

**XXVI International Scientific Conference of
Young Scientists and Specialists
(AYSS-2022)**

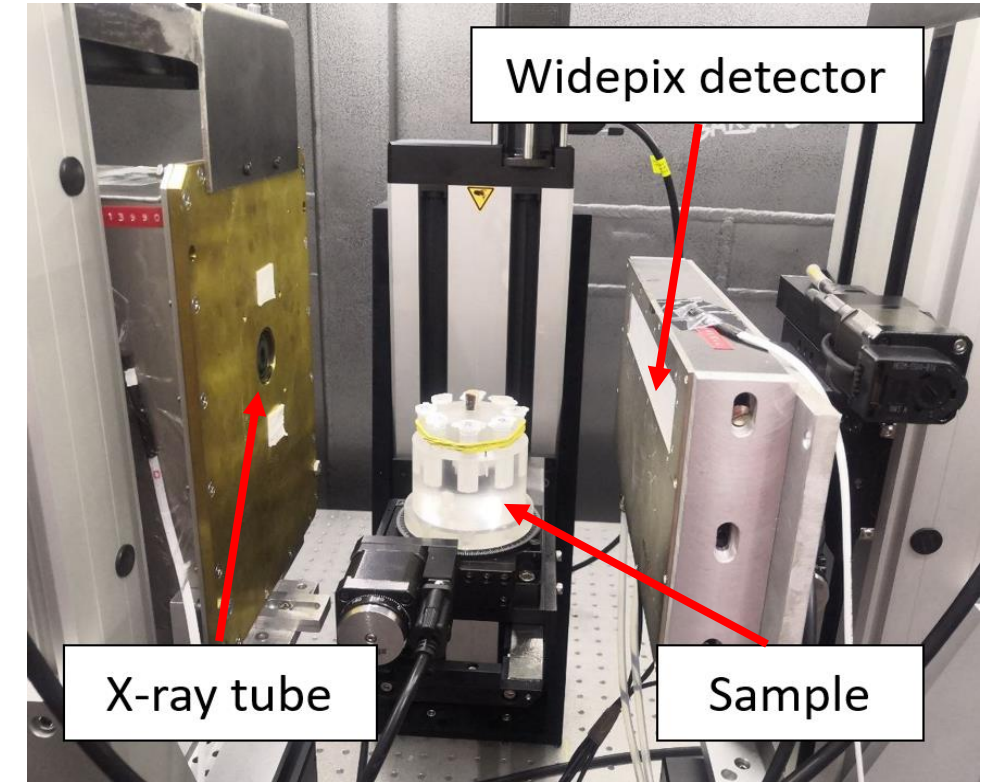
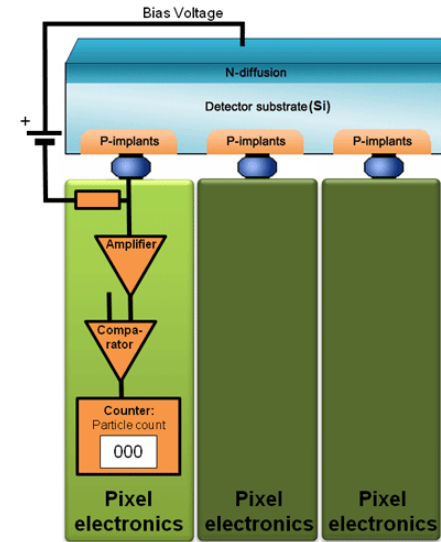
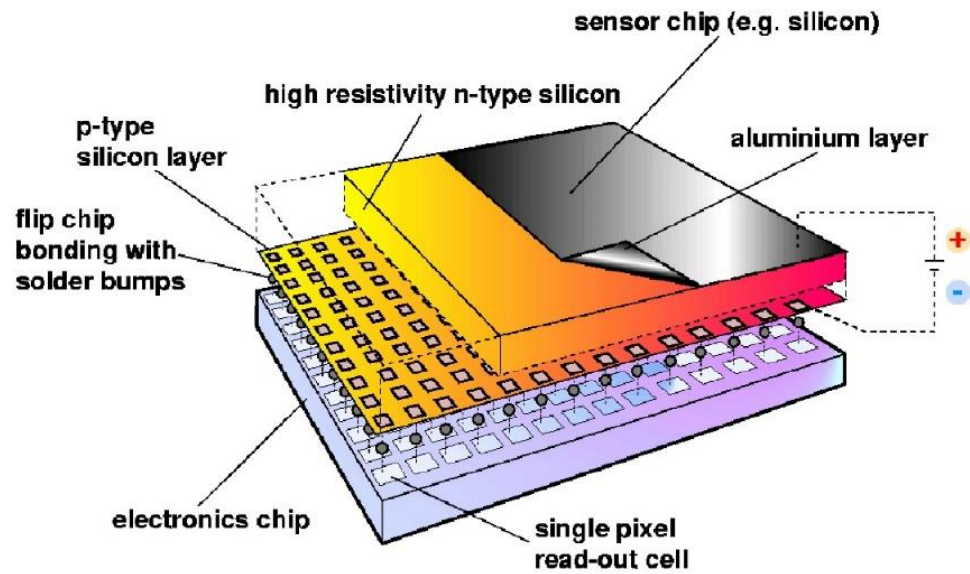
**DEVELOPMENT OF A CRITERION FOR IDENTIFYING CONTRAST
AGENTS BASED ON HIGH-Z ELEMENTS IN MULTI-ENERGY
COMPUTED TOMOGRAPHY**

