Monte-Carlo Exploration of Focused Neutron Guide and Monochromator Geometries

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New Cold Source

- A new cold source will be replacing the current cold source
- This produces most of the cold neutrons used at the NCNR
Replacing NG5 and SPINS
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Software used

- Mcstas
  - http://www.mcstas.org/
- Guide_bot_distribution
  - Courtesy of Mads Bertelsen
- iFit
- NCNR Rocks Cluster
NG5

- NG5 is a 41 meter long straight rectangular guide
- Neutron guides contain coatings that line the inner walls that allow the neutrons to bounce down the guide
- Coated in Ni58
Momentum Transfer

- The momentum and collision angle determine the momentum transfer \( Q \)

\[
Q = 2K \sin \theta
\]

\[
\sin \theta \approx \theta
\]
Guide Coatings

• Increasing m-value is one way of increasing flux

Source: Swiss Neutronics
Ballistic Ellipse

- Use a ballistic elliptical geometry
- Each neutron should ideally only bounce once down the guide
Ballistic Ellipse

Horizontal plane

Vertical plane
NG5 Baseline

2.3 meV: $1.5 \times 10^8$ Flux, 30% brilliance transfer

17 meV: $1.6 \times 10^8$ Flux, 6% brilliance transfer
Ballistic Ellipse

2.3 meV: 5e8 Flux, 80% brilliance transfer
17 meV: 11e8 Flux, 45% brilliance transfer
Monochromator Optimization

Source

Guide

White Beam

Source Image

Single Energy

Monochromator

Sample

L1

L2
Mosaic Optimization

[Diagram showing the relationship between source, guide, sample, and crystal planes, with annotations for angular orientation and FWHM.]
Historically 30 minutes has been used
Flat Monochromator

10 cm\(^2\)

Area [cm\(^2\)]

L2 [m]

Rays for different energies:

- 2.5 meV
- 3.125 meV
- 3.75 meV
- 4.375 meV
- 5 meV
- 5.625 meV
- 6.25 meV
- 6.875 meV
- 7.5 meV
- 8.125 meV
- 8.75 meV
- 9.375 meV
- 10 meV
- 10.625 meV
- 11.25 meV
- 11.875 meV
- 12.5 meV
- 13.125 meV
- 13.75 meV
- 14.375 meV
- 15 meV

NIST
National Institute of Standards and Technology
U.S. Department of Commerce
Doubly Focusing Monochromator

Source: Johns Hopkins University
Vertical Focusing

• Use Lens Maker Eqn. to place and rotate individual blades

\[
\frac{1}{L_0} + \frac{1}{L_1} = \frac{2 \sin \theta_M}{R}
\]
Horizontal Focusing

- Blade group lays tangent to Rowland circle
• The focal point of the elliptical guide is NOT where the source image is produced.
Monochromator Results
Future Plans

• Compare intensities at sample position of flat monochromator with optimized focused monochromator.
• Integrate the monochromator into guide optimization
• Vary the m-value of the coating along the ellipse
• Build the best guide/spectrometer ever
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