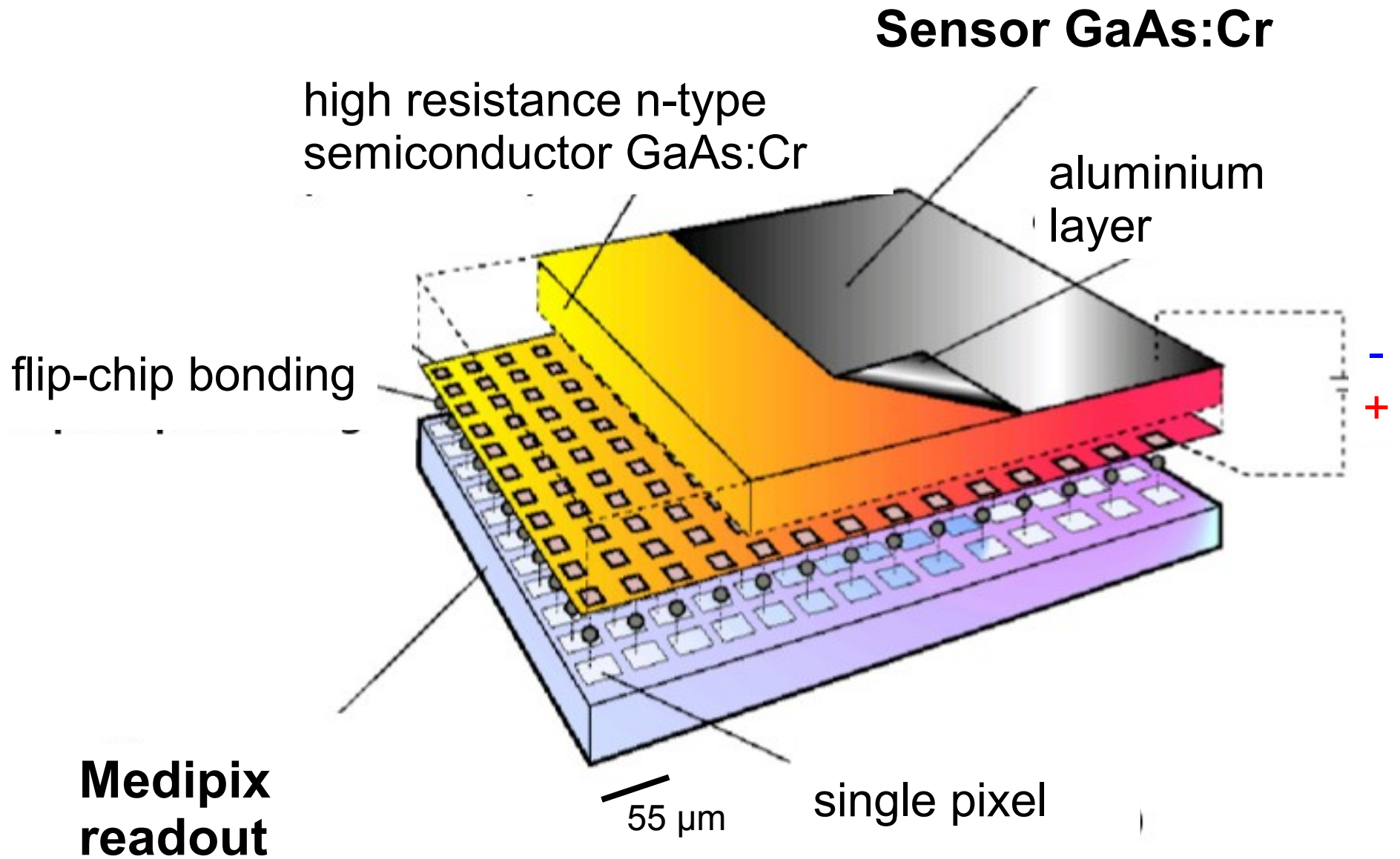
- Fully-functional microCT scanner equipped with GaAs:Cr Medipix detectors
- X-ray energy up to 120 keV
- Current up to 350 μ A
- Sample size up to \varnothing 10 cm X 30 cm
- The sample is immovable
- Geometrical magnification up to 1.8 times (big samples) or up to 4 times (small samples)



Manufactured by MARS Bioimaging Ltd., New Zealand

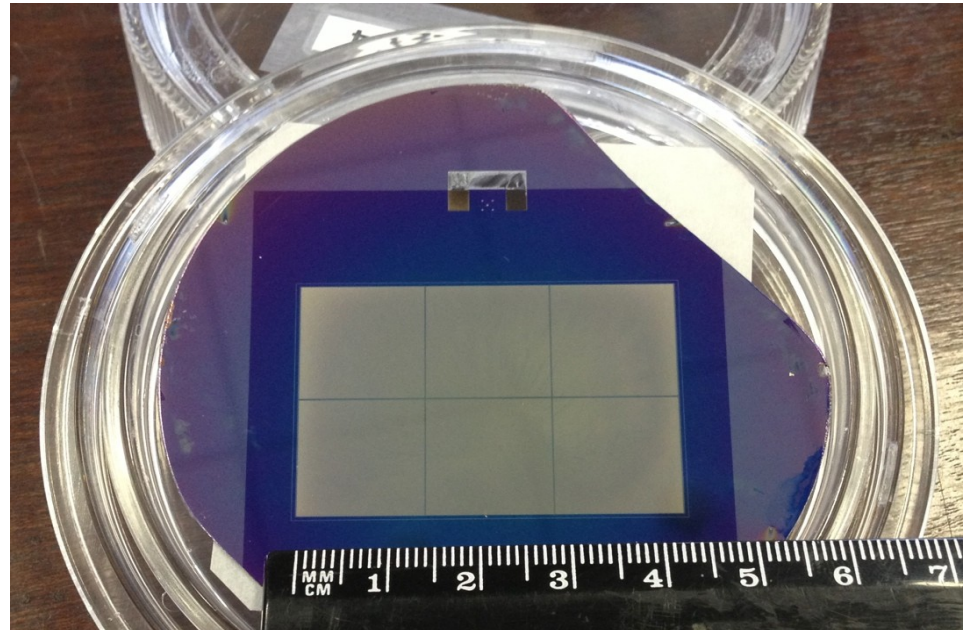


Hybrid pixel detector



Gallium arsenide

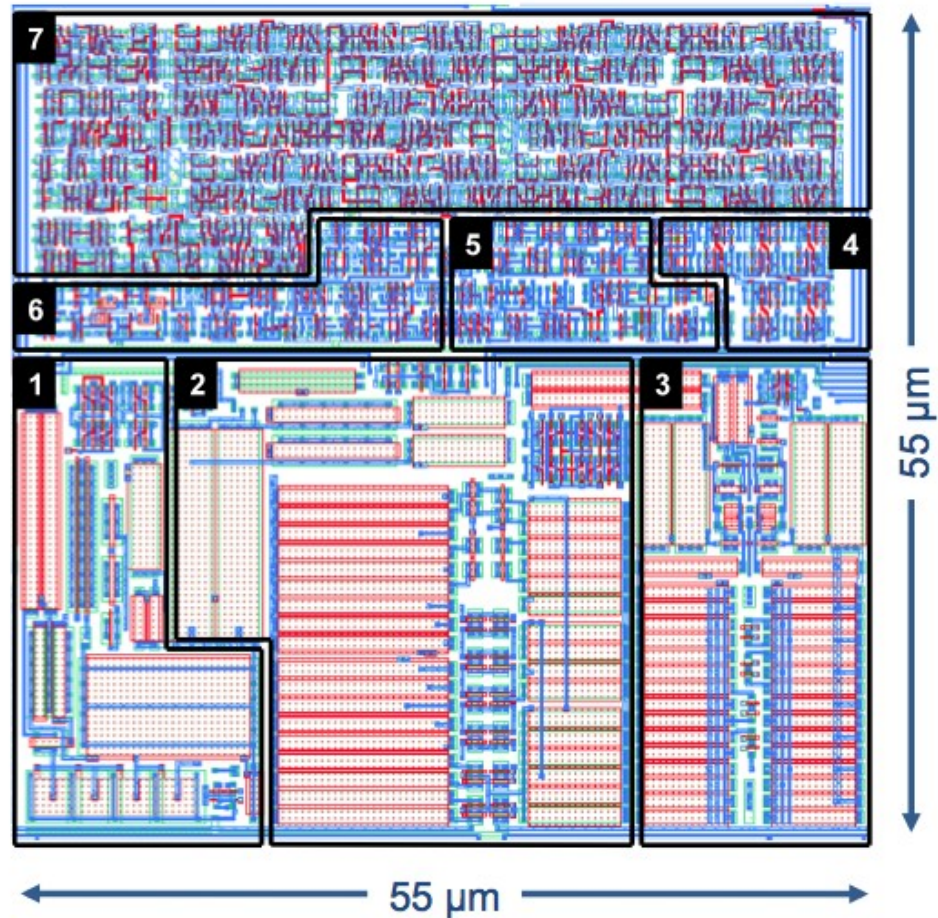
- Well known III/V semiconductor. Mass production exists since a long ago.
- $Z=31$
- Radiation hard
- Tomsk modification $GaAs:Cr$ is suitable for imaging detectors
- Pixel sensor technology is developed in Tomsk University by JINR's request



Medipix readout chip

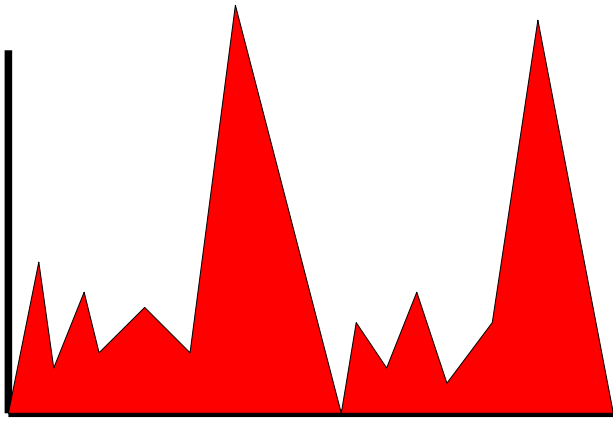
- Fully exploit the available 130 nm CMOS technology
- ~1600 transistors per pixel

1. Preamplifier
2. Shaper
3. Two discriminators with 5-bit threshold adjustment
4. Pixel memory (13-bits)
5. Arbitration logic for charge allocation
6. Control logic
7. Configurable counter



Single photon counting

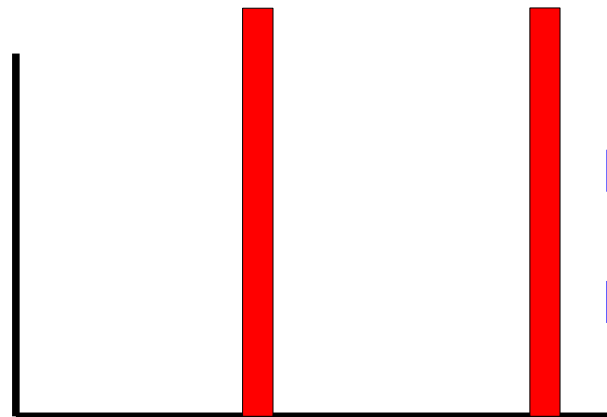
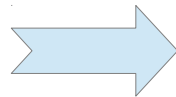
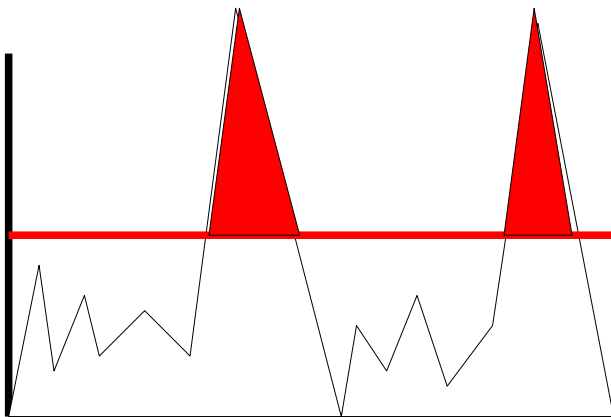
- Integration (like CCD)



