CENTRE-OF-MASS CORRECTION ISSUES: DETERMINING INTENSITY DEPENDENCY AT A MULTI-PHOTON (MOBLAS-5) STATION.

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Introduction

As reported by T. Otsubo and G. Appleby at the workshop in Koetzting, in the drive towards mm ranging accuracy, the effects of signal intensity on centre-of-mass correction values needs to be evaluated. While some work has been done on data sets from single photon (Herstmonceux) and other C-SPAD stations, evaluation of the effect on multi-photon MCP systems still needed to be undertaken.

Background

To determine the effect that varying return energy has on residuals, passes need to be taken using a special tracking regime. It involves varying the return energy via ND wheel, so that the level alternates between high and low throughout the pass. This was not as simple as we had assumed and took some practice to perfect.

So far three test passes have been taken, Ajisai, Lageos-2 and Envisat. Getting a significant dynamic separation on the strong/weak returns for Ajisai and Envisat was relatively simple due to the normally strong receive energies associated with these satellites. However we had to wait for good conditions (post summer dust), to get a good separation on Lageos-2.

Initial Results

The passes were processed in three ways. Firstly the passes were processed normally and the Quick Look (ql) data submitted. Secondly the raw data was delogged to give O-C vs time for all returns. Thirdly, each pass had its strong and weak segments separated and each part was processed separately.

Initial analysis of the passes shows good separation between strong and weak returns. See Figures 1 to 3 for this separation with Blue diamonds for O-C and Pink Rectangles for received energy.

