Neutronics Studies for a Long-Wavelength Target Station at SNS

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Abstract. The Spallation Neutron Source (SNS), under construction at Oak Ridge National Laboratory, will be the premier facility for neutron scattering studies in the United States. From the outset the SNS can achieve additional flexibility and accommodate a broader range of scientific investigation than would be possible with only the High Power Target Station by utilizing two target stations, each operating under a separate set of conditions and optimized for a certain class of instruments. A second target station, termed the Long-Wavelength Target Station (LWTS), would operate at a lower pulse rate (e.g., 10 vs. 60 Hz) and utilize very cold moderators to emphasize low-energy (long wavelength) neutrons. The LWTS concept discussed here obtains the highest low-energy fluxes possible for neutron scattering instruments by using a heavy-water-cooled solid tungsten target with two moderators in slab geometry and one in a front wing position. The primary focus has been on solid methane moderators, with liquid methane and hydrogen also considered. We used MCNPX to conduct a series of optimization and sensitivity studies to help determine the optimal neutronic parameters of the LWTS. We compared different options based on the thermal and epithermal fluxes as determined by fitting the spectral intensity of the moderators with a Maxwellian peak and a modified Westcott function. The primary parameters are the moderator positions and composition and the target size. We report results for spectral intensity, pulse shapes, high-energy neutron emission, heating profiles in the target, and target activation.

1. INTRODUCTION

The Spallation Neutron Source (SNS) project has always planned that two target stations would eventually be built at the SNS facility, although only one is funded under the current project. Having two target stations, each operating under a separate set of conditions and optimized for a certain class of instruments, would permit greater flexibility in design and accommodate a broader range of scientific investigation. The High Power Target Station (HPTS) will offer both ambient-temperature and cryogenic moderators, designed to deliver the highest-intensity beams for applications that can exploit the 60-Hz pulsing frequency. The proposed Long Wavelength Target Station (LWTS) will operate at 10 Hz, allowing a broader spectrum of neutrons to be used while simultaneously permitting the use of colder, more efficient moderators for producing long-wavelength neutrons. Optimization for long-wavelength neutrons implies extensive implementation of curved guides and compact beam benders, which in turn enables use of tall slab moderators. Discussion of the philosophy of the design effort may be found elsewhere.[1] Herein we describe neutronics design studies for the LWTS effort.

Section 2 describes the neutronically relevant aspects of the LWTS, Sec. 3 presents some of the performance characteristics of the current LWTS concept, and Sec. 4 outlines some sensitivity studies performed as part of the design process. We discuss high-energy neutron aspects of the LWTS design in Sec. 5, and target heating and activation in Sec. 6.