Neutron Tomography and Simulation of Compton Imaging

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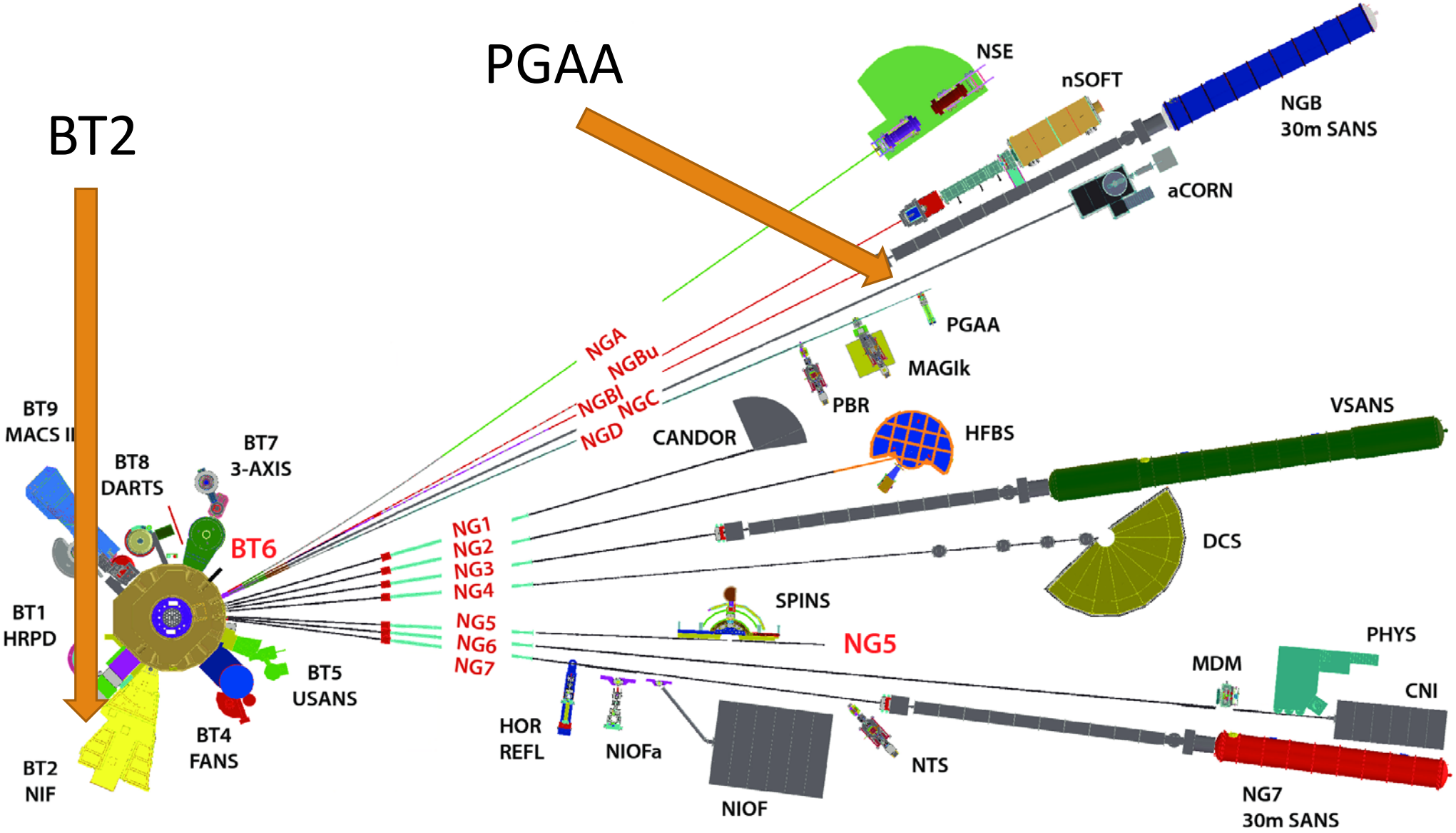
Projects

- Implement Neutron Tomography system
  - Software controls
  - Automated data collection
- Continue design work on Compton Imaging Detector
  - Geant4 Simulations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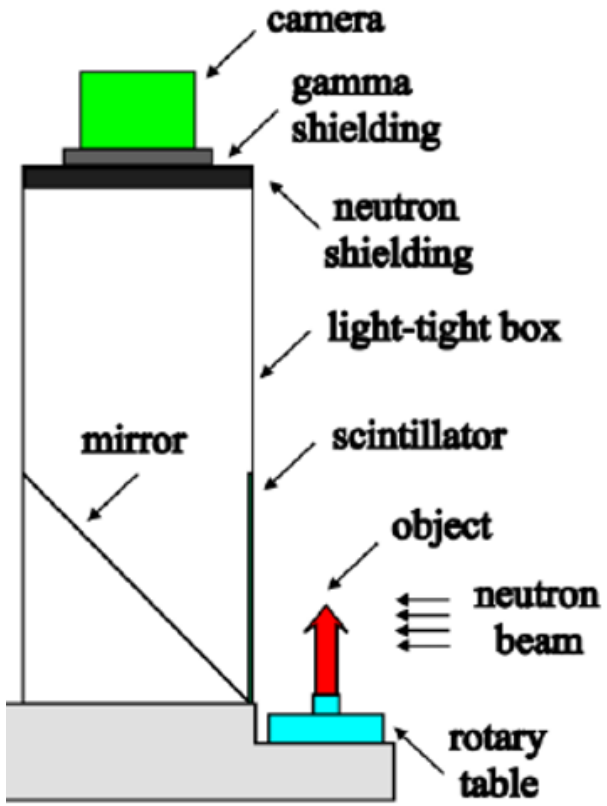
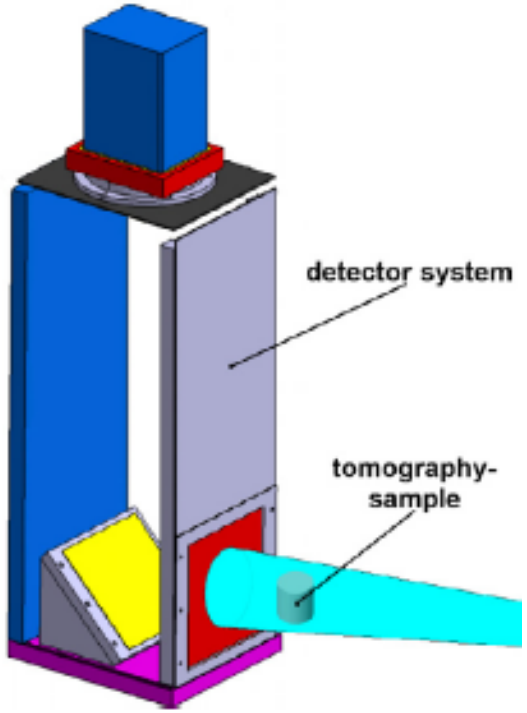
What is neutron tomography?