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Medipix detector. Experimental Microtomograph “Kalan”



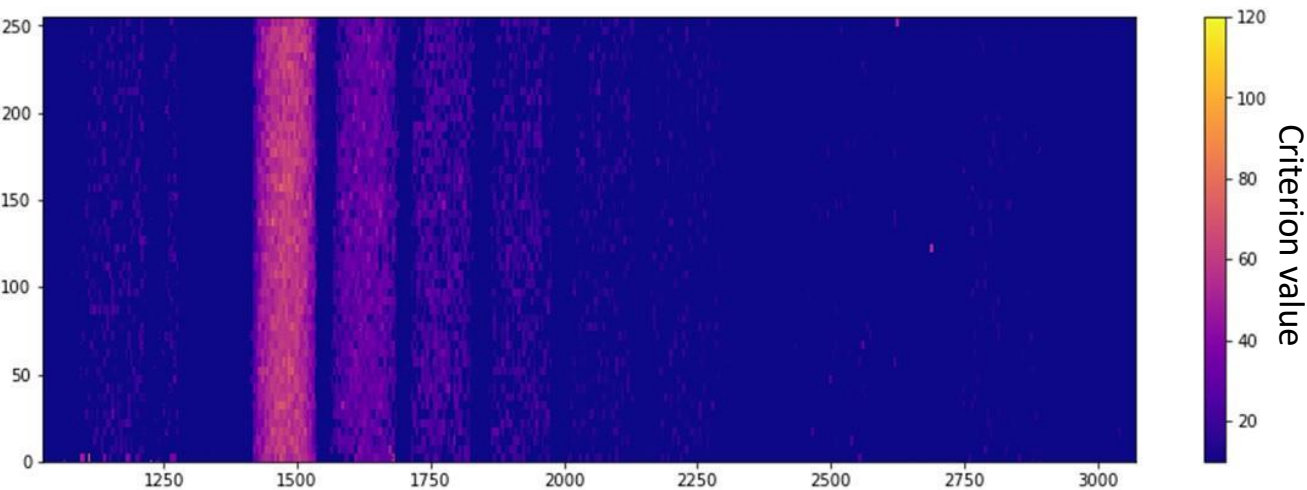
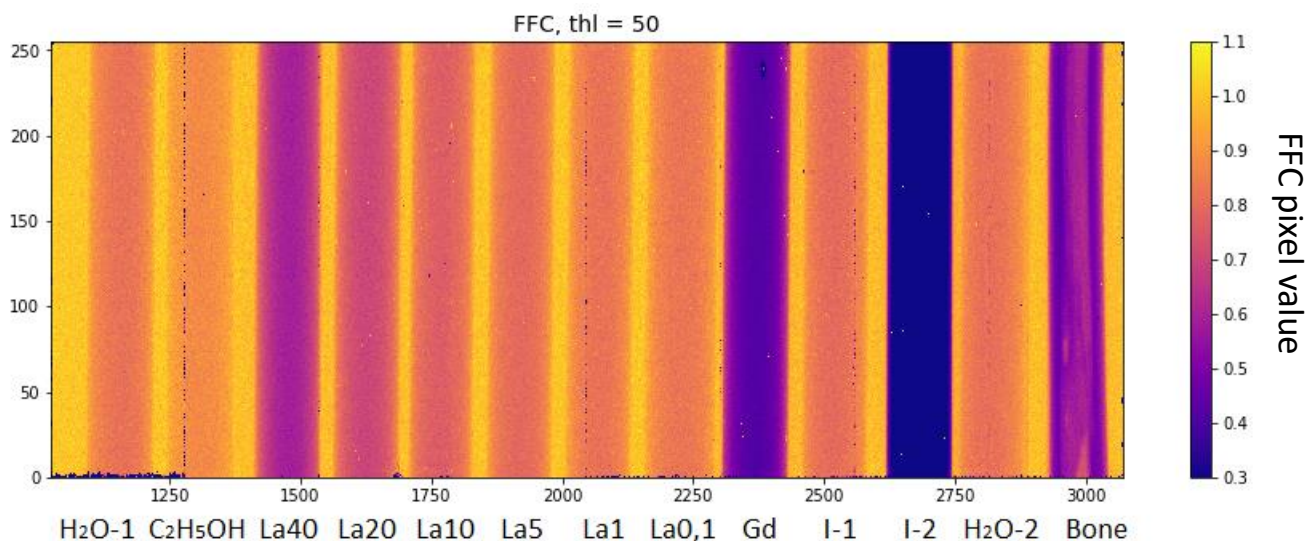
- Medipix series detectors are hybrid semiconductor pixel detectors;
- Developed by Medipix collaboration (<https://medipix.web.cern.ch/>);
- Consist of a semiconductor sensor and a readout integrated circuit;
- Photons are detected by their transferring energy to electrons. The appeared free electrons move to the pixel contact pads, causing a signal.
- The signal is digitized and compared with the threshold in a pixel. Pixels operate independent.

