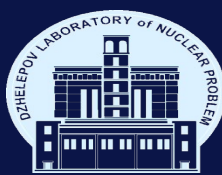
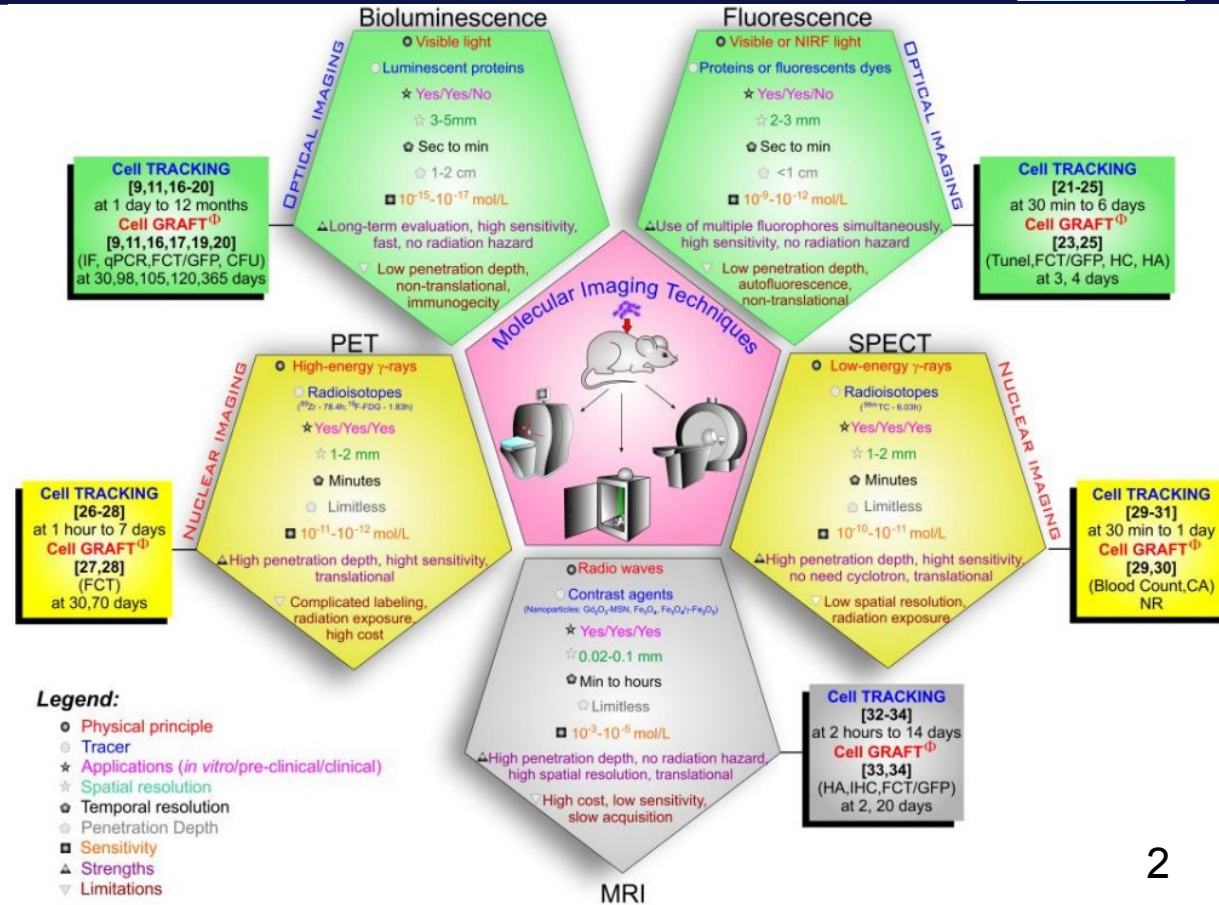


Multimodal microSPECT/CT tomograph for preclinical studies

V.A. Rozhkov

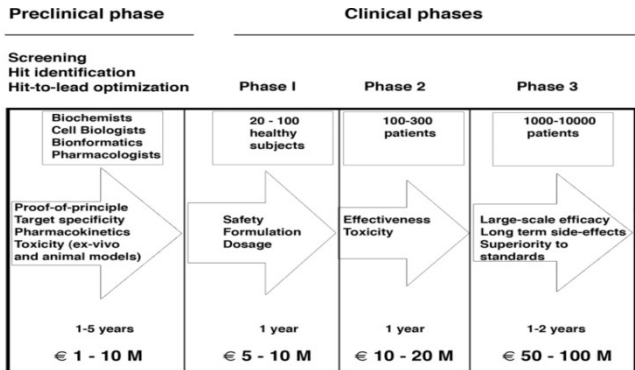
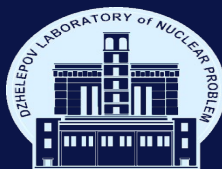


