



SHIP Research Project:

Using Tomography to Scan and Create a 3D Model

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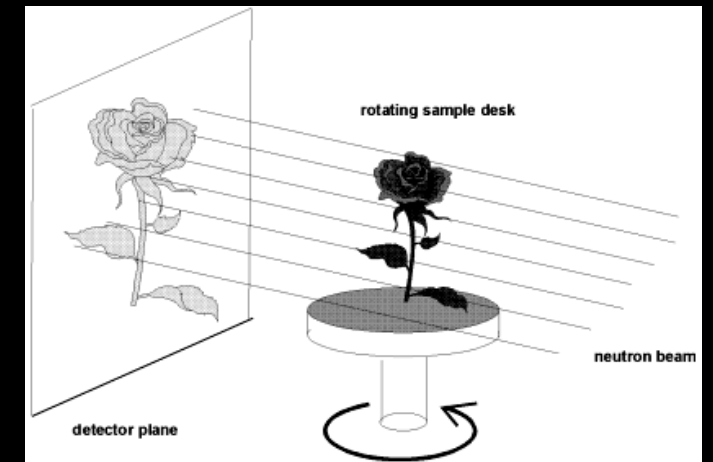
Mentor: **Heather Chen-Mayer**

Introduction

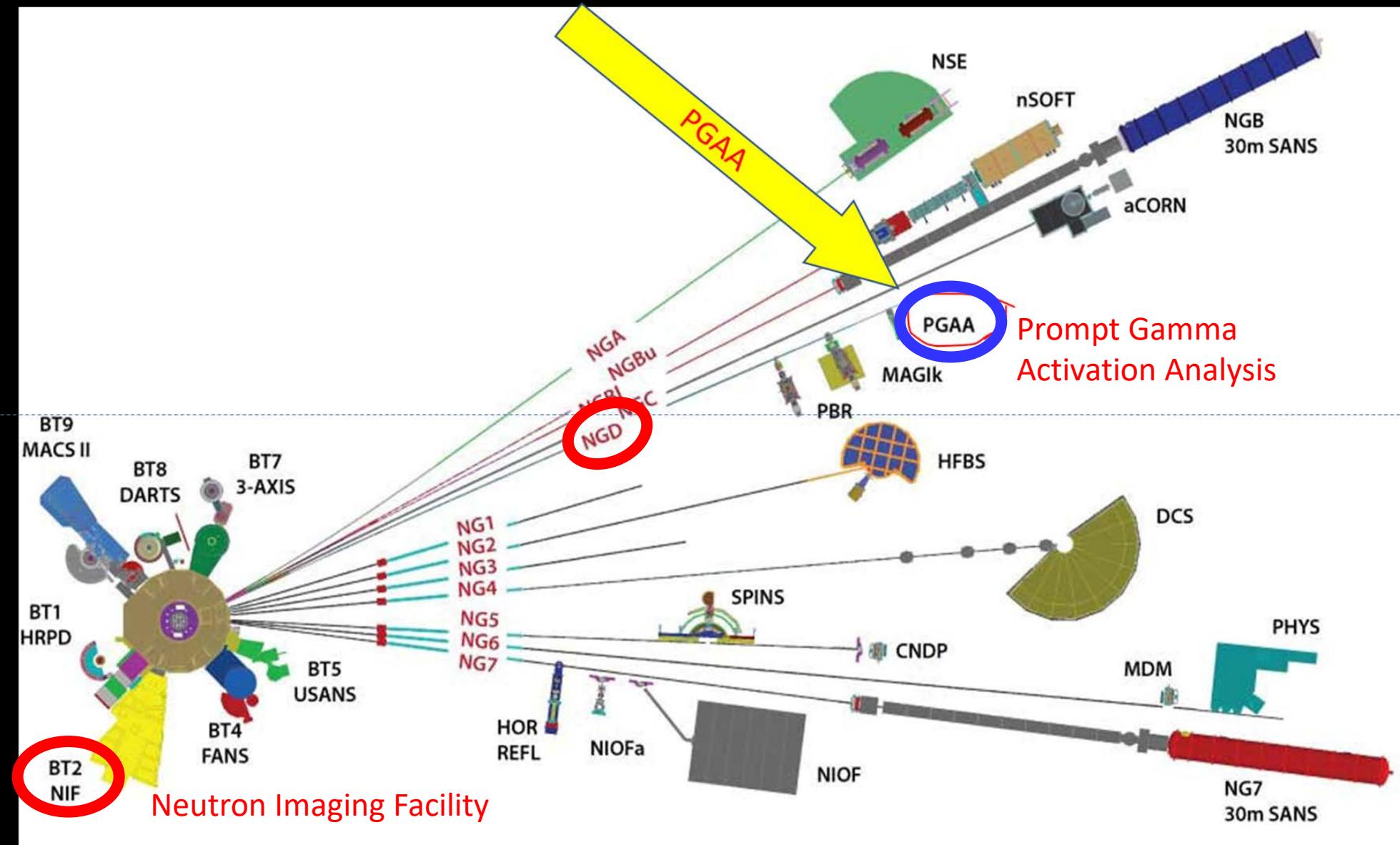
- Tomography
 - Taking pictures with penetrating force
 - X-ray CT Used in medical field
 - Neutron tomography developed at NIST