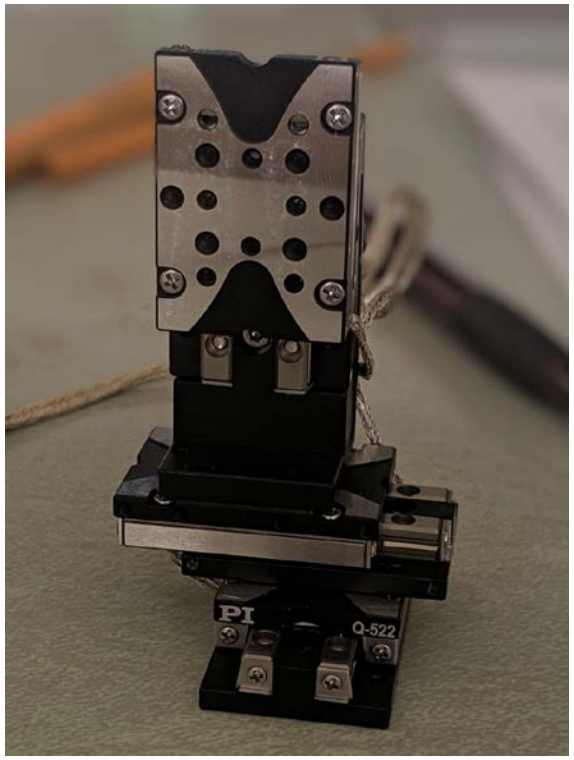


Stanojev Pereira, Marco & Marques, J.G. & Pugliesi, Reynaldo. (2012). A Simple Setup for Neutron Tomography at the Portuguese Nuclear Research Reactor. Brazilian Journal of Physics. 42. 10.1007/s13538-012-0083-0.

