Mastering CT: Advanced Techniques in Practice

Episode 1 – High-attenuation Sample Imaging with X-ray Computed Tomography

Wednesday, August 20 at 10 am CDT

Presenter: Ted Huang

- *You will be muted during the workshop*
- *You can ask questions using the Q&A tool.*
- *You should hear music if your sound is working*

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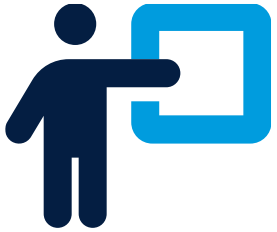
Presenter:
Ted Huang



Co-presenter:
Angela Criswell

Host:
Katelynn Stuchlik

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You can ask questions during the presentation. Please use the Q&A to ask questions.

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Recording will be available tomorrow.

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What is X-ray CT?

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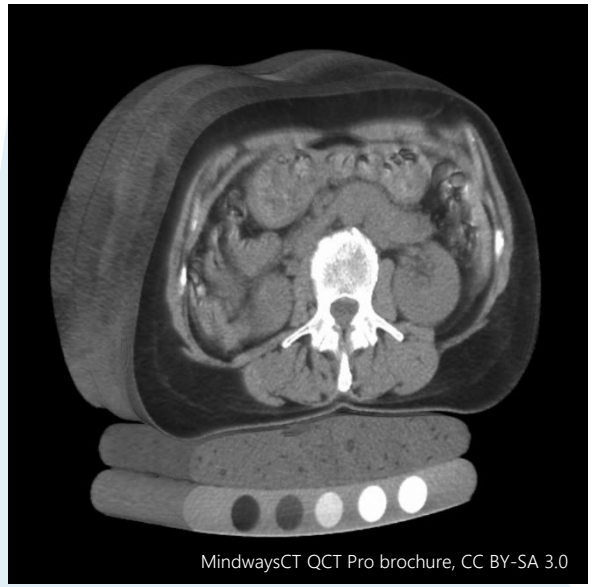
What is CT (Computed Tomography)



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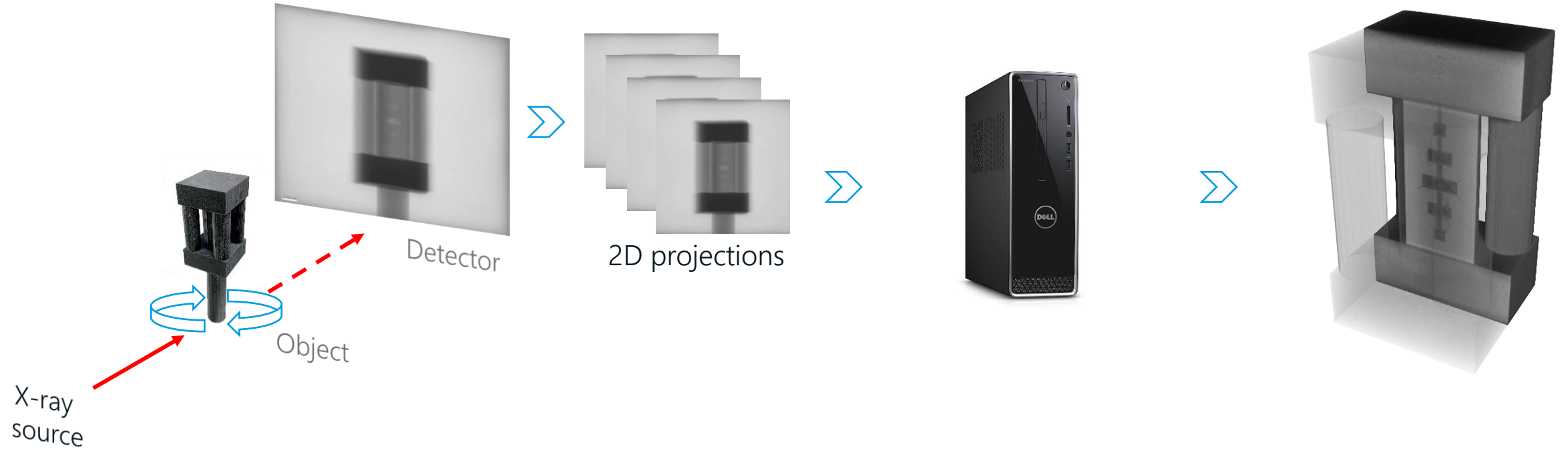
How does x-ray CT acquire 3D structural data?



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Very simple
Until it is not

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Challenges

1. Hard to scan samples
2. Too many samples
3. Changing sample structures

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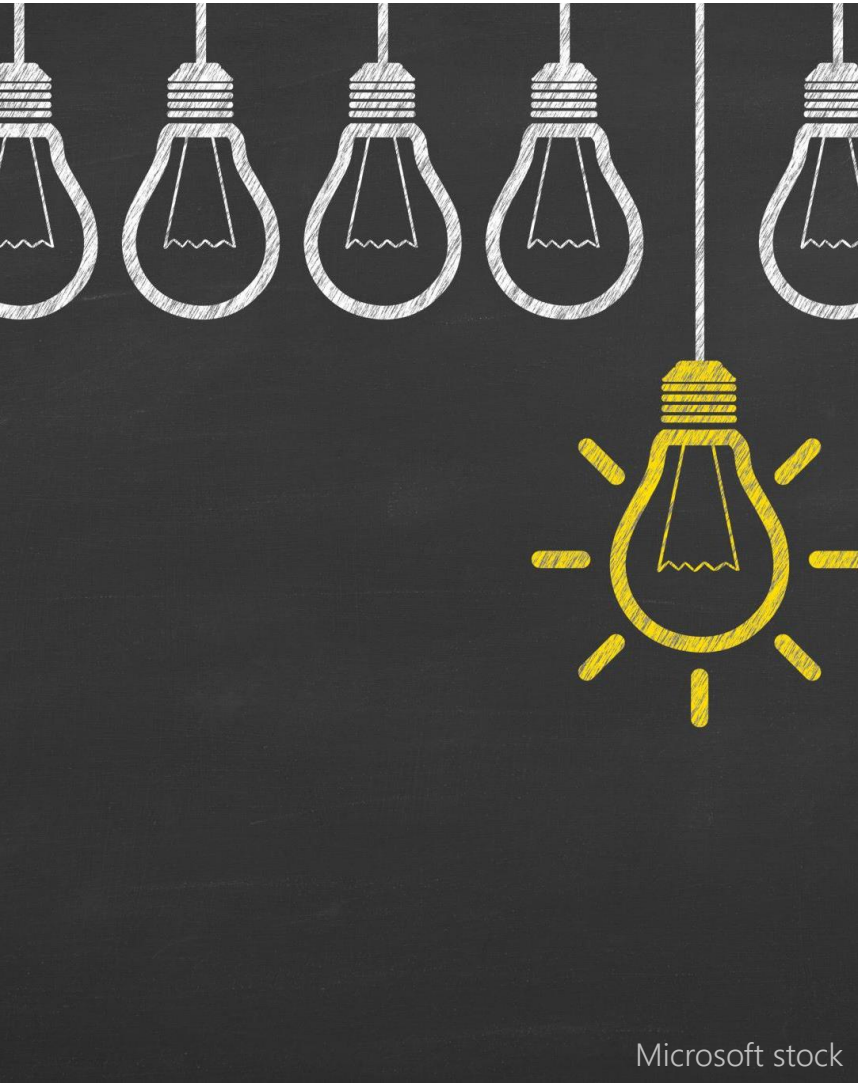

Series episode topics

1. High-attenuation Sample Imaging
2. Automating Workflows
3. 4D Structure Study

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High-attenuation Sample Imaging with X-ray Computed Tomography

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You will learn

- What is high attenuation sample
- What challenges do they pose
- How to address these challenges
- Real world example scans

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What is attenuation ?

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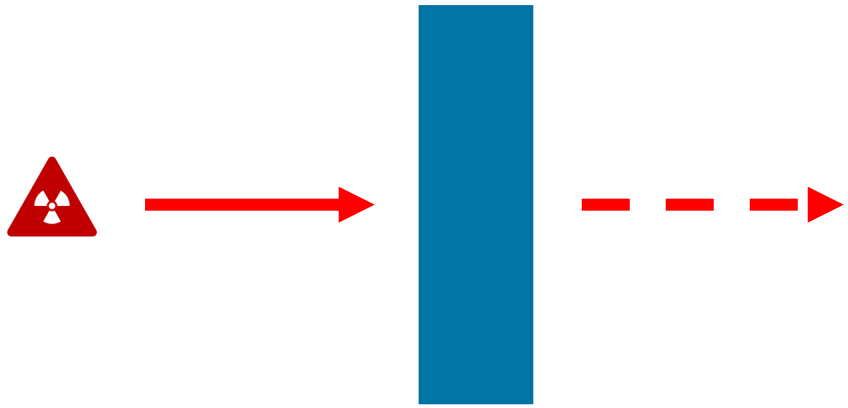
X-ray imaging contrast



Things absorb X-rays.

Object thickness

$$I_{transmitted} = I_{incident}\, e^{-\mu t}$$

Attenuation coefficient

$$\mu \propto \frac{\rho A Z^4}{E^3}$$

- $\propto$ Density (ρ)
- $\propto$ Atomic number (Z)
- $\propto$ Atomic mass (A)
- $\propto \frac{1}{\text{X-ray energy } (E)}$

Very absorptive materials

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High attenuation samples

Bones

Rocks/Concrete

Academic/Excavation research

Metals

Manufacturing

Bulky samples

Anywhere

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What are the challenges ?

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High attenuation sample challenges

1. Low contrast
2. Artifact
   - Metal artifact
   - Beam hardening
3. Mounting issues

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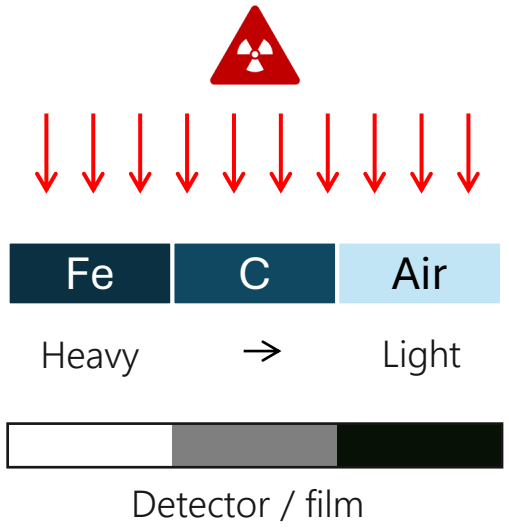
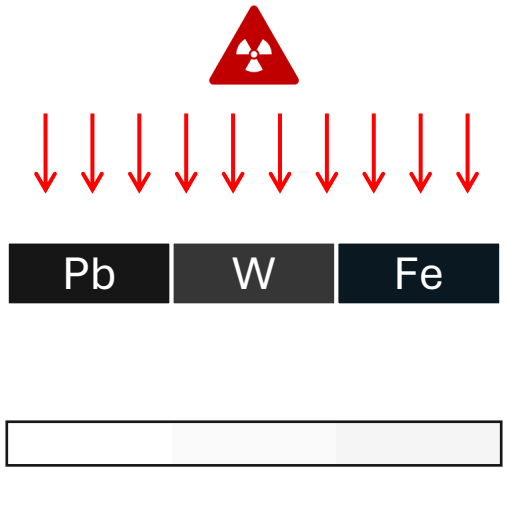
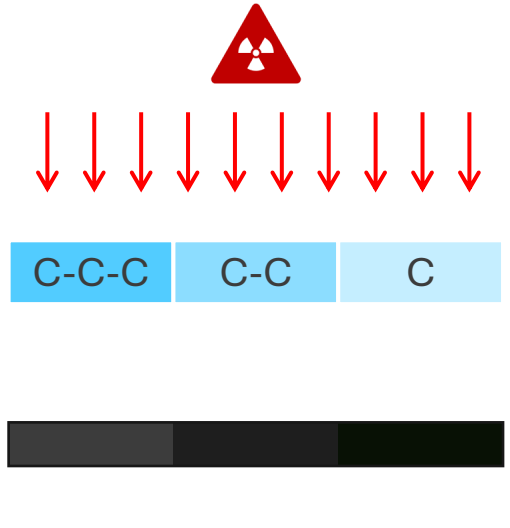
What is low contrast ?







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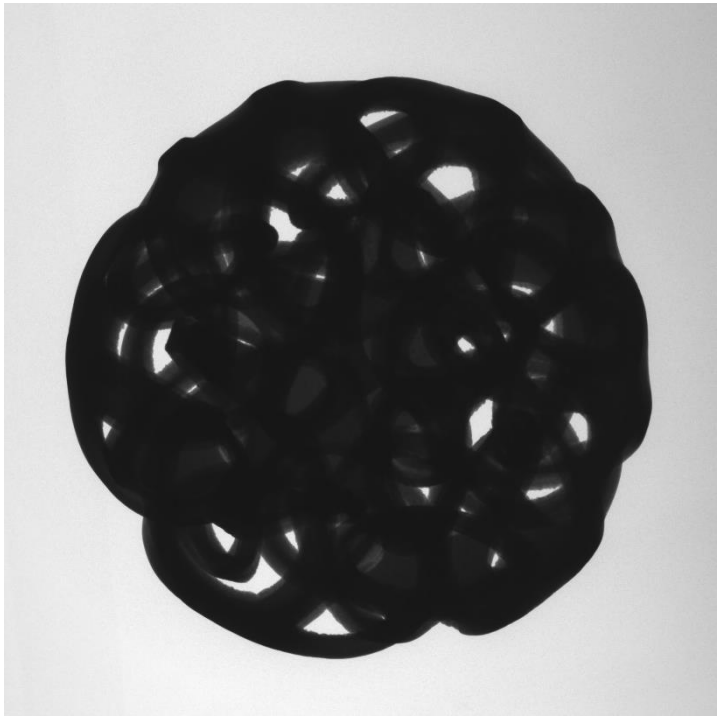
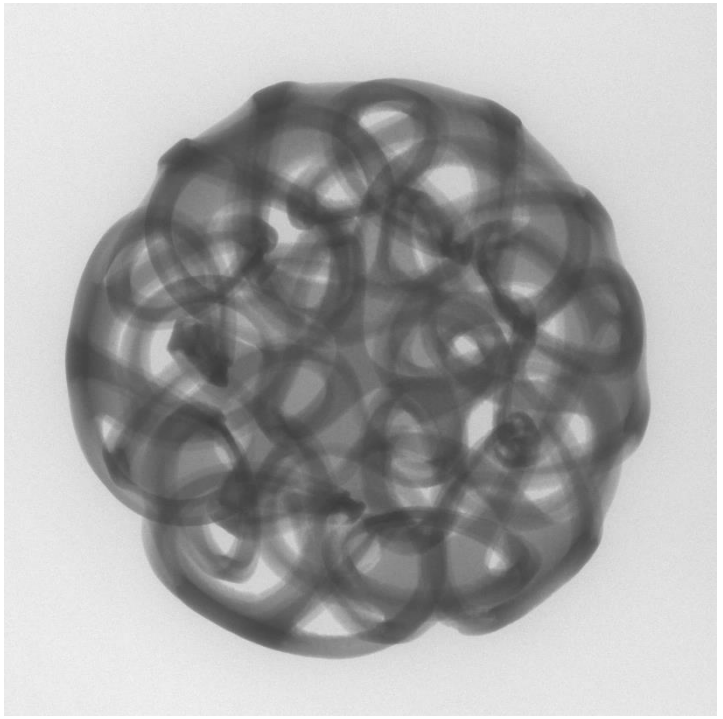
Low contrast



Low contrast radiograph



High contrast radiograph

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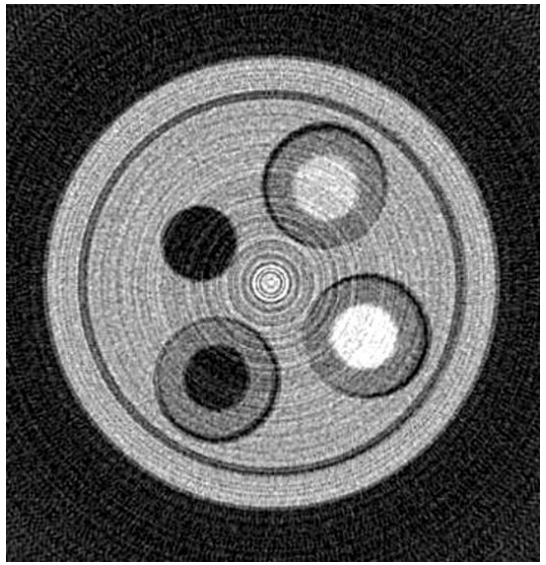
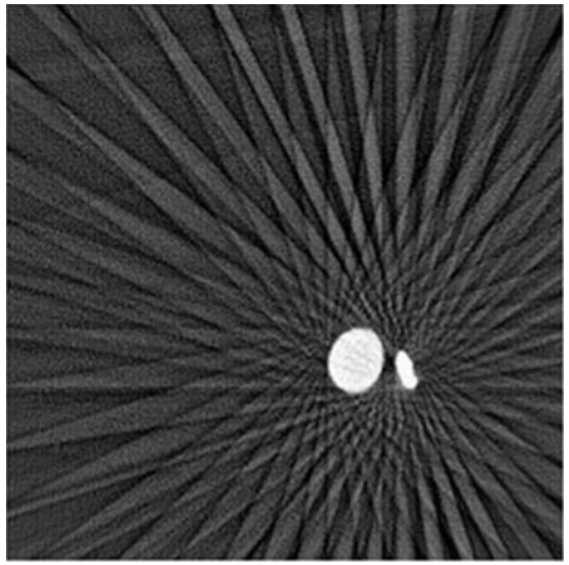
What are artifacts ?

Features, patterns, or change in images that do not represent true features of scanned objects.

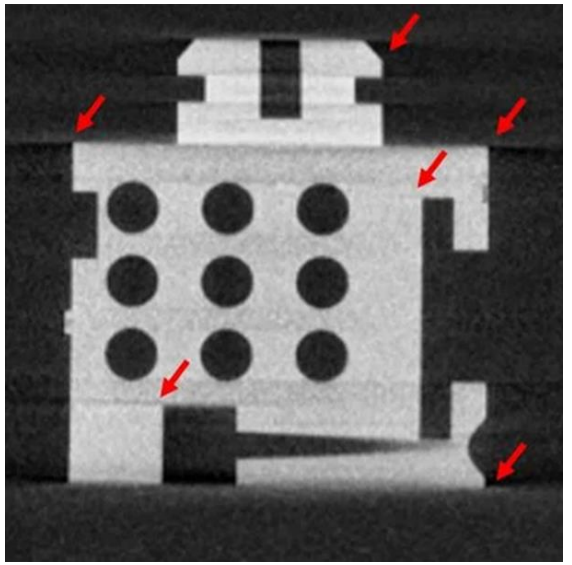
Artifacts arise from the imperfection of the measurement procedure.