Goals:

- Identify materials that differ in composition. In particular, select a contrast agent that has an absorption edge in the working energy range;
- Determine the main element of the contrast agent;
- Determine the concentration of the contrast agent.

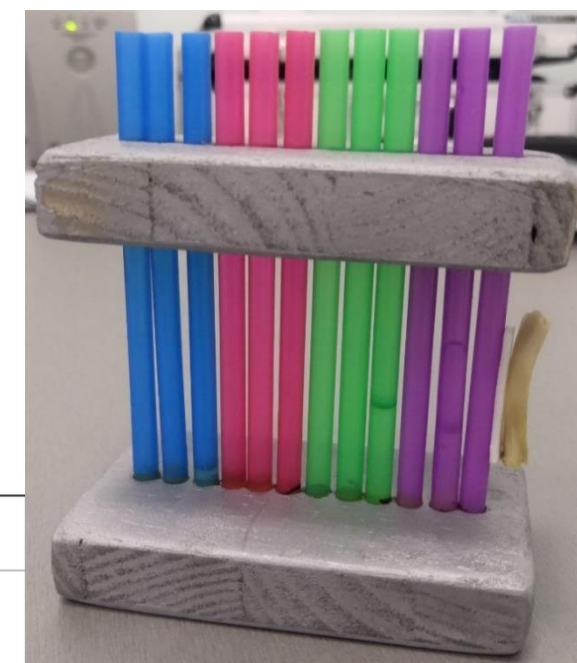
In this case, it is necessary to use as little energy as possible to reduce the scanning time.

