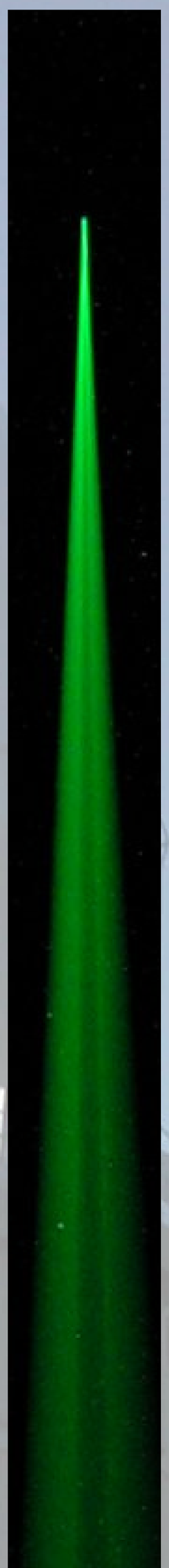
PPARC

University of Durham

Astronomical Instrumentation Group

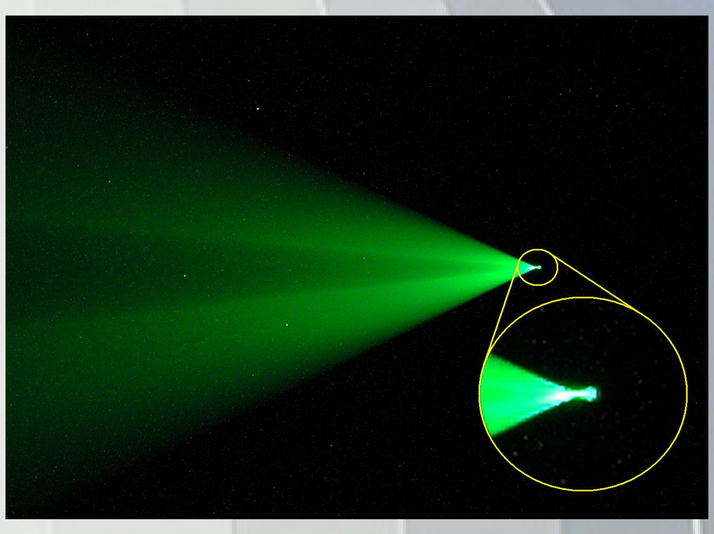
# Restricted Conjugate Adaptive Optics Rayleigh Laser Guide Star Project

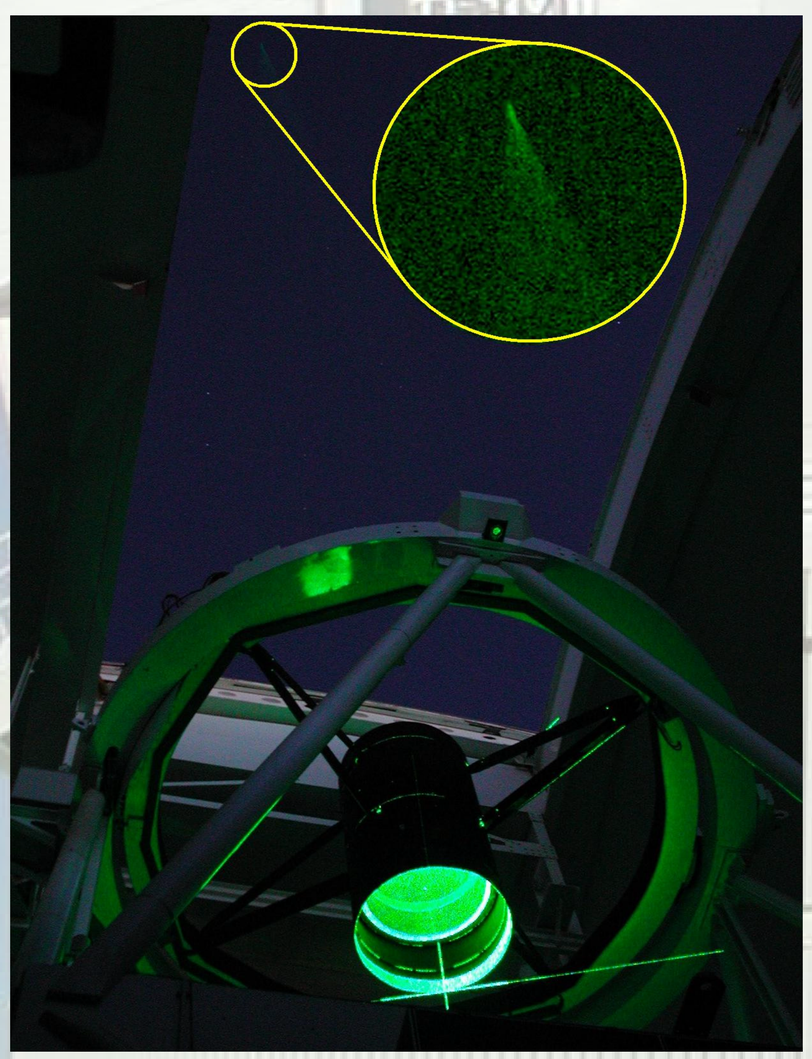


## Rayleigh Phase A Run: Results

The Restricted Conjugate project is part of the University of Durham Astronomical Instrumentation Group's rolling grant programme, funded by PPARC. The project aims to demonstrate the feasibility of using commercially available laser technology to provide a Rayleigh back-scatter laser guide star system for use with Adaptive Optics. In particular the project investigates low order AO correction over a wide field of view for use with multi-object spectroscopy on the WHT.