Ring



Streak



Scatter

https://imaging.rigaku.com/blog/recognize-and-minimize-ct-artifacts

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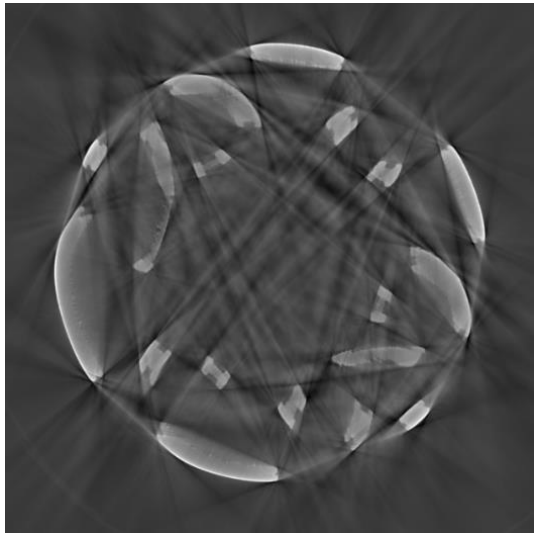
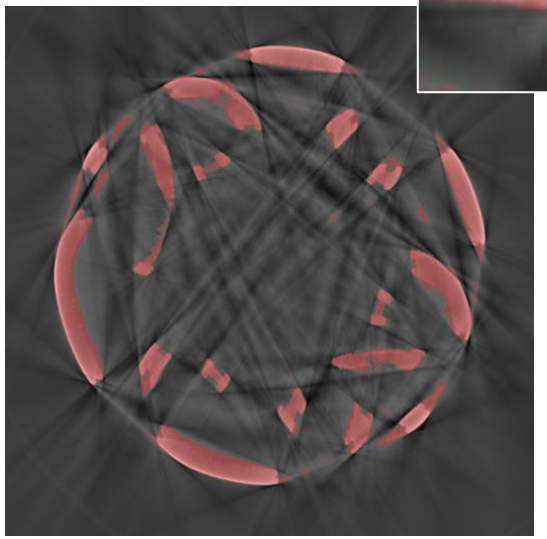
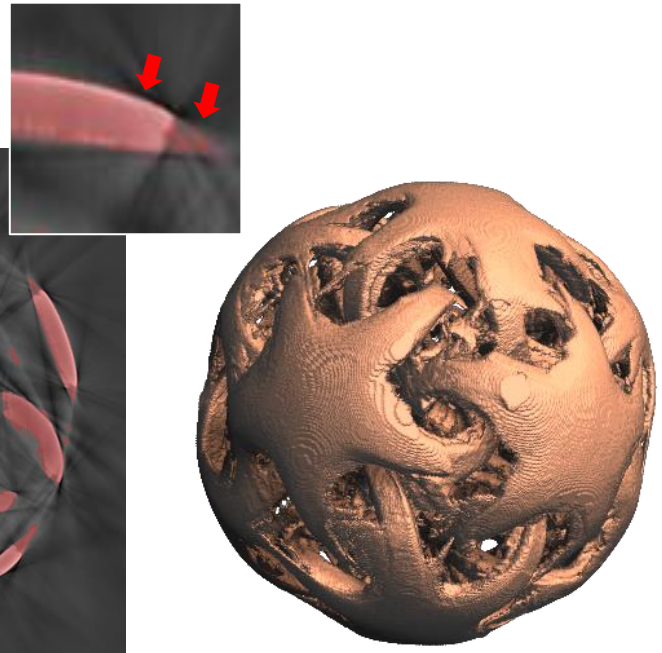
What do artifacts disrupt?







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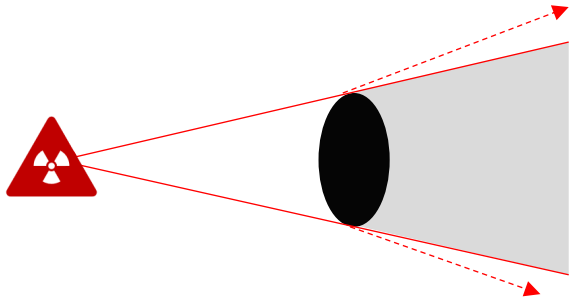
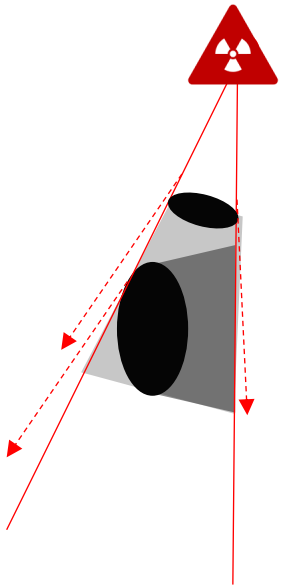
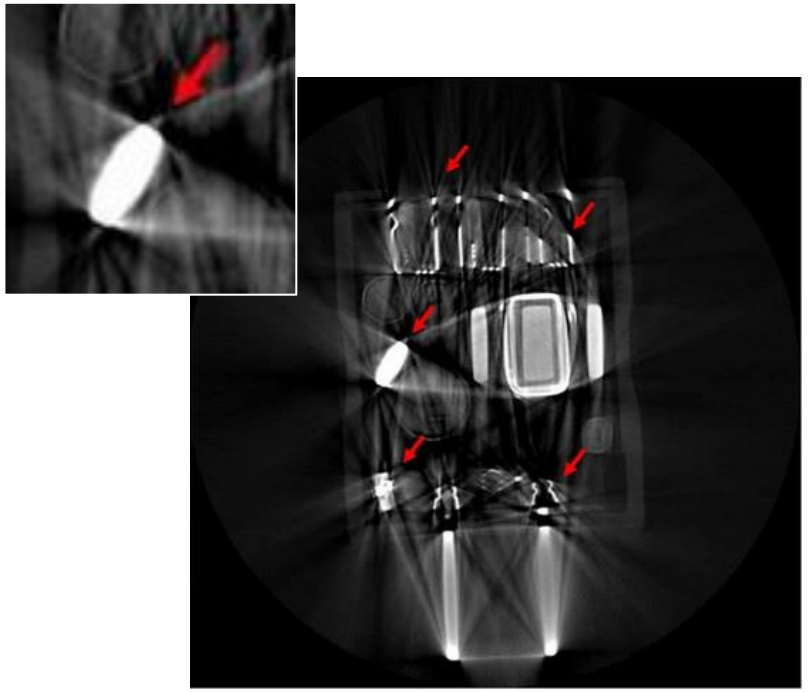
Artifact – Metal artifact







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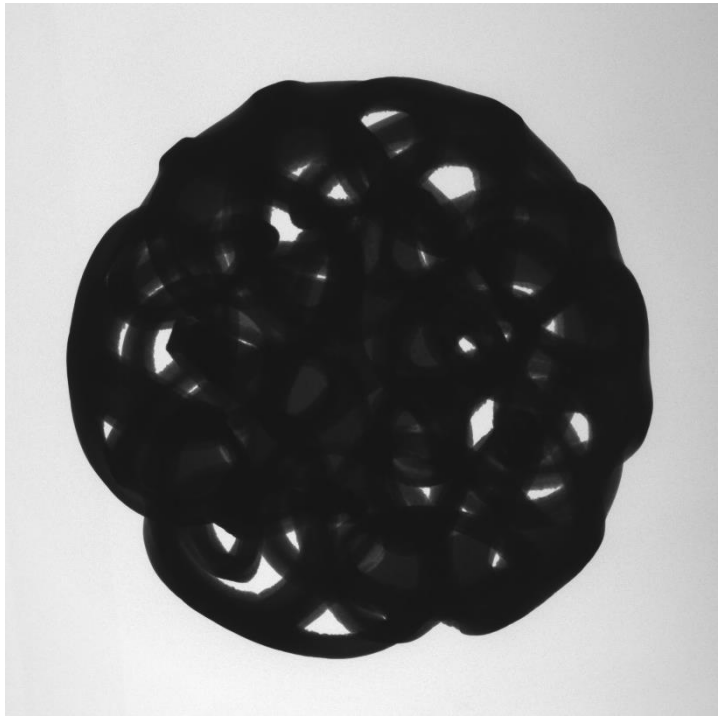
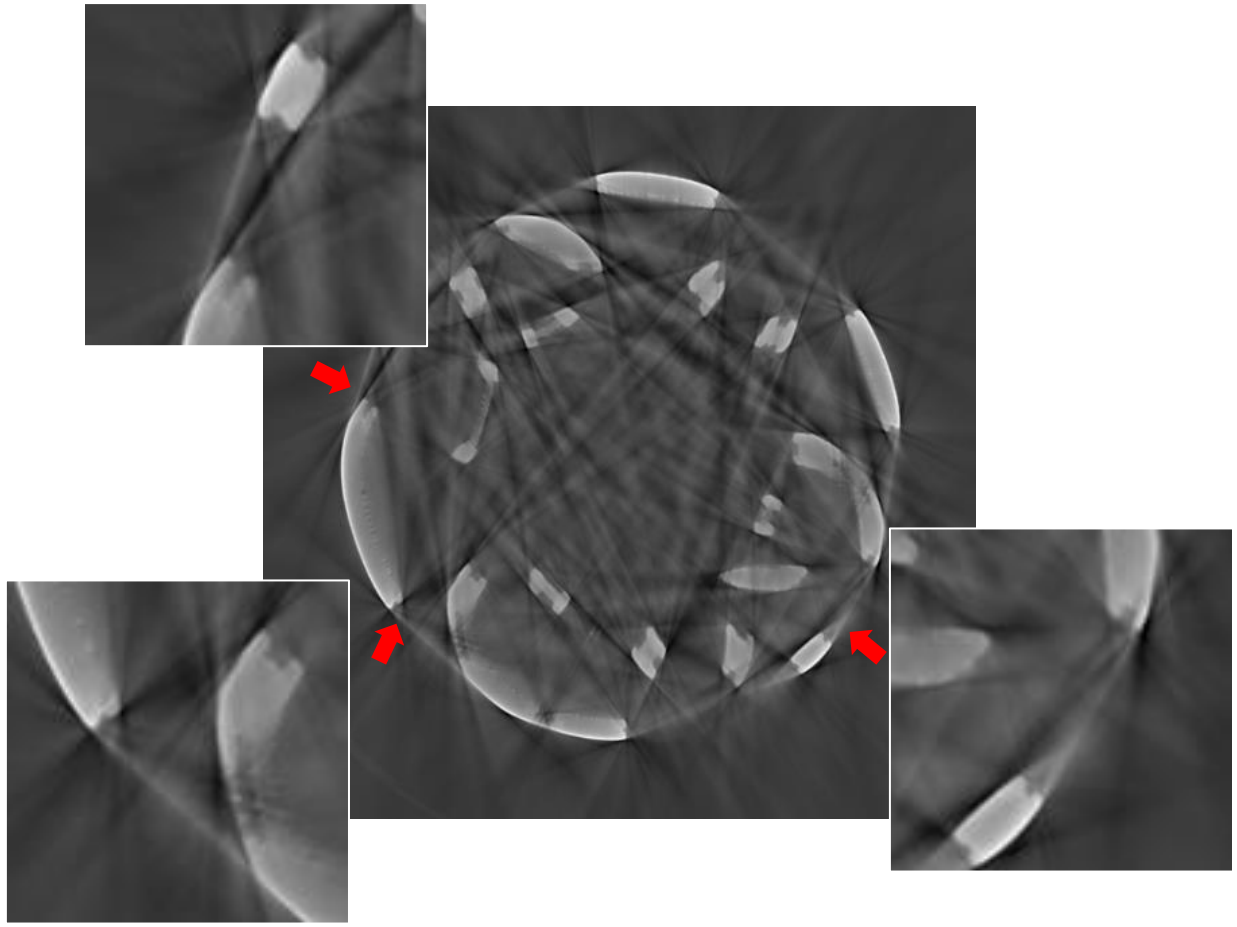
Artifact – Metal artifact





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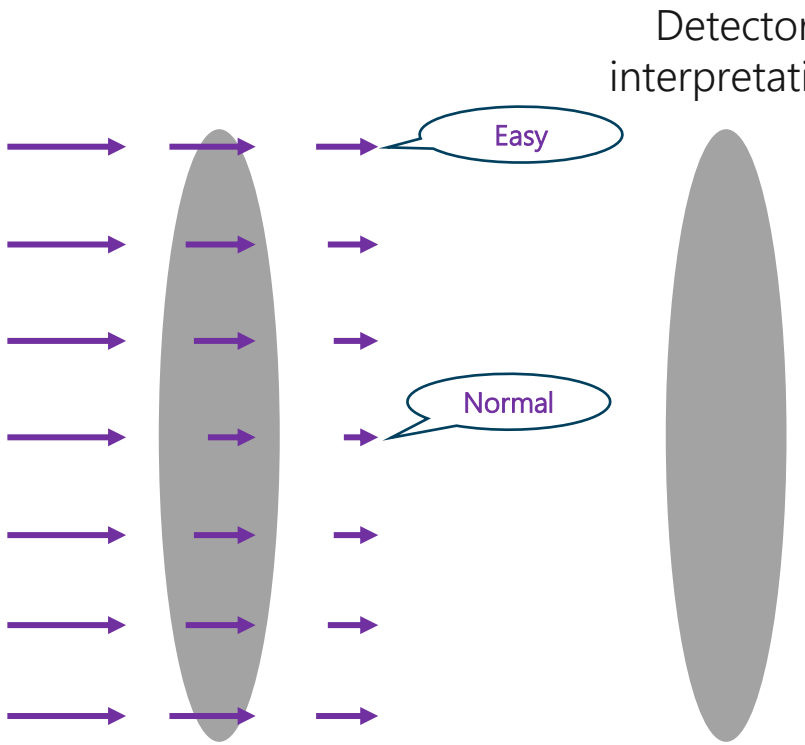
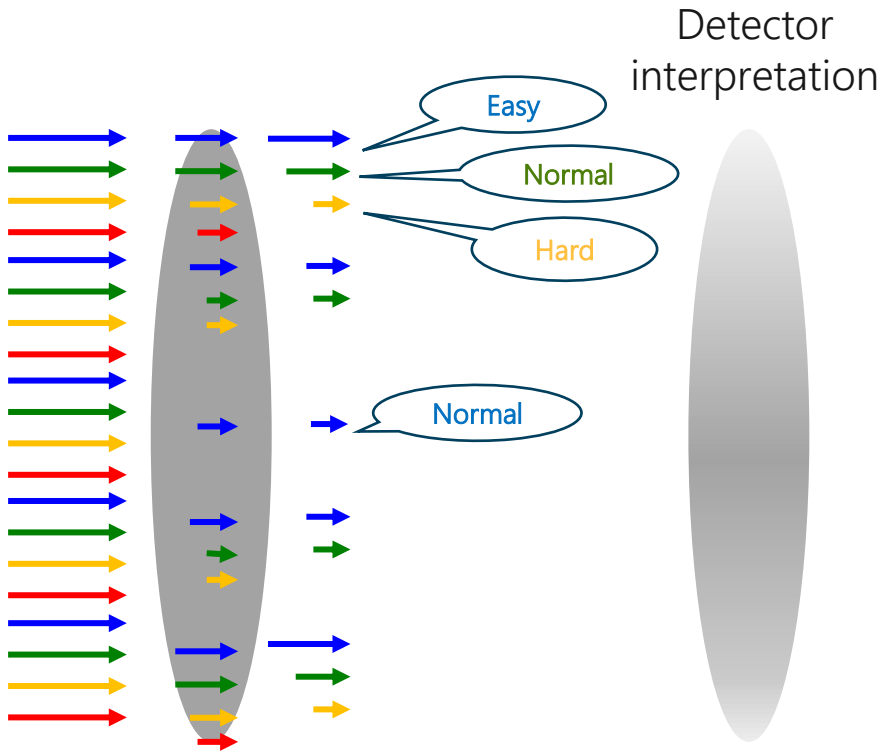
Artifact – Beam hardening



Monochromatic X-rays
(same energy photons)



Polychromatic X-rays
(different energy photons)

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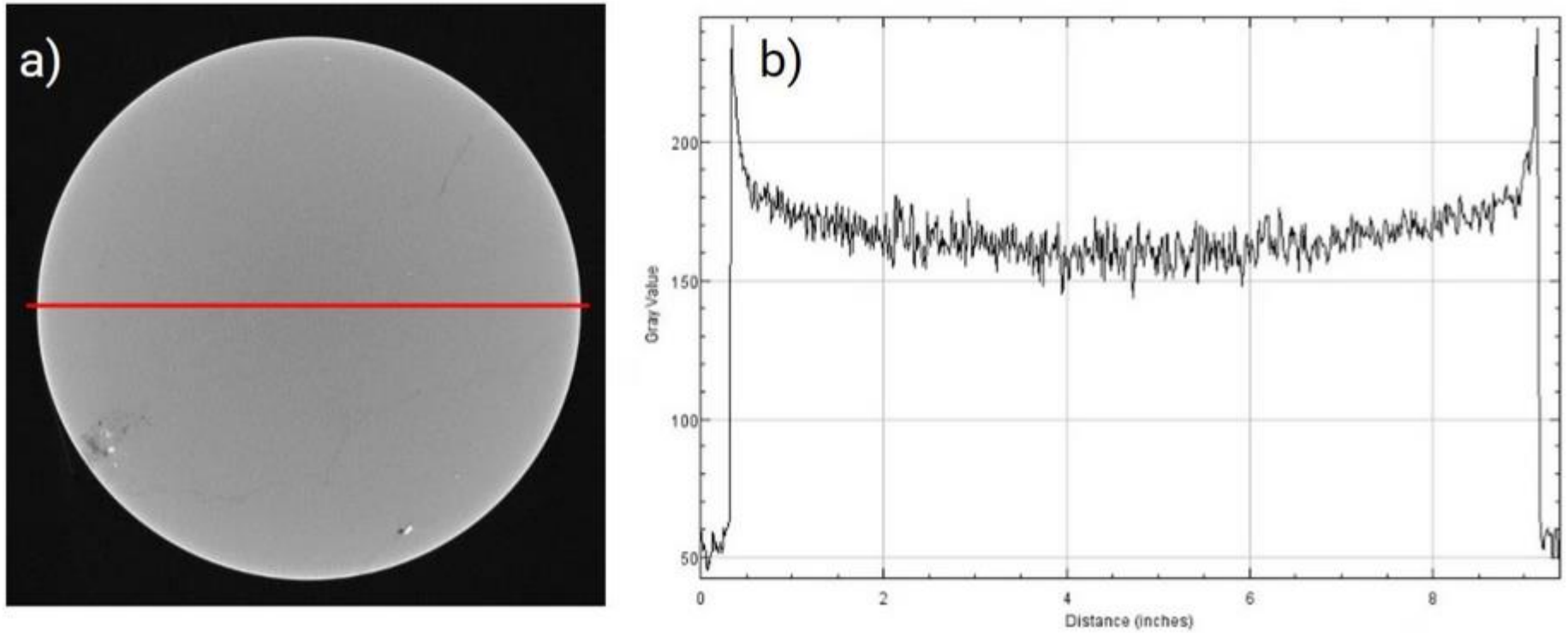
Artifact – Beam hardening



https://rigaku.com/products/imaging-ndt/x-ray-ct/learning/blog/what-is-beam-hardening-in-ct

