Upgrading kHz SLR at the SGF, Herstmonceux

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Introduction

The history of kHz SLR at Herstmonceux is a mix of successes and difficulties.

In the last few weeks we again began kHz SLR with significantly modified laser hardware, electronics and operation procedures.

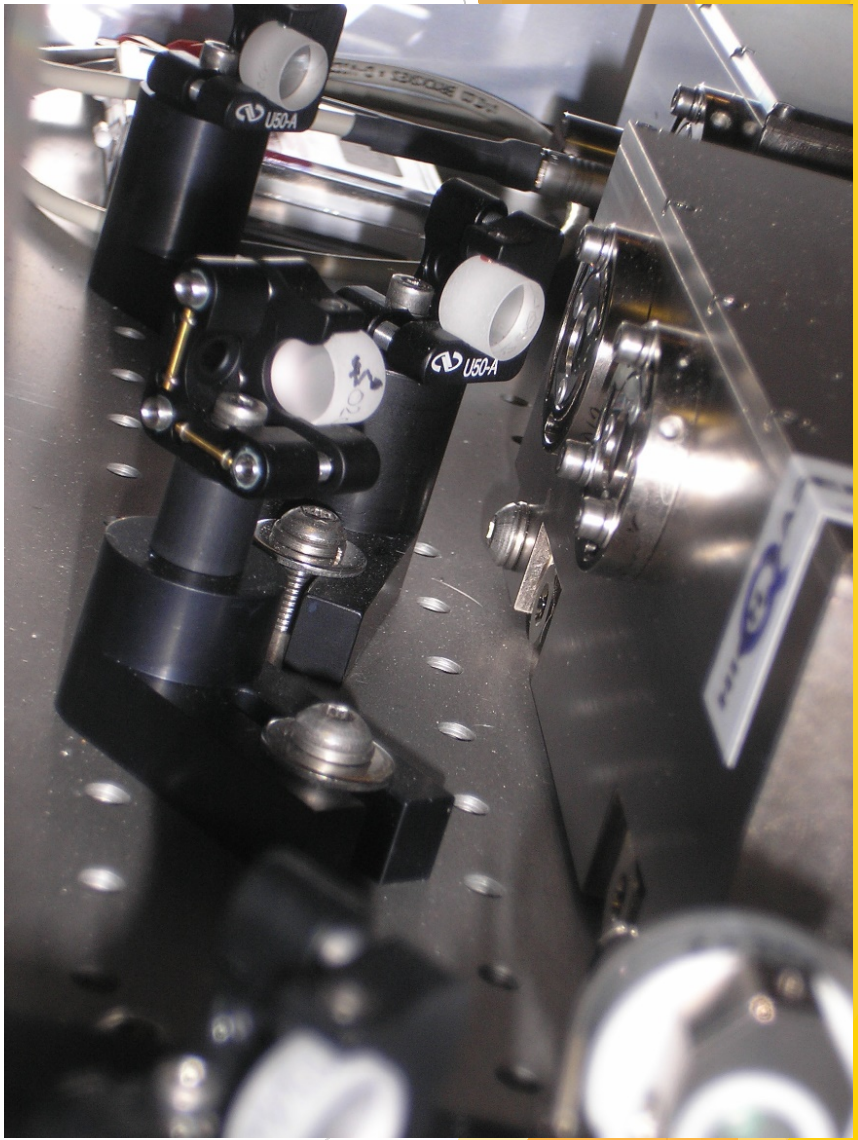
- kHz experience at Herstmonceux
- kHz laser upgrade
- Firing - best practice implementation
- Results
- Auto track searching and locking
- Narrow daytime filter

kHz at Herstmonceux

Herstmonceux has at one time or another successfully tracked all ILRS targets with our High-Q 2kHz laser.

However our initial experience with kHz SLR did not meet our expectations for acquisition, productivity or reliability.

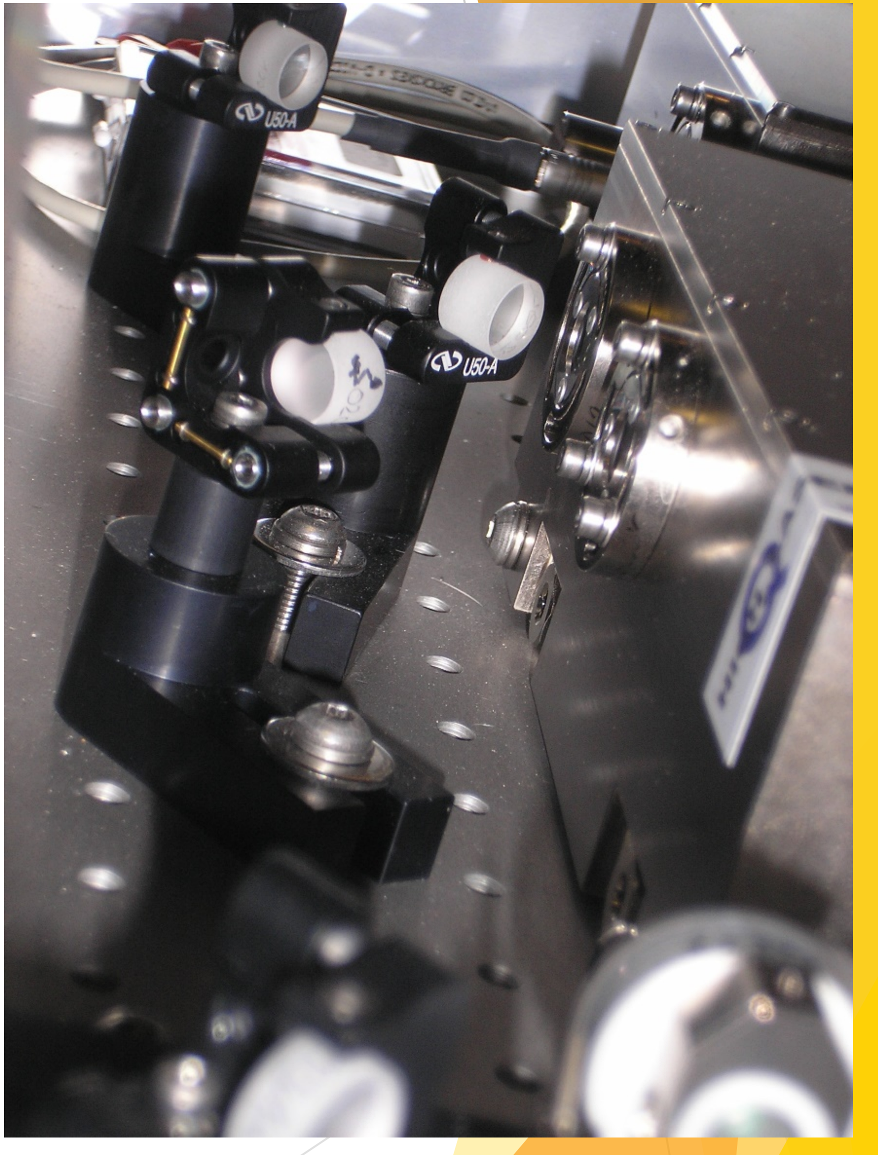
Fortunately, we retained the 12Hz Nd:YAG laser and continue to operate a dual laser system.