Results of applying the criterion in 2D-CT

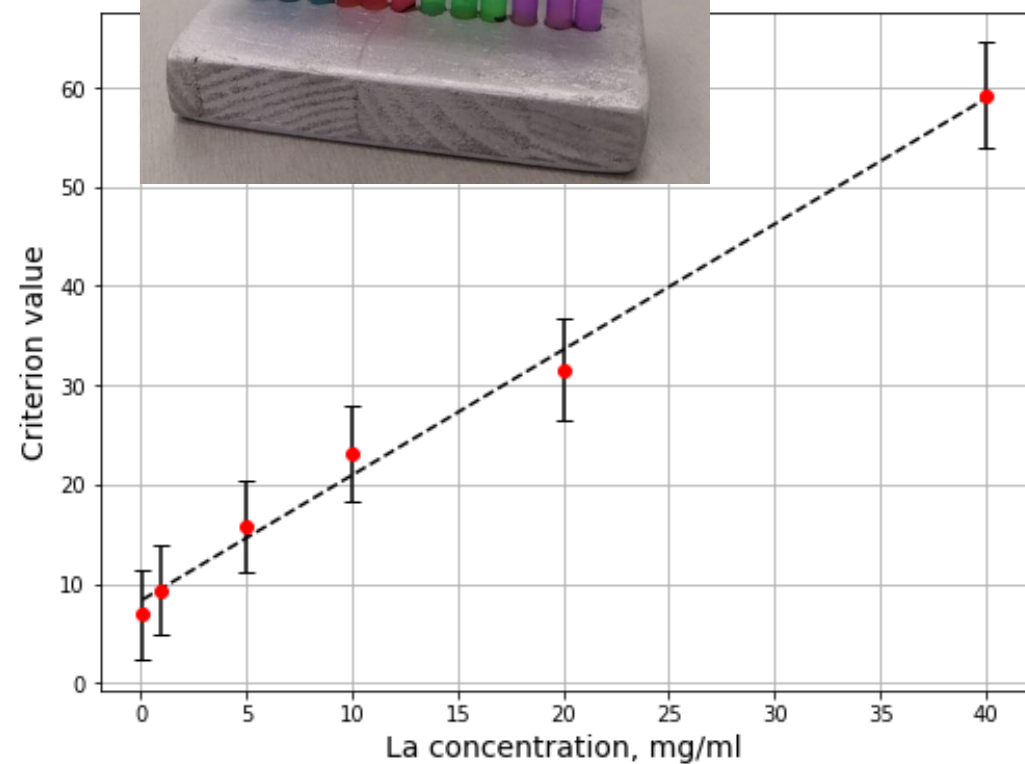


Flat Field Correction:
 $FFC = F(\text{object}) / F(\text{flat field})$
 $\Rightarrow FFC = \exp(-\mu \rho x)$

5 energies were used to identify the contrast agent.

