



ADVANTAGES AND DISADVANTAGES OF TIMEPIX DETECTOR FOR SPECT/CT



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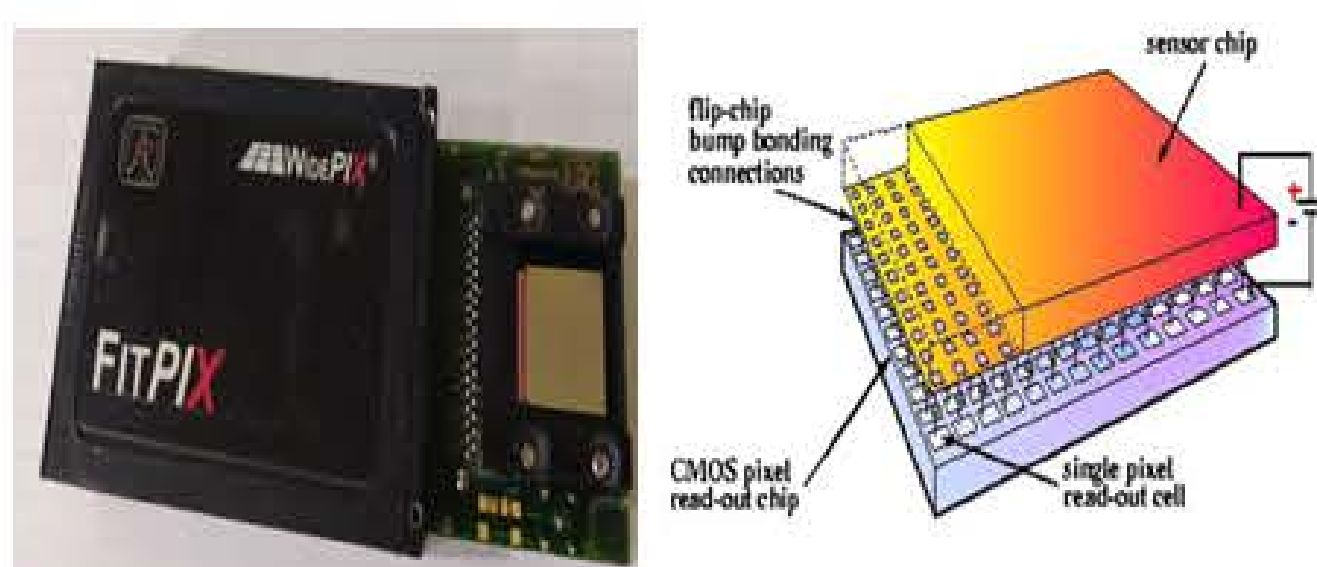
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Introduction

The visualization of internal organs of small animals *in vivo* has become one of the main tasks in preclinical studies over the last decade. Single-photon emission computed tomography (SPECT) allows obtaining tomographic images of the biodistribution of radiolabeled compounds, both throughout the patient's body and in separate organs. The use of computed tomography (CT) in conjunction with SPECT significantly increases the amount of information obtained as a result of scanning.

TimePIX detector

The hybrid semiconductor pixel detector Timepix consisting of the Timepix ASIC chip bump-bonded to the radiation sensitive semiconductor sensor (CdTe 2000 μm thick). The detector radiation sensitive area is 14 mm \times 14 mm



