Herstmonceux

towards kHz ranging and multi-technique status

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Herstmonceux, UK

Session 5: New and Upgraded Stations, Extended Facilities

NATURAL
ENVIRONMENT
RESEARCH COUN

Introduction

Herstmonceux NSGF

The Space Geodesy Facility at Herstmonceux, UK developed a kHz ranging system while maintaining Hz ranging ability.

This presentation will highlight some of the important steps along the way and report on 2 years of kHz ranging.

The NSGF also manages two IGS systems, an absolute gravimeter and an emerging LIDAR programme to run simultaneously with laser ranging.

Recent Upgrades

Event timer

The HxET event timer came online **at the beginning of 2007** and improved the accuracy and precision of all observations.

kHz laser

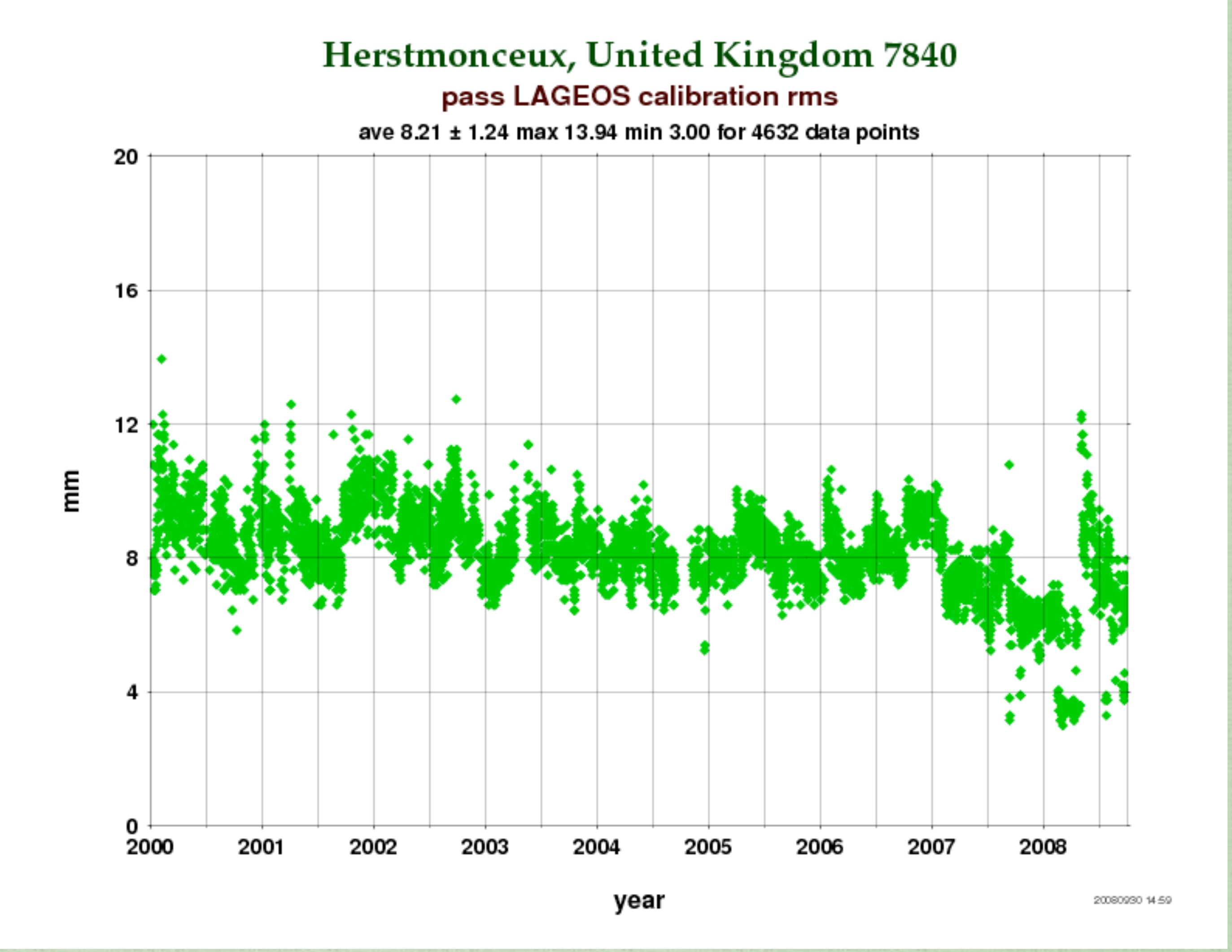
The short pulse width and increased number of observations give better precision. The first test kHz observations were made in October 2006 and data was first submitted in the **spring of 2007**. The system was developed while continuing regular 10 Hz laser ranging. The kHz laser fires a 10ps, 0.42mJ pulse at 2000Hz.

Recent Upgrades

Calibrations

Both upgrades have given clear improvement to the calibration rms.

This plot is taken from the ILRS website.