Learning the specifics of:

- How to create instrumentation for a neutron tomographic system
- How to take images
- How to reconstruct images



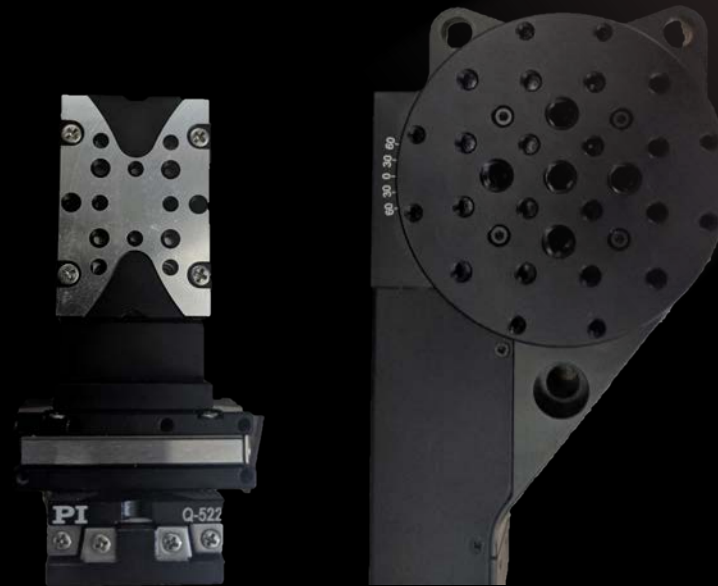
Prompt Gamma Activation Analysis



- NGD restrictions
- Create system at NGD
- My role

Specifics of Project

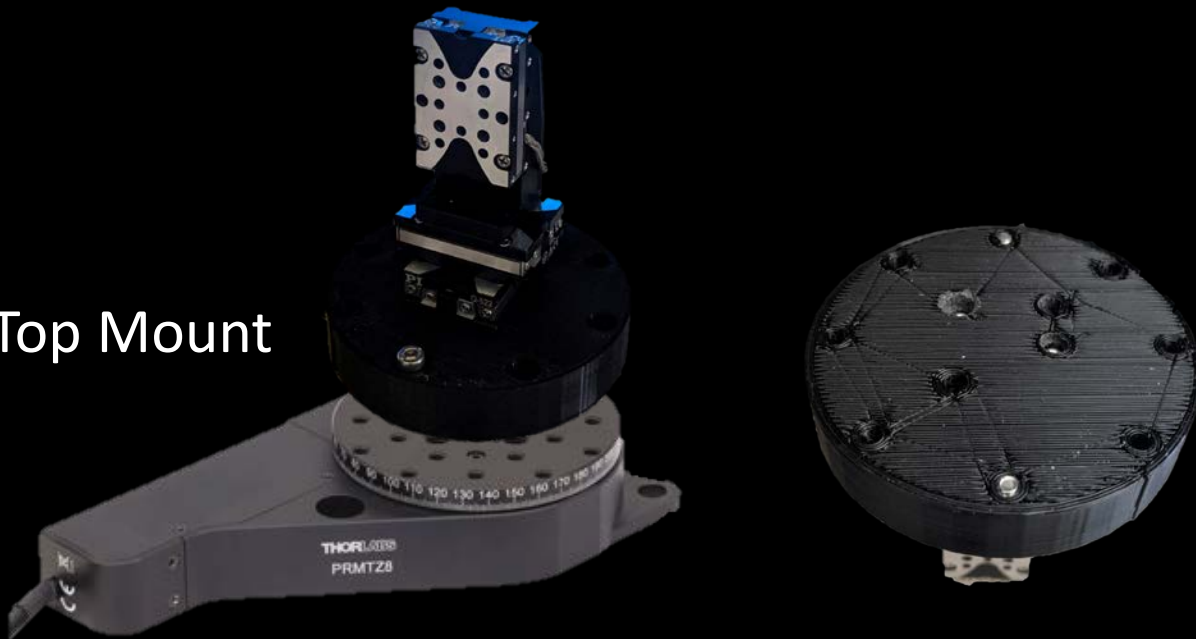
- Main Goal:
 - Learn from BT-2
 - Demonstrate process and apply to NGD PGAA
- Instrumentation needs:
 - XYZ stage (left)
 - Rotational stage (right)
 - Camera
 - Control Software