Analog signal

Noise is integrated and inherent in signal

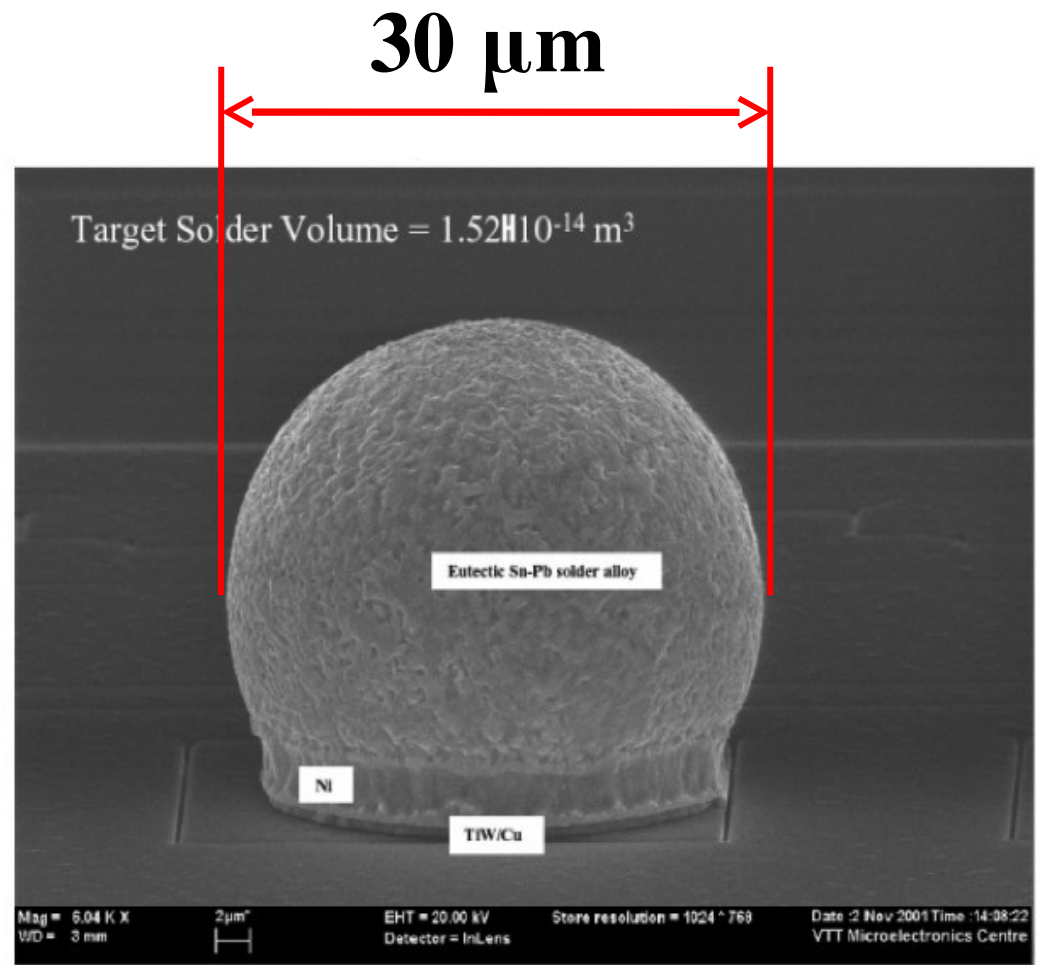
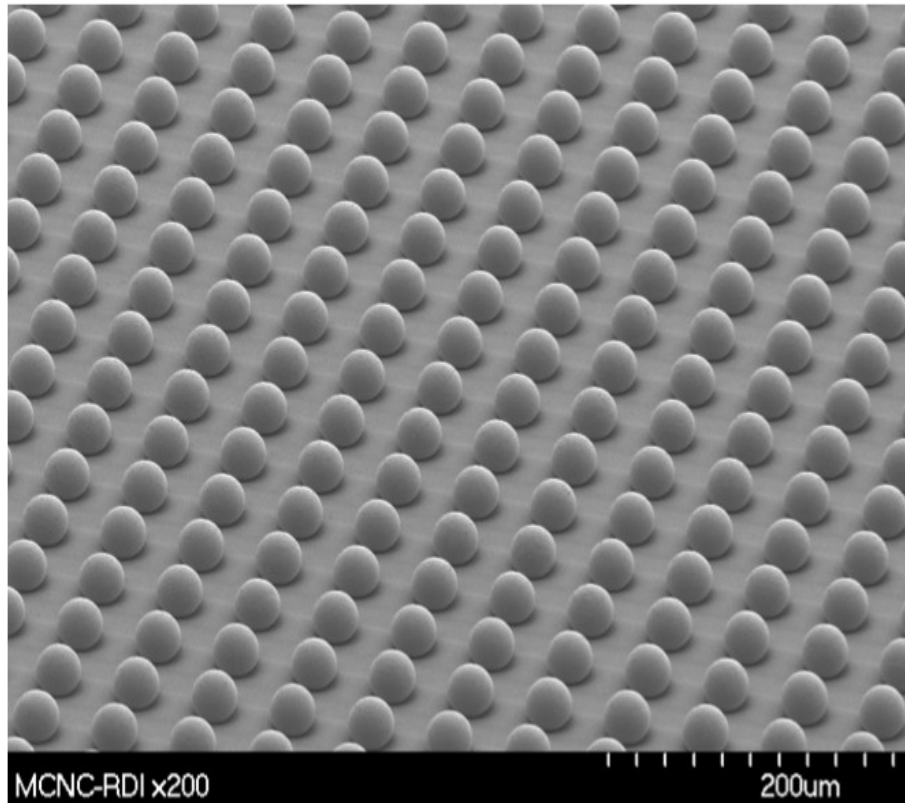
- Single photon counting