kHz at Herstmonceux

The reliability of the 2kHz laser has at times been poor and at on occasions the laser has not been available due to, for example:

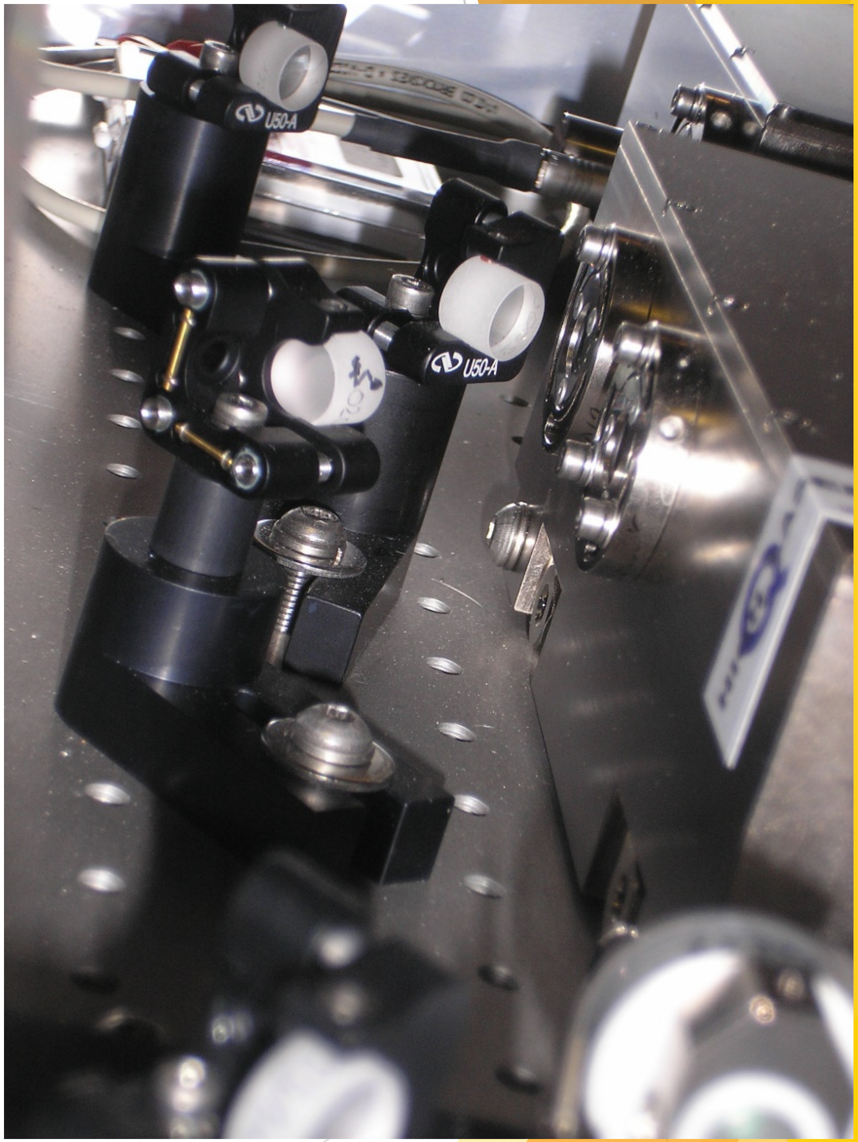
- Burnt out frequency doubler crystals and/ or surrounding optics.
- Shot to shot pulse energy instability
- Energy loss in the post amplifier.
- Other problems with the frequency doubler peltier and the TEC controller.