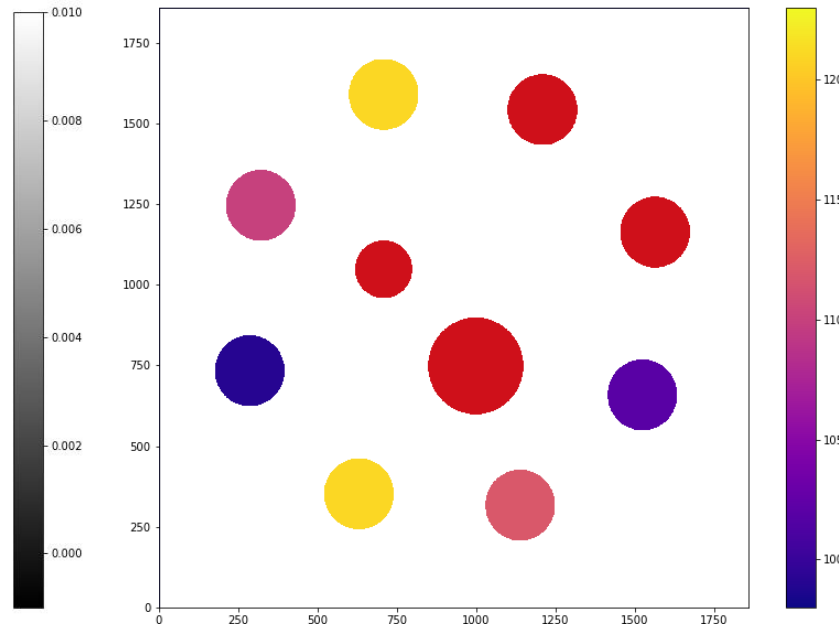
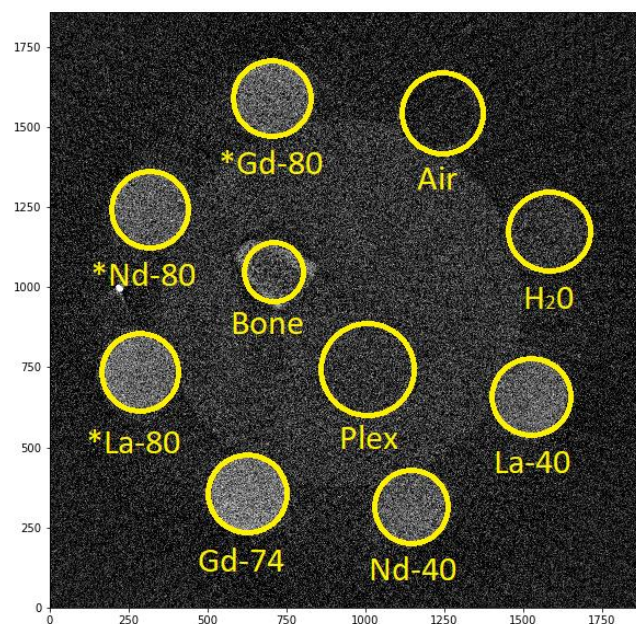


2D Cocktail phantom





Separation of several different CAs in 3D-CT



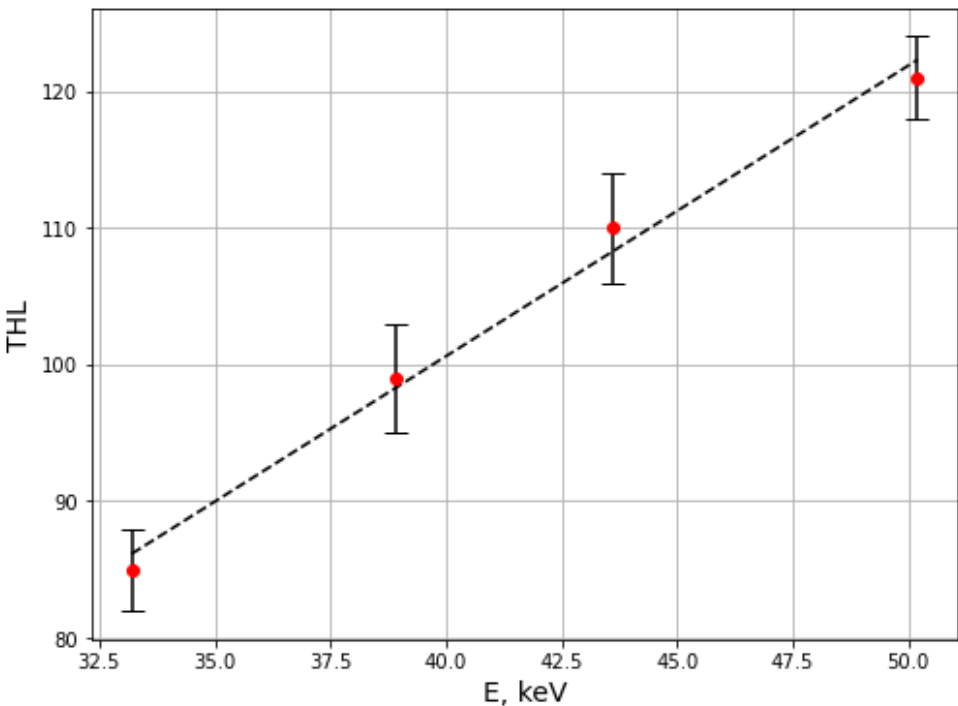
Energy K-edge (thl) in Rols.
Red color – K-edge not found.



