3-DIMENSIONAL PRINTING RADIAL COLLIMATORS FOR NEUTRON REFLECTOMETRY

ETHAN SEIDE (NCNR, MARET SCHOOL)

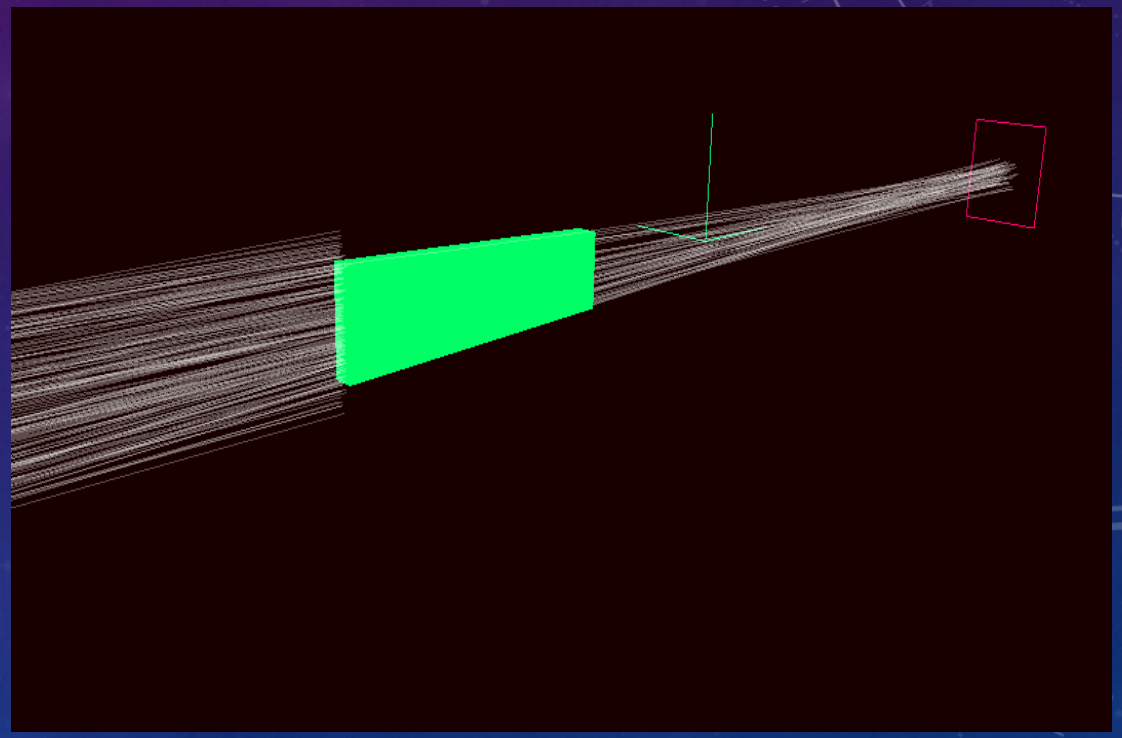
MENTOR: BRIAN MARANVILLE (NCNR)

