Hydrogen at the Lunar Poles: Search Strategies and Tradeoffs for a Surface-based Neutron Spectrometer. R. S. Miller[1], Mikhail V. Gubarev[2], D. J. Lawrence[3], Brian D. Ramsey[2], A. Souza[1], [1]University of Alabama in Huntsville (richard.s.miller@uah.edu), [2]NASA/MSFC (VP62), [3]Applied Physics Laboratory, Johns Hopkins University.

Introduction: One of the major science and exploration objectives of future lunar studies is to determine the distribution and compositional state of hydrogen on meter-sized spatial scales. This is particularly true for the lunar-polar regions where substantial deposits are anticipated within permanently shadowed craters. The morphology of these hydrogen deposits will enable a deeper understanding of the sources of lunar polar volatiles, and provide critical information and additional insights into transport processes operating at the poles.

Results from multiple lunar missions show strong evidence for hydrogen deposits at the lunar poles. Unfortunately, the lateral distribution information provided by these missions is limited to very large areas (e.g. 1-10 km^2) [1, 2], with limited knowledge of composition or depth. A straightforward and robust way to make detailed hydrogen composition and distribution measurements is via surface-based neutron spectroscopy.

We will present preliminary analysis of the tradeoffs, capabilities, and survey strategies for a rover-mounted neutron telescope capable of addressing the lunar-polar hydrogen exploration challenge. In addition, performance of one relevant instrument concept under consideration, a grazing-incidence neutron telescope, will also be presented.

Developmental Approach: Our development effort, supported in part by a NASA Lunar Science Institute, is focused on simulation and software development. Specifically, we have developed a set of tools that enable neutron spectroscopic tradeoff analyses in the context of a surface-based hydrogen search. The foundation of the numerical simulation is a (user defined) crater geometry, as well as variable hydrogen morphologies incorporated into this geometry.

Given knowledge of the neutron flux expected from dry regolith and anticipated changes in the flux due to the presence of hydrogen (as a % weight of H_2O) [3, 4], as well as other physical parameters (e.g. backgrounds), the neutron environment can be estimated within the crater. This simulation tool enables detailed tradeoff analyses to be performed, ultimately maximizing the telescope design and science return from a future surface-based neutron endeavor.

Issues related to neutron count rates, dwell times, and backgrounds effects, will be reported within the context of characterizing the presence of any hydrogen deposits within lunar craters. In addition, we are leveraging these tools to produce search strategies capable of producing neutron maps having high-spatial resolution.

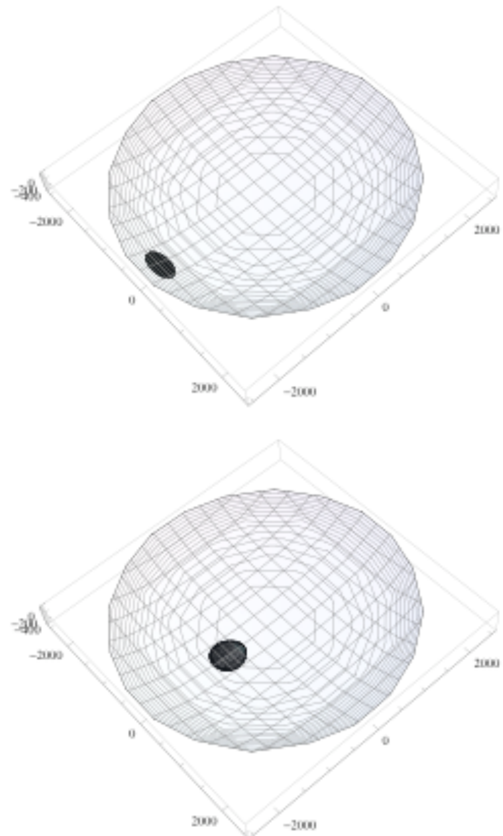

Figure 1. Examples of lunar crater simulation. Hypothetical neutron telescope, with user defined field-of-view, pointing direction, and flux sensitivity, placed into ellipsoidal crater. Sampled area shown (dark) for two different telescope pointing directions.

Summary: Surface-based neutron spectroscopy holds promise for future investigations of hydrogen deposits within craters at or near the lunar poles. The work presented here will provide important information with which to optimize search strategies and instrument specifications needed to characterize this interesting and valuable resource.

References: [1] W.C. Feldman, et al. (1999), *Nucl. Instr. Meth.*, *A422, 562*. [2] D.J. Lawrence, et al. (2010) *Astrobiology, 10,* 1. [3] D.J. Lawrence, et al. (2005), *J. Geophys. Res., 111,* E08001. [4] S.D. McKinney, et al. (2005), *J. Geophys. Res., 111,* E06004.