Molecular Imaging

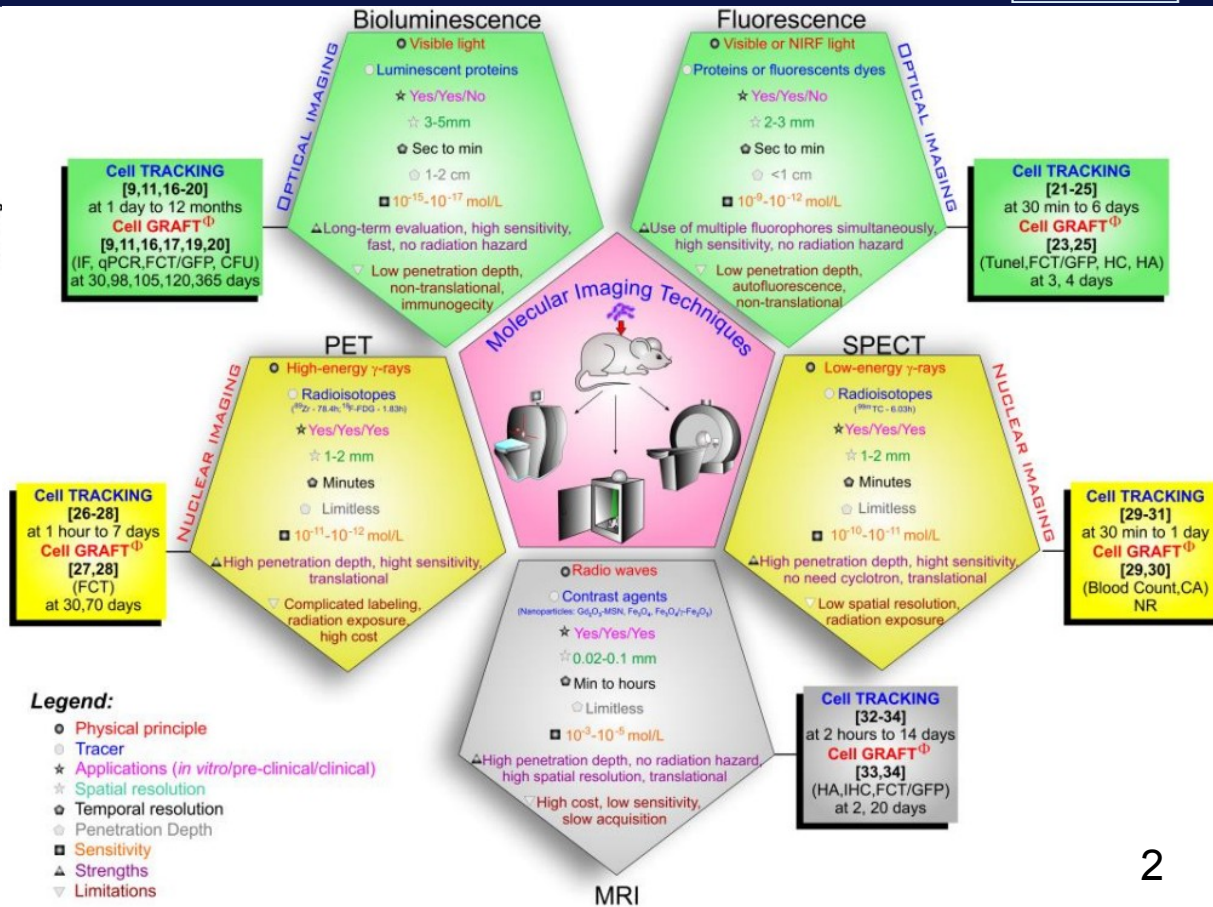




Molecular Imaging



New Drug



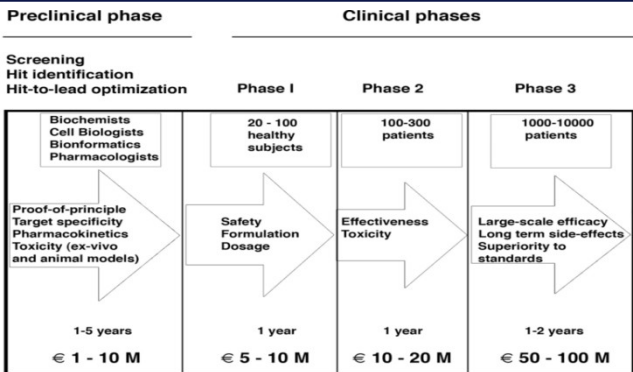
Legend:

- ⊙ Physical principle
- ⊙ Tracer
- ★ Applications (in vitro/pre-clinical/clinical)
- ☆ Spatial resolution
- ⌚ Temporal resolution
- ⊙ Penetration Depth
- Sensitivity
- △ Strengths
- ▽ Limitations

doi: 10.2174/138920101405131111105023
 doi: 10.3390/cells9040939
 doi: 10.1016/S0167-6296(02)00126-1