Creating Adapters by 3D printing

- Inventor CAD software
 - XYZ sits on top of rotary
 - Copied rotary layout
 - Middle holes go through bottom
 - Head can't stick out
- XYZ sits below rotary
 - Top holes fit on rotary
 - XYZ screws in front hole panel
 - Restricts XYZ vertical movement

Top Mount

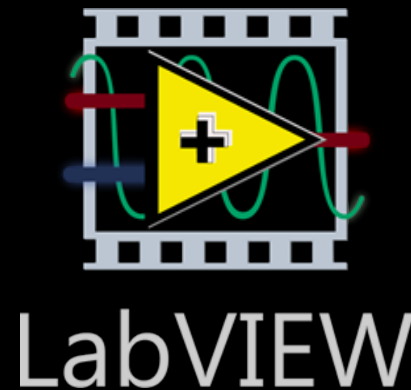
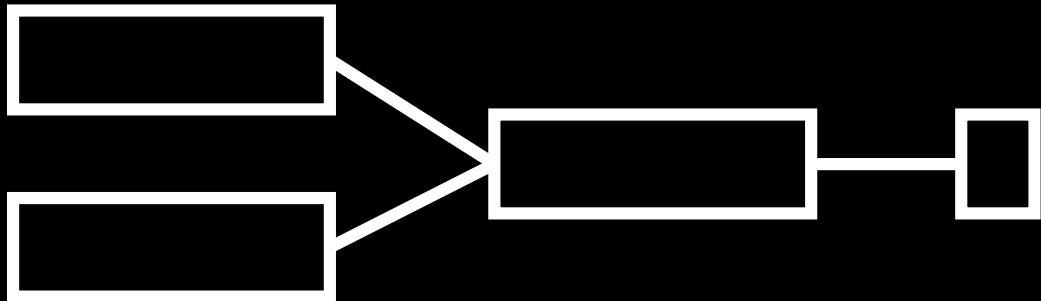