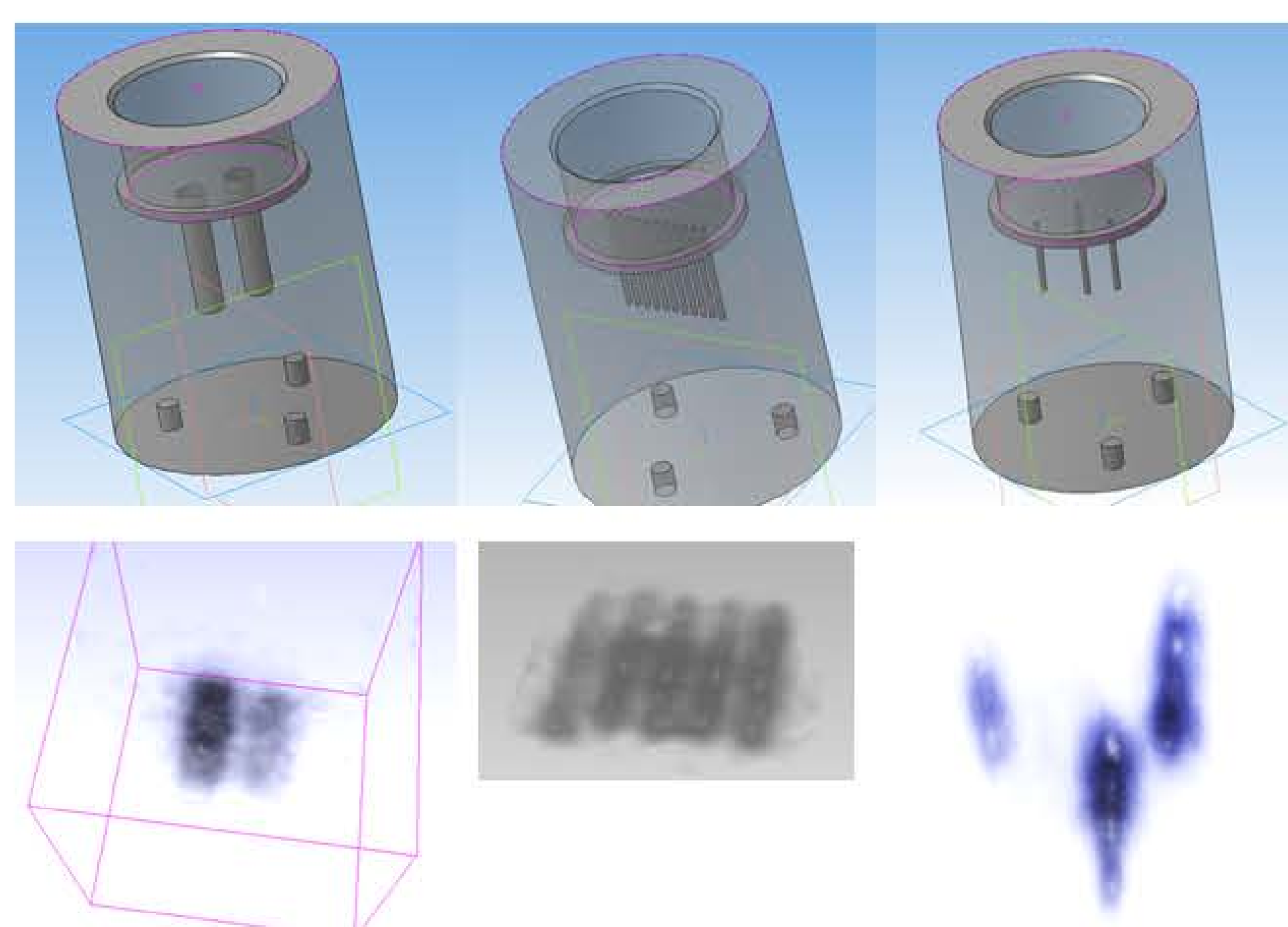
Sensor material	CdTe
Sensor size	14.1x14.1 mm
Sensor thickness	2 mm
Matrix size	256x256
Pixel size	55x55 μm
Energy resolution 140 KeV	10%
Efficiency 140 KeV	60%

Operating modes

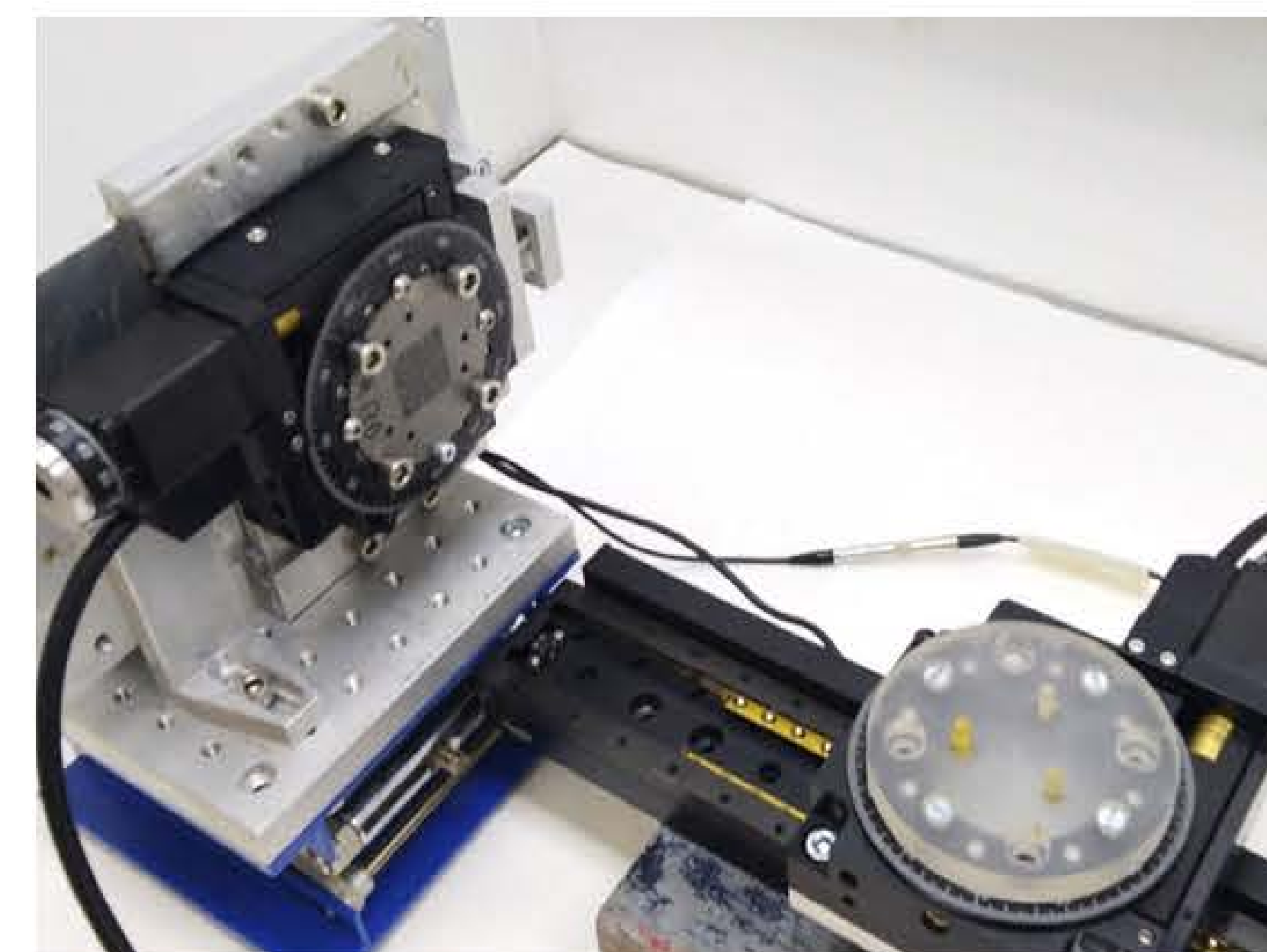
1. Medipix – counting mode
2. Time-over-Threshold (TOT) each pixel records the energy deposite of particles interaction with corresponding sensor segment
3. Time-of-arrival (TOA) - each pixel records the arrival time of particles interaction with corresponding sensor segment

