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Improvements in understanding systematic effects in laser ranging observations

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The satellite laser ranging technique enables extremely precise measurements to retro-reflector clusters on spherical geodetic satellites, with current normal point precision at a level of better than one mm for the major ILRS tracking stations. To realise a similar level of measurement accuracy to the mass-centres of the satellites and ultimately in the derived parameters of the ITRF requires accurate evaluation of key elements in the technique: an accurate model to refer the range measurements to the centres of mass of the geodetic satellites and an accurate determination of potential non-linearity in the electronic devices that measure laser-pulse times-of-flight. Any error in the modeling of these key error sources will of course contaminate the determinations of the ITRF origin and scale.

Otsubo and Appleby (2003) found that there exist tracking-system dependent centres-of-mass (CoM) corrections for the LAGEOS and ETALON satellites, for example, which can vary across the ILRS network by up to one and five cm respectively. As a result of this work, the analysis community now utilises system-dependent CoM values during reduction of laser data, but there remain small systematic effects which we will discuss.

Work by Gibbs *et al* (2006) on non-linearity present in some time-of-flight devices has highlighted both the magnitude of the effect which can reach 10mm and the value of using newer, highly-accurate devices to post-calibrate historical laser data. A case study showing application of this technique to data from the UK Space Geodesy Facility from 1994 onwards will highlight the improvements that can be achieved. We

also discuss our results of measurements and estimates of non-linearity effects for distances from LEO to MEO for the ten or so mainly European ILRS systems that have used similar electronic devices.