The project is ongoing with the first (Phase A) run having been completed at the Isaac Newton Group of telescopes on La Palma during May 2001. Launch tests were conducted using both the 4.2m William Herschel Telescope and a custom-made 30cm f/6 launch system housed in an outbuilding adjacent to WHT.

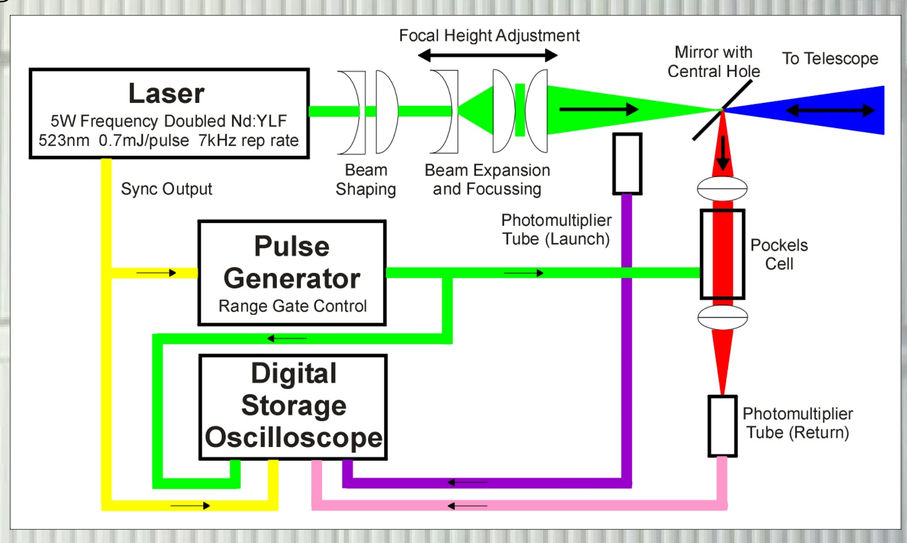




These two images show the high power laser launch through the 30cm f/6 launch system (above) and the WHT (left). Safety considerations form a major part of the project. The laser is only operated by trained staff using protective goggles to prevent eye damage. A plane spotter is used to ensure that no harm comes to aircraft that may fly through the laser beam (the mountain top itself is actually a 'no fly' zone).

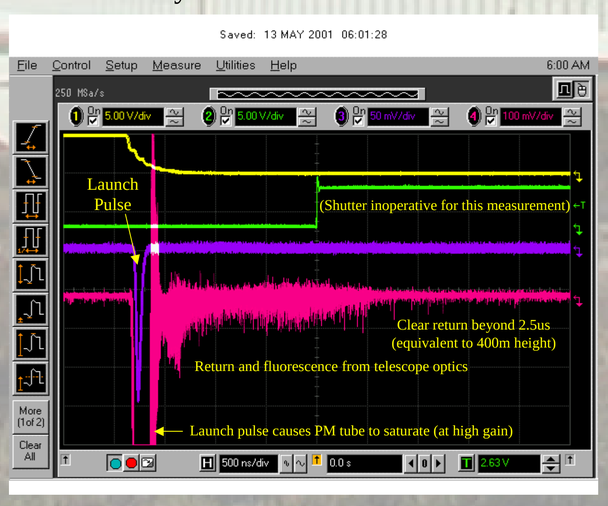
The 'bow tie' structure seen in the above photograph is a result of focussing the laser at a particular altitude. The laser is actually pulsed (although the beam appears continuous to the human eye) and a high speed pockels cell shutter is used to range-gate the return pulse at the focal height. The focal spot then appears as a low altitude star which can be used to correct atmospheric turbulence with an Adaptive Optics system.

The novel optical configuration used during the Phase A run is shown in the diagram below.



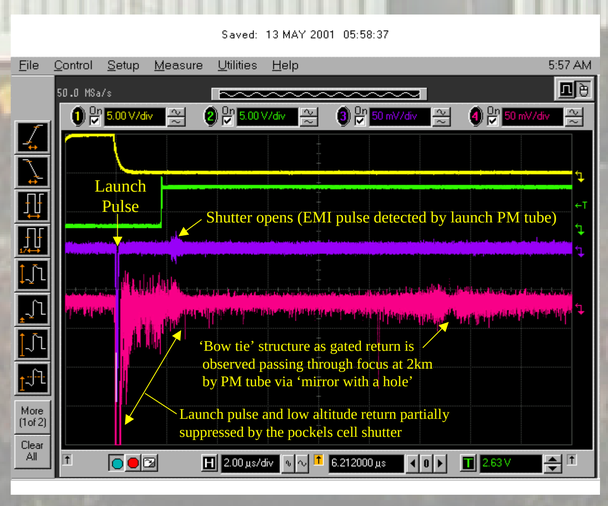

## Fluorescence Measurement

One of the main objectives of the run in WHT was to establish if fluorescence from the telescope optics would prevent return measurements during the next phase of the project. This trace, taken just before sunrise on May 13th using a photomultiplier tube, shows return scatter and fluorescence from the telescope optics decaying within 2.5µs, establishing that return above 400m should be able to be observed without difficulty.




## Range-Gated Return

The range-gate pockels cell shutter was tested during the May 13th slot on WHT. The return from differing altitudes was observed using a photomultiplier tube looking at the telescope via a 'mirror with a hole' (to separate launch and return beams – see above diagram). The 'bow tie' structure is formed as the return passes through focus where most of the light is lost through the hole. The bow tie was seen to change position as expected as the focal height was altered.




## Cloud Ceiling Detection

An interesting by-product of the Rayleigh laser system, when used with photomultiplier return detection, is the ability to accurately resolve cloud layers above the telescope. This trace was taken on May 15th using the 30cm f/6 launch system from the $LN_2$ building. Two thin cloud layers at 2.8km and 4.7km are clearly visible.