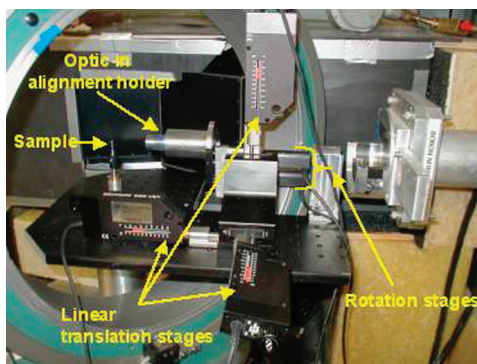




System for Neutron Focusing and Analysis

This unique system provides a fully integrated neutron focusing and alignment solution for analysis enhancement. The main component of the system is a polycapillary neutron focusing optic for achievement of a small neutron beam focal spot and high intensity gain. The system is also equipped with a sophisticated, user-friendly PC-based alignment apparatus for aligning the optic to the neutron source, as well as the focused beam to the sample. Both the optic and alignment can be customized for a particular instrument, beam-line, or application.



SYSTEM DESIGN:

- Neutron focusing optic
- PC-based optic alignment and positioning system with auto-scanning option
- Optic simulation support

FEATURES AND BENEFITS:

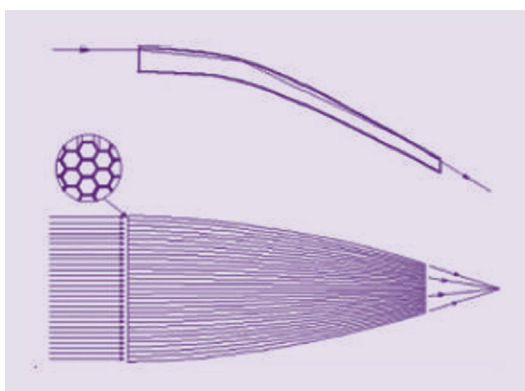
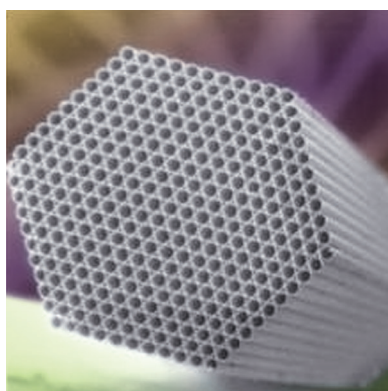
- Small focal spot size
- Controlled focal spot position
- High intensity gain
- Adjustable beam convergence

APPLICATIONS:

- Single-crystal neutron diffraction (small sample, high pressure, low temperature, etc.)
- General-purpose neutron powder diffraction
- High spatial-resolution strain and phase distribution
- Prompt gamma activation micro analysis
- Measurement of source angular distribution

Polycapillary Neutron Focusing Optics

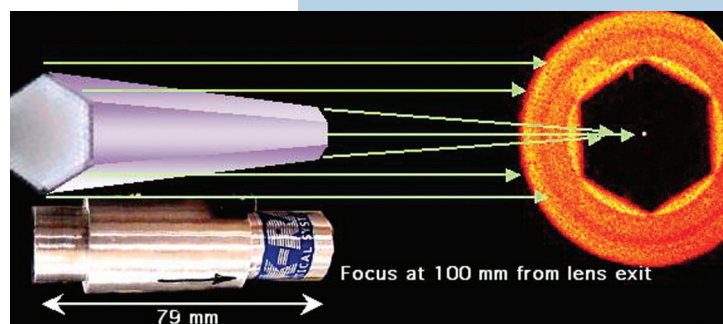
Neutrons can be focused into a small spot (50–500 μm) using state-of-the-art polycapillary monolithic focusing optics resulting in an increased neutron current density on the sample. The principle behind the operation of these lenses is the convergence of a parallel beam of neutrons to a point through multiple total-external reflection of neutrons from the smooth inner walls of the capillary channels.



Small Focal Spot Size

EXAMPLE: Image of the neutron beam obtained when an imaging detector of circular cross section is placed at the focal spot of the optic. The hexagon is the shadow of the optic and the very small spot at its center is the focal spot, which is < 0.5 mm in diameter for this particular optic.

Focal spot size depends on the neutron wavelength and the output focal distance of the optic.



