A comparison of event timers HxET and A033-ET installed at Herstmonceux

M. Wilkinson (matwi@nerc.ac.uk)

NERC Space Geodesy Facility, Herstmonceux, UK

http://sgf.rgo.ac.uk

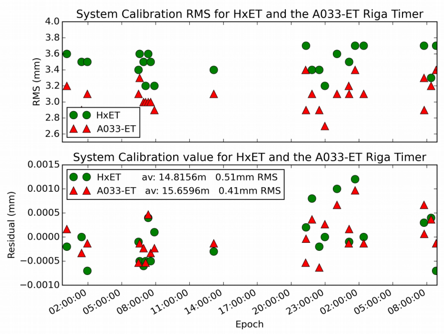
The newly integrated A033-ET Riga timer at Herstmonceux allows dual, simultaneous recording of laser ranges. A comparison was made between the A033-ET and the HxET timer, installed in 2006.

Introduction - HxET

In 2006 an epoch event timer (HxET), built in-house from two Thales Systems timing modules and a clock module, was installed at the Space Geodesy Facility (SGF) in Herstmonceux, UK. The new timer greatly improved both the accuracy and precision of the SGF satellite laser ranging normal points. It also enabled multiple shots to be in-flight, which was an essential prerequisite for the development of kHz laser ranging. The inputs to the two HxET channels are from the laser fire, termed a 'start' pulse, and the SPAD detector, the 'stop' pulse. The start and stop epochs are matched and differenced in real-time to give time-of-flight measurements.

Installation of A033-ET Riga Timer

In 2014, the SGF purchased an A033-ET timer manufactured by Eventech Ltd and the Institute of Electronics and Computer Science in Riga, Latvia. It was integrated in to the SLR system so that range measurements could be made simultaneously using both timers. This was achieved using software built in-house to record the TCP/IP data stream, form the 1ps precision epochs and match the laser fire 'starts' with the detector signal 'stops' using the predicted satellite range function. This software is performing reliably and automatically records satellite and calibration range data as instructed by the SLR system.



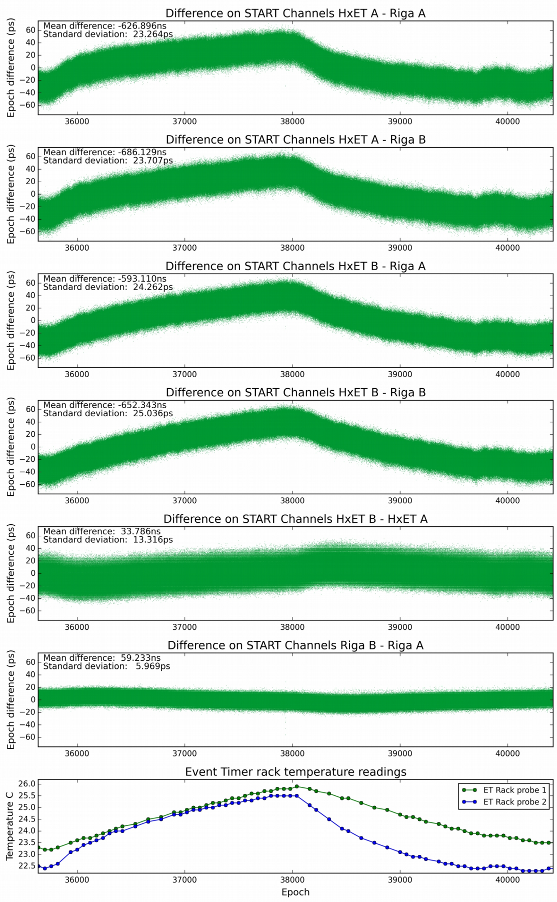
Terrestrial Ranging Performance

The SGF makes regular terrestrial range calibration measurements to a retro-reflecting flat panel target approximately 130 metres away. A typical calibration consists of about 1000 detected laser returns with a precision of less than 1mm. Calibration datasets were recorded from the same start and stop events by both the HxET and the A033-ET timers. These were then processed using a Gaussian fit to extract the range returns. A mean measurement and a RMS value were recorded for each calibration and these are plotted to the left. The plot shows the A033-ET data with reduced RMS for individual calibrations, from approximately 3.5mm to 3.1mm, and the RMS of the measurements over time is also reduced, from 0.51mm to 0.41mm.

4-Channel Direct Comparison

Differencing the epochs recorded by the different timers showed good stability, but with a jitter of about 11ps. This value is larger than expected from the 2-3ps jitter specification of both timers. Some long term drift was also present. To investigate this further, an experiment was setup to feed the laser 'start' pulse to the two channels of the HxET timer and to the two channels of the A033-ET timer. The differences between the channels are plotted to the right. Also in this experiment, the ambient temperature was increased by switching off the air conditioning, which was later switched back on.

The first 4 plots show the difference in the epochs recorded at a HxET channel and a A033-ET channel. All 4 show larger jitter and an increase and then decrease with the environmental temperature. The 5th and 6th plots show the difference between the HxET channels and A033-ET channels respectively. The larger jitter is present only in the HxET plot, with the A033-ET performing to specification.



Conclusion:

The installation of the A033-ET timer has allowed, for the first time, the assessment of the performance of the operational HxET timer. It was shown to be performing well with a jitter of approximately 9ps. This is, however, greater than its specification. The temperature dependence of one of the timers is significant but manageable in the temperature controlled environment in which both timers are kept. There may be an advantage if the Herstmonceux station were to switch to the A033-ET as its primary timing instrument for SLR.

BGS 1835

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