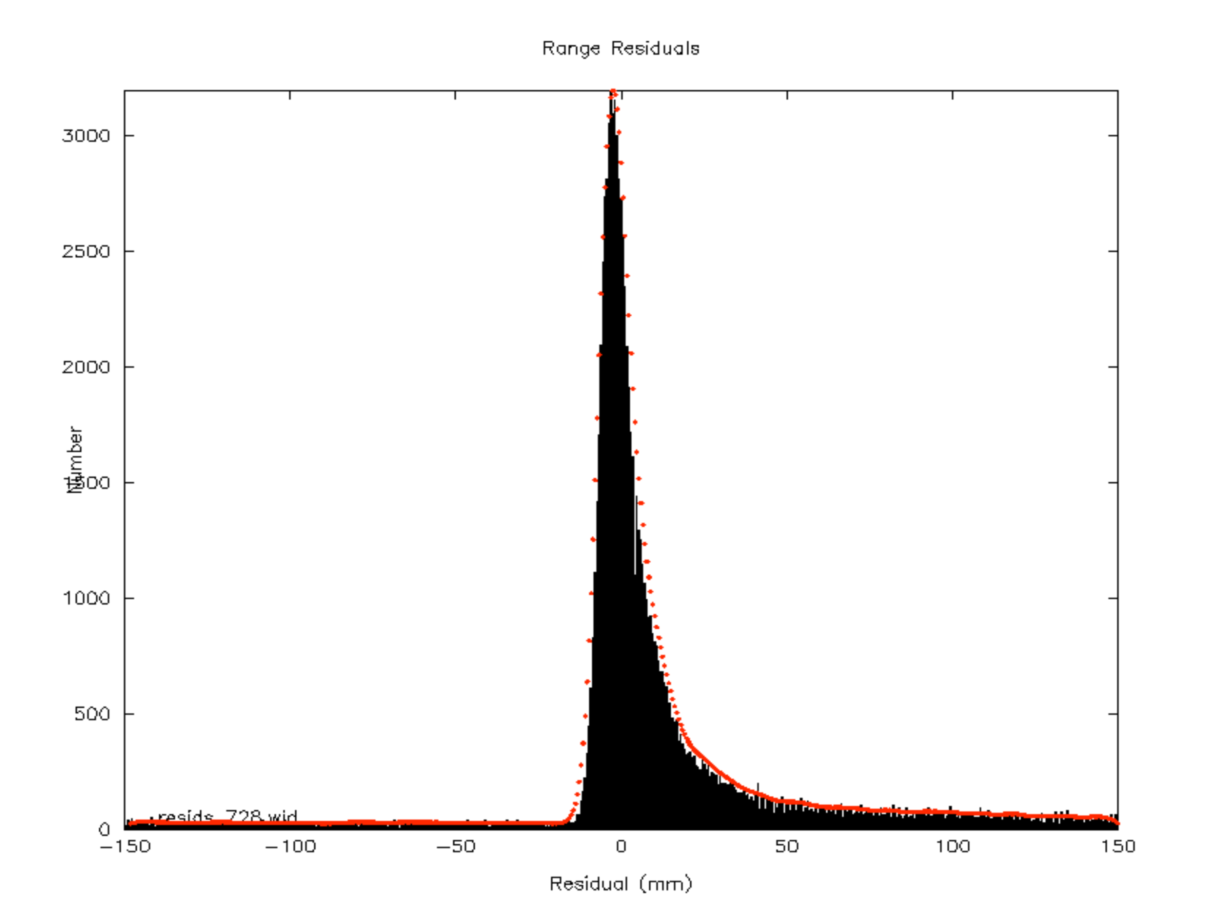


Recent Upgrades

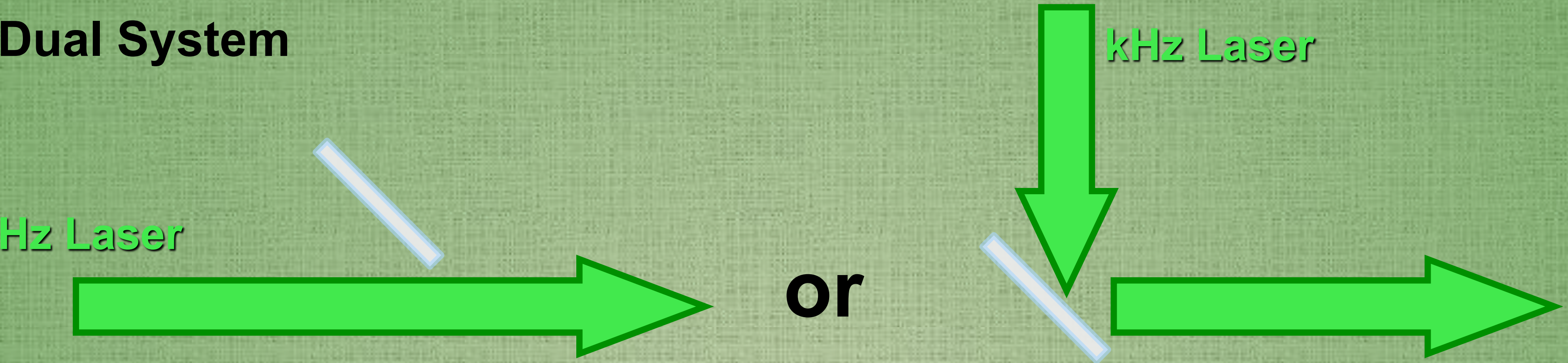
kHz LAGEOS Residuals

A model of LAGEOS residuals was generated using a number of kHz calibration runs and the LAGEOS response function.

kHz residuals from LAGEOS observations fit this model very well.



Laser Development



Moveable mirror allows Hz laser through or directs the kHz laser to the coudé path. This is controlled automatically. Alignment between the two lasers must be closely matched.

In the near future, switching from kHz to Hz and back again will be controlled by software. This will involve automatically switching the start diode, laser fire and directing the safety systems, including the radar, telescope switches and observer control, to the appropriate laser.

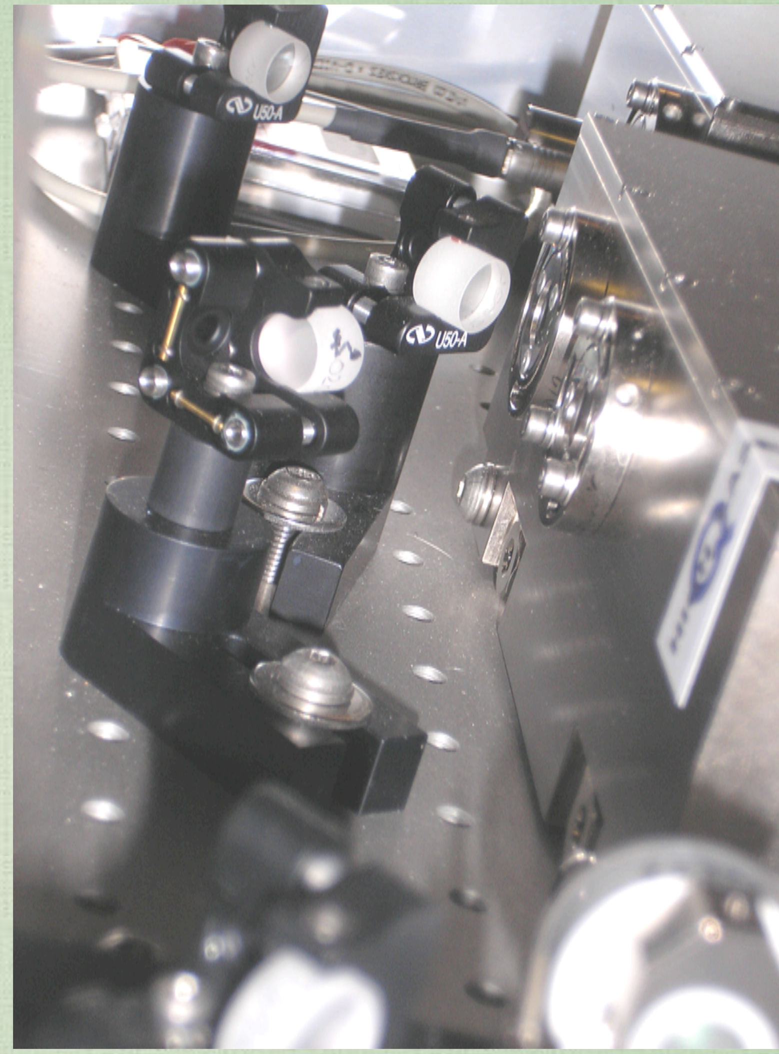
Laser Development

kHz Laser

The kHz system was in operation less than 50% of the time in the last year.

Different reasons for this were

- ✘ Loss of energy due to:
  - a) Burnout of optics
  - b) Problems with the frequency doubler crystal.
- ✘ Damage to C-SPAD detector
- ✘ Failure of daytime intensifier
- ✘ Work on the laser



Due to the narrow beamwidth incident at the eyesafe filter, the beam path was increased by about 2m to better disperse the laser energy. This was to avoid critical damage of the ND filters.

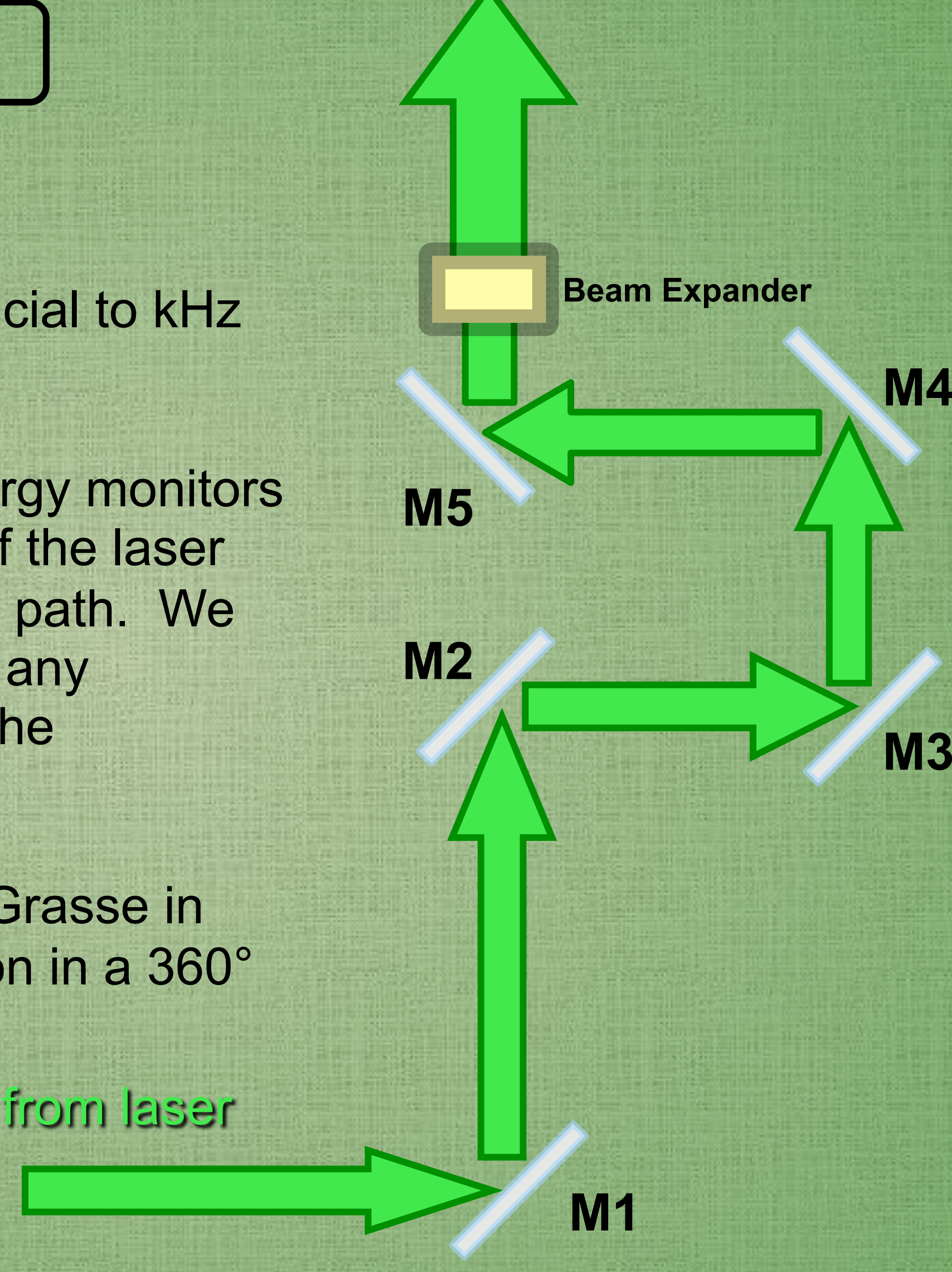
Laser Development

Energy losses in Coudé path?