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

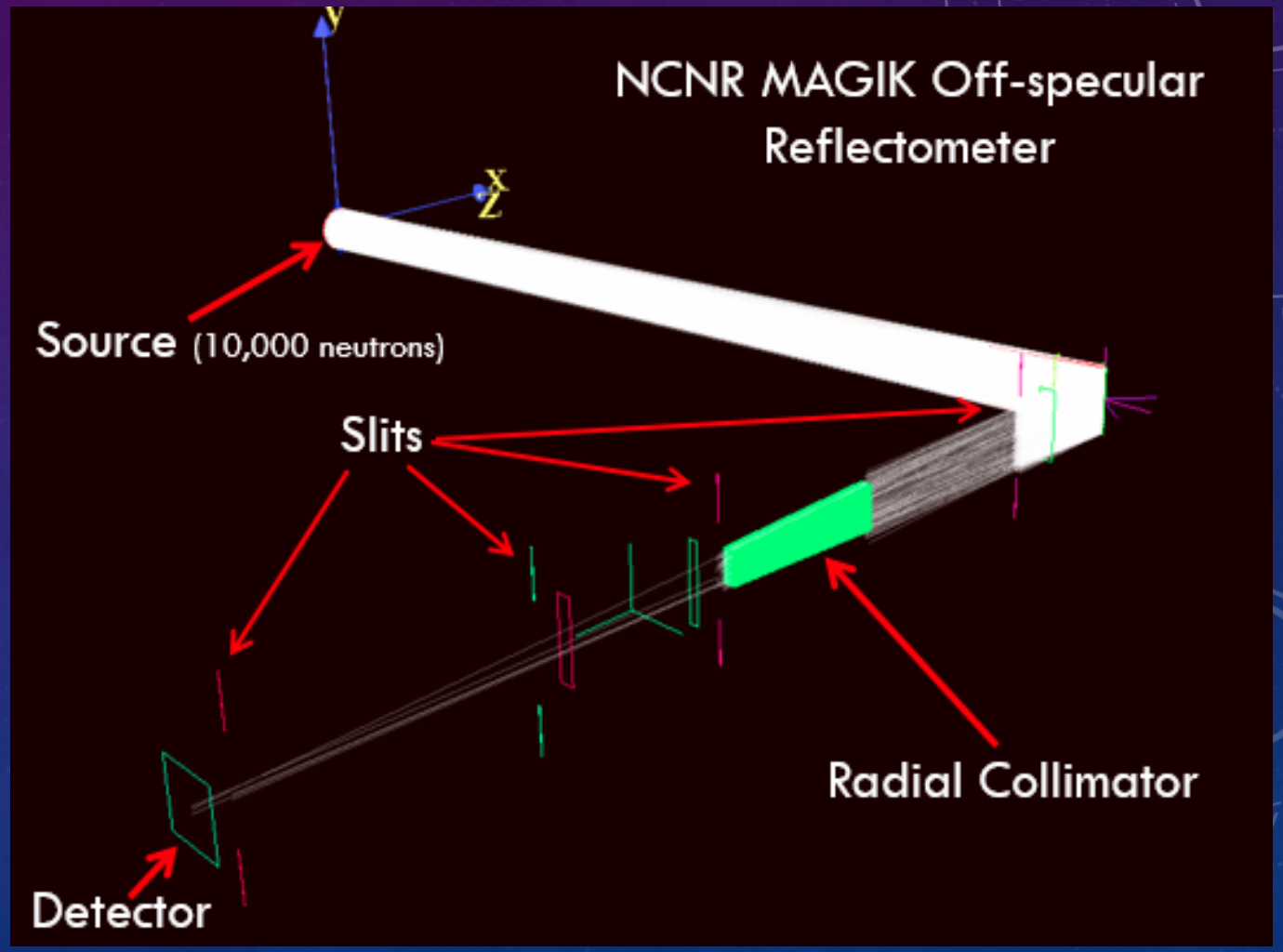


OVERVIEW

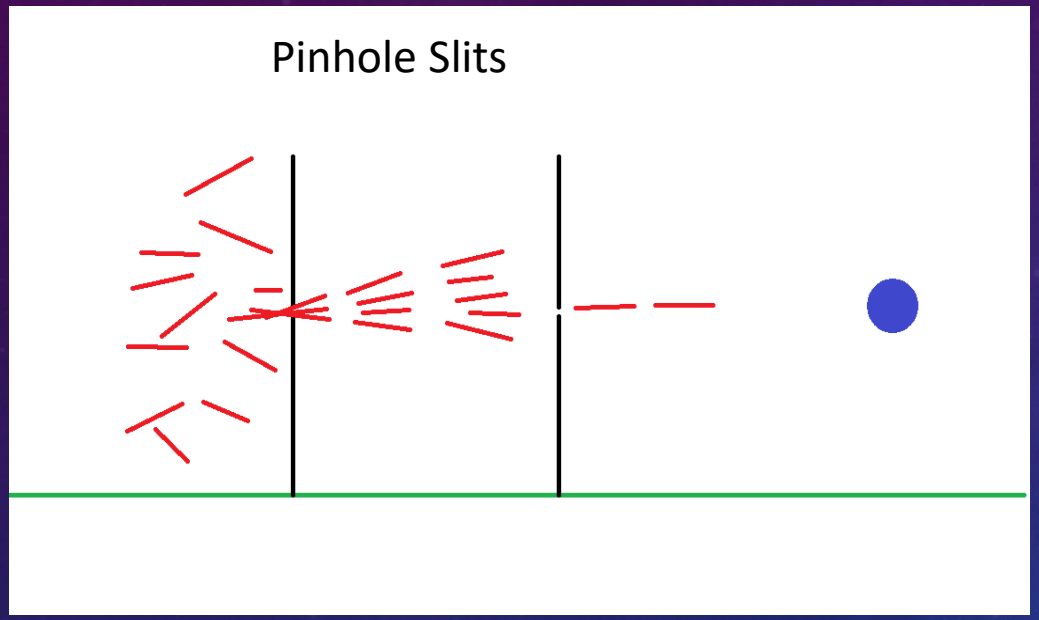
Build a radial collimator for the NCNR's MAGIK off-specular reflectometer