Bottom Mount

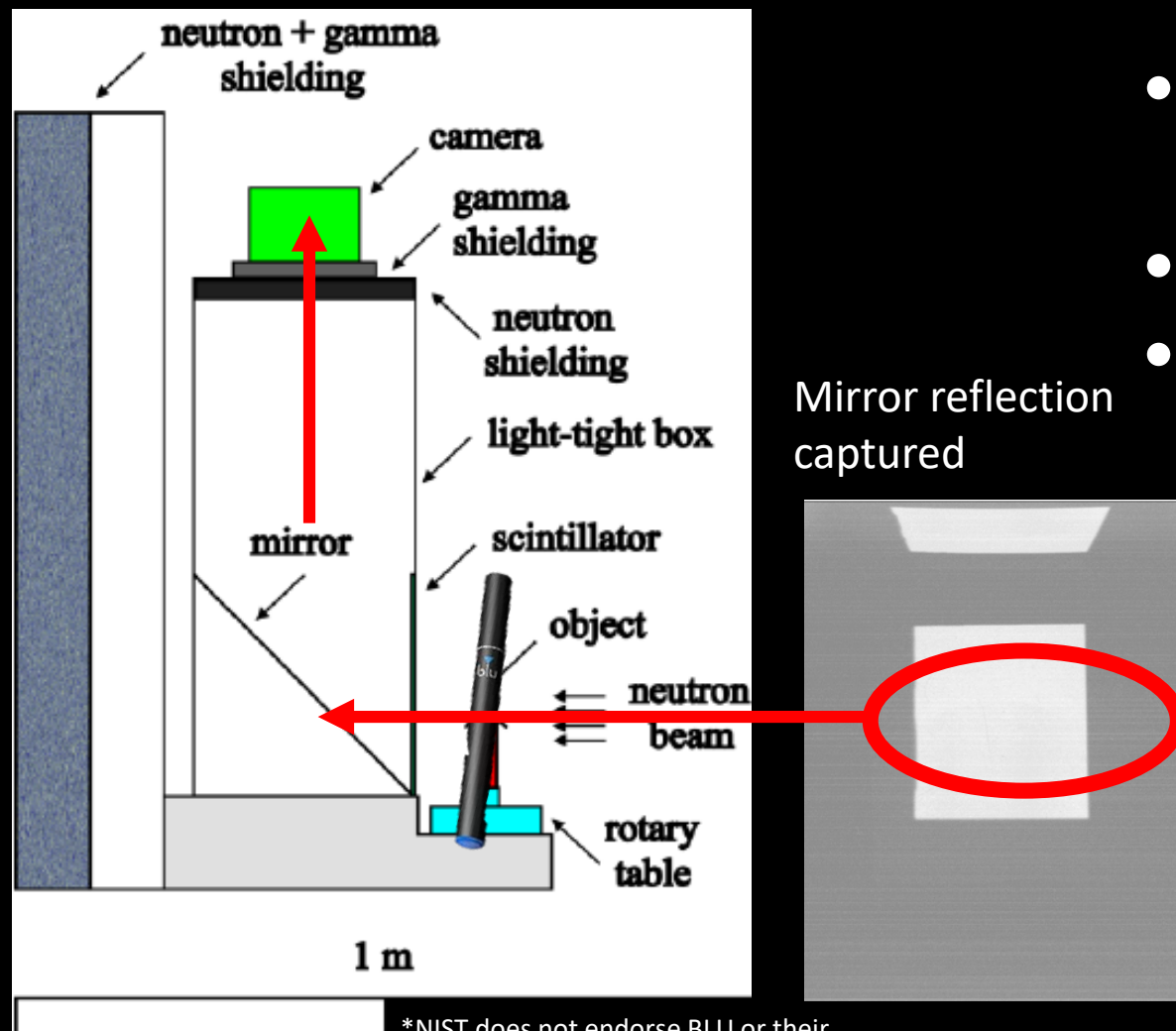


Control Software

- Made on LabView
 - Versatile visual programming language
 - Motion Control: Rotary rotates 1.1 degrees per step
 - Take a projection image and save onto computer
 - Do this for the entire 360 deg rotation



How Neutron Images Are Taken



- Neutron Beam is absorbed by the scintillator
- Converts into visible light
- Light hits mirror and is reflected
 - Camera is able to capture light and forms an image

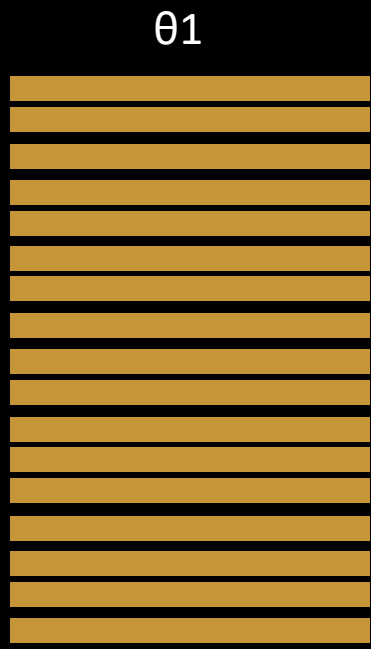
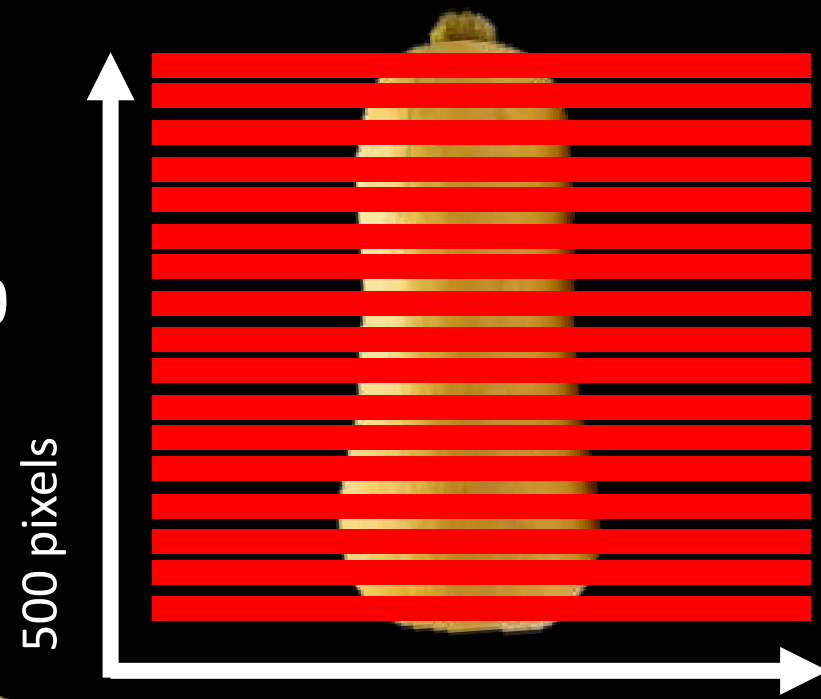
Sinograms