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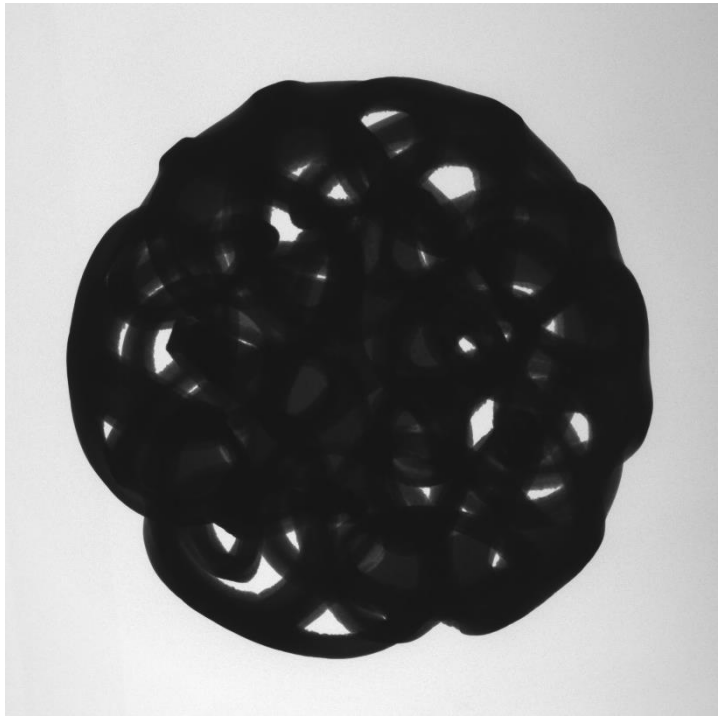
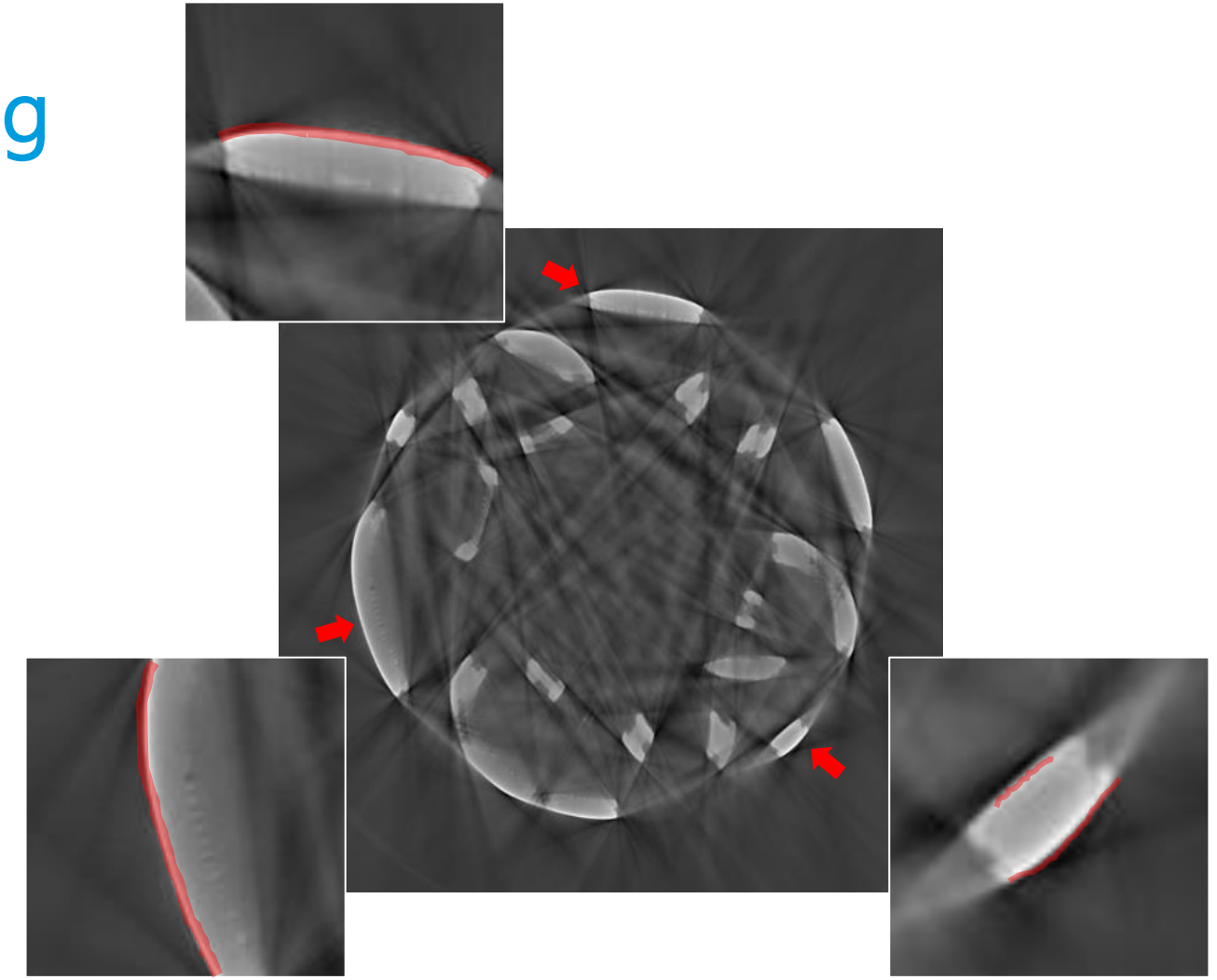
Artifact – Beam hardening





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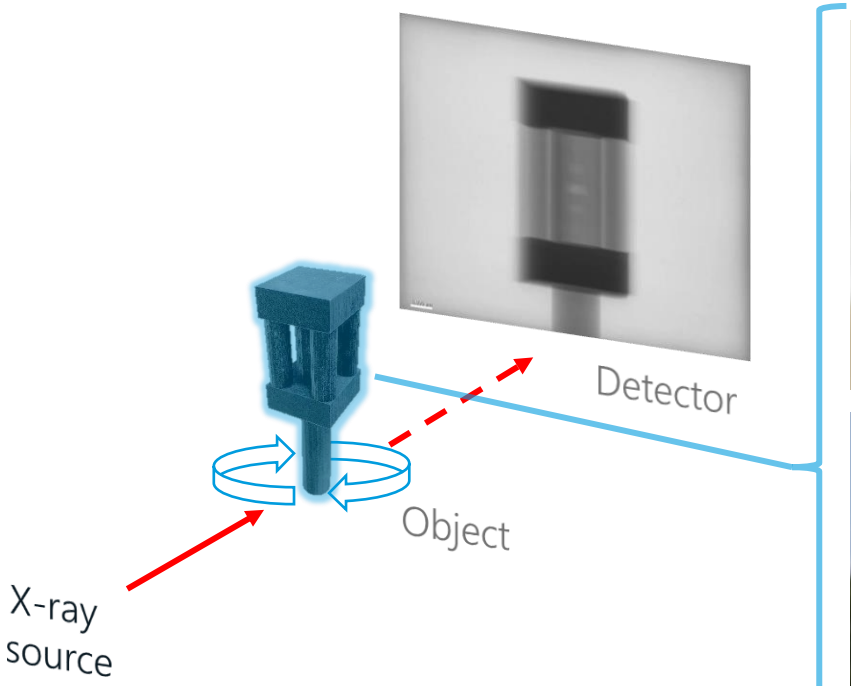
Why is sample mounting even a topic?



Bad
mounting

+

Artifacts

=

Bad
Image quality

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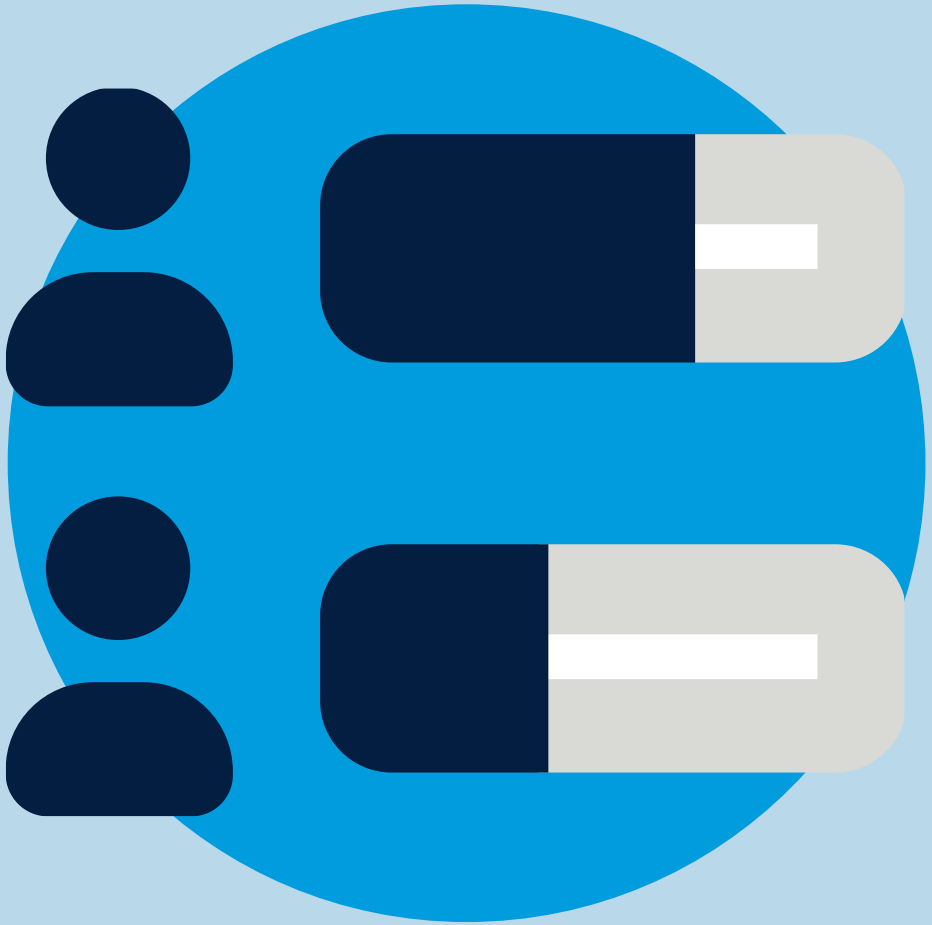
Polling Question



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How to address the challenges

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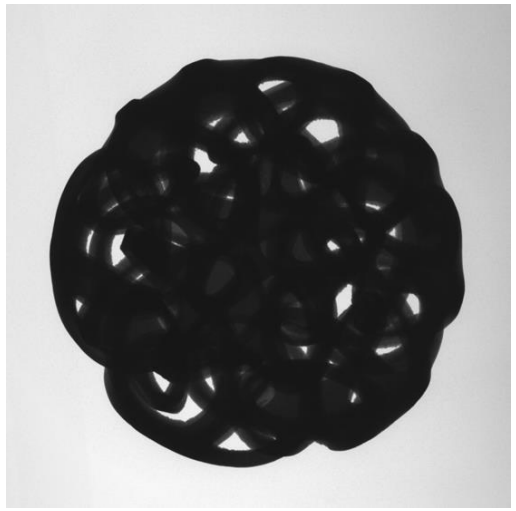
Scan improvements



Original scan

?

Improve contrast

?

Reduce artifact

?

Final improvement

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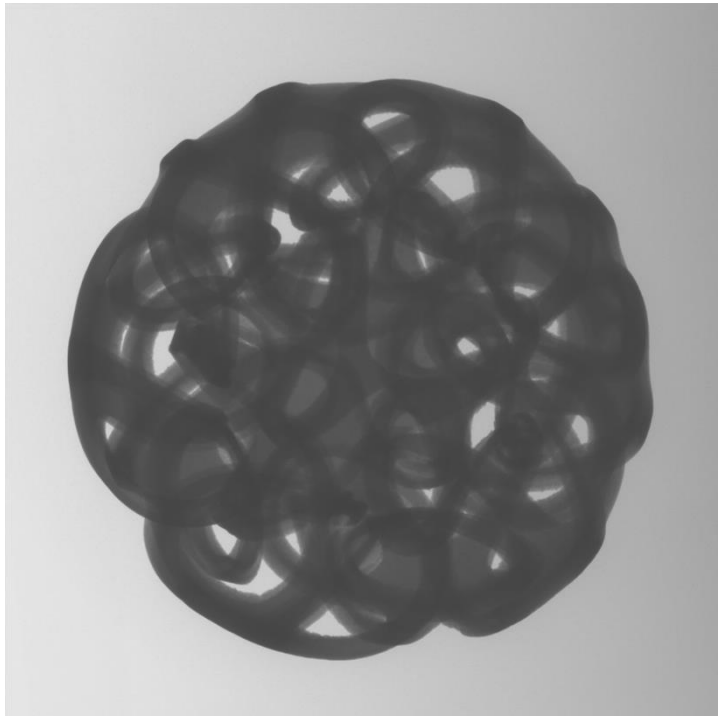
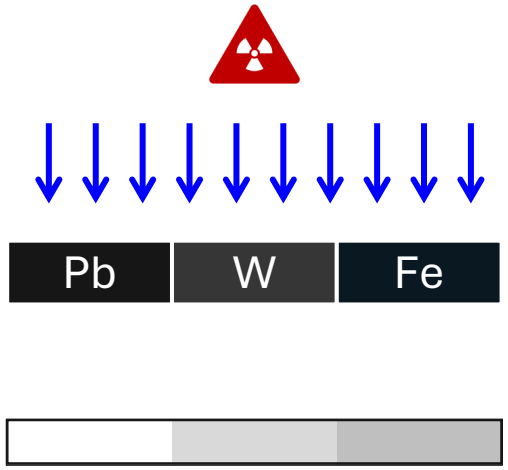
Scan improvements – Low contrast





Increase
acceleration voltage

130kV → 200kV

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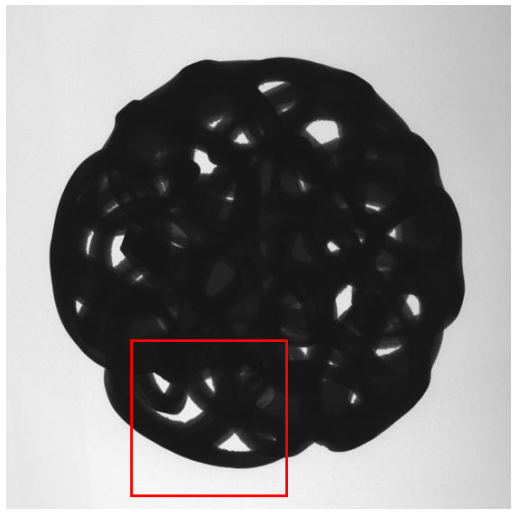
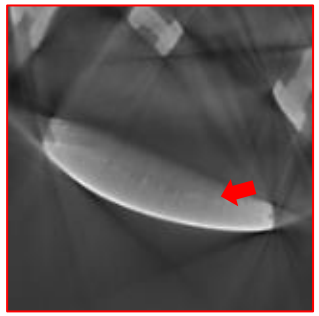
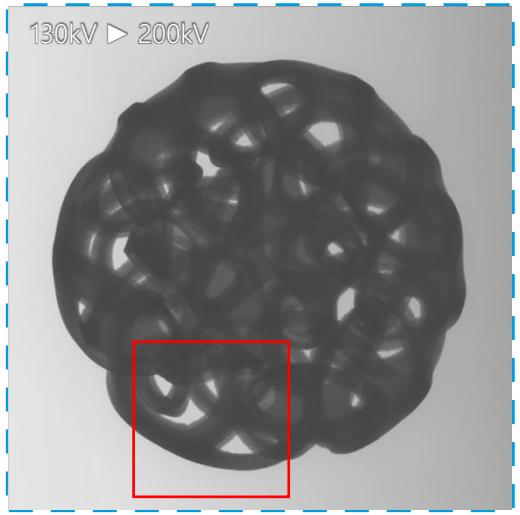
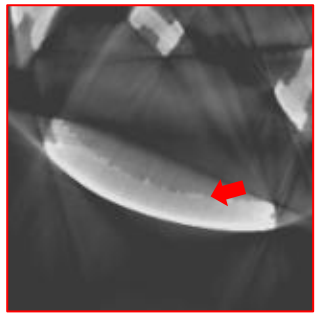
Scan improvements









Reduce artifacts

Final improvement

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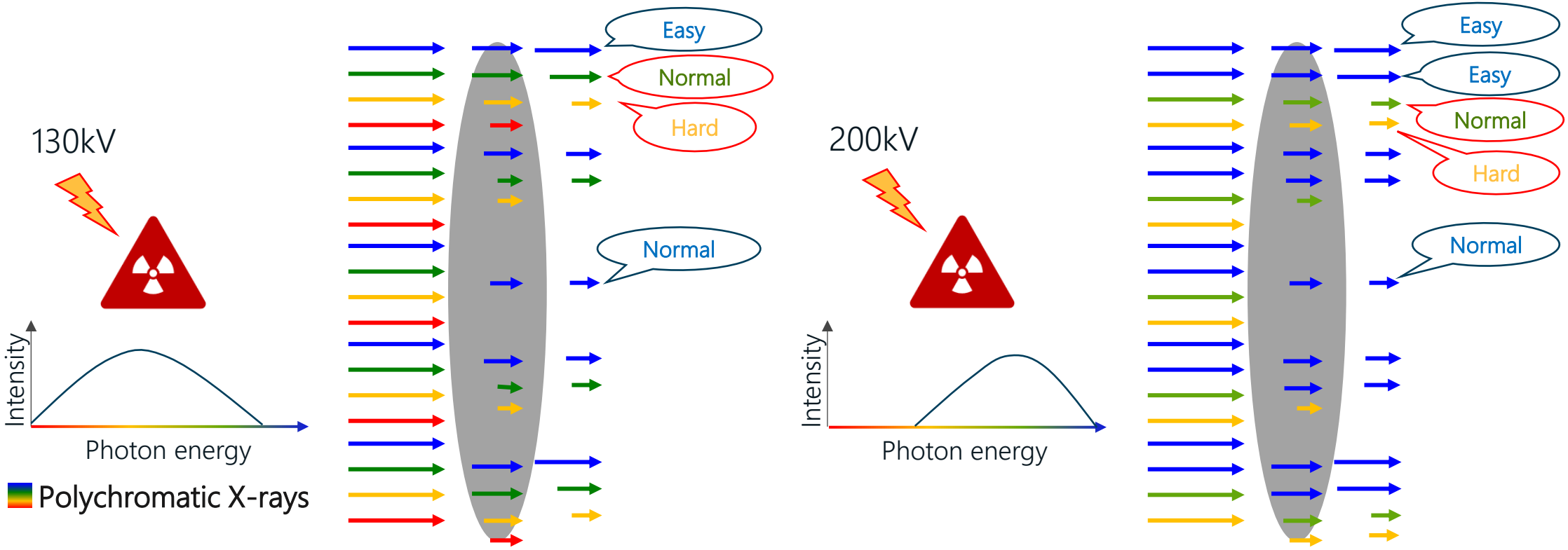
Scan improvements – Artifacts