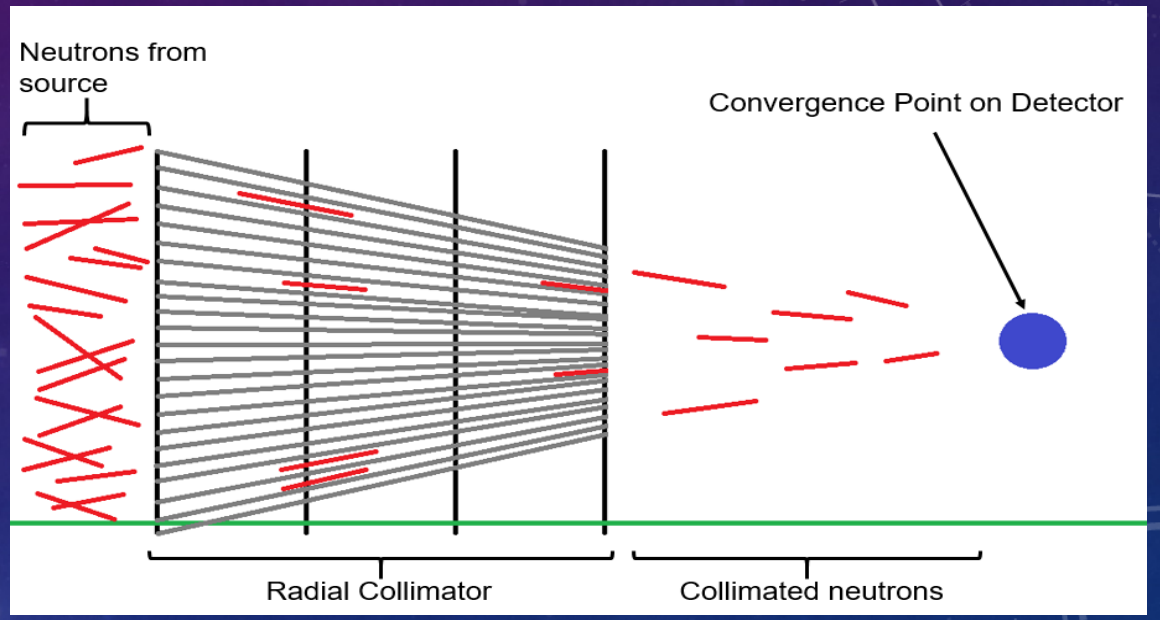
Radial collimators can cost $30,000 and are made with huge pieces of metal