Molecular Imaging

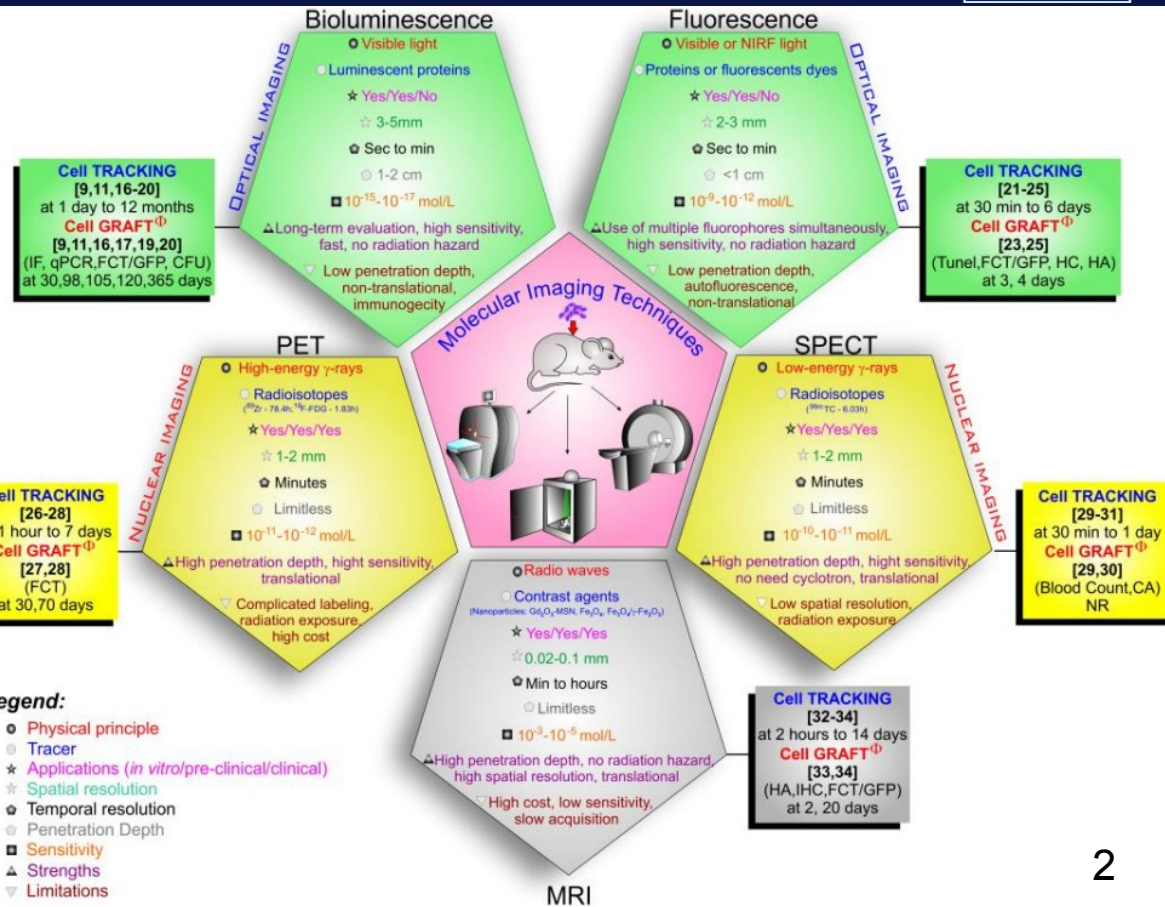


New Drug



SPECT system:

- High resolution
- High SNR
- High contrast
- High sensitivity



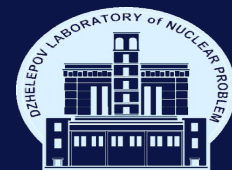
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doi: 10.3390/cells9040939

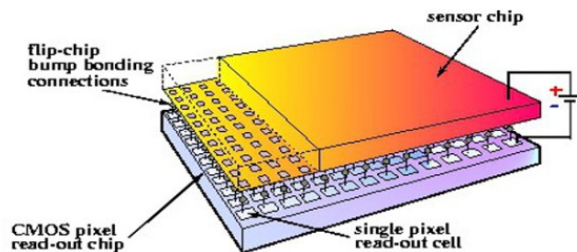
doi: 10.1016/S0167-6296(02)00126-1



Timepix detector



Sensor material	CdTe
Sensor size	14.1x14.1 mm
Sensor thickness	2 mm
Matrix size	256x256
Pixel size	55x55 μm
Energy resolution 140 KeV	10%
Efficiency 140 KeV	60%



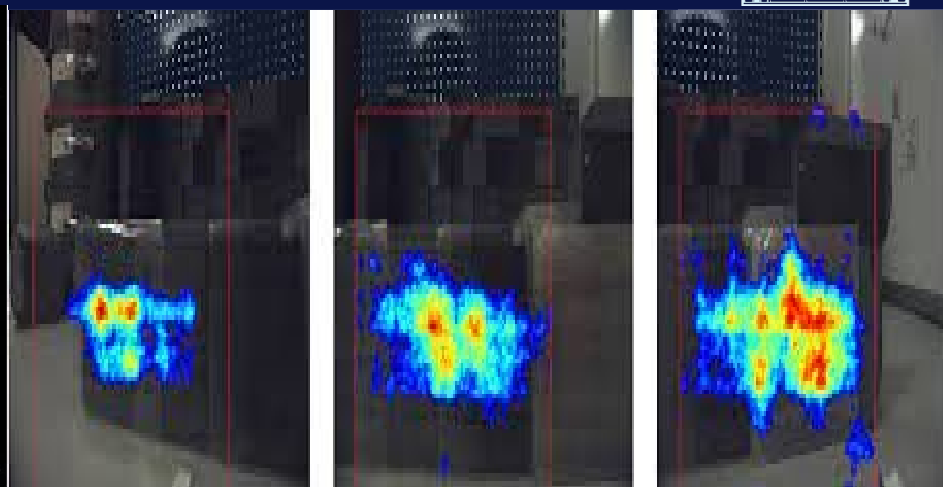
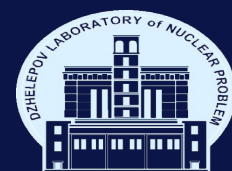
1. Medipix – counting mode

2. Time-over-Threshold (TOT) each pixel records the energy deposit of particles interaction with corresponding sensor segment

3. Time-of-arrival (TOA) - each pixel records the arrival time of particles interaction with corresponding sensor segment