Task: Integrate hardware and software into one system

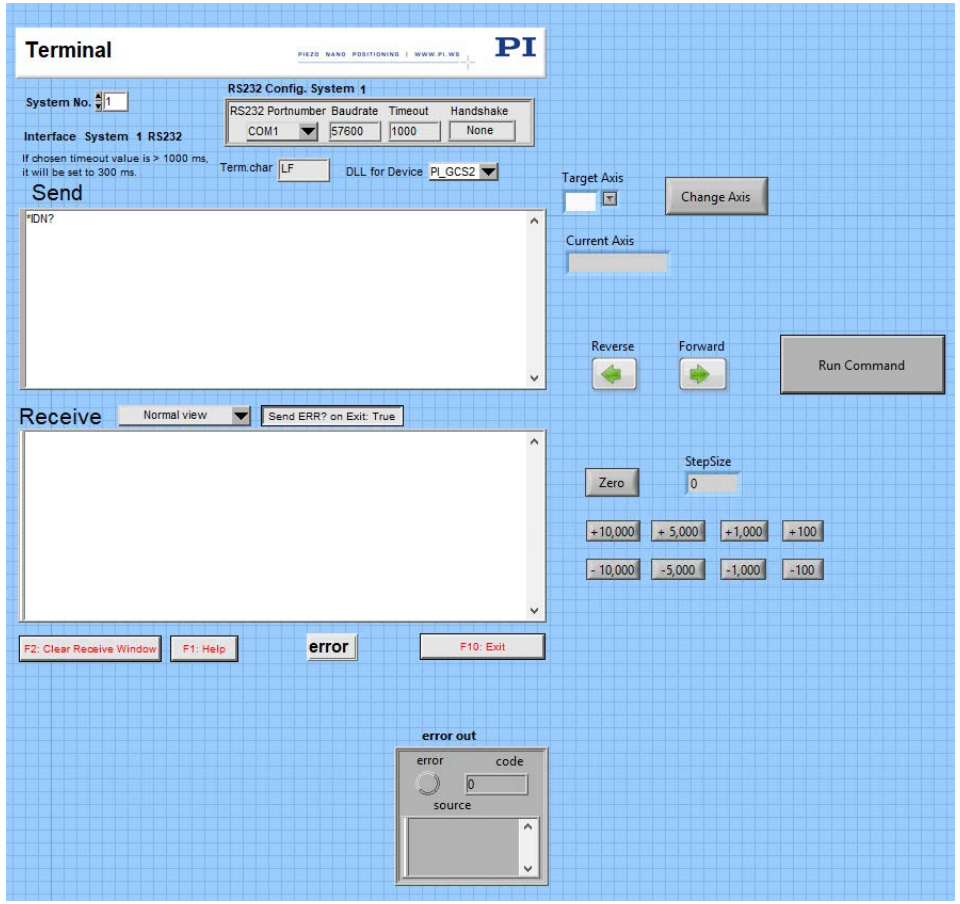
CCD Camera from Oxford Instruments

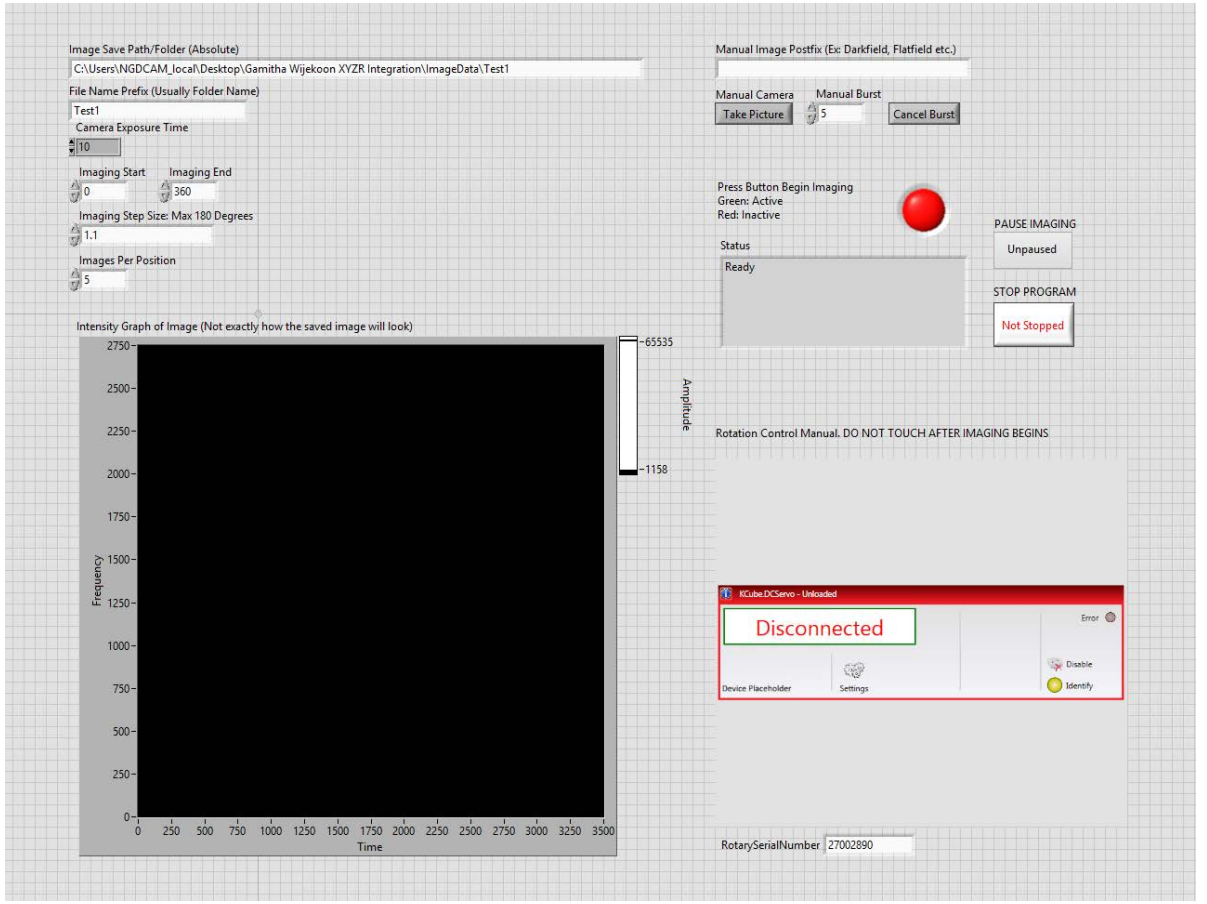
Rotary Stage from Thorlabs



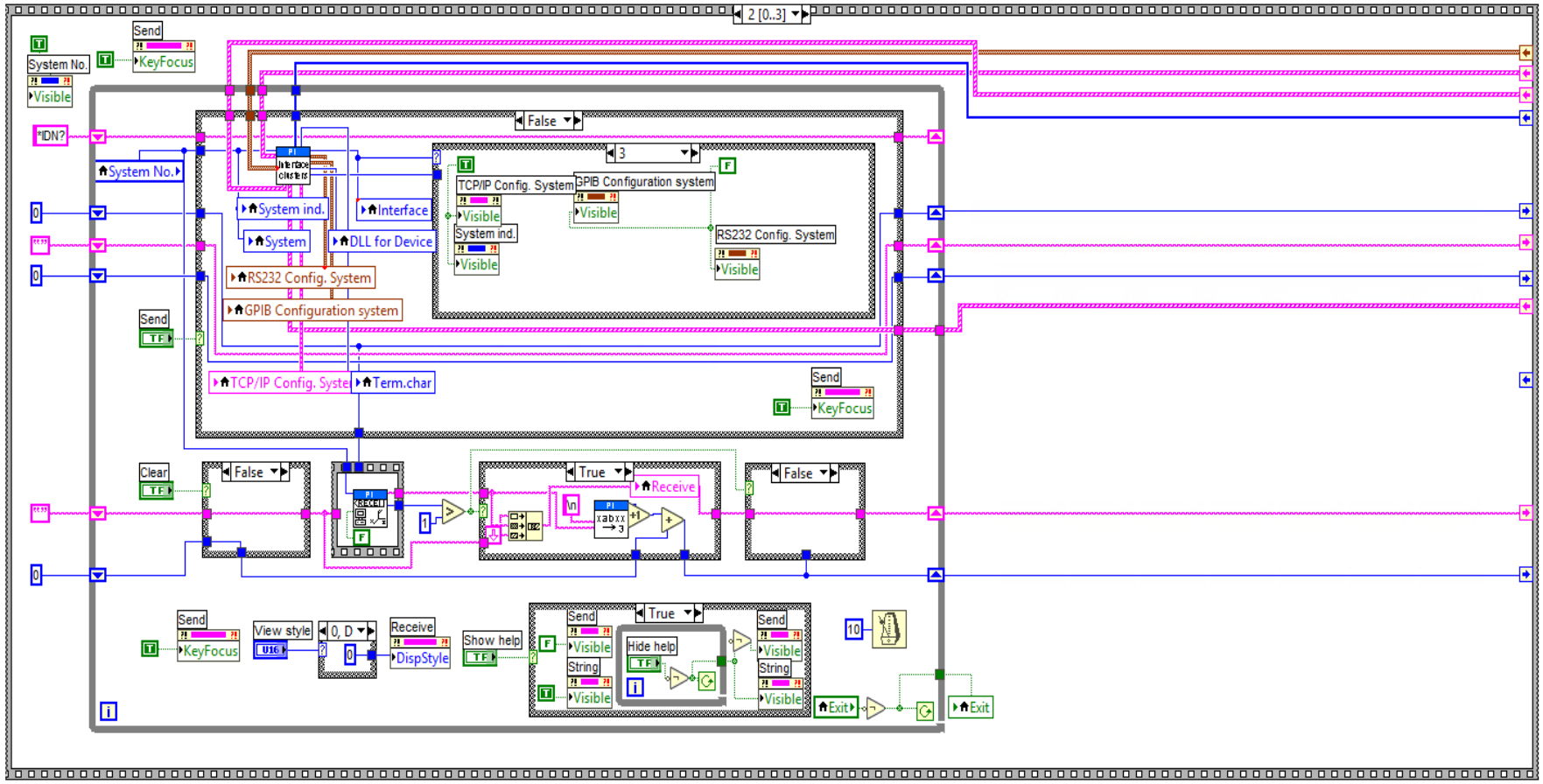
XYZ translational stages from physik instrumente (PI)

