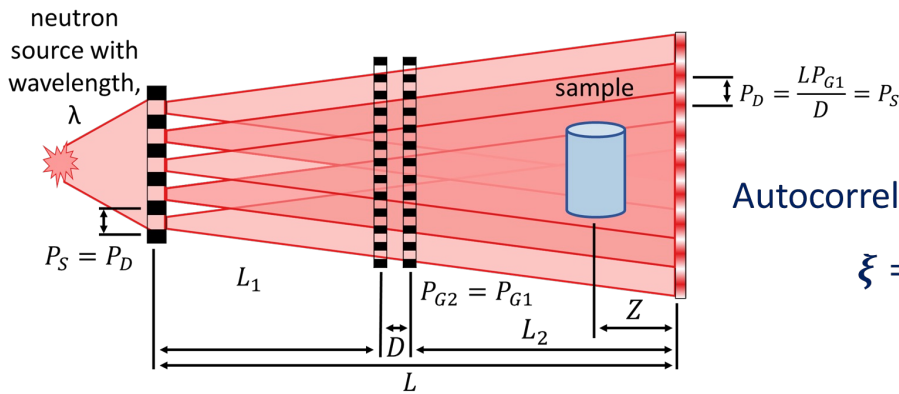




Cold Neutron Imaging

Offering NeXT, dark-field, Bragg edge and spin-polarized modalities



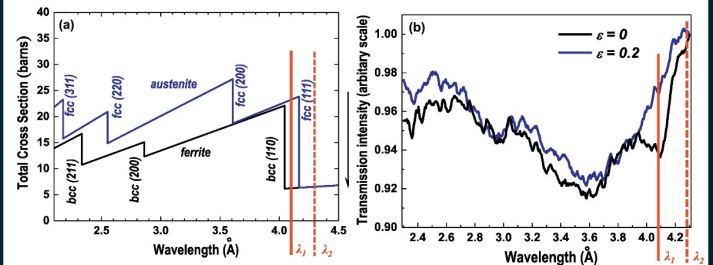
Autocorrelation length:

$$\xi = \frac{Z\lambda}{P_D}$$

INFER (dark-field) Parameters

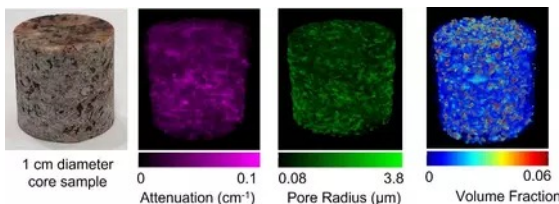
Symbol	Parameter	Function
P_D	Moire period	Component of ξ
L	Total Interferometer Length	Distance
Z	Sample-to-Detector Distance	Distance, component of ξ and geometric blur
D	Spacing of gratings	Varies P_D
λ	Neutron wavelength	Set by velocity selector with $d\lambda/\lambda \sim 0.1$
ξ	Autocorrelation length	Ranges from ~ 1 nm to ~ 1 μ m

Bragg Edge to measure Crystal Phase volume fraction



Example

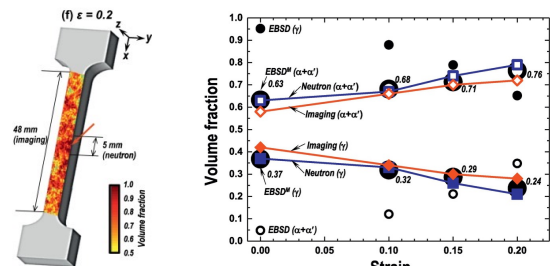
Far-field Interferometry for Measurement of Heterogeneous and Hierarchical Structures



Dark field tomography of a Westerly Granite core sample. From left to right, photo of samples, neutron attenuation image of sample, with pore radius volume fraction of pores extracted from dark field measurement.

G. Artioli & D.S. Hussey, *Elements* (2021) 17(3), 189

Example



Bragg edge imaging provides macroscopic spatial distributions in a trip-assisted duplex stainless steel with a resolution of about 50 μm . The martensite is concentrated on the necking region and estimates its volume fraction of 14% at a strain of 0.2.

W. Woo *et al.*, *Scripta Materialia*, (2019) 158,105

Cold Neutron Imaging Instrument (CNII)

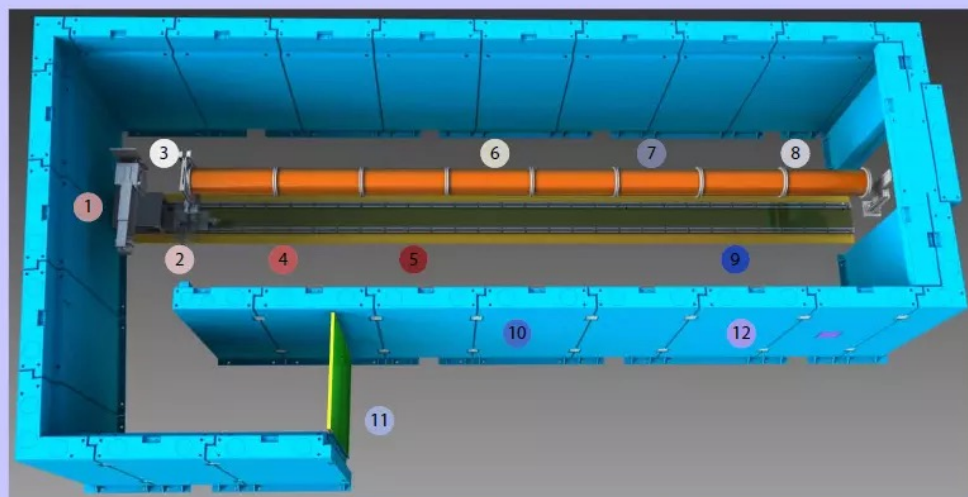


Instrument Paper: <https://doi.org/10.1016/j.phpro.2015.07.006>

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

The Cold Neutron Imaging Instrument (CNII) was designed to be flexible and employ novel neutron imaging methods to realize different sources of image contrast. The instrument is capable of polarized neutron imaging, dark-field imaging to create multi-scale images that can be thought of as “3D-SANS”, and Bragg-edge imaging.

Conventional Radiography Configuration



- 1 Detector Stand
- 2 5-axis Motorized Sample Table
- 3 Beam Mask
- 4 Epoxy Floor
- 5 Instrument Rail
- 6 1:1 Wolter Optic Location
- 7 Variable Length Evacuated Flight Path and Guide Field
- 8 3-He, Double Monochromator, Microscope Sample Position
- 9 Aperture Selector
- 10 Wax and Steel Shot Shields with seismic protection features
- 11 Cave Entry Gate
- 12 Feed-Thru for Samples in Microscope setup

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 [μm]	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 150 kV and spot size about 7 μm .

Neutron optical components

CNII is designed to allow installation of neutron optical components at any point along the beamline. Components available to users include: a pair of curved neutron polarizers, a Talbot-Lau neutron interferometer, a suite of transmission and phase gratings to realize 2- and 3-grating far field neutron interferometers. The vacuum tubes that define the flight path are wrapped with wire to create a solenoidal guide field and the tubes can be optionally installed along the flight path per measurement need.