NEXT GENERATION LUNAR LASER RETROREFLECTOR. **D. G. Currie**[1,2,3], currie@umd.edu, S. Dell'Agnello[2], G. O. Delle Monache[2] and B. Behr[1] [1]University of Maryland, College Park, Maryland, USA, (2) [2]INFN-Laboratori Nazionali di Frascati, Italy and [3]Lunar Science Institute, Ames Research Center, Mountain View,

Abstract: Lunar Laser Ranging to the Apollo Retroreflectors arrays has investigated the lunar interior leading to the discovery and evaluation of the size and shape of the liquid core a decade ago, as well as many other lunar properties. It has also produced some of the best tests of General Relativity (i.e., the Strong Equivalence Principal, the Inertial Properties of Gravitational Energy and the Constancy of the Gravitational Constant G) [1, 2]. However, while the measurement accuracy has improved by a factor of over 200, the magnitude of the return signal has decreased by 10 to 100 times. We will discuss the sources of this and the analysis to evaluate it. We will also address our next generation retroreflectors that will improve the accuracy by factors of ten to one hundred, depending upon the method of deployment.

Introduction: The Apollo Retroreflectors were developed by a national team centered at the University of Maryland, and were deployed on the surface of the moon during the Apollo 11, 14 and 15.[1], [2]. Ranging accuracy has improved by more than 200 so the interaction of the retroreflector design and the lunar librations means that the retroreflector arrays now limit the accuracy. The Univ. of Maryland now leads an effort to improve the range accuracy by one or two orders of magnitude, depending upon the method of deployment method. This will be accomplished with a single large solid Cube Corner Reflector.

Figure 1 Current Design of LLRRA-21. The additional sunshade is illustrated in Figure 2.

Description of the LLRRA-21: In this section, we will describe the "**L**unar **L**aser **R**anging **R**etroreflector **A**rray for the **21**st Century" (LLRRA-21).

*Objectives of the LLRRA-21.*The LLRRA-21 will both improve the ranging accuracy and will allow participation by additional lunar observatories. The design will yield a signal level equal to that of Apollo 15. This should improve the science results by similar factors, to investigate the inner lunar solid core and some of the relativity theories addressing Dark Matter and Dark Energy.

Lunar Thermal Environment. To guarantee an acceptable signal, the CCR must provide a diffraction limited beam. A temperature gradient in the CCR will cause a gradient in the index of refraction which, will compromise the performance. An equatorial landing, the temperature range of the regolith will vary from ~70K to ~400K.

LLRRA-21 Design

The current design addresses each of the above challenges. In Figure 1, we see the nominal design.

Thermal Simulation: In order to address the overall design and the selection of the thermal coatings, a series of programs for the simulation of the solar input, the radiation exchange between the regolith and the external surfaces and the internal heat exchanges. This will be described.

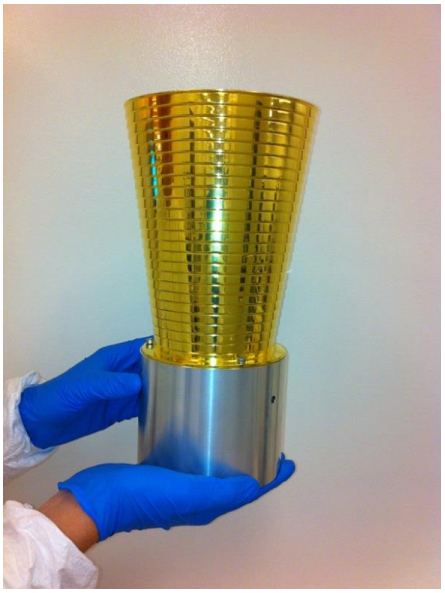

Figure 2 Prototype of LLRRA-21

Prototype of LLRRA-21: A prototype or brass board unit of the LLRRA-21 has been developed and fabricated. This is illustrated in Figure 2 and is essentially appropriate for lunar emplacement.

Thermal/Vacuum/Optical Tests: At the INFN-LNF in Frascati, Italy, a new facility, the SCF has been created, with two thermal vacuum chambers especially configured for testing of retroreflector packages in a large clean room.

Flight Opportunities: While there are a variety of flight possibilities, detailed discussions are being conducted with the most immediate possibility, Moon Express, located at the Ames Research Center, as illustrated in Figure 3.

Figure 3 A model the LLRRA-21 mounted on the instrument platform of the model of their Moon-Ex1. In the background are Joe Lazio, Deputy PI of LUNAR, Jack Burns, PI of LUNAR, Doug Currie, PI of LLRRA-21, Bob Richards, COO of Moon Express, Alan Stern, and Chief Scientist of Moon Express.

Summary and Conclusions: The LLRRA-21 is prepared for flight in the next several years and will greatly enhance the lunar science and tests of General Relativity.

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