Solution: LabVIEW

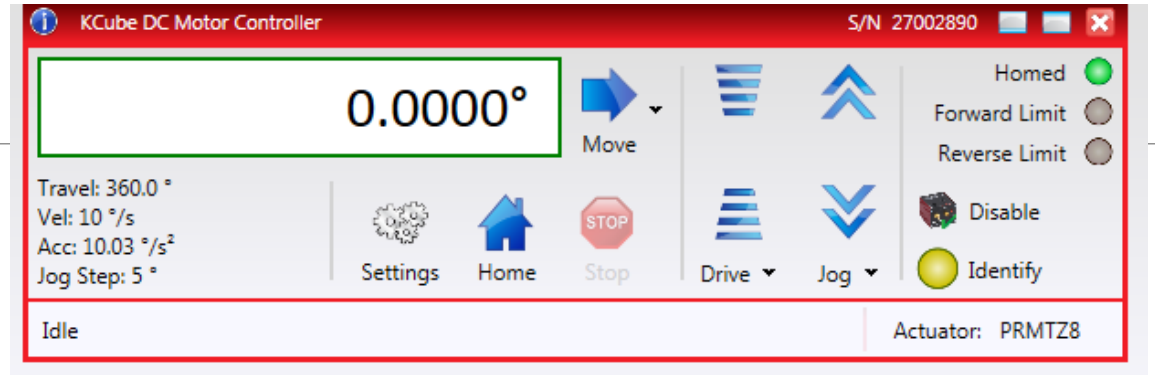




PI LabVIEW Example



ThorLabs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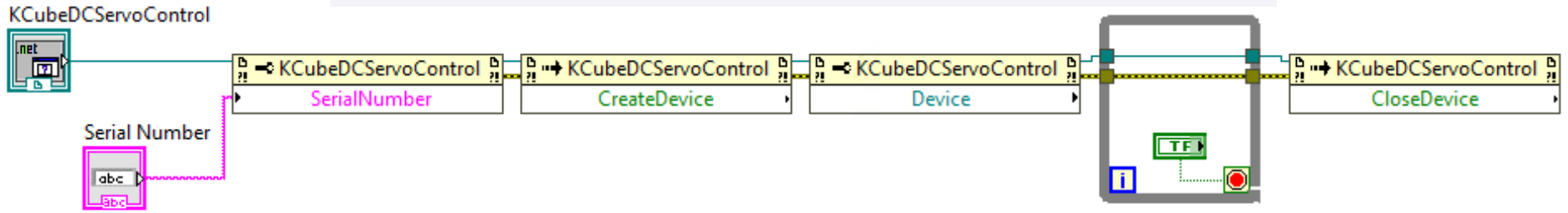
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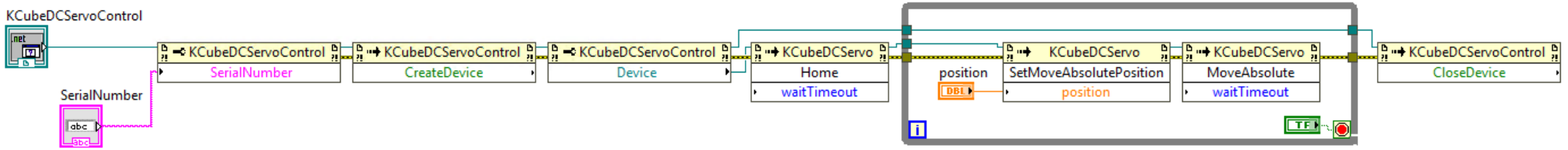
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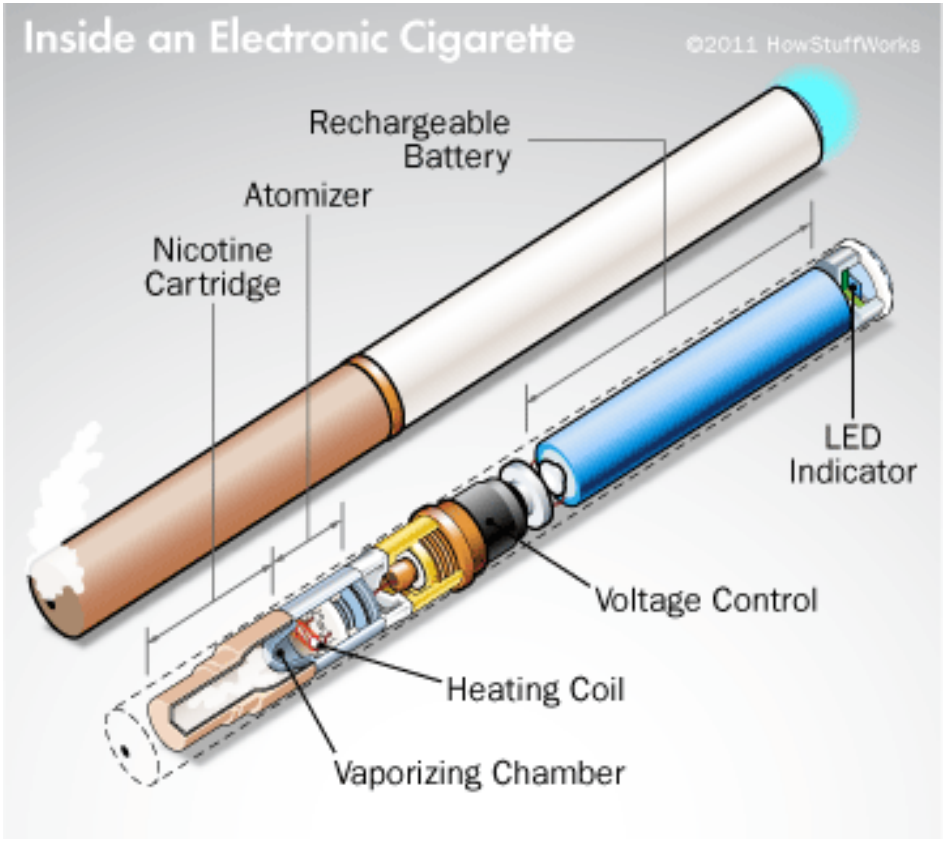
What to perform tomography on?

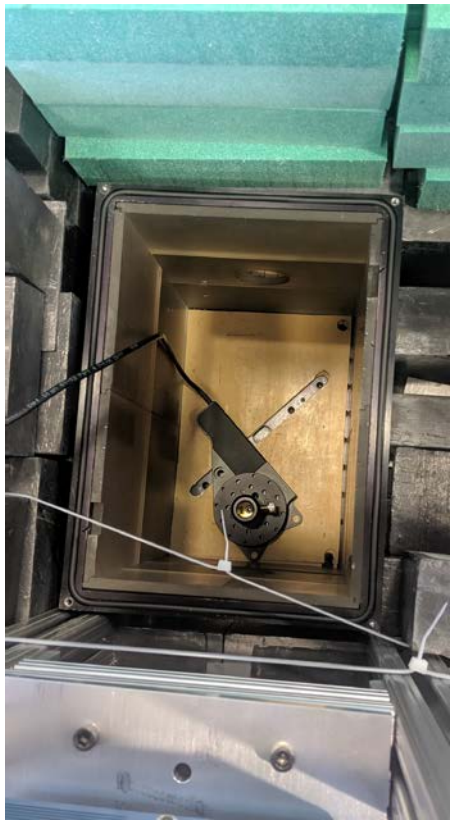


- $8 Disposable Vape
- 2nd most popular on market

Beam Tube 2 (BT2)

