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LROC candidate images with solar glints off Lunar Laser Retroreflectors: A dedicated tool of NASA's Moon Trek

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The Lunar Laser Ranging (LLR) investigations have provided time high-precision measurements of geodesy, dynamics and distance of the Earth-Moon system, and inferences about lunar interior and gravitational physics. LLR studies are supported by a total of five passive Laser Retro-Reflectors (LRR) placed on the Moon surface by the past missions Apollo-11, -14, -15 and Luna-17 and -21. The detection of their positions is decisive to improve the measurement accuracy and the data from alternative instrumentations contributed to their analysis. The Lunar Reconnaissance Orbiter Camera (LROC) operated by using the Standardized Lunar Coordinate System as reference system has acquired images of the Moon surface that represent data applicable to LLR planning and research. Several LROC images present nominal lighting conditions and solar glints reflected off of an LRR. Glints represent specular reflections of light that define higher-precision measurement of LRR position. In this way, their detection plays an important role in LRR analysis. The identification of candidate images with solar glints through time allows researchers to record these measurements. NASA and INFN-LNF (National Lab of Frascati) have collaboratively developed an LLR tool to support glint identification. The tool can be accessed using the Moon Trek (https://trek.nasa.gov/moon) which is one of the web based interactive visualization and analysis portals provided by the NASA's Solar System Trek (https://trek.nasa.gov) project. The tool facilitates current ranging studies as well as planning of future missions that involve ranging activities such as future retroreflector deployments. Glint identification has been performed by using the LLR tool that allows us to investigate the image data, and to compute geometric calculations and LLR analyses. The tool with SPICE computations is provided to search for nominal conditions to catch a solar glint off of a retroreflector, to search for time intervals in which a reflector can be seen from a ground station on Earth, and to search in PDS database for images with these conditions. Moon Trek's LLR tool allows us to find time intervals when spacecraft positioning was able to catch a solar glint reflected off of a retroreflector by setting the maximum incidence and phase angles. This analysis is accompanied by the search for LROC images available in Planetary Data System (PDS) that have solar glint off the LRR. Using the Moon Trek, it is possible to identify LROC images with solar glint off the LRR and to recognize optimal LROC candidates. This research allows us to identify good examples of LROC images that present solar glints. More than six candidate images over a period of 10 years of LROC data were recognized. In this contribution, we present the recognized LROC candidates and we show their detection in the image data, by avoiding the bias of the surface high albedo and the morphological pattern that can interfere with the analysis. The identification of solar glints off LRR

will allow us to find previous observation that might be incorrect and to measure the LRR position in the Standardized Lunar Coordinate System of LROC images. These measures will be then compared with the ephemeris calculations obtained from LLR data.