Suppose the detector area is
1000 pixel horizontal x 500
pixels vertical:

Each row is 1000 pixels

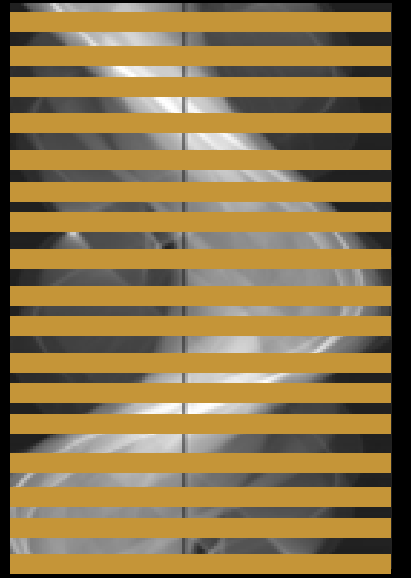
Each row has 360 projections

Cut into 500
rows



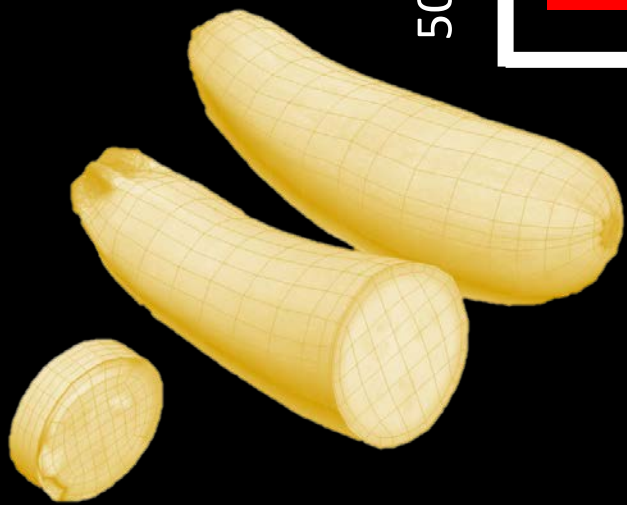
360 projections are
stacked to make a
sinogram

theta_1
theta_2
theta_3...



