Report on DAZLE run on UT3 Oct 30th to Nov 10th

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1.1 Integration Phase

Integration of DAZLE onto the Nasmyth platform of UT3 was completed successfully prior to the start of the scheduled commissioning nights on Oct 30th and 31st. We ensured that the integration of DAZLE on Paranal had minimal impact on ESO staff effort by shipping major components of DAZLE already assembled within a standard 40ft (12.2m) ISO shipping container. DAZLE is now in storage in this container at Paranal. The ship carrying DAZLE changed its advertised route and DAZLE arrived at Paranal after the integration team arrived from Cambridge. The integration phase was consequently reduced by two days. A modified strategy involving off-loading the container beside UT3 rather than at the VLT base-camp helped to speed up the integration process and make up some of the lost time. The ESO staff involved in the integration did a great job and DAZLE was ready for operation at the start of the first commissioning night. At the end of the run DAZLE was completed removed from UT3 and put into its container in two days. Figure 1 shows the arrival of the DAZLE Container on Paranal, various stages during integration on the UT3 Nasmyth focus and the DAZLE commissioning team including ESO staff in the UT3 control room.

1.2 Commissioning and Science Verification

The commissioning of DAZLE went smoothly and the optical axes of the DAZLE instrument and the VLT were aligned within the planned tolerances. On-axis focus tests were carried out using suitable bright stars and the detector was aligned so that image quality was consistent across the full 7'x7' field of view. During this period the delivered instrument seeing was 0.8". Later in the run, we achieved an image quality of 0.4 (fwhm) in 30min exposures with our image scale of 0.2" per pixel. Throughout the run the measured DAZLE 'seeing' was consistently better than the DIMM estimates as one would expect for an IR instrument within the less prone to wind VLT dome.

A series of tracking tests were carried out using a globular cluster field to verify that the stand-alone DAZLE de-rotator that operates at -40C was synchronised with UT3. No measurable image smear was detected in 30min exposures. In better seeing (0.5") later in one exposure only we saw 0.5" shifts between a pair of 30min exposures when a survey field transited extremely close to zenith. Since we observed in NDR mode with 61 reads per 30min exposure images shifts can be corrected for in data reduction. Nevertheless in future we avoided observing so close to the zenith.

During the second night of commissioning(Oct 31st) a higher than expected sky background was identified as scattered light within the DAZLE instrument. A systematic series of tests were carried out in order to identify the possible cause. Various possibilities were considered including a lack of baffling and some make-shift baffles were implemented. However, it turned out that the problem was not inadequate baffling. The systematic tests eventually pointed out that the extra background as actually passing through the narrow-band filters. We found that by rotating the filter wheel slightly away from its nominal position we could reduce the background to the expected level for the 1056nm filter and close to the expected level for the 1063nm filter. We have brought the filters back to Cambridge to further investigate this problem but we suspect that either light was passing between the filter coatings and the metal of the filter holder or there are edge defects in the filter coatings. We will identify and mask-off these light paths before the next run.

Most of our planned commissioning activities were completed on the first commissioning night. The DAZLE de-rotator worked perfectly on its first test without any software modifications which saved a lot of time. However, the investigation into the unforeseen extra background took up most of the second night (it would have compromised our science goals). Consequently, commissioning and optimisation of the observing modes using the visitor templates within P2PP and use of BOB continued through the third night.

Data from a science verification observation is shown in Figure 2. Science verification for the DAZLE program involved the determination of the filter throughputs and sky background via observations of spectrophotometric standards with IR coverage from the FORS2 calibration plan. In addition we selected a quasar with a redshift that placed the narrow forbidden [OIII]5007 line within the bandpass of one of the filters. [OIII] was specifically selected, rather than the broad permitted lines of Hydrogen since these could have been detected in both filters. Figure 2 shows SV images of the z=1.110, QSO 2QZ J0255−2848; [OIII]5007 has a predicted observed wavelength of 1056.5nm. The left hand image is through the NB1056nm filter and the right hand image is through the NB1063nm filter. Each image is 2'x2'. The total exposure time per band is 30minutes. The quasar is clearly detected 15" from the centre of the image in the NB1056 filter centred on the predicted wavelength of redshifted [OIII] whereas the quasar is undetected in the NB1063 image.

1.3 Progress report on Science Program

The Science program was carried out primarily on the 9 nights from Nov 2nd to 10th. Around 0.5 nights was lost over two nights due to high wind when UT3 was closed. Apart from this, no observing time was lost due to DAZLE or the VLT systems. During the remaining time we accumulated a total on-sky integration time of 69hrs excluding time spent on calibration such as spectrophotometric standards and twilight flats. Twilight flat observations were started soon after sunset each night and science observations would commence before the end of astronomical twilight.