Determine whether a radial collimator could be built using a simple 3D printer



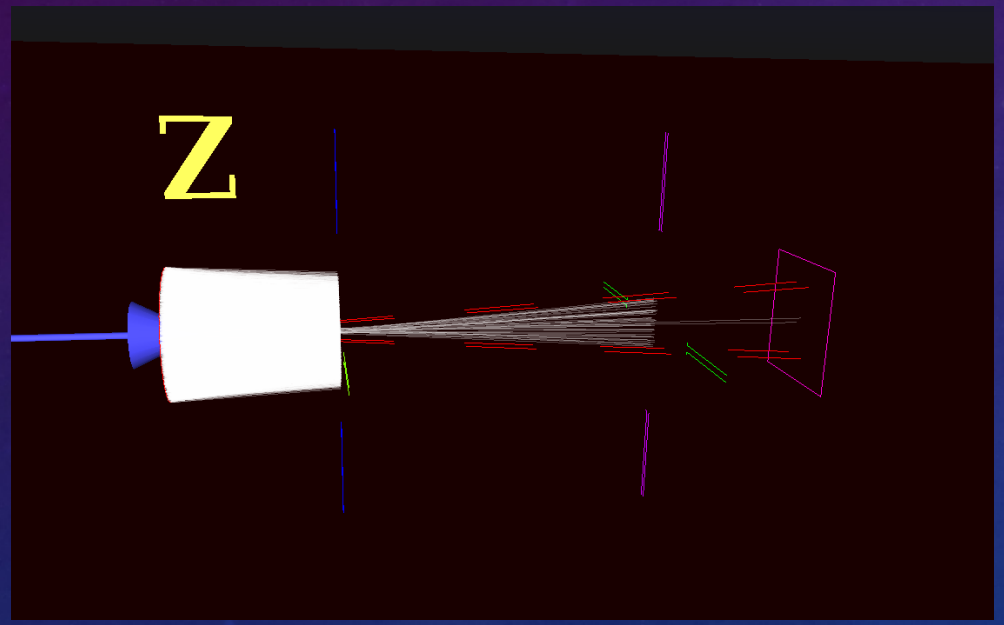
BENEFITS OF A COLLIMATOR



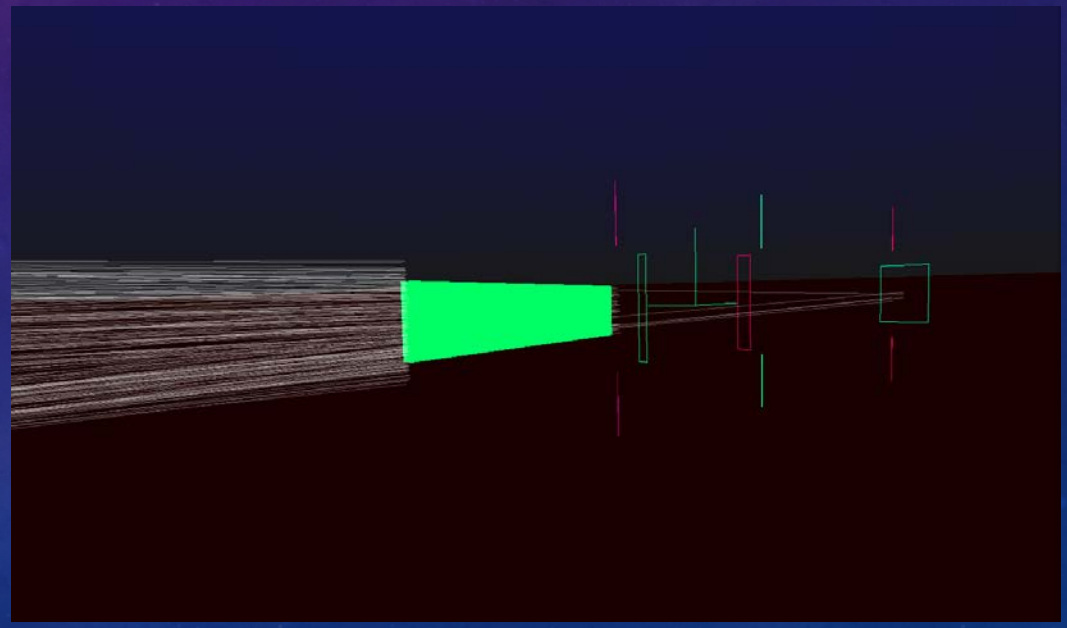


TESTS WITH MCSTAS SIMULATIONS

