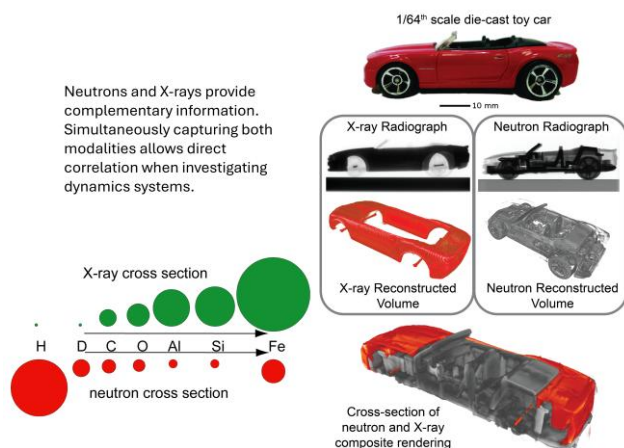
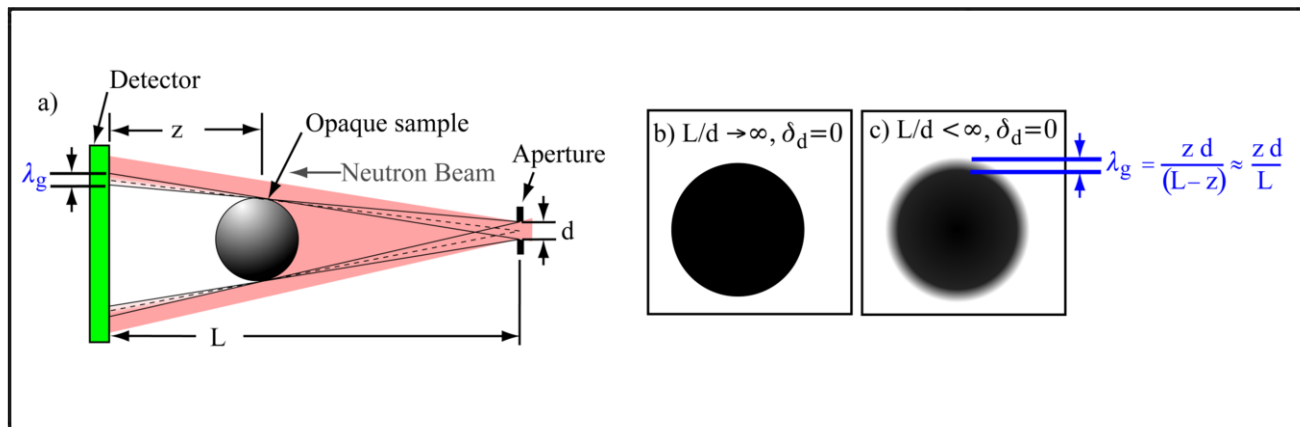




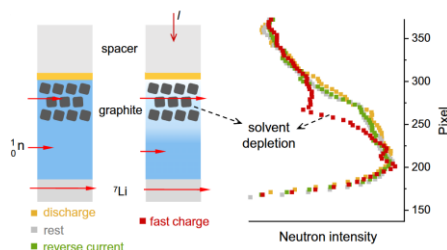
# Thermal Neutron Imaging with X-ray capabilities



## Operating Principles

| Symbol      | Parameter                     | Function                                            |
|-------------|-------------------------------|-----------------------------------------------------|
| $d$         | Aperture Diameter             | Spatial size of the incoming neutron pinhole source |
| $L$         | Aperture-to-Detector Distance | Distance                                            |
| $z$         | Sample-to-Detector Distance   | Distance                                            |
| $\lambda_g$ | Geometric Unsharpness         | Penumbra blur = $zd/L$                              |
| $L/d$       | Collimation Ratio             | figure-of-merit controlling spatial resolution      |

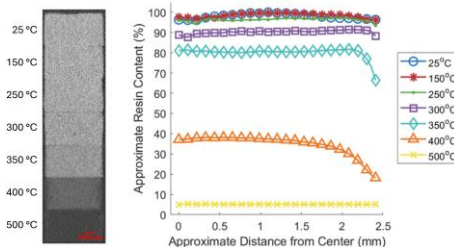
## Example



In operando neutron imaging of a lithium-ion battery under fast charge conditions showing solvent depletion in the porous electrode. Altering electrolyte composition improved fast charging capacity of the battery.

C-X. Zhao *et al.*, Science (2025) 390(6774), 745-750

## Example



Photoresist binder concentration as a function of temperature for 3D printed aluminum ceramics printed with stereolithography. Debinding atmosphere and binder additive optimized to improve final ceramic part quality.

