Feasibility of Operational use of Satellite Laser Ranging observations for GNSS Orbit Determination and Time Synchronisation and GNSS Science

Verification of mm SLR measurements to Galileo satellites by variation of laser beam polarization plane

Executive Summary

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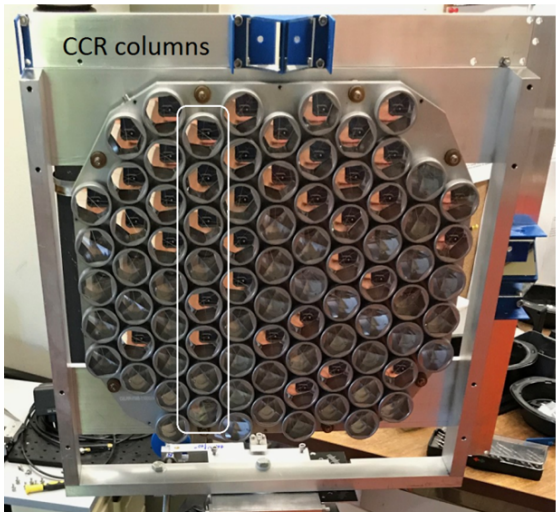
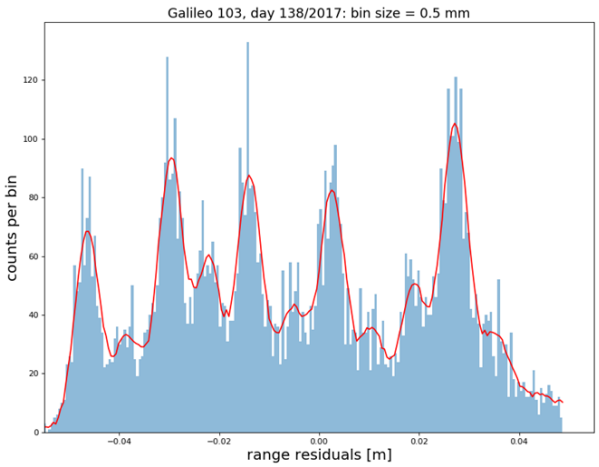
Picture:





Motivation:

The goal of the study was to study the influence of different laser beam polarization states on the satellite laser ranging accuracy. Measurements to 13 different Galileo satellites were compared to ground-based measurements to a spare retroreflector array.

Methodology:

Graz SLR station performs millimeter accuracy satellite laser ranging by using a picosecond pulse length laser with a repetition rate of 2 kHz. With such a performance it is possible to analyze full rate data to draw conclusions on the polarization based offset within the measurements. The polarization direction of the linear polarized laser beam was rotated / changed to circular by using a lambda/2 and a lambda/4 wave plate. In intervals of 1 minute the polarization was switched between along satellite track / across satellite track / circular polarization. The spare Galileo retroreflector panel was mounted on a tripod and ground-based distance measurements were performed for different tilt angles. A selected Galileo pass over Graz was chosen to be compared to the ground-based measurements.

Results:

- No noticeable trend dependent correlated to the laser beam polarization was found within the data which proves the good manufacturing and clocking quality of the Galileo panels.
- The jitter of the polarization offsets is dependent on the incident angle of the laser beam. This was explained by the different contribution of individually clocked retroreflectors to the far field diffraction pattern: An increasing incident angle separates the patterns of different clocking from each other and depending on the polarization a bigger fraction of a single clocking orientation will be detected.
- The full rate data of both the ground based measurements and the measurements to Galileo in space clearly showed the different columns of retroreflectors. From the differences in the distance it was possible to calculate the incident angle of the laser beam.
- Long-arc measurements to Galileo-IOV satellites were performed in cooperation with Mount Stromlo SLR station covering the orbit almost continuously for more than 11 hours.

Highlights:

The Galileo panels are of good manufacturing and clocking quality regarding different laser beam polarization directions. An incident angle dependent jitter was found within the polarization offset data which was explained by the contribution of the far field diffraction pattern of individual retroreflectors. Distance measurements to Galileo 103 and ground based measurements to a spare retroreflector panel clearly showed the different columns of retroreflectors at different distances and allowed to calculate the tilt angle of the retroreflector array.