Mathematically
back projected
into 500 2D slices

Stack all 500 2D
slices to get a 3D
image





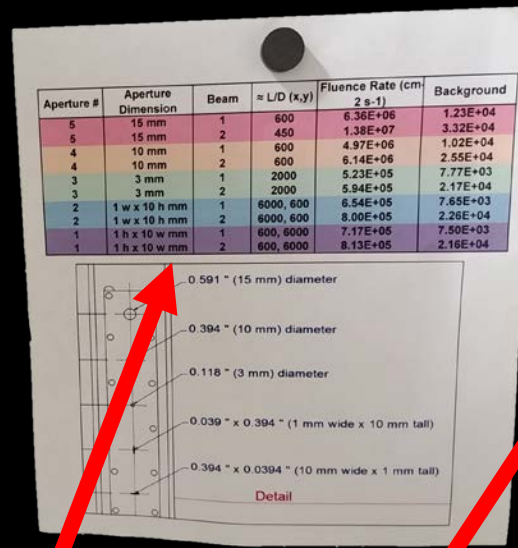
Camera mounted on top of frame

Lead bricks act as gamma radiation shielding

NGD Pictures



Rotary stage inside of frame



Shows resolution values for different beam apertures

Camera hooked up to frame, specimen placed inside along with adapters



Beam collimator used for testing

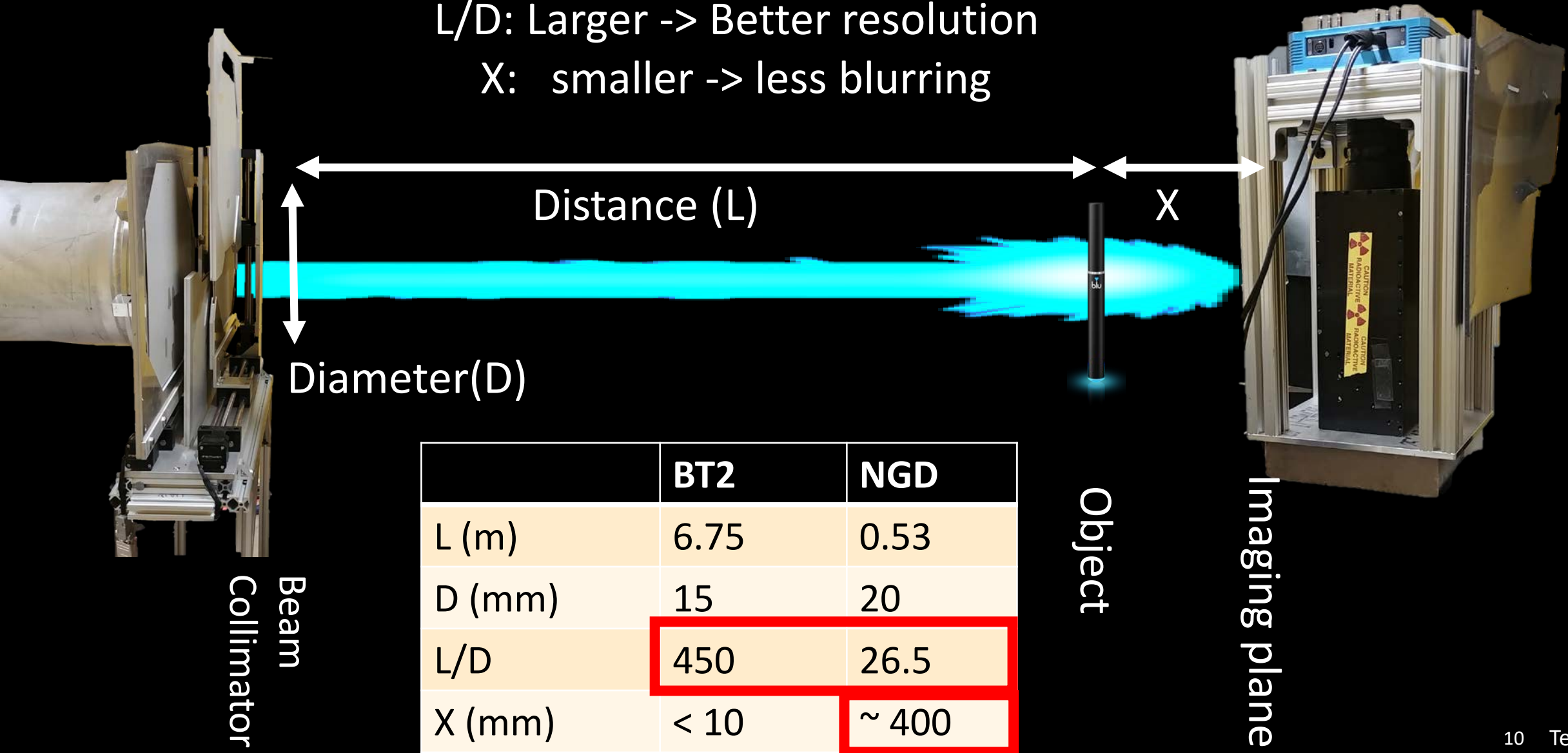


BT-2 Pictures

Parameters affecting image resolution

L/D: Larger -> Better resolution

X: smaller -> less blurring



	BT2	NGD
L (m)	6.75	0.53
D (mm)	15	20
L/D	450	26.5
X (mm)	< 10	~ 400

Test object: E-Cigarette

- Reasons for choosing this specimen:
 - “About 3 million—or 20 percent—of high school students are vaping, according to the findings. In contrast, last year 1.73 million—or 11.7 percent—used e-cigarettes, according to recently published federal data.”
 - Demonstrate process
 - Learn the differences between neutron and x-ray tomography



