Alternative normal point formation strategies for Galileo satellites - 11 normal points instead of 1

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For Galileo satellites corner cube retroreflectors (CCR) are arranged in hexagonal arrays. Each of the individual CCRs also has a hexagonally shaped reflection distribution - the far-field diffraction pattern (FFDP). It consists of a central lobe with six side lobes centered at approx. 25 ?rad. The spoiling of the CCRs (intentional misalignment of the reflective surfaces) was de-signed to compensate for velocity aberration which is also 25 ?rad for 22,000 km orbits. To create a uniform pattern on Earth allowing all different station-satellite configurations, the CCRs are clocked (rotated by 20° or 40°). Furthermore, the FFDP of each individual CCR can be different and can also vary due to changing thermal conditions. All those different effects lead to a distribution of the returns (or normal points) from the panel which can be offset to the optical centre of the panel.

The temporal resolution of Graz' kHz laser ranging system, together with the precision of the Single Photon Avalanche Diode (SPAD) sensors allows to distinguish between tracks of individual CCRs for Low Earth Orbit satellites. For satellites in higher orbits - like Galileo – due to the low amount of reflected photons a single CCR cannot be identified. However, in certain orientations of the panel "symmetry conditions" can occur. Multiple CCRs then appear at equal ranges to form "rows" of increased data density. Based on a histogram analysis during post-processing it is possible to identify and separate up to 11 different rows and create individual normal points for each of them. It was possible to show offsets of up to 2 mm when compared to regular normal points formed using 2.2 sigma iteration based on the full dataset. In addition to that a different technique based on pattern correlation was analysed.