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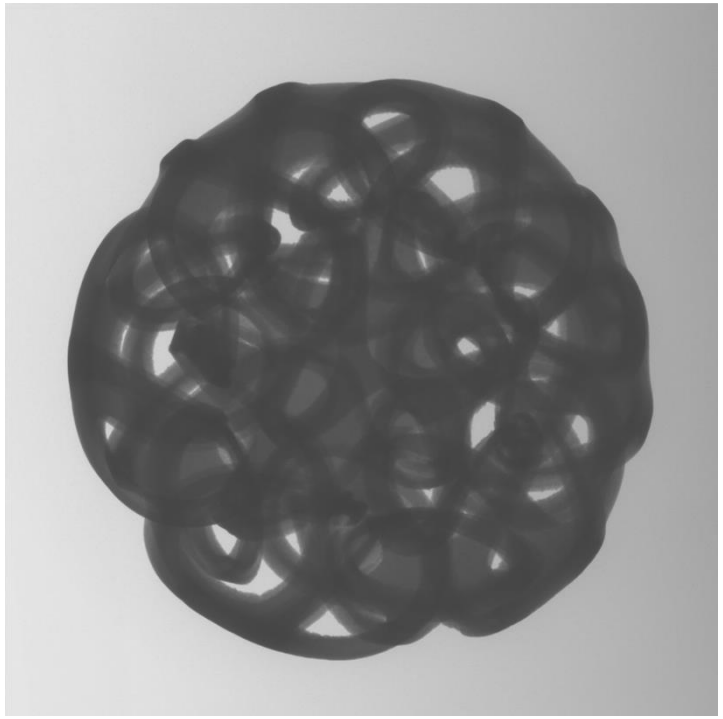
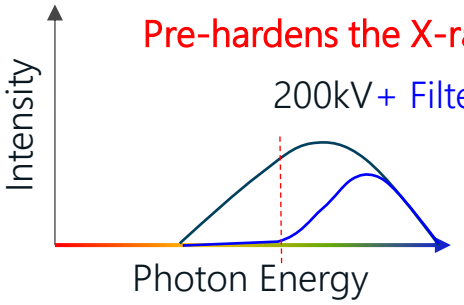
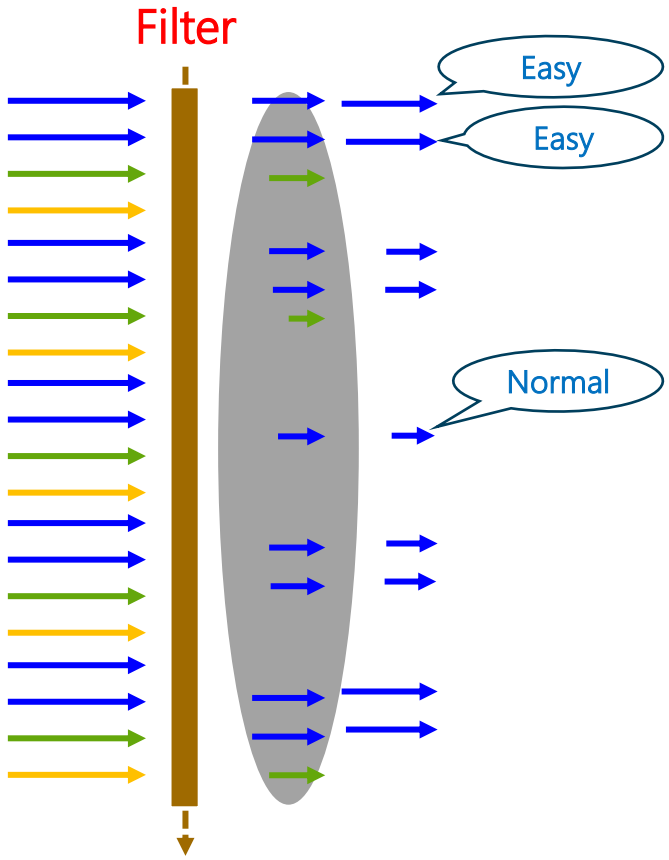
Scan improvements – Artifacts







https://rigaku.com/products/imaging-ndt/x-ray-ct/learning/blog/how-to-reduce-beam-hardening-artifacts-in-ct

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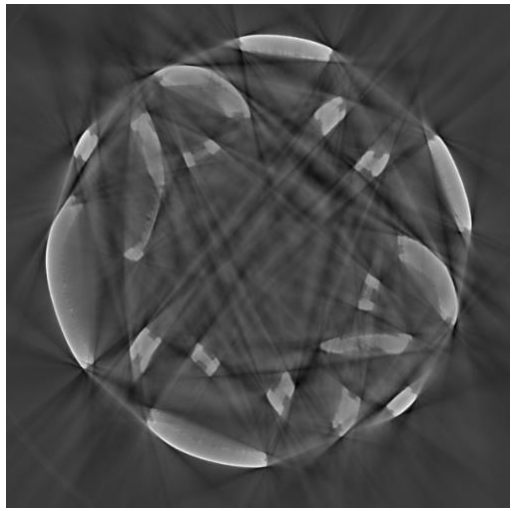
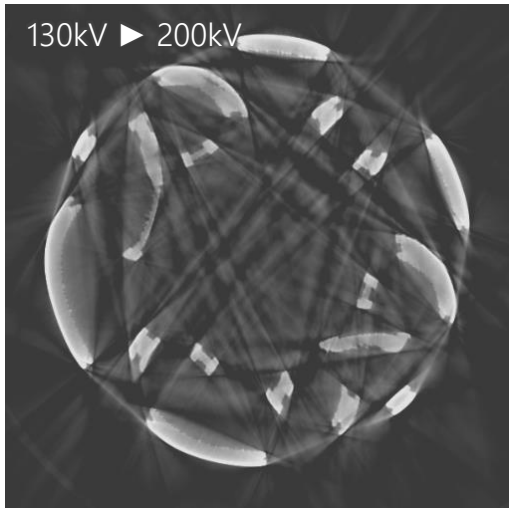
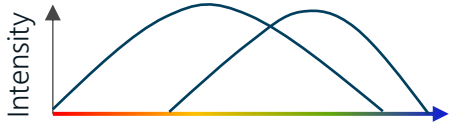
Scan improvements

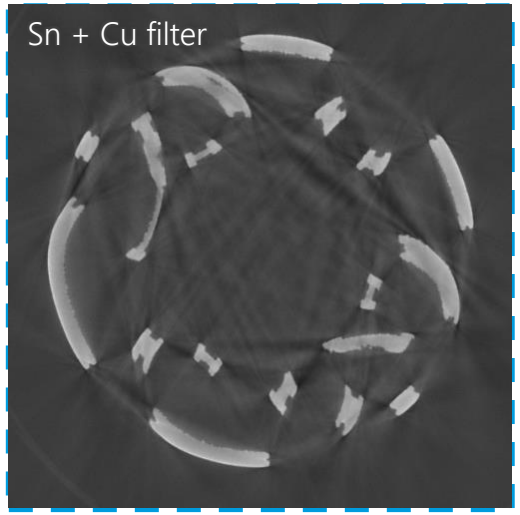


Original scan

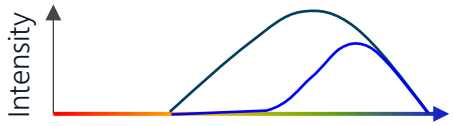


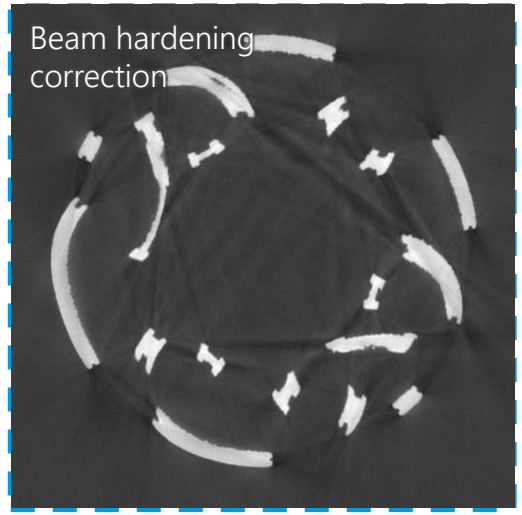
Increase voltage
(Shift photon energy range)





Apply filter
(Cut lower energy photons)





Post-scan processing

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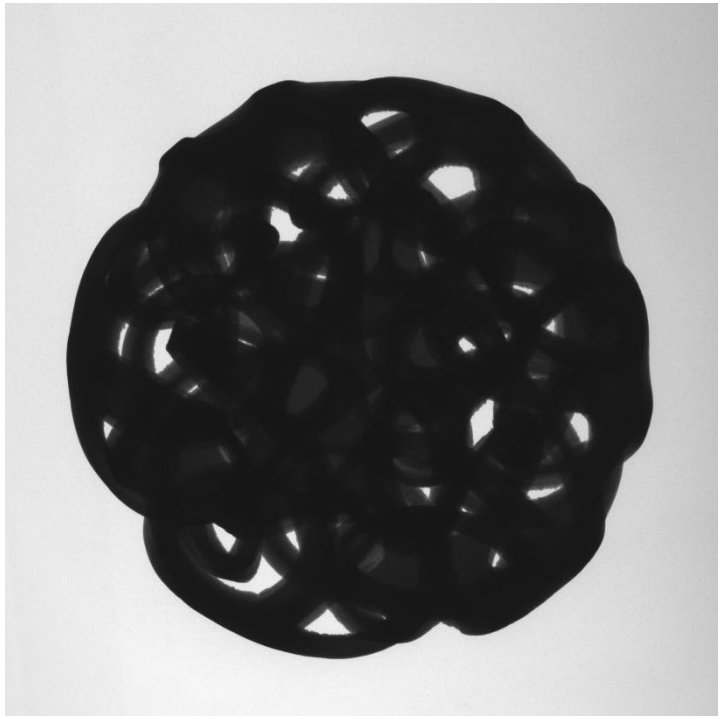
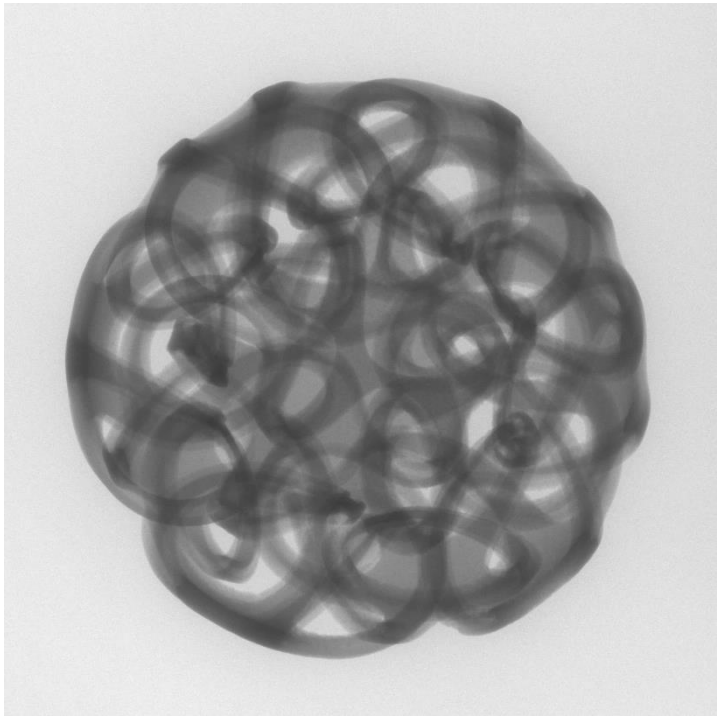
Scan improvements - Comparison



Original scan



Improved scan

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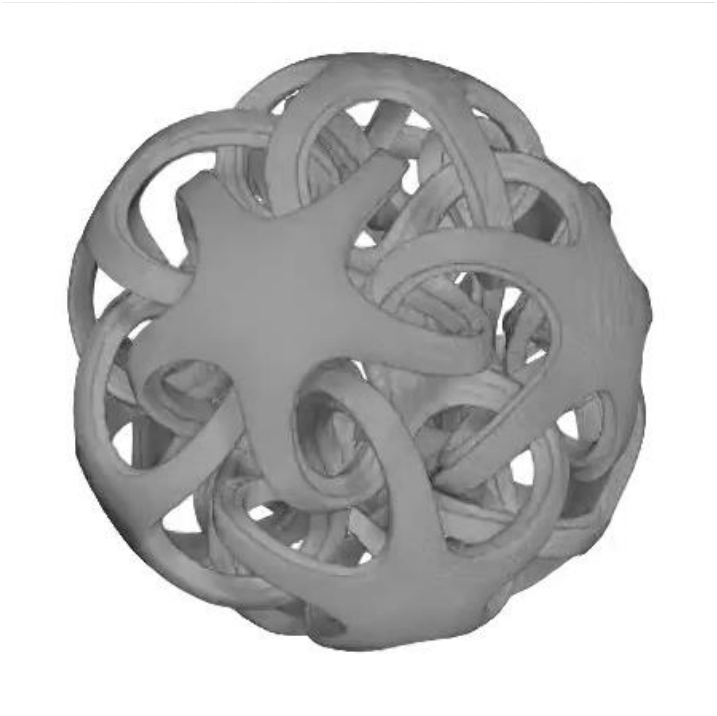
Scan improvements - Comparison

Original scan



Improved scan

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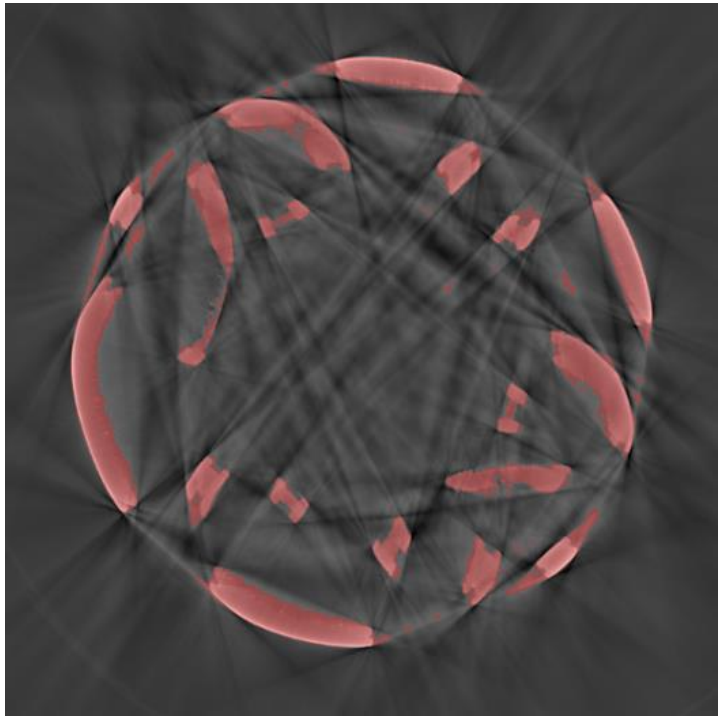
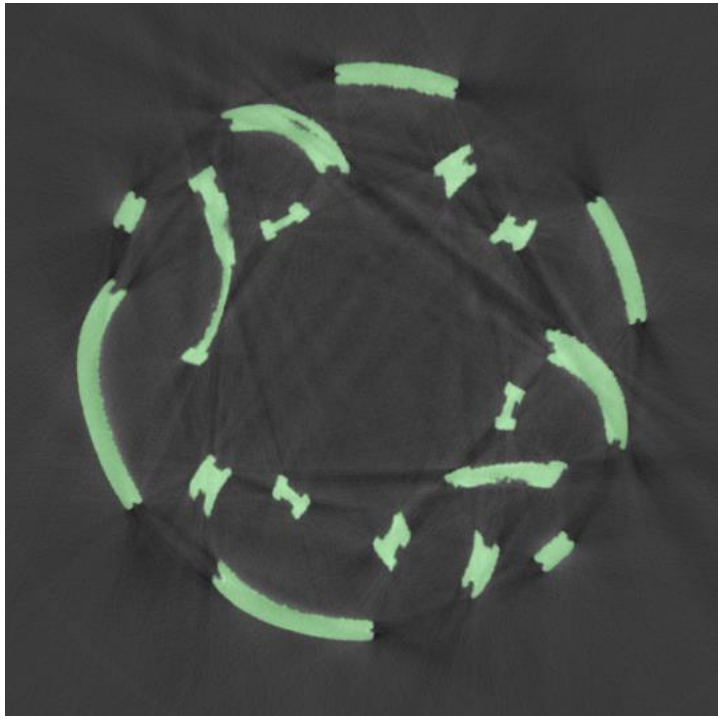
Scan improvements - Comparison