2 Pinhole Slits



Radial Collimator & Vertical Slits

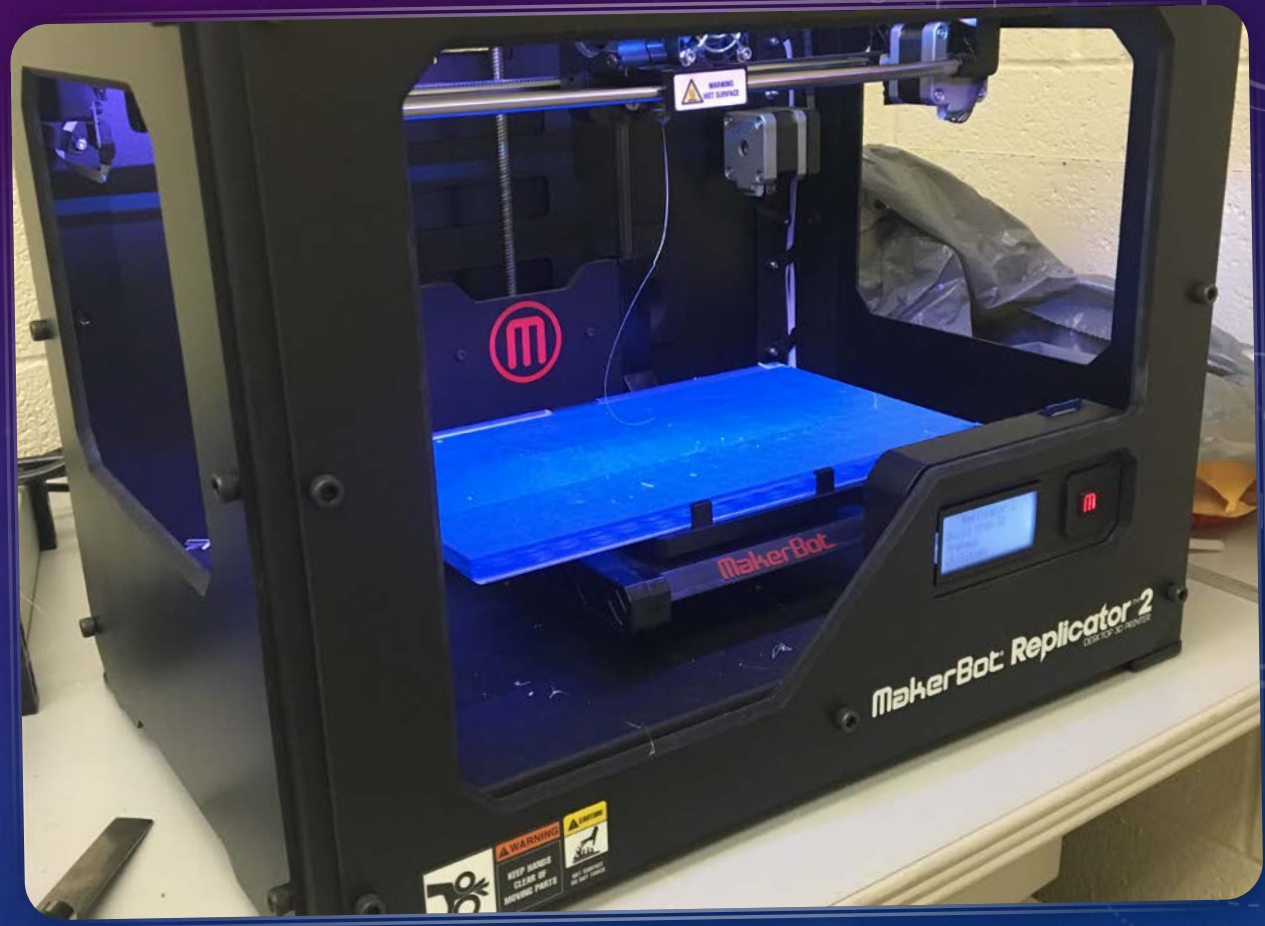


3D PRINTERS

NIST Library: LulzBot® TAZ 5 Printers

NCNR: MakerBot® Replicator 2 Printer

Fused Deposition Modeling (FDM) Printers