Loses in laser energy can be crucial to kHz laser ranging

We have purchased a set of energy monitors which can take measurements of the laser energy at any point in the optical path. We aim to identify any losses due to any individual optic or orientation of the telescope.

Initial results were presented in Grasse in 2007 and showed an 8% variation in a 360° azimuth rotation.



Detector development

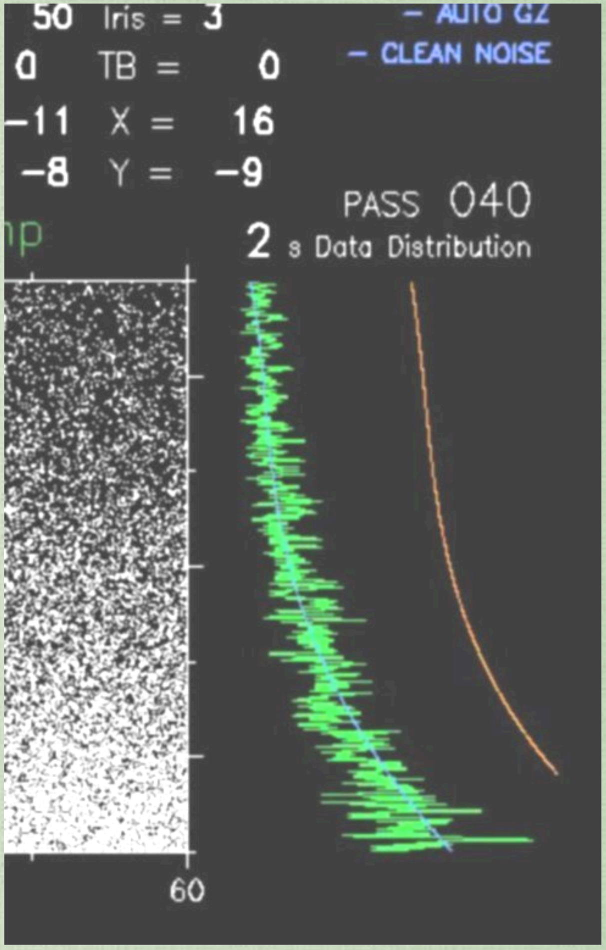
New detector system?

A lot of noise appears in a kHz daytime range gate window.

The satellite return signal cannot be detected if a noise point triggers the C-SPAD earlier in the range gate.

This effectively reduces the firing rate of the SLR system.

A faster gating system is being investigated which involves either introducing a very fast shutter in the form of a Pockels cell or switching detectors to and MCP-PMT.

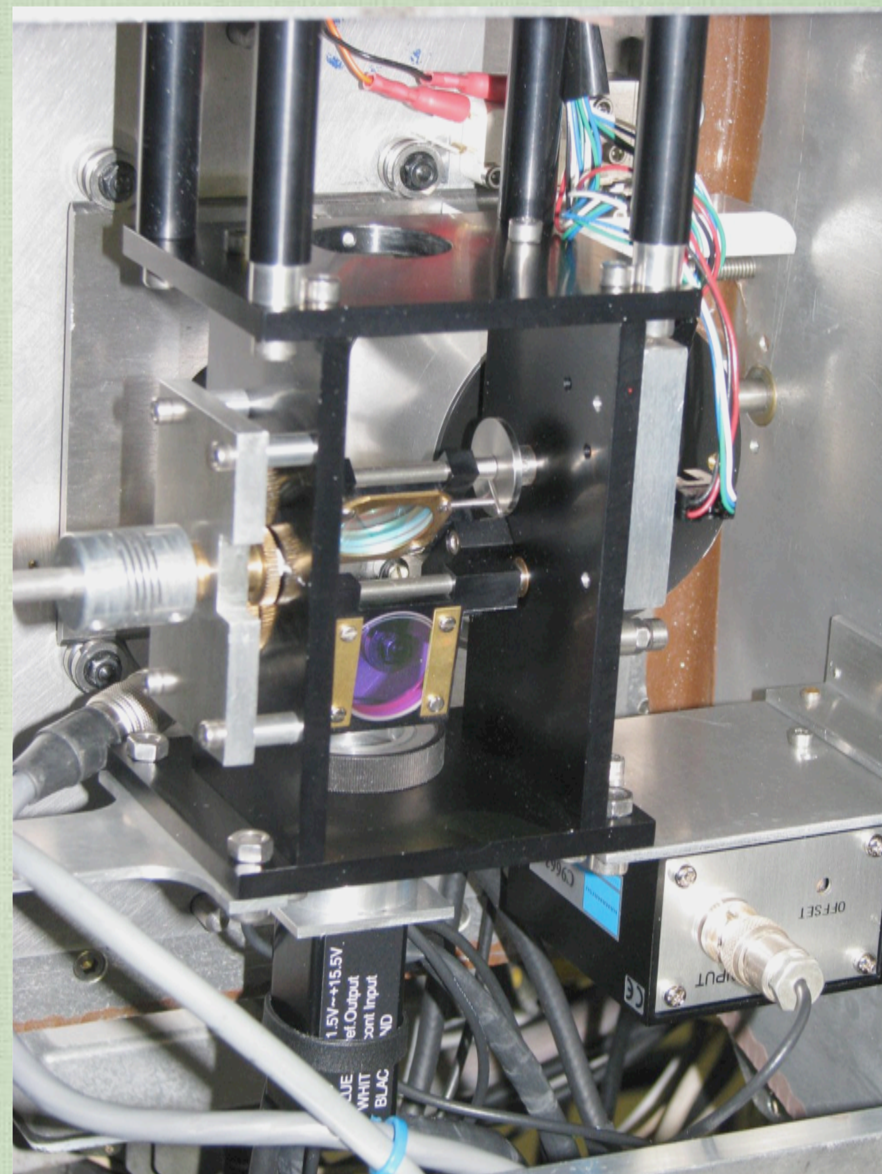


Detector Box upgrade

3 ports

The telescope detector box was recently upgraded and now has 3 working ports for the light to either go to:

- ✓ the C-SPAD detector
- ✓ the daytime camera
- ✓ or a LIDAR photometer

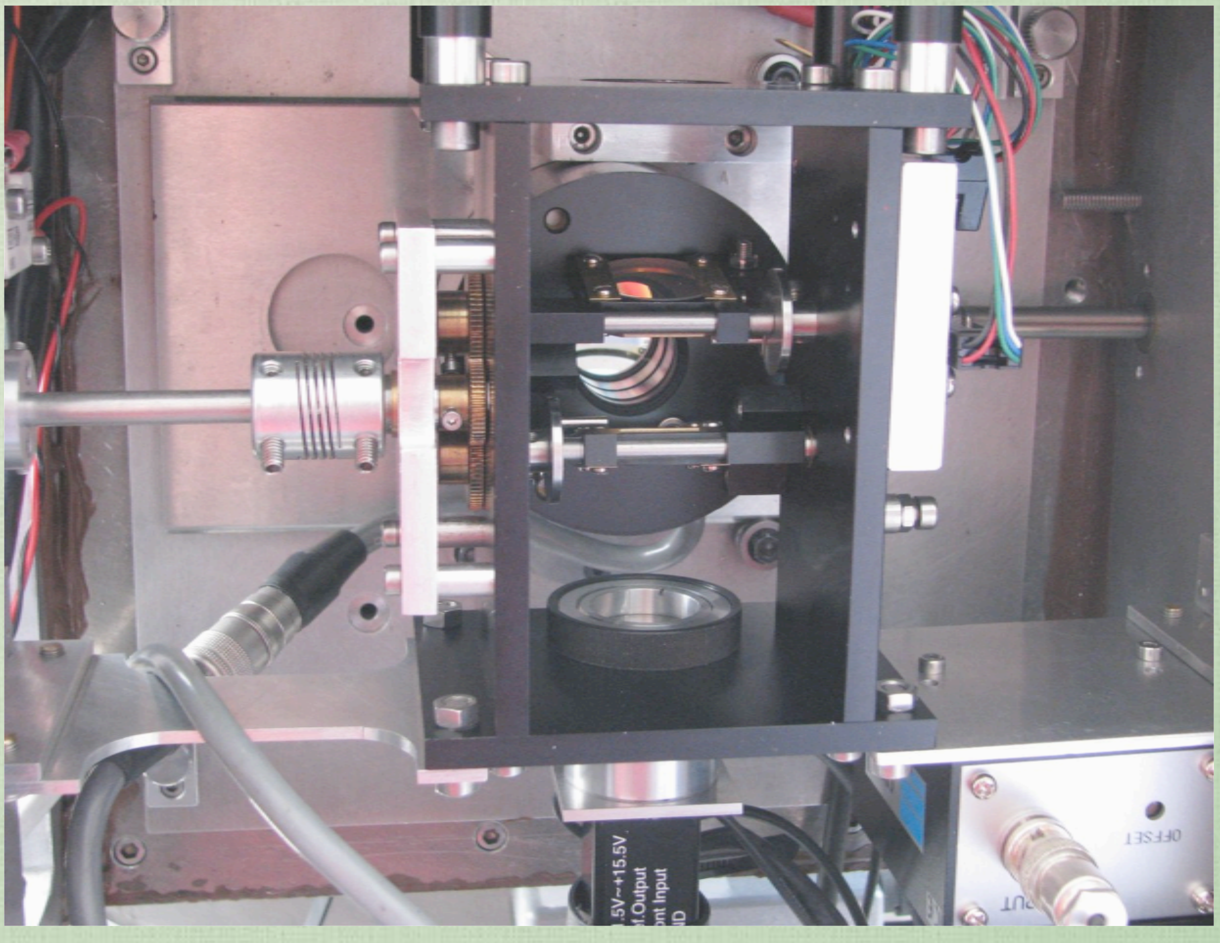


Detector Box upgrade

3 ports

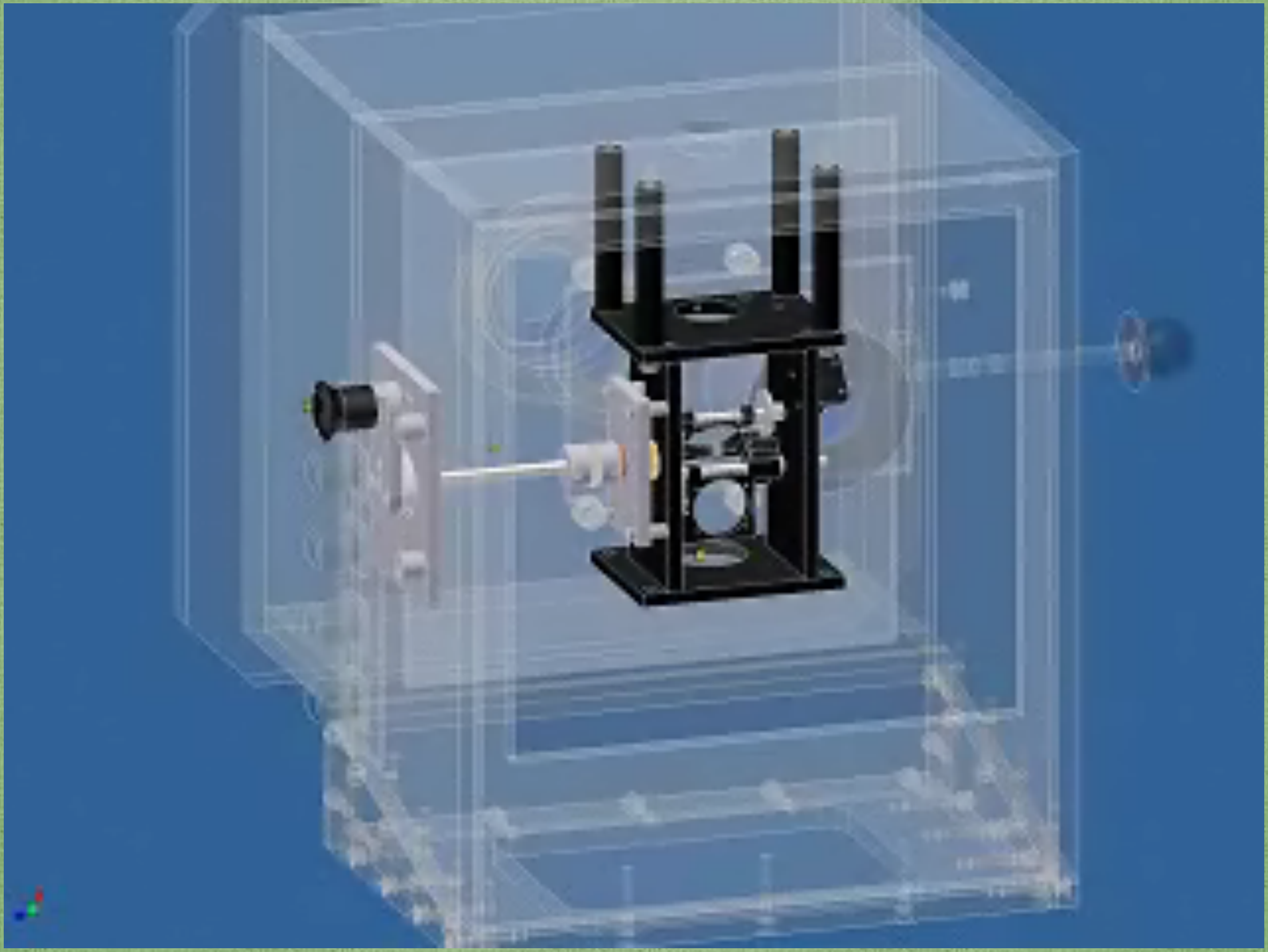
Switching between these ports will eventually be automatically driven.

The LIDAR photometer was originally situated to detect reflections from the dichroic, but this was determined to be too weak a signal.



Detector Box upgrade

3 ports



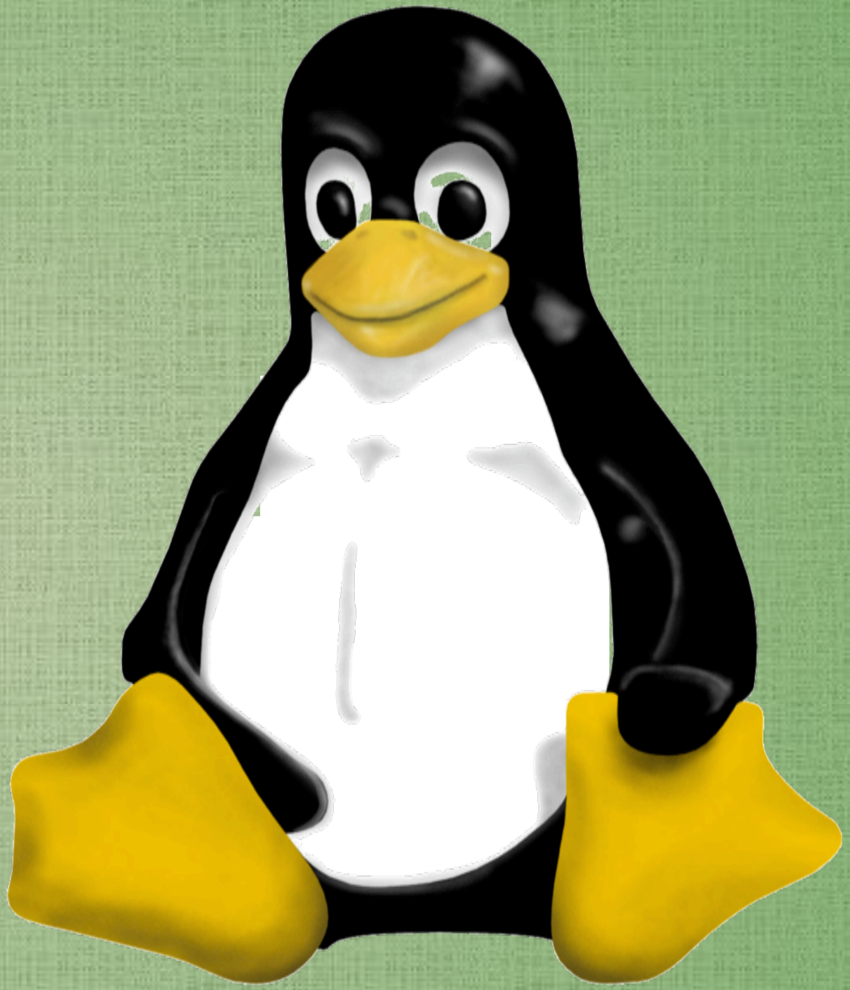
Linux Upgrade

Extra precision

The Linux secondary observing PCs were upgraded to SUSE 11.0.

The new package provides **gfortran**, which gives an additional decimal place or two to a real number variable (REAL*12).

