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Further improvements in understanding subtle systematic effects in laser ranging obsevations.

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The satellite laser ranging technique has a long history of making extremely precise measurements to retro-reflector clusters on geodetic satellites, with current normal point precision at a level of 1mm 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 models of three key elements in the technique; an accurate model to refer the range measurements to the centres of mass of the geodetic satellites, an accurate determination of potential non-linearities in the time-of-flight measurements and an accurate model of atmospheric delay. Any error in the modeling of these key error sources will of course contaminate determinations of ITRF origin and scale. Recent work by Mendes and Pavlis (2004) on improved mapping functions has essentially removed the atmospheric delay effect as an error source in reducing the measurements and will not be discussed further here. Otsubo and Appleby (2003) found that there exist tracking-system dependent centres-of-mass (CoM) corrections for the LAGEOS and ETALON satellites that can vary across the ILRS network by up to 1 cm and 5 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 related small systematic effects which we will discuss. Recent work (Gibbs, et al, 2006) on non-linearities present in some time-of-flight devices has highlighted both the magnitude of the effect which can reach 20mm and the potential 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 a campaign to carry out similar calibration of the ten

or so mainly European ILRS systems that have used similar electronic devices. The re-analysis of laser data from 1993 onwards that is currently being carried out by the ILRS Analysis and Combination Centres will take into account the effects discussed here, with an expected improvement in determination of ITRF scale and origin.