kHz at Herstmonceux

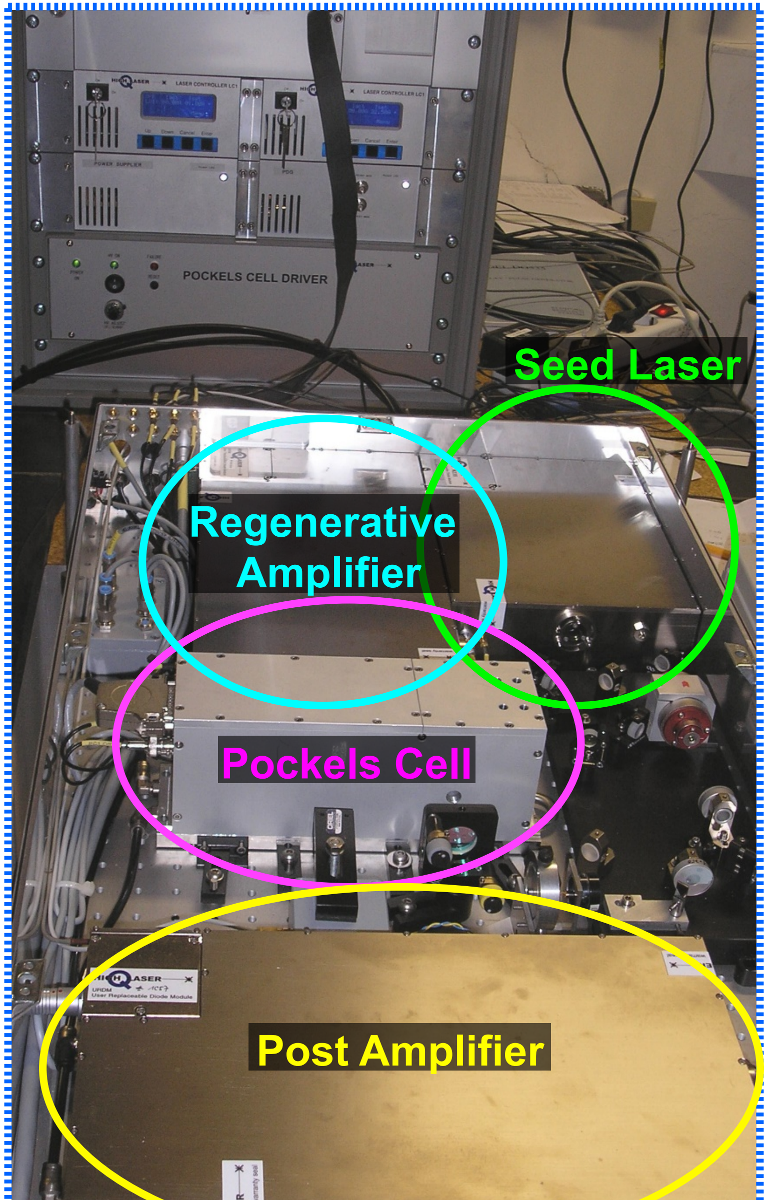
In 2013 the kHz SLR performance improved significantly after a redesign, which moved the focal beam waist. It continued to perform well for 6 months without major failure.

The laser was sent for a planned upgrade towards the end of 2013 and returned to Herstmonceux in March 2014.