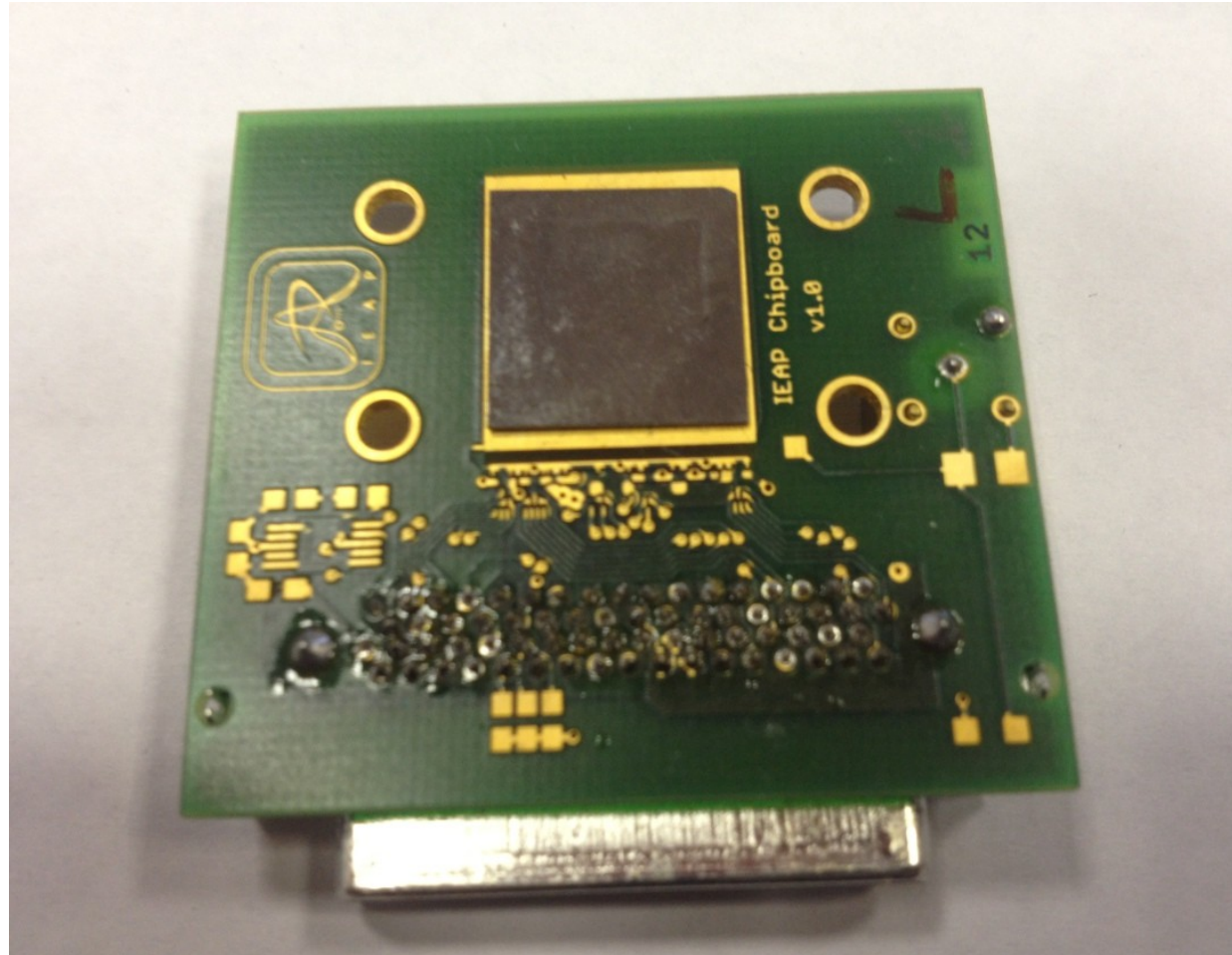
Digital signal

Noise is removed

Flip chip bonding



Detector prototype



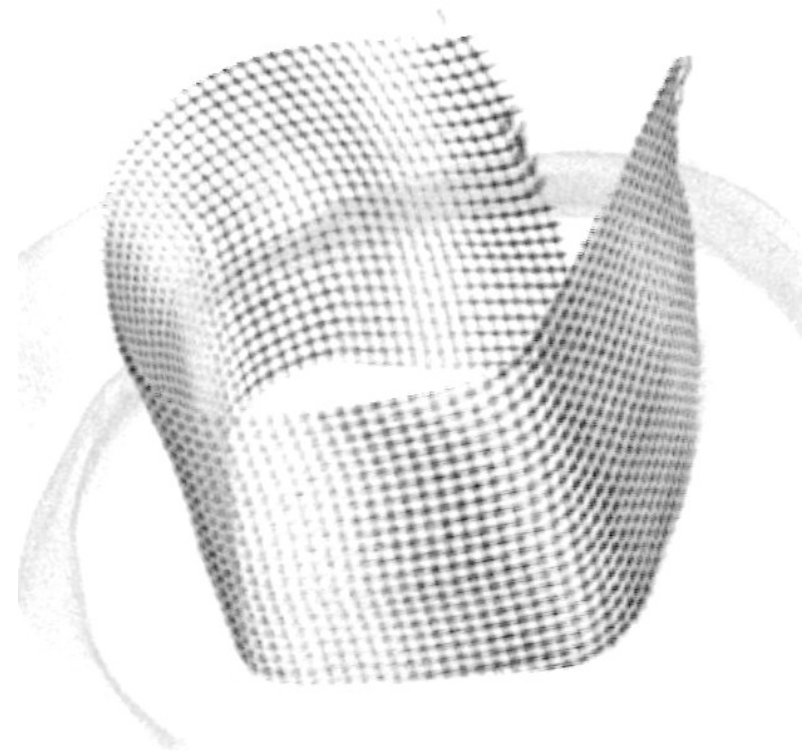
Spatial resolution

Fine mesh

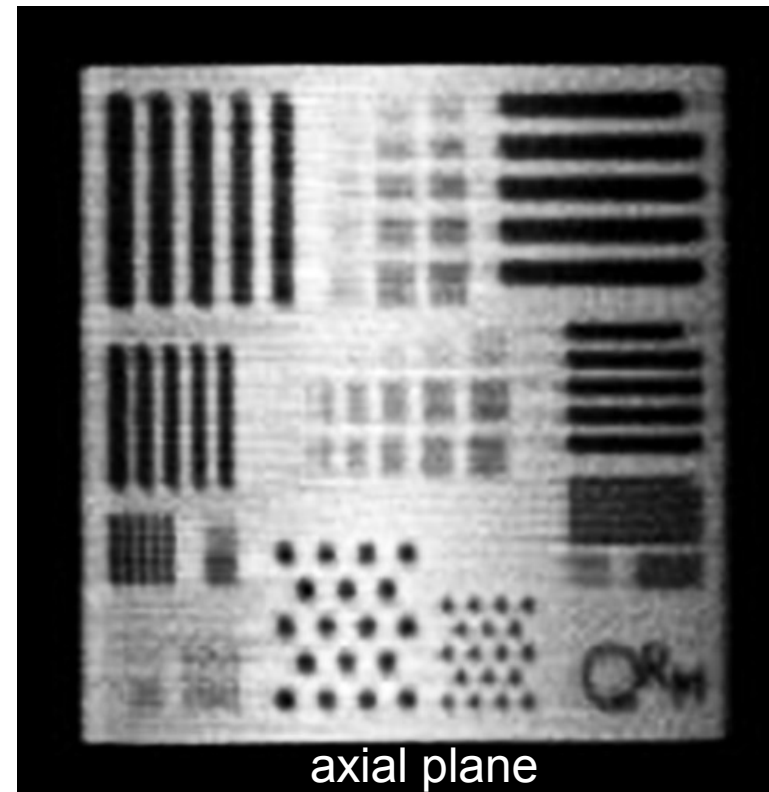
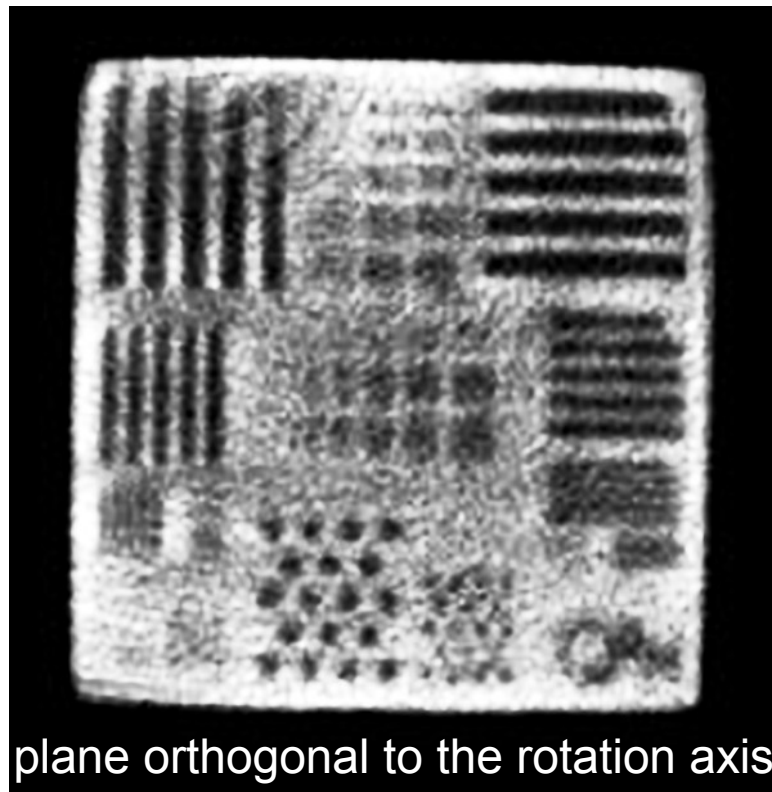
Wire 25 μm Hole size 67 μm



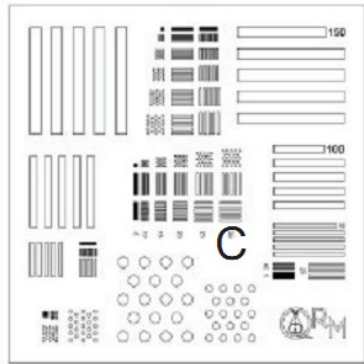
Wire 50 μm Hole size 265 μm



Spatial resolution



B



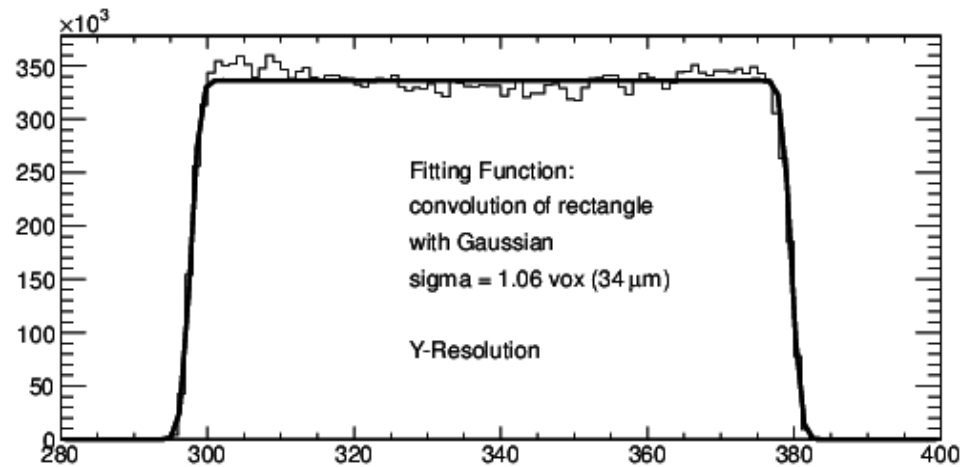
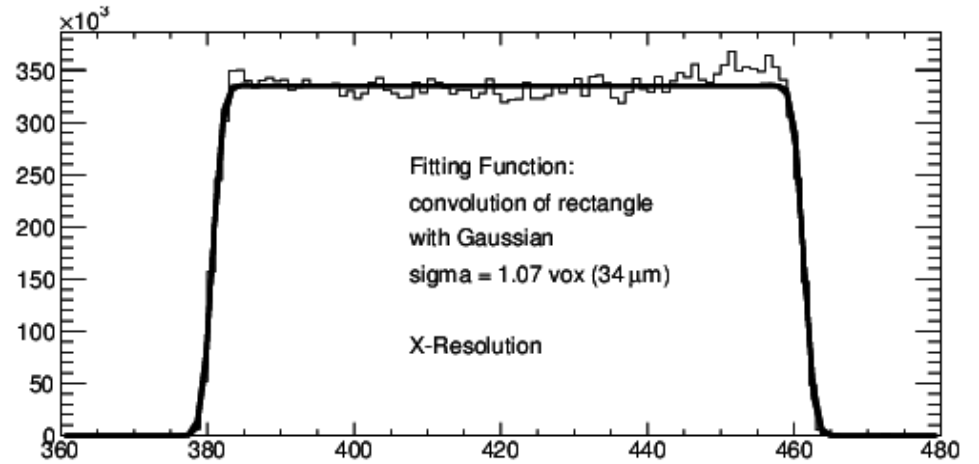
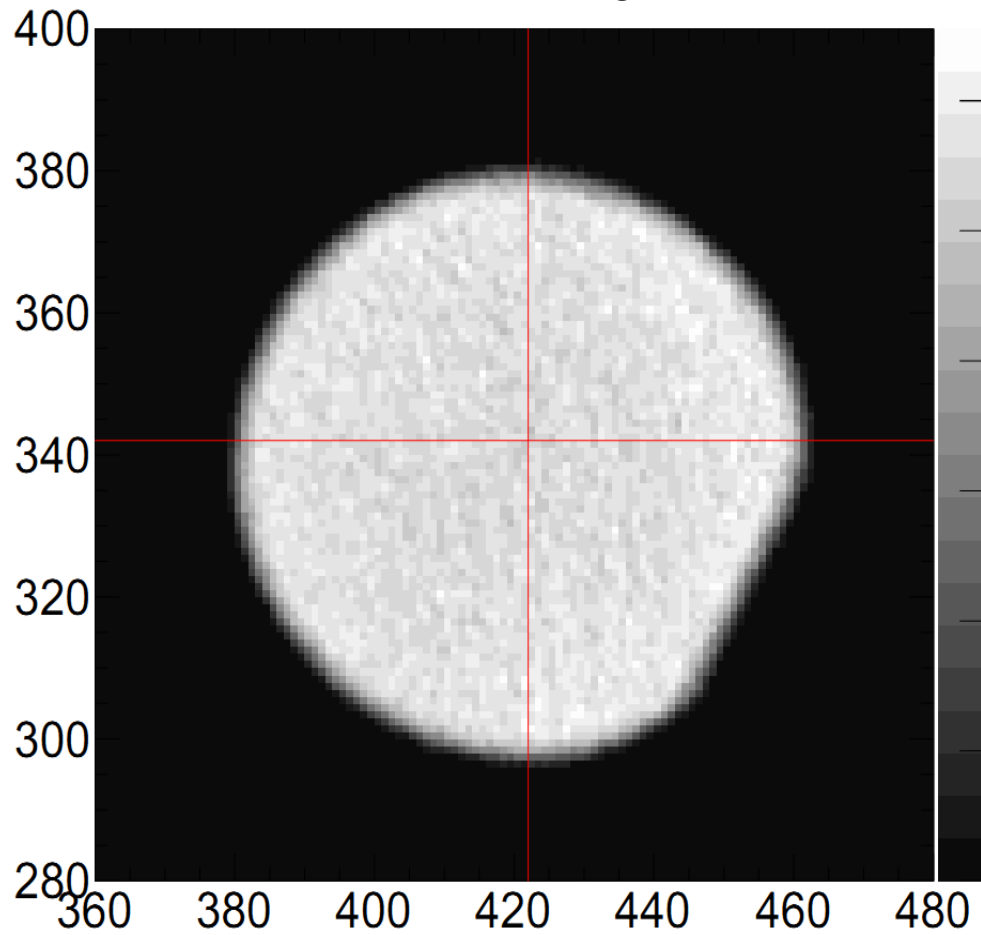
E