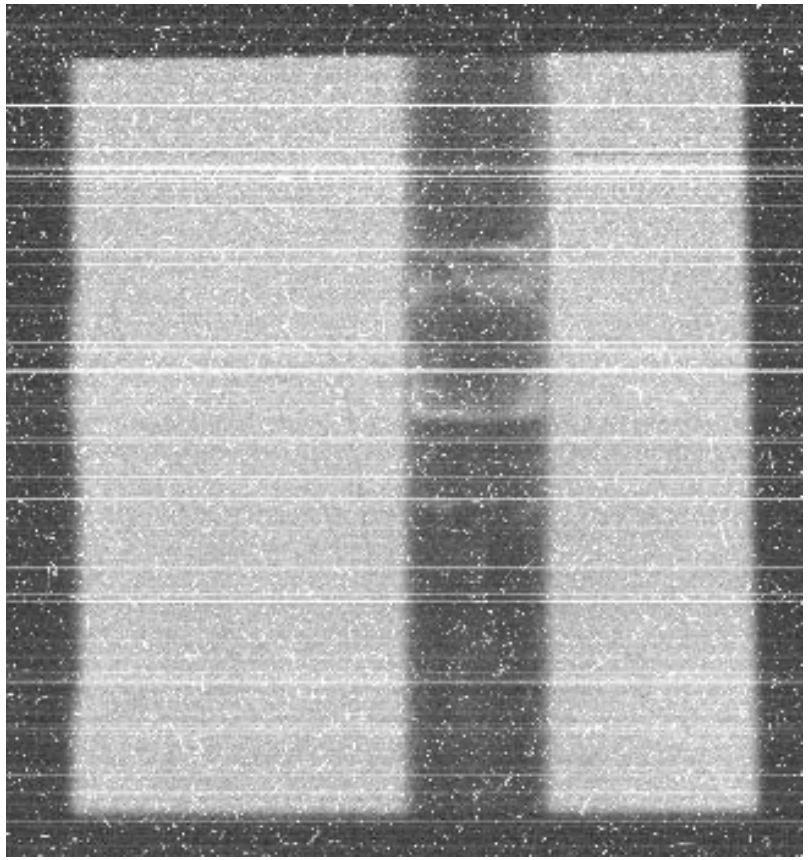
- Closer to reactor → more collimated beam
- Has top tier Neutron & Xray Tomography
- Special Thanks to Jacob LaManna

