James B. R. Battat, Nick R. Colmenares, Rodney Davis, Louisa Huang Ruixue, Thomas W. Murphy, Jr.,

Timing Calibration of the APOLLO Experiment

The Apache Point Observatory Lunar Laser-ranging Operation (APOLLO) has been acquiring millimeter-precision normal points since 2006. We have not yet been able to assess the accuracy of our data, in large part because known limitations to the lunar range models ensure APOLLO residuals at the centimeter scale. To directly measure our system timing accuracy, we have built an Absolute timing Calibration System (ACS) that delivers photons to our detector at known, stable time intervals. We lock an 80MHz pulsed fiber laser to a cesium frequency standard to generate a stable optical pulse train. We then pick out short sequences of these pulses at specific times to overlay calibration photons atop the fiducial and lunar returns. This scheme provides a real-time calibration of our system timing capability, and is synchronous with our range measurements. We installed the calibration system in August, 2016. In this talk, we will describe the design of the ACS, and present preliminary results from the ACS calibration campaign.