Block	linewidth (μm)	linepairs per pattern	points (μm)	points per pattern
A	5, 10, 25, 50, 100, 150	5		
B	5, 10, 15, 20, 25, 30	5	5, 10, 15, 20, 25, 30	18
C	5, 10, 15, 20, 25, 30	5	5, 10, 15, 20, 25, 30	18
D			5, 10, 25, 50, 100, 150	18
E	5, 10, 25, 50, 100, 150	5		

D

Spatial resolution

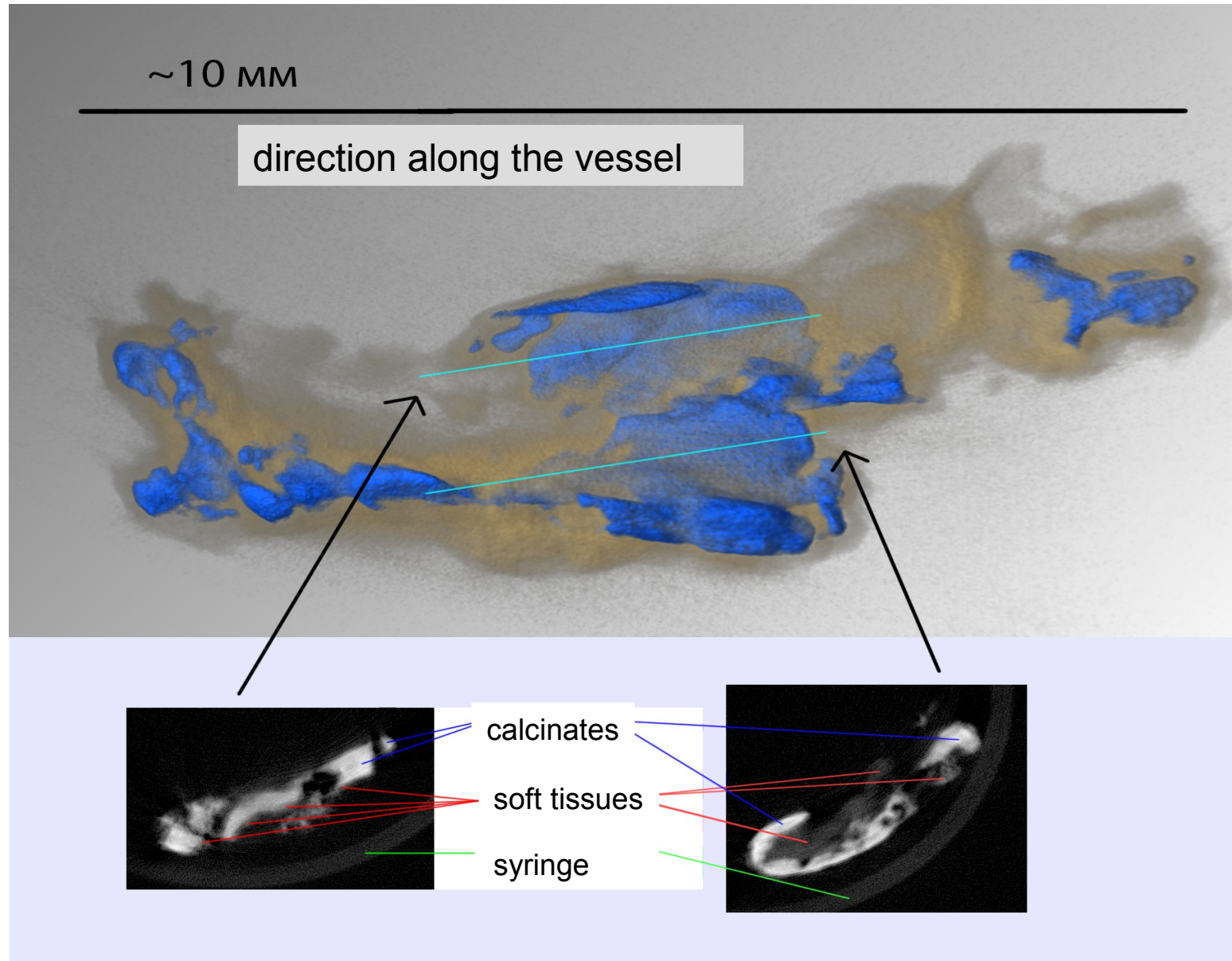
2.7 mm Al wire



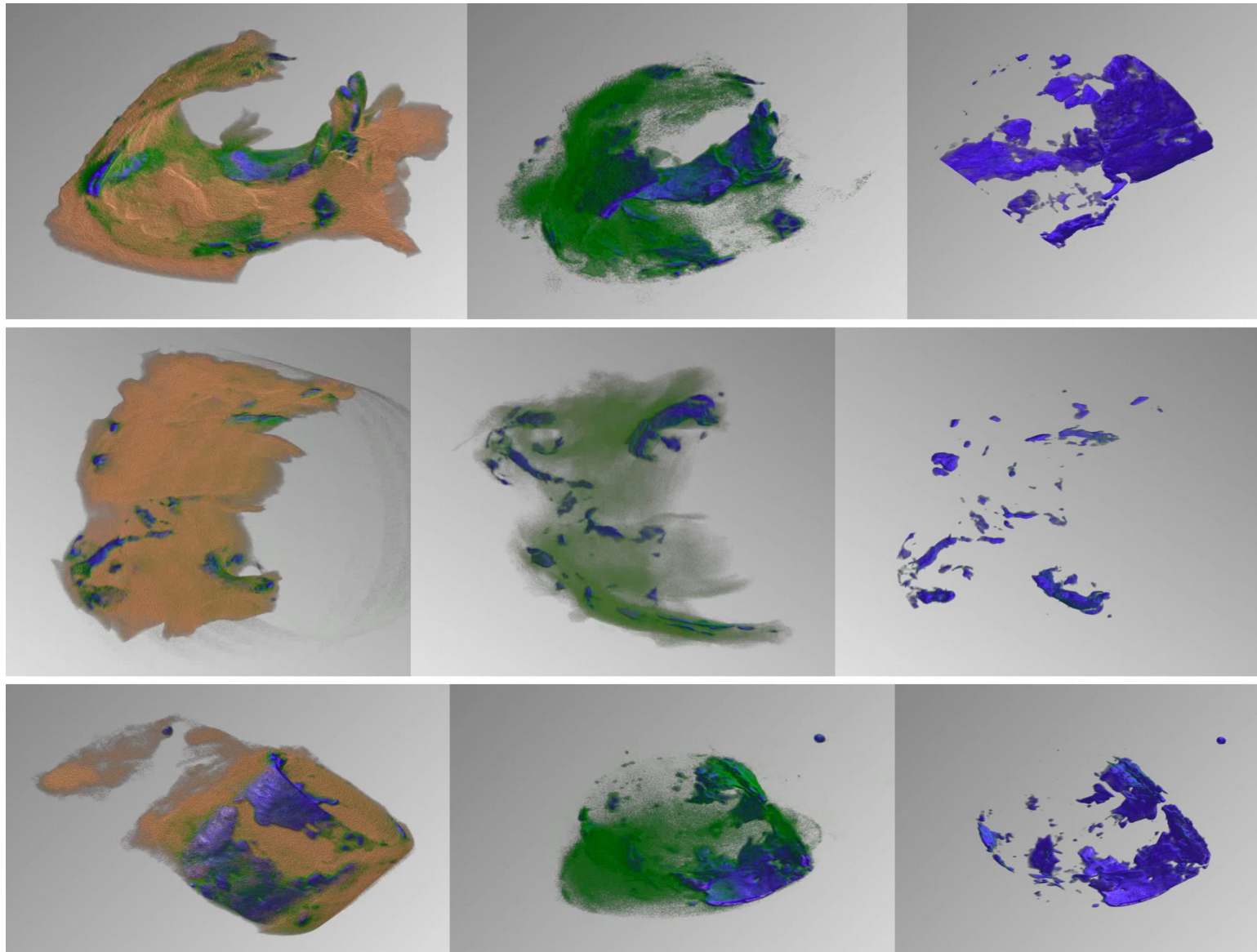
Biomedical research

in cooperation with SPbSU, Mechnicov University,
Clinical hospital №122, MSU, University of Otago

