

Recent Developments of the Apache Point Lunar Laser Ranging Station

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The Apache Point Lunar Laser Ranging Station (formerly the Apache Point Observatory Lunar Laser-ranging Operation, or “APOLLO”) became part of the NASA Space Geodesy Network at the beginning of 2021. In conjunction with the former APOLLO team, best practices were established regarding observation and processing of data into normal points. A quality control process to identify centimeter-level biases was introduced, archival procedures were adjusted to match version 2 of the Consolidated Range Data format, and a fully reduced 2021 dataset was published to the Crustal Dynamics Data Information System’s database.

The APOLLO experiment has achieved median range precision at the (1-3) millimeter level for many years, yet comparisons of measurements against models are nearly an order-of-magnitude larger. Model-measurement disagreement raises the question of whether APOLLO suffers from gross systematic inaccuracies or if models are incomplete in some manner. In 2016, the APOLLO team added an Absolute Calibration System (ACS) consisting of a high-repetition-rate (80 MHz) short-pulsed (< 10 ps) laser that is locked to a cesium clock. The ACS delivers “truth” photons to the APOLLO detector at well-known time intervals which provides an independent assessment of the accuracy of the APOLLO system and an avenue for correcting range data in-situ. ACS results suggest systematic errors are reduced to ≤ 1 mm such that both the accuracy and precision of the data are at the ~ 1 mm level.