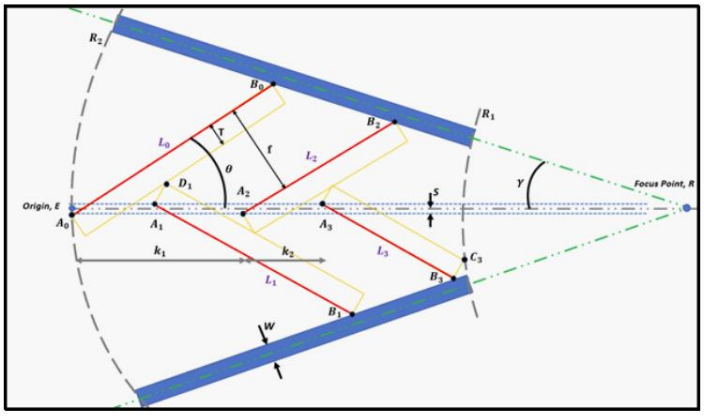
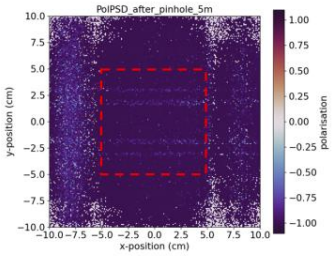
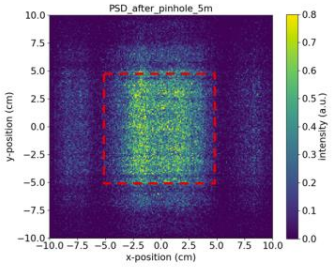
Design and Optimization of a Neutron Polariser for ESS Imaging Instrument ODIN



Schematic of single focusing v- cavity design for ODIN polariser



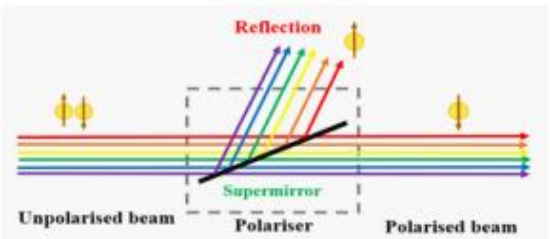
Polarisation



Intensity

Neutrons can be used as a versatile tool to study material properties. Due to neutron having a magnetic moment, it is especially useful for studying magnetic materials. The magnetic moment is associated with an intrinsic property call “spin”. The spins of the neutrons need to be aligned in those studies. In this condition, the neutron beam is called “polarised”. One of the techniques that utilizes a polarised neutron beam is “polarised neutron imaging”.

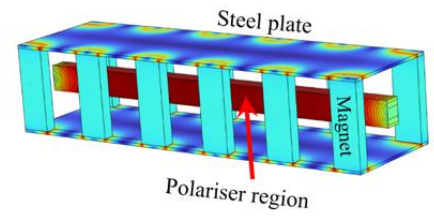
Using this technique, for instance, the magnetic domains inside a metallic sample can be directly seen and their behavior analyzed. At the European Spallation Source, a new large sale facility for the scientific use of neutrons, the imaging instrument ODIN is currently under construction. Polarised neutron imaging will be one of ODIN’s unique capabilities.



Spin-dependent reflection

The device to create a polarised beam is called “polariser”. It is based on a special magnetic layered structured called “polarising supermirrors” which reflects only neutrons with a selected spin-orientation, creating a spin-aligned neutron beam. This work focused on designing a polariser for ODIN by adapting conventional arrangement of polarising supermirrors for non-focusing beam to a focusing polariser that will match ODIN’s strongly focused beam. A key design constraint is that ODIN will use neutrons in a wide energy range and reflection by supermirror is highly energy-dependent. Using “McStas”, a simulation tool for designing neutron instrument components, the performances over a range of polariser design parameters were analyzed.

We succeeded in finding a geometry that satisfied all design requirements, primarily the degree of polarisation achieved for the full range of neutron energies to be used on ODIN.



Magnetic field setup for polariser

The polariser requires a magnetic field to function. Finite element calculations were done using COMSOL software to verify a magnetic housing design to have exceeded the design requirements.