Neutron Guide D (NGD) Tomography Setup

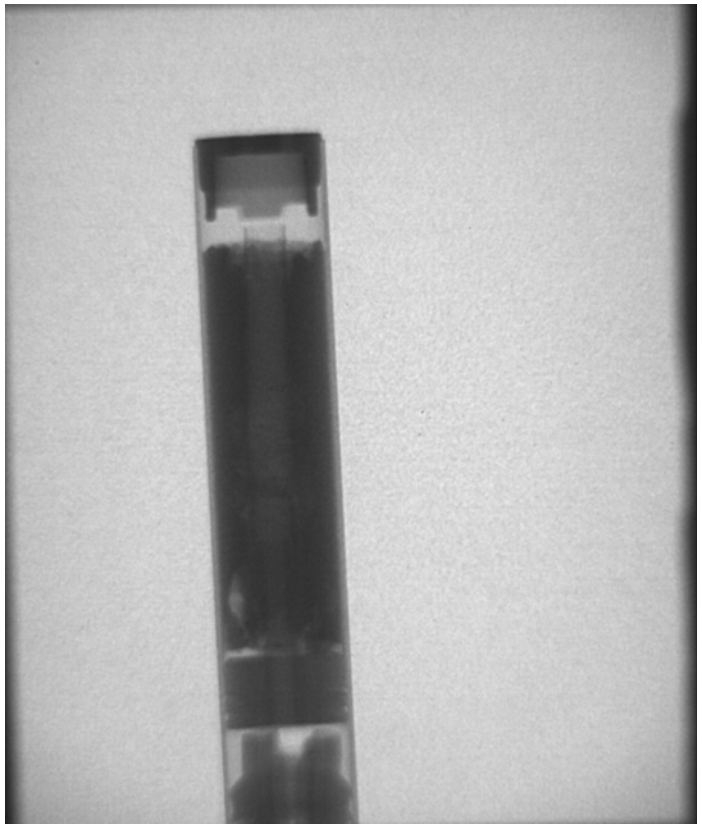


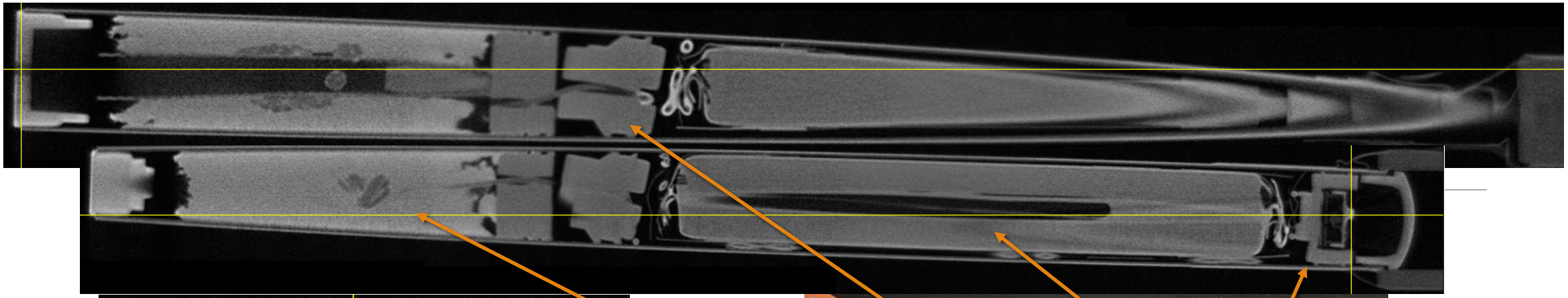
Tomography Images

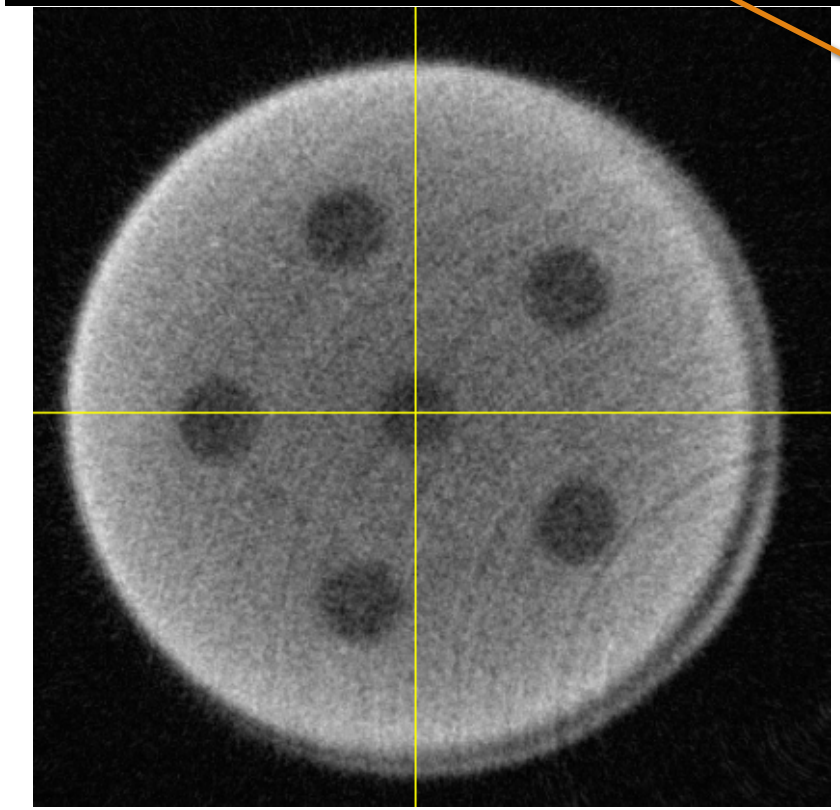
Our camera



BT2 Camera

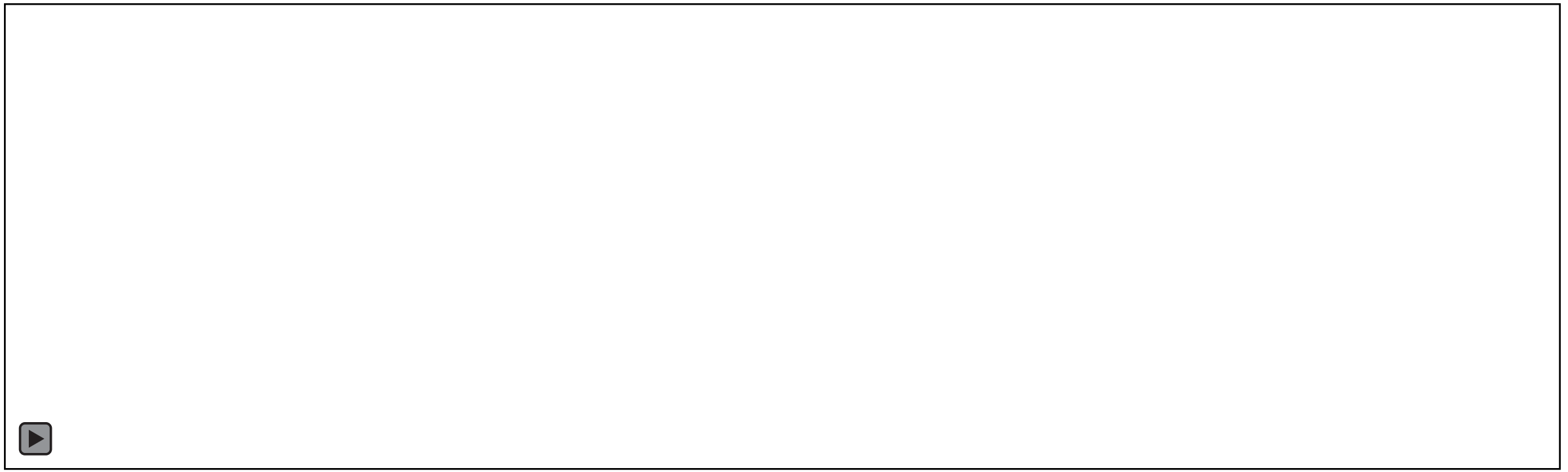






J.M. LaManna et al., Neutron and X-ray Tomography (NeXT) system for simultaneous, dual modality tomography, Review of Scientific Instruments 88 (2017) 113702 https://doi.org/10.1063/1.4989642

3D Renders



Reconstruction Video

Projects

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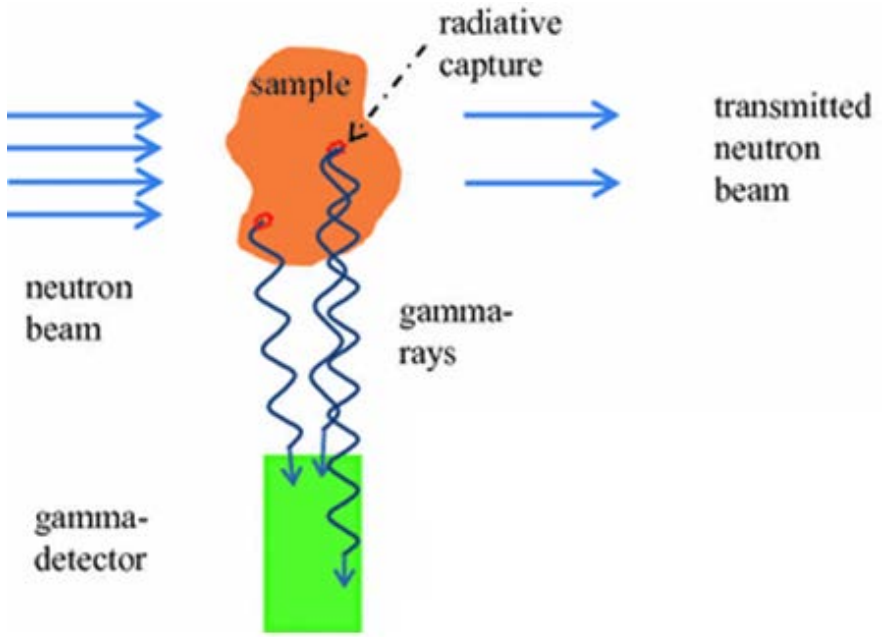
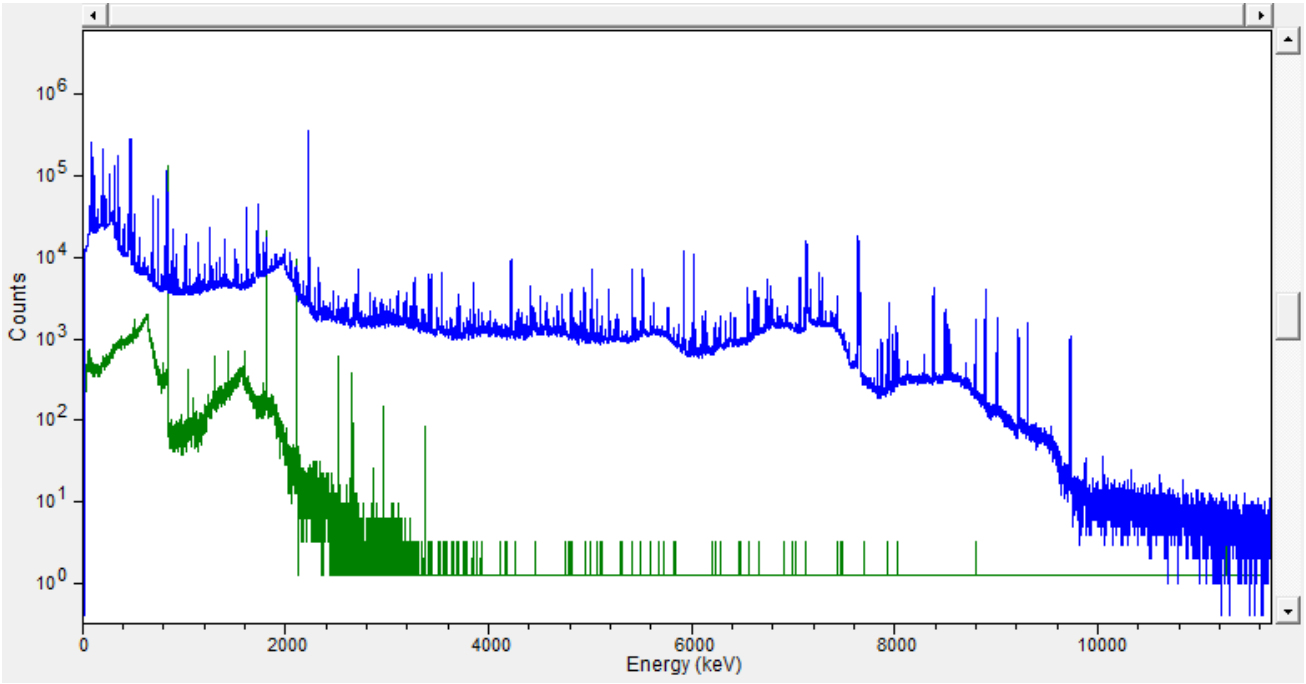
  - Geant4 Simulations