Coded aperture





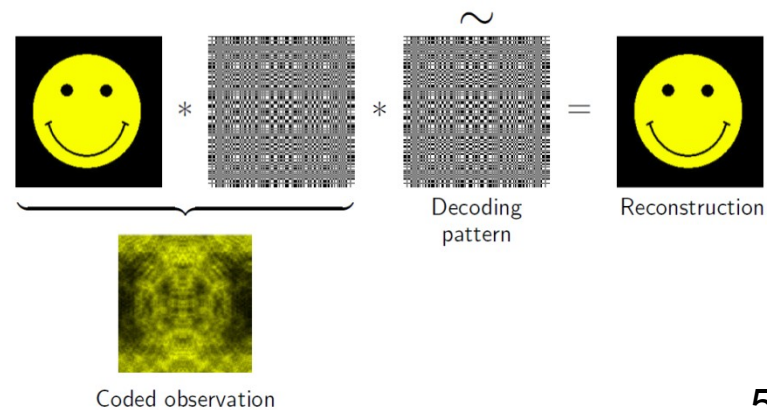
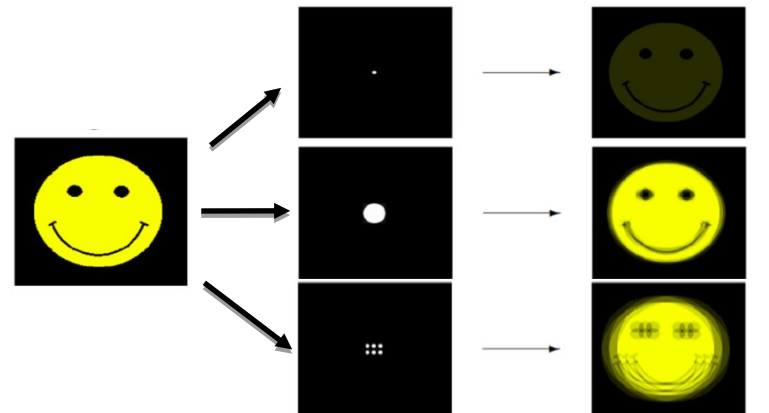
Setup



Thickness	0.5 mm
Material	Tungsten
Mask type	MURA
Mask rank	31
Hole radius	160-180 μm
Work area	22.01 x 22.01 mm

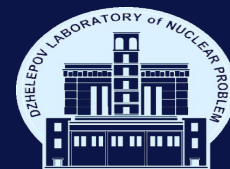


doi: 10.1364/AO.28.004344





Setup



Thickness	0.5 mm
Material	Tungsten
Mask type	MURA
Mask rank	31
Hole radius	160-180 μm
Work area	22.01 x 22.01 mm

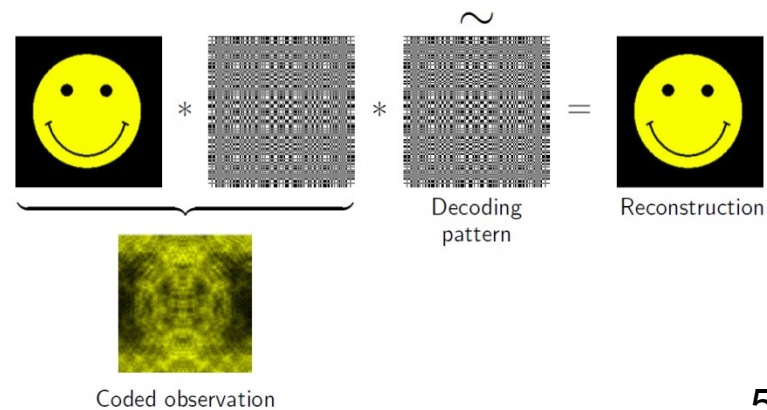
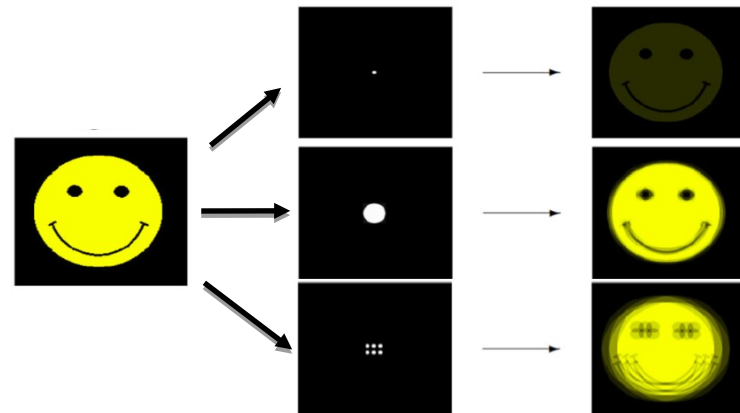


doi: 10.1364/AO.28.004344

Sensor material	CdTe
Sensor size	14.1x14.1 mm
Sensor thickness	2 mm
Matrix size	256x256
Pixel size	55x55 μm
Energy resolution 140 KeV	22%
Registration efficiency 140 KeV	60%



doi: 10.1016/j.nima.2007.08.079





Setup



Thickness	0.5 mm
Material	Tungsten
Mask type	MURA
Mask rank	31
Hole radius	160-180 μm
Work area	22.01 x 22.01 mm

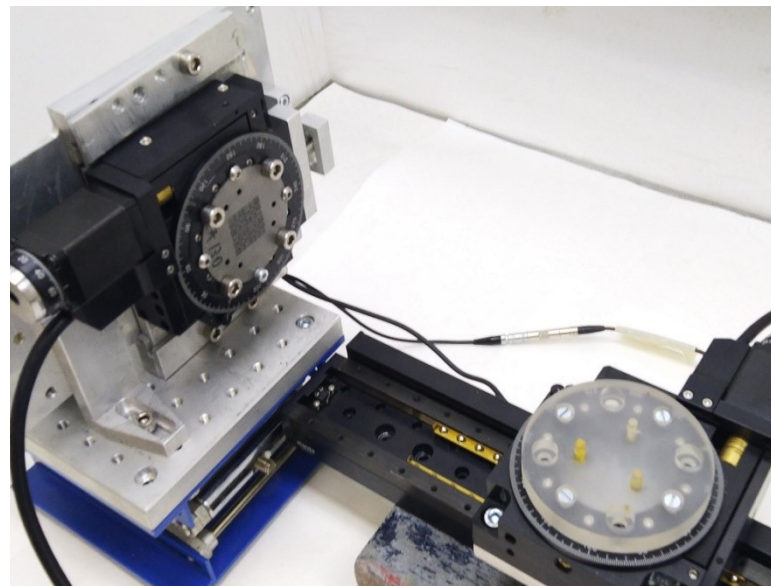


doi: 10.1364/AO.28.004344

Sensor material	CdTe
Sensor size	14.1x14.1 mm
Sensor thickness	2 mm
Matrix size	256x256
Pixel size	55x55 μm
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Registration efficiency 140 KeV	60%



