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Satellite laser ranging ultimate precision limit

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Satellite Laser Ranging (SLR) is a highly accurate measuring technique providing range to the retroreflector equipped Earth orbiting satellites. Among the routinely tracked targets are geodetic satellites (LAGEOS, Etalon, Ajisai), remote sensing missions (Envisat, ERS-2, ICESat, Jason, TOPEX), gravity field mapping satellites (Grace, CHAMP), positioning systems (GPS, GLONASS), and other scientific experiments (Gravity Probe B). The accurate orbits obtained from the laser ranging data are used, among others, for the determination of terrestrial reference frame and the product of the universal gravitational constant and the Earth mass, which represent one of the fundamental constants in physics. In this view, the SLR serves as a fundamental technique to calibrate other measurements. That is why, the precision and accuracy of the SLR data itself is a critical issue.

The single shot precision of the SLR systems is constantly improving, and recently reaches several millimeters. Another improvement consists in grow of repetition rate of the ranging systems, allowing us to acquire more data during the same time interval and hence to improve the ranging precision by averaging. We have investigated limitations of this approach: there exists an ultimate precision limit, which cannot be surpassed by averaging more and more data points. We have identified this limit and its reasons by analysis of ranging data obtained at laser station in Graz, Austria.