Development update of PIONEER, a single-crystal neutron diffractometer at the Second Target Station, ORNL

Yaohua Liu[1], Peter Torres[2]

[1]Oak Ridge National Lab [2]Second Target Station Project

liuyh@ornl.gov

PIONEER is a single-crystal neutron diffractometer in the initial instrument suite at the second target station (STS) at the Spallation Neutron Source, Oak Ridge National Laboratory. By utilizing the high cold-neutron flux provided by the STS moderator and advanced neutron optics, PIONEER will enable scientists to study tiny crystals (0.001 mm3) and ultra-thin films (10 nm), which are comparable to those typically used for x-ray studies but not feasible at existing neutron diffractometers. PIONEER will have a high resolution to study crystals with a unit-cell size up to 200 angstroms, and has a polarized incident beam option for measuring weak magnetic signals. PIONEER will provide a variety of sample environments, including high/low temperatures, high magnetic fields, and high pressures, which aims at accelerating materials discovery for a wide range of research fields to address societal energy and environmental challenges.

Here we will report the instrument development progress, focusing on the beam transportation and collimation system to deliver a high-flux and highly uniform beam to study small volume samples. To achieve this, PIONEER will take a kinked beamline geometry with two sets of Montel mirrors (also known as nested KB mirrors) and a virtual source in between. This design helps reduce the background by moving the sample out of the direct line of sight to the moderator and provides a method to tune the beam size at the sample position. We will present Monte Carlo ray-tracing simulation results to show the performance of the beam transport system and use some virtual experiments to show PIONEER's capabilities for measuring small-volume samples.

This research used resources of the Spallation Neutron Source Second Target Station Project at Oak RidgeNational Laboratory (ORNL). ORNL is managed by UT-Battelle LLC for DOE's Office of Science, the single largest supporter of basic research in the physical sciences in the United States.

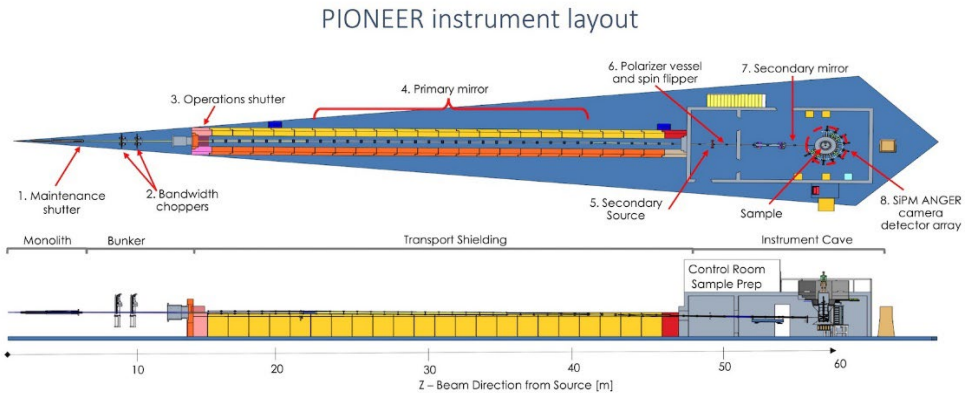

Figure 1. Pioneer Instrument Layout