Atherosclerotic plaque

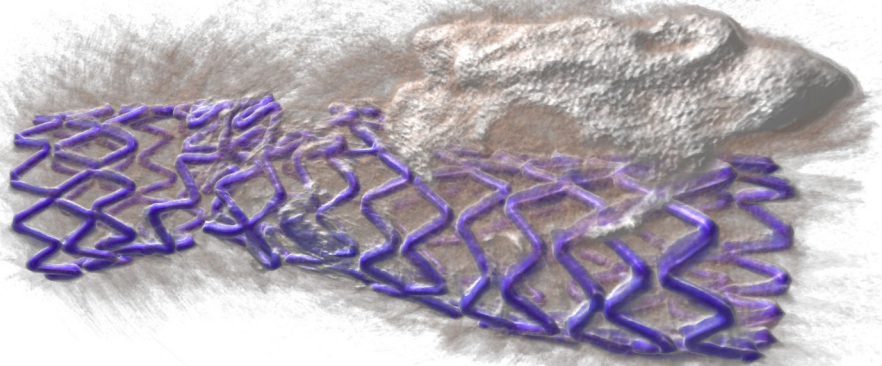


Sample of an abdominal aorta

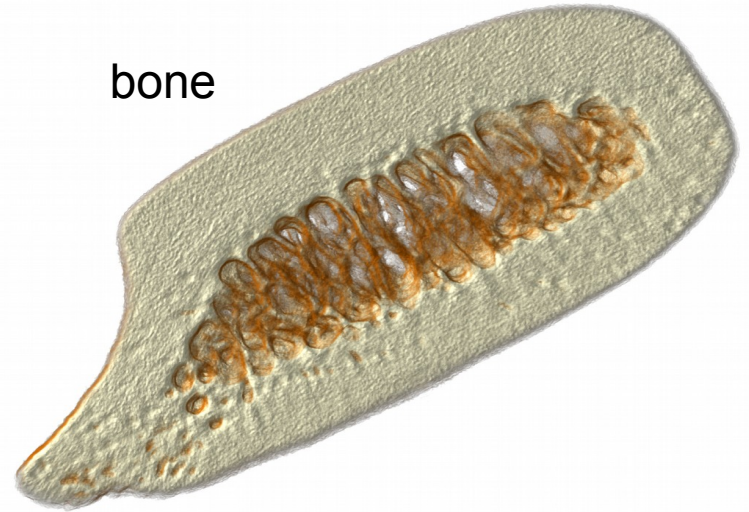


More samples

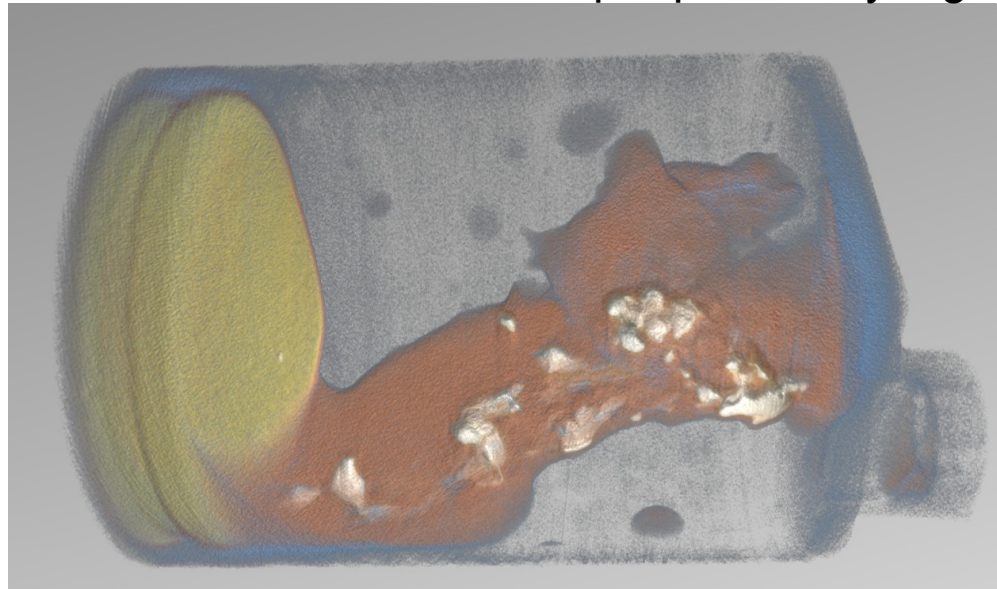
stent in a vessel



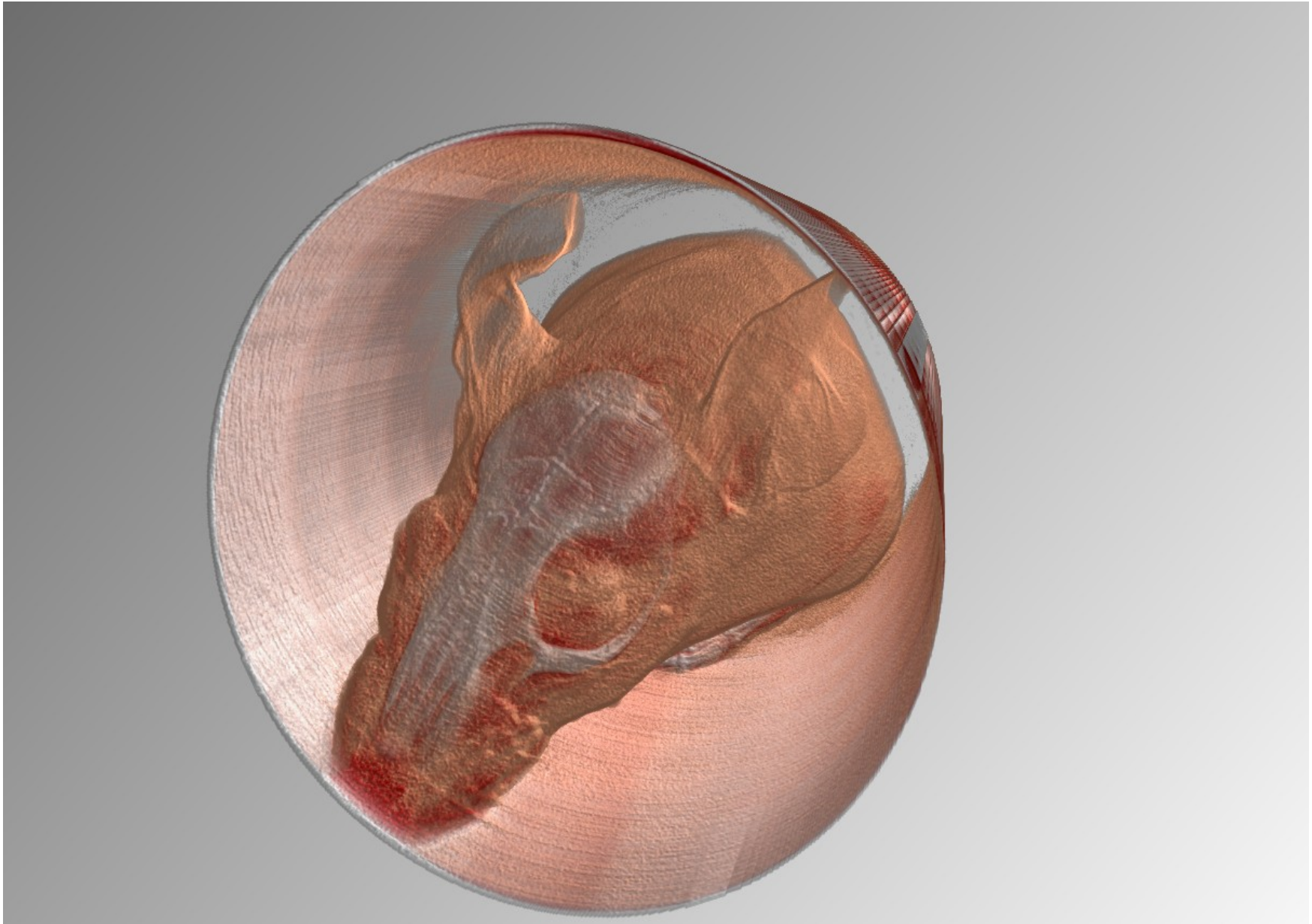
bone