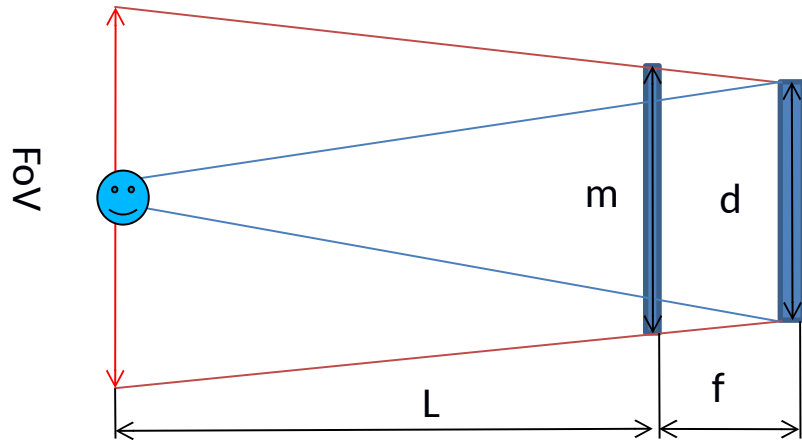
doi: 10.1016/j.nima.2007.08.079



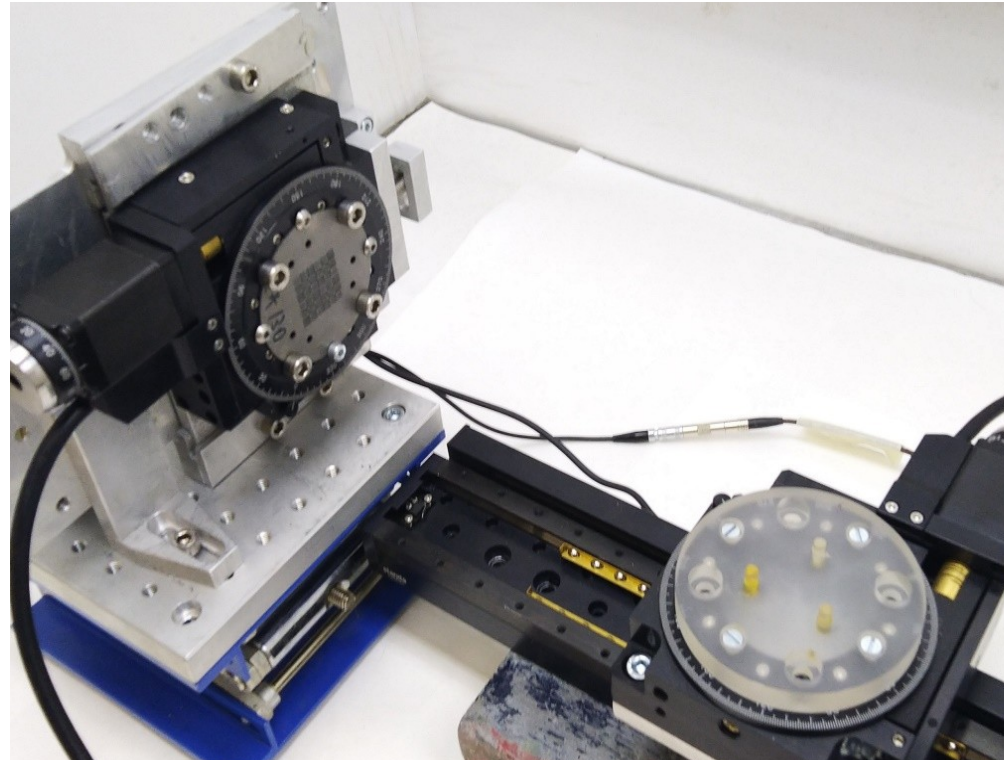
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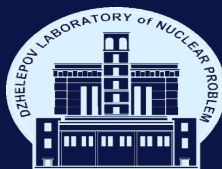