Taking it Apart



Casing

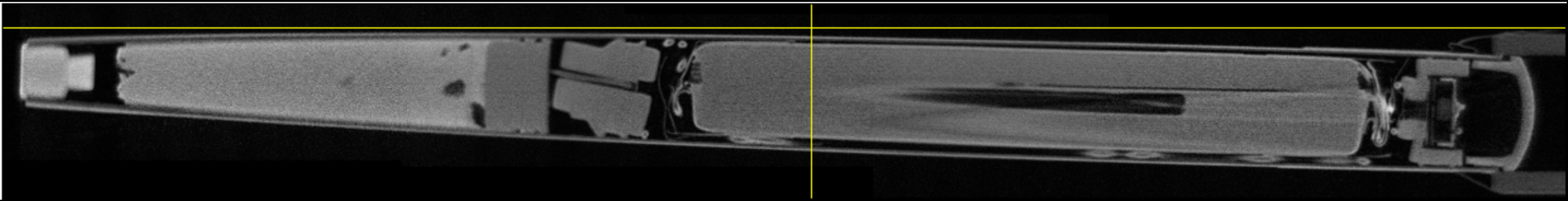
Liquid

Battery

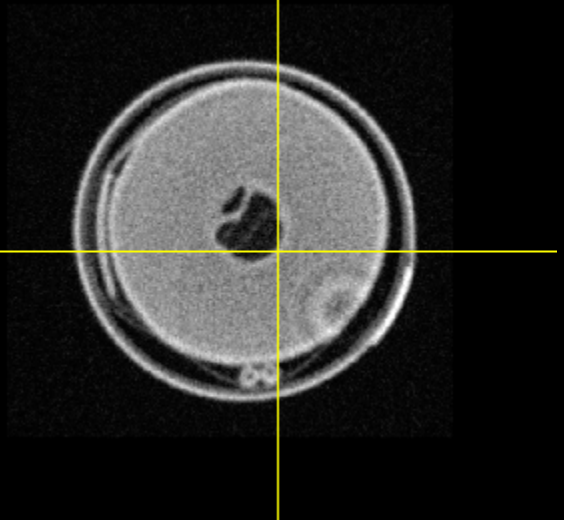
Heating Coil



Side View of The Model



Cross-section view



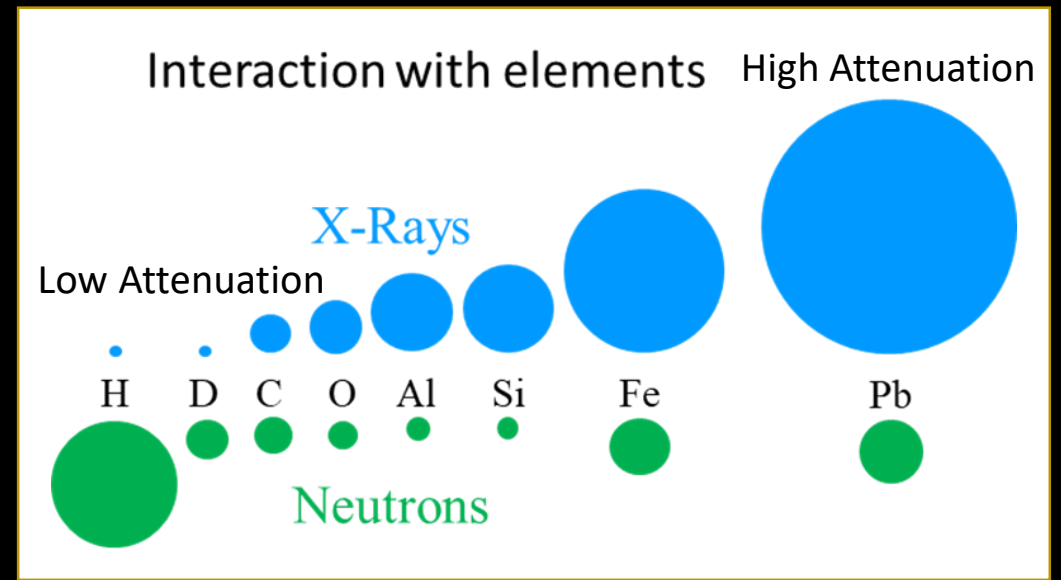
Understanding The Difference

Attenuation:

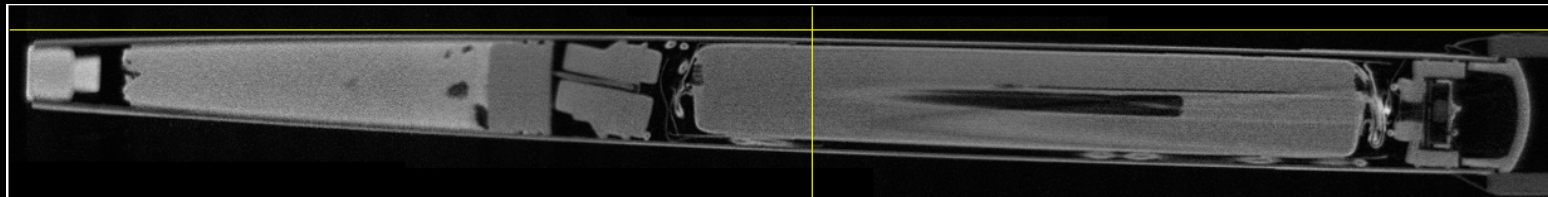
How much of the beam a material can absorb