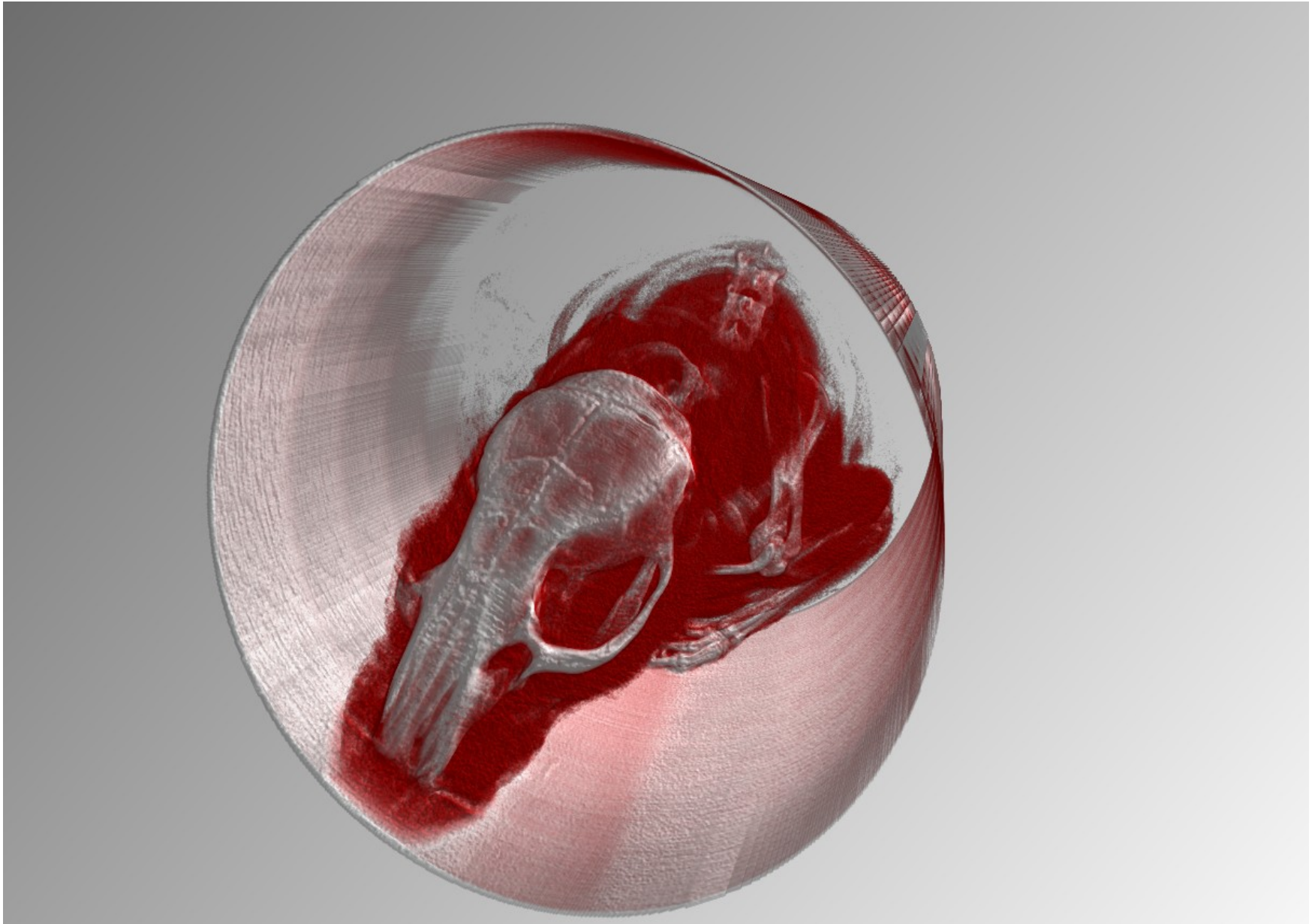
carotid plaque in a syringe



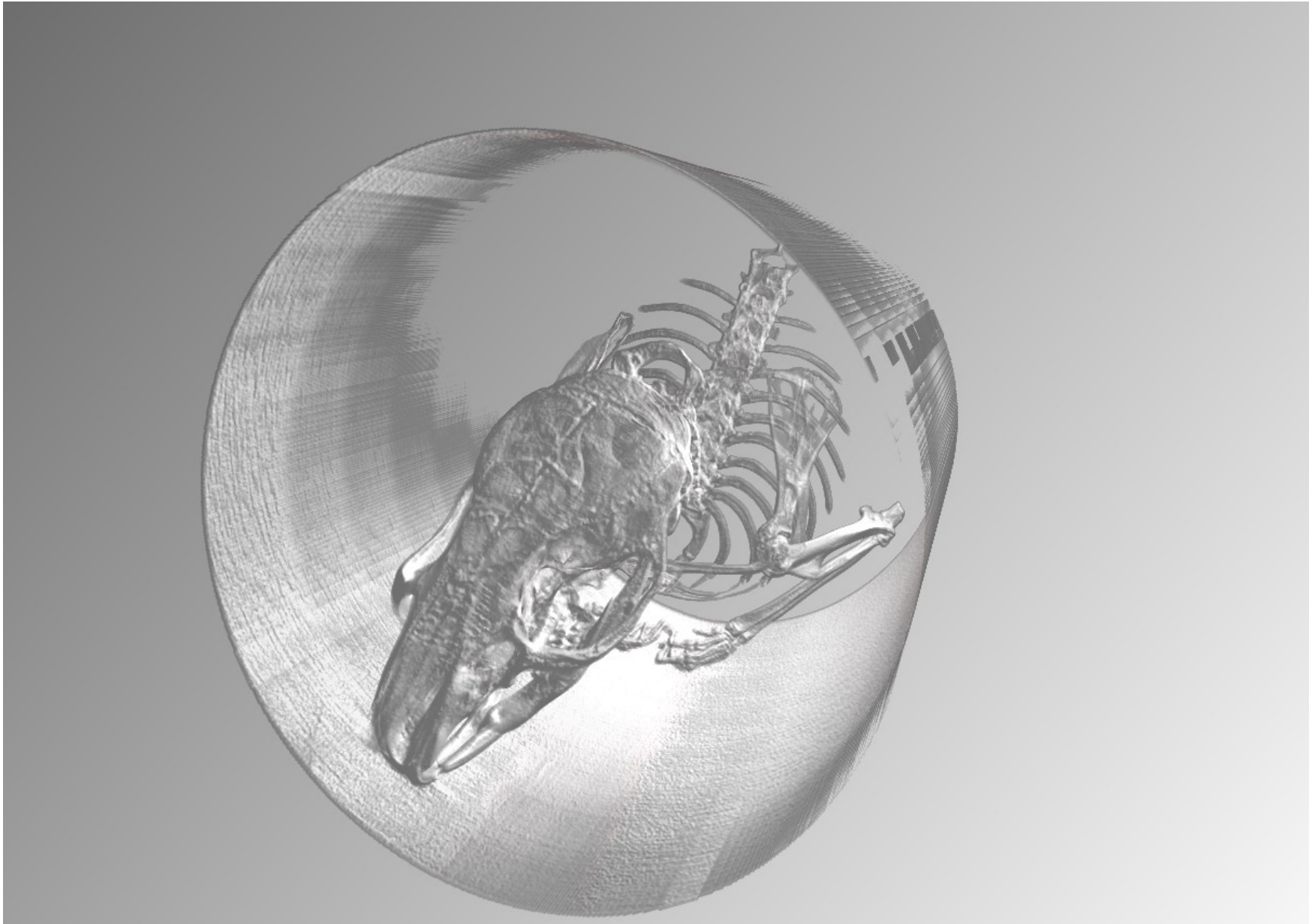
Mouse



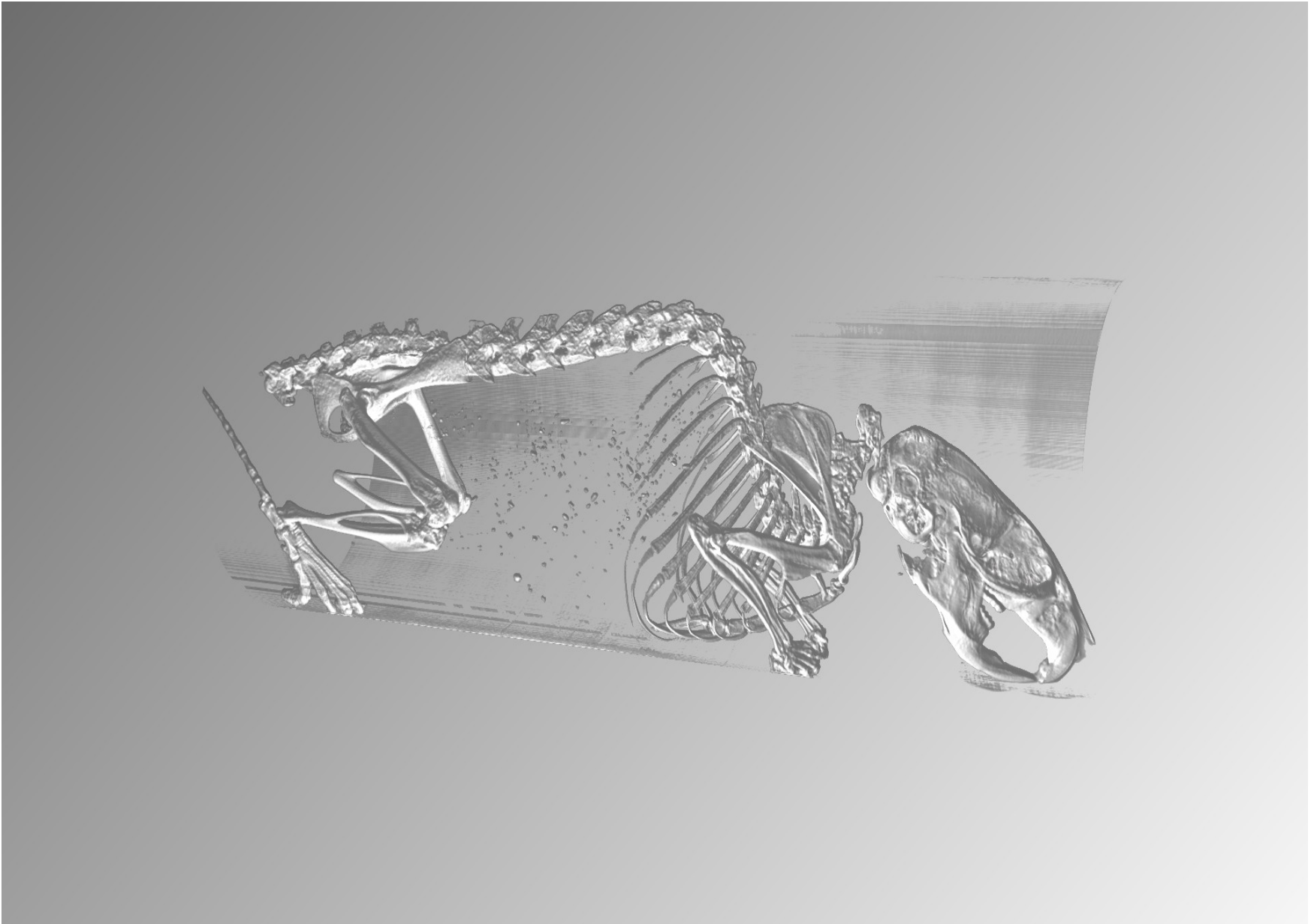
Mouse



Mouse



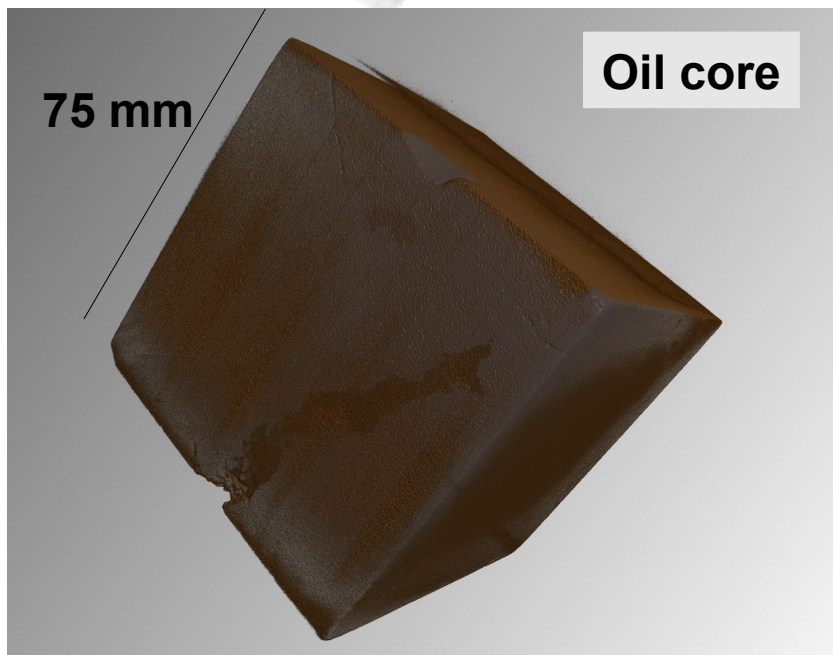
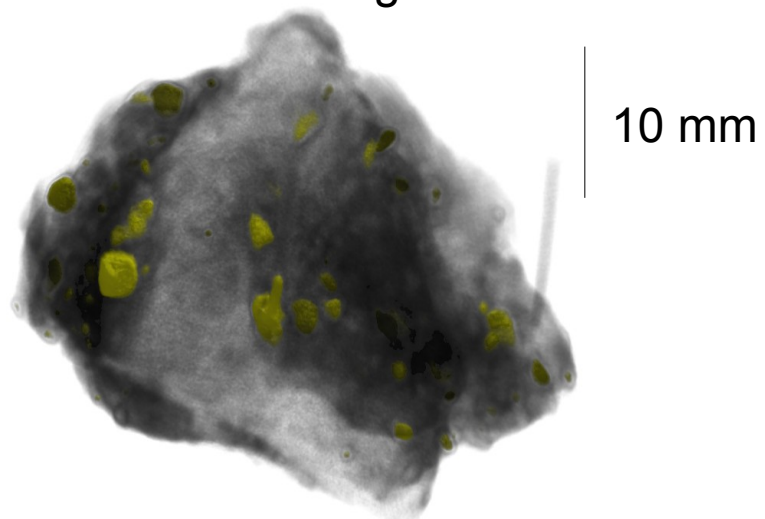
Mouse