High Intensity Gain

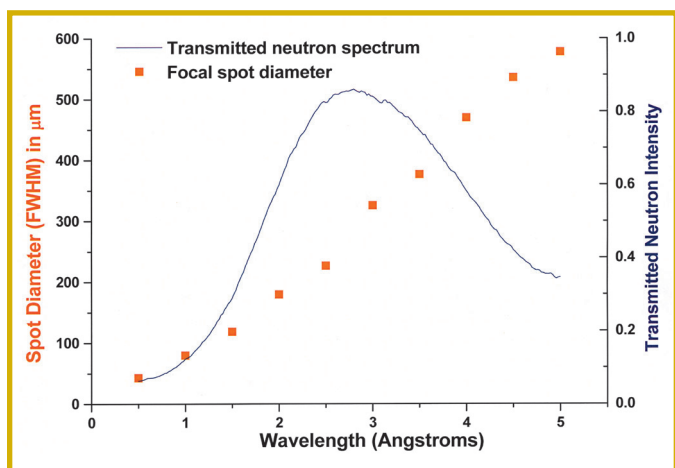
Polycapillary optics can provide large gains over conventional unfocused neutron beams. Intensity gain is dependent on the neutron wavelength spectrum and angular distribution from the source, as well as the input area and the output focal distance of the optic. Gains from 5–100x have been measured in the single crystal diffraction (SCD) beam-line at the Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory. Gains up to 500x have been achieved on the general purpose powder diffraction (GPPD) instrument at IPNS.

Simulation Support

Simulation support will be available for optic design and selection. Specifically, simulations will:

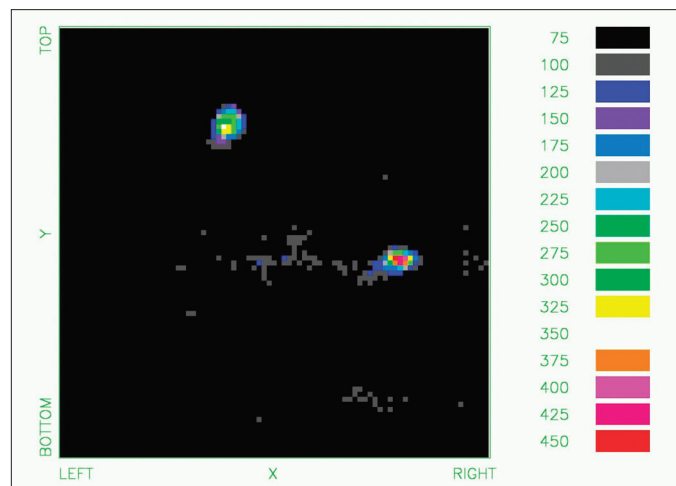
- Help identify the optimum optics for specific applications
- Show output characteristics of the chosen optic, such as transmitted neutron spectrum, transmission efficiency, spot diameter and angular divergence

EXAMPLE: Simulated transmitted neutron spectrum and focal spot diameter as a function of neutron wavelength for a neutron focusing optic designed for the IPNS-SCD spectrometer (15 mm diameter, 14 μm channel size, 50 mm output focal distance, adjustable convergence angle 0.5–4.5°).

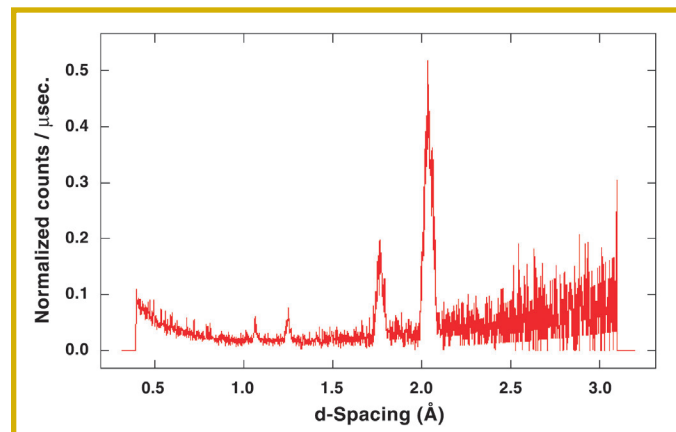


Convergent Beam Neutron Diffraction Using Neutron Focusing Optics

The Neutron Focusing and Analysis system uses the convergent beam method (CBM) to enhance both single crystal and powder neutron diffraction studies. Convergent beam neutron crystallography using capillary optics can be effectively used in crystal structure or phase distribution studies for small samples of small to medium-size molecules and possibly even for proteins. This is particularly important for ultra high pressure or low temperature measurements. Powder diffraction using neutron focusing optics enables the analysis of small samples or weakly diffracting polycrystalline materials such as polymers. High spatial resolution studies of strain, phase, and texture distributions in extended samples may also be possible.



Above: Single Crystal Diffraction Pattern of Quartz (with a 2.0° convergent beam) (W.M. Gibson et al, *J. Appl. Cryst.*, 35, 677-683 (2002).) Below: Powder Diffraction Pattern of Nickel Powder (with a 15.0° convergent beam) (W.M. Gibson et al, *J. Appl. Cryst.*, (to be published, 2004).)



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