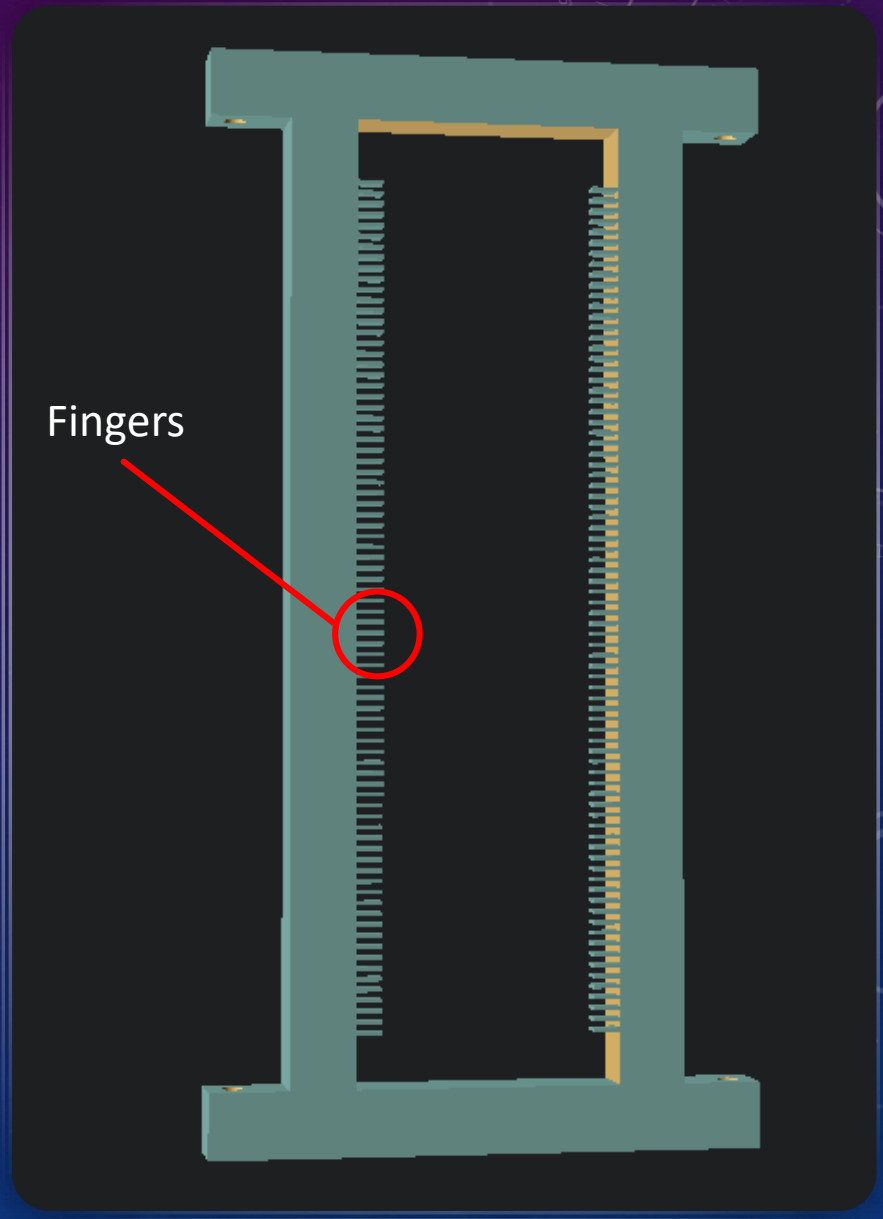
Makerbot® Replicator 2 at NCNR

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

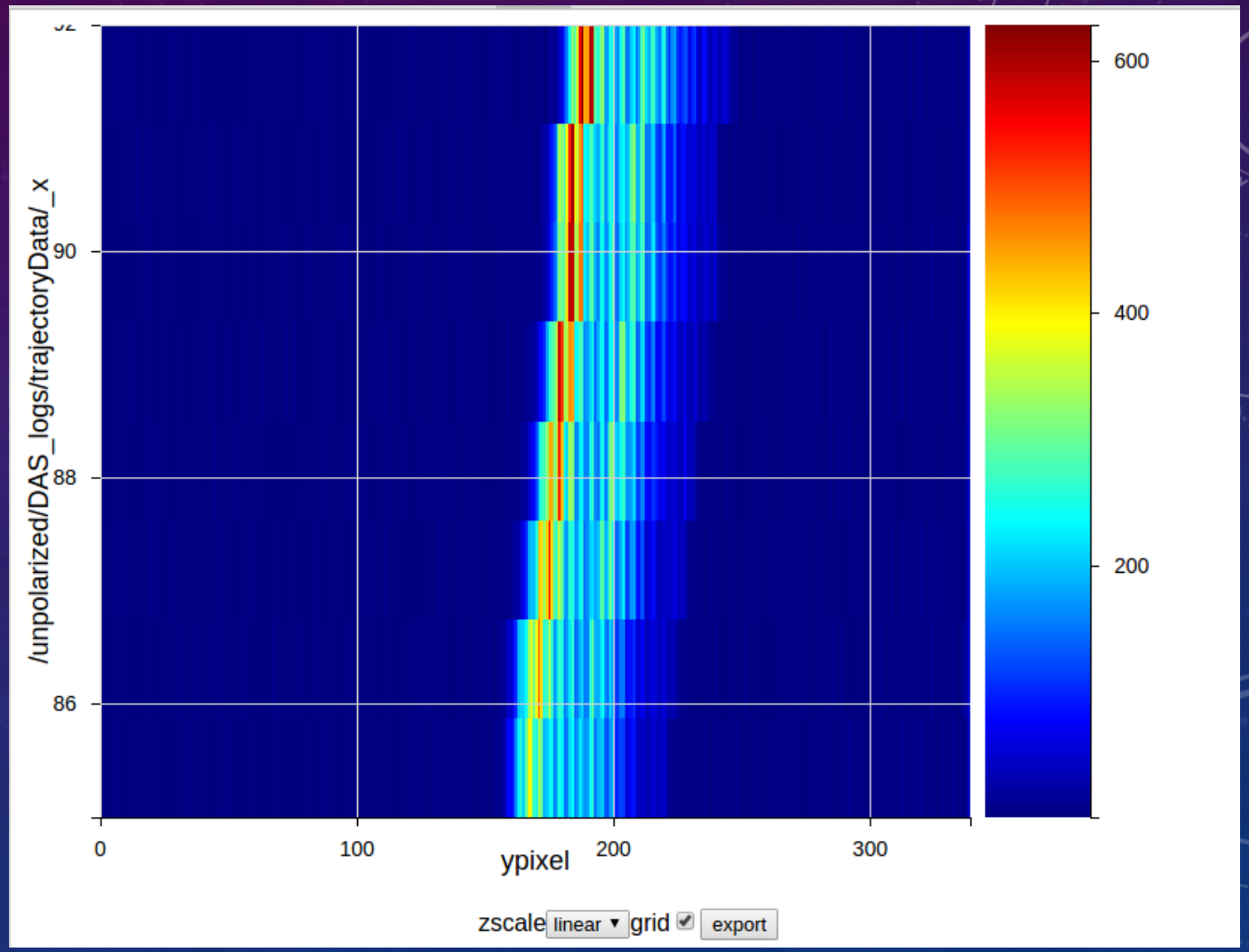
Easily print prototypes in 2-4 hours out of PLA/ABS plastics