The measured seeing in our images during the run ranged from 0.4arcsec to 1.3arcsecs. As proposed we executed the shallow survey when the seeing was poor. The two deep survey pointings have exposures of between 9.8hrs and 10.0hrs per filter as proposed. In addition we imaged 6 shallow survey pointings in seeing of 0.8 to 1.3arcsecs, with an average exposure time of 2.5hrs per filter (we proposed to do 8 shallow fields).

The on sky measured sensitivity of DAZLE which includes, detector (Rockwell HgCdTe HAWAII-2 2048^2) dark current, read out noise, instrument and sky background gives a 5σ sensitivity of 3×10^{-18}erg s^{-1}cm^{-2} in 10 hours for a source spread over 25 pixels (i.e. one square arc second). This value is to be compared with our predicted sensitivity of 2×10^{-18}erg s^{-1}cm^{-2}.

This difference is almost entirely due to the higher than expected inter OH line sky background. We had previously assumed the Maihara et al value but our measured value seems to be more consistent with the ESO value derived by Cuby et al which is approximately twice as high. We are reasonably confident that for our 1056nm filter we were seeing the 'true' sky background because we could see rings of very marginally higher background due to expected faint OH lines encroaching on the wings of the filter transmission profile. However, it may be that the extra background is due to filter defects (e.g. pinholes or excessive wings) and if so we may be able to reduce the measured background. We also saw that the DAZLE background varied with lunar phase and distance. Note we were observing through full moon.

These results are extremely encouraging and combined with the good image quality delivered by UT3 and well sampled DAZLE images (0.2" per pixel) and efficient observing system i.e. low overheads we are confident that we shall soon have redshift z=7.7 galaxy candidates that require spectroscopic confirmation. Data analysis is currently underway and we envisage that we will apply for ESO DDT time in Dec/Jan for spectroscopic follow-up of candidate z=7.7 galaxies in the GOODS/GEMS fields.

We are grateful for the level of support provided by ESO staff over the last few years and particularly over the last 12months from Pascal Robert and Keiran O'Brian and are looking forward to our next VLT run.