E.G. McAleer *et al.*, J. Am Ceram Soc, (2023) 106(7), 4399

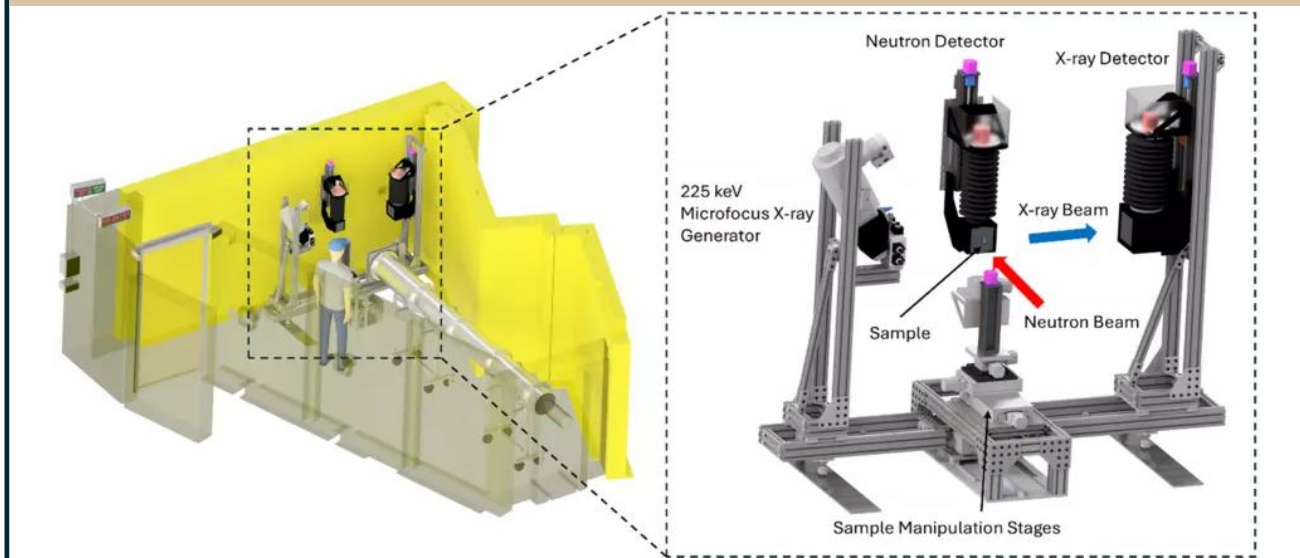
# Thermal Neutron Imaging Facility (NNIF)



Instrument Paper: <https://doi.org/10.1063/1.4989642>

Instrument Webpage: <https://www.nist.gov/laboratories/tools-instruments/neutron-imaging-facility-nif>

The Thermal Neutron Imaging Facility (NNIF) was designed to be flexible while providing plug-and-play testing capabilities for electrochemical devices. The instrument provides thermal neutrons and high-energy X-rays capable of penetrating larger samples or samples contained within environmental chambers. Built-in gas handling equipment facilitates engineering experiments.



## Cameras and Detectors

The most commonly used [detector](#) at the NIST imaging beamlines is a lens coupled camera detector box. The spatial resolution and field-of-view can be adjusted by switching between various photo lenses. Field-of-view decreases with increasing resolution. Example expected pixel sizes and field-of-view for the 62 Megapixel camera system are:

| Lens                   | Effective pixel size [ $\mu\text{m}$ ] | resolution | [mm]          |
|------------------------|----------------------------------------|------------|---------------|
| 105 mm or 200 mm macro | 3.76                                   | 7.52       | 36.0 x 24.0   |
| 85 mm                  | 5.244                                  | 10.488     | 50.2 x 33.5   |
|                        | 6.118                                  | 12.236     | 58.6 x 39.1   |
|                        | 8.74                                   | 17.48      | 83.7 x 55.8   |
|                        | 10.032                                 | 20.064     | 96.1 x 64.1   |
|                        | 13.946                                 | 27.892     | 133.5 x 89.1  |
|                        | 17.556                                 | 35.112     | 168.1 x 112.1 |
| NOCT (55 mm)           | 20                                     | 40         | 191.5 x 127.8 |
| 50 mm                  | 30.02                                  | 60.04      | 287.5 x 191.8 |

## Sample manipulation

A wide variety of motorized stages for rotation, tip/tilt, and translation are available to align and manipulate samples during an experiment for complete 6-axis motion.

## Simultaneous dual mode tomography

The X-ray generator is a tungsten Bremsstrahlung micro-focus source with maximum electron acceleration of 225 kV and spot size about 3  $\mu\text{m}$ .

## Experimental Support Equipment

The NNIF provides gases and deionized water to support hydrogen fuel cell research. Fuel cell test stations include a small, research scale station that supports up to 50 cm<sup>2</sup> cells and a large-scale station that supports full sized, industrial relevant fuel cells.

Battery research is supported with a Gamry Ref3000 potentiostat and an Arbin multichannel cycler that can handle coin cells and larger commercially available cylindrical and pouch cells.

Pressure vessels are available to support flow in porous media experiments where the sample must be under confining pressure to avoid external flow bypass.