RESULTS

Initial tests successfully focuses neutrons

Performs better farther away from the detector



MODIFIED FRAMES & RAIL SYSTEM

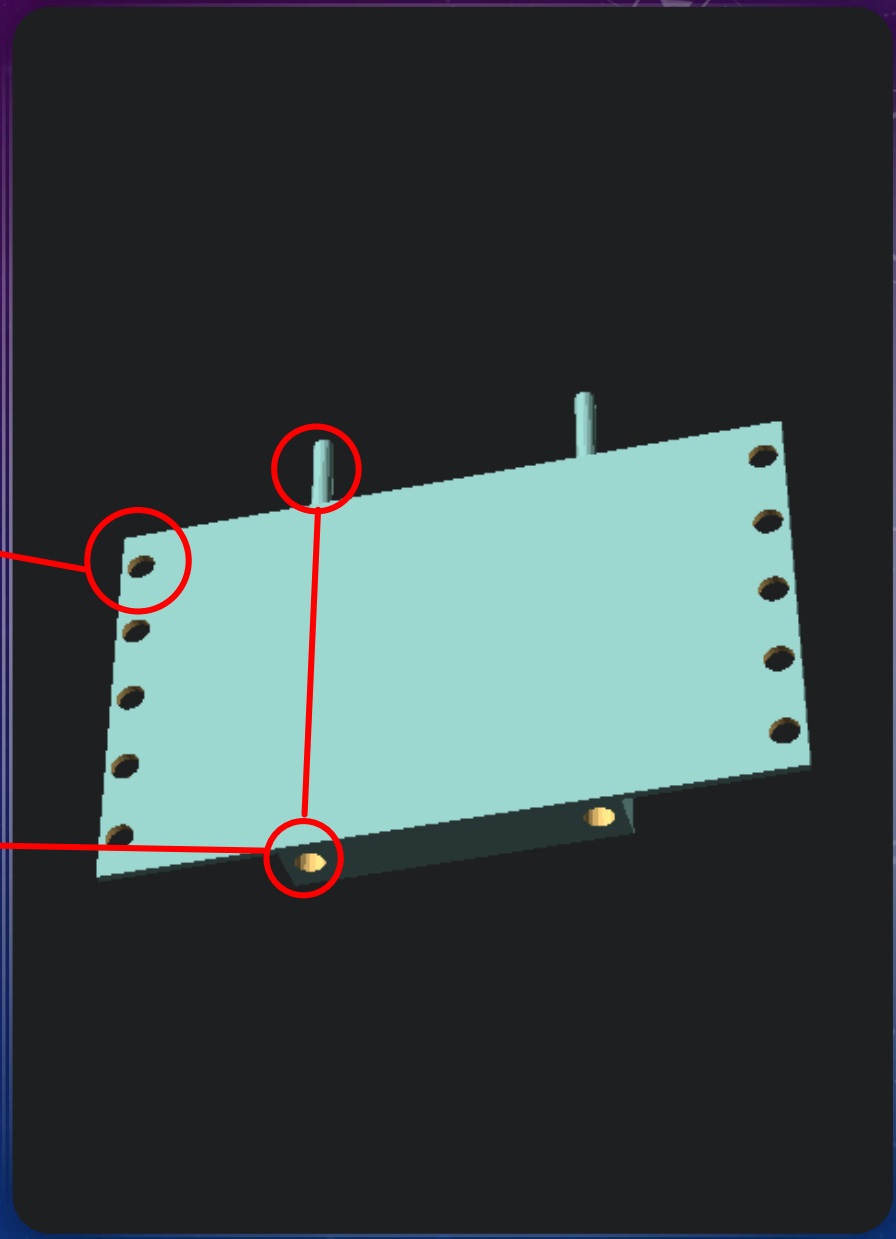
Added a groove on the bottom of the frame to fit on a rail