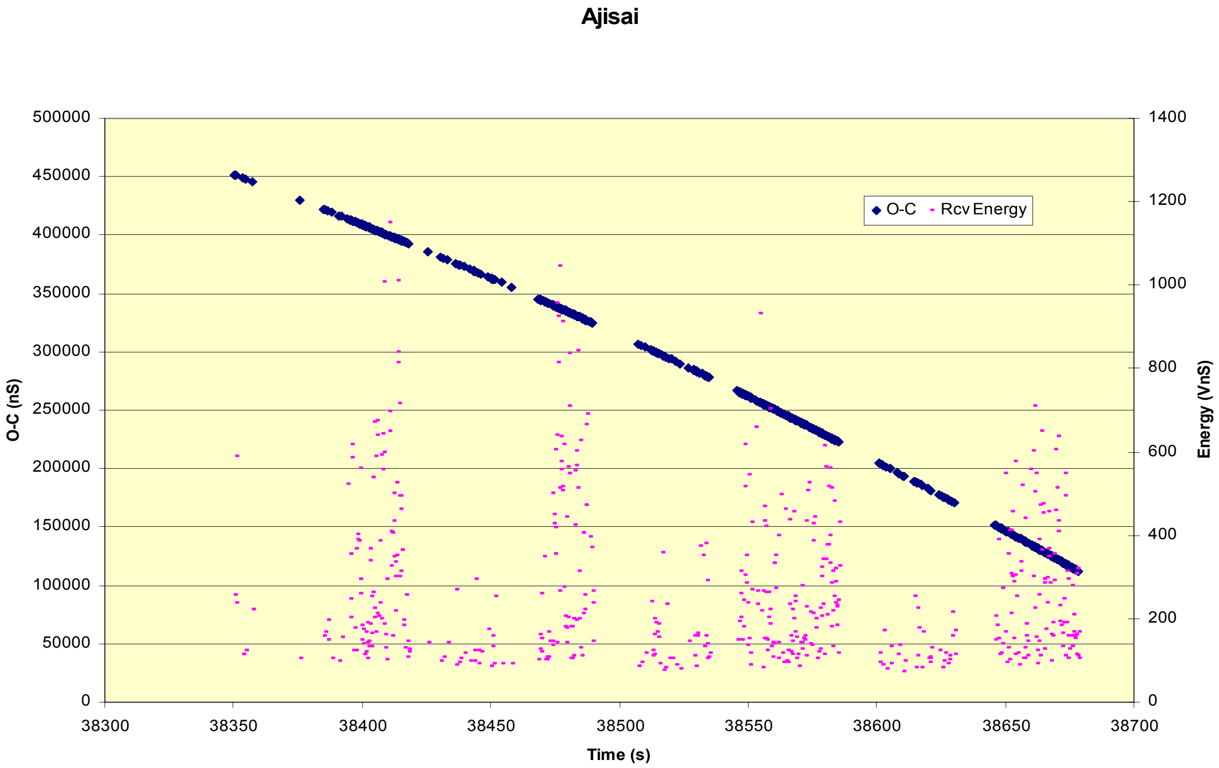

Figure 1. O-C and Received Energy plots for Ajisai

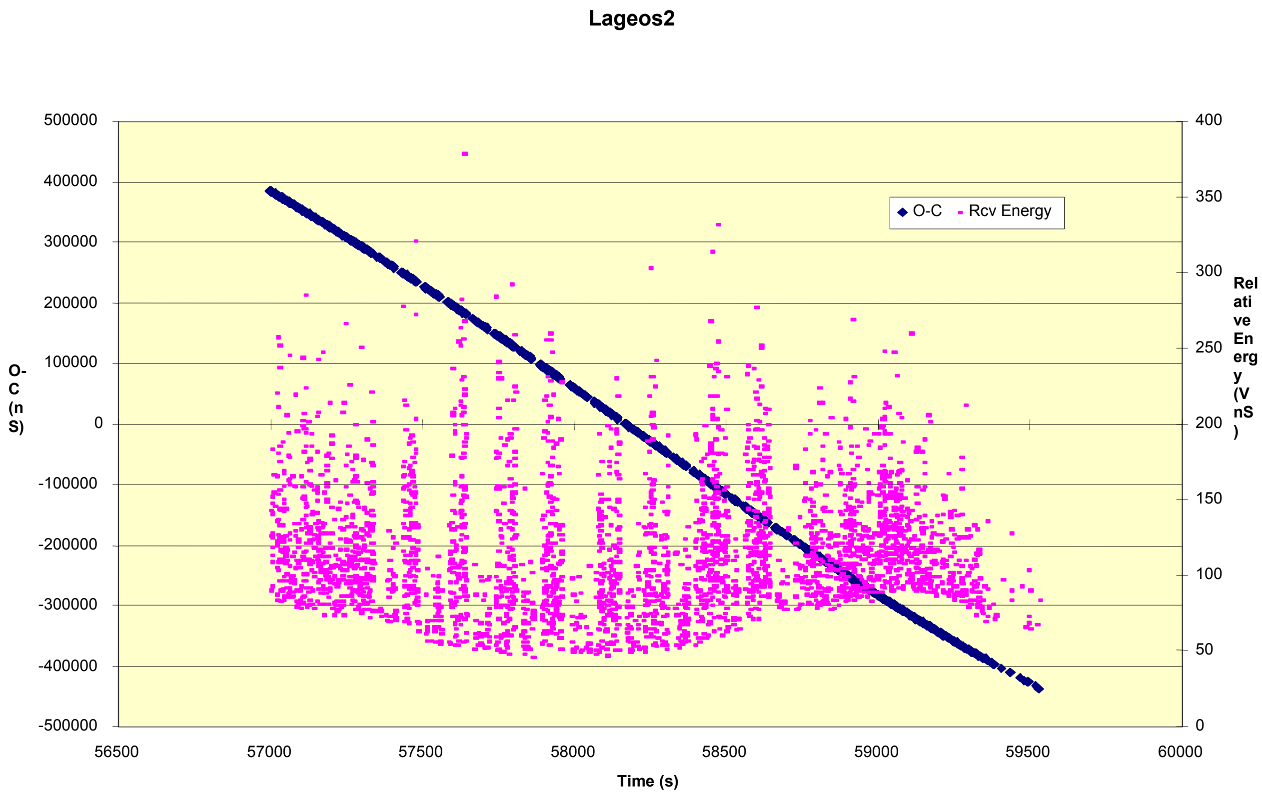

Figure 2. O-C and Received Energy plots for Lageos-2

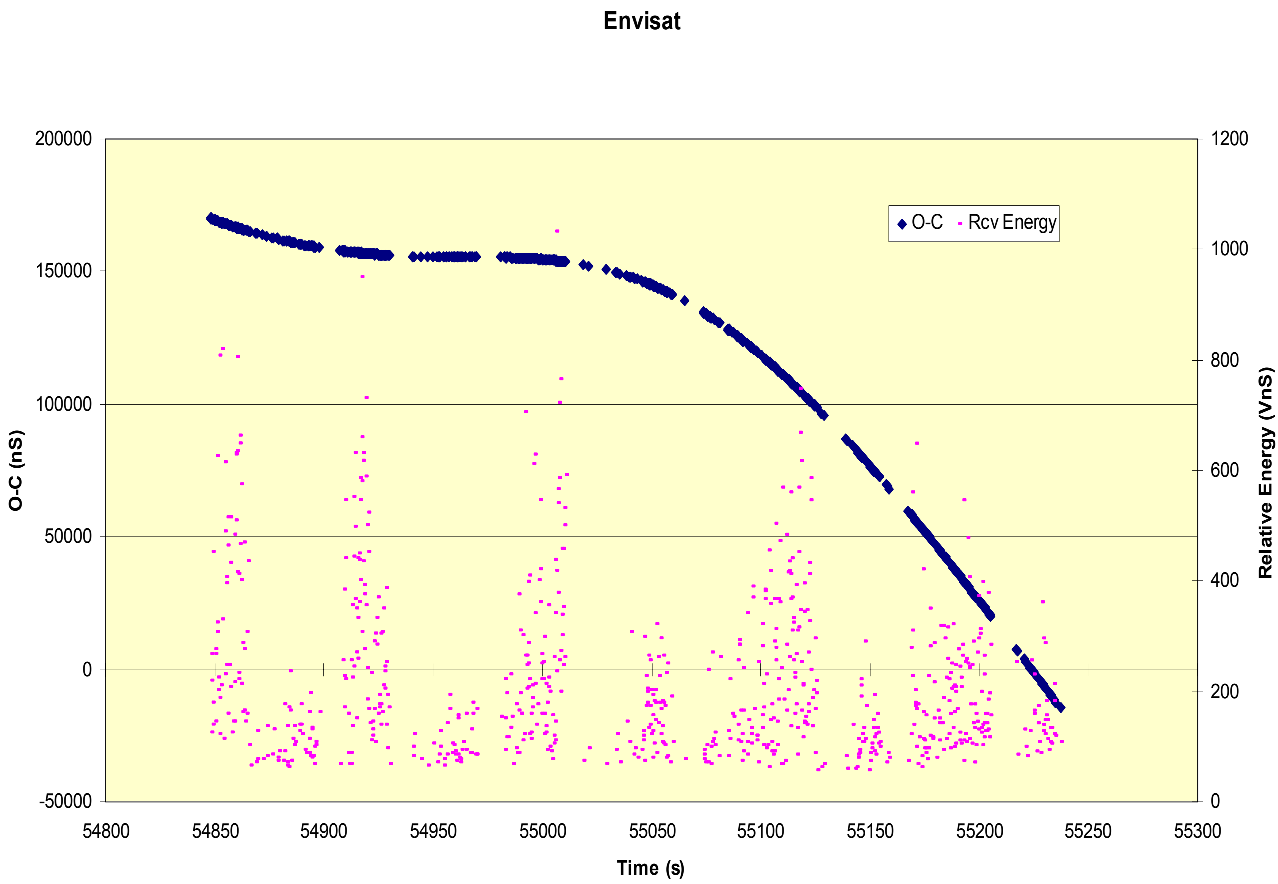

Figure 3. O-C and Received Energy plots for Envisat

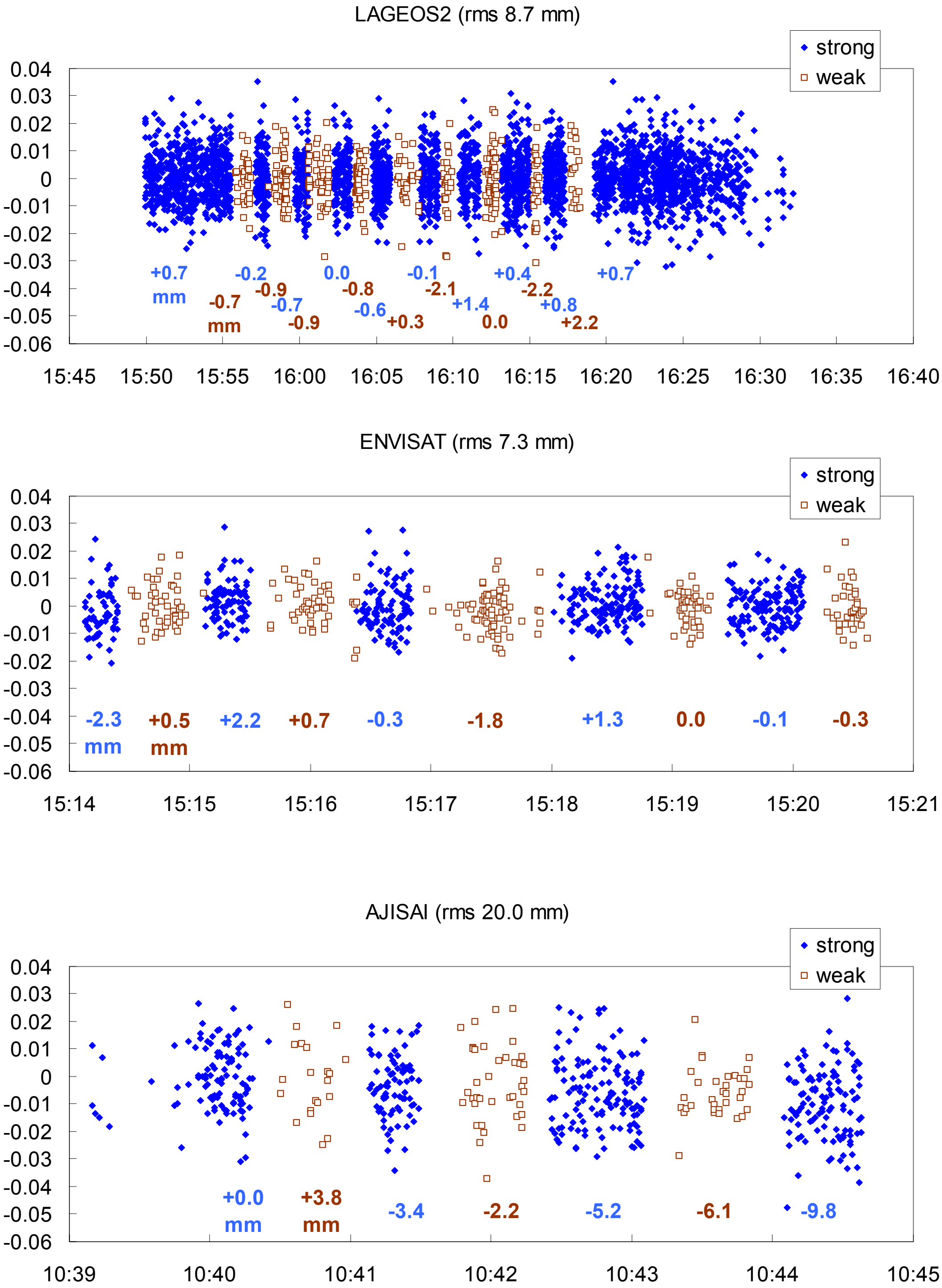

Figure 4. Flattened shot-by-shot returns.

Data Flattening Procedure and Results

Now we need to see whether there is a range offset between the strong returns and the weak returns. To do so, we flattened the full-rate data of the three passes (LAGEOS-2, ENVISAT and AJISAI). Using NICT analysis software 'concerto', orbital parameters (six elements, along-track constant acceleration