Prompt Gamma Activation Analysis (PGAA)





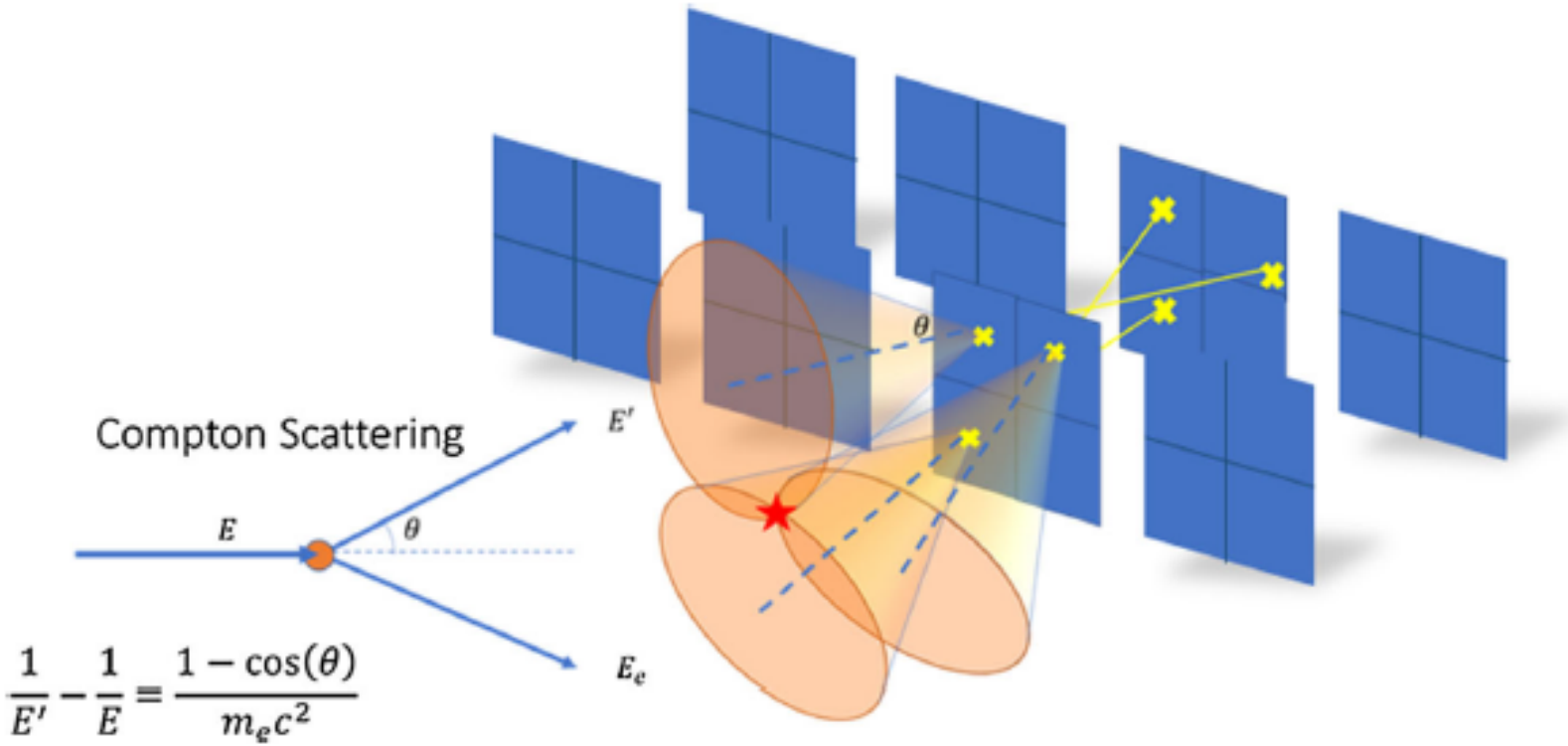
Hope to find sources of some metals: Aluminum, Arsenic, Cadmium, Chromium, Copper, Iron, Manganese, Nickel, Lead, Antimony, Tin, Titanium, Uranium, Tungsten, Zinc

Belgya T., Révay Z. (2017) Prompt Gamma Activation Analysis (PGAA). In: Kardjilov N., Festa G. (eds) Neutron Methods for Archaeology and Cultural Heritage. Neutron Scattering Applications and Techniques. Springer, Cham

Olmedo, Pablo et al. "Metal Concentrations in e-Cigarette Liquid and Aerosol Samples: The Contribution of Metallic Coils." *Environmental health perspectives* vol. 126,2 027010. 21 Feb. 2018, doi:10.1289/EHP2175