Setup

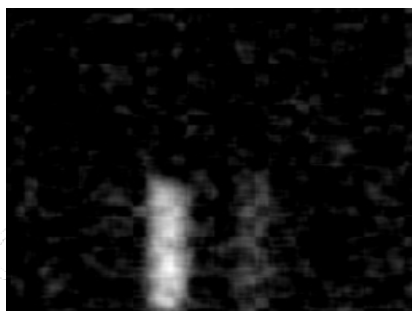
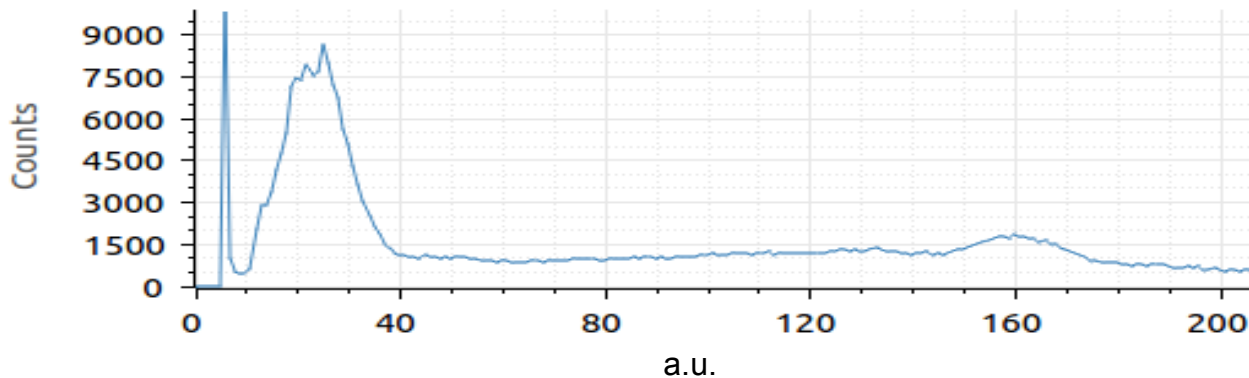
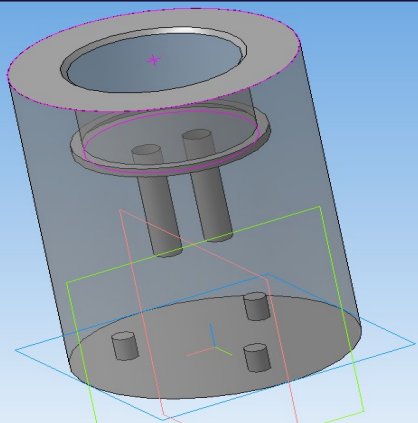


$$FoV = \frac{(m - d)(L - f)}{f}$$

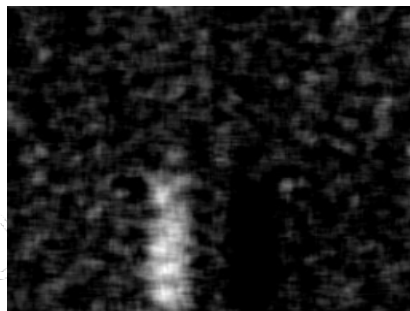




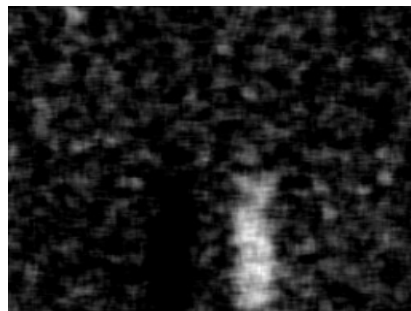
Contrast Phantom



$^{99m}\text{Tc} + ^{125}\text{I}$



^{125}I (84 MBq)

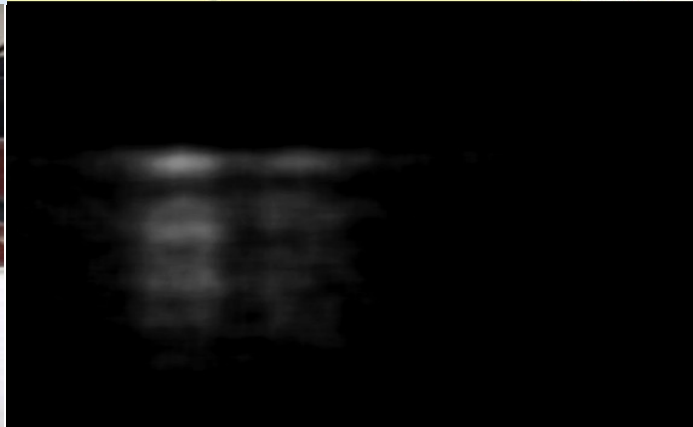
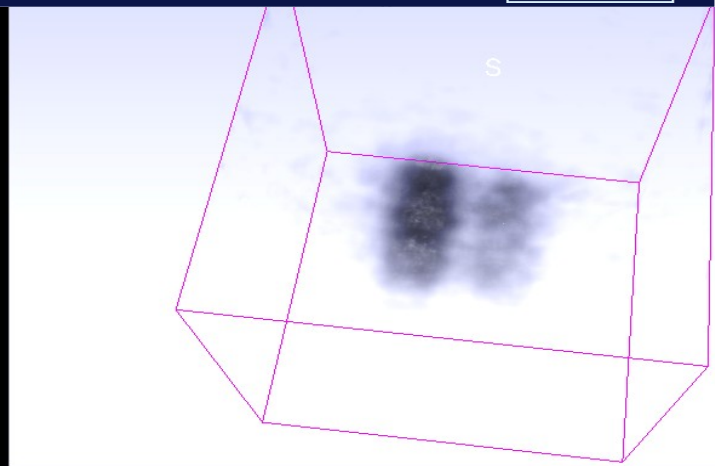
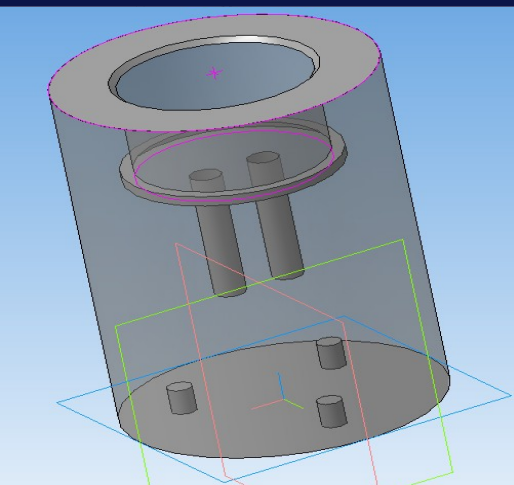