Original scan



Improved scan

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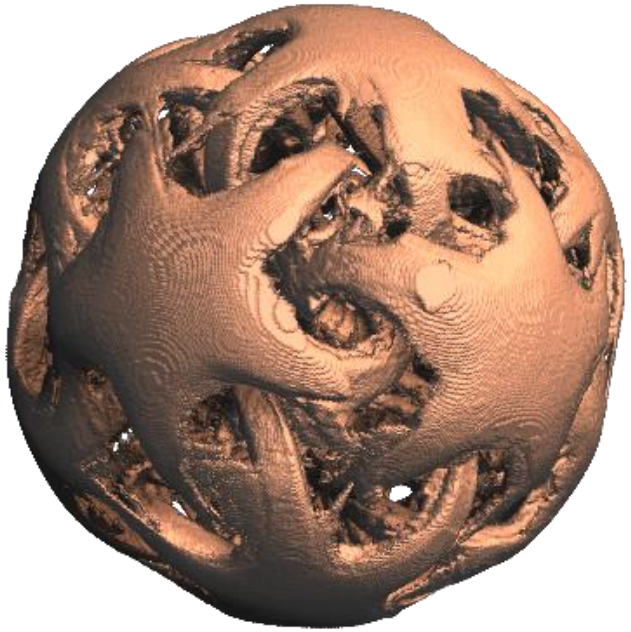
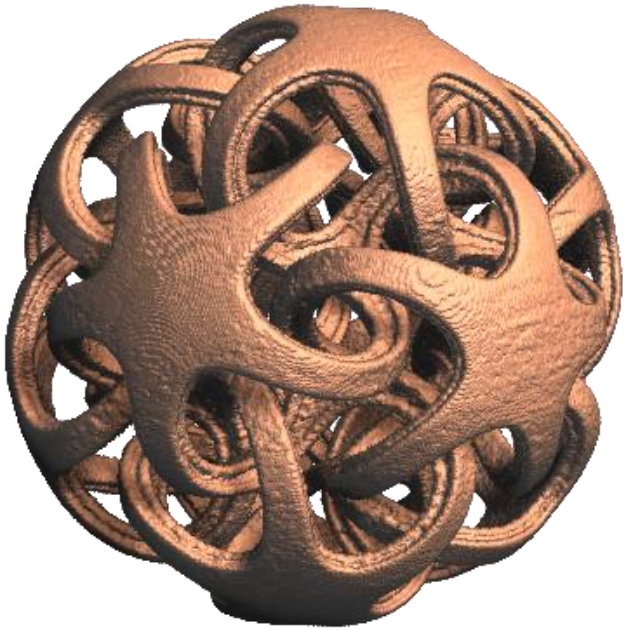
Scan improvements - Comparison



Original scan



Improved scan

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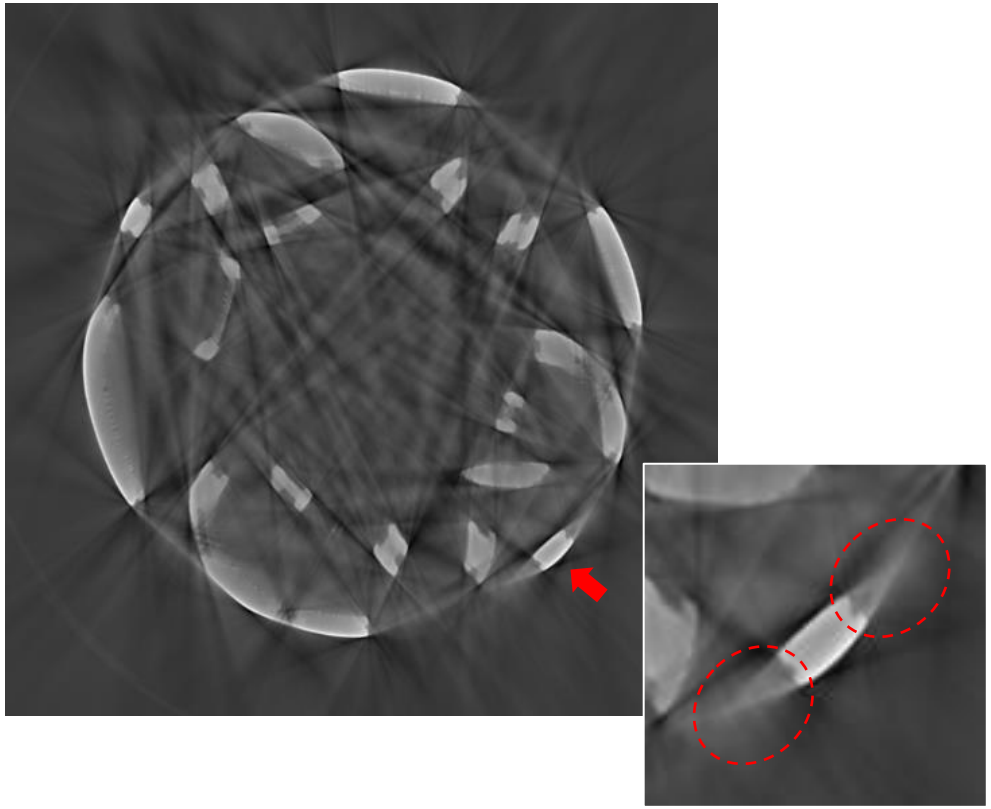
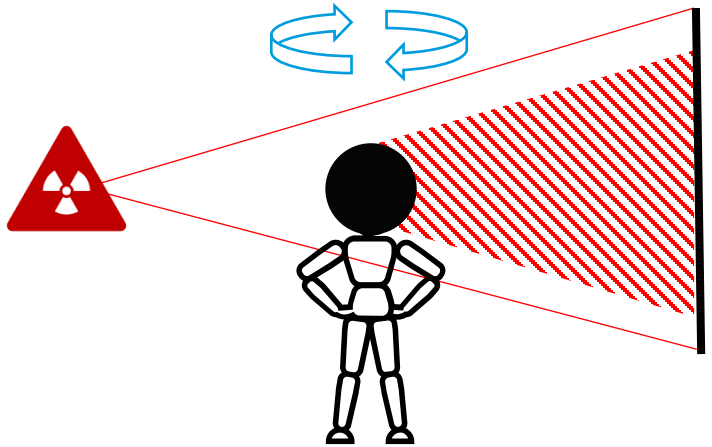
Scan improvements – Sample mounting





Optimize X-ray travel path

(if possible)

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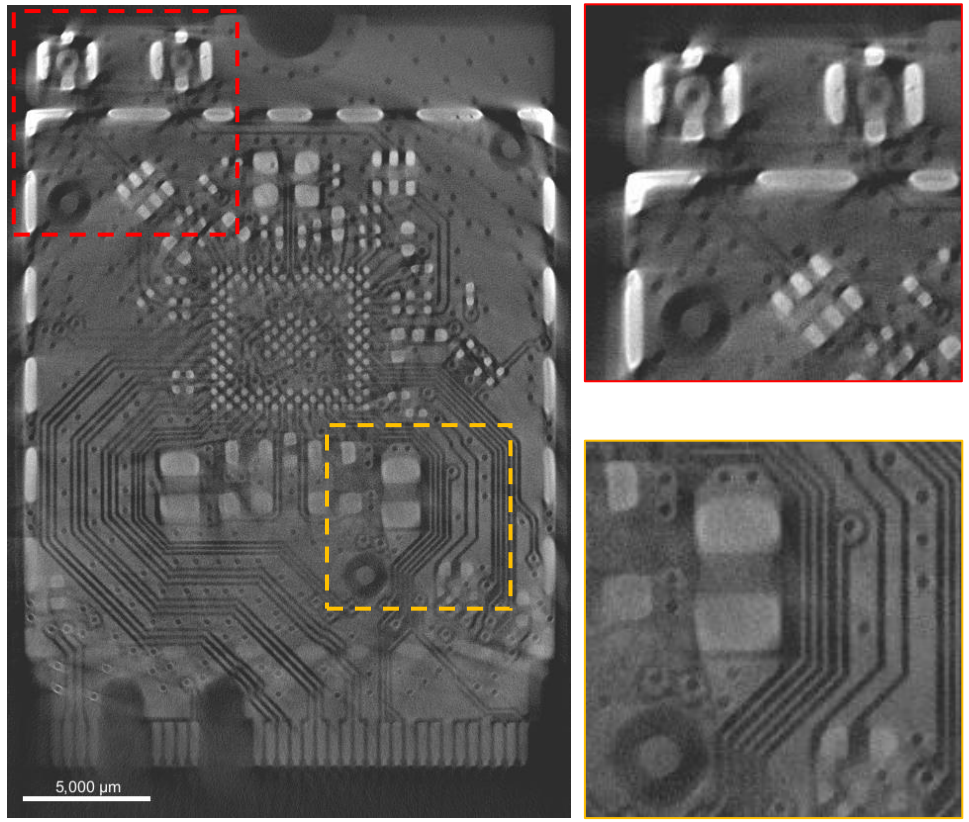
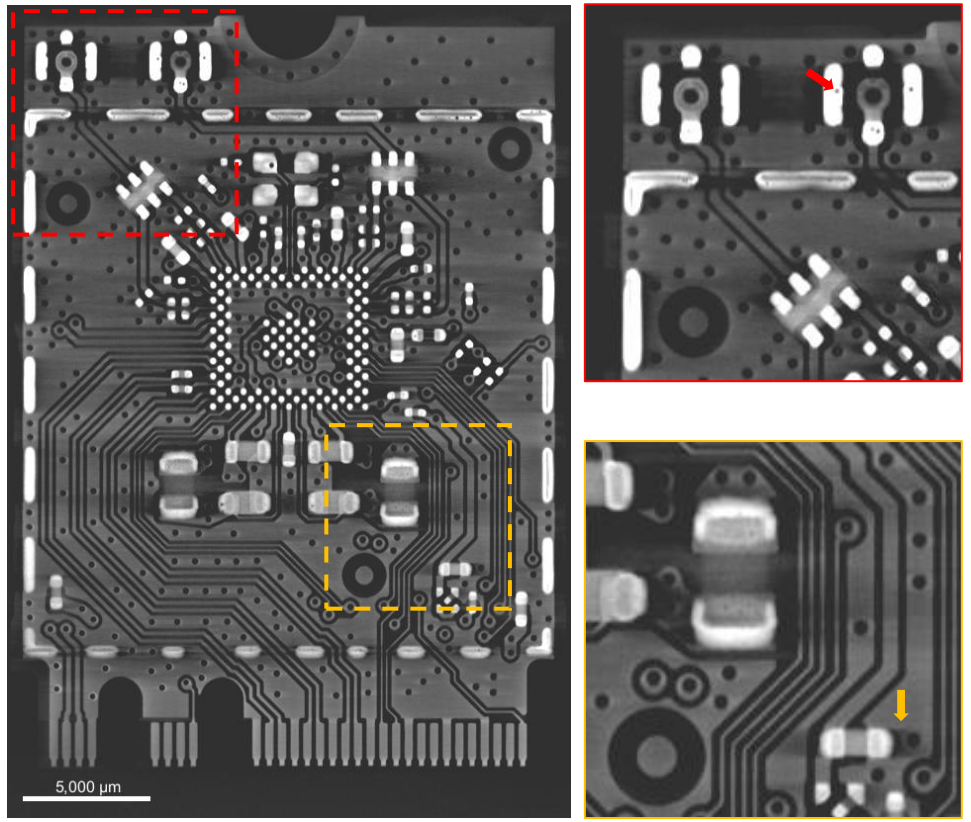
Scan improvements – Sample mounting





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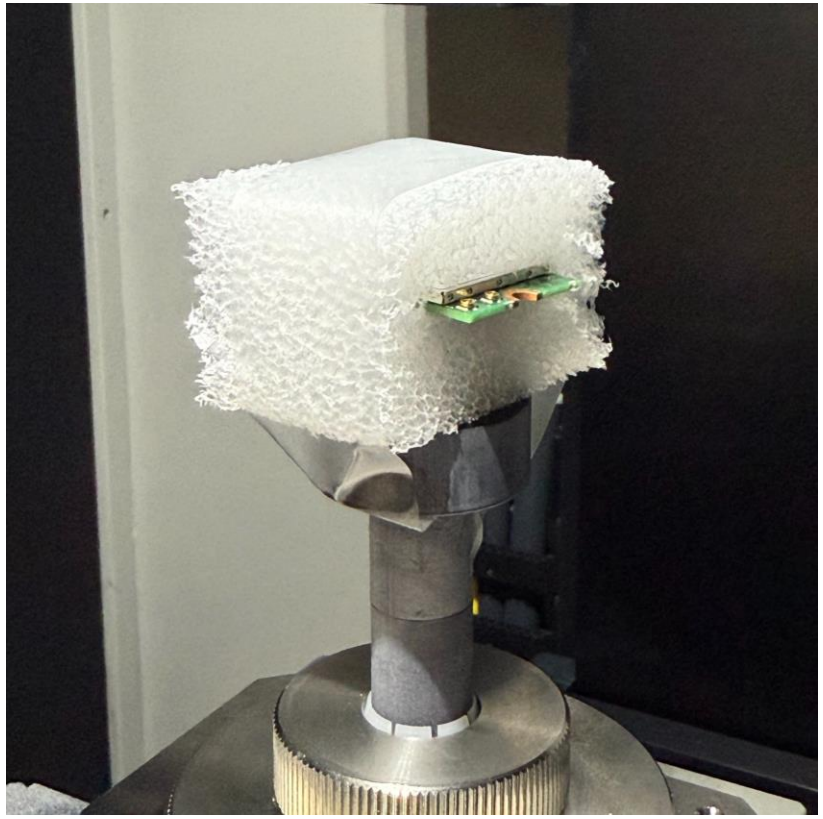
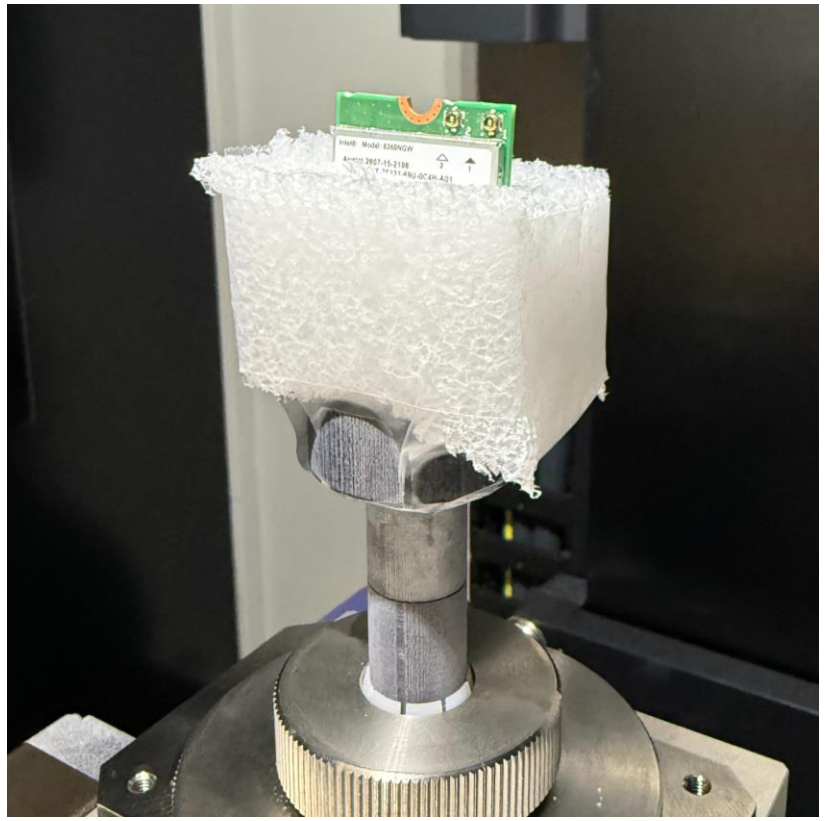
Scan improvements – Sample mounting





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Scan improvements – Sample mounting

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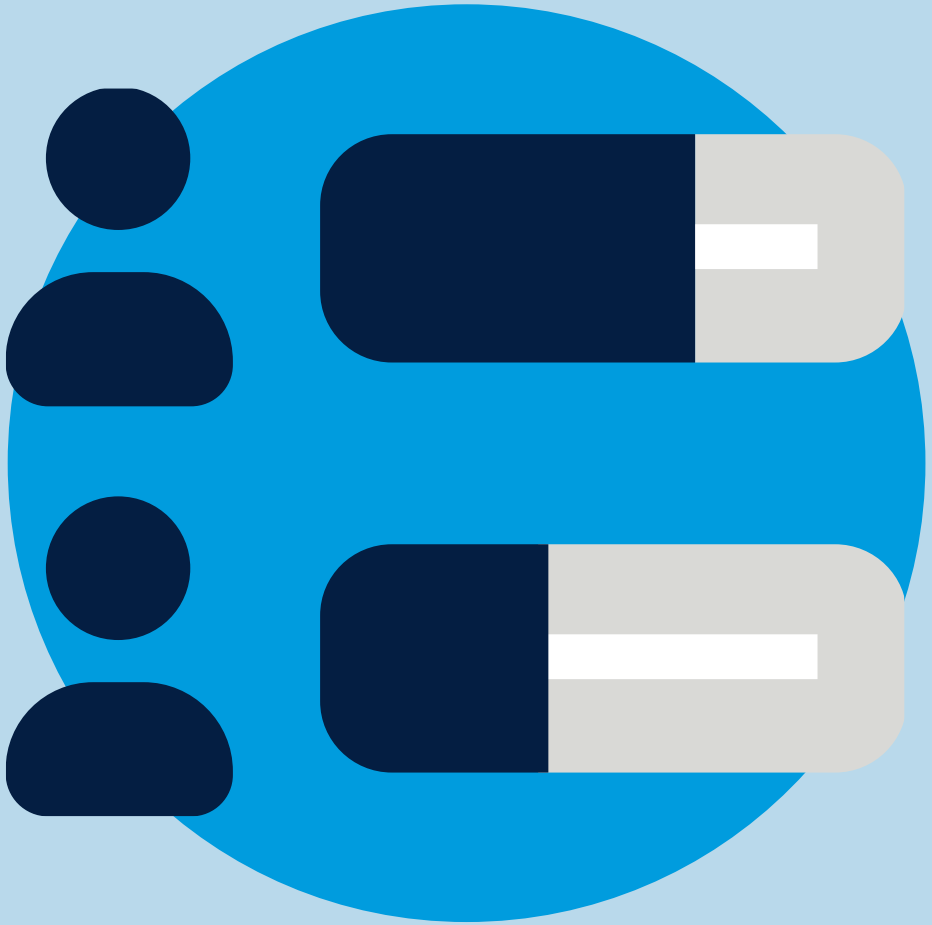
Polling Question



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Questions?