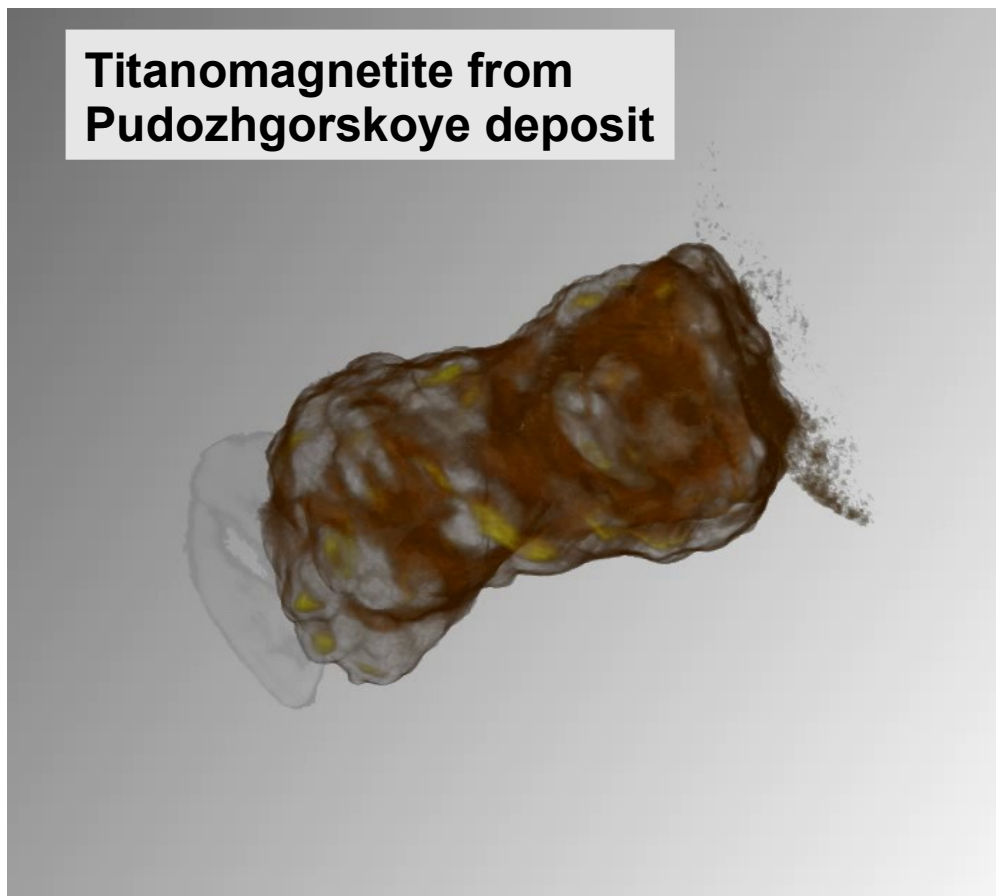
Geophysics research

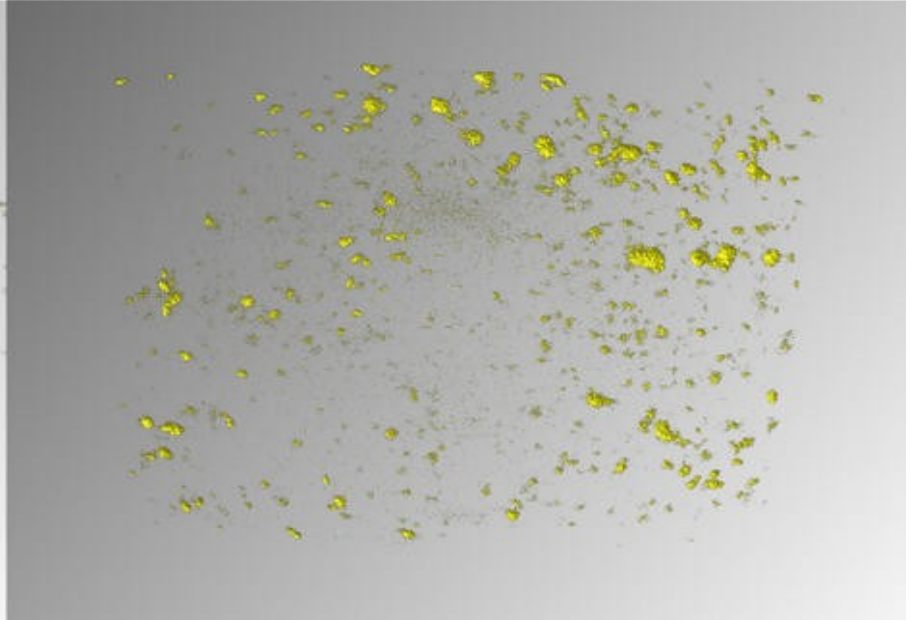
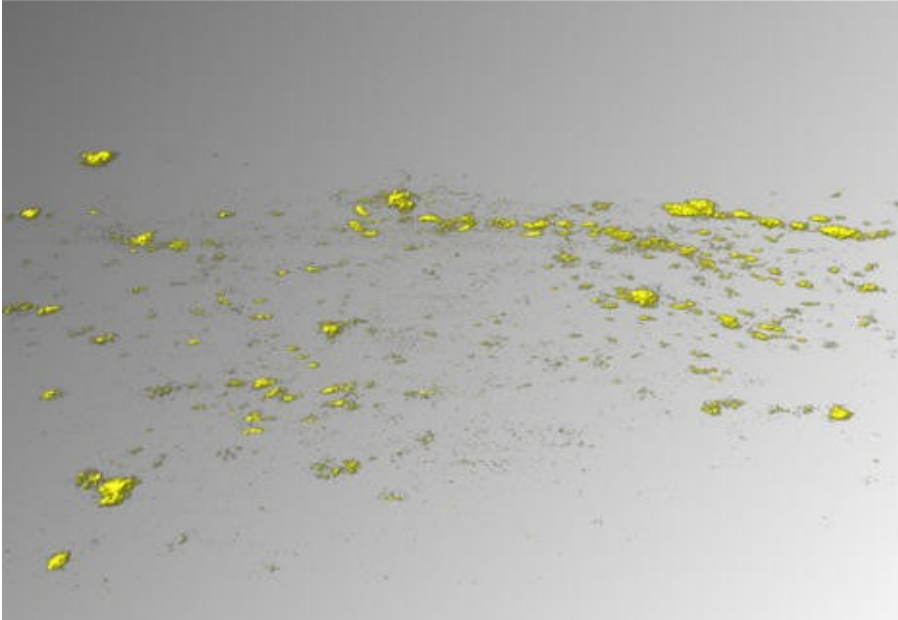
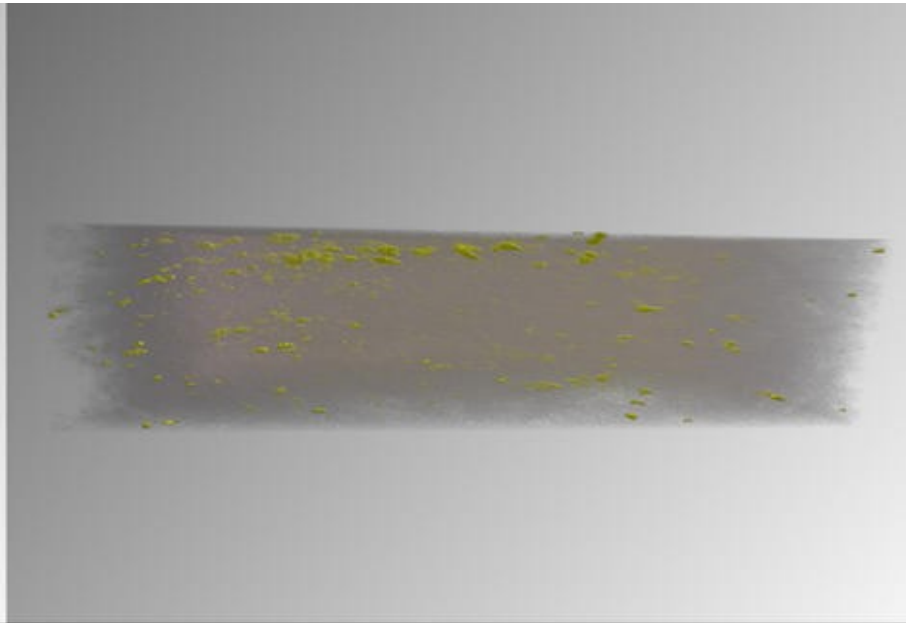
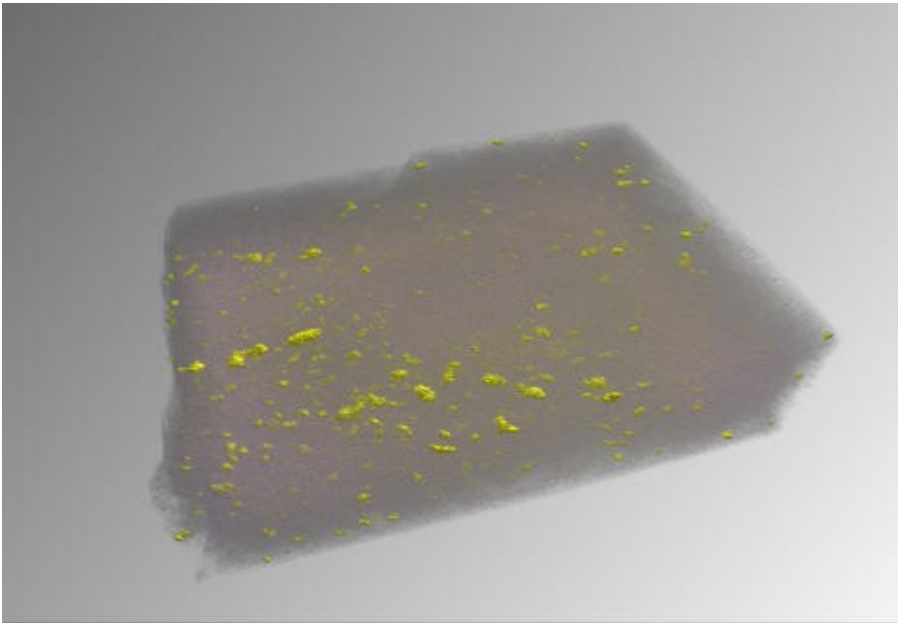
in cooperation with Dubna University, VIMS

Chromites in manganese ore



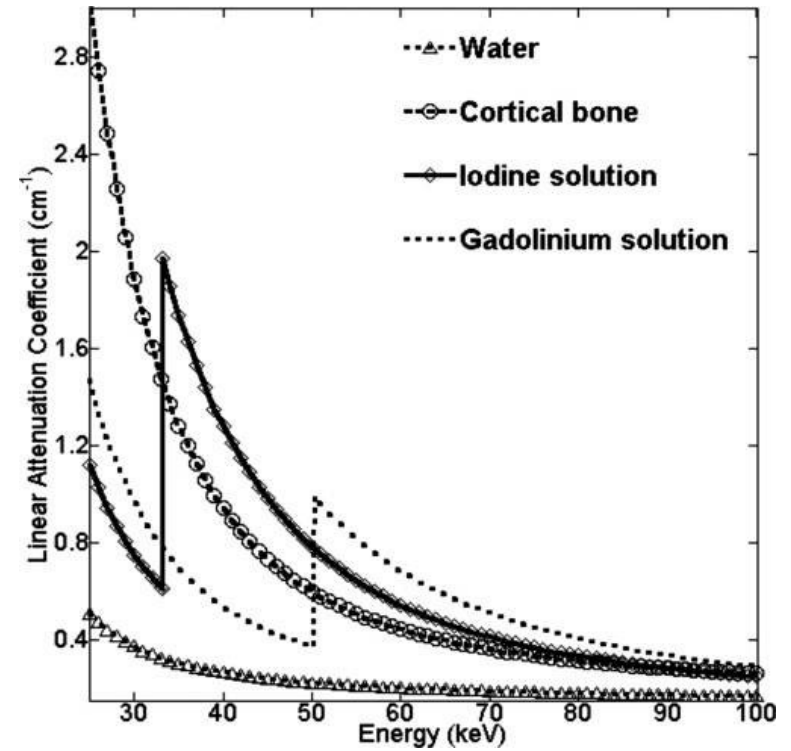
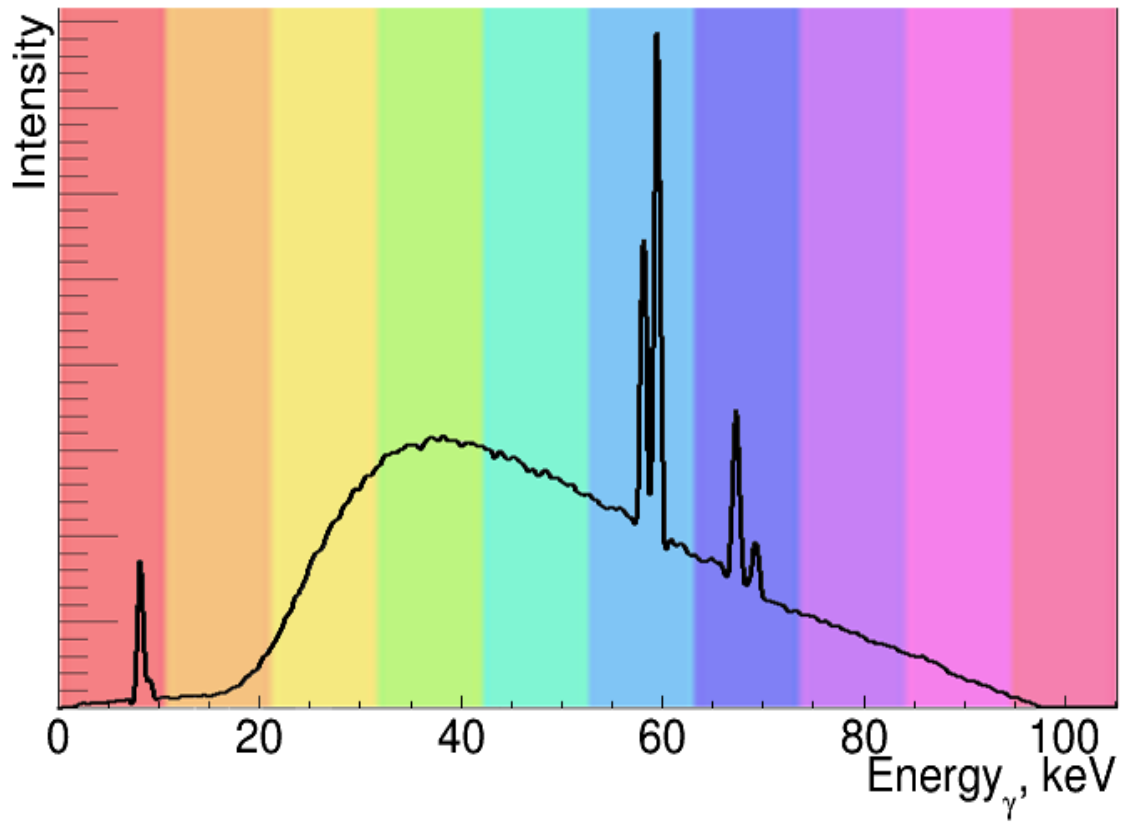
Titanomagnetite from Pudozhgorskoye deposit