^{99m}Tc (47 MBq)

^{99m}Tc activity — 47 MBq
 ^{125}I — 84.8 MBq
Acquisition time — 5 min

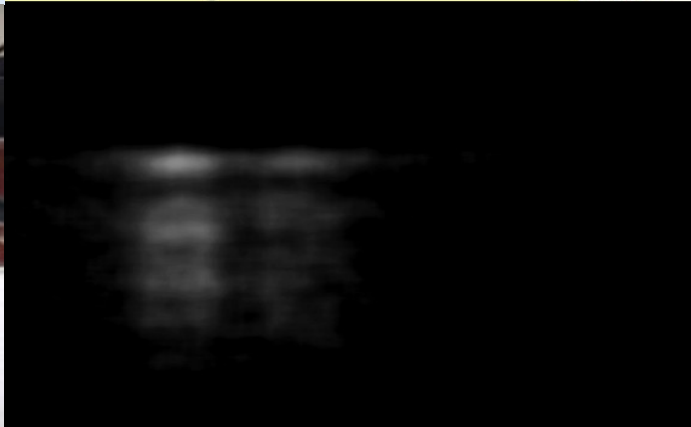
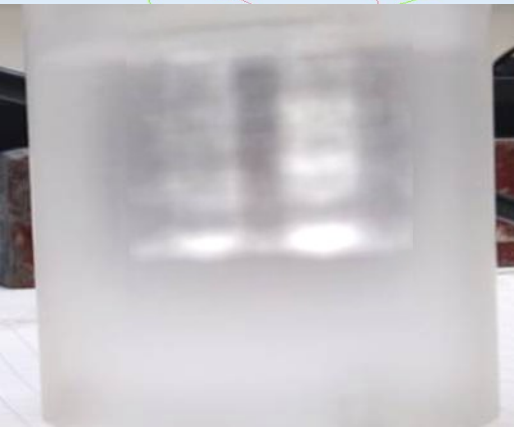
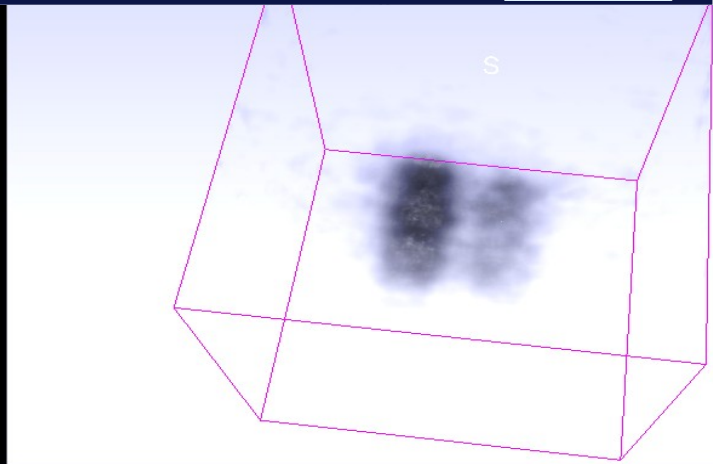
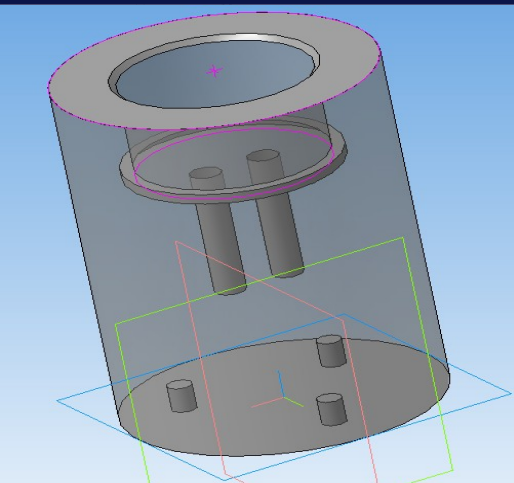


Contrast Phantom



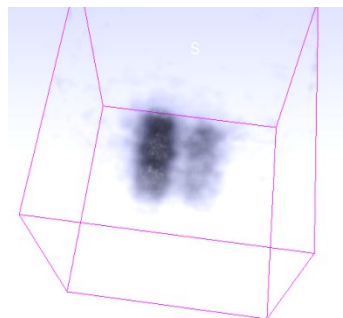
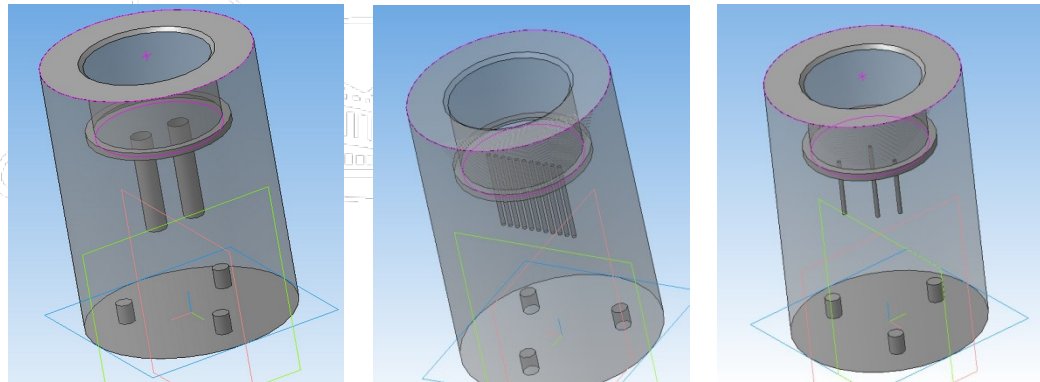
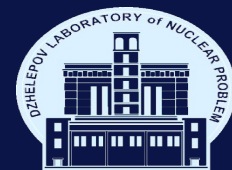