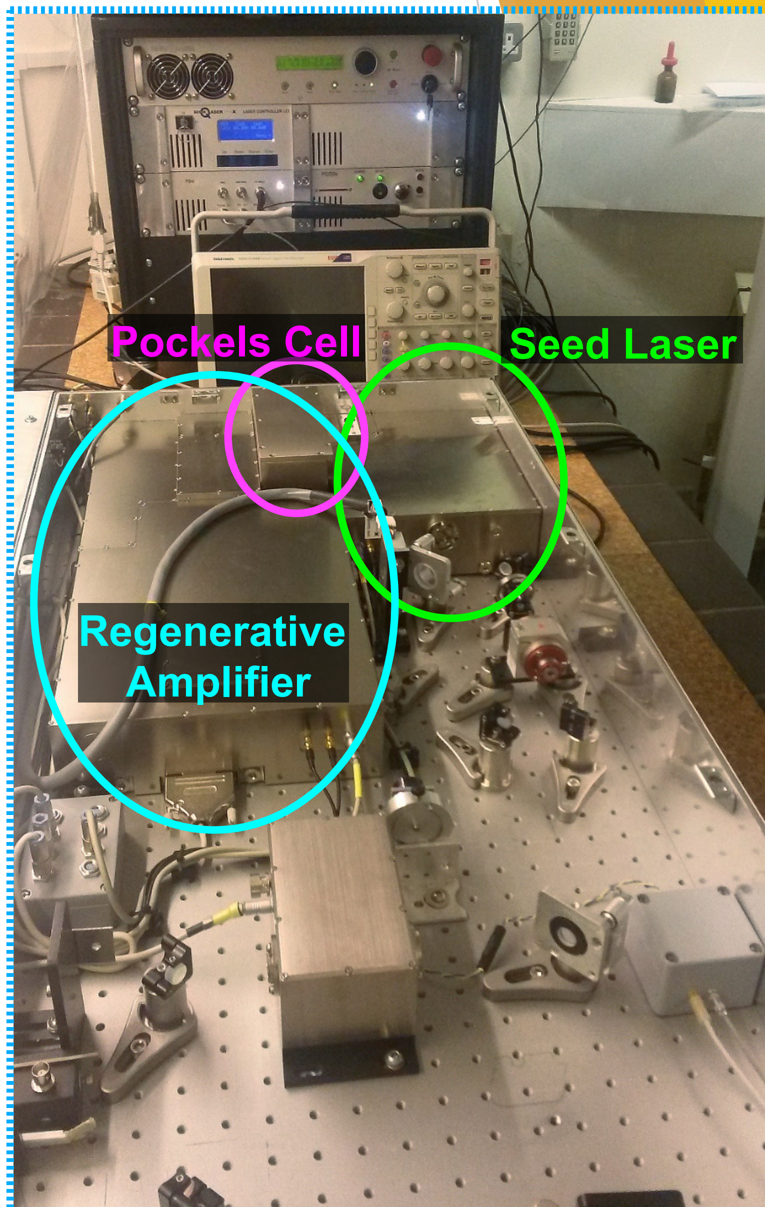


Hardware Upgrade

Original laser



Upgraded laser



Hardware Upgrade

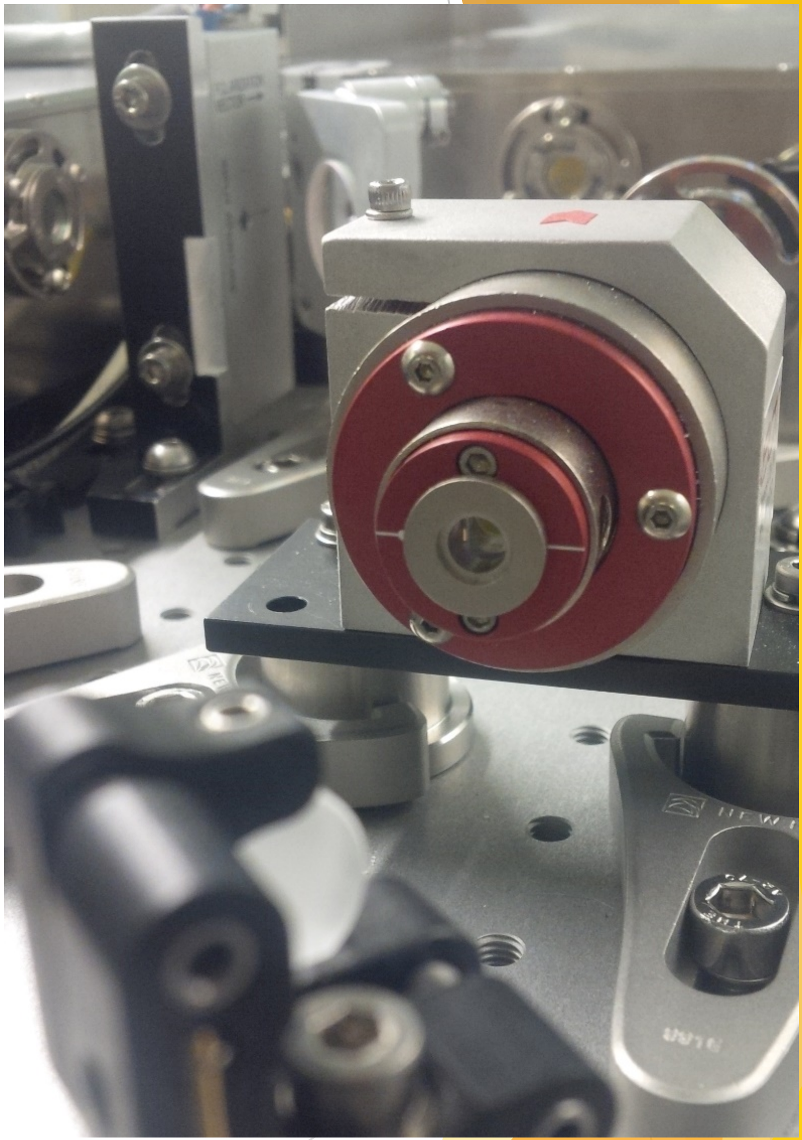
Major changes have been made in the hardware and optical generation in the High-Q laser.

The post amp has been removed entirely, all amplification now takes place inside the regenerative amplifier, which has new beam paths & design.

The seed laser is original and was cleaned and aligned.

The Pockels cell is new and has been relocated.

The new electronics include the Pockels cell and the laser diode drivers and TEC controller.



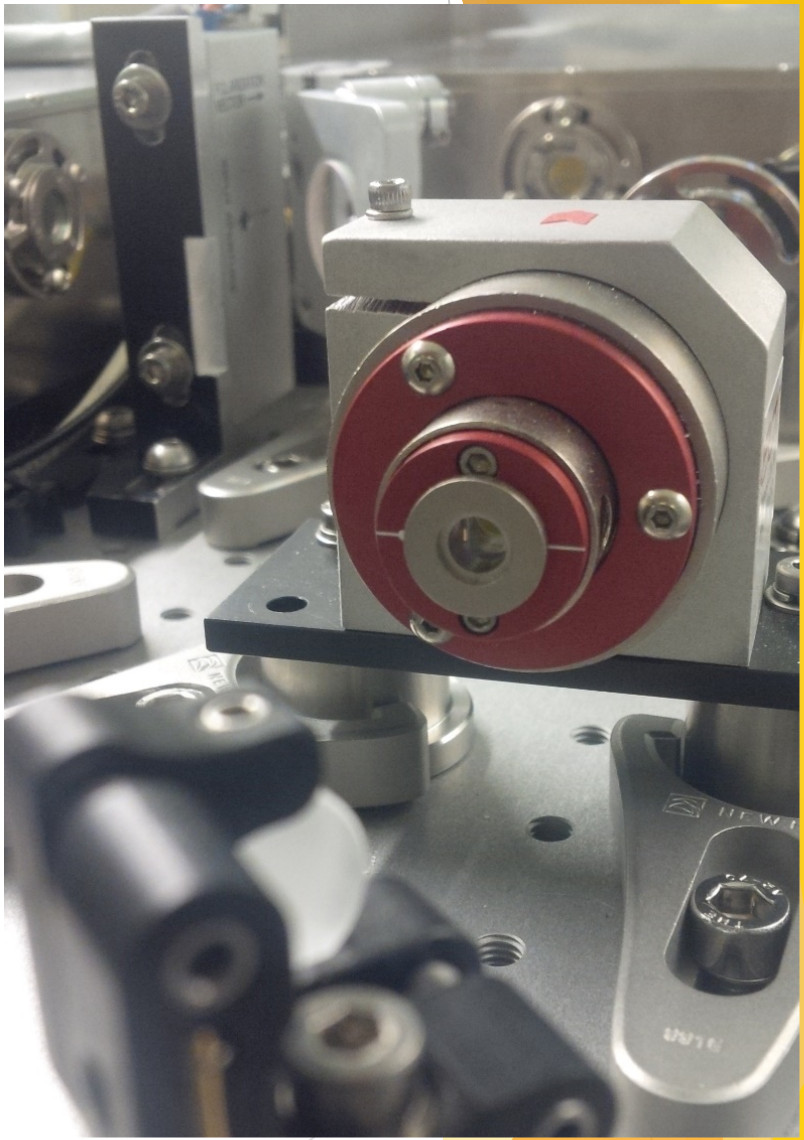
Hardware Upgrade

Due to the higher energy density at the crystal, Nd:VAN had to be replaced with Nd:YAG.

This change in output wavelength from VAN to YAG helps with our dual laser system daylight filter.

The reworked laser has a reported functionality of being able to switch from 1kHz to 2kHz without optical realignment

The pulse energy has increased to 0.7mJ per pulse at 2kHz, or 1.1mJ per pulse at 1kHz.