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

RAIL

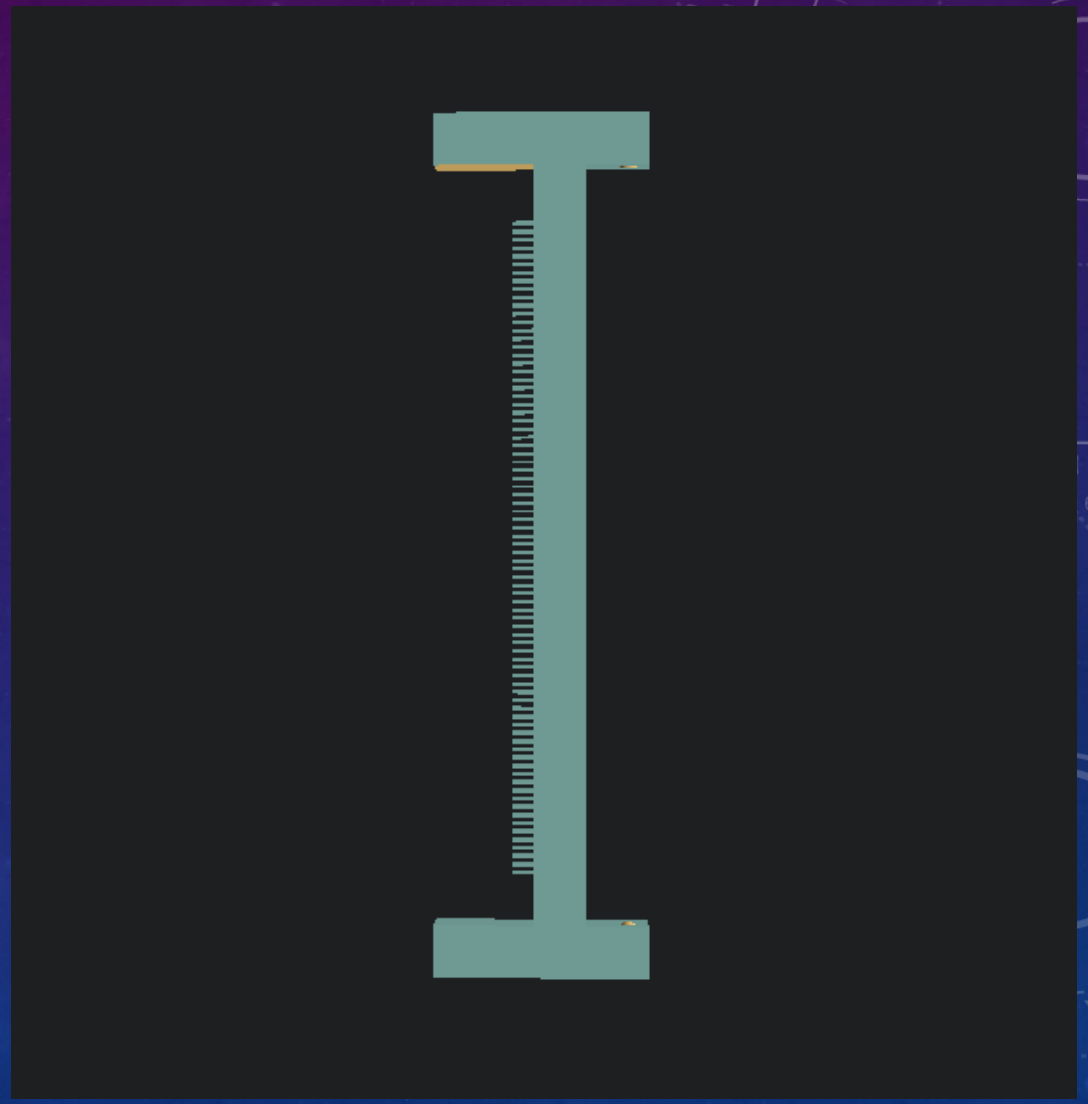
Rail-to-frame holes spaced 10 mm apart, which allow for a wide range of different frame positioning

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 (B_4C)
- Develop a spring system to automatically adjust the angle of convergence



Comb prototype

ACKNOWLEDGMENTS

Charles Majkrzak

Nick Maliszewskyj & Phil Chabot

Julie Borchers & Yamali Hernandez