Figures

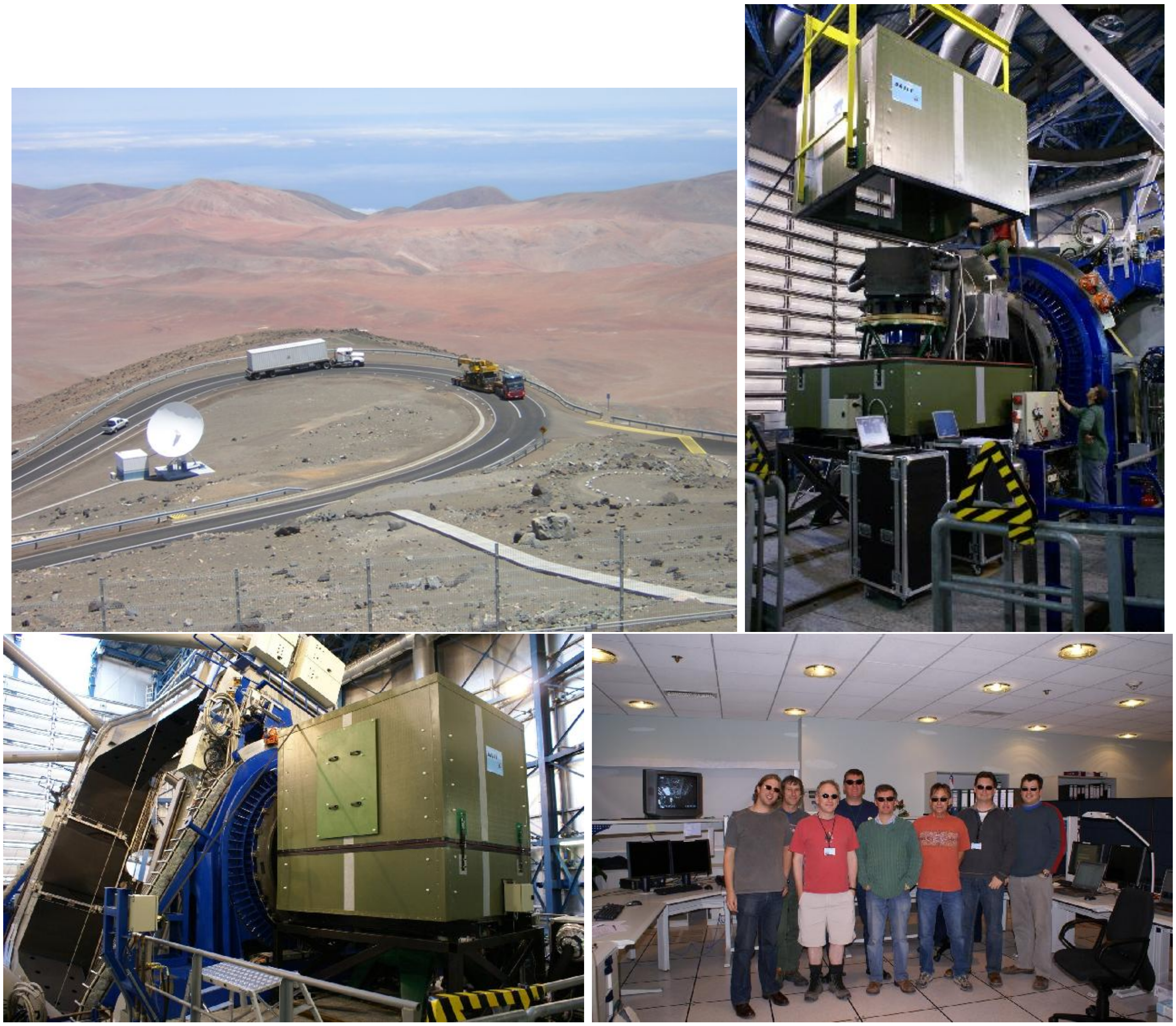

Figure 1: The DAZLE container arriving on Paranal on 24th October; DAZLE being assembled on UT3, final assembly; the commissioning team in the UT3 control room.

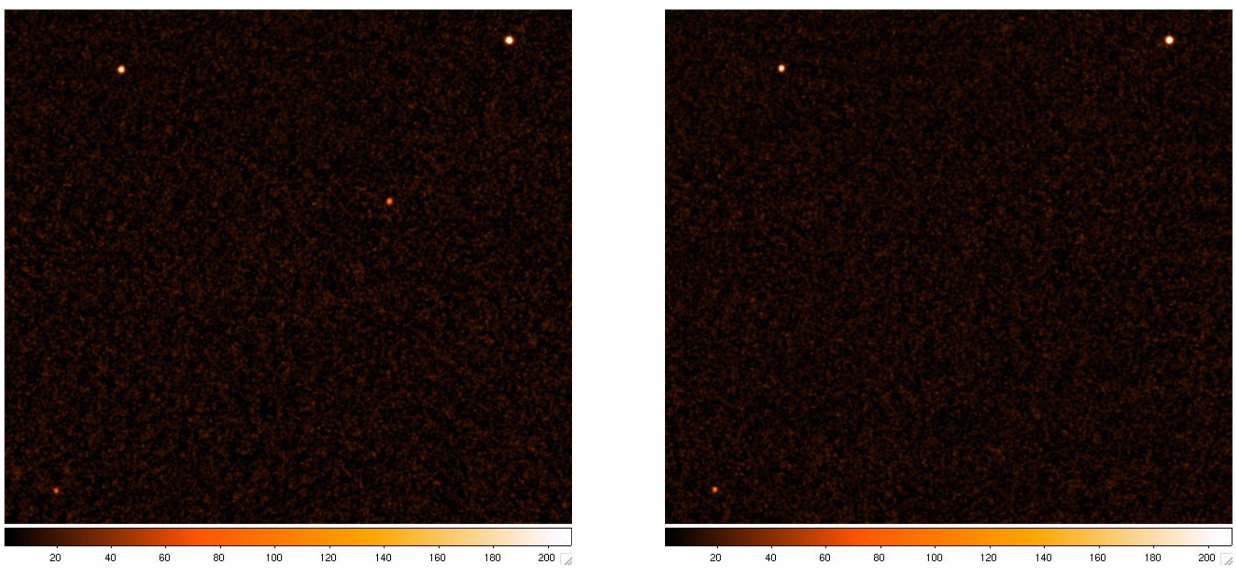

Figure 2: SV images of the z=1.110, QSO 2QZ J0255−2848; [OIII]5007 has a predicted observed wavelength of 1.0565microns. The left hand image is through the NB1056 filter and the right hand image is through the NB1063 filter. Each image is 2'x2'. The total exposure time per band is 30minutes. The quasar is clearly detected 15" from the centre of the image in the NB1056 filter centred on the predicted wavelength of redshifted [OIII] whereas the quasar is undetected in the NB1063 image.