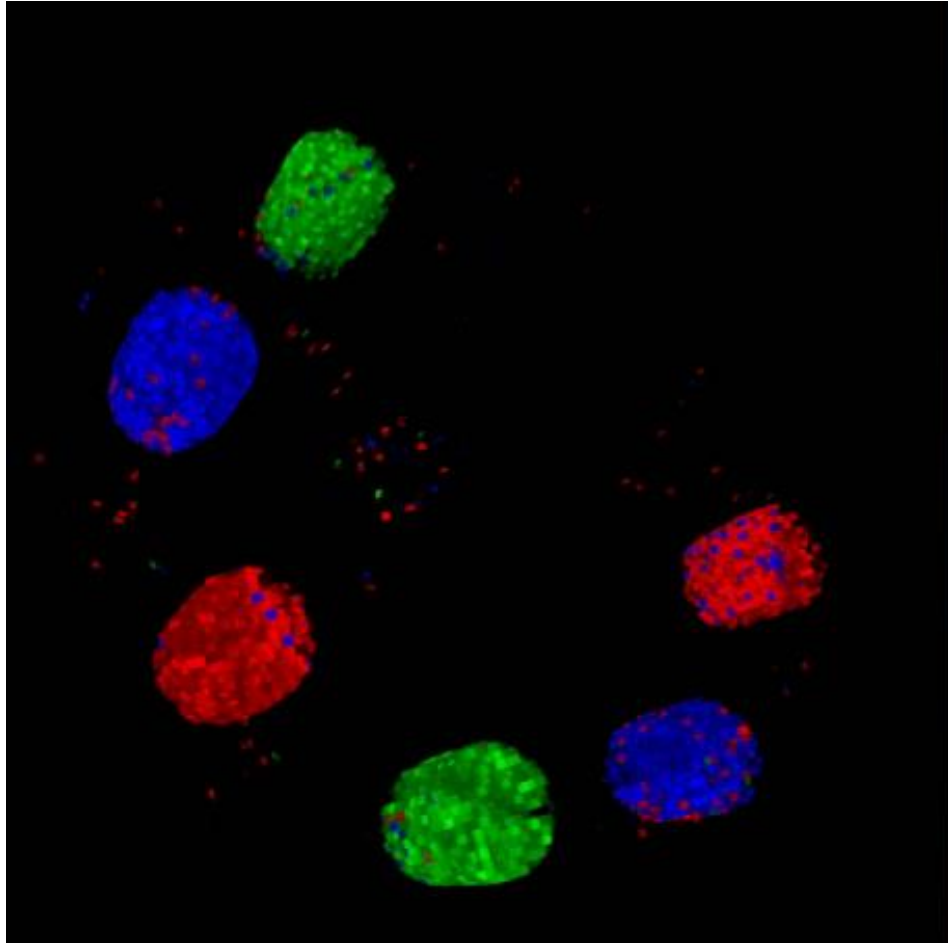
12 energies were used to separate several different contrast agents.

Phantom composition:

- La-40, Nd-40, Gd-74 – samples with water solution;
- *La-80, *Nd-80, *Gd-80 – samples mixed with powder graphite;
- H₂O, Bone, Air, Plex – additional samples.



Dependence of energy K-edges by criterion from experimental energy K-edges



3D CT images of phantom with Cas. Color division of:

- La – red
- Nd – blue
- Gd – green

- The proposed method makes it possible to separate the contrast agent from other materials and classifying them;
- The developed criterion can be used to estimate the concentration of the contrast agent;
- The criterion was developed for lanthanum contrast agents, but it can be used for other contrast agents based on high-Z elements;
- This criterion can be used in 2D-CT and 3D-CT;
- 5 energies are required to separate one contrast agent;
- Multiple contrast agents can be separated at the same time.

Other methods for identifying and classifying contrast agents are also being tested. For example – machine learning.

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