A COMPACT COSMIC-RAY AND NEUTRON SPECTROMETER TO SEARCH FOR WATER ICE ON THE MOON. M. J. Losekamm and T. Pöschl, Technical University of Munich, Germany; m.losekamm@tum.de.

Introduction: Local resources will likely prove to be crucial for the establishment of a sustained human presence on the Moon. They may also be essential for the development of near-Earth space and form the basis for a cis-lunar economy [1]. In-situ resource utilization (ISRU), especially the extraction of water and oxygen from the lunar regolith, promises to substantially decrease the amount of material that must be re-supplied to a permanently manned outpost from Earth. Our current knowledge of the Moon's resource potential, however, is too incomplete to assess the technical feasibility and economic viability of ISRU and other resource-extraction efforts.

In this contribution, we will present the ongoing development of the Lunar Cosmic-Ray and Neutron Spectrometer (LCNS), one of three major scientific instruments developed in the context of the LUVMI-X project. LUVMI-X is a compact rover equipped with complementary instrumentation designed to prospect illuminated and shadowed areas in the Moon's polar regions. The rover's purpose is to address the shortage of in-situ data and to help resolve the remaining ambiguities in our knowledge of the distribution of lunar water ice [2,3]. Its main objective is to measure and compare the concentration and distribution of water and other volatiles in fully illuminated, partially illuminated, and permanently shadowed regions. The mission shall also determine the lunar regolith's mineralogical composition in regions for which no reliable in-situ or sample data exists yet and characterize the surface radiation environment in preparation for future manned exploration missions.

The LCNS: The LCNS consist of two primary sub-detectors: a neutron spectrometer (CNS) and a charged-particle telescope (CPT). The primary purpose of the CNS is to aid the search for water and hydroxyl deposits by measuring the (relative) fluxes of thermal, epithermal, and fast neutrons. Neutrons are created by highly energetic cosmic rays that penetrate the lunar surface to depths of several meters. While diffusing upwards through the regolith, the neutrons scatter with the soil's constituent nuclei and assume an energy spectrum that is characteristic for the composition of the regolith [4]. The presence of hydrogen (and thus water or hydroxyl) elicits a detectable change in this energy spectrum by lowering the relative flux of epithermal neutrons, a fact that has, for example, previously been exploited by the neutron spectrometers aboard Lunar Prospector [5] and LRO [6]. We devised and simulated an instrument concept that allows us to construct a compact yet relatively capable neutron spectrometer based on plastic and glass scintillators.

The CPT, the second detector of the LCNS, can detect and identify charged cosmic-ray and solar-wind particles (i.e., protons and ions) with energies larger than 10 MeV (protons) and 50 MeV per nucleon (ions). This capability allows the characterization of the radiation environment on the lunar surface, which is a crucial prerequisite for future manned exploration missions [7]. The lunar proton albedo may contain information about the distribution of volatiles in the regolith as well [8]. The CPT is a telescope comprising three silicon-pixel detectors with a calorimeter made from plastic scintillators in between. In concert with several complementary dosimeters, the CPT will help to address the shortage of radiation measurements on the lunar surface by providing particle-dependent energy spectra for charged particles with energies between ten and several hundred MeV per nucleon and by measuring the ionization dose of all radiation particles, including neutrons and gamma rays.

We will present the overall instrument concept of the LCNS and the current state of development of its various detectors. We will also provide preliminary performance parameters based on simulations with particle physics frameworks and explain how the data from all three major instruments aboard the LUVMI-X rover can provide strong evidence for water deposits at different depths at the lunar poles.

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