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High attenuation X-ray CT examples

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VTOL drone

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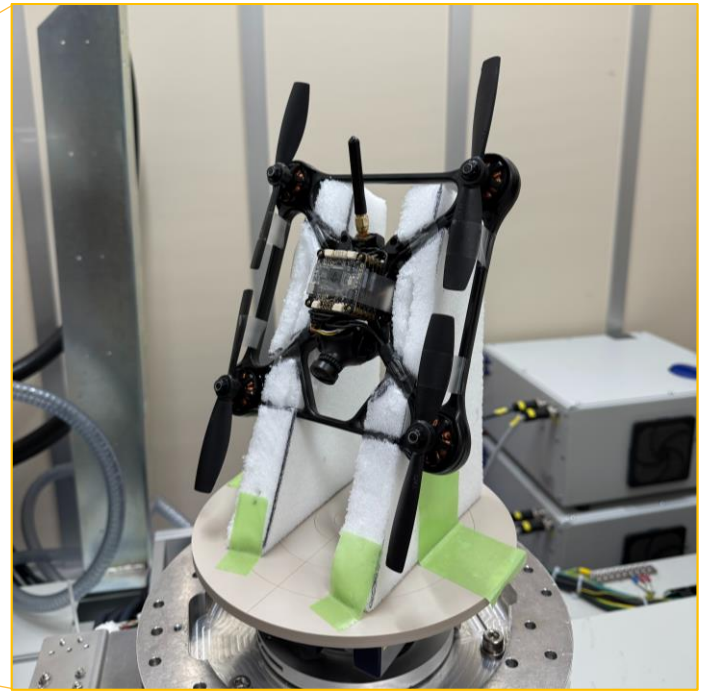
VTOL drone – CT scan process



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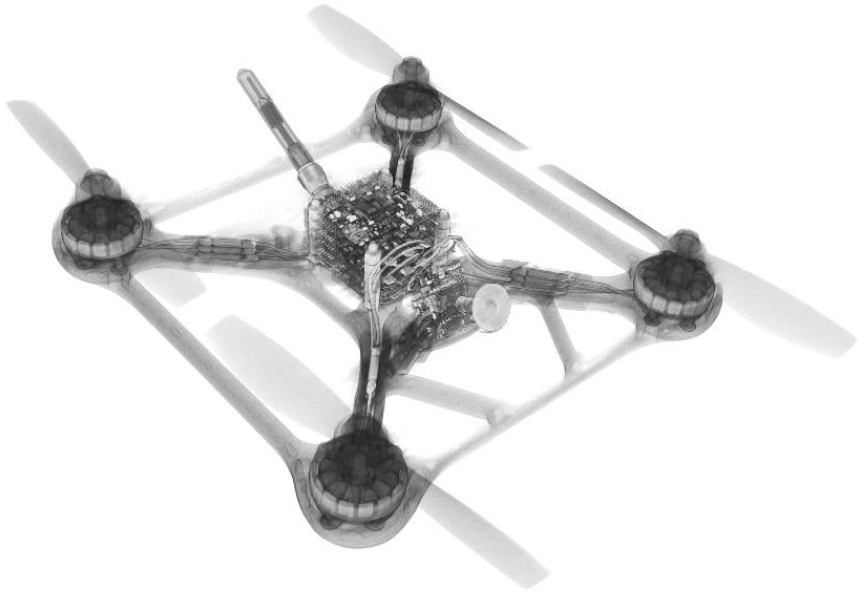
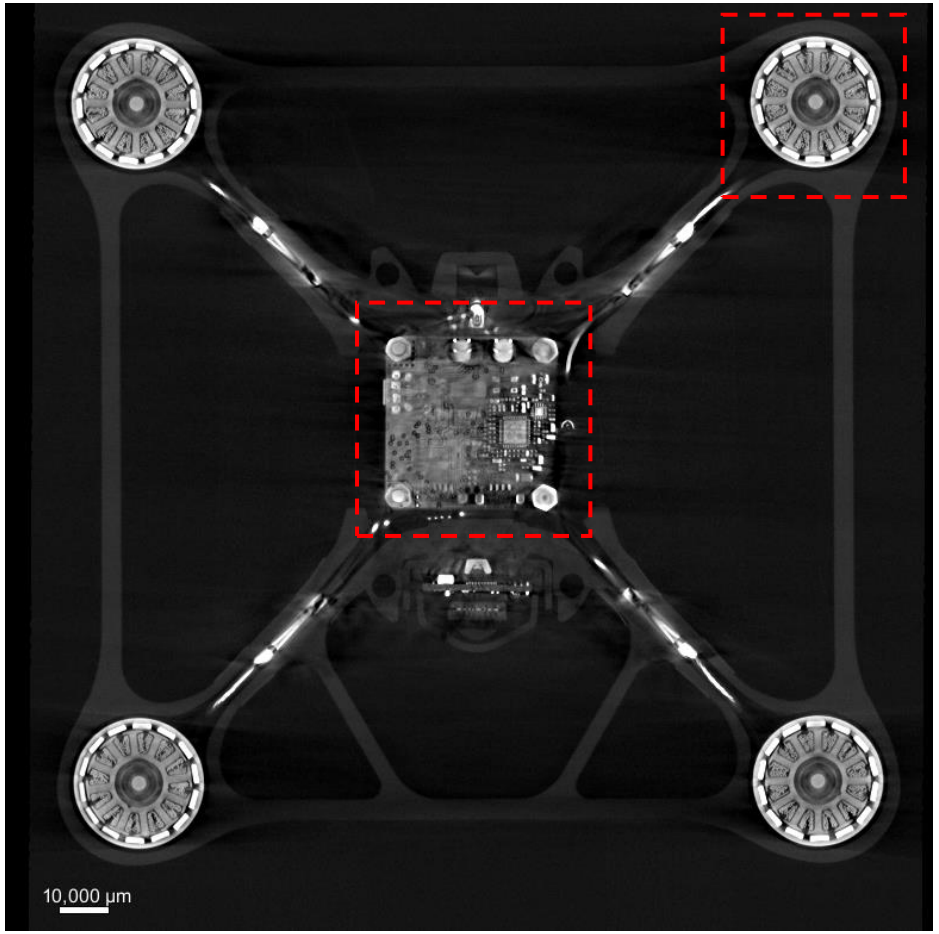
VTOL drone – Inspection





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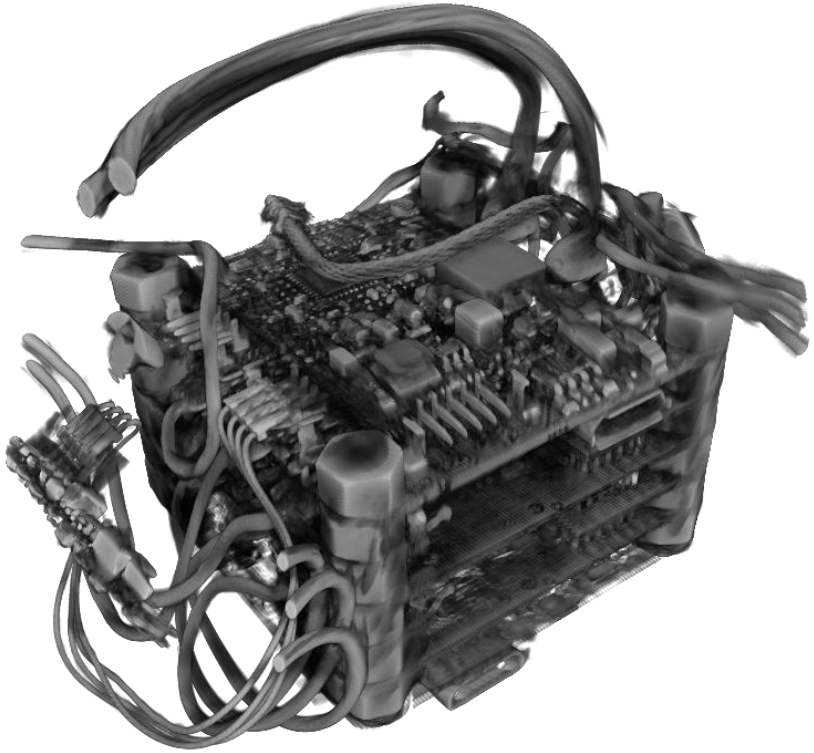
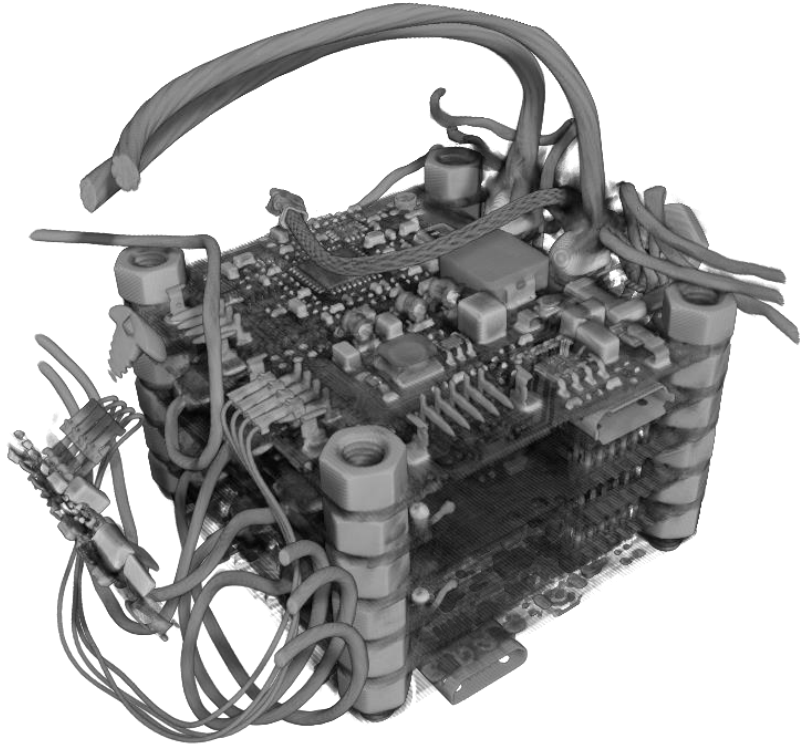
VTOL drone – Center PCB



130kV no filter



225kV Sn filter

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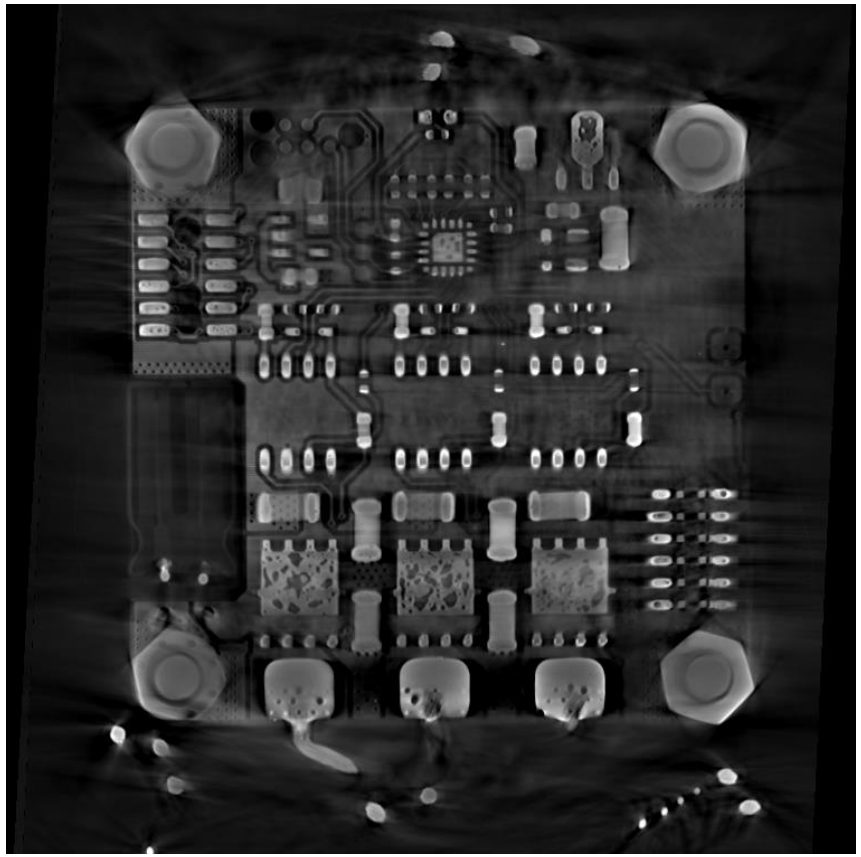
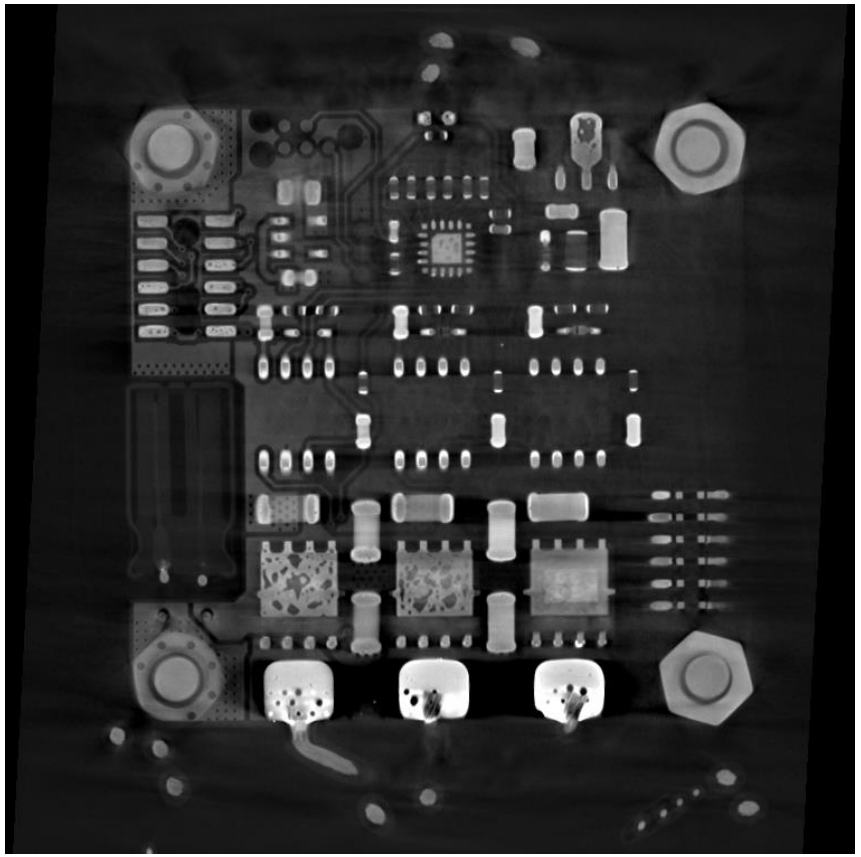
VTOL drone – Center PCB



130kV no filter



225kV Sn filter

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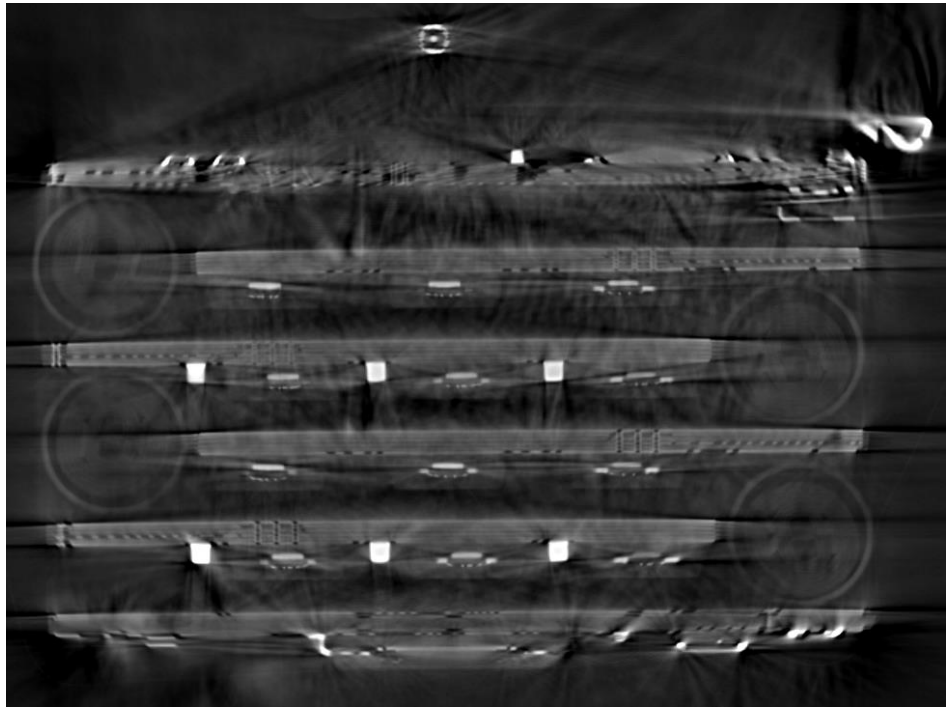
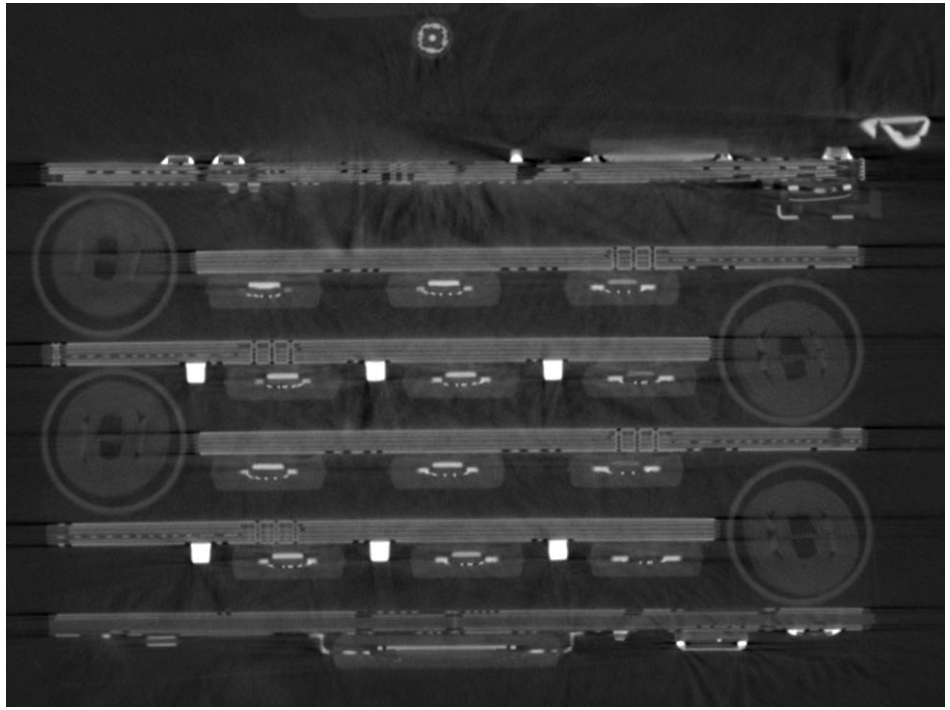
VTOL drone – Center PCB



