A Data Processing Approach to High Precision , High Return Rate kHz SLR Stations

Dr. John Degnan[1]
[1]*Sigma Space Corp, Lanham, United States*

At the 2017 ILRS Workshop in Riga, the author proposed the use of an electronic centroid detection circuit, similar to that used in some longer pulse microwave radars, as a bias-free and high return rate alternative to the threshold detection approach common to the global ILRS network. The current paper discusses an alternative data processing approach which is applicable to kHz threshold detection systems operating at high return rates, thereby producing higher data volumes.
The threshold detection process is modelled as a Two State (i.e., Detection vs No Detection) Markov Process. The Probability Distribution Function (PDF) for a given normal point can be modeled as a sum of weighted PDF's, each corresponding to a different signal strength (n = 1, 2, 3 photoelectrons, etc.) with the weighting of each PDF determined by the observed return rate within the normal point. Each of these PDFs includes an instrument contribution, which can be modelled via range statistics to a single cube corner calibration target, convolved with a satellite contribution corresponding to the satellite impulse response. As the number of photoelectrons detected within a given return increases, the centroid of the overall Normal Point PDF is shifted toward shorter ranges but in a predictable manner that can be compensated for by a statistical model based solely on the observed return rate within the normal point. The validity of the compensation model can be tested by comparing the corrected range to the calibration target over a wide range of return rates.