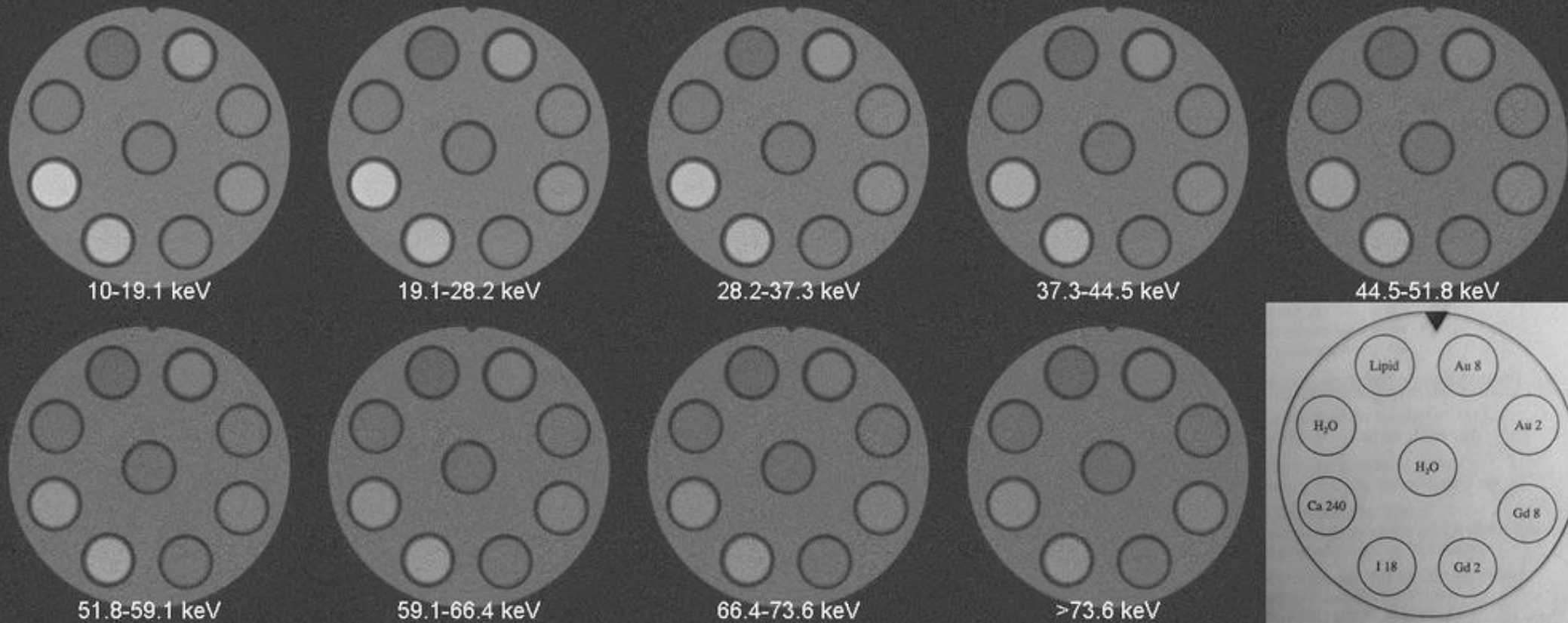


Spectral CT

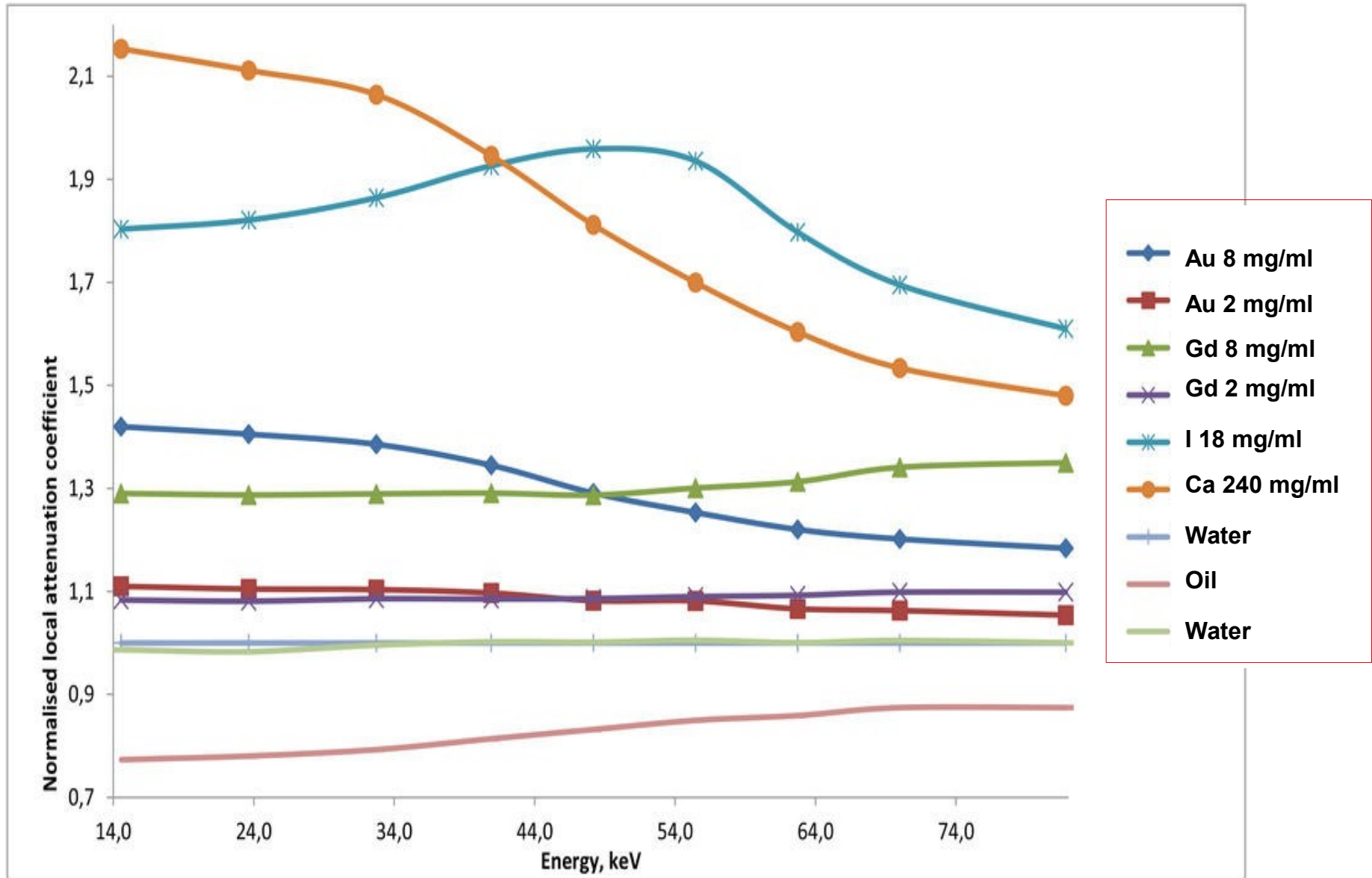
The idea



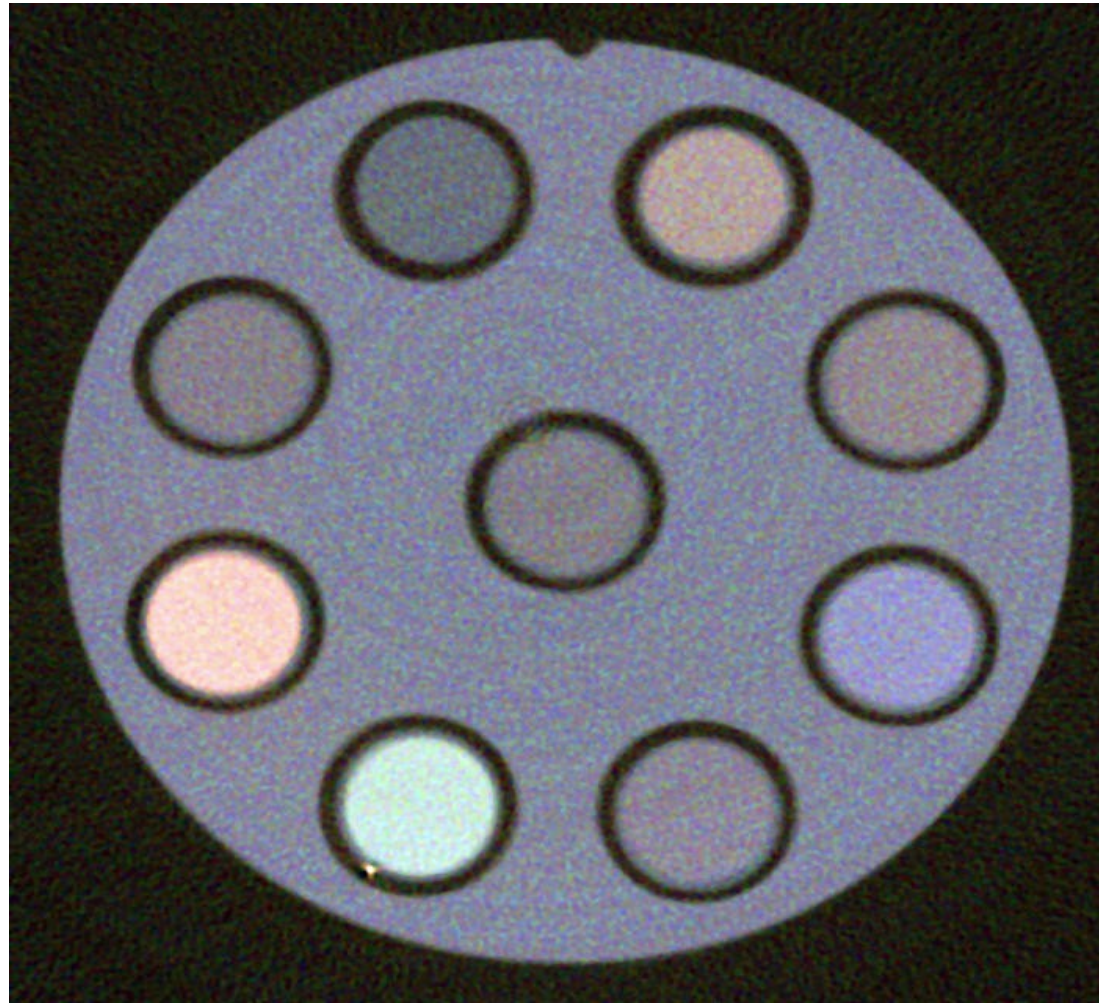
Tests with a standard phantom



Attenuation vs. X-ray Energy (measured)



Colour X-ray CT



Summary

- A microCT scanner MARS is working well in Dubna
- Scans of real samples are under way for medical research and Russian oil&gas industry.
- Spectral CT images have been obtained for the first time using GaAs:Cr detector
- We are going to move from the tests using phantom to the real applications of spectral CT soon!