Neutron Diffractometer Concept(s) for the Second Target Station at the Spallation Neutron Source*

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Neutrons are a unique tool for structural science. They carry no electrical charge and interact directly with the nuclei in a material, they are sensitive to light elements and isotopic differences, and they have a magnetic moment that interacts directly with magnetic structures. Additionally, neutrons penetrate deep into materials, so they are frequently used to study samples in extreme and complex conditions, such as pressure or reaction vessels.

In this talk, I will introduce the next-generation neutron diffractometer concept(s) proposed for the Second Target Station (STS) at the Spallation Neutron Source (SNS). The STS is designed to deliver small and cold-neutron beams with higher peak brightness and broader ranges of neutron energies to meet the challenges at the frontiers of matter and energy research. I will present exemplary science cases that address grand challenges from national studies and reports but are not feasible or over-challenging for globally existing neutron diffractometers. The new STS instrument concept(s) can fill these gaps by taking advantage of the unique source characteristic and the advanced neutron optics, such as elliptical guide and mirror elements. Virtual experiment simulations have demonstrated the transformative capabilities of the new instrument concept(s), such as measuring samples with volumes one or two orders-of-magnitude smaller than those required at existing instruments. Then, I will discuss how the new diffractometer(s) complement those of the SNS First Target Station (FTS) and High Flux Isotope Reactor (HFIR) and how it is (they are) aligned with the ORNL three-neutron-source strategy that aims at more advanced studies of a wide range of materials and enables breakthrough discoveries in many areas of materials research and development. I will outline the potential user communities of the new diffractometer(s) and compare the instrument characteristics with similar beamlines worldwide.

*The STS officially received the Critical Decision 1 (CD-1) approval from the US Department of Energy (DOE) in November 2020. It will have the capacity for 22 beamlines and is currently working with research communities on developing, evaluating, and selecting instrument concepts to build 8 initial beamlines. The STS plans to announce the selection result around the end of June 2021. This work used resources at the Spallation Neutron Source, a DOE Office of Science User Facility operated by the Oak Ridge National Laboratory.