This was enough to give the necessary precision for the new CRD format, 1 picosecond for epoch.



Problems this year

Failure of intensifier

Loss of daytime camera intensifier restricted kHz to nightime only. This has been redesigned to include a temperature controlled cooling fan and to automatically supply power when required.

C-SPAD loss

Damage to the C-SPAD meant that system could only operate at Hz for 2-3 months.

Problems this year

TCP-IP Communication loss

Data is matched by the primary observing PC and is then sent to two secondary PCs by TCP-IP communication for displaying and recording of data.

Occasionally this flow has been too slow to catch up with the continuous sending of data and PCs have crashed.

A congested data display port is now 'flushed' for continuous operation should it get behind.

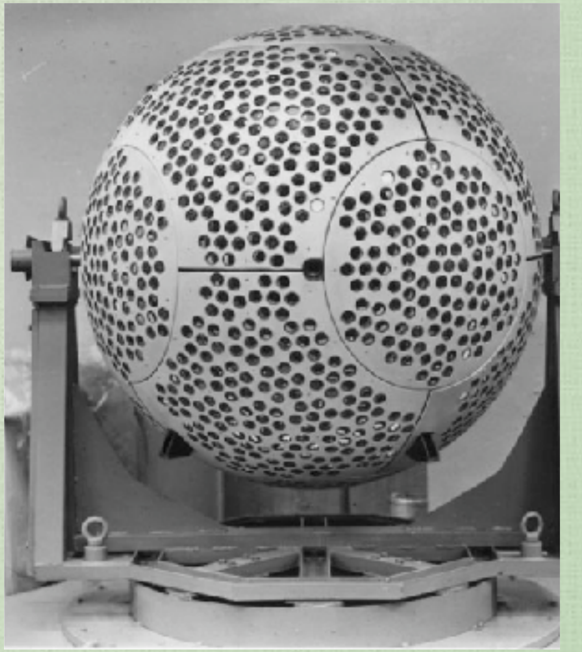
Problems with kHz reductions

More noise than signal

The NSGF reduction system now uses a single software program for both Hz and kHz data.

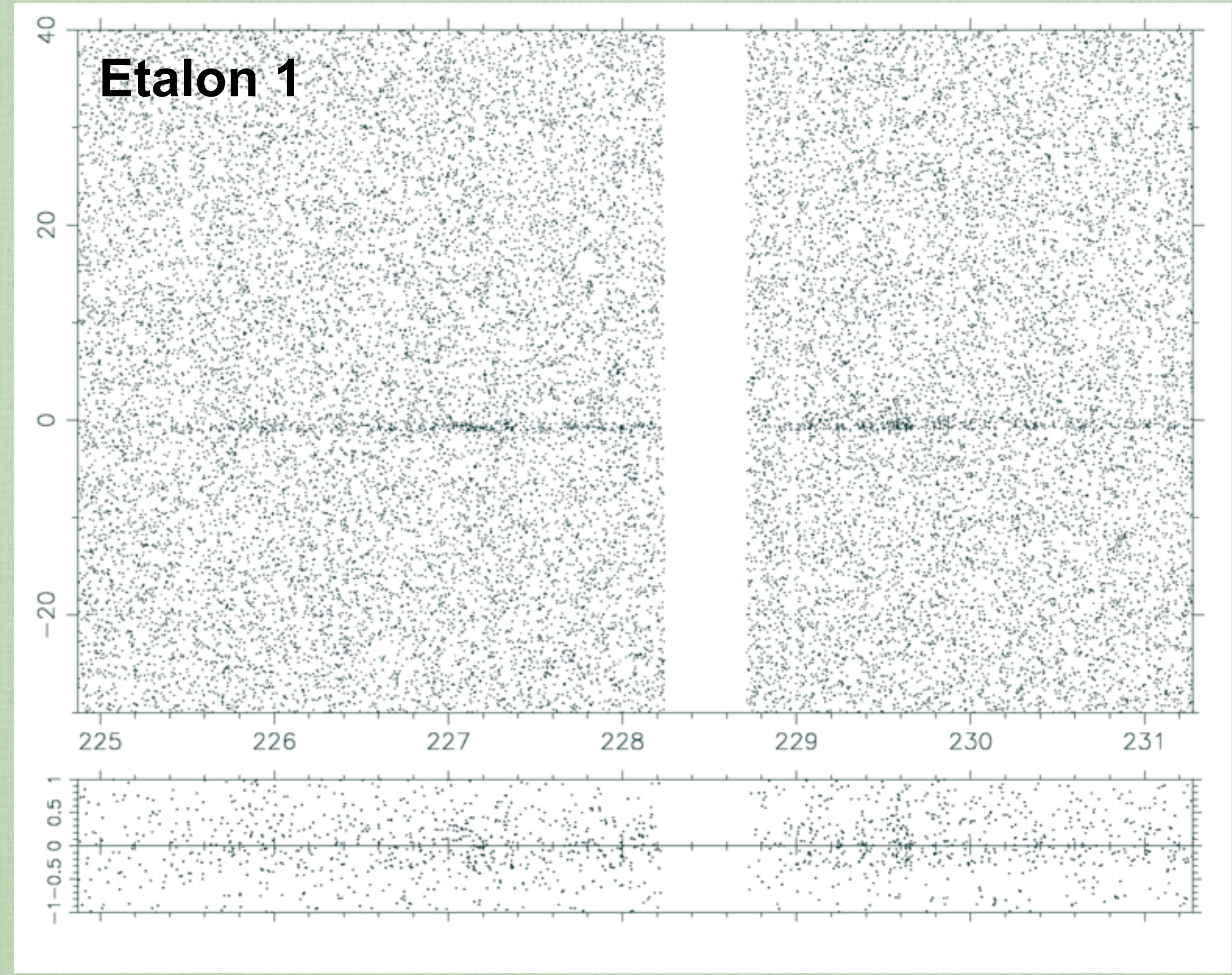
Satellite track is identified in real time by software and this serves as a starting point for the reduction.

It is important that enough satellite observations are present in any part of the data set used. This is particularly a problem for Etalon satellites



Problems with kHz reductions

More noise than signal



<u>Etalon 1</u>

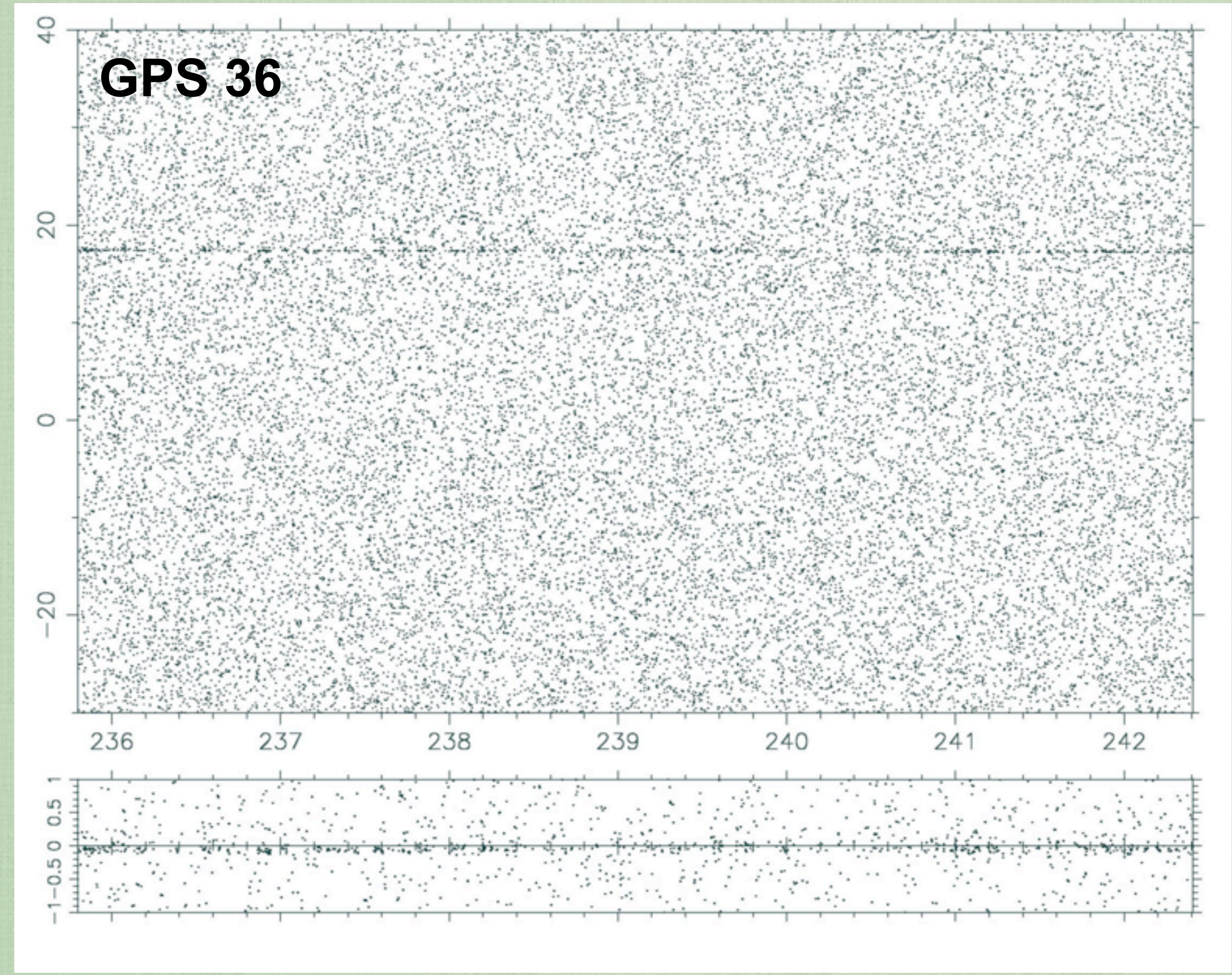
6 minutes of pass.

