Lunar Cellular Network Neutron Spectrometer C. W. Clark[1] (charles.clark@nist.gov), M.A. Coplan[1], J. G. Graybill[1], R. Haun[1], T. A. Livengood[1,2], L.F. Lutz[1], A. M. Parsons[2], L. Putnam[1], C. B. Shahi[1], J. J. Su[1] and A. K. Thompson[1], [1]National Institute of Standards and Technology and University of Maryland, Gaithersburg, MD 20899-8420 [2]NASA Goddard Space Flight Center, Greenbelt, MD 20771.

Introduction: Neutron spectroscopy is a key tool in analysis of the planetary regoliths, particularly for discovery of subsurface hydrogenous material. It has been deployed on the lunar surface by the Apollo 17 astronauts [1], flown in lunar orbit by Lunar Prospector [2] and Lunar Reconnaisance Orbiter [3]. Neutron spectroscopy is a key component of the Volatiles Investigating Polar Exploration Rover planned for delivery to the lunar surface in 2022 [4]. It has also been deployed on the Martian surface by Mars Science Laboratory rover Curiosity [5], in orbit by Mars Odyssey and ExoMars [6], and will be key in assessing candidate bases on the Moon and Mars.

We propose a novel neutron spectroscopy architecture for the Artemis mission: a cellular network of compact, lightweight, low-voltage/low-power neutron detectors, based on optical scintillation in noble gases induced by the $n(^{10}B,^{7}Li)\alpha$ reaction that is detected by silicon photomultipliers (SiPMs) [7-9]. Our detectors are now at NASA TRL 4, with their development supported by a FY18 NASA PICASSO award. We have identified applications well suited to the Artemis mission.

Applications: We envisage an array of diverse autonomous neutron spectrometry cells spread across a detector base of area ~ 1 km^2, displaced by ~ 1 km from other active mission spaces to minimize extrinsic neutron backgrounds. Each cell would have a small photovoltaic panel, storage battery, long-range Wi-Fi communication transceiver and a neutron physics package. Each individual cell would provide partial directional and energy information on the neutron field in its immediate vicinity, which would be broadcast to a receiver in the Artemis command module.

This configuration could provide a significant neutron field map with minimal background contamination for the duration of a landed astronaut mission. If the astronaut mission leaves behind a master telemetry module, the cellular network could continue to broadcast information for an extended period, perhaps operating only lunar daylight.

There are options for lowering detector cells into lunar crater PSRs.

Footprint: Our basic unit cell is 25 mm square and 15 mm thick. It contains micron thick films of ^{10}B deposited on thin metal substrates and is filled with xenon gas at one atmosphere pressure. Neutron capture in the ^{10}B film produces scintillations in the xenon. These scintillations are detected by ultra-violet sensitive SiPMs. The mass of the basic unit cell is 25 gm. Power consumed by the low-voltage photomultipliers does not exceed 30 mW. The entire system runs on s standard USB bus.

Attachments of high-density polyethylene and cadmium are added to the cells in order to map the direction and energy of incident neutrons. These attachments will take different forms dependent on the neutron properties to be determined, and will, on average, add 25 to 50 gm to the mass of each detector cell. Overall, we envisage a network of 25 cells. With attachments, the network mass will be 1500 gm, and require 750 mW for operation of the photomultipliers. Other operational overheads include mass and power consumption of long-range WiFi transceivers and mass of photovoltaic panels and batteries. These remain to be estimated in detail.

Summary: Our network spectrometer has low mass, is mechanically robust, is simple in design and materials, has modest voltage and power requirements, is field configurable, and is insensitive to gamma radiation.

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