THE NEXT GENERATION LUNAR RETROREFLECTOR (NGLR) FOR 2021 DEPLOYMENT. D. G. Currie[1], D. D. Wellnitz[2], G. O. Delle Monache[3], C. Wu[4], B. B. Behr[5] and S. Dell'Agnell[6], [1]Department of Physics, University of Maryland, College Park, College Park, MD, 20742 currie@umd.edu, [2]Department of Astronomy, University of Maryland, College Park, College Park, MD, 20742 wellnitz@astro.umd.edu, [3]Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Frascati Via Enrico Fermi, 40, 00044 Frascati RM, Italy giovanni.dellemonache@lnf.infn.it, [4]Department of Electrical & Computer Engineering, University of Maryland, College Park, College Park, MD, 20742, cwu2011@umd.edu , [5]Department of Physics, University of Maryland, College Park, College Park, MD, 20742, bradfordbehr@gmail.com, [6]Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Frascati Via Enrico Fermi, 40, 00044 Frascati RM, Italy, Simone.DellAgnello@lnf.infn.it,

Introduction: From a Historical Science and Exploration point of view our Lunar Laser Ranging (LLR) program, using the retroreflector arrays that were deployed during the Apollo 11, 14 and 15 missions, provides the basis for the two fundamental selenodetic coordinate systems of the moon. The program also discovered and measured the properties of the liquid core of the moon and continues to collaborate with the GRAIL program to produce a crust to core description of the interior structure of the moon. On the astrophysics/cosmology side, the LLR program has provided many of the best tests of Gravitation and General Relativity. It has also addressed theories of Dark Matter, pushing the open parameters of some of the theories beyond practical physical consideration.

Objectives: With today's improvements in lasers and electronics, a combination of the lunar librations and our Apollo design limits the accuracy of critical individual range measurements to about 150 mm and of normal points (using large telescopes) to a few millimeters. To improve the range accuracy and thus the scientific results and to permit LLR operation by ground stations with smaller apertures, we have developed a scientific payload that will support an improvement in the accuracy of each range measurement by a factor of 100. Under NASA's Lunar Surface Instrument and Technology Payload (LSITP) program, the University of Maryland, College Park has been selected to provide three Next Generation Lunar Retroreflectors (NGLRs) for deployment to the lunar surface. The NGLRs will be deployed by landers supported under NASA's Commercial Lunar Payload Services (CLPS) program, with the deployment of the NGLRs starting in 2021.

Landing Sites and Missions: Among the following considerations to be addressed are the projected methods of deployment for the CLPS landers and then future methods of deployment. Possible landing sites and the factors that are involved in selecting an optimal family of landing sites for deployment of our Next Generation Retroreflectors (NGRs) will be considered. This will address the possible lunar landing missions that could deploy the NGRs, illustrating some of the considerations involved in collaborating with other missions by considering the proposed Lunar Geophysical Network mission.

Use of Meteorite Names: All meteorites that are cited in abstracts must have official names approved by the Nomenclature Committee. Authors can use the Meteoritical Bulletin Database to check the status of a meteorite name. New meteorites without approved names may be rejected. The instructions for submitting new meteorite names can be found on the Meteoritical Society website.

Flight Status and Design: This will be followed by a discussion of the current status of the NGLRs, the current flight schedule, the current fabrication progress and the results of our simulations addressing the expected return signal levels throughout an entire lunar cycle. The latter will also address the critical parameters in the design and the current work to address the optimization of the design.

Future Goals: Finally, in order to take optimal advantage of the fact that the NGRs can support an improvement in the accuracy of a single range measurement by a factor of 100, we will address the upgrades in the operating hardware and parameters of the LLR Observatories that will be required – above and beyond the current operational parameters of the existing LLR observatories. On the other hand, the NGLRs will allow the development of additional observatories to become regular contributors to the LLR program. Current Satellite Laser Ranging (SLRs) stations with smaller apertures will be able to make contributions. Already the Wettzell SLR in Germany is able to provide highly precise range measurenmts. Increasing the number of LLR Observatories will improve our ability to detect and correct systematic biases in the LLR Observatories.

On the other hand, the improved accuracy, multiple lunar deployments and additional LLR Observatories will provide large advances in the lunar coordinate system. Although the GRAIL mission has a finite lifetime, the LLR program has a lifetime of many decades, probably extending to a century. Thus, the lunar science and the collaboration with the GRAIL database will continue to improve the science of the lunar interior over the next decades.

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