3-DIMENSIONAL PRINTING RADIAL COLLIMATORS FOR NEUTRON REFLECTOMETRY

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RADIAL COLLIMATORS

Focus neutrons by absorbing any that are not directed at a point on the detector

When a sample is placed in front of the collimator, the neutrons are scattered

The detector measures how far the neutrons scatter from the convergence point of the collimator
OVERVIEW

Build a radial collimator for the NCNR’s MAGIK off-specular reflectometer

Radial collimators can cost $30,000 and are made with huge pieces of metal

Determine whether a radial collimator could be built using a simple 3D printer
BENEFITS OF A COLLIMATOR

Pinhole Slits

Neutrons from source
Convergence Point on Detector
Radial Collimator Collimated neutrons
TESTS WITH MCSTAS SIMULATIONS

2 Pinhole Slits

Radial Collimator & Vertical Slits
3D PRINTERS

NIST Library: LulzBot® TAZ 5 Printers

NCNR: MakerBot® Replicator 2 Printer

Fused Deposition Modeling (FDM) Printers

Makerbot® Replicator 2 at NCNR
GUIDE FRAMES

5 Frames, each with different finger spacing

Thin strips of polypropylene are placed between the fingers to direct neutrons towards point on detector

Easily print prototypes in 2-4 hours out of PLA/ABS plastics
RESULTS

Initial tests successfully focuses neutrons
Performs better farther away from the detector
MODIFIED FRAMES & RAIL SYSTEM

Added a groove on the bottom of the frame to fit on a rail

Shifting the frames along the rail will allow for the angle of convergence of the neutrons on the detector to be changed
RAIL

Rail-to-frame holes spaced 10 mm apart, which allow for a wide range of different frame positioning

Rail-to-rail connections allow the rail to be customizable in length
FUTURE ADDITIONS

• Replace frames with half-frame, "combs"

• Print on higher resolution 3D printers

• Print out of Boron Carbide (B₄C)

• Develop a spring system to automatically adjust the angle of convergence

Comb prototype
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