Contrast Phantom





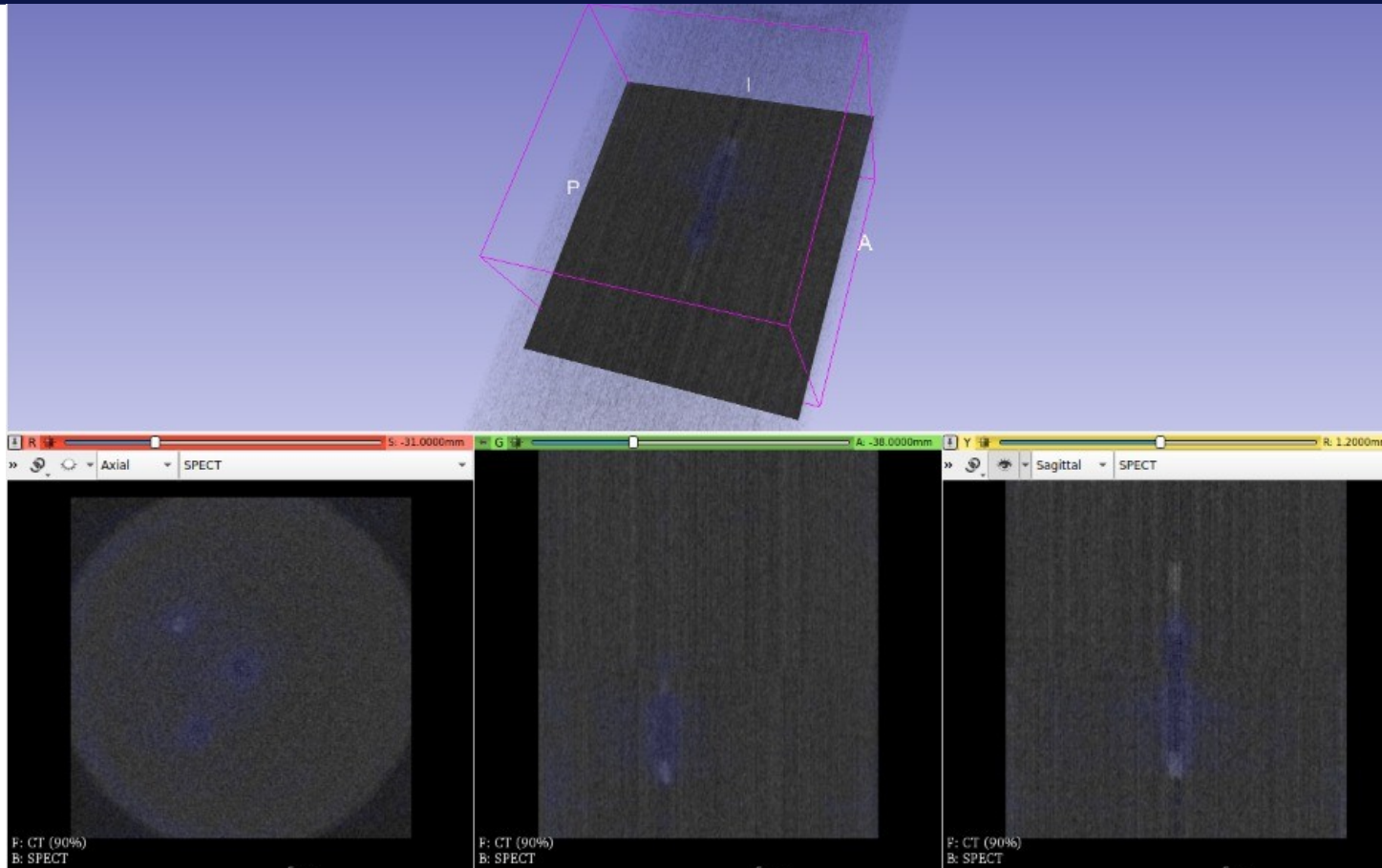
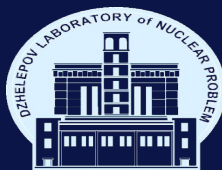
Measurements with Phantom



Parameter	Contribution to the efficiency
Geometric factor	$3,4 \cdot 10^{-4}$
Air attenuation	0,57
System efficiency including:	0,21
Collimator	0,39
Air attenuation	0,88
Detector efficiency	0,6



SPECT/CT





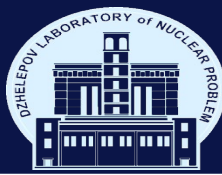
System parameters



Detector	Timepix CdTe 2 mm
Tomography spatial resolution	2.5 mm (FoV 57 mm x 57 mm)
Spatial resolution	0.8 mm (FoV 30 mm x 30 mm)
Energy resolution	22% (140keV)
Sensitivity	35 cps/MBq
Linearity	99,9%
Scanning time	<2 min/projection
Radiopharmacy energy	30 – 300 keV
SNR	>70%



Summary



- A prototype micro SPECT system was developed with a spatial resolution of 0.8 mm for the field of view 30mm x 30mm based on Timepix detector.
- Lot of the micro-SPECT system parameters can be adjusted over a wide range without significant replacement of components.
- The developed system can be used for preclinical studies on laboratory animals.
- The system can be used in conjunction with CT, which will significantly improve the quality and information content of preclinical studies.