Identified in a large range gate

Difficult to see close up.

Problems with kHz reductions

More noise than signal



GPS 36

6 minutes of pass.

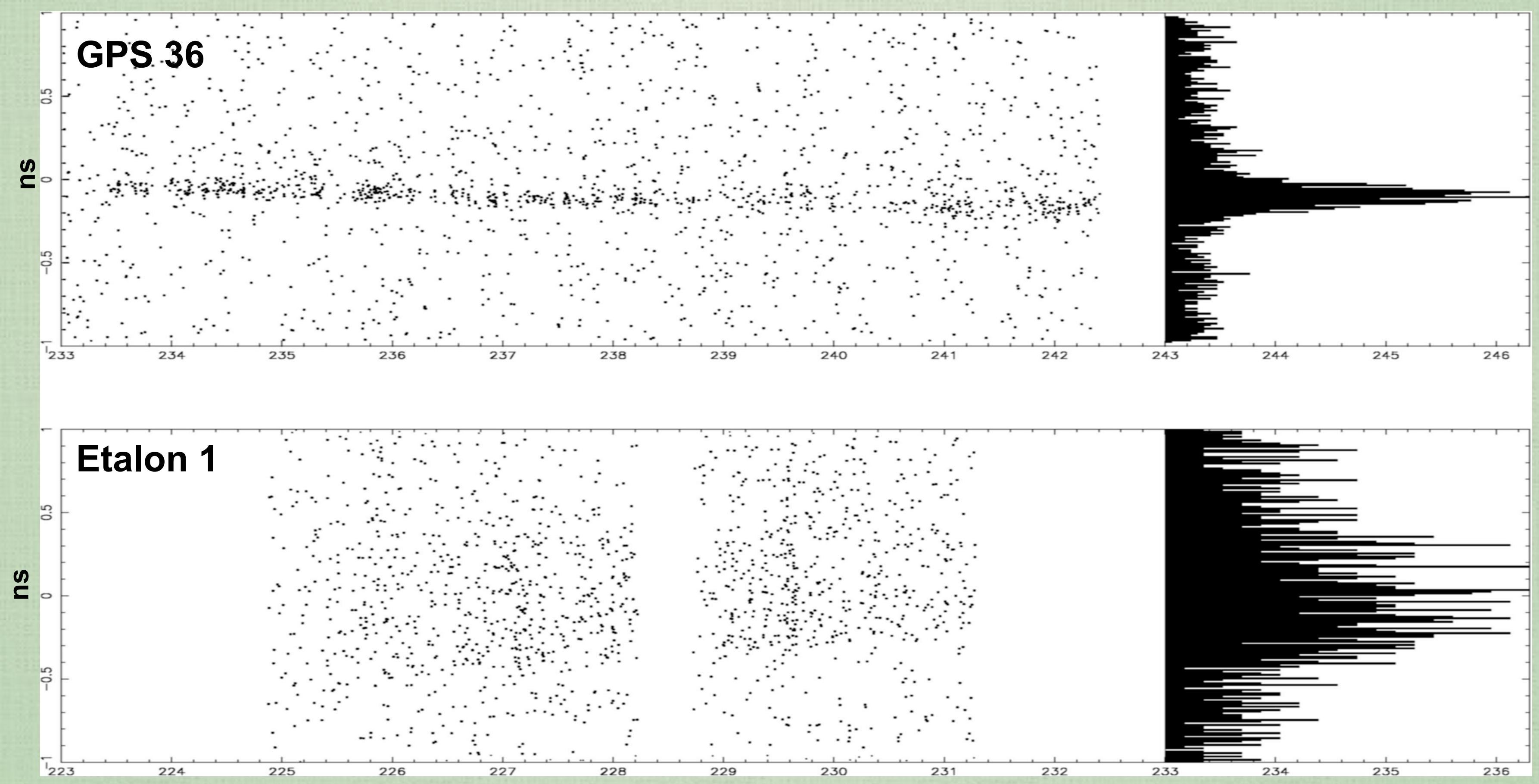
Identified in a large range gate

Still easy to see close up.

Problems with kHz reductions

More noise than signal

Because of the larger spread of the data back from the Etalon satellites it is more difficult to reduce passes.

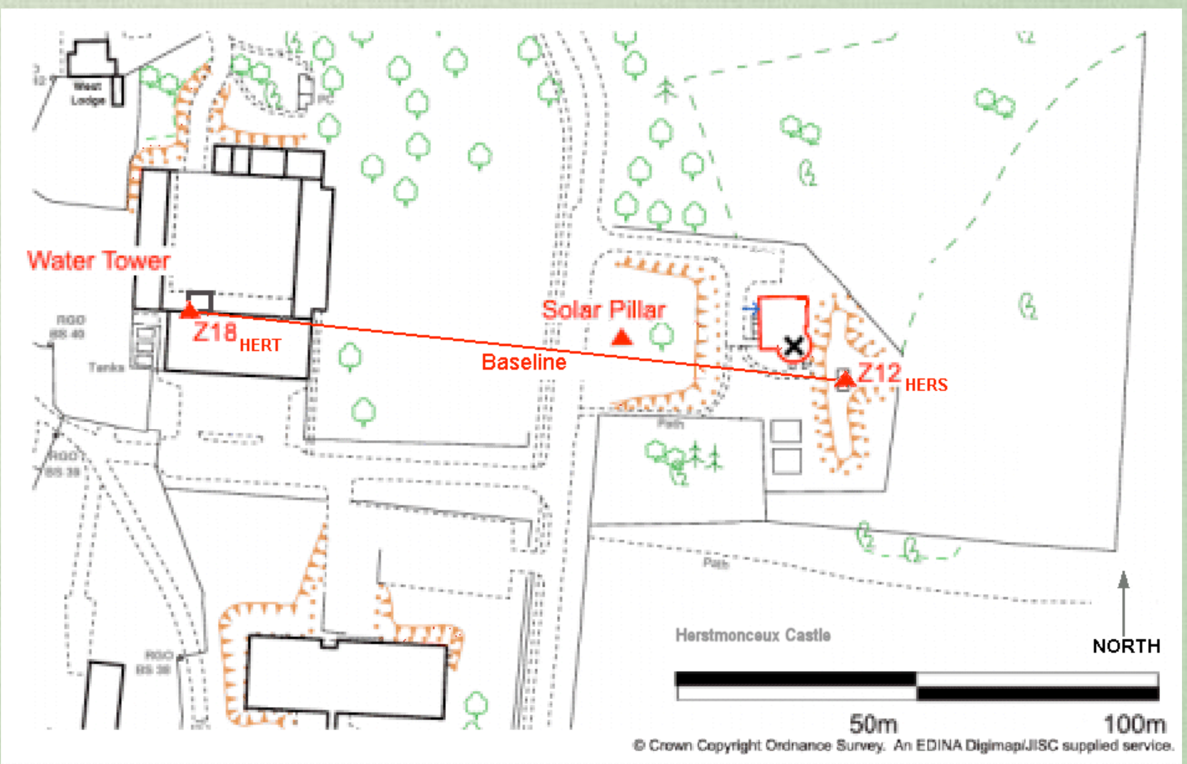


Other Techniques at Herstmonceux

GPS baseline analysis

The NSGF has two IGS GPS receivers, HERS and HERT, and recently installed third on the nearby Solar Pillar situated between the two