and along-track once-per-revolution acceleration) were fitted to the full-rate pass and several normal-point passes before and after the pass. The shot-by-shot post-fit residuals are plotted in Figure 4 above. The scatter rms of the full-rate points was 8.7 mm for LAGEOS, 7.3 mm for ENVISAT, and 20.0 mm for AJISAI.

According to the target signature studies [*Otsubo and Appleby*, 2003] for multi-photon C-SPAD systems, a strong return makes the laser range shorter than a weak return, and the difference is dependent on the target's depth—AJISAI the largest with up to 5 cm and LAGEOS-2 the second with 1 cm.

In Figure 4 above, strong returns are plotted as solid blue points and weak returns are plotted as hollow red points. There seems to be a small difference for AJISAI but no clear intensity dependence for LAGEOS-2 and ENVISAT. The average 'strong minus weak' differences are:

LAGEOS-2	-0.6 mm
ENVISAT	-0.3 mm
AJISAI	+3.1 mm

Comments

Although this is still a preliminary result, we find the MCP+CFD system at Yarragadee more robust over the intensity variation than multi-photon C-SPAD systems. More strong/weak signal returns from dedicated satellites need to be taken before any conclusions could be drawn.

References:

Otsubo, T., and G. M. Appleby, System-dependent center-of-mass correction for spherical geodetic satellites, J. Geophys. Res., 108(B4), 2201, doi:10.1029/2002JB002209, 2003.