130kV no filter



225kV Sn filter

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VTOL drone – Rotor

130kV no filter

225kV Sn filter

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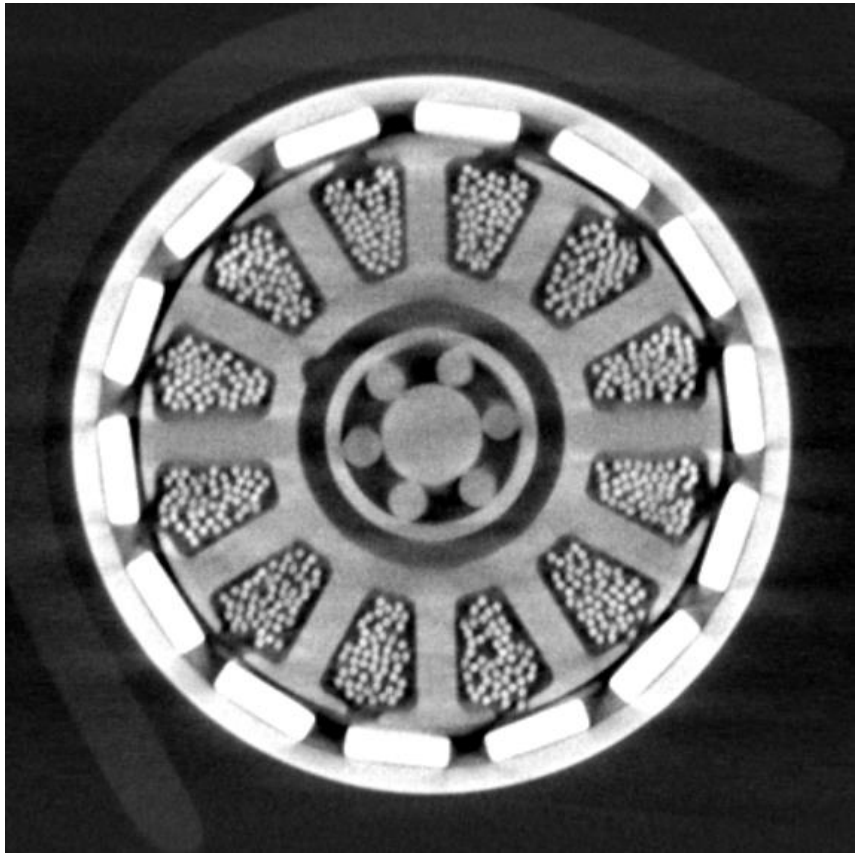
VTOL drone – Rotor

130kV no filter



225kV Sn filter

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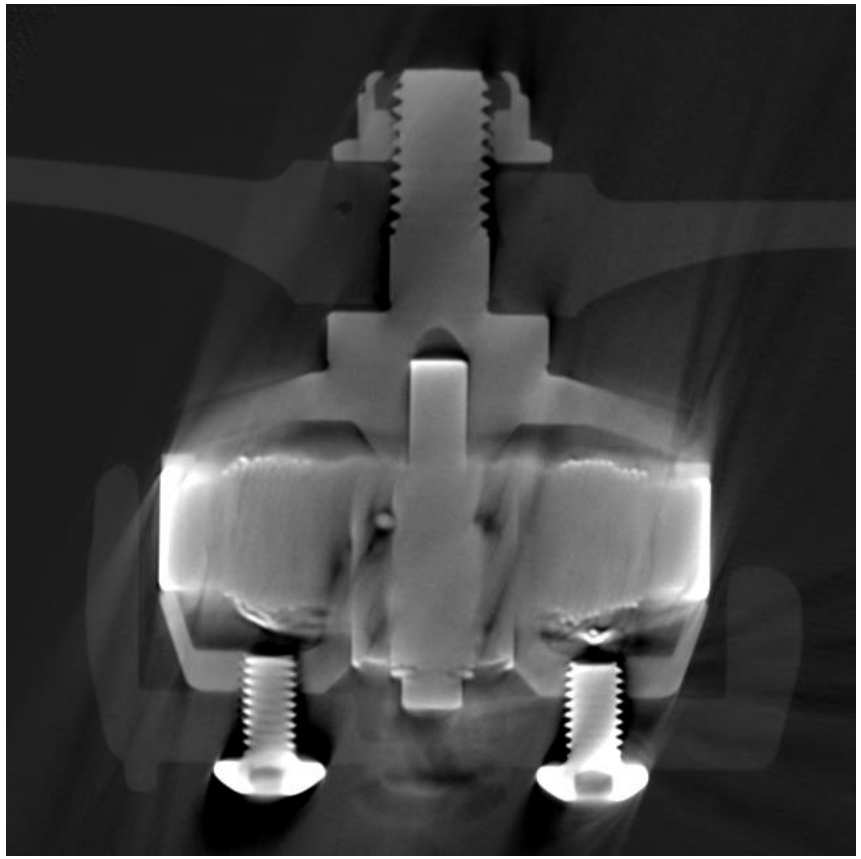
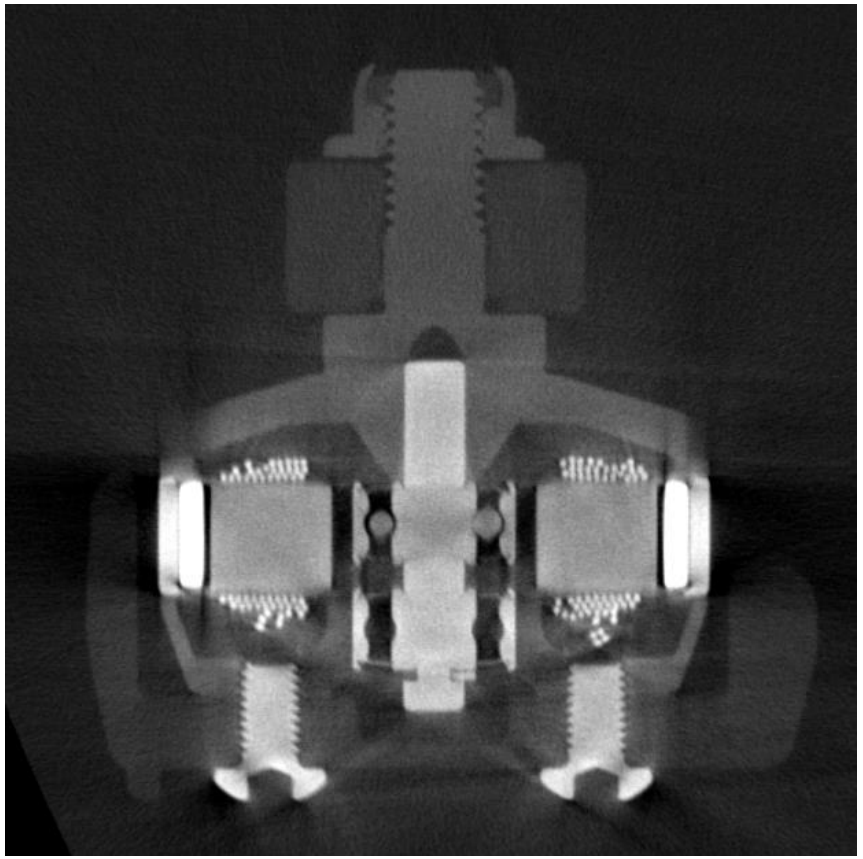
VTOL drone – Rotor



130kV no filter



225kV Sn filter

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Prismatic Li-ion battery

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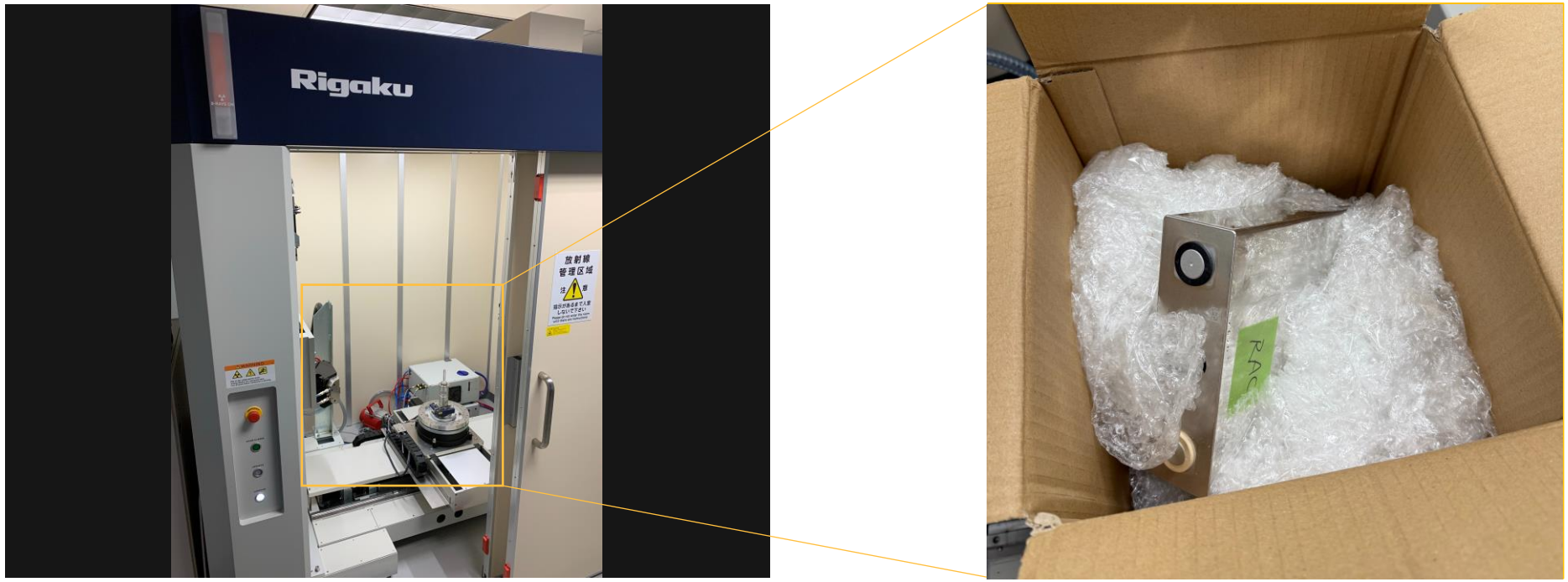
Battery – CT scan process



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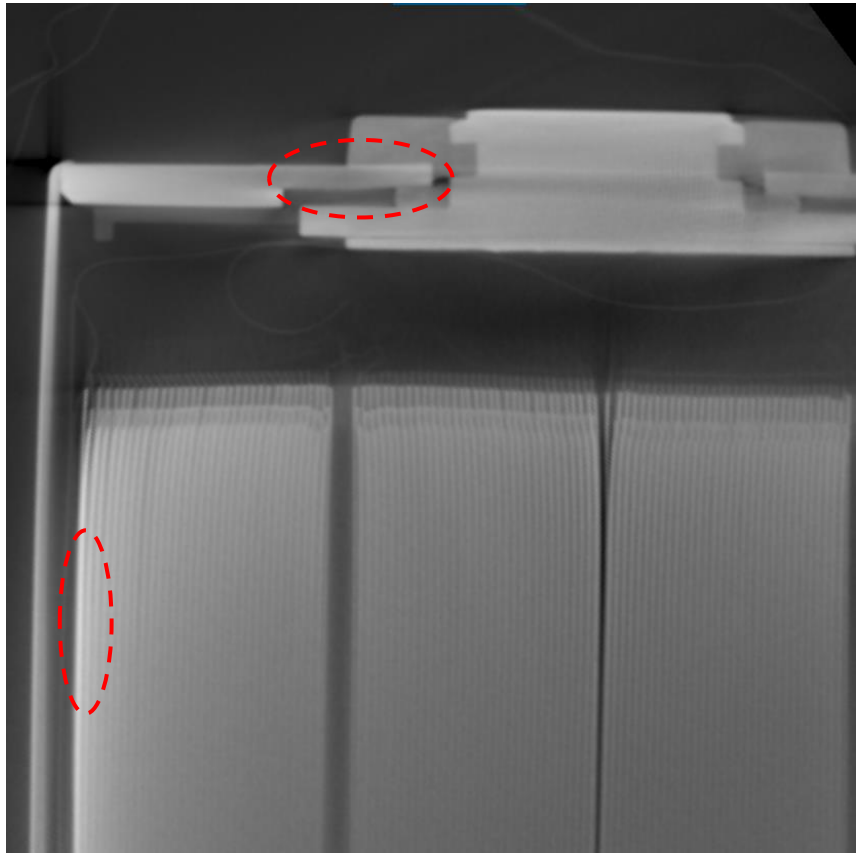
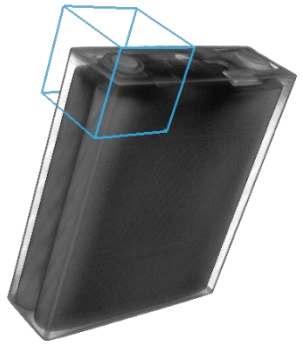
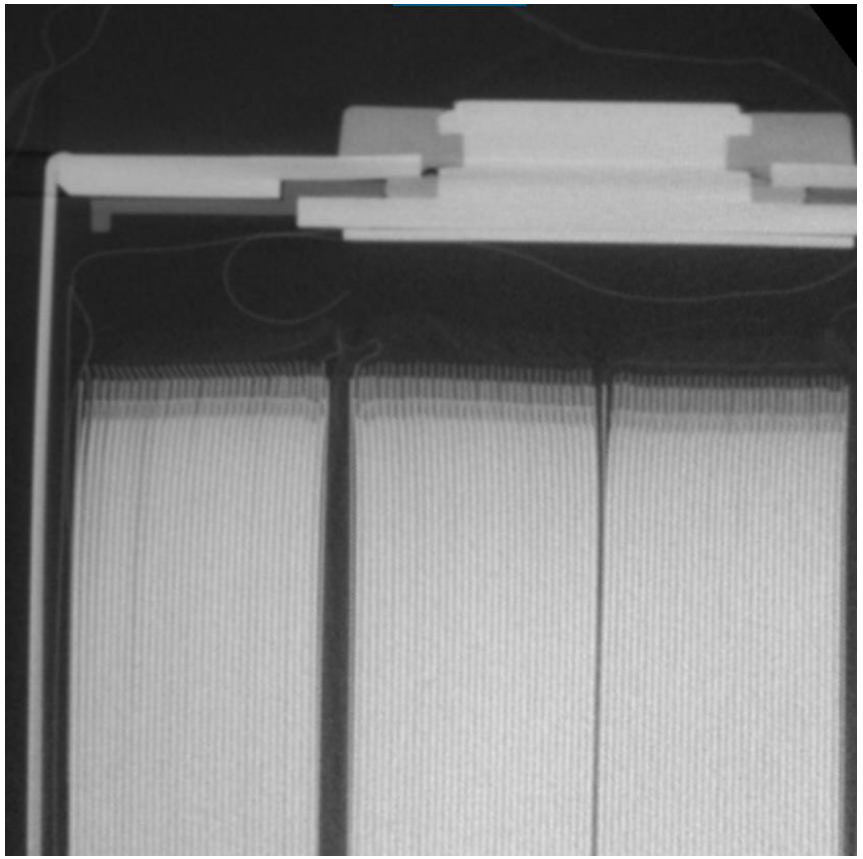
Battery – Inspection



90kV Sn filter





225kV Sn filter

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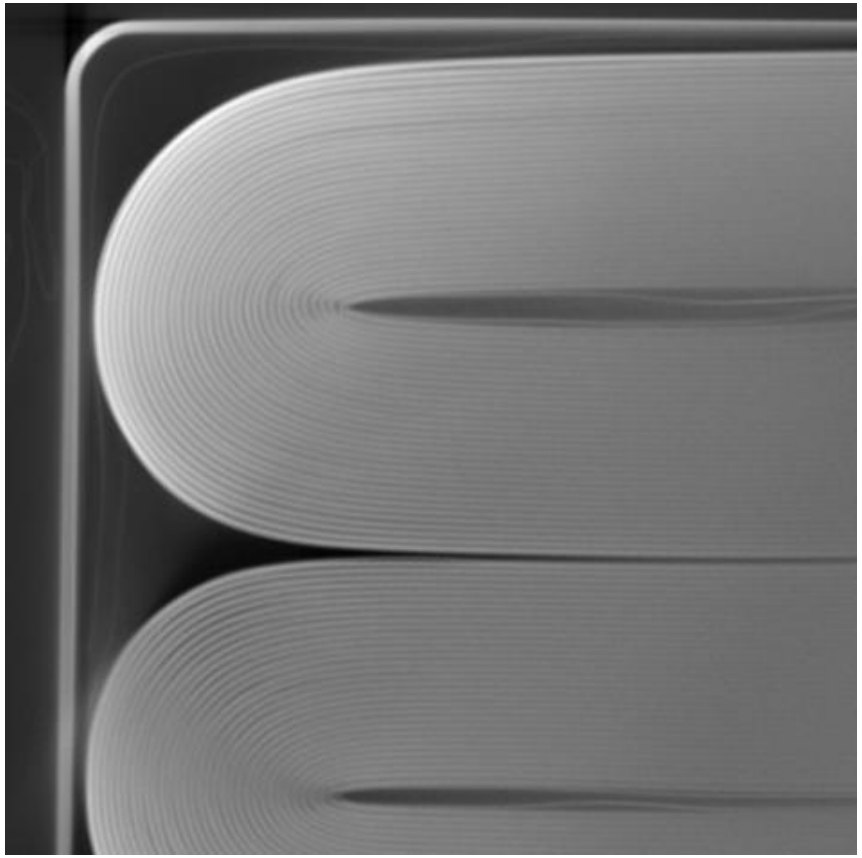
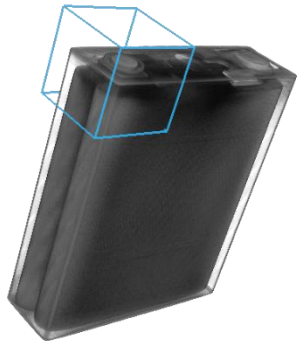
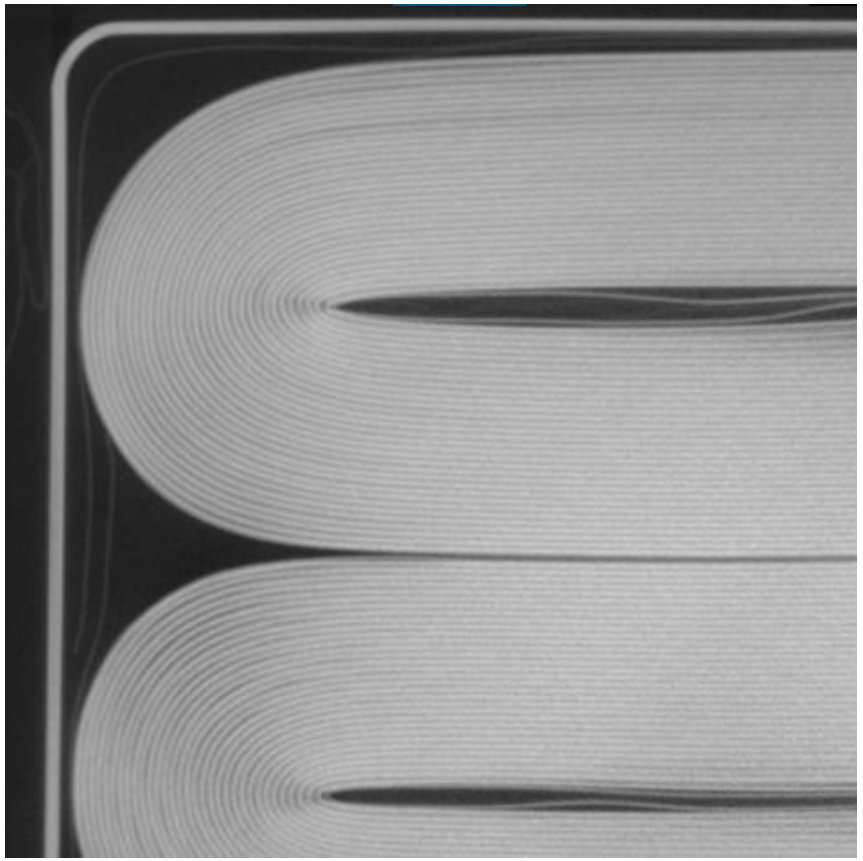
Battery – Inspection