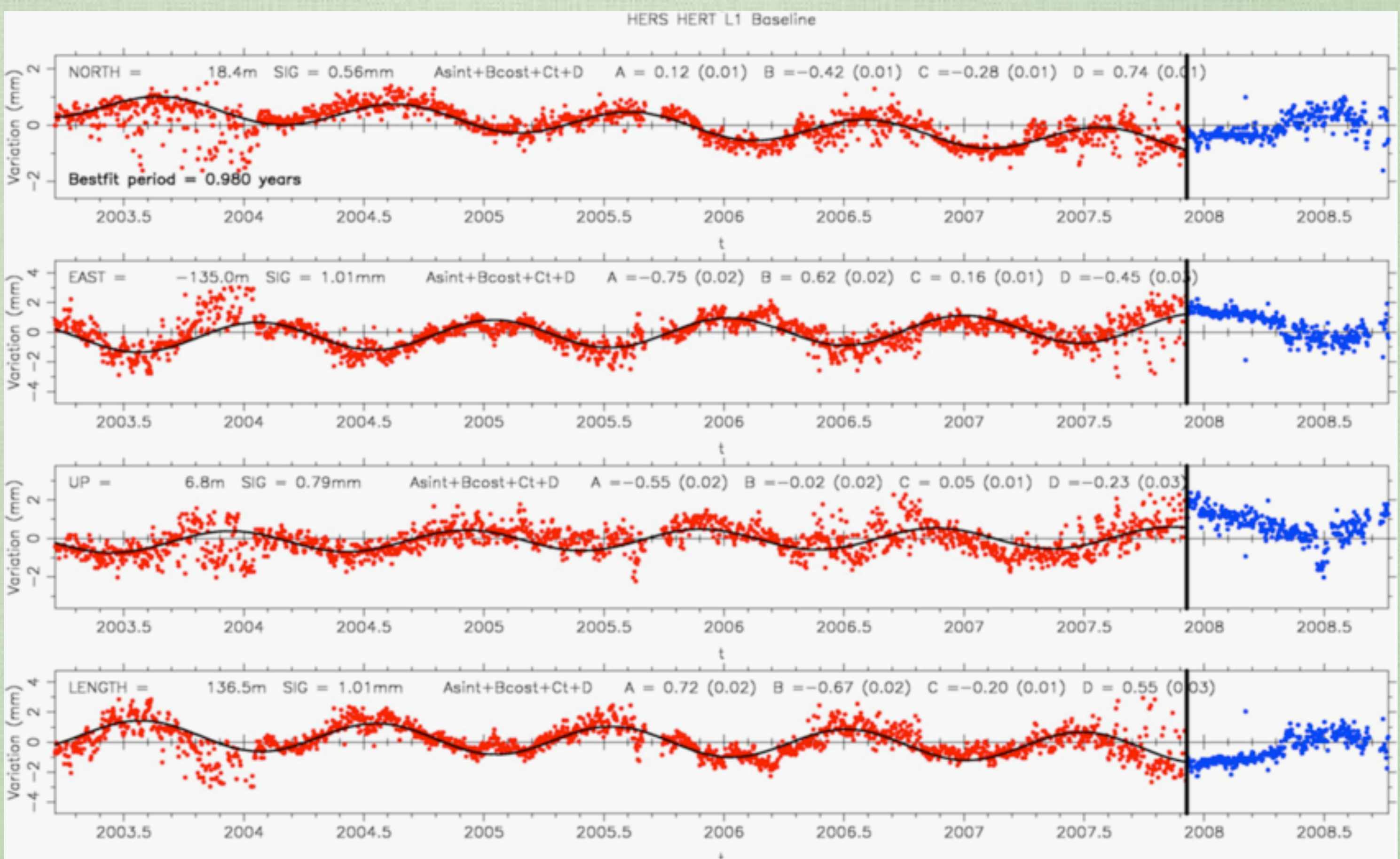
HERS and HERT are approximately 136.5m apart. Their close proximity allows single frequency (L1 or L2) baselines to be calculated because they share the same atmospheric delays.



Other Techniques at Herstmonceux

GPS baseline analysis

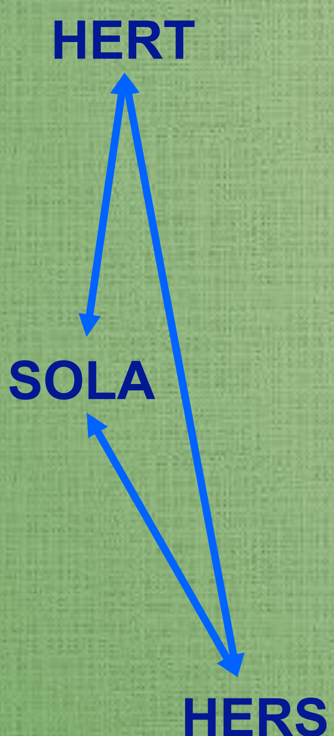
Using the freely available GAMIT GPS analysis software, a daily baseline i calculated between the HERS and HERT sites.

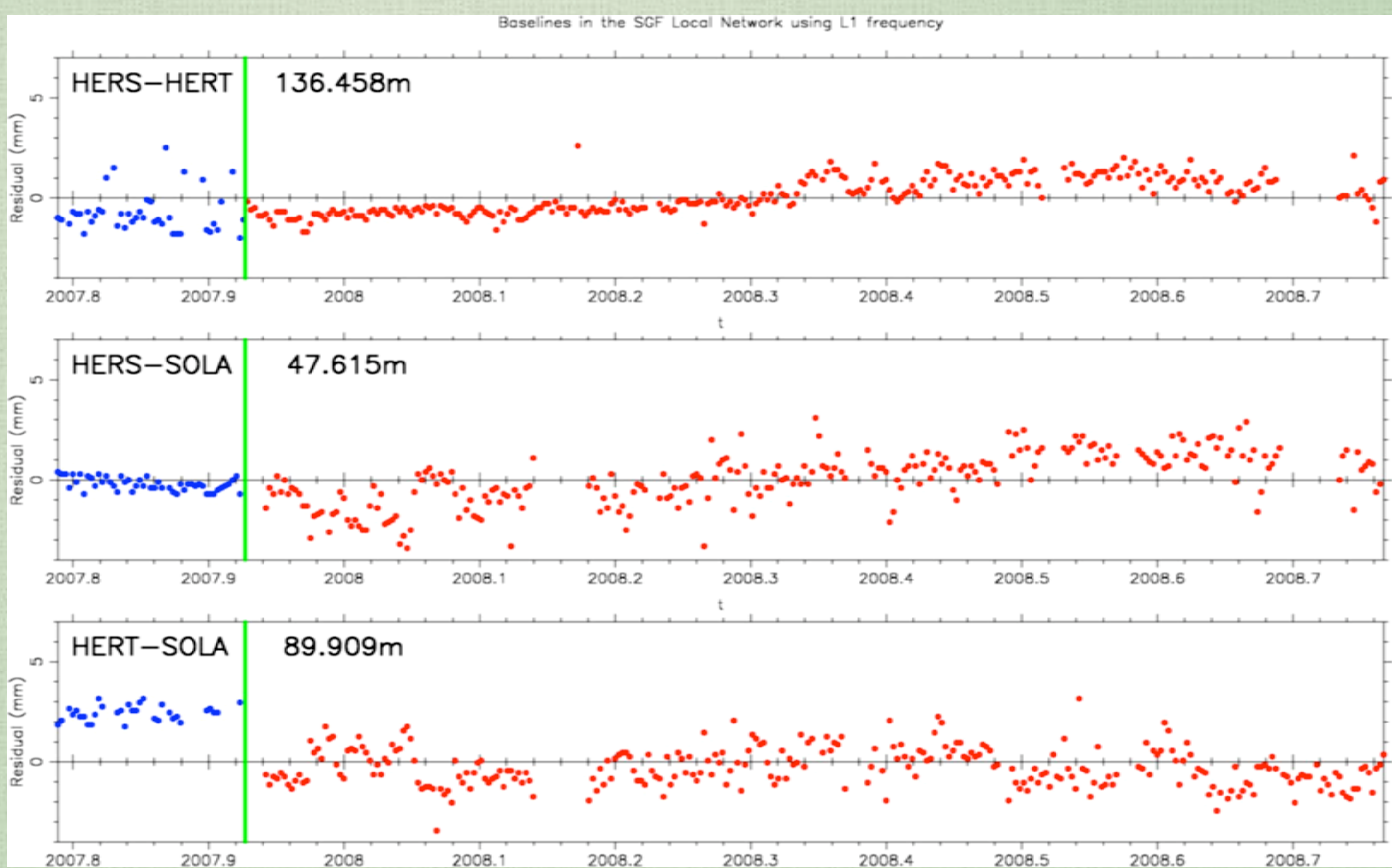


Other Techniques at Herstmonceux

GPS baseline analysis

The new site between HERS and HERT called SOLA identified the poor data quality from the HERT Z-18 receiver. Hopefully it will also explain the annual variation in the baseline.





