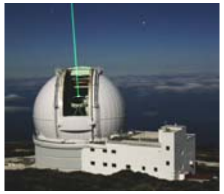

Optimisation of the range gating and calibration processes on the GLAS Rayleigh Laser Guide Star at the WHT

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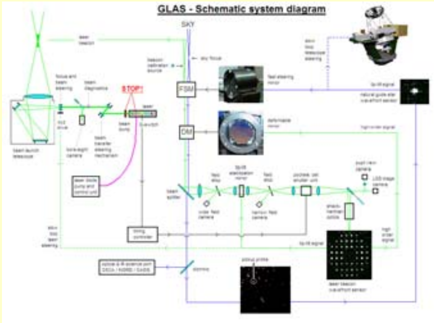
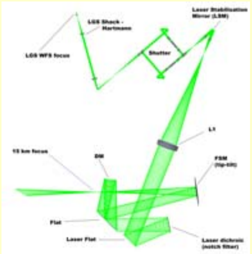
The Laser Guide Star commissioned in 2007 at the WHT on La Palma is based on Rayleigh backscattering of a 515 nm beam provided by a diode pumped Q-switched doubled frequency Yb:YAG laser launched from behind the WHT secondary mirror. At the time the laser beam is focused at a distance of 15km above the telescope ground and its power just under 20W. With such a pulsed laser, careful fine tuning of the range gate system is essential to isolate the most focused part of the LGS and eliminate parts of the laser plume which would degrade the Shack-Hartmann spots and consequently AO correction. This is achieved by an electro-optic shutter using Pockels cells, triggered by a delay generator synchronised on the laser pulses, and by spatial filters. Images of 0.15" resolution in J and H bands, very close to expected performance, have been routinely taken as soon as the third and fourth commissioning runs. Here we show the performance of the range gate system as measured and improved over the successive commissioning runs, as well as the off sky and on sky calibration procedures of the LGS AO system.

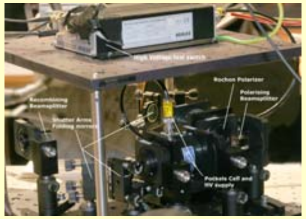


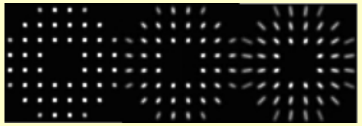
Sketch of the complete LGS AO system at the WHT.



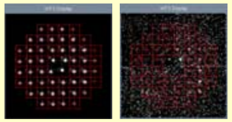
Left: layout of the GLAS WFS optical path.

Right: two-arm Pockels cell shutter. Before and after the shutter are positioned spatial filters (pinholes) of 8" and 4" apertures, to help cut-off portions of the defocused Rayleigh laser plume. *s* and *p* polarisations states of the beam are separated in the shutter by a beamsplitter. The high contrast ratio between "open" and "closed" states are obtained with orthogonal Rochon prisms. The Pockels cells are electro-optical switches, triggered by the laser launch pulses.

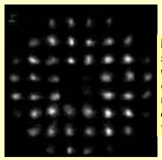




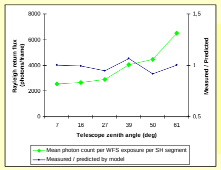
Aspects of the LGS spots as modelled for a 20km launch distance and range gates of 200m, 600m and 1000m, using 2" aperture stops. *From Morris, Proc. SPIE Vol. 6272, paper 672737-5.*



Contrast ratio obtained with the calibration source. Best extinction is above 500:1 and everywhere above the required 100:1 ratio.

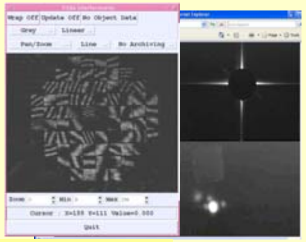


LGS Shack-Hartmann spots on the WFS as seen with GLAS. Laser launch distance is 15km, the range gate is 300m on sky and the field of view of the lenslets was set to 4".



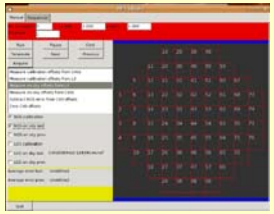
Rayleigh return flux measured on the LGS WFS during the April 2008 run. Measurements are very close to values predicted by the Rayleigh backscattering model for a 15km beacon and 300m range gate.

Observing with GLAS



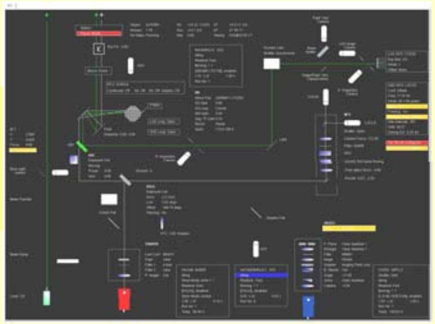
Interferogram of the Deformable Mirror. DM flattening is the first step in preparation of the AO instrument.

Centring the LGS using the aperture stops



Taking LGS offsets on sky to compensate for non common path errors between the LGS WFS and the science cameras (IR camera INGRID, IFU visible and near-IR spectrograph OASIS).

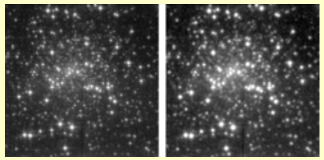
AO Mimic: live observing tool showing the complete configuration of the AO facility (with LGS and NGS WFS's), information of the laser beam launch status, science cameras and instrument configurations, calibration units.



Example of image obtained during commissioning: central 40" of globular cluster M15, observed with INGRID in J band, 20s exposures.

Left: closed loop, FWHM=0.2".

Right: open loop, seeing limited image, ~0.5" FWHM.



CONCLUSIONS

The commissioning period of the Ground Layer Adaptive-optics System (GLAS) at the William Herschel Telescope is nearing completion. Because GLAS is based on a pulsed Rayleigh laser guide star, the quality of the Shack-Hartmann spots on the LGS WFS is fundamental to reach the desired high order AO correction level. This is achieved by carefully adjusting the parameters of range gating, using several aperture stops as spatial filters and a highly selective electro-optical shutter which has been aligned with the greatest care to be able cut off the laser plume. During the commissioning period we have proved that although not in optimal conditions (lower laser power than expected, hence lower LGS distance and more elongated laser spots), the AO performance requirements could indeed be achieved when the atmospheric turbulence conditions were favourable (no turbulent layer above 15km). The performance will be further improved with the upgrades to a more powerful laser, which will allow launching the LGS to 20km or 25 km.