90kV Sn filter





225kV Sn filter

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Radiator

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Radiator – CT scan process

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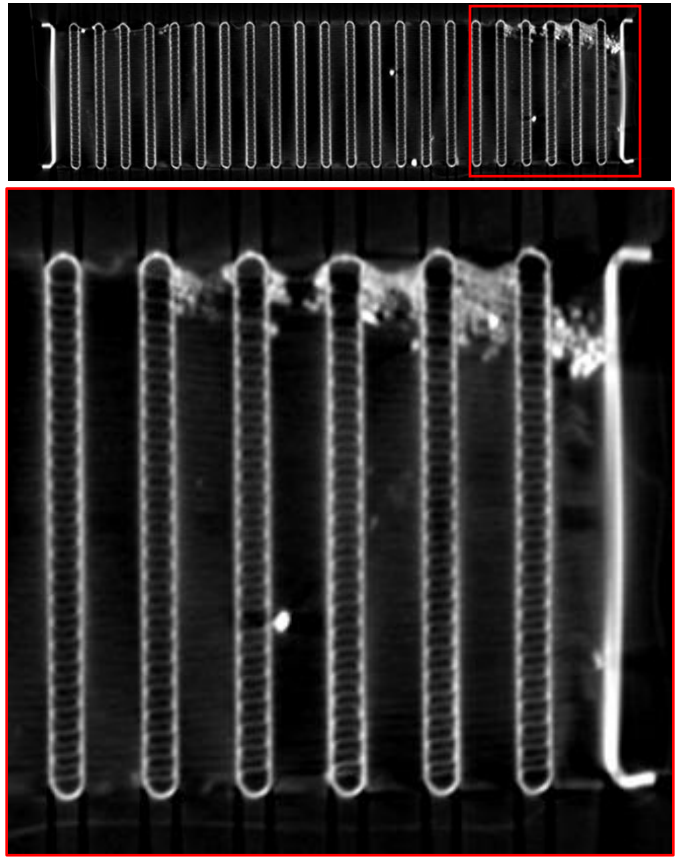
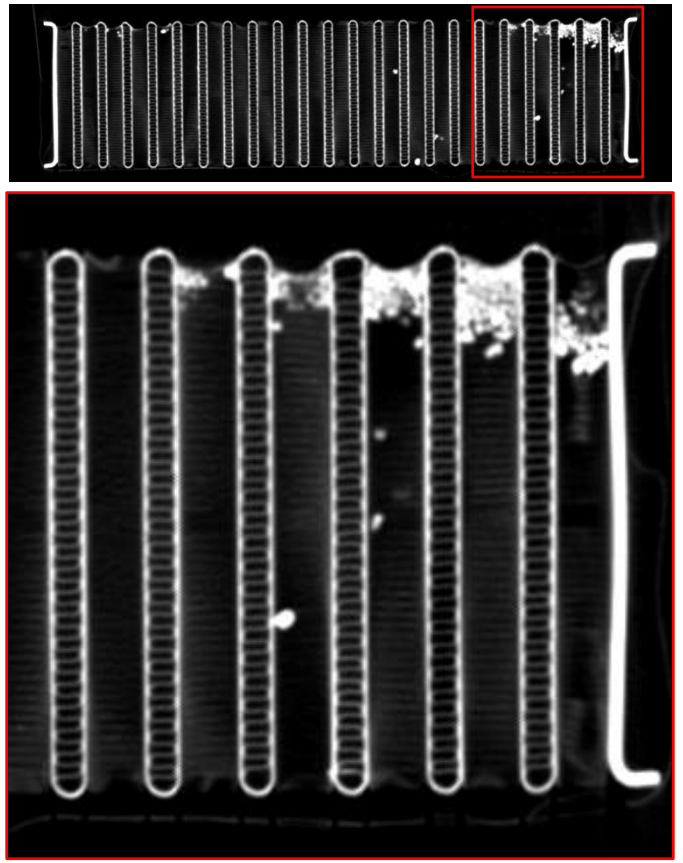
Radiator – Inspection



70kV no filter



200kV Cu filter

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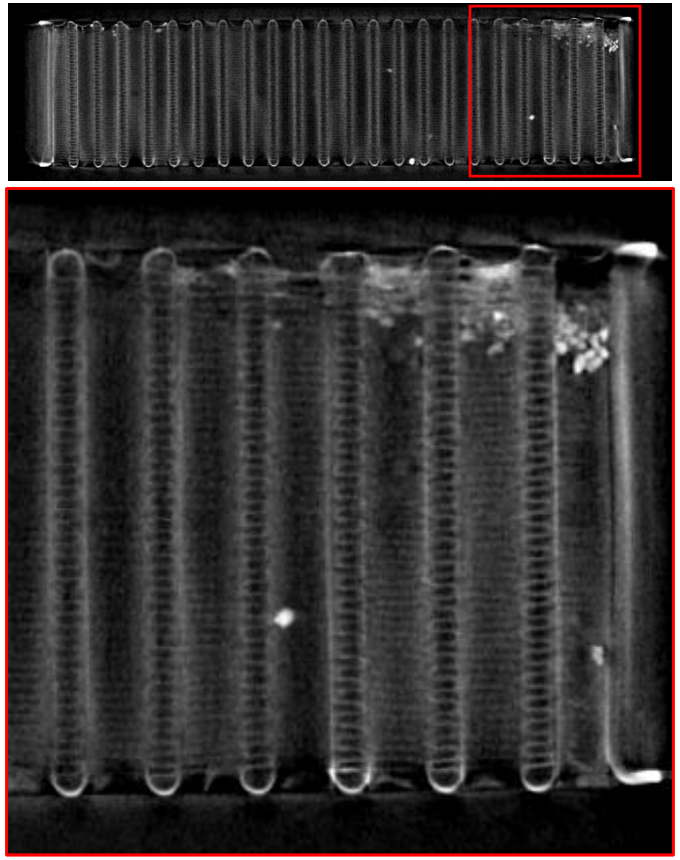
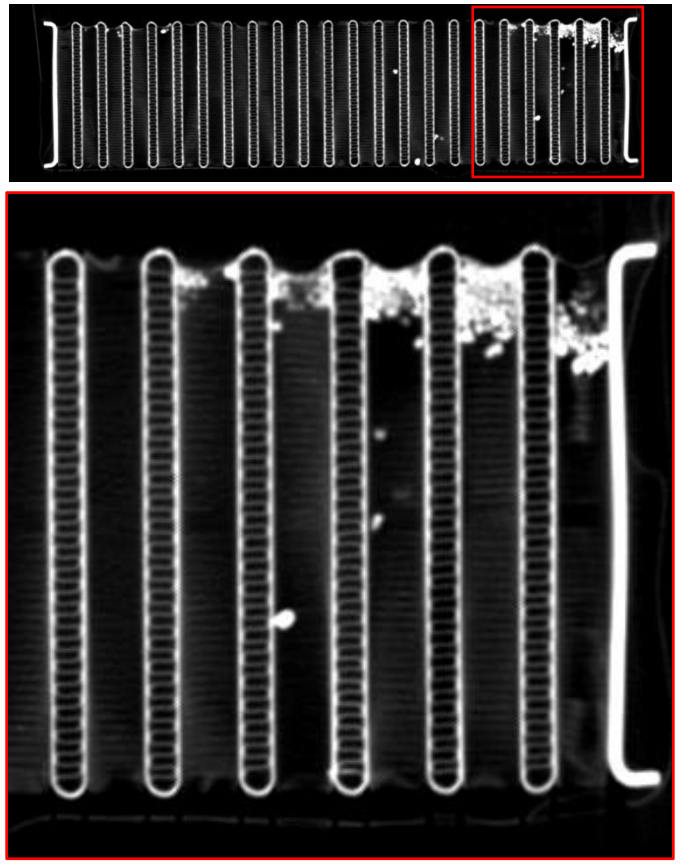
Radiator – Inspection



70kV no filter + Bad mounting



200kV Cu filter

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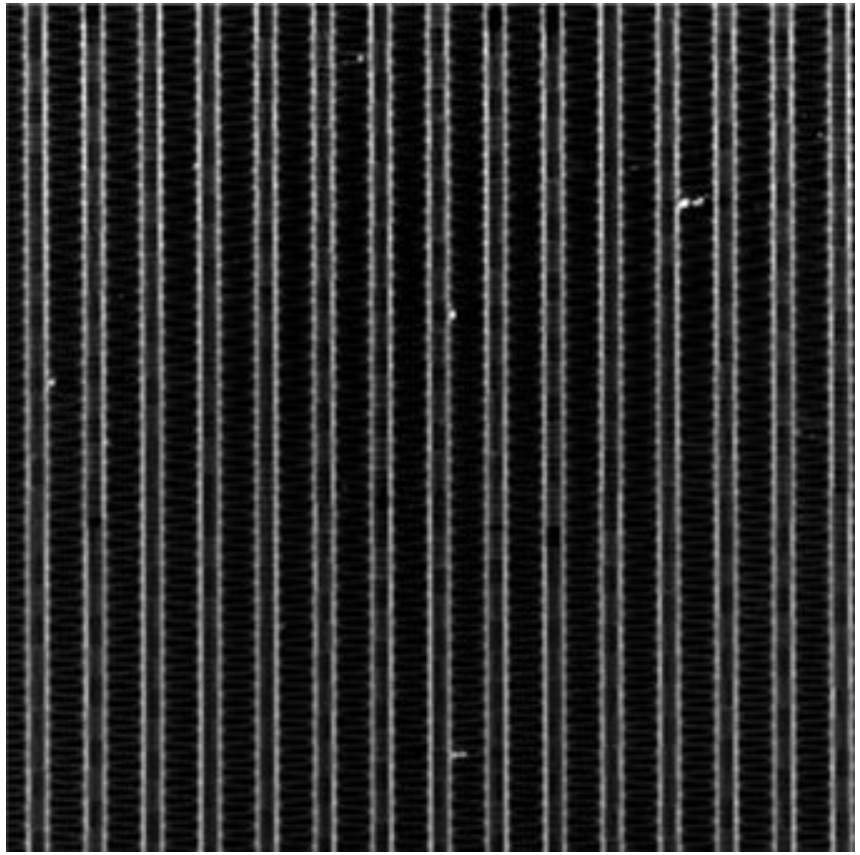
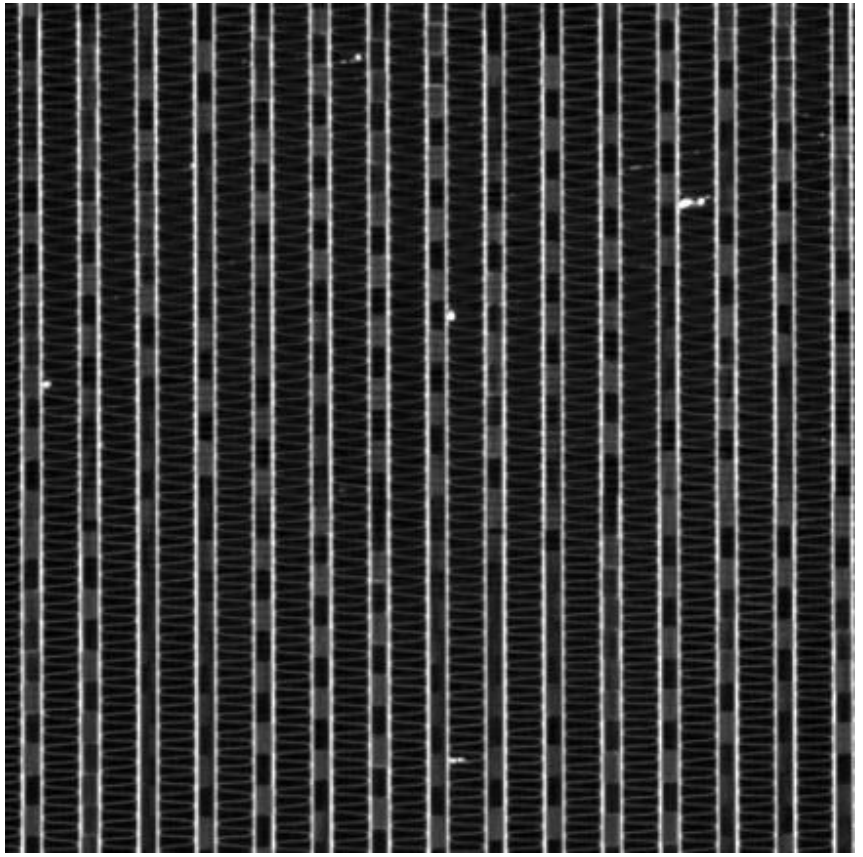
Radiator – Inspection



70kV no filter



200kV Cu filter

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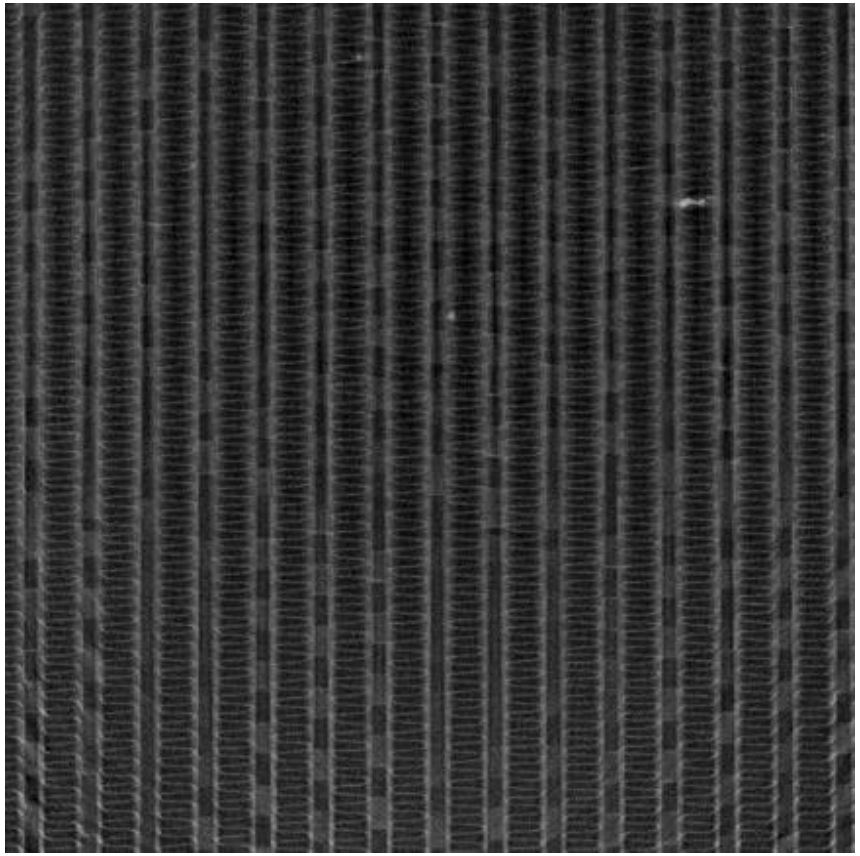
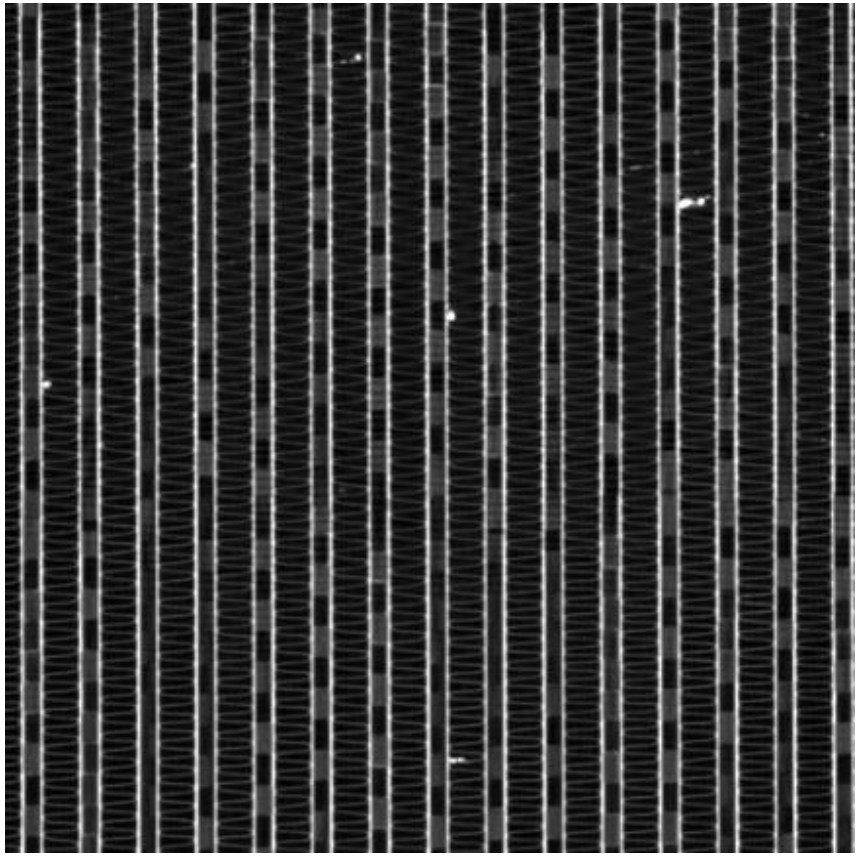
Radiator – Inspection





70kV no filter + Bad mounting

200kV Cu filter

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You have learned

- What is high attenuation sample
- What challenges do they pose
- How to address these challenges
- Real world example scans

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Questions?

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We'll follow up with your questions.

Recording will be available tomorrow.

Register for webinar.

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Mastering CT: Advanced Techniques in Practice

Episode 2 – Automating Workflows for X-ray CT

Wednesday, September 17 at 10 am CDT

Presenter: Angela Criswell

Don't forget to register for the next episode!

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