Other Techniques at Herstmonceux

Gravimeter

The NSGF Absolute gravimeter is permanently installed in the facility basement and has been operational since October 2006.

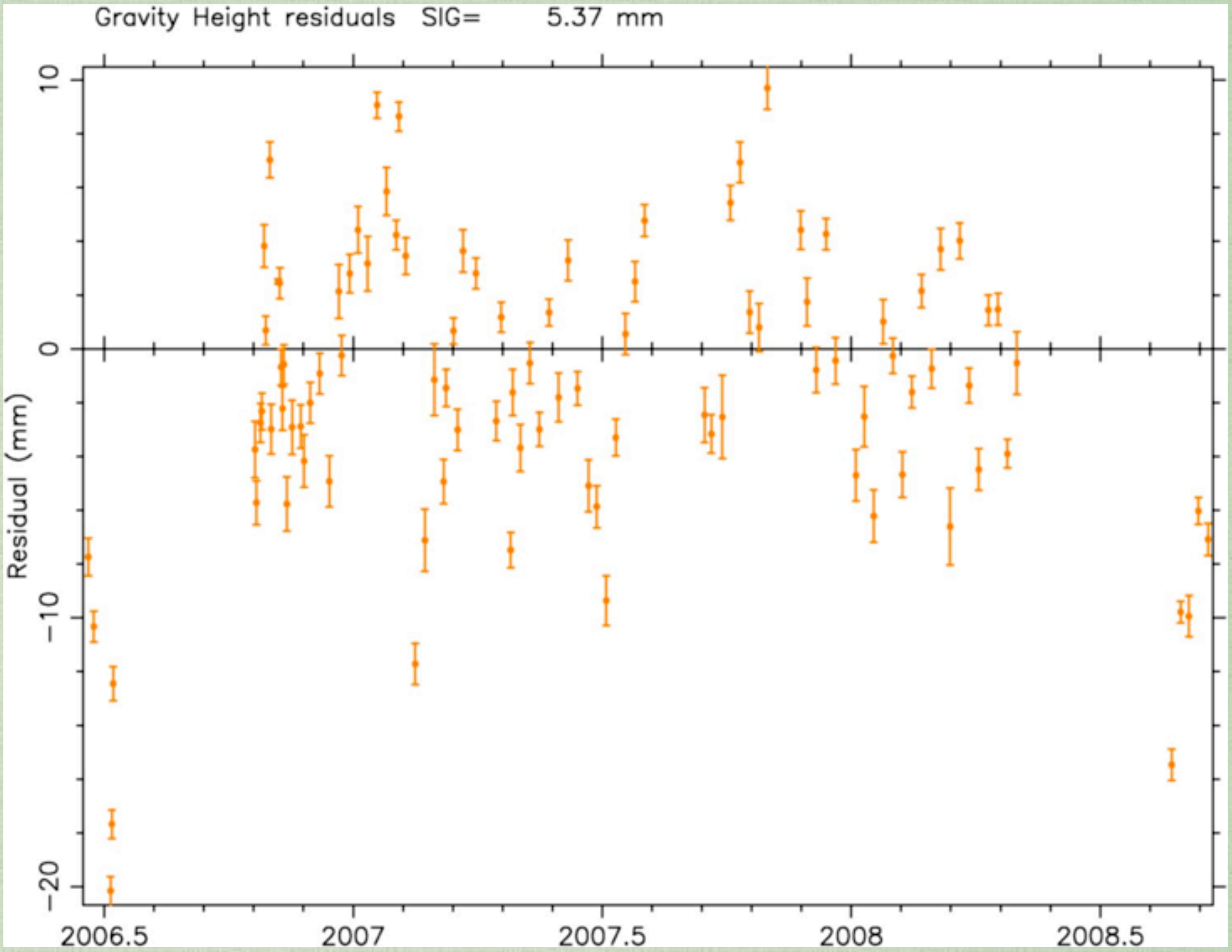
Other Techniques at Herstmonceux

Gravimeter

The gravimeter routinely is run mid week for 24 hours and gives a gravity reading to ±2μGal.

1μGal is equivalent to ~3mm.

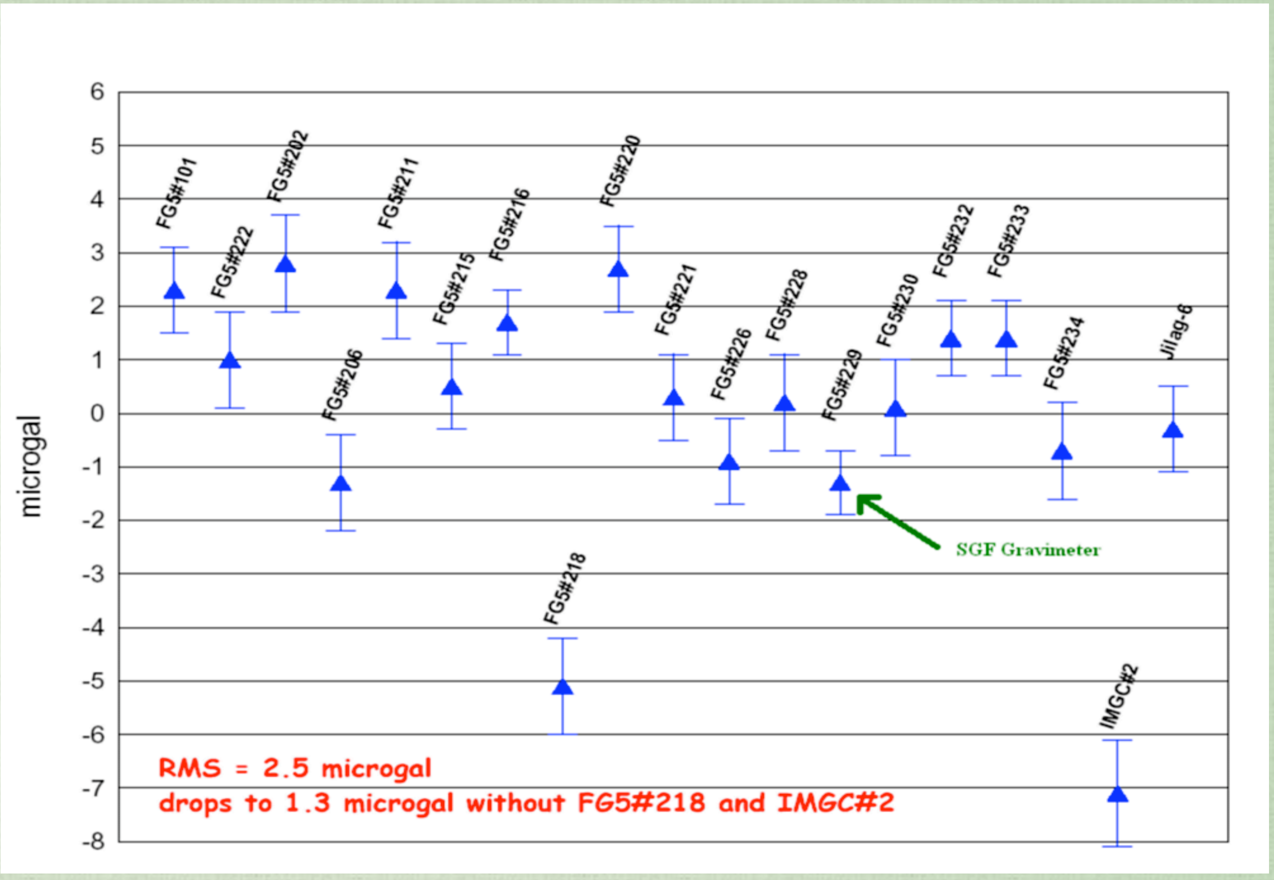
The gravimeter recently returned from its 2 year service.



Other Techniques at Herstmonceux

Gravimeter

In Novemebr 2007, the gravimeter was taken to the intercomparison in Walferdange, Luxembourg and was found to agree within specification with other gravimeters.



At the GGEO conference in Crete this year, the very close proximity of the NSGF gravimeter to the SLR telescope and GPS receivers was highlighted as important for future GGOS developments.

Conclusions

NSGF is now a more accurate laser station with better precision thanks to an event timer and a kHz laser.

The dual laser system has many advantages including being able to make modifications without stopping satellite tracking and the ability to take part in the LRO satellite and T2L2 missions.

kHz still needs to prove itself as a fully capable SLR system so that we can break our 10 Hz habit.