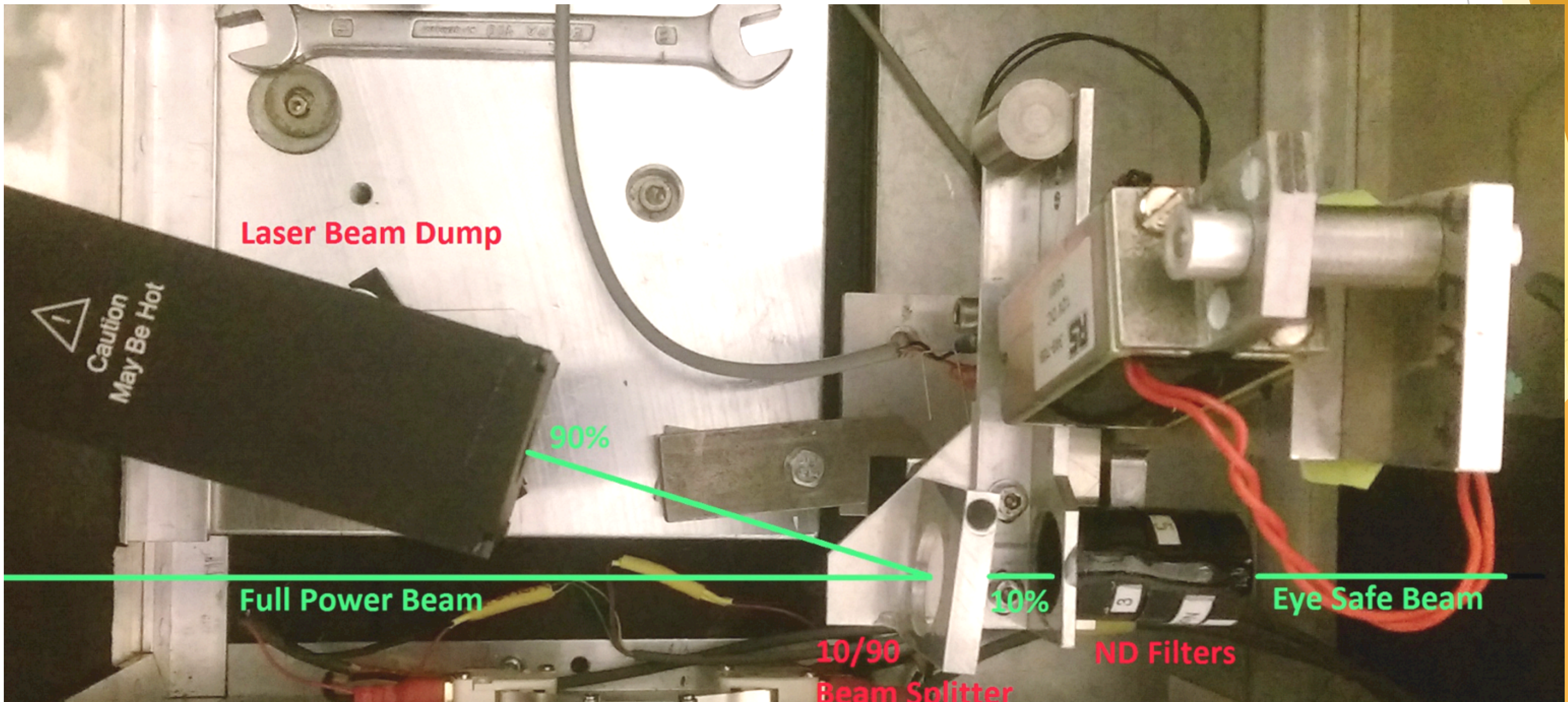


Upgrade to kHz calibration eyesafe filter

The extra pulse energy and no longer being able to desynchronise the post-amp led us to modify our calibration eye-safe filter arrangement.

This now includes an initial stage of a 90% mirror directing the reflected beam to a beam dump, before the transmitted signal is further reduced with ND filters

The glass element is corrected for at the calibration application stage.



Firing kHz control -best practice

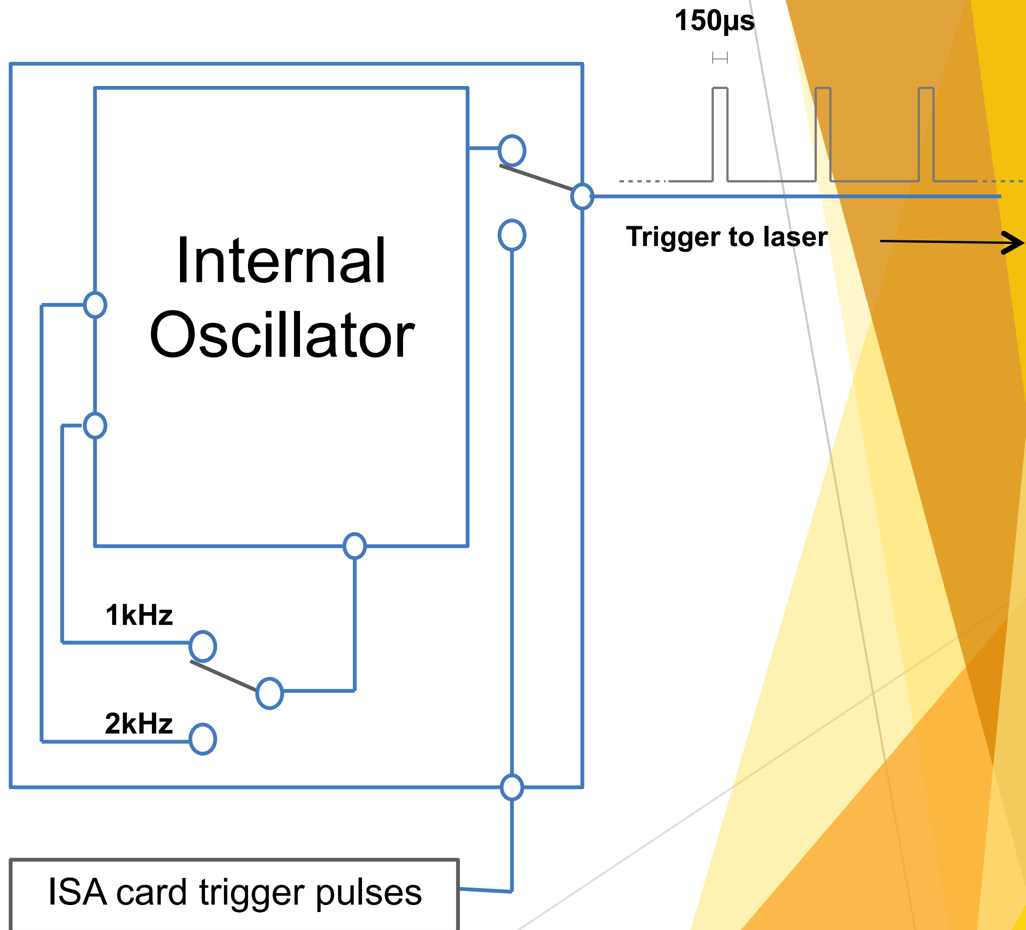
Following the upgrade, we were warned of the possibility of thermal lensing in the laser medium and the necessary procedures we should undertake to ensure stability and a long laser lifetime.