Certain materials can be seen better with each beam

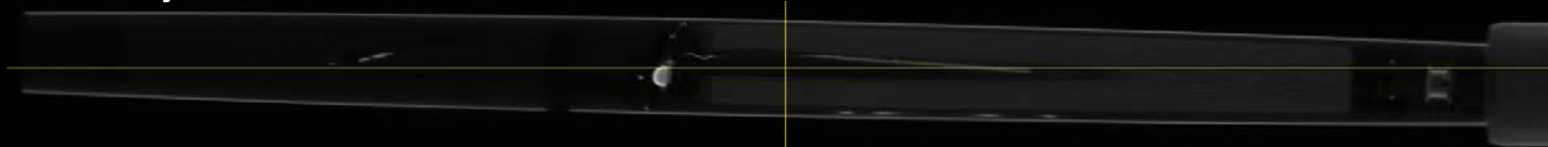
Combining both can help with reconstruction



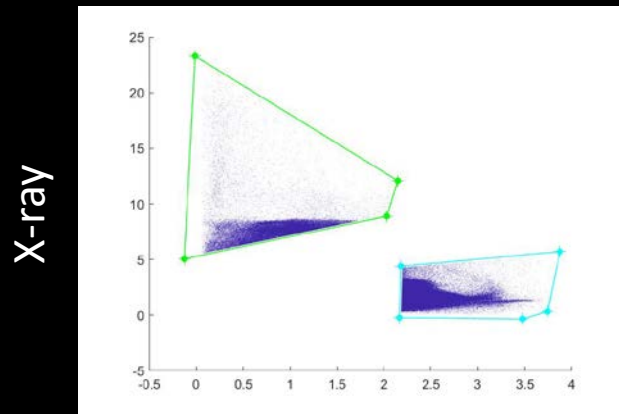
Neutron



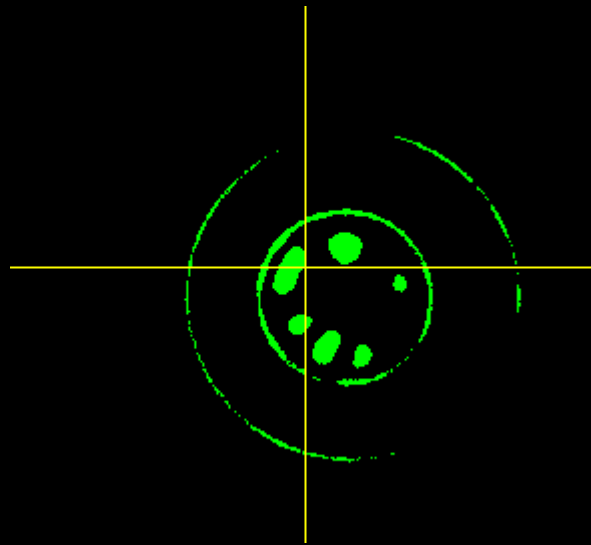
X-ray



Segmentation



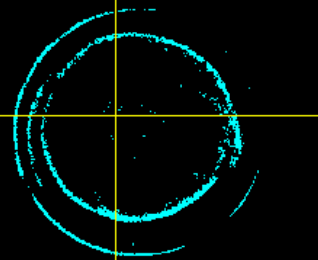
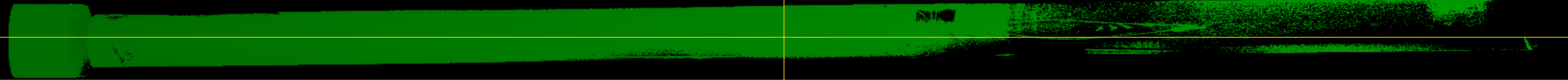
Neutron



X-ray

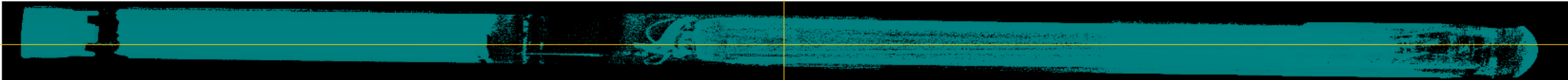
Based on my observation...

This green segment would be metal, because of the visibility of some of the wiring and components.



Neutron

This blue segment would be plastic, because it gives us more material.



Summary

- Learning the process of tomography, looking at both hardware and software
- Explain the differences between NGD and BT-2
- Understanding how reconstruction works and showing data

Progress

- Neutron tomography image taken at BT-2
- Limited resolution
- Attempted again at NGD
- Similar results