Results

The developed tomographic system was based on the Timepix detector. Measurement of the parameters of the developed system (figure on the right) was carried out on the phantoms presented below using a solution of technetium-99m. All parameters indicate that the system has high sensitivity and high spatial resolution, which allows it to be used for preclinical testing.



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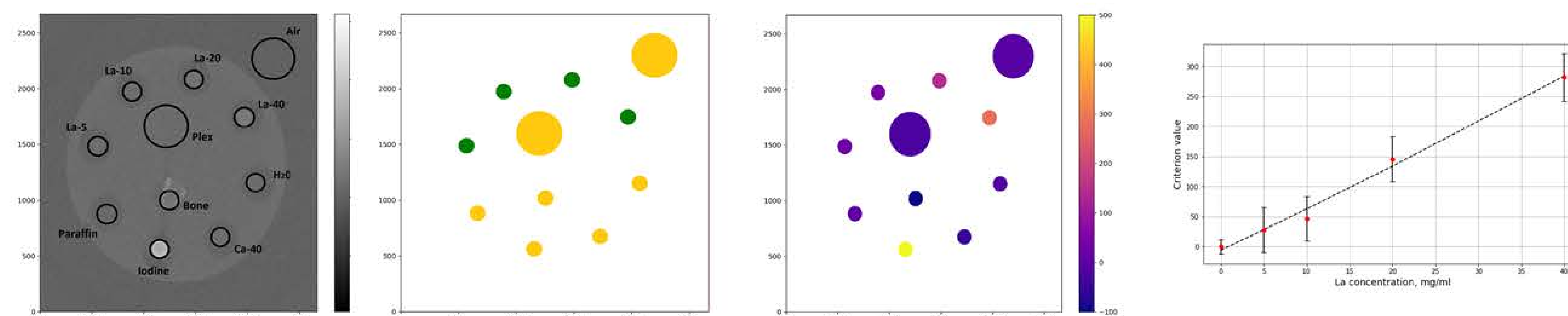


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System parameters	
Detector	Timepix CdTe 2 mm
Tomography spatial resolution	2.5 mm (FoV 57 mm x 57 mm)
Spatial resolution	0.8 mm (FoV 30 mm x 30 mm)
Energy resolution	22% (140keV)
Sensitivity	35 cps/MBq
Linearity	99,9%
Scanning time	<2 min/projection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

It should be noted that the feature of a pixel detector with the ability to count individual photons also makes it possible to provide information on the composition of the test substance, which in turn opens up wide opportunities for studying the interaction of combinations of various drugs under development.

Below are the measurement results of a phantom with lanthanum containing contrast of various concentrations, as well as other substances that are indistinguishable from each other in classical tomography. Using the photon counting mode, it is possible to localize and distinguish the desired substance from others, as well as to determine its concentration with high accuracy.



Conclusions

- A micro SPECT system prototype with a spatial resolution 0.8 mm for 30 mm x 30 mm field of view has been developed using Timepix detector.
- The micro SPECT system parameters can be adjusted in wide range without changing the assembly components.
- The system can be used for laboratory animal studies.
- The system can be used in conjunction with CT, which will significantly improve the quality and information content of preclinical studies.