Firstly, the laser requires a 10-15 minute period to warm up with an input of trigger pulses.

In this period the laser is being triggered, but is not firing at full power.

Once the laser has warmed up it can then be fired at full power with the application of a 5V signal to the diode lase.

This required a modification to our ISA card, *with thanks to our Graz colleagues*.

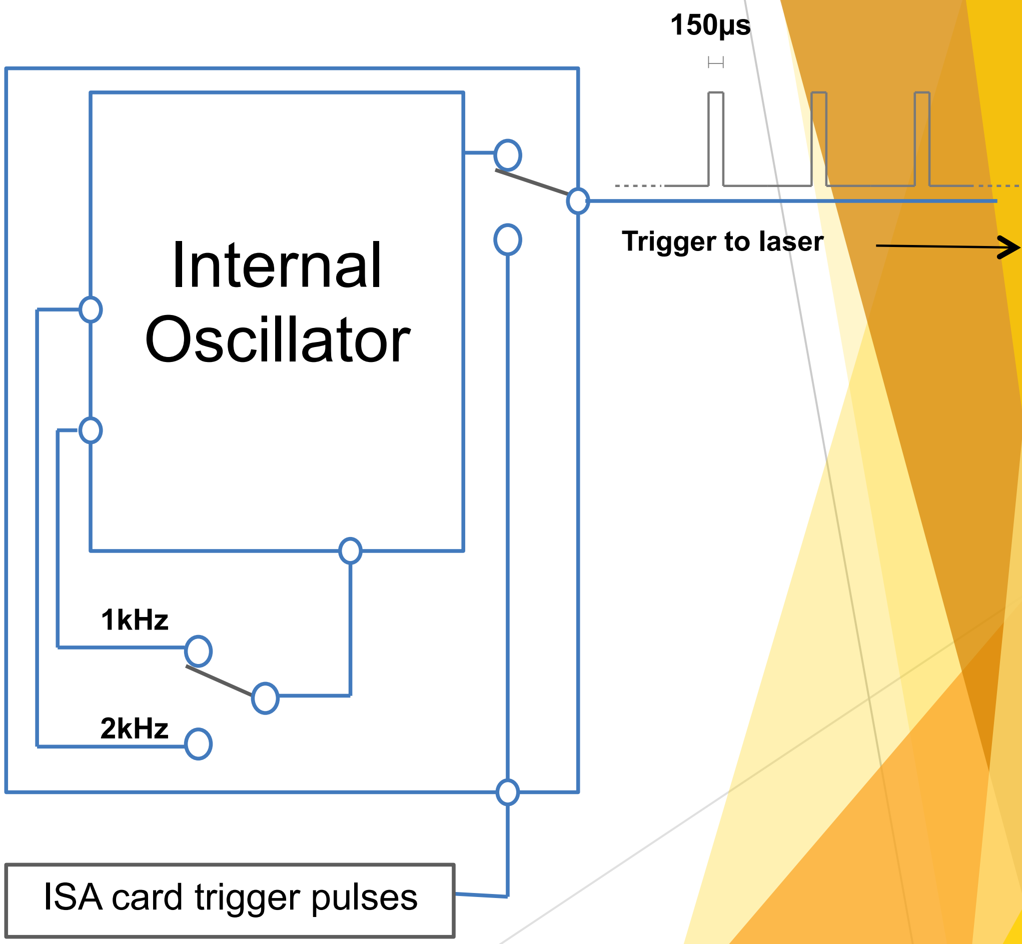


Firing kHz control -best practice

Secondly to maintain stability, laser trigger pulses must be provided continuously at the selected rate (1kHz or 2kHz).

However, triggers are only provided by the ISA card when the system is in a satellite or calibration loop.

To provide continuous triggering a card was designed and built at the SGF to switch between sending the ISA card trigger pulses or providing pulses from an internal oscillator.



Results

In the few weeks since Herstmonceux returned to kHz SLR we have continued to track targets successfully.

Data was briefly put in to quarantine by the AWG but has since been given the all clear.

Daytime passes so far include:

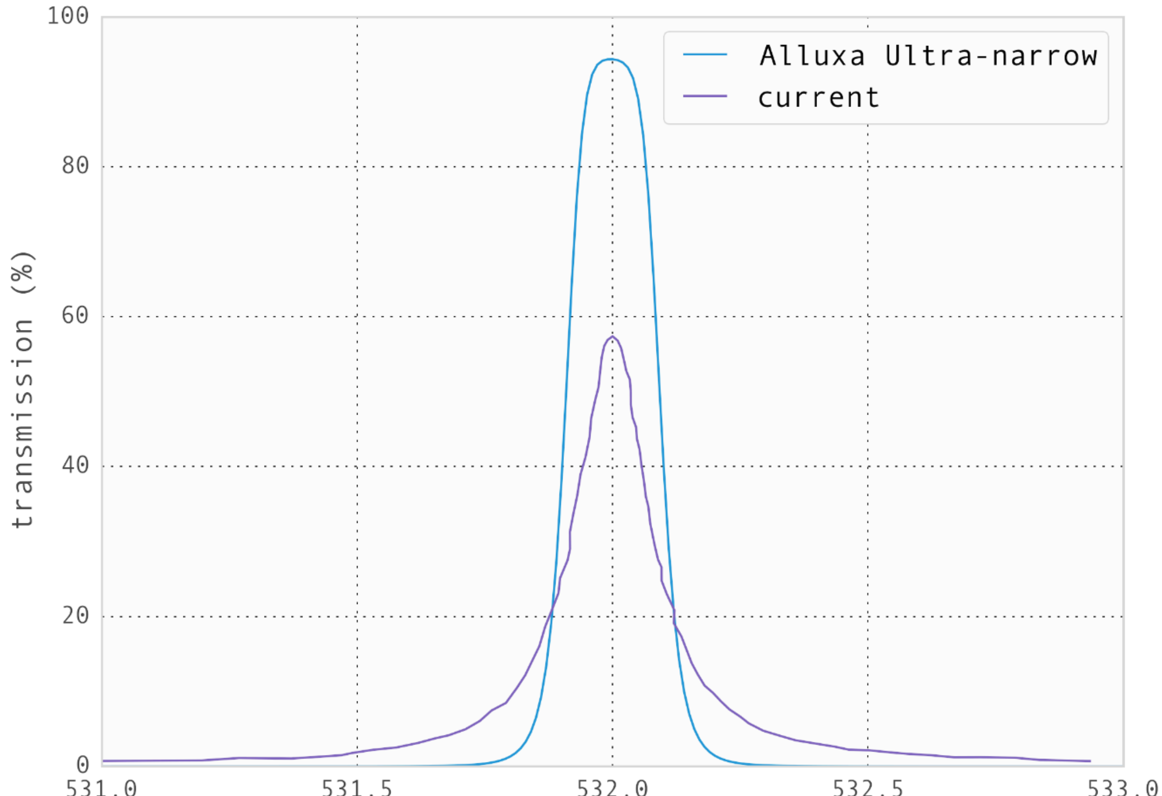
- Glonass 133
- Galileo 102
- CompassM3

Daytime narrow filter

Further improvement is possible with the replacement of our narrowband daytime filter for and Alluxa Ultra narrow filter.

This filter offers greater transmission and is a single filter, not requiring an additional blocking filter.

Available only as a batch purchase.

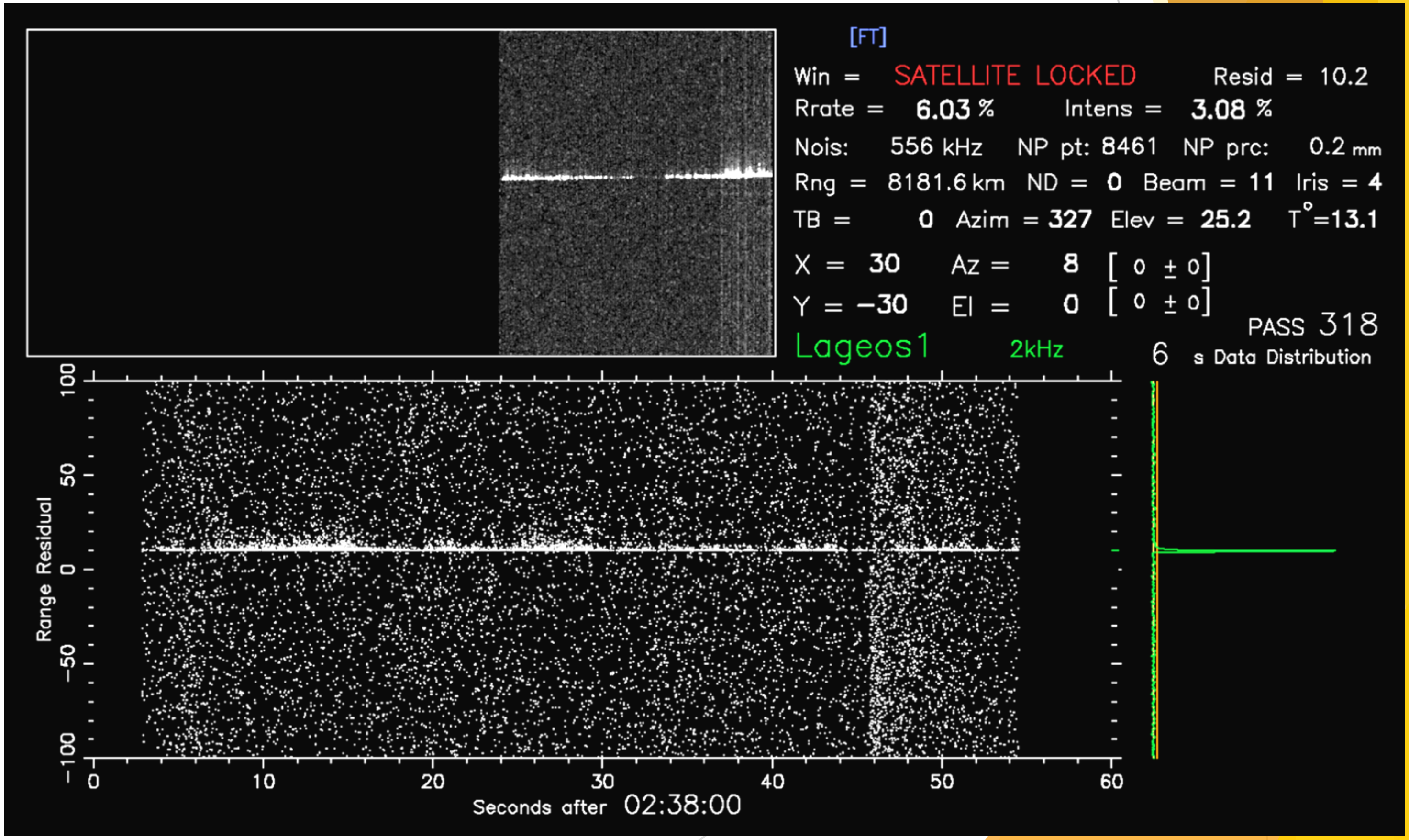


Automated searching

kHz SLR has the advantage of a rapid response once a target is acquired. This is certainly the case with return rates > 1%.