Compton Imaging

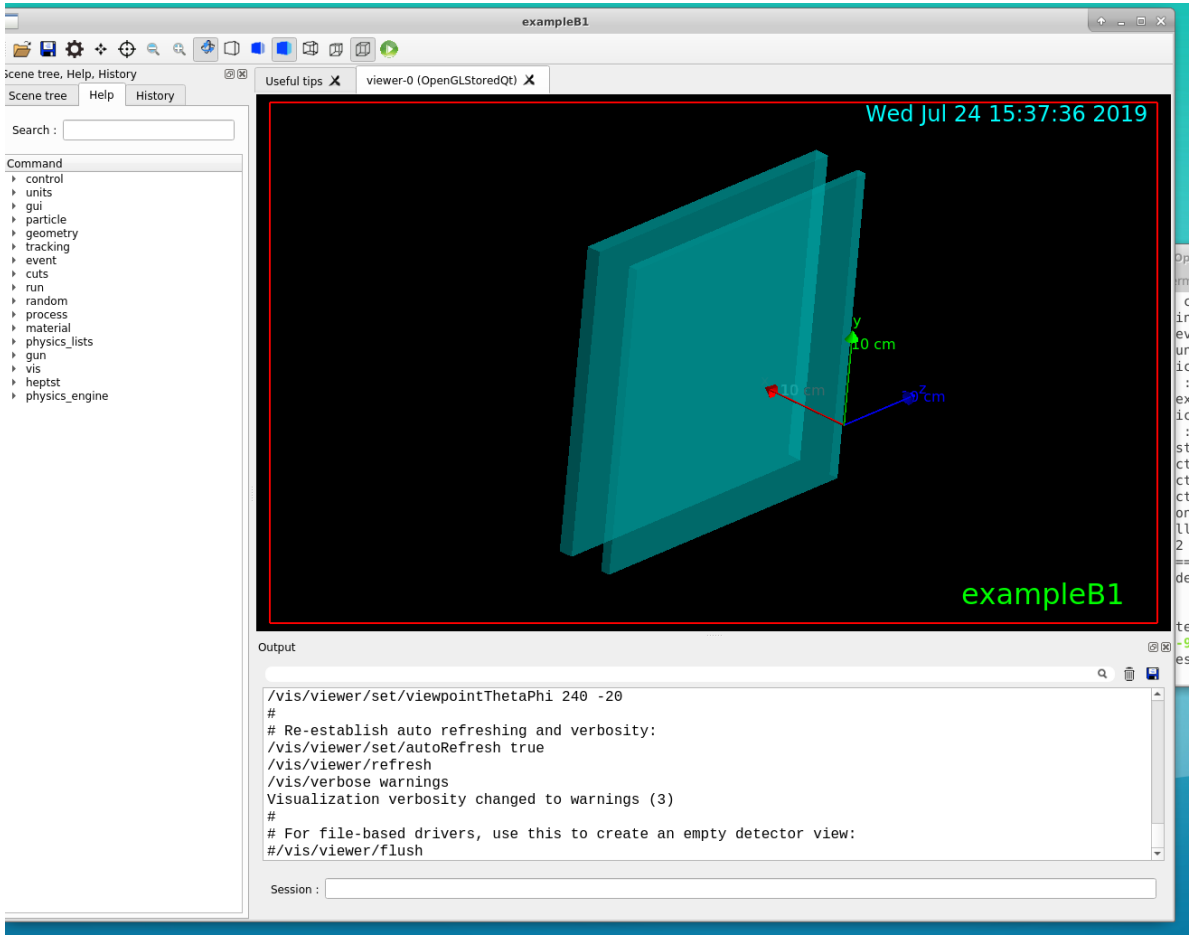
Fig. 1 Principle of Compton imaging with a two-stage pixelated detector. The Compton cones are generated based on the energy and location of the scattered gamma rays to determine the origin of the emission

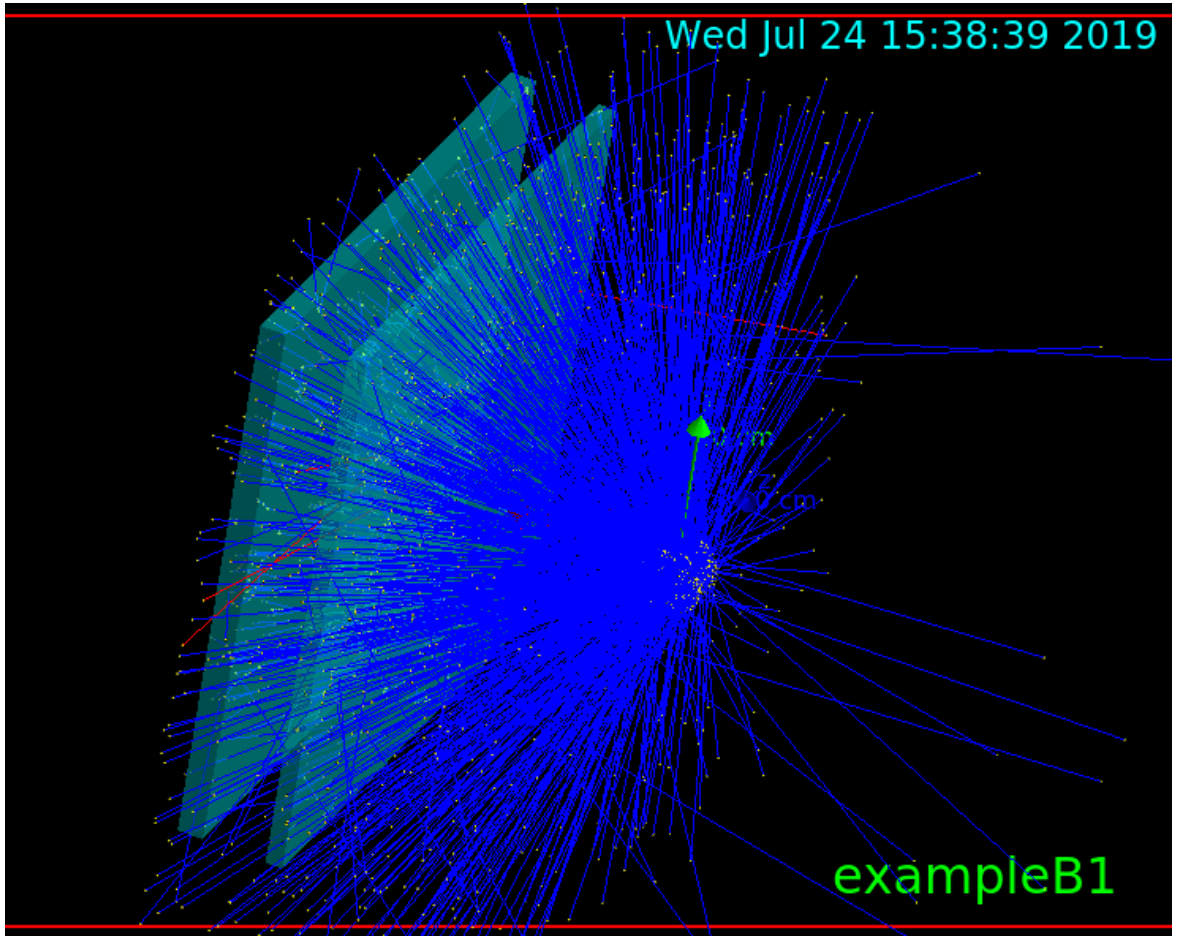


H. Chen et al. Spectroscopic Compton imaging of prompt gamma emission at the MeV energy range. J. Radioanal. Nucl. Chem. 318 (2018) doi: 10.1007/s10967-018-6070-3

Geant4

- Particle Simulation software developed by CERN
- Expanding on work by Ben Riley (SURF 2017) and Nathaniel Kaneshige (SURF 2018)





Status of projects

- Automated Neutron Tomography Controls: Complete
- Gamma Ray Compton Imaging Geant4: Fixed and ready to simulate
- To do:
  - 3D Model Reconstruction Process for Neutron Tomography
  - Optimize Geant4 Simulation Model for detector design

Bibliography

- Stanojev Pereira, Marco & Marques, J.G. & Pugliesi, Reynaldo. (2012). A Simple Setup for Neutron Tomography at the Portuguese Nuclear Research Reactor. Brazilian Journal of Physics. 42. 10.1007/s13538-012-0083-0.
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Acknowledgements

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