This lends itself to fast automated satellite searching and a method has been developed and is now available to the observer at Herstmonceux.

Adjustments are made to the telescope pointing by the display software through a TCP/IP feedback loop with the primary Ranging PC.



Automated searching

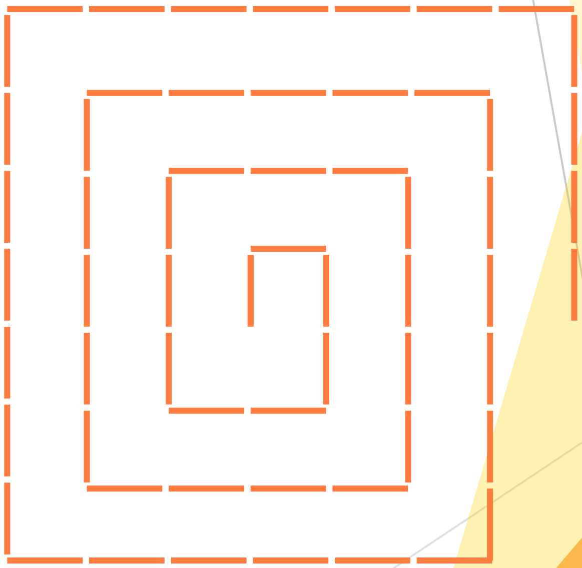
To find a satellite the search step size and interval between steps must be decided.

For targets giving greater return signal strength, less time can be spent on before moving the next step, typically a few seconds.

For larger beam divergence settings, the step size can be larger.

The offsets move in a spiral pattern until a satellite signal is detected.

The ability of automatic searching is limited if the beam is moving in the iris and if clear skies are intermittent with clouds.



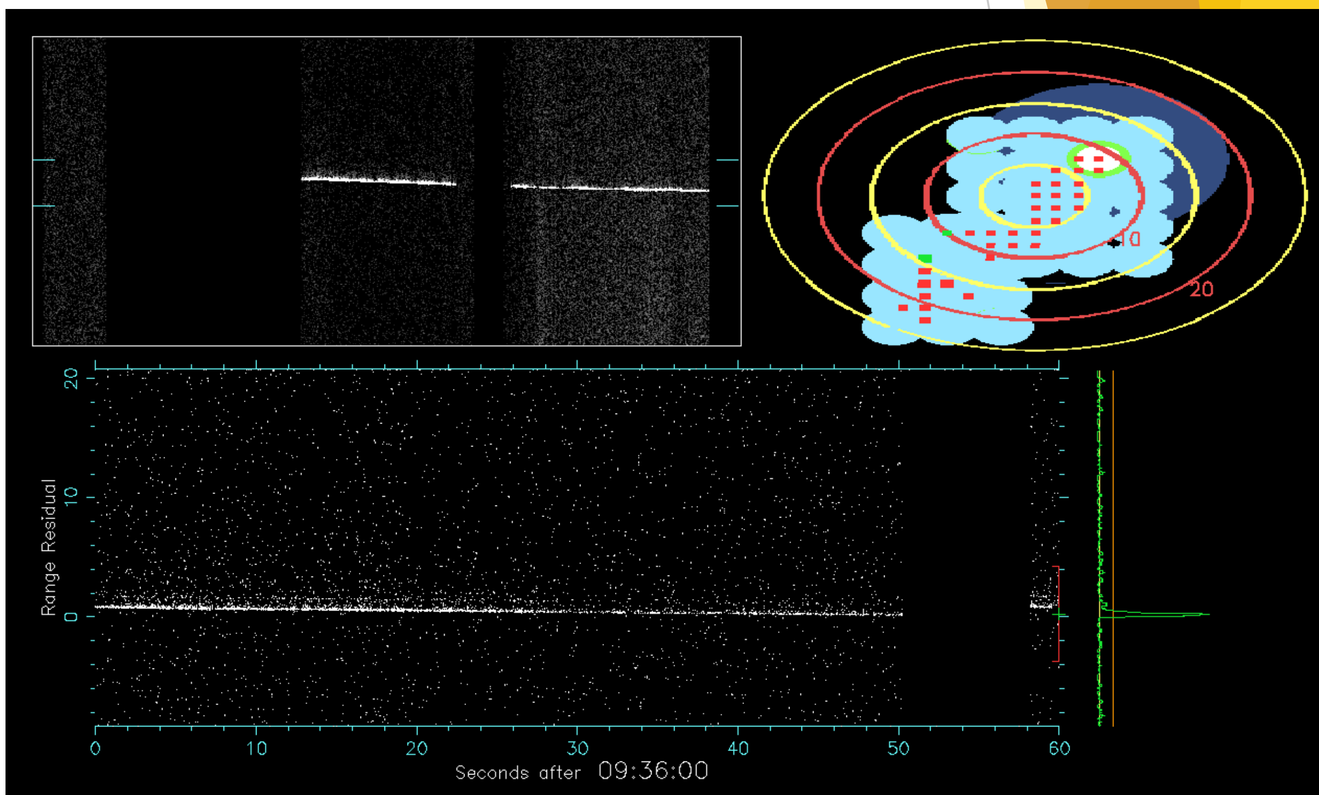
Automated searching - SATELLITE LOCKED

Once the satellite is found the automatic searching software enters a different mode in which small azimuth and elevation corrections are made.

The return rate is fed back continually and if after a correction it improves then that correction is kept.

If the return rate is reduced the correction is removed and if it improves by a large amount the same correction is applied again.

This is intended to help with the imperfections of the pointing model at Herstmonceux and to keep hold of the satellite as it moves across the zenith.



Thank you

http:// sgf.rgo.ac.